Very-Near Surface Salinity in the Intertropical Convergence Zone

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OSST 2017 Meeting

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Salinity Snake: A Brief History

- During SPURS I (September 2012):
  - Surface salinity enhancements (ΔSSS 0m-5m) up to 0.2 measured by Ecomappers & Wave Gliders
  - No surface samples could be taken to confirm instrumental measurements (vessel 'stirring')
- In collaboration with Gary Lagerloef and Ray Schmitt, I designed the 'SPURS Surface Salinity Sea Snake' to obtain verifiable surface measurements
- Found freshwater lenses during SPURS-1, completely new design for SPURS-II

Development

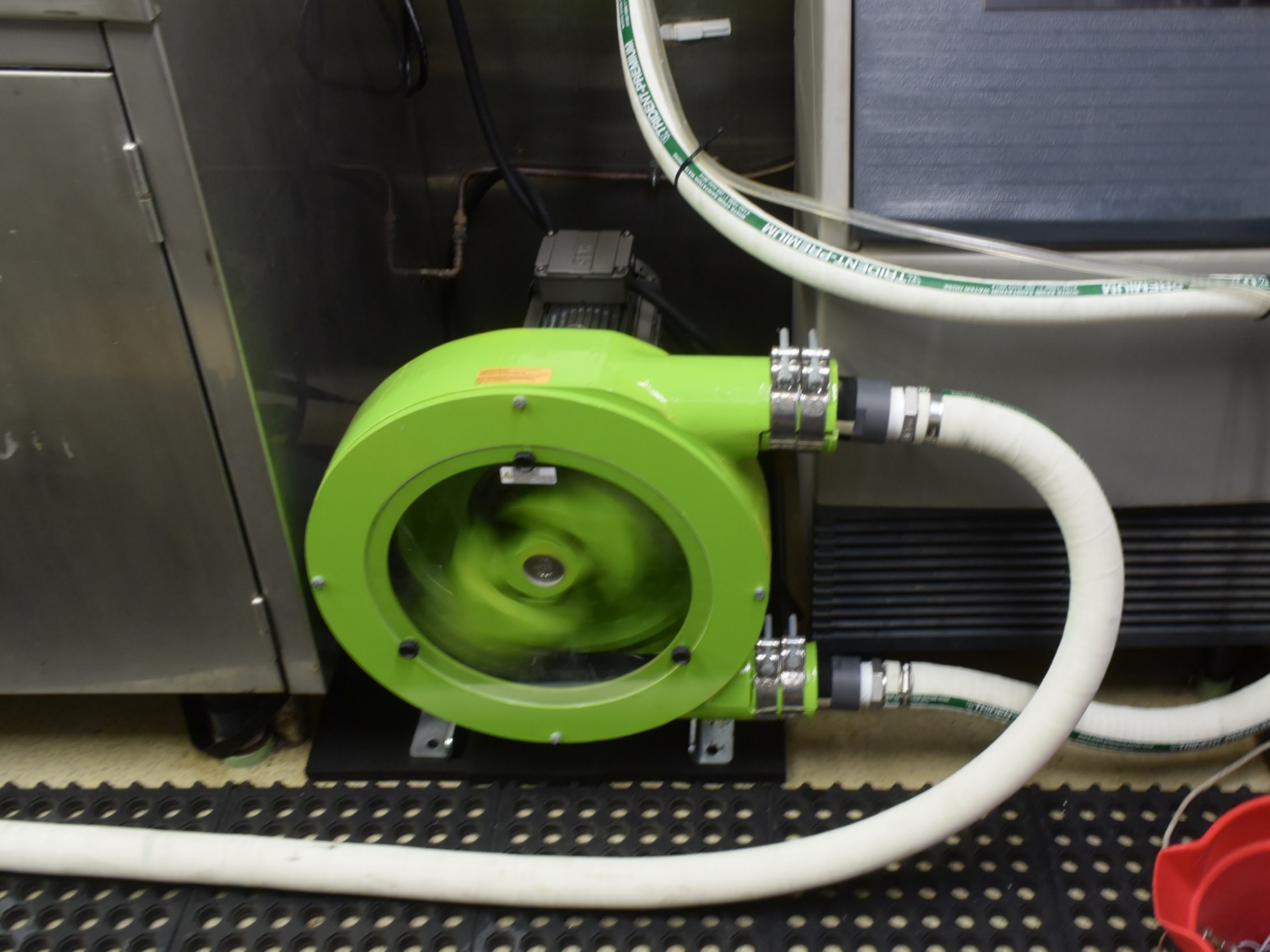
- Early tests: simpler is better
- At 12 knots, most initial designs proved unstable
- Advances in pumps, intake design and de-bubbling

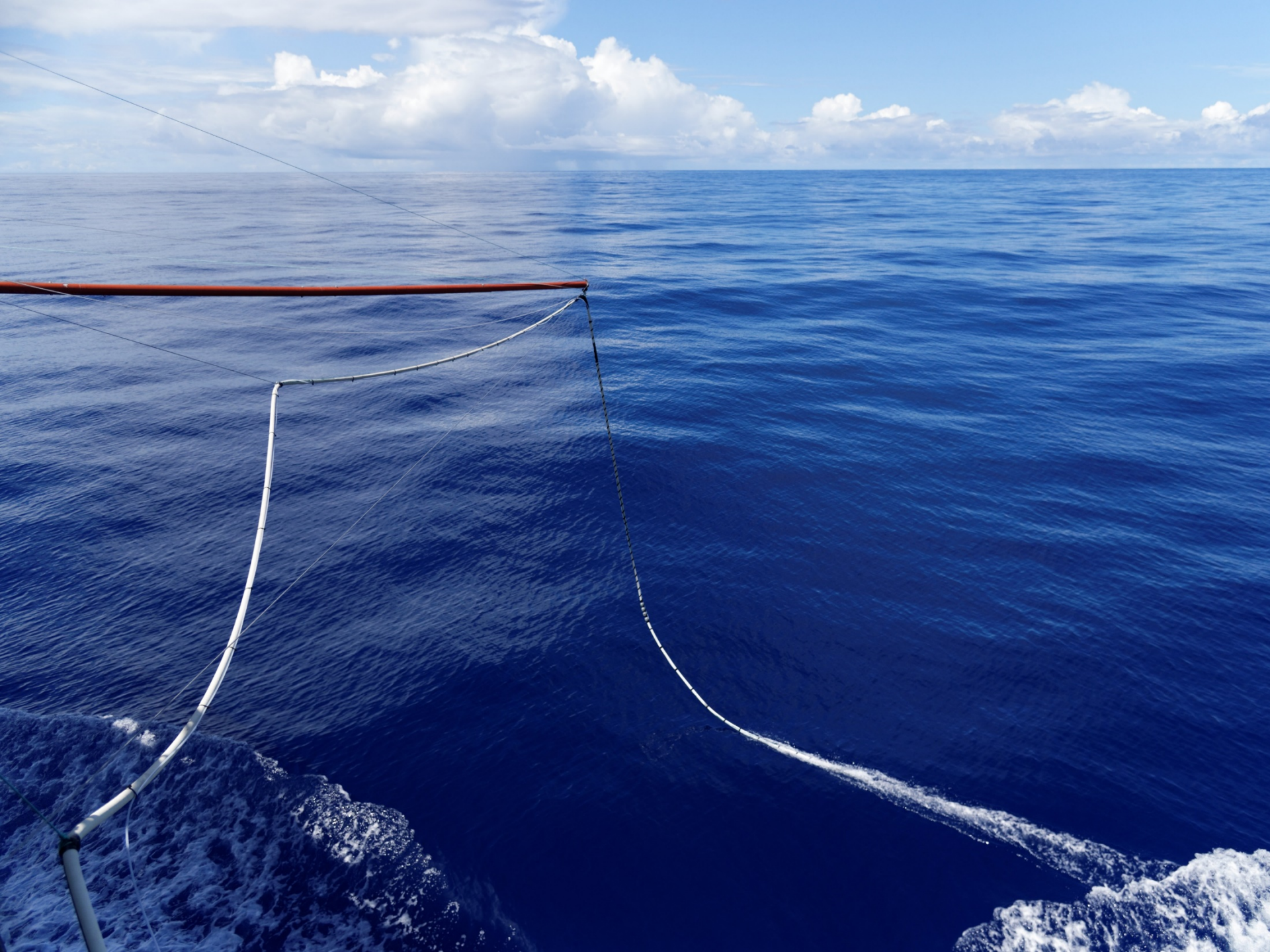
Salinity Snake: Overview

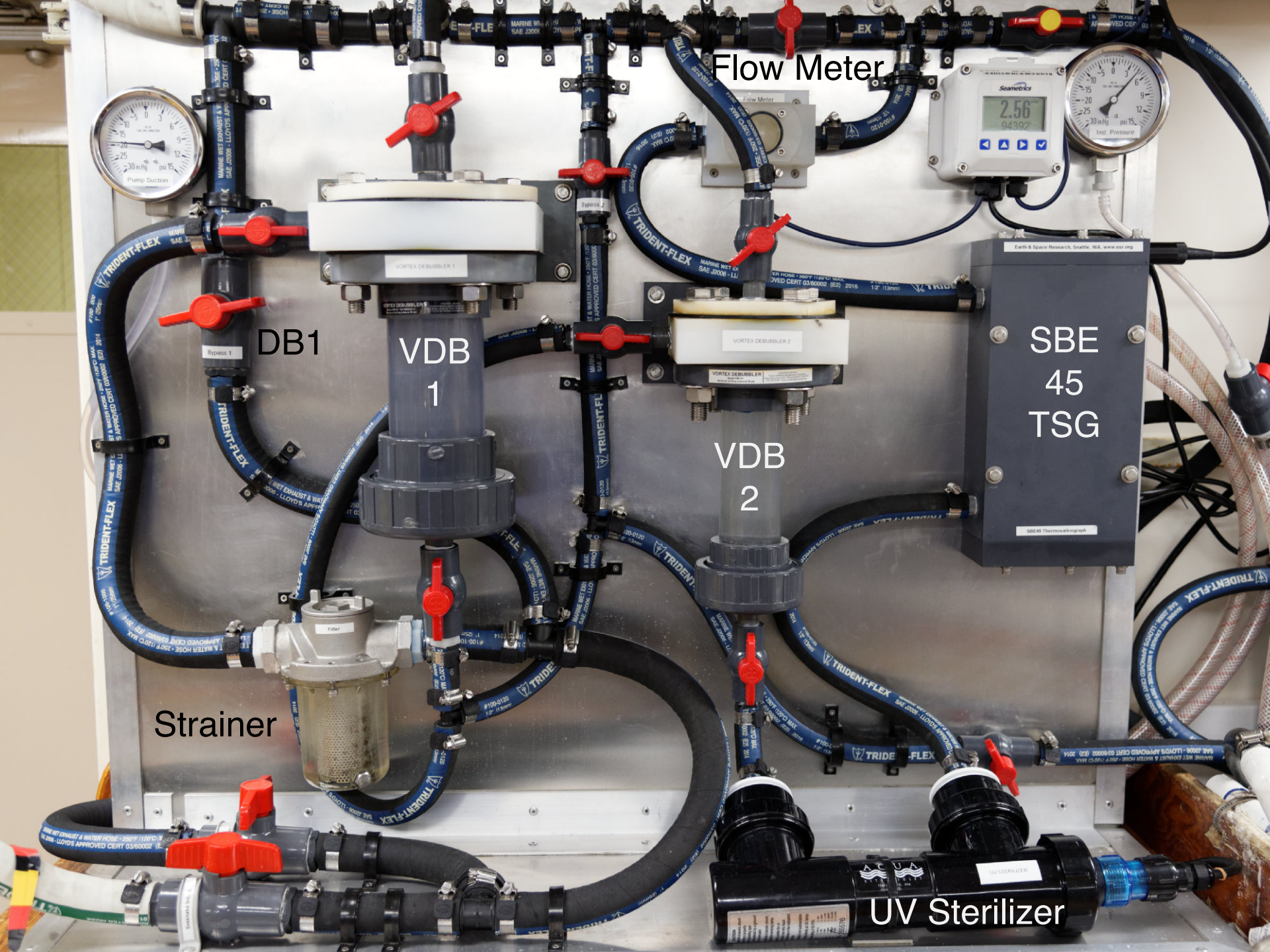
- Why do we care about a measurement at 1-2cm depth?
  - L-Band satellite measurements vs Argo
  - Air-sea interaction
  - Variance generation
  - Mixing rates
- No/very little dedicated ship time required
- Works best at speeds of 6-15 knots
- Measurement depth identical to L-Band (~1.4GHz) radiometric depth

Salinity Snake Today

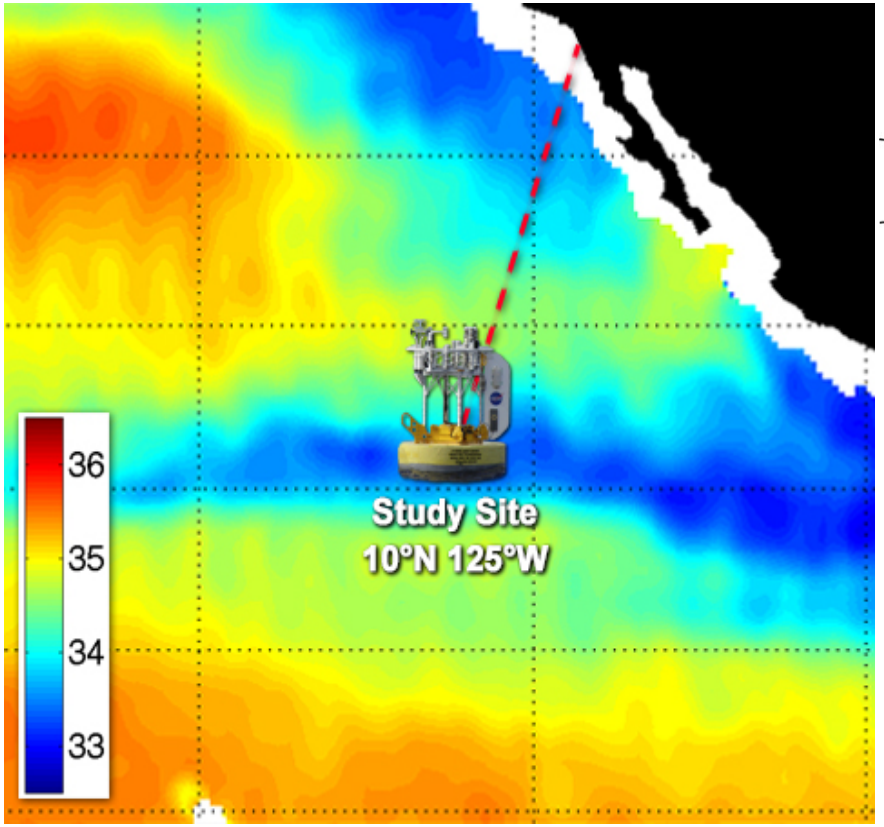
- Peristaltic (hose) pump capable of pumping up to 60 liters per minute
- Triple de-bubbling (including cascading vortex de-bubblers)
- SBE56 used as hose end plug provides WOCE-grade temperature measurements at running depth of 1-2cm
- GPS-controlled pump speed
- Flow speeds logged for quality control (pump, TSG)
- TSG is regularly sampled for salinometer-analysis
- Also analyzing pCO_2, DIC, pH, O_2 (collaboration with D. Ho)

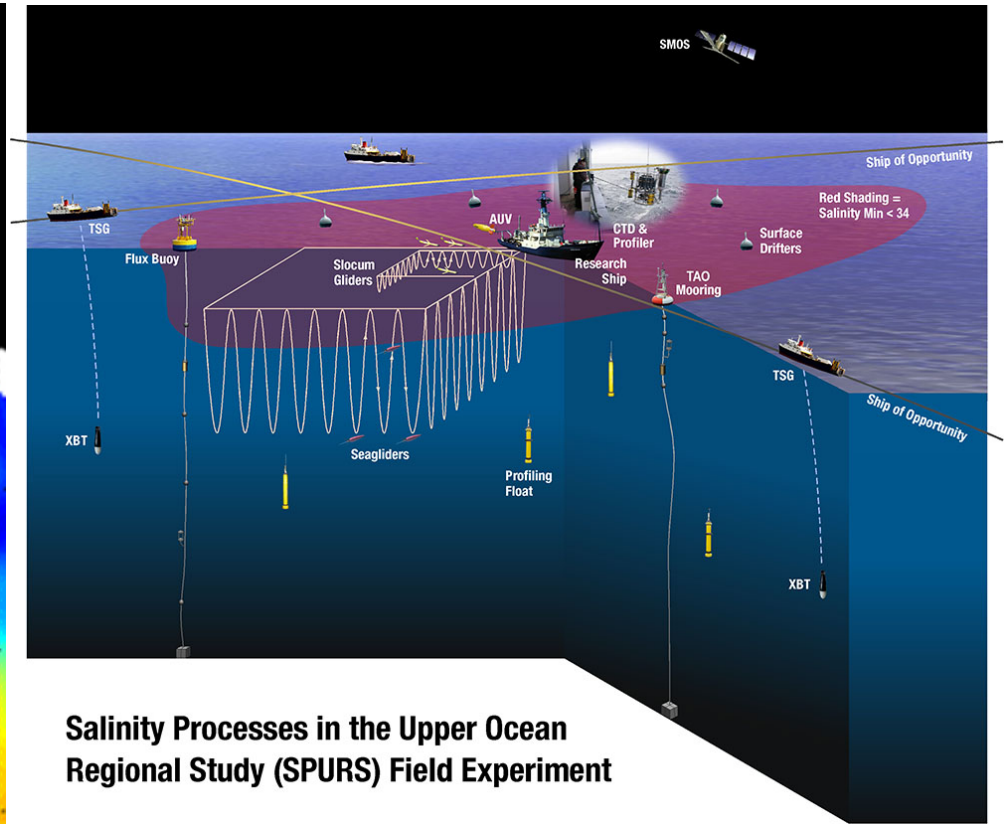




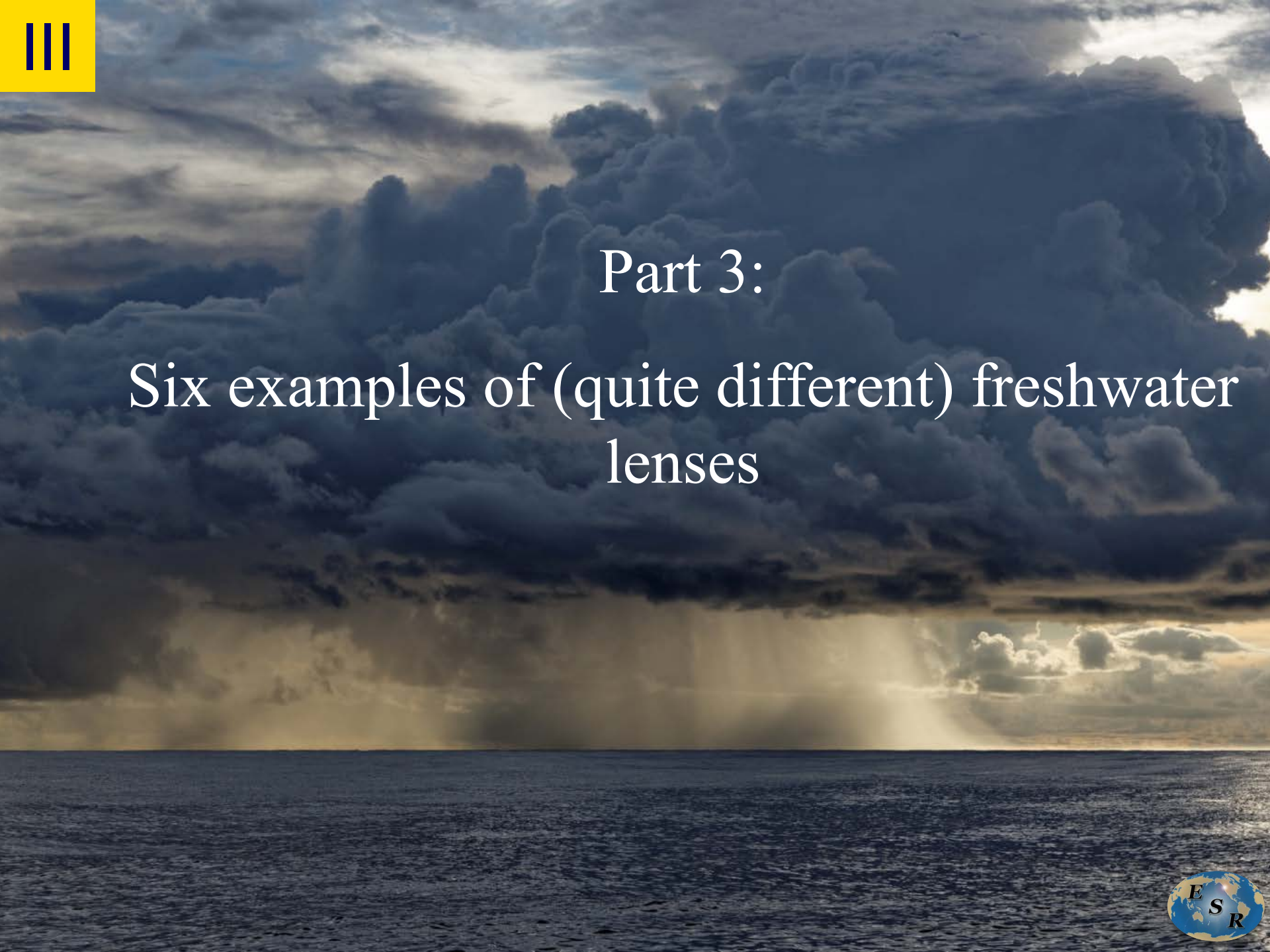

Flow Meter
DB1
VDB
1
VDB
2
SBE
45
TSG
Strainer
UV Sterilizer

SPURS 2





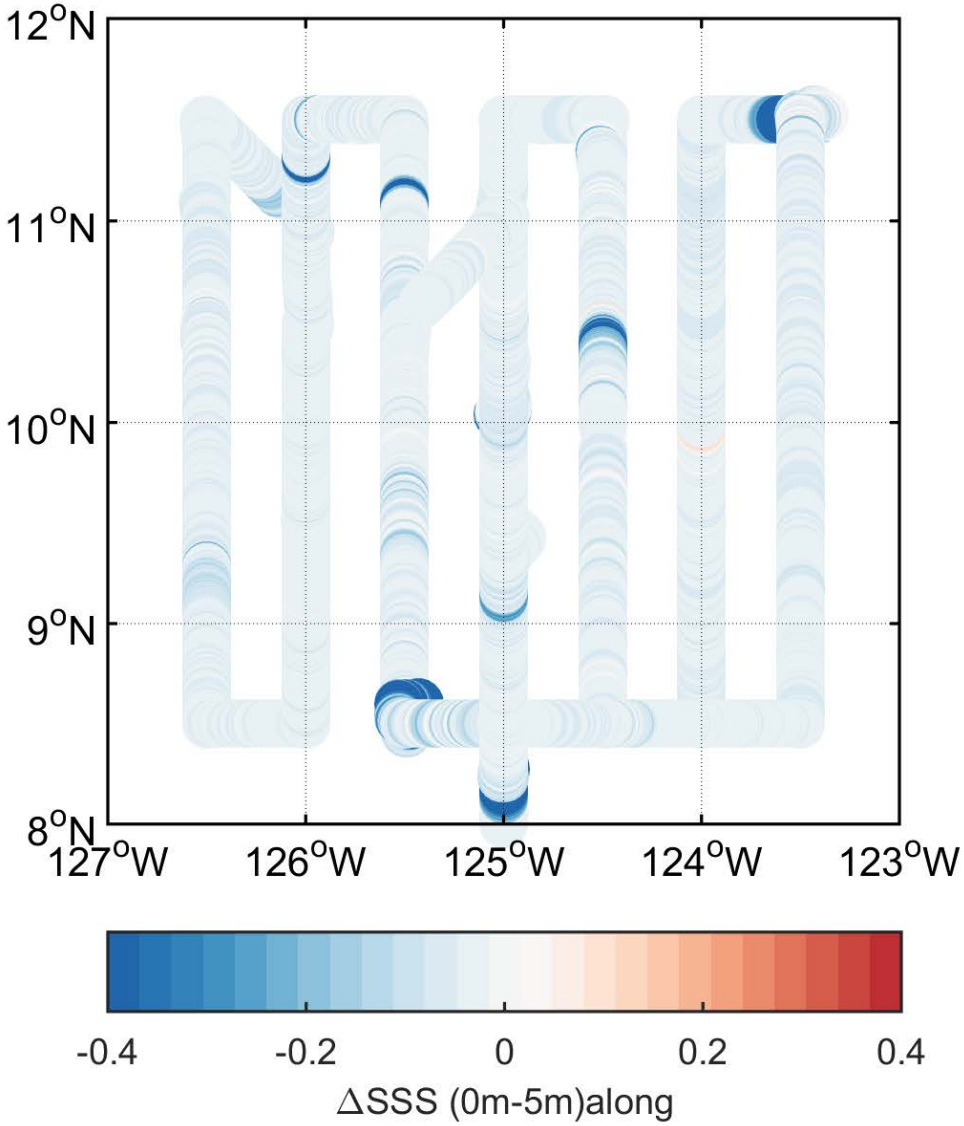
Salinity Processes in the Upper Ocean Regional Study (SPURS) Field Experiment



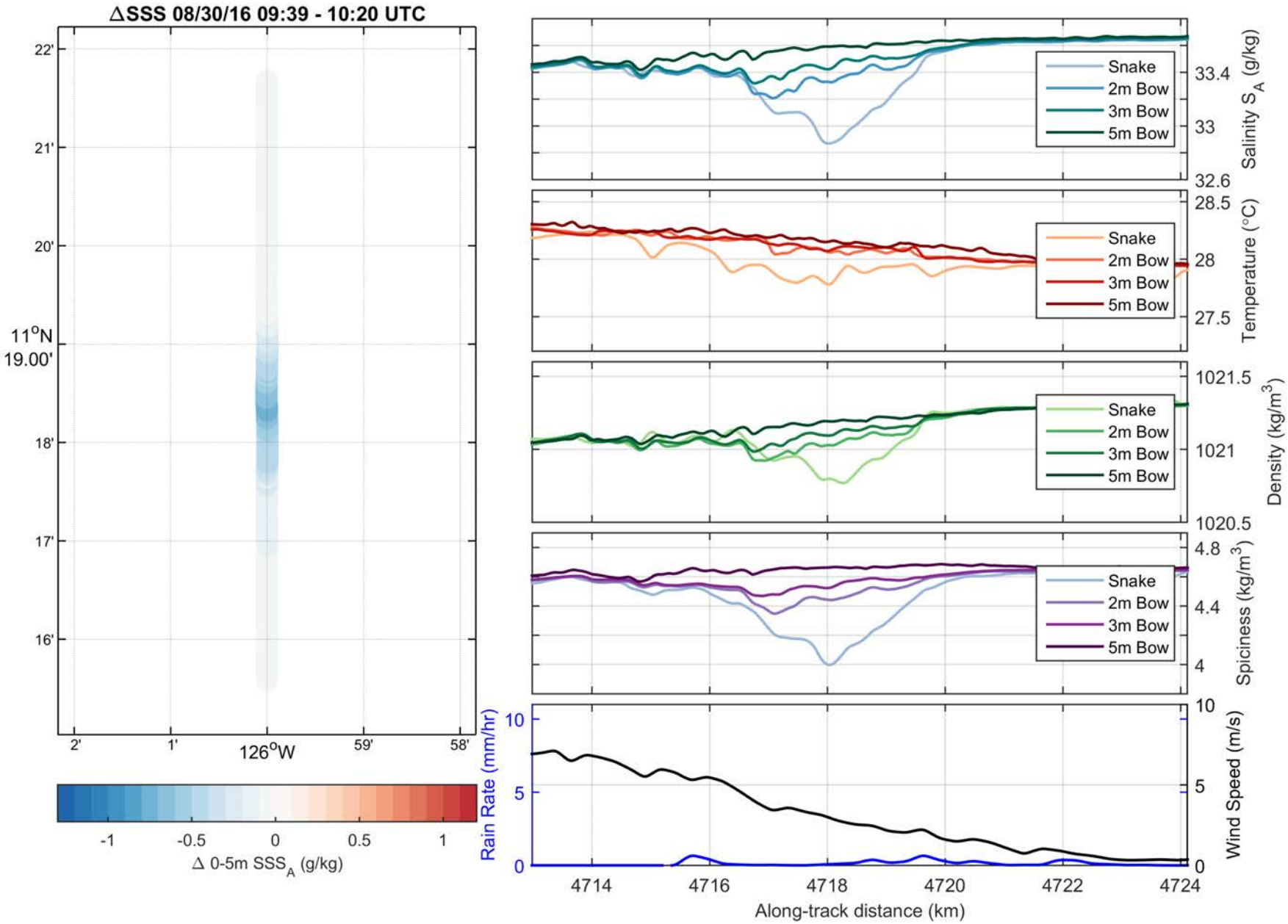
Part 3:

Six examples of (quite different) freshwater lenses

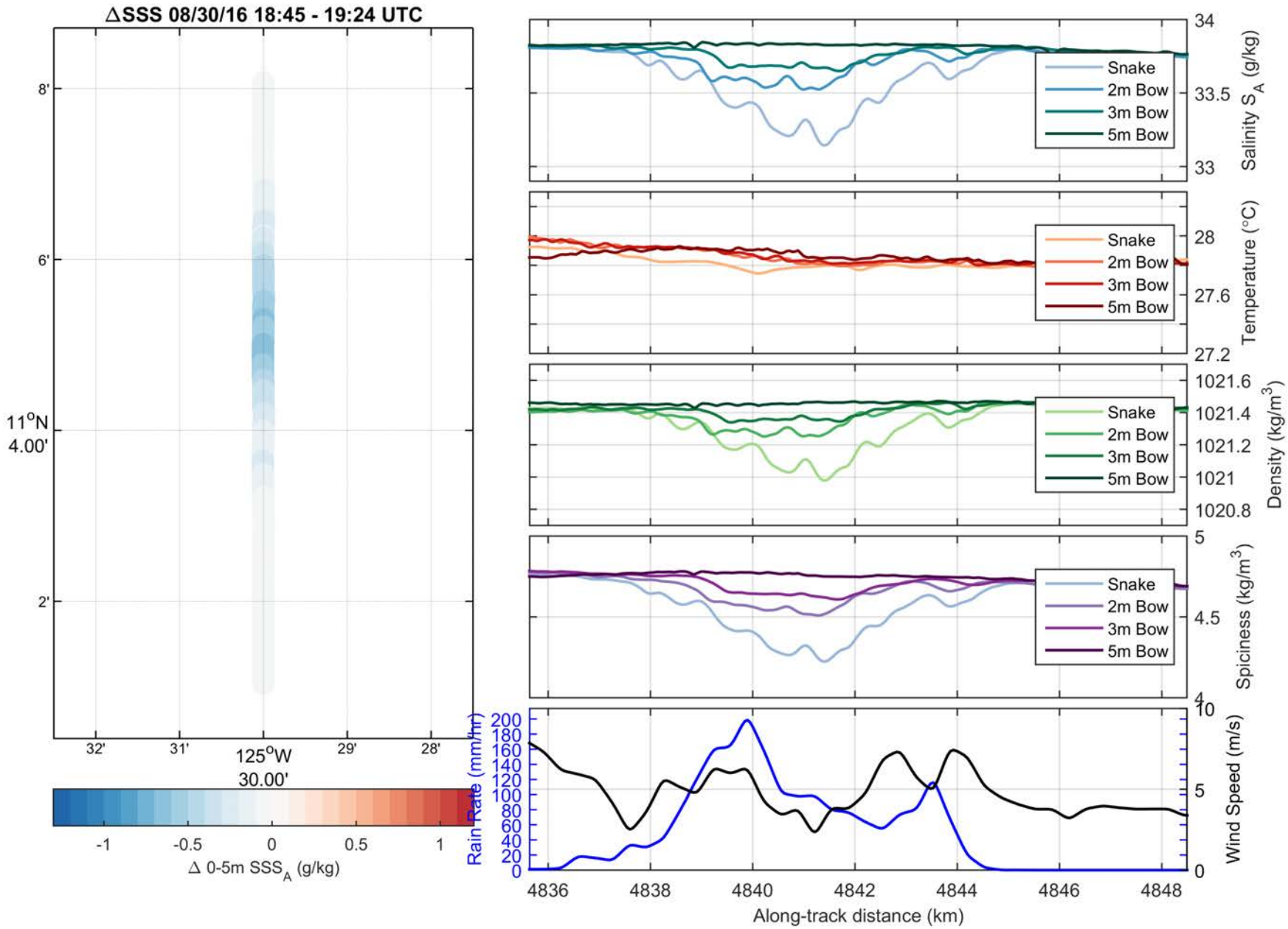
SPURS-2 Box Overview



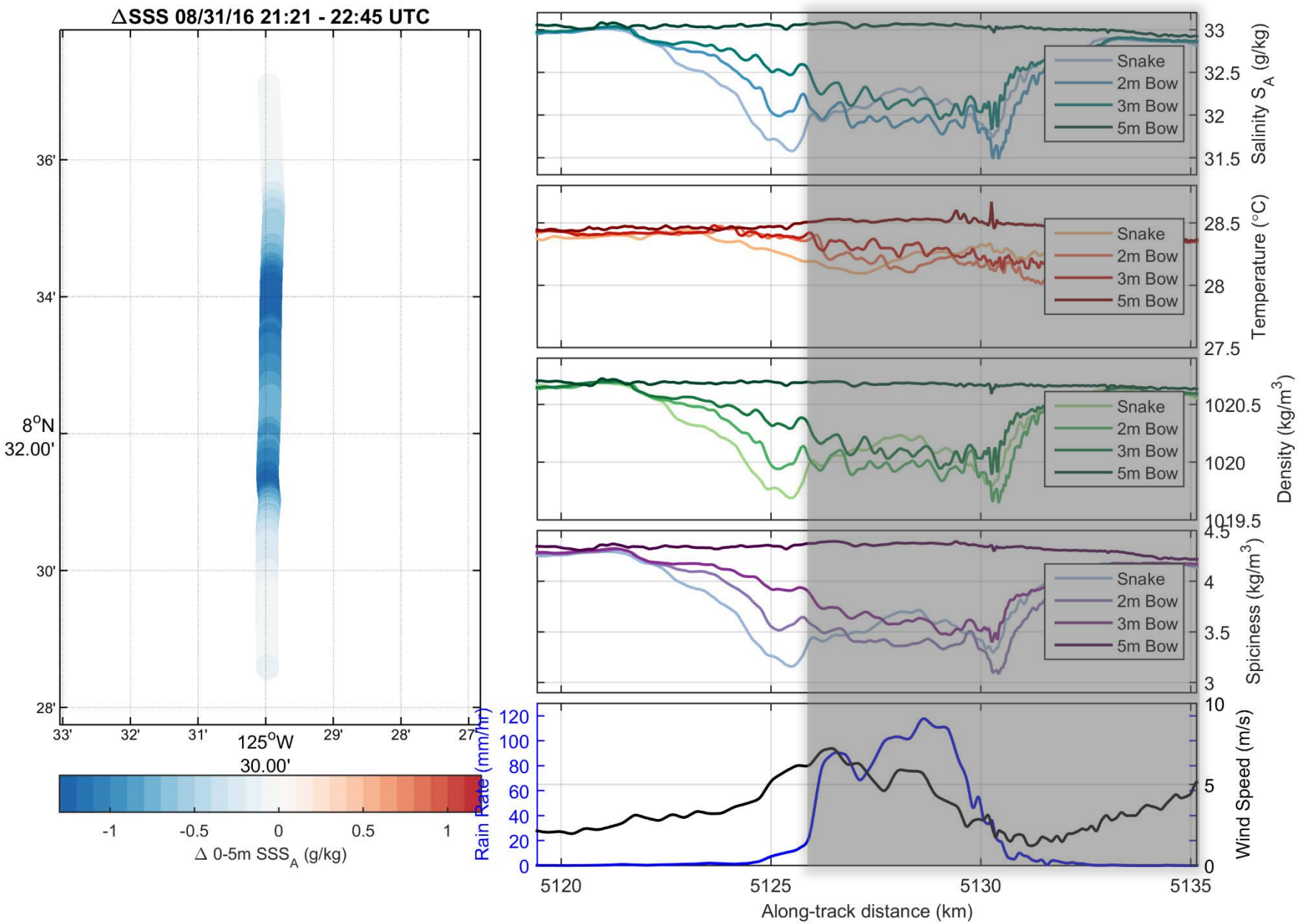
August 30 – Wind Dependent



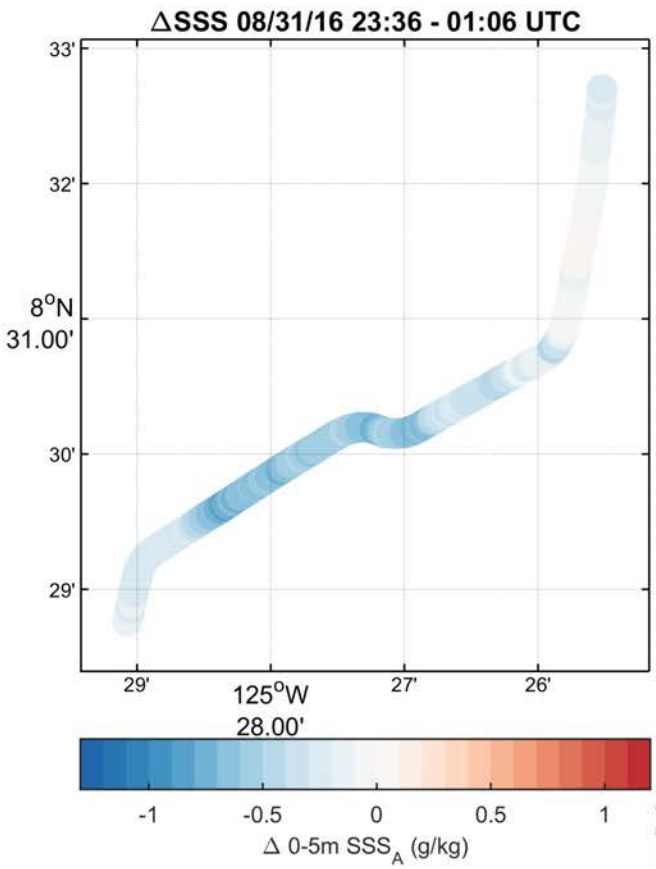
III August 30 – Smooth haline stratification

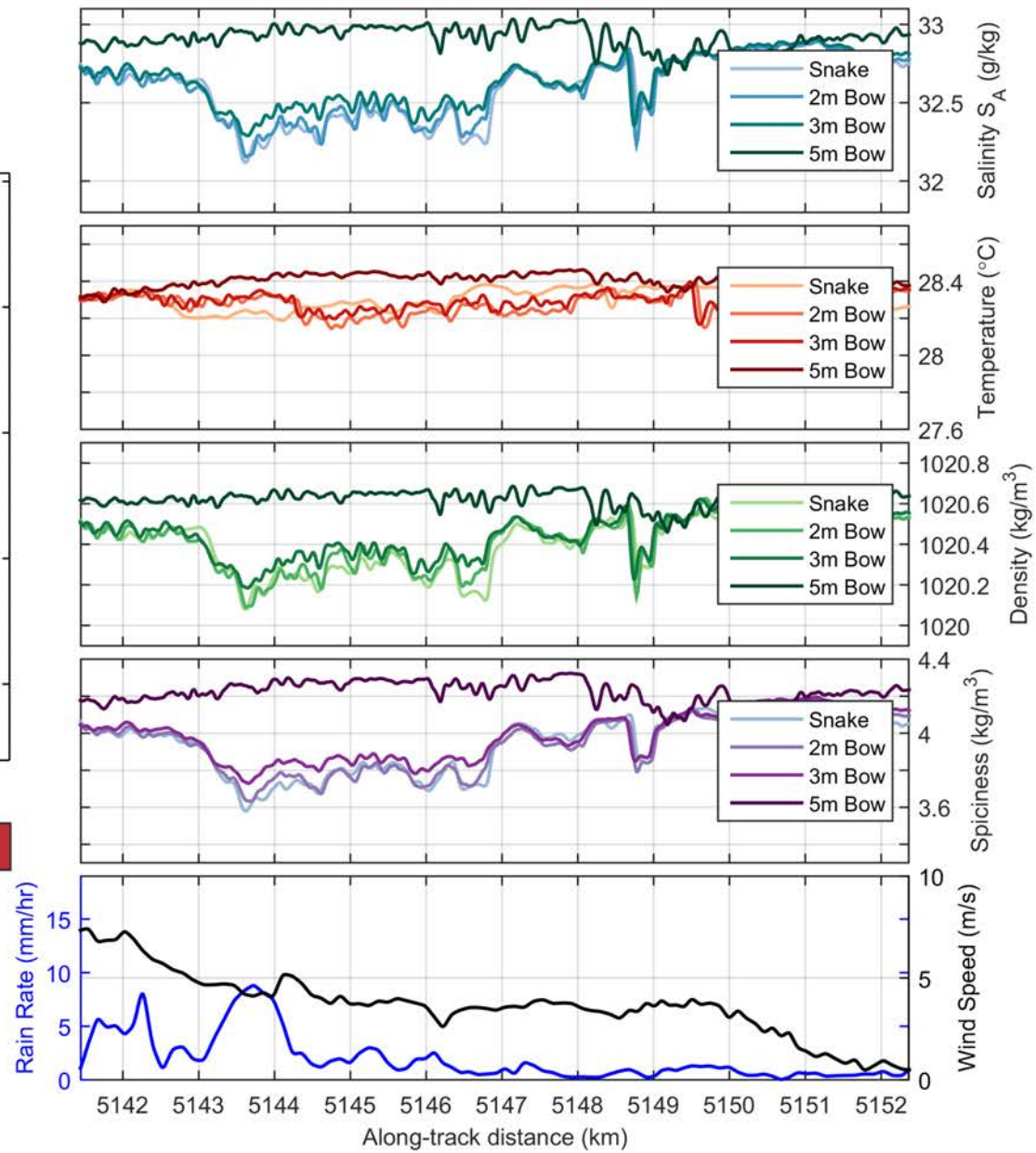


August 31 – High Precipitation

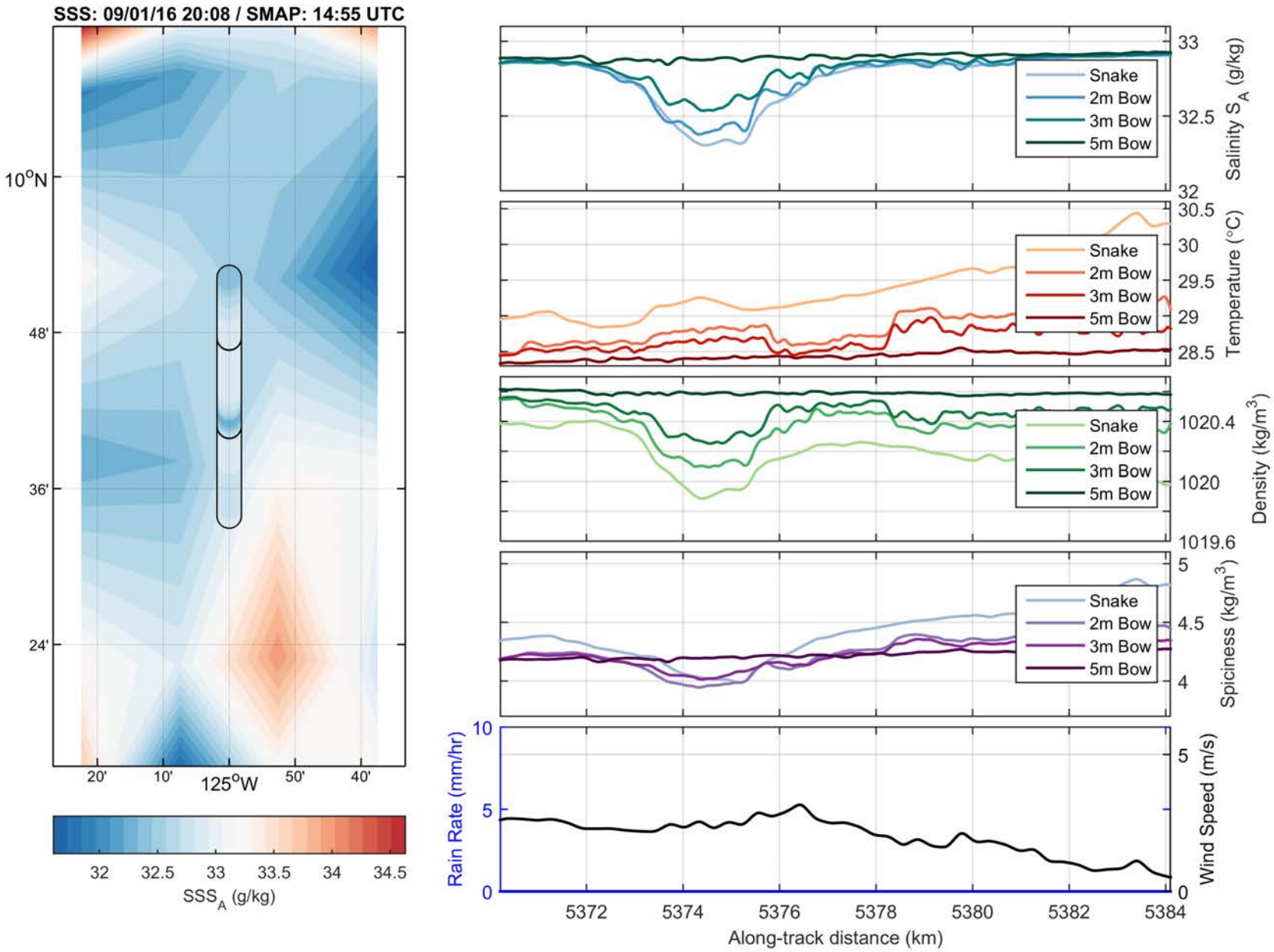


August 31 – Mixed to 3m but not 5m





III September 1: Persistent puddle



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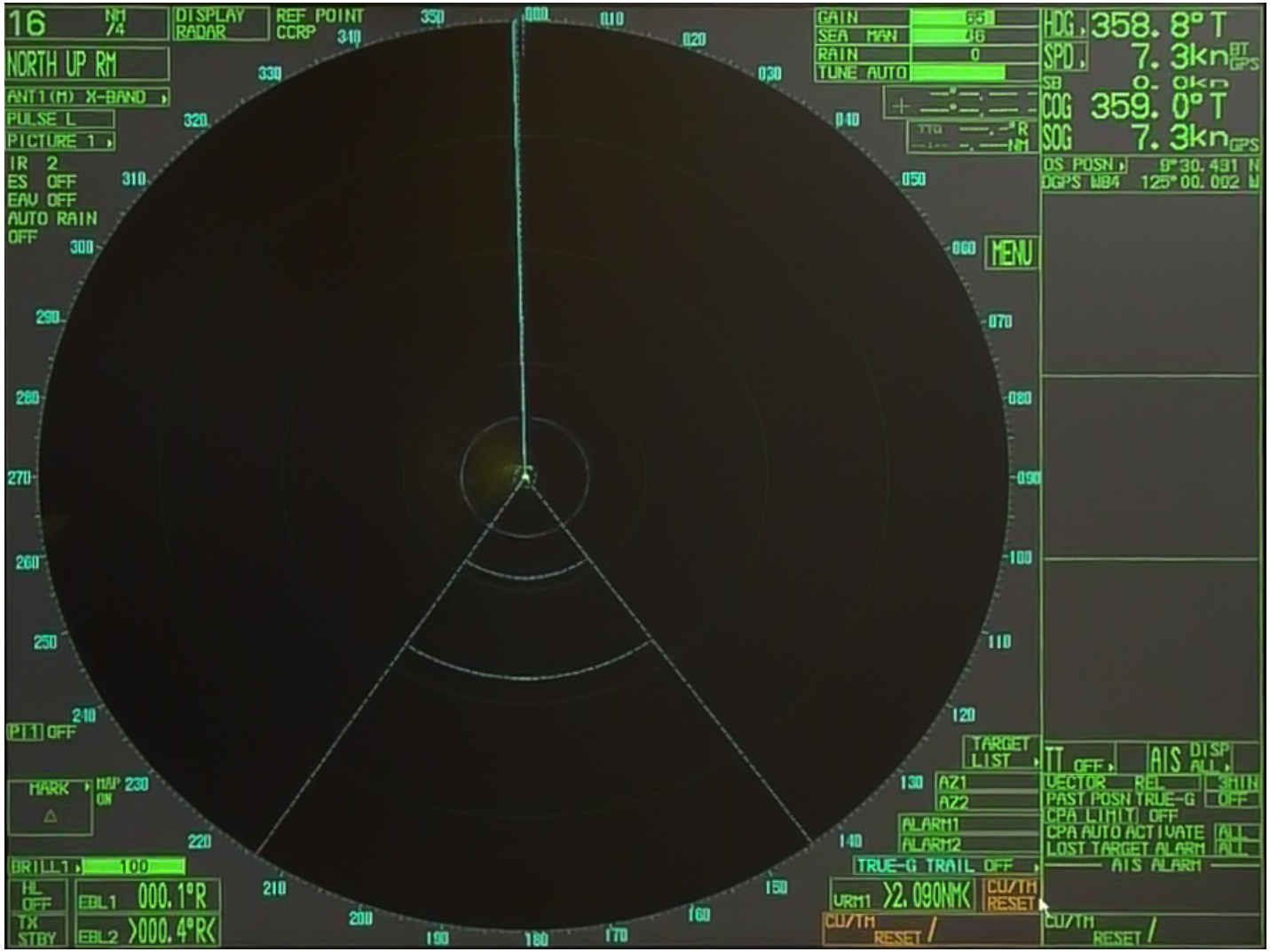
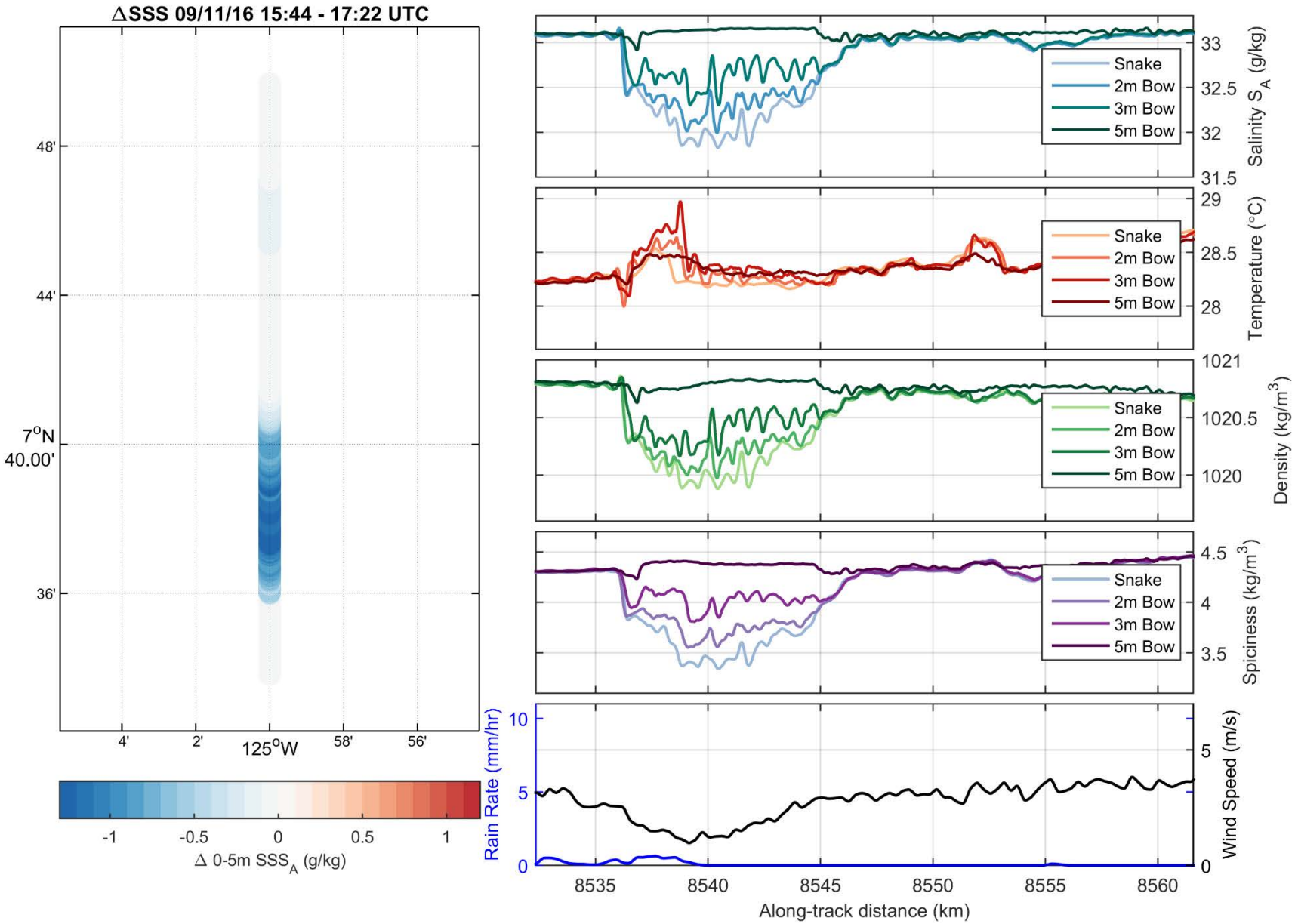


- One hour ahead, no precipitation on radar
- Heading north, no blanking
- However, there was a CTD station, so looking back further…

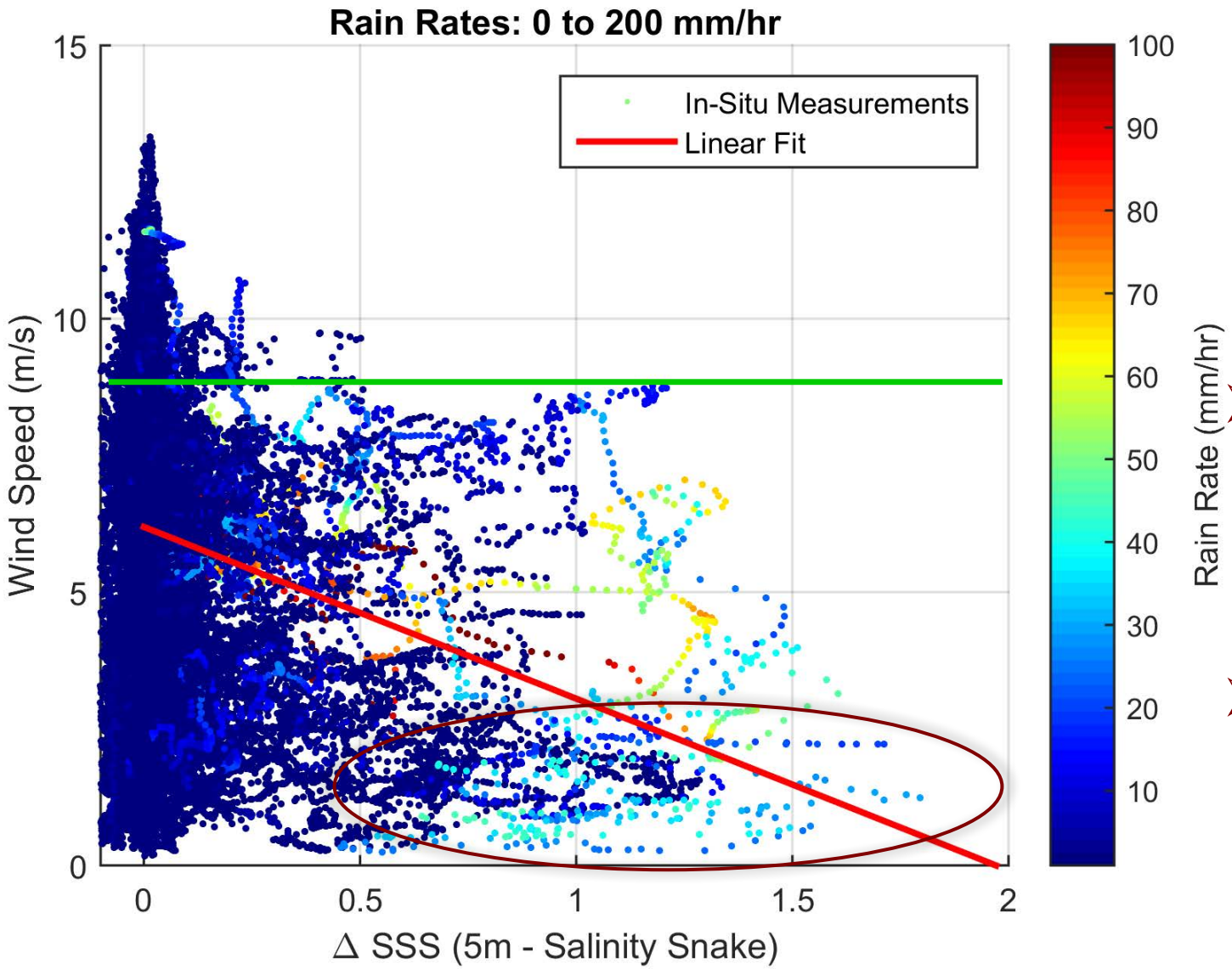
III September 1: Persistent puddle

- Convective cells present where lens is later encountered
- 2 hours 40 minutes before observation
- Low currents (COG-HDG)

III September 11: Low wind, low rain

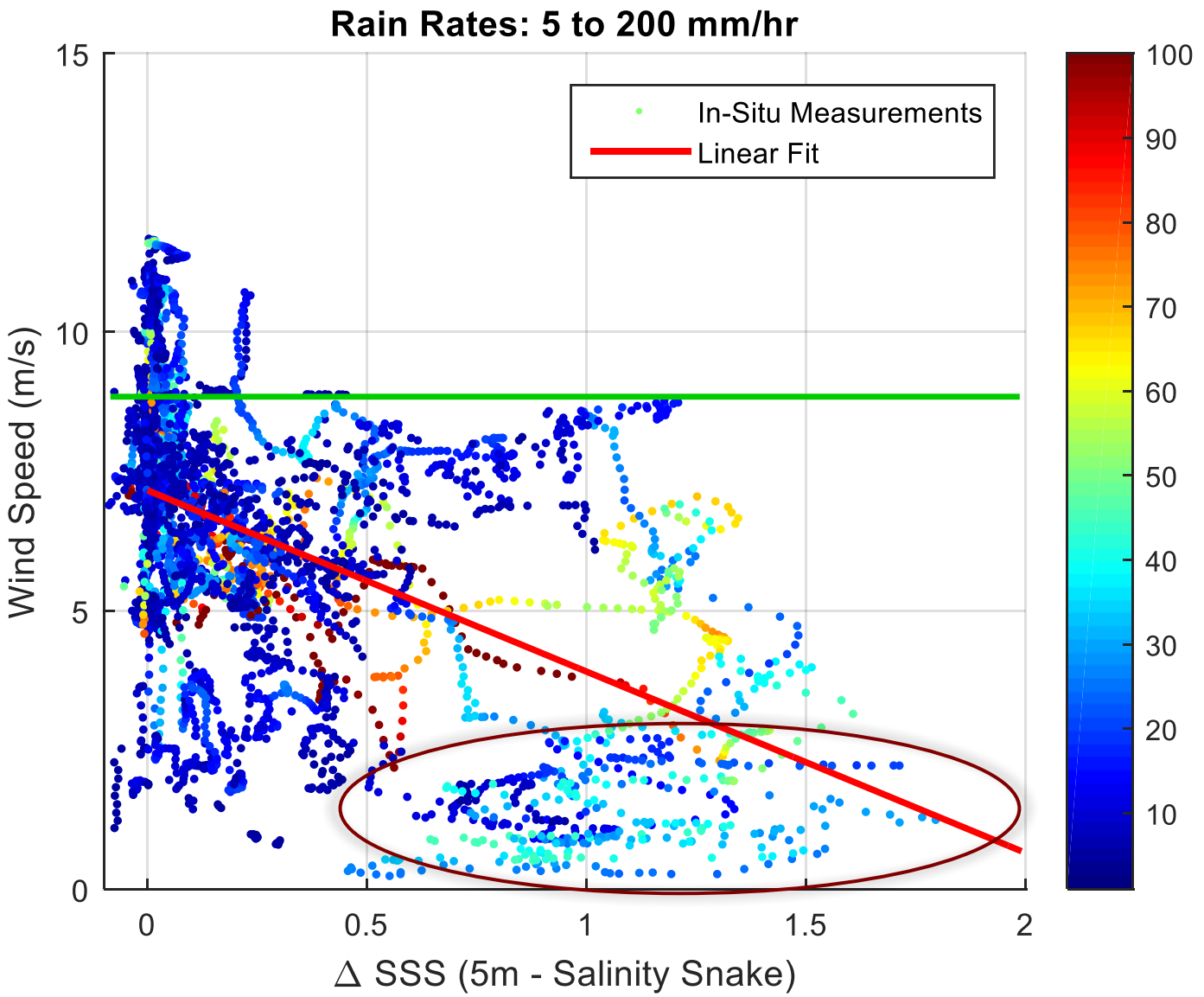


Wind Speed and SSS difference



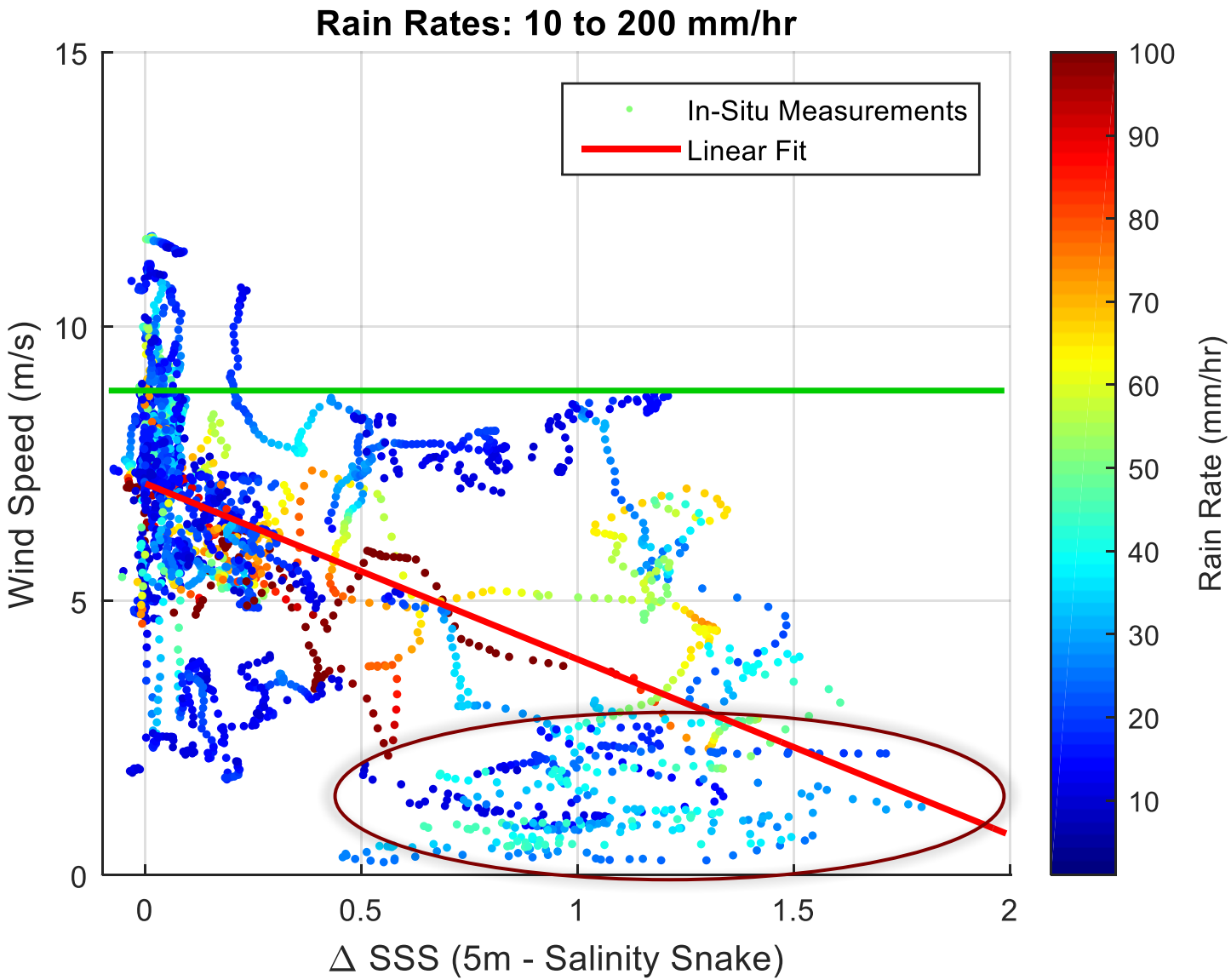
- Wind speeds of over 8 m/s result in negligible salinity differences
- includes about ~150 hrs at >8m/s wind speeds
- Differences of >0.2 g/kg occur 4% of the time

Wind Speed and SSS difference



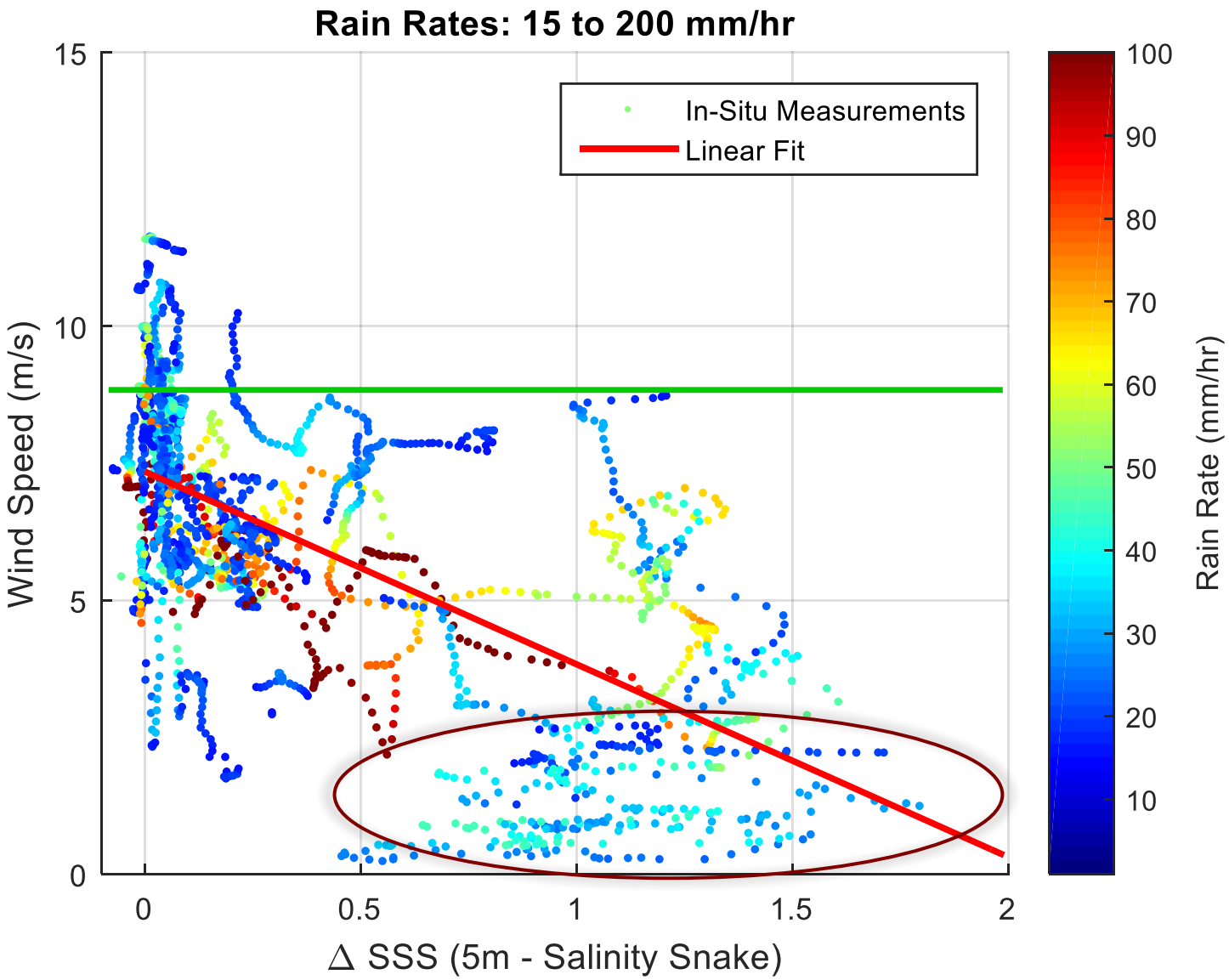
- Observations with 5+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

Wind Speed and SSS difference



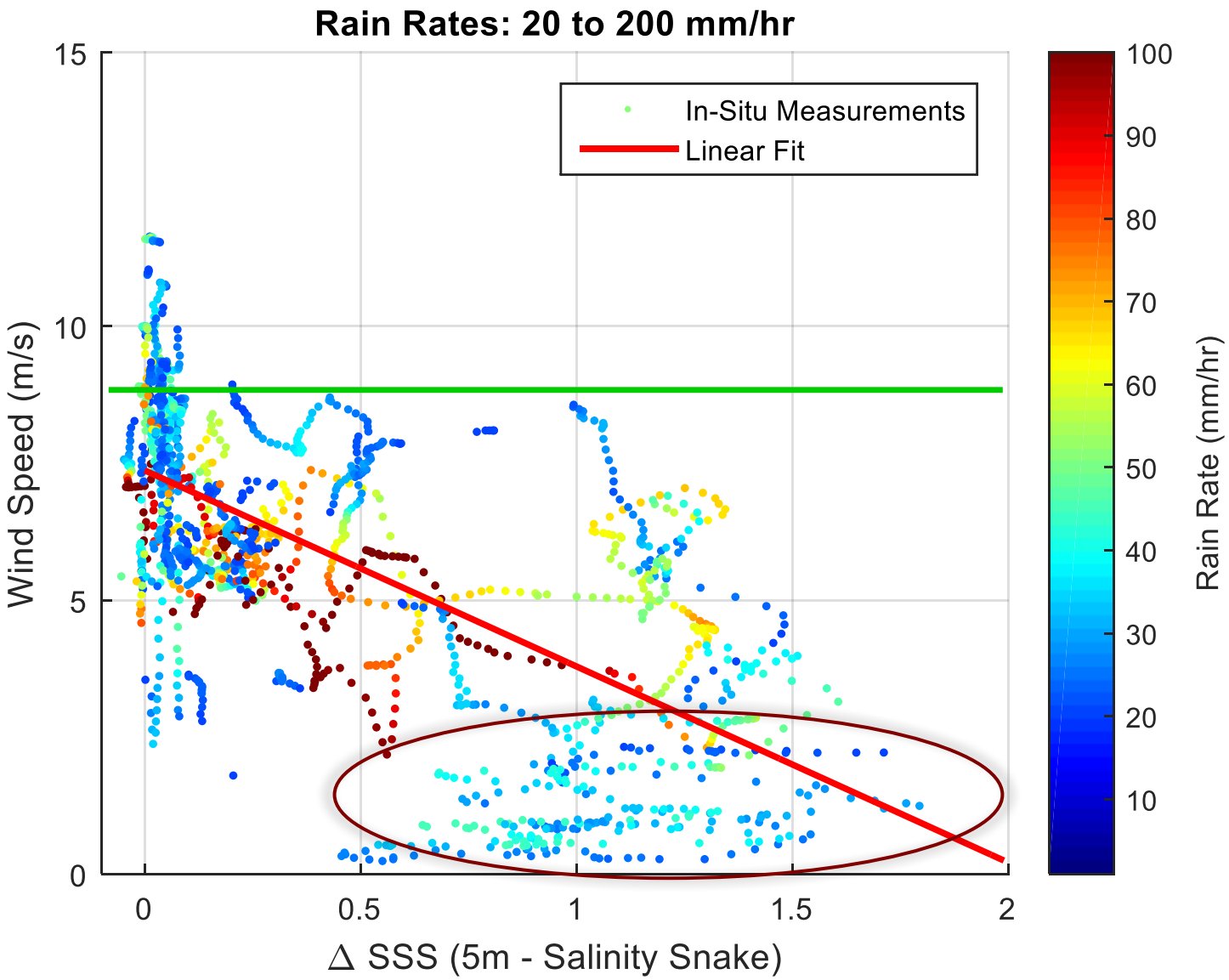
- Observations with 10+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

Wind Speed and SSS difference



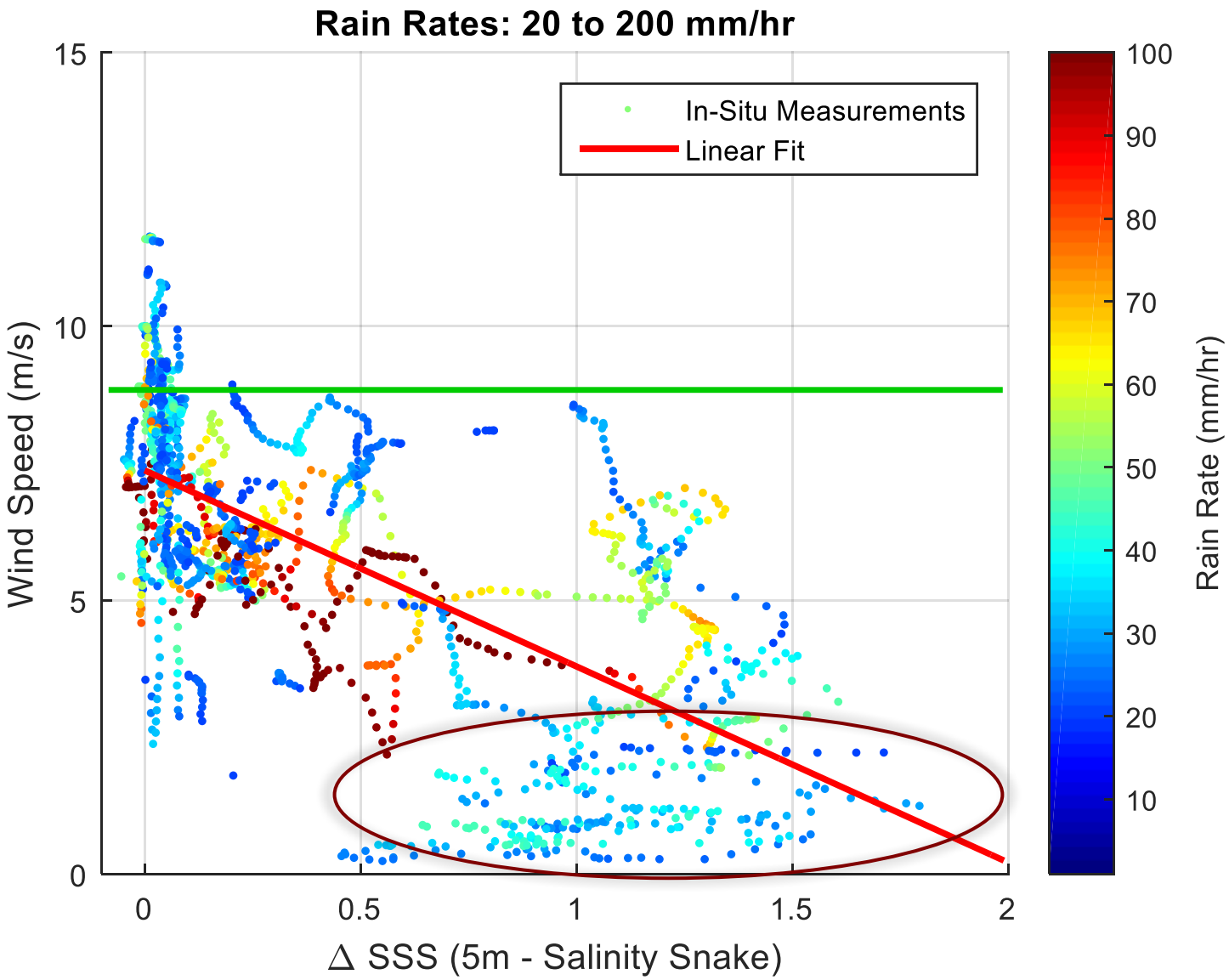
- Observations with 15+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

Wind Speed and SSS difference



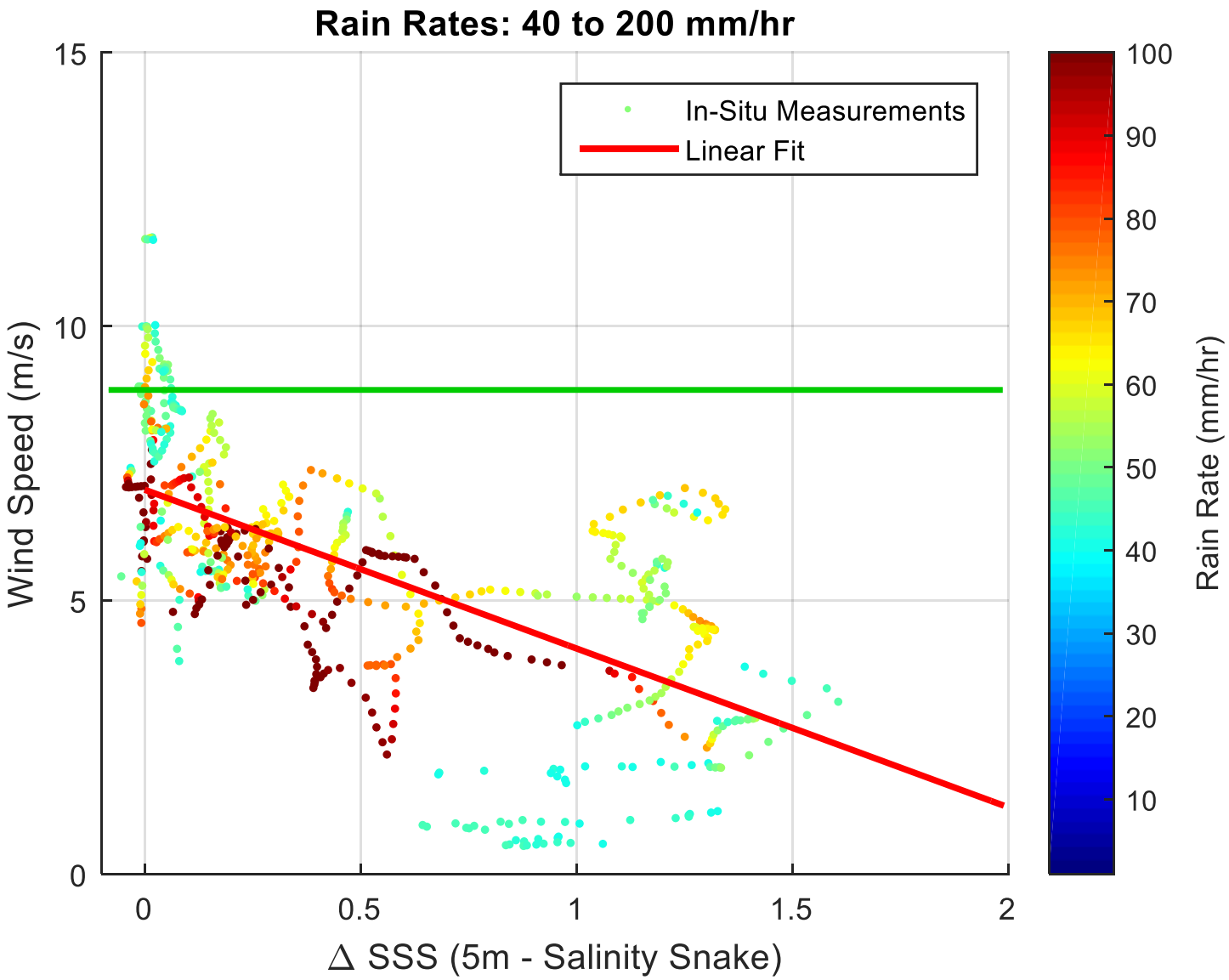
- Observations with 20+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

Wind Speed and SSS difference



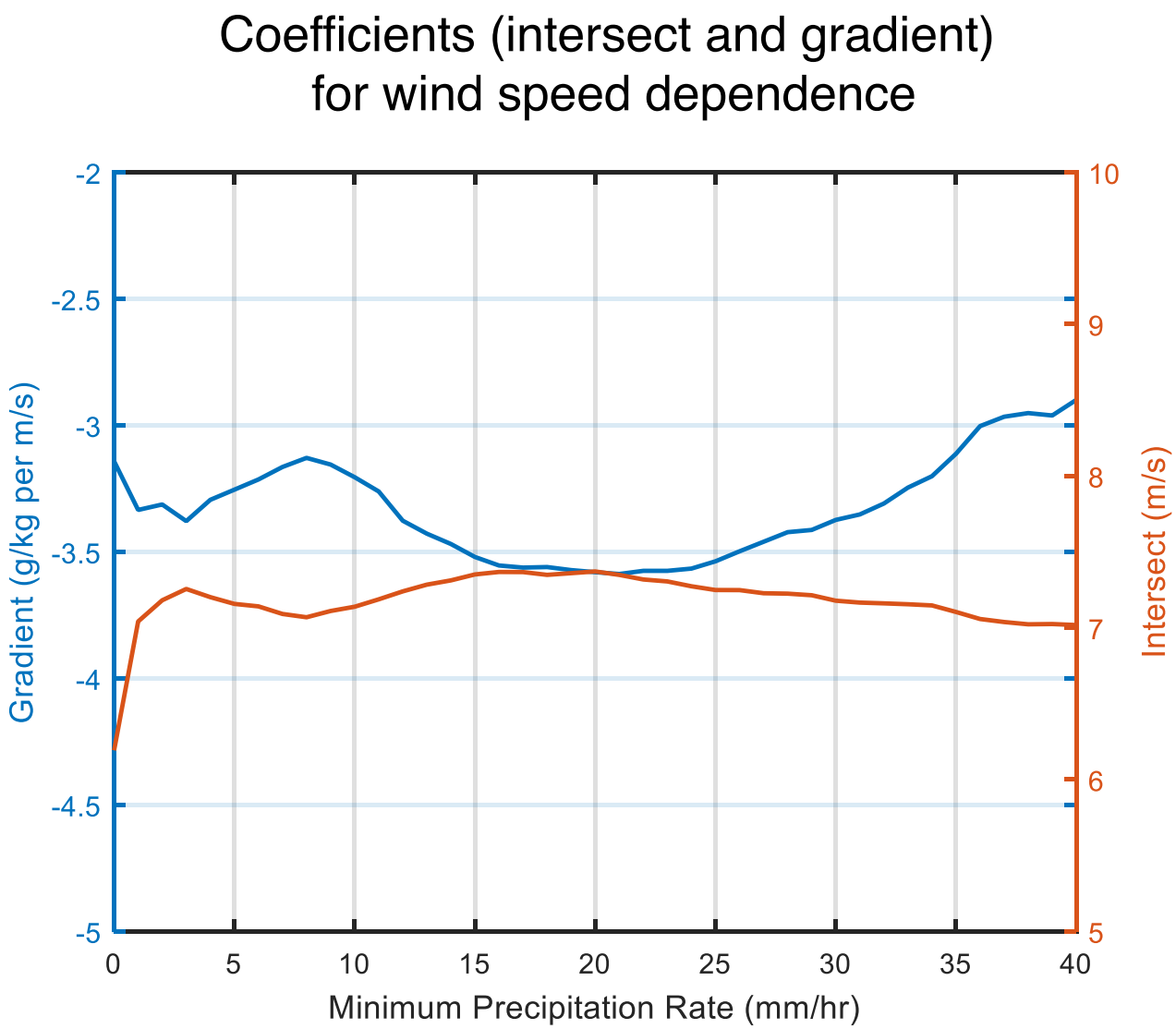
- Observations with 20+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

Wind Speed and SSS difference



- Observations with 40+ mm/hr precipitation as seen on the ship
- Not including rain ahead of the ship
- Next cruise will provide quantitative rain within 150km of ship

III Wind Speed and SSS difference



- (Surprisingly) fairly robust with minimum precipitation
- Vastly oversimplified, not actually linear and dependent on more than 1 variable
- Quantitative rain radar on next SPURS-2 cruise

IV

Conclusions

- 50 identified freshwater lenses so far (40 greater than 0.5 g/kg), Significant for L-Band cal-val!
- Approximately half without recorded precipitation ('persistent lenses'?)
- OSSPRE 2m/3m intakes provide vertical resolution, strong asset!
- Heavily dependent on surface mixing (wind speed, surface roughness, fetch duration)
- Rainfall does not guarantee significant salinity differences (as defined here between 5m and the surface)
- Ship-based rainfall measurements are severely limited (persistence study would require 'real' rain radar)

IV

Work in Progress / Future

- Statistical comparison with SMAP and SMOS overpasses in L2 / Quantification of impact on retrievals.
- Computation/modelling of implied mixing rates and stratification persistence, frontal dynamics
- Compare with snapshots of non-quantitative ship radar (Furuno X-Band) for qualitative analysis
- Next cruise: Better slow-speed performance (‘light snake’)
- Next cruise: Quantitative SEA-POL radar (~150 km range)


Thank You!
Questions?