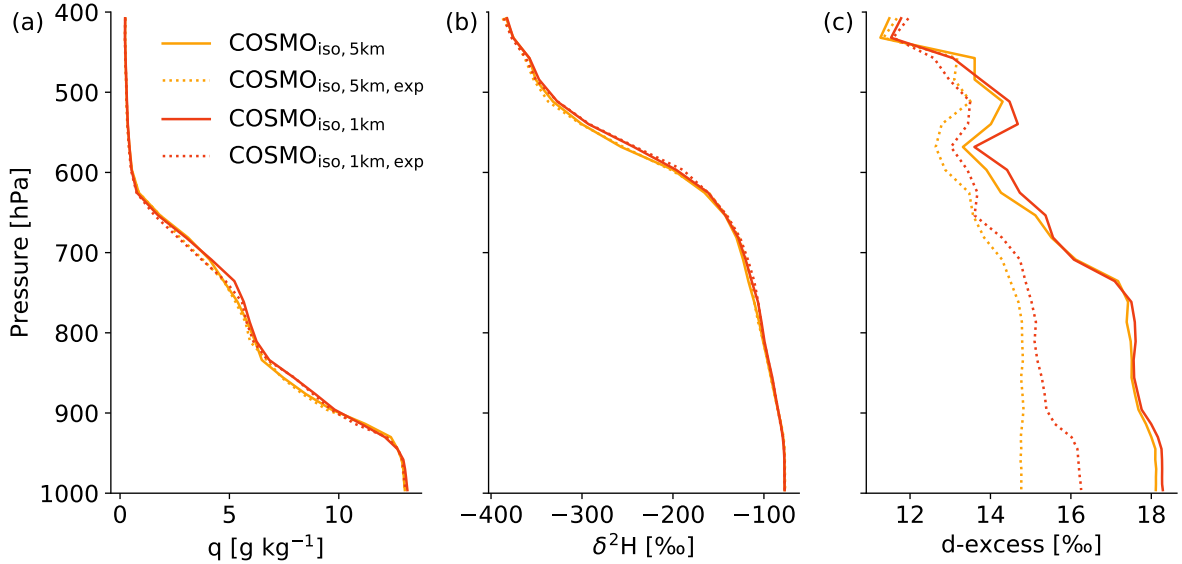
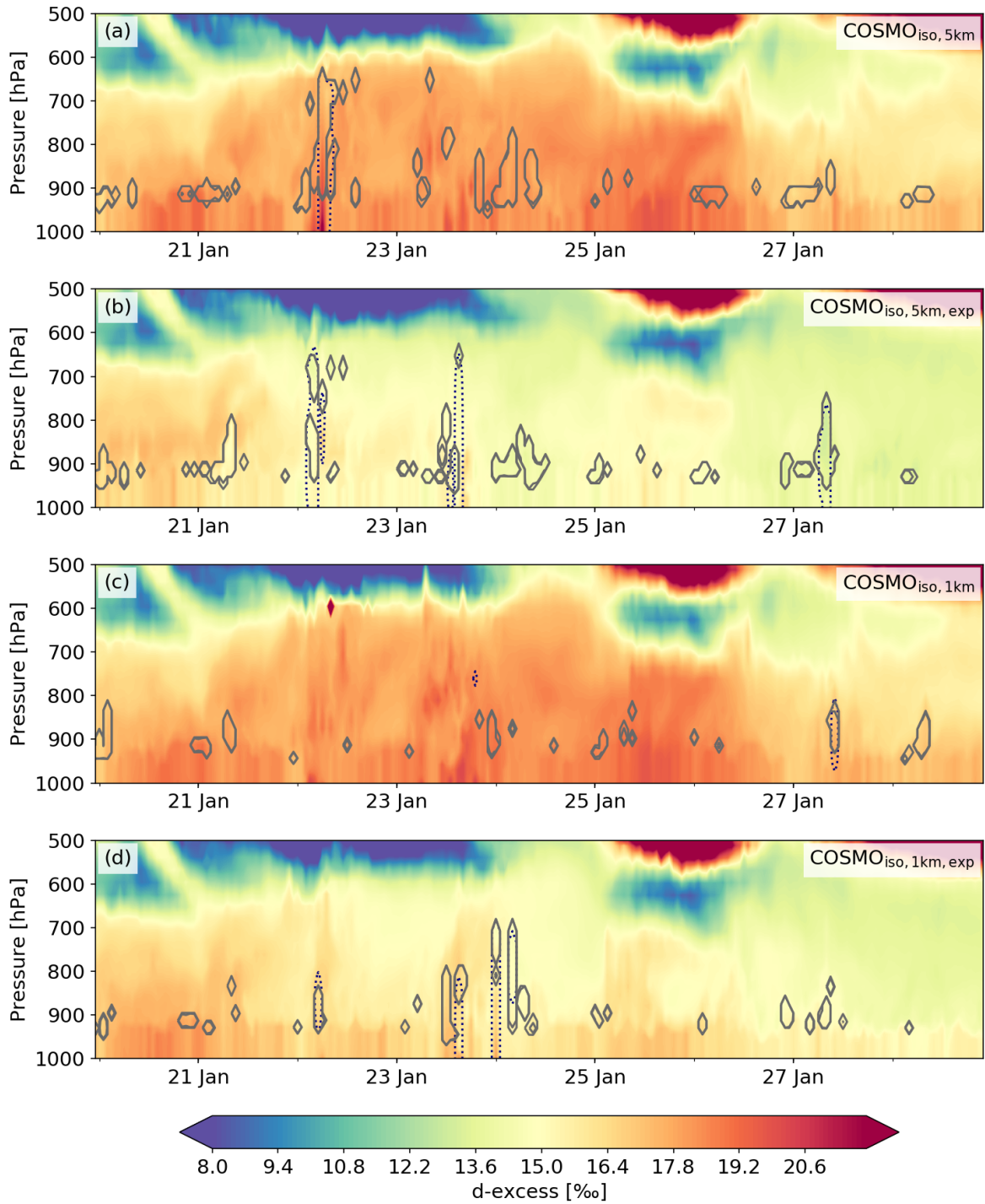


## Different non-equilibrium fractionation factors

In this supplement, two formulations of the non-equilibrium fractionation factors are compared. The one used for the COSMO<sub>iso</sub> simulations in the paper (i.e., the smooth regime of Merlivat and Jouzel, 1979) is compared to the recently developed formulation by Düttsch et al. (2023). The formulation by Düttsch et al. (2023) represents a new theoretical framework that explicitly accounts for the momentum flux carried by waves at the ocean surface. We implemented Düttsch et al. (2023)'s formulation into the COSMO<sub>iso,5km</sub> and COSMO<sub>iso,1km</sub> model setup and performed nested simulations from 20 January to 29 January 2020. We refer to these experimental simulations as COSMO<sub>iso,5km,exp</sub> and COSMO<sub>iso,1km,exp</sub>. Fig.S4.1 and Fig.S4.2 show that COSMO<sub>iso,5km,exp</sub> and COSMO<sub>iso,1km,exp</sub> have lower d-excess values in the lower troposphere and show a resolution-dependency in contrast to the simulations used in the paper. Specific humidity and  $\delta^2\text{H}$  are not notably affected by the formulation of the non-equilibrium fractionation factors (Fig. S4.1).



**Figure S4.1:** Median vertical profiles of (a) specific humidity ( $q$ ), (b)  $\delta^2\text{H}$  in vapour, and (c) d-excess in vapour. Shown are the median of the profiles extracted from COSMO<sub>iso,5km</sub> (continuous yellow), COSMO<sub>iso,5km,exp</sub> (dashed yellow), COSMO<sub>iso,1km</sub> (continuous red), COSMO<sub>iso,1km,exp</sub> (dashed red) at the centre of the EUREC<sup>4</sup>A circle (57.717° W, 13.3° N) every hour from 20 to 29 January 2020. The COSMO<sub>iso,\*km</sub> and COSMO<sub>iso,\*km,exp</sub> simulations differ with regard to the formulation of the non-equilibrium fractionation, which is the smooth regime of Merlivat and Jouzel (1979) and the formulation by Düttsch et al. (2023), respectively. The profiles are limited to 400 hPa because the four profiles are identical above.



**Figure S4.2:** Temporal overview of the vertical profiles of d-excess in vapour extracted from (a) COSMO<sub>iso</sub>, 5km, (b) COSMO<sub>iso</sub>, 1km, (c) COSMO<sub>iso</sub>, 5km, exp, (d) COSMO<sub>iso</sub>, 1km, exp at the centre of the EUREC<sup>4</sup>A circle (57.717° W, 13.3° N). The grey contours indicated cloud liquid water of 0 and 10 mg kg<sup>-1</sup>; the dotted blue contours rainwater of 1 mg kg<sup>-1</sup>.

## References

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