# The ocean component of CERA:

# diagnostics and developments

**Eric de Boisséson**, Patrick Laloyaux, Magdalena Balmaseda, Shoji Hirahara , Dick Dee and others

ERA-CLIM2 General Assembly, 19-21 November 2014

**Objective**: production of a coupled reanalysis of the 20$^{th}$ century CERA-20C

1. Analysis of short CERA runs

1. Preparing for century reanalysis

# First CERA runs

- **ERA-20C** is forced by HadISST2 monthly SST product

- At such resolution the system is **missing** submonthly and part of the subseasonal SST variability

- On these timescales, ocean-atmosphere **coupled processes** such as MJO, Tropical instability waves …

- The coupled system allows **high-frequency ocean-atmosphere interactions**

- How well does the **coupled reanalysis** represents high-frequency coupled processes? What is the impact of subsurface ocean observations? **Case study** of Tropical Instability Waves in the Pacific

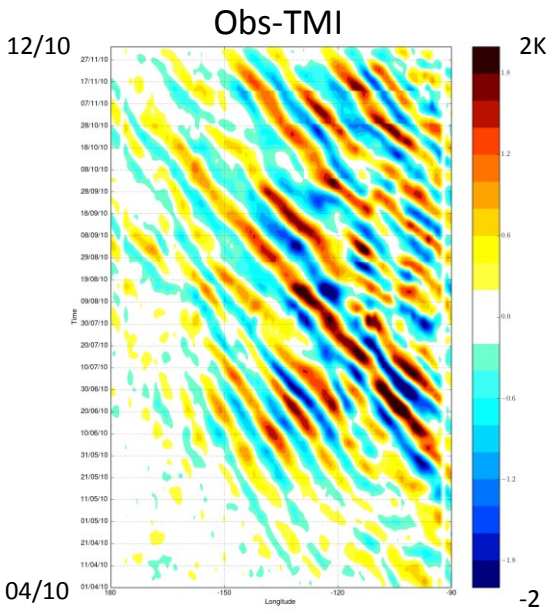
  - ✓ **CERA** assimilates the same atmospheric observations as ERA-20C and relax the SST from the ocean model toward HadISST2

  - ✓ 2-year analysis runs (2009-2010):
    1- **CTL**: CERA **without** assimilation of ocean subsurface obs
    2- **ODA**: CERA **with** assimilation of ocean subsurface observations

# First CERA runs

## Tropical Instability waves

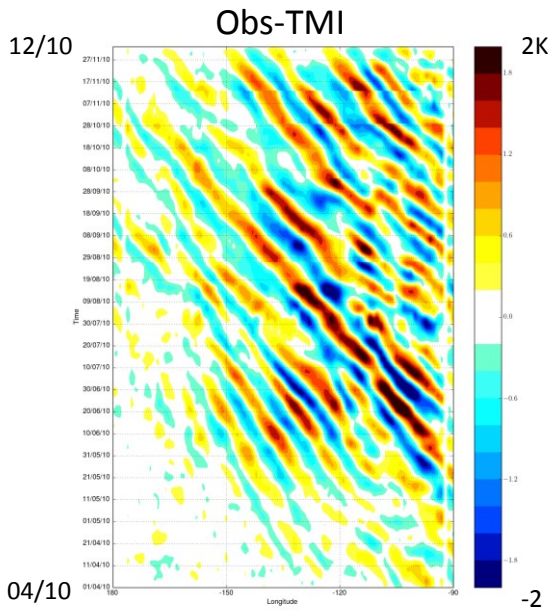
- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of SST anomalies

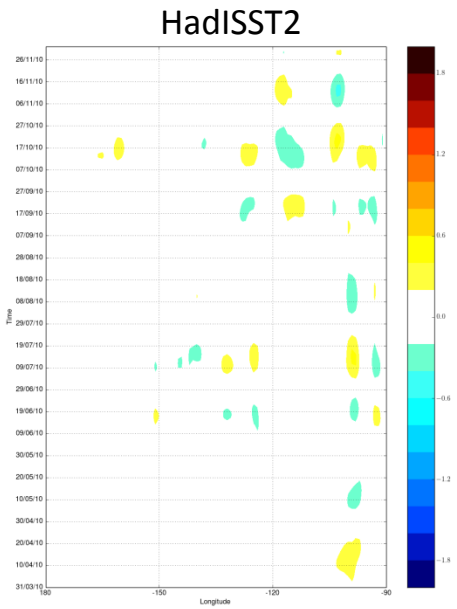


# First CERA runs

## Tropical Instability waves

- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of SST anomalies
- Not captured in HadISST2 monthly and thus not seen by the atmosphere of ERA20C



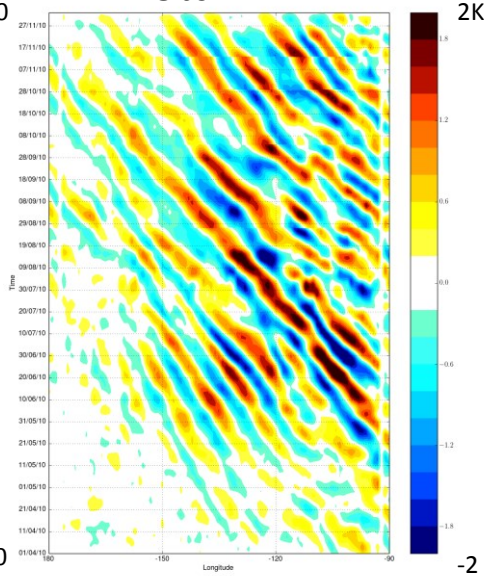
# First CERA runs

## Tropical Instability waves

- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of SST anomalies
- Not captured in HadISST2 monthly and thus not seen by the atmosphere of ERA20C
- CERA runs relaxed to HadISST able to represent TIWs

Obs-TMI

12/10

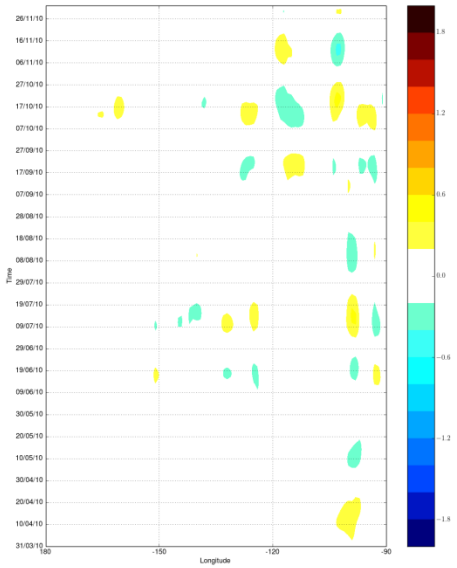



04/10

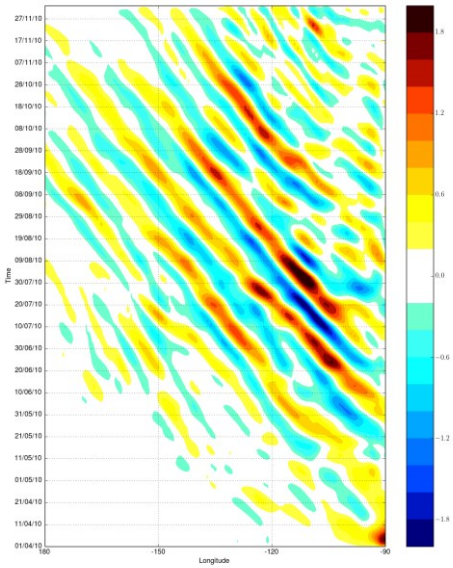
2K

-2

HadISST2




CERA CTL



# First CERA runs

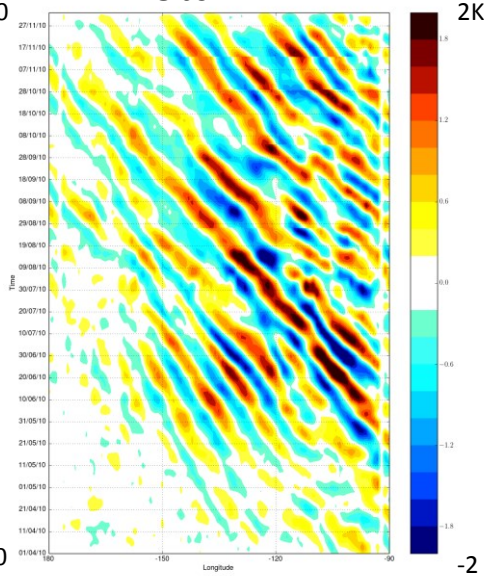
## Tropical Instability waves

- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of SST anomalies
- Not captured in HadISST2 monthly and thus not seen by the atmosphere of ERA20C
- CERA runs relaxed to HadISST able to represent TIWs
- Assimilation of ocean subsurface obs reduces intensity of anomalies
- CERA improvement vs ERA-20C in that respect

Obs-TMI

12/10

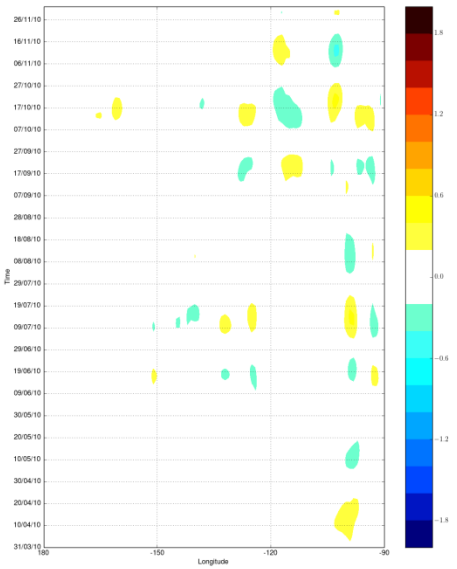
2K



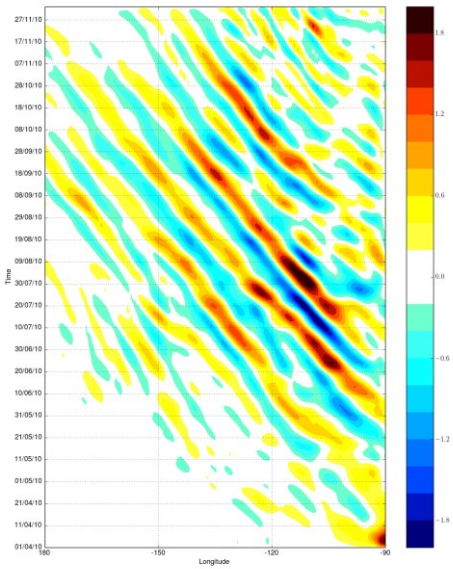

04/10

-2

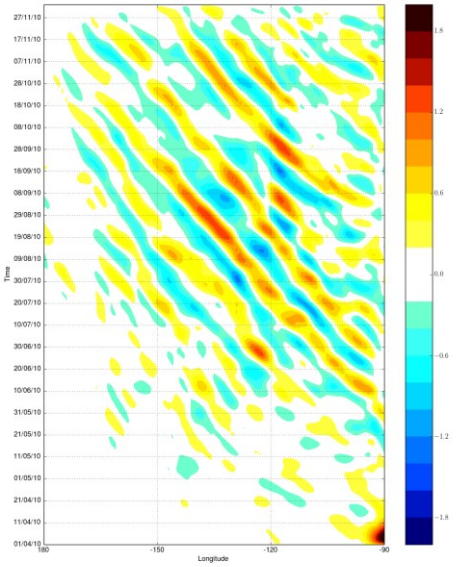
HadISST2




CERA CTL



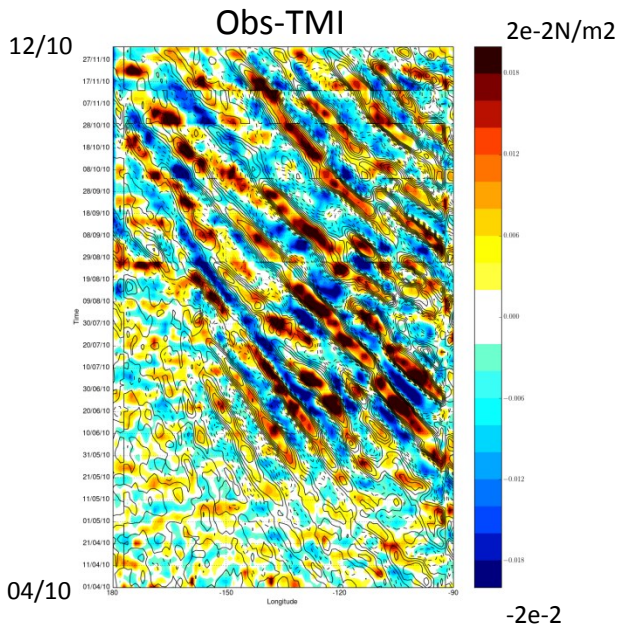

CERA ODA



# First CERA runs

## Tropical Instability waves

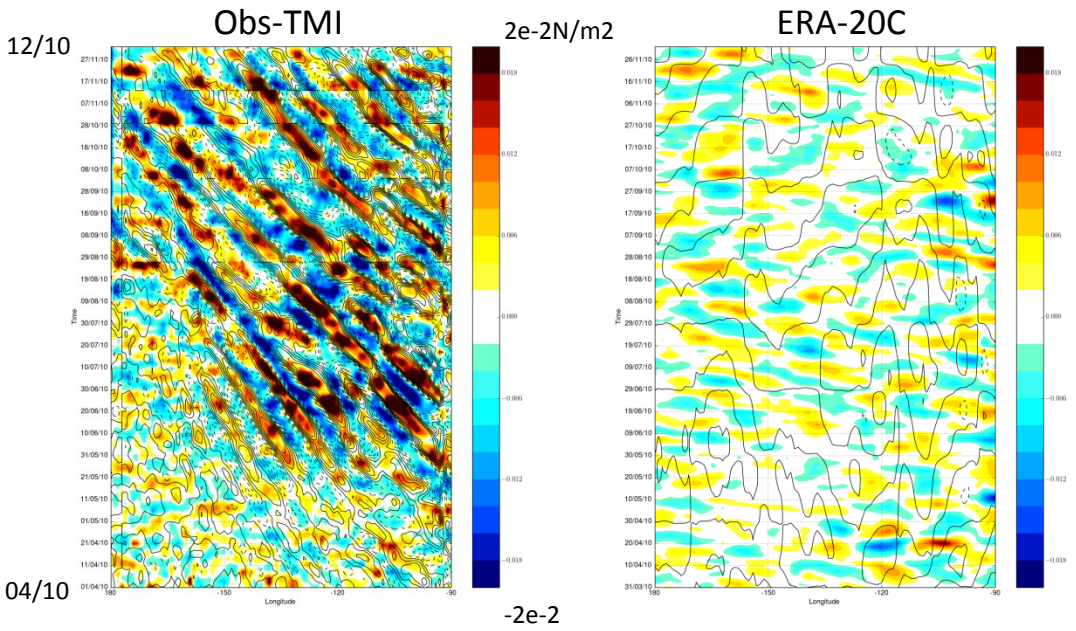
- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of wind stress anomalies in phase with SST anomalies



# First CERA runs

## Tropical Instability waves

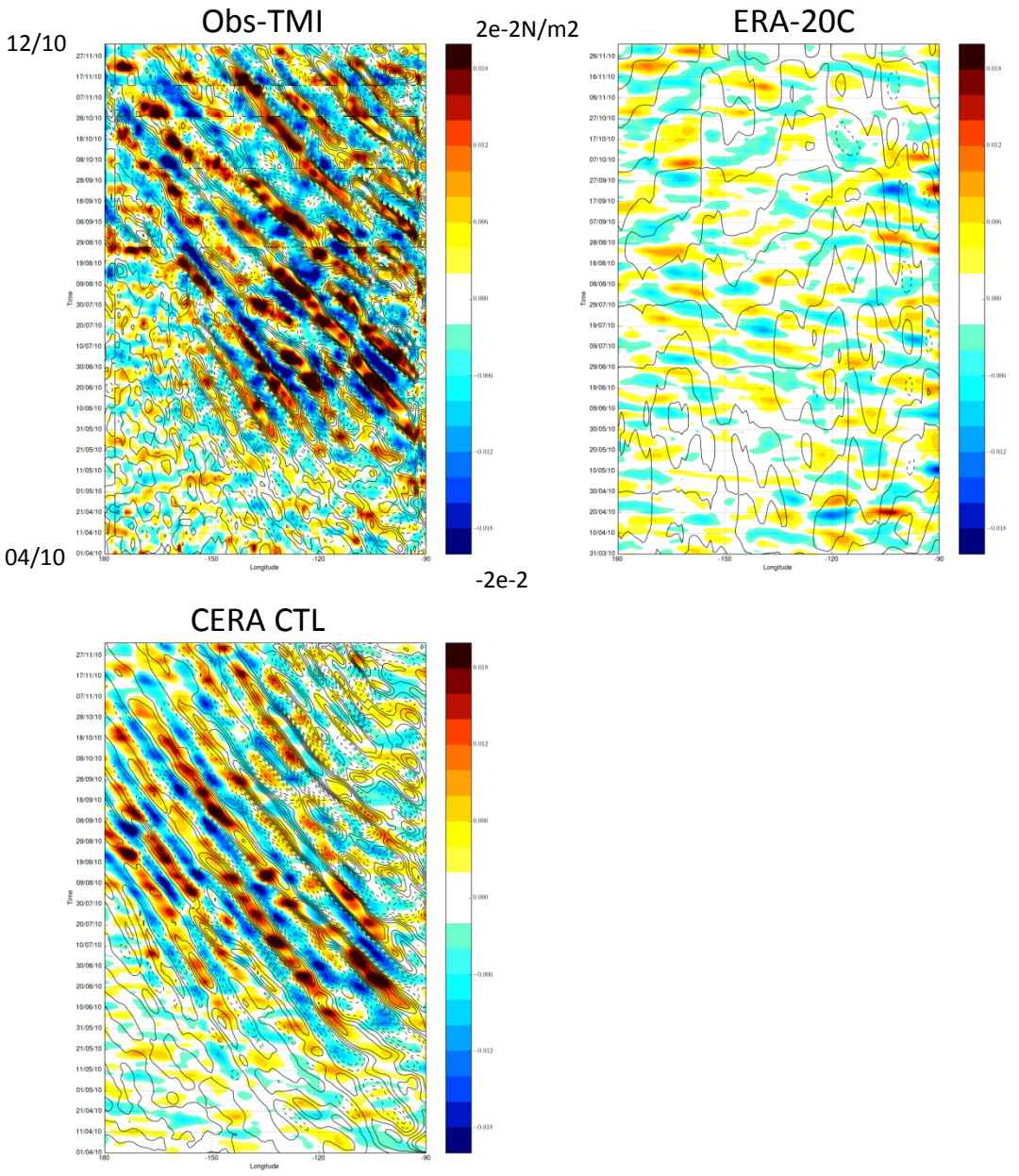
- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of wind stress anomalies in phase with SST anomalies
- Not represented in ERA20C



# First CERA runs

**Tropical Instability waves**

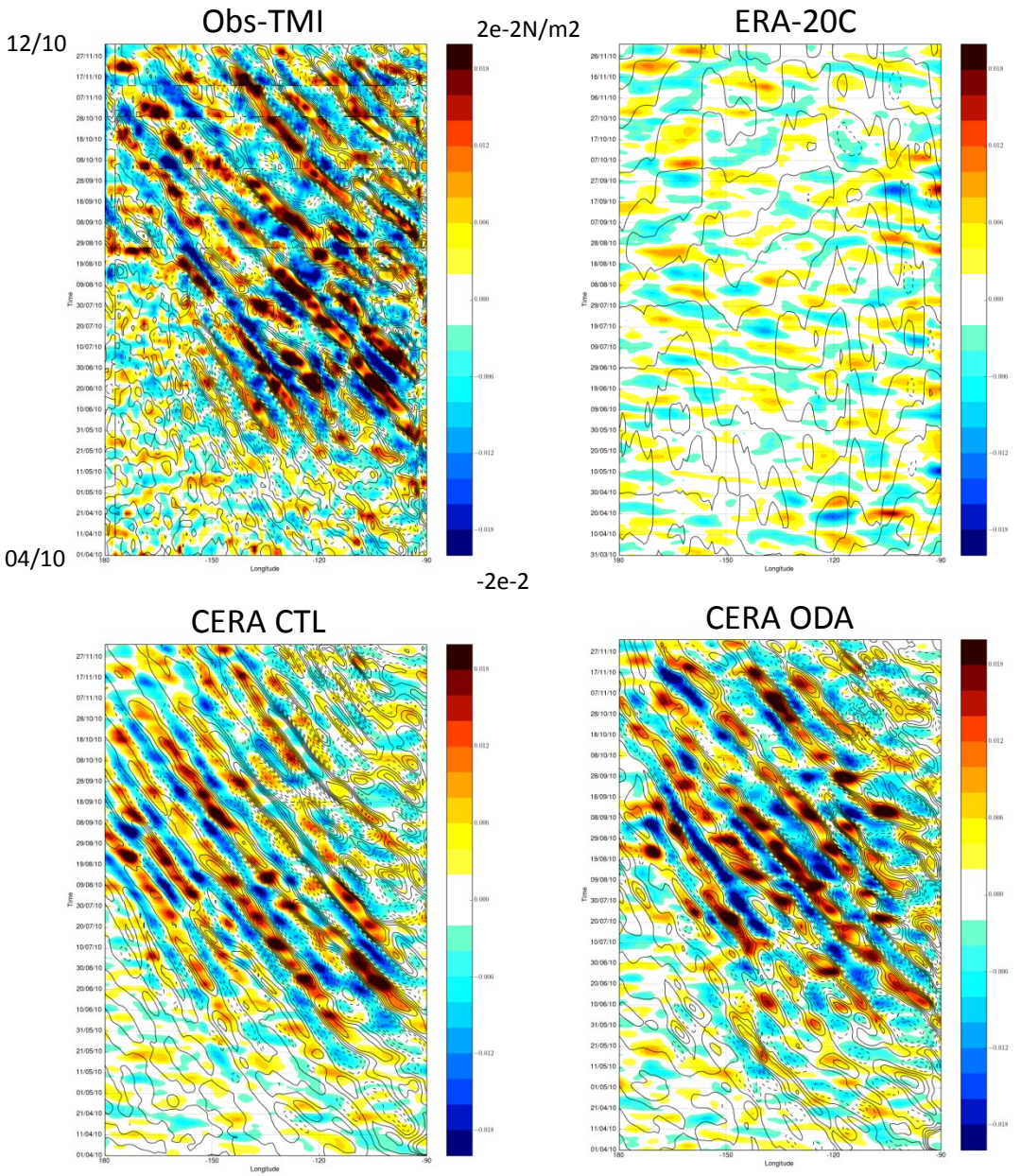
- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of wind stress anomalies in phase with SST anomalies
- Not represented in ERA20C
- CERA runs able to represent wind anomalies associated to TIWs



# First CERA runs

## Tropical Instability waves

- Equatorial Pacific (1N) from April to December 2010
- Westward propagation of wind stress anomalies in phase with SST anomalies
- Not represented in ERA20C
- CERA runs able to represent wind anomalies associated to TIWs
- The assimilation of ocean obs allow a better phasing between SST and stress
- CERA improvement vs ERA-20C in that respect



Preparing for century reanalysis

## 20th century ocean runs

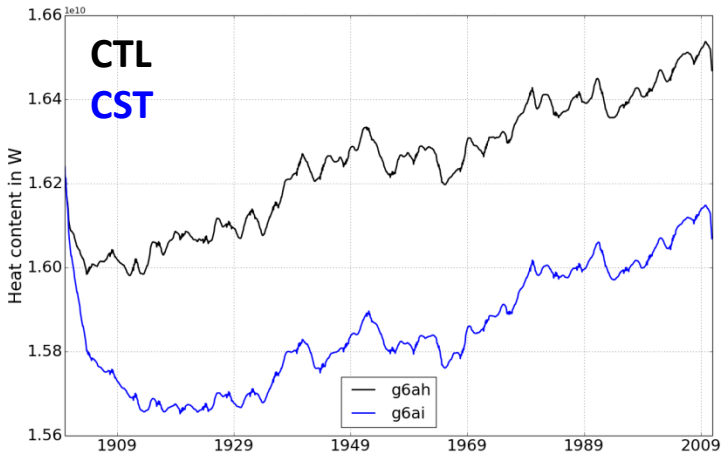
- Ensembles of CERA-20C planned to be produced in streams of several years
- Ocean component of the coupled system needs ocean IC
- 20th ocean reanalysis needed to provide IC. The ocean IC should be balanced enough to avoid drift
- 1st step: 20th century ocean simulations forced by ERA-20C
  - Response of the ocean to ERA-20C forcing ? Spin up? Constraint?
  - Two simulations: 1) CTL: free ocean run

    2) CST: SST relax to HadISST2 + 3D relax to climatology

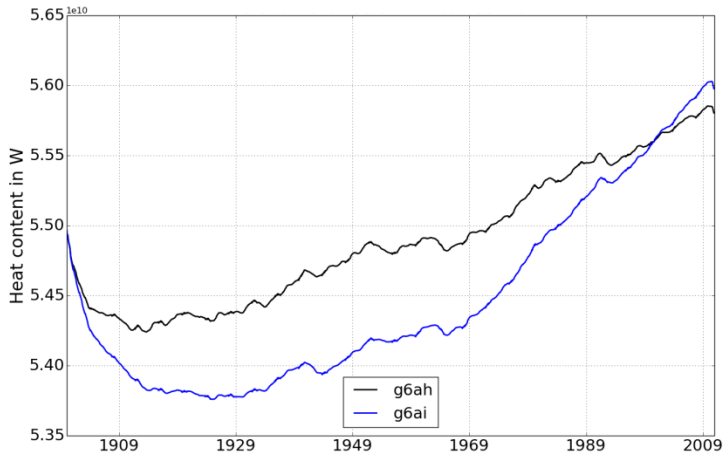
# Preparing for century reanalysis

## 20th century ocean runs

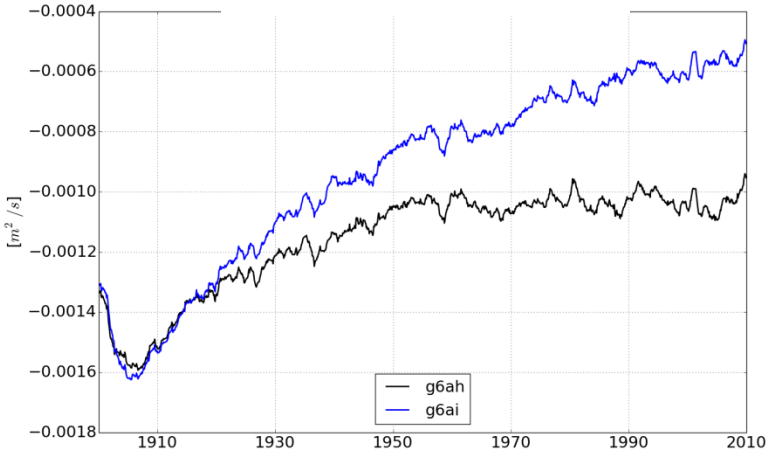
Heat content 0-300m




Heat content total column




AMOC 26N




- Spin up of the model can take a couple of decades or more if no constraint
- The constraint allows the AMOC to stabilize faster, and steady trends in heat content
- Enough to provide IC? More constraint?

# Preparing for century reanalysis

## Perturbations

- Ensembles of CERA-20C conducted from perturbed IC
- 10 ensembles from ERA-20C can be used to generate perturbations of solar, momentum and freshwater fluxes
- 10 ensembles from HadISST2 for SST perturbations (work of S. Hirahara)

## To do

- Produce and analyse perturbations
- Change of structure of the ocean suite to ingest the new perturbations