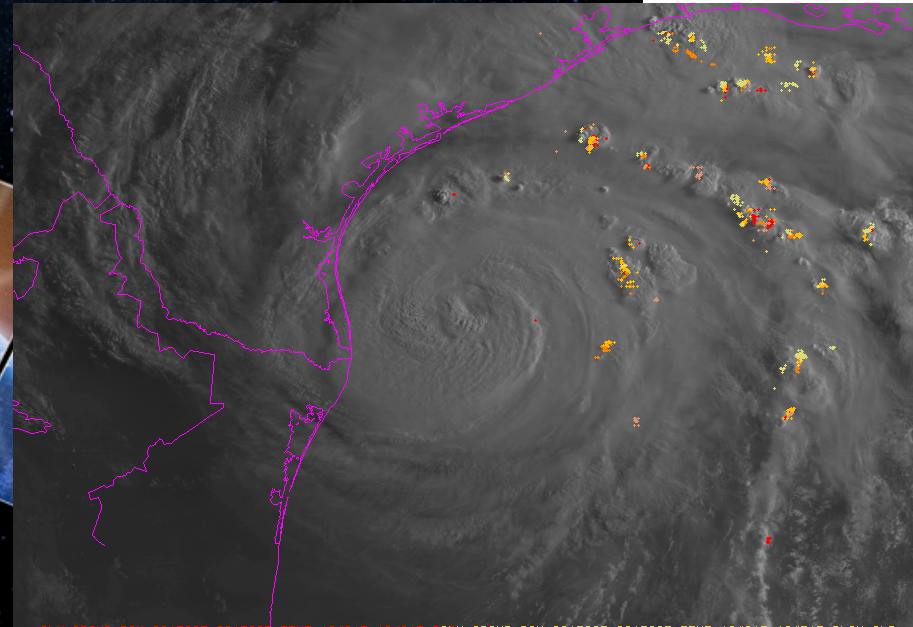
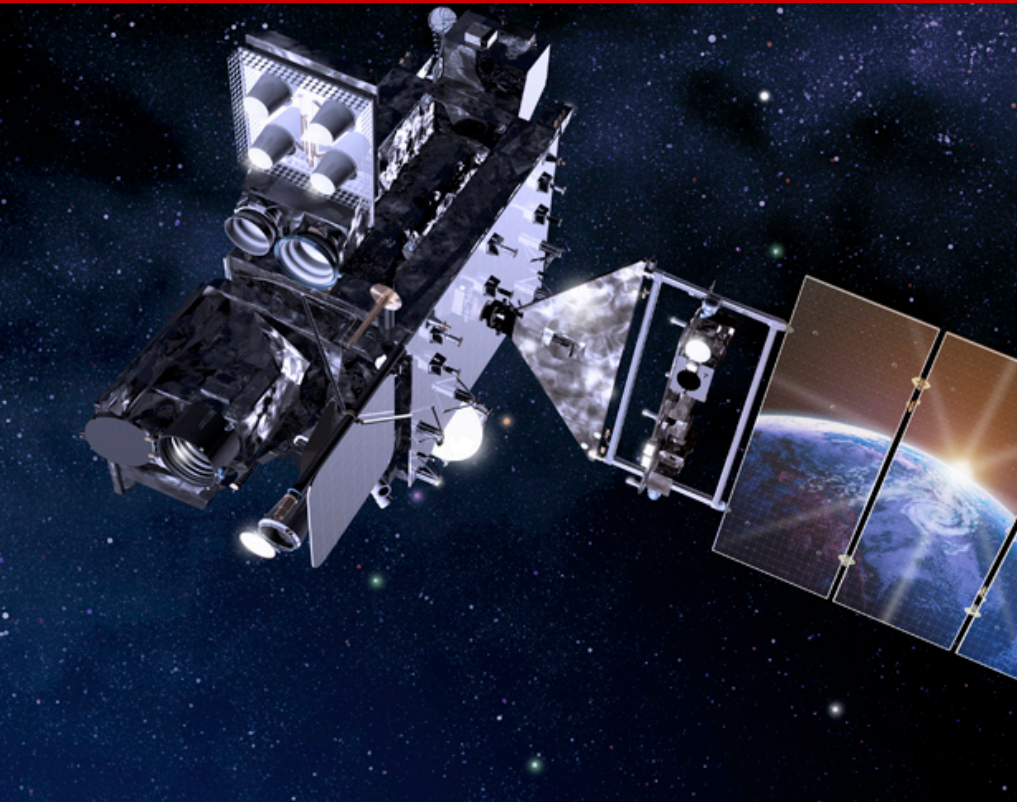


# Using the GOES-16 GLM



```
GLM GROUP DAY 2017237 2017237 TIME 124317 124317; GLM GROUP DAY 2017237 2017237; TIME 124617 124717; PLAX CLD  
GLM GROUP DAY 2017237 2017237; TIME 124317 124417; PLAX CLD  
GLM GROUP DAY 2017237 2017237; TIME 124317 124517; PLAX CLD  
GLM GROUP DAY 2017237 2017237; TIME 124517 124617; PLAX CLD
```

10001 G-16 IMG 1 25 AUG 17237 124717 02907 03193 02 00

McIDAS

# First and Foremost:



**Find it here!**

<https://github.com/deeplycloudy/glmttools>





# Gridding Data



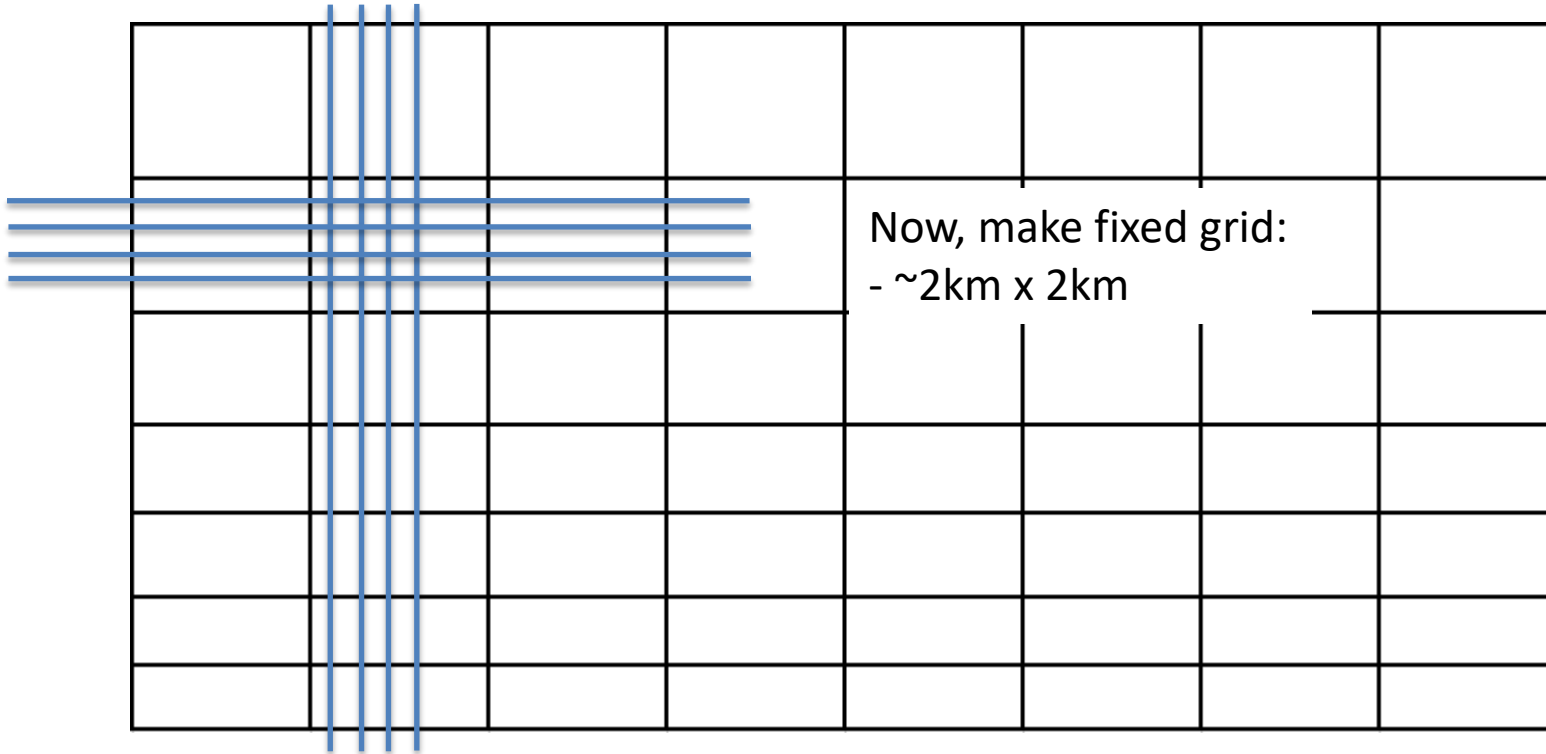
				GLM pixel grid:			
				-Geostationary Projection (rads)			
				-Pixel size varies!			

# Gridding Data

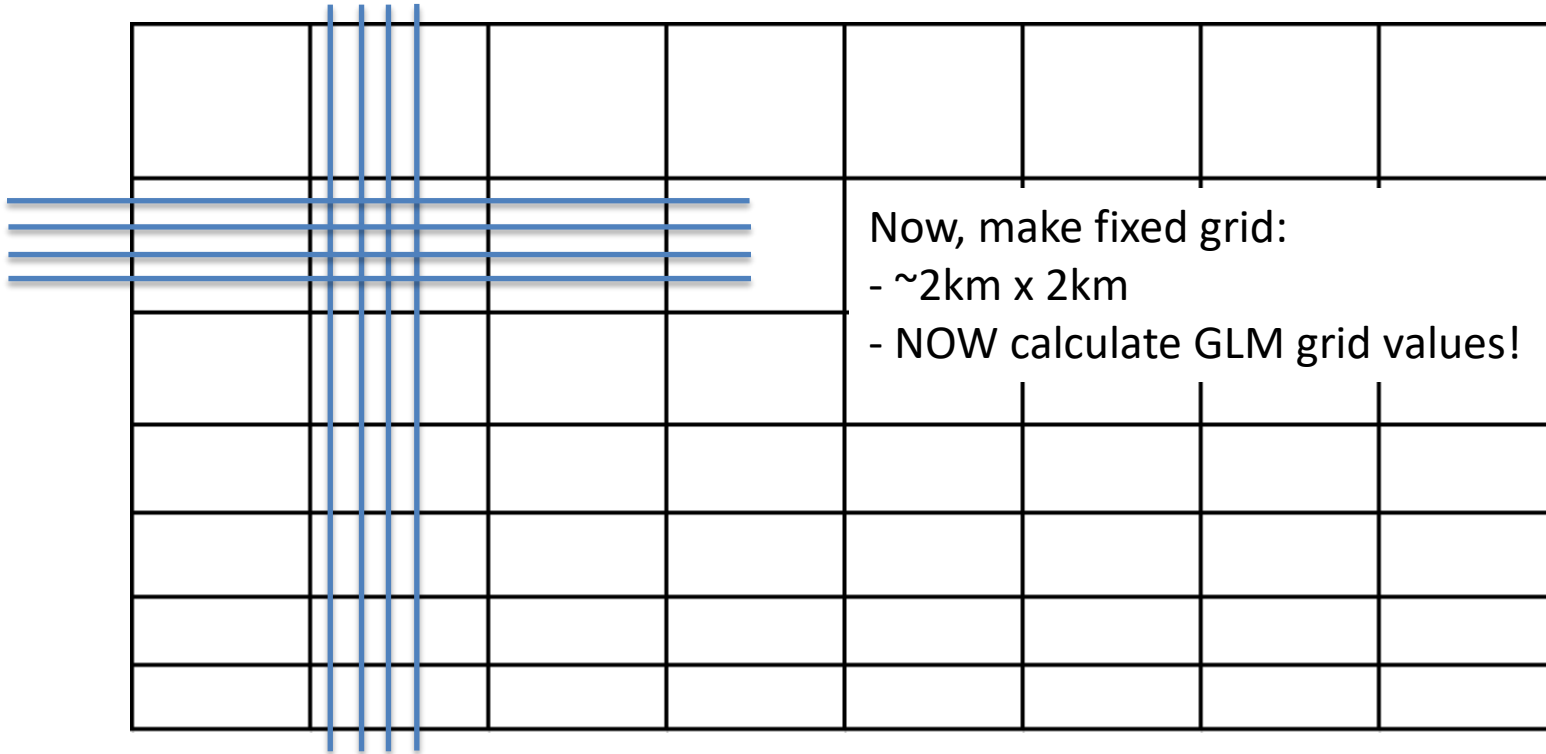



GLM pixel grid:  
-Geostationary Projection (rads)  
-Pixel size varies!  
-Keeps same res. in all latitudes

# Gridding Data

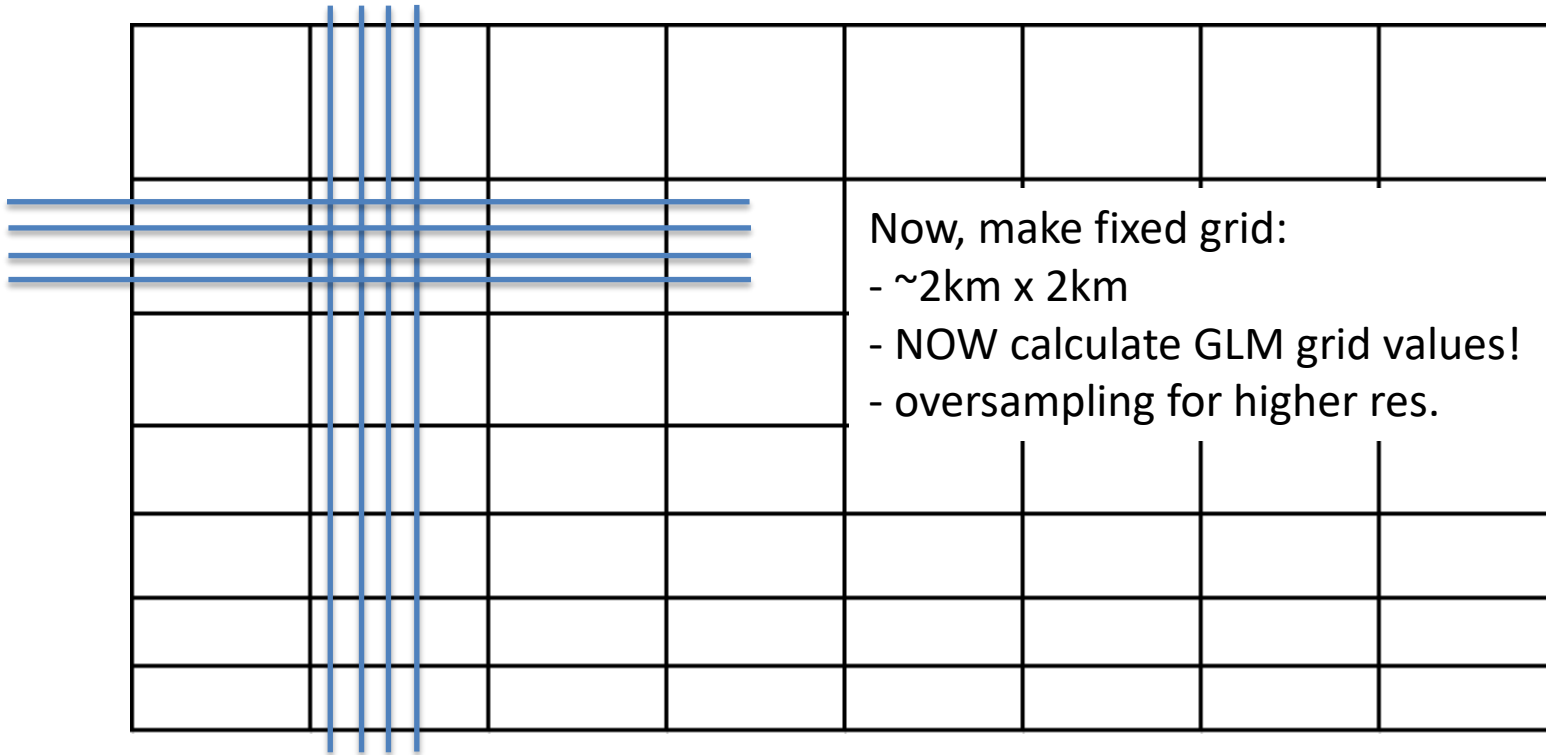


# Gridding Data

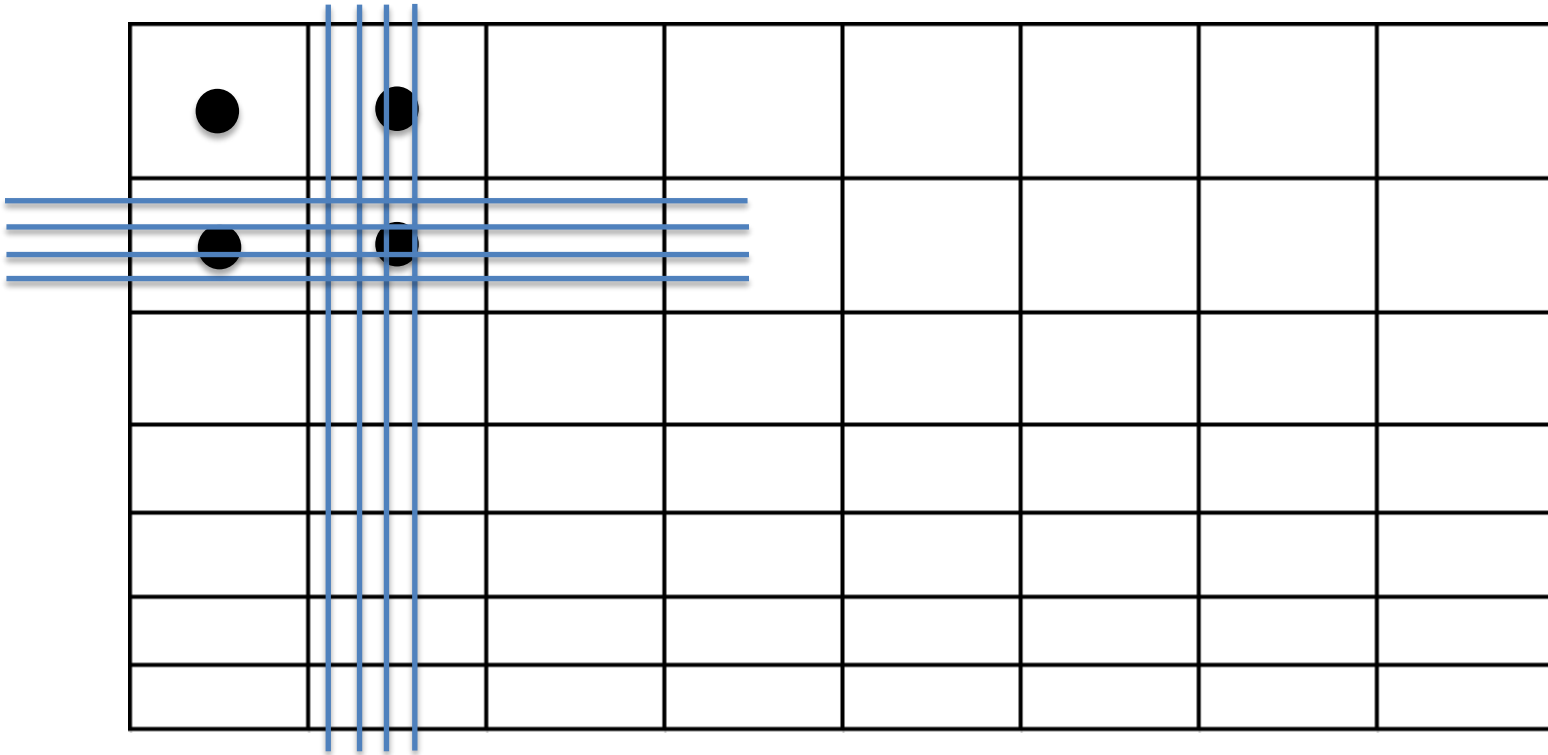




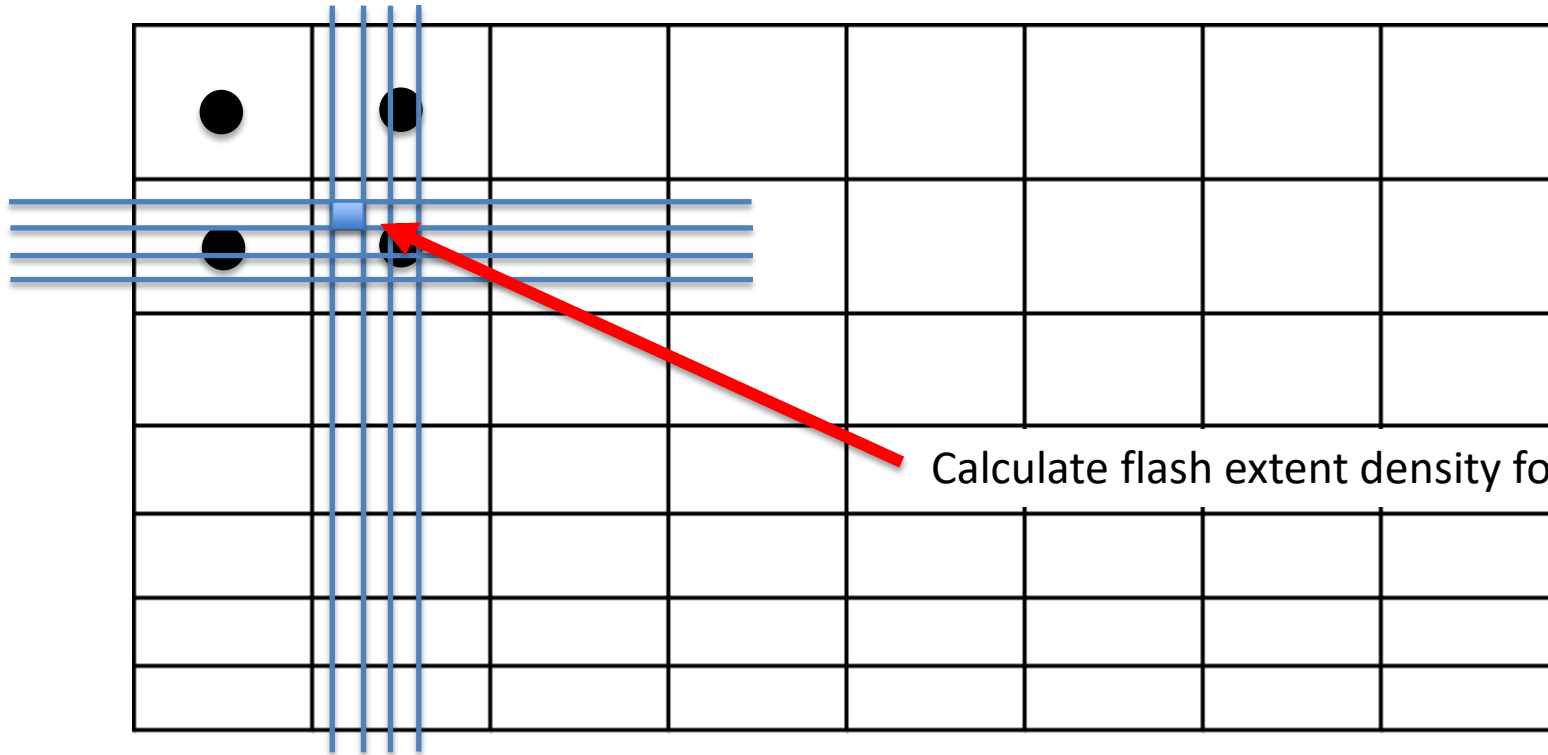
# Gridding Data



# Gridding Data

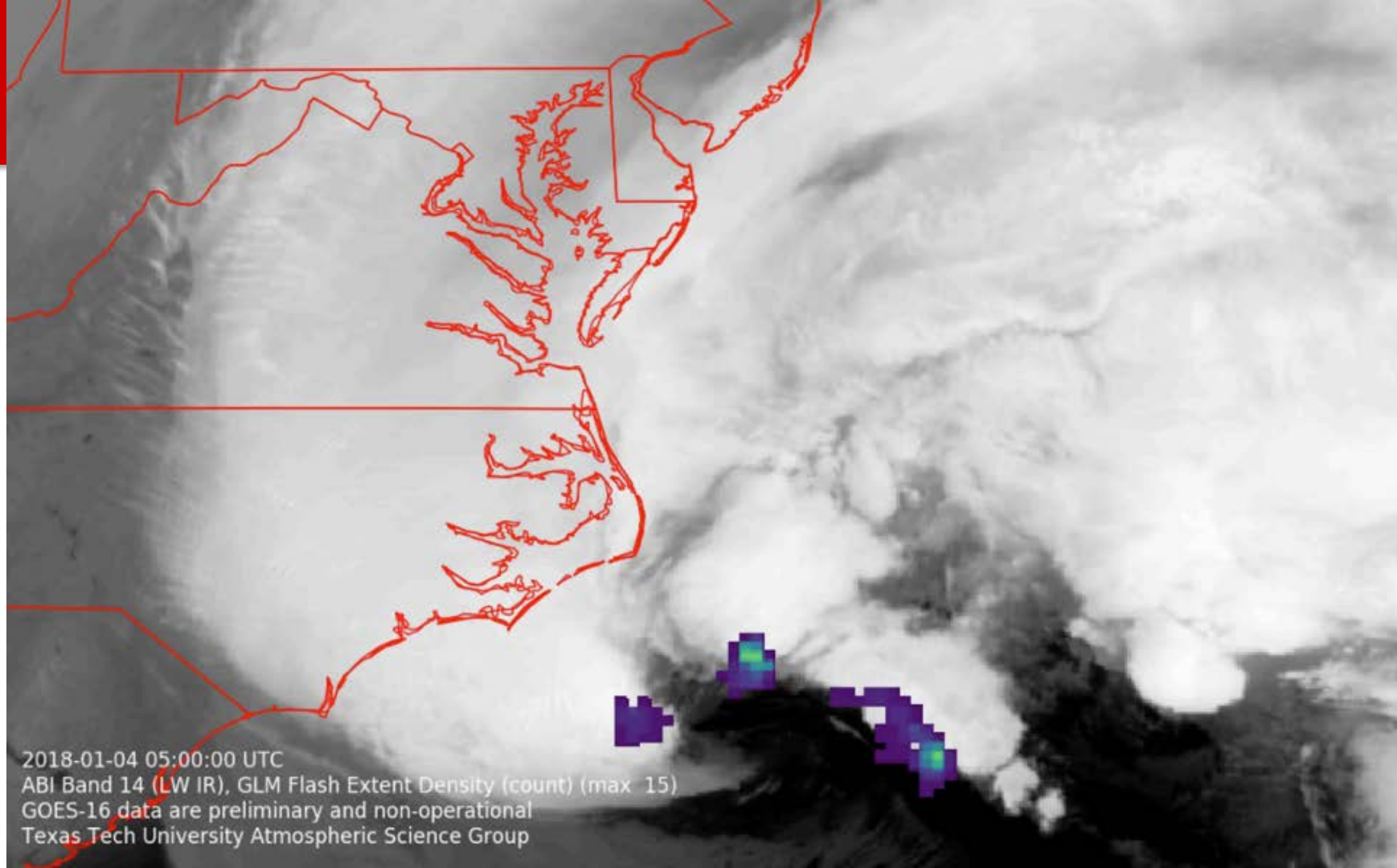


# Gridding Data

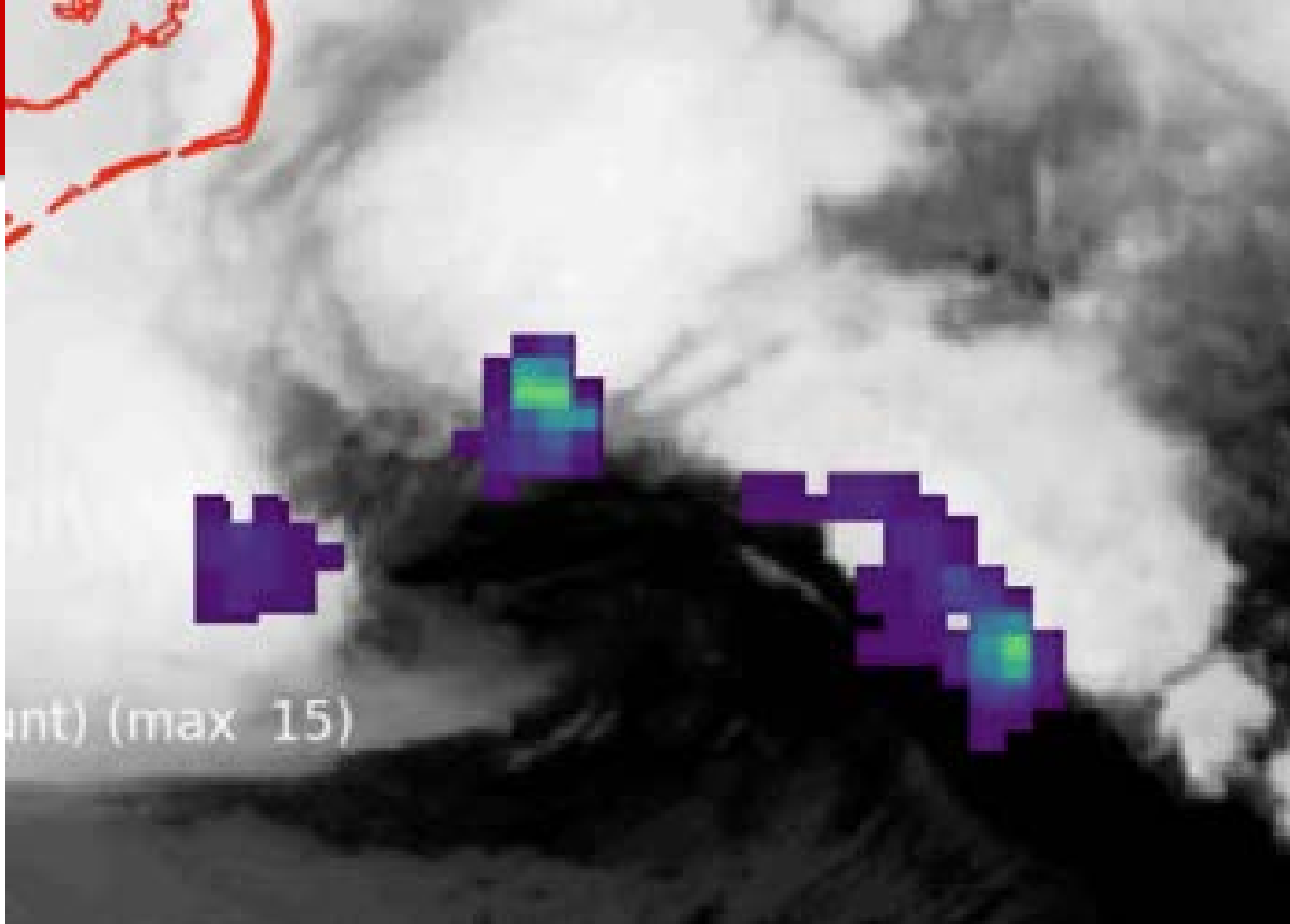


Calculate flash extent density for each point!

More here: <https://github.com/deeplycloudy/glmtools/blob/master/docs/callgraph.rst>



2018-01-04 05:00:00 UTC  
ABI Band 14 (LW IR), GLM Flash Extent Density (count) (max 15)  
GOES-16 data are preliminary and non-operational  
Texas Tech University Atmospheric Science Group



int) (max 15)





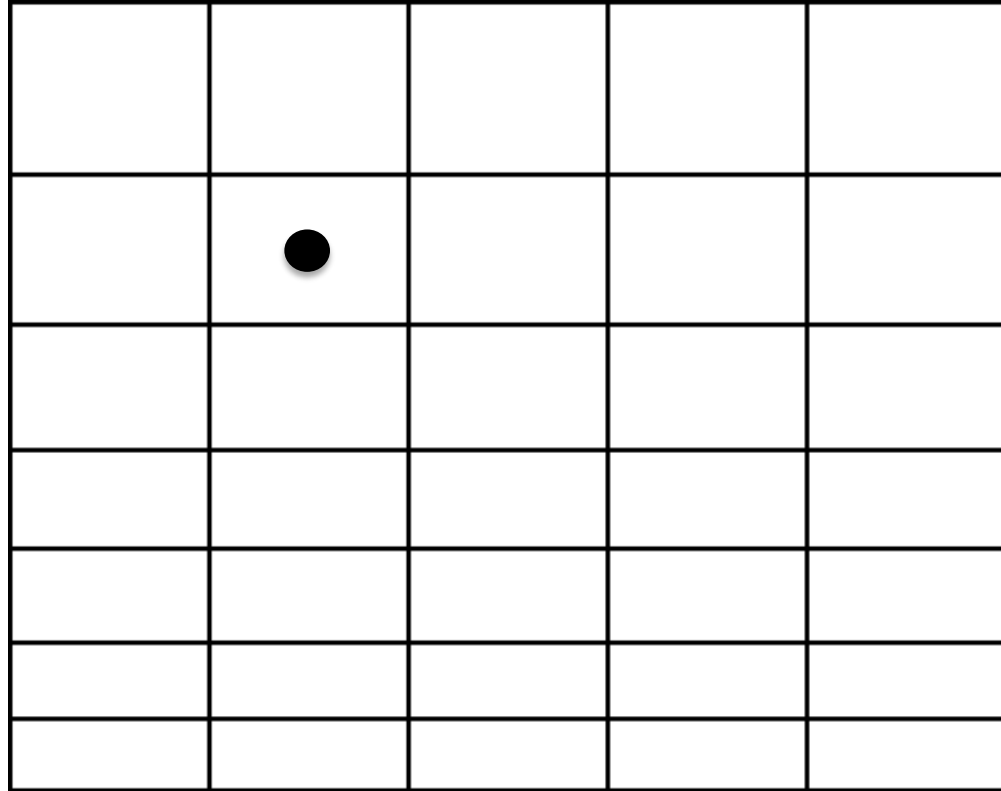


# Variables & Vocab!



## Event

A luminance threshold is achieved on a pixel







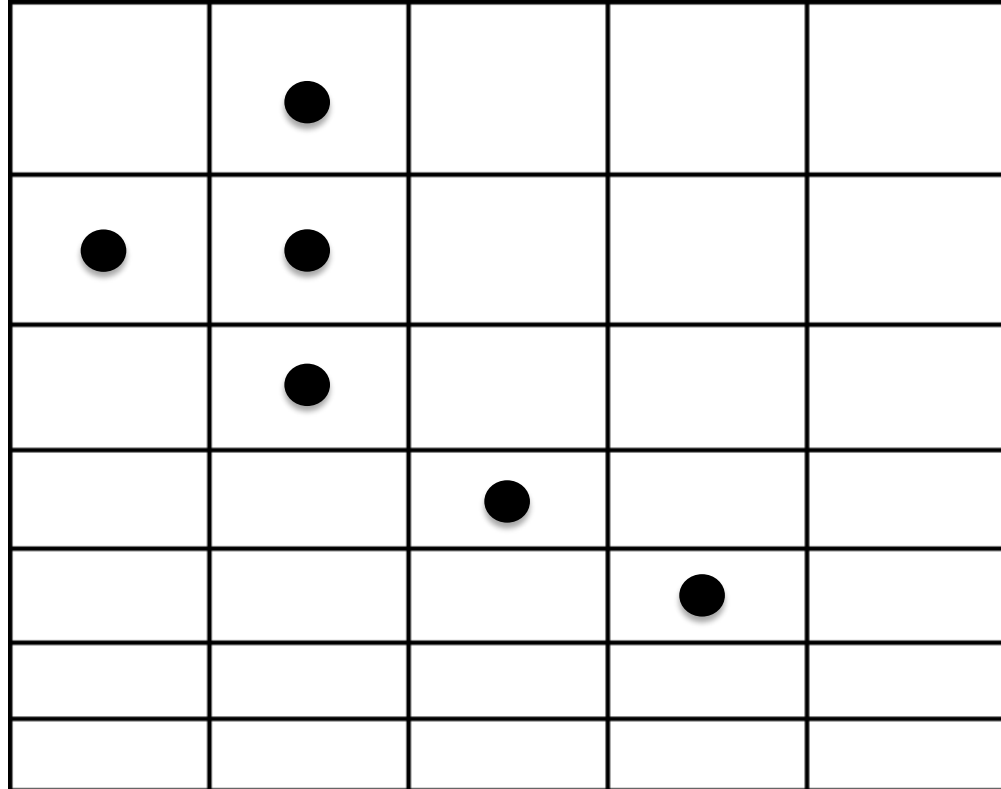


# Variables & Vocab!



## Group

A spatially-coherent cluster of events

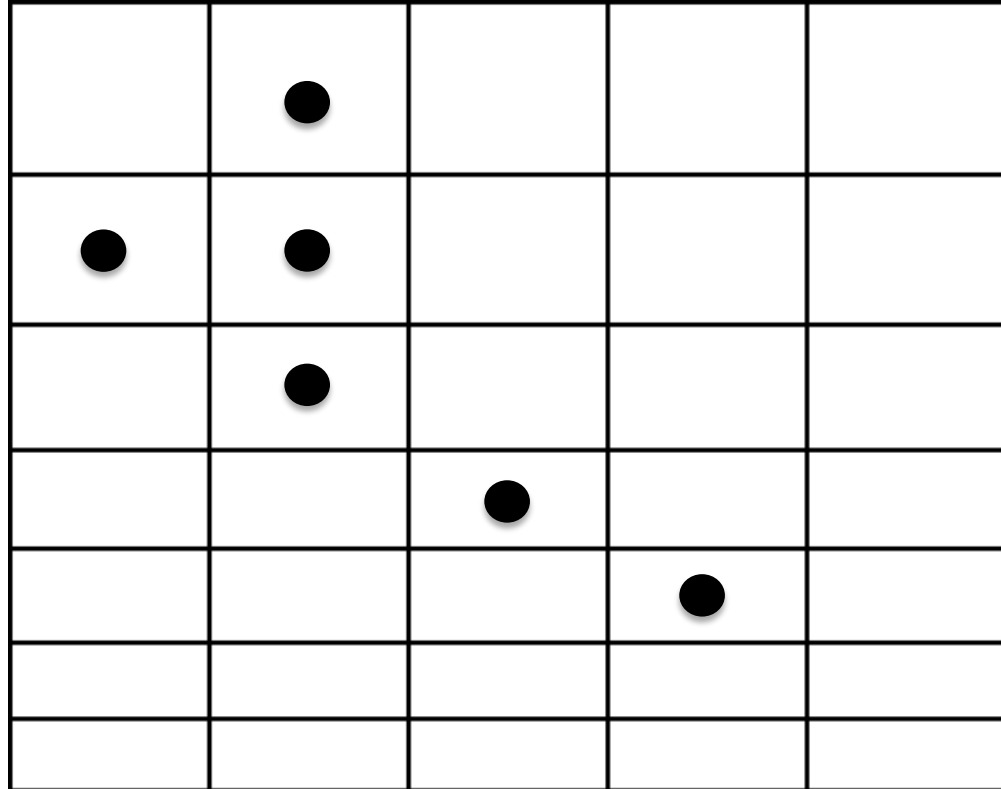


# Variables & Vocab!



## Group

A spatially-coherent cluster of events

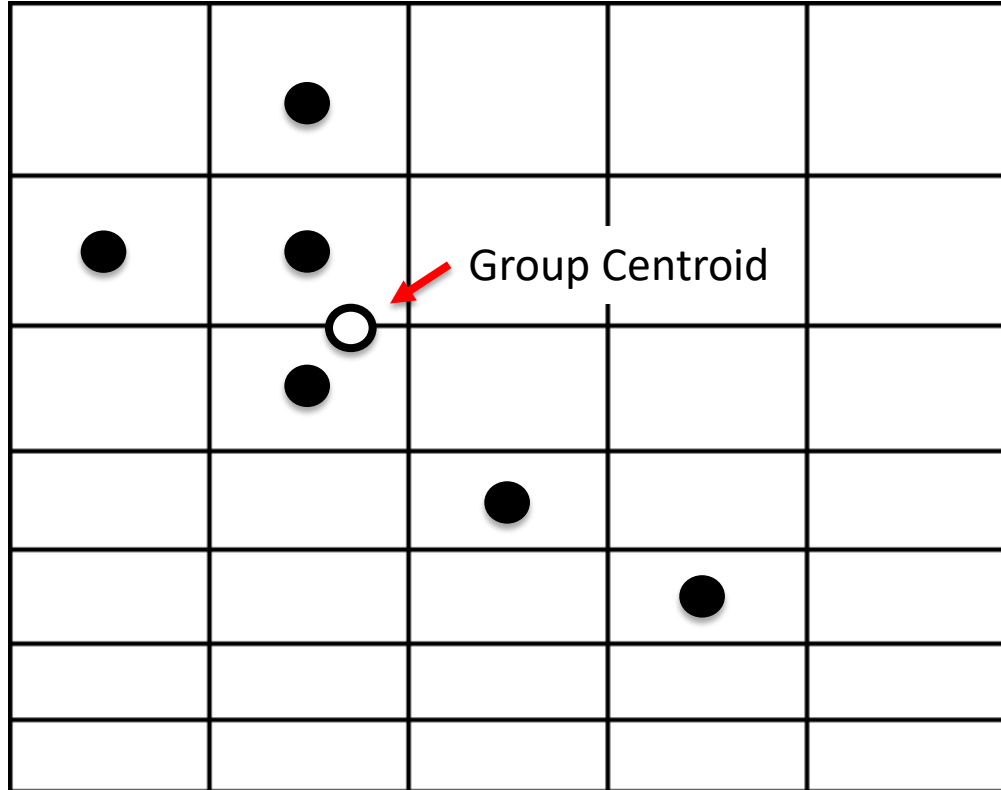


# Variables & Vocab!



## Group

A spatially-coherent cluster of events





# Variables & Vocab!



## Flash

A spatially-  
and temporally-coherent  
cluster of groups

●	●			
	●			





# Variables & Vocab!



## Flash

A spatially-  
and temporally-coherent  
cluster of groups

●	●			
	●	●	●	●



# Variables & Vocab!



## Flash

A spatially-  
and temporally-coherent  
cluster of groups

				●
				●
			●	
		●		

# Variables & Vocab!



## Flash

A spatially-  
and temporally-coherent  
cluster of groups

Single Flash! ->

●	●			
	●	●	●	●
				●
				●
			●	
		●		

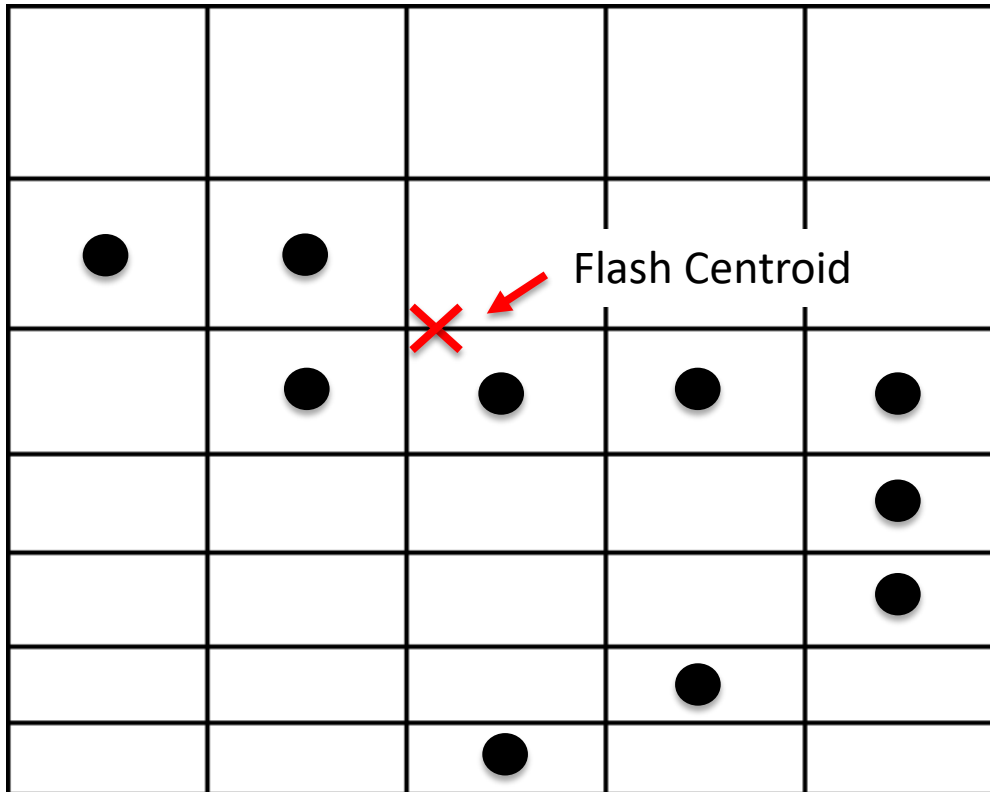
# Variables & Vocab!



## Flash

A spatially-  
and temporally-coherent  
cluster of groups

Single Flash! ->



# Variables & Vocab!



**Average Flash Area:**

Average size of all flashes that hit a pixel

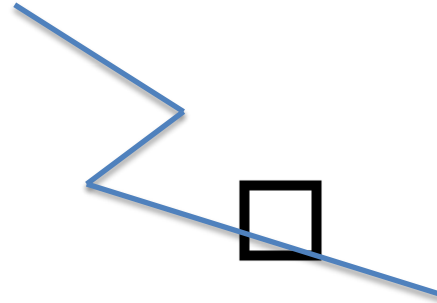


# Variables & Vocab!



**Average Flash Area:**

Average size of all flashes that hit a pixel





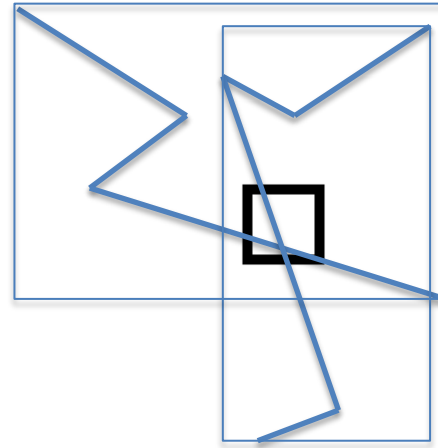


# Variables & Vocab!



**Average Flash Area:**

Average size of all flashes that hit a pixel



= ??? km<sup>2</sup>

# Variables & Vocab!



**Average Group Area:**

Average size of all groups that hit a pixel

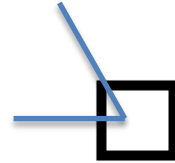


# Variables & Vocab!



**Average Group Area:**

Average size of all groups that hit a pixel

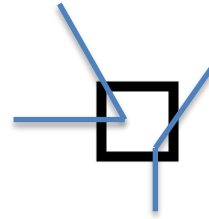


# Variables & Vocab!



**Average Group Area:**

Average size of all groups that hit a pixel

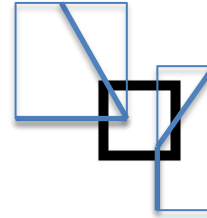


# Variables & Vocab!



**Average Group Area:**

Average size of all groups that hit a pixel



= ??? km<sup>2</sup>

# Variables & Vocab!



## Event Density:

Sum of all events that hit a pixel



# Variables & Vocab!



## Event Density:

Sum of all events that hit a pixel



# Variables & Vocab!



## Event Density:

Sum of all events that hit a pixel



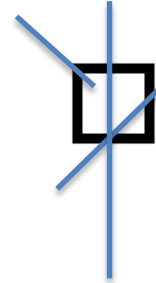


# Variables & Vocab!



## Event Density:

Sum of all events that hit a pixel



# Variables & Vocab!



## Event Density:

Sum of all events that hit a pixel



= 3 events

# Variables & Vocab!



## Flash Centroid Density:

Sum of all radiance-weighted flash centroids  
that hit a pixel

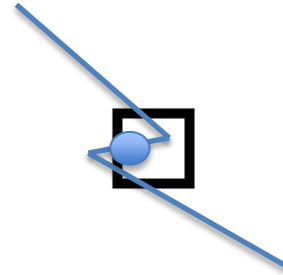


# Variables & Vocab!



## Flash Centroid Density:

Sum of all radiance-weighted flash centroids that hit a pixel

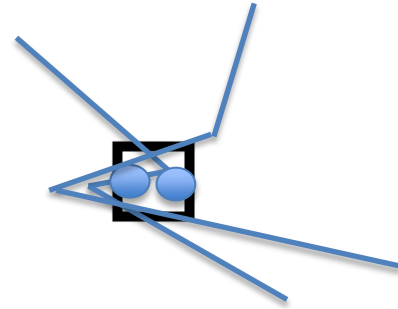


# Variables & Vocab!



## Flash Centroid Density:

Sum of all radiance-weighted flash centroids that hit a pixel

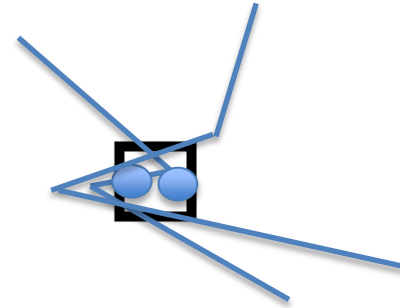


# Variables & Vocab!



## Flash Centroid Density:

Sum of all radiance-weighted flash centroids that hit a pixel



= 2 flash centroids

# Variables & Vocab!



## Flash Extent Density:

Sum of all individual flashes that hit a pixel

Avg Flash Area =  
Total Area / Flash Extent Density



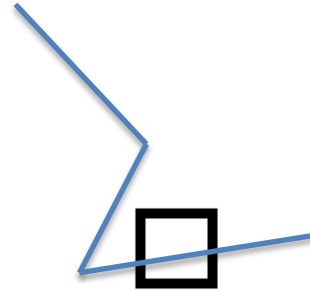
# Variables & Vocab!



## Flash Extent Density:

Sum of all individual flashes that hit a pixel

Avg Flash Area =  
Total Area / Flash Extent Density





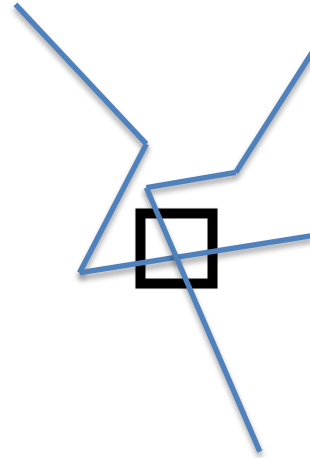
# Variables & Vocab!



## Flash Extent Density:

Sum of all individual flashes that hit a pixel

Avg Flash Area =  
Total Area / Flash Extent Density



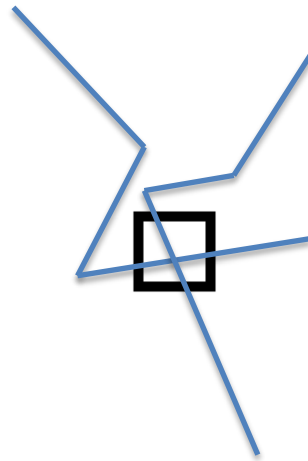
# Variables & Vocab!



## Flash Extent Density:

Sum of all individual flashes that hit a pixel

Avg Flash Area =  
Total Area / Flash Extent Density



= 2 flashes

# Variables & Vocab!



## Group Centroid Density

Sum of all radiance-weighted group centroids  
that hit a pixel

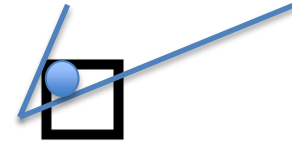


# Variables & Vocab!



## Group Centroid Density

Sum of all radiance-weighted group centroids  
that hit a pixel

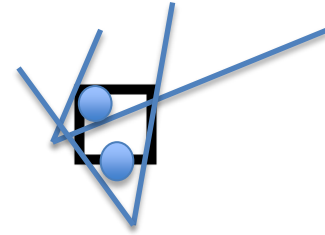


# Variables & Vocab!



## Group Centroid Density

Sum of all radiance-weighted group centroids that hit a pixel

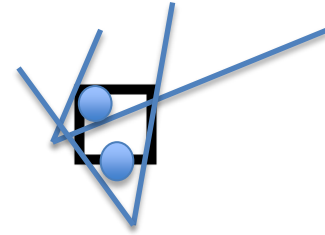


# Variables & Vocab!



## Group Centroid Density

Sum of all radiance-weighted group centroids that hit a pixel



= 2 group centroids

# Variables & Vocab!



## Group Extent Density

Sum of all individual groups that hit a pixel

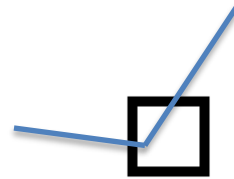


# Variables & Vocab!



## Group Extent Density

Sum of all individual groups that hit a pixel



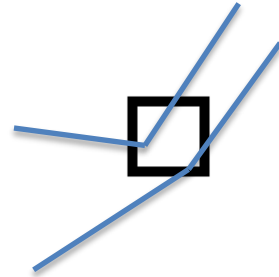


# Variables & Vocab!



## Group Extent Density

Sum of all individual groups that hit a pixel

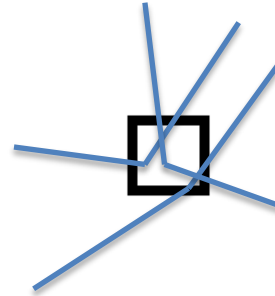


# Variables & Vocab!



## Group Extent Density

Sum of all individual groups that hit a pixel

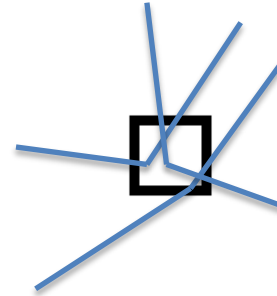


# Variables & Vocab!



## Group Extent Density

Sum of all individual groups that hit a pixel



= 3 groups

# Variables & Vocab!



## Total Energy

Sum of the radiances of all events  
that hit a pixel



# Variables & Vocab!



## Total Energy

Sum of the radiances of all events  
that hit a pixel

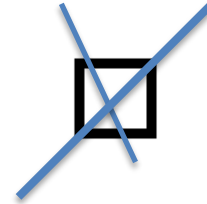


# Variables & Vocab!



## Total Energy

Sum of the radiances of all events  
that hit a pixel

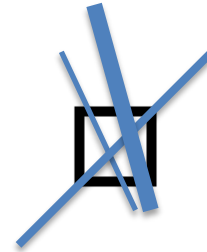


# Variables & Vocab!



## Total Energy

Sum of the radiances of all events  
that hit a pixel



# Variables & Vocab!



## Total Energy

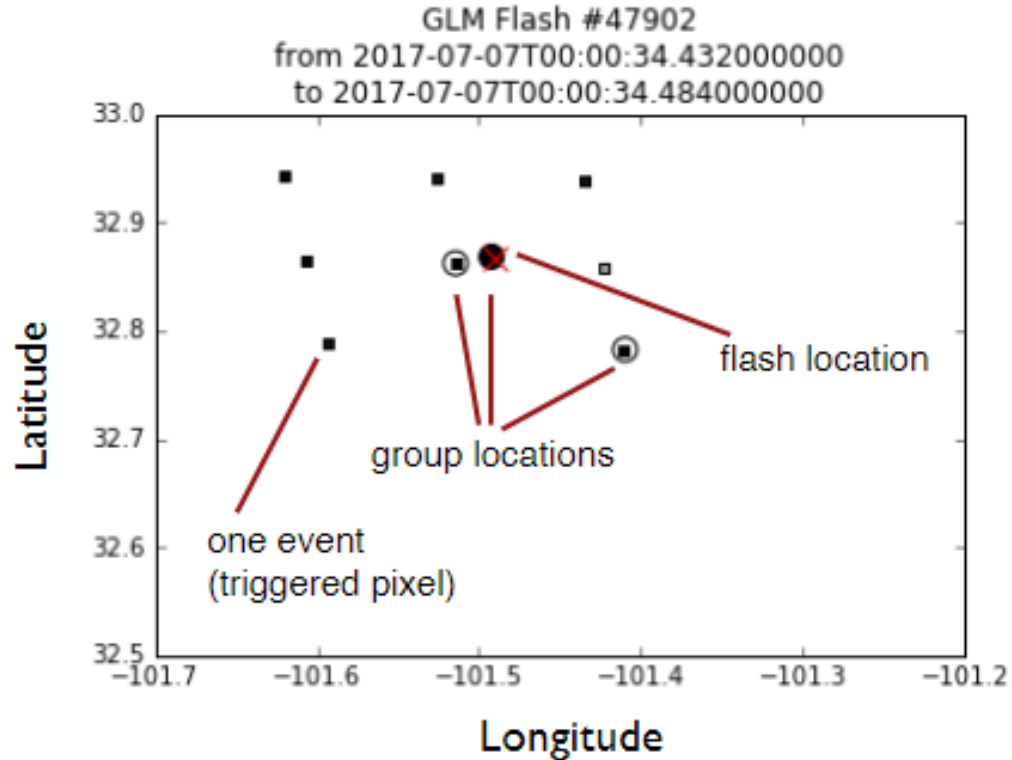
Sum of the radiances of all events  
that hit a pixel



= ??? Joules ( $\sim 10^{-12}$ )



# The Full Picture



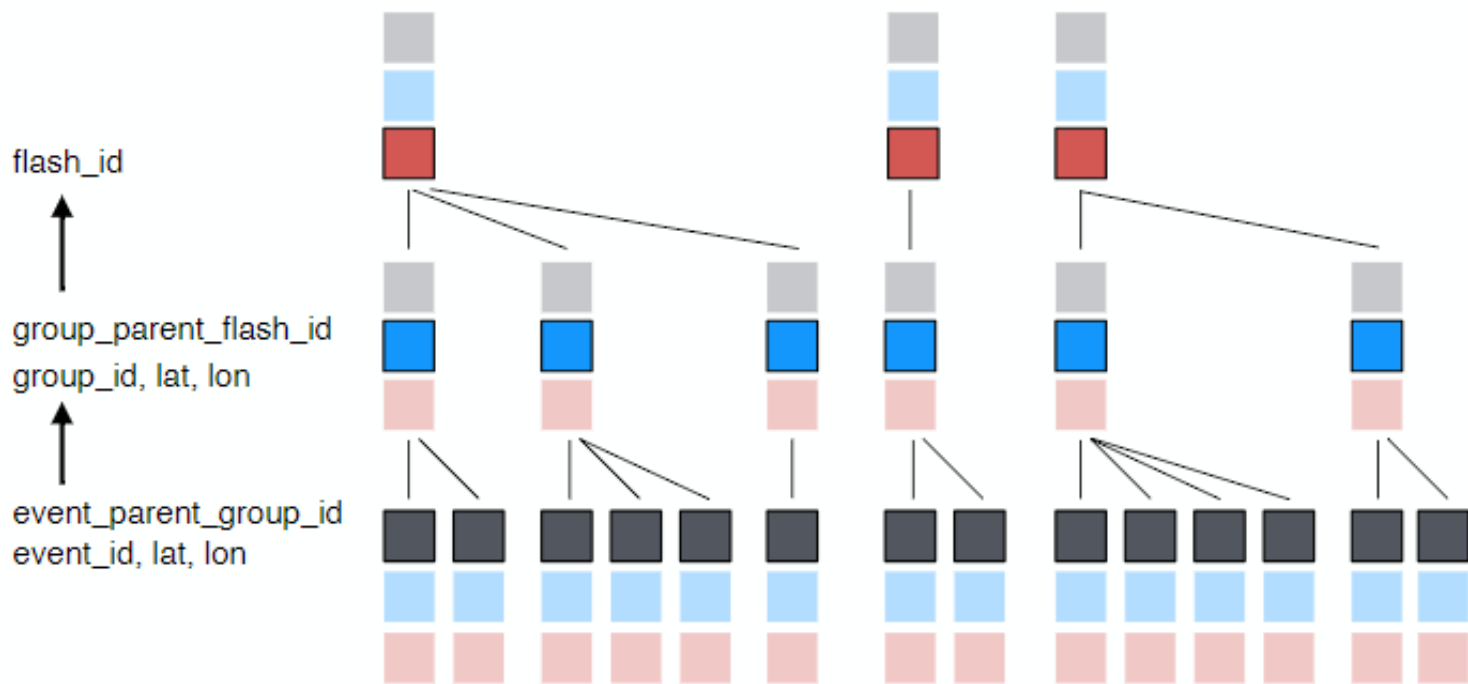
# Data Hierarchy



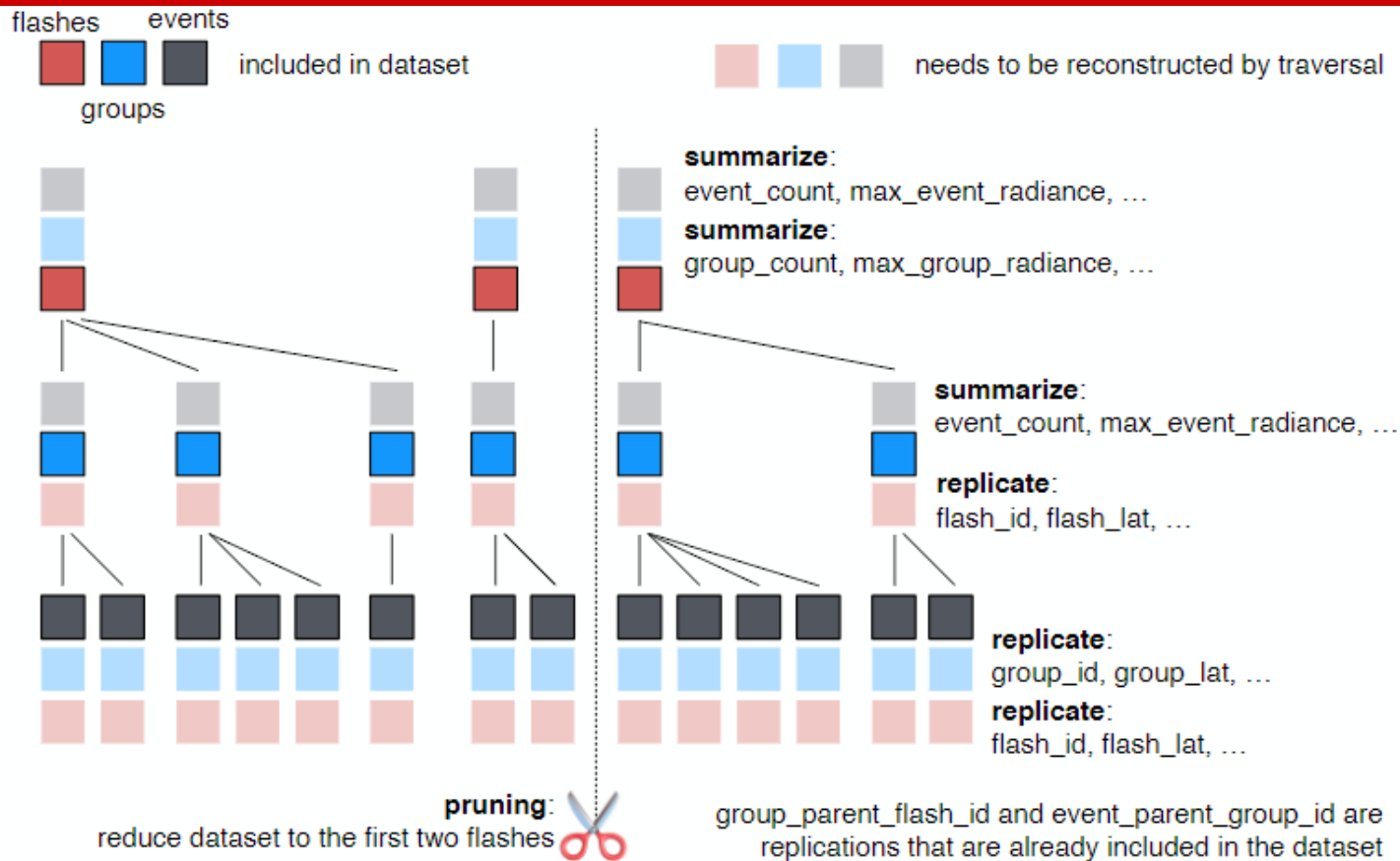
included in dataset



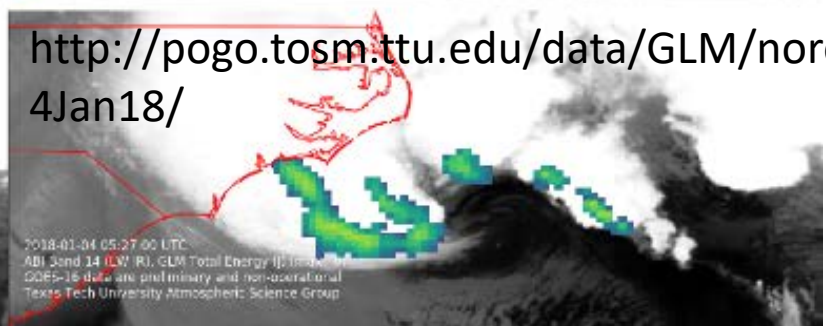
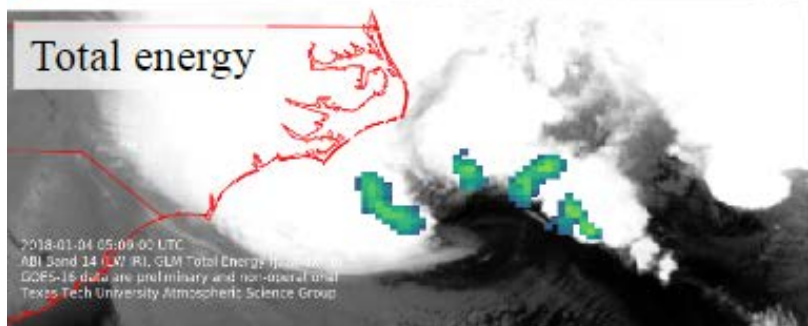
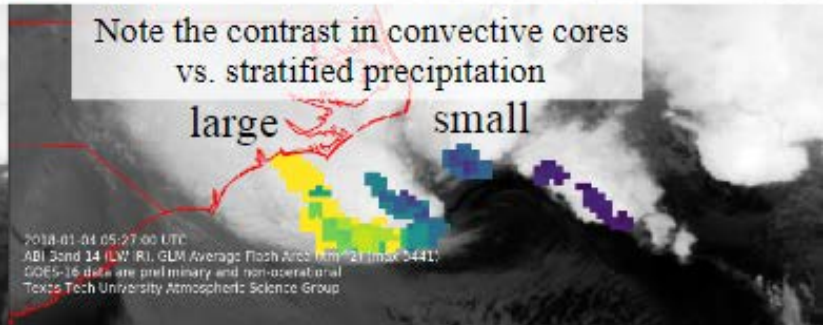
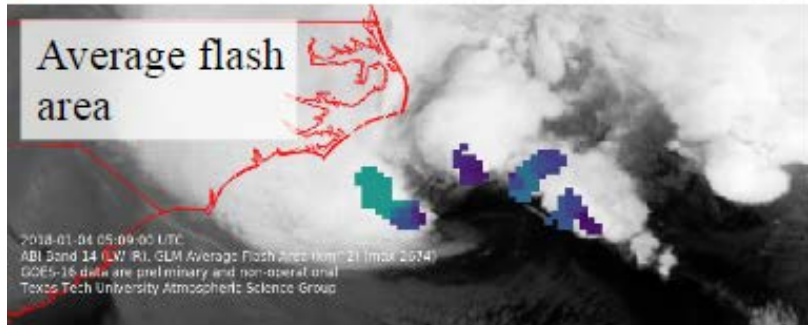
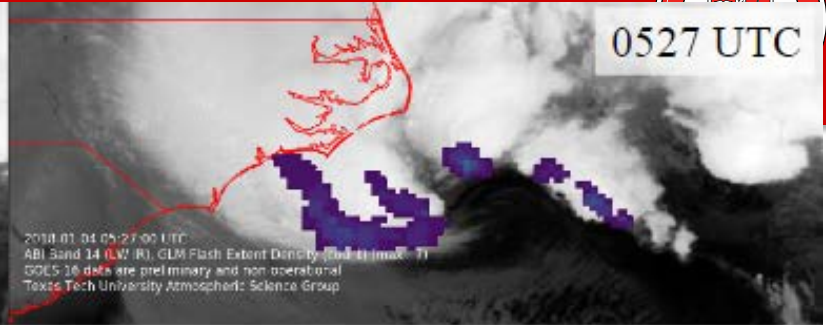
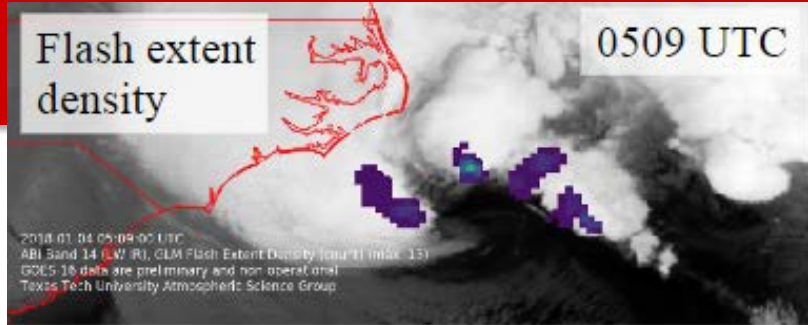
needs to be reconstructed by traversal  
(next slide)



# Data Hierarchy







<http://pogo.tosm.ttu.edu/data/GLM/noreaster4Jan18/>

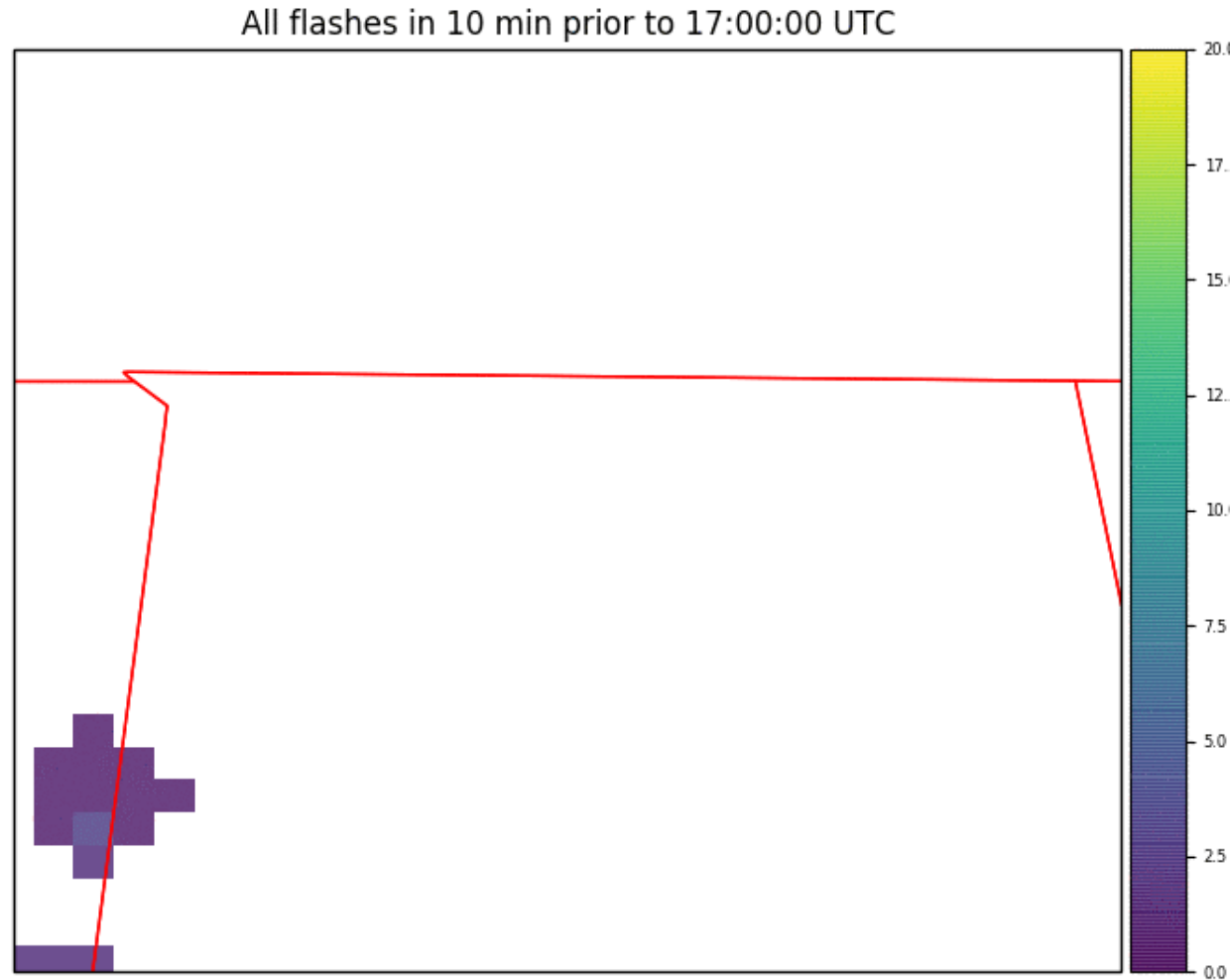
# Live Data!



Let's take a look at some live data!

# Gridded Data!

Let's take a look at some past gridded data!



# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension



# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e20171202135000\_c20171202135027.nc

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-**LCFA**\_G16\_s20171202134400\_e20171202135000\_c20171202135027.nc

algorithm that processes events into flashes

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s**20171202134400**\_e20171202135000\_c20171202135027.nc

start

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e**20171202135000**\_c20171202135027.nc

end

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e20171202135000\_**c20171202135027**.nc

created

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s**2017**1202134400\_e20171202135000\_c20171202135027.nc

year

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s2017**120**2134400\_e20171202135000\_c20171202135027.nc

Julien Day

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s2017120**21**34400\_e20171202135000\_c20171202135027.nc

hour (UTC)



# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s201712021**34**400\_e20171202135000\_c20171202135027.nc

minute

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134**400**\_e20171202135000\_c20171202135027.nc

second

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e20171202135000\_c20171202135027.nc

tenth of second

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e20171202135000\_c20171202135027.nc

Data began **2017 4/30 21:34:40z**

Data ended **2017 4/30 21:35:00z**

File created **2017 4/30 21:35:02.7z**

# My Workflow



Raw data files:

- 20s data
- Contain “event”, “group” and “flash” dimension

Naming:

OR\_GLM-L2-LCFA\_G16\_s20171202134400\_e20171202135000\_c20171202135027.nc

Data began **2017 4/30**

Data ended **2017 4/30**

File created **2017 4/30**

**Yes, that's a lot of files a day**

# My Workflow



Gridding data

\*activate glmval

**Want a 500km by 500km box around Huntsville:**

# My Workflow



Gridding data

\*activate glmval

**Want a 500km by 500km box around Huntsville:**

```
make_GLM_grids.py -o ~/grid_files -fixed_grid -split_events -  
goes_position east -goes_sector conus -dx=2.0 -dy=2.0 --ctr_lat 34.7 --  
ctr_lon -86.6 --start=(time) --end=(time) OR*.nc
```

\*netCDF files

# My Workflow



What I get from this (.nc files):

- flash\_extent
- flash\_init
- flashsize\_std
- footprint
- group\_area
- group\_extent
- group\_init
- source
- specific\_energy
- total\_energy



# My Workflow



Viewing Data / Making Lassos:

\*activate glmval

**Want a box around a specific storm for a certain length of time:**

# My Workflow



Viewing Data / Making Lassos:

\*activate glmval

**Want a box around a specific storm for a certain length of time:**

jupyter notebook - GridLassoAnalysis.ipynb

-log lasso

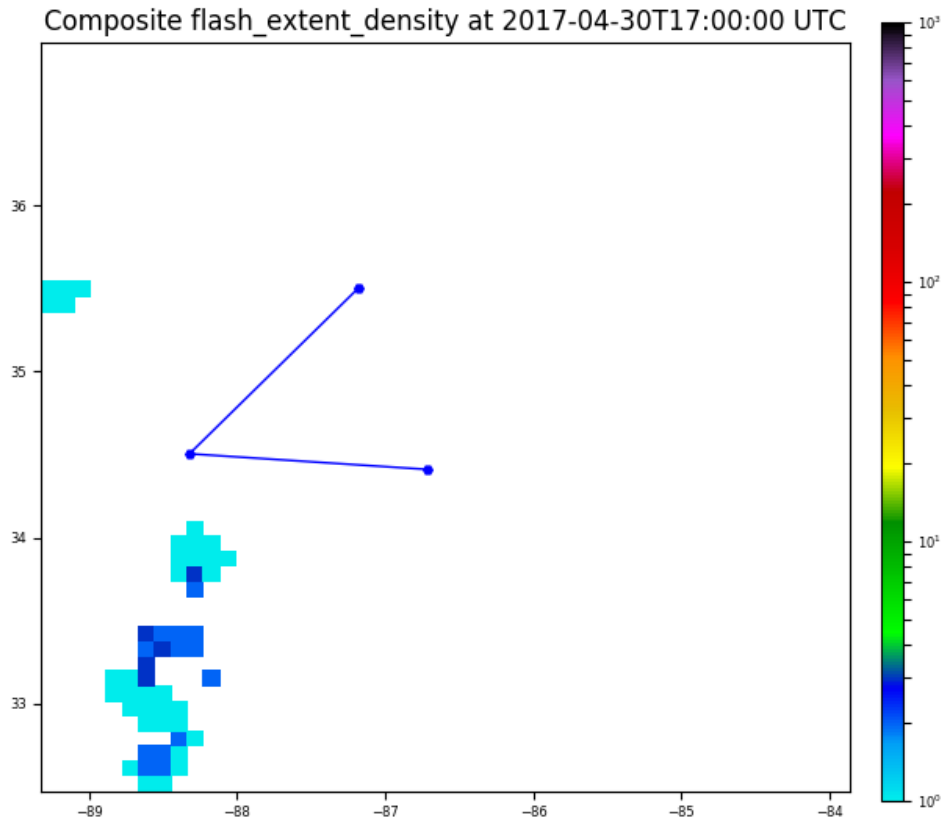
-draw lasso

-edit lasso .txt file

# My Workflow



Viewing Data / Making Lassos:



# My Workflow



Calculating Flash Stats

\*activate glmval

**Want to know stats of lightning in a given area / timeframe**

# My Workflow



Calculating Flash Stats

\*activate glmval

**Want to know stats of lightning in a given area / timeframe**

glm\_lma\_param\_space.sh

(Timeseries, etc.)

# The Future



## Collaborations!

Funding for Unidata cloud service:

- Put glmtools on Unidata jetstream cloud service with browse notebooks
- Run local processing at Tech on glm grids
- Distribute grids with LDM/Thredds
- Perform variety of data analysis
  
- *Make glmtools \*simple\* and available to the community!*

# The Future



## Collaborations!

Funding for Unidata cloud service:

- Put glmtools on Unidata jetstream cloud service with browse notebooks
- Run local processing at Tech on glm grids
- Distribute grids with LDM/Thredds
- Perform variety of data analysis
  
- *Make glmtools \*simple\* and available to the community!*

GOES-R HWT blog: <http://goesrhwt.blogspot.com/>