



Norwegian
Meteorological
Institute

Validation of the CMEMS forecasting for the Arctic Region

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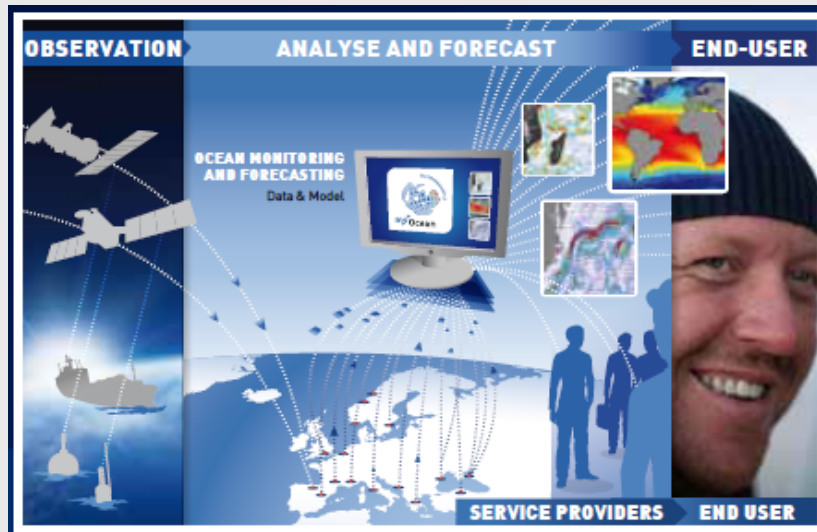
¹ MET Norway, ² NERSC, ³ IMR

June 2-4, 2015

CMEMS ?

Copernicus Marine Environment Monitoring Services

- **European Service lead by Mercator, France:**
 - Providing regular and systematic ocean information
 - Global to regional
 - Science based
 - Free and easy accessibility

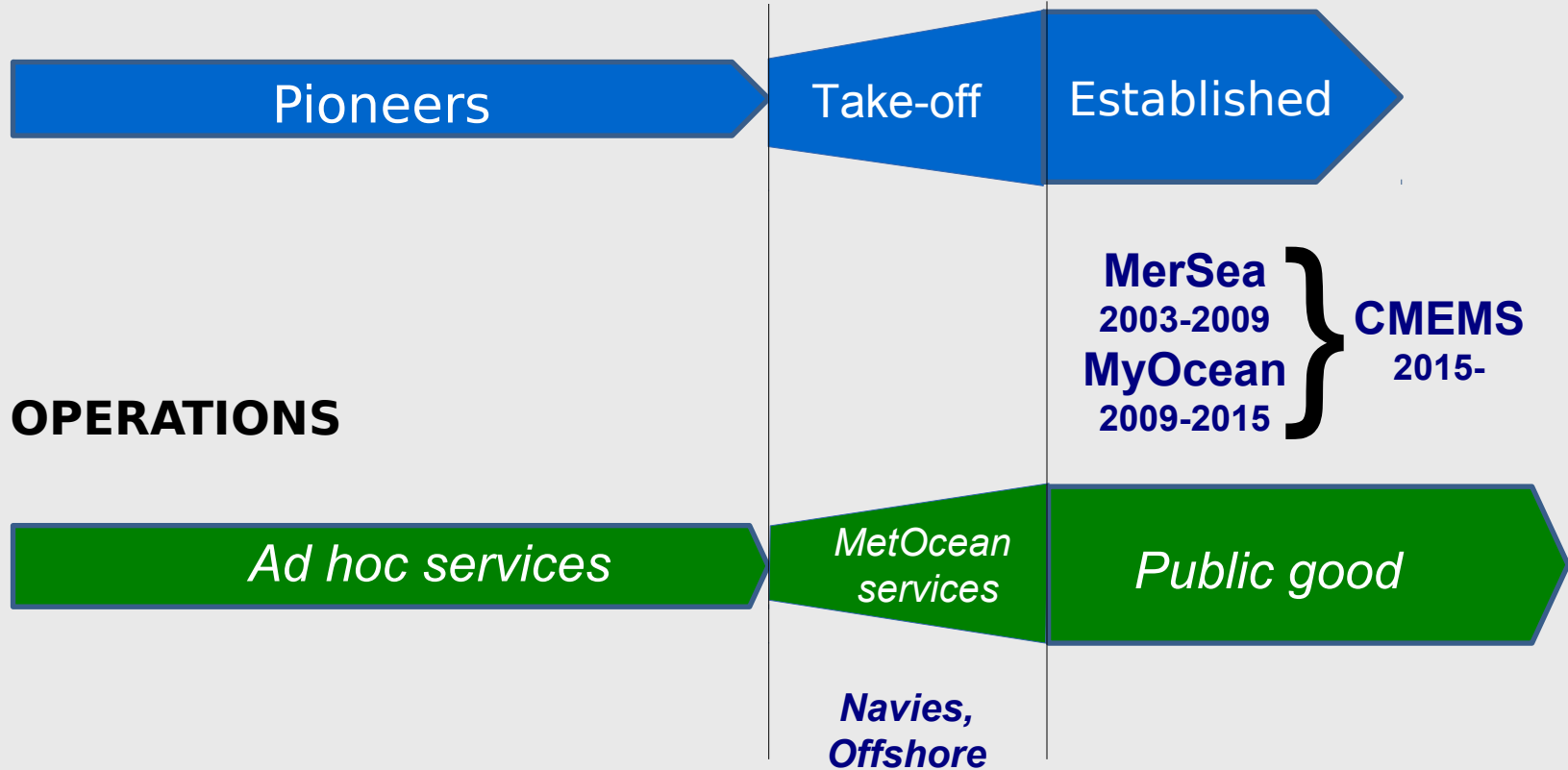


From Research to Operations

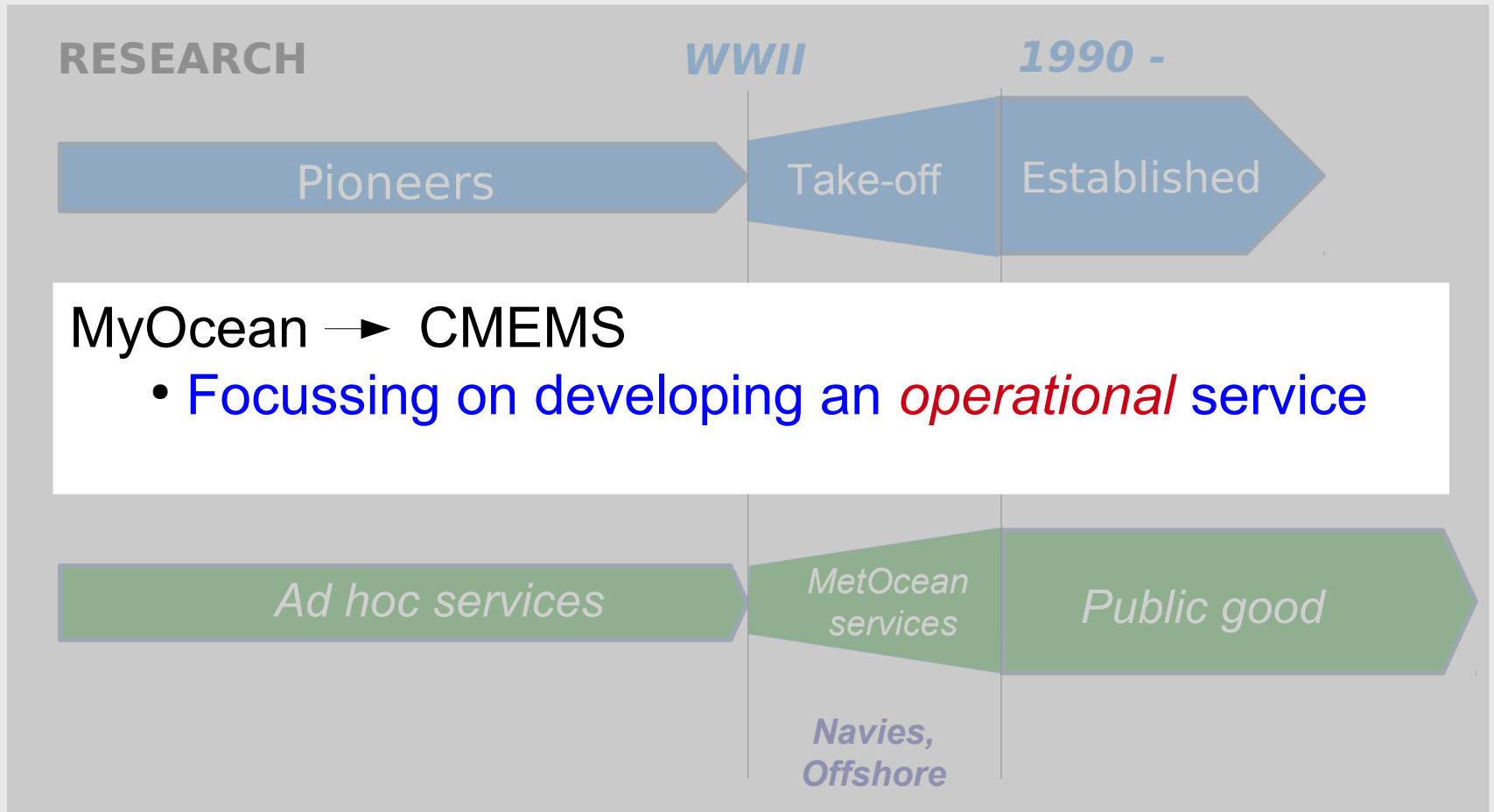
RESEARCH

WWII

1990 -



From Research to Operations



Distributed Activities

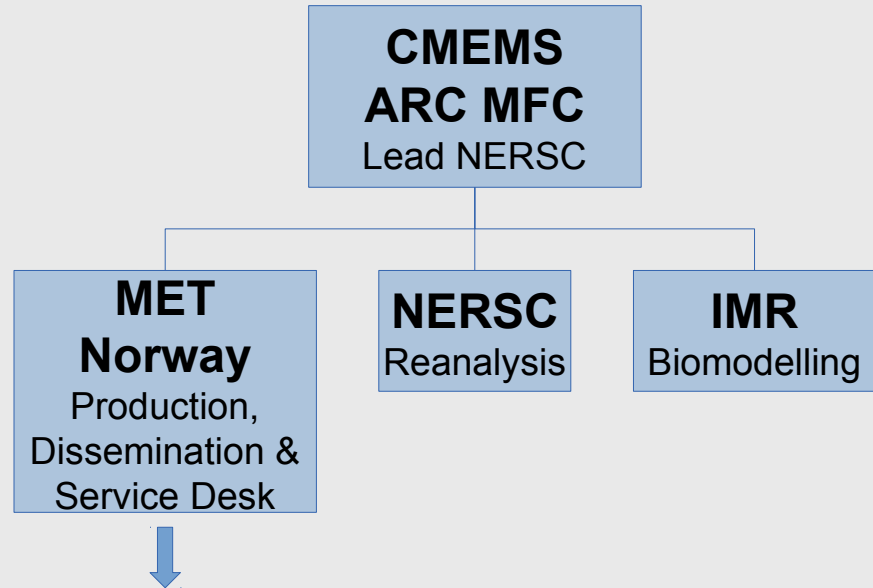
- Distributed Production and dissemination
 - Seven Monitoring and Forecasting Centers (MFCs)
 - Several Thematic Assembly Centers (TACs)
- Common netCDF format & validation metrics
- One portal



- 1 Global
- 2 Arctic
- 3 Baltic
- 4 NWS
- 5 IBI
- 6 Med Sea
- 7 Black Sea

CMEMS ARC MFC

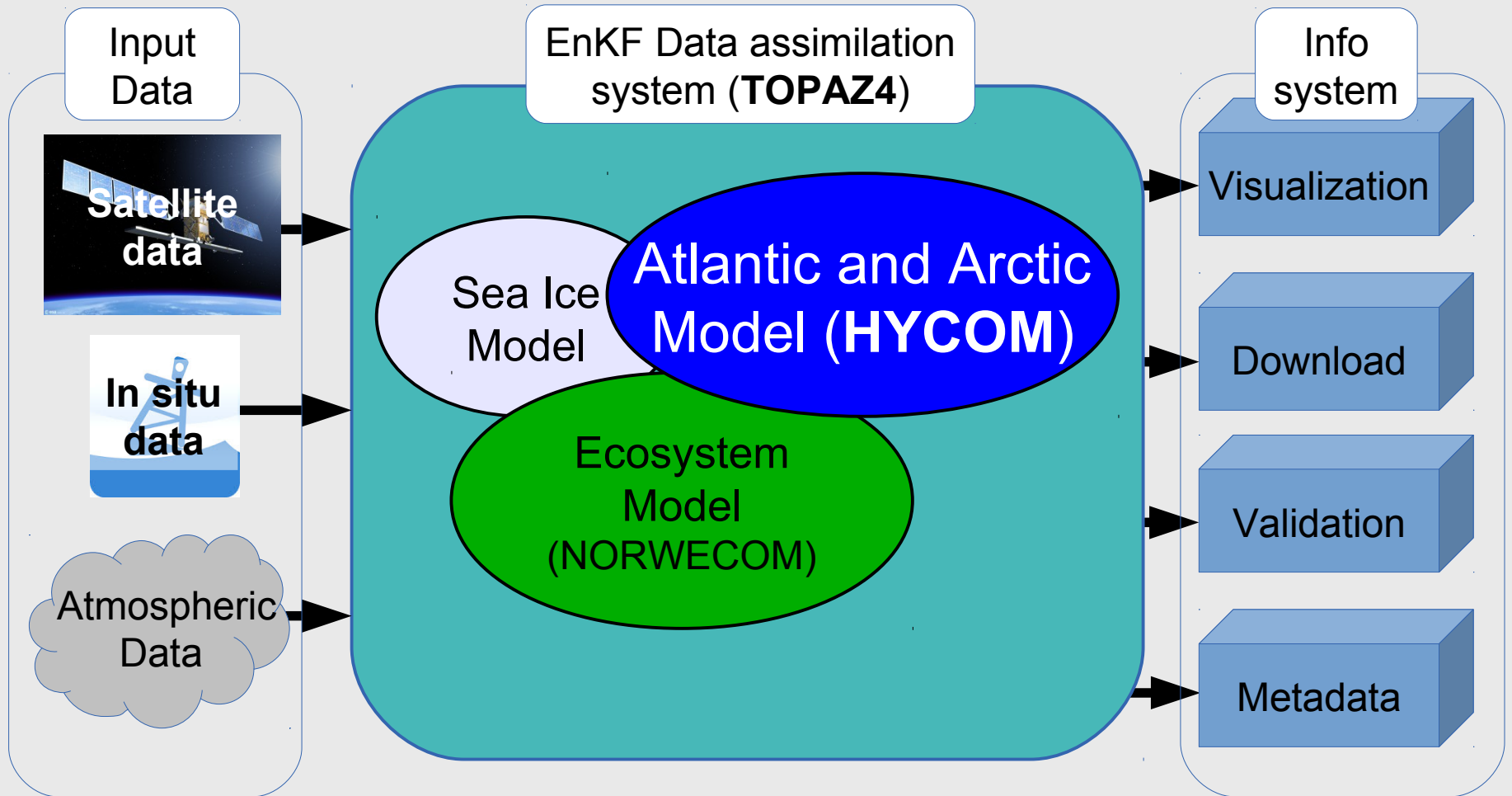
Arctic Monitoring and Forecasting Center



Daily forecasts:

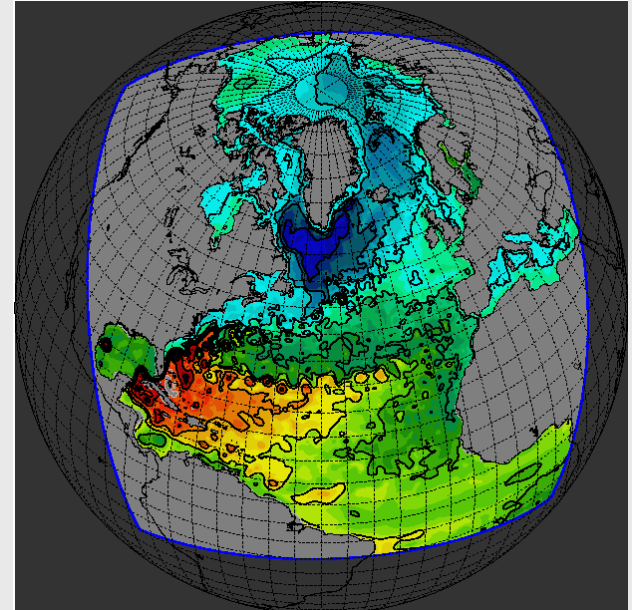
- Sea ice, water level, temp, salinity, biochemical components
- 10 days lead time
- Arctic region (north of $\sim 50^{\circ}\text{N}$)

The ARC forecasting system:



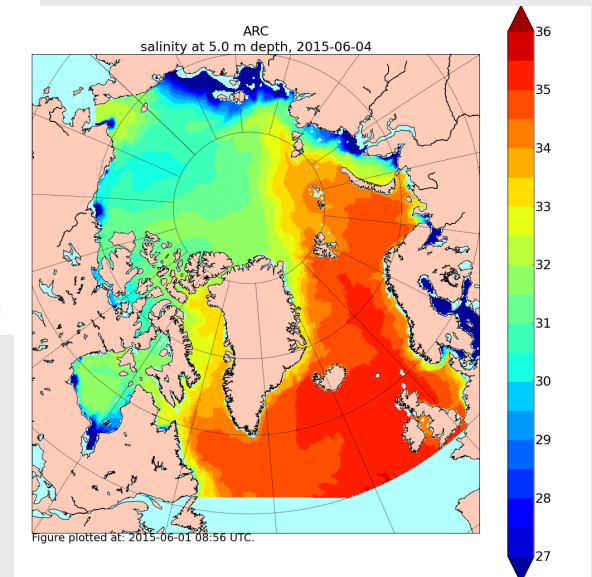
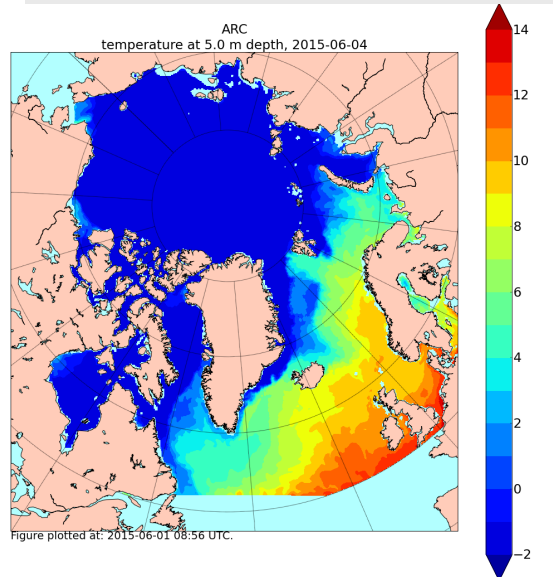
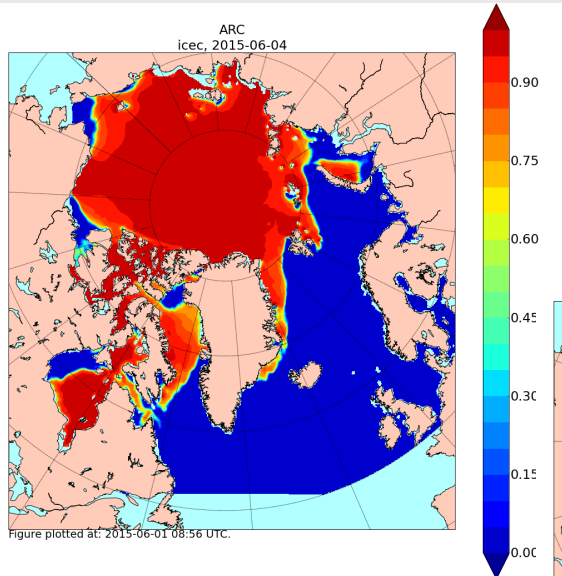
The TOPAZ4 system

- Physical model is **HYCOM**
 - Native grid covers the Arctic and North Atlantic Oceans (conformal mapping)
 - Grid size 11-16 km
 - 28 hybrid layers
 - Coupled to a sea ice model and a biogeochemical model (NORWECOM)
- Analysis is run once a week (Mondays)
 - lead time: Past week (- 7 days)
 - 100 ensemble members
 - Provides ensemble means (best estimate)
 - Assimilate remotely sensed SLA, SST, SIC, Lagrangian SIV, and in situ temperature and salinity profiles (all provided by the TACs)
- Forecast run once every day with a lead time of 10 days (7/365)
 - Forecast is the mean of 10 ensemble members run forward
 - Atmospheric input from updated ECMWF (6 hourly on a 16 km grid)



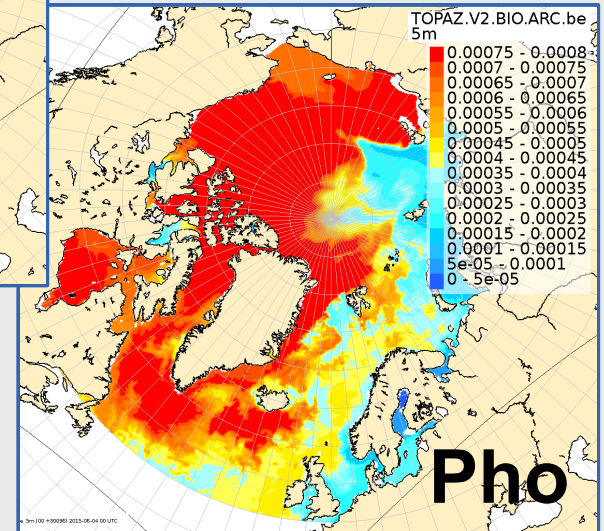
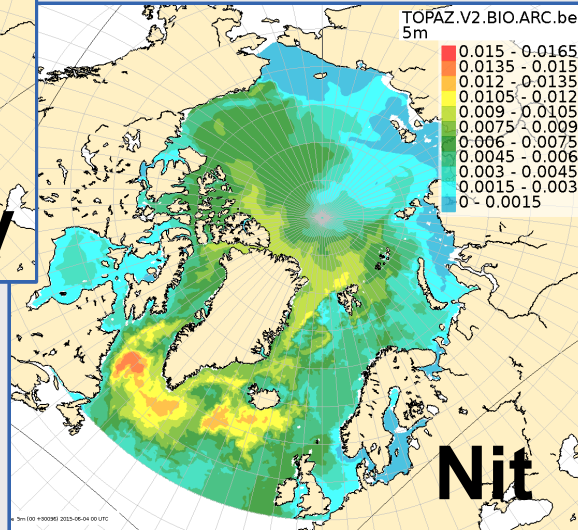
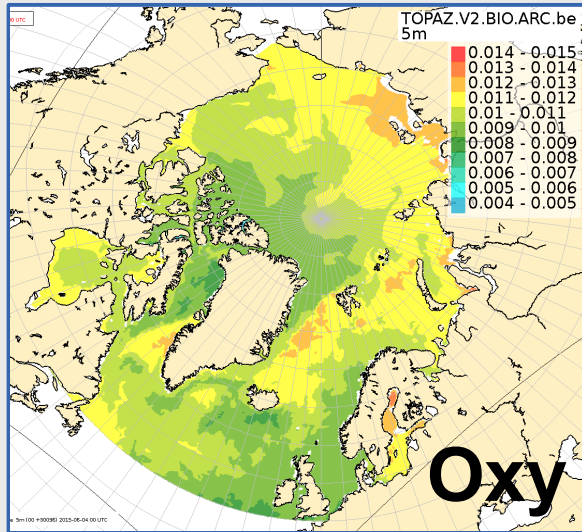
Sample physical forecast

Valid: 2015-06-04
Produced: 2015-06-01



Sample biogeochemical forecast

Valid: 2015-06-04
Produced: 2015-05-29



The CMEMS portal

Online catalogue: <http://marine.copernicus.eu/>

The screenshot shows the Copernicus Marine Environment Monitoring Service (CMEMS) portal. At the top, there is the European Commission logo and the text "COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE Providing PRODUCTS and SERVICES for all marine applications". A search bar is located in the top right corner. Below the header, there is a navigation menu with links for "ABOUT US", "BENEFITS", "NEWS", "SCIENCE & LEARNING", "TRAINING", and "SERVICES PORTFOLIO". The main content area features a "SHORT-CUT TO SERVICES" sidebar with options like "REGISTER NOW", "ONLINE TUTORIALS", and "COLLABORATIVE FORUM". The central part of the page is titled "ACCESS TO PRODUCTS" and includes a "FIRST VISIT ?" button. Below this, there are sections for "AREA", "PARAMETERS", "TIME COVERAGE", and "OBSERVATIONS/MODELS", each with a corresponding button. A list of ocean regions is displayed, including "GLOBAL OCEAN", "ARCTIC OCEAN", "BALTIC SEA", "EUROPEAN NORTH WEST SHELF SEAS", "IBERIA-BISCAY-IRELAND REGIONAL SEAS", "MEDITERRANEAN SEA", and "BLACK SEA". A "2015 27 MAY" badge is visible next to the list. At the bottom, there is a "WELCOME TO YOUR COPERNICUS MARINE SERVICE !" section with a "READ MORE" button and a "LATEST NEWS FLASH" section with the title "CMEMS:2768 Catalogue Upgrade for Marine Copernicus Information".

Note 1:
All information have the same netCDF format (standardized)

Note 2:
Free access, (but you must register)

Choosing the Arctic

COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE
Providing PRODUCTS and SERVICES for all marine applications

ONLINE CATALOGUE

YOUR SEARCH

Found 29 products matching your criteria.

ARCTIC OCEAN PHYSICS ANALYSIS AND FORECAST

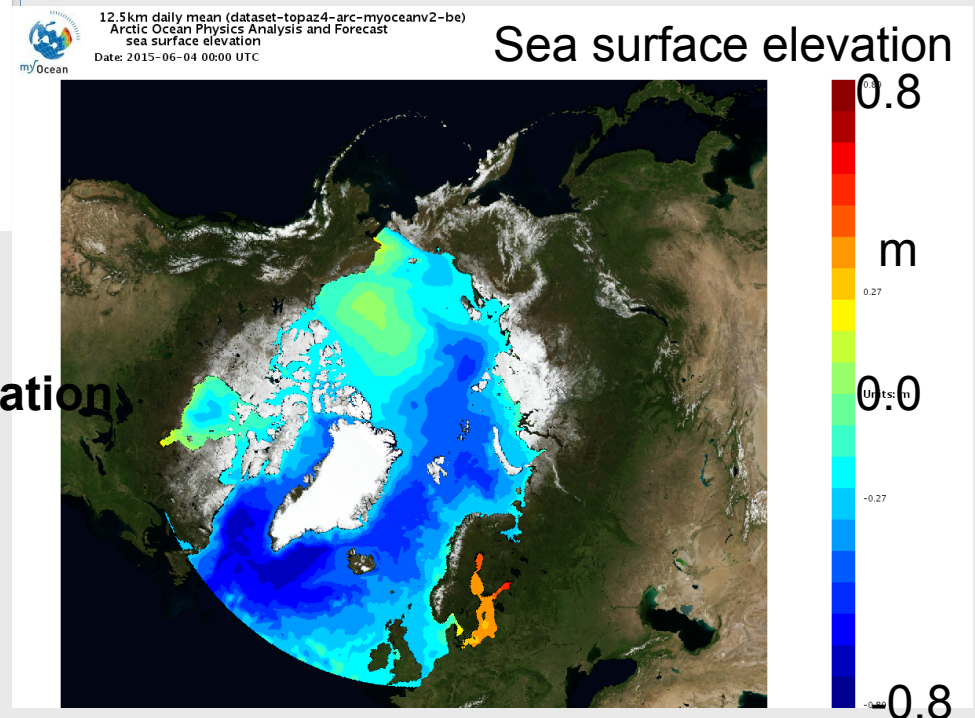
Numerical-model, Salinity, Sea-ice, Temperature, Currents, Sea-level, Near-real-time, Forecast, Arctic-ocean

ARCTIC_ANALYSIS_FORECAST_PHYS_002_00_1_a

ARCTIC OCEAN BIOGEOCHEMISTRY ANALYSIS AND FORECAST

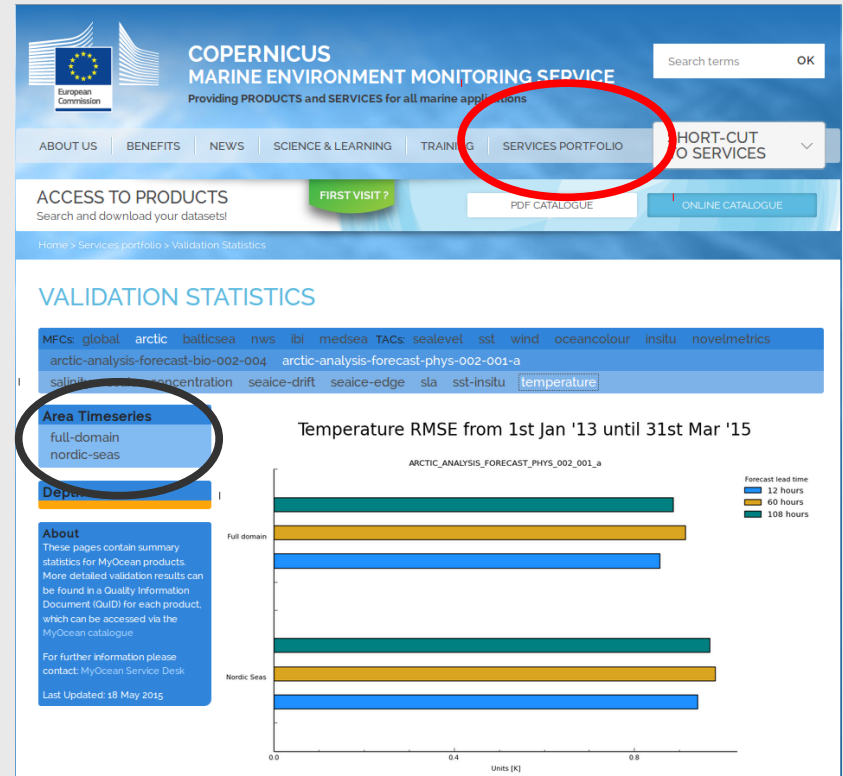
Download

Visualization

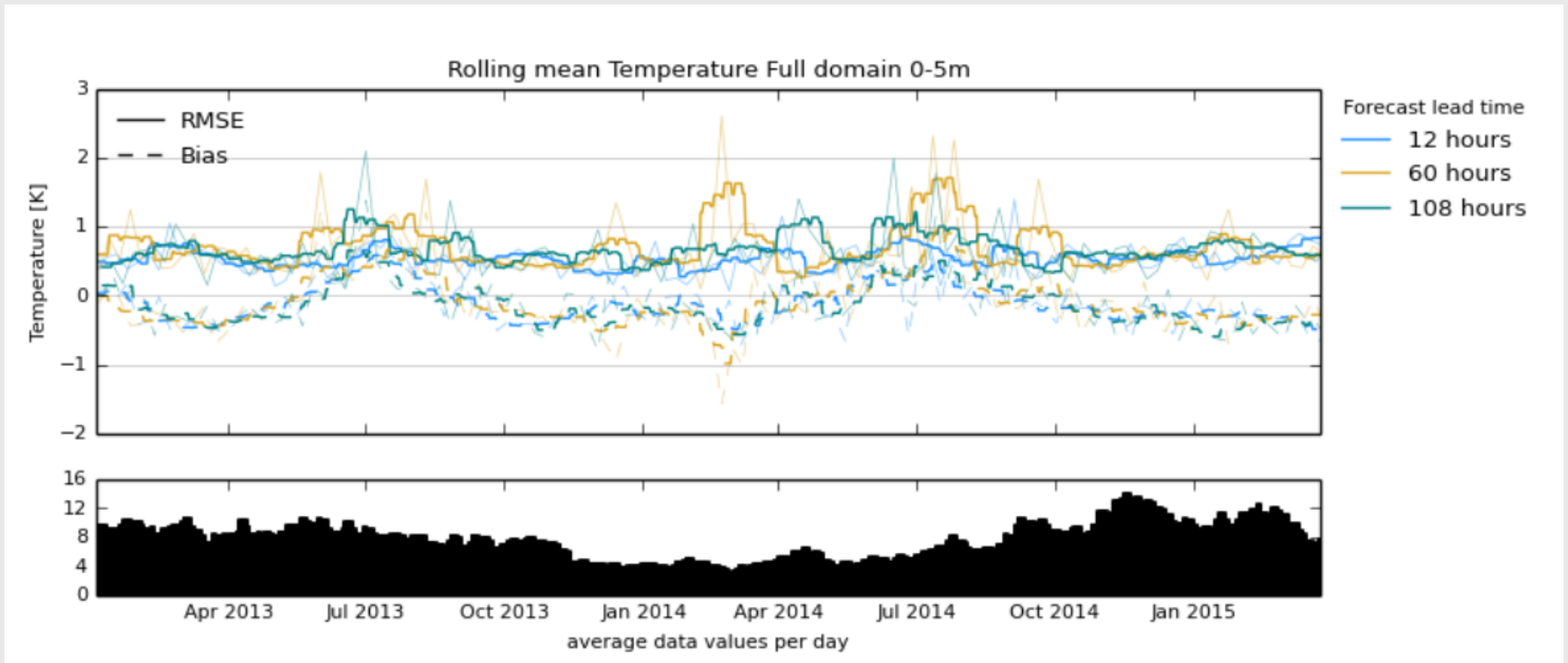


Validation

- All contributors deliver bias and rmse
- Standard format (netCDF)
- All statistics freely accessible
- Validation products (ARC):
 - SST vs. data from drifting buoys & vs. satellite data
 - T, S profiles vs. data from ARGO profiling buoys
 - Sea level anomalies vs. JASON-2 data
 - Sea ice drift vs. SAR data
 - Sea ice concentration vs. Ice chart data
 - Ice edge position vs. ice chart data

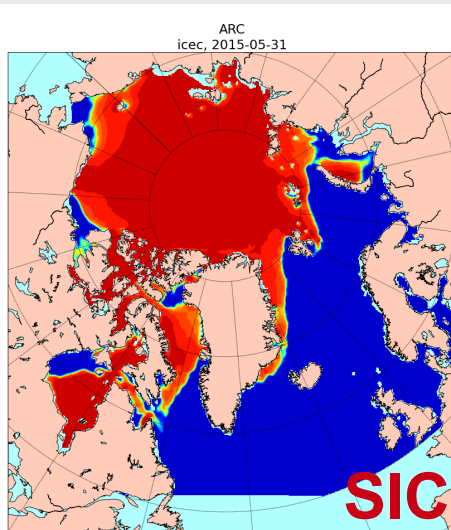


Rolling Mean time series of SST

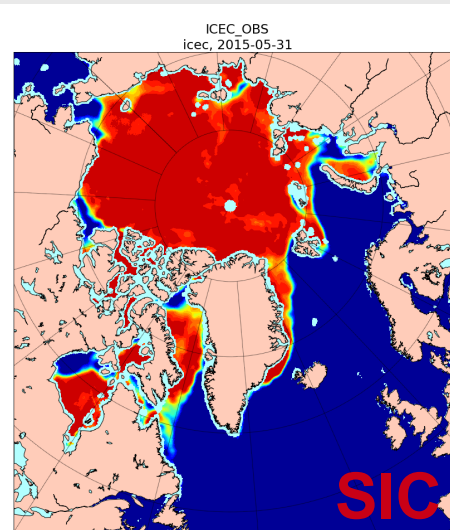
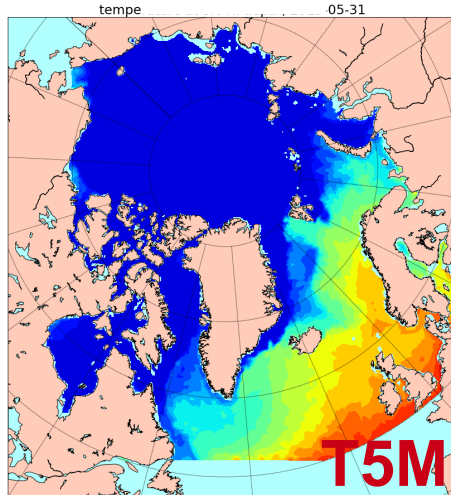


region: Full domain
parameter: Temperature
depth_range: 0-5m
reference: Profile observations from in-situ TAC

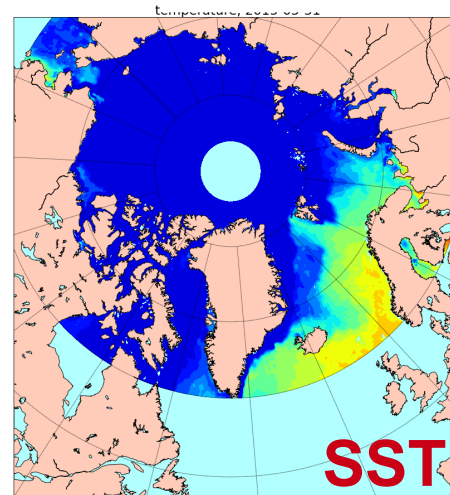
Weekly assessment (human expert)



Forecast



Observations



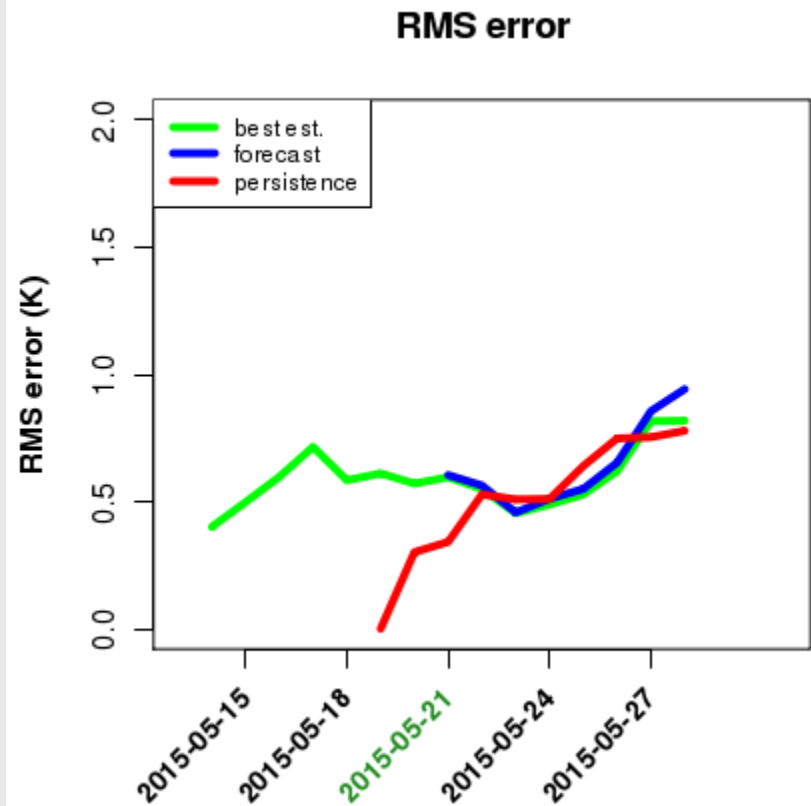
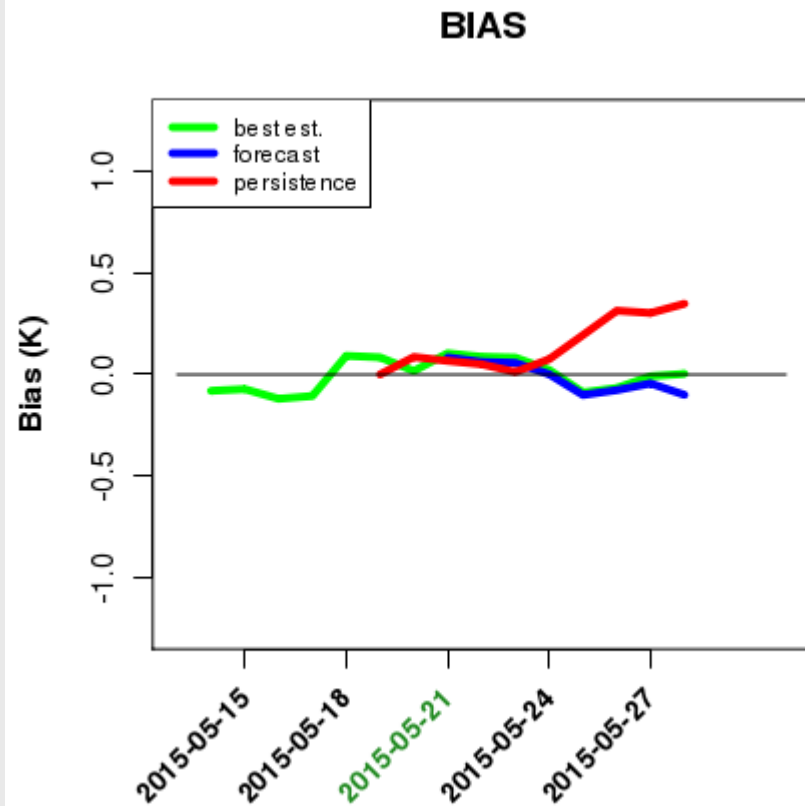
Sea ice

2015-05-31
Lead time: -1 day
Ensemble mean

Temperature

Bias and rmse of SST

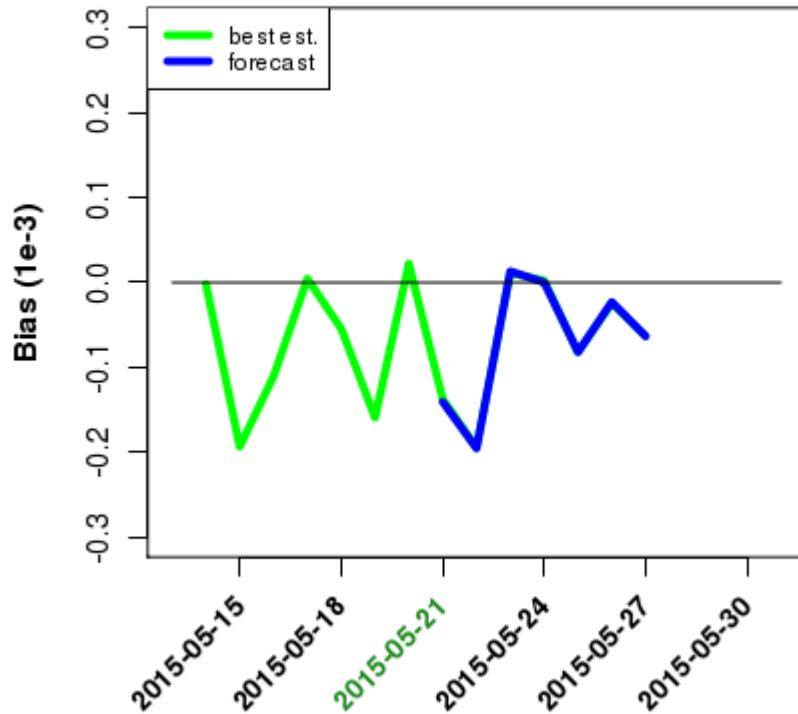
<http://myocean.met.no/ARC-MFC/Validation/index.html>



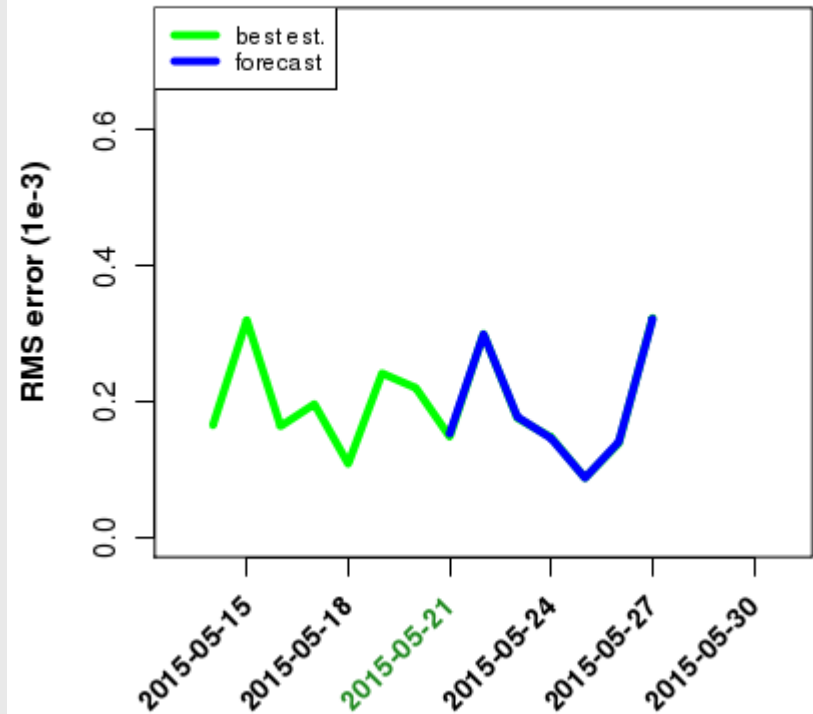
**Bulletin date:
2015-05-21**

Bias and rmse of salinity (5-100 m)

BIAS, layer 2 salinity

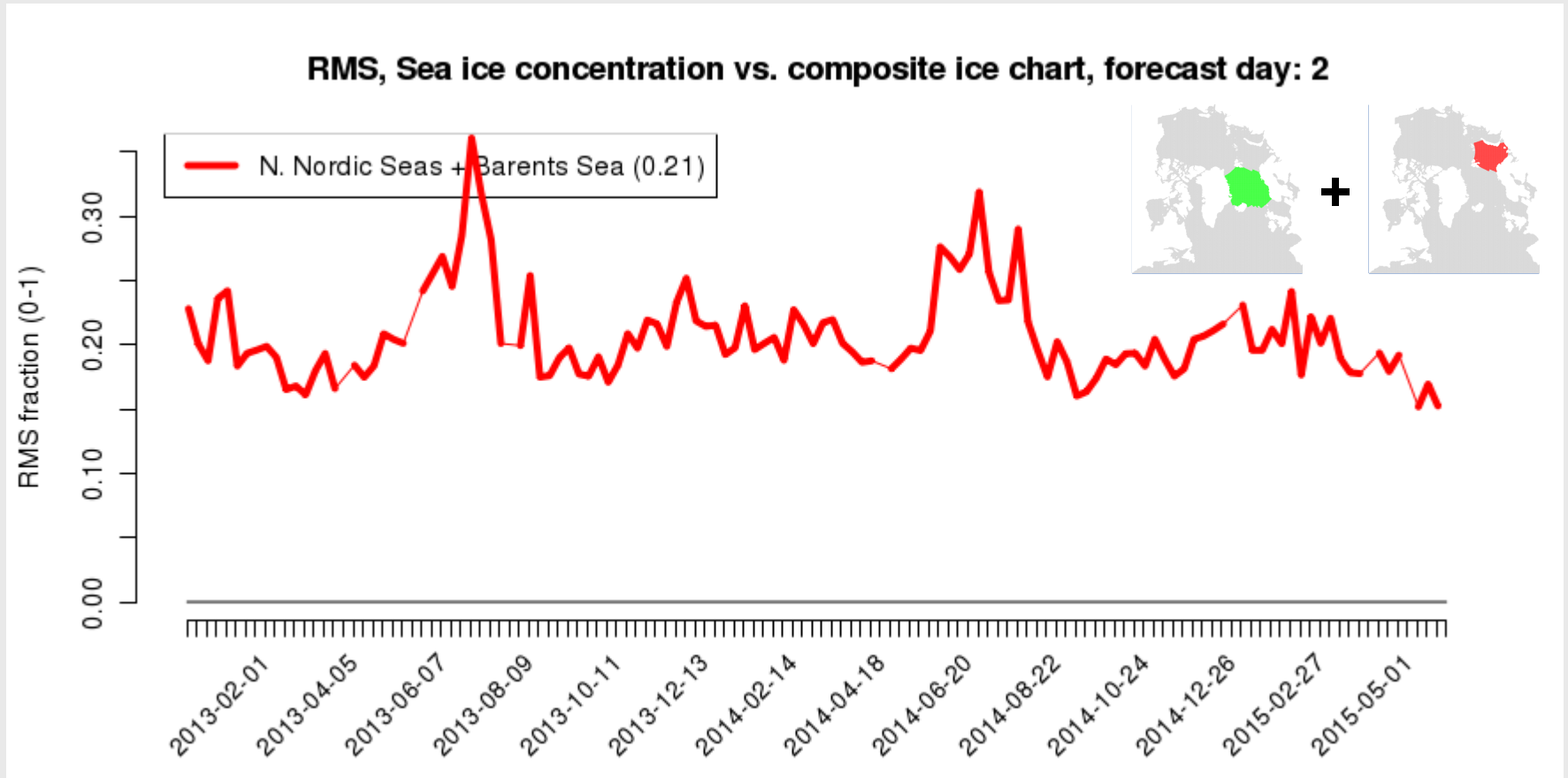


RMS error, layer 2 salinity



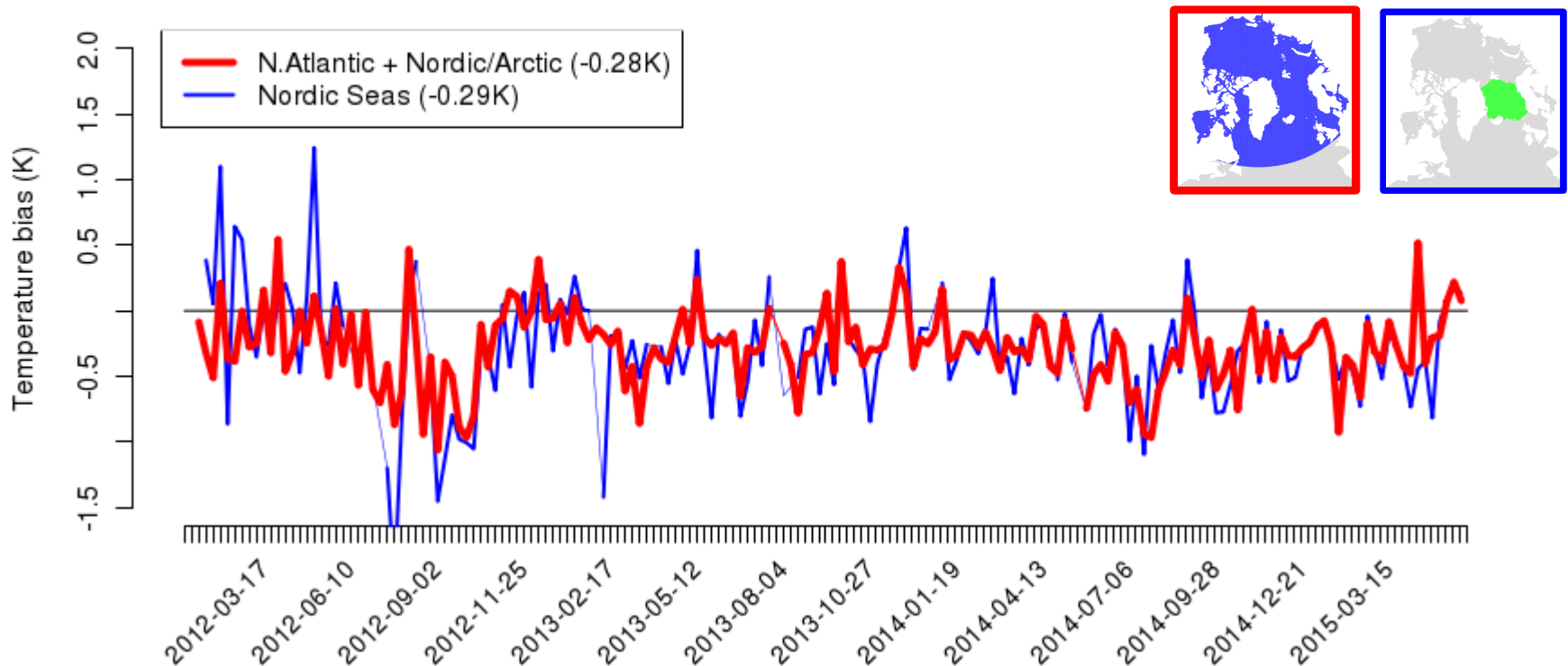
**Bulletin date:
2015-05-21**

Validation time series: SIC



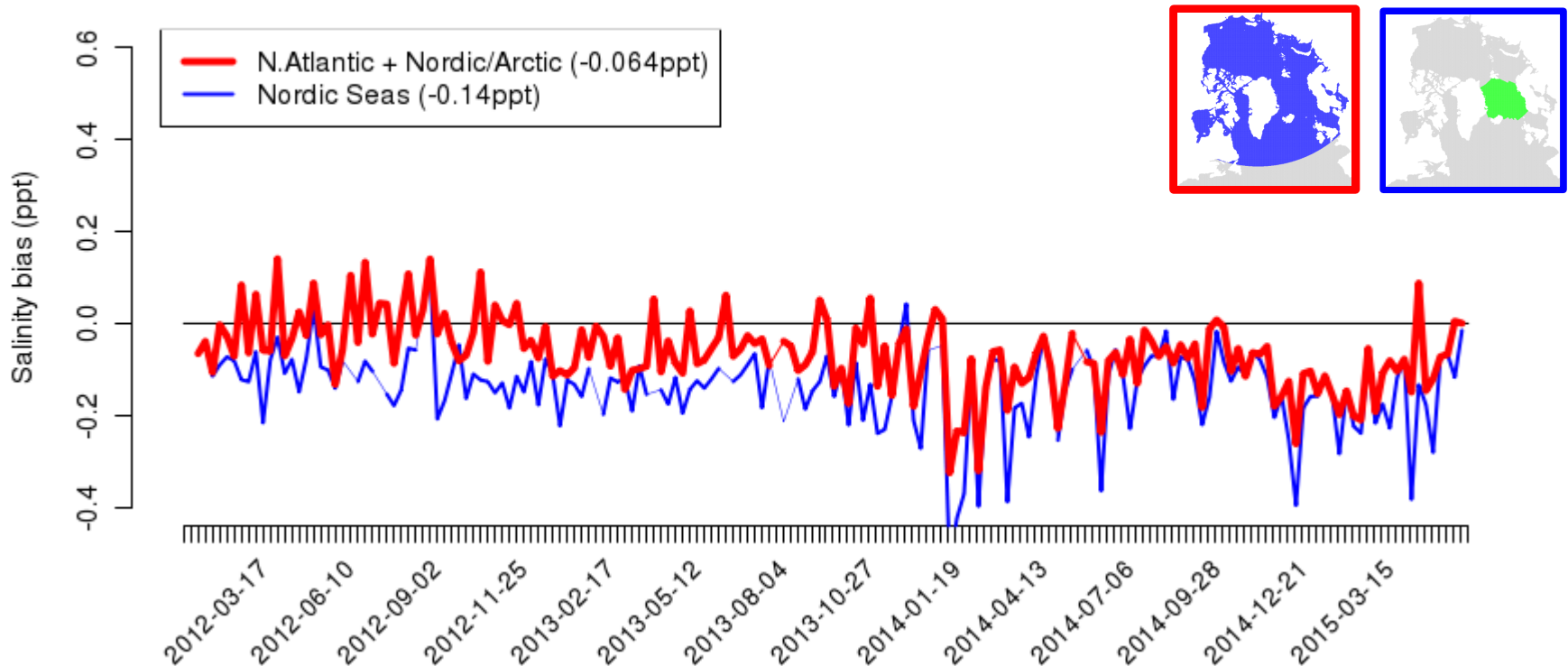
Validation time series: Temp

Bias, Layer temperature (5-100m) vs. ARGO data, forecast day: 4



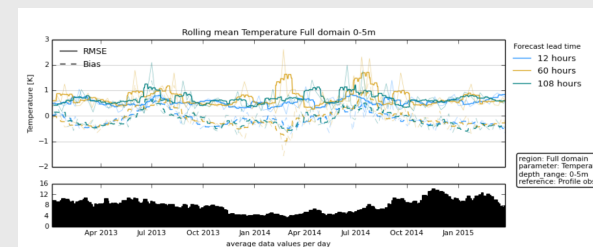
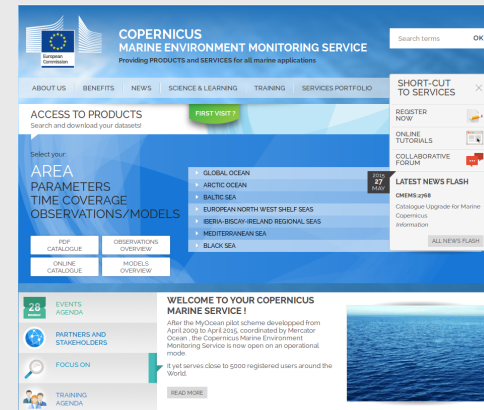
Validation time series: Salinity

Bias, Layer salinity (5-100m) vs. ARGO data, forecast day: 4



Summary

- A European ocean monitoring and forecasting service established (Copernicus Marine Environment Monitoring Service - CMEMS)
- One user portal
- Production of forecasts, reanalyses and observations distributed across Europe in MFCs and TACs
- Common format (netCDF) for all information products whether it is model results or observations
- Common validation metrics (bias + rmse) freely accessible



Summary

- In summary the validation of the CMEMS forecasting for the Arctic region gives
 - Sea ice fraction (rmse): ~ 0.2
 - Temperature (bias): ~ -0.3 °C
 - Salinity (bias): ~ -0.1 psu
- Norway also leads the wind, ice and SST TAC (WITS)



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Thank you