

Small-scale surface temperature variability affected by rain during SPURS-2

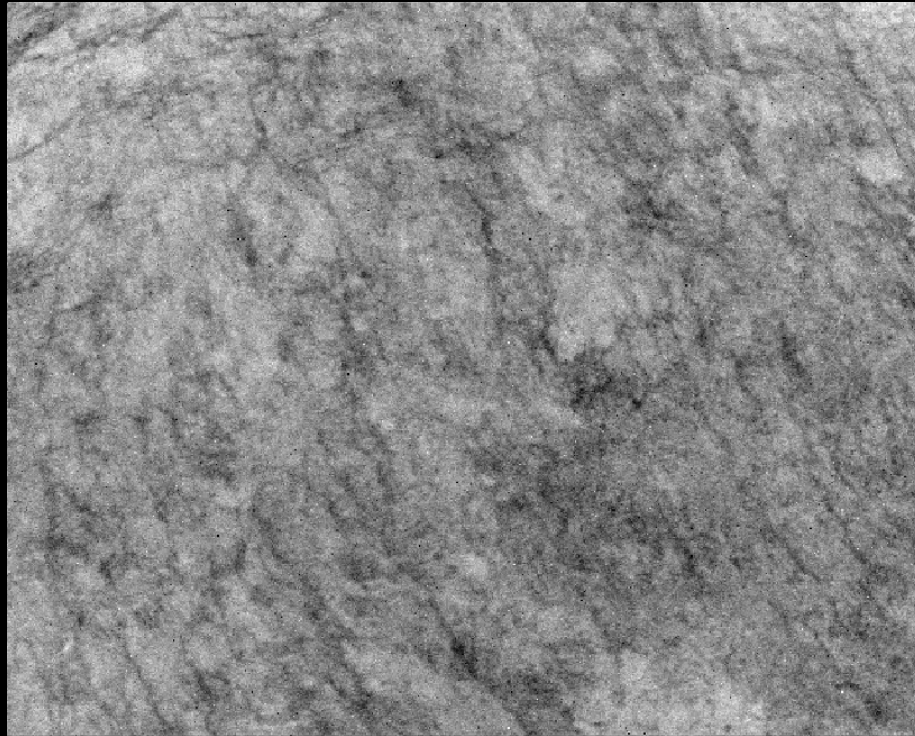
Chris Chickadel, Kyla Drushka, Bill Asher,
Elizabeth Thompson, Pete Gaube, Andy Jessup

Global Ocean Salinity and the Water Cycle Workshop 2017, WHOI

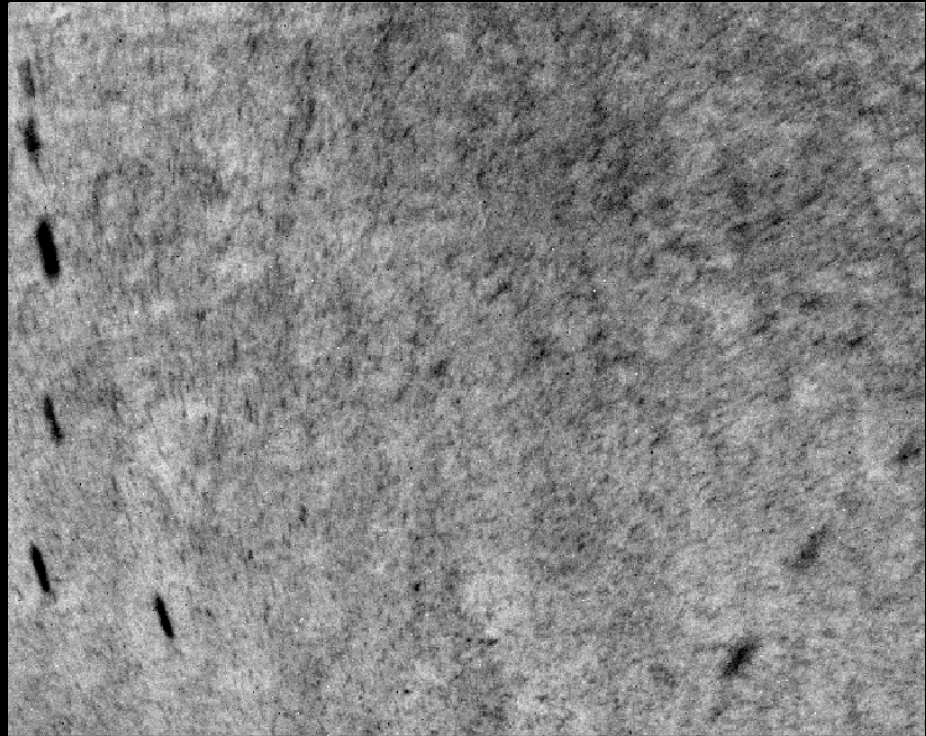


Thermal imagery from SPURS-2

Wind 6 m/s, no rain



Wind 5.6 m/s, 55 mm/hr rain

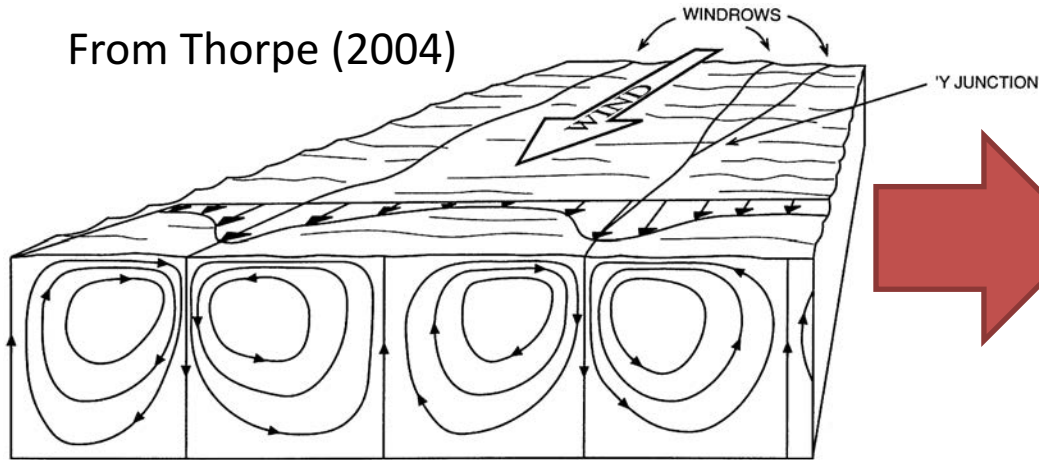


0.5 Δ C temperature range displayed
warm = bright

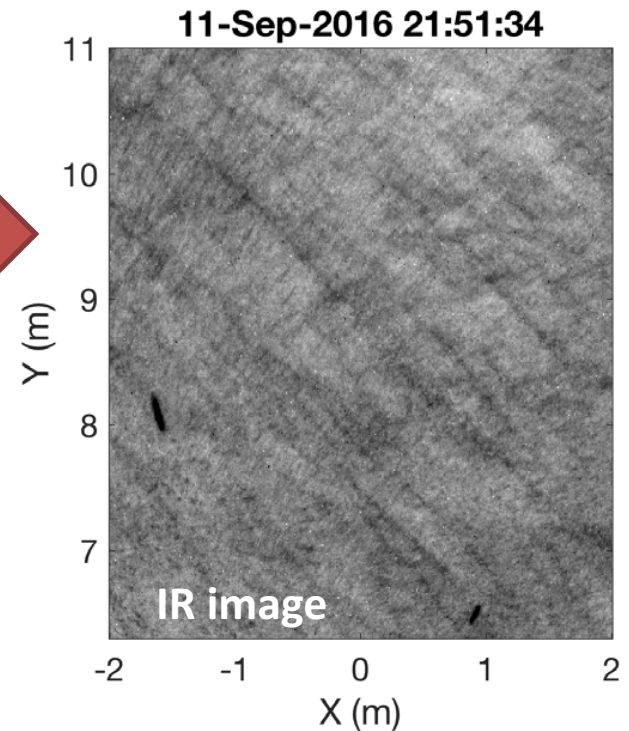


Goal: Use thermal imaging to understand ocean surface mixing during rain events.

From Thorpe (2004)



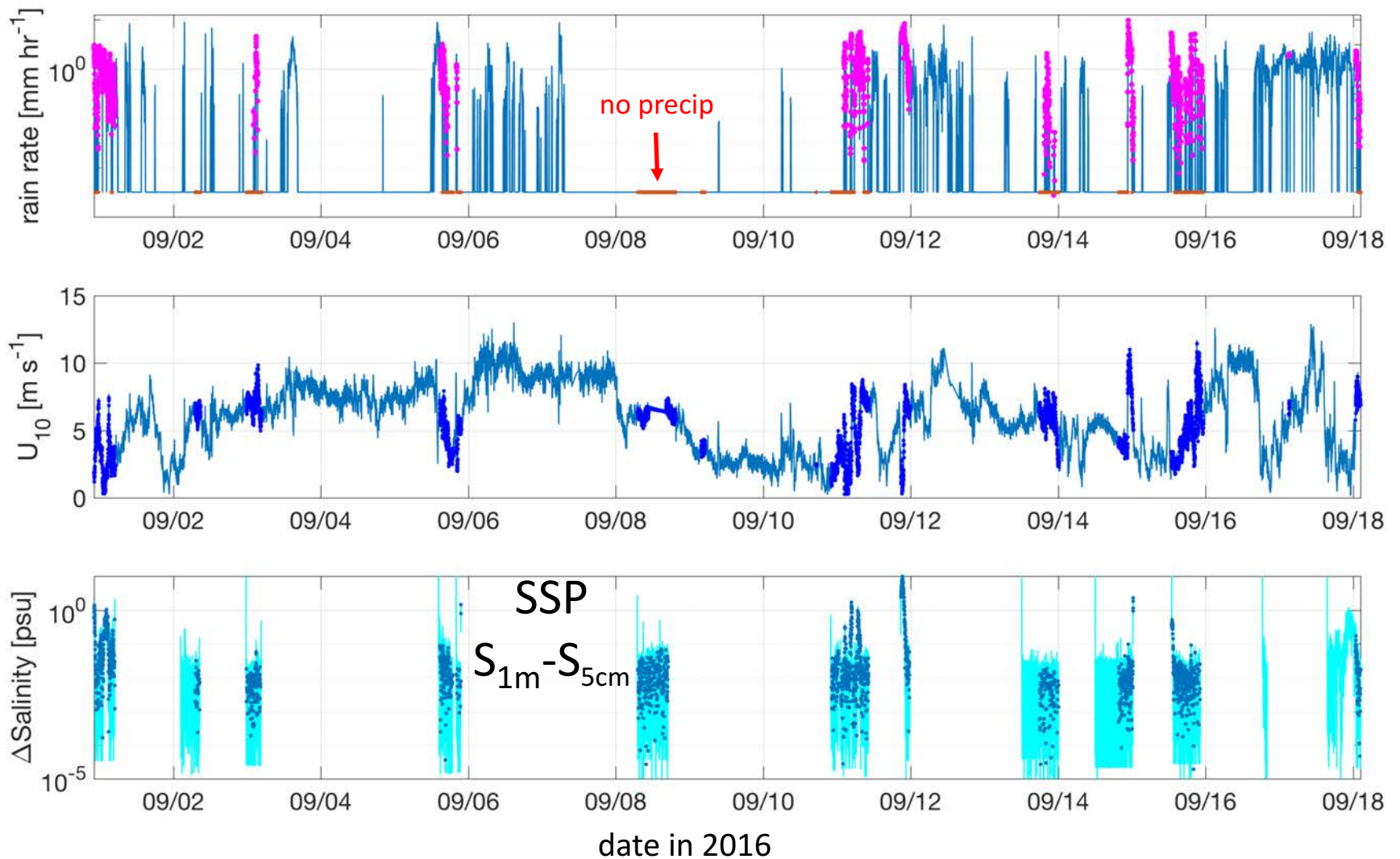
- LC scale with some mixing depth
- *Veron and Melville (2001)* suggest small streaks scale with shear layer depth



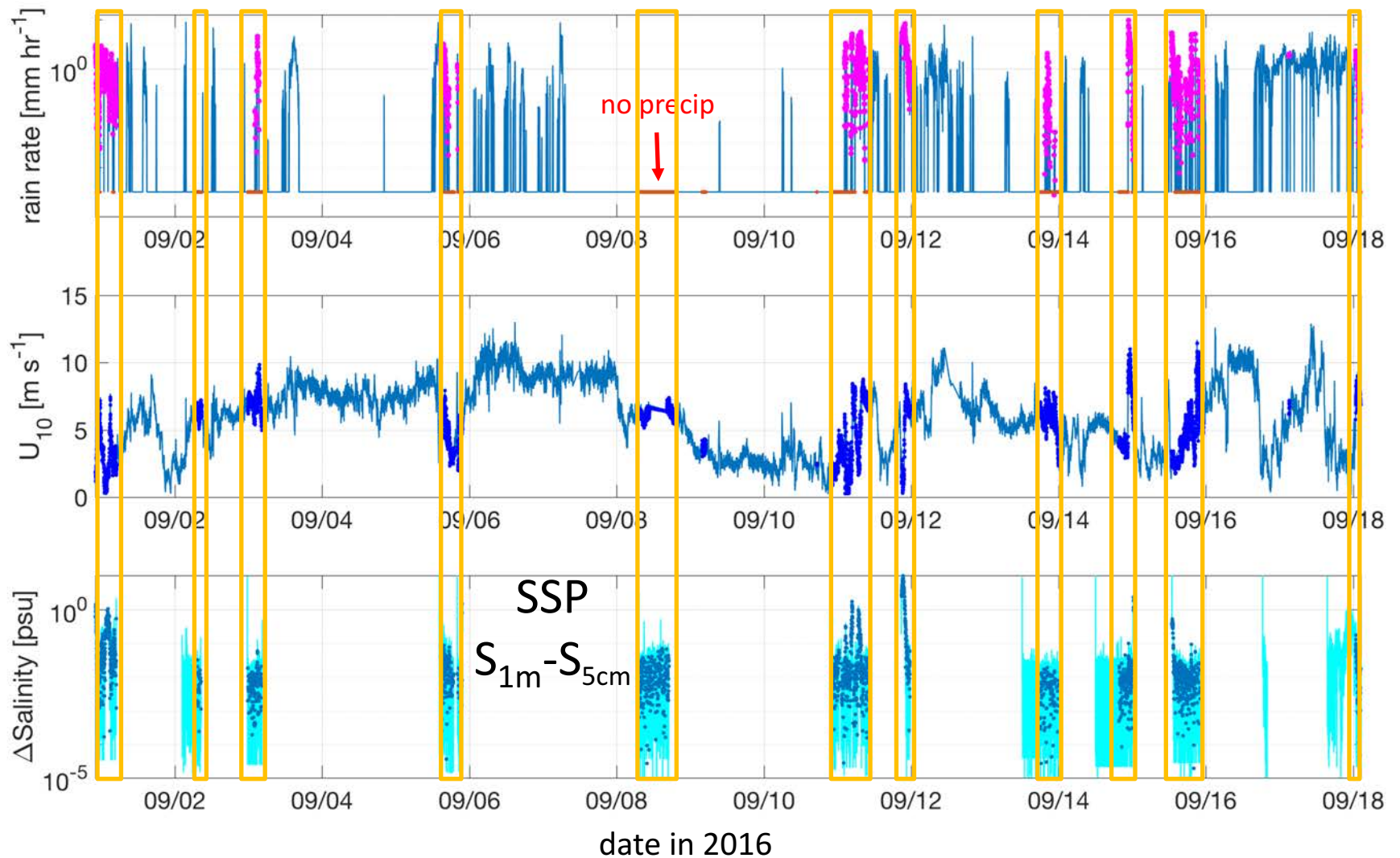
Surface streaks represent secondary circulation mixing scales and are part of the processes in mixing rain lenses

- How do streaks vary with rain events?

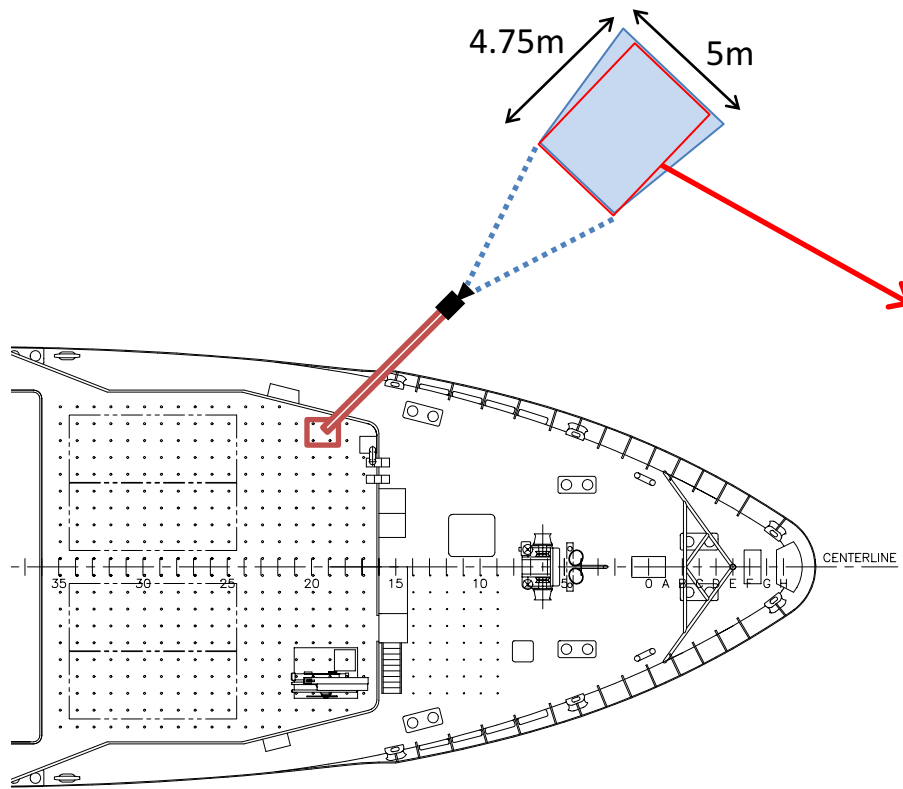
Sampling Conditions



Sampling Conditions

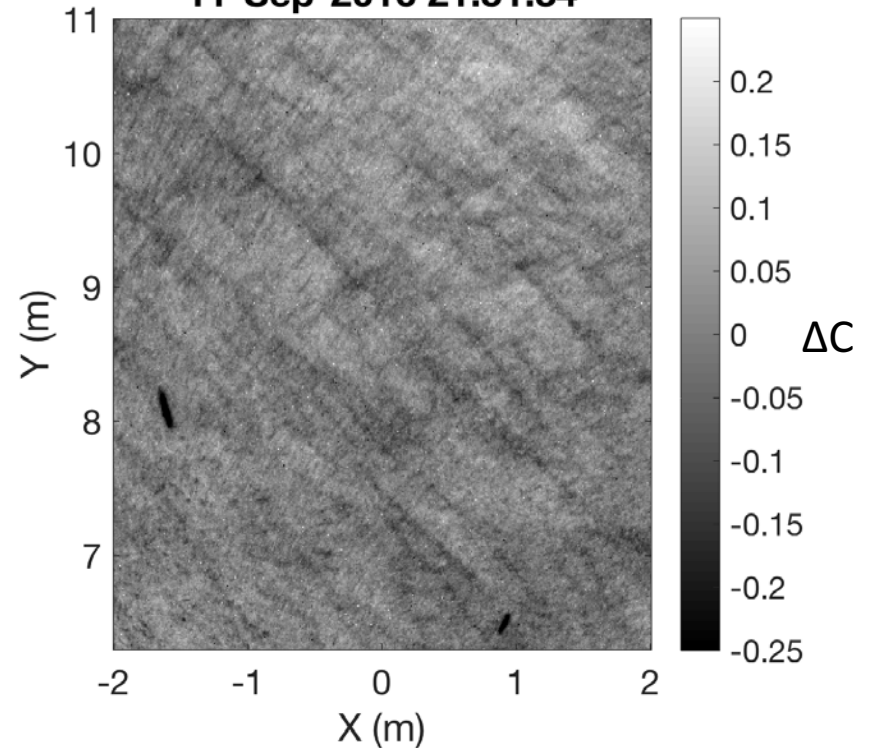


SPURS-2 thermal camera deployment

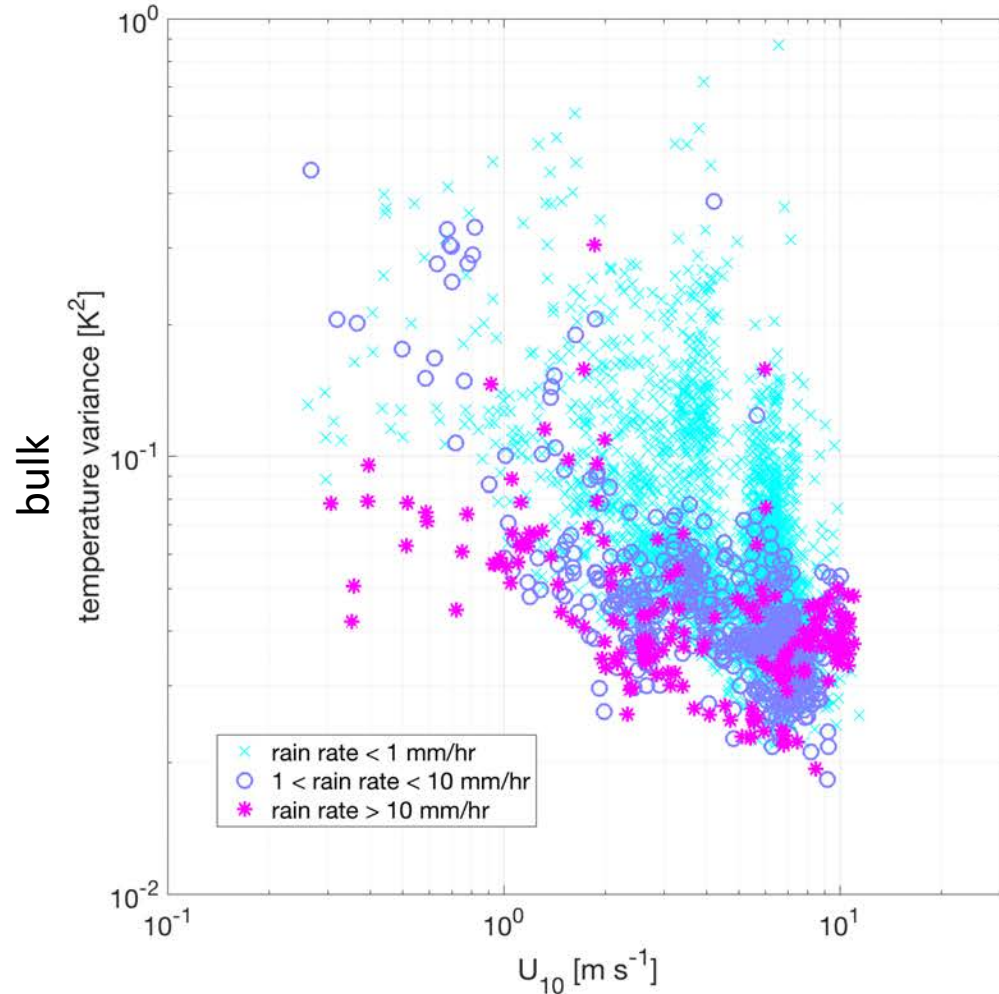


Rectified IR image

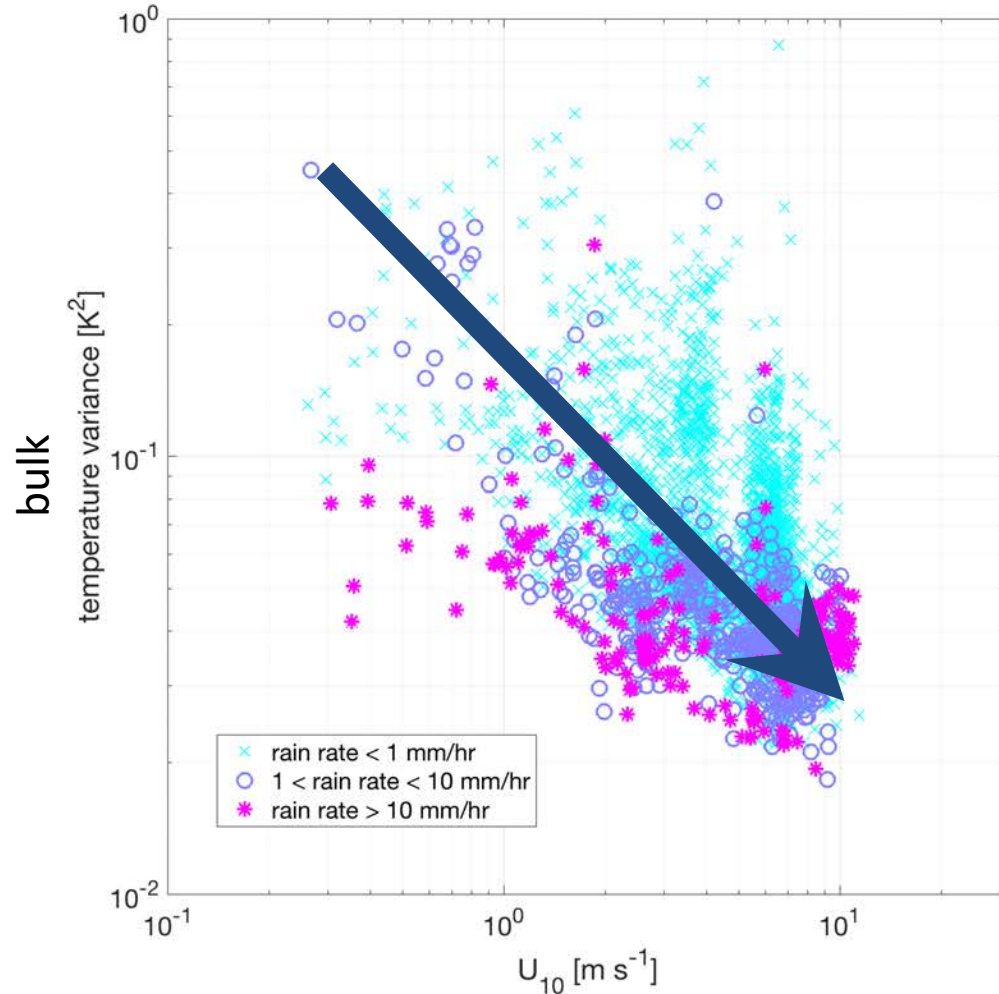
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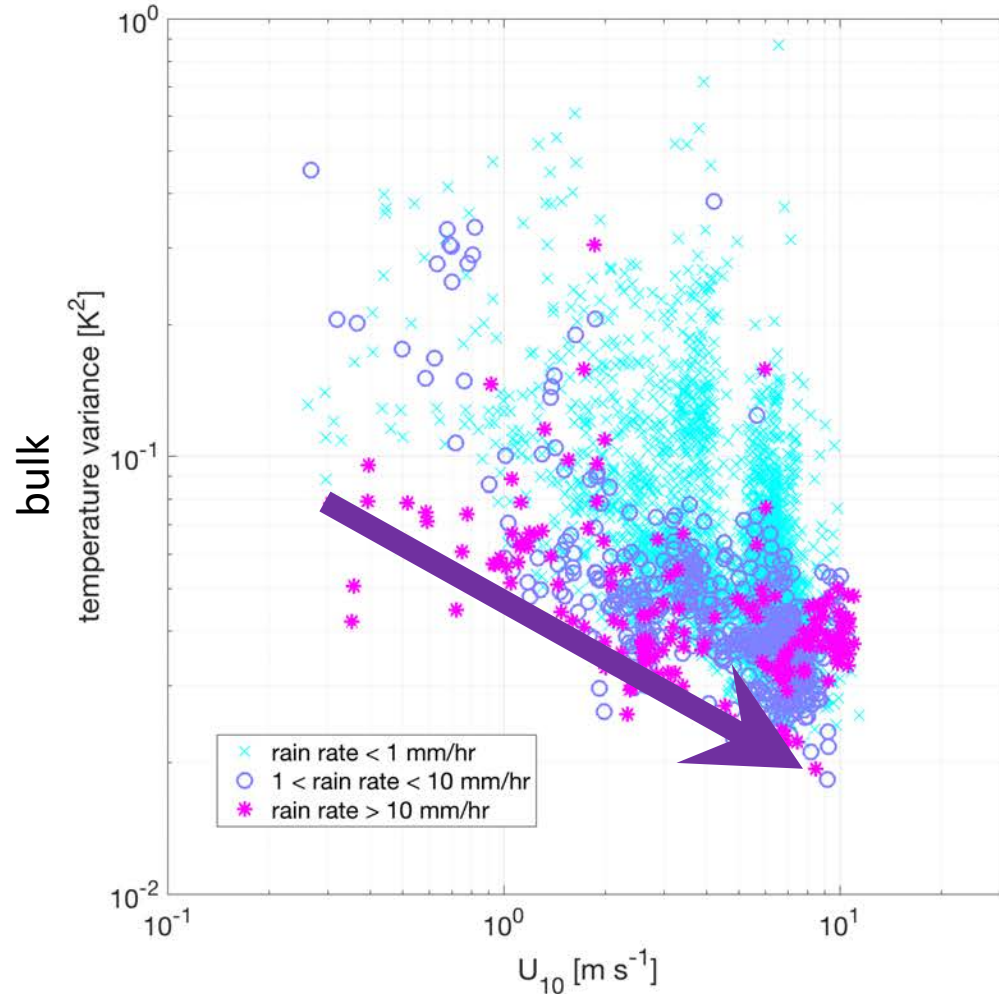
Skin temperature variance and rain rate



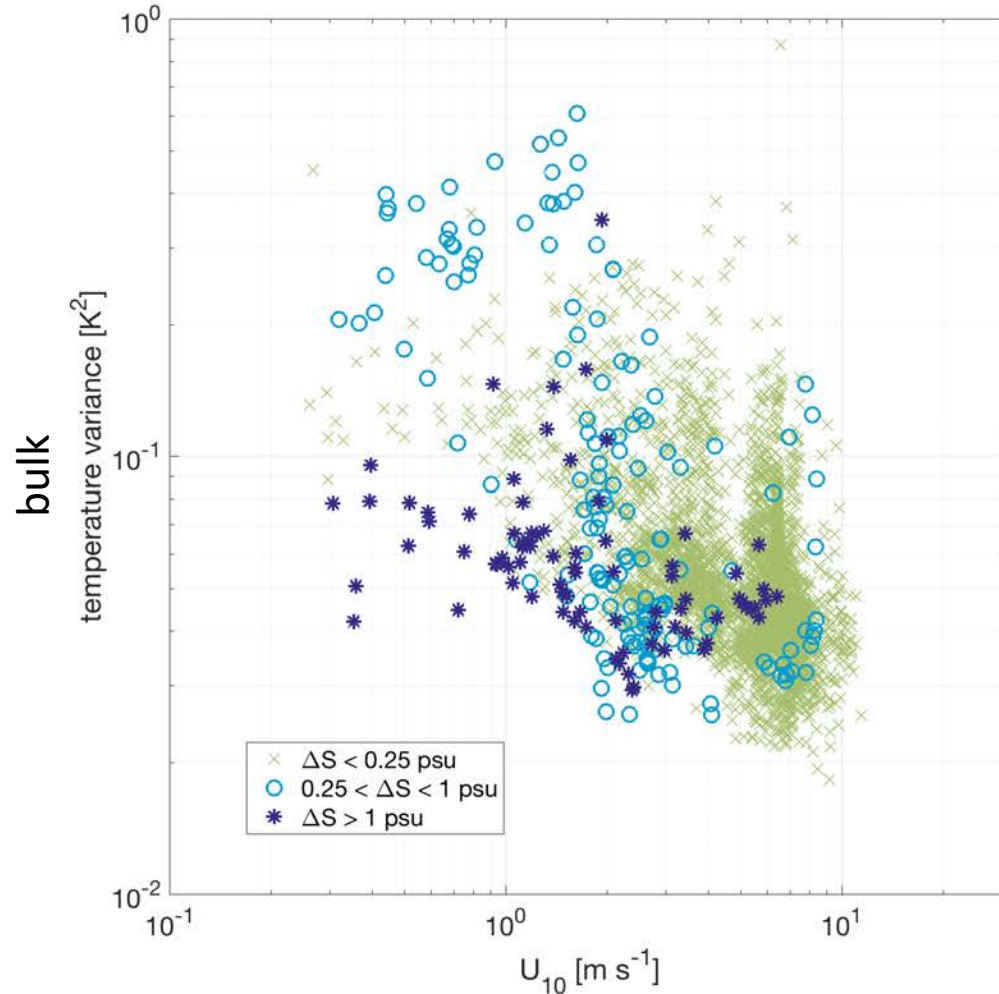
Skin temperature variance and rain rate



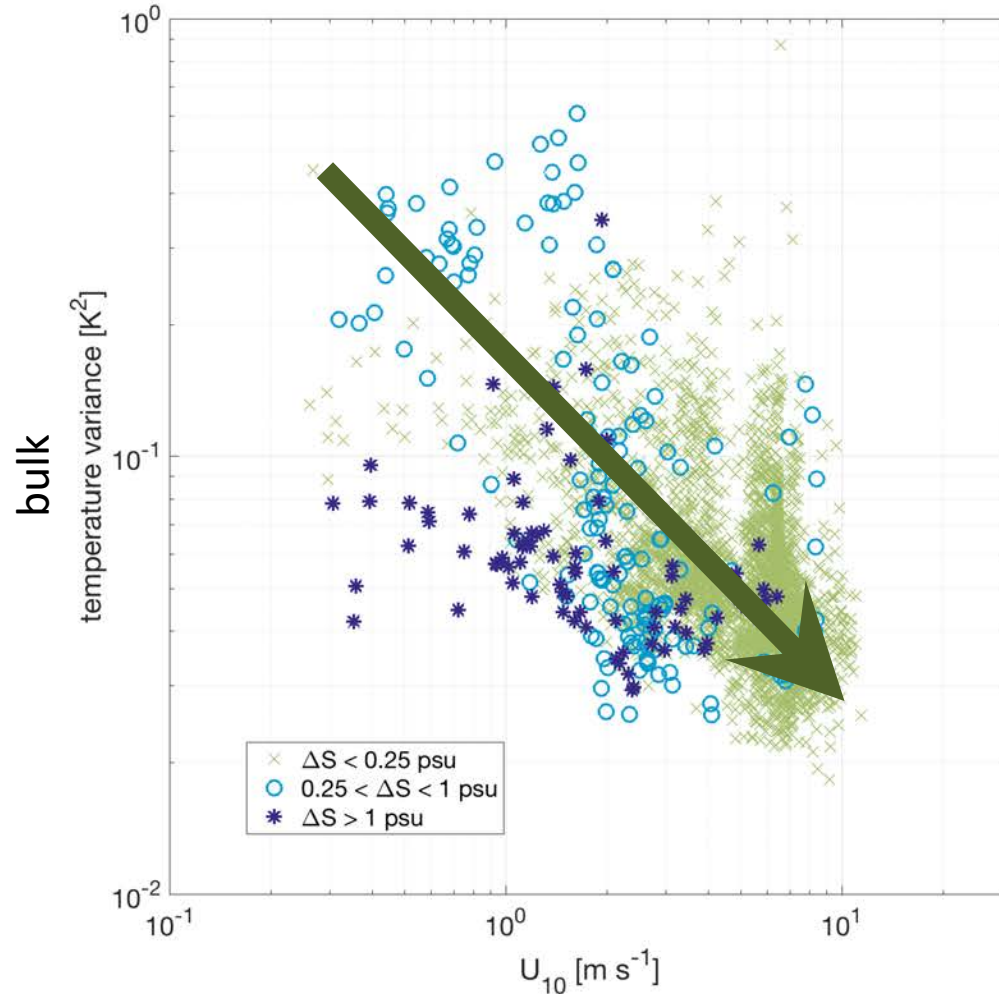
Skin temperature variance and rain rate



Skin temperature variance and stratification



Skin temperature variance and stratification



Skin temperature variance and stratification

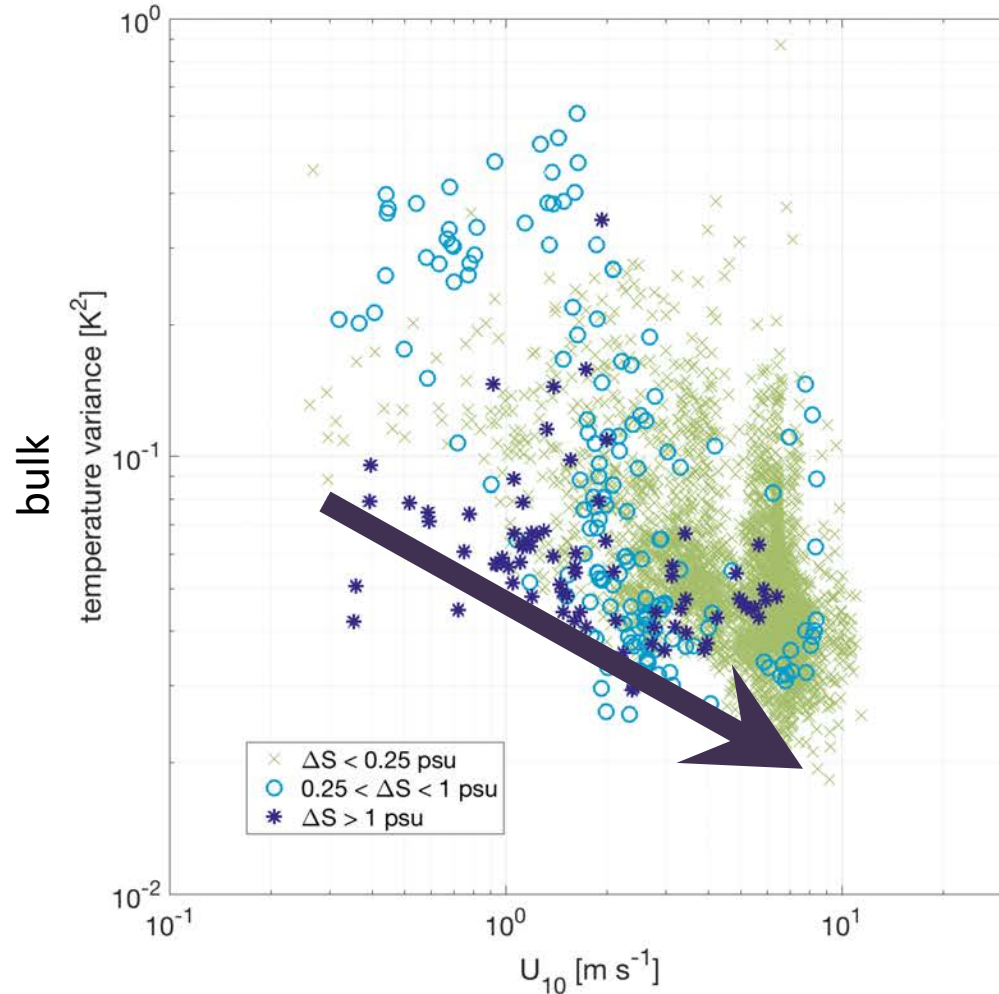


Image processing for streaks

2D Fourier transform

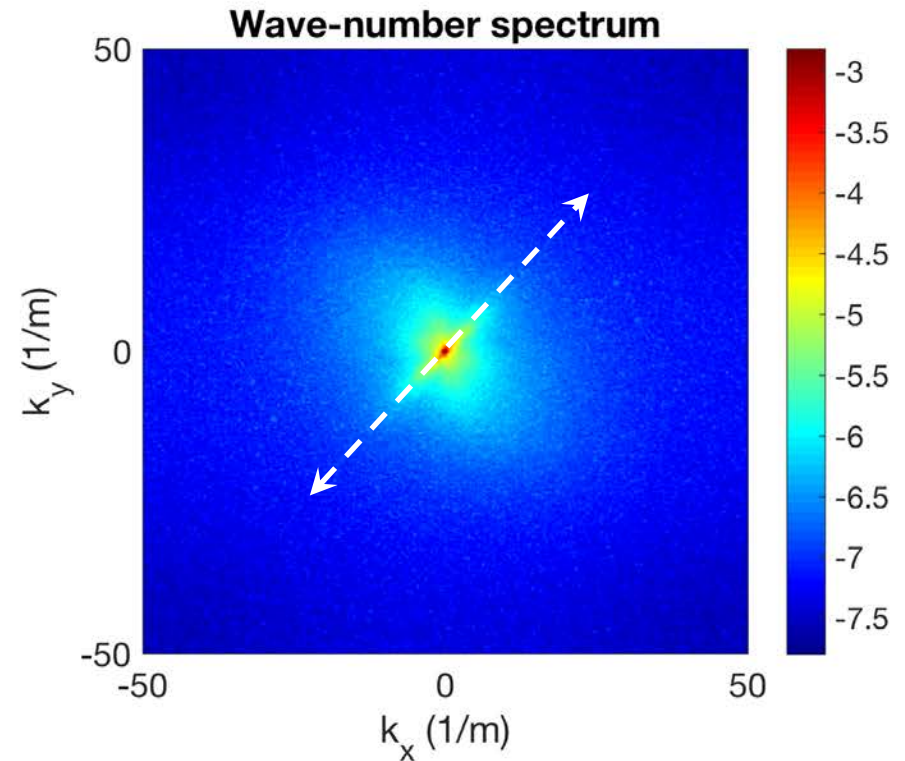
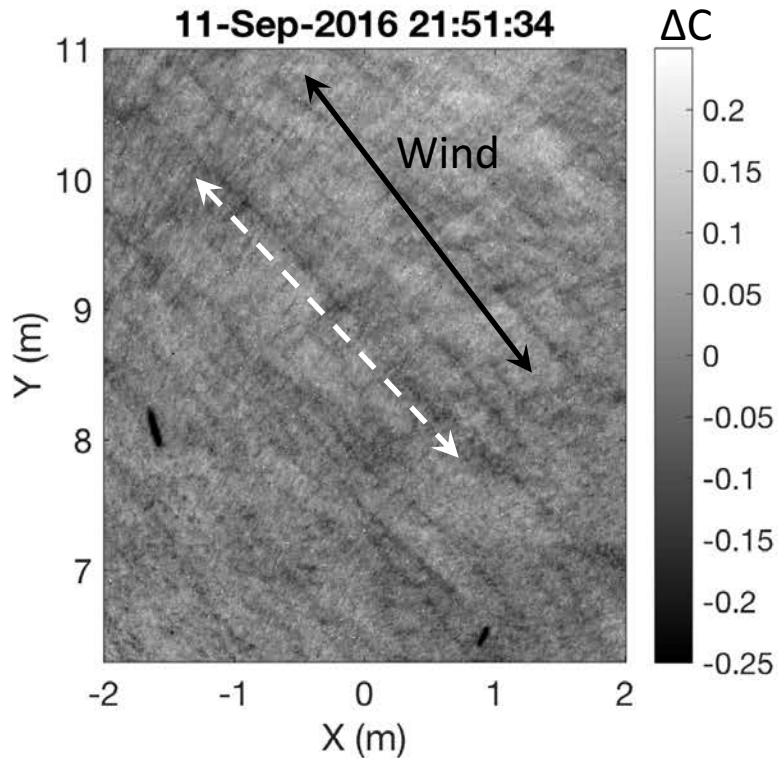
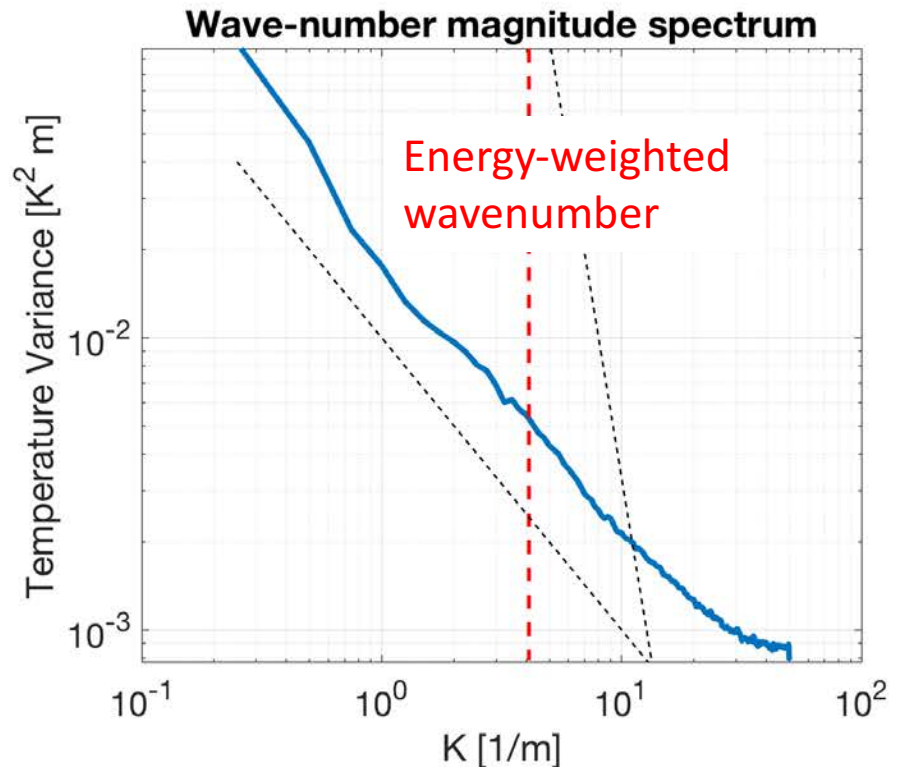
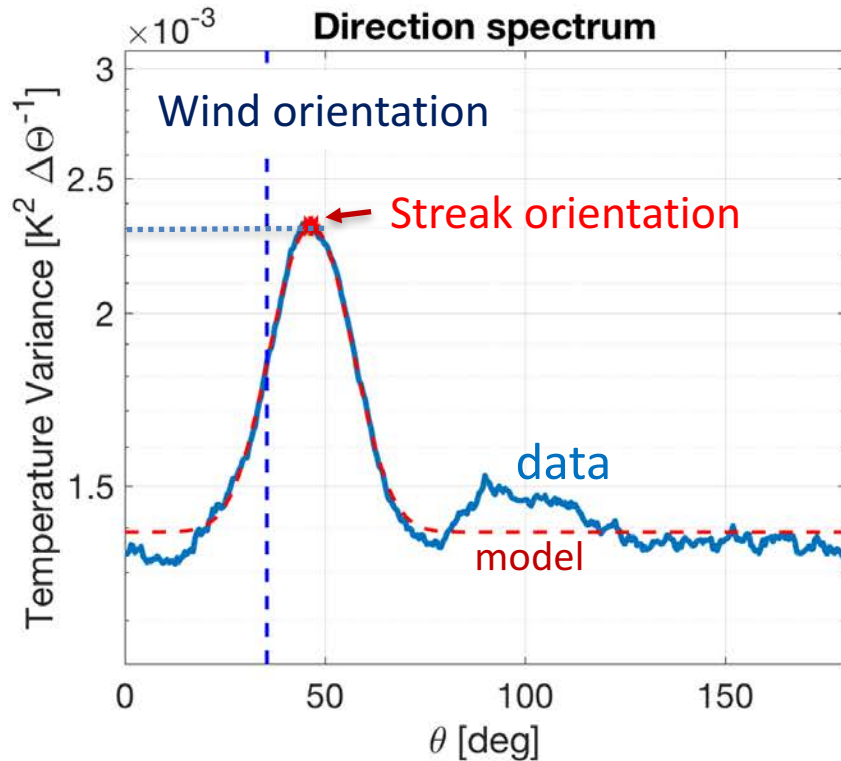
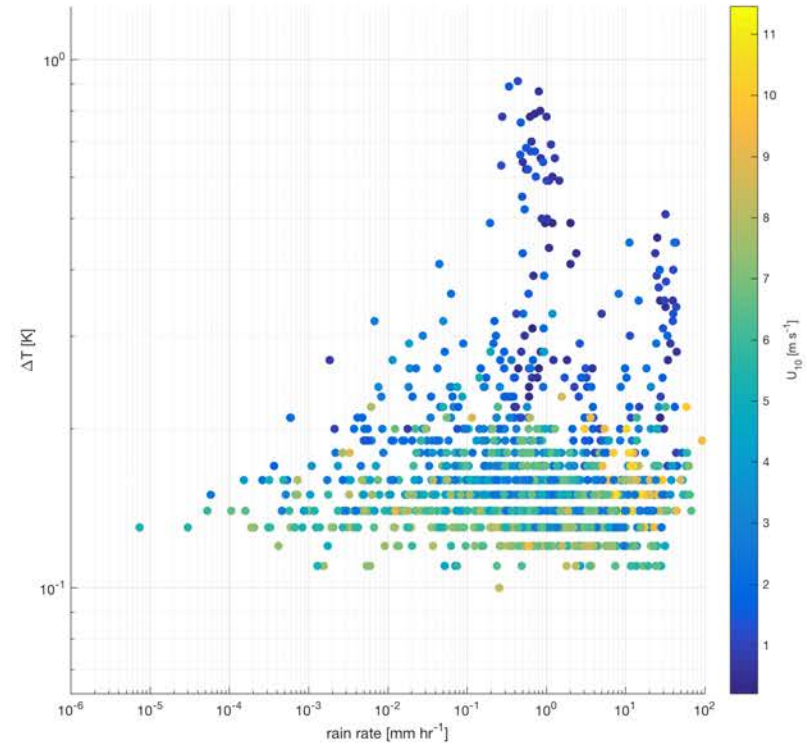
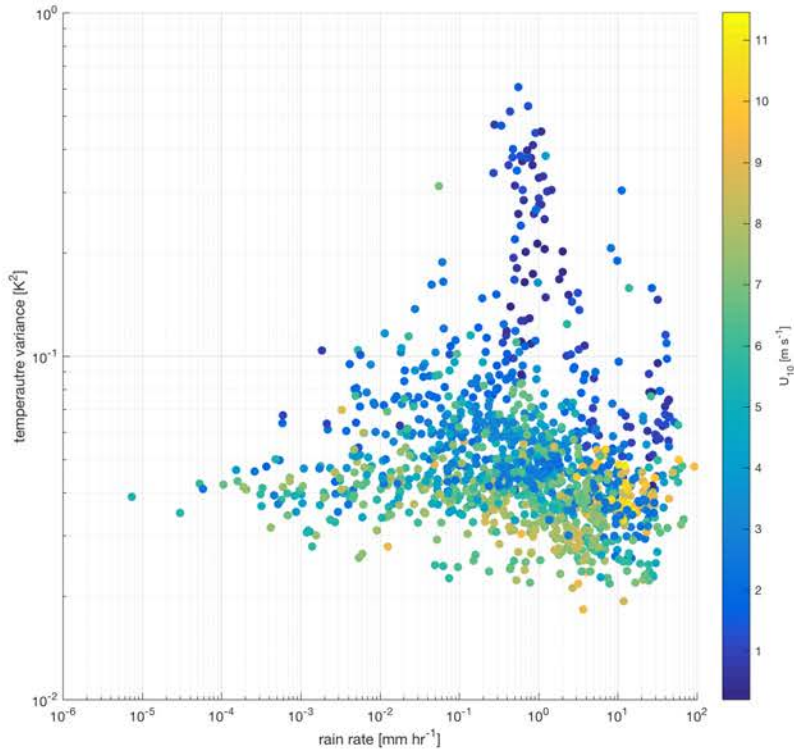


Image processing for streaks

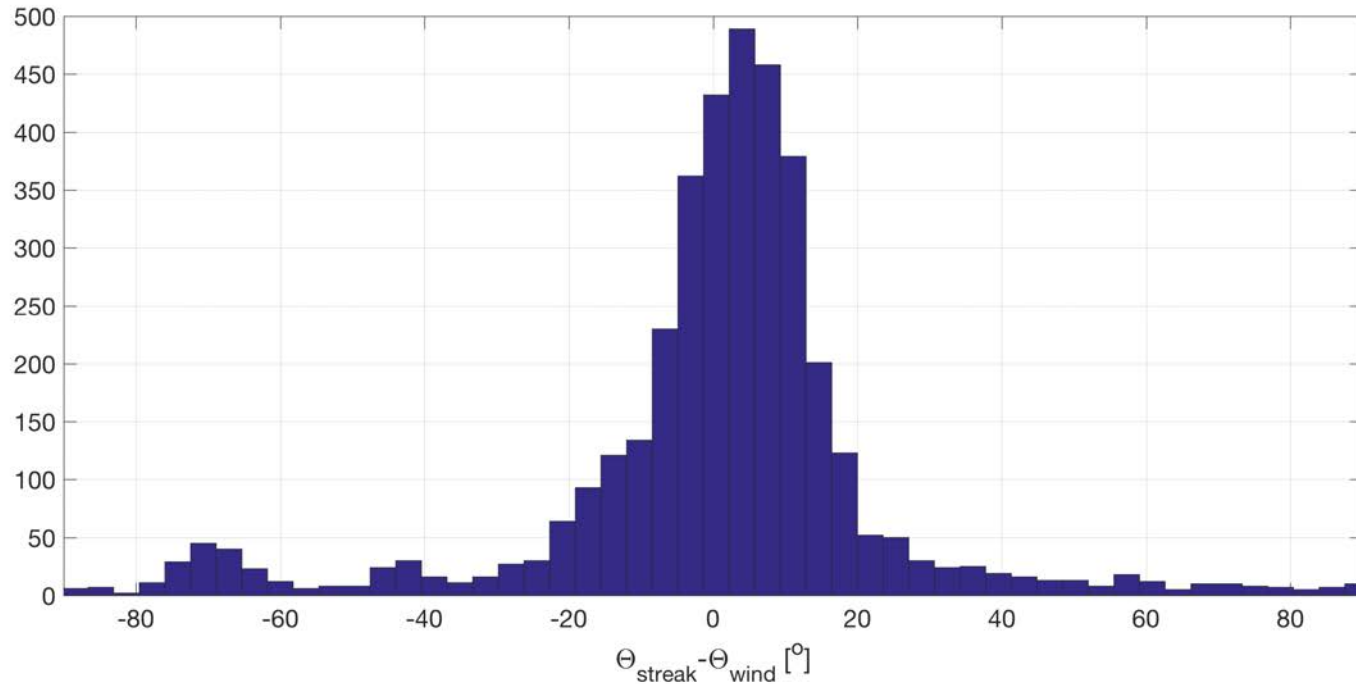
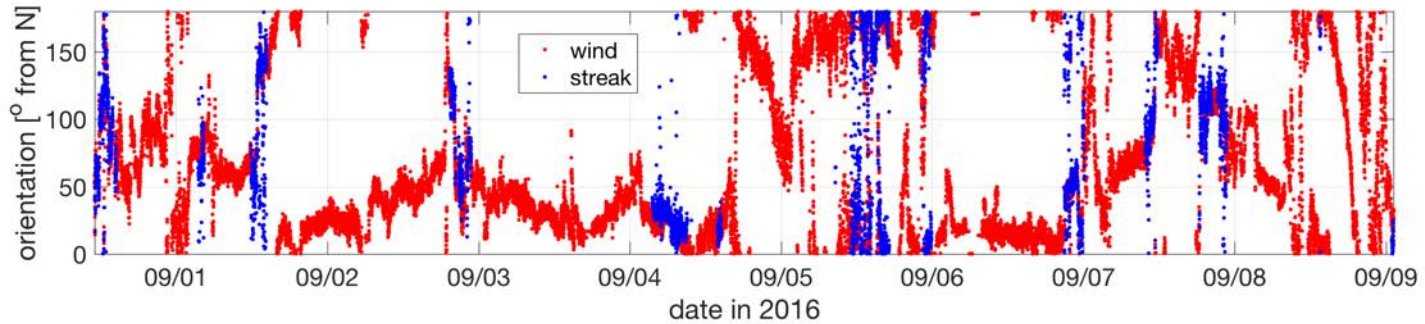
- Transform k_x - k_y spectrum to K and θ spectra
- Determine streak orientation and scale (spacing)



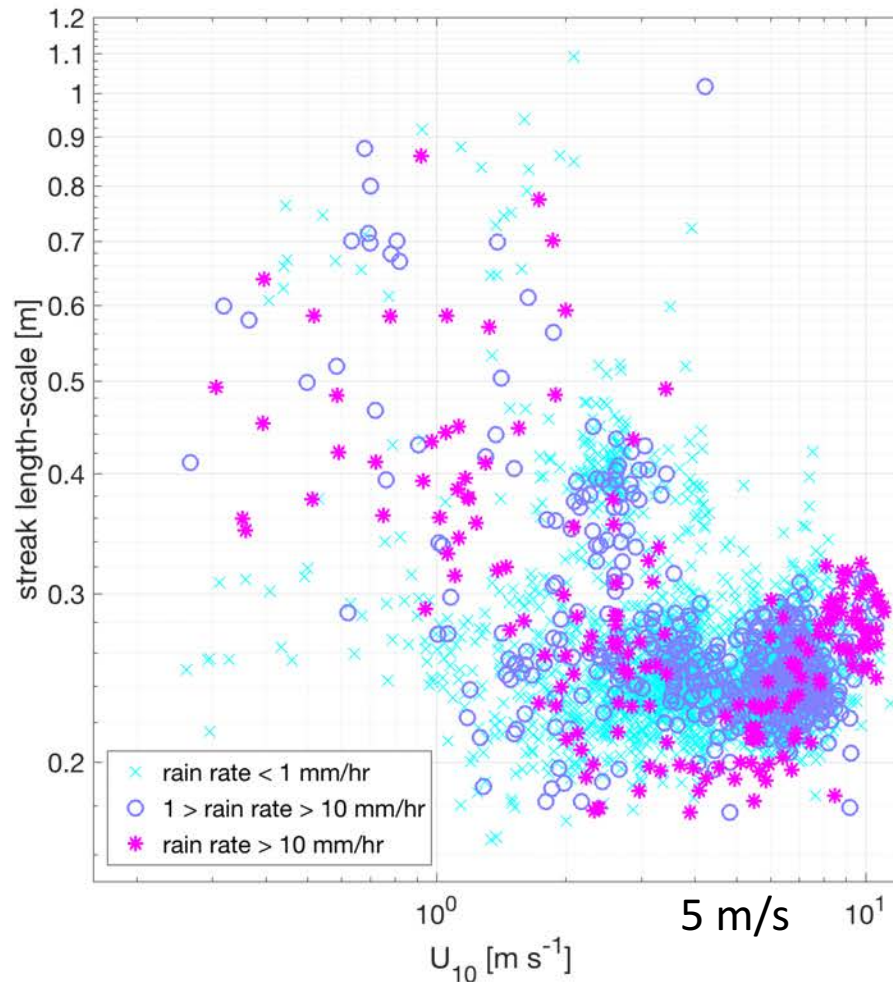
Temperature variance vs. rain rate and wind



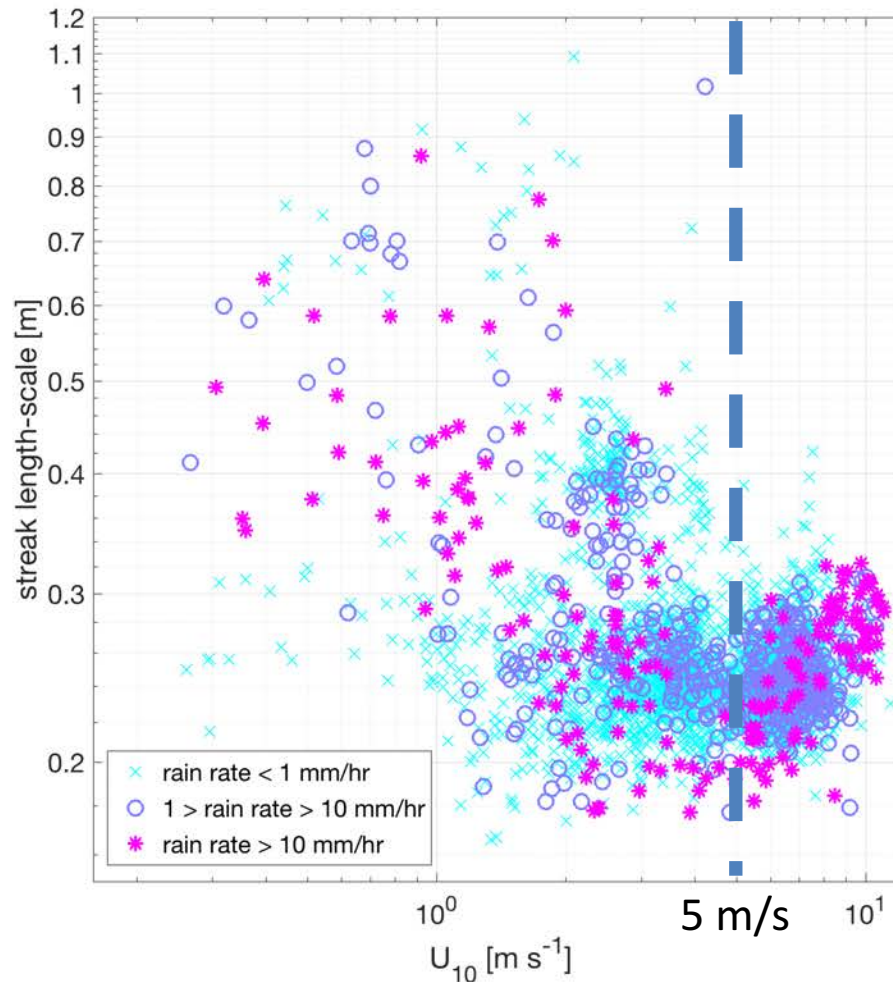
Streak-wind alignment



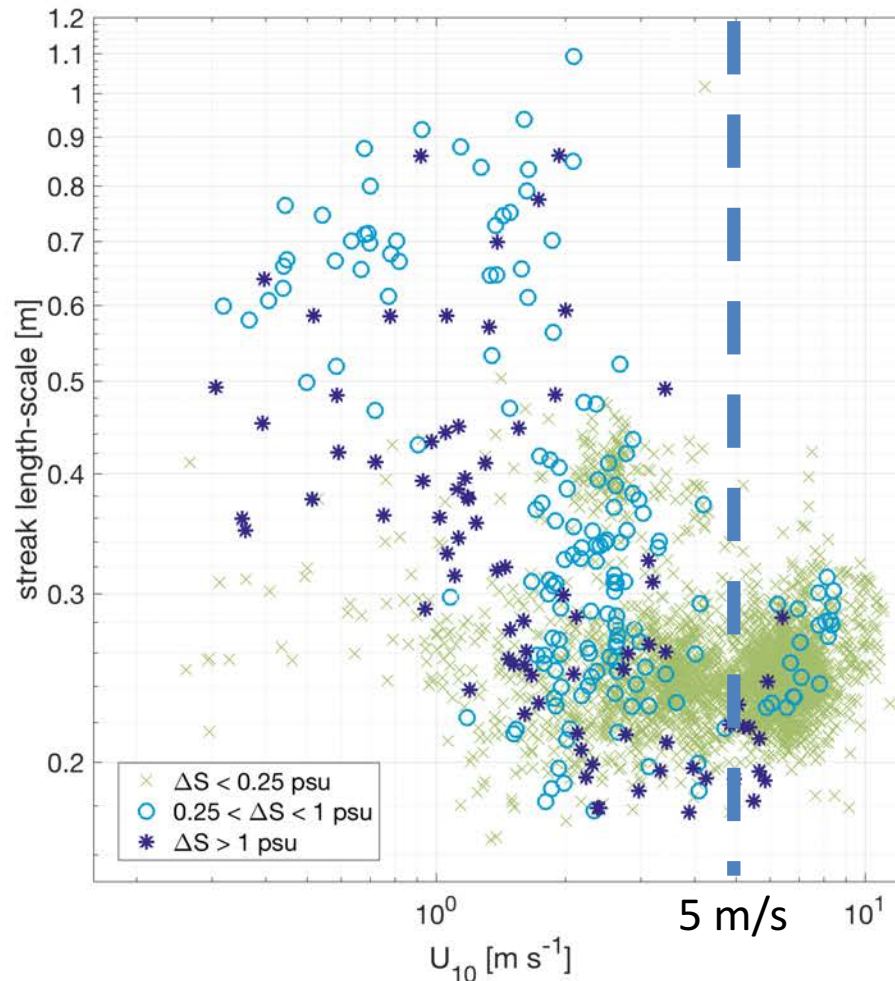
Streak length-scale and rain rate



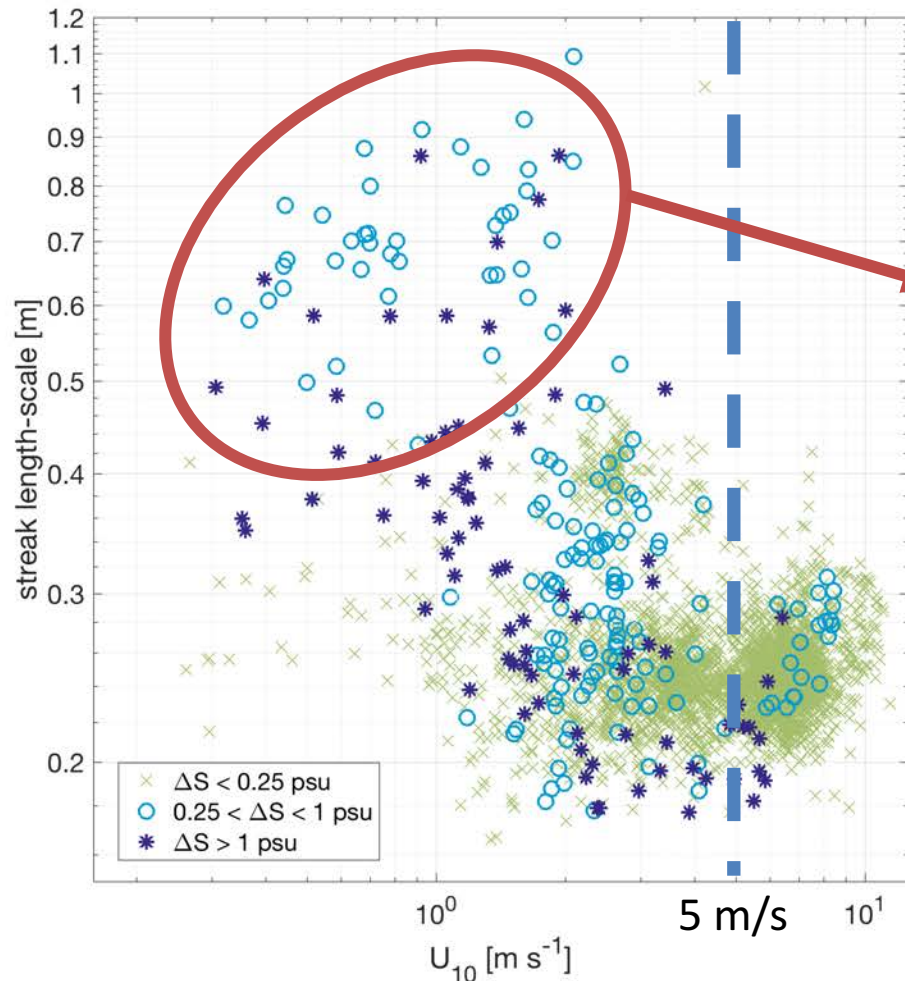
Streak length-scale and rain rate



Streak length-scale and stratification



Streak length-scale and stratification



Well-defined surface layer from previous events?

Summary

- Overall skin temperature variance
 - Largest under lowest winds
 - Moderated by rain (most variability with least/no rain)
- Streaks
 - Aligned with wind, consistent with Langmuir-type circ.
 - Length-scale decreases with wind, largest under highest stratification
 - Length-scale minimum wind $\approx 5\text{m/s}$
 - Hysteresis with rain events? Stabilization?
- Implies rain-mediated mixing important under low wind conditions



Future directions

- Explore expectation of streak scaling
 - LC literature predictions
 - Compare with evolution of stratification
- Role of:
 - rain mixing
 - heat flux
 - micro-breaking

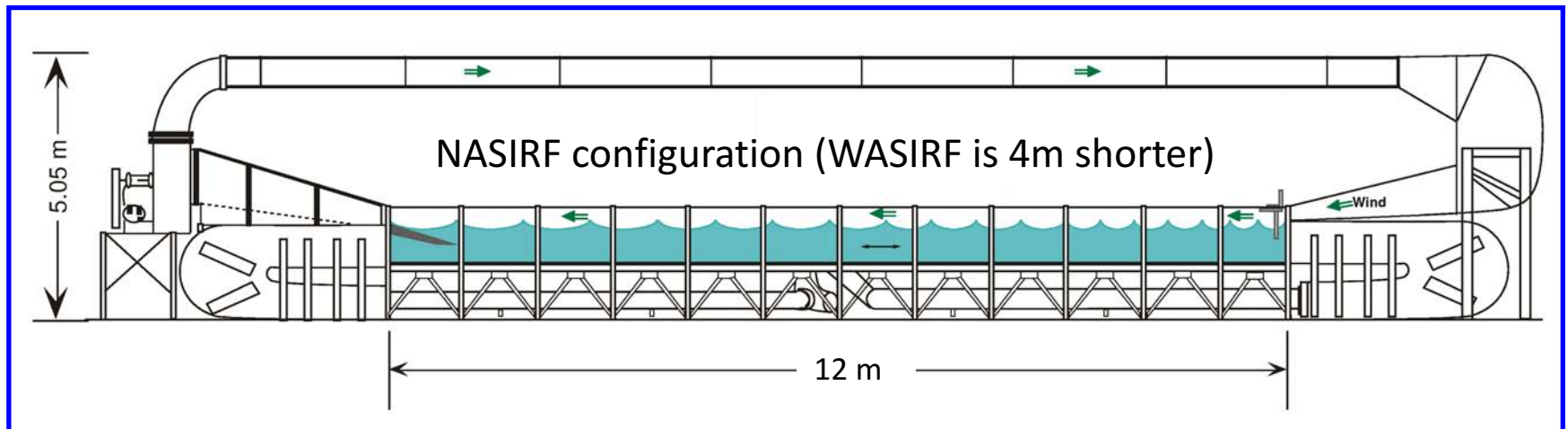
Suggests a controlled laboratory experiment



WA Air-Sea Interaction Research Facility (WASIRF)

Controlled experiment:

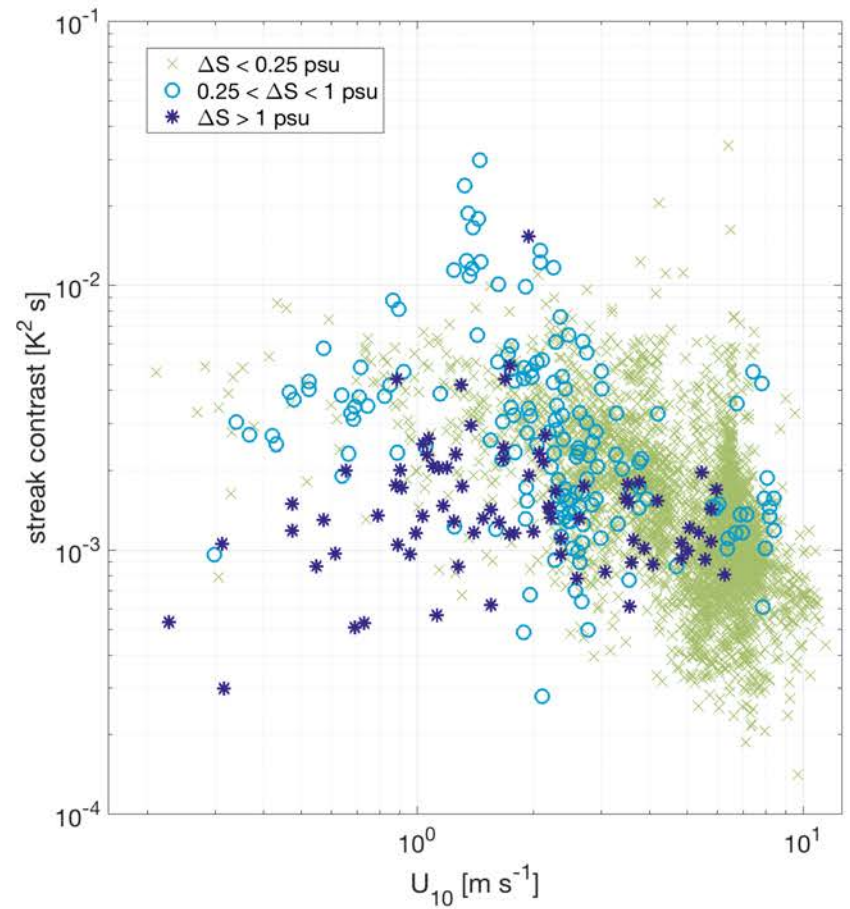
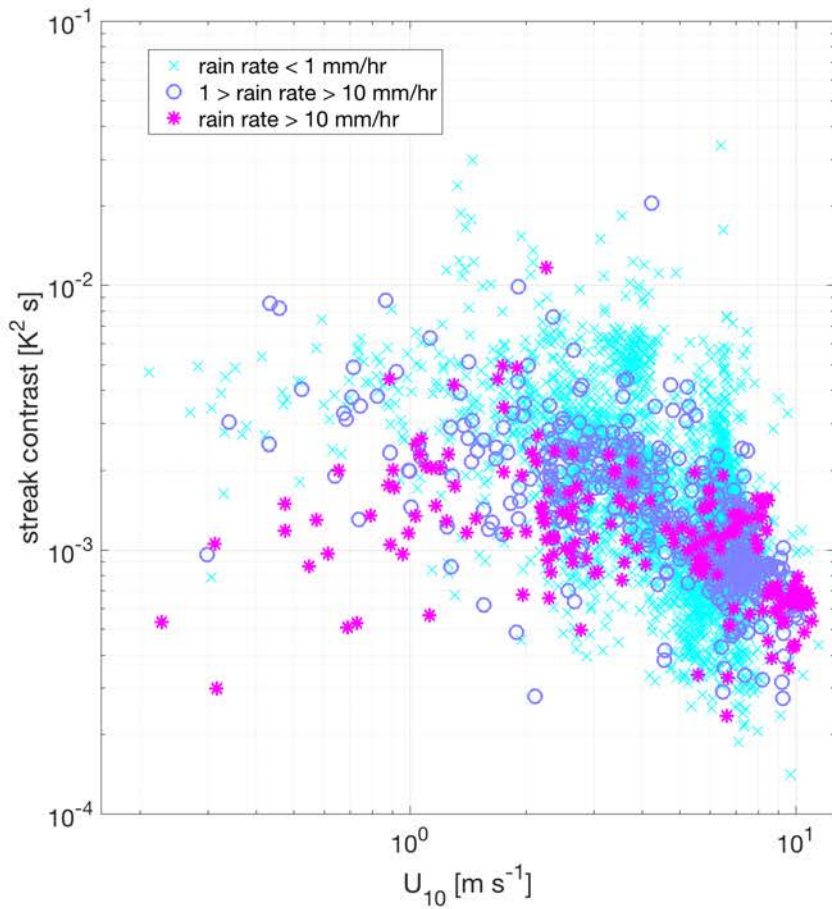
- Wind speed: (0 – 10 m/s)
- Air temperature and humidity
- Water temperature
- *Add rain*



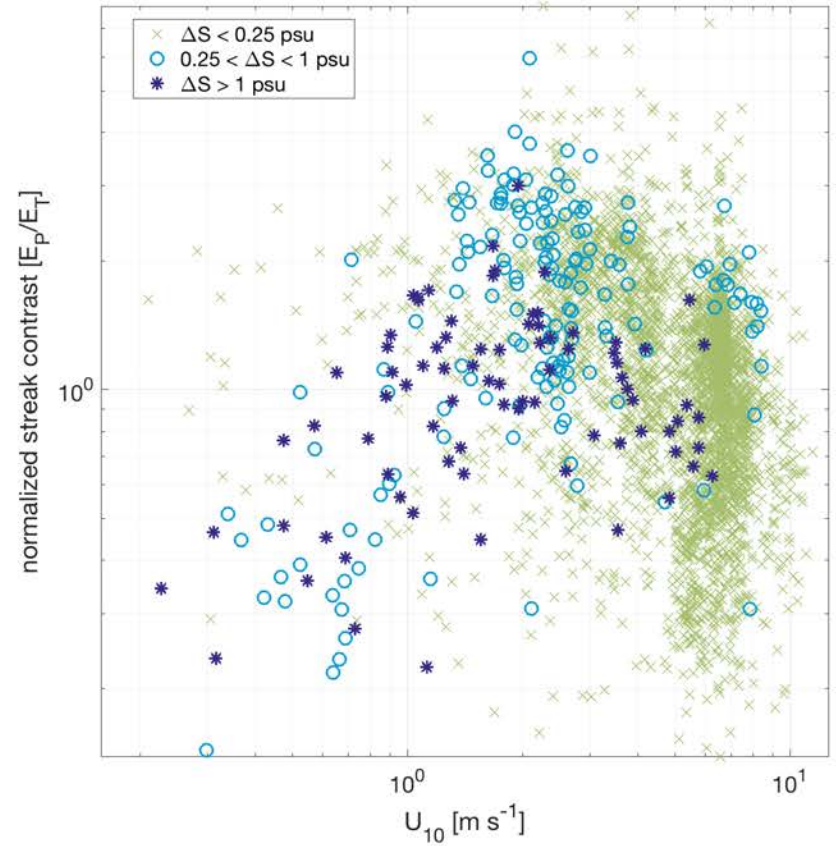
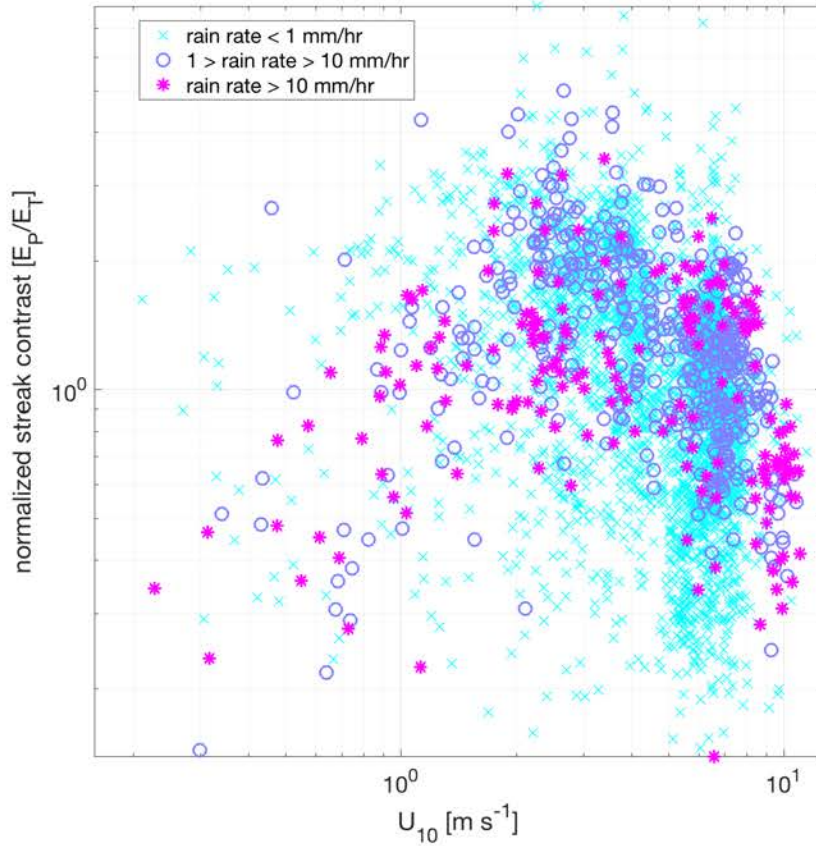
Extra slides



Streak temperature contrast



Streak temperature contrast



Streak length-scale

