UNIVERSITY OF MIAMI
ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

Oceanic resolution controls differences between fast-SST-error-growth in CCSM4 simulations of subtropical Southeast Pacific

Isabel Porto da Silveira, Paquita Zuidema, Benjamin Kirtman

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Introduction

- Significant *sea surface temperature (SST) errors* in the tropical oceans are common in coupled ocean-atmosphere general circulation models (e.g., Kirtman et al., 2012; Toniazzo and Woolnough 2014; Zuidema et al., 2016).

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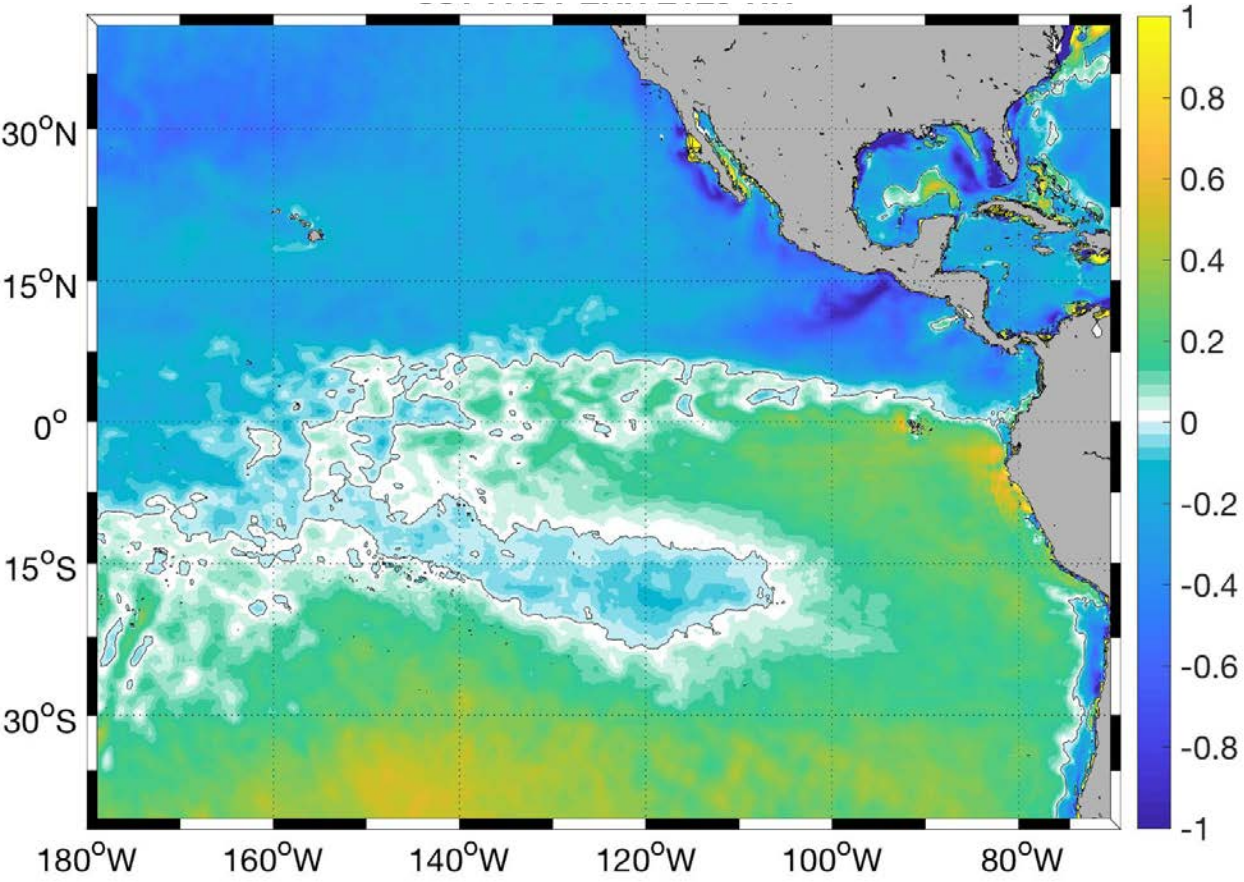
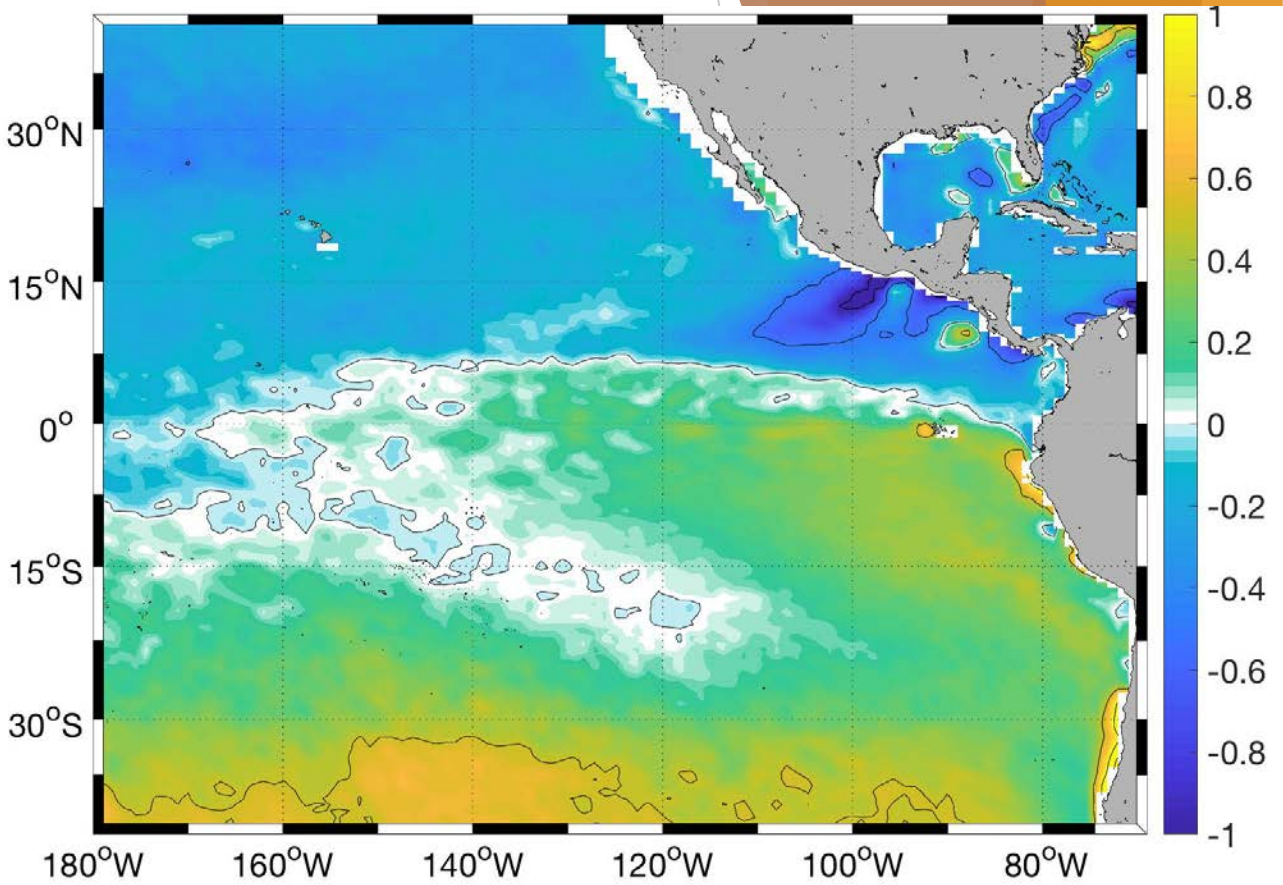
- One hypothesis holds that the *errors may decrease* if a *model's resolution is increased* and more of the *sub-grid-scale processes* become *resolvable*;

- *Local air-sea feedbacks* are significantly *modified by the increased ocean resolution* (eddy-resolving). *High-resolution simulation* in the extra-tropics presented a compelling evidence of *stronger forcing of the atmosphere by SST* variability arising from ocean dynamics. *This coupling* is very *weak or absent in the low-resolution model* (*Kirtman et. al, 2012*).

SST FAST ERR HIGH RESOLUTION



SST FAST ERR LOW RESOLUTION



SST Fast Errors for the high resolution ensembles (left) and for the low resolution ensembles (right). The red ellipses highlight the SE Pacific as the region of highest differences between both resolutions.

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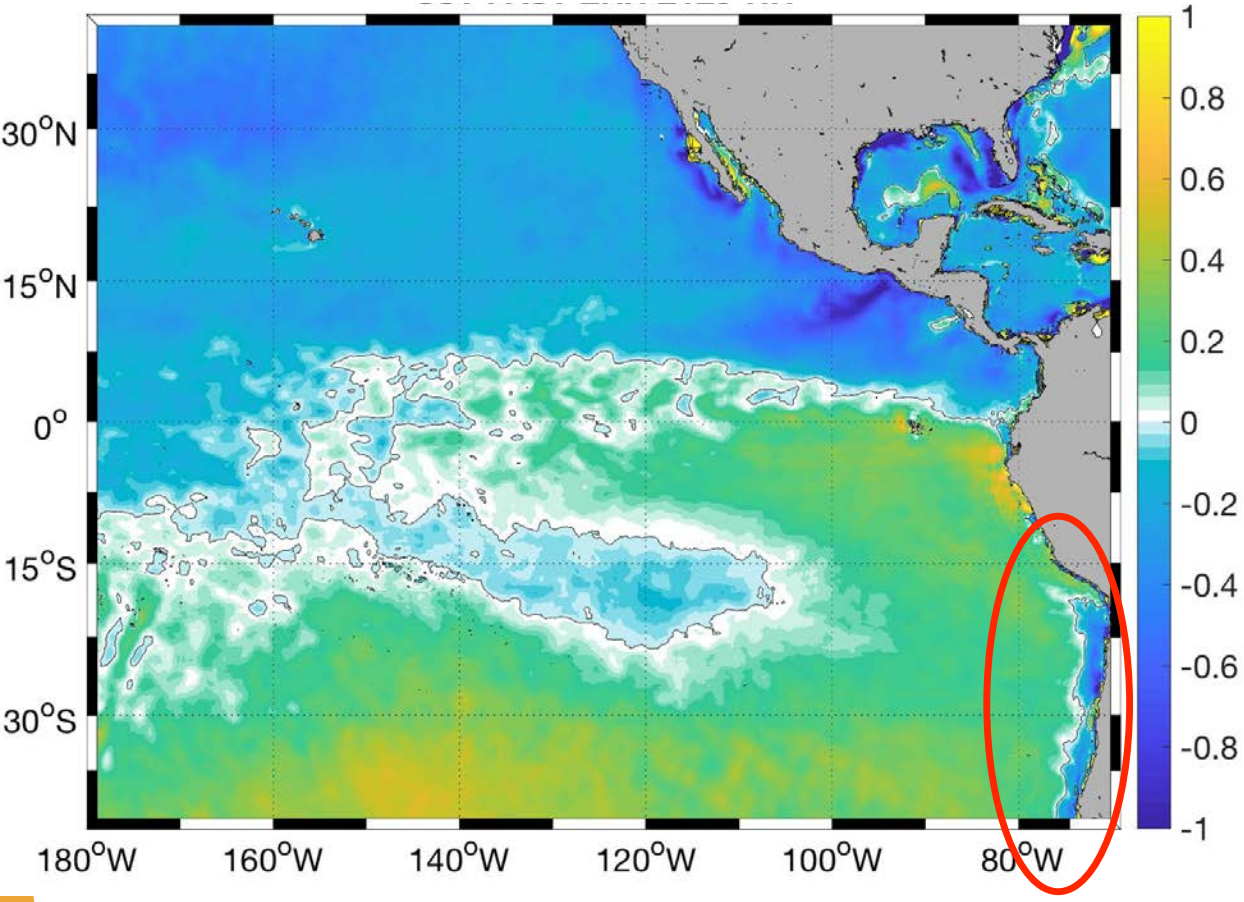

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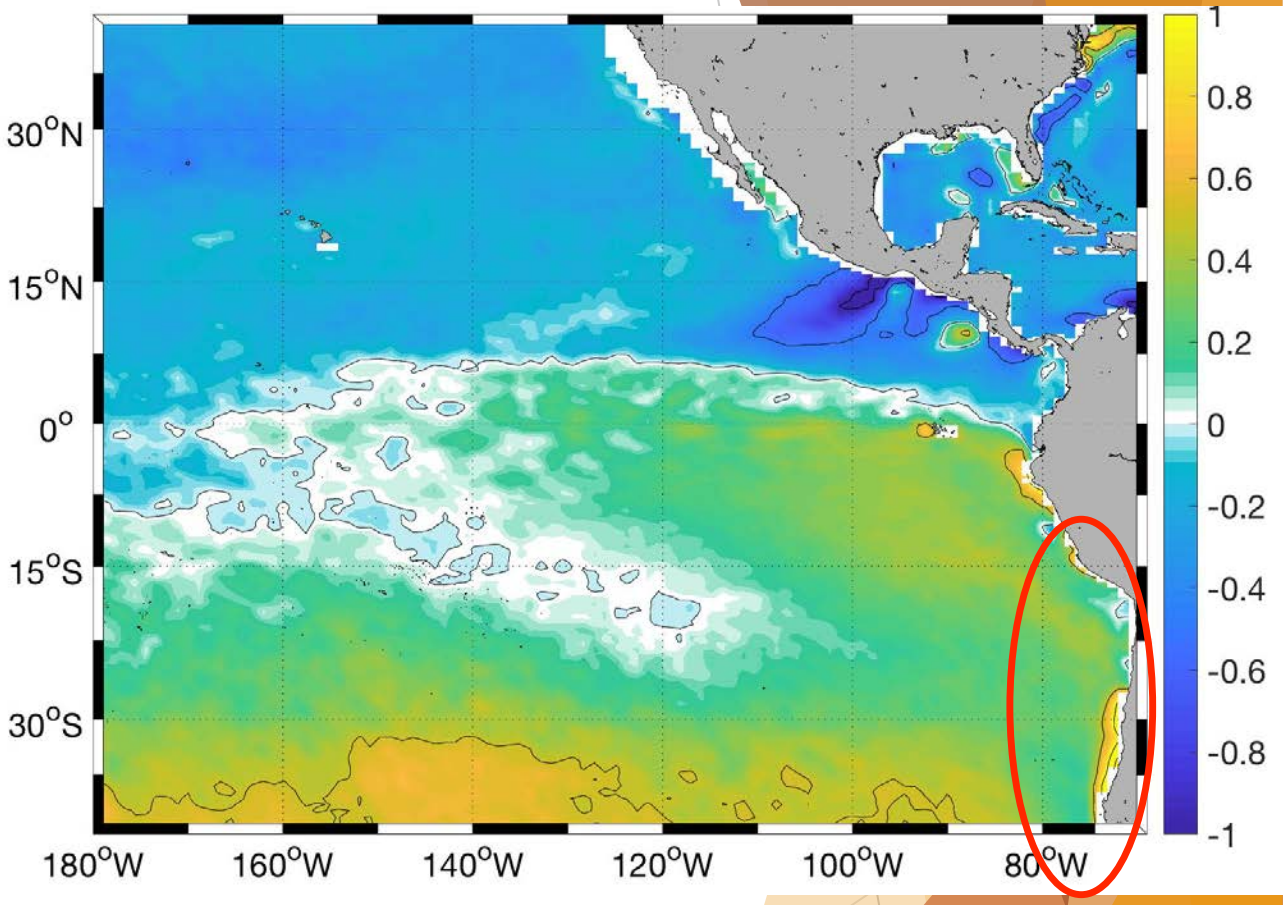

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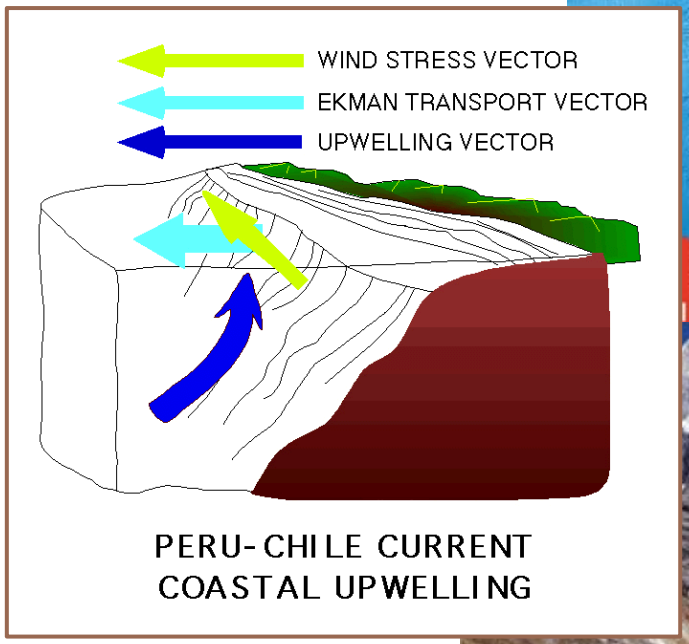
Objectives

- *How does increasing resolution affect SST error growth?*
- *Do the physical processes responsible for the errors growth change with resolution?*

Understand SST fast error evolution in the Southeast Pacific

The Southeast Pacific

The rugged Andes topography along with strong coastal upwelling, intense SST gradients and extensive but geometrically-thin stratocumulus decks turns the SE Pacific into a challenge for numerical modeling.



Community Climate System Model (CCSM4)

Community Atmosphere Model (CAM4) + Parallel Ocean Program (POP2)

High Resolution

- 0.1º oceanic (~11km), 42 vertical levels
- 0.5º atmospheric (~55 km), 26 vertical levels
- 3 members

Low resolution

- 1.125º oceanic (~125 km), 60 vertical levels
- 0.9º atmospheric (~100 km), 26 vertical levels
- 10 members

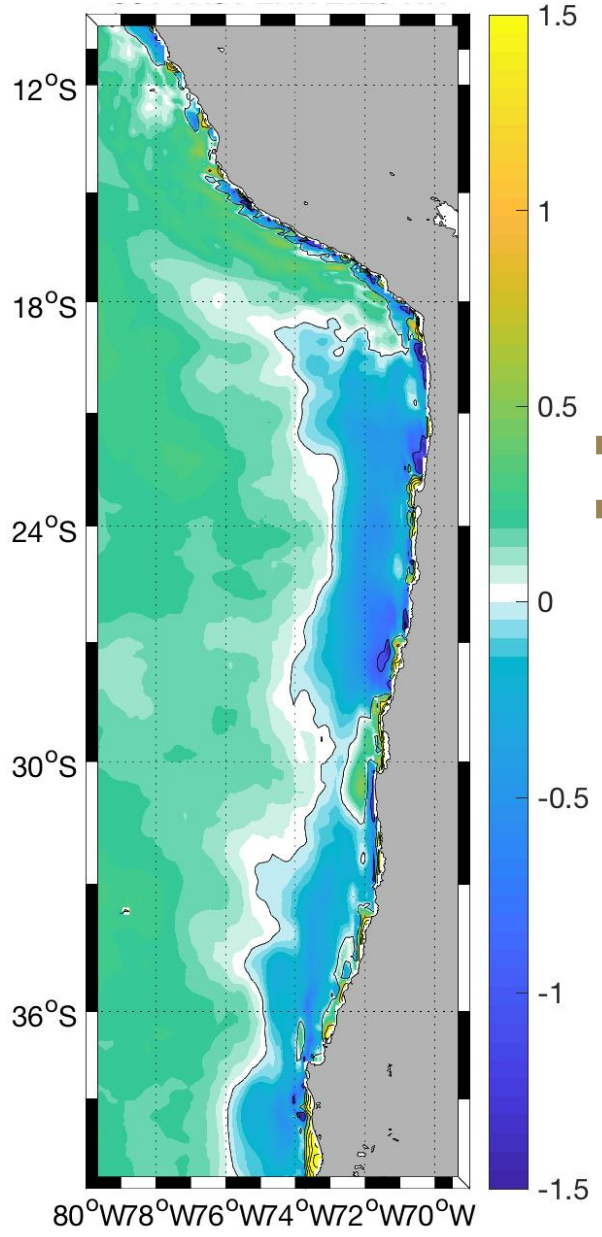
- ***Hindcasts: 12 months free running integrations***
- ***From 1982 to 2003, daily***
- ***Retrospective forecasts initialized with oceanic and atmospheric reanalysis (CFSR) every January 1st***

Fast Errors

$$T_{err}^{Fast} = \frac{\sum_{i=2}^{i=6} T_{jan_i}}{5} - T_{(Jan1)}$$

WHY THEY'RE SO

HIGH RESOLUTION



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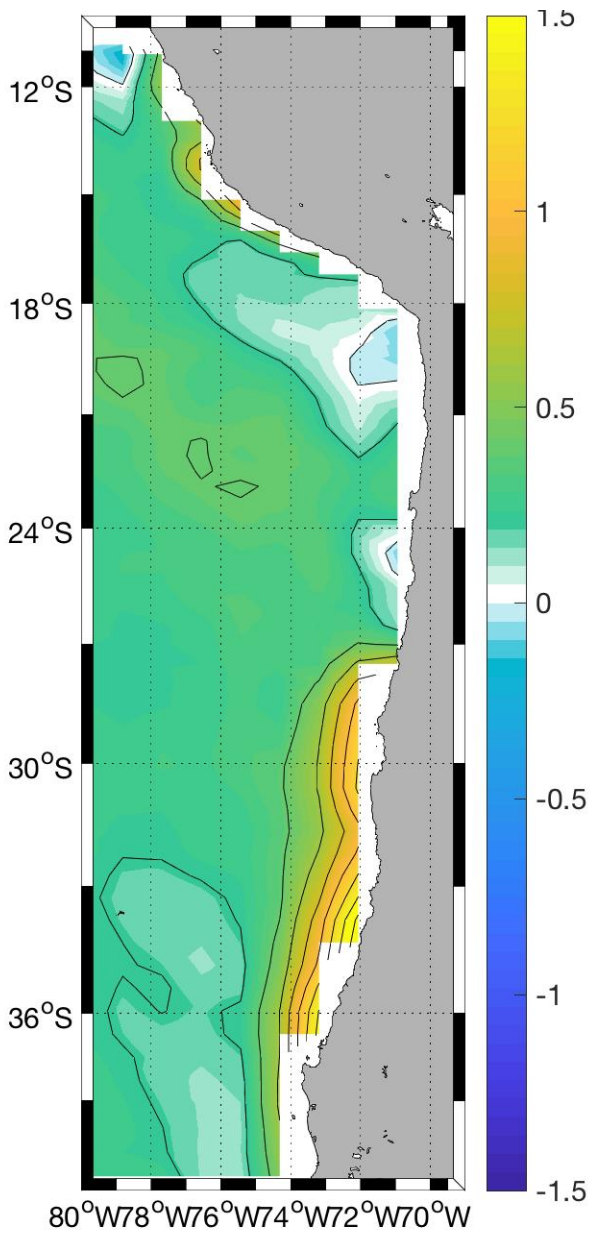

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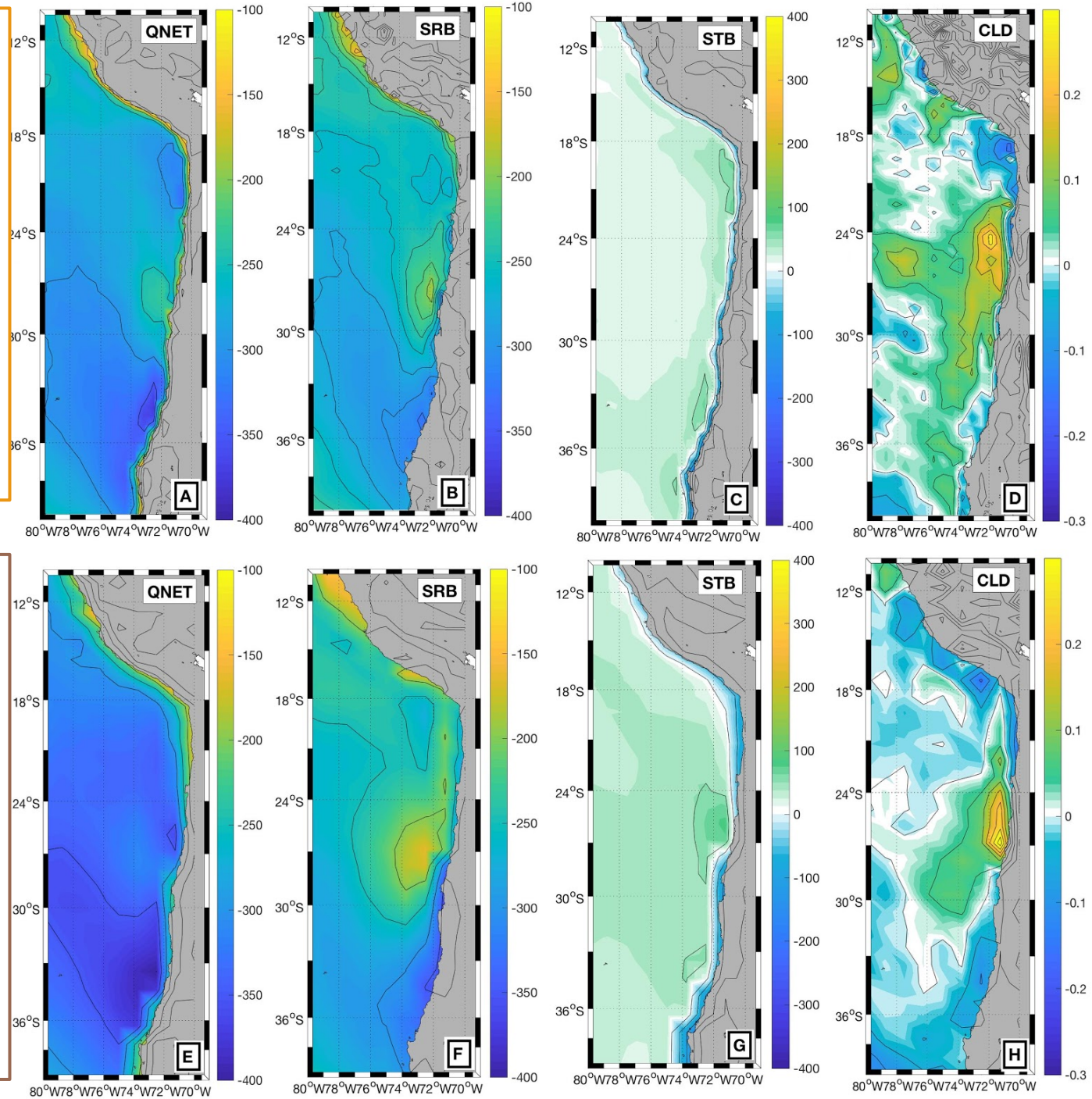
Ensemble mean Fast Errors

HIGH RESOLUTION

LOW RESOLUTION



QNET: total surface energy budget
SRB: surface net radiative budget
STB: surface net turbulent budget
+ : surface gaining heat,
- : surface losing heat
CLD: cloud cover
+ : increase and - :decrease cloud cover

Ensemble mean Fast Errors

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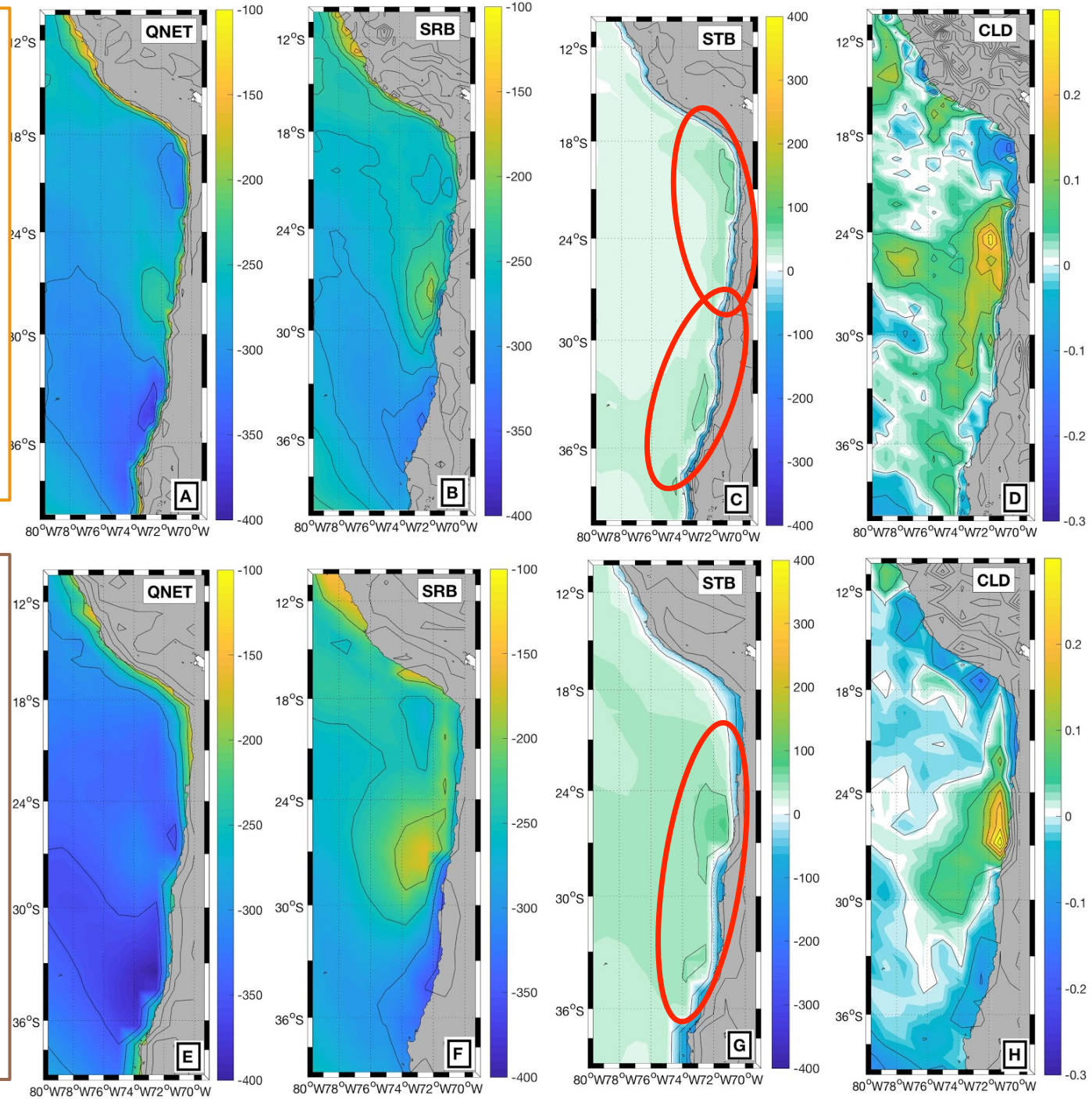

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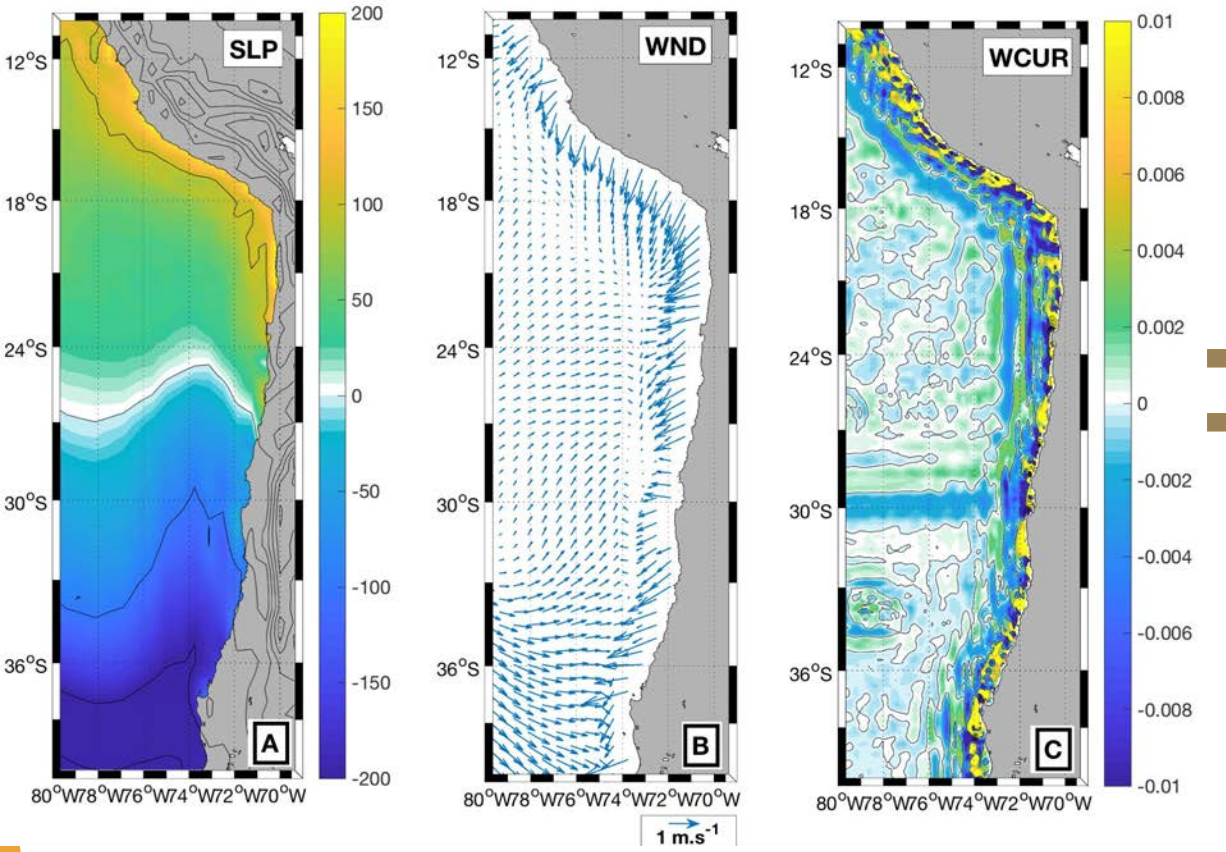

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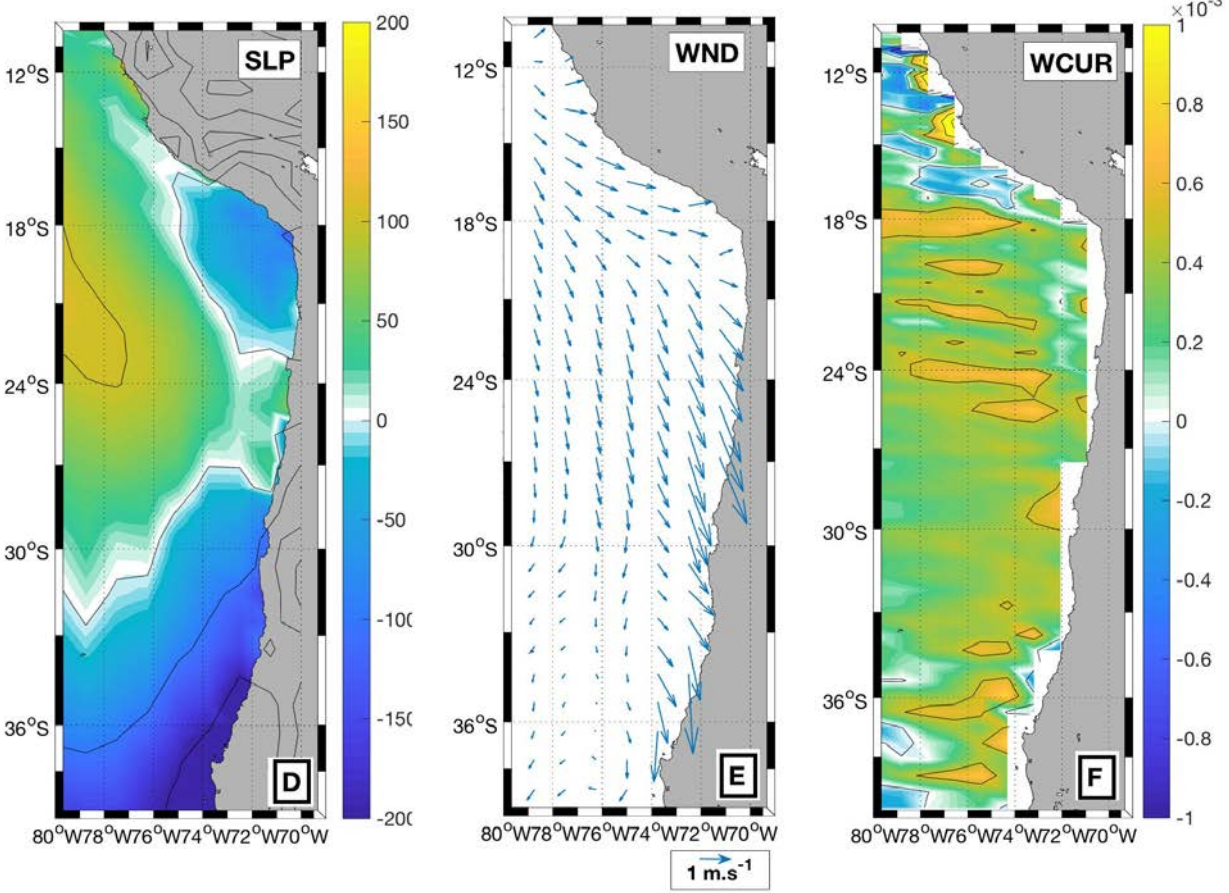

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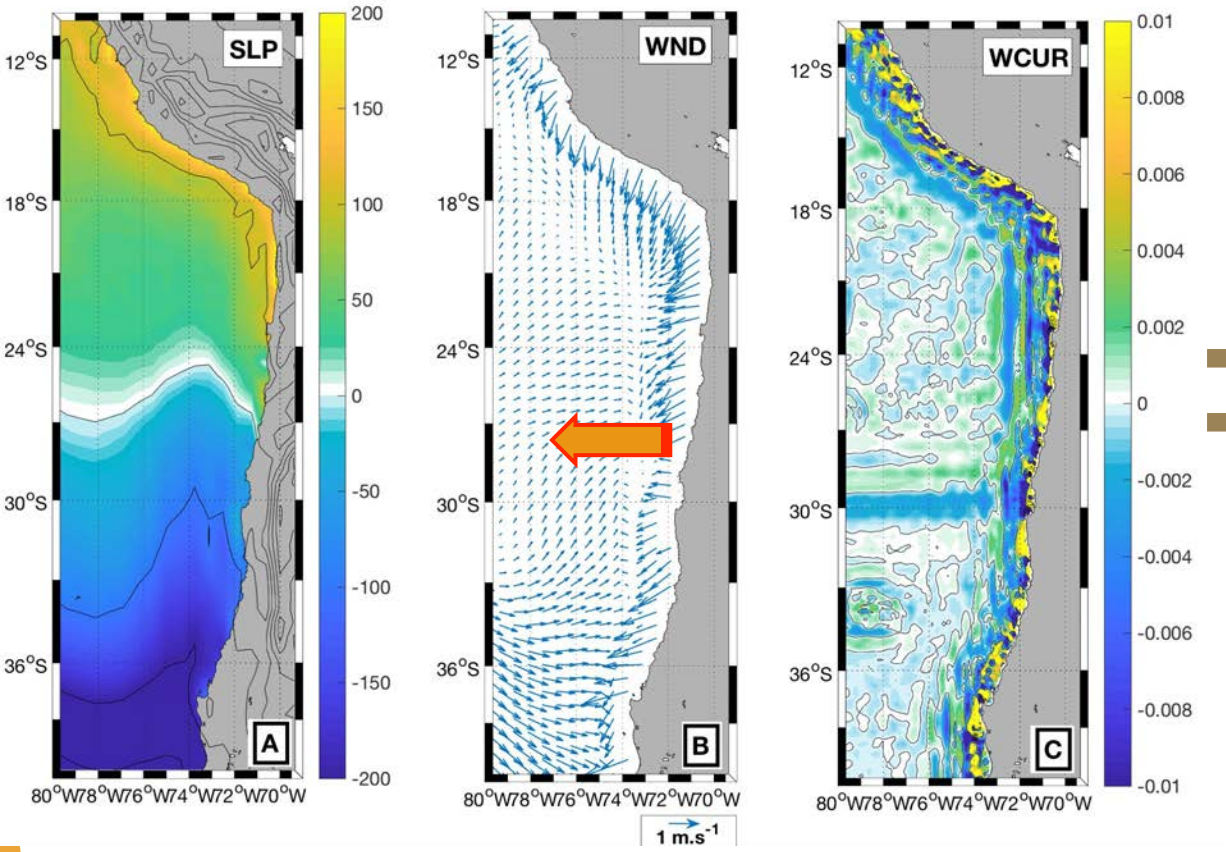

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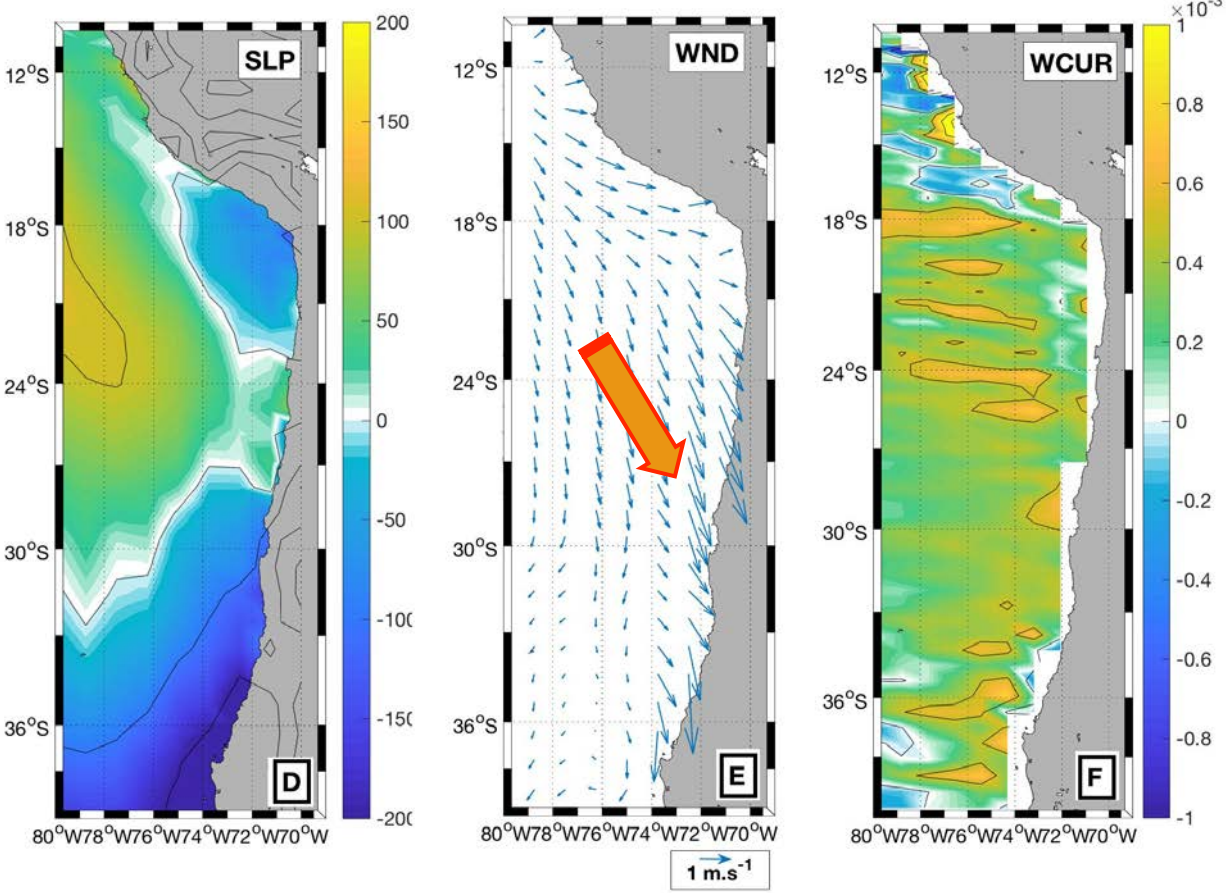

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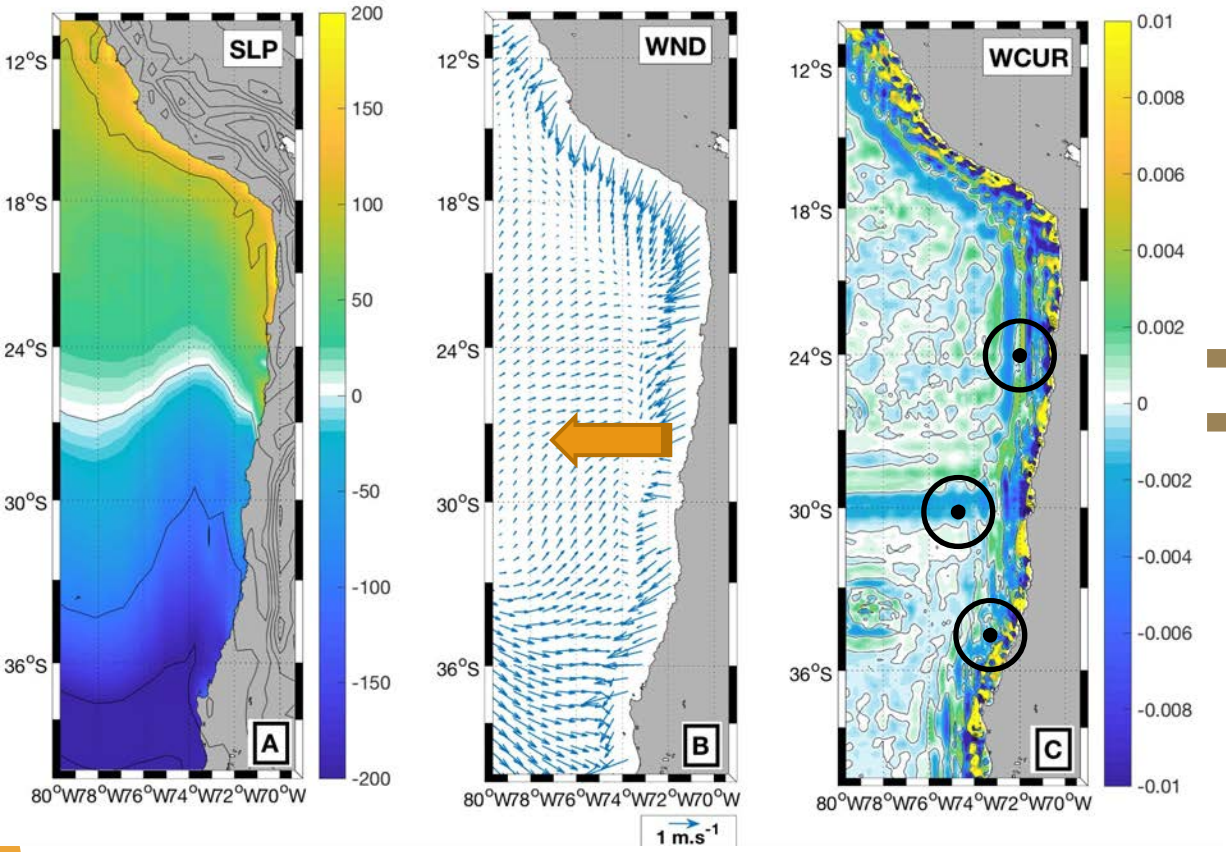

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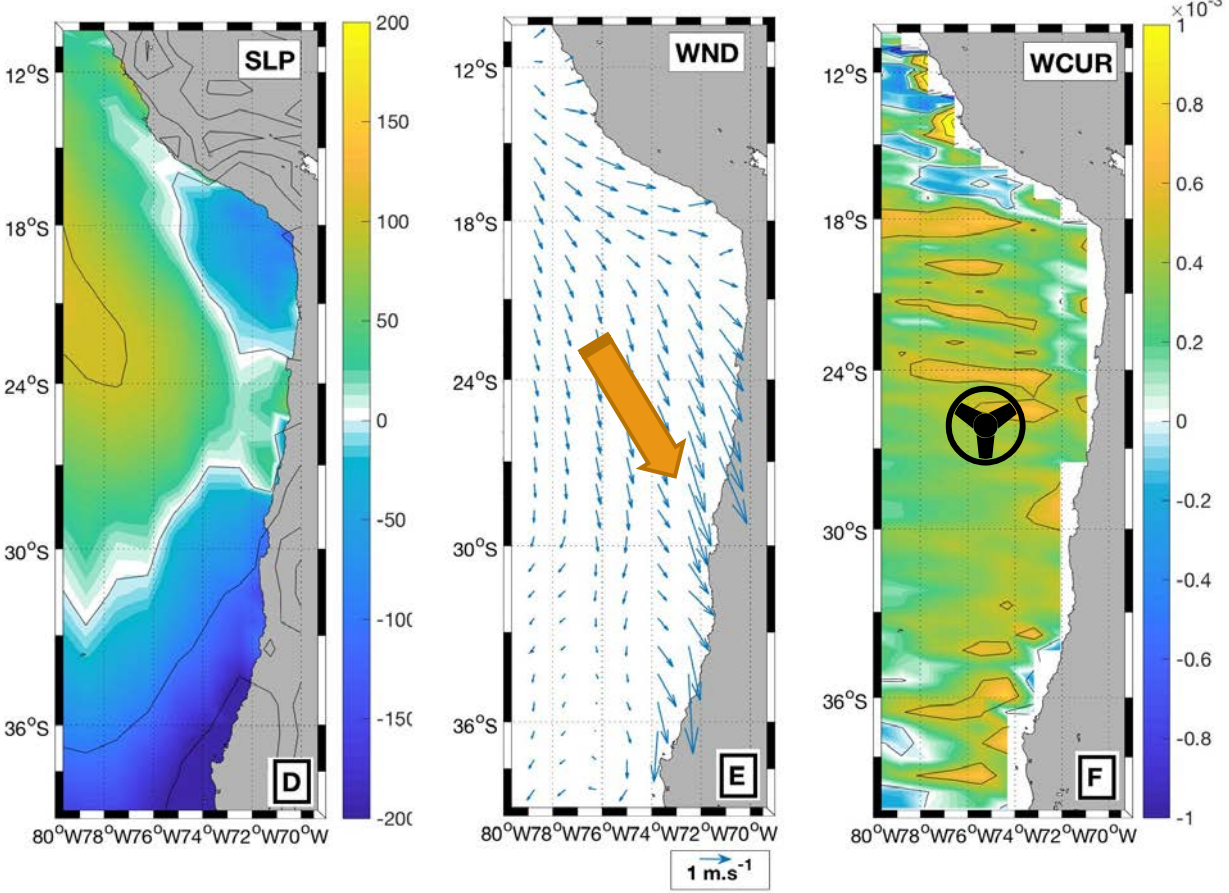

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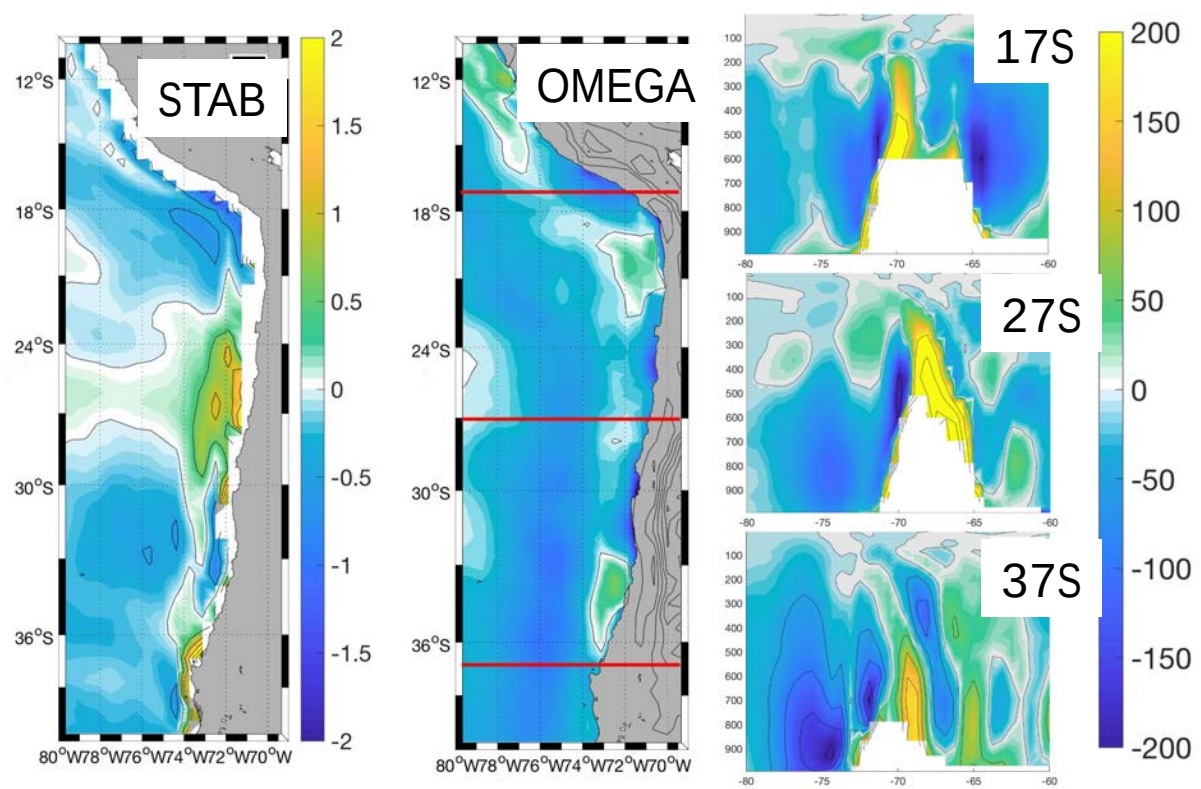

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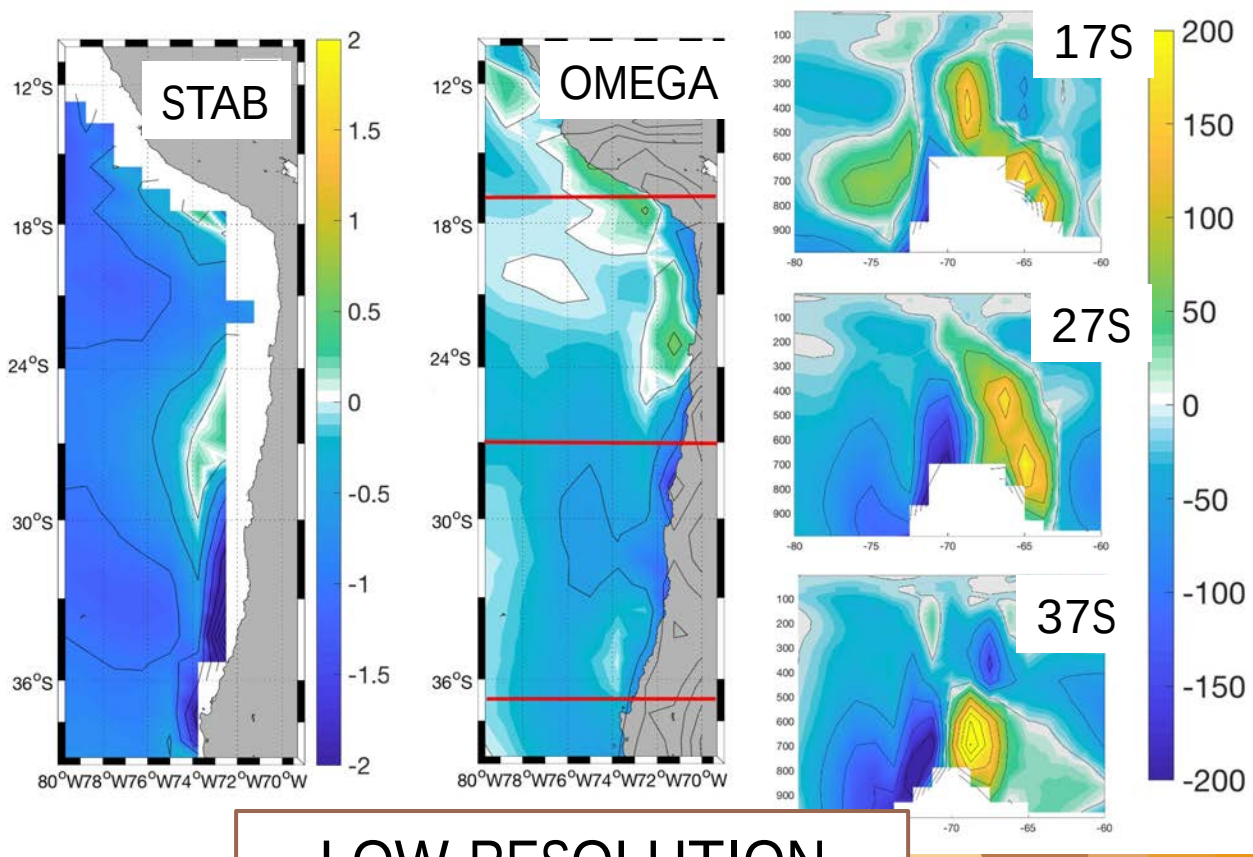

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OMEGA: vertical velocity at 500hPa (Pa.day-1)

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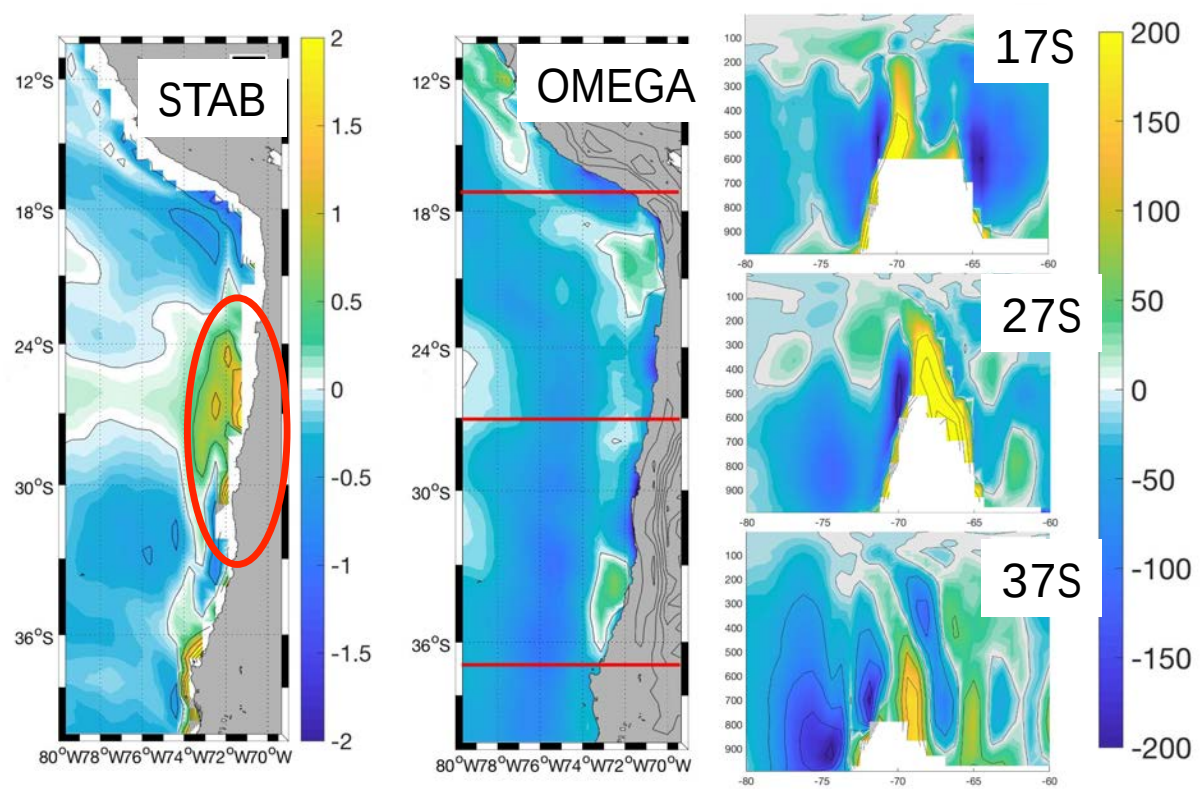

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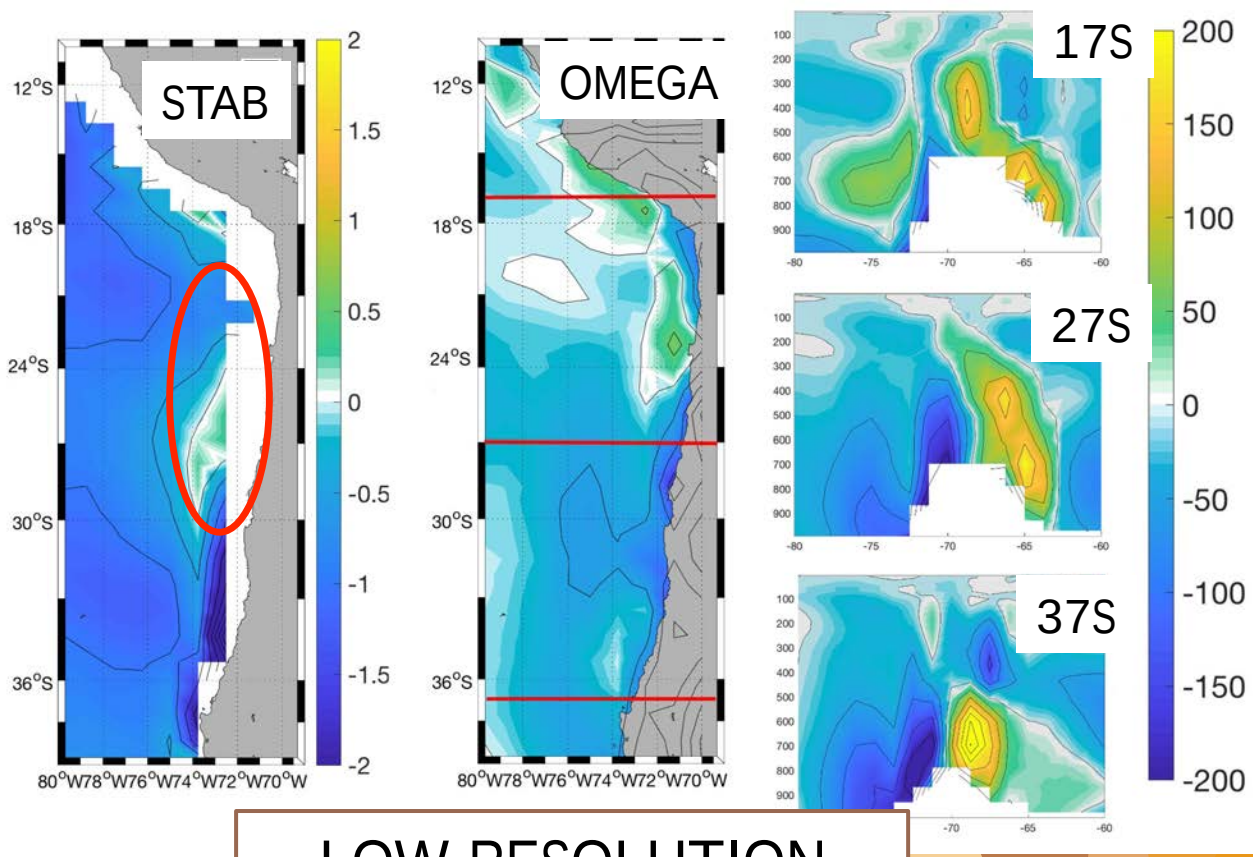

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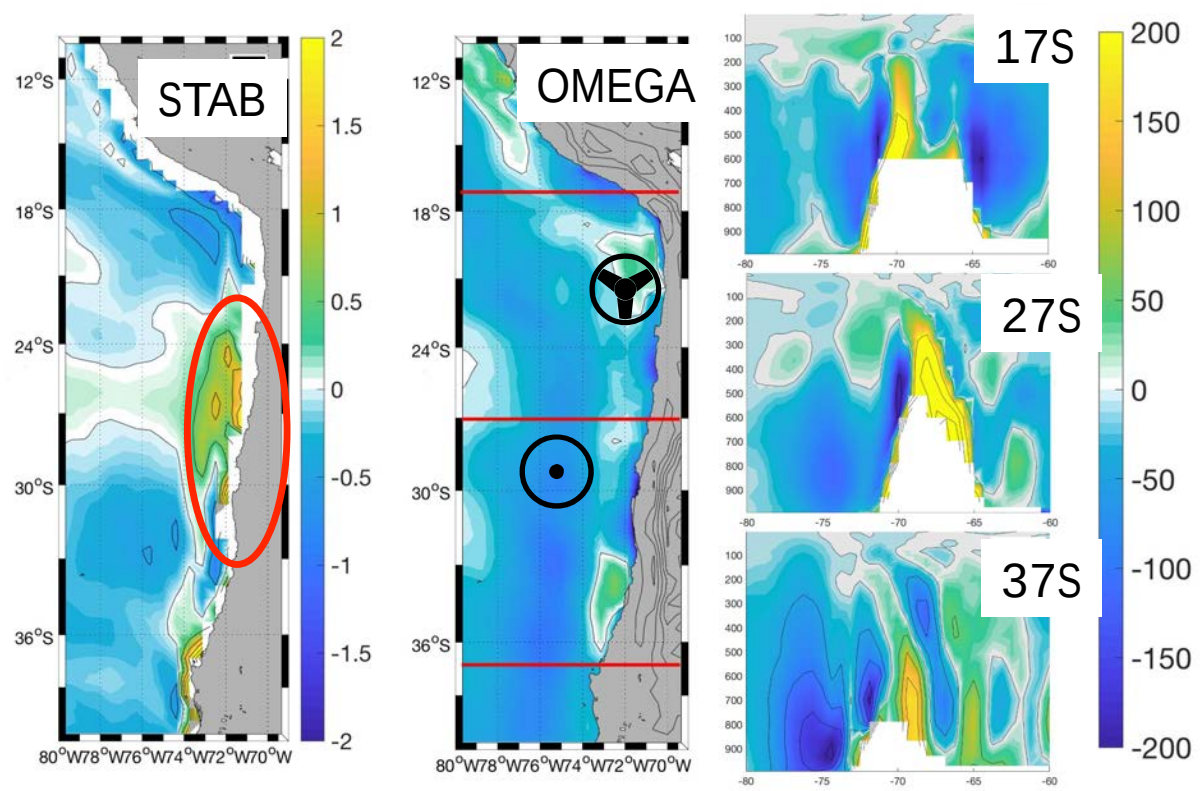

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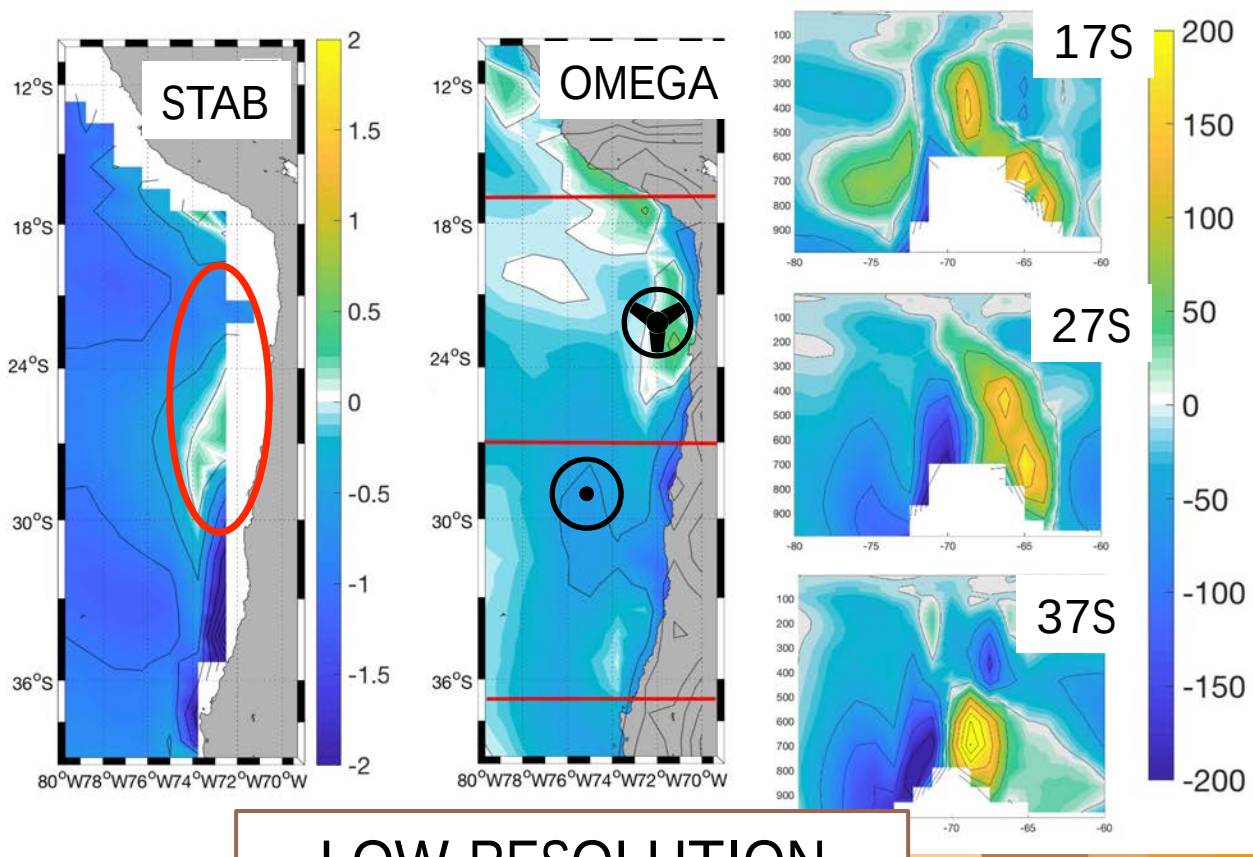

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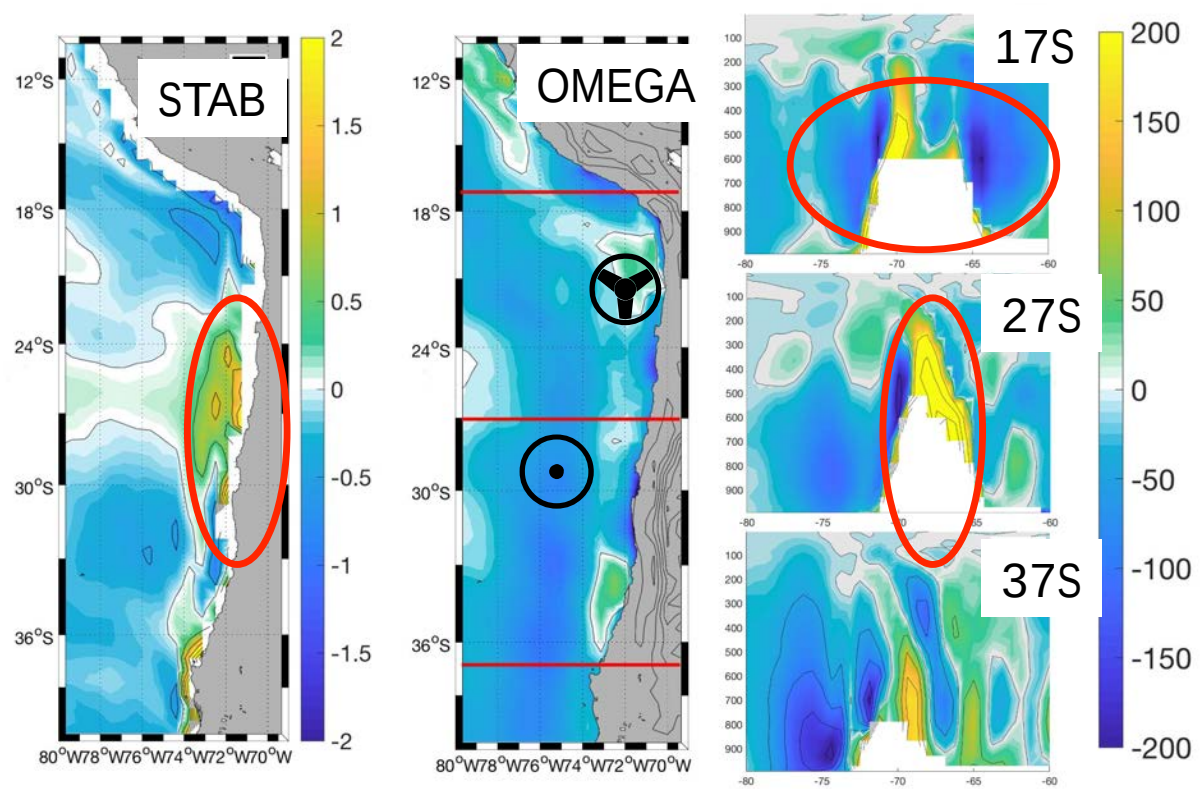

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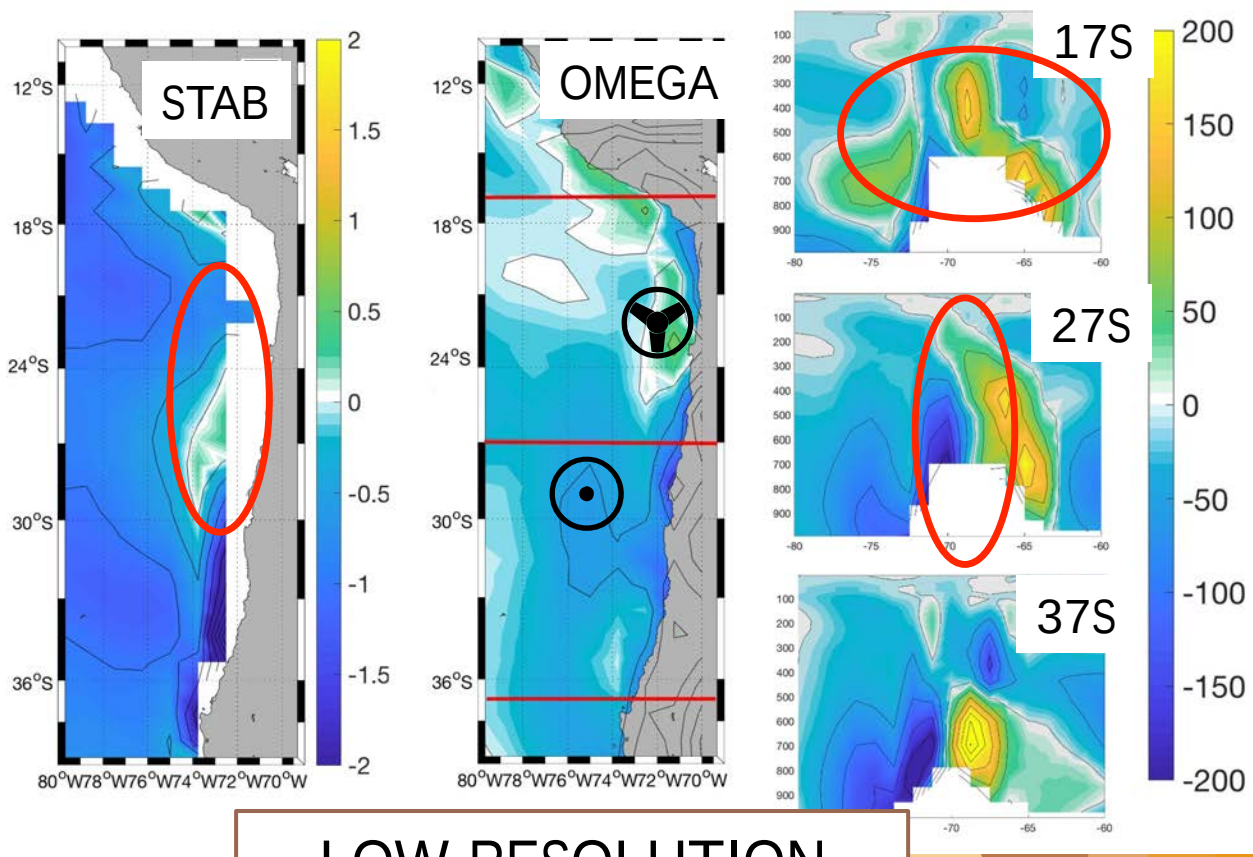

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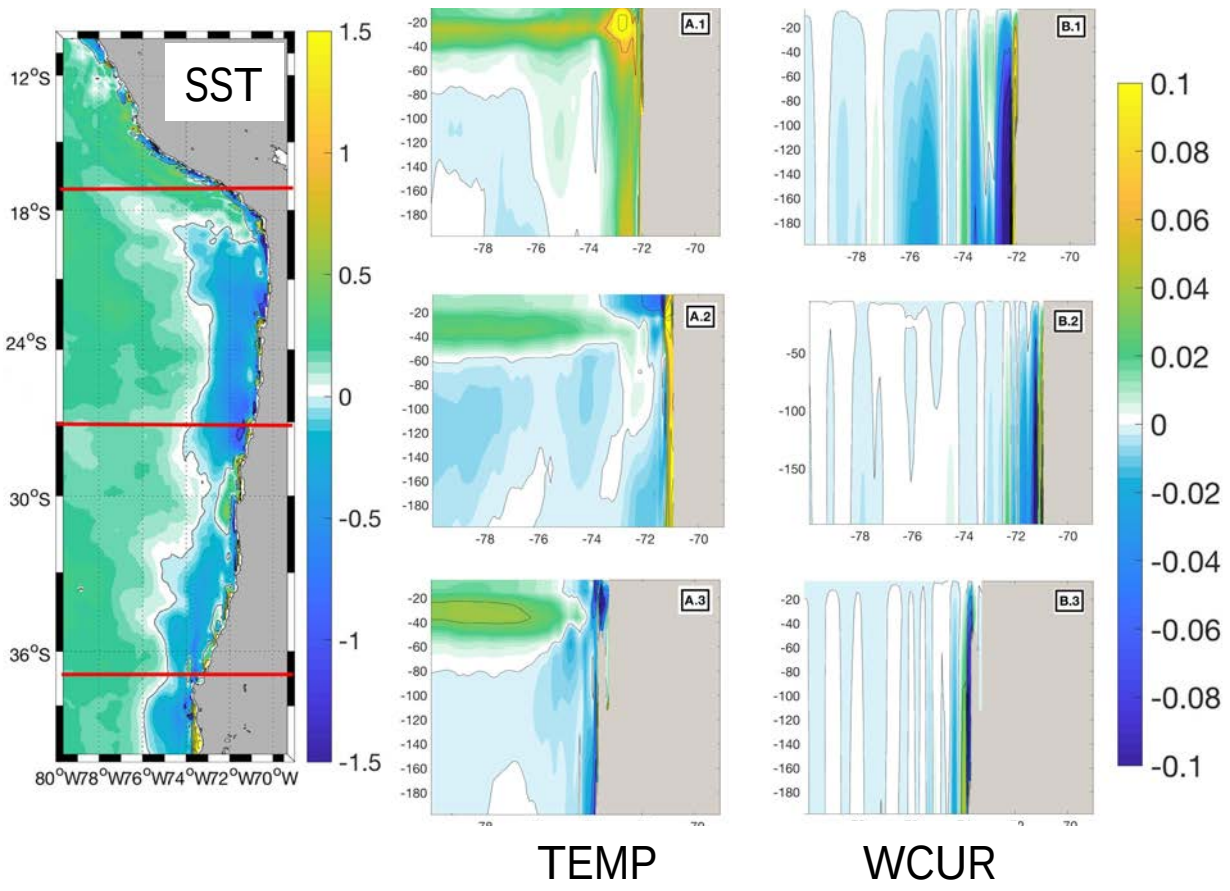

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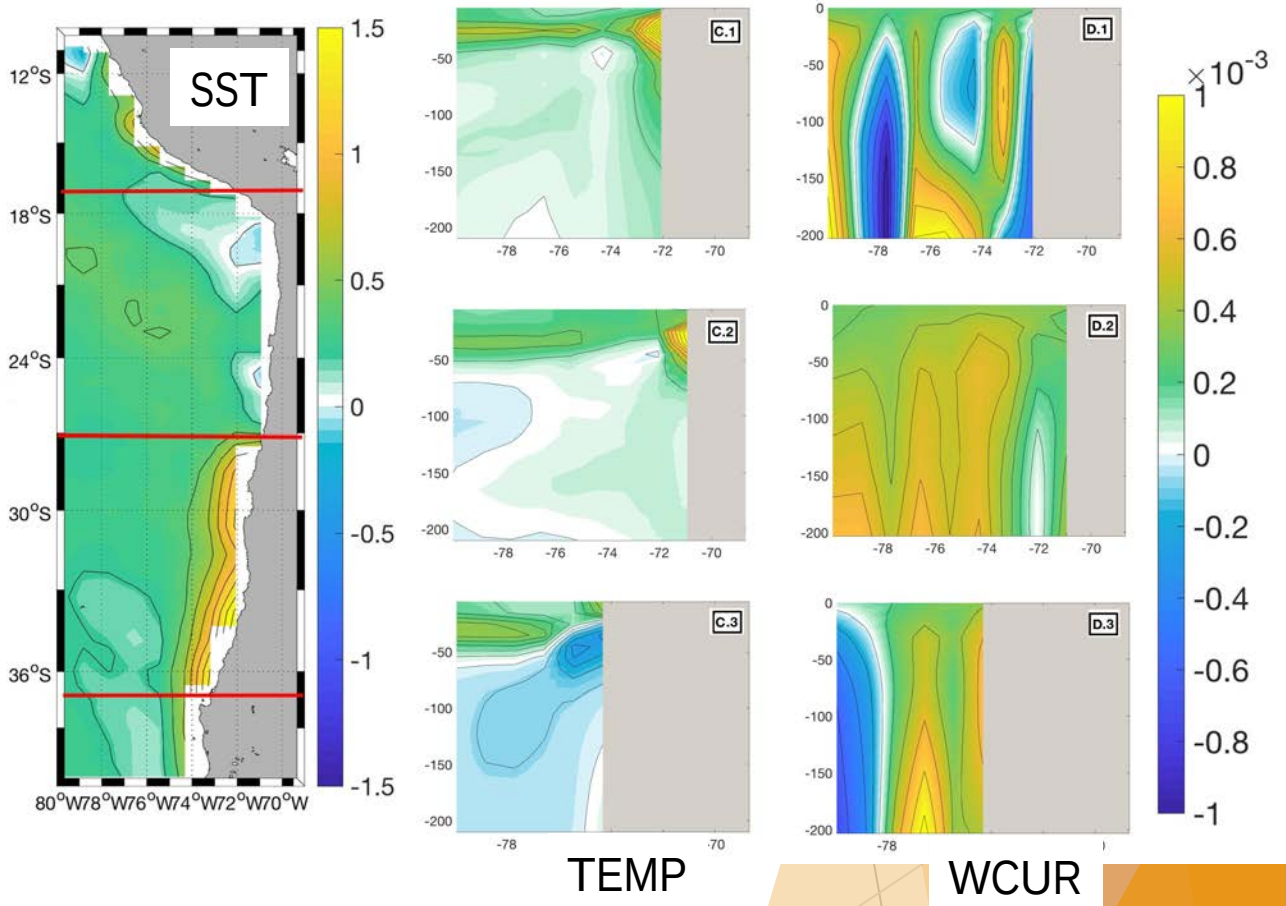

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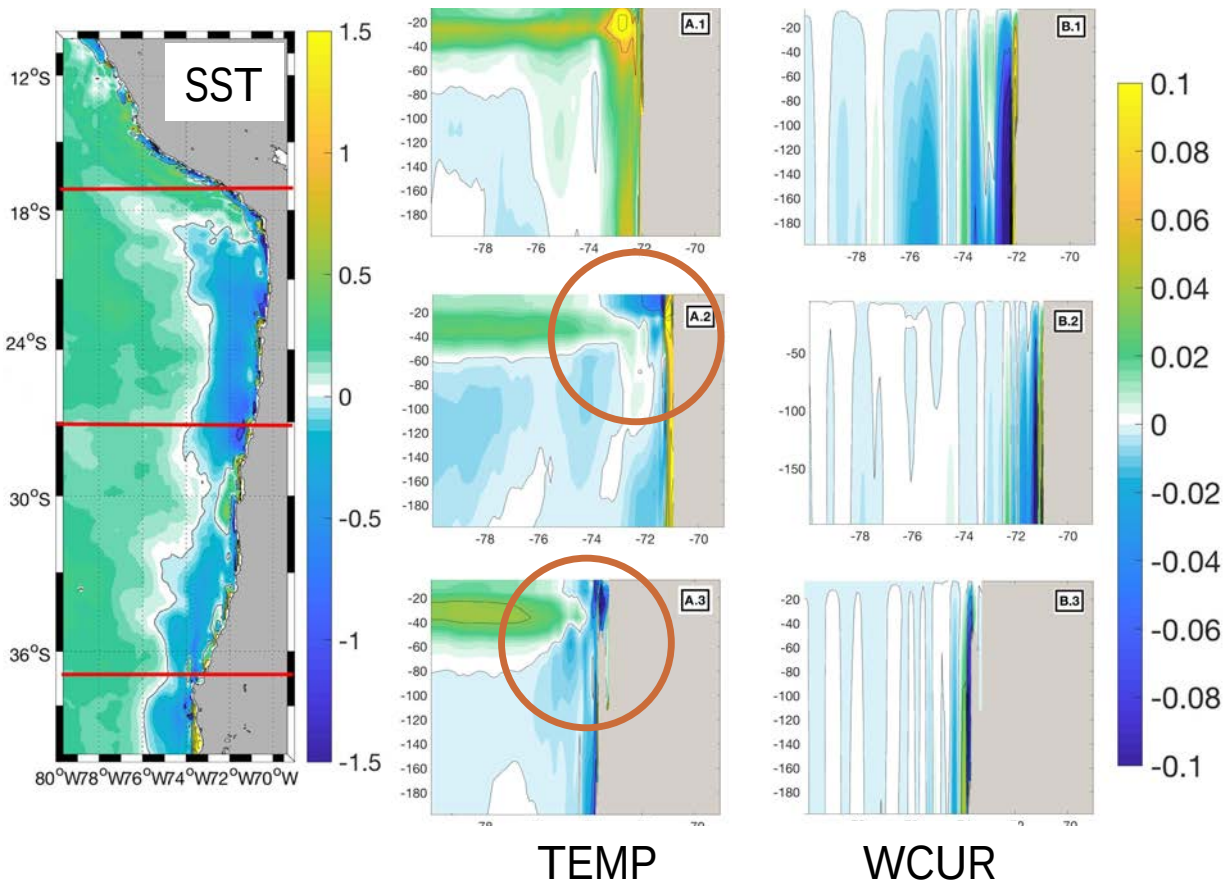

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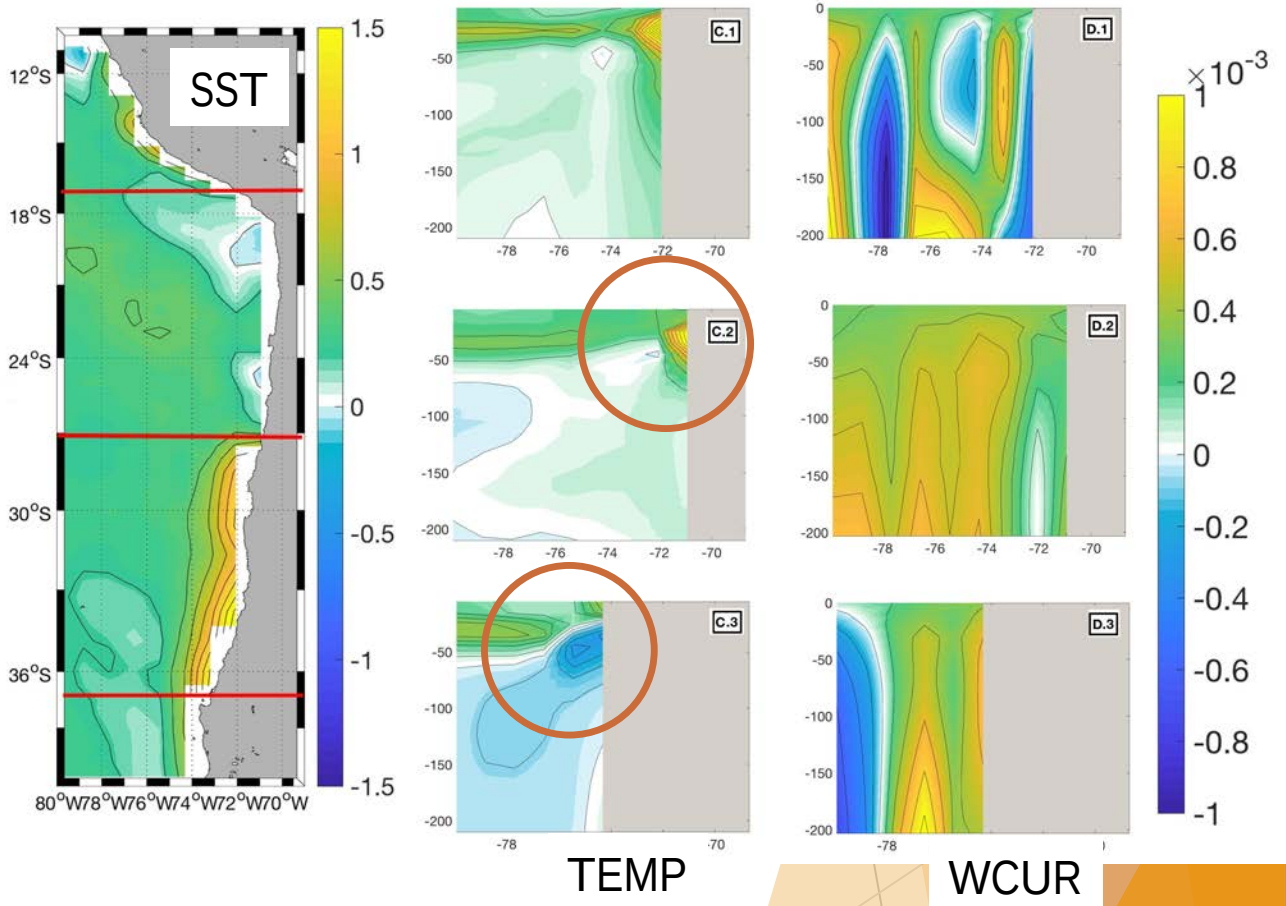

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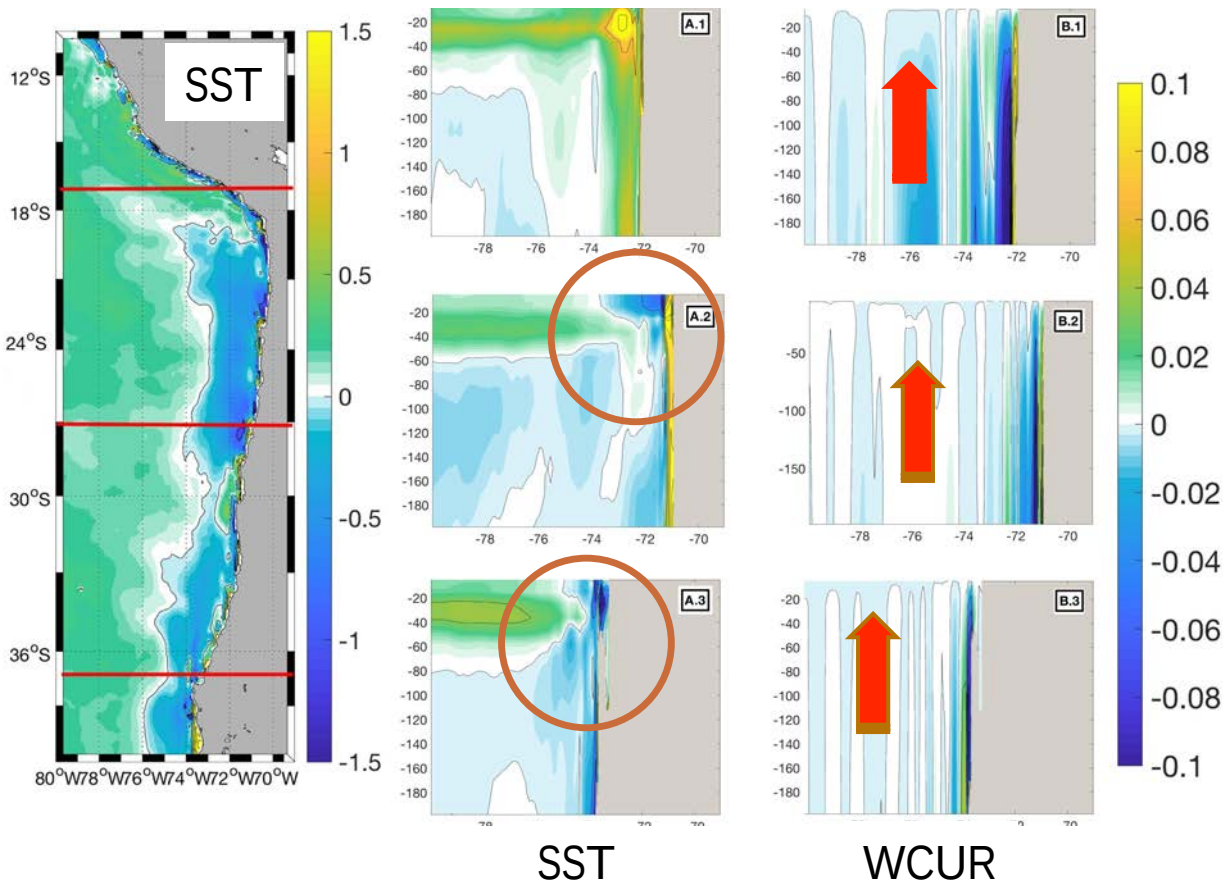

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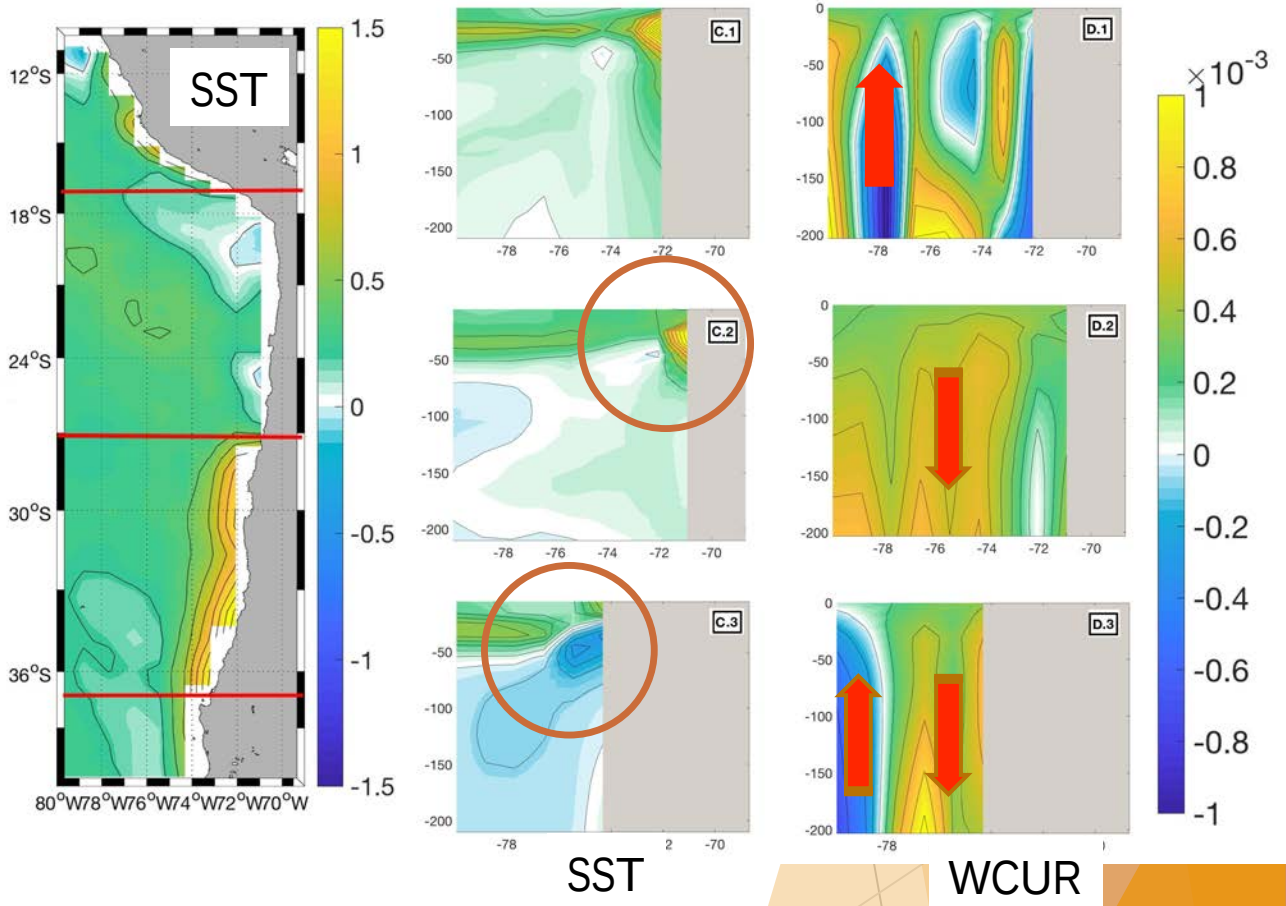

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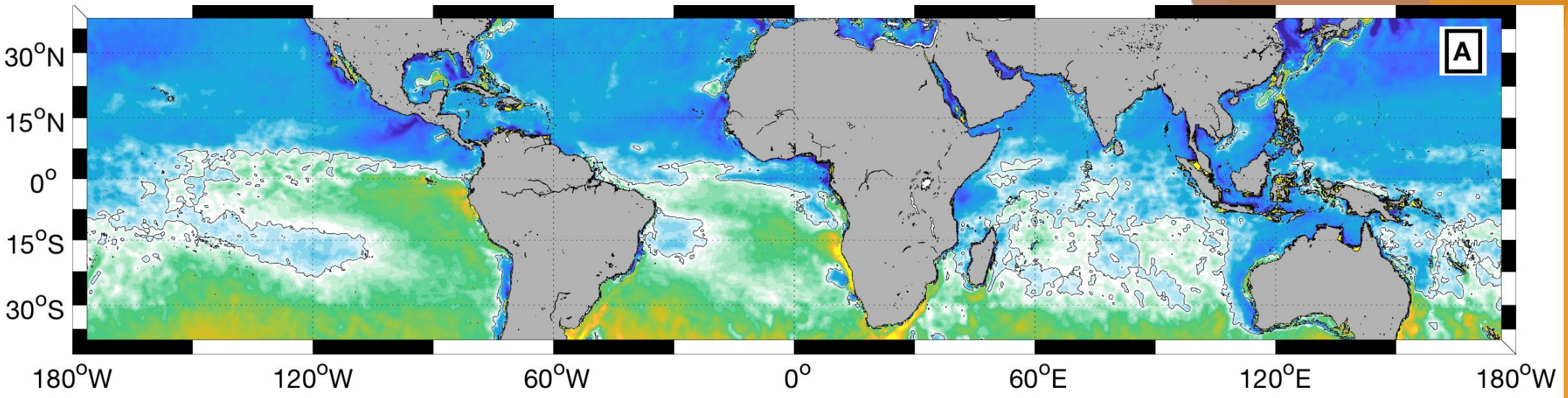

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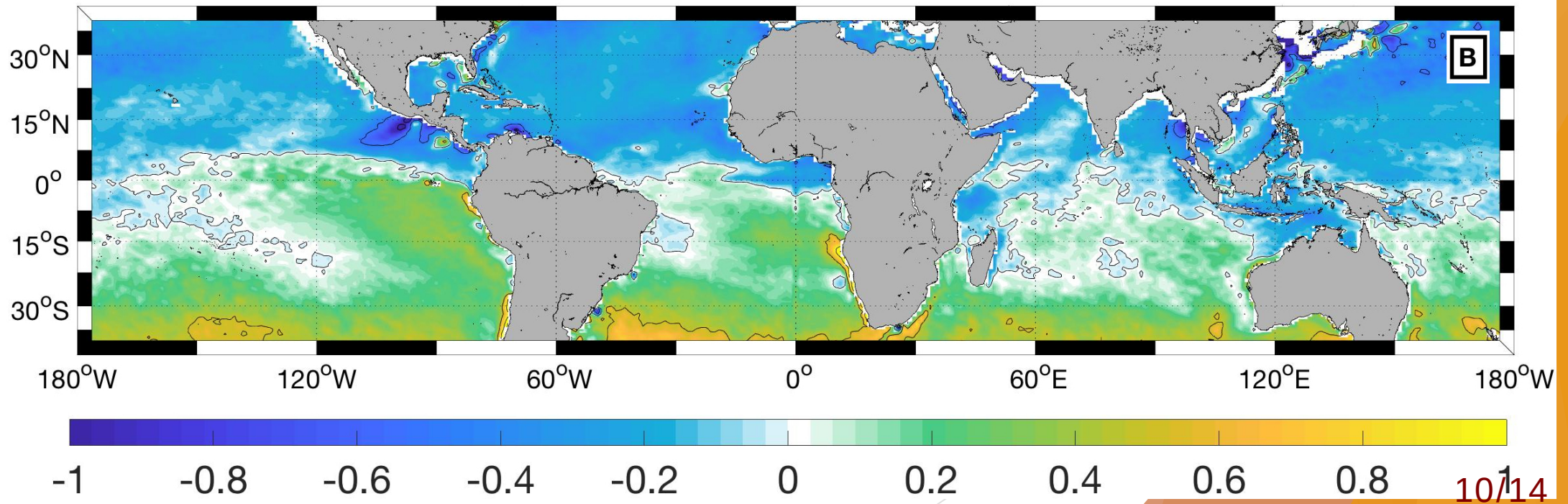

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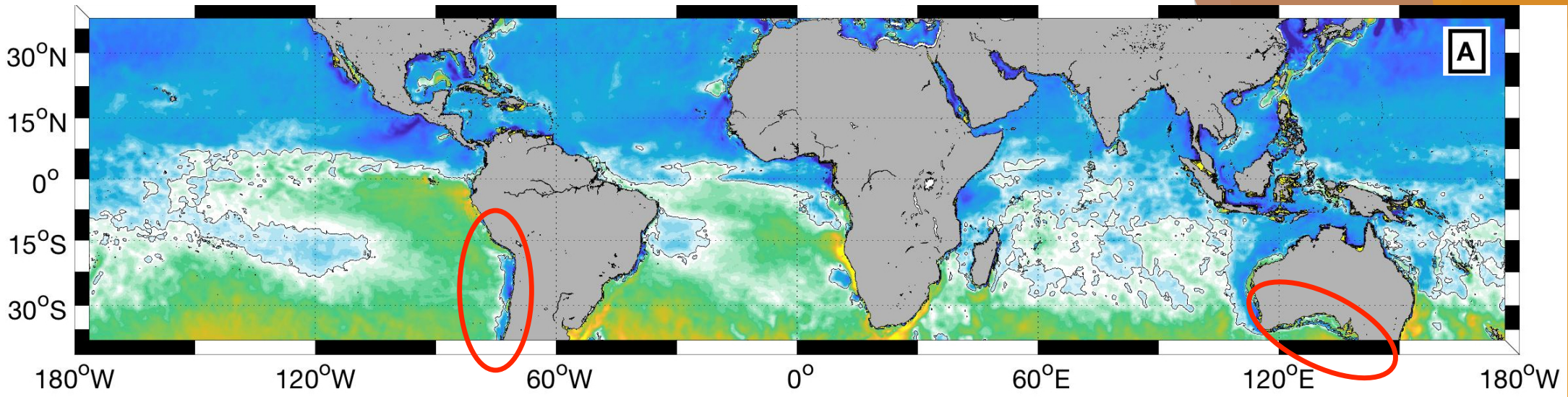

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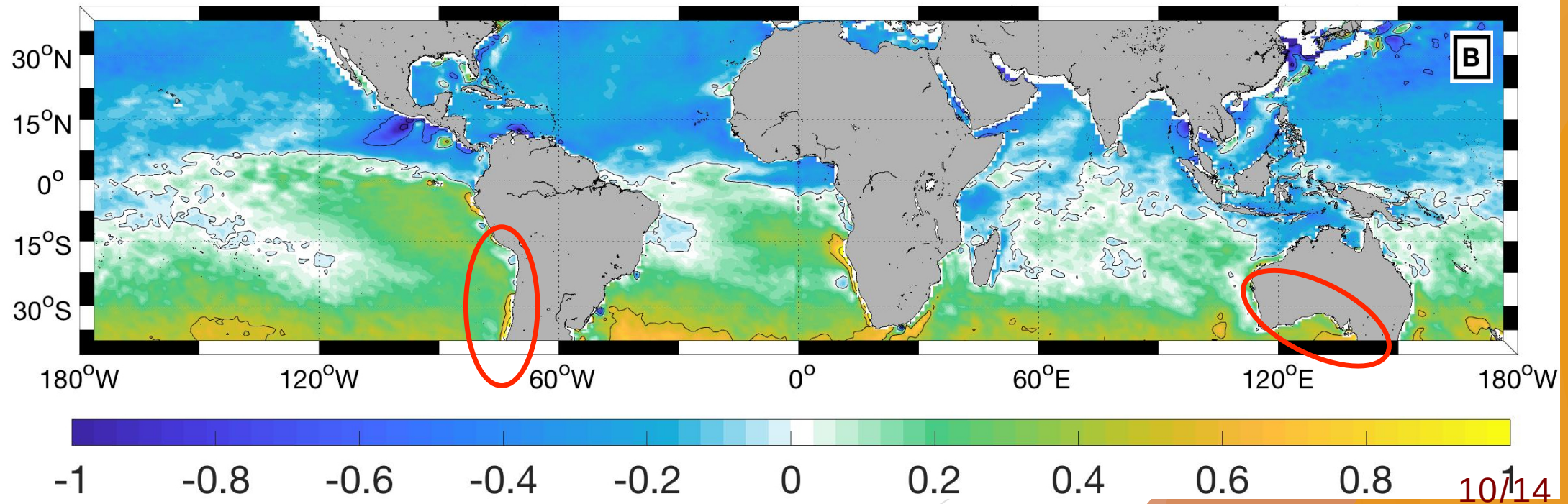

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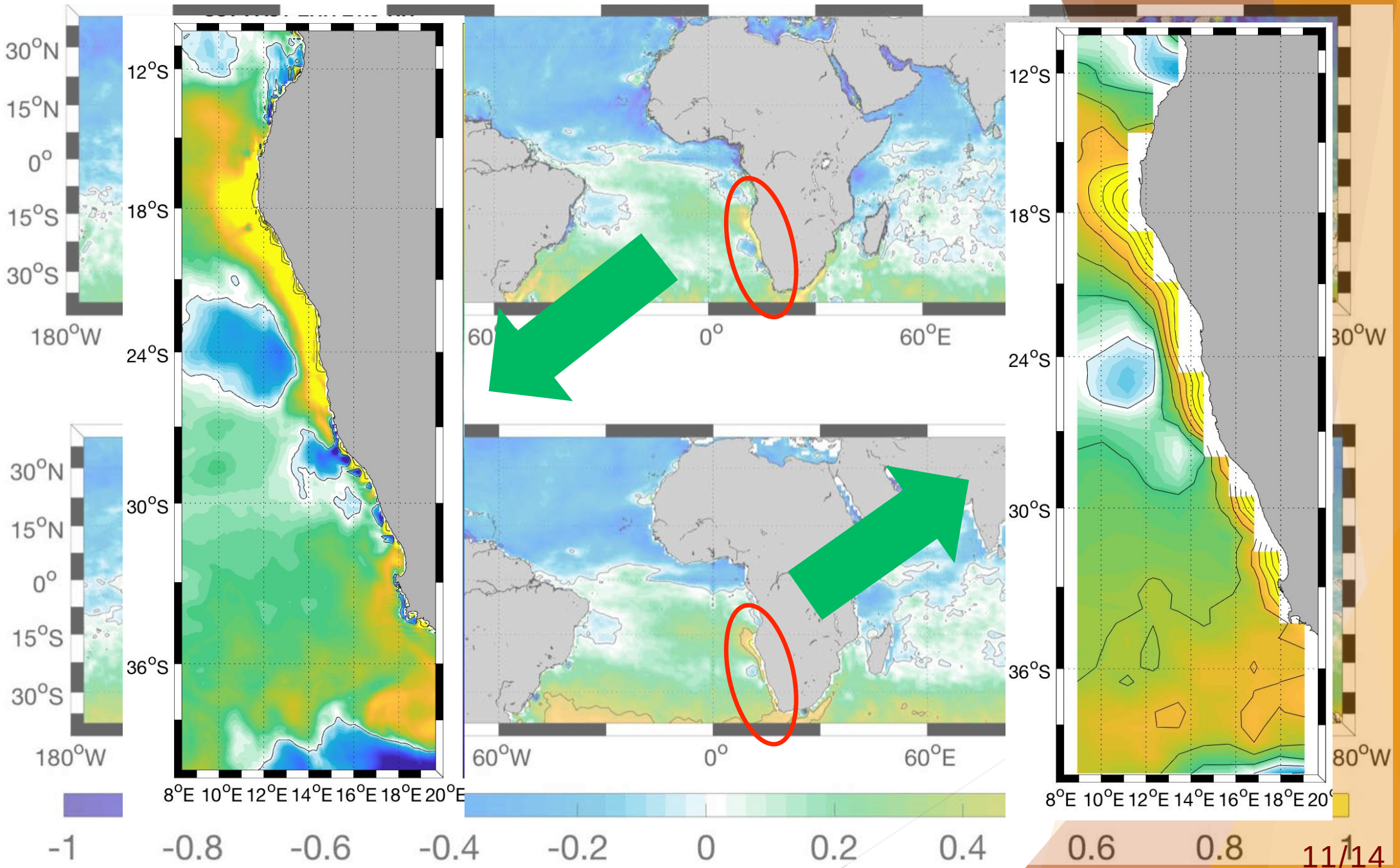

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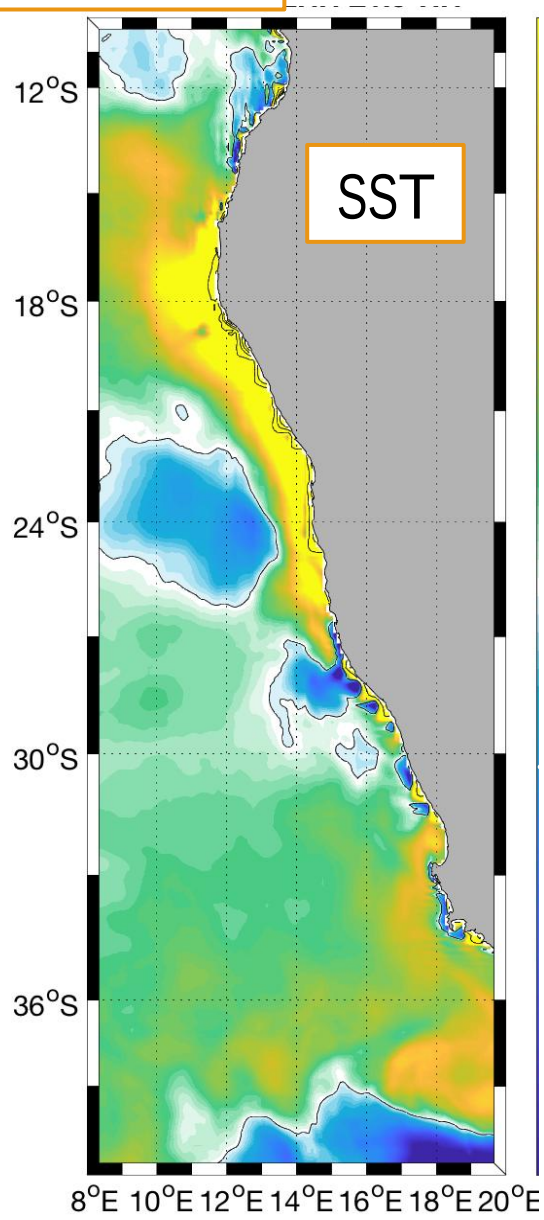

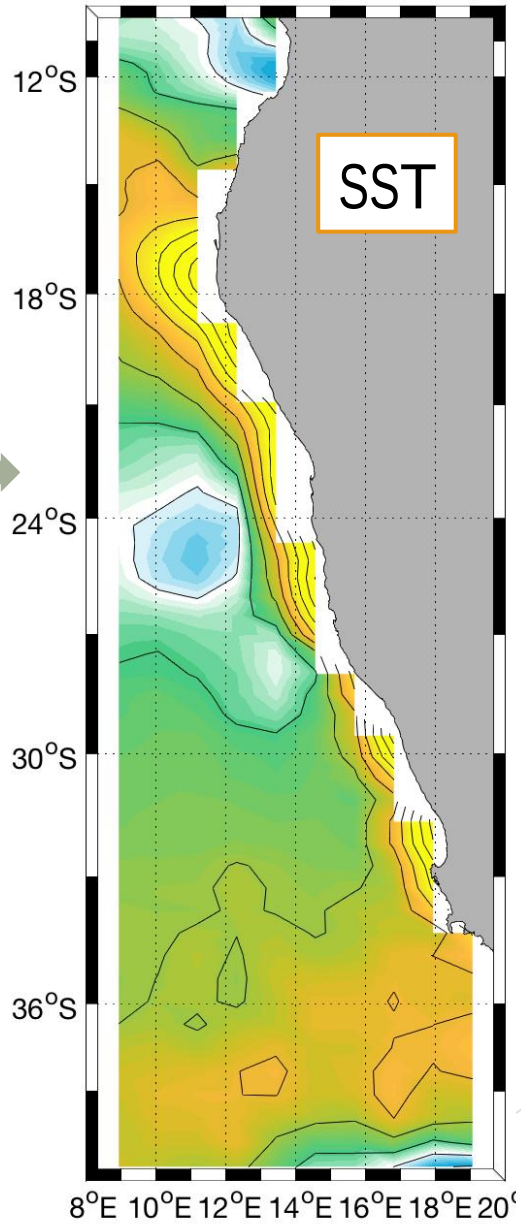

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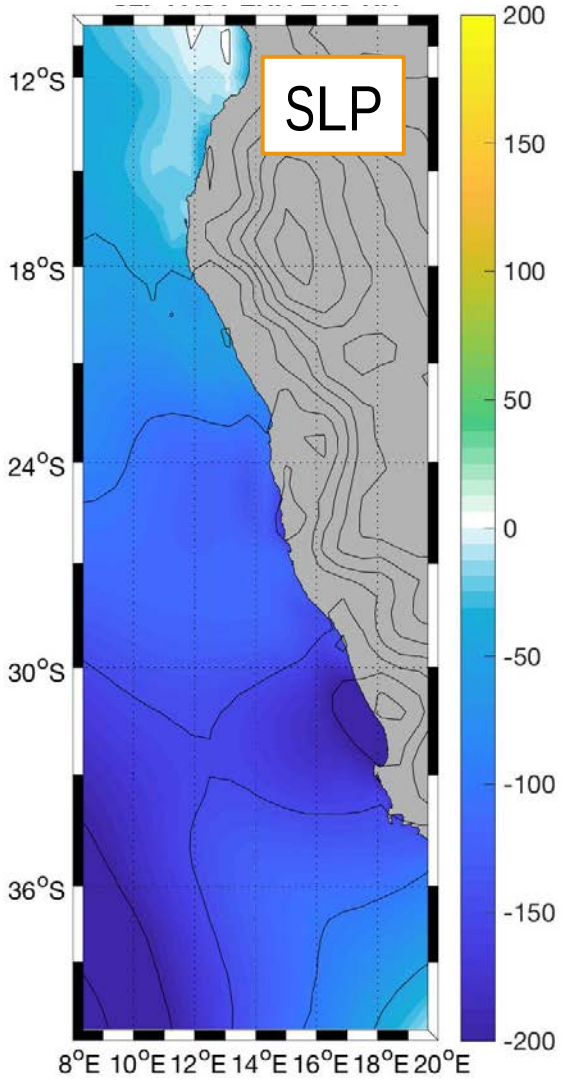

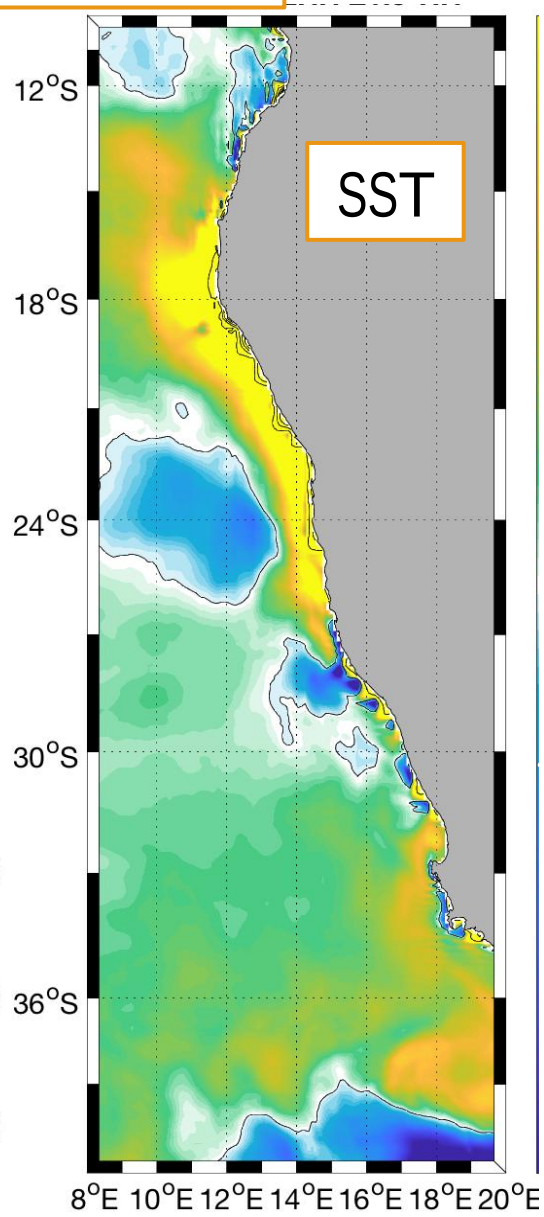

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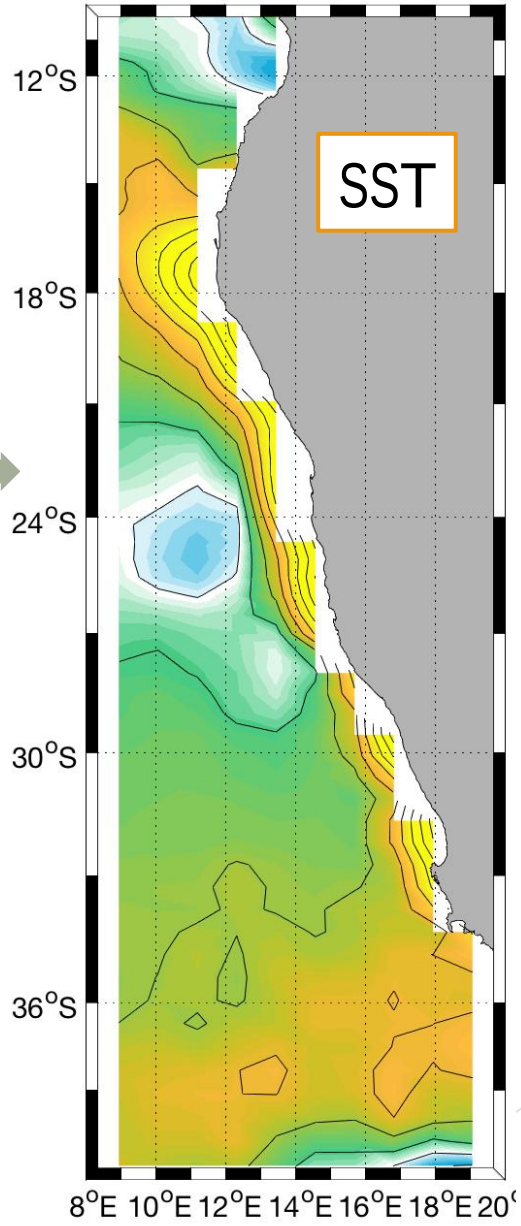
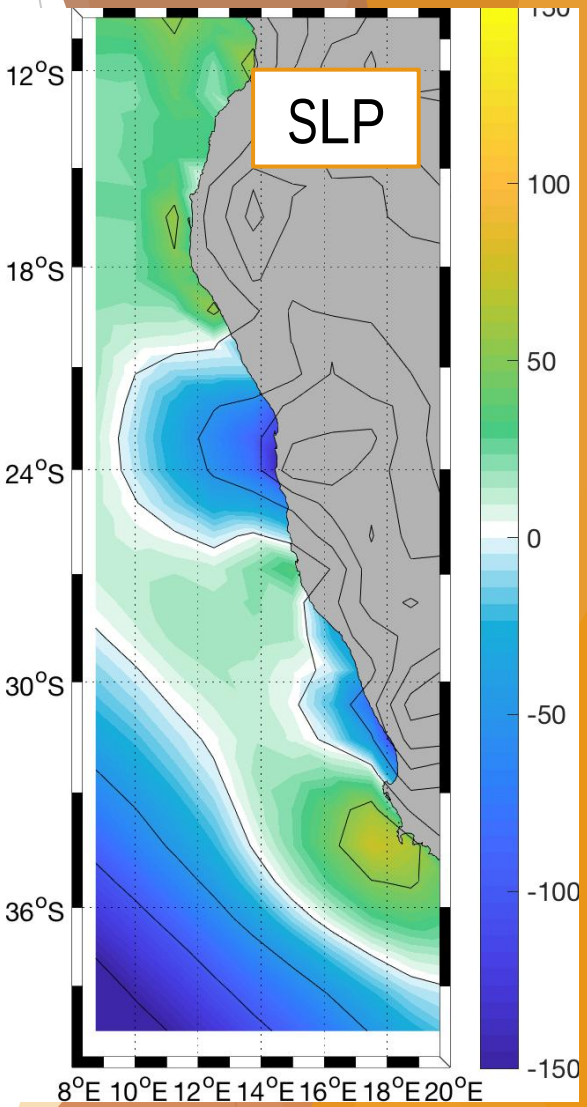




Conclusions

RADIATIVE COMPONENTS ARE SIMILAR FOR BOTH RESOLUTIONS

DO NOT EXPLAIN THE DIFFERENCES

BUT DIFFERENCES IN TURBULENT FLUXES SHOW THE HIGH COUPLING FOR THE HR

WIND, SLP DIFFERENCES

UPWELLING

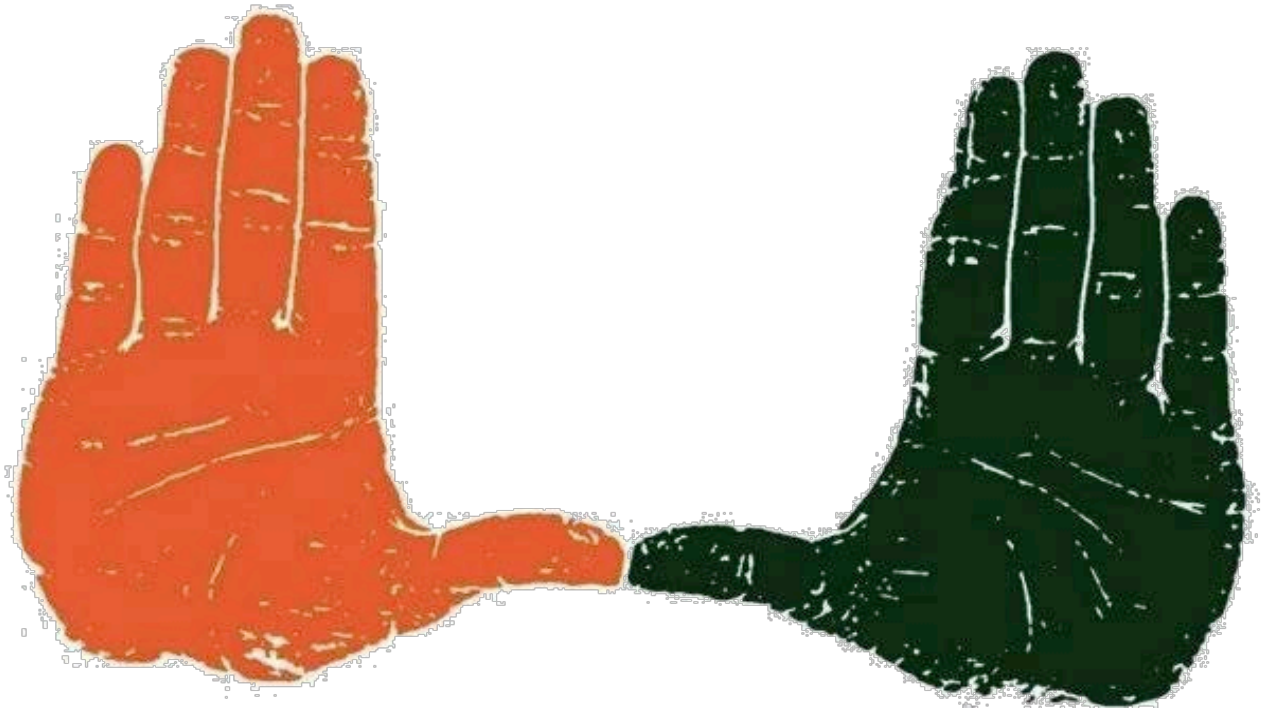
SST FAST ERRORS

COASTAL SHAPE

CONCAVE COAST LINES WHITH A EASTERN BOUNDARY CURRENT

RESOLVES THE COAST LINE AND THE OCEAN DYNAMICS STRONGER AIR-SEA COUPLING

Thank you!



isilveira@rsmas.miami.edu

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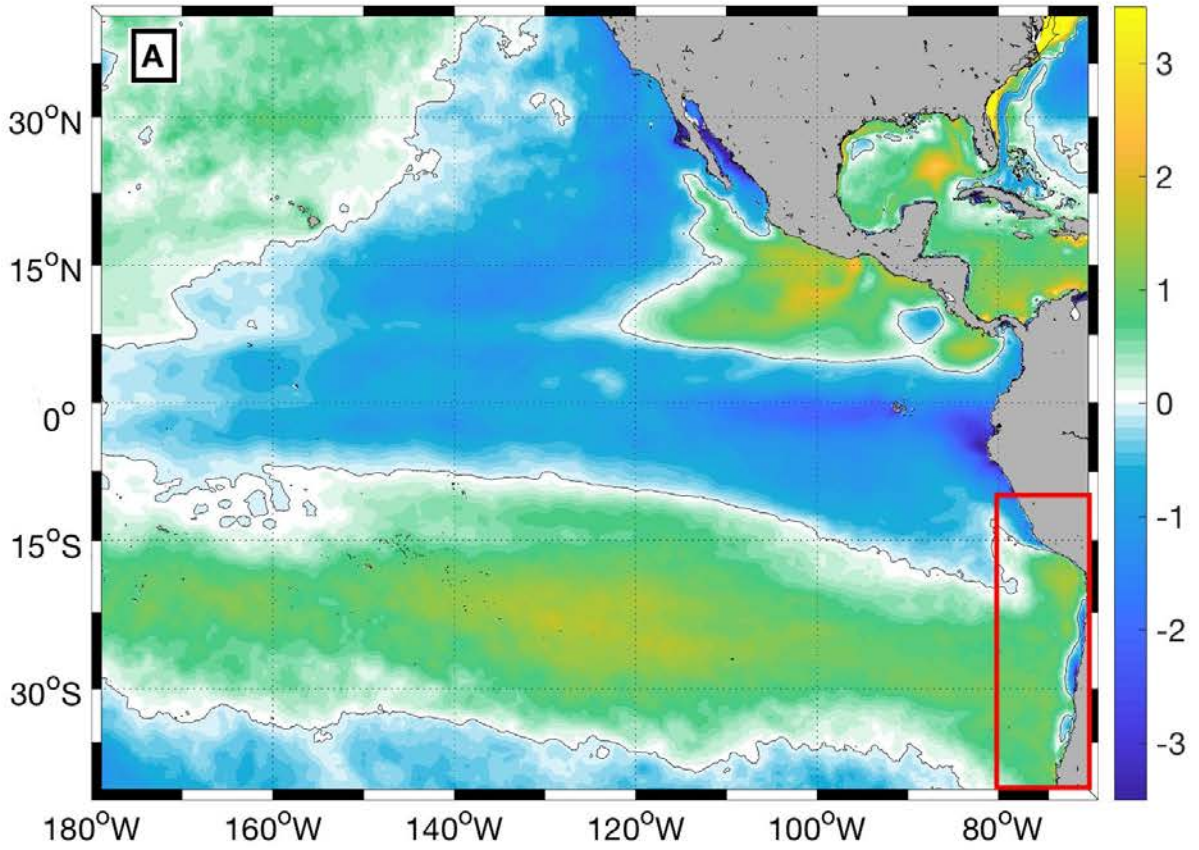

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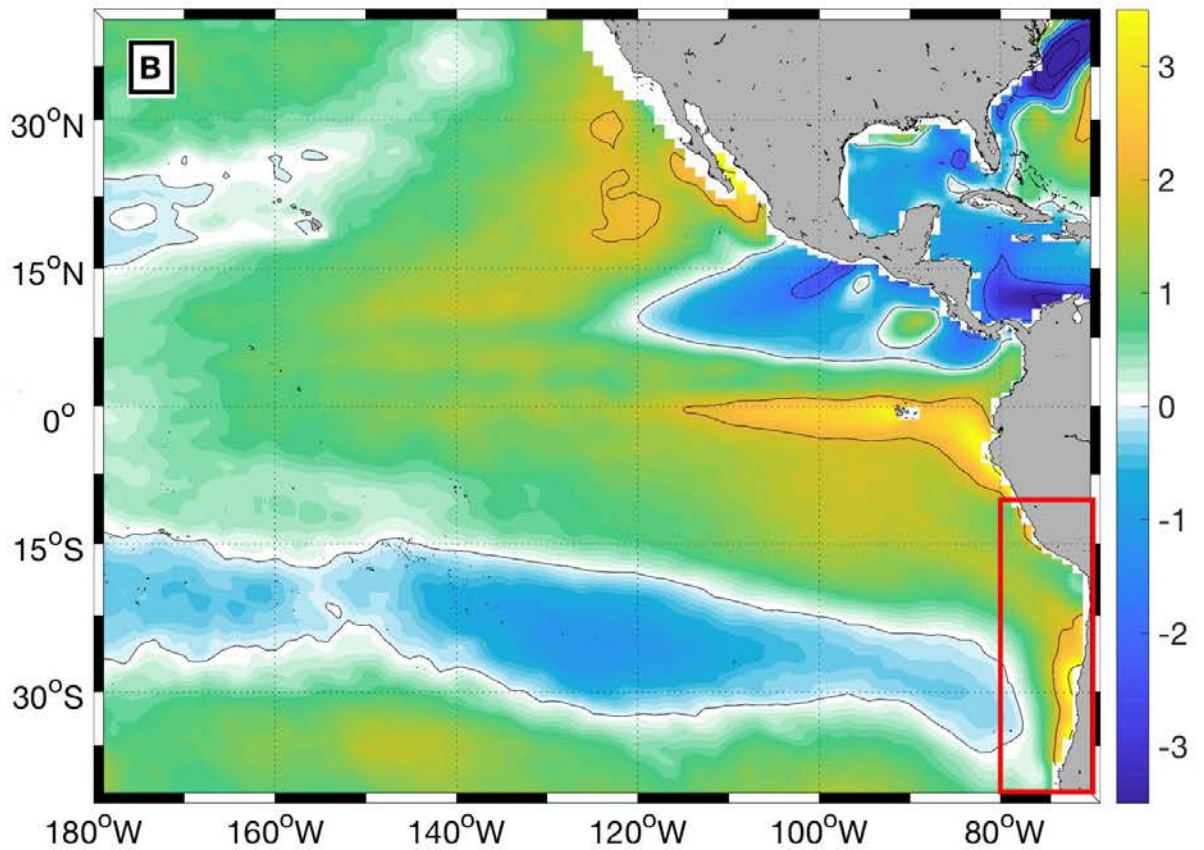

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