Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

AAS02-P01 Room:Poster Time:April 29 18:15-19:30

Decadal climate prediction using 4D-VAR data assimilation approach

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It is very recently that decadal climate prediction experiments have been carried out with initialization. As a first step in decadal prediction, simple initialization approaches have usually been used so far, particularly focusing on ocean states. An advanced initialization technique is a pressing concern toward further enhancing the decadal predictability by obtaining suitable atmospheric and oceanic initial conditions that are compatible with both the model and observations. Here, by employing a 4D-VAR data assimilation approach to initialize the atmosphere-ocean coupled climate model, we attempt to perform ensembles of decadal hindcast experiments in line with the CMIP5 protocol. We perform full-field initialization rather than anomaly initialization and assimilate the atmospheric states together with the ocean states. We can validate the predictive skills in the atmosphere and ocean temperature hindcasts in some areas and, roughly speaking, the spatial patterns of the hindcast skills are similar to those of the multi-model ensembles of the CMIP5 decadal hindcasts. While our assimilation system has been developed originally for the purpose of seasonal-to-interannual climate simulations and we use 9-month assimilation window in these experiments, the hindcast results suggest that the atmosphere and ocean states associated with low-frequency variations beyond annual timescales can also be effectively initialized through the iterations of the forward and backward runs of the 4D-VAR data assimilation.

Keywords: decadal prediction, climate prediction, global warming, data assimilation, 4D-VAR

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Assimilation of TRMM-PR bright band heights

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Bright band heights in TRMM PR 2A23 are assimilated as temperature observations. Bright bands are strong radio echo from the melting layer. Bright band heights are located several hundred m below the 0C isotherms (Harris et al. 2000). In the TRMM PR algorithms (Awaka et al 2009), bright band heights are computed as the nadir projection of the distance between the satellite and the Earth ellipsoid minus the distance between the bright band peaks. Although the 0C isotherms from reanalysis or operational analysis are required in detection of bright bands, bright band heights are direct observations. Because bright band heights are valuable information to complement sparse direct measurements over ocean, the analysis can be improve when assimilated. Satellite radiances are mainly used in cloud-free area and assimilation of water substances are not straightforward. By contrast, because bright bands are associated with stratiform clouds, bright band heights are easily assimilated as conventional data over cloudy regions.

The data assimilation system ALEDAS2 (Enomoto et al. 2013) used in this study is composed of the atmospheric general circulation model for the Earth Simulator (AFES) and the local ensemble transform Kalman filter (LETKF). The resolution of the model is T119L48 (1 degree horizontally and 48 levels vertically) and the ensemble size is 63. ALERA2 produced with this system is regarded as the control. Bright band observations are processed as follows. First, each record is regarded as a 0C temperature observation at 500 m above the bright band height. Second, in order to avoid excessive horizontal correlations and computational load, super-observations are produced by the average of observations within 0.5 degree radius linearly weighted with the distance and converted to the LETKF input format in the 1 h window.

The number of the original bright band heights in January 2010 is 2572986 and that of the super-observations is 61905. The super-observations are widely distributed in the tropics and subtropics between 35S and 35N. In the Northern Hemisphere bright bands are clustered along the 30N over ocean, indicating bright bands due to stratiform associated with cyclones along the storm track (Yamamoto et al. 2006). A few bright bands are detected in the horse latitudes between the equator and 25N. In the Southern Hemisphere bright bands are distributed in the tropical and subtropical convergence zones. ALEDAS2 uses the 7 h data window for each analysis time every 6 h. The number of temperature observations increases by a few percent in synoptic hours of 0 and 12 UTC, but by a factor of 1.5 or 2 at 6 and 18 UTC.

In a preliminary experiment from 0 UTC 3 January for 4 d, the analysis ensemble spread, a measure of the analysis error, is reduced by 0.51 Pa and 0.94 Pa over the globe and in the Souther Hemisphere (35S–0), respectively at 0 UTC 7 January. The root mean square of the analysis increment increases by 2.4 % and 5.9 % in the global domain and in the Souther Hemisphere (35S–0).

Keywords: melting layer, satellite data assimilation in cloudy area, observing-system experiment