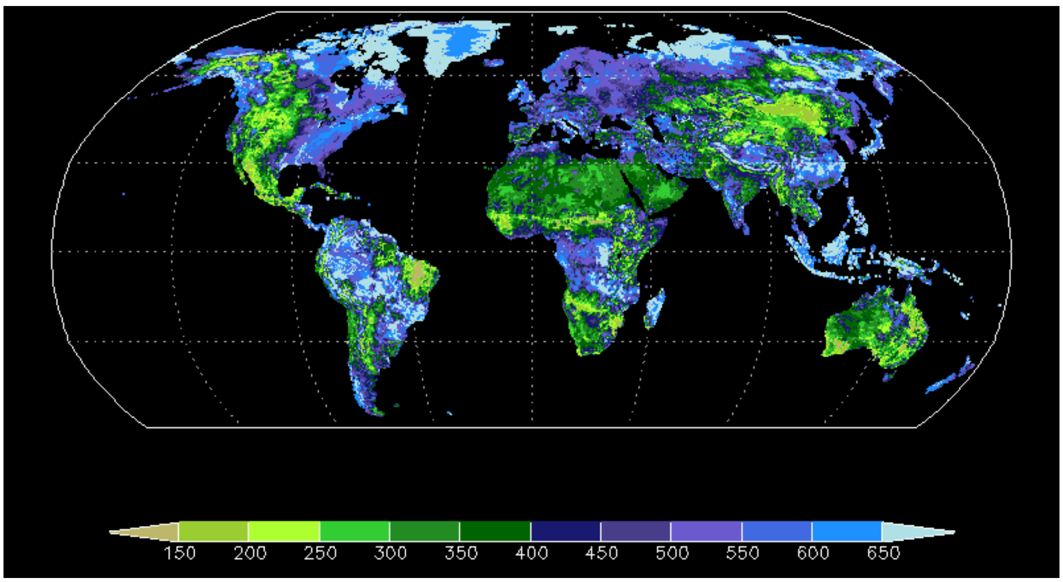
Updated 9/06

Water and Energy Balance Variables Output from NASA's Global Land Data Assimilation System (GLDAS)

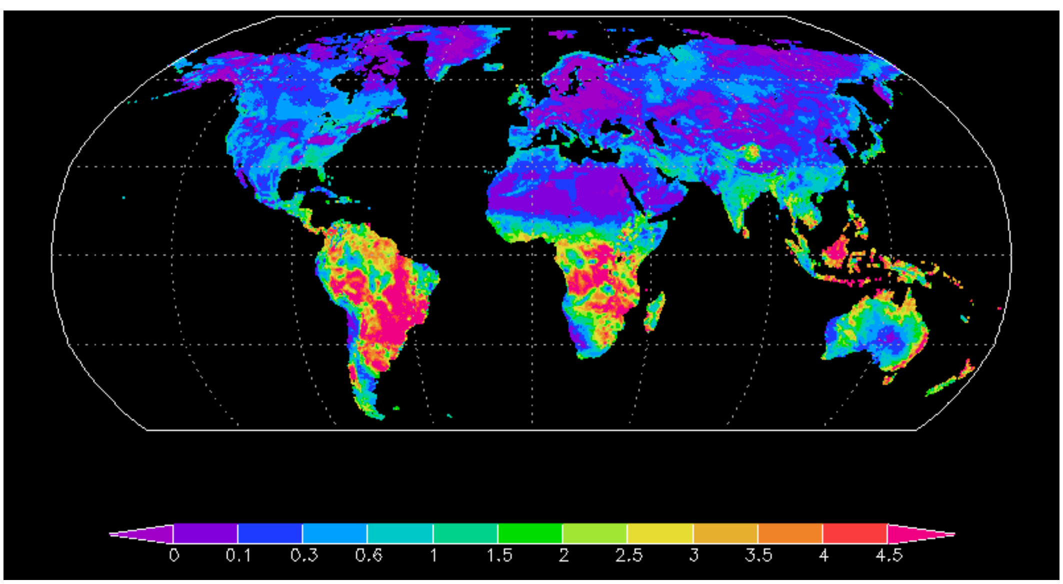
1. The product and its purpose

Here we offer a set of global time series of land surface water and energy cycle variables simulated by the Global Land Data Assimilation System (GLDAS; http://ldas.gsfc.nasa.gov/; Rodell et al., 2004) driving the Noah land surface model (LSM) (Ek et al., 2003). GLDAS products support weather and climate model initialization studies, water resources and other applications, and water and energy cycle investigations. The project is led by scientists at NASA Goddard Space Flight Center and funded by NASA's Energy and Water Cycle Study (NEWS) Program (http://wec.gsfc.nasa.gov/).

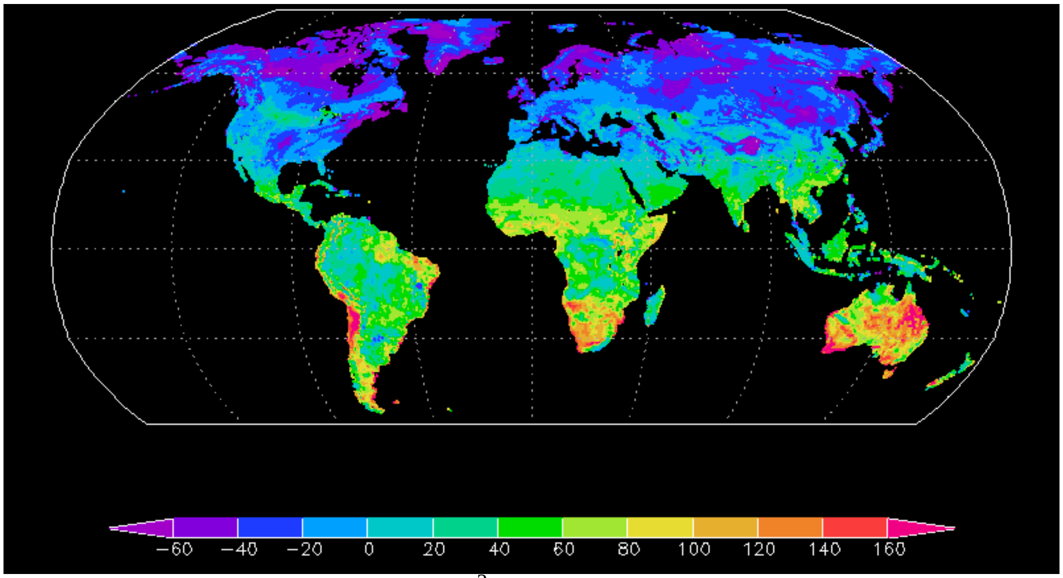
2. Several examples of the product showing it under a range of different climate conditions



Example 1. Total column (2 m) soil moisture (mm), 1 January 2005.



Example 2. Total evapotranspiration (mm/day), 1 January 2005.



Example 3. Sensible heat flux (W/m^2), 1 January 2005.

3. A brief outline of how the product was derived

In this particular configuration, GLDAS drove the Noah LSM at 0.25° resolution, with sub-grid, vegetation based tiling, forced by a combination of atmospheric analyses from NOAA's Global Data Assimilation System (GDAS; Derber et al., 1991), spatially and temporally downscaled precipitation from the NOAA Climate Prediction Center (CPC) Merged Analysis of Precipitation (CMAP; Xie and Arkin, 1997), and downward shortwave and longwave radiation derived using data and algorithms (Shapiro, 1987; Idso, 1981) from the Air Force Weather Agency (AFWA). Key parameters included global, 5' resolution soils maps produced by the USDA (Reynolds et al., 2000) and global, 1 km resolution land cover maps from the University of Maryland (Hanson et al., 2000).

4. Details on its resolution

The product is gridded at 0.25° resolution, covering all of the land north of 60°S, though the results over most of Greenland are unreliable. The dataset offered here is a daily time series, averaged up from 3-hourly output from a simulation with a 15 minute model timestep.

5. Frequency of new product releases

There is no set schedule for new product releases. Several GLDAS products already exist, including 1.0° resolution simulations of the Noah, Common Land Model (CLM), and Mosaic LSMs. Others are currently running or planned, including a 0.25° Noah simulation that includes assimilation of MODIS snow cover, Catchment and Variable Infiltration Capacity (VIC) LSM simulations, and a 0.25° CLM2 simulation.

6. Lag time between the last observation and the release of the product

GLDAS has the capability of producing output within 48 hours of real time. For this particular configuration, which relied on CMAP and AFWA forcing data, the lag time would be closer to a week. However, given that there is not currently a pressing need for near real time output, GLDAS simulations are typically updated on a monthly basis.

7. Necessary metadata

Please see the README file at the end of this document.

8. The duration of the data product

Output from 1 December 2004 to 31 December 2005 is currently being disseminated. The full duration of the simulation is much longer, and a longer time series could easily be made available. This simulation was initialized on 1 January 1979, forced by bias corrected ECMWF and NCEP/NCAR reanalysis data. GDAS forcing data replaced those in 2000, and the CMAP and AFWA products were incorporated in March and April 2001. The simulation is complete to near present and will continue into the foreseeable future.

9. Any known error estimates or considerations

Output over most of Greenland and also a few other polar land pixels are not reliable and should be ignored. Noah and the other LSMs do not include ice flow mechanisms, hence snow accumulates indefinitely on pixels whose temperatures rarely or never exceed freezing. Uncertainty in other parts of the world varies by output field, spatially, and in time. Several studies have examined individual variables (e.g., Rodell et al., 2004b; Gottschalck et al., 2005) or attempted point or regional evaluation (e.g., Luo et al., 2003; Robock et al., 2003; Kato et al., 2006), but no comprehensive study of the uncertainty in GLDAS inputs or outputs exists.

10. Availability and access

Data are currently available via anonymous FTP. Because anonymous FTP servers are vulnerable to attack, we ask that users contact Matthew.Rodell@nasa.gov for further instructions. The data format is gridded binary (GRIB).

11. Anything else

The goal of GLDAS is to ingest satellite- and ground-based observational data products, using advanced land surface modeling and data assimilation techniques, in order to generate optimal fields of land surface states and fluxes (Rodell et al., 2004a). The software, which has been streamlined and parallelized by the Land Information System (LIS) sister project (Kumar et al., 2006), drives multiple, offline (not coupled to the atmosphere) land surface models, integrates a huge quantity of observation based data, executes globally at high resolutions (2.5° to 1 km), and is capable of producing results in near-real time. A vegetation-based “tiling” approach is used to simulate sub-grid scale variability, with a 1 km global vegetation dataset as its basis. Soil and elevation parameters are based on high resolution global datasets. Observation-based precipitation and downward radiation products and the best available analyses from atmospheric data assimilation systems are employed to force the models. The project has resulted in a massive archive of modeled and observed, global, surface meteorological data, parameter maps, and output. All of these are publicly available, save for two products of which distribution is restricted by our agreements with the source agencies.

References

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Ek, M. B., K. E. Mitchell, Y. Lin, E. Rogers, P. Grunmann, V. Koren, G. Gayno, and J. D. Tarpley, Implementation of Noah land surface model advances in the National Centers for Environmental Prediction operational mesoscale Eta model, J. Geophys. Res., 108(D22), 8851, doi:10.1029/2002JD003296, 2003.

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Luo, L., A. Robock, K. E. Mitchell, P. R. Houser, E. F. Wood, J. C. Schaake, D. Lohmann, B. Cosgrove, F. Wen, J. Sheffield, Q. Duan, R. W. Higgins, R. T. Pinker, and J. D. Tarpley, Validation of the North American Land Data Assimilation System (NLDAS) retrospective forcing over the Southern Great Plains, J. Geophys. Res., 108 (D22), 8843, doi:10.1029/2002JD003246, 2003.

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Robock, A., L. Luo, E. F. Wood, F. Wen, K. E. Mitchell, P. R. Houser, J. C. Schaake, D. Lohmann, B. Cosgrove, J. Sheffield, Q. Duan, R. W. Higgins, R. T. Pinker, J. D. Tarpley, J. B. Basara, and K. C. Crawford, Evaluation of the North American Land Data Assimilation System over the Southern Great Plains during the warm season, J. Geophys. Res., 108 (D22), 8846, doi:10.1029/2002JD003245, 2003.

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README.gldas.dave.noah.0.25.txt

Filename: gldas.YYYYMM.dave.VAR.noah.grb
YYYY = 4-digit year
MM = 2-digit month
VAR = variable names (see below)

Creator: Hiroko Kato
File format: GRIB
Contents: Daily average water budget components from
GLDAS/Noah 2.7.1 experiment 891
Lat extent: 60S to 90N
Lon extent: 180W to 180E
Resolution: 0.25 deg x 0.25 deg (lat x lon)
Temporal coverage: 2004/12/01 - 2005/12/31
Undefined value: 9.999E+20

This simulation was forced by a combination of NOAA/GDAS atmospheric analysis fields, spatially and temporally disaggregated NOAA Climate Prediction Center Merged Analysis of Precipitation (CMAP) fields, and observation based downward shortwave and longwave radiation fields derived using the method of the Air Force Weather Agency's AGRicultural METeorological modeling system (AGRMET).

The simulation was initialized on 1 January 1979 using soil moisture and other state fields from a GLDAS/Noah model climatology for that day of the year.

Reading the files: WGRIB or other GRIB reader is required. The GrADS control file pasted at the bottom provides a list of the forcing variables with a key to the kpds arrays. Sample control files are found in GrADSctl directory at the FTP server.

Variables:
```
evap     * surface Total Evapotranspiration      kg/m^2/s
qs       * Surface Runoff                        kg/m^2/s
qsb      * Subsurface Runoff                     kg/m^2/s
qsm      * surface Snowmelt                      kg/m^2/s
rainf    * surface Rainfall rate                 kg/m^2/s
snowf    * surface Snowfall rate                 kg/m^2/s
canopint * surface Total canopy water storage    kg/m^2
swe      * surface Snow Water Equivalent         kg/m^2
soilm1   * layer 1 soil moisture                 kg/m^2
soilm2   * layer 2 soil moisture                 kg/m^2
soilm3   * layer 3 soil moisture                 kg/m^2
soilm4   * layer 4 soil moisture                 kg/m^2
```

Notes:

1) The correct depths of the four soil layers are 0-10 cm, 10-40 cm, 40-100 cm, and 100-200 cm. The generic grib table may define them differently.
2) Due to the fact that forcing data for Greenland are unreliable and the lack of a glacier/ice sheet model in Noah, snow water equivalent accumulates indefinitely in Greenland and a few other Arctic points. Therefore it is highly recommended that Greenland and other points with abnormally large SWE be masked out when performing global analyses.
3) Total precipitation will be the sum of rainf and snowf.
4) Total runoff will be the sum of subsurface runoff (qsb) and surface runoff (qs).
5) The daily mean is created by averaging 3-hourly GLDAS outputs (8 per day). To get daily accumulation of total precipitation on Jan 1, 2005, for example,

   total_prec(jan1) = (rainf(jan1)+snowf(jan1)) * 3600{sec/hr} * 24{hr/day}

6) The generic grib table may incorrectly identify Snowf as LFTX, Rainf as 4LFTX, and Canopint as TCDC. The KPDS 5-7 values for Snowf (and LFTX) are 131, 1, 0, for Rainf (and 4LFTX) are 132, 1, 0, and for Canopint (and TCDC) are 71,1,0.

Sample GrADS control file:

```
dset ^gldas.%y4%m2.dave.rainf.noah.grb
index ^gldas.dave.rainf.noah.grb.idx
undef 9.999E+20
options template
title Daily average Rain forcing field
*  produced by grib2ctl v0.9.12.5p32l
dtype grib 0
ydef 600 linear -59.875000 0.25
xdef 1440 linear -179.875000 0.250000
tdef 396 linear 00Z01dec2004 1dy
zdef 1 linear 1 1
vars 1
Rainfsfc  0 132,1, 0  ** surface Rainfall rate  kg/m^2/s
ENDVARS
```

Questions/Comments: hkato@hsb.gsfc.nasa.gov , Matthew.Rodell@nasa.gov

Reference:

Rodell, M., P. R. Houser, U. Jambor, J. Gottschalck, K. Mitchell, C.-J. Meng, K. Arsenault, B. Cosgrove, J. Radakovich, M. Bosilovich, J. K. Entin, J. P. Walker, D. Lohmann, and D. Toll, The Global Land Data Assimilation System, Bull. Amer. Meteor. Soc., 85 (3), 381-394, 2004.