Development of Observing Quantitative Assessment Capabilities for Ocean Applications at NOAA

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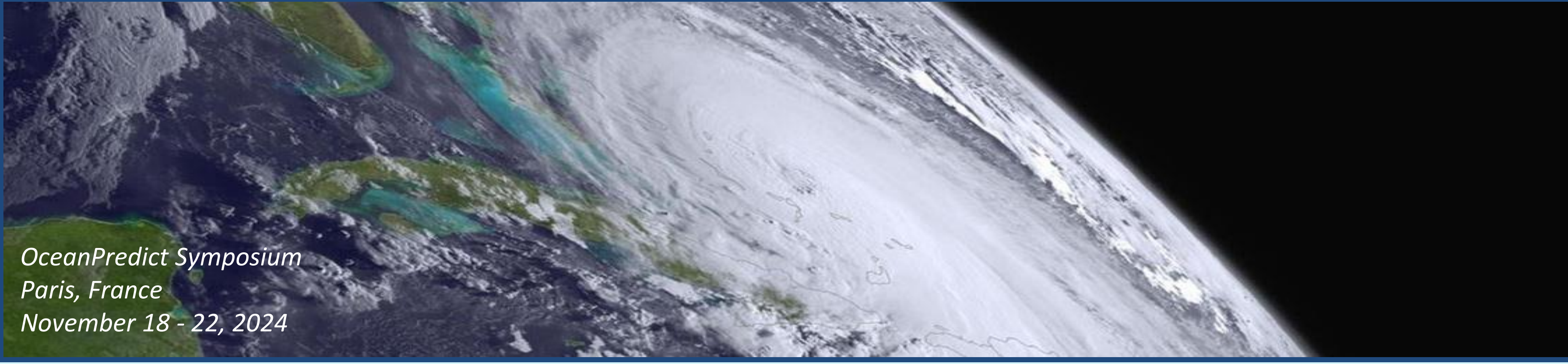

OceanPredict Symposium
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NOAA QOSAP Program

Inform major decisions on the design and implementation of optimal configurations of observing systems

- Increase NOAA's capacity to conduct quantitative observing system assessments
- Investigate impacts and trade-offs of alternative mix of current and/or proposed instruments for better understanding and prediction of Earth Systems

QOSAP Program Key Activities

- Maintain and improve infrastructure to conduct quantitative assessments
  - observing system experiments (OSEs) and observing system simulation experiments (OSSEs) capabilities for Earth Systems
- Conduct trade-off studies to optimize observing system architectures
  - OSSEs to investigate impacts and trade-offs of alternative mix of current and/or proposed instruments for better understanding and prediction of Earth systems
- Evaluation and optimization of current in-situ and satellite observations
  - Perform OSEs to quantify and improve impact of existing observations
- Provide information on the impact of proposed changes to observing systems

Benefits

- QOSAP is a comprehensive resource tool for evaluating the impact of Earth systems observations (current and proposed) in numerical weather prediction
    - Improvements in weather models' performance translates into societal benefits (i.e. early warnings on hurricane forecasting)
- Results help inform major decisions on the design and implementation of optimal configurations of observing systems for constellation planning
- Many critical investment decision factors are not addressed by modeling exps
    - real cost, opportunity costs, partnership implications, exploitability and sustainability
- **Overall, OSE/OSSE evaluations are a powerful tool to support architecture tradeoff analysis for decision making**

Today's modeling and observing systems capabilities: Observing System Experiments (OSEs)

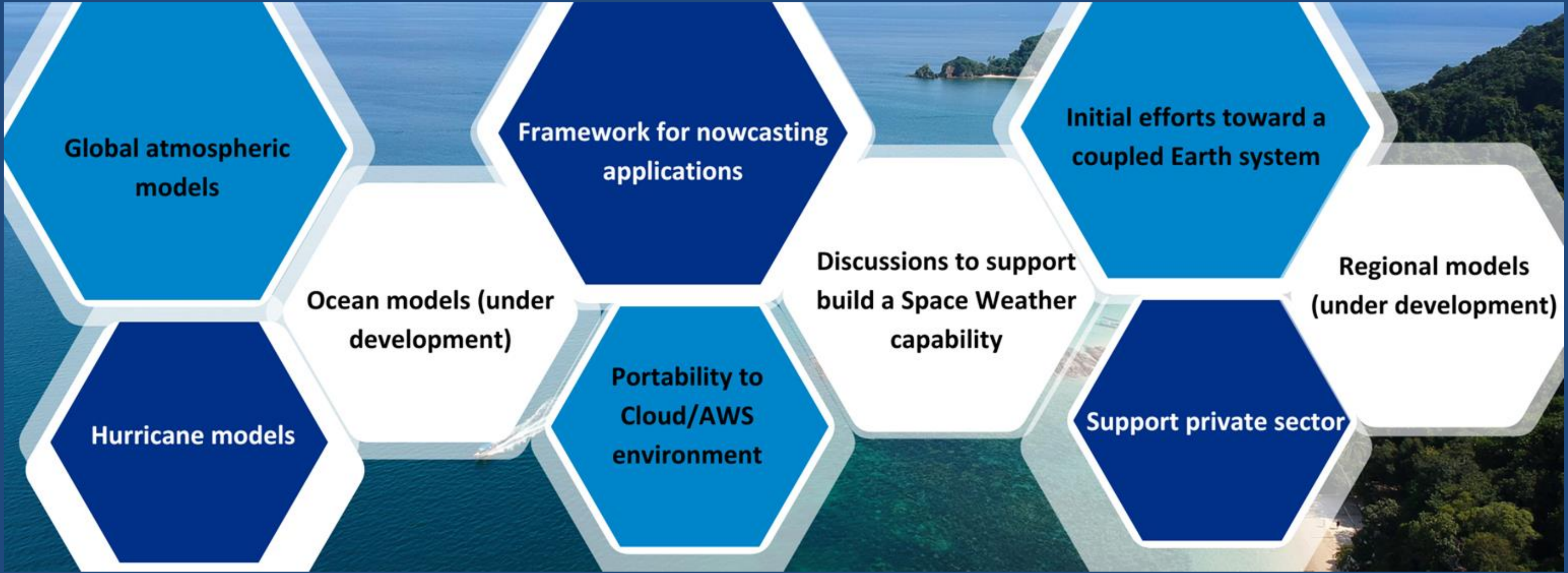
- Can we do better? - Optimize use of current observations in current modeling systems
  - Enhanced data assimilation strategies
  - More realistic characterization of observations
  - Management of large volume of data
  - Timeliness for model upgrades

- Can we leverage existing observations not currently utilized?
  - Driven by requirements and priorities
  - Investment in personnel and HPC resources

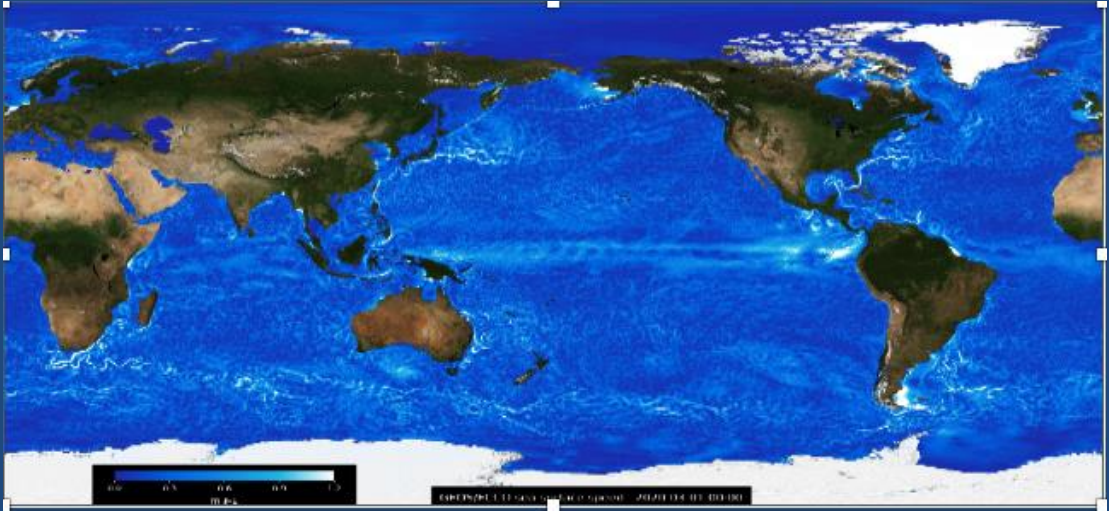
Looking ahead and simulating the future: Observing System Simulation Experiments (OSSEs)

- Costs of developing, deploying and maintaining new space-based architectures typically exceed $100-500 million/instrument
- Need to provide quantitative information on the impact of proposed observing systems in the next planned generation of numerical weather prediction systems
- Help inform major decisions by evaluating the impact of alternative mix of current and/or proposed instruments for better understanding and prediction of Earth systems.
- OSSE studies provide an ideal platform for this
  - Analyze tradeoffs (coverage, resolution, accuracy and data redundancy)
  - Optimize data assimilation and modeling strategies

QOSAP Quantitative Assessment Capabilities



QOSAP ocean OSSE system

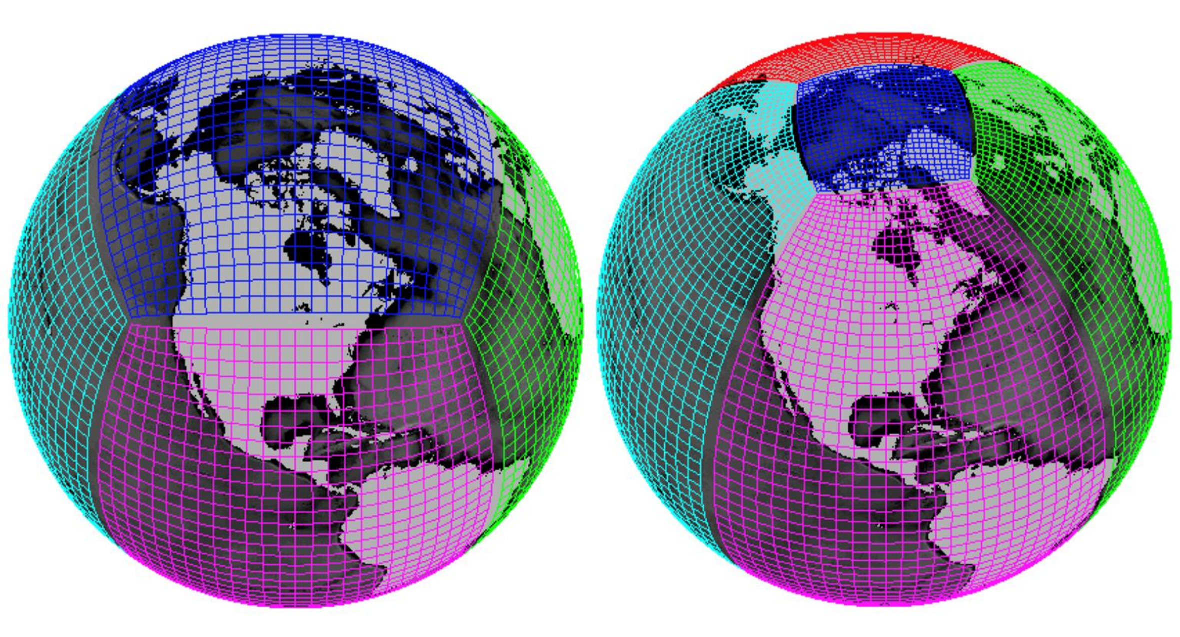


Courtesy of Dimitris Menemelis (JPL, Caltech) and David Ellsworth and Nina McCurdy (ARC/NAS)

- Nature run: GEOS/MITgcm; coupled
- High interest from the ocean modeling community
- Synergism with OceanPredict and SynObs
- Purpose: Enables enhanced leveraging
  - Optimization of observing system design, targeting techniques, trade-offs
  - Impact of current and proposed in-situ/satellite ocean observations
- Longer-term plans for an ocean-fisheries OSSE
  - Identify requirements, biological and physical variables to be measured
  - Ocean-Ecosystems, 3-step process?
  - Physics, circulation
  - Biological, chemistry
  - Fish and other marine ecosystems

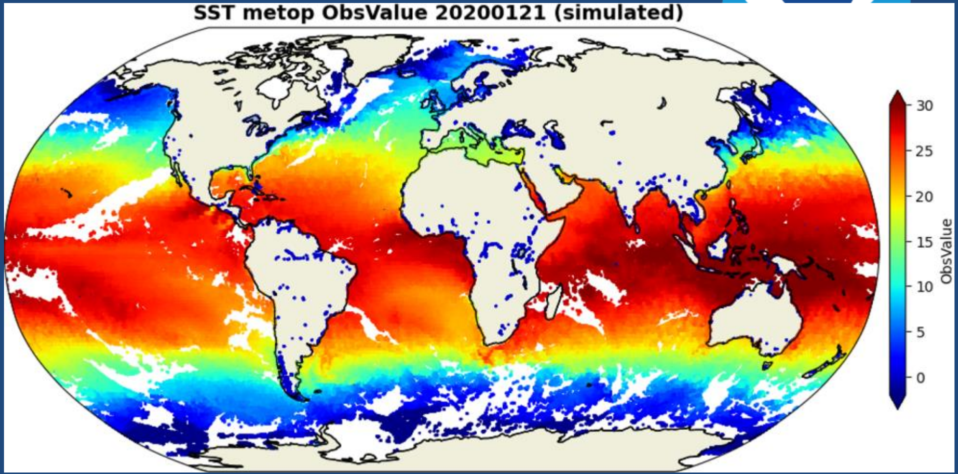
QOSAP ocean OSSE system (con't)

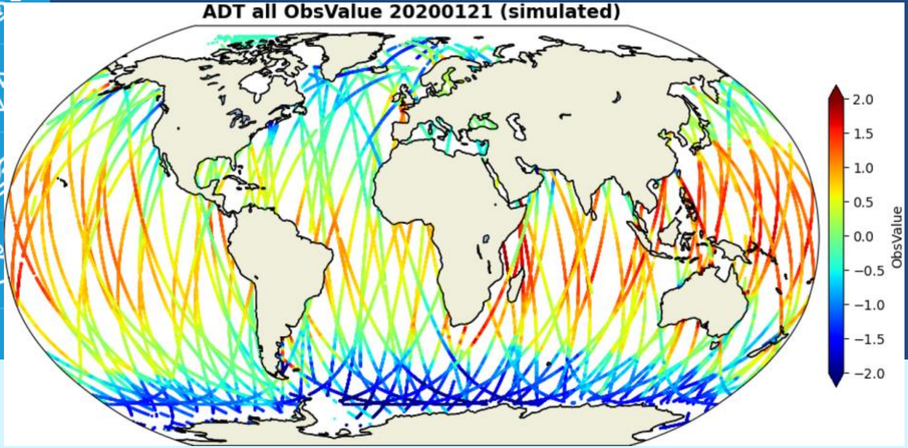
- Nature run: ECCO model
- Available variables:
  - o SSH
  - o Theta (potential temperature)
  - o Salinity
- Written as tiles: 13 titles
- Resolution: 2-4 km, vertical: 90 levels; hourly output
- Period:2020/01/19-2021/03/26

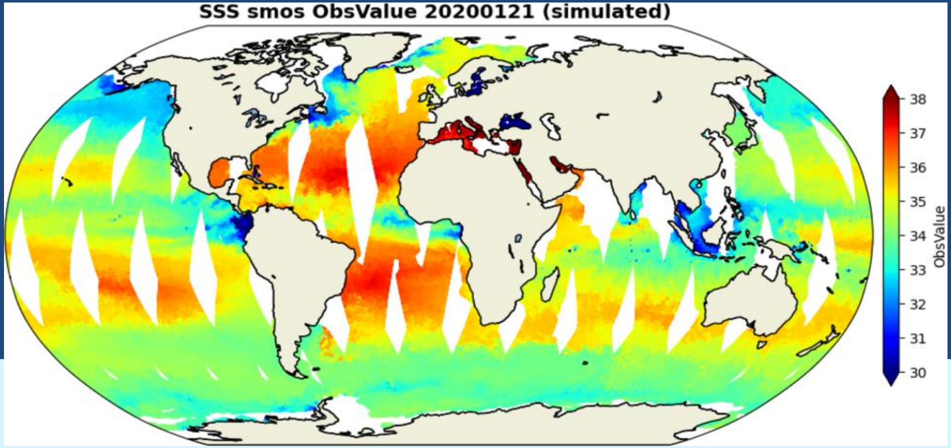


Interpolation of model fields at obs location

- **MITgcm ocean model:** ～2-4 km grid spacing, 90 levels, time-step: 45 s, hourly output, period: 2020/01/19-2021/03/26
- KDTree algorithm is applied to interpolate the model fields at geolocations of SSS (SMOS_esa), SST (MetOp_A/B/C) and ADT (Sentinel 3a/3b,CryoSat-2, Jason 2/3,SARAL)





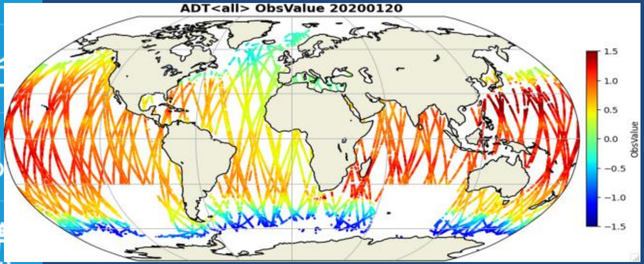


QOSAP ocean OSE/OSSE model

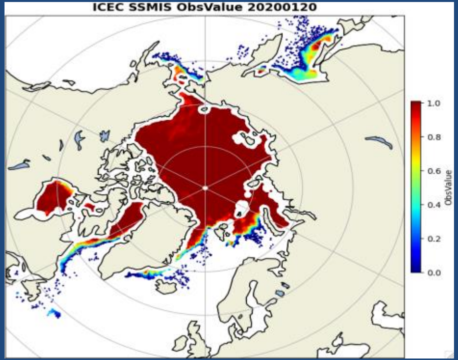
- Model: JEDI-SOCA 3DVAR with MOM6, 6 hr DA
- Resolution: ¼ deg (horizontal), 75 vertical layers (global)
- Atmospheric forcing: CFSR (¼ deg)
- Ocean IC from CPC
- Ocean Observations

Observation Variable	Platforms
ADT (Absolute dynamic topography)	Jason-<2,3>, Sentinel-<3a,3b>, CryoSat-2, SARAL/AltiKa
SST (Sea surface temperature)	VIIRS-<NPP, N20>, MetOp-<A,B,C>, NOAA-<18,19>
SSS (Sea surface salinity)	SMAP, SMOS
In-situ (T/S profile, sea water temperature/salinity)	Argo floats, XBT, CTD, Glider, drifting and moored buoys, TAO/TRITON, PIRATA, RAMA

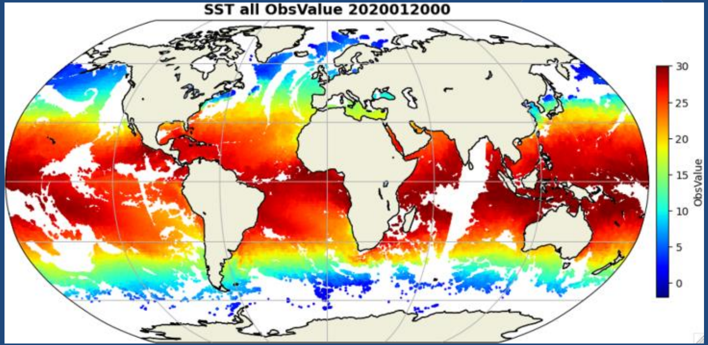
Observations



Obs count: ~153K (daily)

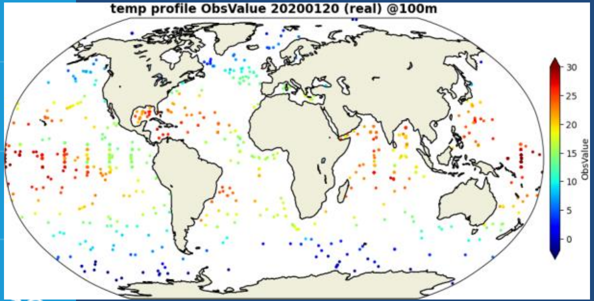


Obs count: ~193K (daily)

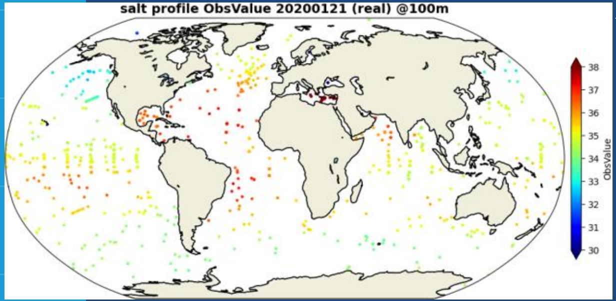


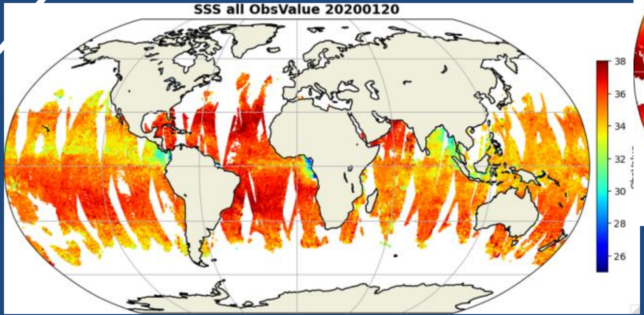
SST: metop_<A,B,C>, VIIRS_<npp, n20), NOAA<18,19)

Obs count: ~879 K per cycle

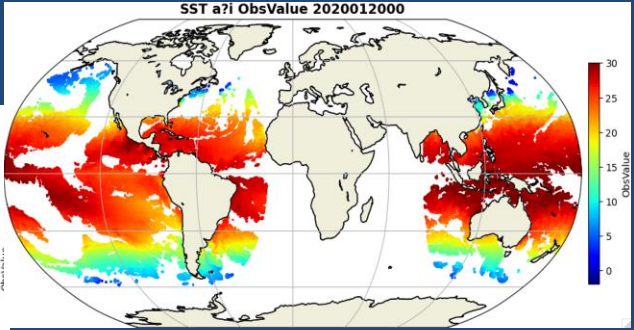


Obs count (profile): ~149K (daily)





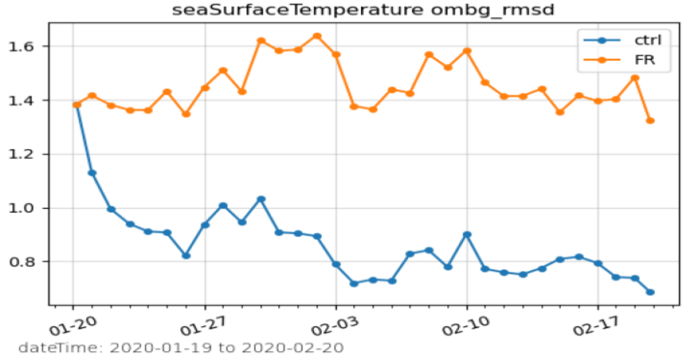
Obs count: ~623K (daily)



SST: ABI_G<16,17>, AHI_H08 (**Not used yet)**

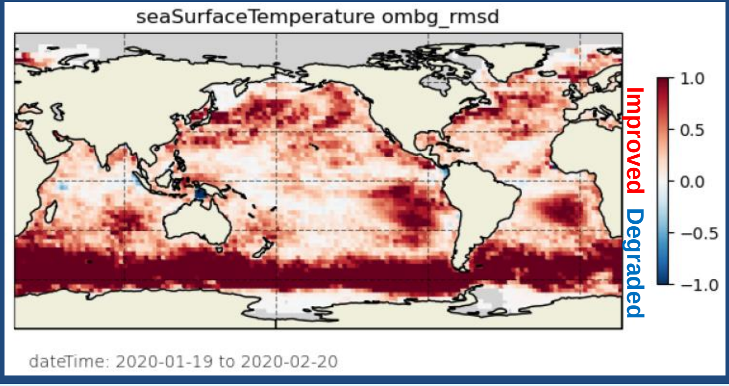
Obs count: ~1.1m per cycle

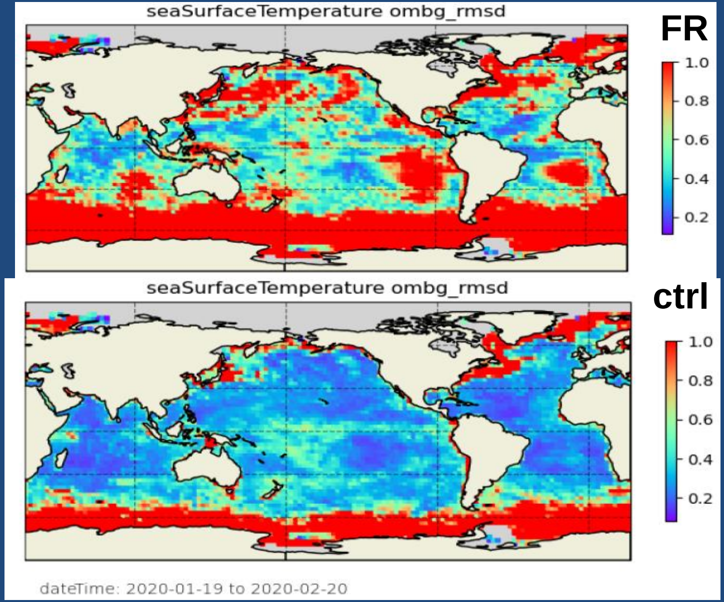
Ongoing Work: SST (FR-ctrl)



FR: <u>FREE RUN</u> without assimilation of ocean observations; restart files from CPC; Period: 20191201 to 20200220
ctrl: <u>CONTROL</u> with assimilation of ocean observations; restart files from FR; Period: 20200120 to 20200220

FR-ctrl





Questions?

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