A strategy to quantify characteristics of updraft and downdraft events associated with oceanic Mesoscale Convective Systems using ASCAT winds and MSG rain (and TRMM data)

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Motivation

NWP resolution too coarse

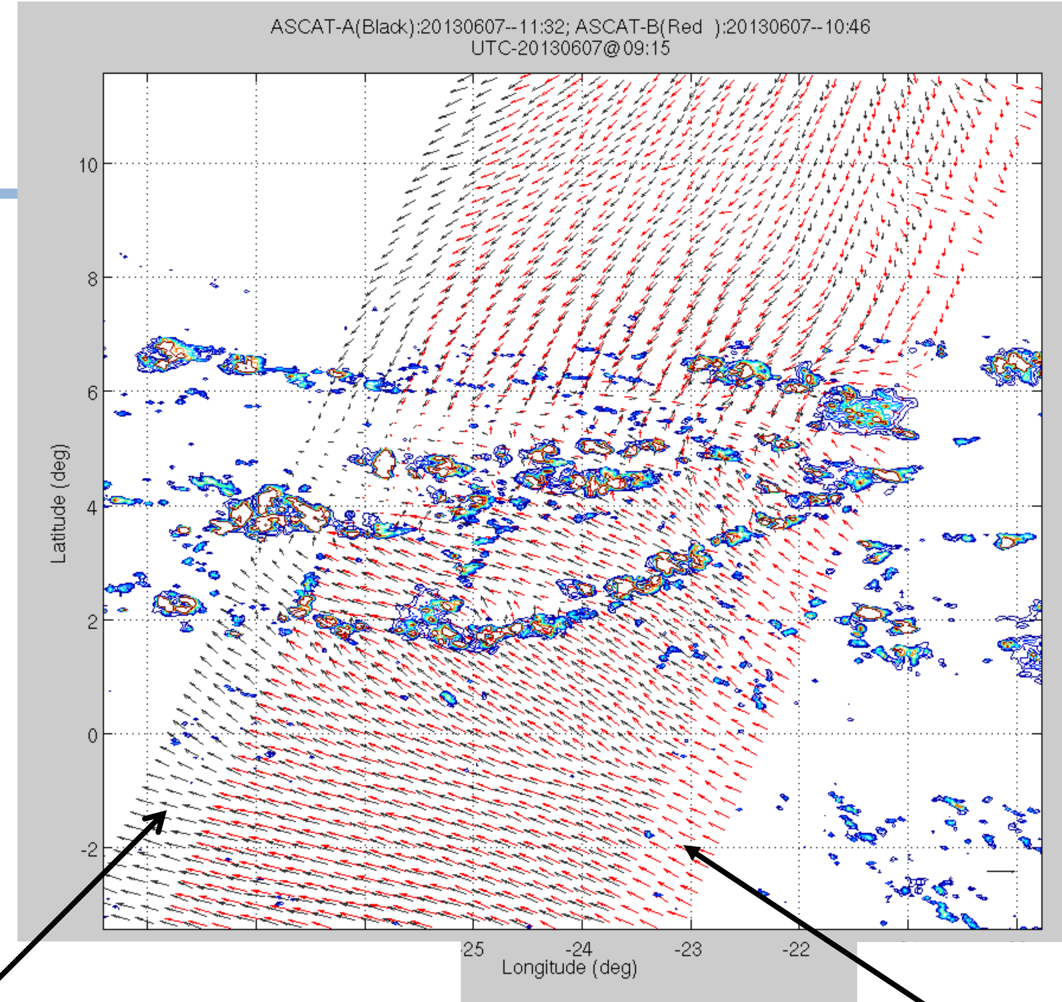
- to resolve downbursts
- hence, convective storms are modelled less accurately

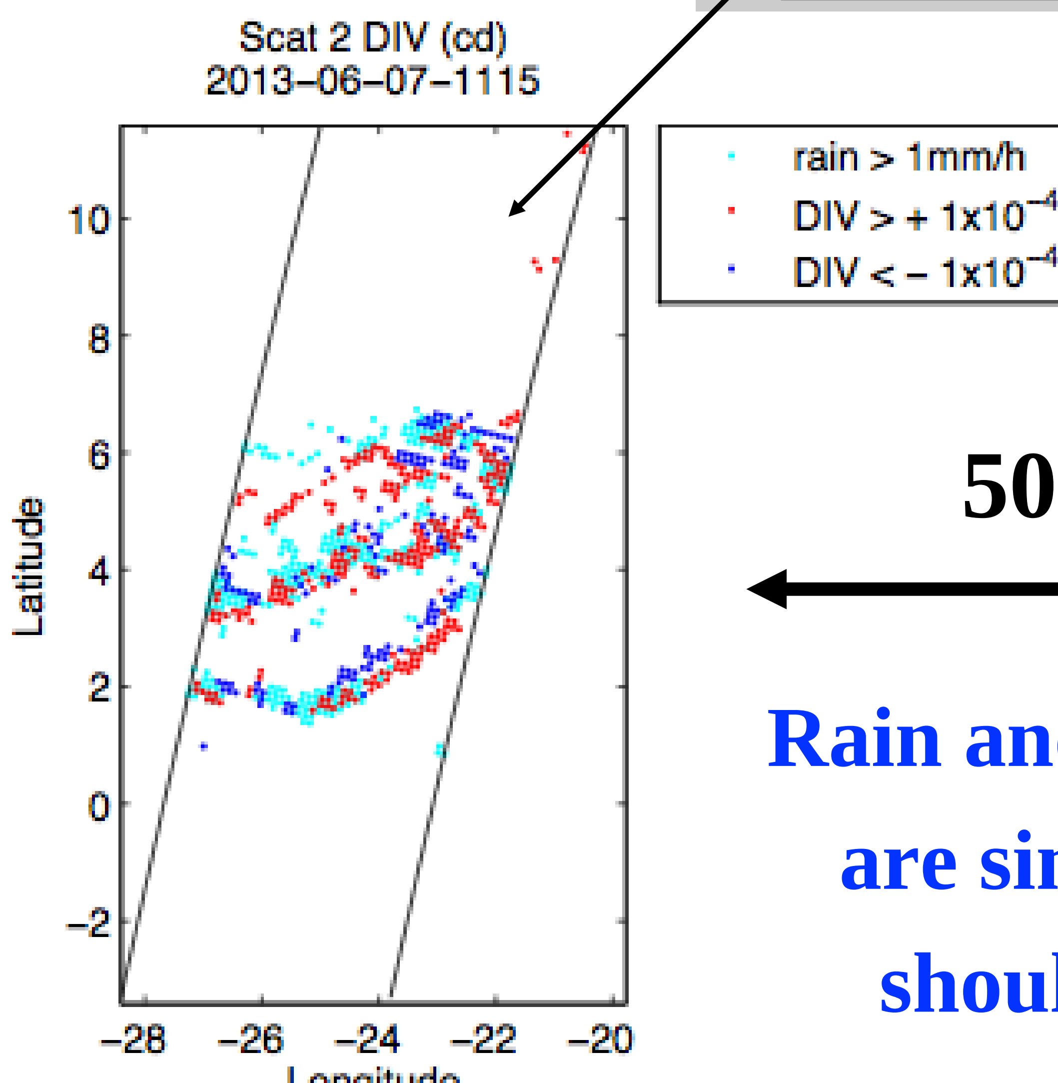
Project aim

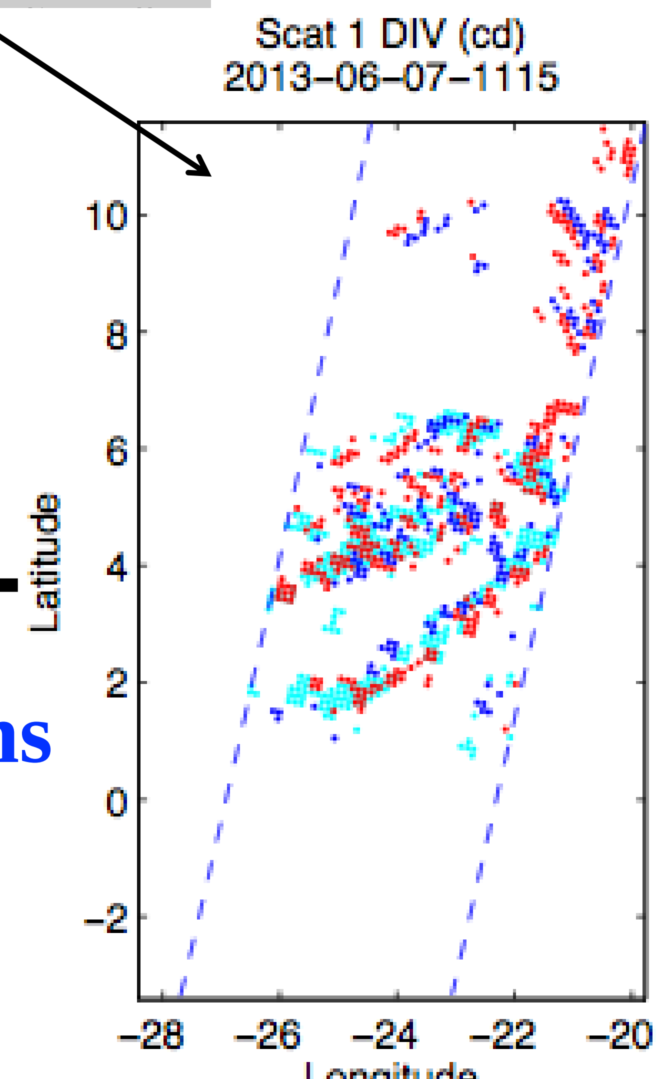
Use collocated ASCAT-A, ASCAT-B and Meteosat MSG rain …

- characterise ocean winds near precipitation events in Mesoscale Convective Systems
- focus on the Tropical Atlantic
- New: make use of a TRMM PR MCS database (Liu & Zipser)

Mid-Atlantic Collocation







50 mins later

Rain and DIV patterns are similar, so they should correlate.

Contingency Tables

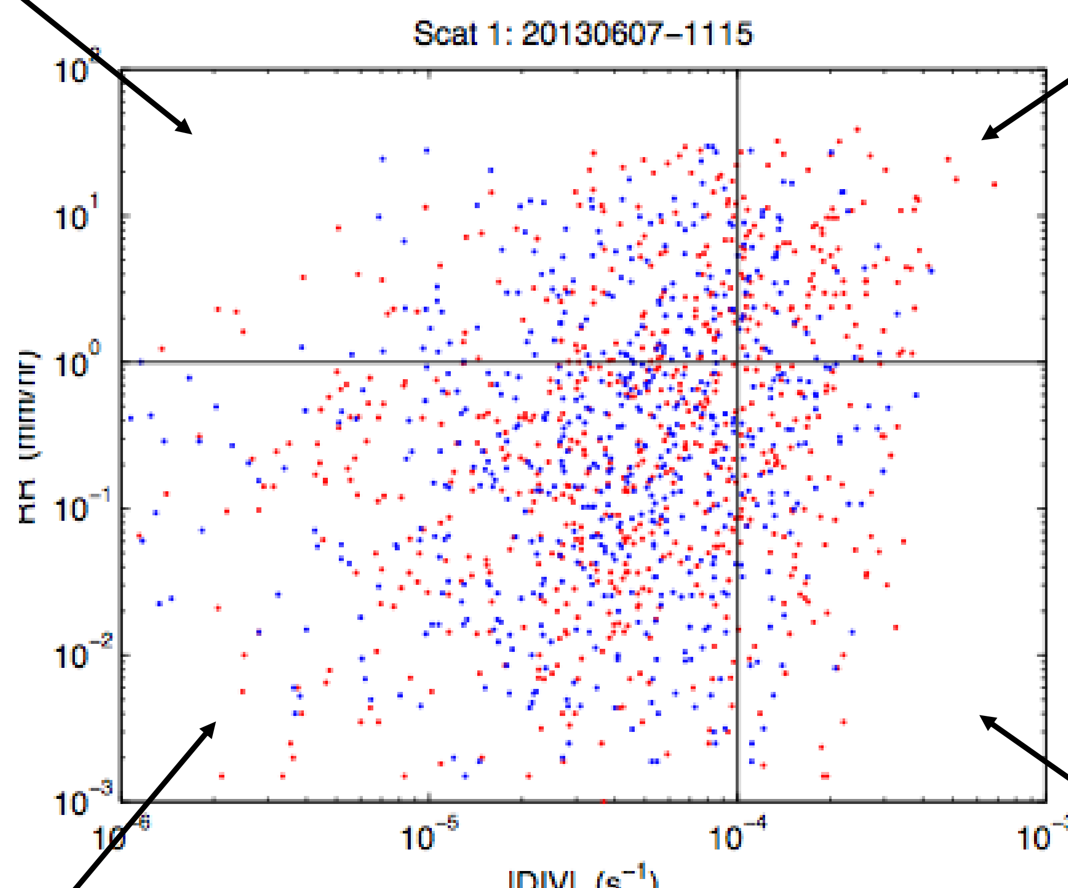
Set thresholds,

partition the space, and count

False Alarms

Hits

log(RR)



log(|DIV|)

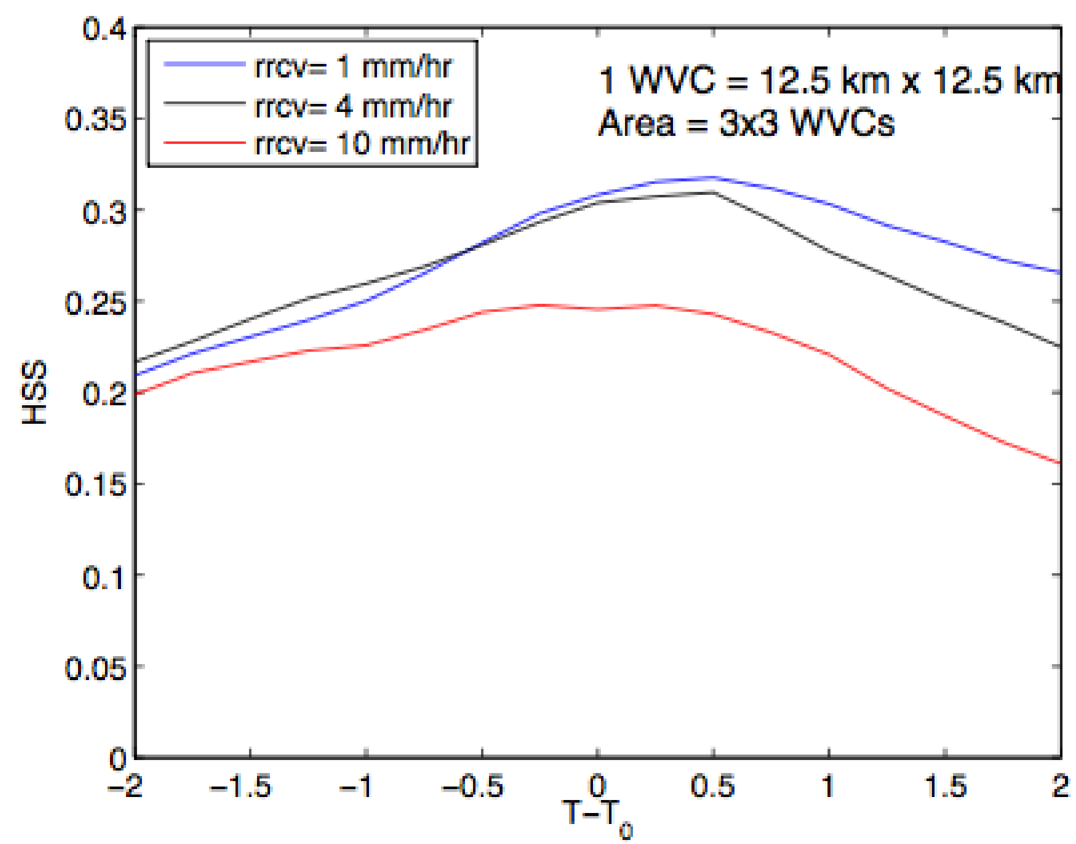
Correct Nulls

Misses

Heidke Skill Score (HSS)

- **Use results from all collocations during month**
- **MSG RR every 15 minutes so…**
  - **compile contingency table vs time**
- **Construct skill score vs time**

HSS



Forecast has skill when HSS > 0

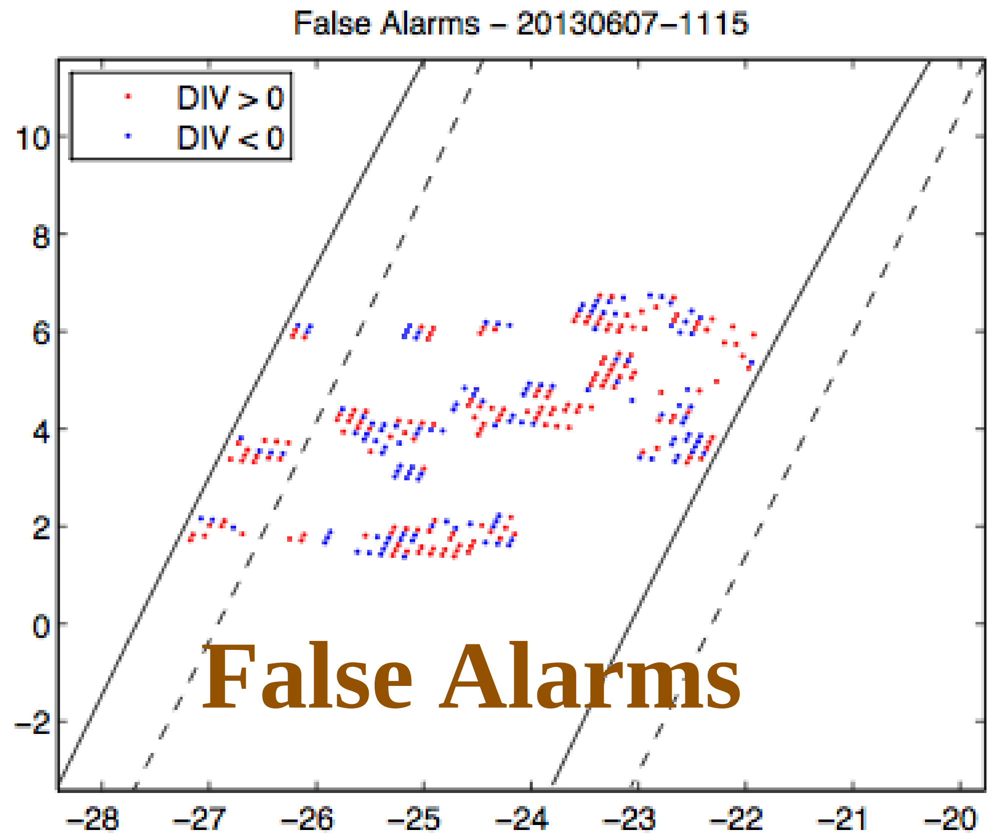
$T - T_0$

T_0 is time of ASCAT pass

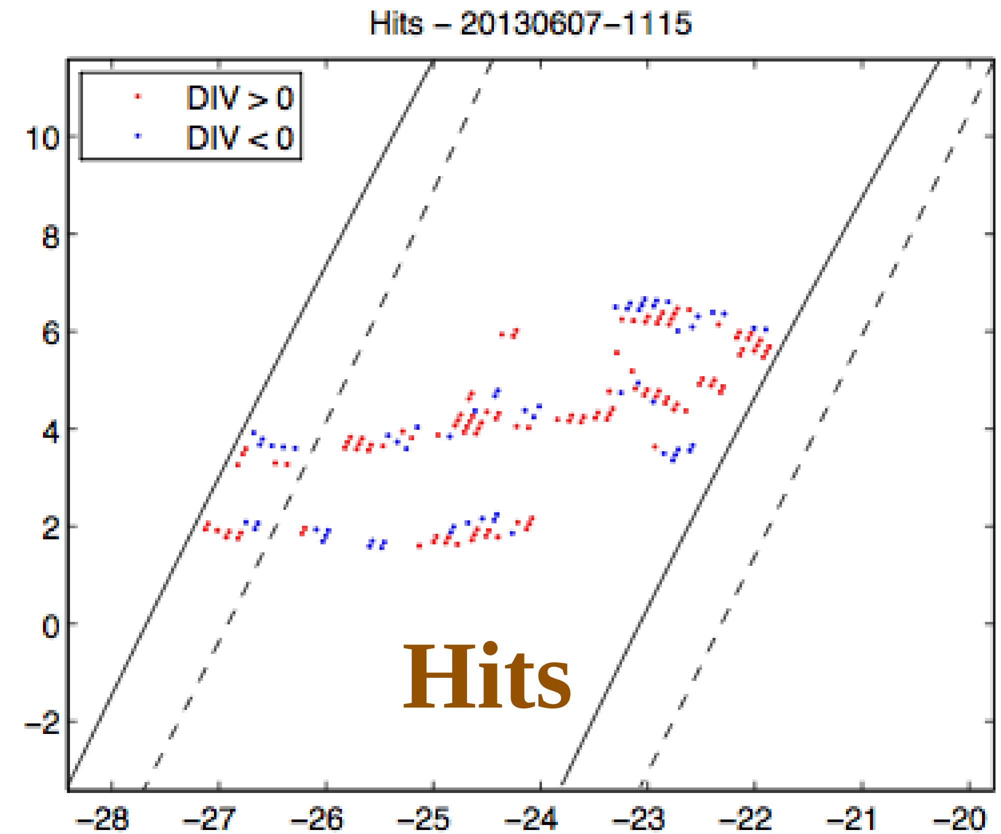
http://www.eumetcal.org/resources/ukmeteocal/verification/www/english/msg/ver_categ_forec/uos3/uos3_ko1.htm

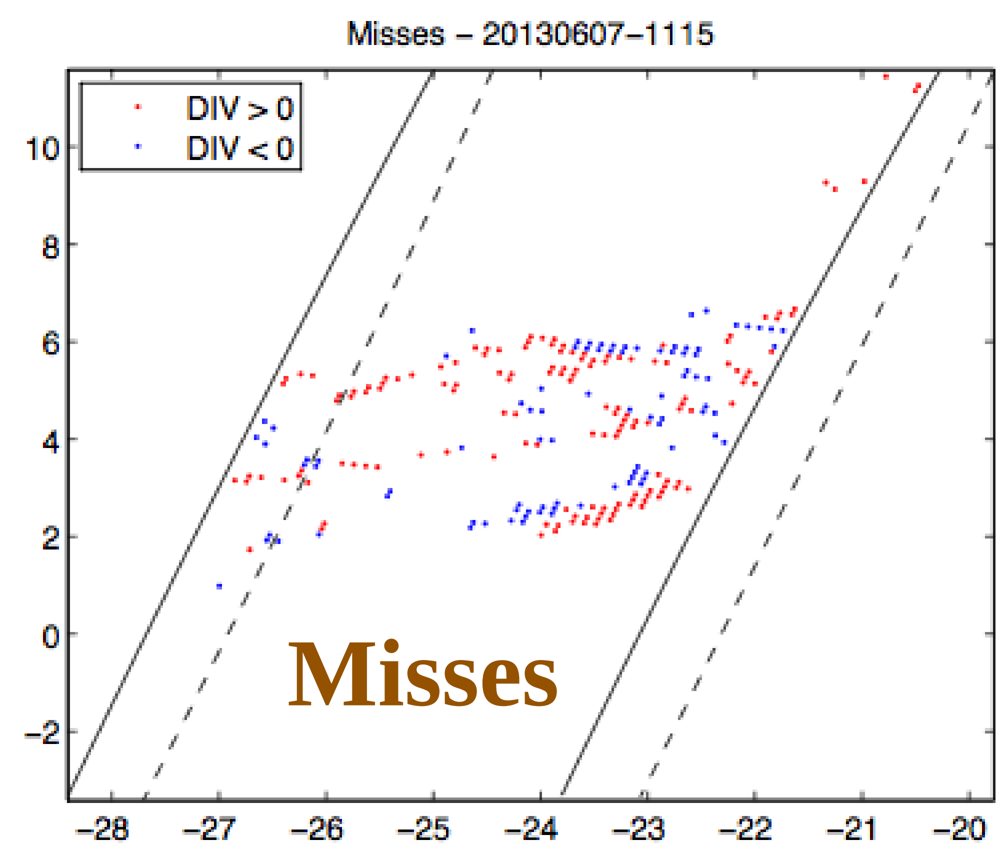
Mid-Atlantic Example — Plot Locations …

Latitude



Longitude

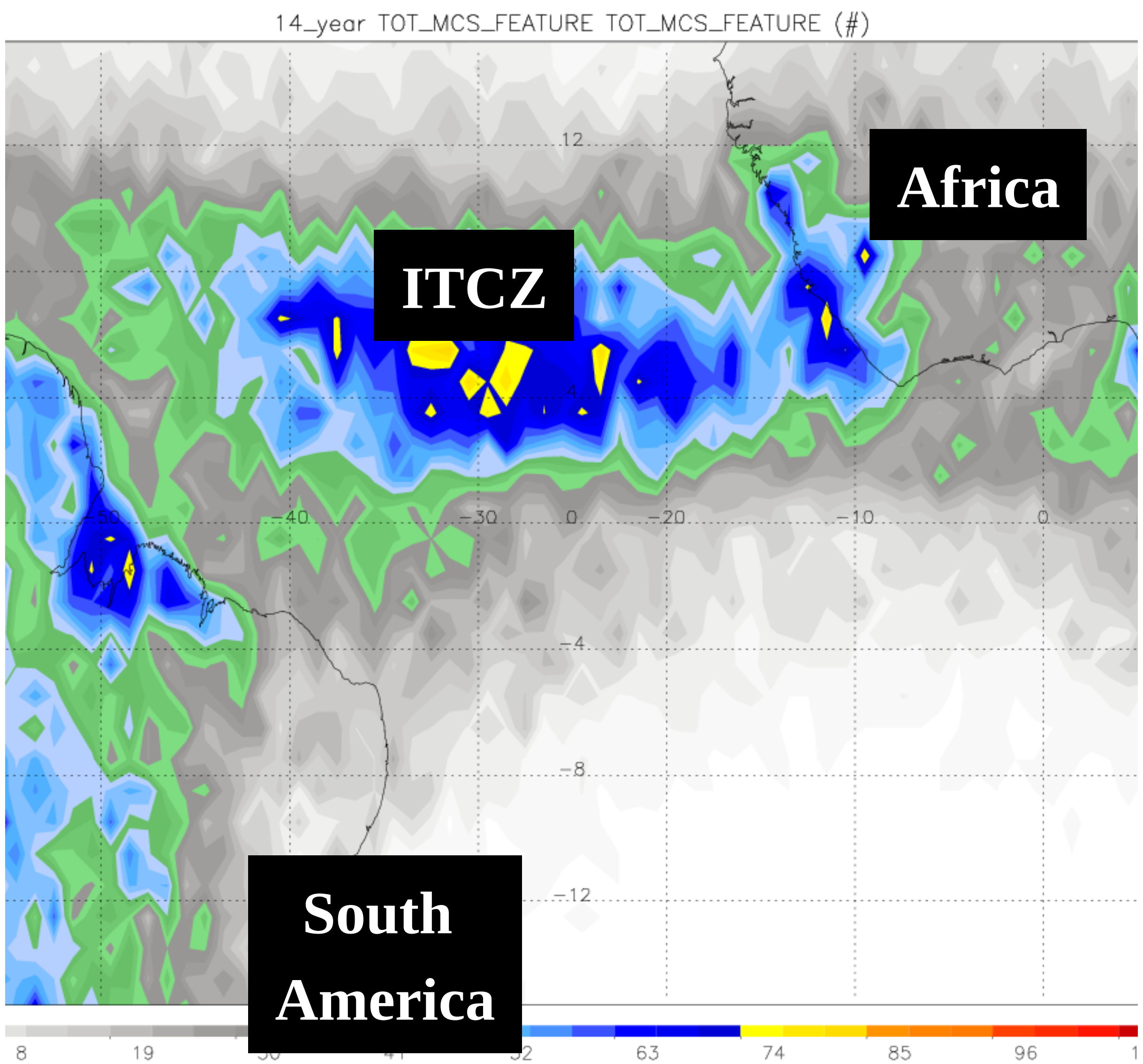




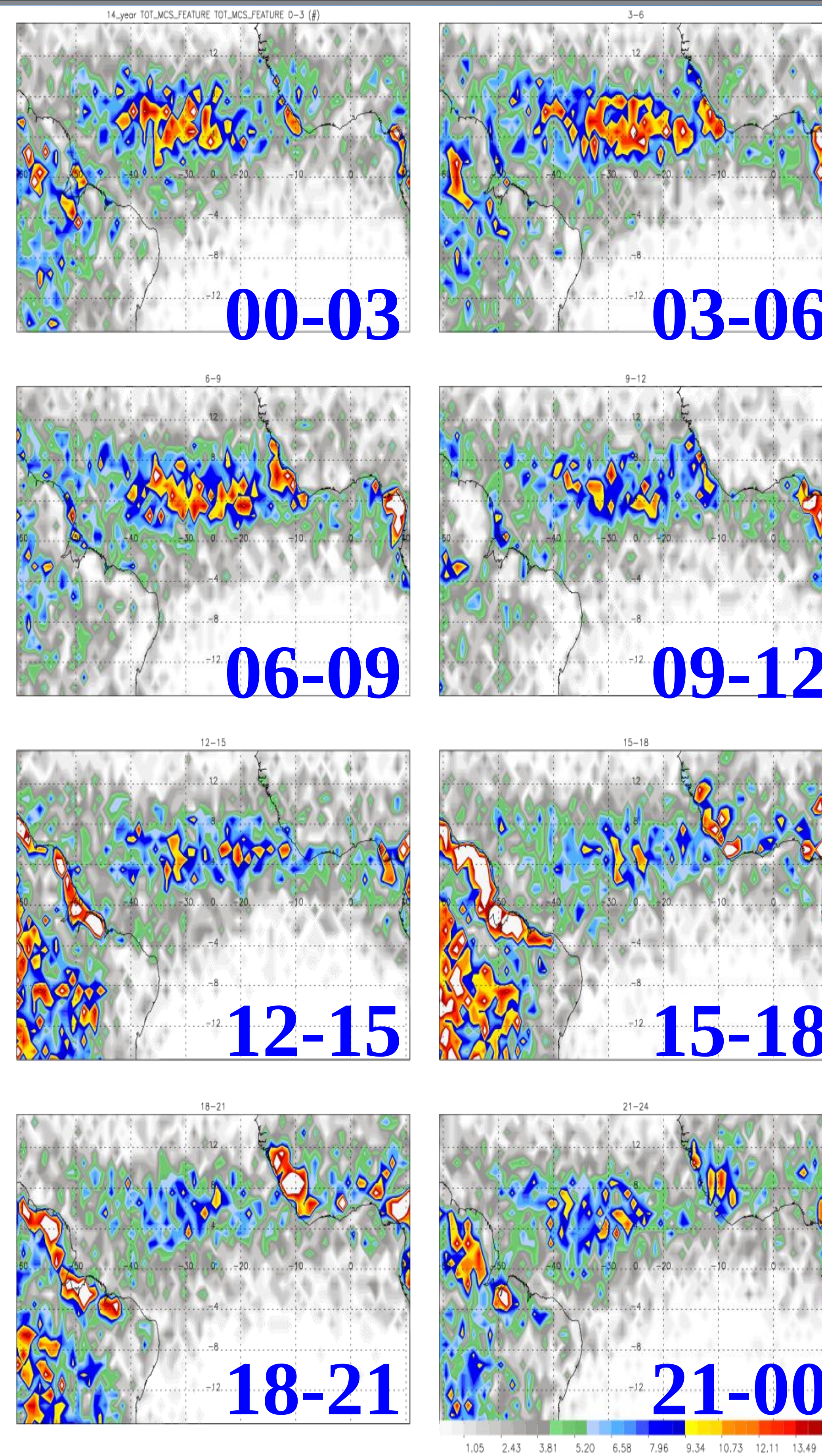
For our example collocation,
we can see where
the skill came from
(and where it did not).

Diurnal Change

MCSs (Tropical Atlantic) from 14 years of TRMM PR (Liu and Zipser, 2013)



MCS: a system with contiguous precipitating area > 2000 km^2



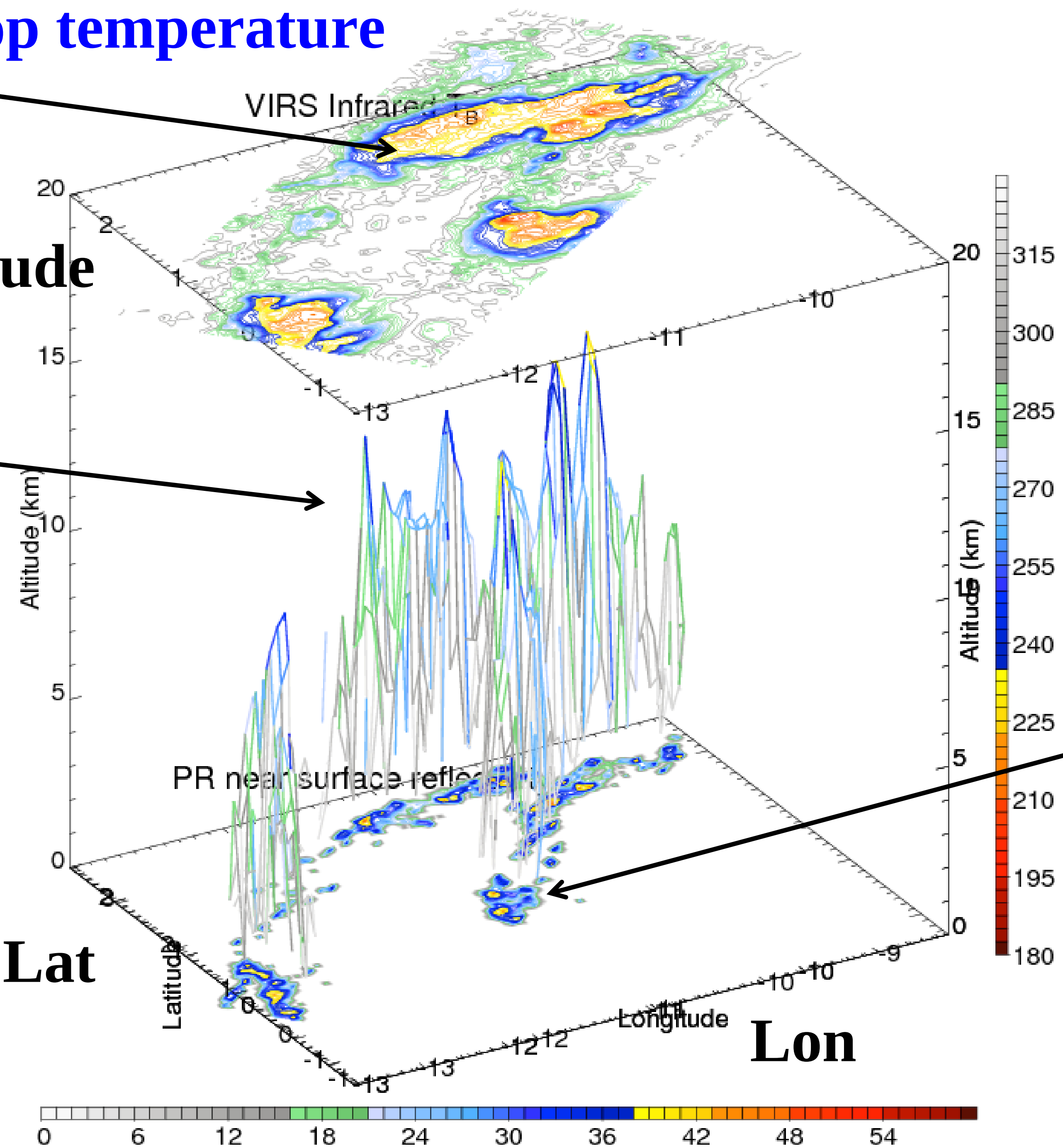
Case Number 01.25.1

MSG and ASCAT will be compared with this case extracted from the MCS database.

cloud top temperature

Altitude

Storm height (from reflectivity profiles)



Lat

Lon

PR near-surface reflectivity

Note the lambda shape. It will be seen in subsequent slides

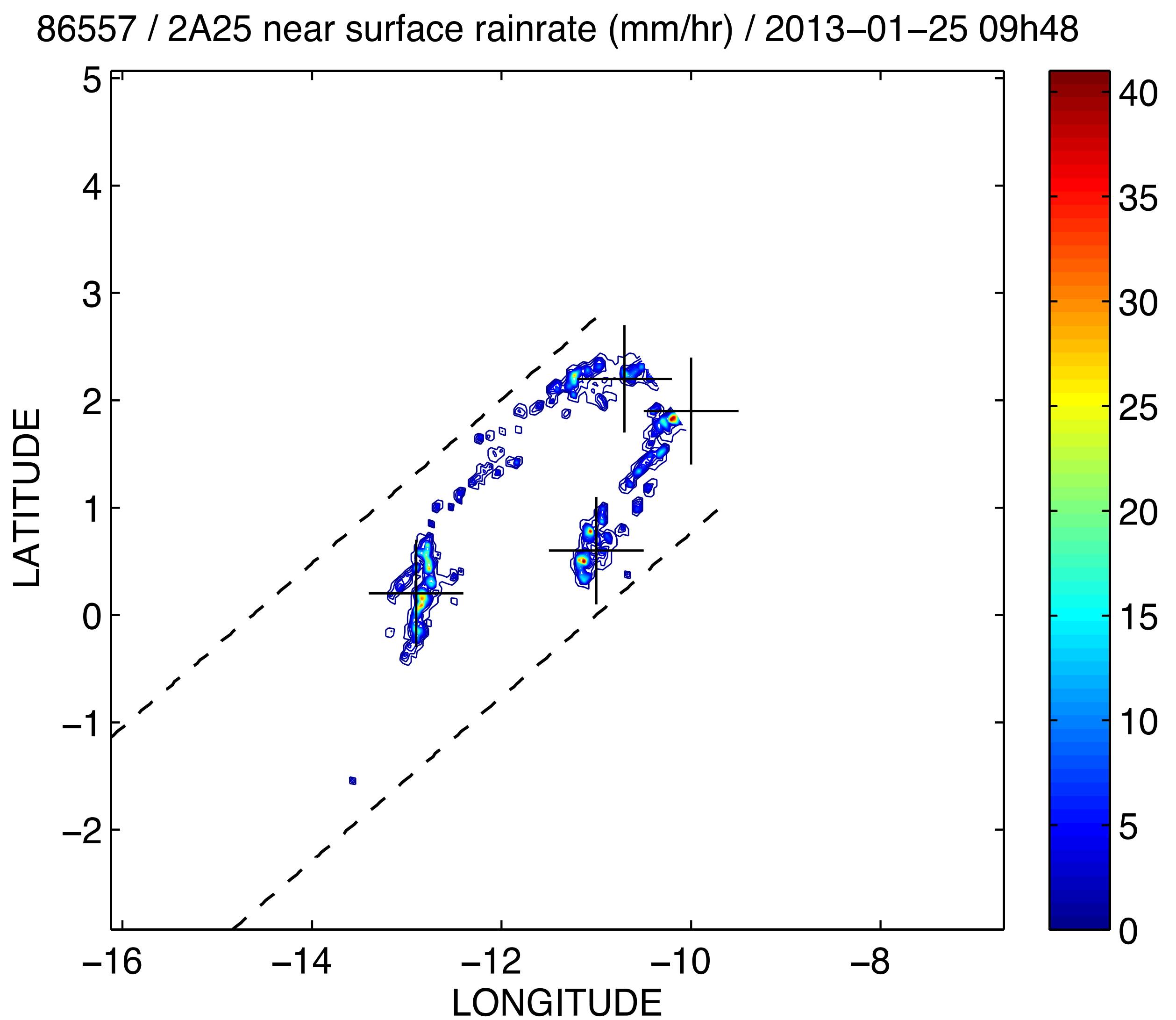
TRMM PR (Near Surface Rain)

Four groups of contiguous rain pixels

Matlab "bwlabel"

Group centroids indicated by a cross

Near Surface Rain **mm/hr**

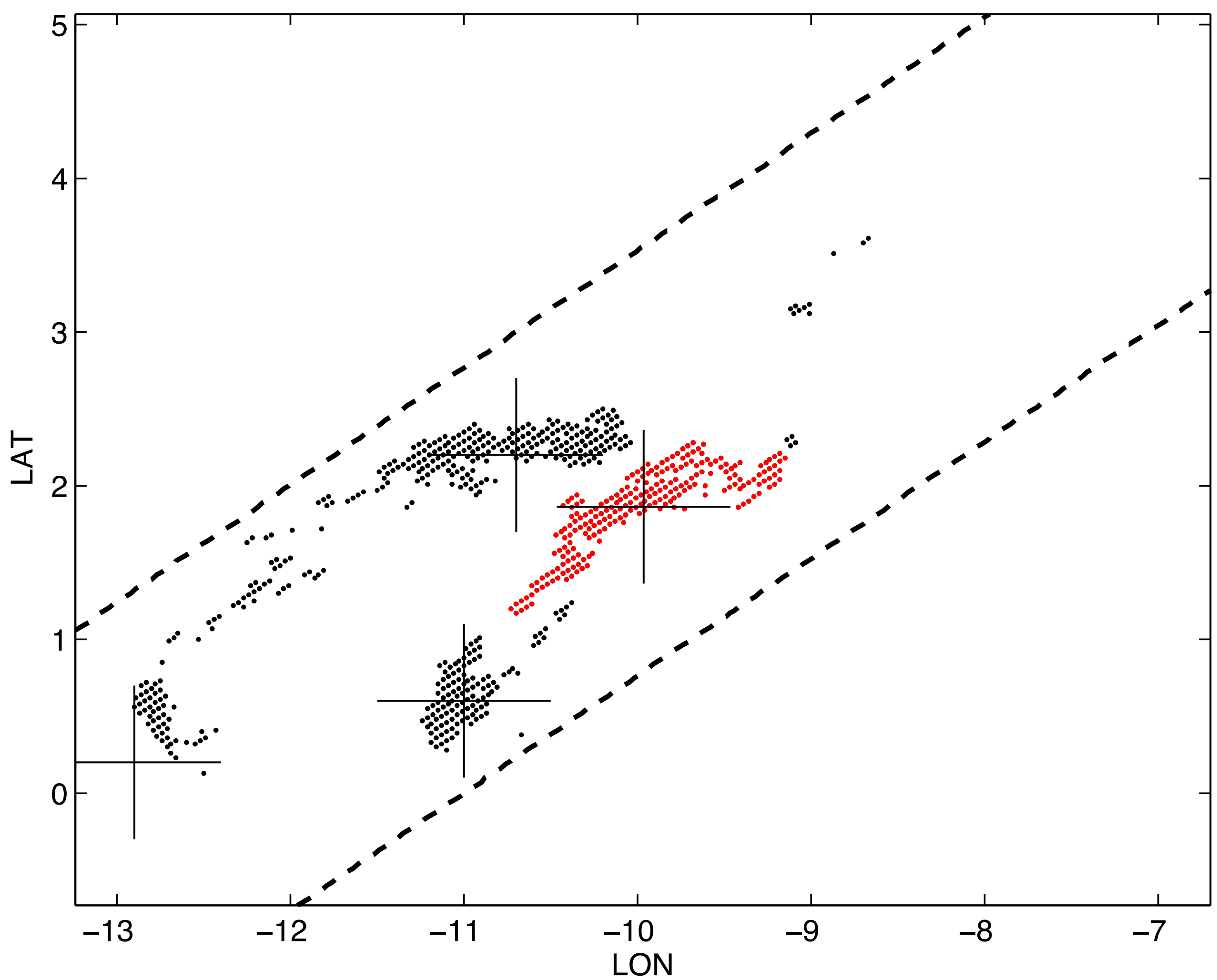


Compare TRMM with MSG

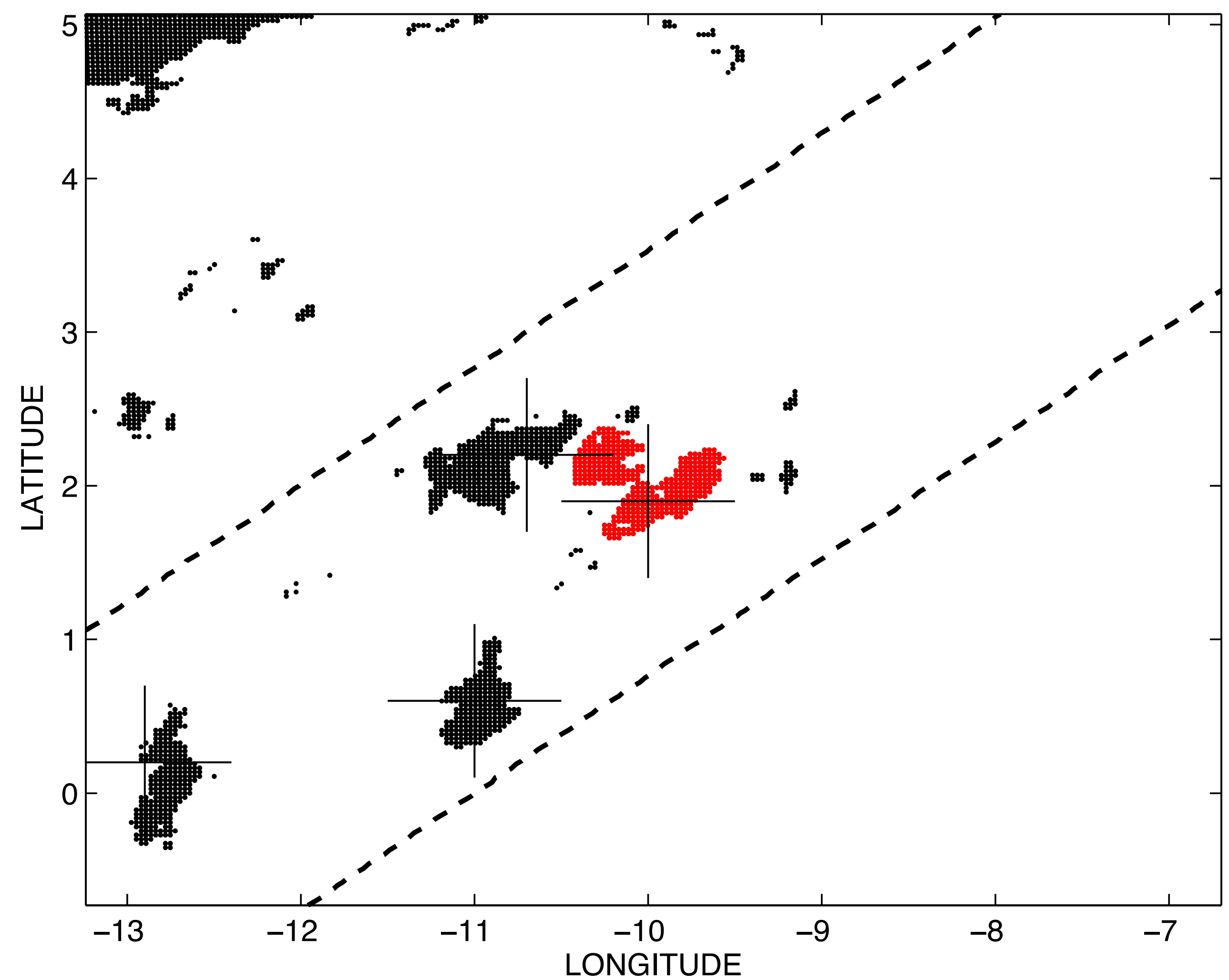
Note:

In both figures the crosses indicate the TRMM group centroids

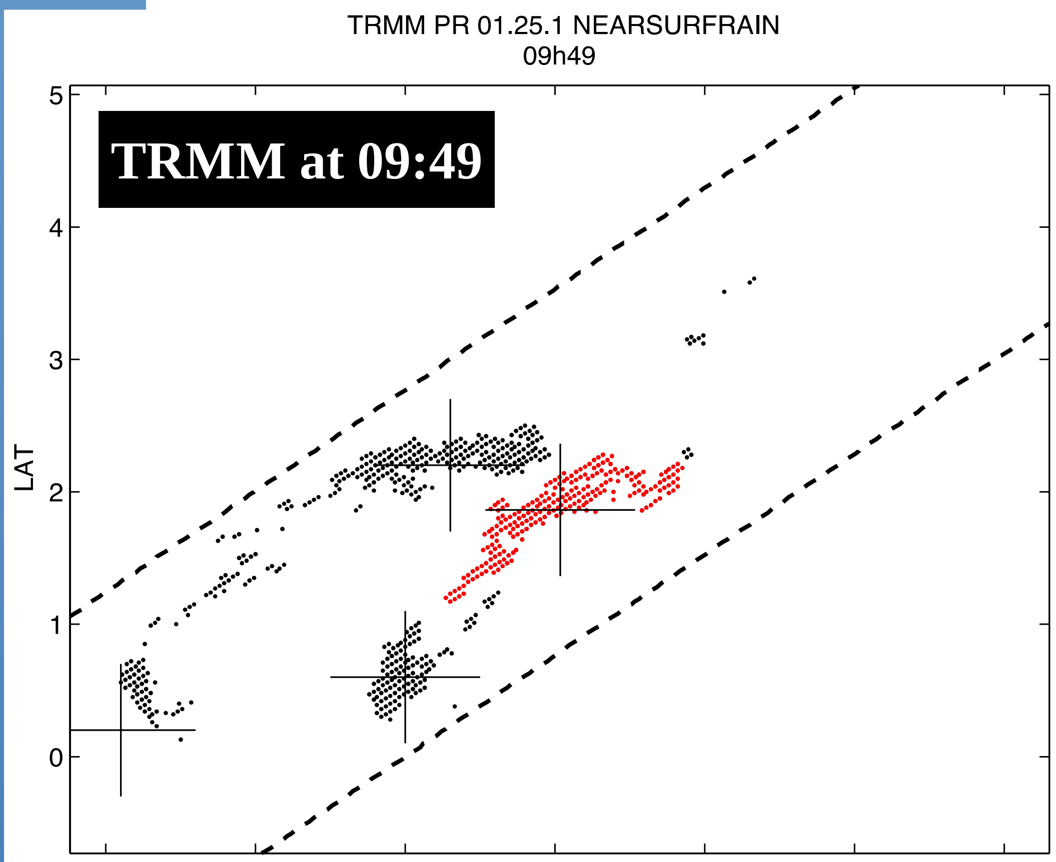
TRMM at 09:49

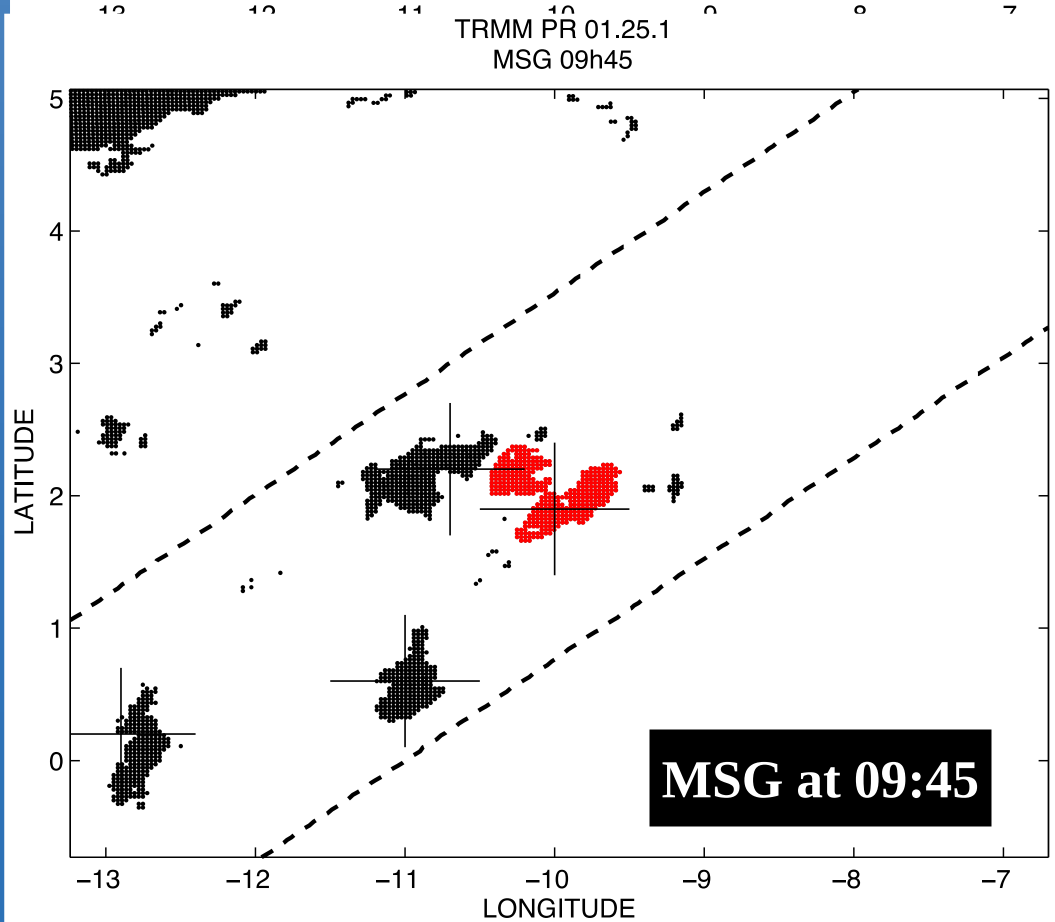


MSG at 09:45



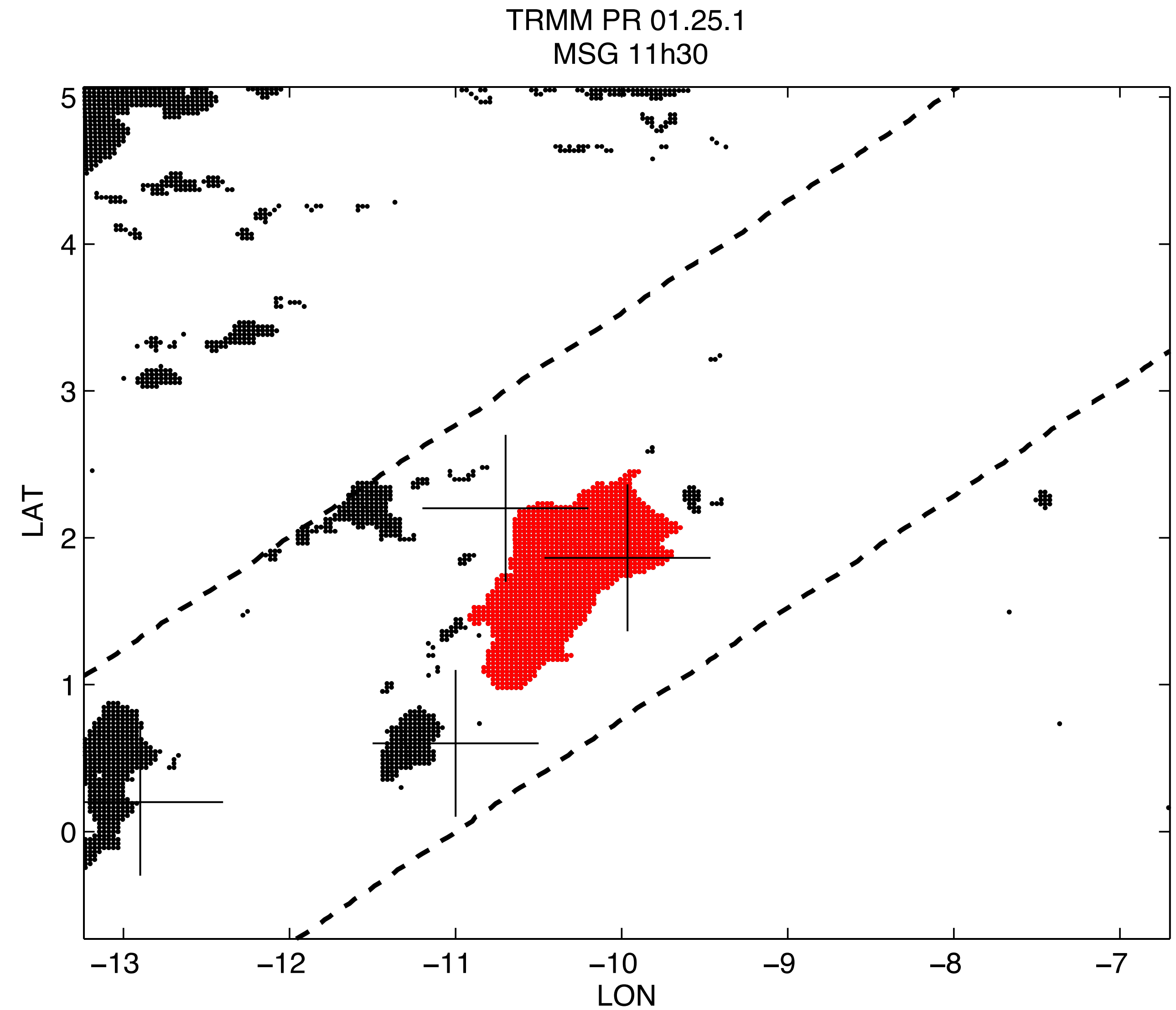
Blob time evolution



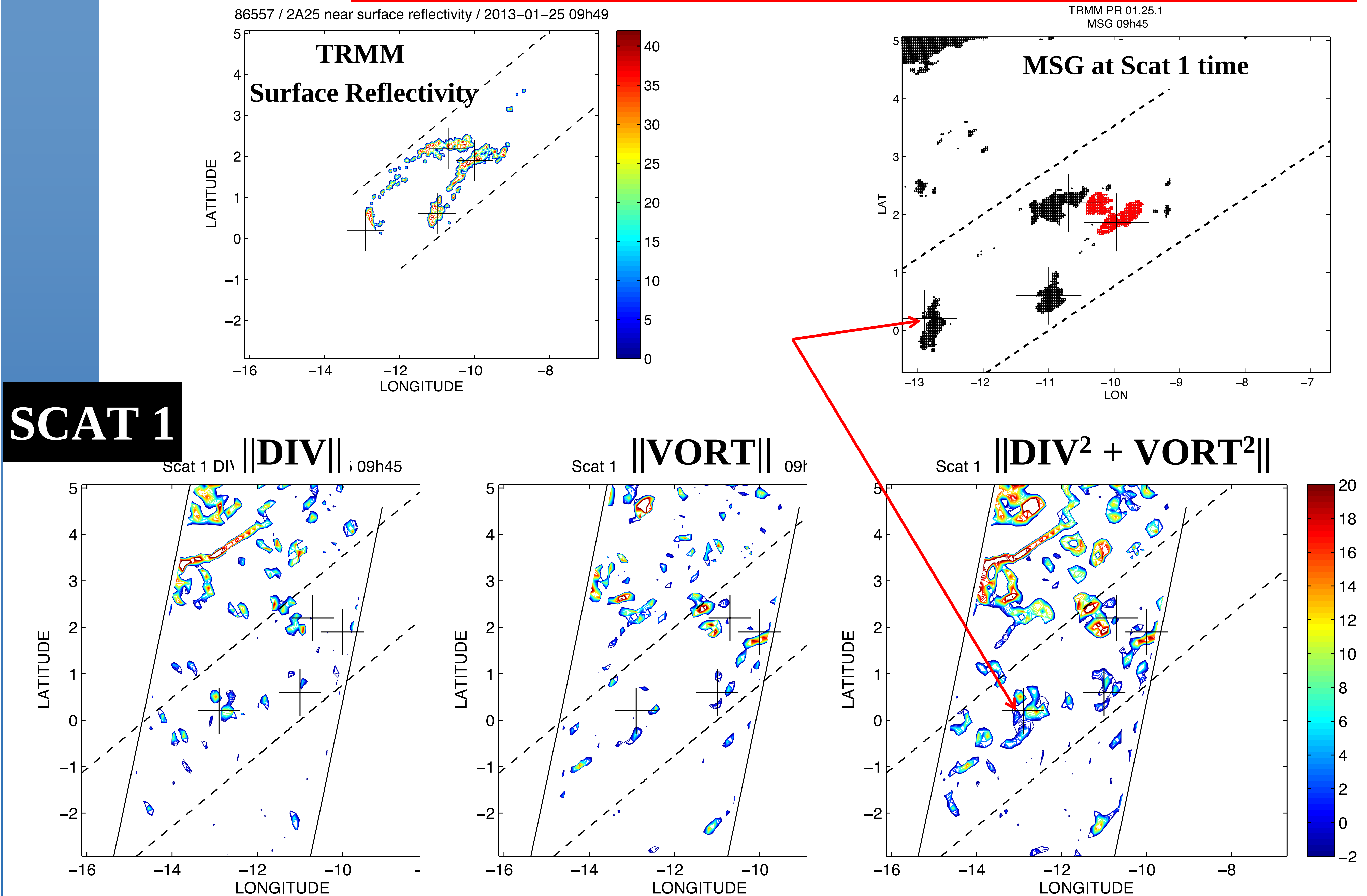


MSG Time Sries

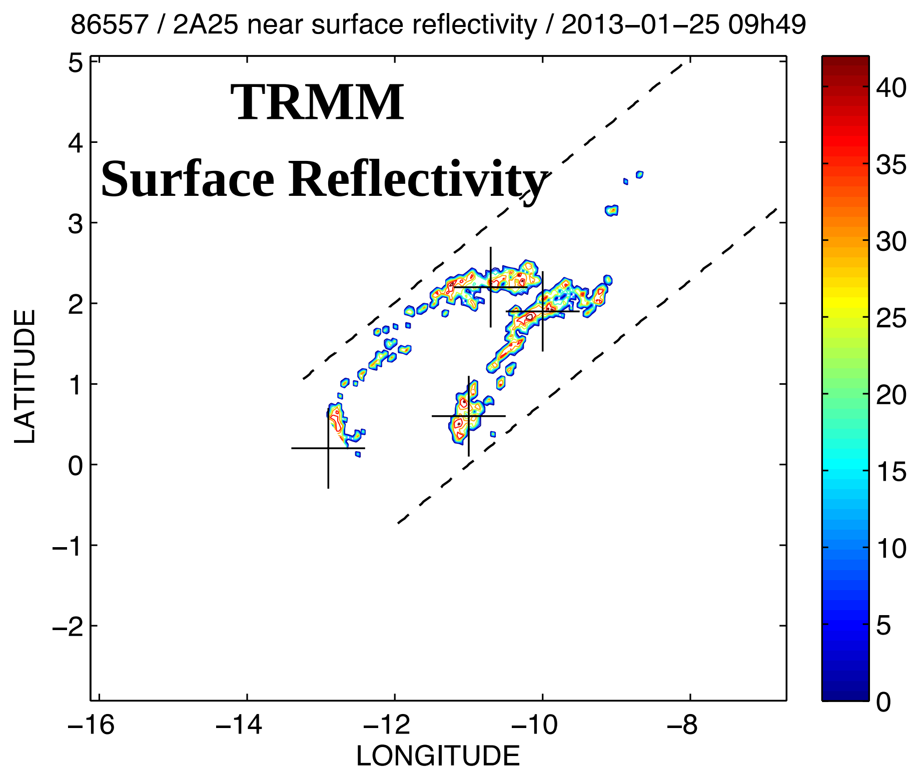
08:00 – 11:30

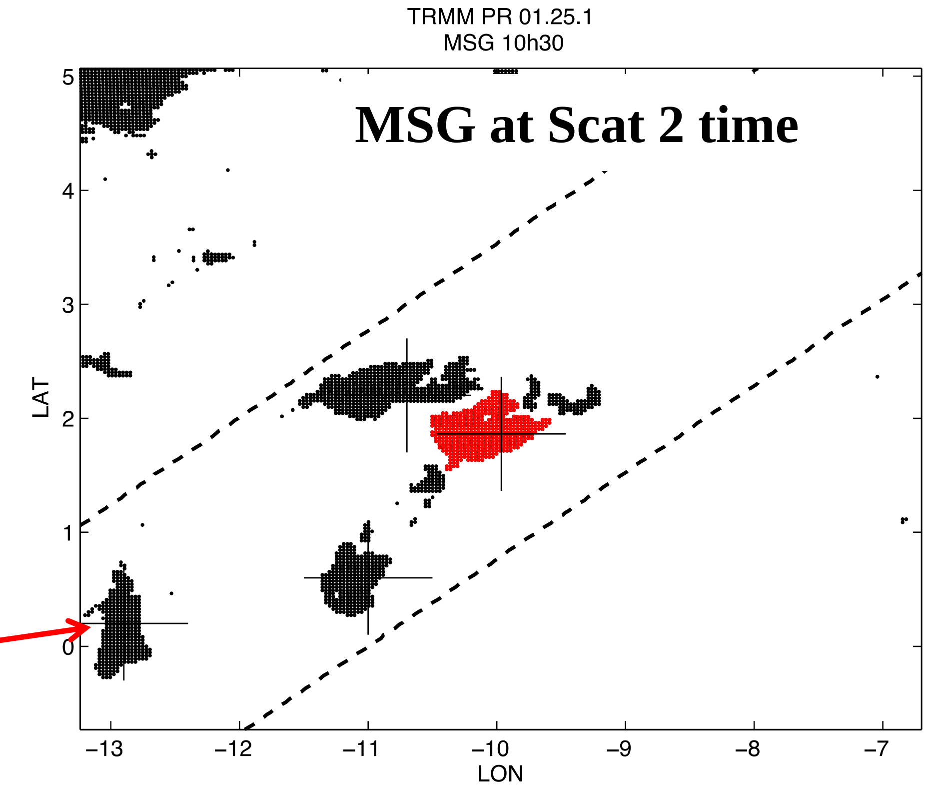


ASCAT (1) DIV and VORT (dB)

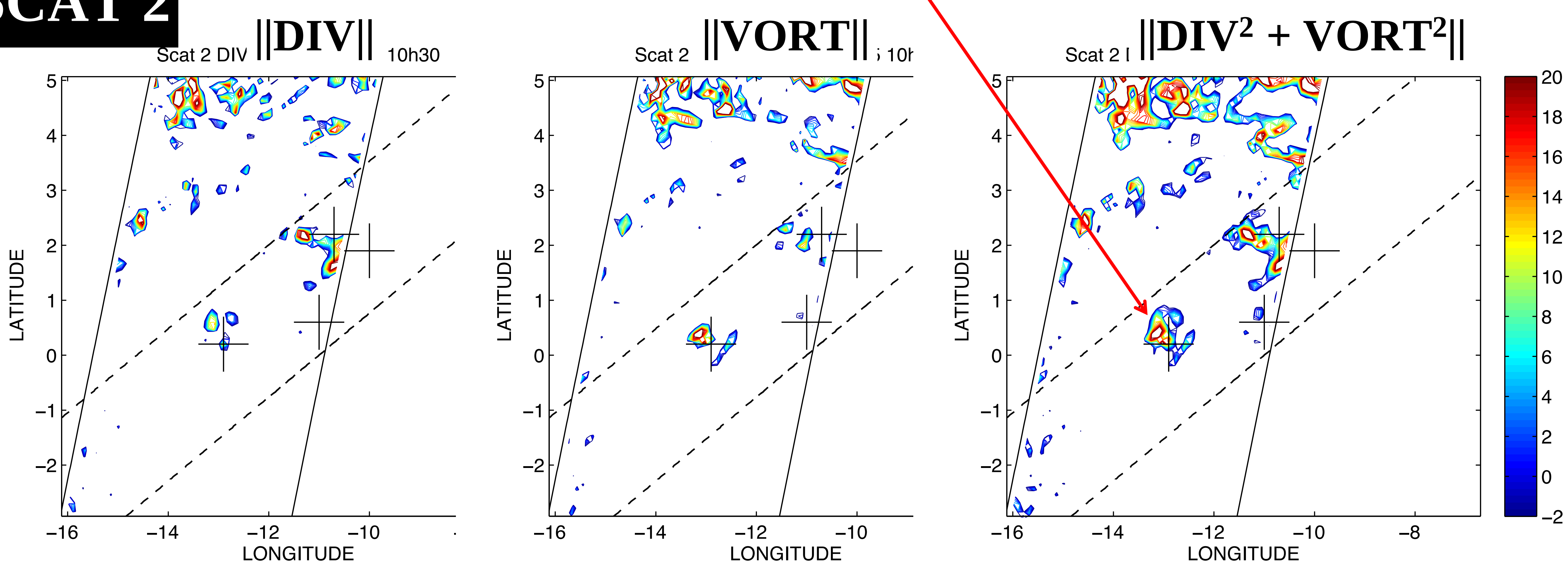


ASCAT (2) DIV and VORT (dB)





SCAT 2

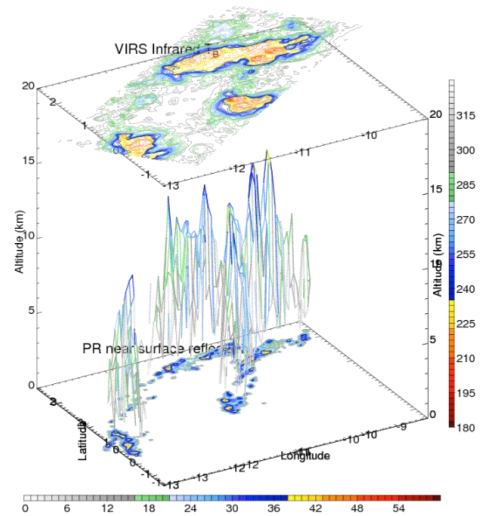


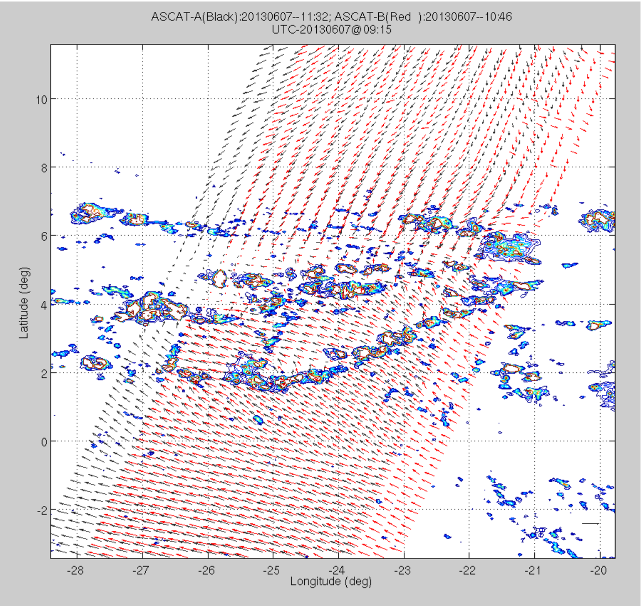
Summary

- MSG RR and ASCAT DIV&VORT (dB) are well-correlated with MCSs identified in TRMM PR

- Contingency Table offers a useful framework
  (hits, false alarms, misses, correct nulls)

- Future: Adapt contingency table to feature-based approach (as done in fuzzy NWP verification)

The Way Forward = 

+ 

- **Vacancy on scatterometer data processing and applications (to be issued in October 2016)!**

Why ASCAT DIV and VORT was plotted in dB

P.M. Austin (1987) MWR vol 115, p 1055:

Measurements with vertically pointing radars have shown that ...

- In the upper portions of convective cells, the strongest echoes are generally in **updraft** regions where presumably there are large concentrations of growing drops or graupel particles.
- At low levels, regions of maximum reflectivity are almost always in **downdrafts** triggered by the falling drops.

Therefore it seemed appropriate to try to make a correspondence between the TRMM reflectivity measurements and ASCAT DIV and VORT by plotting the latter in the dB scale.

What is inside the black box called Singularity Analysis?

- Generalization of Taylor expansion to neighborhood of a singularity

$$\frac{1}{r}|s(\vec{x}+\vec{r})-s(\vec{x})|\sim r^{h(\vec{x})}$$

$$||\nabla s||(\vec{x},r)\sim r^{h(\vec{x})}$$

h > 0.1 => locally regular/smooth
h < -0.1 => locally rough/spiky

*i.e., steep gradients / jumps have **h < -0.1***

inside the SA black box...

$$s \to \vec{s} \to \vec{u}$$

$$\vec{u} = (u, v)$$

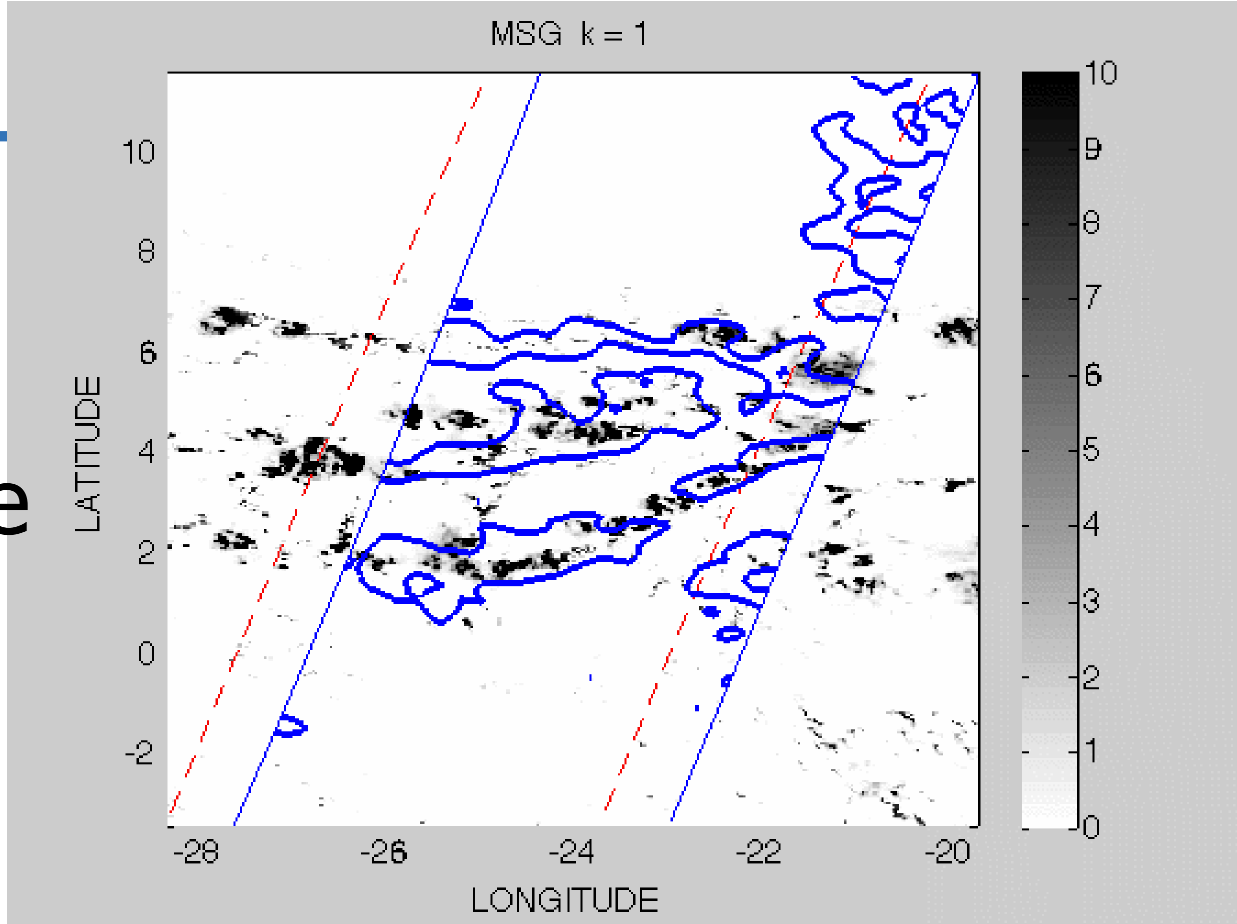
$$||\nabla \vec{u}||(\vec{x}, r) = \left|\left| \begin{array}{cc} \frac{\partial u}{\partial x} & \frac{\partial v}{\partial x} \\ \\ \frac{\partial u}{\partial y} & \frac{\partial v}{\partial y} \end{array} \right|\right|$$

$$||\nabla \vec{u}||^2 = ||\partial_x u||^2 + ||\partial_y v||^2 \qquad \text{DIV}$$

$$|| + \partial_y u||^2 + ||\partial_x v||^2 \qquad \text{VORT}$$

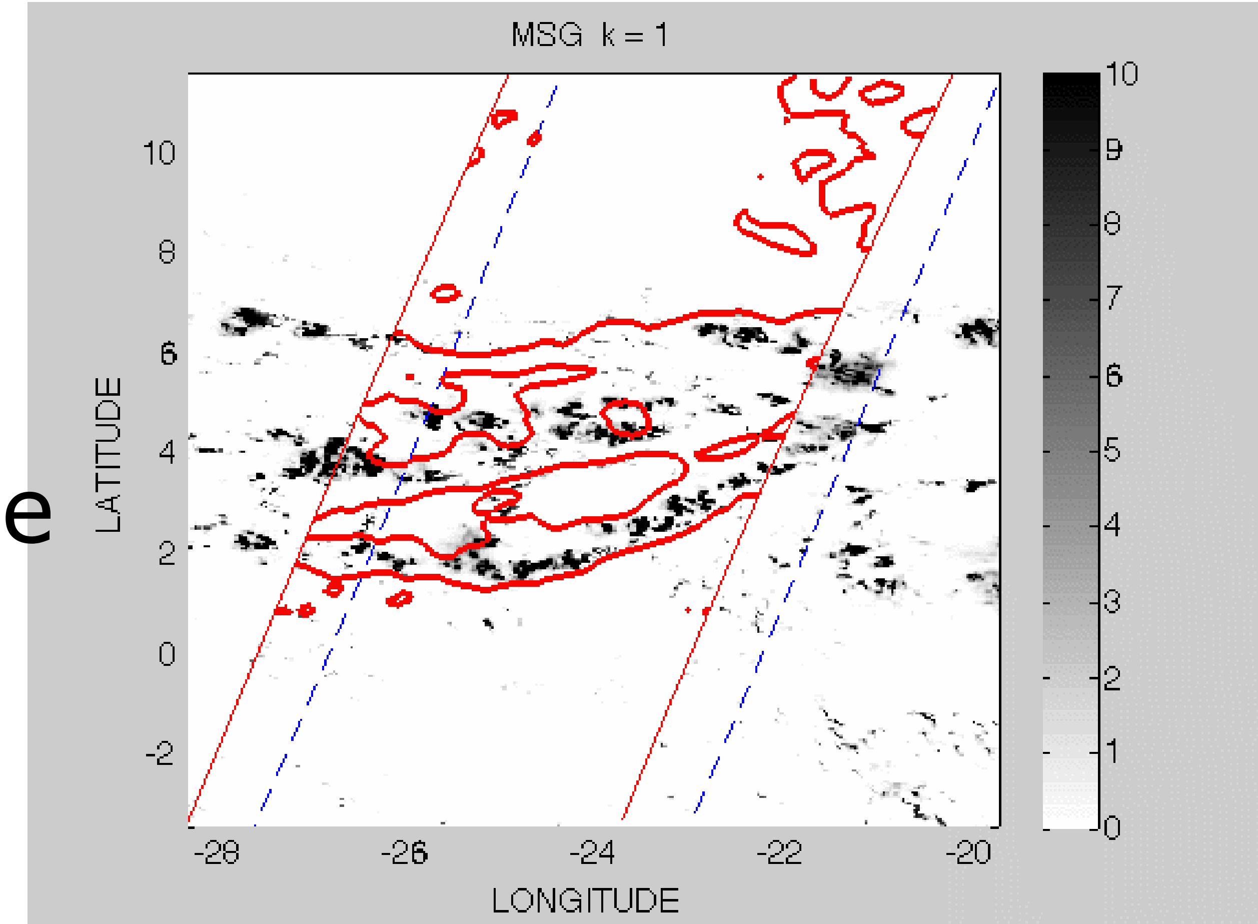
SEs for
s = *u*, *s* = *v*, and *s* = *(u,v)*
mix DIV and VORT info

ASCAT-B
Nearest-in-time
at k = 7



Contours
SE = -0.1

Animation of
17 frames of MSG
(15 minutes apart)



ASCAT-A
Nearest-in-time
at k = 10