Deuterium-excess of water vapor

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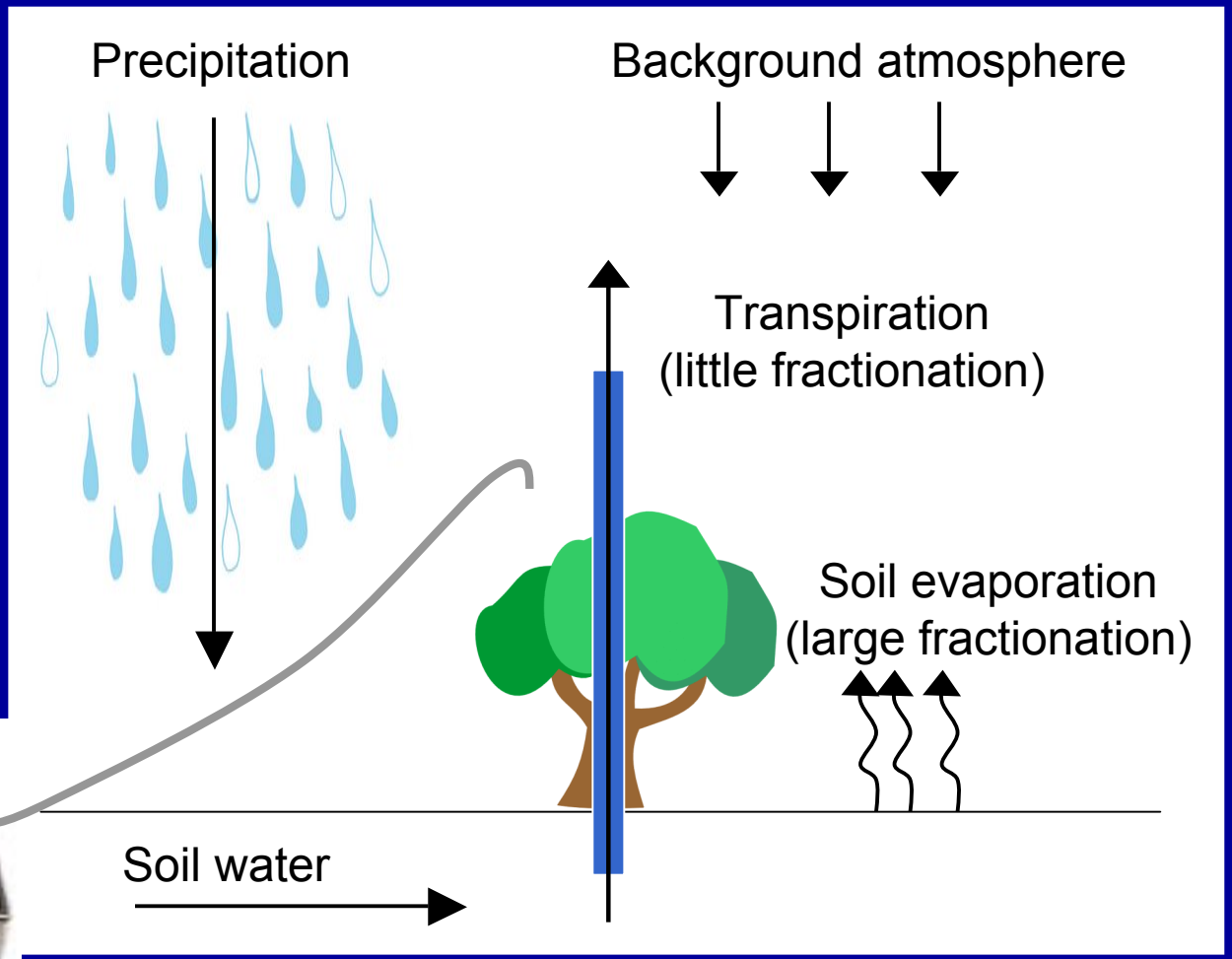
Isotopes in partitioning ET

$$\delta^{18}O \propto \frac{^{18}O}{^{16}O}$$

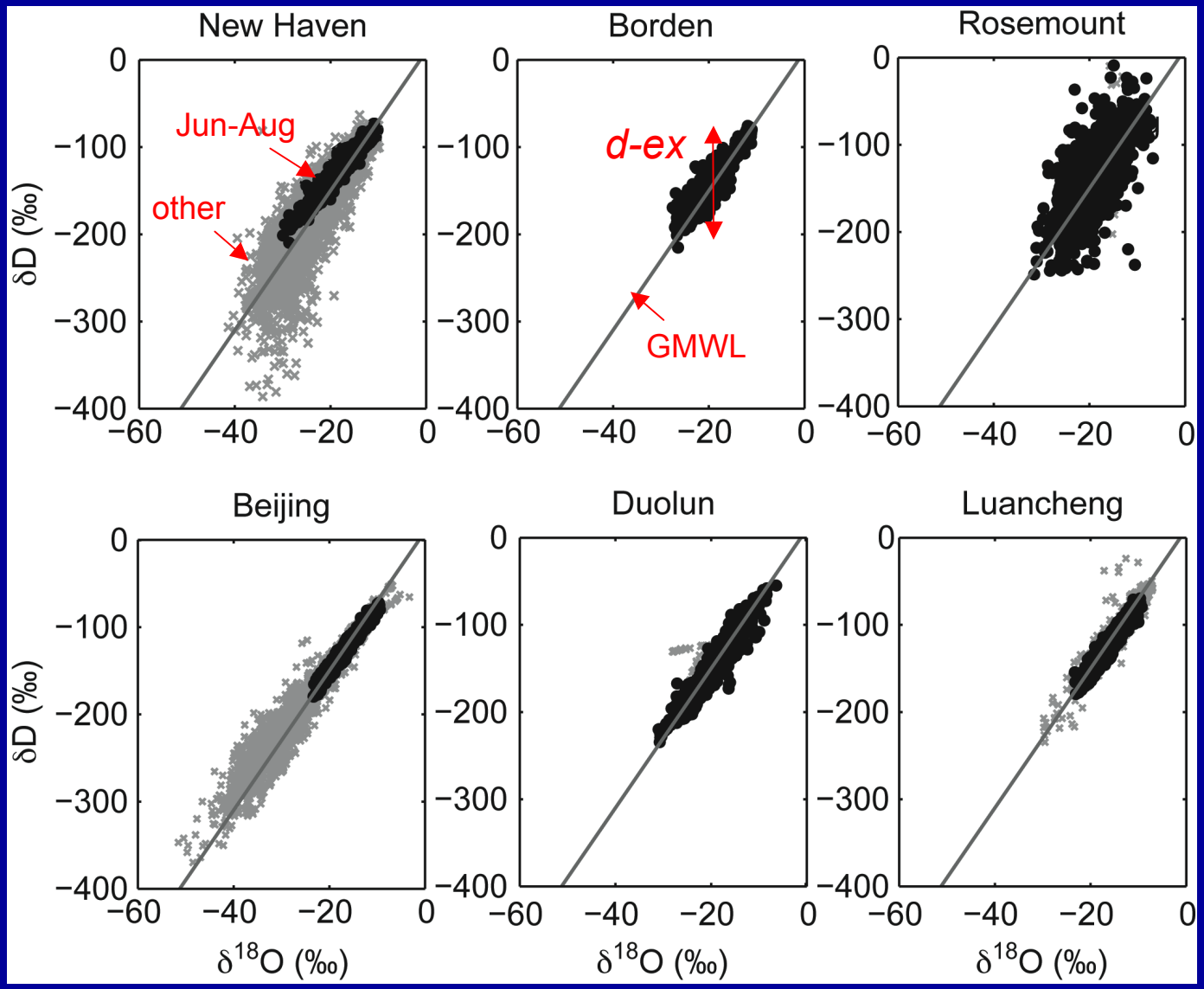
$$\delta D \propto \frac{^{2}H \text{ or } D}{^{1}H}$$

Tunable Diode Laser

Campbell Scientific TGA100A

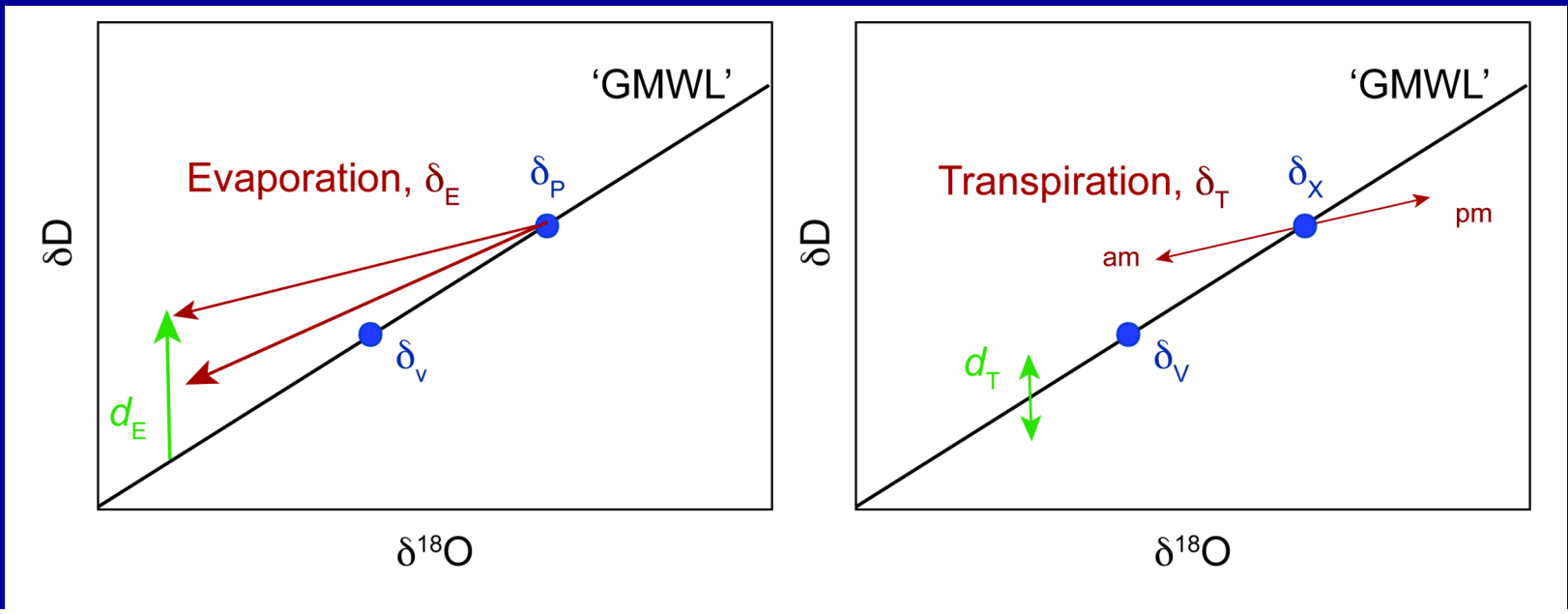


d-ex = δD - 8*$\delta^{18}O$



Vapor *d-ex* is set by the moisture source region and modified by…

1. Rainout processes: do not alter *d-ex* much.
2. Soil evaporation: high *d-ex* that depends on relative humidity. Lower humidity = higher *d-ex*.
3. Plant transpiration: *d-ex* values on average near the plant source water, but they vary over the diurnal cycle.



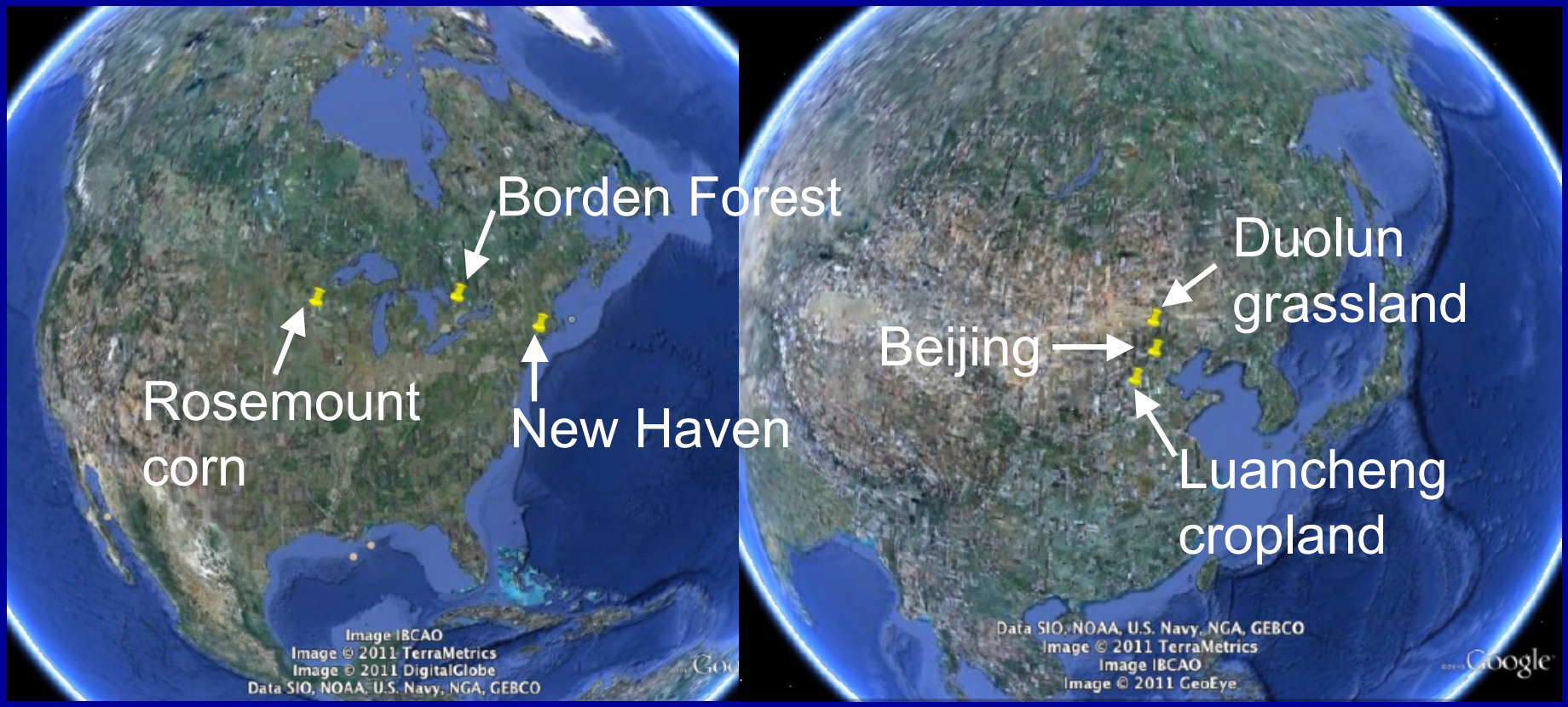
Research objectives

- It's possible that *d-ex* could provide additional information useful in partitioning ET at either the local or regional scales.

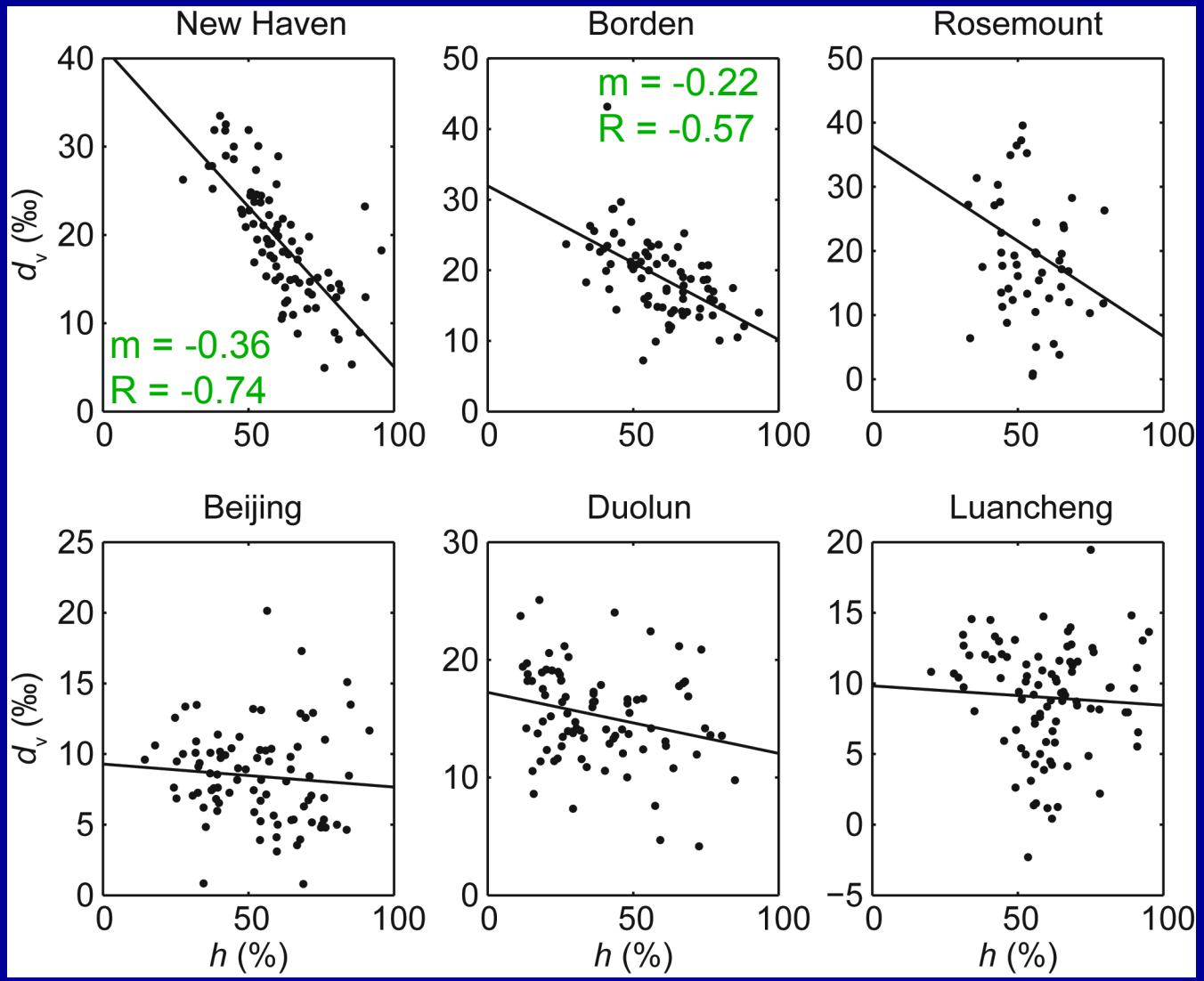
1. Characterize *d-ex* variability in the surface 'background' atmosphere.
2. Qualitatively identify local ET influence on vapor *d-ex*.

- How do these vary from place to place?

Station locations



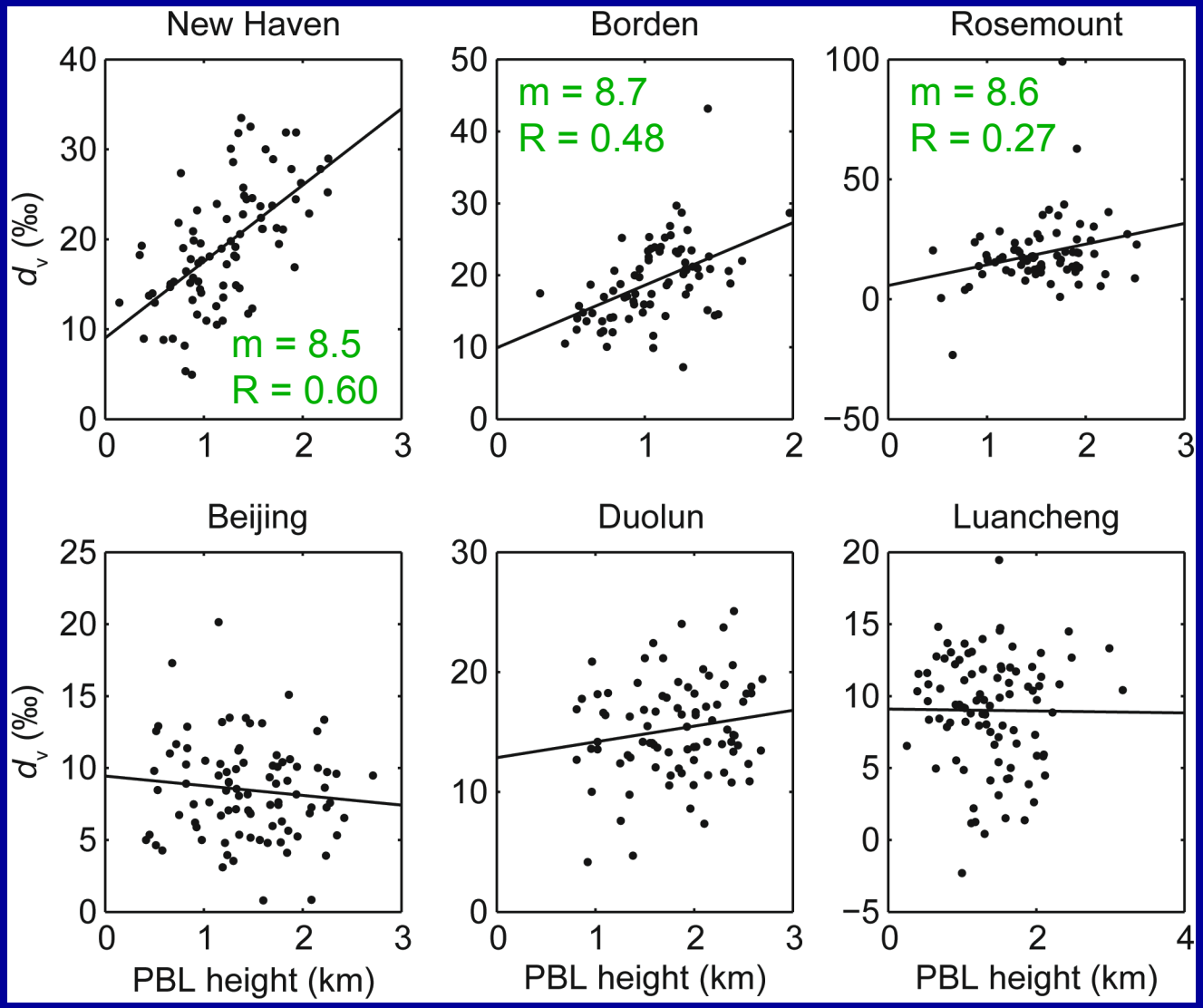
Daily mid-day *d-ex* and local relative humidity



North America

Asia

Daily midday *d*-*ex* and planetary boundary layer height



North America

Asia

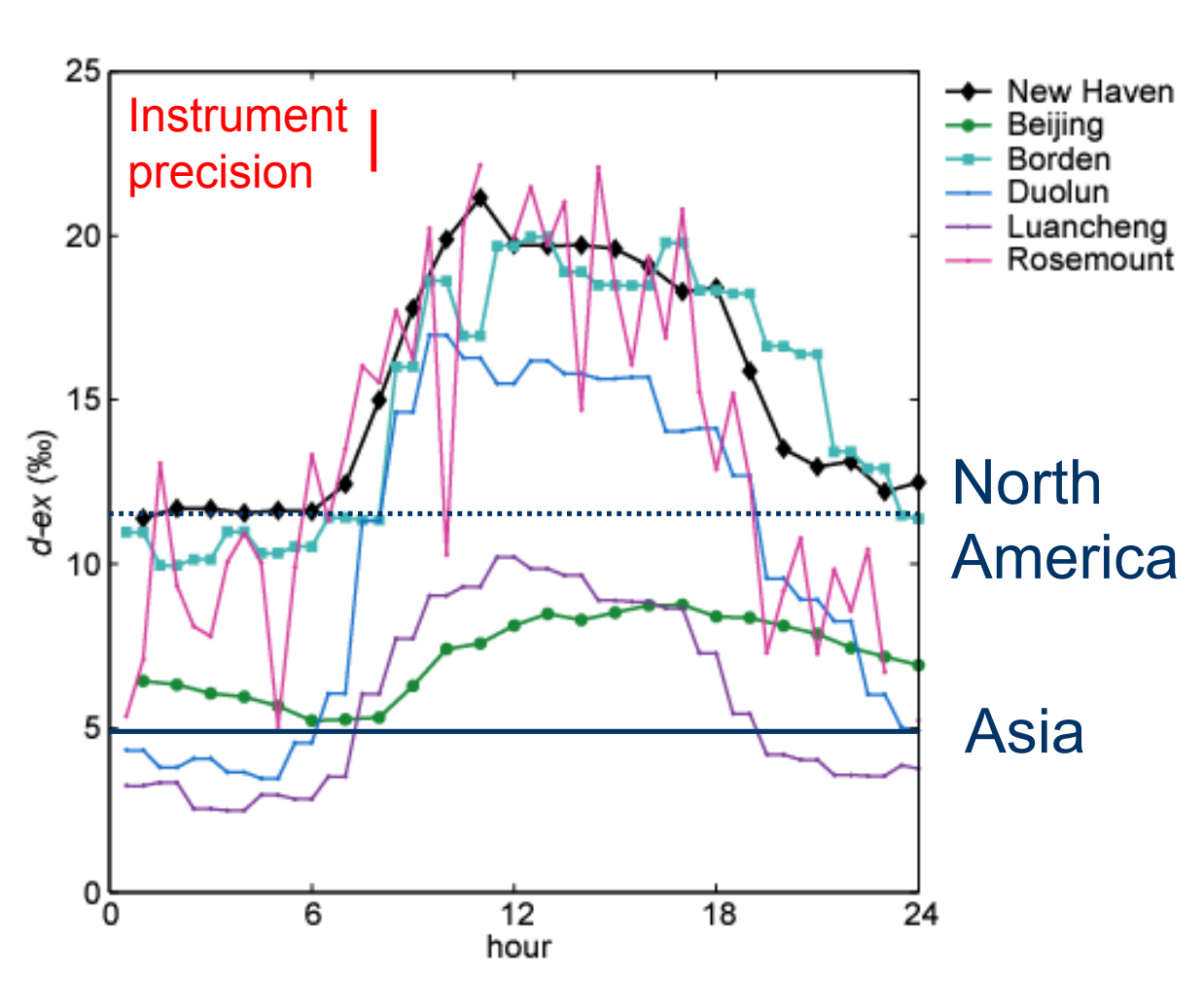
Great Lakes influence North American vapor *d-ex*

- Gat et al. (1994) used high *d-ex* in precipitation from the Northeastern US to estimate that evaporation from the Great Lakes contribute to 4-16% of precipitation downwind in the summer.

- Our measurements show evidence in the vapor phase as well. Same % contribution to the vapor phase?

- Additional isotope measurements from a 200 m tall tower in Minnesota also support this interpretation (Schulze et al., submitted).

Diurnal *d-ex* peaks in daytime



Mid-day *d*-ex increase can be a combination of…

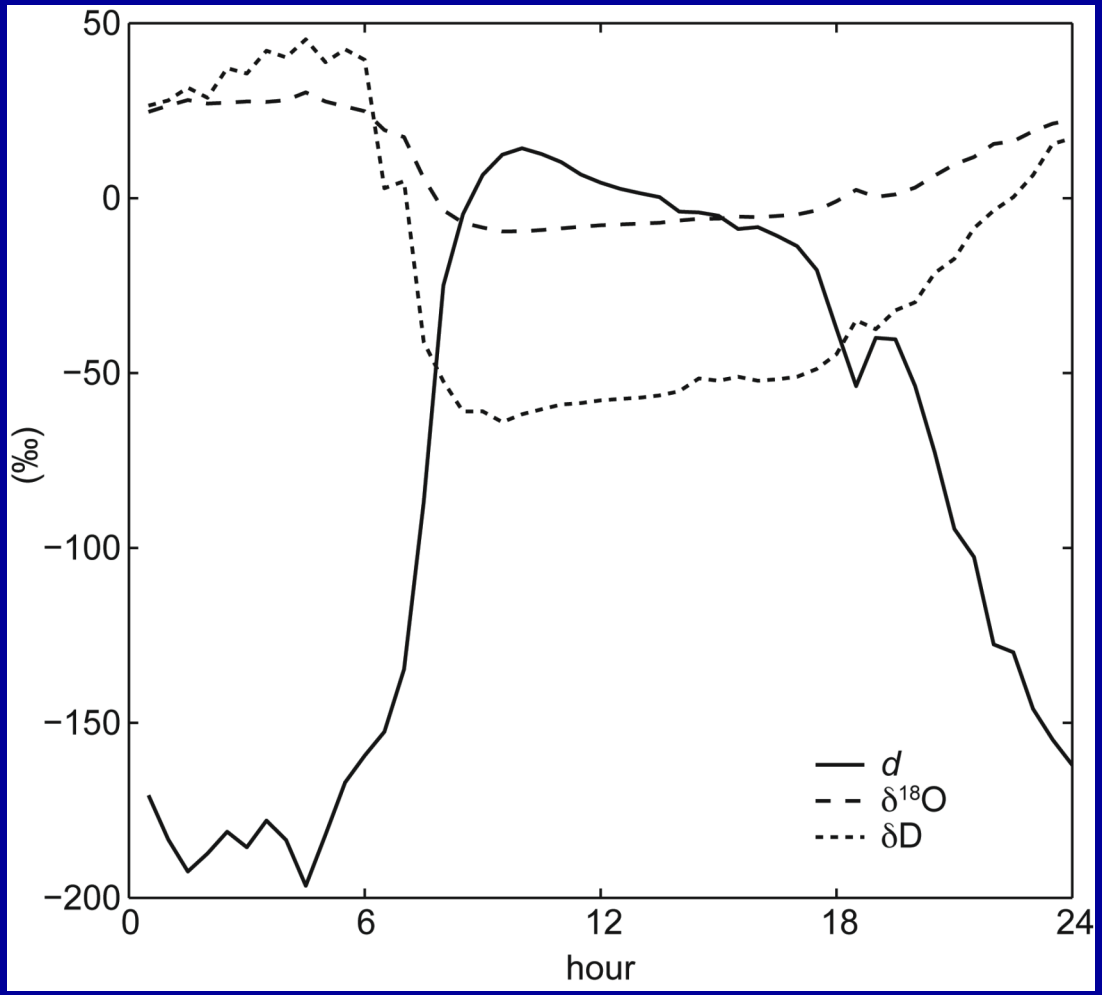
1. Evaporation from local soils: increase *d-ex*

2. Plant transpiration: diurnal cycle in *d-ex*

3. Vertical mixing with the background atmosphere: gradient in *d-ex* increasing with height in North America, increase in *d-ex*

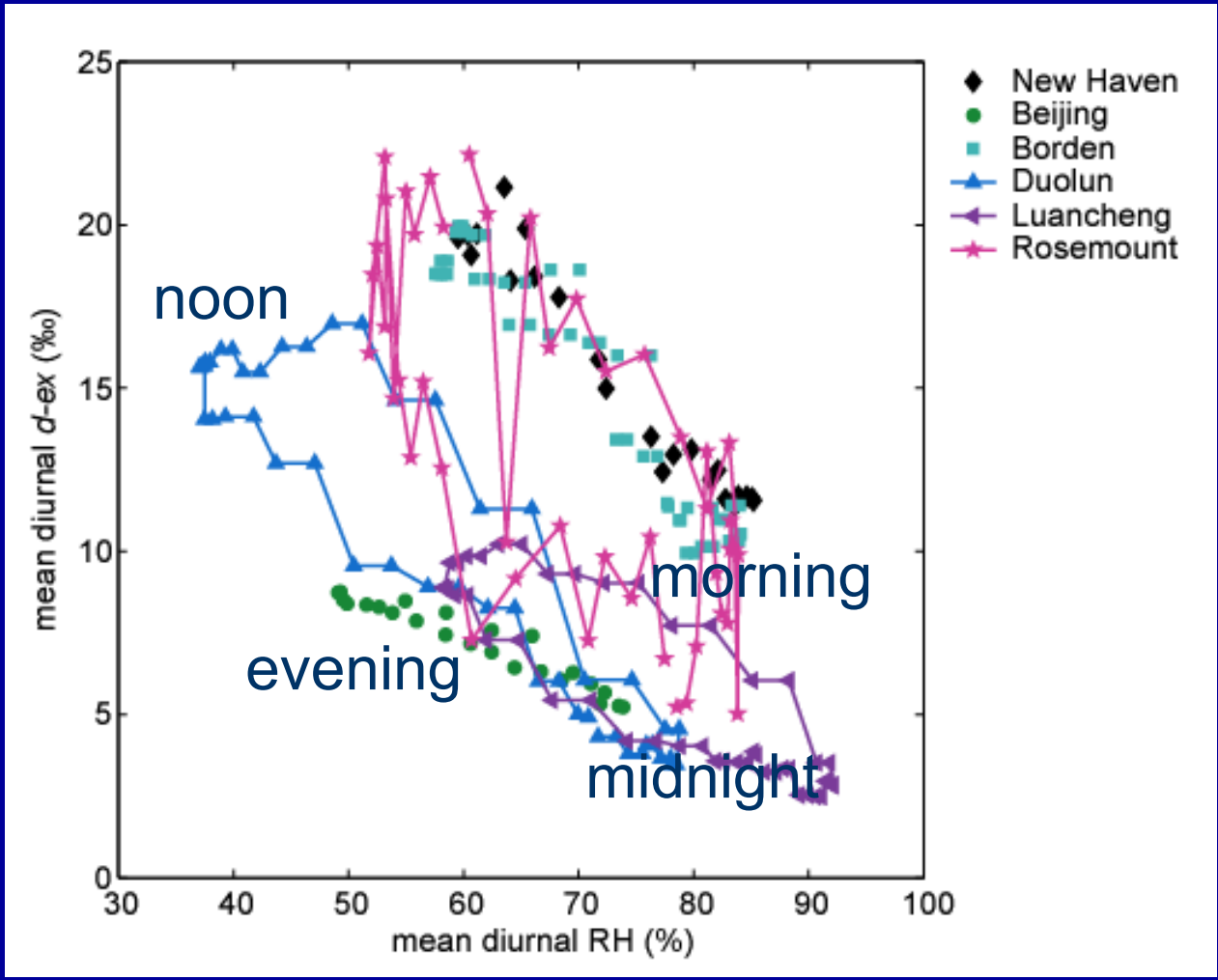
Mid-day *d-ex* variability is not a simple 2-endmember mixing problem.

Transpiration modeled diurnal cycle



SiLSM described by Xiao et al. (2010) JGR.

Diurnal *d-ex* at crop and grass sites show influence of transpiration



Conclusions

1. Evaporation from the Great Lakes likely contributes significantly to atmospheric vapor in Northeastern North America and influences regional vapor *d-ex*.
2. Data and modeling results provide some indications that transpiration contributes to changes in *d-ex* and must be accounted for at least on the diurnal time scales in partitioning attempts.
3. More sophisticated modeling is needed to determine the feasibility of using *d-ex* to partition ET, but there seem to be some measurable signals to work with.
4. This set of measurements provides a good overview of key regional and local influences.

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  - US National Science Foundation
  - University of Minnesota
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  - and others...
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