Coincident, High Resolution Measurements of Ocean Surface Rain in Support of Improved ASCAT-Retrieved Winds

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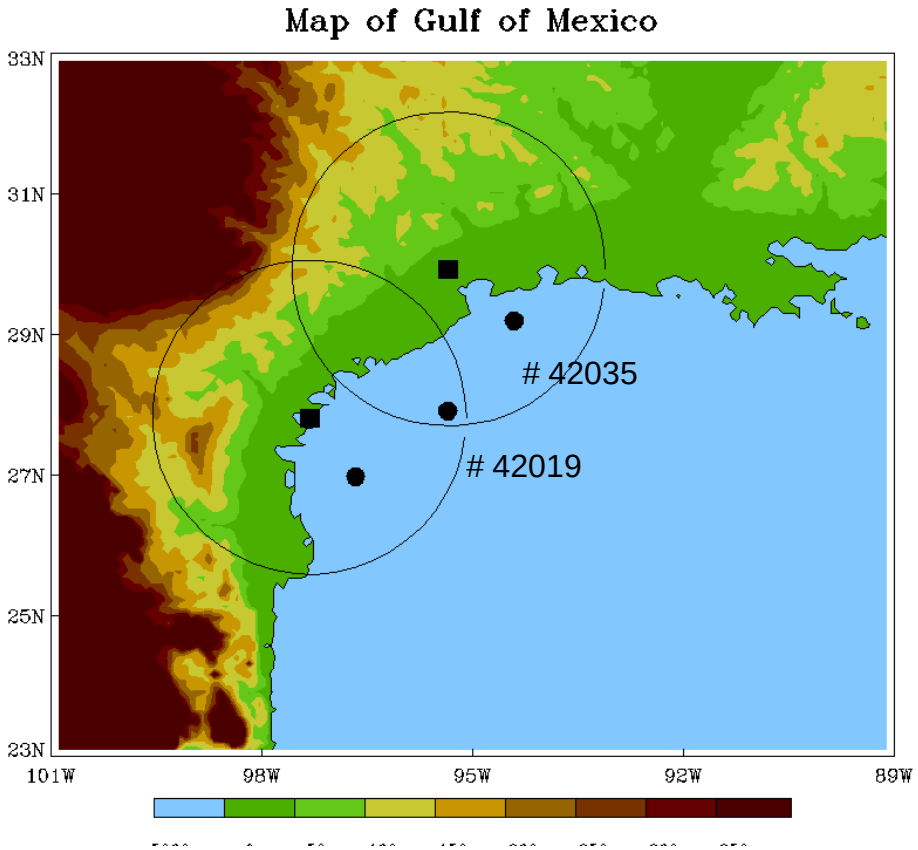
Motivation:

a) Provide an improved rain estimate to study the performance of ASCAT Operational Level 2 Retrieved Winds, using NEXRAD coincident measurements, over a range of wind conditions

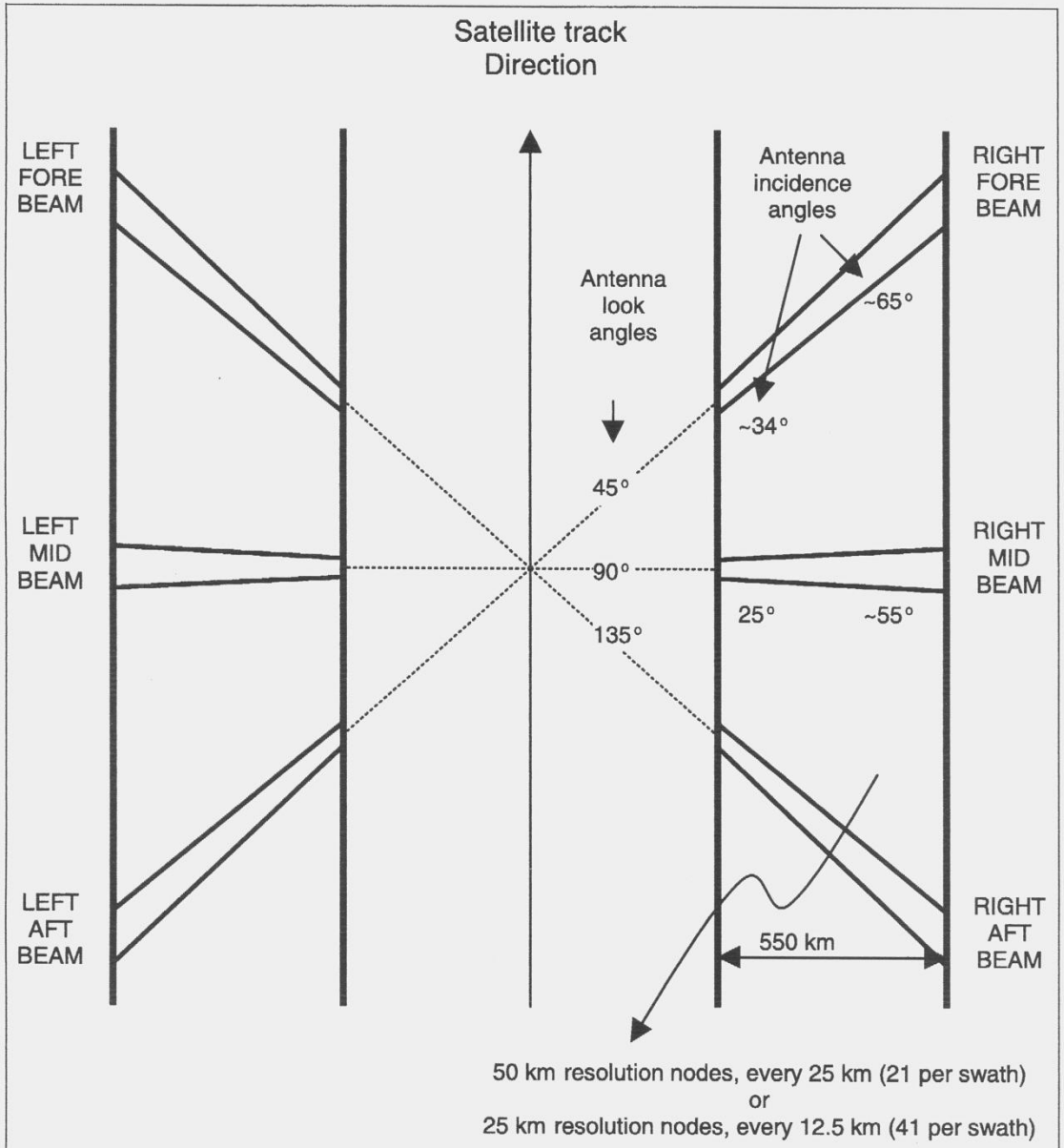
b) Investigate the correlation between the K_p and MLE parameters and the high resolution rainrates over a range of wind speeds

c) Support the development of the combined Singularity Exponent and MLE approach to filtering poor quality winds



Buoys 42035 and 42019 are identified by filled circles

Simultaneous NEXRAD Radar Provides **3-D Volume Reflectivity** (S-band) within scatterometer beam (Inherent resolution is about 2 km) – **Observations are made every 6 minutes -> therefore the Δt with ASCAT is ≤ 3 min.** The useful range from the station is assumed to be 250 km



ASCAT swath geometry. Dimensions are given for the right swath, and the left swath is symmetric with respect to the satellite ground track.

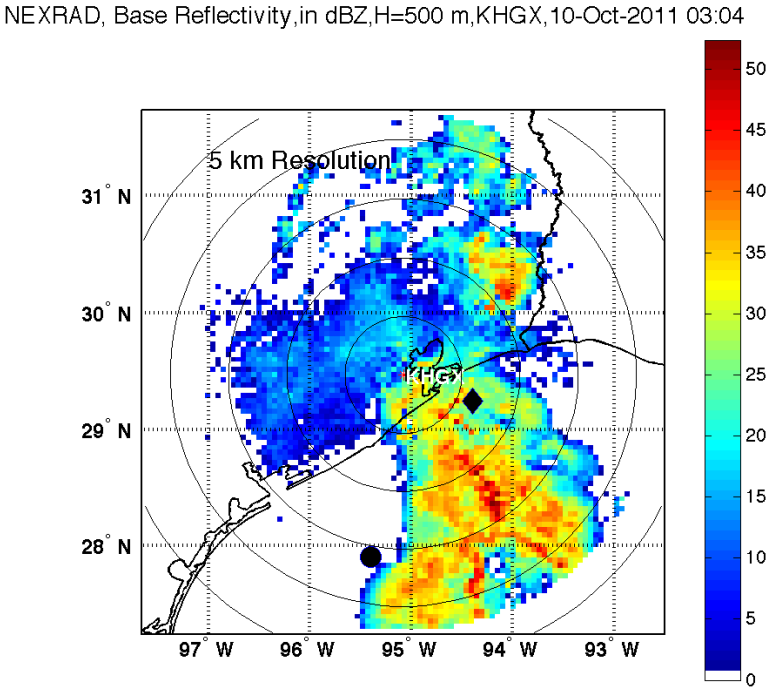
Measurements collected on two days will presented here: January 9, 2011 and October 10, 2011

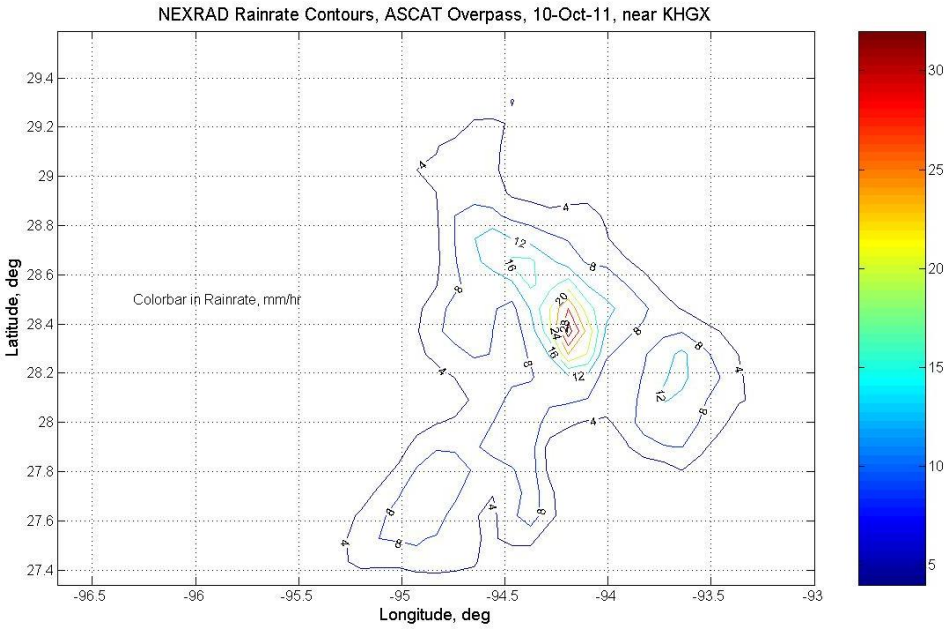
The results to be here utilize the combination of:

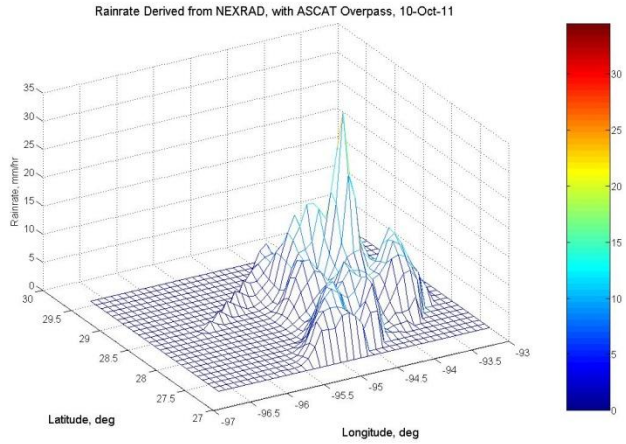
a) ASCAT level 2 data products: wind speed and direction (selected from ambiguities), Sigma0's for the fore,aft and mid-beams (with geometric parameters), the inversion residuals (MLE) and Kp

b) ECMWF wind speeds and direction

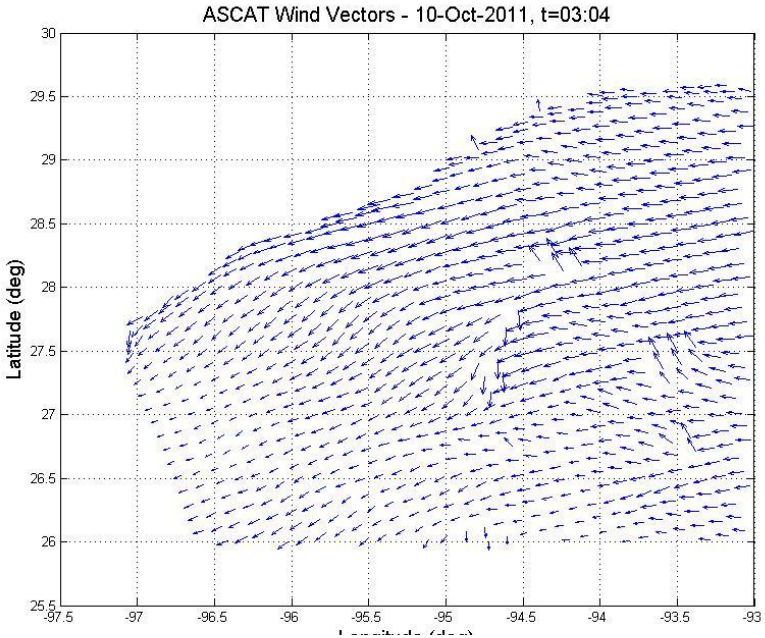
c) Rainrates averaged over an ASCAT cell

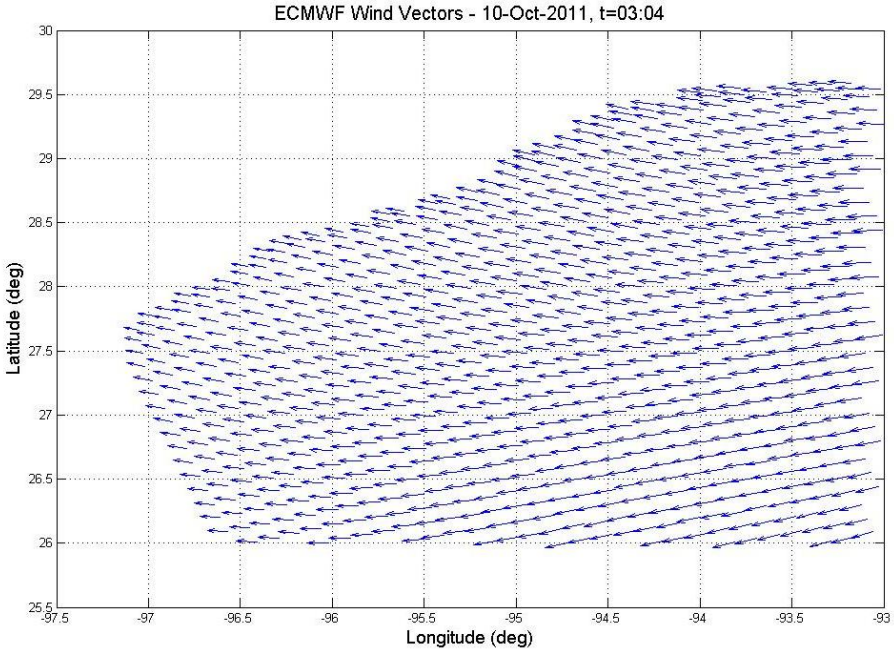


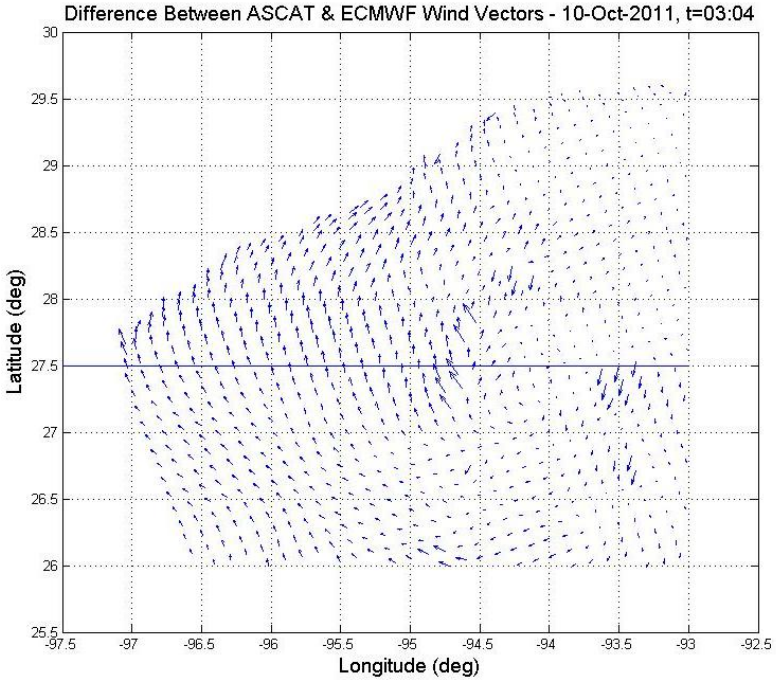


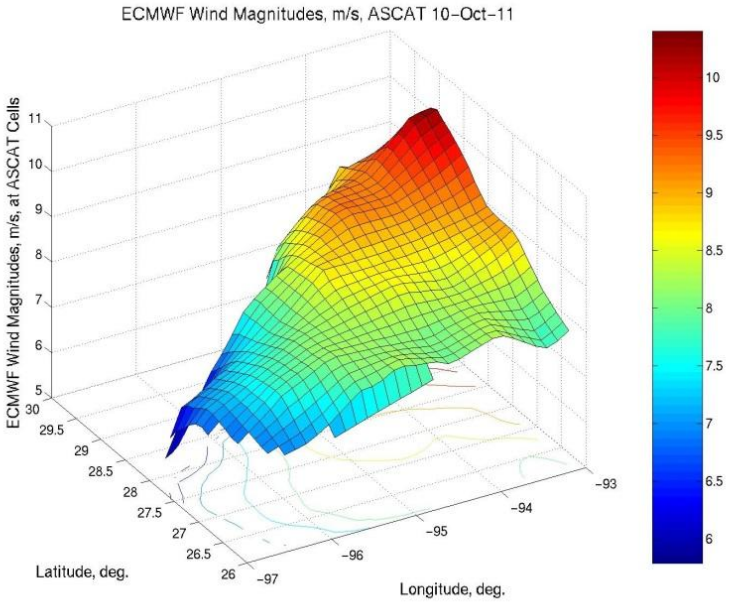


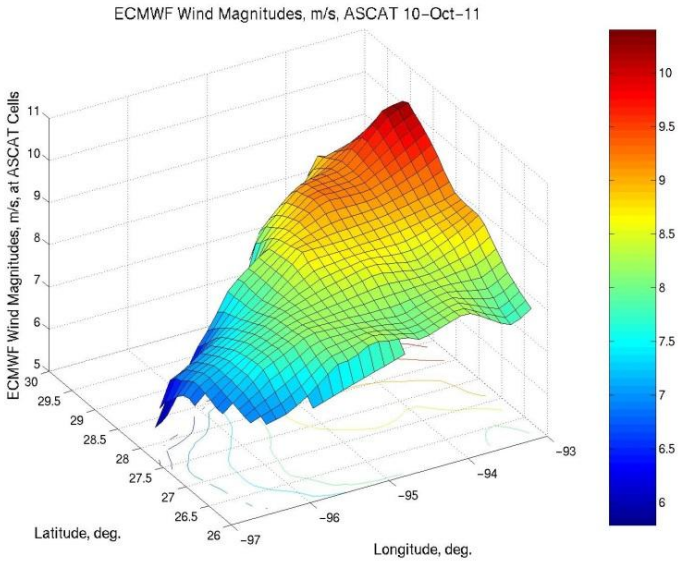
Contour diagram and surface plots show rainrates in mm/hr

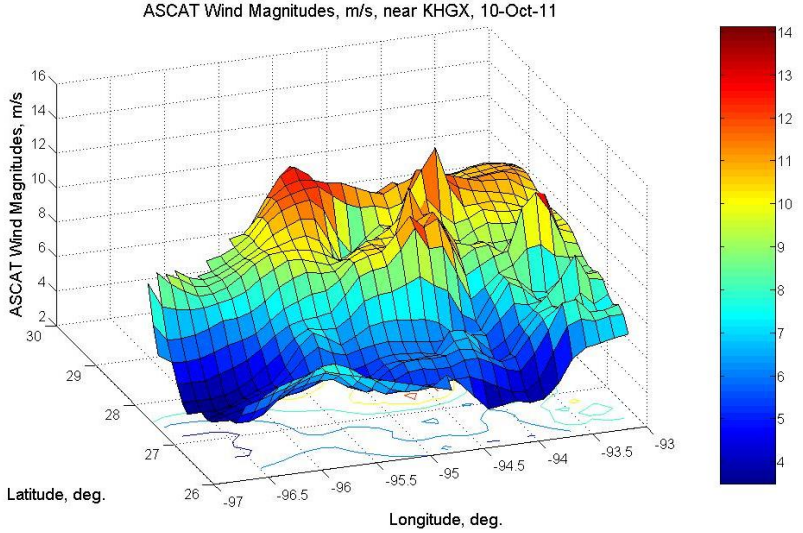

ASCAT Wind Vectors - 10-Oct-2011, t=03:04
Latitude (deg)
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
-97.5
-97
-96.5
-96
-95.5
-95
-94.5
-94
-93.5
-93

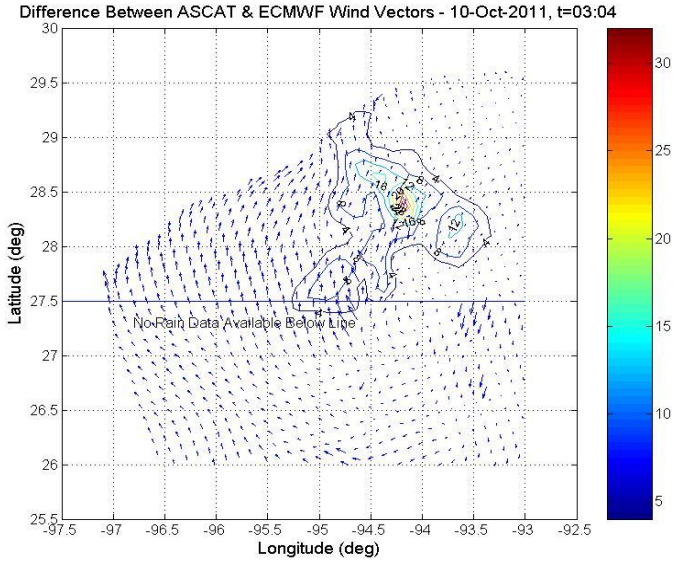

ECMWF Wind Vectors - 10-Oct-2011, t=03:04
Latitude (deg)
Longitude (deg)
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
-97.5
-97
-96.5
-96
-95.5
-95
-94.5
-94
-93.5
-93


Difference Between ASCAT & ECMWF Wind Vectors - 10-Oct-2011, t=03:04
Latitude (deg)
Longitude (deg)
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
-97.5
-97
-96.5
-96
-95.5
-95
-94.5
-94
-93.5
-93
-92.5

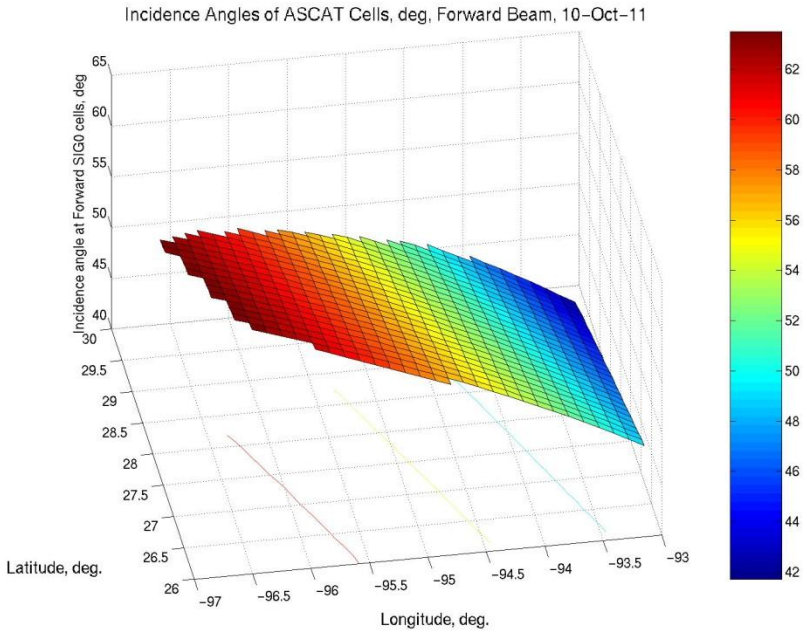

ECMWF Wind Magnitudes, m/s, ASCAT 10-Oct-11
ECMWF Wind Magnitudes, m/s, at ASCAT Cells
Latitude, deg.
Longitude, deg.
11
10
9
8
7
6
5
30
29.5
29
28.5
28
27.5
27
26.5
26
-97
-96
-95
-94
-93
10
9.5
9
8.5
8
7.5
7
6.5
6

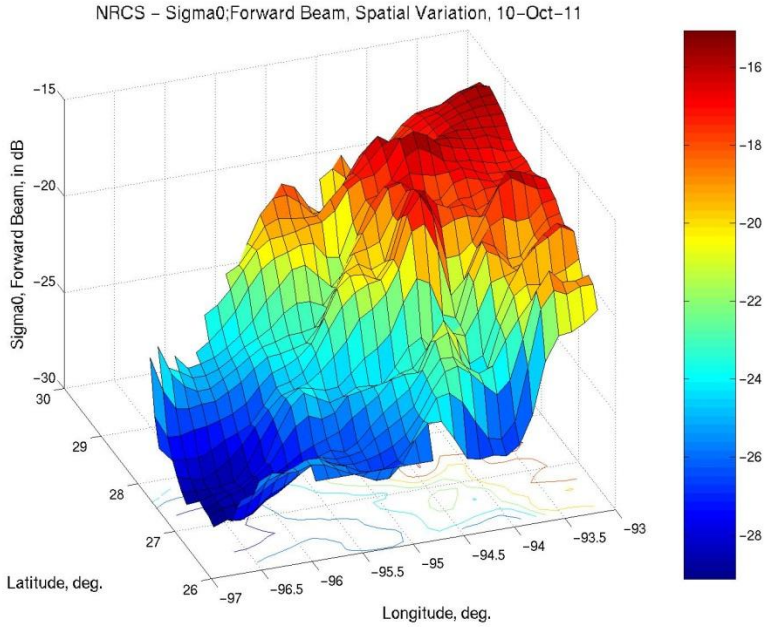


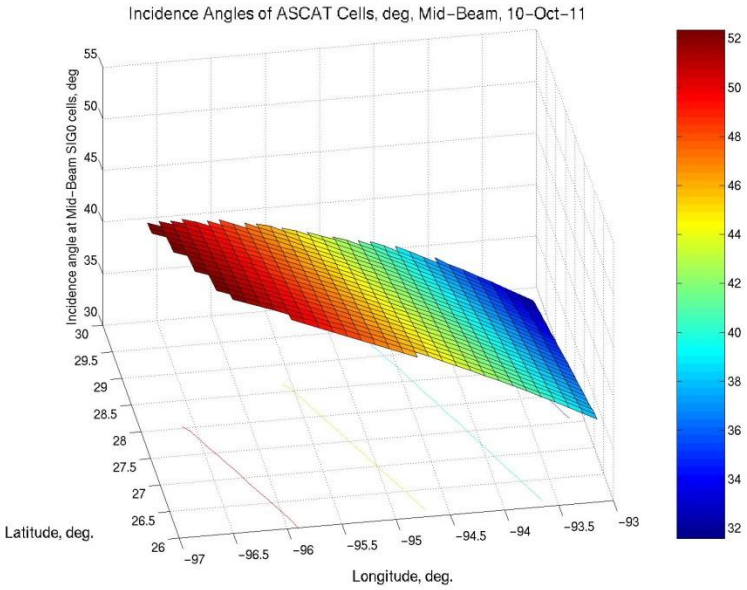


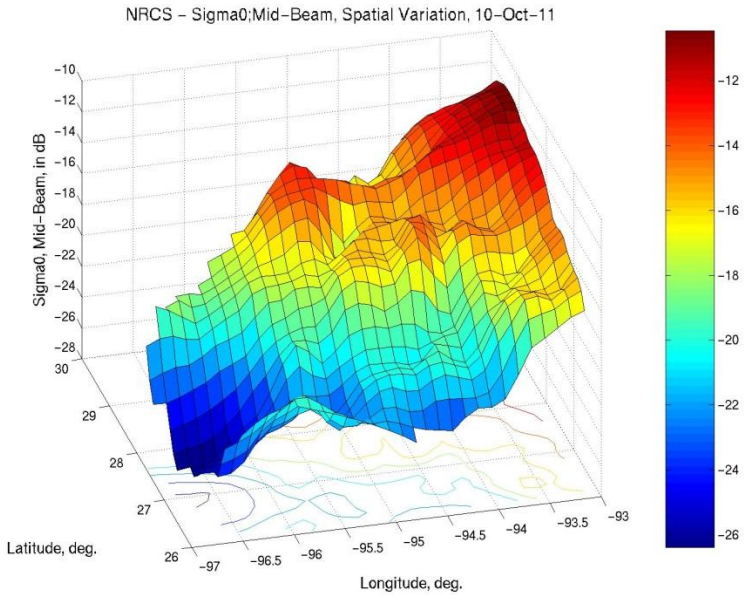


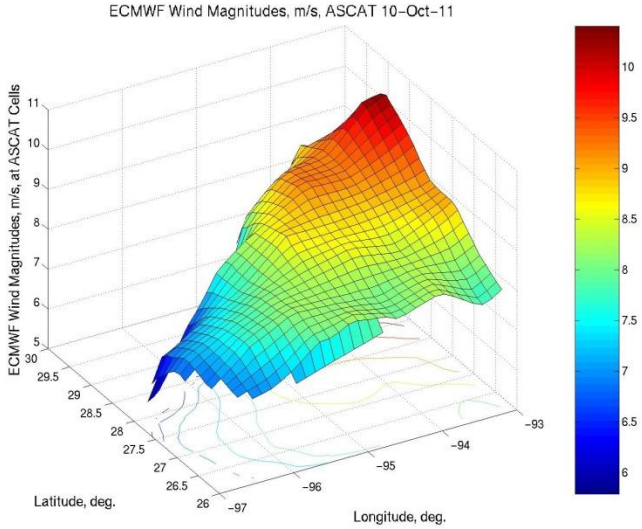
This suggests that the weather patterns that are associated rain events have irregular structures that extend well outside the rain affected areas

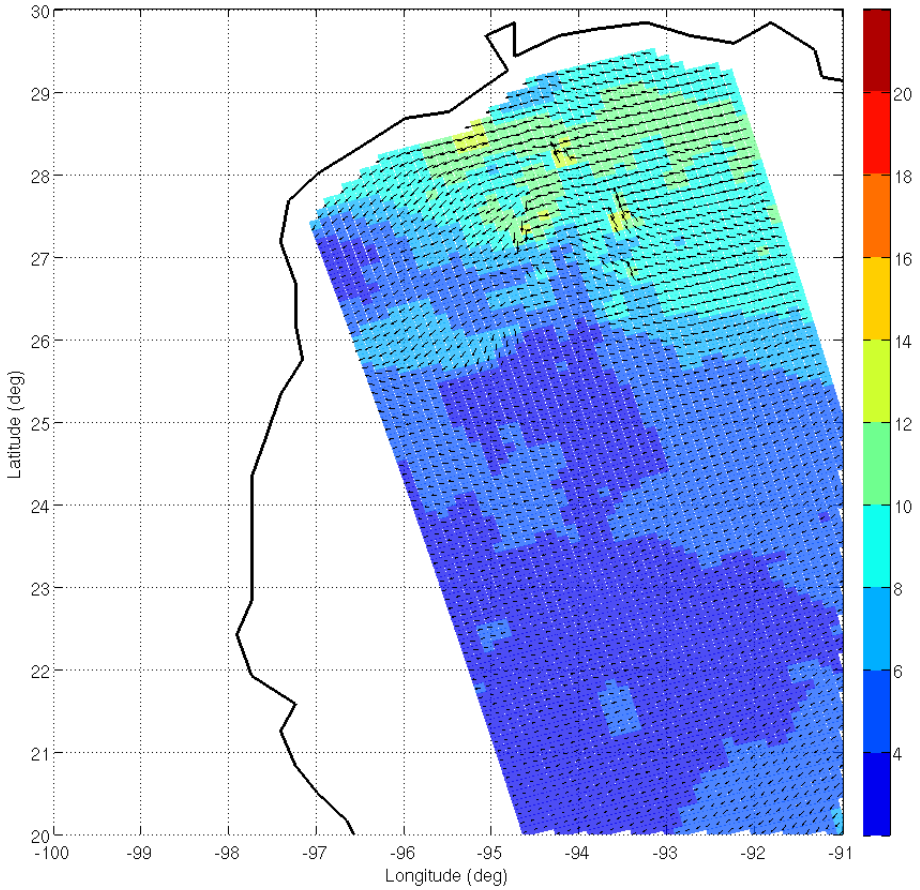

Incidence Angles of ASCAT Cells, deg, Forward Beam, 10-Oct-11
Incidence angle at Forward SIG0 cells, deg
65
60
55
50
45
40
30
29.5
29
28.5
28
27.5
27
26.5
26
Latitude, deg.
-97
-96.5
-96
-95.5
-95
-94.5
-94
-93.5
-93
Longitude, deg.
62
60
58
56
54
52
50
48
46
44
42

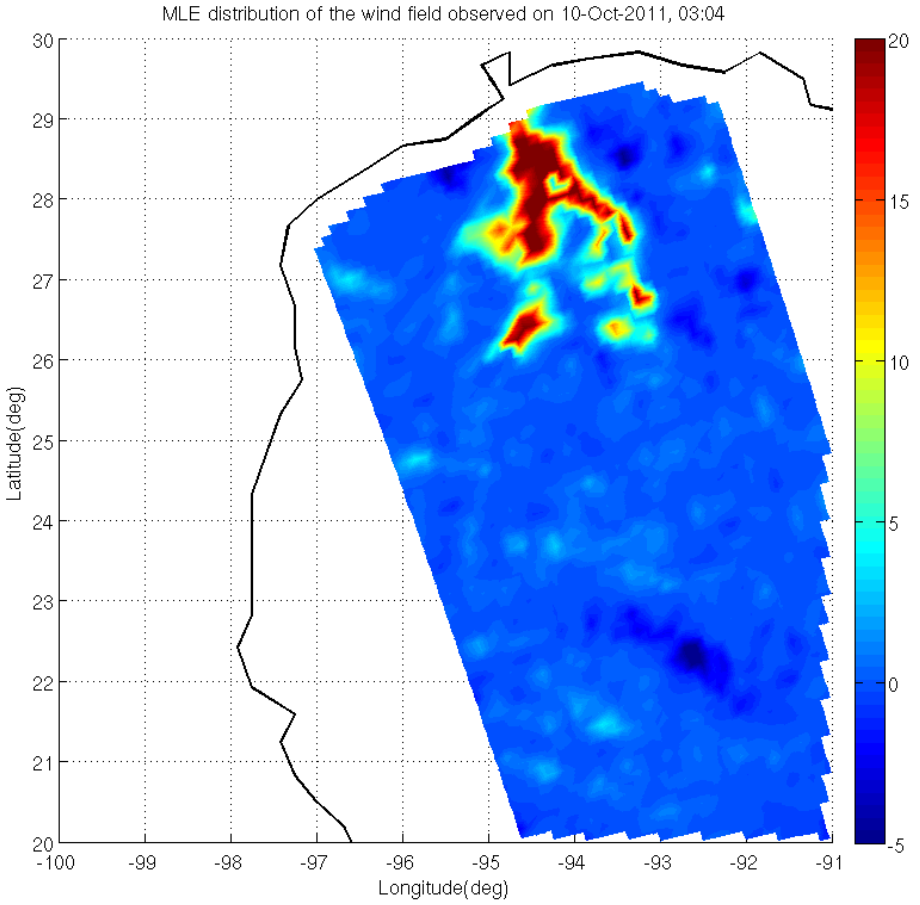

NRCS - Sigma0;Forward Beam, Spatial Variation, 10-Oct-11
Sigma0, Forward Beam, in dB
-15
-20
-25
-30
30
29
28
27
26
Latitude, deg.
-97
-96.5
-96
-95.5
-95
-94.5
-94
-93.5
-93
Longitude, deg.
-16
-18
-20
-22
-24
-26
-28


Incidence Angles of ASCAT Cells, deg, Mid-Beam, 10-Oct-11
Incidence angle at Mid-Beam SIG0 cells, deg
Latitude, deg.
Longitude, deg.

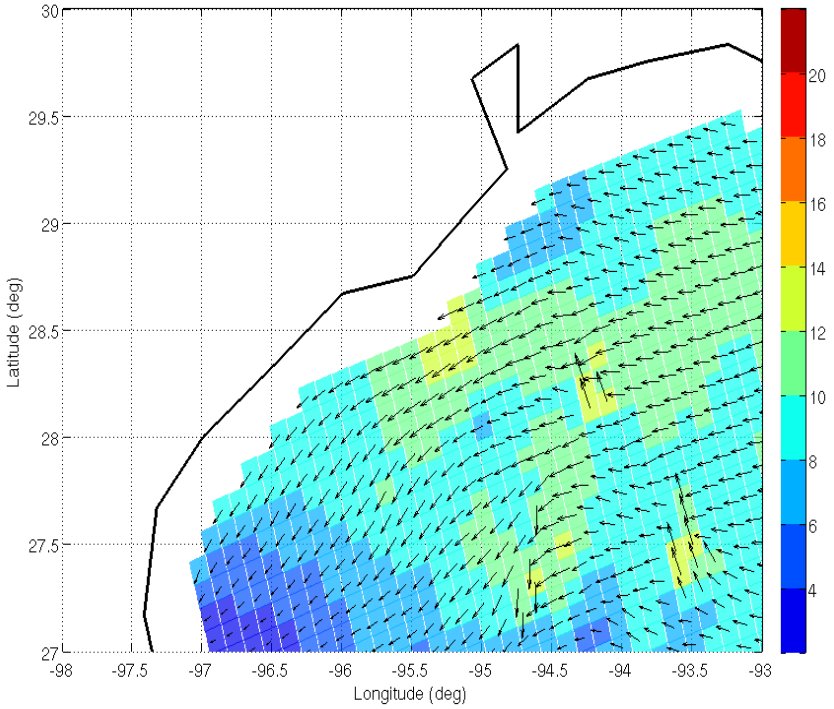

NRCS - Sigma0;Mid-Beam, Spatial Variation, 10-Oct-11
Sigma0, Mid-Beam, in dB
Latitude, deg.
Longitude, deg.

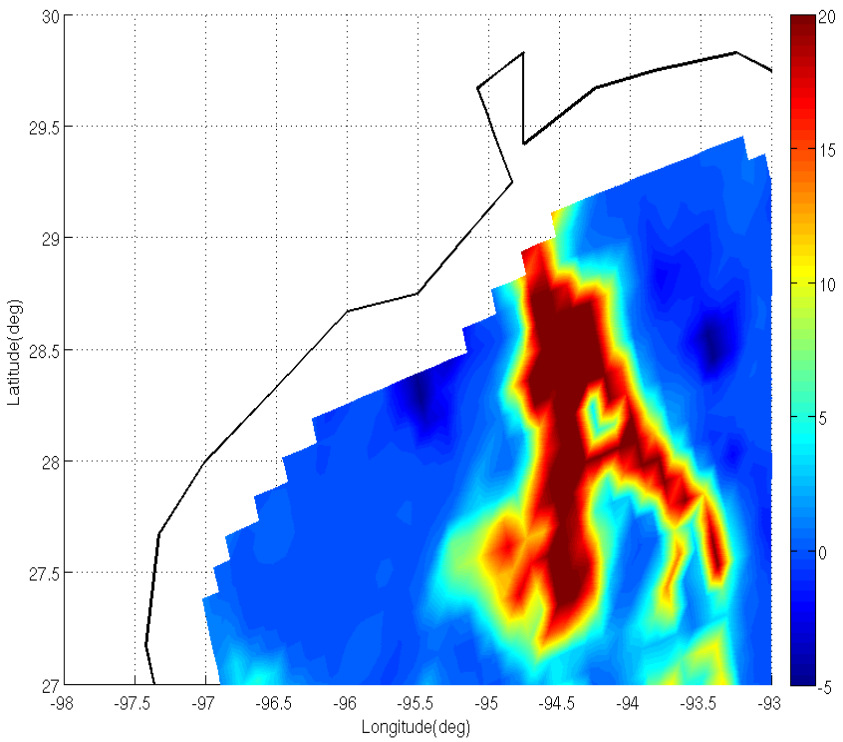

ECMWF Wind Magnitudes, m/s, ASCAT 10-Oct-11
ECMWF Wind Magnitudes, m/s, at ASCAT Cells
Latitude, deg.
Longitude, deg.





(Left-panel) An ASCAT wind field field observed on Oct. 10 2011, UTC 03:04. It shows that rain increases the retrieved wind speed and wind variability. (Right-panel) The MLE distribution of the wind field. High MLE means low anisotropy and low wind retireval quality.

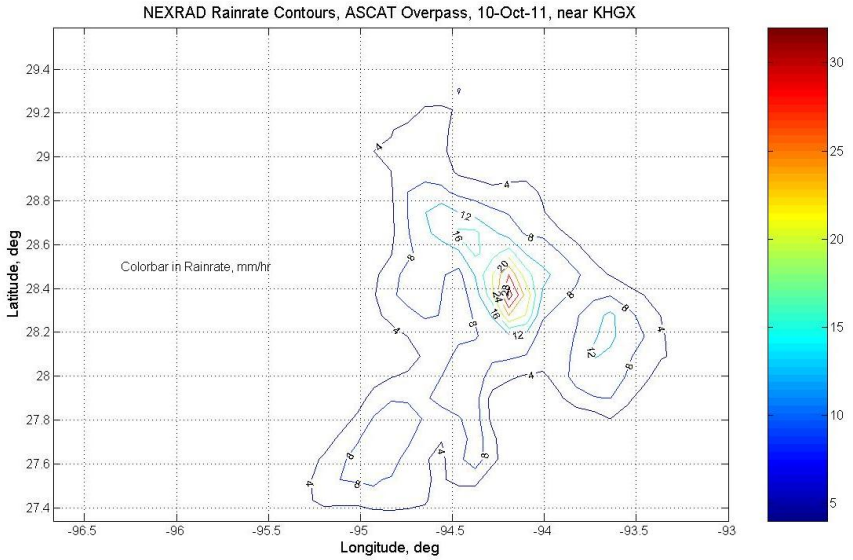


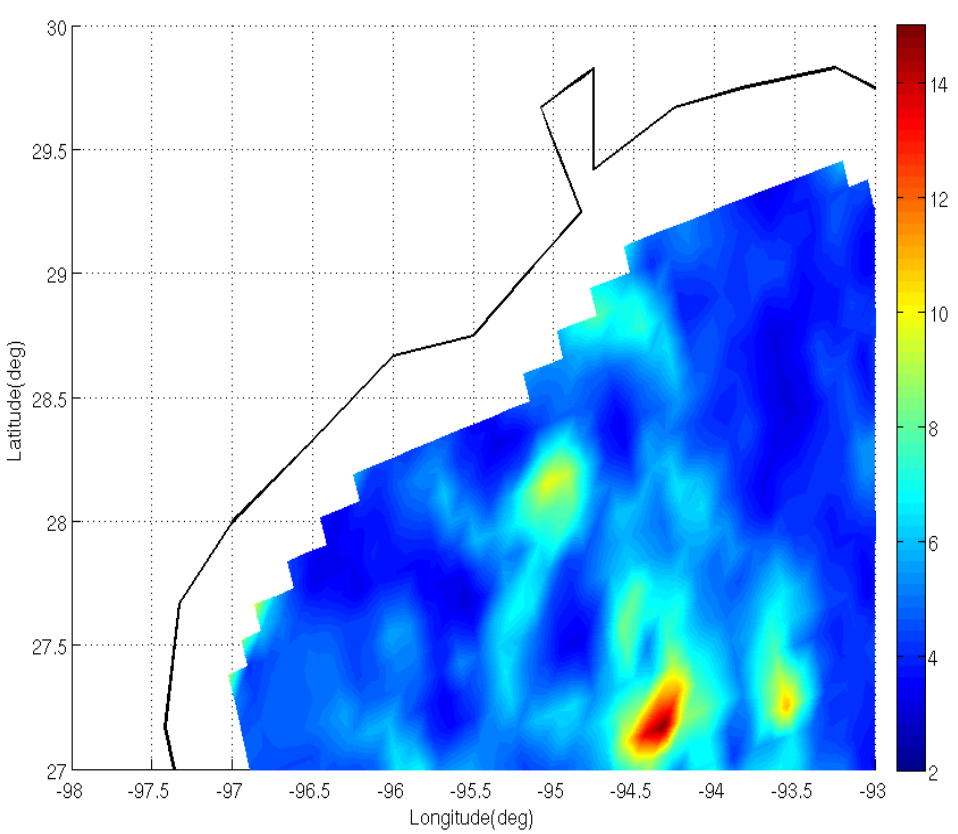


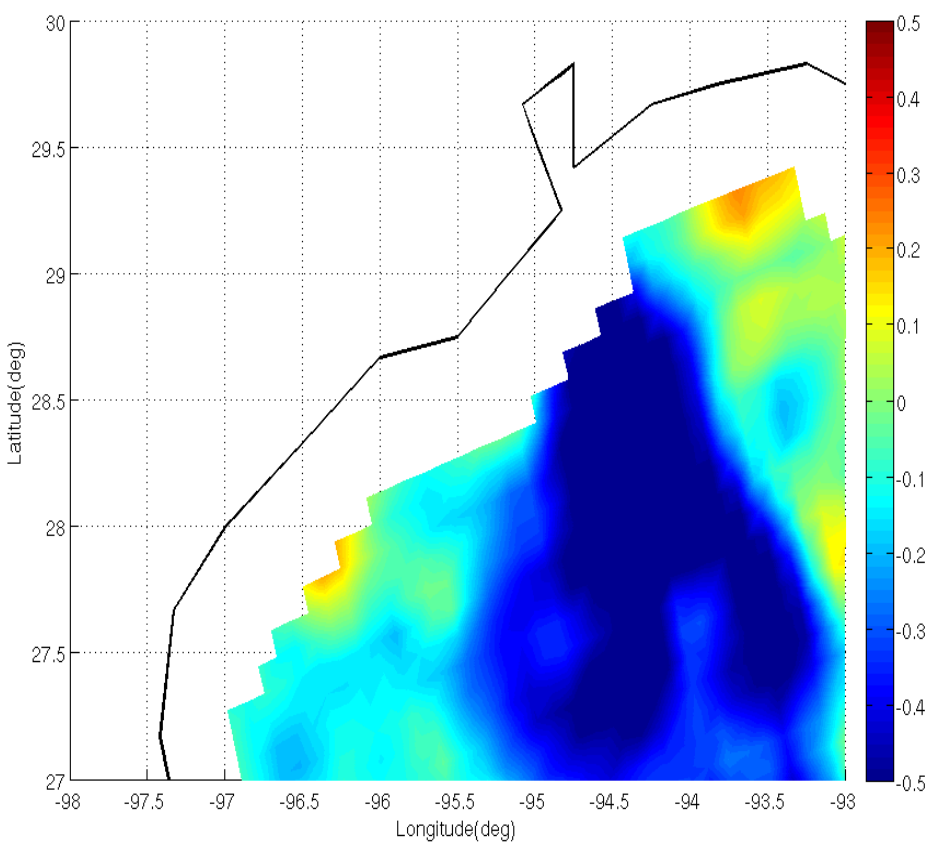
Upper Left: Wind field distribution, colorbar in m/s

Upper Right: MLE distribution of the wind field, large values means lower anisotropy and retrieval quality

Lower right: Rainrate Contours, mm/hr



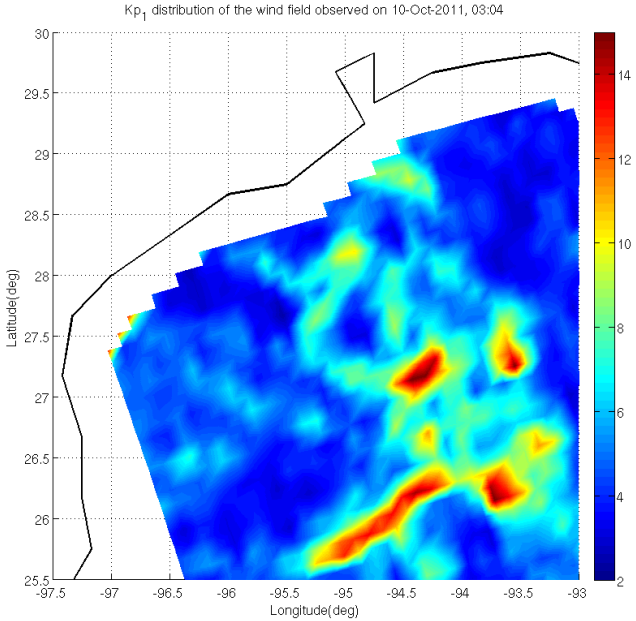




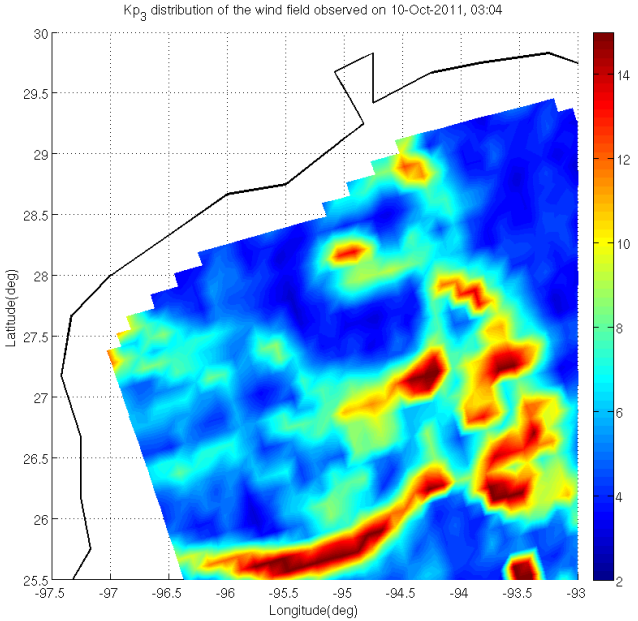
(Left-panel) The mean Kp value of fore- and aft-beams,

(Right-panel) The singularity exponent of the wind field.

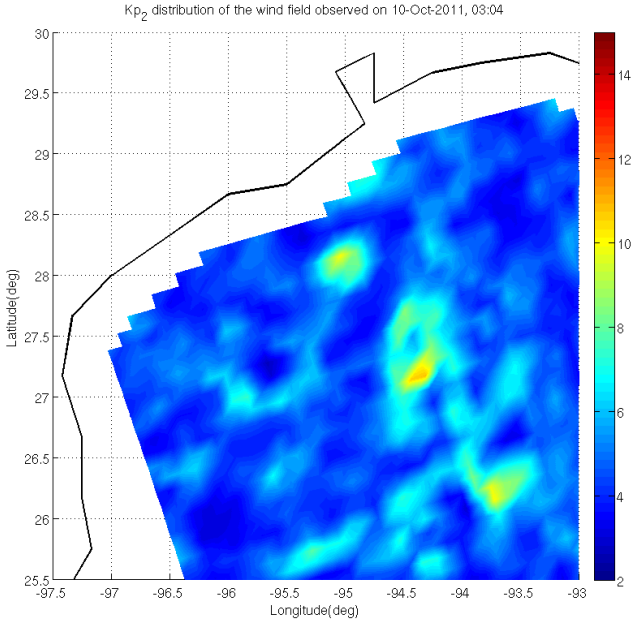
Both correspond well to the rainy areas.



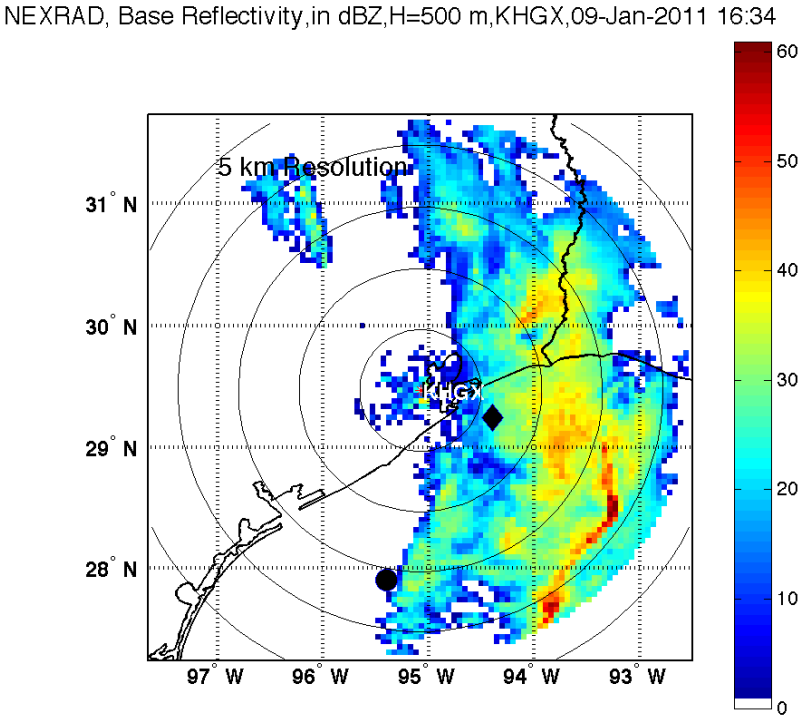
Kp (fore beam)

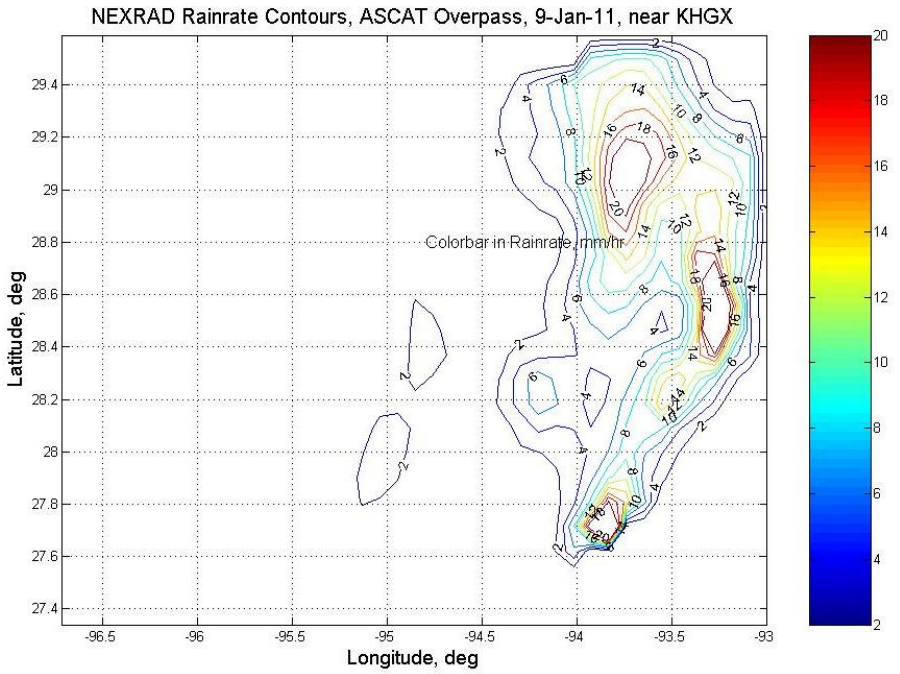


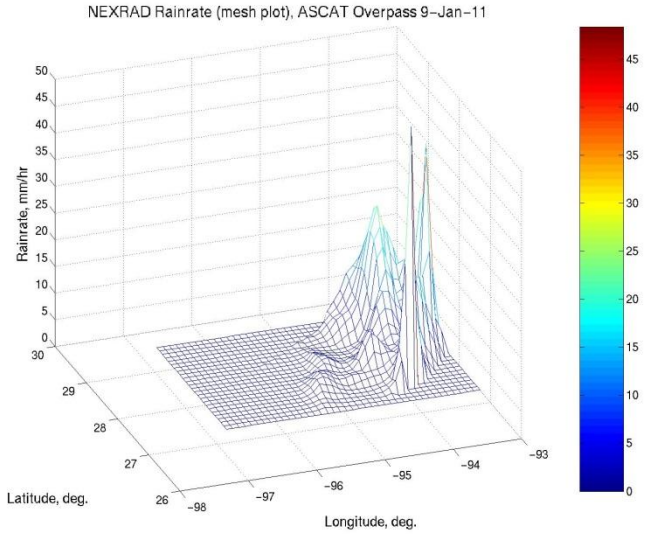
Kp (aft beam)



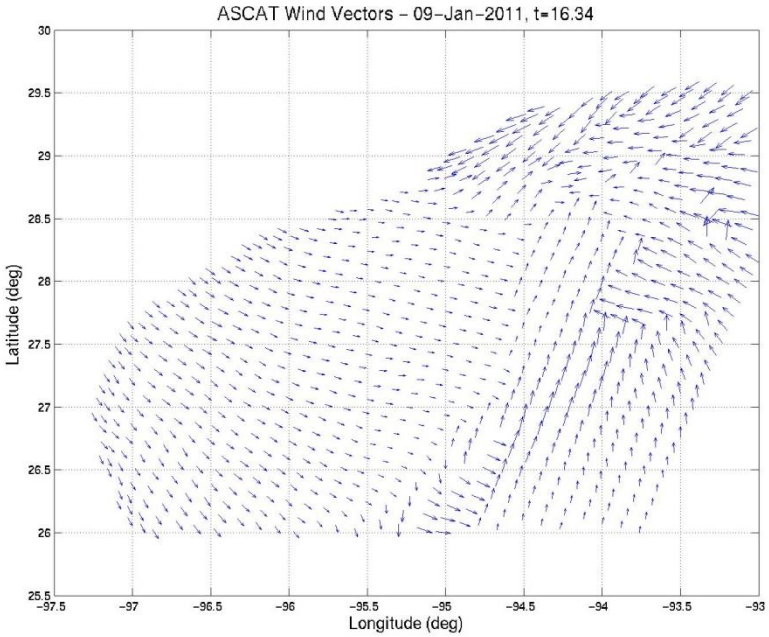
Kp (mid beam)

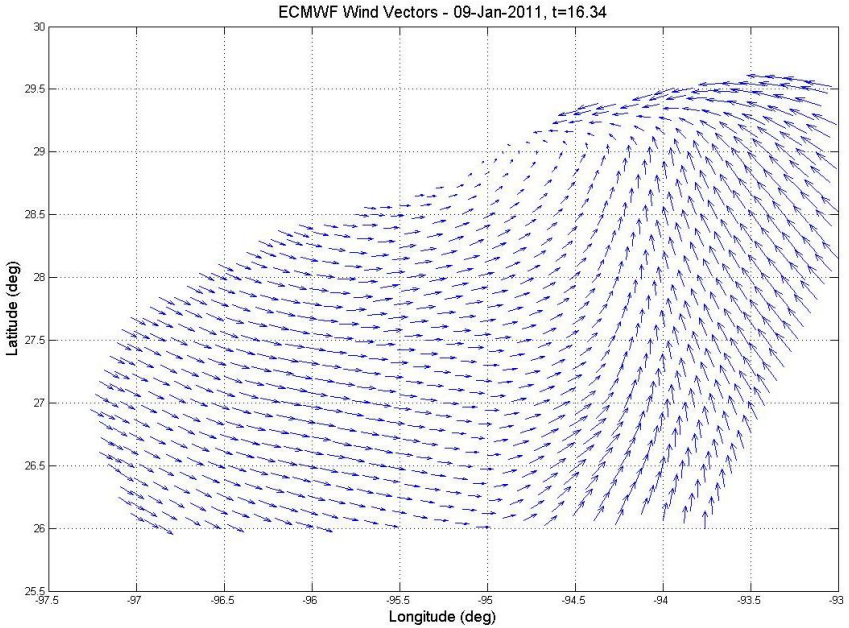


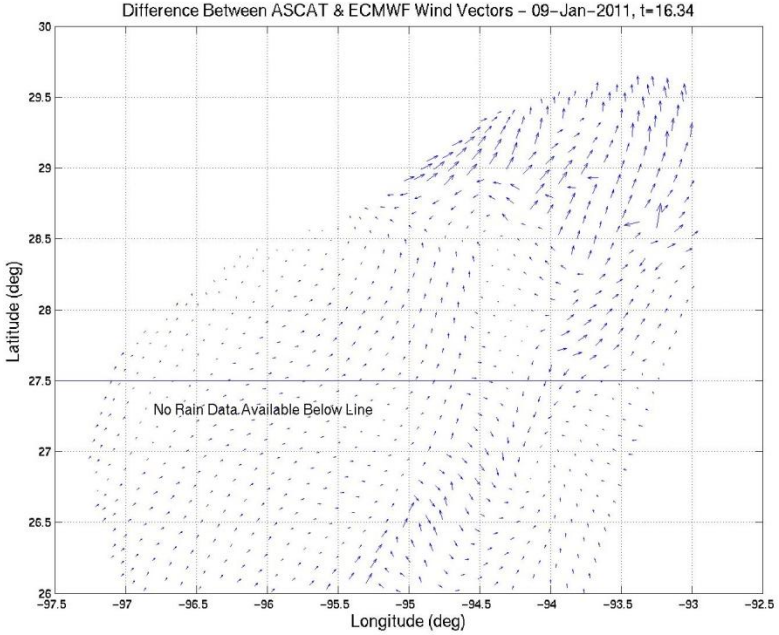


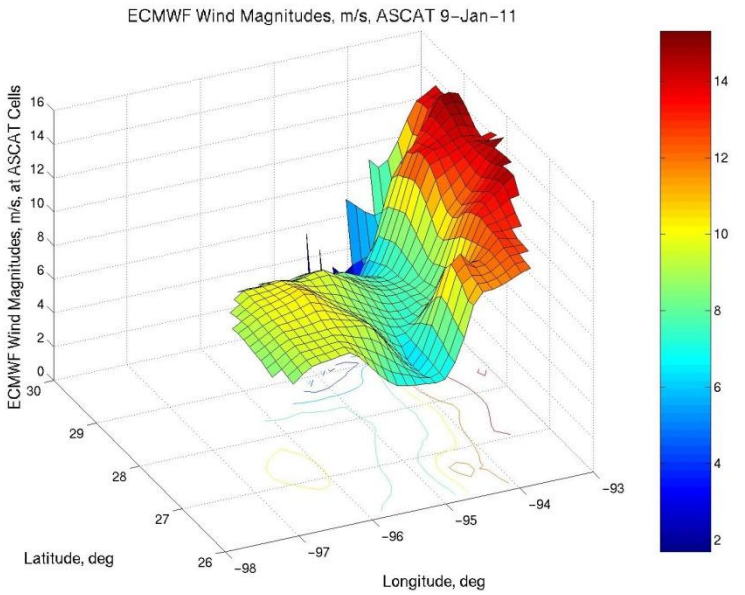


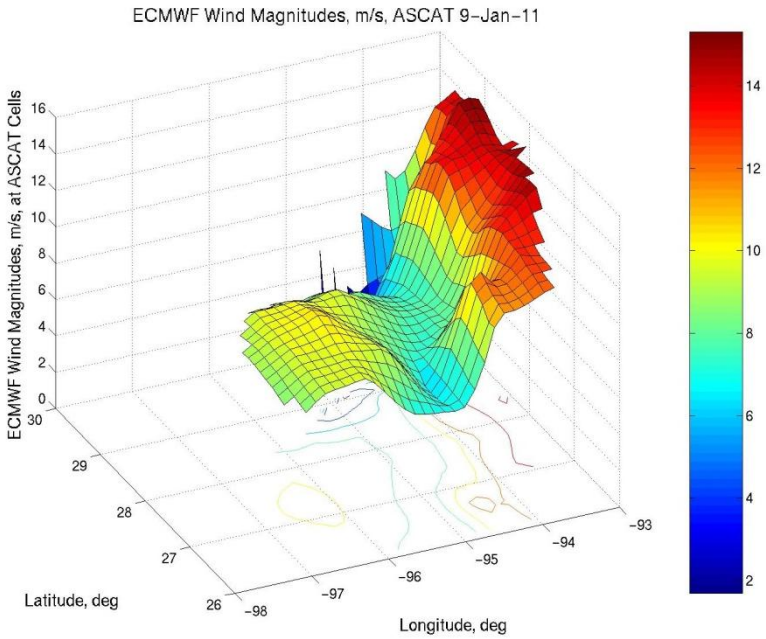
Contour diagram and surface plots show rainrates in mm/hr

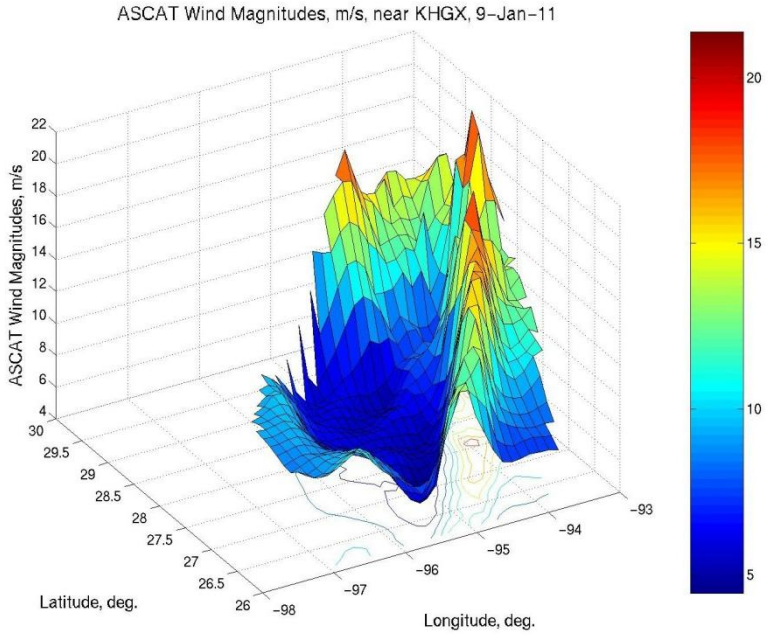

ASCAT Wind Vectors – 09–Jan–2011, t=16.34
Latitude (deg)
Longitude (deg)

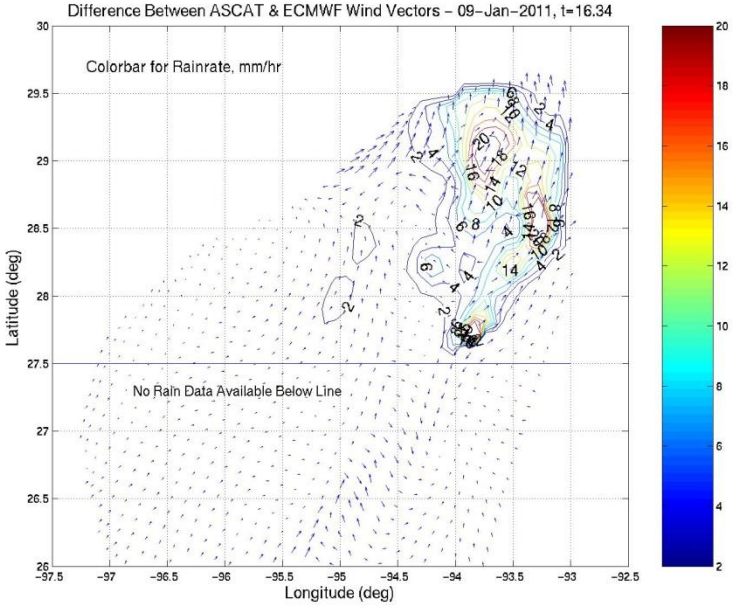

ECMWF Wind Vectors - 09-Jan-2011, t=16.34
Latitude (deg)
Longitude (deg)

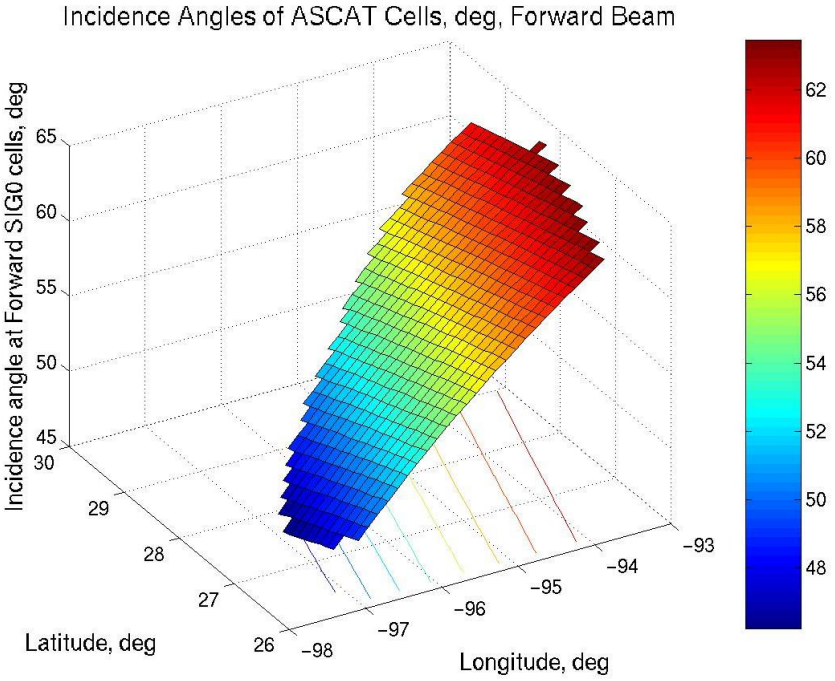

Difference Between ASCAT & ECMWF Wind Vectors – 09–Jan–2011, t=16.34
No Rain Data Available Below Line
Latitude (deg)
Longitude (deg)

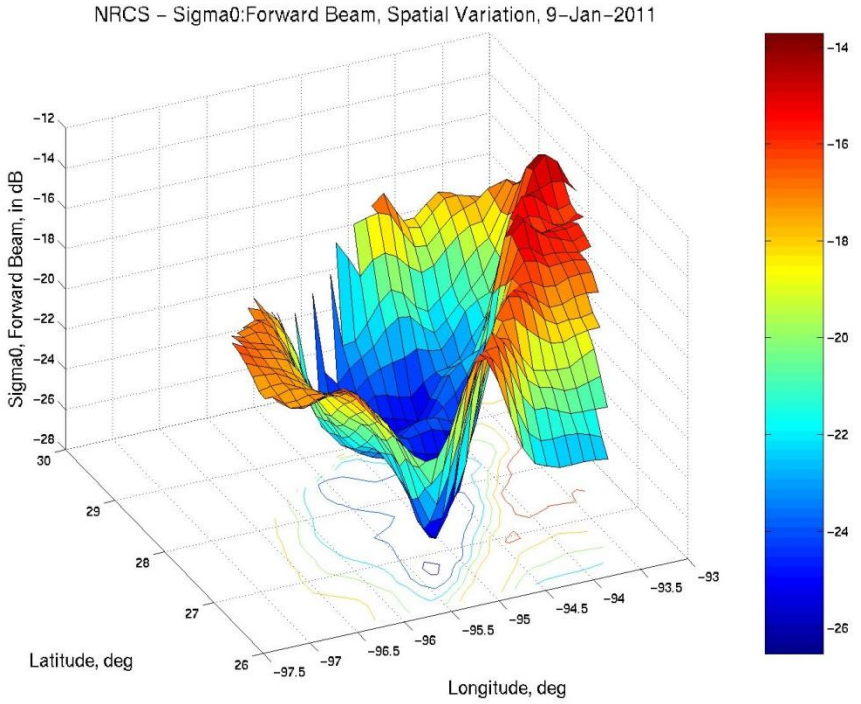

ECMWF Wind Magnitudes, m/s, ASCAT 9–Jan–11
ECMWF Wind Magnitudes, m/s, at ASCAT Cells
Latitude, deg
Longitude, deg

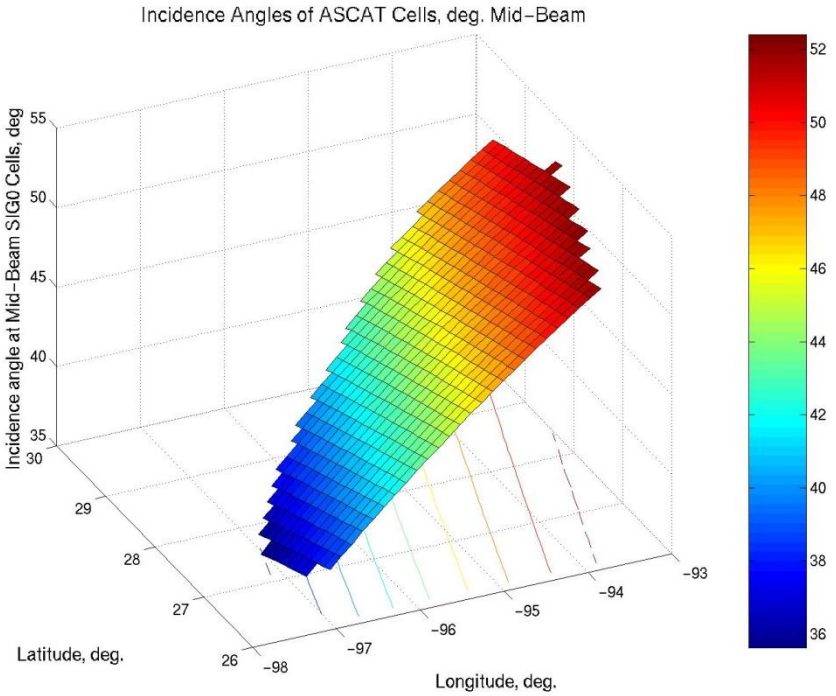

ECMWF Wind Magnitudes, m/s, ASCAT 9-Jan-11
ECMWF Wind Magnitudes, m/s, at ASCAT Cells
Latitude, deg
Longitude, deg

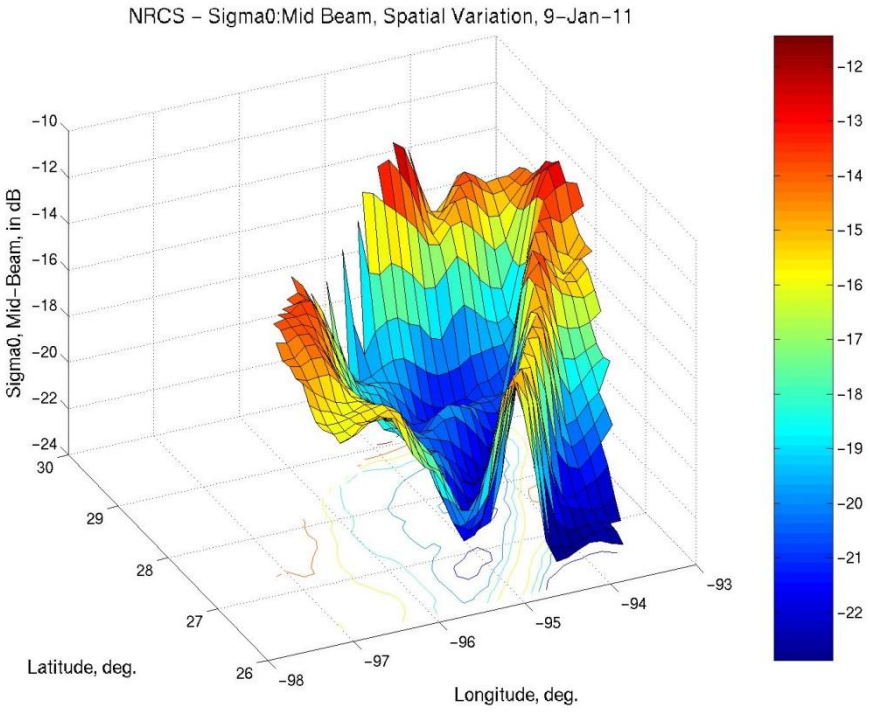

ASCAT Wind Magnitudes, m/s, near KHGX, 9-Jan-11
ASCAT Wind Magnitudes, m/s
Latitude, deg.
Longitude, deg.

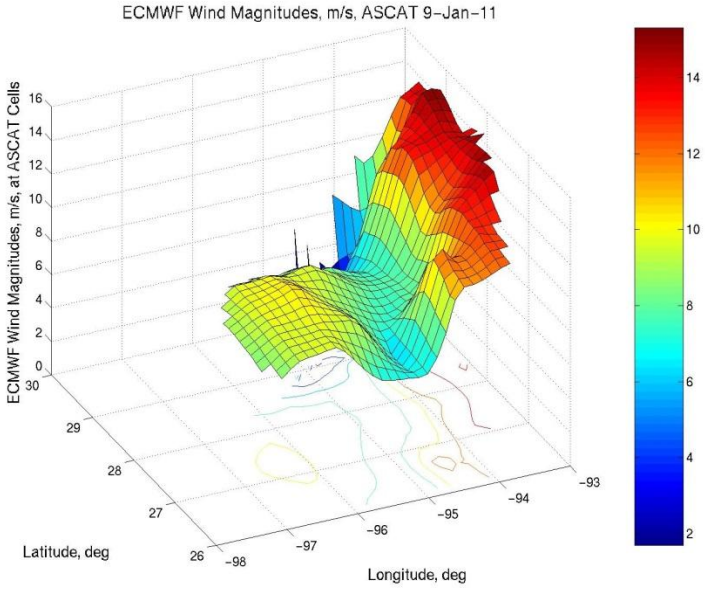

Difference Between ASCAT & ECMWF Wind Vectors - 09-Jan-2011, t=16.34
Colorbar for Rainrate, mm/hr
No Rain Data Available Below Line
Latitude (deg)
Longitude (deg)

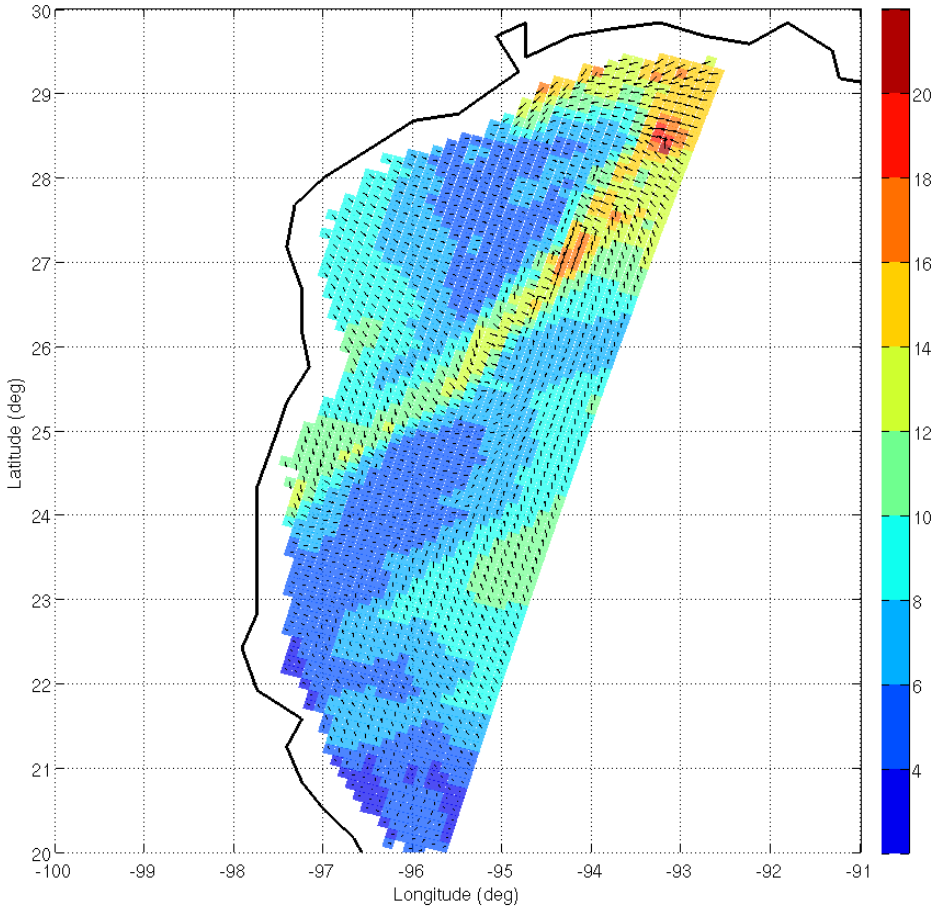

Incidence Angles of ASCAT Cells, deg, Forward Beam
Incidence angle at Forward SIG0 cells, deg
65
60
55
50
45
30
29
28
27
26
Latitude, deg
−98
−97
−96
−95
−94
−93
Longitude, deg
62
60
58
56
54
52
50
48

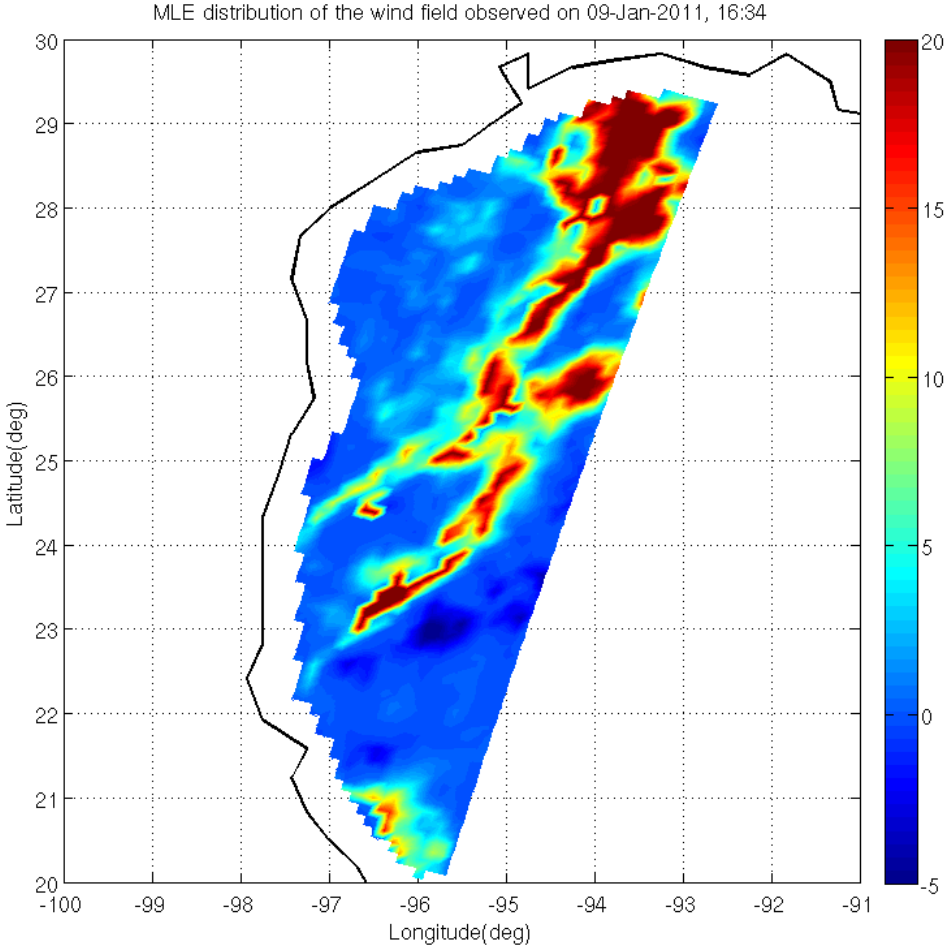

NRCS – Sigma0:Forward Beam, Spatial Variation, 9–Jan–2011
Sigma0, Forward Beam, in dB
−12
−14
−16
−18
−20
−22
−24
−26
−28
30
29
28
27
26
Latitude, deg
−97.5
−97
−96.5
−96
−95.5
−95
−94.5
−94
−93.5
−93
Longitude, deg
−14
−16
−18
−20
−22
−24
−26


Incidence Angles of ASCAT Cells, deg. Mid-Beam
Incidence angle at Mid-Beam SIG0 Cells, deg
55
50
45
40
35
30
29
28
27
26
Latitude, deg.
-98
-97
-96
-95
-94
-93
Longitude, deg.
52
50
48
46
44
42
40
38
36


NRCS - Sigma0:Mid Beam, Spatial Variation, 9-Jan-11
Sigma0, Mid-Beam, in dB
-10
-12
-14
-16
-18
-20
-22
-24
30
29
28
27
26
Latitude, deg.
-98
-97
-96
-95
-94
-93
Longitude, deg.
-12
-13
-14
-15
-16
-17
-18
-19
-20
-21
-22

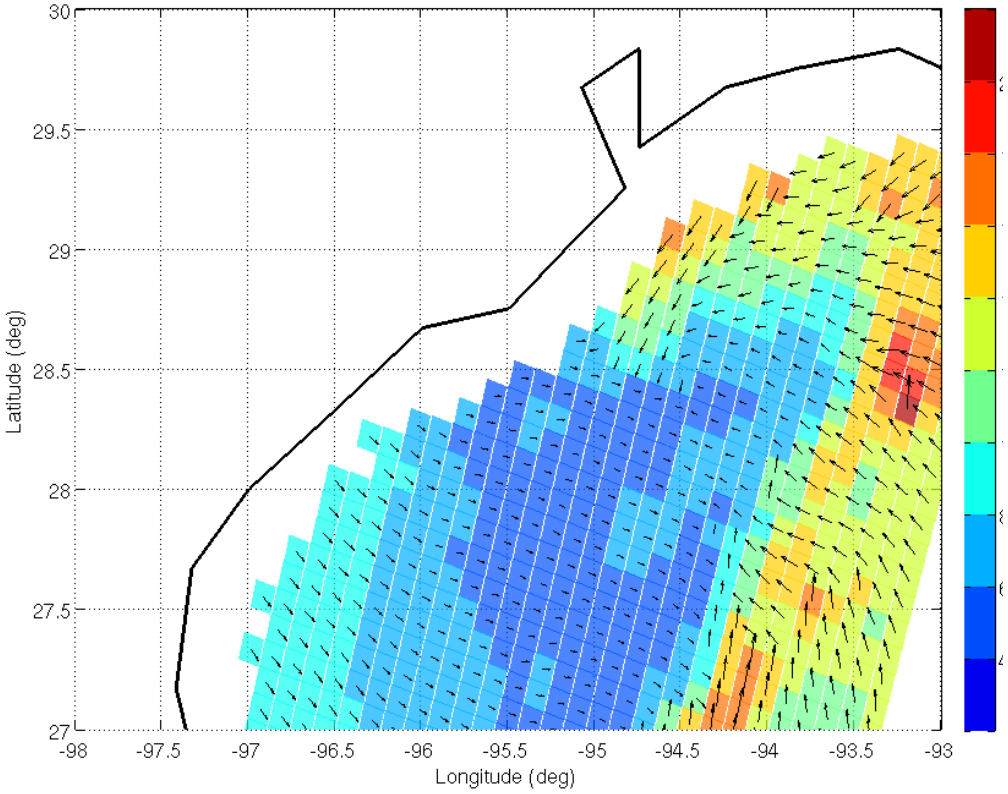

ECMWF Wind Magnitudes, m/s, ASCAT 9-Jan-11
ECMWF Wind Magnitudes, m/s, at ASCAT Cells
16
14
12
10
8
6
4
2
0
30
29
28
27
26
Latitude, deg
-98
-97
-96
-95
-94
-93
Longitude, deg
14
12
10
8
6
4
2

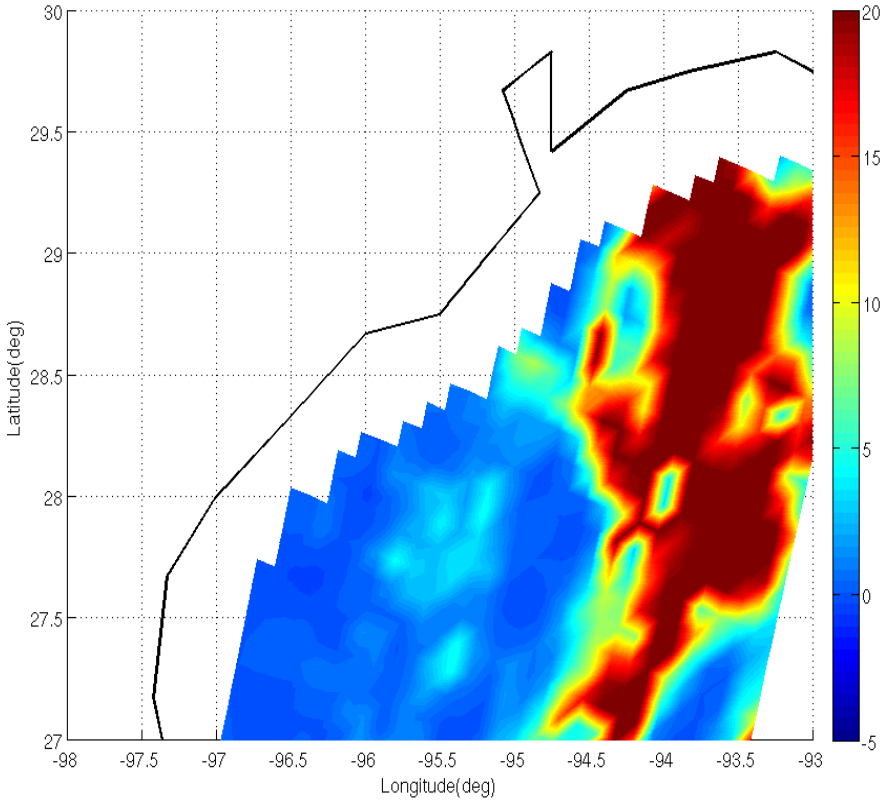




(Left-panel) ASCAT wind field field observed on Jan. 09 2011, UTC 16:34.

(Right-panel) The MLE distribution of the wind field. High MLE means low anisotropy and low wind retireval quality.





ZOOM-IN

(Left-panel) ASCAT wind field field observed on Jan. 09 2011, UTC 16:34.

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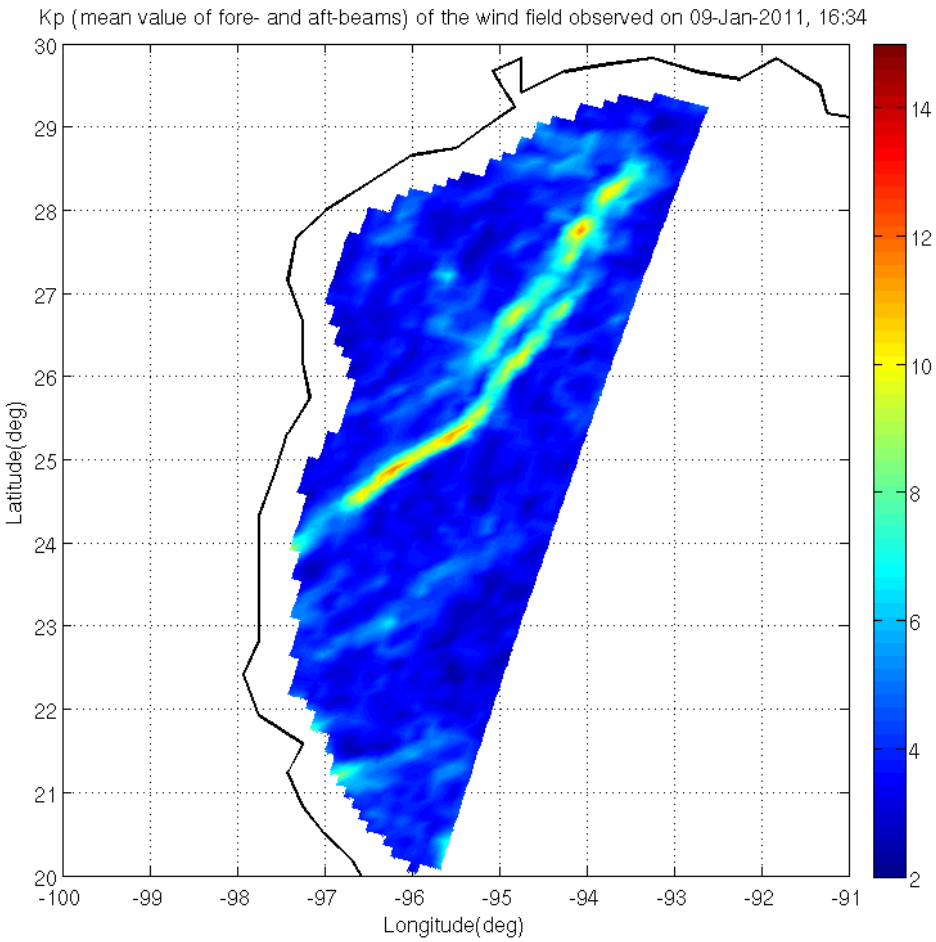
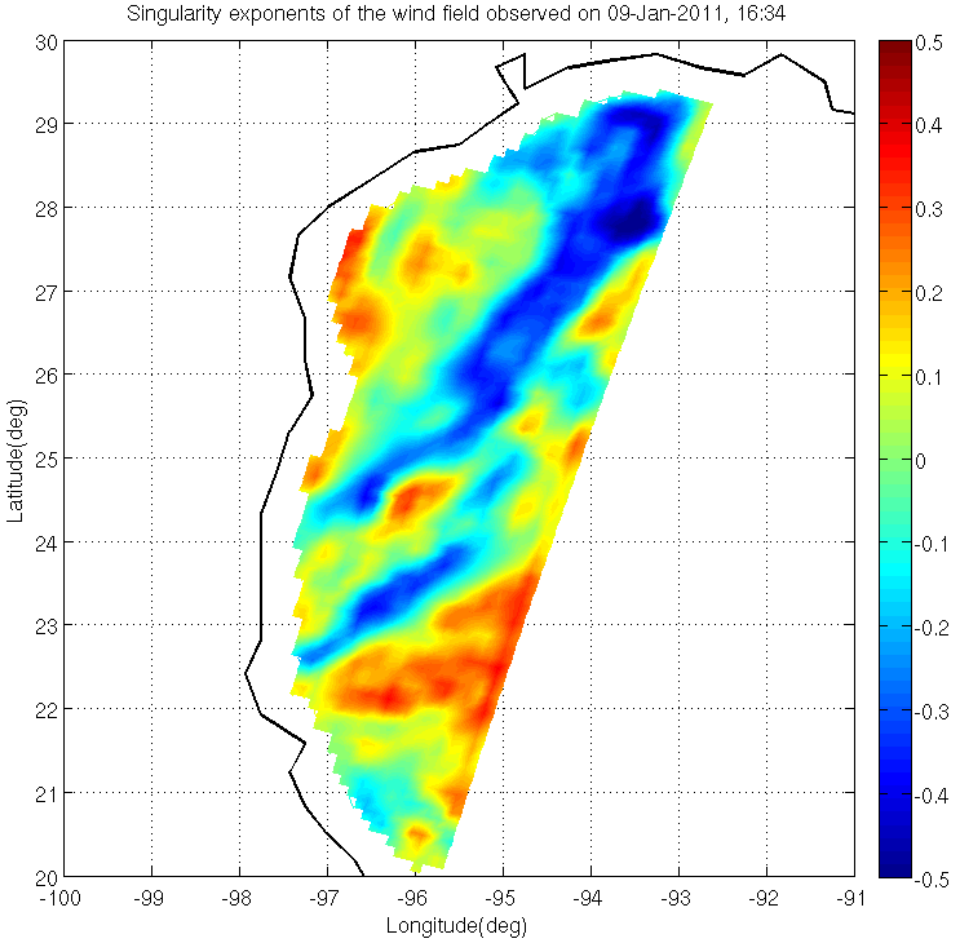
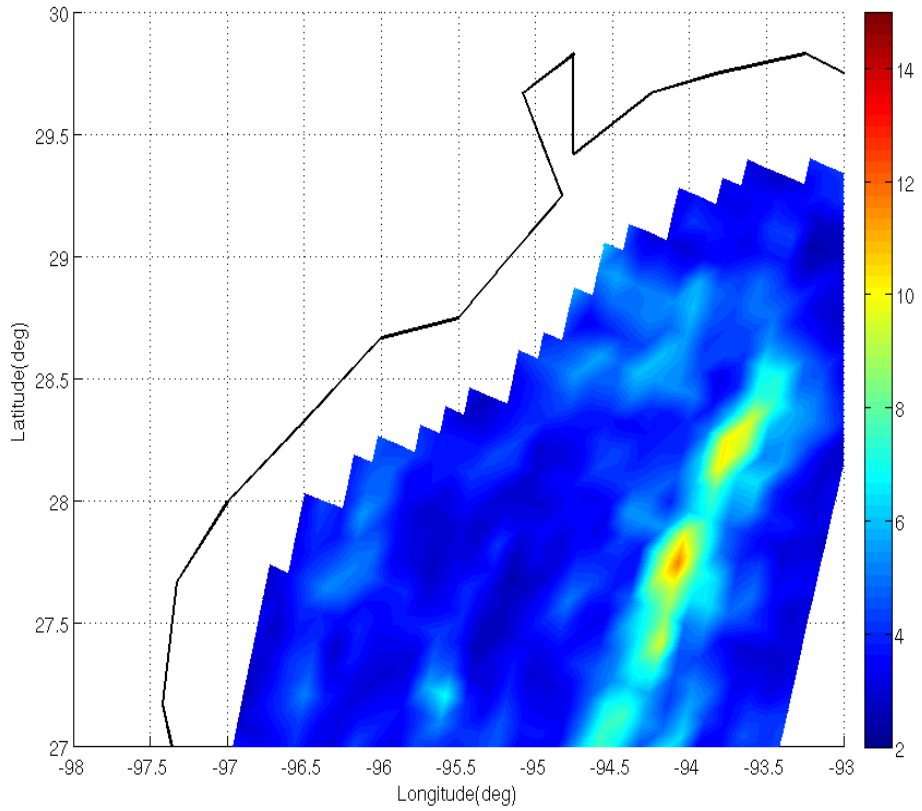
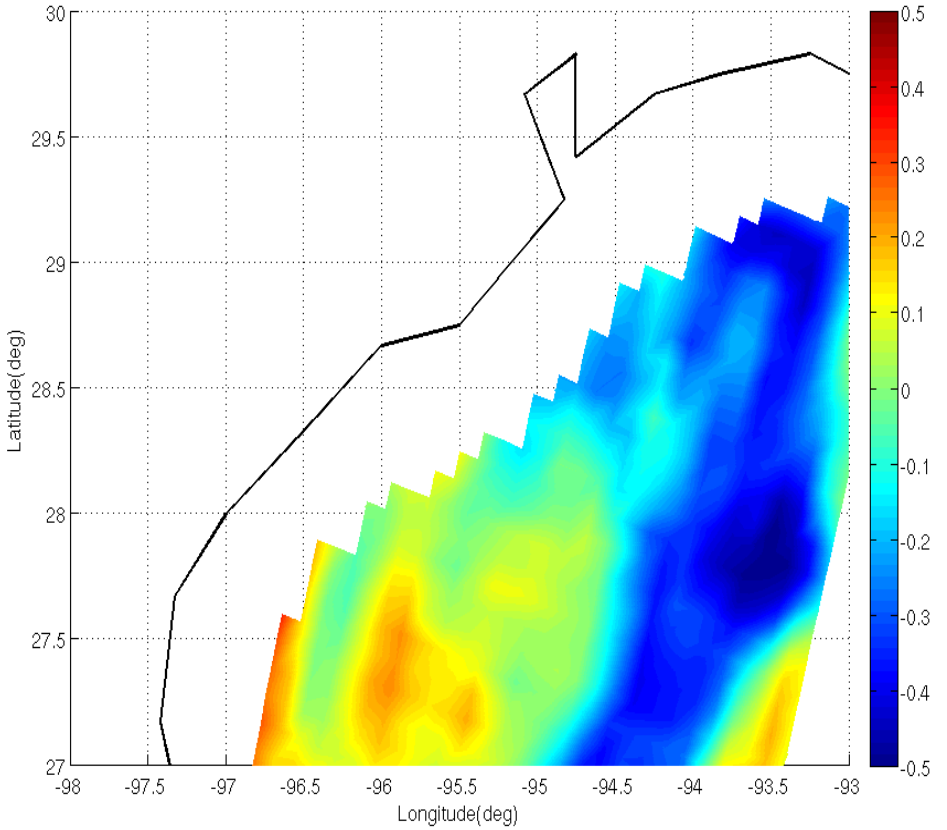




(Left-panel) The mean Kp value of fore- and aft-beams,

(Right-panel) The singularity exponent of the wind field.
Both correspond well to the rainy areas.





ZOOM-IN >>

(Left-panel) The mean kp value of fore- and aft-beams,

(Right-panel) The singularity exponent of the wind field.
Both correspond well to the rainy areas.

SUMMARY

We observe two important effects from these data analysis:

1. The direct quantitative effects on the NRCS in individual ASCAT cells and on the retrieved winds on the corresponding grid, as function of rainrate and wind magnitude for the different conditions

2. The larger scale wind variability outside the immediate areas where rain is striking the surface. One contributor can be the downdrafts from convective cells that cause outflow across the ocean accompanied by variable wind speeds and directions.

Reference: “Rain effects on ASCAT-Retrieved Winds; Toward an Improved Quality Control”, Portabella, M., et al, IEEE TGRS, July 2012, Vol. 50, No. 7, pp 2495-2506

Summary (continued)

There are also indications that the ECMWF winds are not able to incorporate rain events and their air-sea interaction properties.