

# Low frequency variability of the Southern Indian Ocean

## A modelling Approach

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# Background

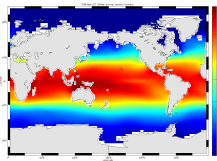
- Climate model development in South Africa still in its infancy stage.
- Past decade as seen giant strides being taken by the CSIR and the climate modelling community in SA in towards the development of an Earth System Model to be used for African climate studies.
- Centres currently involved in climate model development are CSIR (CMeH-SOCCO-CHPC), SAWS, CSAG, and Department of Oceanography (UCT).
- Climate model development in SA would be impossible without the computing facilities provided by the CHPC.

# Activities Towards South African Earth System Model Development

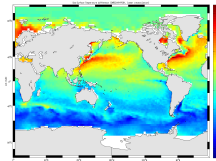
- Part of my Ph.D activities involved installing and compiling the Parallel Cubic Ocean Model (PCOM) source code (JAMSTEC origin) on the old and new supercomputer. This was followed by running scaling tests.
- Set-up and run a 3000 year PCOM integration and validate results.
- Some configuration attributes include;

- Running the ocean model at approx  $2^0$  horizontal resolution with 32  $z$  – *coordinate* vertical layers of varying thickness.
- **Initial condition** of the tests was motionless and homogeneous oceans with constant potential temperature ( $5^0\text{C}$ ) and constant salinity ( $37\text{psu}$ ).
- **Surface Boundary Condition:** ERA-40 atmospheric reanalysis with Hellerman & Rosenstein wind forcing.
- **Lateral Boundary Condition:** Global simulations.
- **Dynamical Core:** Mode splitting approach where internal modes are solved using the leap-frog advection with Matsuno correction every 15 timesteps and centered-difference advection for external modes both on an Arakwa B-grid.

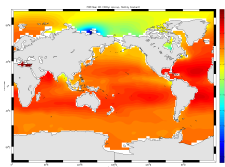
# PCOM results and validation



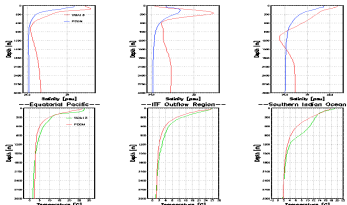
(a) Annual Mean SST (PCOM)



(b) SST Difference PCOM-CARS2009



(c) Annual Mean SSS (PCOM)



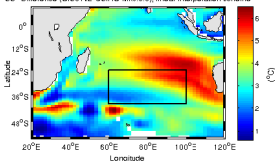
(d) Vertical Temperature and Salinity Profiles

# Coupled Model Inter-Comparison Project (CMIP5), Historical Runs

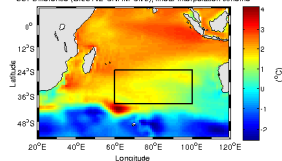
- Coupled climate-carbon and Earth System Model simulations designed to facilitate climate-change detection and attribution studies.
- **Initial Condition:** Initialized from pre-industrial control runs 1750 (gaseous emissions/concentrations data begin in 1765) or 1850 (beginning of ozone data) and continue for 500 years after completion of model spin-up.
- **Boundary Condition:** Changing appropriately over the chosen time period ( 1750-2005 or 1850-2005).

# CMIP5 Historical Outputs - SST Difference (Model-Obs)

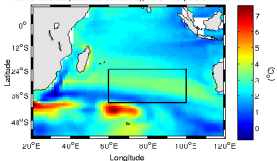
SST Difference (CISS1v2-CSIRO-Mk3.6.0), linear interpolation scheme



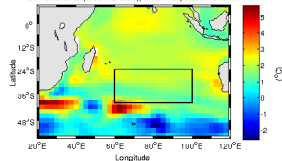
SST Difference (CISS1v2-CNRM-CM3), linear interpolation scheme



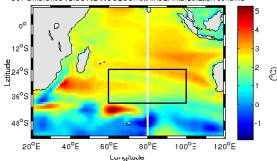
SST Difference (JIS1v2-Cant-SM2), linear interpolation scheme



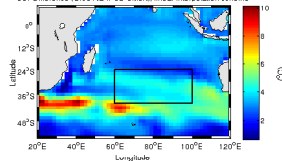
SST Difference (JIS1v2-GISS), linear interpolation scheme



SST Difference (CISS1v2-ACCESS1.0), linear interpolation scheme



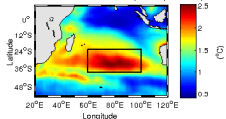
SST Difference (CISS1v2-IPSL-CM5A), linear interpolation scheme



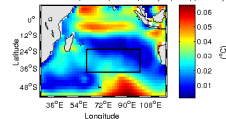


# CMIP5 Historical Outputs - Model SST Standard Deviation vs Obs

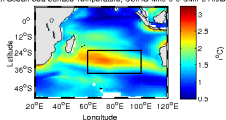
Standard Deviation Indian Ocean Sea Surface Temperature, OISSTv2 (1982-2017)



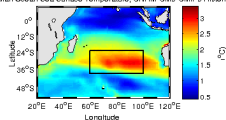
Standard Deviation Indian Ocean Sea Surface Temperature, PCCM (2000yr Spin-Up, Monthly Mean Haney Forcing)



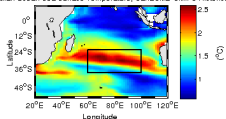
Standard Deviation Indian Ocean Sea Surface Temperature, CSIRO-Mk3-6-0-CMIP5 Historical (1850-2012)



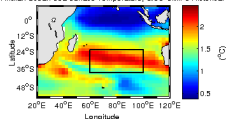
Standard Deviation Indian Ocean Sea Surface Temperature, CNRM-CM5-CMIP5 Historical (2000-2009)



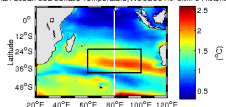
Standard Deviation Indian Ocean Sea Surface Temperature, CanESM2-CMIP5 Historical (1850-2012)



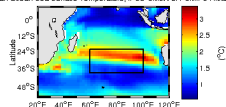
Standard Deviation Indian Ocean Sea Surface Temperature, GISS-CMIP5 Historical (1850-2010)



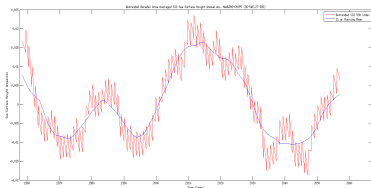
Standard Deviation Indian Ocean Sea Surface Temperature, ACCESS1.0-CMIP5 Historical (1850-2005)



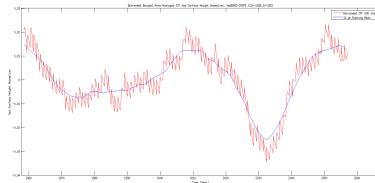
Standard Deviation Indian Ocean Sea Surface Temperature, IPSL-CM5A-LR-CMIP5 Historical (1859-2015)



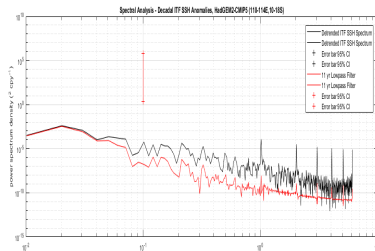
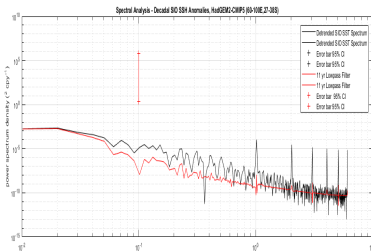
# Indian Ocean Low Frequency Variability



(a) 11 year moving average - SIO



(b) 11 year moving average - IITF



The End...for now