NOOS annual report 2021

**Member report – DMI**

Nov 24th 2021

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| **Country** | Denmark |
| **Institution** | Danish Meteorological Institute |
| **Observations****Status and new initiatives**  | ***Status:*** ***Operational***:*Tide gauges.* DMI acts as data centre for a national network of ~90 coastal sites, roughly 1/3 owned by DMI, 1/3 by Danish Coastal Authority, 1/3 by local agencies/authorities. An increasing number of sites have two recorders of different types (e.g.1.radar, 2.pressure gauge). A single off-shore station remains, others have been closed down due to maintenance cost. New municipal stations are added, climate adaptation being an increasing concern.*Current meter moorings.* None are operated by DMI. FCOO has resumed the responsibility*Water temperature.* Recorded at some metres' depth by harbour located DMI pressure tide gauges. May not be represenatative for open waters.*Sea surface temperature*: Daily SST and SST anomaly maps based on midnight infra-red remote sensing.***New Initiatives:***Doubly equipped tide gauge staitons encouraged as standard but not a requirement.***Under development:***On-line and NRT sea level QC by a modified version of SELENE software package, obtained thru Puertos del Estrado, Spain. |
| **Modelling****Status and new initiatives** | *Status:*The modelling tools described below are implemented for the North Sea – Baltic Sea region. The DMI Arctic involvement is left out.Development is mainly on implementation, less on code level..* *Circulation*: HBM model code in a two-way nested implementation
	+ Storm set-up with 6 nested grids (3 to 1/10 n.m. resolution)..Oil Drift stand-by module.
	+ Copernicus set-up with 4 nested grids (3 to ½ n.m resolution), and increased vertical resolution in the Baltic to properly resolve benthic processes and salt intrusions. Tidal potential and marine ecology optional, but switched off.
* *Circulation*: NEMO 4.0
	+ Copernicus re-analysis run using the NEMO Nordic 1 n.m. set-up.
* *Waves*: WAM cy4.5
	+ A three-level nested set-up, with a coarse grid North Atlantic model run mainly as a swell generator, a regional 3 n.m model, and a ½ n.m. model for Dansh Domestic Waters.
* *Tracer model:*
	+ An Eulerian tracer model has been developed in HBM framework to modelling the fate of microplastics in the sea, by adding sinking and biofouling processes.
	+ A BSH developed Lagrangian drift model simulates drift of objects, drift and spreading of substances, drifrt, spreading and weathering of oil, in off-line mode.
* *Weather forcing:*
	+ 2.2 km DMI-Harmonie (non-hydrostatic) 0-2½ days
	+ 9 km ECMWF 0-10 days.

*Operational** *Storm surge*: A 5 day forecast is updated every 6 hours.
* *Tides*: A one-year tidal run (no atm. forcing) carried out for use in NOOS surge forecast exchange.
* *Drift*: An off-line Lagrangian drift/dispersion model (BSHdmod) for substances and objects interfaced. To be run on demand.
* *Copernicus*: A 6 day forecast is updated every 12 hours..
* *Hydrology*: SMHI E-hype3 hydrological model for daily run-off and (optionally) bioloads interfaced to HBM. Of the 8-day forecast, only the analysis is used so far.
* *Waves*: A 5½ day forecast is updated every 6 hours.

*New initiatives** Storm surge ensemble prediction. Validation study to inter-compare the quality of deterministic vs. ensemble mean or median predictions.
* Ensemble forecasts based on DMI-Harmonie NWP (COMEPS) forcing. 18 ensemble members. Only weather forcing is perturbated, ocean models run as deterministic threads. Ensemble mean, spread, and risk assessment results
* Tidal potentail has been extended beyopnd 2020
* Tidal boundary phase correction study
* Nudging Baltic deep water salinity towards climatology to avoid long.term freshening
* Scale E-hype3 river inflow, with the same purpose
* Flooding pilot project. The DMI storm surge forecast of coastal sea level is combined with a high-resolution (0.4m) height model to give a real-time estimate of flooding potential.

*Pre-operational** Wave model ensembles. See <http://ocean.dmi.dk/validations/waves/ensemble.php>

 Operationalisation is an open question.* Storm surge ensembles. See <http://ocean.dmi.dk/validations/surges/ensemble.php>

Inactive due to hpc resource problems.* Wave model upgrade. WAM cycle 4.5.4 run on a Gaussian grid for Greenland/Arctic wave forecasting, using Osisaf as ice data source for wave modeling.

 To be operationalised.*Under development** Increase model resolution in the Wadden Sea / German Bight.
* Pdaf data assimilation for NEMO under BALMFC. Pdaf in HBM ocean model put on hold.

*Planning:** Nemo vs. HBM storm surge comparison
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| **Dissemination****Status and new initiatives** | *Status:** Ocean forecast service ([www.dmi.dk](http://www.dmi.dk/), [ocean.dmi.dk](http://ocean.dmi.dk/)), including
	+ Sea level
	+ Tide
	+ Water temperature
	+ Surface salinity
	+ Sea ice
	+ Waves
	+ Sea state
* Ocean monitoring service, including
	+ Sea level
	+ Tide
	+ Daily SST map
* Ftp box service (for NOOS):
	+ Tide gauge data (DMI and other providers)
	+ Wave buoy data (third party)
	+ Sea level forecast at North Sea ports
	+ Wave forecast at buoy/platform locations
	+ Modelled transport for North Sea cross-sections
	+ Modelled hydrodynamics for North Sea multi-model ensemble
* in-NOOS service
	+ Responsible for North Sea – Baltic Sea region real-time synoptic sea level information system at noos.eurogoos.eu .Maintenance level is low due to lack of internal technical support and general re-building of DMI web services.

*New initiatives:** “Free Data” project funded and kicked off. A four-year project with six milestones, the first being synop data, the last forecast data.
* Climate atlas for future climate adaption. Funded and underway. Includes hydrodynamic and wave modelling and statistics in 30-year time slots; historical and one or two future scenario(s).
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| **Relevant national projects** | Climate Atlas: Information system aimed at municipalities for climate adaptation. First release primo Oct 2019 included air temperature, precipitation, mean sea level and storm surges.MEMC:On-going national co-operation on marine ecological modelling (DTUaqua, DCE, DMI)Flooding: Pilot study, setting up a warning system for in-land flooding caused by storm surges. Combines a high-resolution height model with coastal surge prediction.COHERENT: Development of software tools, data, and recommendations for effective coastal hazard risk reduction and management, to be presented at a multidisciplinary digital platform. |
| **Relevant International projects** | Copernicus: EU Marine Core Service project, Baltic physics and ecosystem.ESA-CCI: long-term SST re-analysis from satelliteLC-WFV: Operational wave model validation project, global and regional. Managed by ECMWF.CLAIM: Cleaning marine Litter by developing and Applying Innovative Methods – a H2020 project coordinated by HCMR. DMI combines operational wave, circulation and drift models to simulate the fate of plastic litter in the Baltic Sea in high resolution. EuroSea: European Contribution to the Future of the Seas and Oceans Flagship Initiative, H2020 project. DMI works on BOOS-HELCOM integration with Technical University of Tallinn (TTU) via near real time delivery of HELCOM ship observations and rapid assessment of environment by assimilating the ship data.FORCOAST: Earth Observation services for Fishery, bivalves Mariculture and Oyster ground Restoration along European COASTs, H2020 project. DMI’s role is to develop information service together with DCE/AU for Limfjord oyster restoration.JERICO-S3: Joint European Research Infrastructure for coastal observatories – S3, H2020 project. DMI’s role is to assess added value by integrating monitoring and modelling for resolving challenging issues in regional connectivity and to on integrated monitoring strategy in Kattegat-Skagerrak- East North Sea region together with SMHI, NIVA, IMR and HZG.FRONTEX Oceanographic data aggregation and operational visualization service in the pan-European Seas. Provision of a dedicated pan-European Seas DMI wave model forecast and aggregated/multi-model ensemble forecast products.Ph.D. study of pollutant transport and water mass composition in the North Sea and Baltic Sea using anthropogenic radionuclide tracers. |
| **Additional information** | [http://ocean.dmi.dk](http://ocean.dmi.dk/) DMI ocean products, studies and services.<http://research.dmi.dk/home/research-topics/ocean> DMI ocean research projects |