Rain-Induced Ocean Surface Salinity Gradients:
Can they tell us anything about near surface physics?

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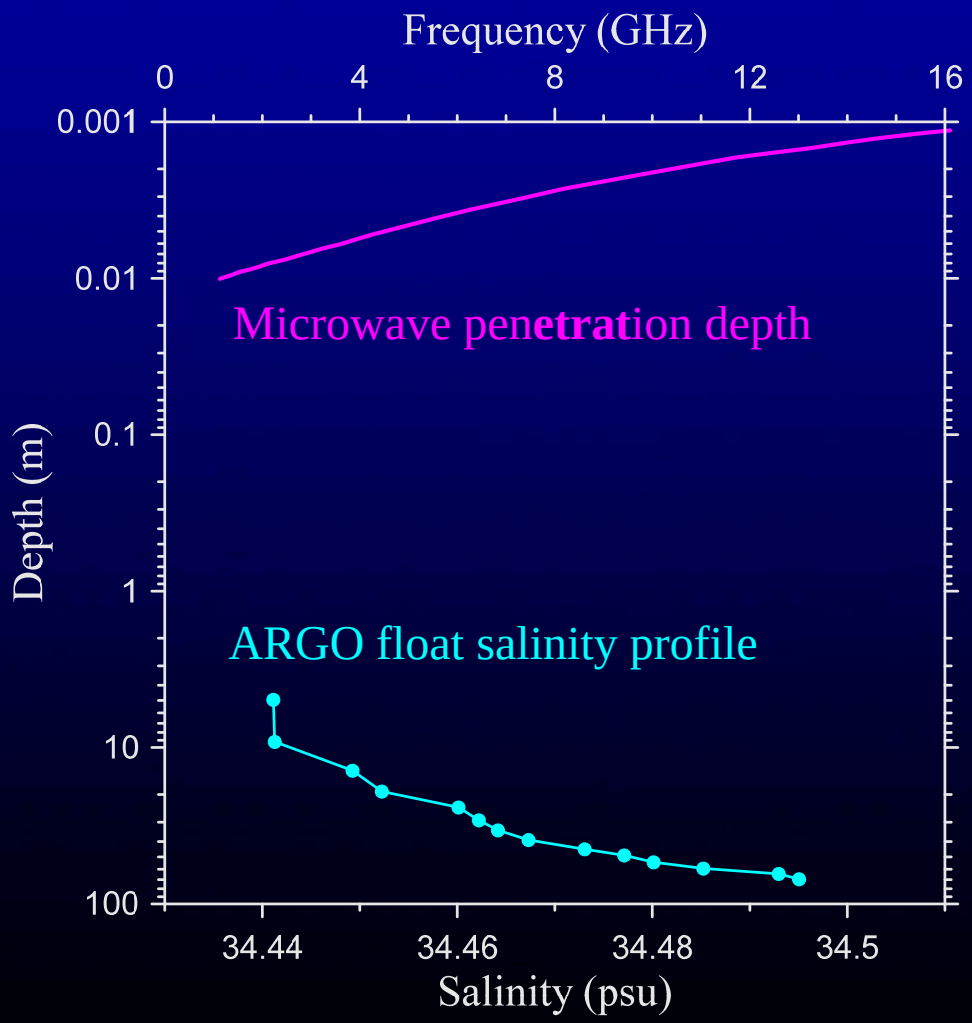
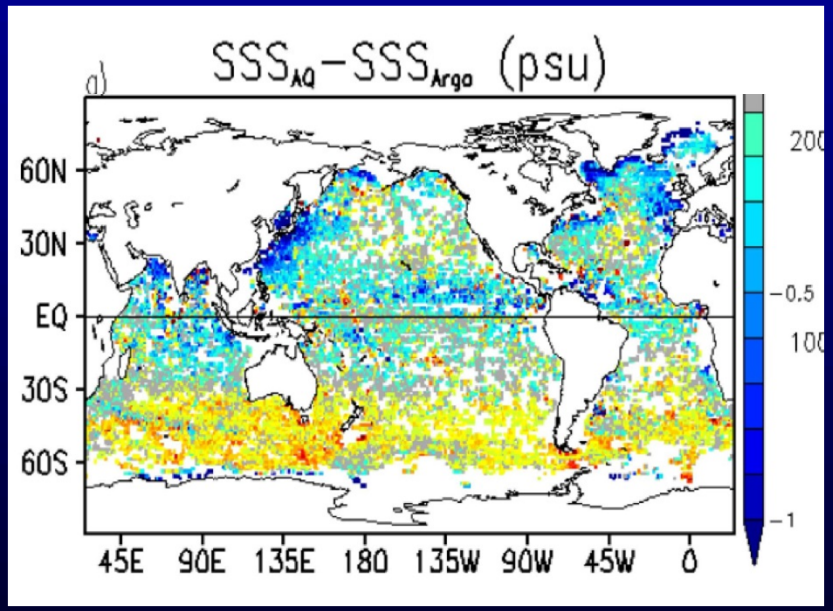
Why are salinity gradients at the ocean surface important?

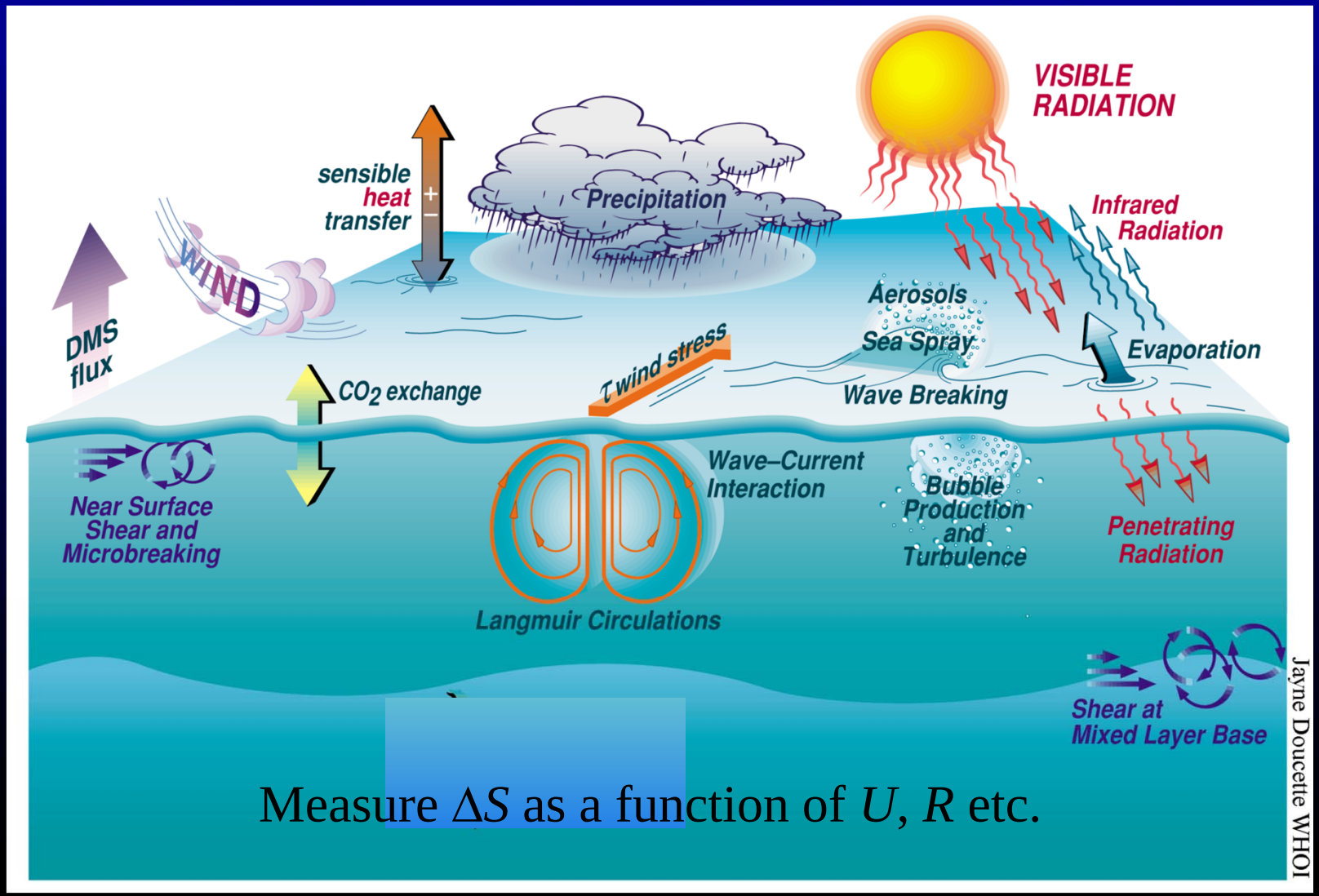


Mis-match between SMOS/Aquarius with respect to measurement depths



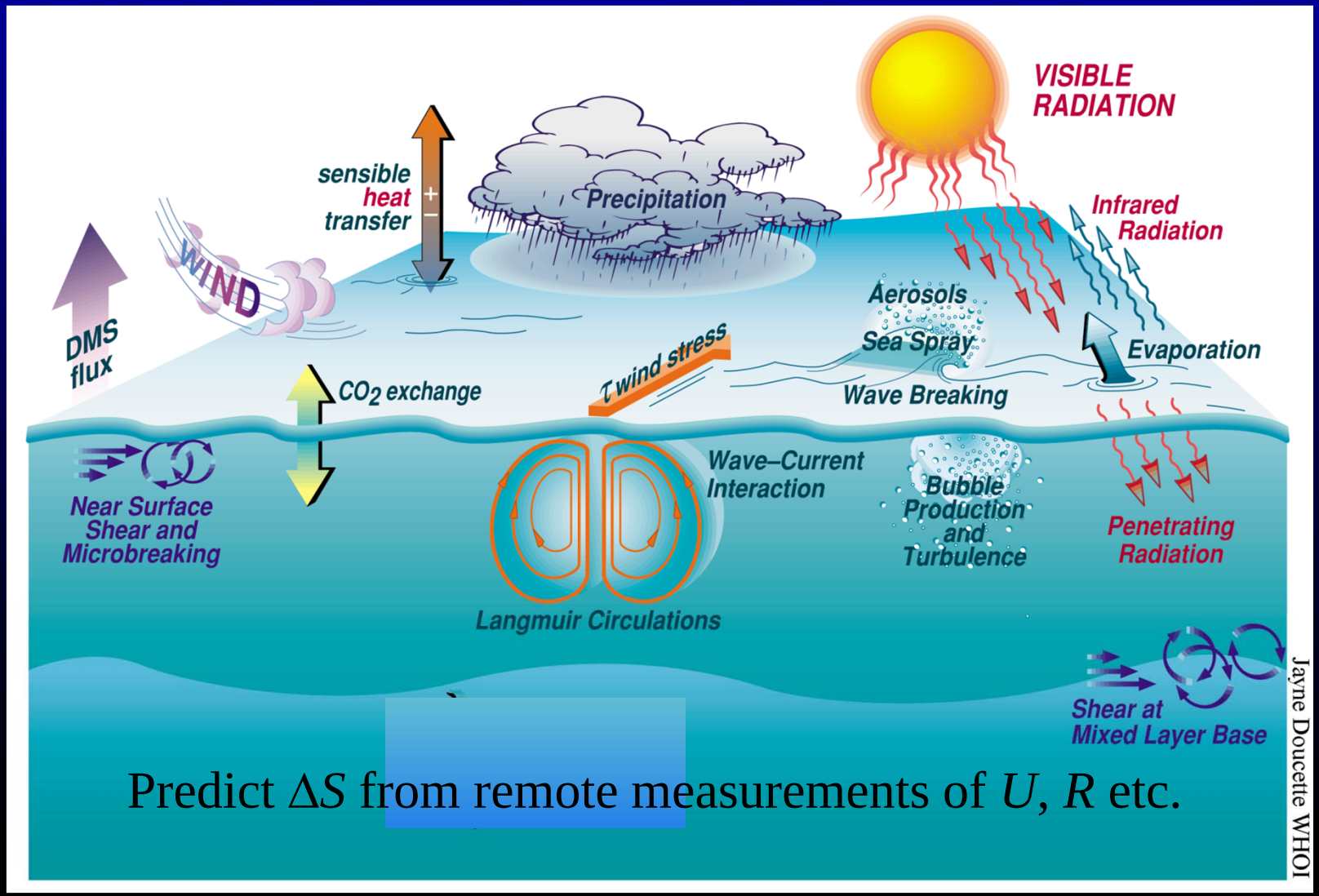
Grodsky and Carton, 2012

How do salinity gradients form?



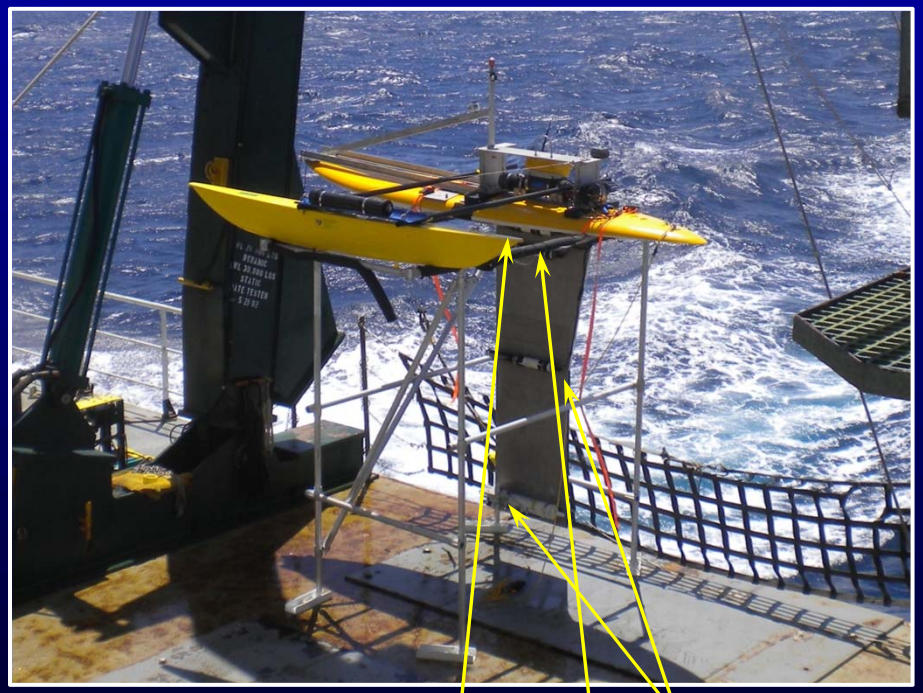
Measure ΔS as a function of U, R etc.

Can their presence be predicted from surface meteorological measurements?



Predict ΔS from remote measurements of U, R etc.

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

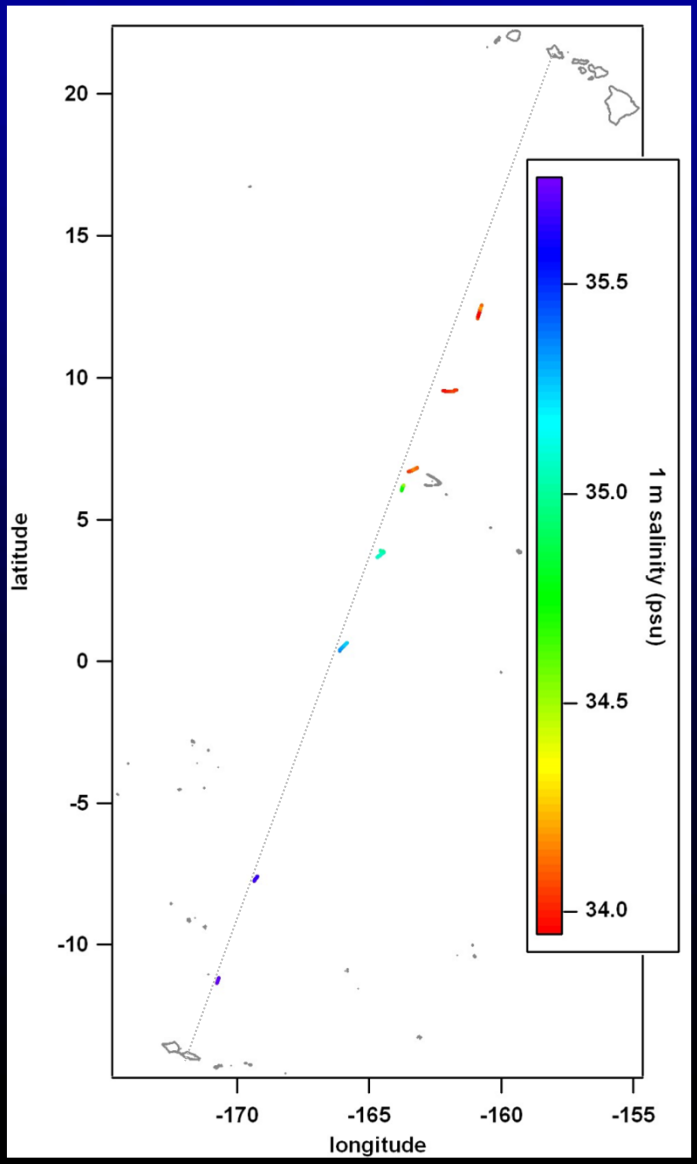
SSP deployed from the *R/V Kilo Moana*

Cruise conducted December 6-16, 2011

Sailed from Apia, Western Samoa to Honolulu, Hawaii

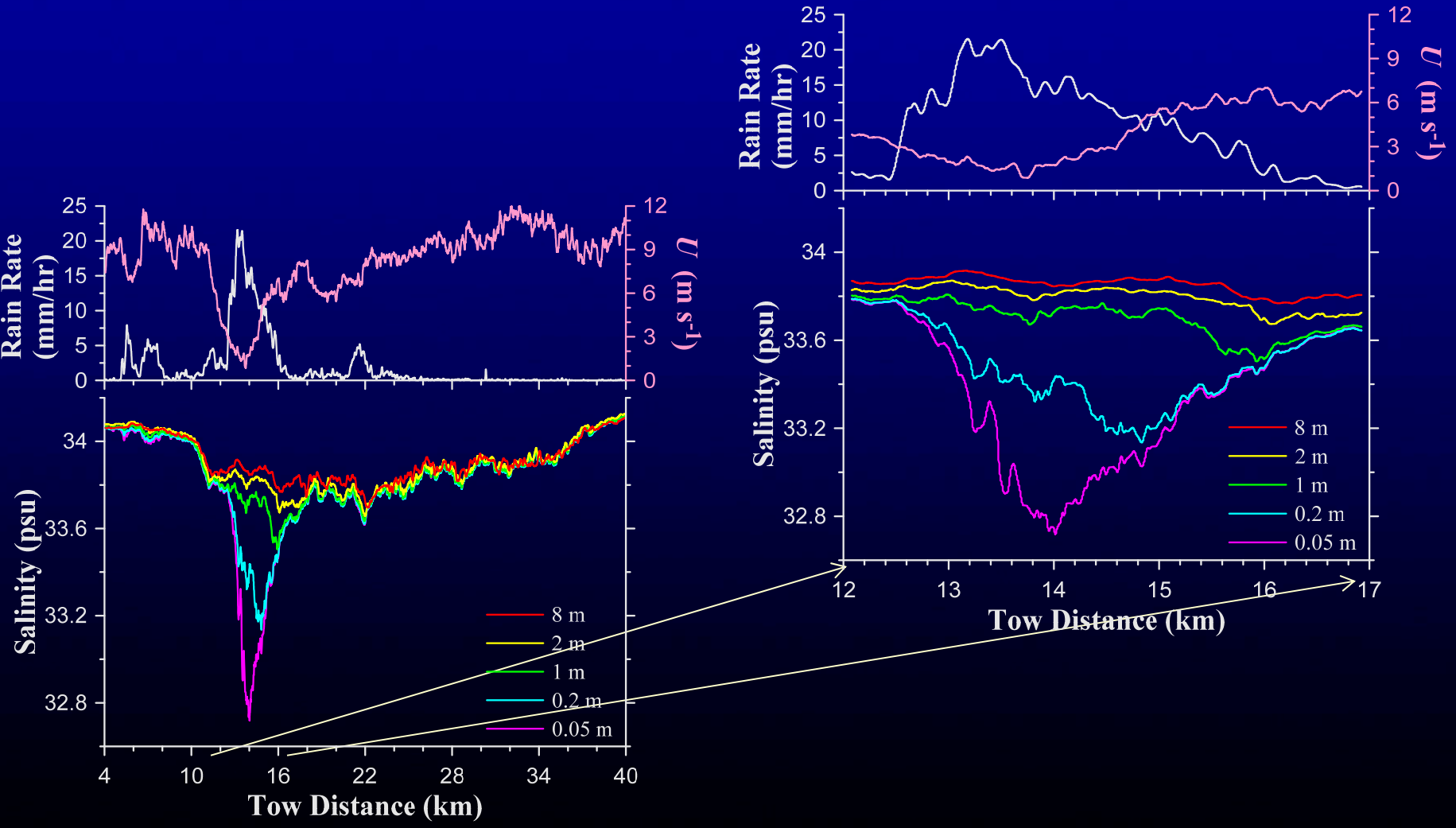
Deployed the SSP a total of eight times

Sampled 3 rain events

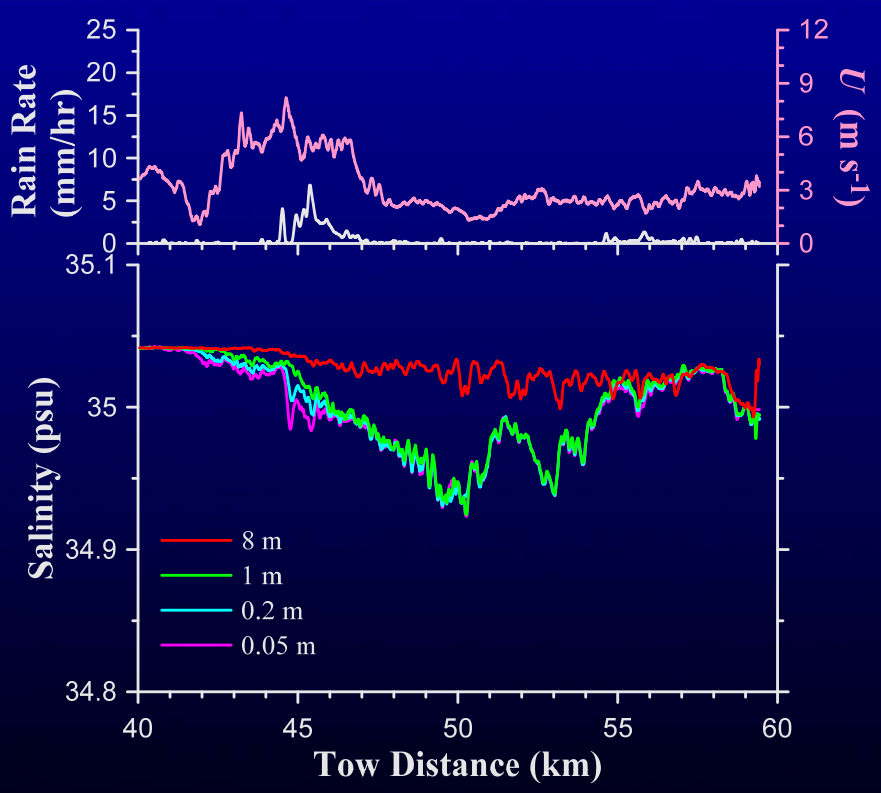


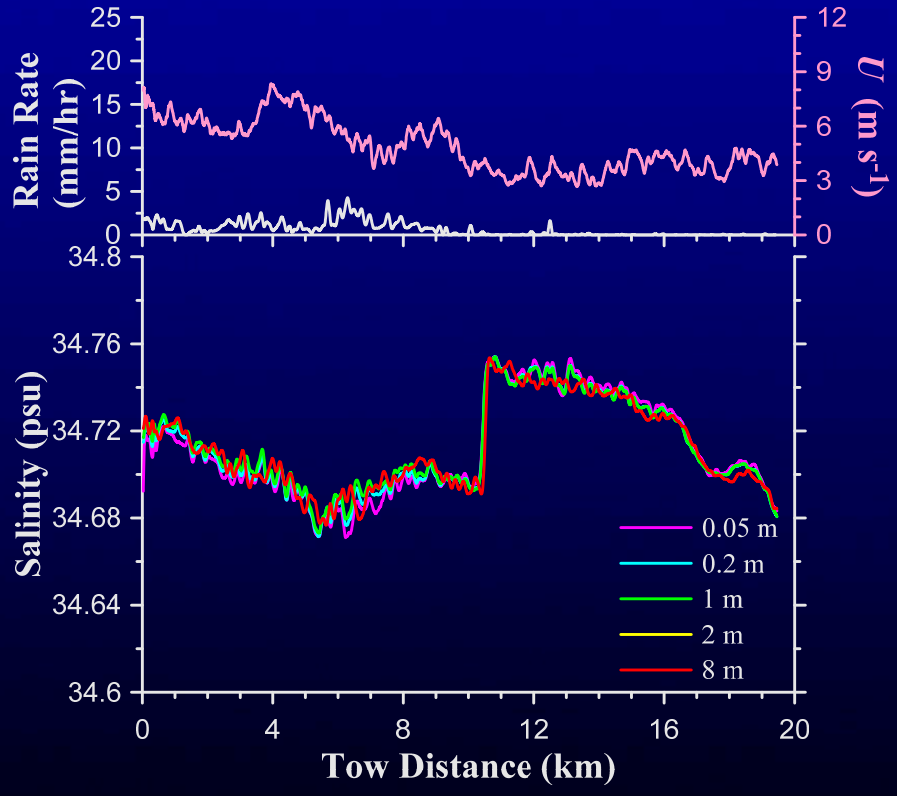
SSP Observation of Rain, Equatorial Pacific

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

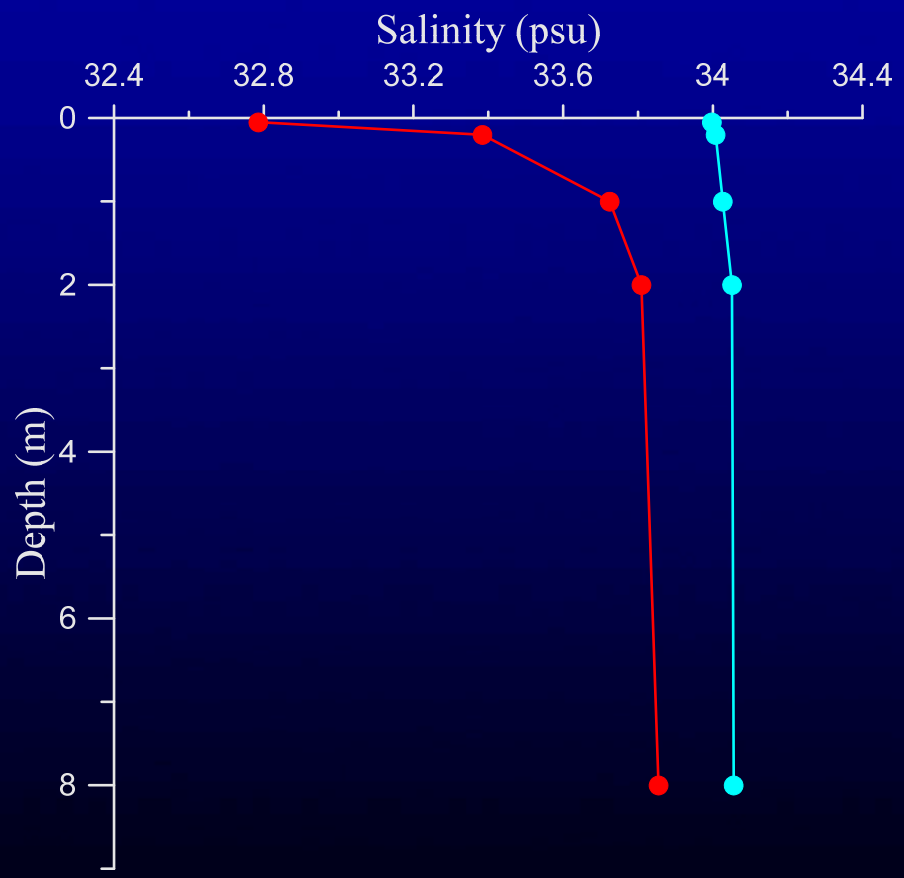


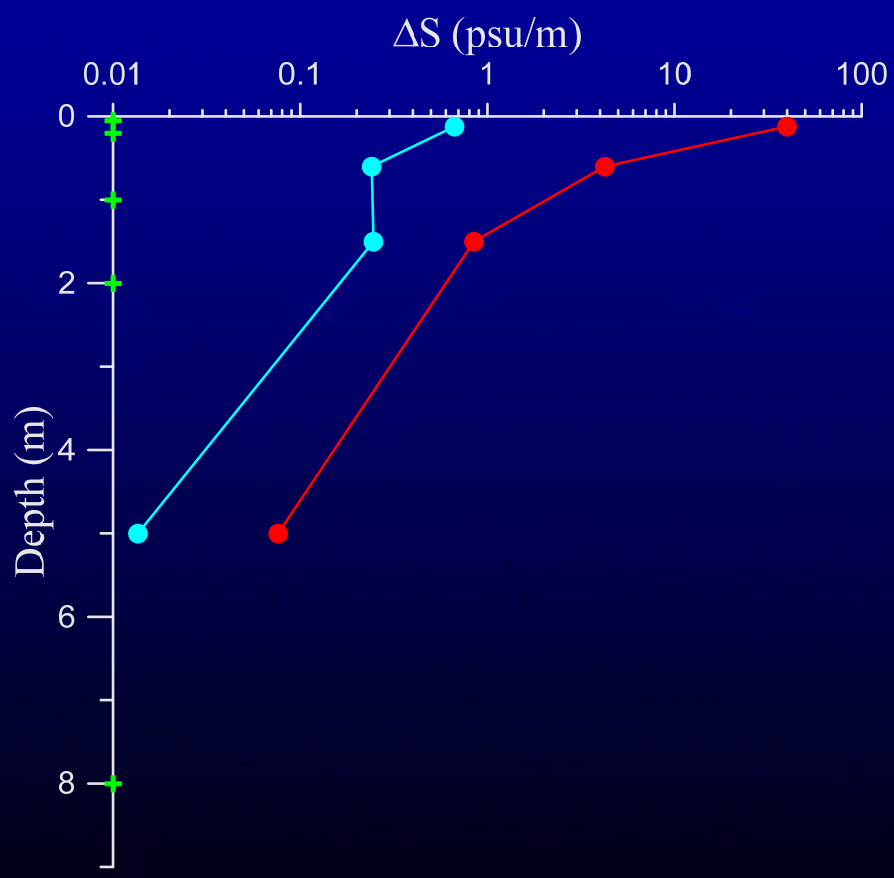
SSP Observation of Rain, Equatorial Pacific



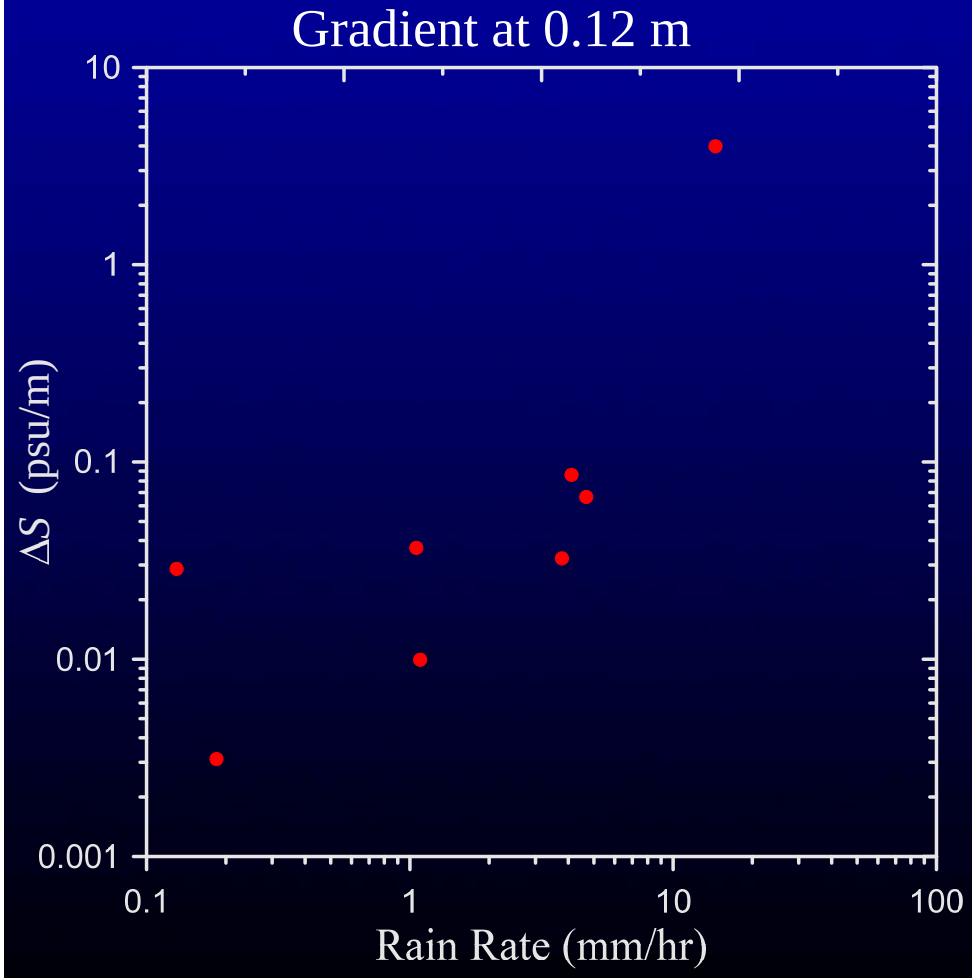


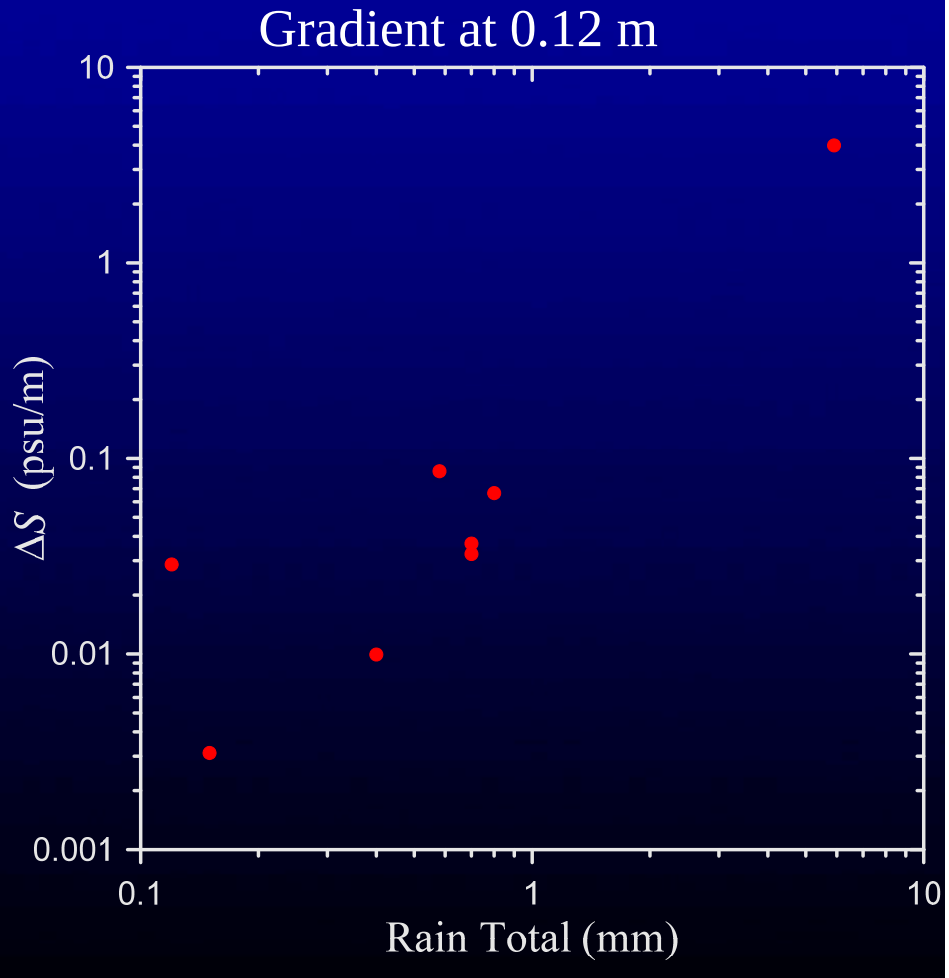
Salinity profiles and gradients



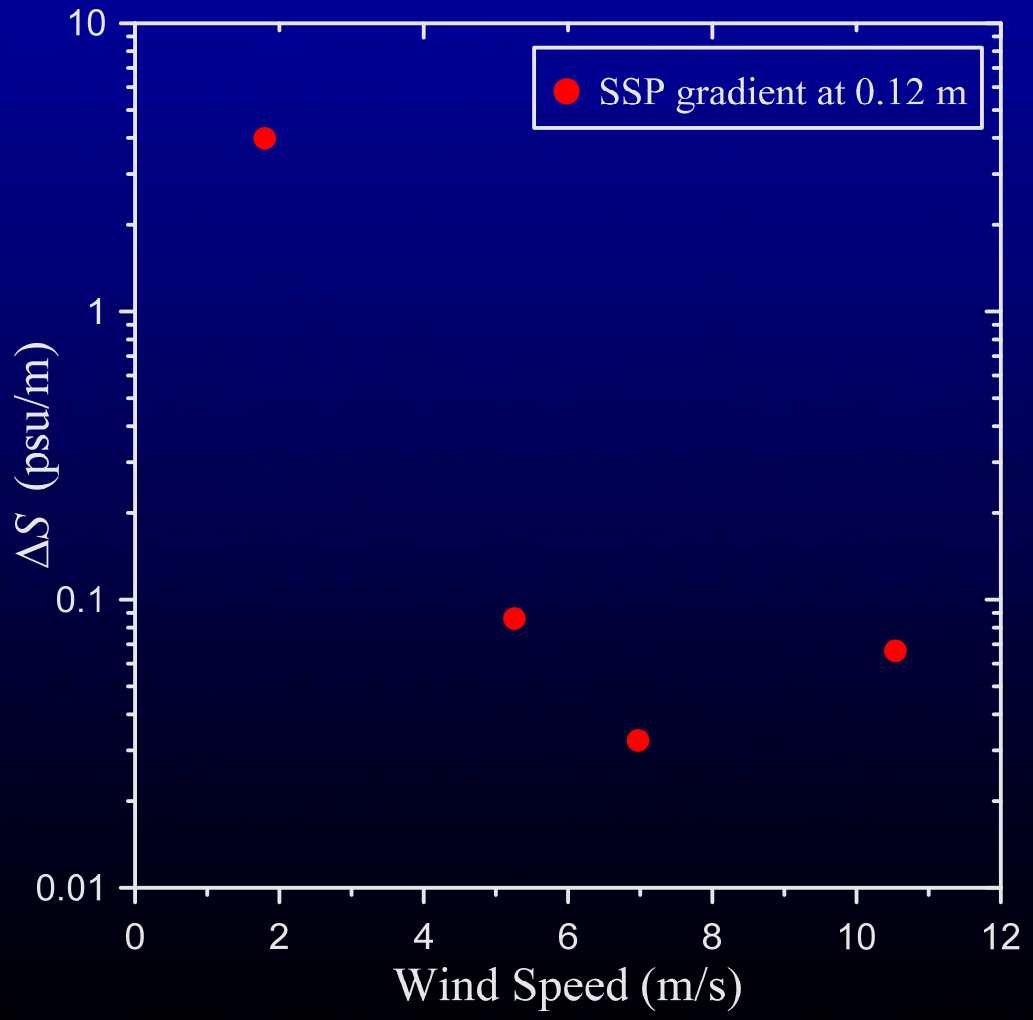


Salinity Gradient vs. rain rate and accumulation





Salinity gradients as a function of wind speed

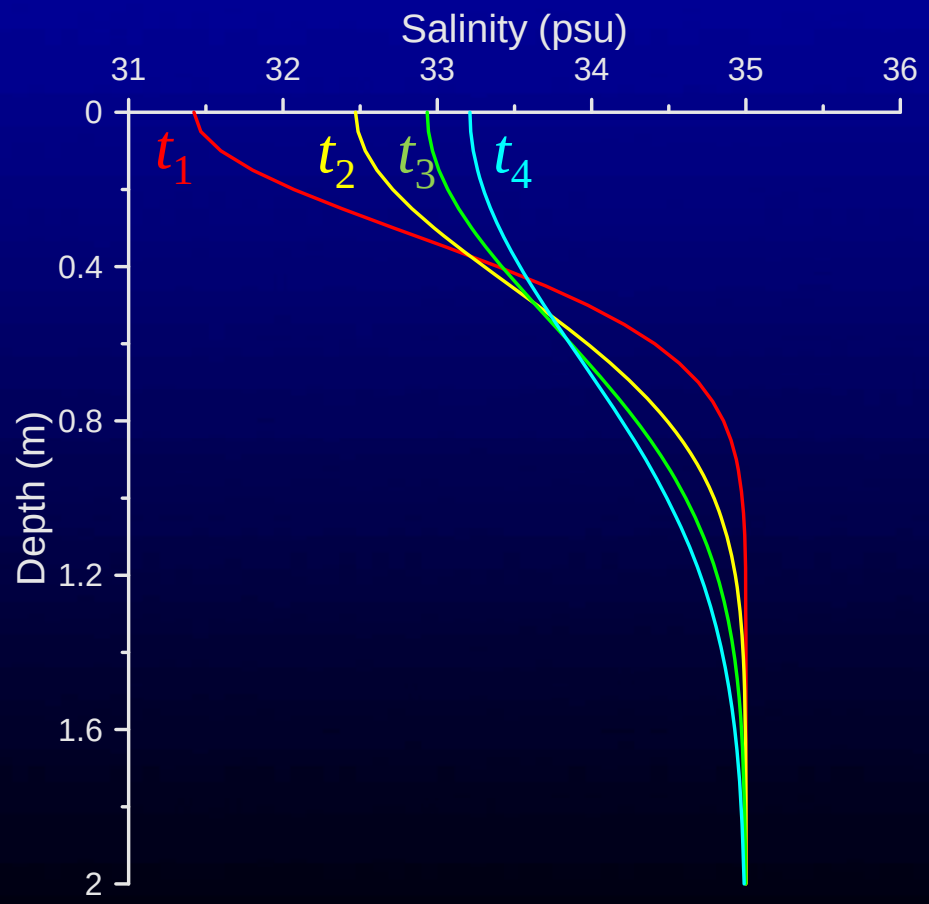


Is there dynamical information in the gradients?

Assume simple 1-d diffusion

Vertical eddy diffusivity, κ_z

$$S(z,t) = S_0 - \frac{A}{\sqrt{\kappa_z t}} e^{-\frac{z^2}{4\kappa_z t}}$$



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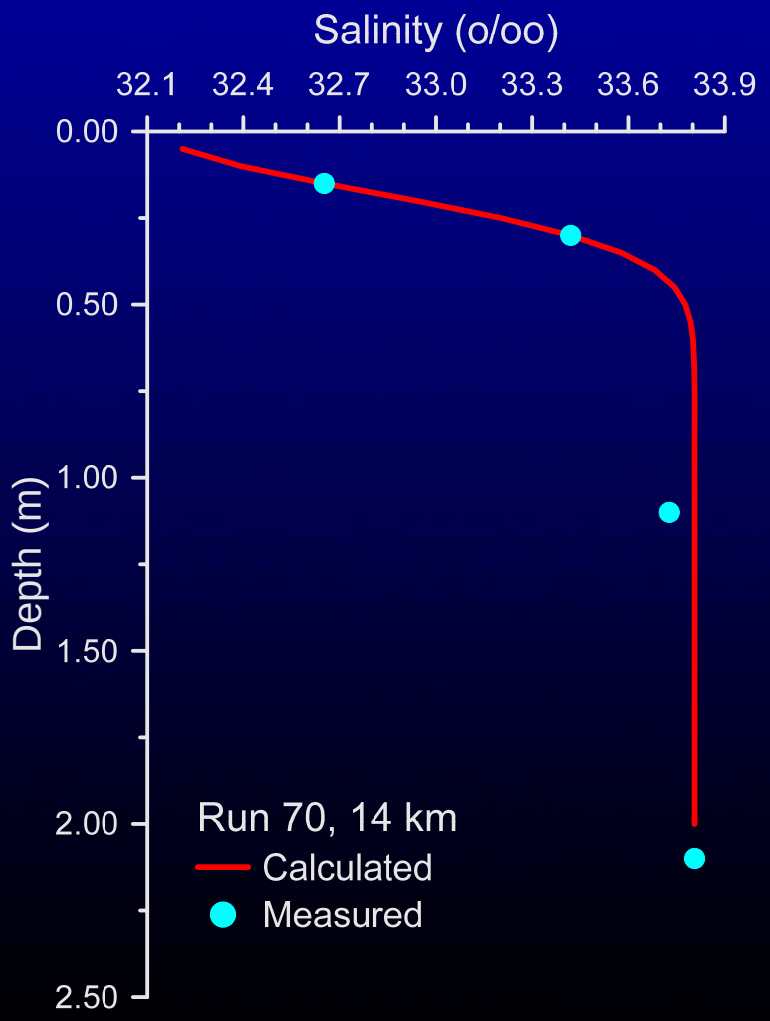
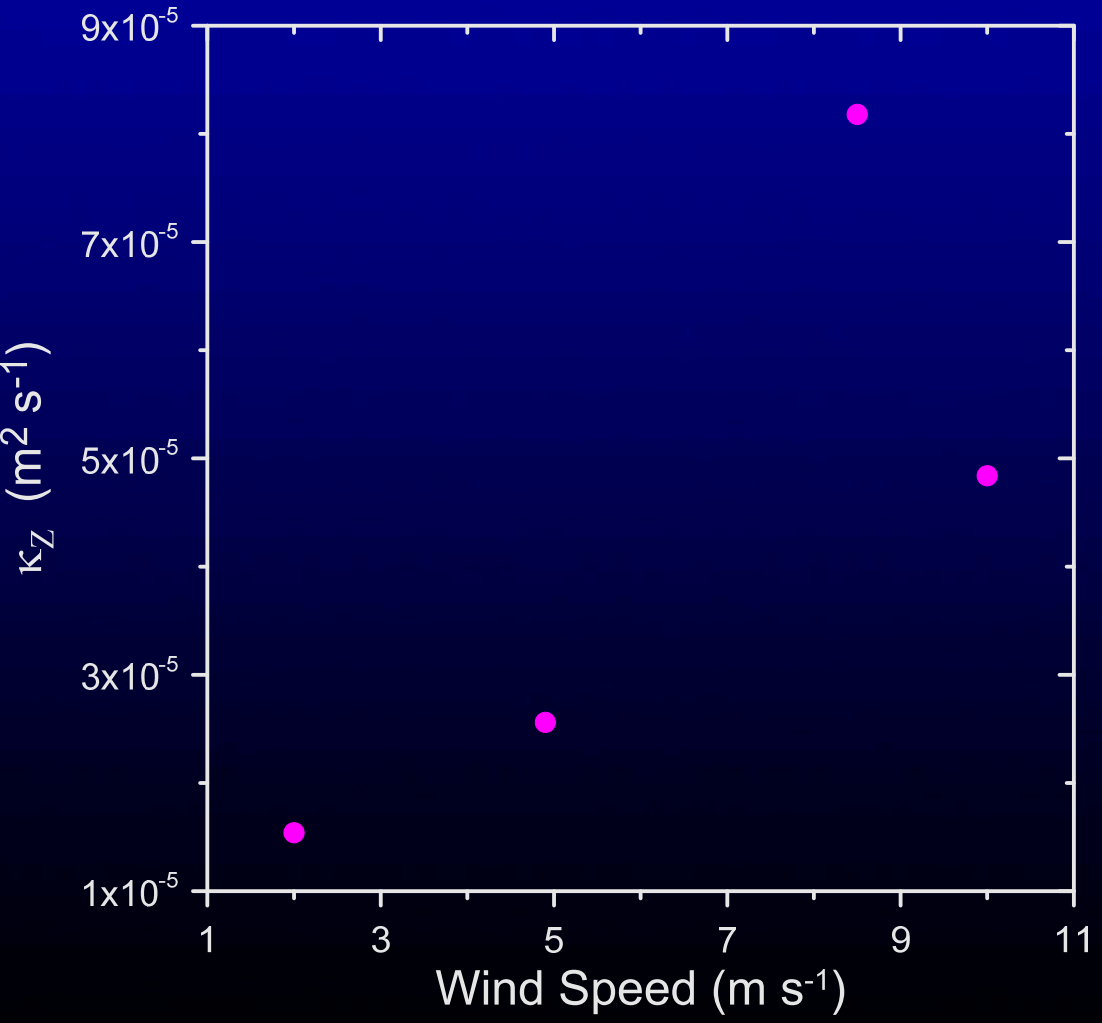
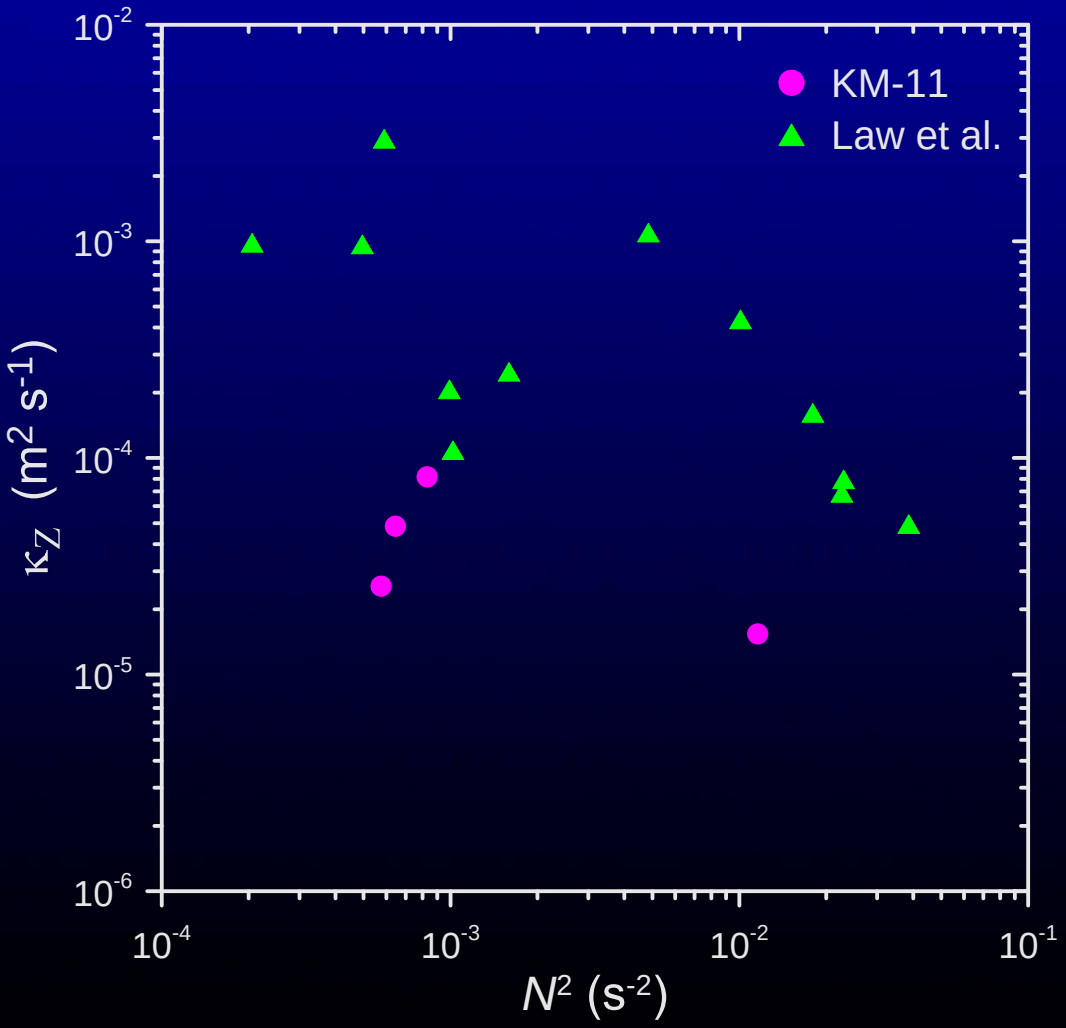


Eddy diffusivity vs. wind speed



Eddy diffusivity vs. buoyancy frequency



Conclusions

1. Rain generates measurable near-surface (top 0.5 m) salinity gradients that can form at wind speeds up to 10 m/s

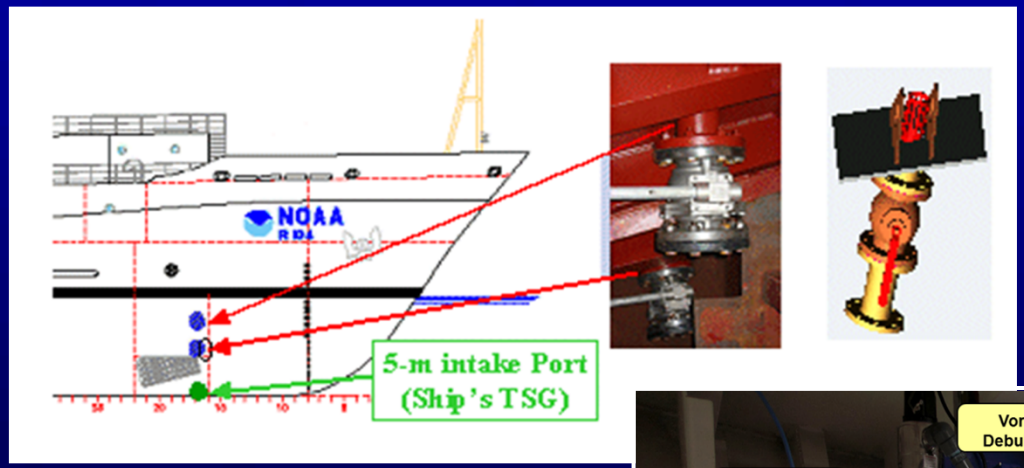
2. The magnitude of the gradient is related to total rain amount and the stability and mixing in the near surface

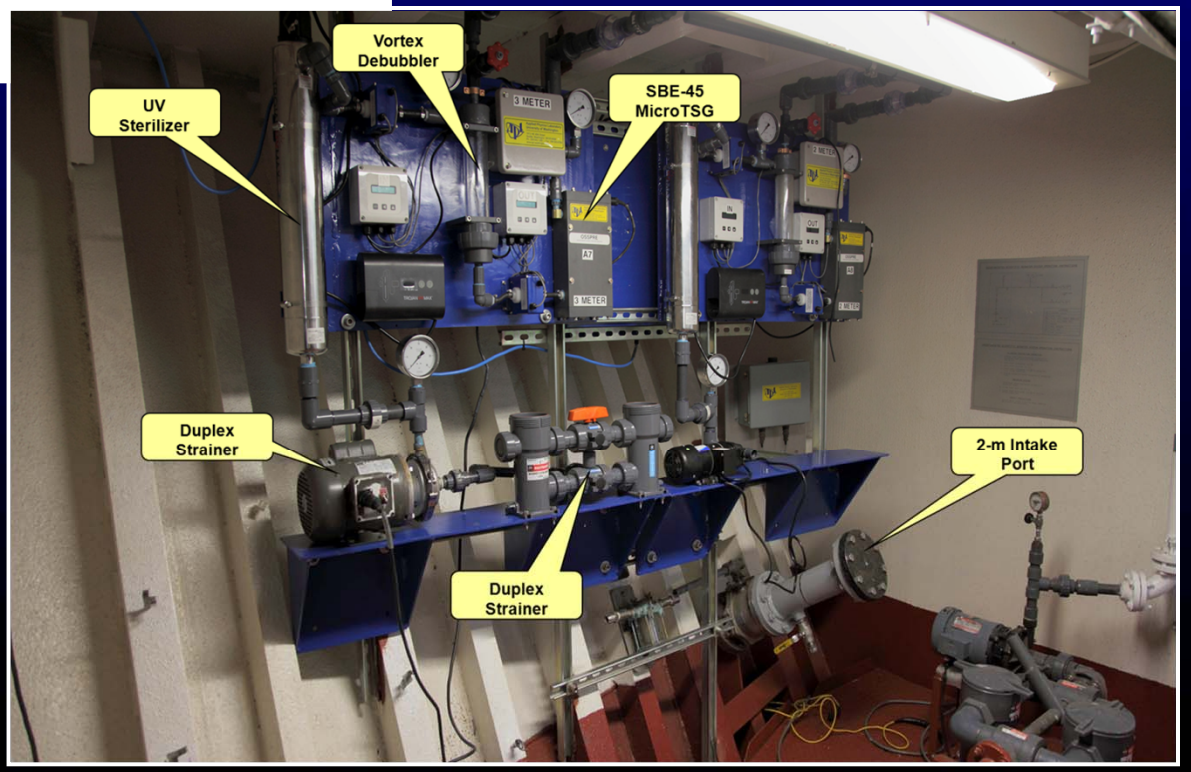
3. These gradients are large enough (in terms of ΔS) to affect Aquarius

4. Extend over large enough areas to affect satellite measurements

The Surface Salinity Profiler (SSP) in tow from the *R/V Thomas G. Thompson*

The underway salinity gradient instrument package on the *R/V Thomas G. Thompson*





Underway salinity measurements: *R/V T. G. Thomson*