



Free, public, standardized Zarr stores of geospatial data in the cloud for all! Now in Beta.

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1 - NASA Goddard Earth Science Data and Information Science Center (GES DISC), 2 - Telophase,
3 - Adnet

- A little history
- Data
- Demo!
- Documentation
- Limitations and future plans
- How to contact us



A quick intro to Giovanni

<https://giovanni.gsfc.nasa.gov/giovanni>

GIOVANNI The Bridge Between Data and Science v 4.39 Feedback Help Log out (csmit)

Select Plot: Time Series, Area-Averaged

Select Date Range (UTC): 1986 - 10 - 01 00 : 00 to 1987 - 09 - 30 23 : 59

Select Region (Bounding Box or Shape): -121.4,38.6,-120.40.5

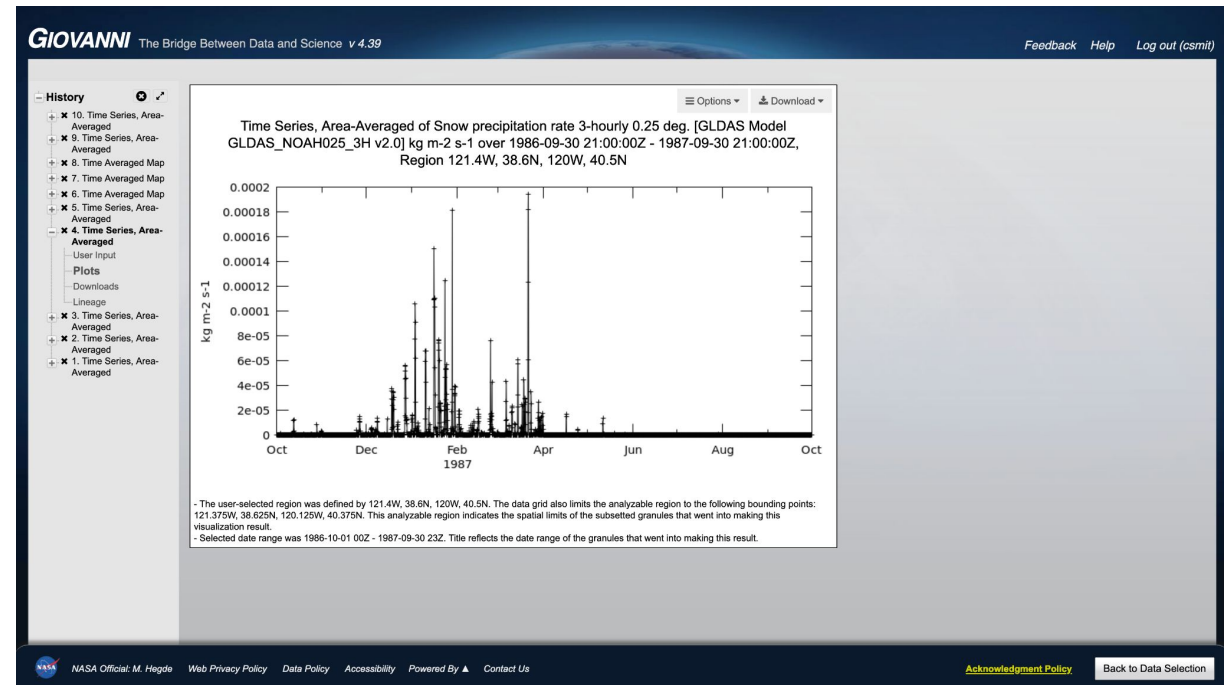
Valid Range: 1948-01-01 to 2014-12-31

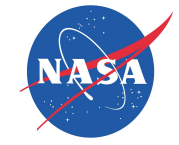
Number of matching Variables: 38 of 2088 Total Variable(s) Included in Plot: 1

Keyword: GLDAS_NOAH025_3H_v2.0 Search Clear

Variable	Units	Source	Temp. Res.	Spat. Res.	Begin Date	End Date
<input checked="" type="checkbox"/> Snow precipitation rate (GLDAS_NOAH025_3H_v2.0)	kg m ⁻² s ⁻¹	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Albedo (GLDAS_NOAH025_3H_v2.0)	%	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Evapotranspiration (GLDAS_NOAH025_3H_v2.0)	kg m ⁻² s ⁻¹	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Transpiration (GLDAS_NOAH025_3H_v2.0)	W m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Specific humidity (GLDAS_NOAH025_3H_v2.0)	kg kg ⁻¹	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Snow depth (GLDAS_NOAH025_3H_v2.0)	m	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Canopy water evaporation (GLDAS_NOAH025_3H_v2.0)	W m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Soil temperature (0 - 10 cm underground) (GLDAS_NOAH025_3H_v2.0)	K	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Snow melt (GLDAS_NOAH025_3H_v2.0)	kg m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Soil temperature (40 - 100 cm underground) (GLDAS_NOAH025_3H_v2.0)	K	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Soil moisture content (0 - 10 cm underground) (GLDAS_NOAH025_3H_v2.0)	kg m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Ground heat flux (GLDAS_NOAH025_3H_v2.0)	W m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Total precipitation rate (GLDAS_NOAH025_3H_v2.0)	kg m ⁻² s ⁻¹	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Snow depth water equivalent (GLDAS_NOAH025_3H_v2.0)	kg m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31
<input type="checkbox"/> Baseflow-groundwater runoff (GLDAS_NOAH025_3H_v2.0)	kg m ⁻²	GLDAS Model	3-Hourly	0.25 °	1948-01-01	2014-12-31

Reset Plot Data Go to Results





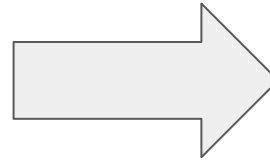
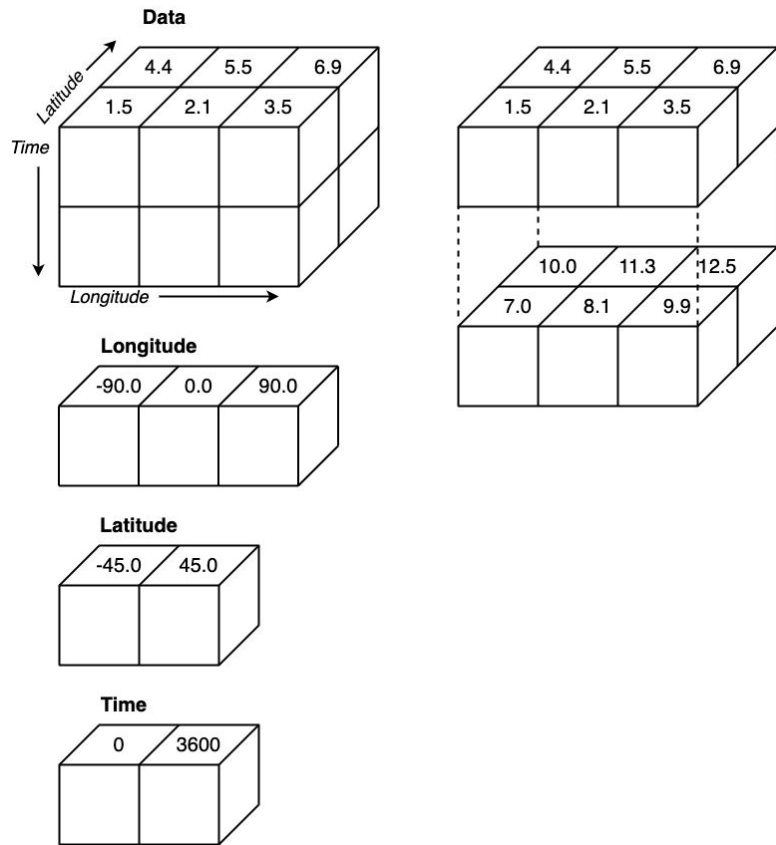
Cloud Part 1: Parquet

~2018-2020



Parquet

Multi-dimensional array with dimension variables



Point data (Data frame)

Longitude	Latitude	Time	Data
-90.0	-45.0	0	1.5
0.0	-45.0	0	2.1
90.0	-45.0	0	3.5
-90.0	45.0	0	4.4
0.0	45.0	0	5.5
90.0	45.0	0	6.9
-90.0	-45.0	3600	7.0
0.0	-45.0	3600	8.1
90.0	-45.0	3600	9.9
-90.0	45.0	3600	10.0
0.0	45.0	3600	11.3
90.0	45.0	3600	12.5



Parquet highlights (~2018-2020)

The good :

- Easiest algorithm writing ever!
- Clean, simple architecture



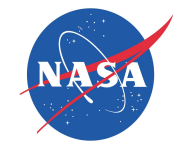
Parquet highlights (~2018-2020)

The good :

- Easiest algorithm writing ever!
- Clean, simple architecture

The bad :

- Lack of open source solutions that performed well for our tasks
- Inconsistent performance from AWS Athena



Parquet highlights (~2018-2020)

The good :

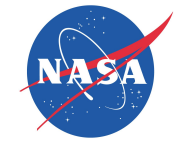
- Easiest algorithm writing ever!
- Clean, simple architecture

The bad :

- Lack of open source solutions that performed well for our tasks
- Inconsistent performance from AWS Athena

The ugly :

- Looming cost problems with AWS Athena
- Difficulty of updating enormous parquet files



Cloud Part 2: Zarr

> 2020



Moving to zarr

The good :

- Supports multi-dimensional arrays natively. Is largely compatible with NetCDF and HDF data models, which is a good fit for our data.
- Easy to update as new observations come in.
- Excellent open source support.



Moving to zarr

The good :

- Supports multi-dimensional arrays natively. Is largely compatible with NetCDF and HDF data models, which is a good fit for our data.
- Easy to update as new observations come in.
- Excellent open source support.

The bad :

- Making zarr stores public that need to be updated requires additional instrumentation beyond the zarr library.



What we're making public

24 "complete" zarr stores (no new data coming in)



What we're making public

24 "complete" zarr stores (no new data coming in)

- hydrology variables from [GLDAS NOAH025 3H v2.0](#)
 - GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0
 - Global spatial extent
 - Land-only
 - 1948-01-01 to 2014-12-31

Product /
collection

Granules / files

GLDAS_NOAH025_3H.A19480101.0300.020.nc4
GLDAS_NOAH025_3H.A19480101.0600.020.nc4
GLDAS_NOAH025_3H.A19480101.0900.020.nc4
GLDAS_NOAH025_3H.A19480101.1200.020.nc4
GLDAS_NOAH025_3H.A19480101.1500.020.nc4
GLDAS_NOAH025_3H.A19480101.1800.020.nc4
GLDAS_NOAH025_3H.A19480101.2100.020.nc4
GLDAS_NOAH025_3H.A19480102.0000.020.nc4
GLDAS_NOAH025_3H.A19480102.0300.020.nc4
GLDAS_NOAH025_3H.A19480102.0600.020.nc4
GLDAS_NOAH025_3H.A19480102.0900.020.nc4
GLDAS_NOAH025_3H.A19480102.1200.020.nc4
GLDAS_NOAH025_3H.A19480102.1500.020.nc4
GLDAS_NOAH025_3H.A19480102.1800.020.nc4
GLDAS_NOAH025_3H.A19480102.2100.020.nc4
GLDAS_NOAH025_3H.A19480103.0000.020.nc4
GLDAS_NOAH025_3H.A19480103.0300.020.nc4
GLDAS_NOAH025_3H.A19480103.0600.020.nc4
GLDAS_NOAH025_3H.A19480103.0900.020.nc4
GLDAS_NOAH025_3H.A19480103.1200.020.nc4
GLDAS_NOAH025_3H.A19480103.1500.020.nc4
GLDAS_NOAH025_3H.A19480103.1800.020.nc4
GLDAS_NOAH025_3H.A19480103.2100.020.nc4
GLDAS_NOAH025_3H.A19480104.0000.020.nc4
GLDAS_NOAH025_3H.A19480104.0300.020.nc4
GLDAS_NOAH025_3H.A19480104.0600.020.nc4
GLDAS_NOAH025_3H.A19480104.0900.020.nc4
...

Product /
collection



Sidebar: how NASA archives earth science data

Granules / files

GLDAS_NOAH025_3H.A19480101.0300.020.nc4
GLDAS_NOAH025_3H.A19480101.0600.020.nc4
GLDAS_NOAH025_3H.A19480101.0900.020.nc4
GLDAS_NOAH025_3H.A19480101.1200.020.nc4
GLDAS_NOAH025_3H.A19480101.1500.020.nc4
GLDAS_NOAH025_3H.A19480101.1800.020.nc4
GLDAS_NOAH025_3H.A19480101.2100.020.nc4
GLDAS_NOAH025_3H.A19480102.0000.020.nc4
GLDAS_NOAH025_3H.A19480102.0300.020.nc4
GLDAS_NOAH025_3H.A19480102.0600.020.nc4
GLDAS_NOAH025_3H.A19480102.0900.020.nc4
GLDAS_NOAH025_3H.A19480102.1200.020.nc4
GLDAS_NOAH025_3H.A19480102.1500.020.nc4
GLDAS_NOAH025_3H.A19480102.1800.020.nc4
GLDAS_NOAH025_3H.A19480102.2100.020.nc4
GLDAS_NOAH025_3H.A19480103.0000.020.nc4
GLDAS_NOAH025_3H.A19480103.0300.020.nc4
GLDAS_NOAH025_3H.A19480103.0600.020.nc4
GLDAS_NOAH025_3H.A19480103.0900.020.nc4
GLDAS_NOAH025_3H.A19480103.1200.020.nc4
GLDAS_NOAH025_3H.A19480103.1500.020.nc4
GLDAS_NOAH025_3H.A19480103.1800.020.nc4
GLDAS_NOAH025_3H.A19480103.2100.020.nc4
GLDAS_NOAH025_3H.A19480104.0000.020.nc4
GLDAS_NOAH025_3H.A19480104.0300.020.nc4
GLDAS_NOAH025_3H.A19480104.0600.020.nc4
GLDAS_NOAH025_3H.A19480104.0900.020.nc4
...

Data variables / parameters

```
float Swnet_tavg(time, lat, lon) ;  
    Swnet_tavg:standard_name = "surface_net_downward_shortwave_flux" ;  
    Swnet_tavg:long_name = "Net short wave radiation flux" ;  
    Swnet_tavg:units = "W m-2" ;  
    Swnet_tavg:_FillValue = -9999.f ;  
    Swnet_tavg:missing_value = -9999.f ;  
    Swnet_tavg:cell_methods = "time: mean" ;  
    Swnet_tavg:vmin = 0.f ;  
    Swnet_tavg:vmax = 1041.f ;  
float Lwnet_tavg(time, lat, lon) ;  
    Lwnet_tavg:standard_name = "surface_net_downward_longwave_flux" ;  
    Lwnet_tavg:long_name = "Net long-wave radiation flux" ;  
    Lwnet_tavg:units = "W m-2" ;  
    Lwnet_tavg:_FillValue = -9999.f ;  
    Lwnet_tavg:missing_value = -9999.f ;  
    Lwnet_tavg:cell_methods = "time: mean" ;  
    Lwnet_tavg:vmin = -309.47f ;  
    Lwnet_tavg:vmax = 42.44998f ;  
float Qle_tavg(time, lat, lon) ;  
    Qle_tavg:standard_name = "surface_upward_latent_heat_flux" ;  
    Qle_tavg:long_name = "Latent heat net flux" ;  
    Qle_tavg:units = "W m-2" ;  
    Qle_tavg:_FillValue = -9999.f ;  
    Qle_tavg:missing_value = -9999.f ;  
    Qle_tavg:cell_methods = "time: mean" ;  
    Qle_tavg:vmin = -73.88426f ;  
    Qle_tavg:vmax = 553.9257f ;  
...
```

Product /
collection









Example: original NetCDF data granule for GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600)

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00	 
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9	 
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88	 

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...	 
Swnet_tavg	(time, lat, lon)	float32	...	 
Lwnet_tavg	(time, lat, lon)	float32	...	 
...				
Evdown_tavg	(time, lat, lon)	float32	...	 

► Indexes: (3)

▼ Attributes:

CDI : Climate Data Interface version 1.9.8 (<https://mpimet.mpg.de/cdi>)
Conventions : CF-1.6
history : created on date: 2019-10-01T11:36:20.505

...



Example: original NetCDF data granule for GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600) ← Data for just a single time slice

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00		
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9		
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88		

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...		
Swnet_tavg	(time, lat, lon)	float32	...		
Lwnet_tavg	(time, lat, lon)	float32	...		
...					
Evdown_tavg	(time, lat, lon)	float32	...		

► Indexes: (3)

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xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600) ← Data for just a single time slice

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00	← Coordinates
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9	
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88	

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...	
Swnet_tavg	(time, lat, lon)	float32	...	
Lwnet_tavg	(time, lat, lon)	float32	...	
...				
Evdown_tavg	(time, lat, lon)	float32	...	

► Indexes: (3)

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...



Example: original NetCDF data granule for GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600) ← Data for just a single time slice

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00	← Coordinates
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9	
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88	

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...	← Bounds for one dimension
Swnet_tavg	(time, lat, lon)	float32	...	
Lwnet_tavg	(time, lat, lon)	float32	...	
...				
Evdown_tavg	(time, lat, lon)	float32	...	

► Indexes: (3)

▼ Attributes:

CDI : Climate Data Interface version 1.9.8 (<https://mpimet.mpg.de/cdi>)

Conventions : CF-1.6

history : created on date: 2019-10-01T11:36:20.505

...



Example: original NetCDF data granule for GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600) ← Data for just a single time slice

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00	← Coordinates
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9	
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88	

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...	← Bounds for one dimension
Swnet_tavg	(time, lat, lon)	float32	...	
Lwnet_tavg	(time, lat, lon)	float32	...	
...				← 36 data variables
Evdown_tavg	(time, lat, lon)	float32	...	

► Indexes: (3)

▼ Attributes:

CDI : Climate Data Interface version 1.9.8 (<https://mpimet.mpg.de/cdi>)

Conventions : CF-1.6

history : created on date: 2019-10-01T11:36:20.505

...



Example: original NetCDF data granule for GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (time: 1, bnds: 2, lon: 1440, lat: 600) ← Data for just a single time slice

▼ Coordinates:

time	(time)	datetime64[ns]	1948-01-01T03:00:00	← Coordinates
lon	(lon)	float32	-179.9 -179.6 ... 179.6 179.9	
lat	(lat)	float32	-59.88 -59.62 ... 89.62 89.88	

▼ Data variables:

time_bnds	(time, bnds)	datetime64[ns]	...	← Bounds for one dimension
Swnet_tavg	(time, lat, lon)	float32	...	
Lwnet_tavg	(time, lat, lon)	float32	...	
...				← 36 data variables
Evapot_tavg	(time, lat, lon)	float32	...	

► Indexes: (3)

▼ Attributes:

CDI :	Climate Data Interface version 1.9.8 (https://mpimet.mpg.de/cdi)	← Metadata about granule and product
Conventions :	CF-1.6	
history :	created on date: 2019-10-01T11:36:20.505	
...		



Zarr store normalization



Zarr store normalization

- Standardize dimensions and bounds:
 - name
 - order
 - units



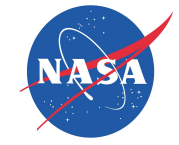
Zarr store normalization

- Standardize dimensions and bounds:
 - name
 - order
 - units
- Aggregate across time



Zarr store normalization

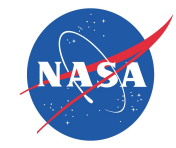
- Standardize dimensions and bounds:
 - name
 - order
 - units
- Aggregate across time
- Include only one measurement in each zarr store



Zarr store normalization

- Standardize dimensions and bounds:
 - name
 - order
 - units
- Aggregate across time
- Include only one measurement in each zarr store

⇒ Makes the data look "weird" if you know the original product, but makes writing algorithms easier.



Example: Zarr store for Snowf_tavg variable in GLDAS_NOAH025_3H v2.0









xarray.Dataset

► Dimensions: (latitude: 600, bounds: 2, longitude: 1440, time: 196000)

▼ Coordinates:

latitude	(latitude)	float64	-59.88 -59.62 ... 89.62 89.88		
longitude	(longitude)	float32	-179.9 -179.6 ... 179.6 179.9		
time	(time)	datetime64[ns]	1948-01-01T03:00:00 ... 1947-...		

▼ Data variables:

latitude_bounds	(latitude, bounds)	float64	dask.array<chunksize=(18, 2), ...		
longitude_boun...	(longitude, bounds)	float64	dask.array<chunksize=(36, 2), ...		
time_bounds	(time, bounds)	datetime64[s]	dask.array<chunksize=(800, 2),...		
variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...		
long_name :	Snow precipitation rate				
units :	kg m-2 s-1				

► Indexes: (3)

▼ Attributes:

Conventions : CF-1.10
DOI : 10.5067/342OHQM9AK6Q
product_long_n... GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0
product_short_... GLDAS_NOAH025_3H
product_version : 2.0



Example: Zarr store for Snowf_tavg variable in GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (latitude: 600, bounds: 2, longitude: 1440, time: 196000) ←

▼ Coordinates:

latitude	(latitude)	float64	-59.88 -59.62 ... 89.62 89.88		
longitude	(longitude)	float32	-179.9 -179.6 ... 179.6 179.9		
time	(time)	datetime64[ns]	1948-01-01T03:00:00 ... 1947-...		

▼ Data variables:

latitude_bounds	(latitude, bounds)	float64	dask.array<chunksize=(18, 2), ...		
longitude_boun...	(longitude, bounds)	float64	dask.array<chunksize=(36, 2), ...		
time_bounds	(time, bounds)	datetime64[s]	dask.array<chunksize=(800, 2),...		
variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...		

long_name : Snow precipitation rate
units : kg m-2 s-1

► Indexes: (3)















▼ Attributes:

Conventions : CF-1.10
DOI : 10.5067/342OHQM9AK6Q
product_long_n... GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0
product_short_... GLDAS_NOAH025_3H
product_version : 2.0

Data consolidated across all granules.

Example: Zarr store for Snowf_tavg variable in GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions:	(latitude: 600, bounds: 2, longitude: 1440, time: 196000) ←			
▼ Coordinates:				
latitude	(latitude)	float64	-59.88 -59.62 ... 89.62 89.88	 
longitude	(longitude)	float32	-179.9 -179.6 ... 179.6 179.9	 
time	(time)	datetime64[ns]	1948-01-01T03:00:00 ... 1947-...	 
▼ Data variables:				
latitude_bounds	(latitude, bounds)	float64	dask.array<chunksize=(18, 2), ...	 
longitude_boun...	(longitude, bounds)	float64	dask.array<chunksize=(36, 2), ...	 
time_bounds	(time, bounds)	datetime64[s]	dask.array<chunksize=(800, 2),...	 
variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...	 
long_name :	Snow precipitation rate			
units :	kg m-2 s-1			
► Indexes: (3)				
▼ Attributes:				
Conventions :	CF-1.10			
DOI :	10.5067/342OHQM9AK6Q			
product_long_n...	GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0			
product_short_...	GLDAS_NOAH025_3H			
product_version :	2.0			

Data consolidated across all granules.

Standardized coordinates with standardized names and units.

Example: Zarr store for Snowf_tavg variable in GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions: (latitude: 600, bounds: 2, longitude: 1440, time: 196000) ←

▼ Coordinates:

latitude	(latitude)	float64	-59.88 -59.62 ... 89.62 89.88	 
longitude	(longitude)	float32	-179.9 -179.6 ... 179.6 179.9	 
time	(time)	datetime64[ns]	1948-01-01T03:00:00 ... 1947-...	 

▼ Data variables:

latitude_bounds	(latitude, bounds)	float64	dask.array<chunksize=(18, 2), ...	 
longitude_boun...	(longitude, bounds)	float64	dask.array<chunksize=(36, 2), ...	 
time_bounds	(time, bounds)	datetime64[s]	dask.array<chunksize=(800, 2),...	 
variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...	 

long_name : Snow precipitation rate
units : kg m-2 s-1

► Indexes: (3)

▼ Attributes:

Conventions : CF-1.10
DOI : 10.5067/342OHQM9AK6Q
product_long_n... GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0
product_short_... GLDAS_NOAH025_3H
product_version : 2.0















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Standardized coordinates with standardized names and units.

Bounds on dimensions

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xarray.Dataset

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variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...	 
long_name :	Snow precipitation rate ←			
units :	kg m-2 s-1			
► Indexes: (3)				
▼ Attributes:				
Conventions :	CF-1.10			
DOI :	10.5067/342OHQM9AK6Q			
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product_short_...	GLDAS_NOAH025_3H			
product_version :	2.0			

Data consolidated across all granules.















Standardized coordinates with standardized names and units.

Bounds on dimensions

A single data parameter with coordinates in a standard order

Example: Zarr store for Snowf_tavg variable in GLDAS_NOAH025_3H v2.0

xarray.Dataset

► Dimensions:	(latitude: 600, bounds: 2, longitude: 1440, time: 196000) ←			
▼ Coordinates:				
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variable	(latitude, longitude, time)	float32	dask.array<chunksize=(18, 36, ...	 
long_name :	Snow precipitation rate ←			
units :	kg m-2 s-1			
► Indexes: (3)				
▼ Attributes:				
Conventions :	CF-1.10			
DOI :	10.5067/342OHQM9AK6Q			
product_long_n...	GLDAS Noah Land Surface Model L4 3 hourly 0.25 x 0.25 degree V2.0 ←			
product_short_...	GLDAS_NOAH025_3H			
product_version :	2.0			

Data consolidated across all granules.

Standardized coordinates with standardized names and units.

Bounds on dimensions

A single data parameter with coordinates in a standard order

Metadata tying zarr store to source data product



Chunking dilemmas



Chunking dilemmas





Chunking dilemmas



vs.



Chunking dilemmas



vs.





Chunking dilemmas



VS.



VS.



Chunking dilemmas



VS.



VS.





Chunking dilemmas



VS.



VS.





Chunking dilemmas



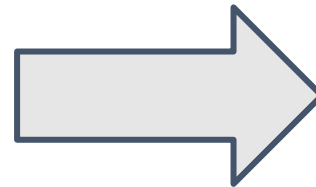
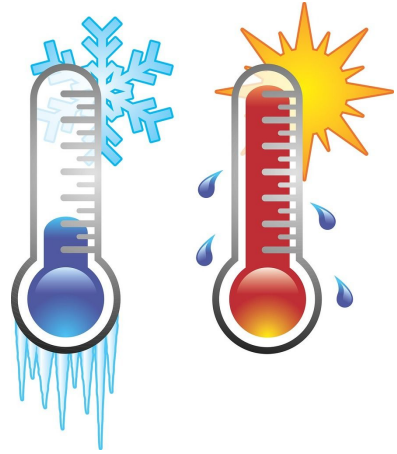
VS.



VS.



Compromise



~ 40 (on prem with pre-downloaded NetCDF files) → ~ 1 second (in AWS with zarr)

How to Search and Access Giovanni Variable Zarr Stores



Known limitations



Known limitations

- AWS credentials expire after an hour



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- Data must be accessed from AWS US-West-2



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- Data discovery is clunky



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- AWS credentials expire after an hour
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- Data discovery is clunky
- Metadata in attributes is imperfect and may not work with your preferred tool, especially if we are unfamiliar with your preferred tool!
- Dimensions need to be re-chunked to improve loading speed with tools like xarray.
- Dimensions have fill values, which some libraries do not like. You may need to mask these fill values before plotting.

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- Deal with fill values in dimensions



Future plans

- Improve chunking of dimensions to make loading zarr stores with xarray faster
- Make more data public
- Improve metadata
- Improve discoverability
- Deal with fill values in dimensions
- Incorporate community feedback into zarr stores



Tell us what you think!

gsfc-dl-help-disc@mail.nasa.gov



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 - Garry Knight's [churros](#)
 - rawpixel's [mountains](#)
 - chanellelloyd1's [river](#)
 - picryl's [thermometers](#)