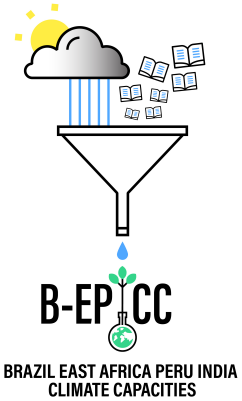
# Long-term El Niño forecasting

Josef Ludescher


Potsdam Institute for Climate Impact Research

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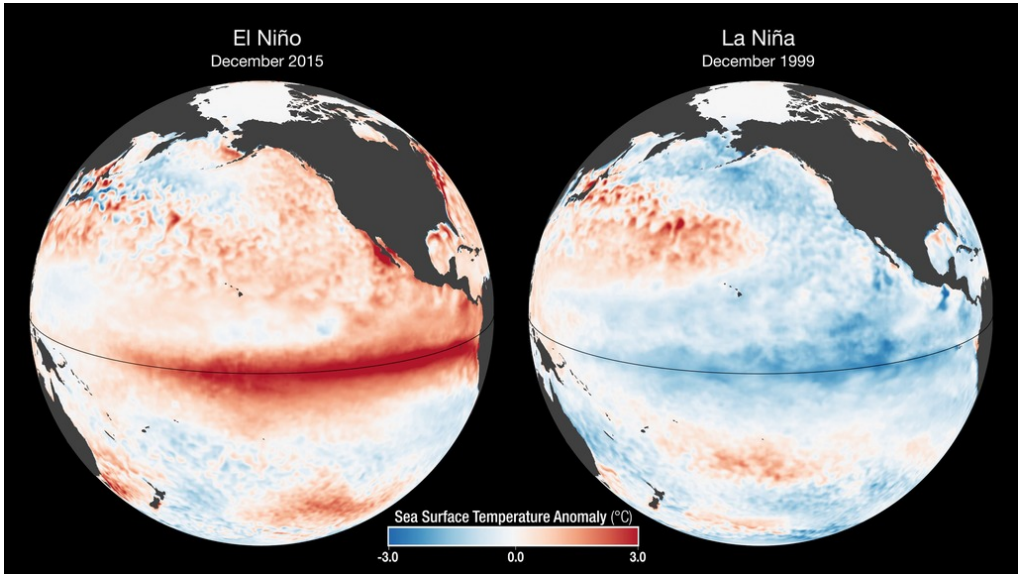
IKI INTERNATIONALE KLIMASCHUTZ INITIATIVE

# Outline

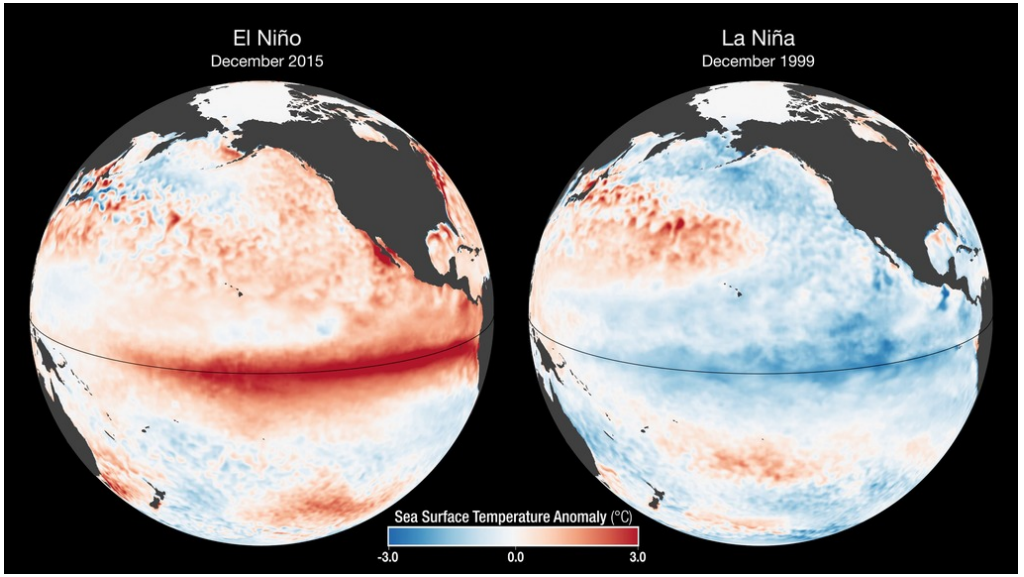
- El Niño and its impacts
- Spring predictability barrier
- Climate network-based El Niño forecasting

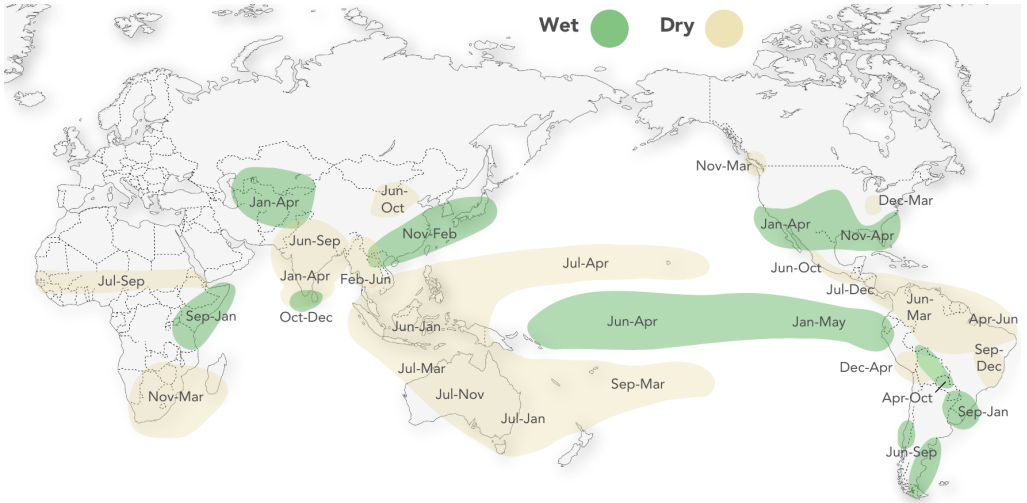
# El Niño Southern Oscillation




Figs: NASA, IRI

# El Niño Southern Oscillation




Figs: NASA, IRI

# Social and economic consequences

Floodings

Agriculture

Fresh Water & Power

Fisheries

Infrastructure

Wildfires

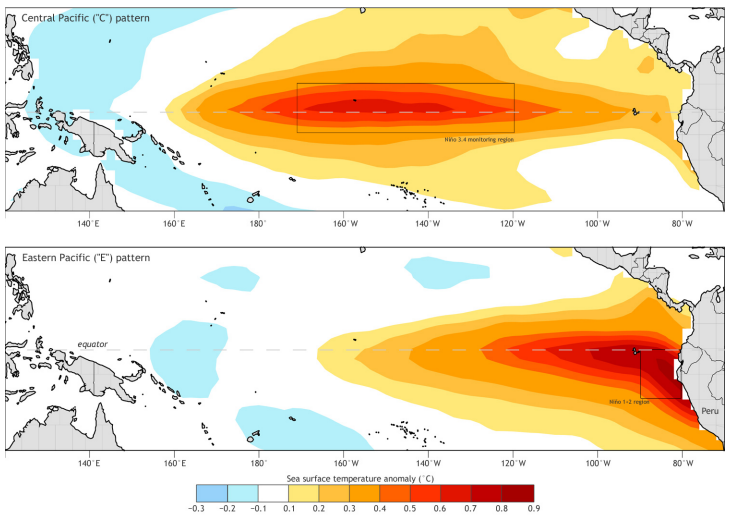
Public health

Biodiversity

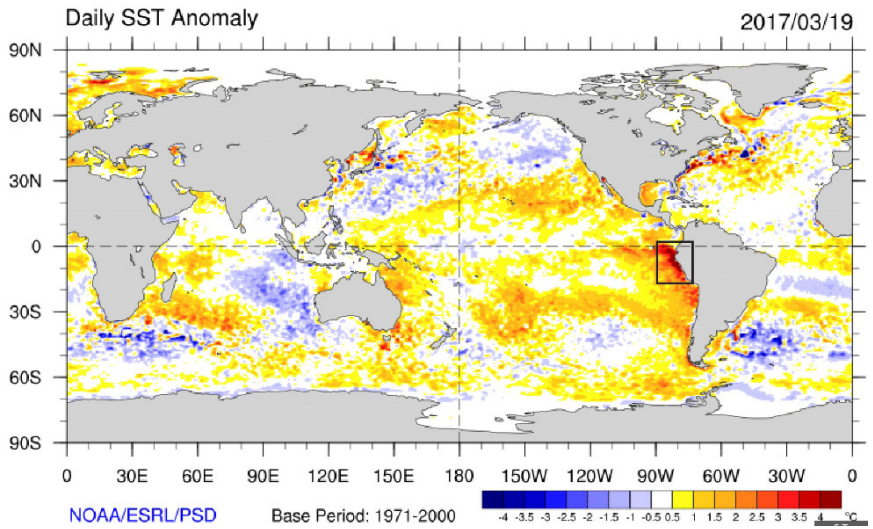
Figs: Ministerio de Defensa del Peru; wikimedia

# Types of El Niño

## Basin wide CP/EP El Niño

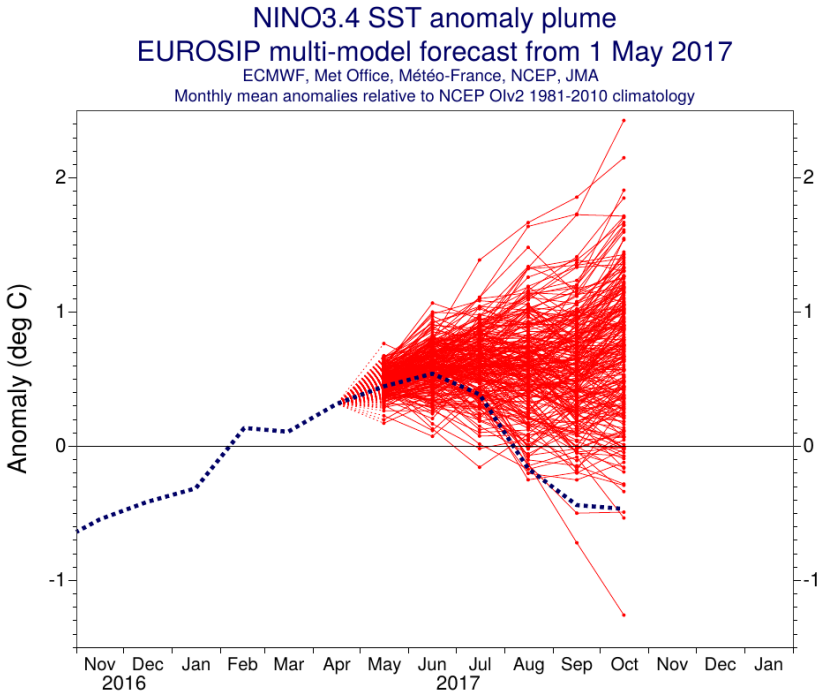


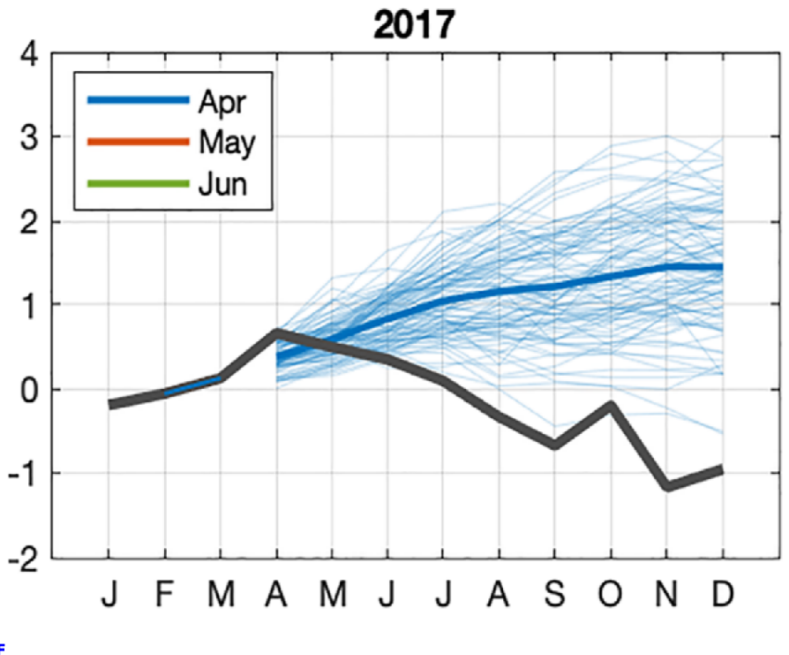

## Coastal El Niño with local warming




Figs: NOAA climate.gov, NOAA/ESRL/PSD

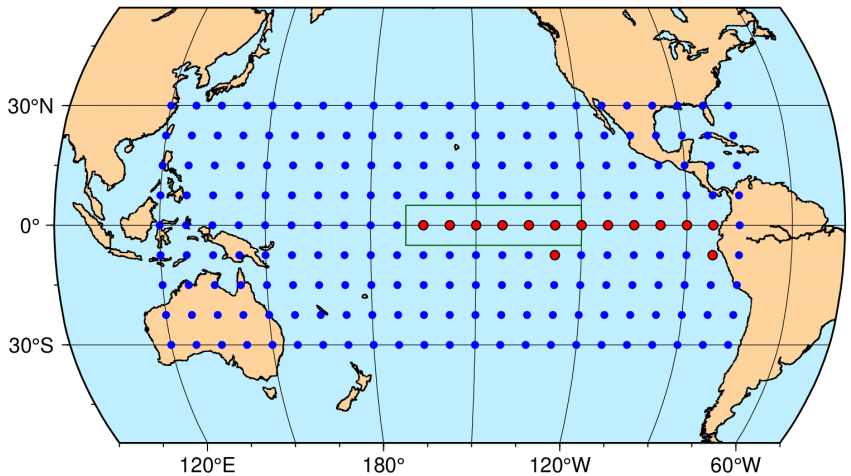
# Spring predictability barrier




Figs: ECMWF, Tippett et al., GRL 2020

# Climate network-based El Niño prediction




**Nodes** are reanalysis grid points

**Link** strength $S_{ij}$ is derived from time-lagged cross-correlation between nodes $i$ and $j$

Predictive **network quantity**: mean link strength S(t)

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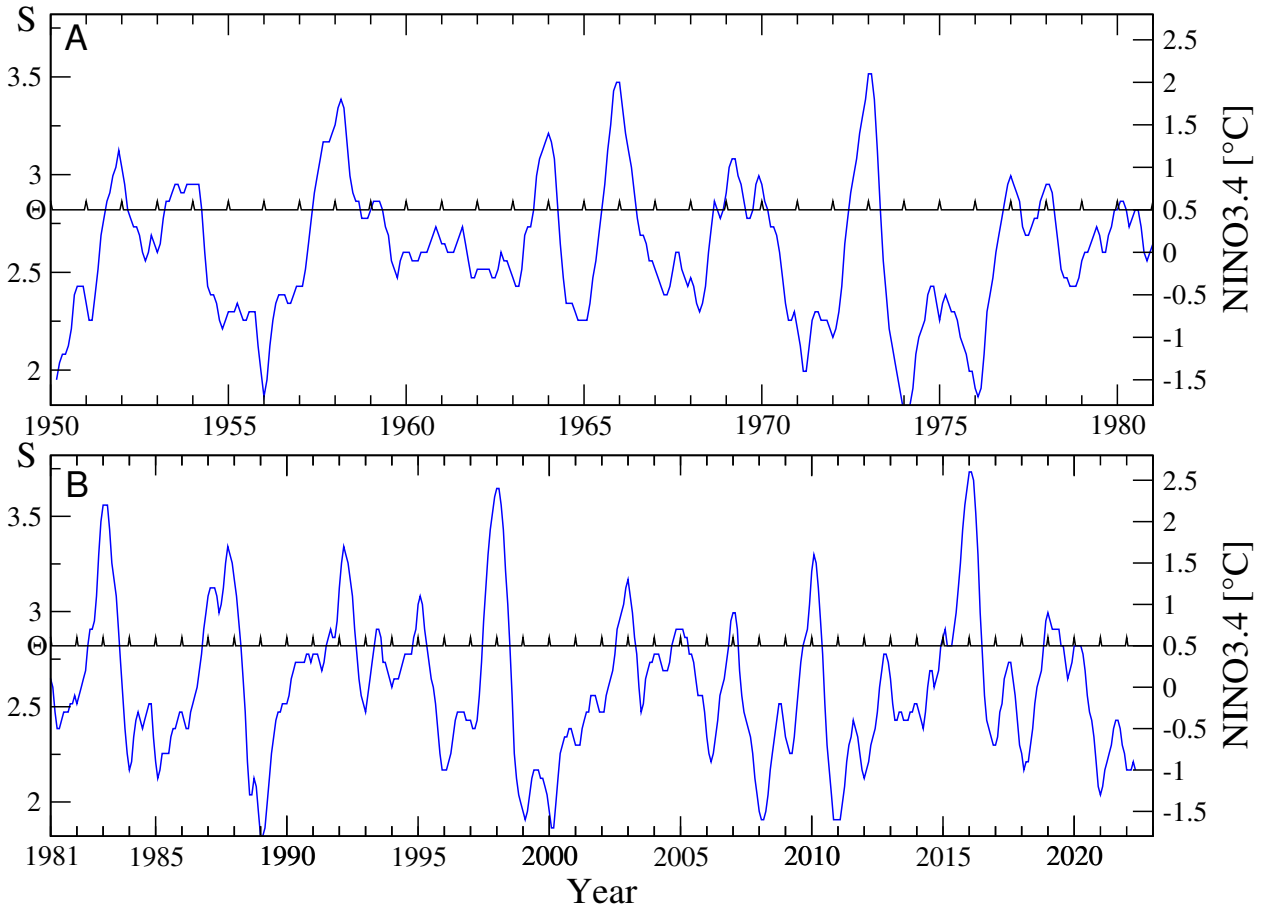
JL et al., PNAS 2013, 2014

# Forecasting approach



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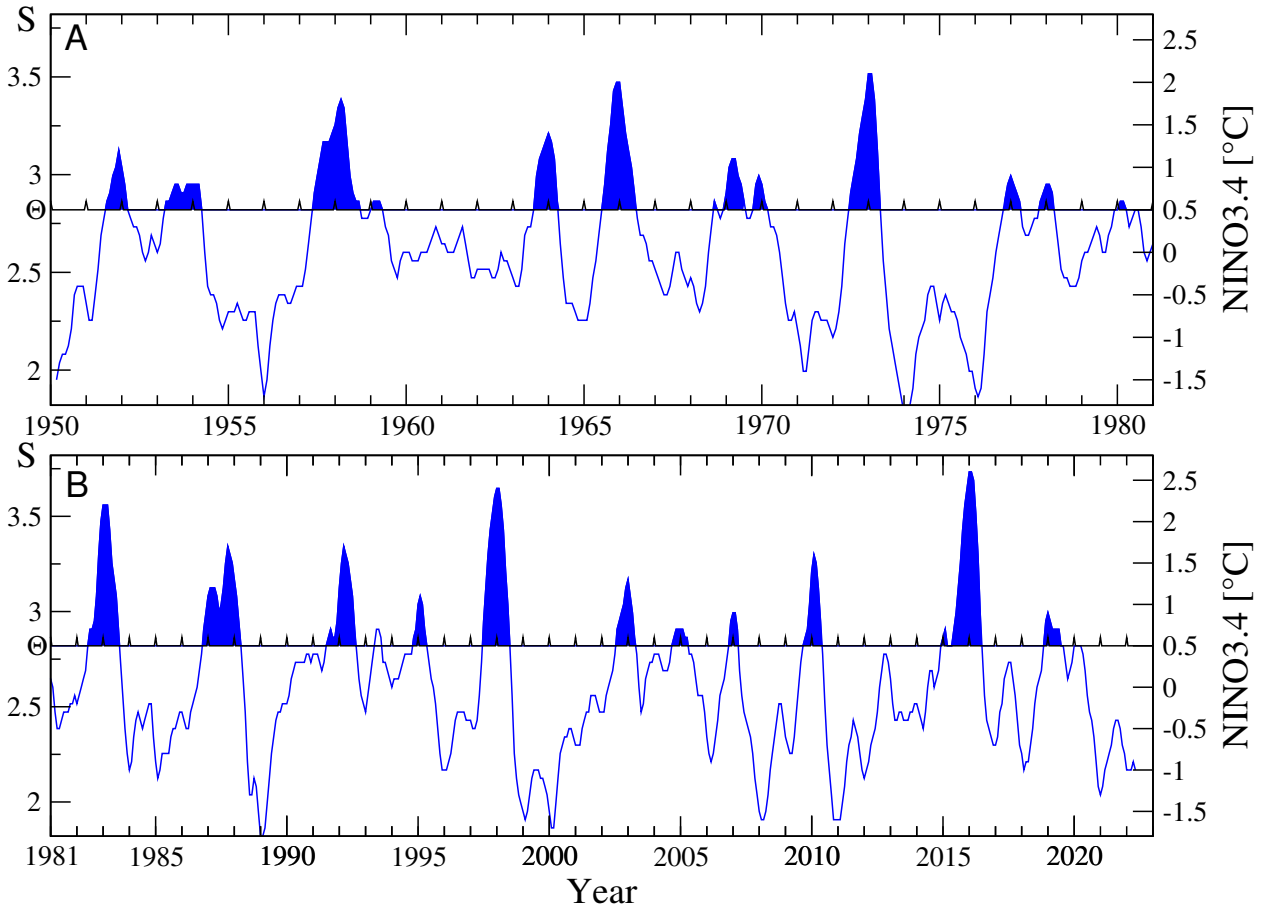

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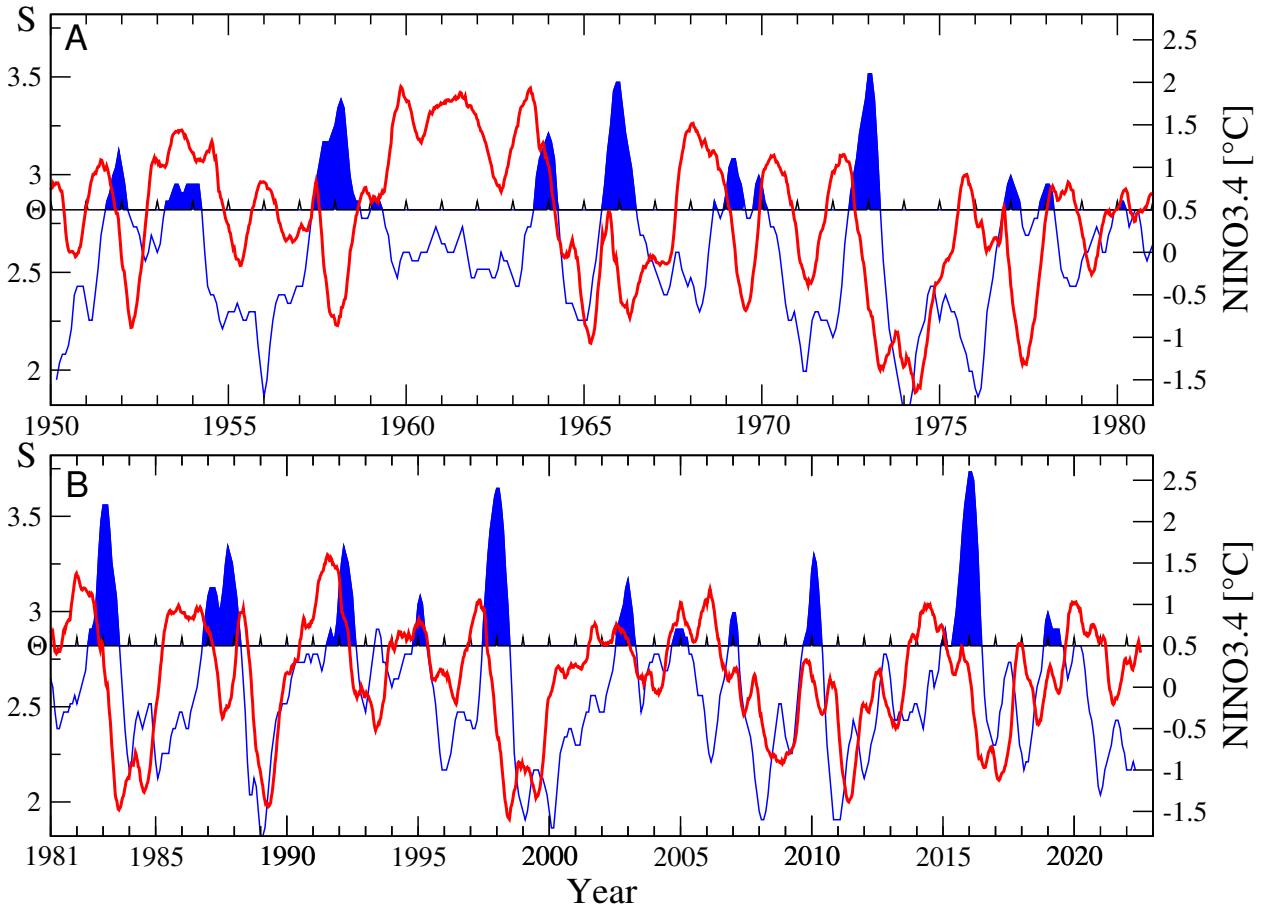

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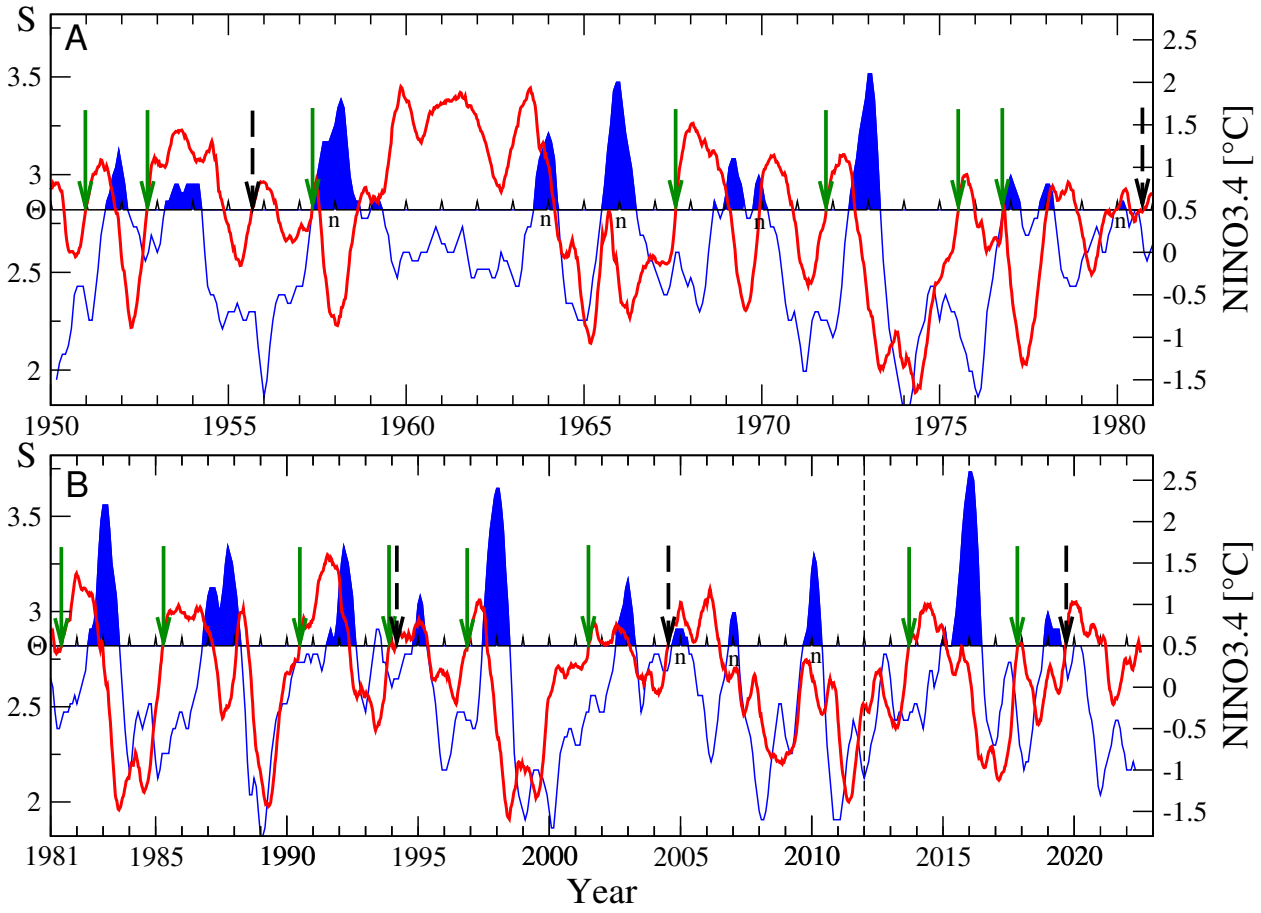
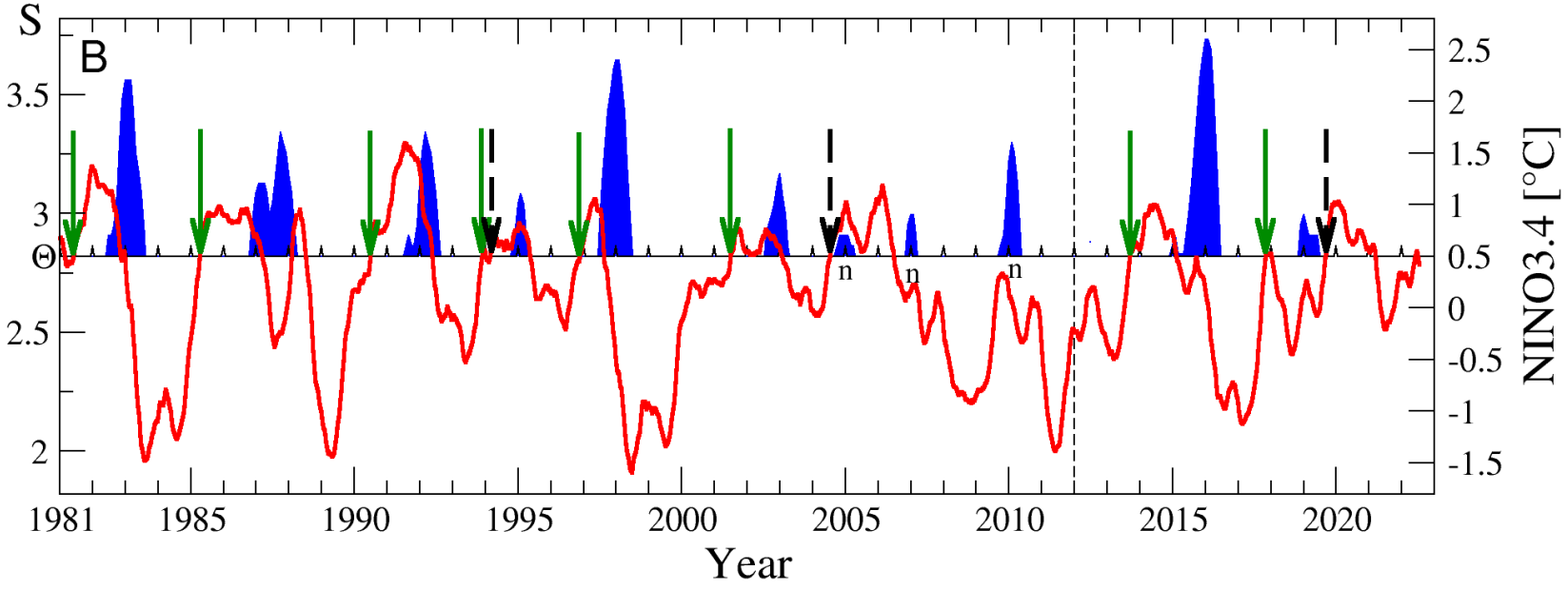


# Climate network predictive performance



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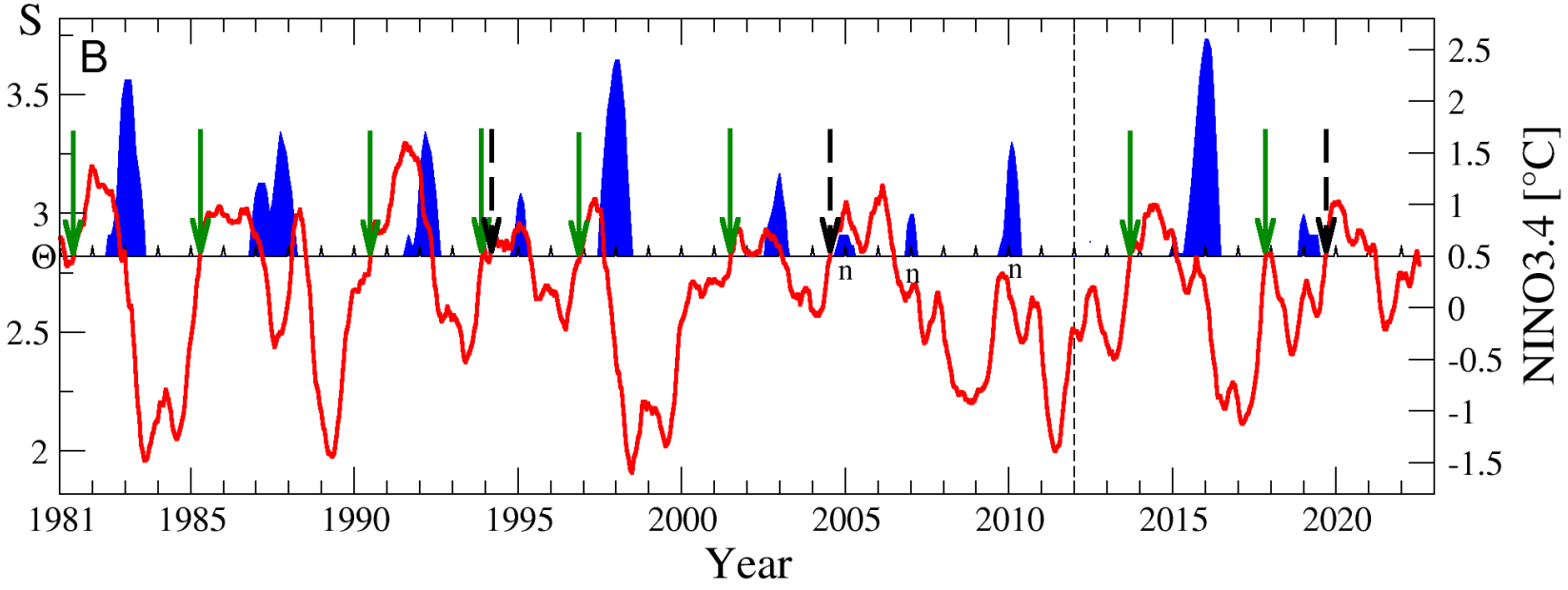


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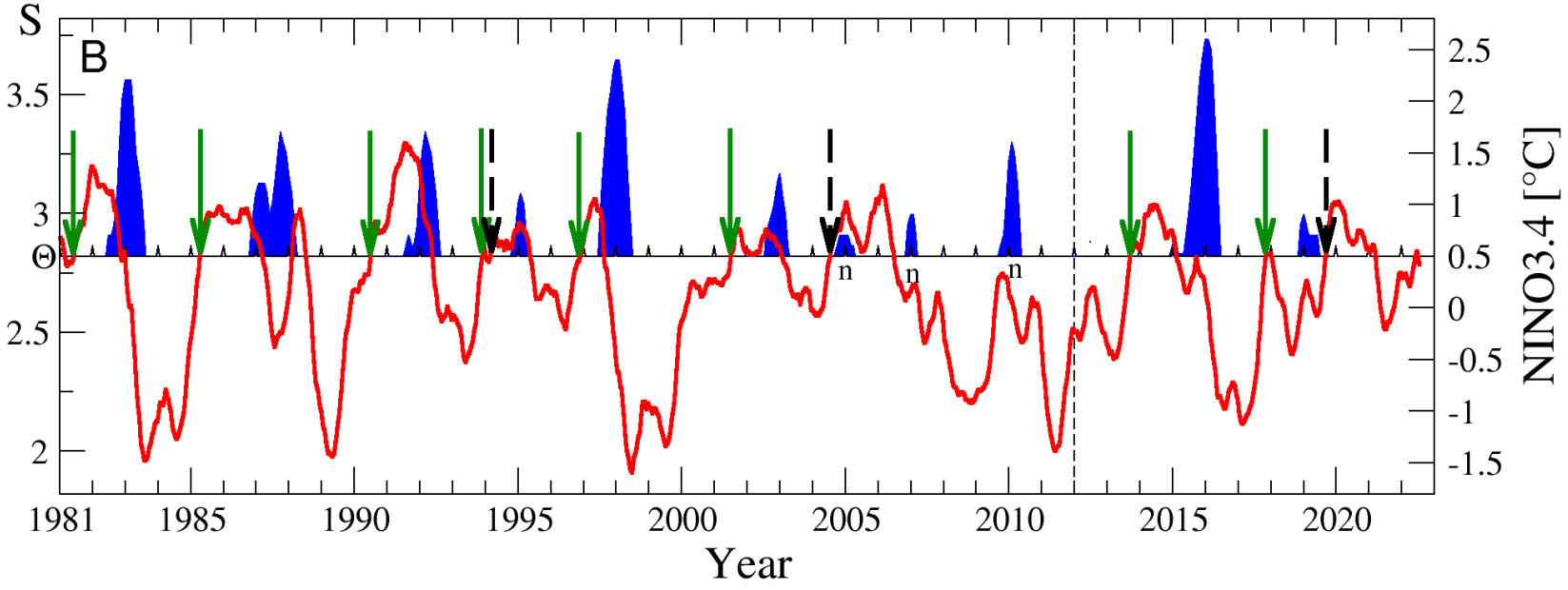


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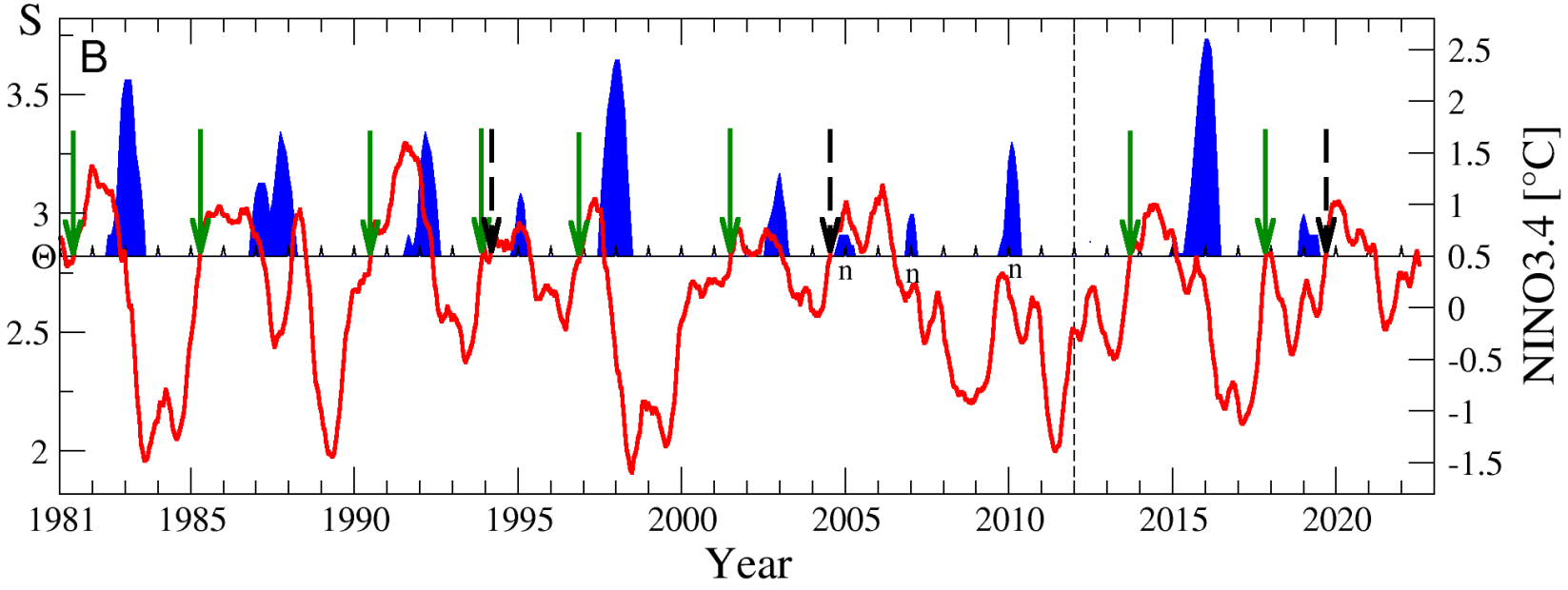


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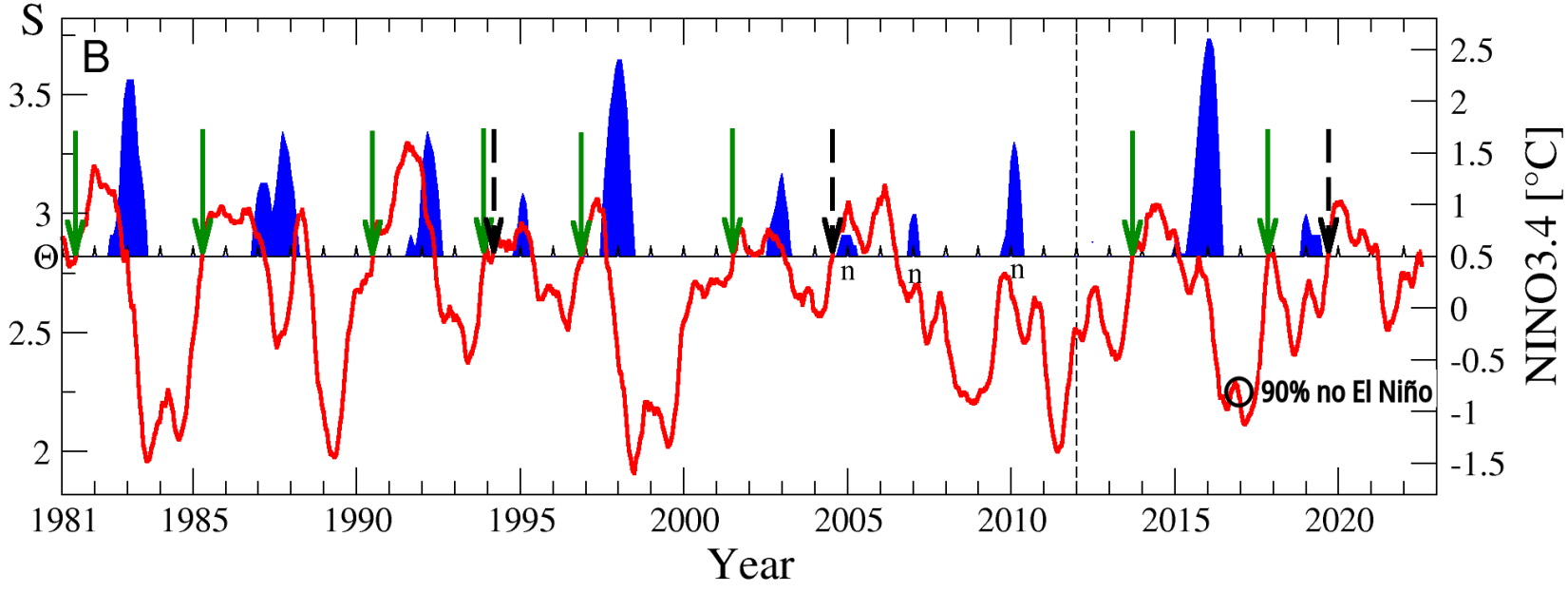


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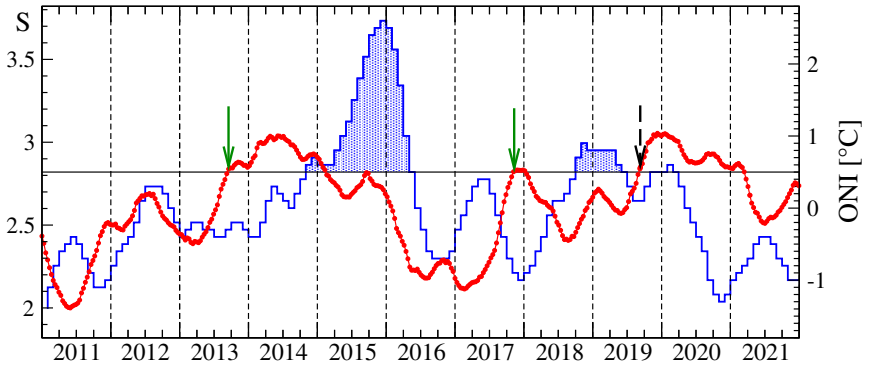


Figs: JL et al., arXiv:2102.02192v2; NOAA

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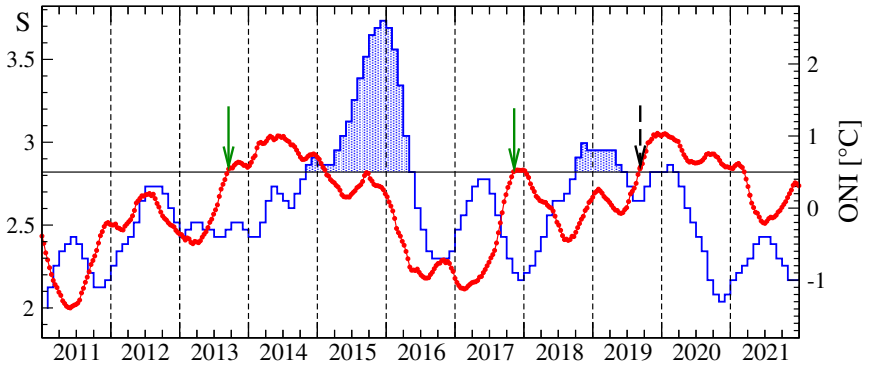


The climate network approach forecasted the absence of El Niño with 90% probability

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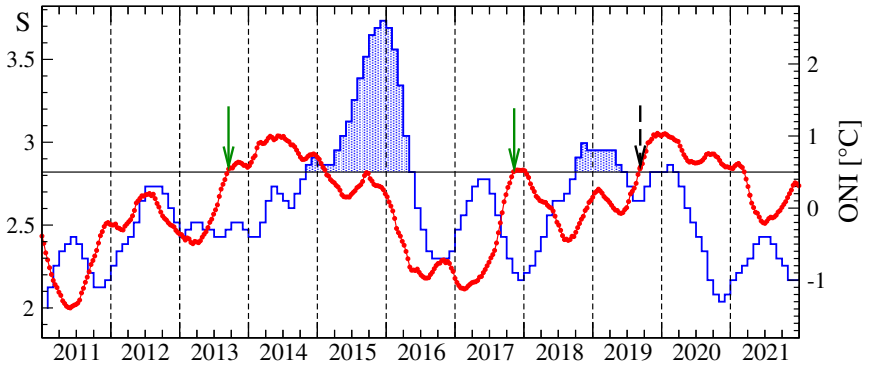


**Climate network and complexity based El Niño forecast for 2022**

Josef Ludescher[1], Jun Meng[2,1], and Jingfang Fan[3,1]

[1]*Potsdam Institute for Climate Impact Research, 14412 Potsdam, Germany*
[2]*School of Science, Beijing University of Posts and Telecommunications, Beijing 100876, China*
[3]*School of Systems Science, Beijing Normal University, 1000875 Beijing, China*

**Abstract**

The El Niño Southern Oscillation (ENSO) is the most important driver of interannual global climate variability and can trigger extreme weather events and disasters in various parts of the globe. Recently, we have developed two approaches for the early forecasting of El Niño. The climate network-based approach allows forecasting the onset of an El Niño event about 1 year ahead [1]. The complexity-based approach allows additionally to forecast the magnitude of an upcoming El Niño event in the calendar year before [2]. Here we communicate the forecasts of both methods for 2022.

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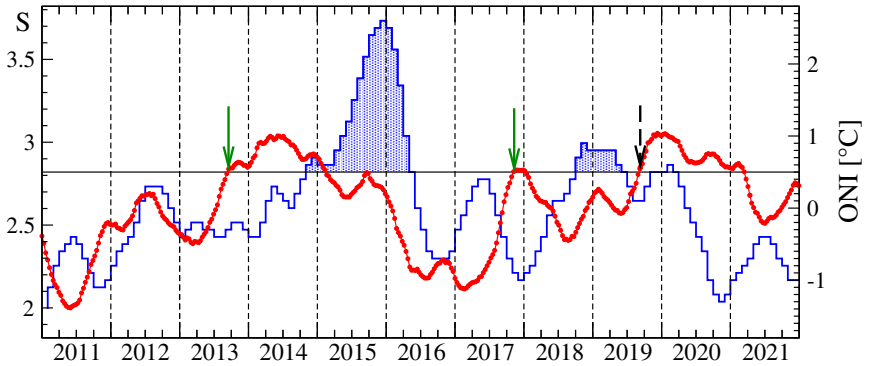


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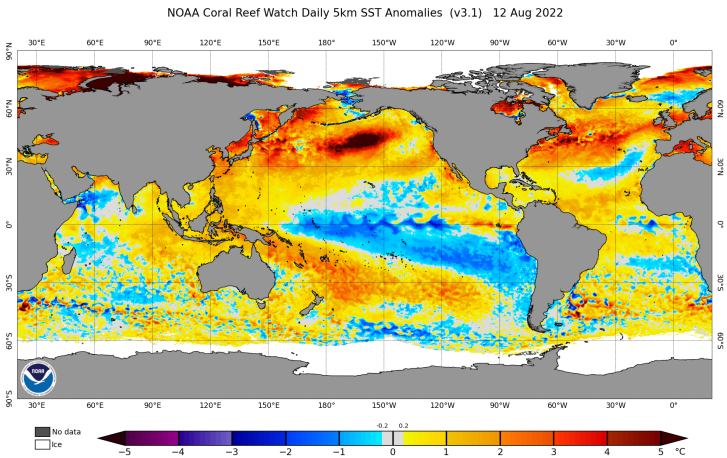


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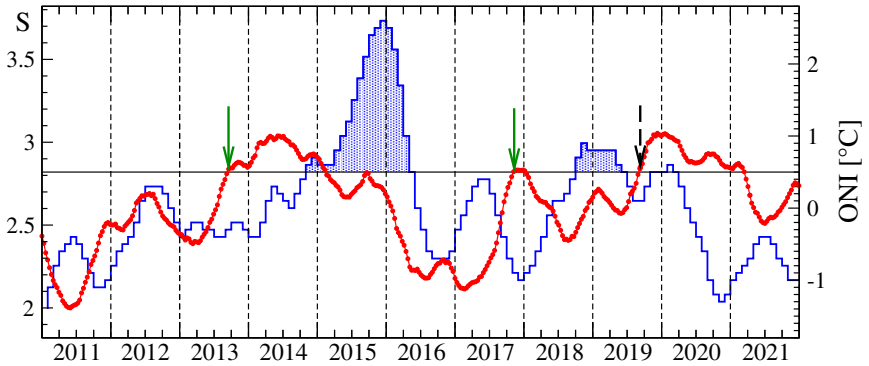


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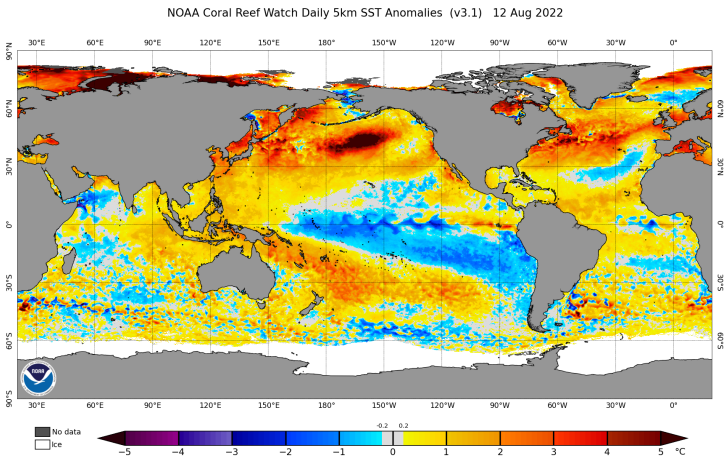


The climate network approach forecasted the absence of El Niño with 90% probability ⇒ forecast correct

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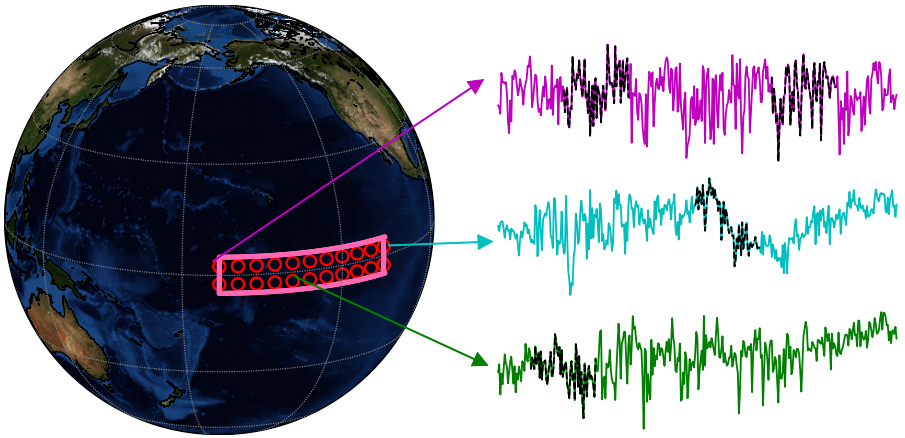
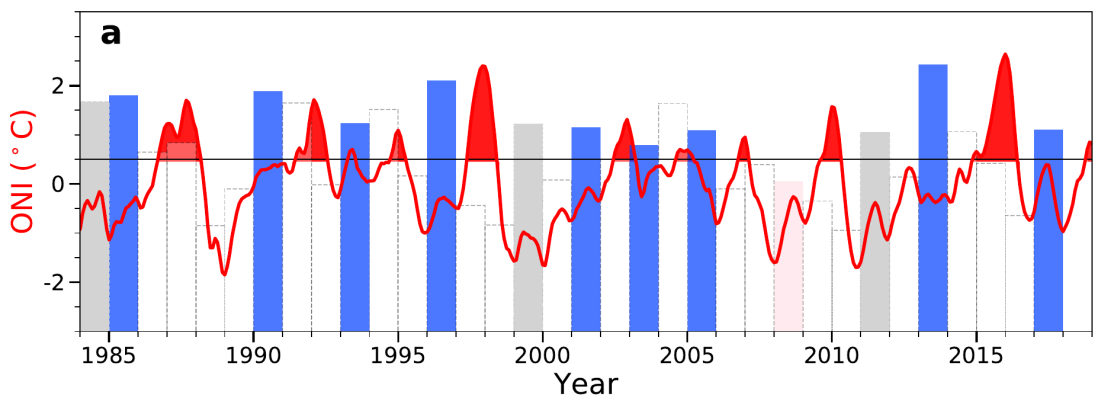
# Early EN magnitude forecast via information entropy






J Meng et al., PNAS 2020

# Conclusion

Skillful probabilistic El Niño predictions across the spring barrier are possible:

- The climate network approach can predict the **onset** of an El Niño event or its absence about 1 year in advance
- A **magnitude** forecast is possible via information entropy
- We are working on including a **type** (EP/CP) forecast