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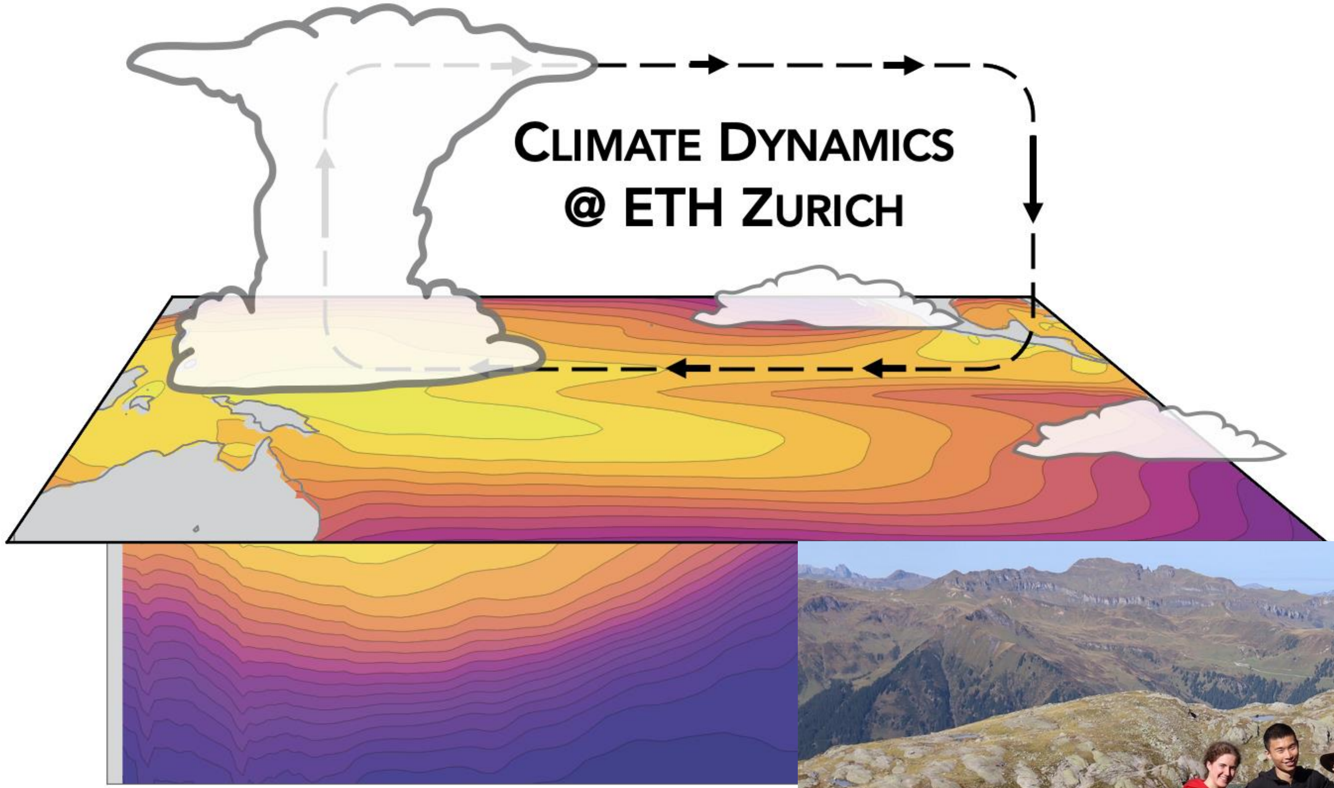


# Climate Dynamics Group

Prof. Robb Jnglin Wills
Postdocs: Clarissa Kroll
PhDs: Joas Müller, Nora Fahrenbach, Zhenghe Xuan

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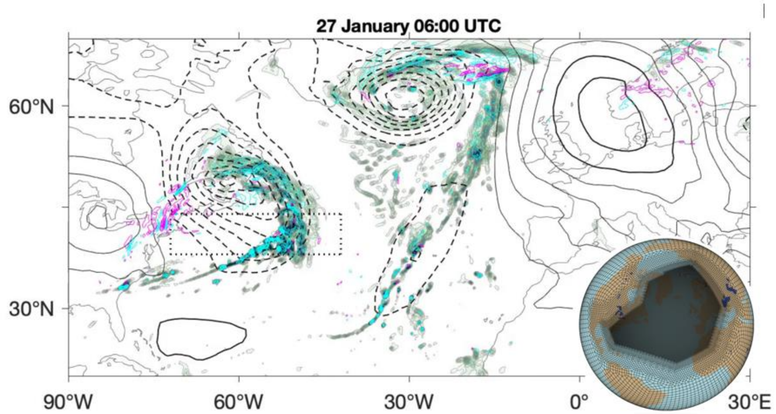
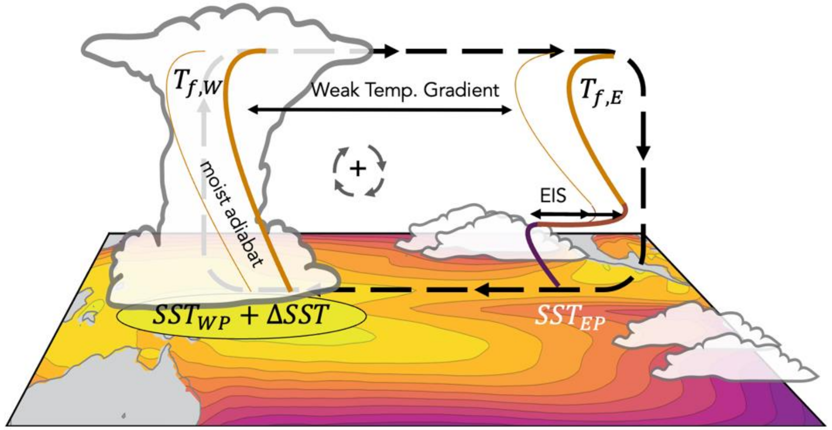
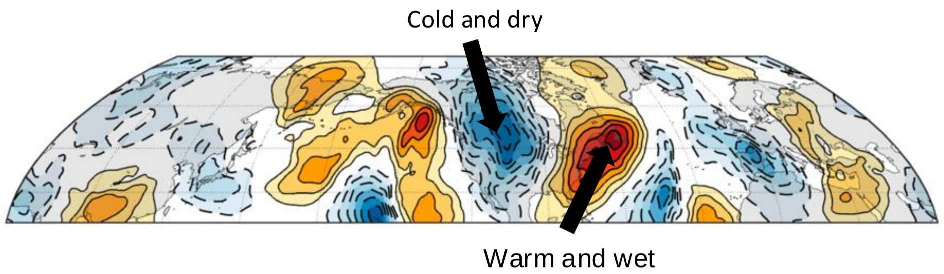
# What we work on



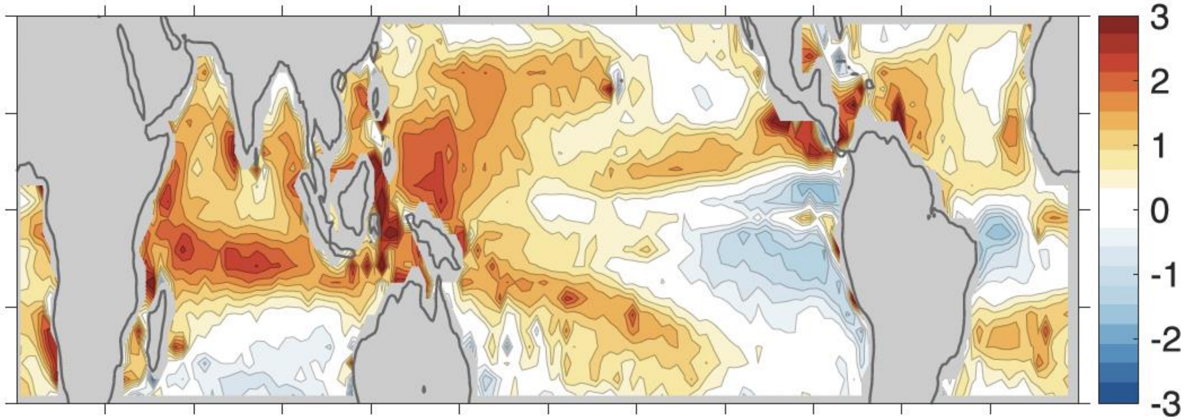

- Influence of small-scale processes (fronts, convection) on the global atmospheric circulation and climate
- Sensitivity of global and regional climate to the pattern of ocean warming
- Pattern recognition methods to isolate anthropogenic climate responses from internal variability
- Influence of non-GHG forcing (anthropogenic and volcanic aerosols, land-use change, geoengineering) on tropical climate change
- Changes in atmospheric variability (e.g., jet stream waviness) and weather extremes

# Ocean evaporation in different wind regimes and its implication for climate model biases

**Background:**

- Evaporation is an essential for energy redistribution from the surface back to the atmosphere, and it drives the atmospheric hydrological cycle by providing a source of moisture.
- Despite its importance, current generation CMIP models struggle to reproduce observed evaporation rates.
- One potential source of model biases are small-scale wind variations that are not captured by the bulk flux formula used to calculate evaporation rates.

**Normalized Evaporation Efficiency Bias**
**CMIP6 – Observations (ERA5 & ERSST5)**




**Research questions:**

- How does ocean evaporation respond to different wind regimes in current generation CMIP models, especially in the lower end of the velocity distribution?
- Under what conditions do model and observational evaporate rates deviate from those derived from the bulk flux formula?
- Can a connection be made between different treatment of wind velocities and larger-scale climate model biases?

$$E = \rho_a \, C_E \, W(q_s - q_a)$$

$E$ - evaporation
$\rho_a$ - air density
$C_E$ - Transfer coefficient
$W$ - Wind speed
$q_s$ - Sea surface specific humidity
$q_a$ - Air specific humidity

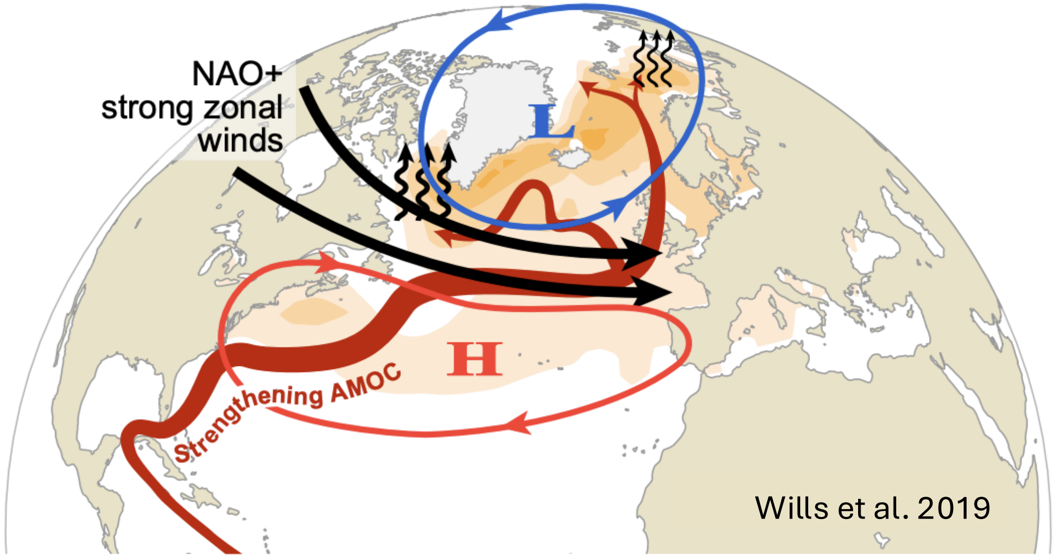
**Approach:** Statistical analysis of high-frequency CMIP6 model output (historical simulations), ERA5 reanalysis, and OAFlux observational data. Depending on the findings, the work can be complemented by analyzing new sensitivity experiments run with ICON.

*Supervision: Clarissa Kroll, Robb Jnglin Wills*

# Low-frequency variability in the North Atlantic circulation and coupling with decadal SST variability

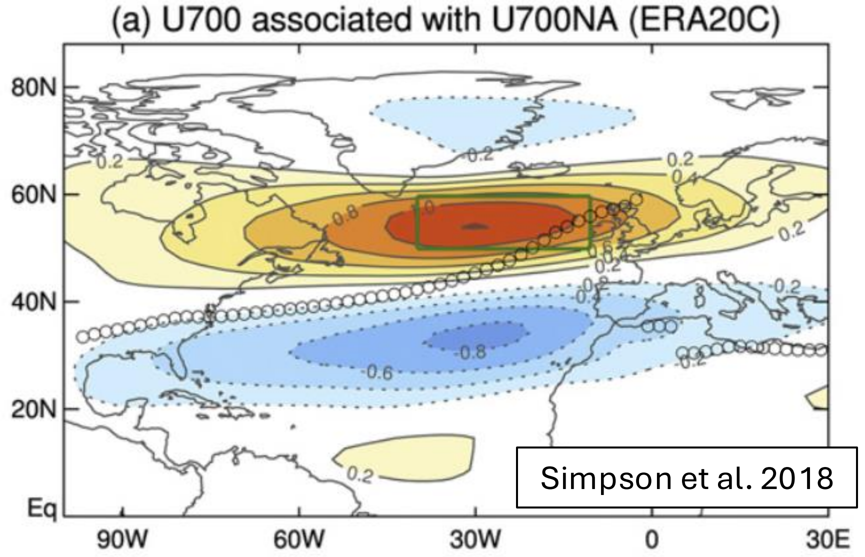
**Background:**

- Observations show much stronger decadal variability in the jet stream than climate models.
- The weak decadal circulation variability in models is hypothesized to result from too weak coupling with SSTs, a problem which might be alleviated in high-resolution models




**Research questions:**

- What are the patterns of decadal atmospheric circulation variability in observations? What are their mechanisms?
- How do the decadal variability patterns and mechanisms differ across observations and high- and low-resolution models?




**Approach:** Statistical pattern-recognition methods (low-frequency component analysis, maximum covariance analysis) applied to reanalysis and climate model data (Python); lead-lag analysis to give insight into mechanisms and causality (Python)

*Supervision: Robb Jnglin Wills, TBD postdoc*

# Summary of Master's Topics in Climate Dynamics

1. **Ocean evaporation in different wind regimes and its implication for climate model biases**
2. **Low-frequency variability in the North Atlantic circulation and coupling with decadal SST variability**

- Our group only has capacity to supervise up to 2 MSc theses this semester (due to supervising many last semester), but other topics might be possible
- For questions about these topics or if you want to discuss other possible topics, please contact Robb Jnglin Wills (r.jnglinwills@usys.ethz.ch)