Enabling NLDAS-2 Anomaly Analysis Using Giovanni

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Summary

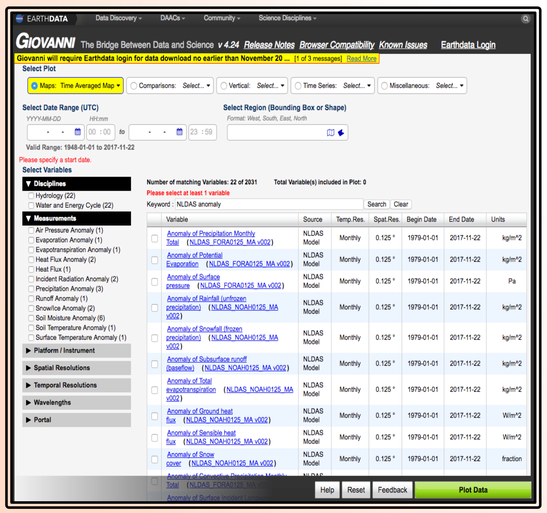
- Analyzing anomalies is important for monitoring droughts, determining weather trends, and studying land surface processes relevant for meteorology, hydrology, and climate.
- Using the North American Land Data Assimilation System Version 2 (NLDAS-2) monthly data and monthly climatology data, we computed the anomalies (differences between monthly climatology and monthly data) for several of the variables available in the NLDAS Primary Forcing and Noah land-surface model (LSM) data sets.
- Table below: NLDAS-2 Anomaly Variables in NASA Giovanni.
- Use case to the right: Application of NLDAS-2 anomaly to the 1988 North American Drought.

NLDAS

- Integrates observation and model data to produce LSM data sets, executed at 1/8th degree grid spacing over central North America.
- NLDAS forcing drives four land-surface models: NASA's Mosaic, NOAA's Noah, the NWS Office of Hydrological Development's (OHD) SAC, and Princeton's implementation of VIC.
- NLDAS-2, the second phase of the NLDAS project, provides hourly and monthly forcing data and model output for central North America from January 1, 1979 through present.
- Several monthly climatology products are also available, calculated as 30-year (1980-2009) monthly averages, for the forcing data and various model outputs.

NLDAS-2 Anomaly Variables in Giovanni

- The NASA Geospatial Interactive Online Visualization and Analysis Interface (Giovanni) is a Web-based application developed by the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science data without having to download the data.
- Figure below: Example of the Giovanni user interface
- At top right: Giovanni options



NLDAS Primary Forcing Data L4 Monthly Anomaly 0.125 x 0.125 degree V002 (NLDAS_FORA0125_MA.002)	
Convective Precipitation Monthly Total	kg/m^2
Potential Evaporation	kg/m^2
Precipitation Monthly Total	kg/m^2
Surface Incident Longwave Radiation Flux	W/m^2
Surface Incident Shortwave Radiation Flux	W/m^2
Surface pressure	Pa
NLDAS Noah Land Surface Model L4 Monthly Anomaly 0.125 x 0.125 degree V002 (NLDAS_NOAH0125_MA.002)	
Ground heat flux	W/m^2
Latent heat flux	W/m^2
Rainfall (unfrozen precipitation)	kg/m^2
Sensible heat flux	W/m^2
Snow cover	fraction
Snowfall (frozen precipitation)	kg/m^2
Soil moisture content (layer 1, 0-10 cm)	kg/m^2
Soil moisture content (layer 2, 10-40 cm)	kg/m^2
Soil moisture content (layer 3, 40-100 cm)	kg/m^2
Soil moisture content (layer 4, 100-200 cm)	kg/m^2
Soil moisture content (top 1 meter, 0-100 cm)	kg/m^2
Soil moisture content (total column, 0-200 cm)	kg/m^2
Soil temperature (layer 1, 0-10 cm)	K
Subsurface runoff (baseflow)	kg/m^2
Temperature (average surface skin)	K
Total evapotranspiration	kg/m^2

Visualization and Download Options

- Visualization options in Giovanni include Time-Averaged Map, Area-Averaged Time Series, Animation Map, Time-Averaged Overlay Map, Correlation Map, Area-Averaged Scatter Plot, Seasonal Time Series, and Histogram.
- Users can modify minimum and maximum values, color palettes, and map projections.
- Resulting images can be saved as GeoTIFF, KMZ, or PNG files.
- For maps, data can be saved as a NetCDF file (NASA Earthdata login credentials needed).
- For time series plots, resulting data can be saved as a CSV file.

Use Case: The 1988 North American Drought

- The 1988 drought was one of the most notable droughts in the midwestern United States of the last century, and the worst since the "Dust Bowl" of the 1930s.
- Drought developed quickly as rainfall totals hit record lows in April through June 1988.
- NLDAS-2 anomaly analysis capabilities in Giovanni enable the study of atmospheric and land conditions of major drought events through time-averaged maps and area-averaged time series.

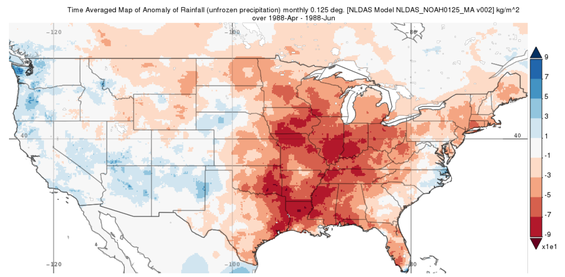


Figure 1. Monthly anomaly of rainfall (kg/m^2) averaged over April-June 1988 over central North America.

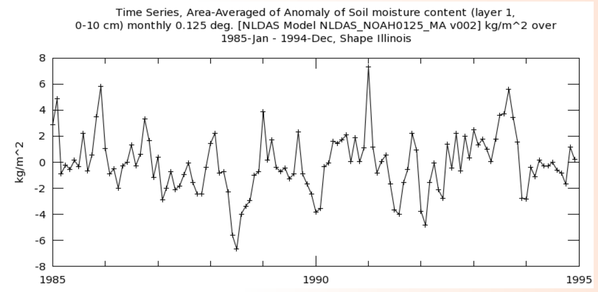


Figure 2. Monthly anomaly of soil moisture content from 0-10cm (kg/m^2) from January 1985 to December 1994 averaged over Illinois.

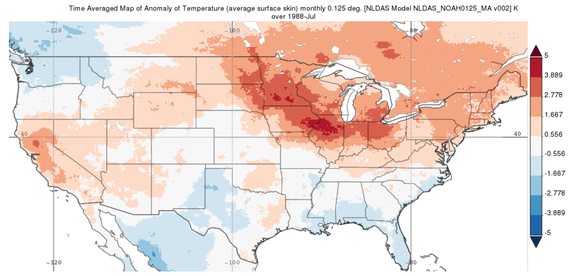


Figure 3. Monthly anomaly of average surface skin temperature (K) for July 1988 over central North America.

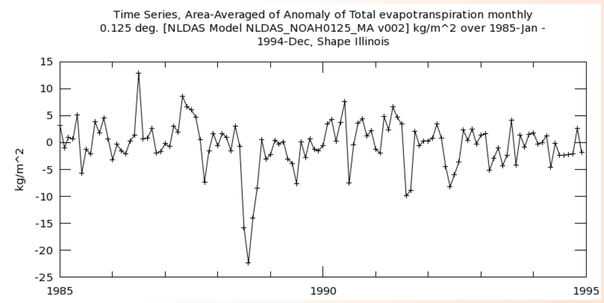


Figure 4. Monthly anomaly of total evapotranspiration (kg/m^2) from January 1985 to December 1994 averaged over Illinois.

Figure 1 shows the monthly anomaly of accumulated rainfall averaged over April, May, and June 1988 compared to the 30-year climatology. Large portions of the midwestern United States saw average rainfall of 7+ mm below normal. These below-average rainfall accumulations were evident in the soil moisture content during the summer of 1988, as shown by the time series for Illinois in Figure 2. Other factors related to this drought event included higher than average surface skin temperatures in the northern states of Illinois, Minnesota, and Indiana, reaching 4 K above average. The total evapotranspiration accumulation was much lower than average during this summer, shown by the time series for Illinois in Figure 4.

References

David Mocko, NASA/GSFC/HSL(2012), NLDAS Primary Forcing Data L4 Monthly 0.125 x 0.125 degree V002, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed 12/17, doi:10.5067/Z62LT6J96R4F

David Mocko, NASA/GSFC/HSL(2012), NLDAS Noah Land Surface Model L4 Monthly 0.125 x 0.125 degree V002, Greenbelt, Maryland, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed 12/17 doi:10.5067/NOXZSD0Z6JGD

Mitchell et al., 2004: The multi-institution North American Land Data Assimilation System (NLDAS): Utilizing multiple GCIP products and partners in a continental distributed hydrological modeling system, J. Geophys. Res., 109, D07S90, doi:10.1029/2003JD003823.

Xia, et al., 2012: Continental-scale water and energy flux analysis and validation for North American Land Data Assimilation System project phase 2 (NLDAS-2): 2. Validation of model-simulated streamflow, J. Geophys. Res., 117, D03110, doi:10.1029/2011JD016051.