Analysis and modelling of the upwelling region of the Somali coast

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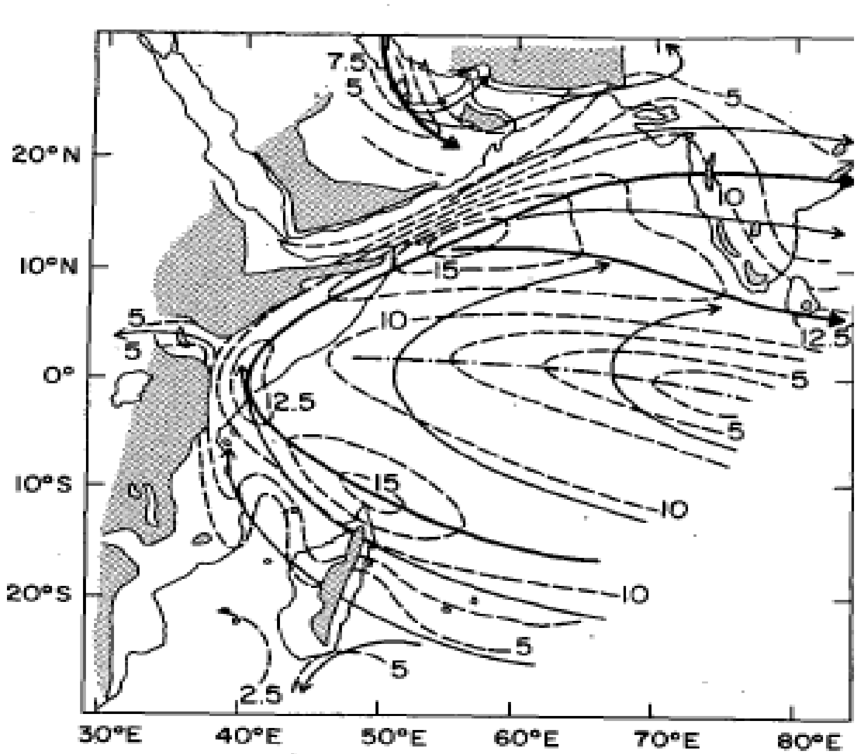
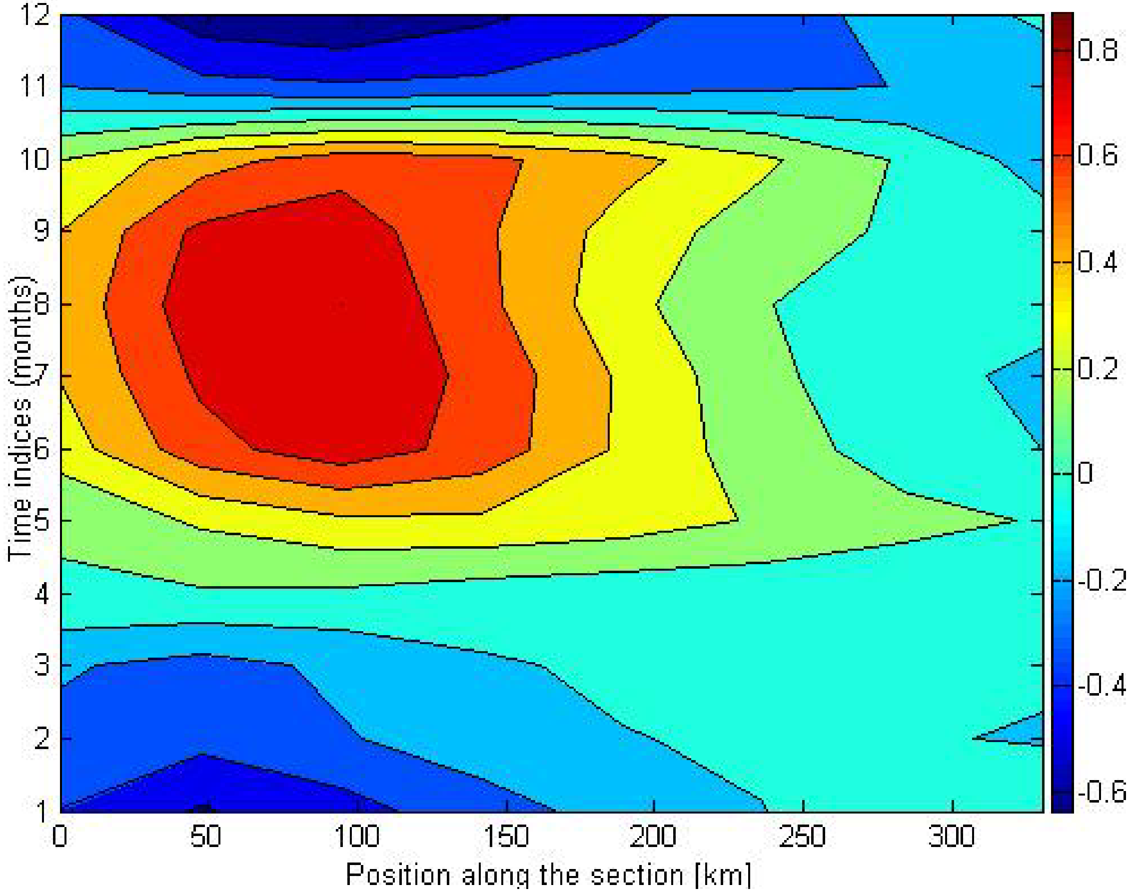
Introduction - Somali Jet



Mean flow pattern at 1 Km level for July. Solid lines denote streamlines. Heavy line is the axis of maximum flow. Dashed lines are isotachs. Dot-dashed line is axis of minimum wind speed. *Shaded areas correspond to orography greater than 1km.*

Findlater (1971)

Introduction - Somali Current Variability



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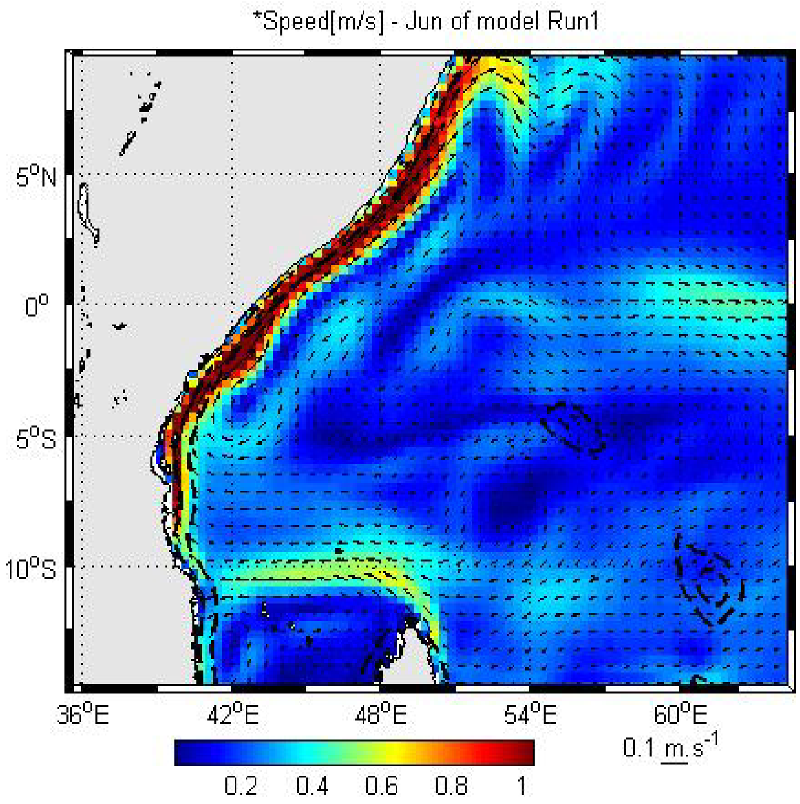
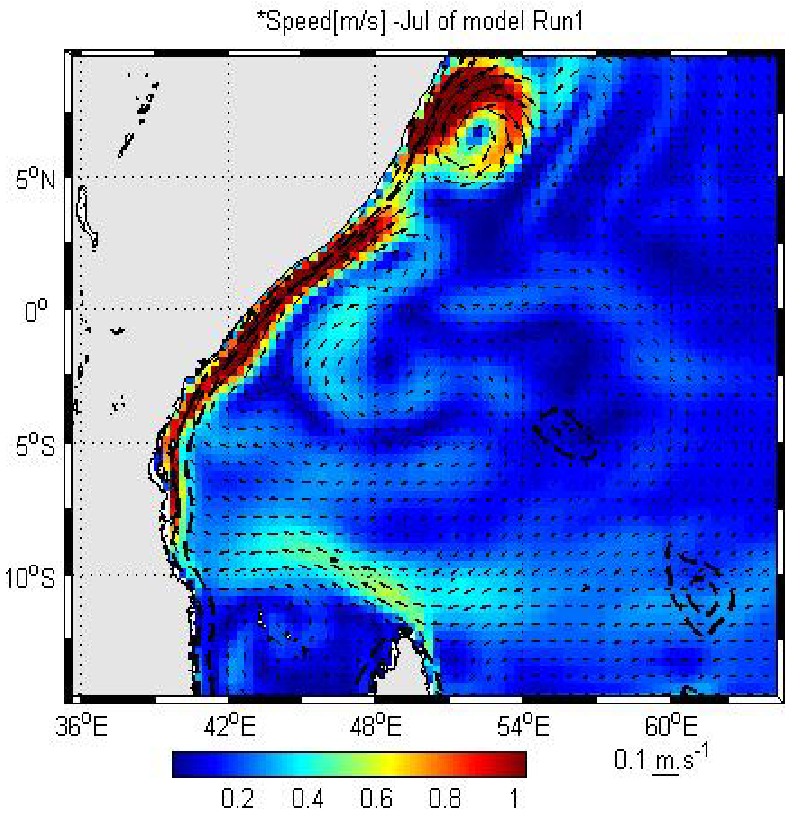
Model Results – Somali Current





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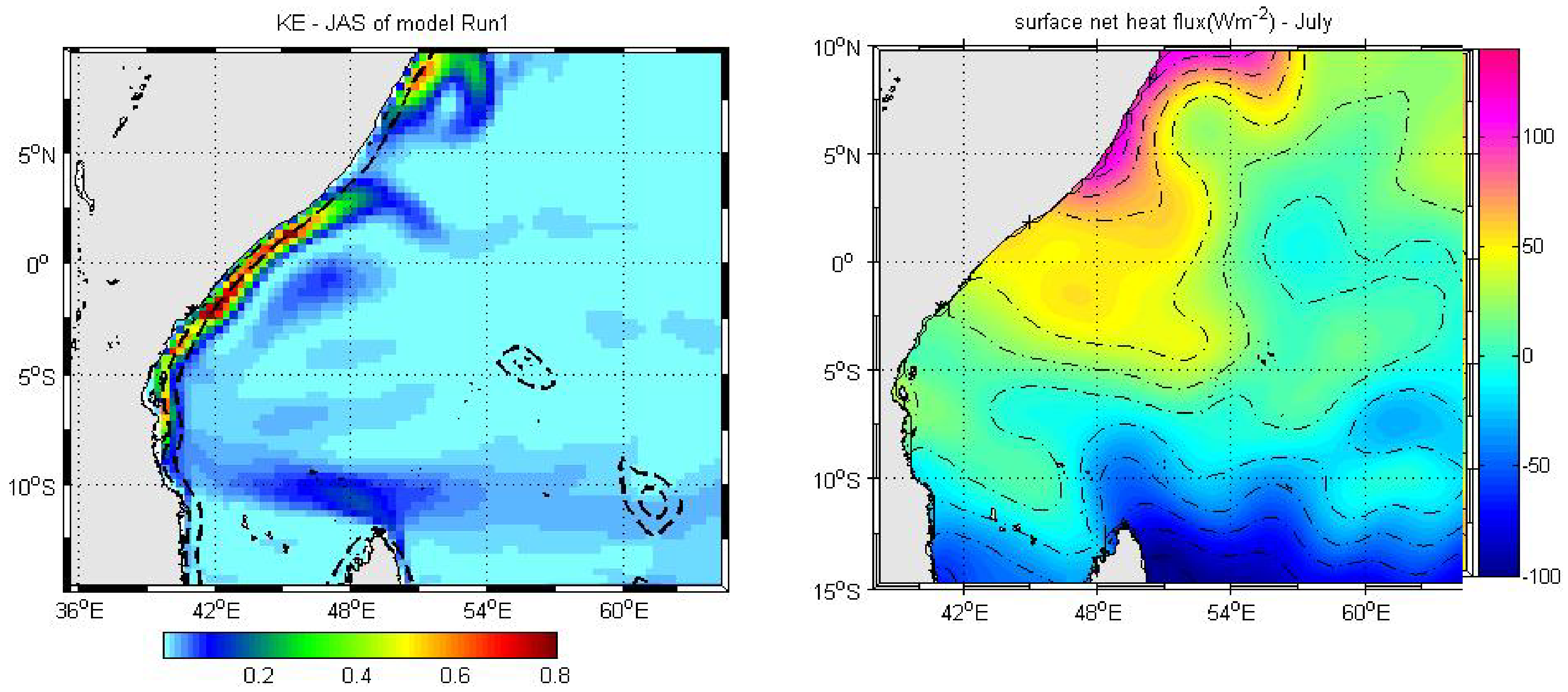
Model Results – Somali Current K.E & Flux



Kinetic Energy (m^2s^{-2}) (left) and Heat Flux (Wm^{-2}) (right) for July

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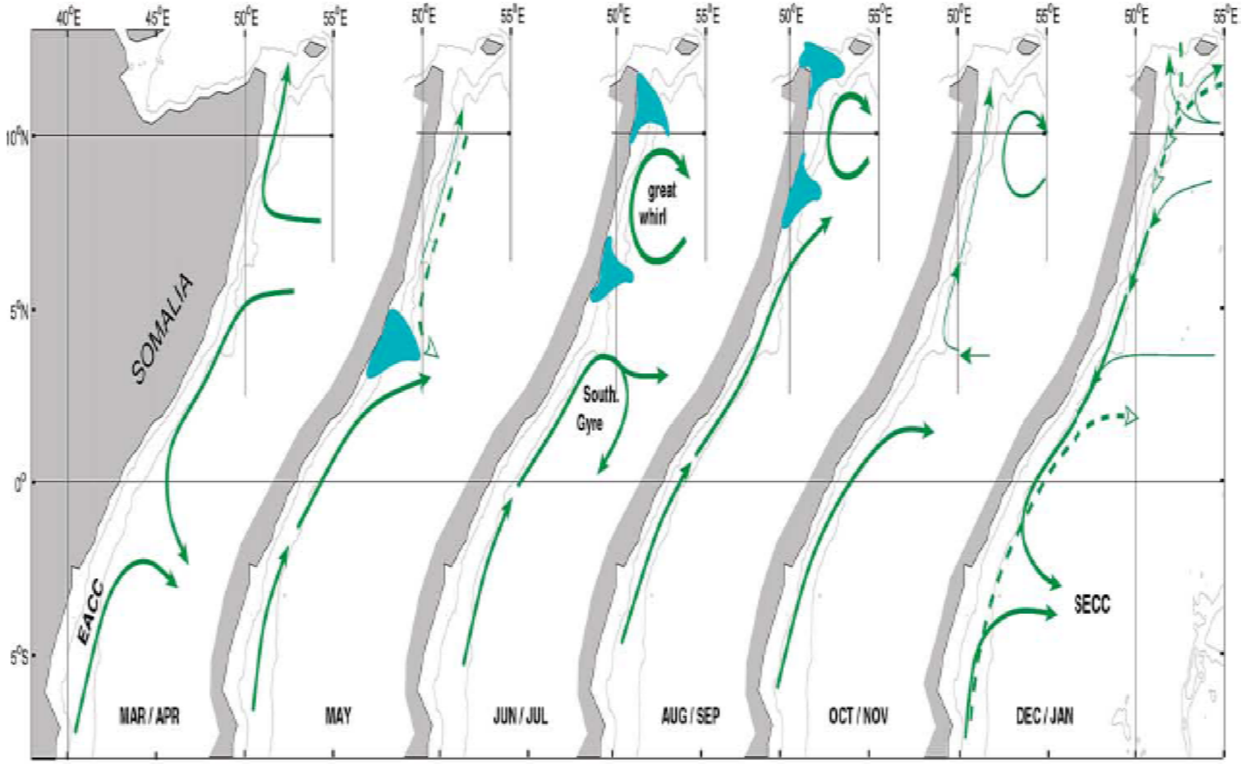
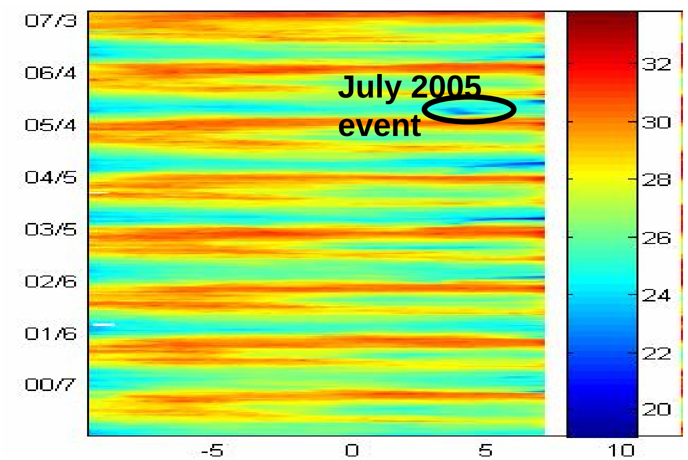
Upwelling Regions



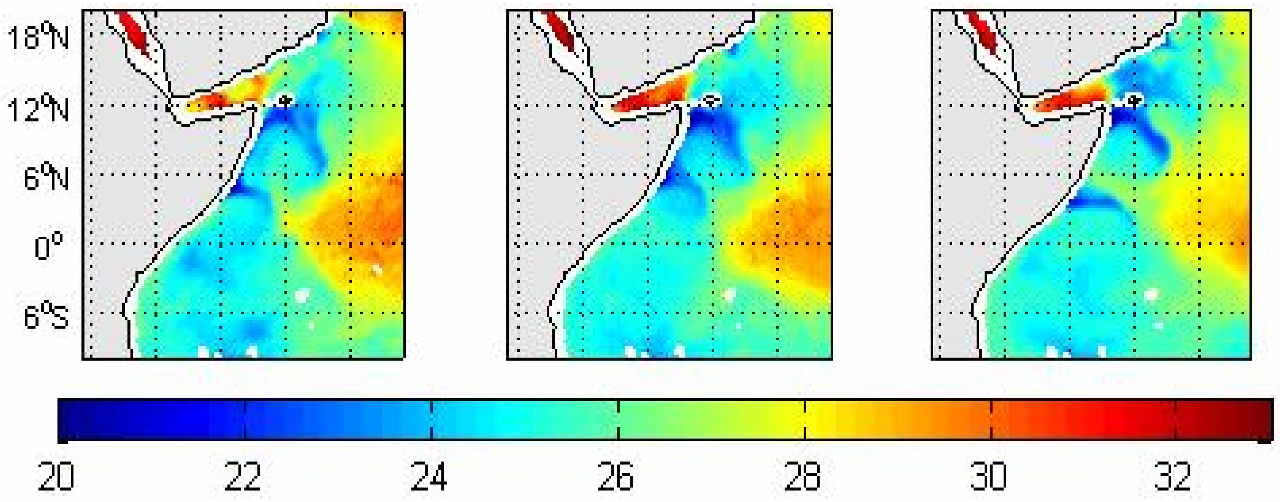
Schematic diagram showing the development of the two upwelling regions on the Somali coast up to the horn of Africa in June/July, adapted from Schott et al (2001)

SST – TMI satellite



Left, Meridional Hovmuller plot along 50.125E between latitudes 10S and 10N.

Highly localized southern upwelling is clearly discernible somewhere between 05/4 and 06/4. SSTs in ^{0}C)



July SSTs for (left to right) 2003, 2004 and 2005 showing the significant upwelling during 2005

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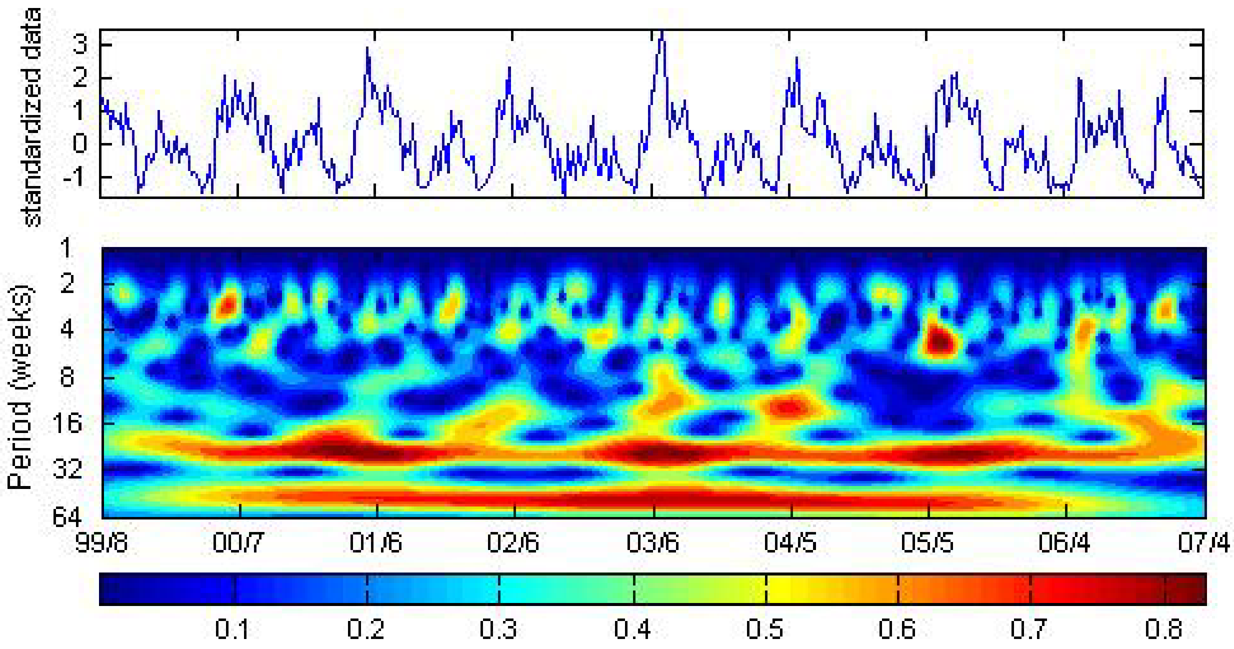
Somali Jet Variability Modes



The spectral power of the wind with period in weeks (top)

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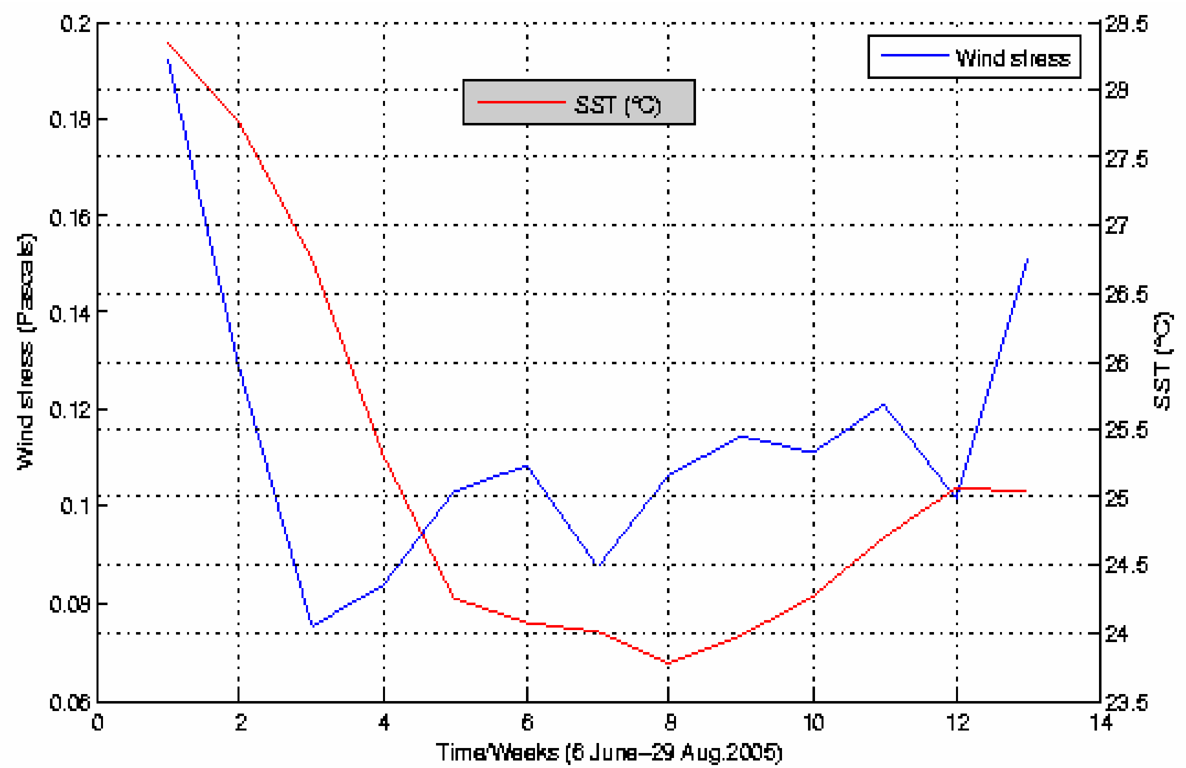
Mesoscale SST-Wind Co-variability over the Upwelling Region



Time series of alongshore wind stress(Nm-2) (blue) and SSTs (0C) (red) extracted from the box bounded by 3.25 - 4.250N and 49.25 - 52.250E over the upwelling region for the period 6 June - 29 August.

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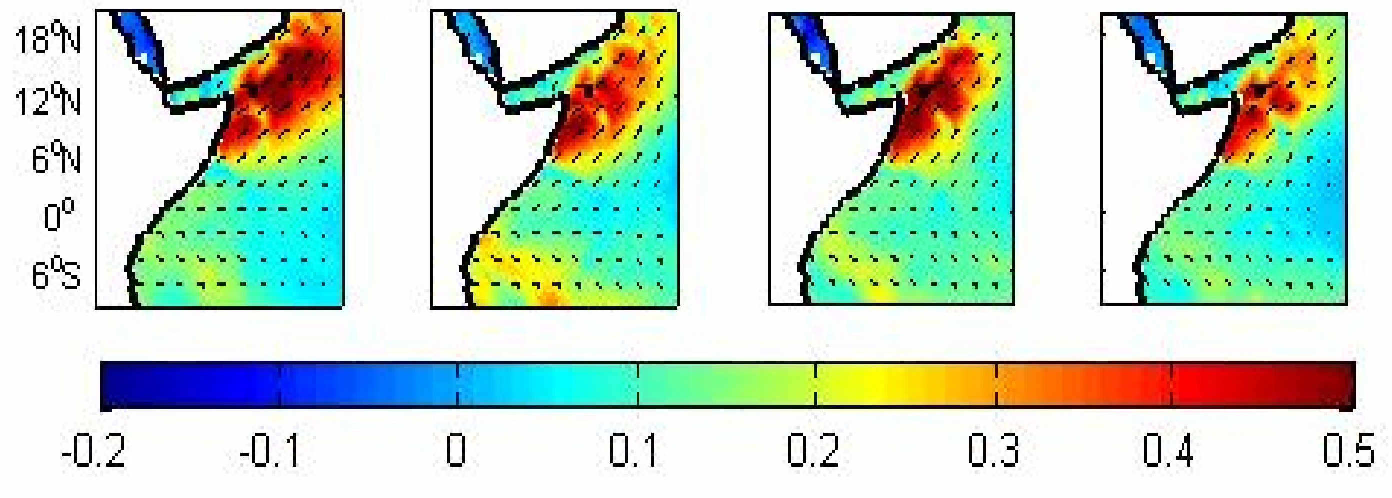
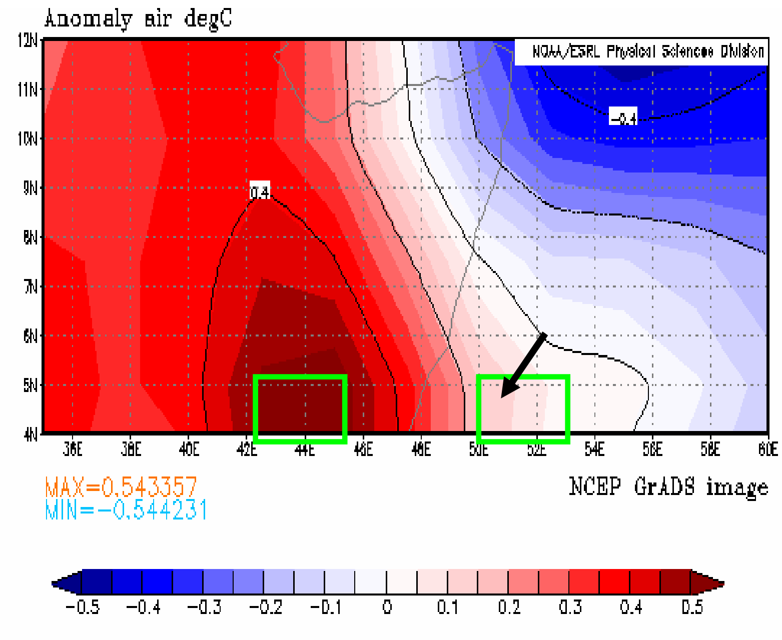
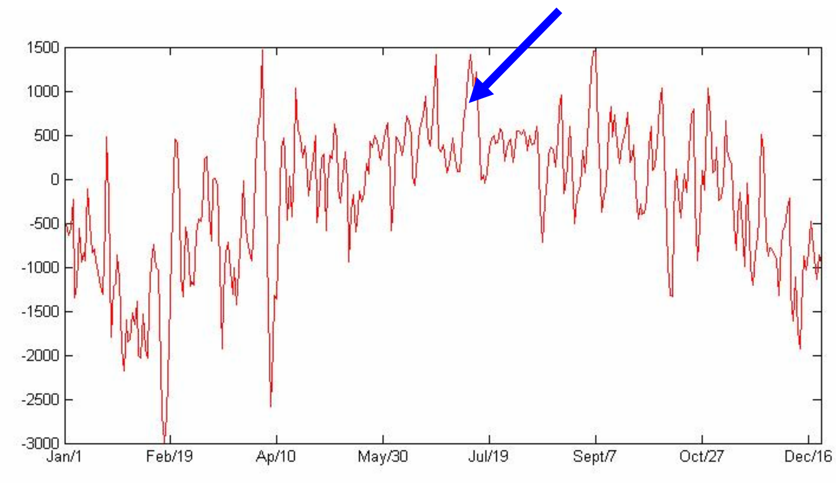
Wind Stress (Quickscat) and SST (TMI)



Alongshore winds (colour shaded) and wind stress vectors for (left to right) 2nd, 9th, 16th and 23rd July 2005 showing the acceleration and deceleration of the jet (36-66E)

Land-Sea Temperature Anomaly (NCEP)





July 2005 surface temperature anomalies (^{0}C) showing zonal thermal gradient (left). Box average SLPI (Nm^{-2}) between the boxes 2.50 – 5.00N, 50.0 0 – 52.5.0E over the ocean and 2.50 – 5.00N, 42.50 – 45.00E over land for the year 2005 . Note high values around 19 July indicated with a black arrow

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Conclusion

- From 26 June – 30 July 2005 Somali jet oscillated at a lower frequency than the observed bi-weekly mode
- Strong alongshore winds persisted from week ending 2 July to that ending 16 July enhanced by offshore pressure gradient.
- Somali current strengthened and enhanced Ekman pumping hence strong upwelling.
- Subsequent weakening of winds during the week of 23 July decelerated current turning it east and south-eastwards over the upwelling region
- A cold wedge of upwelled waters then developed along the gyre's shoreward shoulder organizing the upwelling into a cold filament by advecting the cold coastal upwelled waters offshore, first eastward and then to the south.

Conclusion

- The mesoscale changes in speeds as the winds cross over the cold filament result in changes of wind convergence and divergence upstream and downstream of the cold filament respectively.

- A wind stress curl dipole forms over the cold filament with positive curl upstream.

- cyclonic (positive) wind stress curl, which corresponds with local oceanic divergence, strengthened the upwelling and generated the observed highly localized pool of cold waters

Research Questions

- Ocean-atmosphere interaction in the Indian Ocean is highly dynamic, involving significant exchanges of heat across the air-sea interface.

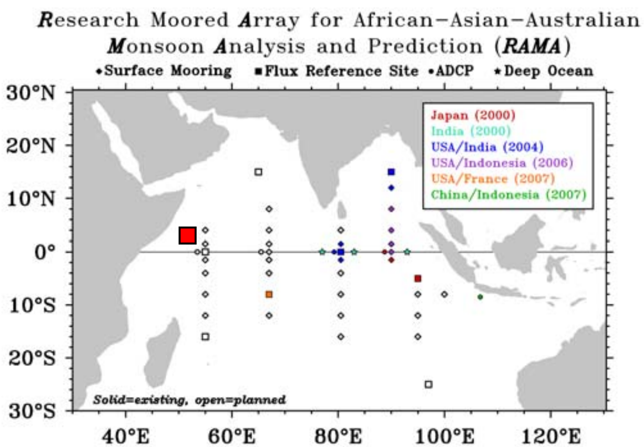
- Connections between the evolvement of the low SSTs over the upwelling region, the modified winds and rainfall over Kenya coast.

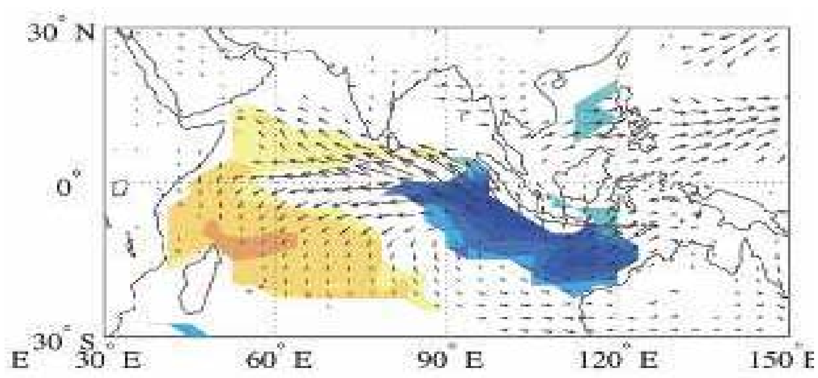
- The fact that the cold filament seems fixed to a latitude near 4-5Nsuggests that it is not just a randomly located air-sea feedback.

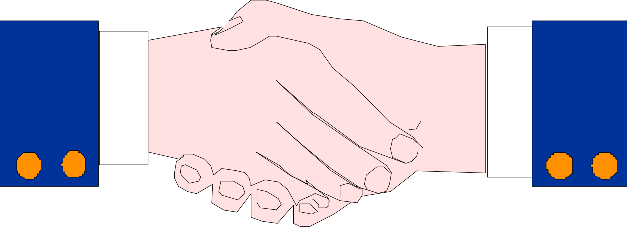
- Improved observations in the equatorial western Indian Ocean may help understand onset and the co-occurrence of ENSO and IODZM signals all of which have severe impacts on East African climate.

Comprehensive data records for this region will improve our knowledge of the physical processes and our ability to provide reliable forecasts.

We recommend/propose deployment of ADCP along the equator especially in the western Indian Ocean near 45E and 5N (red sqaure).







Thank you for your attention