A Study of the Rain Impact Model (RIM) under Different Wind Speed Conditions

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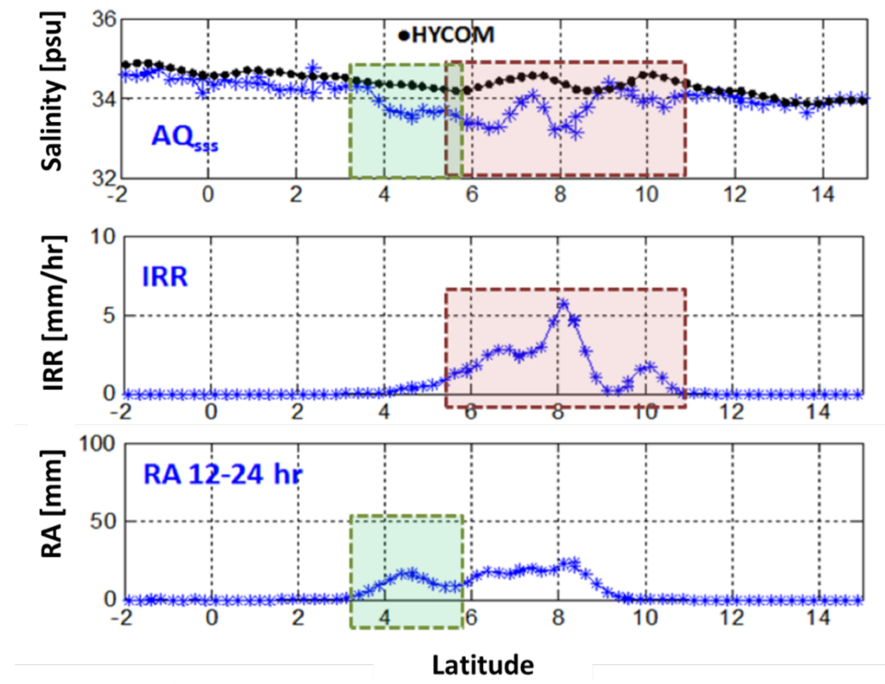
OBSERVATIONS DURING RAIN



Motivation:

During rain, AQ measures fresher SSS compared to HYCOM

Hypothesis:

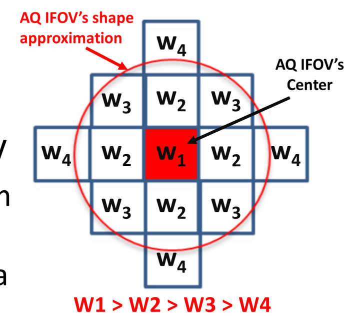
- Rainfall reduces SSS and causes salinity stratification
- Following rain event, turbulent diffusion and wave mixing reduce salinity over a period of several hours
- AQ SSS in the presence of rain can be significantly fresher than the bulk salinity at > 1 m depth

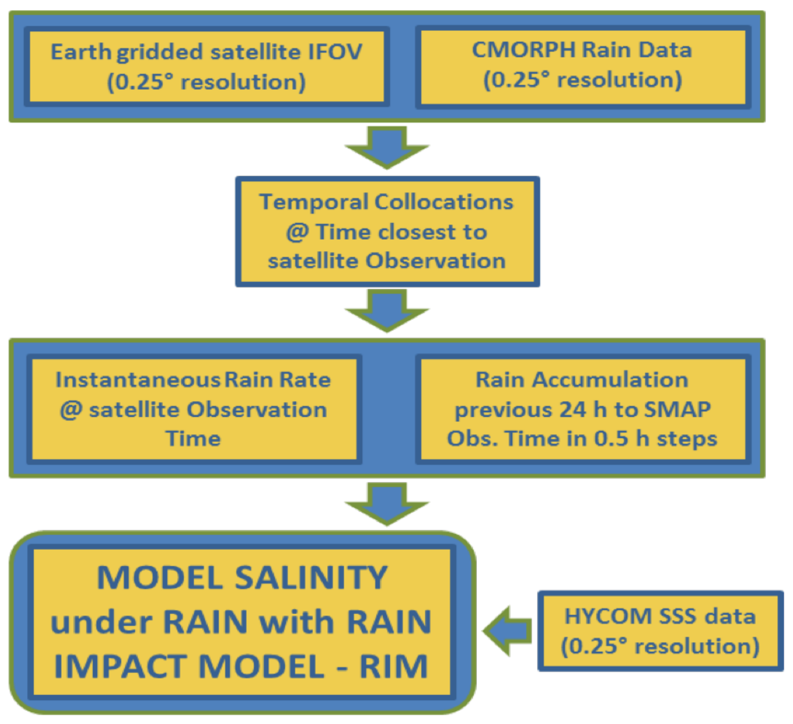
RIM Model

- Estimates SSS under rainy conditions at different depths

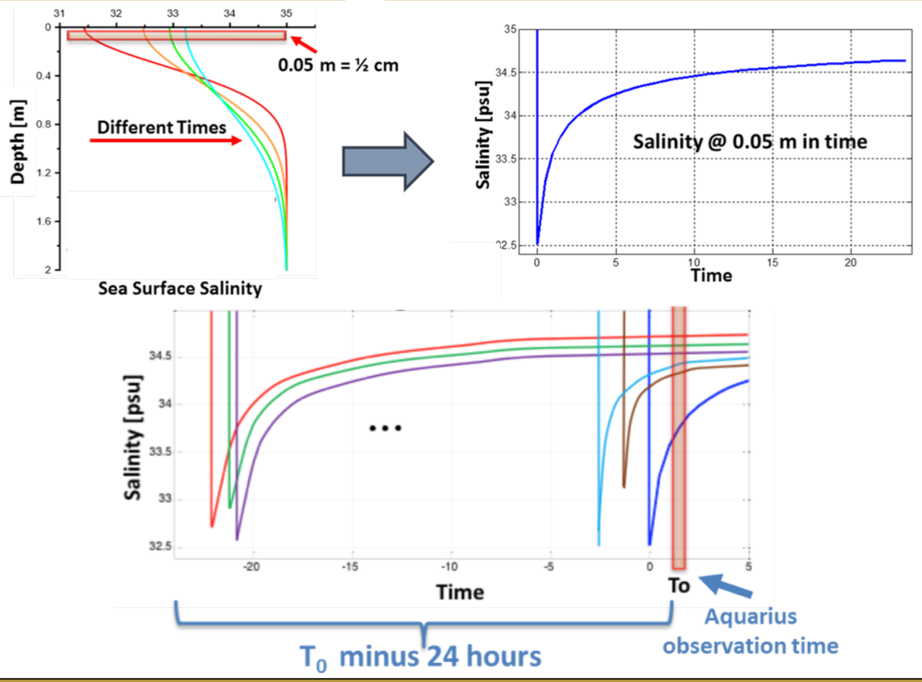
METHODOLOGY

- Rain Accumulation based on NOAA CMORPH Rain data
  - Global coverage between ±60°lat
- Spatial integration over AQ IFOV
  - Assumes circular footprint of 100 km
  - Uses 13 x 0.25° boxes
  - Weighted average based on antenna beam efficiency





APPROACH



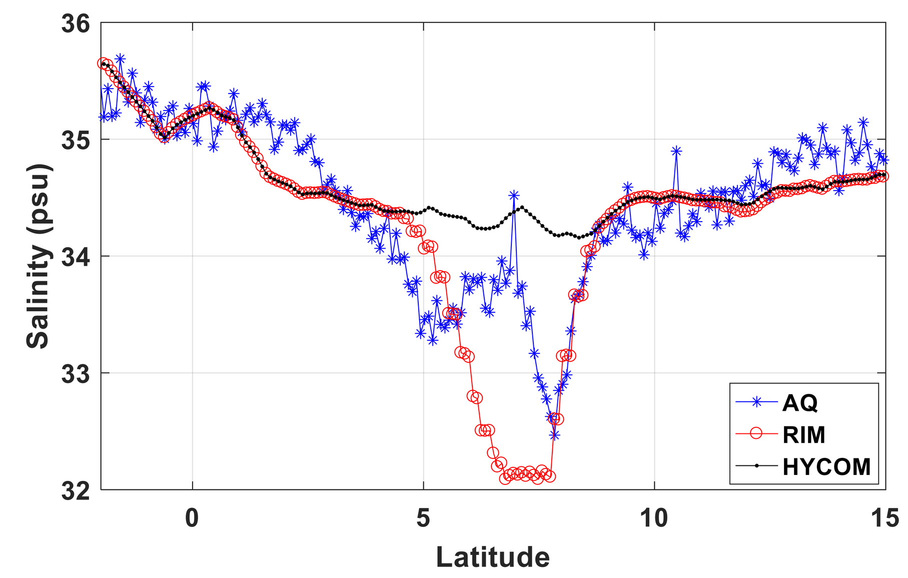
RIM FORMULATION

$$RIM_{SSS} = S_0\left(\prod_{i=1}^{48}\left[d_{0i} + \frac{R_{1i}}{\sqrt{K_{zi} * t_i}}e^{-z^2/4K_{zi}t_i}\right] * \left[d_0 + \frac{R}{\sqrt{K_z * t}}e^{-z^2/4K_z t}\right]\right)^{-1}$$

S_0 = HYCOM Salinity (psu)	K_z = vertical eddy diffusivity (m²/s)
z = depth (m)	R = rain impulse function (m) = f(RR)
t = time (s)	d_0 = mixing depth(m)

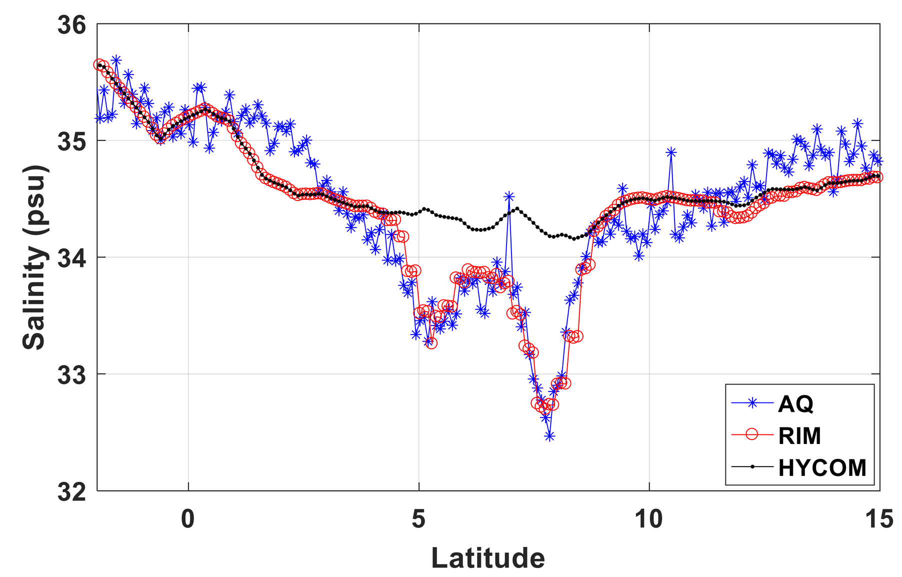
RIM V1.0 - CONSTANT WS

Without Rain Weighting

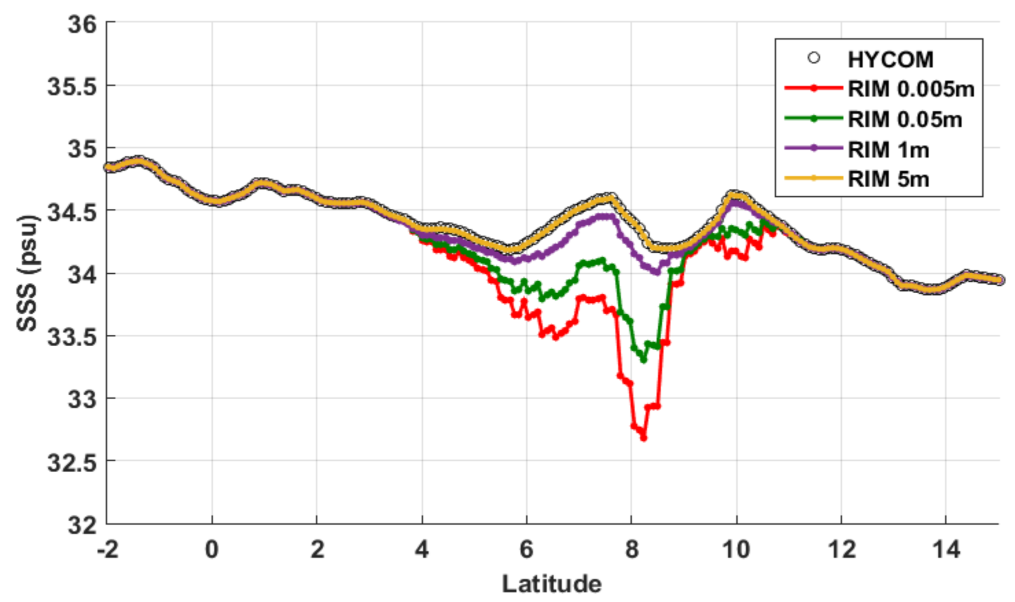


With Rain Weighting

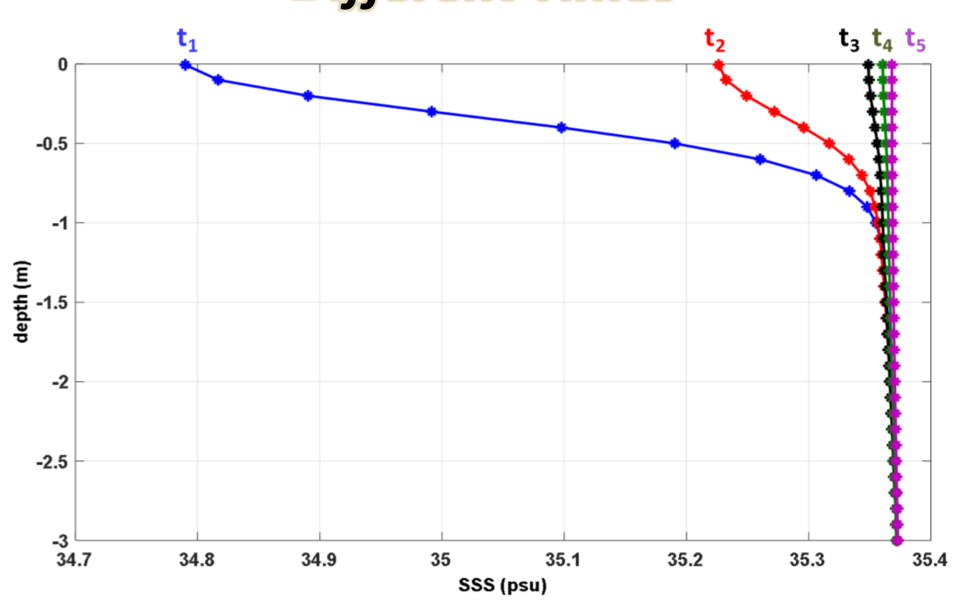
$R_{1i} = c_1 * f(RR_i)$	$R_2 = c_2 * f(IRR)$	c1, c2 = empirically derived



Different Depths



Different Times



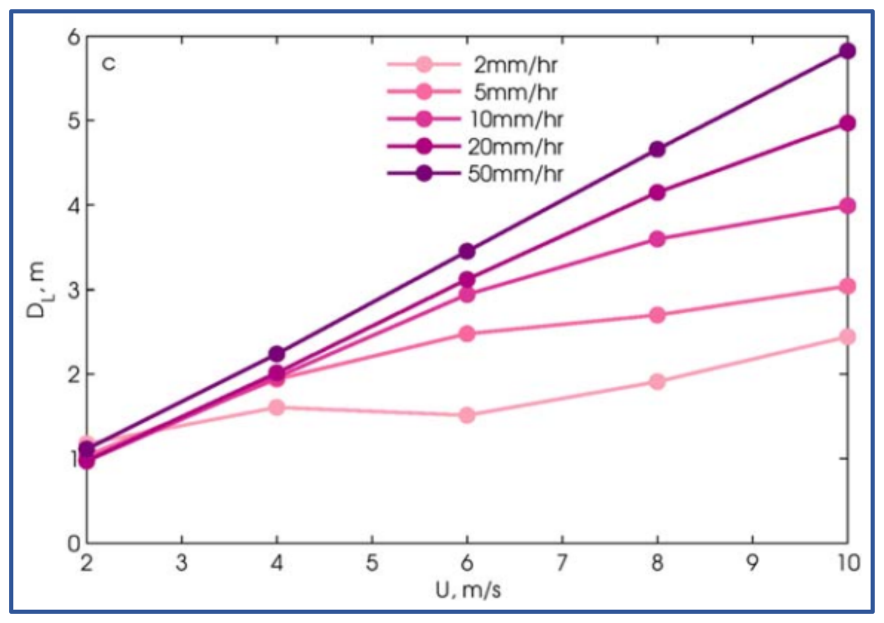
RIM V2.0 - VARIABLE WS

Vertical Diffusivity

$$K_z = 2.5 * 10^{-5} * ws^2 \;\dagger$$

† Wenegrat, J. O., M. J. Mc Phaden, and R. C. Lien (2014), Wind Stress and Near-Surface Shear in the Equatorial Atlantic Ocean, Geophys. Res. Lett., 41, 1226-1261, doi: 10.1002/2013GL059149

Mixing Depth

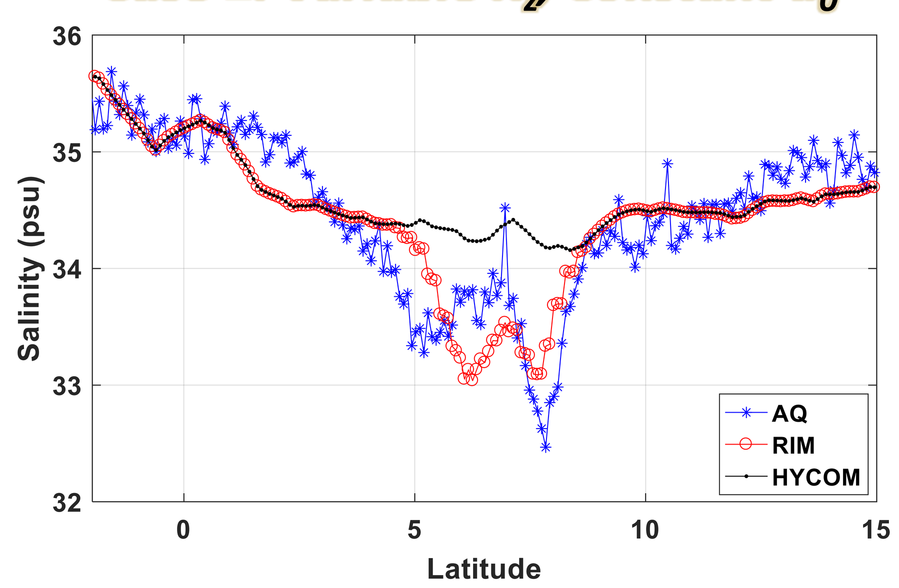


Drushka, K., W. E. Asher, B. Ward, and K. Walesby (2016), Understanding the formation and evolution of rain-formed fresh lenses at the ocean surface, J. Geophys. Res. Oceans, 121, 2673–2689, doi:10.1002/2015JC011527

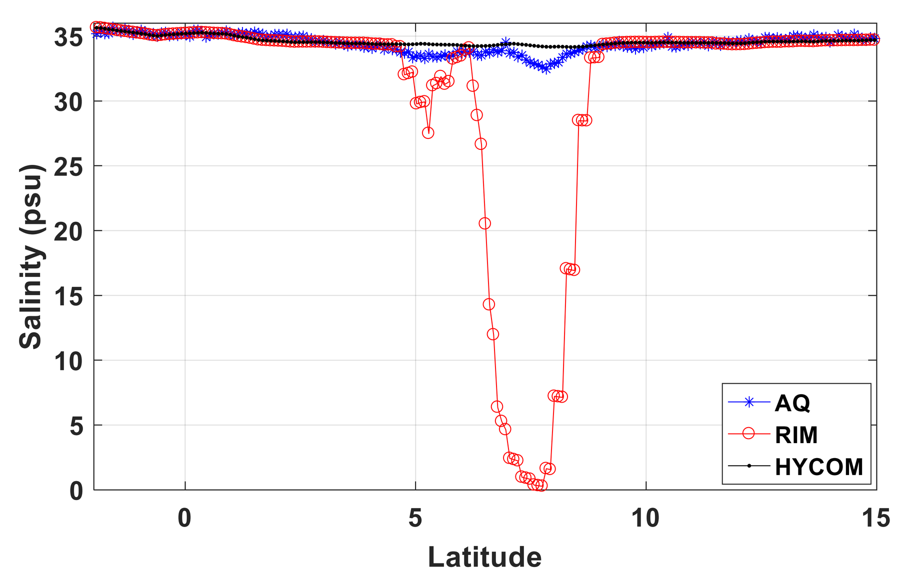
Wind Speed

AQ Scatterometer (Instantaneous)	NCEP (Wind Speed History)

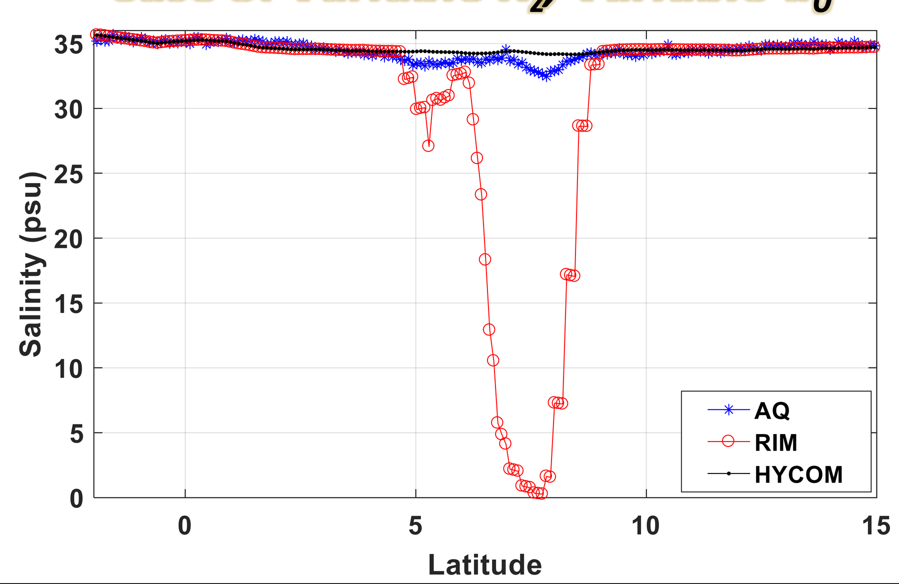
Case 1: Variable K_z, Constant d_0



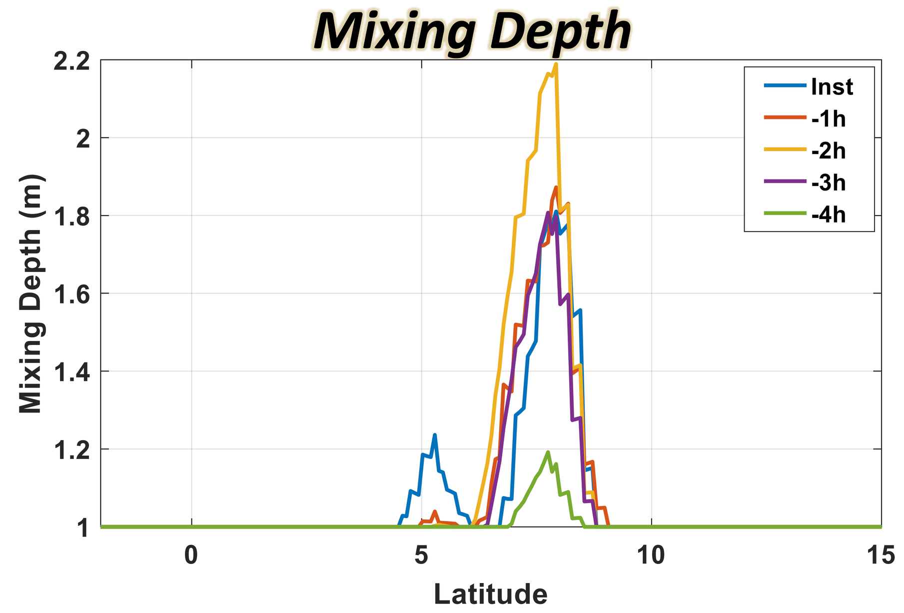
Case 2: Constant K_z, Variable d_0



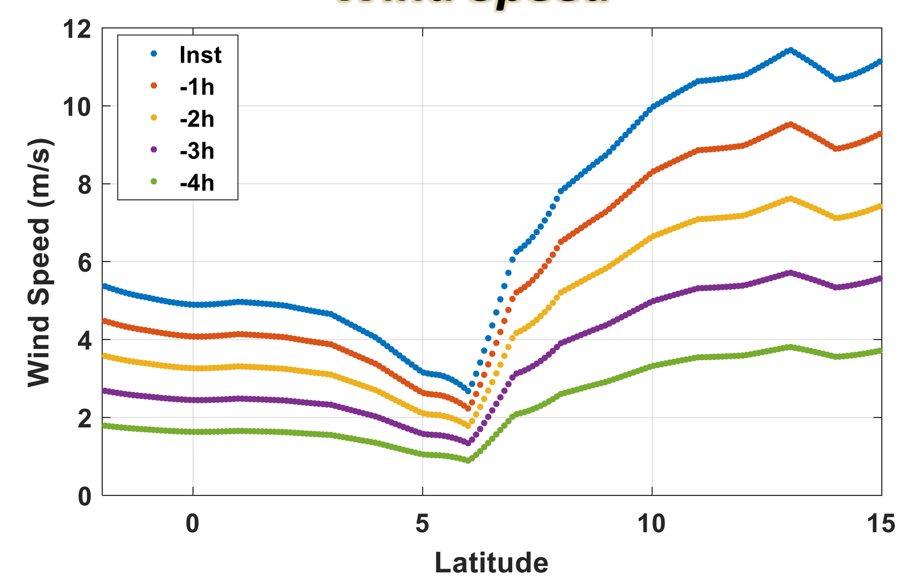
Case 3: Variable K_z, Variable d_0



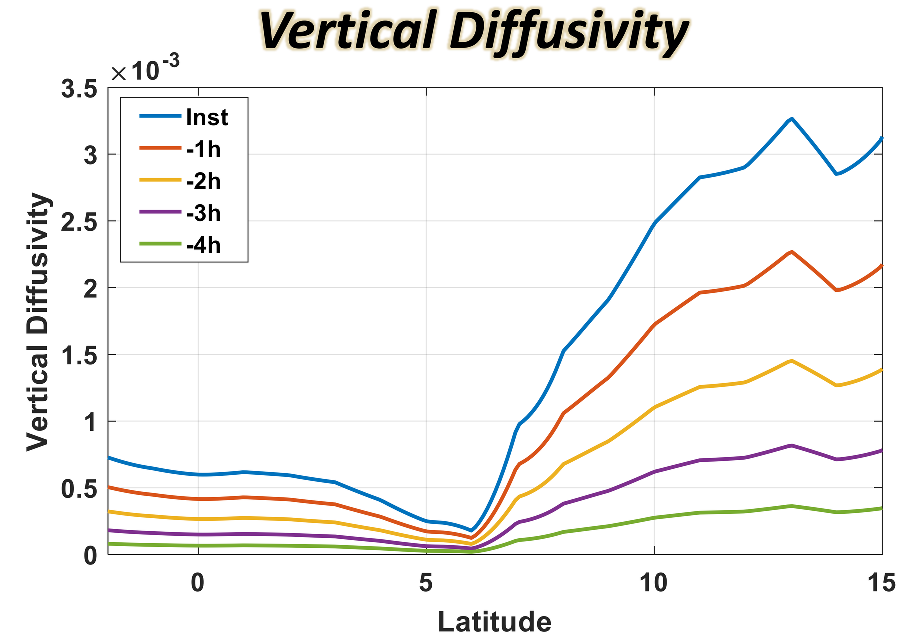
Mixing Depth



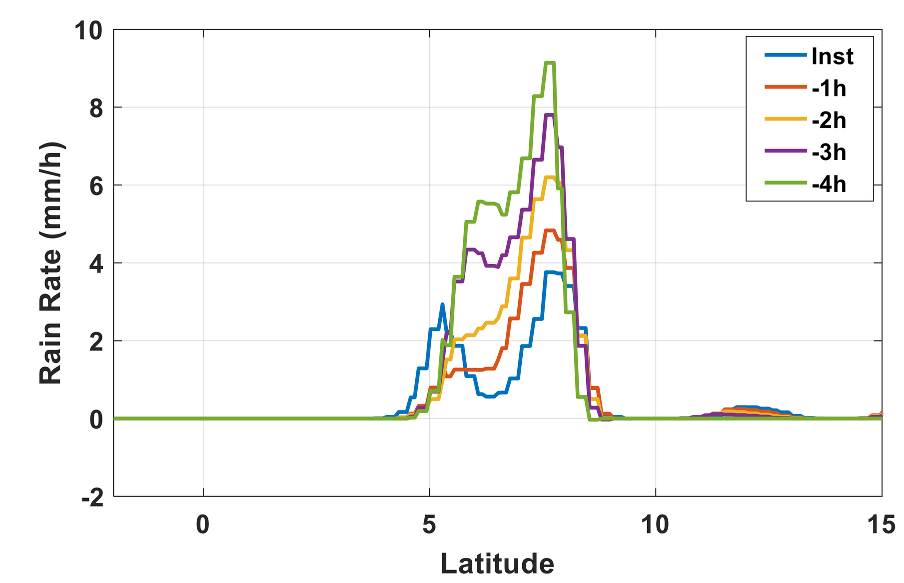
Wind Speed



Vertical Diffusivity



Rain Rate



SUMMARY

- Rain stratifies the ocean, creating a fresh layer near the ocean surface
  - This layer mixes laterally and vertically over a few hours
  - Satellite-measured salinities would be fresher than in-situ measurements (5 m - 10 m depth)
  - Therefore, knowledge of rain history is critical for accurately predicting rain effect
- RIM v1.0 has been demonstrated to work for Aquarius, SMAP & SMOS
  - RIM v1.0 provides a robust quality flag for identification of salinity stratification
- RIM v2.0 development seems to suggest that CMORPH doesn't provide an accurate description of rain field