

GRACE-assimilated drought indicators, with improved spatial and temporal resolutions, should provide a more comprehensive and objective identification of drought conditions.

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Introduction

The Gravity Recovery and Climate Experiment (GRACE) mission detects changes in Earth's gravity field, by precisely monitoring the changes in distance between two satellites orbiting the Earth in tandem. Scientists at NASA's Goddard Space Flight Center generate GRACE-assimilated groundwater and soil moisture drought indicators each week, for drought monitor-related studies and applications. The GRACE-assimilated Drought Indicator Version 2.0 data product (GRACE-DA-DM V2.0) is archived at, and distributed by, the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC).

Basic Characteristics

Table 1. Basic Characteristics of GRACE-Assimilated Data

Spatial Coverage	25°N to 53°N, 125°W to 67°W
Spatial resolution	1/8 th degree
Temporal resolution	Daily, archived one day (Monday) per week
Temporal coverage	2002/04/01 to 2017/08/28 (will be extended)
Dimension	224 (lat) x 464 (lon)
Land surface models	Catchment Land Surface Model (LSM) Fortuna 2.5
Format	NetCDF-4
Forcing data	NLDAS Phase 2 (NLDAS-2)

What is new in the GRACE-DA-DM V2.0 data

- Based on the Catchment Land CLSM Fortuna 2.5 version simulation.
- Created by the Land Information System (LIS) data assimilation framework.
- Used the latest gridded GRACE solutions, at 0.5 degree resolution, from the University of Texas at Austin. Version 1.0, in contrast, was created by the stand-alone CLSM (an older version), using the GRACE-Tellus 1-degree data (CSR) from NASA's Jet Propulsion Laboratory (JPL).
- Gridded data assimilation in Version 2.0 (Kumar et al., 2016); whereas, basin average data assimilation was used in Version 1.0.
- Upgraded the Data Assimilation (DA) and increased bedrock depth by 3 meters, to enhance the drought indicator calculations.

DOI for the GRACE Assimilated 2.0 data product: [10.5067/ASNKR4DD9AMW](https://doi.org/10.5067/ASNKR4DD9AMW)



NASA Land Information System (LIS): <https://lis.gsfc.nasa.gov>

The LIS is a software framework for high performance terrestrial hydrology modeling and data assimilation.

NASA LIS twitter feed: https://twitter.com/NASA_LIS

Earthdata Login system

Access to GES DISC data requires all users to be registered with the Earthdata Login system. Data continue to be free of charge. Detailed instructions on how to register and receive authorization to access GES DISC data are provided at <https://wiki.earthdata.nasa.gov/display/EL/How+To+Register+With+Earthdata+Login>.

Reference

Kumar, S. V., B. F. Zaitchik, C. D. Peters-Lidard, et al., 2016: Assimilation of gridded GRACE terrestrial water storage estimates in the North American Land Data Assimilation System, *J. Hydrometeorol.*, 17 (7), 1951-1972, doi:10.1175/jhm-d-15-0157.1

Drought Indicators for the U.S. Drought Monitor

The GRACE-Assimilated data contain three drought indicators

- ❖ Groundwater Percentile
- ❖ Root Zone Soil Moisture Percentile
- ❖ Surface Soil Moisture Percentile

These drought indicators are of wet or dry conditions, expressed as a percentile, indicating the probability of occurrence within the period of record from 1948 to 2012.

These GRACE-assimilated drought indicators, with improved spatial and temporal resolutions, should provide a more comprehensive and objective identification of drought conditions. A few figures are presented here to demonstrate a simple way to explore the GRACE-assimilated drought indicator data.

Figures 1 and 2 show good consistency between the GRACE-assimilated Groundwater Percentile and the U.S. Drought Monitor map. Both indicate exceptional drought conditions (less than 15% and D4, respectively), centered on Alabama and southern California.

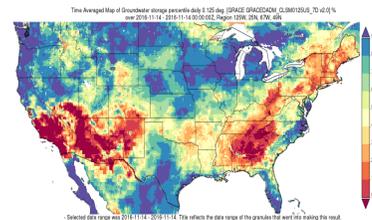


Figure 1. GRACE-assimilated groundwater storage percentile map for Nov. 14, 2016, with lower values (warmer colors) indicating dryer than normal conditions, and higher values (colder colors) indicating wetter than normal conditions. The map was generated by [Giovanni](#).

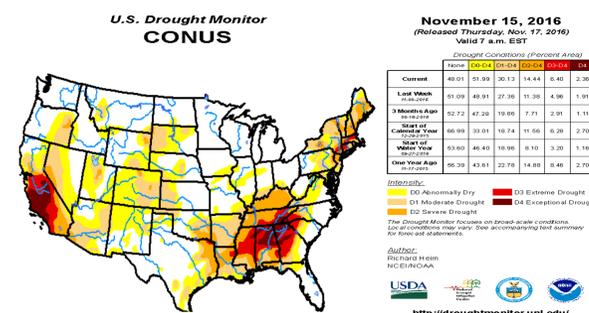


Figure 2. U.S. Drought Monitor Map for Nov. 15, 2016, downloaded from <http://droughtmonitor.unl.edu/Maps/MapArchive.aspx> (on Dec. 20, 2017).

The time series of GRACE-assimilated Groundwater Storage Percentile (Fig. 3) clearly indicates severe drought events in Alabama (the red circles in Fig. 3), for 2002, 2007, 2011 ~ 2012, and 2016. These events are also clearly seen in the time series of Drought Severity Percent Area for Alabama (the green circles in Fig. 4).

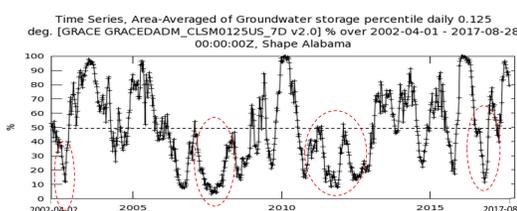


Figure 3. Time series of GRACE-assimilated groundwater storage percentile of Alabama from Apr. 1, 2002 to Aug. 28, 2017, generated by [Giovanni](#) (Time Series of Shape).

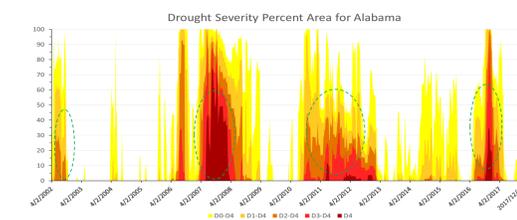
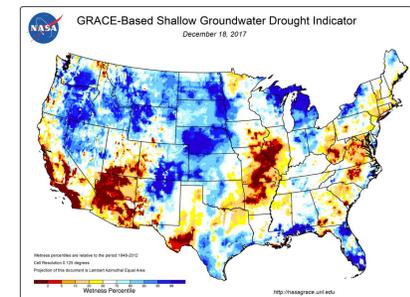


Figure 4. Time Series of Drought Severity Percent Area for Alabama, generated by Excel with the data downloaded from <http://droughtmonitor.unl.edu/Data/DataTables.aspx> (on Dec. 20, 2017).

Real-time GRACE-Assimilated Drought Indicators

Real-time GRACE-Assimilated drought indicators describe **current wet or dry conditions**; therefore, they can be used for drought monitor. The data can be download from <http://nasagrace.unl.edu/> in PNG, PDF, and binary. Maps of different times can also be compared.

Figure 5. Real-time GRACE-assimilated groundwater storage percentile map for Dec. 18, 2017, with lower values (warmer colors) indicating dryer than normal conditions, and higher values (colder colors) indicating wetter than normal conditions. The map was download from <http://nasagrace.unl.edu/> (on Dec. 20, 2017).



Data Access

Data access methods:

- HTTPS download
- OPeNDAP subset and download
- EarthData search and download
- Visualization and analysis



Data Rods Capability

To enhance the access to and use of its data, NASA GES DISC provides "data rods" capability, enabling the access of long-term time series at selected points, to better serve the hydrology community. More information is available at [https://disc.sci.gsfc.nasa.gov/information/tools?title=Hydrology Data Rods](https://disc.sci.gsfc.nasa.gov/information/tools?title=Hydrology+Data+Rods)

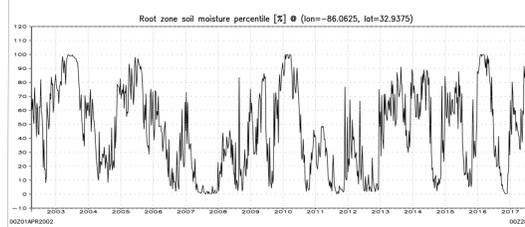


Figure 6. Time series of GRACE-assimilated root zone soil moisture percentile for a grid in Alabama (86.0635W, 32.9375N), from Apr. 1, 2002 to Aug. 28, 2017, downloaded via the Data Rods method.

Summary

- NASA scientists generated GRACE-assimilated drought indicators for drought monitor-related studies and applications.
- GRACE-assimilated groundwater data show good consistency with U.S. Drought Monitor maps and time series.
- GRACE-assimilated drought indicators version 2.0 data are archived at and distributed by NASA GES DISC: http://disc.sci.gsfc.nasa.gov/datacollection/GRACEDADM_CLSM0125US_7D_2.0.html
- Real-time GRACE-Assimilated drought indicators can be downloaded from <http://nasagrace.unl.edu/> in PNG, PDF, and binary.
- NASA scientists are working to generate GRACE-assimilated global data.