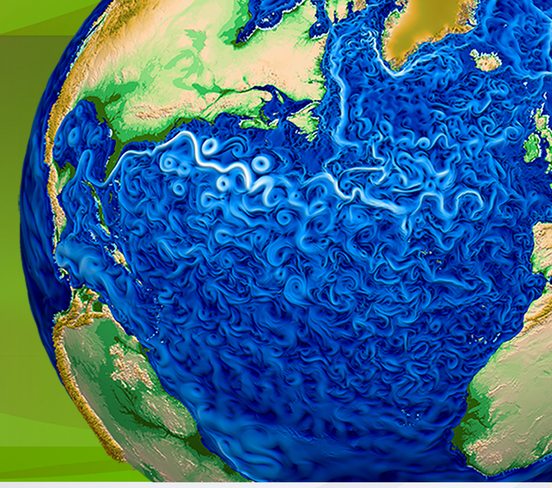
R: Variability of the Arabian Sea Circulation from ACME V0.1

Julie McClean, Milena Veneziani, Jack Ritchie, Mark Taylor, Dave Bader, Mathew Maltrud, Marcia Branstetter, Kate Evans, Judy Gaukel, and Salil Mahajan

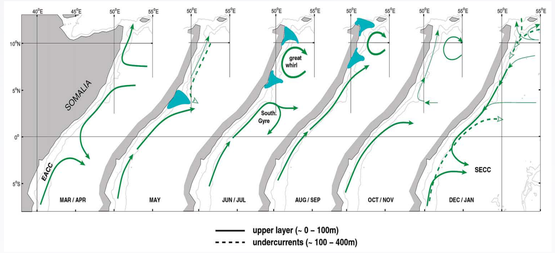


Objective

Predictability of the Indian monsoon is limited due to incomplete understanding of the influence of the Indian Ocean on monsoon variability. It is the objective of this study to to better understand the variability of the Arabian Sea (AS) circulation on seasonal and interannual time scales, with the eventual goal of relating this variability to regional rainfall, especially over western India.

Approach

- AS surface circulation reverses seasonally due to monsoon winds.
- The strong western boundary Somali Current (SC), reverses from southwestward in boreal winter to northeastward in summer. Coastal upwelling is induced by summer southwesterly monsoon winds (Schott & McCreary, 2001).

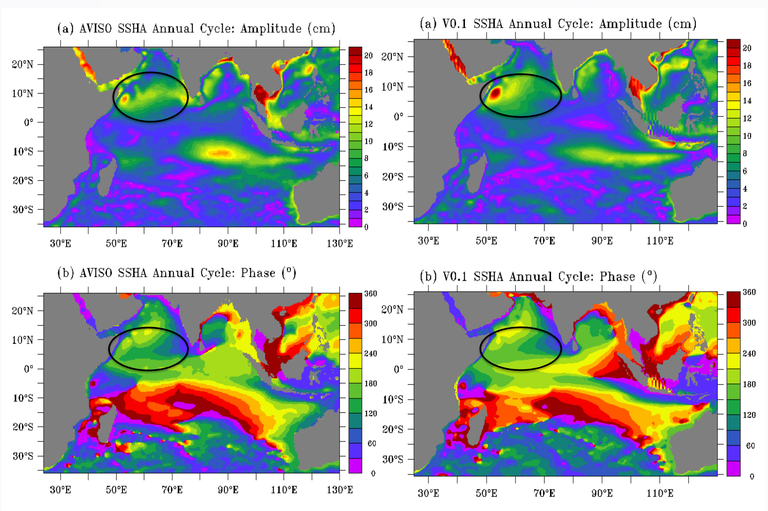


Schematic representation of the seasonal cycle of the Somalia Current system. Blue patches represent upwelling centers (Schott and McCreary, 2001; Prog. Ocean., 51, 1-123, Fig.32).

- Downwelling (upwelling) Rossby waves triggered off the southwest coast of India and reinforced by local wind stress curl during December – April (June-October) propagate across the southern AS (Rao et al. 2010, DSR I, 57, 1-13.).
- Recent observations show that poleward flow appears along the western boundary of the AS one to two months prior to the onset of southwesterly winds; this flow has been attributed to the arrival of the annual downwelling Rossby at the western boundary during March/April (Beal and Donohue, 2013, JGR-O, 118, 1-13).

To study the variability of AS circulation and the processes responsible for the modification of the monsoon-driven seasonal surface circulation, we use ACME V0.1:

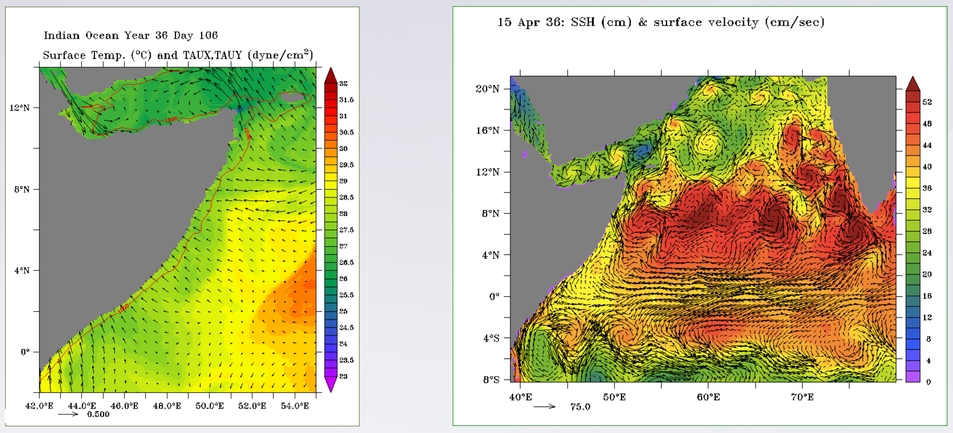
- 0.25° CAM5-SE/CLM4
- tripolar 0.1° POP2/CICE4
- Constant 1850 preindustrial forcing
- Run for 100+ years;
- daily-averaged output: yrs 35-37



Amplitude (cm) and phase (°) of the annual cycle of sea surface height anomaly (SSHA) from AVISO-altimetry (left) and ACME V0.1 (right).

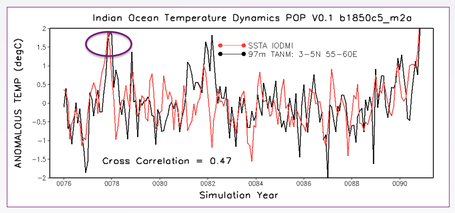
15 April 36: Inter-Monsoon Period

Wind Stress (dyne/cm^2) & SST (°C) on left and SSH (cm) and 5-m velocity (cm/sec) on right

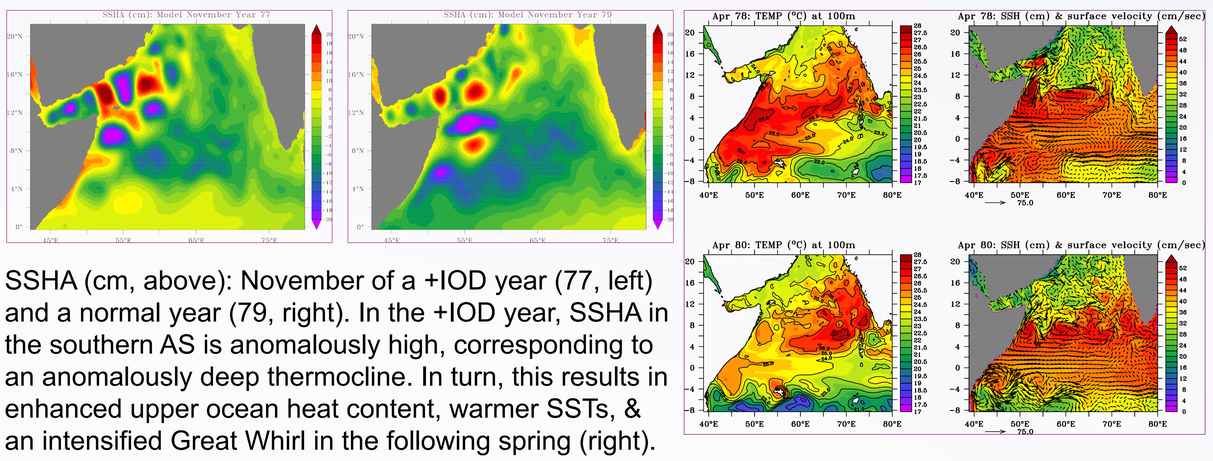


Poleward flow is seen all along the Somali coast due to the approaching downwelling Rossby wave ridge (5°-10°N) & a coastal onshore wind (0-10°N).

Indian Ocean Dipole Mode Events



POP Temperature Anomaly (°C) at 97m averaged over 3°-5°N and 55°-60°E and IODM index (red). Rossby waves propagate through this region. +IOD event in 79/80 is circled.



SSHA (cm, above): November of a +IOD year (77, left) and a normal year (79, right). In the +IOD year, SSHA in the southern AS is anomalously high, corresponding to an anomalously deep thermocline. In turn, this results in enhanced upper ocean heat content, warmer SSTs, & an intensified Great Whirl in the following spring (right).

Impact

ACME V0.1 has been used to study air-sea interaction on seasonal and interannual time scales in the AS. The anomalously high upper ocean heat content and SSTs in the AS during a positive IOD event will likely impact atmospheric convection. The anomalously high SSHA was found to impact the strength of the western boundary current circulation (*e.g.* the Great Whirl) in the spring. To be explored is the variability of the strength of the upwelling in the western boundary current region and its impact on the advection of heat into the central AS, and consequently the monsoon.

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ACME Accelerated Climate Modeling for Energy

For additional information, contact:

Julie McClean
Research Oceanographer

Scripps Institution of Oceanography/UCSD
(858) 534-3030
jmcclean@ucsd.edu

climatemodeling.science.energy.gov/acme

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