Relating MSG Rain over the Tropical Atlantic with ASCAT derived surface DIV and VORT

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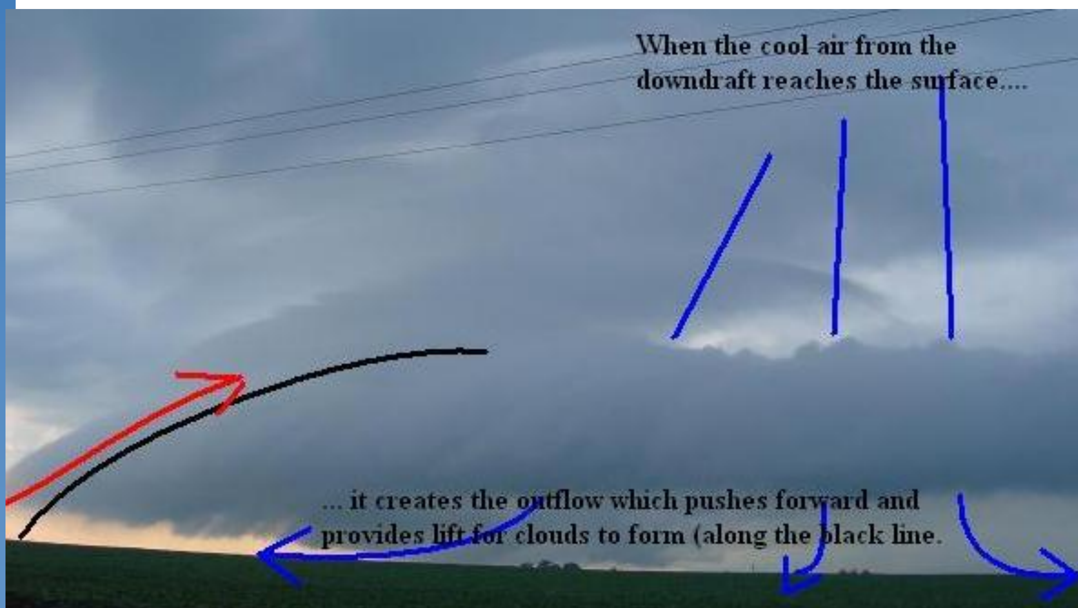
OSI SAF
Ocean and Sea Ice

Downbursts trigger new convection

- The disbursing cool dry air can create an outflow boundary around the system called a gust front made up of the strongest, most damaging w

- Can form a shelf cloud on top of gust front that can produce lighter pre



Motivation

- NWP often too coarse resolution to resolve downbursts
- Inaccurate modelling of the air-sea interaction leads to less accurate modelling of convective storms

Aim of the project

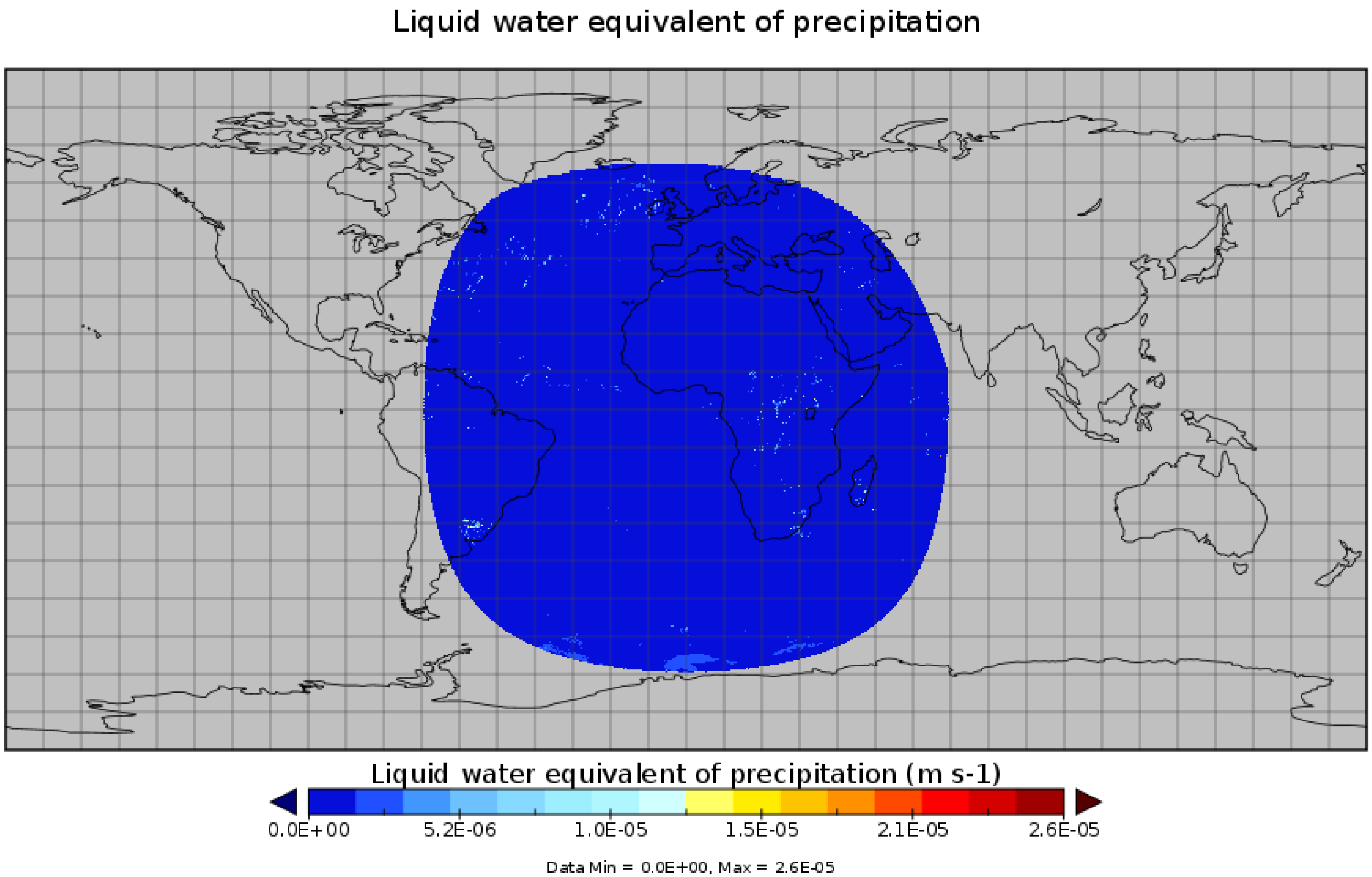
- Investigate the dynamics associated with rain events in Mesoscale Convective Systems (MCS) in the Tropical Atlantic
- using collocated ASCAT-A, ASCAT-B and Meteosat MSG Rain

Methods

- Surface divergence, vorticity, singularity exponents

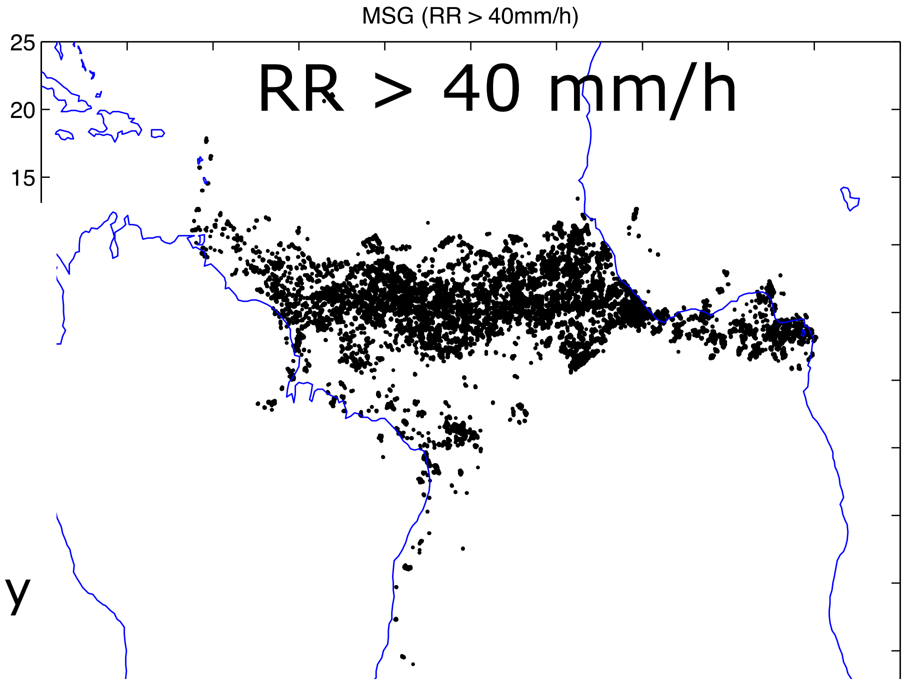
METEOSAT

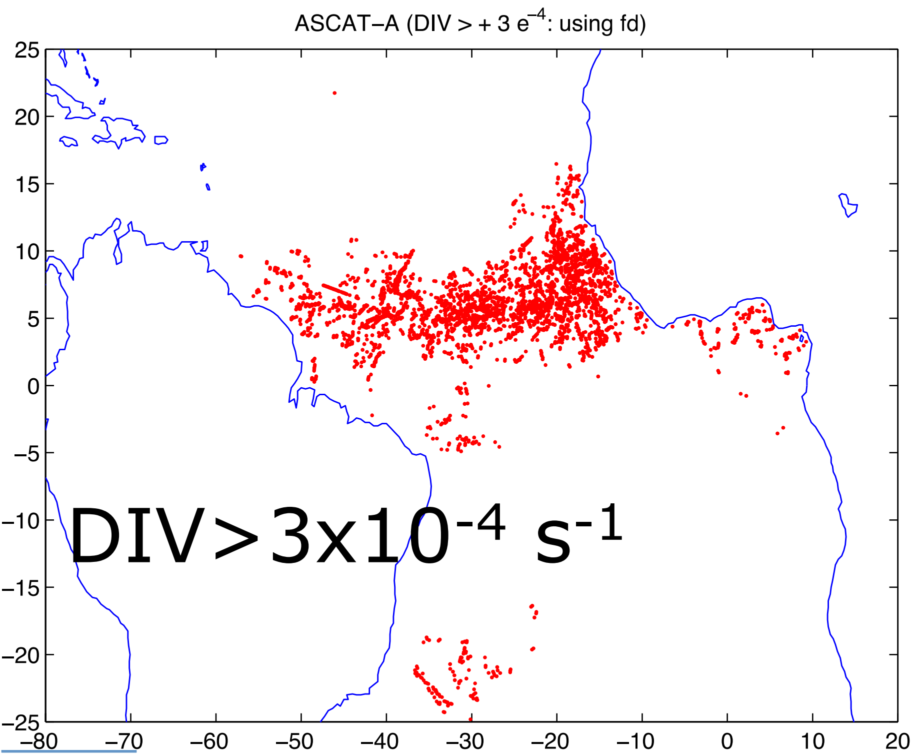
- Data available every 15 minutes from VIS and INFRA imager

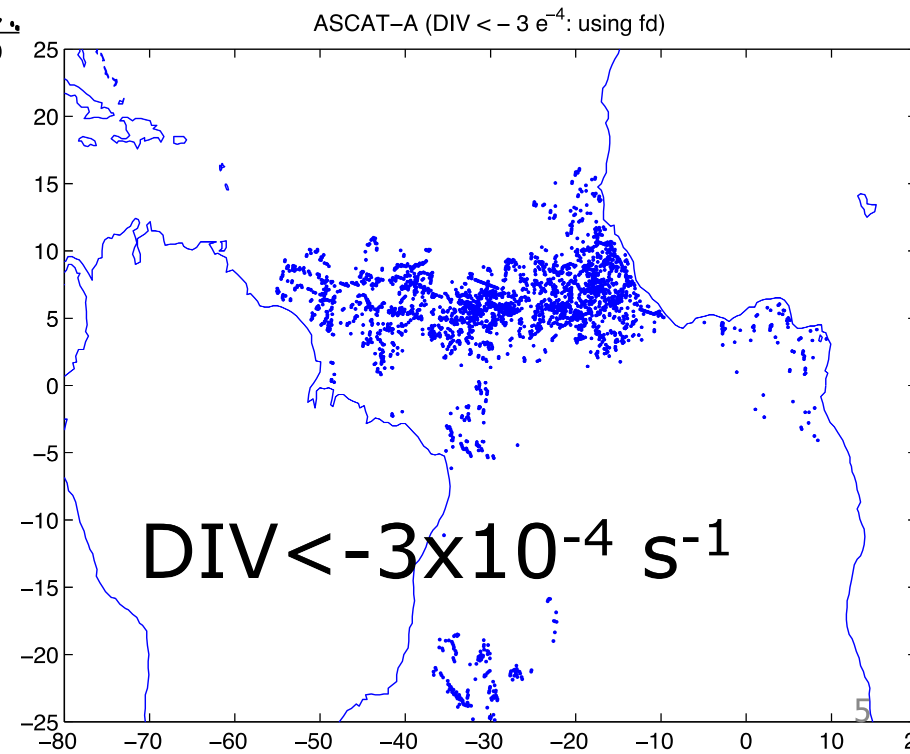


June 2013
(82 collocations)

In tropics,
ASCAT-A & B are
50 minutes apart
and swaths partially
overlap

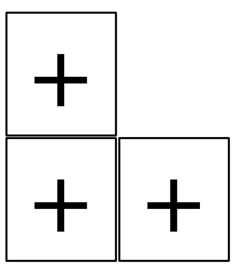




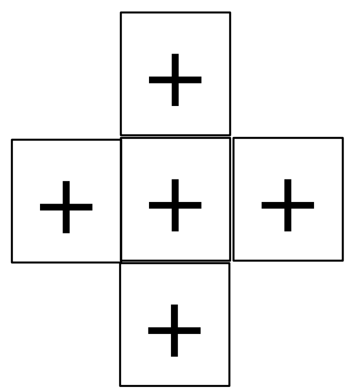


Information used in methods to estimate DIV and VORT

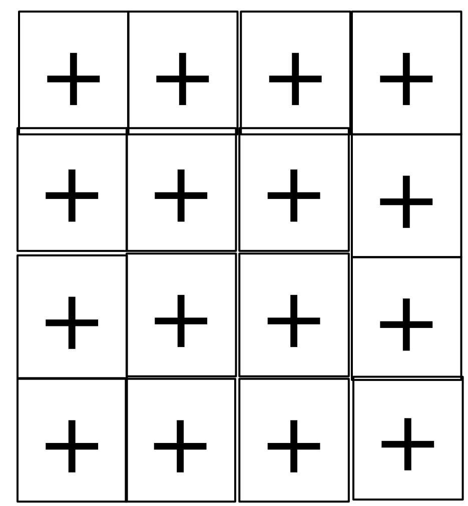
First Diffs



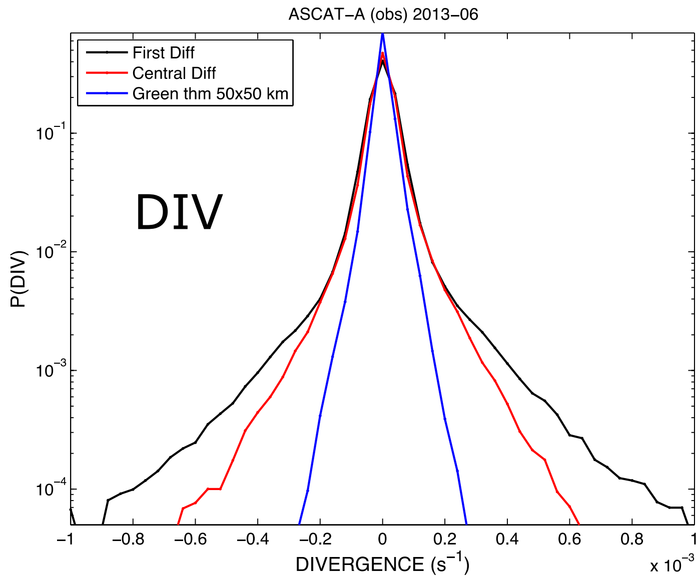
Central Diffs



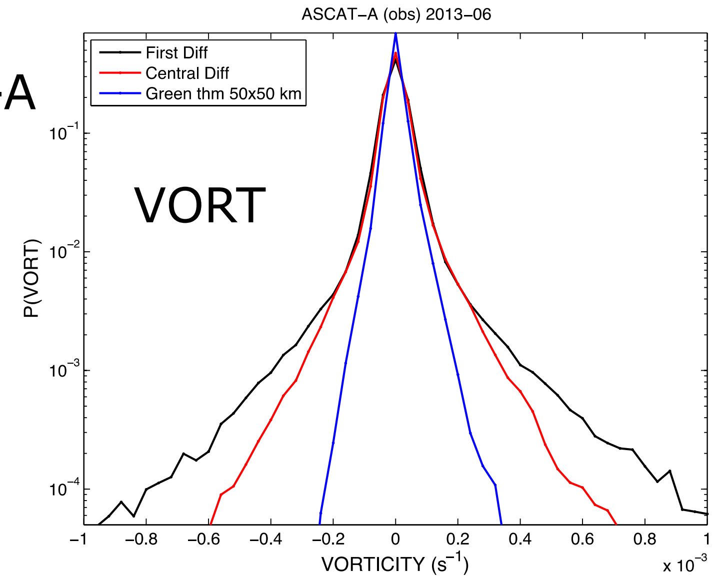
50x50km Greens Thm

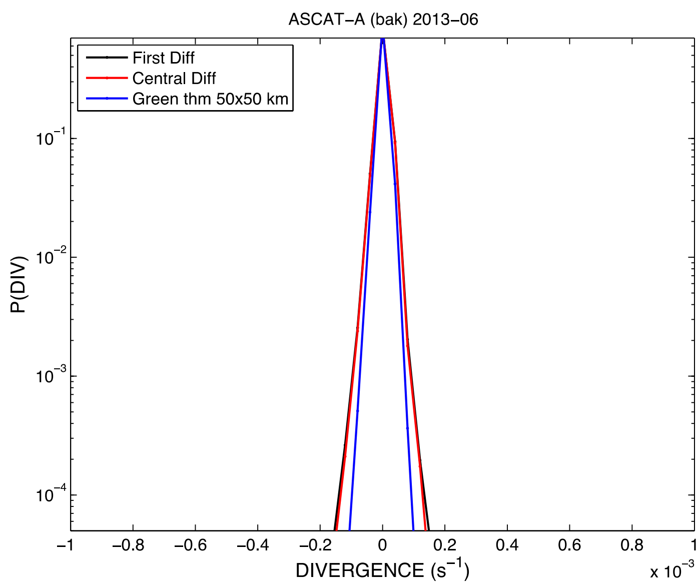


PDFs of DIV and VORT

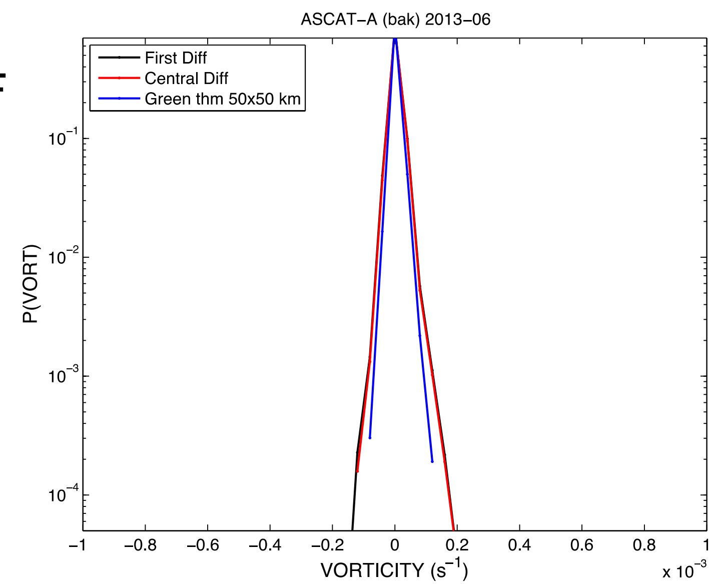


ASCAT-A

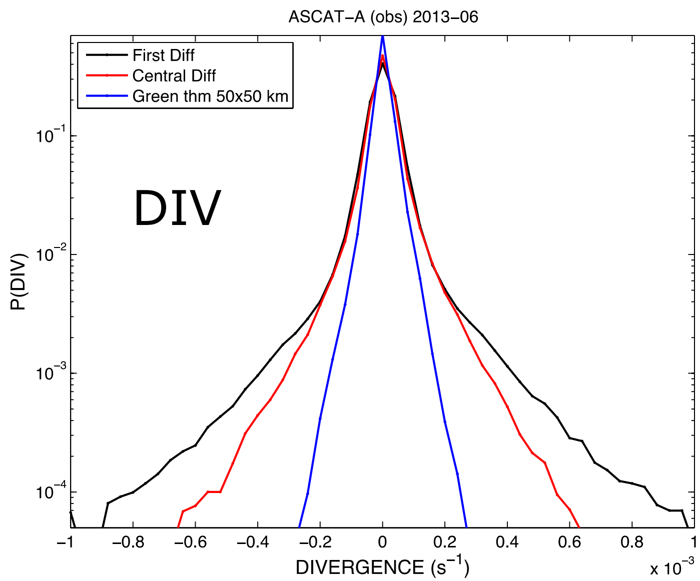




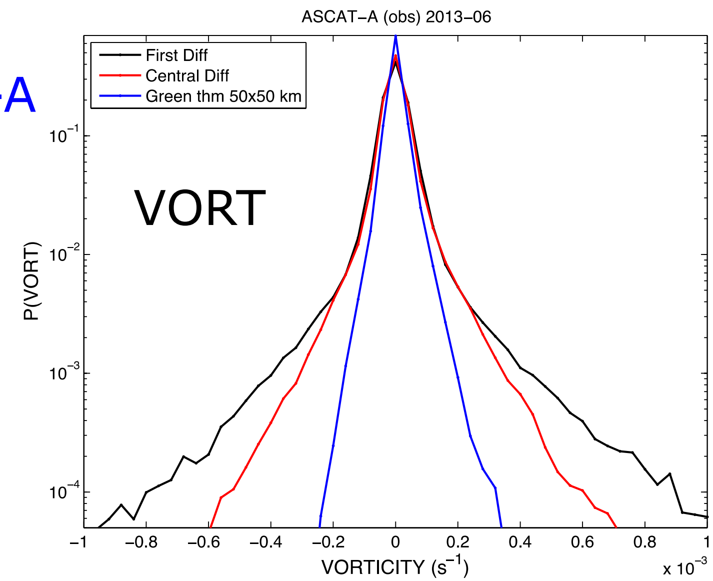
ECMWF

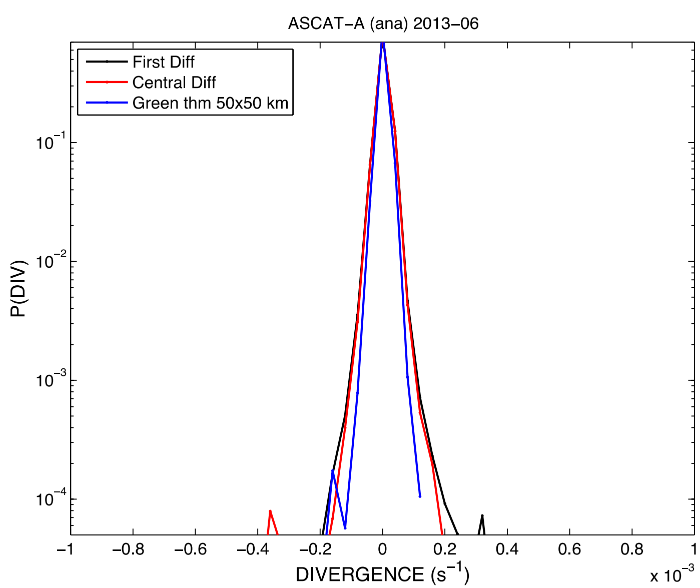


PDFs of DIV and VORT

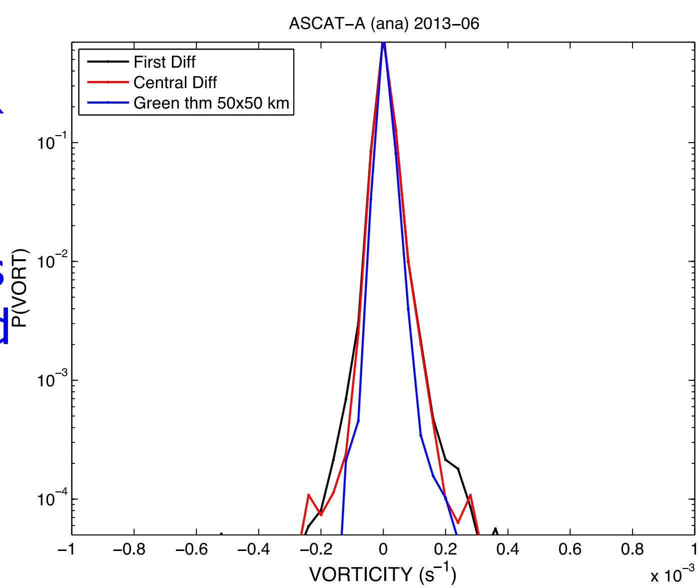


ASCAT-A





2DVAR
Not
what
Marcos
showed

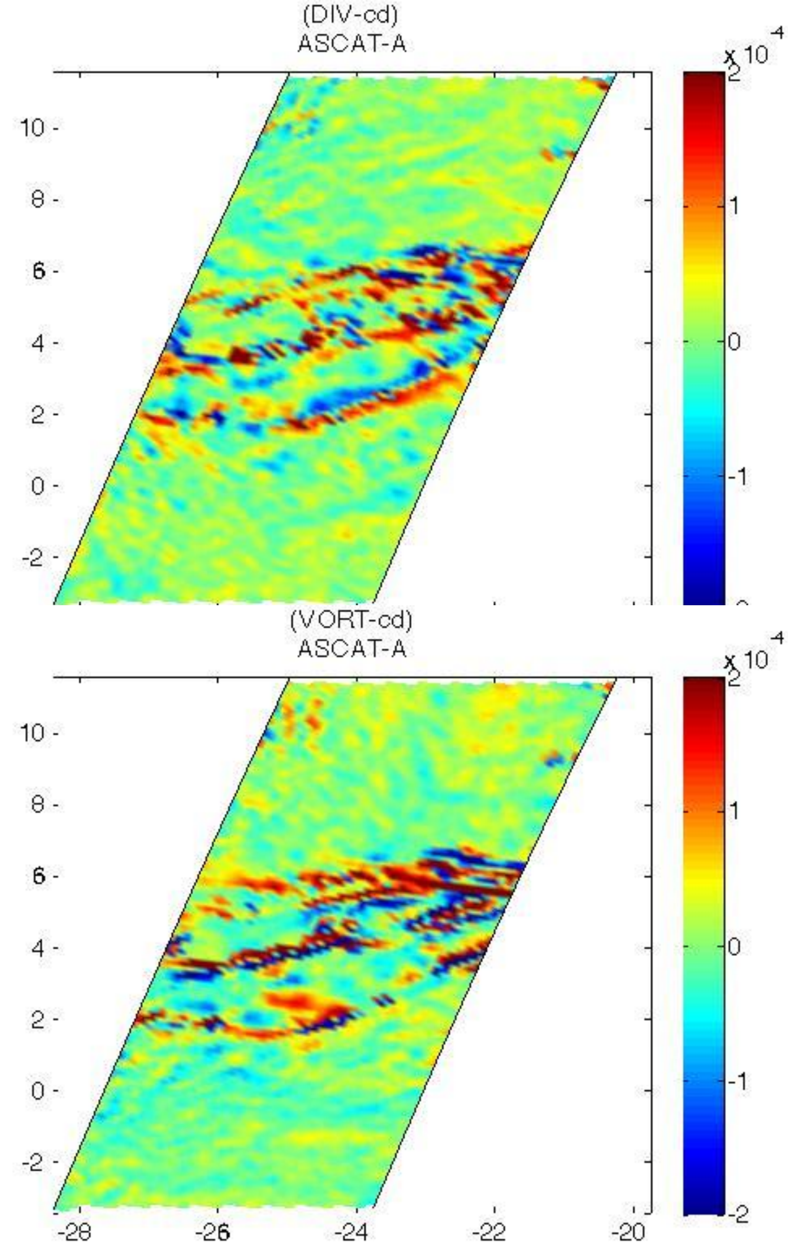


3 minute snapshots

Results for Central Differences

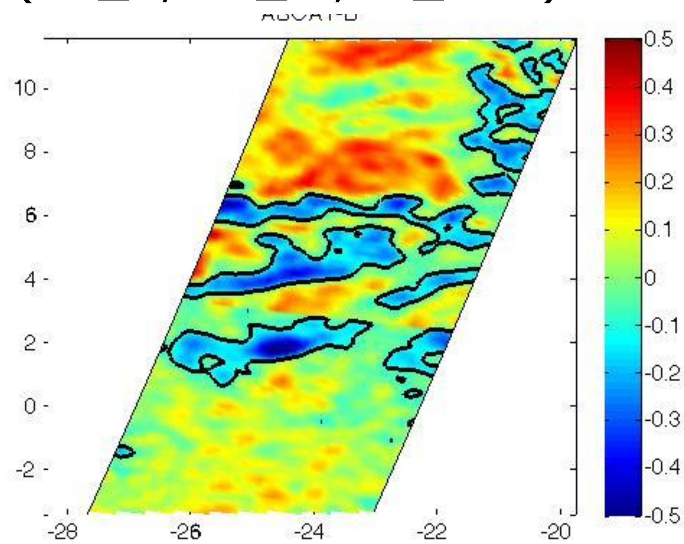
DIV

VORT



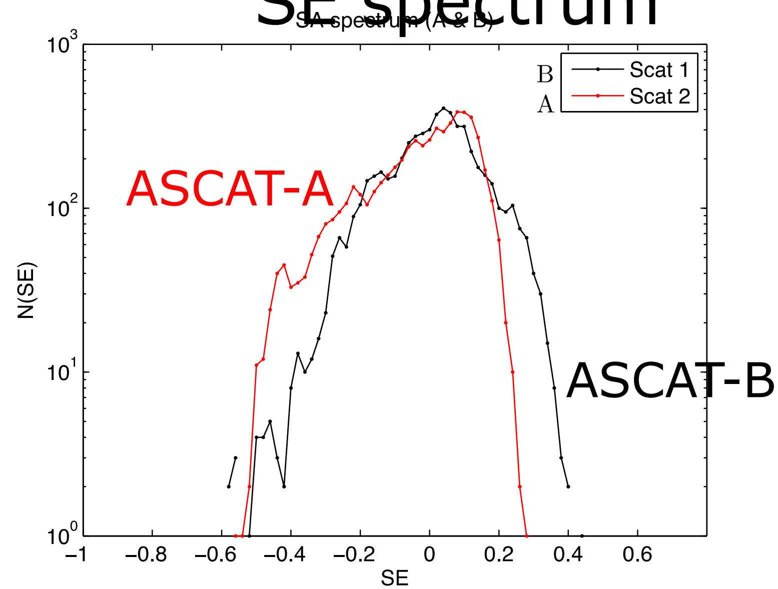
Singularity Exponents

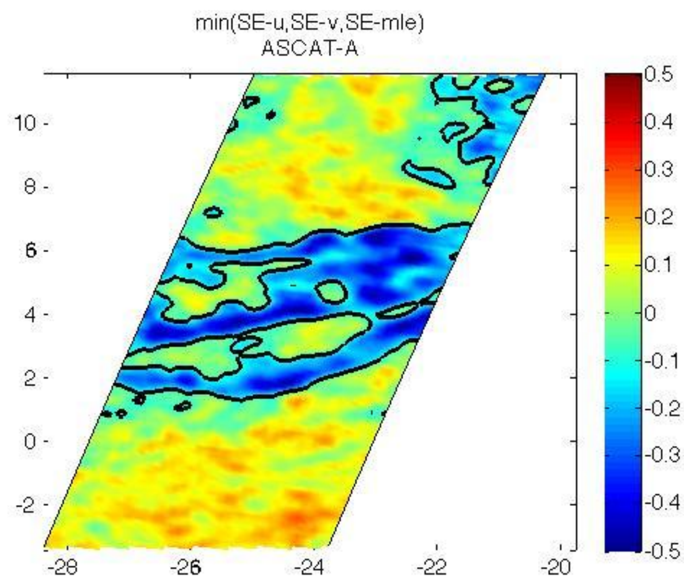
min(SE_u, SE_v ,SE_MLE)



ASCAT-B

SE spectrum



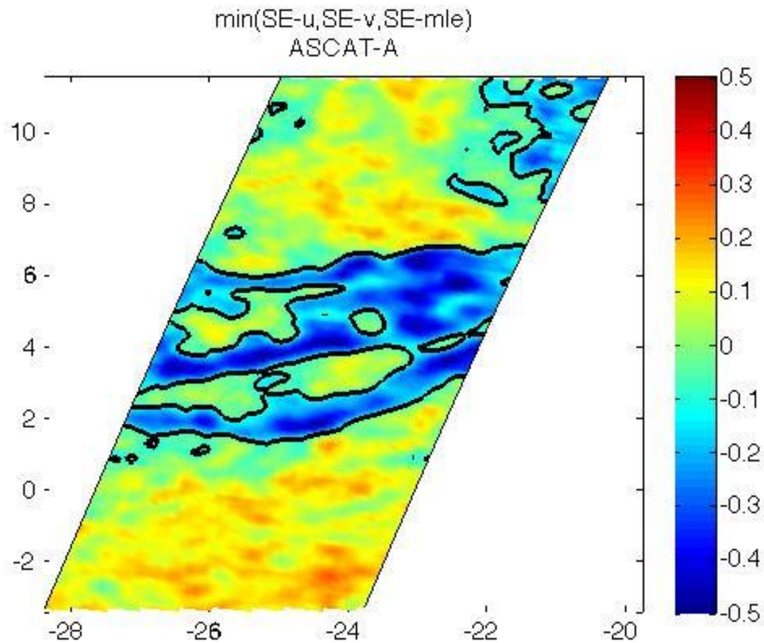


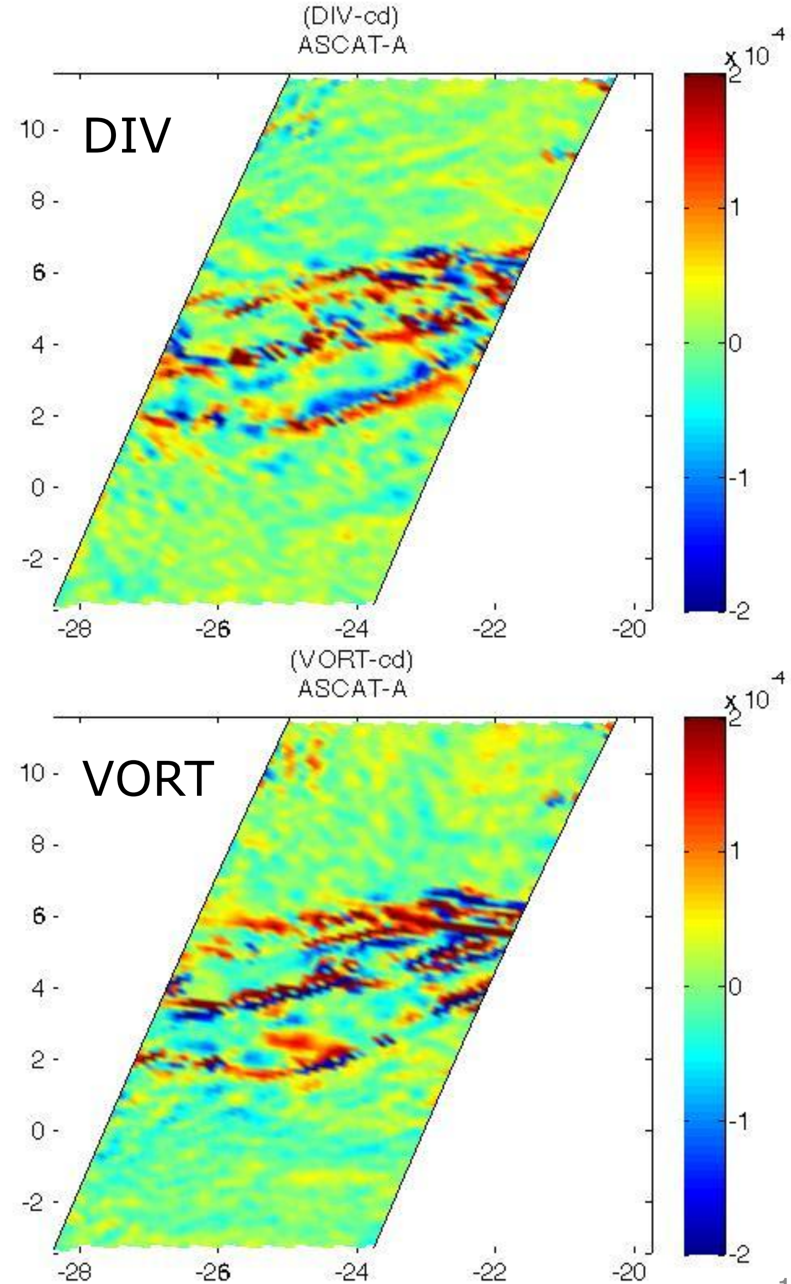
50 minutes later

ASCAT-A

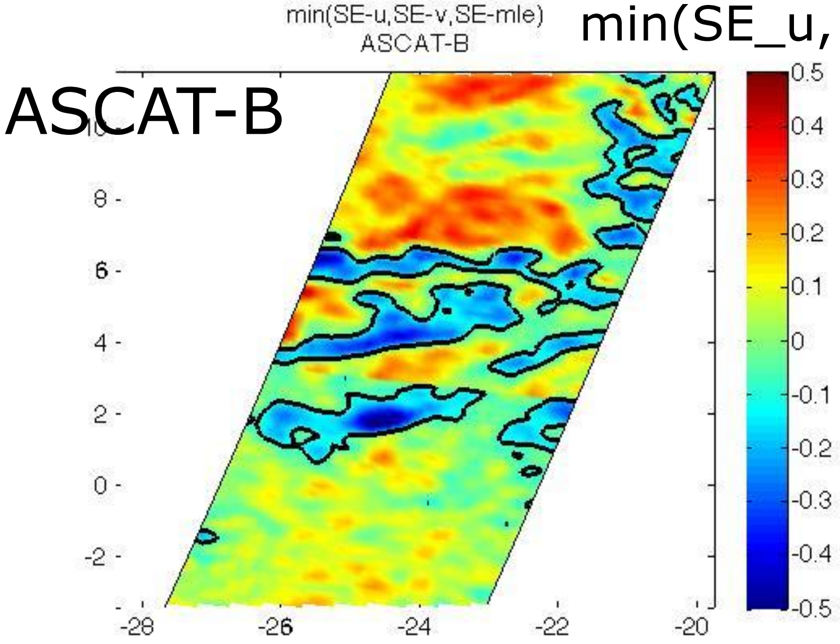
NOTE Left-Right SIMILARITY

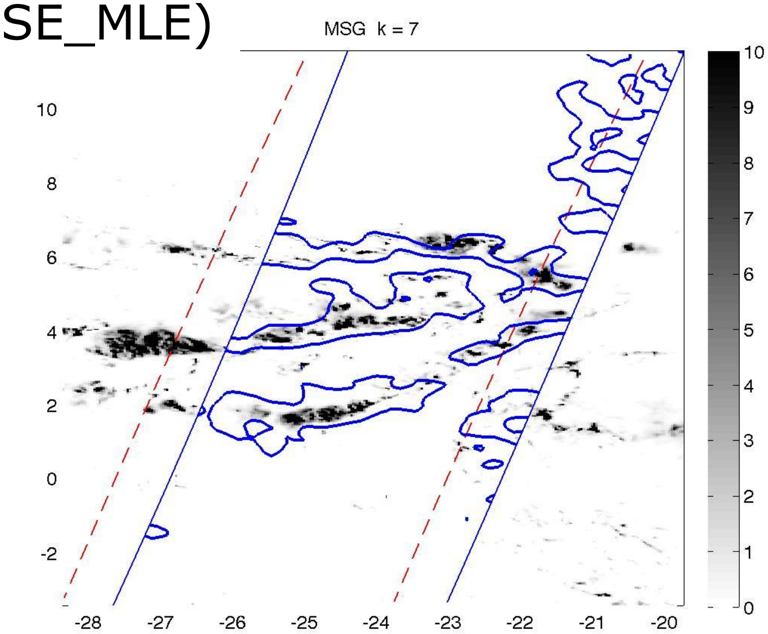
min(SE_u, SE_v ,SE_MLE)



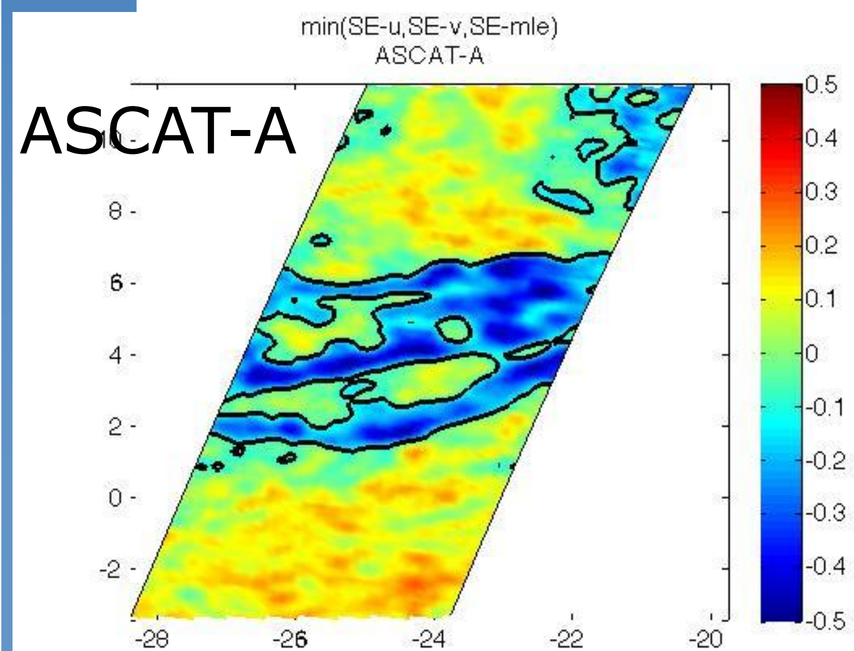


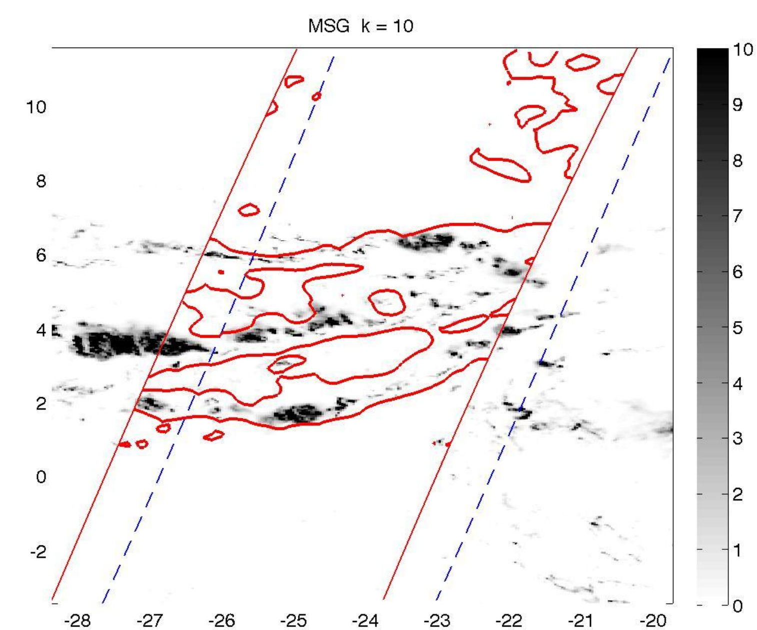
min(SE_u, SE_v ,SE_MLE)



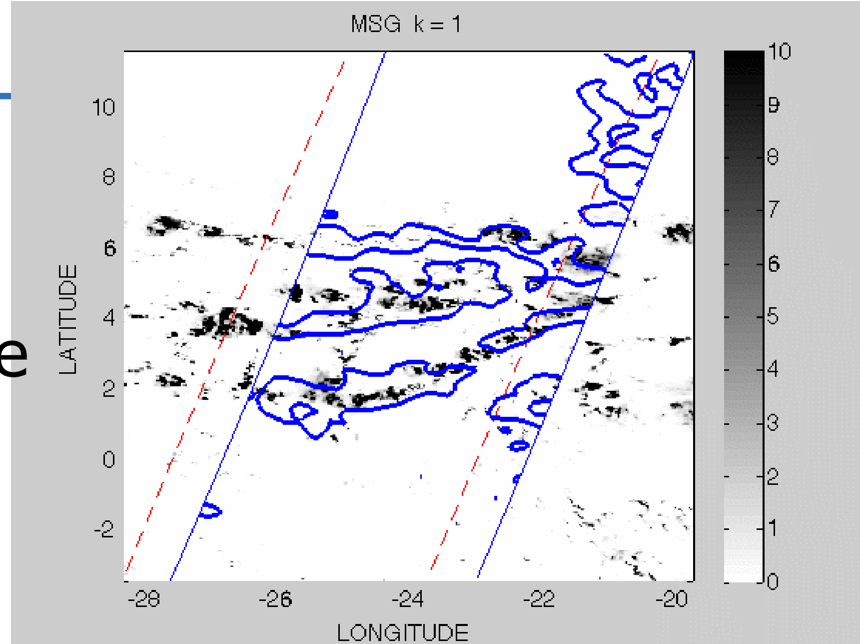


Nearest-in-time MSG RR





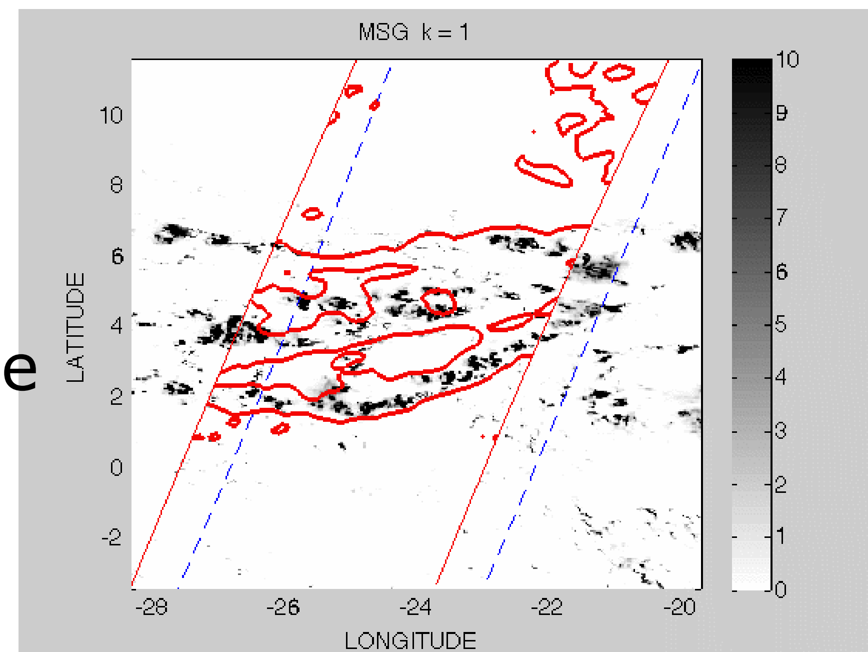
ASCAT-B
Nearest-in-time
at k = 7



Contours
SE = -0.1

Animation of
17 frames of MSG
(15 minutes apart)

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



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...

$$s \rightarrow \vec{s} \rightarrow \vec{u}$$

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

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

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

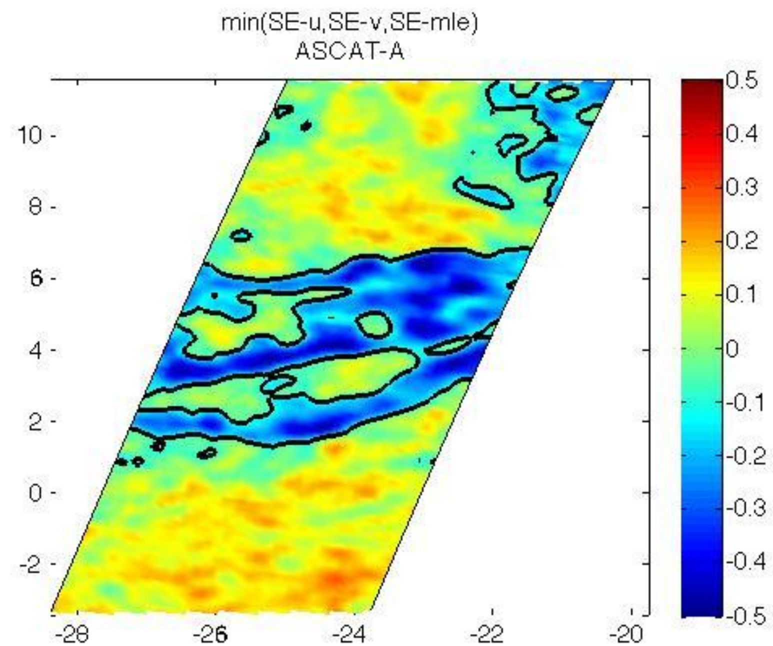
$$|| + \partial_y u||^2 + ||\partial_x v||^2 \qquad \text{VORT}$$

SEs for

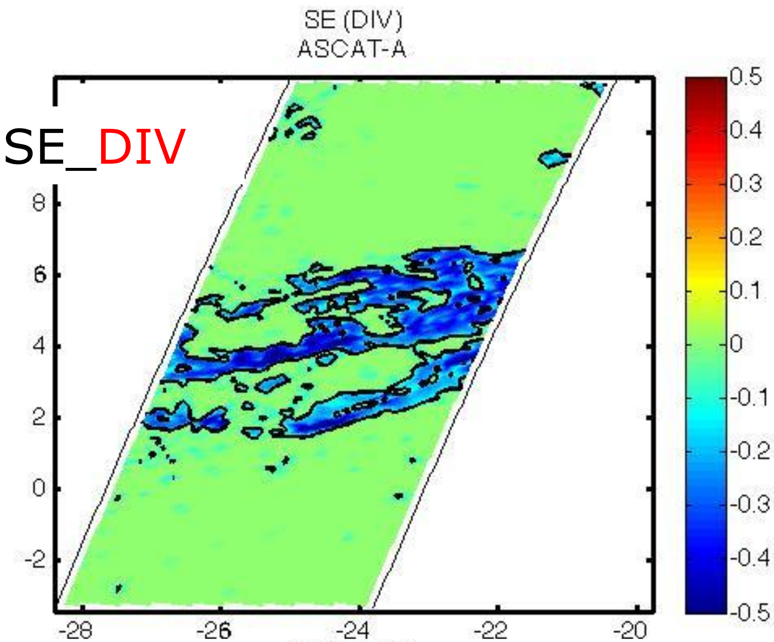
s = *u*, *s* = *v*, and *s* = *(u,v)*

mix DIV and VORT info

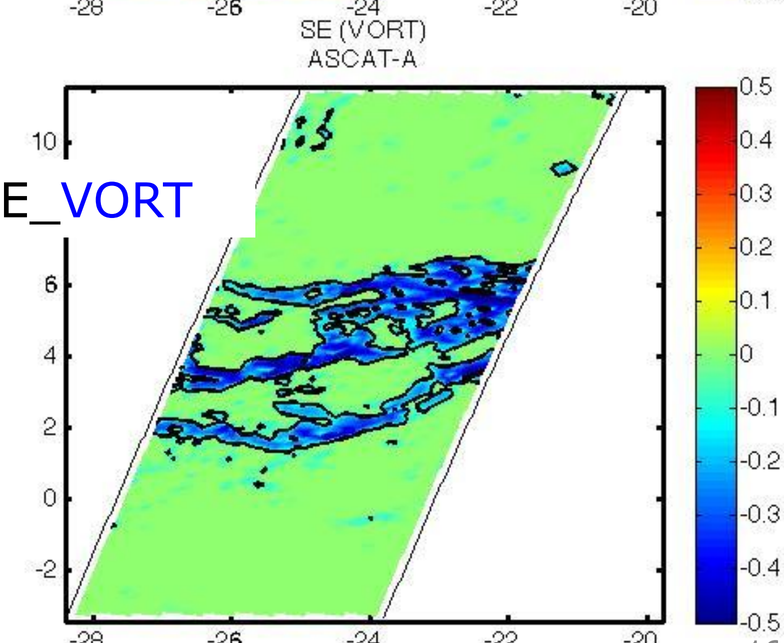
min(SE_u, SE_v ,SE_MLE)



SE_DIV



SE_VORT

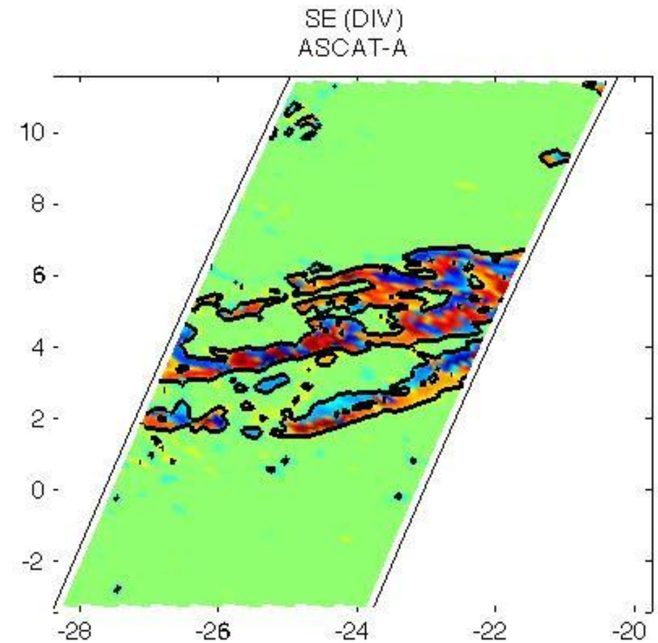


Can retain info about the sign of DIV and VORT in the Singularity Exponent

SE_DIV

DIV > 0

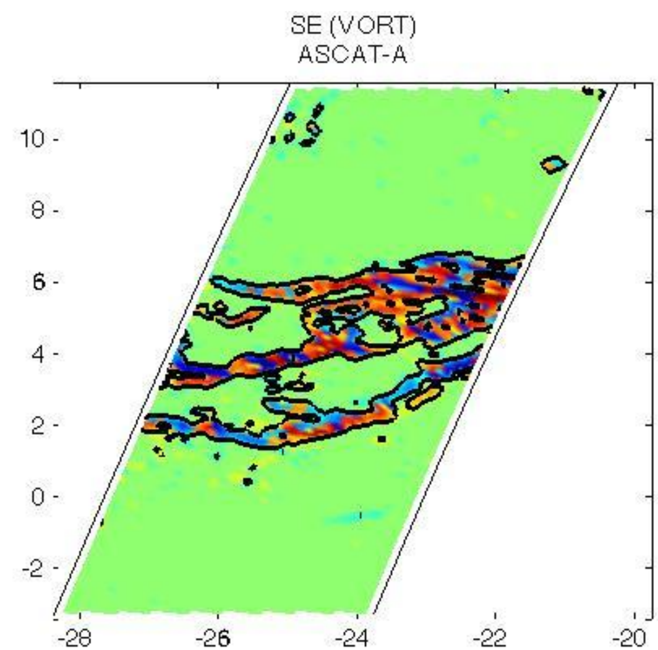
DIV < 0



SE_VORT

VORT > 0

VORT < 0



SUMMARY

MSG Rain and Singularity Exponents strongly correlated.

Singularity Exponents:

DIV (+/-),
VORT (+/-),
and QC

Future:

- Quantify how DIV and VORT vary in between ASCAT-A and B passes
- Want to relate this with what is going on up top (how to make it quantitative?).

Continued...

Speculation:

- Can Singularity Exponents be useful in Tropical Cyclone monitoring?

  (*We believe so*.)

ASCAT-A SE_DIV

Apply KNMI QC flag

Apply KNMI and 2DVAR QC flags