Coupled Modelling of Air-Sea Interaction over the Bay of Bengal during the 2018 Southwest Monsoon

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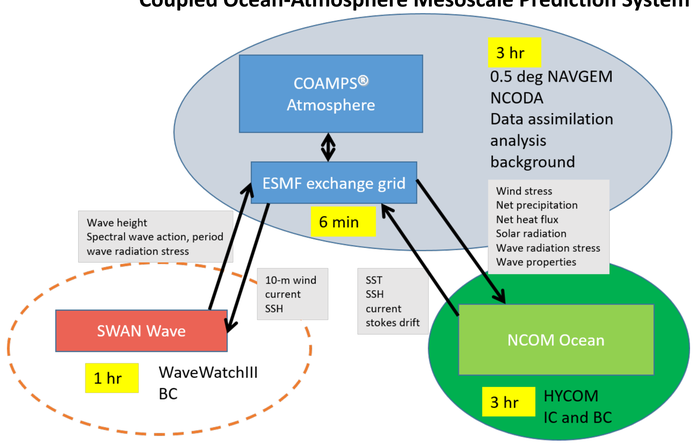
ABSTRACT

Simulations of oceanic and atmospheric conditions and air-sea interaction over the Bengal are presented from a high resolution fully coupled from atmosphere-ocean-waves models based on the Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS). The model is covering the Indian Ocean north of 18S, with a horizontal resolution of about 3.5 km in the ocean, 9 km in the atmosphere and 10 km for the spectral surface wave model component. Both the atmosphere model and ocean model have up to 60 vertical levels. The ocean model has a minimum of 0.5 m resolution between the surface and 10 m and at least 45 levels between the surface and 330 m. Fluxes between each model module are exchanged every 10 min. The wave model is Simulating Waves Nearshore and has 33 frequency bands and 48 directions. A three-dimensional variational method (3D-var) of data assimilation is applied in the atmosphere and ocean models. The model runs on 622 cores on the Cray XC40 at the Navy DoD Supercomputing Resource Center.

A remarkably strong anti-cyclonic eddy developed in mid-June 2018 between 2°N and 6°N centered on 85°E. It was connected to a strong eastward flow from the Arabian Sea into the Bay of Bengal and a westward flow from Sumatra along the equator and present for 2 weeks. The eddy advected cold surface water from the coastal upwelling region near the southern Sri Lankan coast to the equator and advected warmer equatorial water northward. High temperature anomalies in the core of the eddy were found at depth above 100 m. The eddy impacted net surface heat flux over its northern and western edges, where the colder water gained heat as it moved toward the equator. Its strong currents had an impact on surface wave height driven by the southwest monsoon. The eddy reduced the significant wave height in its northeast quadrant and increased it in the southwest quadrant due to differences in surface stress induced by strong ocean currents.

COAMPS

Coupled Ocean-Atmosphere Mesoscale Prediction System



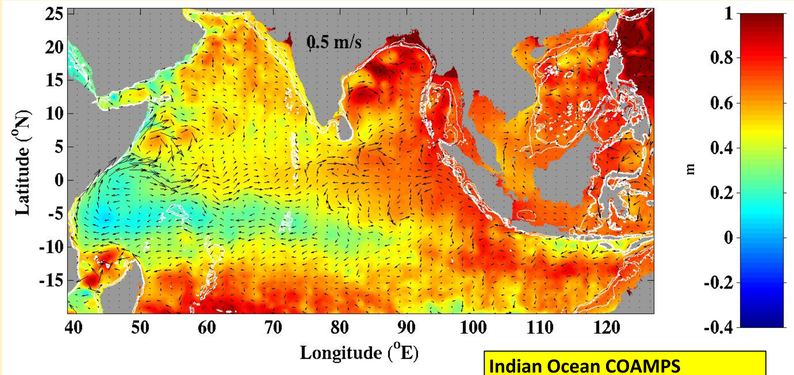
Daily forecasts since June 1, 2015 and ongoing

2018 SIMULATION

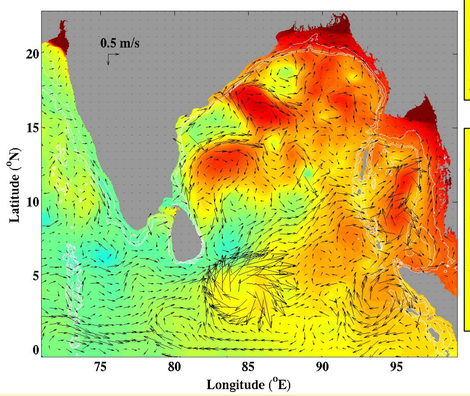
Here we show examples of daily averaged fields for the ocean from 2018. COAMPS was used in two configurations: One covering the entire Indian Ocean as described in the abstract. A second configuration covers the Bay of Bengal with 6 km atmospheric resolution and 2 km ocean resolution and 13 km wave resolution.
Plots of daily averaged fields are available on https://www7320.nrlssc.navy.mil/MISO/

THE SOUTHEAST SRI LANKA WHIRL

DAILY AVERAGED SURFACE CURRENTS AND SEA SURFACE HEIGHT on 12 JUNE 2018



SEA SURFACE HEIGHT on 20 JUNE 2018



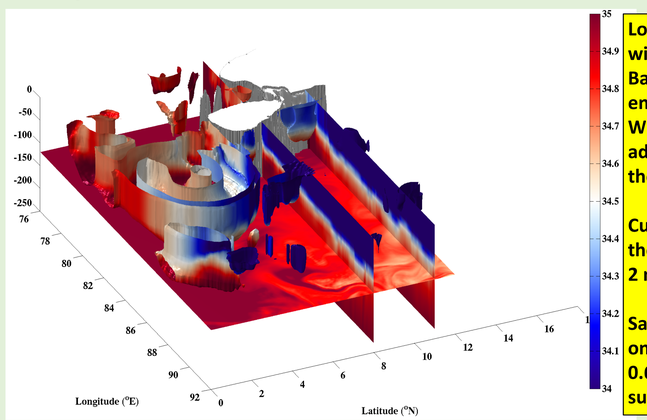
Indian Ocean COAMPS
ocean grid: 2820 x 1467 x 60
3.5 km res., 60 vert. levels
(0.5 m res. from 0-10 m)
3Dvar data assimilation
HYCOM BC
248 mill pts/variable

Bay of Bengal COAMPS HI-RES
ocean grid: 1600 x 1320 x60
1/54° (~ 2 km)
60 vert. levels
(0.5 m res. from 0-10 m)
3Dvar data assimilation
HYCOM BC
126.7 mill pts/variable

The Great Southeast Sri Lanka Whirl present from June 11 to Aug 15 in 2018

SALINITY AND TEMPERATURE ADVECTION BY SRI LANKA WHIRL

Salinity advection on June 20, 2018

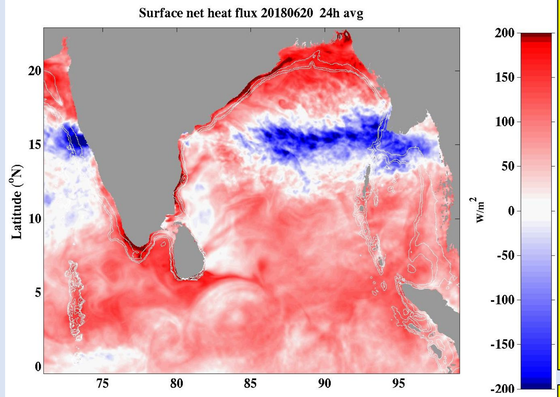


Low salinity water with origin in the Bay of Bengal is entrained into the Whirl and advected towards the equator

Current speeds in the whirl are up to 2 m/s

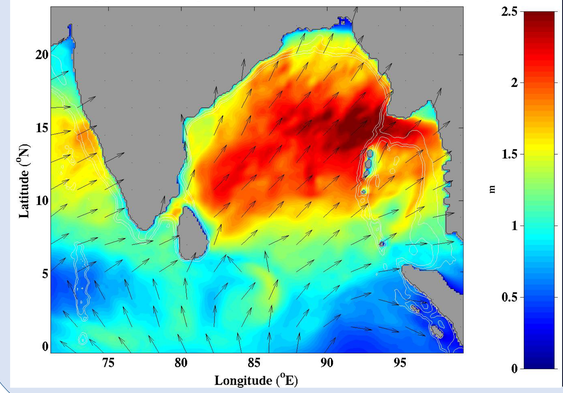
Salinity is shown on 1.7 m/s and 0.6 m/s isotach surfaces

NET HEAT FLUX AND SURFACE WAVE IMPACT



COAMPS atmosphere
18 km nest
(208 x 168 x 60 grid)
6 km nest
(502 x 424 x 60 grid)
NAVDAS assimilation
NAVGEM BC
14.9 mill pts/variable

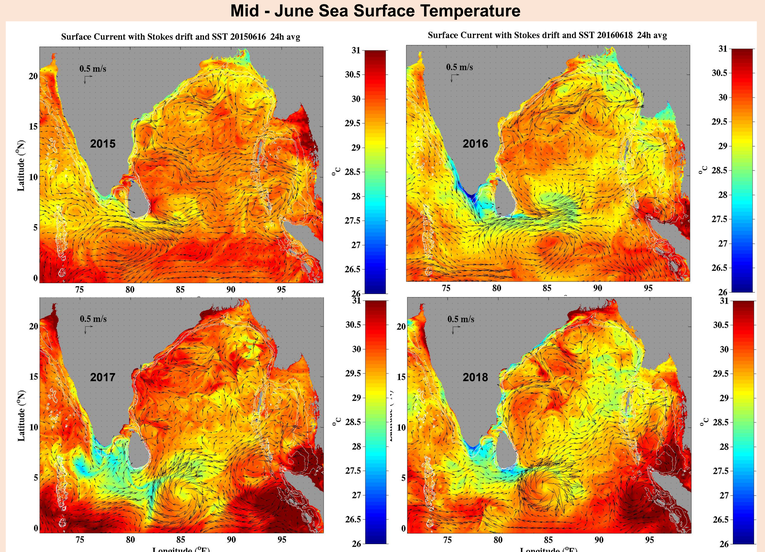
Net surface heat flux is modified over the Sri Lanka Whirl. Positive values are heating the ocean.



Simulating WAves Nearshore (SWAN)
Wave grid: 240 x 200
1/8° spatial resolution
33 spectral frequencies
48 directions.
76.0 mill pts/variable
Surface winds are in the direction of the surface wave propagation. On the western edge of the Sri Lanka Whirl currents are in the wind direction and significant wave height is reduced compared to the east where currents are against the wind, increasing wave height

INTER-ANNUAL VARIABILITY

Mid - June Sea Surface Temperature



Inter-annual variability
The Great Southeast Sri Lanka Whirl has been present during the early southwest monsoon season every year since simulation started in 2015

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