Observations and Modeling of Rain-Induced Near Surface Salinity Anomalies

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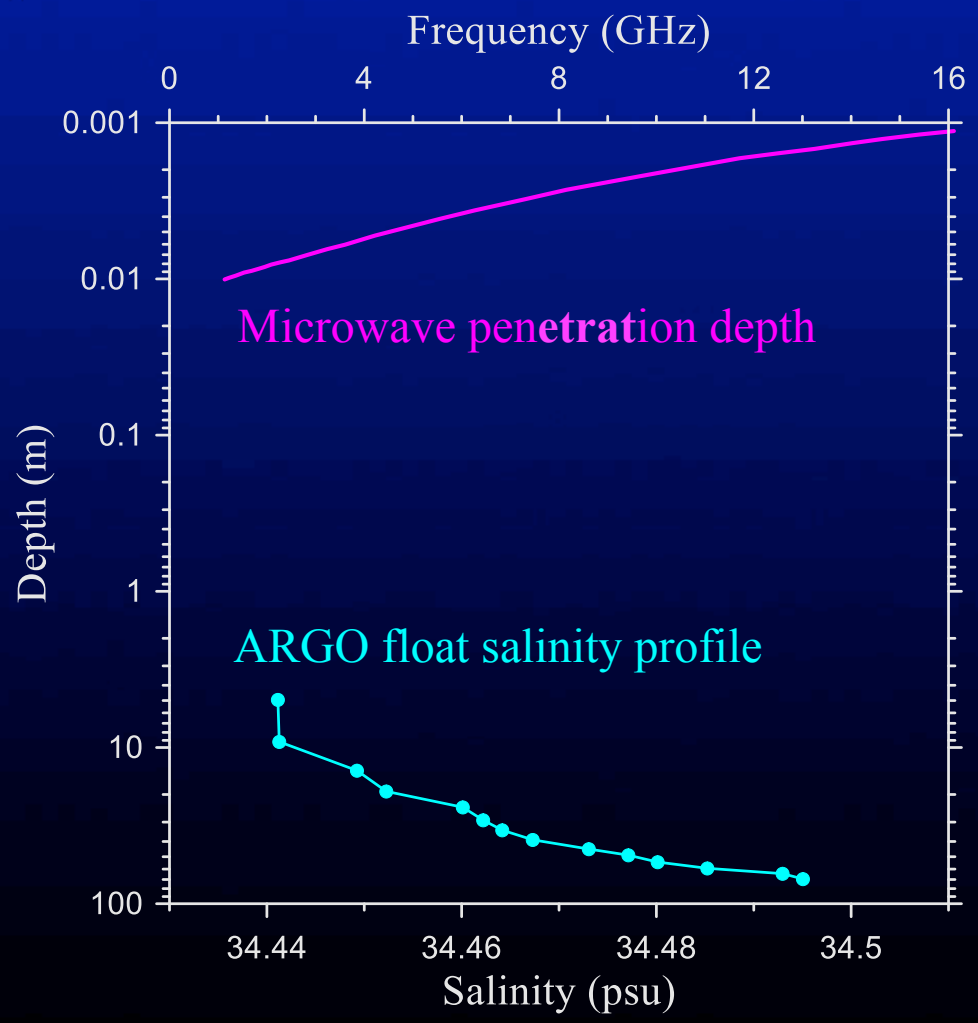
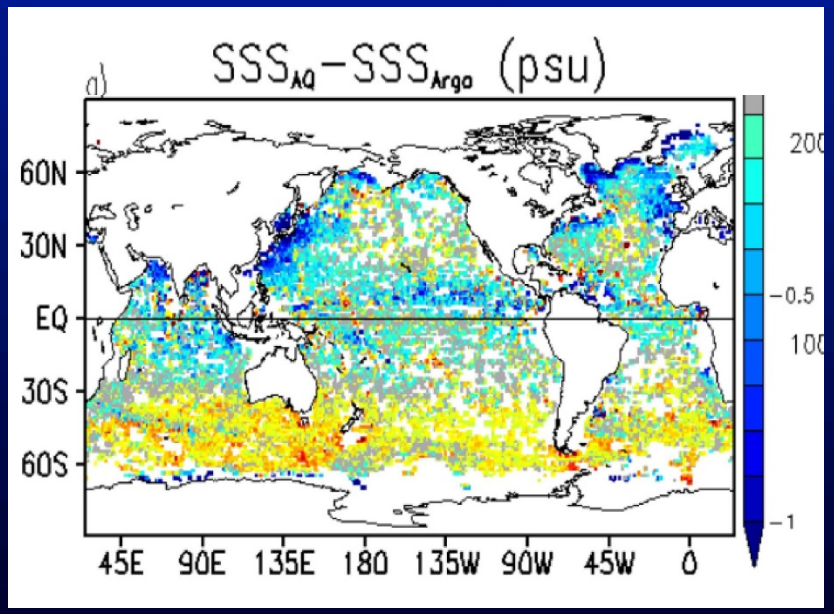
Why are salinity gradients at the ocean surface important?

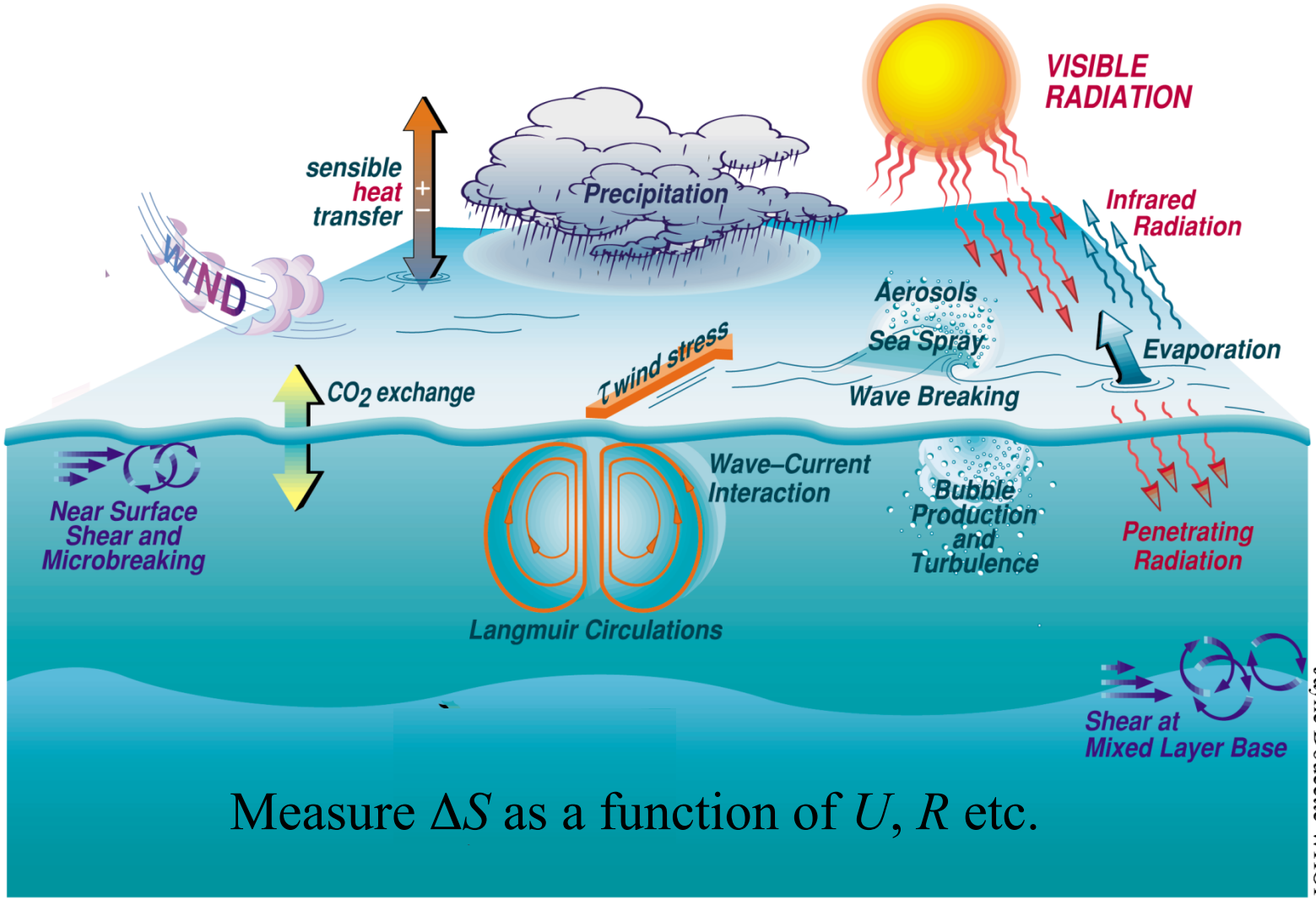




Grodsky and Carton, 2012

Mis-match between SMOS/Aquarius with respect to measurement depths

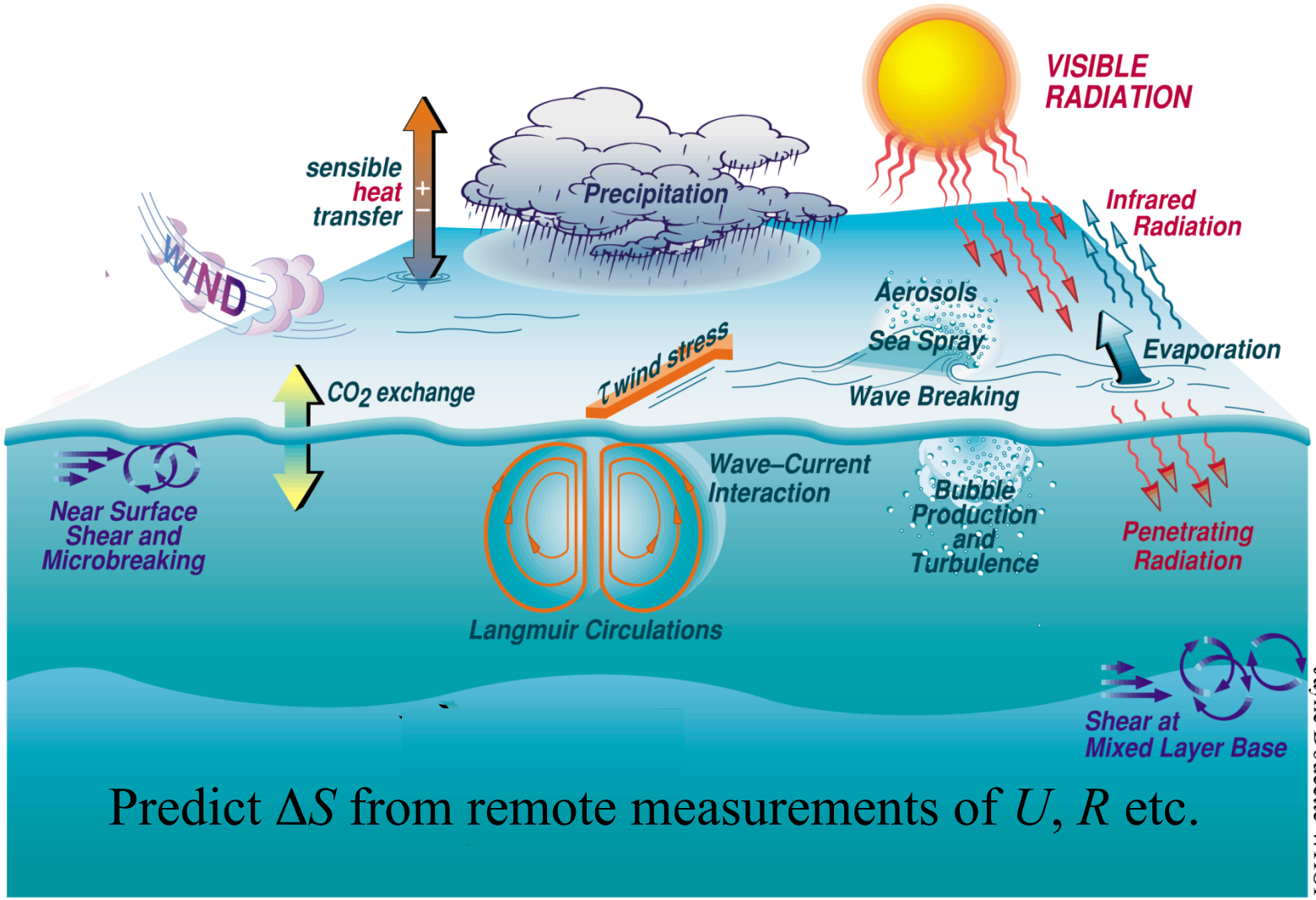
How do salinity gradients form?



Measure ΔS as a function of U, R etc.

Jayne Doucette WHOI

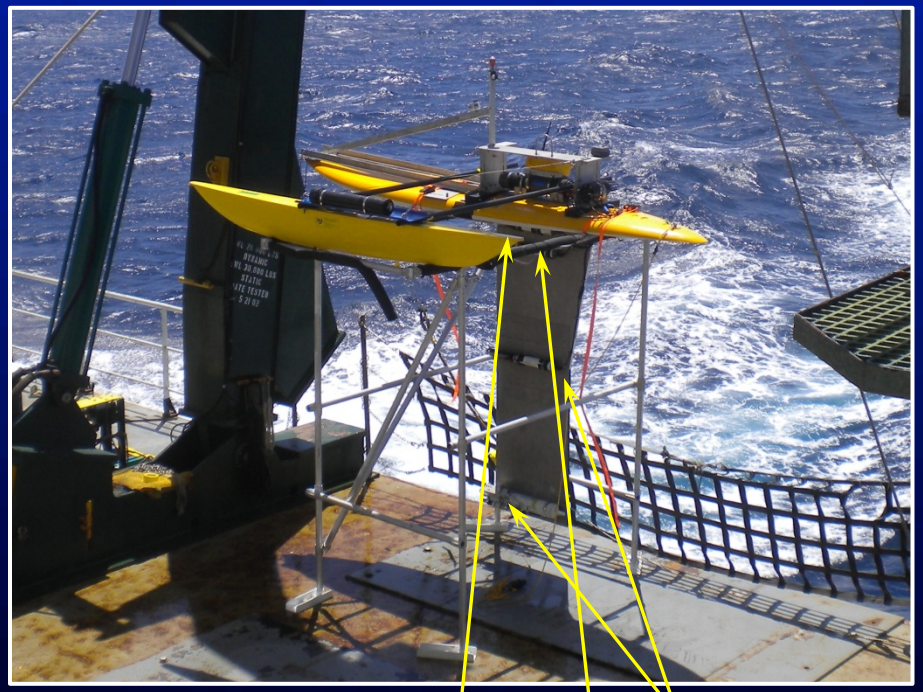
Can their presence be predicted from surface meteorological measurements?



Predict ΔS from remote measurements of U, R etc.

Jayne Doucette WHOI

Measuring salinity gradients: The Surface Salinity Profiler (SSP)



Towed from ship
Follows surface at tow speeds of 2 m/s
Rides outboard of wake
Instruments mounted on rigid keel

Instrumented with:
0.05 m Seabird 49 CTD
0.20 m Seabird 49 CTD
1.00 m Seabird 49 CTD
2.00 m Seabird 19 CTD

Measuring salinity gradients in the equatorial Pacific Ocean using the SSP

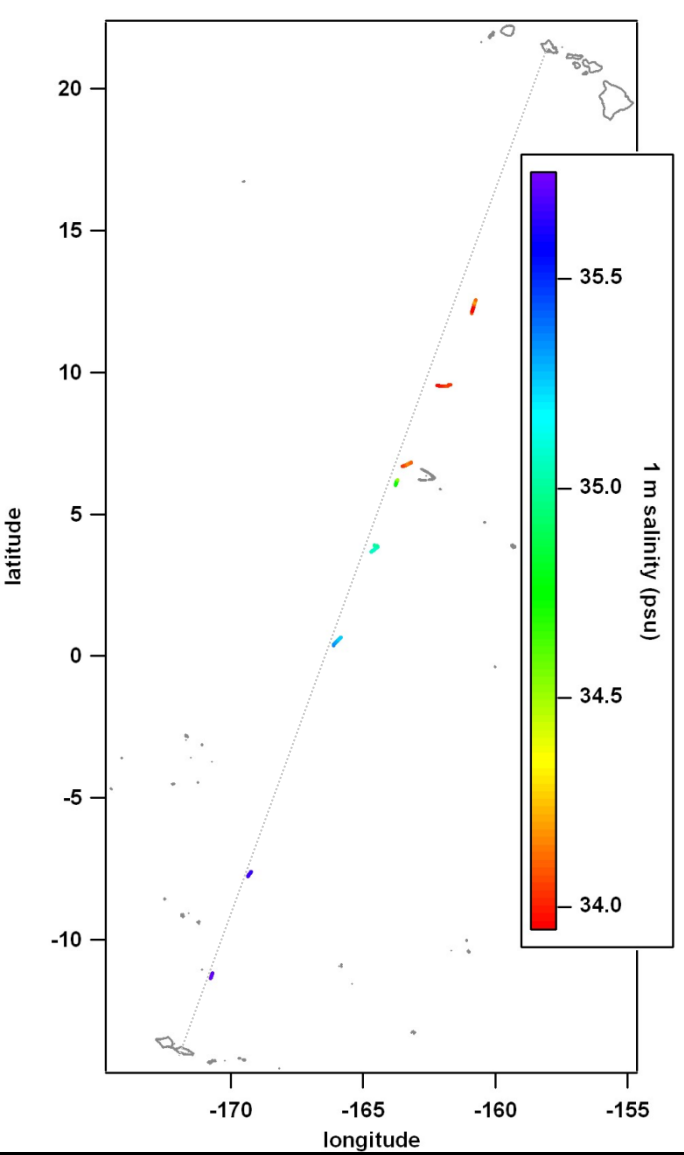
SSP deployed from the *R/V Kilo Moana*

Cruise conducted December 6-16, 2011

Sailed from Apia, Western Samoa to Honolulu, Hawaii

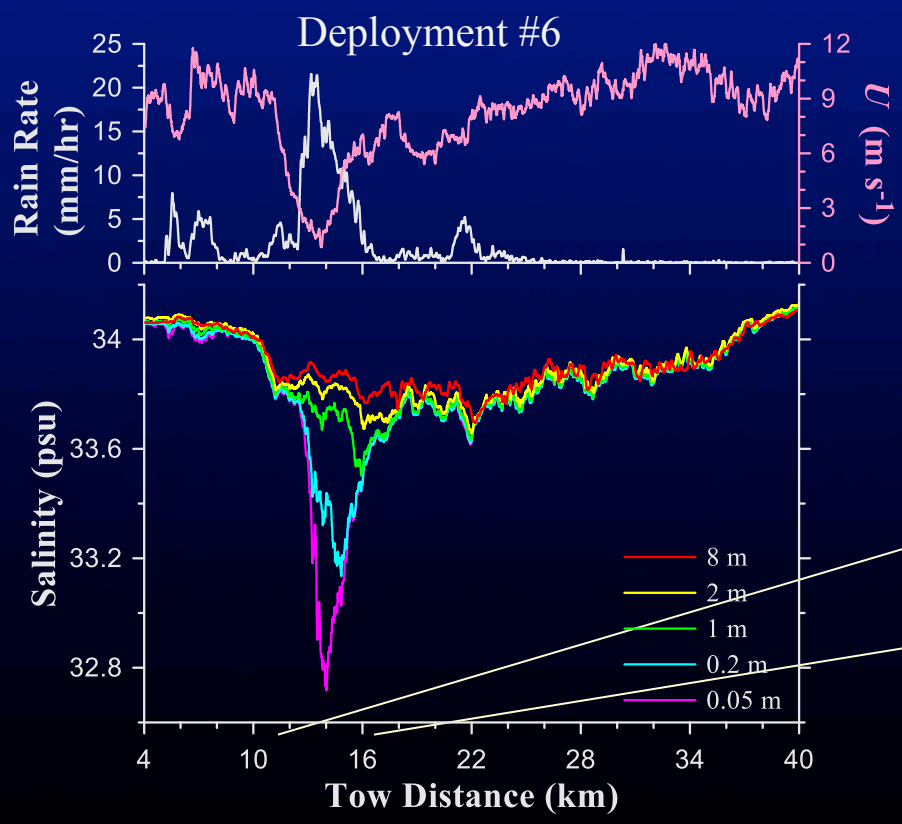
Deployed the SSP a total of eight times

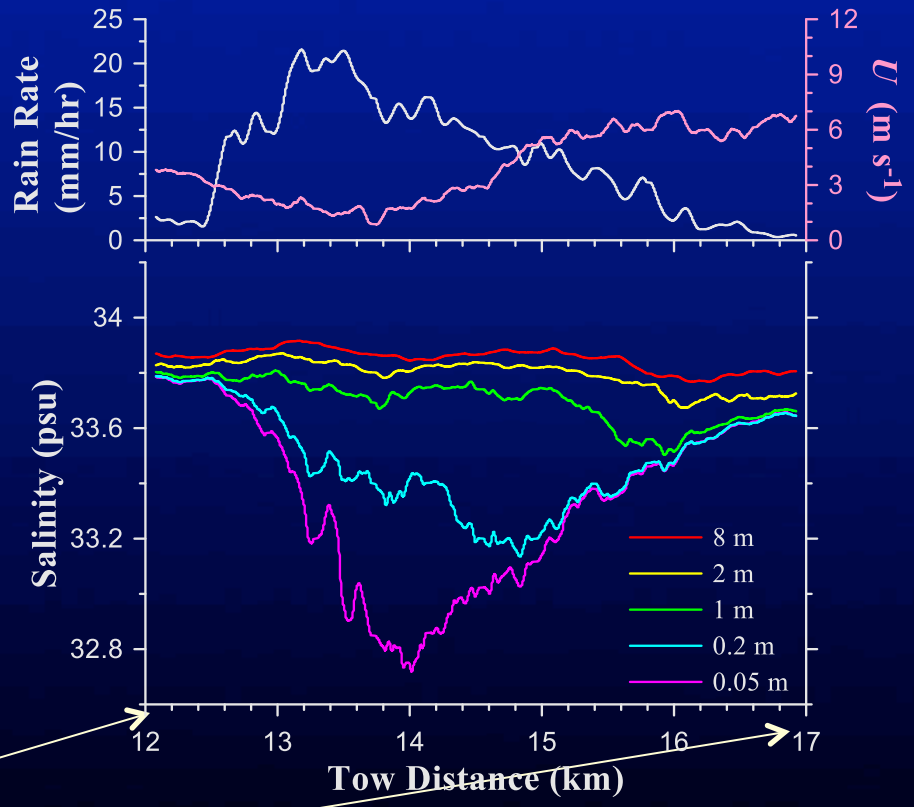
Sampled 3 rain events



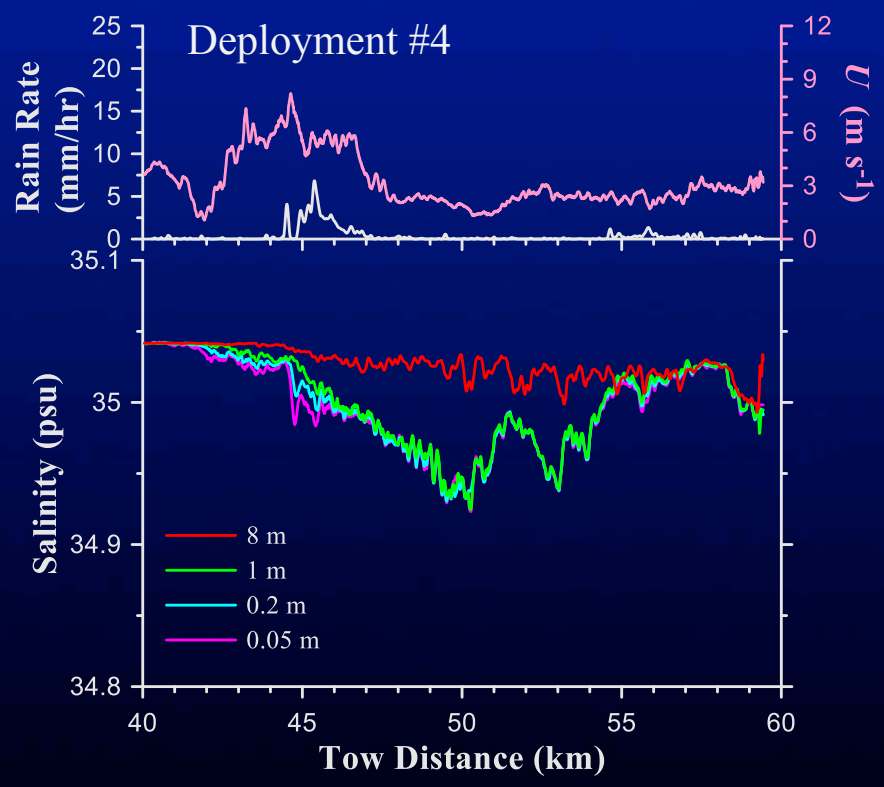
SSP Observation of Rain, Equatorial Pacific

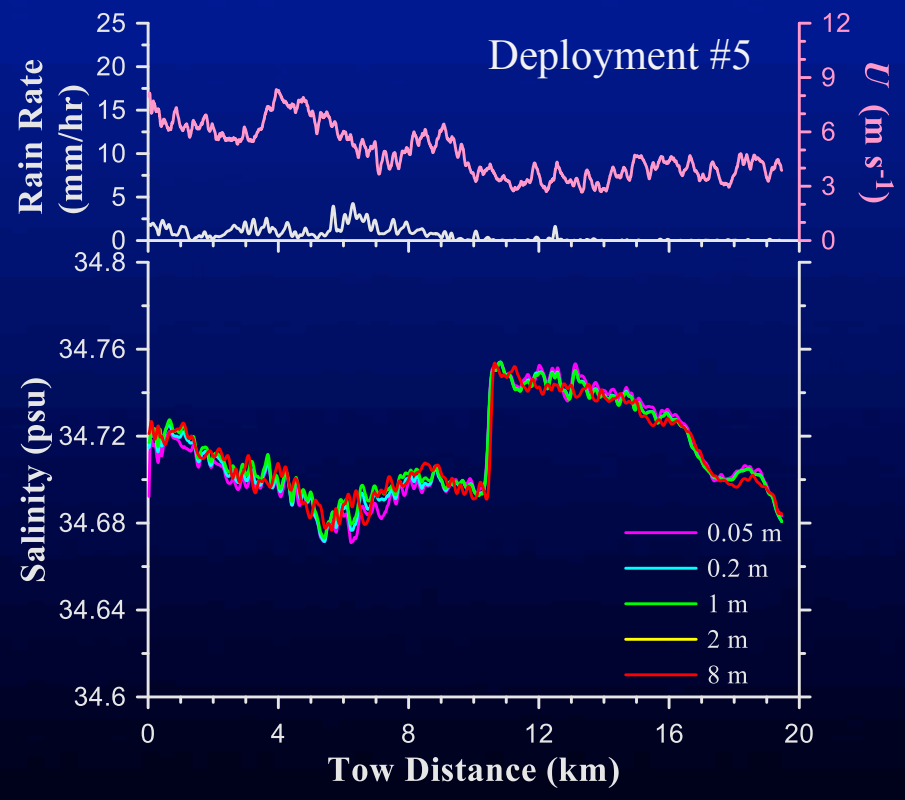
***R/V Kilo Moana*, December 13, 2011 12.07 N, 160.9 W**



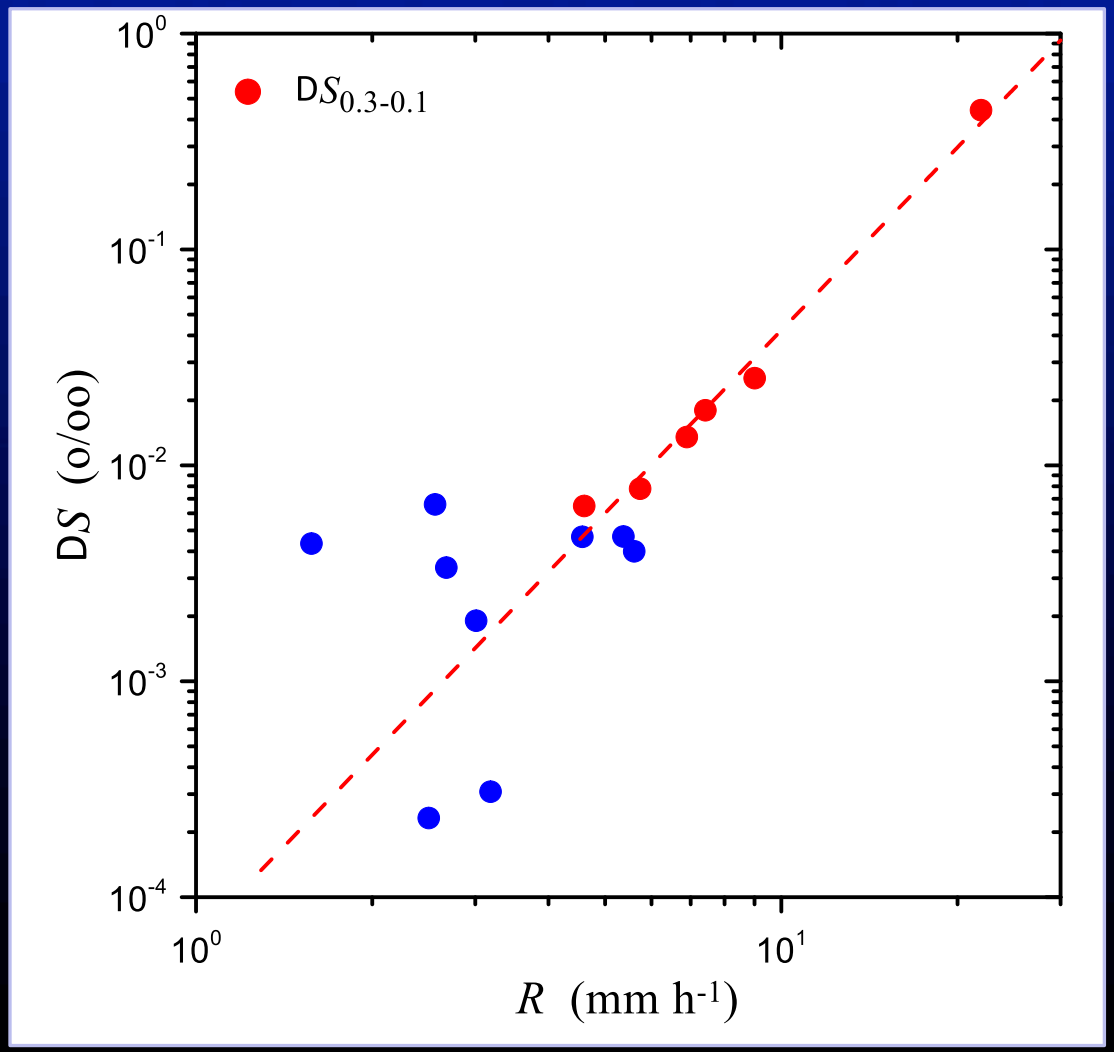


SSP Observation of Rain, Equatorial Pacific



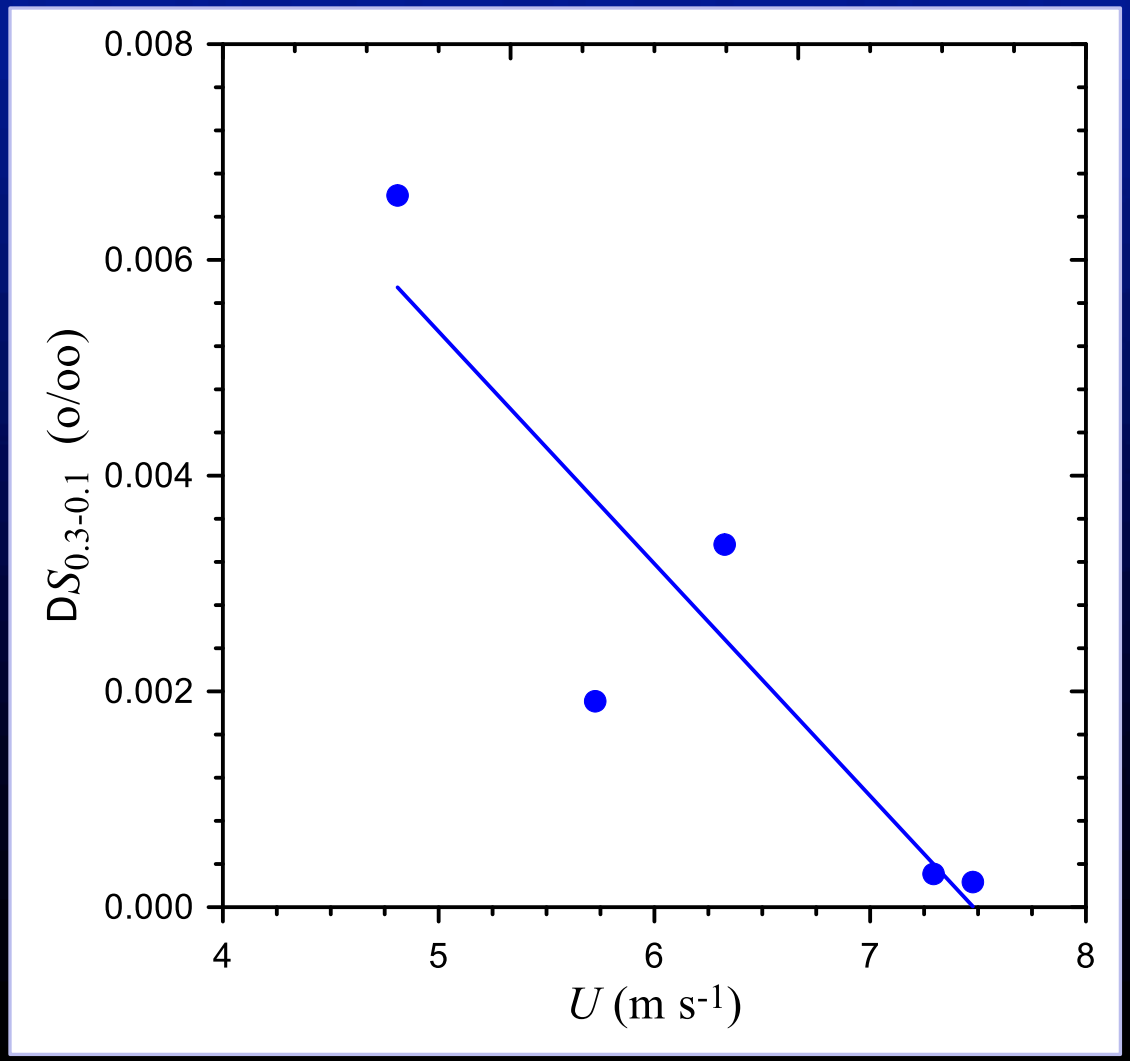


Salinity gradients and rain rate

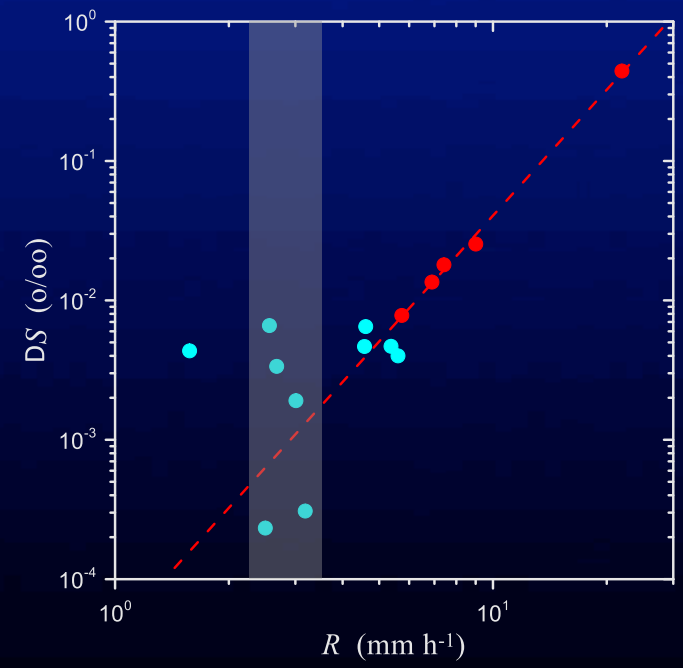


$$\Delta S = S_{0.3} - S_{0.1}$$

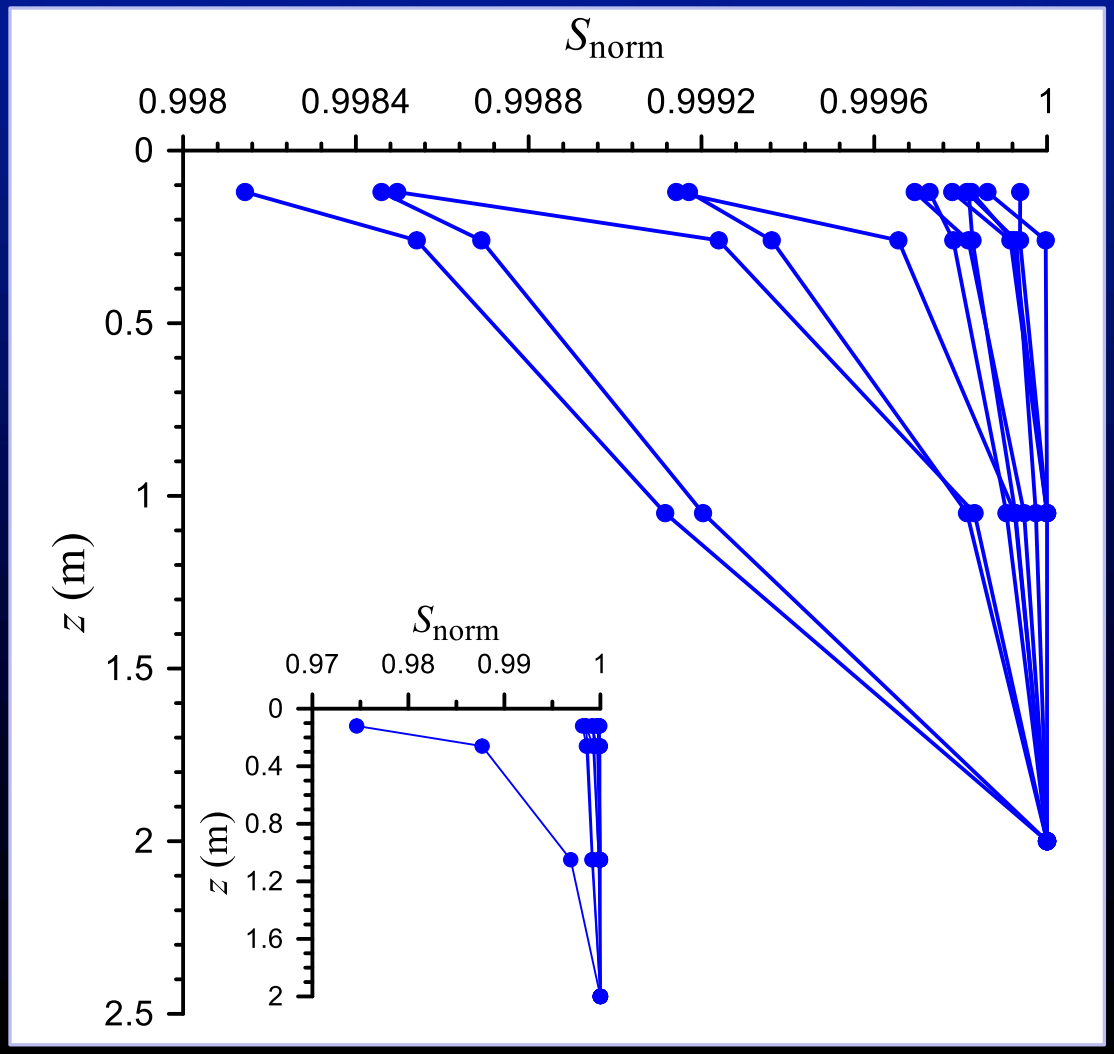
Salinity anomaly vs. wind speed



$$\Delta S = S_{0.3} - S_{0.1}$$

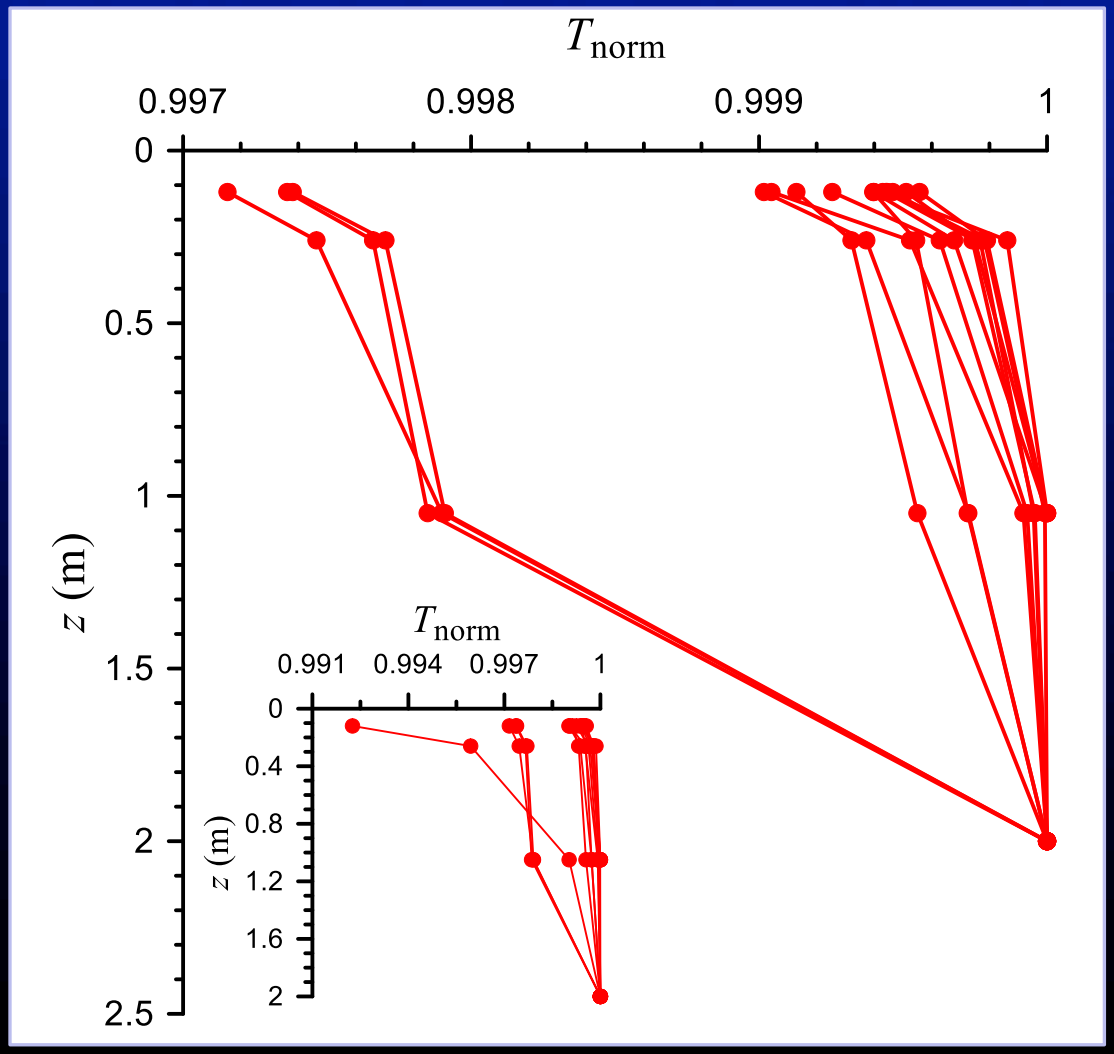


Why is there more variability at low rain rates: Is it something about the salinity profiles?



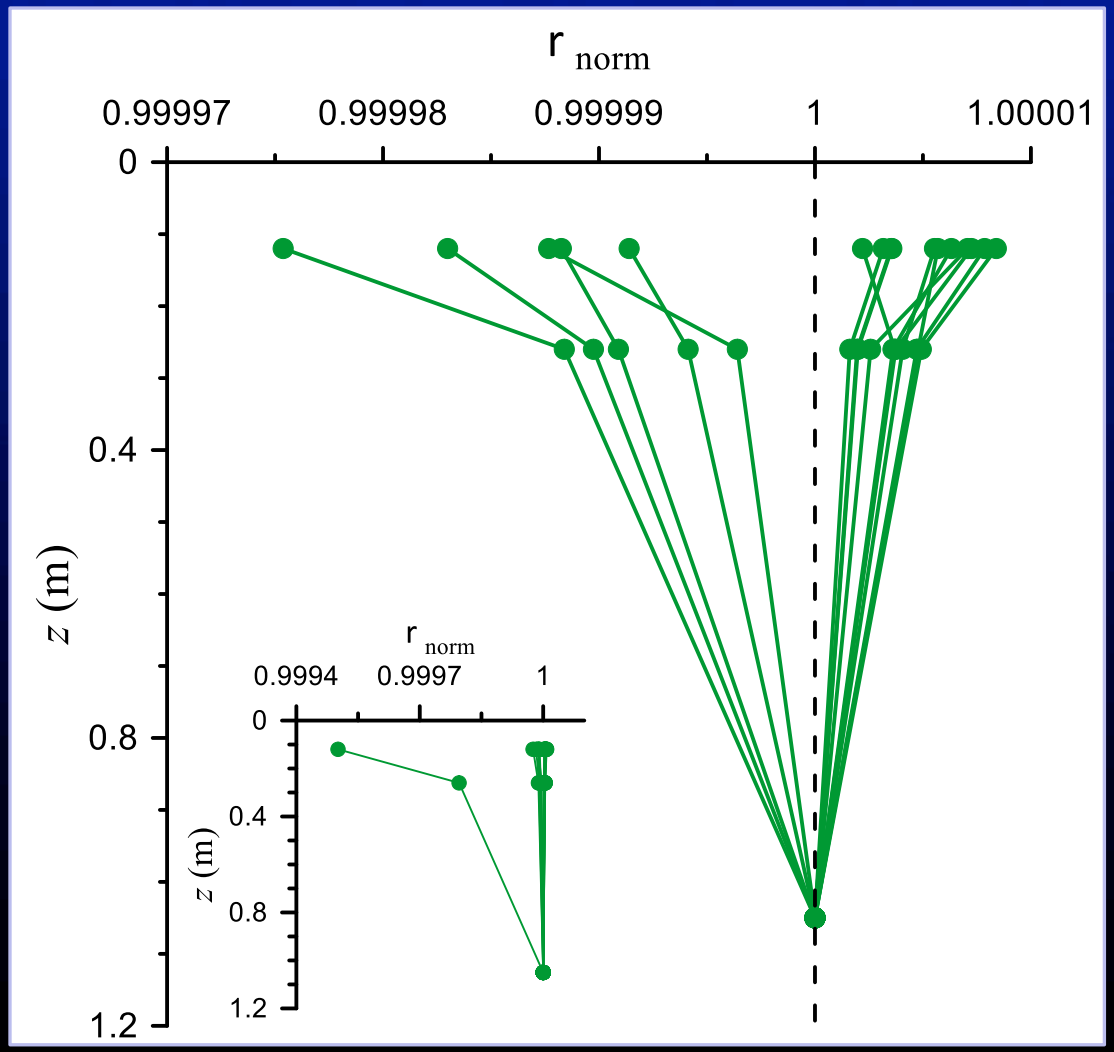
$$S_{norm} = S_Z / S_2$$

Why is there more variability at low rain rates: Is it something about the temperature profiles?

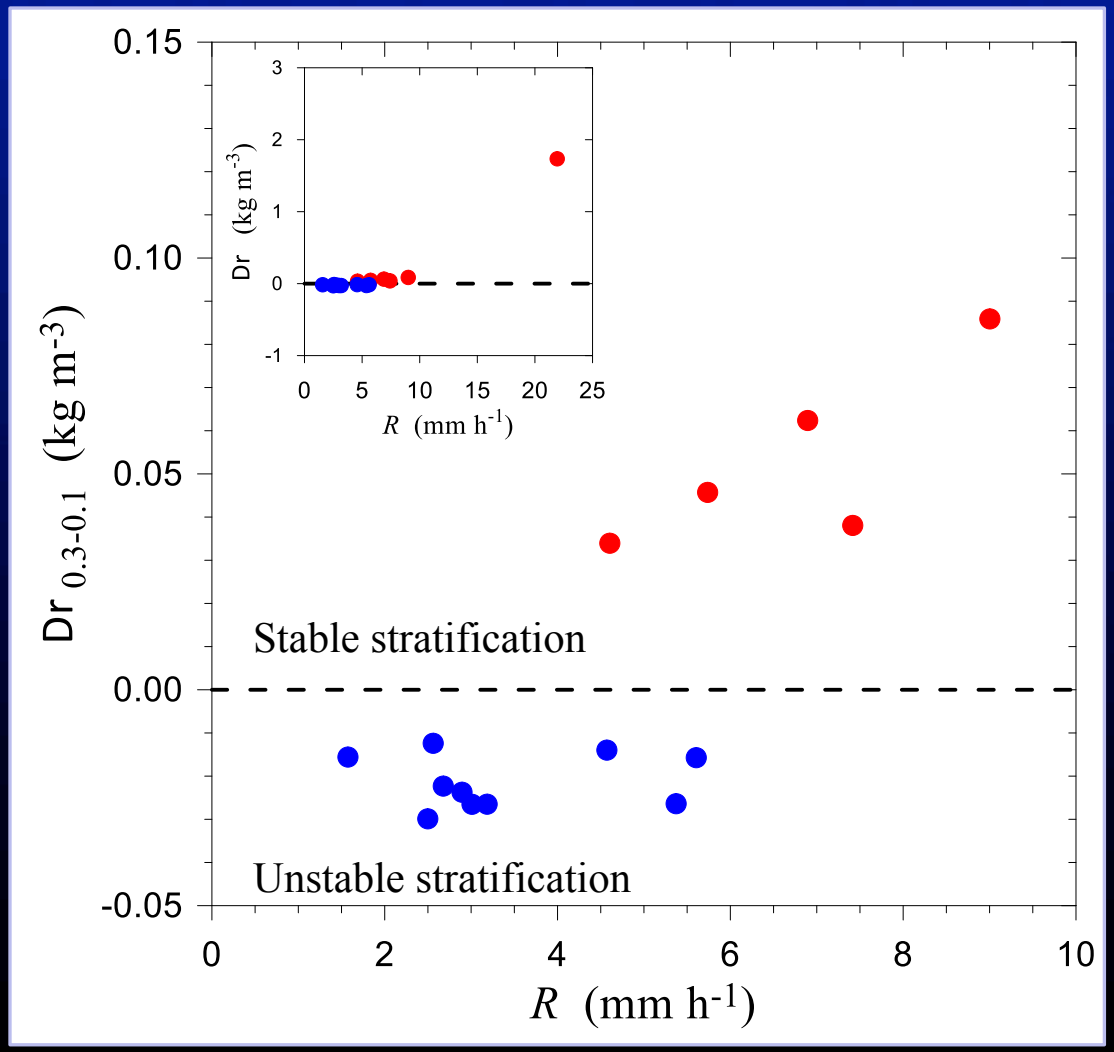


$$T_{norm} = T_Z / T_2$$

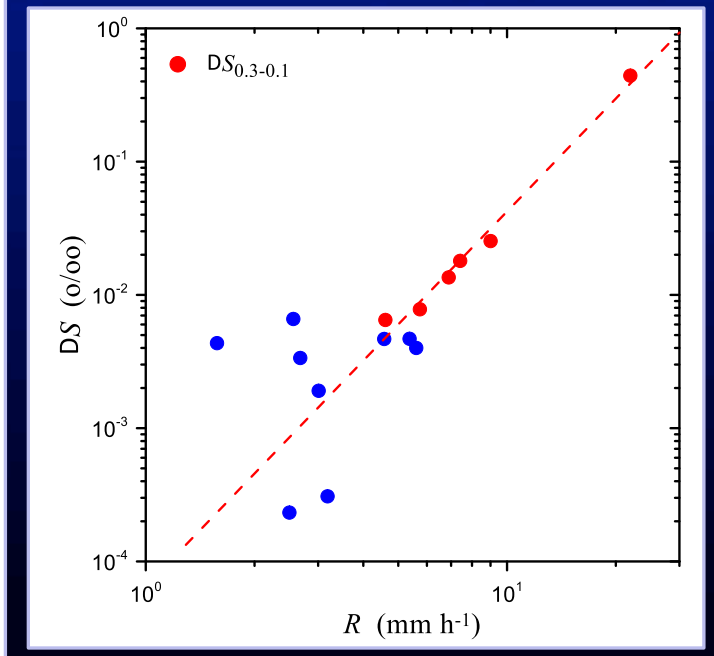
Why is there more variability at low rain rates: Is it something about the density profiles?



Correlation of density gradient with rain rate

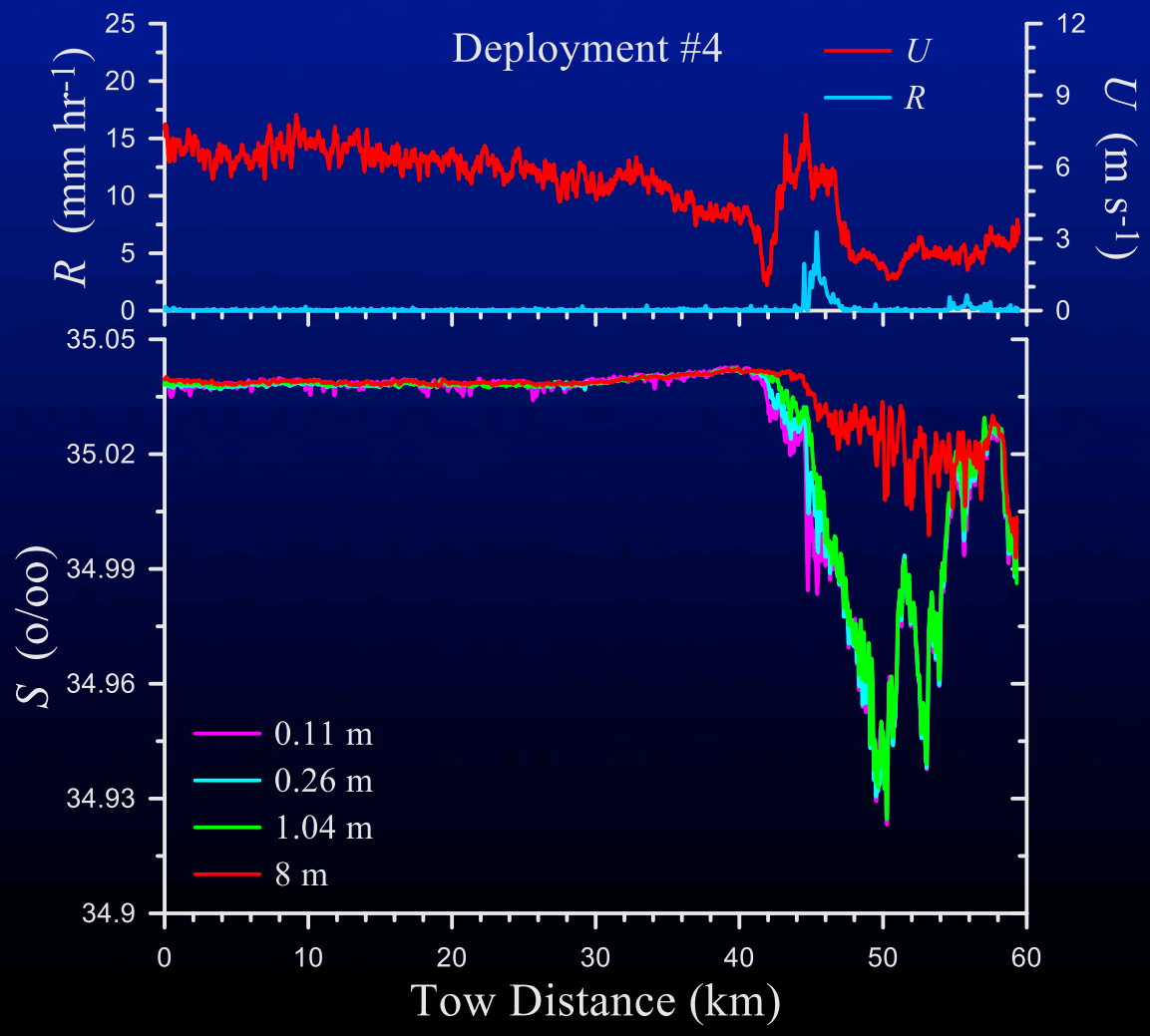


$$\Delta\rho = \rho_{0.3} - \rho_{0.1}$$

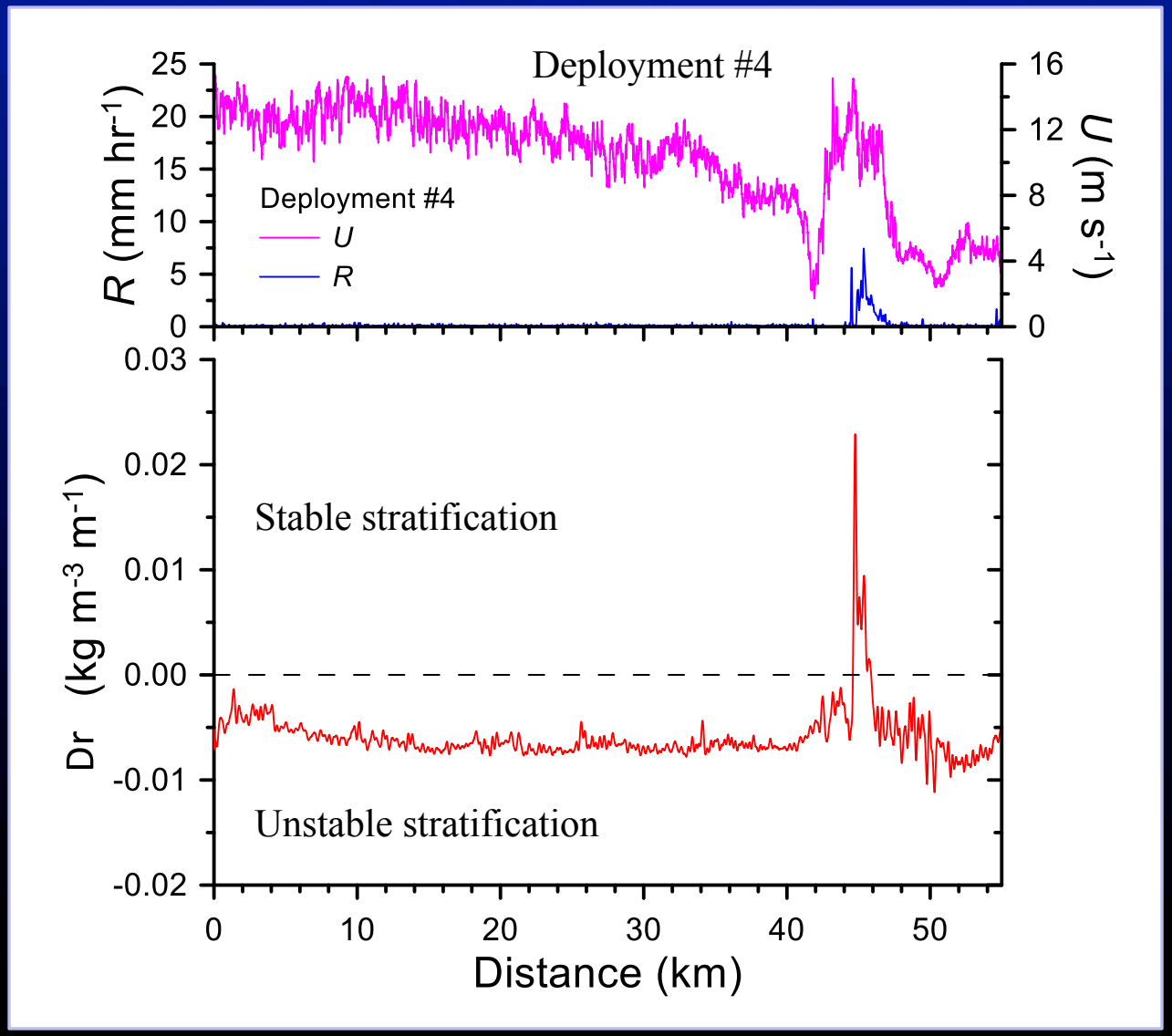


$$\Delta S = S_{0.3} - S_{0.1}$$

A detailed look at the salinity anomalies: Moderate rain rates

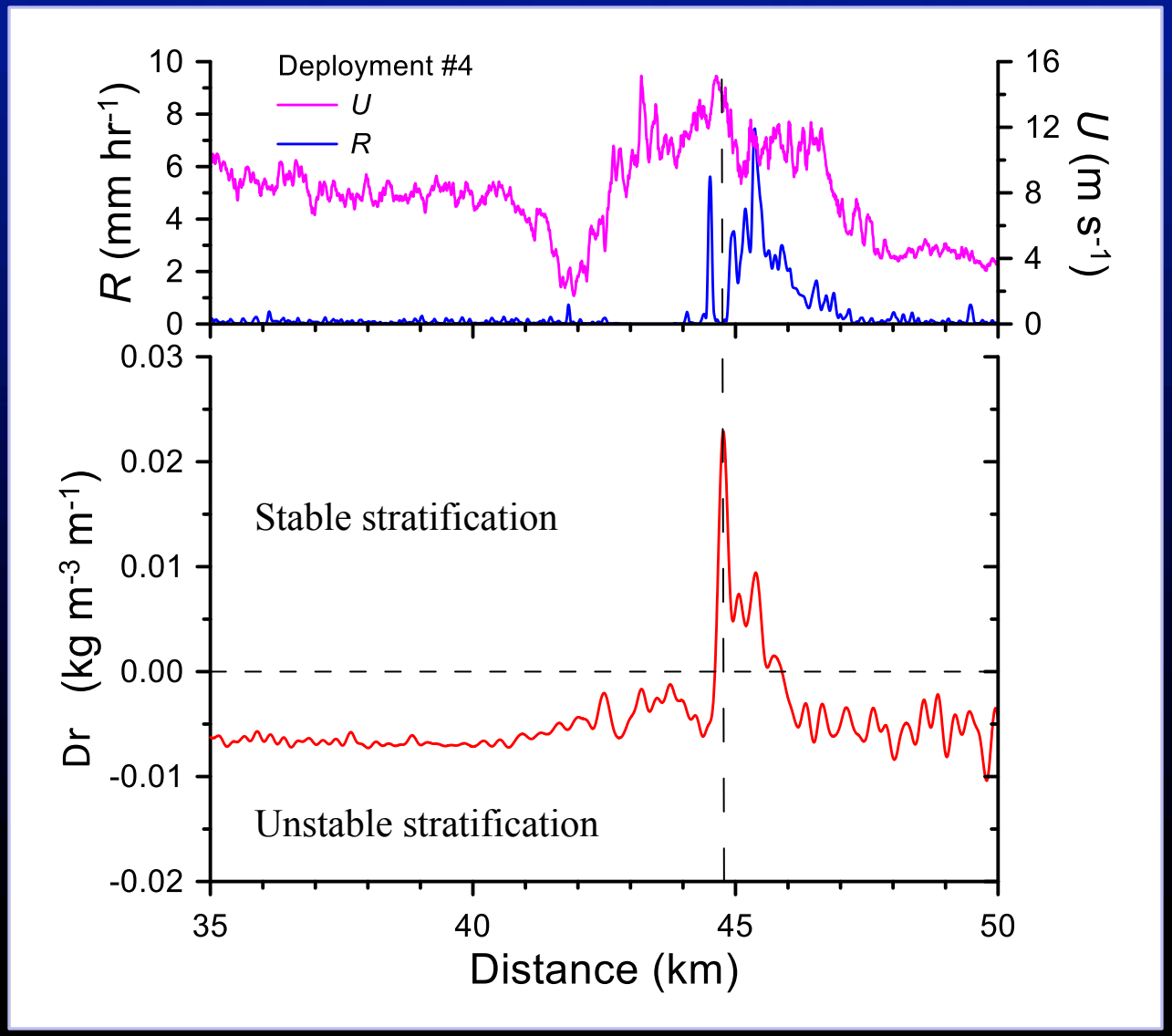


The surface density gradient: Moderate rain rates



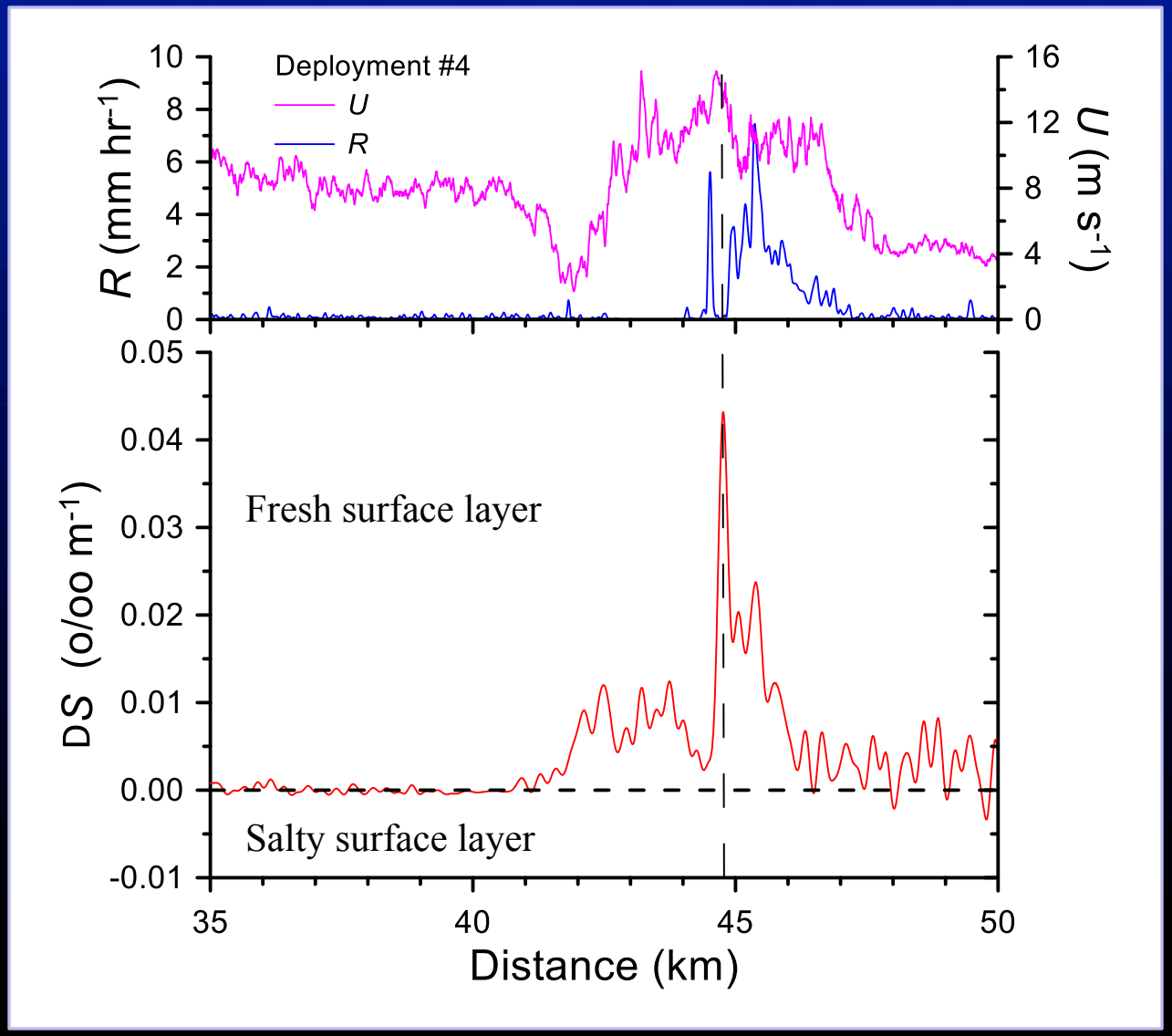
$$\Delta\rho = \rho_{0.3} - \rho_{0.1}$$

Details of the surface density gradient: Moderate rain rates



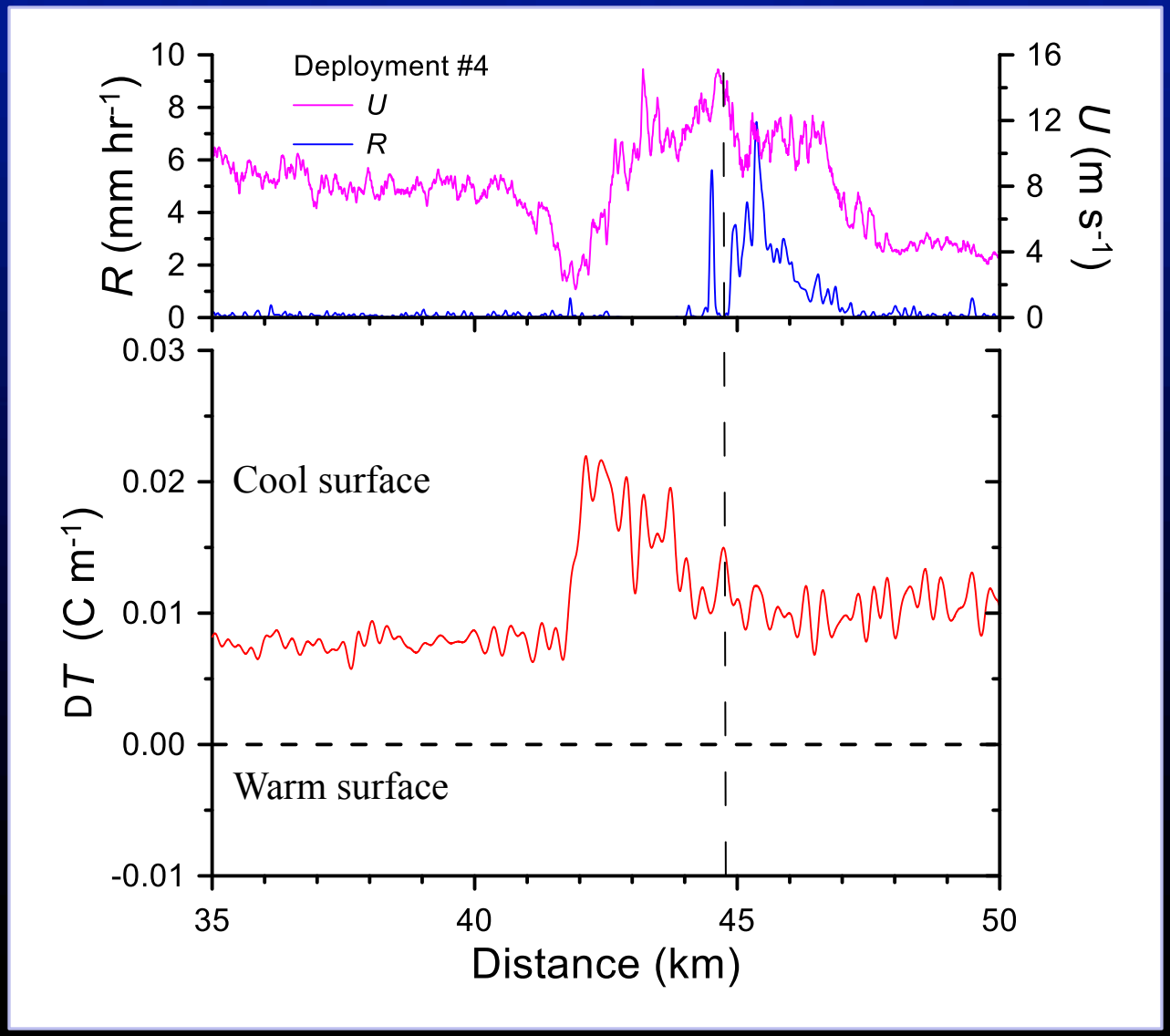
$$\Delta\rho = \rho_{0.3} - \rho_{0.1}$$

Details of the surface salinity gradient: Moderate rain rates



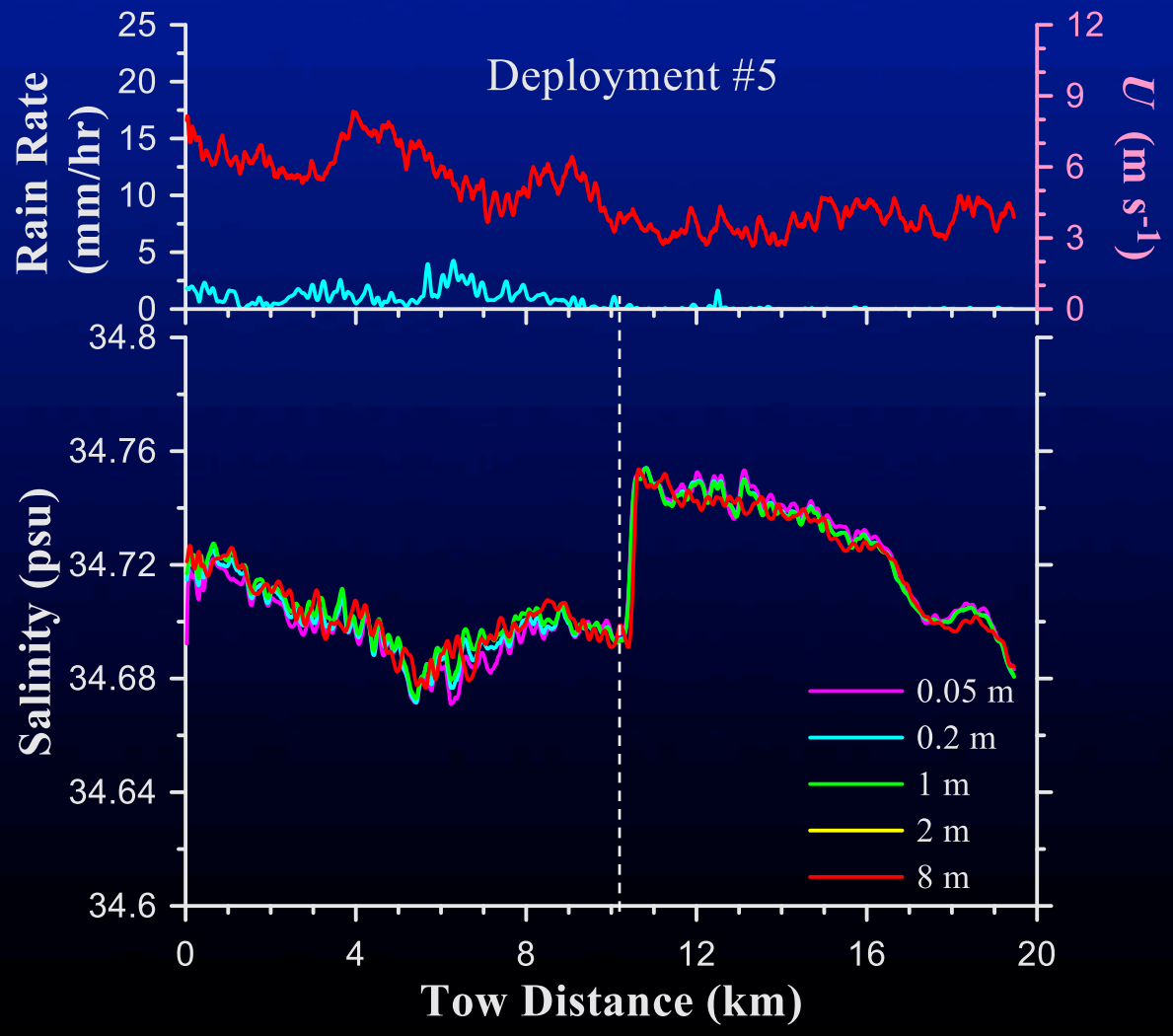
$$\Delta S = S_{0.3} - S_{0.1}$$

Details of the surface temperature gradient: Moderate rain rates

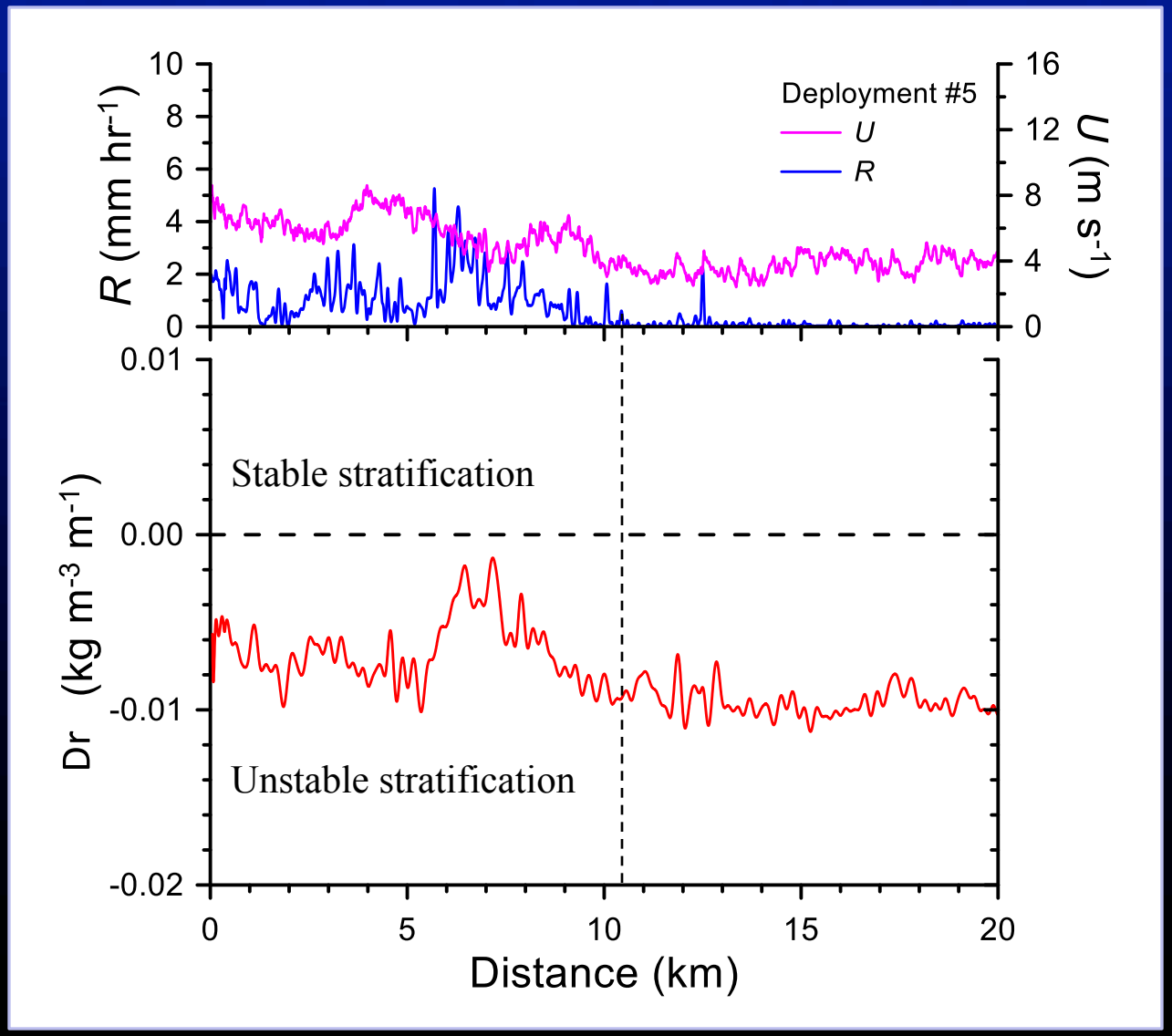


$$\Delta T = T_{0.3} - T_{0.1}$$

A detailed look at the salinity anomalies: Low rain rates

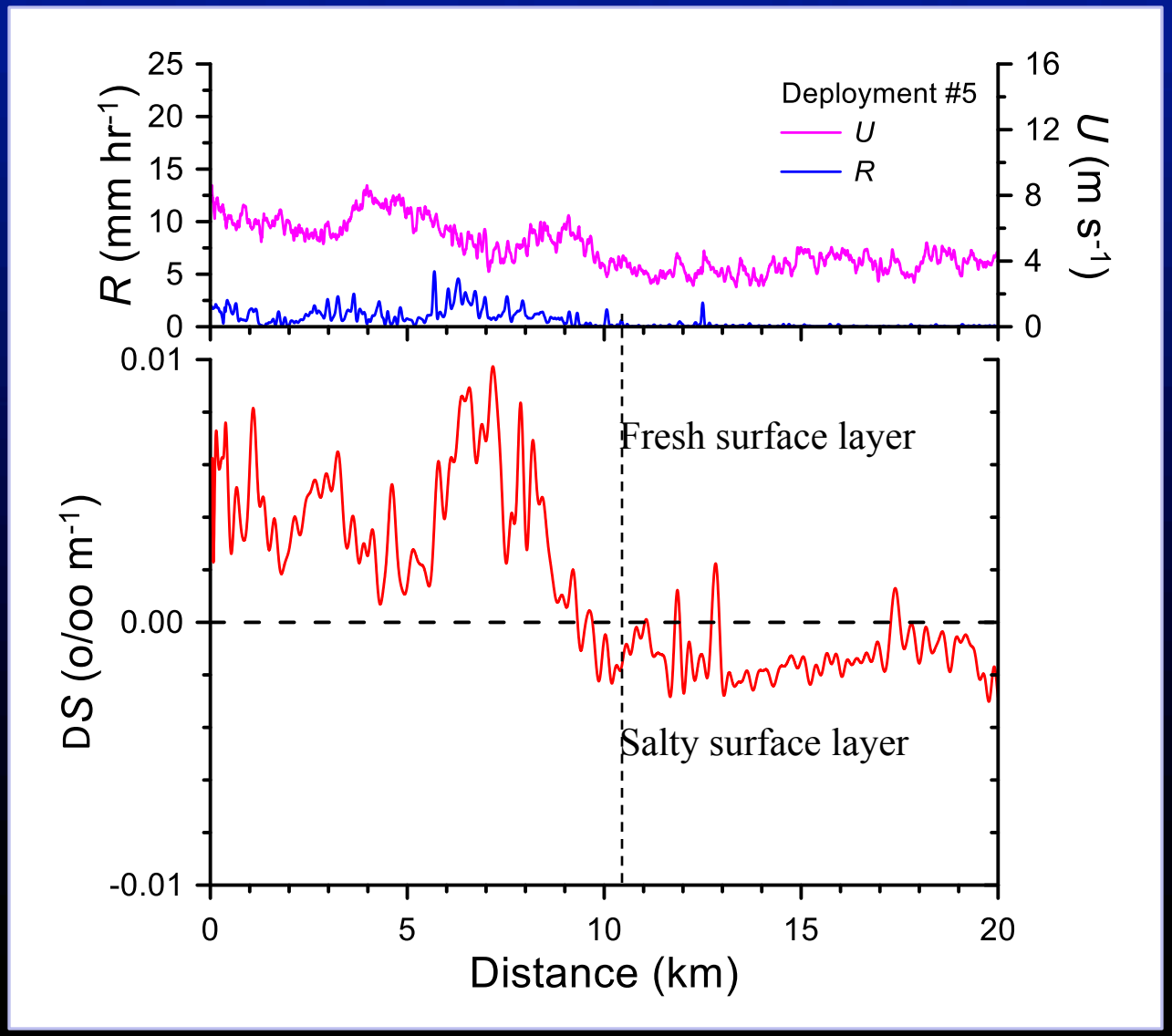


Details of the surface density gradient: Low rain rates



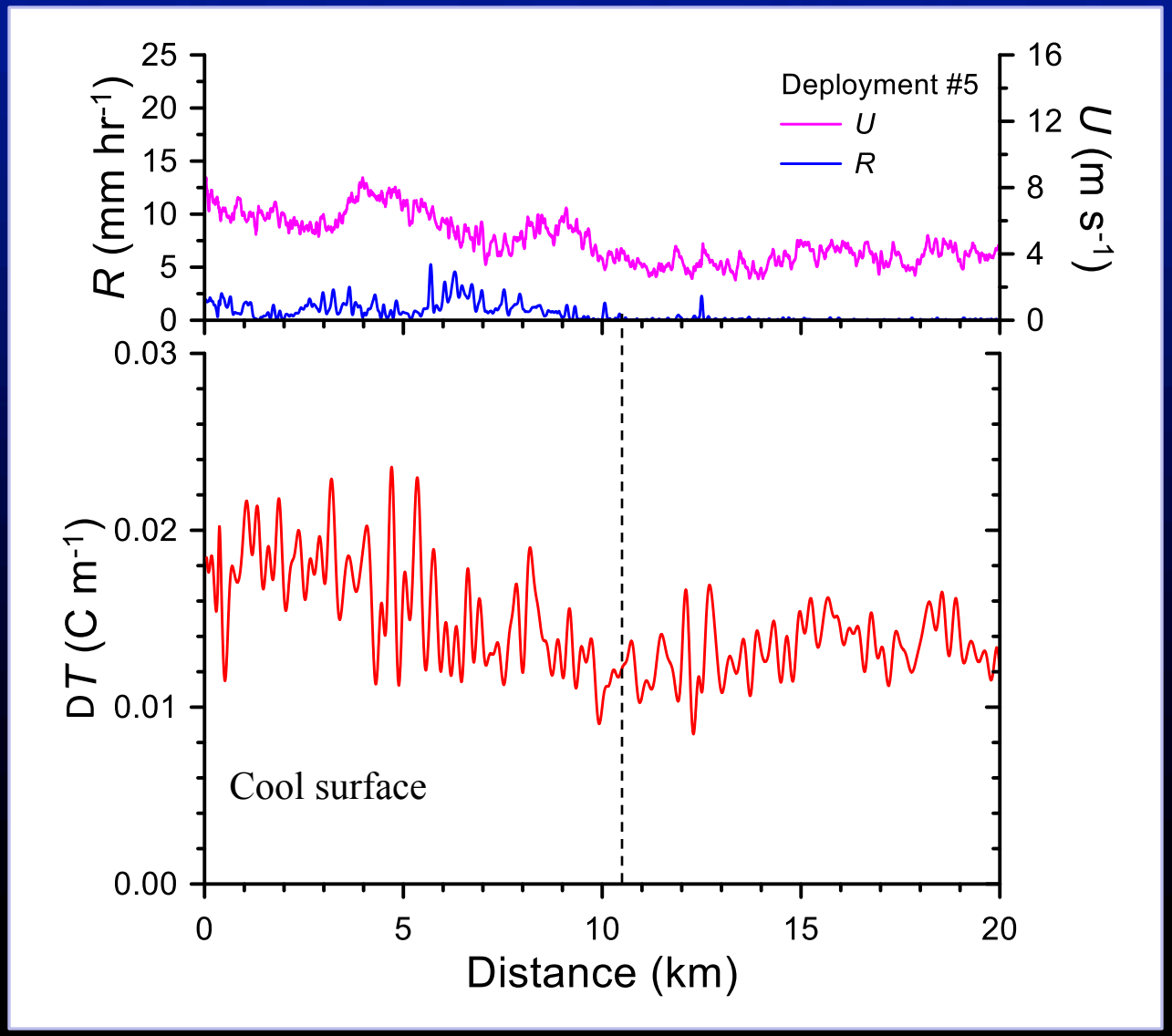
$$\Delta\rho = \rho_{0.3} - \rho_{0.1}$$

Details of the surface salinity gradient: Low rain rates



$$\Delta S = S_{0.3} - S_{0.1}$$

Details of the surface temperature gradient: Low rain rates



$$\Delta T = T_{0.3} - T_{0.1}$$

Conclusions

1. Salinity anomaly magnitudes in the top meter of the ocean surface are correlated with rain rate and wind speed

2. However, the salinity anomaly maximum measured below the surface occurs after the maximum rain rate

3. At low rain rates the presence of cool skin layer affects salinity anomalies

4. These salinity anomalies might occur in a very shallow layer, implying the salinity offset are large