Study on development of satellite-based ocean data assimilation system

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Abstract

To enable satellite information ore familiar and easy to utilize, we develop “ocean forecast” without missing area by using the ocean model and data assimilation system with the highest spatial resolution (about 3km) in Japan to utilize satellite-based ocean, snow and ice products produced by JAXA at the maximum. At the same time, we promote studies on climate variations, with a focus on polar region, to improve accuracy of prediction of global warming and evaluation of its impacts.

Ref. URL: https://www.eorc.jaxa.jp/en/earth_observation_priority_research/ocean/

Reasons for using JSS2

The data assimilation system and model cannot execute in Linux computers generally used at EORC, since the regional ocean models are high spatial resolution (3km), satellite data is assimilated to the system daily, and forecast three-dimensional ocean physical parameters about 10-80 days in future. Therefore, we need super computer to do this study.

Achievements of the Year

Under collaboration with Japan Agency for Marine Earth Science and Technology (JAMSTEC), we improved and reconstructed the high-resolution ocean data assimilation system for South of Japan, which had been constructed until last FY, with Nagoya university. We have changed the forcing data to run the ocean model from US National Weather Service (NOAA/NCEP) reanalysis data to JMA’s 55-year Reanalysis (JRA55) data, and incorporated flesh water flux data using Macro-scale Floodplain model (CaMa-Flood) river discharge data and Global Satellite Mapping of Precipitation (GSMaP) rain data. Furthermore, we have incorporated Incremental Analysis Updates (IAU) to make the assimilation system using Local Ensemble Transform Kalman Filter (LETKF) stable. Through this reconstructing, we recognized that this system became easier to transfer the other environment and to change the calculating domain because this system was packaged.

In addition, Under collaboration with Nagoya University, we have incorporated assimilation of satellite sea surface salinity and freshwater fluxes (evaporation, precipitation, and river discharge) into a one-way nest high-resolution ocean data assimilation system (large-scale western Pacific and southeast Asian coastal system with a horizontal resolution of 1/12° and 1/36°, respectively) constructed in the last fiscal year, and conducted integrations of the system on JSS2. The large-scale western Pacific system reproduces decrease of sea surface temperature and salinity with the passage of typhoons and improves the Kuroshio and Kuroshio Extension path. The southeast Asian coastal system shows low salinity water formation around the Mekong river during summer with the large amount of river discharge as well as the localized cool SST in summer and cold tongue in winter near the Vietnam coast (Fig. 1), that provides a basis for marine environmental monitoring.

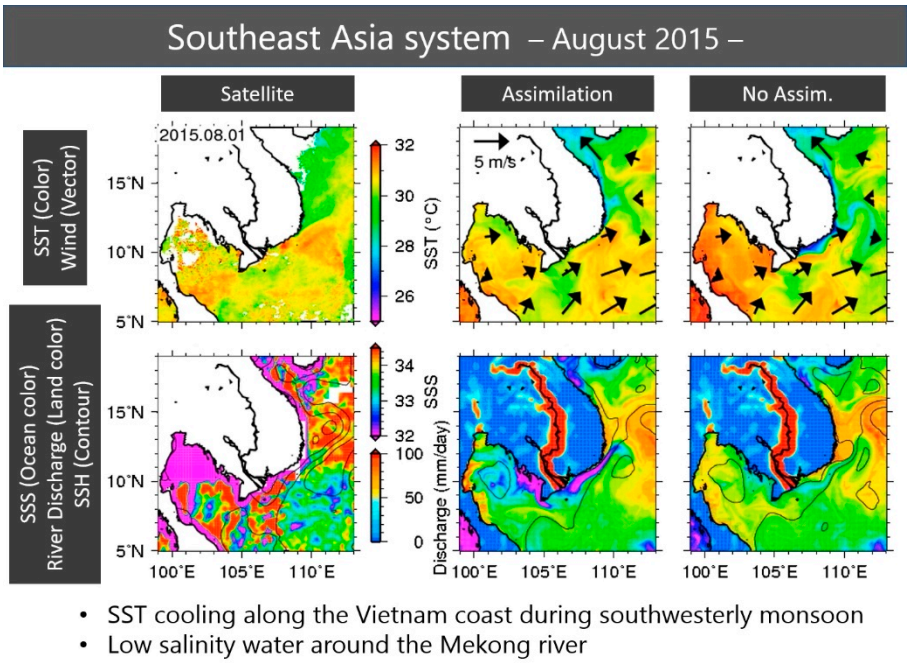

Fig. 1: Simulation results of August 2015 by South-Asia system. Upper panels are sea surface temperature, and lower panels are sea surface salinity. Left panels are satellite observations, middle panels are simulation with data assimilation, and right panels are simulation without data assimilation.
(Video. Video is available on the web.)

Publications

- Peer-reviewed papers

Miyazawa, Y., S. M. Varlamov, T. Miyama, X. Guo, T. Hihara, K. Kiyomatsu, M. Kachi, Y. Kurihara, H. Murakami, “Assimilation of high-resolution sea surface temperature data into an operational nowcast/forecast system around Japan using a multi-scale three dimensional variational scheme”, Ocean Dynamics, 67, 713-728, 2017.

- Oral Presentations

Aiki, H., Coastal physical data from satellite and assimilation, 11th GEOSS Asia-Pacific Symposium, Kyoto, Oct. 2018

Ohishi, S., T. Hihara, H. Aiki, J. Ishizaka, Y. Miyazawa, and M. Kachi, An LETKF-based ocean reanalysis for the Asia-Oceania region using Himawari-8 SSTs, JpGU 2018, Makuhari, Chiba, May 2018

Ohishi, S., T. Hihara, H. Aiki, J. Ishizaka, Y. Miyazawa, and M. Kachi, An LETKF-based ocean reanalysis for the Asia-Oceania region using Himawari-8 SSTs, IWMO2018, Brazil, Jun. 2018

Ohishi, S., T. Hihara, H. Aiki, J. Ishizaka, Y. Miyazawa, and M. Kachi, An LETKF-based ocean reanalysis for the Asia-Oceania region using Himawari-8 SSTs and SMOS/SMAP SSS, 4th International Joint Workshop on Computationally-Intensive Modeling of the Climate System and 9th OFES International Workshop, Fukuoka, Mar. 2019

Ohishi, S., T. Hihara, H. Aiki, J. Ishizaka, Y. Miyazawa, and M. Kachi, An LETKF-based ocean reanalysis for the Asia Oceania region using Himawari-8 SSTs and SMOS/SMAP SSS, 20th Pacific Asian Marginal Seas, Kaohsiung, Mar. 2019

Miyazawa, Y., T. Hihara, S. M. Varlamov, T. Miyama, M. Kachi, H. Murakami, N. Ono, Y. Kurihara, Utilization of satellite observation data for ocean state forecasts, The Joint PI Meeting of JAXA Earth Observation Missions FY 2018, Tokyo, Jan. 2019

- Poster Presentations

Hihara, T., Y. Miyazawa, T. Miyama, M. Kachi, H. Murakami, and Y. Kurihara, Bias Correction of satellite SST for ocean assimilation product using LETKF, GHRSST XIX, Darmstadt, Germany, Jun. 2018

Ohishi, S., T. Hihara, H. Aiki, J. Ishizaka, Y. Miyazawa, and M. Kachi, An LETKF-based ocean reanalysis for the Asia Oceania region using Himawari-8 SSTs, The Joint PI Meeting of JAXA Earth Observation Missions FY 2018, Tokyo, Jan. 2019

Hihara, T., Y. Miyazawa, V. Sergey, T. Miyama, M. Kachi, and H. Murakami, The high resolution regional ocean assimilation product “JCOPE-T DA” using satellite SST data, The Joint PI Meeting of JAXA Earth Observation Missions FY 2018, Tokyo, Jan. 2019

- Web

https://www.eorc.jaxa.jp/ptree/ocean_model/index.html

Usage of JSS2

Computational Information

Process Parallelization Methods	MPI
Thread Parallelization Methods	Automatic Parallelization
Number of Processes	20 - 32
Elapsed Time per Case	2.75 Minute (s)

- **Resources Used**

Fraction of Usage in Total Resources[*1] (%): 0.77

Details

Computational Resources		
System Name	Amount of Core Time (core x hours)	Fraction of Usage[*2] (%)
SORA-MA	6,661,725.81	0.82
SORA-PP	0.00	0.00
SORA-LM	0.00	0.00
SORA-TPP	0.00	0.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage*2 (%)
/home	42.92	0.04
/data	83,866.16	1.48
/ltmp	8,789.07	0.75

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage*2 (%)
J-SPACE	0.00	0.00

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage: Percentage of usage relative to each resource used in one year.