

ROMS application south of South Africa

Nicolette Chang^a, Pierrick Penven^b, Frank Shillington^c and Pedro Monteiro^a

^a Ocean Systems and Climate, CSIR, Stellenbosch, South Africa
^b IRD, Institut de Recherche pour le Développement, Plouzane, France
^c Department of Oceanography, University of Cape Town, South Africa

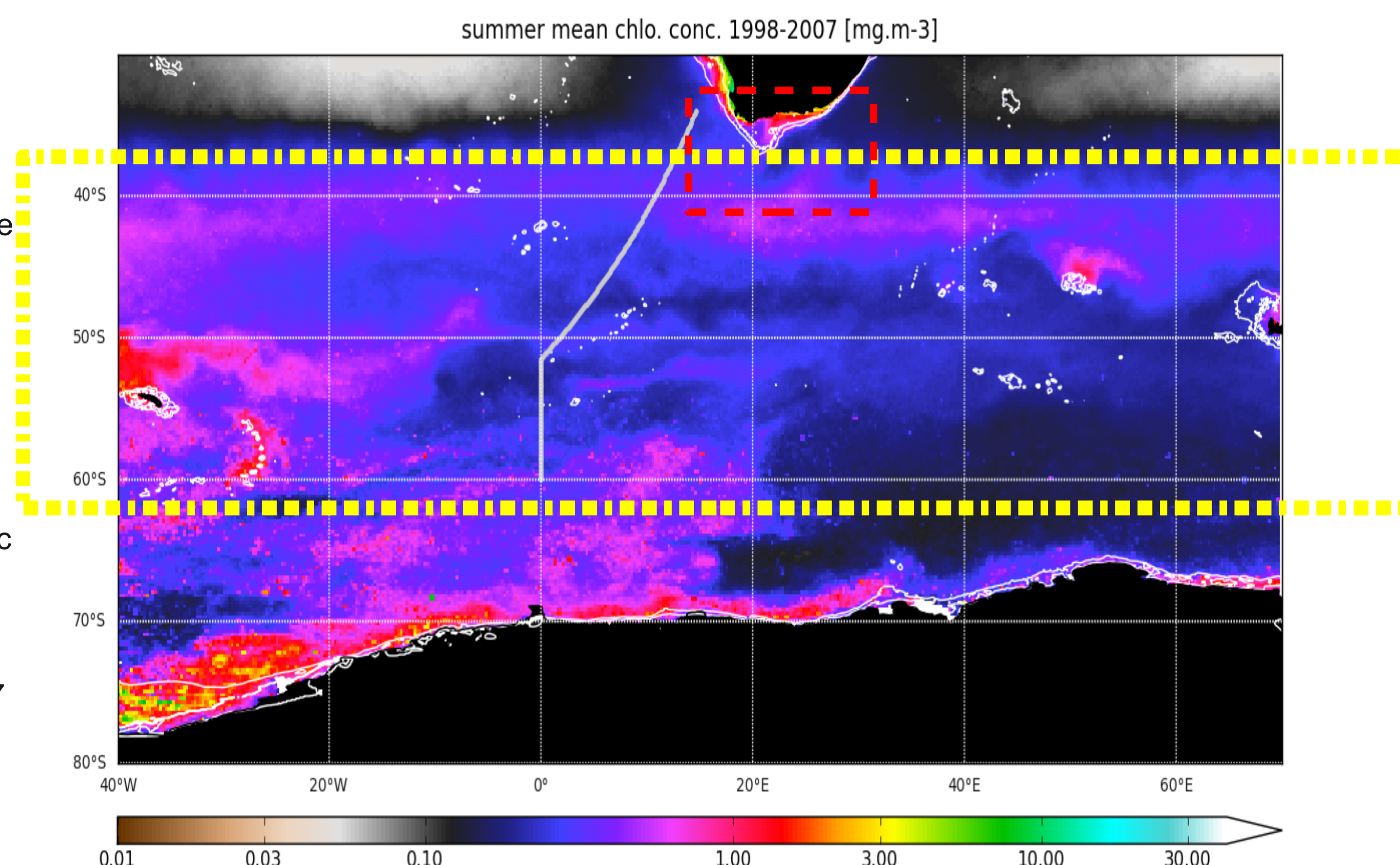
Introduction

The Regional Ocean Modeling System (ROMS) is applied to the oceans around and south of South Africa to understand the physical mechanisms that drive biological variability in the region.

Two regions are being explored:

1. The Agulhas Bank – this regional study looks the oceanography on the shallow shelf,
2. The Southern Ocean – this includes the Indian and Atlantic sectors of the Southern Ocean.

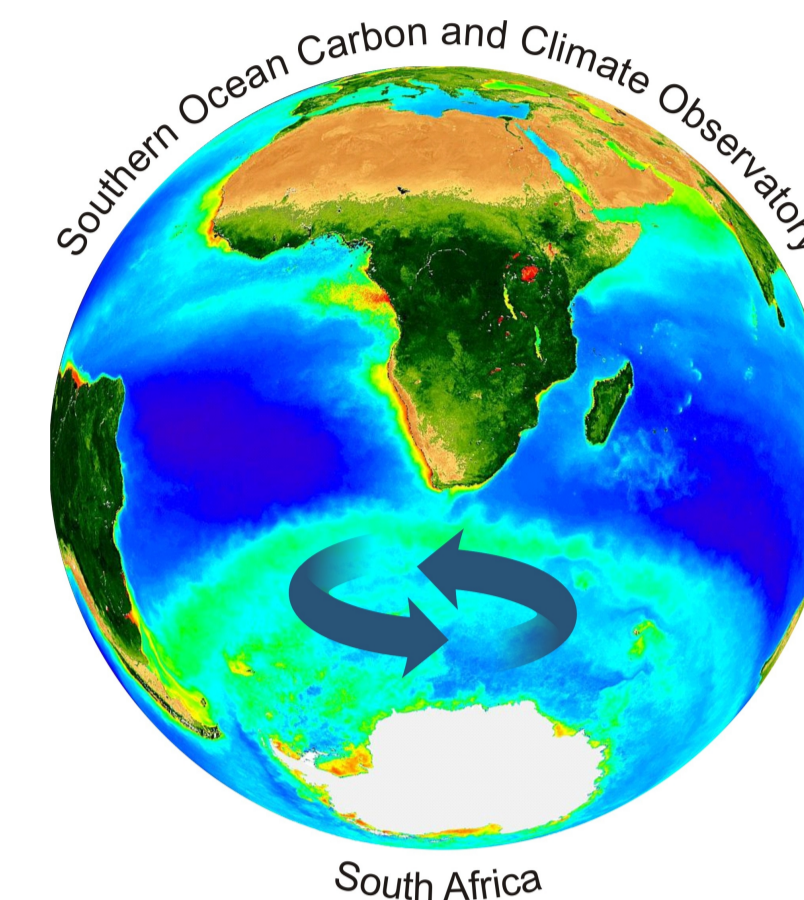
Right: Summer mean chlorophyll a concentration 1998-2007 from SeaWiifs. This map shows regions of high productivity around South Africa.



Acknowledgements

Thanks to the following members of the Ocean Systems and Climate Group, CSIR for providing satellite images:

- Nicolas Fauchereau
- Sebastian Swart



Regional Study: The Agulhas Bank

The Agulhas Bank is the continental shelf south of Africa. It is a complex oceanic region due to its position between two diverse regimes: the strong western boundary current, the Agulhas Current, and the eastern boundary regime of the Benguela Upwelling System.

Increased productivity on the eastern Agulhas Bank is associated with the Cool Ridge- the doming of isotherms on the East Agulhas Bank and is observed as a large tongue of cold water on the East Agulhas Bank. The Agulhas Bank is the spawning and nursery ground to many fish species. Changes to the physical environment and the cool ridge may influence the ecosystems the Agulhas Bank supports.

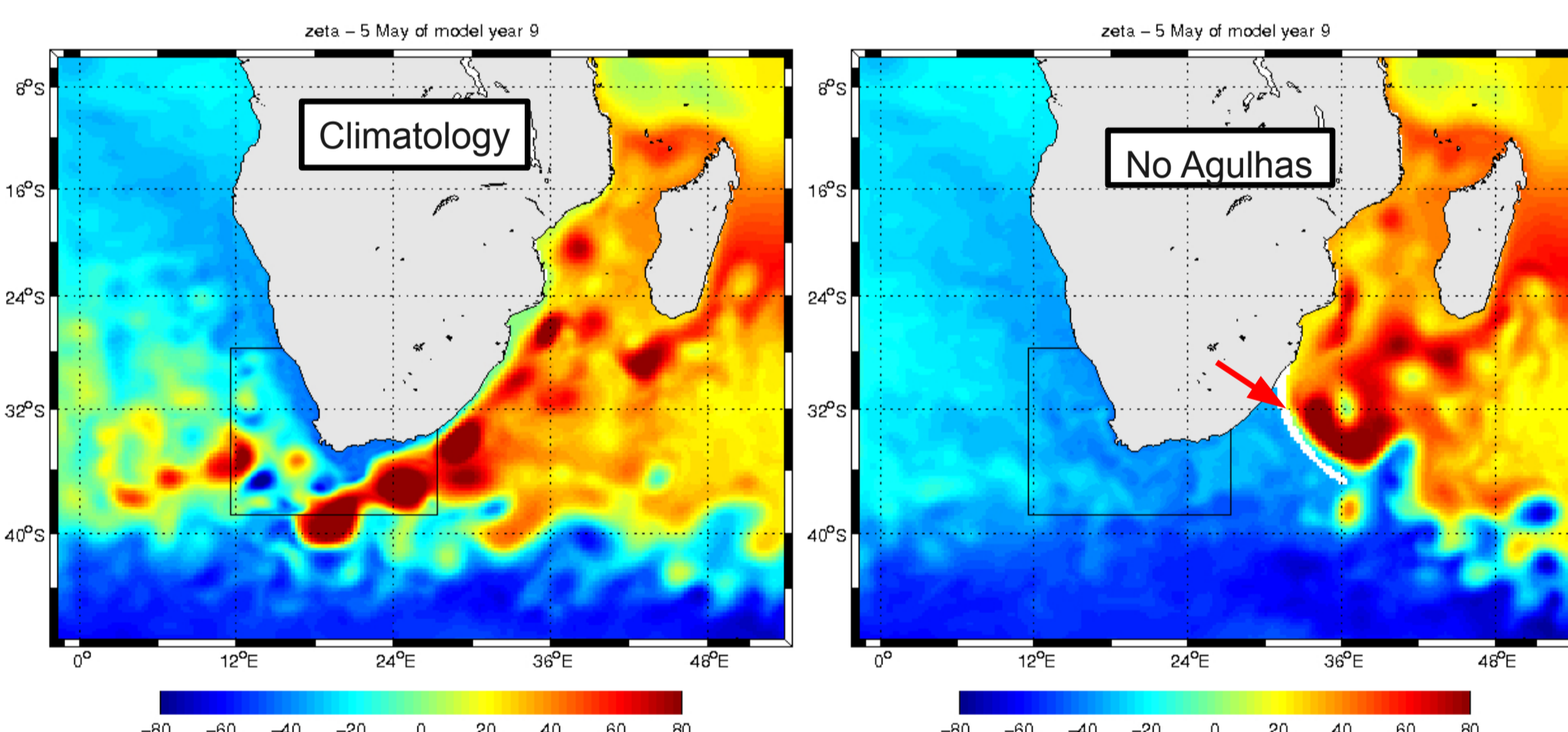
By understanding the dominant forcings and response of the shelf ocean on the Agulhas Bank, the possible changes to the region can be addressed.

Model Configuration

- The Regional Ocean Modeling System (ROMS) was used to model the Agulhas Bank.
- Parent model: SAFE (South African Experiment) - 25km resolution
- Child model: Agulhas Bank - one-way embedding – 8km

- Boundary and initial conditions: WOA2005
- Surface fluxes: COADS monthly climatology

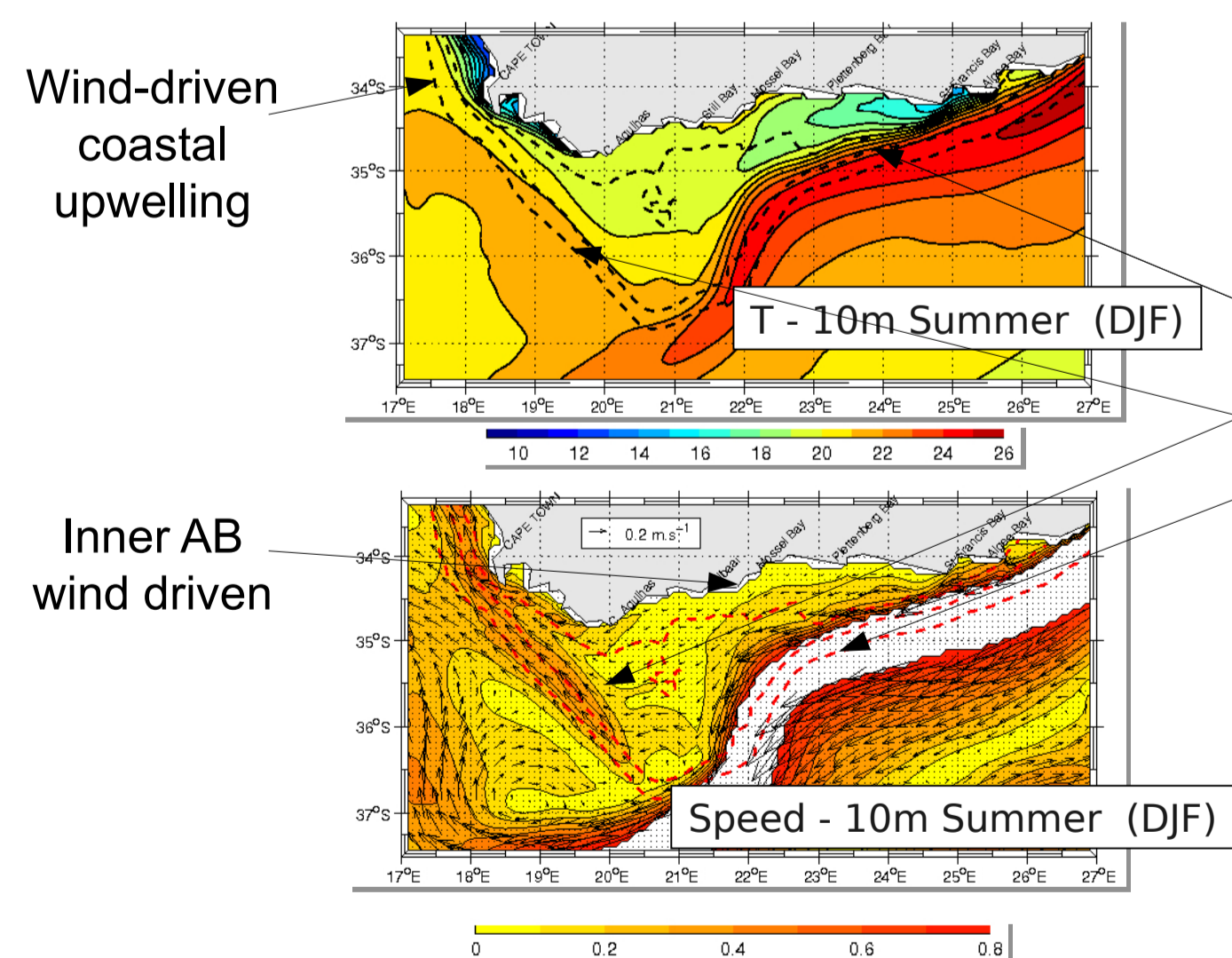
Right: SSH for the parent model (SAFE) with child model SSH superimposed for the Reference Experiment. Box indicates child domain.



Left: SSH for the parent model (SAFE) with child model SSH superimposed for the No Agulhas Experiment. Box indicates child domain. Red arrow indicates the dam.

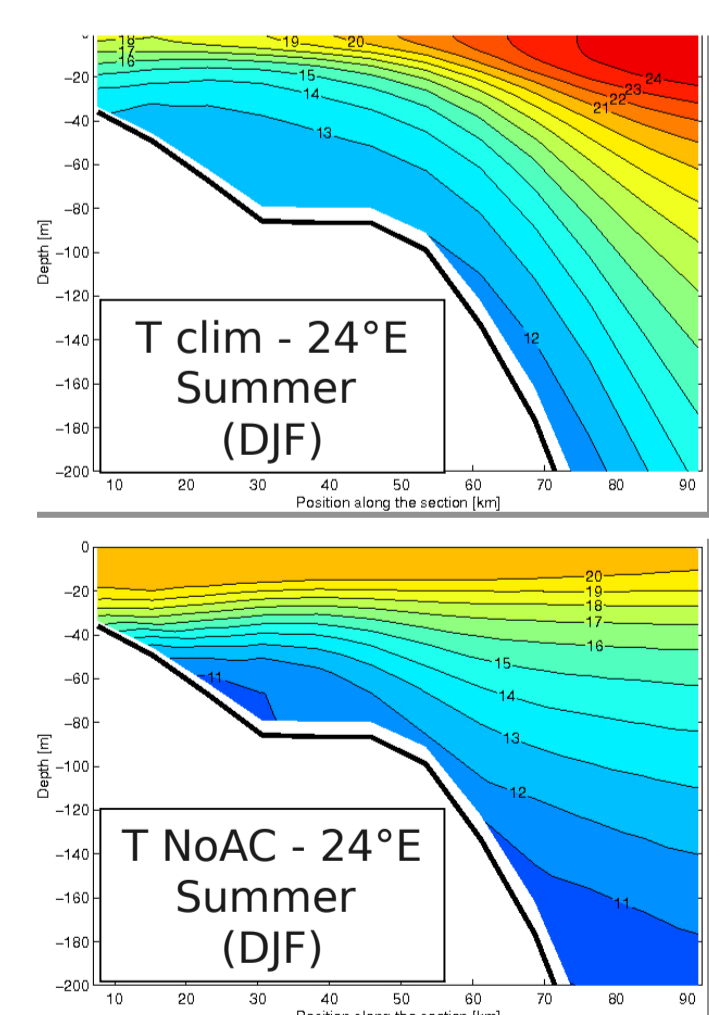
Results

1. The Agulhas Bank mean state



The Agulhas Current determines structure on the Outer Agulhas Bank

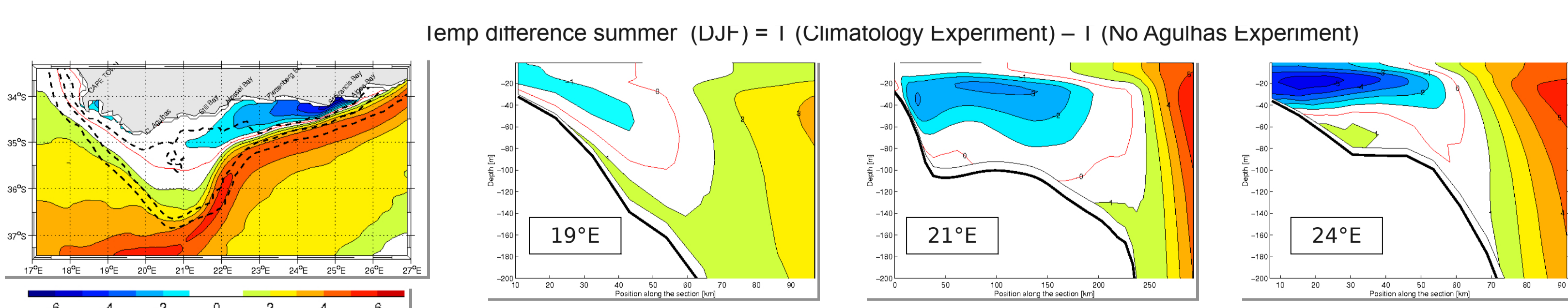
2. The interaction of the Agulhas Current with the East Agulhas Bank forms the cool ridge



In the vertical the cool ridge manifests as the doming of cool waters (and the thermocline) onto the East Agulhas Bank.

Without the Agulhas Current, cool waters remain at depth on the shelf.

3. The Agulhas Current plays a large role in cooling the Agulhas Bank from the shelf edge



At 10m, temperatures are colder on the Agulhas Bank in the Climatology Experiment due to the cool ridge.

The Agulhas Current warms the outer shelf. Advection of cool waters from the cool ridge by predominantly westward summer currents cools the rest of the Agulhas Bank particularly at the mid- to upper-water column.

Discussion

Changes in the Agulhas Current may translate to changes to the structure and circulation on the Agulhas Bank. Particularly, in relation to the cool ridge and cold waters on the Agulhas Bank. Since the Agulhas Bank is the spawning and nursery ground to many fish species, changes to this region will have an influence on production and biology.

Large-scale Study: The Southern Ocean

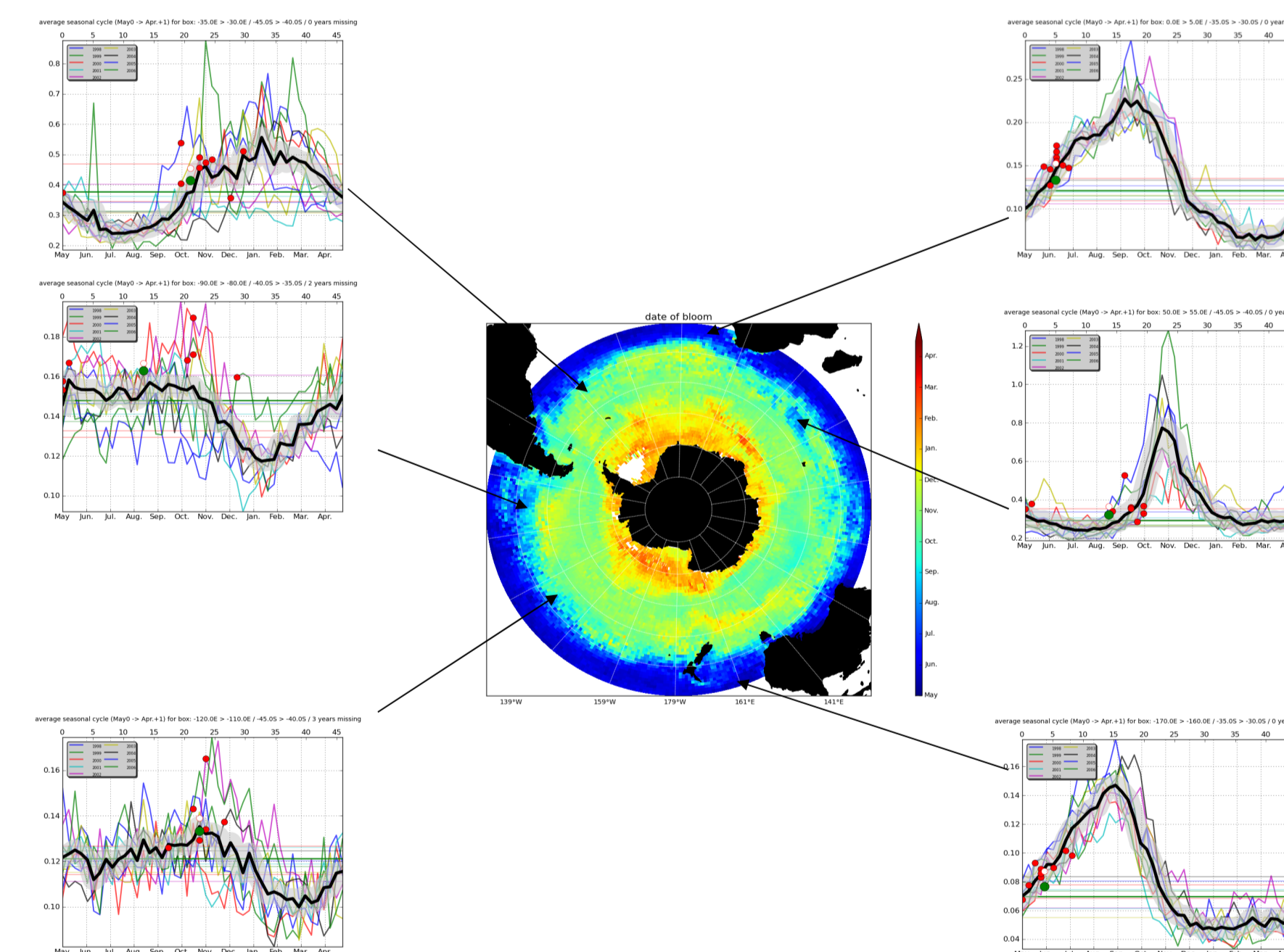
The Southern Ocean region is important as a sink for atmospheric carbon particularly that of anthropogenic origin. Changes to the forcing and/or upper ocean dynamics will impact this through the solubility and biological pump. Important processes in the region are related to eddies and fronts which are investigated.

Research Questions

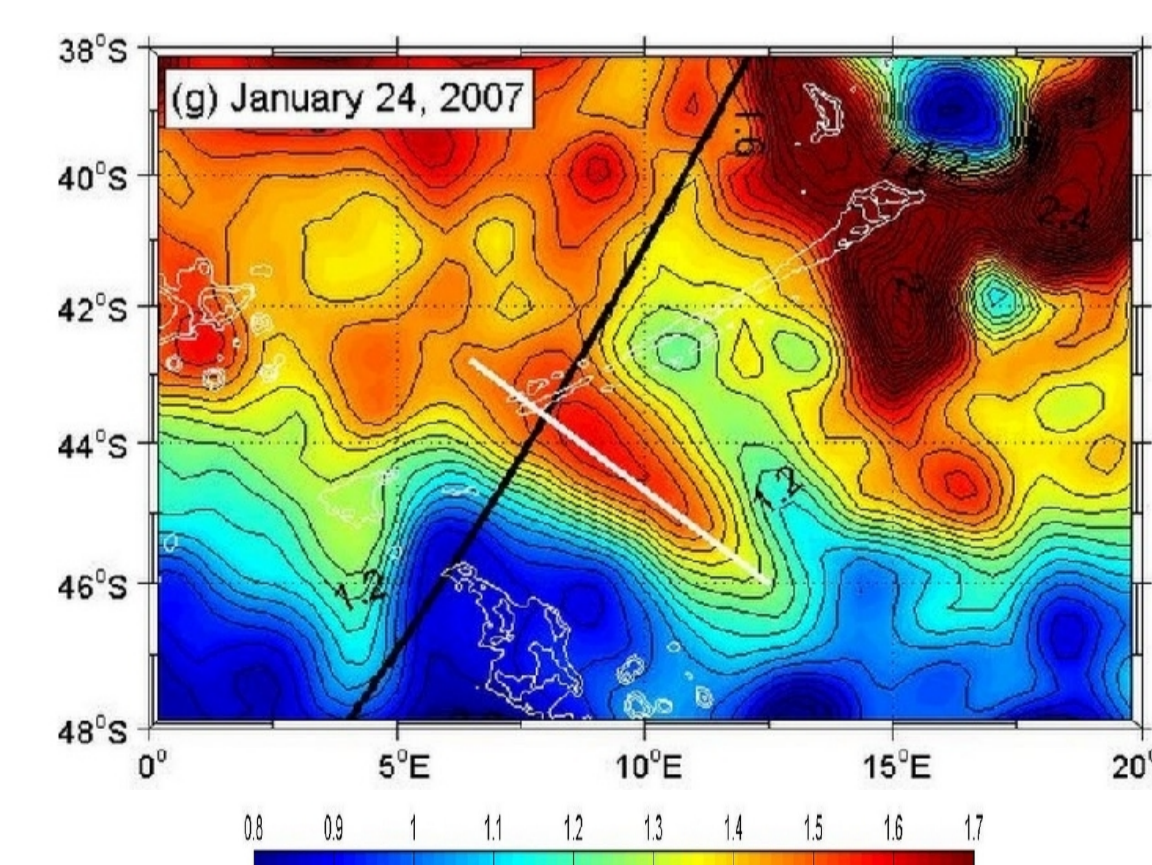
The Southern Ocean Carbon and Climate Observatory is investigating carbon fluxes in Southern Ocean. To help understand the processes involved, the following questions are being looked at.

What physical processes influence productivity in the Southern Ocean? MLD?

What is the seasonal cycle and subseasonal forcing of chlorophyll concentrations in the Southern Ocean?



How do frontal dynamics influence chlorophyll concentration? Rings from the Agulhas Current interact with the STF and are observed south of the front. Region of high EKE.



MADT south of Africa in the Agulhas Retroflection Region