Controlling Lateral Boundary Conditions of a Regional Ocean Model by an Approximate Kalman Filter

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Background

Satellite altimeter data have been assimilated into ocean models aiming at a better estimation of the current and past ocean states and thus leading more accurate predictions. We attempt to develop a regional and short-term ocean forecasting system, hoping the new forecasting system can provide a swift and accurate prediction of background fields at all levels to fishery, ocean power, and so on (see https://dreams-d.riam.kyushu-u.ac.jp/vwp/epsilon). In this study, the lateral boundary conditions are modified by satellite sea surface height data assimilation (DA) using the approximate Kalman filter. Traditionally, the system error (process noise) has been basically attributed to the surface meteorological conditions. The assimilation result in 2014 is compared with the case without DA and the traditional surface meteorological conditions assimilation.

Methods

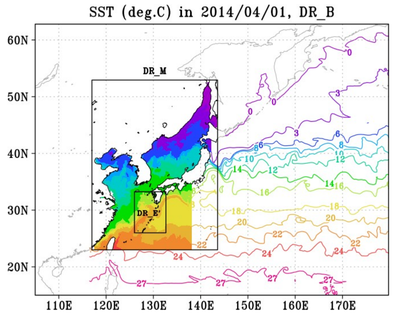
open boundary condition: DR_M model

meteorological forcing: MSM

DR_E' model

data assimilation: Approximate Kalman Filter

assimilated data: AVISO sea level anomaly

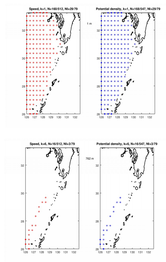


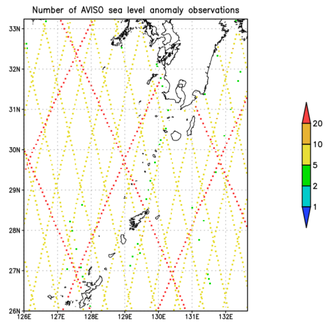
Main parameters:	
Number of zonal grids	400
Zonal resolution	1/60°
Number of meridional grids	544
Meridional resolution	1/75°
Number of vertical levels	114
Smagorinsky constant	0.17
Bottom drag coefficient	0.001

Assimilated data used in this study:

Along-track multi-mission sea level anomaly (without tidal signal) distributed by AVISO from 2014

(multi-mission products:
Jason-2, Cryosat, HY-2A, Saral, Jason-3, Sentinel-3A, Sentinel-3B, CFOSAT, HY-2C, Jason-CS/Sentinel-6)





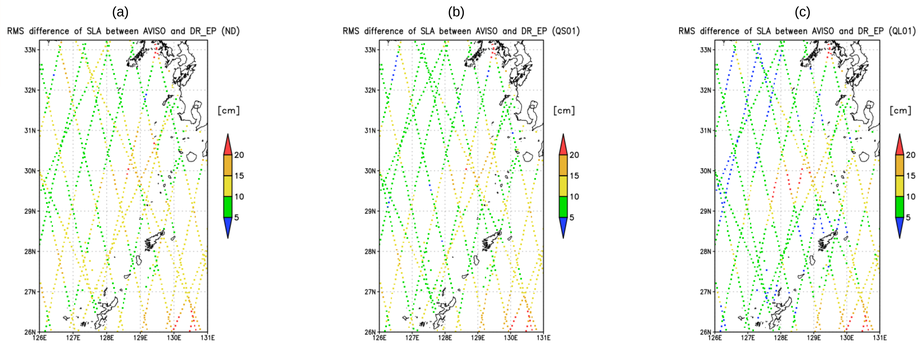
$$x_t^f = M_{t-1}(x_{t-1}^a, w_{t-1})$$
$$P_t^f = A' P_{t-1}^a A'^T + G_s' Q_s G_s'^T \quad \text{(QS01)}$$
$$\text{or } P_t^f = A' P_{t-1}^a A'^T + G_l' Q_l G_l'^T \quad \text{(QL01)}$$

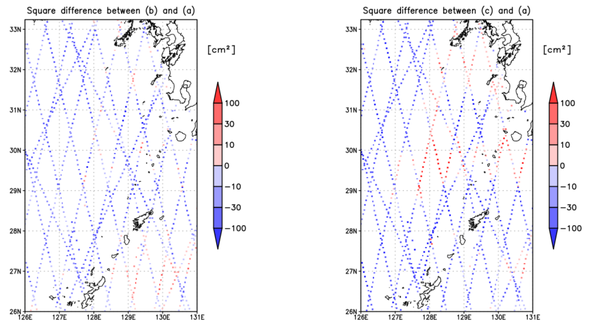
ND : The case without DA from 2014-01-01 to 2014-12-31

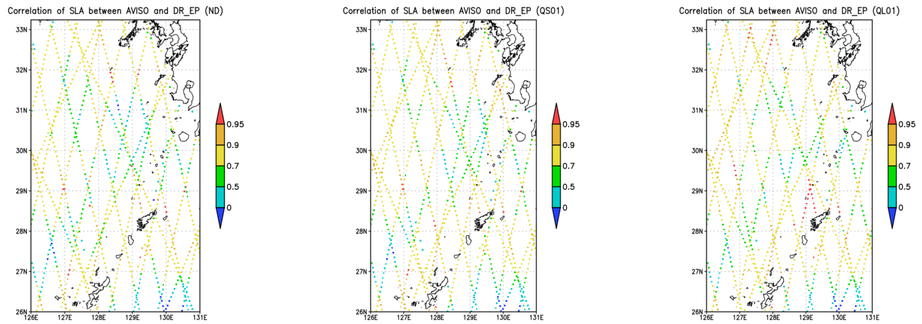
QS01 : Same period, but DA with the surface boundary noise (meteorological forcing variance ×0.1)

QL01 : Same period, but DA with the lateral boundary noise (lateral forcing variance ×0.1)

Results







Summary

The DA impacts of traditional surface meteorological conditions decay rapidly to depths and can not propagate into deep layers, while the lateral boundary controlled in this study extends the effective persistency of DA effect temporally and spatially.