An assessment of tropopause characteristics of the ERA5 and ERA-Interim meteorological reanalyses

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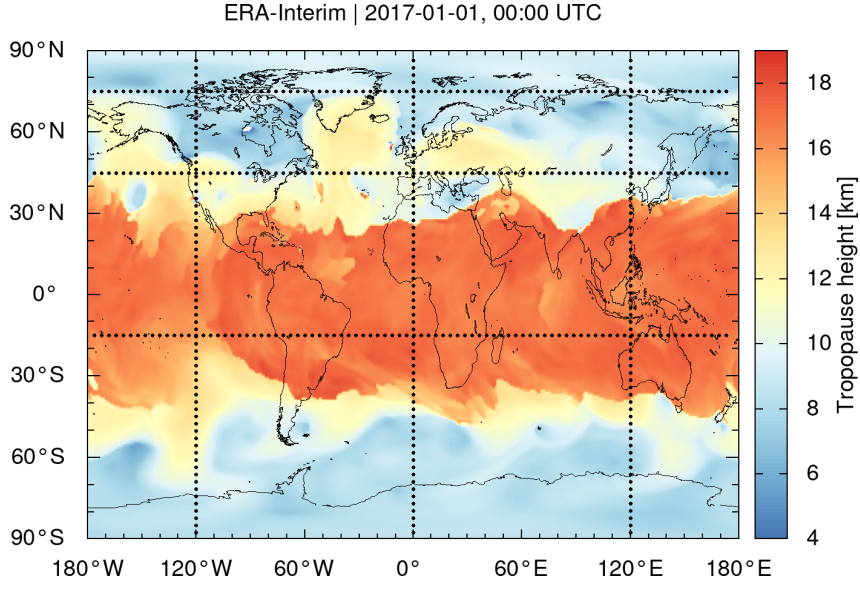
Motivation

- The tropopause layer plays a key role in manifold processes in atmospheric chemistry and physics:
  - stratosphere–troposphere exchange and mixing
    (e.g., Gettelman et al., 2011; Boothe and Homeyer, 2017)
  - transport of water vapor from the troposphere into the stratosphere and related effects on ozone (Holton et al., 1995; Fueglistaler et al., 2009; Anderson et al., 2012; Robrecht et al., 2021)
  - formation of cirrus and convective ice clouds in the lowermost stratosphere
    (Spang et al., 2015; Zou et al., 2020, 2021)
  - long-term changes of the tropopause as an indicator of climate change
    (Seidel et al., 2001; Santer et al., 2003a, b; Sausen and Santer, 2003; Seidel and Randel, 2006)
- Main aim of this study: To assess the representation of the thermal tropopause (WMO, 1957) in global meteorological reanalyses, in particular to compare the tropopause characteristics of ERA5 and ERA-Interim.

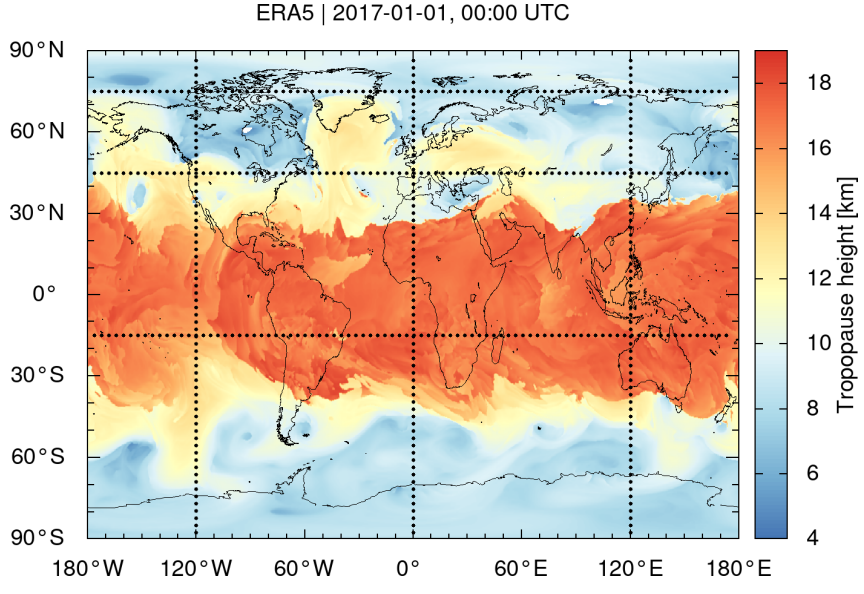
Examples of ERA5 and ERA-Interim tropopause data

- Example: A global map of ERA-Interim tropopause heights...



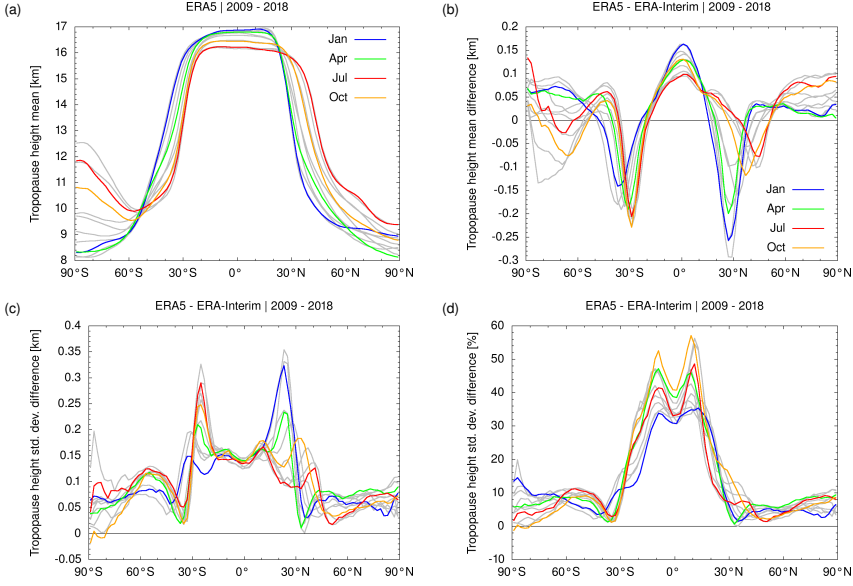
Examples of ERA5 and ERA-Interim tropopause data

- ERA5 shows the same large-scale features, but larger mesoscale variability...



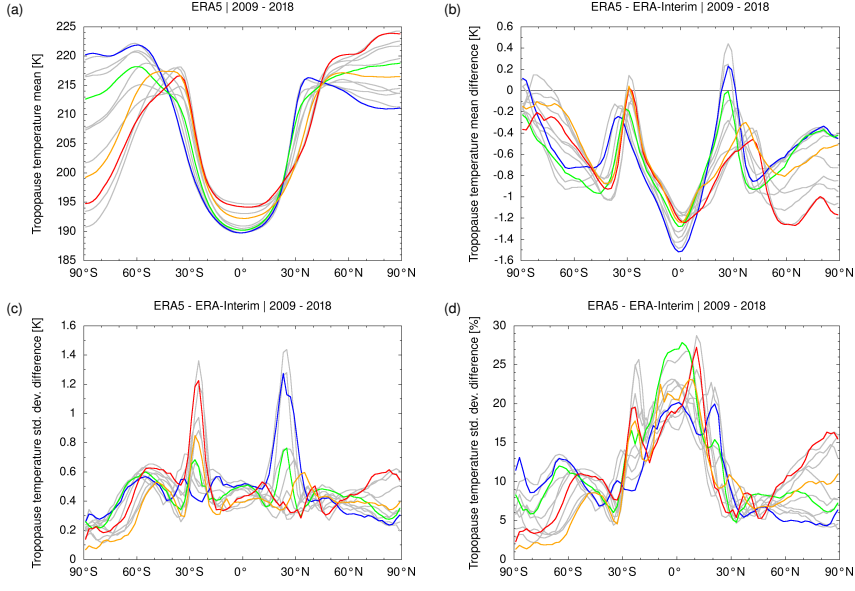
10-year statistics of tropopause data

- Differences of ERA5 and ERA-Interim monthly tropopause heights:



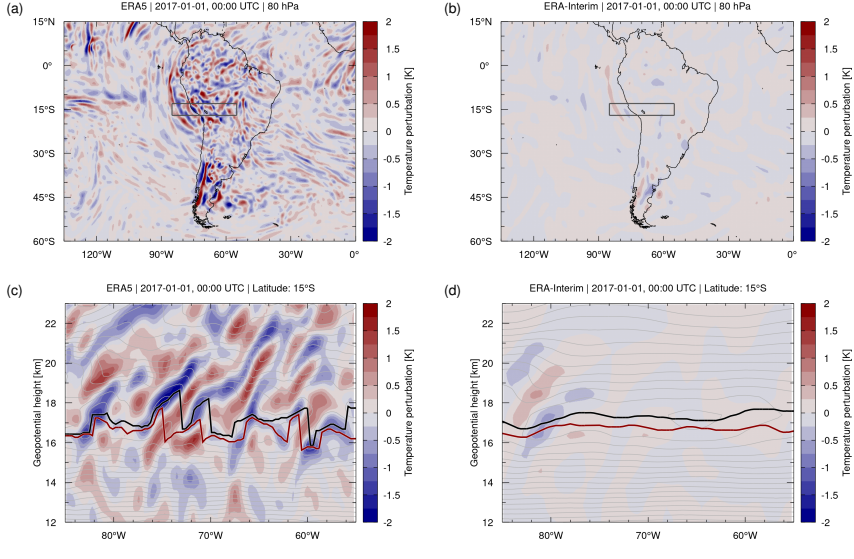
10-year statistics of tropopause data

- Differences of ERA5 and ERA-Interim monthly tropopause temperatures:



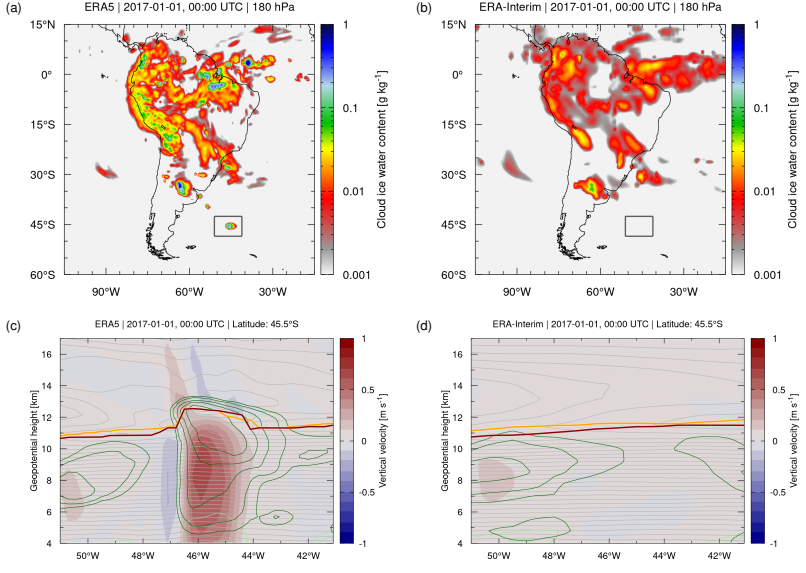
Gravity waves affecting the tropopause

- Mesoscale variability of ERA5 tropopause heights largely related to better representation of gravity waves (as simulated IFS dynamical core):



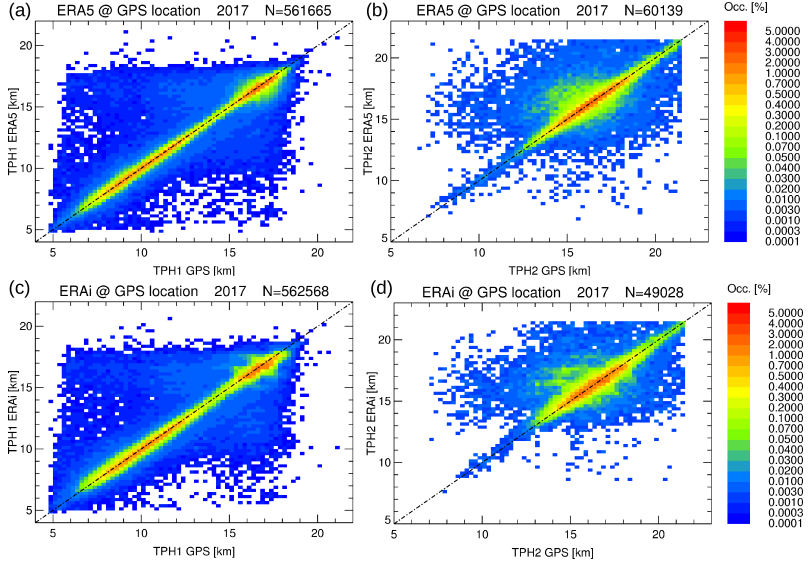
Deep convection affecting the tropopause

- Deep convection may uplift the ERA5 tropopause (in a few cases), but effect still largely underestimated in global reanalysis data.



Evaluation of tropopause heights

- Despite larger variability, ERA5 shows slightly better agreement with GPS and radiosonde measurements than ERA-Interim.



New ACP paper

- Key point: ERA5 realistically shows larger tropopause variability than ERA-Interim due to better resolution and representation of mesoscale features like gravity waves in newer version of IFS model.

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Research article

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Abstract. The tropopause layer plays a key role in manifold processes in atmospheric chemistry and physics. Here we compare the representation and characteristics of the lapse rate tropopause according to the definition of

New data repository

- Open access data repository providing ERA5, ERA-Interim, MERRA-2, and NCEP/NCAR R1 tropopause data: http://doi.org/10.17616/R31NJMOH