

Assimilated Hydrological Data at NASA GES DISC with Examples of Extreme Events

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Open access to hydrological land surface data, including forcing, land surface states and flux fields, and water balance and energy balance variables, from Land Surface Model (LSM) assimilations.

Hualan Rui^{1,2}, Carlee Loeser^{1,2}, Bill Teng^{1,2}, Dana Ostrenga^{1,2}, Jennifer Wei¹, and Bruce Vollmer¹
¹NASA Goddard Space Flight Center, ²ADNET Systems, Inc. Hualan.Rui@nasa.gov

Introduction

NASA and NOAA, based on independent analyses, recently announced that global surface temperatures in 2018 are the fourth warmest since 1880, behind only those of 2016, 2017, and 2015 (nasa.gov). Also in 2018, the United States experienced 14 billion-dollar disasters, ranking as the fourth highest total number of such events, behind only the years 2017, 2011, and 2016 (climate.gov). Many research studies have focused on acquiring observational and modeling data, to reveal linkages between increasing extreme events, global water and energy cycle, and global climate change. However, drawing conclusions is still a challenge. NASA GES DISC (<https://disc.gsfc.nasa.gov/>) is one of twelve NASA Earth Observing System (EOS) data centers that process, archive, document, and distribute data from Earth science missions and related projects. The GES DISC hosts a wide range of remotely-sensed and model data and provides reliable and robust data access and services to users worldwide. This presentation provides a summary table of the hydrological data holdings, recent updates, data access and services; and three examples of extreme event studies that use Land Surface Model (LSM) assimilated, quality-controlled, and spatially and temporally consistent, hydrological data from the GES DISC (<https://disc.gsfc.nasa.gov/datasets?keywords=Hydrology>).

Hydrological Land Surface Data Products

Land Surface Model	Coverage	Temporal						Spatial							
		Latency in days			Resolution			Coverage			Resolution				
		Climateology	Anomaly	1-hour	3-hour	1 day	7 days	1 month	North America	Global Land	Africa	0.1 deg	0.125 deg	0.25 deg	1.0 deg
NLDAS-2	Forcing A	1979-01-01 ~ present	~ 4	X	X	X			X	X			X		
	Forcing B	1979-01-01 ~ present	~ 4	X	X	X			X	X			X		
	Noah	1979-01-02 ~ present	~ 4	X	X	X			X	X			X		
	Mosaic	1979-01-02 ~ present	~ 4	X		X			X	X			X		
	VIC	1979-01-02 ~ present	~ 4	X		X			X	X			X		
NLDAS-1	Forcing	1996-08-01 ~ 2007-12-31							X	X			X		
NCALDAS-2.0	Noah	1979-01-02 ~ 2016-12-31					X						X		
	Noah	1948-01-01 ~ 2010-12-31				X		X					X	X	
GLDAS-2.0	Catchment	1948-01-01 ~ 2014-12-30				X		X					X	X	
	VIC	Coming soon				X							X		
	VIC	Coming soon				X							X		
GLDAS-2.1	Noah	2000-01-01 ~ present	~45			X		X	X	X			X	X	
	Catchment	Coming soon				X		X	X	X			X		
	VIC	Coming soon				X		X	X	X			X		
GLDAS-1	CLM	1979-01-02 ~ present	~45			X		X	X	X			X		
	Mosaic	1979-01-02 ~ present	~45			X		X	X	X			X		
	Noah	1979-01-02 ~ present	~45			X		X	X	X			X		
	VIC	1979-01-01 ~ present	~45			X		X	X	X			X		
GRACEDADM-2.0	Catchment	2002-04-01 ~ 2017-09-03							X				X		
FLDAS-1	Noah	1982-01-01 ~ present	~ 1	X	X		X	X	X	X					
	VIC	1982-01-01 ~ present	~ 1			X		X		X			X		
SMERGE-2.0	Noah-CCI	1979-01-02 ~ 2016-12-31				X		X					X		
LPRM	AMS2	2012-07-03 ~ present	~ 1			X			X						
	AMSRE	2002-06-19 ~ 2011-10-03				X			X				X		
	TMI	1997-12-07 ~ 2015-04-08				X			X				X		
	WINDSAT	2003-02-01 ~ 2012-08-01				X			X				X		

Table 1. Hydrology land surface data products at NASA GES DISC, listed along with spatial & temporal resolution & coverage, and latency.

Data Access and Services

Data Set Landing page provides a detailed description of a data collection, product summary, data citation, access to official documentation, links to available services, and direct access to download the data.

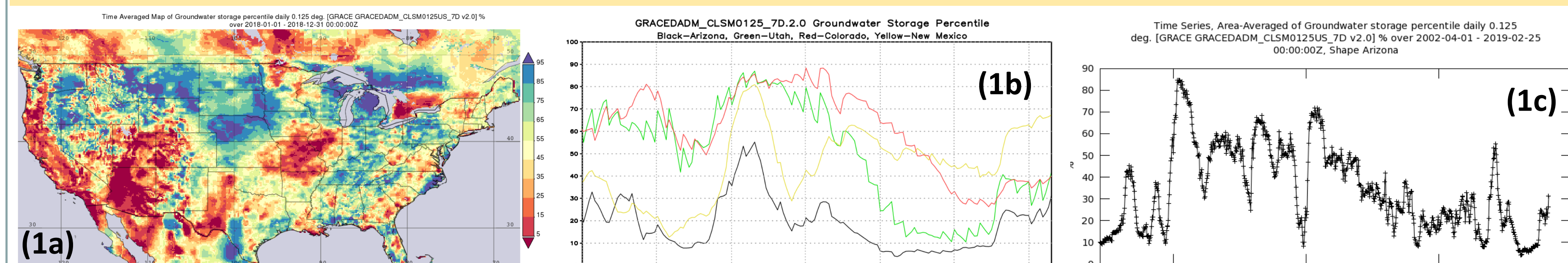
Hydrology Data Set Landing pages: <https://disc.gsfc.nasa.gov/datasets?keywords=Hydrology>

- **HTTPS:** Navigate by data product & date/time and download the data via HTTPS
- **EarthData Search:** Search for and retrieve data sets across multiple data centers
- **Subset & Regrid:** Create variable and spatial (and/or regrided) subsets and download data in various data formats
- **OPeNDAP:** Search, subset, and download data via OPeNDAP
- **GDS:** Subset, analyze, and download data via GrADS Data Server (GDS)
- **Giovanni:** Web-based tool enabling users to interactively visualize and analyze data
- **Data Rods:** View and download long time series of a single data point



Examples of Extreme Events

Intense 2018 Drought in the Four Corners Region of the U.S. Southwest Shown by Assimilated GRACE Indicators



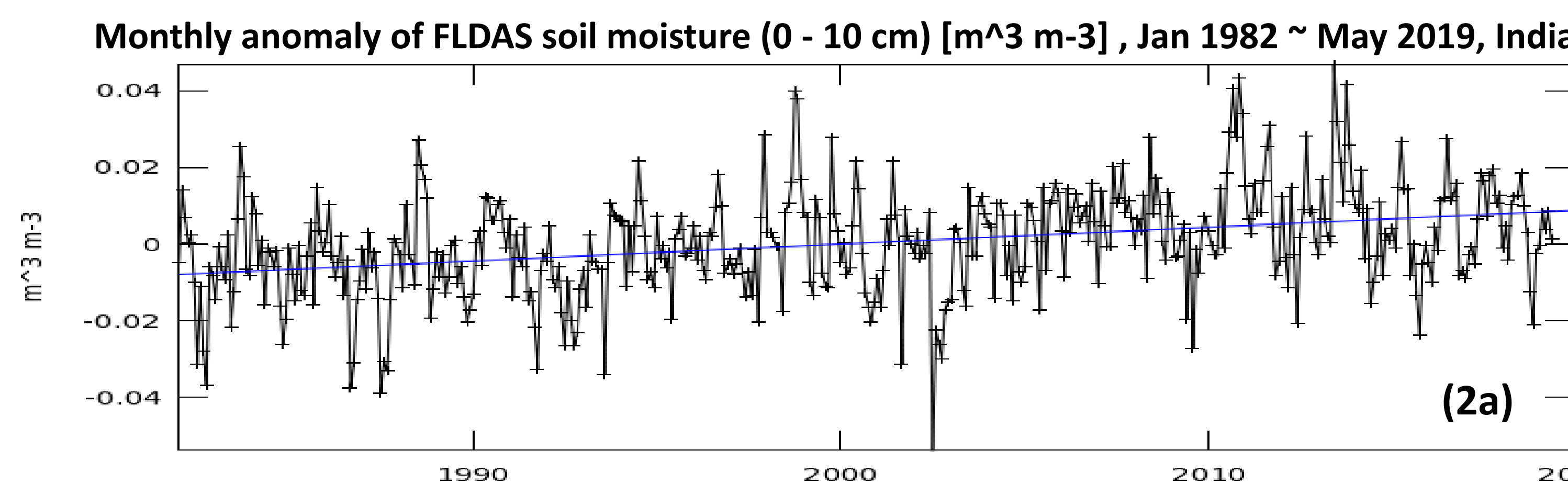
How well did the GRACE-assimilated data capture the intense 2018 drought? The above figures show views of the 2018 drought over the Four Corners states (Utah, Colorado, New Mexico, and Arizona), using the GRACE-assimilated data.

Fig 1a. 2018 annual mean map of groundwater storage indicates very low percentiles over most of the Four Corners region, with percentiles 5 or lower over large areas of Arizona, Utah, and Colorado, and small areas of New Mexico.

Fig 1b. The area-averaged time series of groundwater storage percentiles over Arizona (black), Utah (green), Colorado (red), and New Mexico (yellow), from January 1, 2016 to February 25, 2019.

Fig 1c. Area-averaged time series of groundwater storage percentiles for Arizona, from April 1, 2002 to February 25, 2019.

India Droughts Viewed by Monthly Climatology and Anomaly of FLDAS Soil Moisture



FLDAS: Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System

The data used here is a FLDAS monthly 0.1° x 0.1° global product from Noah LSM assimilation.

Fig 2a. Time series of FLDAS soil moisture (0 – 10cm) anomalies over India from Jan 1982 to May 2019, with a maximum negative anomaly in July 2002.

Fig 2b. FLDAS soil moisture (0 – 10 cm) climatology map for India July (1982 ~ 2016).

Fig 2c. A negative extreme of FLDAS soil moisture anomaly map for July 2002 coincides with a major drought occurrence over India during the same time period.

Seasonal Variations and Extremes over Australia Shown by GLDAS-2.1 Temperature and Precipitation

GLDAS: Global Land Data Assimilation System

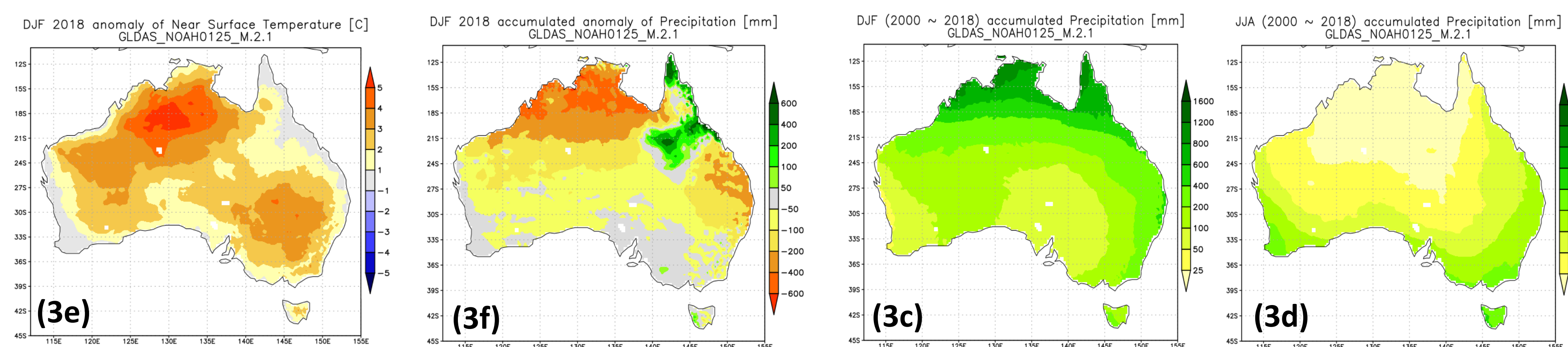
Fig 3a & 3b. Near surface air temperature seasonal means (2000 ~ 2018) over Australia (DJF, 3a) and winter (JJA, 3b).

Fig 3c & 3d. Precipitation seasonal accumulations (2000 ~ 2018) over Australia summer (DJF, 3c) and winter (JJA, 3d).

Fig 3e & 3f. Near surface air temperature (3e) and precipitation (3f) seasonal anomalies over Australia summer (DJF).

The seasonal climate maps (3a – 3d) are consistent with reports from the Australia Bureau of Meteorology.

The anomaly maps (3e and 3f) capture the major characteristics of Australia's third-warmest year on record.



Variables

Type	Variable	Unit
Meteorological Forcing	Wind speed	m/s
	Total precipitation rate	kg/m ² /s
	Near surface air temperature	K
	Near specific humidity	kg/kg
	Surface pressure	Pa
	Downward short-wave radiation flux	W/m ²
Energy Balance	Downward long-wave radiation flux	W/m ²
	Net short-wave radiation flux	W/m ²
	Net long-wave radiation flux	W/m ²
	Latent heat flux	W/m ²
	Sensible heat flux	W/m ²
	Ground heat flux	W/m ²
Water Balance	Rain rate	kg/m ² /s
	Snow rate	kg/m ² /s
	Evaporation	kg/m ² /s
	Transpiration	kg/m ² /s
	Evapotranspiration	kg/m ² /s
	Surface runoff	kg/m ² /s
Land Surface Model (LSM) Output	Baseflow runoff	kg/m ² /s
	Snow melt	kg/m ² /s
	Surface temperature	K
	Albedo	~
	Snow depth water equivalent	kg/m ²
	Soil moisture	kg/m ²
State	Soil temperature	K
	Stream flow	m ³ /s
	Flooded Fraction	~
	Flooded area	m ²
Others	Irrigated water rate	kg/m ² /s
	Terrestrial water storage	mm
	Ground water storage	mm

Table 2. Major land surface variables included in the hydrological data products.

Summary

- NASA GES DISC (<https://disc.gsfc.nasa.gov/>) is one of twelve NASA EOS data centers; it hosts a wide range of remotely-sensed and model data and provides reliable and robust data access and services to users worldwide.
- Table 1 lists hydrology land surface data products at NASA GES DISC, along with spatial & temporal resolution & coverage, and latency.
- Table 2 lists the meteorological forcing, water and energy balance variables included in the LDAS data.
- Data Set Landing pages (services & documents): <https://disc.gsfc.nasa.gov/datasets?keywords=Hydrology>
- Examples of extreme event studies that use LSM-assimilated hydrology data at NASA GES DISC:
 - Intense 2018 drought in the Four Corners region of the U.S. Southwest shown by assimilated GRACE indicators
 - India droughts shown by monthly climatology and anomaly of FLDAS soil moisture
 - Seasonal variations and extremes over Australia shown by GLDAS-2.1 temperature and precipitation
- Figs 1a & 1c and 2a – 2c were generated via Giovanni.