Received: 19 October, 2011

IOTC–2011–WPEB07–17

Outline of climate and oceanographic conditions in the Indian Ocean: an update to August 2011

Francis Marsac
IRD
University of Cape Town
South Africa

Institut de recherche pour le développement

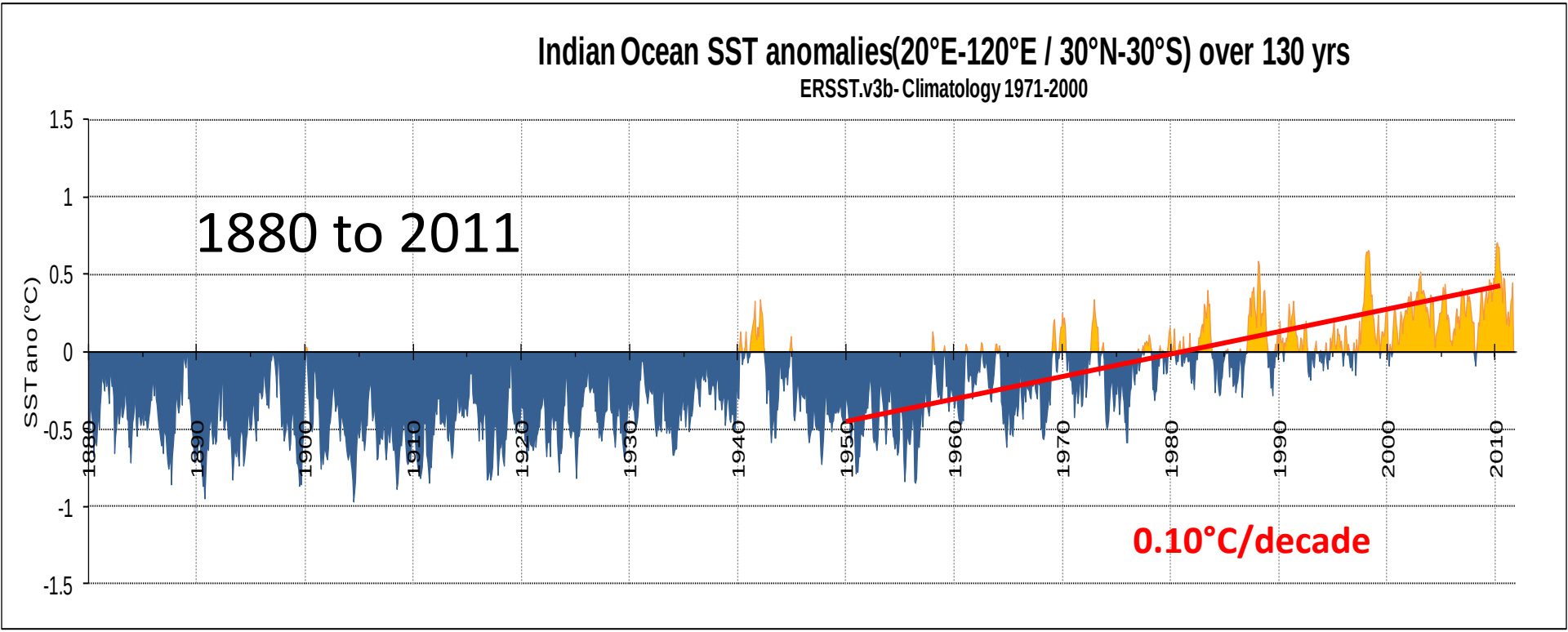
ICEMASA
International Centre for Education, Marine and Atmospheric Sciences over Africa

1- Long term, basin-scale trends

Variables used :

- SST
  - NOAA-NESDIS Extended Reconstructed Seas Surface Temperature (ERSST.v3b) based on the International Comprehensive Ocean-Atmosphere Data Set, release 2.4 (Smith et al 2008, J. Climate)
  - In situ SST data (no satellite) and improved statistical methods that allow stable reconstruction using sparse data
  - Climatology 1971-2000
  - Series 1854-2011, but more reliable from 1880 onwards
  - SST by 2° area boxes and month
- Atmospheric indices
  - Southern Oscillation Index (SOI)
  - Indian Oscillation Index (IOI) *(Marsac & le Blanc 1998)*

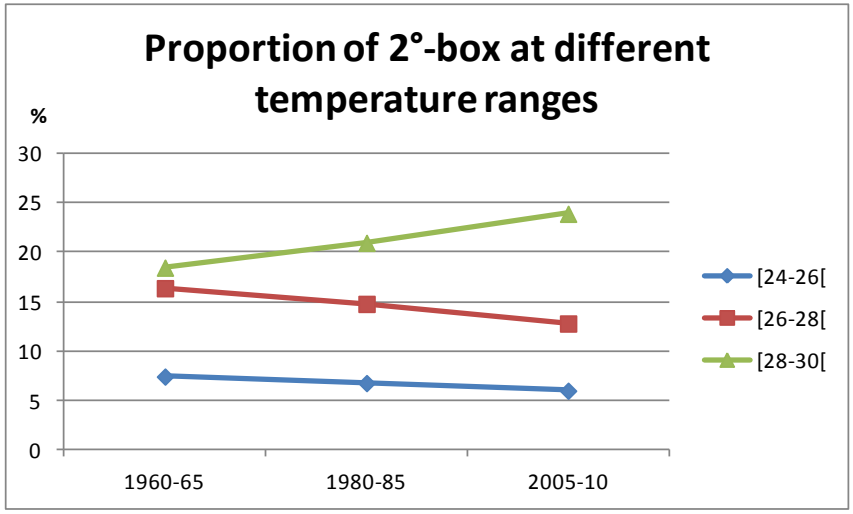
SST trend

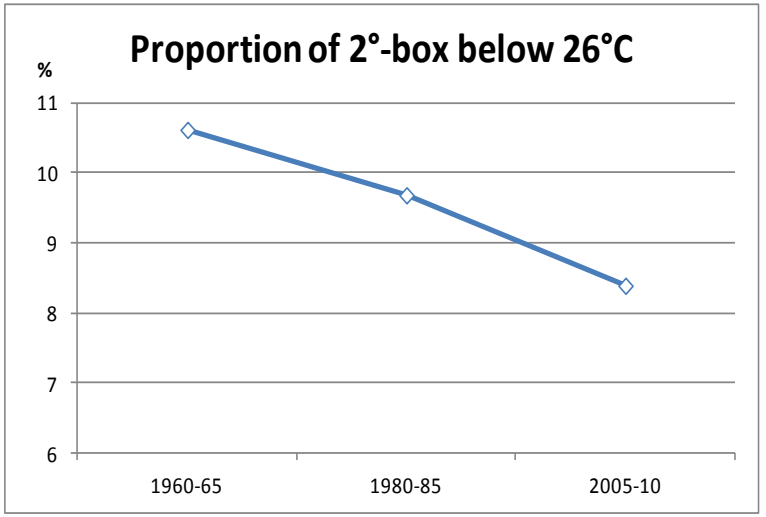


- The West IO gets warmer at a higher rate than the whole IO: 0.13°C/decade

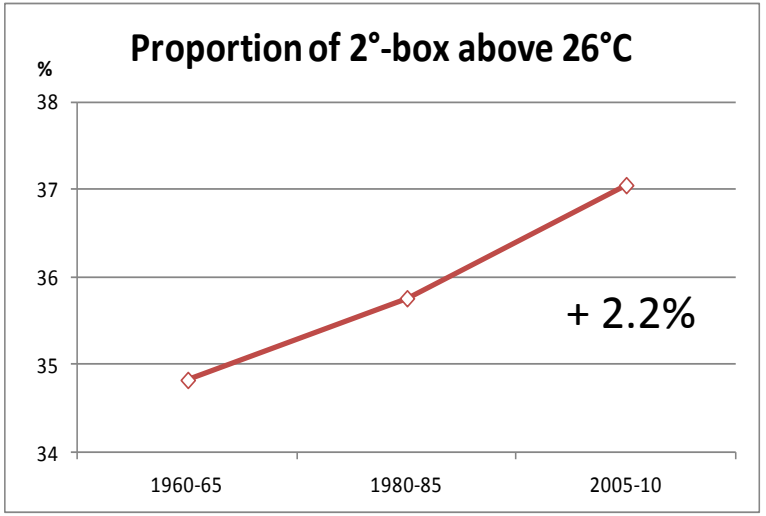
A greater occurrence of warm waters :

comparing 1960-65, 1980-85 and 2005-10



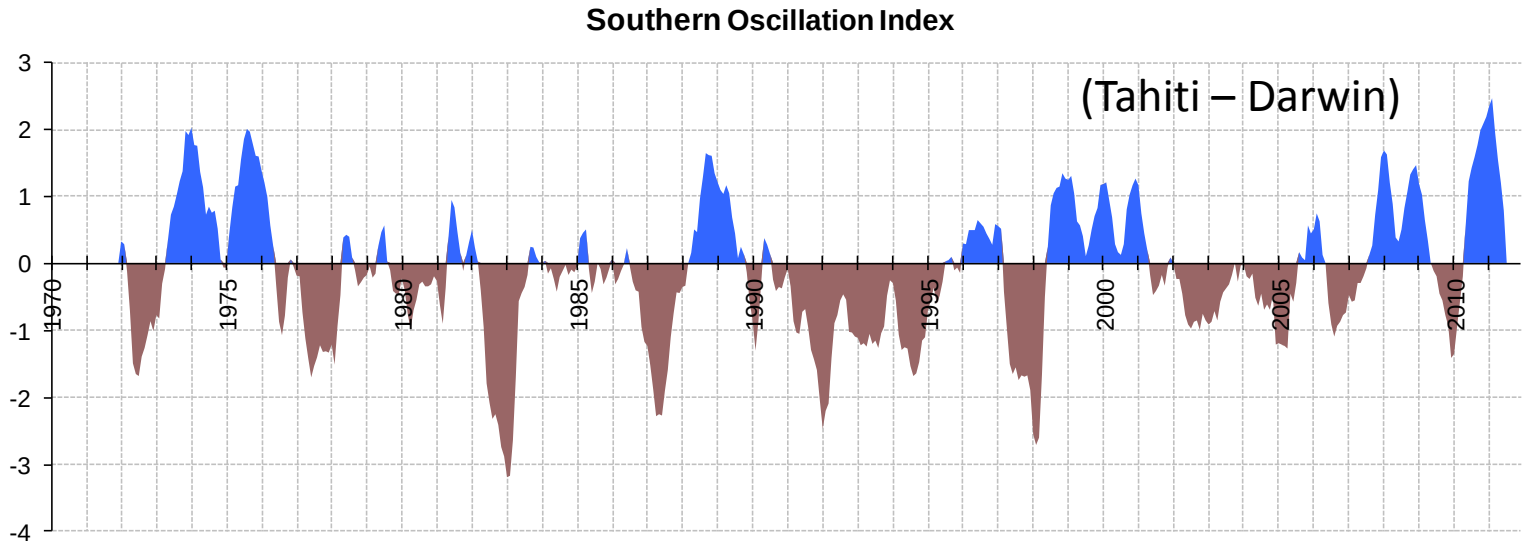


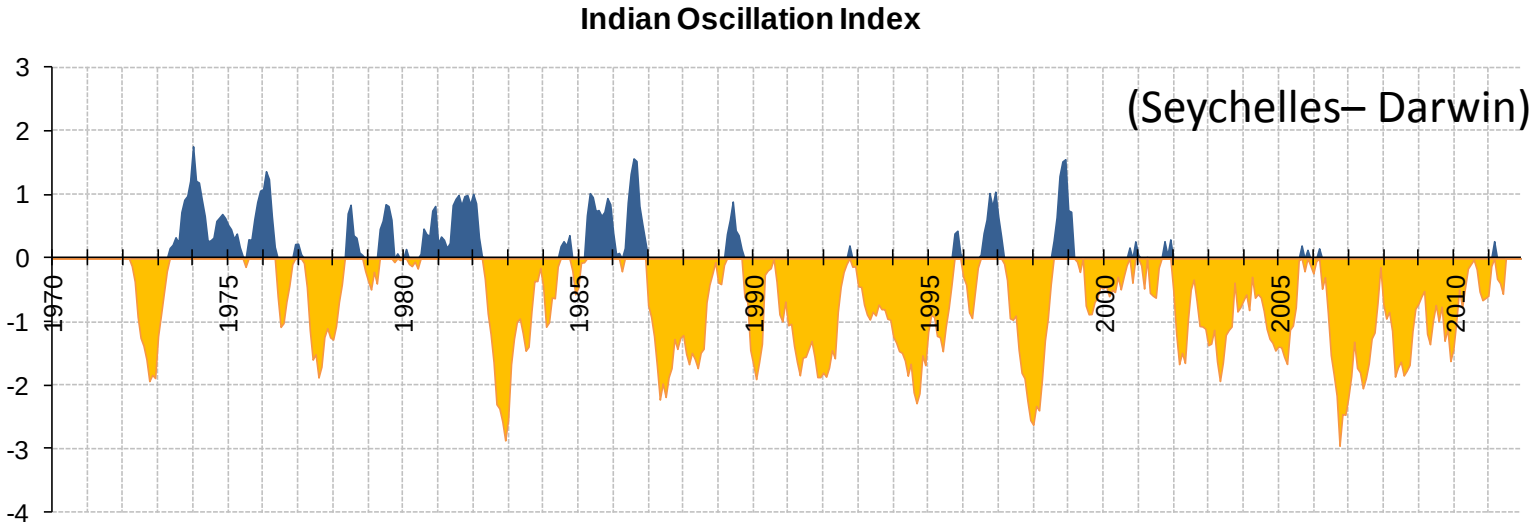
- Analysis carried out for Jan-Mar (core of spawning season) in 3 different time periods.
- During the last 50 yrs, there are 2% more 2°box-month strata with SST>26°C (threshold for tuna larvae survival)



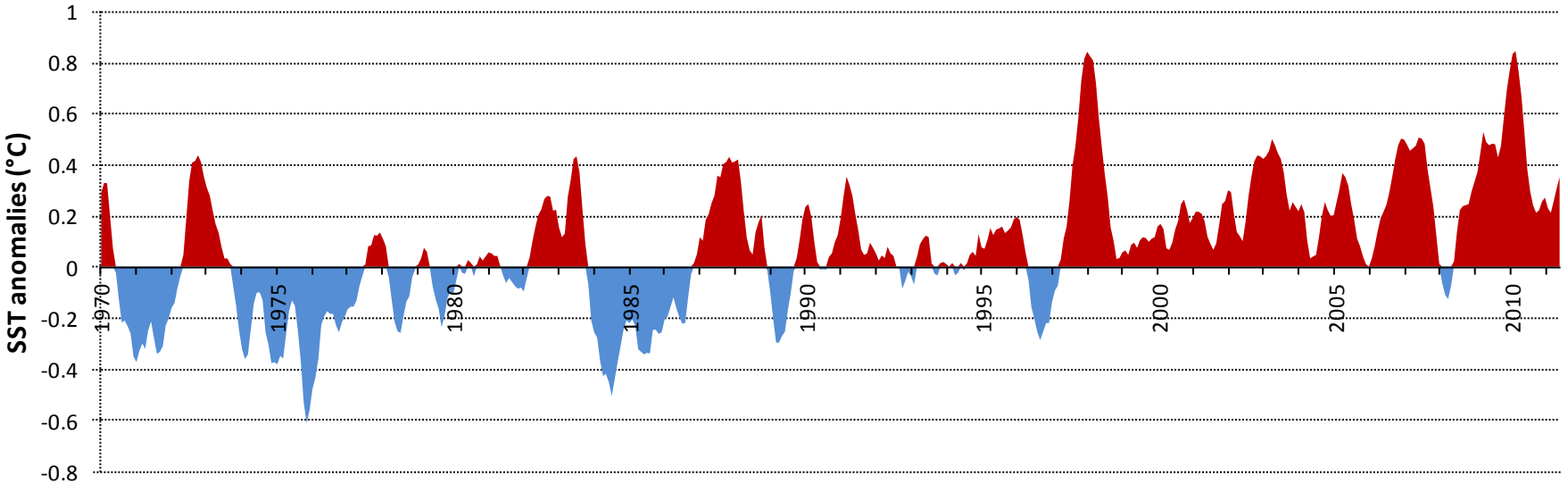
Climate indices : SOI and IOI

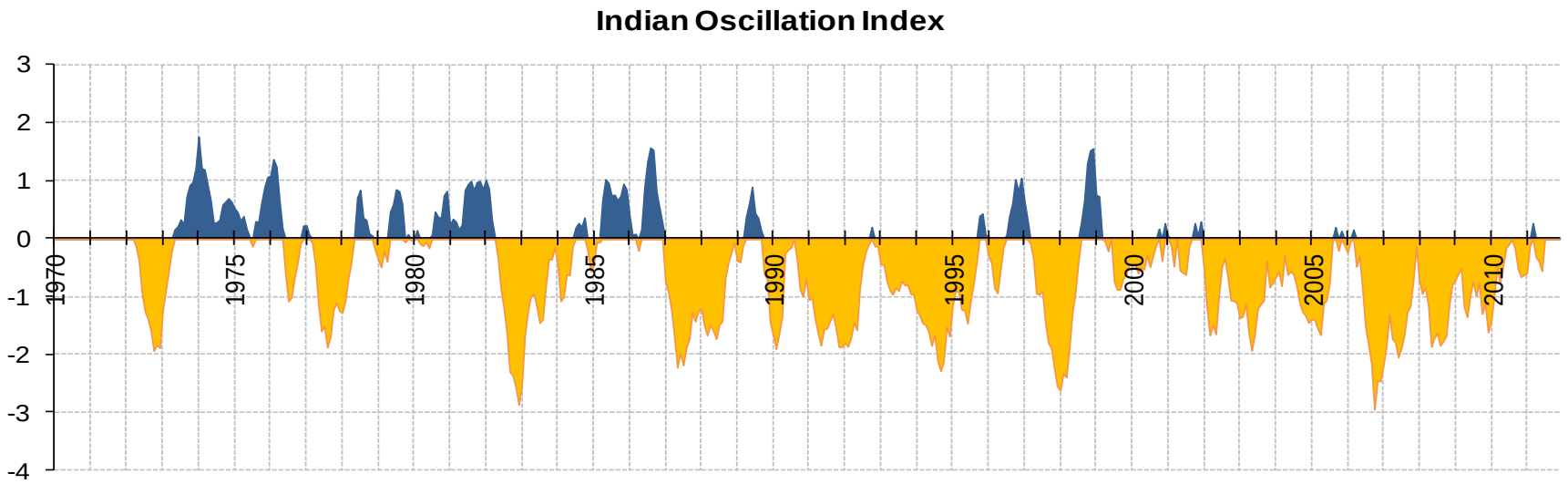
(up to June 2011)





SST anomalies in the WIO and IOI

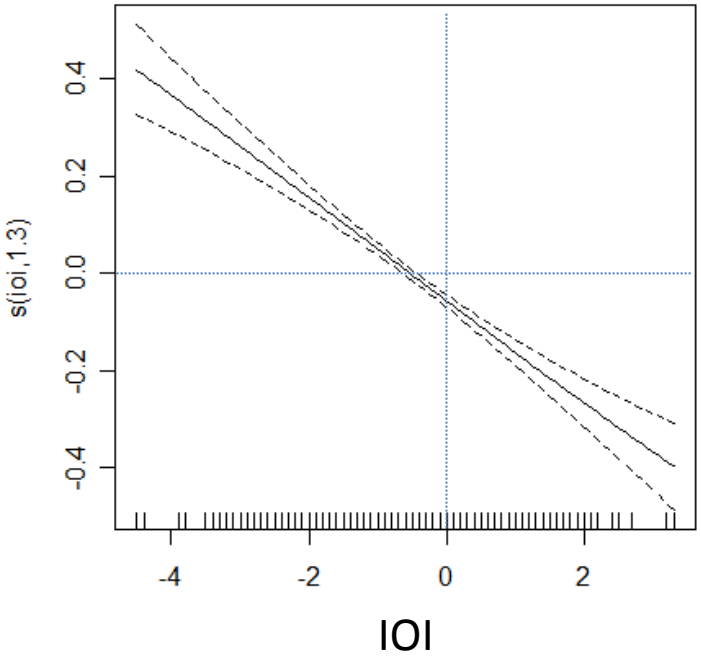




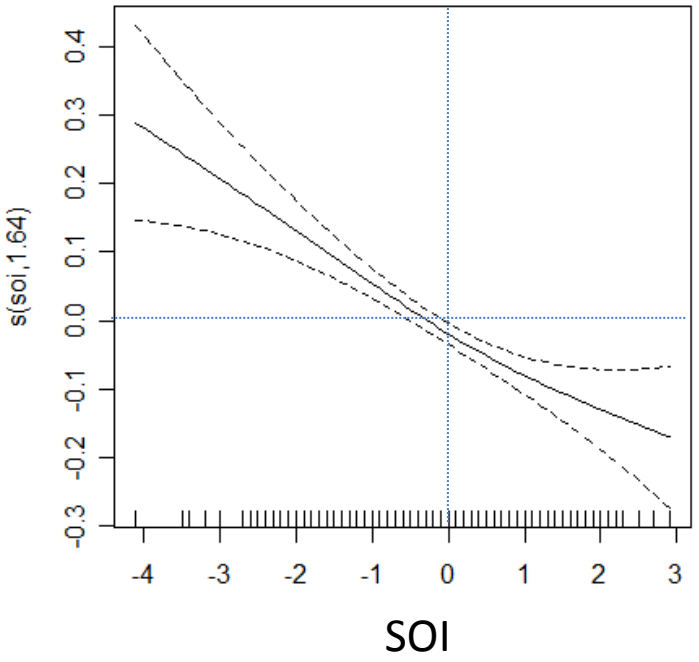
SST anomalies in the WIO versus IOI and SOI using GAMs

1972-2011 (473 months)

26.1% deviance explained



8.2% deviance explained

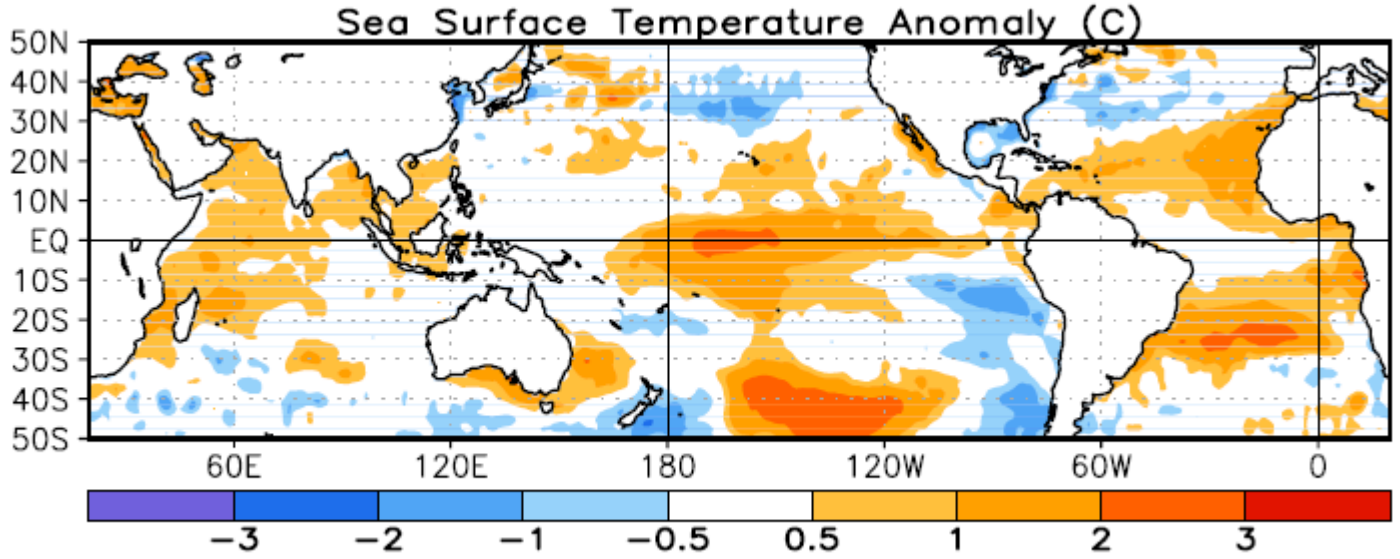


The IOI is more closely related to SST anomalies in the WIO than does the SOI

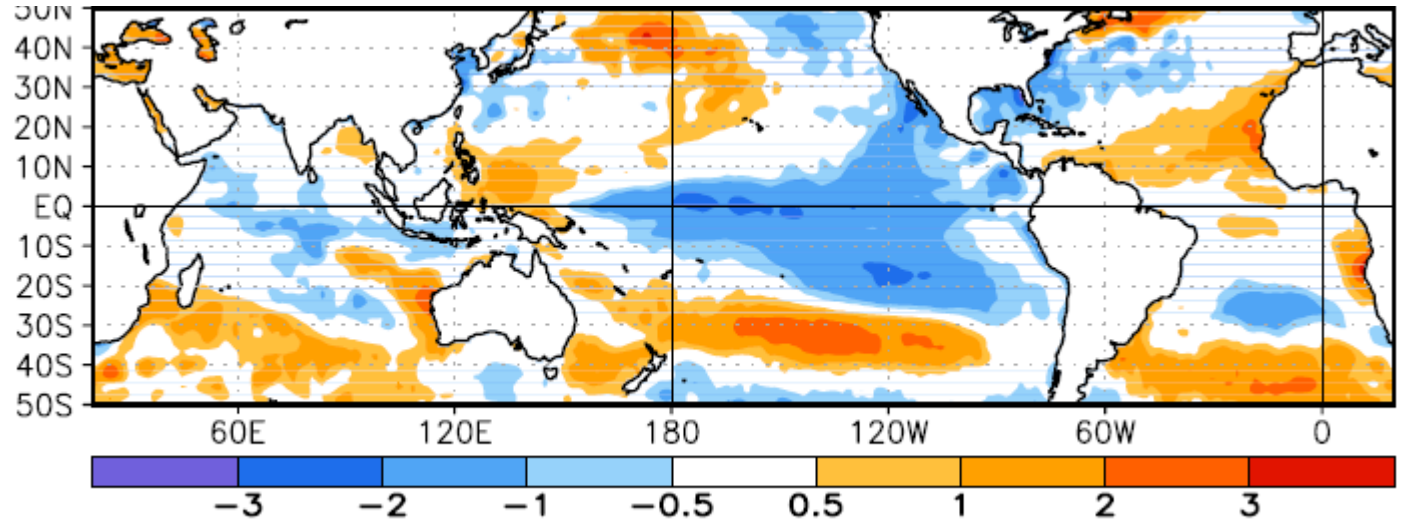
SST anomalies, Jan 2010 and Jan 2011

(Diagnostic Bulletin, NOAA)

Jan 2010
Warm event



Jan 2011
Nina



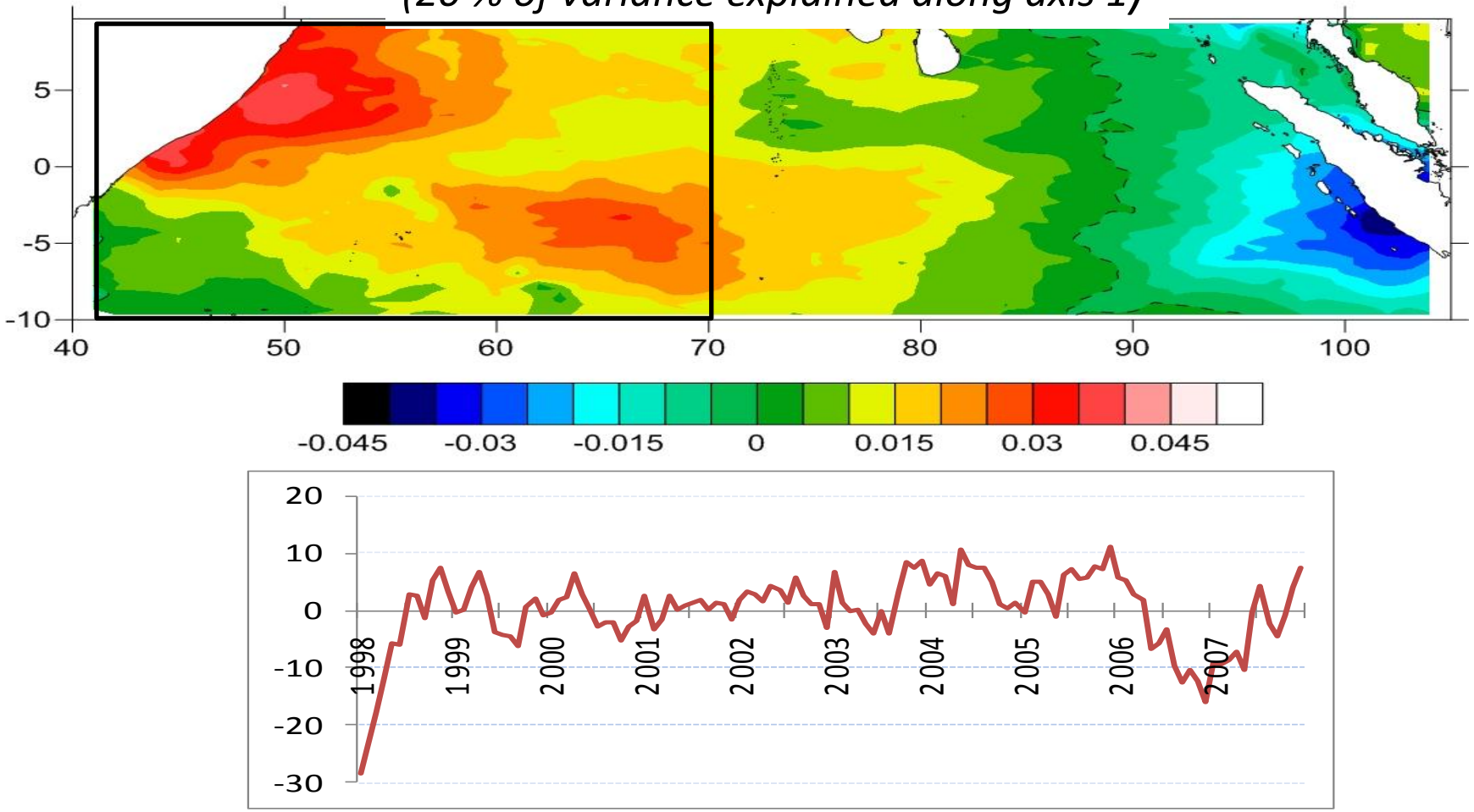
2 – Regional Analyses

Variables used :

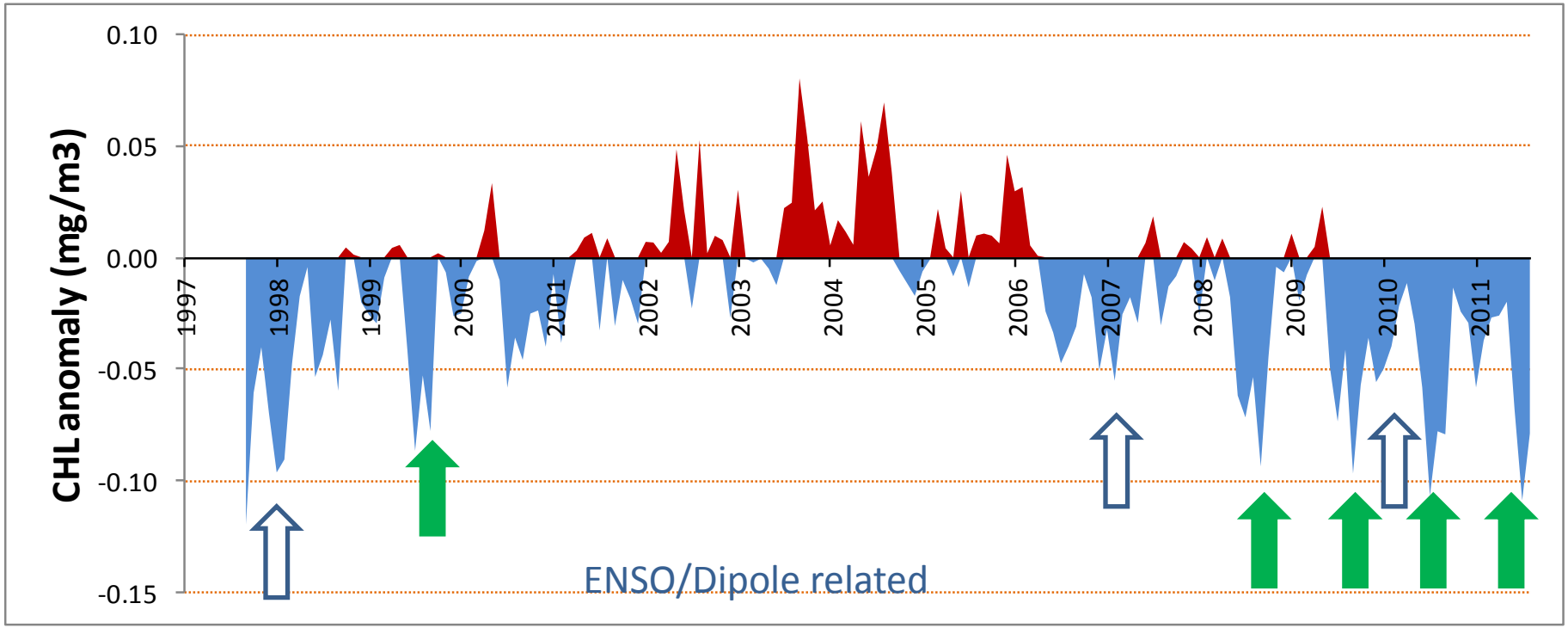
- Satellite-derived sea surface Chlorophyll-a
  - SeaWifs 1997-2009
  - Modis 2002-2011
  - Climatology 2003-2008 (common period between 2 datasets)
  - 9 km level-3 data aggregated by 1°lon/0.33° lat, by month
- Wind stress
  - FSU dataset (COAPS)
  - In situ based fields: VOS, moored buoys, drifting buoys
  - Climatology 1971-2000
  - Series 1970-2011
  - meridional wind stress, by 1° area box and month

Sea Surface Chlorophyll: variability pattern from principal component analysis

(20 % of variance explained along axis 1)

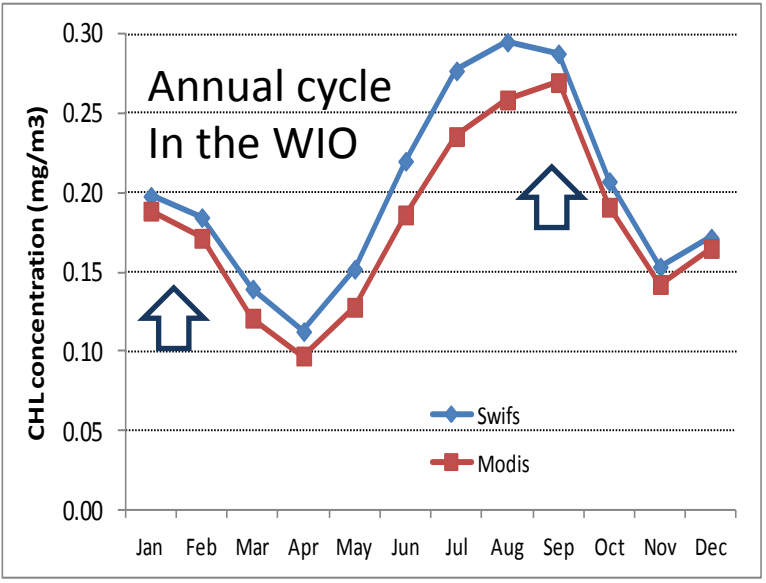


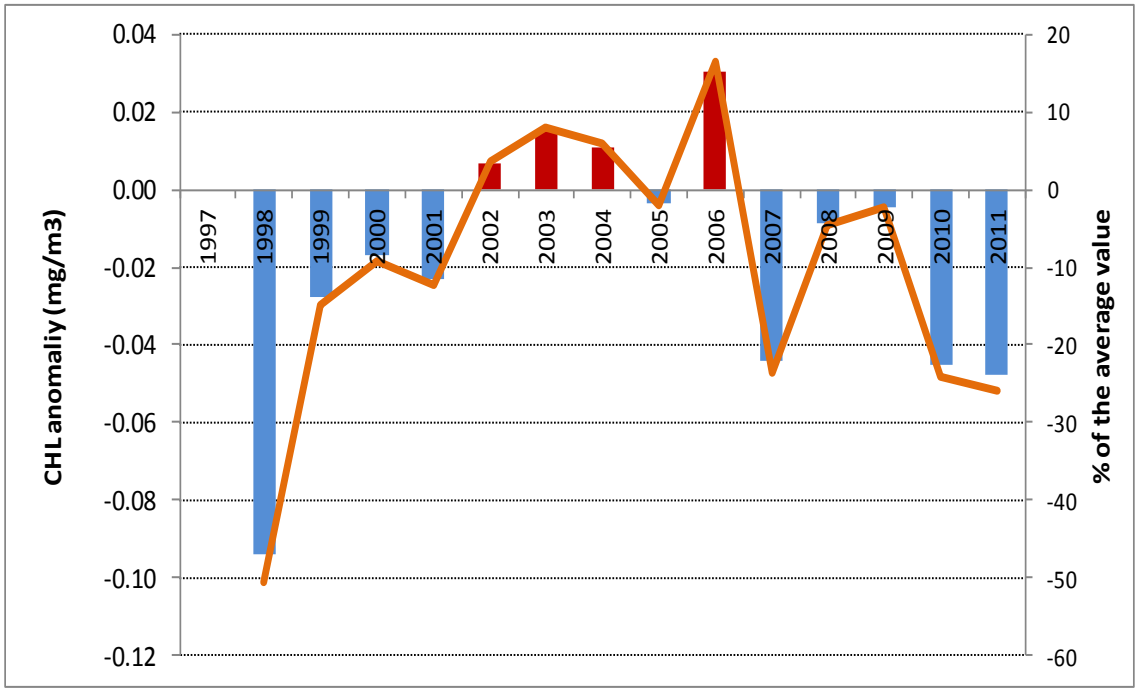
Surface CHL-a anomalies in the whole WIO : a composite series



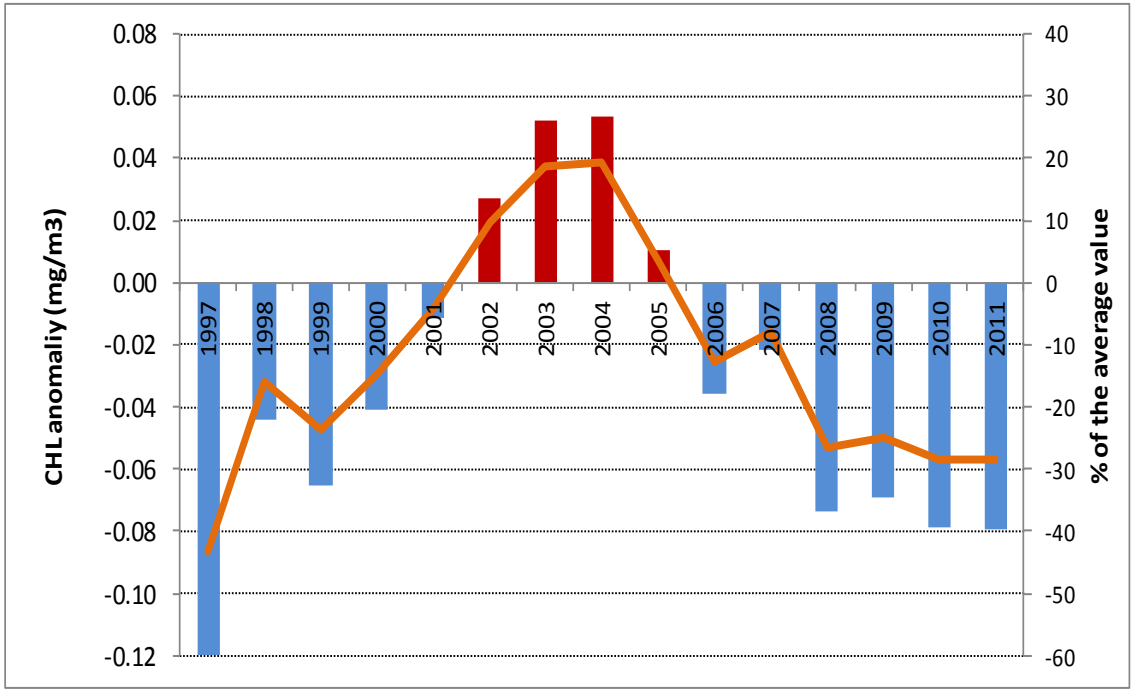
- Negative anomalies occurring in Dec-Feb are generally related to ENSO-Dipole
- Negative anomalies occurring during the South west monsoon would reflect a weaker than normal Somali upwelling, this being observed every single year since 2008

Chlorophyll-a anomalies
January – February



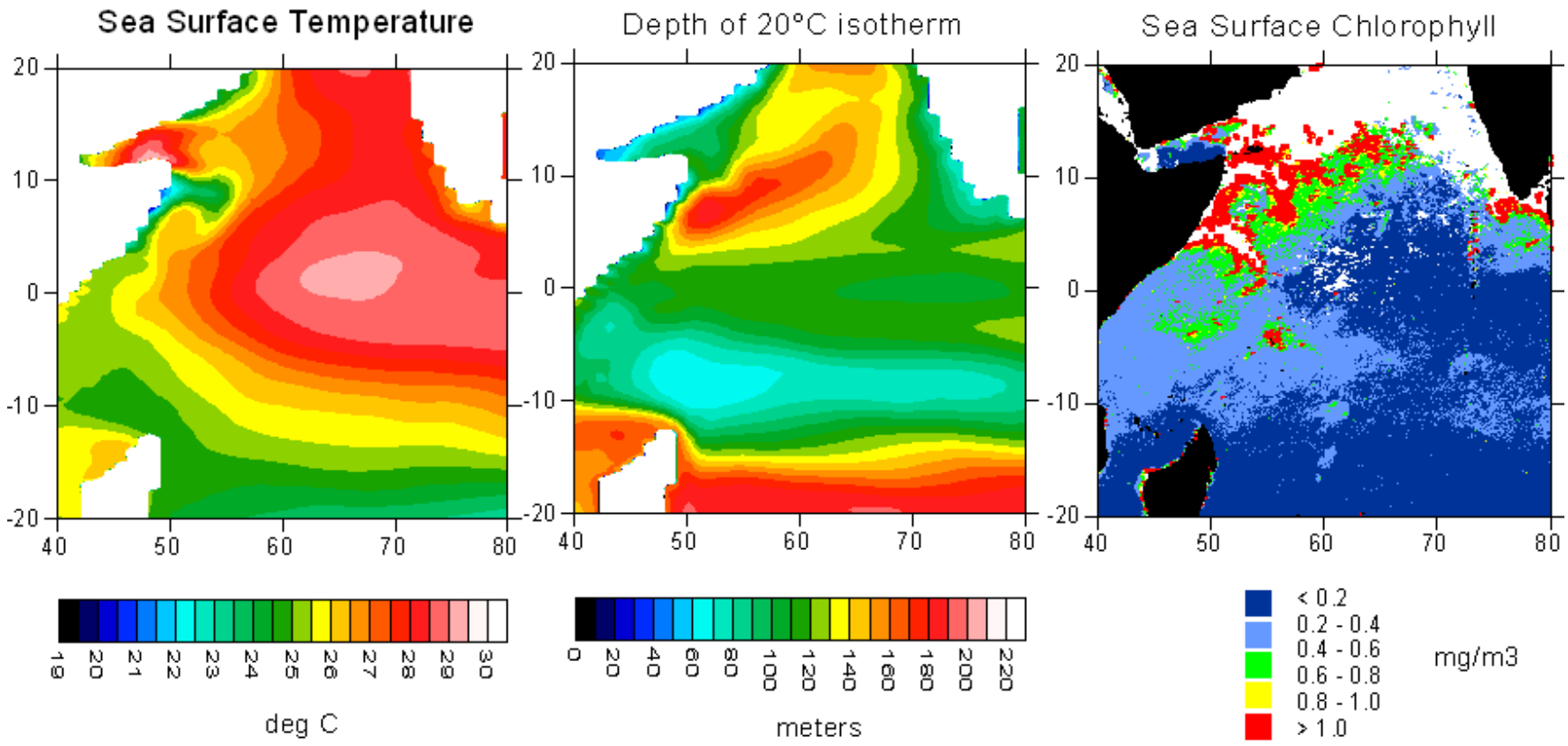


Chlorophyll-a anomalies
August - Sept



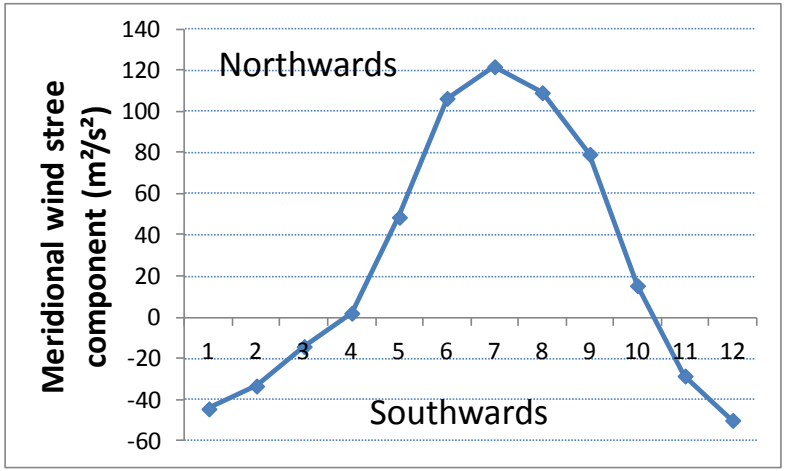
Decline of 20-40% of primary productivity in the recent years

A focus on the Somali upwelling

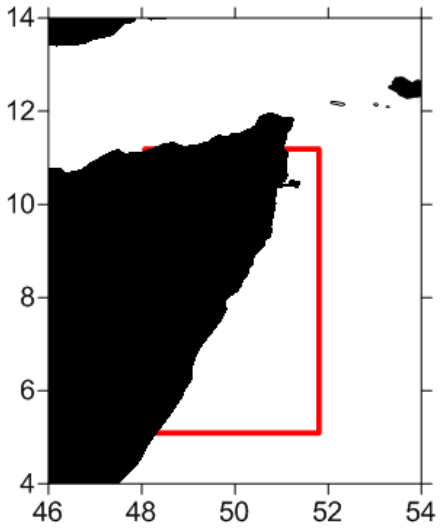


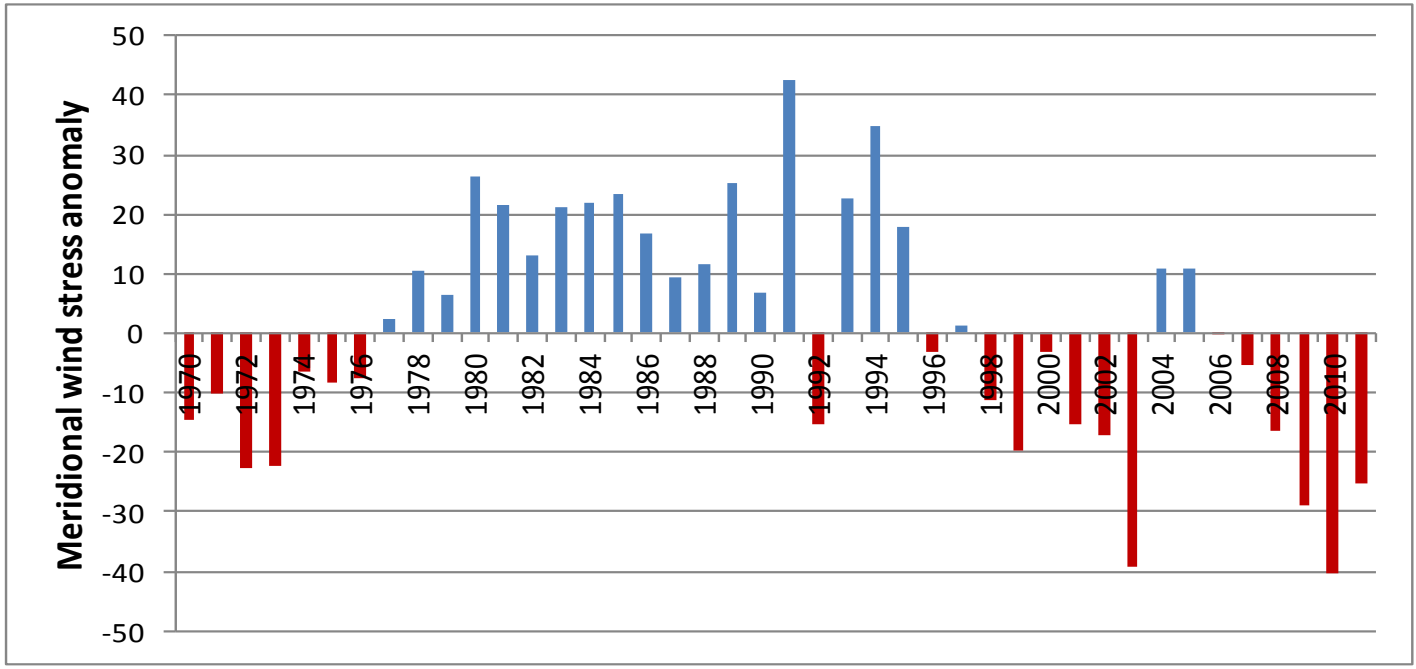
Average for July

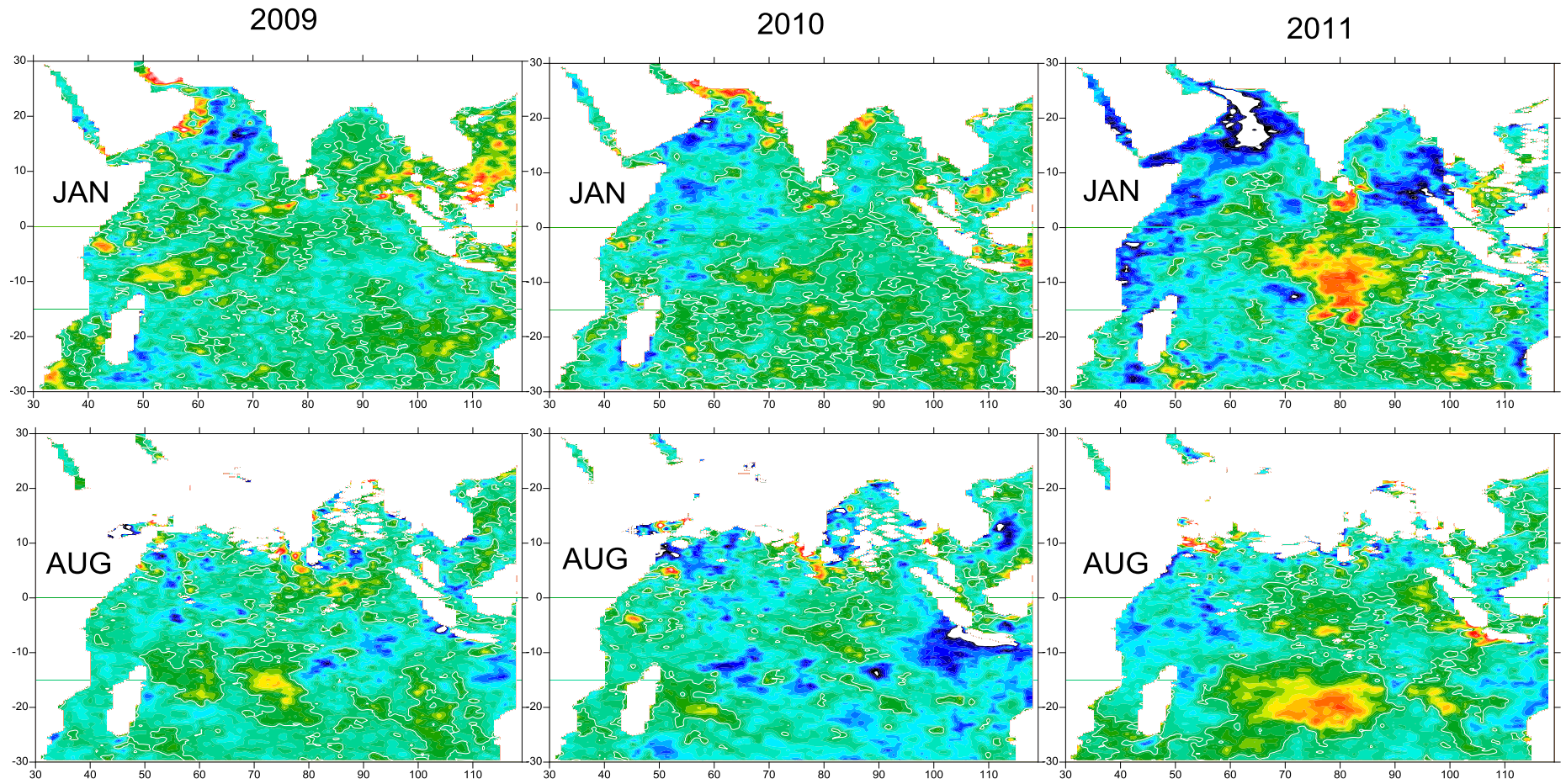
Wind trend in the Somali upwelling



- We use the meridional component of the wind stress and calculate the average for Jun-Aug
- The result points out alternating phases (decadal variability ?)
- Since 1998, **greater occurrence of weak winds** off Somali, with only 2 years having above normal wind stress (2004-2005)



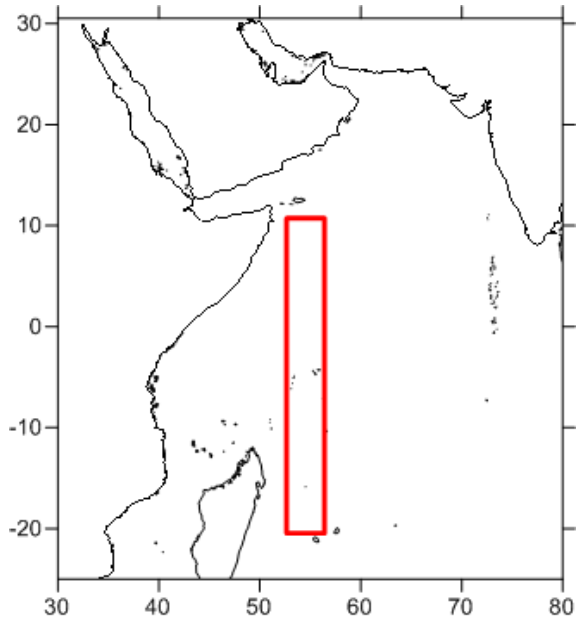


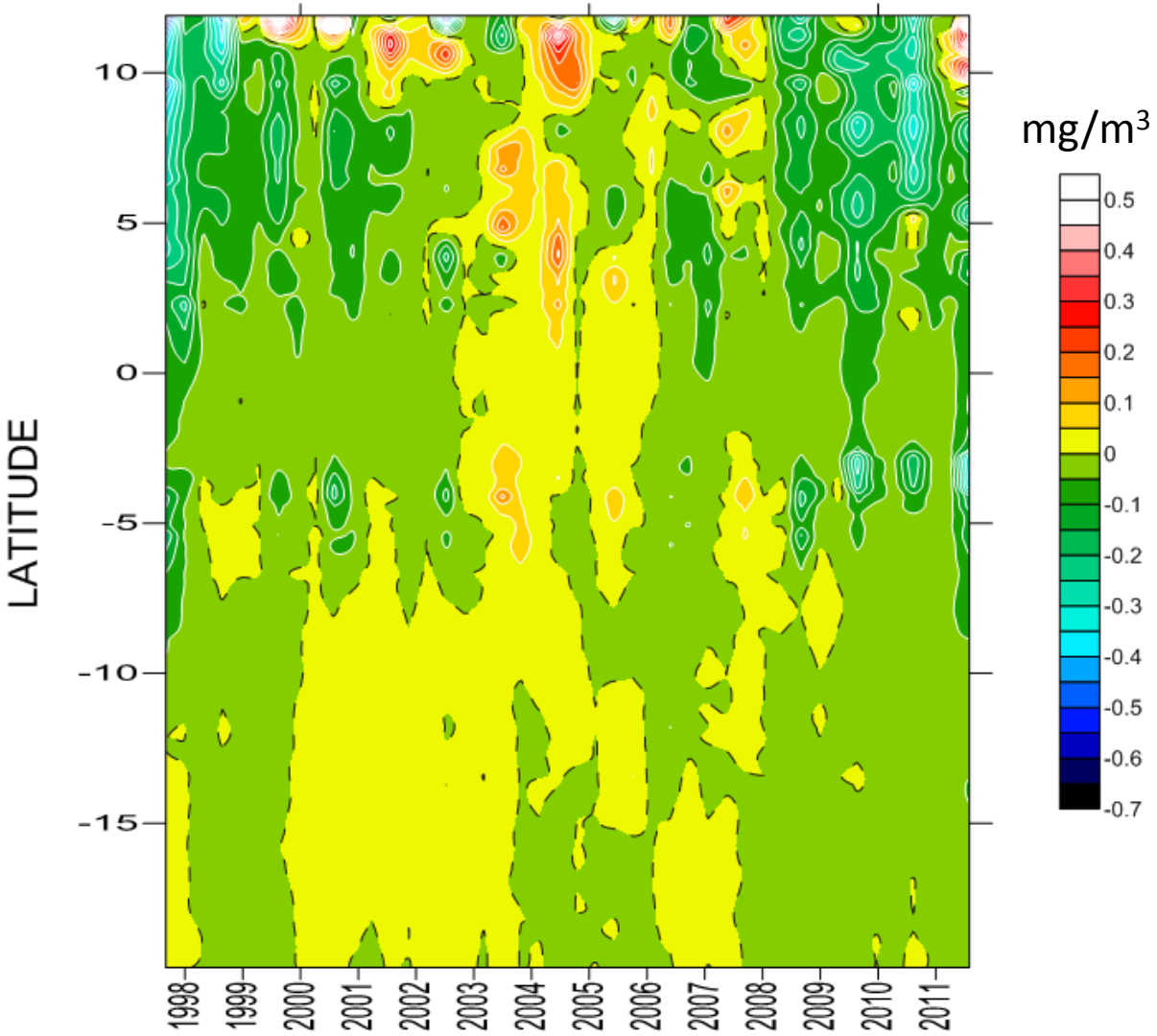


Chlorophyll a (MODIS), January and August 2009 to 2011

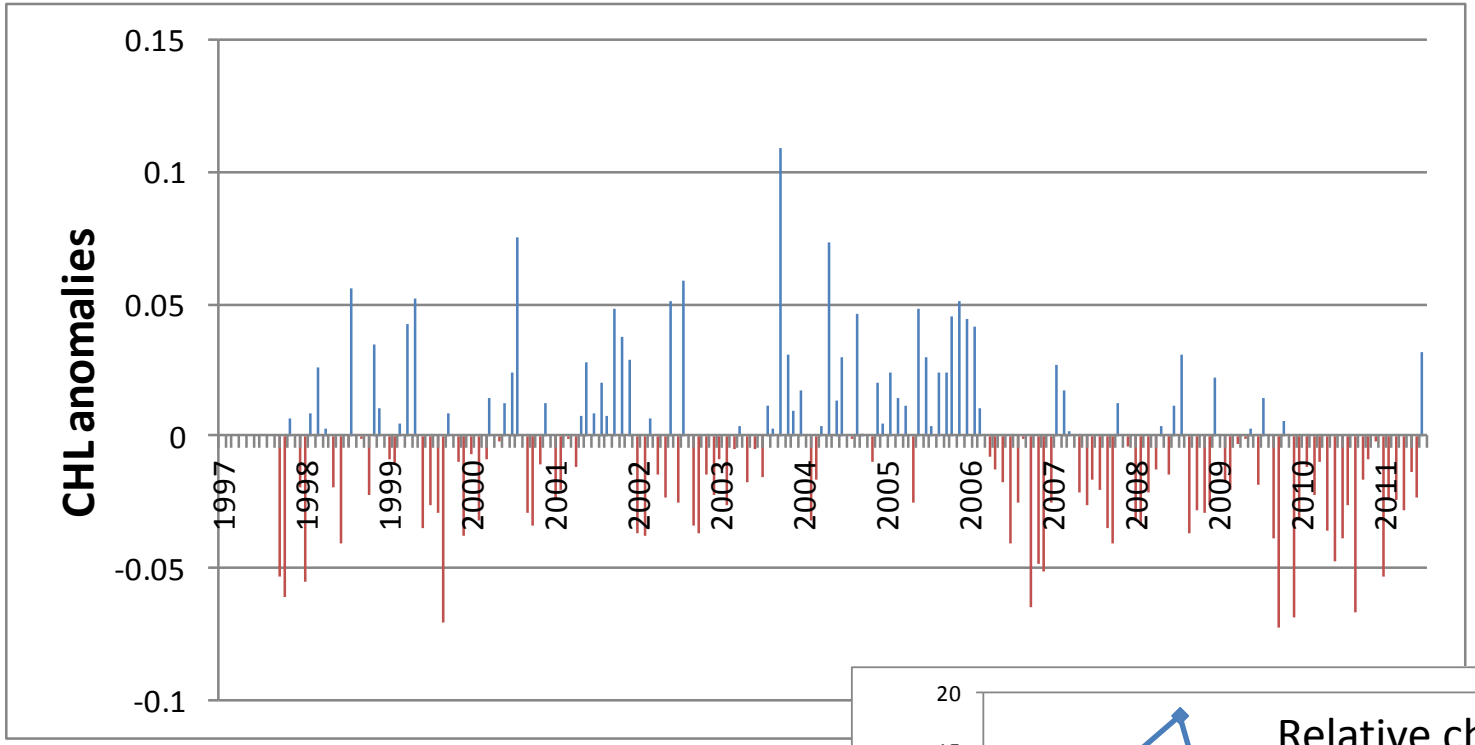
This sequence shows the decreasing trend in primary productivity of the westernmost region of the equatorial Indian Ocean, especially during the boreal winter

Time-latitude distribution of CHL anomalies in the WIO (53)E-56°E)



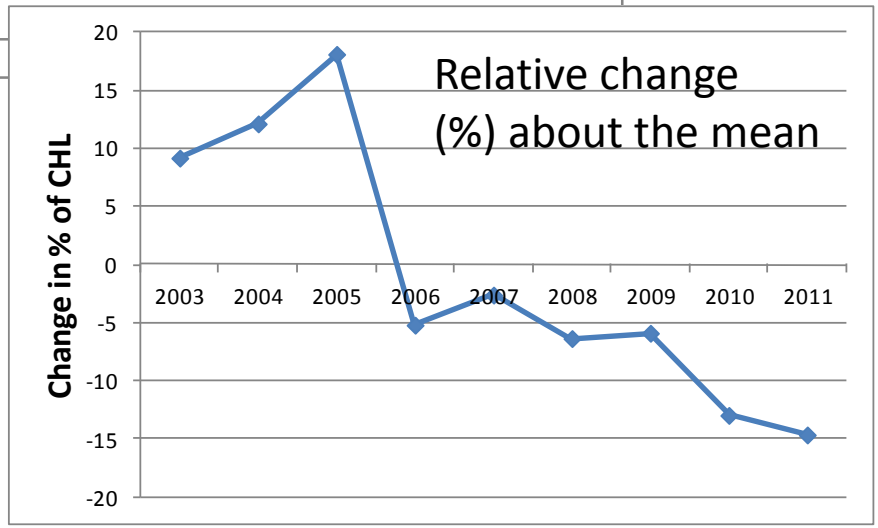


Surface chlorophyll trend in Maldives



Each bar represents a monthly CHL anomaly

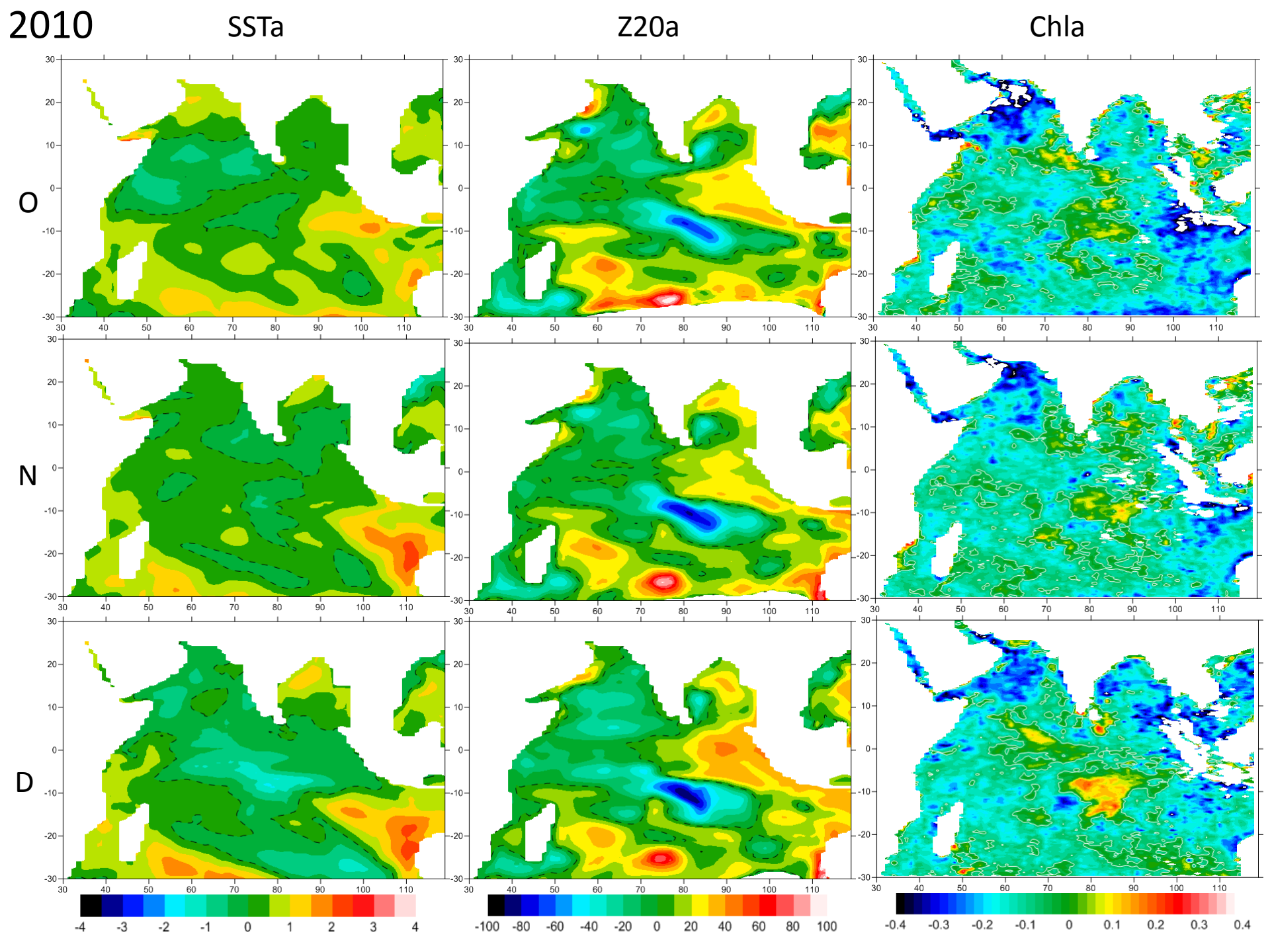
Since 2006, the average productivity is less than the 1998-2002 values and the relative change (in %) about the mean is around -15% in 2011

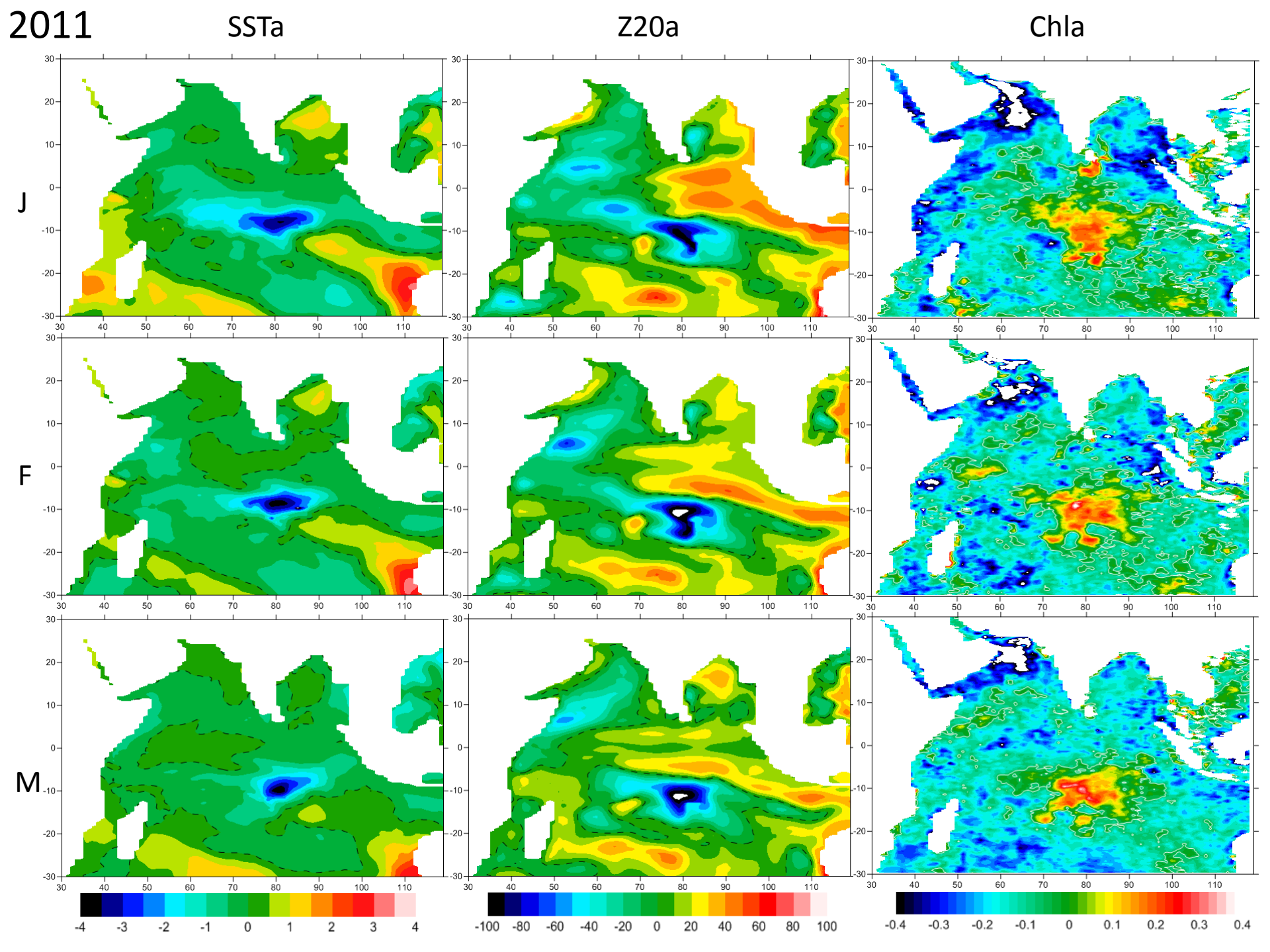


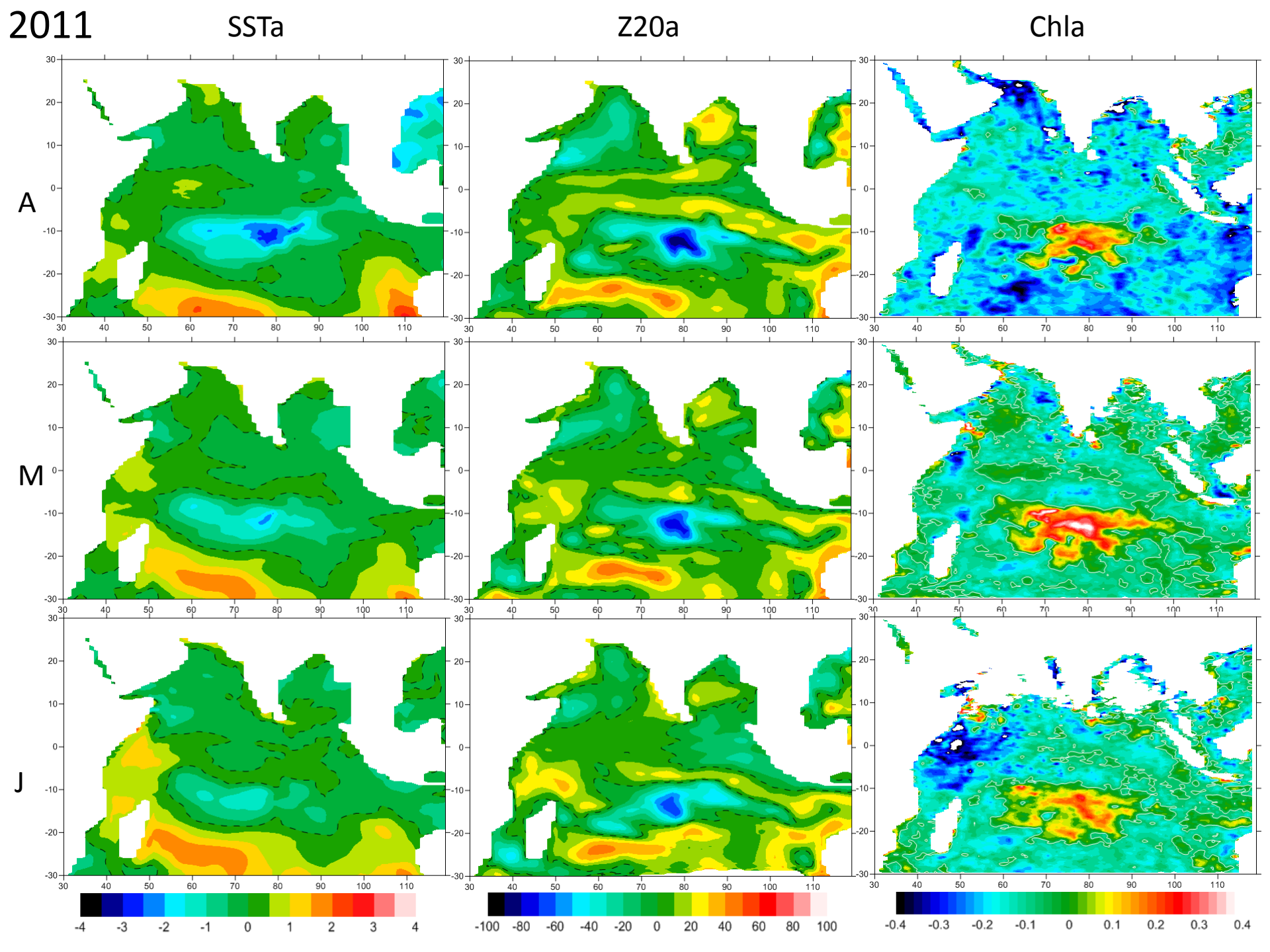
An anomalous and lasting event in the Central Indian Ocean

- From October 2010 to August 2011 (possibly beyond, data not available yet), an positive anomaly of primary productivity was detected in the Central Indian Ocean, between 5°S-15°S/75°E-90°E. The high productivity was triggered by a very shallow thermocline leading to a cooling of the mixed layer, then becoming visible in the SST and SCC after 2 months.
- Potential effect on forage enhancement for top predators might be considered for such a lasting event.

Anomalies on SST (SSTa), depth of 20°C isotherm (Z20a) and Surface Chlorophyll (Chla)


2010
SSTa
Z20a
Chla
O
N
D
-4 -3 -2 -1 0 1 2 3 4
-100 -80 -60 -40 -20 0 20 40 60 80 100
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4


2011
SSTa
Z20a
Chla
J
F
M
-4 -3 -2 -1 0 1 2 3 4
-100 -80 -60 -40 -20 0 20 40 60 80 100
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4


2011
SSTa
Z20a
Chla
A
M
J
-4 -3 -2 -1 0 1 2 3 4
-100 -80 -60 -40 -20 0 20 40 60 80 100
-0.4 -0.3 -0.2 -0.1 0 0.1 0.2 0.3 0.4

Chlorophyll decline might reflect changes in the pelagic ecosystem of the WIO

- Overall decreasing trend of productivity in the WIO. Levels in 2010 and 2011 are 25% and 30% below the average for respectively Jan-Feb and Aug-Sept
- Aug-Sept low figures would suggest a less active Somali upwelling, as shown by the weaker wind stress nearshore. However, this should be further investigated using other variables.
- The depressed primary productivity in the WIO might decrease the carrying capacity of the ecosystem, with adverse effects on foraging conditions for top predators, tuna concentration (less free schools) and biological processes (slower growth, higher natural mortality).