

A Satellite-based atmosphere-land coupled data assimilation system

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ABSTRACT

A Satellite-based atmosphere-land coupled data assimilation system was developed by combining a land data assimilation system (LDAS) and a cloud microphysics data assimilation system (CMDAS). LDAS and CMDAS include a physically based land-atmosphere coupled radiative transfer model (LA-RTM) that can represent microwave radiative transfer in soil by considering surface roughness effects, volume scattering and emission in the soil volume, and atmospheric emission and scattering. Both data assimilation schemes use the advanced regional prediction system (ARPS) coupled with Simple Biosphere Model 2 (SiB2). The coupled system was implemented in the following way:

Step 1:

LDAS, with LA-RTM as the observation operator, assimilates the brightness temperature observed by AMSR-E at its lower frequencies (6.9, 10.7 and 18.7 GHz). Cloud water, ice and light precipitation can be assumed transparent to lower microwave frequencies, and thus the retrieved land surface conditions are representative of prevailing surface conditions.

Step 2:

Output from LDAS is used to provide initial and boundary conditions for CMDAS. LA-RTM embedded in CMDAS uses microwave emissivities converted from the lower frequencies to higher frequencies (23.8 and 89.0 GHz) as the boundary condition of LA-RTM in the atmosphere. Then CMDAS retrieves water vapor, cloud water, cloud ice, rain and snow columns describing the atmospheric state coupled with the ARPS Lin ice microphysics scheme.

Step 3:

This retrieved atmospheric condition is fed back to the LDAS step to refine the surface condition. SALDAS can then provide a reliable land surface and atmospheric state that can improve the accuracy of rainfall prediction.

The coupled data assimilation system was applied to the National Centers for Environmental Prediction (NCEP) global forecast system (GFS) reanalysis data and AMSR-E data, for downscaling to a mesoscale area of the Tibetan Plateau. The result shows that the distribution of the assimilated integrated cloud liquid water is in consistency with the satellite infrared observation.

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