Rain Impact Model V2.0 for Sea Surface Salinity: A Flag for Salinity Stratification

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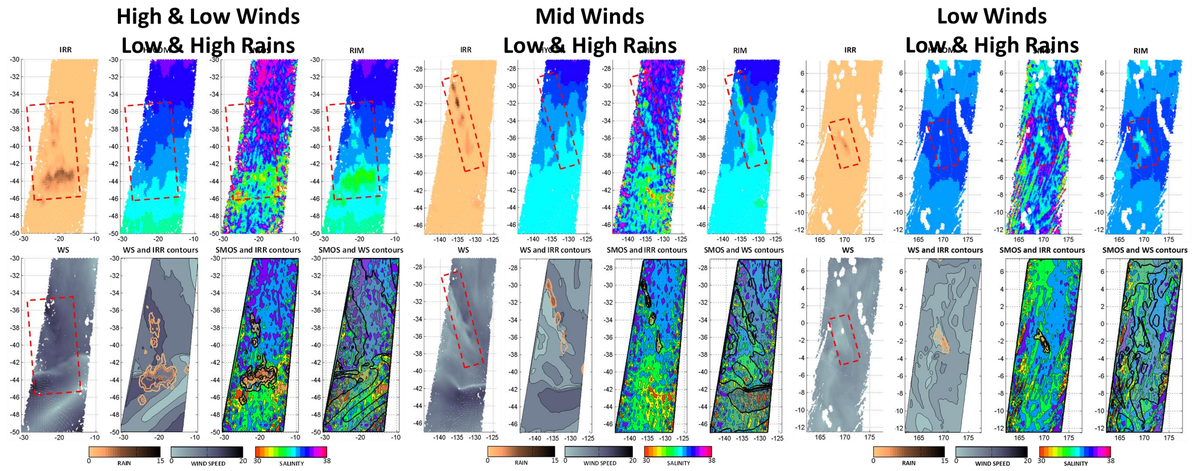
ABSTRACT

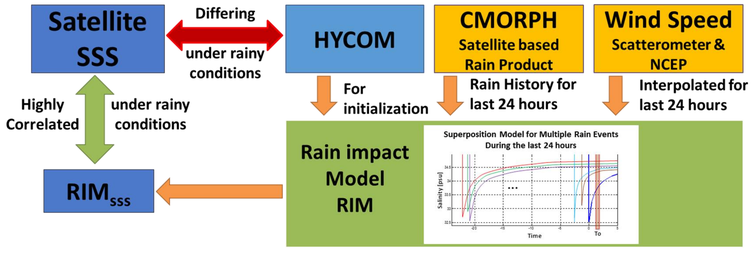
This research addresses the effects of rainfall on Aquarius (AQ) and Soil Moisture Ocean Salinity (SMOS) satellite sea surface salinity (SSS) retrievals using a macro-scale Rain Impact Model (RIM) that predicts transient SSS stratification based upon the rain accumulation and ocean surface wind speed over the previous 24 hours. The RIM V2.0 is an extension of V1.0, which only includes the rain accumulation effect but ignores the effect of wind speed on the vertical mixing. This new version introduces a term in the model that takes into account the effect of wind speed in the mechanical mixing, which translates into a dynamic vertical diffusivity. Thus, RIM can provide a valuable quality flag for the interpretation of AQ & SMOS SSS retrievals, and comparisons among 2-D rain patterns between SMOS, AQ and RIM will be presented as validation of the RIM performance.

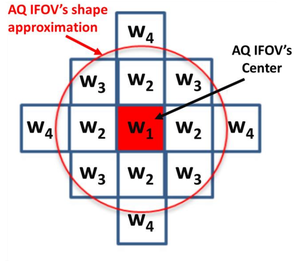
A common reference for satellite SSS measurements is the Hybrid Coordinate Ocean Model (HYCOM), but there is a significant mismatch between the remote sensing sampling depth of approximately 0.01 m and the typical range of 5-10 m of in situ instruments. Under normal ocean conditions the upper layer of the ocean is well mixed and there is approximately uniform salinity; therefore satellite SSS retrievals are good estimates of the bulk salinity. Conversely, under rainy conditions, there is a dilution of the near-surface salinity that mixes downward by diffusion and mechanical mixing of gravity waves/wind speed forcing. This transient salinity stratification, significantly modifies the salinity gradient in the upper 1-2 m of the ocean; and therefore invalidates the usual assumption of well-mixed salinity. Typically, these salinity stratifications dissipate in a few hours and the upper layer becomes well mixed at a slightly fresher salinity.

INTRODUCTION

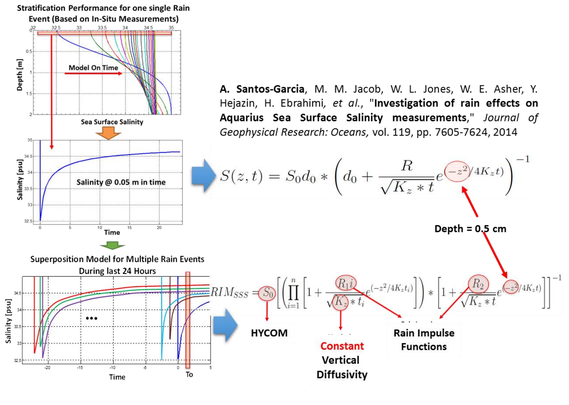


APPROACH





Rain Impact Model – RIM V1.0



A. Santos-Garcia, M. M. Jacob, W. L. Jones, W. E. Asher, Y. Hejazin, H. Ebrahimi, *et al.*, "**Investigation of rain effects on Aquarius Sea Surface Salinity measurements,**" *Journal of Geophysical Research: Oceans*, vol. 119, pp. 7605-7624, 2014

$$S(z,t) = S_0 d_0 * \left(d_0 + \frac{R}{\sqrt{K_z * t}} e^{(-z^2/4K_z t)} \right)^{-1}$$

Depth = 0.5 cm

$$RIM_{SSS} = S_0 \left[\left(\prod_{i=1}^{n} \left[1 + \frac{R_1 i}{\sqrt{K_z} * t_i} e^{(-z^2/4K_z t_i)} \right] \right) * \left[1 + \frac{R_2}{\sqrt{K_z * t}} e^{(-z^2/4K_z t)} \right] \right]^{-1}$$

HYCOM — Constant Vertical Diffusivity — Rain Impulse Functions

Rain Impact Model - RIM V2.0

superposition of rain events using 1D stratification model

- HYCOM as initialization (From AQ L2)
- CMORPH to build the Rain History (CMORPH_V0.x)
- WS from Scatterometer and NCEP for Kz estimation

$$RIM_{SSS} = S_0 \left[\left(\prod_{i=1}^{n} \left[1 + \frac{R_1 i}{\sqrt{K_z} * t_i} e^{(-z^2/4K_z t_i)} \right] \right) * \left[1 + \frac{R_2}{\sqrt{K_z * t}} e^{(-z^2/4K_z t)} \right] \right]^{-1}$$

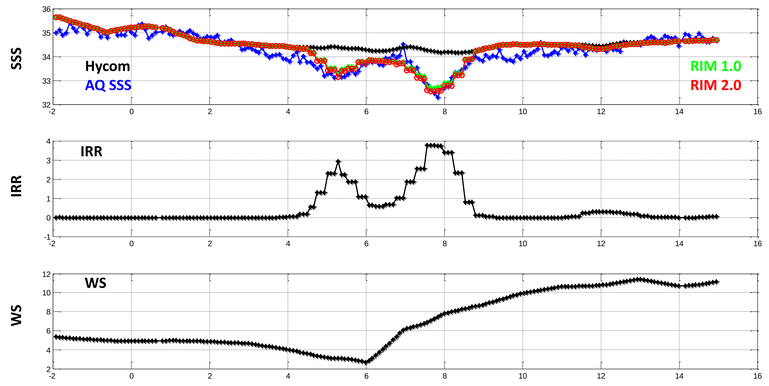
HYCOM — Vertical Diffusivity — Rain Impulse Functions — Depth = 0.5 cm

$$Kz = 2.5 \times 10^{-5} * ws^2 \,\dagger$$

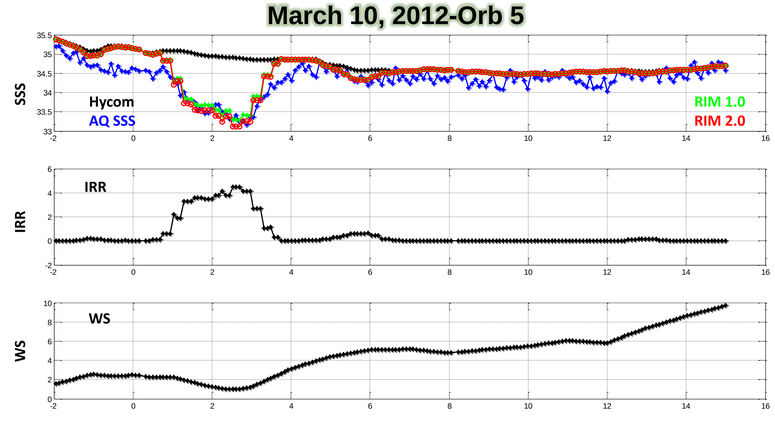
†Wenegrat, J. O., M. J. McPhaden, and R.-C. Lien (2014), Wind stress and near-surface shear in the equatorial Atlantic Ocean, Geophys. Res. Lett., 41, 1226–1231, doi:10.1002/2013GL059149.

DATA ANALYSIS

January 10, 2012-Orb 5



March 10, 2012-Orb 5



March 20, 2012-Orb 5