

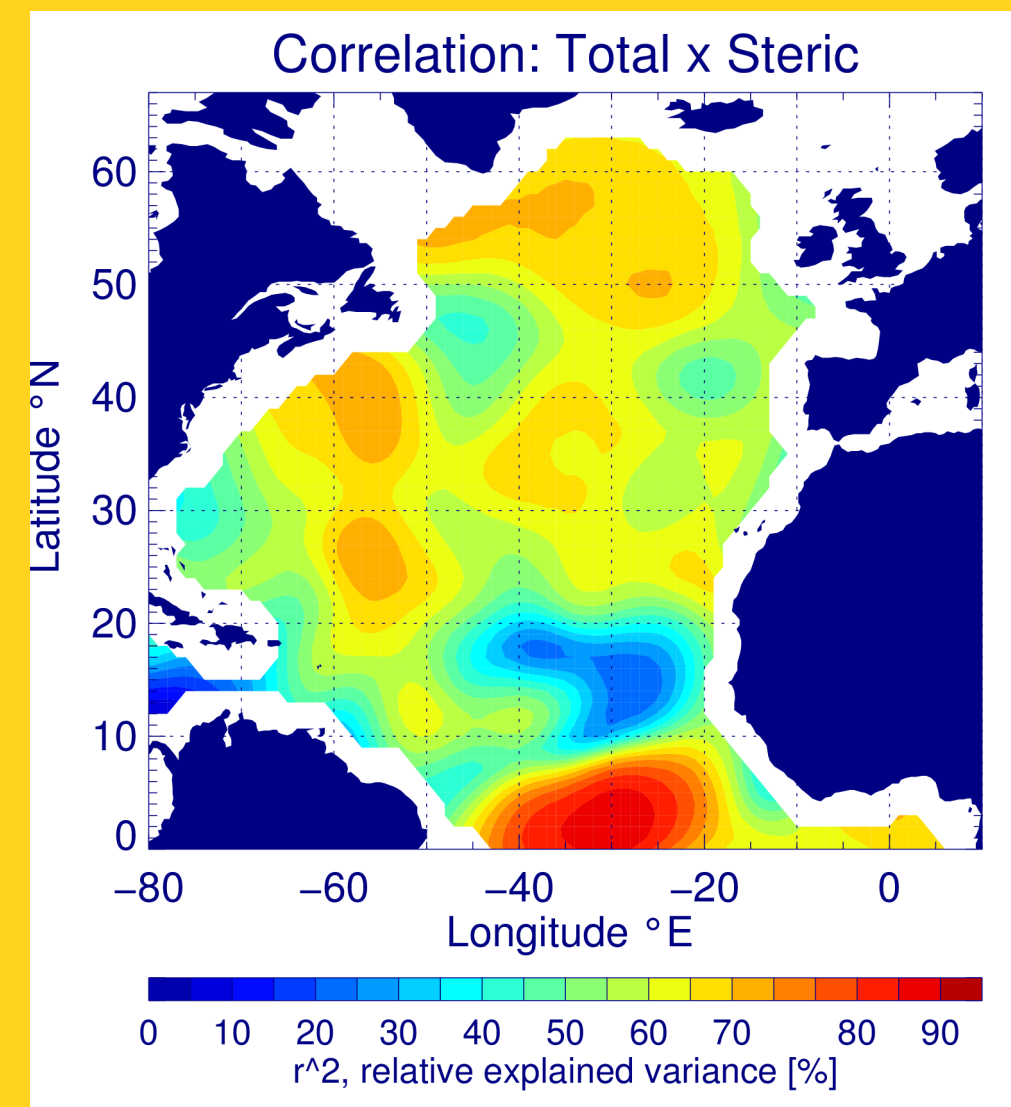
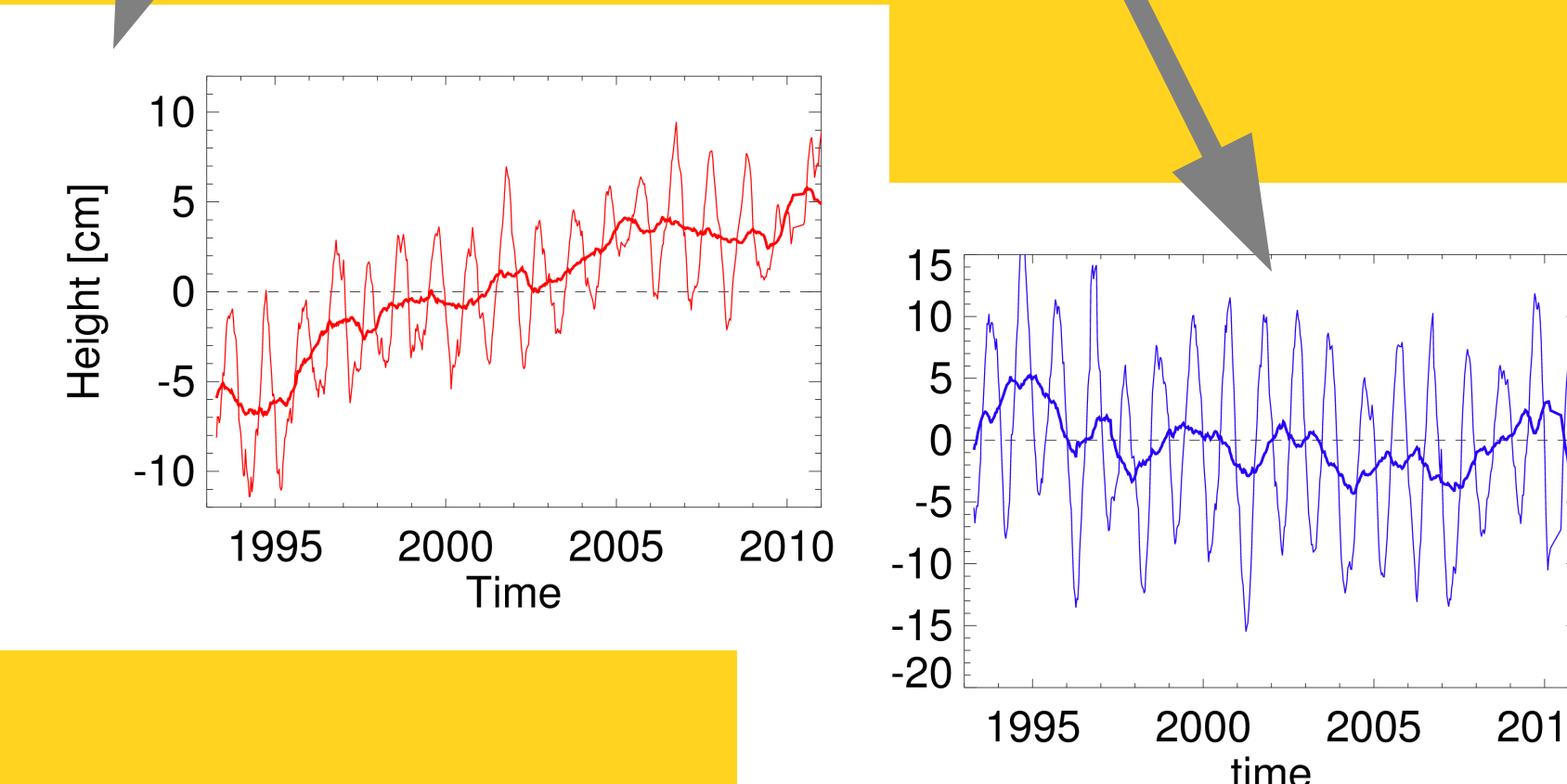
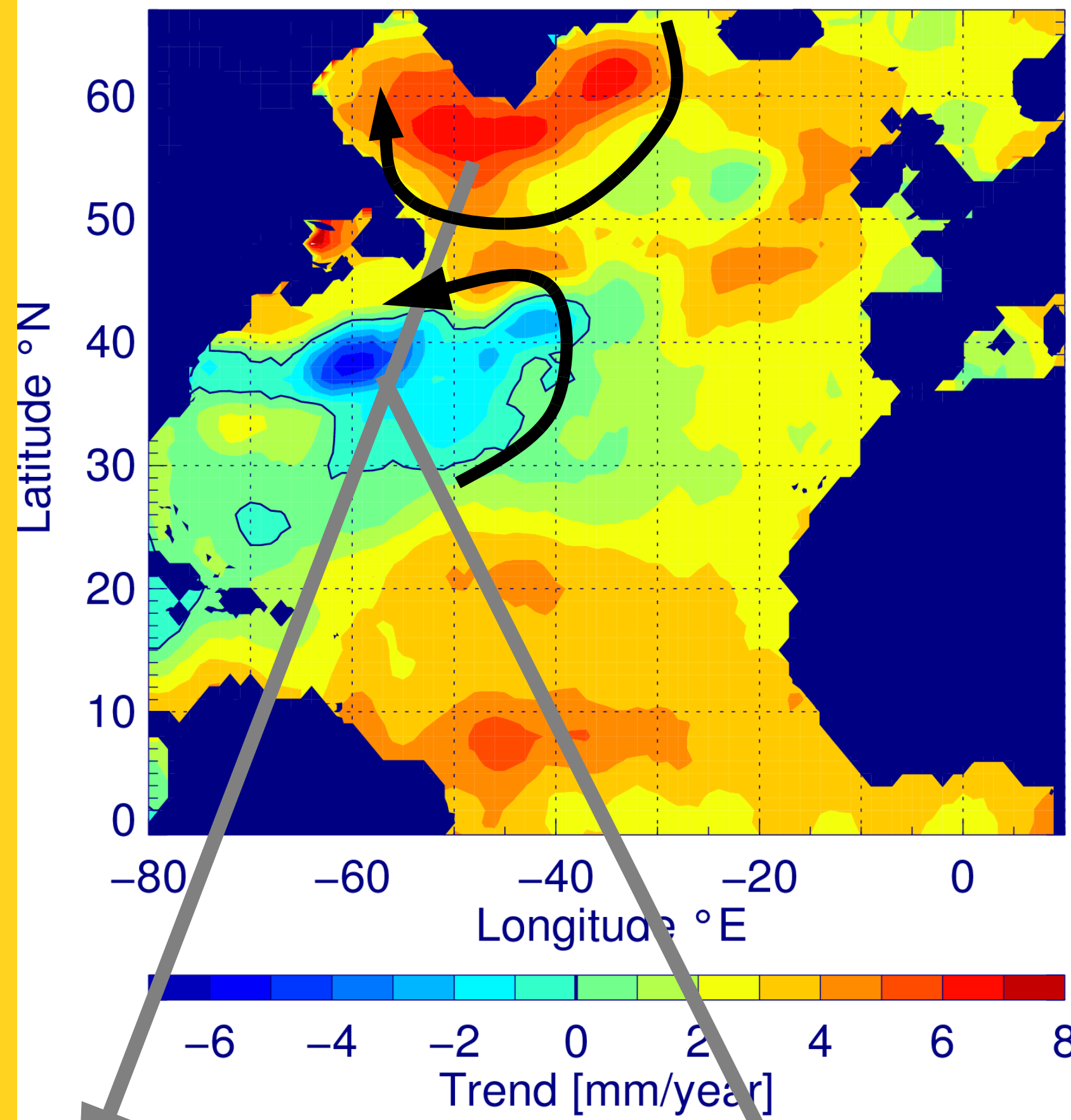
Patterns of Sea Level Variability in the North Atlantic

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Sea Level Trend (03/1993–07/2011)

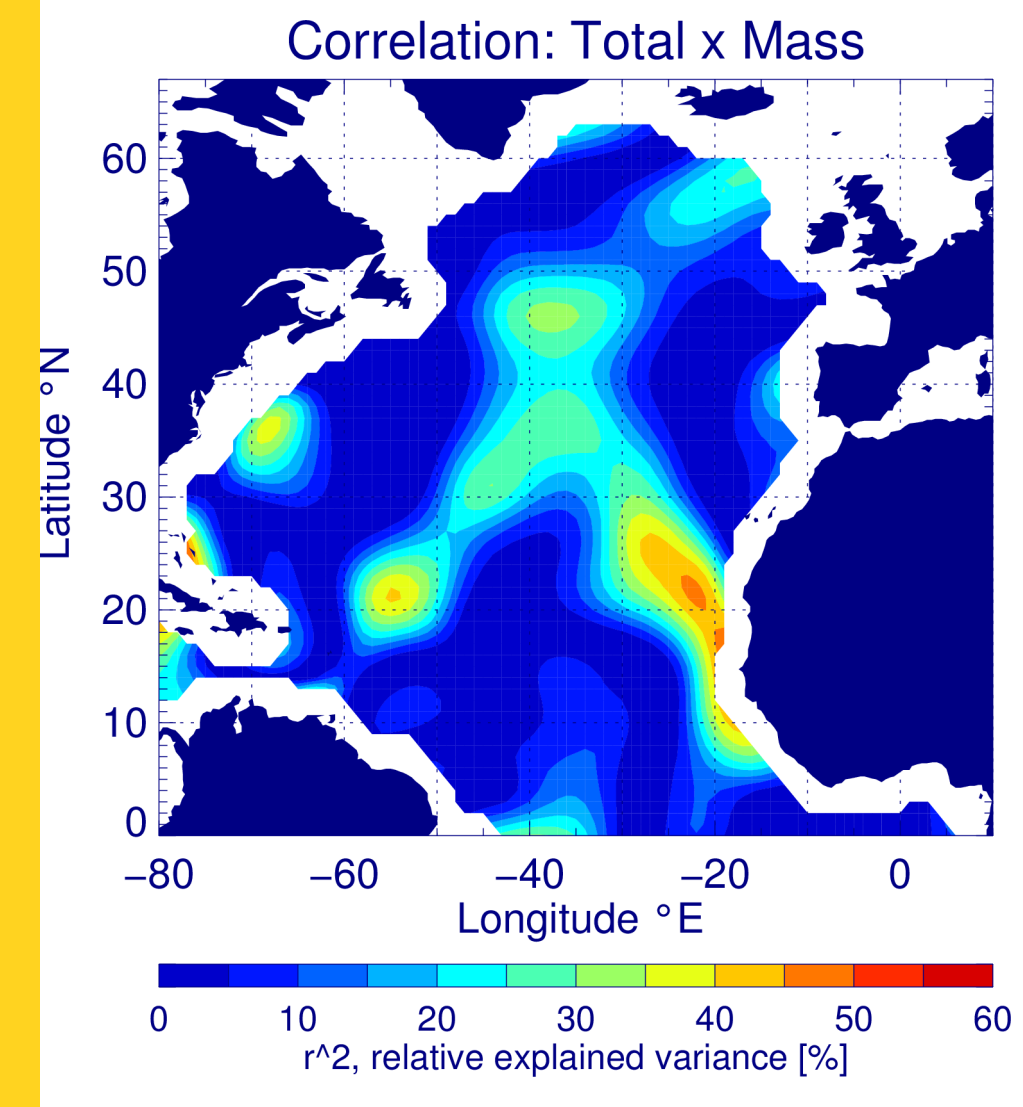


Sea level variability is in most areas dominated by the steric component – especially in the Tropics. However, there are areas like the Mid-Atlantic-Ridge where the mass component plays an important role as well.

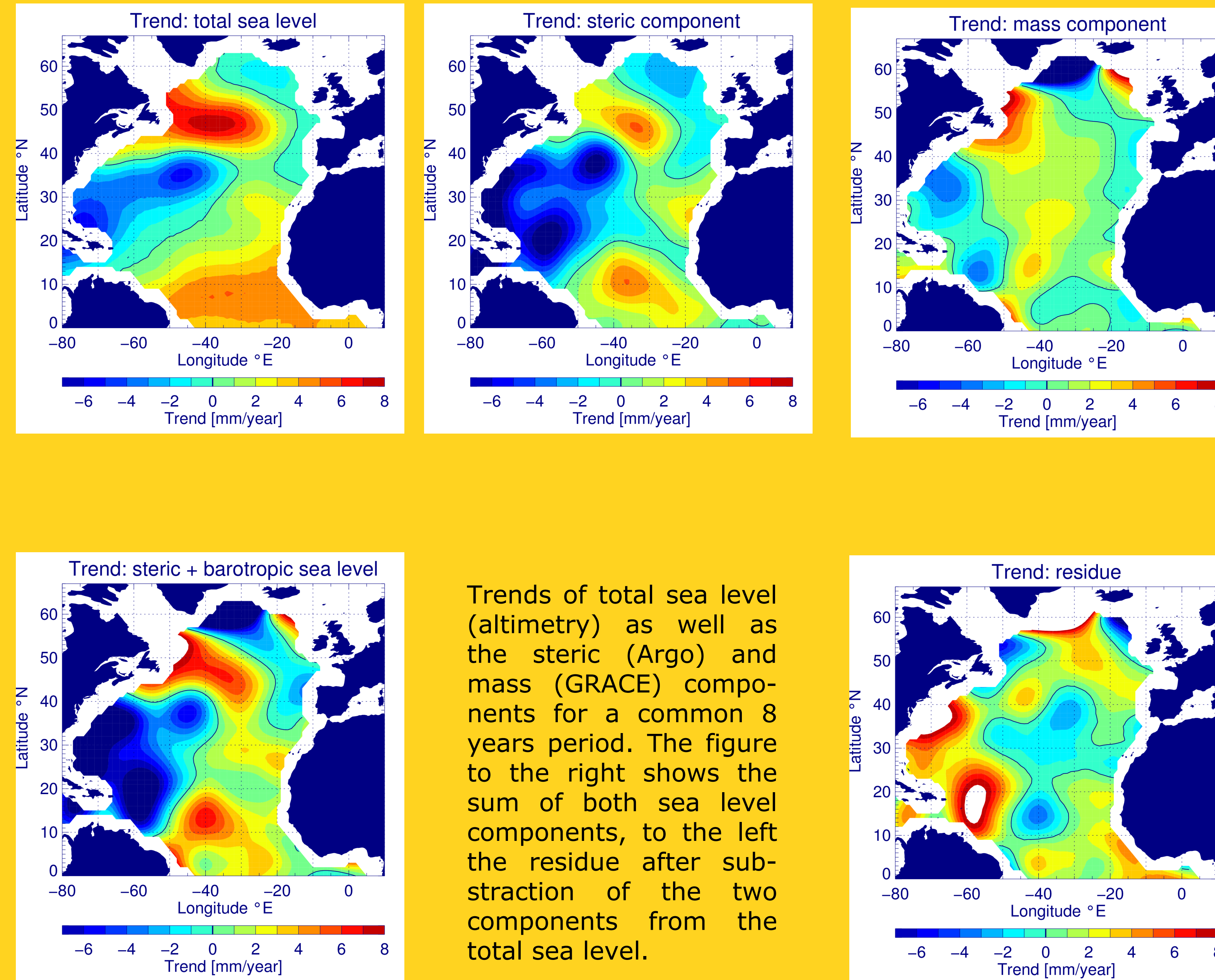
Introduction

Maps of sea level trends over the last 18 years derived from Topex, Jason-1 and Jason-2 altimetry show a tripole pattern in the North Atlantic. Sea level has increased by about 3 mm/year in the Tropics, decreased by about 3 mm/year in the Western Subtropics and increased in the Labrador and Irminger Sea by up to 6 mm/year. These patterns indicate that the oceanic circulation has been subject to changes during the last decades. What are the typical temporal scales connected to this and how are they related to steric and mass changes in the area?

Typical spatio-temporal modes of sea level and its steric and mass related components are studied for the period 2002 to 2011 in the North Atlantic. Therefore, monthly gridded sea levels from the Jason-1/Jason-2 satellite altimeters as well as gridded steric sea levels from Argo floats (Metoffice) and mass related sea level from the GRACE mission (GFZ RL04) are analyzed. All three data sets are spatially filtered in order to resolve consistently scales greater than 1000km.



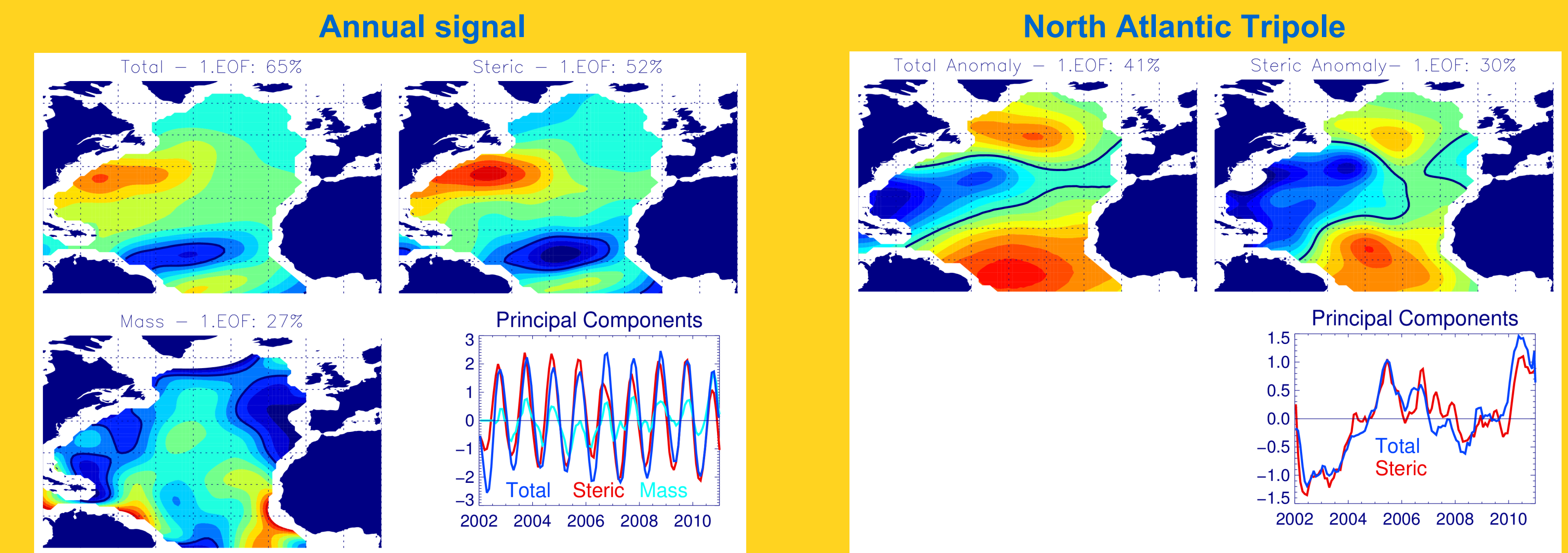
Sea Level Trends (08/2002 to 12/2010)



Trends of total sea level (altimetry) as well as the steric (Argo) and mass (GRACE) components for a common 8 years period. The figure to the right shows the sum of both sea level components, to the left the residue after subtraction of the two components from the total sea level.

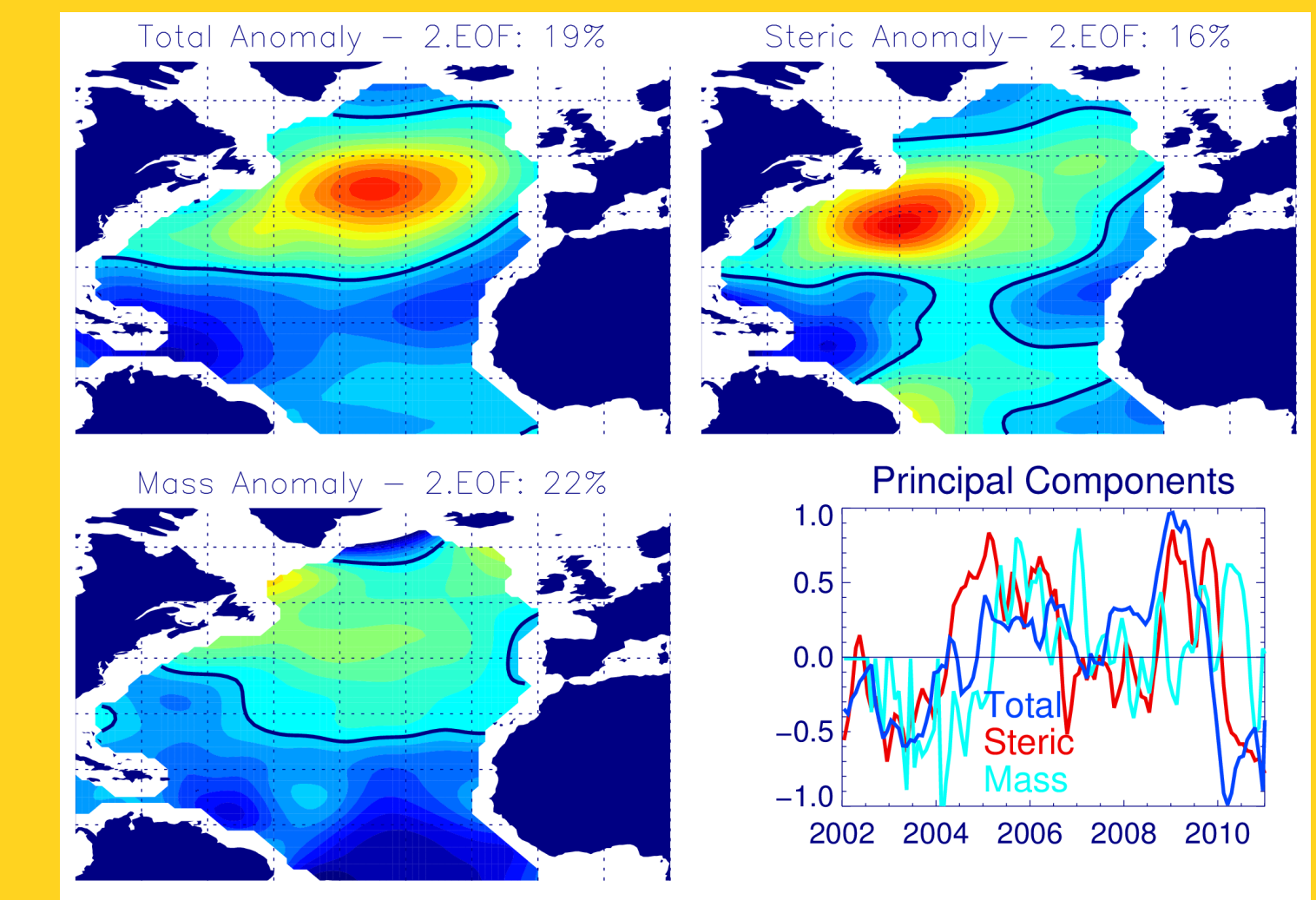
Sea level trends for the period 8/2002 to 12/2010 are derived in the North Atlantic from different data types. Monthly total sea level is derived from Jason-1/Jason-2 altimeter data, the steric component for the upper 2000m from gridded Argo profiles, the mass component from the GRACE satellites. All three data types show similar patterns. For the area 0° to 55°N the total trend is ~0mm/year, the steric ~-1mm/year and the mass component ~ 0.5mm/year with errors of at least ±0.5mm/year. Even though the budget is closed within the error bounds there might as well be contributions from steric changes in the deep ocean which is not sampled by the Argo floats (below 2000m).

Empirical Orthogonal Functions



The spatio-temporal patterns are studied using Empirical Orthogonal Functions (EOFs). For all three data sets the first EOF mode corresponds to the annual signal. For the anomaly series (annual signal subtracted) the dominant modes are connected to the North Atlantic Tripole and suggest a decreasing height gradient between subtropical and subpolar gyre. Other important modes seem to be related to the position and strength of the Gulf Stream/North Atlantic current system. Note, that the main EOF modes of the total sea level from this analysis are also dominant modes in the 18 years long series of altimeter data.

N/S shift of the North Atlantic Current



Summary

- Good agreement between total sea level and steric and mass contributions for annual signals
- North Atlantic Tripole dominant signal in total and steric sea level anomalies
- Shift of North Atlantic Current to the North/South in total, steric and mass anomalies, ca. 4 year period
- North Atlantic sea level trends for August 2002 to December 2010 reflect the North Atlantic Tripole