



Arctic MFC  
marine.copernicus.eu

# Arctic modelling and prediction from the Copernicus Marine Services

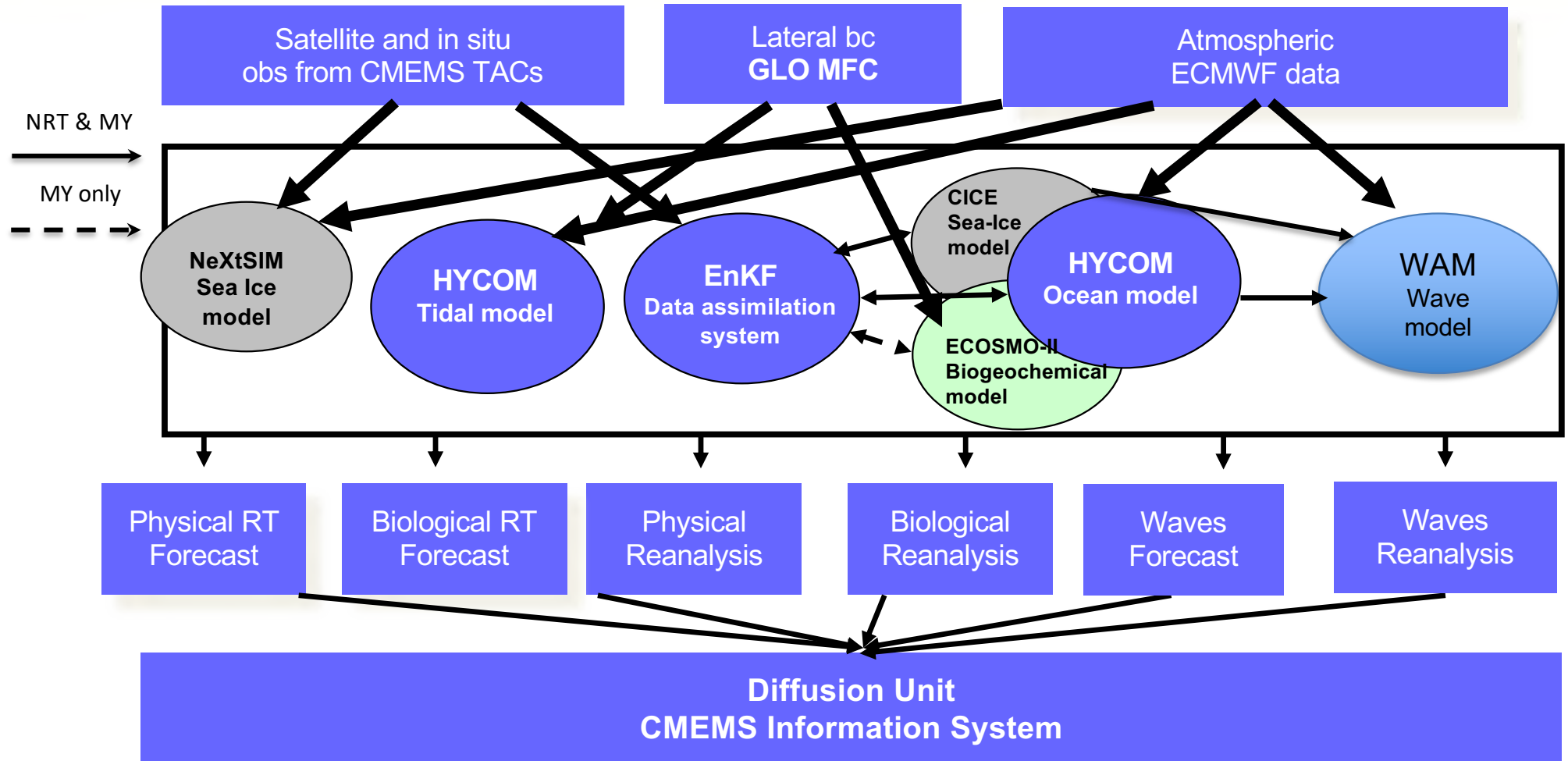
*L. Bertino, A. Samuelsen, J. Xie, T. Williams, T. Wakamatsu, V.Ç. Yumruktepe, A. Othmani, NERSC  
A. Ali, A. Carrasco, A. Melsom, MET Norway  
V. S. Lien, IMR*



<http://marine.copernicus.eu>



# Arctic Marine Forecasting Center: An integrated modeling system 2015– 2021



# New generation of sea ice forecasts

## neXtSIM-F sea ice forecast

- Lagrangian triangular mesh
- ~10km mesh size
- Brittle-Bingham-Maxwell rheology
- Scaling laws of sea ice deformations

## Stand-alone model

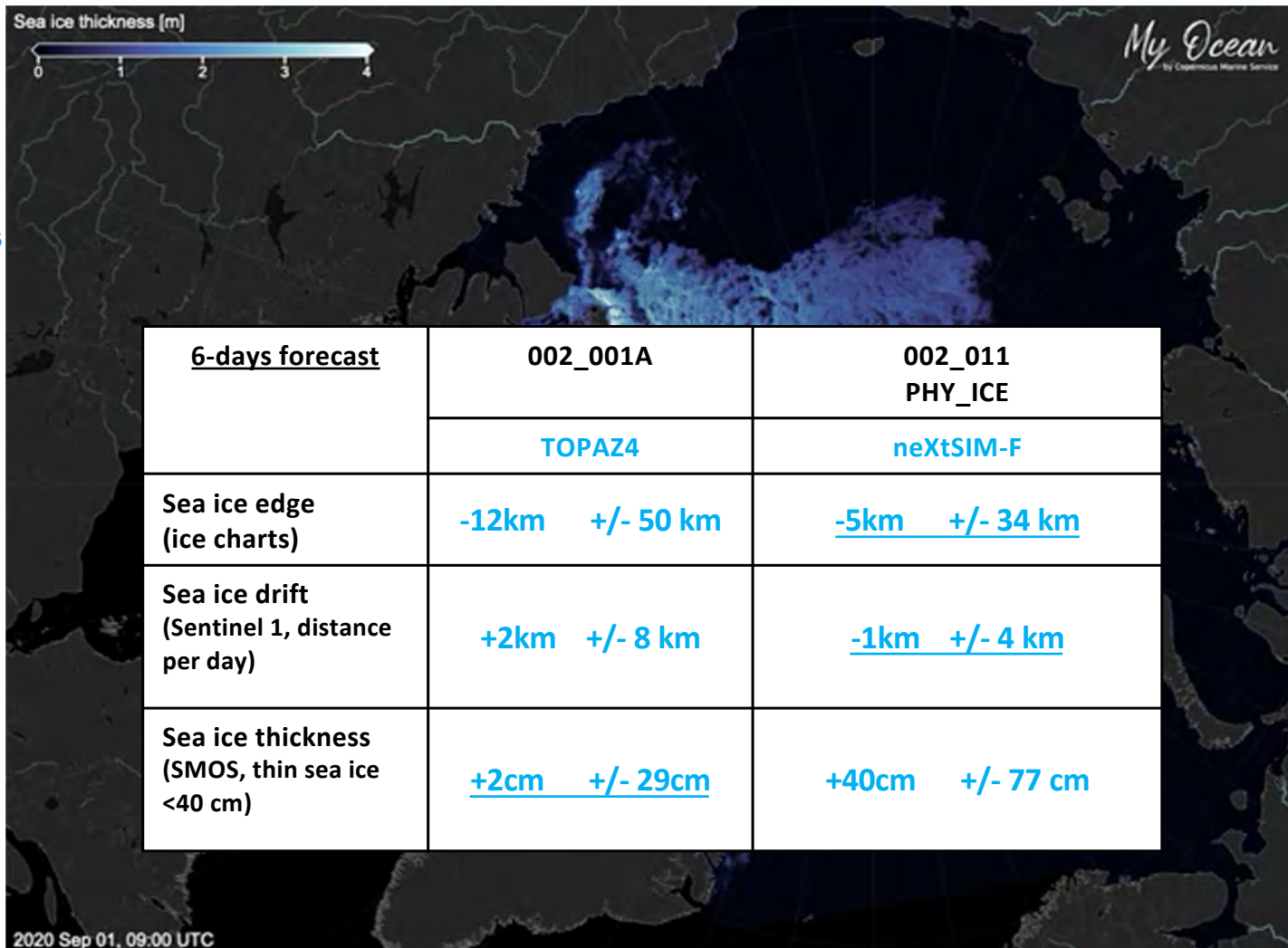
- ECMWF atmosphere
- Arctic MFC ocean

## Daily assimilation of

- OSI-SAF & AMSR-2 concentrations (nudging)
- Next: Ice thickness (CS2SMOS)

## In CMEMS since July 2020

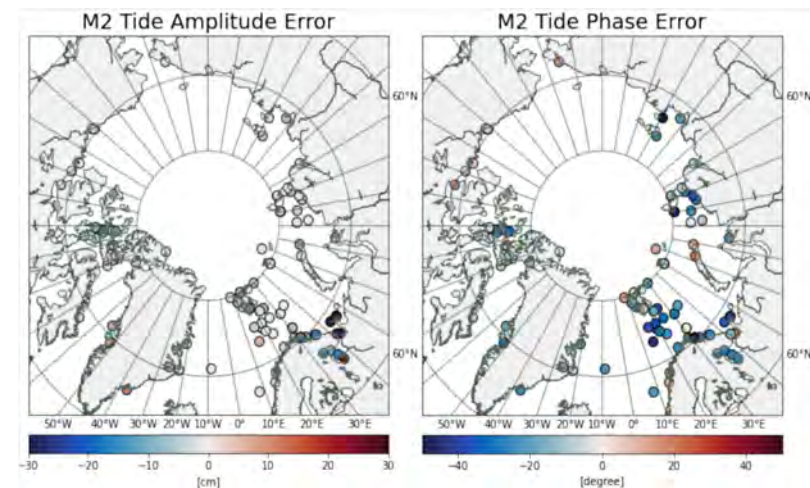
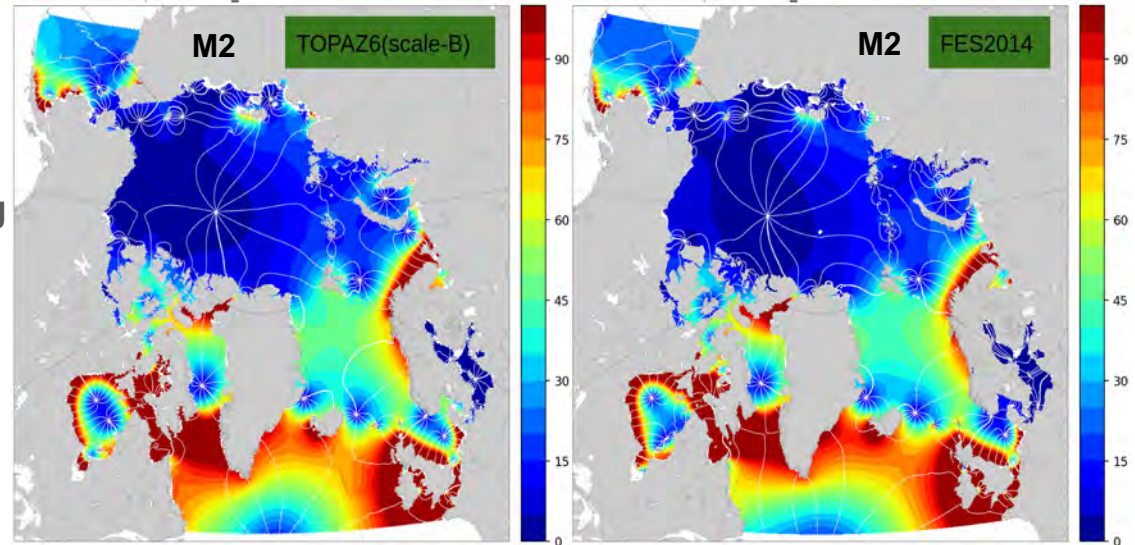
- Daily updated 7-d forecasts
- Hourly output frequency
- 3km resolution square grid





# Ocean currents at 3 km with storm surge and tides

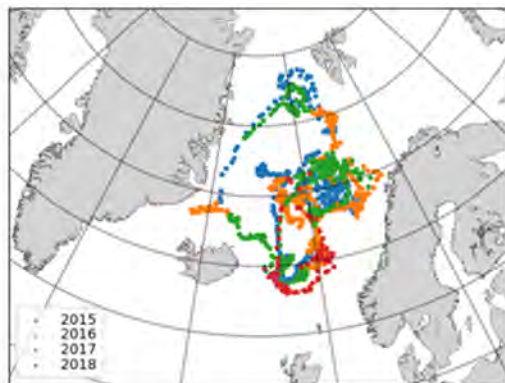
- **TOPAZ6: HYCOM v2.2.98 + CICE5.1**
  - 3km horizontal resolution
  - 50 hybrid z-isopycnic layers
- **Atmospheric forcing data: ECMWF, including pressure forcing**
- **Lateral boundary conditions from NEMO (CMEMS-GLO-HR)**
- **Lateral boundary FES2014 tides (tide elevations, currents and loading).**
  - 34 tidal constituents.
- **Operational since March 2020**
- **No data assimilation**
  - **Plan: spectral nudging to TOPAZ5**
- **Output: 10 days forecasts**
  - SSH, surface currents
  - 3km grid, 15 minutes frequency
- **Replaces national 4km system at MET Norway**
  - Preparedness (oil spills, search and rescue)
  - Boundary conditions to ROMS800



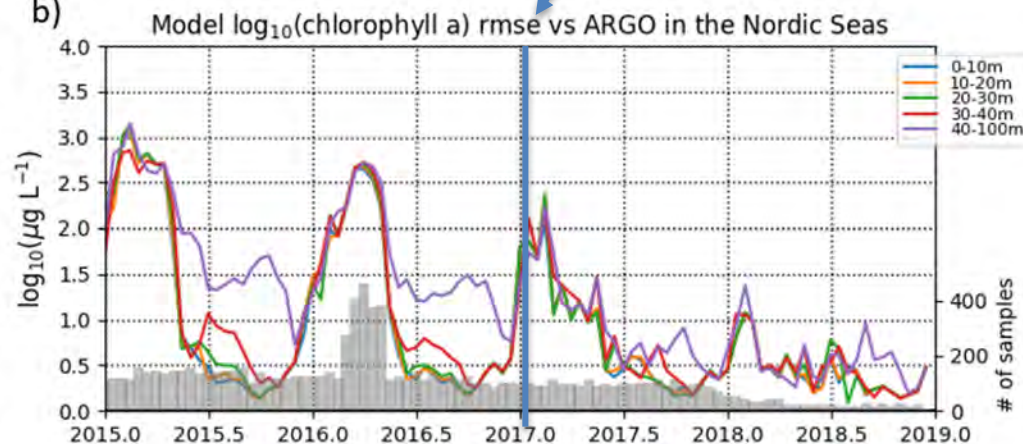
# TOPAZ5-ECOSMO new features in NRT

- HYCOM 2.2.98, 6 km resolution, 50 layers (40 interpolated levels in output)
- FABM online (high-frequency) coupling to ECOSMO-II
- Inclusion of the carbon cycle
  - New variables pH, DIC, spCO<sub>2</sub>, POM sinking
- Light through sea ice
- Improved inputs
  - Atmospheric deposition of Nitrate and Phosphate from EMEP
  - River discharge (water, not nutrients) from A+E-HYPE and GrIS CCI.
  - Lateral BC from GLO-MFC (PISCES), daily frequency
- Direct insertion of vertically projected Chlorophyll-a maps (Uitz et al. 2006)
- Pre-operational but without assimilation of physics

a)



b)



# Ongoing updates:

## Biogeochemical products

- **Reanalysis 2007-2019 (Dec 2021)**
  - **ECOSMO 25 km resolution**
  - **Ensemble Kalman Smoother**
    - Assimilation of satellite ocean colour
    - Assimilation of nutrient profiles
  - **40 vertical output levels**
- **10 days Forecast (May 2021)**
  - **Previous slide**

## Sea Ice forecast (neXtSIM-F)

- **Larger domain (Dec 2021)**
  - **Canadian Archipelago**

## Wave products

- **Wave hindcast 1998-2020 (May 2021)**
  - **WAM 3 km resolution**
  - **Latest parameterisations**
  - **ERA5 forcing**
  - **Hourly frequency**

## Ocean physics

- **New reanalysis 1991-2020 (Dec 2021)**
  - **HYCOM 12 km resolution**
  - **From 28 to 50 vertical z-isopycnic layers**
  - **ERA5 forcing**
  - **Assimilation of CCI data records**
  - **Arctic+Salinity SSS from SMOS**
  - **40 vertical output levels**

## Near-term (3 years)

- **Improve accuracy**
  - Higher resolution 12 km -> 6 km
  - River inputs in NRT from A-HYPE
- **Improve mutual consistency**
  - Wave terms in ocean (Ali et al. 2019, SE project WAVEFLOW)
  - Uptake from SE WIZARD and ZOOMBI
- **User-targeted**
  - Long biogeochemical hindcast
  - Ensemble forecasts
  - Bias correction

## Long-term (6 years)

- **Improve accuracy**
  - Assimilate sea ice deformations from Sentinel-1
  - Assimilate new missions (SWOT, CIMR, CRISTAL)
  - Coastal observations (HF radar, Ferrybox, glider transects)
  - New IBCAO bathymetry
- **Improve consistency**
  - Coupling framework
  - Extended range forecast
  - Sea ice biogeochemistry

## Blocking issues – external

- Poor WOA Arctic climatology
- Scattering of in situ data (hydrographic, biogeochemical, waves)
- Availability of HPC



A winter scene featuring a large, partially frozen pond. The ice is a mix of white and light blue, with some open water reflecting the sky. In the foreground, a group of ducks is swimming in the open water. In the background, a small, arched stone bridge spans across the pond. The surrounding area is covered in snow, with trees and bushes also blanketed in white. The overall atmosphere is serene and cold.

**Thank you!**