What controls the 3D distribution of water vapor isotopic composition in China

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1. Introduction

Stable isotopic signals preserved in natural precipitation archives, such as ice cores, provide information on past climatic changes. When measured in the water vapor, water isotopes bear information on large-scale transport, convective and cloud processes.

We aim at better understanding the physical processes controlling the water isotopic composition. Here we made two snapshots of vehicle-based spatially-continuous near-surface water vapor isotope in a large spatial region across China, with a focus on the interaction between summer monsoon and the westerlies. Additionally, we measured the vertical distribution up to the upper troposphere, with a focus on convection in the southeastern Tibetan Plateau.

2. Spatial and seasonal distribution of vapor isotopes in China——Vehicle-based in-situ observations

Pre-monsoon

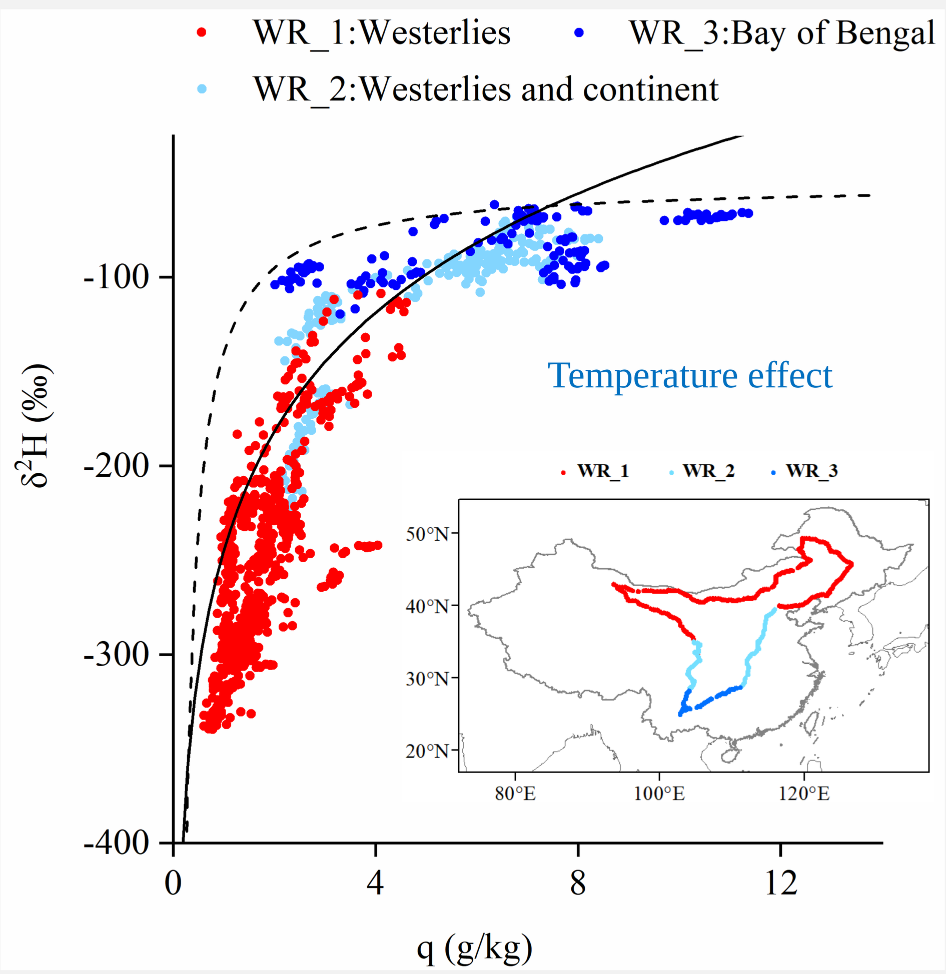


Fig. 1 Scatterplot of observed vapor δ^2H values versus specific humidity (q, g/kg). The solid black curves show the Rayleigh distillation line calculated for the initial conditions of δ^2H_0 = -50‰ at T=15 °C.

Monsoon

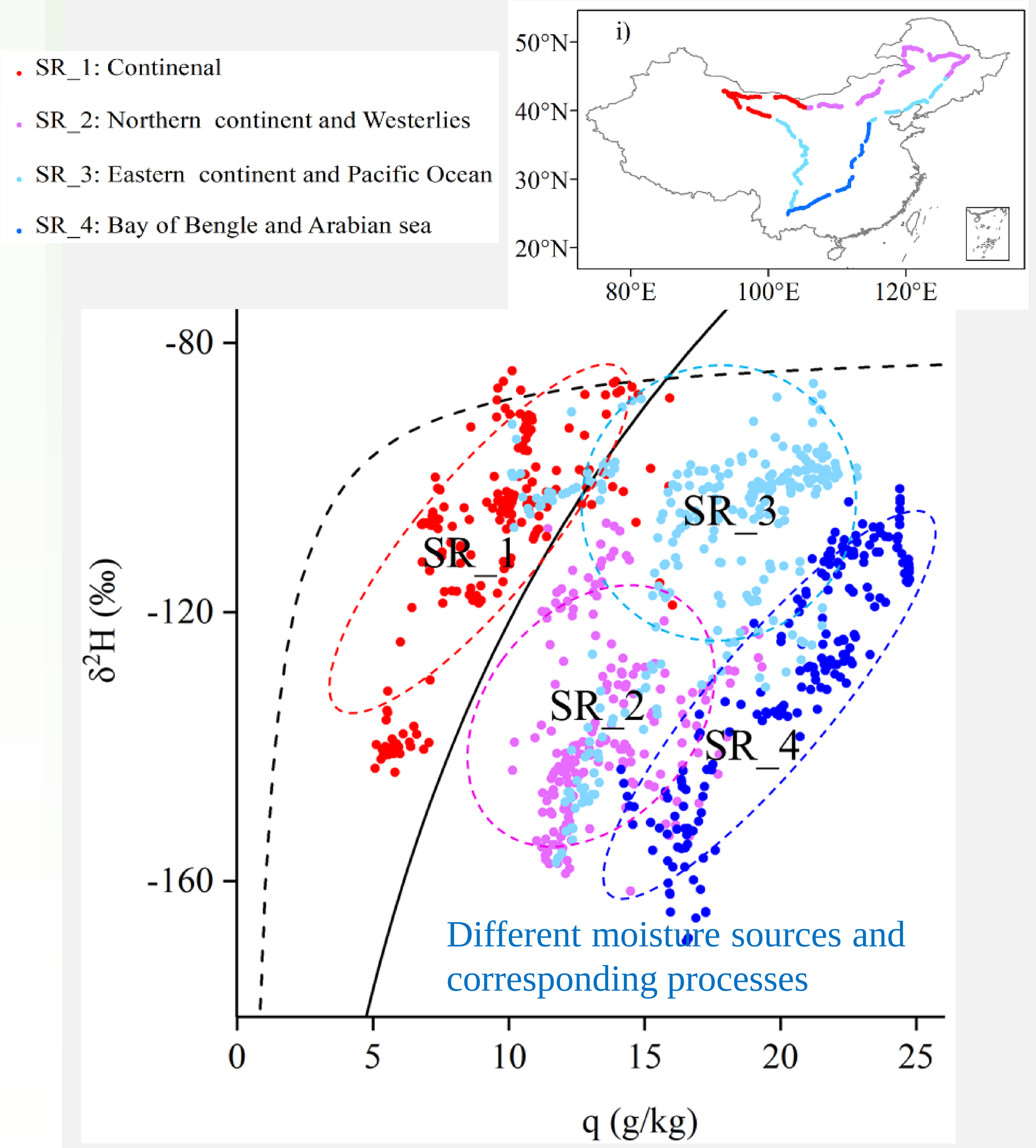


Fig.2 Scatterplot of observed vapor δ^2H values versus specific humidity (q, g/kg). The solid black curves show the Rayleigh distillation line calculated for the initial conditions of δ^2H_0 = -50‰ at T=15 °C.

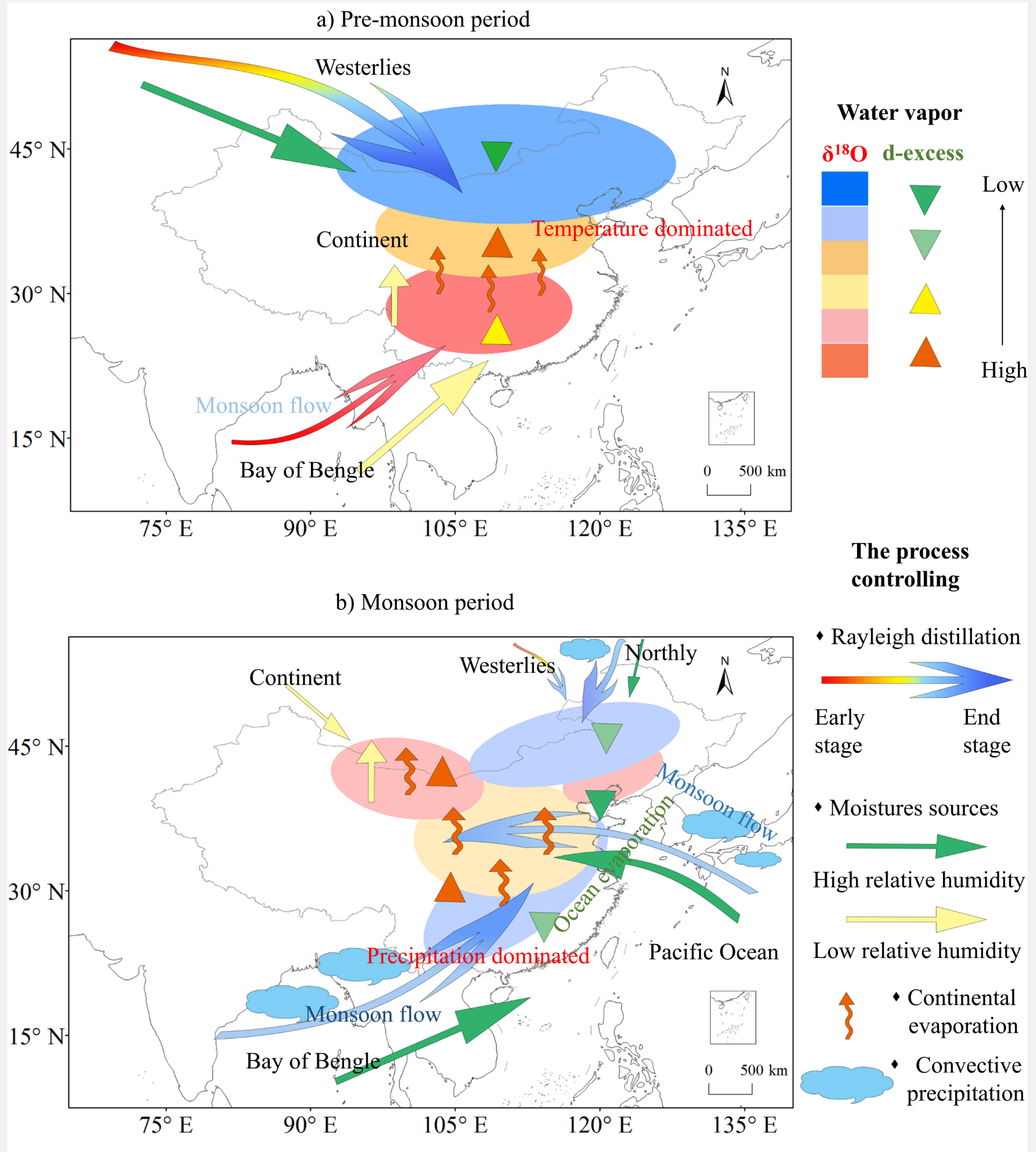


Fig.3 Schematic picture summarizing the different processes controlling the observed spatial patterns and seasonality of vapor isotopes.

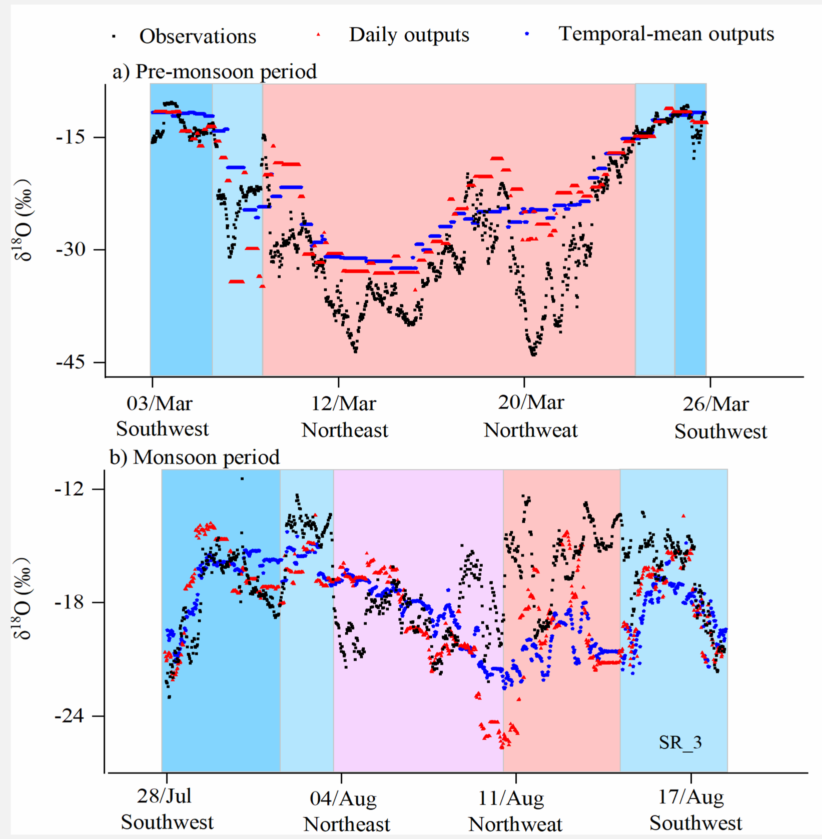


Fig.4 Comparison of observed vapor δ^{18}O (observations) with outputs of Iso-GSM during the pre-monsoon period (a) and monsoon period (b).

Conclusion

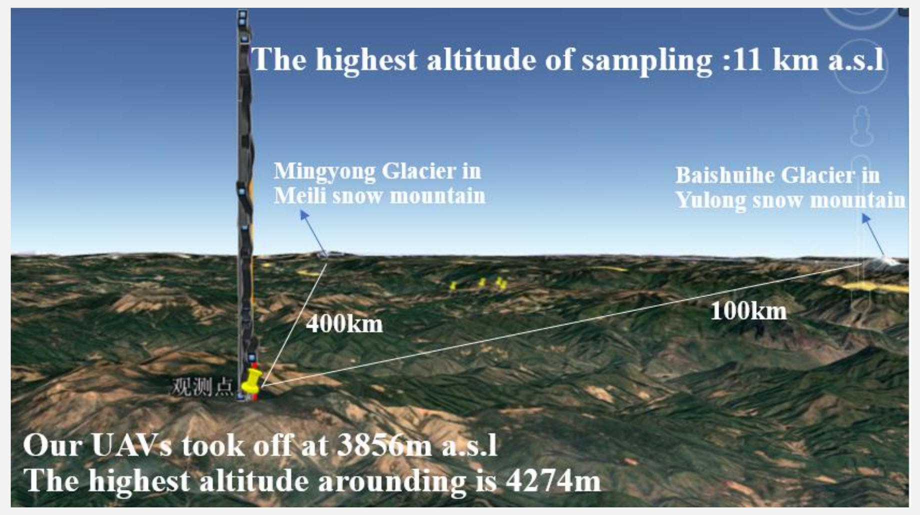
1.Vehicle-based in-situ observations capture spatial variations in the isotopic composition of water vapor.

2.Both during the pre-monsoon and monsoon periods, the different moisture sources and corresponding processes on transport pathways explain the spatial patterns both in vapor δ^{18}O and d-excess.

3. Vertical profiles of vapor isotopes in the southeastern Tibetan Plateau——UAV based

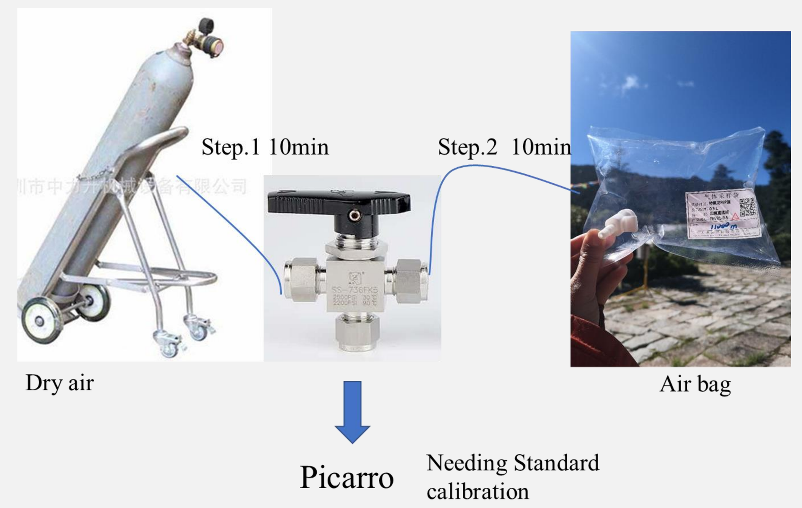
Experiment design

At a top of a mountain for vertical profiles



Sounding system

Measurements of vapor isotopes



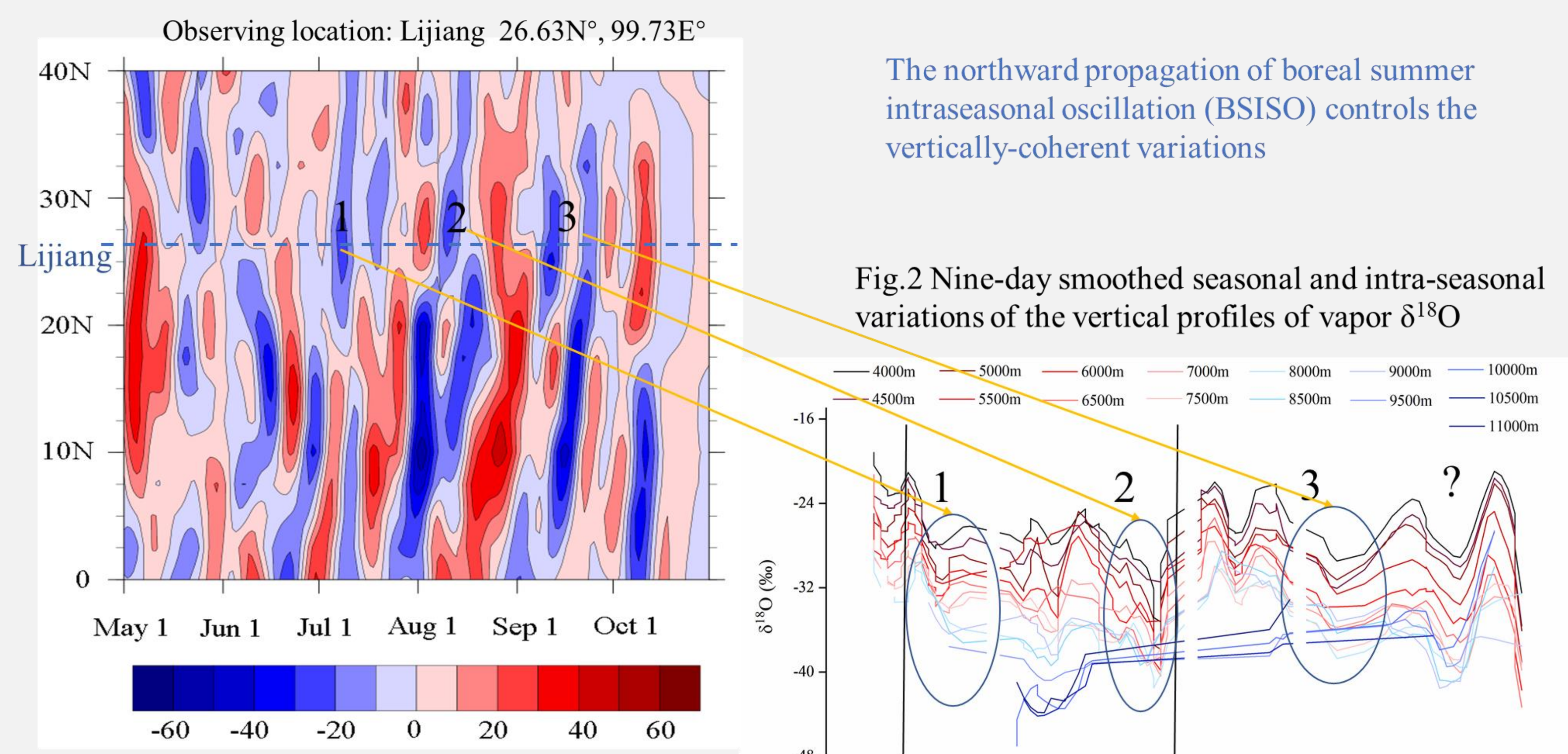
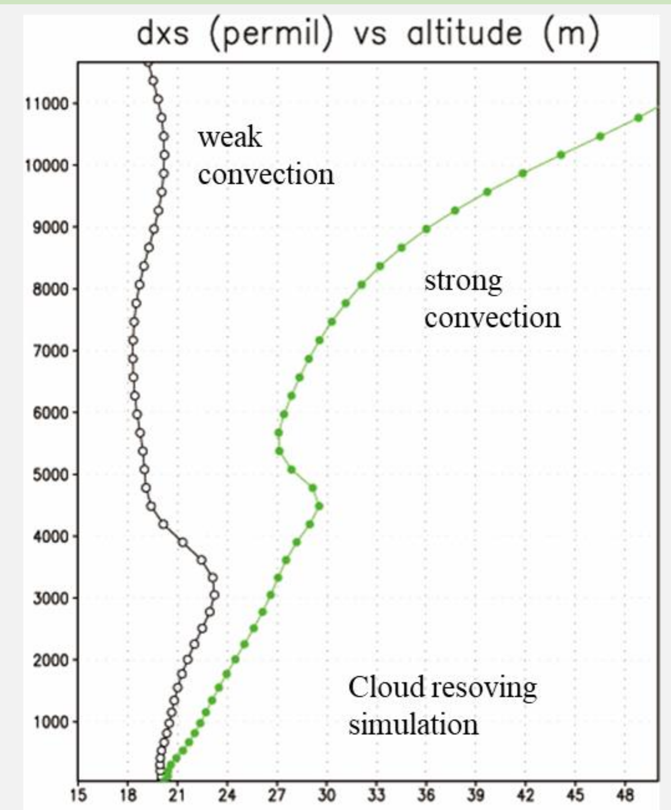


Fig. 1 Longitude averaged (90°E to 110°E) time-latitude representation (Hovmoller plot) of 10 to 80 day filtered OLR anomaly (shaded, in W/m2) during May 2020 to October.



Cloud-resoving simulations in radiative convective equilibrium can capture the higher d-excess when convection is stronger → local impact of convection ?

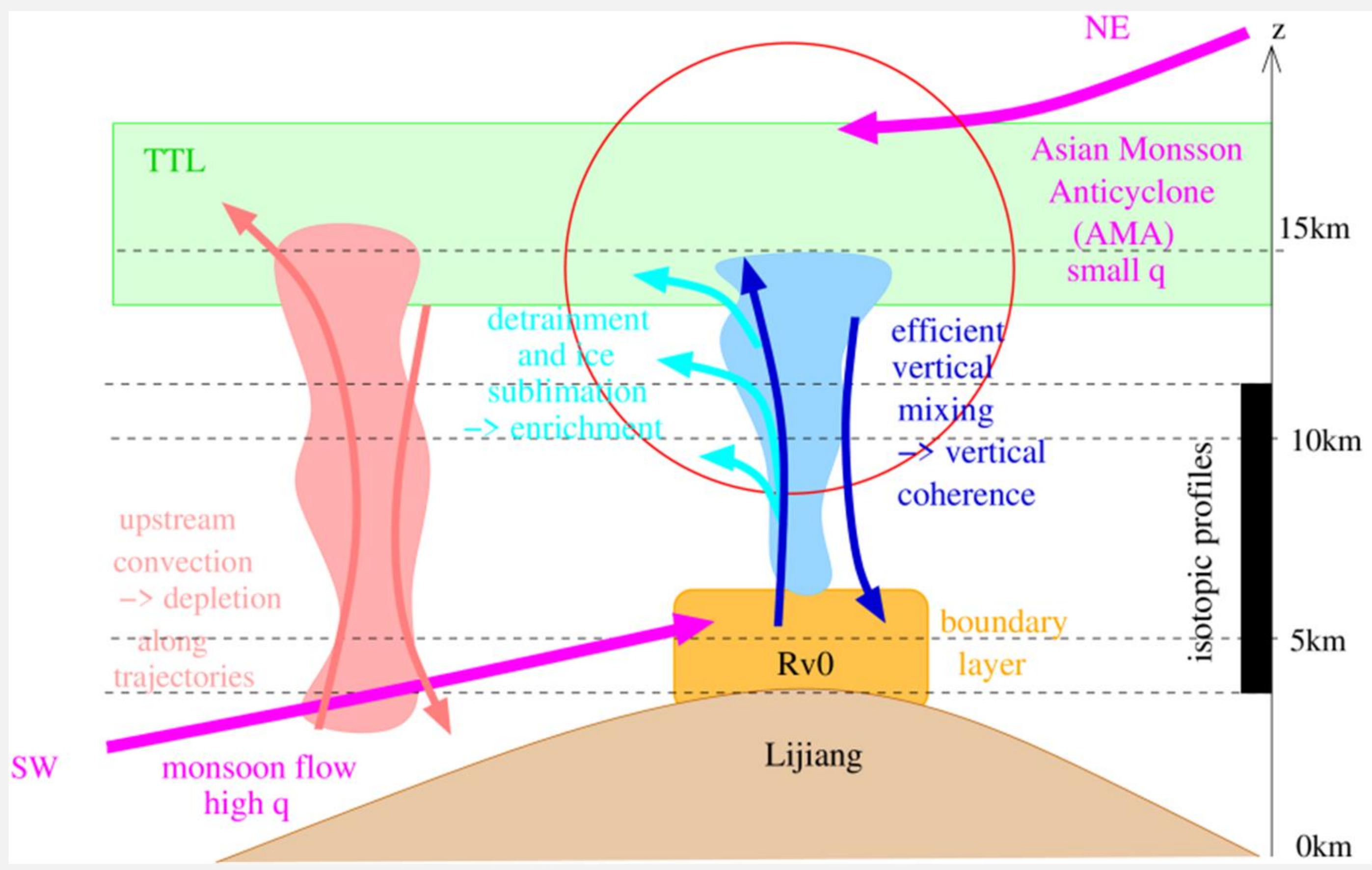


Fig.4 Schematic summarizing the different processes controlling the vertical profiles of vapor isotopes.

Conclusion

Perspective

Key points of difficulty

1. At the top of the troposphere, the water vapor content is very low and the measurement of vapor isotopes may introduce some errors.

2. Choose air collection device carefully. Fractionation may occur during storage of the air after collection. Isotope measurements should be completed as quickly as possible after sampling. Tthe data also should be corrected for changes in time.

4. References