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Testing isotopologues as diabatic heating proxy for atmospheric data analyses

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The strong coupling between atmospheric circulation, moisture pathways and atmospheric diabatic heating is a great challenge in atmospheric research since this coupling is responsible for most climate feedback mechanisms and controls the evolution of severe weather events. Although diabatic heating rates are the major driving force of atmospheric circulation on weather and climate time scales, the diabatic heating rates obtained from current meteorological reanalyses show significant inconsistencies. This is mainly indebted to the fact that diabatic heating rates cannot be directly observed. Isotopologue observations assimilated into meteorological reanalyses can make an invaluable contribution since the isotopologue composition depends on the history of phase transition. Therefore, isotopologue observations can provide information that is closely linked to latent heating processes. Here, we analyse idealized experiments performed with the isotopes-incorporated General Spectral Model (IsoGSM) to investigate whether the additional assimilation of isotopologue observations can improve the diabatic heating rates. To do so, we use a Local Transform Ensemble Kalman Filter (LETKF) for data assimilation, and mock the high-density isotopologue MUSICA IASI observational data. The MUSICA IASI data apply the retrieval recipe of MUSICA (MUlti-platform remote Sensing of Isotopologues for investigating the Cycle of Atmospheric water) to the thermal nadir spectra recorded by the IASI (Infrared Atmospheric Sounding Interferometer) satellite instrument. The mocked isotopologue observations are then assimilated into the model in addition to temperature, humidity and wind profiles obtained from radiosonde and satellite data. By comparing the ensemble runs with and without the additional assimilation of the isotopologue data we can reveal the potential of MUSICA IASI isotopologue data for constraining uncertainties in diabatic heating rates.