

Introduction

In collaboration with the French operational ocean forecasting centre Mercator-Océan, a Canadian capacity for operational ocean forecasting is being developed as part of the CONCEPTS (Canadian Operational Network of Coupled Environmental Prediction Systems) project. The main aim of CONCEPTS is the eventual development of global and regional operational coupled atmosphere-ice-ocean forecasting systems.

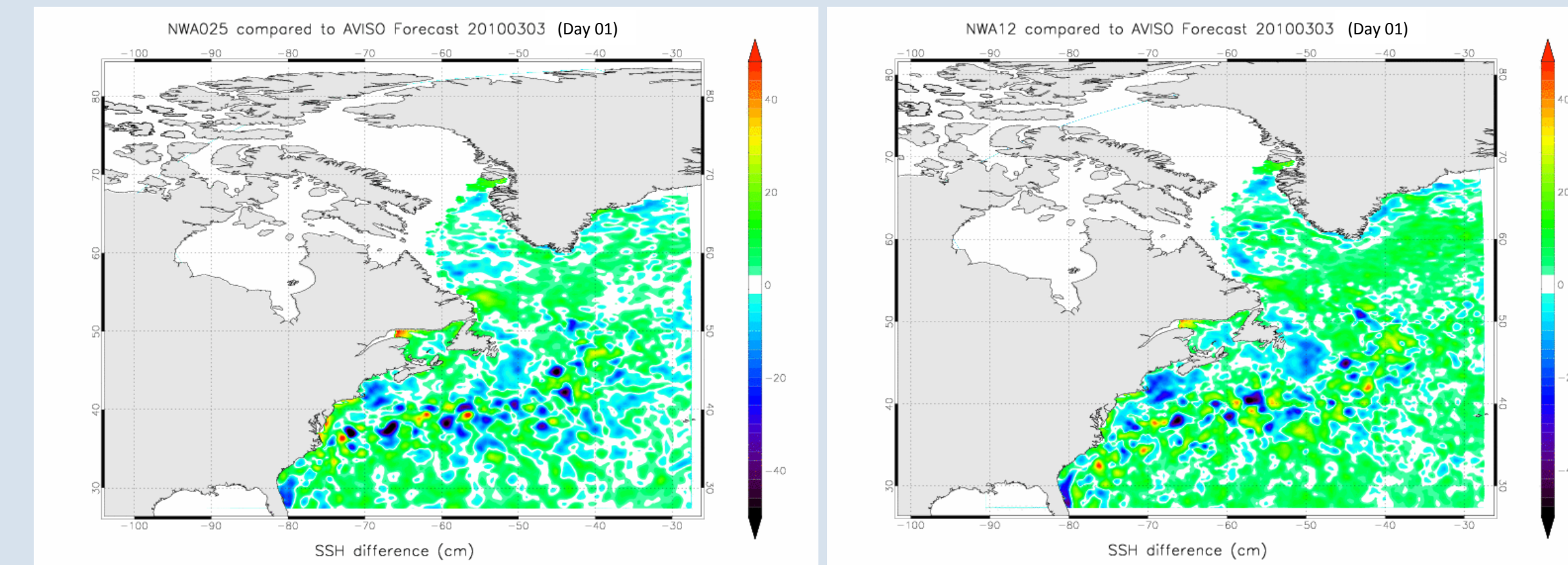
The regional ocean forecasting component of CONCEPTS is the Canadian-Newfoundland Operational Ocean Forecasting System (CNOOFS). The validation system for C-NOOFS is presented herein. The C-NOOFS system runs two forecasts daily: NWA025 and NWA12 with 1/4 (20km) and 1/12 (6 km) degree resolution respectively. The system is initialized from Mercator-Océan analysis (PSY3V2R2 for NWA025 and PSY2V3R1 for NWA12, Wednesdays, only) from which a 10 day forecast is produced. Lateral boundary conditions are provided by Mercator-Océan and sea surface fluxes are provided by the Canadian Meteorological Center (CMC).

Currently the monitoring system validates sea surface parameters since they are easily measured from satellite. However an in-situ validation protocol is underway. Sea surface height (SSH) from AVISO, sea surface temperature (SST) and ice analysis provided by CMC and Canadian Ice Services (CIS) are used to estimate the error in C-NOOFS forecast runs.

Comparison Models and Data

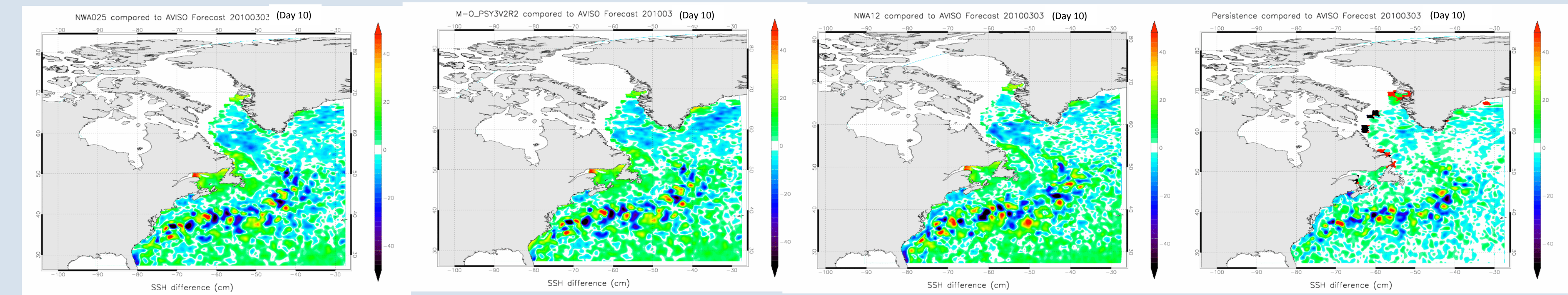
- **PSY3V2R2 by Mercator-Océan:** Operational NEMO (OPA9 + LIM) model; global, 1/4° horizontal resolution, 50 vertical layers, nested with LIM ice model. SST, in-situ temperature and salinity, and SSH are assimilated using the SAM2 system (a SEEK filter). (www.mercator-ocean.fr, Madec et al., 1998)
- **SST by Canadian Meteorological Center (CMC):** Incorporates in-situ observations and retrievals from one microwave and three infrared sensors. Statistical interpolation is used to update the analysis daily on a global grid with a resolution of 1/3°. (Brasnett, 2008)
- **3DVAR Ice by CMC/Canadian Ice Services (CIS):** An ice analysis system that uses the 3DVAR method to assimilate daily ice charts and RADARSAT data. (Caya et al., 2010)
- **SSH by AVISO (Archiving, Validation and Interpretation of Satellite Oceanographic data):** SSH (absolute dynamic topography) above the geoid on a 1/3°x1/3° Mercator projection grid. (<http://www.aviso.oceanobs.com>)

Examples of Difference Maps (SSH)

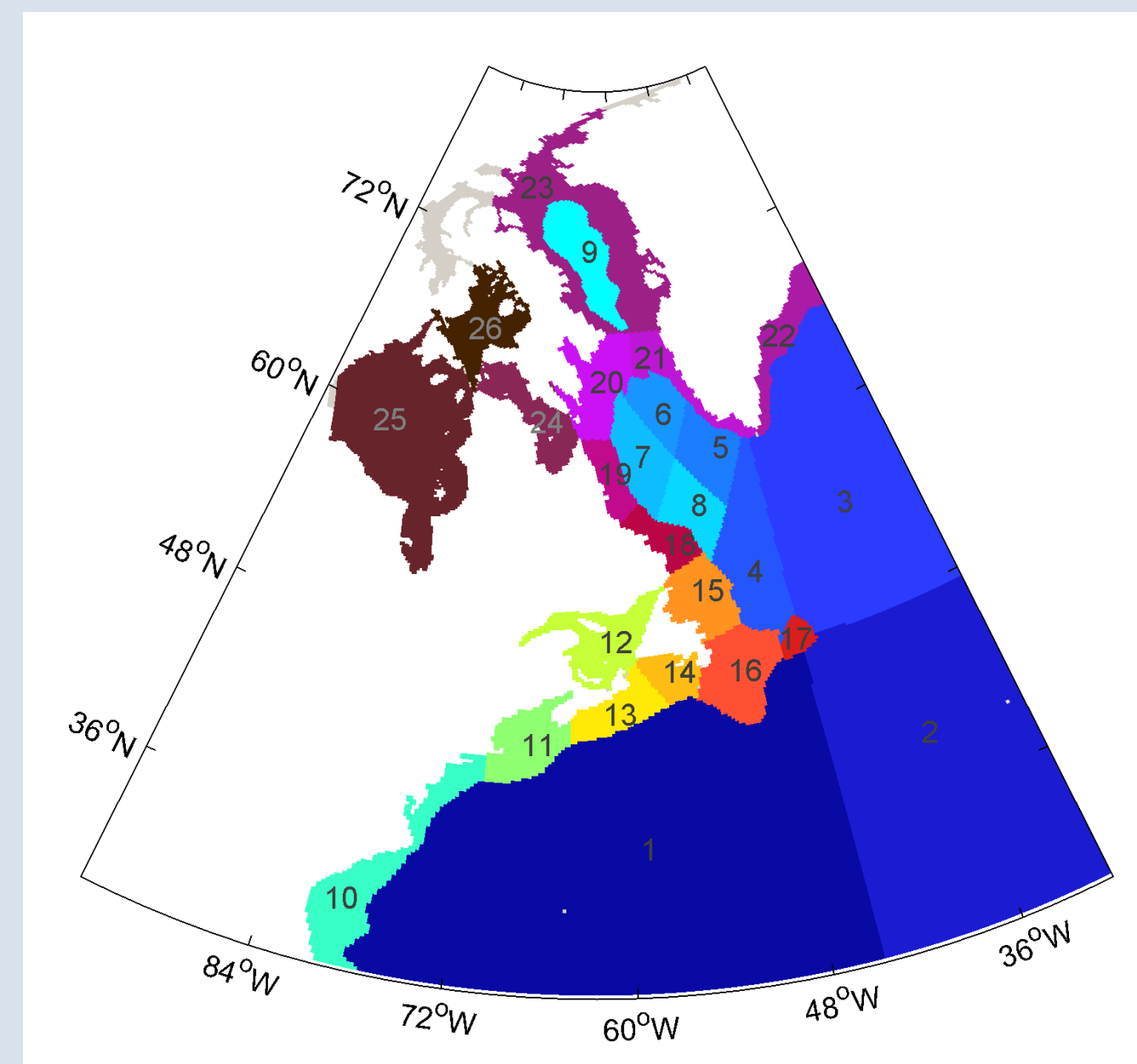


- On Day 1, NWA025 and M-O are identical – they use the same restart. NWA12 is slightly different than NWA025 because it uses a different restart. The NWA12 has been reduced to a 1/4° resolution for the comparisons and so some details are lost here.
- On Day 10 we are able to see the differences between the models.

The main departure from observations differences occur along the East Greenland Current. M-O is closer to observations than NWA025. However, the NWA12 run has smaller departures from SSH observations than both other 1/4 degree systems. For Persistence differences, the forecast error remains small outside of the Gulf Stream.



Monitoring Zones



The 26 geographical monitoring zones represent regions of distinct bathymetries and dynamics. Statistics are calculated over the entire model domain and the 26 individual zones to allow a detailed analysis of forecast accuracy.

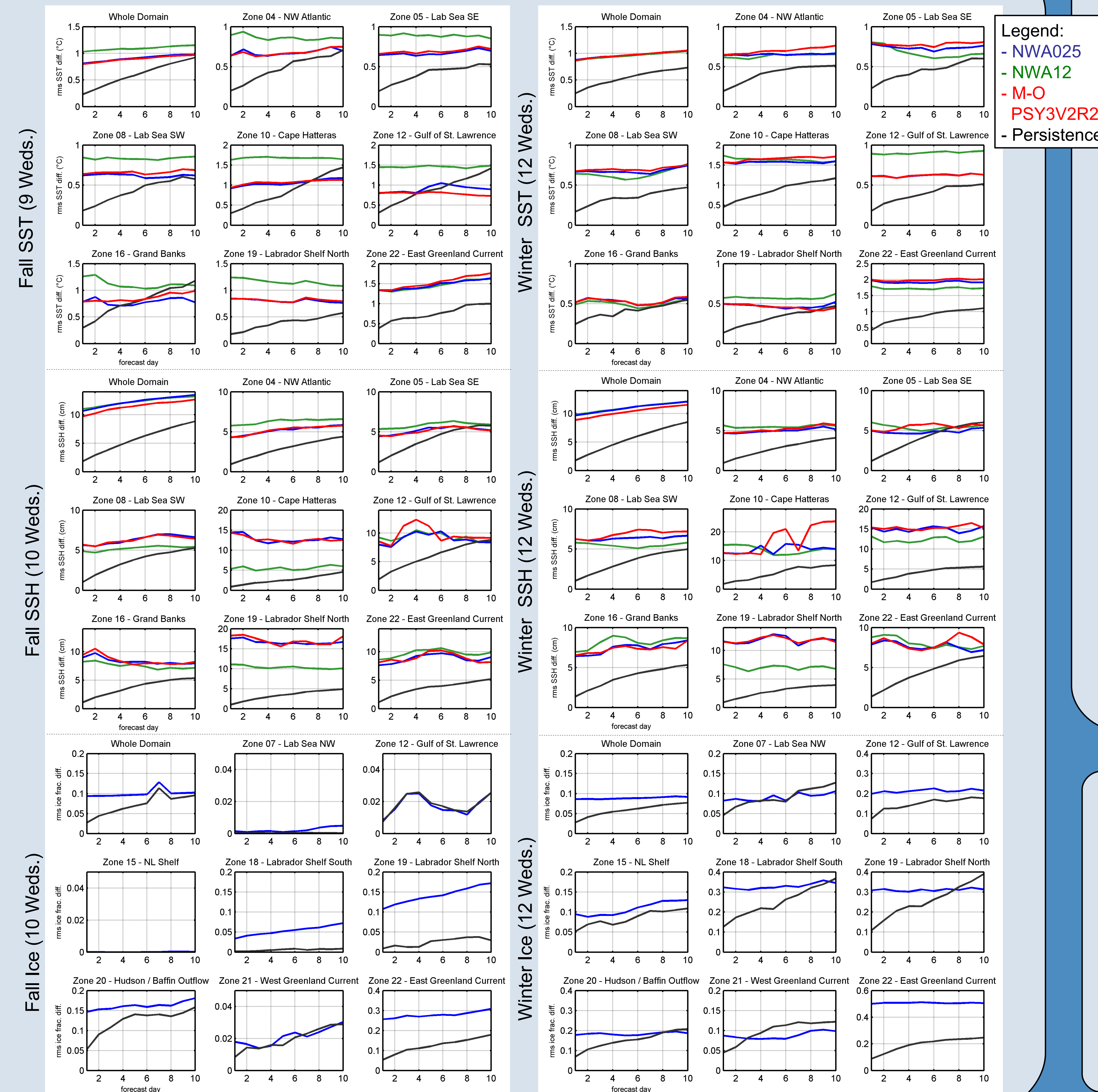
Method

The model outputs forecasts four times daily, and this is averaged to a daily mean for analysis, as is the Mercator output. Comparison data sets (CMC SST, AVISO SSH and CMC/CIS 3DVAR Ice) are daily averaged as well. The mean is removed from the AVISO SSH, and all ice fractions less than 0.1 in the CMC/CIS Ice are removed. Only the common area between the model and data is used in the calculation of comparison statistics. For each model run (each real-time day), the monitoring outputs:

- Difference maps between each model and each comparison data set.
- The RMS difference and the mean difference over the whole domain and over each individual monitoring zone (see Fig. 1) for each forecast day
- A time series of the RMS and mean differences vs forecast day

Persistence statistics are also created. (Persistence represents the current day's observational data as a proxy for future states of the ocean (either at 1 or 10 days).

Averaged RMS difference vs forecast day for Fall (NOD) 2009 and Winter (JFM) 2010 (SST, SSH and Ice)



Discussion

- SST:** Overall, NWA025 is marginally closer to the CMC SST data than is M-O, while NWA12 has a much greater RMS difference.
- NWA025 performs exceptionally well in Zone 16 (Grand Banks) in the fall, but not in the winter.
 - NWA025 is able to beat persistence in Zones 10, 12 and 16 in the fall and zone 19 in the winter.
 - There is a fairly pronounced seasonal difference in the RMS differences in most zones.
 - The larger RMS differences associated with NWA12 may be due to the SST restart field used. This issue requires further investigation.
- SSH:** Overall, all models perform similarly, but M-O is closer to AVISO than NWA025 and NWA12.
- NWA12 has a greater RMS difference in open ocean regions, but more closely resembles AVISO SSH where small scale processes are more dominant (i.e. Zones 8, 10, 19).
- We note that for SSH, we do not remove the mean SSH over the domain. However it is evident that modelled SSH has less forecast error growth than persistence
- Pronounced seasonal differences exist in Zones 10 and 12
- Ice:** Overall, NWA025 is close to, but does not beat persistence.
- NWA025 does especially well in Zones 18, 19, 20 and 21 (coastal Labrador Sea), but large differences between it and the 3DVAR Ice data exist along the East Greenland Current (Zone 22).

Differences in performance between the NWA model output and the Mercator-Ocean model output may be due to the difference in atmospheric fields (CMC vs ECMWF) used to force the model. It may also point to an issue with the bulk formula. It is possible that since NEMO is tuned to ECMWF, CMC forcing may result in a bias for some regions.

References

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