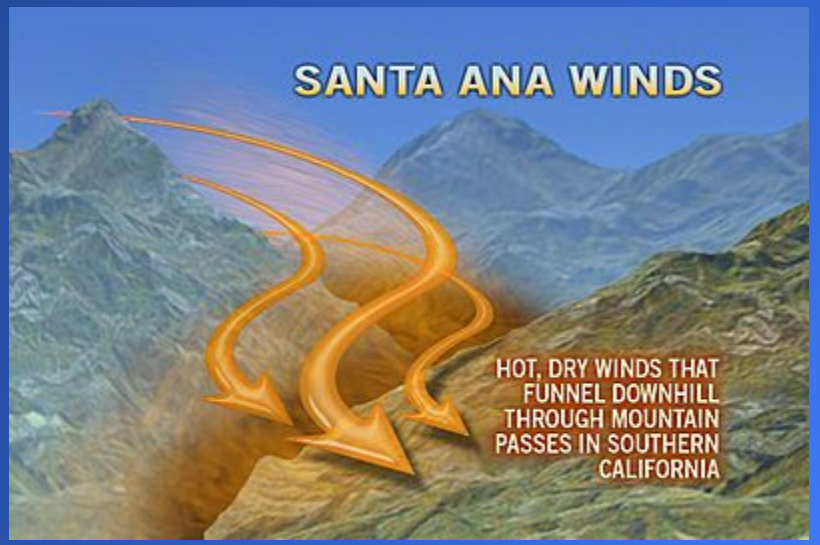
What you may not know about Santa Ana winds: A case study for water vapor sourcing using isotope tracers

Chun-Ta Lai

Associate Professor
chun-ta.lai@mail.sdsu.edu
Department of Biology
San Diego State University



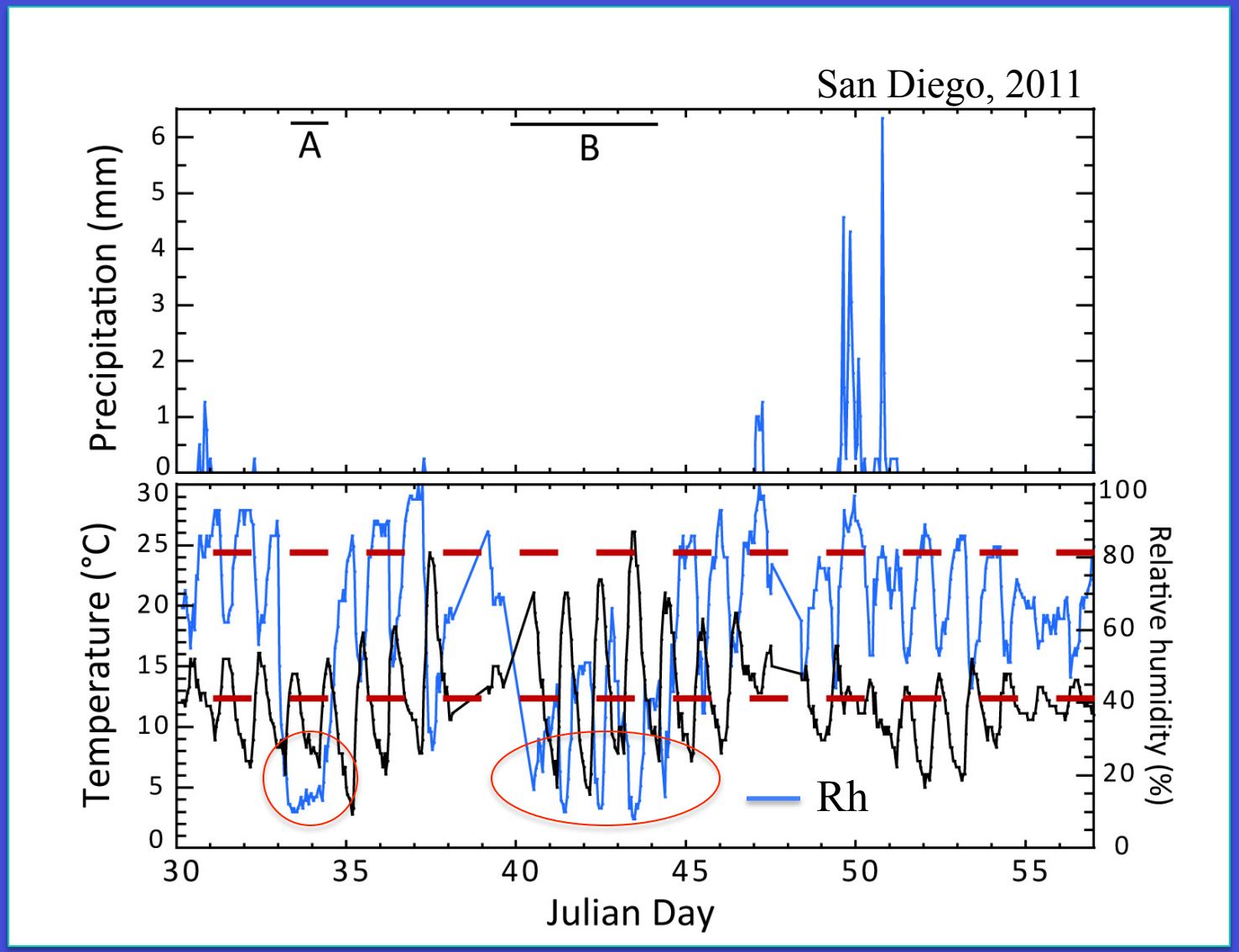
Which processes are the primary controls of the isotopic composition of atmospheric water vapor in San Diego?

Sampling location: San Diego State University campus

Sampling period: February 2011

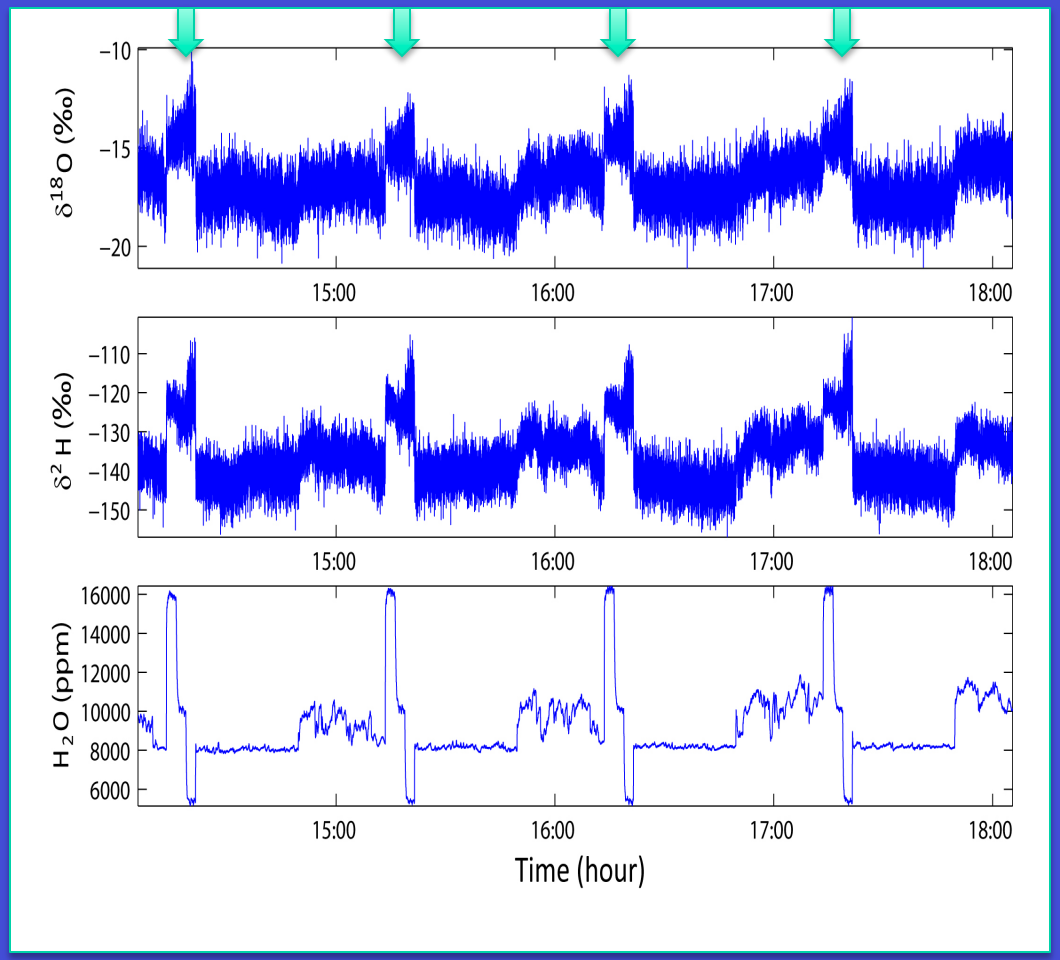
Data: hourly averages of near-surface water vapor mixing ratios and their isotopic composition

Vapor isotope ratios were measured in locally extreme weather conditions (Santa Ana and winter rainstorms)



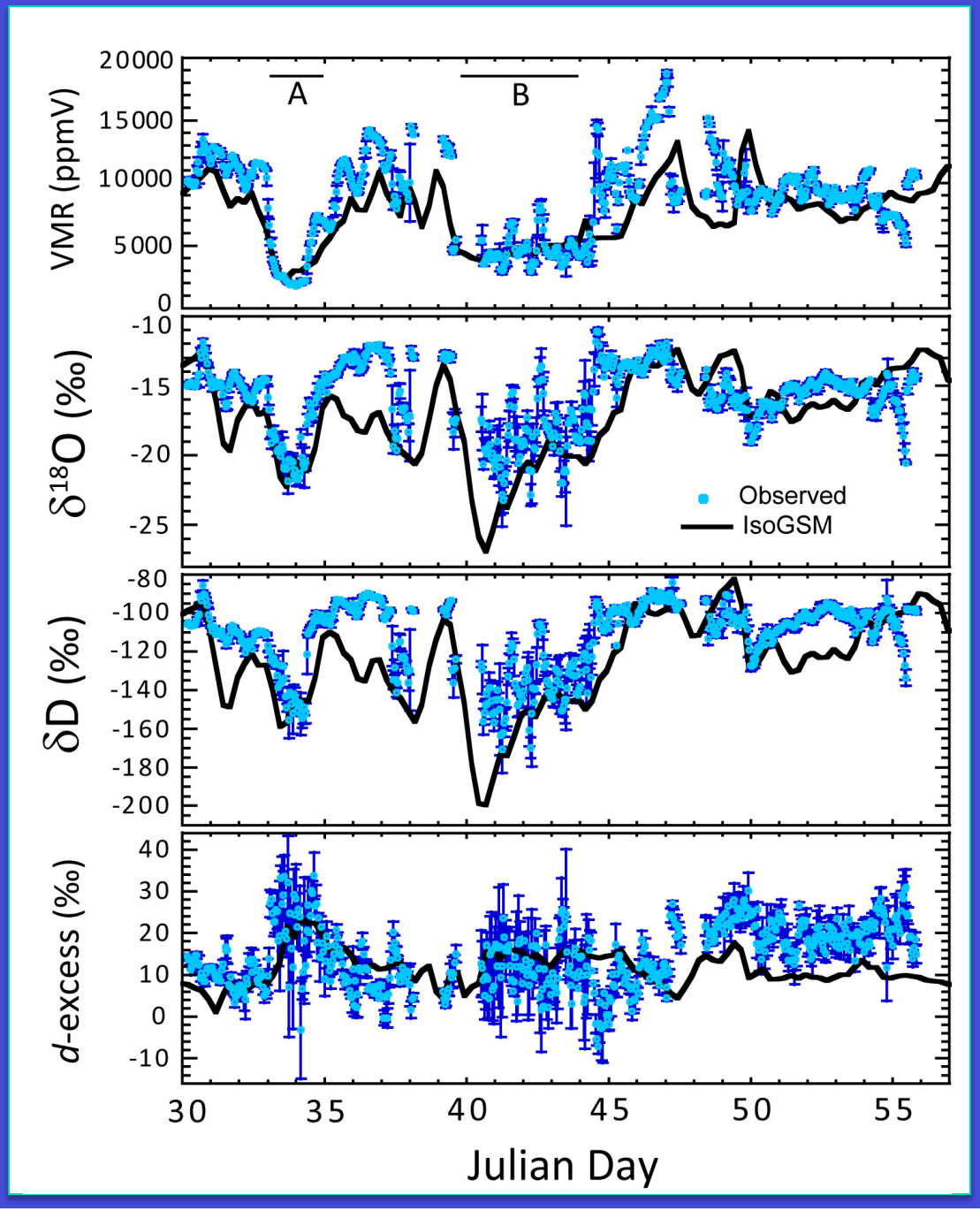
Hourly calibration is performed to ensure high data quality

Accuracy: ±0.5 ‰ for δD and ±0.1 ‰ for $\delta^{18}O$



A LGR analyzer and a water standard source unit allows for in-situ, hourly water vapor isotope measurements

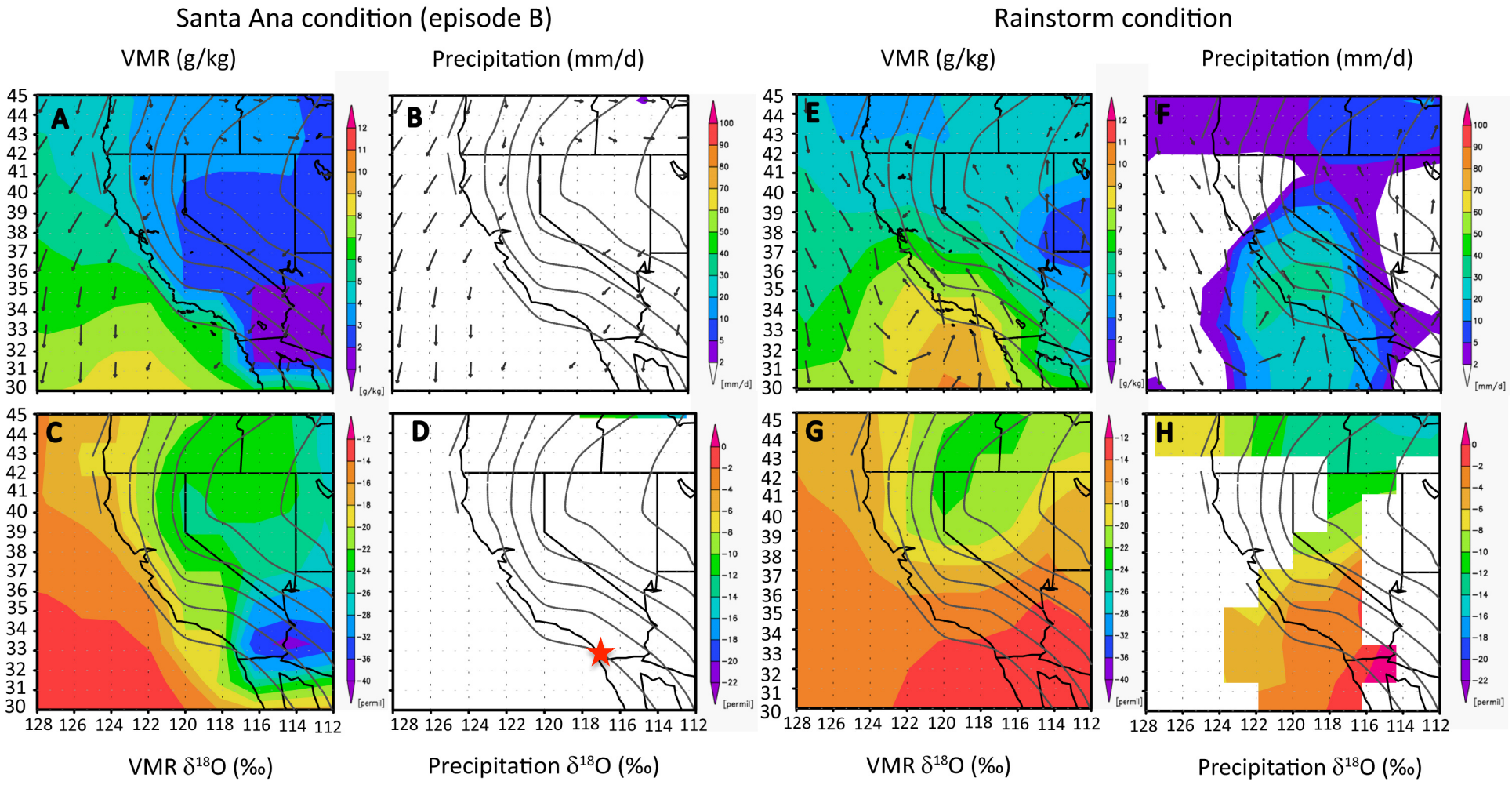
Rambo et al. (2011) J. Atm. Ocean Tech 28: 1448-1457



Synoptic weather cycles depict large day-to-day variability in the mixing ratio and isotopic composition of near-surface atmospheric moisture.

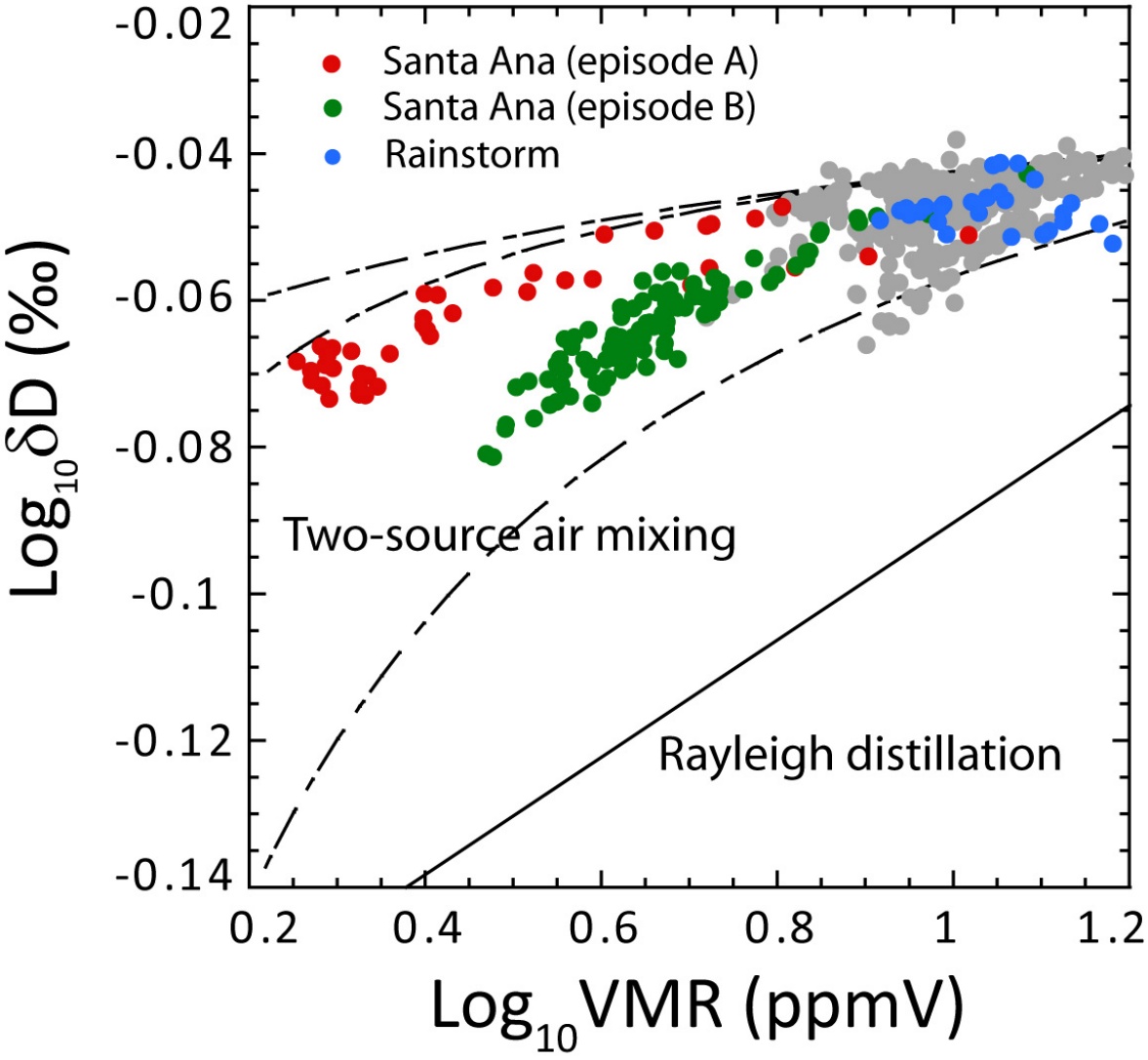
Remarkably low mixing ratio and isotope ratios were observed during Santa Ana conditions.

Examples of IsoGSM simulation for two extreme weather events



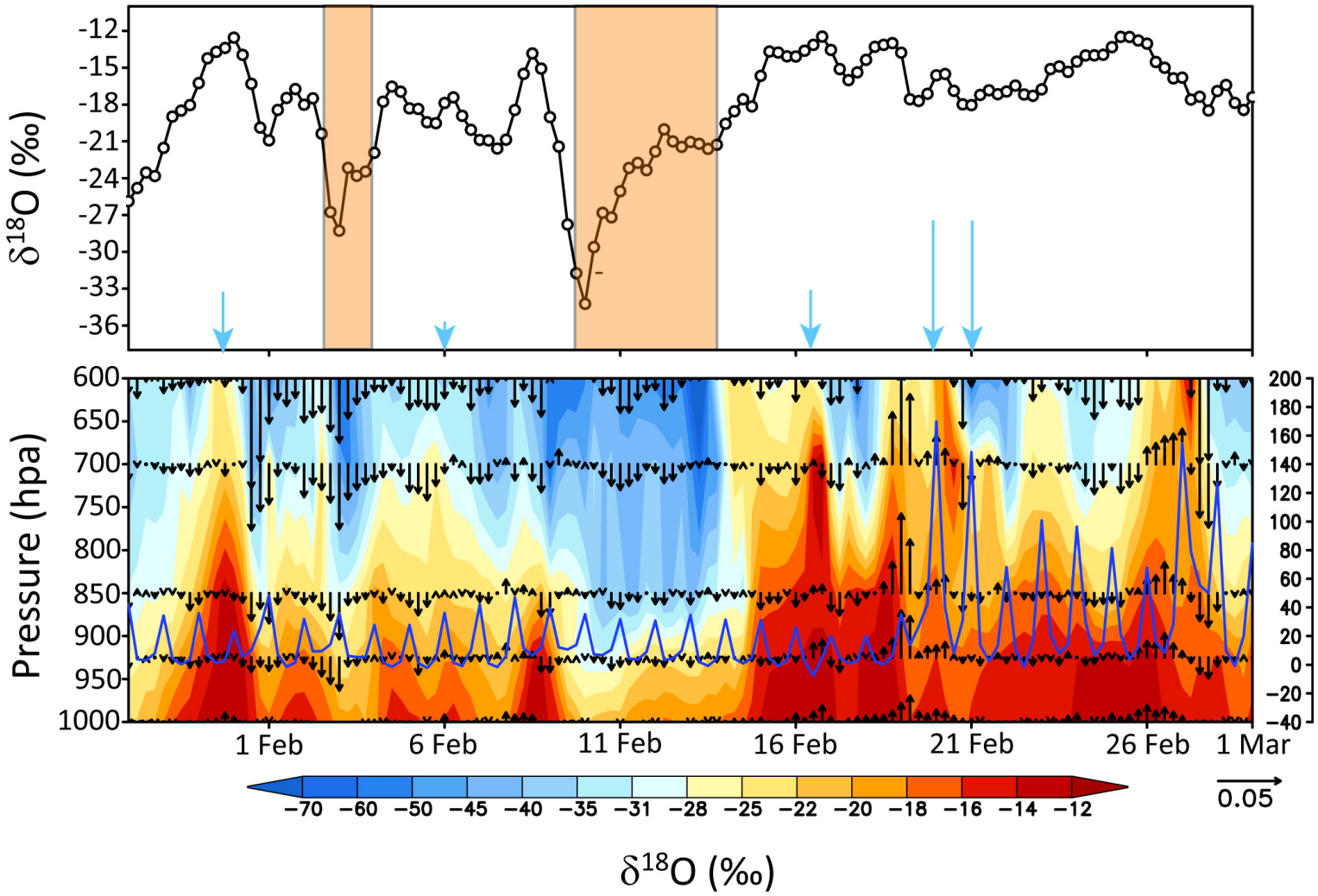
Farlin, Lai & Yoshimura (2013) WRR 49:3685-3696

Paired δ-q analysis suggests atmospheric mixing is the dominant process during Santa Ana conditions



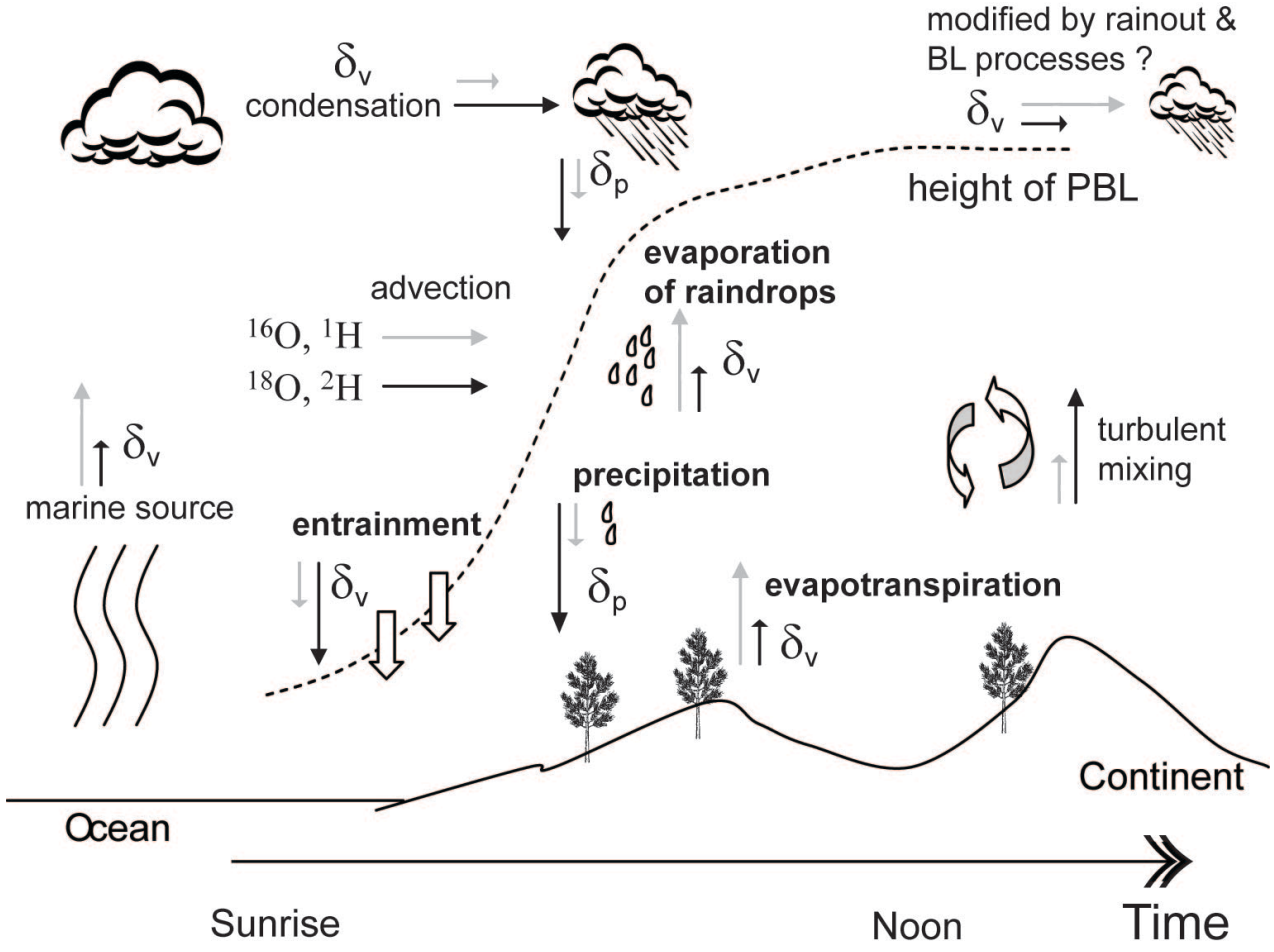
Farlin, Lai & Yoshimura (2013) WRR 49:3685-3696

During Santa Ana winds, strong subsidence transports air of low humidity and low $\delta^{18}O$ from the free troposphere, which then mixes with the relatively moist air in the ABL.



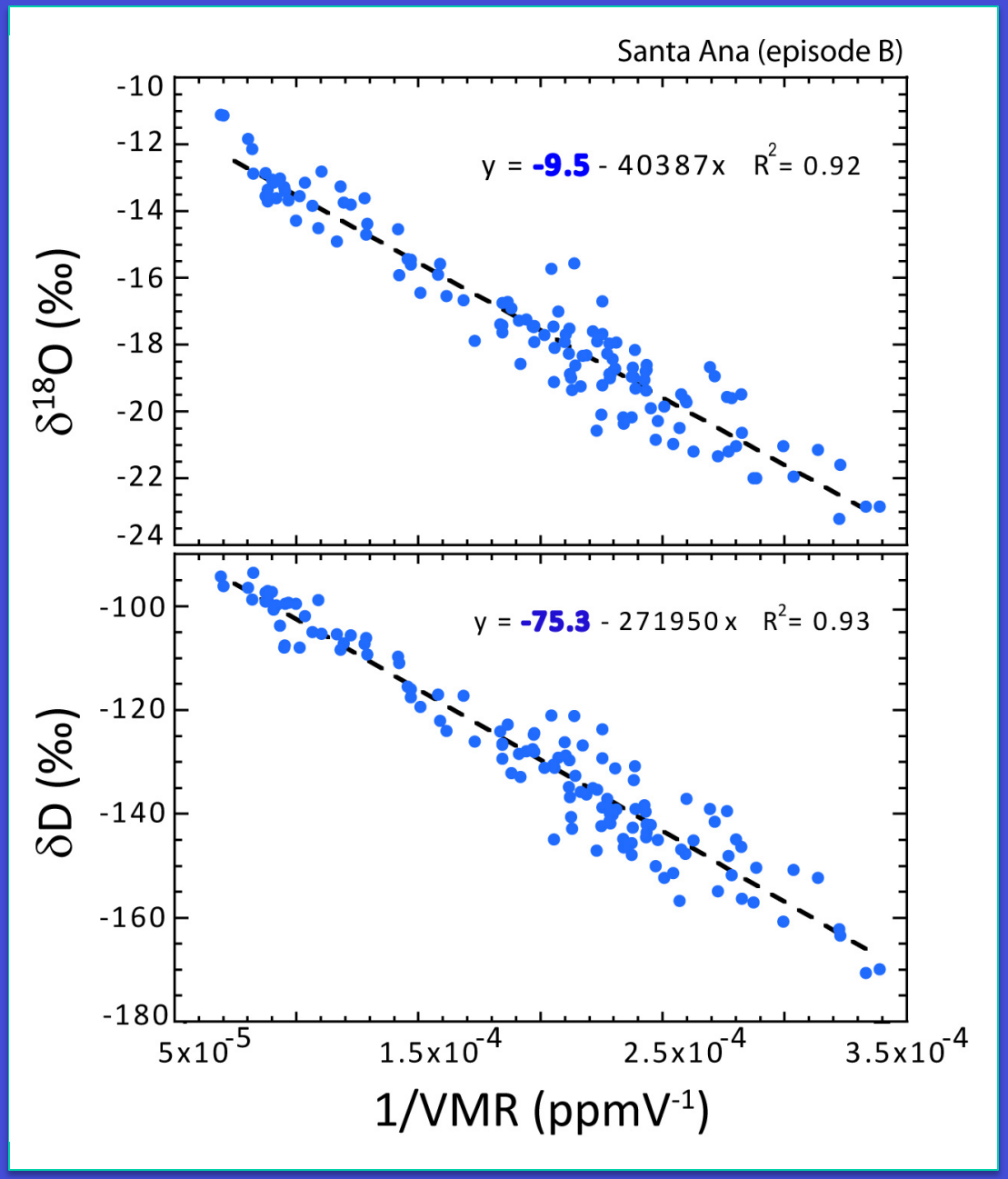
Farlin, Lai & Yoshimura (2013) WRR 49:3685-3696

Major processes that influence vapor isotopes in the atmosphere over terrestrial landscape



Lai and Ehleringer (2011) Oecologia 165: 213-223

Santa Ana conditions are great examples of mixing events.



Using a two-source mixing model, the isotope ratios of the source moisture were estimated:

δD = -75.3 ‰

$\delta^{18}O$ = -9.5 ‰

d-excess = 0.7 ‰

These values are close to a source of marine vapor in equilibrium with the ocean water at SST ≈ 23°C (tropical origin)