A Global Ocean eddyng Forecasting System at 1/16°

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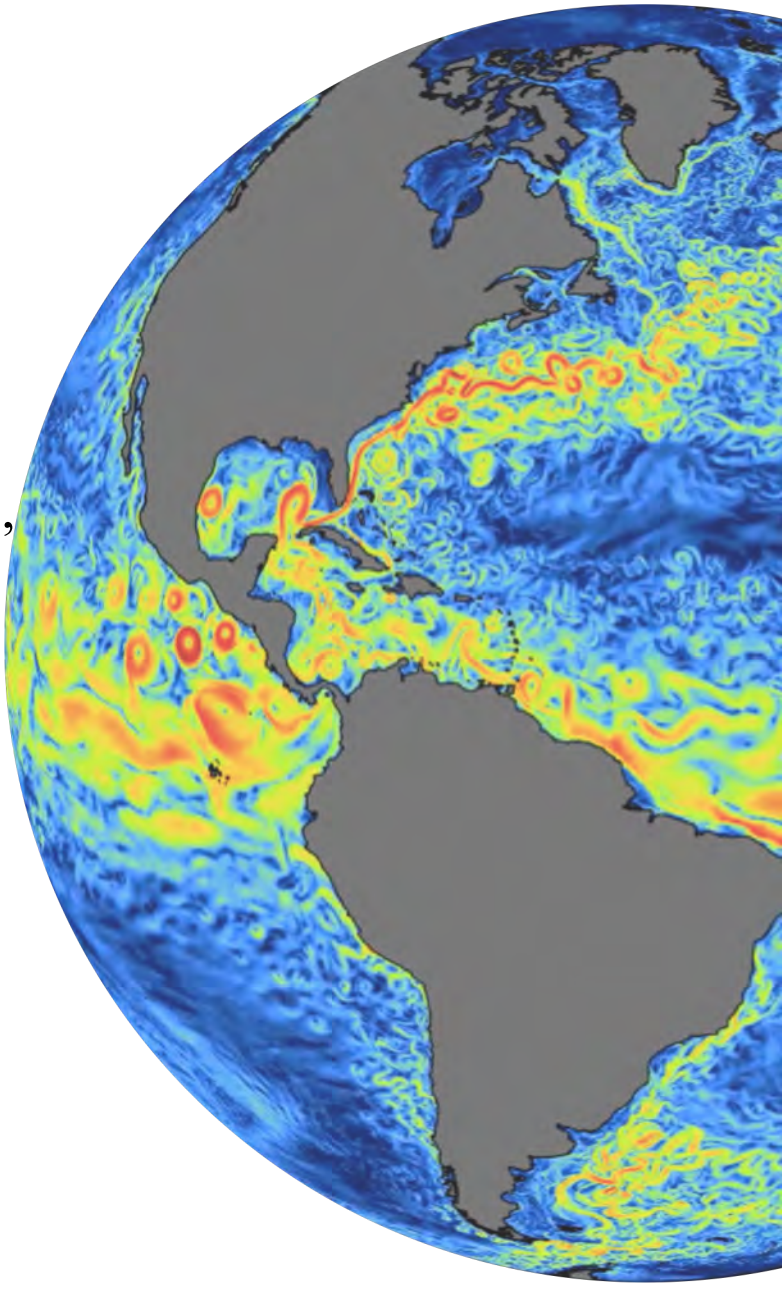
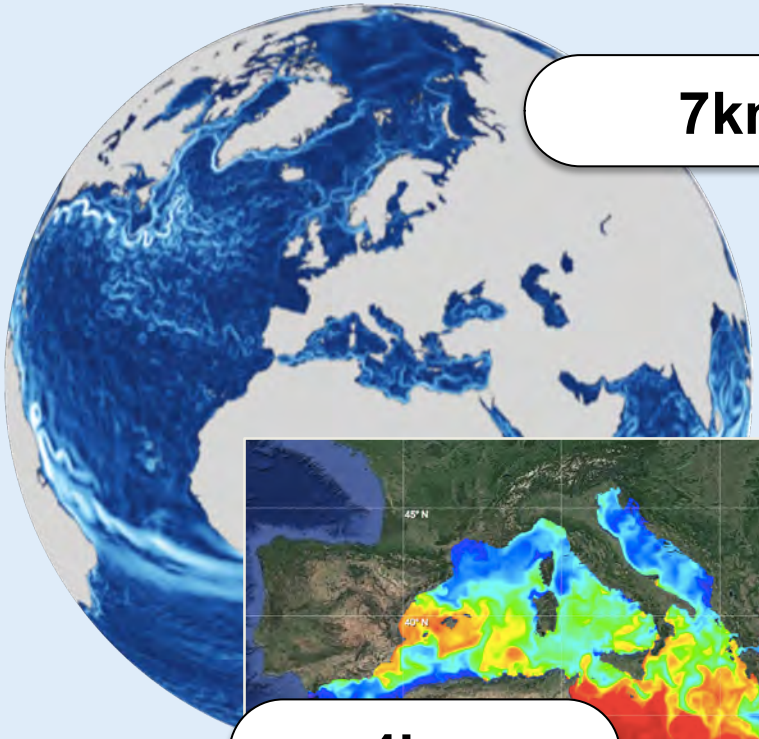
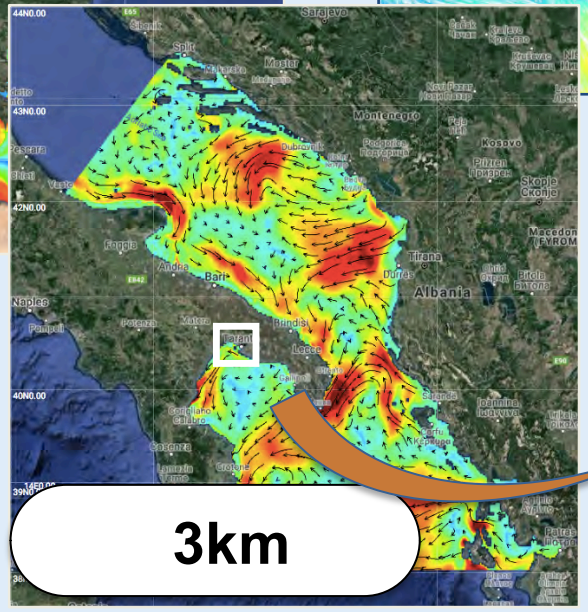
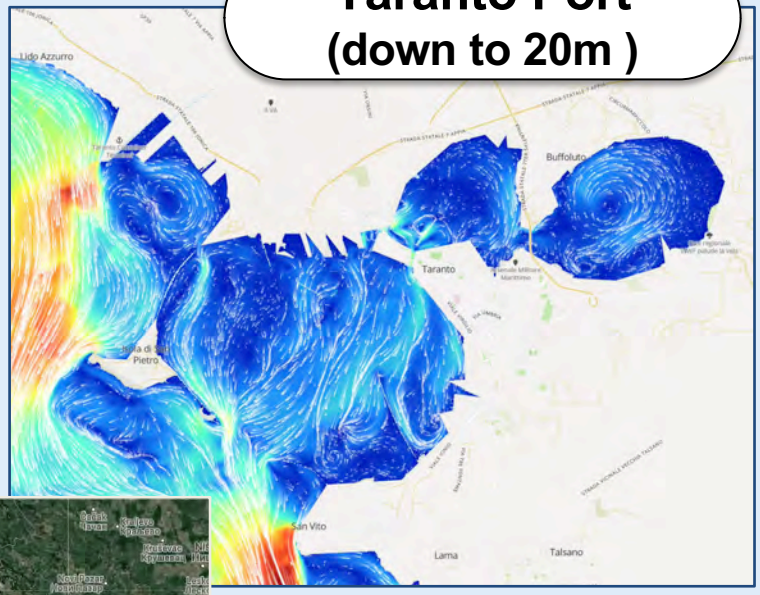


9th EuroGOOS International Conference
3-5 May 2021, virtual event

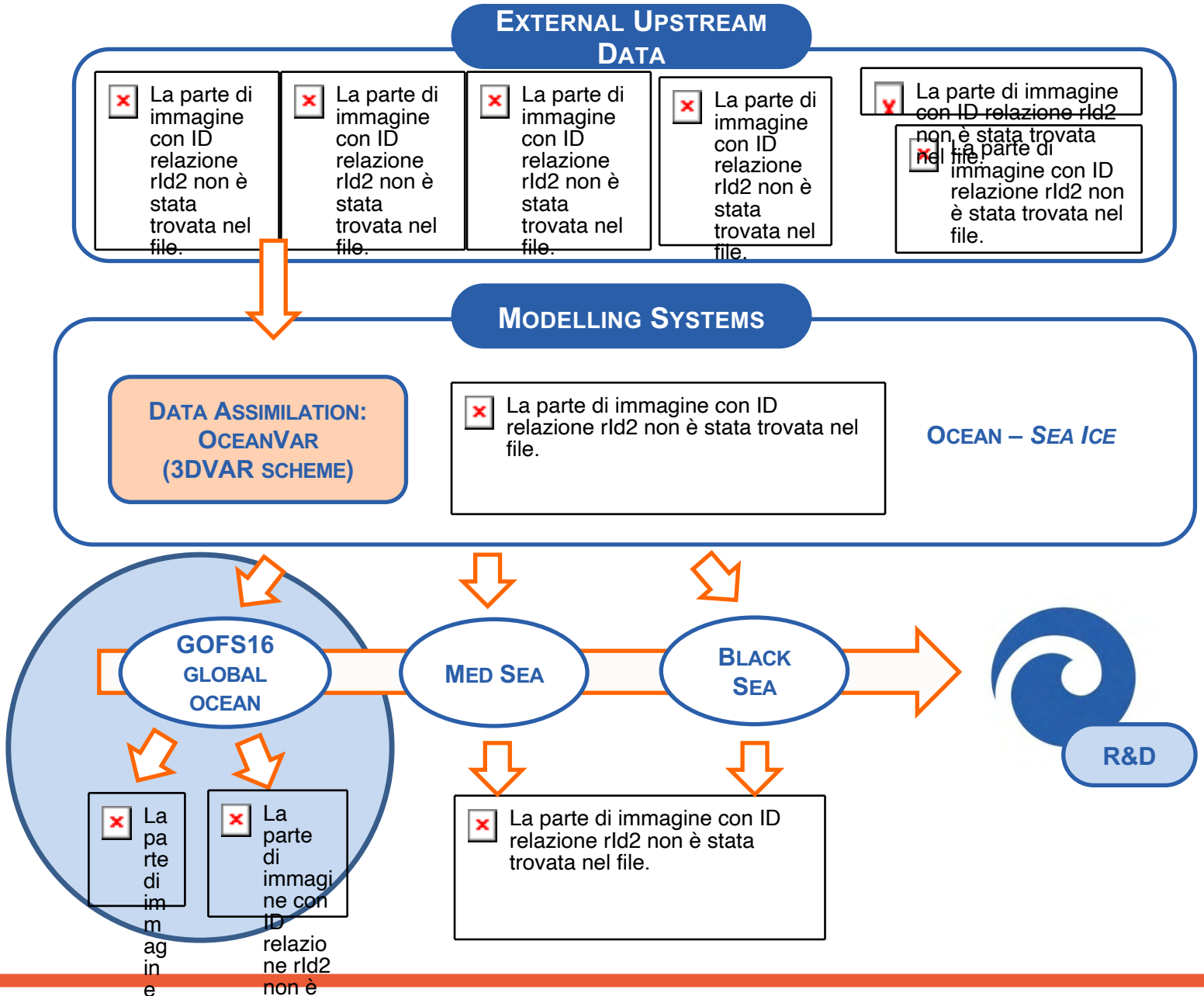
FROM THE GLOBAL TO THE LOCAL SCALES







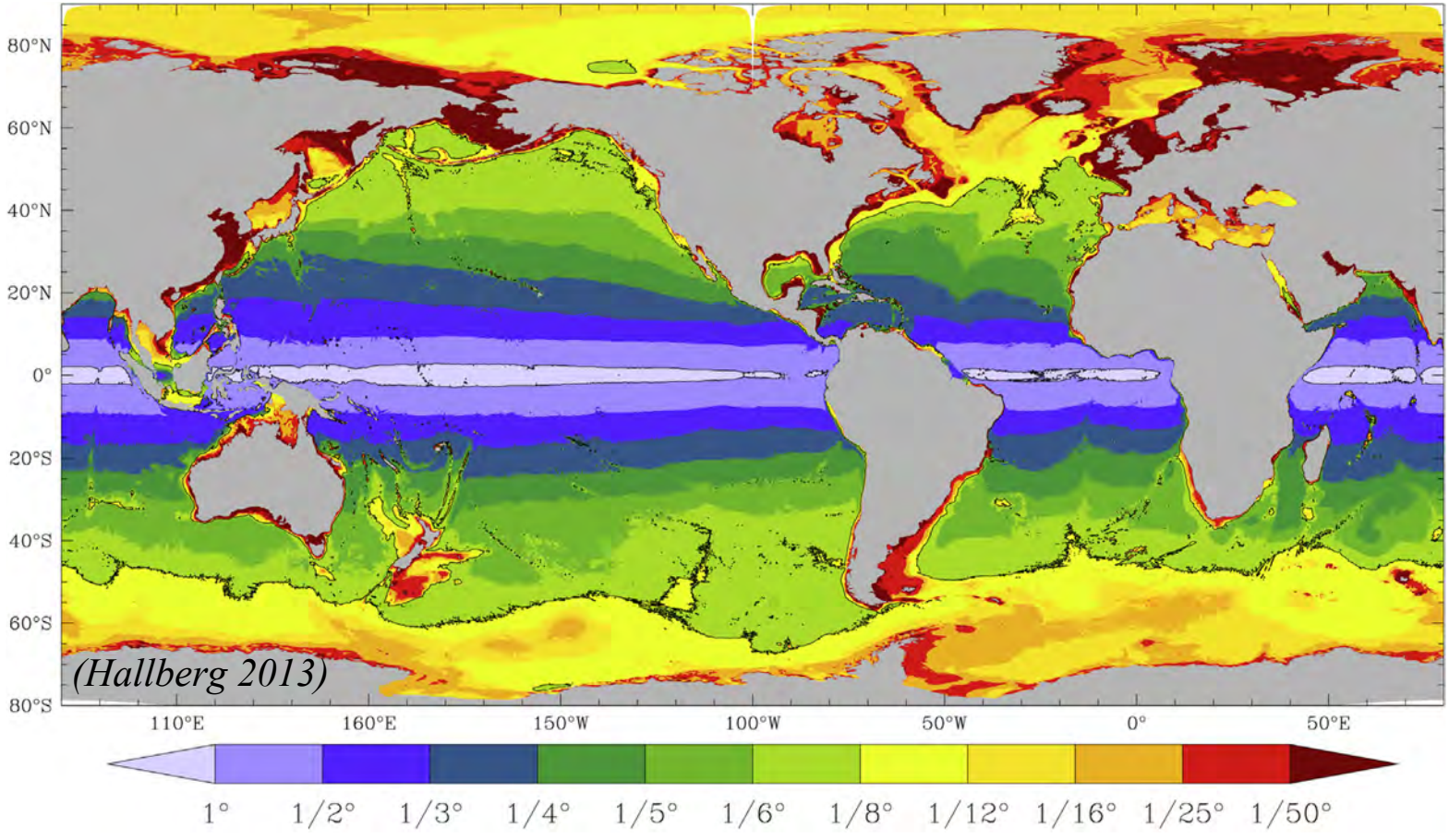
OPERATIONAL FORECASTING SYSTEMS AT CMCC



MOTIVATION: MESOSCALE FEATURES

"Eddy-resolving" at 1/10° (Smith et al. 2000) is not enough to resolve ocean "weather"

The horizontal resolution needed to resolve the first baroclinic deformation radius with two grid points



At all (present-day) resolution, OGCMs resolve the mesoscale in some regions but not others

GLOB16 - A GLOBAL EDDY-RESOLVING MODEL AT 1/16°

Ocean/Sea Ice code

NEMO v3.4 coupled to Louvain-la-Neuve sea Ice Model LIM2

Mesh

Global tri-polar grid: horizontal resolution spacing from 6.9km at the equator to ~2km at high latitudes with 98 vertical levels

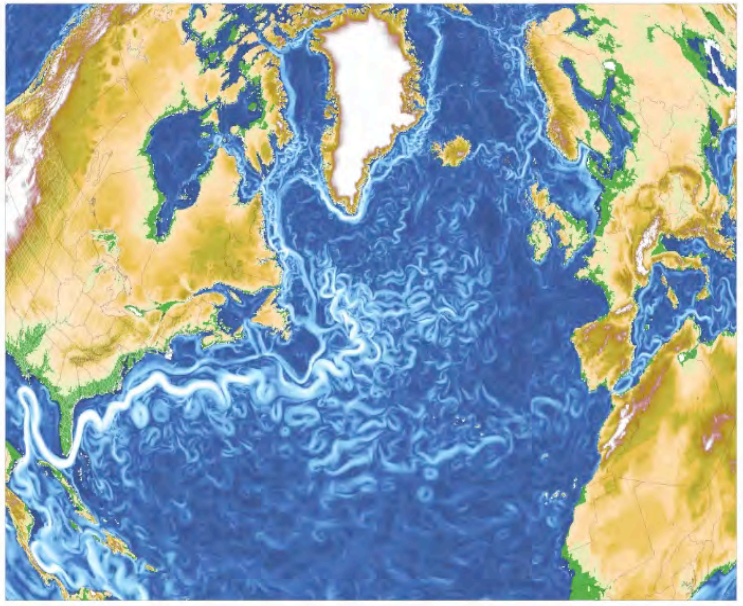
Bathymetry Etopo2 (deep ocean) + GEBCO (continental shelves) + Bedmap2 (Antarctic region)

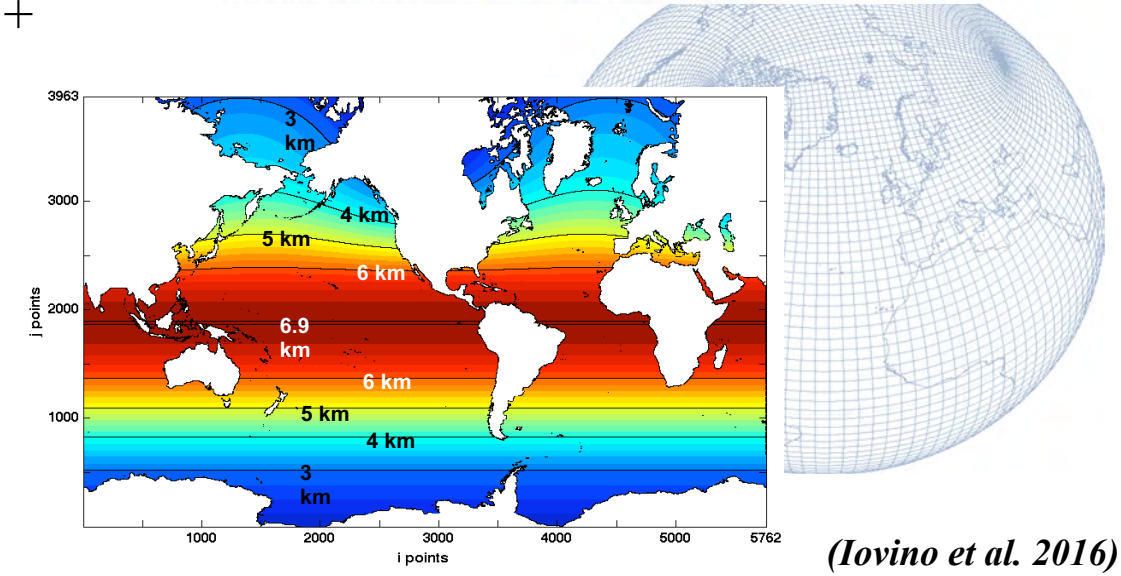
Atmospheric forcing

Bulk CORE-II formulation

NCEP atmospheric forcing (1/4°)

Arctic region at 3 Km or less



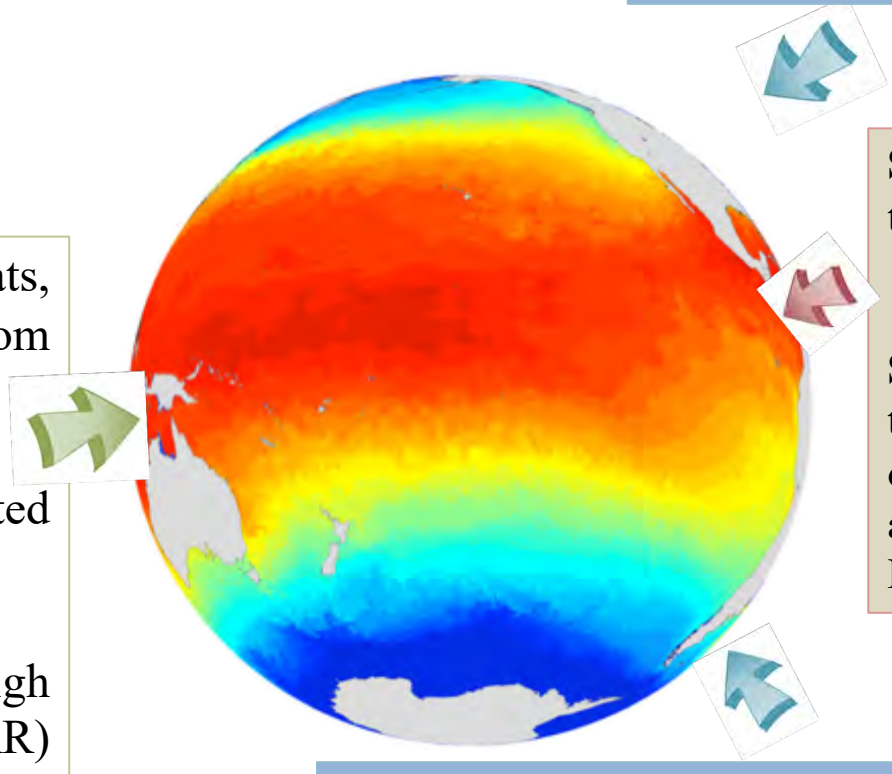


(Iovino et al. 2016)

OCEANVAR ASSIMILATION SCHEME AT 1/16°

- **OceanVar is a three-dimensional variational (3Dvar) assimilation scheme**
- **OceanVar works with daily updates from multiple data sources**

nudging of sea-ice concentration satellite data from NOAA



SST relaxation toward NOAA 1/4° Analyses

SSS relaxation toward monthly objective analysis EN4 of MetOffice

In-situ data: Argo floats, moorings, XBTs, CTDs from **CMEMS**

Altimetric data: SLA distributed by **CMEMS**

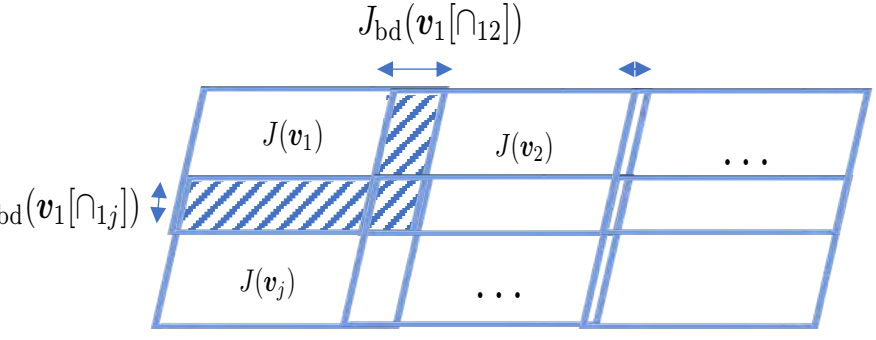
SST data: Advanced Very High Resolution Radiometer (AVHRR) from OSI-SAF and Advanced Microwave Scanning Radiometer2 (AMSR2) from NOAA

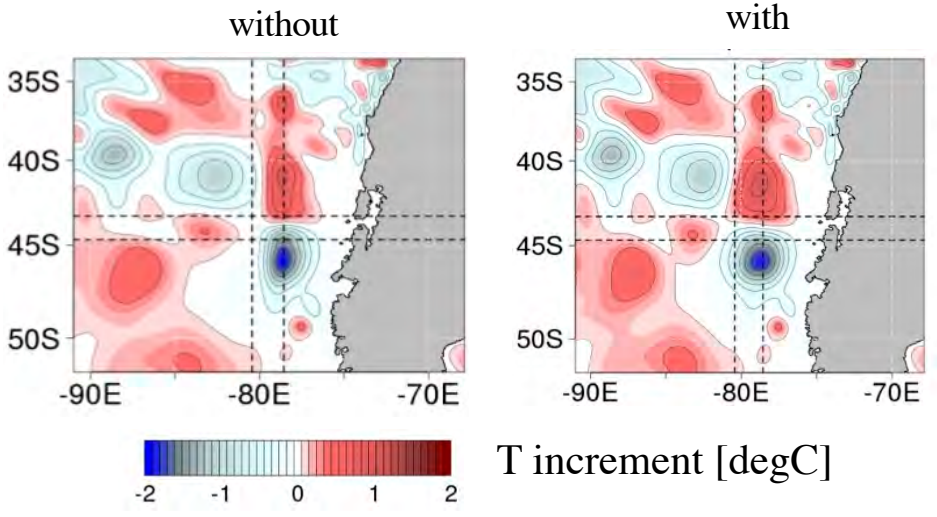
nudging of sea-ice concentration satellite data from NOAA

PARALLELIZATION OF THE OCEANVAR

- Horizontal (MPI) and vertical domain decomposition of the bathymetry (OpenMP)

- Domains interact through a penalty term in the cost function that constrains the same solution across boundaries (transparent boundaries)



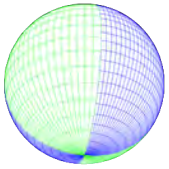


Cipollone et al., JTECH 2020

IMPACT OF RESOLUTION ON ASSIMILATION

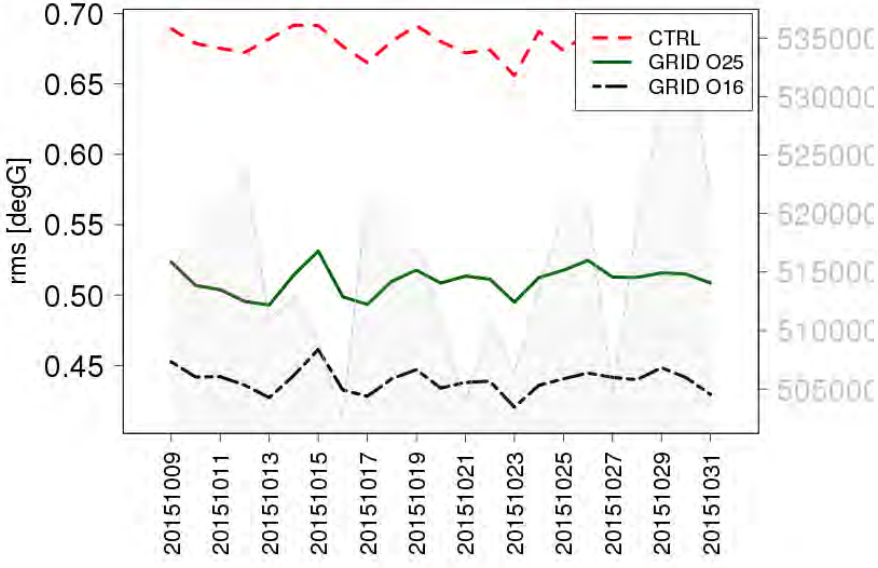
CTRL: SIM 1/16°(SST restoring)
GRID 025: GRID SIM 1/16° , GRID ASSIM 1/4°
GRID 016: GRID SIM 1/16° , GRID ASSIM 1/16°

ORCA 1/4°



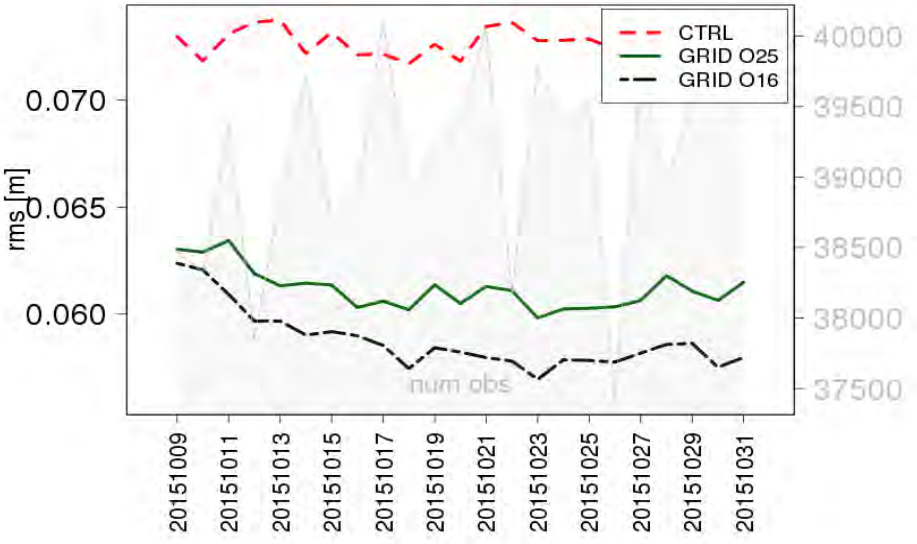
ORCA 1/16°
Same as the model grid

Time series of RMSE SST



15% error reduction for SST

Time series of RMSE SLA

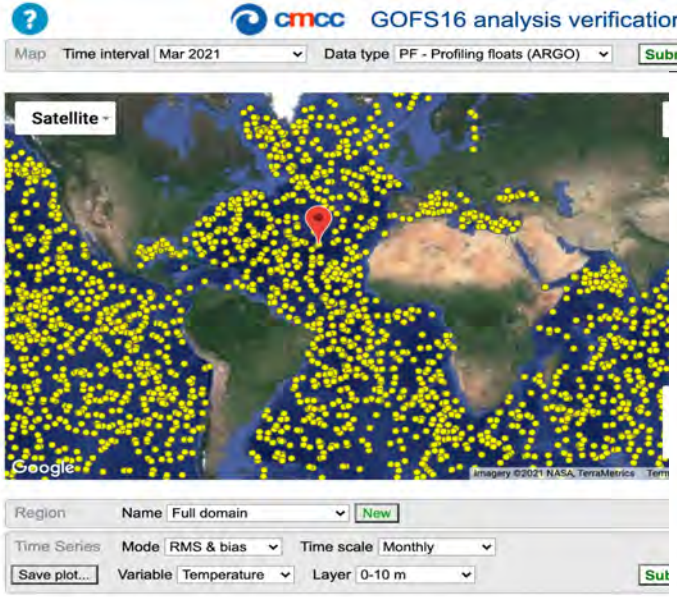


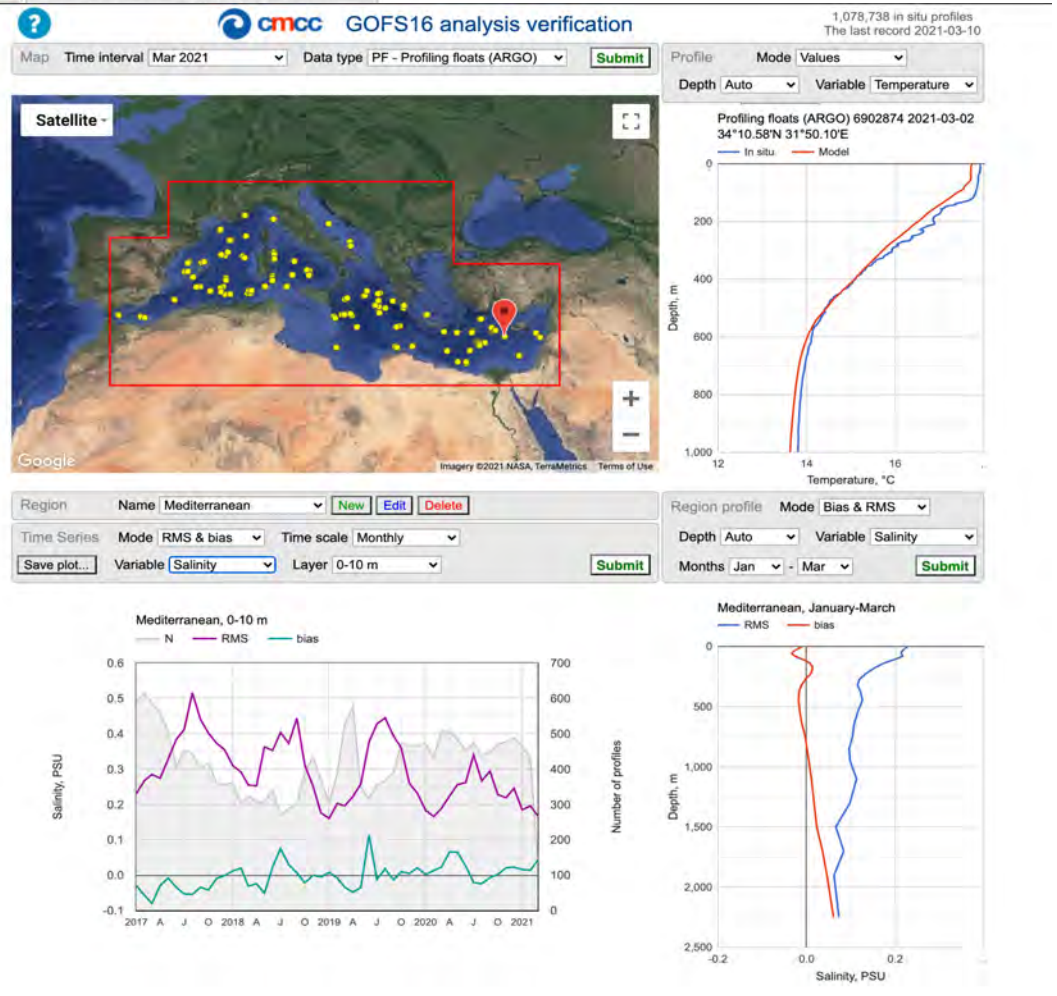
8% error reduction for SLA

Cipollone et al., JTECH 2020

VALIDATION: GOFS16 ANALYSIS VS. ARGO

- An interactive validation webpage is available online for the GOFS16 analysis of vertical profiles and time series at selected depth against ARGO data



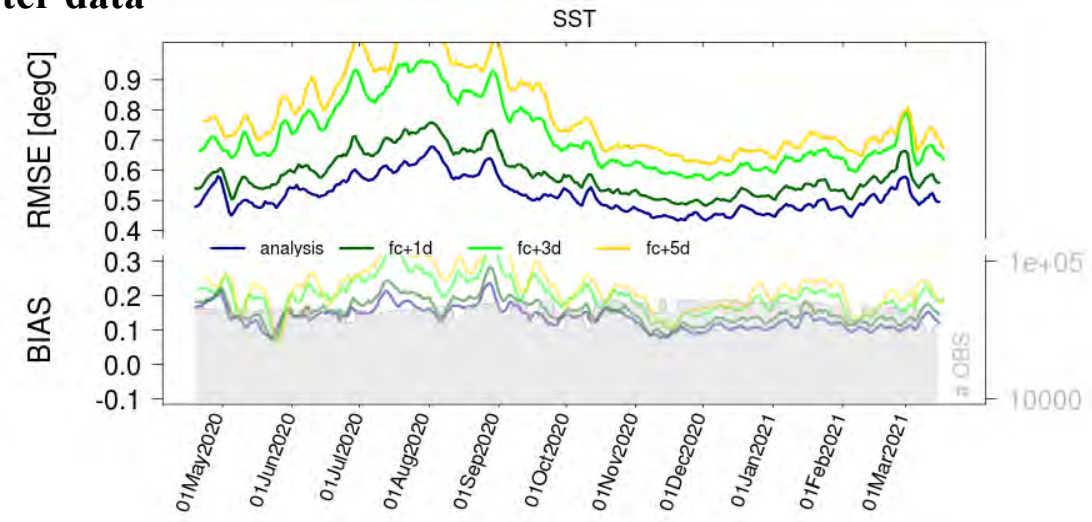


http://evalid.cmcc.it/evaluation/gofs/

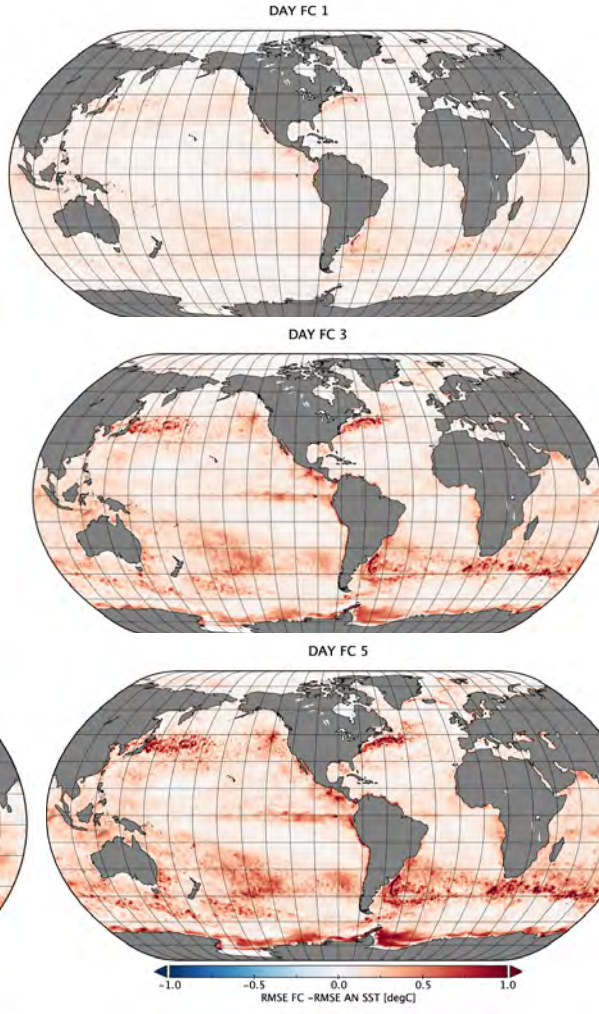
GOFS16 CLASS4 VALIDATION: SST

SST Obs from independent drifter data

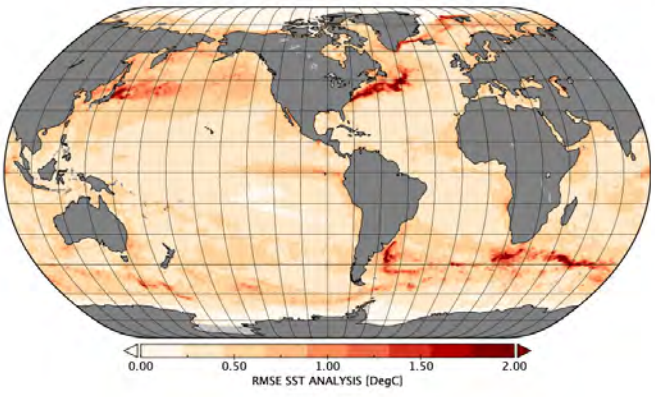
FORECAST RMSE AND BIAS



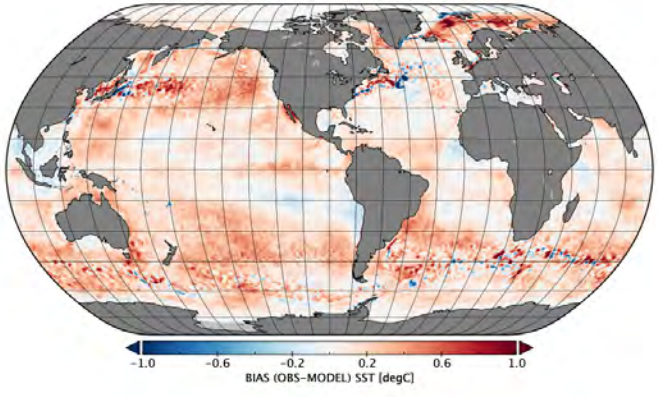
DAY 1 – 3 – 5 (Oct2020-Mar2021)



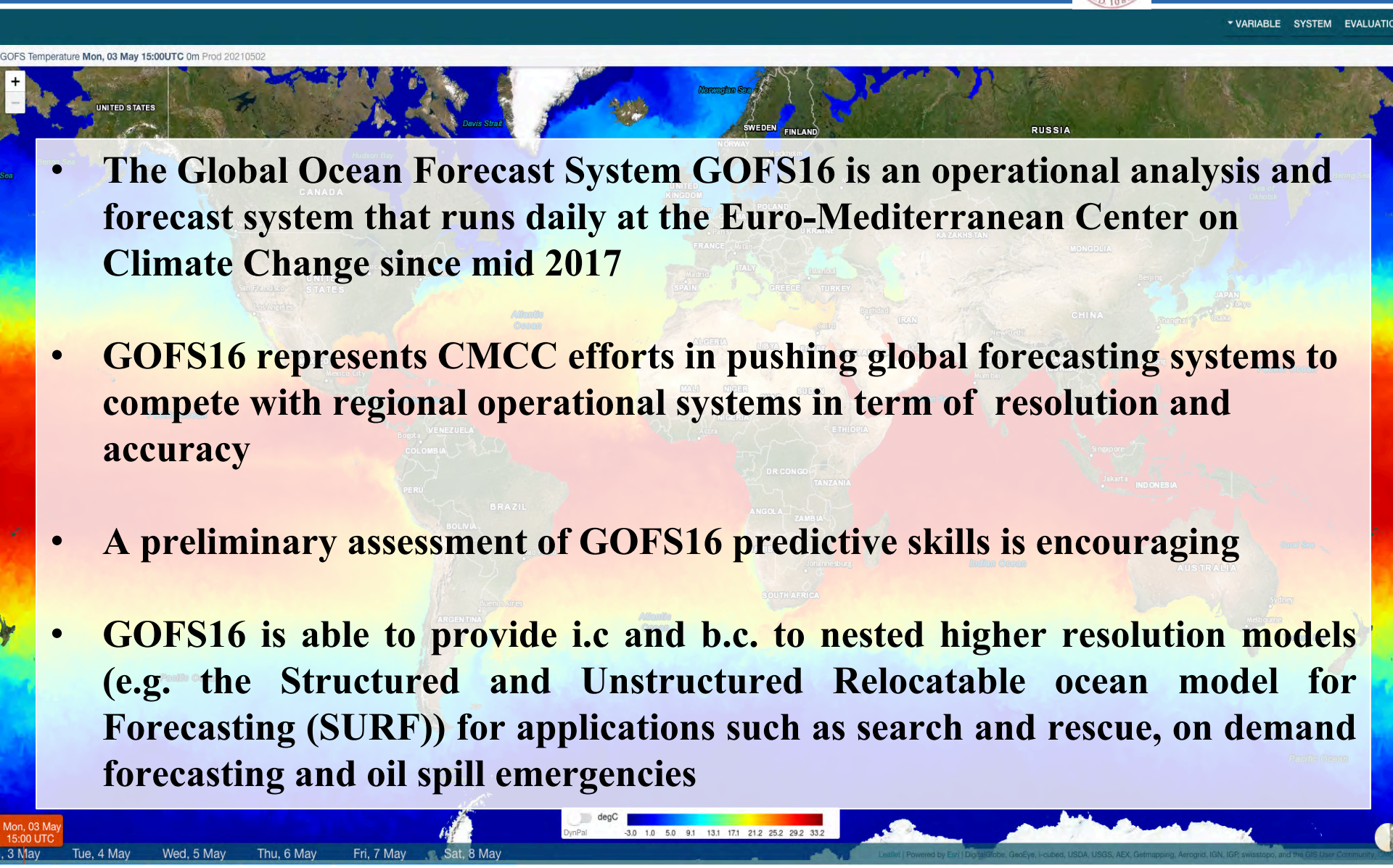
ANALYSIS RMSE



ANALYSIS BIAS



CONCLUSIONS



- **The Global Ocean Forecast System GOFS16 is an operational analysis and forecast system that runs daily at the Euro-Mediterranean Center on Climate Change since mid 2017**

- **GOFS16 represents CMCC efforts in pushing global forecasting systems to compete with regional operational systems in term of resolution and accuracy**

- **A preliminary assessment of GOFS16 predictive skills is encouraging**

- **GOFS16 is able to provide i.c and b.c. to nested higher resolution models (e.g. the Structured and Unstructured Relocatable ocean model for Forecasting (SURF)) for applications such as search and rescue, on demand forecasting and oil spill emergencies**

http://gofs.cmcc.it/