The MERRA-Land data product: Assessment and enhancement of MERRA land surface hydrology estimates

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The Modern-Era Retrospective Analysis for Research and Applications (MERRA) is a state-of-the-art reanalysis data product that provides, in addition to atmospheric fields, global estimates of soil moisture, latent heat flux, snow, and runoff for 1979-present. A supplemental and improved set of land surface hydrological fields ("MERRA-Land") was generated by re-running a revised version of the land component of the MERRA system (Reichle et al., 2012). Specifically, the MERRA-Land estimates benefit from corrections to the precipitation forcing with the global gauge-based NOAA Climate Prediction Center "Unified" (CPCU) precipitation product and from revised parameter values in the rainfall interception model, changes that effectively correct for known limitations in the MERRA surface meteorological forcings.

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. As an example, Figure 1 examines the drought conditions experienced across the western United States and along the East Coast. The MERRA and MERRA-Land drought indicator shown in the figure is derived by ranking, separately for each grid cell, the normalized, monthly mean root zone soil moisture anomalies for June, July, and August of 1980 through 2011 and converting the rank into percentile units. For comparison, the drought severity assessed independently by U.S. Drought Monitor is also shown. The figure clearly demonstrates that MERRA-Land data are more consistent with the Drought Monitor than MERRA data.

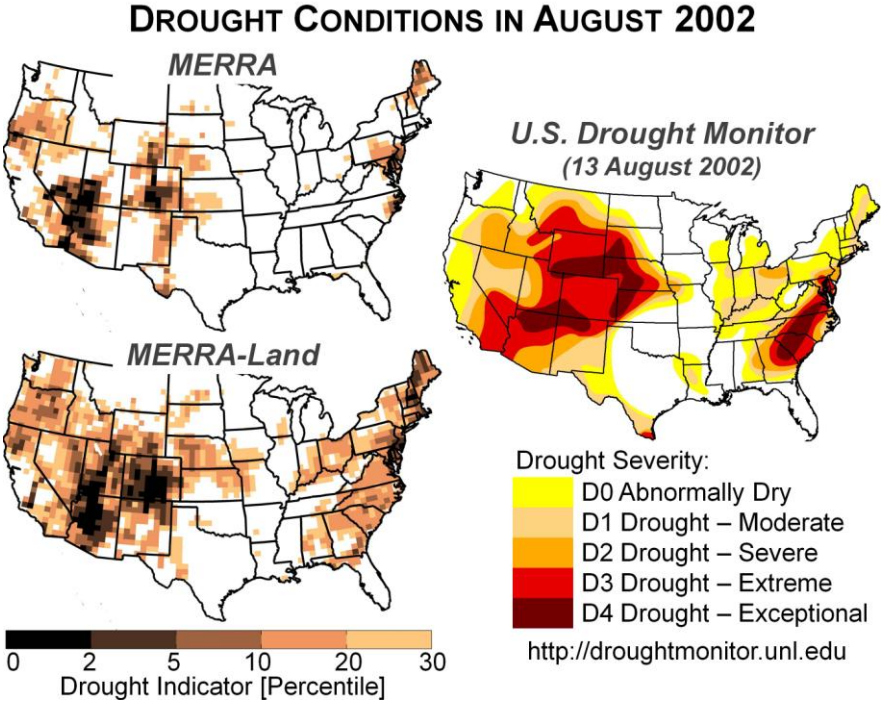

Figure 1: Drought indicator derived from (top left) MERRA and (bottom left) MERRA-Land root zone soil moisture estimates for August 2002. Darker colors indicate more severe drought conditions. MERRA-Land estimates are more consistent than MERRA estimates with an independent drought assessment from the US Drought Monitor for 13 August 2002 (right).

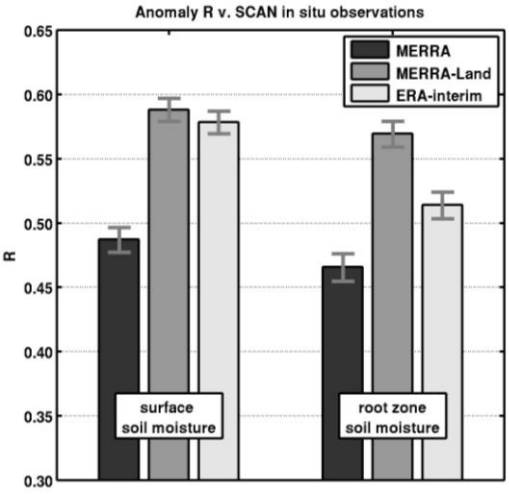

Figure 2: Skill (pentad anomaly R; dimensionless) of MERRA, MERRA-Land, and ERA-I estimates (2002-2009) versus SCAN in situ surface and root zone soil moisture measurements. Error bars indicate approximate 95% confidence intervals.

A quantitative analysis of the skill (defined as the correlation coefficient of the anomaly time series) in land surface hydrological fields from MERRA and MERRA-Land was conducted against observations and compared to the skill of the state-of-the-art ERA-Interim (ERA-I) reanalysis. Figure 2 shows that MERRA-Land and ERA-I root zone soil moisture skills (against in situ observations at 85 US stations) are comparable and significantly greater than that of MERRA. Figure 3 shows that runoff skill (against naturalized stream flow observations from 18 US basins) of MERRA and MERRA-Land is typically higher than that of ERA-I. 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 (not shown).

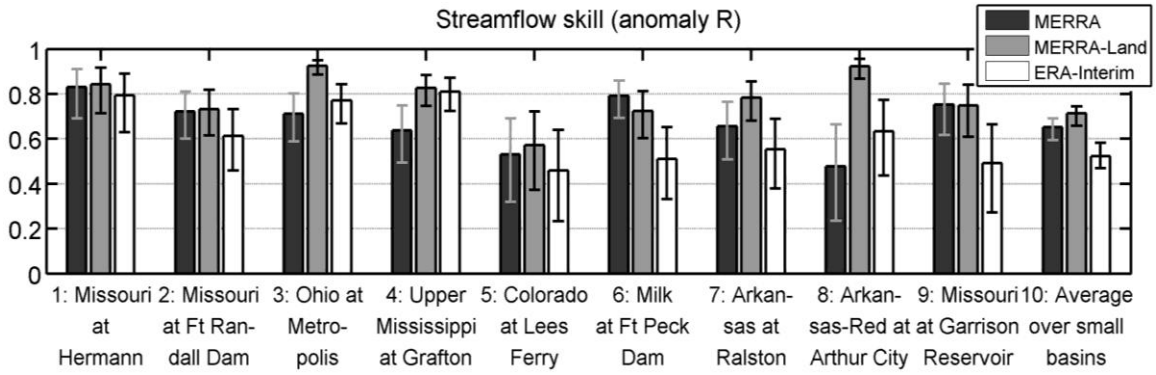

Figure 3: Seasonal anomaly time series correlation coefficients (dimensionless) for runoff estimates from MERRA, MERRA-Land, and ERA-I. See Table 1 of Reichle et al. (2011) for more information on the basins and time periods examined.

Publications:

Reichle, R. H., R. D. Koster, G. J. M. De Lannoy, B. A. Forman, Q. Liu, S. P. P. Mahanama, and A. Toure, 2011: Assessment and enhancement of MERRA land surface hydrology estimates, *Journal of Climate*, *24*, 6322-6338, doi:10.1175/JCLI-D-10-05033.1.

Reichle, R. H., 2012: The MERRA-Land Data Product, Global Modeling and Assimilation Office, available at http://gmao.gsfc.nasa.gov/research/merra/file_specifications.php.