



Regional Class-4 verification of the Canadian operational ice-ocean prediction systems

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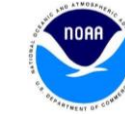
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Application of Class-4 metrics

- **Validation and intercomparison** of operational oceanography systems initiated by the **GODAE OceanView** (now **OceanPredict**) **Intercomparison and Validation Task Team (IV-TT)** based on Class4-metrics → monitoring the forecasting system performance in near real time against observations
- **Model forecast/analysis fields interpolated** to a **common shared dataset of observations** (model equivalents) → Class-4 metrics limited to the “observational space”
 - Sea Surface Temperature (SST) vs surface drifter data
 - Sea Level Anomaly (SLA) vs altimeter data
 - Temperature and salinity profiles vs *in-situ* ARGO data } daily ocean Class-4 files generated by UK Met Office since late 2012
- Sea ice (contingency table) vs AMSR2 observation data → daily sea ice Class-4 file generated by CONCEPTS since late 2014

Class-4 near real-time monitoring

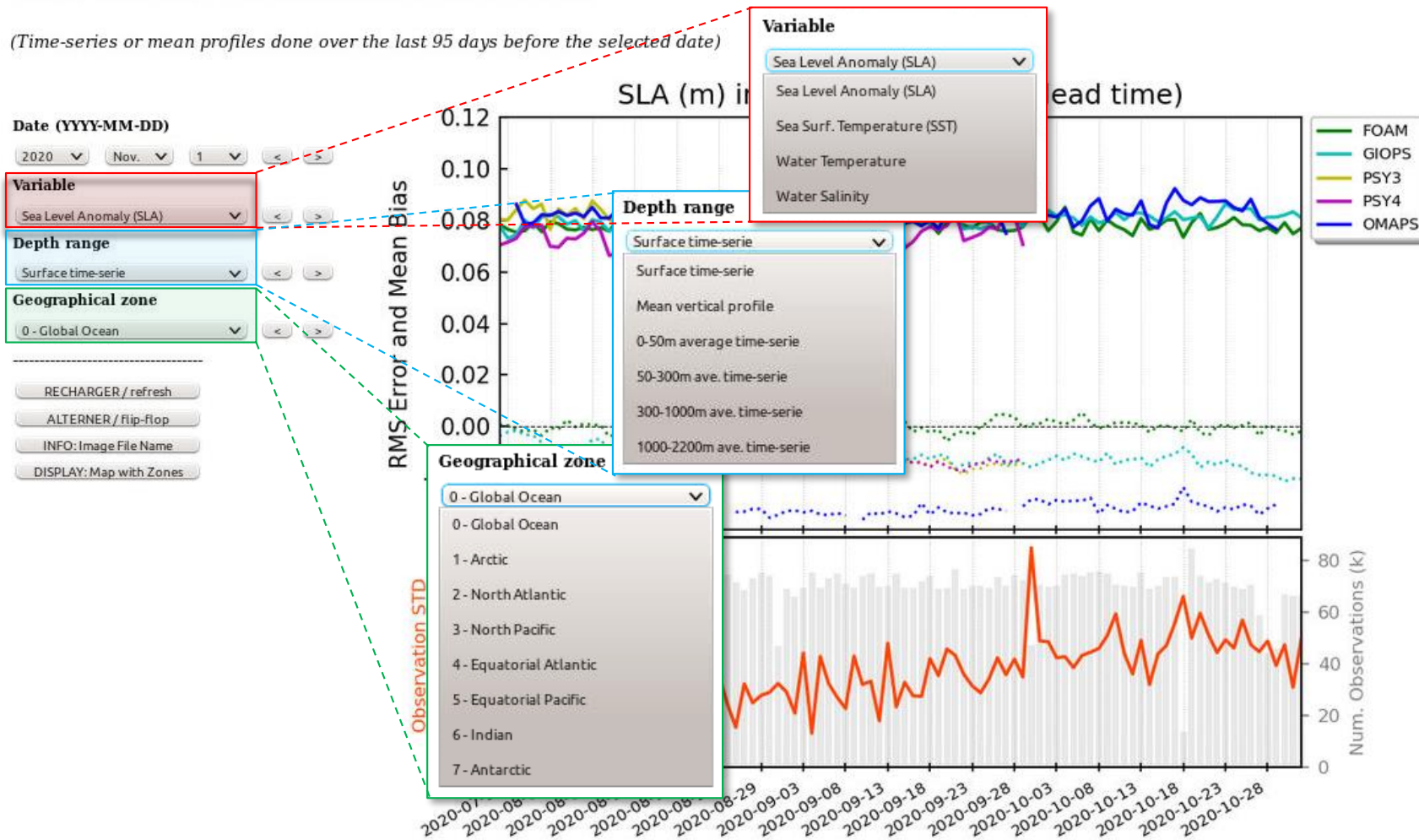
- Global **ocean Class-4 files** produced by several operational centers on a regular basis:
 - ✓ UK Met Office (**FOAM**)
 - ✓ Mercator Ocean International (**PSY3 & PSY4**)
 - ✓ Canadian CONCEPTS (**GIOPS**)
 - ✓ Australian Bureau of Meteorology (**OMAPS**)
 - ✓ NOAA National Weather Service (**RTOFS**) → *production stopped in Jan. 2019*
- Monitoring global ocean forecasting system skill in near real-time
 - ✓ evaluation against observations (Class-4)
 - ✓ multi-system intercomparison



Near real-time global ocean comparison

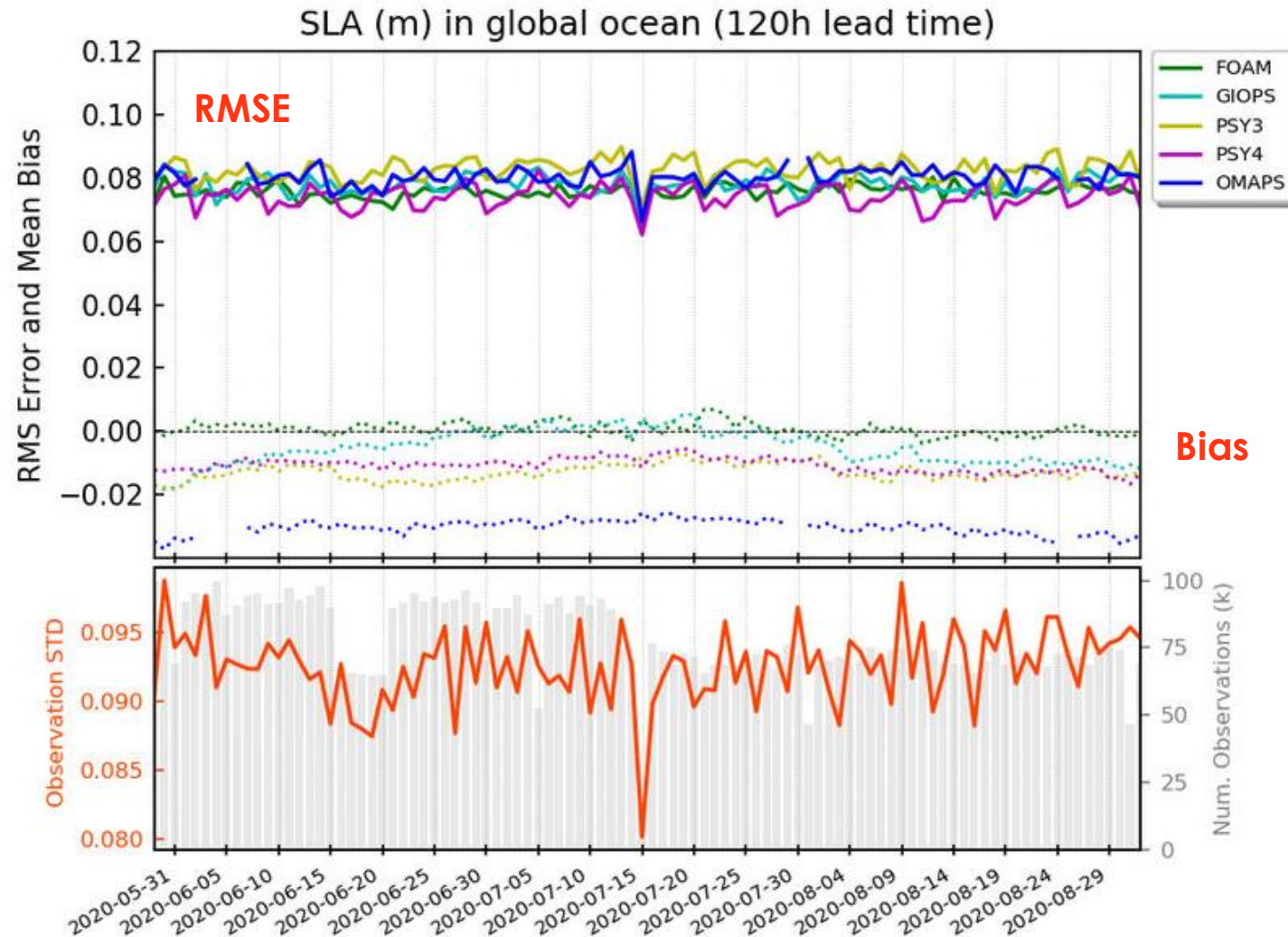
Class 4 GIOPS v3.0 Forecasts Verification

(Time-series or mean profiles done over the last 95 days before the selected date)



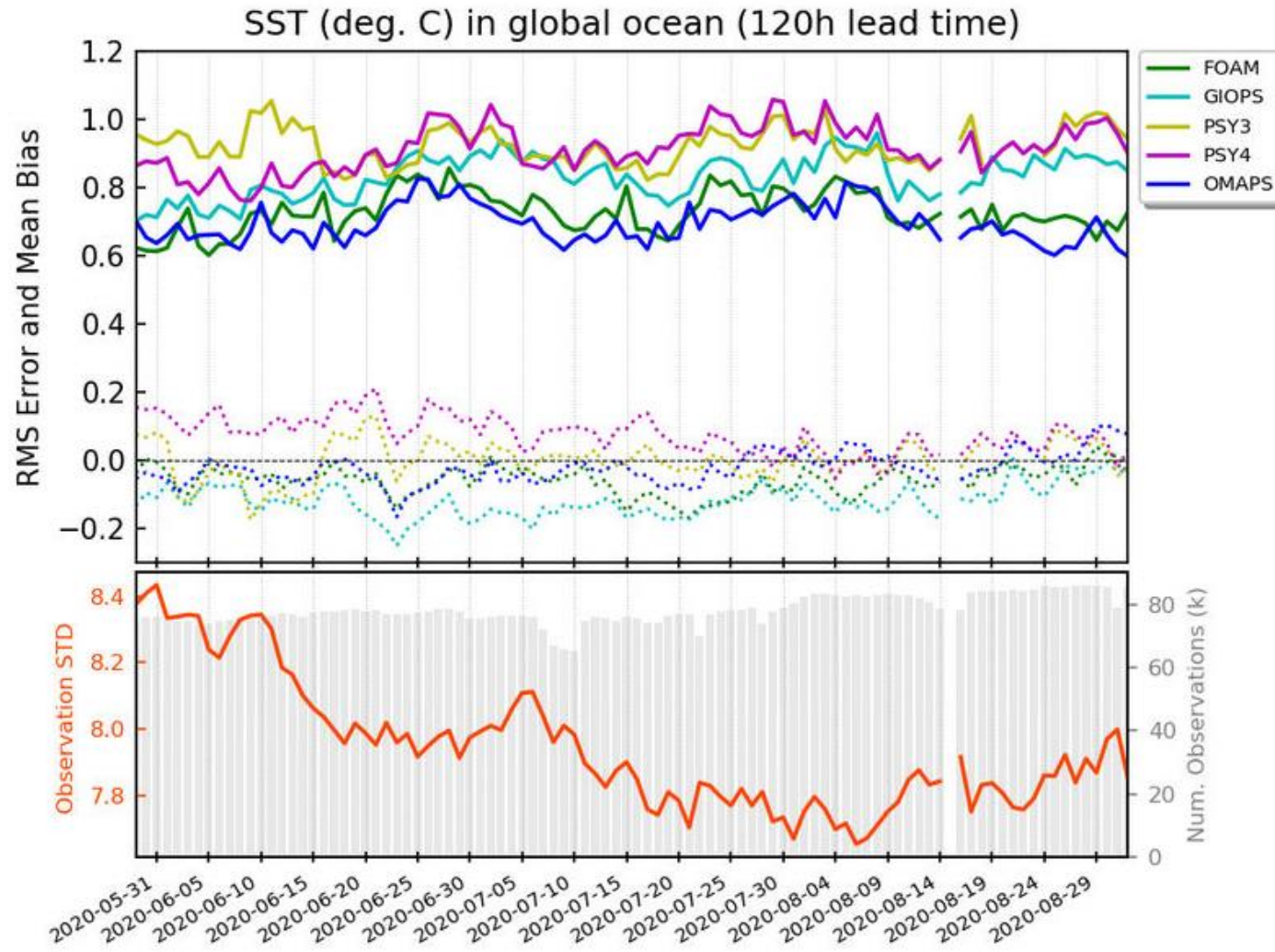
- **User web-interface** to display the 96 images that are daily produced
- Comparison of **5 global operational forecasting systems**
 - ✓ 95 days time window
 - ✓ 120 hours lead time
 - ✓ Strong consistency among products
 - ✓ Stability of the scores

Near real-time global ocean comparison



- Comparison of 5 operational forecasts against satellite altimeter **Sea Level Anomalies**
 - ✓ Time-series over 95 days for the global domain
 - ✓ Using 120-h lead time forecasts
 - ✓ Strong consistency among products
 - ✓ Stability of the scores

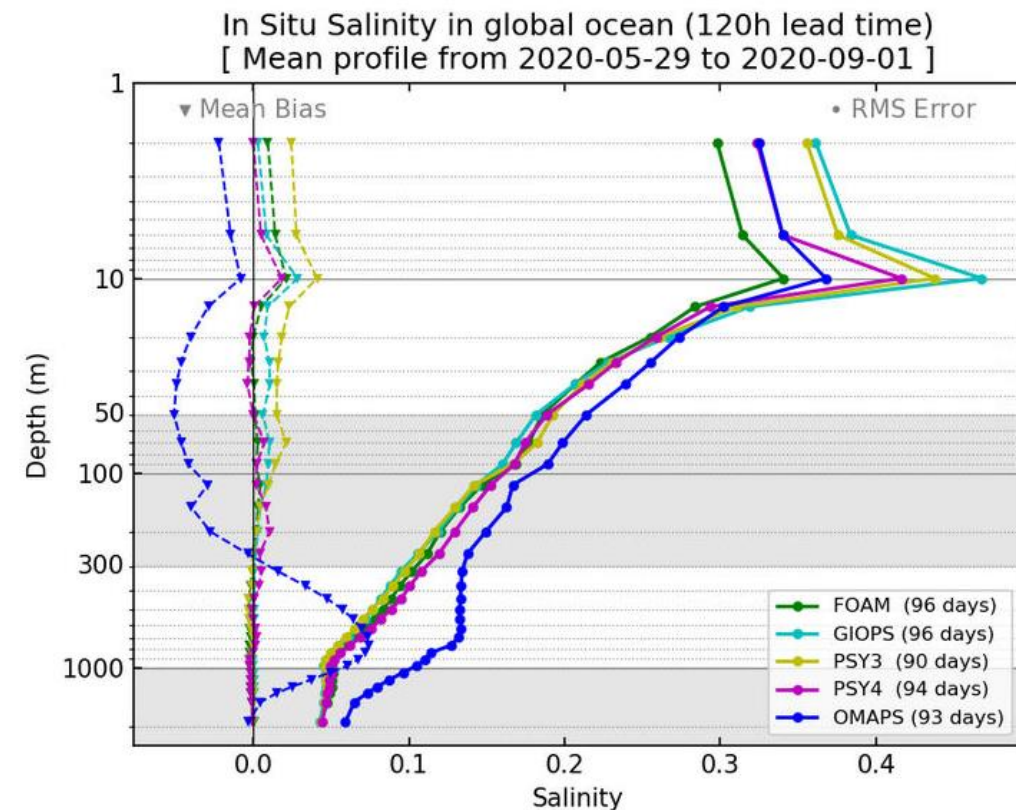
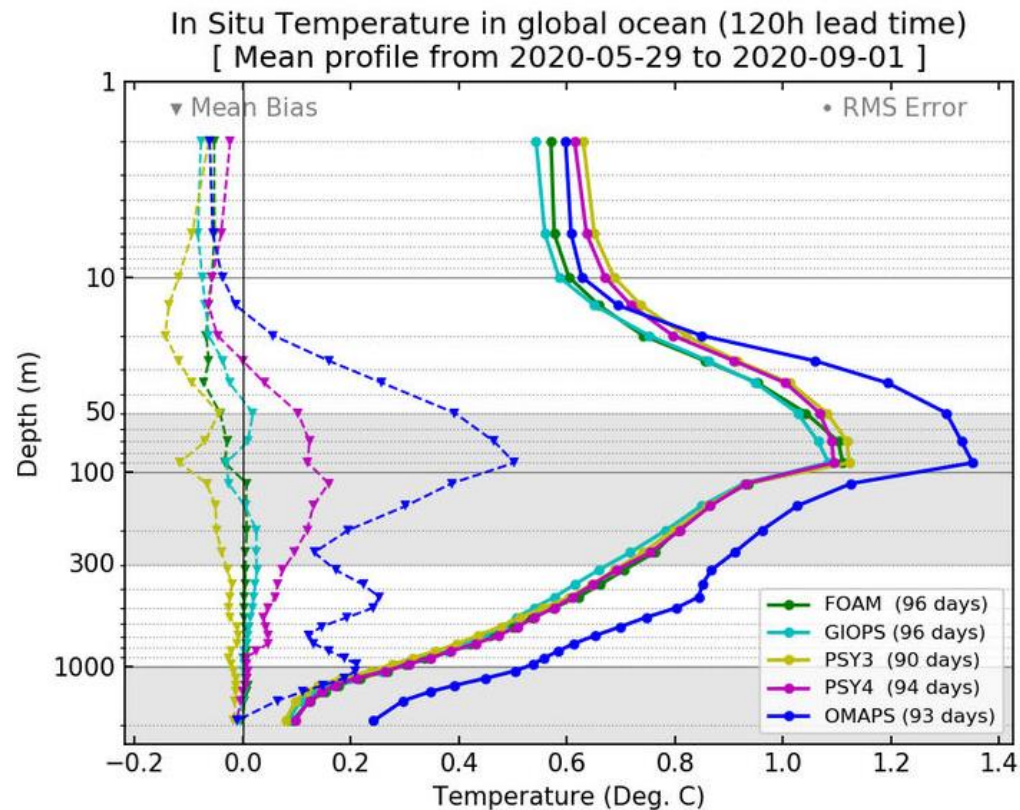
Near real-time global ocean comparison



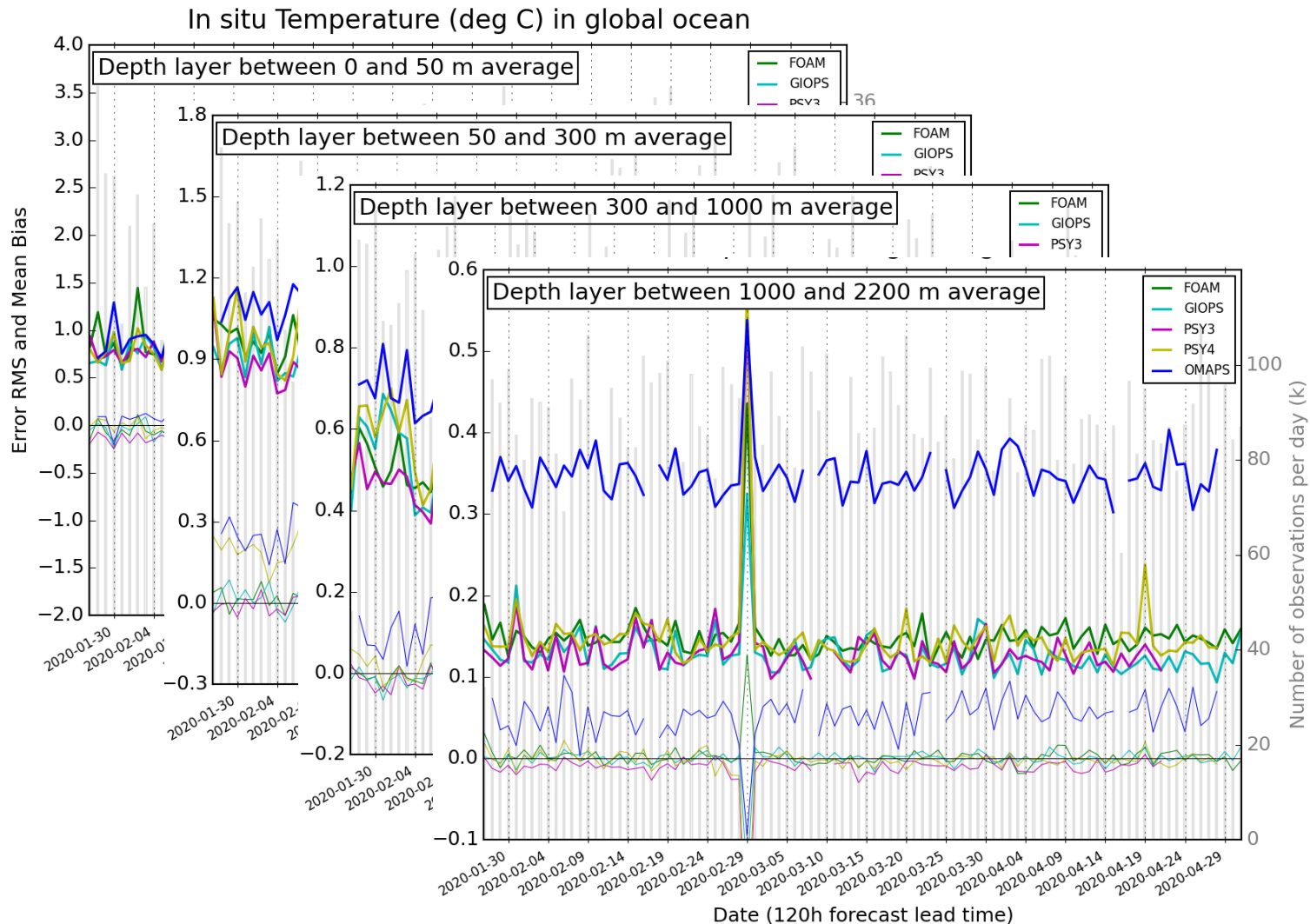
- Comparison of 5 operational forecasts against ocean surface **temperature** observations from surface drifters
 - ✓ Time-series over 95 days for the global domain
 - ✓ Using 120-h lead time forecasts
 - ✓ Strong consistency among products
 - ✓ Stability of the scores

Near real-time global ocean comparison

- Comparison against averaged **Temperature** and **Salinity** profiles (*in situ* T/S ARGO data)
 - ✓ Averages over 95 days for the global domain using 120-h lead time forecasts
 - ✓ Statistics calculated over fixed depth bins (common depth profile)

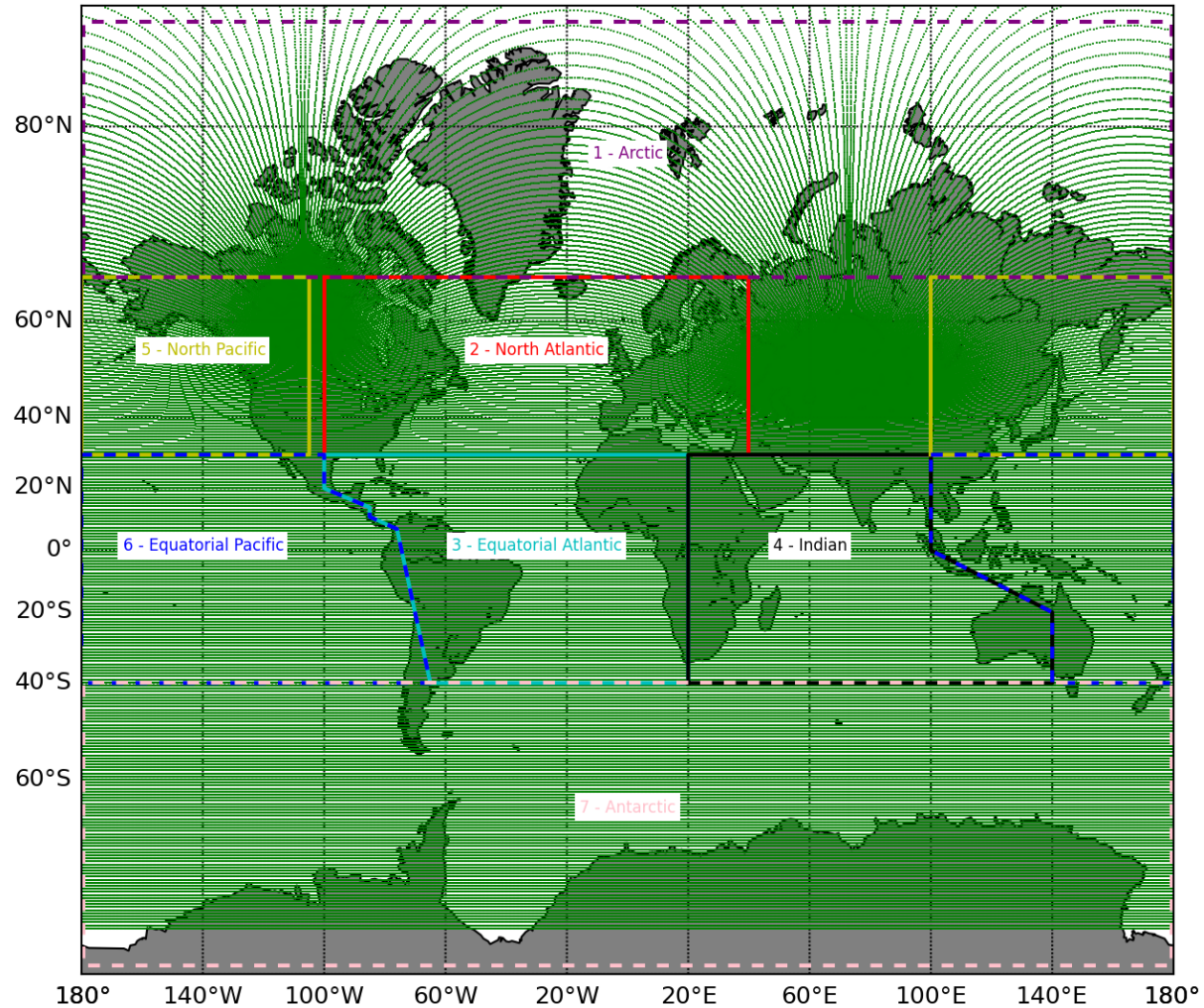


Near real-time global ocean comparison



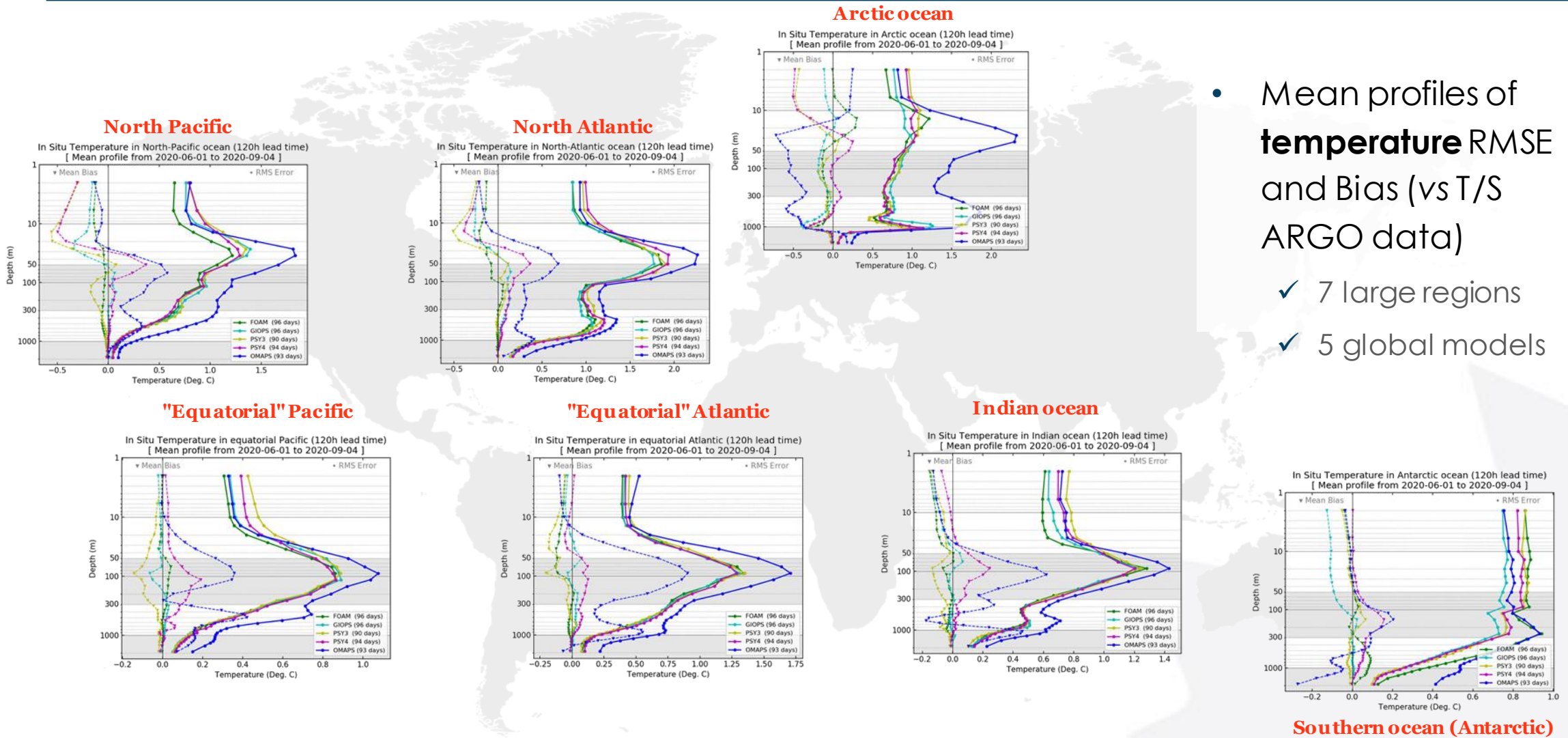
- Multilayer time-series for **Temperature** and **Salinity** (T/S ARGO profiles) averaged in 4 depth layers
 - ✓ Time-series over 95 days for the global domain
 - ✓ Using 120-h lead time forecasts
 - ✓ Some data QC issues remain (especially in deeper layer)

Near real-time monitoring per oceanic “basin”



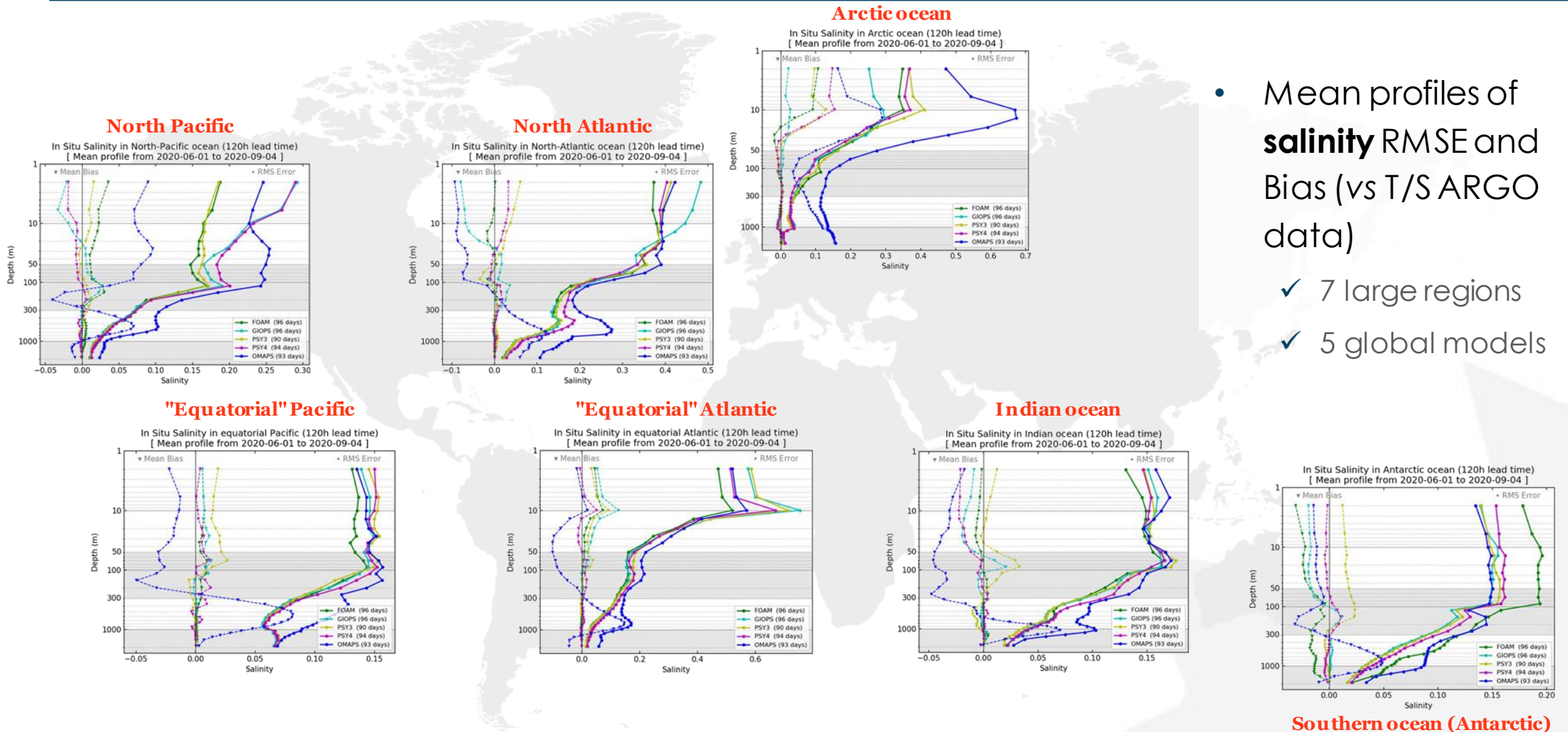
- Definition of **7 large oceanic regions** (~ “**basin**”) to refine the assessment
 - ✓ Mutually exclusive zones
 - ✓ For each zone:
 - 7 × Time-series of SLA and SST
 - 7 × multilayer time-series of ocean temperature and salinity (4 × layers)
 - 7 × averaged profiles of ocean temperature and salinity
 - ✓ Total of **84 images (+ 12 global)** generated automatically and displayed via a user web-interface

Near real-time monitoring per region

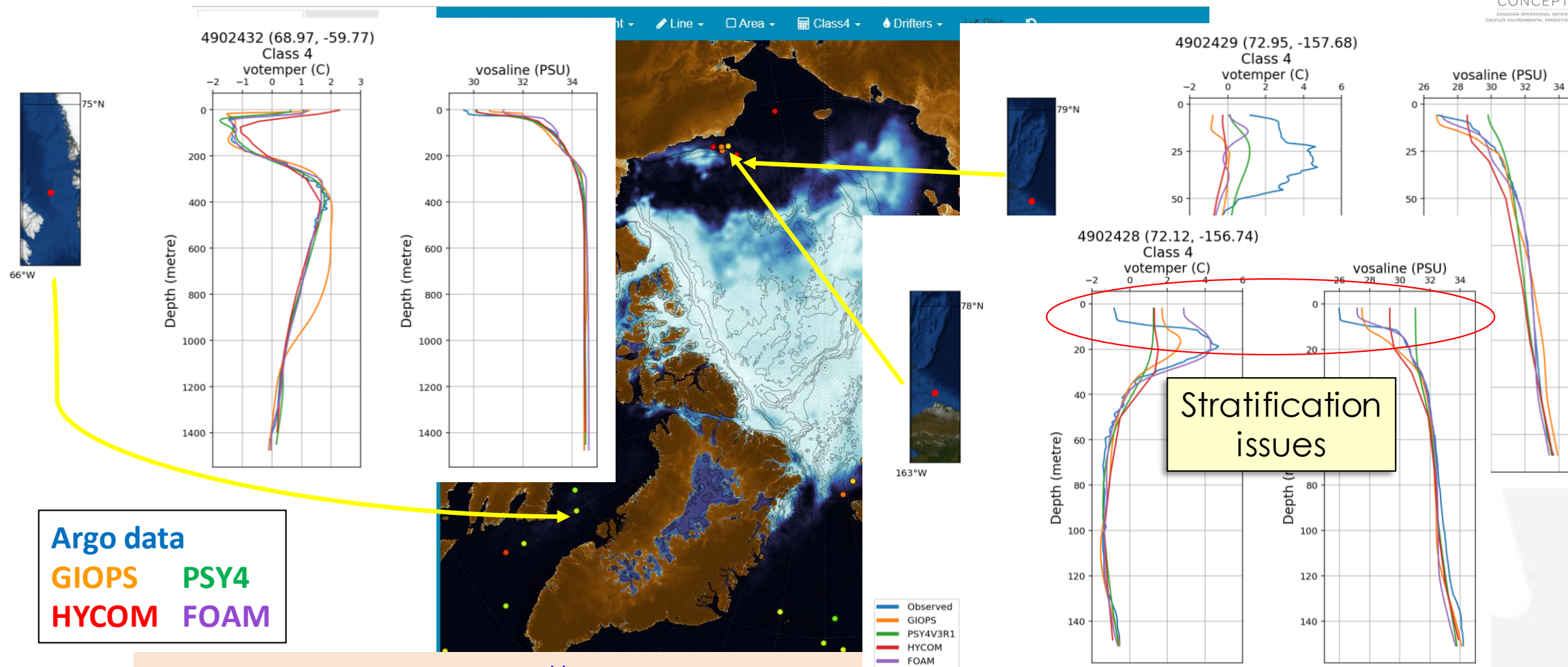


- Mean profiles of **temperature** RMSE and Bias (vs T/S ARGO data)
 - ✓ 7 large regions
 - ✓ 5 global models

Near real-time monitoring per region



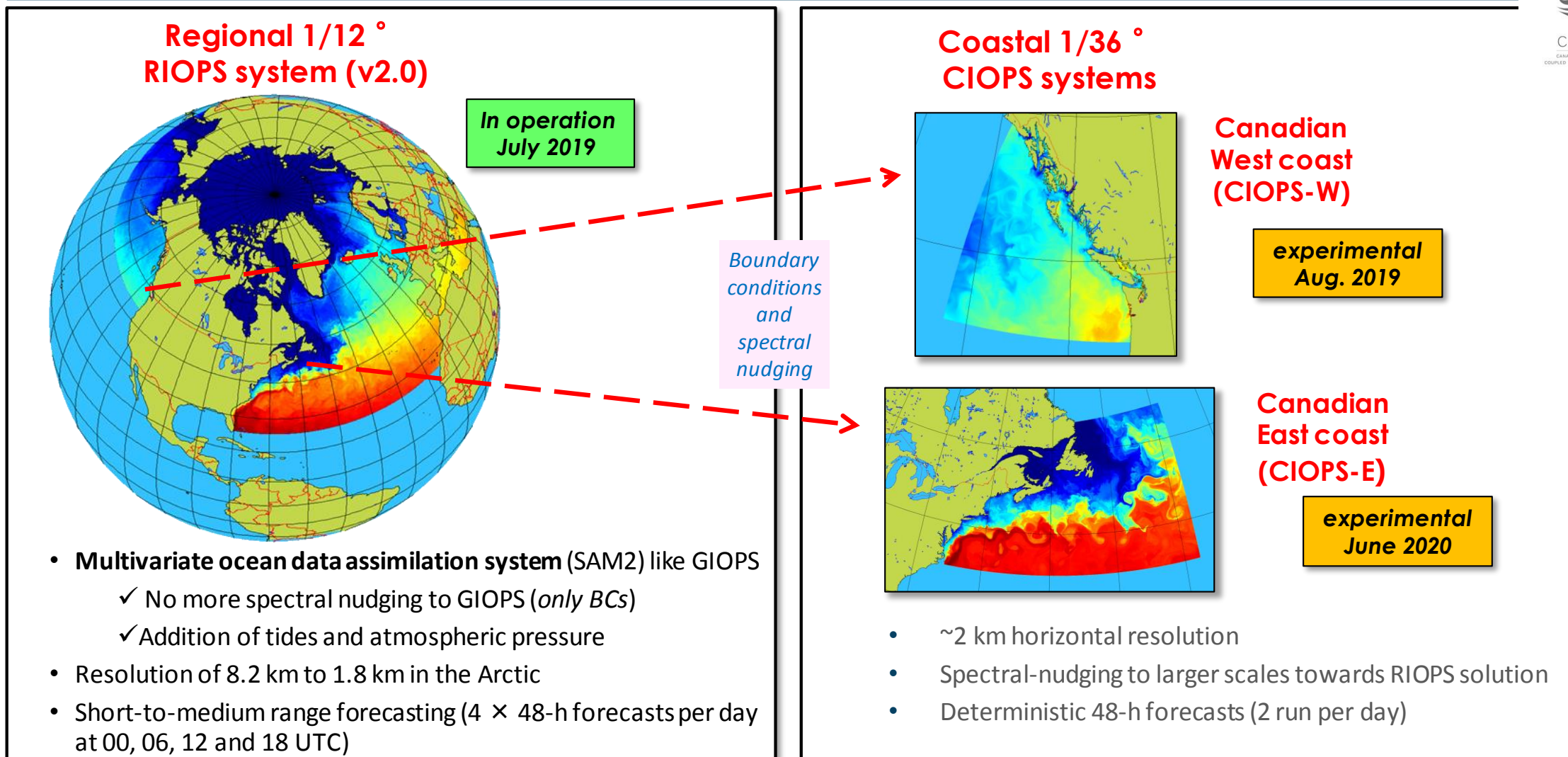
T/S profiles in GOV Class 4 files (2018-09-01)



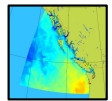
Argo data
 GIOPS PSY4
 HYCOM FOAM

CONCEPTS OceanNavigator: <http://navigator.oceansdata.ca>
 showing GIOPS sea ice on 2018-09-01 and dots corresponding to Argo profiles included in GOV Class 4 files

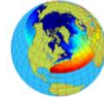
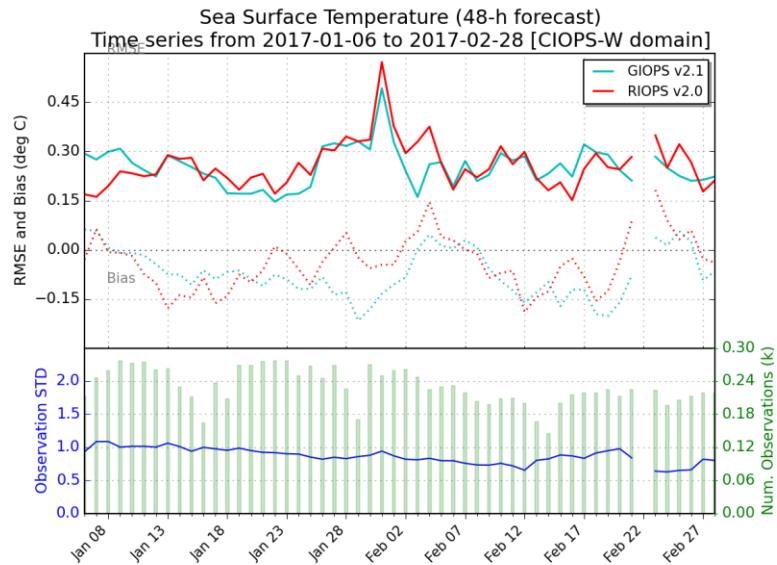
Class-4 for other CONCEPTS ice-ocean prediction systems



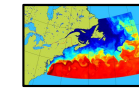
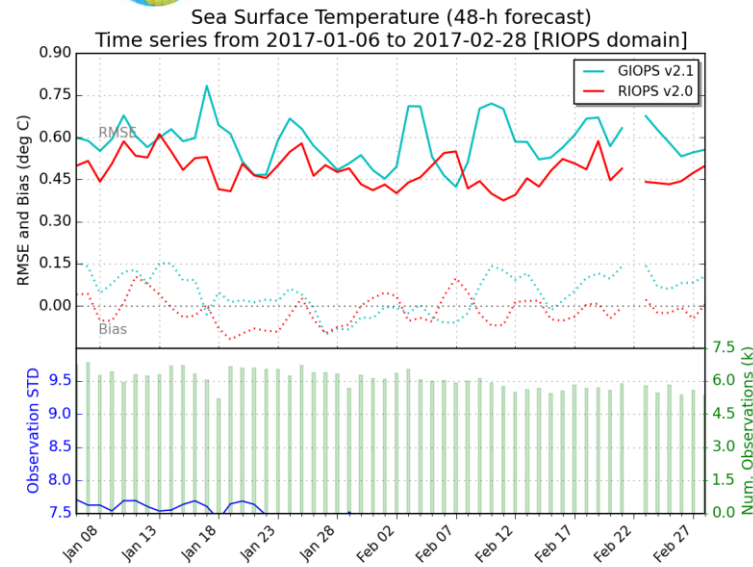
Example: RIOPS vs GIOPS comparison



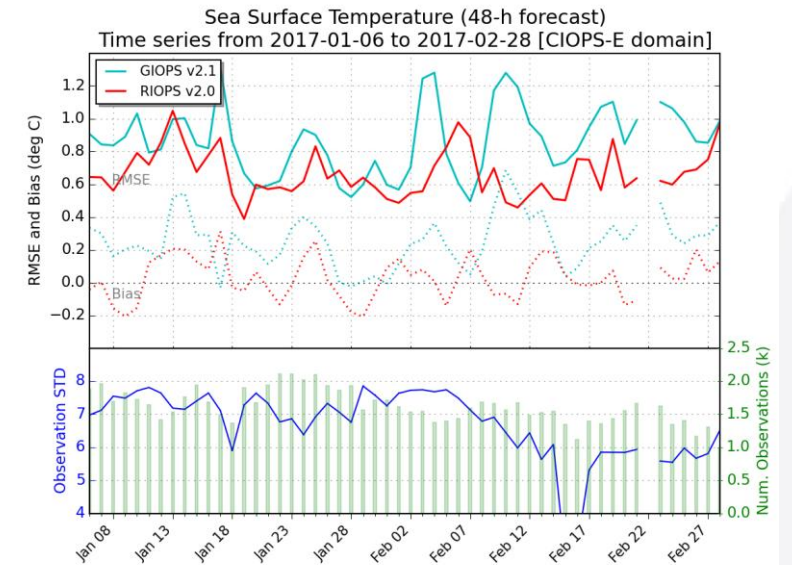
CIOPS-W NEP36 domain



RIOPS domain



CIOPS-E NWA36 domain



- RMSE and bias of **SST** over the whole **RIOPS domain** and the **two CIOPS domains**
- **Comparison for winter season** (Jan.-Feb. 2017) using 48-h lead time forecasts

Summary

- **GOV IV-TT Ocean and Ice Class-4** metrics (*evaluation against observations*) are **very valuable** for:
 - ✓ near real time operational model monitoring
 - ✓ inter-comparison of models, including various resolution
 - ✓ evaluation of new model improvement or version
 - ✓ examine how systems perform in poorly-observed area → *need for regionalisation*



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Future works

- Implement Class-4 for CONCEPTS systems (**RIOPS** and **CIOPS**) (*in progress*)
 - ✓ Including regionalisation over sub-domains
- Integrate **sea ice Class-4** metrics in near real-time monitoring (*in progress*)
- Implement **Class-4** evaluation for near-surface **currents** based on reference dataset produced by Mercator International Ocean



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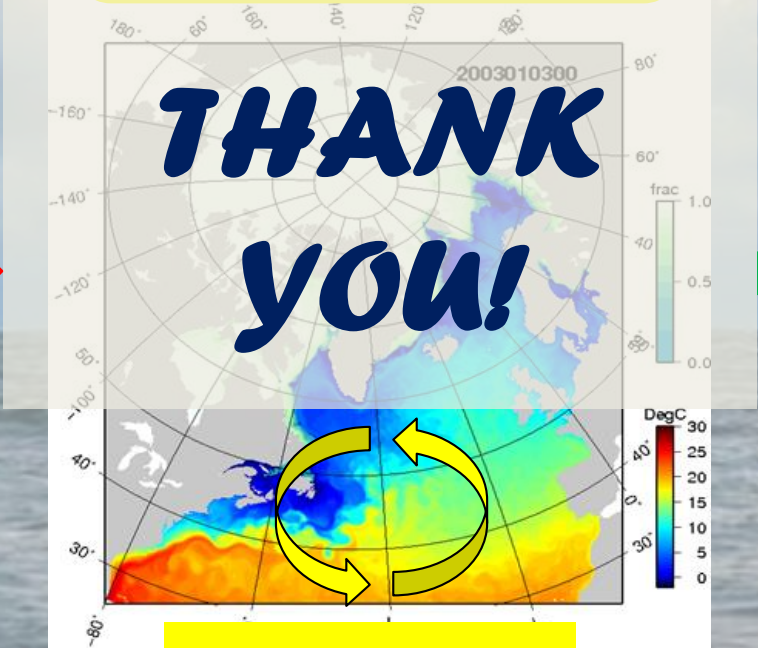
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Observations →



→ **Informations**



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