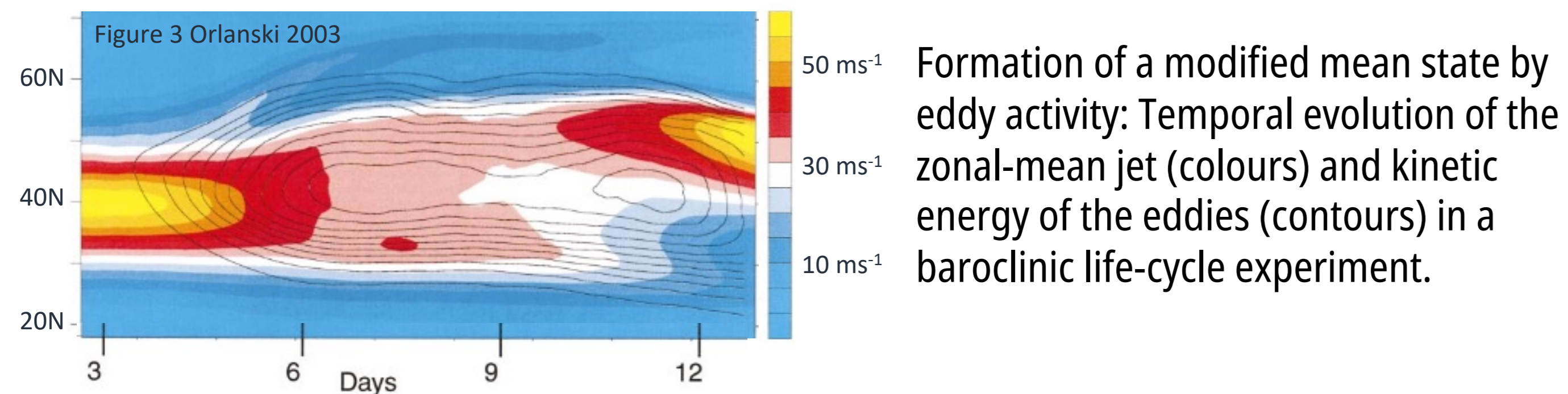


Michael Riemer and Annette Miltenberger (JGU)

Motivation

- UTLS water vapour and clouds are poorly represented in state-of-the-art numerical models and impact on circulation by substantial gradients in radiative temperature tendencies.
- Impact on the extra-tropical mean circulation is not well understood and exhibits a crucial link to regional surface climate.
- The extra-tropical mean circulation is a coupled system of moist-baroclinic eddies evolving along and shaping the midlatitude jet.



- UTLS moisture and clouds *directly* shape the tropopause, implying changes to the jet, with potential eddy feedback.
- Eddies themselves exhibit sensitivities to model formulation (moist processes, clouds, resolution), which impact on mean circulation.
- Basic understanding is lacking
 - of the *indirect* impact of UTLS moisture by *upscale effects* of transient weather features.
 - of the relative importance of model sensitivities.

Collaborations within TPChange

Collaborations

- B01** Use of TPEX observations of UTLS moisture structure
- B08** UTLS moisture profile variability; exchange of diagnostics
- C03** Comparison of GCM with idealized storm-track experiments
- C05** Moisture budget: provides context, help interpretation
- B06** Quantify impact of newly developed schemes on UTLS moisture distribution and circulation feedback in storm tracks
- B07**
- C08**

Contribution to TPChange synthesis

- Z03** Integrating B09N analysis tools and model set-ups in UTLS toolbox; test of developed parameterisations
- Z02** Making available data from reference and sensitivity runs

Preliminary work

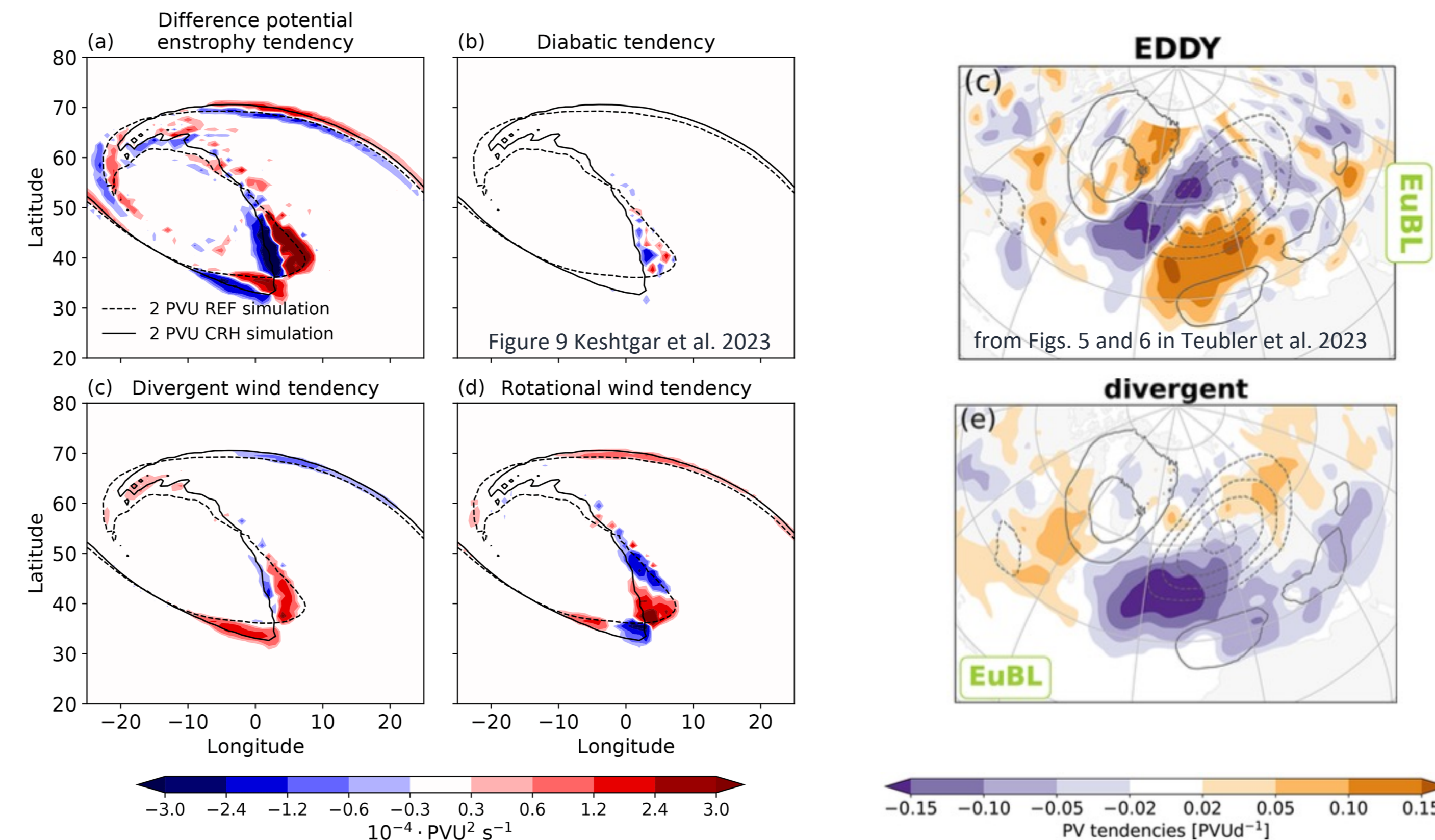
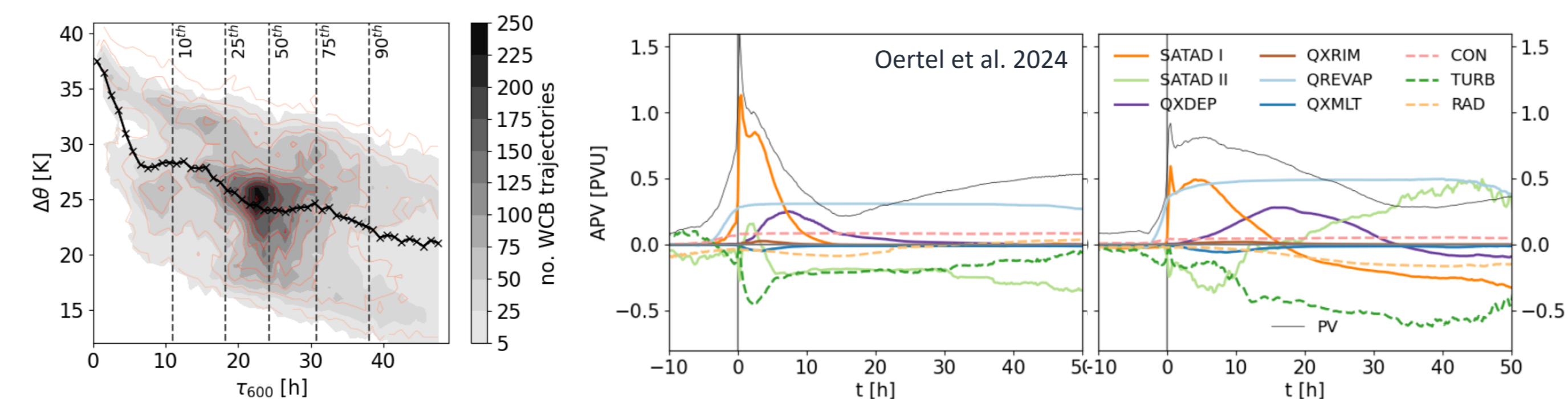
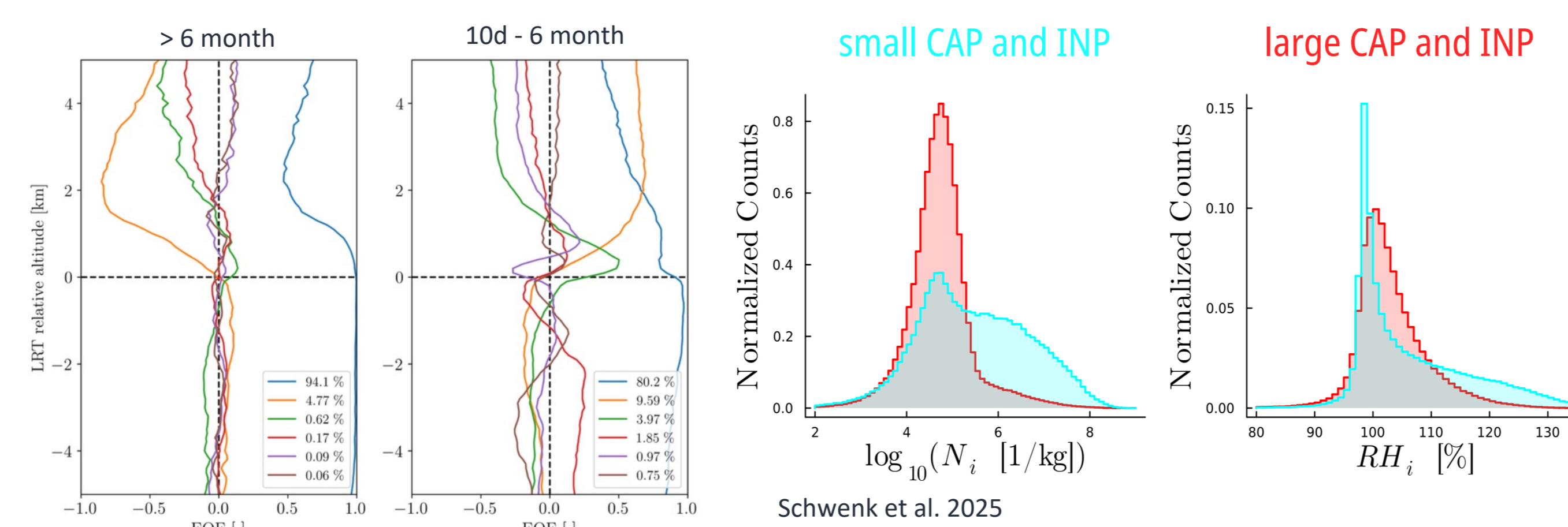


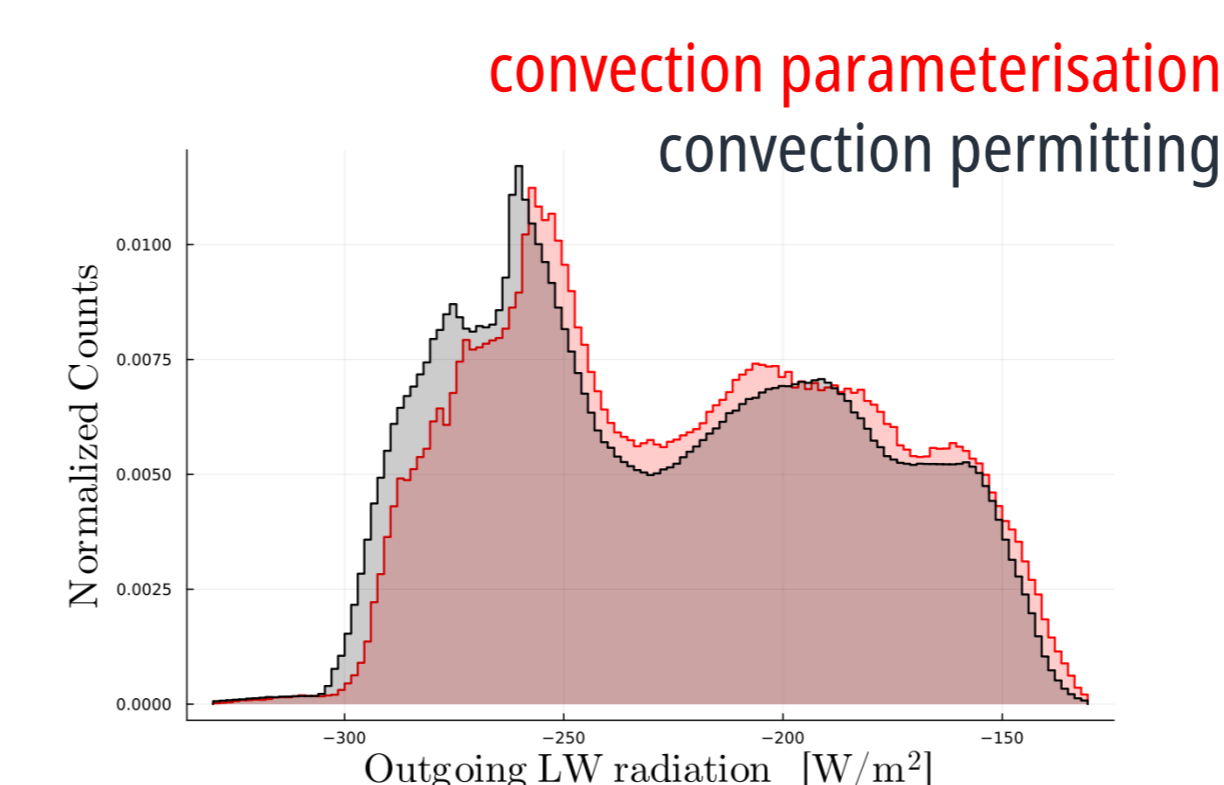
Illustration of piecewise PV tendencies to quantify individual impacts: (left) diagnosing cloud-radiative impacts in an idealised cyclone and (right) low-frequency evolution at the end of the North-Atlantic storm track (onset of European blocking).



Detailed separation of diabatic PV contributions during WCB ascent: (left) ascent timescale distribution, diabatic PV modification in (middle) fast and (right) slow ascent.



UTLS humidity structure and controlling processes: (top left) UTLS humidity anomaly structure functions on different timescales. Variability of WCB outflow properties with (top right) microphysical parameters and (bottom right) convection parameterisation.



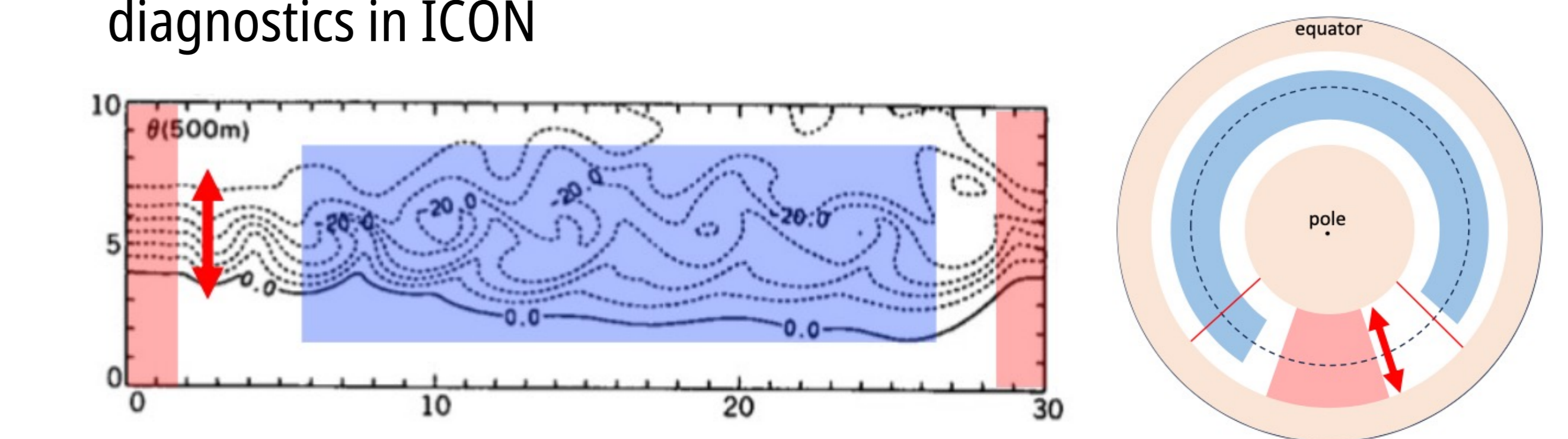
Research plan phase II

Main goal: Quantify the role of transient, weather-scale processes in the storm tracks in shaping the impact of UTLS moisture on the extra-tropical mean state.

- **Objective:** Advance mechanistic and process understanding of the impact of UTLS moisture and clouds on the extra-tropical mean circulation with a focus on the transient eddy dynamics during transition towards a new mean state.
- **Strategy:** Isolate processes in the storm track in idealised experiments; collaborate with C03 to put results in the context of the general circulation.

B09N bridges gap between RAB smaller-scale mixing processes (GWs, cirrus, convection) and the larger, planetary-scale perspective of RAC.

- **Work plan:**
- **WP1:** Implementation of the idealised storm-track set-up and online PV diagnostics in ICON



Integrates set-up and developed diagnostics in common framework (Z03).

- **WP2:** Reference run and cloud/ moisture diagnostics
- Provides definition of “mean state”, transition time scale, and diagnostics of cloud/ moisture structure and radiative impacts (with B08 and GLACIATE).

- **WP3:** PV dynamics of the mean state
- $$\frac{\partial [PV]}{\partial t} = -[\nabla_{\theta} \cdot (\mathbf{v}_{rot} PV)] - [\mathbf{v}_{div} \cdot \nabla_{\theta} PV] + [N]$$
- ‘eddy fluxes’ ‘LHR below’
- separate N into individual contributions, including cirrus

Quantifies eddy-driven changes and individual diabatic contributions to mean state, thereby linking transient, synoptic-scale processes to large-scale flow.

- **WP4:** Experiments with prescribed UTLS moisture perturbations
- Explores impact of present-day variability, observed model biases, and expected future changes in UTLS moisture (with C03 and C05 for GCM context).

- **WP5:** Impact of model formulation
- Quantifies *relative* sensitivities of mean state to model formulation, using B06, B07, C08N developments with focus on cirrus, moisture gradients and eddies.