Observing System Simulation Experiments for Tidal Motion from Wide-Swath Ocean Satellite Altimeter Data

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Satellite altimeters have been measuring sea-level in almost area for about 30 years. A new type of satellite altimeter called Wide-Swath (WS) satellite altimeter was put forward to increase the measurement frequency in time and space. The WS altimeter upgrades the measurement coverage from line to area,basically. Comparing with the nadir altimeters, the WS satellite altimeters can provide more observation per unit period. There are two projected WS satellite altimeter missions. One is Surface Water and Ocean Topography (SWOT) mission from NASA and Coastal, and the other is Ocean Measurement mission with Precise and Innovative Radar (COMPIRA) mission from JAXA.

Observing system simulation experiment (OSSE) is a methodology to estimate observation data, which simulated in different situations, and the initial setting for data assimilation, which means OSSE can estimate several sets of satellite altimeter observations by simulating their observation data for data assimilation.

The purpose of this study is to investigate the contribution of the WS satellite altimeter observation to the accuracy of data assimilation and to find an optimal setting for data assimilated by OSSE.

The study domain is 23N to 55N, 117E to 138E. This area includes the East of China Sea, the Bohai Sea, the Japan Sea, and the northwestern of the Pacific Ocean. A shallow-water model (Kim and Yoon 1996), using potential enstrophy and energy conserving scheme in Arakawa C-grid (Arakawa & Lamb 1981) is used in this study for modeling the tide motion, which is the main course of sea-level variation. Two groups of tide data are set as the initial tide boundary condition. The data from the NAO.99 tidal model drives Nature Run (NR, the control group for OSSE).

On the other hand, Oregon State University tide prediction software (OTPS) is used for Experimental Run (ER, data assimilated in ER with different simulated observation data). The two experiments are also distinguished by bottom topography data (Hirose, 2005; Smith & Sandwell 1997). The WS altimeter data are simulated based on the outcome from NR with artificial pseudo-COMPIRA and SWOT observing error, which is deduced by model. These error does not have representation error (the instrumented error). The representation error is assumed from no tide version of DREAMS_M(Hirose et al., 2013).

Simulated observation data are nudged into the ER by different nudging coefficients. Only data in the first 50 days are calculated by the model. The harmonic analysis allows the prediction after 100day.

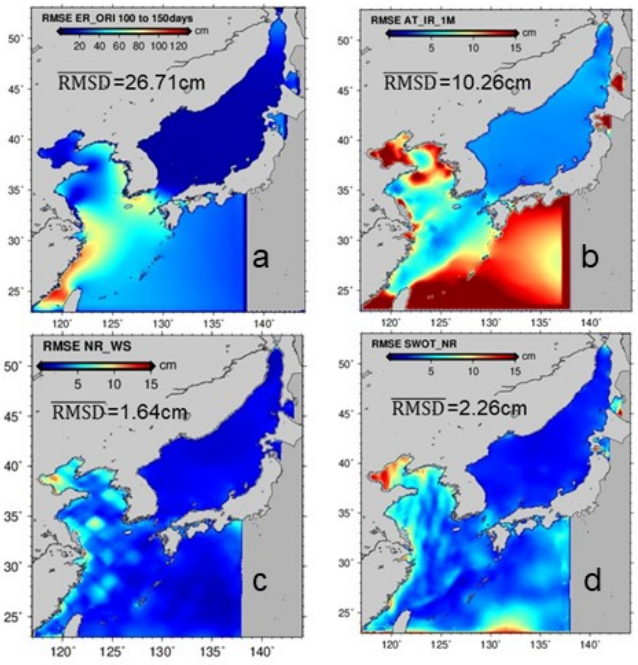
SSH assimilated by COMPIRA Along-Track measurement data reduces the error by 52.2% from the first guess ER. Meantime, the WS altimeter measurement reduces error by 99.3%. However, some area, like the middle of the East China Sea, 123E, 34N, COMPIRA-WS group, has a big RMSD because of the aliasing error in the simulation of observation since we only considering observation in one year. For the comparison of data assimilating results of COMPIRA and SWOT error types, COMPIRA groups have slightly (only by 2~5%) better performance. RMS of 1-day nudging was larger than that of 1 hour. The optimal

best-nudging coefficient time scale is falls around 1 minute.

The RMSD of the WS groups becomes smaller than the AT groups, although the instrumental error of Nadir-type is smaller than the WS. That indicates the number of observed points influences the RMSD significantly.

The WS did well in all OSSE groups; however, there still some odd rhombus areas appeared in figures (not shown in the abstract) of RMSD between simulated WS-observation and NR. These areas generally have a larger RMSD than the surrounding areas. That is because the simulation of observation based on only one year's observation error data in this study. Some points only have 1 or 2 measurements in one satellite cycle (about 9.3 days). Aliasing error has a high probability of occurring at these points. The aliasing error can also explain why the area, where has been observed more times, has a smaller RMSD. Therefore, a high precision fitting method is demanded for the high accuracy of analysis, especially in the first early years of the formal use of WS satellite altimeters.

Keywords: Wide-Swath Satellite Altimeter, Tide, OSSEs



The RMSD between NR and ER(a), data assimilation with different pseudo observations. (b) for COMPIRA-AT group. (c) for COMPIRA-WS group. (d) for SWOT-WS group. The nudging coefficient is 1 minute.

