



Extreme Convection vs. Extreme Rainfall: A Global View

[A largely unanswered question, even today?]

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Acknowledgments: Many current and former students; conversations and interactions with too many colleagues to name; Chuntao Liu for creating and maintaining the TRMM and GPM precipitation feature database



MOTIVATION AND SPECIFIC OBJECTIVE



CONVENTIONAL VIEW: Deep and intense convection normally is accompanied by intense convective rainfall rates *but.....*

Some catastrophic flood events (Big Thompson CO, 1976; Ft. Collins CO, 1997, were shown to be from less intense convection with “low echo centroid” radar profiles, similar to those from tropical oceanic convection (Petersen et al. 1999)

Smith et al. (2001...2019) countered with examples of excessive rainfall rates and flooding from very intense convection, including supercell thunderstorms, reinforced by many other examples by Nielsen and Schumacher (“TORFF” storms; 2015-2020).

Hamada et al. (2015) used TRMM radar data to show global distribution of both types of events but were criticized by Wang and Tang (2020) for using percentages; here we use GPM radar data showing global distributions of *both* types selecting the strongest ~1000 events of each type.

Use GPM Precip Database to find top ~1000 instances during 2017, 65°N – 65°S satisfying the following conditions:

Type	Max near-sfc dBZ	Max Ht 40 dBZ	Number found
R++ ; shallow conv - small	50-60	0 – 6.2 km	930
R++ ; shallow conv -large	51-60	0 – 5.6 km	980
Intense Conv+R+small	48-60	9-20 km	965
Intense Conv+R+large	48-60	9-20 km	967
Intense Conv w/o R++ small	0-49	9-20 km	911
Intense Conv w/o R++ large	0-48	9-20 km	31 (!)

Searching MCSs for the following conditions:

Satellite:GPM

Date from 20170101 to 20171231

VolRain from 0 to 10000 mm*km²/hr

Flashes -100-5000

Land or Ocean: Both

reading data...

Latitude from -65 to 65

Max Height of 20 dB 0-20 km

Max NearSurf 50-60 dB

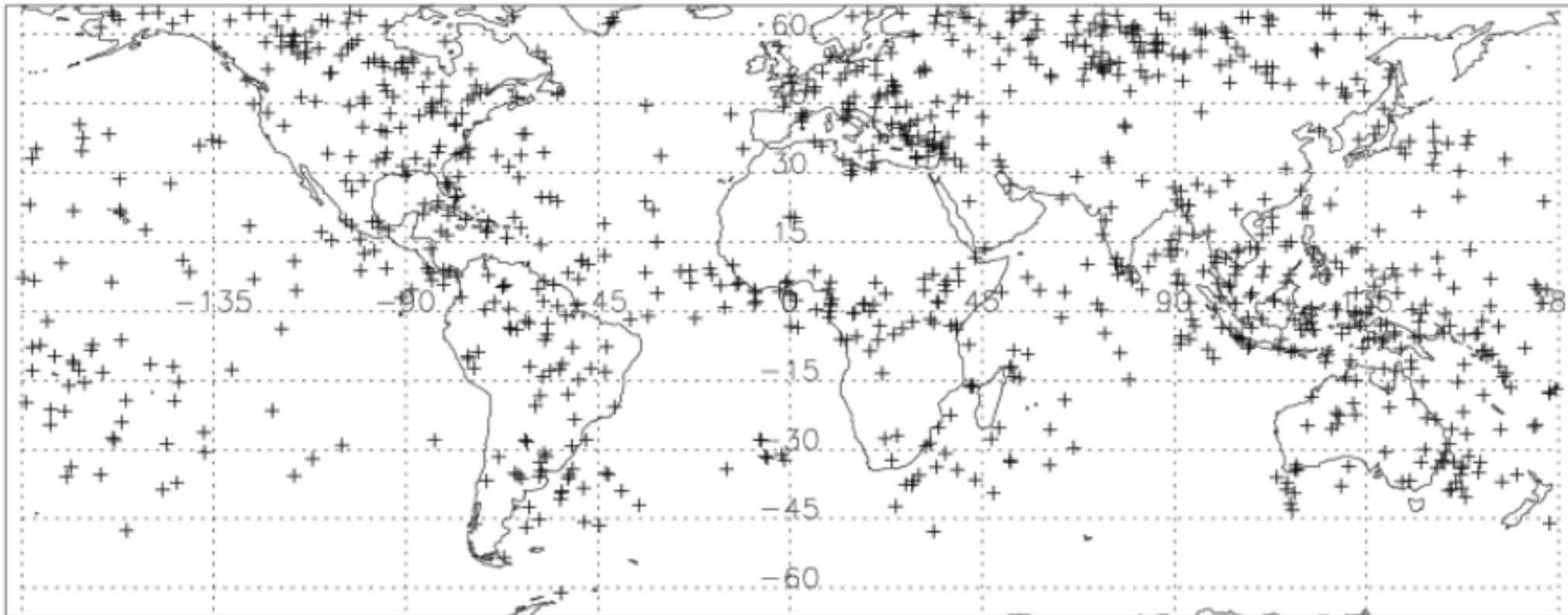
Sort By: rain volume

Longitude from -180 to 180

Max Height of 40 dB 0-6.2 km

% Convective rain 0-100 %

930 MCSs were found *EXTREME RAIN RATE; SHALLOW CONVECTION;
.....BUT SMALL RAIN AREA*



Searching MCSs for the following conditions:

Satellite:GPM

Date from 20170101 to 20171231

VolRain from 50000 to 4000000 mm*km^2/hr

Flashes -100-5000

Land or Ocean: Both

reading data...

Latitude from -65 to 65

Max Height of 20 dB 0-20 km

Max NearSurf 51-60 dB

Sort By: rain volume

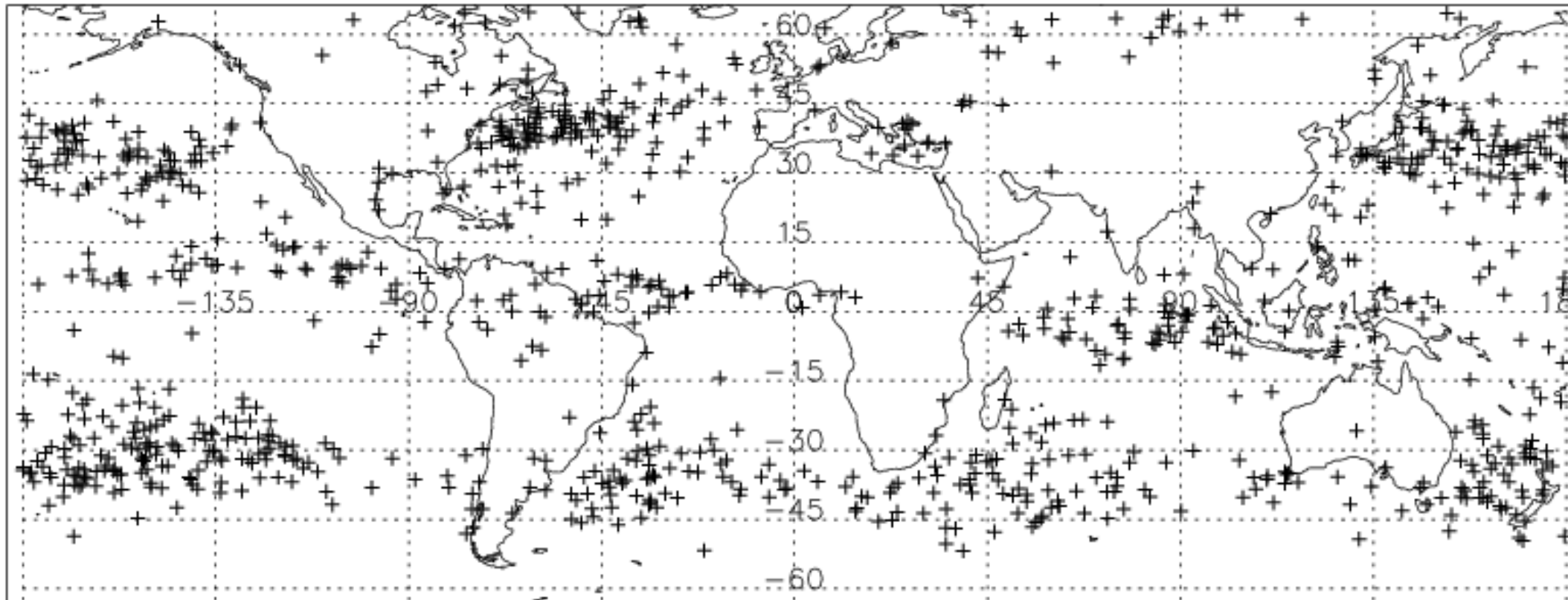
Longitude from -180 to 180

Max Height of 40 dB 0-5.6 km

% Convective rain 0-100 %

980 MCSs were found

*EXTREME RAIN RATE; SHALLOW CONVECTION;
.....BUT VERY LARGE RAIN AREA*



Searching MCSs for the following conditions:

Satellite:GPM

Date from 20170101 to 20171231

VolRain from 0 to 10000 mm*km²/hr

Flashes -100-5000

Land or Ocean: Both

reading data...

Latitude from -65 to 65

Max Height of 20 dB 0-20 km

Max NearSurf 48-60 dB

Sort By: rain volume

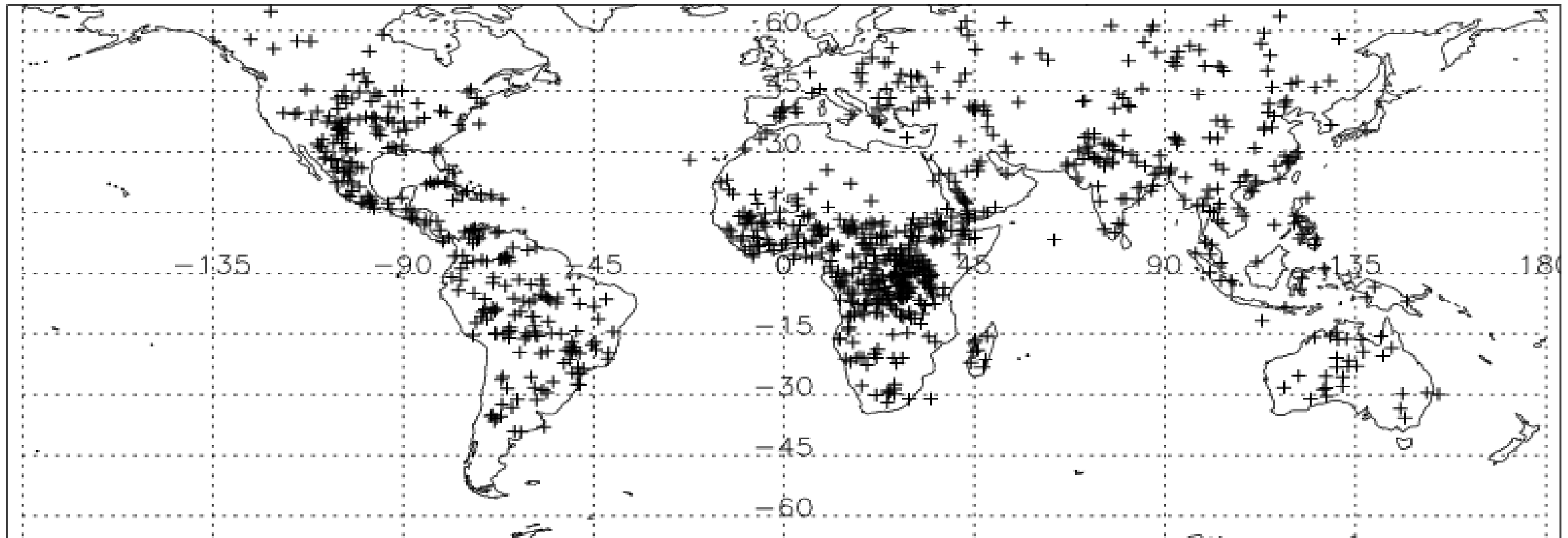
Longitude from

Max Height of 4

% Convective r

965 MCSs were found

*EXTREME RAIN RATE + INTENSE CONVECTION;
.....SMALL RAIN AREA*



Searching MCSs for the following conditions:

Satellite:GPM

Date from 20170101 to 20171231

VolRain from 20000 to 4000000 mm*km²/hr

Flashes -100-5000

Land or Ocean: Both

reading data...

Latitude from -65 to 65

Max Height of 20 dB 0-20 km

Max NearSurf 48-60 dB

Sort By: rain volume

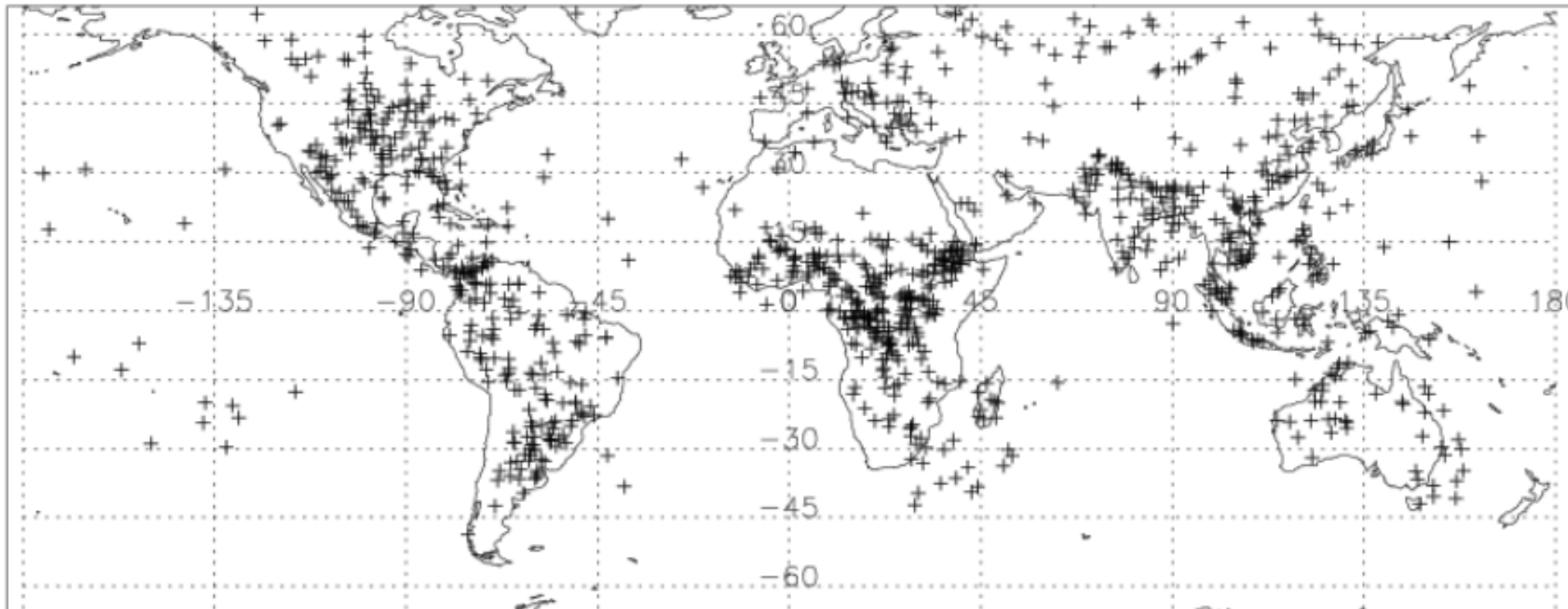
Longitude from -180 to 180

Max Height of 40 dB 9-20 km

% Convective rain 0-100 %

967 MCSs were found

*EXTREME RAIN RATE+ INTENSE CONVECTION;
.....BUT LARGE RAIN AREA*



Searching MCSs for the following conditions:

Satellite: GPM

Date from 20170101 to 20171231

VolRain from 0 to 20000 mm*km²/hr

Flashes -100-5000

Land or Ocean: Both

reading data...

Latitude from -65 to 65

Max Height of 20 dB 0-20 km

Max NearSurf 0-49 dB

Sort By: rain volume

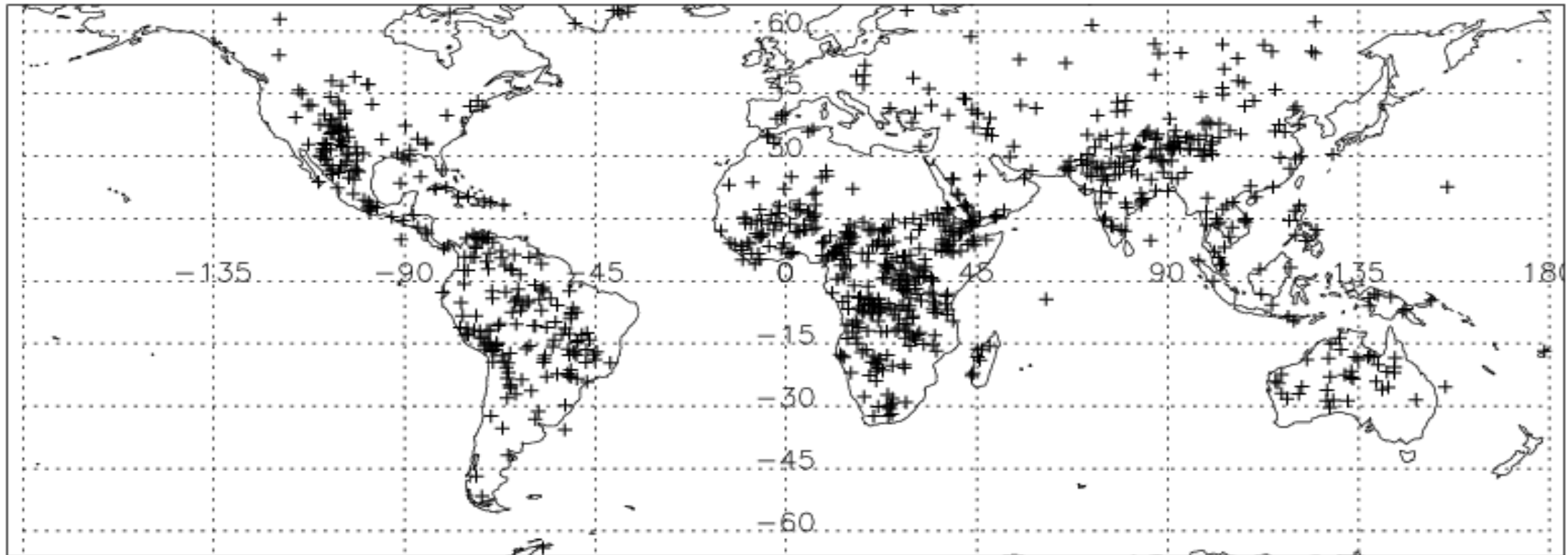
Longitude from -180 to 180

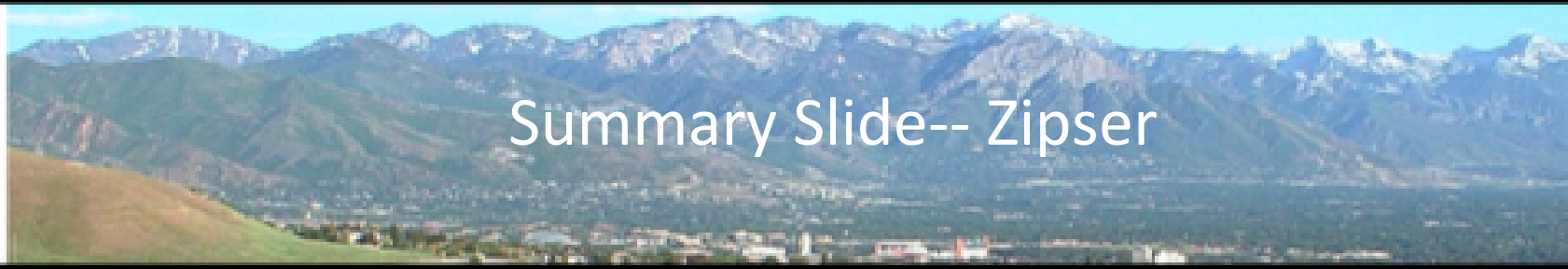
Max Height of 40 dB 9-20 km

% Convective rain 0-100 %

911 MCSs were found

*DEEP, INTENSE CONVECTION..... WITHOUT EXCESSIVE RAIN RATES
.....AND SMALL RAIN AREA (HARDLY ANY AT LARGER RAIN AREAS)*





Summary Slide-- Zipser



Locate the top ~1000 rain features for 2017, 65°S – 65°N in following categories:

- Excessive rainfall rate **without** deep, intense convection; (low echo centroid):
Small area: All latitudes land/ocean; *Large area: mostly mid-latitude ocean*
- Excessive rainfall rate **together with** deep, intense convection: Land areas favored overwhelmingly for all sizes.
- Deep, intense convection **without** excessive rainfall rates: Land only.

Note that there are hardly any instances of this combination anywhere on earth, land or ocean. Conclusion: intense convection commonly exists together with extreme rainfall rates (validating Smith et al.).