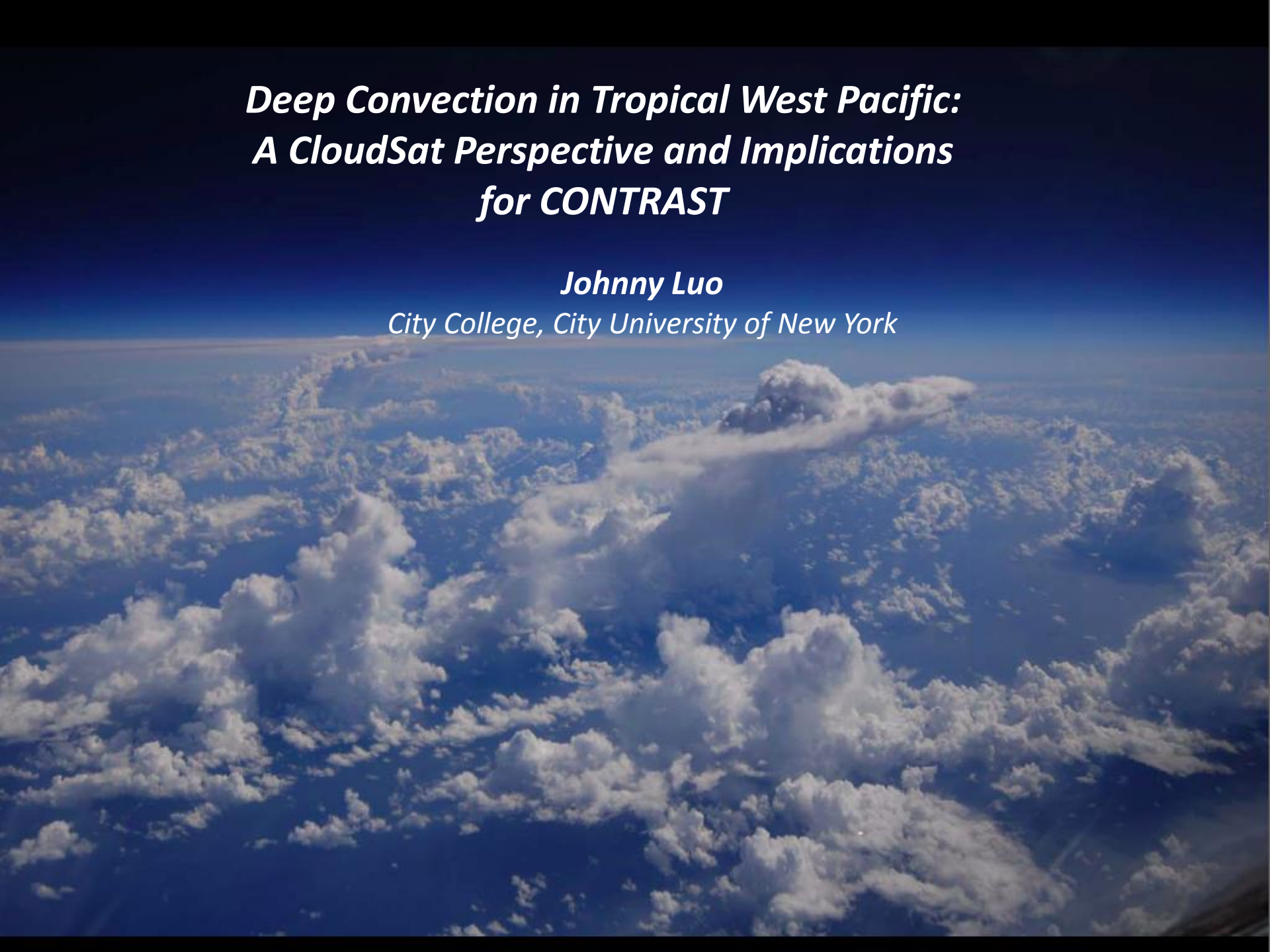
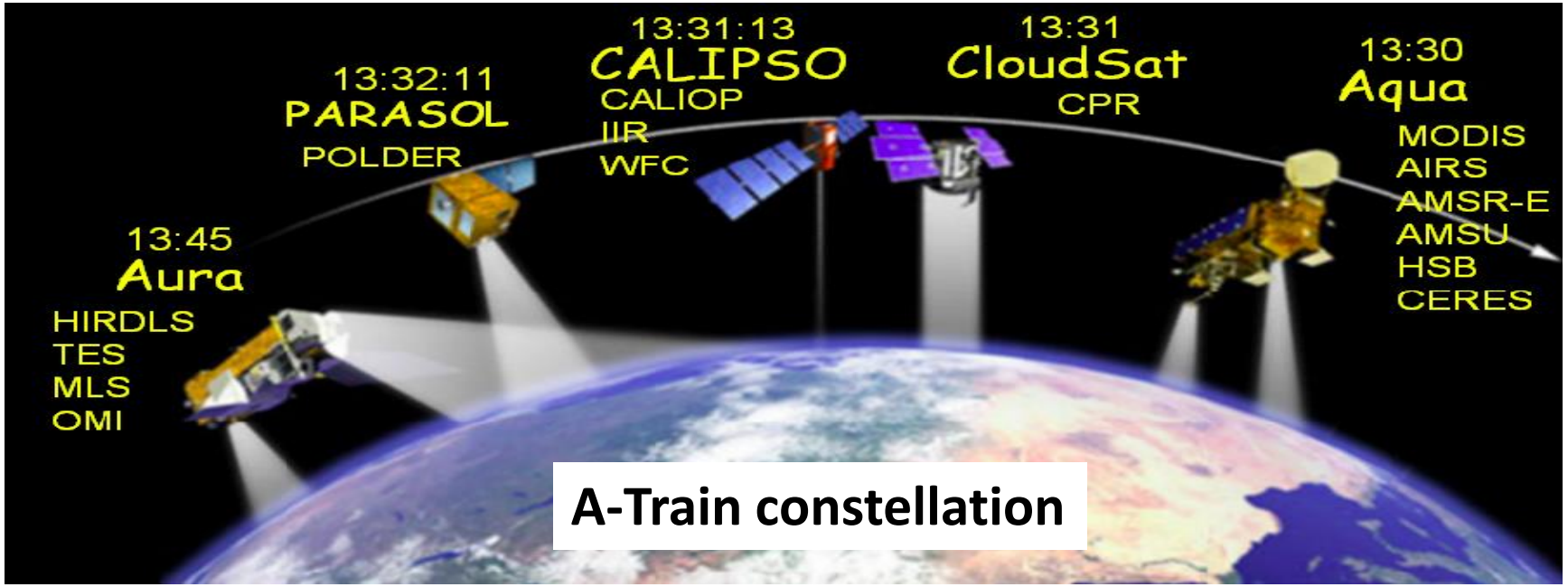


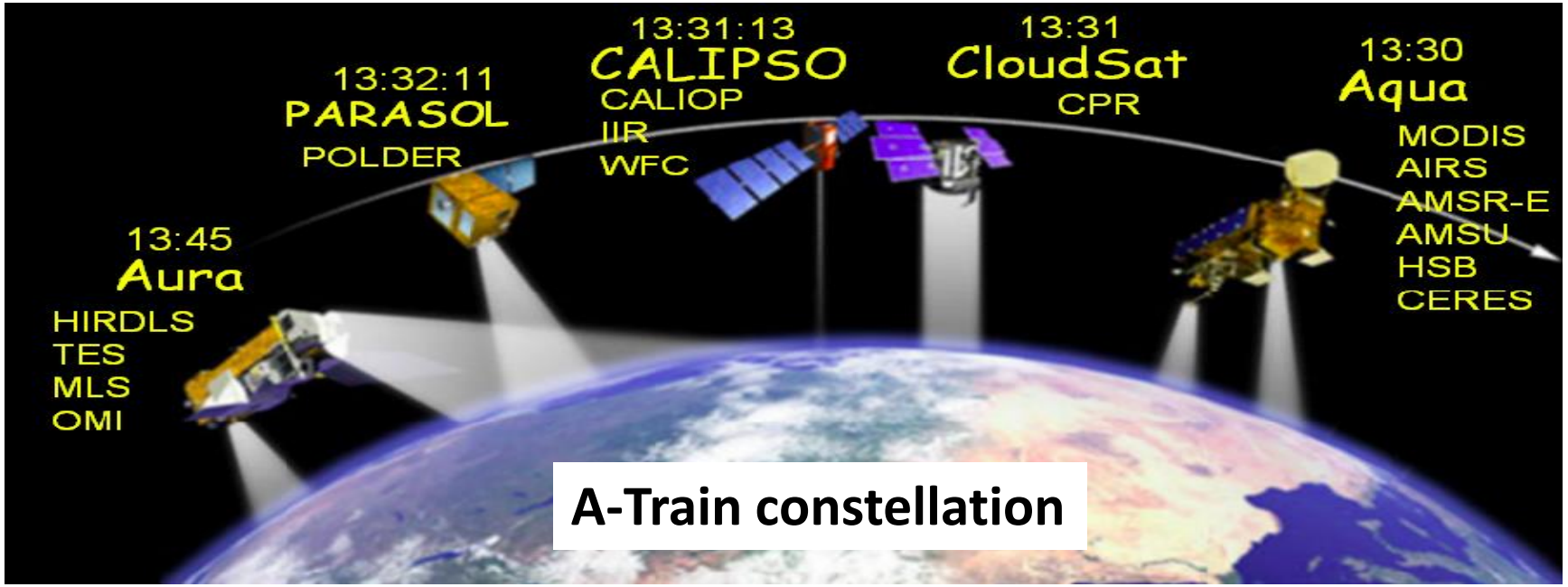
Deep Convection in Tropical West Pacific: A CloudSat Perspective and Implications for CONTRAST

Johnny Luo

City College, City University of New York



A-Train constellation



A-Train constellation

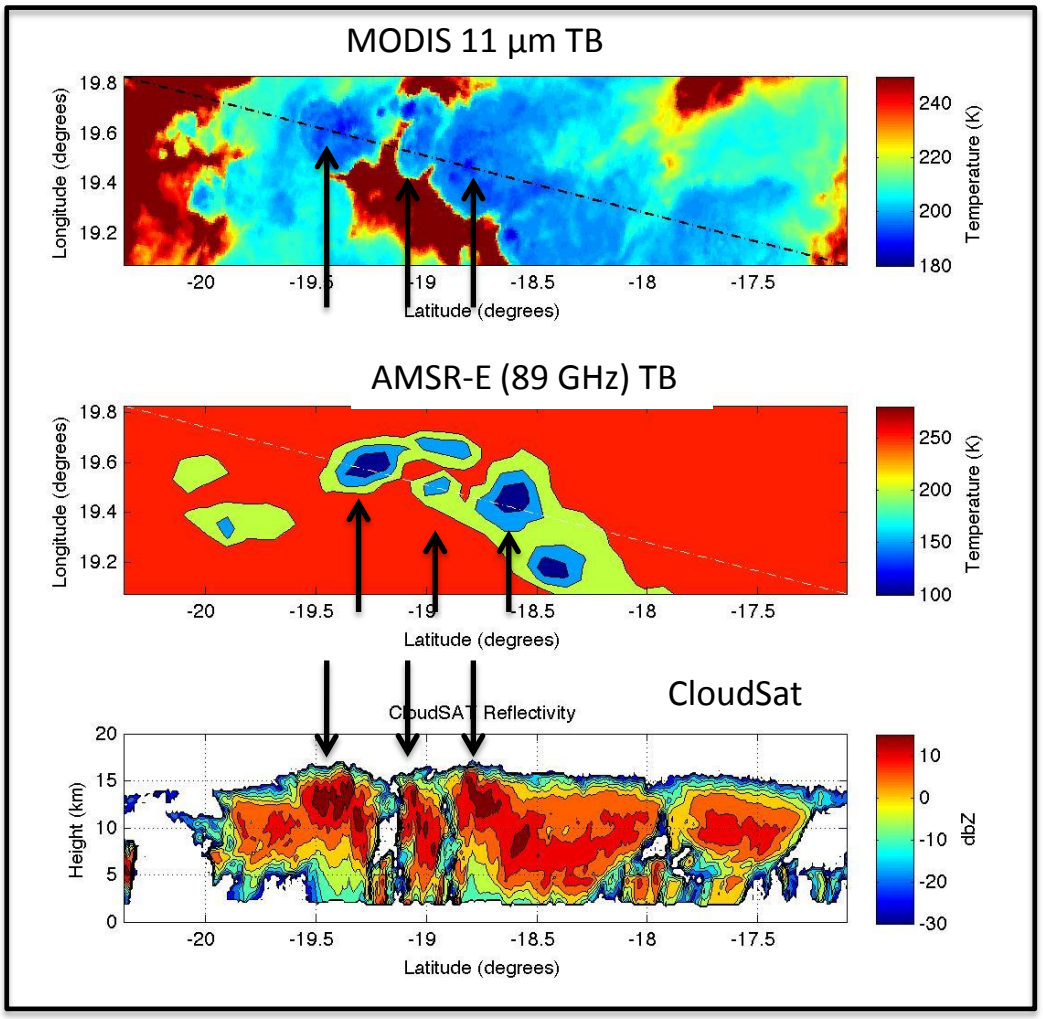
City College of New York

Outline

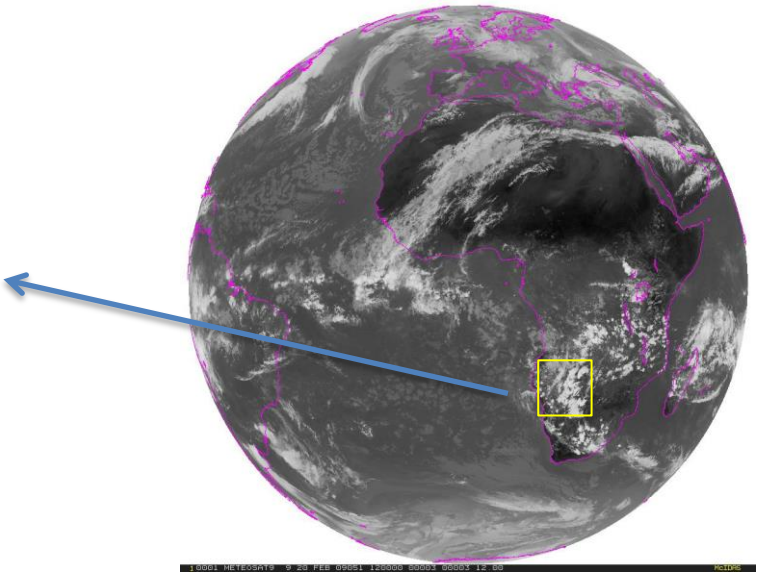
1. A CloudSat (and A-Train) view of tropical convection

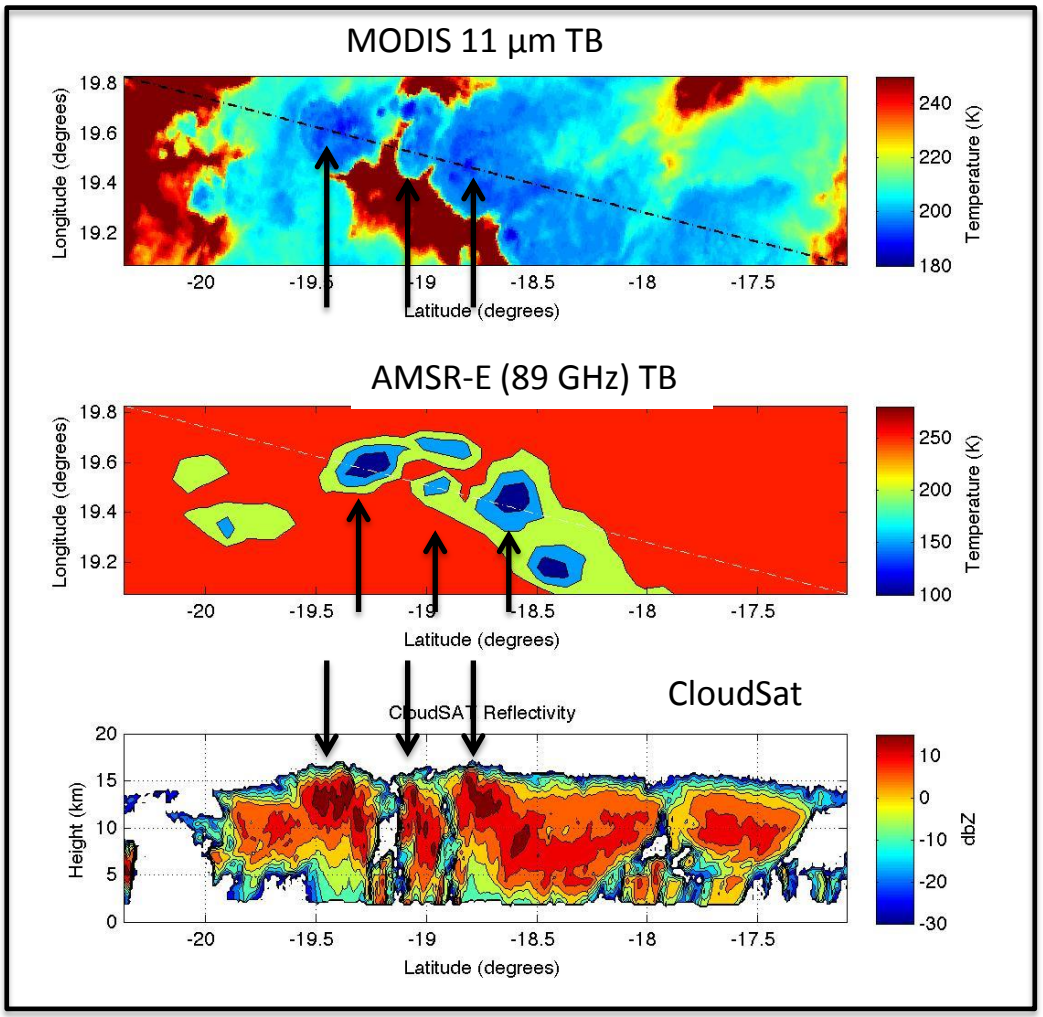
2. A few interesting features of deep convection in TWP during Boreal winter

3. Examples of SEAC4RS convection-penetration flights relevant to CONTRAST



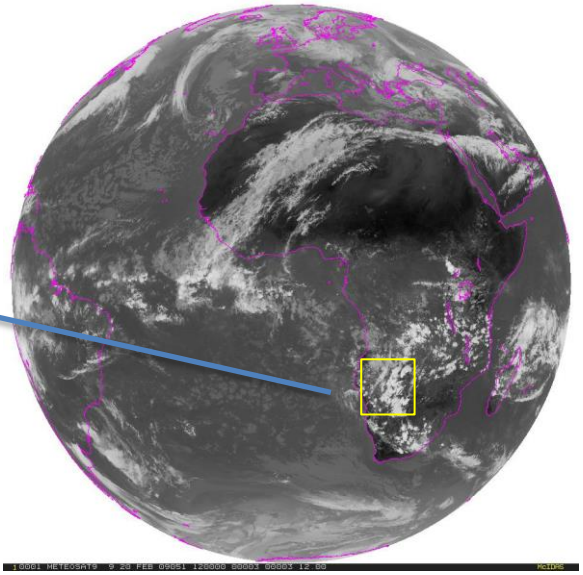
A-Train observations of deep convection

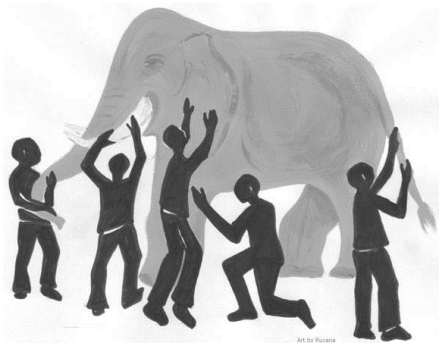




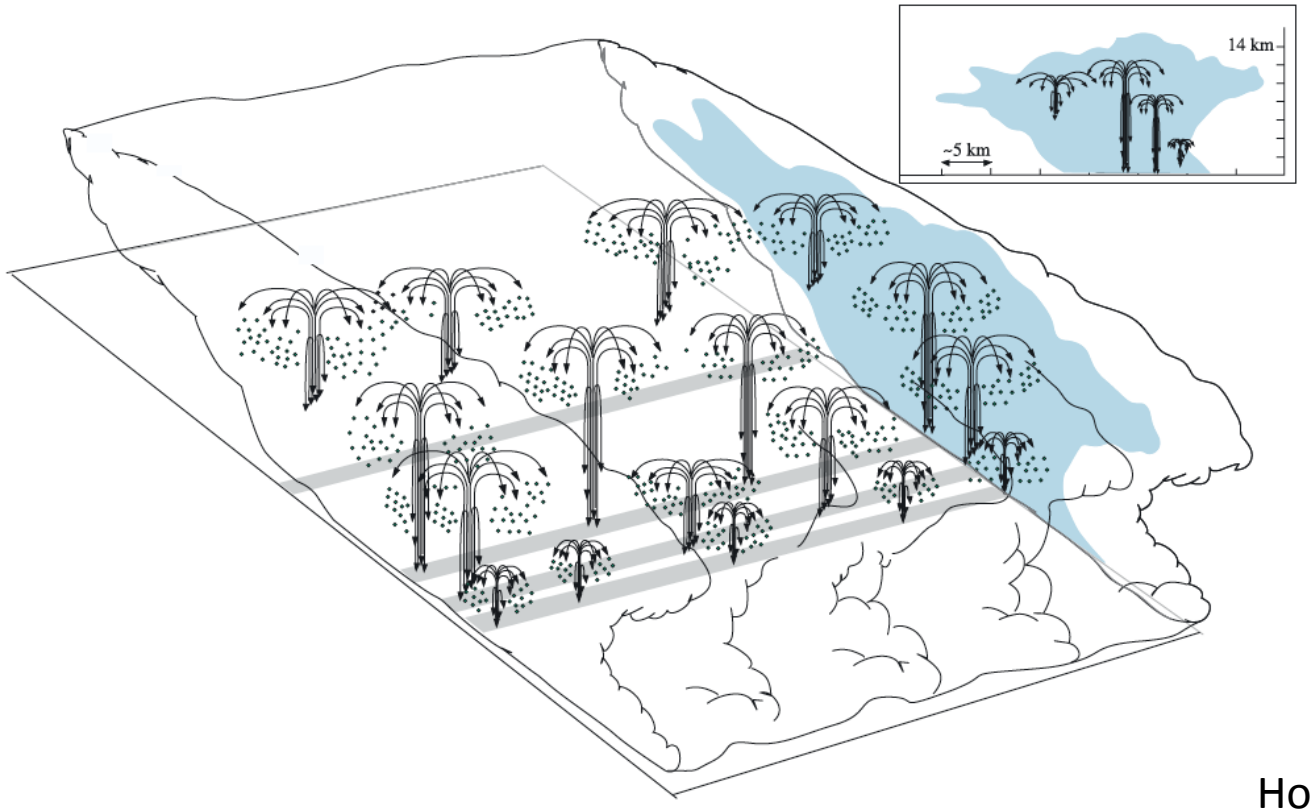
CloudSAT Granule # 14987

A-Train observations of deep convection





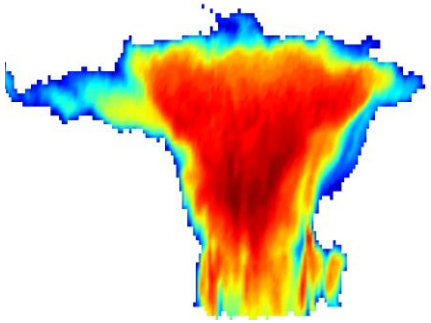
<u>An important consideration</u>: which part of the convective cloud system is most relevant to transporting chemicals to the TTL and LS?

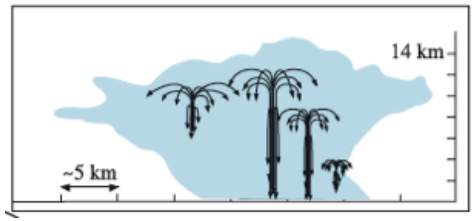


Houze 2004

CONTRAST Experiment Design Overview (EDO) Document

"…profiles of these species (e.g., VSL iodine, bromocarbons, etc) through the TTL should allow us to evaluate the relative importance of detrainment at different altitudes of convection."





Perhaps analyzing space-borne active cloud remote sensing data can help gain some insight into this question.

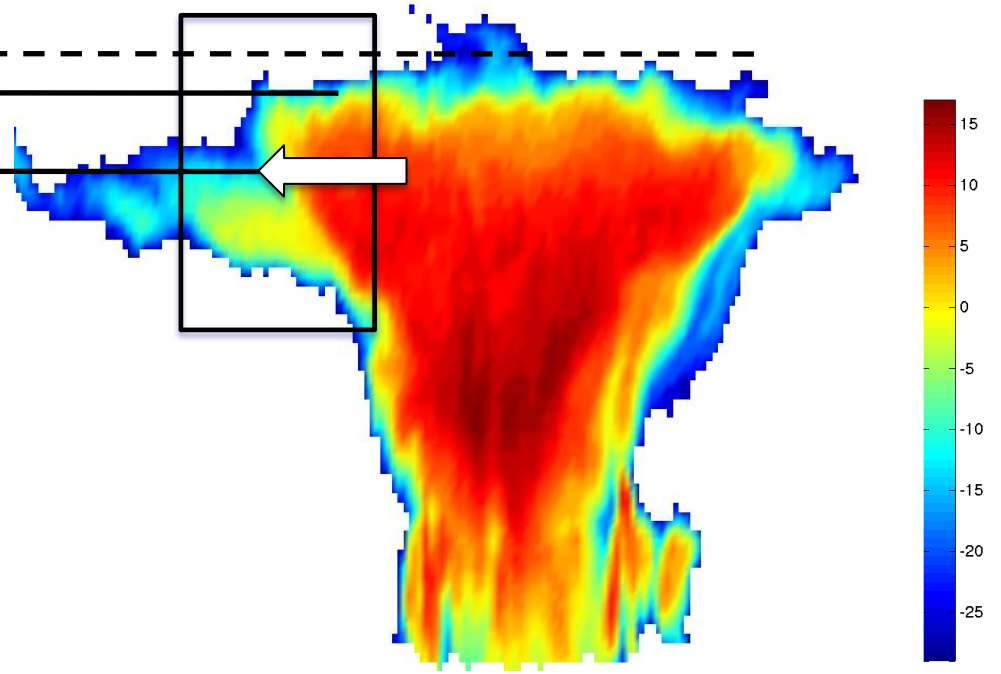
We assume that well-developed anvil defines the deep convective outflow and "betray" where convective motions loses buoyancy (level of neutral buoyancy)

LNB_sounding (14.2 km)

LNB_CTH (13.4 km)

LNB_maxMass (10.7 km)

These numbers are tropical (30S-30N) means



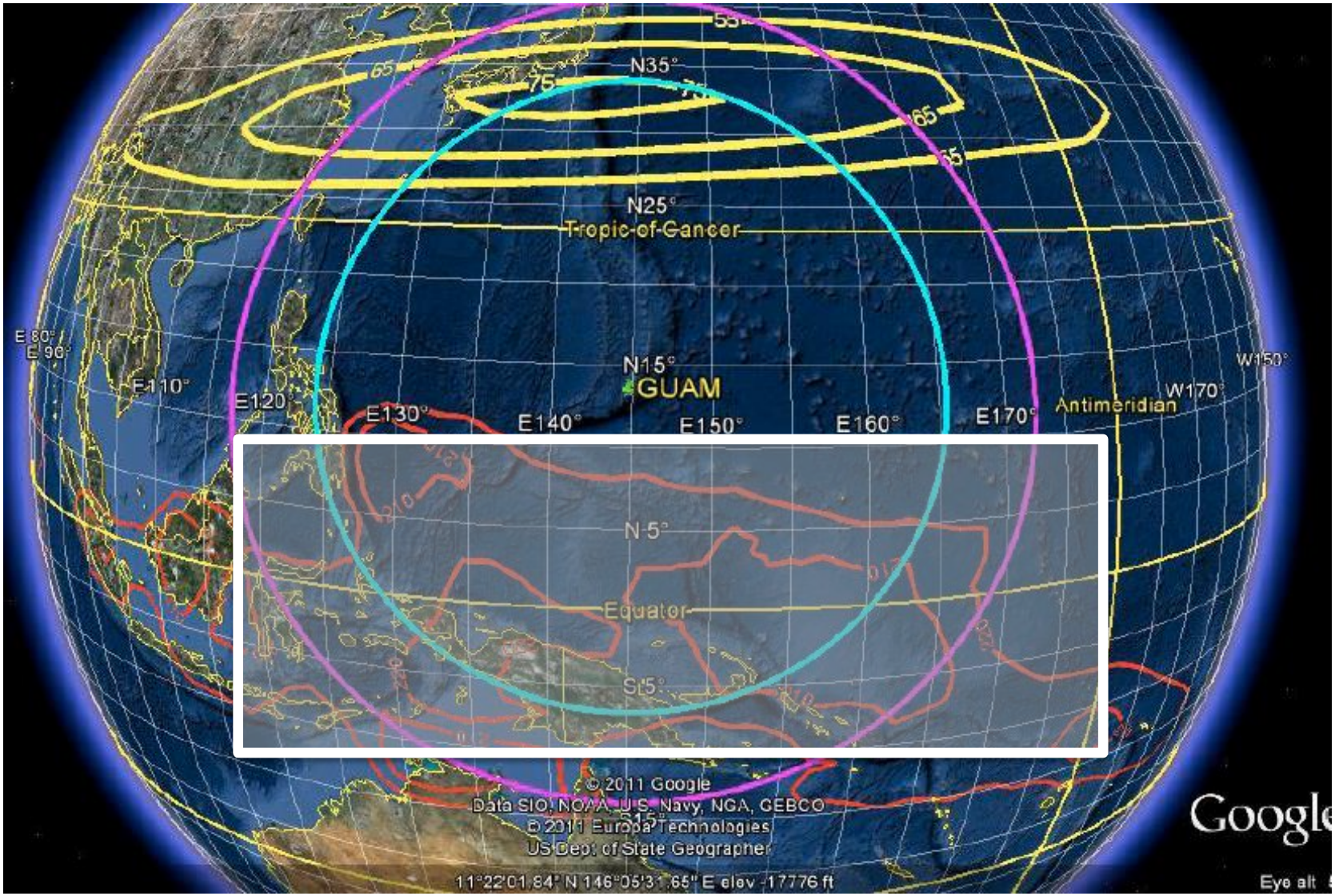
Takahashi and Luo (2012)

Outline

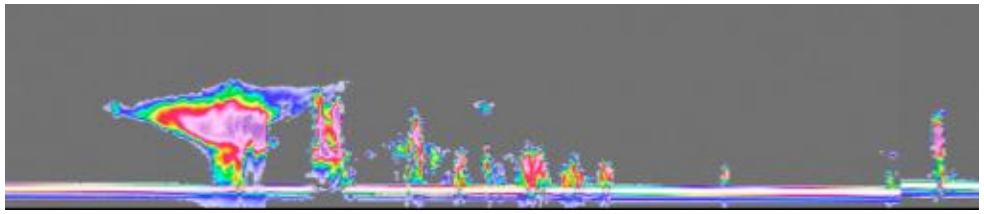
1. CloudSat (and A-Train) perspective of tropical convection
2. A few interesting features of deep convection over TWP during Boreal winter
3. Examples of SEAC4RS convection-penetration flights relevant to CONTRAST

120E-180E, 10S – 10N

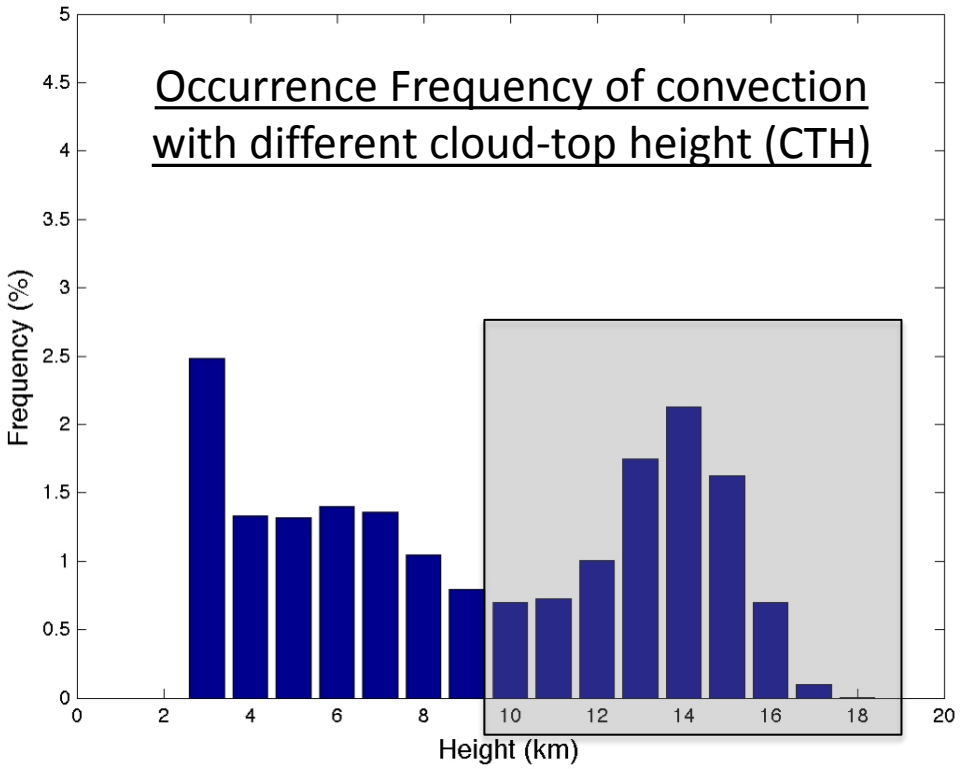
(4 years of Jan/Feb data: 2007 – 2010)



Total number of radar profiles analyzed: ***2,182,175***



Attached anvils are excluded. This is different from IR based analysis.



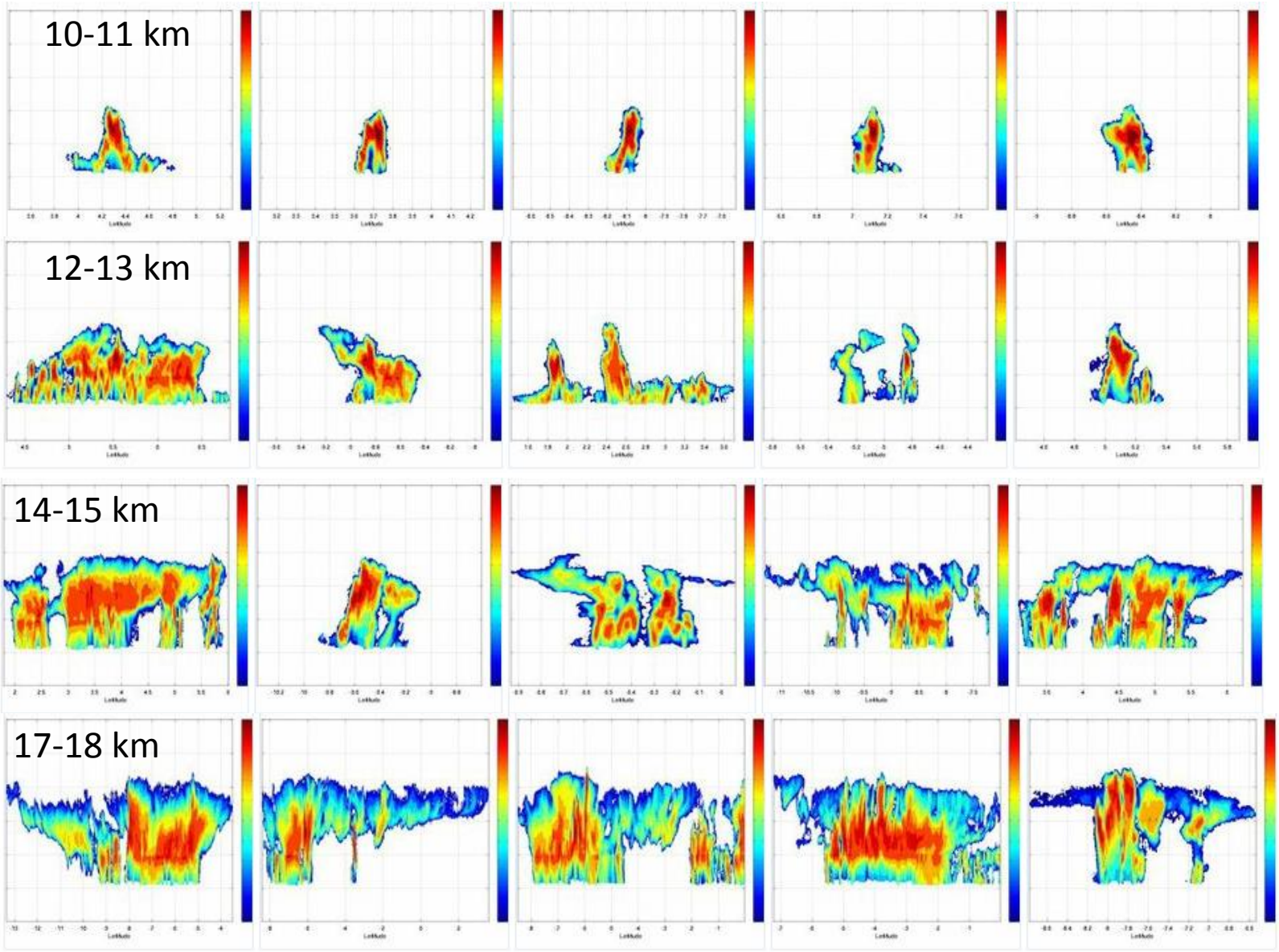
Note: the denominator for the occurrence freq is all scenes, both clear and cloudy

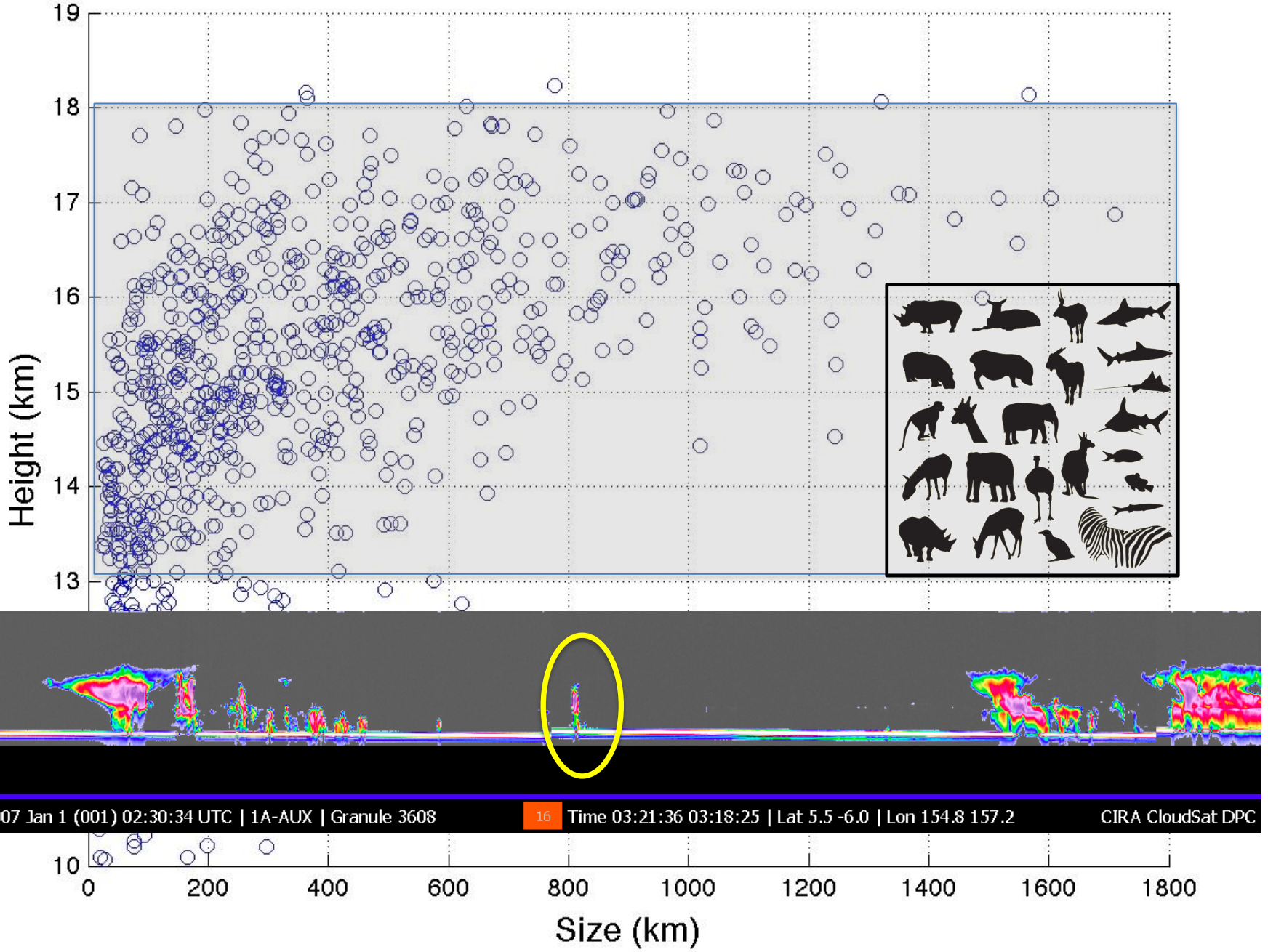
"Typical" deep convection in TWP during Boreal winter is 14-15 km (c.f., CONTRAST Scientific Program Overview used 12-13 km).

5% of the TWP has convection w/ CTH > 14 km; 1% has CTH > 16 km (c.f., CONTRAST EDO: 3% reaches the tropopause; based on IR?)

Deep convection in TWP:

Fewer but *deeper* than previously thought


10-11 km
12-13 km
14-15 km
17-18 km


Cloud Size vs. Cloud Top Height
Height (km)
19
18
17
16
15
14
13
10
0
200
400
600
800
1000
1200
1400
1600
1800
Size (km)
2007 Jan 1 (001) 02:30:34 UTC | 1A-AUX | Granule 3608
16
Time 03:21:36 03:18:25 | Lat 5.5 -6.0 | Lon 154.8 157.2
CIRA CloudSat DPC

Outline

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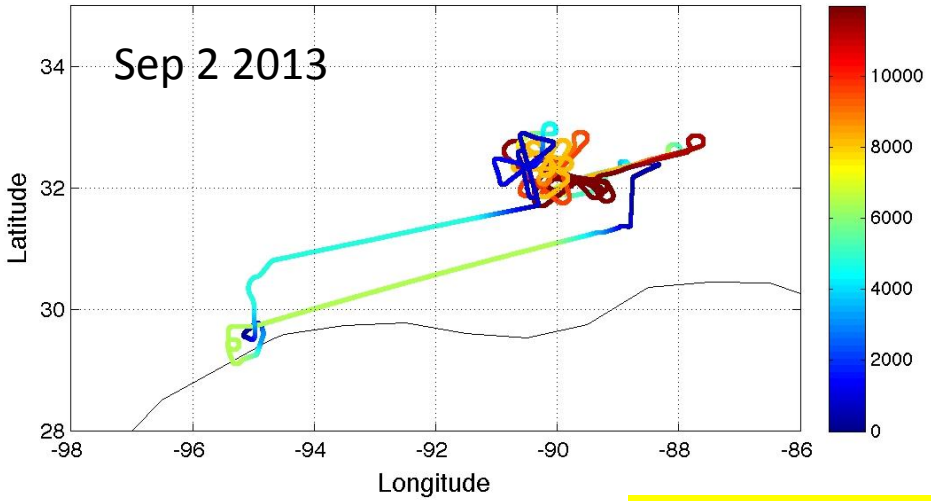
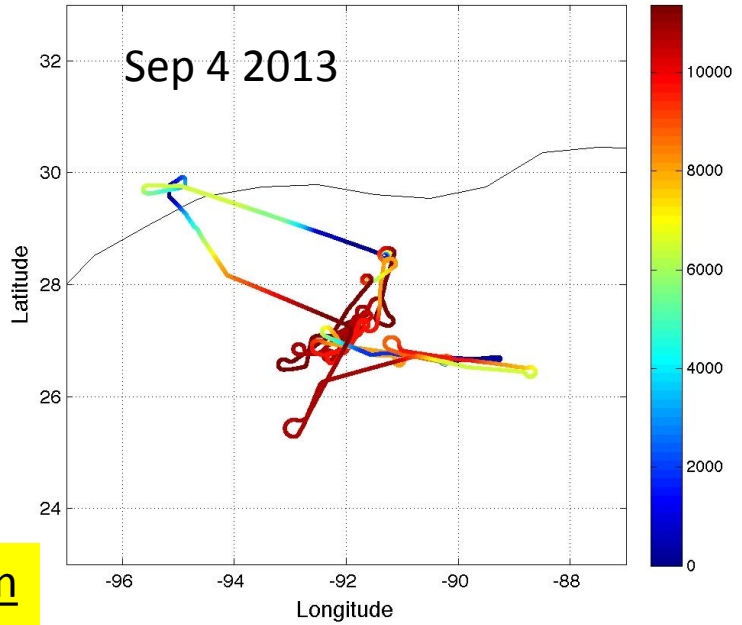
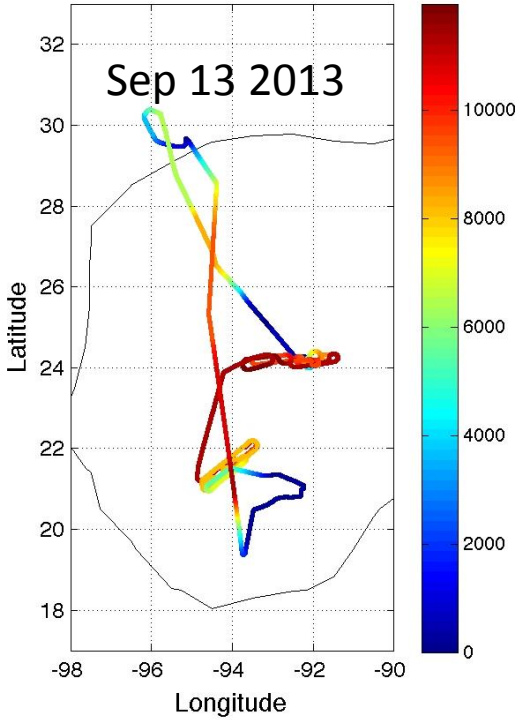
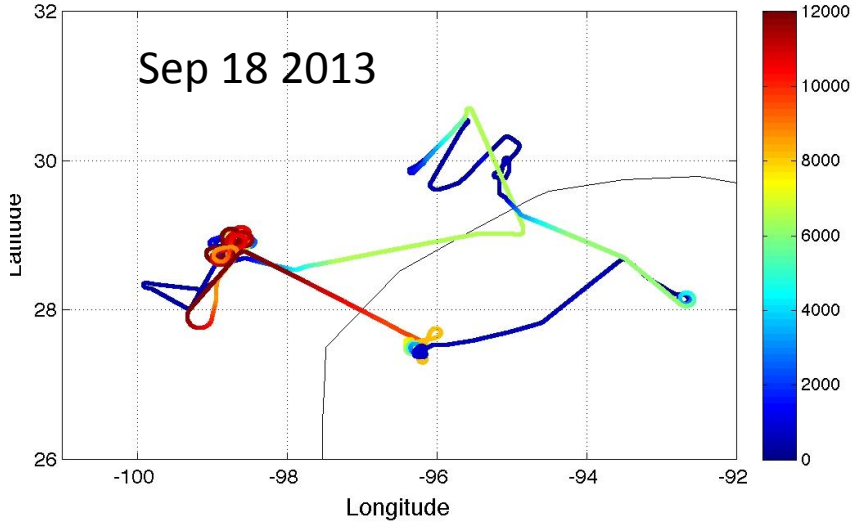
3. Example of a SEAC4RS convection-penetration flight relevant to CONTRAST



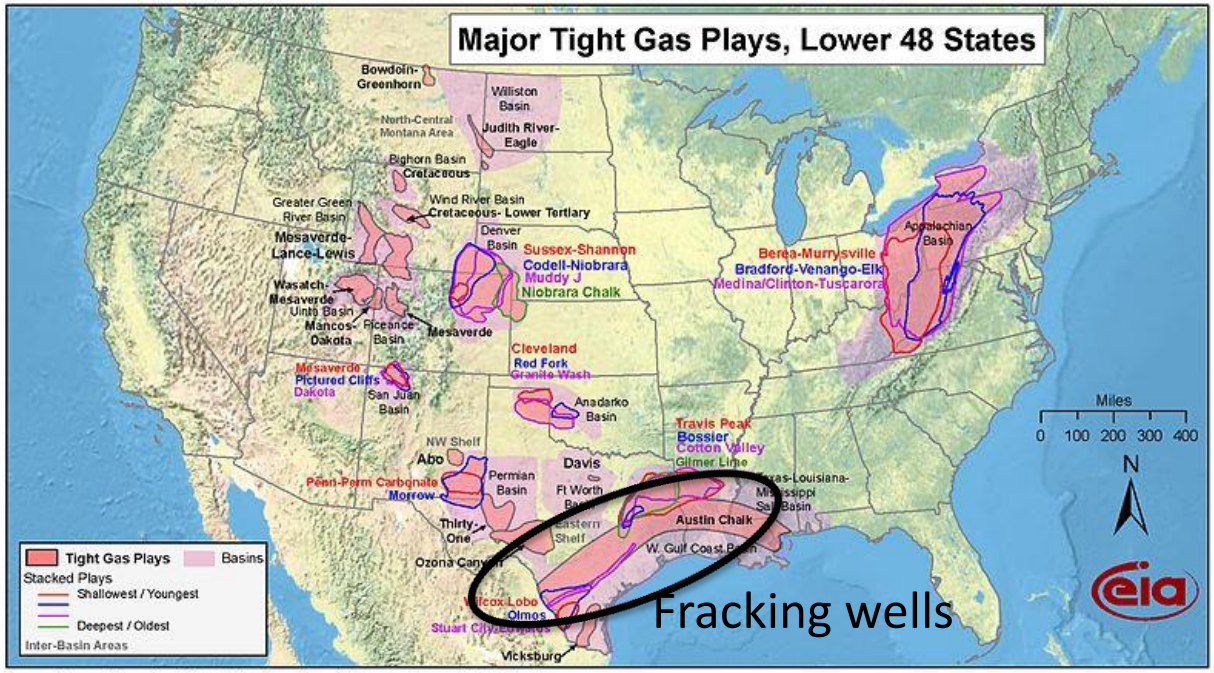


SEAC4RS convection flights: color shows flight altitude (m)

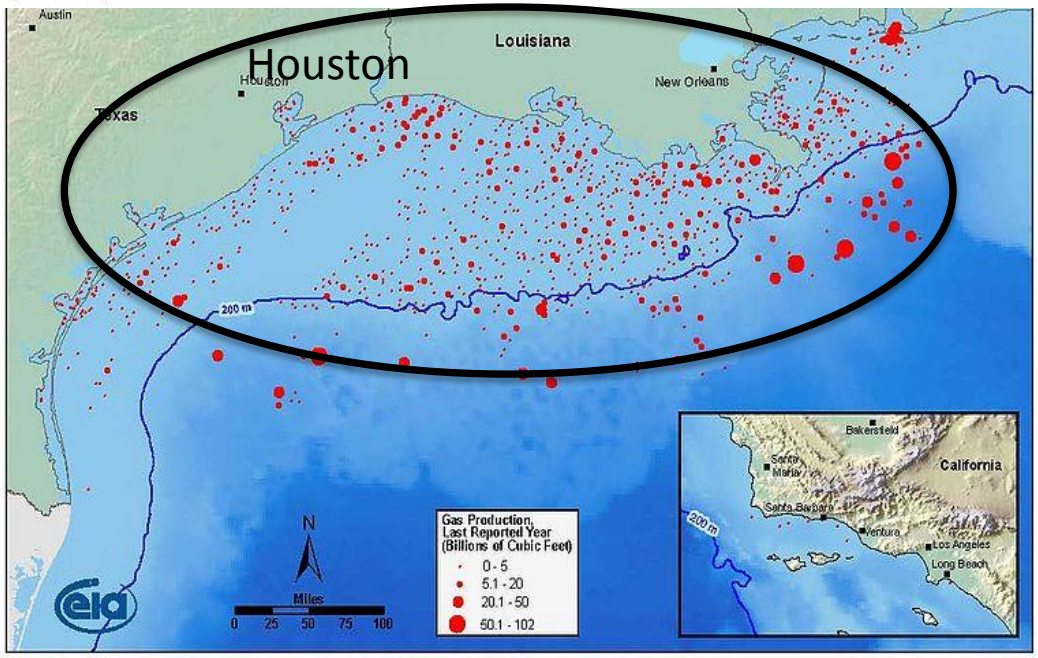




Objective: Emission and convective transport of petroleum chemicals



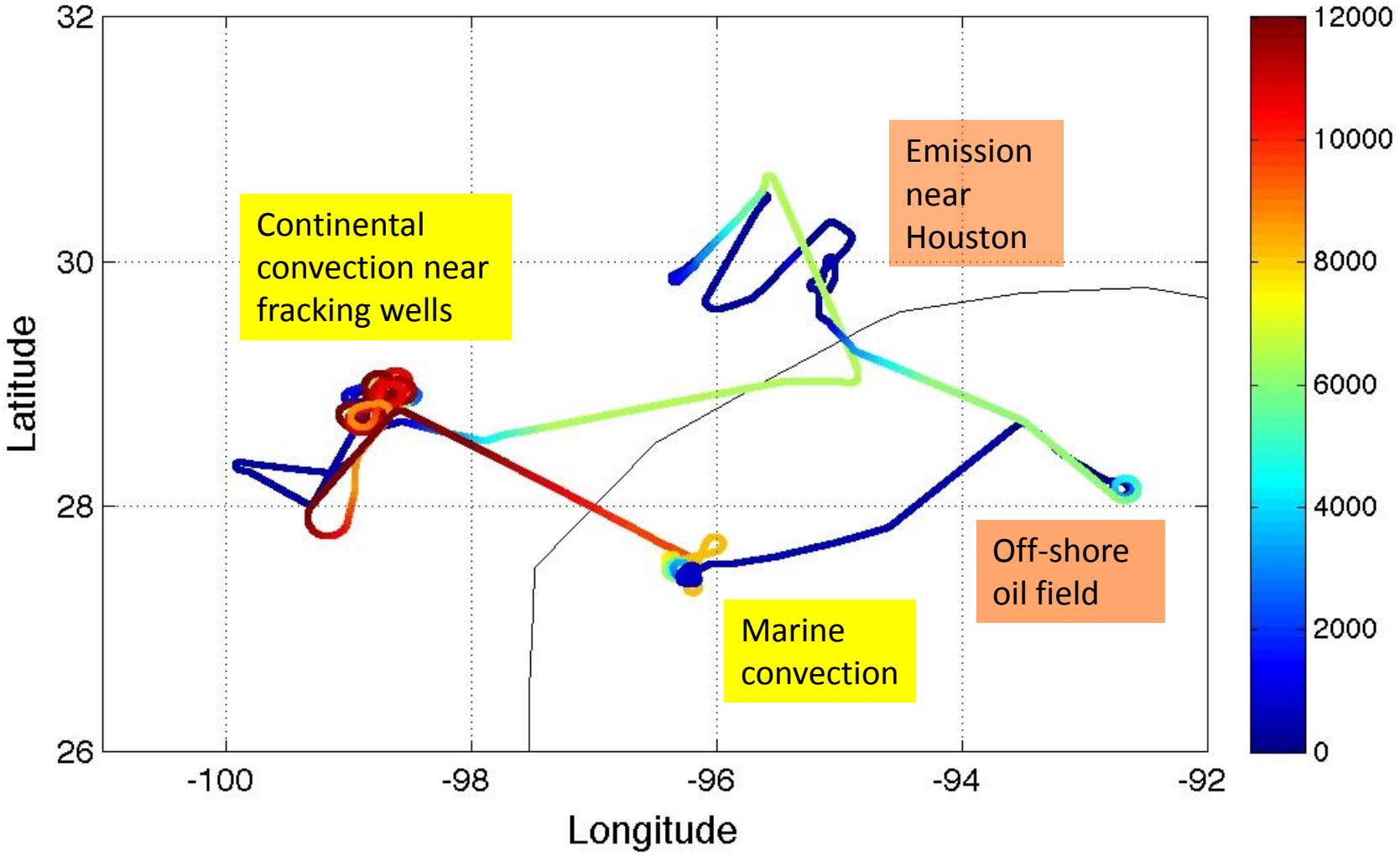
Source: Energy Information Administration based on data from various published studies
Updated: June 6, 2010

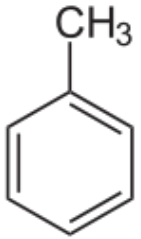


Source: Energy Information Administration based on data from MMS, HPDI, CA Dept of Oil , Gas & Geothermal
Updated: April 8, 2009

Most of the US offshore oil fields are in this area

Objective: Emission and convective transport of petroleum chemicals



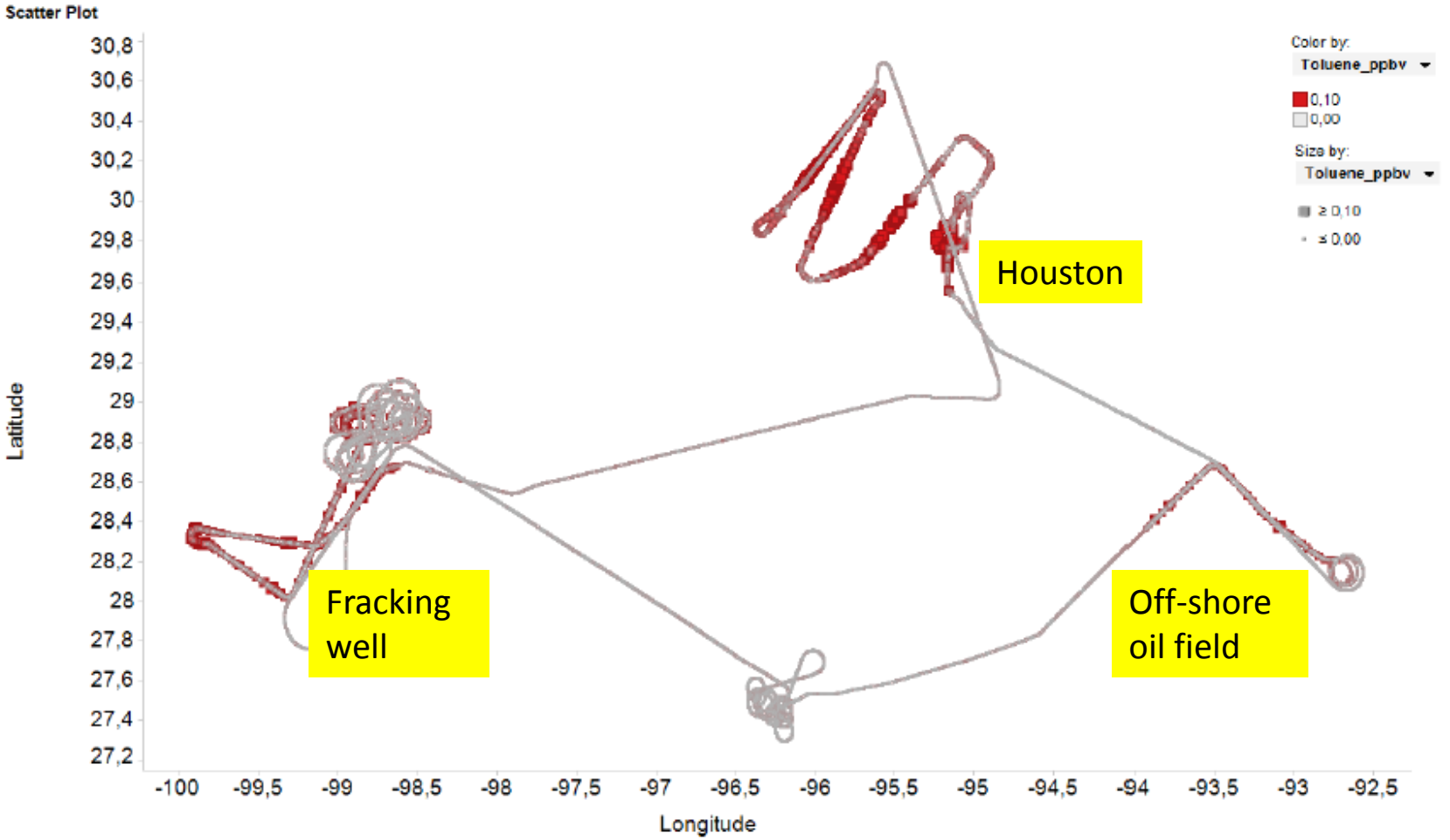


Measurement of Toluene (C_7H_8)

(Darker color represents higher readings)

Courtesy: Armin Wisthaler

Objective: Emission and convective transport of petroleum chemicals



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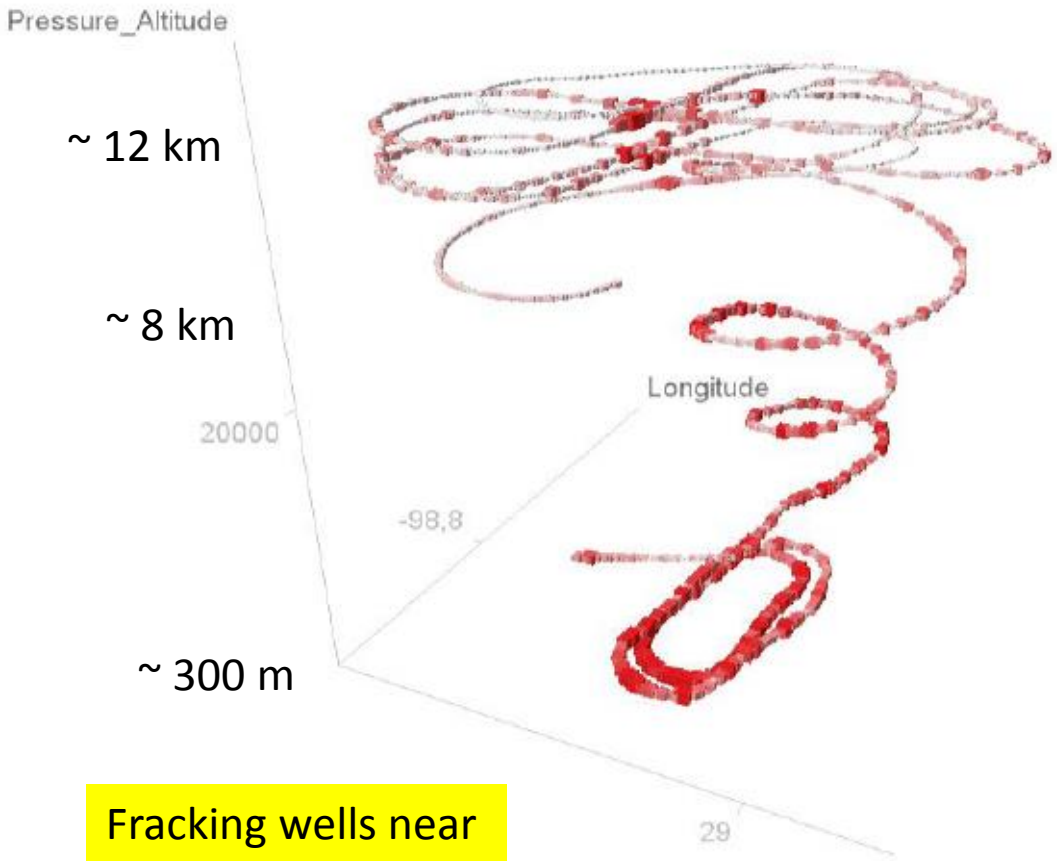
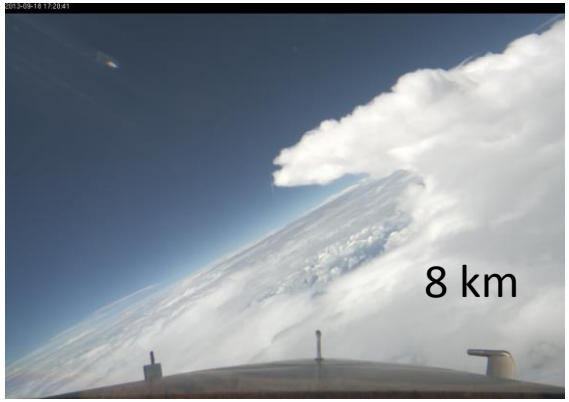
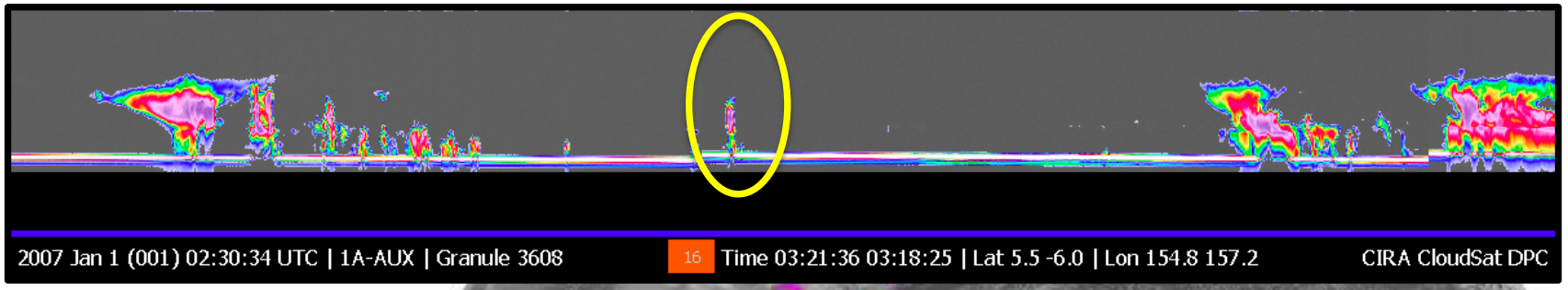
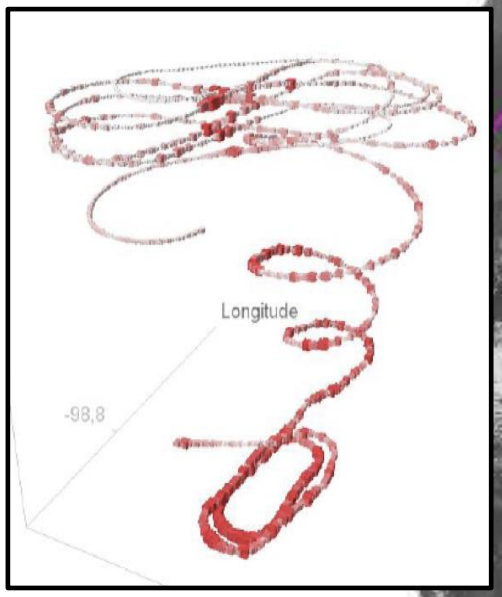


Fracking wells near San Antonio







Consider sampling those isolated deep convective cells. They are "cleaner" for studying convective transport.

Summary

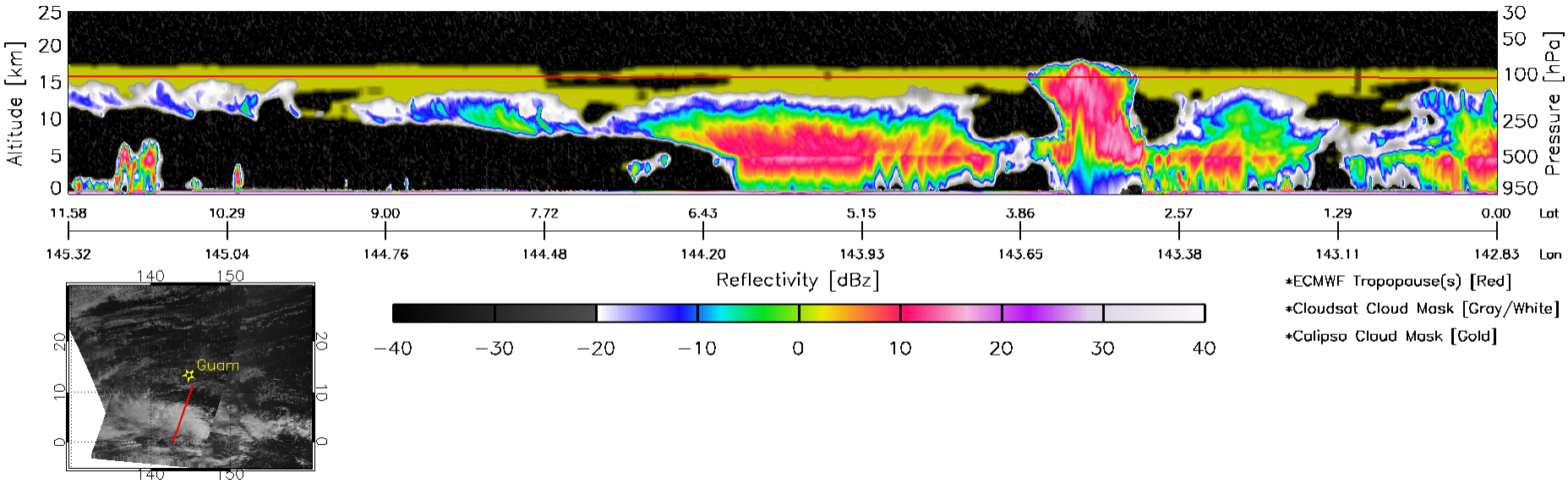
1. Convective cloud systems have complicated internal structures; it's an important question which part of the system is most relevant to transport of chemicals into the TTL.

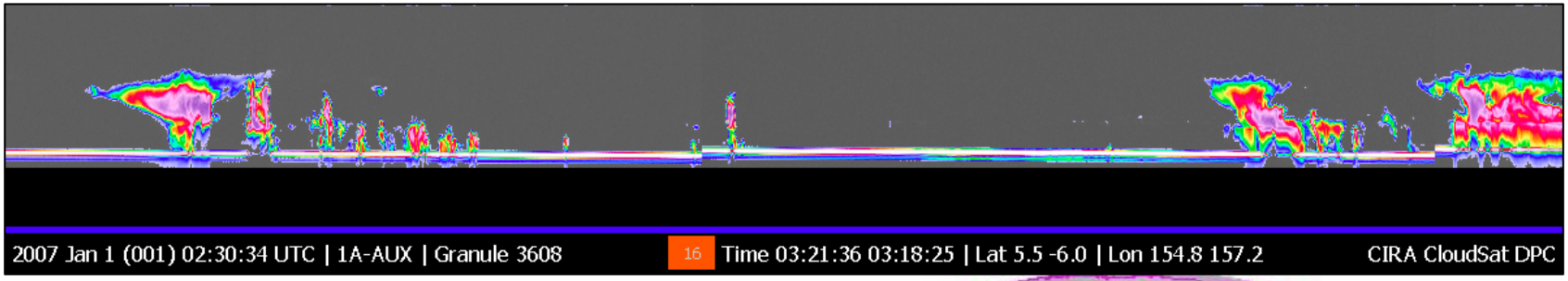
2. Analysis of CloudSat over TWP during Boreal winter shows that the active part of deep convective systems is fewer but deeper than previously expected (previous analysis was probably based on IR data).

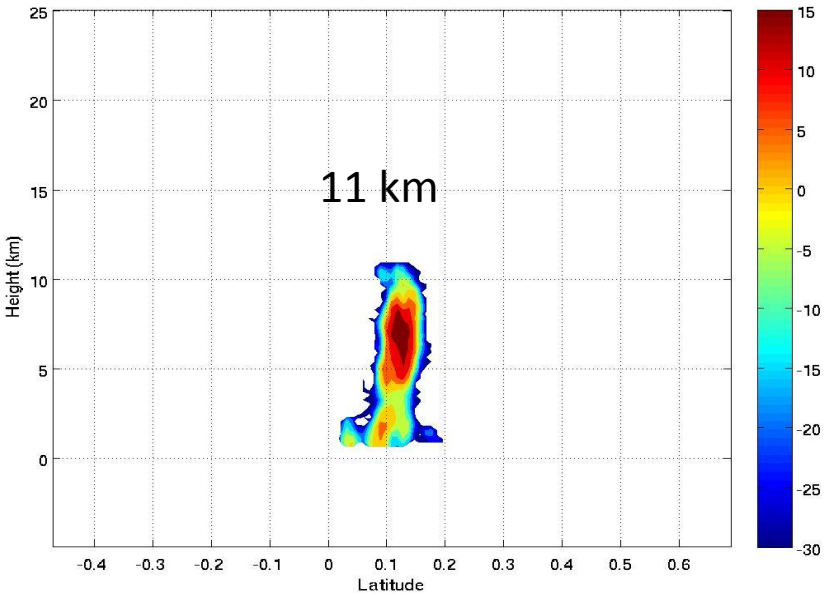
3. In addition to large convective systems (e.g., MCSs), isolated deep convection may also be of interest to CONTRAST because it offers a "cleaner" opportunity to study convective transport.

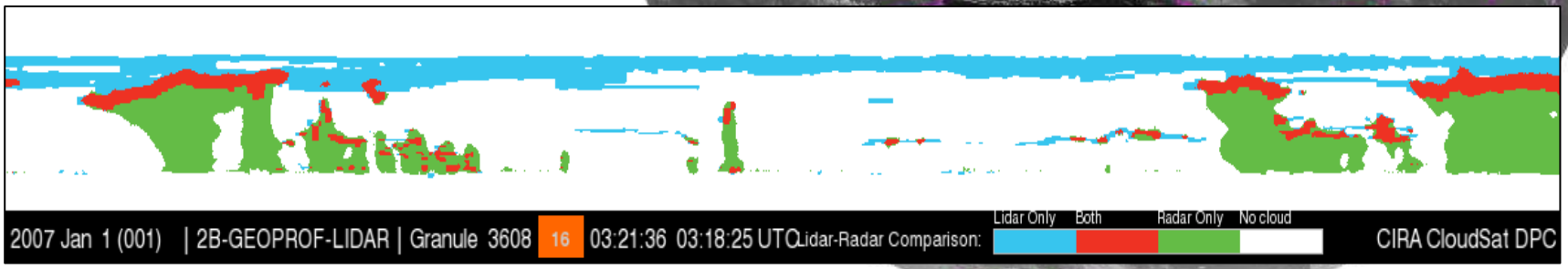
Backup

2007004143339_03659_CS_2B-GEOPROF_GRANULE_P_R04_E02_Sect_31.png – Night

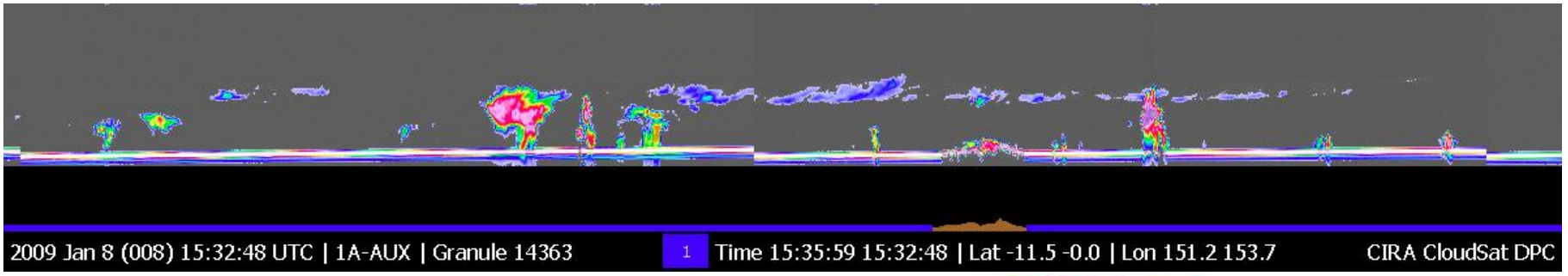


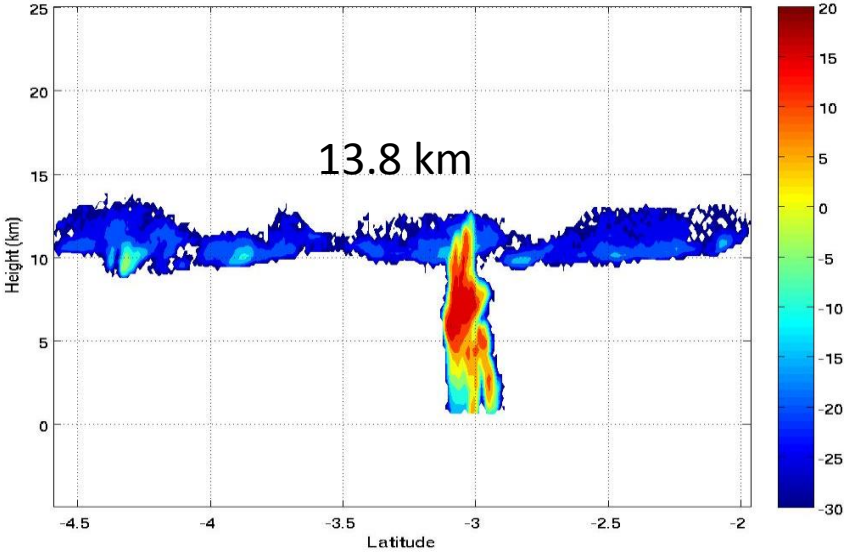

2007 Jan 1 (001) 02:30:34 UTC | 1A-AUX | Granule 3608
16
Time 03:21:36 03:18:25 | Lat 5.5 -6.0 | Lon 154.8 157.2
CIRA CloudSat DPC

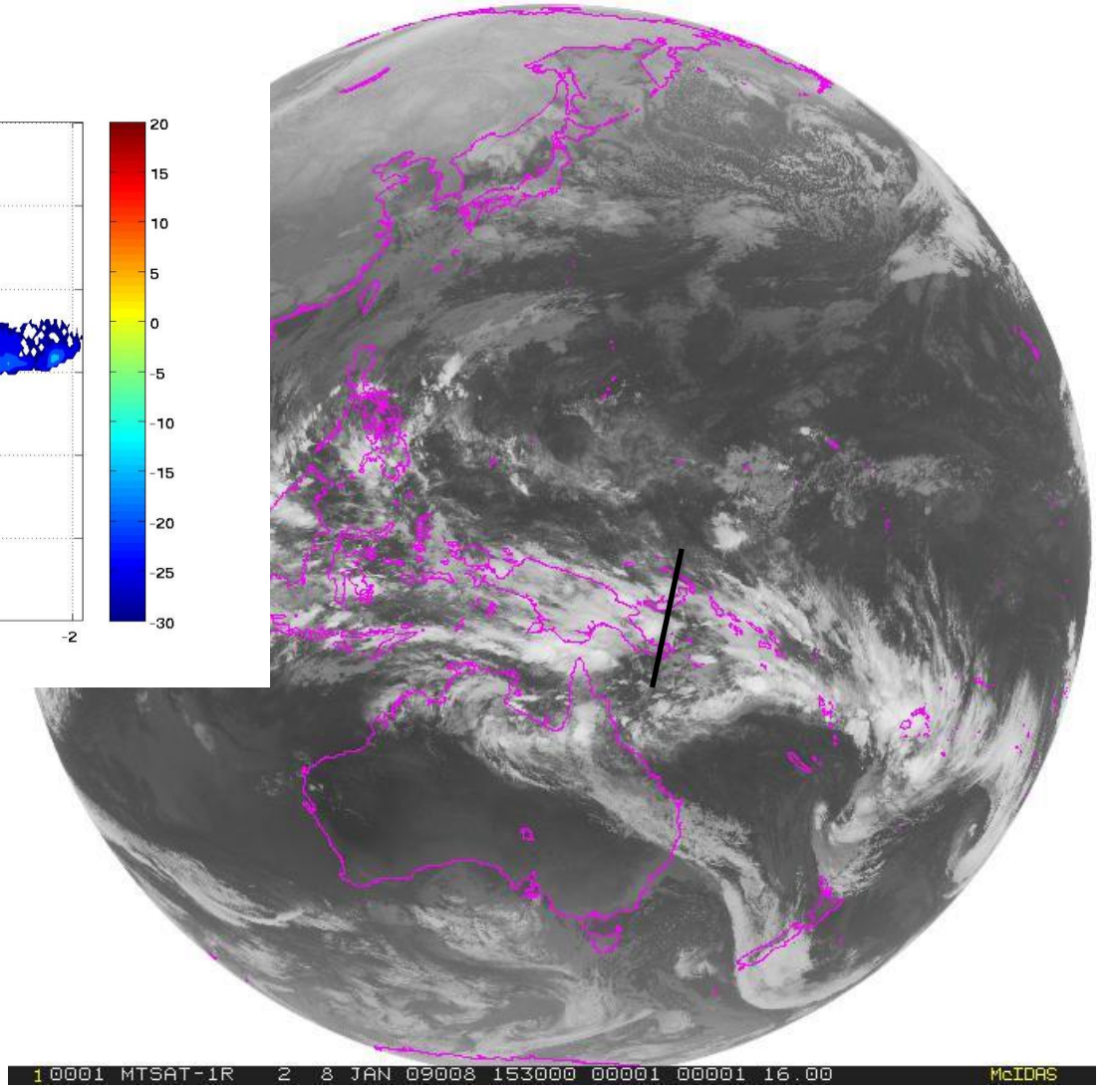

11 km
Height (km)
Latitude
25
20
15
10
5
0
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
15
10
5
0
-5
-10
-15
-20
-25
-30

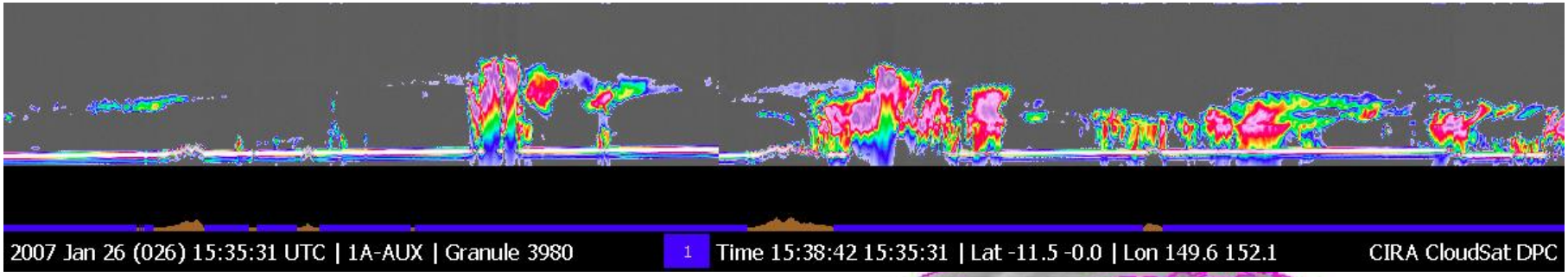

2007 Jan 1 (001) | 2B-GEOPROF-LIDAR | Granule 3608
16
03:21:36 03:18:25 UTC
Lidar-Radar Comparison:
Lidar Only
Both
Radar Only
No cloud
CIRA CloudSat DPC

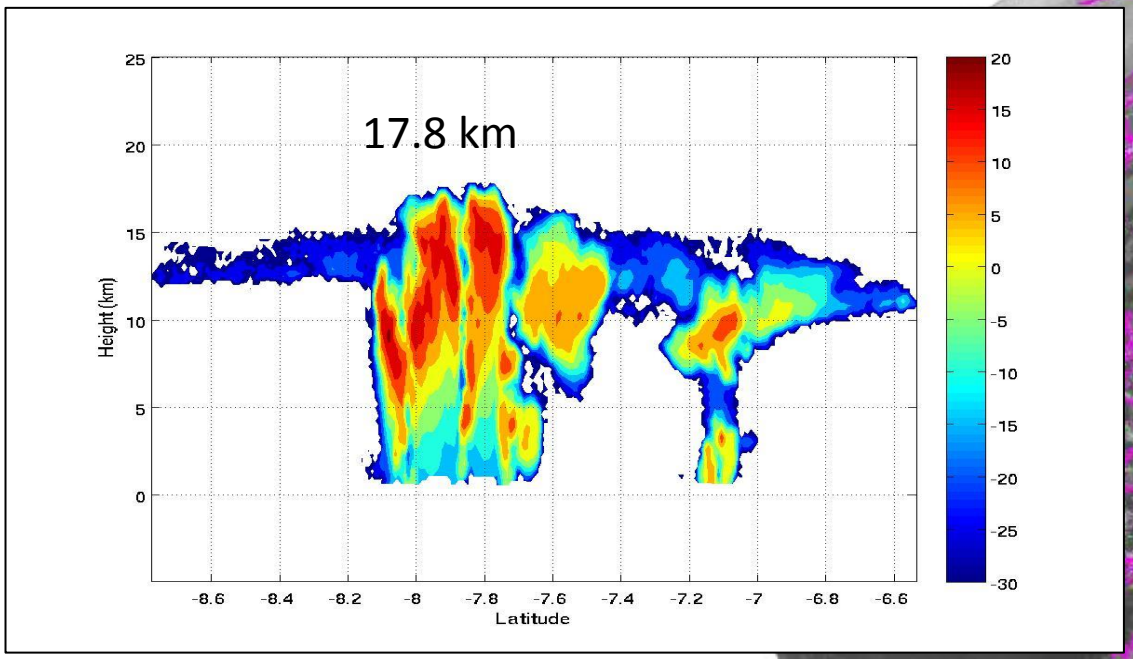
1 0001 MTSAT-1R 2 1 JAN 07001 033300 01225 00001 16.
MCIDAS

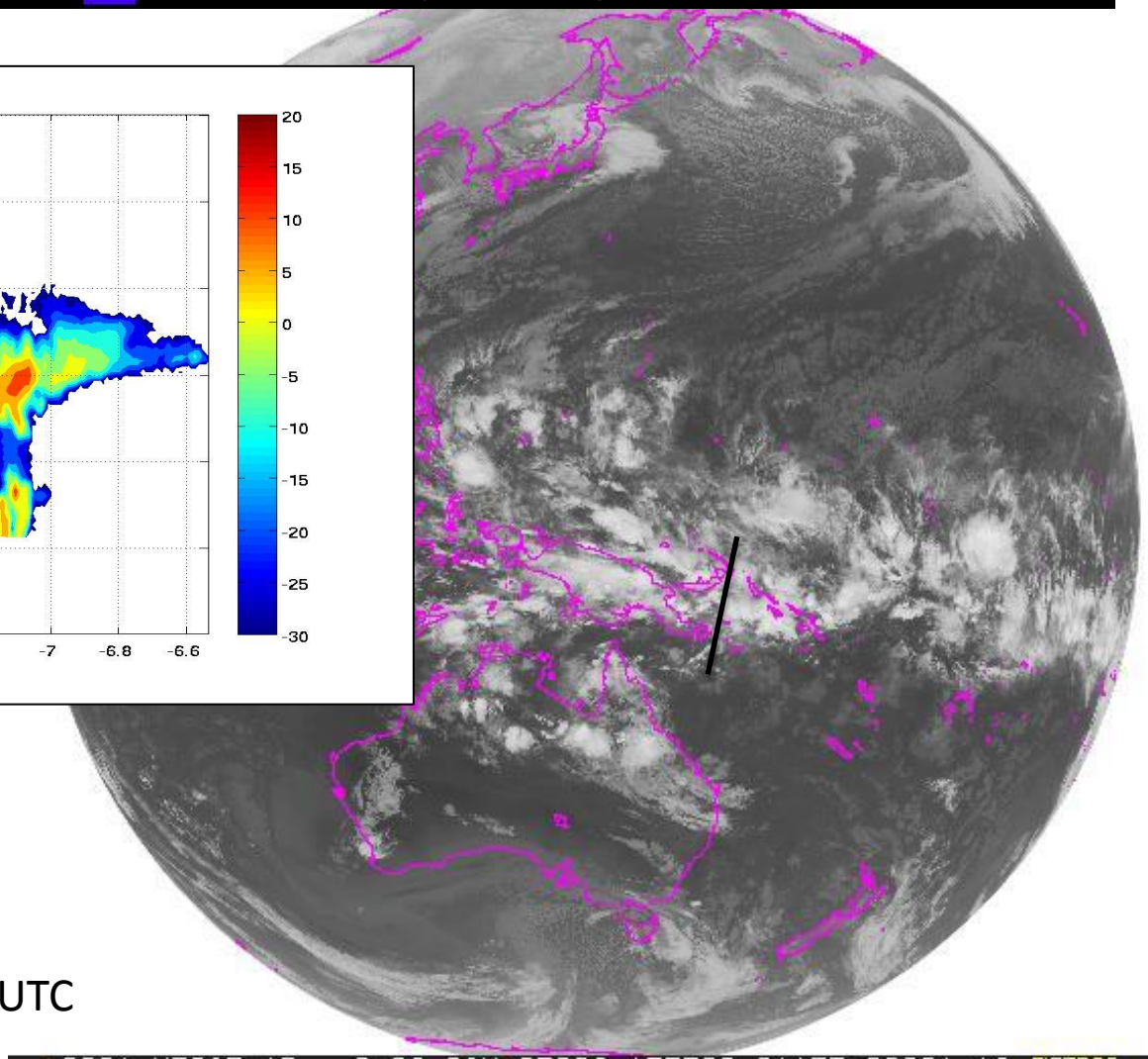

2009 Jan 8 (008) 15:32:48 UTC | 1A-AUX | Granule 14363
1
Time 15:35:59 15:32:48 | Lat -11.5 -0.0 | Lon 151.2 153.7
CIRA CloudSat DPC


13.8 km
Height (km)
Latitude
25
20
15
10
5
0
-4.5
-4
-3.5
-3
-2.5
-2
20
15
10
5
0
-5
-10
-15
-20
-25
-30


1 0001 MTSAT-1R 2 8 JAN 09008 153000 00001 00001 16.00
McIDAS



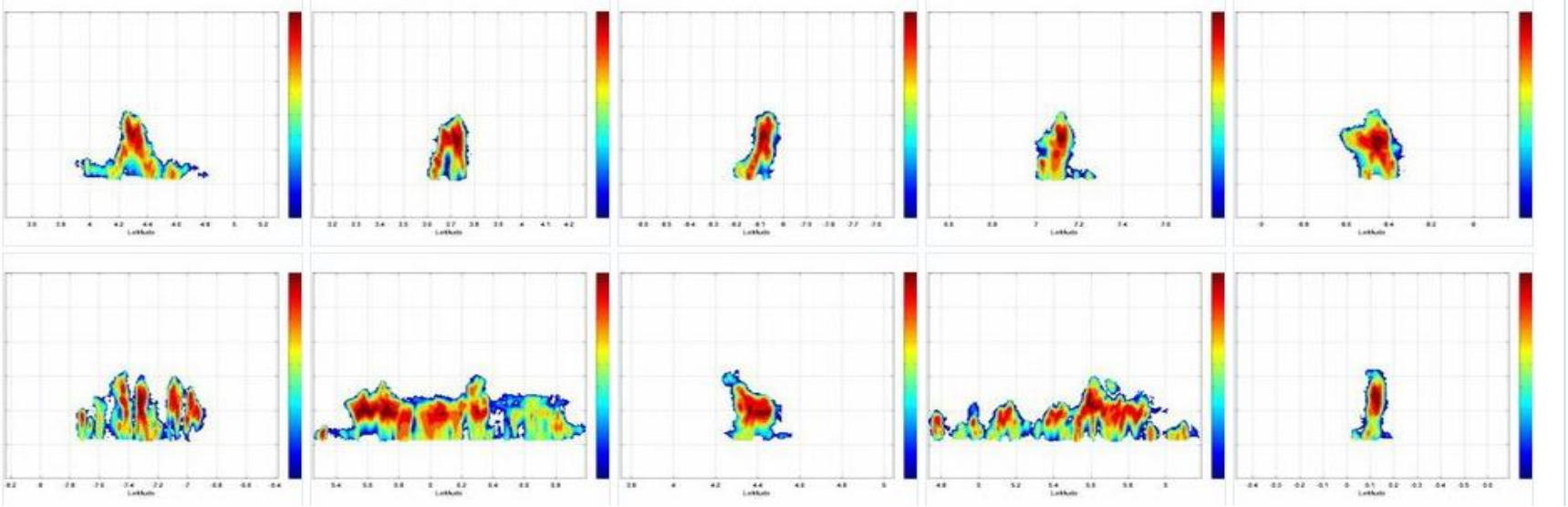




1/26/2007 15:33 UTC

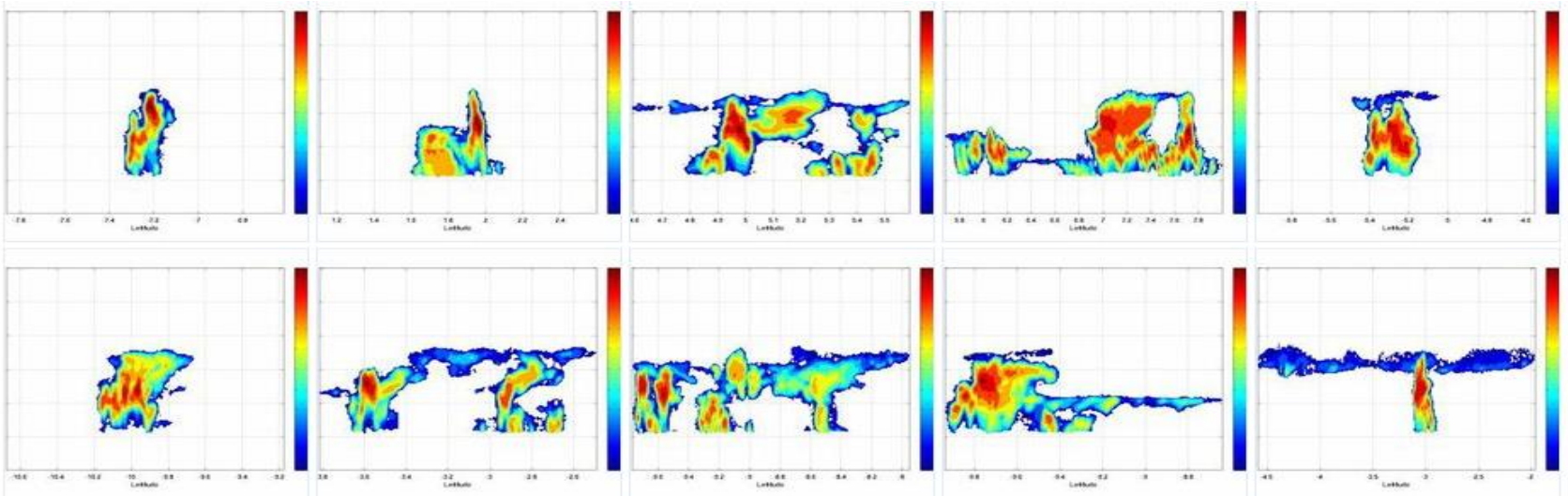
Might be still growing (none has developed anvil)

CTH: 10-11 km



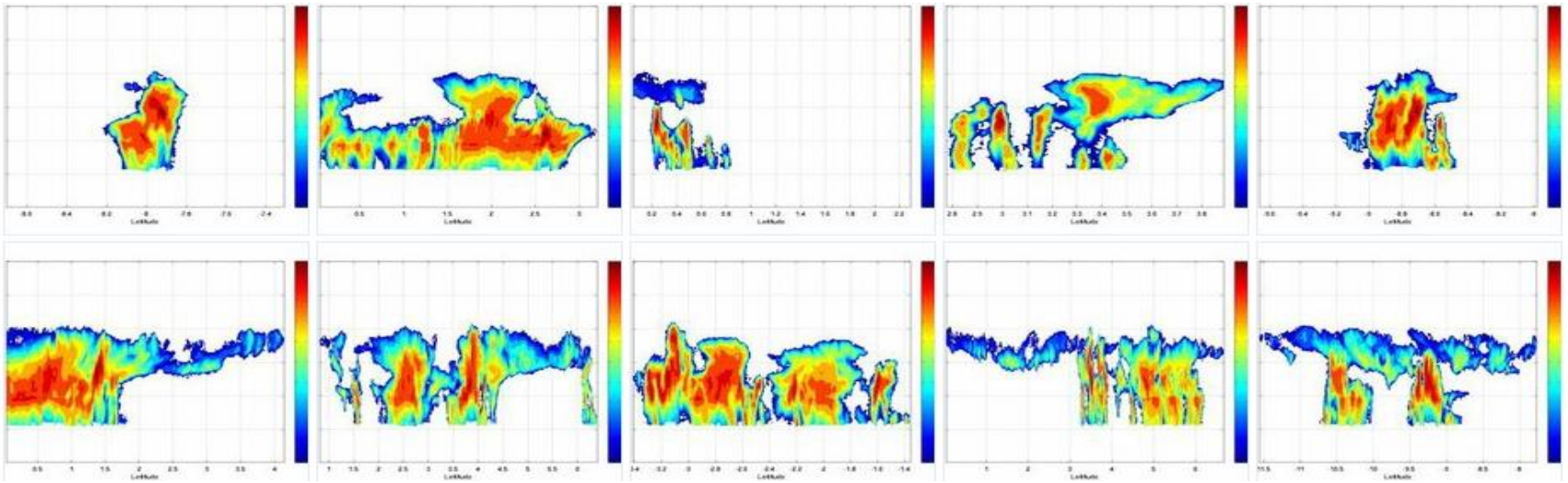
~ 150 km

CTH: 13-14 km



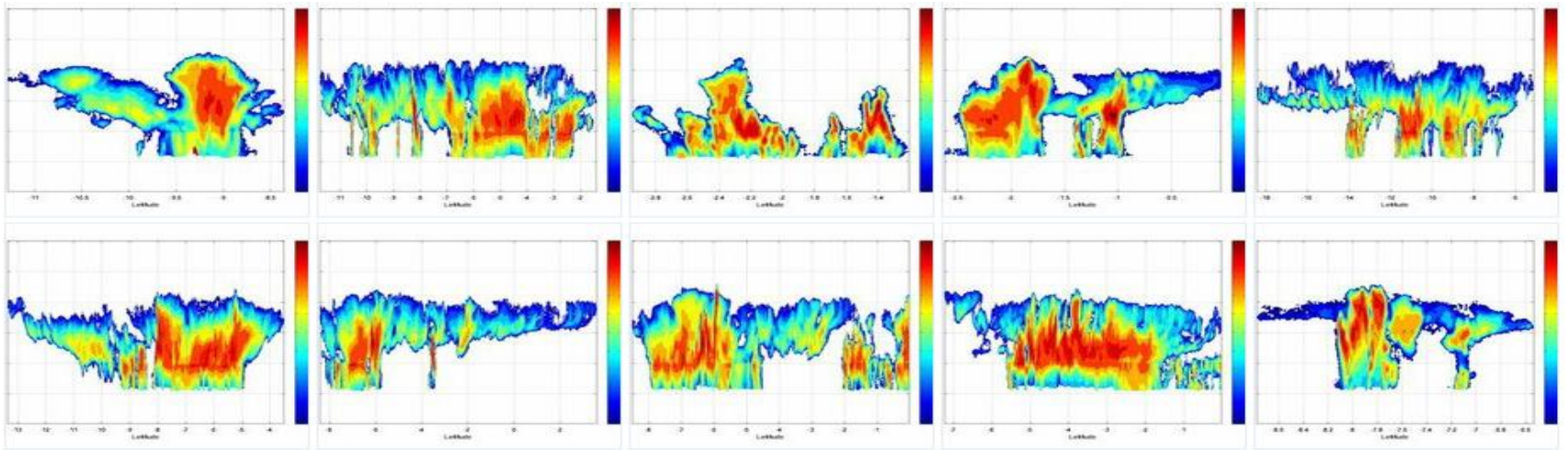
~ 150 km

CTH: 15-16 km



~500-1000 km

CTH: 17-18 km



~1000 km