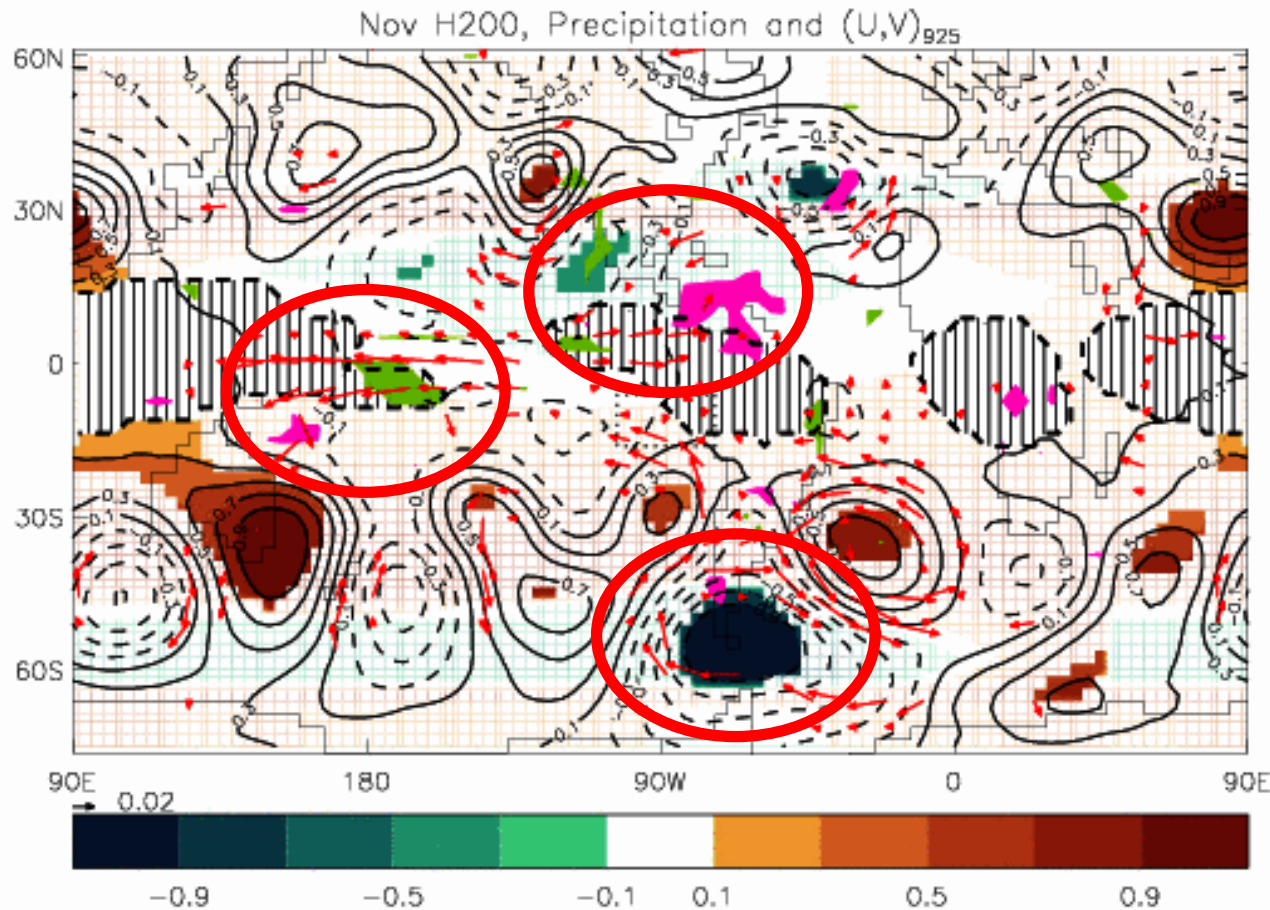# Coupled climate modelling in the South East Pacific

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Large-scale forcing vs local PBL coupling in the SEP from HadCM3 (Toniazzo 2009, Climate Dyn., on-line)

Nov H200, Precipitation and (U,V)$_{925}$

Correlations with surface SW flux in the tropical SE Pacific for November

Surface SW cloud forcing anomalies are associated with **both tropical and mid-latitude teleconnections** of the subtropical anticyclone.

In Spring(SON), cloud-cover is affected by **meridional temperature advection in the lower free troposphere.** It does not correlate with PBL anomalies.
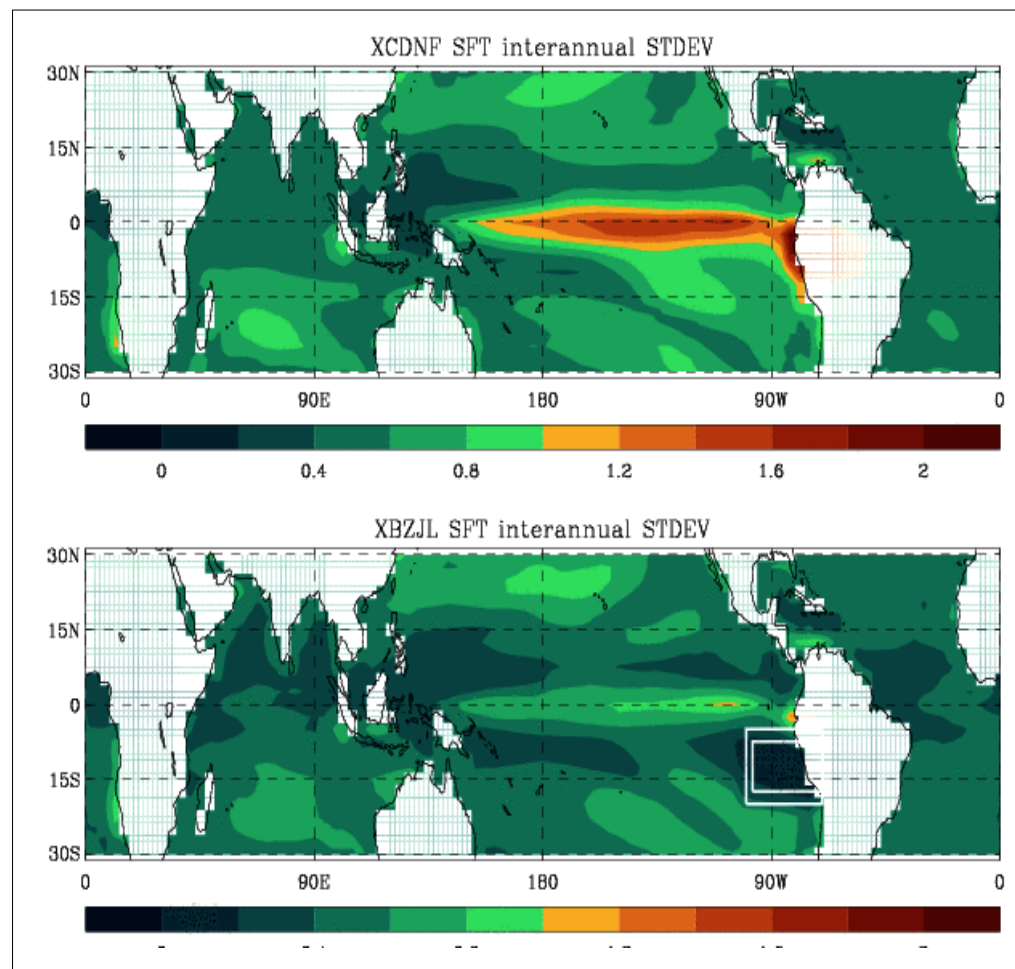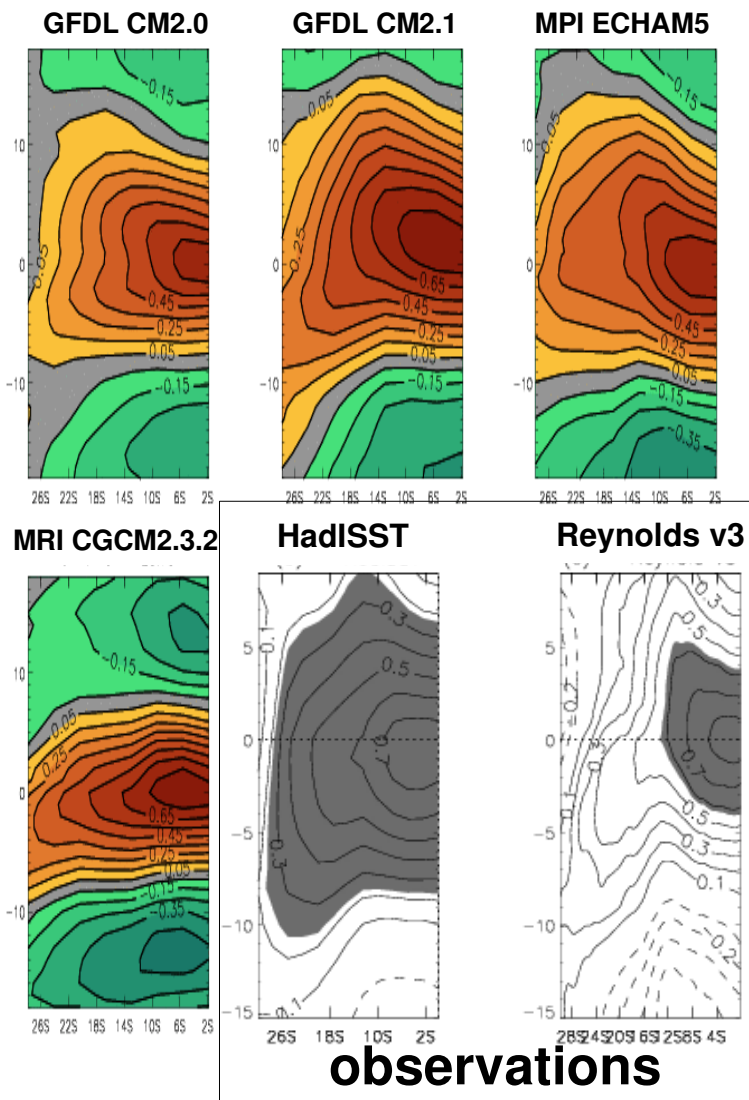

(e) T advection
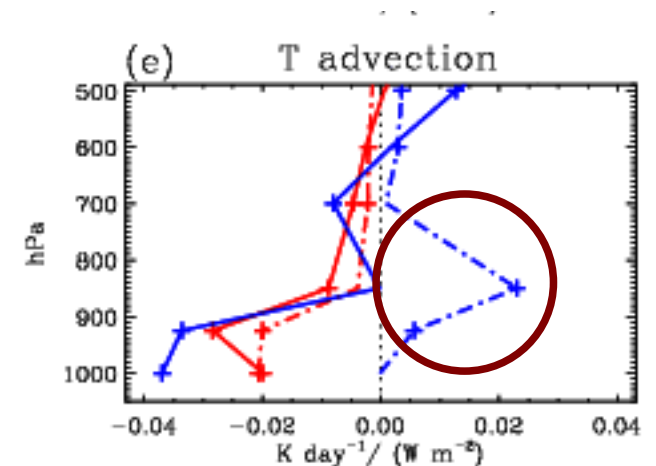
ENSO-SEP coupling in HadCM3

(Toniazzo 2009, Climate Dyn., on-line)

ENSO is weakened when SEP variability is damped.

An SEP-ENSO connection recognisable in some IPCC models and in SST data

- Large-scale controls in HadCM3 - teleconnections between the South East Pacific, tropical convection, and the Southern Hemisphere storm track

- Clouds "slaved" to other processes

- Broadly consistent with synoptic and large-scale behaviour observed in VOCALS-REx

- There is an interaction between SEP variability and ENSO via diabatic processes

but...

- Large warm SST bias and too little cloud

- Ocean dynamics not resolved

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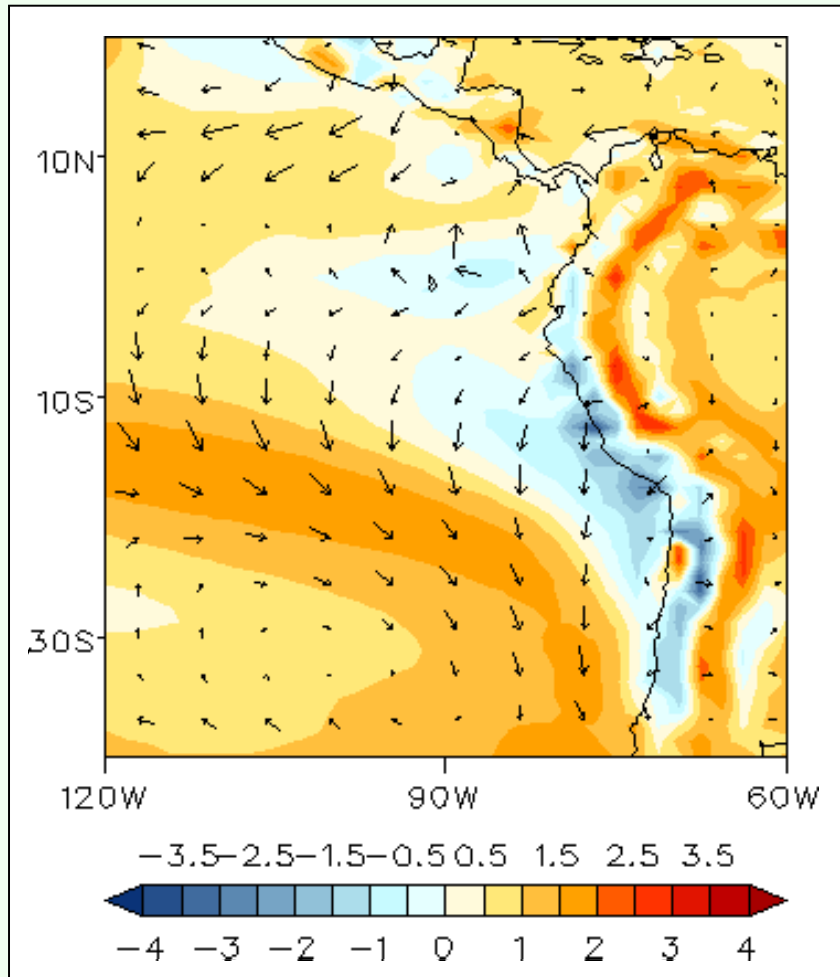- HiGEM is a climate model based on the Met Office Hadley Centre coupled ocean-atmosphere GCM, HadGEM1
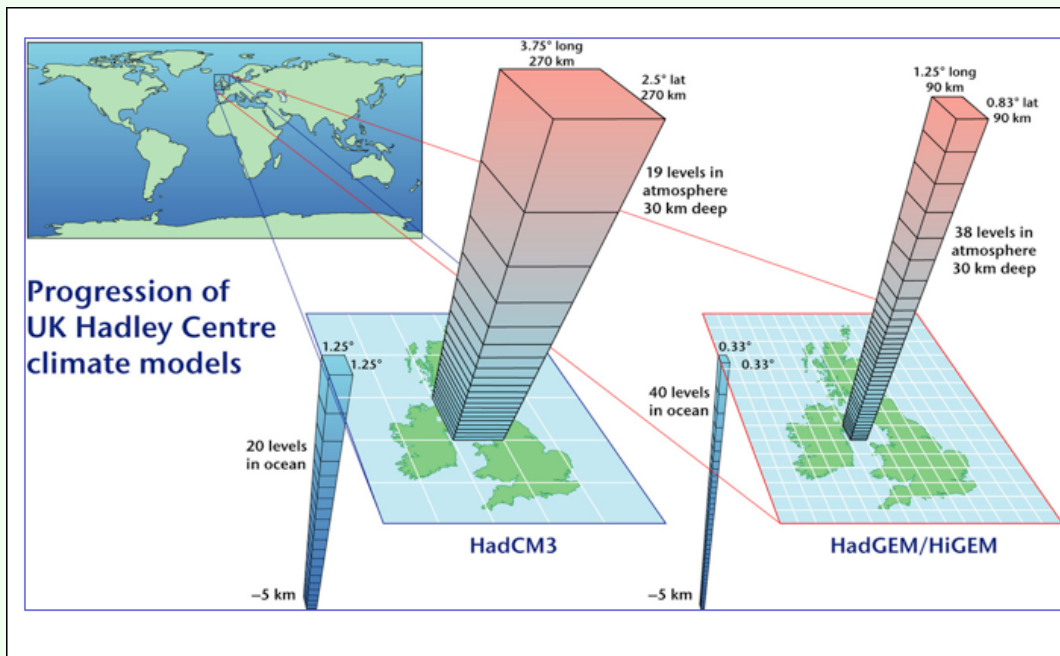
- In the atmospheric component, its resolution is $1.25^{\circ} \times 0.83^{\circ}$ longitude by latitude, and 38 levels in the vertical.
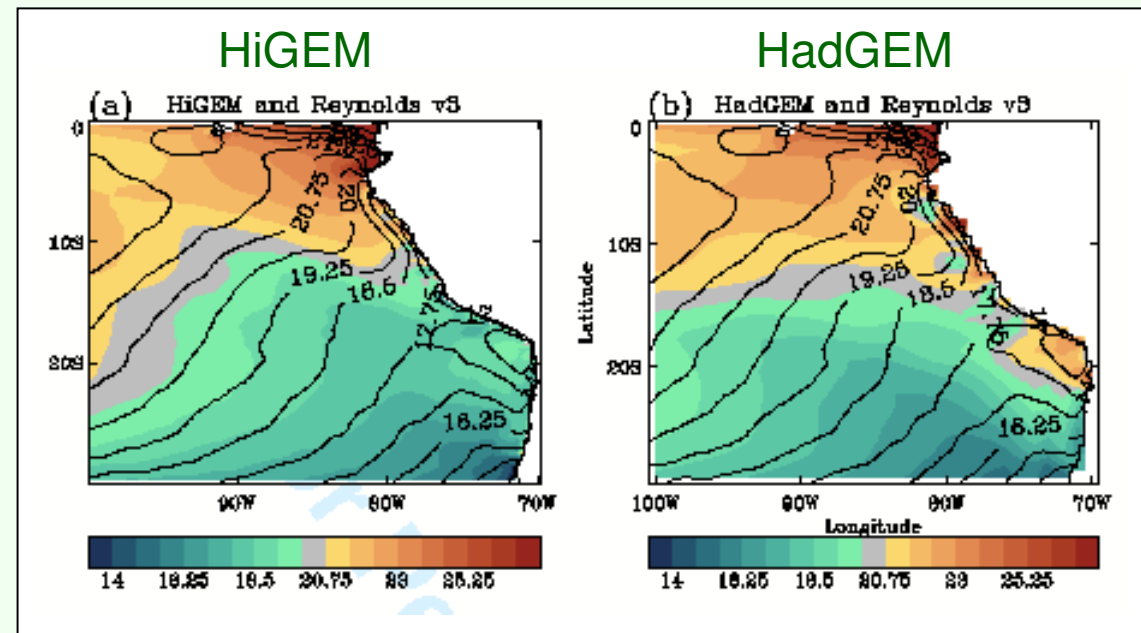
- The ocean resolution is $1/3^{\circ} \times 1/3^{\circ}$ (*"eddy-permitting"*), with 40 depth levels.

- Centennial-length integrations

South East Pacific (SEP) Stratocumulus Decks

HiGEM minus HadGEM annual mean 1.5m temperature difference (colours), 10m wind differences (vectors) and total cloud differences (contour interval=0.1).

HiGEM and HadGEM october SST (colours) overlayed in top of observed October SSTs (¼ degreee NOAA OI SSTs)
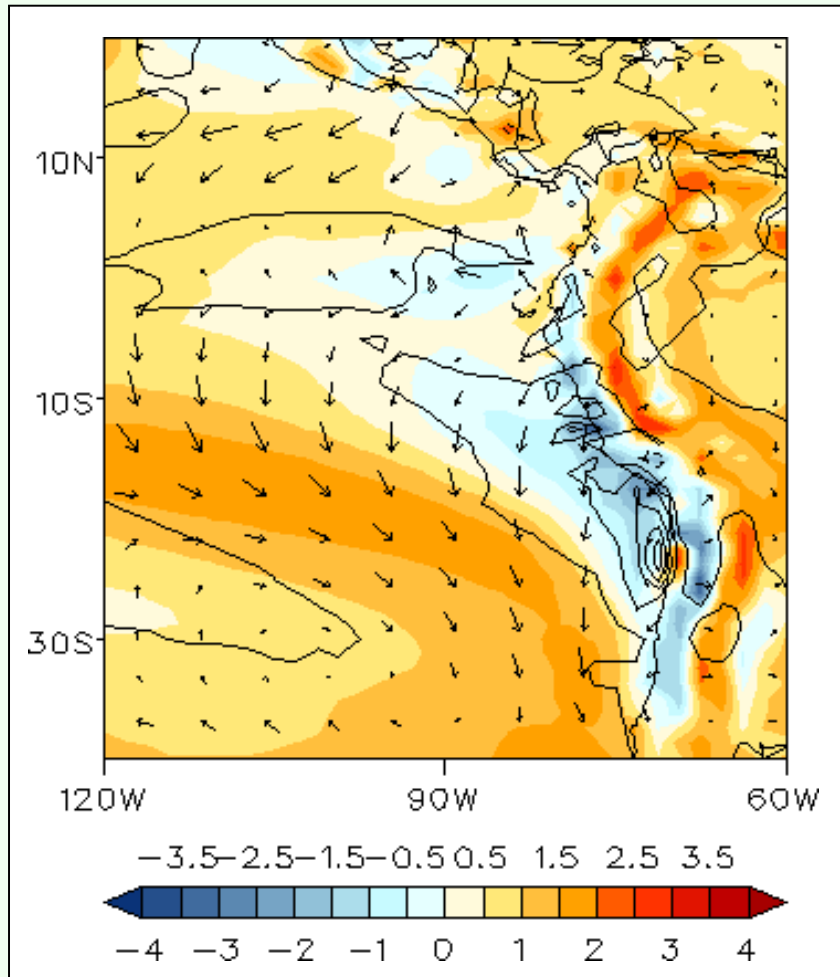
HiGEM minus HadGEM annual mean 1.5m temperature difference (colours), 10m wind differences (vectors) and total cloud differences (contour interval=0.1).
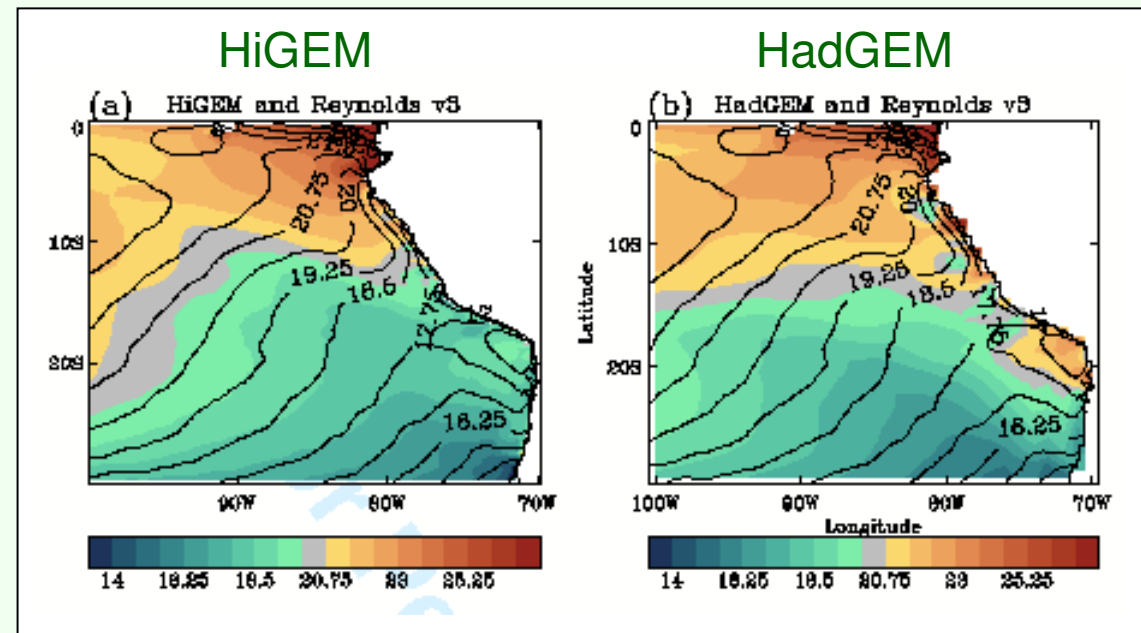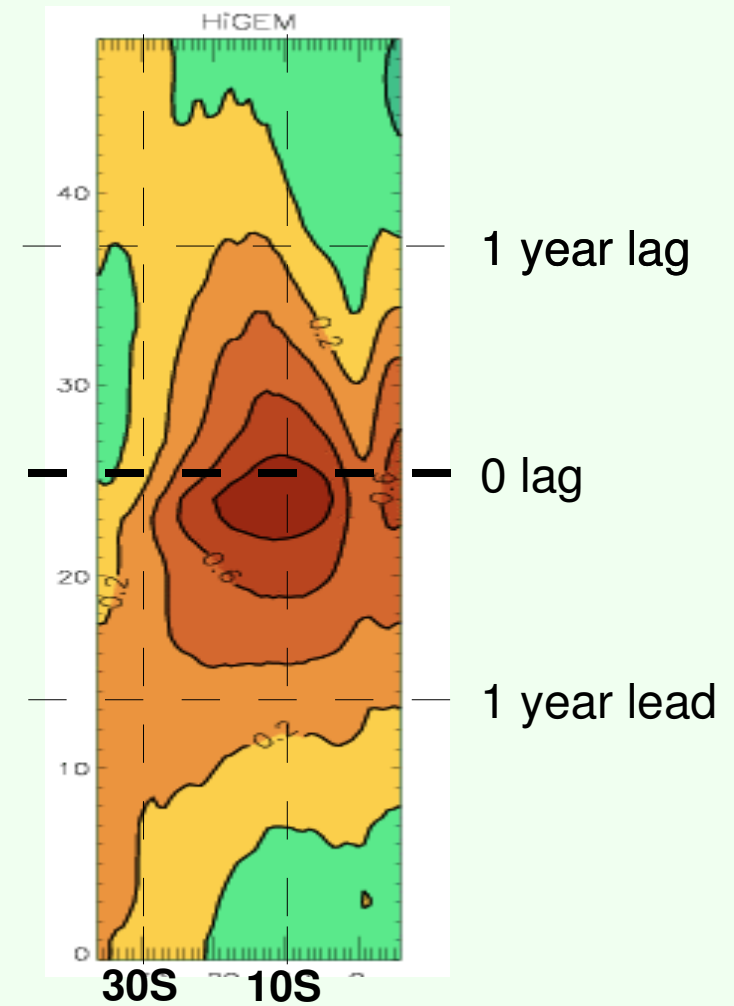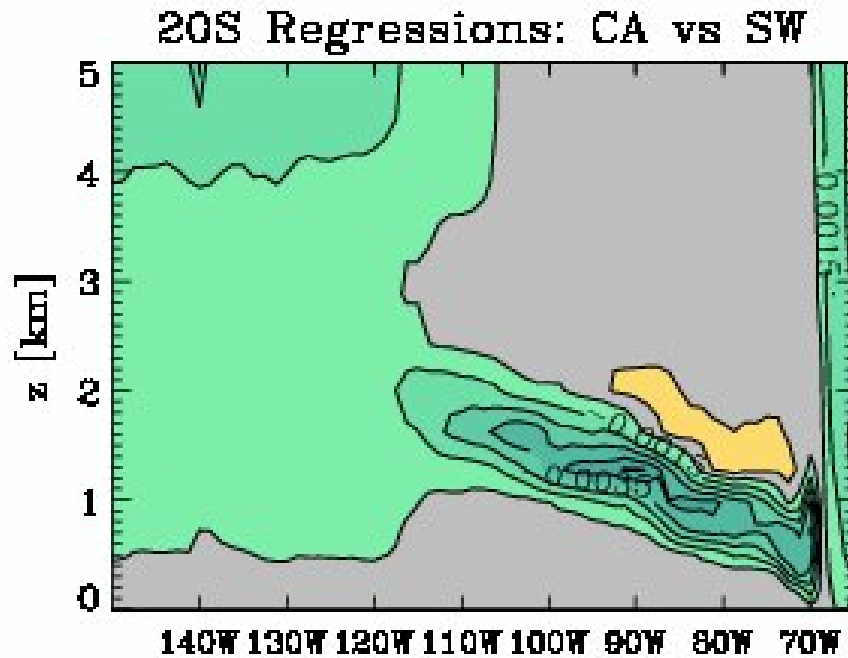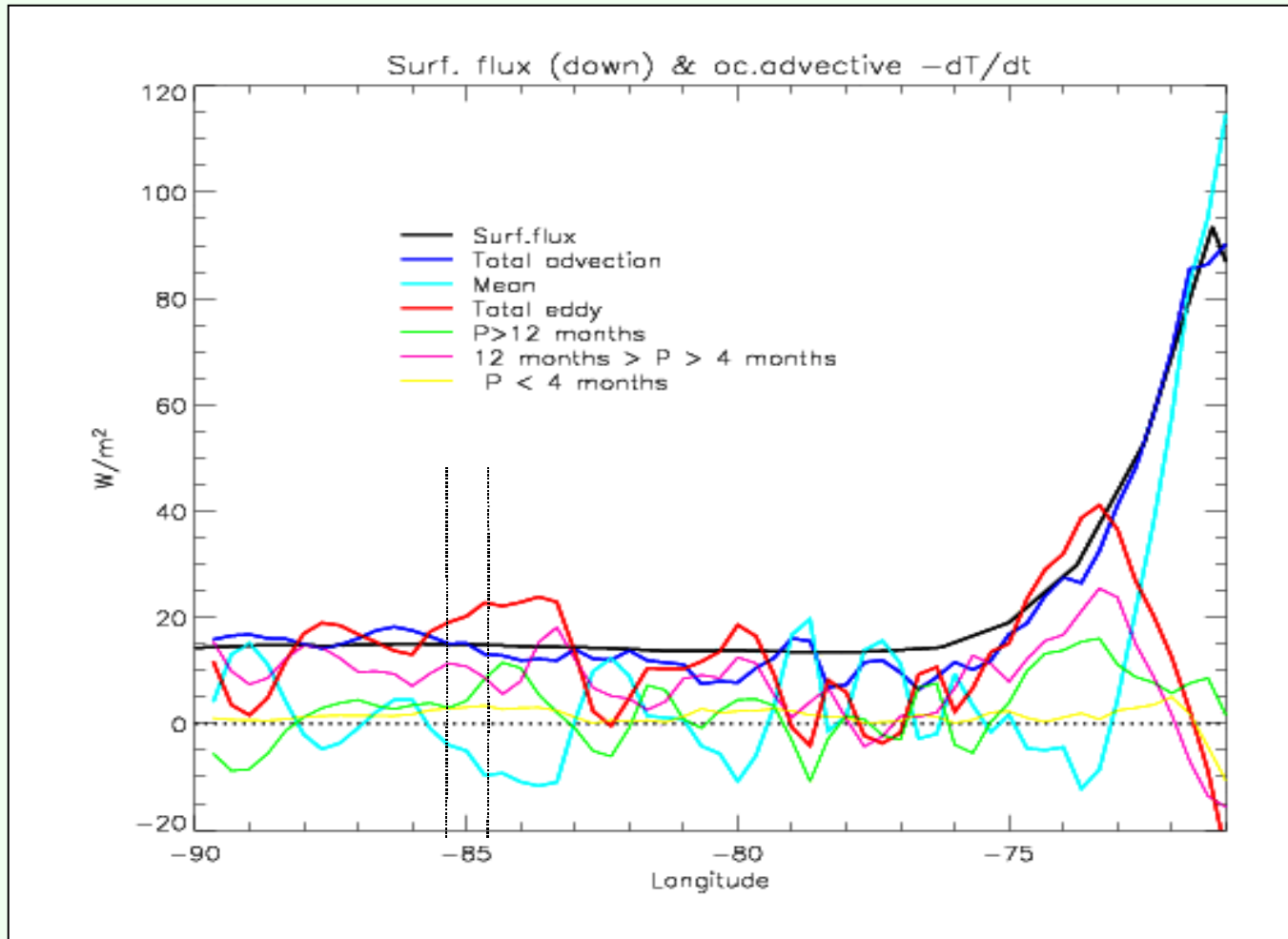

HiGEM and HadGEM october SST (colours) overlayed in top of observed October SSTs (¼ degreee NOAA OI SSTs)

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- **HiGEM shows similar lead-lag relations for the SSTs in the East Pacific**
- **SW control more important**
- **Cloud behaviour consistent with observations**

20S Regressions: CA vs SW

HiGEM

1 year lag

0 lag

1 year lead

30S   10S

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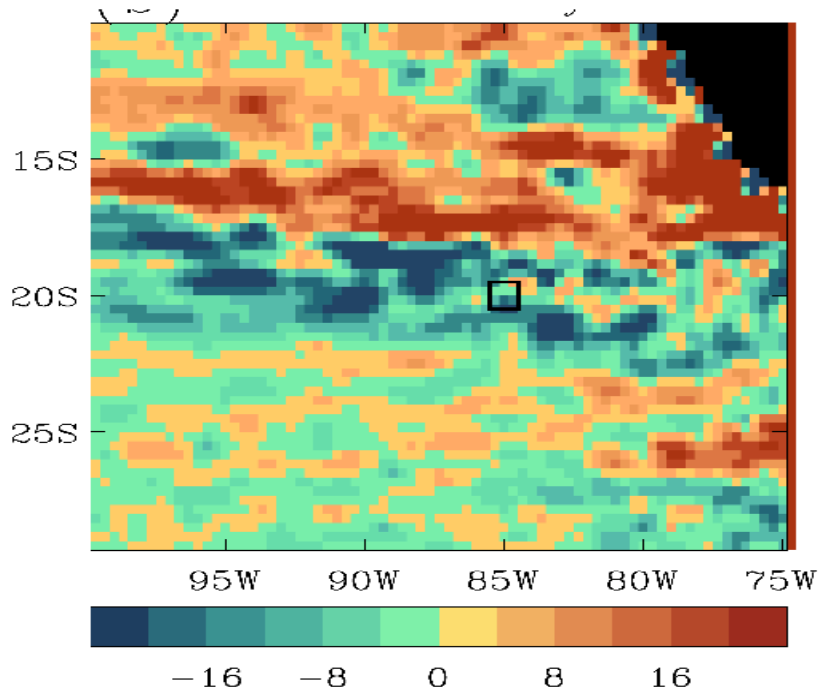
The ocean heat budget in HiGEM along 20°S

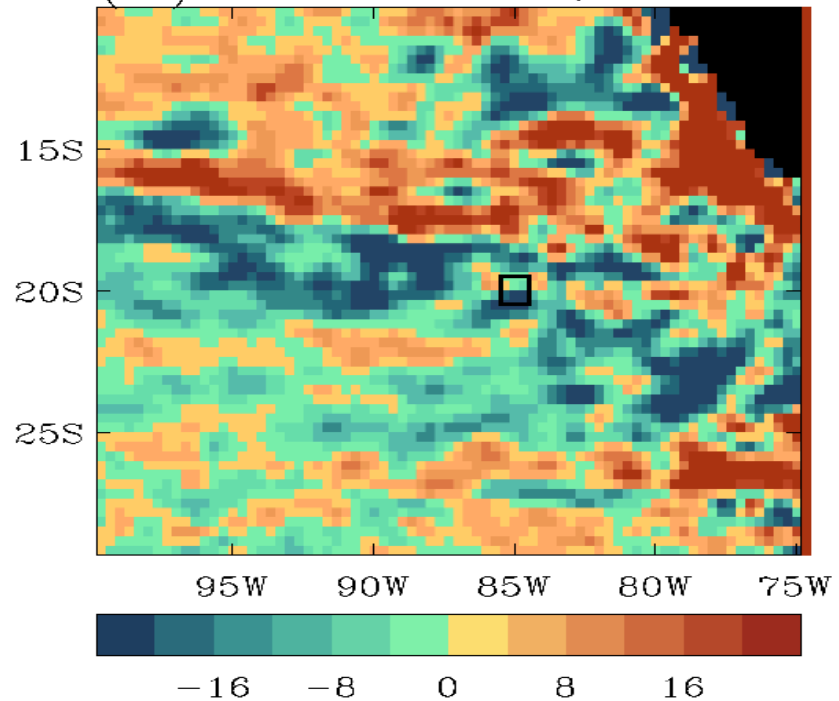Toniazzo, Mechoso, Shaffrey and Slingo 2009, Climate Dyn. submitted

Data from the IMET buoy suggests eddies are fundamental to the SEP heat budget. The heat budget from HiGEM is consistent with buoy estimates (Toniazzo et al. 2009, submitted to Clim. Dyn.)

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In HiGEM, most of the transient oceanic temperature advection at interseasonal time-scales is associated with the geostrophic, horizontal flow

$u' \cdot \nabla T'$
4m < T < 12m
total (u,v,w)

$u' \cdot \nabla_h T'$
4m < T < 12m
geostrophic (u,v)

Toniazzo, Mechoso, Shaffrey and Slingo, 2009

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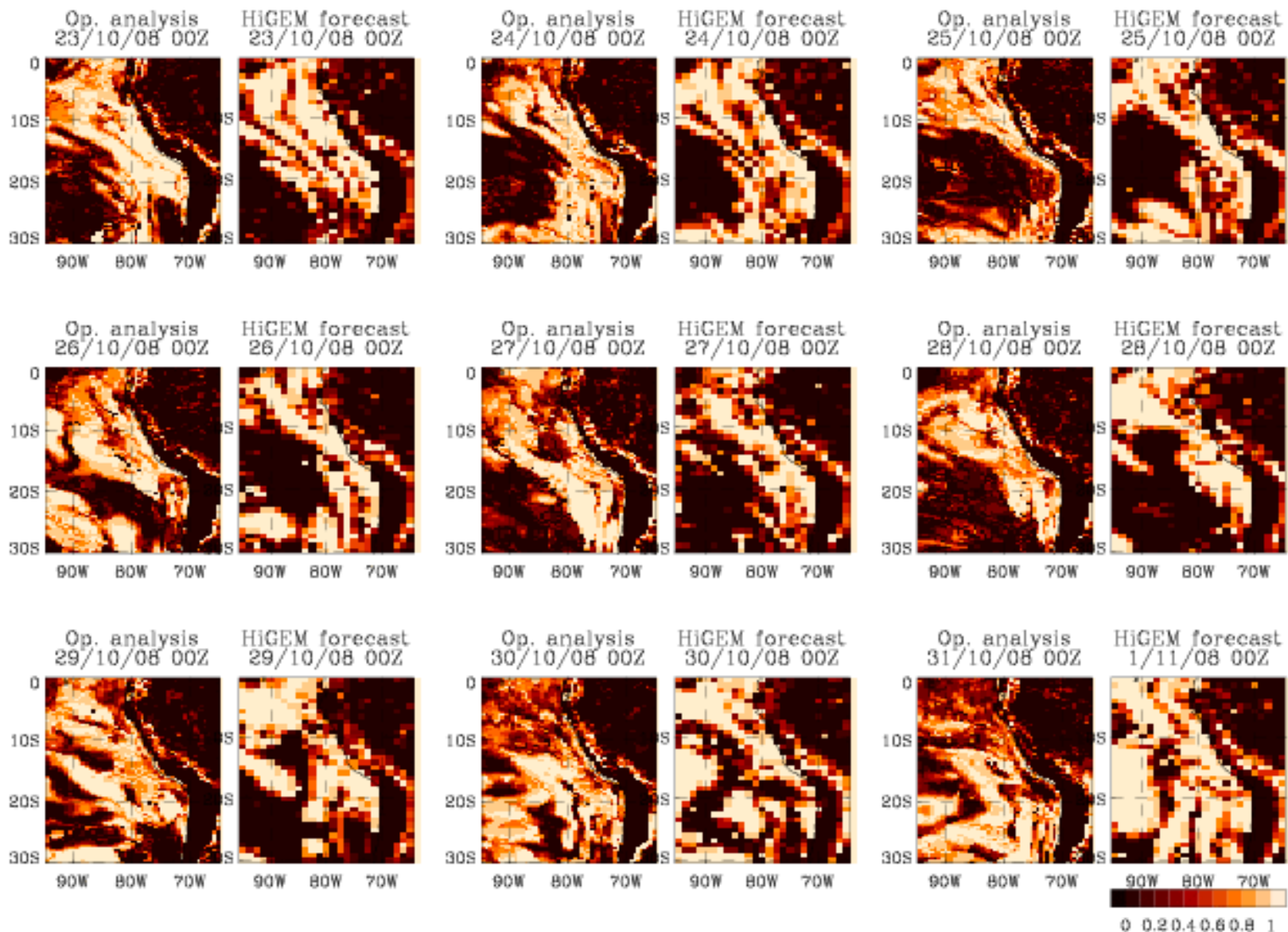NATURAL ENVIRONMENT RESEARCH COUNCIL
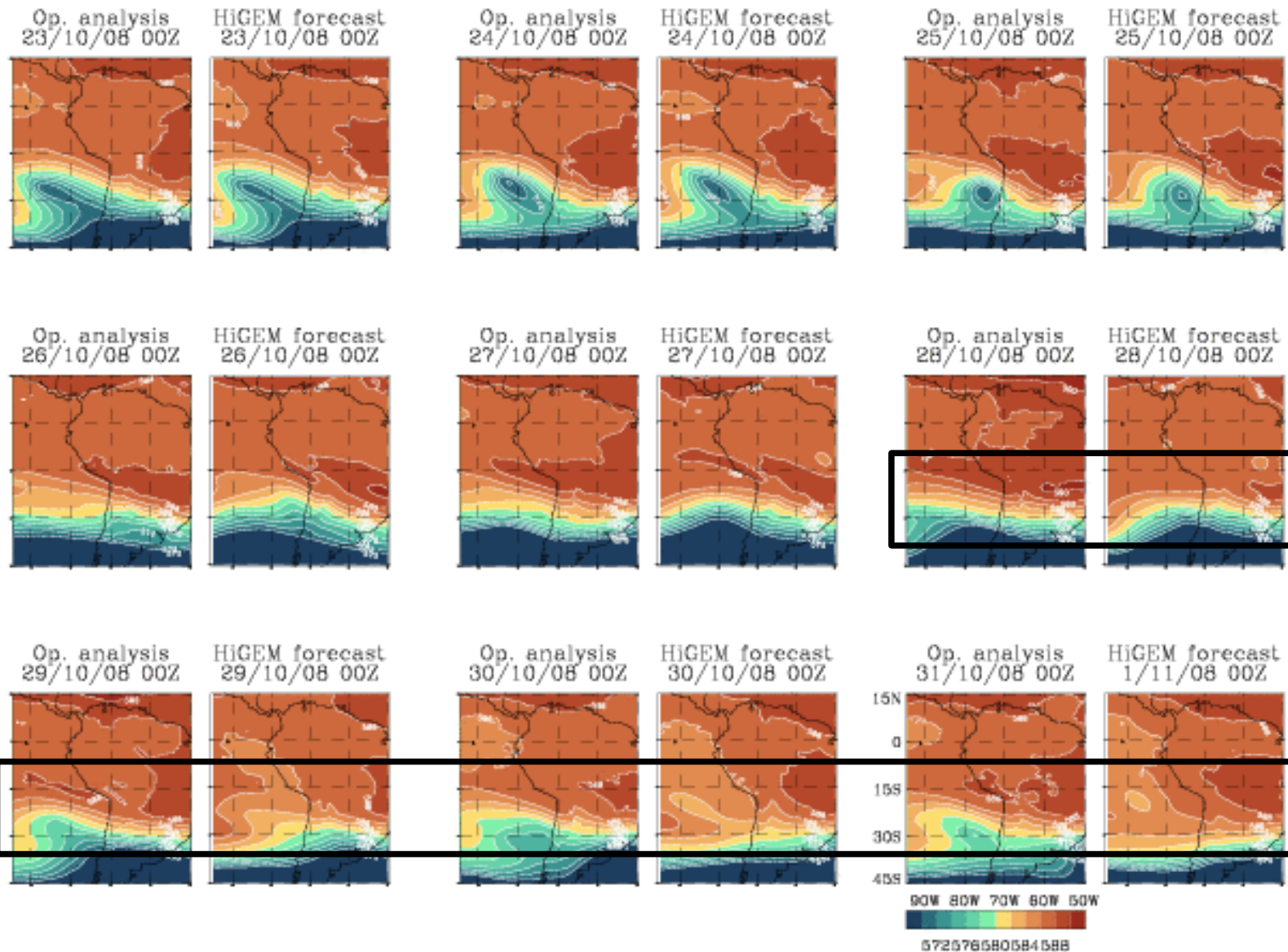
HiGEM hindcast from 22th October 2008 00UTC UKMO global analysis.

1 to 9-day 00z H500 compared to UKMO reanalyses

HiGEM hindcasts

HiGEM hindcast from 22th October 2008 00UTC UKMO global analysis.

1 to 9-day 00z low cloud fraction compared to UKMO reanalysis

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- Large scale controls in HadCM3 – teleconnections from the Southern Hemisphere storm track

- Improved representation of the SEP in the high resolution coupled climate model HiGEM. Centennial-length integrations completed.

  - Warm, clear SST bias in the South East Pacific is reduced

  - In HiGEM, geostrophic horizontal terms dominate the eddy heat transport

  - The HiGEM upper ocean heat budget is consistent with buoy estimates at 85W, 20S. There are, however, large spatial variations in the eddy heat transport across the SEP in HiGEM

- Preliminary HiGEM hindcasts for VOCALS-REX period show some skill

- In conjunction with Leeds University, we're attempting to drive WRF over the VOCALS region with HiGEM boundary conditions

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