Deltares

dfm_tools

A Python package for D-FlowFM input and output

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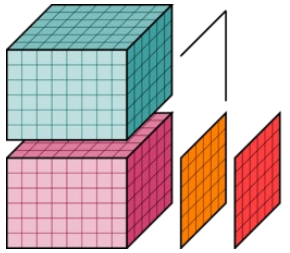
dfm_tools: the concept

- What:
  - Python package for pre- and postprocessing D-FlowFM input and output files
  - convenience functions built on top of other packages like xarray, hydolib-core and more
  - features: https://github.com/openearth/dfm_tools#features
- Why:
  - sharing of workflows among users (colleagues/external)
  - no need to reinvent the wheel
  - developments driven by projects like hydrolib-core, MassBay, FutureMares, TCOMS
- Where:
  - code on github: https://github.com/openearth/dfm_tools
  - installable via pip: https://github.com/openearth/dfm_tools#installation

xarray: io of netcdf files



xarray

- lazy loading of netcdf files with knowledge of the entire structure
- easy indexing over all dimensions with .isel() and .sel()
- preprocess_his() enables indexing via station names (and other labels)

```
import xarray as xr
import matplotlib.pyplot as plt
plt.close('all')

from dfm_tools.xarray_helpers import preprocess_hisnc

file_nc =  r'c:\DATA\dfm_tools_testdata\DFM_3D_z_Grevelingen\\computations\\run01\\DFM_OUTPUT_Grevelingen-FM\\Grevelingen-FM_000

data_xr = xr.open_mfdataset(file_nc, preprocess=preprocess_hisnc)
```

```
Out[41]:
<xarray.Dataset>
Dimensions:                                          (stations: 24, time: 145,
                                                      laydim: 36, laydimw: 37,
                                                      source_sink_pts: 2,
                                                      source_sink: 1)
Coordinates:
    station_x_coordinate                             (stations) float64 4.747e+0...
    station_y_coordinate                             (stations) float64 4.188e+0...
    zcoordinate_c                                    (time, stations, laydim) float64 dask.array<chunksize=(145, 24, 36), meta=np.n
    zcoordinate_w                                    (time, stations, laydimw) float64 dask.array<chunksize=(145, 24, 37), meta=np.
  * time                                             (time) datetime64[ns] 2007-...
  * stations                                         (stations) <U25 'GTSO-01' ....
  * source_sink                                      (source_sink) <U2 ''
Dimensions without coordinates: laydim, laydimw, source_sink_pts
Data variables: (12/42)
    station_id                                       (stations) |S64 dask.array<chunksize=(24,), meta=np.ndarray>
    waterlevel                                       (time, stations) float64 dask.array<chunksize=(145, 24), meta=np.ndarray>
    bedlevel                                         (stations) float64 dask.array<chunksize=(24,), meta=np.ndarray>
    waterdepth                                       (time, stations) float64 dask.array<chunksize=(145, 24), meta=np.ndarray>
    x_velocity                                       (time, stations, laydim) float64 dask.array<chunksize=(145, 24, 36), meta=np.n
    y_velocity                                       (time, stations, laydim) float64 dask.array<chunksize=(145, 24, 36), meta=np.n
    ...                                               ...
```

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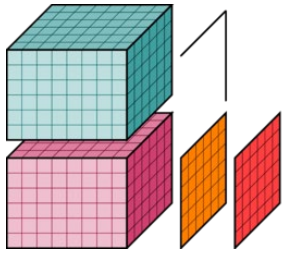
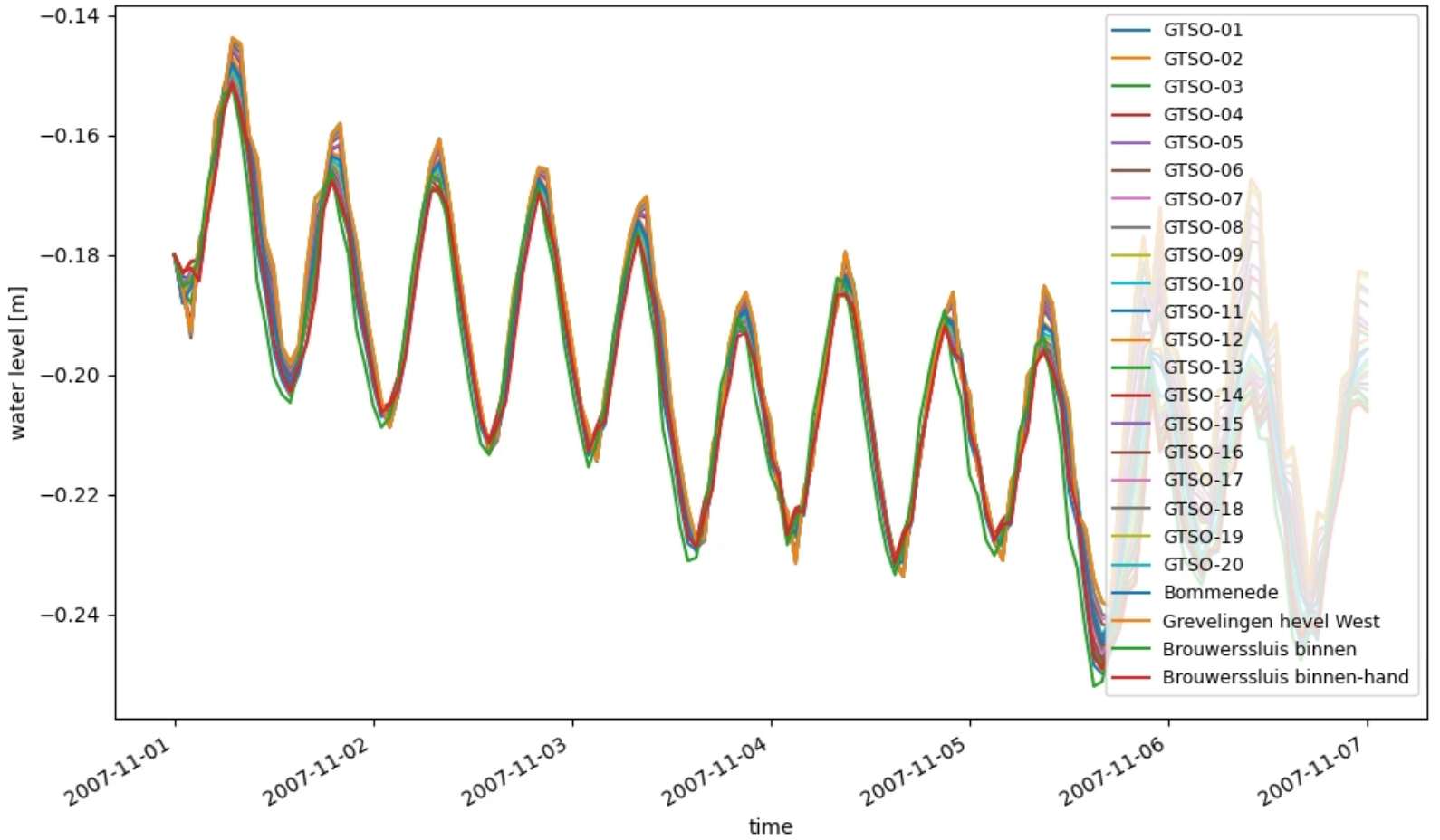
xarray: io of netcdf files



xarray

- easy indexing (subsetting)
- easy and complete plotting
- *.../tests/examples/postprocess_hisnc.py*

```
data_fromhis_xr = data_xr.waterlevel.sel(stations=stations_requested,time=slice('2007-11-01','2011-11-07'))
fig, ax = plt.subplots(figsize=(10,6))
data_fromhis_xr.plot.line('-',ax=ax,x='time')
```



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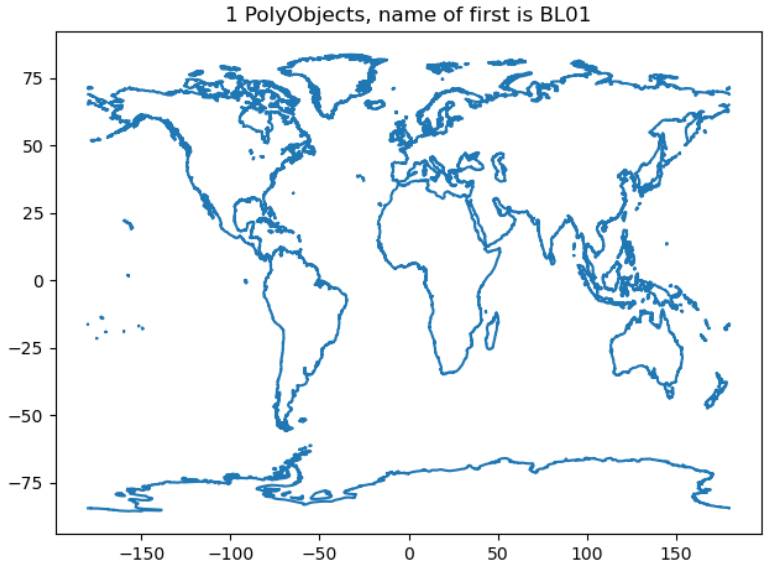
HYDROLIB: io of D-FlowFM input files

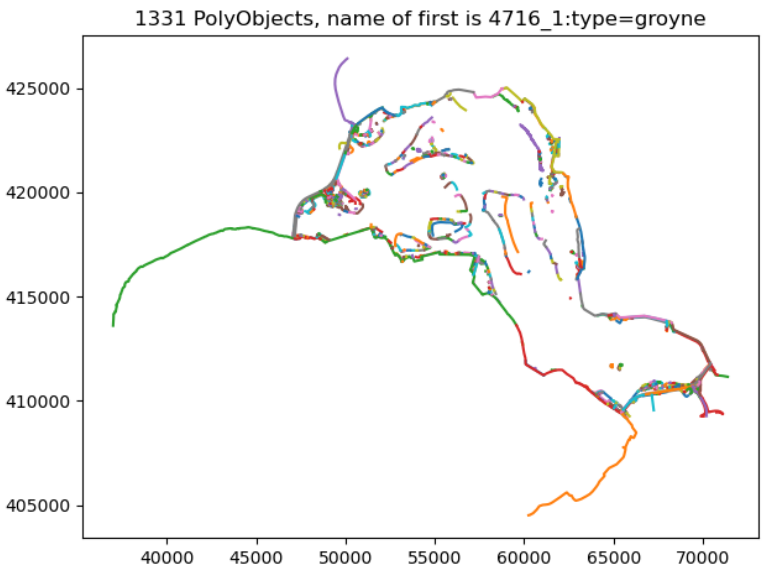
Core scripts & tools for interaction with D-FlowFM:

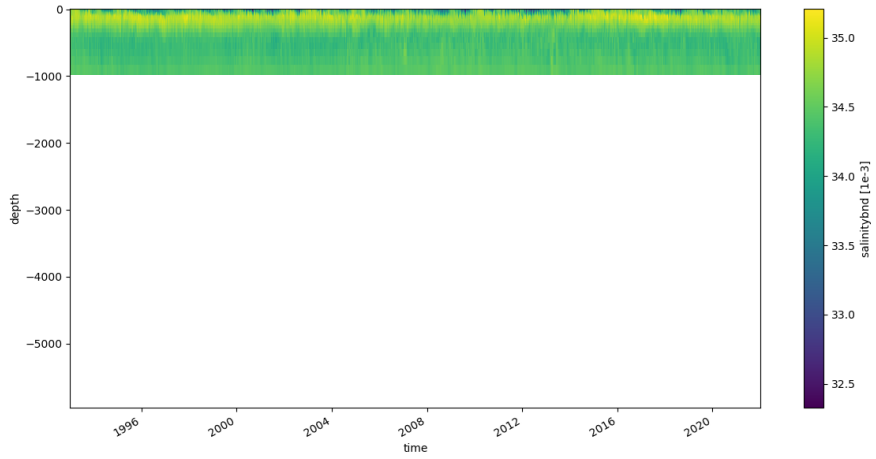
- reading/writing of (almost all) D-FlowFM input files (mdu, ext, bc, pli, etc)
- full functionalities: https://deltares.github.io/HYDROLIB-core/0.3.1/topics/dhydro_support/
- supported, documented, maintained
- available on github: https://github.com/Deltares/HYDROLIB-core
- users do not need to re-invent the wheel about “basic stuff/file formats”, focus on the analysis itself

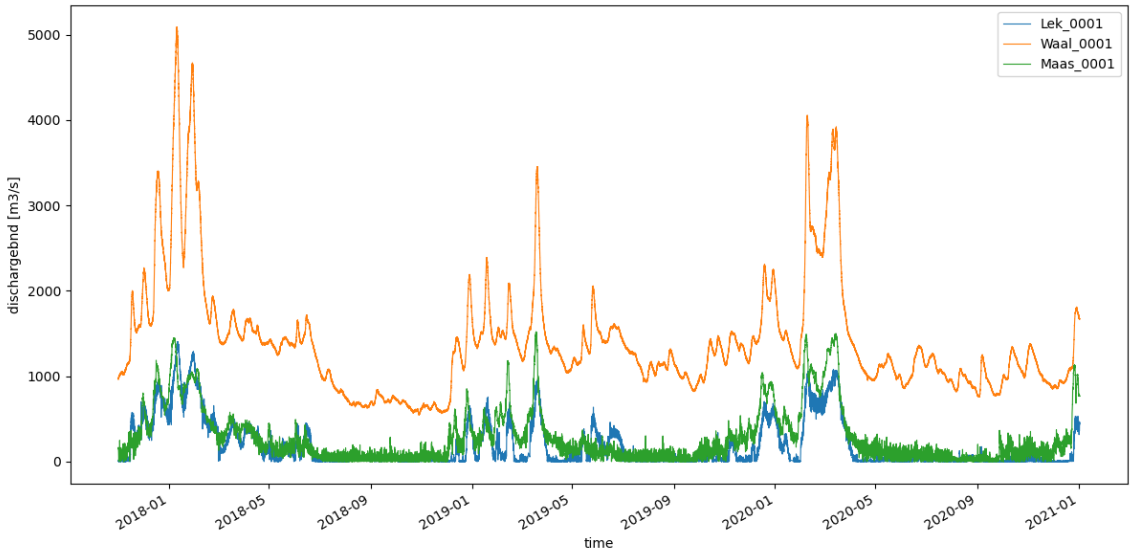
Examples: reading+plotting of D-FlowFM input files

- hydrolib for reading files
- conversion to xarray dataset
- pli/pliz/ldb/tek (global, Grevelingen)
- bc (T3D salinity, bc (TimeSeries discharge)
- *.../tests/examples/preprocess_hydrolib_readbc.py*
- *.../tests/examples/preprocess_hydrolib_readwritepol.py*









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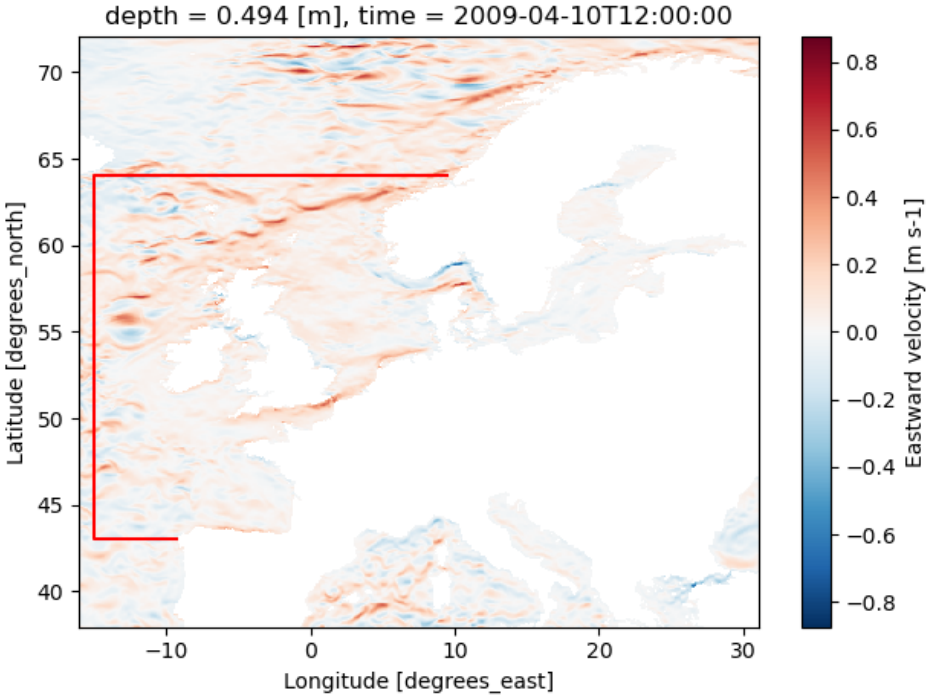
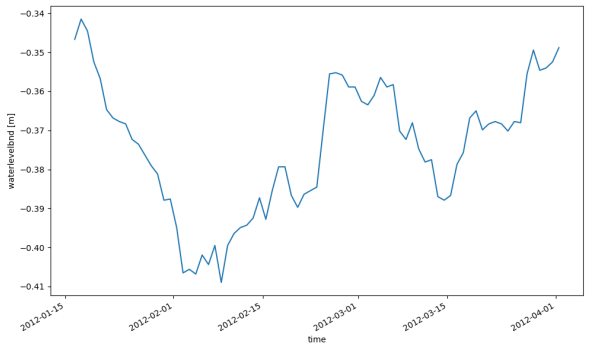
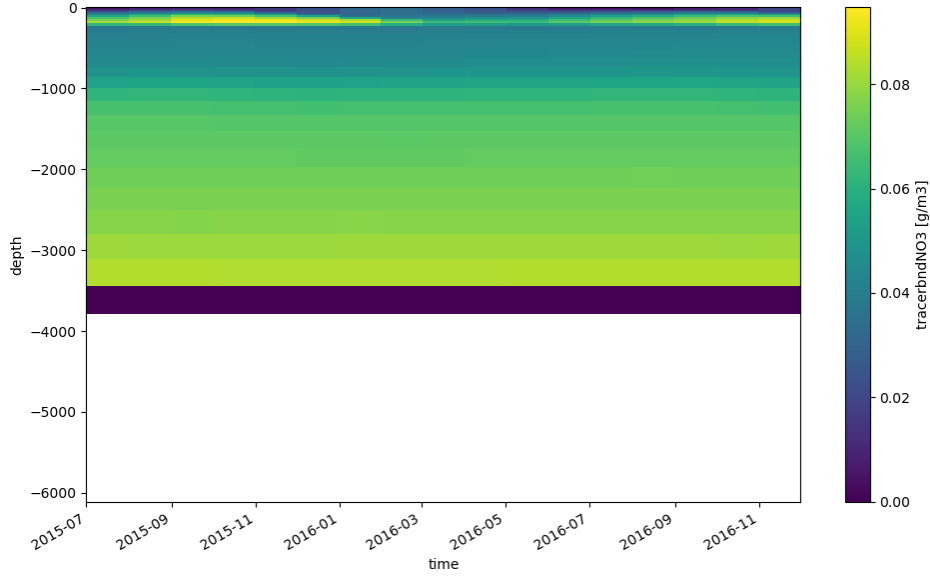
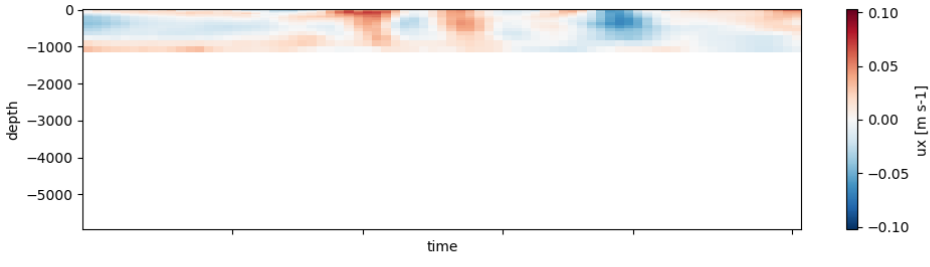
Examples: interpolate oceanmodel to bc

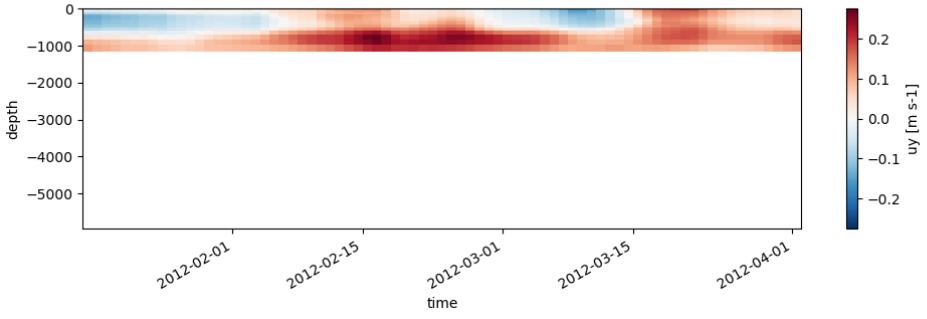
- xarray for reading netcdf data and .interp() to polyline points
- hydrolib for writing bc/ext and model structure
- *.../tests/examples/preprocess_interpolate_nc_to_bc.py*











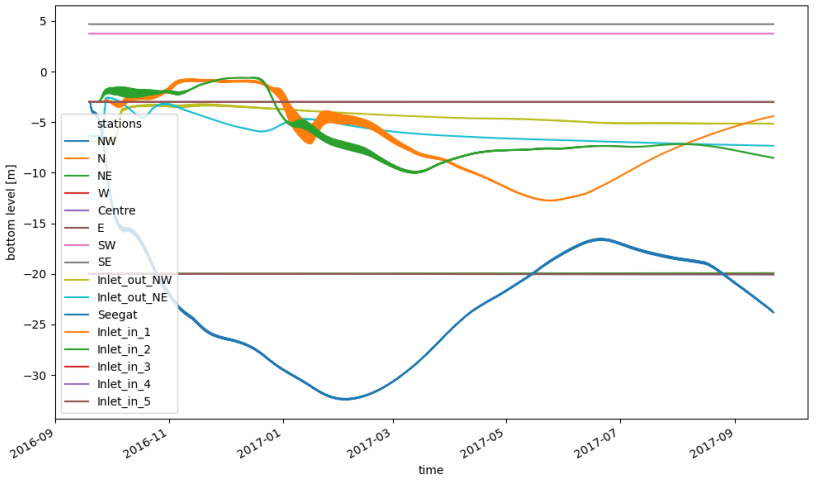
Application for regional models

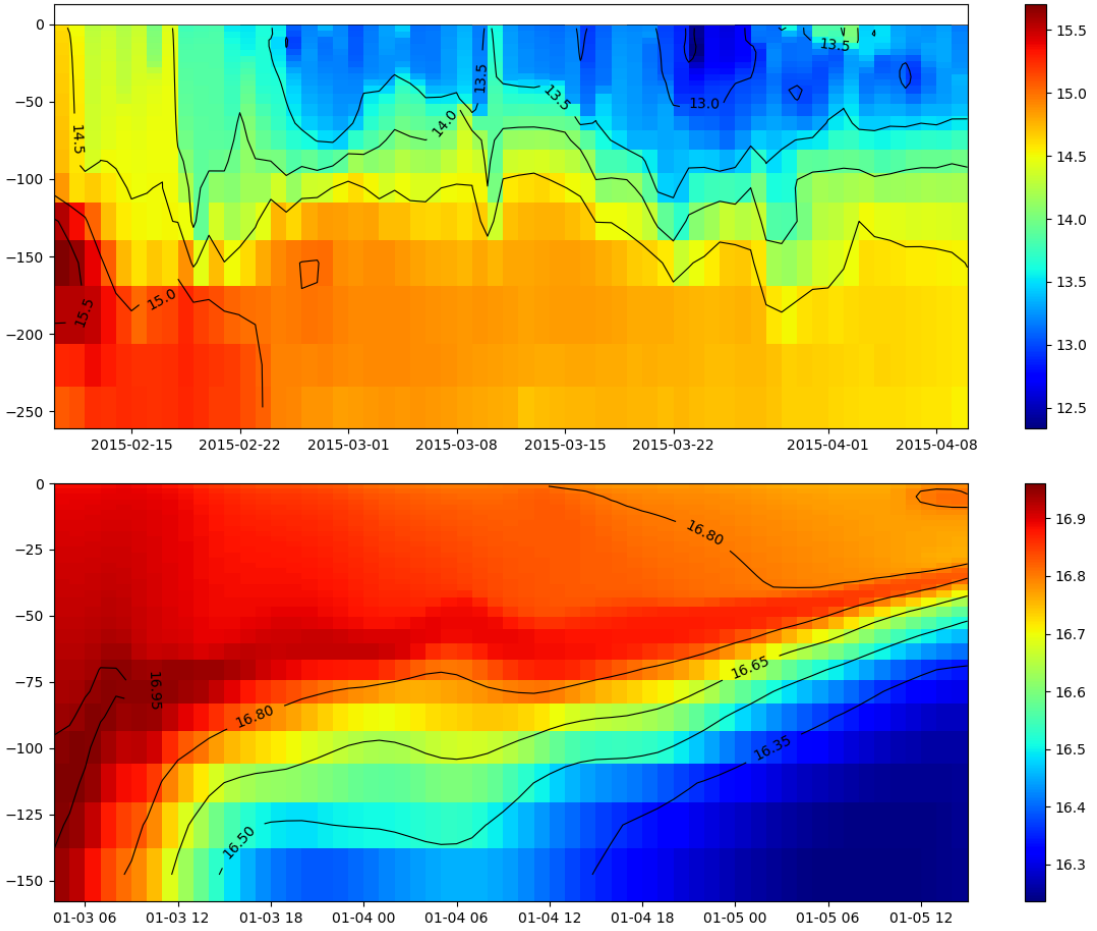
- Manually defined model boundaries, used for:
  - Grid cut-out of GTSM (currently manual)
  - Download of ERA5 and CMEMS field
    .../tests/examples/download_meteodata_oceandata.py
  - Generation of (2D) open boundary forcing from FES2014 (tidal constituents)
    .../tests/examples/preprocess_interpolate_nc_to_bc.py
  - Generation of (3D) open boundary forcing from CMEMS (salinity, temperature and sealevel anomaly)
    .../tests/examples/preprocess_interpolate_nc_to_bc.py
  - Generation of 3D initial fields from CMEMS (salinity and temperature)
    .../tests/examples/preprocess_ini_cmems_to_nc.py
  - Generation of meteorological forcing fields
    .../tests/examples/preprocess_meteo_mergenetCDFtime_xarray.py

- The *dfm_tools* enables the quick set-up of the basis of a 3D model

Examples: read+plot hisfile

- xarray for reading hisfile (D-FlowFM and sfincs)
- selection of data over dimensions: time, depth, stations, cross_sections, structures, etc
- zt-plot (timeseries of one point with depth dim)
- *.../tests/examples/postprocess_hisnc.py*
- coming up:
  - interpolation
  - nesting





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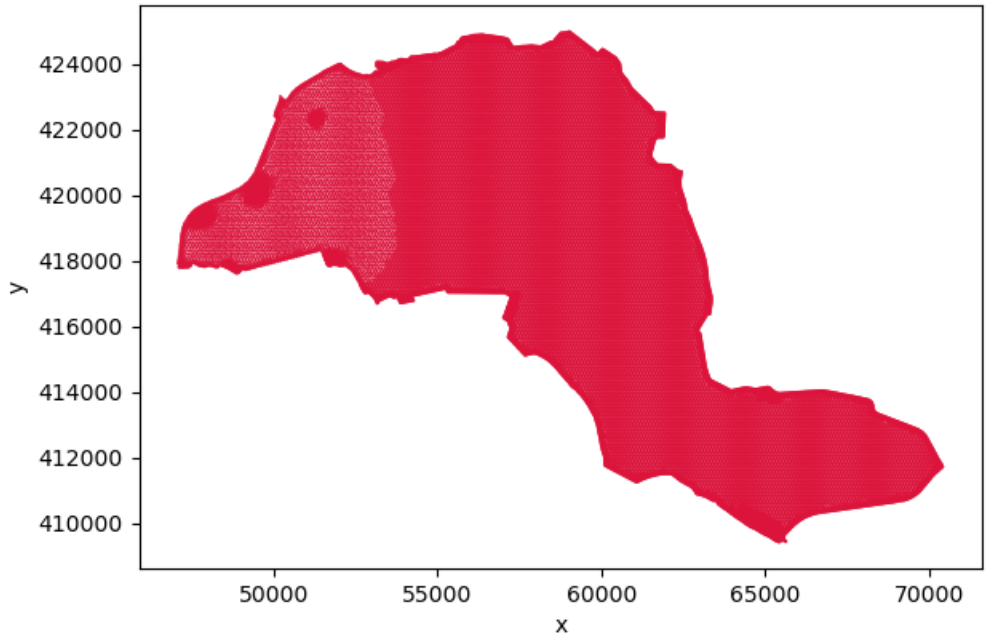
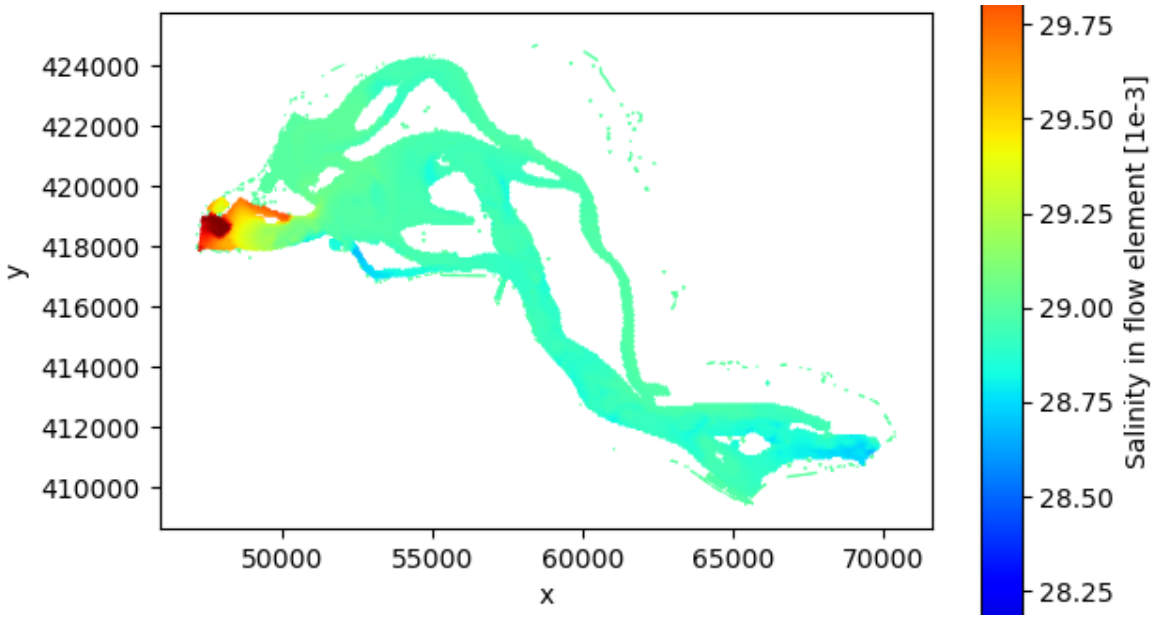
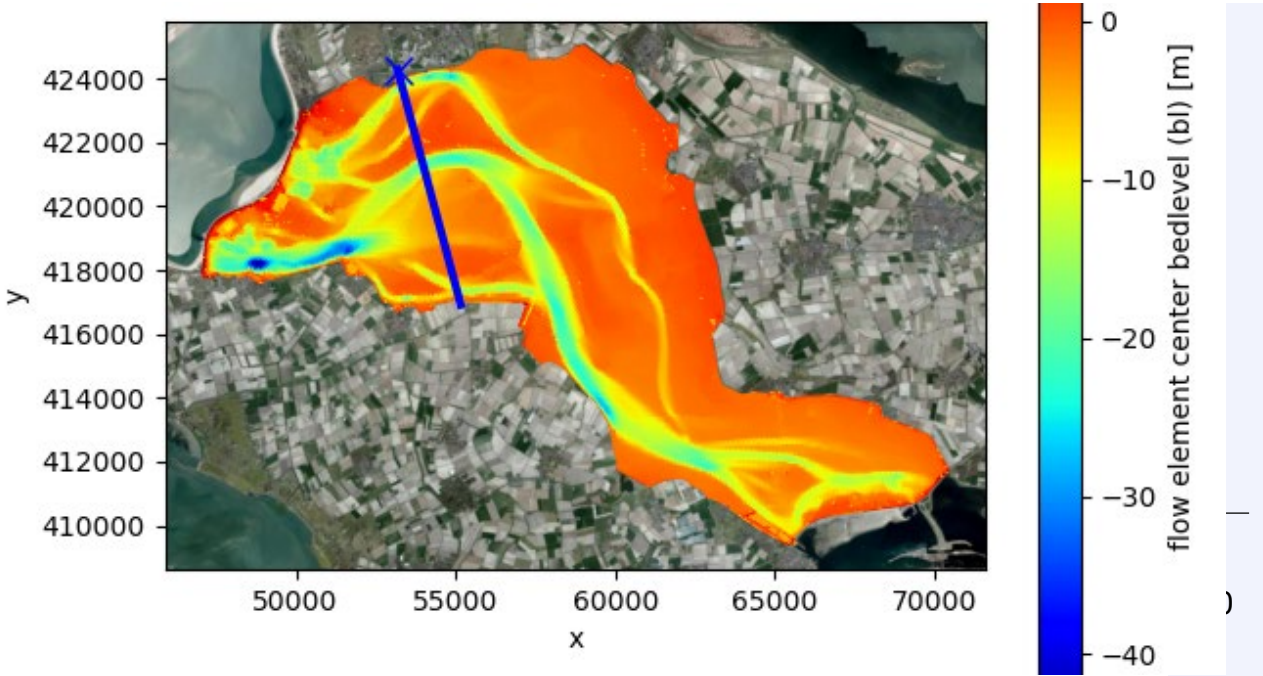
Examples: read+plot mapfiles

- supports flexible meshes (unstructured) map/fou/rst/net
- supports partitions (and handles ghost cells)
- will be converted to xarray for more convenience/performance
- 3D slicing: next slide

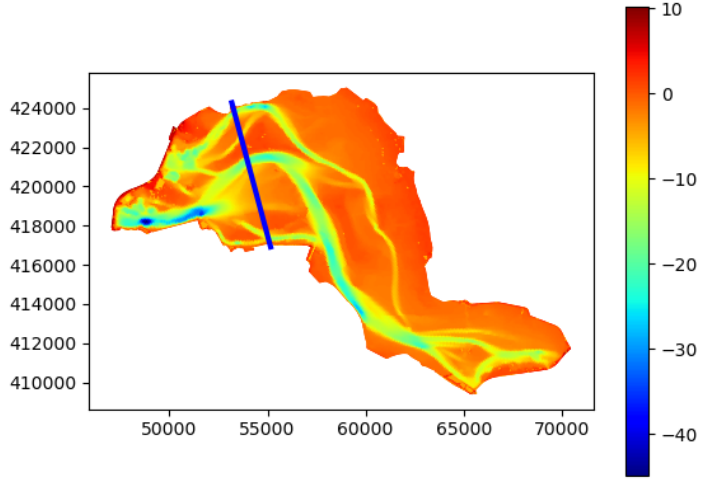


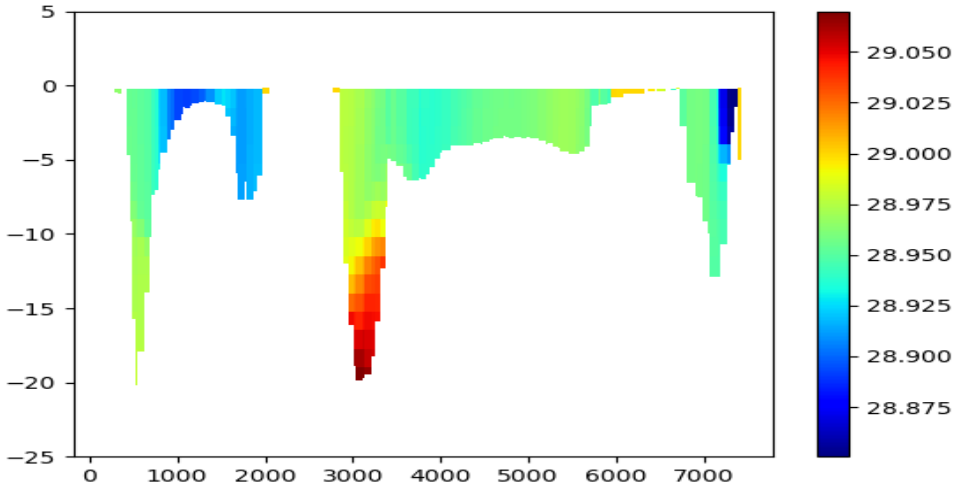


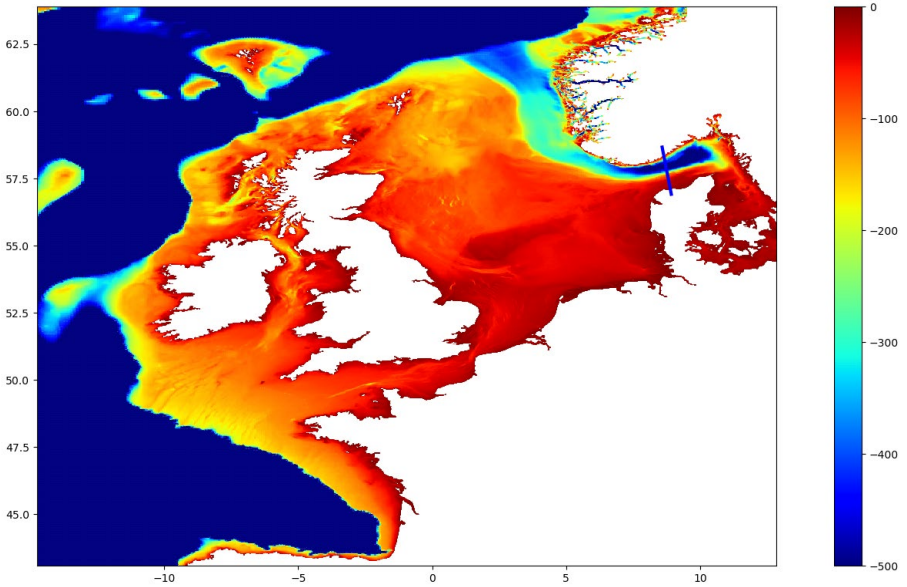


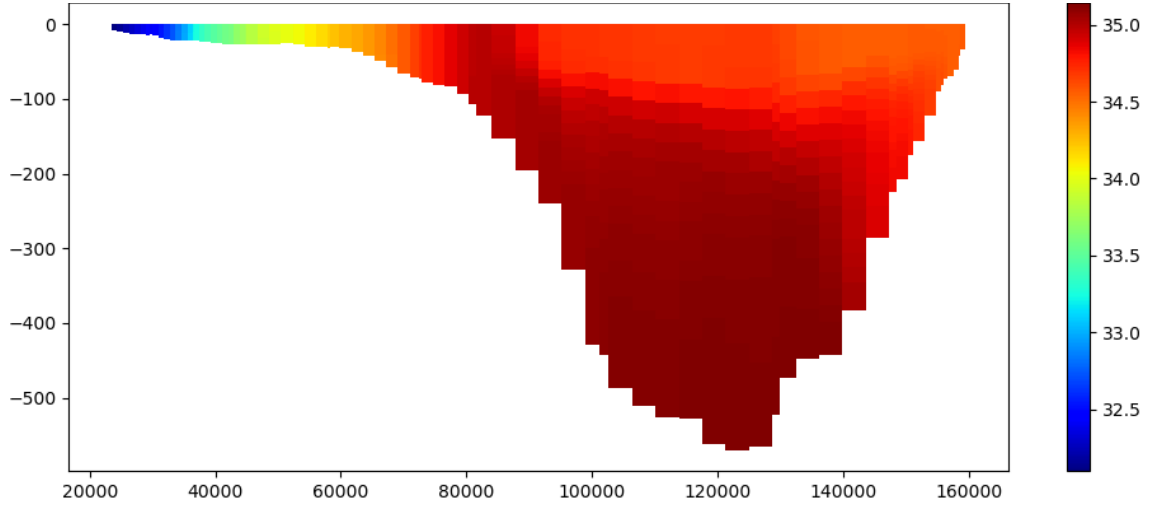
Examples: slice trough 3D partitioned FM map data

- given a polyline (blue)
- slice trough 3D partitioned FM map data









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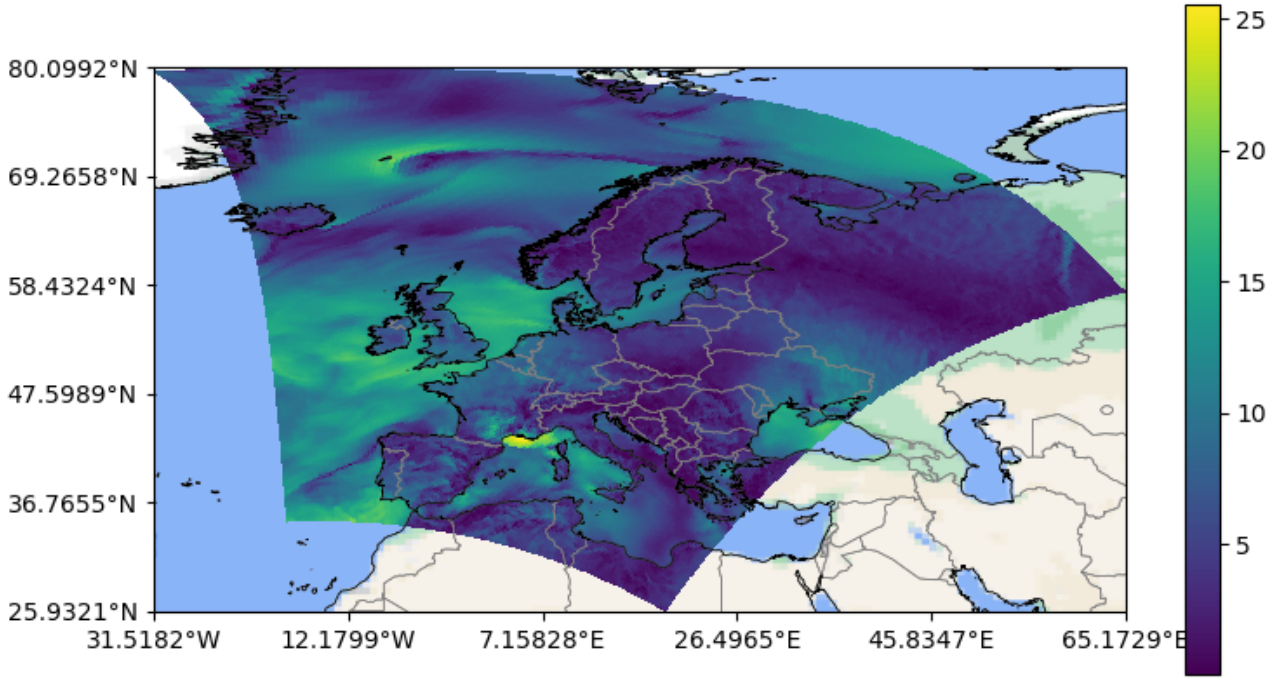
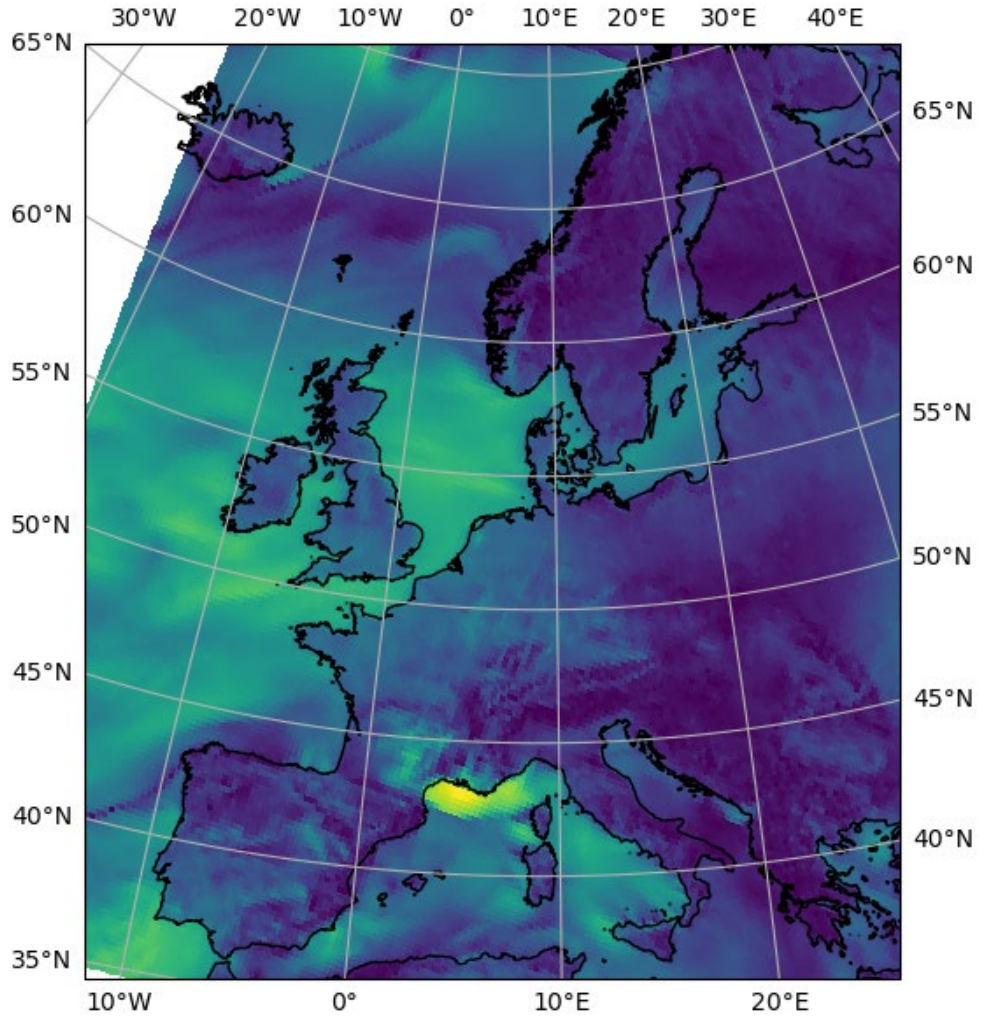
Examples: cartopy basemaps and coastlines/borders

- support for almost any epsg





Examples: vector plots for regulargrids

- SFINCS, Delft3D4, oceanmodels, meteomodels