4th WCRP International Conference on Reanalyses, May 7–11, 2012, Silver Spring, Maryland, U.S.A.

Development of CFES–LETKF Ensemble Data Assimilation System

Nobumasa Komori,[1*] Takeshi Enomoto,[1,2] Takemasa Miyoshi,[3] and Bunmei Taguchi[1]

[1] **Earth Simulator Center**, Japan Agency for Marine-Earth Science and Technology, Yokohama, Japan
[2] Disaster Prevention Research Institute, Kyoto University, Uji, Kyoto, Japan
[3] Department of Atmospheric and Oceanic Science, University of Maryland, College Park, Maryland, U.S.A.

[*] E-mail: komori@jamstec.go.jp

(Link to http://icr4.org/posters/Komori_DA-4.pdf)

1. Introduction

Ensemble-based data assimilation techniques have been rapidly growing because of their advantages of the on-the-fly estimation of analysis and forecast errors, relative ease of implementation, and efficiency with parallel computers.

Miyoshi and Yamane [2007] applied the local ensemble transform Kalman filter (**LETKF**) to an atmospheric general circulation model (GCM), **AFES**, to construct the **AFES–LETKF** ensemble data assimilation system. Miyoshi et al. [2007] performed one and a half years of AFES–LETKF experimental ensemble reanalysis (**ALERA**) using observational dataset of the Japan Meteorological Agency operational system.

Based on ALERA, several observing system and predictability studies have been conducted [Inoue et al., 2009; Enomoto et al., 2010; Moteki et al., 2011]. Currently the second generation of ALERA (**ALERA2**) is underway with the latest version of AFES and LETKF, assimilating observational data of the National Centers for Environmental Prediction (NCEP) global data assimilation system (PREPBUFR).

ALERA data are available from:
http://www.jamstec.go.jp/esc/afes/

	ALERA	ALERA2
Resolution	T159L48	T119L48
Ensemble size	40	63+1
Boundary conditions	NOAA OISST weekly 1°	NOAA OISST daily 1/4°
Covariance localization	21x21x13	400km/0.4 lnp
Spread inflation	0.1	
Obs compiled by	JMA	NCEP

Table 1. Comparison of configurations of ALERA and ALERA2.

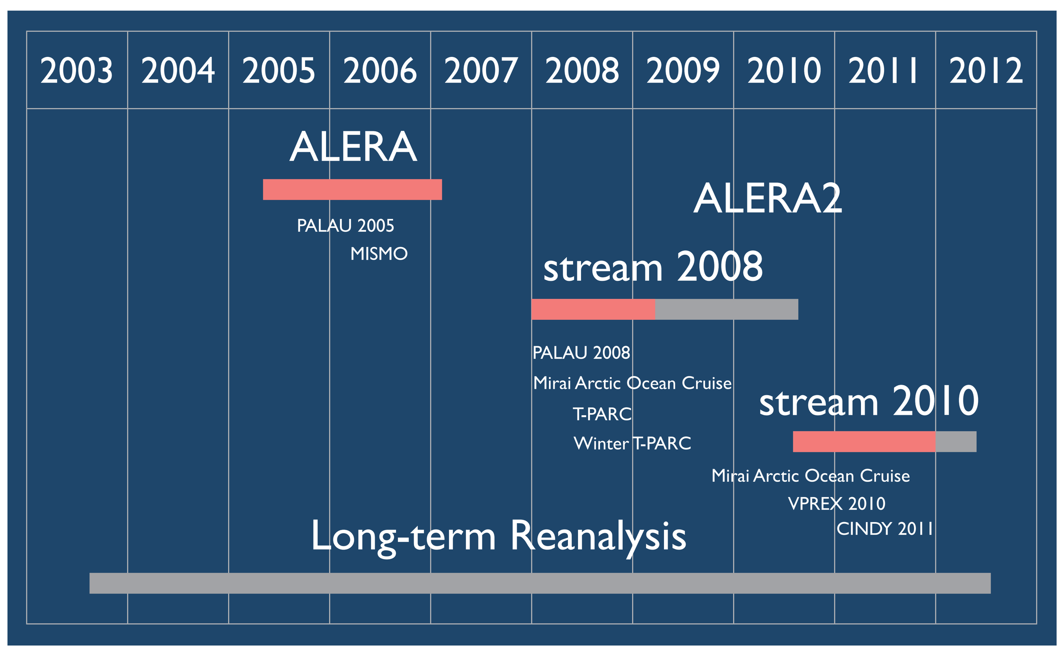

Figure 1. Status of ALERA2, and field campaigns to be evaluated based on ALERA2.

In ensemble data assimilation systems based on atmospheric GCMs (including AFES–LETKF), however, surface boundary conditions such as sea surface temperature (SST) and sea-ice distribution are the same among all ensemble members, which leads to an underestimation of the ensemble spread near the surface. Additionally air–sea coupled phenomena, e.g., lead–lag relationship between SST and precipitation over the tropics, are not well reproduced in such systems. To overcome these problems, we replace AFES with a coupled atmosphere–ocean GCM, **CFES**, to develop **CFES–LETKF** ensemble data assimilation system.

2. CFES–LETKF Ensemble Data Assimilation System

The resolution of the atmospheric component of CFES used in the system is **T119** (~100 km) in the horizontal and **48 layers** in the vertical, the same as in ALERA2. The oceanic component has a resolution of **1/2°** (~50 km) in the horizontal and **54 levels** in the vertical, and is coupled with the atmospheric component every hour.

Atmospheric observational data (NCEP PREPBUFR) are assimilated every 6 hours to update the atmospheric variables, whereas the oceanic variables are kept unchanged throughout the assimilation procedure. The analysis–forecast cycle starts on August 1, 2008, and the atmospheric initial conditions (40 members) are taken from ALERA2 analyses. Outputs from a stand-alone oceanic simulation on August 1 from 1967 through 2006 are used as the 40-member oceanic initial conditions.

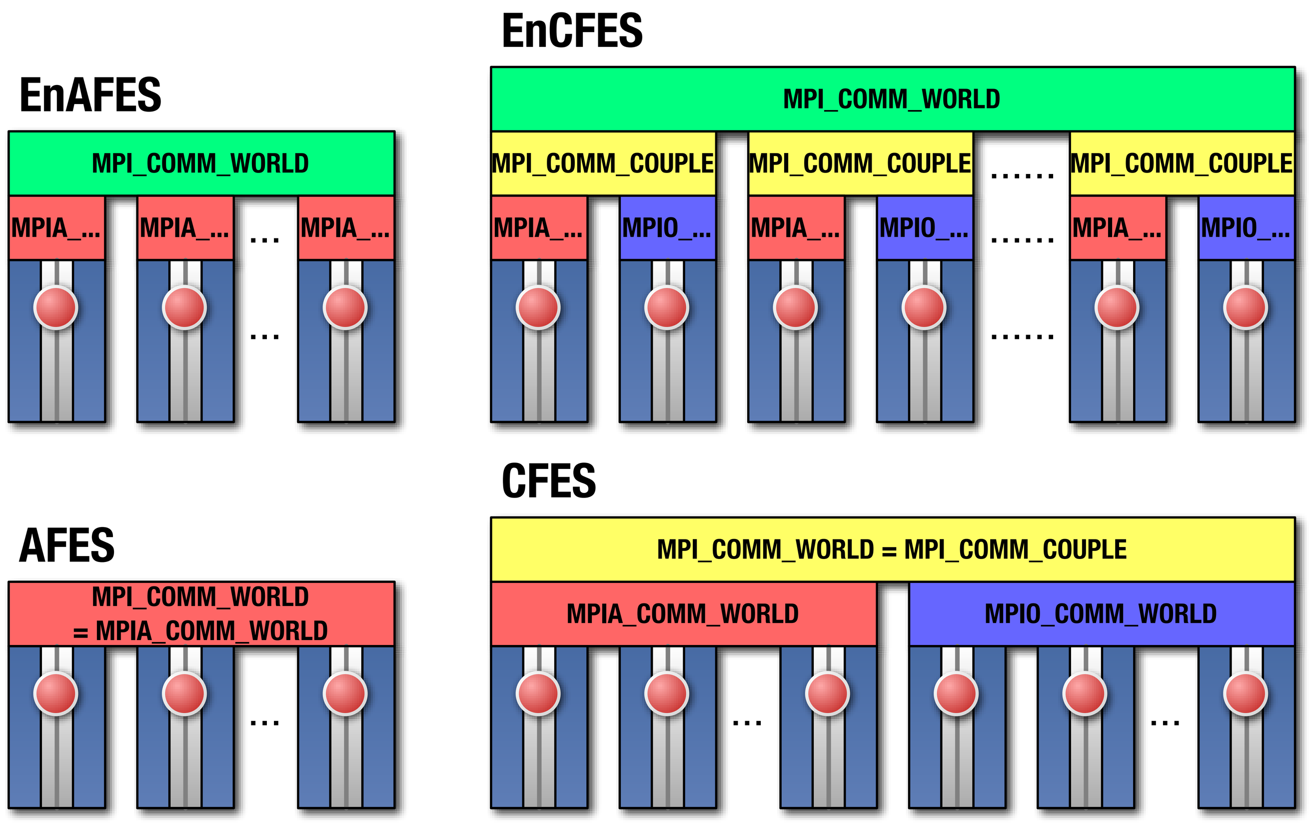

Figure 2. Schematics of the MPI communicators used in AFES, ensemble AFES (EnAFES), CFES, and ensemble CFES (EnCFES).

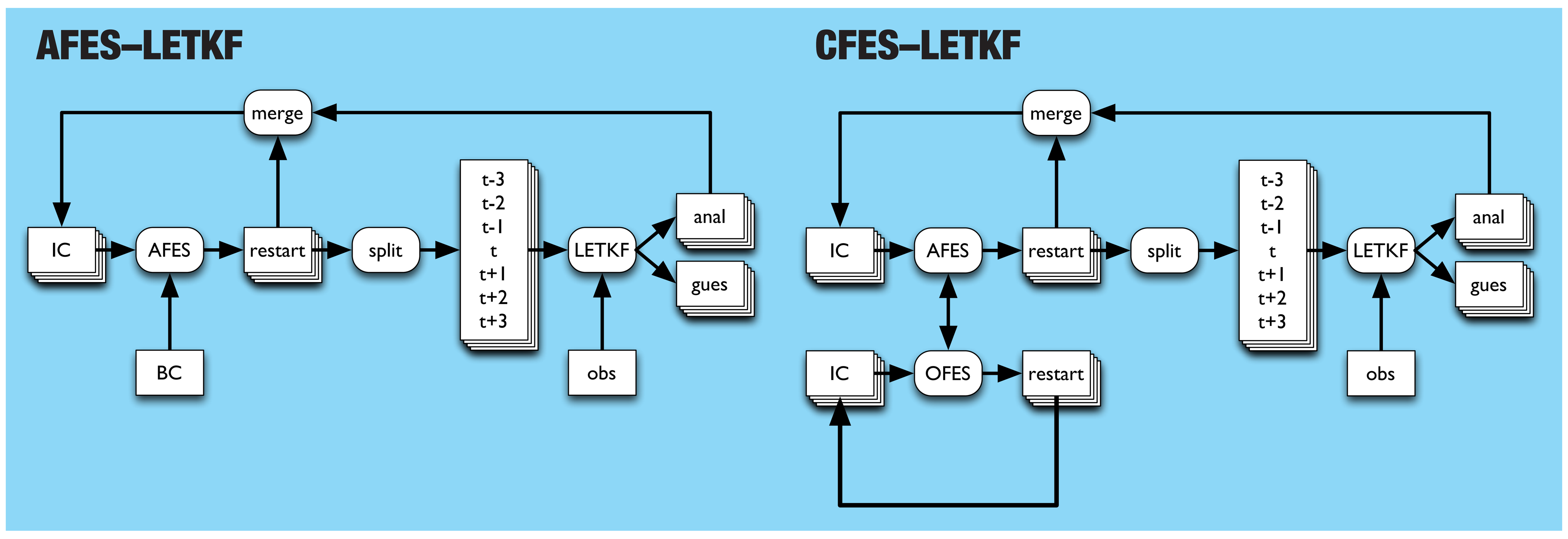

Figure 3. Data flow charts of (left) AFES–LETKF and (right) CFES–LETKF ensemble data assimilation systems. Rectangles represent data and round rectangles processes.

3. Preliminary Results

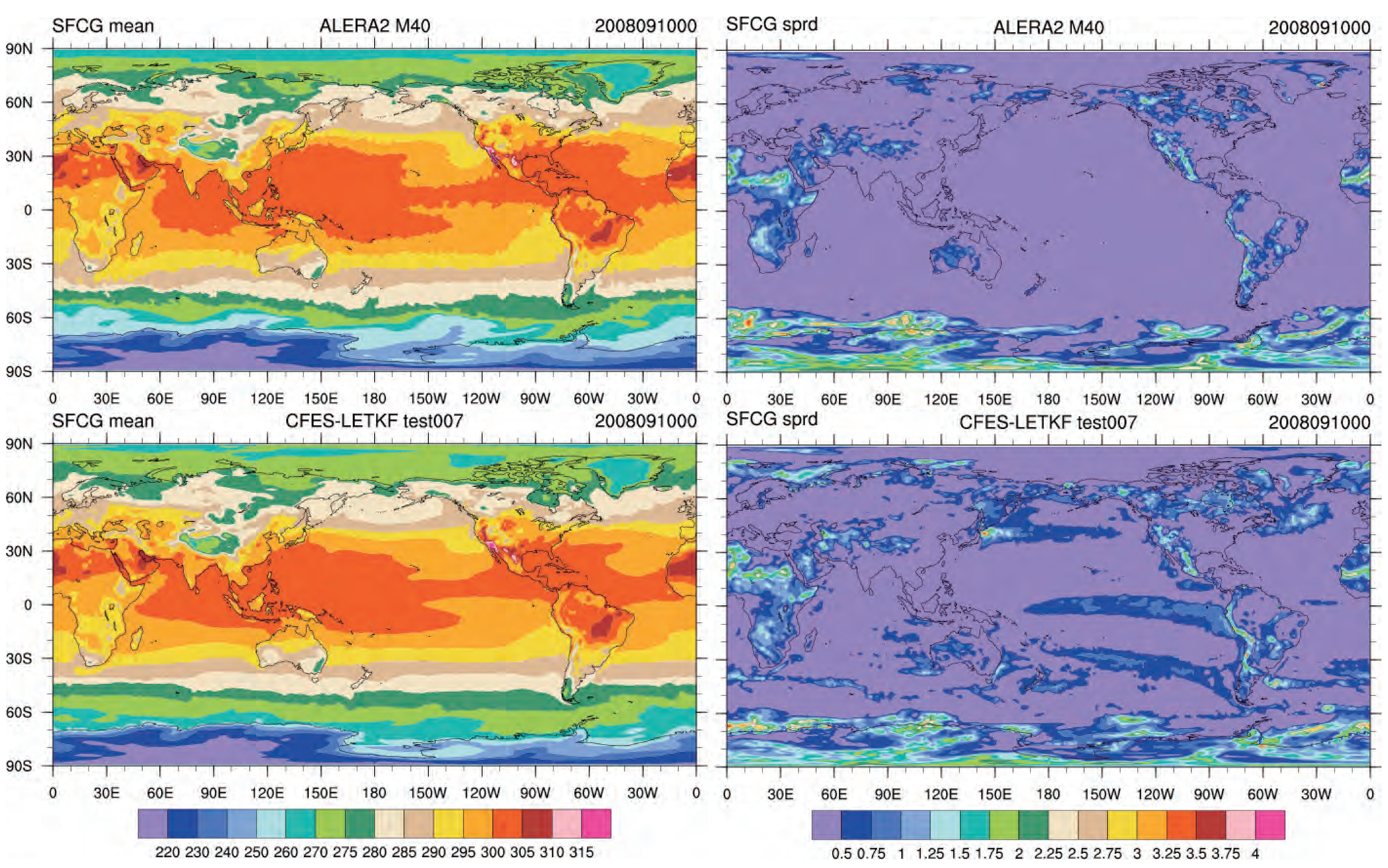

Figure 4. (left) Ensemble mean and (right) spread of surface temperature [K] at 00 UTC September 10, 2008 from (top) ALERA2 and (bottom) CFES–LETKF.

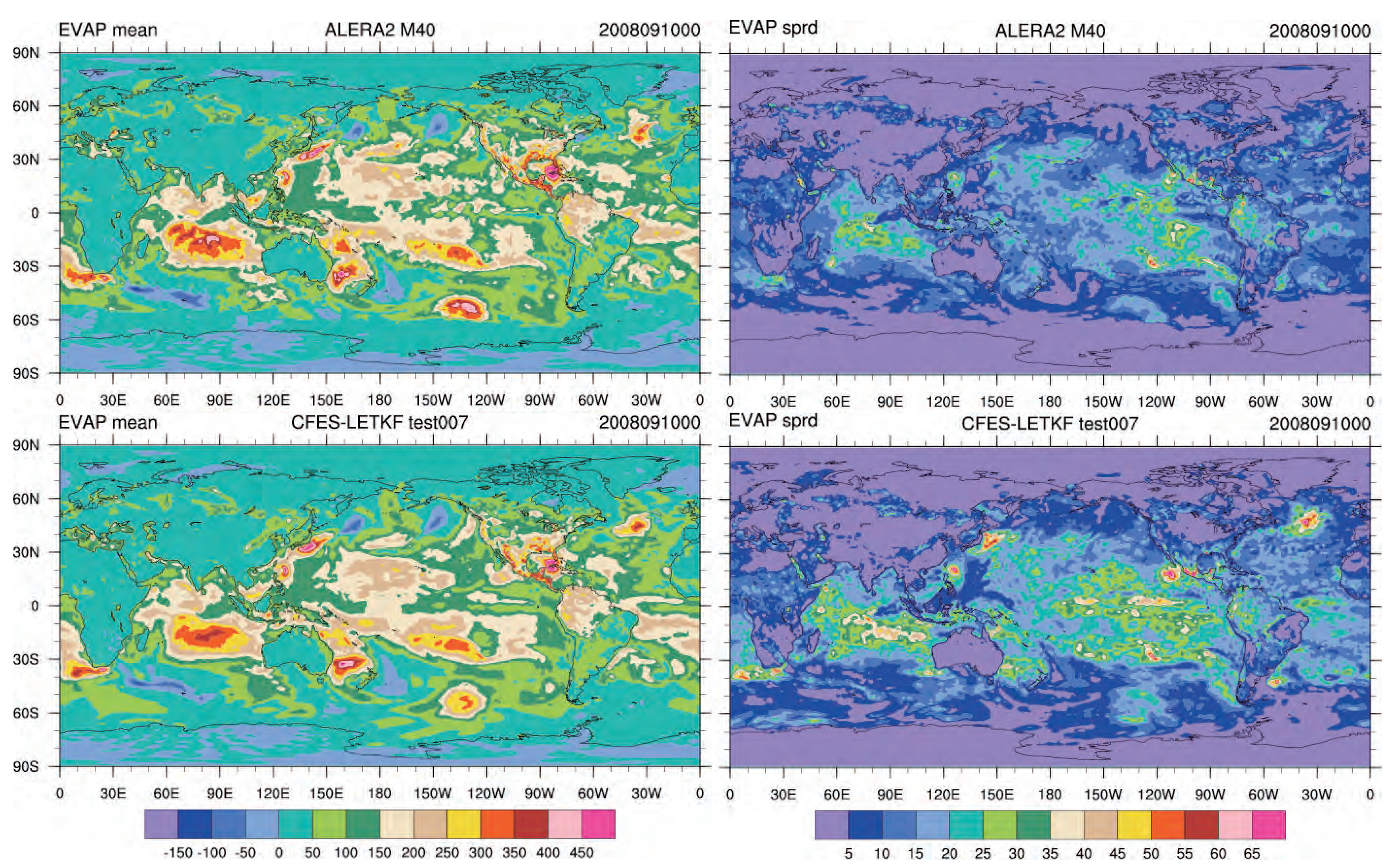

Figure 5. Same as in Fig. 4 but for latent heat flux [W m^{-2}].

Figures 4 and 5 compare surface variables between ALERA2 and CFES-LETKF at 00 UTC September 10, 2008. Ensemble means are not so different between the two systems, but the ensemble spreads from CFES–LETKF are much larger than those from ALERA2. The spread of SST from ALERA2 is exactly zero as mentioned, whereas that from CFES-LETKF has maxima corresponding to the oceanic variability. The large spread of latent heat flux from CFES–LETKF, however, does not necessarily correspond to the large spread of SST, indicating that the air–sea interaction is also important for increased surface spread along with the variability of boundary conditions.

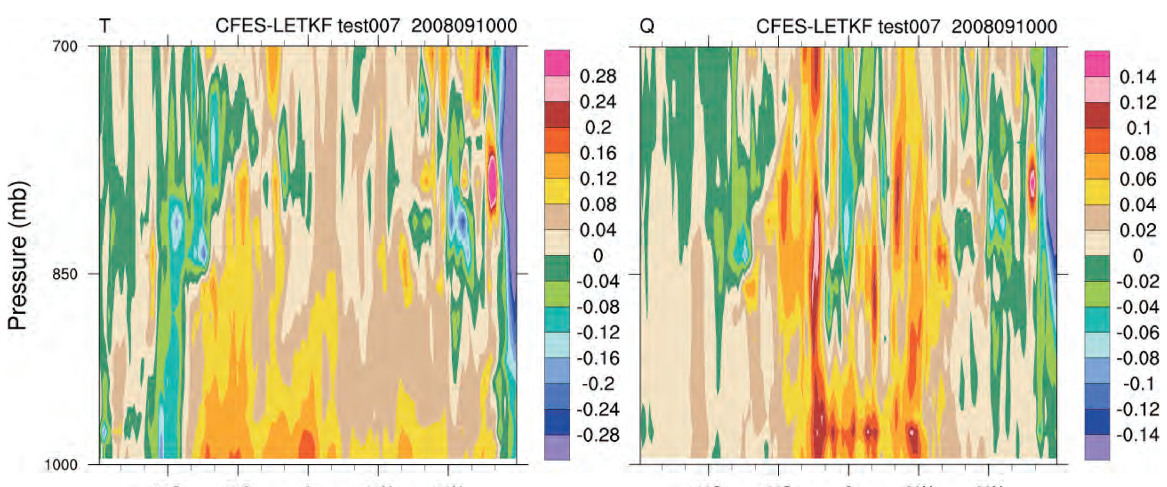

Figure 6. Difference in zonal-mean ensemble spread between ALERA2 and CFES–LETKF at 00 UTC September 10, 2008 for (left) air temperature [K] and (right) specific humidity [g kg^{-1}].

Figure 6 shows the vertical section of difference in zonal-mean ensemble spread (CFES–LETKF minus ALERA2) at the same time. Replacement of AFES with CFES successfully contributes to increased ensemble spread in the lower troposphere.

Acknowledgements

This study is partially supported by Grant-in-Aid for Scientific Research on Innovative Area **'Multi-scale air–sea interaction under the East-Asian monsoon: A "hot spot" in the climate system'** and so on. The numerical calculation was carried out on the Earth Simulator under support of JAMSTEC.