Analysis of Water and Energy Budgets and Trends Using the NLDAS Monthly Data Sets

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Introduction

The North American Land Data Assimilation System (NLDAS) is a collaborative project between NASA GSFC, NOAA, Princeton University, and the University of Washington. NLDAS has created surface meteorological forcing data sets using the best-available observations and reanalyses. The forcing data sets are used to drive four separate land-surface models (LSMs), Mosaic, Noah, VIC, and SAC, to produce data sets of soil moisture, snow, runoff, and surface fluxes. NLDAS hourly data, accessible from the NASA GES DISC Hydrology Data Holdings Portal, are widely used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events. More information is available at http://ldas.gsfc.nasa.gov.

To further facilitate analysis of water and energy budgets and trends, NLDAS monthly data sets have been recently released by NASA GES DISC.

NLDAS Data Characteristics

<table>
<thead>
<tr>
<th>Content</th>
<th>Water and energy budget data, forcing data, soil moisture/temperature data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial coverage</td>
<td>Continental U.S., parts of southern Canada and northern Mexico (2.5° × 2.5°)</td>
</tr>
<tr>
<td>Spatial resolution</td>
<td>0.125° × 0.125°</td>
</tr>
<tr>
<td>Temporal resolution</td>
<td>Hourly and Monthly (NEW AND JUST RELEASED)</td>
</tr>
<tr>
<td>Forcing</td>
<td>Multiple data sets derived from satellite measurements, radar estimation, precipitation gauges, and atmospheric analyses</td>
</tr>
<tr>
<td>Land surface models</td>
<td>Mosaic, Noah, SAC, VIC</td>
</tr>
<tr>
<td>Output format</td>
<td>Gridded Binary (GRIB)</td>
</tr>
<tr>
<td>Elevation definition</td>
<td>GTOPO 30</td>
</tr>
<tr>
<td>Vegetation definition</td>
<td>University of Maryland, 1 km</td>
</tr>
</tbody>
</table>

NLDAS Data Access and Services

All NLDAS data sets available from the NASA GES DISC can be accessed from the Hydrology Data Holdings Portal, http://ldas.gsfc.nasa.gov/hydrology/data-holdings, via the following access methods:

- Direct flip: simple, fast, and navigation
- Mirador: keyword search, navigation, subsetting, and format conversion
- BODC Data Server (GDS): data aggregation and retrieving data in ASCII
- Giovanni: visualization, analysis, and data download
- Simple Subset Wizard (SSW): Keyword search, subsetting, and format conversion (GRIB to NetCDF), currently for all hourly data sets and, in the future, for all monthly data.

To further analyze water and energy budgets and trends, NLDAS monthly data sets have been recently released by NASA GES DISC.

How are the NLDAS monthly data generated?

- NLDAS monthly data are generated from their corresponding hourly data by monthly accumulation for some water-related variables and monthly average for others.
- Time period for each month is from 002 at the start of the month to 2359 at the end of the month, except for the first month (Jan. 1979). The period for Jan. 1979 is dependent on data set starting date and time (more details available in NLDAS README documents).
- NLDAS-1 Monthly Forcing Data Set:
  - Monthly accumulation for precipitation variables (ACPzPsdC, APCIpsdC, PEDASfC, and PRORAsfC) and monthly average for others.
  - Two new variables for NLDAS-1 monthly forcing data set:
    - Convective precipitation monthly total (CONVAPCpsdC)
    - Shortwave radiation flux downwards (surface) blended from EDAS and GOMS-UMD Pinker (RSWRFsfdC)
- NLDAS-2 Monthly Forcing Data Set:
  - Monthly accumulation for total precipitation, convective precipitation, and potential evaporation, and monthly average for other variables.
- NLDAS-2 Monthly Secondary Forcing Data Set:
  - Monthly accumulation for convective precipitation and monthly average for others.
- NLDAS-2 Monthly Mosaic and Noah Model Data Sets:
  - Monthly accumulation for rainfall, snowfall, subsurface runoff, surface runoff, total evapotranspiration, and snow melt, and monthly average for others.

More detailed information is available in the NLDAS README documents, located at http://ldas.gsfc.nasa.gov/hydrology/documentation.

Summary

- NLDAS monthly data, accessible from NASA GES DISC, are widely used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.
- To further facilitate analysis of water and energy budgets and trends, NLDAS monthly data products have been recently released by NASA GES DISC.
- NLDAS monthly data are generated from their corresponding hourly data by monthly accumulation for some water-related variables and monthly average for others.
- NLDAS provides major water and energy balance variables and can be used for studying water and energy budgets and trends.
- NLDAS monthly Climatology data will be released in Jan. 2013 and will facilitate analysis of trends and anomalies.

NLDAS Water and Energy Variables

![Figure 1: A simplified schematic diagram showing the energy and water balances studied by the LDAS Project. More detailed diagrams and references for NLDAS-2 models (Mosaic, Noah, VIC, and SAC) are at http://ldas.gsfc.nasa.gov/nldas/NLDASmodel.php](https://ntrs.nasa.gov/search.jsp?R=20130010791)

<table>
<thead>
<tr>
<th>Variables of NLDAS Forcing Data Sets and Model Outputs</th>
<th>Energy Balance</th>
<th>Water Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longwave radiation flux downwards</td>
<td>Precipitation</td>
<td>Average layer soil moisture</td>
</tr>
<tr>
<td>Shortwave radiation flux downwards</td>
<td>Rainfall (unsnow precipitation)</td>
<td>Average layer soil temperature</td>
</tr>
<tr>
<td>Ground heat flux</td>
<td>Snowfall (frozen precipitation)</td>
<td>Humidity</td>
</tr>
<tr>
<td>Latent heat flux</td>
<td>Snowmelt</td>
<td>Snow melt</td>
</tr>
<tr>
<td>Sensible heat flux</td>
<td>Snow cover</td>
<td>Snow melt</td>
</tr>
<tr>
<td>Snow phase-change heat flux</td>
<td>Potential evaporation</td>
<td>Snow depth</td>
</tr>
<tr>
<td>Snow melt</td>
<td>Total evapotranspiration</td>
<td>Albedo</td>
</tr>
</tbody>
</table>

NLDAS provides more than 33 years of data for these major water balance and energy balance variables, and the data can be used for studying water and energy budgets and trends. For the complete list of NLDAS variables, please go to NLDAS README Documents.

How will NLDAS be used in the future?

- NLDAS hourly data, accessible from NASA GES DISC, are widely used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.
- To further facilitate analysis of water and energy budgets and trends, NLDAS monthly data products have been recently released by NASA GES DISC.
- NLDAS monthly data are generated from their corresponding hourly data by monthly accumulation for some water-related variables and monthly average for others.
- NLDAS provides major water and energy balance variables and can be used for studying water and energy budgets and trends.
- NLDAS monthly Climatology data will be released in Jan. 2013 and will facilitate analysis of trends and anomalies.

How does NLDAS benefit hydrology and water management?

- NLDAS data are used for modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.
- NLDAS data are widely used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.

Upcoming New Data and Services

- NLDAS data are widely used by various user communities in modeling, research, and applications, such as drought and flood monitoring, watershed and water quality management, and case studies of extreme events.

All plots in Figures 2, 3, 4, and 5 are generated by Giovanni NLDAS Monthly Portal.

![Figure 2: Long-term mean (Jan. 1980 – Dec. 2009), averaged from NLDAS-2 FORA and Noah monthly data, showing spatial distributions of these water balance variables of precipitation (2a), evapotranspiration (2b), surface runoff (2c), and top 1 meter soil moisture content (2d).](https://ntrs.nasa.gov/search.jsp?R=20130010791)

![Figure 3: Time series (Jan. 1980 - Dec. 2009) of Water Balance Variables from NLDAS-2 FORA and Noah monthly data, averaged over the entire NLDAS region. The 30-year NLDAS time series of precipitation (3a) and surface runoff (3c) show a slight up trend, but total evapotranspiration (3b) and the top 1 meter soil moisture (3d) show a slight down trend.](https://ntrs.nasa.gov/search.jsp?R=20130010791)

![Figure 4: Time series (Jan. 1980 - Dec. 2009) of Energy Balance variables from NLDAS-2 Noah monthly data, averaged over the entire NLDAS region. The 30-year time series of net shortwave radiation flux (4a) and sensible heat flux (4c) show a slight up trend, but ground heat flux (4b) and latent heat flux (4c) show a slight up trend.](https://ntrs.nasa.gov/search.jsp?R=20130010791)

![Figure 5: Time series (Jan. 1980 – Dec. 2009) of Water and Energy Balance variables from NLDAS-2 Mosaic monthly data, averaged over the entire NLDAS region. Similar to the results from Noah monthly data, the 30-year time series of evapotranspiration (5a) and latent heat flux (5d) show a slight down trend, but surface runoff (5b) and net shortwave radiation flux (5c) show a slight up trend.](https://ntrs.nasa.gov/search.jsp?R=20130010791)