

# Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System (LDAS) and Other Assimilated Hydrological Data at NASA GES DISC

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## Introduction

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) provides science support for several data sets relevant to agriculture and food security, including the Famine Early Warning Systems Network (FEWS NET) Land Data Assimilation System (LDAS), or FLDAS, data set. The NASA GES DISC is one of 12 NASA Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs) and hosts a wide range of remote sensing and model data. Beyond data archive and access, the GES DISC offers reliable and robust services to visualize and analyze data. This presentation provides a summary of the hydrological data available at the NASA GES DISC, along with an overview of related data services, with an emphasis on the FLDAS data set.

## Hydrological Data at NASA GES DISC

Table 1. An overview of the hydrological data accessible at the NASA GES DISC, listed by mission name, land surface model or forcing or instrument type, temporal coverage and resolution, and spatial coverage and resolution.

Mission	Land Surface Model/ Forcing/ Instrument	Temporal									Spatial						
		Coverage		Resolution							Coverage		Resolution				
				Anomaly	Climatology	Trends	1 hour	3 hours	1 day	7 days	1 month	North America	Global Land	0.1 degree	0.125 degree	0.25 degree	1.0 degree
FLDAS	Noah	1982-01-01 to present	x	x							x	x	x				
NLDAS-2	Forcing "A"	1979-01-01 to present	x	x		x					x	x		x			
	Forcing "B"	1979-01-01 to present		x		x					x	x		x			
	Noah	1979-01-02 to present	x	x		x					x	x		x			
	Mosaic	1979-01-02 to present		x		x					x	x		x			
	VIC	1979-01-02 to present		x		x					x	x		x			
NLDAS-1	Forcing	1996-08-01 to 2007-12-31		x		x					x	x		x			
NCALDAS-2.0	Noah	1979-01-02 to 2016-12-31				x			x		x			x			
GLDAS-2.1	Noah	2000-01-01 to present					x				x	x			x	x	
	Catchment	Coming soon						x			x	x				x	
	VIC	Coming soon						x			x	x				x	
GLDAS-2.0	Noah	1948-01-01 to 2010-12-31					x				x	x			x	x	
	Catchment	1948-01-01 to 2014-12-30						x			x	x			x		
GLDAS-1	CLM	1979-01-02 to present					x				x	x				x	
	Mosaic	1979-01-02 to present						x			x	x				x	
	Noah	1979-01-02 to present						x			x	x				x	
	VIC	1979-01-01 to present						x			x	x				x	
GRACEDADM-2.0	Catchment	2002-04-01 to 2019-03-03							x					x			
SMERGE-2.0	Noah/CCI	1979-01-02 to 2019-05-10							x		x			x			
LPRM	AMSR2	2012-07-03 to present							x			x	x			x	
	AMSRE	2002-06-19 to 2011-10-03										x				x	
	TMI	1997-12-07 to 2015-04-08										x				x	
	WindSat	2003-02-01 to 2012-08-01										x				x	

## Data Services at NASA GES DISC

Each data set archived and distributed at the NASA GES DISC has a data set landing page that provides a summary of the data and links to documentation and access methods. FLDAS data and other hydrology data at the NASA GES DISC are available through:

- **HTTPS direct download:** Download data directly from the archive and retrieve the full file in the original format.
- **Earthdata Search:** Download data from the Earthdata Search platform, where all DAAC data can be retrieved.
- **Giovanni:** Visualize and download data by variable, time, and spatial selection with various plot options.
- **OPeNDAP:** Subset data by variable, time, and spatial selection, and download it in multiple output formats, including ASCII.
- **Level 3/4 Subsetter and Regridder:** Subset data by variable, time, and spatial selection, map data to various grids using several interpolation options, and convert GRIB data to netCDF.
- **GrADS Data Server (GDS):** Subset data by variable, time, and spatial selection, similarly to the OPeNDAP service.
- **Single-point time series (Data Rods):** Access and download data at a single latitude and longitude point for an extended time period in ASCII or time series plot output.



## FLDAS Data and Application

The FLDAS data set has been adapted to work with domains, data streams, and monitoring and forecast requirements associated with food security assessment in data-sparse, developing country settings. Adopting the NASA Land Information System (LIS) allows FEWS NET to leverage existing land surface models and generate ensembles of soil moisture, evapotranspiration (ET), and other variables based on multiple meteorological inputs or land surface models. The FLDAS data archived at NASA GES DISC are produced from the Noah Land Surface Model, forced by the combination of the new version of Modern-Era Retrospective analysis for Research and Applications version 2 (MERRA-2) data and Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS).

Table 2. The variables available in the FLDAS data, listed by meteorological forcing and model output.

Meteorological Forcing	Land Surface Model Output		FLDAS References:
	Energy Balance	Water Balance	
Downward longwave radiation flux	Latent heat net flux	Baseflow-groundwater runoff	<ul style="list-style-type: none"> <li>• McNally, A. et al. A land data assimilation system for sub-Saharan Africa food and water security applications. <i>Sci. Data</i> 4:170012 doi: 10.1038/sdata.2017.12 (2017).</li> <li>• Amy McNally NASA/GSFC/HSL (2018), FLDAS Noah Land Surface Model L4 Global Monthly 0.1 x 0.1 degree (MERRA-2 and CHIRPS), Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/5NH22T9375G</li> <li>• Amy McNally NASA/GSFC/HSL (2018), FLDAS Noah Land Surface Model L4 Global Monthly Climatology 0.1 x 0.1 degree (MERRA-2 and CHIRPS), Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/9JBLK69HNL3V</li> <li>• Amy McNally NASA/GSFC/HSL (2018), FLDAS Noah Land Surface Model L4 Global Monthly Anomaly 0.1 x 0.1 degree (MERRA-2 and CHIRPS), Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: [Data Access Date], 10.5067/GNKZZBAYDF4W</li> </ul>
Downward shortwave radiation flux	Net longwave radiation flux	Evapotranspiration	
Near surface air temperature	Net shortwave radiation flux	Snowfall rate	
Near surface wind speed	Sensible heat net flux	Soil moisture (0-10cm, 10-40cm, 40-100cm, and 100-200cm depths)	
Rainfall flux	Soil heat flux	Soil temperature (0-10cm, 10-40cm, 40-100cm, and 100-200cm depths)	
Specific humidity	Surface radiative temperature	Storm surface runoff	
Surface pressure		Snow cover	
		Snow depth	
		Snow water equivalent	

According to the Australian Government's Bureau of Meteorology (BOM), a substantial portion of Australia has experienced below average rainfall and soil moisture content throughout the Southern Hemisphere spring season of 2019, with southern Australia marking the driest October on record. This dryness has been accompanied by record high temperatures, amplifying the drought conditions in the area. The plots below were created using the NASA GES DISC Giovanni service to visualize Australia's recent conditions using the FLDAS monthly, monthly climatology, and monthly anomaly data.

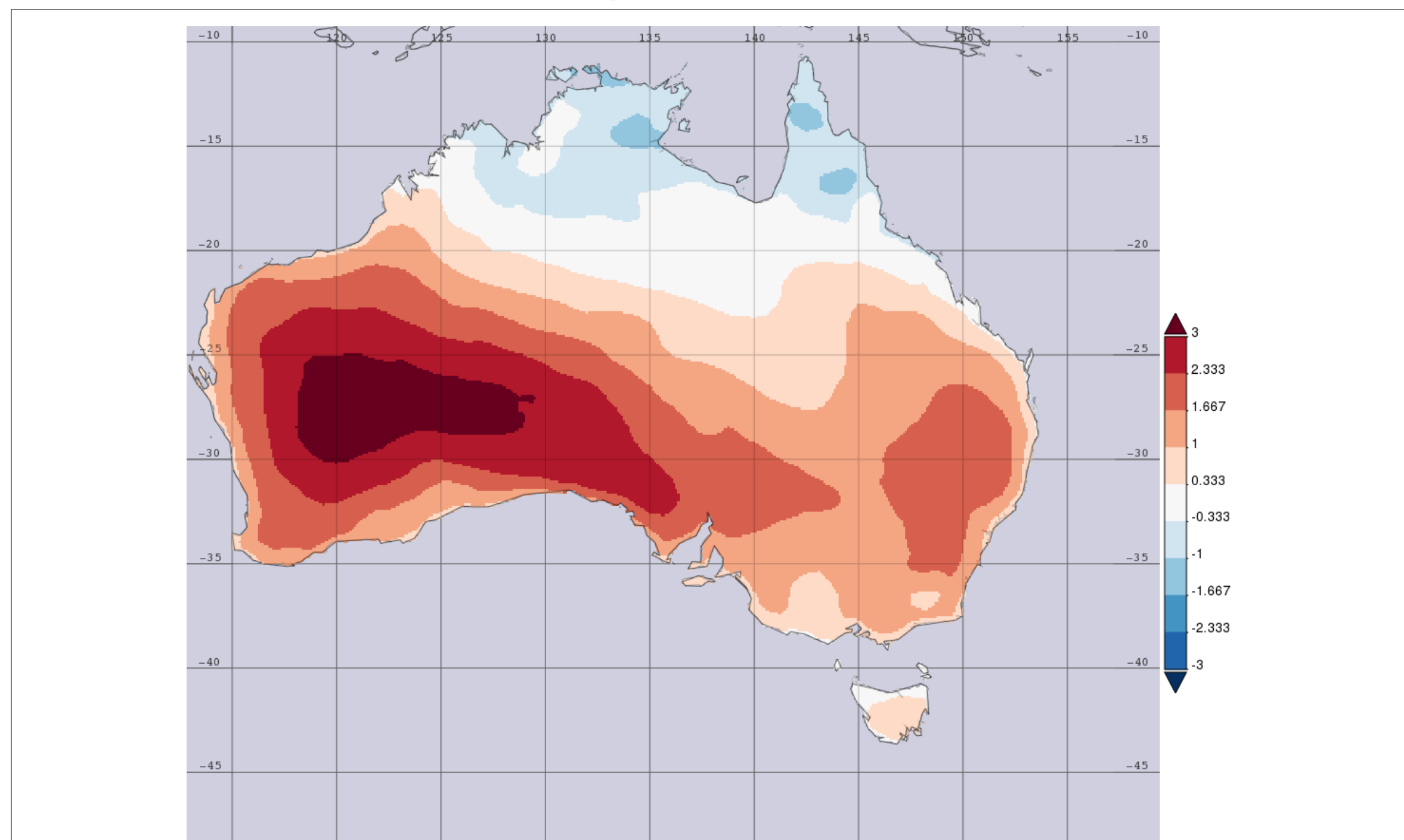


Figure 1: The anomaly of surface air temperature (in K) in Australia for September and October 2019, compared to the 35-year average from 1982 to 2016. Eastern Australia experienced temperatures greater than 3 K (~5.4 degrees F) warmer than the 35-year average.

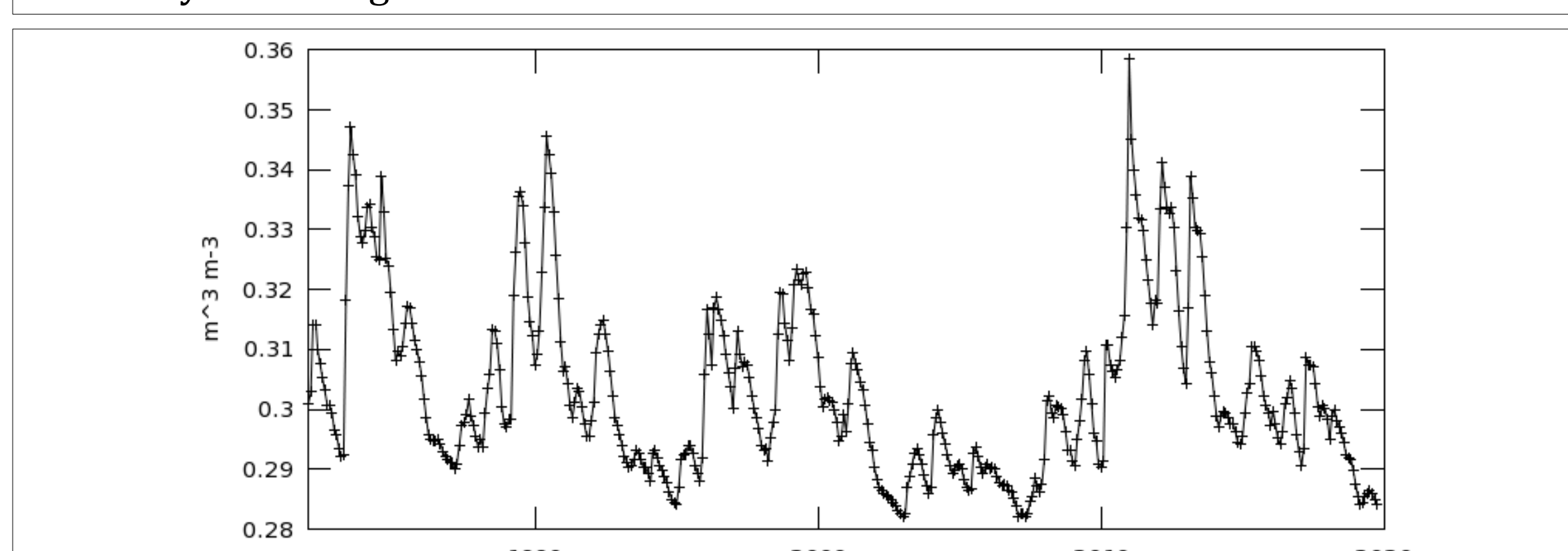


Figure 3: The soil moisture content of the 100-200 cm underground layer (in m<sup>3</sup> m<sup>-3</sup>) from January 1982 through October 2019, the entire available FLDAS data set period, over eastern Australia in the Brisbane area (147.13, -31.82, 154.86, -25.22). Soil moisture at this depth is indicative of long-term drought.

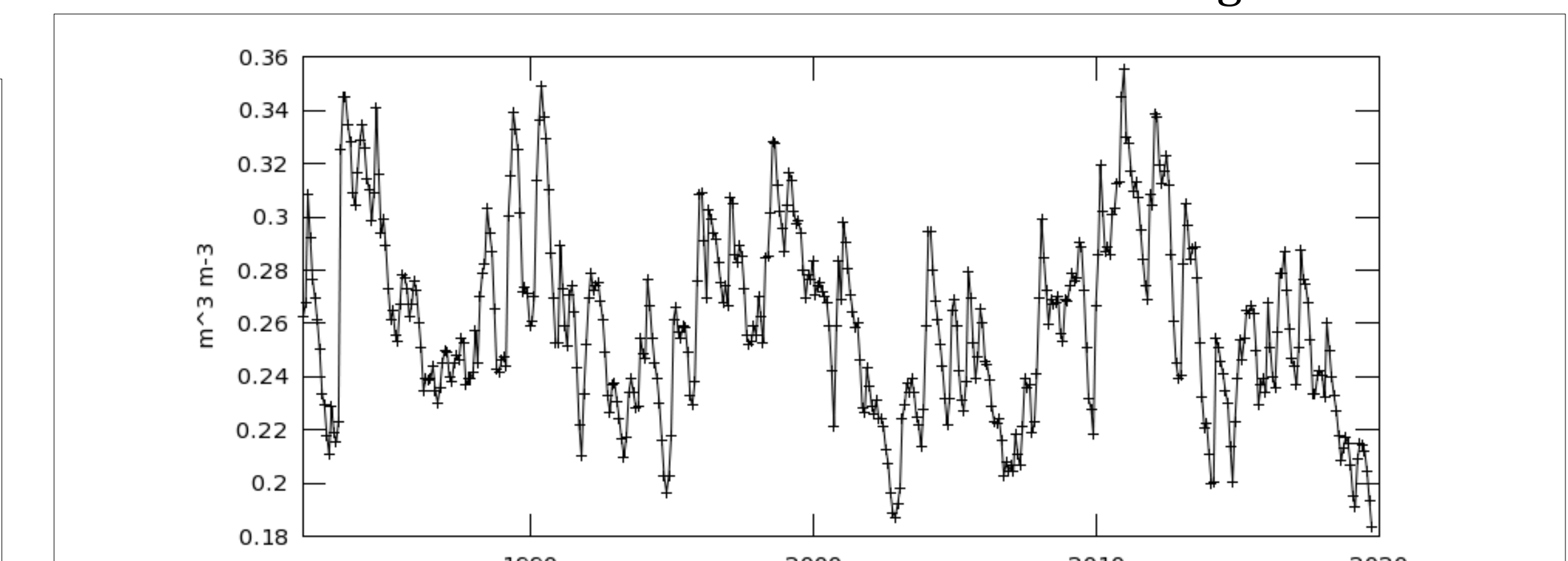


Figure 2: The soil moisture content of the 40-100 cm underground layer (in m<sup>3</sup> m<sup>-3</sup>) from January 1982 through October 2019, the entire available FLDAS data set period, over eastern Australia in the Brisbane area (147.13, -31.82, 154.86, -25.22). October 2019 shows the lowest soil moisture content during this time period of 0.1835 m<sup>3</sup> m<sup>-3</sup>.

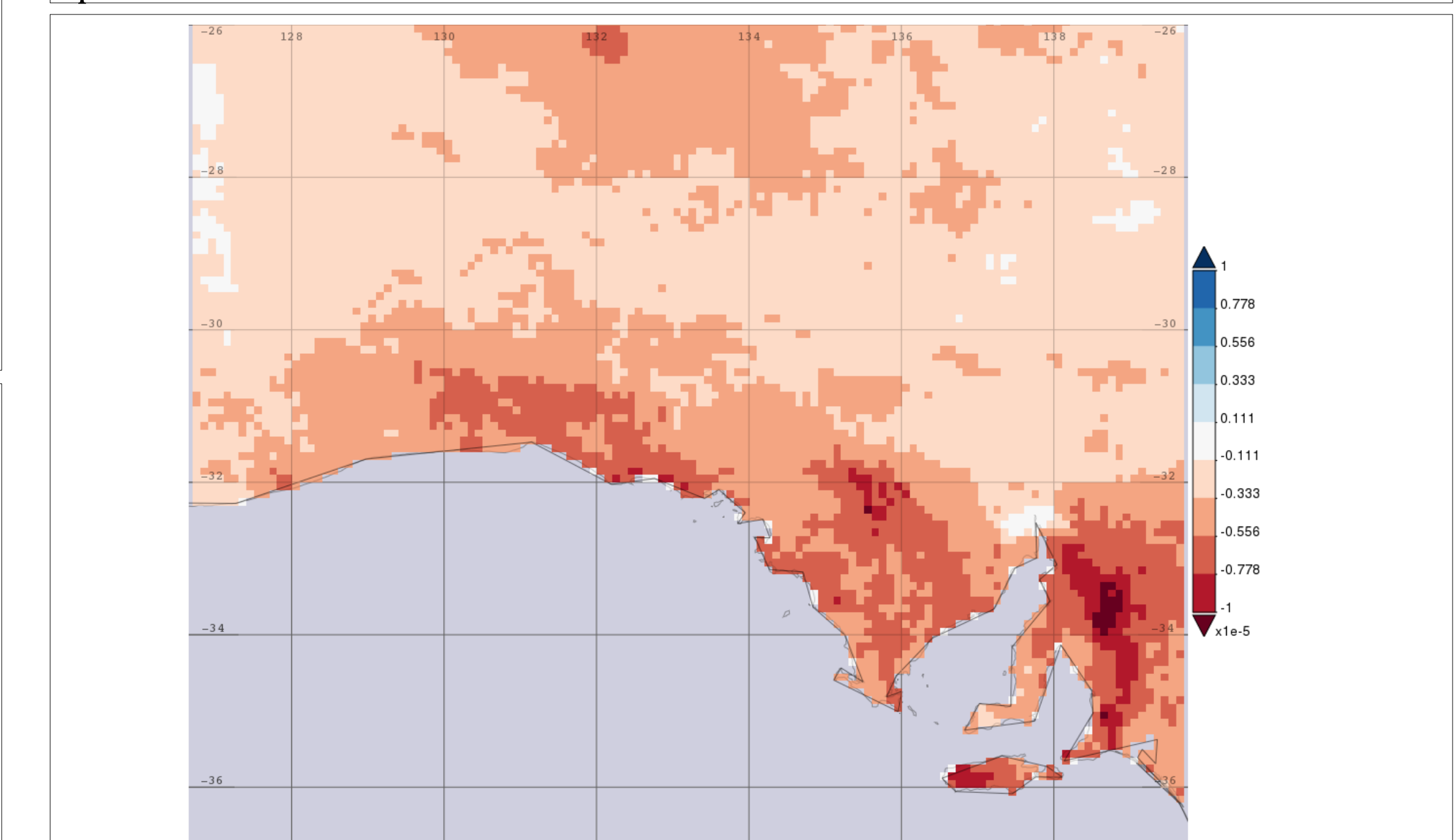


Figure 4: The anomaly of rainfall flux (in kg m<sup>-2</sup> s<sup>-1</sup>) in southern Australia for October 2019, compared to the 35-year average from 1982 to 2016. The Adelaide area experienced rainfall rates 0.00001 kg m<sup>-2</sup> s<sup>-1</sup> less than the 35-year average, which is equivalent to 26.784 mm less rainfall in October 2019 than average.