Modelling Breakout

What have we achieved - best examples

- MIPs - but we can do better
- Improved interpretation of isotopic records e.g. ending the paleothermometer assumption, and circulation versus amount effect for terrestrial records, Ocean d18O gradient and AMOC,
- Iso reanalysis / or nudged isotope simulation – improved the interpretation of modern observations
- Isotopes for model evaluation and process understanding

-observation constraint of moisture sources

-understanding circulation (e.g. vertical velocities) and the impact of constraining physical parameters

-isotopes helped improve the coding of the water cycle (bugs found!)

Where do we want to be in 10 years

- Best estimate of fields for climate model initialization
- Source Trajectory analysis – easier to access model output for analysis
- Identify and fix the regions of the greatest model-data mismatch in terms of model climatology and variability - isotopes can develop process understanding to address model biases
- Isotopes in the main trunk for model development
- Water isotopes in higher resolution and idealized – bridge the gap between the eddy resolving and large-scale (GCM) with more mesoscale

How do we get there, what can we achieve in the next 3-5 years

- Standardize and improve fractionation equations – e.g. assumption related to evaporation / evapotranspiration and kinetic fractionization
- More water tagging capacity
- More isotope model inter-comparison in a standard framework
- Keep computational efficiency in mind for the paleoclimate modelling community
- Application of water isotopes to atmospheric chemistry

Observations

Best-in-show

PAST CLIMATE

- Monsoon variability (speleothems)
- "Paleothermometer" (ice cores)
- T-sea level rise relationship
- Indicators of abrupt change
- Past ENSO variability (corals)

MODERN CLIMATE

- Humidity biases in GCMs
- UTLS exchange
- Convective processes
- Importance of transpiration

Moisture transport

- How does water enter/leave atmosphere?
- Do we get mean state right for right reasons?
- Often measure at sink, what about source?
- Network need
- Measure sea water and vapor from research ships?
- Opportunity for satellites?

Cloud processes

- Key microphysics and effects on climate sensitivity
- More measurements of cold, mixed-phase cloud
- Identify locations where microphysical exceeds isotopic uncertainty
- Need targeted campaigns, specialized tech (inlets, planes, drones)
- Cloud chamber experiments

Soil moisture, evaporation

- Need E and T end-members
- More systematic observations
- Leverage NEON? Supplement?

Regional hydroclimate extremes

- Not just about mean state changing, how is variability changing?
- Start with pilot studies, existing sites.
- Build out GNIP, other networks
- Use citizen science for event-based sampling?
- International collaboration, funding?
- Archiving will be important!

ARCTIC CHANGE

Cross-cutting tools, approaches

- Soil water maps
- Satellite coverage of total column water
- In situ isotopic profiles
- Optimizing networks with model/proxy information
- Plug into existing networks (national, international)
- Citizen science

Proxy perspectives on climate change

- **Key contributions:** What climate processes (relevant to modern climate change) have isotope-based paleoclimate records already helped to illuminate?
- **New frontiers:** What emerging techniques or tools are most promising for bridging paleodata & climate dynamics?
- **Challenges & opportunities:** What obstacles do we face in the proxy, observational, & modeling realms? What do we need to accomplish these on a ~2-3 year and 10-year horizon?
- **10-year vision:** What is our 10-year vision for leveraging isotopes & paleo for climate science?

Vision: what we could achieve

- **Understand critical climate processes & patterns:**
  - Decadal variability
  - Polar amplification
  - Precipitation extremes
  - Continental recycling/vegetation-atmosphere feedbacks with global warming and cooling
  - Position of the jet stream with climate forcings/variability
  - Natural vs. forced, and forcing-specific, hydroclimate variability in the Asian monsoon region, the tropical Pacific, north America, other regions of interest
  - ITCZ shifts/Widening/shifting of the tropical rain belt
  - Sustainability of water resources in places where moisture is derived from nonlocal sources

How we could achieve those goals

- Strategic, coordinated networks of “supersites” : observations of proxy system parameters, environmental parameters, and climate variables (soils, plants, groundwater, precipitation, vapor, etc), At places that:
  - have high spatial coherence, i.e. say something about a large area
  - Dynamically important: changes matter elsewhere
  - Data exist: Paleoclimate records exist or can exist
- Process-based understanding of proxy systems with quantitative error estimates at all levels of PSMs
- Coordination between data, obs, modelers in order to strategically scale site-level to climate process level
- Clear isotope synthesis products for coordination with paleoclimate modeling efforts

What we need now (next few years)

- Studies that translate d18O/dD of vapor into d18O/dD of precipitation, soil water, seawater, etc (the ENVIRONMENT)
- Studies that translate environmental variables into proxy sensors (the SENSOR)
- Archive-specific community summits to decide on best practices for each proxy system in terms of analytical errors, resolution, terminology, metadata
- Replication, replication, replication
- Coordination (national and international) of new networks, leveraging of existing datasets within our community, and making use of other existing networks (NEON, AfricaArray, water chemistry network, agricultural networks like mesoNet)