Linking Seacolor to Near-Surface Ocean Dynamics in the Indian Ocean

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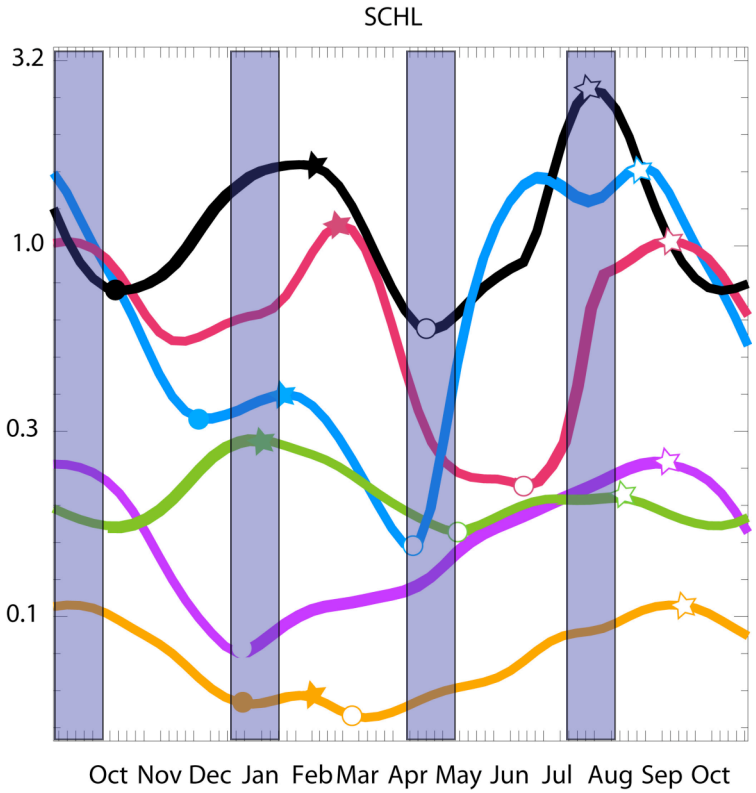
Original motivation



SeaWiFS Chla (Climatology)

- Semi-annual Chla cycles : but not everywhere
- Strong regional variations in intensity
- Variations in timing (cycles not in phase)

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1- How can we describe these cycles globally ?

- Focus on specific periods
- How to account for variations in the phase ?

2- How do they relate with the dynamics of the IO ?

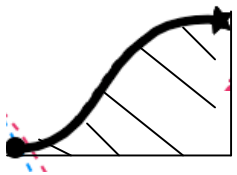
- Associated with semi-annual reversal of the monsoon
- What are the physical controls of these seasonal cycles ? Are physical models of any use to interpret the seacolor variability ?

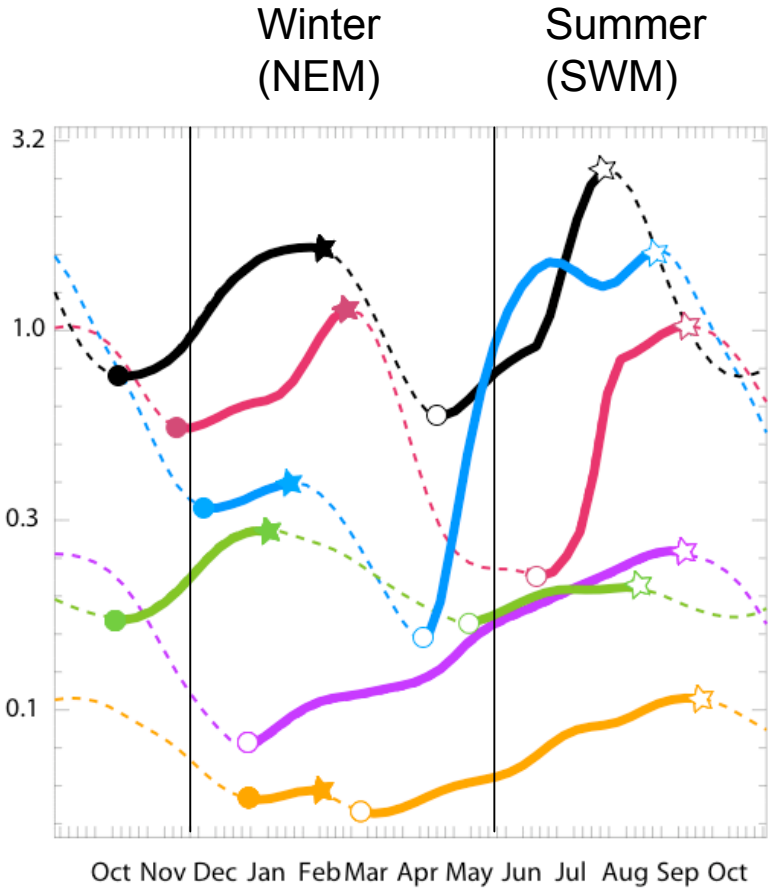
Method

Important parameters to describe the cycles from a perspective of bio-physical coupling:

1- Time of the bloom onset
(when physical driving comes into play)

2- Cumulated Increase in Chla





2 periods of 6 months
- Summer: 15 May-15 Nov
  covers the period of SWM influence
- Winter: 15 Nov-15 May
  covers the period of NEM influence

Search for the peak of the bloom (if it exists)
Within each period
Search for the previous minimum

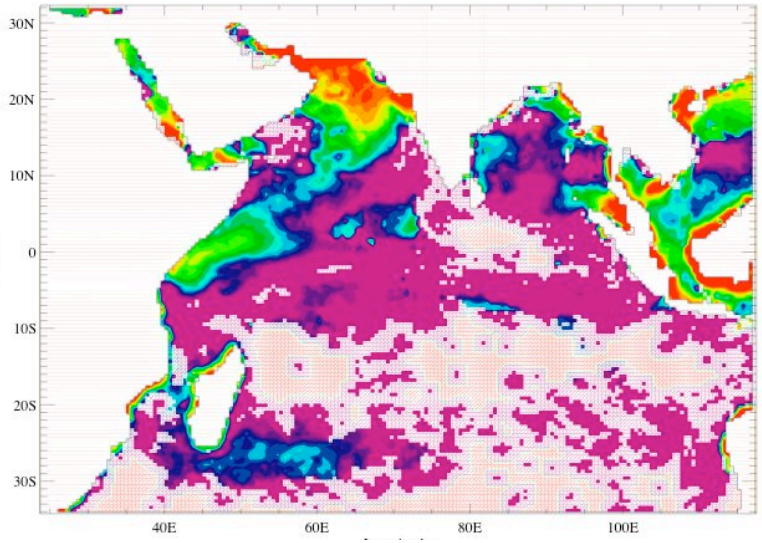
Data

Seawifs : Level 3 weekly 9x9 km SeaWiFS Sea Surface Chlorophyll (SCHL)
Climatology is constructed from 7 years (April 1998- March 2006) of data:
- Interpolation in space and time is performed over missing data
- Low-pass space (81 x 81 km) and time (40 days) filtering
- Binning onto 0.5°x0.5°

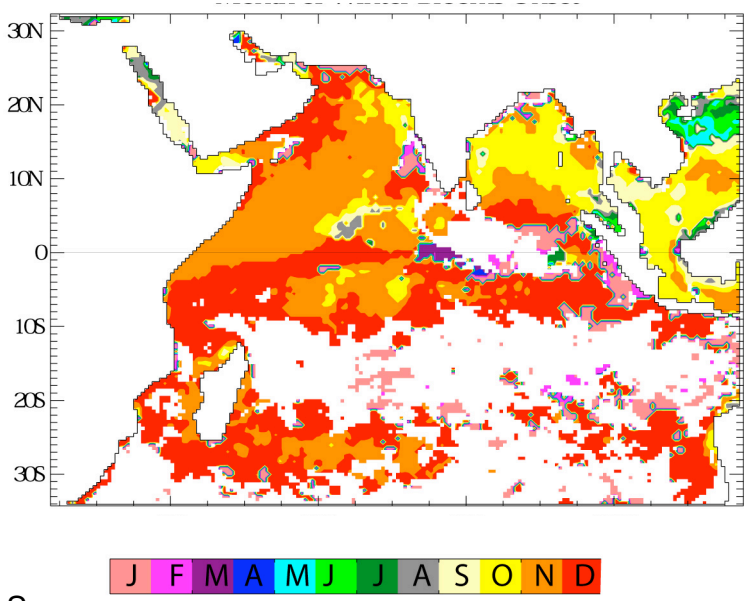
OGCM
-Global 0.5° OGCM (OPA) forced with ERS1-2 wind stress and of CMAP precipitation flux
-Heat and evaporation are diagnosed through bulk formulae
-Years 1993 to 2000 of the model run are used to construct a climatology

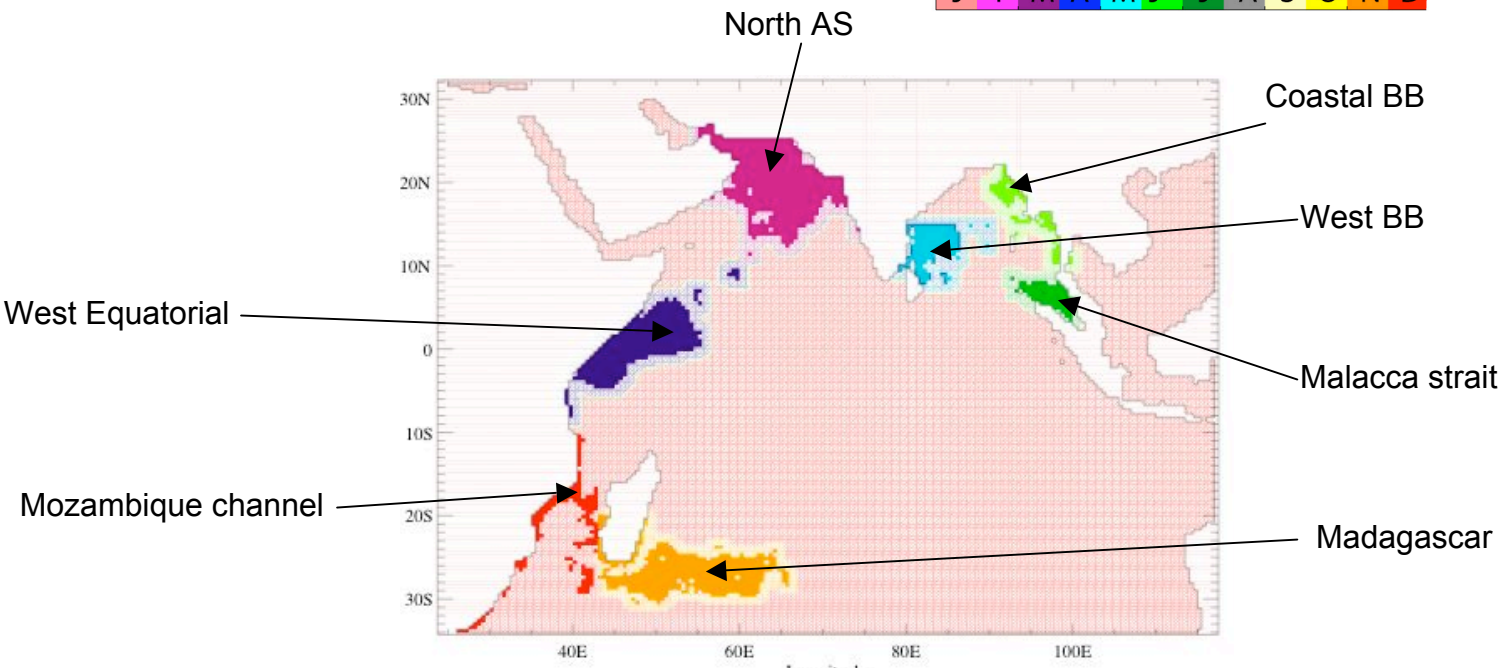
WINTER

Cumulated Increase in Chla



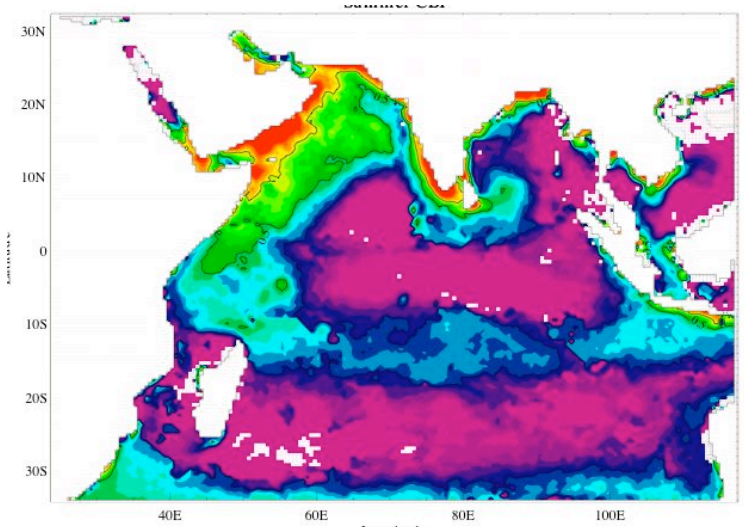
Month of bloom onset



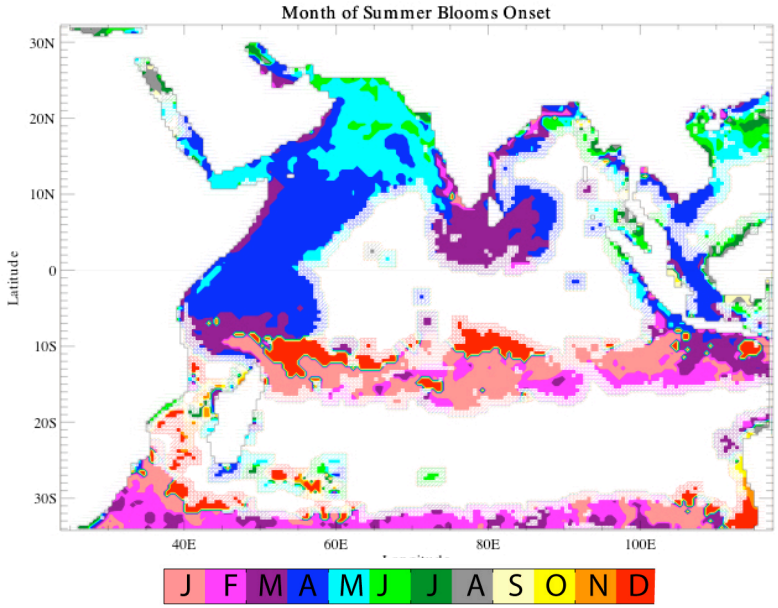


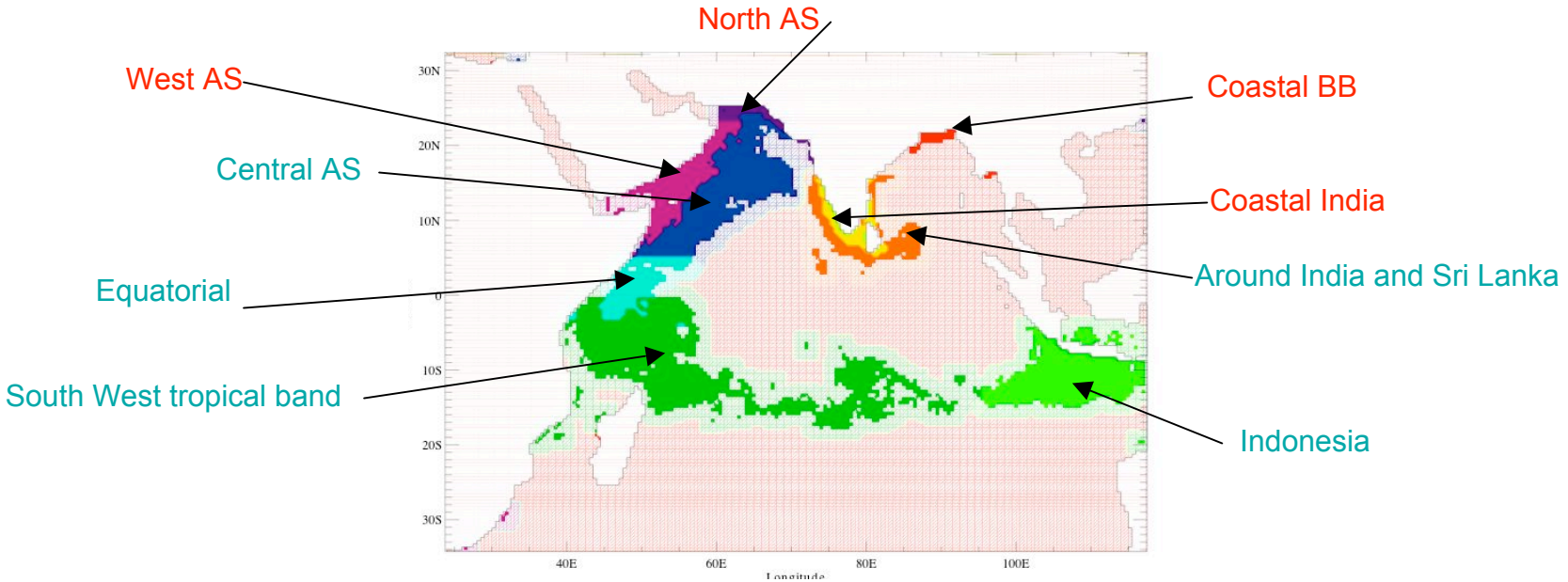
SUMMER

Cumulated Increase in Chla



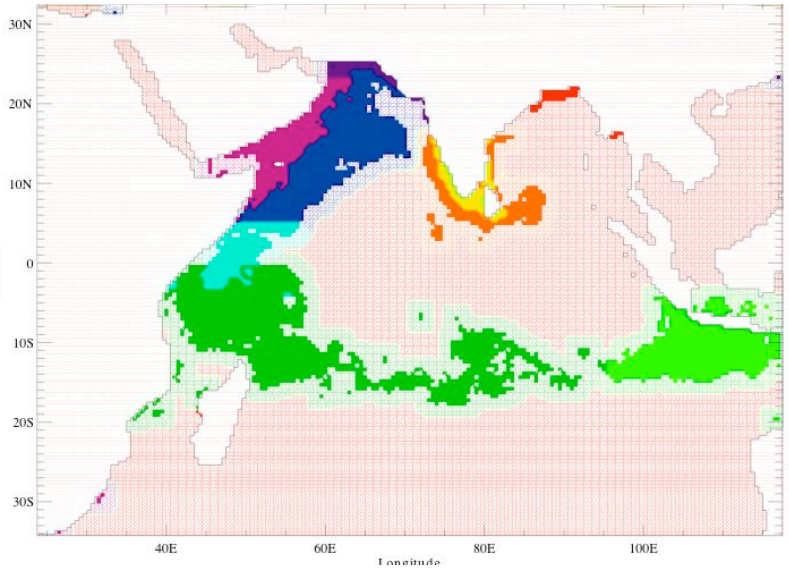
Month of bloom onset



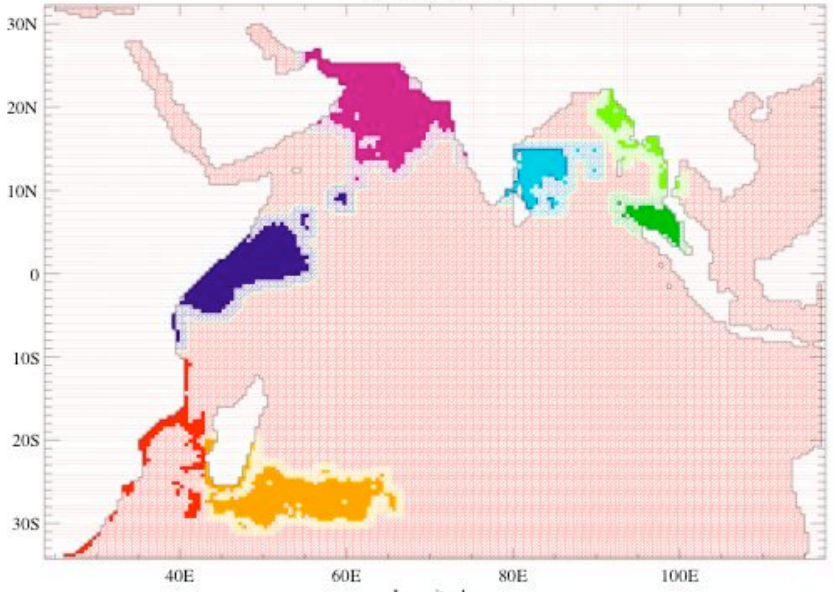


Contrary to other ocean regions, not possible to classify the IO into unique biogeochemical provinces. Need to account for the two seasons.

Summer



Winter



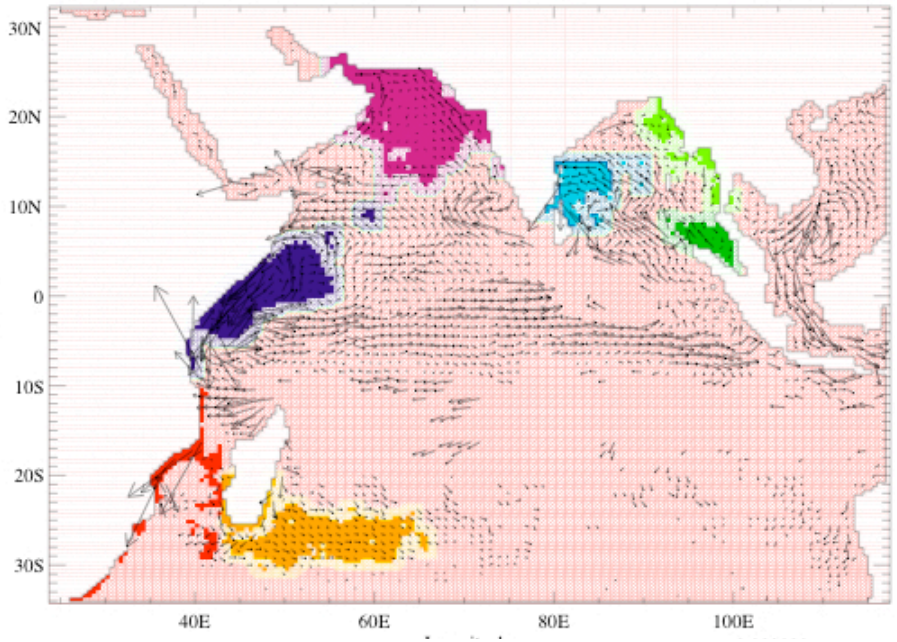
Do these biogeochemical provinces correspond to bio-physical provinces ?

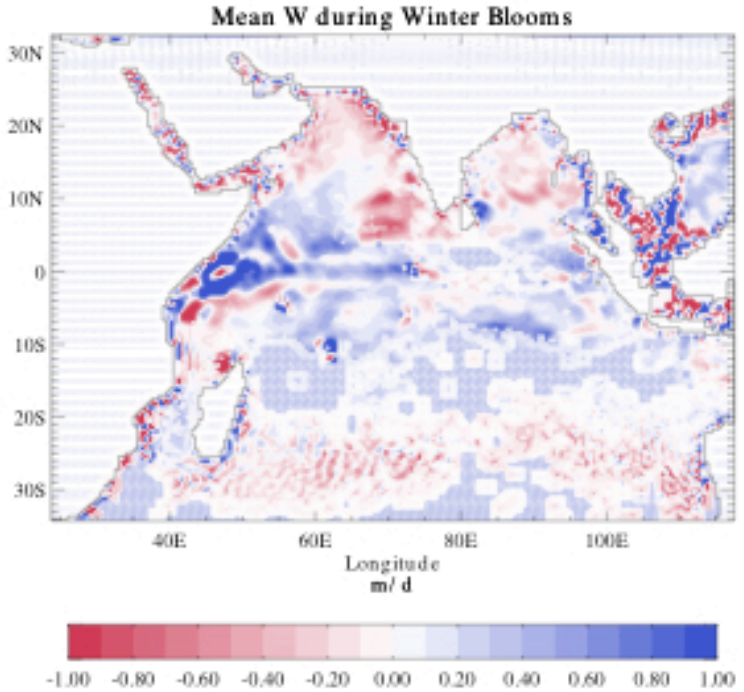
What is the correspondence between the regional patterns derived from Chla and the regional patterns of the physical parameters ?

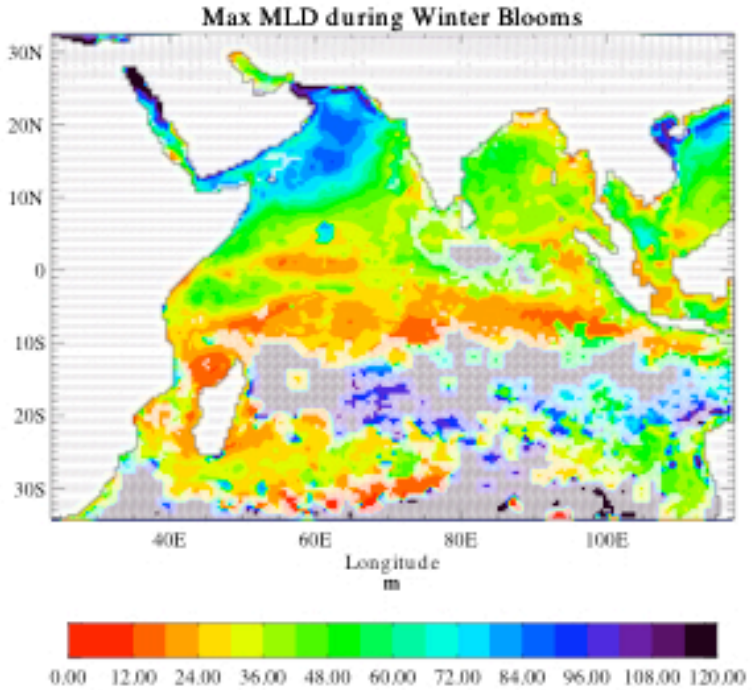
Physical parameters from OGCM

- Proxy for horizontal advection
  - U, V : 0-30m
  - Average over the bloom period
- Proxy for vertical advection
  - W : 30m
  - Average over the bloom period
- Proxy for entrainment
  - Mixed-Layer depth (MLD)
  - Max over the bloom period

WINTER



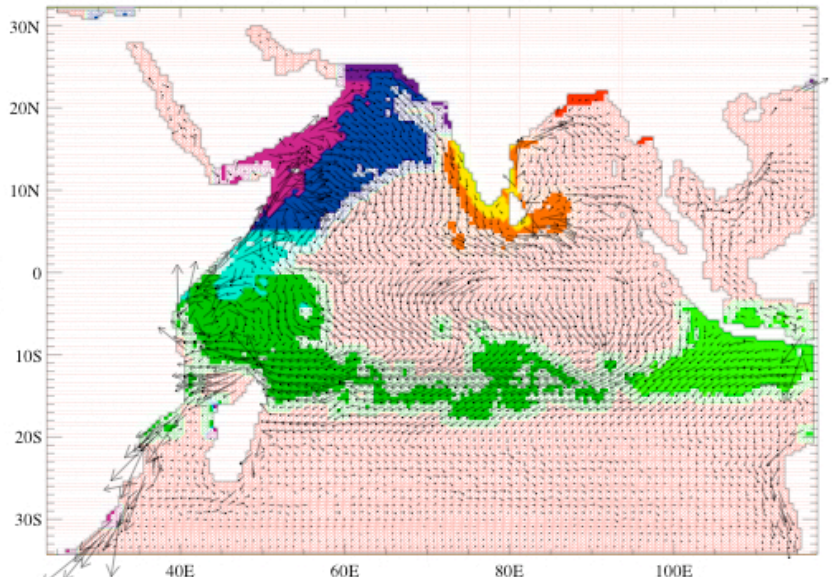




•Convection : NAS, WBB
•Upwelling: WBB, WE, coast Madagascar
•Horizontal Advection: Malacca (shallow shelf)

CBB: river discharges
Madagascar: advection from coast, N2 fixers ?
Mozambique channel: eddies ?

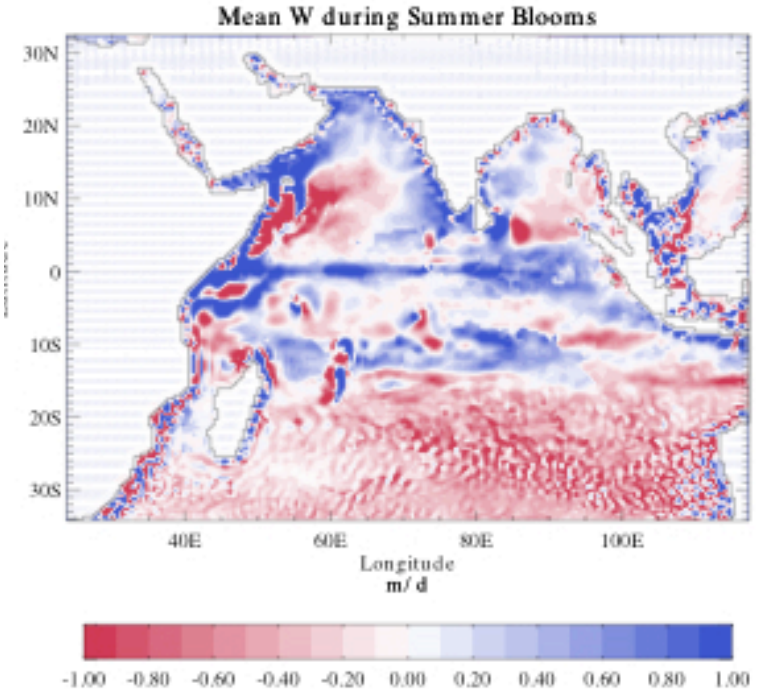
SUMMER

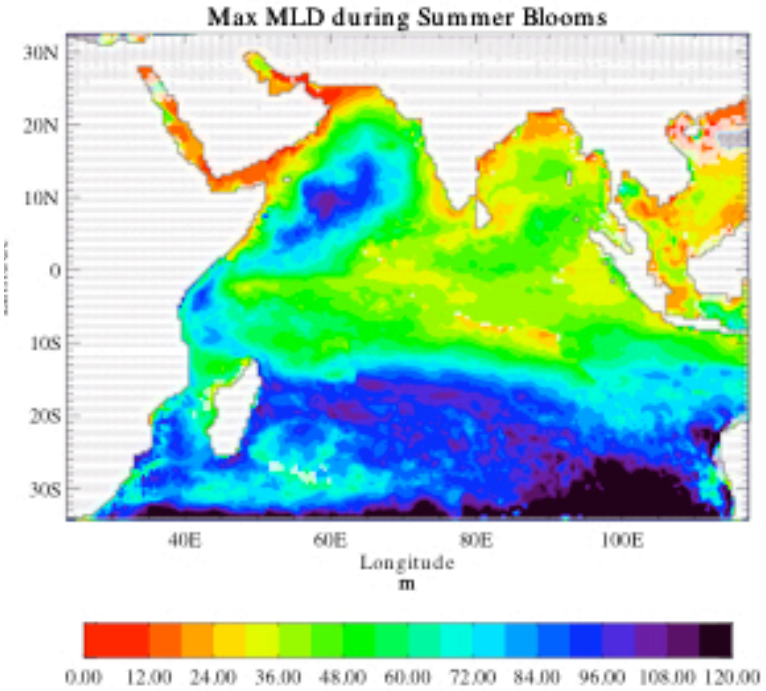


Upwelling: coastal AS, Sri Lanka, W Equ, off Indonesia, Northern Tropical branch

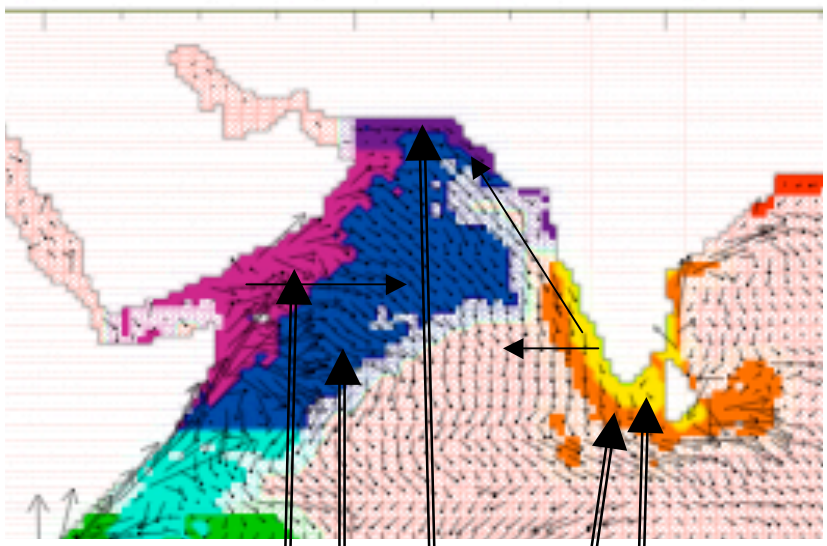
Entrainment: CAS, Southern Tropical branch

Horizontal Advection : CAS (wedge shape) around India- Sri Lanka



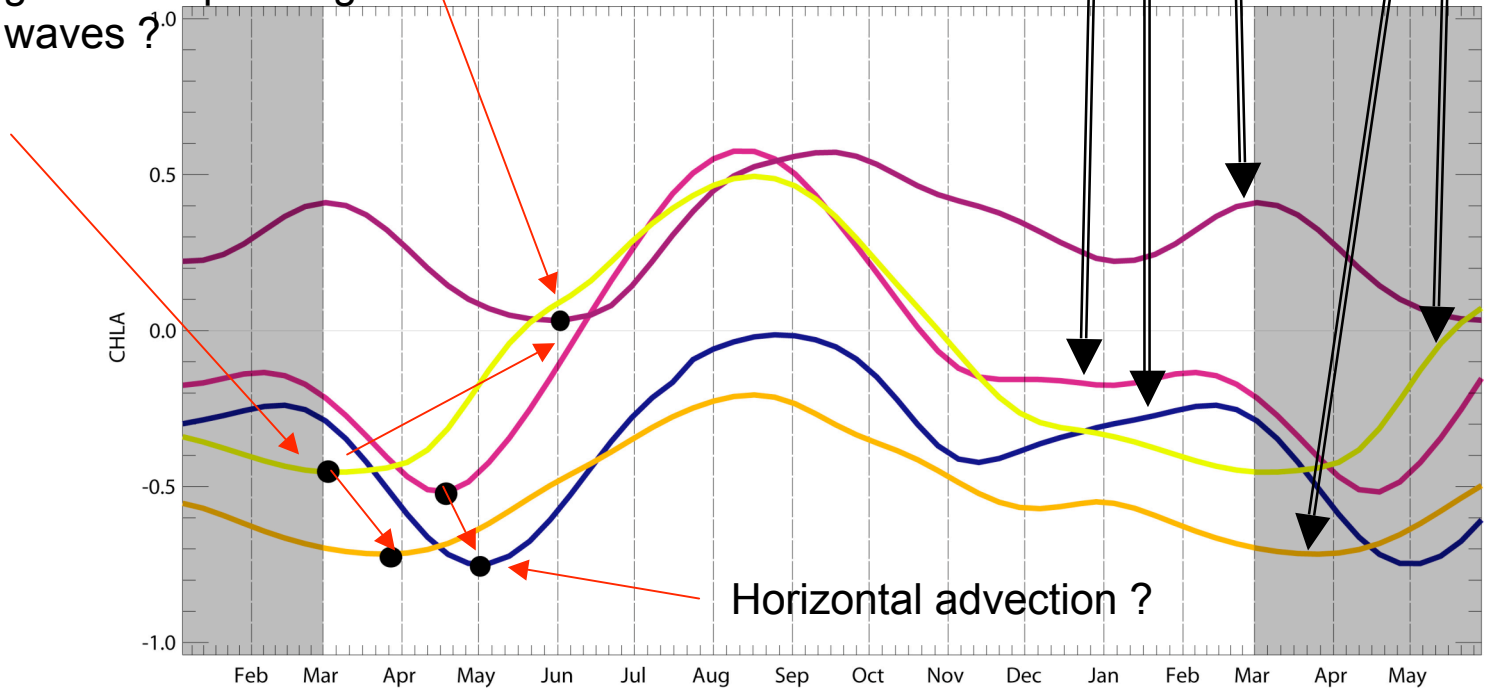


Time shifts in Arabian Sea
Summer blooms



S-N Propagation of upwelling Kelvin Waves ?

W Propagation of upwelling
Rossby waves ?



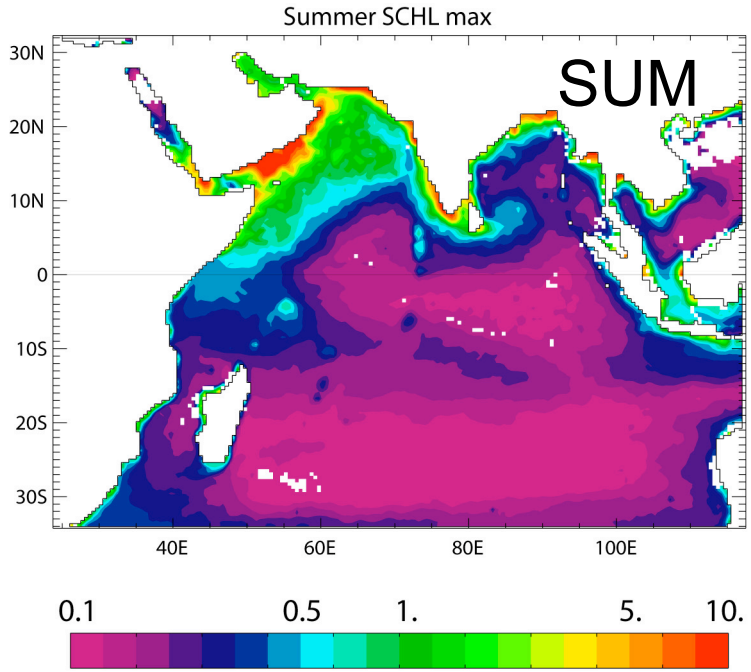
Conclusions

- The Increase in Chla during the bloom is a good proxy for defining bio-physical regions: to a certain extent, the Chla patterns and the patterns of the physics coincide.

- Different Bio-physical regions are associated with the SWM and NEM

- They are regional patterns in the timing of the blooms. They can be related with horizontal advection and propagation of Rossby waves and Kelvin waves. They are important for understanding the bio-physical couplings.

- This classification could be use to guide :
  - studies on inter-annual variability (change in the extension, location, of each bio-physical region)
  - Validation of 3D coupled models : timing of bloom onset
  - Field experiments (when and where to go)


Summer SCHL max
SUM
30N
20N
10N
0
10S
20S
30S
40E
60E
80E
100E
0.1
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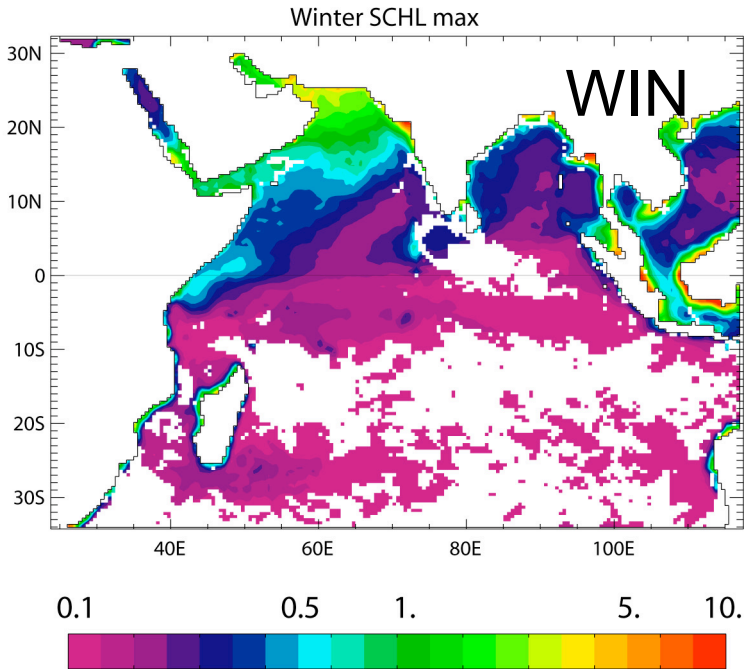
1.
5.
10.


Winter SCHL max
WIN
30N
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10S
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30S
40E
60E
80E
100E
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Chla peaks


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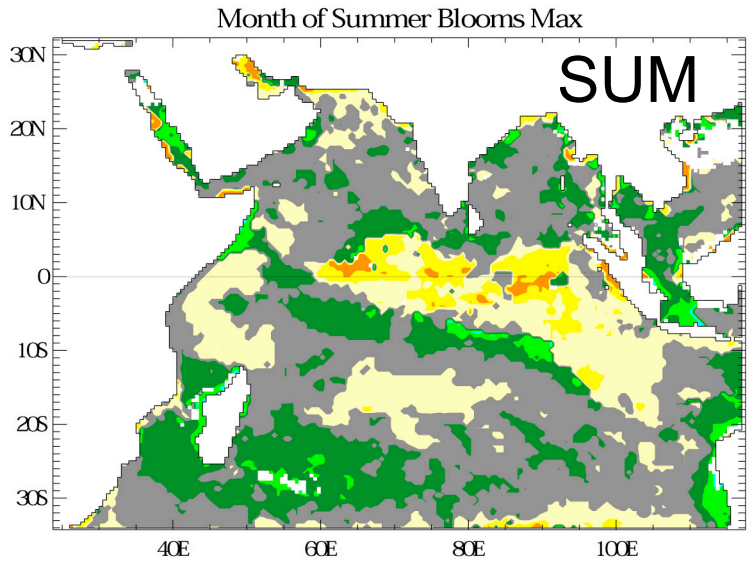
Month of Summer Blooms Max
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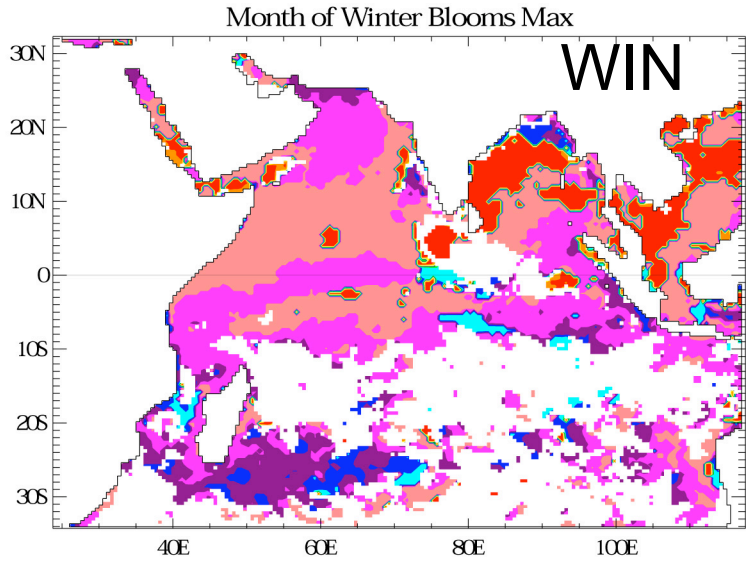
Month of Winter Blooms Max
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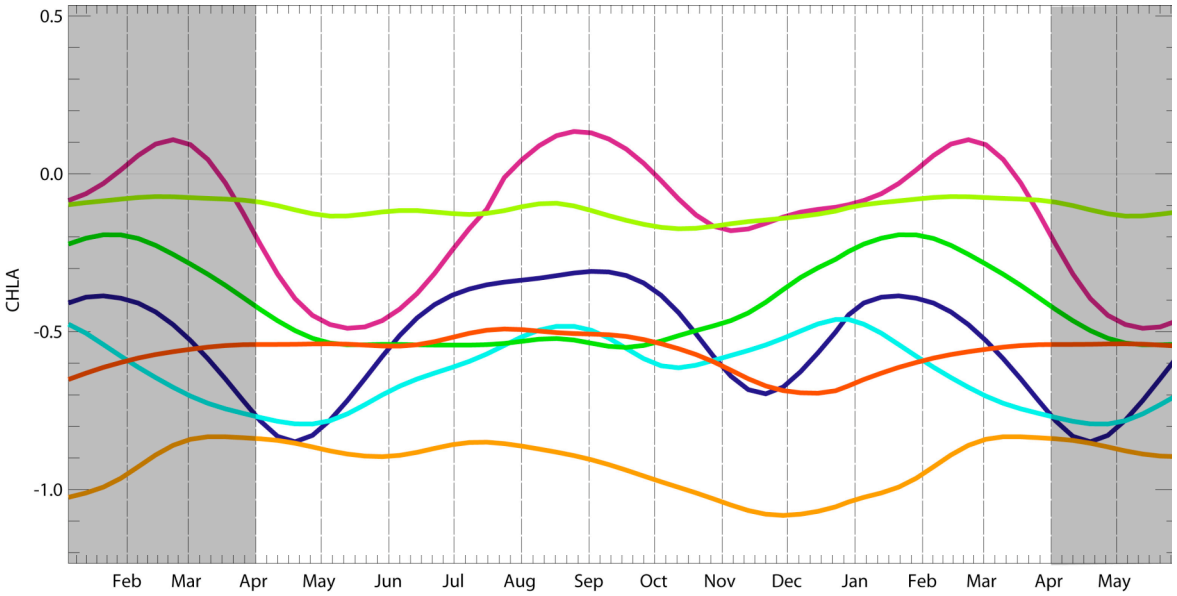
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CHLA
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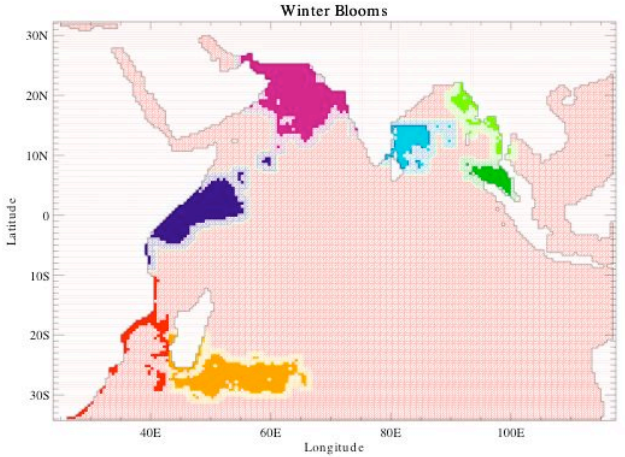
Winter Blooms
30N
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20S
30S
Latitude
40E
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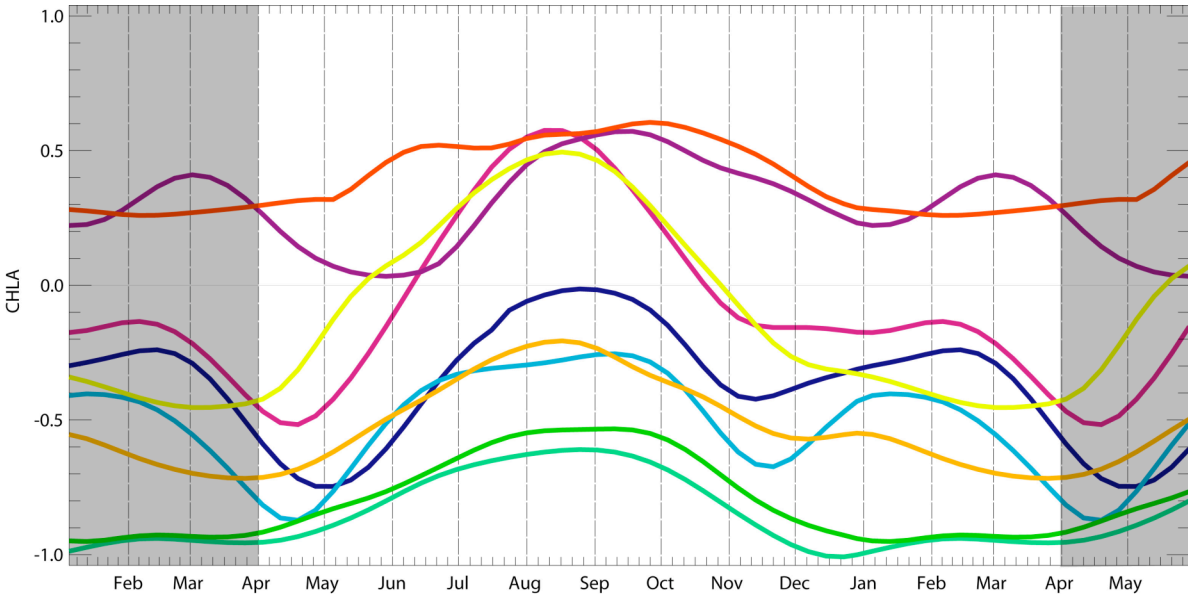
80E
100E
Longitude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CHLA
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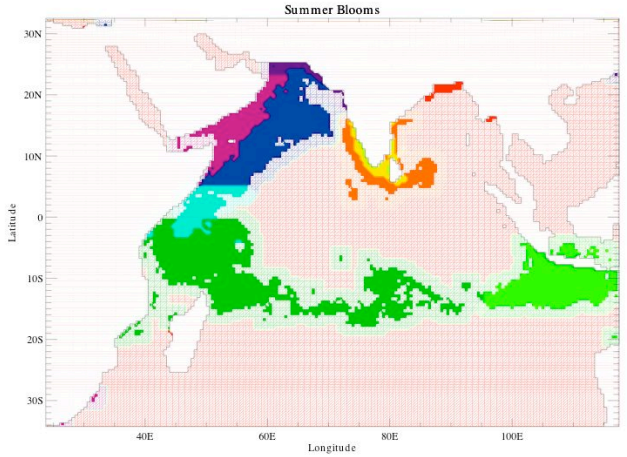
Summer Blooms
30N
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30S
Latitude
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Longitude