Global distribution of the largest, deepest and most intense precipitation systems - a perspective from GPM precipitation features

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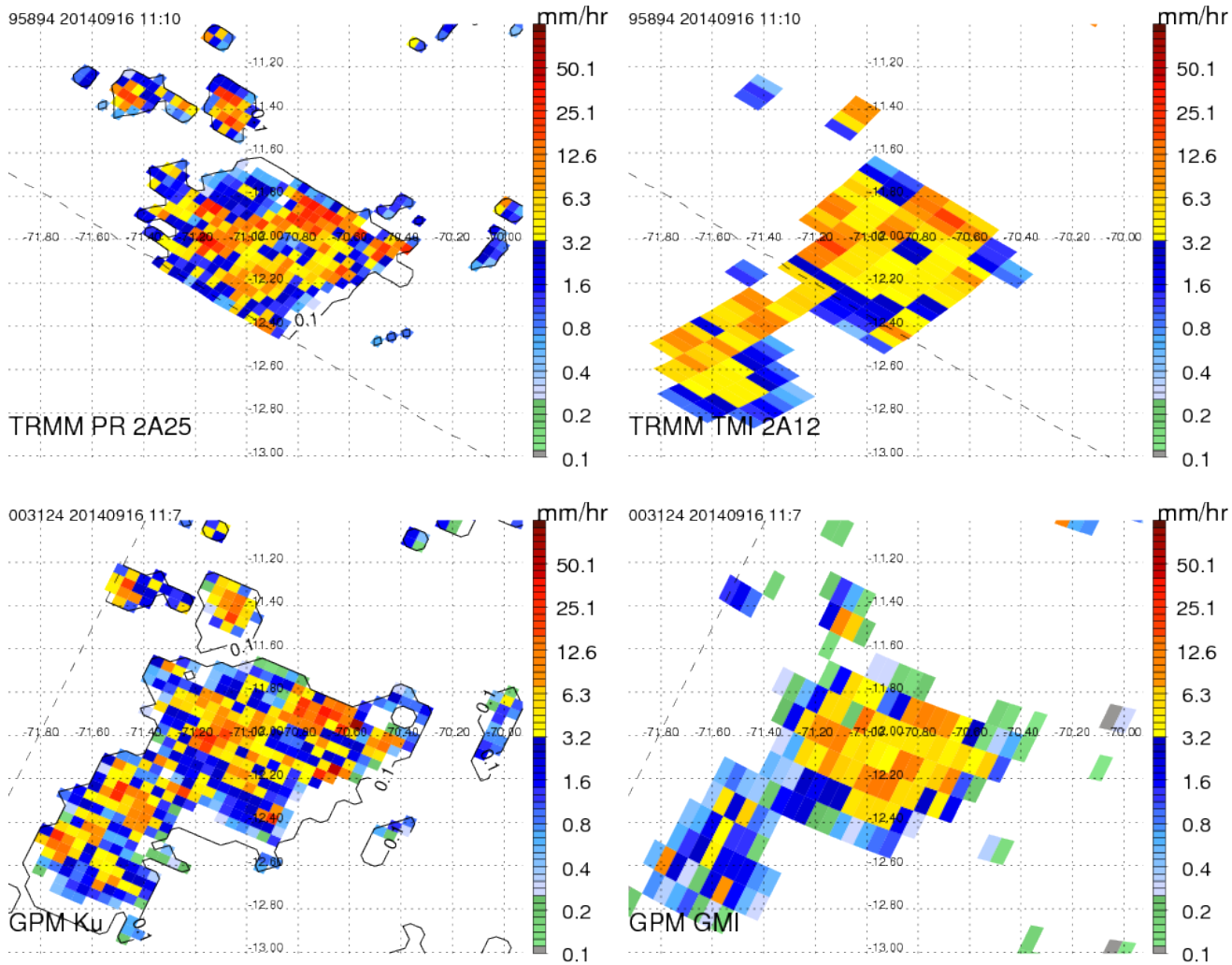
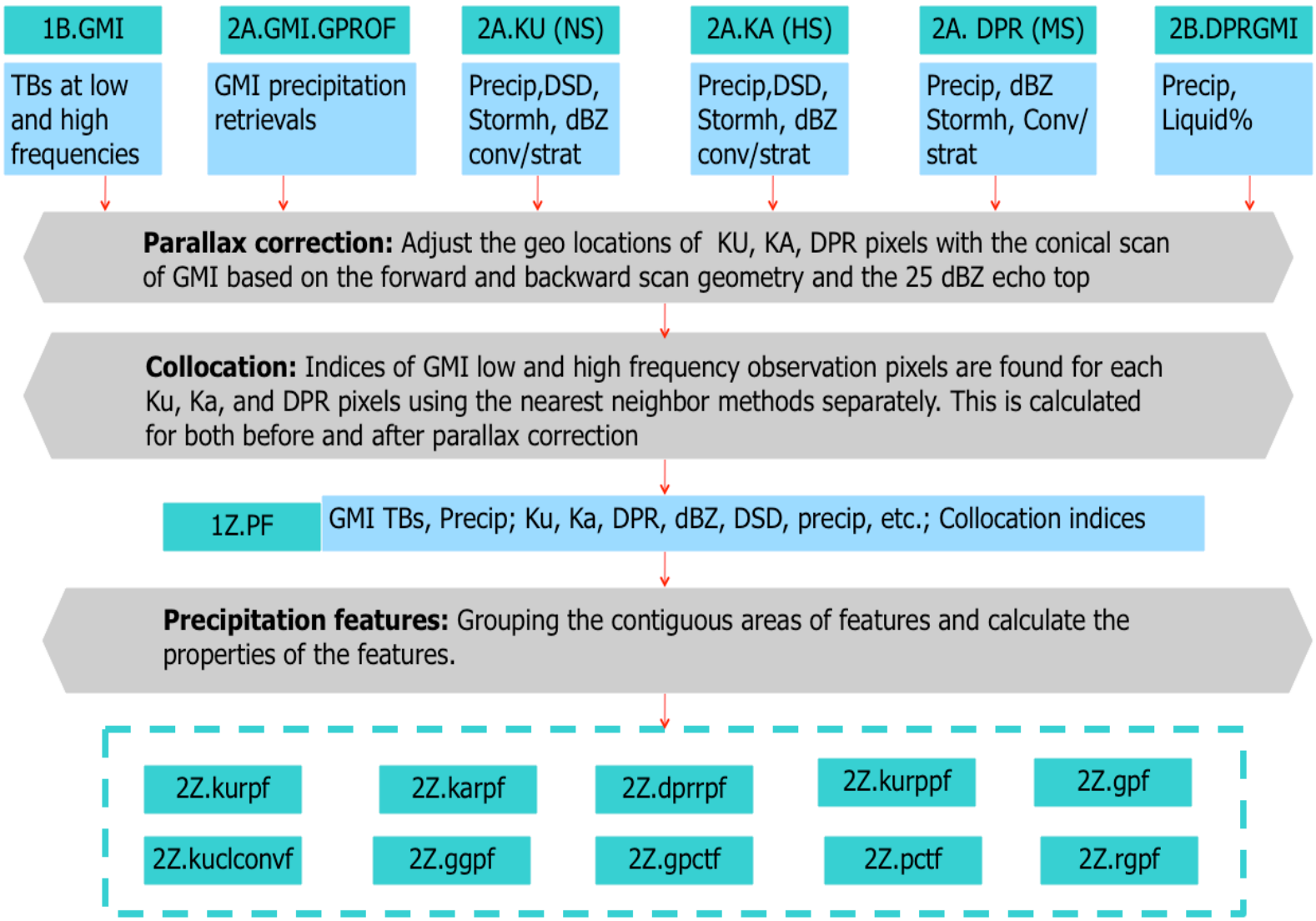
With acknowledgment and appreciation to Ramesh Kakar and Erich Stocker for their long-term support, and to Dan Cecil and many colleagues for the valuable inputs in building the precipitation feature database

Grouping Precipitation Features from TRMM and GPM



160 coincidences of TRMM and GPM at
http://atmos.tamucc.edu/trmm/gpm_coincidence/

GPM data processing flow chart



Thanks to Erich and PPS, it is being processed with only a few days latency at PPS.

GPM PF definitions and 1 + year inventory

	Definitions of precipitation features
Kurpf	area with Ku near surface precipitation rate > 0 (Normal Swath)
karpf	area with Ka near surface precipitation rate > 0 (High Resolution Swath)
dprrpf	area with DPR near surface precipitation rate > 0 (Matched swath)
kurppf	area with Ku dBZ > 10 dBZ in the column (Ku normal swath)
gpf	area with GMI precipitation rate > 0.1 mm/hr (Ku normal swath)
kuclconvf	area with Ku convective precipitation (Normal swath)
rgpf	area with either Ku precipitation rate > 0 or GMI precipitation rate > 0.1 mm/hr (Ku normal swath)
ggpf	area with GMI precipitation rate > 0.1 mm/hr (GMI swath)
gpctf	area with GMI 85 GHz Polarization corrected temperature < 250 K (GMI swath)

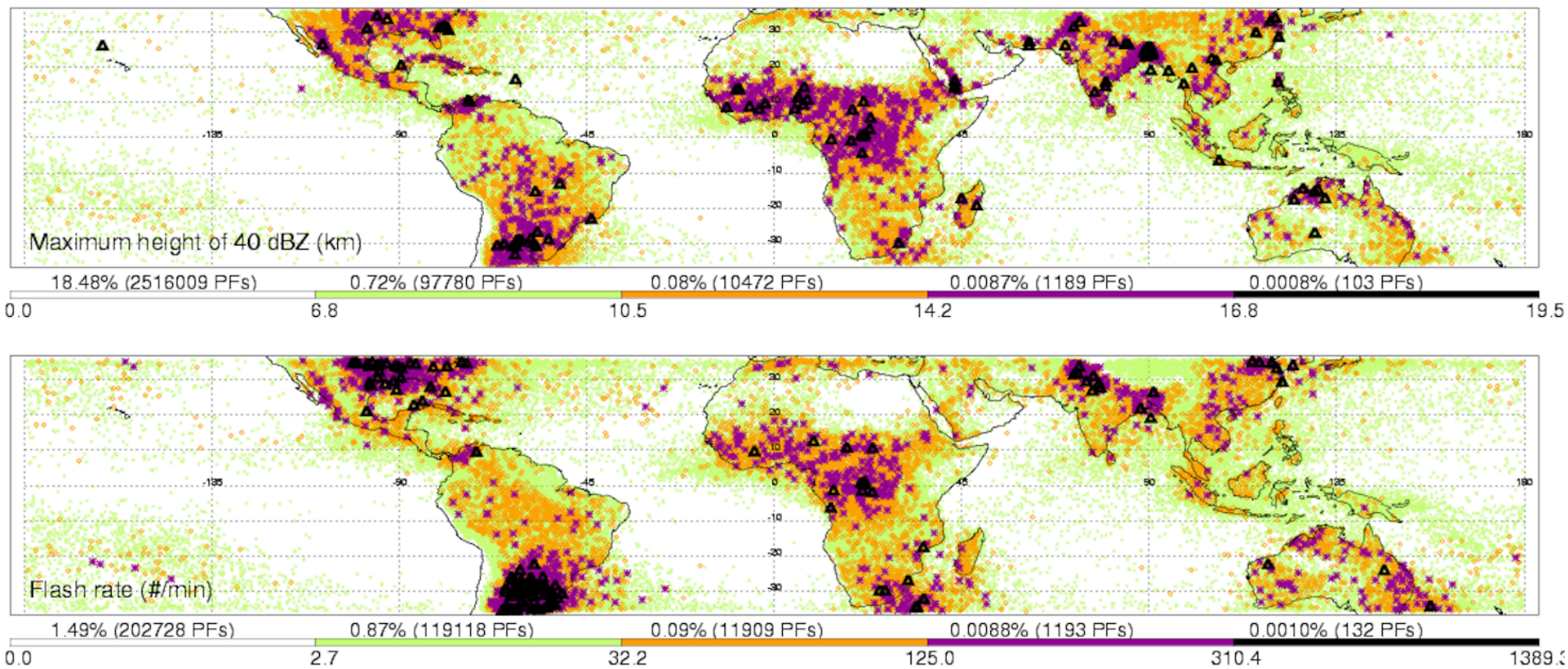
level-1	~240 MB per orbit	1yr ≈ 1.3 TB	
level-2	~1200 Kurpfs per orbit	1yr ≈ 1.1 GB	6.7 million features

- All level 1 and 2 data are available at:

http://atmos.tamucc.edu/trmm/data/gpm/

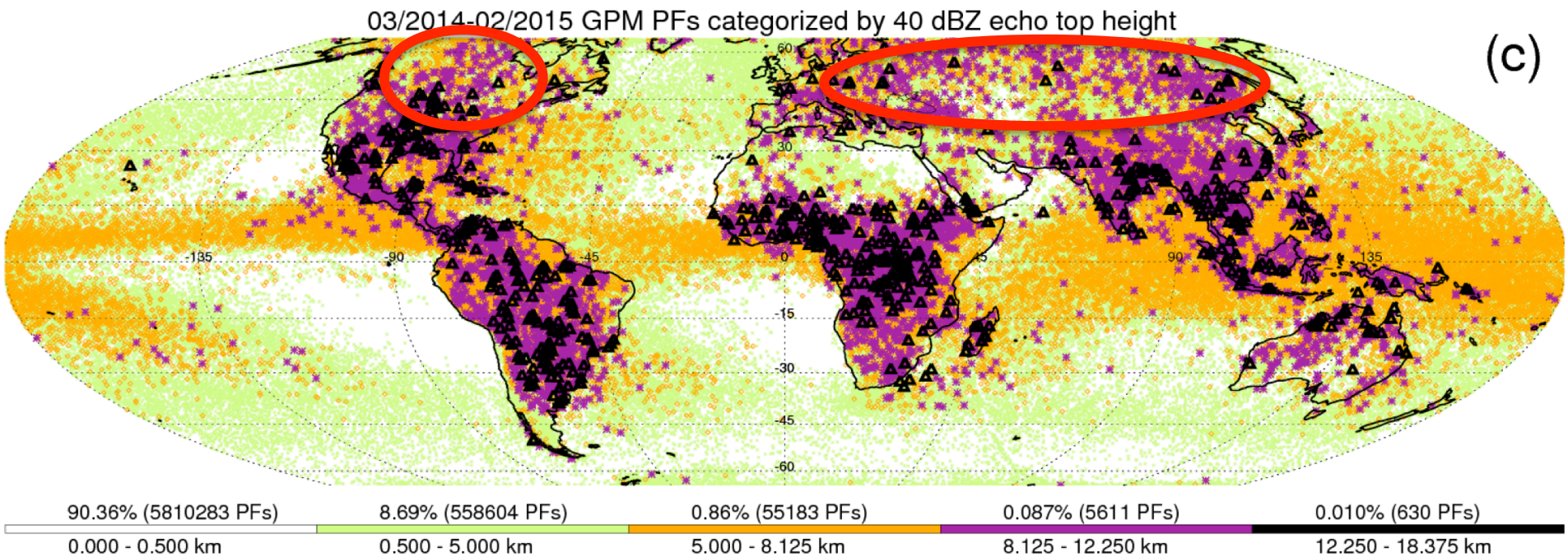
The most intense thunderstorms on earth TRMM

- Zipser et al. 2006 (BAMS)



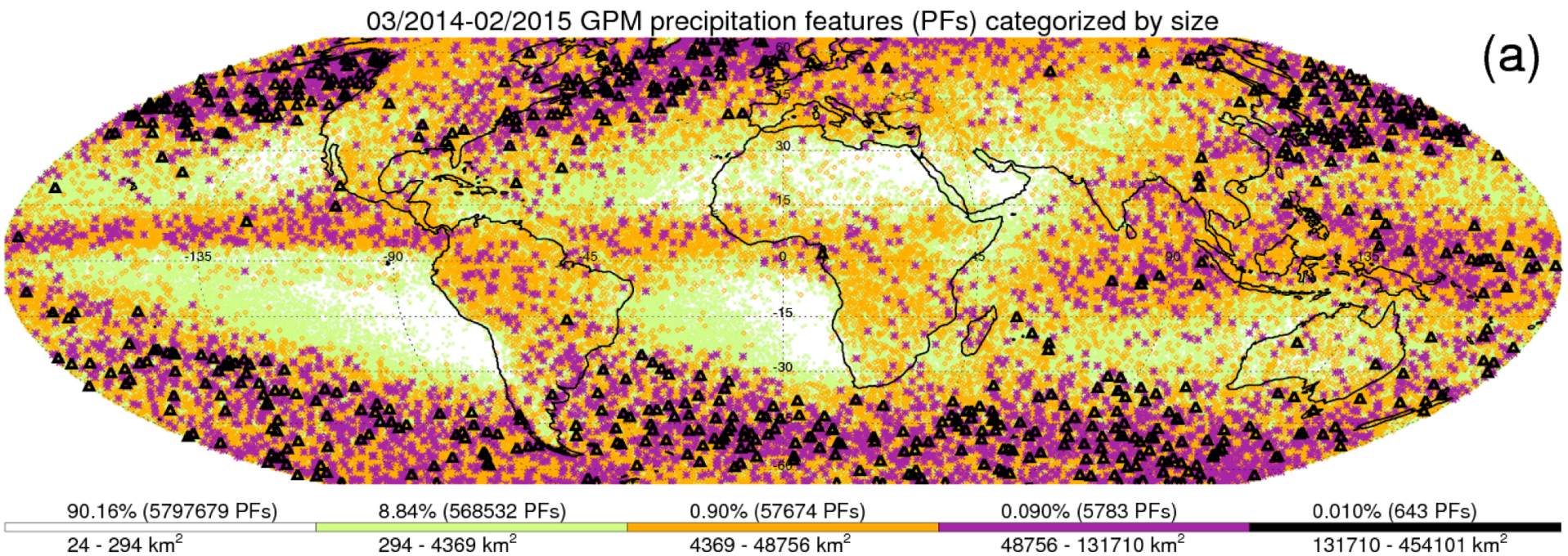
The most intense thunderstorms on Earth GPM

- Liu and Zipser, 2015 (GRL)



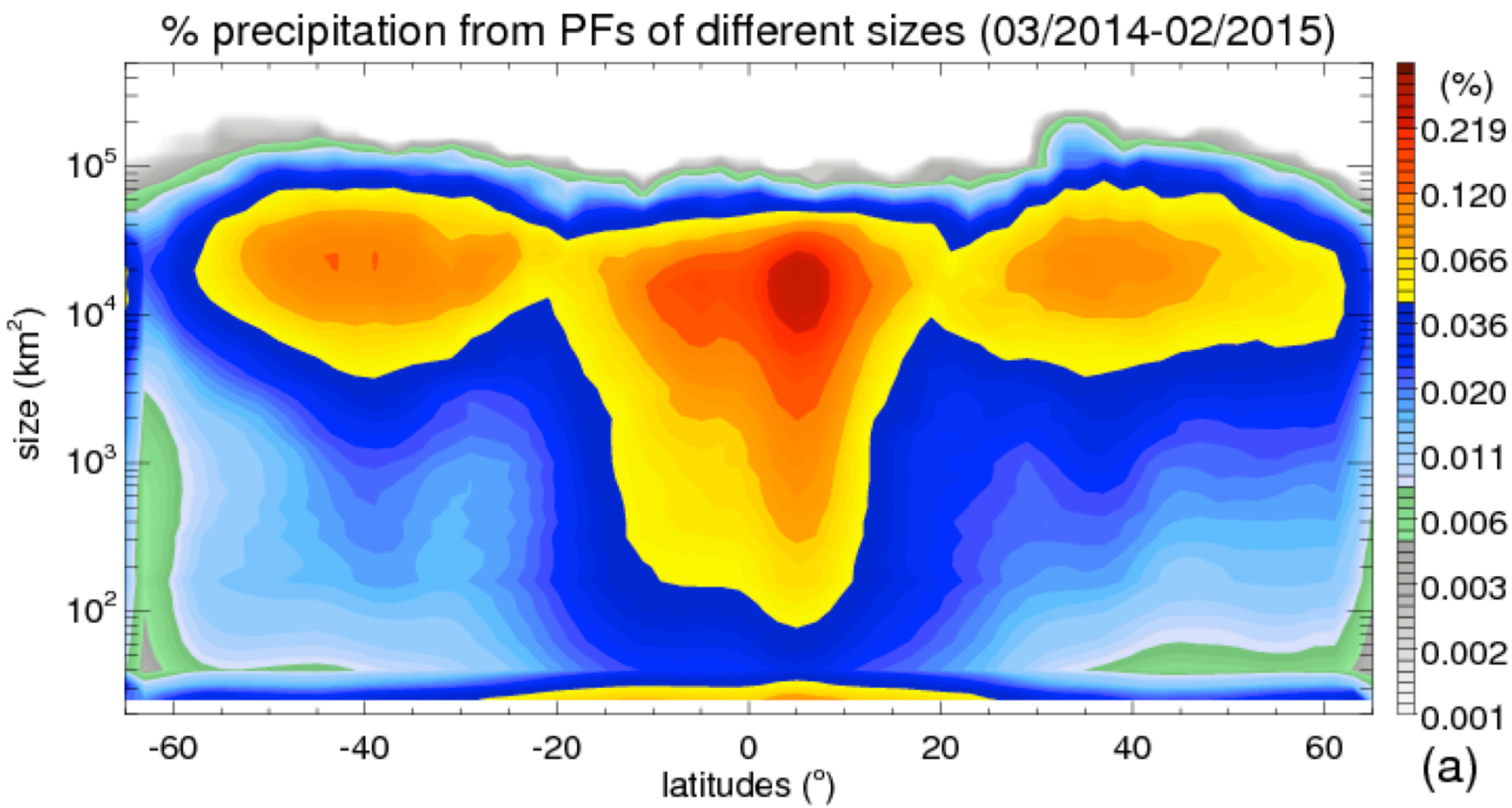
more intense over land than over ocean

The largest precipitation systems on Earth
GPM



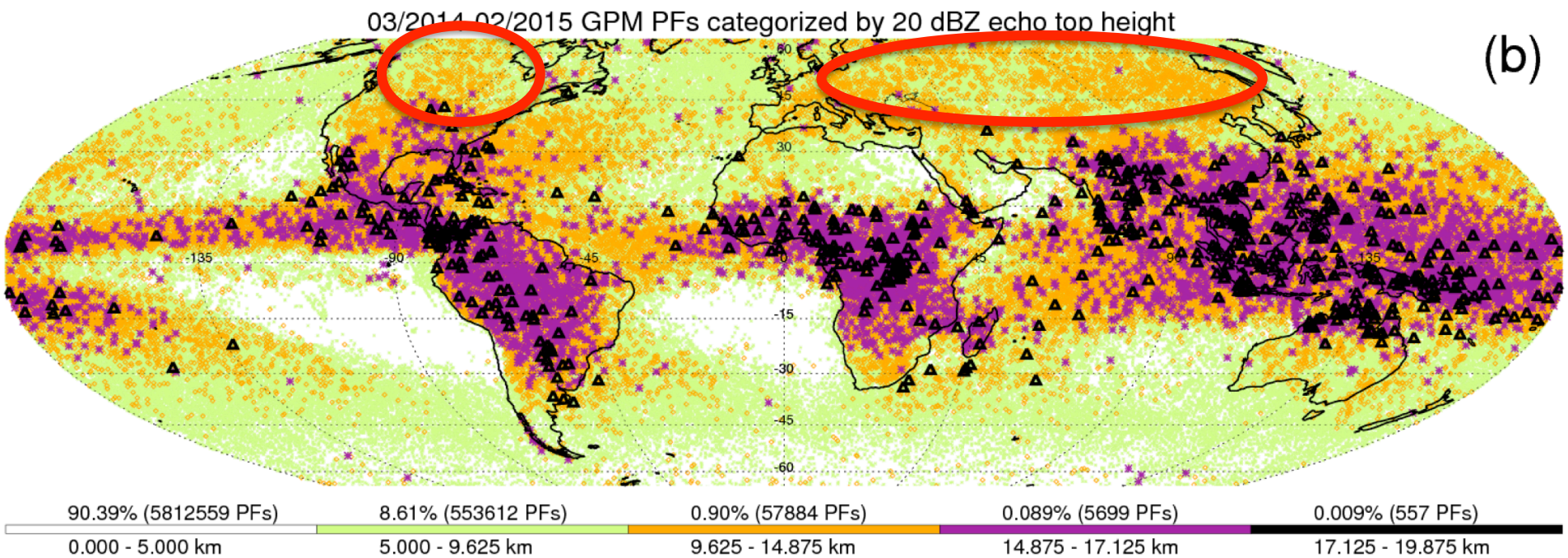
Larger over ocean than over land
Larger over mid-high latitudes than tropics

Contribution of the global precipitation from systems of different sizes



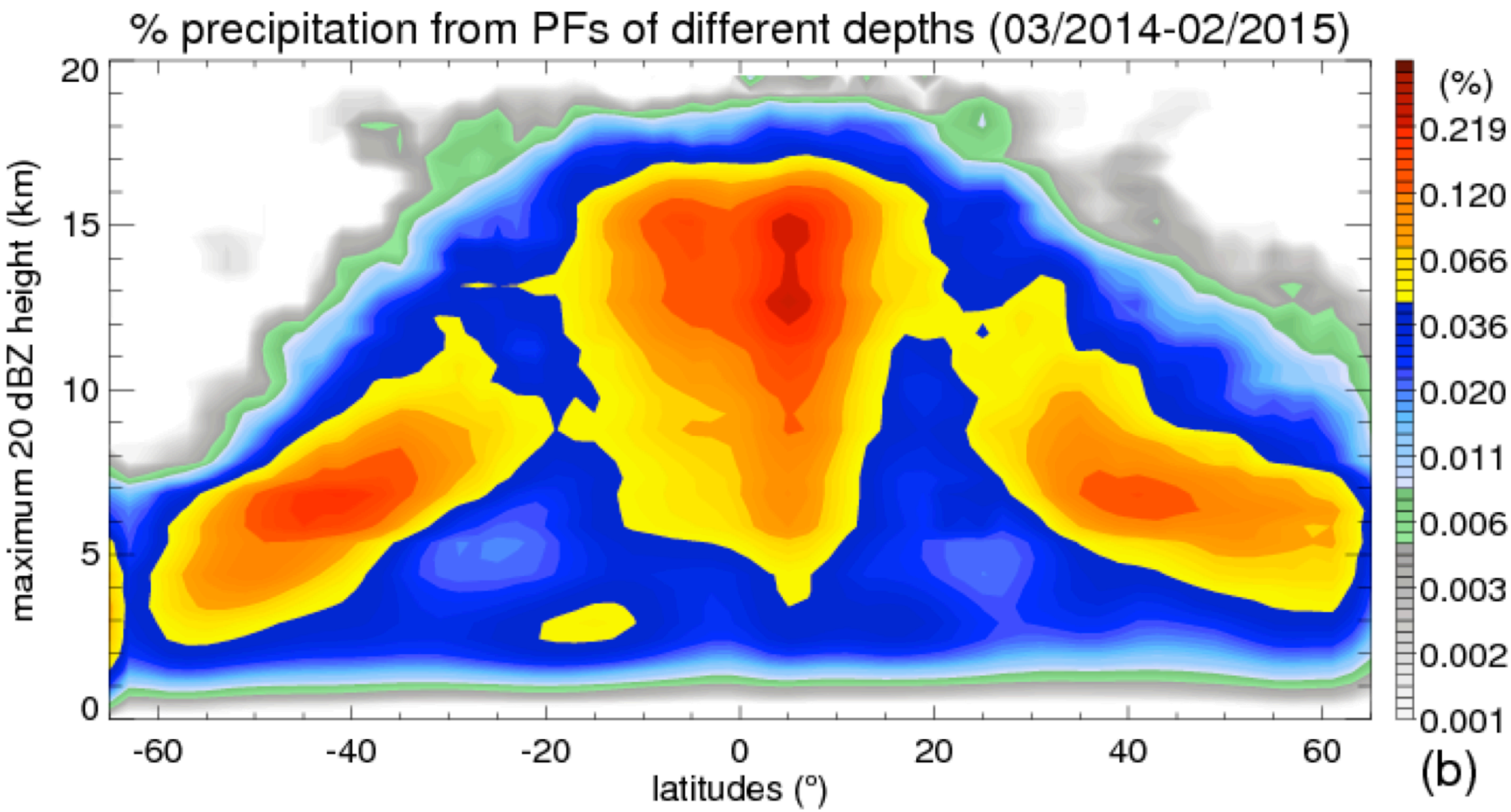
Most precipitation in mid-high latitudes are dominantly from synoptic systems
Small systems contribute a larger proportion of precipitation in tropics

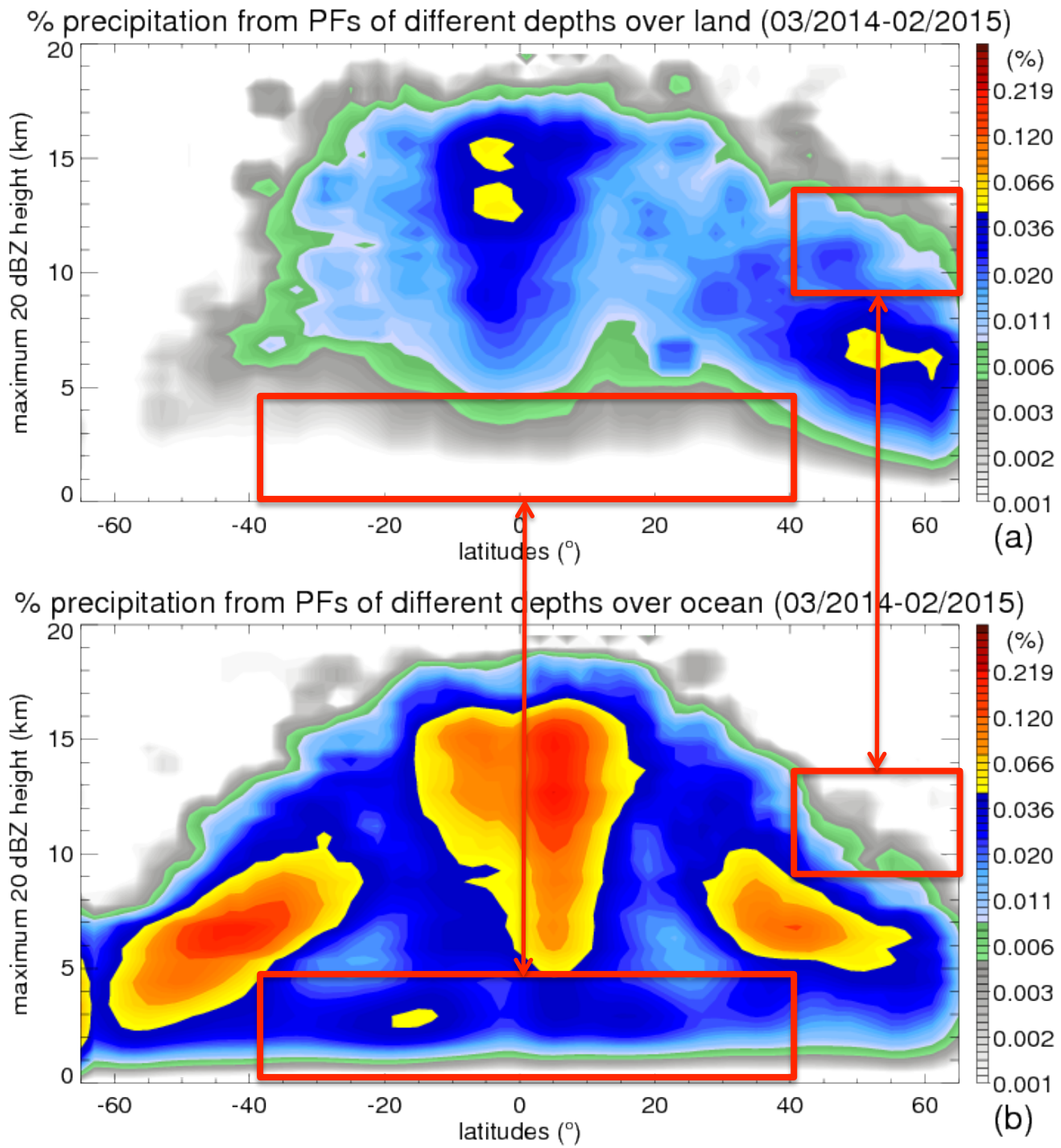
The tallest precipitation systems on Earth
GPM



Taller in tropics
Taller over land in mid-high latitudes

Contribution of the global precipitation from systems of different heights

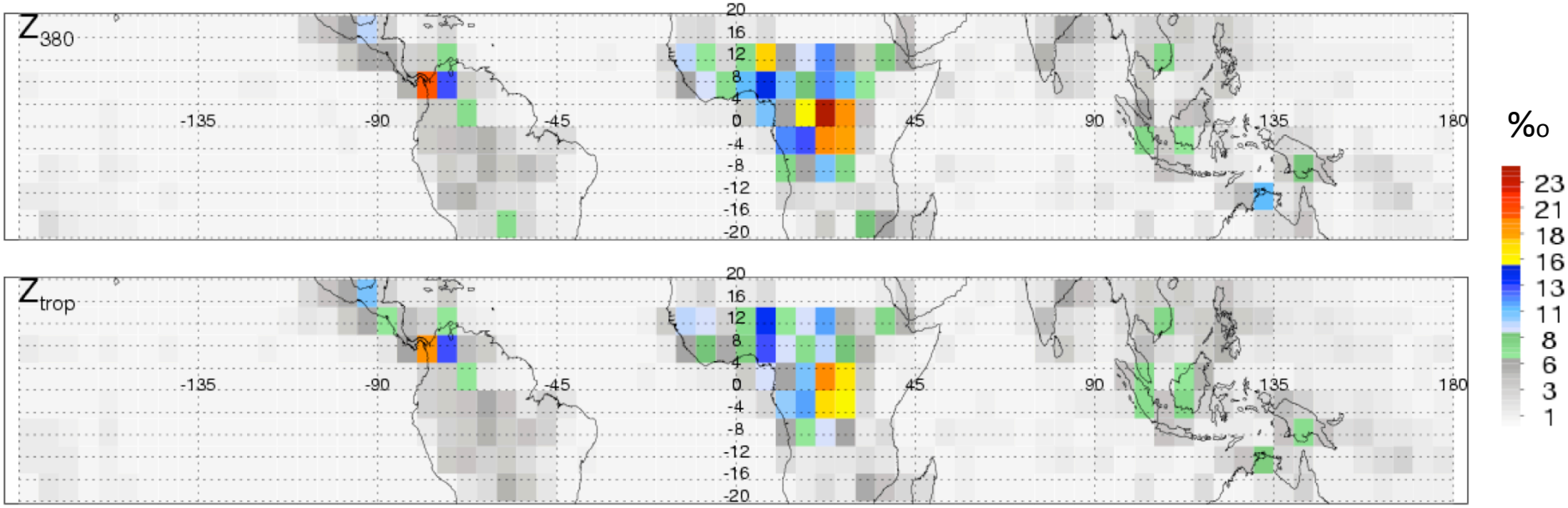



% precipitation from PFs of different depths over land (03/2014-02/2015)
maximum 20 dBZ height (km)
latitudes (°)
(%)
0.219
0.120
0.066
0.036
0.020
0.011
0.006
0.003
0.002
0.001
(a)
% precipitation from PFs of different depths over ocean (03/2014-02/2015)
maximum 20 dBZ height (km)
latitudes (°)
(%)
0.219
0.120
0.066
0.036
0.020
0.011
0.006
0.003
0.002
0.001
(b)

Global distribution of intense convection penetrating tropical tropopause

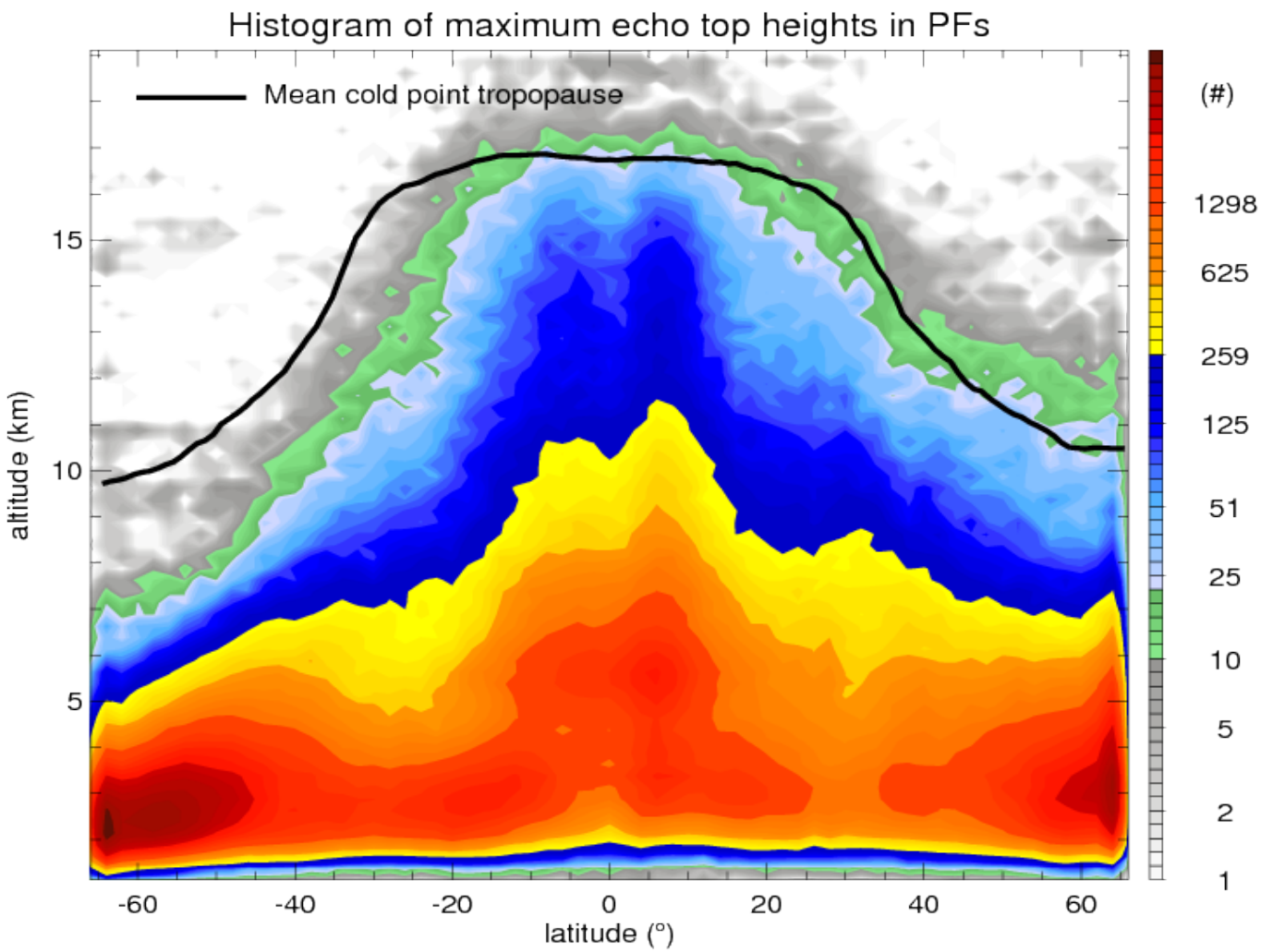
- Liu and Zipser, 2005

Overshooting area distribution from 5 years of TRMM PR

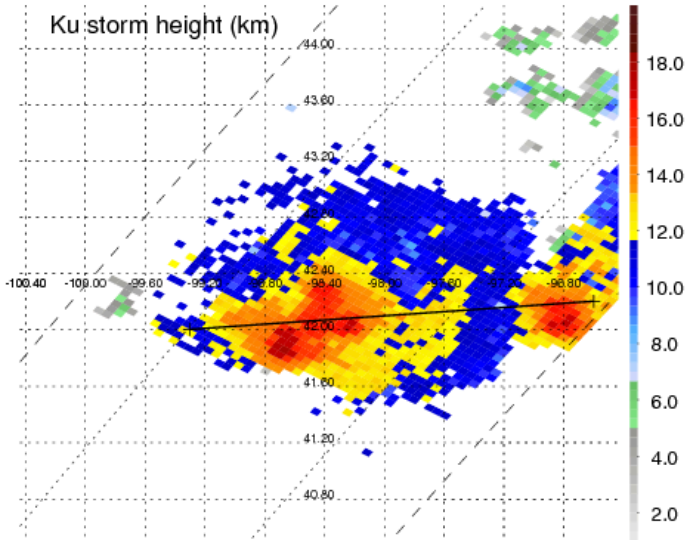


Congo and Panama are two hotspots for overshooting convection

Histogram of the maximum Ku echo top heights in GPM PFs



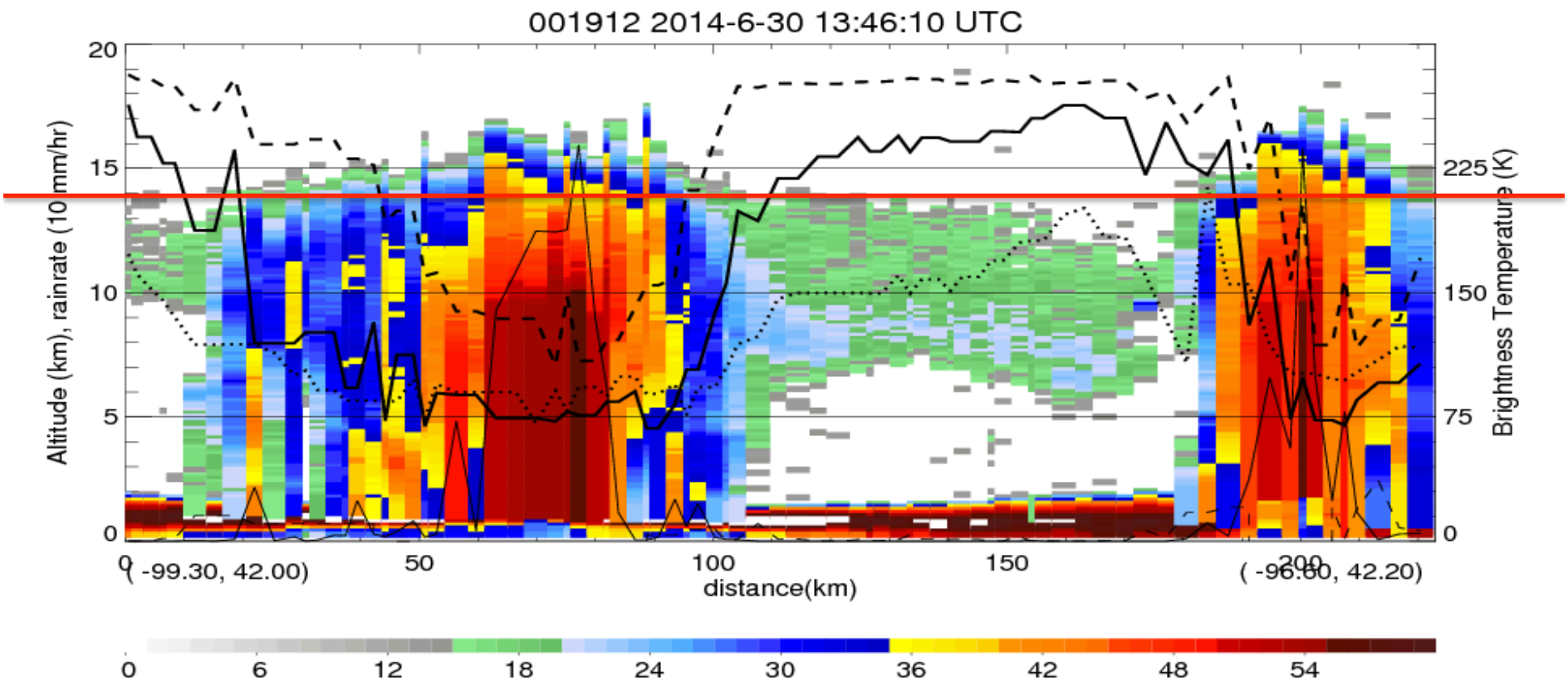
ERA-Interim reanalysis temperature profiles with 6 hourly 0.75°x 0.75° resolution are interpolated to PF times and locations, then the cold point tropopause heights are calculated for each PF



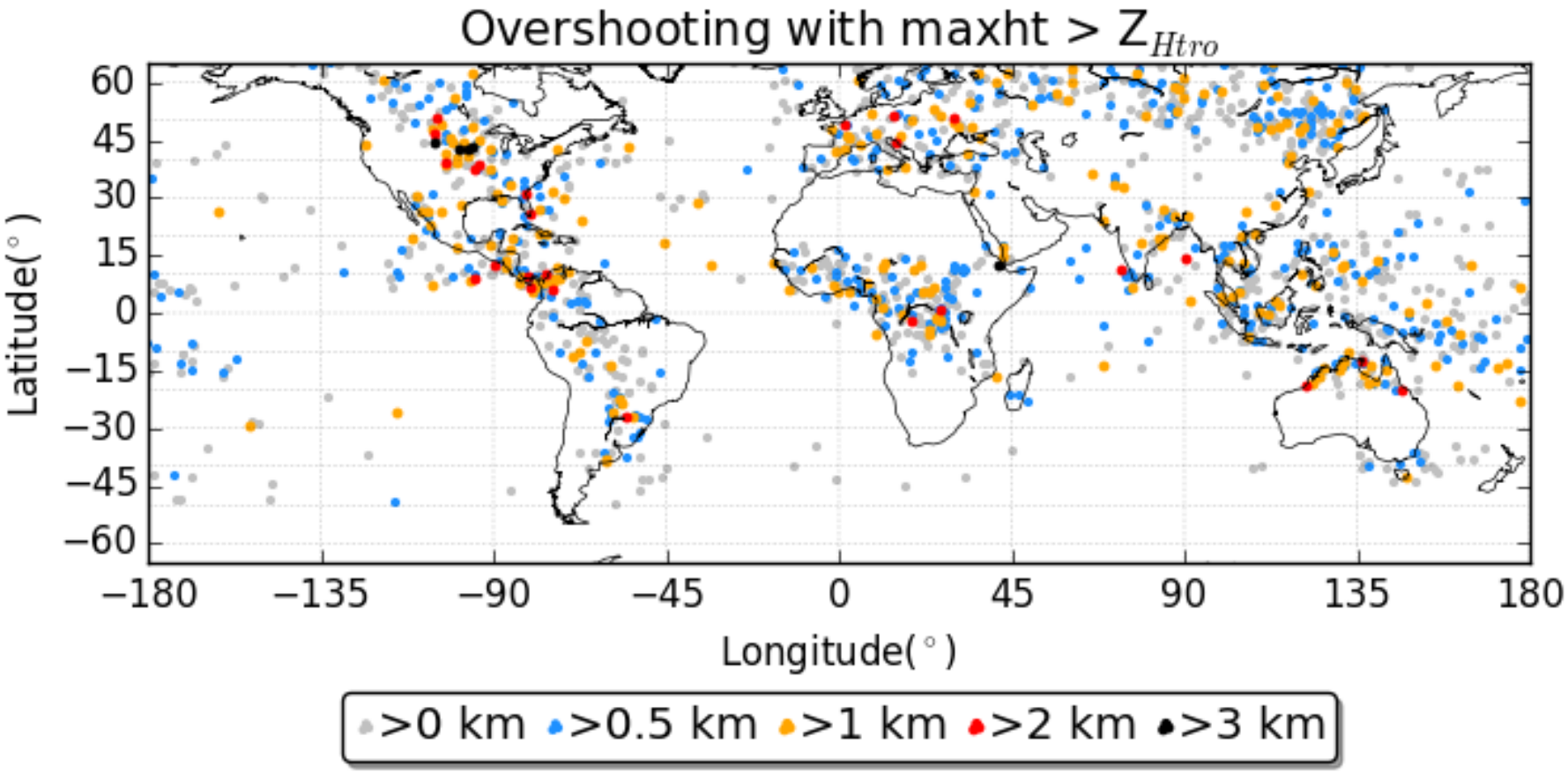
A storm over Nebraska

$Z_{tropopause}$= 13.7 (km)

$N_{tropopause}$=97 (# pixels) ≈ 2400 km^2

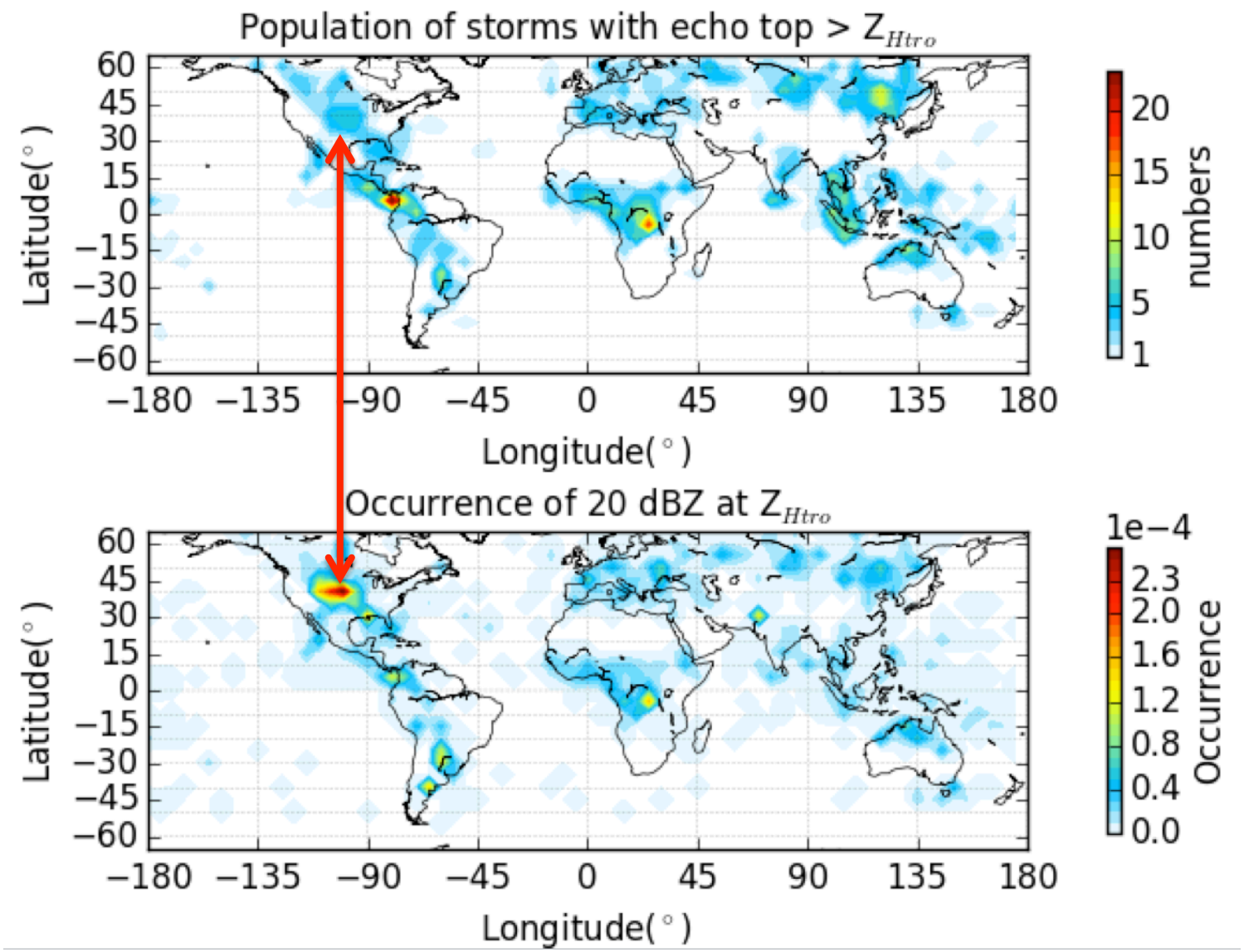


Locations of intense convection penetrating tropopause - GPM

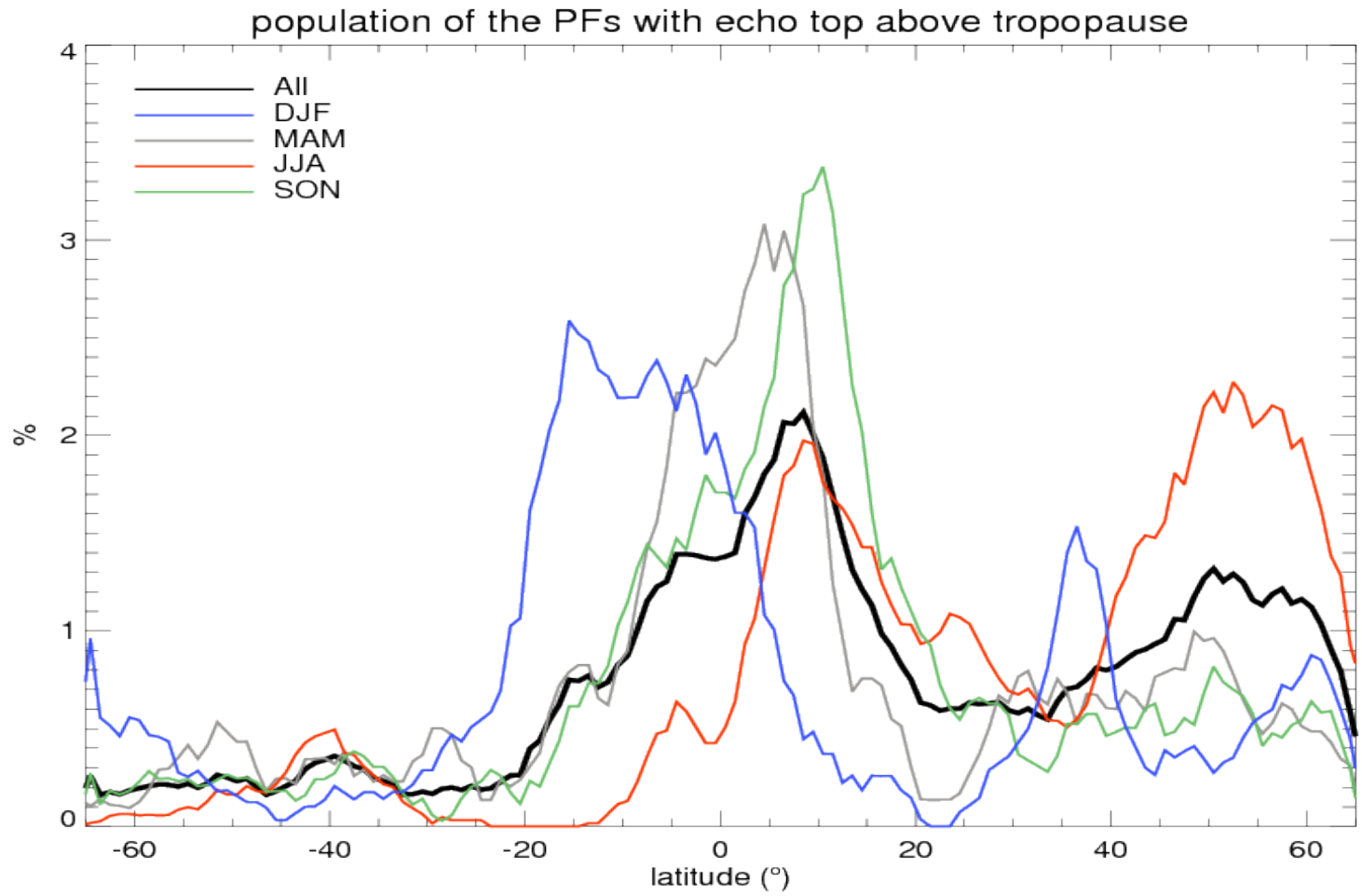


During 201403-201502, total 3516 PFs are found having echo top above tropopause

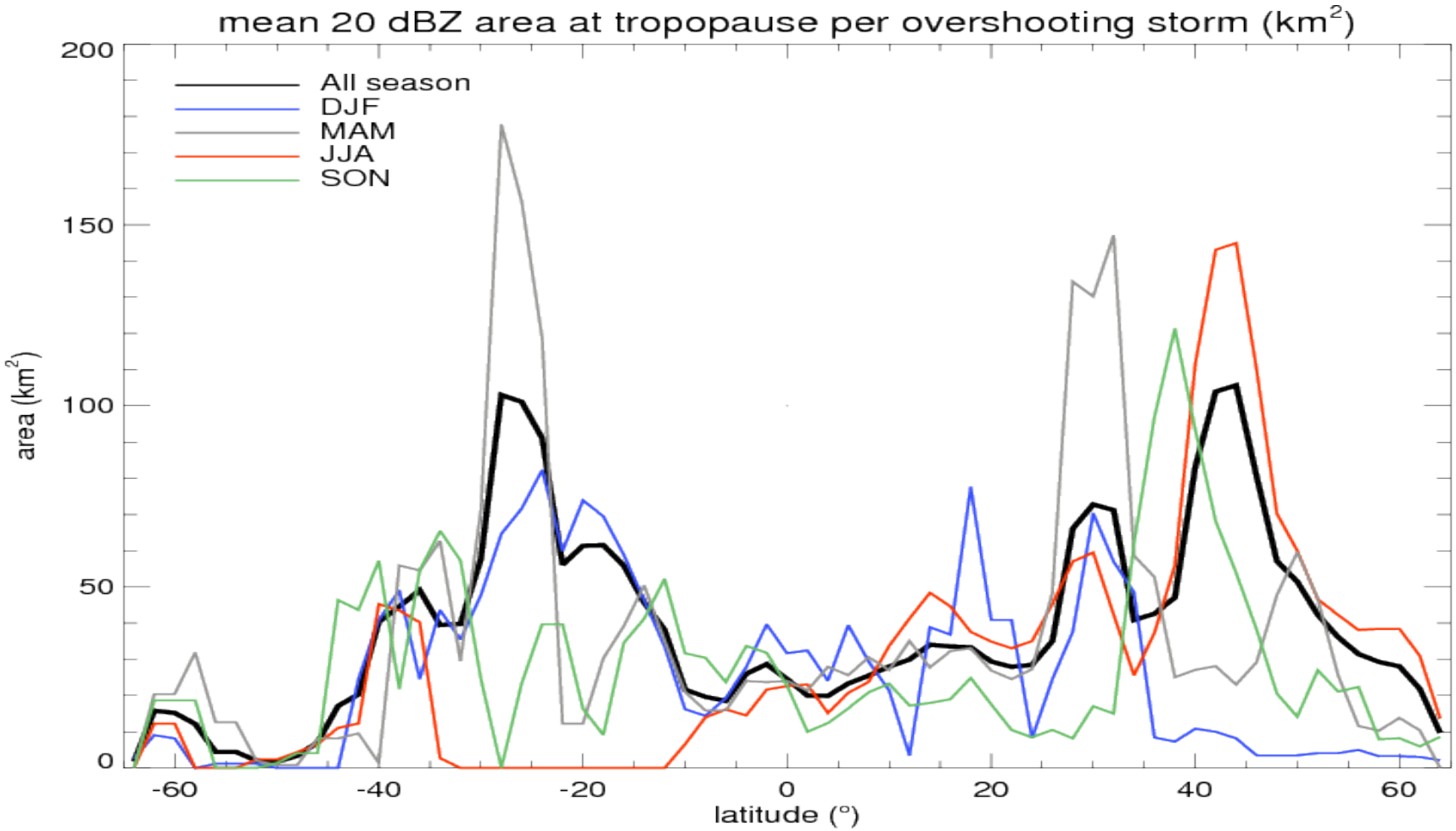
Global distribution of population of the overshooting storms and 20 dBZ occurrence at tropopause height



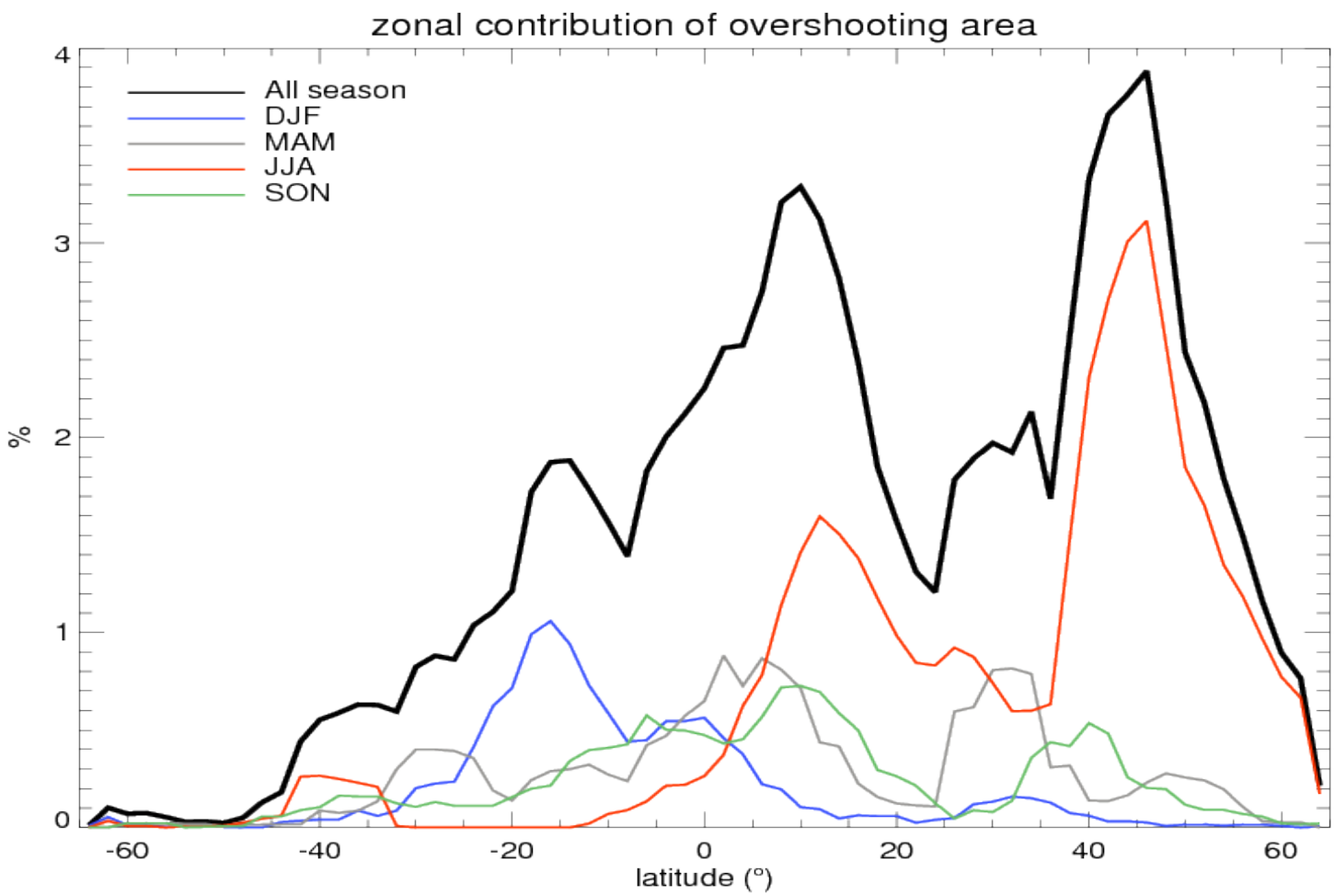
Population of the overshooting storms



Mean overshooting area



Zonal contribution of overshooting indicated by 20 dBZ at tropopause height



Summary

- GPM PF database has been built and is open to public at:

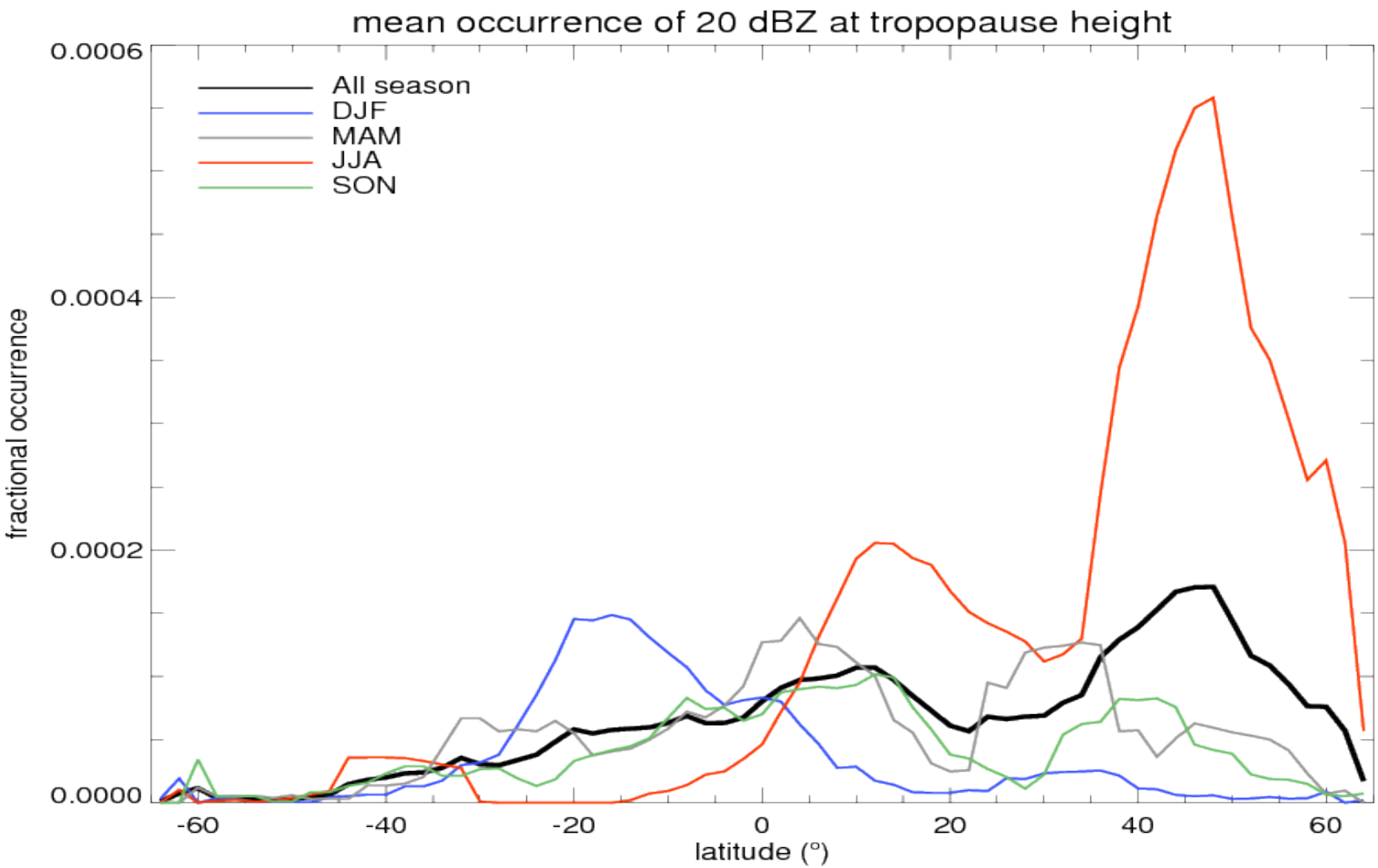
  http://atmos.tamucc.edu/trmm/data/gpm/

- GPM PF database can be used to quantify the size, intensity and depth of various precipitation systems globally.

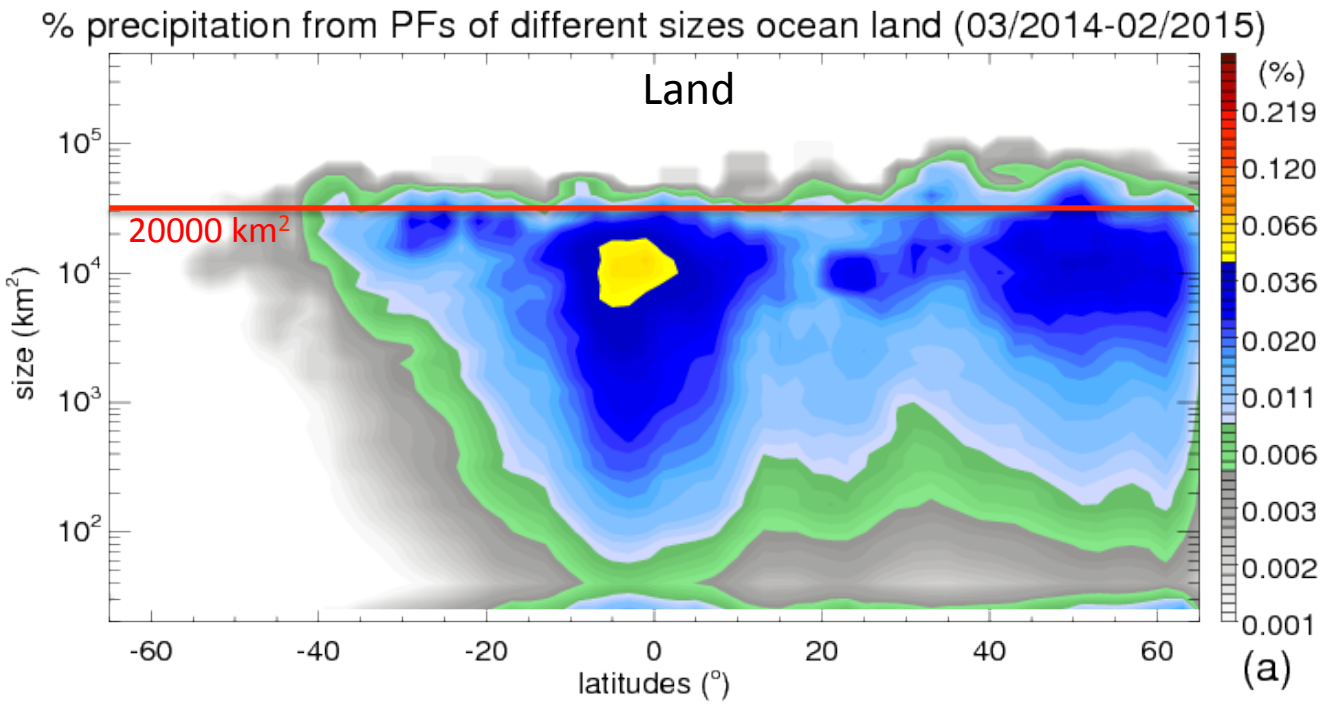
- Many convection overshooting tropopause is found over at northern mid-high latitude land. Overshooting areas in these storms are relatively larger than those in tropics and may have significant contribution to the cross-tropopause transport. Because overshooting storms are rare events, more samples are still needed to make these statistics robust.

Backup slides

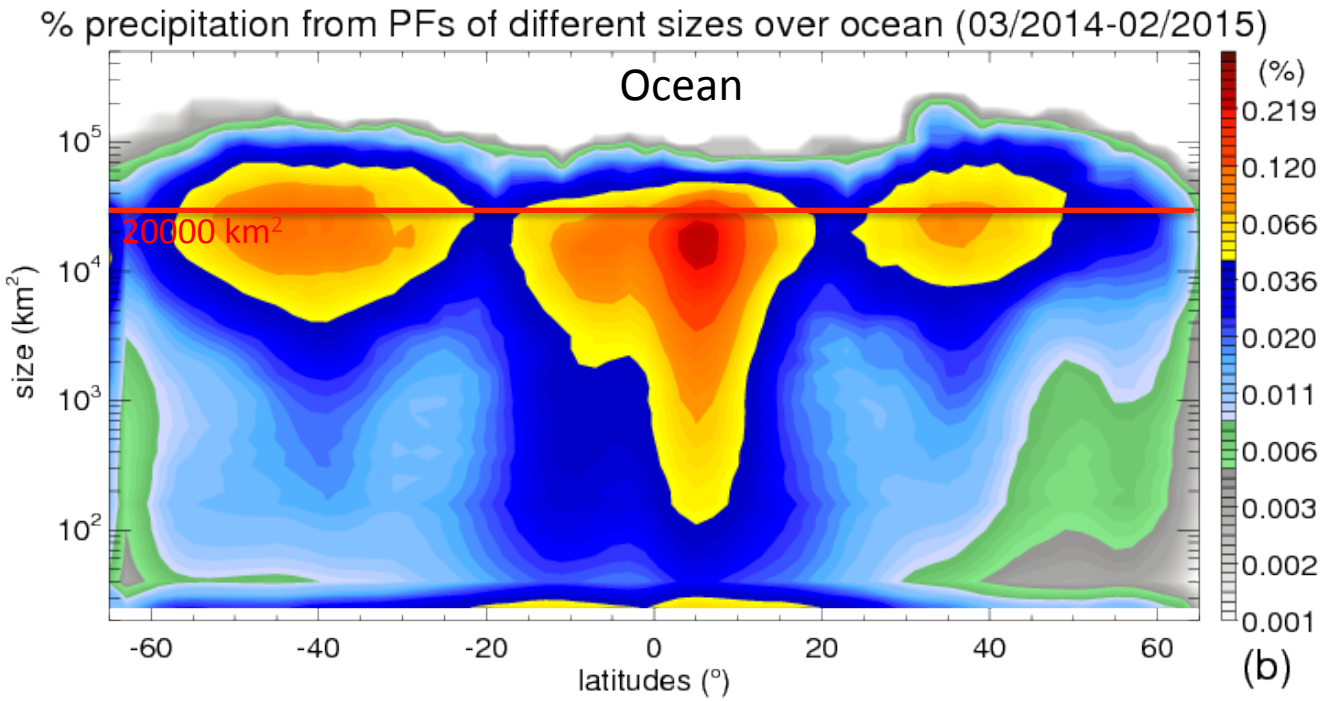
occurrence of overshooting
(overshooting area per unit area and time)



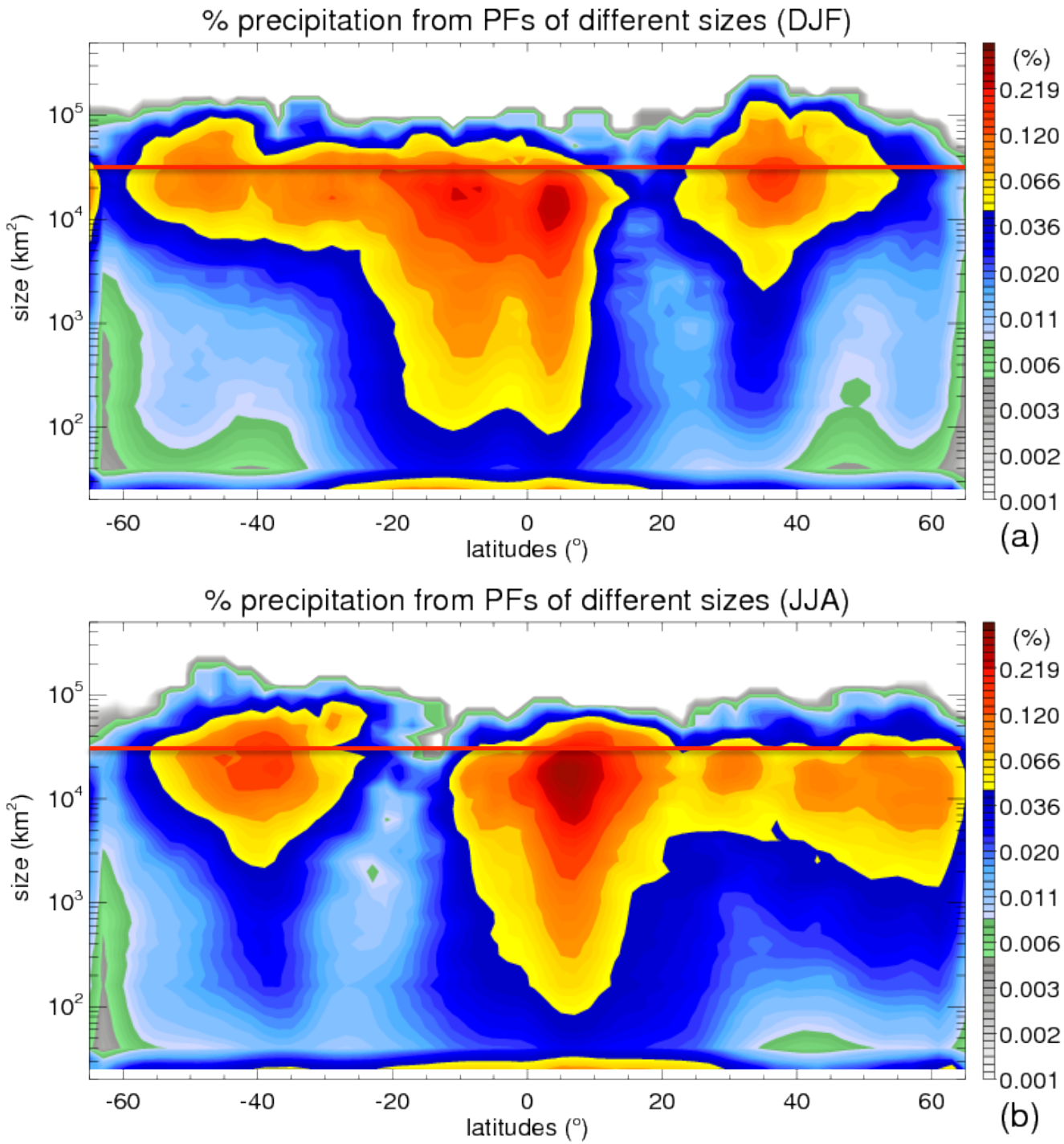
Synoptic systems over mid-high latitude land are relatively smaller than those over ocean.

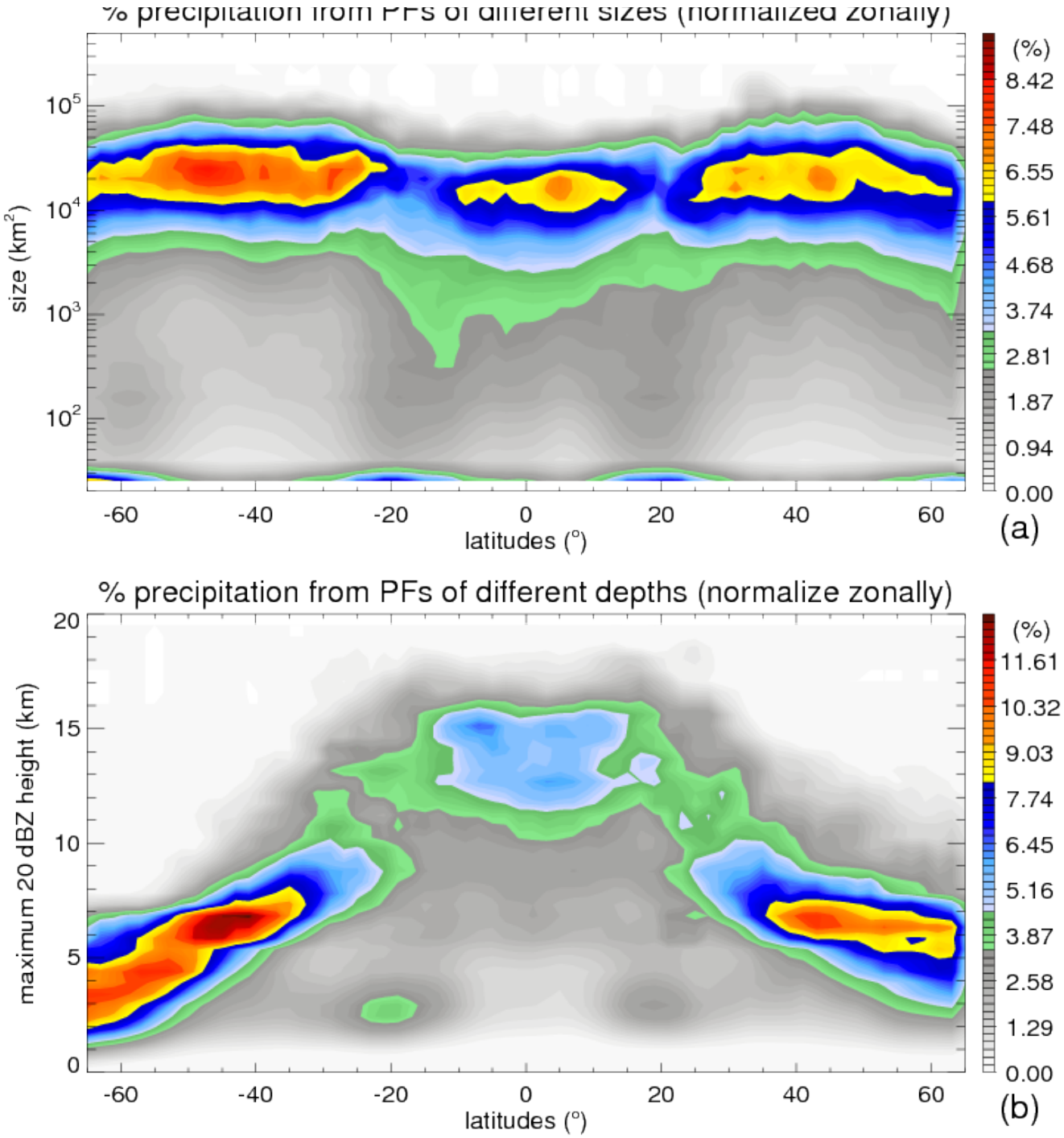


Large oceanic systems contributes significant amount of precipitation

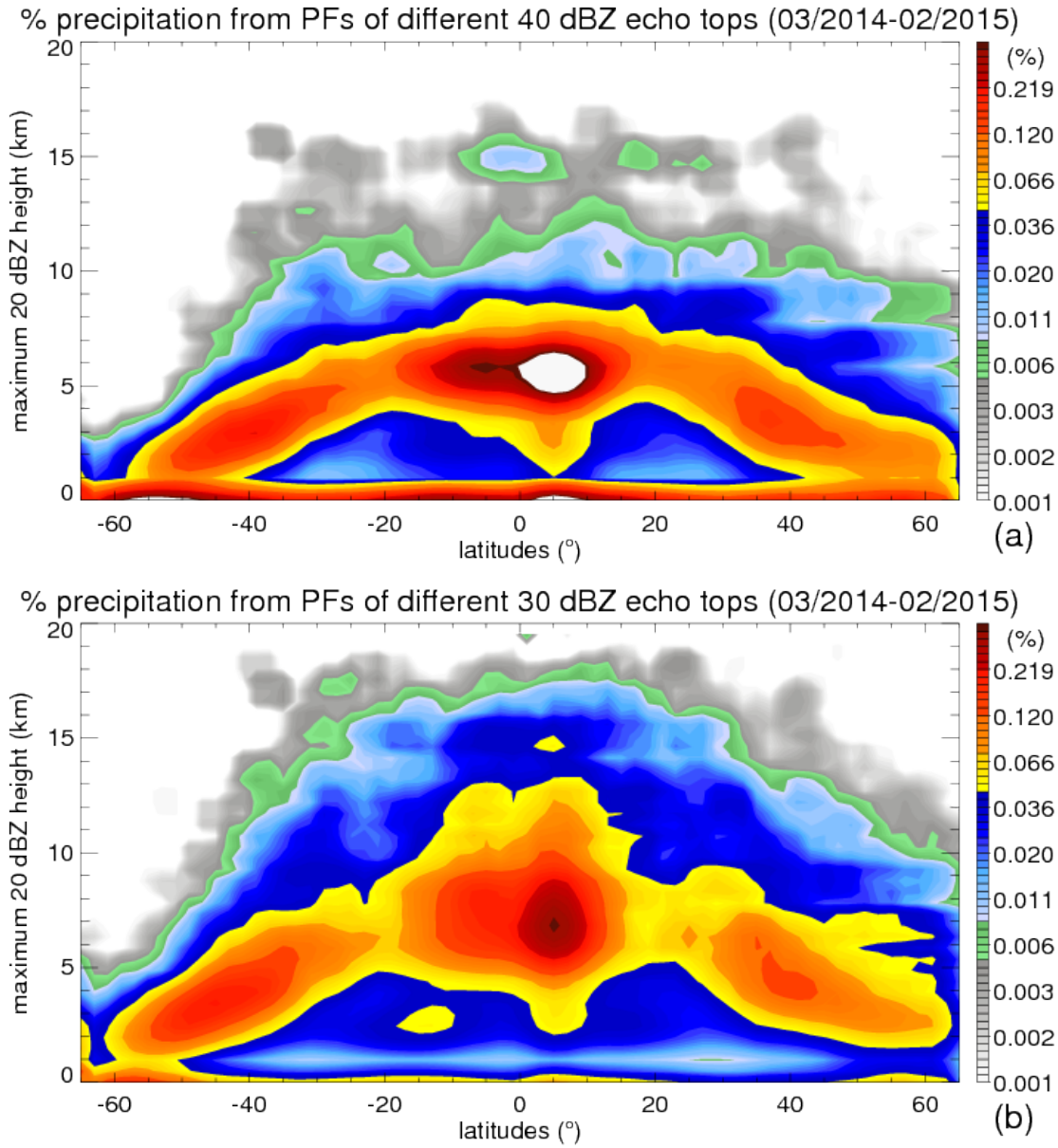


Winter systems are larger

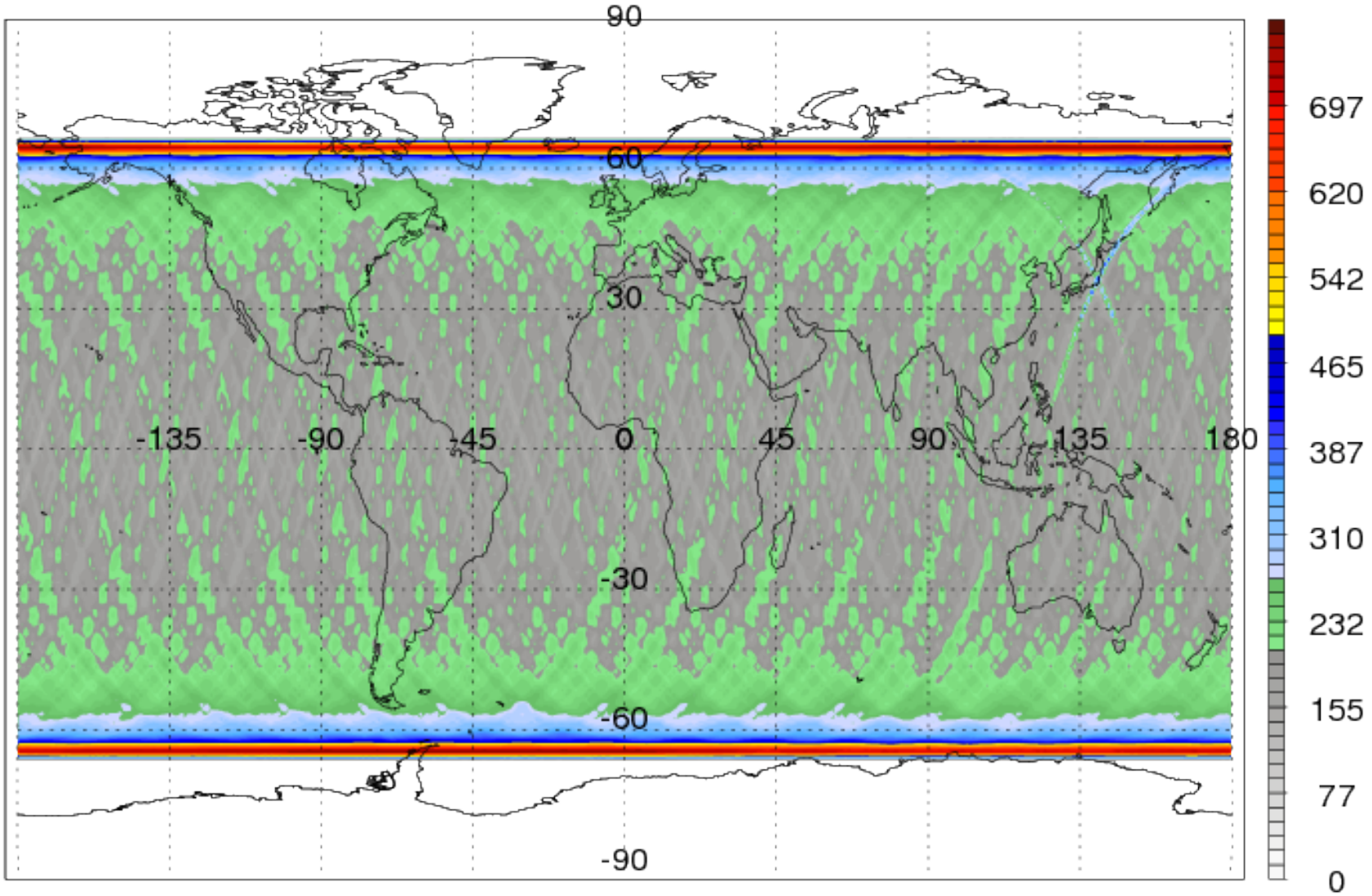
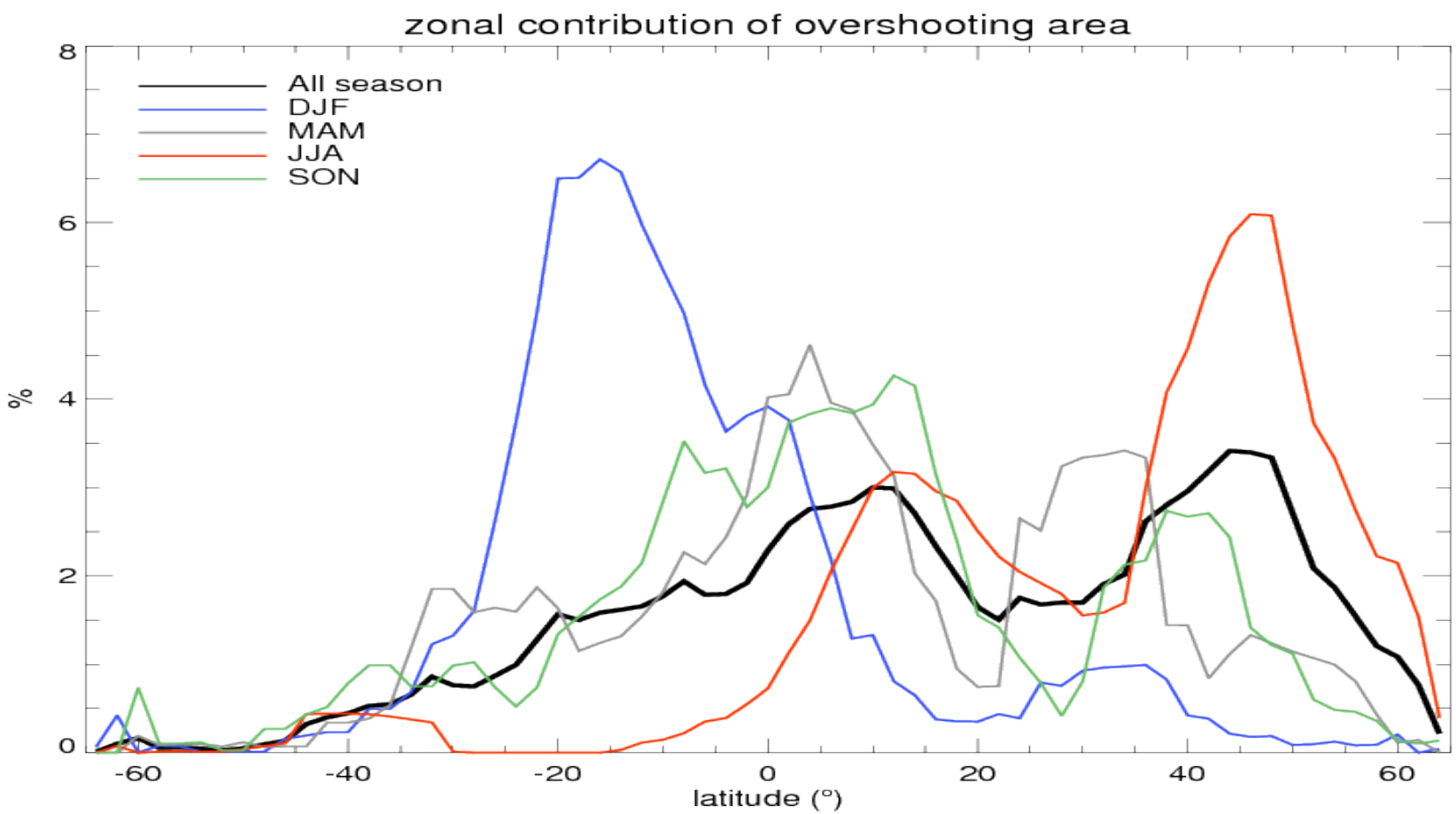



% precipitation from PFs of different sizes (normalized zonally)
size (km^2)
10^5
10^4
10^3
10^2
-60
-40
-20
0
20
40
60
latitudes (°)
(%)
8.42
7.48
6.55
5.61
4.68
3.74
2.81
1.87
0.94
0.00
(a)
% precipitation from PFs of different depths (normalize zonally)
maximum 20 dBZ height (km)
20
15
10
5
0
-60
-40
-20
0
20
40
60
latitudes (°)
(%)
11.61
10.32
9.03
7.74
6.45
5.16
3.87
2.58
1.29
0.00
(b)

Contribution of the global precipitation from systems of different intensities



Sample frequencies by Ku radar



Zonal contribution of overshooting indicated by 20 dBZ at tropopause height