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63

A SIMULATED STUDY OF THE IMPACT OF WIDE-SWATH ALTIMETRY MEASUREMENTS ON THE QUALITY OF OCEAN MESOSCALE FEATURES RETRIEVED BY 3DVAR

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1. Background /Purpose

Sea level anomaly (SLA) data provided from wide-swath altimetery measurement have a huge potential to improve retrieval of ocean meso/sub-meso scale features. Two wide-swath satellite altimetry missions, SWOT and COMPIRA, are planned to be launched in 2020's and their feasibility studies are important tasks.

The satellite altimetry mission, COMPIRA, by Japan Aerospace Exploration Agency is designed for enhancing the operational oceanography skill in the western North Pacific region, where the western boundary current and its extention (Kuroshio and Kuroshio extension) characterize its meso/sub-meso scale ocean current features.

Cross points (mesh) of COMPIRA ground tracks are aligned with the Kuroshio extension path at 35N (see figure 1 and figure 2) and it is expected to provide better resolved physical oceanography parameters in the region such as potential vorticity.

The impact of the wide-swath data on the quality of ocean mesoscale features retrieved by 3DVar system is evaluated by using simulated SLA data.

This presentation shows some preliminary results from this study and discusses an adequate design of data assimilation system designs.

2. Simulated COMPIRA SLA data

COMPIRA is the planned Japanese satellite with a wide-swath (80kmx2) altimeter. Its orbit (Fig.1) is determined from the following orbital configuration (table 1) and simulated sea level anomaly (SLA) data are created from high resolution regional ocean model (see Box 4) output (Isoguchi et al. 2013).

revisit time	inclination	altitude	grid size (this study)
9.87 day	51.0 degree	937 km	5 km (10 km)

Table. 1 COMPIRA orbital configuration

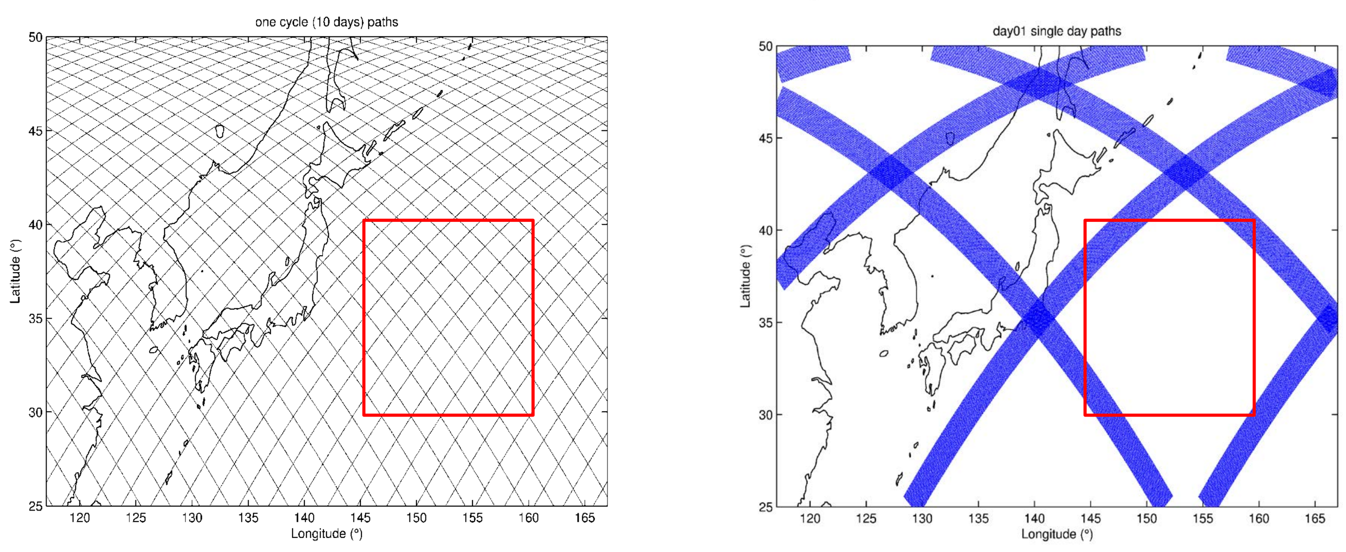


Figure. 1 (left) 1 cycle of COMPIRA ground paths on its nadir track. (right) Example of a single day COMPIRA path coverage (corresponding to day 1 in the following assimilation experiments) . Rectangle with red line in ech picture is the area of analyses where simulated SLA data are assimilated to the ocean model.

3. Data Assimilation System/Experiment Settings

3DVar ocean analysis system, MOVE (Usui et al., 2006) is used to conduct the data assimilation experiments. Here is the brief overview of the system:

System Settings:

1. Cost function is a function of the initial temperature (T) and salinity (S) profiles:

$$J(\mathbf{x}_0)=\frac{1}{2}(\mathbf{x}_0-\mathbf{x}_0^b)^T\mathbf{B}^{-1}(\mathbf{x}_0-\mathbf{x}_0^b)+\frac{1}{2}(\mathbf{y}-\mathbf{H}\mathbf{x}_0)^T\mathbf{R}^{-1}(\mathbf{y}-\mathbf{H}\mathbf{x}_0),\ \text{where, } \mathbf{x}_0=\begin{bmatrix}\mathbf{x}_0^T\\ \mathbf{x}_0^S\end{bmatrix}$$

2. Background error covariance matrix is parameterized by a multivariate vertical modes ($\mathbf{U}$) and their coefficients ($\mathbf{a}$):

$$\mathbf{B}=\left\langle\delta\mathbf{x}_0\delta\mathbf{x}_0^T\right\rangle=\mathbf{\Sigma}\mathbf{U}\left\langle\mathbf{a}\mathbf{a}^T\right\rangle\mathbf{U}^T\mathbf{\Sigma}^T,\ \text{where, } \mathbf{\Sigma}=diag(\sigma_n)$$

$\mathbf{U}$ and $\mathbf{a}$ are determined from EOF of historical hydrographic data.

3. Initialization scheme is incremental analysis update (IAU)

Experiment Settings:

1. Analyses are made from nadir and wide-swath data assimilation experiments.
2. Assimilation period is set to 10 days (2012MAR01-2012MAR10)
3. Only results from the initial cycle starting from $\delta\mathbf{x}_0=0$ are examined/presented.
4. Only SLA data from the simulated Kuroshio extension system are assimilated.

4. Simulated true and the first guess

Simulated true data (figure 2 left panel) is derived from high resolution regional ocean model(see figure 1 for its domain). The model is constructed on MRICOM (Meteorological Research Institute Community Ocean Model) and has 1/50 degree horizontal resolution and 46 vertical levels. The simulated true data are created from one day mean sea surface height interpolated to the COMPIRA track with 1/10 degree resolution. The ocean model for the 3DVar system has a similar domain configuration, but with lower horizontal resolution, 1/10 degree.

The first guess (figure 2 right panel) is set to be the end condition of 20 years spin-up run.

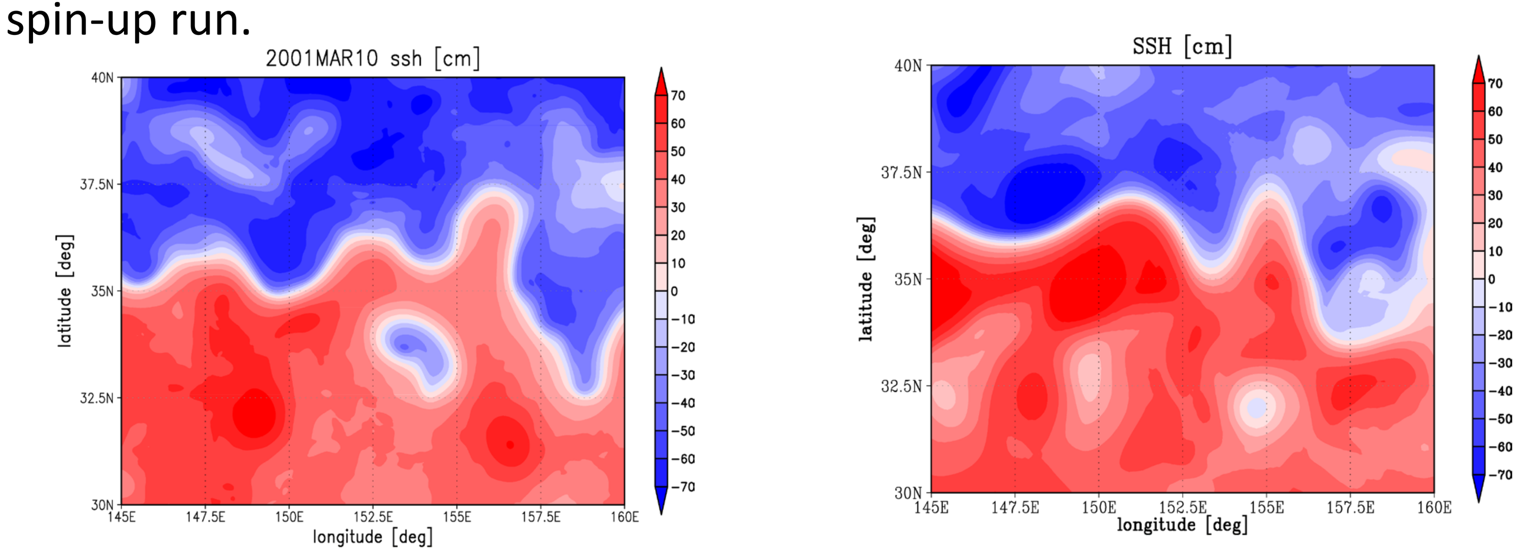
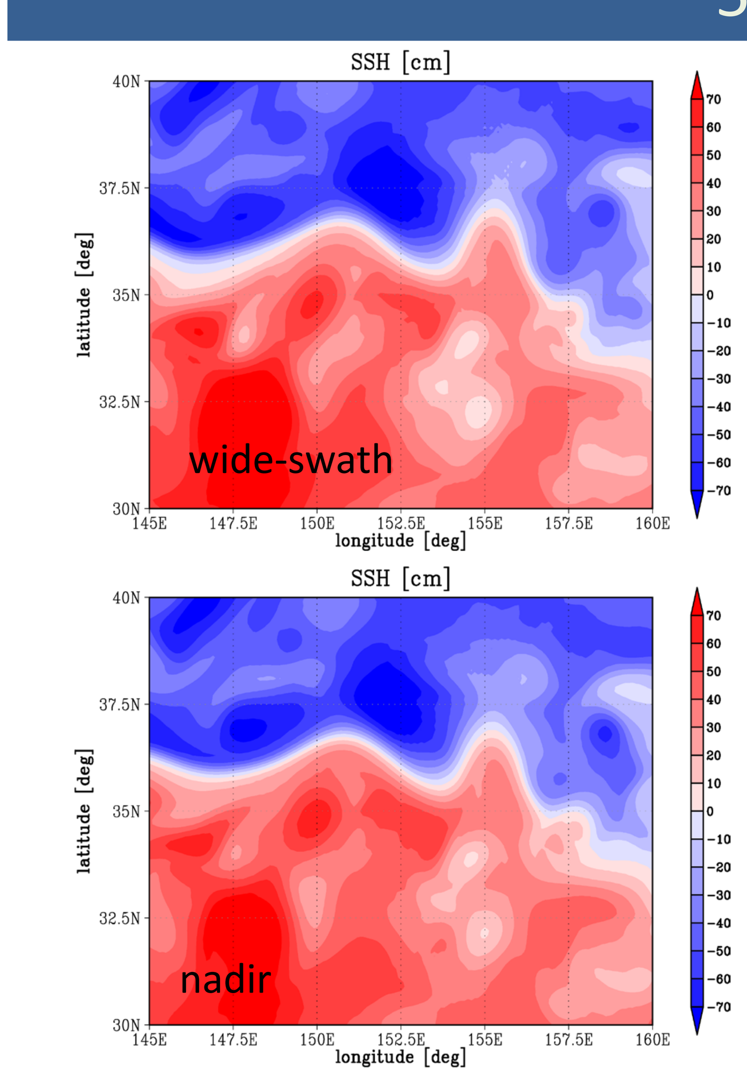


Figure. 2 Sea surface height fields on March 10, 2012 from the simulated true run (left panel) and from the first guess (right panel). Unit is cm.

5. Results



Analysis with wide-swath SLA data shows better performance in correcting Kuroshio-extension path in its up-stream over the analysis with nadir track data.

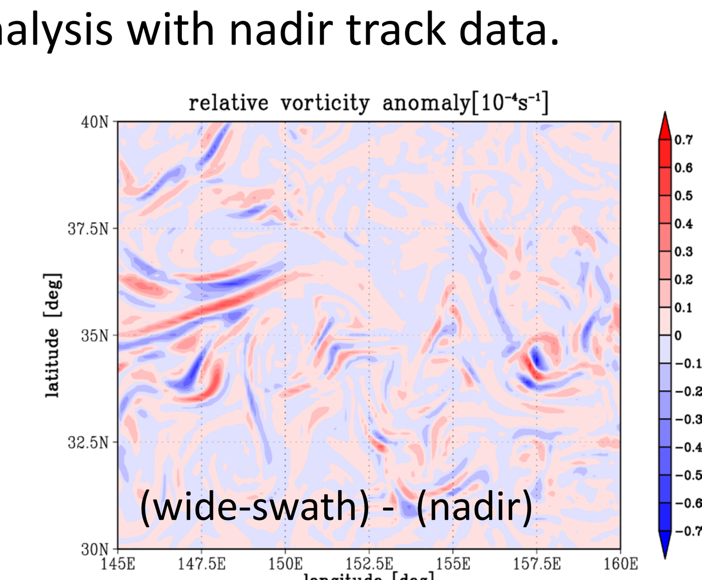


Figure. 3 (upper left) SSH field estimated from COMPIRA wide-swath track data. (lower left) SSH field estimated from COMPIRA nadir track data. (right) Relative vorticity difference between two analyses.

6. Discussions and Future work

Though improvements are observed, the preliminary results from our experiments do not show significant difference between nadir and wide-swath sea level anomaly observation in their impact to 3DVar analysis (as opposed to our expectation). Some reasons behind the results can be pointed out here:

- 10 days assimilation window is long enough to advect assimilated information from one path to others.
- Horizontal correlation length scale (= 50km) of the background error covariance makes our analyses too smooth whilst SLA data have 10km resolution.
- Vertical projection function in the background error covariance does not include surface-intensified modes, which is predicted from mid-latitude SQG theory (e.g., LaCasce 2012).

Currently, we are working on re-designing background error covariance by combining data-based EOF modes and SQG-based vertical transfer function. Horizontal correlation function of the background error covariance for the surface intensified modes are also being re-designed.

References

Usui et al. 2006: Meteorological Research Institute multivariate ocean variational estimation (MOVE) system: Some early results. Advances in Space Res., 37, 806-822. doi: 10.1016/j.asr.2005.09.022
Isoguchi et al., 2013: Generation of COMPIRA simulated data, OSTST 2013, poster presentation (http://www.aviso.altimetry.fr/fileadmin/documents/OSTST/2013/posters/isoguchi_OSTST_Poster_20131007_rev2.pdf).
LaCasce, 2012: Surface Quasigeostrophic Solutions and Baroclinic Modes with Exponential Stratification, Journal of Physical Oceanography, 42, 569–580. doi: http://dx.doi.org/10.1175/JPO-D-11-0111.1