particle-tracking-manager

Release 0.8.4

axiom-data-science

Apr 24, 2024

EXAMPLES AND DEMOS

CHAPTER

ONE

INSTALLATION

To install from conda-forge:

    conda install -c conda-forge particle-tracking-manager

To install from PyPI:

    pip install particle-tracking-manager

1.1 Quick Start Guide

The simplest way to run `particle-tracking-manager` is to choose a built-in ocean model and select a location to initialize drifters, then use the built-in defaults for everything else (including start time which defaults to the first time step in the model output). You can do this interacting with the software as a Python library or using a command line interface.

Alternatively, you can run the package with new model output by inputting the necessary information into the `Manager`.

Details about what setup and configuration are available in *Configuration and Setup Options*.

1.1.1 Python Package

Run directly from the Lagrangian model you want to use, which will inherit from the manager class. For now there is one option of `OpenDriftModel`.

```
import particle_tracking_manager as ptm

m = ptm.OpenDriftModel(ocean_model="NWGOA", lon=-151, lat=59, steps=1)
# Can modify `m` between these steps, or look at `OpenDrift` config with `m.drift_model_
↪config()`
m.run_all()
```

Then find results in file `m.outfile_name`.

1.1.2 Command Line Interface

The equivalent for the set up above for using the command line is:

```
ptm lon=-151 lat=59 ocean_model=NWGOA steps=1
```

To just initialize the simulation and print the `OpenDrift` configuration to screen without running the simulation, add the `--dry-run` flag:

```
ptm lon=-151 lat=59 ocean_model=NWGOA steps=1 --dry-run
```

`m.outfile_name` is printed to the screen after the command has been run. `ptm` is installed as an entry point with `particle-tracking-manager`.

1.1.3 Python package with local model output

This demo will run using easily-available ROMS model output from `xroms`.

```
import particle_tracking_manager as ptm
import xroms
import xarray as xr


m = ptm.OpenDriftModel(lon = -90, lat = 28.7, number=10, steps=20,
                       use_static_masks=True)


url = xroms.datasets.CLOVER.fetch("ROMS_example_full_grid.nc")
ds = xr.open_dataset(url, decode_times=False)
m.add_reader(ds=ds)

# m.run_all() or the following
m.seed()
m.run()
```

```
18:17:23 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:17:23 INFO    opendrift:391: do3D is False so disabling vertical motion.
```

```
18:17:23 INFO    opendrift.models.oceandrift:380: Setting config: drift:vertical_
↪advection -> False
```

```
18:17:23 INFO    opendrift.models.oceandrift:380: Setting config: drift:vertical_mixing -
↪> False
```

```
18:17:23 INFO    opendrift:372: Turning off vertical_mixing since do3D is False
```

```
18:17:23 INFO    opendrift:428: vertical_mixing is False, so setting value of vertical_
↪mixing_timestep to None.
```

```
Downloading file 'ROMS_example_full_grid.nc' from 'https://github.com/xoceanmodel/xroms/
↪raw/main/xroms/data/ROMS_example_full_grid.nc' to '/home/docs/.cache/xroms'.
```

```
18:17:27 INFO    opendrift:359: Since ocean_model is user-input, changing horizontal_
↪diffusivity parameter from None to 0.0.
                    You can also set it to a specific value with `m.horizontal_
↪diffusivity=[number]`.
```

```
18:17:27 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:17:27 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:17:27 INFO    opendrift:584: Dropping vertical velocity (w) because do3D is False
```

```
18:17:27 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:17:27 INFO    opendrift:610: Dropping salt and temp variables because drift_model is␣
↪not LarvalFish nor OpenOil
```

```
18:17:27 INFO    opendrift:621: Dropping ice variables because drift_model is not OpenOil
```

```
18:17:27 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:17:27 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:17:27 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:17:27 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:17:27 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:17:27 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:17:27 INFO    opendrift.readers.basereader.structured:90: Making interpolator for lon,
↪lat to x,y conversion...
```

```
18:17:28 INFO    opendrift.readers.basereader.structured:108: Saving interpolator for␣
↪lon,lat to x,y conversion.
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         x_wind: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         y_wind: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         upward_sea_water_
↪velocity: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪period_at_variance_spectral_density_maximum: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪mean_period_from_variance_spectral_density_second_frequency_moment: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_to_direction: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_peak_period_from_variance_spectral_density: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_significant_height: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_to_direction: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_mean_period: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_significant_height: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         surface_downward_x_
↪stress: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         surface_downward_y_
↪stress: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         turbulent_kinetic_
↪energy: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         turbulent_generic_
↪length_scale: 0.000000
```

```
18:17:28 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:17:28 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪13:40:00, steps: 20.0, duration: 0 days 01:40:00
```

```
18:17:28 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:17:28 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:17:28 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:17:28 WARNING opendrift.models.basemodel:701: Seafloor check not being run because␣
↪sea_surface_height is missing. This will happen the first time the function is run but␣
↪if it happens subsequently there is probably a problem.
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:17:28 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:17:28 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 20 -␣
↪10 active elements (0 deactivated)
```

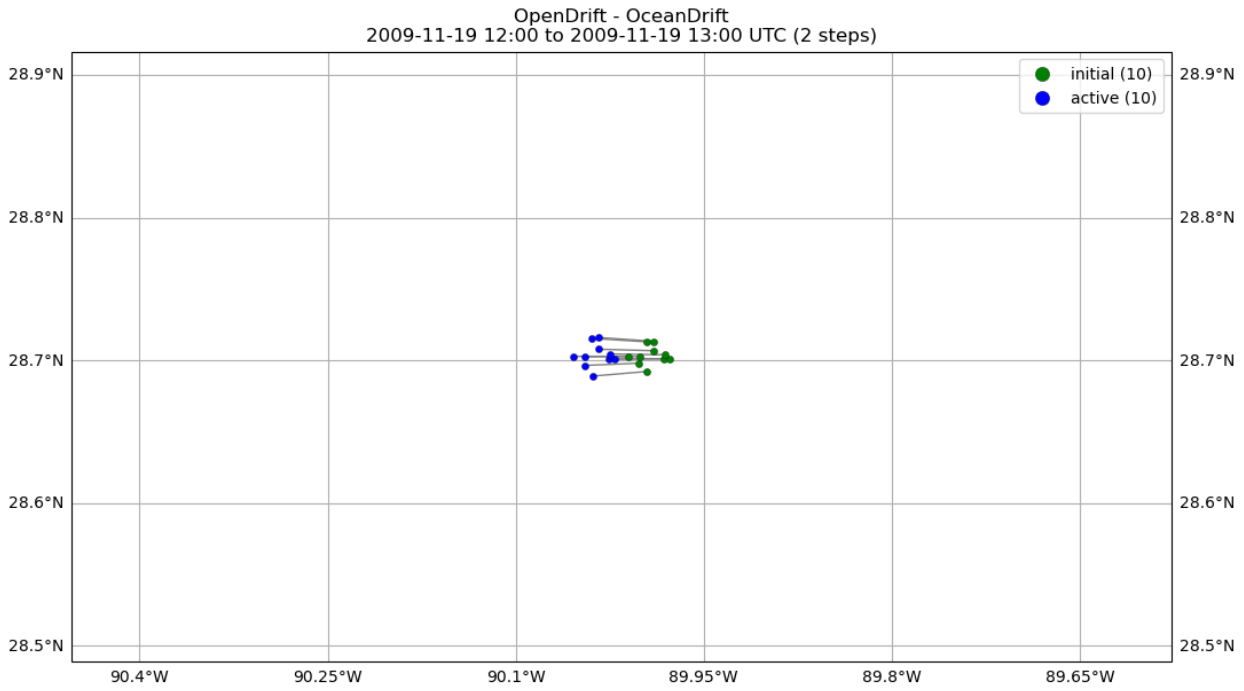
```
18:17:28 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 20 -␣
↪10 active elements (0 deactivated)
```

```
18:17:28 INFO    opendrift.export.io_netcdf:112: Wrote 2 steps to file None_initial
```

Plot using `OpenDrift`'s built in plotting. Many options are available, including animations (see OpenDrift docs for more information).

```
m.o.plot(fast=True)
```

```
18:17:29 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```




```
(<GeoAxes: title={'center': 'OpenDrift - OceanDrift\n2009-11-19 12:00 to 2009-11-19␣
↪13:00 UTC (2 steps)'}>,
 <Figure size 1100x610.583 with 1 Axes>)
```

1.1.4 Idealized simulation

To run an idealized scenario, no reader should be added but configuration parameters can be manually changed, for example:

```
import particle_tracking_manager as ptm
from datetime import datetime
m = ptm.OpenDriftModel(lon=4.0, lat=60.0, start_time=datetime(2015, 9, 22, 6),
                       use_auto_landmask=True, steps=20)

# idealized simulation, provide a fake current
m.o.set_config('environment:fallback:y_sea_water_velocity', 1)

# seed
m.seed()

# run simulation
m.run()
```

```
18:17:36 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:17:36 INFO    opendrift:391: do3D is False so disabling vertical motion.
```

```
18:17:36 INFO    opendrift.models.oceandrift:380: Setting config: drift:vertical_
↪advection -> False
```

```
18:17:37 INFO    opendrift.models.oceandrift:380: Setting config: drift:vertical_mixing -
↪> False
```

```
18:17:37 INFO    opendrift:372: Turning off vertical_mixing since do3D is False
```

```
18:17:37 INFO    opendrift:428: vertical_mixing is False, so setting value of vertical_
↪mixing_timestep to None.
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:220: Adding a dynamical landmask␣
↪with max. priority based on assumed maximum speed of 5 m/s. Adding a customised␣
↪landmask may be faster...
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         x_sea_water_
↪velocity: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         y_sea_water_
↪velocity: 1.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_height:␣
↪0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         x_wind: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         y_wind: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         upward_sea_water_
↪velocity: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪period_at_variance_spectral_density_maximum: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪mean_period_from_variance_spectral_density_second_frequency_moment: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_to_direction: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_peak_period_from_variance_spectral_density: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_significant_height: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_to_direction: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_mean_period: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_significant_height: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         surface_downward_x_
↪stress: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         surface_downward_y_
↪stress: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         turbulent_kinetic_
↪energy: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         turbulent_generic_
↪length_scale: 0.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:17:37 INFO    opendrift.models.basemodel.environment:250:         sea_floor_depth_
↪below_sea_level: 10000.000000
```

```
18:17:37 INFO    opendrift:492: start_time: 2015-09-22 06:00:00, end_time: 2015-09-22␣
↪07:40:00, steps: 20.0, duration: 0 days 01:40:00
```

```
18:17:37 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:17:37 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:00:00 - step 1 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:05:00 - step 2 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:10:00 - step 3 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:15:00 - step 4 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:20:00 - step 5 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:25:00 - step 6 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:30:00 - step 7 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:35:00 - step 8 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:40:00 - step 9 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:45:00 - step 10 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:50:00 - step 11 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 06:55:00 - step 12 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:00:00 - step 13 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:05:00 - step 14 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:10:00 - step 15 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:15:00 - step 16 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:20:00 - step 17 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:25:00 - step 18 of 20 -␣
↪100 active elements (0 deactivated)
```

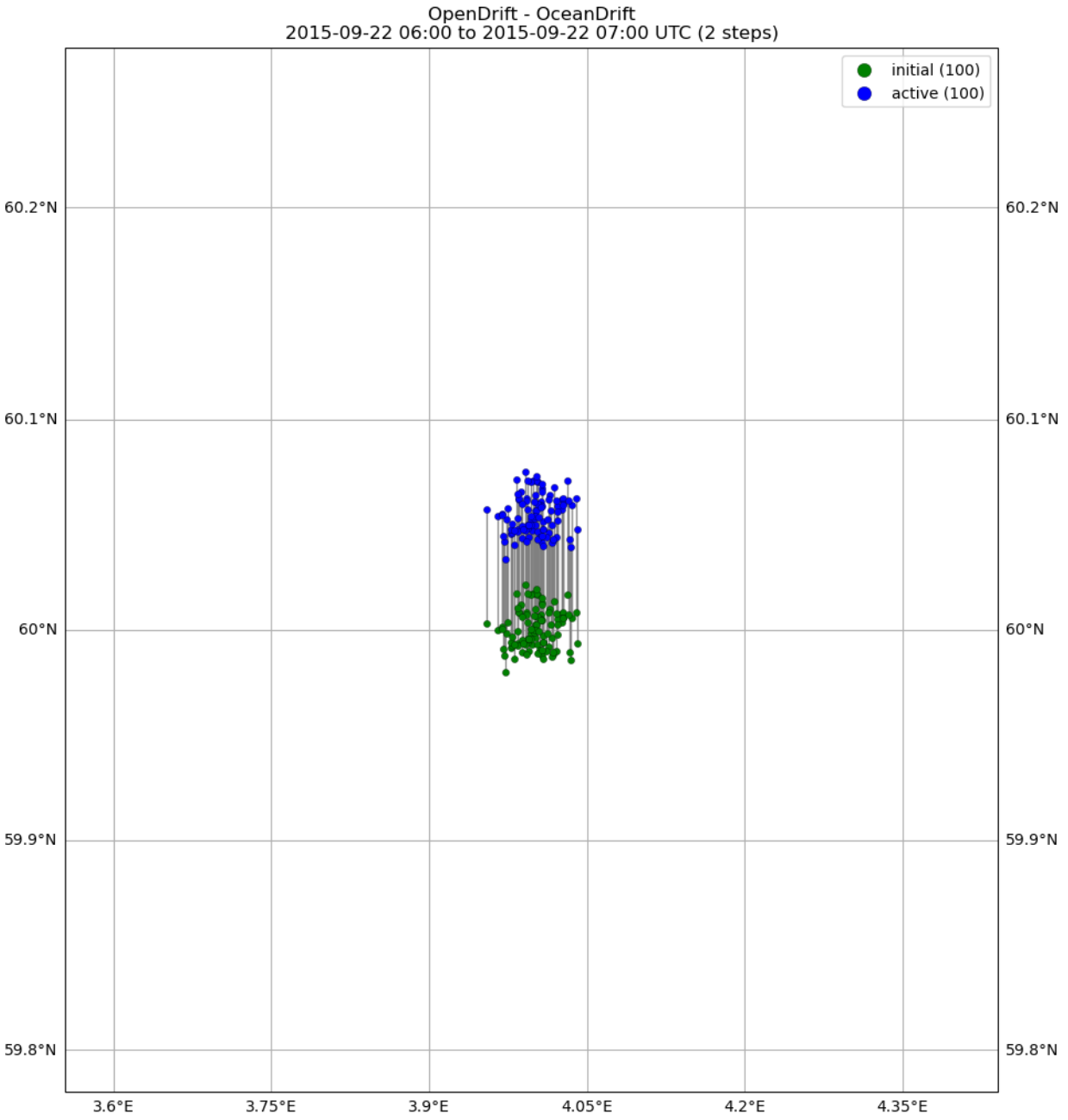
```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:30:00 - step 19 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.models.basemodel:2011: 2015-09-22 07:35:00 - step 20 of 20 -␣
↪100 active elements (0 deactivated)
```

```
18:17:37 INFO    opendrift.export.io_netcdf:112: Wrote 2 steps to file None_initial
```

```
m.o.plot(fast=True)
```

```
18:17:37 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```




```
(<GeoAxes: title={'center': 'OpenDrift - OceanDrift\n2015-09-22 06:00 to 2015-09-22␣
↪07:00 UTC (2 steps)'}>,
 <Figure size 983.698x1100 with 1 Axes>)
```

1.1.5 Ways to Get Information

Check drifter initialization properties:

```
m.initial_drifters
```

Look at reader/ocean model properties:

```
m.reader
```

Get reader/ocean model properties (gathered metadata about model):

```
m.reader_metadata(<key>)
```

Show configuration details — many more details on this in *Configuration and Setup Options*:

```
m.show_config()
```

Show `OpenDrift` configuration for selected `drift_model`:

```
m.drift_model_config()
```

1.2 Tutorial

Particle Tracking Manager (PTM) is a wrapper around particle tracking codes to easily run particle simulations in select (or user-input) ocean models. Currently, `OpenDrift` is included. In this tutorial we demonstrate using the four wrapped drift models from `OpenDrift` along with some high level configuration changes.

```
import xarray as xr
import particle_tracking_manager as ptm
import xroms
import cmocean.cm as cmo
```

1.2.1 Ocean Models

Known Models

Three ocean models are built into PTM and can be accessed by name `ocean_model`= "NWGOA", "CIOFS", and "CIOFSOP", and either accessed remotely or locally if run on an internal server (at Axiom) (with `ocean_model_local=True`).

Wet/dry vs. Static Masks

The known models in PTM have wet/dry masks from ROMS so they have had to be specially handled, requiring some new development in `OpenDrift`. There are two options:

- (DEFAULT) Use the typical, static, ROMS masks (`mask_rho`, `mask_u`, `mask_v`). For ROMS simulations run in wet/dry mode, grid cells in `mask_rho` are 0 if they are permanently dry and 1 if they are ever wet. This saves some computational time but is inconsistent with the ROMS output files in some places since the drifters may be allowed (due to the static mask) to enter a cell they wouldn't otherwise. However, it doesn't make much of a difference for simulations that aren't in the tidal flats.

- Use the time-varying wet/dry masks (`wetdry_mask_rho`, `wetdry_mask_u`, `wetdry_mask_v`). This costs some more computational time but is fully consistent with the ROMS output files. This option should be selected if drifters are expected to run in the tidal flats.

User-input Models

As opposed to known models, a user can input their own xarray Dataset, which we will do for this tutorial. When you input your own Dataset, you have to add the reader by hand as opposed to being able to input the `ocean_model` name in the initial call.

```
url = xroms.datasets.CLOVER.fetch("ROMS_example_full_grid.nc")
ds = xr.open_dataset(url, decode_times=False)
```

1.2.2 Drift Models

After a drift simulation is run, results can be found in file with name `m.outfile_name`.

OceanDrift (Physics)

This model can in 2D or 3D with or without horizontal or vertical mixing, wind drift, Stokes drift, etc. By default this would be run at the surface in 2D but we can input selections to run in 3D starting at depth.

Initialize manager `m`

```
m = ptm.OpenDriftModel(lon=-90, lat=28.7, number=10, steps=40,
                       z=-5, do3D=True, horizontal_diffusivity=100,)
```

```
18:17:50 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:17:50 INFO    opendrift:399: do3D is True so turning on vertical advection.
```

```
18:17:50 INFO    opendrift:336: Setting horizontal_diffusivity to user-selected value␣
↪100.
```

The drift_model-specific parameters chosen by the user and PTM for this simulation are:

```
m.drift_model_config()
```

```
[('environment:fallback:ocean_mixed_layer_thickness', 30),
 ('general:use_auto_landmask', False),
 ('drift:current_uncertainty', 0),
 ('general:coastline_action', 'previous'),
 ('seed:number', 10),
 ('drift:horizontal_diffusivity', 100),
 ('drift:wind_uncertainty', 0),
 ('seed:z', -5),
 ('seed:wind_drift_factor', 0.02),
```

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```
 ('drift:vertical_mixing', True),
 ('vertical_mixing:timestep', 60),
 ('vertical_mixing:diffusivitymodel', 'windspeed_Large1994'),
 ('drift:wind_drift_depth', 0.02),
 ('drift:stokes_drift', True),
 ('general:seafloor_action', 'previous'),
 ('seed:seafloor', False),
 ('drift:vertical_advection', True),
 ('drift:truncate_ocean_model_below_m', None),
 ('drift:use_tabularised_stokes_drift', True),
 ('model', 'opendrift'),
 ('lon', -90),
 ('lat', 28.7),
 ('seed_flag', 'elements'),
 ('run_forward', True),
 ('time_step', 300),
 ('time_step_output', 3600),
 ('steps', 40),
 ('ocean_model_local', False),
 ('do3D', True),
 ('use_static_masks', True),
 ('drift_model', 'OceanDrift'),
 ('export_variables', ['z', 'origin_marker']),
 ('radius', 1000.0),
 ('radius_type', 'gaussian'),
 ('log', 'low')]
```

You can also find the full PTM and `OpenDrift` configuration information with:

```
m.show_config()
```

```
{'environment:constant:x_sea_water_velocity': {'type': 'float',
  'min': -15,
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```
  'value': None},
 'general:use_auto_landmask': {'type': 'bool',
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  'enum': ['none', 'stranding', 'previous'],
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```

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```
  'description': 'None means that objects may also move over land. stranding means that␣
↪objects are deactivated if they hit land. previous means that objects will move back␣
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  'value': None},
 'drift:advection_scheme': {'type': 'enum',
  'enum': ['euler', 'runge-kutta', 'runge-kutta4'],
  'default': 'euler',
  'level': 3,
```

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```
  'description': 'Numerical advection scheme for ocean current advection',
  'value': 'euler'},
 'drift:horizontal_diffusivity': {'type': 'float',
  'default': None,
  'min': 0,
  'max': 100000,
  'units': 'm2/s',
  'description': 'Add horizontal diffusivity (random walk)',
  'level': 2,
  'value': 100,
  'od_mapping': 'drift:horizontal_diffusivity',
  'ptm_level': 2},
 'drift:wind_uncertainty': {'type': 'float',
  'default': 0,
  'min': 0,
  'max': 5,
  'units': 'm/s',
  'description': 'Add gaussian perturbation with this standard deviation to wind␣
↪components at each time step.',
  'level': 3,
  'value': 0,
  'od_mapping': 'drift:wind_uncertainty',
  'ptm_level': 2},
 'drift:relative_wind': {'type': 'bool',
  'default': False,
  'description': 'If True, wind drift is calculated for absolute wind (wind vector minus␣
↪ocean surface current vector).',
  'level': 3,
  'value': False},
 'drift:deactivate_north_of': {'type': 'float',
  'default': None,
  'min': -90,
  'max': 90,
  'units': 'degrees',
  'description': 'Elements are deactivated if the move further north than this limit',
  'level': 3,
  'value': None},
 'drift:deactivate_south_of': {'type': 'float',
  'default': None,
  'min': -90,
  'max': 90,
  'units': 'degrees',
  'description': 'Elements are deactivated if the move further south than this limit',
  'level': 3,
  'value': None},
 'drift:deactivate_east_of': {'type': 'float',
  'default': None,
  'min': -360,
  'max': 360,
  'units': 'degrees',
  'description': 'Elements are deactivated if the move further east than this limit',
  'level': 3,
```

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```
  'value': None},
 'drift:deactivate_west_of': {'type': 'float',
  'default': None,
  'min': -360,
  'max': 360,
  'units': 'degrees',
  'description': 'Elements are deactivated if the move further west than this limit',
  'level': 3,
  'value': None},
 'seed:origin_marker': {'type': 'float',
  'min': None,
  'max': None,
  'units': None,
  'default': 0,
  'description': 'An integer kept constant during the simulation. Different values may␣
↪be used for different seedings, to separate elements during analysis. With GUI, only a␣
↪single seeding is possible.',
  'level': 3,
  'value': 0},
 'seed:z': {'type': 'float',
  'default': 0,
  'min': -10000,
  'max': 0,
  'units': 'm',
  'description': 'Depth below sea level where elements are released. This depth is␣
↪neglected if seafloor seeding is set selected.',
  'level': 1,
  'value': -5,
  'od_mapping': 'seed:z',
  'ptm_level': 1},
 'seed:wind_drift_factor': {'type': 'float',
  'min': None,
  'max': None,
  'units': '1',
  'default': 0.02,
  'description': 'Elements at surface are moved with this fraction of the vind vector,␣
↪in addition to currents and Stokes drift',
  'level': 3,
  'value': 0.02,
  'ptm_level': 2,
  'od_mapping': 'seed:wind_drift_factor'},
 'seed:current_drift_factor': {'type': 'float',
  'min': None,
  'max': None,
  'units': '1',
  'default': 1,
  'description': 'Elements are moved with this fraction of the current vector, in␣
↪addition to currents and Stokes drift',
  'level': 3,
  'value': 1},
 'seed:terminal_velocity': {'type': 'float',
  'min': None,
```

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```
  'max': None,
  'units': 'm/s',
  'default': 0.0,
  'description': 'Terminal rise/sinking velocity (buoyancy) in the ocean column',
  'level': 3,
  'value': 0.0},
 'drift:vertical_advection': {'type': 'bool',
  'default': True,
  'description': 'Advect elements with vertical component of ocean current.',
  'level': 2,
  'value': True},
 'drift:vertical_mixing': {'type': 'bool',
  'default': True,
  'level': 2,
  'description': 'Activate vertical mixing scheme with inner loop',
  'value': True,
  'od_mapping': 'drift:vertical_mixing',
  'ptm_level': 2},
 'vertical_mixing:timestep': {'type': 'float',
  'min': 0.1,
  'max': 3600,
  'default': 60,
  'level': 3,
  'units': 'seconds',
  'description': 'Time step used for inner loop of vertical mixing.',
  'value': 60,
  'od_mapping': 'vertical_mixing:timestep',
  'ptm_level': 3},
 'vertical_mixing:diffusivitymodel': {'type': 'enum',
  'default': 'windspeed_Large1994',
  'enum': ['environment',
   'stepfunction',
   'windspeed_Sundby1983',
   'windspeed_Large1994',
   'gls_tke',
   'constant'],
  'level': 3,
  'units': 'seconds',
  'description': 'Algorithm/source used for profile of vertical diffusivity. Environment␣
↪means that diffusivity is aquired from readers or environment constants/fallback.',
  'value': 'windspeed_Large1994',
  'od_mapping': 'vertical_mixing:diffusivitymodel',
  'ptm_level': 3},
 'vertical_mixing:background_diffusivity': {'type': 'float',
  'min': 0,
  'max': 1,
  'default': 1.2e-05,
  'level': 3,
  'units': 'm2s-1',
  'description': 'Background diffusivity used below mixed layer for wind␣
↪parameterisations.',
  'value': 1.2e-05},
```

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```
 'vertical_mixing:TSprofiles': {'type': 'bool',
  'default': False,
  'level': 3,
  'description': 'Update T and S profiles within inner loop of vertical mixing. This␣
↪takes more time, but may be slightly more accurate.',
  'value': False},
 'drift:wind_drift_depth': {'type': 'float',
  'default': 0.02,
  'min': 0,
  'max': 10,
  'units': 'meters',
  'description': 'The direct wind drift (windage) is linearly decreasing from the␣
↪surface value (wind_drift_factor) until 0 at this depth.',
  'level': 3,
  'value': 0.02,
  'od_mapping': 'drift:wind_drift_depth',
  'ptm_level': 3},
 'drift:stokes_drift': {'type': 'bool',
  'default': True,
  'description': 'Advection elements with Stokes drift (wave orbital motion).',
  'level': 3,
  'value': True,
  'od_mapping': 'drift:stokes_drift',
  'ptm_level': 2},
 'drift:stokes_drift_profile': {'type': 'enum',
  'default': 'Phillips',
  'enum': ['monochromatic', 'exponential', 'Phillips', 'windsea_swell'],
  'description': 'Algorithm to calculate Stokes drift at depth from surface value',
  'level': 3,
  'value': 'Phillips'},
 'drift:use_tabularised_stokes_drift': {'type': 'bool',
  'default': False,
  'description': 'If True, Stokes drift is estimated from wind based on look-up-tables␣
↪for given fetch (drift:tabularised_stokes_drift_fetch).',
  'level': 3,
  'value': True},
 'drift:tabularised_stokes_drift_fetch': {'type': 'enum',
  'enum': ['5000', '25000', '50000'],
  'default': '25000',
  'level': 3,
  'description': 'The fetch length when using tabularised Stokes drift.',
  'value': '25000'},
 'general:seafloor_action': {'type': 'enum',
  'default': 'previous',
  'enum': ['none', 'lift_to_seafloor', 'deactivate', 'previous'],
  'description': '"deactivate": elements are deactivated; "lift_to_seafloor": elements␣
↪are lifted to seafloor level; "previous": elements are moved back to previous position;
↪ "none"; seafloor is ignored.',
  'level': 3,
  'value': 'previous',
  'od_mapping': 'general:seafloor_action',
  'ptm_level': 2},
```

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```
 'general:seafloor_action_dcrit': {'type': 'float',
  'default': 0.0,
  'min': 0.0,
  'max': 10000,
  'units': 'm',
  'description': 'This parameter represents the amount of water left in a grid cell to␣
↪keep it wet in a wet/dry simulation for numerical stability. The condition checked for␣
↪seafloor_action is z < -(sea_floor_depth + sea_surface_height + `general:seafloor_
↪action_dcrit`. It is 0 by default to assume that a wet/dry case is not being run,␣
↪however, if it is and the correct value is not known 0.1 is a good default to use.',
  'level': 3,
  'value': 0.0},
 'drift:truncate_ocean_model_below_m': {'type': 'float',
  'default': None,
  'min': 0,
  'max': 10000,
  'units': 'm',
  'description': 'Ocean model data are only read down to at most this depth, and␣
↪extrapolated below. May be specified to read less data to improve performance.',
  'level': 3,
  'value': None},
 'seed:seafloor': {'type': 'bool',
  'default': False,
  'description': 'Elements are seeded at seafloor, and seeding depth (z) is neglected.',
  'level': 1,
  'value': False,
  'od_mapping': 'seed:seafloor',
  'ptm_level': 2},
 'model': {'type': 'enum',
  'enum': ['opendrift'],
  'default': 'opendrift',
  'ptm_level': 1,
  'description': 'Lagrangian model software to use for simulation.',
  'value': 'opendrift'},
 'lon': {'type': 'float',
  'default': -151.0,
  'min': -180,
  'max': 180,
  'units': 'degrees_east',
  'description': 'Central longitude for seeding drifters. Only used if `seed_flag==
↪"elements"`.',
  'ptm_level': 1,
  'value': -90},
 'lat': {'type': 'float',
  'default': 58.0,
  'min': -90,
  'max': 90,
  'units': 'degrees_north',
  'description': 'Central latitude for seeding drifters. Only used if `seed_flag==
↪"elements"`.',
  'ptm_level': 1,
  'value': 28.7},
```

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```
 'geojson': {'type': 'geojson',
  'default': None,
  'description': 'GeoJSON describing a polygon within which to seed drifters. To use␣
↪this parameter, also have `seed_flag=="geojson"`. If None, seed drifters at or around␣
↪a single point defined by lon and lat along with seed_flag=="elements".',
  'ptm_level': 1},
 'seed_flag': {'type': 'enum',
  'enum': ['elements', 'geojson'],
  'default': 'elements',
  'ptm_level': 1,
  'description': 'Method for seeding drifters. Options are "elements" or "geojson". If
↪"elements", seed drifters at or around a single point defined by lon and lat. If
↪"geojson", seed drifters within a polygon described by a GeoJSON object.',
  'value': 'elements'},
 'number': {'type': 'int',
  'default': 100,
  'min': 1,
  'max': 100000000,
  'units': 1,
  'description': 'The number of elements for the simulation.',
  'level': 2,
  'value': 10,
  'od_mapping': 'seed:number',
  'ptm_level': 1},
 'start_time': {'type': 'datetime.datetime',
  'default': 'pd.Timestamp.now()',
  'min': 'datetime.datetime(1999,1,1)',
  'max': 'pd.Timestamp.now() + pd.Timedelta("48H")',
  'units': 'time',
  'description': 'Start time for drifter simulation.',
  'ptm_level': 1},
 'run_forward': {'type': 'bool',
  'default': True,
  'description': 'Run forward in time.',
  'ptm_level': 2,
  'value': True},
 'time_step': {'type': ['float', 'datetime.timedelta'],
  'default': 300,
  'min': 1,
  'max': 86400,
  'units': 'seconds',
  'description': 'Interval between particles updates, in seconds or as timedelta.',
  'ptm_level': 3,
  'value': 300},
 'time_step_output': {'type': ['float', 'datetime.timedelta'],
  'default': 3600,
  'min': 1,
  'max': 604800,
  'units': 'seconds',
  'description': 'Time step at which element properties are stored and eventually␣
↪written to file.',
  'ptm_level': 3,
```

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```
  'value': 3600},
 'steps': {'type': 'int',
  'default': None,
  'min': 1,
  'max': 10000,
  'units': 'None',
  'description': 'Maximum number of steps. End of simulation will be start_time +␣
↪steps*time_step. steps, end_time, or duration must be input by user.',
  'ptm_level': 1,
  'value': 40},
 'duration': {'type': 'datetime.timedelta',
  'default': None,
  'min': 'None',
  'max': 'None',
  'units': 'None',
  'description': 'The length of the simulation. steps, end_time, or duration must be␣
↪input by user.',
  'ptm_level': 1},
 'end_time': {'type': 'datetime.datetime',
  'default': None,
  'min': 'None',
  'max': 'None',
  'units': 'None',
  'description': 'The end of the simulation. steps, end_time, or duration must be input␣
↪by user.',
  'ptm_level': 1},
 'ocean_model': {'type': 'enum',
  'enum': ['NWGOA', 'CIOFS', 'CIOFSOP'],
  'default': None,
  'ptm_level': 1,
  'description': 'Name of ocean model to use for driving drifter simulation, by default␣
↪None. Use None for testing and set up. Otherwise input a string. Options are "NWGOA",
↪"CIOFS", "CIOFSOP". Alternatively keep as None and set up a separate reader (see␣
↪example in docs).'},
 'ocean_model_local': {'type': 'bool',
  'default': False,
  'ptm_level': 3,
  'description': 'Set to True to use local version of known `ocean_model` instead of␣
↪remote version.',
  'value': False},
 'surface_only': {'type': 'bool',
  'default': None,
  'description': 'Set to True to keep drifters at the surface, by default None. If this␣
↪flag is set to not-None, it overrides do3D to False, vertical_mixing to False, and the␣
↪z value(s) 0. If True, this flag also turns off reading model output below 0.5m if␣
↪drift_model is not Leeway to save time.',
  'ptm_level': 1},
 'do3D': {'type': 'bool',
  'default': False,
  'description': 'Set to True to run drifters in 3D, by default False. This is␣
↪overridden if surface_only==True. If True, vertical advection and mixing are turned on␣
↪with options for setting diffusivitymodel, background_diffusivity, ocean_mixed_layer_
```

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```
↪thickness, vertical_mixing_timestep. If False, vertical motion is disabled.',
  'ptm_level': 1,
  'value': True},
 'vertical_mixing': {'type': 'bool',
  'default': True,
  'level': 2,
  'description': 'Activate vertical mixing scheme with inner loop',
  'value': True,
  'od_mapping': 'drift:vertical_mixing',
  'ptm_level': 2},
 'z': {'type': 'float',
  'default': 0,
  'min': -10000,
  'max': 0,
  'units': 'm',
  'description': 'Depth below sea level where elements are released. This depth is␣
↪neglected if seafloor seeding is set selected.',
  'level': 1,
  'value': -5,
  'od_mapping': 'seed:z',
  'ptm_level': 1},
 'seed_seafloor': {'type': 'bool',
  'default': False,
  'description': 'Elements are seeded at seafloor, and seeding depth (z) is neglected.',
  'level': 1,
  'value': False,
  'od_mapping': 'seed:seafloor',
  'ptm_level': 2},
 'use_static_masks': {'type': 'bool',
  'default': True,
  'ptm_level': 3,
  'description': 'Set to True to use static masks for known models instead of wetdry␣
↪masks. If False, the masks are change in time.',
  'value': True},
 'output_file': {'type': 'str',
  'default': None,
  'description': 'Name of file to write output to. If None, default name is used.',
  'ptm_level': 3},
 'drift_model': {'default': 'OceanDrift',
  'ptm_level': 1,
  'type': 'enum - OceanDrift - LarvalFish - OpenOil - Leeway',
  'description': 'Which model in OpenDrift to use. This corresponds to the type of drift␣
↪scenario the user wants to run.',
  'value': 'OceanDrift'},
 'export_variables': {'default': ['z', 'origin_marker'],
  'ptm_level': 3,
  'type': 'list',
  'description': "List of variables to export. Options available with `m.all_export_
↪variables` for a given `drift_model`. ['lon', 'lat', 'ID', 'status'] will always be␣
↪exported.",
  'value': ['z', 'origin_marker']},
 'radius': {'default': 1000.0,
```

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```
  'ptm_level': 2,
  'type': 'float',
  'min': 0.0,
  'max': 1000000,
  'units': 'm',
  'description': 'Radius around each lon-lat pair, within which particles will be␣
↪randomly seeded. This is used by function `seed_elements`.',
  'value': 1000.0},
 'radius_type': {'default': 'gaussian',
  'ptm_level': 3,
  'type': 'enum - gaussian - uniform',
  'description': "If 'gaussian' (default), the radius is the standard deviation in x-y-
↪directions. If 'uniform', elements are spread evenly and always inside a circle with␣
↪the given radius. This is used by function `seed_elements`.",
  'value': 'gaussian'},
 'wind_drift_factor': {'type': 'float',
  'min': None,
  'max': None,
  'units': '1',
  'default': 0.02,
  'description': 'Elements at surface are moved with this fraction of the vind vector,␣
↪in addition to currents and Stokes drift',
  'level': 3,
  'value': 0.02,
  'ptm_level': 2,
  'od_mapping': 'seed:wind_drift_factor'},
 'diffusivitymodel': {'type': 'enum',
  'default': 'windspeed_Large1994',
  'enum': ['environment',
   'stepfunction',
   'windspeed_Sundby1983',
   'windspeed_Large1994',
   'gls_tke',
   'constant'],
  'level': 3,
  'units': 'seconds',
  'description': 'Algorithm/source used for profile of vertical diffusivity. Environment␣
↪means that diffusivity is aquired from readers or environment constants/fallback.',
  'value': 'windspeed_Large1994',
  'od_mapping': 'vertical_mixing:diffusivitymodel',
  'ptm_level': 3},
 'stokes_drift': {'type': 'bool',
  'default': True,
  'description': 'Advection elements with Stokes drift (wave orbital motion).',
  'level': 3,
  'value': True,
  'od_mapping': 'drift:stokes_drift',
  'ptm_level': 2},
 'use_auto_landmask': {'type': 'bool',
  'default': False,
  'description': 'A built-in GSHHG global landmask is used if True, otherwise landmask␣
↪is taken from reader or fallback value.',
```

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```
  'level': 3,
  'value': False,
  'od_mapping': 'general:use_auto_landmask',
  'ptm_level': 3},
 'mixed_layer_depth': {'type': 'float',
  'min': None,
  'max': None,
  'units': None,
  'default': 30,
  'level': 2,
  'description': 'Fallback value for ocean_mixed_layer_thickness if not available from␣
↪any reader',
  'value': 30,
  'od_mapping': 'environment:fallback:ocean_mixed_layer_thickness',
  'ptm_level': 3},
 'coastline_action': {'type': 'enum',
  'enum': ['none', 'stranding', 'previous'],
  'default': 'previous',
  'level': 2,
  'description': 'None means that objects may also move over land. stranding means that␣
↪objects are deactivated if they hit land. previous means that objects will move back␣
↪to the previous location if they hit land',
  'value': 'previous',
  'od_mapping': 'general:coastline_action',
  'ptm_level': 2},
 'seafloor_action': {'type': 'enum',
  'default': 'previous',
  'enum': ['none', 'lift_to_seafloor', 'deactivate', 'previous'],
  'description': '"deactivate": elements are deactivated; "lift_to_seafloor": elements␣
↪are lifted to seafloor level; "previous": elements are moved back to previous position;
↪ "none"; seafloor is ignored.',
  'level': 3,
  'value': 'previous',
  'od_mapping': 'general:seafloor_action',
  'ptm_level': 2},
 'max_speed': {'type': 'float',
  'default': 5,
  'min': 0,
  'max': inf,
  'units': 'seconds',
  'description': 'Typical maximum speed of elements, used to estimate reader buffer size
↪',
  'level': 3,
  'value': 5,
  'od_mapping': 'drift:max_speed'},
 'horizontal_diffusivity': {'type': 'float',
  'default': None,
  'min': 0,
  'max': 100000,
  'units': 'm2/s',
  'description': 'Add horizontal diffusivity (random walk)',
  'level': 2,
```

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```
  'value': 100,
  'od_mapping': 'drift:horizontal_diffusivity',
  'ptm_level': 2},
 'current_uncertainty': {'type': 'float',
  'default': 0,
  'min': 0,
  'max': 5,
  'units': 'm/s',
  'description': 'Add gaussian perturbation with this standard deviation to current␣
↪components at each time step',
  'level': 3,
  'value': 0,
  'od_mapping': 'drift:current_uncertainty',
  'ptm_level': 2},
 'wind_uncertainty': {'type': 'float',
  'default': 0,
  'min': 0,
  'max': 5,
  'units': 'm/s',
  'description': 'Add gaussian perturbation with this standard deviation to wind␣
↪components at each time step.',
  'level': 3,
  'value': 0,
  'od_mapping': 'drift:wind_uncertainty',
  'ptm_level': 2},
 'wind_drift_depth': {'type': 'float',
  'default': 0.02,
  'min': 0,
  'max': 10,
  'units': 'meters',
  'description': 'The direct wind drift (windage) is linearly decreasing from the␣
↪surface value (wind_drift_factor) until 0 at this depth.',
  'level': 3,
  'value': 0.02,
  'od_mapping': 'drift:wind_drift_depth',
  'ptm_level': 3},
 'vertical_mixing_timestep': {'type': 'float',
  'min': 0.1,
  'max': 3600,
  'default': 60,
  'level': 3,
  'units': 'seconds',
  'description': 'Time step used for inner loop of vertical mixing.',
  'value': 60,
  'od_mapping': 'vertical_mixing:timestep',
  'ptm_level': 3},
 'object_type': {'default': 'Person-in-water (PIW), unknown state (mean values)',
  'od_mapping': 'seed:object_type',
  'ptm_level': 1,
  'value': 'Person-in-water (PIW), unknown state (mean values)'},
 'diameter': {'default': 0.0014,
  'od_mapping': 'seed:diameter',
```

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```
 'ptm_level': 2,
 'value': 0.0014},
'neutral_buoyancy_salinity': {'default': 31.25,
 'od_mapping': 'seed:neutral_buoyancy_salinity',
 'ptm_level': 2,
 'value': 31.25},
'stage_fraction': {'default': 0.0,
 'od_mapping': 'seed:stage_fraction',
 'ptm_level': 2,
 'value': 0.0},
'hatched': {'default': 0,
 'od_mapping': 'seed:hatched',
 'ptm_level': 2,
 'value': 0},
'length': {'default': 0,
 'od_mapping': 'seed:length',
 'ptm_level': 2,
 'value': 0},
'weight': {'default': 0.08,
 'od_mapping': 'seed:weight',
 'ptm_level': 2,
 'value': 0.08},
'oil_type': {'default': 'GENERIC MEDIUM CRUDE',
 'od_mapping': 'seed:oil_type',
 'ptm_level': 1,
 'value': 'GENERIC MEDIUM CRUDE'},
'm3_per_hour': {'default': 1,
 'od_mapping': 'seed:m3_per_hour',
 'ptm_level': 2,
 'value': 1},
'oil_film_thickness': {'default': 1,
 'od_mapping': 'seed:oil_film_thickness',
 'ptm_level': 3,
 'value': 1},
'droplet_size_distribution': {'default': 'uniform',
 'od_mapping': 'seed:droplet_size_distribution',
 'ptm_level': 3,
 'value': 'uniform'},
'droplet_diameter_mu': {'default': 0.001,
 'od_mapping': 'seed:droplet_diameter_mu',
 'ptm_level': 3,
 'value': 0.001},
'droplet_diameter_sigma': {'default': 0.0005,
 'od_mapping': 'seed:droplet_diameter_sigma',
 'ptm_level': 3,
 'value': 0.0005},
'droplet_diameter_min_subsea': {'default': 0.0005,
 'od_mapping': 'seed:droplet_diameter_min_subsea',
 'ptm_level': 3,
 'value': 0.0005},
'droplet_diameter_max_subsea': {'default': 0.005,
 'od_mapping': 'seed:droplet_diameter_max_subsea',
```

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```
 'ptm_level': 3,
 'value': 0.005},
'emulsification': {'default': True,
 'od_mapping': 'processes:emulsification',
 'ptm_level': 2,
 'value': True},
'dispersion': {'default': True,
 'od_mapping': 'processes:dispersion',
 'ptm_level': 2,
 'value': True},
'evaporation': {'default': True,
 'od_mapping': 'processes:evaporation',
 'ptm_level': 2,
 'value': True},
'update_oilfilm_thickness': {'default': True,
 'od_mapping': 'processes:update_oilfilm_thickness',
 'ptm_level': 2,
 'value': True},
'biodegradation': {'default': True,
 'od_mapping': 'processes:biodegradation',
 'ptm_level': 2,
 'value': True},
'log': {'type': 'enum',
 'enum': ['low', 'high'],
 'default': 'low',
 'ptm_level': 3,
 'description': 'Log verbosity',
 'value': 'low'},
'seed:object_type': {'default': 'Person-in-water (PIW), unknown state (mean values)',
 'od_mapping': 'seed:object_type',
 'ptm_level': 1,
 'value': 'Person-in-water (PIW), unknown state (mean values)'},
'seed:diameter': {'default': 0.0014,
 'od_mapping': 'seed:diameter',
 'ptm_level': 2,
 'value': 0.0014},
'seed:neutral_buoyancy_salinity': {'default': 31.25,
 'od_mapping': 'seed:neutral_buoyancy_salinity',
 'ptm_level': 2,
 'value': 31.25},
'seed:stage_fraction': {'default': 0.0,
 'od_mapping': 'seed:stage_fraction',
 'ptm_level': 2,
 'value': 0.0},
'seed:hatched': {'default': 0,
 'od_mapping': 'seed:hatched',
 'ptm_level': 2,
 'value': 0},
'seed:length': {'default': 0,
 'od_mapping': 'seed:length',
 'ptm_level': 2,
 'value': 0},
```

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```
 'seed:weight': {'default': 0.08,
  'od_mapping': 'seed:weight',
  'ptm_level': 2,
  'value': 0.08},
 'seed:oil_type': {'default': 'GENERIC MEDIUM CRUDE',
  'od_mapping': 'seed:oil_type',
  'ptm_level': 1,
  'value': 'GENERIC MEDIUM CRUDE'},
 'seed:m3_per_hour': {'default': 1,
  'od_mapping': 'seed:m3_per_hour',
  'ptm_level': 2,
  'value': 1},
 'seed:oil_film_thickness': {'default': 1,
  'od_mapping': 'seed:oil_film_thickness',
  'ptm_level': 3,
  'value': 1},
 'seed:droplet_size_distribution': {'default': 'uniform',
  'od_mapping': 'seed:droplet_size_distribution',
  'ptm_level': 3,
  'value': 'uniform'},
 'seed:droplet_diameter_mu': {'default': 0.001,
  'od_mapping': 'seed:droplet_diameter_mu',
  'ptm_level': 3,
  'value': 0.001},
 'seed:droplet_diameter_sigma': {'default': 0.0005,
  'od_mapping': 'seed:droplet_diameter_sigma',
  'ptm_level': 3,
  'value': 0.0005},
 'seed:droplet_diameter_min_subsea': {'default': 0.0005,
  'od_mapping': 'seed:droplet_diameter_min_subsea',
  'ptm_level': 3,
  'value': 0.0005},
 'seed:droplet_diameter_max_subsea': {'default': 0.005,
  'od_mapping': 'seed:droplet_diameter_max_subsea',
  'ptm_level': 3,
  'value': 0.005},
 'processes:emulsification': {'default': True,
  'od_mapping': 'processes:emulsification',
  'ptm_level': 2,
  'value': True},
 'processes:dispersion': {'default': True,
  'od_mapping': 'processes:dispersion',
  'ptm_level': 2,
  'value': True},
 'processes:evaporation': {'default': True,
  'od_mapping': 'processes:evaporation',
  'ptm_level': 2,
  'value': True},
 'processes:update_oilfilm_thickness': {'default': True,
  'od_mapping': 'processes:update_oilfilm_thickness',
  'ptm_level': 2,
  'value': True},
```

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```
 'processes:biodegradation': {'default': True,
  'od_mapping': 'processes:biodegradation',
  'ptm_level': 2,
  'value': True}}
```

Add reader and run

```
m.add_reader(ds=ds)
m.run_all()
```

```
18:17:50 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:17:50 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:17:50 INFO    opendrift:586: Retaining vertical velocity (w) because do3D is True
```

```
18:17:50 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:17:50 INFO    opendrift:610: Dropping salt and temp variables because drift_model is␣
↪not LarvalFish nor OpenOil
```

```
18:17:50 INFO    opendrift:621: Dropping ice variables because drift_model is not OpenOil
```

```
18:17:50 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:17:50 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:17:50 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:17:50 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:17:50 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:17:50 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:17:50 INFO    opendrift.readers.basereader.structured:83: Loading previously saved␣
↪interpolator for lon,lat to x,y conversion.
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         x_wind: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         y_wind: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         upward_sea_water_
↪velocity: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪period_at_variance_spectral_density_maximum: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪mean_period_from_variance_spectral_density_second_frequency_moment: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_to_direction: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_peak_period_from_variance_spectral_density: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_swell_
↪wave_significant_height: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_to_direction: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_mean_period: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wind_
↪wave_significant_height: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         surface_downward_x_
↪stress: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         surface_downward_y_
↪stress: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         turbulent_kinetic_
↪energy: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         turbulent_generic_
↪length_scale: 0.000000
```

```
18:17:50 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:17:50 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪15:20:00, steps: 40.0, duration: 0 days 03:20:00
```

```
18:17:50 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:17:50 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:17:50 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:17:50 WARNING opendrift.models.basemodel:701: Seafloor check not being run because␣
↪sea_surface_height is missing. This will happen the first time the function is run but␣
↪if it happens subsequently there is probably a problem.
```

```
18:17:50 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:50 INFO    opendrift.readers.reader_ROMS_native:370: Using zeta for sea surface␣
↪height
```

```
18:17:50 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:17:51 INFO    opendrift.readers.reader_ROMS_native:592: Time: 0:00:00.210752
```

```
18:17:51 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:17:51 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:40:00 - step 21 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:45:00 - step 22 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:50:00 - step 23 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:55:00 - step 24 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:00:00 - step 25 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:05:00 - step 26 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:10:00 - step 27 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:15:00 - step 28 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:20:00 - step 29 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:25:00 - step 30 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:30:00 - step 31 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:35:00 - step 32 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:40:00 - step 33 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:45:00 - step 34 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:50:00 - step 35 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:55:00 - step 36 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:00:00 - step 37 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:05:00 - step 38 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:10:00 - step 39 of 40 -␣
↪10 active elements (0 deactivated)
```

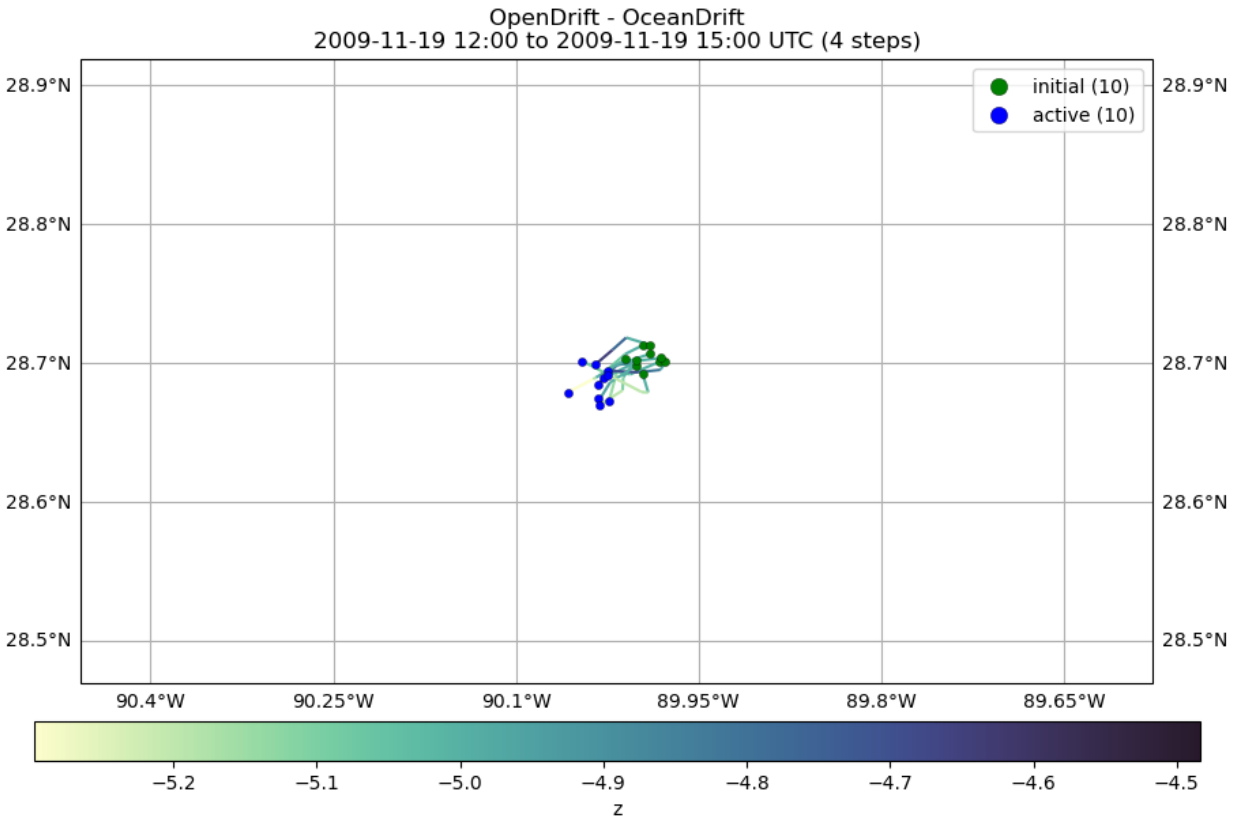
```
18:17:51 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:15:00 - step 40 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:17:51 INFO    opendrift.export.io_netcdf:112: Wrote 4 steps to file None_initial
```

Plot

```
m.o.plot(linecolor="z", fast=True, cmap=cmo.deep)
```

```
18:17:52 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```




```
(<GeoAxes: title={'center': 'OpenDrift - OceanDrift\n2009-11-19 12:00 to 2009-11-19␣
↪15:00 UTC (4 steps)'}>,
 <Figure size 1100x639.286 with 2 Axes>)
```

Leeway (Search and Rescue)

These are simulations of objects that stay at the surface and are transported by both the wind and ocean currents at rates that depend on how much the object sticks up out of and down into the water. The constants to use for those rates have been experimentally determined by the coastguard and are used in this model.

Initialize manager `m`

```
m = ptm.OpenDriftModel(drift_model="Leeway", lon = -89.8, lat = 29.08,
                       number=10, steps=40,
                       object_type="Fishing vessel, general (mean values)")

# This drift model requires wind data to be set which isn't present in model output
m.o.set_config('environment:constant:x_wind', -1)
m.o.set_config('environment:constant:y_wind', 1)
```

```
18:17:59 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:17:59 INFO    opendrift:394: do3D is False but drift_model is Leeway so doing nothing.
```

```
18:17:59 INFO    opendrift:372: Turning off vertical_mixing since do3D is False
```

```
18:17:59 INFO    opendrift:486: stokes_drift cannot be used with Leeway model, so␣
↪changing to False.
```

```
18:17:59 INFO    opendrift:466: wind_drift_factor cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

```
18:17:59 INFO    opendrift:476: wind_drift_depth cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

```
18:17:59 INFO    opendrift:428: vertical_mixing is False, so setting value of vertical_
↪mixing_timestep to None.
```

The objects that can be modeled are:

```
m.show_config(key="seed:object_type")["enum"]
```

```
['Person-in-water (PIW), unknown state (mean values)',
 '>PIW, vertical PFD type III conscious',
 '>PIW, sitting, PFD type I or II',
 '>PIW, survival suit (face up)',
 '>PIW, scuba suit (face up)',
 '>PIW, deceased (face down)',
 'Life raft, deep ballast (DB) system, general, unknown capacity and loading (mean␣
↪values)',
 '>4-14 person capacity, deep ballast system, canopy (average)',
 '>>4-14 person capacity, deep ballast system, no drogue',
 '>>>4-14 person capacity, deep ballast system, canopy, no drogue, light loading',
```

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```
'>>>4-14 person capacity, deep ballast system, no drogue, heavy loading',
'>>4-14 person capacity, deep ballast system, canopy, with drogue (average)',
'>>>4-14 person capacity, deep ballast system, canopy, with drogue, light loading',
'>>>4-14 person capacity, deep ballast system, canopy, with drogue, heavy loading',
'>15-50 person capacity, deep ballast system, canopy, general (mean values)',
'>>15-50 person capacity, deep ballast system, canopy, no drogue, light loading',
'>>15-50 person capacity, deep ballast system, canopy, with drogue, heavy loading',
'Deep ballast system, general (mean values), capsized',
'Deep ballast system, general (mean values), swamped',
'Life-raft, shallow ballast (SB) system AND canopy, general (mean values)',
'>Life-raft, shallow ballast system, canopy, no drogue',
'>Life-raft, shallow ballast system AND canopy, with drogue',
'Life-raft, shallow ballast system AND canopy, capsized',
'Life Raft - Shallow ballast, canopy, Navy Sub Escape (SEIE) 1-man raft, NO drogue',
'Life Raft - Shallow ballast, canopy, Navy Sub Escape (SEIE) 1-man raft, with drogue',
'Life-raft, no ballast (NB) system, general (mean values)',
'>Life-raft, no ballast system, no canopy, no drogue',
'>Life-raft, no ballast system, no canopy, with drogue',
'>Life-raft, no ballast system, with canopy, no drogue',
'>Life-raft, no ballast system, with canopy, with drogue',
'Survival Craft - USCG Sea Rescue Kit - 3 ballasted life rafts and 300 meter of line',
'Life-raft, 4-6 person capacity, no ballast, with canopy, no drogue',
'Evacuation slide with life-raft, 46 person capacity',
'Survival Craft - SOLAS Hard Shell Life Capsule, 22 man',
'Survival Craft - Ovatek Hard Shell Life Raft, 4 and 7-man, lightly loaded, no drogue␣
↪(average)',
'>Survival Craft - Ovatek Hard Shell Life Raft, 4 man, lightly loaded, no drogue',
'>Survival Craft - Ovatek Hard Shell Life Raft, 7 man, lightly loaded, no drogue',
'Survival Craft - Ovatek Hard Shell Life Raft, 4 and 7-man, fully loaded, drogued␣
↪(average)',
'>Survival Craft - Ovatek Hard Shell Life Raft, 4 man, fully loaded, drogued',
'>Survival Craft - Ovatek Hard Shell Life Raft, 7 man, fully loaded, drogued',
'Sea Kayak with person on aft deck',
'Surf board with person',
'Windsurfer with mast and sail in water',
'Skiff - modified-v, cathedral-hull, runabout outboard powerboat',
'Skiff, V-hull',
'Skiffs, swamped and capsized',
'Skiff - v-hull bow to stern (aluminum, Norway)',
'Sport boat, no canvas (*1), modified V-hull',
'Sport fisher, center console (*2), open cockpit',
'Fishing vessel, general (mean values)',
'Fishing vessel, Hawaiian Sampan (*3)',
'>Fishing vessel, Japanese side-stern trawler',
'>Fishing vessel, Japanese Longliner (*3)',
'>Fishing vessel, Korean fishing vessel (*4)',
'>Fishing vessel, Gill-netter with rear reel (*3)',
'Coastal freighter. (*5)',
'Sailboat Mono-hull (Average)',
'>Sailboat Mono-hull (Dismasted, Average)',
'>>Sailboat Mono-hull (Dismasted - rudder amidships)',
'>>Sailboat Mono-hull (Dismasted - rudder missing)',
```

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```
 '>Sailboat Mono-hull (Bare-masted,  Average)',
 '>>Sailboat Mono-hull (Bare-masted, rudder amidships)',
 '>>Sailboat Mono-hull (Bare-masted, rudder hove-to)',
 'Sailboat Mono-hull, fin keel, shallow draft (was SAILBOAT-2)',
 'Sunfish sailing dingy  -  Bare-masted, rudder missing',
 'Fishing vessel debris',
 'Self-locating datum marker buoy - no windage',
 'Navy Submarine EPIRB (SEPIRB)',
 'Bait/wharf box, holds a cubic metre of ice, mean values (*6)',
 'Bait/wharf box, holds a cubic metre of ice, lightly loaded',
 '>Bait/wharf box, holds a cubic metre of ice, full loaded',
 '55-gallon (220 l) Oil Drum',
 'Scaled down (1:3) 40-ft Container (70% submerged)',
 '20-ft Container (80% submerged)',
 'WWII L-MK2 mine',
 'Immigration vessel, Cuban refugee-raft, no sail (*7)',
 'Immigration vessel, Cuban refugee-raft, with sail (*7)',
 'Sewage floatables, tampon applicator',
 'Medical waste (mean values)',
 '>Medical waste, vials',
 '>>Medical waste, vials, large',
 '>>Medical waste, vials, small',
 '>Medical waste, syringes',
 '>>Medical waste, syringes, large',
 '>>Medical waste, syringes, small']
```

The drift_model-specific parameters chosen by the user and PTM for this simulation are:

```
m.drift_model_config()
```

```
[('general:use_auto_landmask', False),
 ('drift:current_uncertainty', 0),
 ('general:coastline_action', 'previous'),
 ('seed:number', 10),
 ('drift:horizontal_diffusivity', 100),
 ('drift:wind_uncertainty', 0),
 ('seed:z', 0),
 ('seed:object_type', 'Fishing vessel, general (mean values)'),
 ('model', 'opendrift'),
 ('lon', -89.8),
 ('lat', 29.08),
 ('seed_flag', 'elements'),
 ('start_time', Timestamp('2009-11-19 12:00:00')),
 ('run_forward', True),
 ('time_step', 300),
 ('time_step_output', 3600),
 ('steps', 40),
 ('duration', Timedelta('0 days 03:20:00')),
 ('end_time', Timestamp('2009-11-19 15:20:00')),
 ('ocean_model', 'user_input'),
 ('ocean_model_local', False),
 ('do3D', False),
```

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```
 ('use_static_masks', True),
 ('drift_model', 'Leeway'),
 ('export_variables', ['z', 'origin_marker', 'object_type', 'object_type']),
 ('radius', 1000.0),
 ('radius_type', 'gaussian'),
 ('log', 'low')]
```

Add reader and run

```
m.add_reader(ds=ds)
m.run_all()
```

```
18:18:00 INFO    opendrift:359: Since ocean_model is user-input, changing horizontal_
↪diffusivity parameter from None to 0.0.
                    You can also set it to a specific value with `m.horizontal_
↪diffusivity=[number]`.
```

```
18:18:00 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:18:00 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:18:00 INFO    opendrift:584: Dropping vertical velocity (w) because do3D is False
```

```
18:18:00 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:18:00 INFO    opendrift:610: Dropping salt and temp variables because drift_model is␣
↪not LarvalFish nor OpenOil
```

```
18:18:00 INFO    opendrift:621: Dropping ice variables because drift_model is not OpenOil
```

```
18:18:00 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:18:00 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:18:00 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:18:00 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:18:00 INFO    opendrift.readers.basereader.structured:83: Loading previously saved␣
↪interpolator for lon,lat to x,y conversion.
```

```
18:18:00 INFO    opendrift.models.leeway:262: Seeding elements of object type 50:␣
↪FISHING-VESSEL-1 (Fishing vessel, general (mean values))
```

```
18:18:00 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪15:20:00, steps: 40.0, duration: 0 days 03:20:00
```

```
18:18:00 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:18:00 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:18:00 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:40:00 - step 21 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:45:00 - step 22 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:50:00 - step 23 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:55:00 - step 24 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:00:00 - step 25 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:05:00 - step 26 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:10:00 - step 27 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:15:00 - step 28 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:20:00 - step 29 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:25:00 - step 30 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:30:00 - step 31 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:35:00 - step 32 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:40:00 - step 33 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:45:00 - step 34 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:50:00 - step 35 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:55:00 - step 36 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:00:00 - step 37 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:05:00 - step 38 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:10:00 - step 39 of 40 -␣
↪10 active elements (0 deactivated)
```

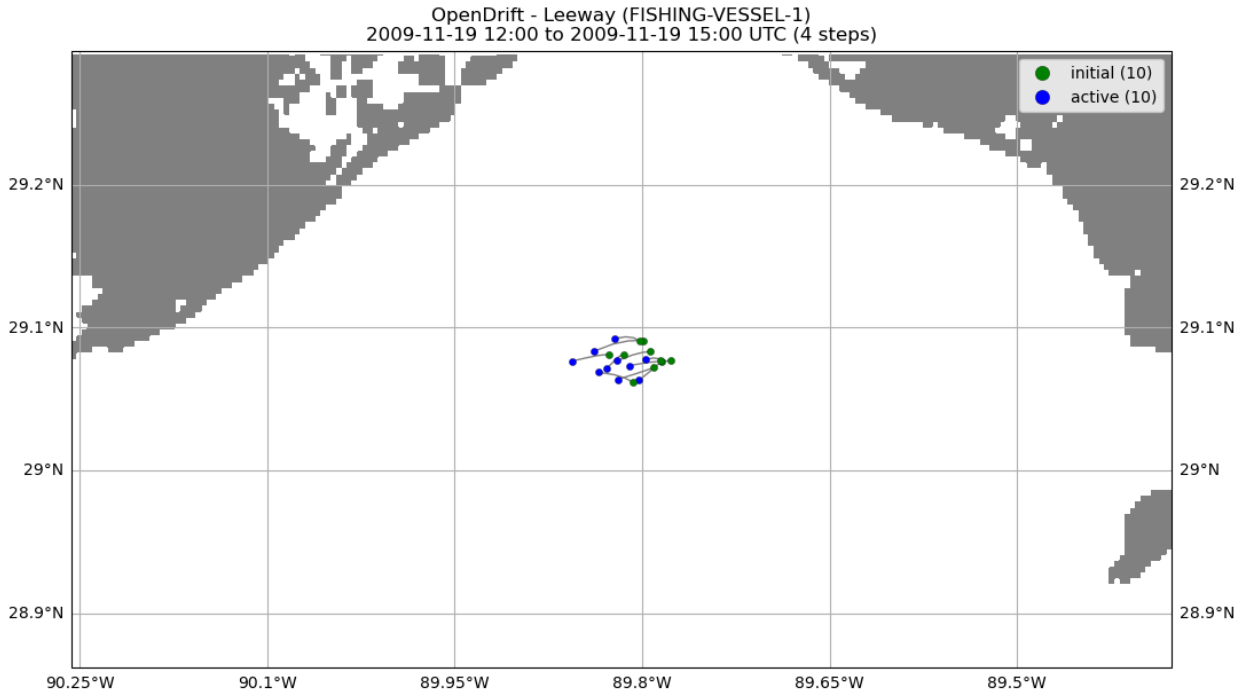
```
18:18:00 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:15:00 - step 40 of 40 -␣
↪10 active elements (0 deactivated)
```

```
18:18:00 INFO    opendrift.export.io_netcdf:112: Wrote 4 steps to file None_initial
```

Plot

```
m.o.plot(fast=True)
```

```
18:18:00 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```




```
(<GeoAxes: title={'center': 'OpenDrift - Leeway (FISHING-VESSEL-1)\n2009-11-19 12:00 to␣
↪2009-11-19 15:00 UTC (4 steps)'}>,
 <Figure size 1100x617.423 with 1 Axes>)
```

LarvalFish

This model simulates eggs and larvae that move in 3D with the currents and some basic behavior and vertical movement. It also simulates some basic growth of the larvae.

There are specific seeding options for this model:

- 'diameter'
- 'neutral_buoyancy_salinity'
- 'stage_fraction'
- 'hatched'
- 'length'
- 'weight'

Eggs

An optional general flag is to initialize the drifters at the seabed, which might make sense for eggs and is demonstrated here.

Initialize manager `m`

```
m = ptm.OpenDriftModel(drift_model="LarvalFish", lon=-89.85, lat=28.8, number=10,␣
↪steps=45,
                       do3D=True, seed_seafloor=True)
```

```
18:18:02 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:18:02 INFO    opendrift:378: setting z to None since being seeded at seafloor
```

```
18:18:02 INFO    opendrift:399: do3D is True so turning on vertical advection.
```

```
18:18:02 INFO    opendrift:466: wind_drift_factor cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

```
18:18:02 INFO    opendrift:476: wind_drift_depth cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

The drift_model-specific parameters chosen by the user and PTM for this simulation are:

```
m.drift_model_config()
```

```
[('environment:fallback:ocean_mixed_layer_thickness', 30),
 ('general:use_auto_landmask', False),
 ('drift:current_uncertainty', 0),
 ('general:coastline_action', 'previous'),
 ('seed:number', 10),
 ('drift:horizontal_diffusivity', 0),
 ('drift:wind_uncertainty', 0),
 ('seed:diameter', 0.0014),
 ('seed:neutral_buoyancy_salinity', 31.25),
 ('seed:stage_fraction', 0.0),
 ('seed:hatched', 0),
 ('seed:length', 0),
 ('seed:weight', 0.08),
 ('drift:vertical_mixing', True),
 ('vertical_mixing:timestep', 60),
 ('vertical_mixing:diffusivitymodel', 'windspeed_Large1994'),
 ('drift:stokes_drift', True),
 ('general:seafloor_action', 'previous'),
 ('seed:seafloor', True),
 ('drift:vertical_advection', True),
 ('drift:truncate_ocean_model_below_m', None),
 ('drift:use_tabularised_stokes_drift', True),
```

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```
 ('model', 'opendrift'),
 ('lon', -89.85),
 ('lat', 28.8),
 ('seed_flag', 'elements'),
 ('start_time', Timestamp('2009-11-19 12:00:00')),
 ('run_forward', True),
 ('time_step', 300),
 ('time_step_output', 3600),
 ('steps', 45),
 ('duration', Timedelta('0 days 03:20:00')),
 ('end_time', Timestamp('2009-11-19 15:20:00')),
 ('ocean_model', 'user_input'),
 ('ocean_model_local', False),
 ('do3D', True),
 ('use_static_masks', True),
 ('drift_model', 'LarvalFish'),
 ('export_variables',
  ['z',
   'origin_marker',
   'object_type',
   'object_type',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
   'hatched',
   'length',
   'weight',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
   'hatched',
   'length',
   'weight']),
 ('radius', 1000.0),
 ('radius_type', 'gaussian'),
 ('log', 'low')]
```

Add reader and run

```
m.add_reader(ds=ds)
m.run_all()
```

```
18:18:02 INFO    opendrift:359: Since ocean_model is user-input, changing horizontal_
↪diffusivity parameter from None to 0.0.
                    You can also set it to a specific value with `m.horizontal_
↪diffusivity=[number]`.
```

```
18:18:02 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:18:02 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:18:02 INFO    opendrift:586: Retaining vertical velocity (w) because do3D is True
```

```
18:18:02 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:18:02 INFO    opendrift:614: Retaining salt and temp variables because drift_model is␣
↪LarvalFish or OpenOil
```

```
18:18:02 INFO    opendrift:621: Dropping ice variables because drift_model is not OpenOil
```

```
18:18:02 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:18:02 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:18:02 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:18:02 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:18:02 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:18:02 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:18:02 INFO    opendrift.readers.basereader.structured:83: Loading previously saved␣
↪interpolator for lon,lat to x,y conversion.
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         x_wind: 0.000000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         y_wind: 0.000000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.010000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:18:02 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:18:02 WARNING opendrift.models.basemodel.environment:465: Simulation has no␣
↪simulation_extent, cannot check reader coverage
```

```
18:18:02 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:18:02 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪15:45:00, steps: 45.0, duration: 0 days 03:45:00
```

```
18:18:02 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:18:02 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:18:02 WARNING opendrift.models.basemodel:701: Seafloor check not being run because␣
↪sea_surface_height is missing. This will happen the first time the function is run but␣
↪if it happens subsequently there is probably a problem.
```

```
18:18:02 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:02 INFO    opendrift.readers.reader_ROMS_native:370: Using zeta for sea surface␣
↪height
```

```
18:18:03 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:18:03 INFO    opendrift.readers.reader_ROMS_native:592: Time: 0:00:00.160475
```

```
18:18:03 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:18:03 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:40:00 - step 21 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:45:00 - step 22 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:50:00 - step 23 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:55:00 - step 24 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:00:00 - step 25 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:05:00 - step 26 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:10:00 - step 27 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:15:00 - step 28 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:20:00 - step 29 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:25:00 - step 30 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:30:00 - step 31 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:35:00 - step 32 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:03 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:40:00 - step 33 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:45:00 - step 34 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:50:00 - step 35 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:55:00 - step 36 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:00:00 - step 37 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:05:00 - step 38 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:10:00 - step 39 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:15:00 - step 40 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:20:00 - step 41 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:25:00 - step 42 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:30:00 - step 43 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:35:00 - step 44 of 45 -␣
↪10 active elements (0 deactivated)
```

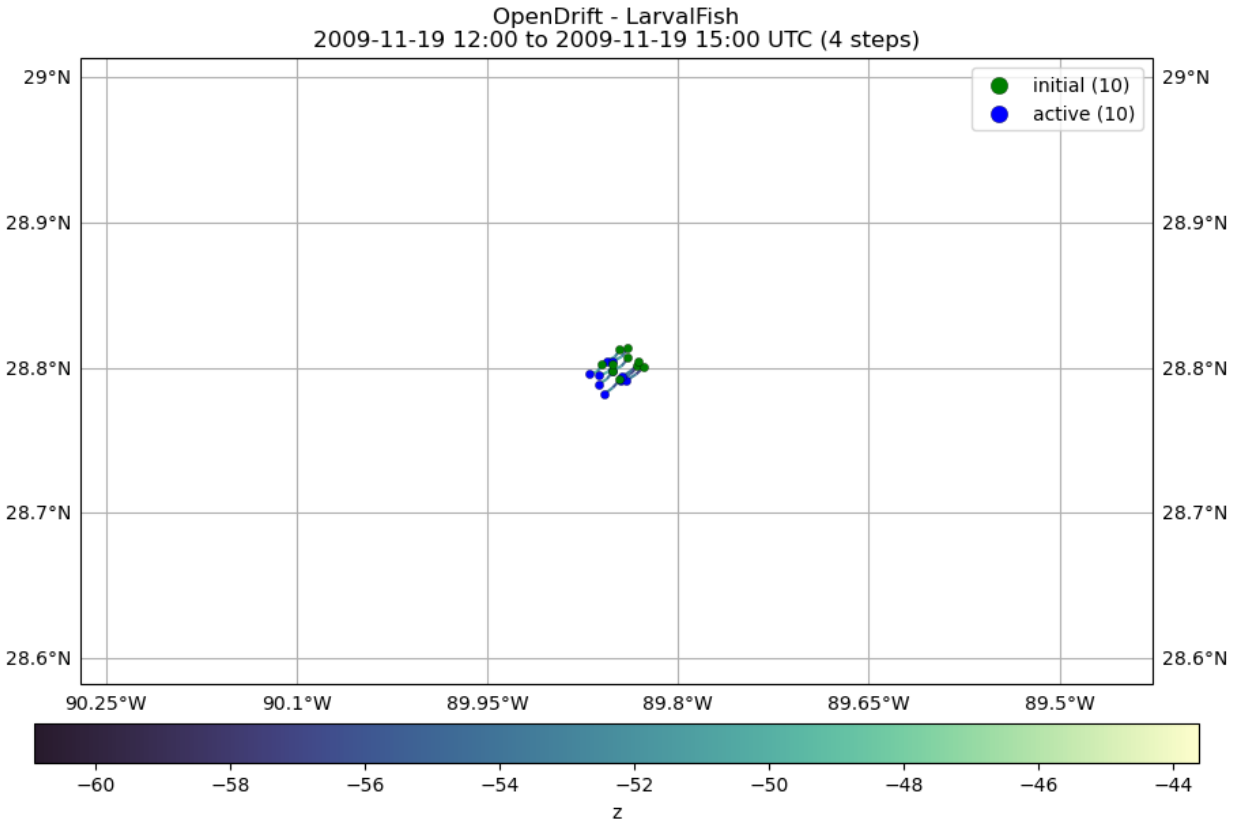
```
18:18:04 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:40:00 - step 45 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:04 INFO    opendrift.export.io_netcdf:112: Wrote 4 steps to file None_initial
```

Plot

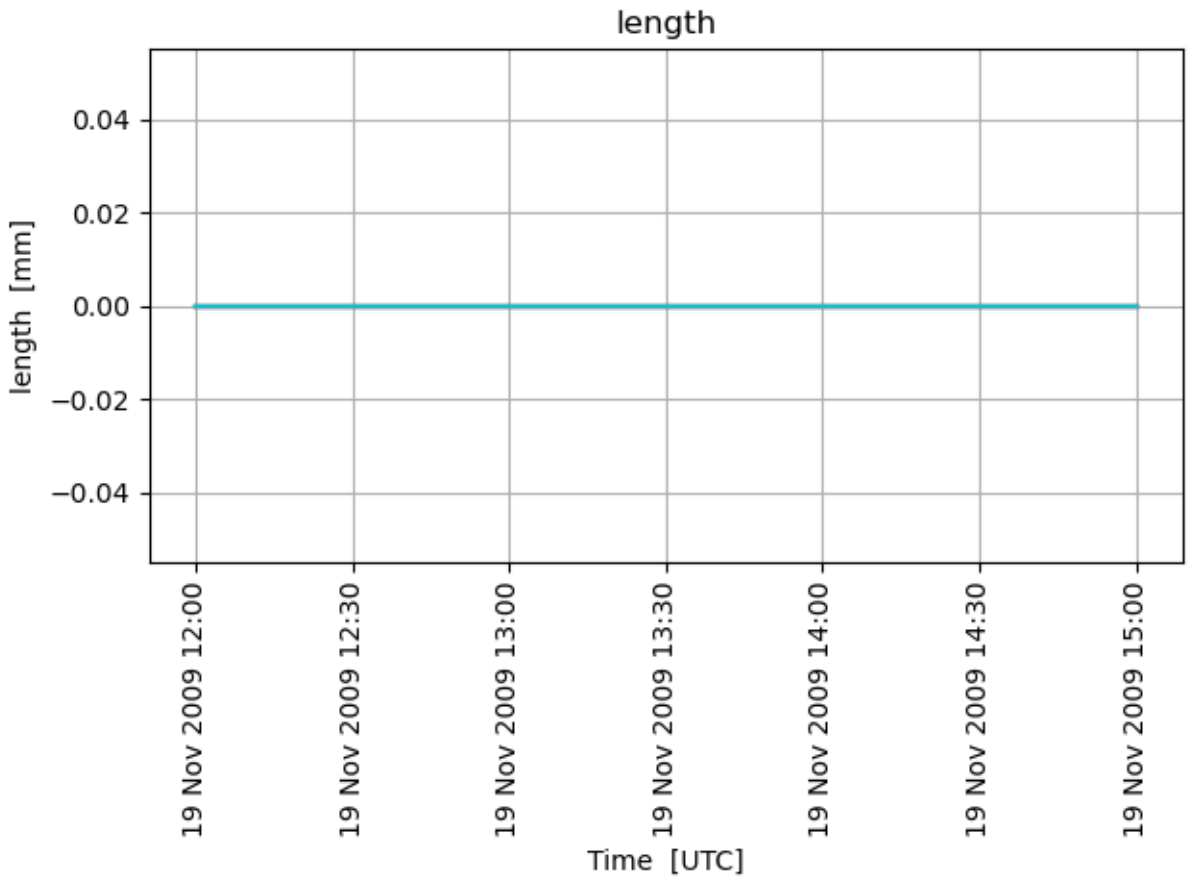
```
m.o.plot(linecolor="z", fast=True, cmap=cmo.deep_r)
```

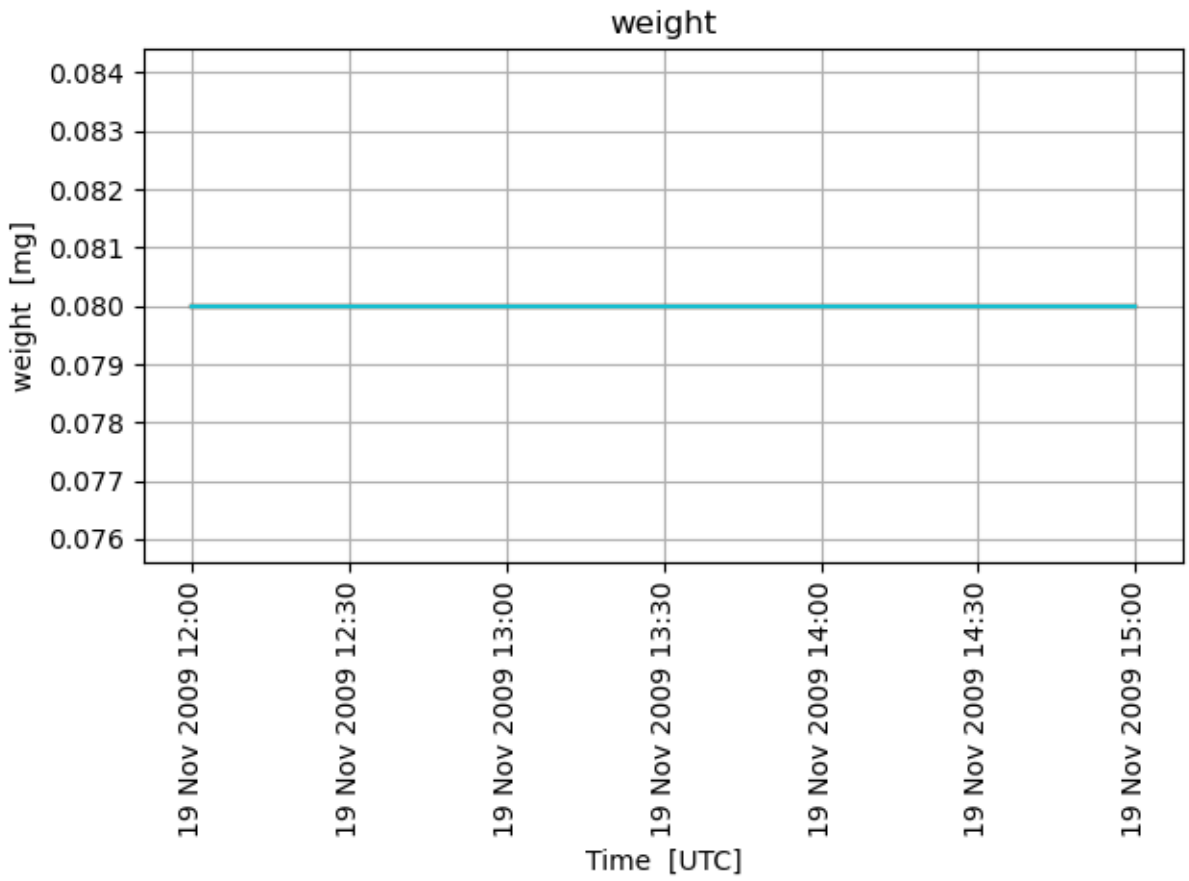
```
18:18:04 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```

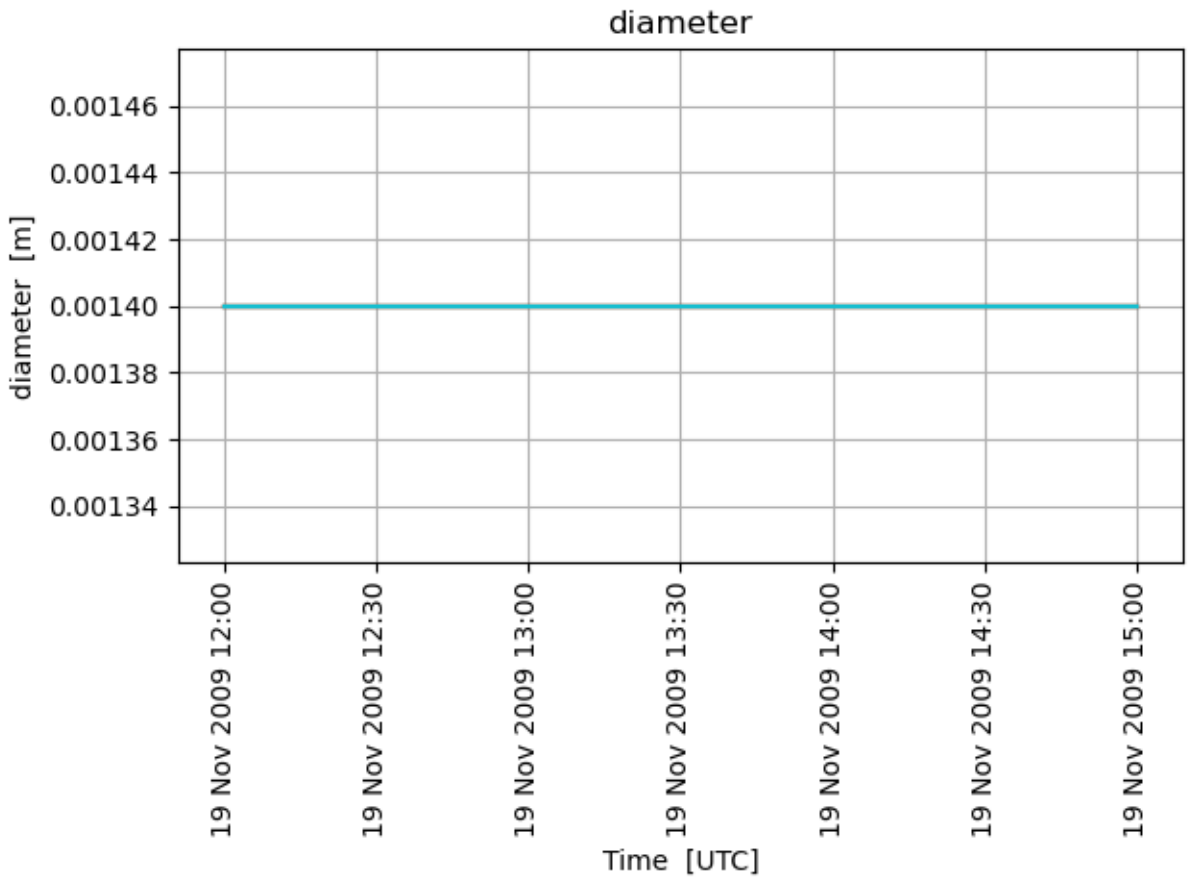


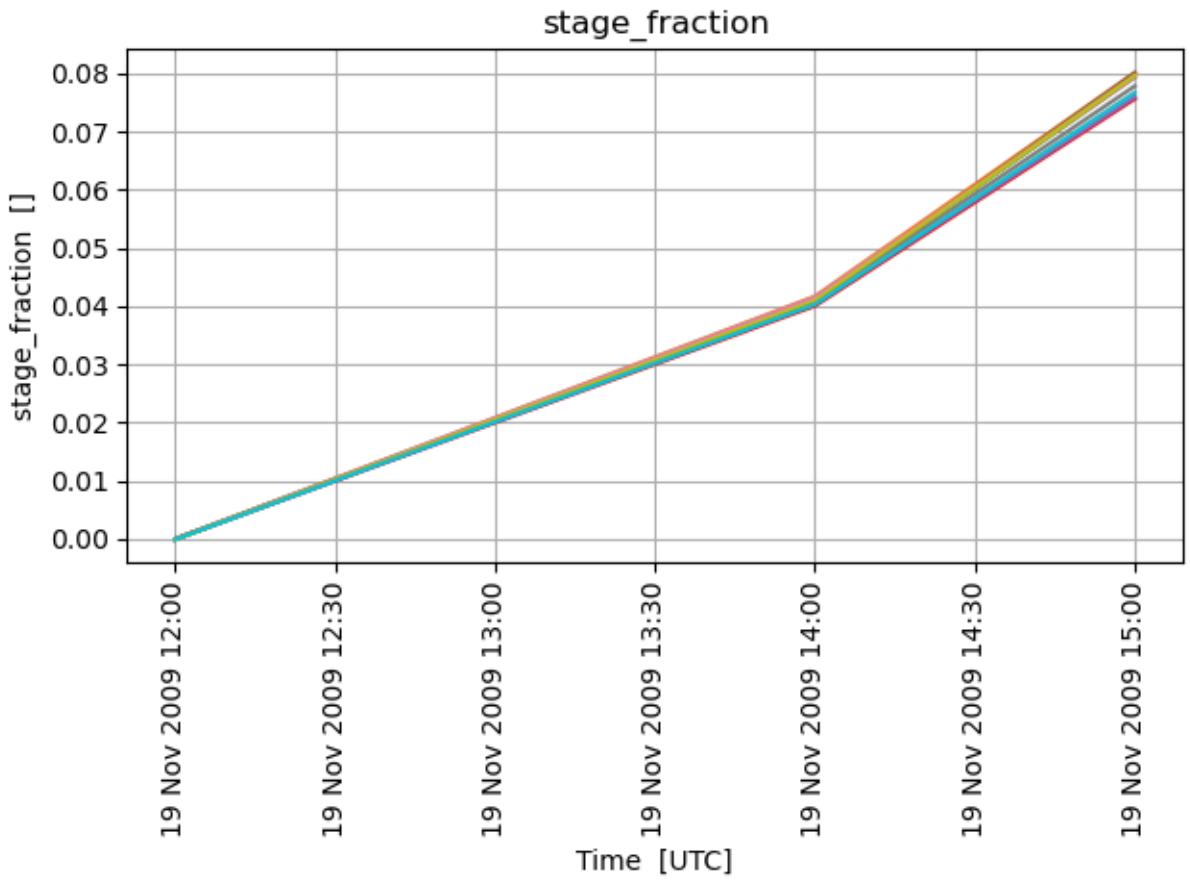

```
(<GeoAxes: title={'center': 'OpenDrift - LarvalFish\n2009-11-19 12:00 to 2009-11-19␣
↪15:00 UTC (4 steps)'}>,
 <Figure size 1100x643.453 with 2 Axes>)
```

```
m.o.plot_property('length')
m.o.plot_property('weight')
m.o.plot_property('diameter')
m.o.plot_property('stage_fraction')
```


length
0.04
0.02
0.00
−0.02
−0.04
length [mm]
19 Nov 2009 12:00
19 Nov 2009 12:30
19 Nov 2009 13:00
19 Nov 2009 13:30
19 Nov 2009 14:00
19 Nov 2009 14:30
19 Nov 2009 15:00
Time [UTC]


weight
0.084
0.083
0.082
0.081
0.080
0.079
0.078
0.077
0.076
weight [mg]
19 Nov 2009 12:00
19 Nov 2009 12:30
19 Nov 2009 13:00
19 Nov 2009 13:30
19 Nov 2009 14:00
19 Nov 2009 14:30
19 Nov 2009 15:00
Time [UTC]


diameter
0.00146
0.00144
0.00142
0.00140
0.00138
0.00136
0.00134
diameter [m]
19 Nov 2009 12:00
19 Nov 2009 12:30
19 Nov 2009 13:00
19 Nov 2009 13:30
19 Nov 2009 14:00
19 Nov 2009 14:30
19 Nov 2009 15:00
Time [UTC]



Output from the simulation can be viewed in the history or elements, or from the output file.

```
m.outfile_name
```

```
'output-results_2024-04-24T1818:04Z.nc'
```

```
m.o.history["z"].data
```

```
array([[-60.042397, -56.878563, -53.624737, -47.847057],
       [-55.971485, -53.033333, -50.11476 , -45.042492],
       [-57.71462 , -53.91859 , -50.45399 , -44.330505],
       [-60.902836, -57.183456, -53.33119 , -47.206745],
       [-59.72285 , -56.80858 , -53.76876 , -47.83425 ],
       [-55.20293 , -52.02814 , -48.959164, -43.62638 ],
       [-56.70956 , -53.567574, -50.65071 , -45.879745],
       [-57.05813 , -54.02638 , -51.029716, -45.621582],
       [-56.572124, -53.22841 , -49.575195, -43.931885],
       [-58.874073, -55.793224, -52.426933, -46.51389 ]], dtype=float32)
```

```
m.o.elements
```

```
ID: [ 1  2  3  4  5  6  7  8  9 10]
status: [0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0]
```

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```
moving: 1
age_seconds: 0.0
origin_marker: [0 0 0 0 0 0 0 0 0 0]
lon: [-89.8448715209961 -89.85617065429688 -89.85160827636719
 -89.84083557128906 -89.843505859375 -89.86956024169922 -89.85101318359375
 -89.86231994628906 -89.86174774169922 -89.85846710205078]
lat: [28.791154861450195 28.804786682128906 28.798250198364258
 28.79107093811035 28.794084548950195 28.79555320739746 28.804616928100586
 28.788558959960938 28.794647216796875 28.781597137451172]
z: [-47.8470573425293 -45.0424919128418 -44.33050537109375 -47.20674514770508
 -47.834251403808594 -43.626380920410156 -45.87974548339844
 -45.62158203125 -43.931884765625 -46.51388931274414]
wind_drift_factor: 0.02
current_drift_factor: 1.0
terminal_velocity: 0.0
diameter: [0.00139999995008111 0.00139999995008111 0.00139999995008111
 0.00139999995008111 0.00139999995008111 0.00139999995008111
 0.00139999995008111 0.00139999995008111 0.00139999995008111
 0.00139999995008111]
neutral_buoyancy_salinity: [31.25 31.25 31.25 31.25 31.25 31.25 31.25 31.25 31.25 31.25]
stage_fraction: [0.07583898305892944 0.08016344159841537 0.07939261198043823
 0.07567048072814941 0.07605403661727905 0.08010949939489365
 0.07944242656230927 0.07785900682210922 0.07972043752670288
 0.0767621174454689]
hatched: [0 0 0 0 0 0 0 0 0 0]
length: [0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0]
weight: [0.07999999821186066 0.07999999821186066 0.07999999821186066
 0.07999999821186066 0.07999999821186066 0.07999999821186066
 0.07999999821186066 0.07999999821186066 0.07999999821186066
 0.07999999821186066]
survival: 1.0
```

Hatched!

Initialize manager `m`

```
m = ptm.OpenDriftModel(drift_model="LarvalFish", lon=-89.85, lat=28.8, number=10,␣
↪steps=45,
                       do3D=True, seed_seafloor=True, hatched=1)
```

```
18:18:07 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:18:07 INFO    opendrift:378: setting z to None since being seeded at seafloor
```

```
18:18:07 INFO    opendrift:399: do3D is True so turning on vertical advection.
```

```
18:18:07 INFO    opendrift:466: wind_drift_factor cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

```
18:18:07 INFO    opendrift:476: wind_drift_depth cannot be used with Leeway or␣
↪LarvalFish models, so setting to None.
```

The drift_model-specific parameters chosen by the user and PTM for this simulation are:

```
m.drift_model_config()
```

```
[('environment:fallback:ocean_mixed_layer_thickness', 30),
 ('general:use_auto_landmask', False),
 ('drift:current_uncertainty', 0),
 ('general:coastline_action', 'previous'),
 ('seed:number', 10),
 ('drift:horizontal_diffusivity', 0),
 ('drift:wind_uncertainty', 0),
 ('seed:diameter', 0.0014),
 ('seed:neutral_buoyancy_salinity', 31.25),
 ('seed:stage_fraction', 0.0),
 ('seed:hatched', 1),
 ('seed:length', 0),
 ('seed:weight', 0.08),
 ('drift:vertical_mixing', True),
 ('vertical_mixing:timestep', 60),
 ('vertical_mixing:diffusivitymodel', 'windspeed_Large1994'),
 ('drift:stokes_drift', True),
 ('general:seafloor_action', 'previous'),
 ('seed:seafloor', True),
 ('drift:vertical_advection', True),
 ('drift:truncate_ocean_model_below_m', None),
 ('drift:use_tabularised_stokes_drift', True),
 ('model', 'opendrift'),
 ('lon', -89.85),
 ('lat', 28.8),
 ('seed_flag', 'elements'),
 ('start_time', Timestamp('2009-11-19 12:00:00')),
 ('run_forward', True),
 ('time_step', 300),
 ('time_step_output', 3600),
 ('steps', 45),
 ('duration', Timedelta('0 days 03:45:00')),
 ('end_time', Timestamp('2009-11-19 15:45:00')),
 ('ocean_model', 'user_input'),
 ('ocean_model_local', False),
 ('do3D', True),
 ('use_static_masks', True),
 ('drift_model', 'LarvalFish'),
 ('export_variables',
  ['z',
   'origin_marker',
   'object_type',
   'object_type',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
```

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```
   'hatched',
   'length',
   'weight',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
   'hatched',
   'length',
   'weight',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
   'hatched',
   'length',
   'weight',
   'diameter',
   'neutral_buoyancy_salinity',
   'stage_fraction',
   'hatched',
   'length',
   'weight']),
 ('radius', 1000.0),
 ('radius_type', 'gaussian'),
 ('log', 'low')]
```

Add reader and run

```
m.add_reader(ds=ds)
m.run_all()
```

```
18:18:07 INFO    opendrift:359: Since ocean_model is user-input, changing horizontal_
↪diffusivity parameter from None to 0.0.
                    You can also set it to a specific value with `m.horizontal_
↪diffusivity=[number]`.
```

```
18:18:07 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:18:07 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:18:07 INFO    opendrift:586: Retaining vertical velocity (w) because do3D is True
```

```
18:18:07 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:18:07 INFO    opendrift:614: Retaining salt and temp variables because drift_model is␣
↪LarvalFish or OpenOil
```

```
18:18:07 INFO    opendrift:621: Dropping ice variables because drift_model is not OpenOil
```

```
18:18:07 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:18:07 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:18:07 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:18:07 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:18:07 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:18:07 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:18:07 INFO    opendrift.readers.basereader.structured:83: Loading previously saved␣
↪interpolator for lon,lat to x,y conversion.
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         x_wind: 0.000000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         y_wind: 0.000000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.010000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:18:07 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:18:07 WARNING opendrift.models.basemodel.environment:465: Simulation has no␣
↪simulation_extent, cannot check reader coverage
```

```
18:18:07 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:18:07 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪15:45:00, steps: 45.0, duration: 0 days 03:45:00
```

```
18:18:07 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:18:07 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:18:07 WARNING opendrift.models.basemodel:701: Seafloor check not being run because␣
↪sea_surface_height is missing. This will happen the first time the function is run but␣
↪if it happens subsequently there is probably a problem.
```

```
18:18:07 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:07 INFO    opendrift.readers.reader_ROMS_native:370: Using zeta for sea surface␣
↪height
```

```
18:18:07 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:18:08 INFO    opendrift.readers.reader_ROMS_native:592: Time: 0:00:00.160127
```

```
18:18:08 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:18:08 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:40:00 - step 21 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:45:00 - step 22 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:50:00 - step 23 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:55:00 - step 24 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:00:00 - step 25 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:05:00 - step 26 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:10:00 - step 27 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:15:00 - step 28 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:20:00 - step 29 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:25:00 - step 30 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:30:00 - step 31 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:35:00 - step 32 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:40:00 - step 33 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:45:00 - step 34 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:50:00 - step 35 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:08 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:55:00 - step 36 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:00:00 - step 37 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:05:00 - step 38 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:10:00 - step 39 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:15:00 - step 40 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:20:00 - step 41 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:25:00 - step 42 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:30:00 - step 43 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:35:00 - step 44 of 45 -␣
↪10 active elements (0 deactivated)
```

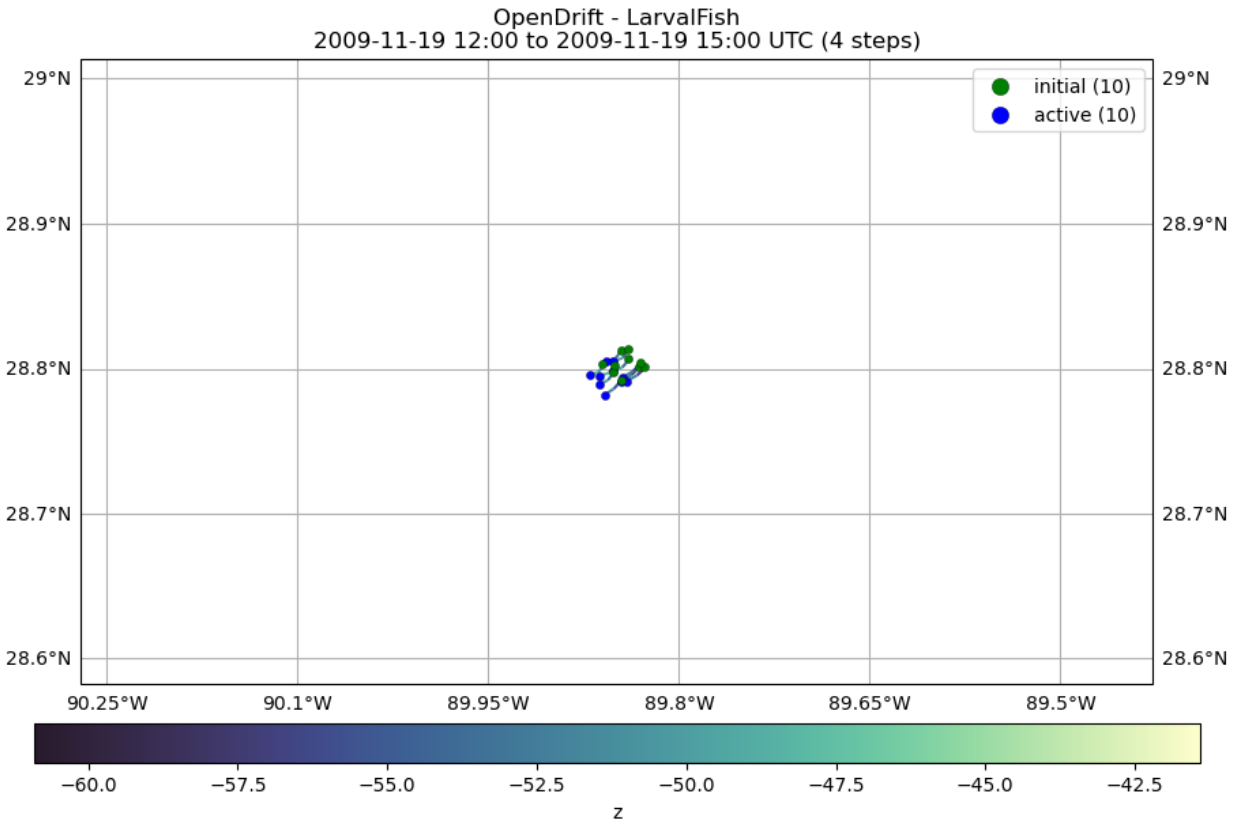
```
18:18:09 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:40:00 - step 45 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:09 INFO    opendrift.export.io_netcdf:112: Wrote 4 steps to file None_initial
```

Plot

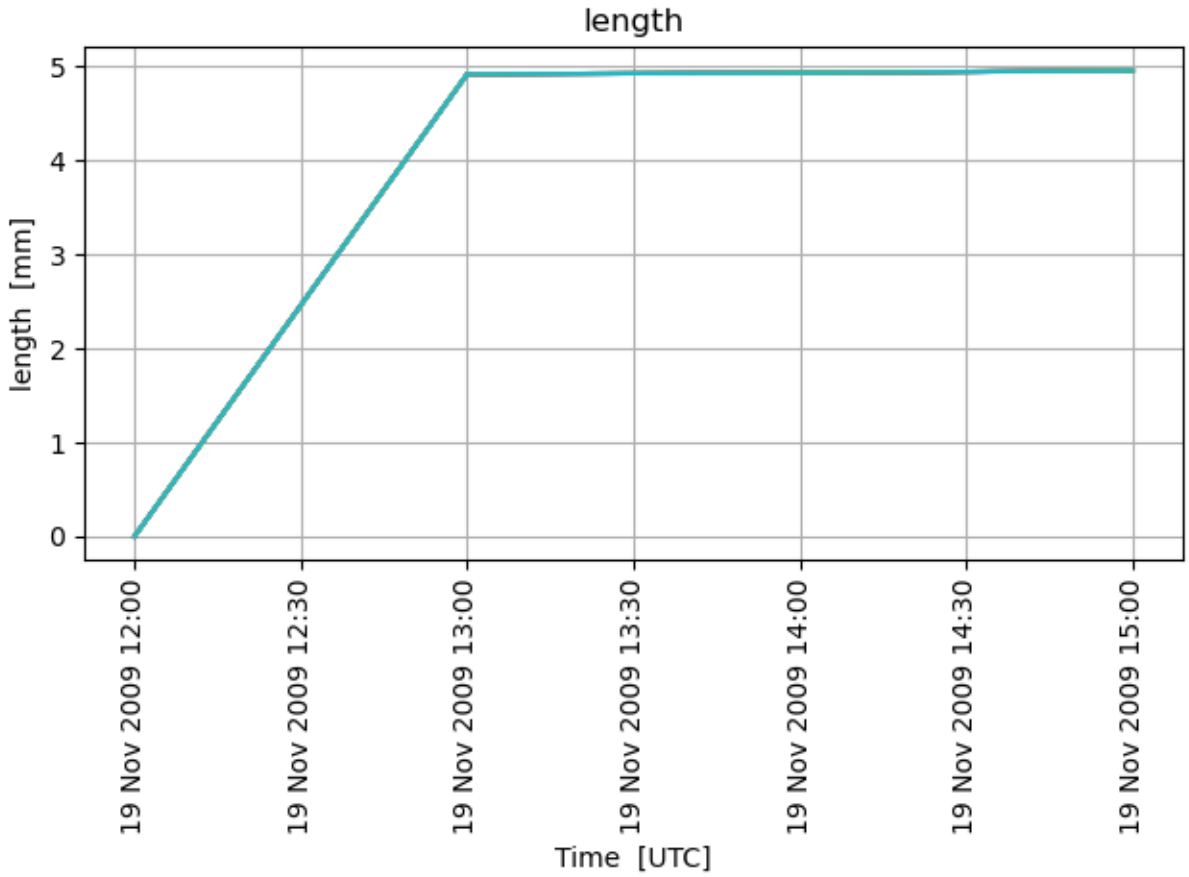
```
m.o.plot(linecolor="z", fast=True, cmap=cmo.deep_r)
```

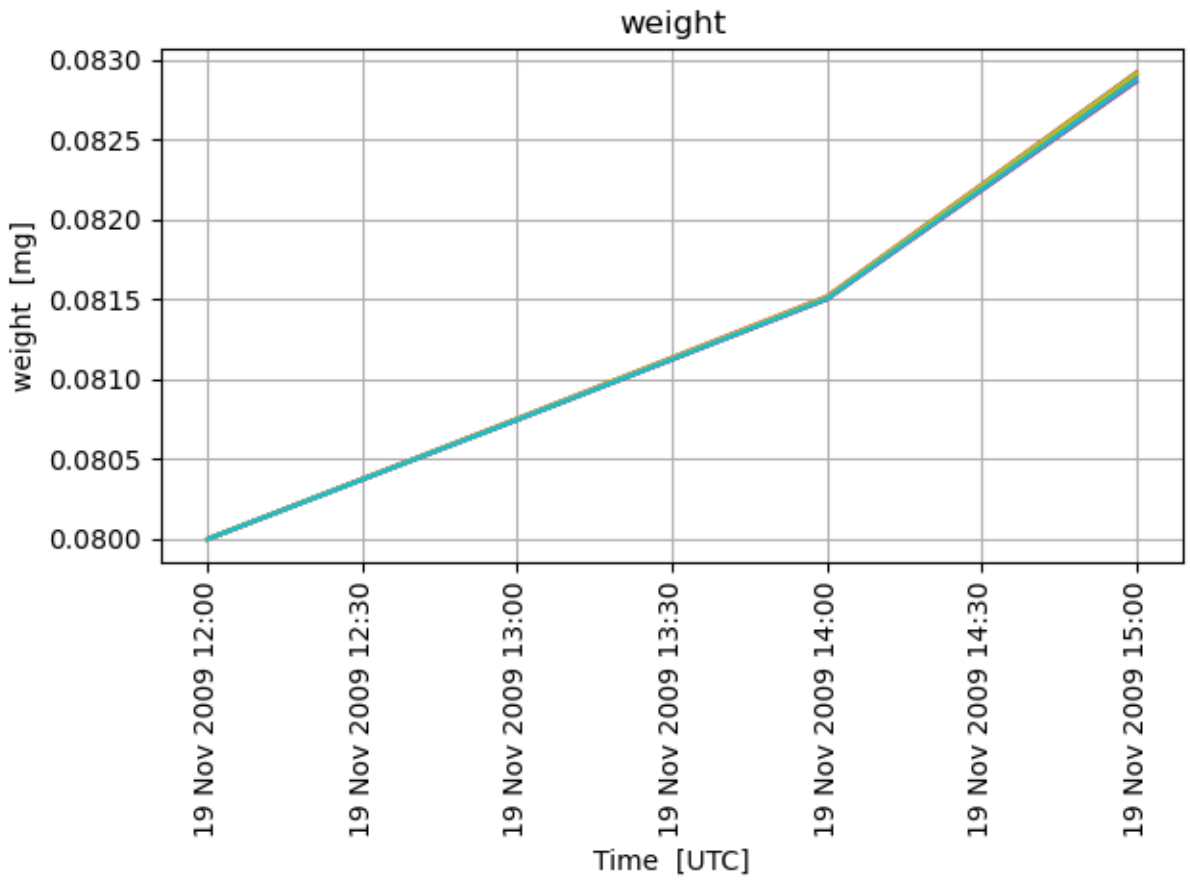
```
18:18:09 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```

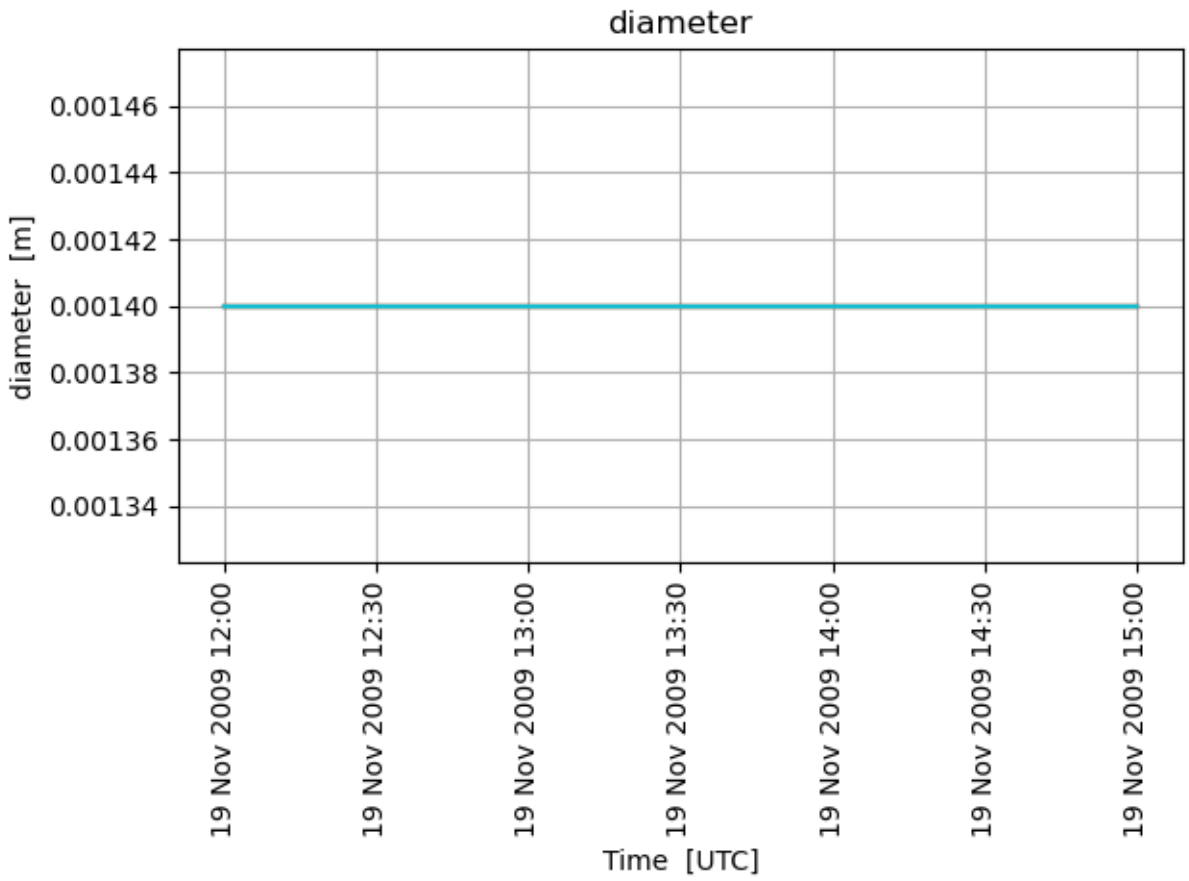


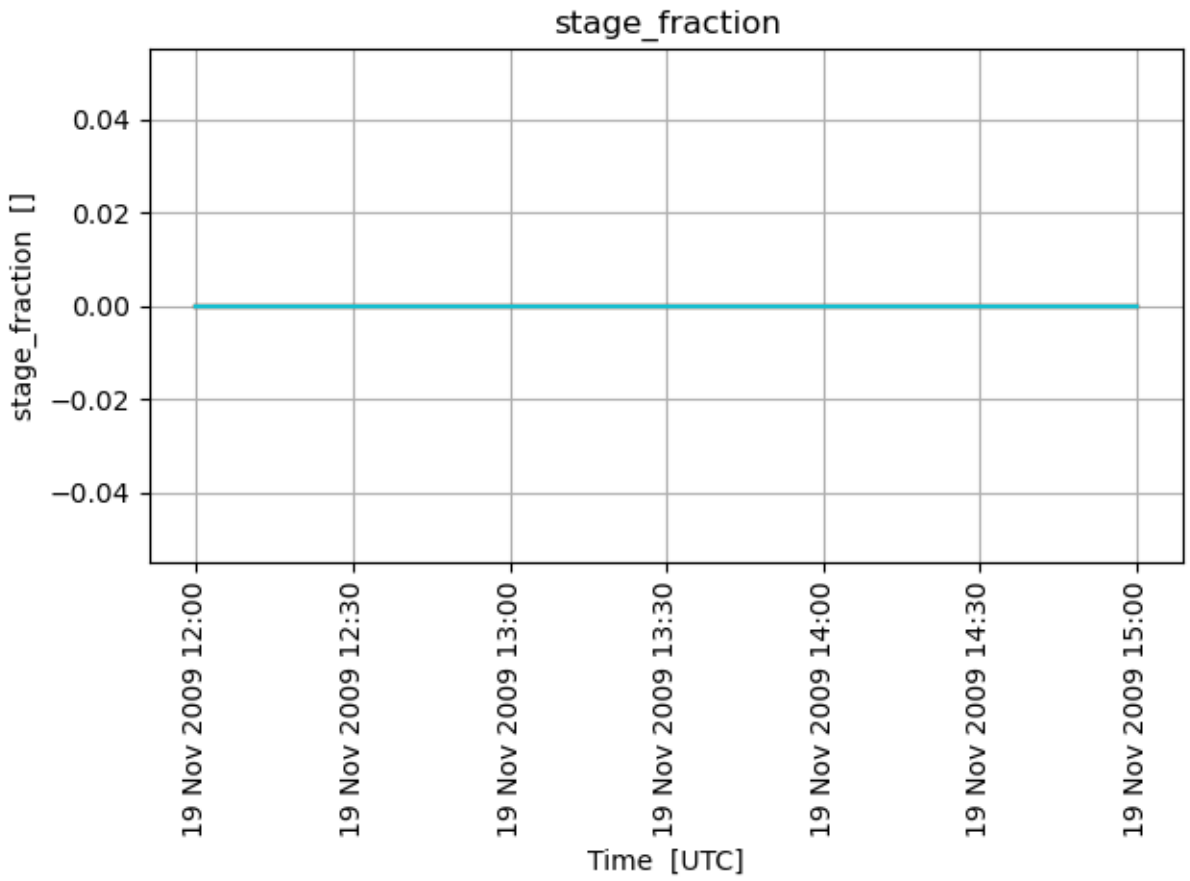
```
(<GeoAxes: title={'center': 'OpenDrift - LarvalFish\n2009-11-19 12:00 to 2009-11-19␣
↪15:00 UTC (4 steps)'}>,
 <Figure size 1100x642.005 with 2 Axes>)
```

```
m.o.plot_property('length')
m.o.plot_property('weight')
m.o.plot_property('diameter')
m.o.plot_property('stage_fraction')
```




weight
0.0830
0.0825
0.0820
0.0815
0.0810
0.0805
0.0800
weight [mg]
19 Nov 2009 12:00
19 Nov 2009 12:30
19 Nov 2009 13:00
19 Nov 2009 13:30
19 Nov 2009 14:00
19 Nov 2009 14:30
19 Nov 2009 15:00
Time [UTC]


diameter
0.00146
0.00144
0.00142
0.00140
0.00138
0.00136
0.00134
diameter [m]
19 Nov 2009 12:00
19 Nov 2009 12:30
19 Nov 2009 13:00
19 Nov 2009 13:30
19 Nov 2009 14:00
19 Nov 2009 14:30
19 Nov 2009 15:00
Time [UTC]



OpenOil

This model simulates the transport of oil. Processes optionally modeled (which are included in PTM by default) include:

- "emulsification"
- "dispersion"
- "evaporation"
- "update_oilfilm_thickness"
- "biodegradation"

There are also specific seeding options for this model:

- "m3_per_hour"
- "oil_film_thickness"
- "droplet_size_distribution"
- "droplet_diameter_mu"
- "droplet_diameter_sigma"
- "droplet_diameter_min_subsea"
- "droplet_diameter_max_subsea"

Initialize manager `m`

```
m = ptm.OpenDriftModel(drift_model="OpenOil", lon=-89.85, lat=28.08, number=10, steps=45,
                       z=-10, do3D=True, oil_type='GENERIC BUNKER C')
m.o.set_config('environment:constant:x_wind', -1)
m.o.set_config('environment:constant:y_wind', 1)
```

```
18:18:12 INFO    opendrift.models.basemodel:529: OpenDriftSimulation initialised␣
↪(version 1.11.2)
```

```
18:18:12 INFO    opendrift:399: do3D is True so turning on vertical advection.
```

List available oil types from NOAA's ADIOS database:

```
m.show_config(key="seed:oil_type")
```

```
{'type': 'enum',
 'enum': ['GENERIC BUNKER C',
  'GENERIC DIESEL',
  'GENERIC FUEL OIL No. 6',
  'GENERIC FUEL OIL No.2',
  'GENERIC GASOLINE',
  'GENERIC HEAVY CRUDE',
  'GENERIC HEAVY FUEL OIL',
  'GENERIC HOME HEATING OIL',
  'GENERIC INTERMEDIATE FUEL OIL 180',
  'GENERIC INTERMEDIATE FUEL OIL 300',
  'GENERIC LIGHT CRUDE',
  'GENERIC MEDIUM CRUDE',
  'AASGARD A 2003',
  'AASGARD BLEND, STATOIL',
  'AASTA HANSTEEN BLEND 2020',
  'ABOOZAR',
  'ABU AL BU KHOOSH',
  'ABU SAFAH, ARAMCO',
  'ADGO',
  'AGBAMI, STATOIL',
  'AIRILE, BP',
  'AL RAYYAN, BP',
  'ALASKA NORTH SLOPE',
  'ALASKA NORTH SLOPE',
  'ALASKA NORTH SLOPE (MIDDLE PIPELINE)',
  'ALASKA NORTH SLOPE (NORTHERN PIPELINE)',
  'ALASKA NORTH SLOPE (SOCSEX)',
  'ALASKA NORTH SLOPE (SOUTHERN PIPELINE)',
  'ALASKA NORTH SLOPE 2019',
  'ALASKA NORTH SLOPE, BP',
  'ALASKA NORTH SLOPE, OIL & GAS',
  'ALASKA NORTH SLOPE-PUMP STATION #9, BP',
  'ALBA',
  'ALBA',
  'ALBERTA',
```

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```
 'ALBERTA SWEET MIXED BLEND',
 'ALBERTA SWEET MIXED BLEND (PETAWAWA)',
 'ALBERTA SWEET MIXED BLEND (REFERENCE #2)',
 'ALBERTA SWEET MIXED BLEND (REFERENCE #3)',
 'ALGERIAN BLEND',
 'ALGERIAN CONDENSATE, CITGO',
 'ALGERIAN CONDENSATE, SHELL OIL',
 'ALGERIAN CONDENSATE, STATOIL',
 'ALPINE',
 'ALPINE SALES OIL',
 'ALTA 2016',
 'ALVE 2010',
 'ALVE 2014',
 'ALVHEIM BLEND 2009',
 'ALVHEIM BOA 2009',
 'ALVHEIM KAMELEON 2009',
 'ALVHEIM KNELER 2009',
 'AMAULIGAK',
 'AMAULIGAK',
 'AMNA',
 'ANTAN, HUVENSA',
 'ARABIAN',
 'ARABIAN EXTRA LIGHT, ARAMCO',
 'ARABIAN EXTRA LIGHT, BOUCHARD',
 'ARABIAN EXTRA LIGHT, MOBIL OIL AUSTRALIA',
 'ARABIAN EXTRA LIGHT, PHILLIPS',
 'ARABIAN EXTRA LIGHT, STAR ENTERPRISE',
 'ARABIAN HEAVY',
 'ARABIAN HEAVY, AMOCO',
 'ARABIAN HEAVY, ARAMCO',
 'ARABIAN HEAVY, CITGO',
 'ARABIAN HEAVY, EXXON',
 'ARABIAN HEAVY, STAR ENTERPRISE',
 'ARABIAN LIGHT',
 'ARABIAN LIGHT',
 'ARABIAN LIGHT, ARAMCO',
 'ARABIAN LIGHT, CITGO',
 'ARABIAN LIGHT, OIL & GAS',
 'ARABIAN LIGHT, PHILLIPS',
 'ARABIAN LIGHT, SHELL OIL',
 'ARABIAN LIGHT, STAR ENTERPRISE',
 'ARABIAN MEDIUM',
 'ARABIAN MEDIUM, AMOCO',
 'ARABIAN MEDIUM, CHEVRON',
 'ARABIAN MEDIUM, EXXON',
 'ARABIAN MEDIUM, PHILLIPS',
 'ARABIAN MEDIUM, SHELL OIL',
 'ARABIAN MEDIUM, STAR ENTERPRISE',
 'ARDJUNA, SHELL REFINING PTY ',
 'ARGYL',
 'ARGYLL, OIL & GAS',
 'ARIMBI',
```

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```
 'ARUN CONDENSATE, SHELL OIL',
 'ASGARD, STATOIL',
 'ASHTART',
 'ATKINSON',
 'ATLA KONDENSAT 2013',
 'ATTAKA',
 'ATTAKA, SHELL REFINING PTY ',
 'AUK',
 'AUTOMOTIVE DIESEL FUEL, SHELL REFINING PTY ',
 'AUTOMOTIVE GASOLINE, EXXON',
 'AVALDSNES 2012',
 'AVALON',
 'AVALON',
 'AVIATION GASOLINE 100',
 'AVIATION GASOLINE 100LL, STAR ENTERPRISE',
 'AVIATION GASOLINE 80',
 'AVIATION GASOLINE 80',
 'AVIATION TURBINE FUEL, SHELL REFINING PTY ',
 'AZERI BTC, STATOIL',
 'AZERI LIGHT, STATOIL',
 'Aasgard Blend',
 'Access West Blend Winter',
 'Alaminos Canyon Block 25',
 'Alaska North Slope',
 'Alaska North Slope [2002]',
 'Alaska North Slope [2010]',
 'Alaska North Slope [2011]',
 'Alaska North Slope [2012]',
 'Alaska North Slope [2015]',
 'Alberta Sweet Mixed Blend #4',
 'Alberta Sweet Mixed Blend #5',
 'Amauligak',
 'Anadarko HIA-376',
 'Arabian Heavy [2004]',
 'Arabian Light [2002]',
 'Atkinson',
 'Azeri Light',
 'BACH HO',
 'BACH HO, SHELL REFINING PTY ',
 'BACHAGUERO, CITGO',
 'BACHAQUERO',
 'BACHAQUERO 17, EXXON',
 'BACHAQUERO, SHELL OIL',
 'BACHAQUERO-DELAWARE RIVER, CITGO',
 'BACHEQUERO HEAVY',
 'BACHEQUERO MEDIUM',
 'BADAK',
 'BADAK, SHELL OIL',
 'BAHIA',
 'BAHRGANSAR/NOWRUZ',
 'BAKR',
 'BALDER 2002',
```

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```
 'BALDER BLEND 2010',
 'BANOCO ABU SAFAH, ARAMCO',
 'BARROW ISLAND',
 'BARROW ISLAND, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'BARROW ISLAND, OIL & GAS',
 'BARROW, BP',
 'BASRAH',
 'BASRAH HEAVY',
 'BASRAH LIGHT',
 'BASRAH LIGHT, MOBIL OIL AUSTRALIA',
 'BASRAH MEDIUM',
 'BASRAH, EXXON',
 'BASRAH, OIL & GAS',
 'BASS STRAIT',
 'BCF 13',
 'BCF 17',
 'BCF 17, AMOCO',
 'BCF 22, CITGO',
 'BCF 24',
 'BEATRICE',
 'BEKAPAI',
 'BEKOK',
 'BEKOPAI, CALTEX',
 'BELAYIM',
 'BELAYIM (LAND)',
 'BELAYIM (MARINE)',
 'BELAYIM, OIL & GAS',
 'BELIDA',
 'BELIDA, BP',
 'BELIDA, CALTEX',
 'BELIDA, MOBIL OIL AUSTRALIA ',
 'BELIDA, OIL & GAS',
 'BELINDA, AMSA',
 'BELRIDGE HEAVY',
 'BENIN RIVER, CHEVRON',
 'BENT HORN',
 'BENT HORN A-02',
 'BERRI',
 'BERRI A-21, ARAMCO',
 'BERYL',
 'BETA',
 'BETA PRODUCTION, SHELL OIL',
 'BFC 21.9, CITGO',
 'BINTULU',
 'BLINA, BP',
 'BOLOBO',
 'BOMBAY HIGH',
 'BONITO P/L SOUR, SHELL OIL',
 'BONNY LIGHT',
 'BONNY LIGHT, CITGO',
 'BONNY LIGHT, SHELL OIL',
 'BONNY MEDIUM',
```

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```
 'BONNY MEDIUM, AMOCO',
 'BONNY MEDIUM, CITGO',
 'BONTANG MIX, BP',
 'BORHOLLA',
 'BOSCAN',
 'BOSCAN, AMOCO',
 'BOSCAN, OIL & GAS',
 'BOW RIVER BLENDED',
 'BOW RIVER HEAVY',
 'BOYLA CRUDE 2016',
 'BRAE',
 'BRAGE 2013',
 'BRASS RIVER',
 'BRASS RIVER, CITGO',
 'BRASS RIVER, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'BRASS RIVER, PHILLIPS',
 'BRASS RIVER, SHELL OIL',
 'BRASSE 2018',
 'BREAM 2011',
 'BREGA',
 'BREGA, ARCO',
 'BREIDABLIKK 2023',
 'BRENT',
 'BRENT BLEND',
 'BRENT MIX, EXXON',
 'BRENT SPAR',
 'BRENT, CITGO',
 'BRENT, OIL & GAS',
 'BRENT, PHILLIPS',
 'BRENT, SUN',
 'BRIGHT STOCK 145, STAR ENTERPRISE',
 'BRIGHT STOCK 150, STAR ENTERPRISE',
 'BRYNHILD CRUDE 2015',
 'BUCHAN',
 'BUNK FUEL OIL (IRVING WHALE)',
 'BUNKER C FUEL OIL',
 'BUNKER C FUEL OIL',
 'BUNKER C FUEL OIL (ALASKA)',
 'BUNKER C FUEL OIL (IRVING WHALE)',
 'BUNYU',
 'BURGAN',
 'Bakken',
 'Balder Blend',
 'Banyu Urip',
 'Basrah',
 'Basrah Heavy',
 'Bonga',
 'Brent Blend',
 'Bunker C - IFO-300 [1994]',
 'Bunker C [1987]',
 'CABINDA',
 'CABINDA BLEND, SHELL OIL',
```

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```
 'CABINDA, CITGO',
 'CABINDA, PHILLIPS',
 'CALIFORNIA (API 11)',
 'CALIFORNIA (API 15)',
 'CAMAR',
 'CANADON SECO',
 'CANDON SEC, PHILLIPS',
 'CANO LIMON',
 'CANO LIMON',
 'CANO LIMON, CITGO',
 'CANO LIMON, PHILLIPS',
 'CARPINTERIA',
 'CATALYTIC CRACKING FEED',
 'CAURUS 2011',
 'CEUTA',
 'CHALLIS, BHP PETROLEUM',
 'CHAMPION EXPORT',
 'CHERVIL, NOVUS WA PTY LTD',
 'CINTA',
 'CINTA, SHELL REFINING PTY ',
 'CLOV',
 'CLOV, STATOIL',
 'COAL OIL POINT SEEP OIL',
 'COBAN BLEND',
 'COBAN BLEND, PHILLIPS',
 'COGNAC-BLOCK 194, SHELL OIL',
 'COHASSET',
 'COHASSET',
 'COLD LAKE BITUMEN',
 'COLD LAKE BLEND',
 'COLD LAKE BLEND, ESSO',
 'COLD LAKE DILUENT, ESSO',
 'COLD LAKE, EXXON',
 'CONDENSATE (SWEET), ENCANA CORP.',
 'COOK INLET, DRIFT RIVER TERMINAL',
 'COOPER BASIN',
 'COOPER BASIN FULL RANGE NAPHTHA, SANTOS LTD',
 'COOPER BASIN HEAVY NAPHTHA, SANTOS LTD',
 'COOPER BASIN LIGHT NAPHTHA, SANTOS LTD',
 'COOPER BASIN, SANTOS LTD',
 'CORMORANT',
 'CORMORANT NORTH',
 'CORMORANT SOUTH',
 'COSSACK',
 'CRACKER FEED, MOBIL OIL AUSTRALIA ',
 'CUSIANA',
 'CUSIANA',
 'CUSIANA, MOTIVA ENTERPRISES LLC',
 'CYRUS, ITOPF',
 'Chayvo',
 'Cold Lake Blend',
 'Cold Lake Blend Summer [2014]',
```

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```
 'Cold Lake Blend Winter [2013]',
 'Cold Lake Blend Winter [2015]',
 'Cook Inlet [2003]',
 'Curlew',
 'DAI HUNG',
 'DALIA, STATOIL',
 'DAN',
 'DANISH NORTH SEA',
 'DANMARK',
 'DAQIN',
 'DESTIN DOME CIS, MMS',
 'DF2 SUMMER (DIESEL), TESORO',
 'DF2 WINTER (DIESEL), TESORO',
 'DIA HUNG, OIL & GAS',
 'DIESEL',
 'DIESEL FUEL OIL (ALASKA)',
 'DIESEL FUEL OIL (CANADA)',
 'DIESEL FUEL OIL (SOUTHERN USA 1994)',
 'DIESEL FUEL OIL (SOUTHERN USA 1997)',
 'DIESEL FUEL OIL NO.2 (BONDED), TESORO',
 'DIESEL/HEATING OIL NO.2, CHEVRON',
 'DJENO BLEND',
 'DJENO, PHILLIPS',
 'DJENO, SHELL OIL',
 'DOBA',
 'DORROOD',
 'DOS CUADRAS',
 'DRAUGEN 2008',
 'DRIVIS 2017',
 'DUAL PURPOSE KEROSINE,  MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'DUBAI',
 'DUBAI, CITGO',
 'DUBAI, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'DUGONG 2022',
 'DUKHAN',
 'DUNLIN',
 'DURI, OIL & GAS',
 'DURI, PHILLIPS',
 'DUVA 2021',
 'DVALIN 2020',
 'Dalia',
 'Diesel [2002]',
 'Doba Blend',
 'Dos Cuadros HE-05 [2011]',
 'Dos Cuadros HE-26 [2011]',
 'EAGLE FORD SHALE',
 'EAST SPAB, MOBIL OIL AUSTRALIA',
 'EAST TEXAS',
 'EAST ZEIT MIX',
 'EC 195-CONDENSATE, PHILLIPS',
 'EKOFISK',
 'EKOFISK',
```

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```
 'EKOFISK 2002',
 'EKOFISK BLEND 2002',
 'EKOFISK BLEND 2015',
 'EKOFISK J 2015',
 'EKOFISK, OIL & GAS',
 'ELDFISK 2002',
 'ELDFISK B 2015',
 'ELDFISK BLEND 2015',
 'ELDFISK KOMPLEKS 2015',
 'ELECTRICAL INSULATING OIL (VIRGIN)',
 'ELECTRICAL INSULATING OIL (VOLTESSO 35)',
 'ELLI 1999',
 'ELLI SOUTH 1999',
 'EMBLA 2002',
 'EMERALD',
 'EMPIRE',
 'EMPIRE ISLAND, AMOCO',
 'ENDICOTT',
 'EOCENE',
 'ERAWAN CONDENSATE, SHELL OIL',
 'ERAWAN, MOBIL OIL AUSTRALIA ',
 'ES SIDER',
 'ESCALANTE',
 'ESCALANTE, ITS',
 'ESCALANTE, PHILLIPS',
 'ESCRAVOS',
 'ESCRAVOS SWAMP BLEND, CHEVRON',
 'ESCRAVOS, AMOCO',
 'ESCRAVOS, CHEVRON',
 'ESCRAVOS, OIL & GAS',
 'ESCRAVOS, SHELL OIL',
 'ESPOIR',
 'ETCHEGOIN, SHELL OIL',
 'EUGENE ISLAND BLOCK 32',
 'EUGENE ISLAND BLOCK 43',
 'EVERDELL',
 'Ebok',
 'Ekofisk',
 'Endicott',
 'Erha',
 'FAO, CITGO',
 'FCC FEED',
 'FCC HEAVY CYCLE OIL',
 'FCC MEDIUM CYCLE OIL',
 'FCC VGO',
 'FEDERATED',
 'FEDERATED (1994)',
 'FEDERATED (1998)',
 'FEDERATED (SOCSEX)',
 'FEDERATED LIGHT AND MEDIUM',
 'FENJA (PIL) 2015',
 'FLOTTA',
```

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```
 'FLOTTA',
 'FLOTTA MIX',
 'FLOTTA, CITGO',
 'FLOTTA, OIL & GAS',
 'FLOTTA, PHILLIPS',
 'FLOTTA, SHELL OIL',
 'FLUID CATALYTIC CRACKER FEED',
 'FLUID CATALYTIC CRACKER HEAVY CYCLE OIL',
 'FLUID CATALYTIC CRACKER LIGHT CYCLE OIL',
 'FLUID CATALYTIC CRACKER MEDIUM CYCLE OIL',
 'FLUID CATALYTIC CRACKER VIRGIN GAS OIL',
 'FOGELBERG CONDENSATE 2021',
 'FORCADOS',
 'FORCADOS BLEND',
 'FORCADOS, AMOCO',
 'FORCADOS, BP',
 'FORCADOS, CITGO',
 'FORCADOS, SHELL OIL',
 'FORKED ISLAND TERMINAL, AMOCO',
 'FOROOZAN',
 'FORSETI 2002',
 'FORTIES',
 'FORTIES BLEND',
 'FORTIES, OIL & GAS',
 'FORTIES, SHELL OIL',
 'FORTIES, STATOIL',
 'FOSSEKALL 2013',
 'FOSTERTON',
 'FRAM 2013',
 'FROSK 2020',
 'FROY 1996',
 'FUEL OIL NO.1 (AVJET A), STAR ENTERPRISE',
 'FUEL OIL NO.1 (DIESEL/HEATING FUEL), PETRO STAR',
 'FUEL OIL NO.1 (JET B, ALASKA)',
 'FUEL OIL NO.1 (JET FUEL A)',
 'FUEL OIL NO.1 (JET FUEL A-1)',
 'FUEL OIL NO.1 (JET FUEL B)',
 'FUEL OIL NO.1 (JP-4)',
 'FUEL OIL NO.1 (JP-6)',
 'FUEL OIL NO.1 (KEROSENE) ',
 'FUEL OIL NO.2 (DIESEL), STAR ENTERPRISE',
 'FUEL OIL NO.2 (HIGH AROMATIC CONTENT HEATING OIL)',
 'FUEL OIL NO.2 (HO/DIESEL), EXXON',
 'FUEL OIL NO.2, AMOCO',
 'FUEL OIL NO.6',
 'FULMAR',
 'FURRIAL, CITGO',
 'FURRIAL, SHELL OIL',
 'FURRIAL/MESA 28, EXXON',
 'Forties Blend',
 'Fuel Oil # 5',
 'GALEOTA MIX',
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 'GALEOTA MIX, AMOCO',
 'GAMBA',
 'GARANTIANA 2013',
 'GARDEN BANKS BLOCK 387',
 'GARDEN BANKS BLOCK 426',
 'GAS OIL 10 ppm S 2017',
 'GAS OIL, EXXON',
 'GAS OIL, TESORO',
 'GASOLINE (UNLEADED), SHELL',
 'GASOLINE BLENDING STOCK (ALKYLATE), EXXON',
 'GASOLINE BLENDING STOCK (REFORMATE), EXXON',
 'GAUPE 2011',
 'GENESIS',
 'GIMBO, STATOIL',
 'GINA KROG CRUDE 2018',
 'GIPPSLAND',
 'GIPPSLAND MIX, ITOPF',
 'GIPPSLAND, AMSA',
 'GIPPSLAND, BHP PETROLEUM',
 'GIPPSLAND, EXXON',
 'GIPPSLAND, SHELL OIL',
 'GIPPSLAND, SHELL REFINING PTY ',
 'GIRASSOL',
 'GIRASSOL, STATOIL',
 'GJOA 2011',
 'GLITNE 2002',
 'GOLIAT BLEND 50/50 2008',
 'GOLIAT BLEND 70/30 2008',
 'GOLIAT KOBBE 2008',
 'GOLIAT REALGRUNNEN 2001',
 'GOLIAT REALGRUNNEN 2008',
 'GORM',
 'GRANE 1997',
 'GRANITE POINT',
 'GREEN CANYON BLOCK 109',
 'GREEN CANYON BLOCK 184',
 'GREEN CANYON BLOCK 65',
 'GREEN CANYON, SHELL OIL',
 'GRIFFIN',
 'GRIFFIN, AMSA',
 'GRIFFIN, BHP PETROLEUM',
 'GRIFFIN, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'GROSBEAK 2012',
 'GUAFITA, CITGO',
 'GUDRUN 2012',
 'GUDRUN 2019',
 'GULF ALBERTA LIGHT AND MEDIUM',
 'GULF OF SUEZ MIX',
 'GULF OF SUEZ, PHILLIPS',
 'GULLFAKS',
 'GULLFAKS A BLEND 2010',
 'GULLFAKS C BLEND 2010',
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 'GULLFAKS SOR 1996',
 'GULLFAKS, EXXON',
 'GULLFAKS, OIL & GAS',
 'GYDA 2002',
 'Gail Well E010',
 'Gail Well E019',
 'Gindungo',
 'Gippsland Blend',
 'Girassol',
 'Gorgon',
 'Grane',
 'Green Canyon Block 200',
 'Gudrun Blend',
 'Gullfaks Blend',
 'HANDIL',
 'HANDIL, BP',
 'HANDIL, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'HARDING, SHELL OIL',
 'HARRIET, APACHE ENERGY LTD',
 'HAVIS 2013',
 'HEAVY CAT CYCLE OIL, EXXON',
 'HEAVY DISTILLATE MARINE ECA 50 2017',
 'HEAVY LAKE MIX',
 'HEAVY REFORMATE',
 'HEBRON',
 'HEIDRUN',
 'HEIDRUN AaRE 2004',
 'HEIDRUN EXPORT BLEND 2004',
 'HEIDRUN TILJE 2004',
 'HFO 6303 [2002]',
 'HI 317, PHILLIPS',
 'HI 330/349 CONDENSATE, PHILLIPS',
 'HI 561-GRAND CHENIER, PHILLIPS',
 'HI A-310-B/CONDENSATE, PHILLIPS',
 'HIBERNIA',
 'HIBERNIA (EPA 86)',
 'HIBERNIA BLEND, STATOIL',
 'HIGH ISLAND BLOCK 154, PHILLIPS',
 'HIGH ISLAND SWEET, SHELL OIL',
 'HIGH ISLAND, AMOCO',
 'HIGH VISCOSITY FUEL OIL',
 'HOME HEATING OIL',
 'HONDO BLEND',
 'HONDO MONTEREY',
 'HONDO SANDSTONE',
 'HOOPS BLEND, ExxonMobil',
 'HOOPS Blend',
 'HOUT',
 'HUIZHOU',
 'HULDRA KONDENSAT 1998',
 'HUNGO BLEND, STATOIL',
 'HUNTINGTON BEACH, SHELL OIL',
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 'HUTTON',
 'HYDRA',
 'Harmony',
 'Hebron',
 'Hebron M-04 [2005]',
 'Hebron [2018]',
 'Heritage HE 05',
 'Heritage HE 26',
 'Hibernia Blend',
 'Hibernia [1999]',
 'Hibernia [2018]',
 'Hungo Blend',
 'Husky Energy SGS',
 'IF-30 FUEL OIL',
 'IF-30 FUEL OIL (SVALBARD)',
 'IF-30 FUEL OIL 180',
 'IFO 180',
 'IFO 180',
 'IFO 300',
 'IFO-180LS 2014',
 'IFO-180NS 2014',
 'IFO-380LS 2014',
 'IFO-80LS 2014',
 'IMA, CALTEX',
 'INTERMEDIATE FUEL OIL 180 (SOCSEX)',
 'INTERMEDIATE FUEL OIL 300',
 'INTERMEDIATE FUEL OIL 300 (SOCSEX)',
 'INTERPROVINCIAL',
 'IPPL LIGHT SOUR BLEND',
 'IRANIAN HEAVY',
 'IRANIAN LIGHT',
 'IRIS CONDENSATE 2020',
 'ISSUNGNAK',
 'ISTHMUS',
 'ISTHMUS, CITGO',
 'ISTHMUS, PHILLIPS',
 'ISTHMUS, SHELL OIL',
 'ISTHMUS/MAYA BLEND',
 'ISTHMUS/REFORMA/CACTUS, API',
 'IVAR AASEN 2012',
 'Independent Hub',
 'Issungnak',
 'JABIRU 1A, BHP PETROLEUM',
 'JABIRU, BHP PETROLEUM',
 'JABIRU, SHELL OIL',
 'JACKSON, BP',
 'JATIBARANG',
 'JET A-1,  MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'JET B',
 'JET B (ALASKA)',
 'JET FUEL, TESORO',
 'JOBO',
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 'JOBO/MORICHAL, ITOPF',
 'JORDBAER 2011',
 'JOTUN, OIL & GAS JOURNAL',
 'JP-4',
 'JP-5',
 'JP-8',
 'JP-8',
 'Jotun Blend',
 'KABINDA, GALLAGER MARINE',
 'KERAPU, BP',
 'KERN COUNTY BLEND',
 'KERN RIVER-SWEPI, SHELL OIL',
 'KHAFJI',
 'KHAFJI,  MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'KHAFJI, BP',
 'KHALDA',
 'KIMKOL',
 'KIRKUK',
 'KIRKUK BLEND',
 'KIRKUK, EXXON',
 'KIRKUK, OIL & GAS',
 'KIRKUK, SHELL OIL',
 'KITTIWAKE',
 'KOAKOAK',
 'KOAKOAK 0-22',
 'KOAKOAK 0-22A',
 'KOLE MARINE BLEND',
 'KOLE MARINE, AMOCO',
 'KOLE, SHELL OIL',
 'KOME',
 'KOMINEFT',
 'KOPANOAR',
 'KOPANOAR 2I-44',
 'KOPANOAR M-13',
 'KOPANOAR M-13A',
 'KRISTIN 2006',
 'KUKAPU, CALTEX',
 'KUPARUK',
 'KUTUBU',
 'KUTUBU LIGHT, BHP PETROLEUM',
 'KUTUBU LIGHT, MOBIL OIL AUSTRALIA ',
 'KUTUBU, AMSA',
 'KUTUBU, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'KUTUBU, SHELL OIL',
 'KUWAIT',
 'KUWAIT',
 'KUWAIT CRUDE OIL (LITERATURE VALUES)',
 'KUWAIT EXPORT, OIL & GAS',
 'KUWAIT LIGHT, PHILLIPS',
 'KUWAIT, ARCO',
 'KUWAIT, BP',
 'KVITEBJORN 2009',
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 'KVITEBJORN 2019',
 'Kearl',
 'Kissanje Blend',
 'Kutubu',
 'LA ROSA',
 'LA ROSA MEDIUM, OIL & GAS',
 'LABUAN BLEND',
 'LABUAN, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'LAGO',
 'LAGO MEDIO',
 'LAGO TRECO',
 'LAGO TRECO, CITGO',
 'LAGOCINCO, SHELL OIL',
 'LAGOMAR, SHELL OIL',
 'LAGOMEDIO',
 'LAGOTRECO',
 'LAGOTRECO, SHELL OIL',
 'LAGUNA',
 'LAGUNA 22, CITGO',
 'LAGUNA BLEND 24, CITGO',
 'LAGUNA, CITGO',
 'LALANG',
 'LALANG, SHELL REFINING PTY ',
 'LARG TRECO MEDIUM, CITGO',
 'LAVRANS 1997',
 'LEDUC WOODBEND',
 'LEONA',
 'LEONA, CITGO',
 'LIGHT CAT CYCLE OIL, EXXON',
 'LIGHT LOUISIANNA SWEET, BP',
 'LIGHT NAPHTHA, EXXON',
 'LIGHT SOUR BLEND',
 'LILLE PRINSEN 2022',
 'LILLEFRIGG KONDENSAT 1996',
 'LINERLE 2005',
 'LISBURNE',
 'LIUHUA, AMOCO',
 'LIVERPOOL BAY',
 'LLOYDMINSTER',
 'LLOYDMINSTER, OIL & GAS',
 'LLOYDMINSTER, SHELL OIL',
 'LOKELE, CITGO',
 'LOKELE, EXXON',
 'LOKELE, SHELL OIL',
 'LORETO',
 'LORETO, SHELL OIL',
 'LOUISIANA',
 'LOW SULFUR VACUUM GAS OIL, CHEVRON',
 'LOW SULFUR WAXY GAS OIL',
 'LOW SULFUR WAXY RESIDUE, AMSA',
 'LOW SULFUR WAXY RESIDUUM',
 'LUBRICATING OIL (AIR COMPRESSOR) NEW',
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 'LUBRICATING OIL (AIR COMPRESSOR) USED',
 'LUBRICATING OIL (AUTO ENGINE OIL, VIRGIN)',
 'LUCINA MARINE',
 'LUCINA, SHELL OIL',
 'LUCKENBACH FUEL OIL',
 'LUCULA',
 'LUFENG, STATOIL',
 'LUNO 2011',
 'LUNO II 2014',
 'Liza',
 'MAGNUS',
 'MAIN PASS 140, PENNZOIL',
 'MAIN PASS 49 CONDENSATE, SHELL OIL',
 'MAIN PASS BLOCK 306',
 'MAIN PASS BLOCK 37',
 'MALONGO',
 'MANDJI',
 'MANDJI, SHELL OIL',
 'MARALAGO 22, CITGO',
 'MARGHAM',
 'MARGHAM LIGHT',
 'MARGHAM, BP',
 'MARIA 2013',
 'MARIB, PHILLIPS',
 'MARINE DIESEL F-76, MANCHESTER FUEL',
 'MARINE DIESEL FUEL OIL',
 'MARINE DIESEL FUEL OIL',
 'MARINE DIESEL, U.S. NAVY',
 'MARINE GAS OIL 500 ppm S 2017',
 'MARINE INTERMEDIATE FUEL OIL',
 'MARJAN/ZULUF, ARAMCO',
 'MARS BLEND',
 'MARS TLP',
 'MARTIN LINGE CONDENSATE 2016',
 'MARTIN LINGE CRUDE 2016',
 'MARULK 2014',
 'MAUI B, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MAUI F SAND, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MAUI, SHELL REFINING PTY ',
 'MAUREEN',
 'MAYA',
 'MAYA (1997)',
 'MAYA, AMOCO',
 'MAYA, CITGO',
 'MAYA, EXXON',
 'MAYA, OIL & GAS',
 'MAYA, PHILLIPS',
 'MAYA, SHELL OIL',
 'MAYOGIAK',
 'MCARTHUR RIVER',
 'MCKEE BLEND 10% NGAT-1, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MCKEE BLEND 10% NGAT-2, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
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 'MCKEE BLEND 10% NGAT-3, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MCKEE BLEND 25%, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MCKEE BLEND 50%, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MCKEE BLEND, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MCKEE, SHELL REFINING PTY ',
 'MEDANITO',
 'MEDANITO, OIL & GAS',
 'MENEMOTA',
 'MENEMOTA, CITGO',
 'MEREY',
 'MEREY, OIL & GAS',
 'MESA 28, CITGO',
 'MESA 30, CITGO',
 'MIANDOUM',
 'MIDDLE GROUND SHOAL',
 'MIDGARD 2003',
 'MILNE POINT',
 'MINAS, SHELL REFINING PTY ',
 'MINERAL TURPS, SHELL REFINING PTY ',
 'MIRI LIGHT',
 'MIRI LIGHT, BP',
 'MIRI LIGHT, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MISSISSIPPI CANYON BLOCK 194',
 'MISSISSIPPI CANYON BLOCK 72',
 'MIX GEISUM, GEISUM OIL',
 'MONTEREY, TORCH',
 'MONTROSE',
 'MORICHAL',
 'MORVIN 2008',
 'MOTOR GASOLINE-LEADED, SHELL REFINING PTY ',
 'MOTOR GASOLINE-PREMIUM UNLEADED, SHELL REFINING PTY ',
 'MOTOR GASOLINE-UNLEADED, SHELL REFINING PTY ',
 'MOUSSE MIX (PETAWAWA)',
 'MTBE, EXXON',
 'MUBAREK',
 'MURBAN',
 'MURBAN, MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'MURBAN, OIL & GAS',
 'MURBAN, SHELL OIL',
 'MURBAN, SHELL REFINING PTY ',
 'MURCHISON',
 'MV Arrow [2015]',
 'Marib Light',
 'Marine Diesel [2018]',
 'Mars TLP [2000]',
 'Maya [2004]',
 'Mondo',
 'Morpeth Block EW921',
 'Mostarda',
 "N'KOSSA EXP BLEND, CHEVRON",
 'NANNAI LIGHT, BP',
 'NAPHTHA CRACKING FRACTION, EXXON',
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 'NAPHTHA N+A, MAPCO',
 'NAPHTHA, EXXON',
 'NAPO',
 'NEKTORALIK K-59',
 'NEKTORALIK K-59A',
 'NEMBA, GALLAGER MARINE',
 'NEPTUNE SPAR',
 'NERLERK',
 'NERLERK M-98B',
 'NERLERK M-98C',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #1',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #12',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #15',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #4',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #5',
 'NEWFOUNDLAND OFFSHORE BURN EXP SAMPLE #7',
 'NEWFOUNDLAND OFFSHORE BURN EXPERIMENT',
 'NIGERIAN EXP. B1',
 'NIGERIAN LGT G',
 'NIGERIAN LGT M',
 'NIGERIAN LIGHT',
 'NIGERIAN MEDIUM',
 'NIKISKI',
 'NINIAN',
 'NINIAN BLEND',
 'NINIAN BLEND',
 'NINIAN, CITGO',
 'NJORD 1997',
 'NJORD 2002',
 'NJORD 2003',
 'NKOSSA, SHELL REFINING PTY ',
 'NORMAN WELLS',
 'NORNE 2010',
 'NORNE BLEND 2010',
 'NORNE CRUDE 2017',
 'NORTH EAST TEXAS',
 'NORTH GEISUM, GEISUM OIL',
 'NORTH SLOPE',
 'NORTH SLOPE, CITGO',
 'NORTH SLOPE, PHILLIPS',
 'NORTHSTAR',
 'NORTHWEST CHARGE STOCK, CHEVRON',
 'NOWRUZ',
 'NSW CONDENSATE, AMSA',
 'Neptune BHP [2009]',
 'Norman Wells',
 'North Star',
 'ODA 2019',
 'ODUDU, EXXON',
 'OFELIA 2023',
 'OGUENDJO, AMOCO',
 'OLMECA, CITGO',
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 'OLMECA, OIL & GAS',
 'OLMECA, SHELL OIL',
 'OMAN',
 'OMAN EXPORT',
 'OMAN,  MARITIME SAFETY AUTHORITY OF NEW ZEALAND',
 'OMAN, PHILLIPS',
 'OMAN, SHELL OIL',
 'OMAN, SHELL REFINING PTY ',
 'OQUENDJO',
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 'ORIENTE',
 'ORIENTE, CITGO',
 'ORIENTE, OIL & GAS',
 'ORIENTE, SHELL OIL',
 'ORIMULSION',
 'ORIMULSION-100',
 'ORMEN LANGE KONDENSAT 2008',
 'OSEBERG',
 'OSEBERG',
 'OSEBERG A 2013',
 'OSEBERG BLEND 2007',
 'OSEBERG C 1995',
 'OSEBERG C 2013',
 'OSEBERG OST 1998',
 'OSEBERG OST 2013',
 'OSEBERG SOR 2000',
 'OSEBERG SOR 2013',
 'OSEBERG, EXXON',
 'OSEBERG, OIL & GAS',
 'OSELVAR 2012',
 'Odoptu',
 'Ormen Lange',
 'Oseberg Blend',
 'Oso Condensate',
 'PALANCA',
 'PALANCA, SHELL OIL',
 'PANUCO',
 'PANUKE',
 'PANUKE',
 'PARENTIS',
 'PECAN ISLAND, AMOCO',
 'PECAN ISLAND, SHELL OIL',
 'PEMBINA',
 'PENNINGTON',
 'PIERCE, OIL & GAS JOURNAL',
 'PILON',
 'PILON, CITGO',
 'PILON-ANACO WAX, CITGO',
 'PIPER',
 'PITAS POINT',
 'PITAS POINT',
 'PL COMPOSITE, STAR ENTERPRISE',
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 'PLATFORM B',
 'PLATFORM GAIL',
 'PLATFORM HOLLY',
 'PLATFORM IRENE',
 'POINT ARGUELLO COMINGLED',
 'POINT ARGUELLO HEAVY',
 'POINT ARGUELLO LIGHT',
 'PORT HUENEME',
 'POSIDEN, EQUILON',
 'POUI, AMOCO',
 'PREMIUM UNLEADED GASOLINE, STAR ENTERPRISE',
 'PROPYLENE TETRAMER',
 'PRUDHOE BAY',
 'PRUDHOE BAY (1995)',
 'PULAI',
 'Pazflor',
 'Petronius Block VK786A',
 'Platform Ellen A038',
 'Platform Ellen A040',
 'Platform Elly',
 'Platform Irene',
 'Platform Irene Comingled',
 'Prudhoe Bay [2004]',
 'QATAR LAND, MOBIL OIL AUSTRALIA ',
 'QATAR MARINE',
 'QATAR MARINE, MOBIL OIL AUSTRALIA',
 'QATAR NORTH FIELD CONDENSATE (NFR-1), MOBIL',
 'QATAR/DUKHAM, CHEVRON',
 'QUA IBOE',
 'QUA IBOE, PHILLIPS',
 'QUA IBOE, SHELL OIL',
 'Qua Iboe',
 'RABBI, COASTAL EAGLE POINT OIL',
 'RABI BLEND, SHELL OIL',
 'RABI, MOTIVA ENTERPRISES LLC',
 'RABI-KOUNGA, SHELL OIL',
 'RAGUSA',
 'RAINBOW LIGHT AND MEDIUM, OIL & GAS',
 'RANGELAND-SOUTH LIGHT AND MEDIUM',
 'RANGELAND-SOUTH, OIL & GAS',
 'RANGELY',
 'RAS LANUF',
 'RATNA',
 'REDWATER',
 'RESIDUAL FUEL 900, TESORO',
 'RINCON DE LOS SAUCES',
 'RINCON DE LOS SAUCES, OIL & GAS',
 'RINGHORNE 2002',
 'RIO ZULIA',
 'ROSSIIELF, RUSSIAN JOINT STOCK CO',
 'ROSTAM',
 'ROTTERDAM DIESEL 2017',
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```
  'Rail Bitumen',
  'Rock',
  'SABLE ISLAND CONDENSATE',
  'SAHARAN BLEND',
  'SAHARAN BLEND ARZEW, SHELL OIL',
  'SAHARAN BLEND BEJAIA, SHELL OIL',
  'SAHARAN BLEND, OIL & GAS',
  'SAJAA CONDENSATE, BP',
  'SAKHALIN',
  'SAKHALIN II',
  'SALADIN',
  'SALAWATI',
  'SALMON',
  'SAN JOACHIM',
  'SANGA SANGA',
  'SANTA CLARA',
  'SANTA CRUZ',
  'SANTA MARIA',
  'SARIR',
  'SARIR, ITOPF',
  'SCHIEHALLION BLEND, STATOIL',
  'SCHOONEBEEK',
  'SCOTIAN LIGHT',
  'SENIPAH, CALTEX',
  'SEPINGGAN-YAKIN MIXED (4:1)',
  'SEPINGGAN-YAKIN MIXED, OIL & GAS',
  'SERIA LIGHT',
  'SF NORD BRENT 2021',
  'SHARJAH',
  ...],
 'default': 'GENERIC MEDIUM CRUDE',
 'level': 1,
 'description': 'Oil type to be used for the simulation, from the NOAA ADIOS database.',
 'value': 'GENERIC BUNKER C',
 'od_mapping': 'seed:oil_type',
 'ptm_level': 1}
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The drift_model-specific parameters chosen by the user and PTM for this simulation are:

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m.drift_model_config()
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[('environment:fallback:ocean_mixed_layer_thickness', 30),
 ('general:use_auto_landmask', False),
 ('drift:current_uncertainty', 0),
 ('general:coastline_action', 'previous'),
 ('seed:number', 10),
 ('drift:horizontal_diffusivity', 0),
 ('drift:wind_uncertainty', 0),
 ('seed:z', -10),
 ('seed:wind_drift_factor', 0.02),
 ('seed:oil_film_thickness', 1),
 ('drift:vertical_mixing', True),
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('vertical_mixing:timestep', 60),
('vertical_mixing:diffusivitymodel', 'windspeed_Large1994'),
('drift:wind_drift_depth', 0.02),
('drift:stokes_drift', True),
('general:seafloor_action', 'previous'),
('seed:seafloor', False),
('seed:m3_per_hour', 1),
('seed:droplet_size_distribution', 'uniform'),
('seed:droplet_diameter_mu', 0.001),
('seed:droplet_diameter_sigma', 0.0005),
('seed:droplet_diameter_min_subsea', 0.0005),
('seed:droplet_diameter_max_subsea', 0.005),
('processes:dispersion', True),
('processes:evaporation', True),
('processes:emulsification', True),
('processes:biodegradation', True),
('processes:update_oilfilm_thickness', True),
('seed:oil_type', 'GENERIC BUNKER C'),
('drift:vertical_advection', True),
('drift:truncate_ocean_model_below_m', None),
('drift:use_tabularised_stokes_drift', True),
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('lat', 28.08),
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('run_forward', True),
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('time_step_output', 3600),
('steps', 45),
('duration', Timedelta('0 days 03:45:00')),
('end_time', Timestamp('2009-11-19 15:45:00')),
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('ocean_model_local', False),
('do3D', True),
('use_static_masks', True),
('drift_model', 'OpenOil'),
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  'hatched',
  'length',
  'weight',
  'diameter',
  'neutral_buoyancy_salinity',
  'stage_fraction',
  'hatched',
```

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```
  'length',
  'weight',
  'diameter',
  'neutral_buoyancy_salinity',
  'stage_fraction',
  'hatched',
  'length',
  'weight',
  'diameter',
  'neutral_buoyancy_salinity',
  'stage_fraction',
  'hatched',
  'length',
  'weight',
  'mass_oil',
  'density',
  'mass_evaporated',
  'mass_dispersed',
  'mass_biodegraded',
  'viscosity',
  'water_fraction',
  'mass_oil',
  'density',
  'mass_evaporated',
  'mass_dispersed',
  'mass_biodegraded',
  'viscosity',
  'water_fraction']),
 ('radius', 1000.0),
 ('radius_type', 'gaussian'),
 ('log', 'low')]
```

Add reader and run

```
m.add_reader(ds=ds)
m.run_all()
```

```
18:18:13 INFO    opendrift:359: Since ocean_model is user-input, changing horizontal_
↪diffusivity parameter from None to 0.0.
                    You can also set it to a specific value with `m.horizontal_
↪diffusivity=[number]`.
```

```
18:18:13 INFO    opendrift:439: ocean_model is not one of ['NWGOA', 'CIOFS', 'CIOFSOP'].
```

```
18:18:13 INFO    opendrift:575: Using remote output for ocean_model user_input
```

```
18:18:13 INFO    opendrift:586: Retaining vertical velocity (w) because do3D is True
```

```
18:18:13 INFO    opendrift:603: Retaining wind variables because stokes_drift, wind_
↪drift_factor, wind_uncertainty, or vertical_mixing are on or drift_model is 'OpenOil'
```

```
18:18:13 INFO    opendrift:614: Retaining salt and temp variables because drift_model is␣
↪LarvalFish or OpenOil
```

```
18:18:13 INFO    opendrift:625: Retaining ice variables because drift_model is OpenOil
```

```
18:18:13 INFO    opendrift:634: Dropping wetdry masks because using static masks instead.
```

```
18:18:13 INFO    opendrift:754: setting reader start_time as simulation start_time
```

```
18:18:13 INFO    opendrift:769: Narrowed model output to simulation time
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:249: 'gls_cmu0'
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:250: Did not find complete set of␣
↪GLS parameters
```

```
18:18:13 WARNING opendrift.readers.basereader.structured:50: No proj string or␣
↪projection could be derived, using 'fakeproj'. This assumes that the variables are␣
↪structured and gridded approximately equidistantly on the surface (i.e. in meters).␣
↪This must be guaranteed by the user. You can get rid of this warning by supplying a␣
↪valid projection to the reader.
```

```
18:18:13 INFO    opendrift.readers.basereader.structured:83: Loading previously saved␣
↪interpolator for lon,lat to x,y conversion.
```

```
18:18:13 INFO    opendrift.models.openoil.openoil:1664: Using uniform droplet size␣
↪distribution between 0.0005 and 0.005 m for elements seeded below sea surface.
```

```
18:18:13 INFO    opendrift.models.openoil.adios.dirjs:90: Querying ADIOS database for␣
↪oil: GENERIC BUNKER C
```

```
18:18:13 INFO    opendrift.models.openoil.openoil:1721: Using density 971.1 and␣
↪viscosity 0.0005020658058702914 of oiltype GENERIC BUNKER C
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:247: Fallback values will be␣
↪used for the following variables which have no readers:
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         upward_sea_water_
↪velocity: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪significant_height: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_x_velocity: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪stokes_drift_y_velocity: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪period_at_variance_spectral_density_maximum: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_surface_wave_
↪mean_period_from_variance_spectral_density_second_frequency_moment: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_ice_area_
↪fraction: 0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_ice_x_velocity:␣
↪0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         sea_ice_y_velocity:␣
↪0.000000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         ocean_vertical_
↪diffusivity: 0.020000
```

```
18:18:13 INFO    opendrift.models.basemodel.environment:250:         ocean_mixed_layer_
↪thickness: 30.000000
```

```
18:18:13 INFO    opendrift:492: start_time: 2009-11-19 12:00:00, end_time: 2009-11-19␣
↪15:45:00, steps: 45.0, duration: 0 days 03:45:00
```

```
18:18:13 INFO    opendrift.models.basemodel:908: Using existing reader for land_binary_
↪mask
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:319: Using mask_rho for mask_rho
```

```
18:18:13 INFO    opendrift.models.basemodel:920: All points are in ocean
```

```
18:18:13 INFO    opendrift.models.openoil.openoil:691: Oil-water surface tension is 0.
↪035282 Nm
```

```
18:18:13 INFO    opendrift.models.openoil.openoil:704: Max water fraction not available␣
↪for GENERIC BUNKER C, using default
```

```
18:18:13 WARNING opendrift.models.basemodel:701: Seafloor check not being run because␣
↪sea_surface_height is missing. This will happen the first time the function is run but␣
↪if it happens subsequently there is probably a problem.
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:00:00 - step 1 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:370: Using zeta for sea surface␣
↪height
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:340: Using mask_u for mask_u
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:592: Time: 0:00:00.160282
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:361: Using mask_v for mask_v
```

```
18:18:13 INFO    opendrift.readers.reader_ROMS_native:384: Using angle from Dataset.
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:05:00 - step 2 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:10:00 - step 3 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:15:00 - step 4 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:20:00 - step 5 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:25:00 - step 6 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:13 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:30:00 - step 7 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:35:00 - step 8 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:40:00 - step 9 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:45:00 - step 10 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:50:00 - step 11 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 12:55:00 - step 12 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:00:00 - step 13 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:05:00 - step 14 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:10:00 - step 15 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:15:00 - step 16 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:20:00 - step 17 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:25:00 - step 18 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:30:00 - step 19 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:35:00 - step 20 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:40:00 - step 21 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:45:00 - step 22 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:50:00 - step 23 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 13:55:00 - step 24 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:00:00 - step 25 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:05:00 - step 26 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:10:00 - step 27 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:14 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:15:00 - step 28 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:20:00 - step 29 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:25:00 - step 30 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:30:00 - step 31 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:35:00 - step 32 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:40:00 - step 33 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:45:00 - step 34 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:50:00 - step 35 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 14:55:00 - step 36 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:00:00 - step 37 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:05:00 - step 38 of 45 -␣
↪10 active elements (0 deactivated)
```

```
18:18:15 WARNING opendrift.models.basemodel:2297: Missing variables: ['x_sea_water_
↪velocity', 'y_sea_water_velocity', 'land_binary_mask']
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:10:00 - step 39 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:15:00 - step 40 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:20:00 - step 41 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:25:00 - step 42 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:30:00 - step 43 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:35:00 - step 44 of 45 -␣
↪9 active elements (1 deactivated)
```

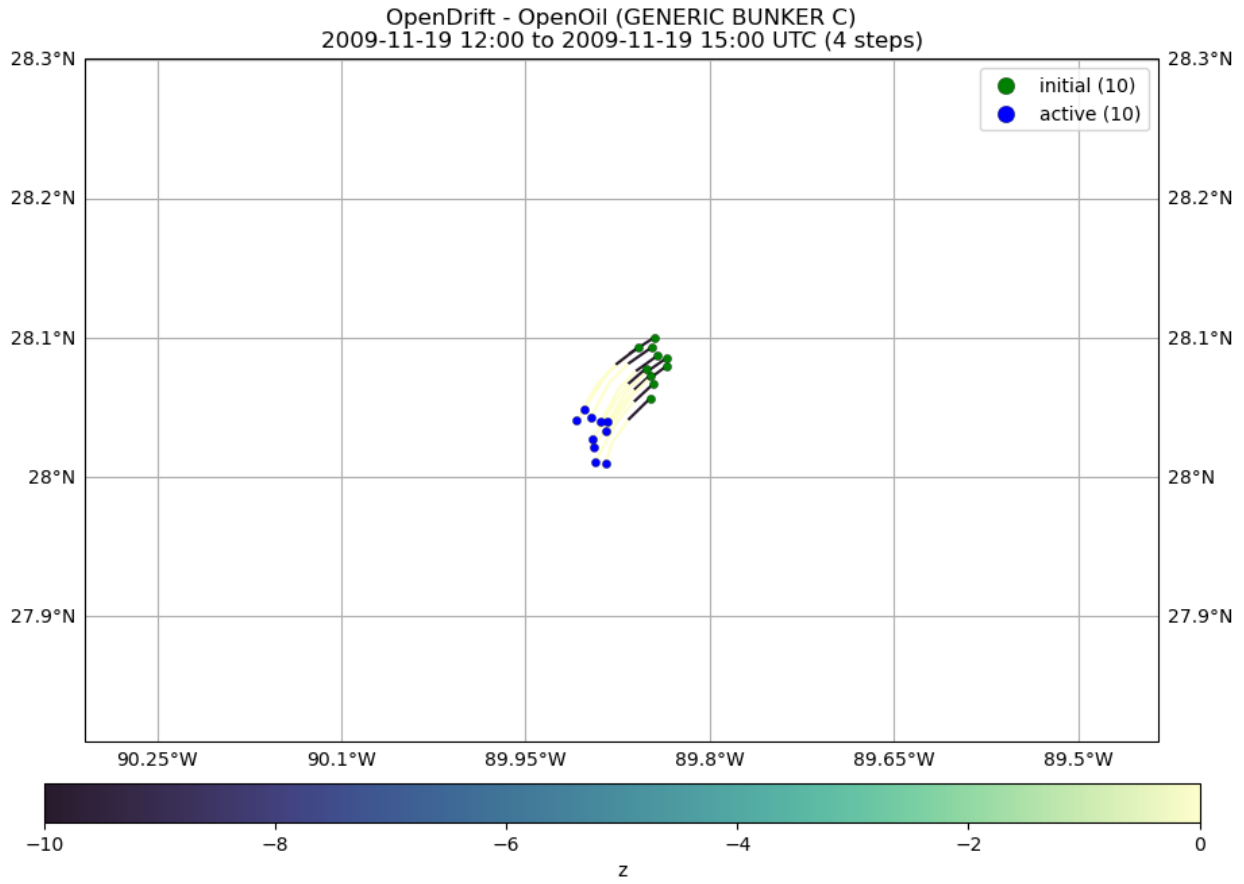
```
18:18:15 INFO    opendrift.models.basemodel:2011: 2009-11-19 15:40:00 - step 45 of 45 -␣
↪9 active elements (1 deactivated)
```

```
18:18:15 INFO    opendrift.export.io_netcdf:112: Wrote 4 steps to file None_initial
```

Plot

```
m.o.plot(linecolor="z", fast=True, cmap=cmo.deep_r)
```

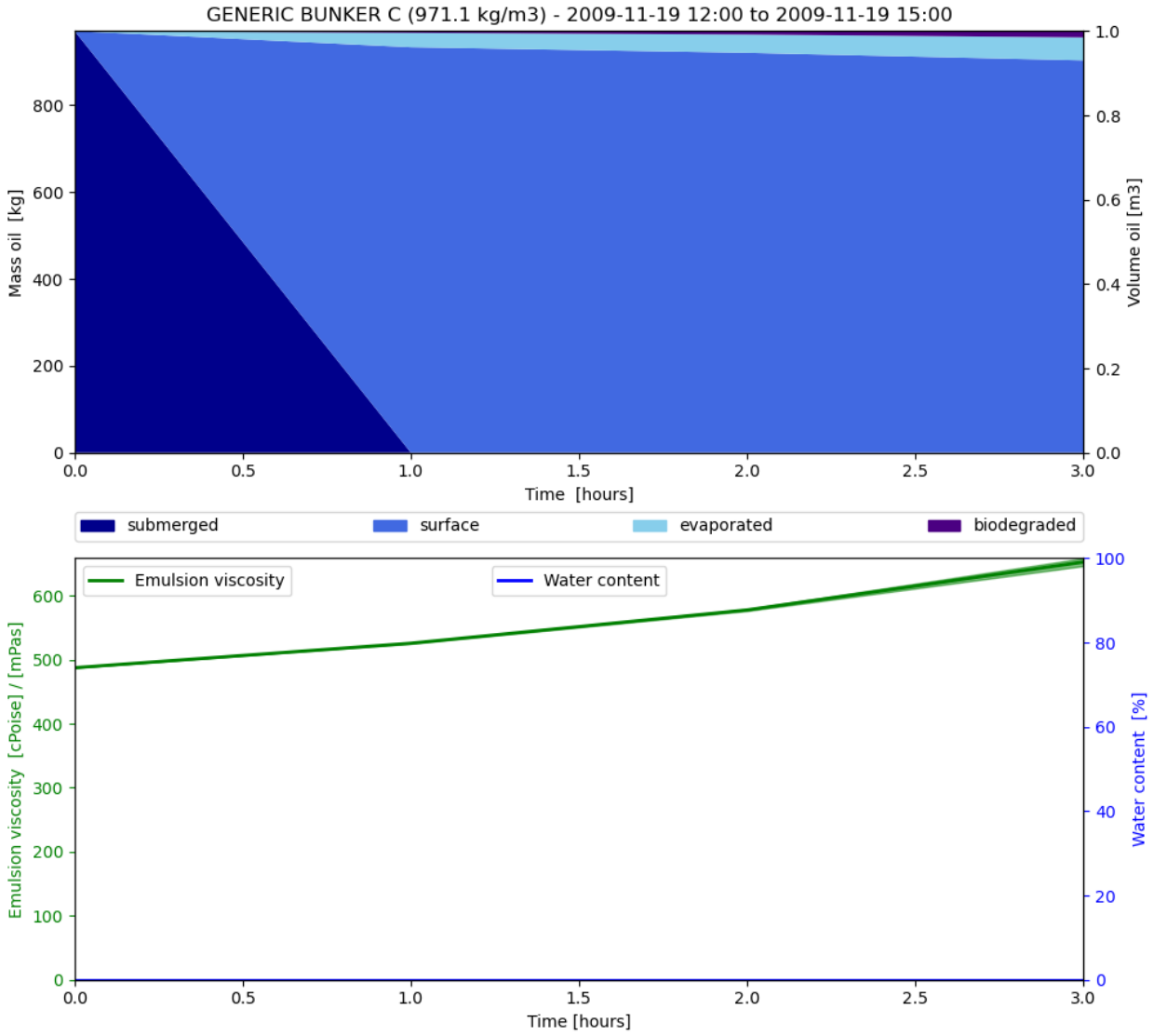
```
18:18:15 WARNING opendrift.models.basemodel:2378: Plotting fast. This will make your␣
↪plots less accurate.
```




```
(<GeoAxes: title={'center': 'OpenDrift - OpenOil (GENERIC BUNKER C)\n2009-11-19 12:00 to␣
↪2009-11-19 15:00 UTC (4 steps)'}>,
 <Figure size 1100x699.183 with 2 Axes>)
```

Plot the oil budget.

```
m.o.plot_oil_budget(show_wind_and_current=False)
```



1.3 Configuration and Setup Options

1.3.1 Configuration Overview

Where possible, configuration information includes items like default, input range or enum options, description, units, and value, and the configuration can be queried as demonstrated in these docs to get that information.

Configuration parameters are shown in `m.show_config()` for:

- the specified `drift_model` (from `m._config` which for OpenDriftModel points to `m.o._config`)
- configuration added from `ParticleTrackingManager` (`config_ptm`)
- configuration added from `OpenDriftModel` (as would also be true with any model included in the future) (`config_model`). This configuration includes parameters that point to configuration parameters from a different `drift_model` than a given instance of `OpenDriftModel` was initialized with, which leads to these parameters being present in `m.show_config()`. The following example shows a `Manager` `m` initialized with `drift_model=="OceanDrift"` but when queried for emulsification, the translated PTM parameter name for

the OpenDrift parameter `emulsification`, or `processes:emulsification` itself, they both show the configuration information added from OpenDriftModel:

```
m.show_config(key="emulsification")
{'default': True, 'od_mapping': 'processes:emulsification', 'ptm_level': 2, 'value':␣
↪True}

m.show_config(key="processes:emulsification")
{'default': True, 'od_mapping': 'processes:emulsification', 'ptm_level': 2, 'value':␣
↪True}
```

For comparison, if `drift_model=="OpenOil"` this would look like the following, in which the parameters contain more config information which came in from OpenDrift itself:

```
m = ptm.OpenDriftModel(drift_model="OpenOil")

m.show_config(key="emulsification")

{'type': 'bool',
 'default': True,
 'description': 'Surface oil is emulsified, i.e. water droplets are mixed into oil due␣
↪to wave mixing, with resulting increase of viscosity.',
 'level': 2,
 'value': True,
 'od_mapping': 'processes:emulsification',
 'ptm_level': 2}

m.show_config(key="processes:emulsification")

{'type': 'bool',
 'default': True,
 'description': 'Surface oil is emulsified, i.e. water droplets are mixed into oil due␣
↪to wave mixing, with resulting increase of viscosity.',
 'level': 2,
 'value': True,
 'od_mapping': 'processes:emulsification',
 'ptm_level': 2}
```

Show different sources of config

PTM-level config:

```
m.config_ptm
```

Model-level config:

```
m.config_model
```

Show OpenDrift config only. This is tricky because the configurations get mixed up together to keep all information consistent across parameters. The kludge way to show these is since all OpenDrift config parameter names have ":" in the name:

```
m.show_config(substring=":")
```

All config:

```
m.show_config()
```

Config for the specified OpenDrift drift_model; that is, the selections going into the OpenDrift simulation that were specified by PTM as opposed to using the defaults (though they might be the same as the OpenDrift defaults):

```
m.drift_model_config()
```

Showing Configuration Parameter Details

Show seed parameters that are in OpenDrift for `drift_model`:

```
m.show_config(prefix="seed", level=[1,2,3]).keys()
```

Show all possible configuration for the previously-selected `drift_model` (parameters that are not options will be included but will not have full config information):

```
m.show_config()
```

Show configuration with a specific prefix:

```
m.show_config(prefix="seed")
```

Show configuration matching a substring:

```
m.show_config(substring="stokes")
```

Show configuration at a specific level (from OpenDrift):

```
m.show_config(level=1)
```

Show all OpenDrift configuration:

```
m.show_config(level=[1,2,3])
```

Show configuration for only PTM-specified parameters:

```
m.show_config(ptm_level=[1,2,3])
```

Show configuration for a specific PTM level:

```
m.show_config(ptm_level=2)
```

Show configuration for a single key:

```
m.show_config("seed:oil_type")
```

Show all possible inputs to PTM:

```
m.show_config(ptm_level=[1,2,3], excludestring=":").keys()
```

1.3.2 Specific Configuration Options

This section is split into two: first options that are available to all models (thus are handled in the Manager) and those for `OpenDriftModel` (the only model option currently).

This is not currently a comprehensive list but a place where extra details are included that might not be clear or available elsewhere. For more information look at the configuration information (previous section) and the docstrings for each class.

Manager options, available to all models

Ocean Model

Setting up an ocean model is also referred to as `add_reader()`.

```
m.show_config(key="ocean_model")
```

The built-in ocean models are:

- NWGOA (1999–2008) over the Northwest Gulf of Alaska (Danielson, S. L., K. S. Hedstrom, E. Curchitser, 2016. Cook Inlet Model Calculations, Final Report to Bureau of Ocean Energy Management, M14AC00014, OCS Study BOEM 2015-050, University of Alaska Fairbanks, Fairbanks, AK, 149 pp.)
- CIOFS (1999–2022) across Cook Inlet, Alaska, a hindcast version of NOAA's CIOFS model. (Thyng, K. M., C. Liu, M. Feen, E. L. Dobbins, 2023. Cook Inlet Circulation Modeling, Final Report to Oil Spill Recovery Institute, Axiom Data Science, Anchorage, AK.)
- CIOFSOP (mid-2021 through 48 hours from present time) which is the nowcast/forecast version of the CIOFS model. (Shi, L., L. Lanerolle, Y. Chen, D. Cao, R. Patchen, A. Zhang, and E. P. Myers, 2020. NOS Cook Inlet Operational Forecast System: Model development and hindcast skill assessment, NOAA Technical Report NOS CS 40, Silver Spring, Maryland, September 2020.)

If you are running locally on an Axiom server you can use `ocean_model_local=True` to access the model output locally instead of remotely.

An alternative ocean model can be used instead by initializing the `Manager` then setting up the reader manually, as shown in a *Quick Start* example:

```
import particle_tracking_manager as ptm
import xroms

m = ptm.OpenDriftModel(lon=-90, lat=28.7, number=1, steps=2)
url = xroms.datasets.CLOVER.fetch("ROMS_example_full_grid.nc")
ds = xr.open_dataset(url, decode_times=False)
m.add_reader(ds=ds)
m.run_all()
```

To run an idealized scenario, no reader should be added (`ocean_model` should be left as None), then fallback configuration parameters (which are not surfaced specifically in `particle-tracking-manager`) can be manually changed, for example:

```
from datetime import datetime
m = ptm.OpenDriftModel(lon=4.0, lat=60.0, start_time=datetime(2015, 9, 22, 6),
                       use_auto_landmask=True, steps=5)

# idealized simulation, provide a fake current
```

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```
m.o.set_config('environment:fallback:y_sea_water_velocity', 1)

# seed
m.seed()

# run simulation
m.run()
```

For testing purposes, all steps can be run (including added a "reader") with the selections above plus including `ocean_model="test"`.

```
from datetime import datetime
m = ptm.OpenDriftModel(lon=4.0, lat=60.0, start_time=datetime(2015, 9, 22, 6),
                       use_auto_landmask=True, ocean_model="test", steps=5)

m.run_all()
```

OpenDriftModel options

Drift model

Though `OpenDrift` has more models available, the currently wrapped `drift_model` options in PTM are:

- OceanDrift: physics-only scenario (default)
- Leeway: scenario for Search and Rescue of various objects at the surface
- OpenOil: oil spill scenarios
- LarvalFish: scenario for fish eggs and larvae that can grow

Set these with e.g.:

```
m = ptm.OpenDriftModel(drift_model="OpenOil")
```

This selection sets some of the configuration details and export variables that are relevant for the simulation.

Export Variables

All possible variables will be exported by default into the outfiles and available in memory (`m.o.history` and `m.o.history_metadata` or `m.o.get_property(<key>)` for `OpenDriftModel`).

The full list of possible variables to be exported is available with

```
m.all_export_variables()
```

To limit the variables saved in the export file, input a list of just the variables that you want to save, keeping in mind that `['lon', 'lat', 'ID', 'status']` will also be included regardless. For example:

```
m = ptm.OpenDriftModel(export_variables=[])
```

The default list of `export_variables` is set in `config_model` but is modified depending on the `drift_model` set.

How to modify details for Stokes Drift

Turn on (on by default, drift model-dependent):

```
m = ptm.OpenDriftModel(stokes_drift=True)
```

If Stokes drift is on, the following is also turned on in OpenDriftModel:

```
m.o.set_config('drift:use_tabularised_stokes_drift', True)
```

or this could be overridden with

```
m.o.set_config('drift:use_tabularised_stokes_drift', False)
```

The defaults beyond that are set but they can be modified with:

```
m.o.set_config('drift:tabularised_stokes_drift_fetch', '25000')  # default
m.o.set_config('drift:stokes_drift_profile', 'Phillips')  # default
```

Find the options with e.g.

```
m.show_config(key='drift:tabularised_stokes_drift_fetch')
```

Implicit Mixing

Vertical Mixing

The user can change the background diffusivity with

```
m.o.set_config('vertical_mixing:background_diffusivity', 1.2e-5)  # default 1.2e-5
```

Horizontal Diffusivity

The user can add horizontal diffusivity which is time-step independent diffusion. In `PTM` (not `OpenDrift`) this is calculated as an estimated 0.1 m/s sub-gridscale velocity that is missing from the model output and multiplied by an estimate of the horizontal grid resolution. This leads to a larger value for NWGOA which has a larger value for mean horizontal grid resolution (lower resolution). If the user inputs their own ocean_model information, they can input their own `horizontal_diffusivity` value. Also a user can use a built-in ocean_model and the overwrite the `horizontal_diffusivity` value to 0.

Additional Uncertainty

One can also add time-step-dependent uncertainty to the currents and winds with `current_uncertainty` and `wind_uncertainty`, respectively.

1.4 API

the_manager	Contains logic for configuring particle tracking simulations.
models	Options for models.

1.4.1 particle_tracking_manager.the_manager

Contains logic for configuring particle tracking simulations.

Classes

ParticleTrackingManager(model[, lon, lat, ...])	Manager class that controls particle tracking model.

class particle_tracking_manager.the_manager.**ParticleTrackingManager**(*model*, *lon=None*, *lat=None*, *geojson=None*, *seed_flag='elements'*, *z=0*, *seed_seafloor=False*, *number=100*, *start_time=None*, *run_forward=True*, *time_step=300*, *time_step_output=3600*, *steps=None*, *duration=None*, *end_time=None*, *ocean_model=None*, *ocean_model_local=False*, *surface_only=None*, *do3D=False*, *vertical_mixing=True*, *use_static_masks=True*, *output_file=None*, ***kw*)

Bases: `object`

Manager class that controls particle tracking model.

Parameters

- **model** (*str*) – Name of Lagrangian model package to use for drifter tracking. Only option currently is "opendrift".
- **lon** (*Optional[Union[int,float]], optional*) – Longitude of center of initial drifter locations, by default None. Use with *seed_flag="elements"*.
- **lat** (*Optional[Union[int,float]], optional*) – Latitude of center of initial drifter locations, by default None. Use with *seed_flag="elements"*.
- **geojson** (*Optional[dict], optional*) – GeoJSON object defining polygon for seeding drifters, by default None. Use with *seed_flag="geojson"*.

- **seed_flag** (*str, optional*) – Flag for seeding drifters. Options are "elements", "geojson". Default is "elements".
- **z** (*Union[int,float], optional*) – Depth of initial drifter locations, by default 0 but taken from the default in the model. Values are overridden if `surface_only==True` to 0 and to the seabed if `seed_seafloor` is True.
- **seed_seafloor** (*bool, optional*) – Set to True to seed drifters vertically at the seabed, default is False. If True then value of z is set to None and ignored.
- **number** (*int*) – Number of drifters to simulate. Default is 100.
- **start_time** (*Optional[str,datetime.datetime,pd.Timestamp], optional*) – Start time of simulation, by default None
- **run_forward** (*bool, optional*) – True to run forward in time, False to run backward, by default True
- **time_step** (*int, optional*) – Time step in seconds, options >0, <86400 (1 day in seconds), by default 300.
- **time_step_output** (*int, Timedelta, optional*) – How often to output model output. Should be a multiple of time_step. By default 3600.
- **steps** (*int, optional*) – Number of time steps to run in simulation. Options >0. steps, end_time, or duration must be input by user. By default steps is 3 and duration and end_time are None. Only one of steps, end_time, or duration can be non-None at initialization time. If one of steps, end_time, or duration is input later, it will be used to overwrite the three parameters according to that newest parameter.
- **duration** (*Optional[datetime.timedelta], optional*) – Length of simulation to run, as positive-valued timedelta object, in hours, such as `timedelta(hours=48)`. steps, end_time, or duration must be input by user. By default steps is 3 and duration and end_time are None. For CLI, input duration as a pandas Timedelta string like "48h" for 48 hours. Only one of steps, end_time, or duration can be non-None at initialization time. If one of steps, end_time, or duration is input later, it will be used to overwrite the three parameters according to that newest parameter.
- **end_time** (*Optional[datetime], optional*) – Datetime at which to end simulation, as positive-valued datetime object. steps, end_time, or duration must be input by user. By default steps is 3 and duration and end_time are None. Only one of steps, end_time, or duration can be non-None at initialization time. If one of steps, end_time, or duration is input later, it will be used to overwrite the three parameters according to that newest parameter.
- **ocean_model** (*Optional[str], optional*) – Name of ocean model to use for driving drifter simulation, by default None. Use None for testing and set up. Otherwise input a string. Options are: "NWGOA", "CIOFS", "CIOFSOP". Alternatively keep as None and set up a separate reader (see example in docs).
- **ocean_model_local** (*Optional, bool*) – Set to True to use local version of known *ocean_model* instead of remote version.
- **surface_only** (*bool, optional*) – Set to True to keep drifters at the surface, by default None. If this flag is set to not-None, it overrides do3D to False, vertical_mixing to False, and the z value(s) 0. If True, this flag also turns off reading model output below 0.5m if drift_model is not Leeway: `o.set_config('drift:truncate_ocean_model_below_m', 0.5)` to save time.
- **do3D** (*bool, optional*) – Set to True to run drifters in 3D, by default False. This is overridden if `surface_only==True`. If True, vertical advection and mixing are turned on with options for setting `diffusivitymodel`, `background_diffusivity`,

ocean_mixed_layer_thickness, vertical_mixing_timestep. If False, vertical motion is disabled.

- **vertical_mixing** (*bool, optional*) – Set to True to include vertical mixing, by default False. This is overridden if surface_only==True.
- **use_static_masks** (*bool, optional*) – Set to True to use static masks ocean_model output when ROMS wetdry masks are available, by default False. This is relevant for all of the available known models. If you want to use static masks with a user-input ocean_model, you can drop the wetdry_mask_rho etc variables from the dataset before inputting to PTM. Setting this to True may save computation time but will be less accurate, especially in the tidal flat regions of the model.
- **output_file** (*Optional[str], optional*) – Name of output file to save, by default None. If None, default is set in the model.

Notes

Configuration happens at initialization time for the child model. There is currently no separate configuration step.

Attributes

outfile_name
Output file name.

Methods

add_reader(**kwargs)	Here is where the model output is opened.
all_export_variables()	Output list of all possible export variables.
calc_duration()	Calculate duration based on end_time and start_time.
calc_end_time(changed_variable)	Calculate end time based on other simulation length parameters.
calc_steps()	Calculate steps based on duration and time_step.
export_variables()	Output list of all actual export variables.
output()	Hold for future output function.
query_reader()	define in child class.
reader_metadata(key)	define in child class
run()	Call model run function.
run_all()	Run all steps.
seed([lon, lat, z])	Initialize the drifters in space and time
show_config(**kwargs)	Show parameter configuration across both model and PTM.
show_config_model()	define in child class

_add_model_config()

Have this in the model class to modify config

_add_ptm_config()

Have this in the model class to modify config

_config()

Model should have its own version which returns variable config

_update_config()
Update configuration between model, PTM additions, and model additions.

add_reader(***kwargs*)
Here is where the model output is opened.

all_export_variables()
Output list of all possible export variables.

define in child class.

calc_duration()
Calculate duration based on end_time and start_time.

calc_end_time(*changed_variable*)
Calculate end time based on other simulation length parameters.

calc_steps()
Calculate steps based on duration and time_step.

config_model

config_ptm

duration

end_time

export_variables()
Output list of all actual export variables.

define in child class.

lat

logger

lon

ocean_model

property outfile_name
Output file name.

define in child class.

output()
Hold for future output function.

query_reader()
define in child class.

reader_metadata(*key*)
define in child class

run()
Call model run function.

run_all()
Run all steps.

seed(*lon=None*, *lat=None*, *z=None*)

Initialize the drifters in space and time

… and with any special properties.

seed_seafloor

show_config(***kwargs*)

Show parameter configuration across both model and PTM.

show_config_model()

define in child class

start_time

steps

surface_only

time_step

timedir

z

1.4.2 particle_tracking_manager.models

Options for models.

Modules

particle_tracking_manager.models.opendrift	OpenDrift files.

particle_tracking_manager.models.opendrift

OpenDrift files.

Modules

particle_tracking_manager.models.opendrift.opendrift	Using OpenDrift for particle tracking.

particle_tracking_manager.models.opendrift.opendrift

Using OpenDrift for particle tracking.

Classes

OpenDriftModel([drift_model, ...])	Open drift particle tracking model.

class particle_tracking_manager.models.opendrift.opendrift.**OpenDriftModel**(*drift_model='OceanDrift'*, *export_variables=['z', 'origin_marker']*, *radius=1000.0*, *radius_type='gaussian'*, *horizontal_diffusivity=None*, *current_uncertainty=0*, *wind_uncertainty=0*, *use_auto_landmask=False*, *diffusivitymodel='windspeed_Large1994'*, *stokes_drift=True*, *mixed_layer_depth=30*, *coastline_action='previous'*, *seafloor_action='previous'*, *max_speed=5*, *wind_drift_factor=0.02*, *wind_drift_depth=0.02*, *vertical_mixing_timestep=60*, *object_type='Person-in-water (PIW), unknown state (mean values)'*, *diameter=0.0014*, *neutral_buoyancy_salinity=31.25*, *stage_fraction=0.0*, *hatched=0*, *length=0*, *weight=0.08*, *oil_type='GENERIC MEDIUM CRUDE'*, *m3_per_hour=1*, *oil_film_thickness=1*, *droplet_size_distribution='uniform'*, *droplet_diameter_mu=0.001*, *droplet_diameter_sigma=0.0005*, *droplet_diameter_min_subsea=0.0005*, *droplet_diameter_max_subsea=0.005*, *emulsification=True*, *dispersion=True*, *evaporation=True*, *update_oilfilm_thickness=True*, *biodegradation=True*, *log='low'*, ***kw*)

Bases: *ParticleTrackingManager*

Open drift particle tracking model.

Defaults all come from config_model configuration file.

Parameters

- **drift_model** (*str, optional*) – Options: "OceanDrift", "LarvalFish", "OpenOil", "Leeway", by default "OceanDrift"
- **export_variables** (*list, optional*) – List of variables to export, by default None. See PTM docs for options.
- **radius** (*int, optional*) – Radius around each lon-lat pair, within which particles will be randomly seeded. This is used by function *seed_elements*.
- **radius_type** (*str*) – If 'gaussian' (default), the radius is the standard deviation in x-y-directions. If 'uniform', elements are spread evenly and always inside a circle with the given radius. This is used by function *seed_elements*.
- **horizontal_diffusivity** (*float*) – Horizontal diffusivity is None by default but will be set to a grid-dependent value for known ocean_model values. This is calculated as 0.1 m/s sub-gridscale velocity that is missing from the model output and multiplied by an estimate of the horizontal grid resolution. This leads to a larger value for NWGOA which has a larger value for mean horizontal grid resolution (lower resolution). If the user inputs their own ocean_model information, they can input their own horizontal_diffusivity value. A user can use a known ocean_model and then overwrite the horizontal_diffusivity value to some value.
- **current_uncertainty** (*float*) – Add gaussian perturbation with this standard deviation to current components at each time step.
- **wind_uncertainty** (*float*) – Add gaussian perturbation with this standard deviation to wind components at each time step.
- **use_auto_landmask** (*bool*) – Set as True to use general landmask instead of that from ocean_model. Use for testing primarily. Default is False.
- **diffusivitymodel** (*str*) – Algorithm/source used for profile of vertical diffusivity. Environment means that diffusivity is acquired from readers or environment constants/fallback. Turned on if `vertical_mixing==True`.
- **stokes_drift** (*bool, optional*) – Set to True to turn on Stokes drift, by default True. This enables 3 settings in OpenDrift:
  - o.set_config('drift:use_tabularised_stokes_drift', True)
  - o.set_config('drift:tabularised_stokes_drift_fetch', '25000') # default
  - o.set_config('drift:stokes_drift_profile', 'Phillips') # default

  The latter two configurations are not additionally set in OpenDriftModel since they are already the default once stokes_drift is True.
- **mixed_layer_depth** (*float*) – Fallback value for ocean_mixed_layer_thickness if not available from any reader. This is used in the calculation of vertical diffusivity.
- **coastline_action** (*str, optional*) – Action to perform if a drifter hits the coastline, by default "previous". Options are 'stranding', 'previous'.
- **seafloor_action** (*str, optional*) – Action to perform if a drifter hits the seafloor, by default "deactivate". Options are 'deactivate', 'previous', 'lift_to_seafloor'.
- **max_speed** (*int*) – Typical maximum speed of elements, used to estimate reader buffer size.

- **wind_drift_factor** (*float*) – Elements at surface are moved with this fraction of the wind vector, in addition to currents and Stokes drift.
- **wind_drift_depth** (*float*) – The direct wind drift (windage) is linearly decreasing from the surface value (wind_drift_factor) until 0 at this depth.
- **vertical_mixing_timestep** (*float*) – Time step used for inner loop of vertical mixing.
- **object_type** (*str = config_model["object_type"]["default"],*) – Leeway object category for this simulation.
- **diameter** (*float*) – Seeding value of diameter.
- **neutral_buoyancy_salinity** (*float*) – Seeding value of neutral_buoyancy_salinity.
- **stage_fraction** (*float*) – Seeding value of stage_fraction.
- **hatched** (*float*) – Seeding value of hatched.
- **length** (*float*) – Seeding value of length.
- **weight** (*float*) – Seeding value of weight.
- **oil_type** (*str*) – Oil type to be used for the simulation, from the NOAA ADIOS database.
- **m3_per_hour** (*float*) – The amount (volume) of oil released per hour (or total amount if release is instantaneous).
- **oil_film_thickness** (*float*) – Seeding value of oil_film_thickness.
- **droplet_size_distribution** (*str*) – Droplet size distribution used for subsea release.
- **droplet_diameter_mu** (*float*) – The mean diameter of oil droplet for a subsea release, used in normal/lognormal distributions.
- **droplet_diameter_sigma** (*float*) – The standard deviation in diameter of oil droplet for a subsea release, used in normal/lognormal distributions.
- **droplet_diameter_min_subsea** (*float*) – The minimum diameter of oil droplet for a subsea release, used in uniform distribution.
- **droplet_diameter_max_subsea** (*float*) – The maximum diameter of oil droplet for a subsea release, used in uniform distribution.
- **emulsification** (*bool*) – Surface oil is emulsified, i.e. water droplets are mixed into oil due to wave mixing, with resulting increase of viscosity.
- **dispersion** (*bool*) – Oil is removed from simulation (dispersed), if entrained as very small droplets.
- **evaporation** (*bool*) – Surface oil is evaporated.
- **update_oilfilm_thickness** (*bool*) – Oil film thickness is calculated at each time step. The alternative is that oil film thickness is kept constant with value provided at seeding.
- **biodegradation** (*bool*) – Oil mass is biodegraded (eaten by bacteria).
- **log** (*str, optional*) – Options are "low" and "high" verbosity for log, by default "low"

Notes

Docs available for more initialization options with `ptm.ParticleTrackingManager?`

Attributes

outfile_name
Output file name.

seed_kws
Gather seed input kwargs.

Methods

add_reader(**kwargs)	Here is where the model output is opened.
all_export_variables()	Output list of all possible export variables.
calc_duration()	Calculate duration based on end_time and start_time.
calc_end_time(changed_variable)	Calculate end time based on other simulation length parameters.
calc_known_horizontal_diffusivity()	Calculate horizontal diffusivity based on known ocean_model.
calc_steps()	Calculate steps based on duration and time_step.
drift_model_config([ptm_level, prefix])	Show config for this drift model selection.
export_variables()	Output list of all actual export variables.
get_configspec(prefix, substring, ...)	Copied from OpenDrift, then modified.
output()	Hold for future output function.
query_reader()	define in child class.
reader_metadata(key)	allow manager to query reader metadata.
run()	Call model run function.
run_add_reader([ds, name, ...])	Might need to cache this if its still slow locally.
run_all()	Run all steps.
run_drifters()	Run the drifters!
run_seed()	Actually seed drifters for model.
seed([lon, lat, z])	Initialize the drifters in space and time
show_config(**kwargs)	Show parameter configuration across both model and PTM.
show_config_model([key, prefix, level, ...])	Show configuring for the drift model selected in configuration.

_add_model_config()

Goal is to combine the config both directions:

- override OpenDrift config defaults with those from opendrift_config as well as include extra information like ptm_level
- bring OpenDrift config parameter metadata into config_model so application could query it to get the ranges, options, etc.

_add_ptm_config()

Add PTM config to overall config.

property _config

Surface the model configuration.

_update_config()

Update configuration between model, PTM additions, and model additions.

add_reader(***kwargs*)

Here is where the model output is opened.

all_export_variables()

Output list of all possible export variables.

calc_duration()

Calculate duration based on end_time and start_time.

calc_end_time(*changed_variable*)

Calculate end time based on other simulation length parameters.

calc_known_horizontal_diffusivity()

Calculate horizontal diffusivity based on known ocean_model.

calc_steps()

Calculate steps based on duration and time_step.

config_model

config_ptm

diffusivitymodel

drift_model

drift_model_config(*ptm_level=[1, 2, 3]*, *prefix=''*)

Show config for this drift model selection.

This shows all PTM-controlled parameters for the OpenDrift drift model selected and their current values, at the selected ptm_level of importance. It includes some additional configuration parameters that are indirectly controlled by PTM parameters.

Parameters

- **ptm_level** (*int, list, optional*) – Options are 1, 2, 3, or lists of combinations. Use [1,2,3] for all. Default is 1.
- **prefix** (*str, optional*) – prefix to search config for, only for OpenDrift parameters (not PTM).

duration

end_time

export_variables()

Output list of all actual export variables.

get_configspec(*prefix*, *substring*, *excludestring*, *level*, *ptm_level*)

Copied from OpenDrift, then modified.

horizontal_diffusivity

lat

log

logger

loglevel

lon

mixed_layer_depth

o

ocean_model

property outfile_name

Output file name.

output()

Hold for future output function.

query_reader()

define in child class.

reader_metadata(*key*)

allow manager to query reader metadata.

run()

Call model run function.

run_add_reader(*ds=None*, *name=None*, *oceanmodel_lon0_360=False*, *standard_name_mapping=None*)

Might need to cache this if its still slow locally.

Parameters

- **ds** (*xr.Dataset, optional*) – Previously-opened Dataset containing ocean model output, if user wants to input unknown reader information.
- **name** (*str, optional*) – If ds is input, user can also input name of ocean model, otherwise will be called "user_input".
- **oceanmodel_lon0_360** (*bool*) – True if ocean model longitudes span 0 to 360 instead of -180 to 180.
- **standard_name_mapping** (*dict*) – Mapping of model variable names to standard names.

run_all()

Run all steps.

run_drifters()

Run the drifters!

run_seed()

Actually seed drifters for model.

seed(*lon=None*, *lat=None*, *z=None*)

Initialize the drifters in space and time

… and with any special properties.

property seed_kws

Gather seed input kwargs.

This could be run more than once.

seed_seafloor

show_config(***kwargs*)

Show parameter configuration across both model and PTM.

show_config_model(*key=None*, *prefix=''*, *level=None*, *ptm_level=None*, *substring=''*, *excludestring='excludestring'*)

Show configuring for the drift model selected in configuration.

Runs configuration for you if it hasn't yet been run.

Parameters

- **key** (*str, optional*) – If input, show configuration for just that key.
- **prefix** (*str, optional*) – prefix to search config for, only for OpenDrift parameters (not PTM).
- **level** (*int, list, optional*) – Limit search by level:
  - CONFIG_LEVEL_ESSENTIAL = 1
  - CONFIG_LEVEL_BASIC = 2
  - CONFIG_LEVEL_ADVANCED = 3

  e.g. 1, [1,2], [1,2,3]
- **ptm_level** (*int, list, optional*) – Limit search by level:
  - Surface to user = 1
  - Medium surface to user = 2
  - Surface but bury = 3

  e.g. 1, [1,2], [1,2,3]. To access all PTM parameters search for *ptm_level=[1,2,3]*.
- **substring** (*str, optional*) – If input, show configuration that contains that substring.
- **excludestring** (*str, optional*) – configuration parameters are not shown if they contain this string.

Examples

Show all possible configuration for the previously-selected drift model:

```
>>> manager.show_config()
```

Show configuration with a specific prefix:

```
>>> manager.show_config(prefix="seed")
```

Show configuration matching a substring:

```
>>> manager.show_config(substring="stokes")
```

Show configuration at a specific level (from OpenDrift):

```
>>> manager.show_config(level=1)
```

Show all OpenDrift configuration:

```
>>> manager.show_config(level=[1,2,3])
```

Show configuration for only PTM-specified parameters:

```
>>> manager.show_config(ptm_level=[1,2,3])
```

Show configuration for a specific PTM level:

```
>>> manager.show_config(ptm_level=2)
```

Show configuration for a single key:

```
>>> manager.show_config("seed:oil_type")
```

Show configuration for parameters that are both OpenDrift and PTM-modified:

```
>>> m.show_config(ptm_level=[1,2,3], level=[1,2,3])
```

start_time

steps

stokes_drift

surface_only

time_step

timedir

vertical_mixing_timestep

wind_drift_depth

wind_drift_factor

z

1.5 What's New

1.5.1 v0.8.4 (April 24, 2024)

- updated the `ptm_level` of a bunch of config parameters

1.5.2 v0.8.3 (April 23, 2024)

- removed `Dcrit` because realized it is not necessary
- improved log handling for CLI
- changed `OpenDrift` default handling so they are now changed to None

1.5.3 v0.8.2 (April 10, 2024)

- updated docs
- improved `drift_model_config()`
- updated tests
- now include PTM metadata with output file

1.5.4 v0.8.1 (April 5, 2024)

- updated docs

1.5.5 v0.8.0 (April 2, 2024)

- `time_step_output` behavior has changed — 1 hour by default
- `time_step` is now 5 min by default
- added `Dcrit` parameter for accurately finding where drifters are stranded in tidal flats
- `vertical_mixing` is True by default now
- added seafloor_action option
- fixed some Leeway/3D handling and log messaging
- export_variables are specific to drift_model as needed
- do not drop zeta anymore since used in opendrift
- output_file is now an option

1.5.6 v0.7.1 (February 21, 2024)

- Small fix to some attributes to be less verbose
- Fix setup.cfg to have correct config path since name changed

1.5.7 v0.7.0 (February 21, 2024)

- Now initialize all class attributes with None and removed usage of `hasattr` which simplifies and clarifies some code.
- Improved handling of `start_time`, `end_time`, `duration`, and `steps` in `manager.py` which fixed a bug in which users couldn't input `start_time` and have the simulation run successfully.
- simplified handling of `horizontal_diffusivity` in `opendrift` model.
- user can change `end_time`, `duration`, and `steps` and have the others update accordingly. Tests added to check this.
- changed known model "CIOFS_now" to "CIOFSOP" to avoid upper/lower issues and include "OP" for "operational".
- many more tests and improved behavior for attribute checks and updates

1.5.8 v0.6.0 (February 15, 2024)

- is set up to tell `opendrift` ROMS reader to save the interpolator to a cache that is set up the first time it is run. This only works with the newest dev version of `opendrift` at the moment, and the files saved are hundreds of MB, but it speeds up the simulations pretty well (12 to 30 seconds).
- reworked which variables are dropped in which scenarios for `opendrift` and integrated with using wetdry vs static masks.
- added package `appdirs` to manage the cache for storing interpolator pickles.
- fix to CLI so duration input is formatted correctly.
- can now input `name` to accompany user-input `xarray Dataset` for `ocean_model`.
- added `ocean_model` "CIOFS_now" local and remote links.

1.5.9 v0.5.0 (February 12, 2024)

- updated to using version of `opendrift` in which you can input an xarray Dataset directly
- added new parameter for built-in ocean_models to specify whether to look locally or remote for the output (`ocean_model_local`)
- added local model output information for known models using parquet files for kerchunk access to model output
- changed `max_speed` parameter, which controls buffer size in `opendrift`, to 2 from 5.
- improved handling of "steps", "duration", and "end_time" parameters.
- improved reader interaction and speed with `opendrift` by dropping unnecessary variables from ocean_model Dataset, separating out the `standard_name` mapping input to the ROMS reader in `opendrift`, added option for whether or not to use wet/dry masks in ocean_model output if available

1.5.10 v0.4.0 (January 25, 2024)

- modified level of surfacing for some configuration parameters
- made `ptm` an entry point
- finished removing WKT code, which hadn't been working
- added "excludestring" as an option for filtering configuration parameters
- updated checks for necessary `drift_model=="Leeway"` and parameter combinations.
- updated docs according to software updates

PYTHON MODULE INDEX

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