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BSV Seminar

Visual Analysis of the Evolution of Moisture Transport Patterns in the North Atlantic for different Climate Scenarios

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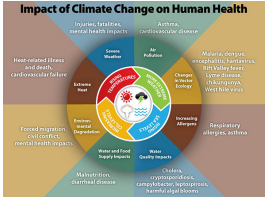
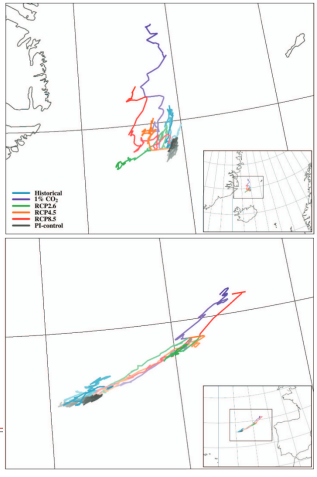
Denis Streitmatter

Universität Leipzig

Introduction

- climate change $\neq$ global temperature rising
- climate change has a lot of complicated consequences





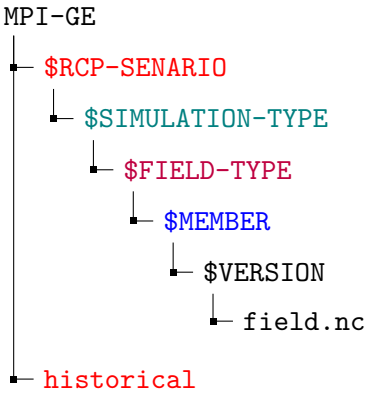
Research Questions

How do the Patterns of Moisture Transport change in the face of various climate scenarios?

The Max Planck Institute - Grand Ensemble [11]

Quick Facts:

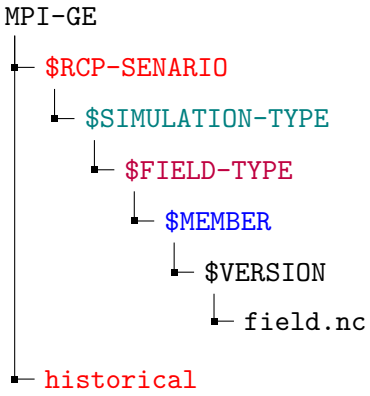
- released in 2019 [11]
- 86 Terabyte of data
- unfortunately not publicly available anymore



The Max Planck Institute - Grand Ensemble [11]

Simulation Time Scopes

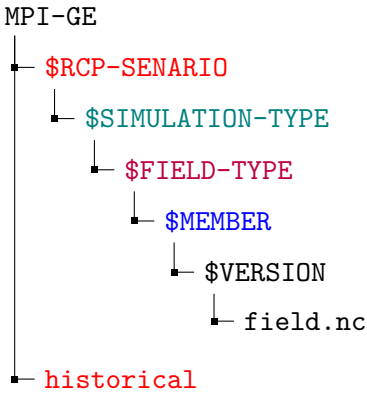
- Future simulations in the form of RCP scenarios (**R**epresentative **C**oncentration **P**athway)
- simulation from 2005-2099 (stringent pathway (rcp2.6), intermediate scenario (rcp4.5), worst case (rcp8.5))
- also a historical (1850-2005) and prehistorical (2000 years) control simulation



The Max Planck Institute - Grand Ensemble [11]

Field Types

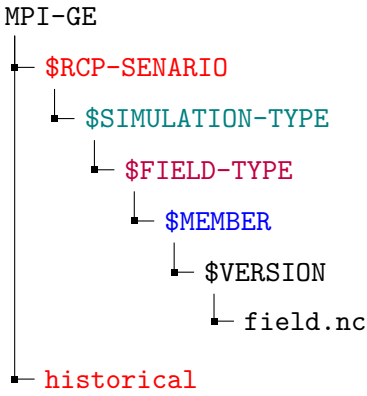
- 32 different fields for the atmosphere
- Resolution: Lat/Long: $1.875°$, Time: monthly averages, Vertical: 26 Levels from 10 to 100000 *Pa*
- Examples: evaporation, preciptation, horizontal wind speed, specific humidity



The Max Planck Institute - Grand Ensemble [11]

Simulation Models

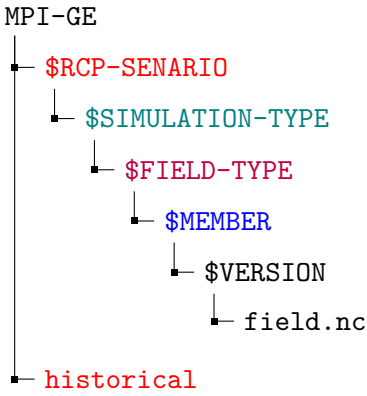
- different simulation models for different areas: land, ocean, **atmosphere** ...
- my focus: atmospheric parts



The Max Planck Institute - Grand Ensemble [11]

Simulation Members

- 100 Members per field → 100 different simulations
- tries to catch the chaotic nature of climate

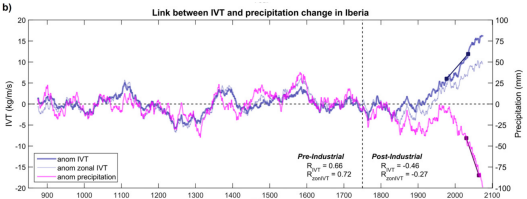


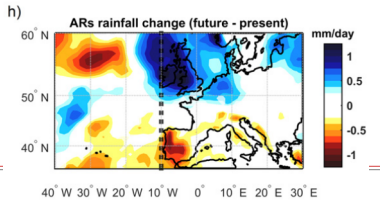
Moisture Transport

1. Vapor Integration
   - Integrated Water Vapor (IWV) [3, 5, 7, 10]
   - **Integrated Water Vapor Transport (IVT)** [1, 2, 9, 12, 13, 17, 21]
   - Moisture Budgets [16, 20]
2. Langrangian Model [10, 14]
3. stable oxygen isotope investigation [10, 18]

Integrated Water Vapor Transport

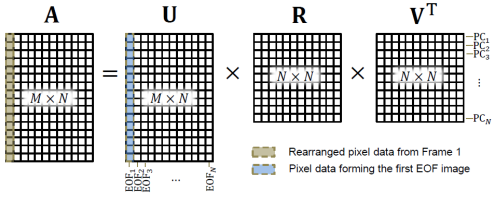
- Zhu and Newell, 1998:
  $IVT = \frac{1}{g} \int_{1000hPa}^{600hPa} q\vec{V} dp$ [21]
- in most cases: $||IVT||_2 \rightarrow$ Scalar field [1, 2, 9, 12, 13, 17]
- often used to find/track atmospheric rivers

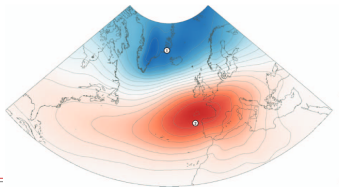




Pattern Analysis with EOF

- For those familiar: it is related to PCA
- very widely used in geospatial sciences [8]
- can be used for dimensionality reduction, filtering, pattern recognition ...
- already been used for IVT fields [2]
- also some interesting modifications: REOFs





My current plan

1. Generate an IVT field from the MPI-GE
2. Implement a similar windowed EOF approach as [19] to track changes in moisture transport patterns
   - maybe also implement/use some other analyses from similar work
3. Visualize the uncertain Scalar Fields over time

- Dataset preparation: CDO [15]
- algorithm implementation: Julia [6]
- Important libraries:
  - Makie for Visualisation
  - KMarkert/EmpiricalOrthogonal-Functions.jl

Visualizing Uncertain Fields

- Problem: 100 Ensemble Members → 100 different results
- Uncertain Isocontours (Countour Boxplot etc., see first presentation)
- reduce to mean
- use animated Perlin noise to visualize uncertainity [4]
- Visualizing Time: probably just an animation

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