

Marine Heatwaves in the South Atlantic

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Premise

- **Marine heatwaves** in the western South Atlantic during austral summer are associated with **atmospheric blocking** events that prevent the establishment of the South Atlantic Convergence Zone (SACZ) as part of the South American Monsoon System

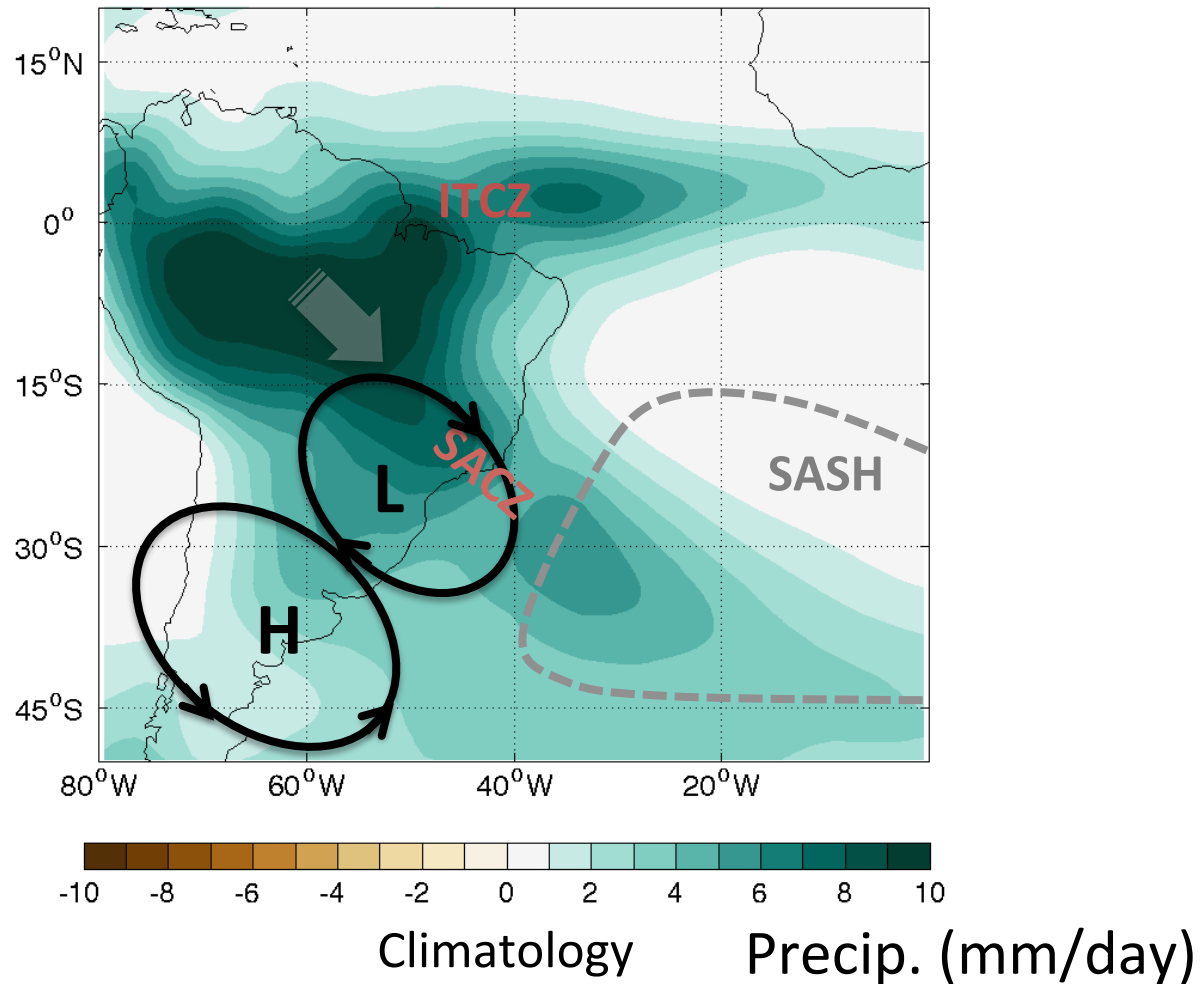
Part I: Atmospheric Blocking

Part II: Marine Heatwaves



Part I: South American Monsoon System

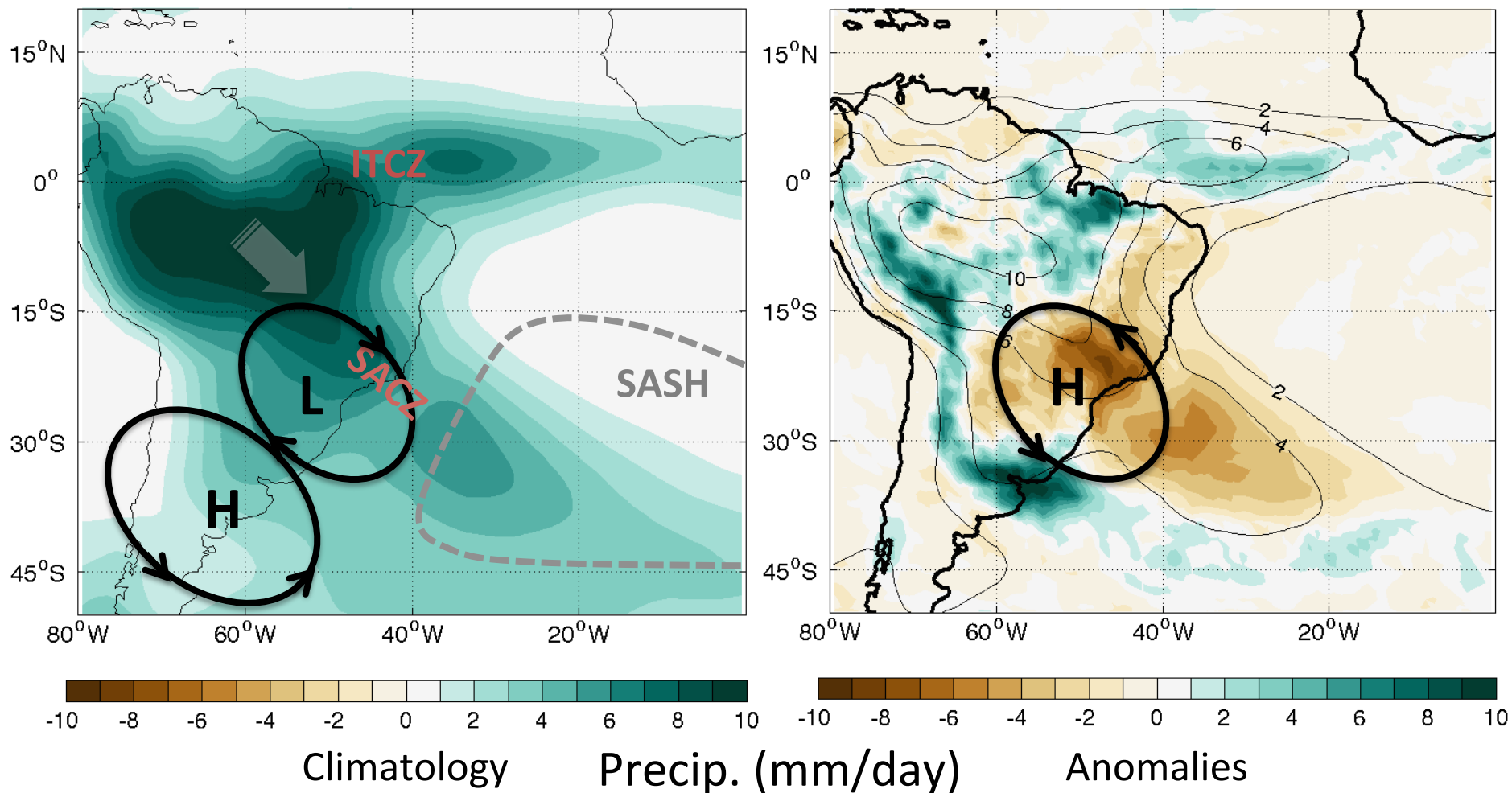
Background:
Summer Rainy Season (DJFM)



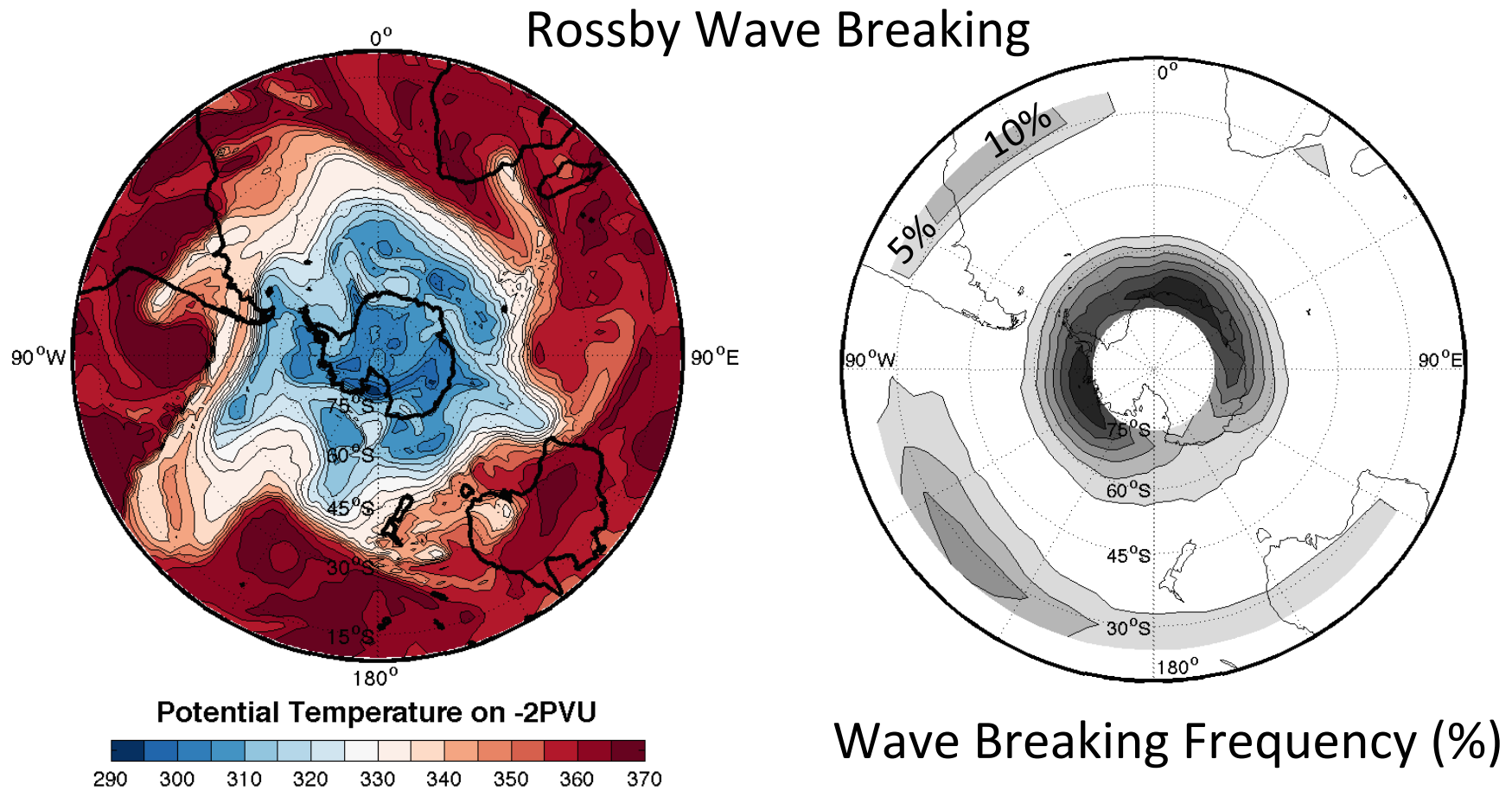
Part I: South American Monsoon System

Background:
Summer Rainy Season (DJFM)

Motivation:
Summer 2013/2014

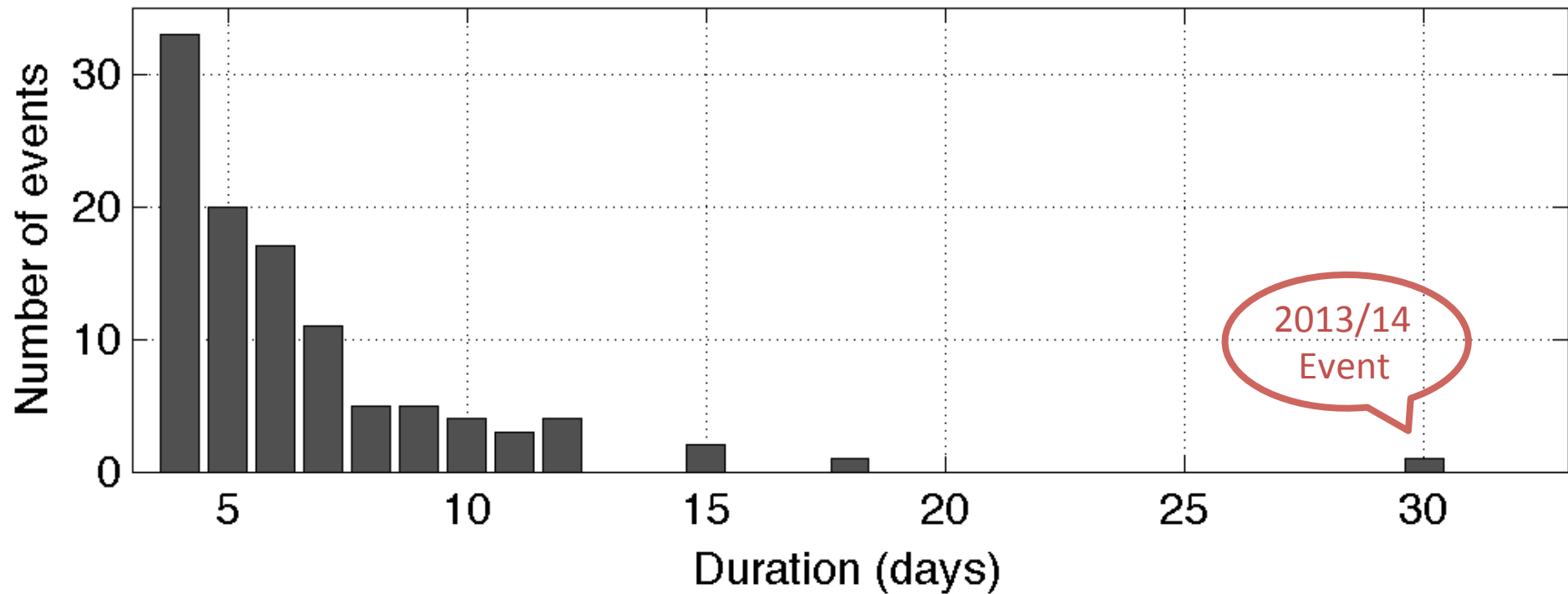


Part I: Atmospheric blocking over the subtropical South America (SSA)



Berrisford et al. (2007), ERA-Interim (1979-2014)

Part I: SSA Blocking Duration (DJFM)

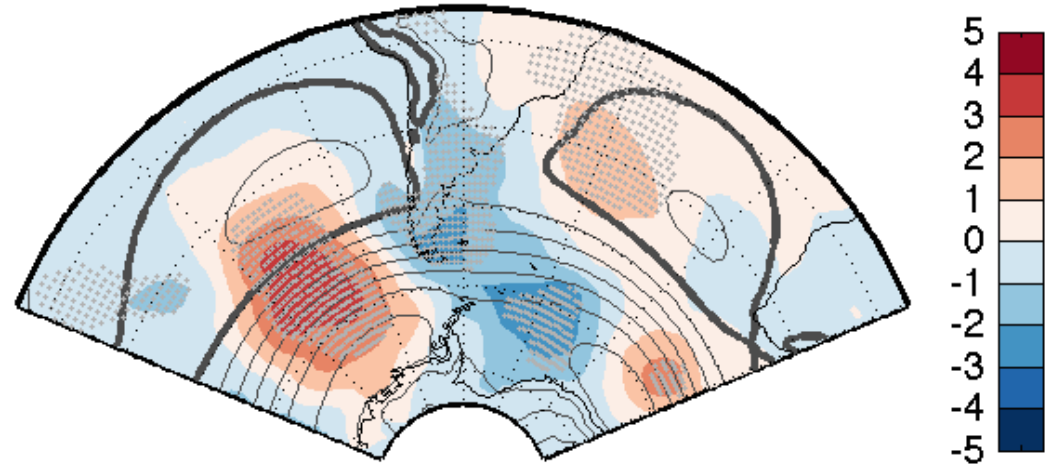


Total of 106 events and (772 out of a possible 4356 DJFM days)

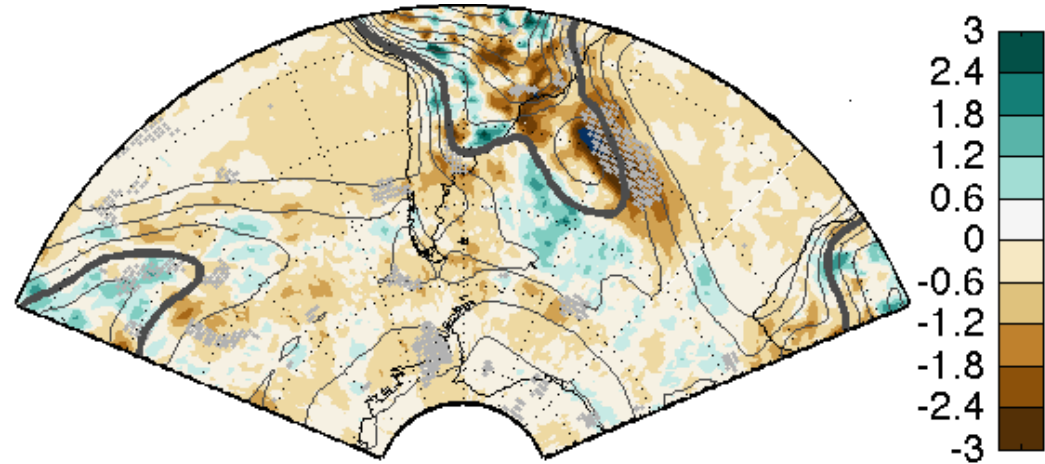
Part I: SSA Blocking Impacts

SSA Blocking Composites

Mean Sea-level Pressure



Precipitation

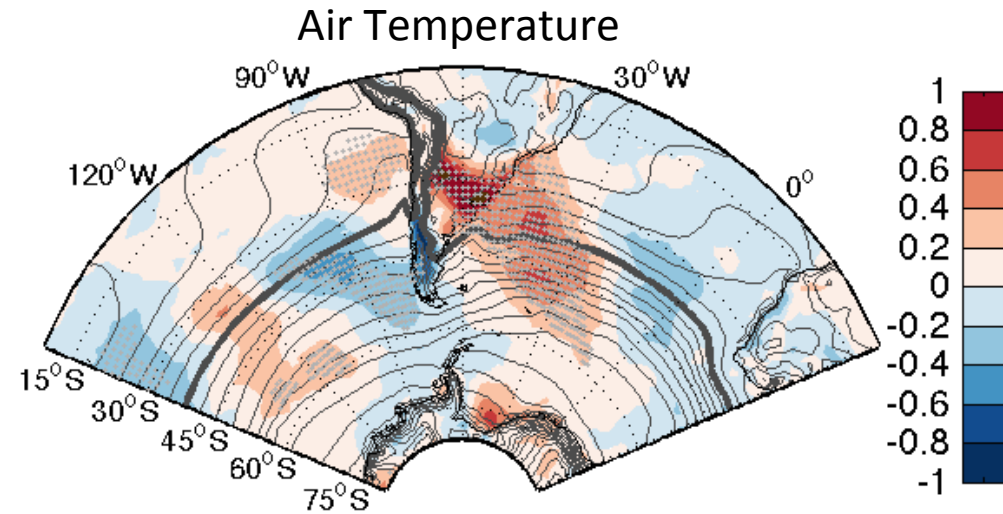


Anomalies (shading)
Climatology (contours)

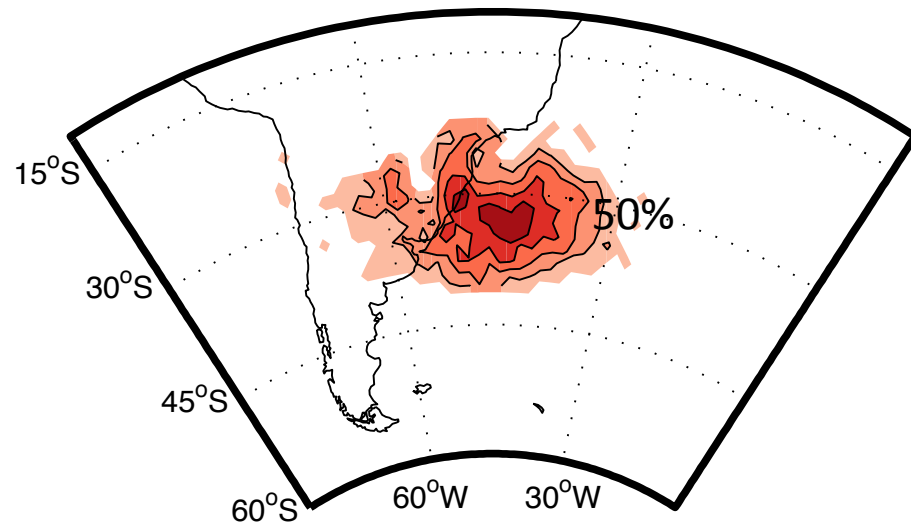
Part I: SSA Blocking Impacts

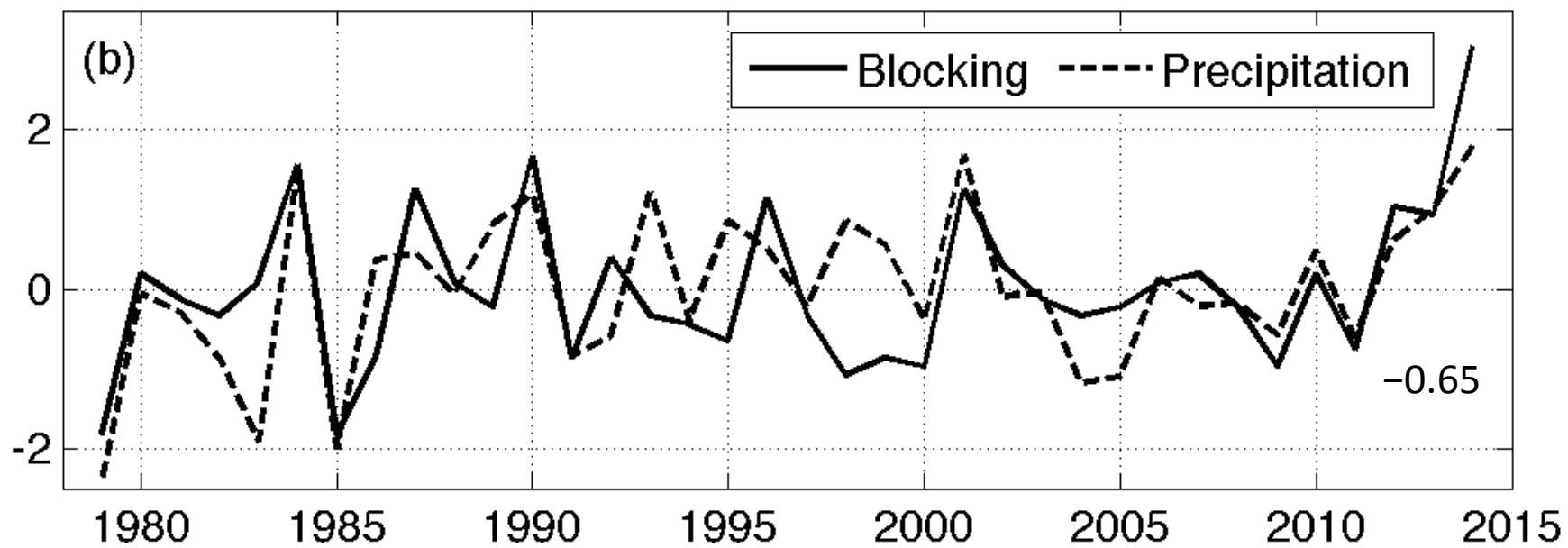
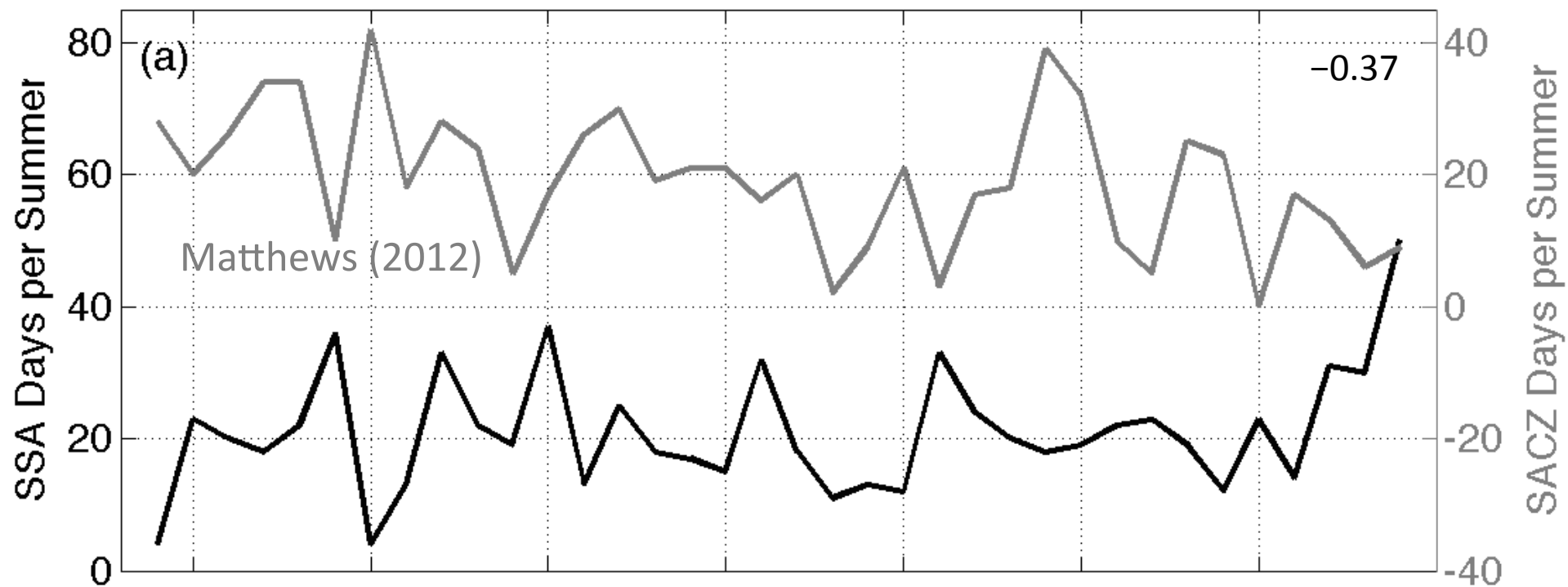
SSA Blocking Composites

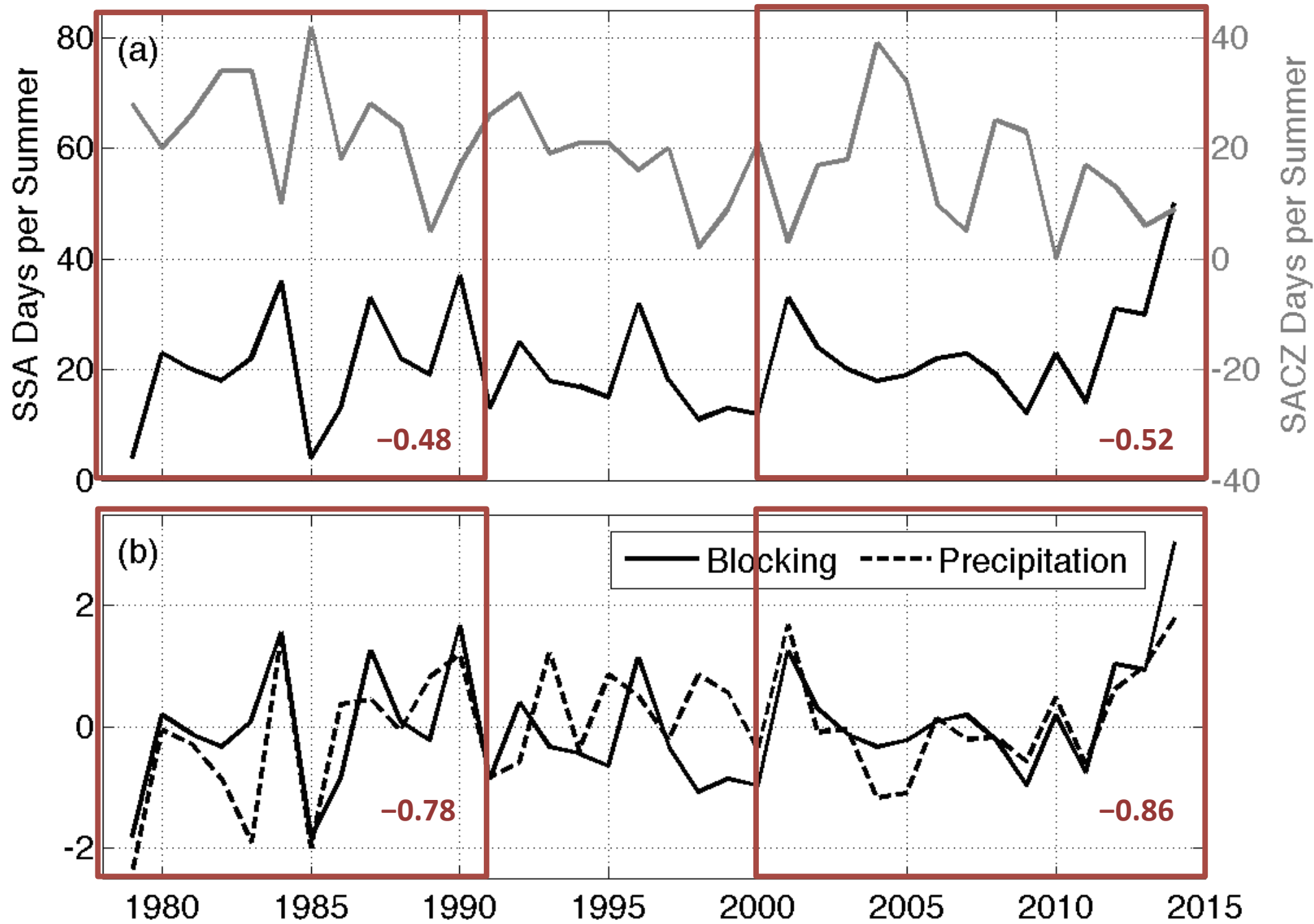
Anomalies (shading)
Climatology (contours)



Synchronized SSA blocking
Air Temperature Extremes
(above the 99th percentile)



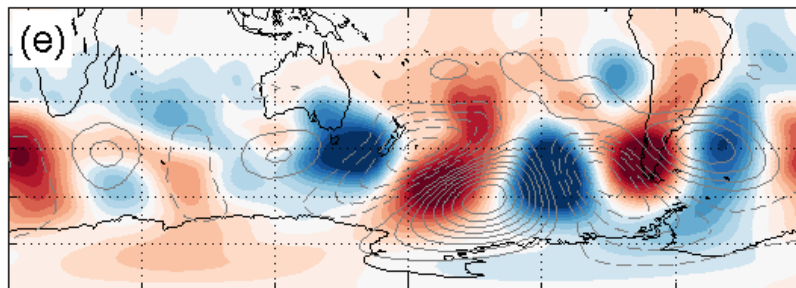
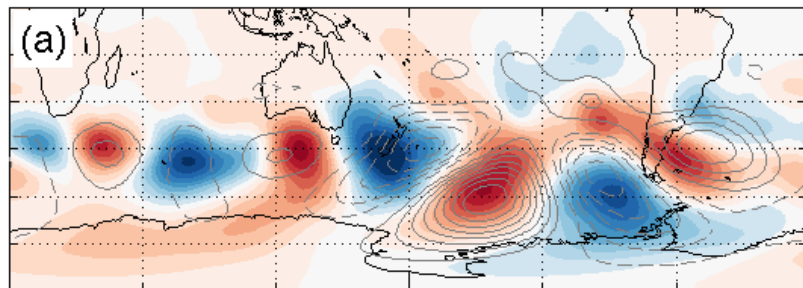




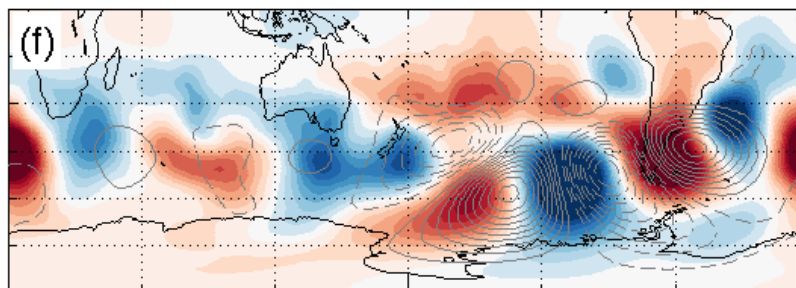
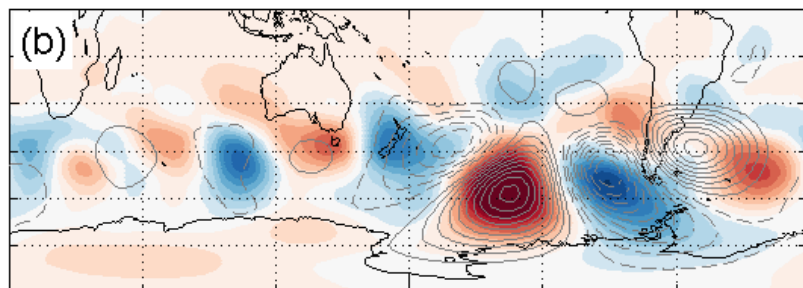
SSA

SACZ

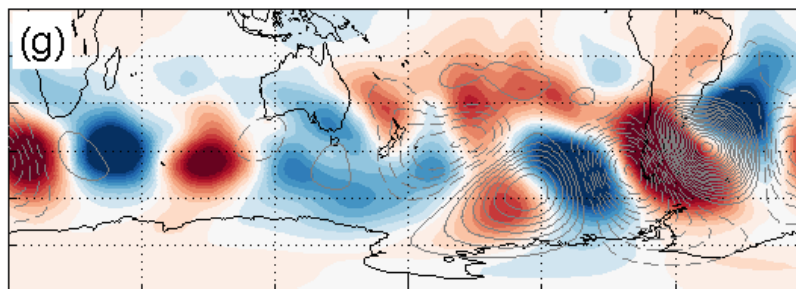
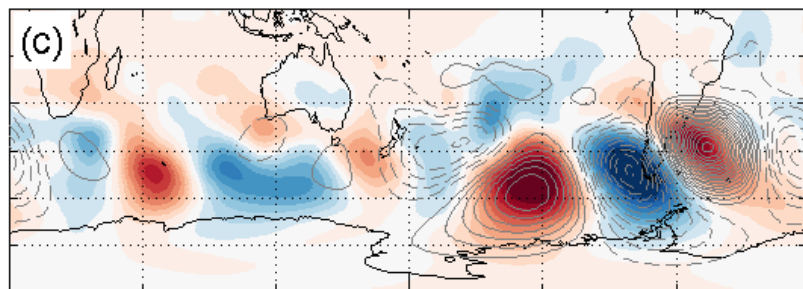
-6 days

15°S
30°S
45°S
60°S
75°S

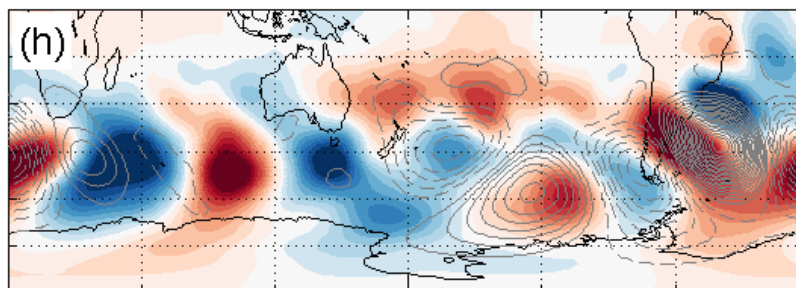
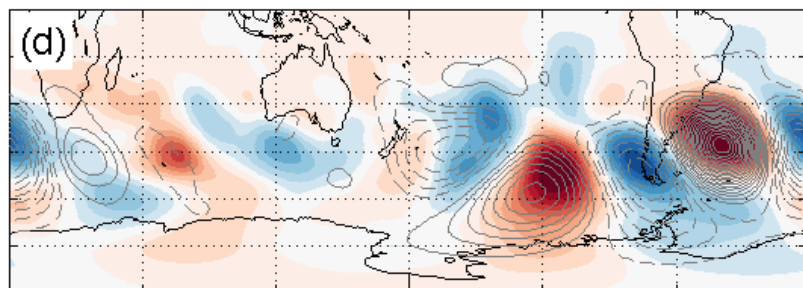
-4 days

15°S
30°S
45°S
60°S
75°S

-2 days

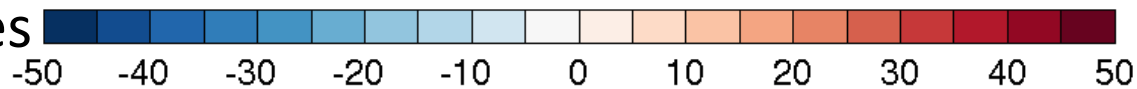
15°S
30°S
45°S
60°S
75°S

onset

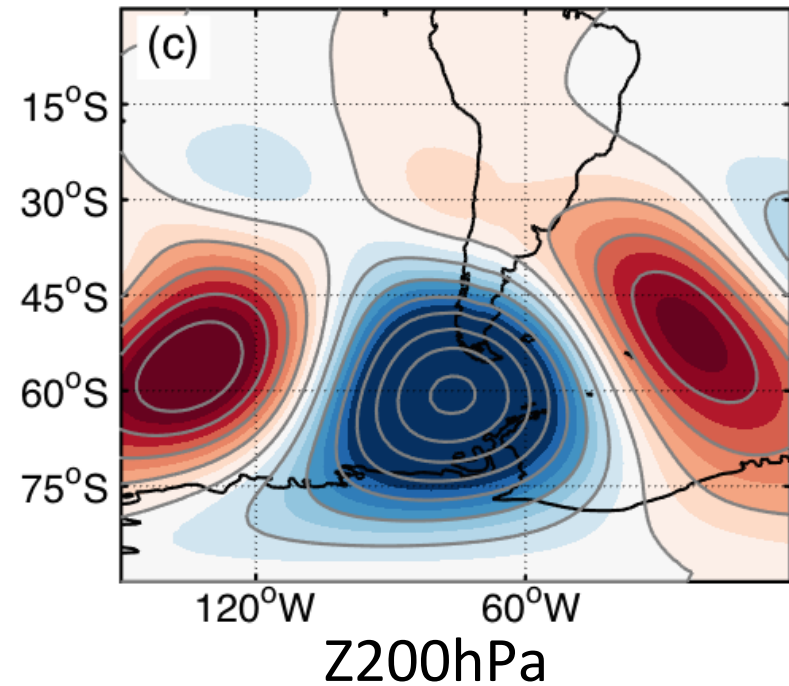
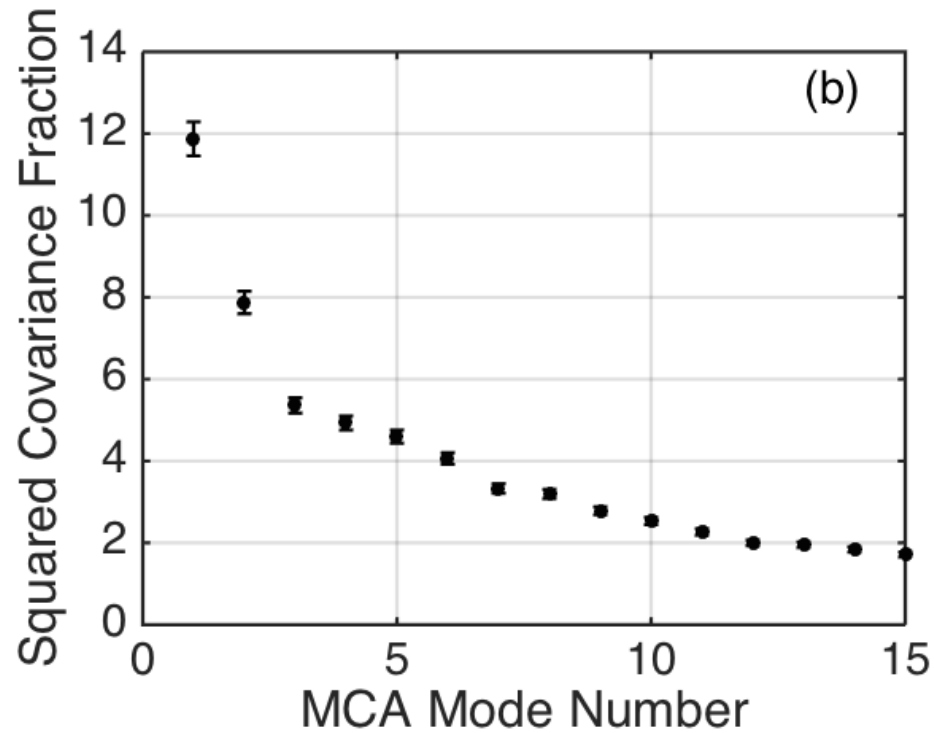
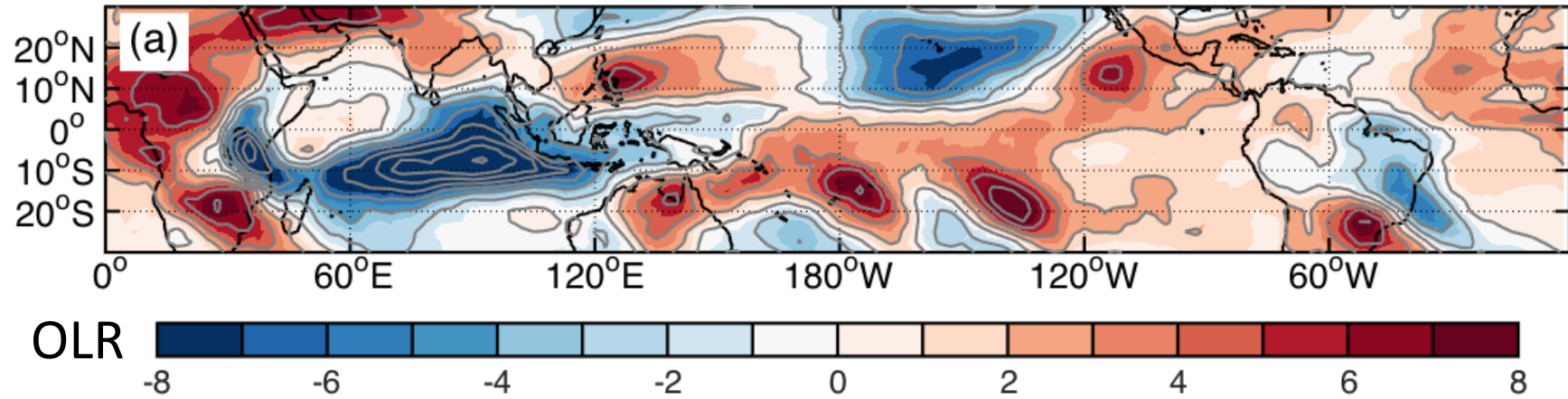
15°S
30°S
45°S
60°S
75°S

0° 60°E 120°E 180°W 120°W 60°W 0° 60°E 120°E 180°W 120°W 60°W

Z200hPa Anomalies



Part I: SSA Blocking Causes



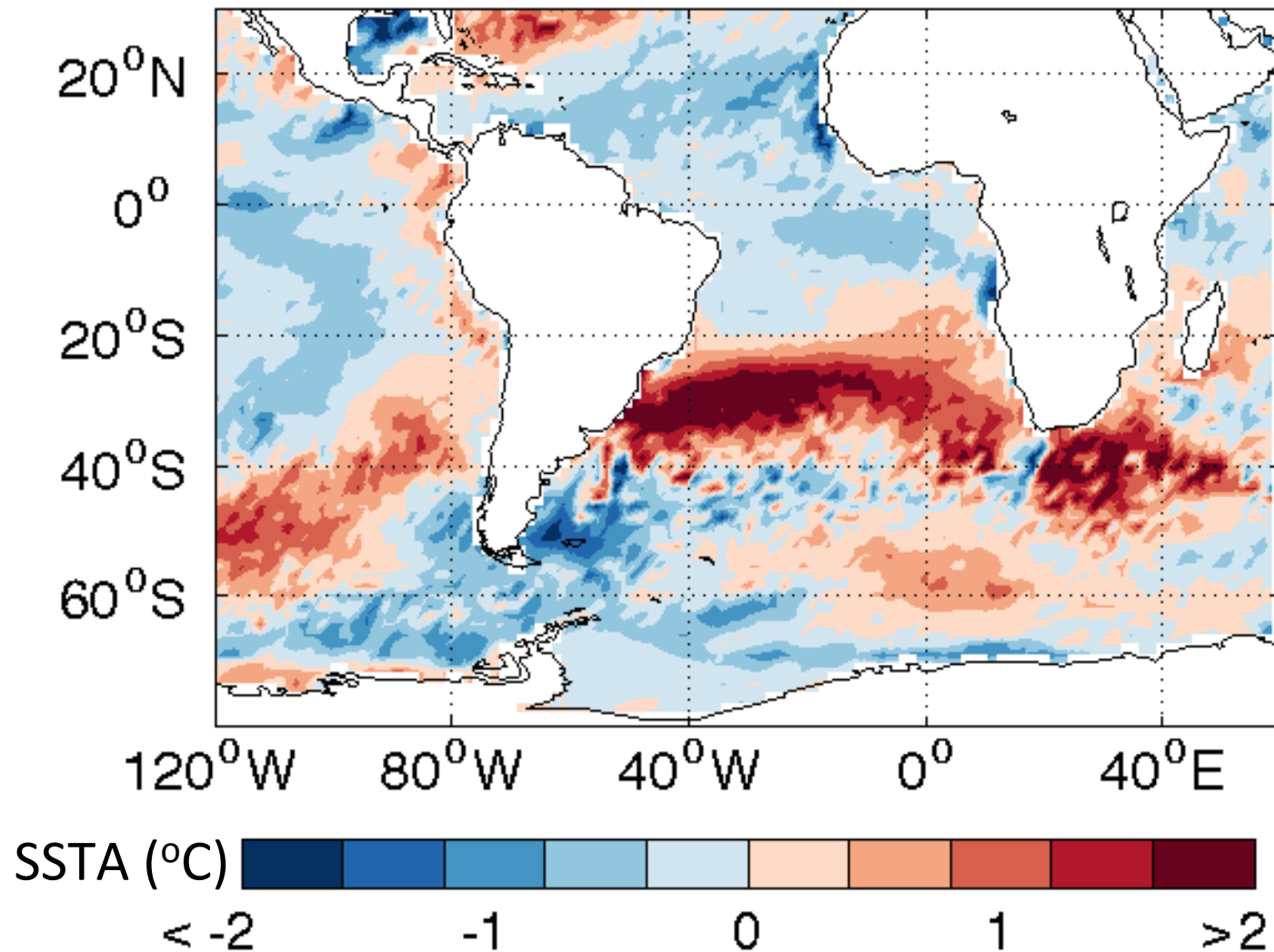
Part I: SSA Blocking Conclusions

- Wave breaking episodes over SSA do cause middle-upper level anomalous anticyclonic circulation preventing the development of the SACZ and leading to precipitation and temperature extremes
- Direct relation to MJO, in particular, phases 1 and 2 associated with convection over the Indian Ocean
- Long-term modulation by the IPO with no direct relation to ENSO and SAM

Rodrigues & Woollings (2017, JCLim)

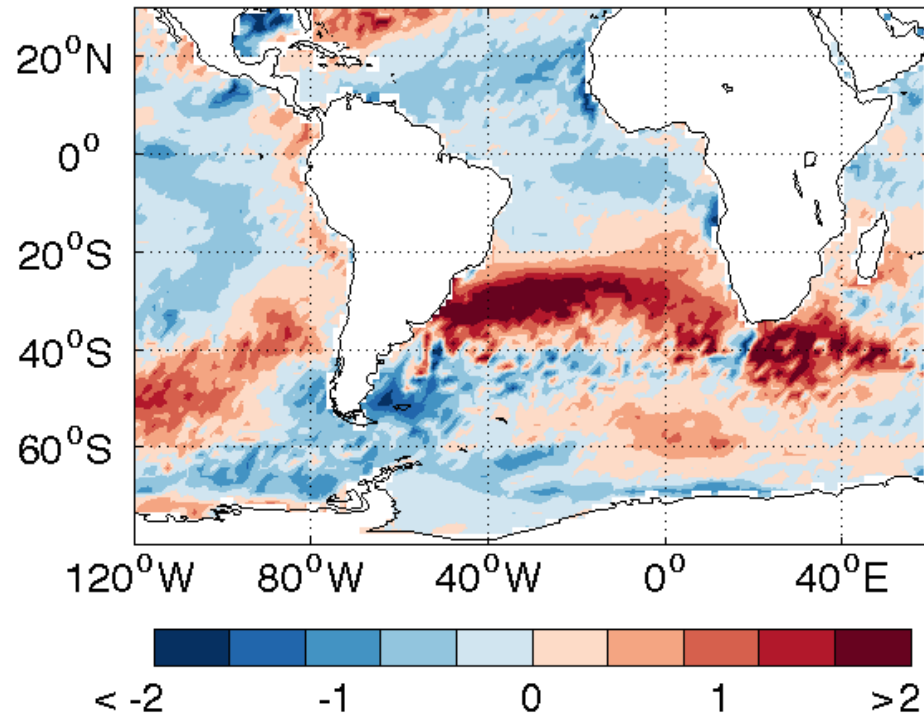
Part II: Impacts of SSA Blocking on Ocean

Extreme blocking event of 2013/14

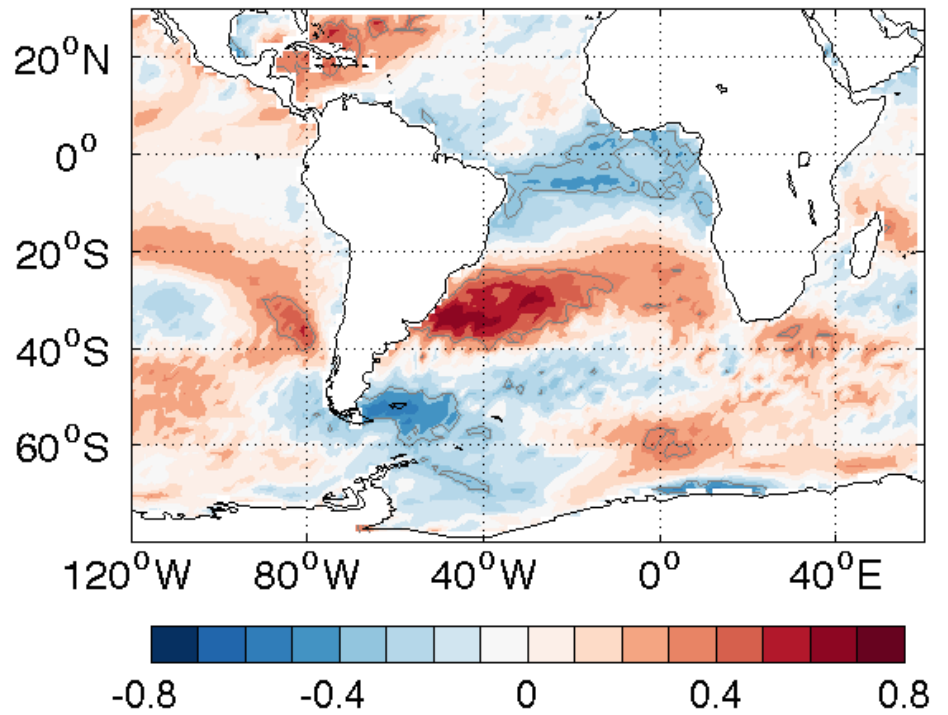


Part II: Impacts of SSA Blocking on Ocean

2013/2014 Event - SSTA ($^{\circ}\text{C}$)



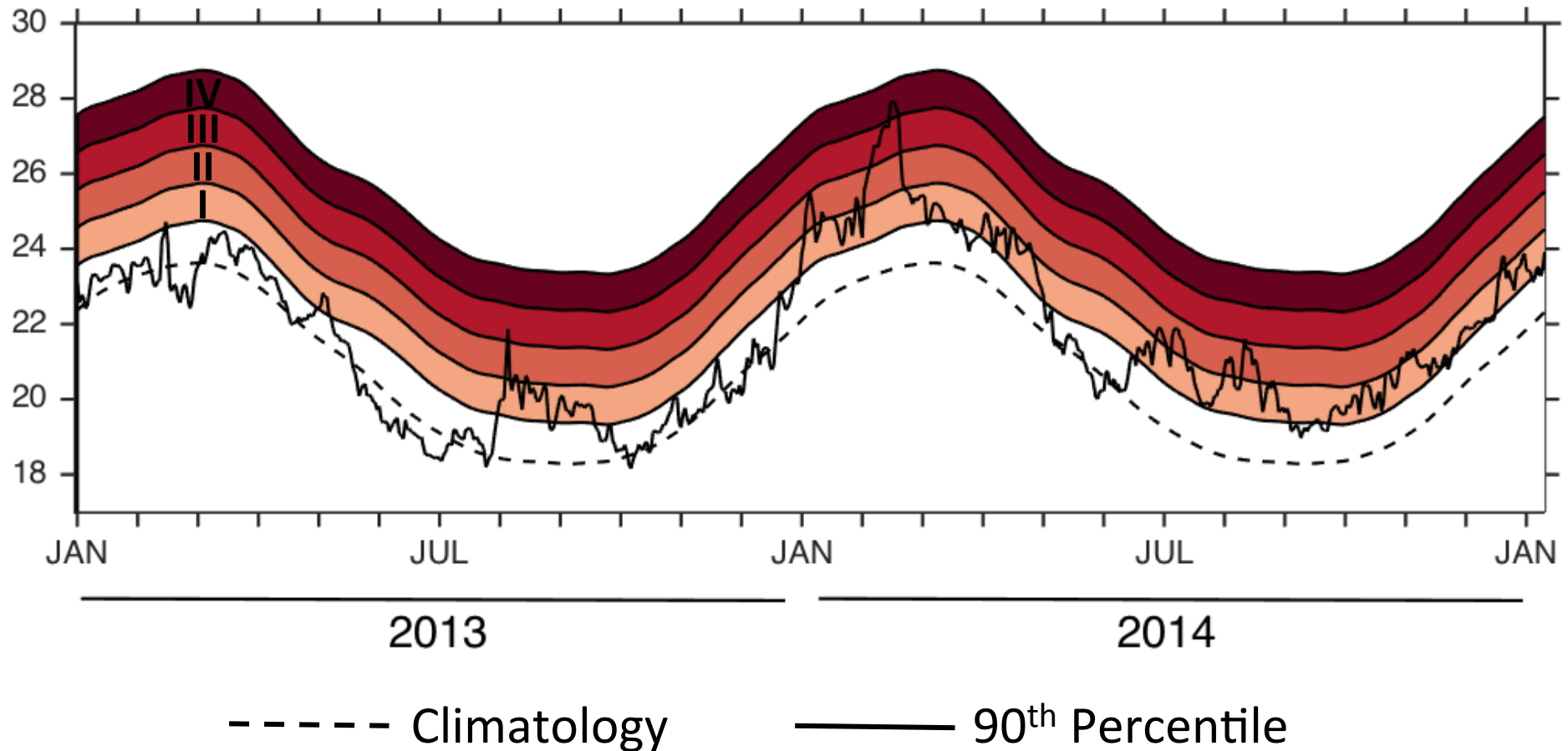
Correlation SST x BLK



Part II: Definition of Marine Heatwave (MHW) (Hobday et al. 2016)

- **Anomalous Warm**: SST must be above a high percentile threshold (90th) relative to a baseline climatology
- **Prolonged**: must persist for at least 5 days, but this might be different depending on the relevant ecological processes
- **Discrete**: with well-defined start and end times

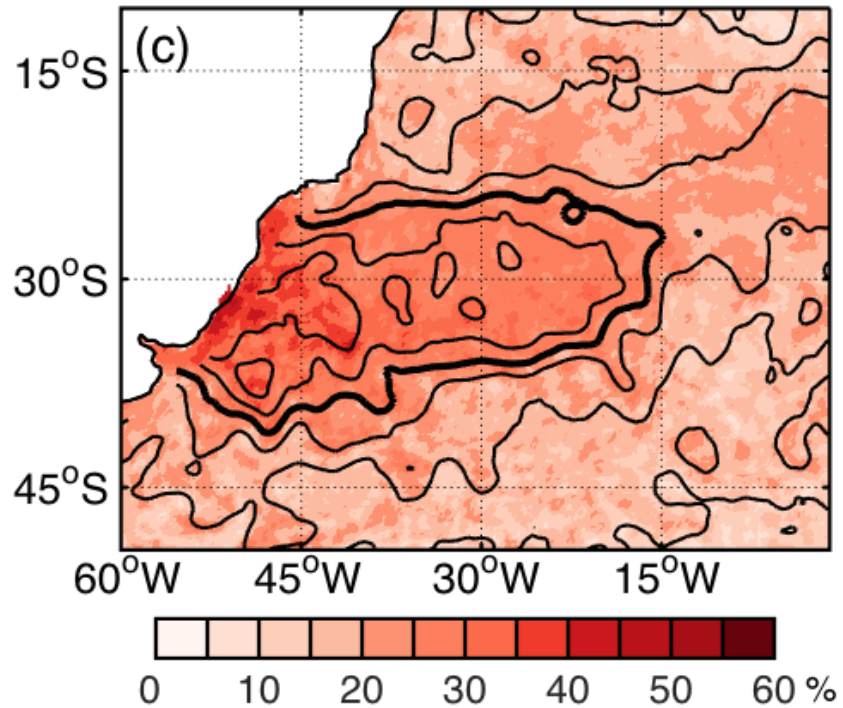
Part II: Western South Atlantic MHW (Severity Index - Hobday et al. 2018)



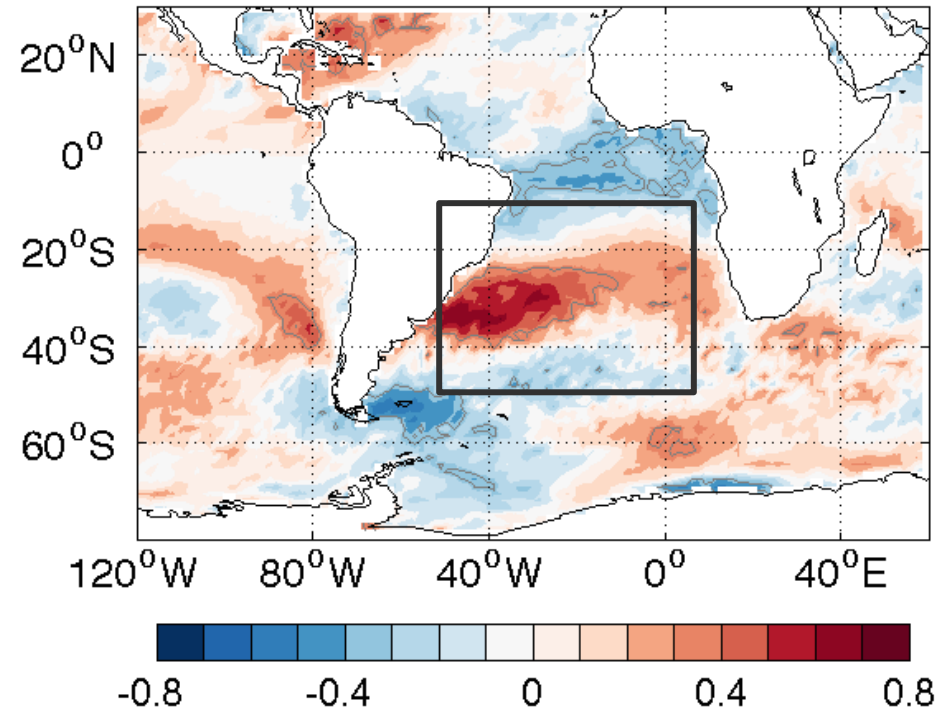
I) moderate (1×), II) strong (2×), III) severe (3×) and IV) extreme (4×)

Part II: Western South Atlantic MHW

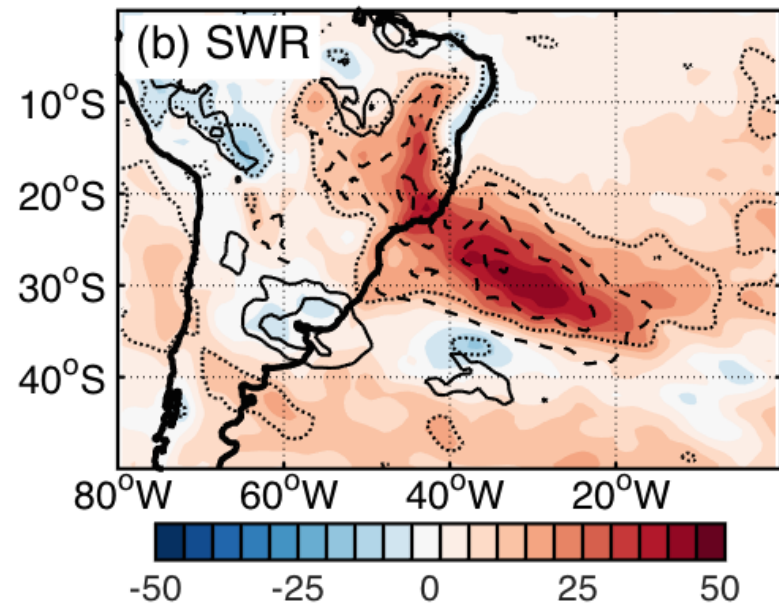
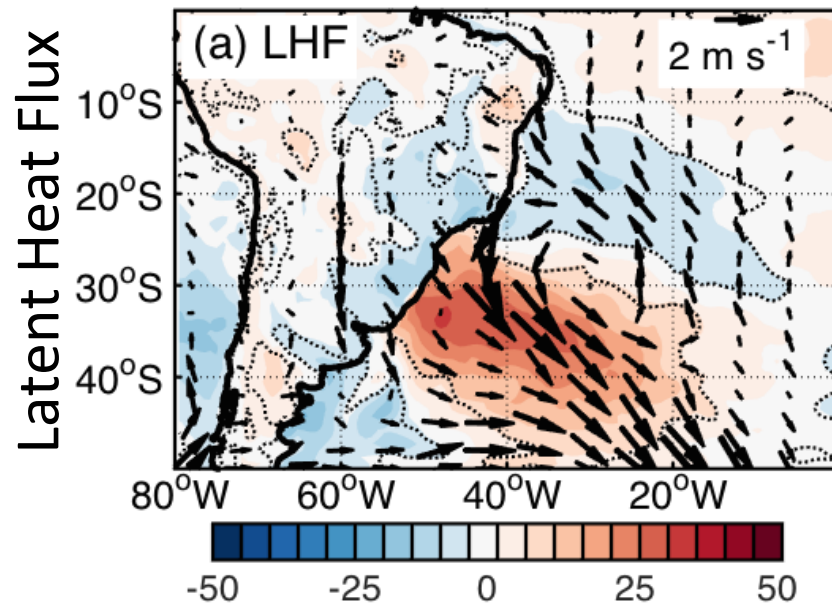
Synchronized MHW x BLK (%)



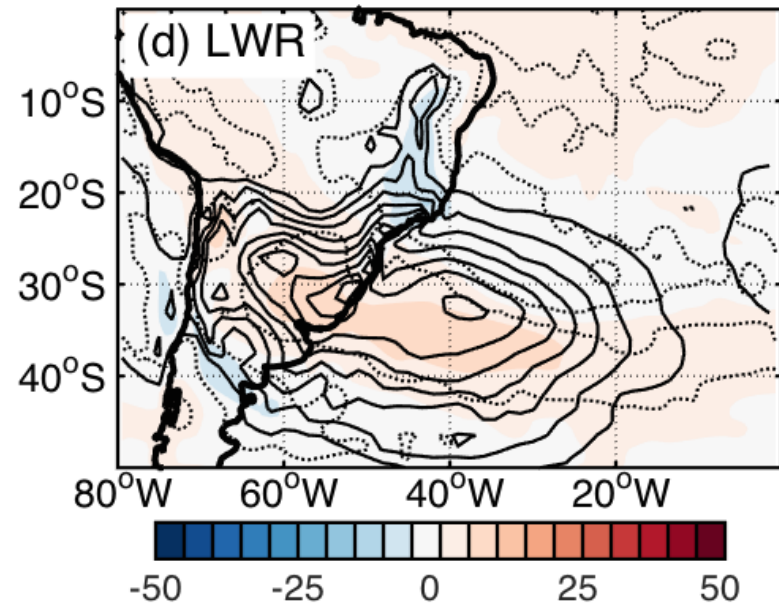
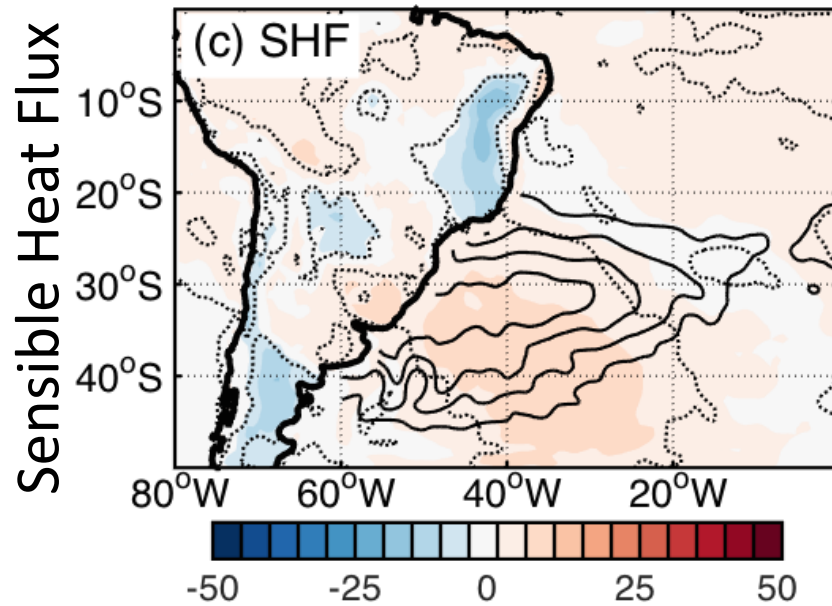
Correlation SST x BLK



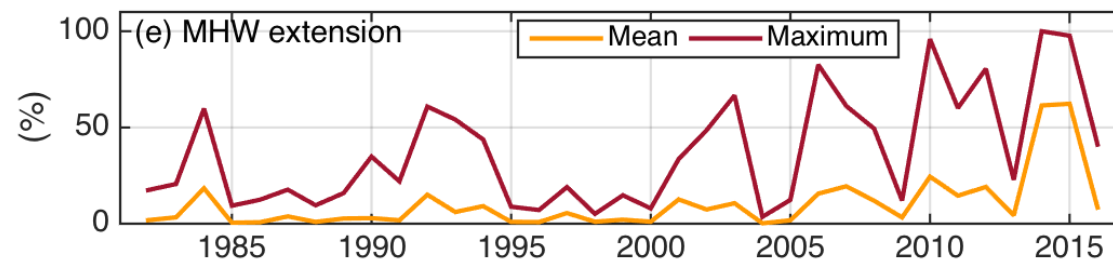
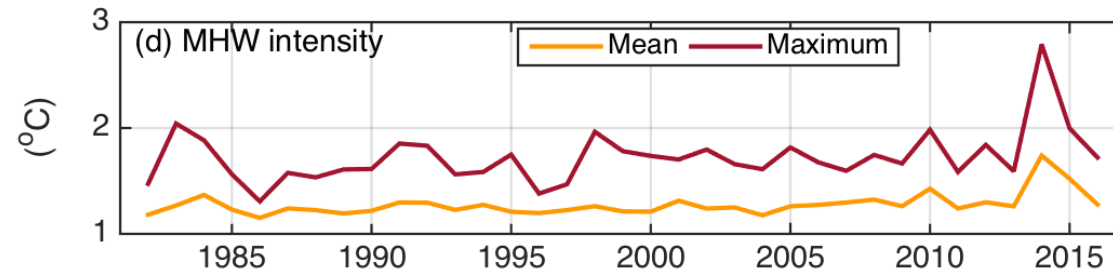
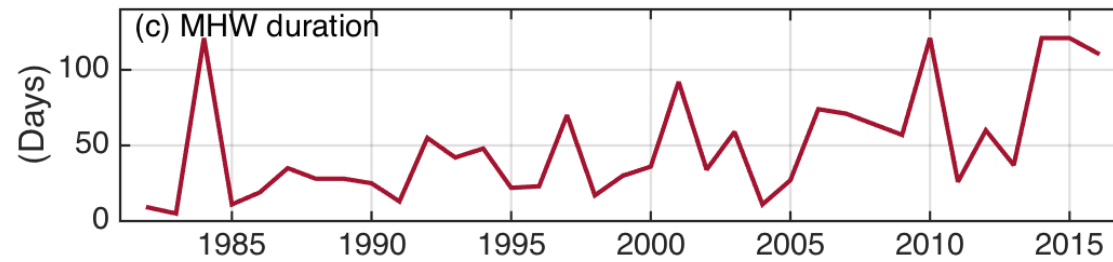
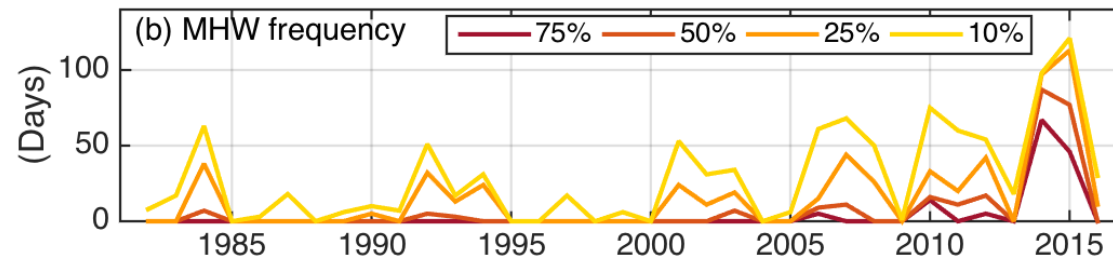
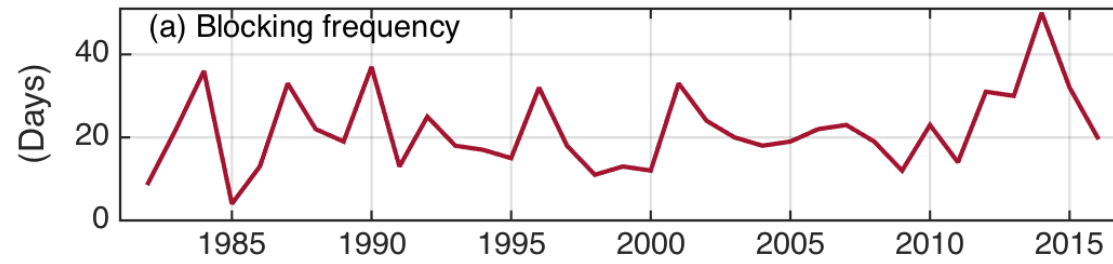
Part II: Western South Atlantic MHW



Shortwave Radiation

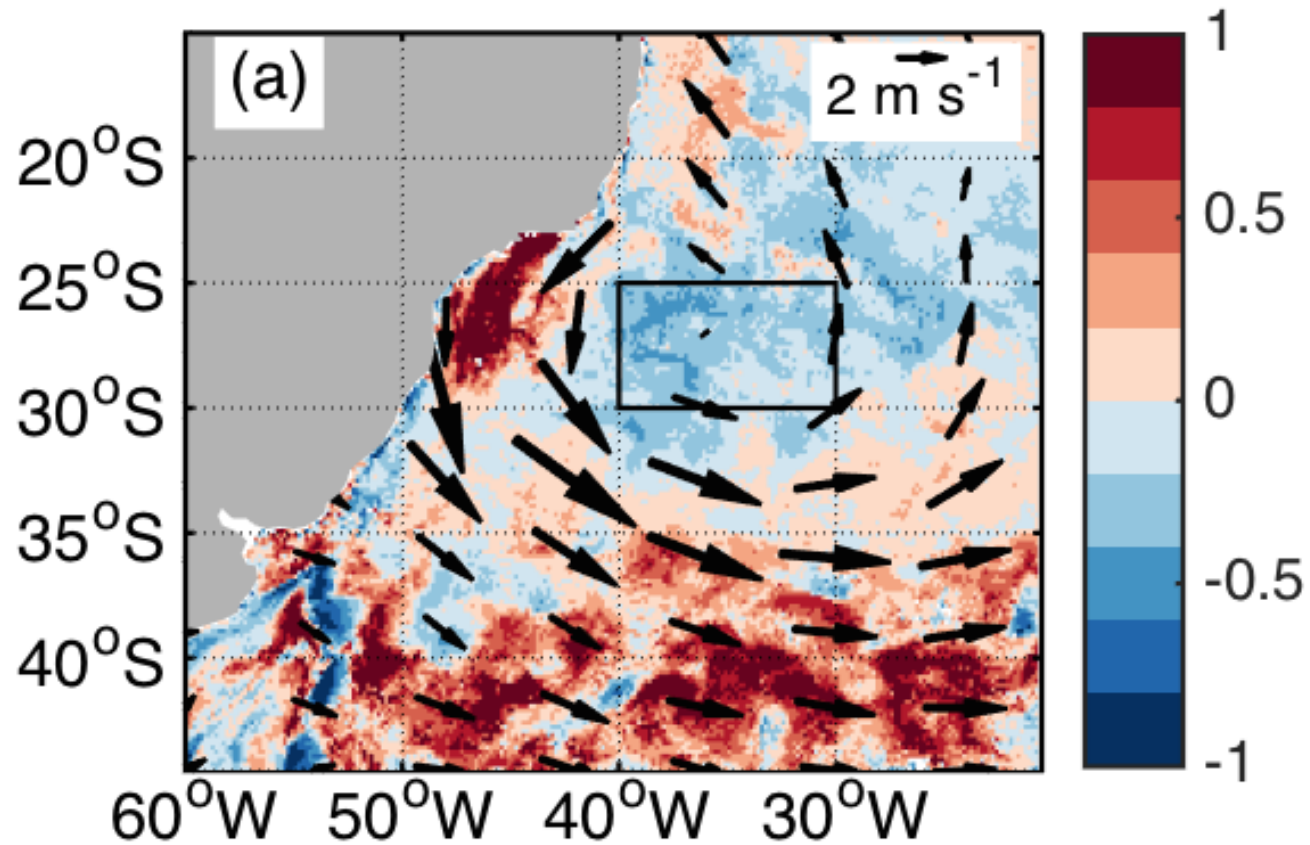


Longwave Radiation



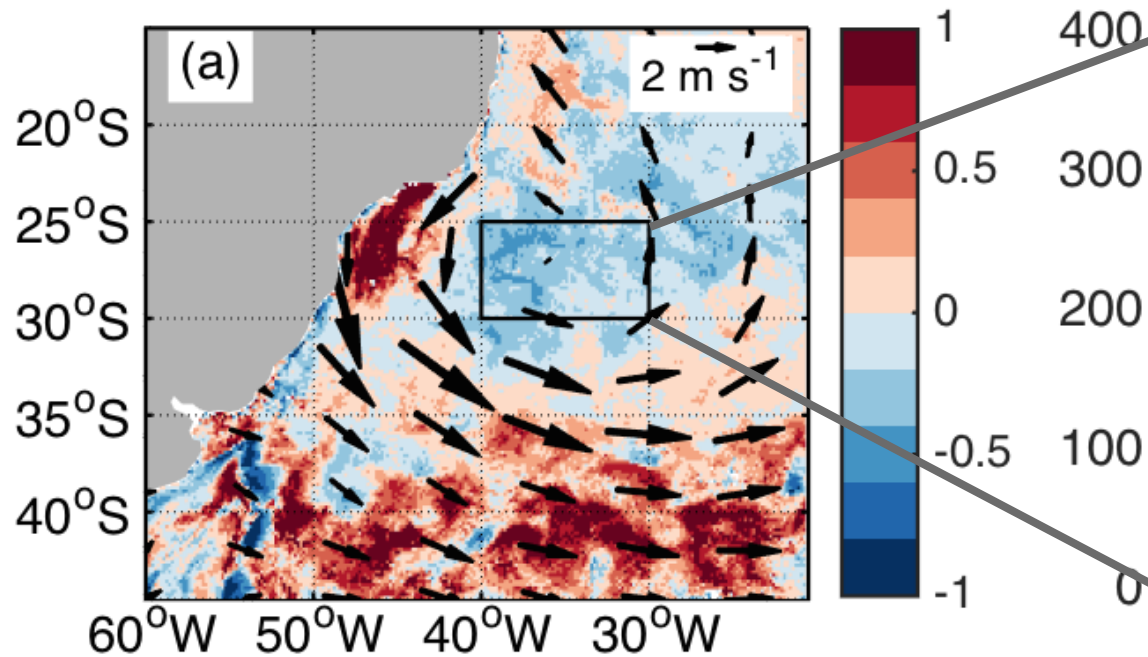
Part II: Western South Atlantic MHW - Impacts

Correlation Chl-a x BLK (2002-2016)

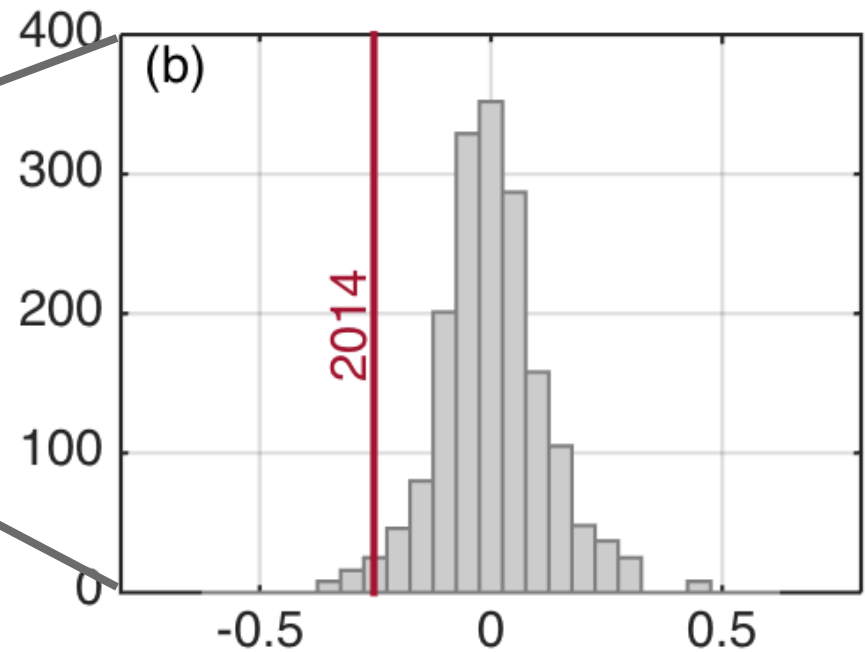


Part II: Western South Atlantic MHW - Impacts

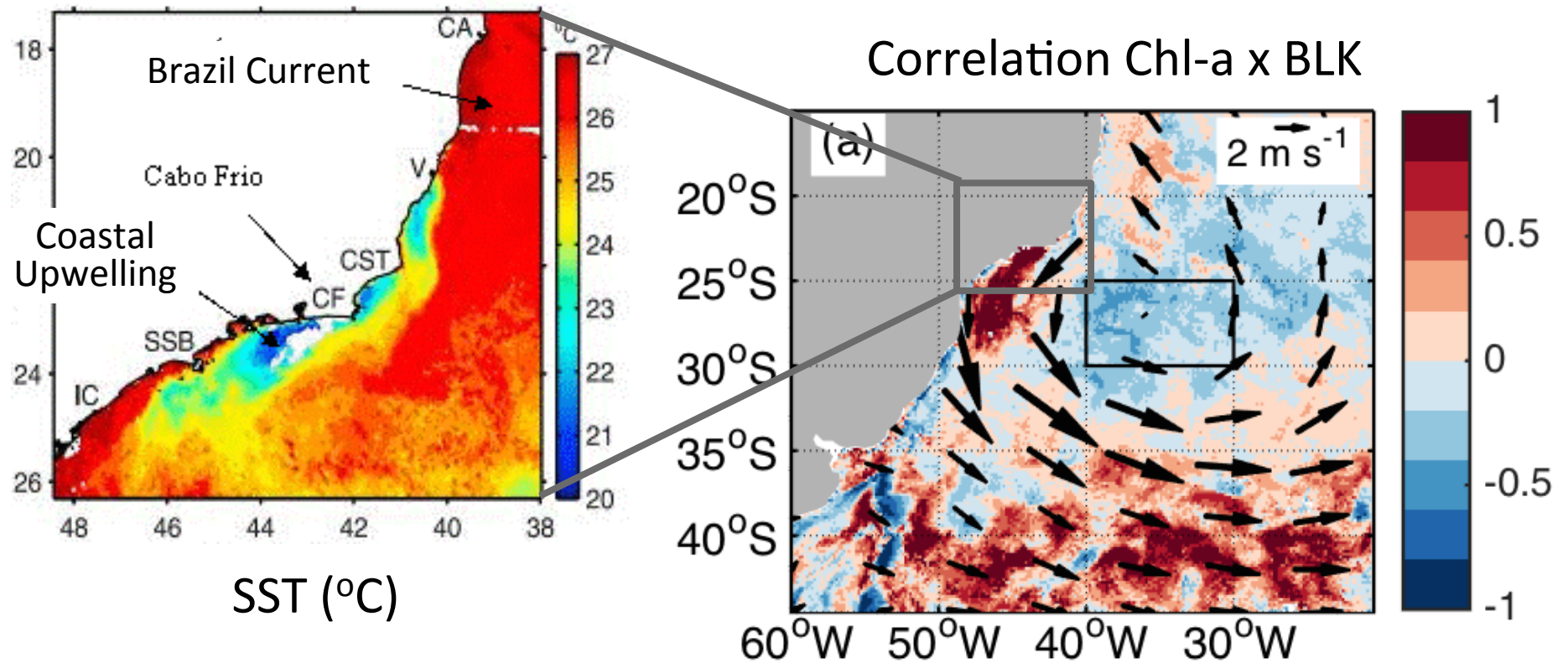
Correlation Chl-a x BLK



Distribution Chl-a

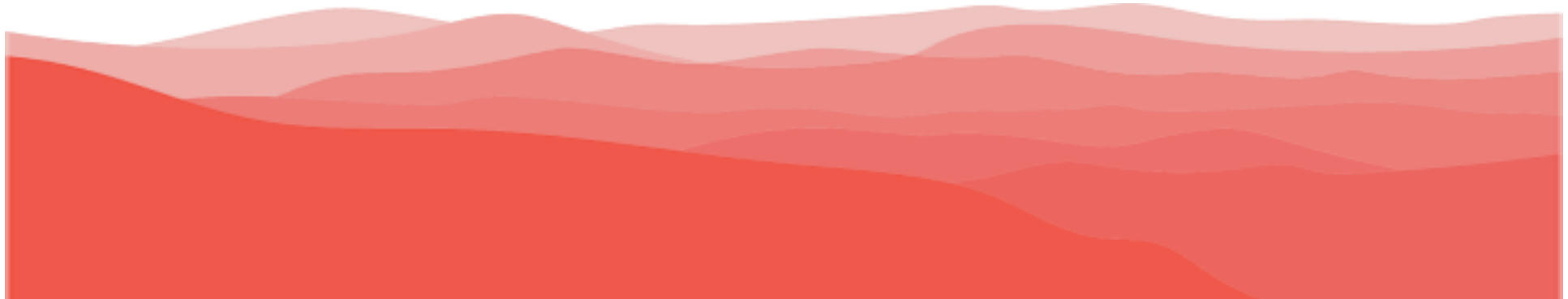


Part II: Western South Atlantic MHW - Impacts



Part II: Western South Atlantic MHW - Impacts

- There is a **decrease in primary productivity** in the western **South Atlantic deep ocean** where the SST is warm
- Along the **Brazilian continental shelf**, the wind anomalies associated with blocking **enhance coastal upwelling** that combined with more available short-wave radiation **increases primary productivity** locally



Part II: Conclusions

- Atmospheric blocking over the subtropical South America (SSA) is the main mechanism of generating **MHW** in the western South Atlantic
- **MHW** are associated with MJO (phases 2 and 3) with a long-term modulation by the IPO because the latter modulates SSA blocking
- The impact of **MHW** on the onshore ocean color and primary productivity is different from that offshore

