

# Multidecadal variability of ENSO in a recharge oscillator framework

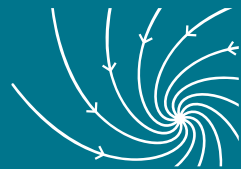
Lander R. Crespo, Belén Rodríguez de Fonseca, Irene Polo,  
Noel Keenlyside and Dietmar Dommenges



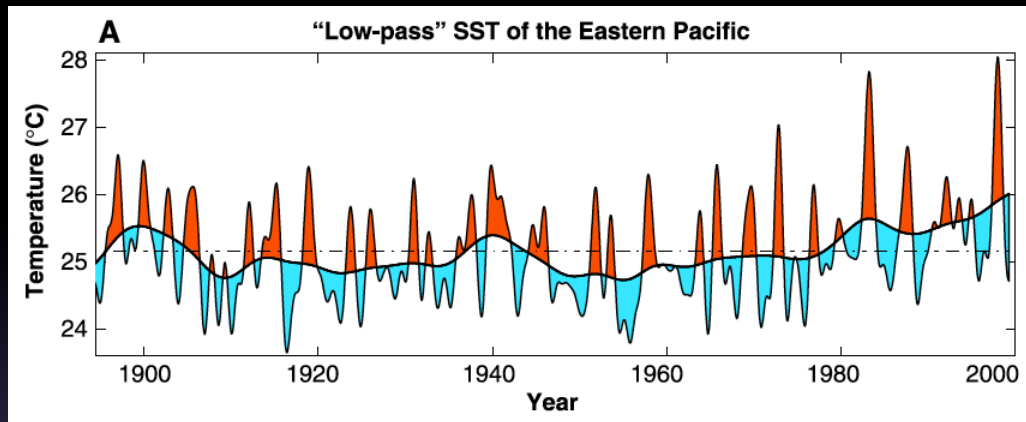
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# ENSO presents multidecadal variability

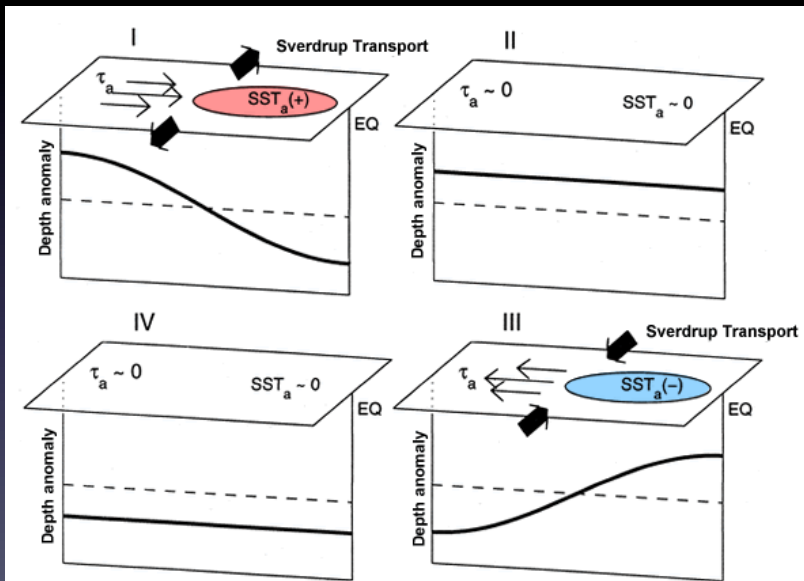


Fedorov and Philander (2000)

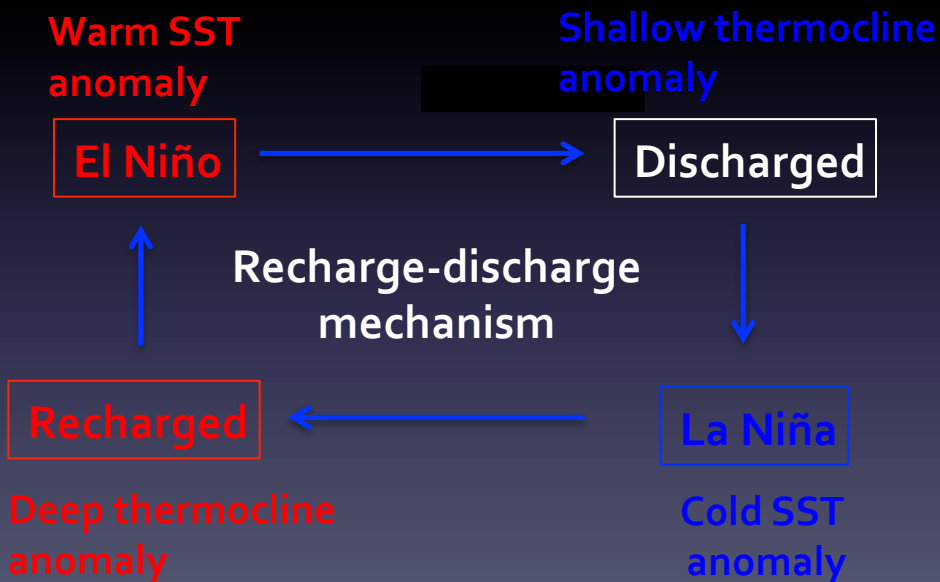
- What properties of ENSO show multidecadal variations during the observational record?
- Why do those properties change?
- Can we relate those changes to changes in the dynamics of ENSO?

# A conceptual model for ENSO: The recharge oscillator

The recharge oscillator model (Jin 1997) is based on the cyclic recharge-discharge process of the upper ocean equatorial heat content and is **based on the coupling between SST and thermocline**.



Schematics: Meinen and McPhaden 2000



# Simplified Recharge Oscillator model (Burgers et al. 2005)

## Model parameters

$a_{11}$  = SST growing rate

$a_{12}$  = coupling of  $h$  to SST

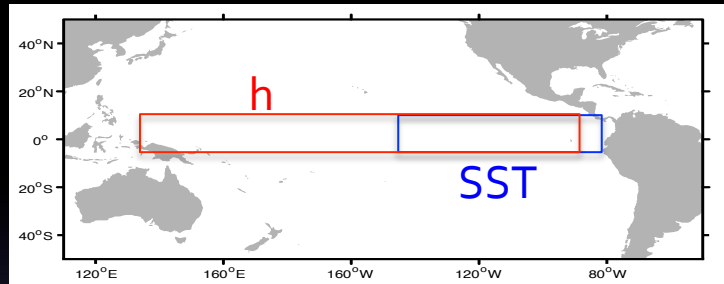
$a_{21}$  = coupling of SST to  $h$

$a_{22}$  =  $h$  growing rate

SST Niño3 region

$$\frac{d}{dt} SST = a_{11} SST + a_{12} h + N_T$$

$$\frac{d}{dt} h = a_{21} SST + a_{22} h + N_h$$



$h$  = zonal average of equatorial Pacific thermocline depth

## Methodology

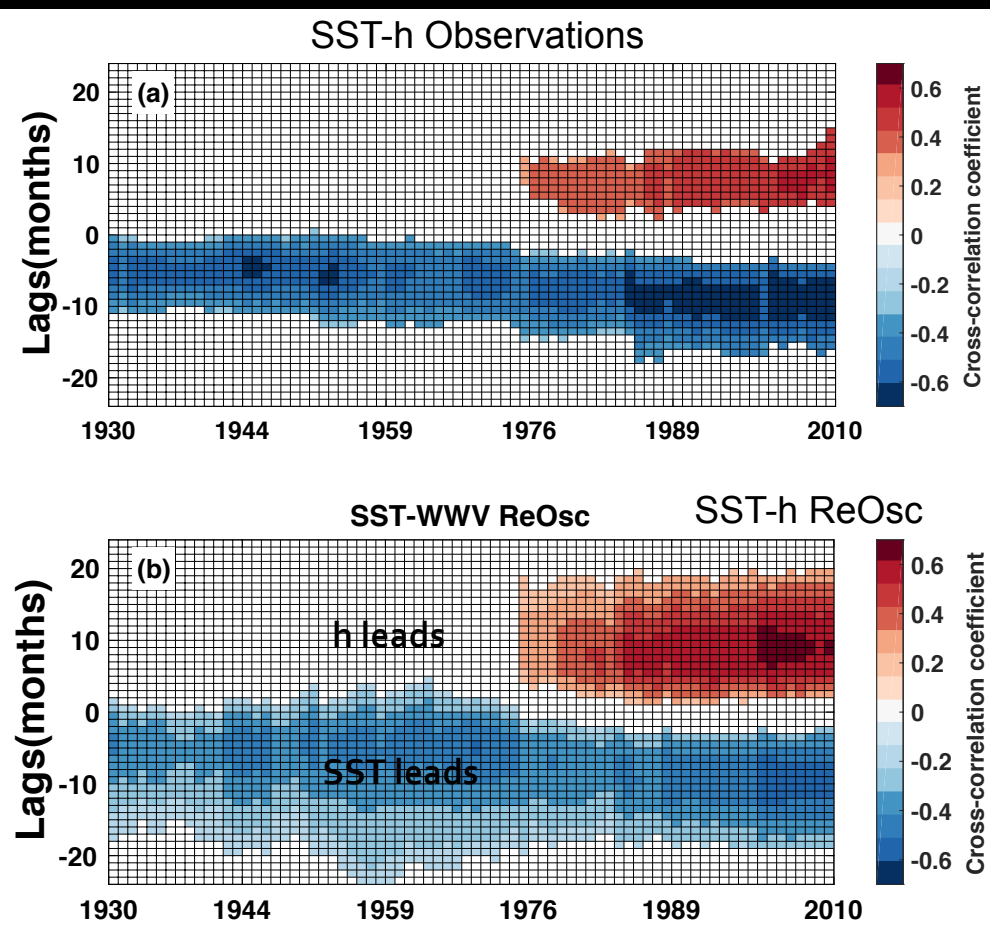
- i) Fit the parameters of the model to the observations in 30-yr running windows for the period 1900-2010.

(Vijayeta and Dommenget 2018)

- ii) Add white noise to create variability.

- iii) Integrate the model forward in time in 1000yr simulations.

# Multidecadal changes in SST-h coupling



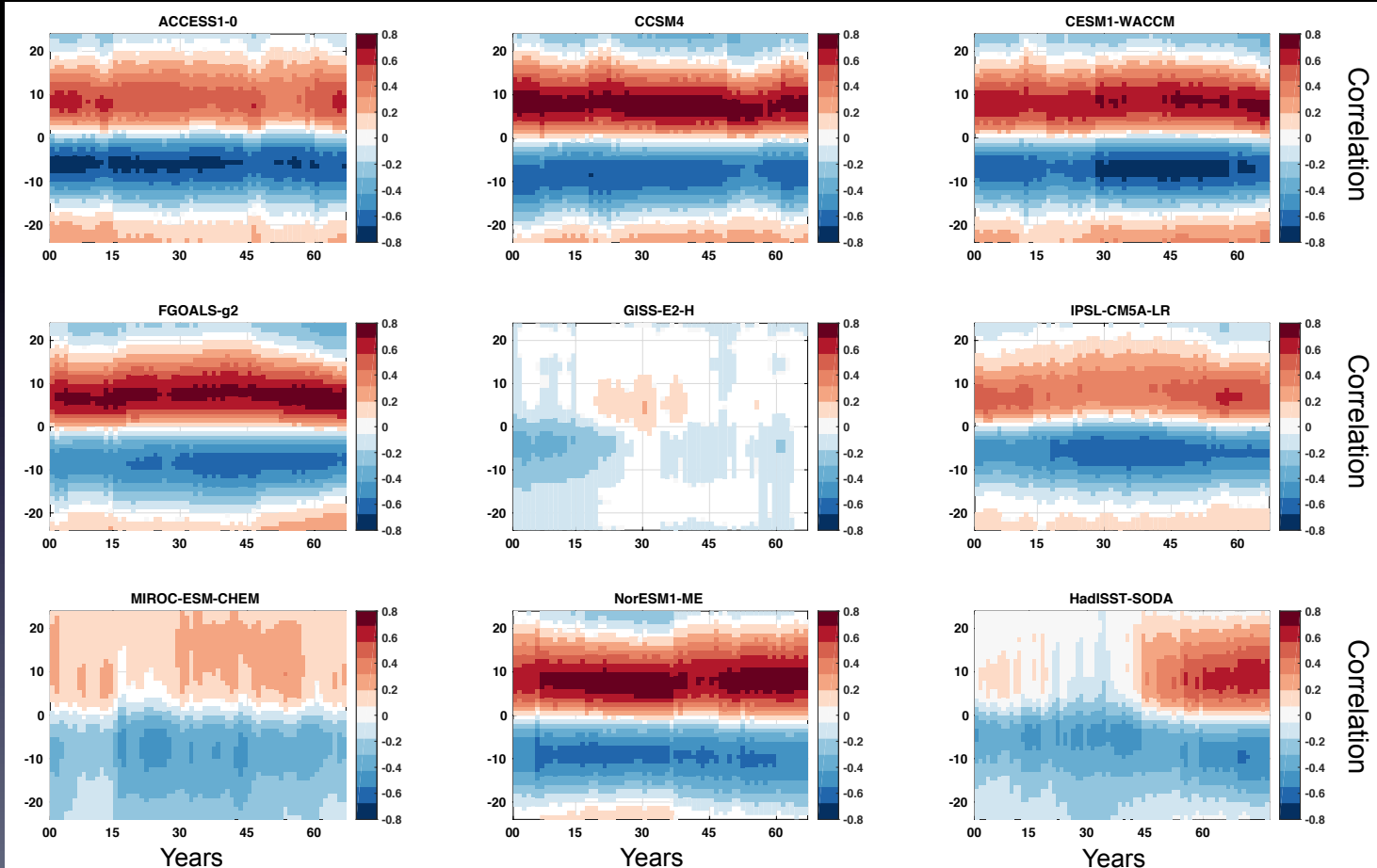
- The SST impact on thermocline is active for all periods in the observations and the ReOsc model.
- The feedback of h on SST is only active in the period 1970-2000.

**We find that the strength of the SST-h coupling in ENSO changes at multidecadal timescales in observations.**

**Can climate models capture these changes?**

- i) Do CMIP5 models reproduce different behaviours?**
- ii) Do they show multidecadal variability?**
- iii) Do they correspond to the observed changes?**

# Multidecadal variability SST-h coupling (CMIP5 models)



**We find that the strength of the SST-h coupling in ENSO changes at multidecadal timescales in observations.**

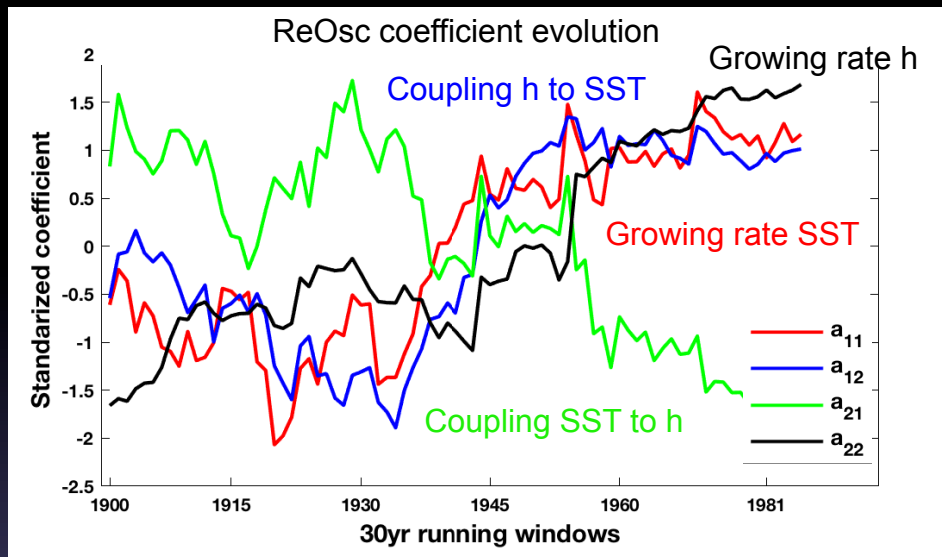
**Can climate models capture these changes?**

- i) Do CMIP5 models reproduce different behaviours? Yes**
- ii) Do they show multidecadal variability? Some of them do**
- iii) Do they correspond to the observed changes? No**

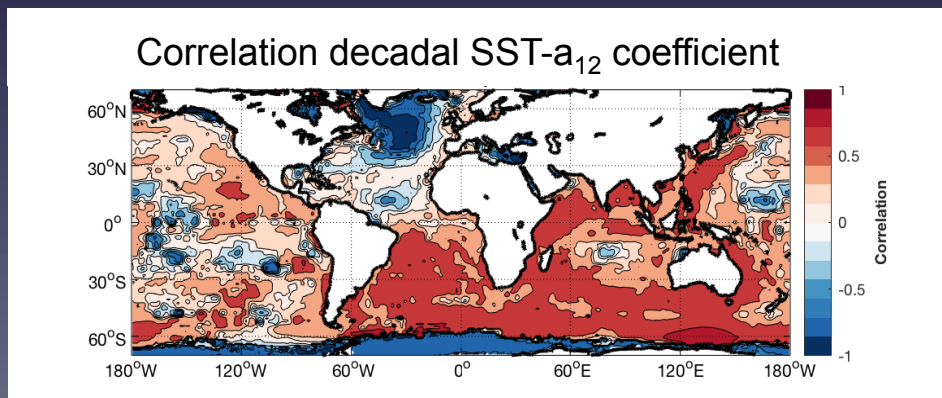
**But the observed behaviour lies within all the different realisations of the climate models.**



# Drivers of multidecadal variability of ENSO



- The coefficients of the ReOsc model show a multidecadal variability.
- The coefficients of the ReOsc are influenced by global warming since the 1950s.
- Ocean-atmosphere coupling is getting stronger under global warming.
- Multidecadal changes of the recharge oscillator dynamic resemble Atlantic Multidecadal Variability SST pattern.



# Summary and conclusions

- ENSO properties show a pronounced multidecadal variability.
- The mechanism of recharge-discharge of the equatorial heat content is the main driver of ENSO dynamics since the 1970s.
- The multidecadal modulation of ENSO appears related to the Atlantic Multidecadal Variability pattern and global warming.
- The thermocline depth is a good predictor of ENSO in recent decades.

e-mail: [lander.crespo@uib.no](mailto:lander.crespo@uib.no)



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