

North American Land Data Assimilation System (NLDAS)

Adapted from slides prepared by
Mike Wimberly on 12/30/2014

North American Land Data Assimilation System

- A Land Data Assimilation System (LDAS) consisting of land-surface models forced with observations
- NASA Homepage
 - More up to date
 - <http://ldas.gsfc.nasa.gov/index.php>
- NOAA Homepage
 - Most material is out of date, but contains links to near-real-time drought monitoring products and forecasts
 - <http://www.emc.ncep.noaa.gov/mmb/nldas/>

NLDAS Phases

- NLDAS 1
 - August 1996 – December 2007
 - Mitchell, Kenneth E., 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. Journal of Geophysical Research: Atmospheres 109.D7.
 - Cosgrove, Brian A., et al. (2003) Real-time and retrospective forcing in the North American Land Data Assimilation System (NLDAS) project. Journal of Geophysical Research: Atmospheres 108.D22.
- NLDAS 2
 - January 1979 – Present
 - Xia, Youlong, et al. (2012) Continental-scale water and energy flux analysis and validation for the North American Land Data Assimilation System project phase 2 (NLDAS-2): 1. Intercomparison and application of model products. Journal of Geophysical Research: Atmospheres 117.D3.
 - Xia, Youlong, 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. Journal of Geophysical Research: Atmospheres 117.D3.
 - Overview presentation for NLDAS-2:
 - <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20130013084.pdf>

NLDAS-2 Specifications

- Projection: Geographic with WGS84 datum
- 0.125 degree grid
- Hourly time step
 - NASA also aggregates these hourly data to generate monthly products available from GES DISC
- Relatively short latency (3-4 days)
- Cells with no data have a value of 9999
- All cells over land should have data – missing data indicates water

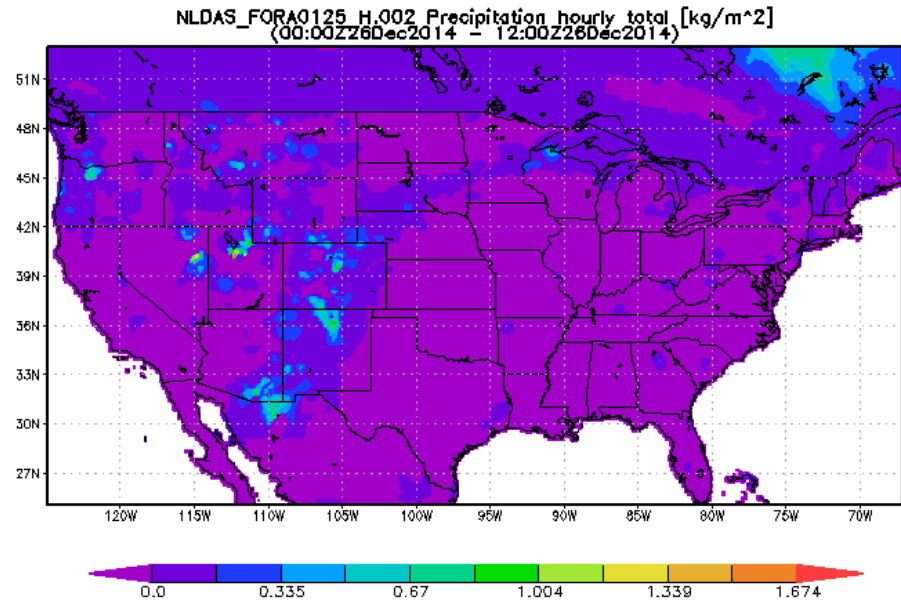
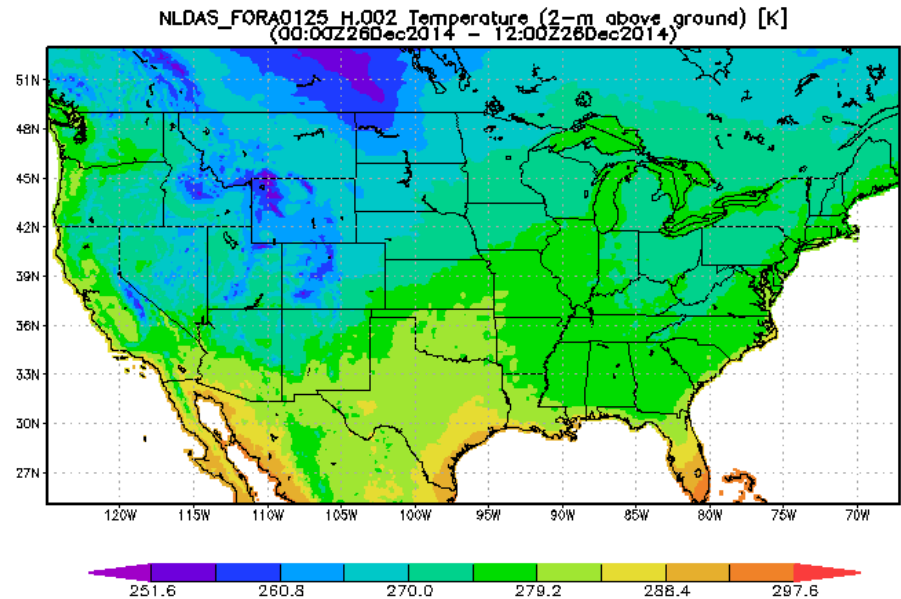
NLDAS-2 Forcings

- Precipitation
 - NCEP/CPC daily gauge-based precipitation
 - <http://data.eol.ucar.edu/codiac/dss/id=21.095>
 - Incorporates parameter-elevation regressions on independent slopes model (PRISM) to correct for orographic effects
 - Various other sources of data are used to interpolate to 1-hour estimates
- Wind, Temperature, Humidity, Radiation
 - North American Regional Reanalysis (NARR)
 - Assimilates a variety of weather observations using a dynamic weather model
 - <http://www.emc.ncep.noaa.gov/mmb/rrean/>
 - Downscaled and bias corrected for NLDAS
- Also see:
 - <http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20130013084.pdf>

NLDAS-2 Primary Forcing Fields ("FORA" Dataset)

- [61:APCPsfc:Precipitation hourly total \[kg/m²\]](#)
- 157:CAPE180_0mb:180-0 mb above ground Convective Available Potential Energy [J/kg]
- 153:CONVfracfc:Fraction of total precipitation that is convective [unitless]
- 205:DLWRFsfc:Longwave radiation flux downwards (surface) [W/m²]
- 204:DSWRFsfc:Shortwave radiation flux downwards (surface) [W/m²]
- 228:PEVAPsfc:Potential evaporation hourly total [kg/m²]
- 1:PRESsfc:Surface pressure [Pa]
- [51:SPFH2m:2-m above ground Specific humidity \[kg/kg\]](#)
- [11:TMP2m:2-m above ground Temperature \[K\]](#)
- 33:UGRD10m:10-m above ground Zonal wind speed [m/s]
- 34:VGRD10m:10-m above ground Meridional wind speed [m/s]

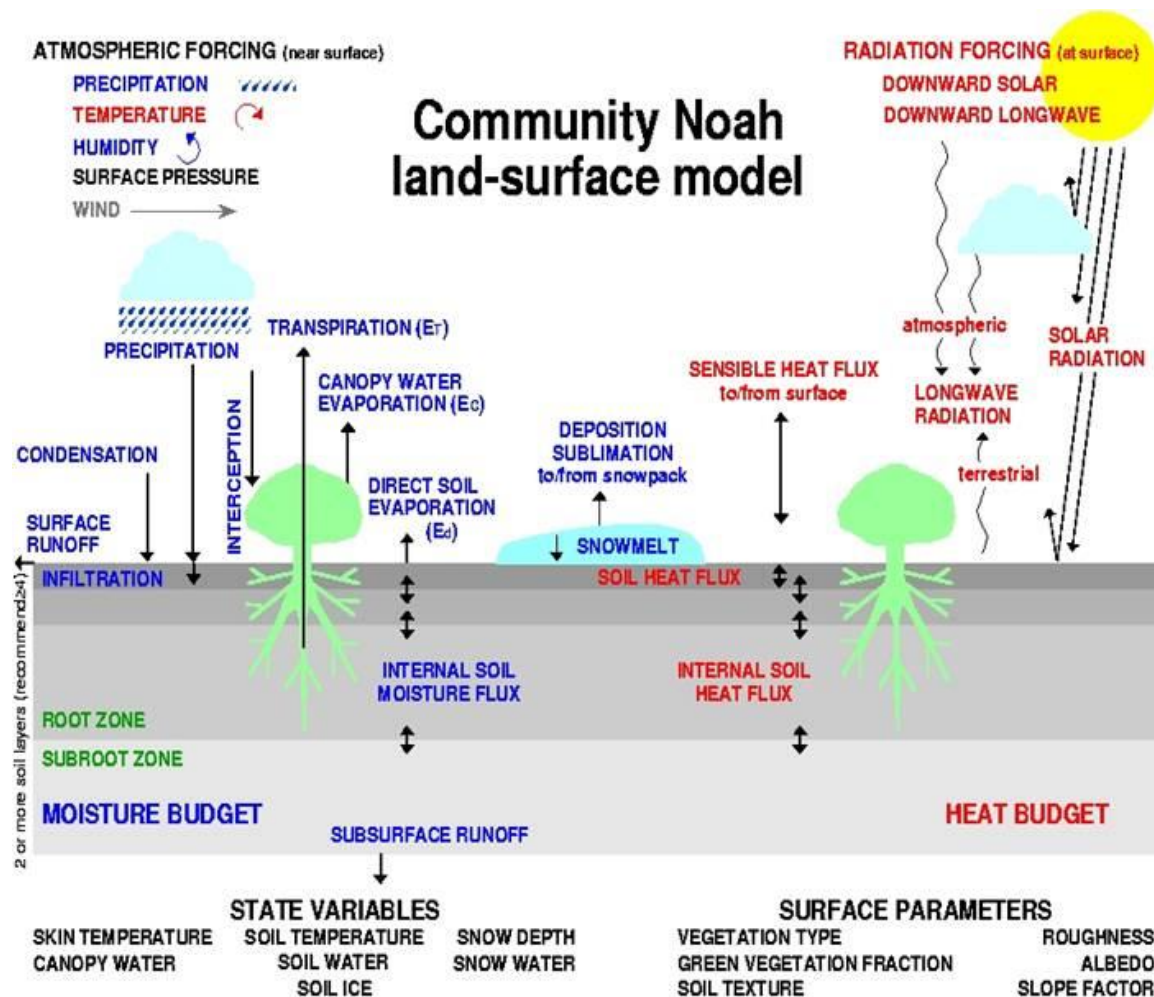
Daily summaries of
NLDAS forcing data. Air
temperature (2-m above
ground) and precipitation
for December 26, 2014.



NLDAS-2 Land Models

- Macroscale models that simulate land surface water and energy balance
- Implemented in NLDAS
 - [NOAH](#)
 - Mosaic
 - Sacramento Soil Moisture Accounting (SAC)
 - Variable Infiltration Capacity (VIC)

NLDAS-2 Land Surface Models



<ftp://ftp.emc.ncep.noaa.gov/mmb/gcp/ldas/noahlsn>

NOAH LSM Model Outputs

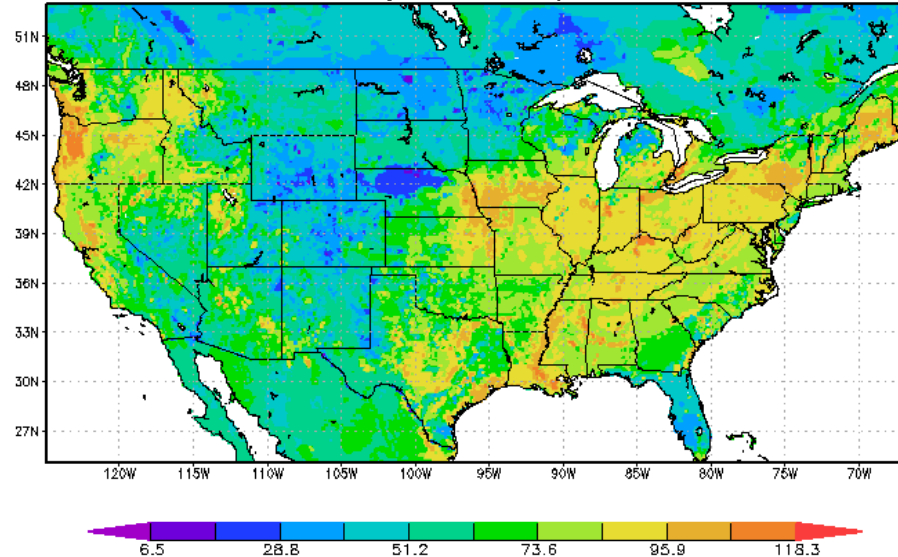
- 179:ACOND:Aerodynamic conductance [m/s]
- 84:ALBDO:Albedo [%]
- 162:ARAIN:Rainfall (unfrozen precipitation) [kg/m²]
- 161:ASNOW:Snowfall (frozen precipitation) [kg/m²]
- 148:AVSFT:Average surface skin temperature [K]
- 234:BGRUN:Subsurface runoff (baseflow) [kg/m²]
- 181:CCOND:Canopy conductance [m/s]
- 223:CNWAT:Plant canopy surface water [kg/m²]
- 205:DLWRF:Longwave radiation flux downwards (surface) [W/m²]
- 204:DSWRF:Shortwave radiation flux downwards (surface) [W/m²]
- 199:EVBS:Direct evaporation from bare soil [W/m²]
- 200:EVCW:Canopy water evaporation [W/m²]
- 57:EVP:Total evapotranspiration [kg/m²]
- 155:GFLUX:Ground heat flux [W/m²]
- 182:LAI:Leaf area index (0-9) [unitless]
- 121:LHTFL:Latent heat flux [W/m²]
- [151:LSOIL0 10cm:0-10 cm Liquid soil moisture content \(non-frozen\) \[kg/m²\]](#)
- [151:LSOIL10 40cm:10-40 cm Liquid soil moisture content \(non-frozen\) \[kg/m²\]](#)
- [151:LSOIL40 100cm:40-100 cm Liquid soil moisture content \(non-frozen\) \[kg/m²\]](#)
- [151:LSOIL100 200cm:100-200 cm Liquid soil moisture content \(non-frozen\) \[kg/m²\]](#)
- 207:MSTAV:Moisture availability [%]
- 112:NLWRS:Longwave radiation flux net (surface) [W/m²]
- 111:NSWRS:Shortwave radiation flux net (surface) [W/m²]
- 145:PEVPR:Potential evaporation rate [W/m²]
- 248:RCQ:Humidity parameter in canopy conductance [fraction]
- 246:RCS:Solar parameter in canopy conductance [fraction]

NOAH LSM Model Outputs

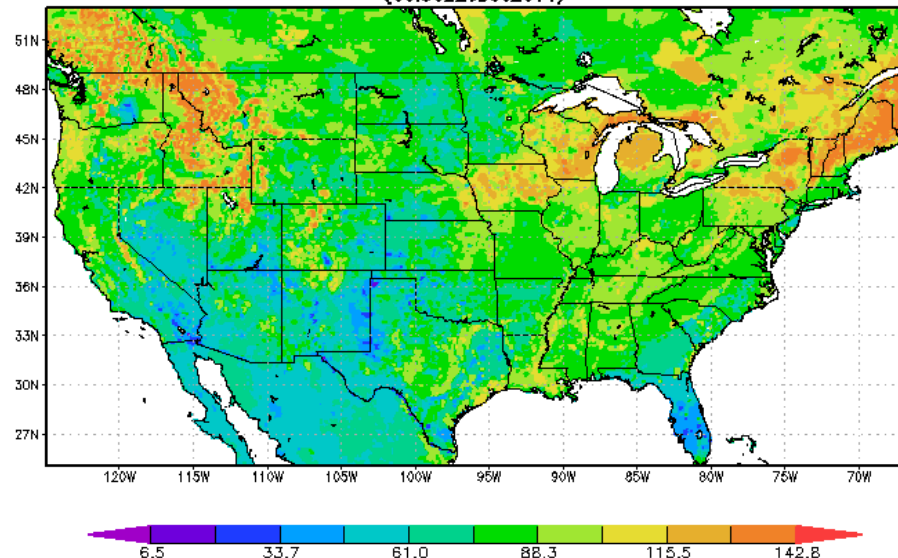
- 249:RCSOL:Soil moisture parameter in canopy conductance [fraction]
- 247:RCT:Temperature parameter in canopy conductance [fraction]
- 255:RSMACR:Relative soil moisture availability control factor [0-1]
- 203:RSMIN:Minimal stomatal resistance [s/m]
- 250:RZSMrzl:Root zone soil moisture content[kg/m²]
- 198:SBSNO:Sublimation (evaporation from snow) [W/m²]
- 122:SHTFL:Sensible heat flux [W/m²]
- [66:SNOD:Snow depth \[m\]](#)
- 229:SNOHF:Snow phase-change heat flux [W/m²]
- 99:SNOM:Snow melt [kg/m²]
- [238:SNOWC:Snow cover \[fraction\]](#)
- 86:SOILM0_10cm:0-10 cm layer 1 Soil moisture content [kg/m²]
- 86:SOILM0_100cm:0-100 cm top 1 meter Soil moisture content [kg/m²]
- 86:SOILM0_200cm:0-200 cm total column Soil moisture content [kg/m²]
- 86:SOILM10_40cm:10-40 cm layer 2 Soil moisture content [kg/m²]
- 86:SOILM40_100cm:40-100 cm layer 3 Soil moisture content [kg/m²]
- 86:SOILM100_200cm:100-200 cm layer 4 Soil moisture content [kg/m²]
- 235:SSRUN:Surface runoff (non-infiltrating) [kg/m²]
- 210:TRANS:Transpiration [W/m²]
- [85:TSOIL0_10cm:0-10 cm Soil temperature \[K\]](#)
- [85:TSOIL10_40cm:10-40 cm Soil temperature \[K\]](#)
- [85:TSOIL40_100cm:40-100 cm Soil temperature \[K\]](#)
- [85:TSOIL100_200cm:100-200 cm Soil temperature \[K\]](#)
- 87:VEG:Vegetation [fraction]
- 65:WEASD:Accumulated snow water-equivalent [kg/m²]

Daily summaries of
NLDAS NOAH LSM
outputs. Liquid soil
moisture content (10-40
cm) and total soil
moisture total (10-40 cm)
for December 26, 2014

NLDAS_NOAH0125_H.002 Liquid soil moisture content (layer 2, 10-40 cm, non-frozen) [kg/m²]
(00:00Z26Dec2014)



NLDAS_NOAH0125_H.002 Soil moisture content (layer 2, 10-40 cm) [kg/m²]
(00:00Z26Dec2014)



NLDAS Applications

- Drought monitoring
 - <http://www.emc.ncep.noaa.gov/mmb/nldas/drought/>
- Seasonal hydrological prediction
 - <http://www.emc.ncep.noaa.gov/mmb/nldas/forecast/TSM/>
- Weather and climate forecasting
- Land-hydrology research
- Climate and hydrological variables for analyses of climatic variations and their effects

Data Access – Goddard Earth Sciences Data and Information Services Center (GES DISC)

DATA HOLDINGS

IMPORTANT MESSAGE Sep 13, 2012
[NLDAS and GLDAS User Mailing List: `ldas-users@lists.nasa.gov`](#)

IMPORTANT MESSAGE Oct 10, 2014 NLDAS-2 near real-time data stream at NASA GES DISC has been restored.
 Near real-time updates of NLDAS-2 datasets at the NASA GES DISC have been restored. [Read More.....](#)

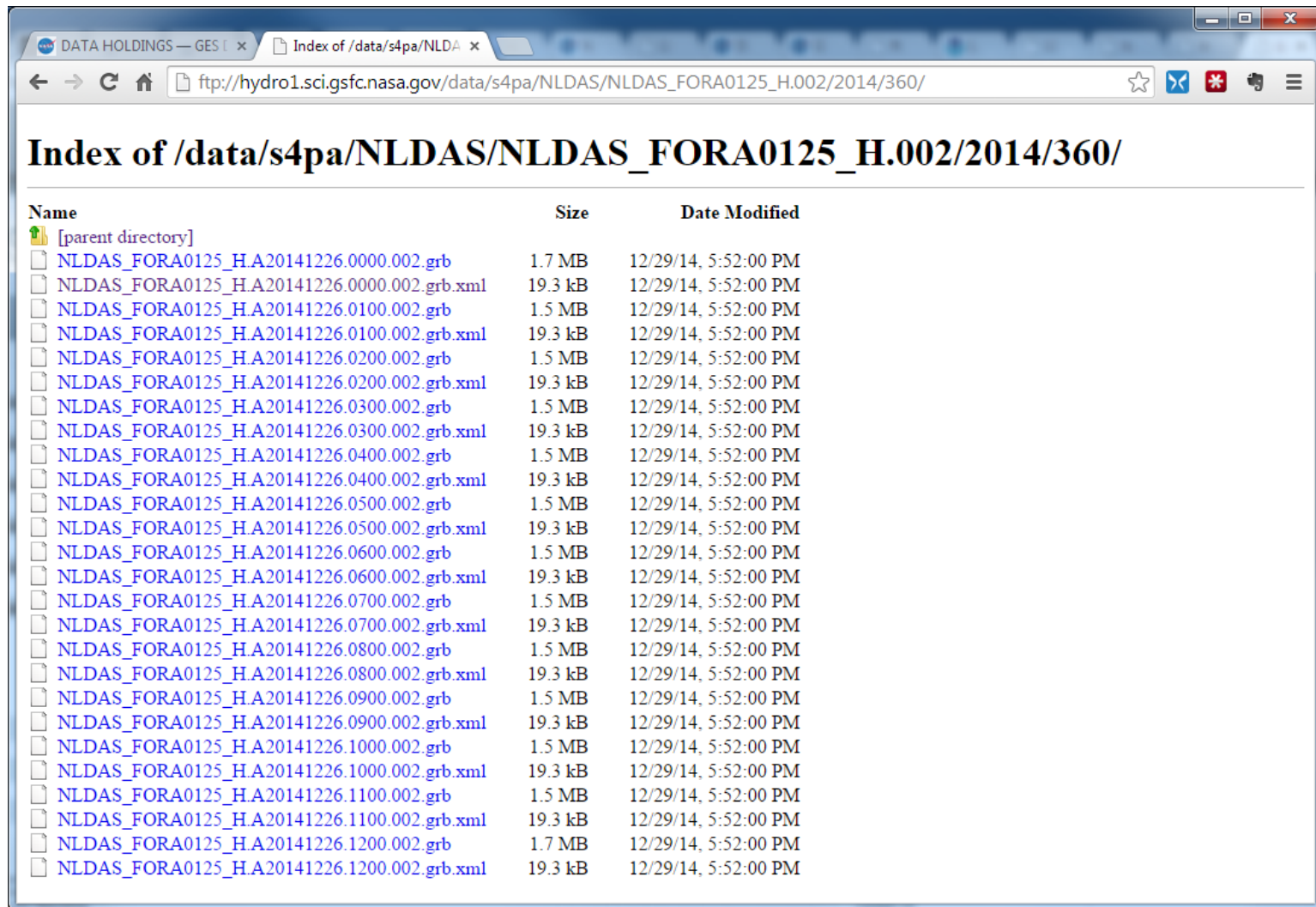
Data Information
 Current data hosted at HDISC include outputs from a series of land surface models in the Land Data Assimilation System (LDAS). Users can access the hourly 1/8th degree product for North America (NLDAS) or the 3-hourly 0.25 and 1.0 degree products globally (GLDAS). The files are in GRIB format. The static parameter data used by the LDAS models are available from the GSFC Land Information System.

Data Access

	Data Type (Short Name)	Description	FTP	GD\$	Mirador	Giovanni*	SSW**
					Navigation	Search	
NLDAS-1, 0.125 degree, North America (NLDAS-1 README)							
Hourly	NLDAS_FOR0125_H.001	Forcing	✓	✓	✓	✓	✓
Monthly	NLDAS_FOR0125_M.001	Forcing	✓	✓	✓	✓	✓
Monthly Climatology	NLDAS_FOR0125_MC.001	Forcing	✓	✓	✓	✓	✓
NLDAS-2, 0.125 degree, North America (NLDAS-2 README)							
Hourly	NLDAS_FORA0125_H.002	Primary forcing	✓	✓	✓	✓	✓
	NLDAS_FORB0125_H.002	Secondary forcing	✓	✓	✓	✓	✓
	NLDAS_MOSA0125_H.002	Mosaic Model	✓	✓	✓	✓	✓
	NLDAS_NOAH0125_H.002	Noah Model	✓	✓	✓	✓	✓
Monthly	NLDAS_VIC0125_H.002	VIC Model	✓	✓	✓	✓	✓
	NLDAS_FORA0125_M.002	Primary forcing	✓	✓	✓	✓	✓
	NLDAS_FORB0125_M.002	Secondary forcing	✓	✓	✓	✓	✓
	NLDAS_MOSA0125_M.002	Mosaic Model	✓	✓	✓	✓	✓
	NLDAS_NOAH0125_M.002	Noah Model	✓	✓	✓	✓	✓
Monthly Climatology	NLDAS_VIC0125_M.002	VIC Model	✓	✓	✓	✓	✓
	NLDAS_FORA0125_MC.002	Primary forcing	✓	✓	✓	✓	✓
	NLDAS_FORB0125_MC.002	Secondary forcing	✓	✓	✓	✓	✓
	NLDAS_MOSA0125_MC.002	Mosaic Model	✓	✓	✓	✓	✓
Monthly Climatology	NLDAS_NOAH0125_MC.002	Noah Model	✓	✓	✓	✓	✓
	NLDAS_VIC0125_MC.002	VIC Model	✓	✓	✓	✓	✓

- <http://disc.sci.gsfc.nasa.gov/hydrology/data-holdings>

GES DISC FTP site



DATA HOLDINGS — GES x Index of /data/s4pa/NLDA x

ftp://hydro1.sci.gsfc.nasa.gov/data/s4pa/NLDAS/NLDAS_FORA0125_H.002/2014/360/

Index of /data/s4pa/NLDAS/NLDAS_FORA0125_H.002/2014/360/

Name	Size	Date Modified
[parent directory]		
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NLDAS_FORA0125_H.A20141226.1200.002.grb	1.7 MB	12/29/14, 5:52:00 PM
NLDAS_FORA0125_H.A20141226.1200.002.grb.xml	19.3 kB	12/29/14, 5:52:00 PM

README File: ftp://hydro1.sci.gsfc.nasa.gov/data/s4pa/NLDAS/NLDAS_FORA0125_H.002/doc/README.NLDAS2.pdf

Giovanni

DATA HOLDINGS — GES | x Giovanni - North America x

gdata1.sci.gsfc.nasa.gov/daac-bin/G3/gui.cgi?instance_id=NLDAS0125_H

NASA National Aeronautics and Space Administration

Giovanni - The Bridge Between Data and Science

+ ABOUT GIOVANNI + NEWS + INSTANCES + FEEDBACK + RELEASE NOTES + HELP

North American Land Data Assimilation System (NLDAS)
0.125 degree Hourly Products

Home Remove All

North American Land Data Assimilation System (NLDAS) is generating a series of land surface forcing (e.g. precipitation, surface meteorology and radiation), state (e.g., soil moisture and temperature, and snow), and flux (e.g., evaporation and sensible heat flux) products simulated by four land surface models (SAC, Mosaic, Noah and VIC).

Current data holdings include a set of 0.125 degree resolution data products from forcing data and Mosaic model, covering 1979 to the present. This instance focuses on NLDAS Phase 1 and Phase 2 0.125 degree hourly products.

Select:

Spatial

Cursor Coordinates: -106.42500, 61.37812

Area of Interest: West: -125 North: 53 South: 25 East: -67 Update Map

Parameters

Display: ☒ Data Product Info ☐ Units

NLDAS Phase 1

☐ NLDAS-1 Forcing (0.125x0.125 degree) (1996/08/01 - 2007/12/31)

Parameter	Data Product Info
<input type="checkbox"/> Convective Available Potential Energy	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31
<input type="checkbox"/> PAR Photosynthetically Active Radiation from GOES-UMD Pinker	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31
<input type="checkbox"/> Precipitation hourly total	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31
<input type="checkbox"/> Precipitation hourly total (convective)	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31
<input type="checkbox"/> Precipitation hourly total from EDAS	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31
<input type="checkbox"/> Precipitation hourly total from Stanell	NLDAS_FOR0125_H.001 Forcing 1996/08/01 - 2007/12/31

NLDAS Phase 2

☐ NLDAS-2 Primary Forcing (0.125x0.125 degree) (1979/01/01 - 2014/12/26)

Parameter	Data Product Info
<input type="checkbox"/> Convective Available Potential Energy (180-0 mb above ground)	NLDAS_FOR0125_H.002 Primary Forcing 1979/01/01 - 2014/12/26
<input type="checkbox"/> Potential evaporation	NLDAS_FOR0125_H.002 Primary Forcing 1979/01/01 - 2014/12/26

File Formats

- GRIdded Binary (GRIB) format
- Files on GES DISC are in GRIB-1 format
- Files from NCEP are in GRIB-2 format (I think)
- Should be able to read these formats with GDAL
- Ordering of data layers (bands) is tricky
 - This appears to be the correct order for the forcing dataset
 - <http://www.nco.ncep.noaa.gov/pmb/products/nldas/nldas.t12z.force-a.grb2f00.shtml>
 - And this should be the correct order for the NOAH model outputs (not sure – need to check)
 - <http://www.nco.ncep.noaa.gov/pmb/products/nldas/noah.t12z.grbf00.shtml>

Incorporating NLDAS into EASTWeb

- Variables (users can select from this list)
 - Mean Daily Air Temperature – Degrees C
 - Maximum Daily Air Temperature – Degrees C
 - Minimum Daily Air Temperature – Degrees C
 - Accumulated heating degree days (Air Temperature) – Degrees C
 - Accumulated freezing degree days (Air Temperature) – Degrees C
 - Mean Daily Specific Humidity –kg/kg
 - Total Daily Precipitation – mm
-
- Mean Daily Snow Depth - m
 - Mean Daily Snow Cover - proportion
 - Mean Daily volumetric liquid soil moisture (non-frozen) (0-10 cm) – proportion
 - Mean Daily volumetric liquid soil moisture (non-frozen) (10-40 cm) – proportion
 - Mean Daily volumetric liquid soil moisture (non-frozen) (40-100 cm) – proportion
 - Mean Daily volumetric liquid soil moisture (non-frozen) (100-200 cm) –proportion
 - Mean Daily Soil Temperature (0-10 cm) – Degrees C
 - Mean Daily Soil Temperature (10-40 cm) – Degrees C
 - Mean Daily Soil Temperature (40-100 cm) – Degrees C
 - Mean Daily Soil Temperature (100-200 cm) – Degrees C

Forcing

Noah

Entries in blue will require a unit conversion

Heating and freezing degree days require additional parameters

- Start date for calculating the indices (day of year)
- Degree-day threshold (degrees Celsius)

Heating Degree-Day Algorithm

- On the start day ($t=0$), GDD_t or FDD_t is reset to zero
- Heating/Cooling degree threshold = T_{crit}
- Mean daily air temperature = T
- $GDD_{t+1} = GDD_t + \text{ifelse}(T_{t+1} > T_{crit}, T_{t+1} - T_{crit}, 0)$
- $CDD_{t+1} = CDD_t + \text{ifelse}(T_{t+1} < T_{crit}, T_{crit} - T_{t+1}, 0)$

Summarizing daily variables to coarser temporal resolutions

- Precipitation – sum
- All other variables - mean