Environnement et Changement climatique Canada | Environment and Climate Change Canada

COUPLED ATMOSPHERE-OCEAN DATA ASSIMILATION IN THE CANADIAN GLOBAL PREDICTION SYSTEM

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Canada

5th Workshop on Coupling Technologies for Earth System Models

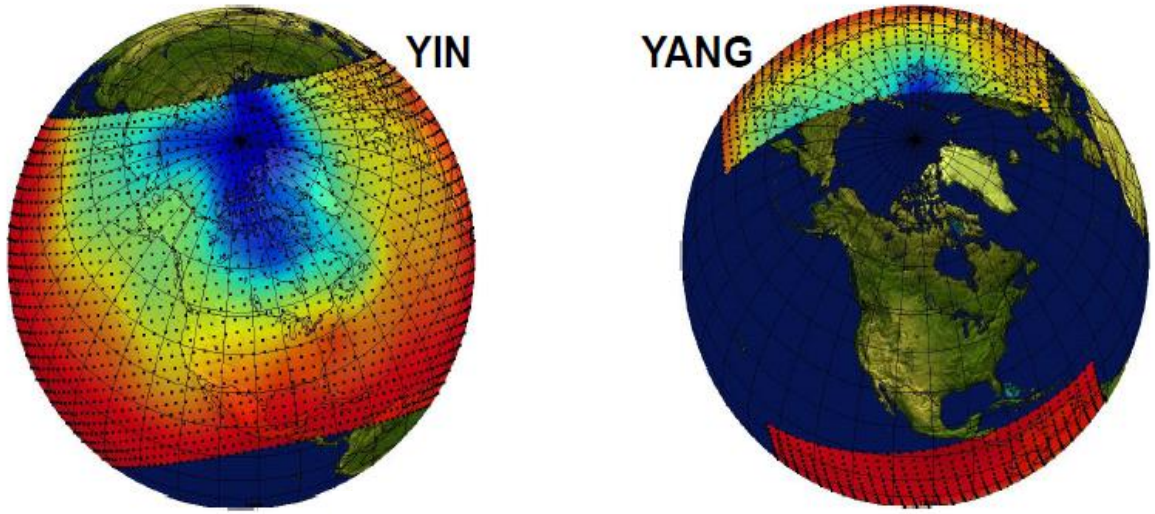
OUTLINE

- WCDA components
- technical implementstion
- some results and discussion
- conclusions and perspectives

ECCC'S GLOBAL DETERMINISTIC PREDICTION SYSTEM (GDPS)

- GEM atmospheric model
  - Current ECCC's NWP system
  - Coupled GEM-NEMO_CICE 6h background
  - Coupled GDPS 10 day forecasts: atmosphere-ocean-ice
- 4D-EnVar data assimilation:
  - Variational approach using 4D ensemble covariances from EnKF
  - Hybrid covariances by averaging the ensemble covariances with the static NMC-method covariances
- Data assimilated by the GDPS:
  - radiosondes, aircraft
  - Surface report (SYNOP, SHIP, BUOYs)
  - ATOVS
  - ATMS
  - SSMIS
  - AIRS/IASI/CrIS
  - GeoRad
  - ASCAT
  - AMVs
  - GPS-RO

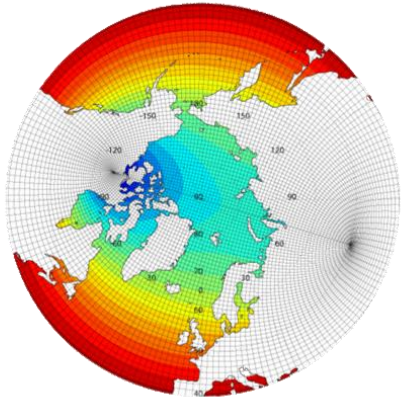
Global, Δx =25km

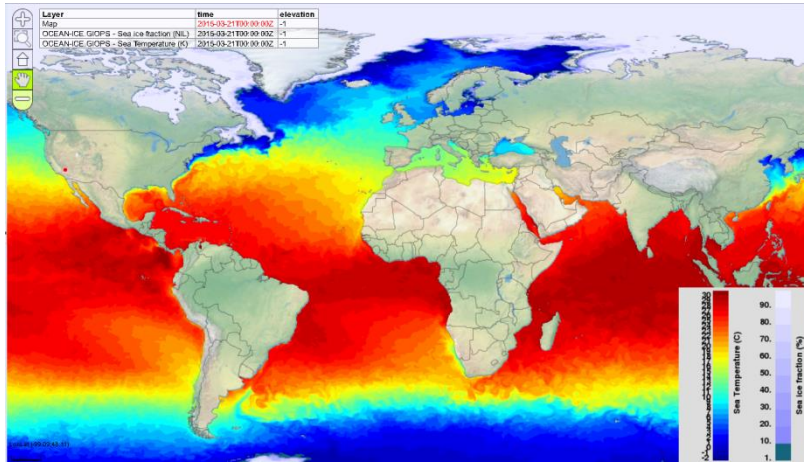


ICE-OCEAN MODELLING AND DATA ASSIMILATION WITH NEMO + CICE

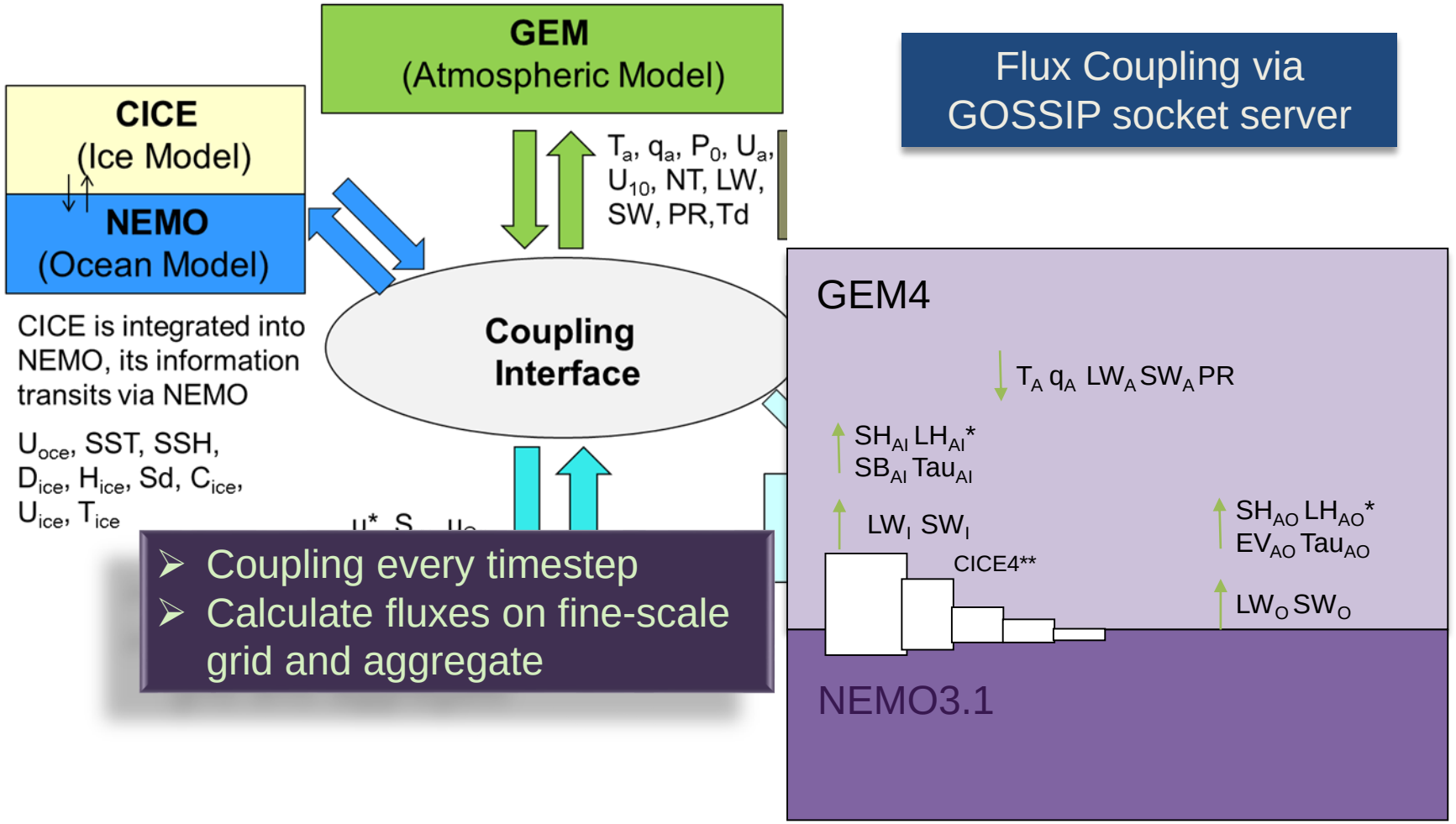
- Global Ice-Ocean Prediction System (GIOPS), NEMO-CICE coupled model
  - Seasonal forecasting
  - Coupled 6-h atmosphere-ocean-ice backgrounds
  - Coupled 10-day forecasts
- Mercator Ocean Assimilation System (SAM2):
  - Sea surface temperature daily
  - Temperature and salinity profiles weekly
  - Sea level anomaly from satellite altimeters weekly
- 3DVar Ice analysis:
  - SSM/I, SSM/IS, ASCAT, AVHRR
  - CIS charts and image analyses
- SST OI analysis:
  - in situ data, AVHRR, AMSR-E, ATSR
  - foundation SST
  - background: previous day analysis

1/4° (ORCAS025)

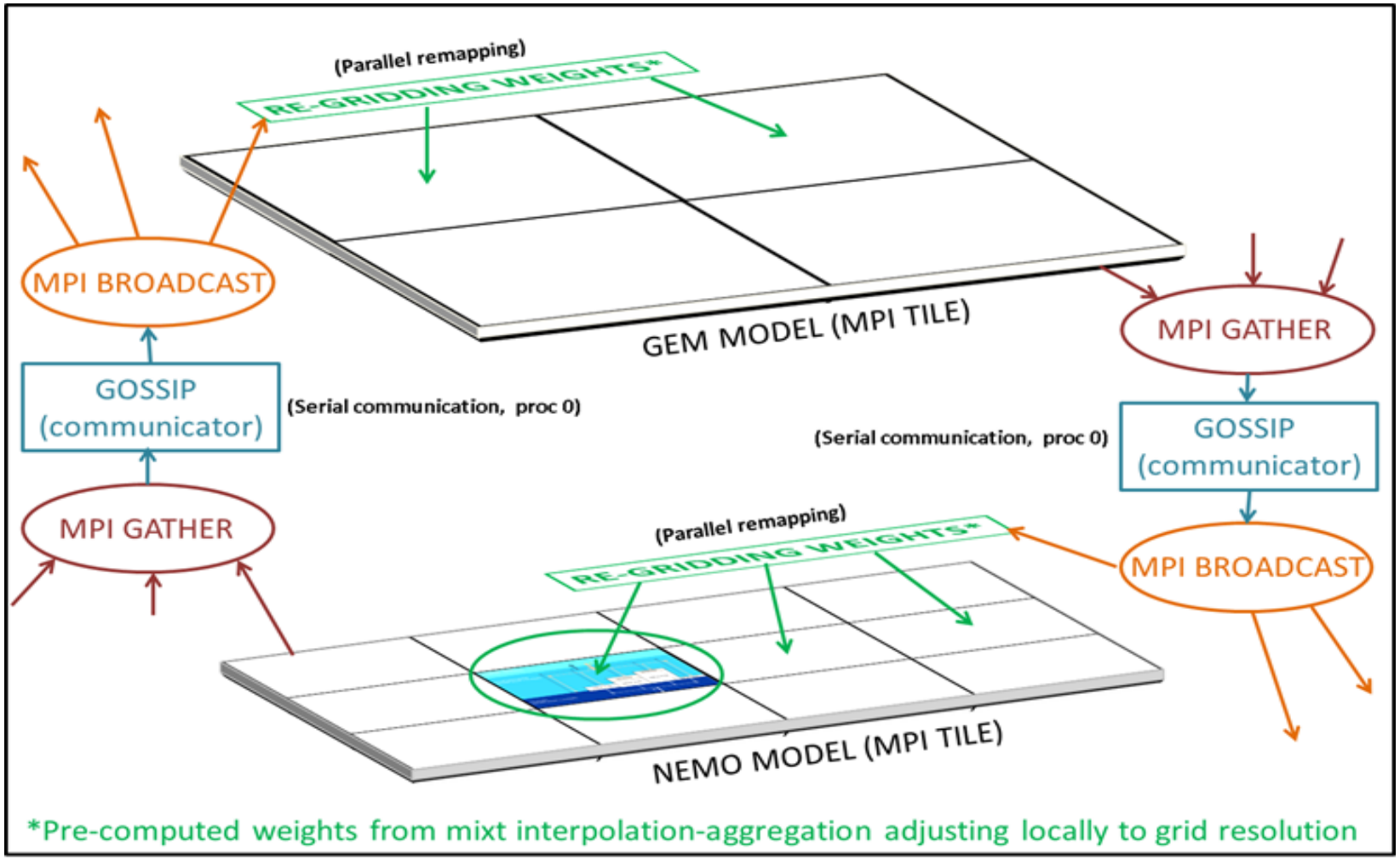




MODELS: Coupling Method

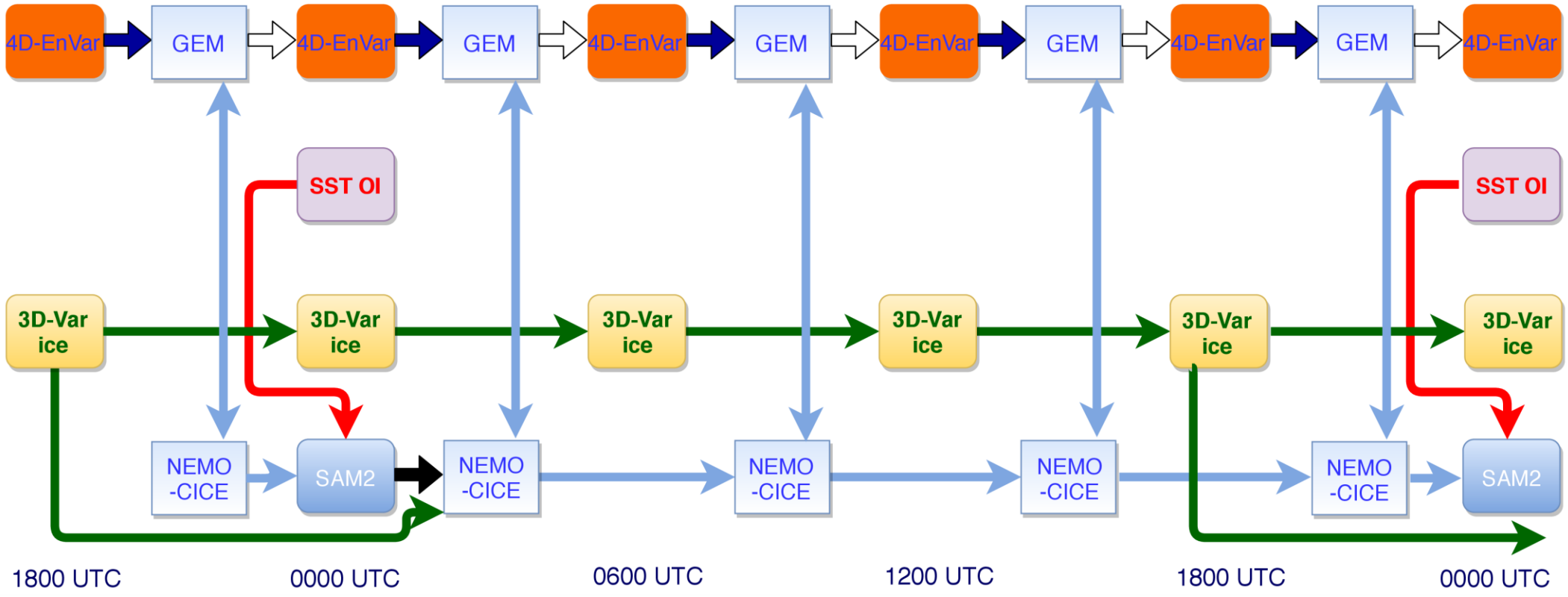


SCHEMATIC OF COUPLING DATA FLOW

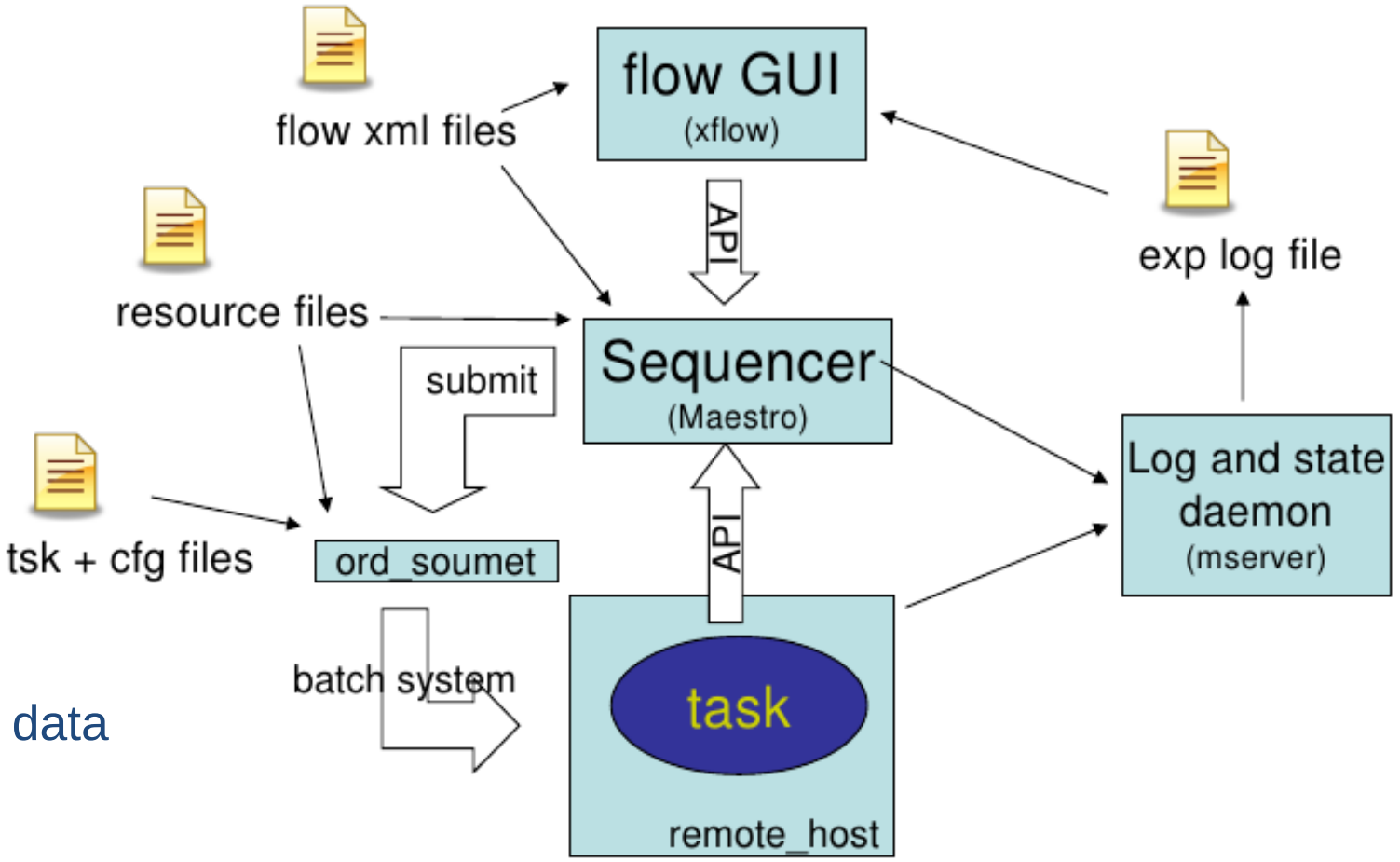


WEAKLY COUPLED DA:

INDEPENDENT OCEAN AND ATMOSPHERE DA; COMMON COUPLED BACKGROUND STATE FOR ATMOSPHERIC AND OCEAN DA.



MAESTRO: TASK SEQUENCER



- relies on xml flow definition files
- cfg files contain node configuration data
- tsk files are node source scripts
- exp log files contain log messages
- Flow GUI: the experience monitoring application

ATMOSPHERIC DA MAESTRO SUITE

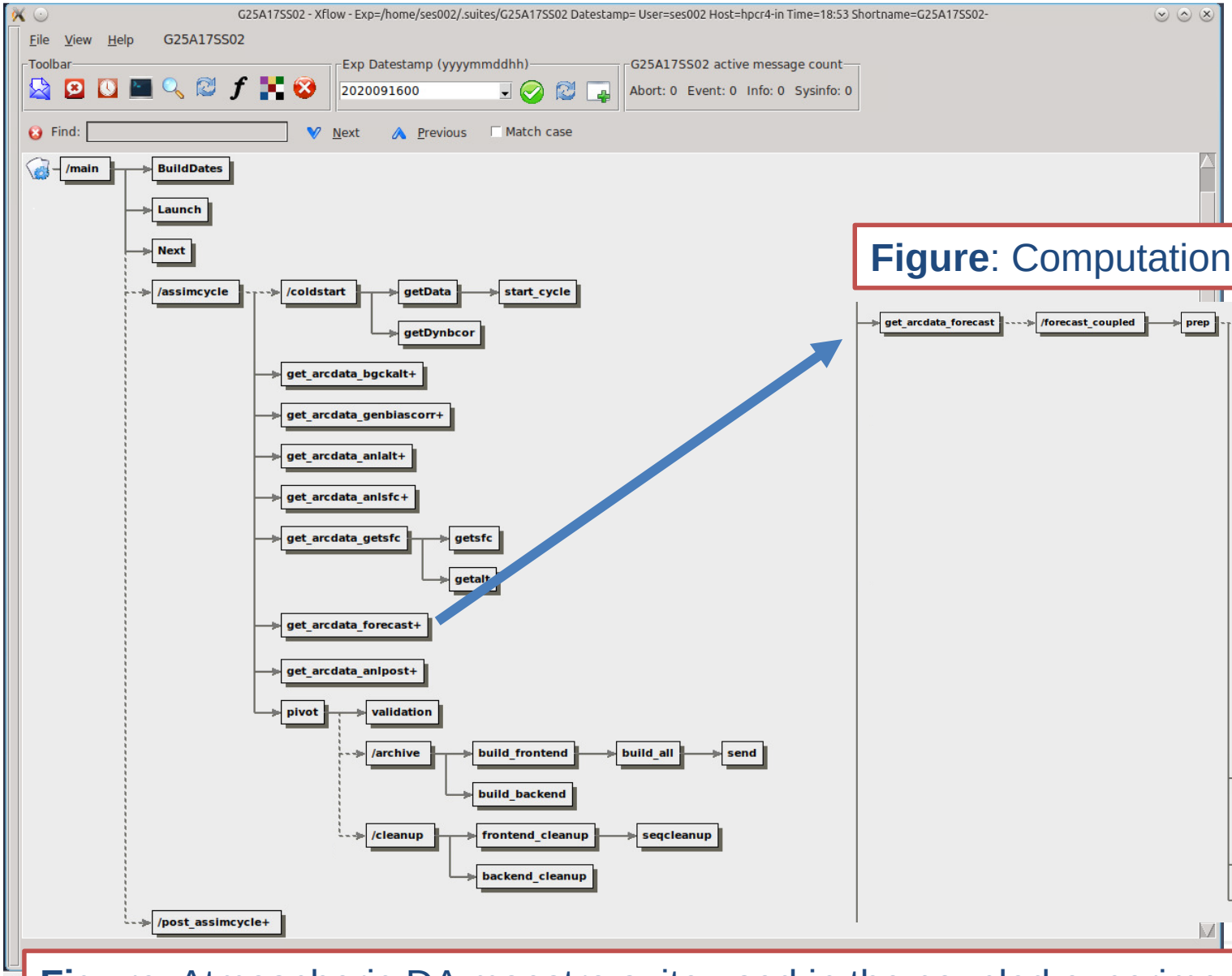


Figure: Computation of coupled atmosphere-ocean-ice forecasts

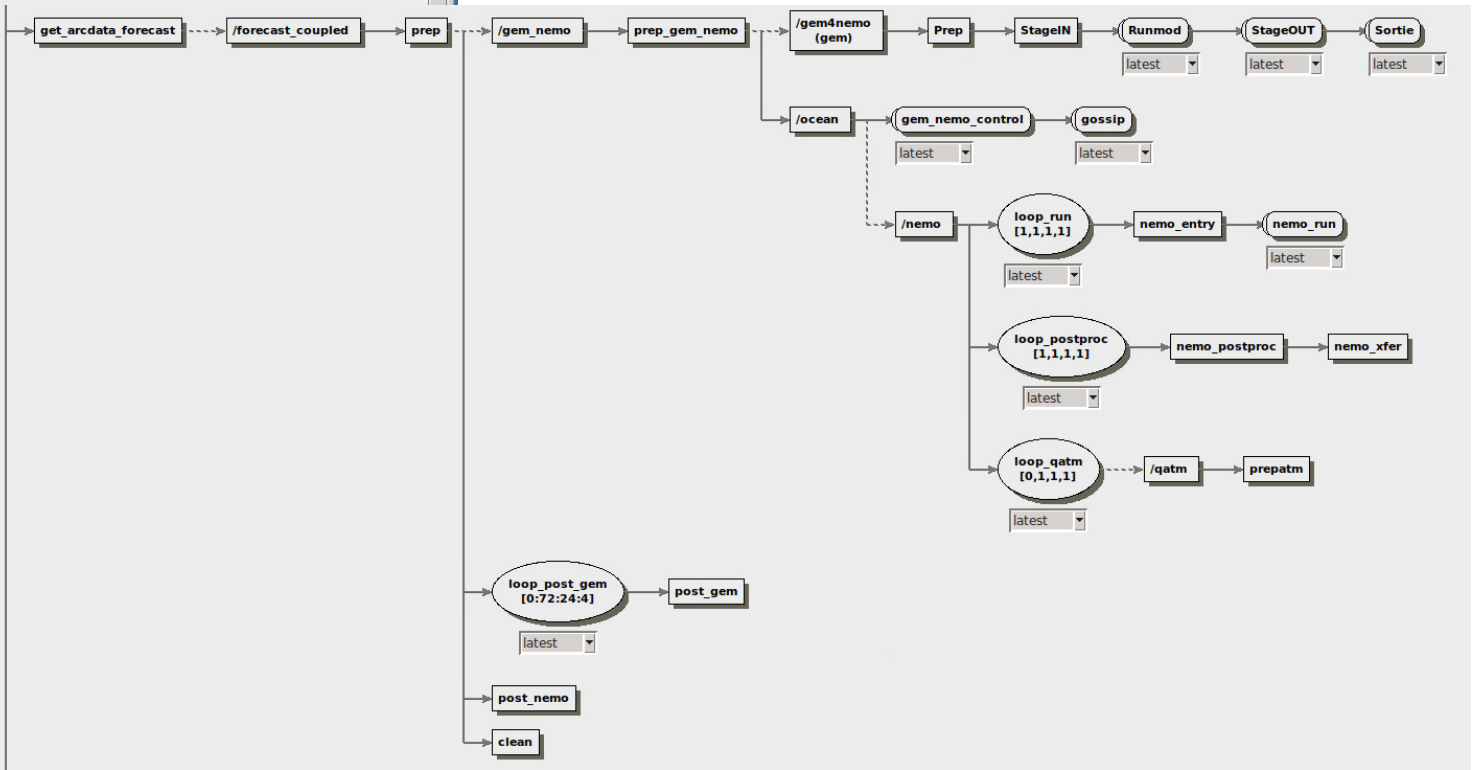
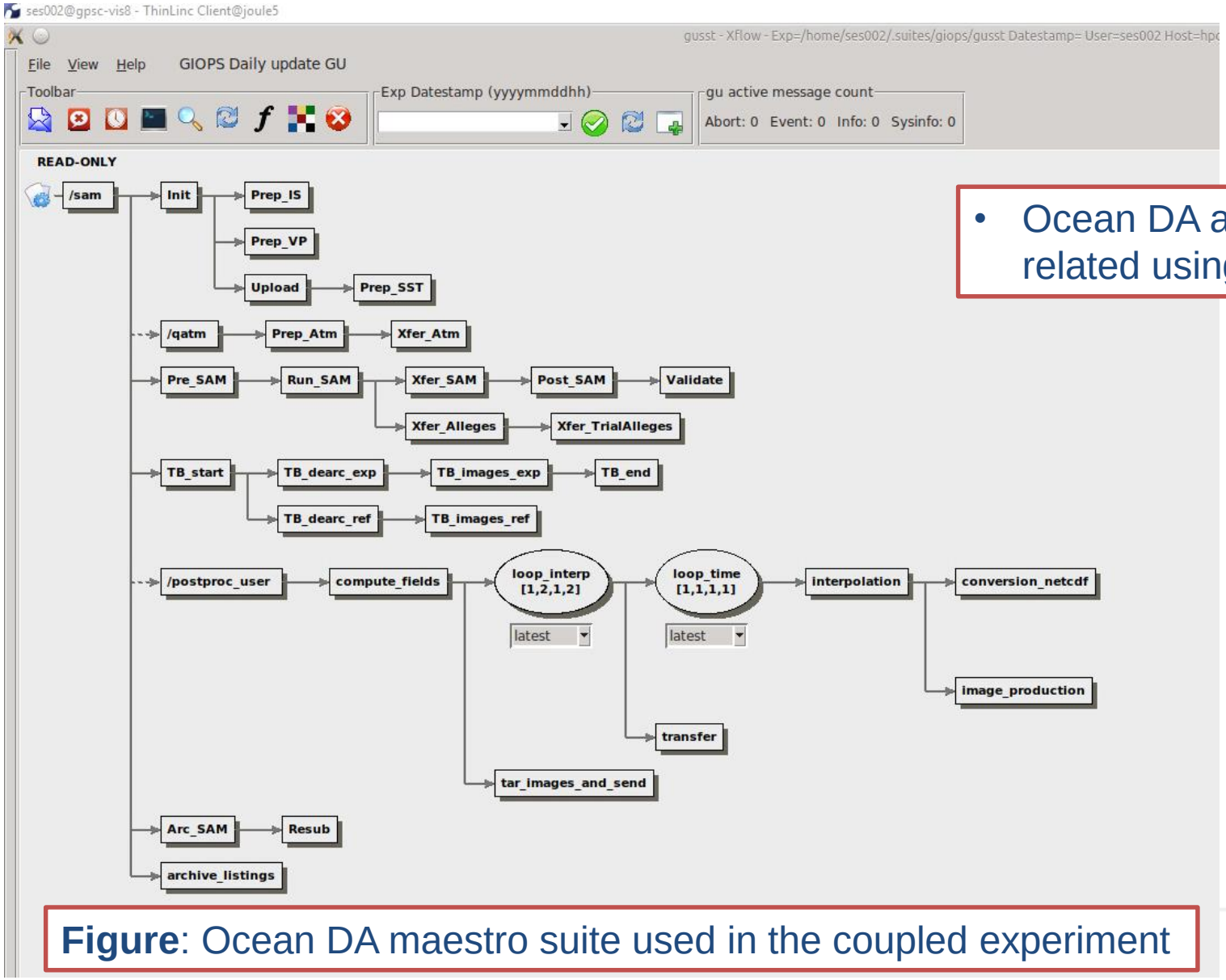


Figure: Atmospheric DA maestro suite used in the coupled experiment

OCEAN DA MAESTRO SUITE



- Ocean DA and Atmospheric DA maestro suites are related using dependancies in the config files

Figure: Ocean DA maestro suite used in the coupled experiment

RESULTS: WCDA VS UNCOUPLED DA

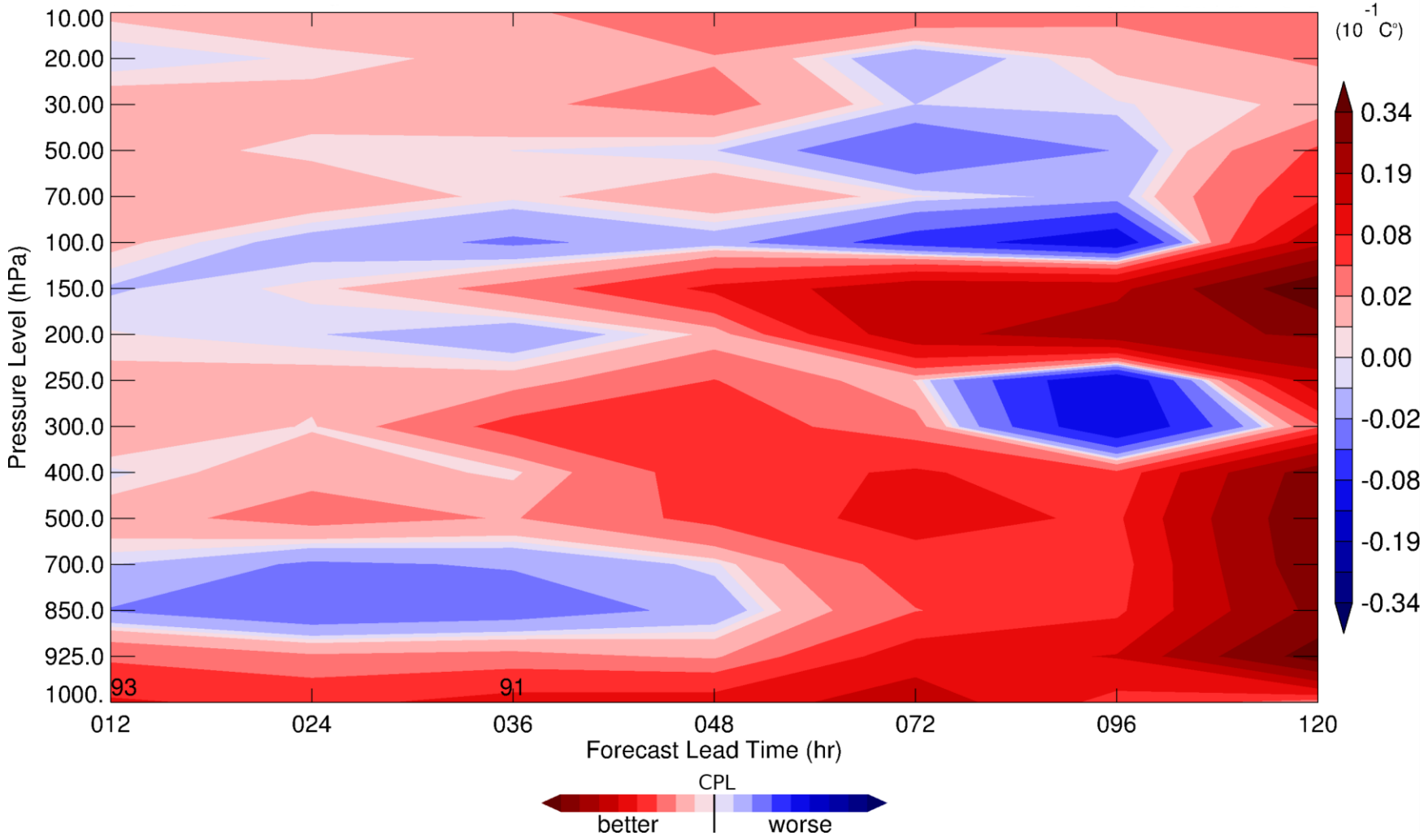


Figure: Difference in STD of Tair (°C) against the mean analysis as a function of forecast lead time. The statistics are computed for CPL and UNCPL in the northern extratropics region between 20 and 60°N. Positive values (red) mean that STD produced by CPL is smaller, negative values (blue) mean the converse.

WCDA VS UNCOUPLED DA

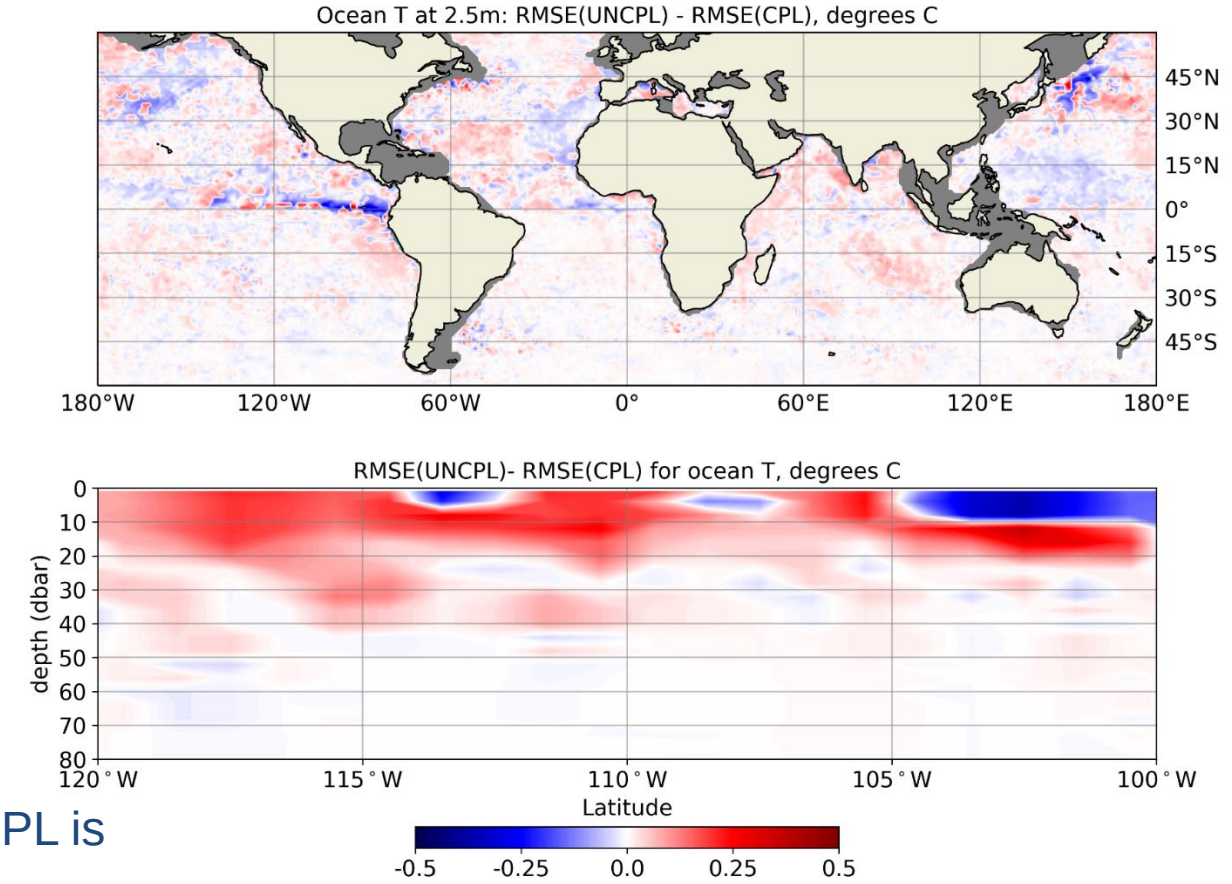


Figure: Difference between the UNCPL and CPL (24-h forecasts) RMSE with respect to Argo measurements.

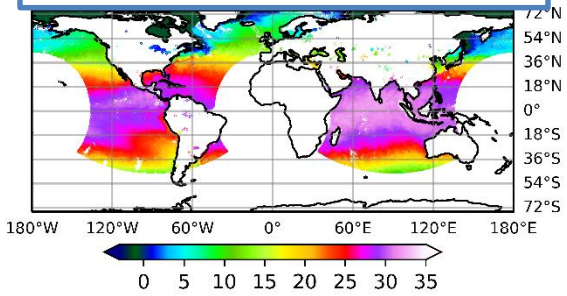
Positive values (red) indicate that the RMSE produced by CPL is smaller, whereas negative values (blue) mean the converse.

(top) The RMSE difference for ocean temperature at 2.5 m of depth. (bottom) T vertical section through 1.5◦N latitude in the eastern tropical Pacific Ocean between 120 and 100◦W.

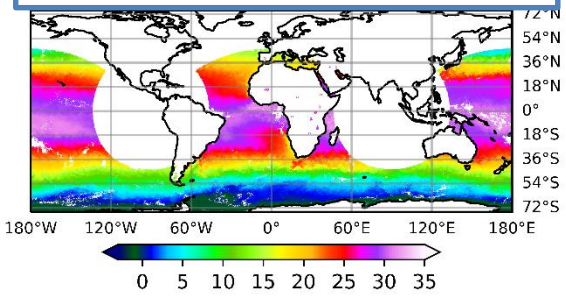
TOWARDS STRONGER COUPLING: NEW SST ANALYSIS

- compute SST analysis within common 4D-EnVar DA framework:
  - background error covariance matrix using diffusion operator,
  - 2 analyses on Yin and Yan grids,

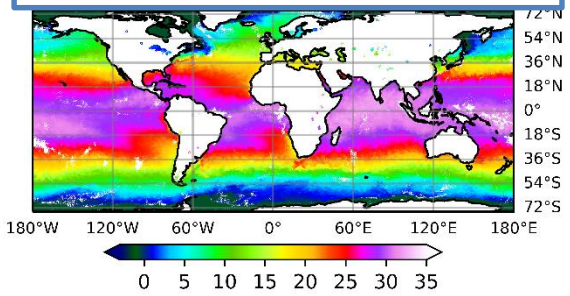
SST obs in Yin domain



SST obs in Yan domain

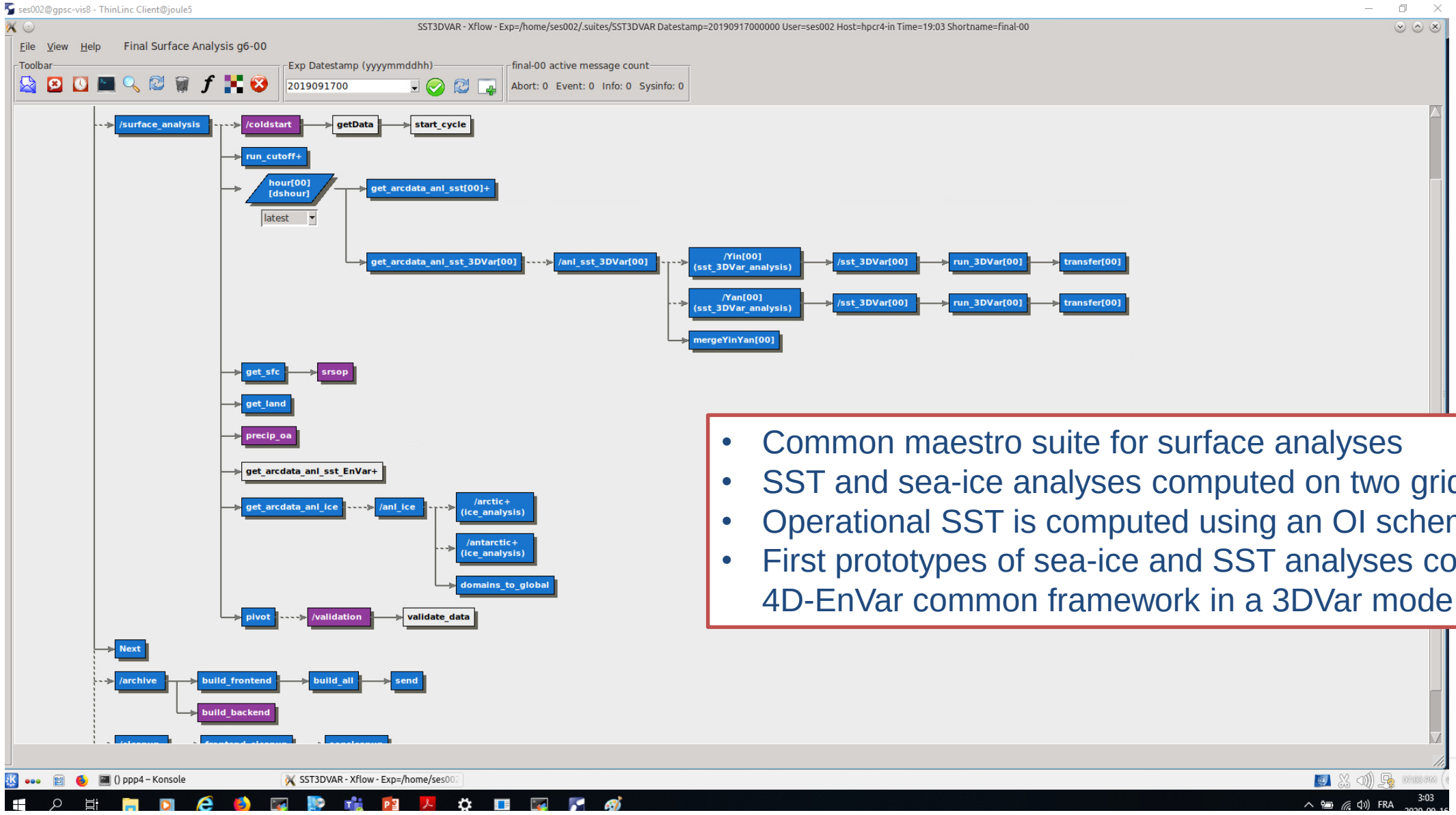


Merged on a global grid



- first, perform 3DVar daily SST analyses and compare them with the operational system,
- then, use 4D-EnVar maestro environment to compute SST and sea-ice analyses.
- compute SST analyses along with the atmosphere and sea-ice every 6 h

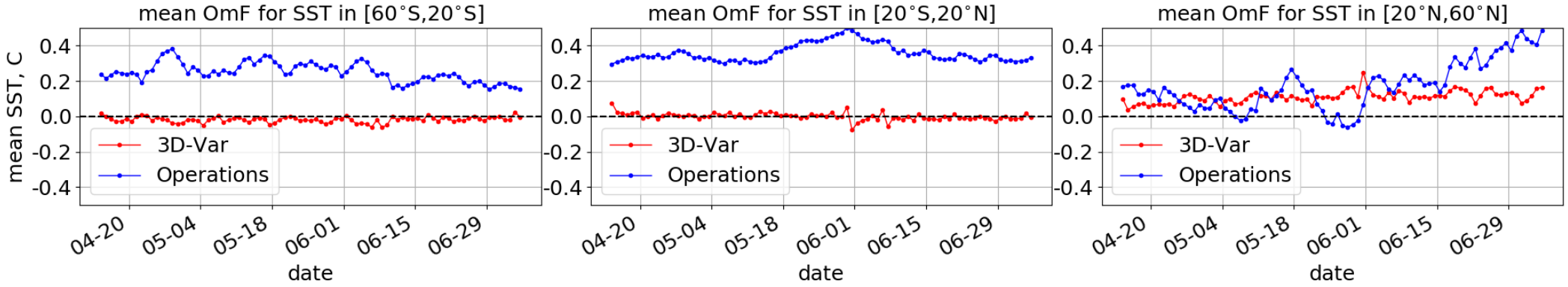
SURFACE DA (SST AND SEA-ICE)



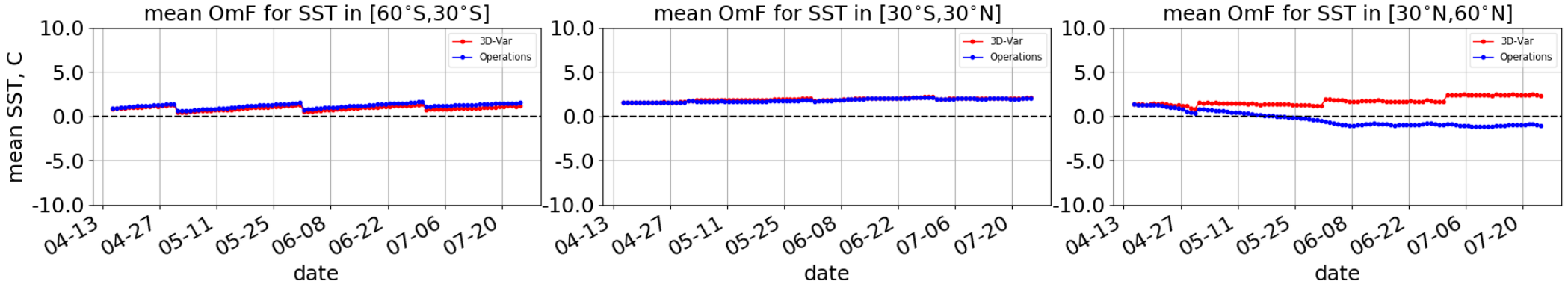
- Common maestro suite for surface analyses
- SST and sea-ice analyses computed on two grids Yin and Yan
- Operational SST is computed using an OI scheme
- First prototypes of sea-ice and SST analyses computed using 4D-EnVar common framework in a 3DVar mode implemented

SST ANALYSIS RESULTS

Against assimilated data



Against ARGO data



CONCLUSIONS AND PERSPECTIVES

- **Weak coupling between Atmospheric and Ocean-Ice DA shows slight improvements w.r.t. uncoupled DA**
- **3D-Var (4D-EnVar) SST daily analysis for future system**
- **Future work: towards stronger coupling**

  Assimilation of SST / ocean mixed layer / Ice using atmospheric 4D-EnVar or EnKF every 6 h