Combined polarimetric Doppler radar and satellite scatterometer observations of organized convection near coastal regions

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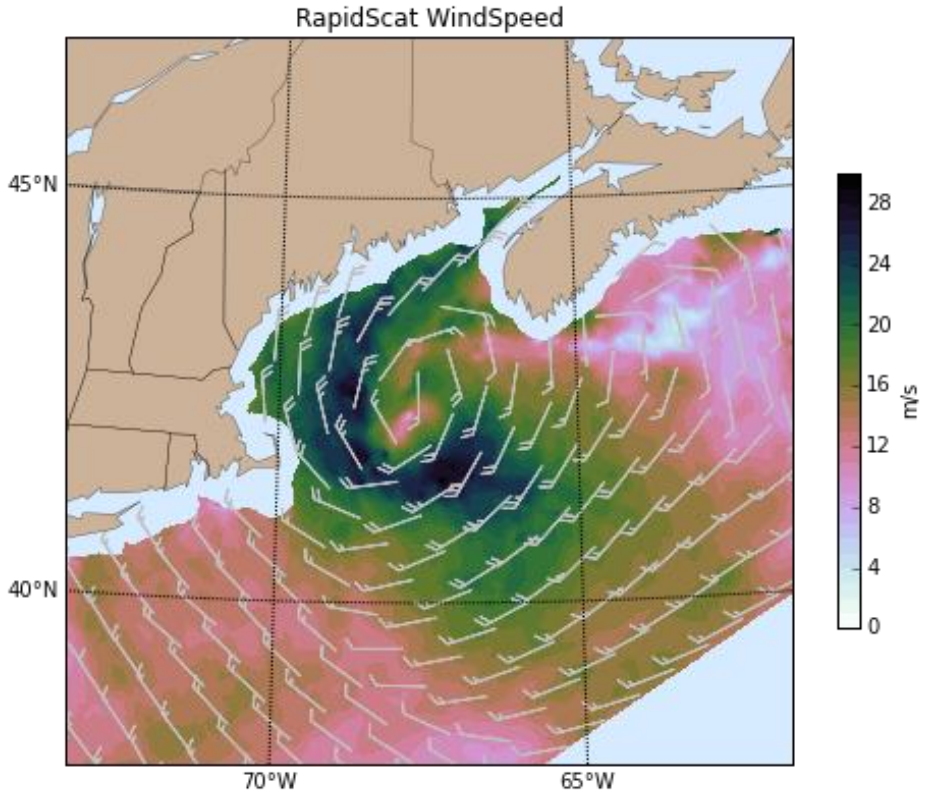
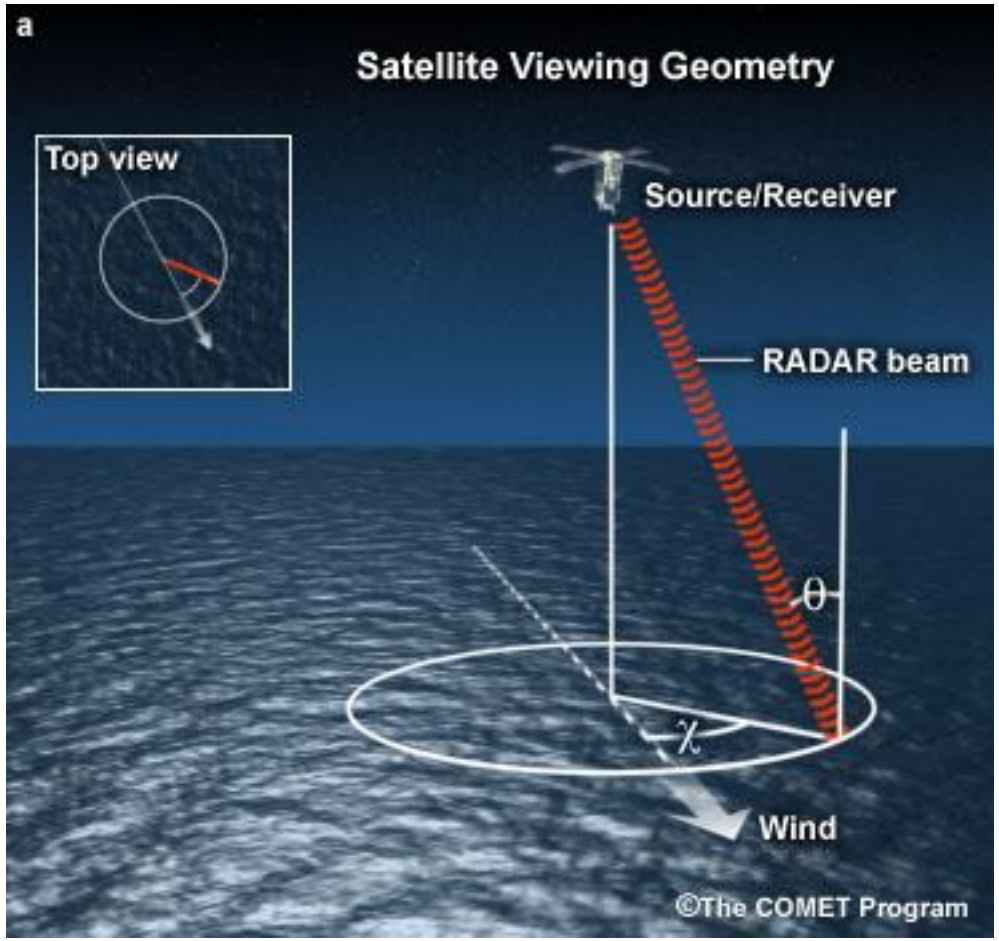


Background

- Scatterometers are radars on satellites that scan the ocean surface at multiple look angles
- Retrieve wind speed and direction via empirical relationships (geophysical model functions) linked to ocean surface state (mean square slope)
- Typically Ku- (e.g., QuikSCAT, RapidScat) or C-band (e.g., ASCAT) - subject to attenuation by rainfall, or spoofing by raindrop-induced surface capillary waves

Our Scientific Questions

- Given limitations of scatterometers in raining areas, how can we best use them to understand near-surface winds in and near organized convective systems?
- What is the value added by combining scatterometry with polarimetric Doppler radars near coastlines/islands?
- Can we identify significant surface wind features (e.g., in/outflow, boundaries, jets, etc.) that may be responsible for organizing convective systems?

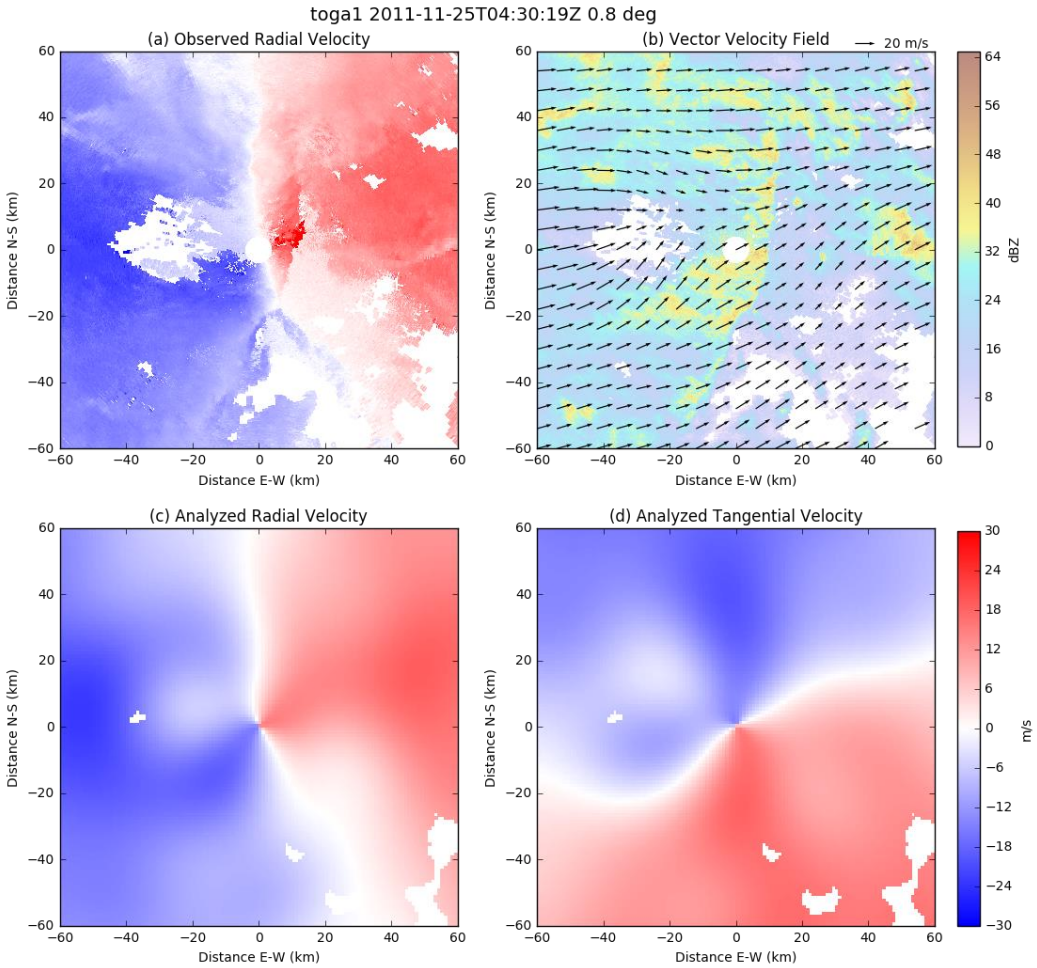


www.goes-r.gov (COMET module)

SingleDop

https://github.com/nasa/SingleDop

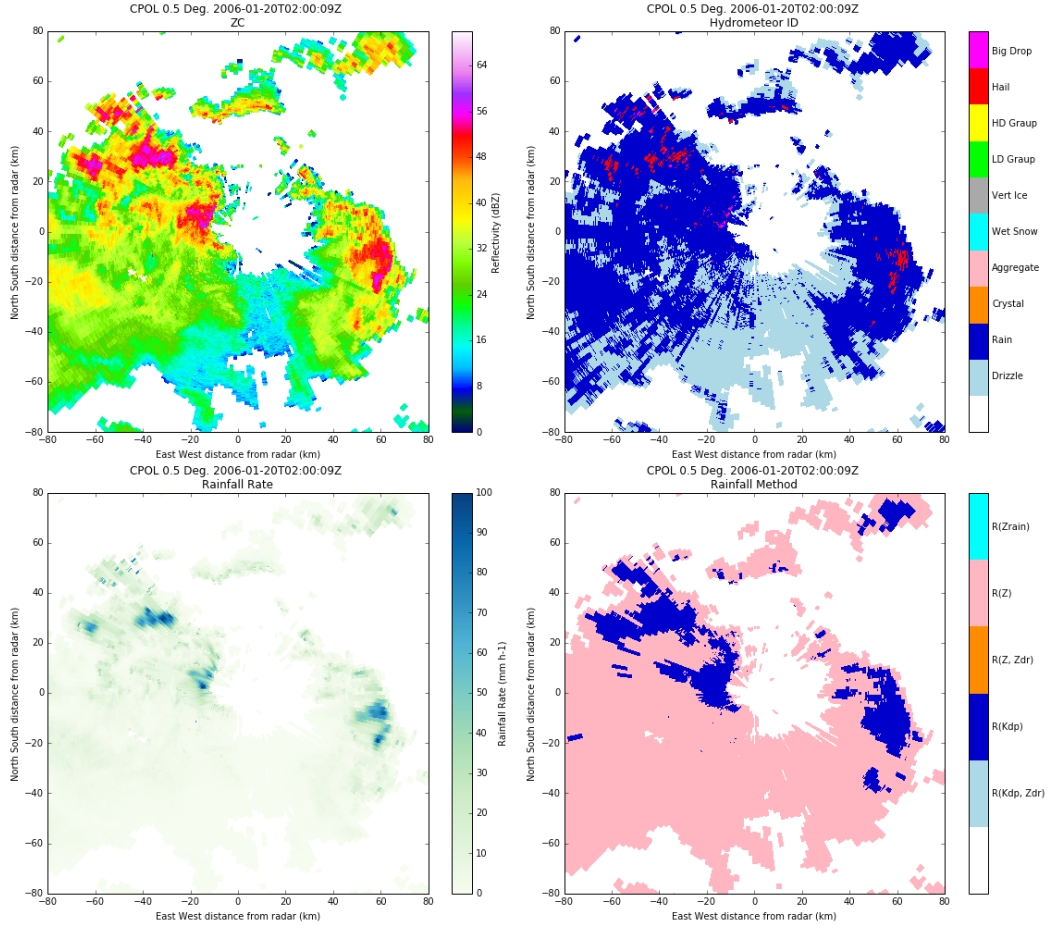
- Single-Doppler retrievals of low-level 2D winds on conical PPI sweep
- Based on Xu et al. (2006) 2DVAR algorithm



DualPol

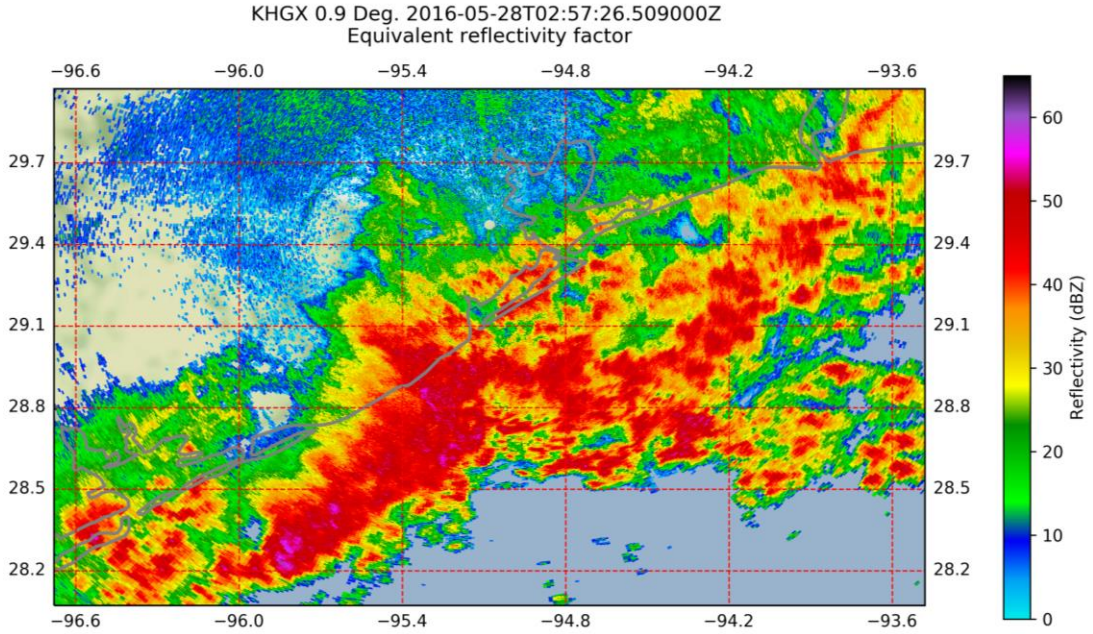
https://github.com/nasa/DualPol

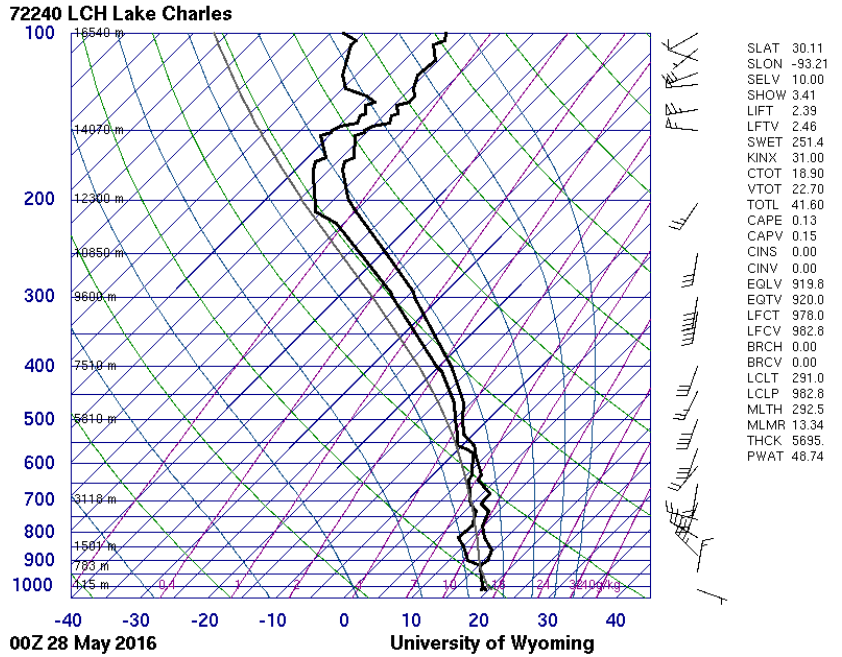
- Dual-pol retrievals from arbitrary radar, including rain, DSD, LWC/IWC, HID, etc.
- Based on CSU algorithm heritage (e.g., Bringi, Chandra, Carey, Cifelli, Dolan, Lang)

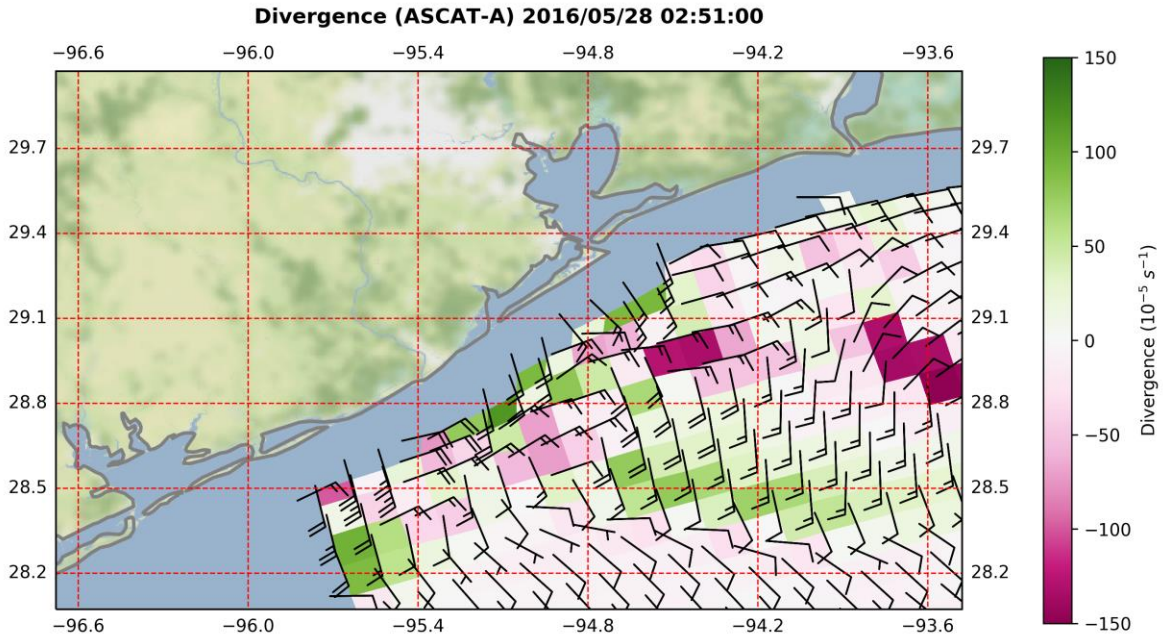


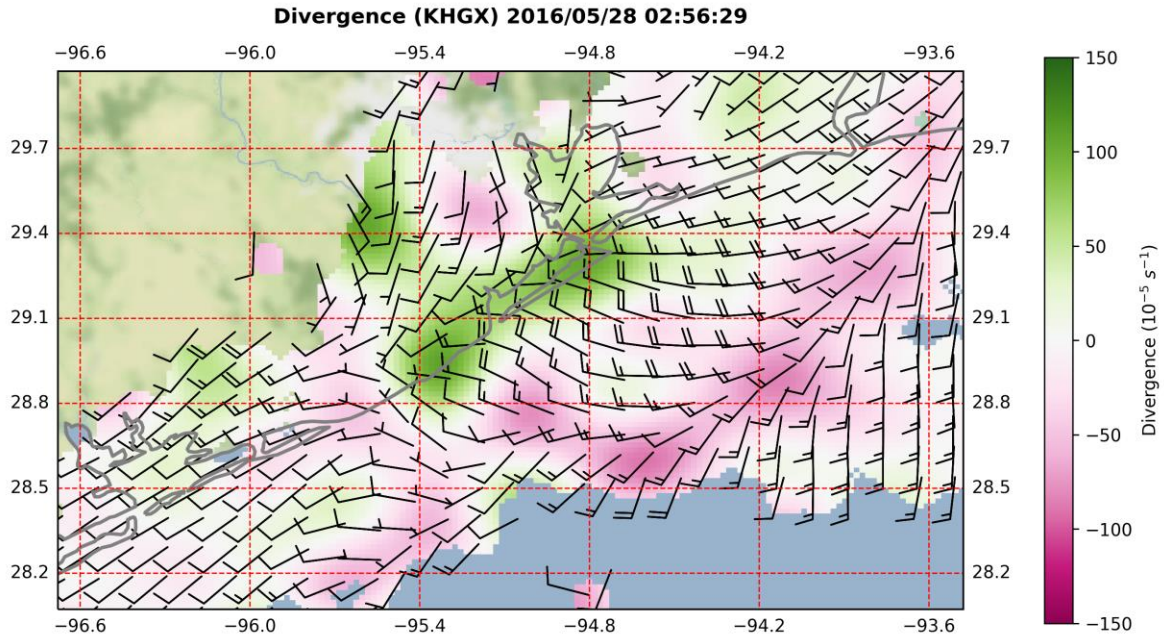
Also – Py-ART, CSU_RadarTools, pyresample, etc.

5/28/2016
Houston

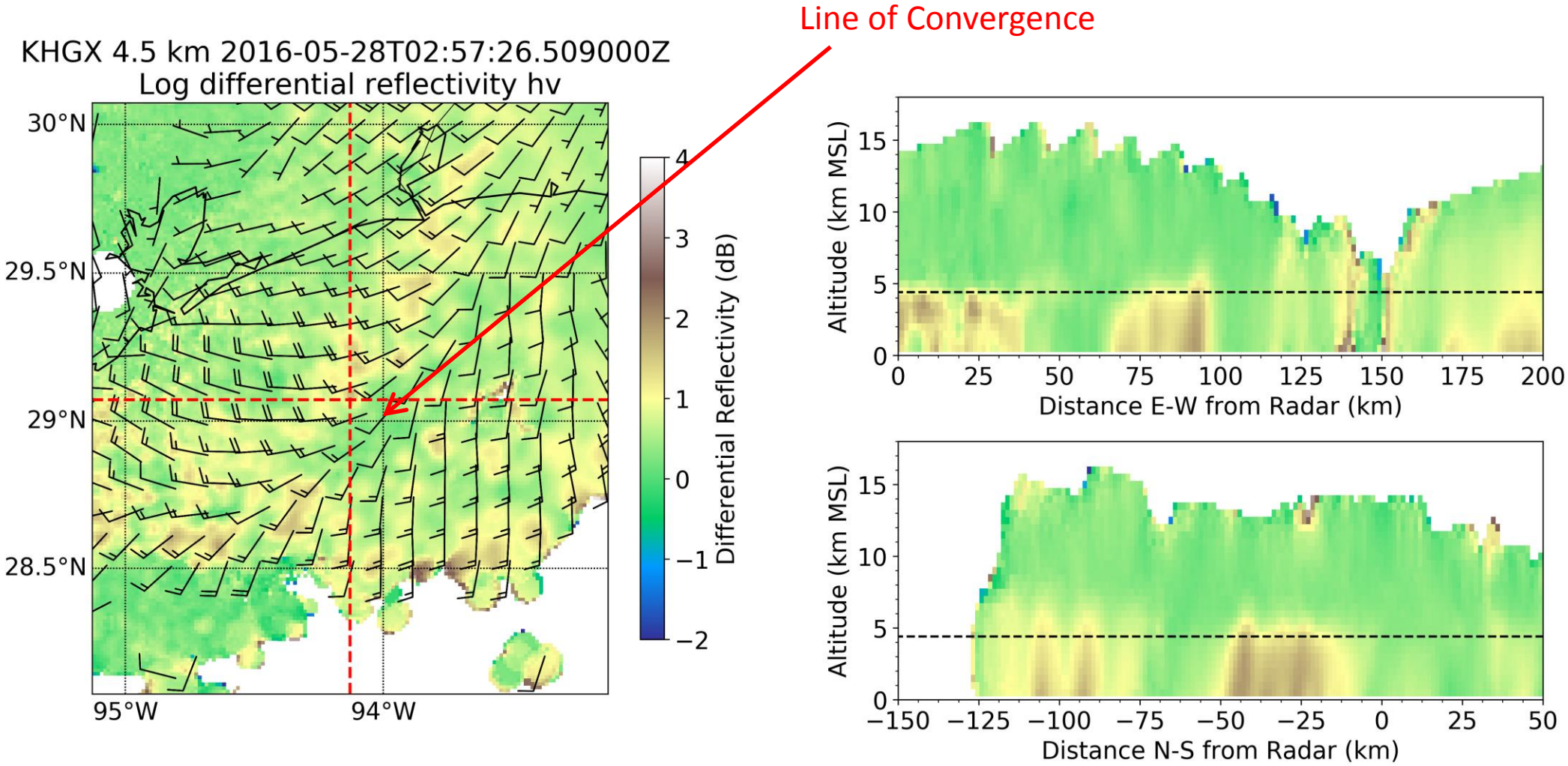




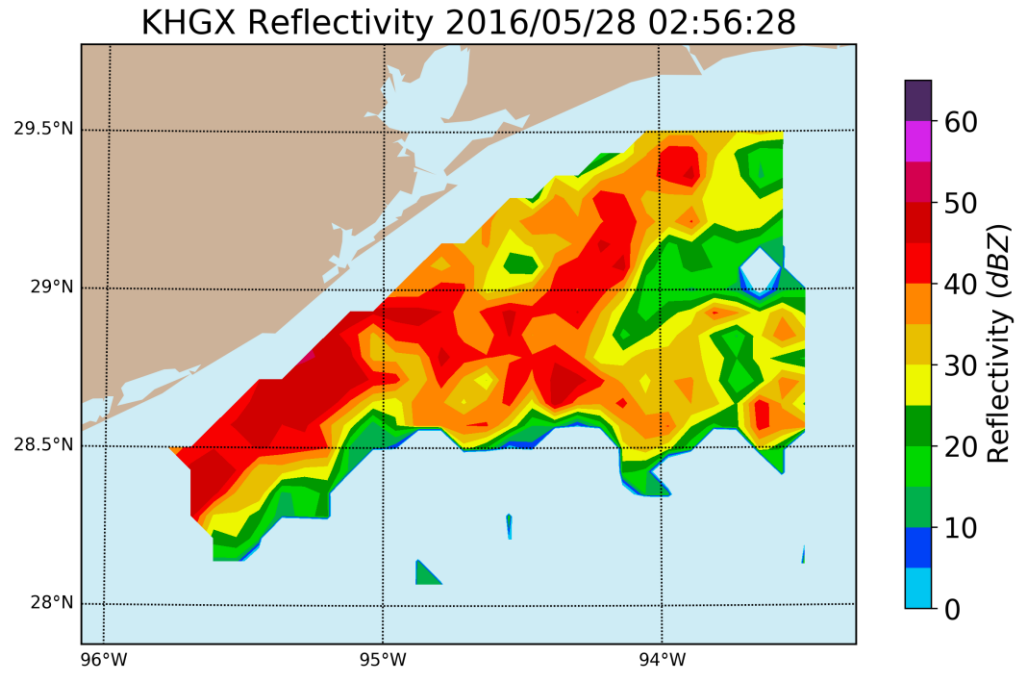


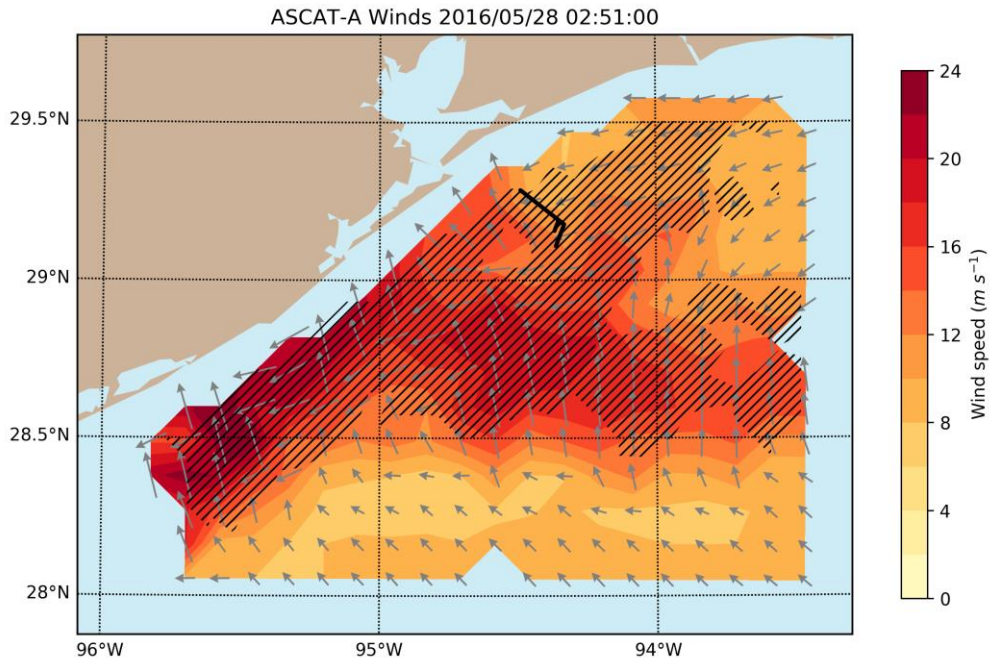


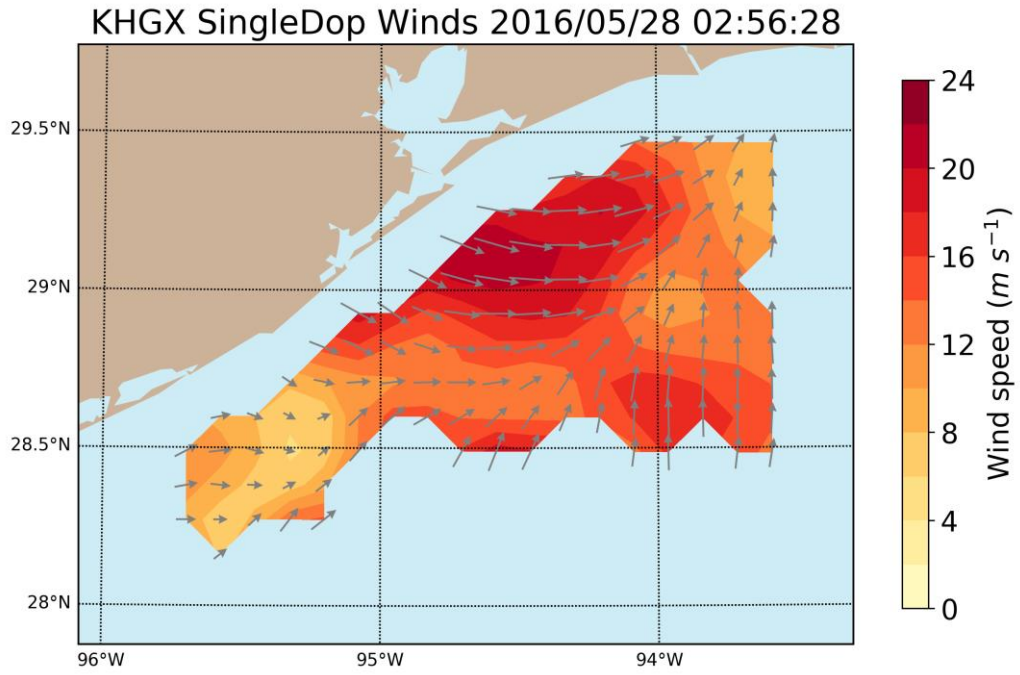
ZDR and SingleDop Winds



ZDR columns reside just rearward of low-level convergence

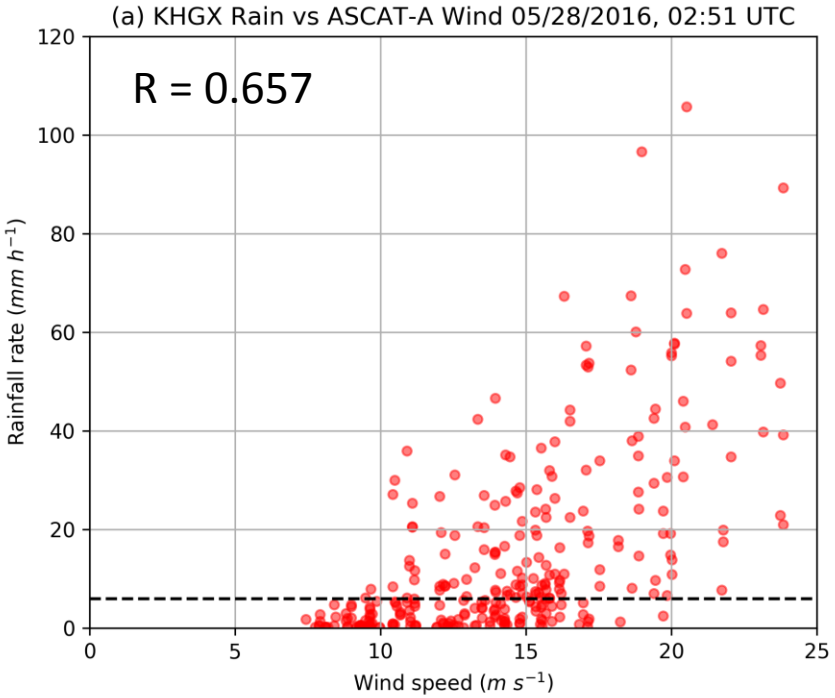

KHGX Reflectivity 2016/05/28 02:56:28
29.5°N
29°N
28.5°N
28°N
96°W
95°W
94°W
60
50
40
30
20
10
0
Reflectivity (dBZ)

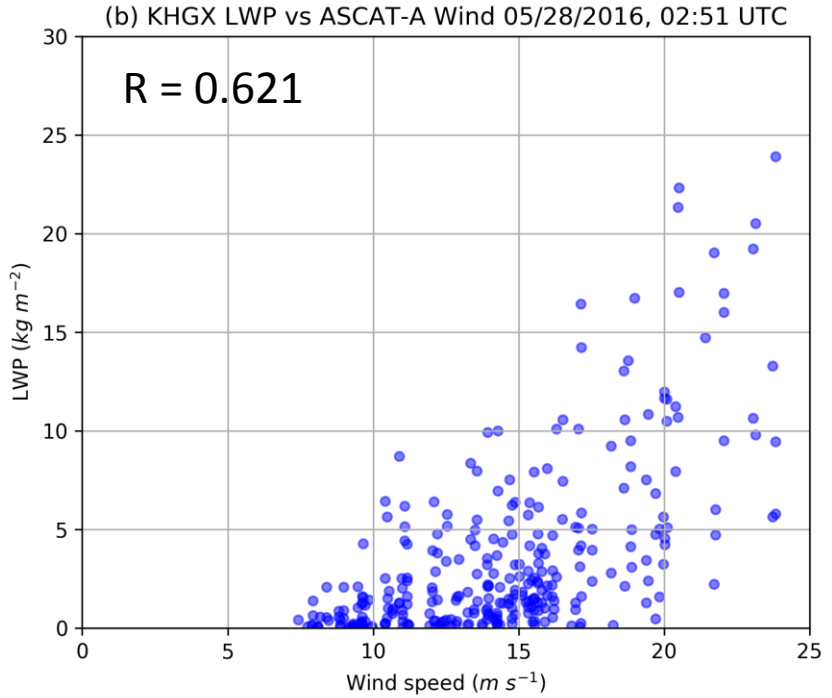

ASCAT-A Winds 2016/05/28 02:51:00
29.5°N
29°N
28.5°N
28°N
96°W
95°W
94°W
24
20
16
12
8
4
0
Wind speed (m s⁻¹)


KHGX SingleDop Winds 2016/05/28 02:56:28
29.5°N
29°N
28.5°N
28°N
96°W
95°W
94°W
24
20
16
12
8
4
0
Wind speed (m s⁻¹)

Resampled to 12.5-km

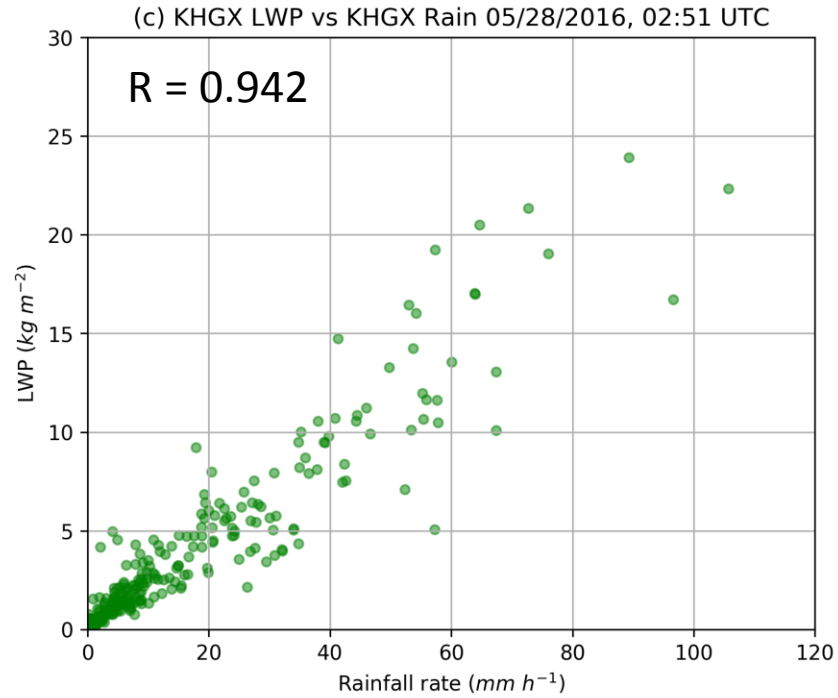
KHGX Rain vs. ASCAT-A Wind

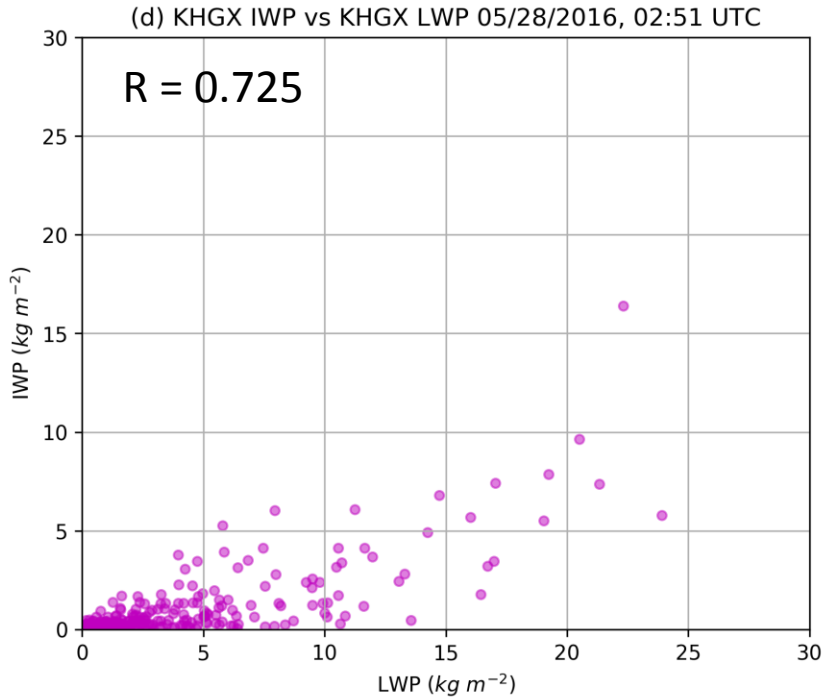




KHGX LWP vs. ASCAT-A Wind

KHGX LWP vs. KHGX Rain

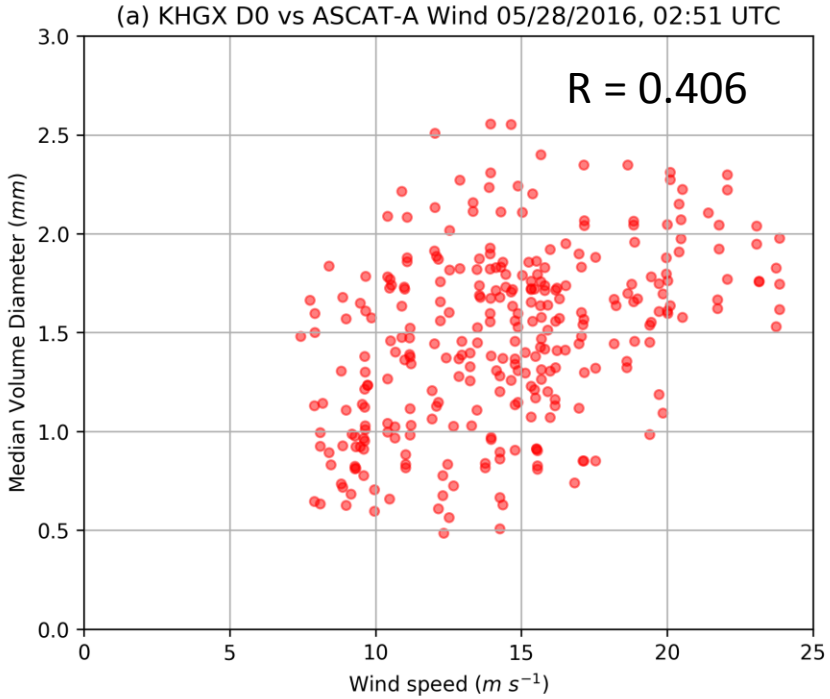


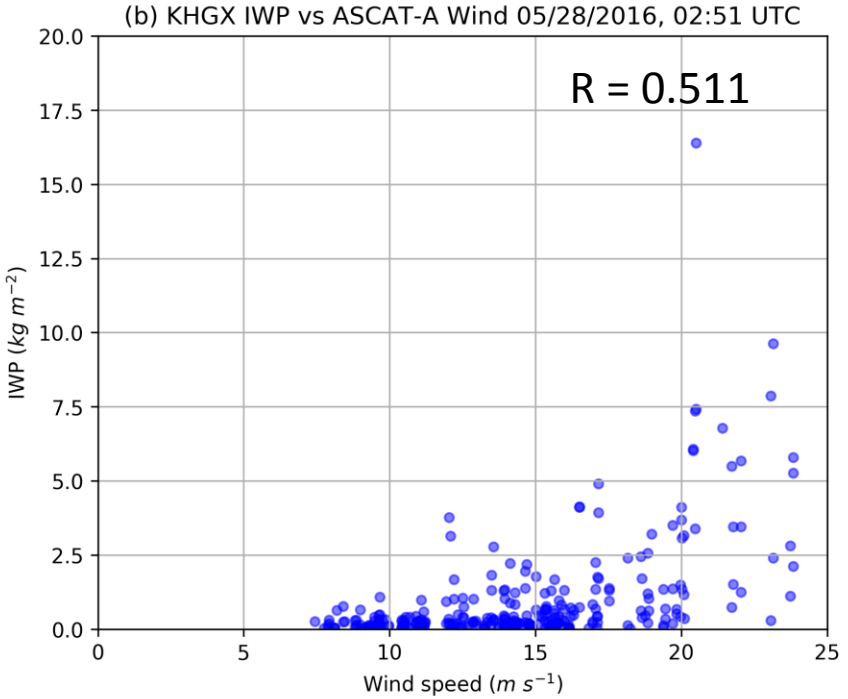


KHGX IWP vs. KHGX LWP

Resampled to 12.5-km

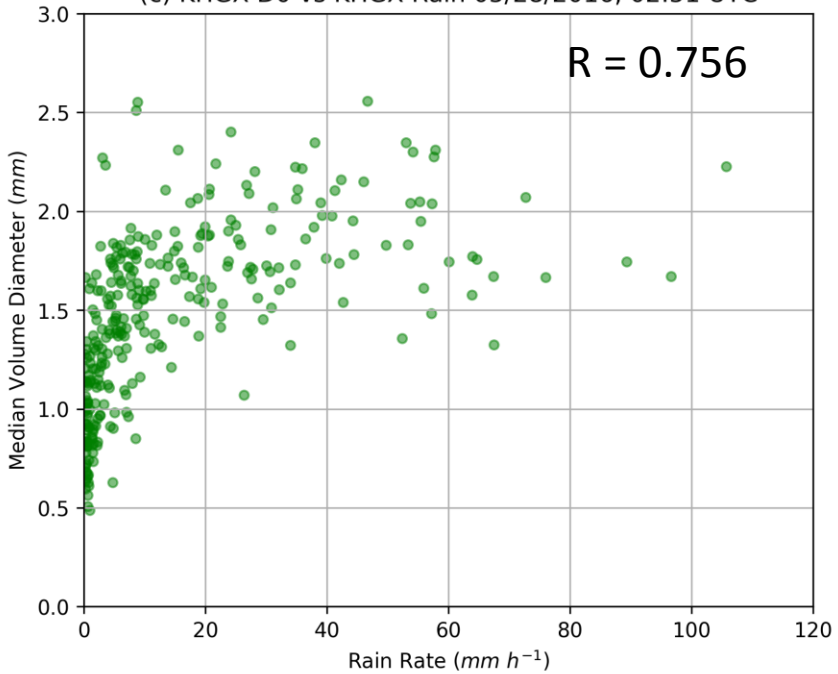
KHGX D_0 vs. ASCAT-A

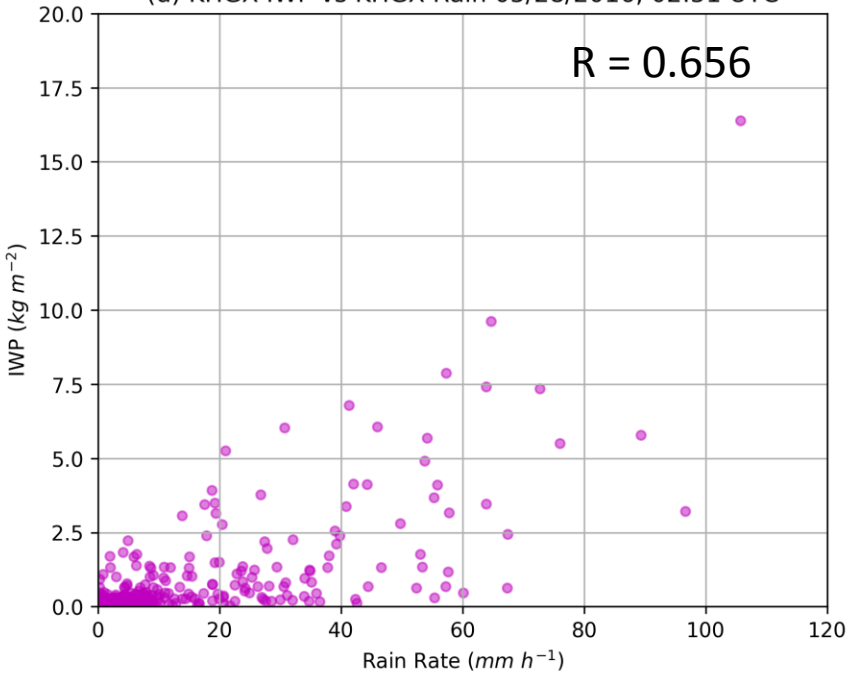




KHGX IWP vs. ASCAT-A

KHGX D_0 vs. Rain

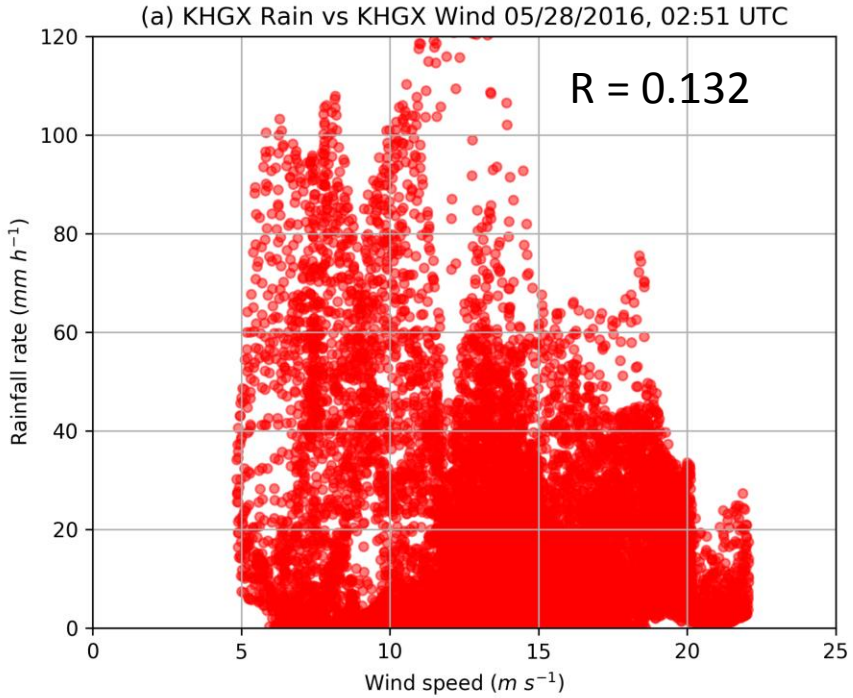


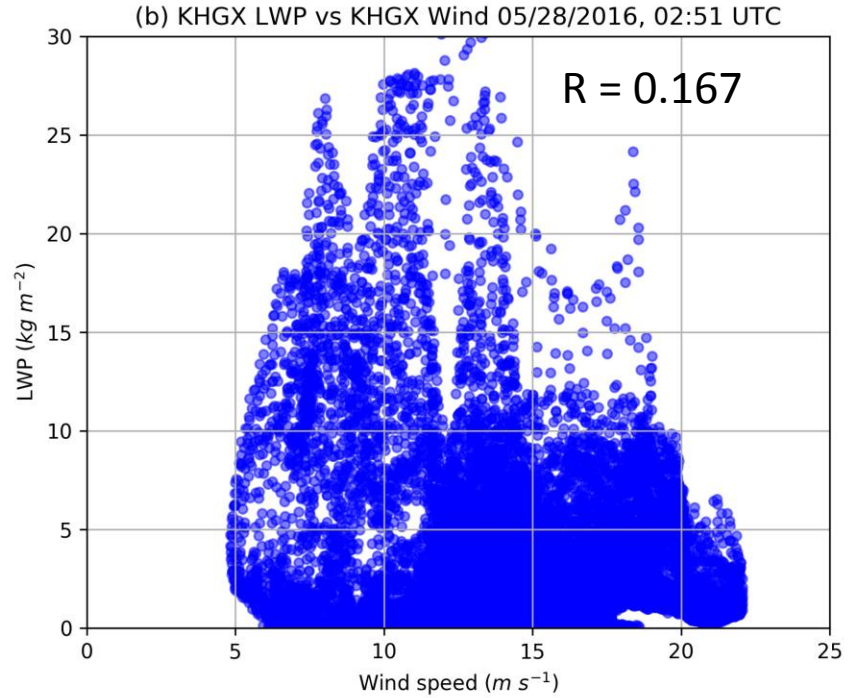


KHGX IWP vs. Rain

Resampled to 2-km

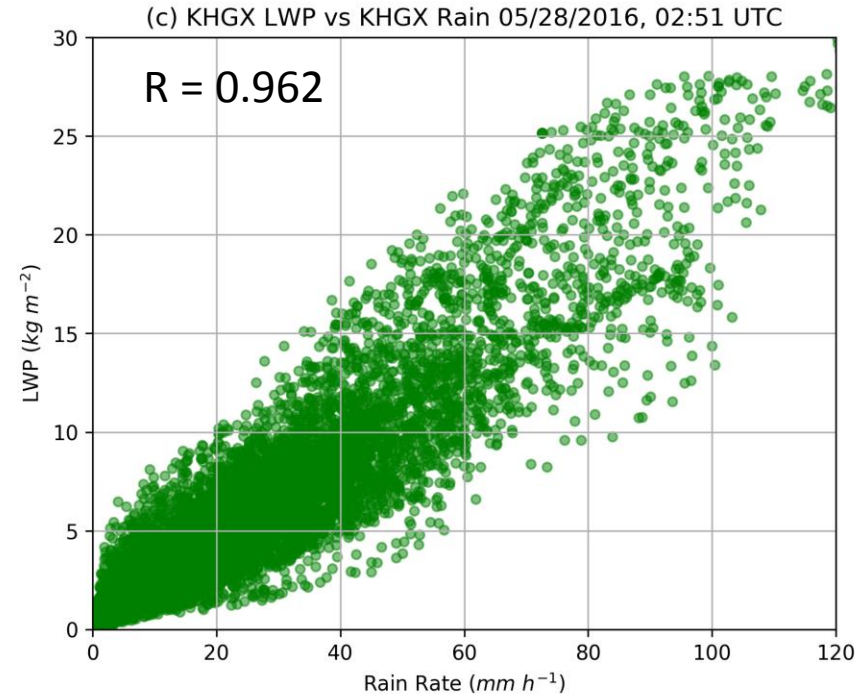
KHGX Rain vs. KHGX Wind

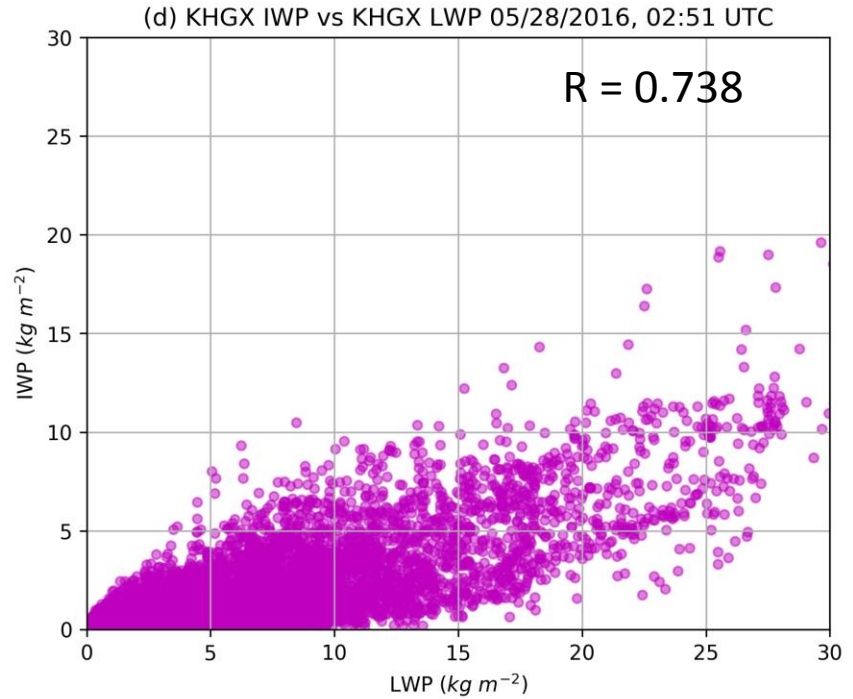




KHGX LWP vs. KHGX Wind

KHGX LWP vs. KHGX Rain

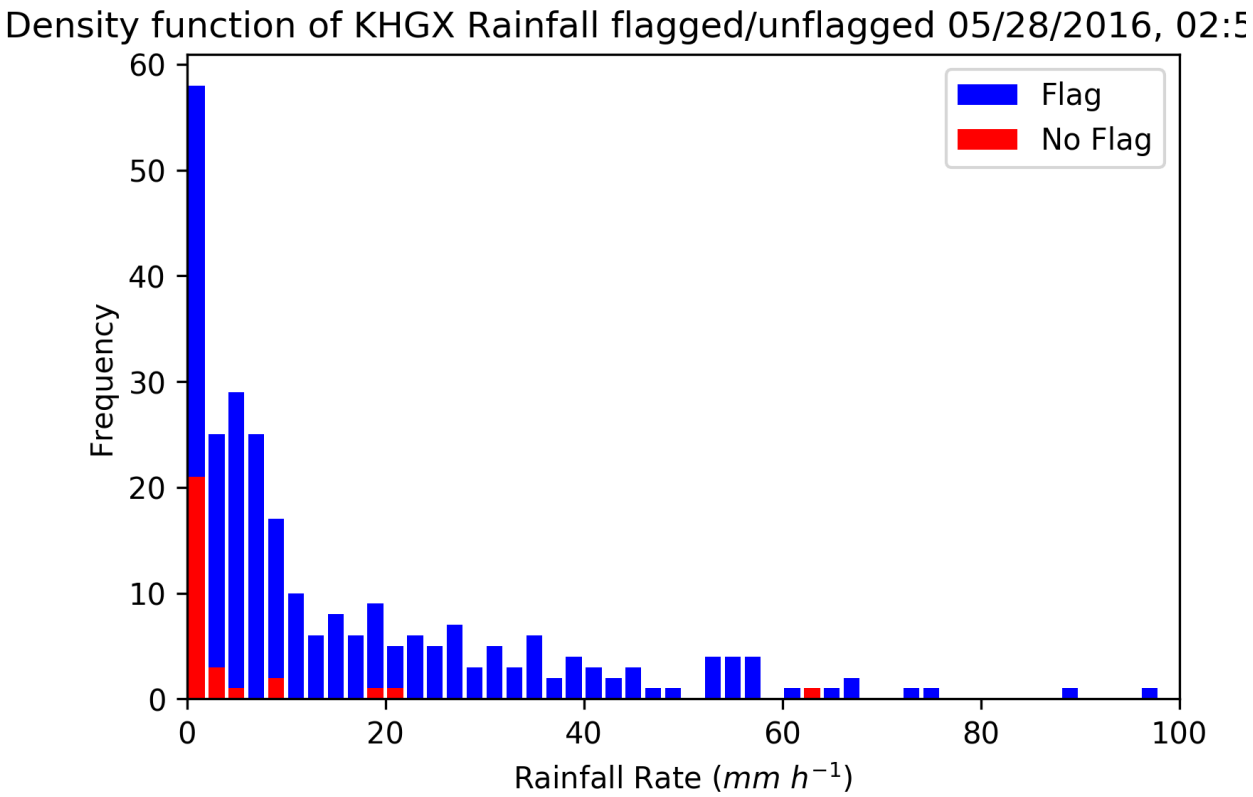


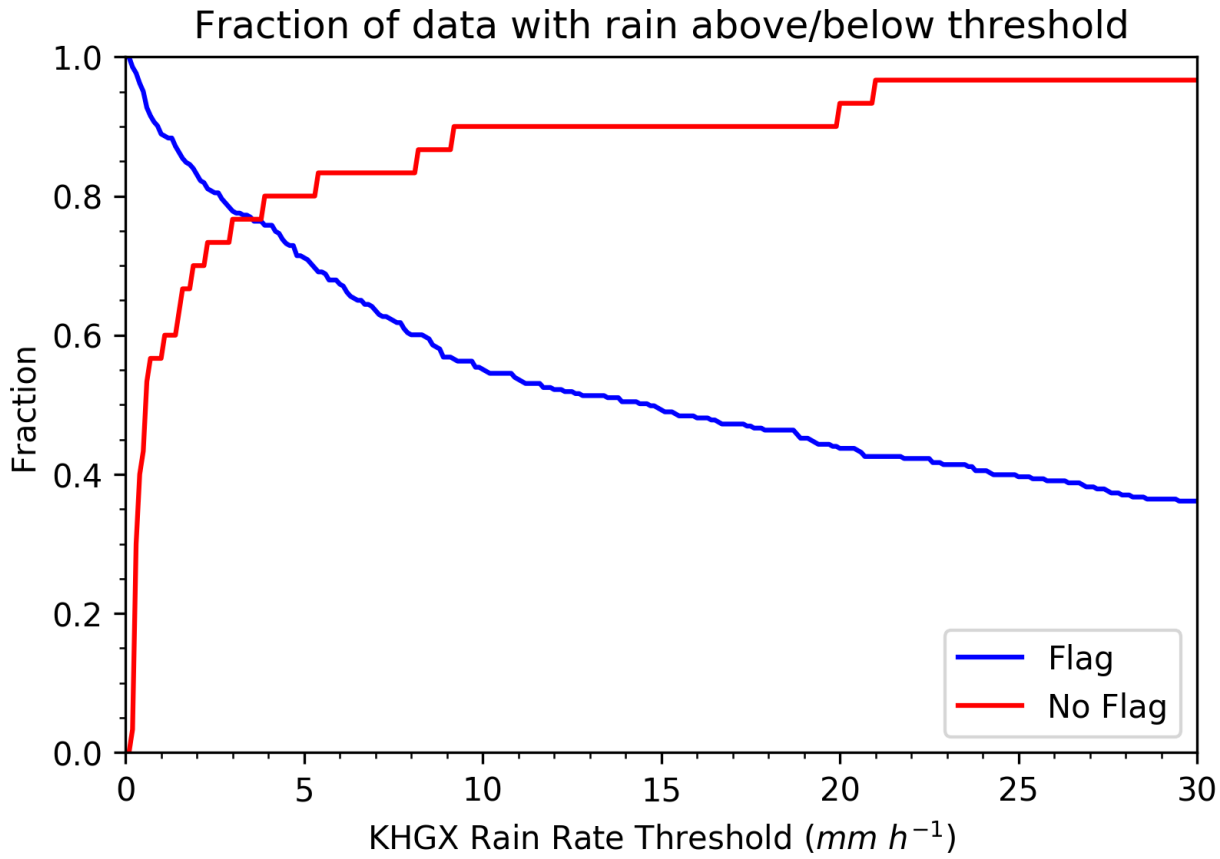


KHGX IWP vs. KHGX LWP

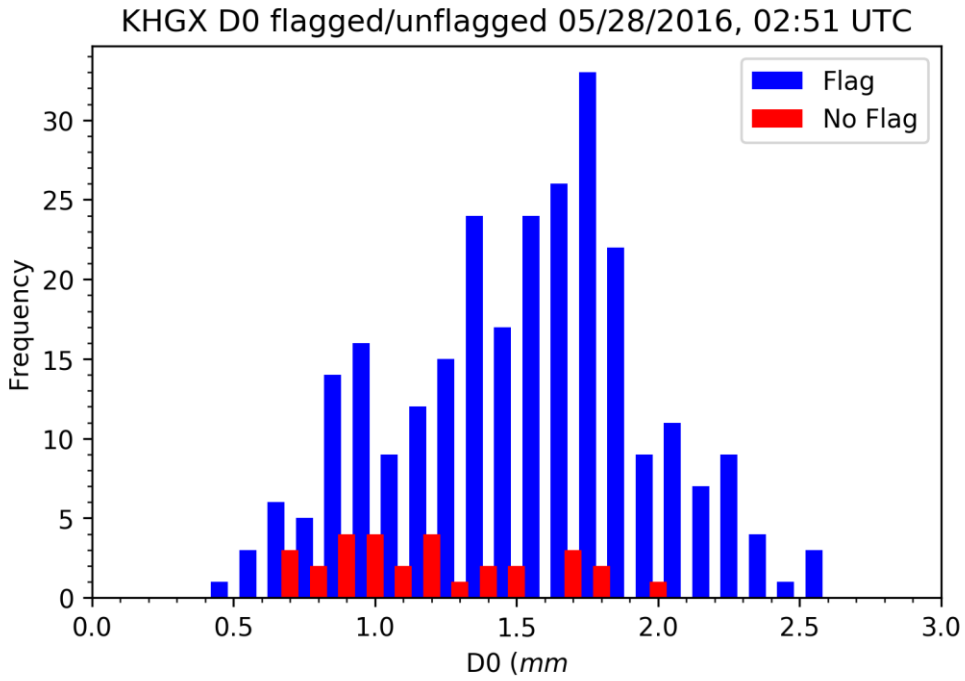
At a threshold of 3 mm h^{-1}:

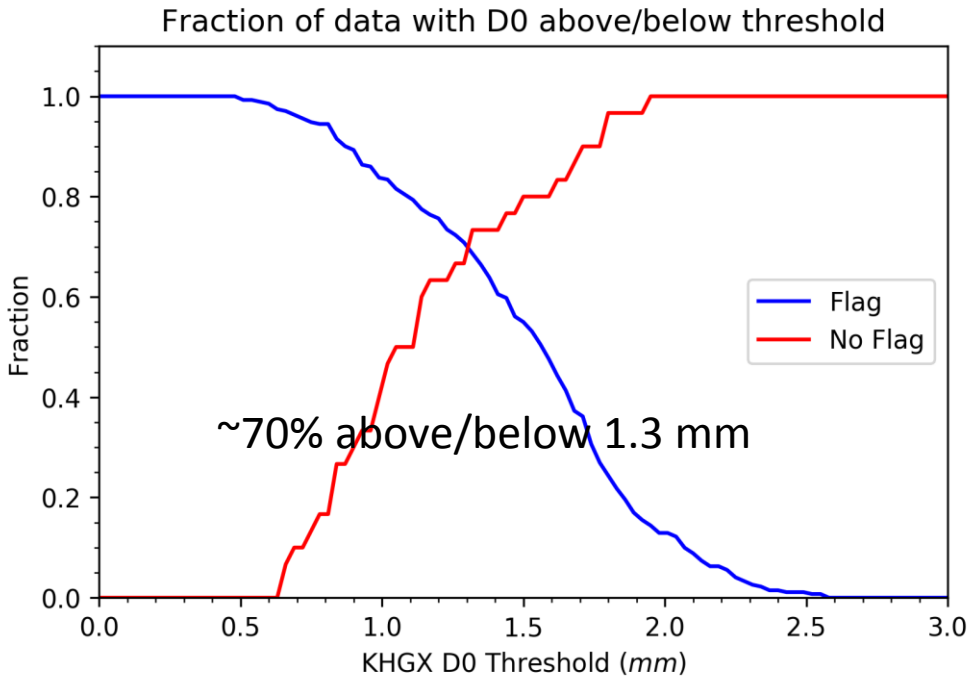
- ~75% of flagged data are above
- ~75% of unflagged data are below



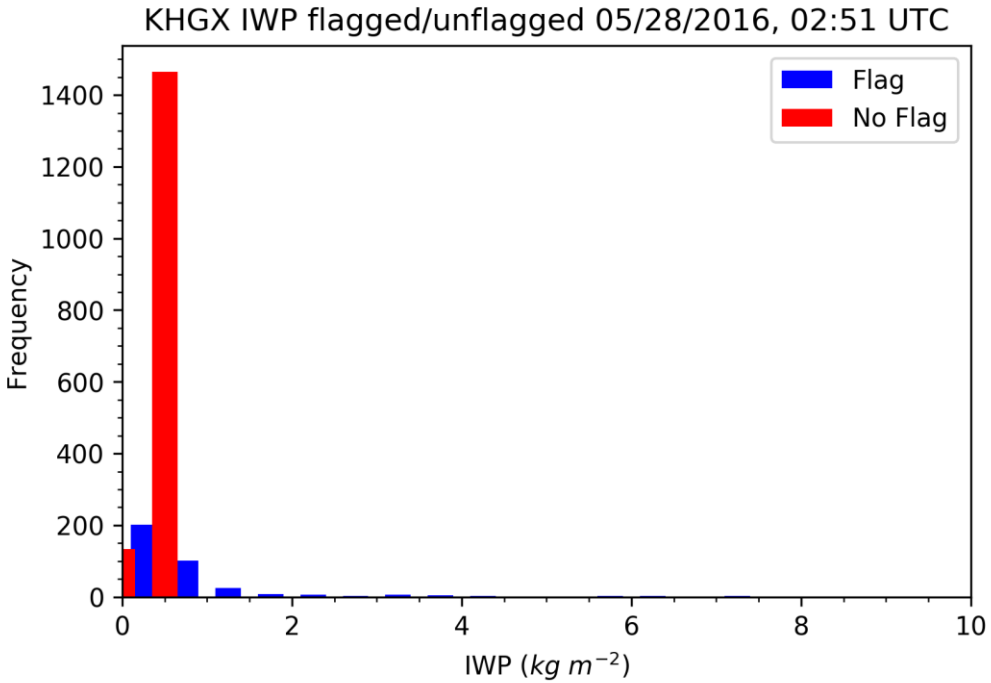


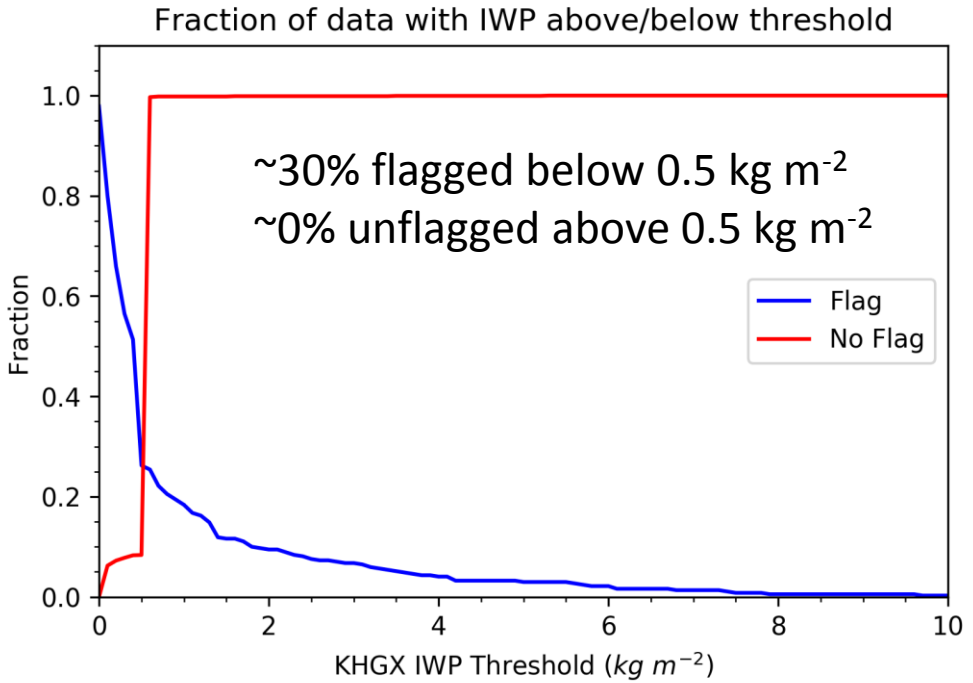
D_0


KHGX D0 flagged/unflagged 05/28/2016, 02:51 UTC
Flag
No Flag
Frequency
D0 (mm)

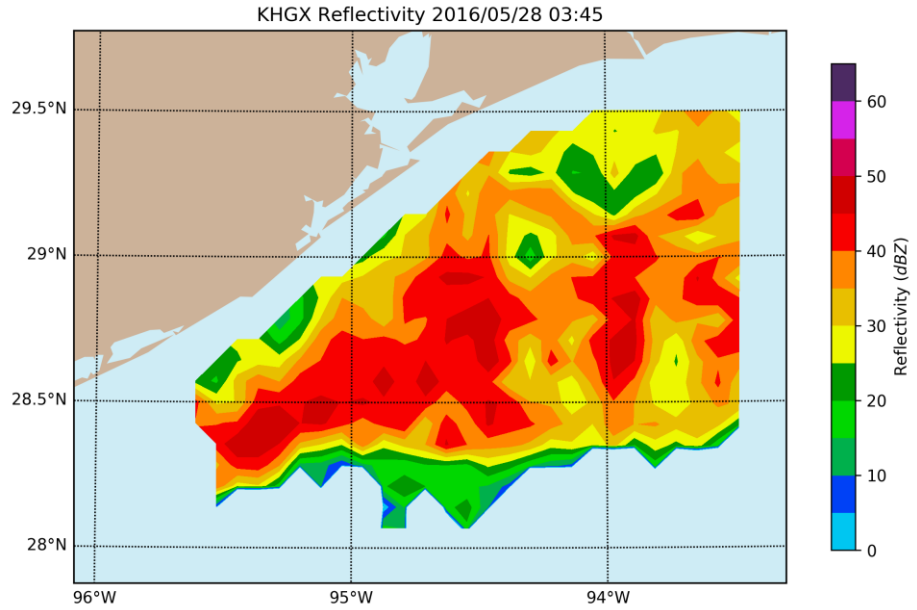

Fraction of data with D0 above/below threshold
Flag
No Flag
~70% above/below 1.3 mm
Fraction
KHGX D0 Threshold (mm)

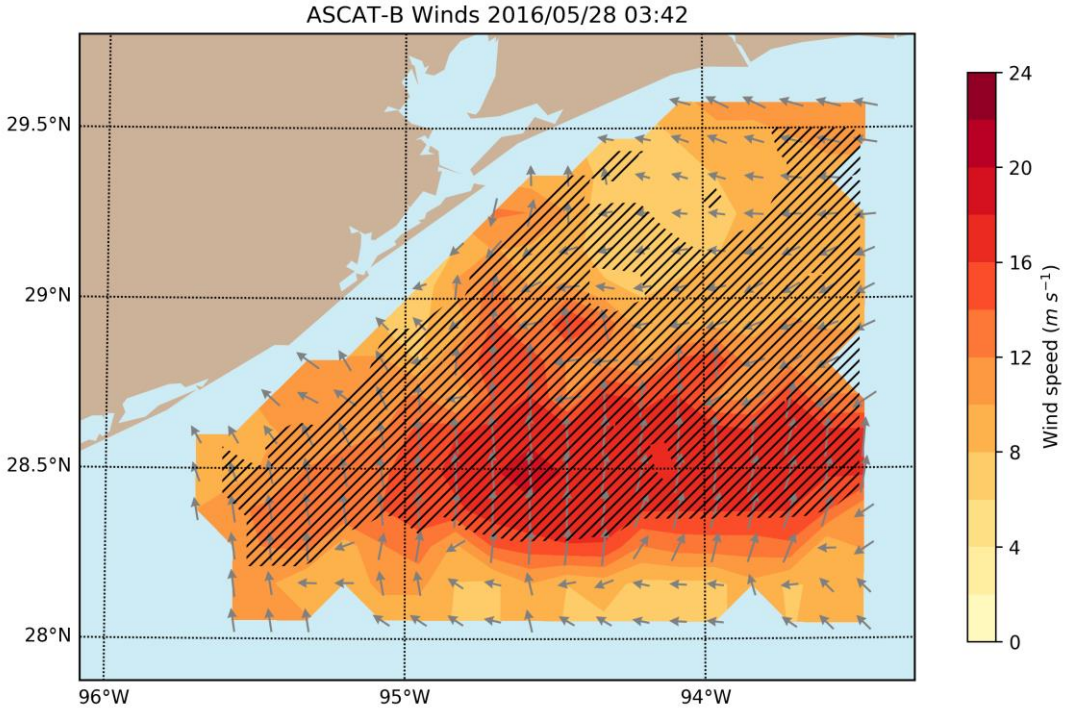
IWP

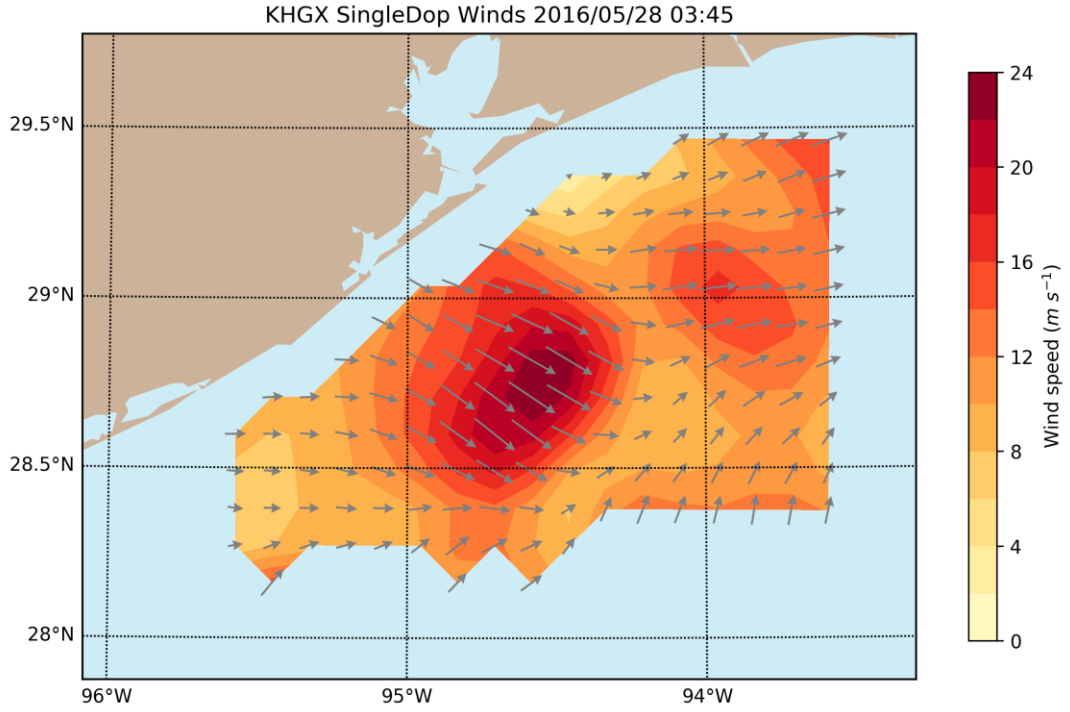

KHGX IWP flagged/unflagged 05/28/2016, 02:51 UTC
Flag
No Flag
Frequency
IWP (kg m⁻²)

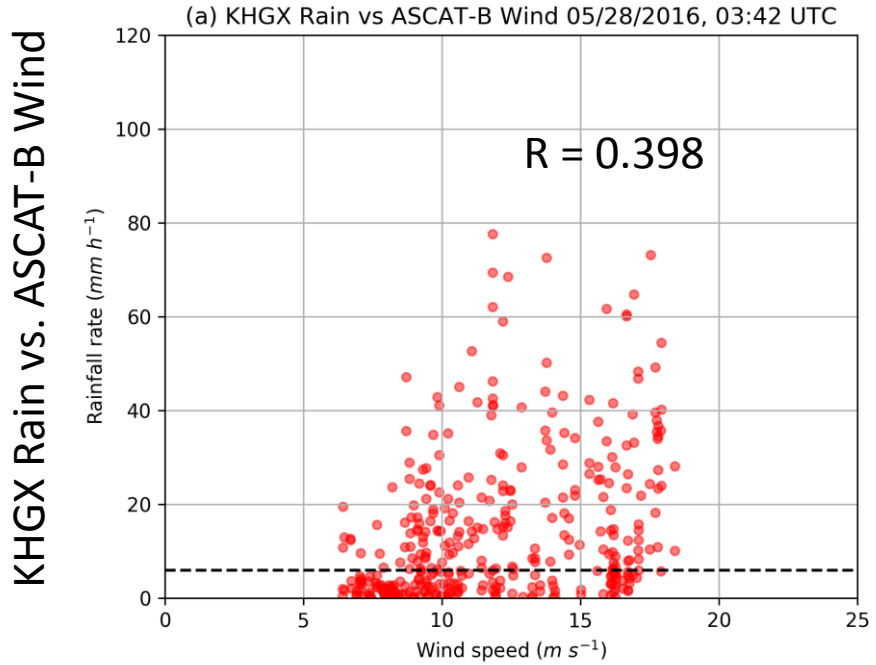

Fraction of data with IWP above/below threshold
~30% flagged below 0.5 kg m-2
~0% unflagged above 0.5 kg m-2
Flag
No Flag
Fraction
KHGX IWP Threshold (kg m⁻²)

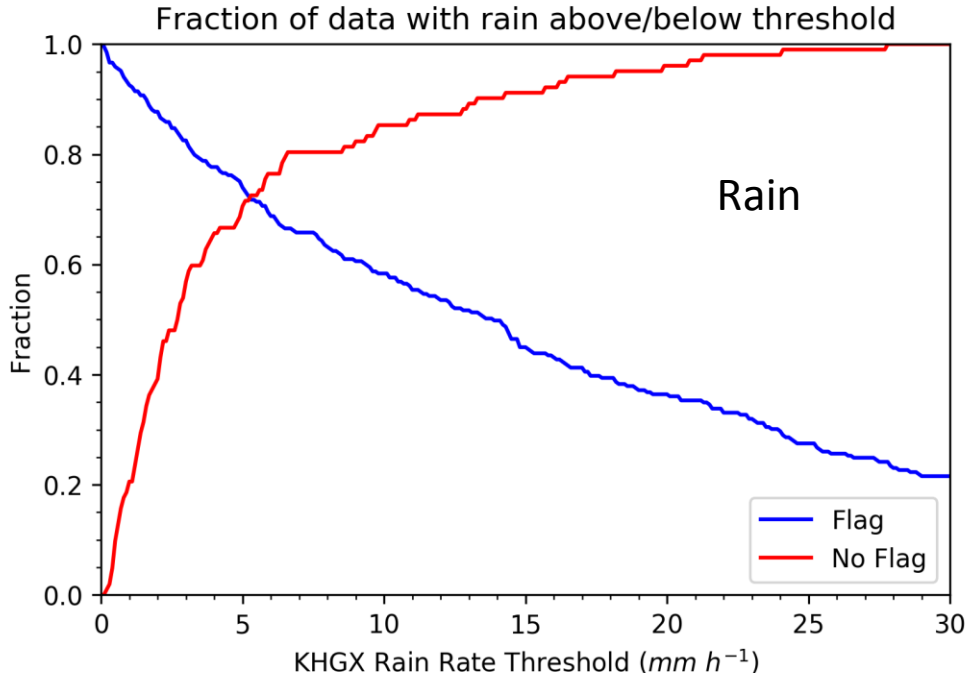
ASCAT-B Overpass
0342 UTC

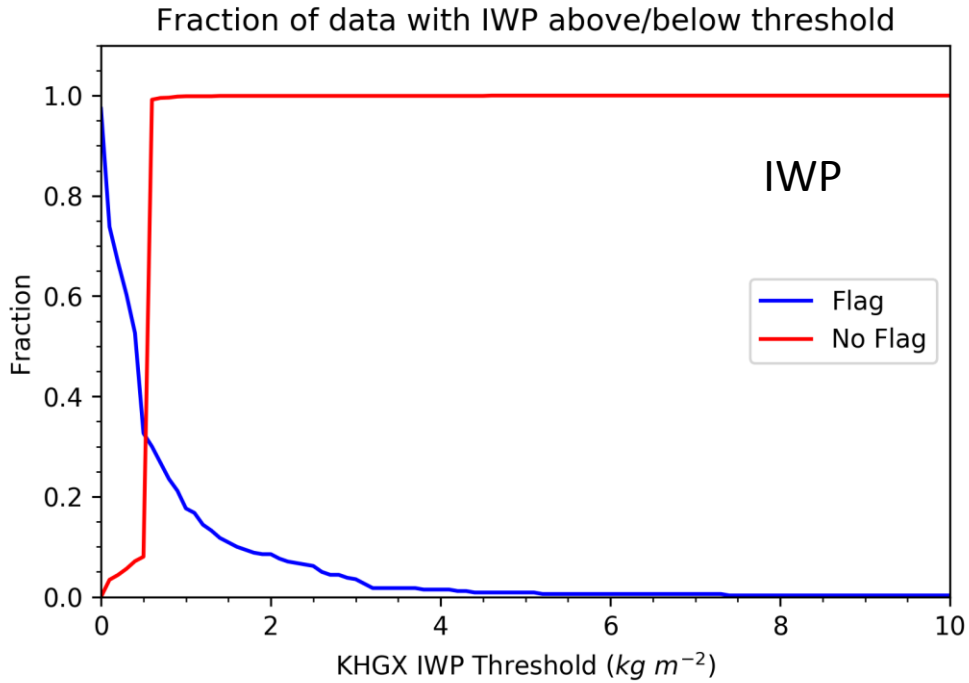


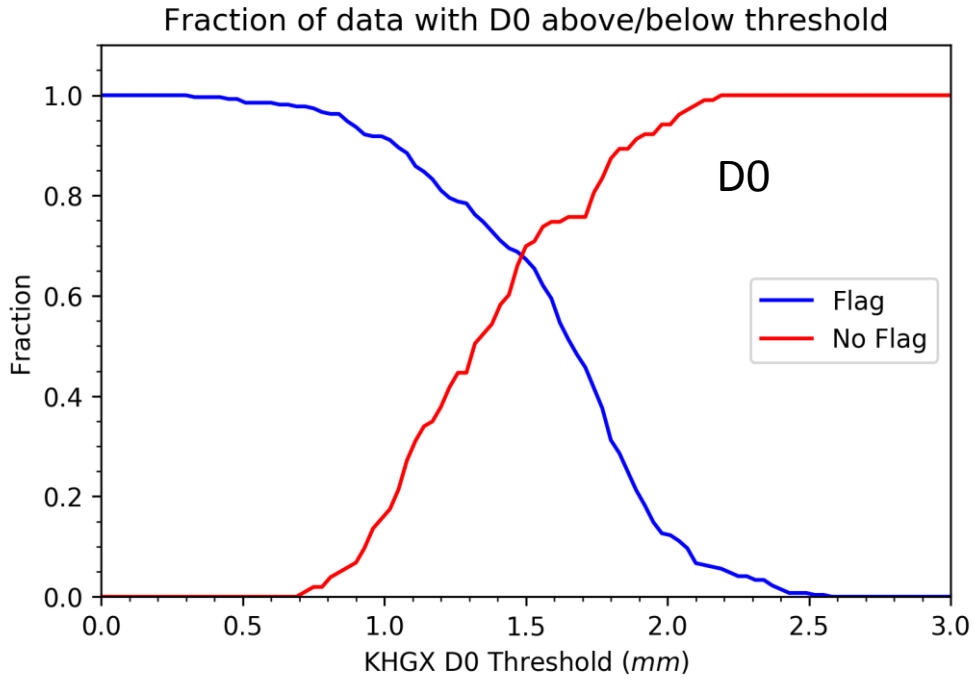




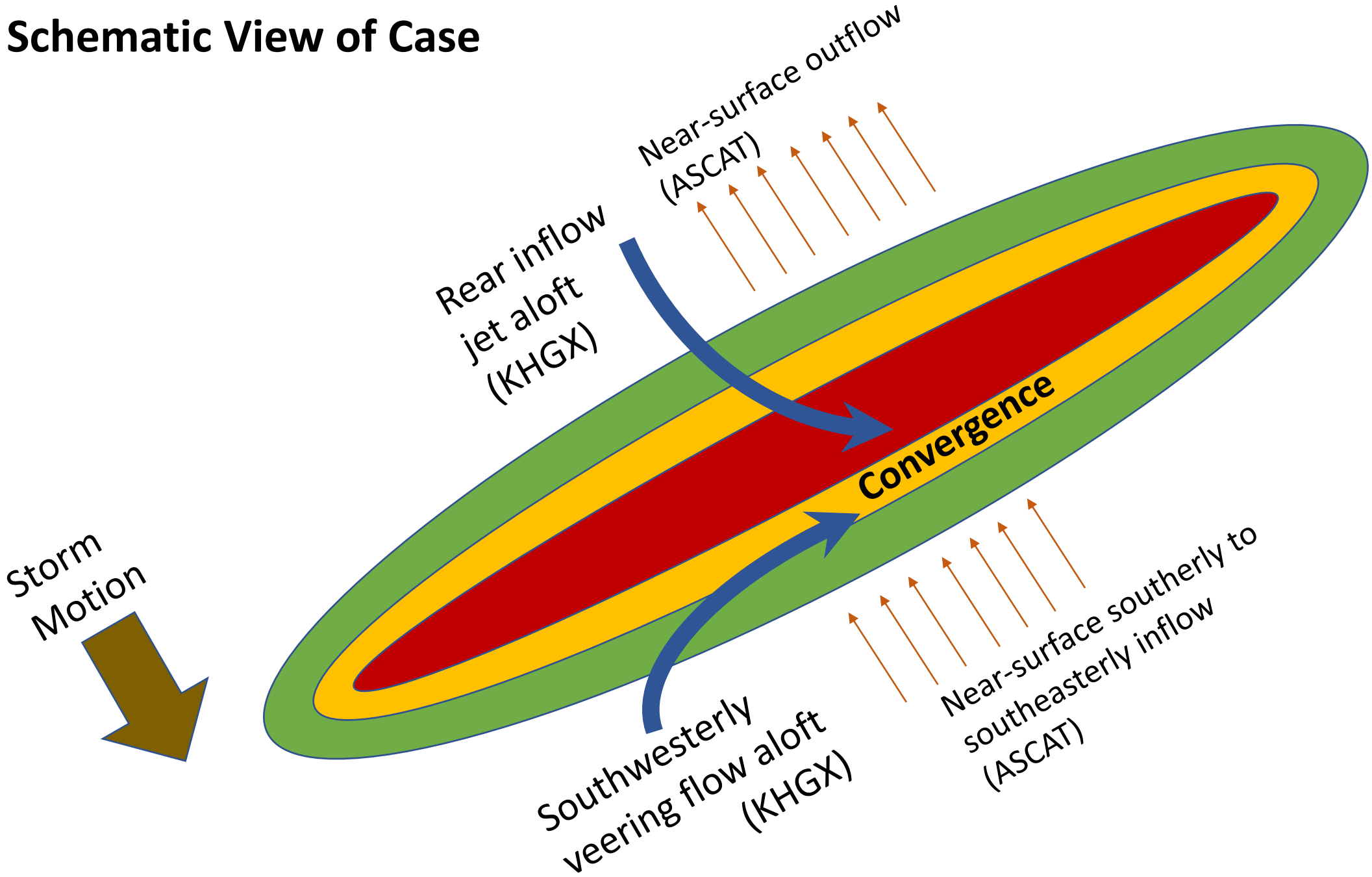

KHGX Rain vs. ASCAT-B Wind
(a) KHGX Rain vs ASCAT-B Wind 05/28/2016, 03:42 UTC
R = 0.398
Rainfall rate (mm h⁻¹)
Wind speed (m s⁻¹)


Fraction of data with rain above/below threshold
Rain
Flag
No Flag
Fraction
KHGX Rain Rate Threshold (mm h⁻¹)


Fraction of data with IWP above/below threshold
IWP
Flag
No Flag
Fraction
KHGX IWP Threshold (kg m⁻²)

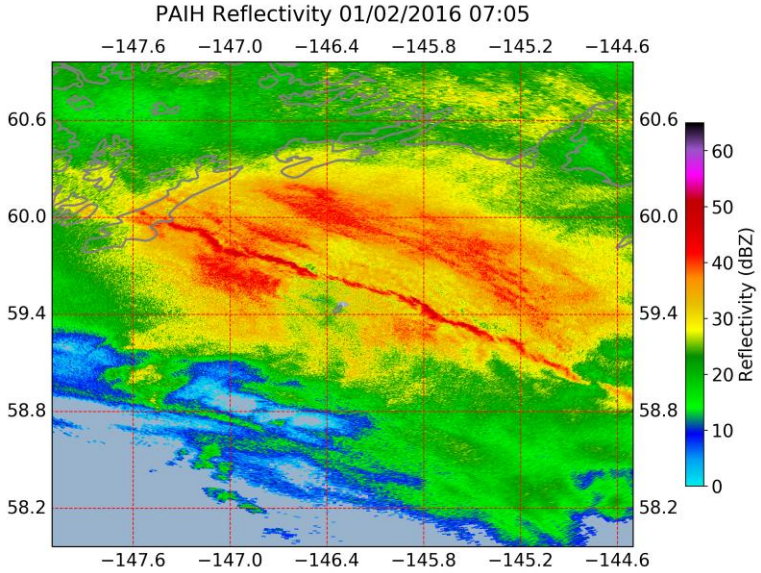

Fraction of data with D0 above/below threshold
D0
Flag
No Flag
Fraction
KHGX D0 Threshold (mm)

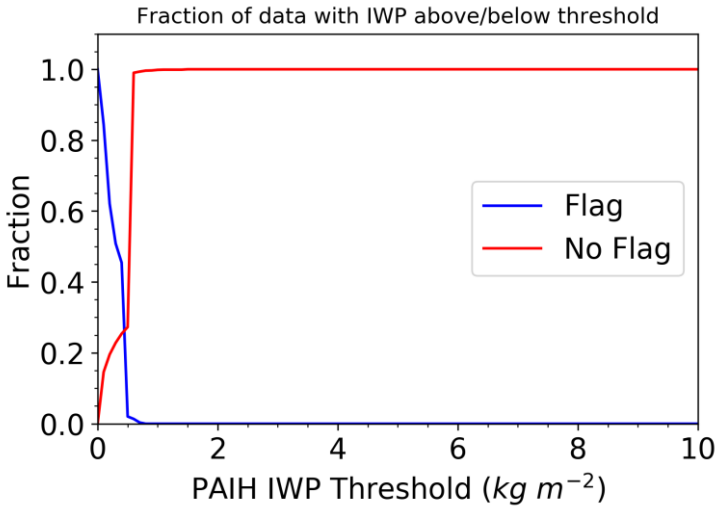
Schematic View of Case

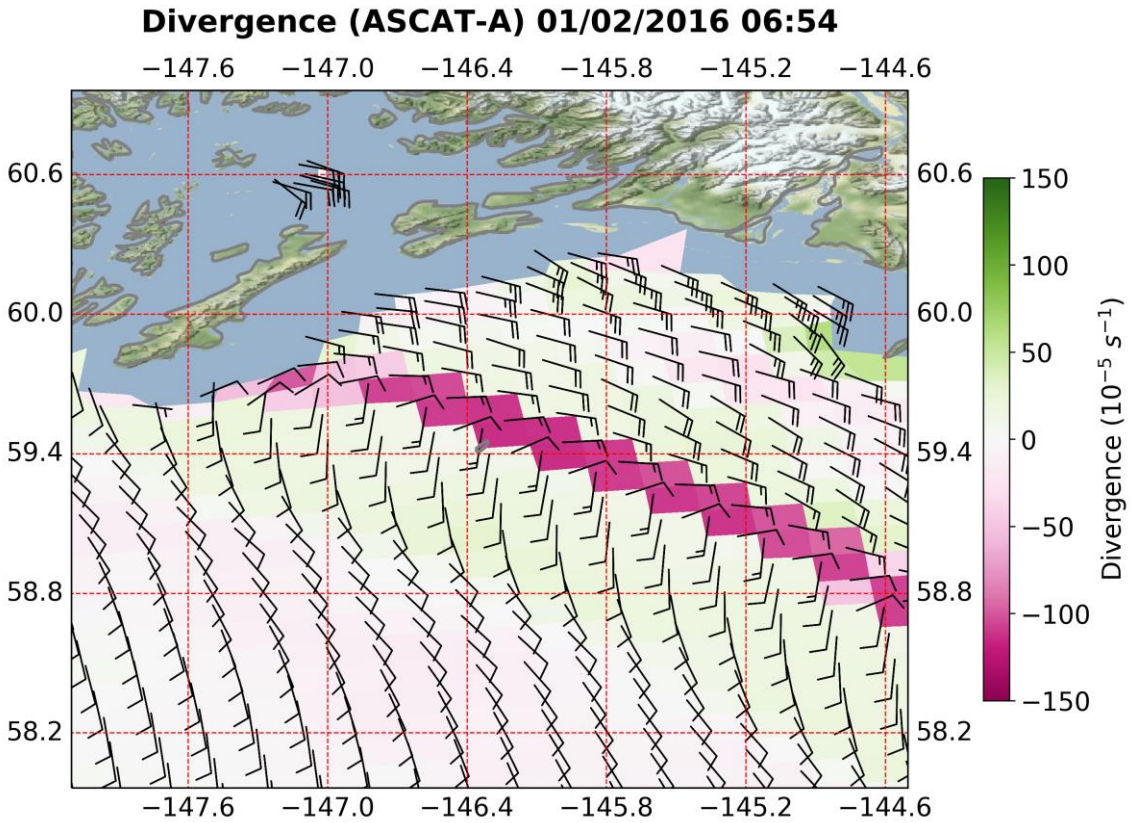


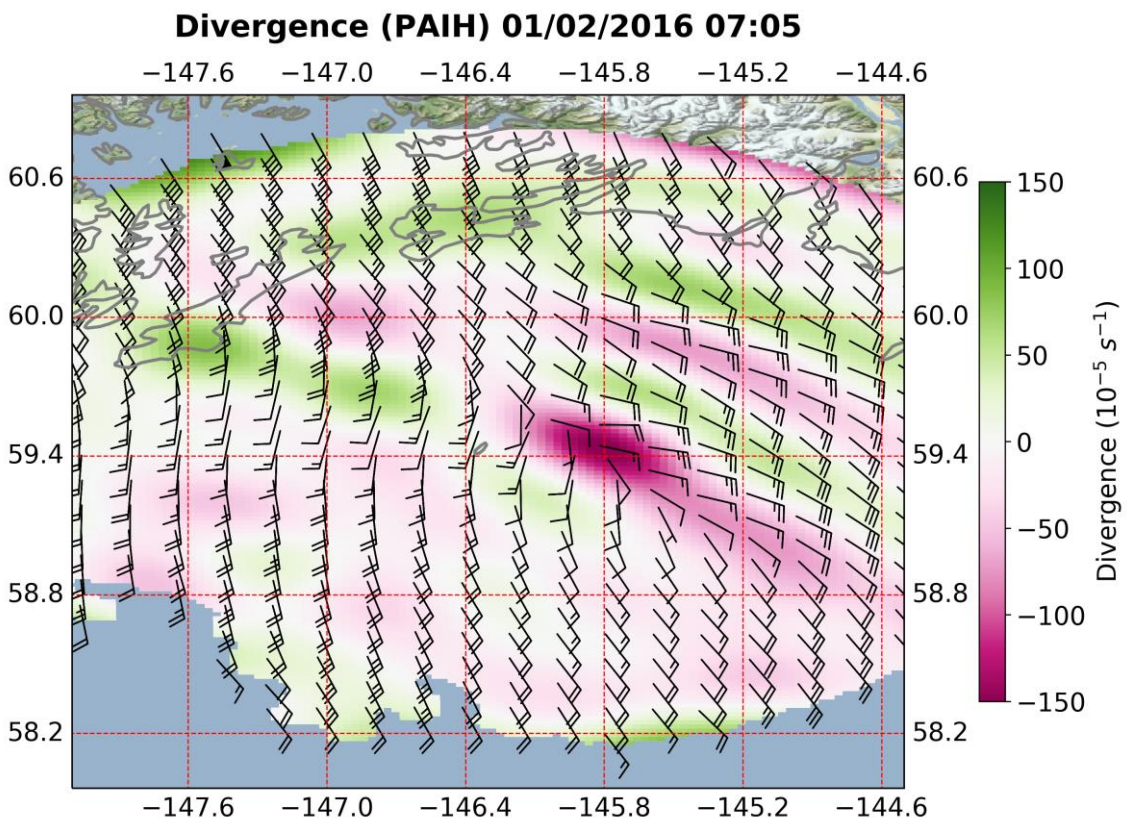
Quick look at another case (we have many!)

1/2/2016 near Alaska









Summary

- Ground radar and scatterometer together provide an understanding of near-surface to low-level flow structures near organized convective systems

- ASCAT quality flags do not appear to correspond to consistent rain properties (e.g., rain rate, D_0, LWP) – case/overpass dependent!

- However, if ASCAT quality flags are not set, that suggests low IWP (< 0.5 kg m^{-2}) overhead

Questions? timothy.j.lang@nasa.gov