A 51-YEAR REANALYSIS OF THE U.S. LAND-SURFACE HYDROLOGY

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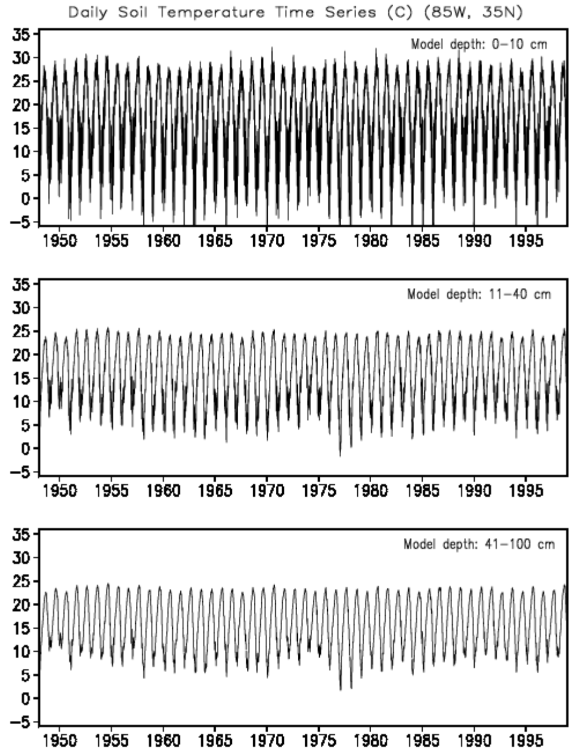
A 51-year (1948–1998) run of the NOAH land model for the conterminous USA has been completed under Office of Global Programs – GEWEX Continental-scale International Project sponsorship. This NOAH model is also used in the North American Land Data Assimilation System (NLDAS) in which the VIC, Mosaic and Sacramento models also participate (Mitchell et al., 2000). The NLDAS activity has been primarily "real-time forward" from April 1999 onward. The primary reason for the 51-year reanalysis is to define climate, including interannual variability, placing extreme events in historical context, and to aid in forecast applications at the NCEP Climate Prediction Center (CPC), which currently runs a much simpler hydrological model (Huang et al., 1996; Van den Dool, 2003). Climatological applications require that the data sets be as homogeneous as possible. As a result, the forcing fields were selected on the basis of their availability over this time period. For example, real time NLDAS solar radiation is obtained through an algorithm based on satellite measurements; however, long-term data are not available. Therefore, the retroactive run is made with downward solar radiation from the global reanalysis (Kalnay et al., 1996).

The forcing input data consists of precipitation, downward solar and longwave radiation, surface pressure, humidity, 2m temperature and horizontal windspeed, all interpolated to the 1/8 by 1/8 degree grid and hourly time resolution. The output consists of soil temperature and soil moisture (both liquid and frozen) in four layers below the ground and the interface heat and moisture fluxes between the layers. At the surface itself we have all of the components of the energy and (water) mass balance, including snow cover, depth, and albedo. Runoff can be routed into streamflow. For more details see Fan et al. (2003).

A few samples of the output are shown in the figure. The greater interannual variance in temperature in winter (compared to summer) is very obvious in layer 3 (41–100 cm). The bottom figure on the back page shows temperature at the same point in all 4 layers in a single year. The amplitude and phase delay of the annual cycle as a function of depth are as expected.



Daily soil temperature in layers 1-3 at 85W, 35N for 51 years, according to a retroactive analysis by the NOAH model.

Maurer et al. (2002) have completed a similar run with the VIC model. Apart from the model (NOAH vs VIC), the forcing data sets are quite different and instead of hourly, the VIC uses 3-hourly input. In the near future the Regional Reanalysis (RR) will offer further material for comparison. As a by-product of retroactive NLDAS we also have generated the precipitation input for RR. So the land surface hydrology in RR starts from the same precipitation input.

The reanalysis output is available in various forms. Potential users should contact yun.fan@noaa.gov to see how their needs can best be accommodated. Users who have an account at NCEP can access all (daily, 3-hourly) data. We can also provide this data via high storage tapes at a nominal fee. For the latest information on this project see: http://www.cpc.ncep.noaa.gov/soilmst/index.htm.

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Fan, Yun, et al. 2003. NWS-CPC'S monitoring and prediction of US soil moisture and associated land surface variables: Land Data Reanalysis. Proc. Climate Diagnostics and Prediction Workshop, 21–25 October, 2002, George Mason University, Virginia.

(Continued on Page 10)

uncertainties), error covariances, their state dependence, and methodologies for the description of their dependence on space and time scales and synoptic conditions. The GPCP analysis project can provide additional valuable information to the NWP community, but more communication between the two groups is needed. This can be achieved through the GPCP, the GEWEX Radiation Panel (GRP) and the International Precipitation Working Group.

As to the future analysis method for GPCP, the data assimilation group believes that developing an assimilation method is not recommended and some other more nonlinear methods (such as Krieging) suitable for analysis of precipitation should be developed. Such work will also complement the data assimilation analysis.

There was an indication that the data assimilation precipitation is known to be more accurate than satellite estimates over some areas, particularly in higher latitudes, orographic areas, snow covered areas and snowfall. Addition of data assimilation precipitation analysis into the observation-only analysis should be considered for providing more accurate, fully global precipitation analysis to general users. In this regard, the examination of the accuracy of data assimilation precipitation needs to be encouraged.

For the observation-only analysis, several improvements were discussed. The analysis of frozen/snow precipitation, analysis over complex terrain and the use of new satellite observations are the major recommendations.

Observations/products are required on smaller scales (space/time) because data assimilation will increasingly employ time-series of data and focus on more regional applications.

There is a need to continue developing high-quality, unbiased reference sites across the range of climate regimes for validation of precipitation analyses. There is also a need for research on radar precipitation estimates, which are increasingly used by regional data assimilation analysis.

Finally, the data assimilation analysis holds the key to the future for precipitation analysis, since its greatest advantage is that it can provide the analysis of observed and derived meteorological variables (together with precipitation) in a dynamically, physically and hydrologically consistent manner. However, it will take several more years before the assimilated precipitation analysis becomes as accurate as currently available observation-only analysis. The collaboration with the GPCP group will certainly accelerate this important development.

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(Continued from Page 6)

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Maurer, E.P, et al., 2002. A Long-Term Hydrologically-Based Data Set of Land Surface Fluxes and States for the Conterminous United States. *J. Climate* 15(22), 3237-3251.

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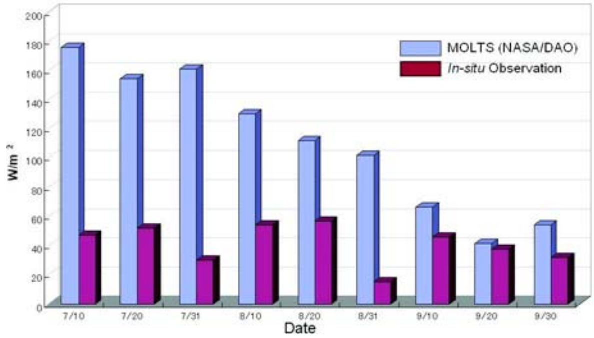
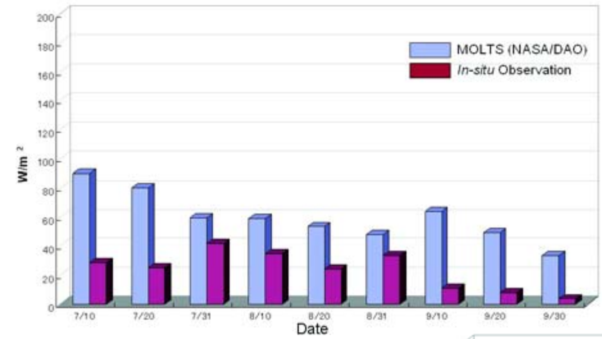
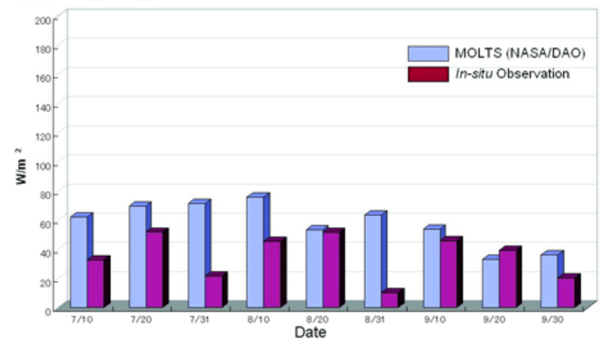


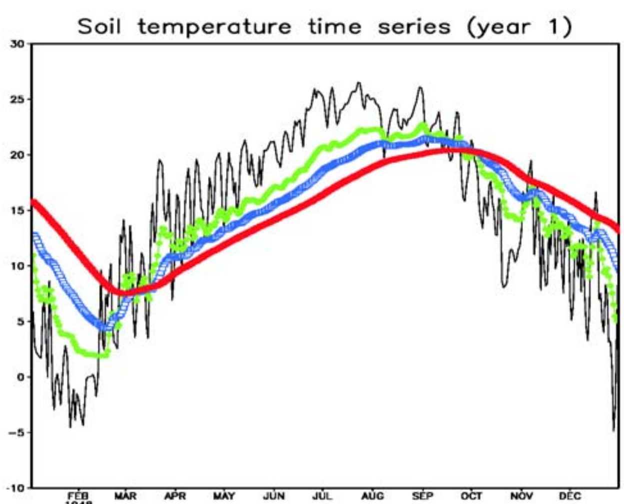
MODEL AND REFERENCE SITE CEOP INTERCOMPARISONS SHOW LARGE DIFFERENCES IN NET RADIATION

(See Article on Page 5)





Ten days of the net radiation (top), sensible heat flux (center) and latent heat flux (right) at Lindenberg from June to September 2001.



RESULTS FROM 51-YEAR REANALYSIS OF U.S. LAND-SURFACE HYDROLOGY

(See Article on Page 6)

The amplitude and phase delay of the annual cycle as a function of depth are as expected in the figure at the left, which shows daily soil temperature in four layers at 85W, 35N for a single year (according to a retroactive analysis by the NOAH model). The black, green, blue and red curves apply to 1-10 cm, 11-40 cm, 41-100 cm and 101-200 cm respectively. See page 6 for more details.

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