On the effect of environmental wind shear on the hurricane boundary layer structure: Update on asymmetry analysis

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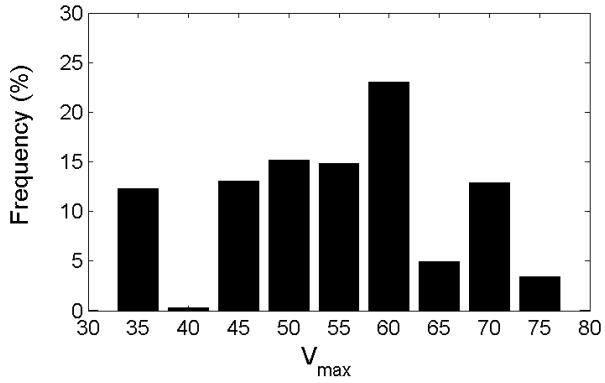
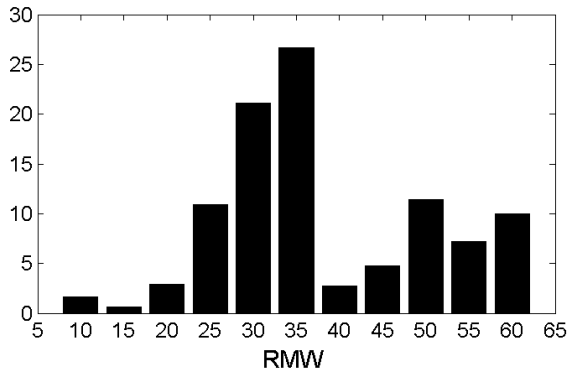
Dropsonde dataset

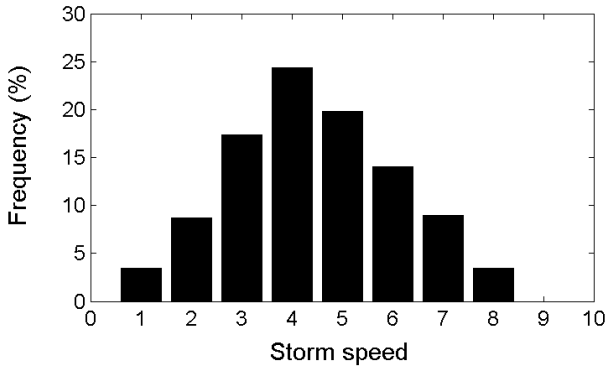
Storm name	Year	Storm Intensity range (kt)	Number of sondes
Erika	1997	83 – 110	40
Bonnie	1998	68 - 93	76
Georges	1998	66 - 78	39
Mitch	1999	145 - 155	28
Bret	1999	75 - 90	33
Dennis	1999	65 - 70	7
Floyd	1999	80 - 110	40
Fabian	2003	68 - 120	131
Isabel	2003	85 - 140	162
Frances	2004	68 - 83	62
Ivan	2004	65 - 135	123
Dennis	2005	65 - 70	7
Katrina	2005	68 - 100	46

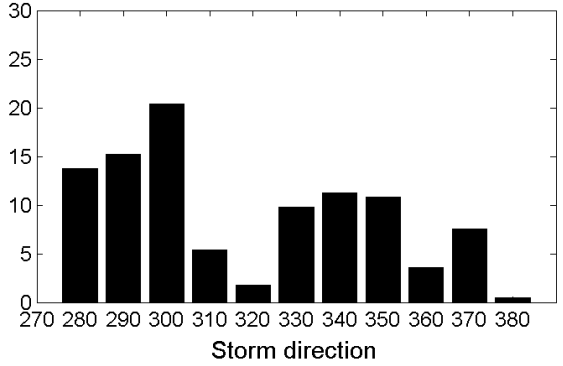
The same sample of data was used by Zhang, Rogers, Nolan and Marks (2011)
These data are also partially used by Zhang and Uhlhorn (2012)

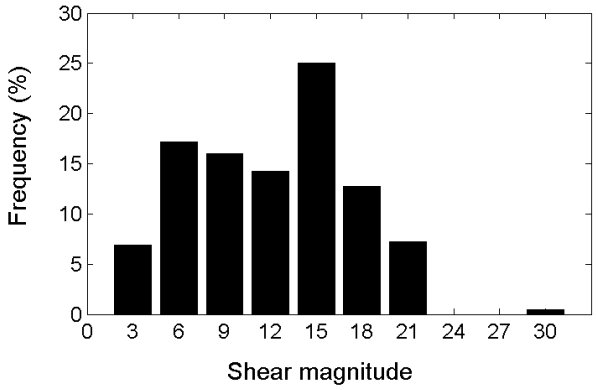
Storm information

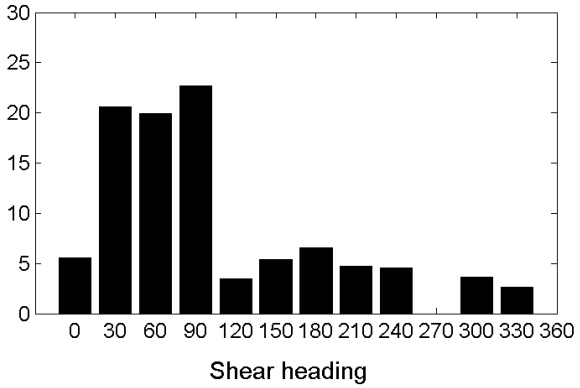






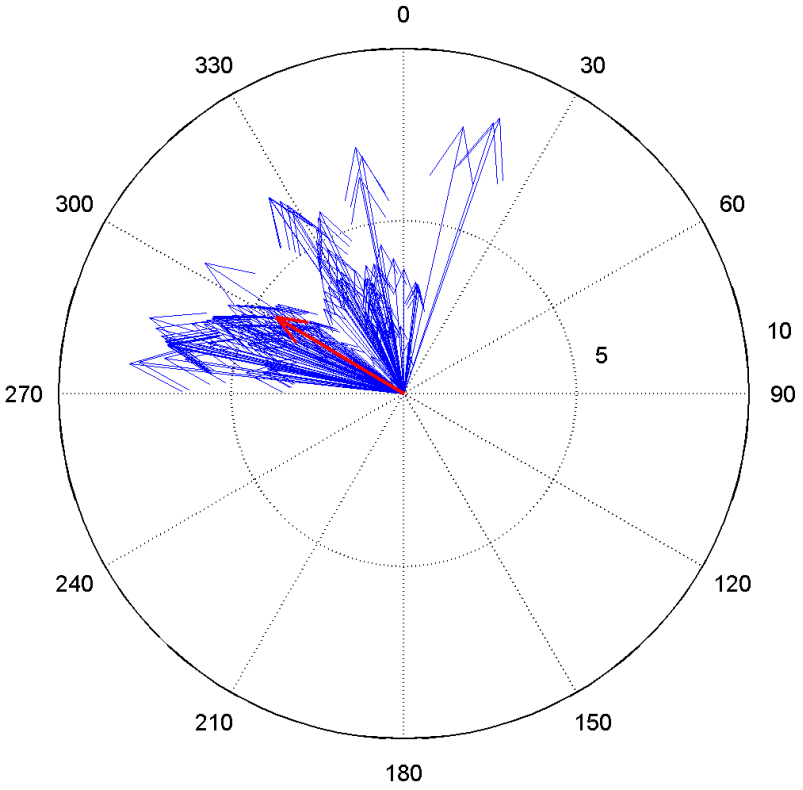


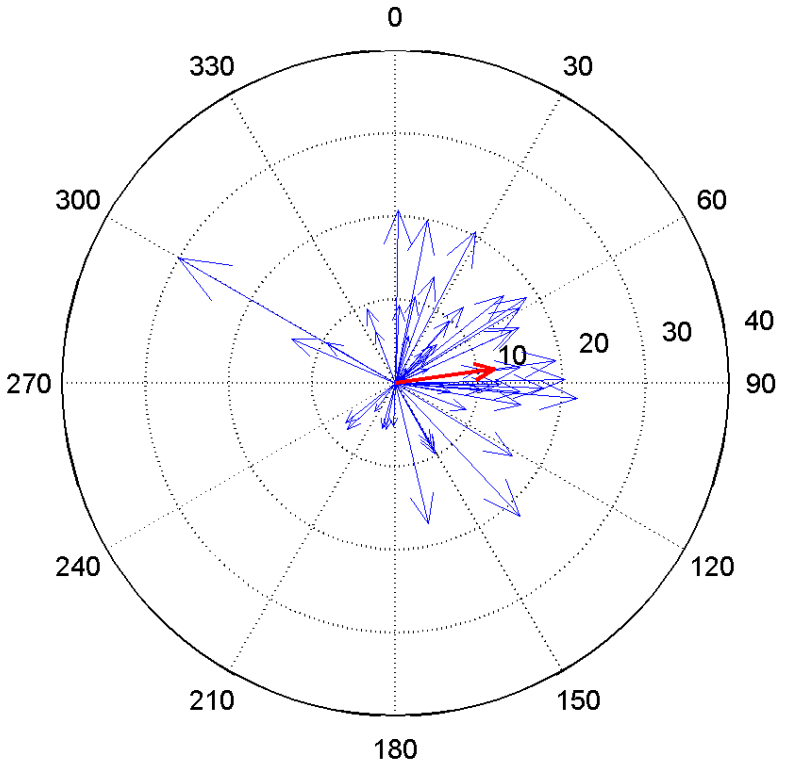




Storm motion (left) and shear (right) vectors

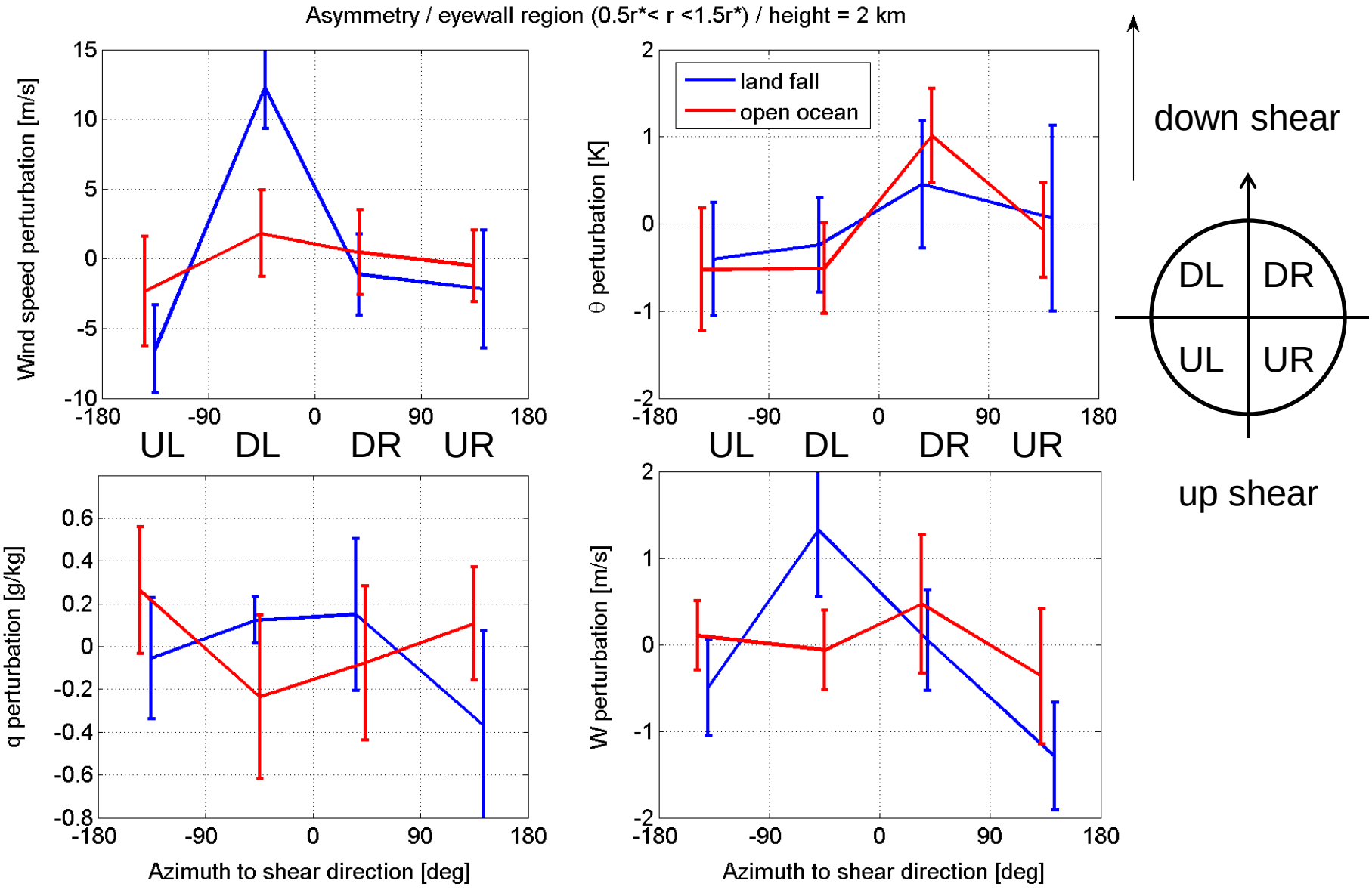
0 degree is from north



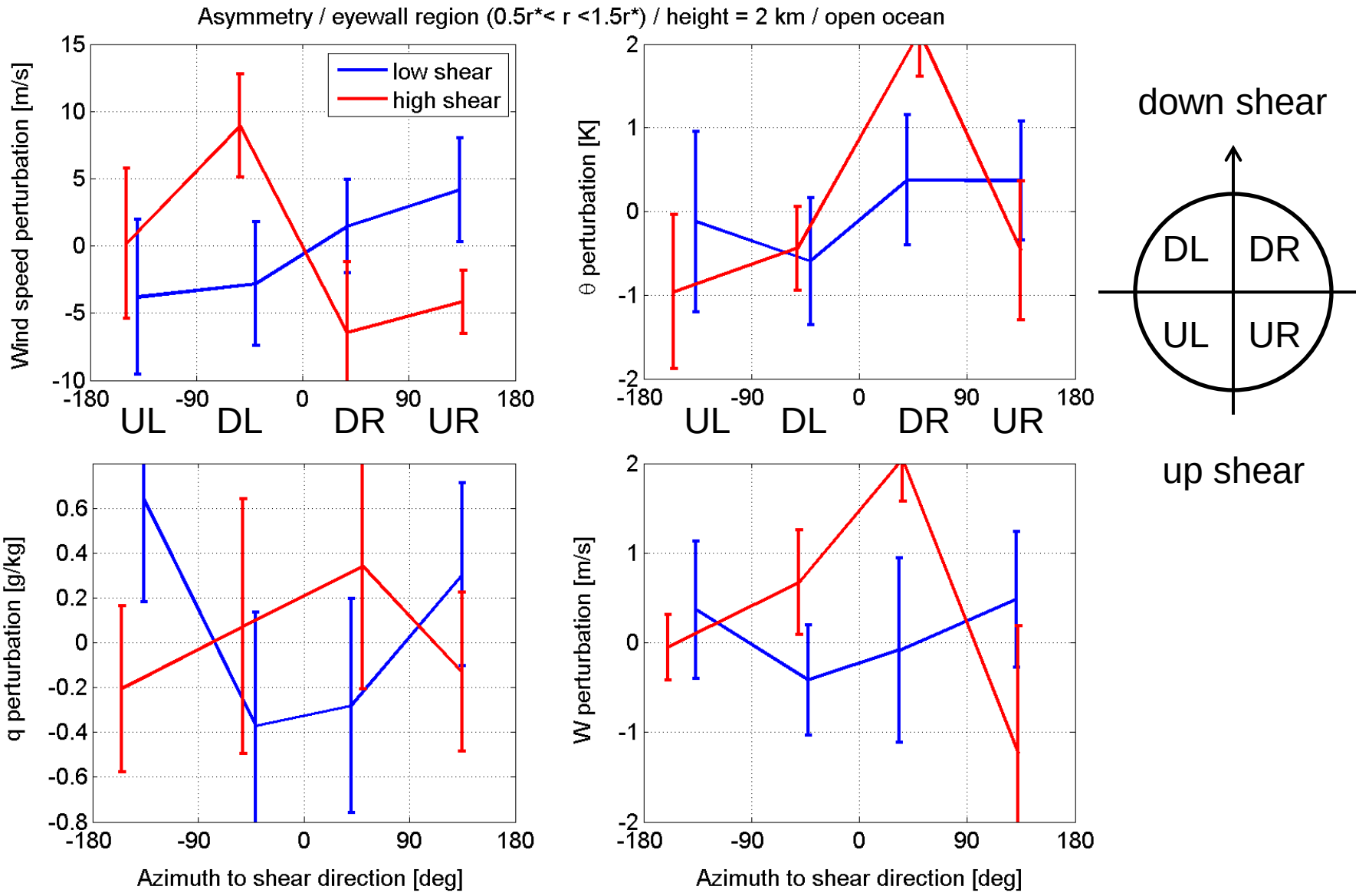


Storm motion data are from the best track data set;
Shear is from the SHIPS database (Courtesy to John Kaplan)

Open ocean vs landfall

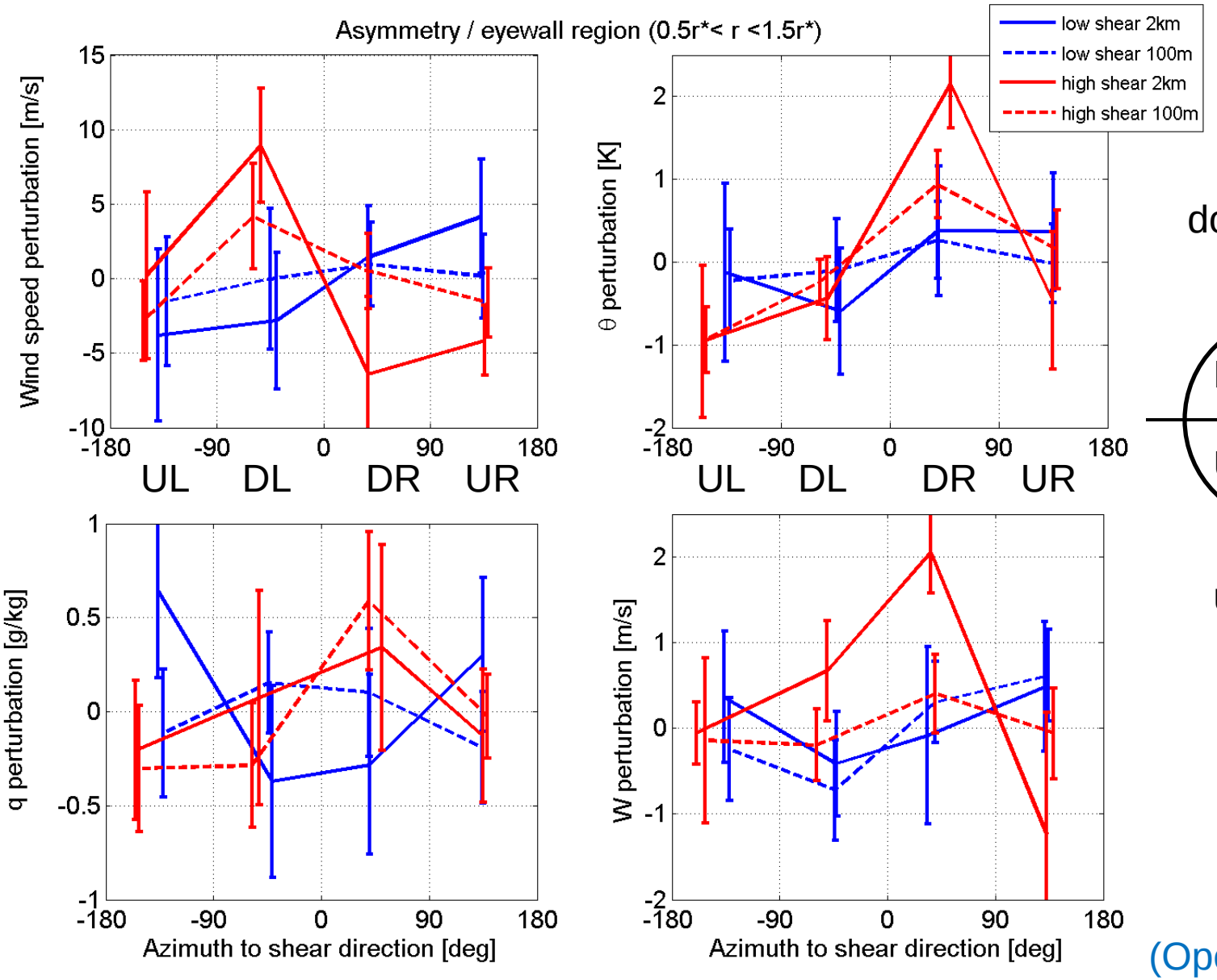


High shear vs low shear



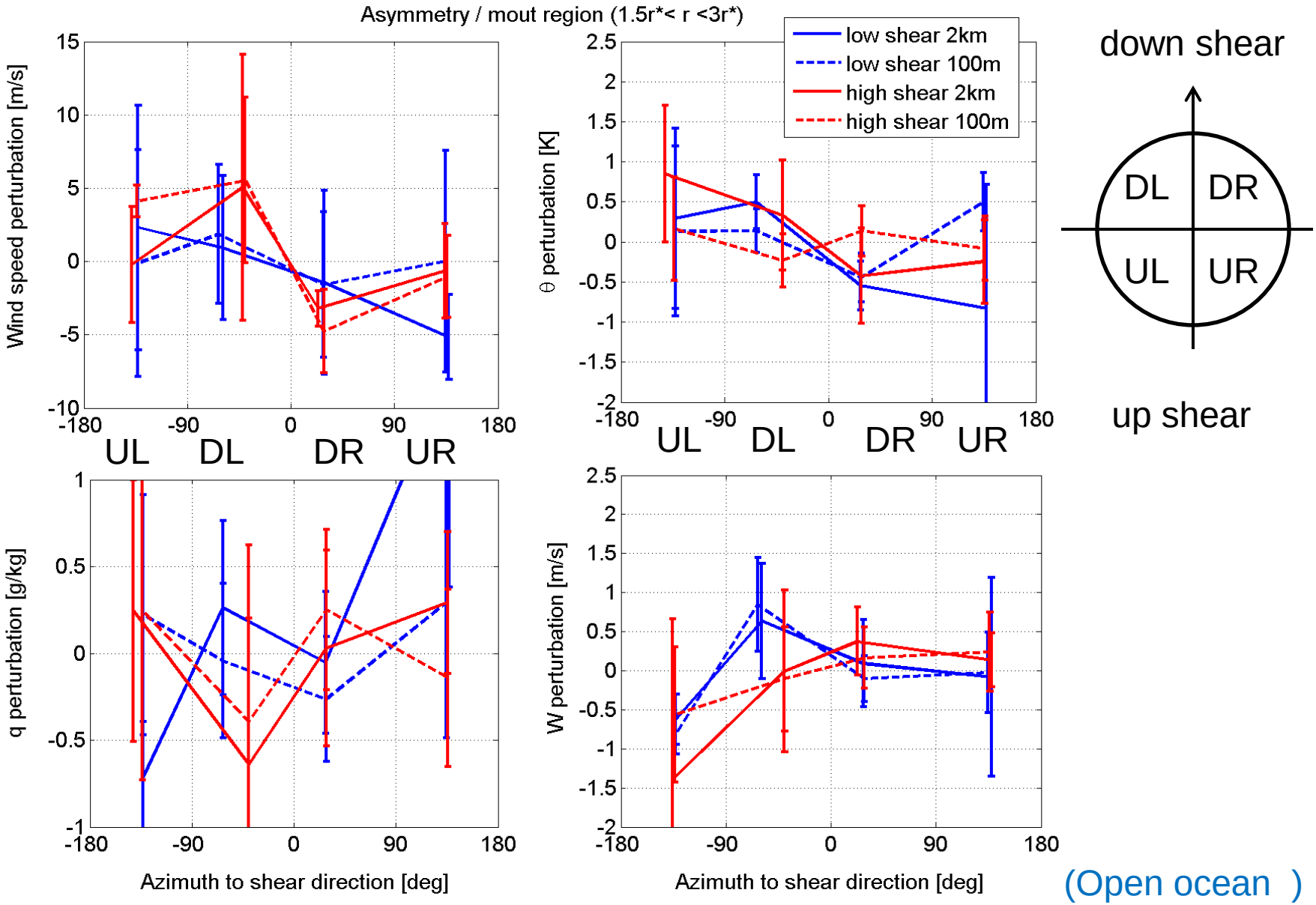
(Open ocean)

2 km vs 100 m [eyewall region]



(Open ocean)

2 km vs 100m [outer core]



(Open ocean)

Summary

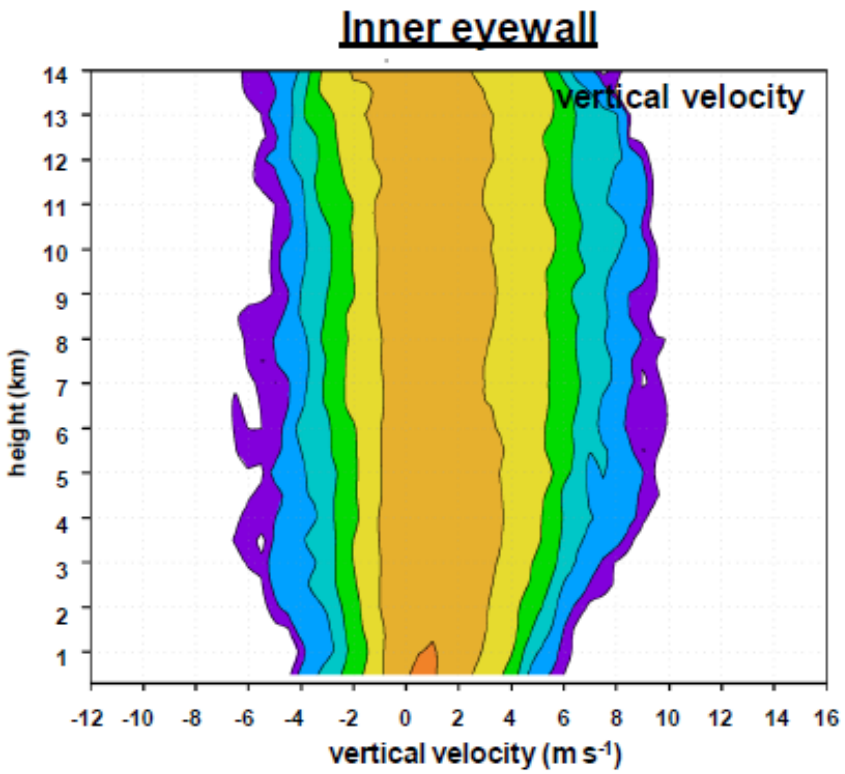
- We found large difference in the BL moisture asymmetry for the data over the ocean and near land, although the phases in the wind speed and potential temperature asymmetries are similar. For the purpose of studying the relationship between vertical wind shear and BL structure asymmetry, we focus on the open ocean cases.
- The results indicate stronger wind speed, cooler and dryer BL structure, at down-shear left region compared to down-shear right at 2 km altitude. The patterns of the asymmetry in the wind speed and vertical velocity are consistent with the composite analysis results conducted by Paul Reasor using the Doppler radar data. The thermal asymmetry agrees also with the reflectivity asymmetry for the two independent datasets.

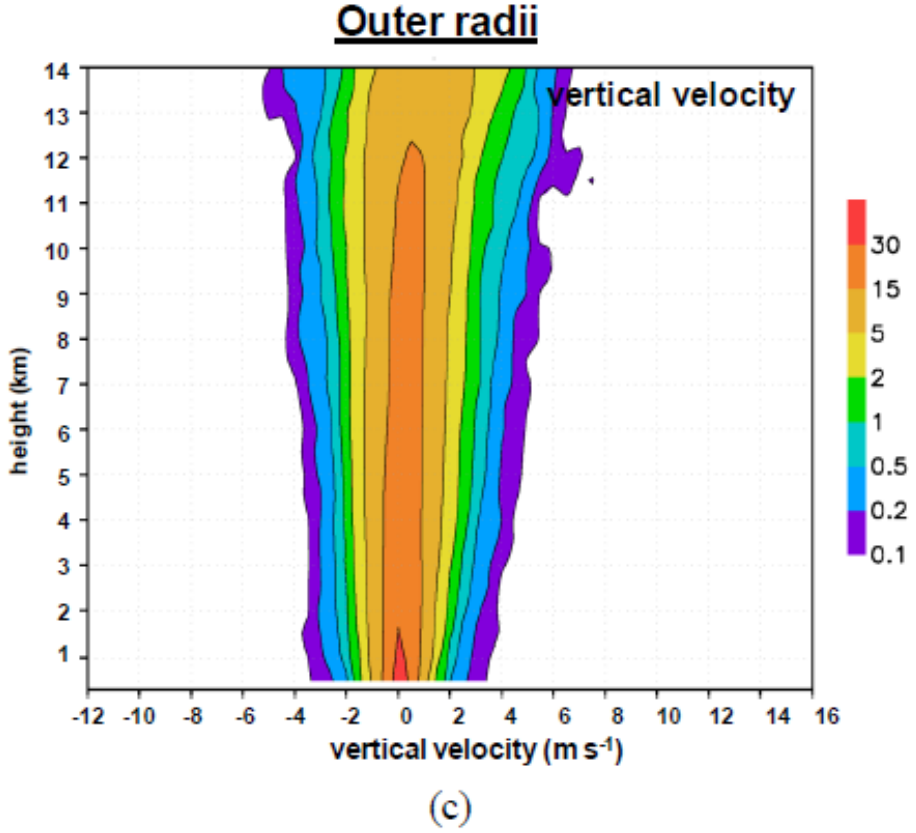
Continue

- The magnitude of the wavenumber one asymmetry in wind speed and temperature is generally larger for the high shear case than the low shear case. The phase of the asymmetry is also different for the two groups. We speculate that the BL asymmetry is influenced more by storm motion than vertical wind shear for the low shear case.
- The magnitude of the temperature asymmetry is larger at higher altitude than near the surface. We hypothesize that convective downdrafts are weaker near the surface compared to the upper levels.
- The patterns of the wind speed asymmetry are comparable to each other in the eyewall and outer core regions, but there is almost no significant thermodynamic asymmetry in the outer core region. The phases in the potential temperature asymmetry changed from the eyewall to the outer core region.

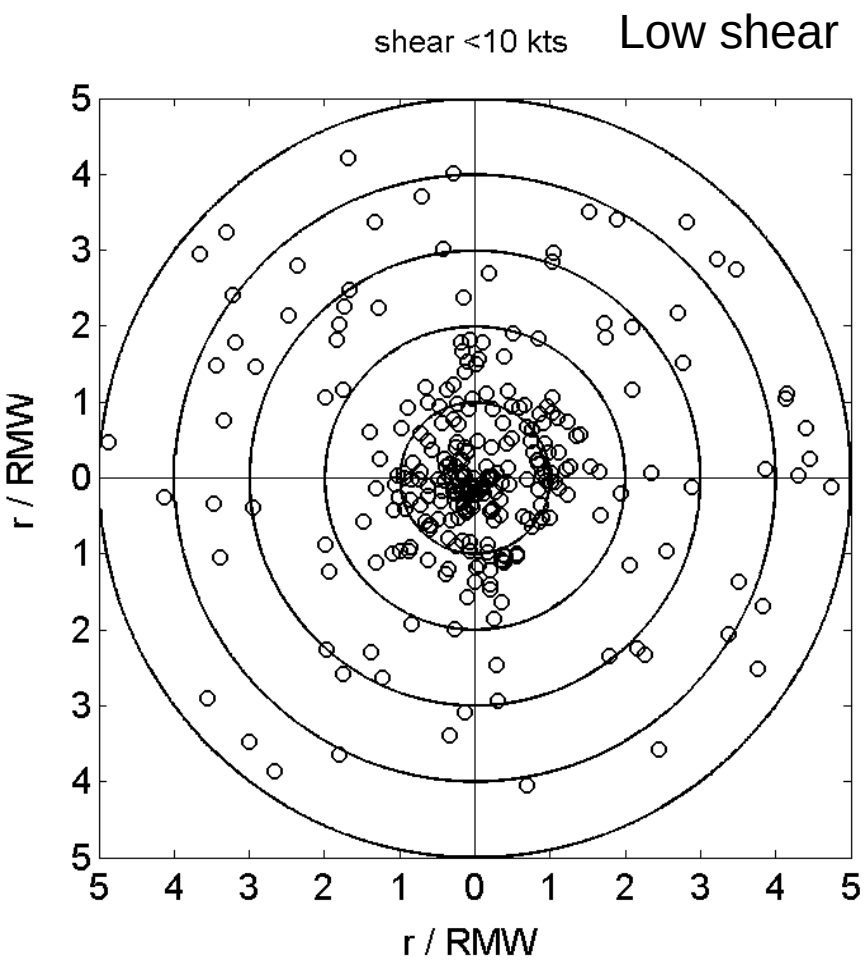
CFAD w from Doppler radar

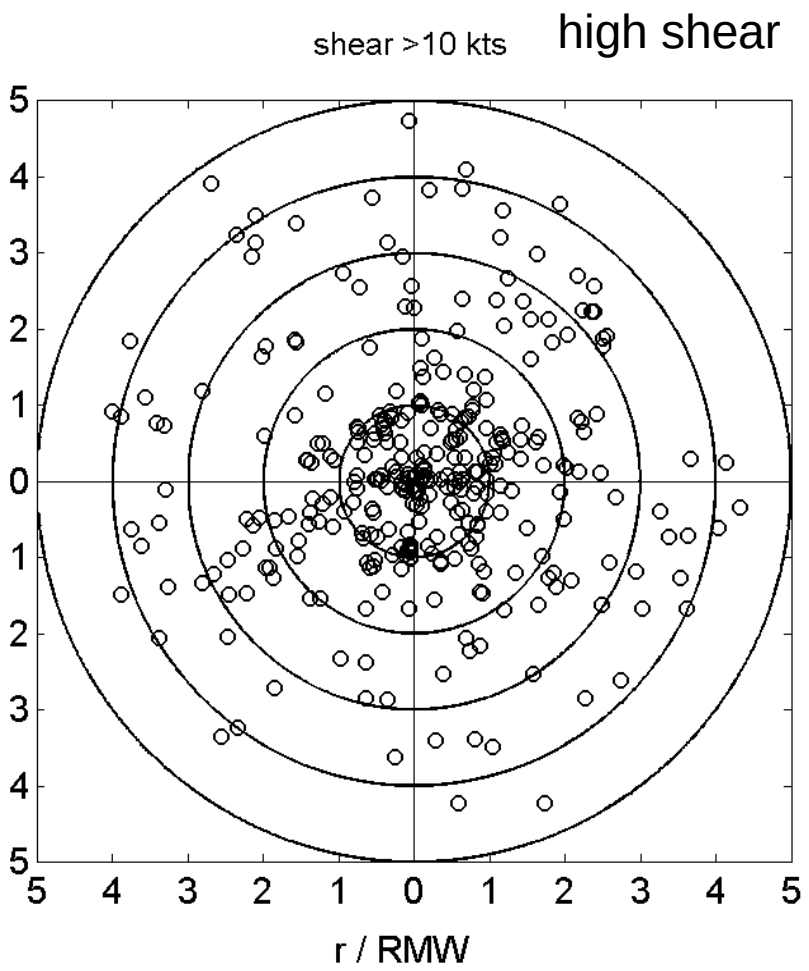
Rogers et al. (2012)





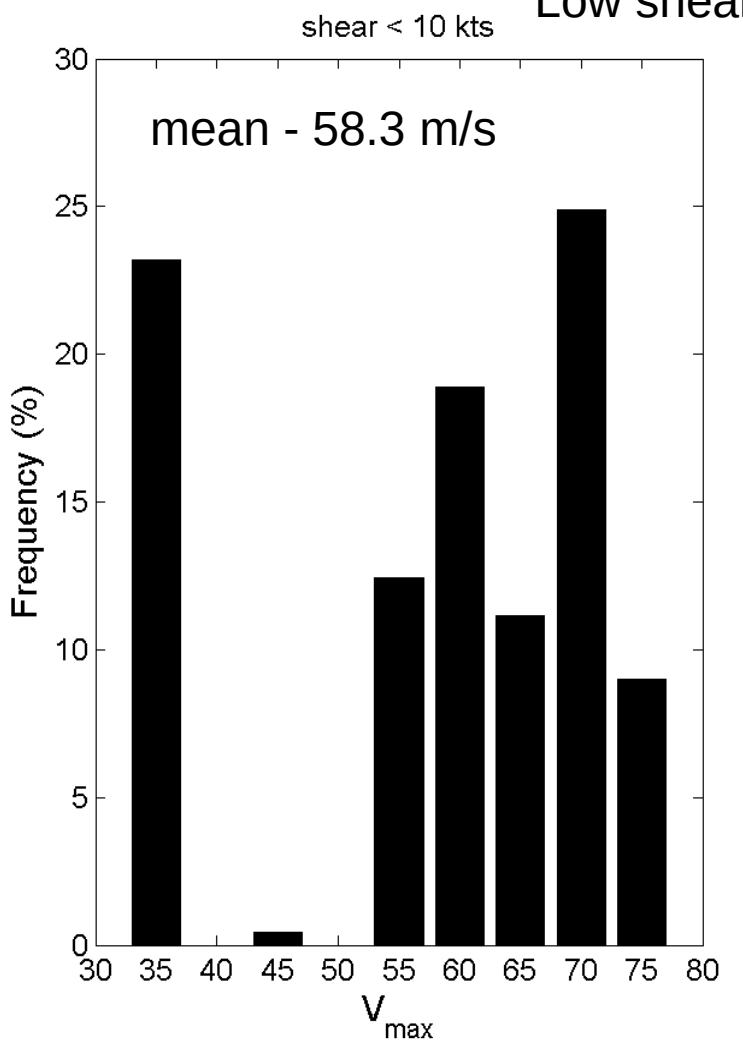
Data distribution





Storm intensity

Low shear



high shear