Identifying the Causal Network of Sea Level Variability Domains in the Southeast Pacific:

An application of satellite altimetry

End of internship presentation by Eike Schütt

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STRUCTURE

Introduction

Datasets

deltaMaps – method and results

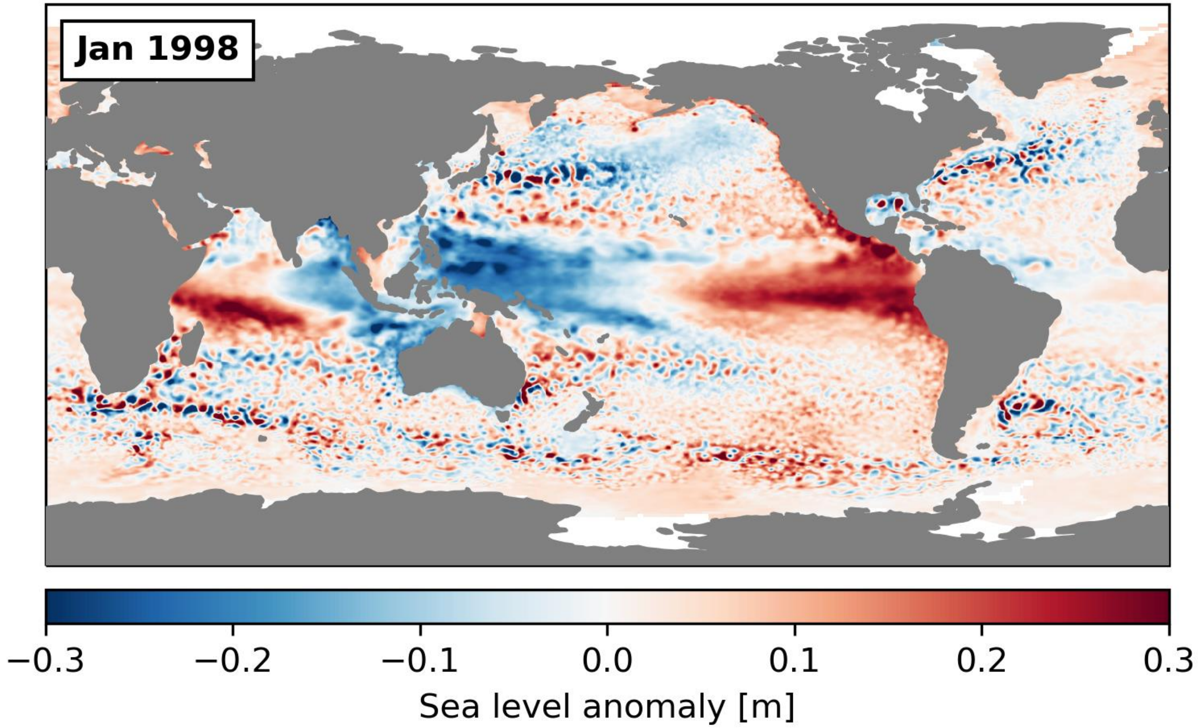
PCMCI – method and results

Causal SLV network in the SE Pacific

Conclusion

Introduction

- To improve SLR projections, sea level variability (SLV) must be better understood
- Many processes contribute to SLV
- Goals:
  - Identify SLV Domains
  - Infer the network between the Domains
  - Interpret SLV network in the Southeast Pacific (SEP)



Datasets

- Monthly SLA satellite altimetry data from AVISO (Jan 1993-Feb 2020)
  - Resampled to 2° and smoothed
  - Removed seasonality and linear trend
  - Removed regions higher than 66°S/N

- Current velocities from GLORYS12V1 reanalysis

- Wind and sea level pressure from ERA5 reanalysis

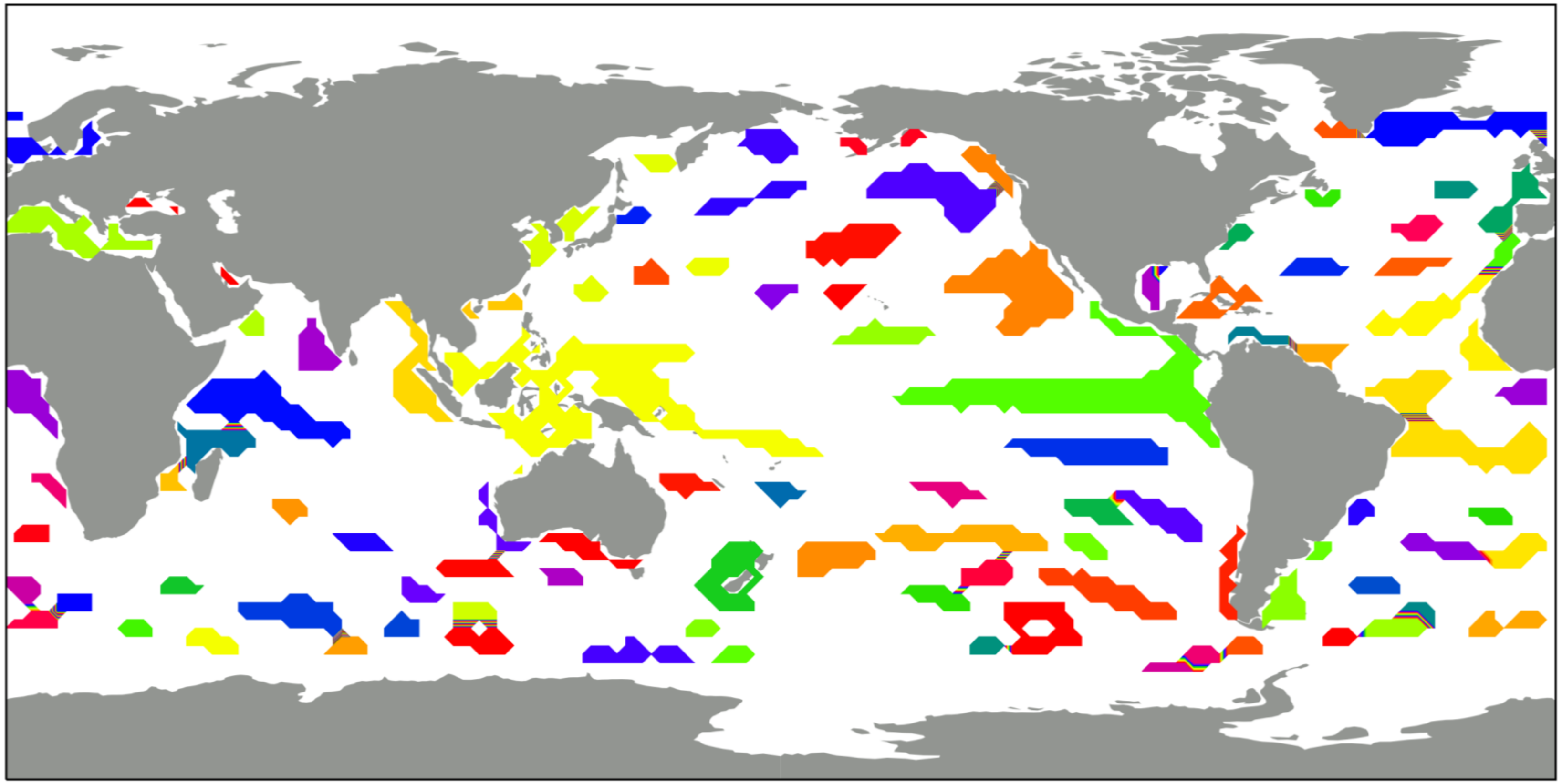
- Niño3.4 SST index from NOAA

deltaMaps - Method

- Novel clustering algorithm by Fountalis et al. (2018) and Falasca et al. (2019)
- Python version on GitHub

- Identifies regions in which the measured signal is relatively similar over time
- Many advantages over similar methods

deltaMaps – Results: Domains



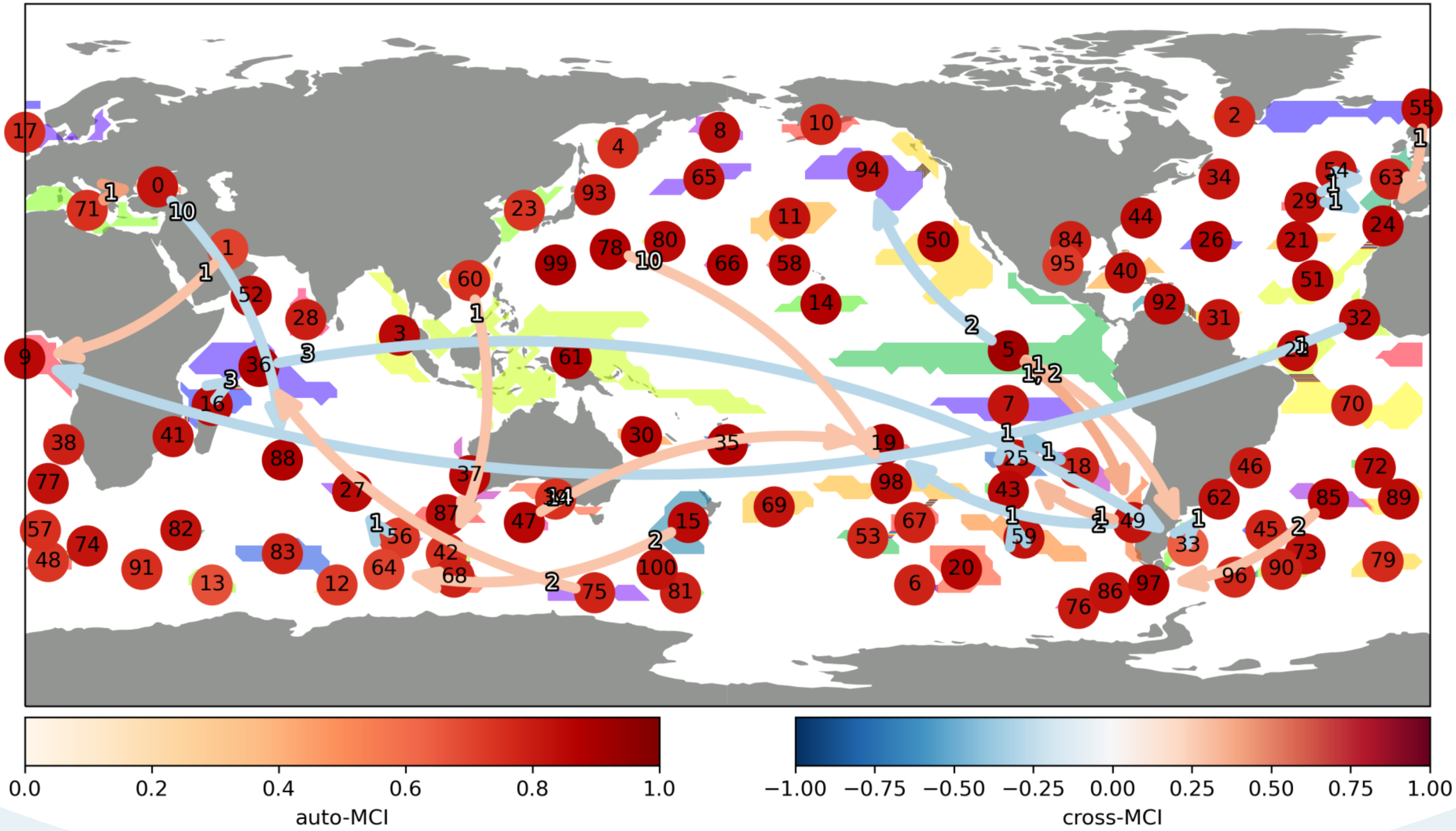
PCMCI - Method

- Method to reconstruct causal graphs from high-dimensional time series data
- Developed by Runge et al. (2019); included in the tigramite-package (Python)

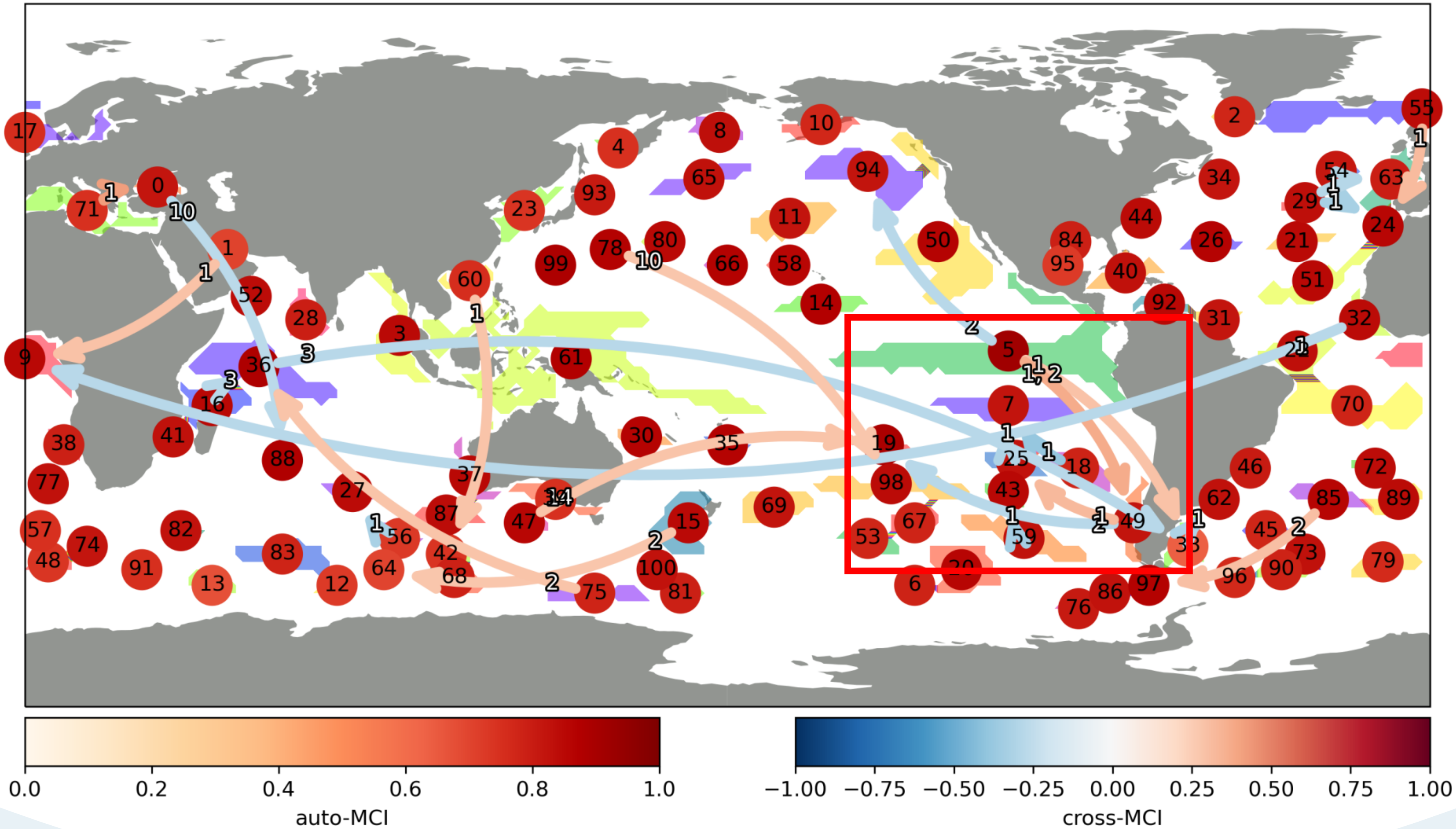
- based on the graphical causal model framework
- High detection power even in large datasets

- Applied PCMCI to the domain signals

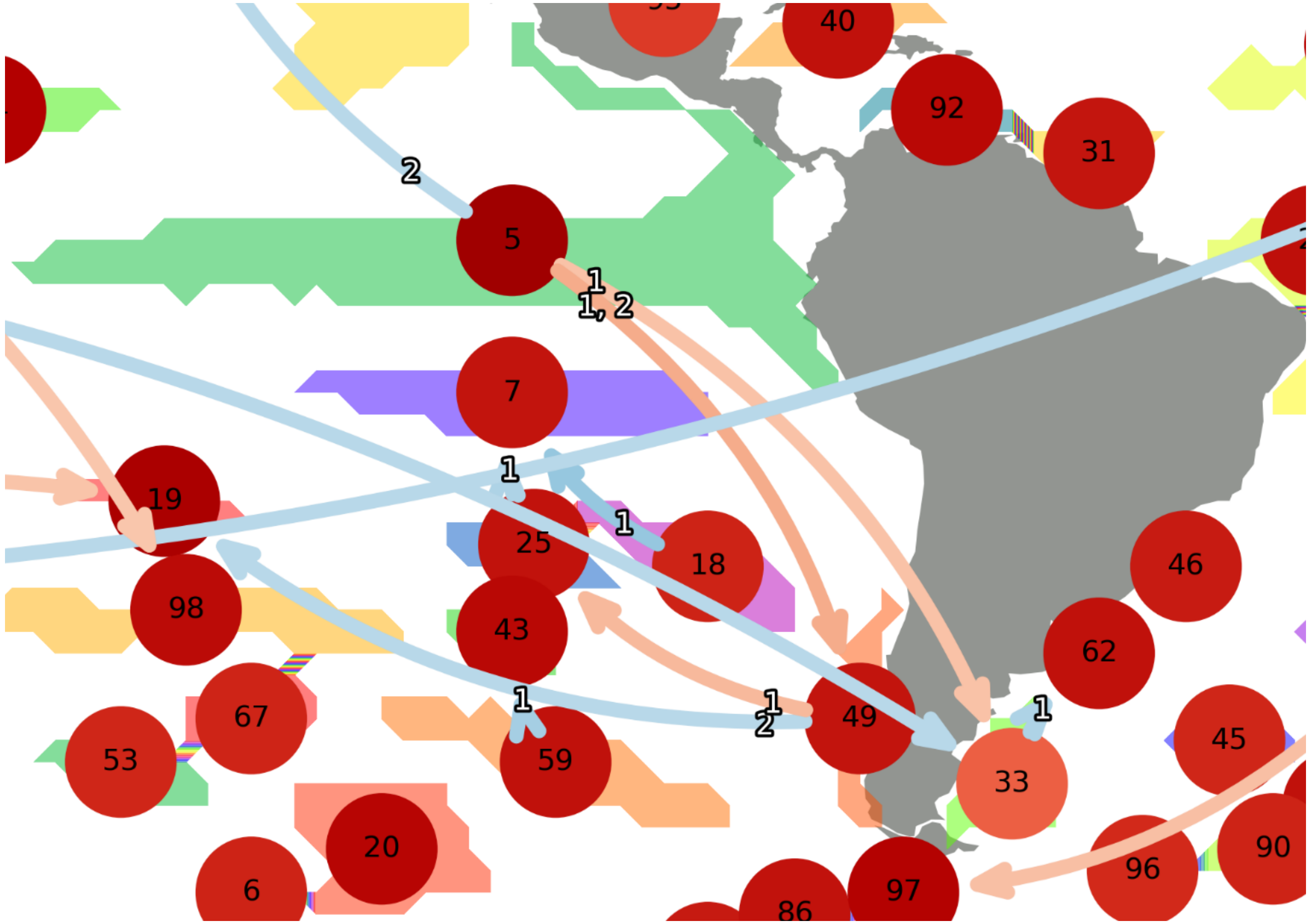
PCMCI - Results

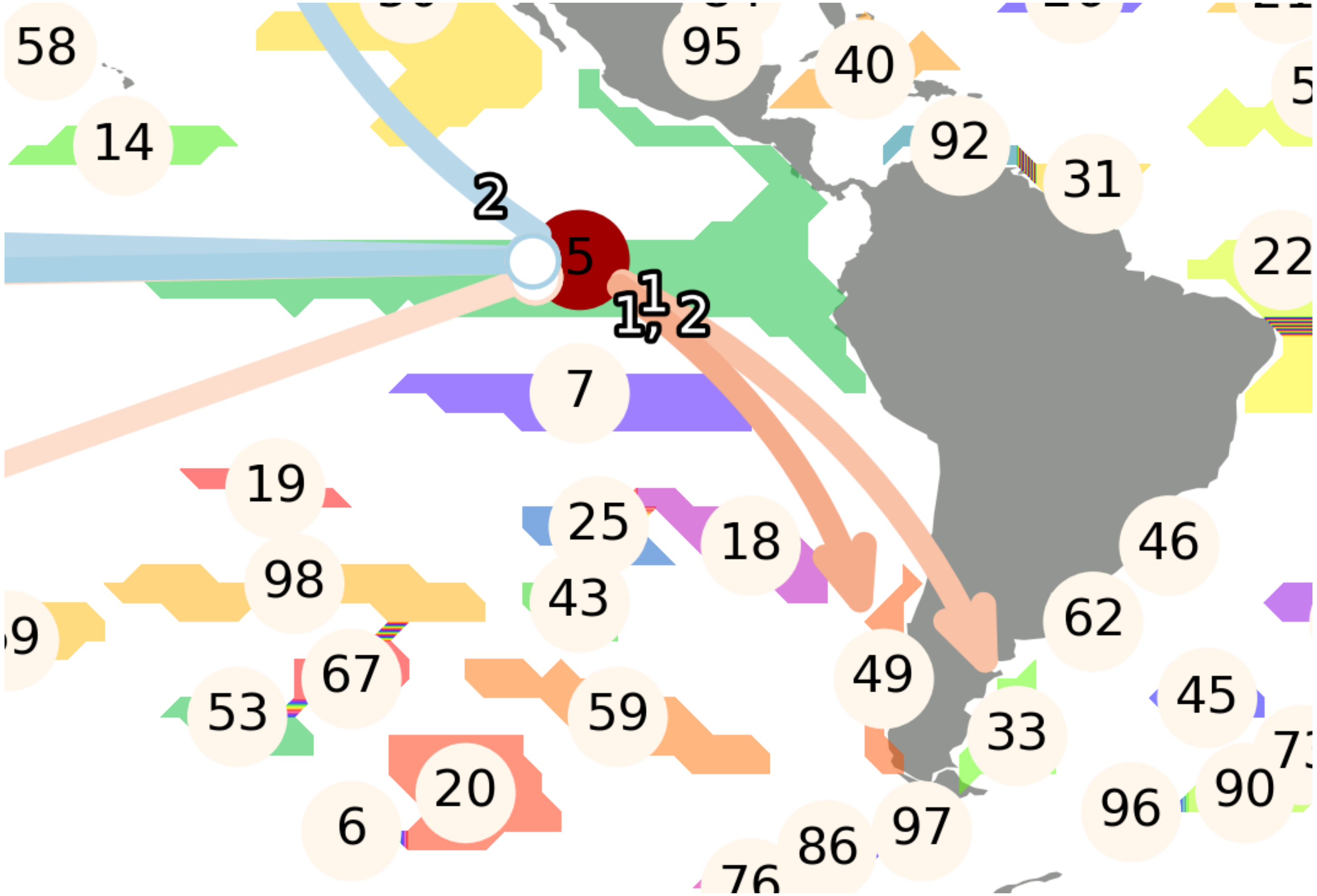


PCMCI - Results



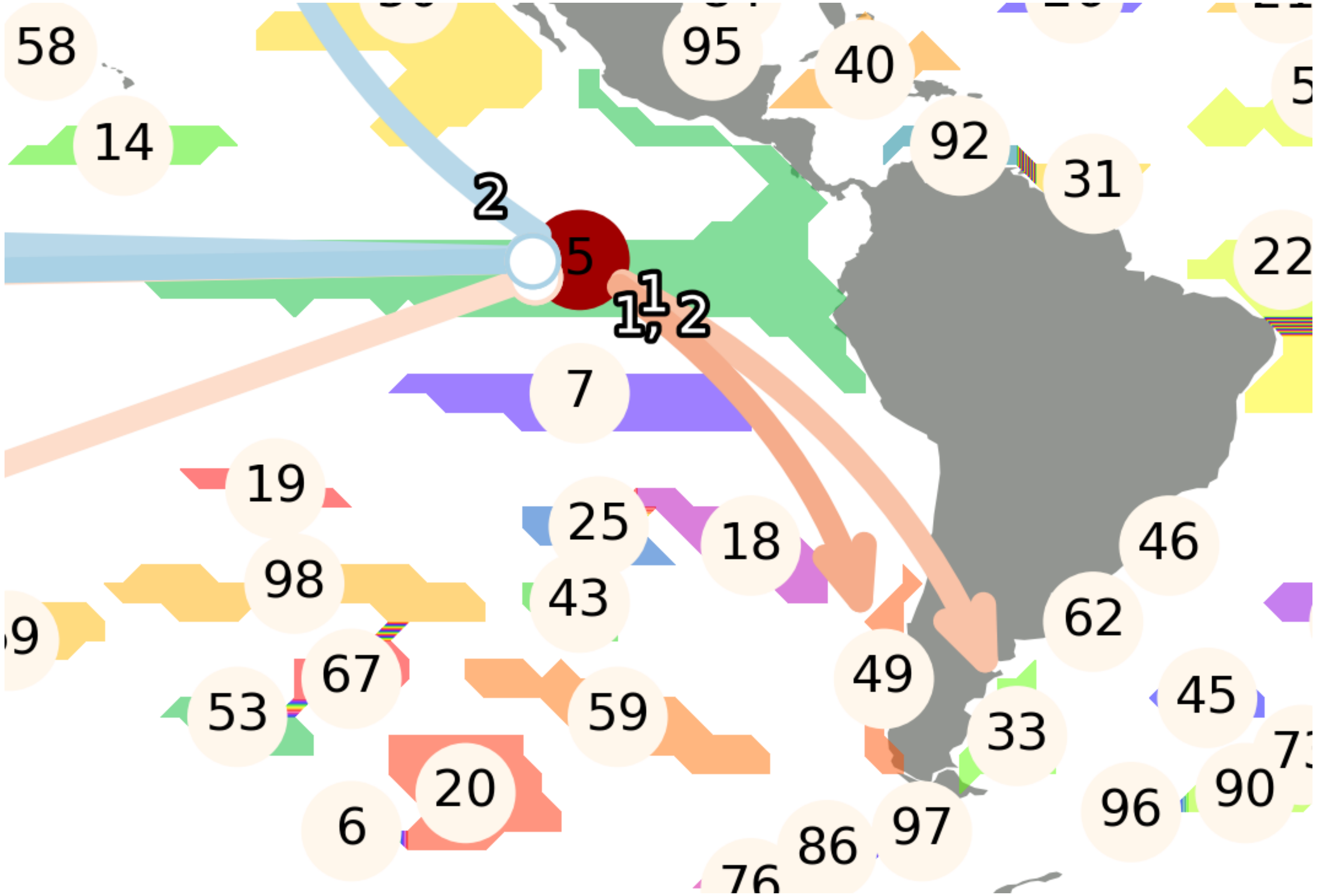
Causal SLV network in the SE Pacific





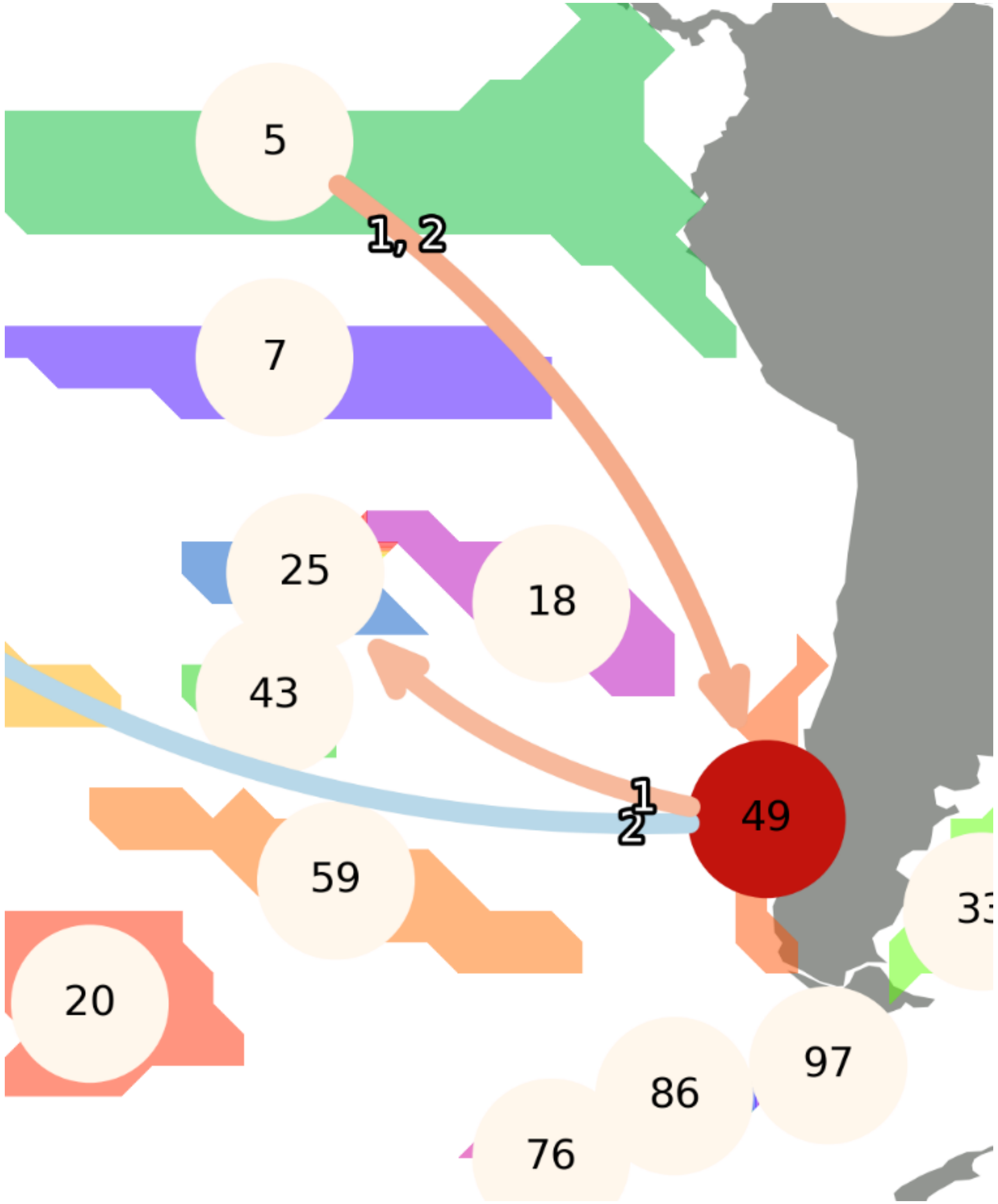
SLV in Domain 5

- Domain 5 SLA is at small lags significantly correlated to ENSO strength (R>0.9)
- SLA leads SST anomalies by a few weeks
- Main source of SLV in this domain is ENSO



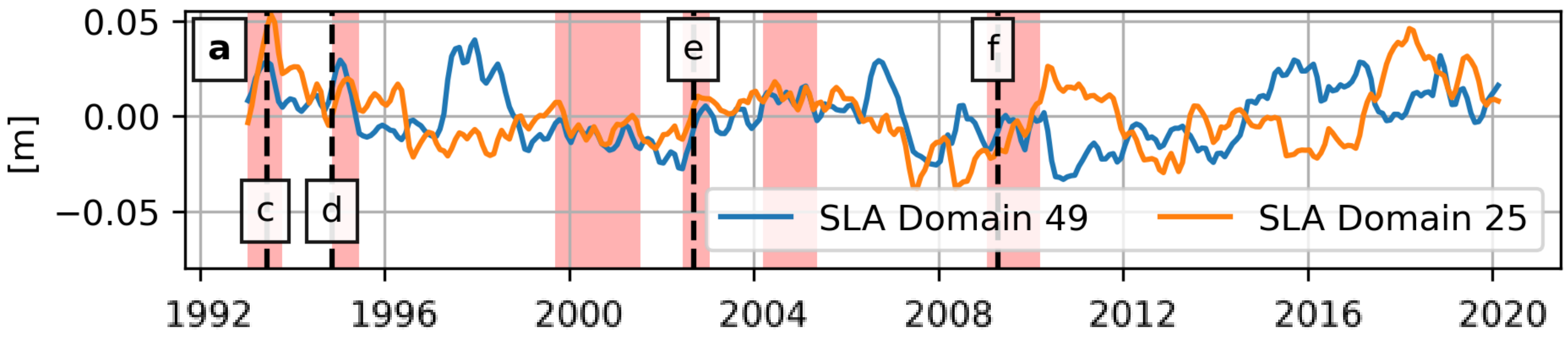
Edge 5-49

- Significant positive cross-MCI at 1- and 2-months lag
- Diffusion processes are too slow
- Kelvin & coastal trapped waves
- Local atmospheric forcing



Edge 49-25

- Significant positive cross-MCI at 1 month lag
- Rossby waves and eddies are too slow
- Atmospheric teleconnection!



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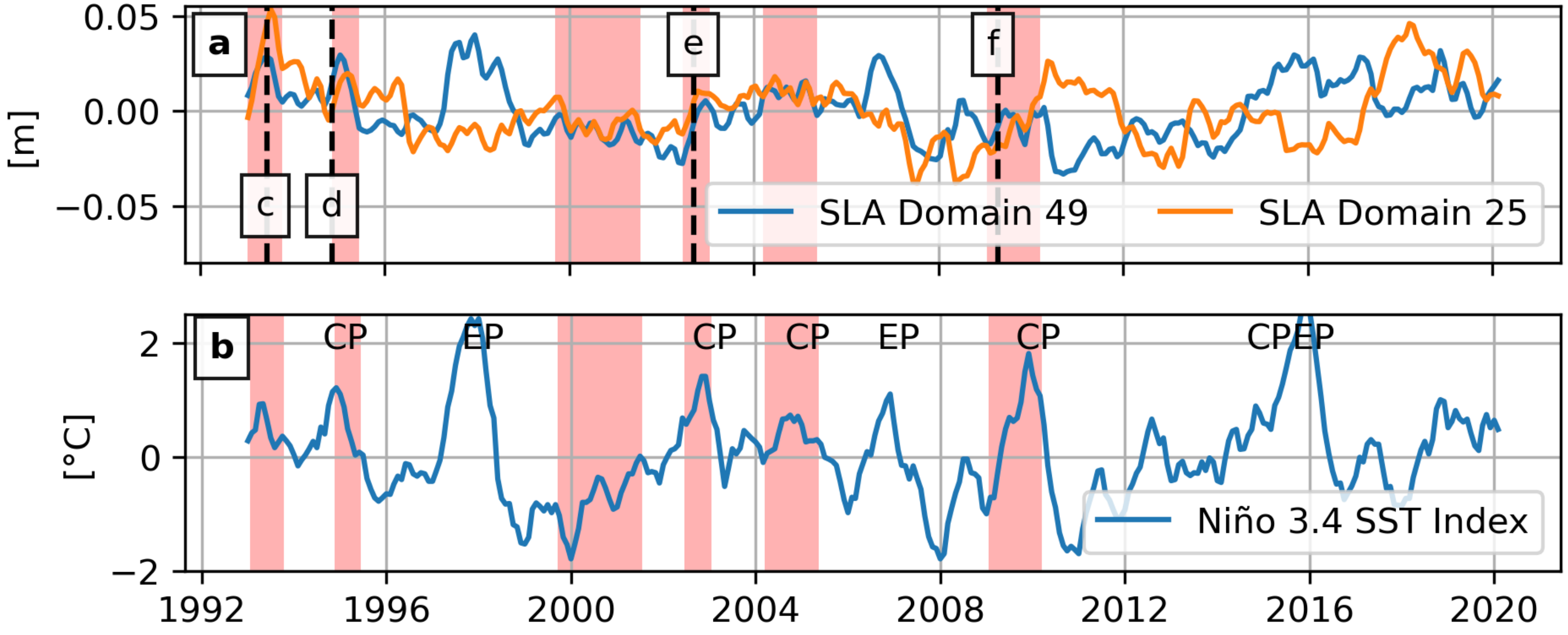

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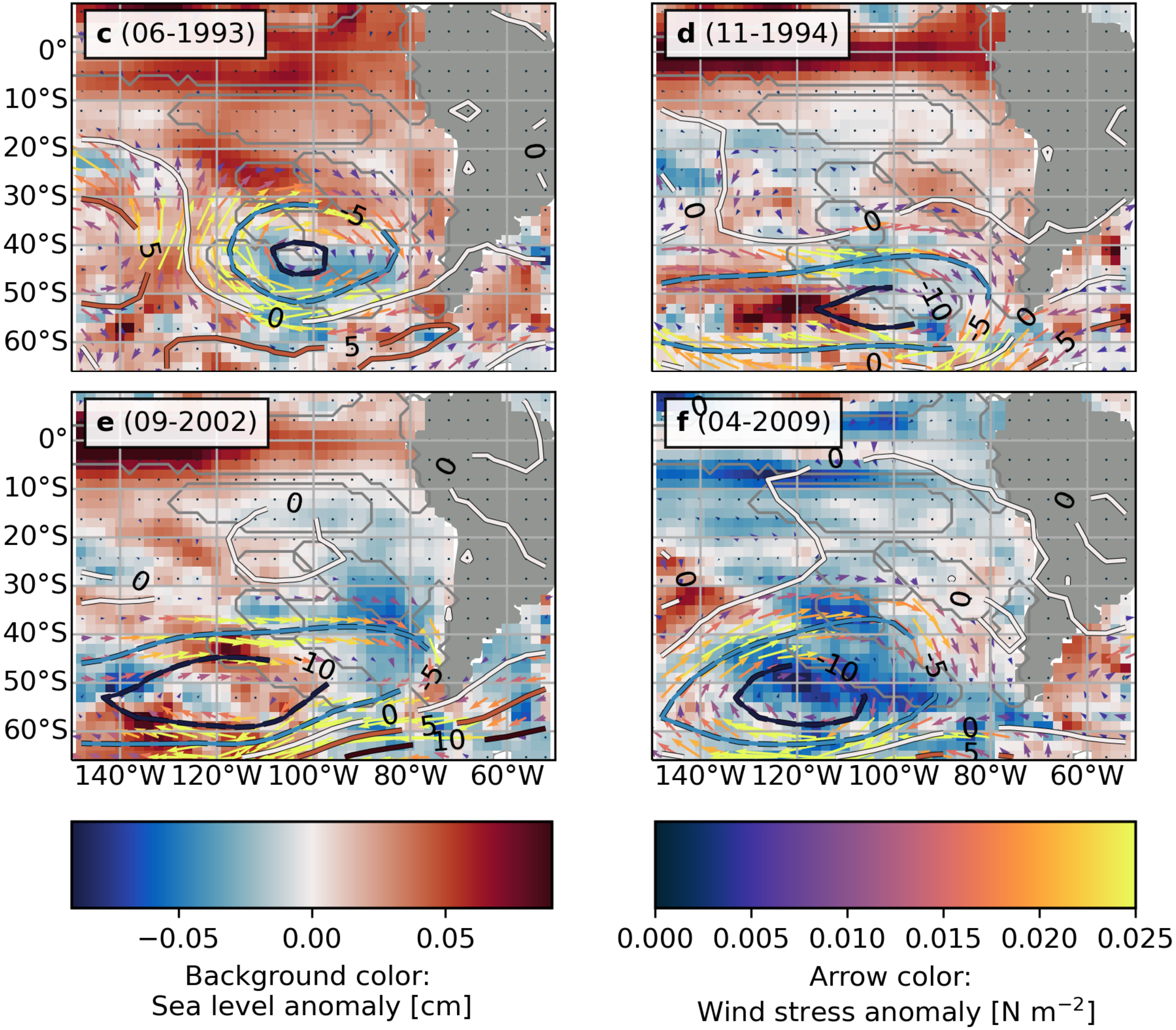

Edge 49-25

- Significant positive cross-MCI at 1 month lag
- Rossby waves and eddies are too slow
- Atmospheric teleconnection!
- Wilson et al. (2014) suggested that ENSO “flavor” influences SLPa in SEP

Conclusion

- PCMCI was able to identify a causal network between SLV domains
- ENSO strongly influences SLV in the Southeast Pacific
- SLA signals are transported through oceanic and atmospheric teleconnections
    - Kelvin & Rossby waves
    - SLPa and Ekman transport
- Network is not static! Flavour of ENSO appears to trigger shift in SLA patterns

- Modelling needed to reveal the underlying processes

- Report, figures and code available on GitHub!
  github.com/eikeschuett/dMaps_SLV/

THANK YOU