Trend patterns in global sea-level variability from satellite altimetry and model data
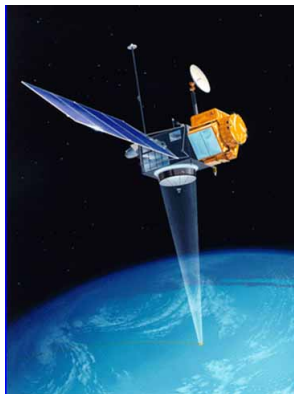
Susana M. Barbosa[1], O.B. Andersen[2], P. Knudsen[2]
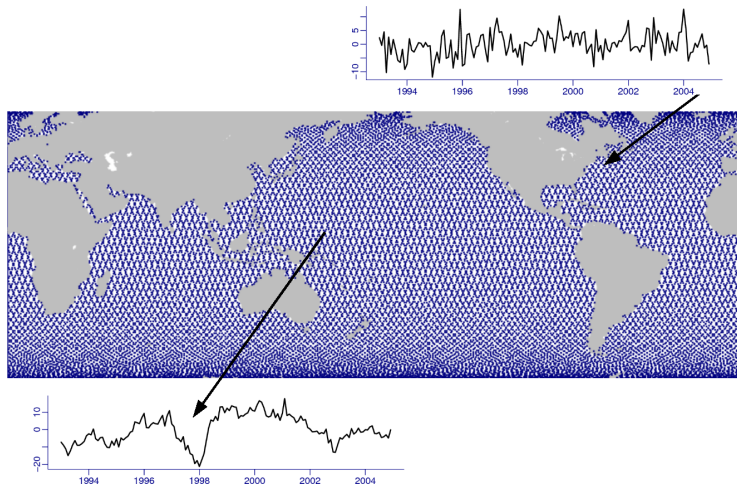
[1]University of Lisbon, IDL, Portugal
[2]DTU, Denmark

Satellite altimetry

Radar altimeters onboard satellites allow to measure the height of the sea surface from space
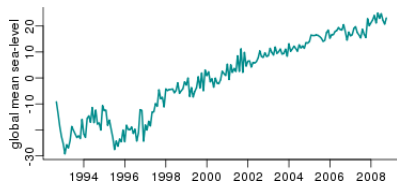
Altimetry data

Objective

To describe long-term variability in sea-level from satellite altimetry data
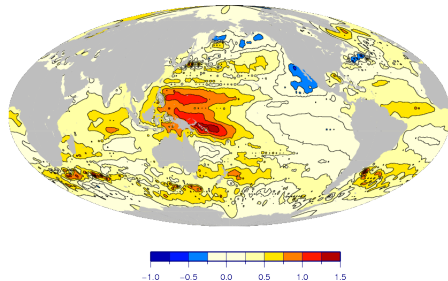
Perspectives

▶ temporal description

   (e.g. global spatial averaging)

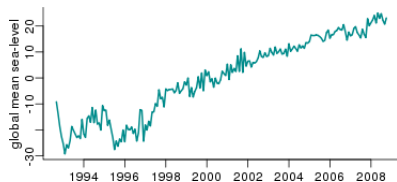▶ spatial description

   (e.g. map of sea-level slopes)

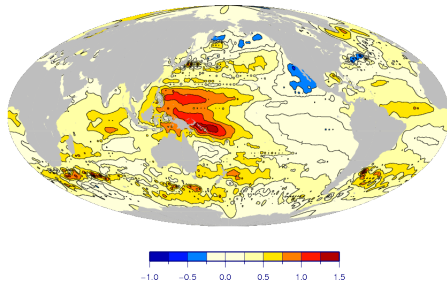▶ spatial + temporal description → e.g PCA / EOFs

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Limitations of EOFs in extracting long-term patterns

- ▶ statistical modes (rather than physical modes)

- ▶ a trend pattern may be physically relevant, but may not explain a large fraction of variance
  $\implies$ a trend signal can be split into different EOF modes

- ▶ lack of robustness (sensitivity to the length of the records)

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Method - Trend-EOFs

▶ Modification of traditional PCA / EOF analysis: EOF analysis of inverted ranks (time positions of sorted observations)

Pros

▶ trend (rather than maximum variance) patterns

▶ robustness (less sensitive to the length of the records)

▶ non-smooth eigen- spectrum

▶ enhanced physical interpretability of the derived modes

Data

- ▶ Satellite altimetry data (Ole/Per)
    - ▶ Topex/Poseidon + Jason
    - ▶ updated pre-processing + geophysical corrections
    - ▶ $\sim$ 17 years (September 1992 - October 2008)
    - ▶ 3° longitude × 2° latitude grid

- ▶ Model data (WCRP-CMIP3)
    - ▶ MIROC model
    - ▶ sea surface height above geoid (zos)
    - ▶ 20th century experiment (September 1992-Dec 2000)
   - ▶ T106 ($\sim$ 1.125° longitude-latitude grid

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Eigen-spectra
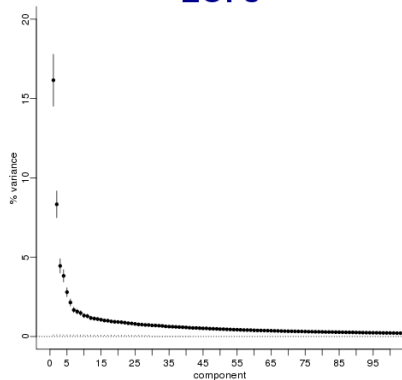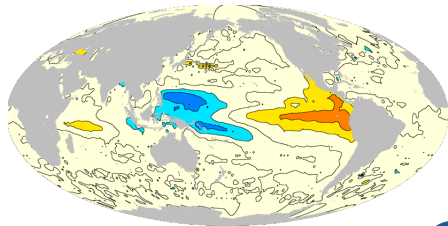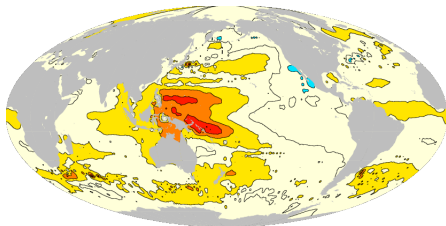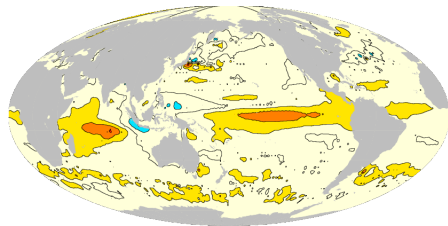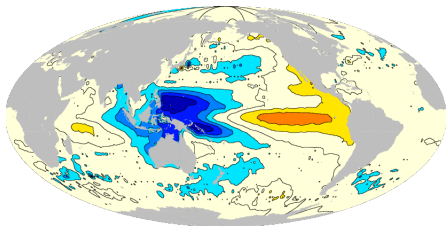

EOFs   **Trend-EOFs**
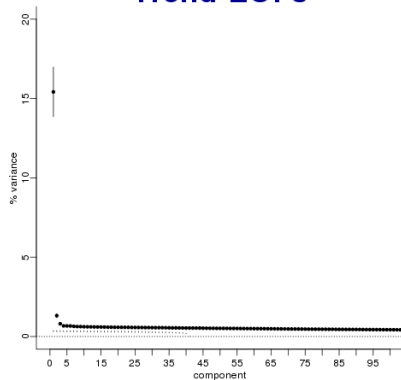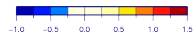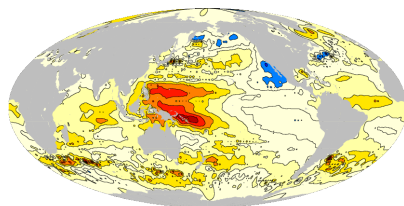
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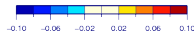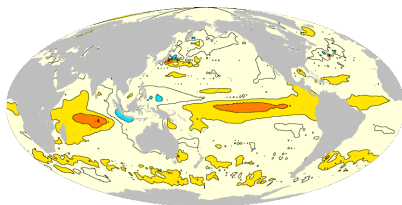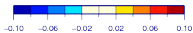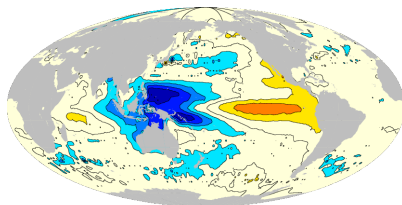
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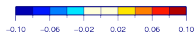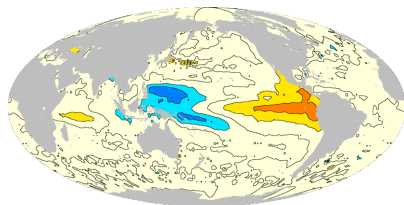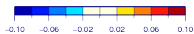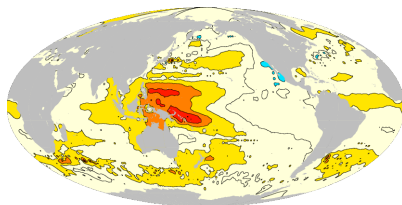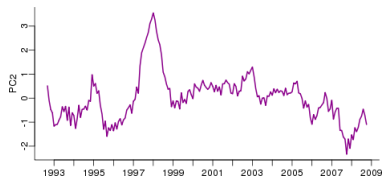
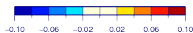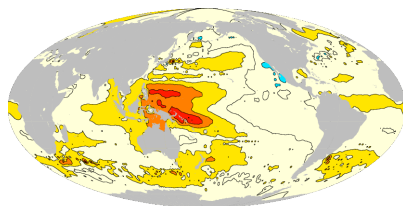# EOFs vs Trend-EOFs: temporal patterns
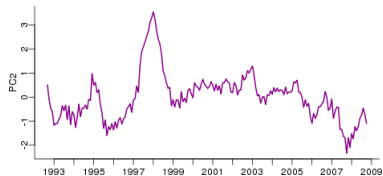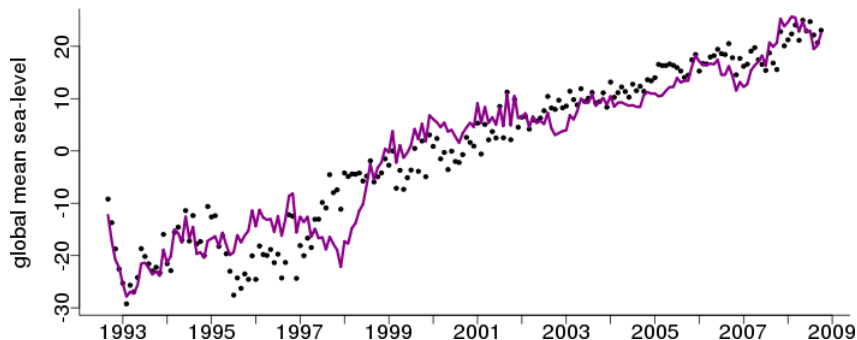
EOFs vs Trend-EOFs: spatial patterns

Global mean sea-level:

1st trend-EOF & linear slopes

Global mean sea-level:

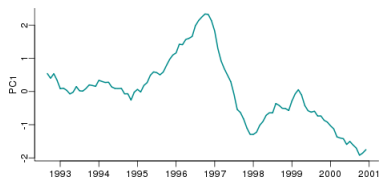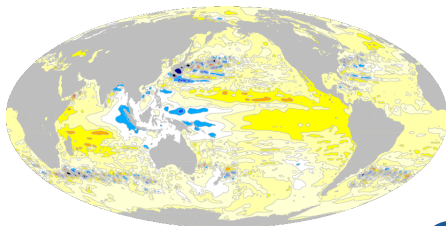## 1st trend-EOF & spatial average

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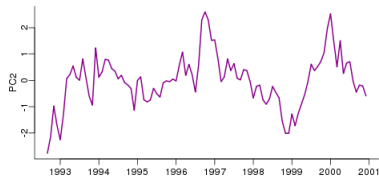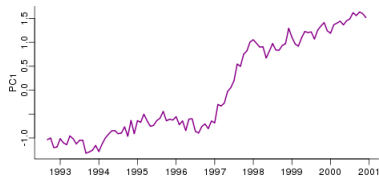
EOFs vs Trend-EOFs: spatial patterns

Summary

- ▶ Trend-EOF analysis

  - ▶ space-time approach based on inverse ranks for the extraction of robust trend patterns (rather than maximum variance patterns)

  - ▶ superior to conventional EOFs for the space-time analysis of long-term variability, particularly for short records

  - ▶ alternative to describe global mean sea-level variability

    - ▶ spatial pattern similar to spatial map of sea-level slopes
    - ▶ temporal pattern without ENSO influence

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Reference

Barbosa, SM, Andersen, OB, 2009. Trend patterns in global sea surface temperature. *International Journal of Climatology*, DOI: 10.1002/joc.1855