Introduction

2011 was marked as one of the most extreme years in recent history. Over the course of the year, weather-related extreme events, such as floods, heat waves, blizzards, tornadoes, and wildfires, caused tremendous loss of human life and property. The North American Land Data Assimilation System (NLDAS) data set, with high spatial and temporal resolutions (0.25° x 0.25°), hourly and various weather- and energy-related variables, is an excellent data source for case studies of extreme events. This presentation illustrates some extreme events from 2011 in North America, including the Groundhog Day Blizzard, the July heat wave, Hurricane Irene, and Tropical Storm Lee, all utilizing NLDAS Phase 2 (NLDAS-2) data.

Groundhog Day Blizzard

The first billion-dollar disaster of 2011 was a large winter storm that impacted the north central, eastern, and northeastern states, with total losses greater than $1.8 billion.

Figure 5. Snow Cover map (above-left, NLDAS-2 Mosaic averaged from Jan 29 to Feb. 3, 2011) of the Groundhog Day Blizzard shows most US regions covered by snow, with high percentage (>80%) over center-north USA.

Hurricane Irene

Hurricane Irene, as it moved northward along the East Coast of the United States from the Caribbean Sea through New England, brought tremendous rainfall and wind and caused at least 45 deaths and more than $7.3 billion in damages.


Tropical Storm Lee

Tropical Storm Lee poured huge amounts of water on the top of the already saturated Northeast and again inundated many inland cities, causing at least 21 deaths and more than $1.0 billion in damages.

Figure 14. Area-averaged time series of hourly Precipitation (right-bottom, NLDAS-2 Primary Forcing) for the three heavy rain regions depicted by the boxes in Figure 13 shows clearly when the heaviest rain started and ended.

Extreme Weather 2011


Billions-dollar Disasters of 2011

Table 1. List of 14 billion-dollar disasters 2011 (above-right).

How does 2011 compare to other years?

Figure 2. 1980-2011 billion dollar weather/climatic disasters. (Courtesy: NOAA).

Figure 4. January monthly-averaged Surface Skin Temperature differences (right, NLDAS-2 Mosaic) between 2012 and 2011. For most of the middle and eastern U.S. regions, Jan. 2012 average temperatures were 3-5 degrees higher than Jan. 2011 average temperatures, with temperature differences greater than 5 degrees for South Dakota, Nebraska, Iowa, Mississippi, Alabama, and Georgia.

Figure 7. July 2011 Monthly-averaged Surface Temperatures (above-left, NLDAS-2 Primary Forcing) averaged over the central United States) shows the daily cycle and the increasing daily lows and highs. More than 20 days in July 2011 had area-averaged daily highs above 100°F (38°C, red line).

Figure 8. Hourly Surface Temperatures (above-right, NLDAS-2 Primary Forcing) for 21 Jul 2011 shows that large areas over Texas, Oklahoma, and Missouri had temperatures above 120°F (49°C).

Figure 9. July 2011 time series of hourly Surface Temperature (left, NLDAS-2 Primary Forcing, averaged over the central United States) shows the daily cycle and the increasing daily lows and highs. More than 20 days in July 2011 had area-averaged daily highs above 100°F (38°C, red line).

Figure 11. Soil Moisture of Aug 14, 2011 (above-right, NLDAS-2 Mosaic) shows high soil moisture content centered on New York correspondently.

Figure 12. Coastal Temperature Differences of Aug 14, 2011 (above-left, NLDAS-2 Mosaic) shows cold water temperatures around the New England coast.

Figure 15. Time series of precipitation and soil moisture (left, NLDAS-2 Primary Forcing and Mosaic, averaged over the three heavy rain regions depicted by the boxes in Figure 13) shows the persistence of high soil moisture content, after the heavy rains from Tropical Storm Lee have contributed to flash flooding in many areas. An hourly animation of precipitation can show the heavy rain rates and locations hour by hour and such animation can be generated via Giovanni NOAA Hourly Portal without having to download any data.

Figure 16. Tropical Storm Lee, as it moved northward along the East Coast of the United States from the Caribbean Sea through New England, bringing tremendous rainfall and wind and caused at least 45 deaths and more than $7.3 billion in damages.

Figure 17. Aerosol Optical Depth of Aug 2011 (above-left, NLDAS-2 Mosaic) shows high aerosol optical depth centered on New York correspondently.

NLDAS Data and Access

NLDAS data are available from the Hydrology Data and Information Services Center (HDISC) at the NOAA GSM GES DISC, http://disc.gsfc.nasa.gov/hydrology

Four ways to access the data

- Parameter and spatial subsetting
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Table 2. List of four billion-dollar disasters 2011.

Figure 1. Spatial distribution (above-left) of billion-dollar disasters 2011.

Figure 3. Time series of hourly Snow Cover (NLDAS-2 Mosaic, averaged over 125°W-87°W, 25°N-49°N) shows the Dec 2011 to Jan 2012 snow cover (black line) much less than that of Dec 2010 to Jan 2011 (green line).

Figure 6. Snow Water-equivalent (above-right, NLDAS-2 Mosaic, averaged over 25°N-60°N, 100°W-150°W) of the Groundhog Day Blizzard. Snow Water-equivalent is one of the variables for monitoring drought and flood during winter.

Other snow related variables from NLDAS-2 Mosaic model outputs (right).

- Snow fall (frozen precipitation)
- Snow cover
- Snow depth
- Snow melt
- Snow phase-change heat flux
- Accumulated snow water-equivalent
- Sublimation (evaporation from snow)
- Albedo
- Surface temperature

Figure 9. July 2011 time series of hourly Surface Temperature (left, NLDAS-2 Primary Forcing, averaged over the central United States) shows the daily cycle and the increasing daily lows and highs. More than 20 days in July 2011 had area-averaged daily highs above 100°F (38°C, red line).

Figure 11. Hourly precipitation of 132 Aug. 28, 2011 (above-middle, NLDAS-2 Primary Forcing) shows the rainfall at the time in New York, with rain rates greater than 25 mm per hour.

Figure 12. Soil Moisture of Aug 14, 2011 (above-right, NLDAS-2 Mosaic) shows high soil moisture content centered on New York correspondently.

Summary

- To date, NLDAS has generated more than 33 (1979–present) years of data. These quality-controlled, spatially and temporally consistent, terrestial hydrologic datasets could help an important role in characterizing the spatial and temporal variability of water and energy cycles and, thereby, improve our understanding of the land-surface-atmosphere interaction and the impact of land-surface processes on climate extremes.
- Using NLDAS 2 Primary Forcing and Mosaic model data, four of the 2011 billion-dollar weather/climate disasters are illustrated. NLDAS-2 data show very well the major characteristics of these extreme events, spatially and temporally.
- NLDAS-2 is an excellent data source for case studies of extreme events.
- NLDAS data are available from the Hydrology Data and Information Services Center (HDISC) at the NASA GSM GES DISC, http://disc.gsfc.nasa.gov/hydrology
- Giovanni NLDAS Hourly Portal provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data.
- NLDAS data sets have been made available via the Giovanni NLDAS Hourly Portal.

Giovanni is a Web-based application developed by the Geophysical Data Disk Center (GDDC) that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data.

NLDAS is a collaboration project among several groups (NOAA/NCEP/EMC, NASA/GSFC, Princeton University, University of Washington, NOAA/CIRES, and NOAA/NCEP/CPC) and is a core project of NOAA/MAPP.


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