Understanding tropical humidity differences in global storm-resolving models

Theresa Lang[1], Ann Kristin Naumann[2], Hauke Schmidt[2], Stefan A. Buehler[1]

[1] Universität Hamburg; [2]Max Planck Institute for Meteorology

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International Max Planck Research School on Earth System Modelling

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- Model spread in tropical relative humidity (RH) and its change with warming limits our ability to predict Earth's clear-sky climate sensitivity
  (e.g. Vial et al., 2013; McKim et al., 2021)

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- RH differences remain an important source of uncertainty for the radiation budget in global storm-resolving models, especially those in the mid troposphere (Lang et al., 2021)

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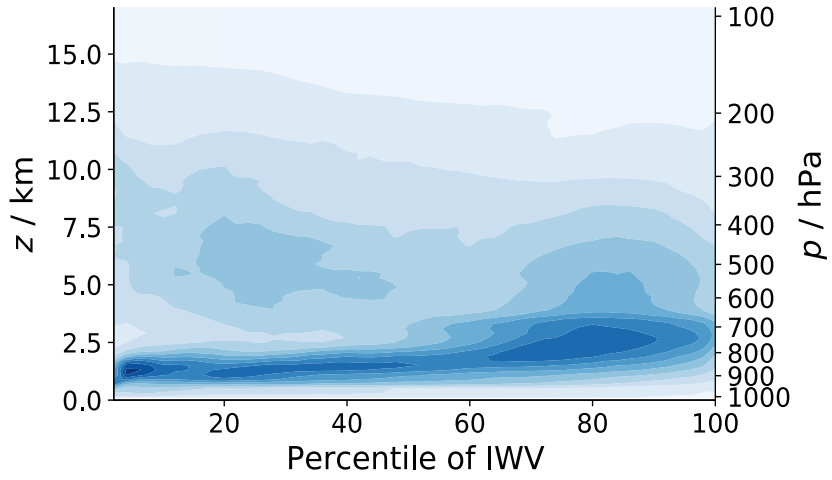
Tropical Free-Tropospheric Humidity Differences and Their Effect on the Clear-Sky Radiation Budget in Global Storm-Resolving Models

Theresa Lang[1,2], Ann Kristin Naumann[1,3], Bjorn Stevens[3], and Stefan A. Buehler[1]

Impact of RH spread on outgoing longwave radiation



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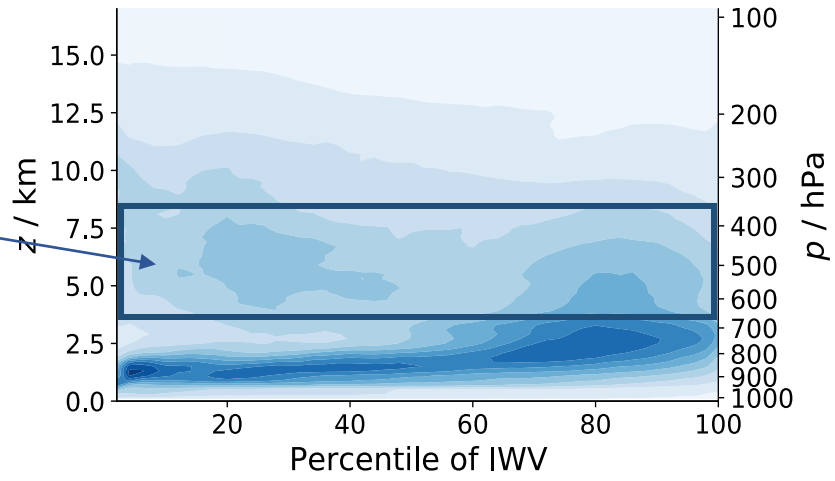

Method: Sensitivity experiments with ICON + back-trajectories

ICON experiments

Control: 45 days in June-August 2021, prescribed SST, 5 km grid spacing

Sensitivity experiments with changes in

- Model resolution
- Parameterizations: microphysics and turbulence

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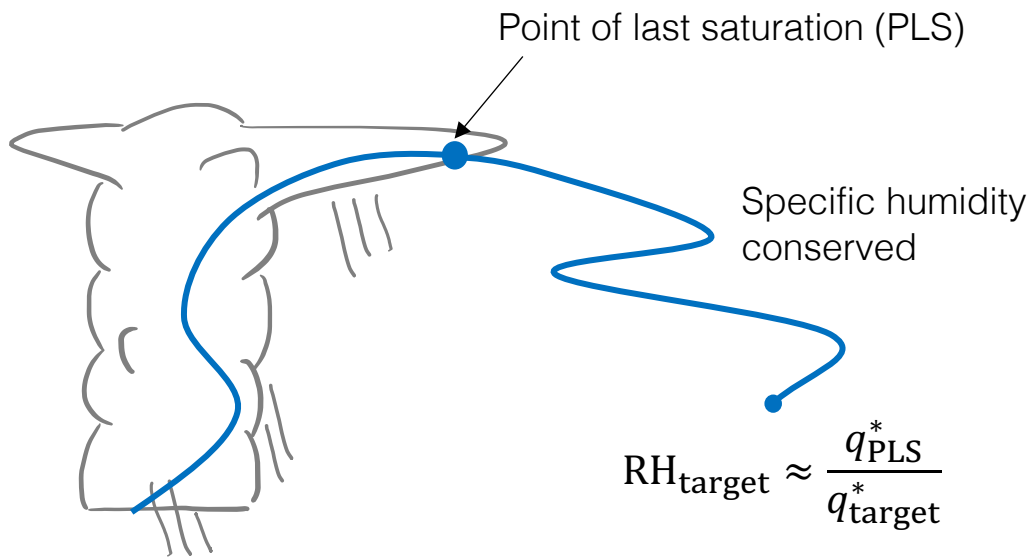
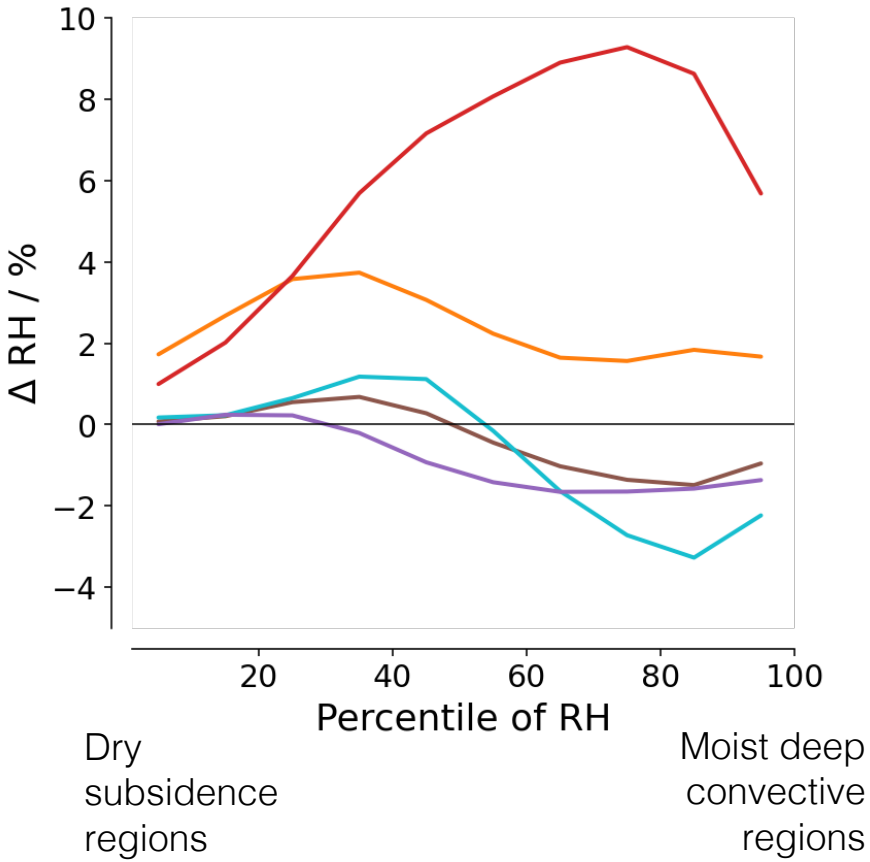
Points of last saturation from back-trajectories

Hypothesis: RH changes are caused by changes in the temperature at which air parcels experience **last saturation**



Choice of turbulence parameterization strongly affects RH



- Resolution: Doubled vert. grid spacing
- Resolution: Halved vert. grid spacing
- Microphysics: Increased ice fall speed
- Microphysics: Exchange 1-mom by 2-mom
- Turbulence: Exchange 3D Smagorinsky with 1D TTE

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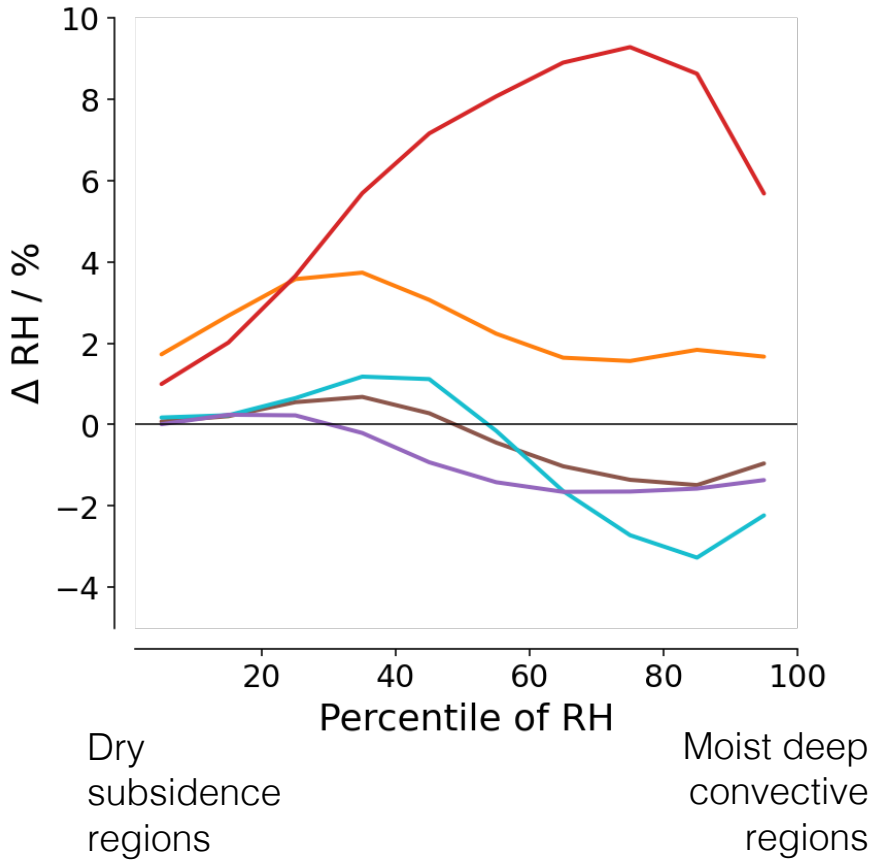
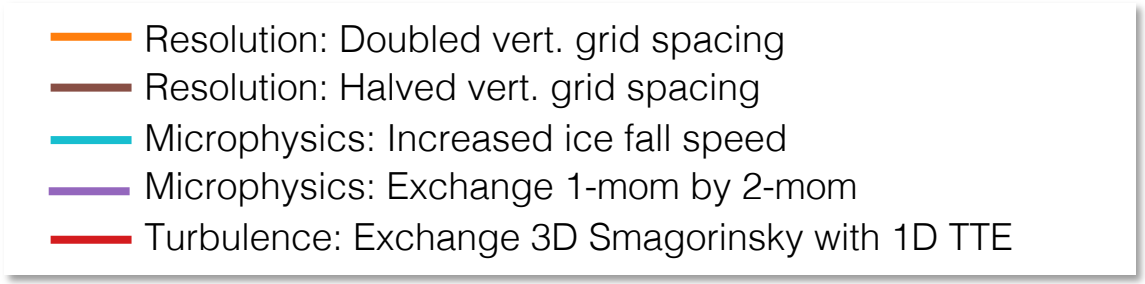
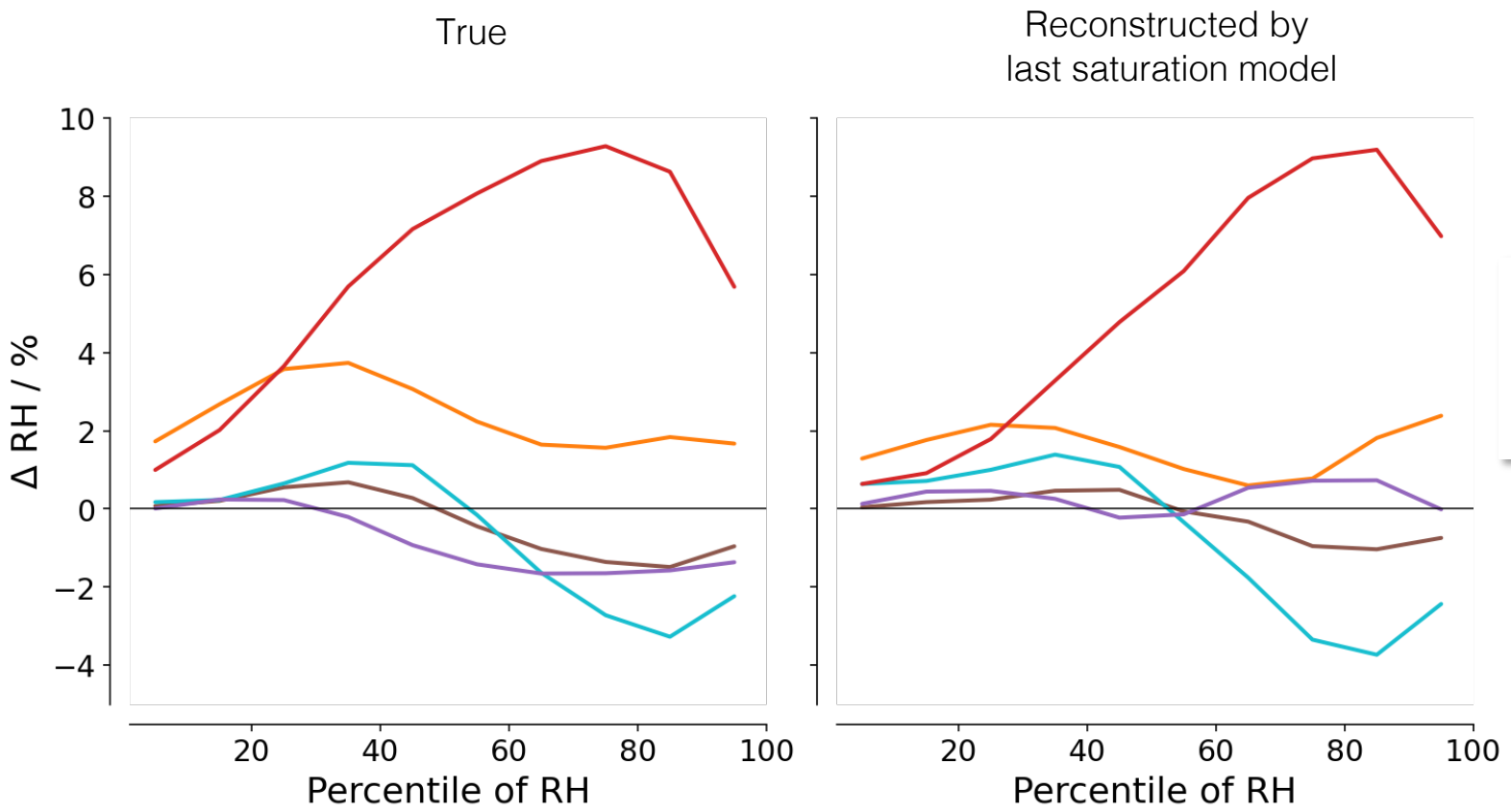




- RH is most sensitive to the choice of the turbulence parameterization
- Weaker sensitivity to changes in microphysics parameterization
- Vertical grid spacing matters if it is too coarse

RH differences are controlled by differences in deep convective source regions



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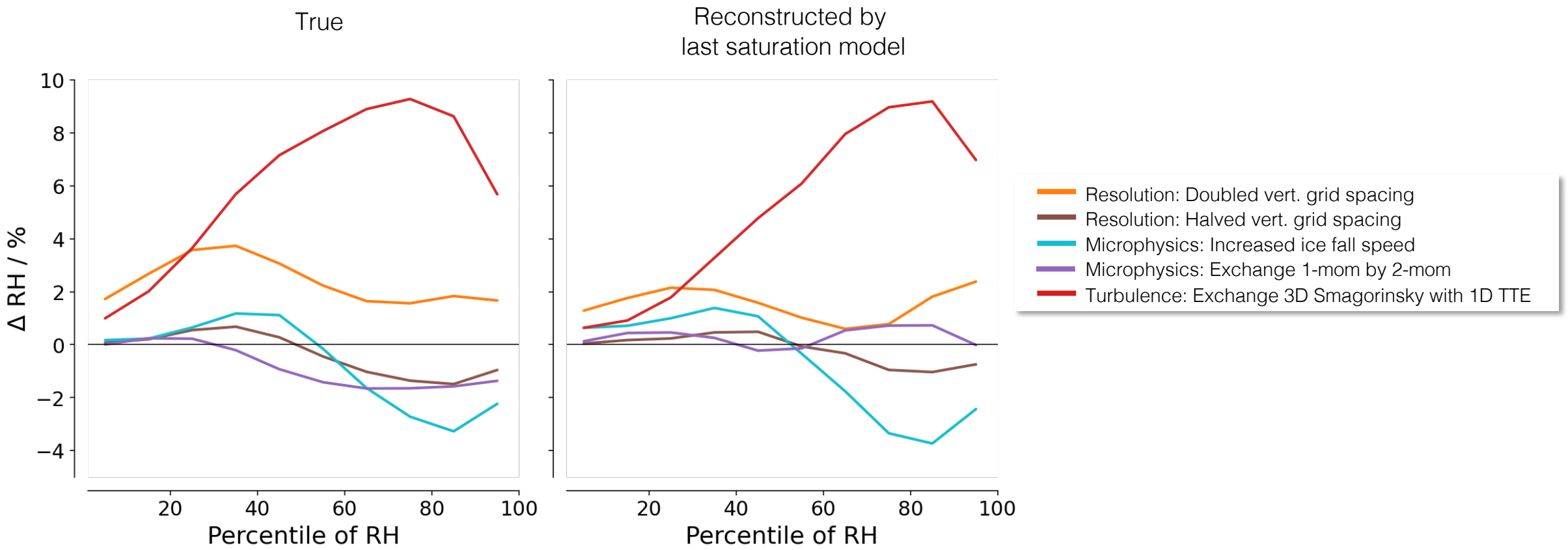

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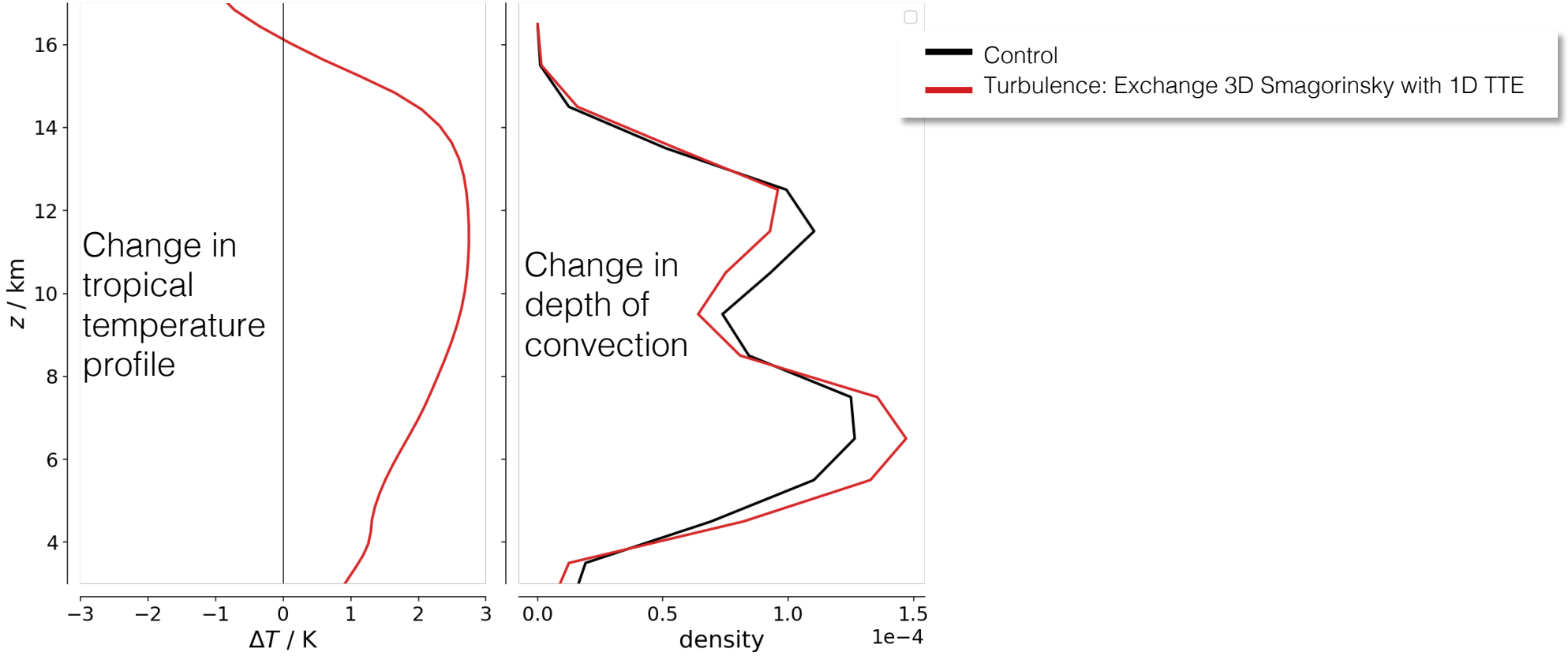

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- The choice of the turbulence scheme affects the height of deep convection and the temperature profile it imposes

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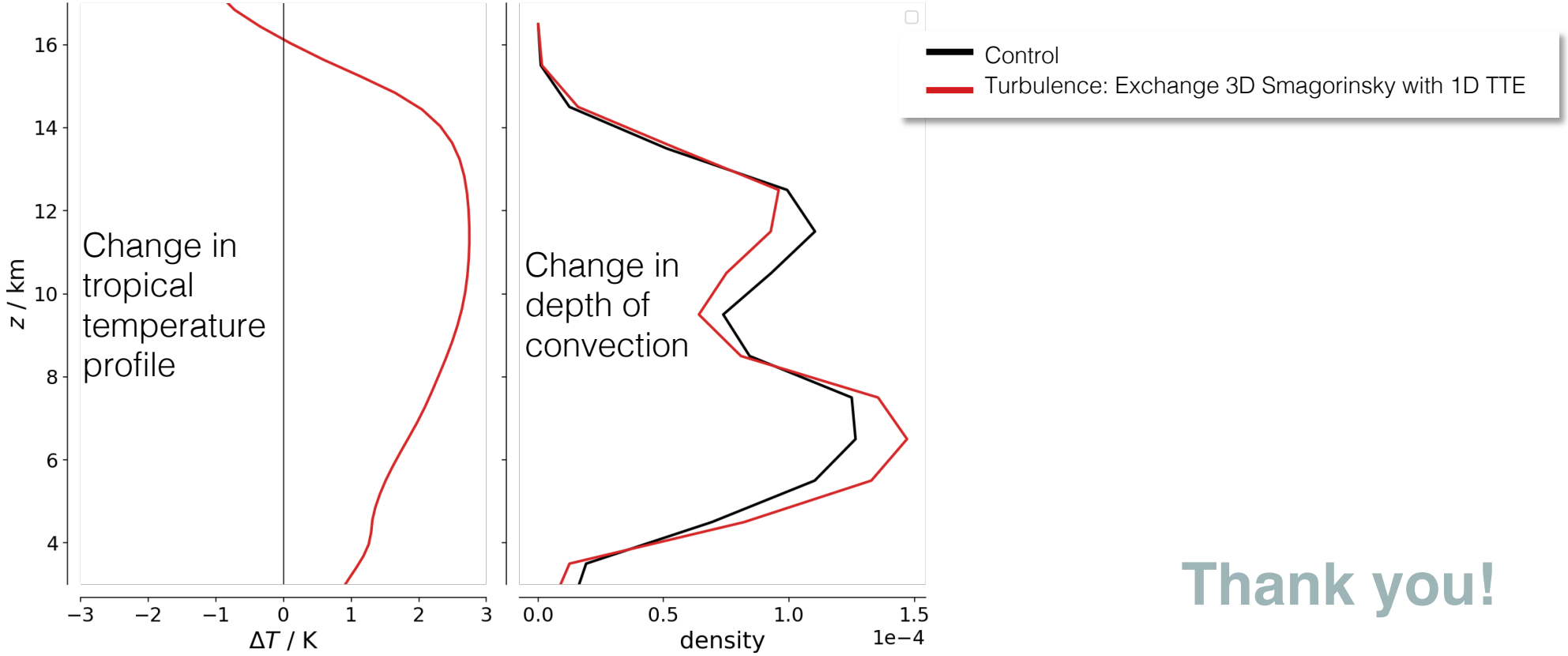

Thank you!

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