

# Assimilation of Earth Rotation Parameters to determine ocean mass change

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Forscherguppe  
Erdrotation  
und Globale  
Dynamische Prozesse

**AWI** Alfred-Wegener-Institut  
für Polar- und Meeresforschung  
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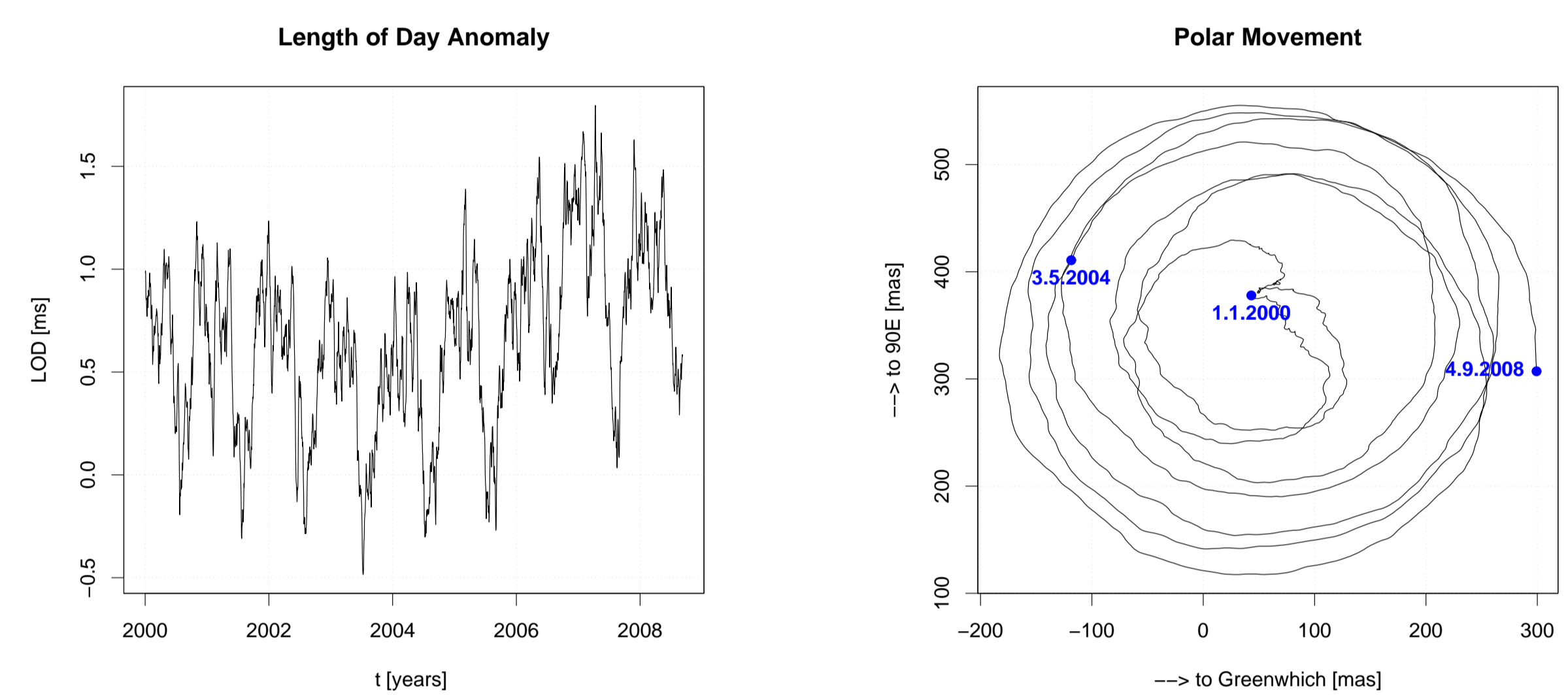
## Abstract

Earth rotation parameters (ERP) are measured with very high accuracy. Changes in the ERP originate in movements of mass within the Earth system. Therefore, these changes can be used to distinguish the eustatic from the steric effects in sea level change. We were able to assimilate measured ERP into a global circulation model of the oceans. On interannual timescales the model shows realistic behaviour and succeeds in the reproduction of the ERP observations. The biggest impact here is on the total ocean mass variation. By simultaneous assimilation of oceanographic data as SSH and SST in addition to ERP conclusions about the ocean heat content could be drawn.

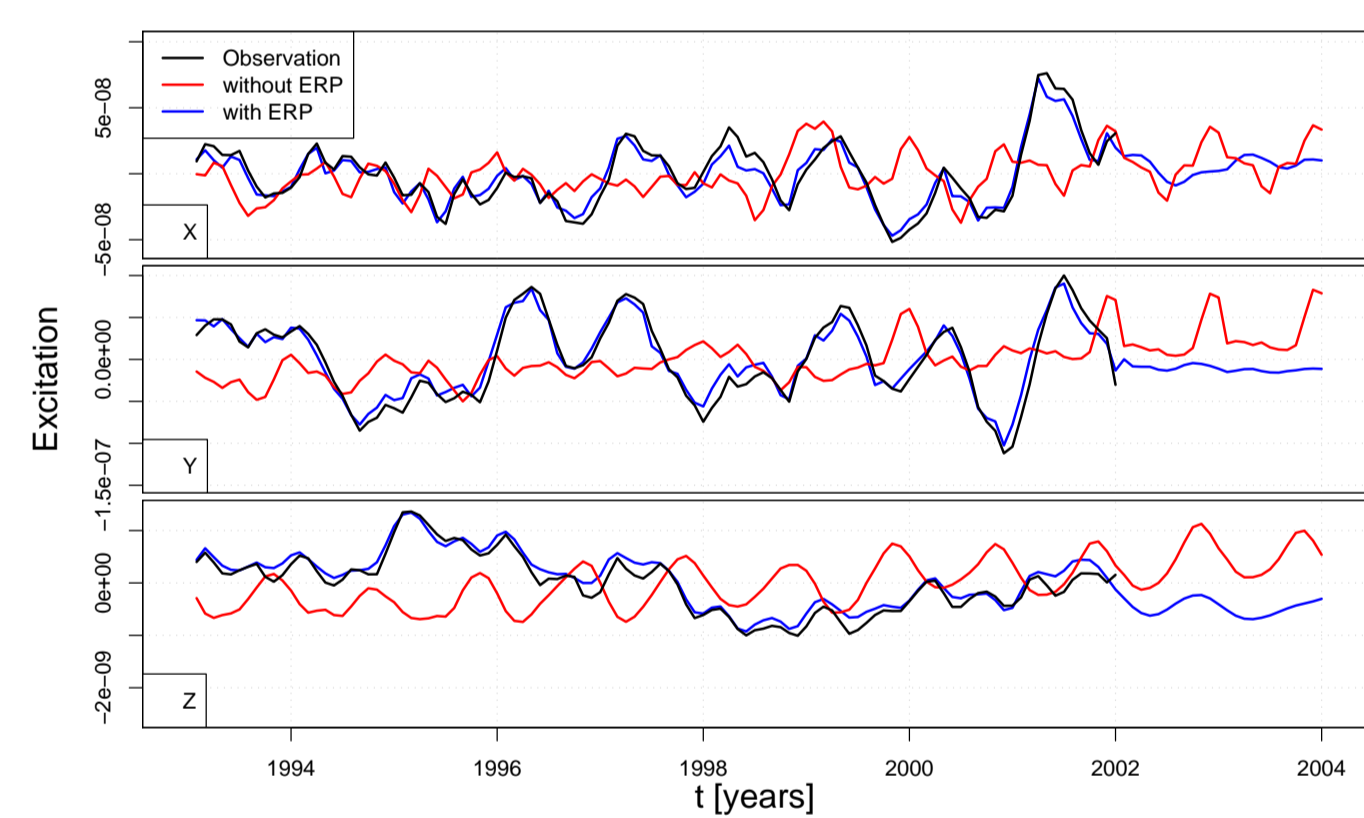
## Introduction

Changes in Earth's rotation rate and axis are described by the Earth rotation parameters (ERP). These changes are induced by mass movements within all of the Earth's subsystems (e.g. Atmosphere, Ocean, Land). The ERP are measured with very high precision. Non-oceanic influences were filtered out and the remaining signal is translated into ocean angular momentum functions ( $\chi$ ). These were assimilated into a global ocean model to reveal information about the ocean's mass changes and movements. TOPEX sea surface height (SSH) measurements constrain the change in the ocean's volume. A combined ERP and TOPEX assimilation determines the ocean's heat content anomalies.

## ERP Observations



## I Angular Momentum Functions



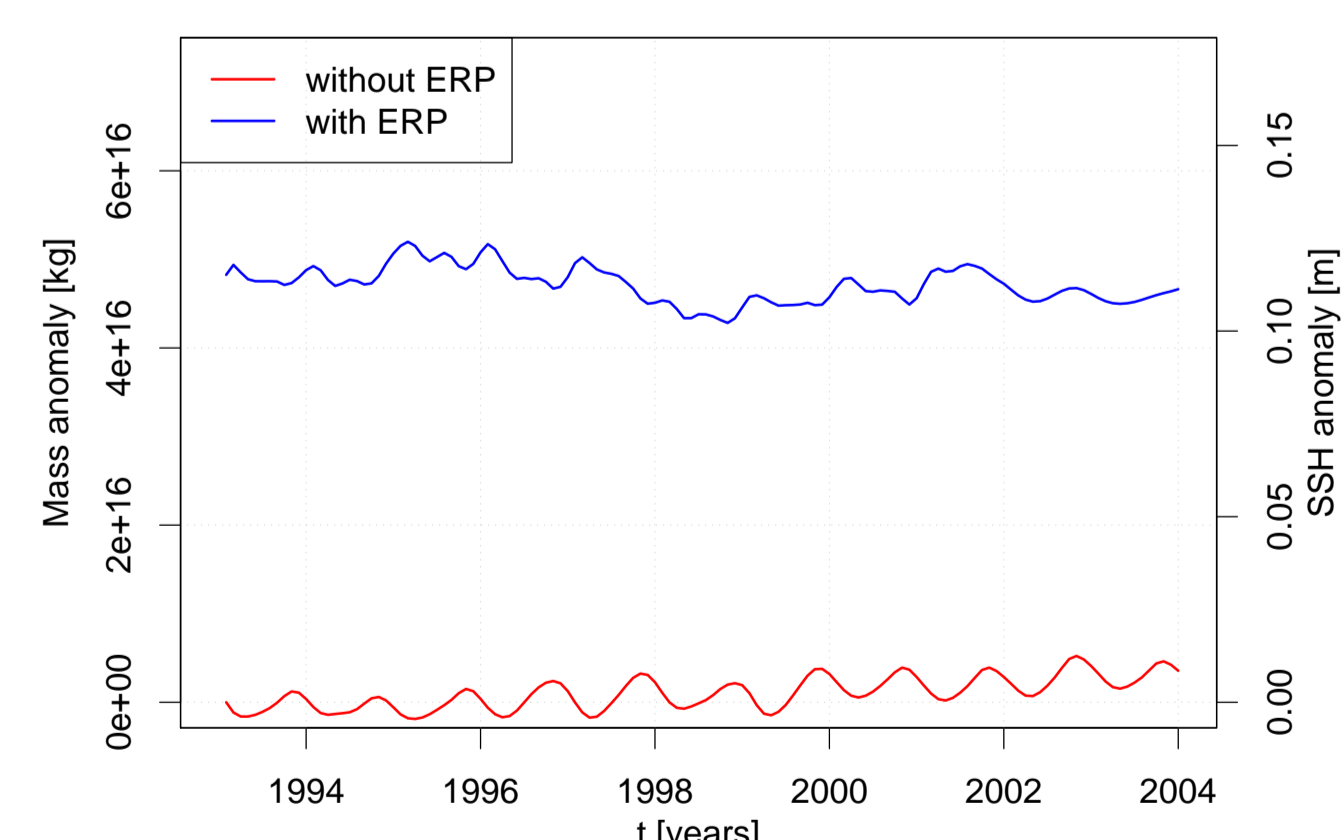
Two assimilation runs were made and compared to the observations:

- Assimilation of TOPEX, REYNOLDS, LEVITUS
- Assimilation of TOPEX, REYNOLDS, LEVITUS and ERP

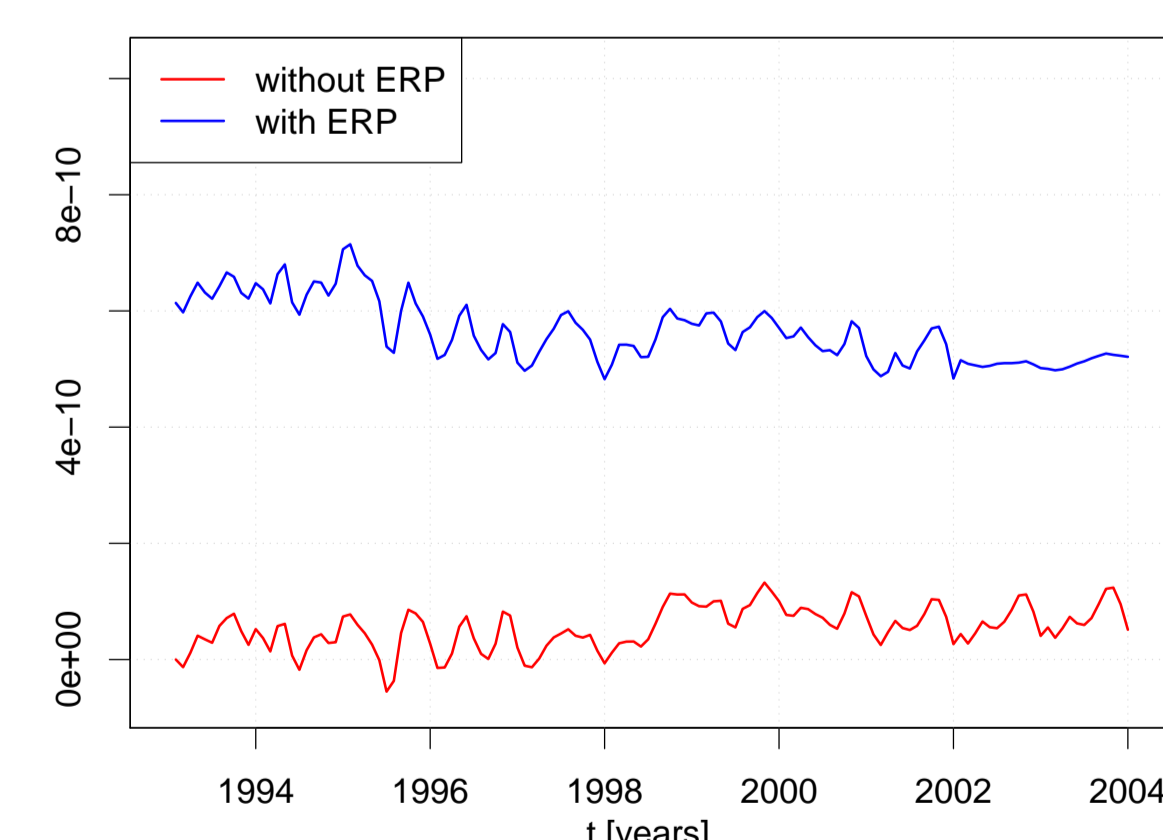
## Model & Method

Ocean model:  $2 \times 2^\circ$  (LSG)  
Assimilation Method: Adjoint (4D-Var)  
ERP Reduction: Highpass filter (2 years)  
Atmosphere model subtracted (ERA-40)  
Land hydrology model subtracted (HDM)  
Assimilated Data: ERP (IERS)  
SSH (TOPEX)  
T,S (Reynolds, Levitus)

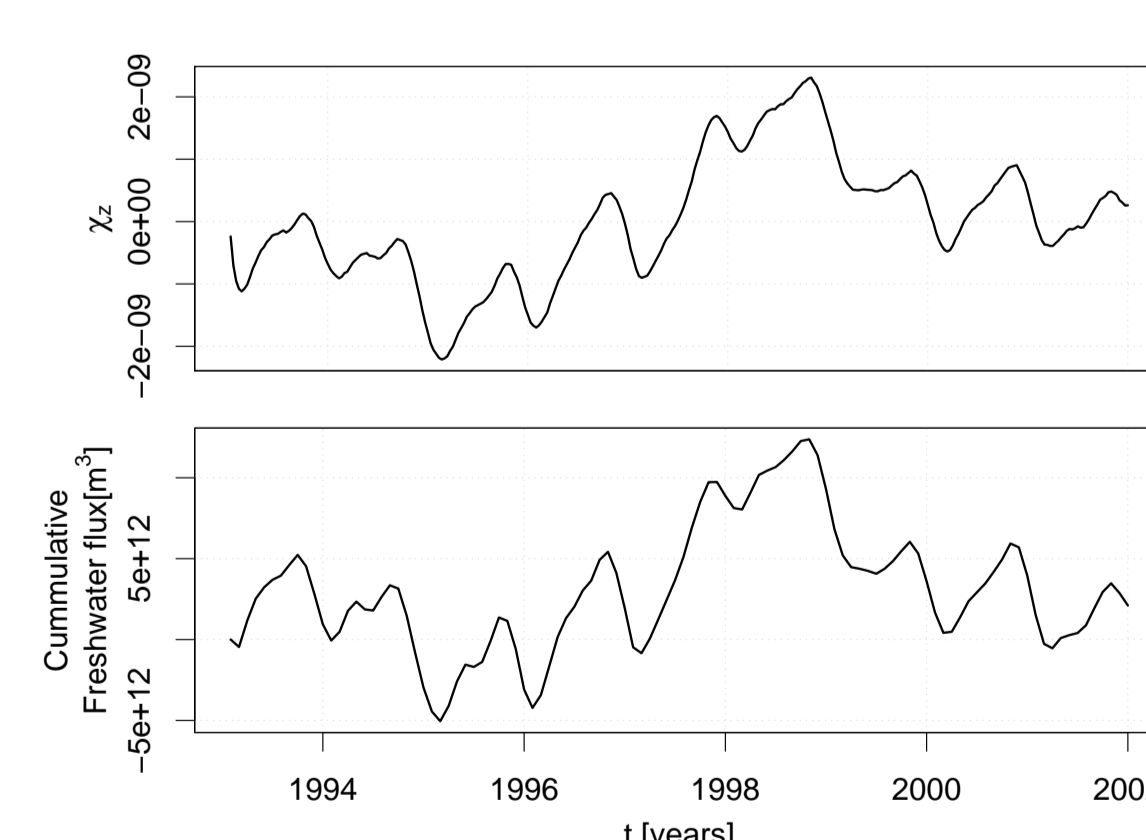
## II Ocean Mass Anomaly



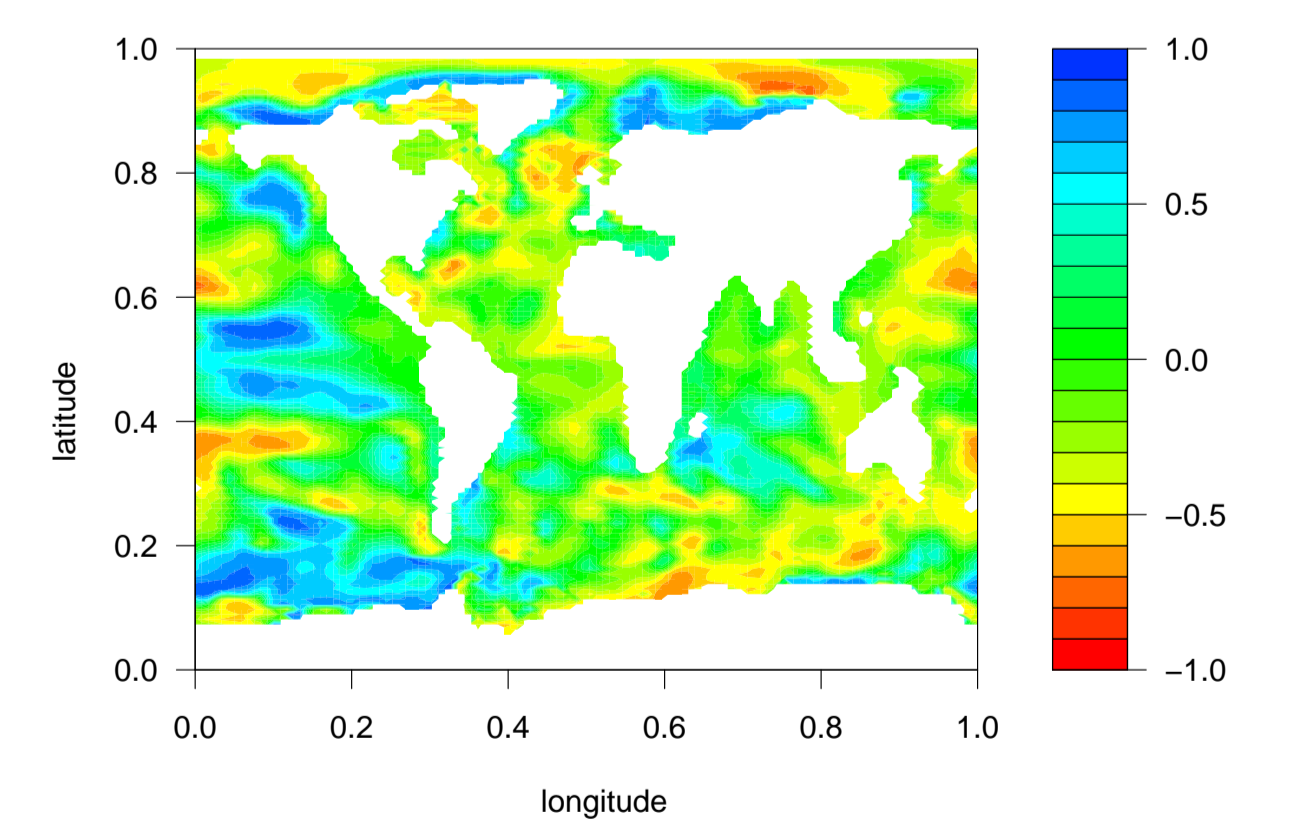
## III Ocean Mass distribution ( $J_2$ )



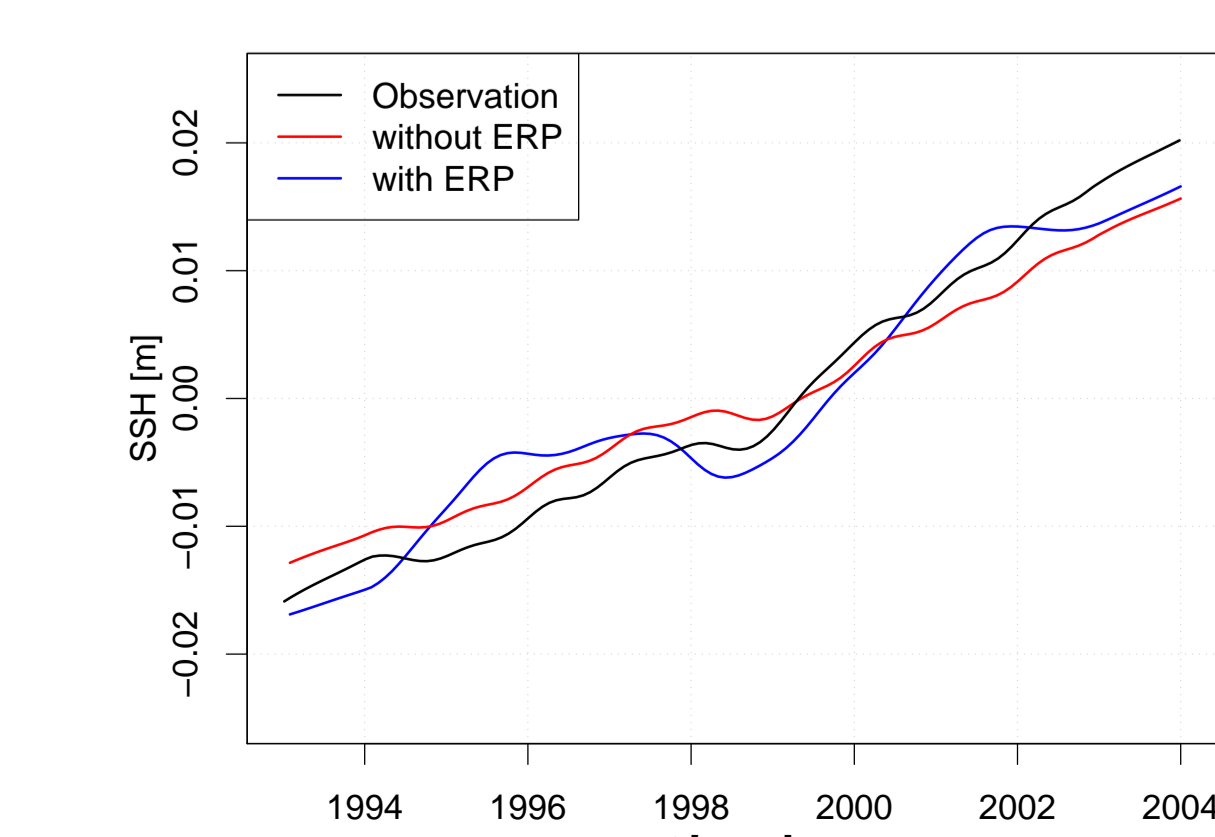
## VI Difference between the two runs



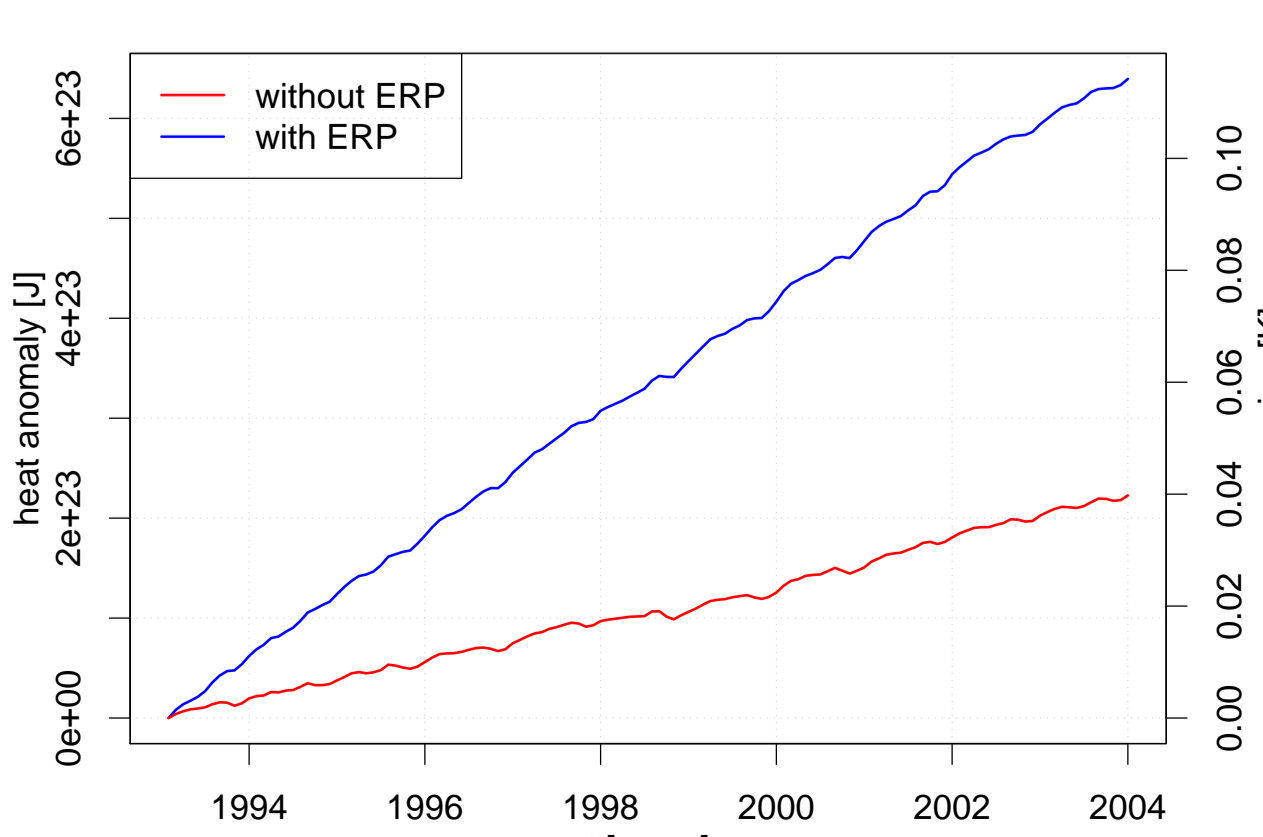
## VII SSH ERP ( $\chi_z$ ) Correlation



## IV Sea level Anomaly(smoothed)



## V Ocean Heat Content



## Conclusions

- Monthly to interannual ERP signals can be well reproduced by the ocean model (I)
- The assimilation of the ERP observations leads to a negative trend in the ocean's total mass and distribution (II, III)
- Trend and low frequency TOPEX constrains can be well reproduced (VI)
- The fit to (I) and (IV) renders the steric contribution to SSH higher than previously modelled (V)
- In our model the  $\chi_{x,y}$  Signal is mainly generated by the ocean currents (not shown)
- In our model the  $\chi_z$  Signal is mainly generated by surface freshwater flux (VI)
- Still, the correlation between SSH and  $\chi_z$  is close to 1 in the main zonal current systems (VII)