Land surface analysis and reanalysis at the NASA Global Modeling and Assimilation Office

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Land surface conditions impact weather and climate. Soil moisture has long been shown to interact with the atmosphere; soil temperature is a key variable in weather and climate models; and snow season characteristics affect weather and climate variability. In situ and remote sensing observations of land surface states and forcing fields can be used in conjunction with reanalysis estimates to simulate and update global land surface conditions, which are in turn critical for improving weather and climate forecasts.

The presentation will first discuss the recently released MERRA-Land reanalysis, a supplemental land surface data product of the Modern-Era Retrospective Analysis for Research and Applications (MERRA) generated at the NASA Global Modeling and Assimilation Office (GMAO). In the second part, current developments and future plans for the assimilation of land surface state observations at the GMAO will be addressed.

MERRA is a state-of-the-art reanalysis that provides, in addition to atmospheric fields, global estimates of soil moisture, latent heat flux, snow, and runoff for 1979–present. The supplemental MERRA-Land data product is a land-only ("off-line") replay of the MERRA land model component that benefits (i) from corrections to the precipitation forcing with the NOAA Climate Prediction Center "Unified" global gauge-based precipitation product and (ii) from revised parameter values in the rainfall interception model, changes that effectively correct for known limitations in the MERRA surface meteorological forcings. The skill (defined as the correlation coefficient of the anomaly time series) in land surface hydrological fields from MERRA and MERRA-Land is assessed against observations and compared to the skill of the state-of-the-art ECMWF Re-Analysis-Interim (ERA-I). MERRA-Land and ERA-I root zone soil moisture skills (against in situ observations at 85 U.S. stations) are comparable and significantly greater than that of MERRA. Throughout the Northern Hemisphere, MERRA and MERRA-Land agree reasonably well with in situ snow depth measurements (from 583 stations) and with snow water equivalent from an independent analysis. Runoff skill (against naturalized stream flow observations from 18 U.S. basins) of MERRA and MERRA-Land is typically higher than that of ERA-I. With a few exceptions, the MERRA-Land data appear more accurate than the original MERRA estimates and are thus recommended for those interested in using MERRA output for land surface hydrological studies.

MERRA-Land does not yet benefit from the assimilation of land surface state observations. Many recent advances in land data assimilation were achieved with ensemble-based Kalman filtering. The presentation will give a brief overview of the challenges and advantages of assimilating satellite observations of land surface states into land surface models. Progress in the assimilation of surface soil

moisture, land surface temperature, snow, and terrestrial water storage at the GMAO will be discussed, including the preparation for assimilation of brightness temperatures from the current Soil Moisture Ocean Salinity (SMOS) mission and the plans for a soil moisture assimilation data product from the future Soil Moisture Active Passive (SMAP) mission.

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