Mesoscale Convective Systems (MCSs) in the Intra-Americas Seas (IAS): Evidence from TRMM (for Session 1)

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The TRMM Precipitation Feature Database is accessible to all at:
http://trmm.chpc.utah.edu/ AND/OR http://atmos.tamucc.edu/trmm/

Questions or assistance? Contact the author, or

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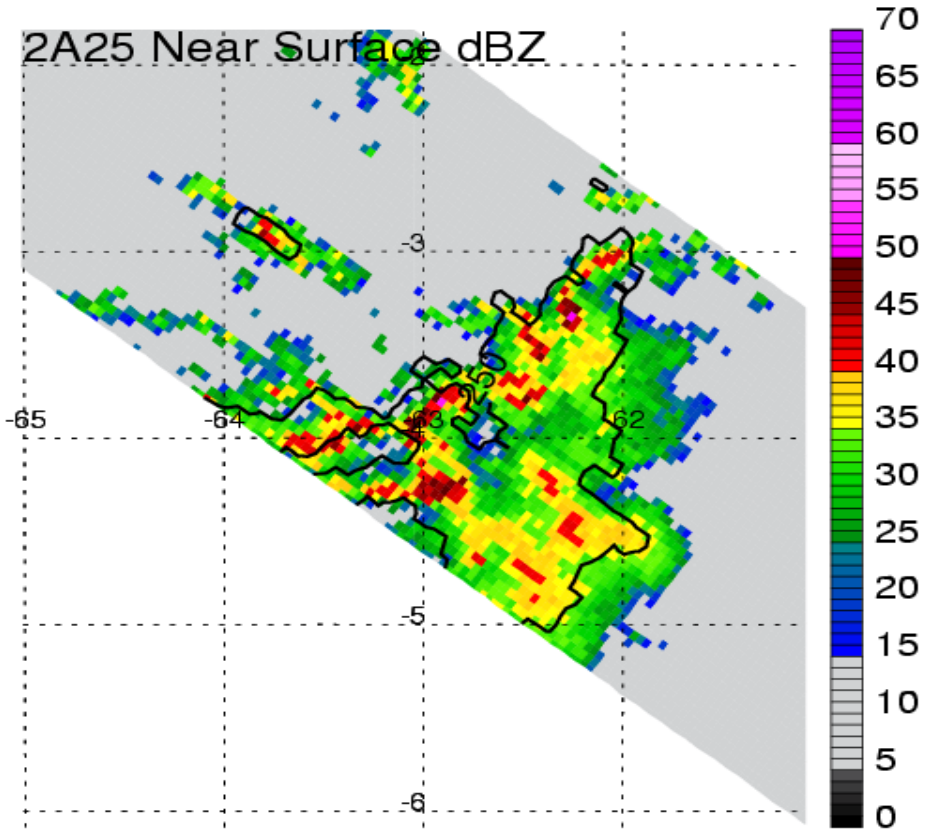
Precipitation Features

How do we define a “precipitation feature” (PF)?

Contiguous rain area at least 4 pixels in size (75 km^2) …

This database was updated to its 4th version in *Liu et al., JAMC 2008*, updated to TRMM V7, and generalized so that the PFs can be defined from any of the TRMM instruments (radar, passive microwave, lightning, IR)

How do we define a “mesoscale convective system” (MCS?) By size of the PF, generally > 100 km linear dimension or > 2000 km^2 in area



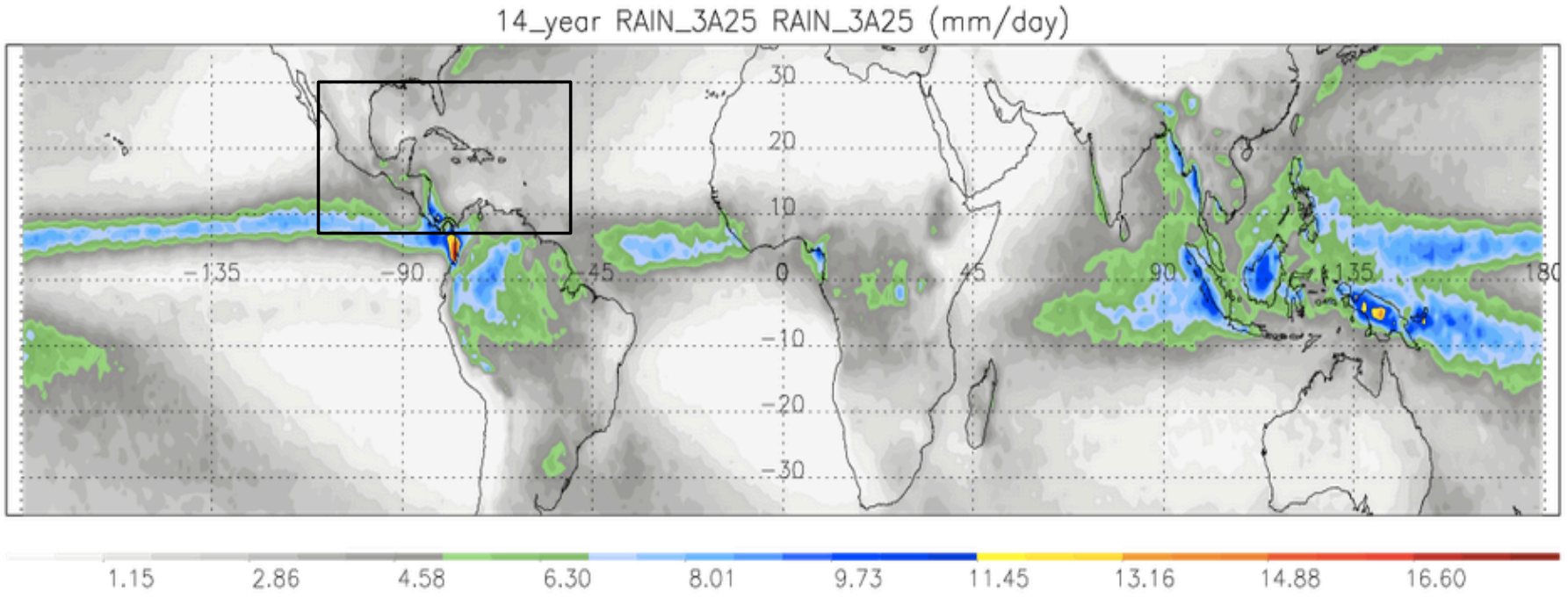
Some early uses of the PF database

- Where in the world does most rain come from large systems (like MCSs)?
- Where does most rain come from light rain rates? Heavy rain rates?
- What fraction of rainfall over land and ocean is from thunderstorms?
- Where are the strongest convective storms on earth?

To answer such questions, we went beyond the radar structure, so valuable from the PR algorithms, to add information from TMI, LIS, and VIRS

Global Annual Rainfall from TRMM *Radar* Retrieval

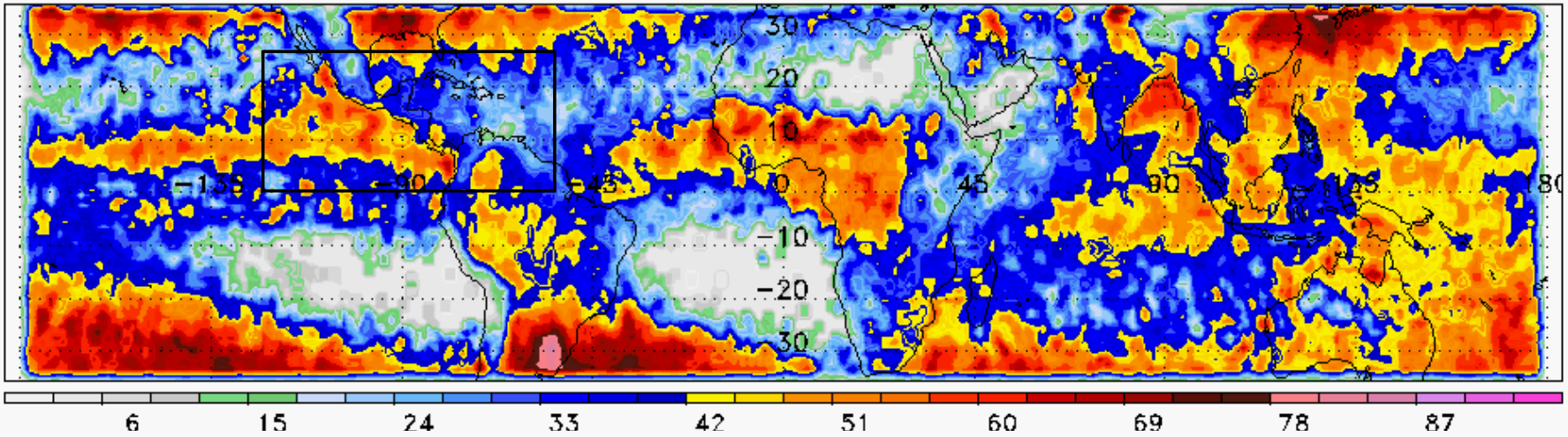
Description: TRMM 3A25 mean monthly rain
Mean: 2.68653
Standard deviation: 2.17340
Download the DATA



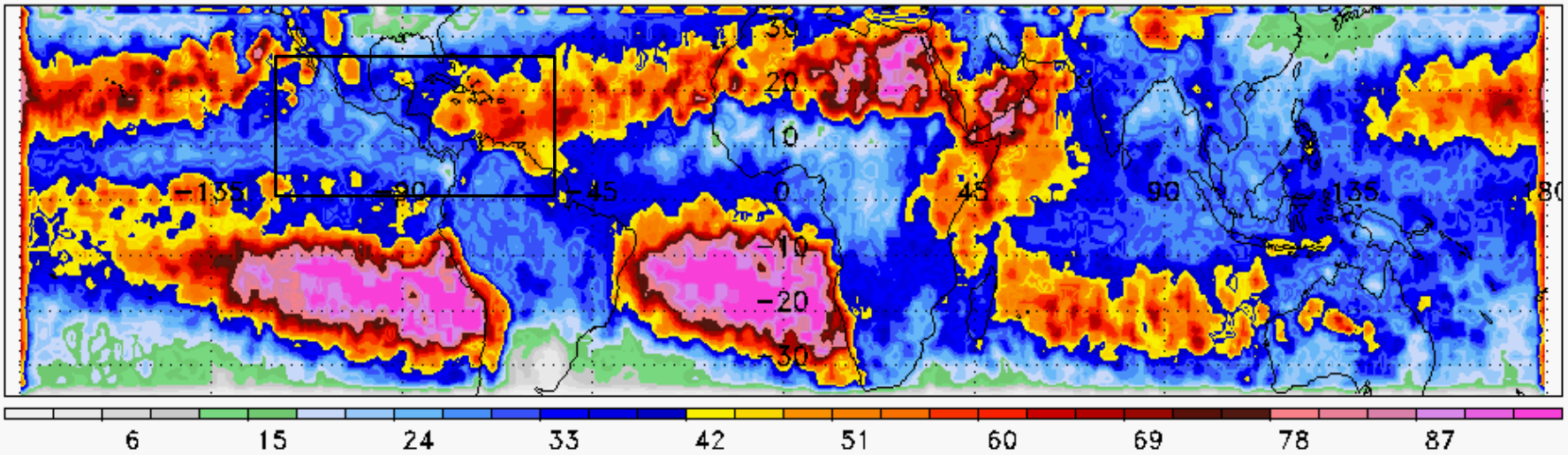
(Rectangle shows IAS domain for later detailed figures)

Fractional rain (%) contributed by large PFs *vs.* small PFs

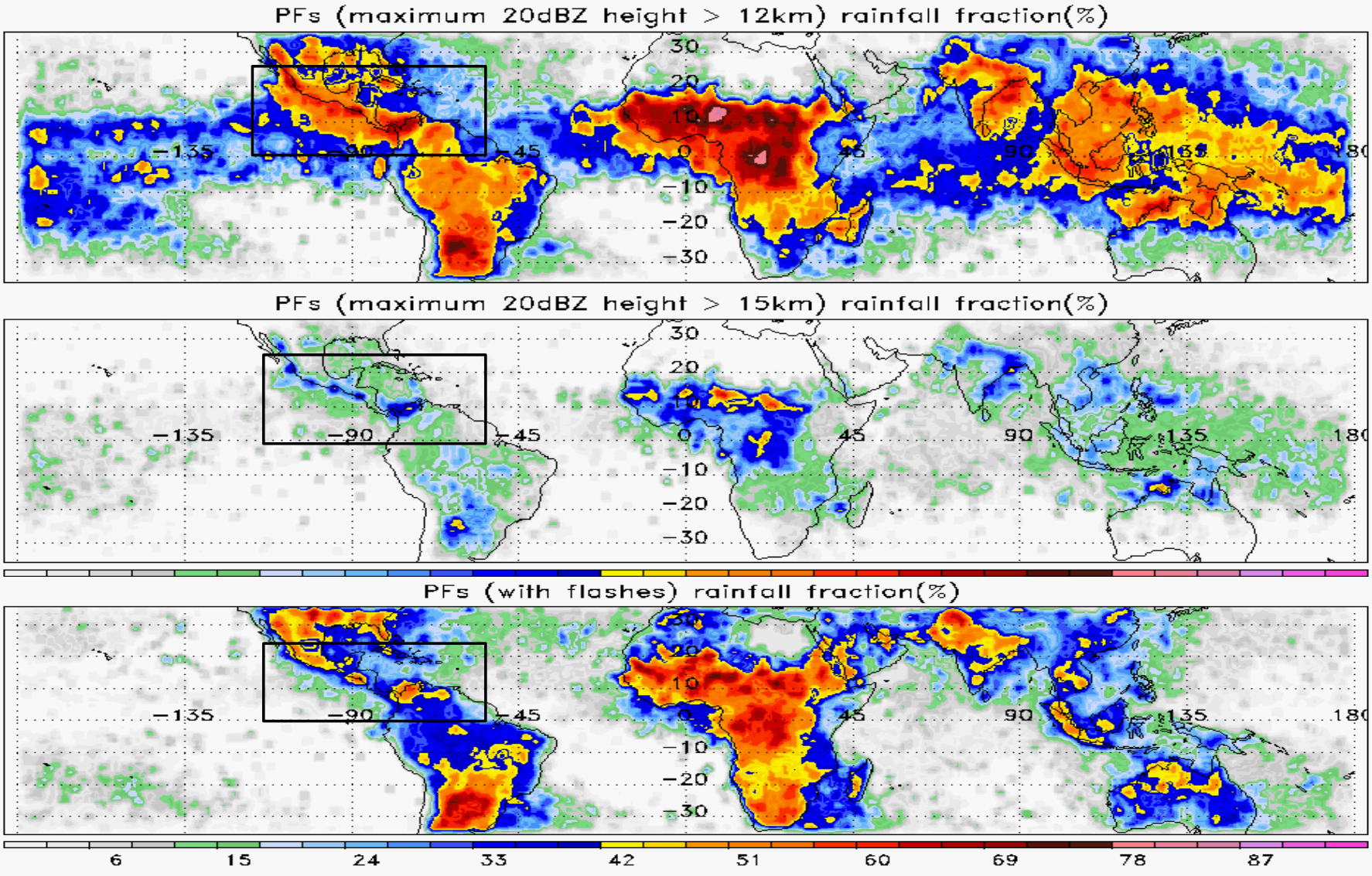
Very large PFs (Surface rain area > 8000km^2) rainfall fraction(%)



Small PFs (Surface rain area < 2000km^2) rainfall fraction(%)

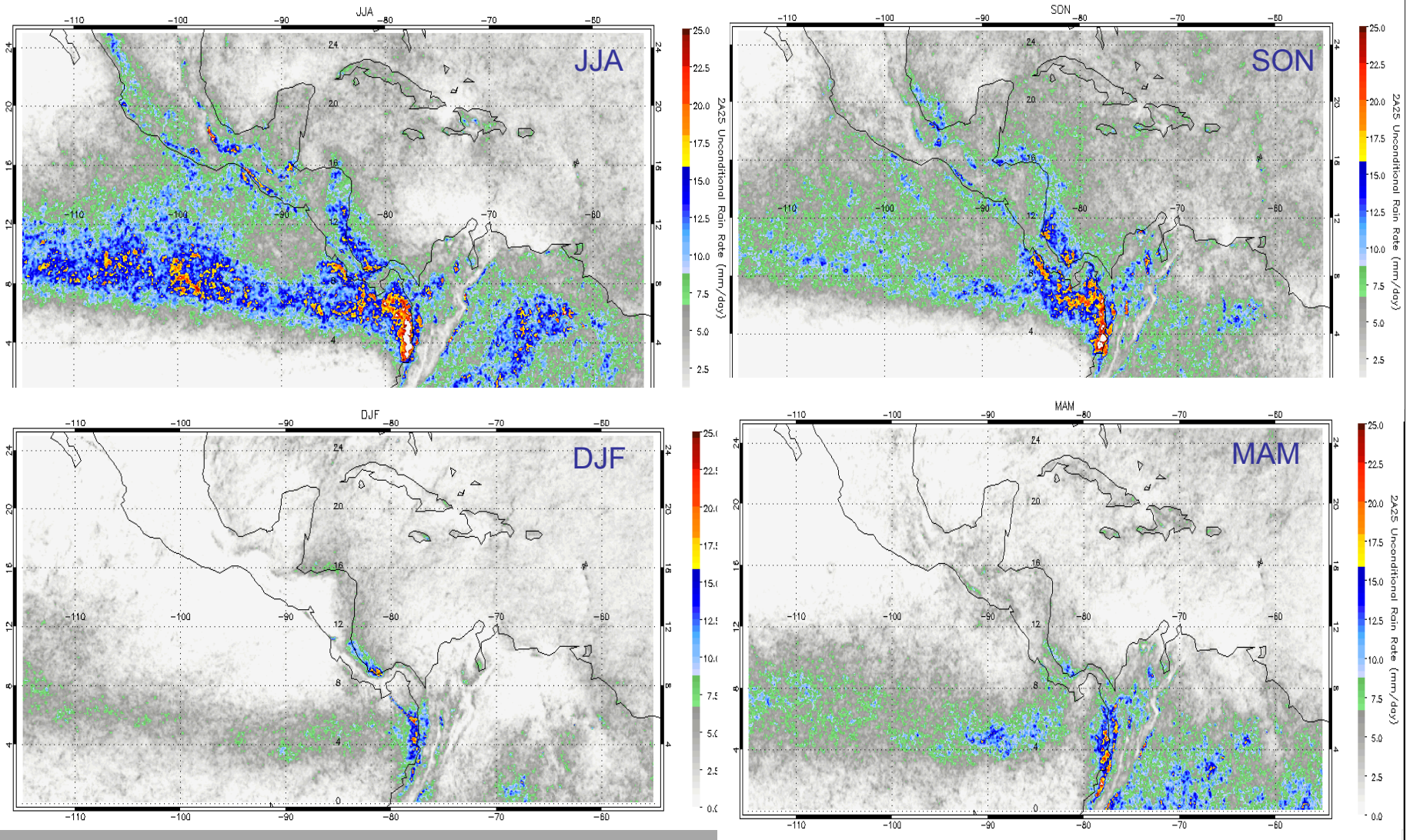


Rain contribution by PFs reaching 12, 15 km, and (bottom panel) with at least one LIS flash

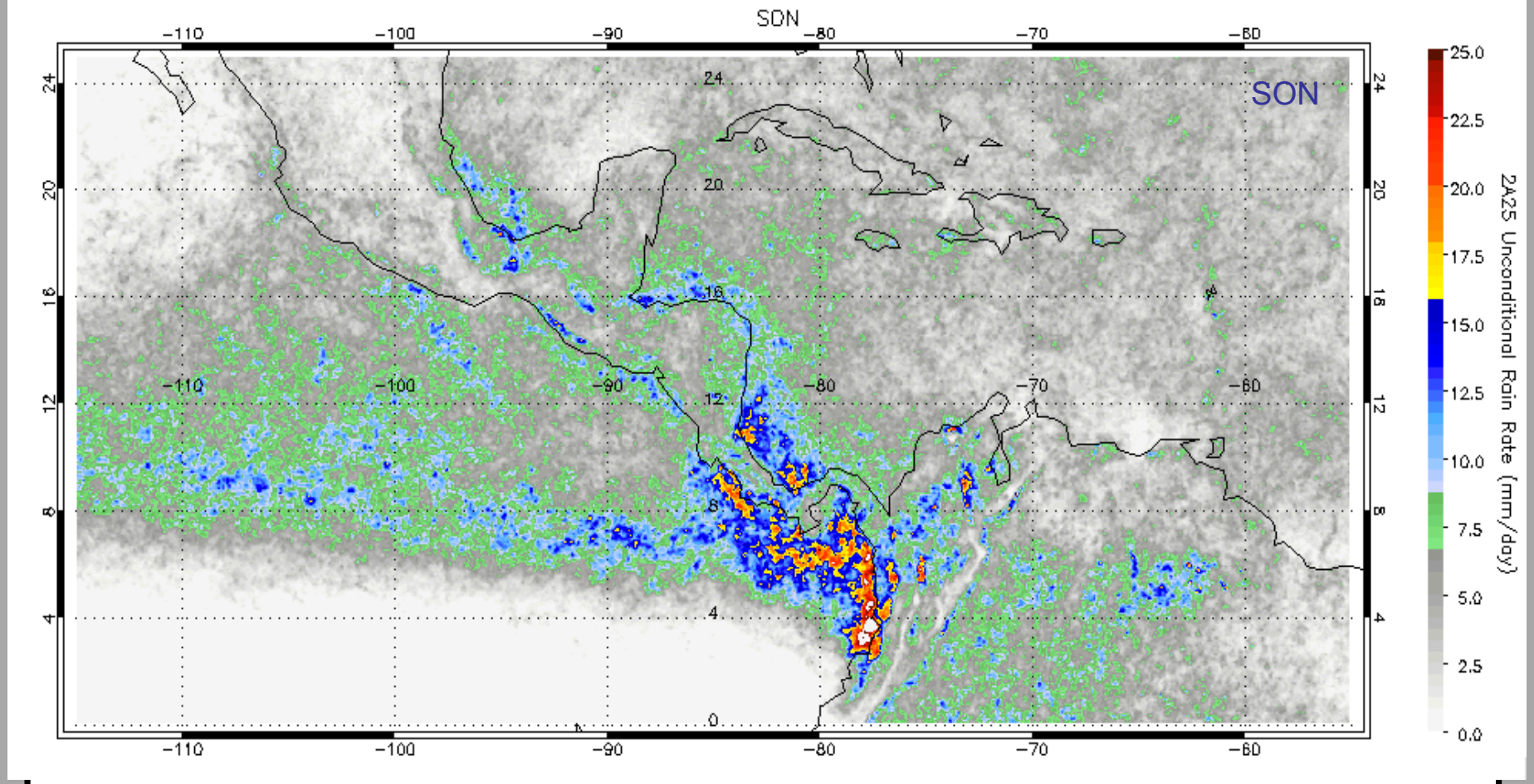


IAS Region: Rainfall from TRMM *Radar* Retrieval – 4 Seasons

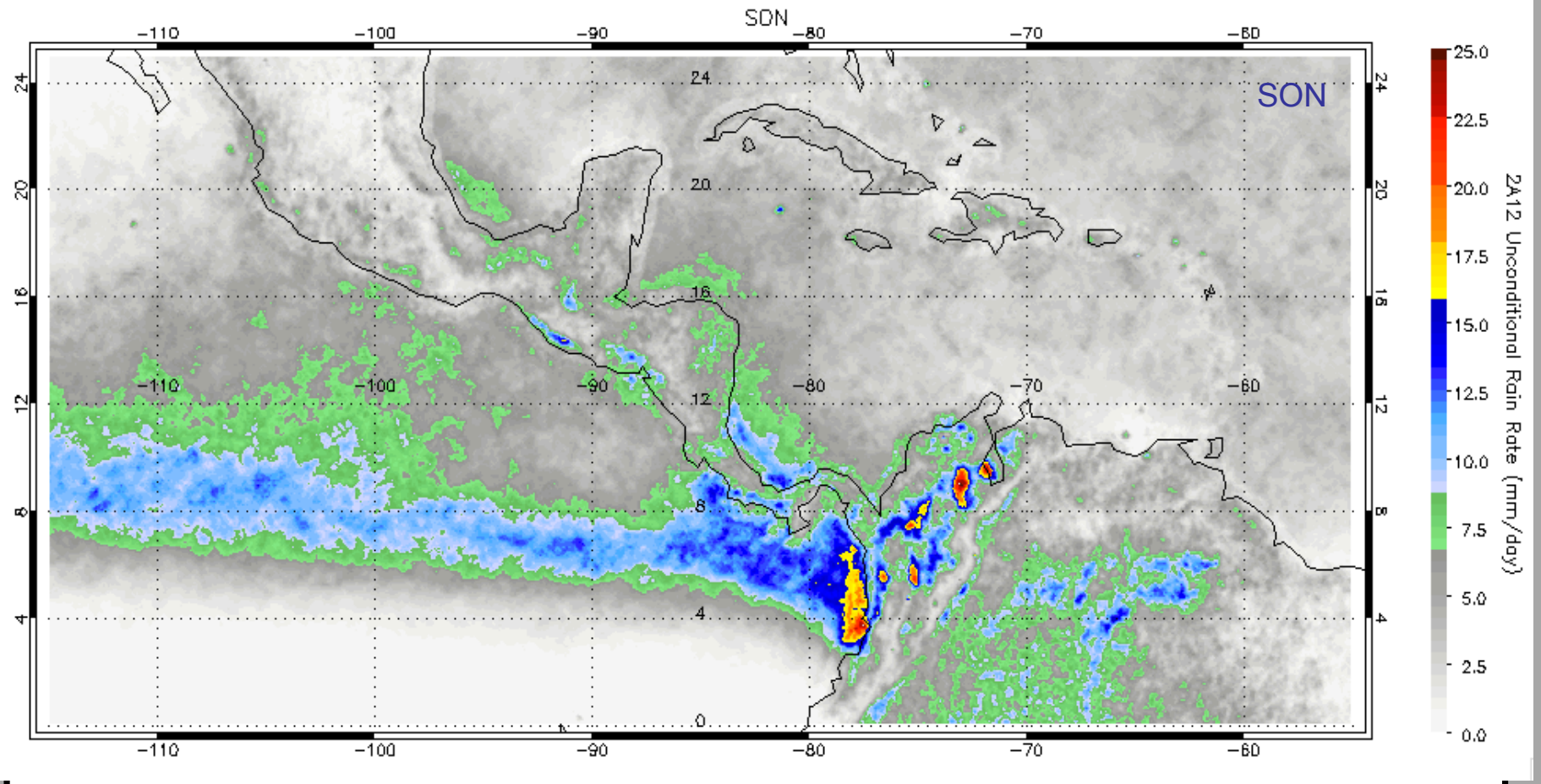
JJA

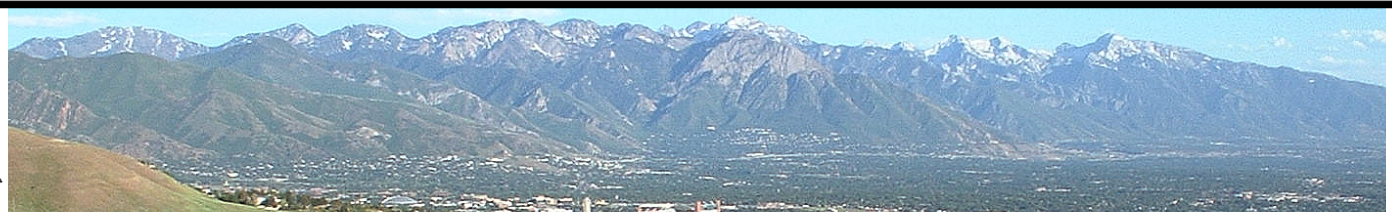


IAS Region: Rainfall from TRMM *Radar* Retrieval –Sept-Oct-Nov



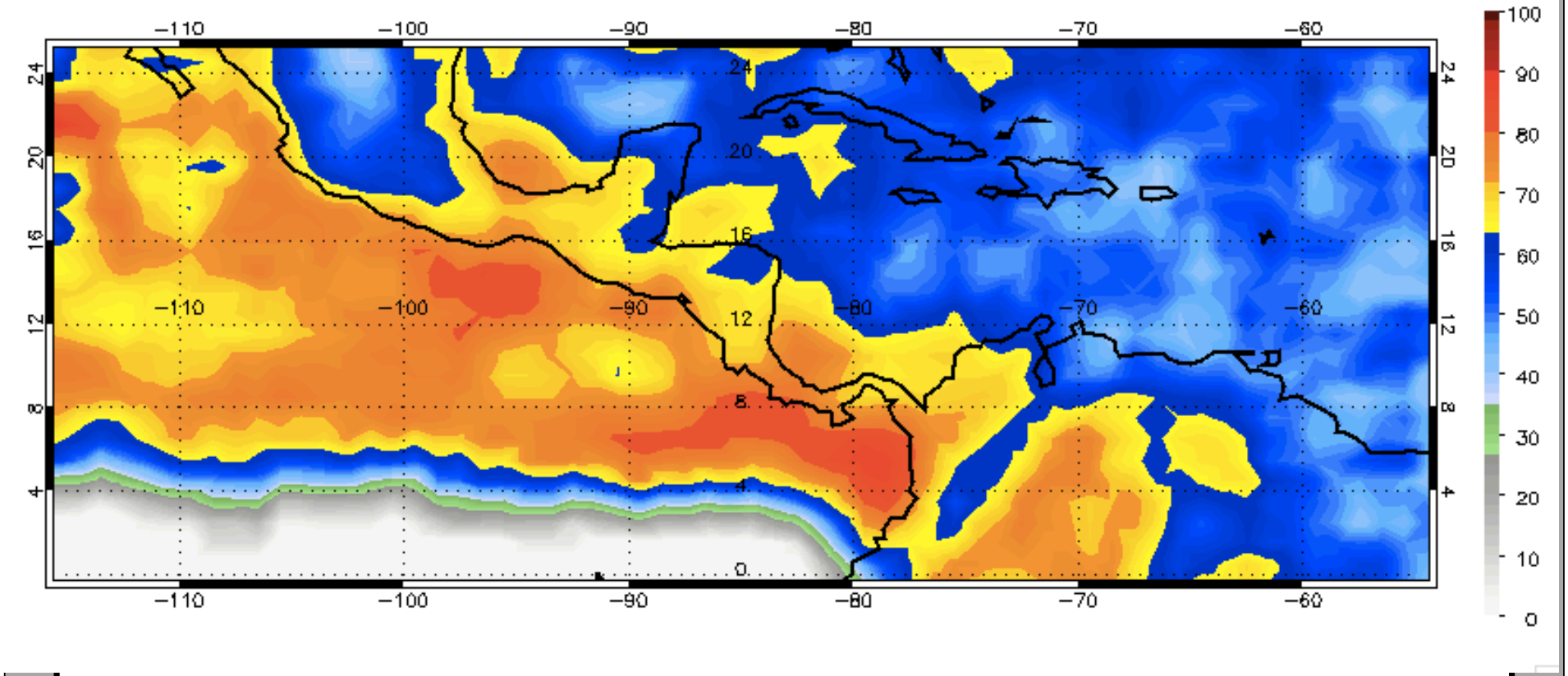
IAS Region: Rainfall from TRMM *Passive Microwave* Retrieval –Sept-Oct-Nov





Fraction of Precipitation from MCSs in SON

SON



JJA

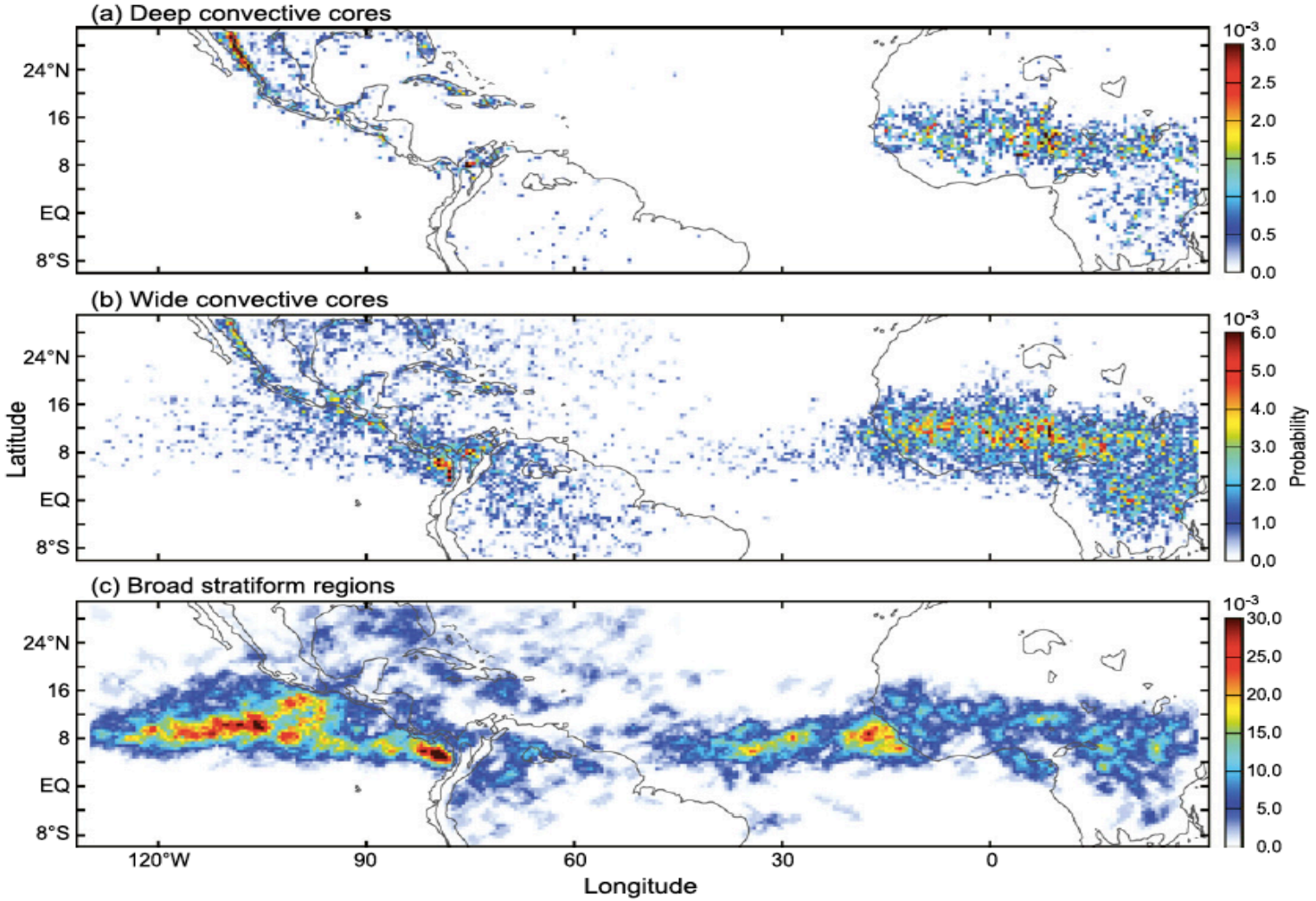


FIG. 3. Spatial distribution of the probability of a location being under (a) a deep convective core, (b) a wide convective core, and (c) a broad stratiform region during the months JJA of 1998–2012. The contour inside the continent represents the 1000-m terrain elevation.

(Zuluaga and Houze, MWR 2015)

Date from 19980101 to 20131231
VolRain from 300000 to 4000000 mm*km^2/hr
Flashes -100-5000
Land or Ocean: Both

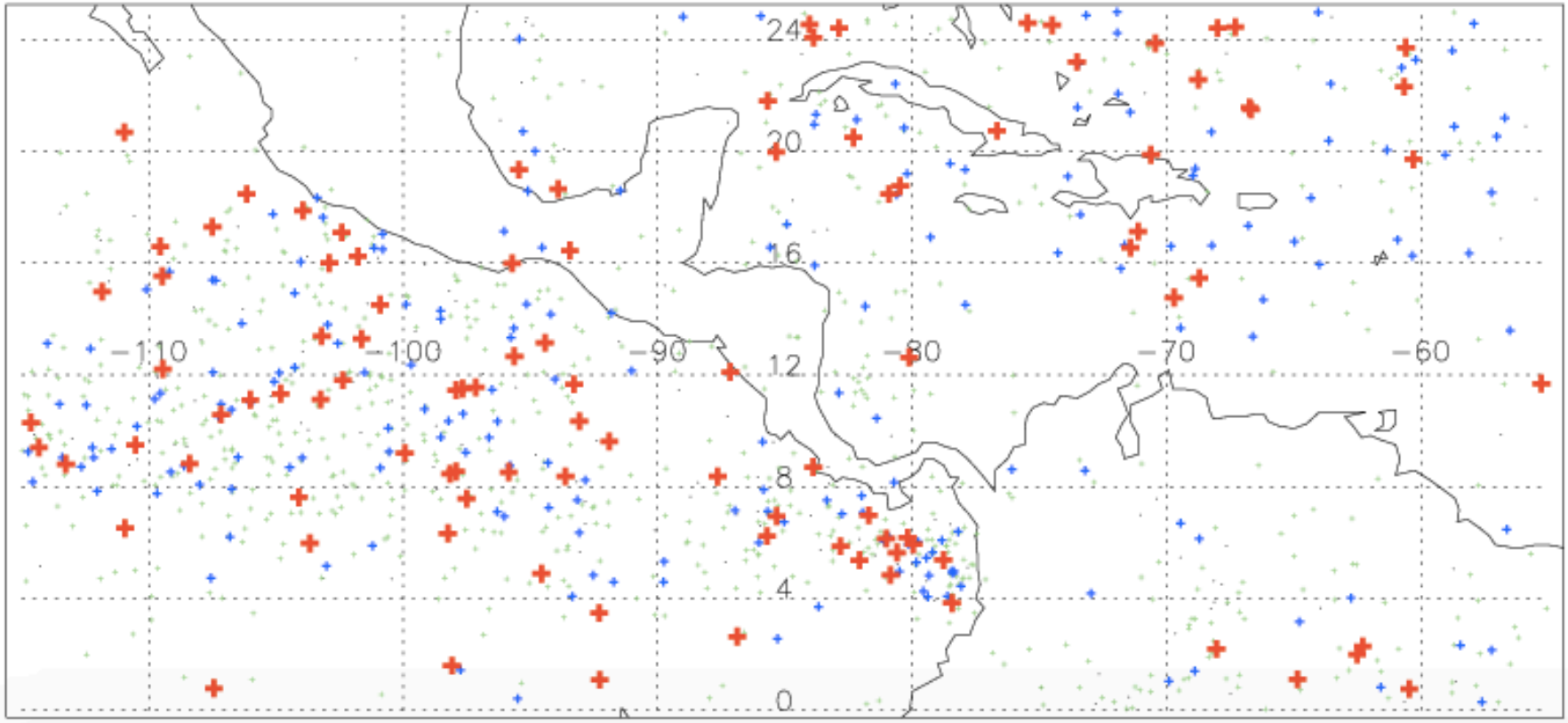
Latitude from 0 to 25
Max Height of 20 dB 0-20 km
Max NearSurf 0-60 dB
Sort By: rain volume

Longitude from -115 to -55
Max Height of 40 dB 0-20 km
% Convective rain 0-100 %

1131 MCSs were found

From PF Database, 1998-2013

Where are the individual precipitation featuures (PFs) with the MOST volumetric rain?
[> 300,000 mm km^2 per hour], e.g., 5 mm/h X 60,000 km^2



Date from 19980101 to 20131231
VolRain from to 4000000 mm*km^2/hr
Flashes 0-0
Land or Ocean: Both

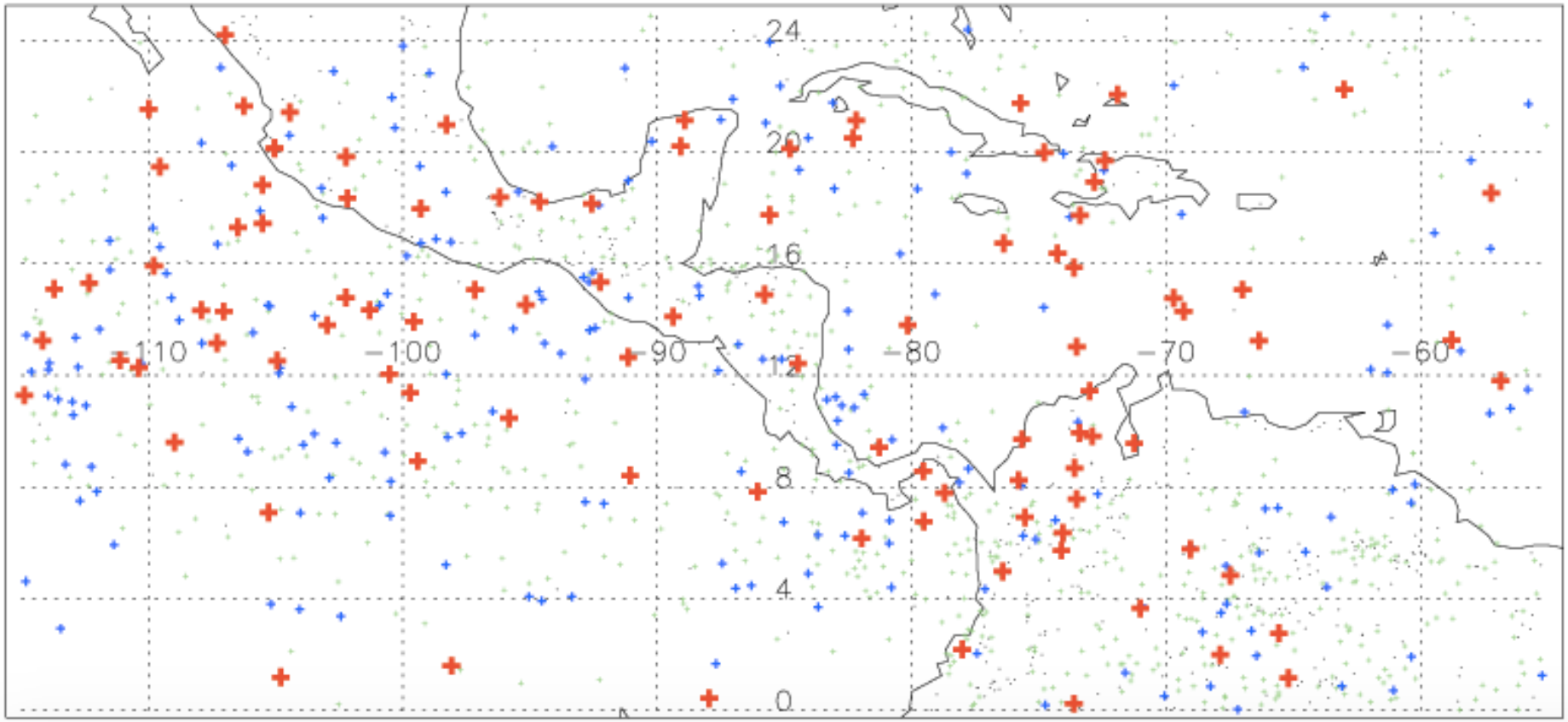
Latitude from 0 to 25
Max Height of 20 dB 0-20 km
Max NearSurf 52-60 dB
Sort By: MaxHt20dBZ

Longitude from -115 to -55
Max Height of 40 dB 0-20 km
% Convective rain 0-100 %

1415 MCSs were found

From PF Database, 1998-2013

Where are the individual precipitation featuures (PFs)
with the HIGHEST NEAR-SURFACE RADAR REFLECTIVITY?
[> 52 dBZ, or ~ ~ 50-100 mm/hour at TRMM pixel scale of ~ 20 km^2]



Date from 19980101 to 20131231
VolRain from to 4000000 mm*km^2/hr
Flashes -100-5000
Land or Ocean: Both

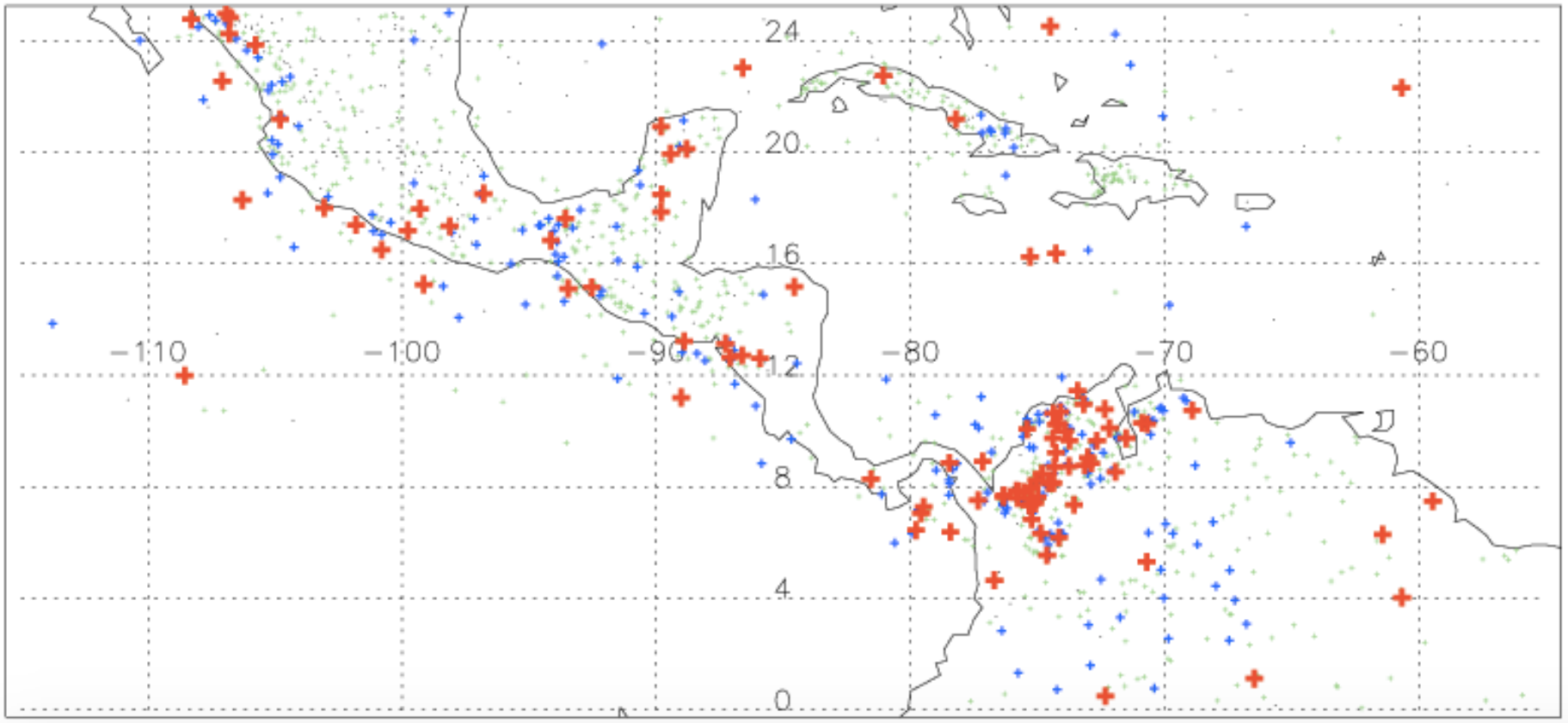
Latitude from 0 to 25
Max Height of 20 dB 0-20 km
Max NearSurf 0-60 dB
Sort By: MaxHt20dBZ

Longitude from -115 to -55
Max Height of 40 dB 10-20 km
% Convective rain 0-100 %

1220 MCSs were found

From PF Database, 1998-2013

Where are the individual precipitation featuures (PFs)
with the HIGHEST LIS-observed lightning flash rates?
> ~ 100 flashes per minute



Date from 19980101 to 20131231
VolRain from to 4000000 mm*km^2/hr
Flashes -100-5000
Land or Ocean: Both

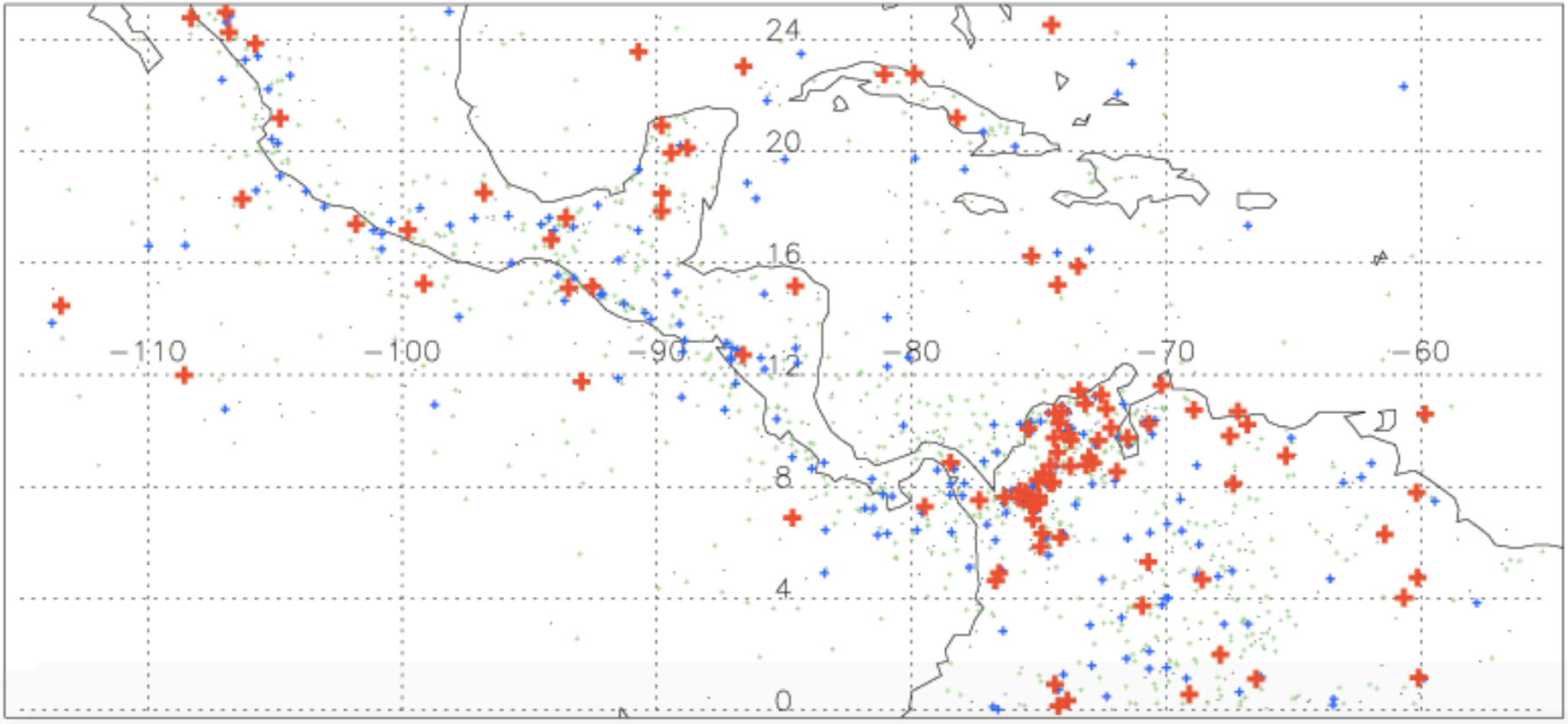
Latitude from 0 to 25
Max Height of 20 dB 16.5-20 km
Max NearSurf 0-60 dB
Sort By: MaxHt20dBZ

Longitude from -115 to -55
Max Height of 40 dB 0-20 km
% Convective rain 0-100 %

1464 MCSs were found

From PF Database, 1998-2013

Where are the individual precipitation featuures (PFs)
with the HIGHEST 20 dBZ radar echo?
[> 16.5 km …IR tops are higher]



Searching MCSs for the following conditions:

Satellite:TRMM

Date from 19980101 to 20031231

VolRain from 0 to 4000000 mm*km^2/hr

Flashes -100-5000

Land or Ocean: Both

Latitude from 0 to 25

Max Height of 20 dB 0-20 km

Max NearSurf 0-60 dB

Sort By: date

Longitude from -115 to -55

Max Height of 40 dB 10-20 km

% Convective rain 0-100 %

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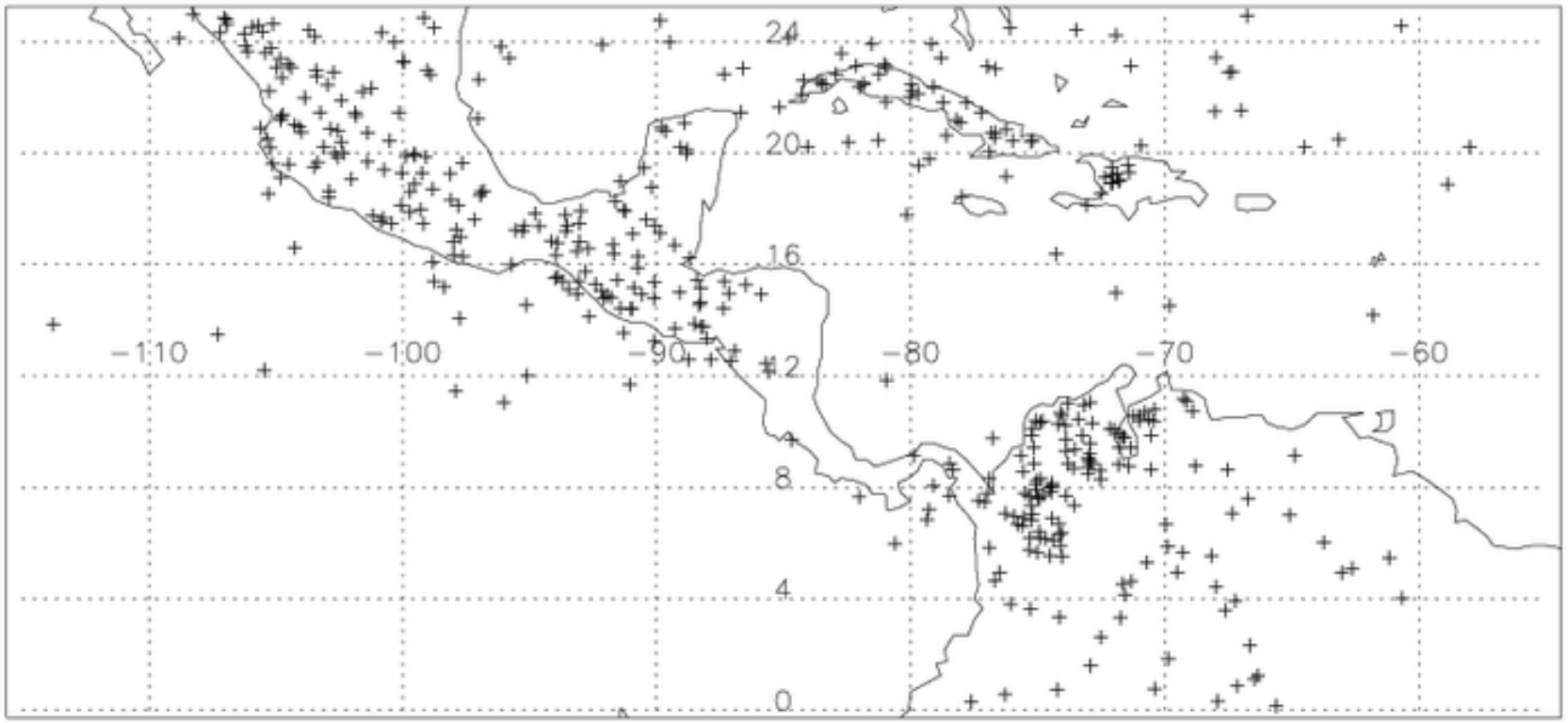
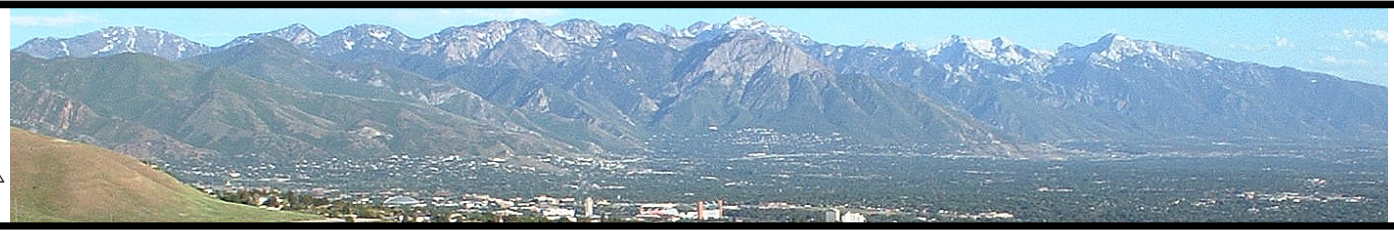
439 MCSs were found

From PF Database, 1998-2013

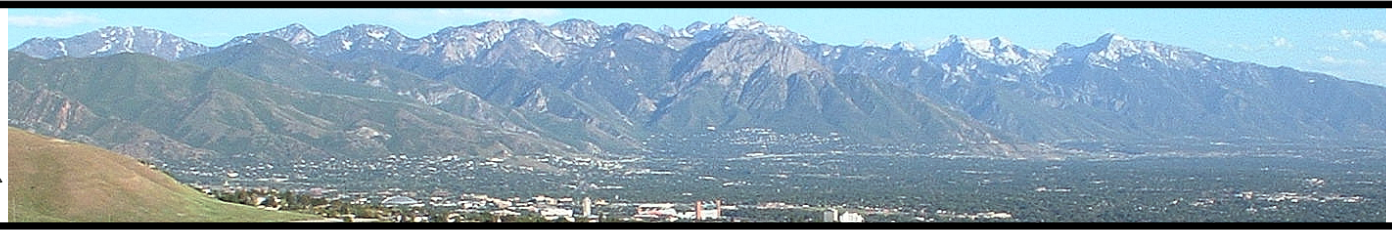
Where are the individual precipitation featuures (PFs)
with the 40 dBZ echo top > 10 km?
[equivalent to Zuluaga & Houze's Deep Convective Cores – DCCs]





THANK YOU!

Comments and questions welcome!

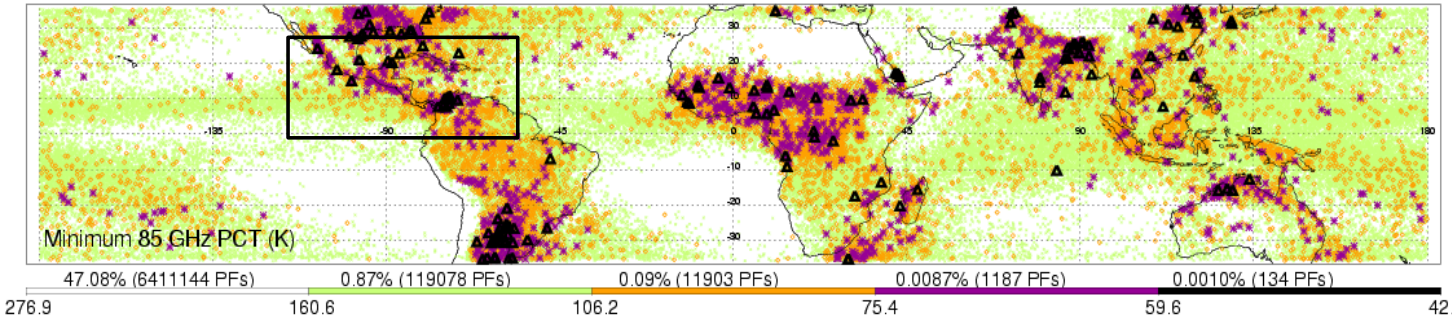


Extra slides

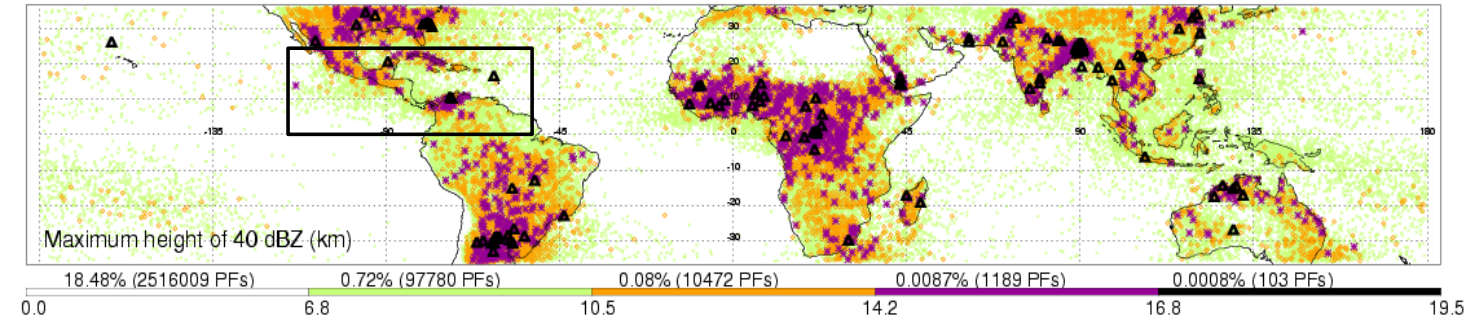
Where are the *most* "intense" storms?

Orange, purple, black: Very strong,(0.1%) Even stronger(.01%), TOP 0.001%

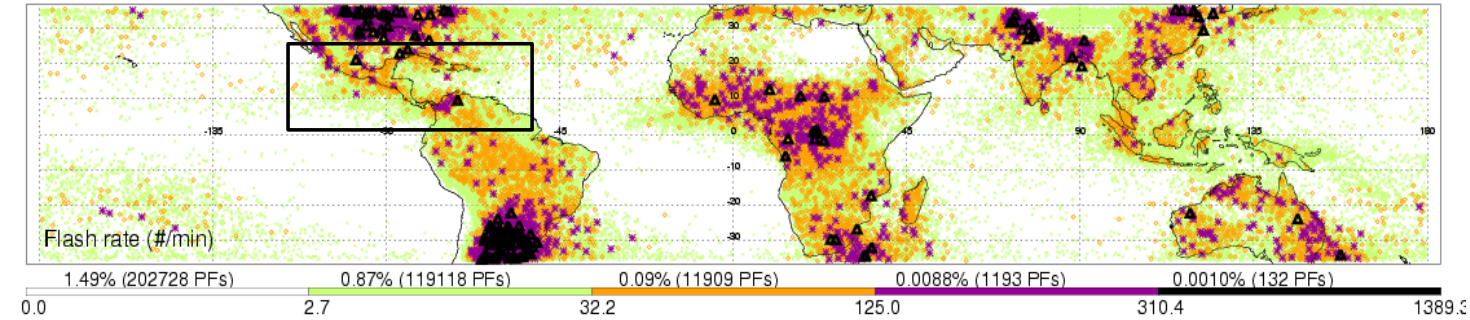
(Zipser et al. BAMS 2006)



Minimum 85 GHz PCT (related to ice water path)



Max height of 40 dBZ echo (a very strong echo for the ice region – large graupel likely)



Lightning flash rate Purple is >125/min Black is >310/min