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GLOBAL DAILY SST ANALYSIS AT ENVIRONMENT AND CLIMATE CHANGE CANADA

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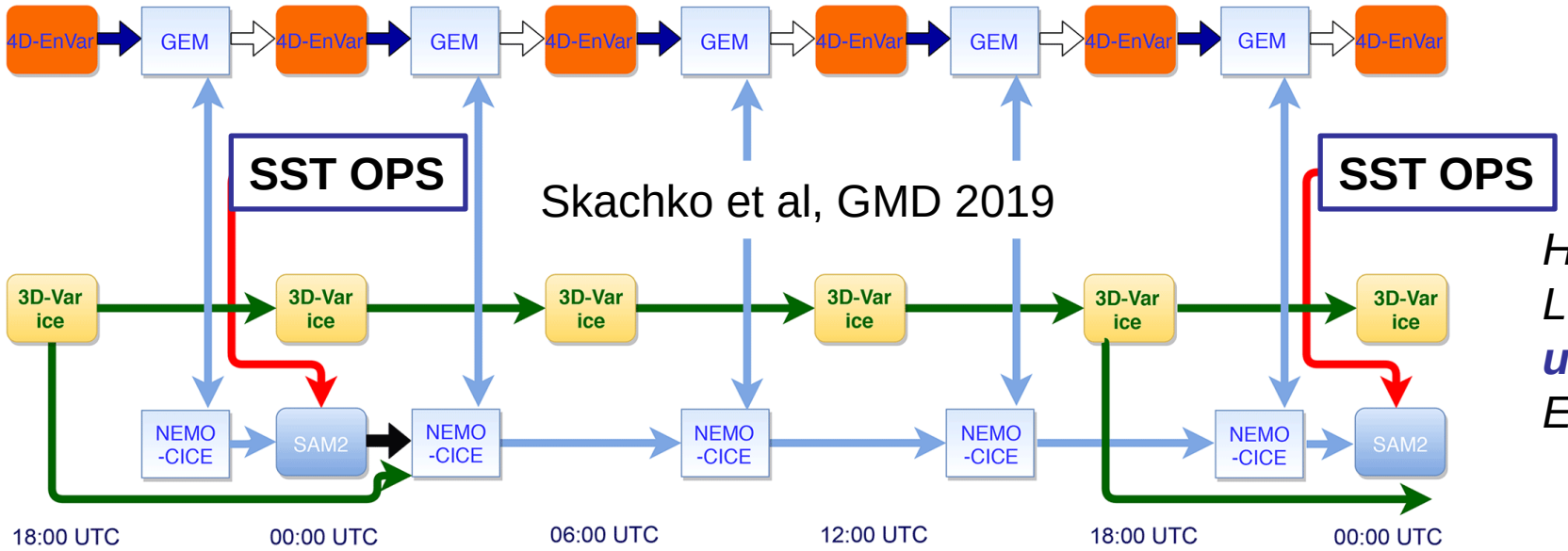
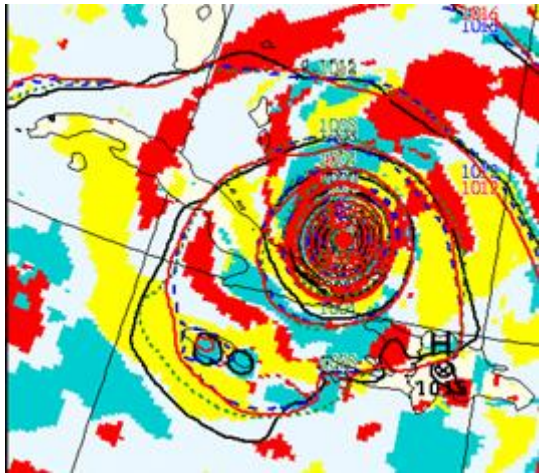
Contents

- Reasons for developing a new system;
- Overview of components of the new system;
- Comparison with the current operational system
- Conclusions

Towards future CDA systems

- Coupled data assimilation (Weakly, **WCDA**) remained sub-optimal due to current uncoupled SST analysis system (OPS);
- SST initial conditions should be cycled within a coupled framework





*Hurricaine positions (as seen by Sea Level Pressure) on 2017-09-08-12 for **uncoupled DA** and **WCDA** compared to ECMWF analyses (**black**).*

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Motivation to develop a new SST analysis system

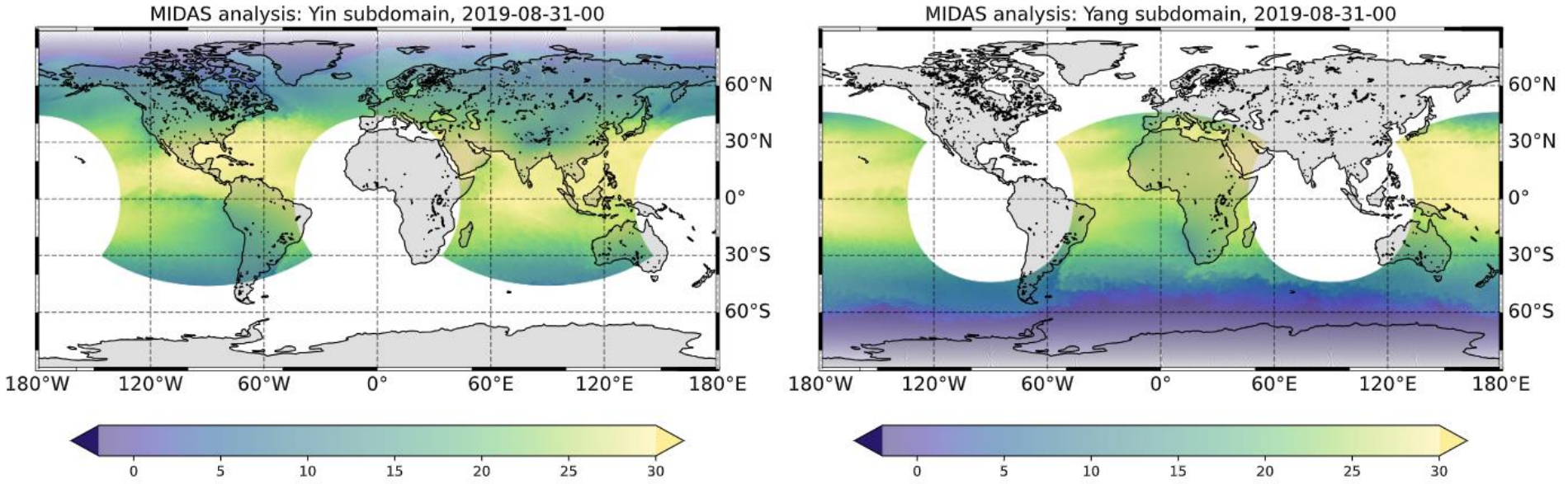
- Work towards coupled DA (CDA);
- Modular and Integrated Data Assimilation System (**MIDAS**):
  - MIDAS is used already for NWP and sea-ice analysis;
  - Easier transition to CDA (stand-alone SST DA -> stand-alone ocean DA -> CDA);
  - The use of existing implementation of DA elements;
  - Faster parrallel computer environment;
  - Flexible (to increase analysis grid resolution, to add new data, etc.)
- Replace current outdated operational SST analysis system;

MIDAS-based SST analysis system elements

- SST analysis,
- Satellite SST data bias estimates,
- Data background check / thinning,
- Pseudo obs in ice-covered areas,
- Background state,
- Analysis error.

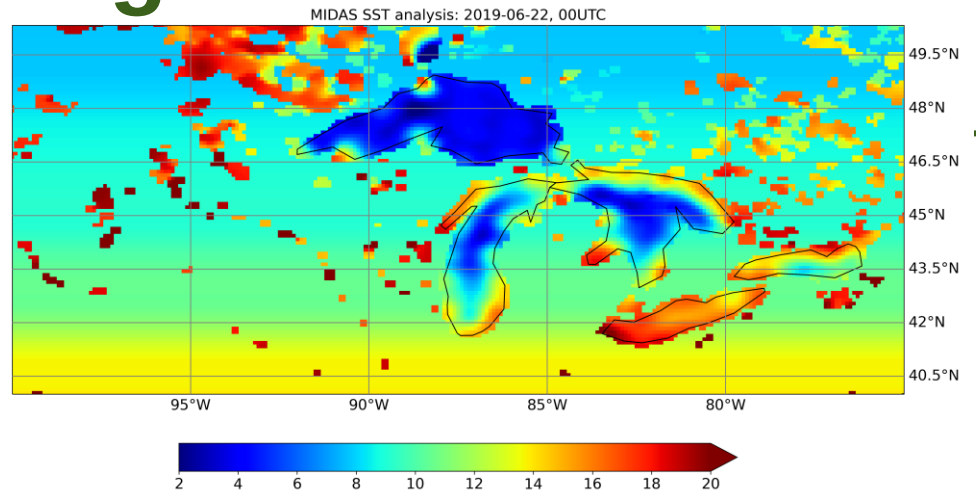
MIDAS-SST Data assimilation method

- Incremental variational 2D-Var;
- B-matrix computed using a diffusion operator;
- correlation length scale L is set to 50 km;
- global analysis computed separately on two grids.



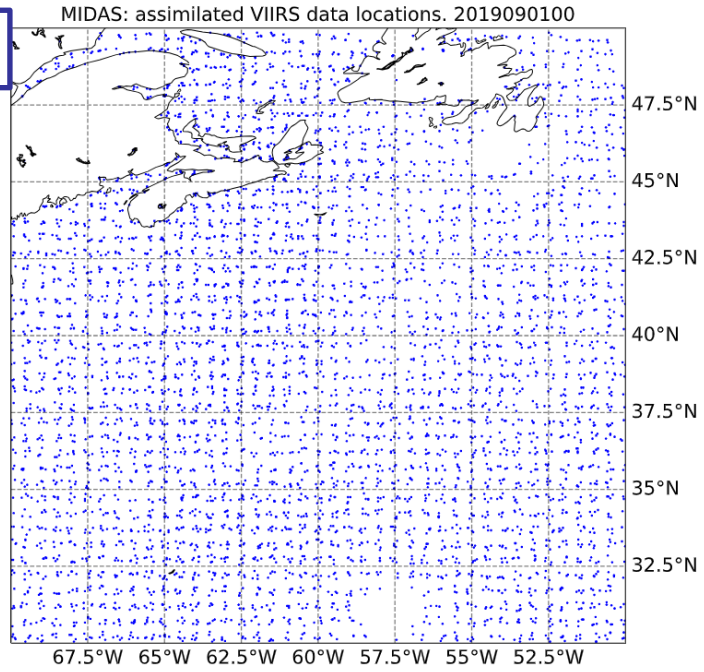
Data background check / thinning

- $bgCheck = \frac{OmB^2}{BGE^2+OBE^2}$,
- rejection level is set separately:
  - for each instrument;
  - for inland and sea waters.

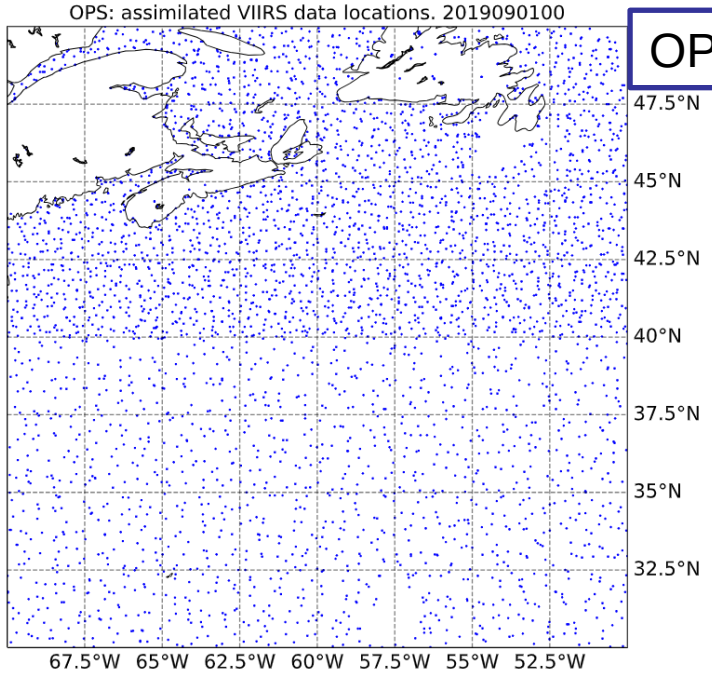


Large daily SST gradients in Spring/early Summer on shallow lakes.

MIDAS



OPS



Thinning using a regular grid in MIDAS vs latitude-dependent in OPS.

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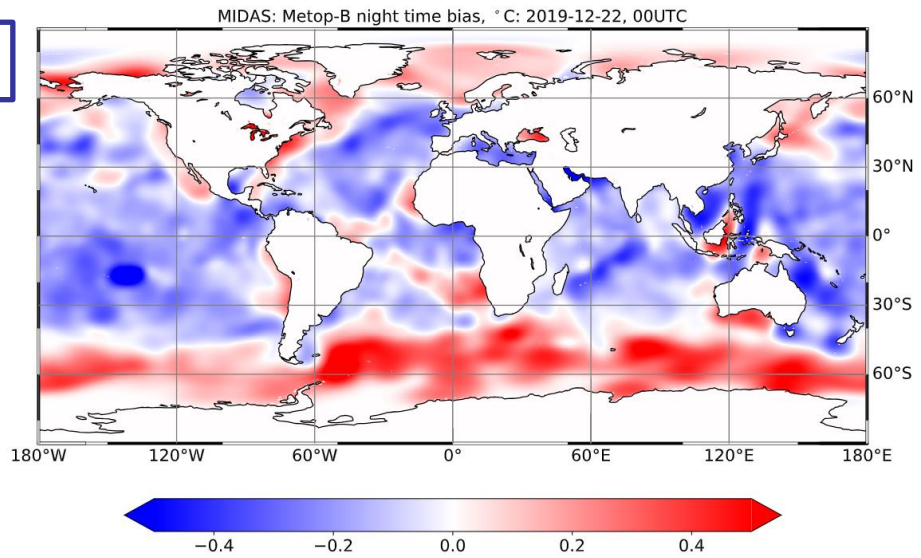
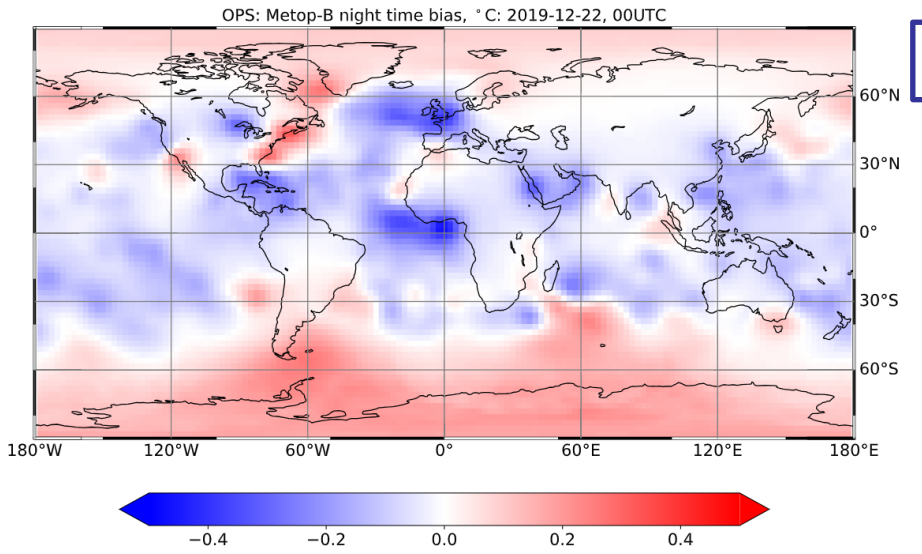
Satellite data bias estimation

- computed in all open water points for every satellite instrument (day/night);
- insitu and satellite obs are put on a grid using small search radius (~25km);
- averaging (sat-insitu) using large search radius (~1200km);
- $B^a(k) = (1 - w(k))\, B^b(k)\beta + w(k)B^a(k)$, where $w(k) = \frac{nobs}{(nobs+nobs^b)}$.

MIDAS





OPS

OPS produces bias estimations in the areas that are very far from where in situ obs are located. MIDAS also produces bias estimate in areas with no in situ obs, but not beyond the specified smoothing distance.

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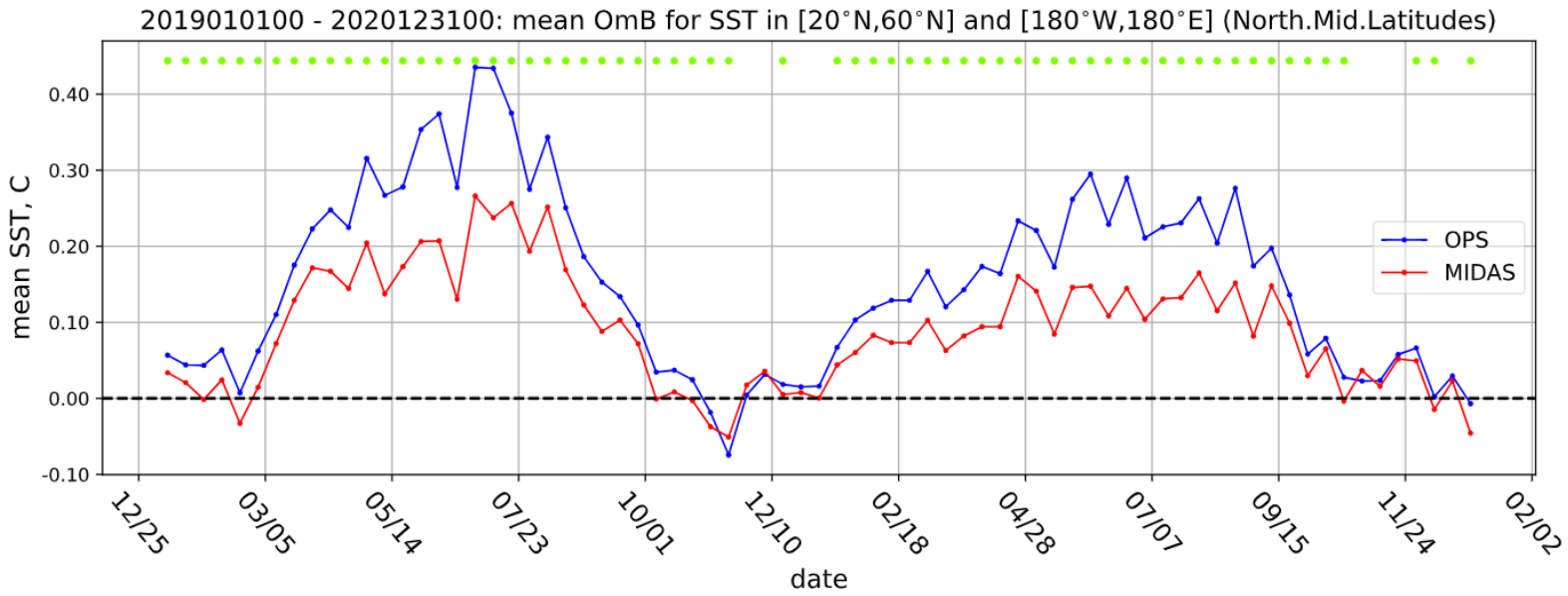
Differences and similarities with the current operational system (OPS).

Component	MIDAS	OPS
Data assimilation method	2D-Var using diffusion operator for background error	Statistical Interpolation
Analysis grid	Two regular rotated *Yin – Yang* grids of 3420x1020 points	Regular 3601x1801 grid
Satellite observations	VIIRS, AMSR2, AVHRR	VIIRS, AMSR2, AVHRR
in situ observations	ships, drifters, moored buoys	ships, drifters, moored buoys
Synthetic pseudo observations	ice-covered areas including small lakes and rivers	ice-covered ocean and large water basins
Quality control procedure	background quality control	background quality control
Thinning of *in situ* data	Temporal thinning, removal of duplicates	Temporal thinning, removal of duplicates
Thinning of satellite data	Spatio-temporal thinning	Spatial thinning
Bias estimation of *in situ* data	No	Ship data only
Bias estimation of satellite data	Averaged collocated differences (satellite - *in situ*)	Statistical interpolation using collocated (satellite - *in situ*)
Simulation of background state	Using relaxation towards climatology	Using relaxation towards climatology

Results in comparison to the current operational system. Against all insitu data (used in assimilation)

Bias

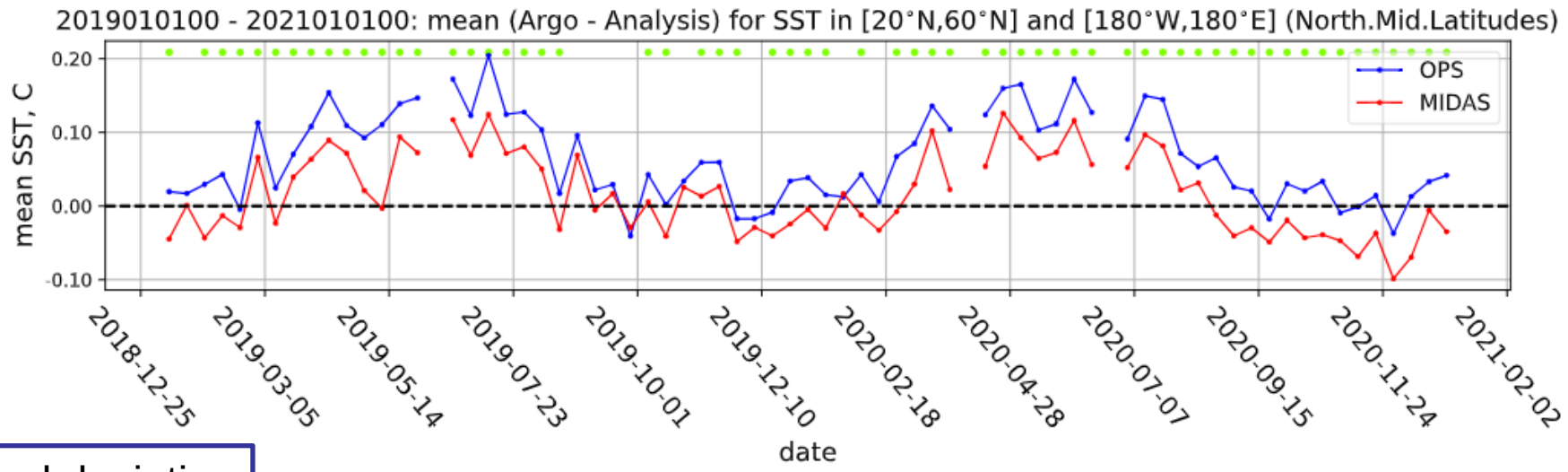


Standard deviation

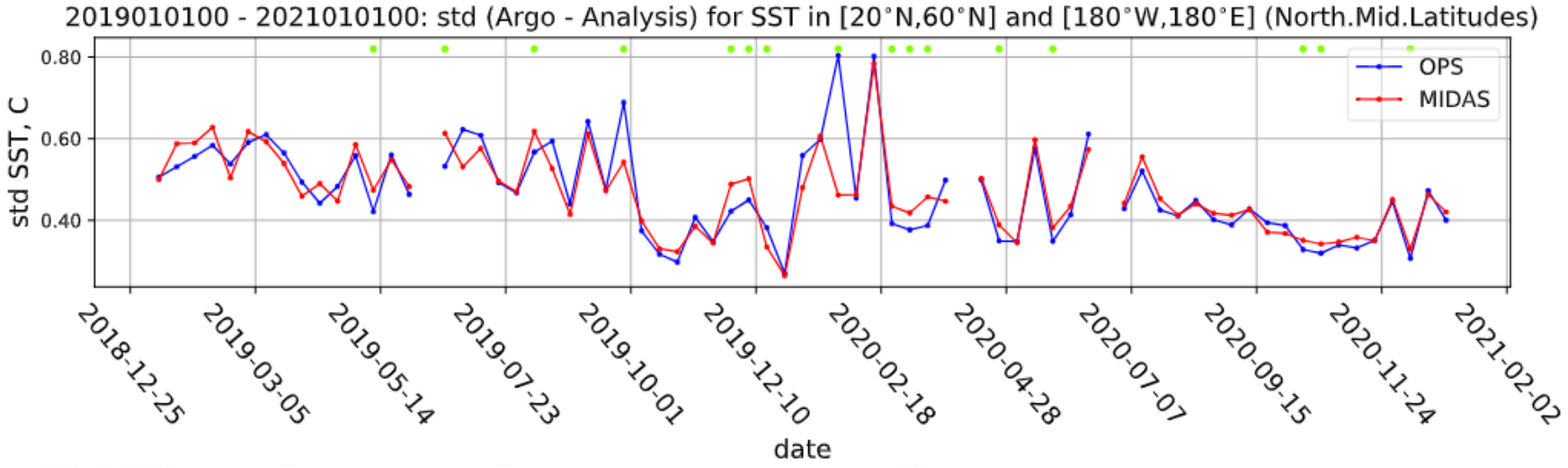
No statistically significant difference between MIDAS and OPS for nearly the entire period

Some results in comparison to the current operational system.
Against ARGO data (independent)

Bias



Standard deviation



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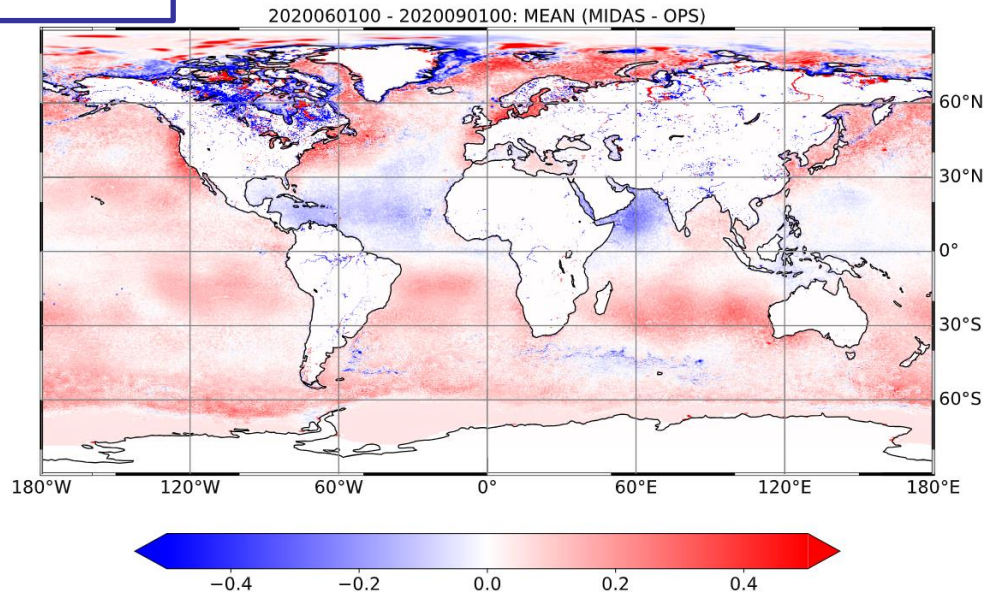
Differences between MIDAS and the current operational analyses

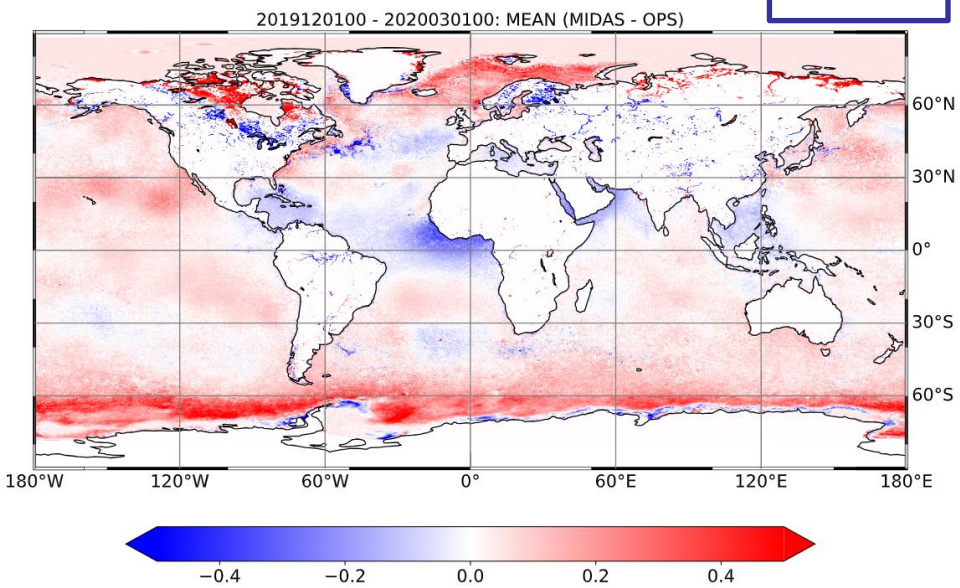
MIDAS and OPA analyses are mainly different due to:

- Bias estimation techniques;
- Data background check / thinning;
- Algorithms of pseudo observation insertion.

Summer



Winter



Testing new MIDAS SST analysis with ECCC operational systems

- Nearly neutral impact on the global NWP system;
- Nearly neutral impact on the global ocean prediction system;

SST analysis in CDA

- SST can be taken from a surface layer of a coupled ocean-atmosphere model;
- Surface temperature on lakes outside the ocean model domain may play an important role in local weather forecasts;

Conclusions and perspectives.

- New global daily SST MIDAS-based analysis system has been implemented and properly compared to the current operational ECCC SST analysis system.
- Due to new algorithms of data background check / thinning and satellite data bias estimation, the new MIDAS-based SST analysis results in better results as compared to the current system using assimilated and independent data.
- Nearly neutral impact on global NWP and ocean prediction systems.
- Getting closer to fully-coupled DA systems.

Tests that are about to start prior to the operational implementation:

- High-resolution Canadian regional NWP system (HRDPS);
- Initialization of coupled ocean-ice-atmosphere 10-day forecasts.

More details in the accepted QJRMS paper:

Quarterly Journal of the Royal Meteorological Society
A journal of the atmospheric sciences and physical oceanography
RMetS Royal Meteorological Society

A new global daily SST analysis system at ECCC

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