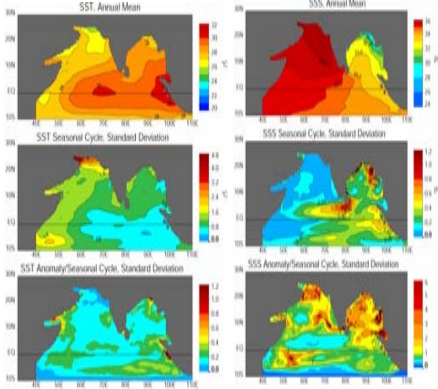


**ABSTRACT**

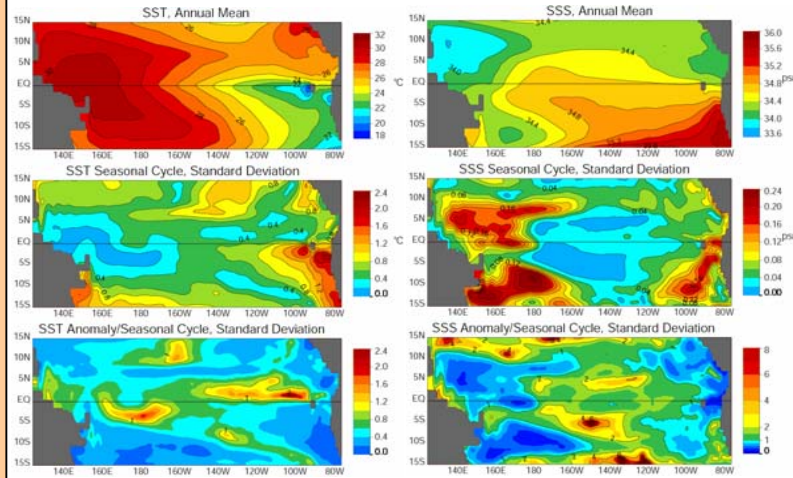
Extensive and synergistic satellite data for SSTs, winds, ocean color, and rainfall have afforded systematic analyses of oceanic mesoscale features in the tropical oceans. The main mesoscale variability in the deep tropics consists of the Tropical Instability Waves (TIWs) which have well-recognized impacts on the mixed layer heat budget, ocean ecosystem and biogeochemistry, and on the air-sea interactions. Our recent studies have demonstrated that lower-frequency rectification of the TIWs on SSTs have spatio-temporal decorrelation scales that are large enough to act as stochastic forcing to the coupled climate system. As we prepare for the launch of AQUARIUS, it is only natural that we explore the impact of ocean mesoscale variability on SSS and understand if the internal variability of SSS generates low-frequency signal that affects the signal/noise ratio of SSS. An eddy-permitting OGCM is forced with climatological winds and an advective atmospheric mixed-layer which computes the surface freshwater and heat fluxes. The SSS and SST are thus allowed to evolve freely without any feedbacks to observations or any restorative fluxes. The dynamical and thermodynamical variabilities generated are thus simply due to the intrinsic nonlinearities of the mesoscale ocean circulation. Since TIWs impact SSTs and mixed layer heat budget, they also affect the SSS and the ratio of variance of the seasonal cycle to anomalies. As can be expected, there are significant regions of the tropical oceans where the variance of the internally generated SSS anomalies are larger than the seasonal variance which poses clear challenges for interpreting the externally forced vs. internally generated SSS signals. A short record of satellite data will only exacerbate this problem. The three oceans are also different in their relative character of the SST vs. SSS internal variability. The Indian and Atlantic Oceans have typically small internal variability of SSTs whereas SSS internal variability is significantly higher due to freshwater inputs from the rivers. The regions of largest SST and SSS variance are also not the same which means there is a potential to subduct SST and SSS anomalies in different regions to generate low-frequency variabilities. It also implies that the impacts on the ecosystem and CO<sub>2</sub> variability can be quite complex. The wave number-frequency spectrum for SSS is being studied to address some of the AQUARIUS retrieval issues related to SSS internal variability.

**Internal Variability of SSS in the Indian Ocean**

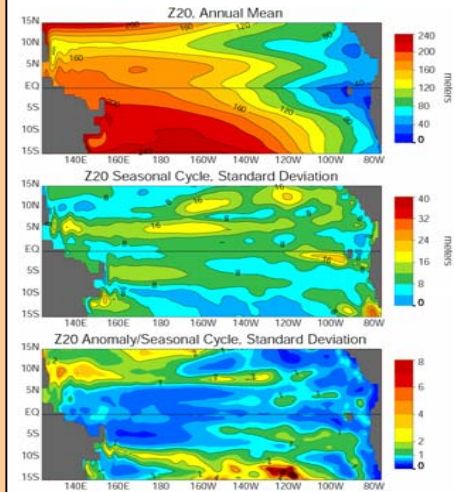


The Indian Ocean is known for its relative small SST anomaly variance at all time-scales. But these anomalies may be climatically important nonetheless due to the high mean SSTs. It is worth noting that internally generated SST anomalies can be larger than the seasonal variability and they occur in the regions where Bjerknes feedback is known to be important. Since the Bay of Bengal and the Arabian Sea are dominated by freshwater and evaporative fluxes respectively, the internal variability of SSS is significantly higher in these regions. The southwestern tropical Indian Ocean is characterized by a thermocline dome related to the wind-stress curl forcing associated with the monsoons. While AQUARIUS will benefit from the large SSS signals, the internal variability will also reduce the signal/noise ratio which needs to be addressed with well-planned *in-situ* ground-validation efforts.

**MESOSCALE VARIABILITY OF SSS IN THE TROPICAL PACIFIC**

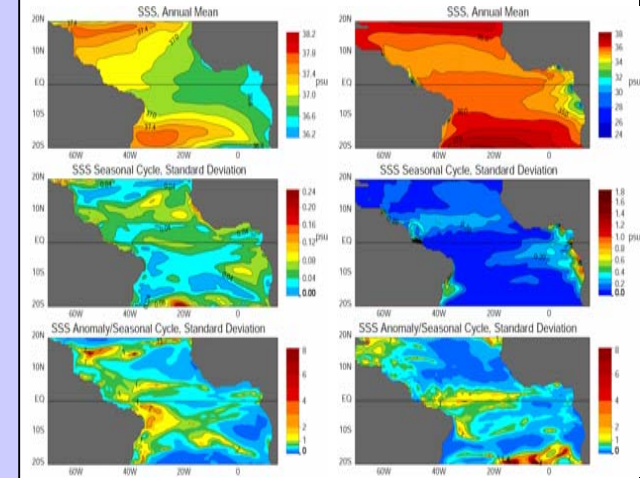


The tropical Pacific is dominated by the ENSO variability. TIWs themselves have interannual variability with typical weakening during strong El Niño's. The impact of TIWs on the cold-tongue SSTs is seen as the enhanced internally generated anomaly variance just to the north of the equator in the eastern Pacific. The edge of the warm-fresh pool has an internal variability maximum due to the nonlinearity of the deep atmospheric convection in the western Pacific warm pool. The ITCZ region in the north generates mesoscale variability due to the transient eddies propagating from the eastern Costa Rica Dome region and also due to the mixed layer-thermocline interactions in relation to the thermocline-ridge under the ITCZ. The SSS anomalies are maximum in the shear region between the NECC and the NEC in the north and the central-tropical SEC maximum region. Note that there is a direct pathway from the southern central Pacific to the equatorial region and this can have consequences for lower-frequency variability such as decadal ENSO or regime shifts. Some of these regions have no significant ENSO impact on SSS implying that interpreting these variabilities from AQUARIUS will require understanding of these internal SSS variabilities.



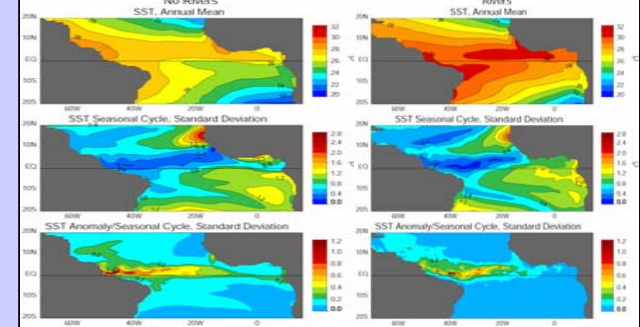
The impact of mesoscale variability in the thermocline is important for understanding where the surface anomalies are generated by air-sea interactions vs. where they are generated by mixed-layer thermocline interactions. The northern ITCZ region is a region where the ocean mesoscale variability can generate significant internal variability in the thermocline. The southeastern band at around 5°S also experiences thermocline variability which is a region where the double ITCZ bias in the current coupled climate models typically occurs. It is likely that the double ITCZ problem is an amplification of this ocean internal variability even though most ocean components of current coupled climate models do not resolve ocean mesoscale variability. The SSS anomaly in this region is clearly related to the mixed-layer thermocline interactions which do not have a signature in the SSTs. The regions with high thermocline internal variability can potentially generate heat content anomalies which can be subducted and propagated to the equatorial thermocline, the impacts of which have to be studied further. Thermocline internal variability can be estimated from altimeter data even though sampling frequency can be inadequate. Having a firm understanding of the internal variabilities in SST and SSH will be helpful for SSS retrievals where they are coincident.

**SSS VARIABILITY IN THE TROPICAL ATLANTIC AND THE IMPACT OF RIVERS**



It is important to know how the river runoffs affect internal variability of SSS and this is shown for the tropical Atlantic by using model simulations with and without river discharges. The impact of the Amazon on the barrier layer variability in the northeast tropical Atlantic has been reported before. Neglecting the riverine inputs mostly enhances the SSS anomaly variance with respect to the seasonal cycle in the ITCZ and SACZ regions. Including the river discharges caps the SSS variability and reduces the internal variability significantly. This is important since it indicates that regions of high SSS signal near the rivermouths are not necessarily low in signal/noise ratio which is favorable for extracting the SSS signal from AQUARIUS. This is however in stark contrast to the Indian ocean where freshwater fluxes appear to significantly increase the internal variability in SSS. Such analyses are helpful for targeted ground-validation efforts. Barrier layer formation in the Bay of Bengal is affected by seasonal reversal of monsoons and not simply to the input of freshwater from the rivers and by precipitation.

**IMPACT OF RIVERS IN INTERNAL VARIABILITY OF SST**



Both zonal and meridional modes of variability in the tropical Atlantic are related to the ITCZ. The largest internal variability is also under the ITCZ raising the specter of internal variability affecting both modes. Riverwater input leads to a barrier layer which obviously reduces the sensitivity of SSTs to thermocline movement thus reducing the internal SST anomalies. In a coupled climate system, ITCZ will affect SSS and SST.