Using simulation results from the Palaeoclimate Model Intercomparison Project

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Session Outline

- Background
  - What is a climate model?
  - PMIP (and its relation to CMIP)
  - What simulations performed and freely available
- Navigating the ESGF
- Using the IPCC’s Interactive Atlas
- Other available resources
The two kinds of “model”

**Empirical**
- Collect relevant observations
- Look at relationships between those observations
- The model is a numerical representation of those relationships
- Hard to capture things outside of observed data
- Can range from linear regression to machine learning

**Dynamical**
- Derive the fundamental physical equations from theory & lab. Work
- Introduce simplifications to make them solvable manageable
- Code those equations on a computer
- Set any unknown parameters (preferably from observations)
- Run on (super-)computer
The Climate System
(with response timescales)

- Atmosphere
  - ≈1 year

- Ocean
  - Tropics ≈50yrs
  - Deep ≈500yrs
  - Bottom ≈2kyrs

- Continents
  - Biosphere ≈500yrs
  - Orography ≈Myrs

- Cryosphere
  - Sea Ice ≈5yrs
  - Ice Sheets ≈10kyrs

- External
  - Volcanoes ≈1yr
  - Solar Input ≈10kyrs

- Different components have different characteristic timescales
PMIP4 is a sub-project of CMIP6
A larger one with 17 models [ScenarioMIP has 48 models]
PMIP4 / CMIP6 Simulations

Equilibrium
- piControl (Preindustrial)
- abrupt4xCO2 (Instantaneous quadrupling of carbon dioxide)
- midHolocene (6,000 yrs ago)
- lgm (last glacial maximum at 21ka)
- lig127k (Last Interglacial, 127ka)
- midPliocene-eoi400 (3.205 Ma)
- DeepMIP (Early Eocene, ~50 Ma)

Transient
- historical (1850-2014): Free-running simulations of industrial era
- 1pctCO2 (Concentrations increase by 1% per year)
- past1000 (last millennium, 850CE onwards)
- LDv1 (last deglaciation, 21,000 years ago to present): Very-long simulation that encompasses all forcings (PMIP-only)
- ScenarioMIP experiments
Earth System Grid Federation

- Distributed network of large data servers
- Search from a single tool
- All data stored in common format with "controlled vocabulary"
  - Same names used across all different models for variables, dimensions etc.
- Download NetCDF files
- Roughly 16 PB of data
PMIP on ESGF

• Data on the ESGF

• Lots of interglacial runs
• A few LGM runs (more elsewhere)
• 3 transient runs
Walkthrough to find AMOC during last interglacial

- Search node: CEDA
- Activity = “PMIP”
- Experiment_ID = “lig127k”
- Source_ID = “EC-Earth3-LR”
- Variable = shows lots… (translations available from here)
- Realm = “Ocean”
- CF standard name = “ocean y overturning mass streamfunction”
- Show files (all 210)
- I then downloaded a file over HTTP and opened it with Panoply (available from NASA GISS)
- Add all the files to the ‘data cart‘ and make a ‘wget script’ to bulk download them
Interactive atlas

https://interactive-atlas.ipcc.ch/

#IPCCData #IPCCAtlas
PMIP in Interactive Atlas

- Only in “Advanced” version
- “Paleoclimate” is listed under Dataset
- Limited variables
- PMIP4 shows anomalies under four equilibrium simulations
- Only 2 for PMIP3
Walkthrough on Interactive Atlas

- Dataset = PMIP4
- Variable = PR (rainfall)
- Scenario = Mid Holocene
- Season = Annual
- Show Annual cycle for a region (click on, say, Madagascar)
- Download image
- Download NetCDF file (provides ensemble mean of whole globe)
- Can be opened in Panoply
Other pre-processed data

- Interactive Atlas is not only source of data that has already been summarized
- PMIP4 organization on GitHub
- Has my version of the IPCC files
- Related to a GMD “workflow” paper
- Climate Variability Diagnostics Package
- `pmip_p2fvar_analyzer`
  - `data_frames` (spreadsheets)
  - `data_netcdf`
  - notebooks (eg ensemble AMOC change)
Others (CESM Last Millennium Ensemble)

- **Open access set of 36 simulations with CESM, running from 850 to 2005**
  - Inc. 6 hourly data, single forcing runs, water isotopes

- Climate Variability Diagnostics Package has been run on it all – [files here](#)

AMO (Monthly)
Recommended steps to get model data

1. Collaborating is easier than you doing all the work. So, talk to a modeler.
2. Is there a relevant PMIP simulation?
3. Is pre-processed data available?
   • Supplement of a published paper
   • IPCC Interactive Atlas
   • My `pmip_p2fvar_analyzer` - `scripts/data`
4. Is the relevant data available on the ESGF?
   • Can you get access to some server-side compute? (Maybe try ENES)
   • Download it – try using Synda from the command (install via conda)
5. Models have loads of fields, such as water isotopes. So, talk to a modeler.