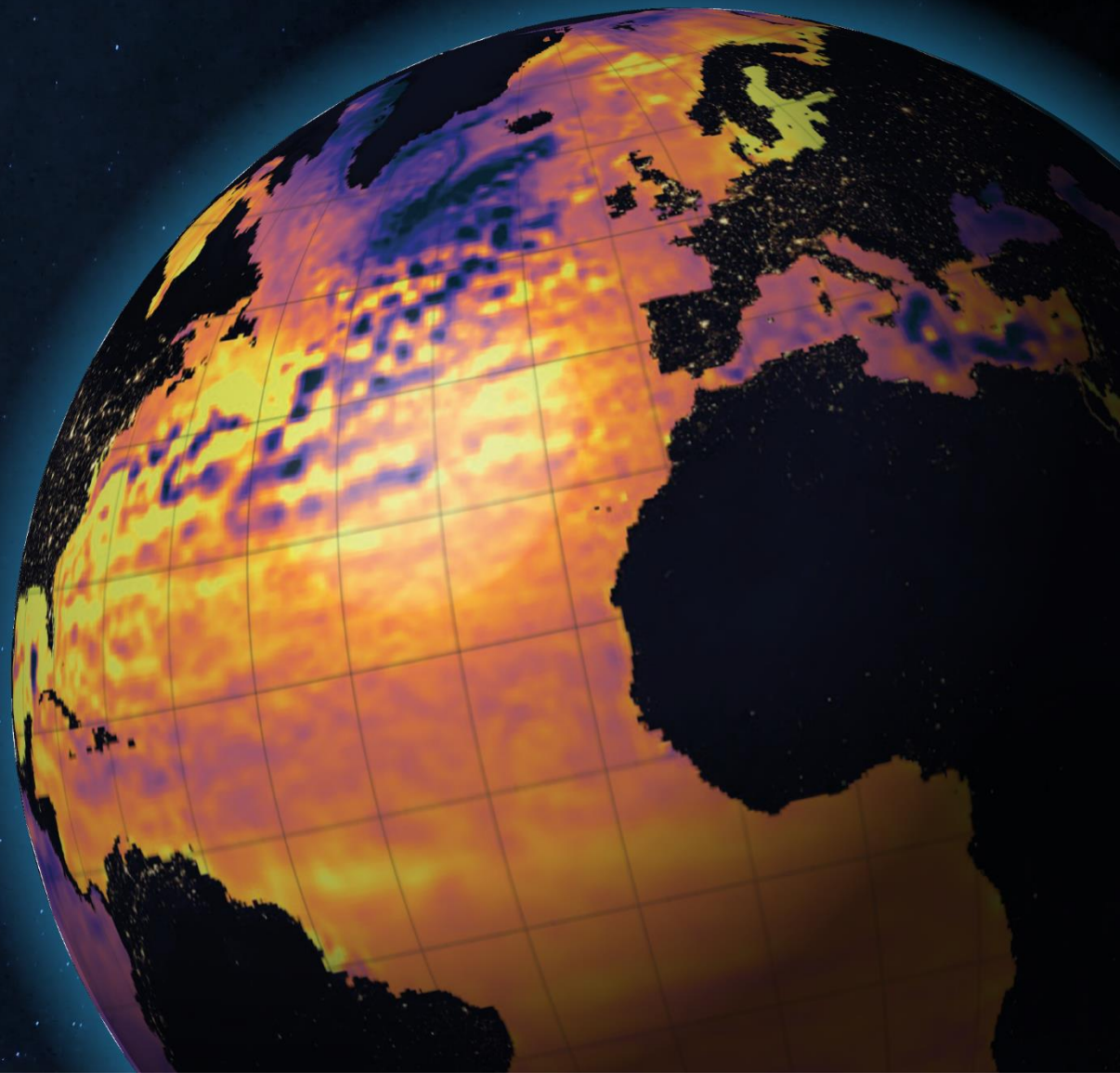
Ocean Predict

SYMPOSIUM OP'24

In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

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



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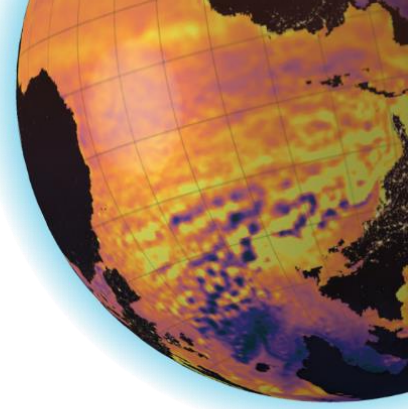
Outline

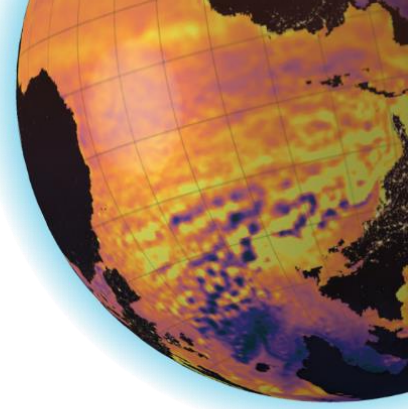
1. Class-4 verification and the Intercomparison and Validation Task Team (IV-TT)
   - What are Class-4 metrics?
   - The Ocean Predict IV-TT
2. CONCEPTS near real-time verification of the Canadian operational ice-ocean systems
   - Ocean Class-4 verification
   - Sea ice Class-4 verification
3. New and future developments for the international Class-4 comparison
   - New sharing approach
   - New reference datasets for ocean Class-4

What are Class-4 metrics?



- **Class-4 metrics** aims **to measure the performance of forecasting system:**
  - capability to describe the ocean (*hindcast mode*)
  - forecasting skill (*analysis and forecast mode*)
- **Common shared dataset** of observations is used **as reference data**, providing ocean 'truth'
- **Model forecast/analysis fields interpolated to observations** (model equivalents)
  - Class-4 metrics limited to the "observational space"
  - Daily average
  - Assess forecast accuracy according to different lead time and persistence
  - Model analysis (initialization) included as best estimate

Application of Class-4 diagnostics

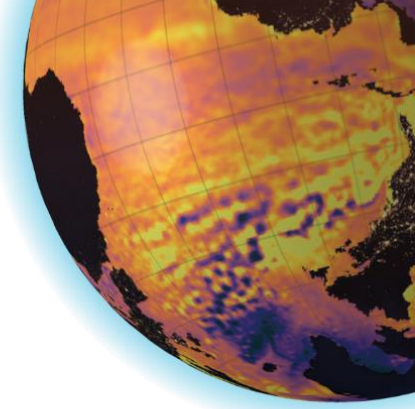


- **Validation and intercomparison** of operational oceanography systems initiated by the **GODAE OceanView** (*now* **Ocean Predict**) **Intercomparison and Validation Task Team (IV-TT)** based on Class4-metrics:
  - Sea Surface Temperature (SST) *vs* surface drifter data
  - Sea Level Anomaly (SLA) *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 data → daily sea ice Class-4 file generated by CONCEPTS since late 2014

Intercomparison and validation

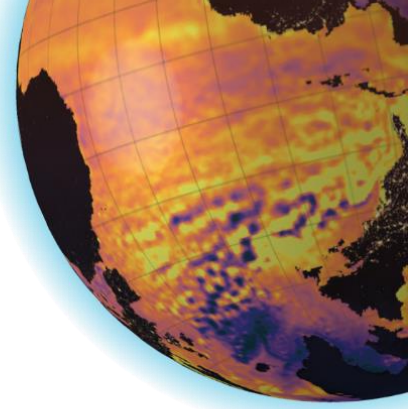


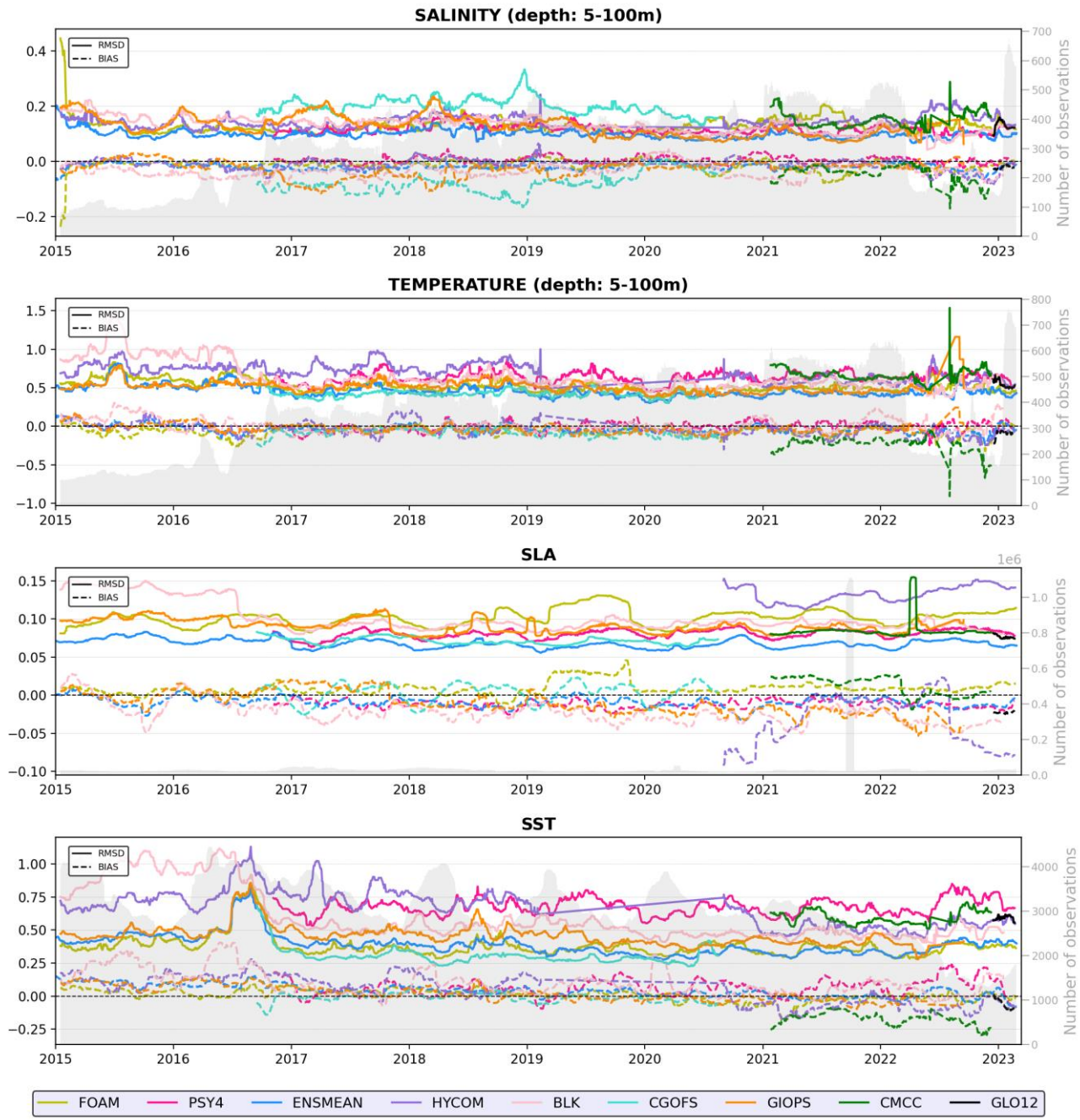
- **Monitoring global ocean** forecasting system skill in near real-time
  - evaluation against observations (Class-4)
  - multi-system inter-comparison

- **Participants** (Global systems)
  - **UK Met Office** (UK): Forecast Ocean Assimilation Model (**FOAM**) system at 1/4°
  - **Mercator Ocean International** (France): PSY3 at 1/4° (*stopped in sept. 2020*) , **PSY4** and now **GLO12** at 1/12°
  - **CONCEPTS** (Canada): Global Ice-Ocean Prediction System (**GIOPS**) at 1/4°
  - Australian Bureau of Meteorology (Australia): BLUElink Ocean Model Analysis and Prediction System (**OMAPS**) at 1/10°
  - **NOAA** National Weather Service (US) : Real Time Ocean Forecast System (HYCOM-**RTOFS**) at 1/12°
  - Centro Euro-Mediterraneo sui Cambiamenti Climatici (**CMCC**; Italy): Global Ocean Forecast System (**GOFS**) at 1/16°
  - National Marine Environmental Forecasting Center (**NMEFC**; China): Chinese Global Ocean Forecasting System (**CGOFS**) at 1/12°

Met Office · MERCATOR OCEAN INTERNATIONAL · CONCEPTS · Australian Government Bureau of Meteorology · NOAA · National Weather Service · U.S. Department of Commerce-NOAA · cmcc Centro Euro-Mediterraneo sui Cambiamenti Climatici · NMEFC

Historic of Global Systems





Ocean salinity
(5-100 m averaged)
Global scores < 0.2

Ocean temperature
(5-100 m averaged)
Global scores < 1°C

Sea Level Anomaly
Global scores < 10 cm

Sea Surface Temerature
Global scores < 0.7°C

Courtesy of Charly Régnier (Mercator Ocean International, 2023)

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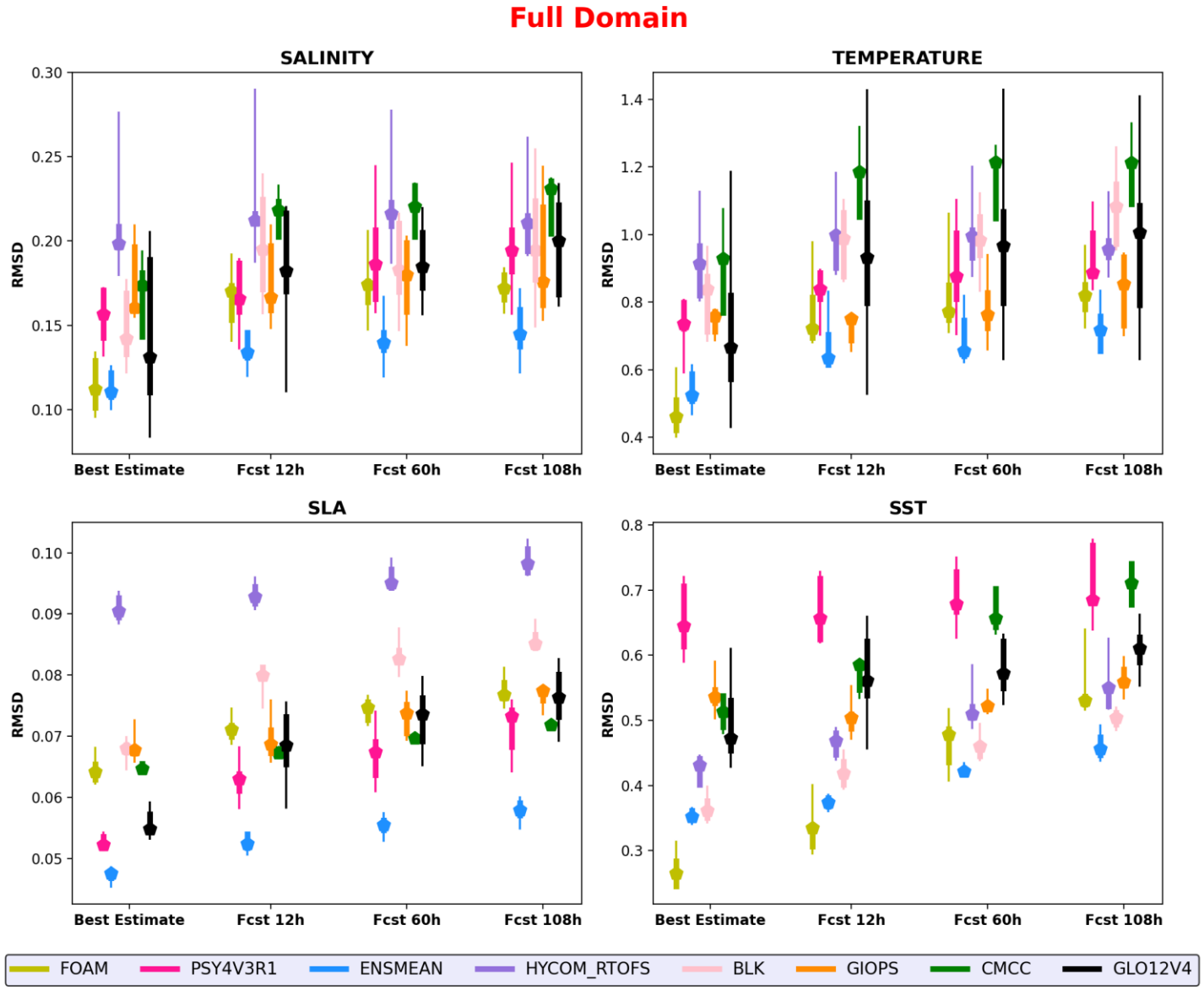
Synthetic View: Forecast accuracy in 2021-2022

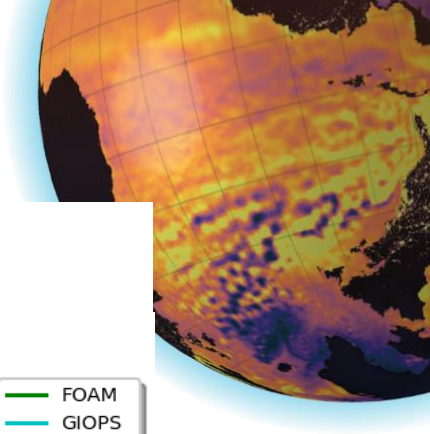


Evolution of the RMSD as a fonction of forecast lead time

- Thick line : percentile 75% distr
- Thin Line : Percentile 95% distr

Courtesy of Charly Régnier (Mercator Ocean International, 2023)

CONCEPTS Class-4 near real-time monitoring



Sea Level Anomaly (SLA)
Sea Surf. Temperature (SST)
Water Temperature
Water Salinity

Surface time-serie
Mean vertical profile
0-50m average time-serie
50-300m ave. time-serie
300-1000m ave. time-serie
1000-2200m ave. time-serie

0 - Global Ocean
1 - Arctic
2 - North Atlantic
3 - North Pacific
4 - Equatorial Atlantic
5 - Equatorial Pacific
6 - Indian
7 - Antarctic

Ocean Class-4 GIOPS forecasts verification and comparison with other global systems

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

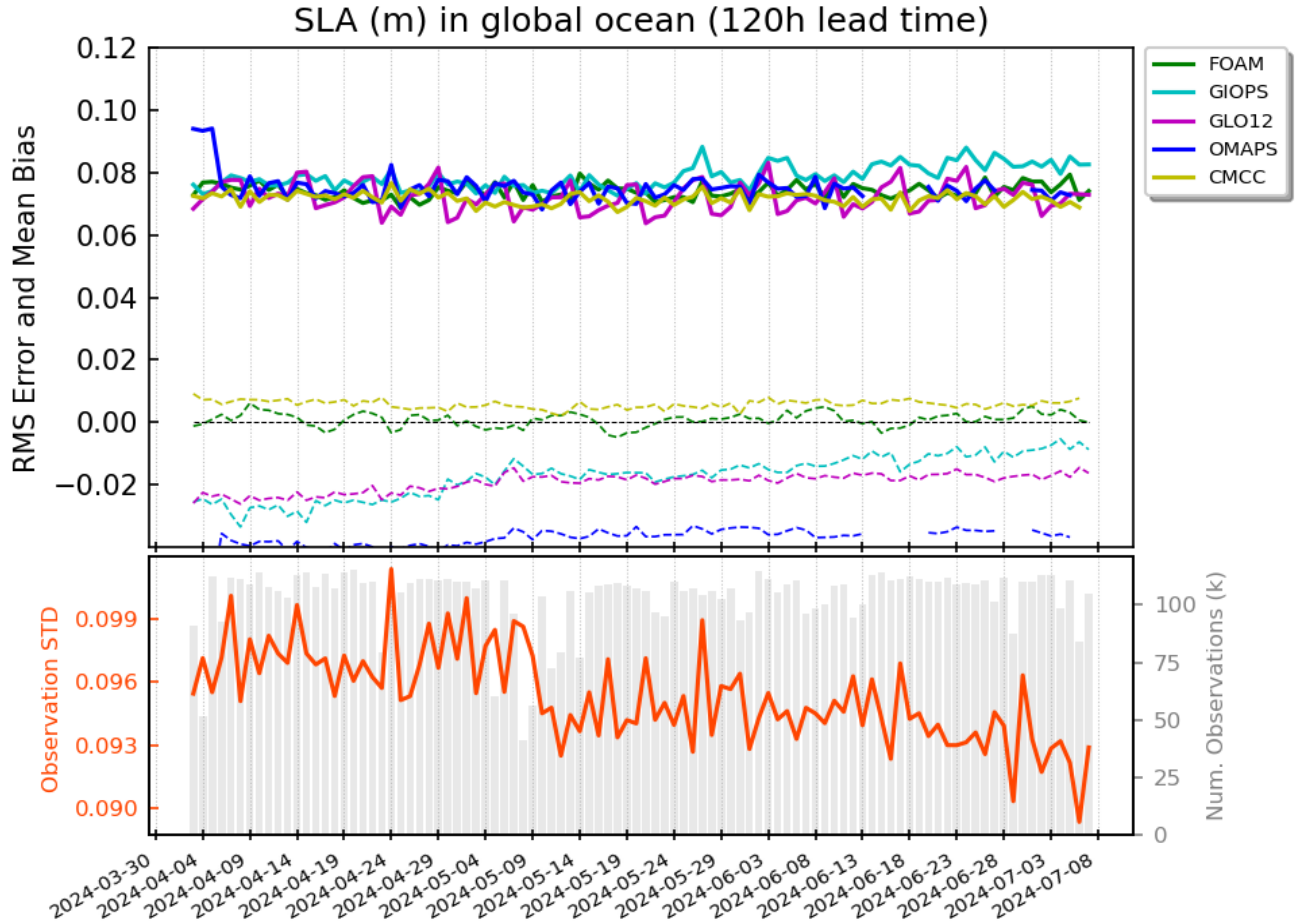
Date (YYYY-MM-DD)
2024 Sep. 12 < >

Variable
Sea Level Anomaly (SLA) < >

Depth range
Surface time-serie < >

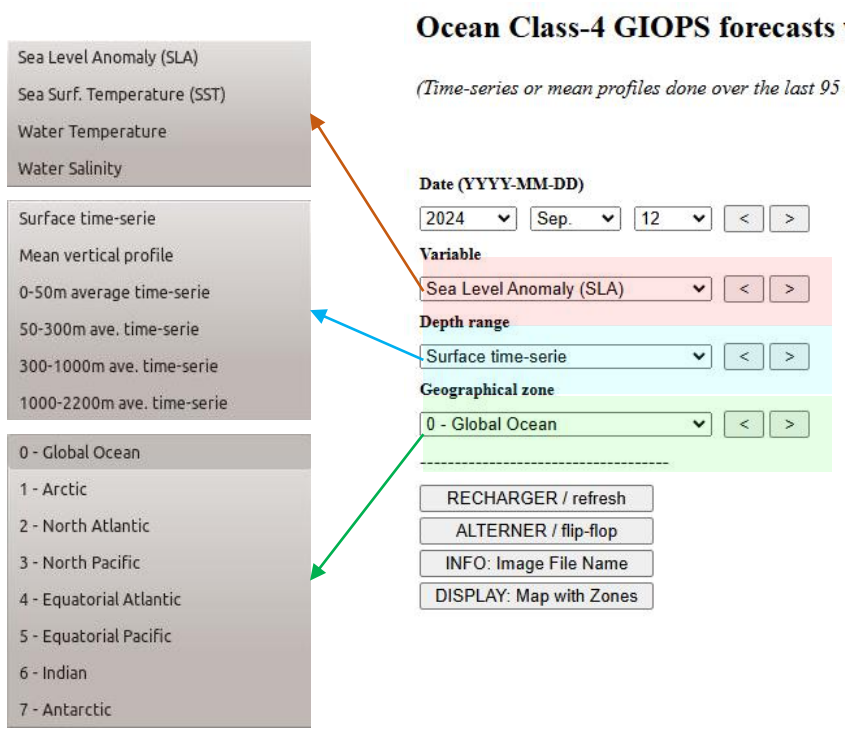
Geographical zone
0 - Global Ocean < >

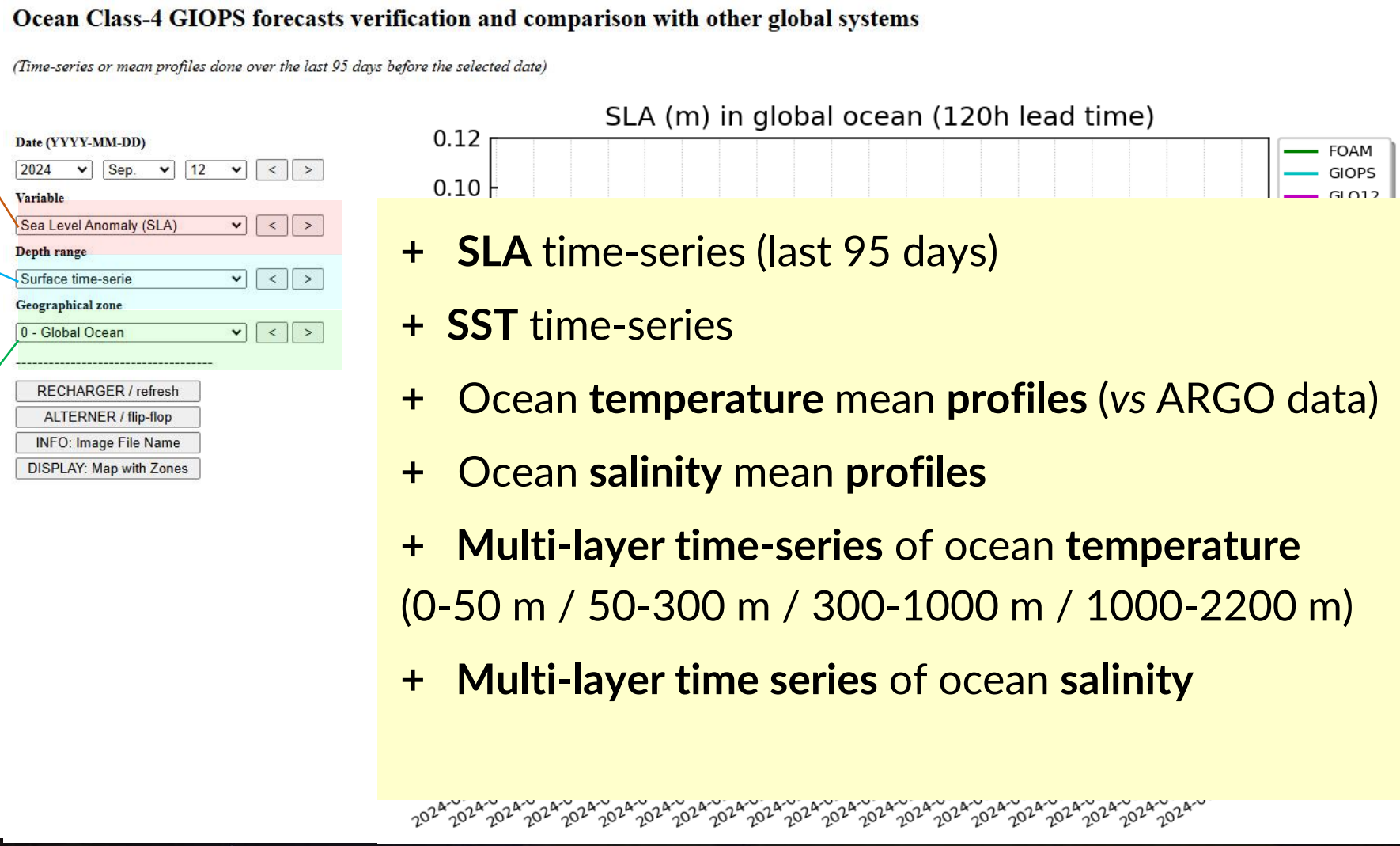
RECHARGER / refresh
ALTERNER / flip-flop
INFO: Image File Name
DISPLAY: Map with Zones



→ **User web interface** to monitor *on-line* in near real-time the **daily scores** from the different global systems, including GIOPS

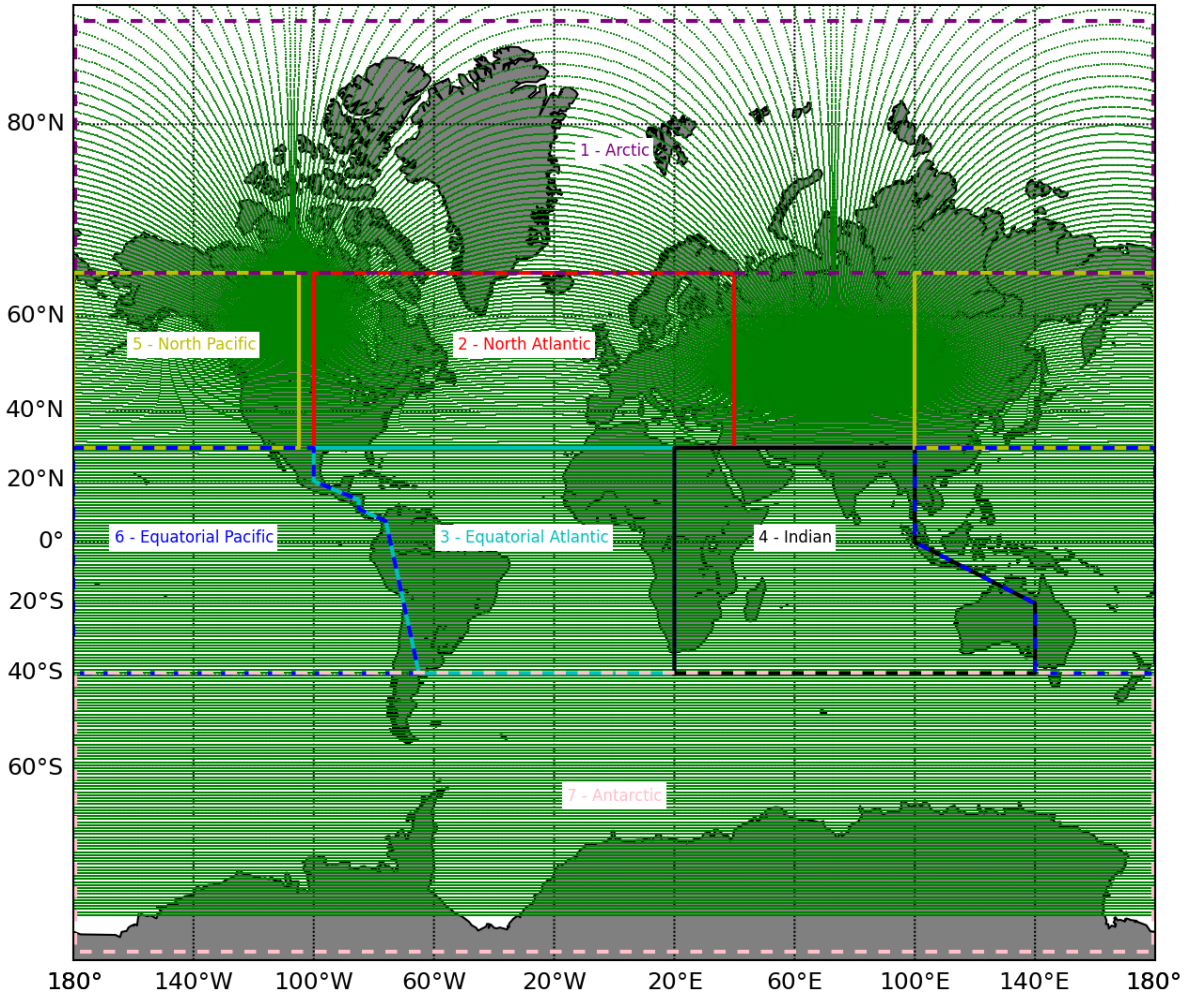
CONCEPTS Class-4 near real-time monitoring





+ **SLA** time-series (last 95 days)
+ **SST** time-series
+ Ocean **temperature** mean **profiles** (*vs* ARGO data)
+ Ocean **salinity** mean **profiles**
+ **Multi-layer time-series** of ocean **temperature** (0-50 m / 50-300 m / 300-1000 m / 1000-2200 m)
+ **Multi-layer time series** of ocean **salinity**

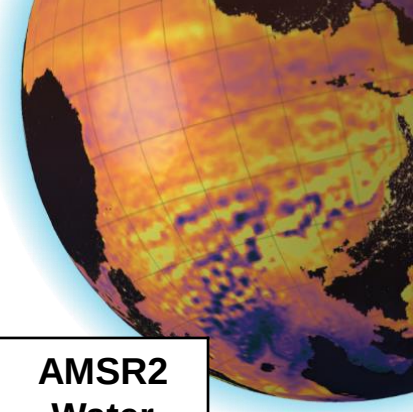
CONCEPTS near real-time monitoring per region



- Definition of **7 oceanic regions** to refine the assessment
  - ✓ Mutually exclusive zones
  - ✓ For each zone:
    - Time-series of SLA and SST
    - Multilayer time-series of ocean temperature and salinity (4 ×layers)
    - Averaged profiles of ocean temperature and salinity

➢ **Total of 96 images** (*including12 global*) generated **per day** and displayed via the user interface

Sea ice Class-4 metrics

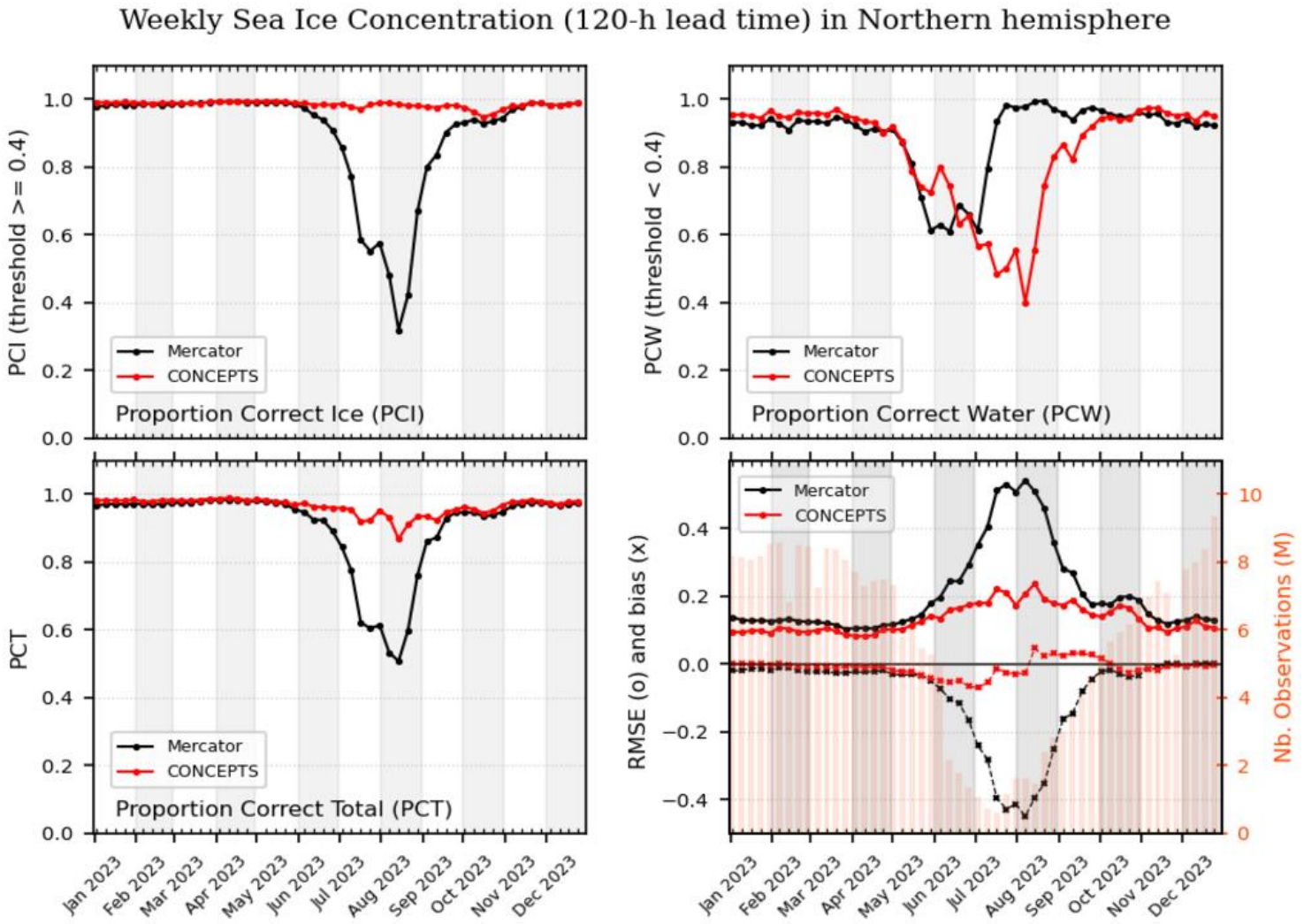


- **Ice data** derived from Advanced Microwave Scanning Radiometer 2 (**AMSR2**) data provided by NOAA NESDIS
- Continuous forecasts mapped to binary (yes/no) forecasts by applying a specified threshold (*e.g. 0.4*)
  → **verification scores** for sea ice are **ratios** calculated **using contingency table metrics**

	AMSR2 Ice	AMSR2 Water
Forecast Ice	**Hits ice (A)**	**False alarms (B)**
Forecast Water	**Misses (C)**	**Hits water (D)**

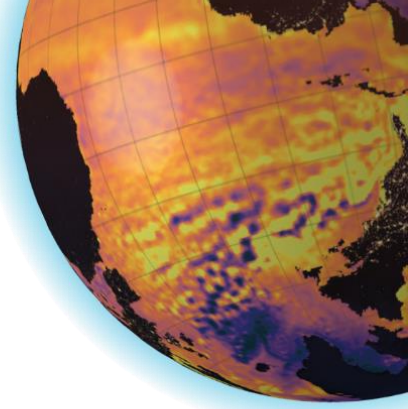
Score	Definition	Range	Signification
Proportion correct total	**PCT** = (A+D) /N	[0,1]; 1 is perfect score	Fraction of all forecasts that were correct (yes and no)
Proportion correct **Ice**	**PCI** = A / (A+C)	[0,1]; 1 is perfect score	Fraction of observed sea ice that were correctly forecast
Proportion correct **Water**	**PCW** = D / (B+D)	[0,1]; 1 is perfect score	Fraction of observed open water that were correctly forecast

Sea ice Class 4 scores for 2023 (NH)



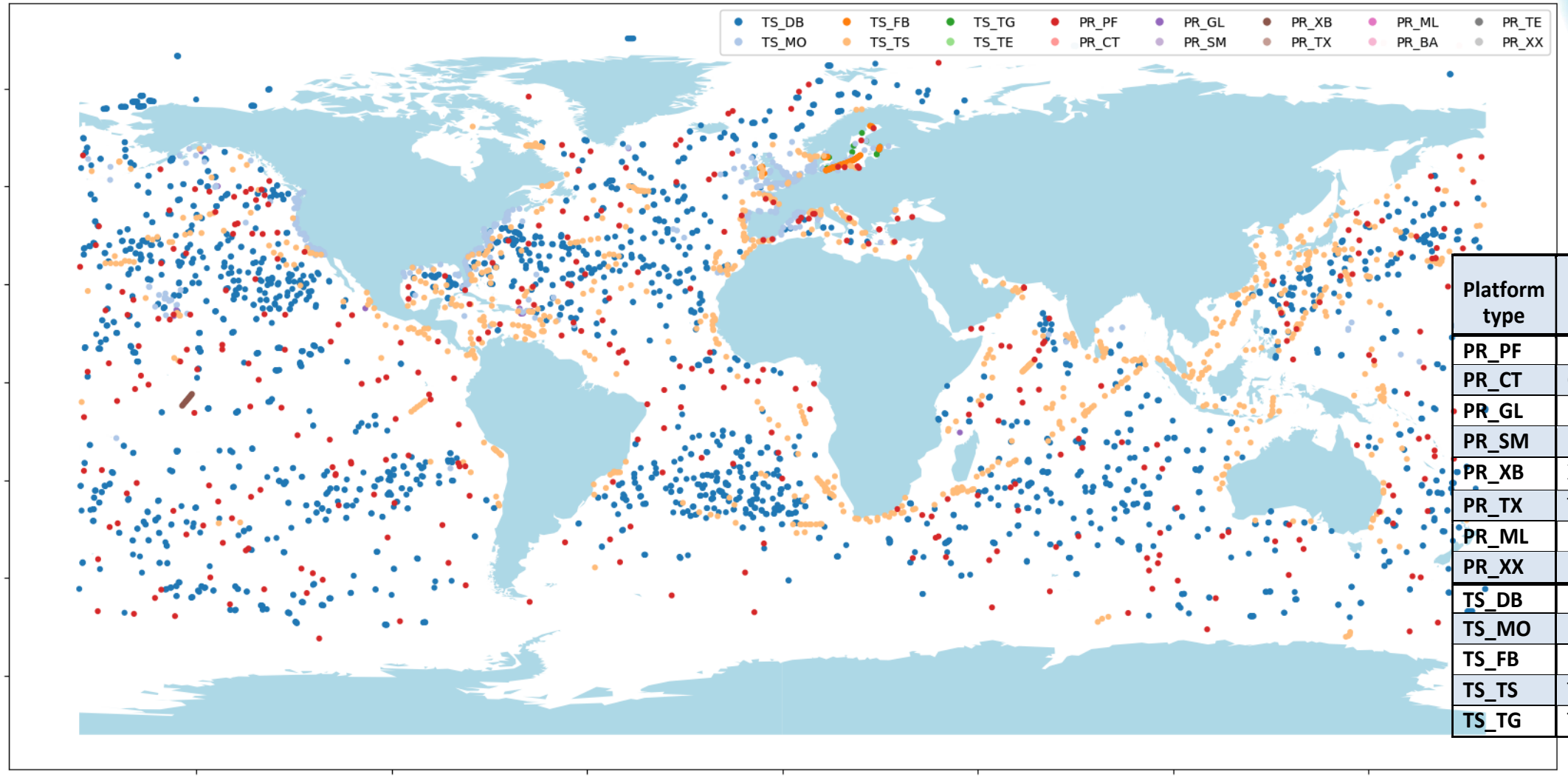
- **Specified threshold** for ice / no ice = **0.4**
- **5 day** lead time
- Scores weekly averaged
  - **Proportion Correct Ice** (or Water): hit rate or probability of detection
  - **Proportion Correct Total:** fraction of all forecasts that were correct (yes and no)

New and future developments



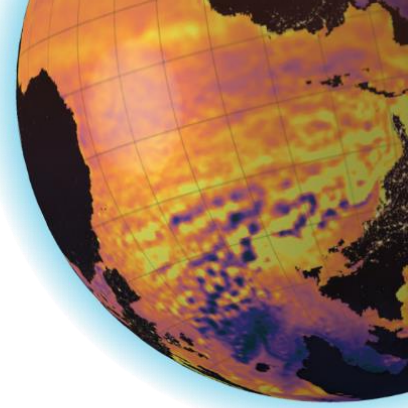
- International **Class-4 data sharing**
  - Historical US GODAE FTP server not supported in near future
  - New technical approach in place using a collaborative machine on the Canadian Science network
  - ***Future developments***: visualization interface available on this machine / opportunity for code sharing and collaborative development of new diagnostics
- **Reference** observation datasets
  - Historical supply by UK Met Office not fully supported *(best effort)*
  - Real-time global observations available *via* Copernicus Marine Service
  - Quality control in place for assimilation of those data in CONCEPTS operational systems
  - ***Proposal in collaboration with MOI***: use those data as reference datasets → QC well documented / fully 24/7 supported / potential to include new observation data, in particular in coastal areas (e.g. moorings)

Data passed QC for 2024-11-07



Platform type	Definition
PR_PF	Profiling float (e.g., ARGO)
PR_CT	CTD profiling system
PR_GL	Underwater glider
PR_SM	Equipped sea mammal
PR_XB	XBT, XCTD profiling systems
PR_TX	Thermistor sensor chain
PR_ML	Mini logger
PR_XX	Undefined
TS_DB	Drifting buoy
TS_MO	Mooring, fixed buoy
TS_FB	Ferrybox
TS_TS	Thermoslinographs
TS_TG	Tide gauge

Conclusion



- Near real-time CONCEPTS GIOPS ocean and sea ice Class-4 production and near real-time monitoring in operation, including comparison with other global systems
- International collaboration on Class-4 (Ocean Predict IV-TT) is fundamental for operational verification → complementary of all the systems (ensemble mean)
- Work initiated and to continue to be more operational and to produce statistics at a regular basis, produce documentation and more publications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ADVANCING OCEAN PREDICTION
SCIENCE FOR SOCIETAL BENEFITS
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