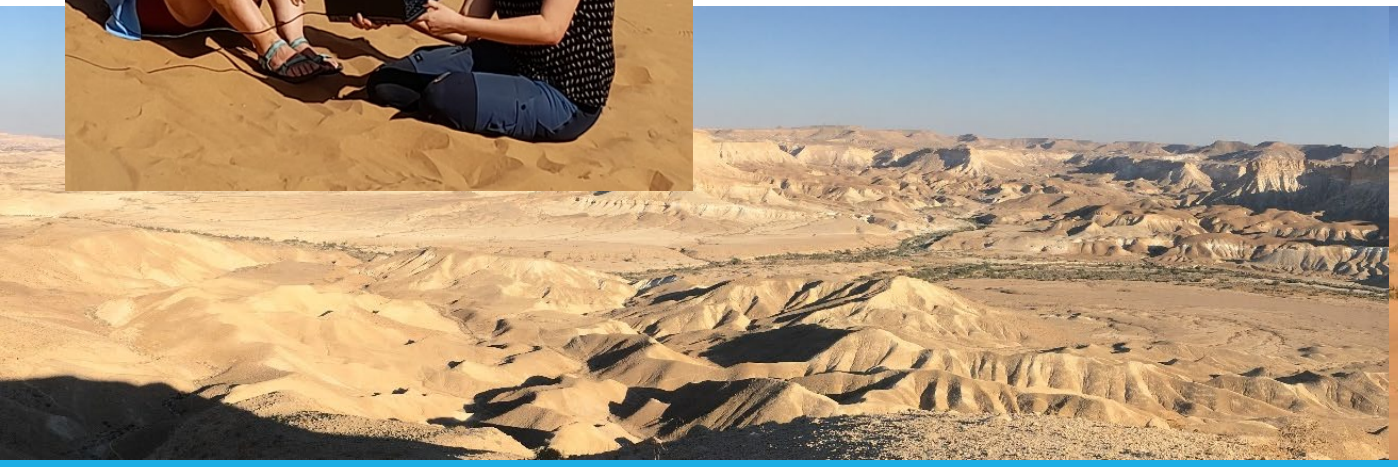
BIDR
The Jacob Blaustein Institutes for Desert Research

Ben-Gurion University of the Negev

Water dynamics in dry soils

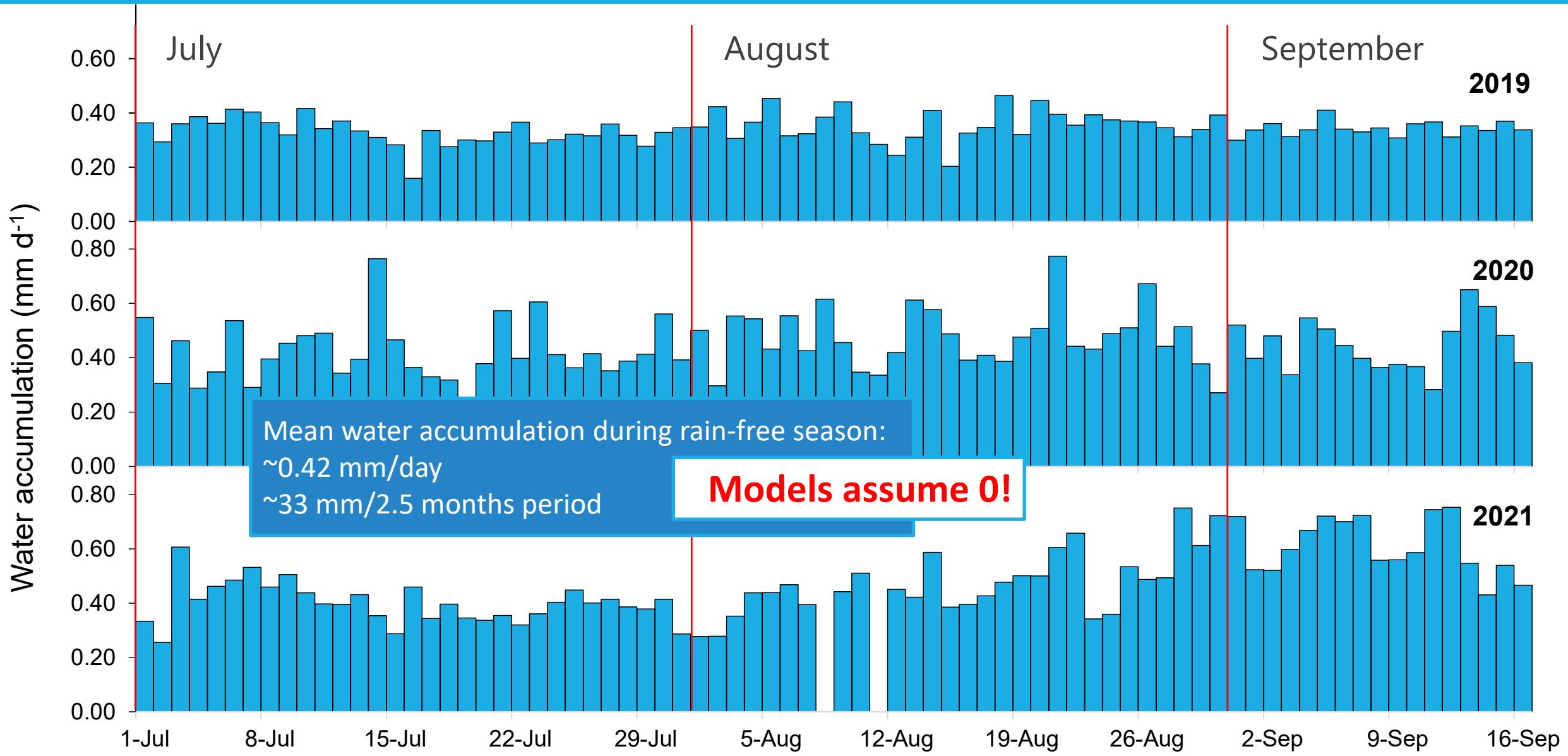
Using relative humidity sensors to measure water vapor adsorption in desert soils

Nurit Agam & Dilia Kool



How it all started

Annual rainfall: ~115 mm



What is the source?

Non-rainfall water inputs

Fog:

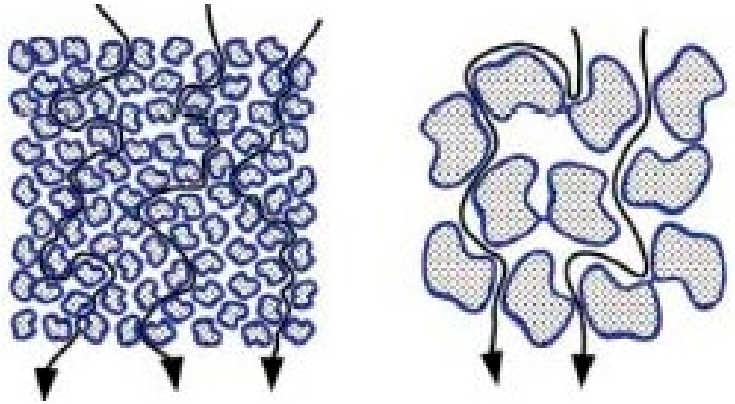
$T_{air} \leq T_{dew}$

Dew:

$T_{surface} \leq T_{dew}$

Adsorption:

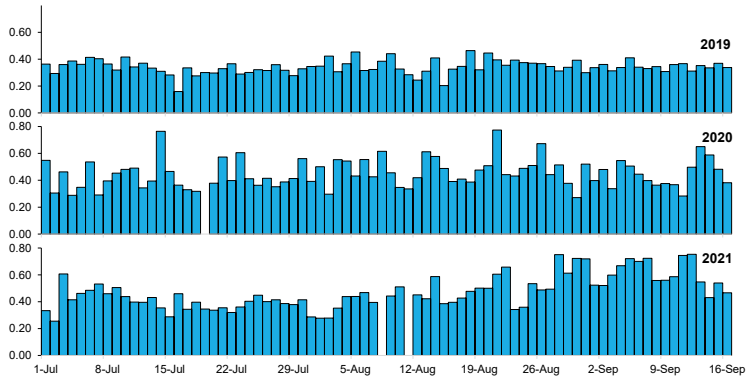
$e_{surface} < e_{air}$



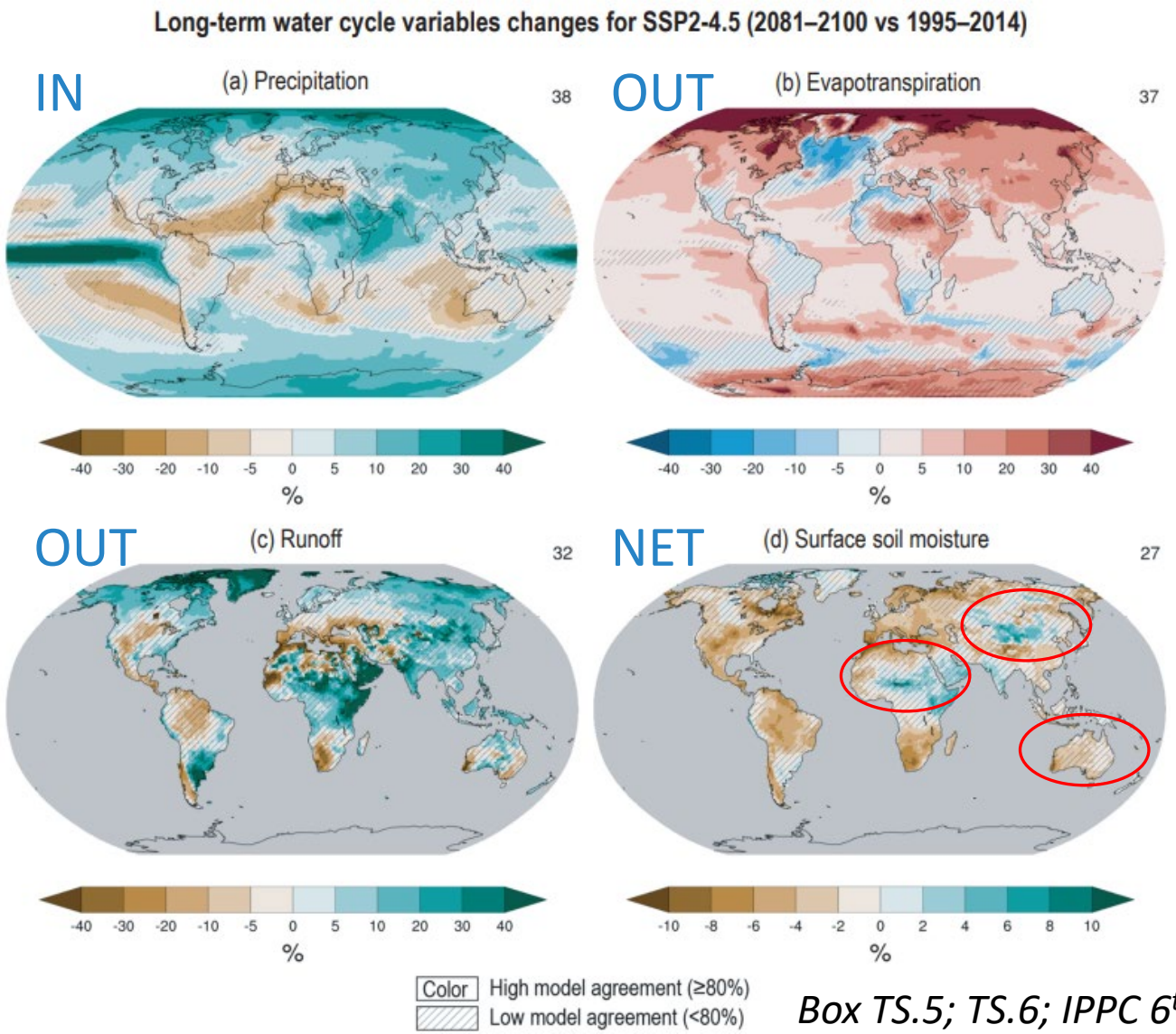
Water vapor adsorption:

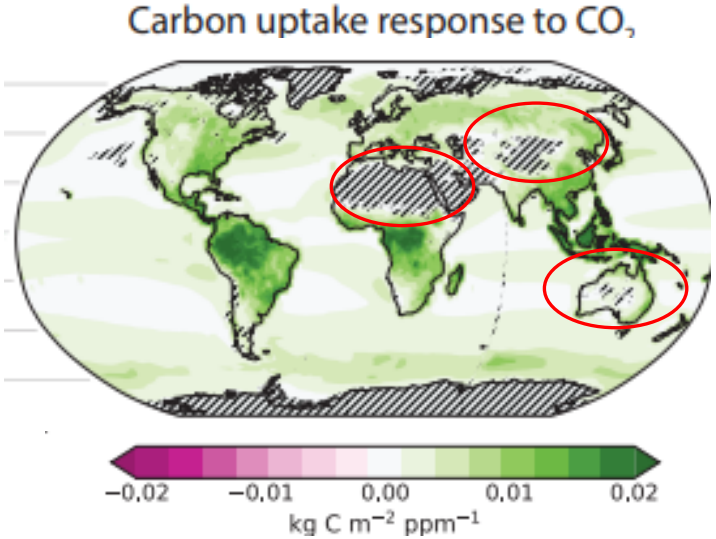
most common

least considered



Are we missing something?





Deserts:
~26% of terrestrial surface
High uncertainty

Box TS.5; TS.6; IPPC 6th assessment report

Is water vapor adsorption unique to the Negev desert?

NEED MEASUREMENT METHOD THAT WILL ALLOW EXPLORING

The challenges

1. Typically used sensors for soil water content cannot detect these small changes

2. Micro-lysimeters are difficult to apply everywhere

The solution

Use relative humidity sensors in the soil

Why? Soil is dry enough

How?

1. Convert soil relative humidity (RH_S) to soil water potential (ψ)

$$\psi = c\,T_s \ln(RH_s)$$

Kelvin equation (c- constant; T_S – soil temperature)

2. Convert soil water potential (ψ) to gravimetric water content (θ_g)

$$\theta_g = a\ln(\psi) + b$$

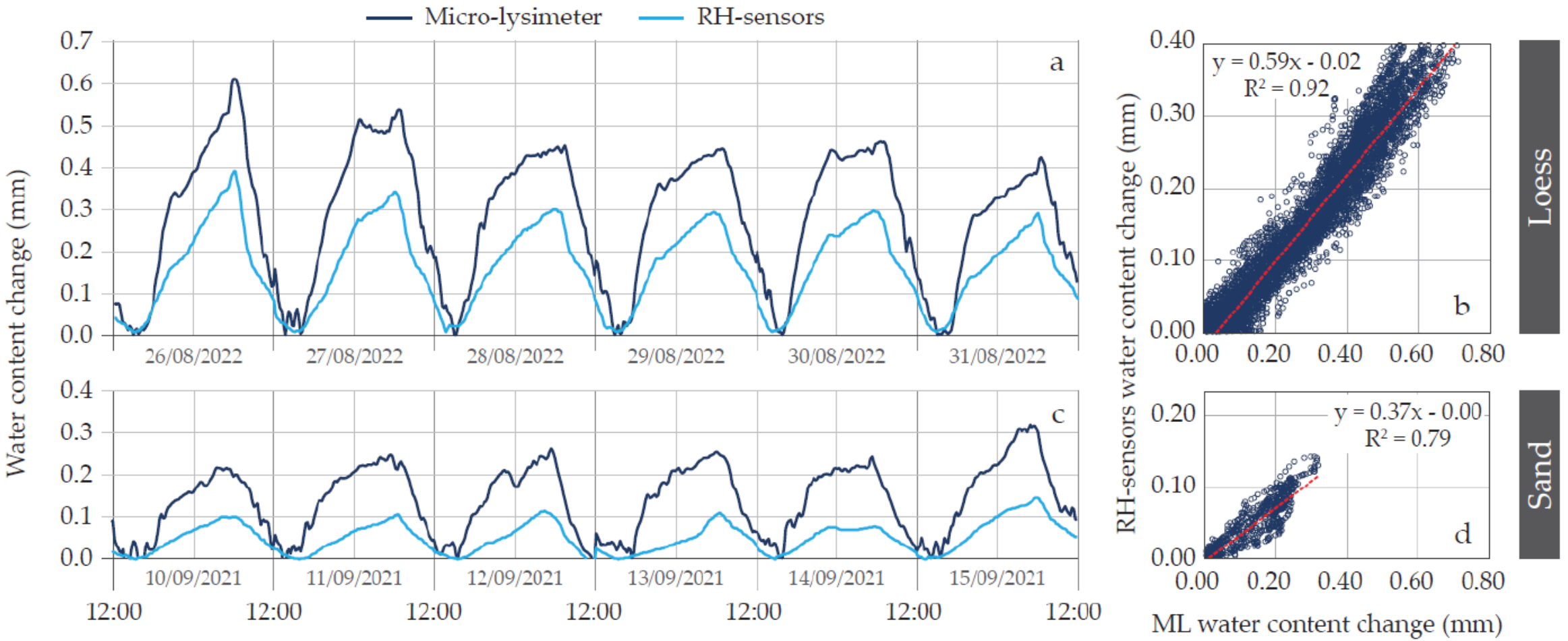
(a, b – soil-specific parameters)

Tested for two different soils

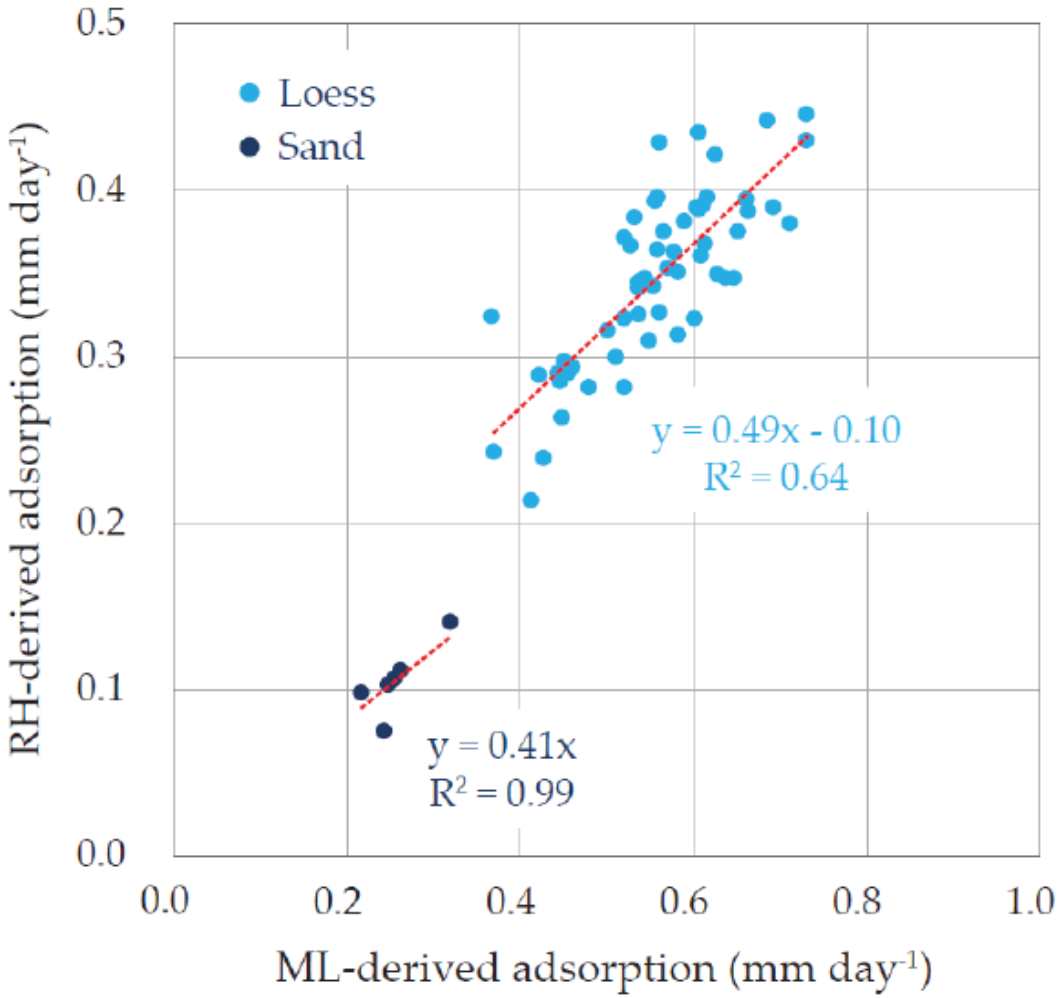
	Water retention regression parameters		
	a	b	r^2
	ln(MPa)	% ln(MPa)$^{-1}$	(-)
Loess	0.56	3.92	0.99
Sand	0.10	0.99	0.98

	Bulk density
	g cm^{-3}
Loess	1.45
Sand	1.60

Compared to micro-lysimeters



Compared to micro-lysimeters



Trends are good but!

Significant underestimation

Why?

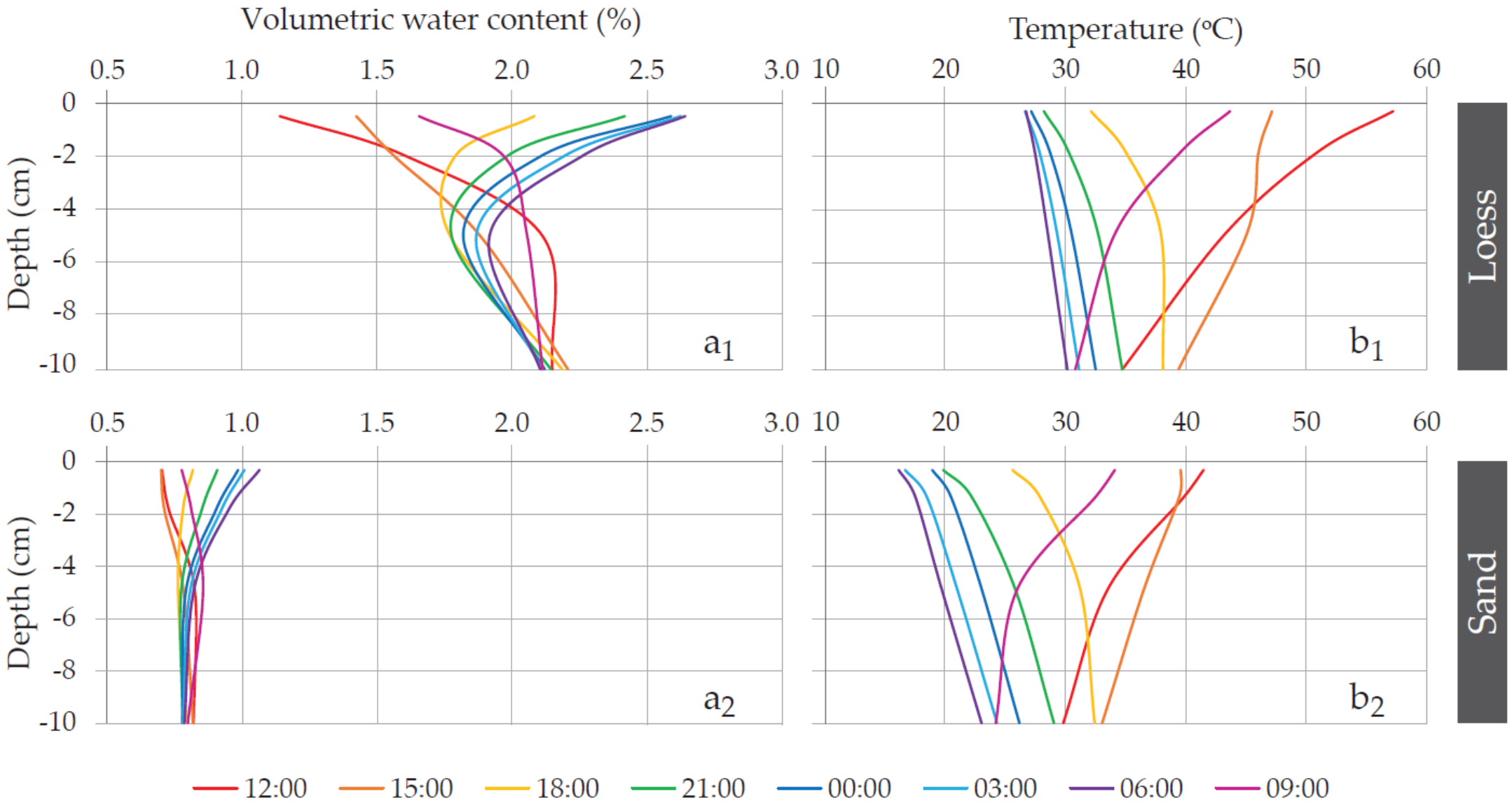
Inability to place sensor at the surface

Loess better than sand

Why?

A smaller amount of water vapor adsorption resulting in higher sensitivity to errors in both methods.

And yet… water contents can be monitored!



Is this unique to the Negev desert?

The Namib Sand Sea, Namibia ✓

Contents lists available at ScienceDirect

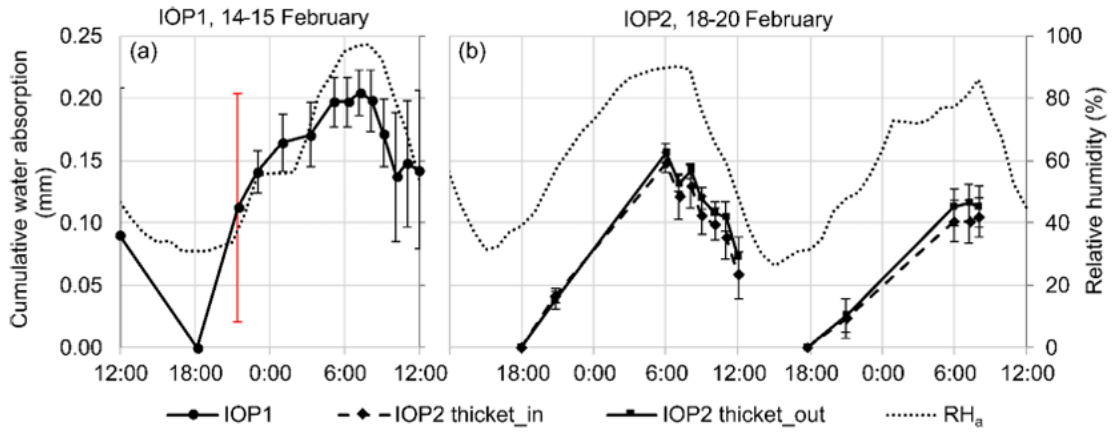
Journal of Hydrology

journal homepage: www.elsevier.com/locate/jhydrol

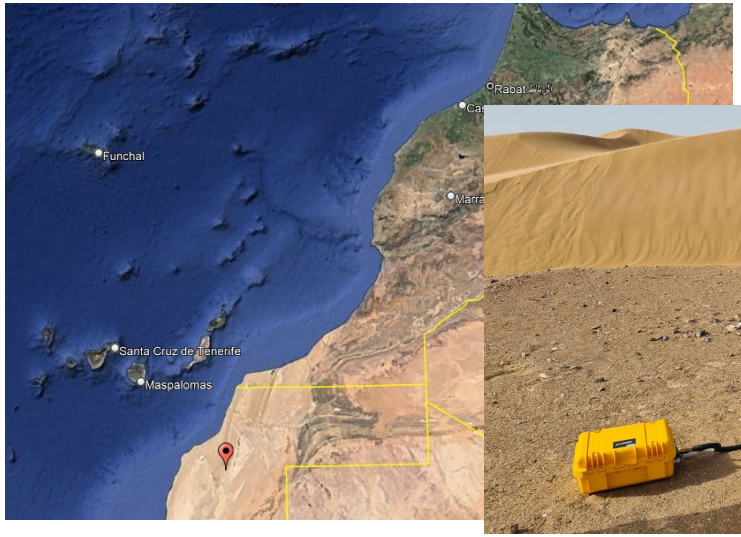
Research papers

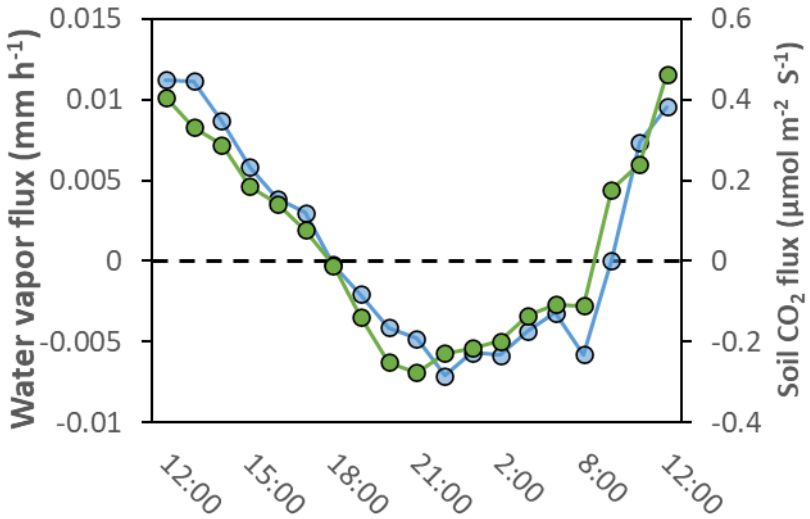
The overlooked non-rainfall water input sibling of fog and dew: Daily water vapor adsorption on a !Nara hummock in the Namib Sand Sea

D. Kool [a], E. Agra [b], A. Drabkin [c], A. Duncan [d], P.P. Fendinat [e], S. Leduc [b], G. Lupovitch [b], A. N. Nambwandja [e,f], N.S. Ndilenga [f], T. Nguyễn Thị [a], B. Poodiack [g], L. Sagi [h], Y. Shmuel [i], G. Maggs-Kölling [f], E. Marais [f], B. Pinshow [b], J.S. Turner [j], N. Agam [a,*]



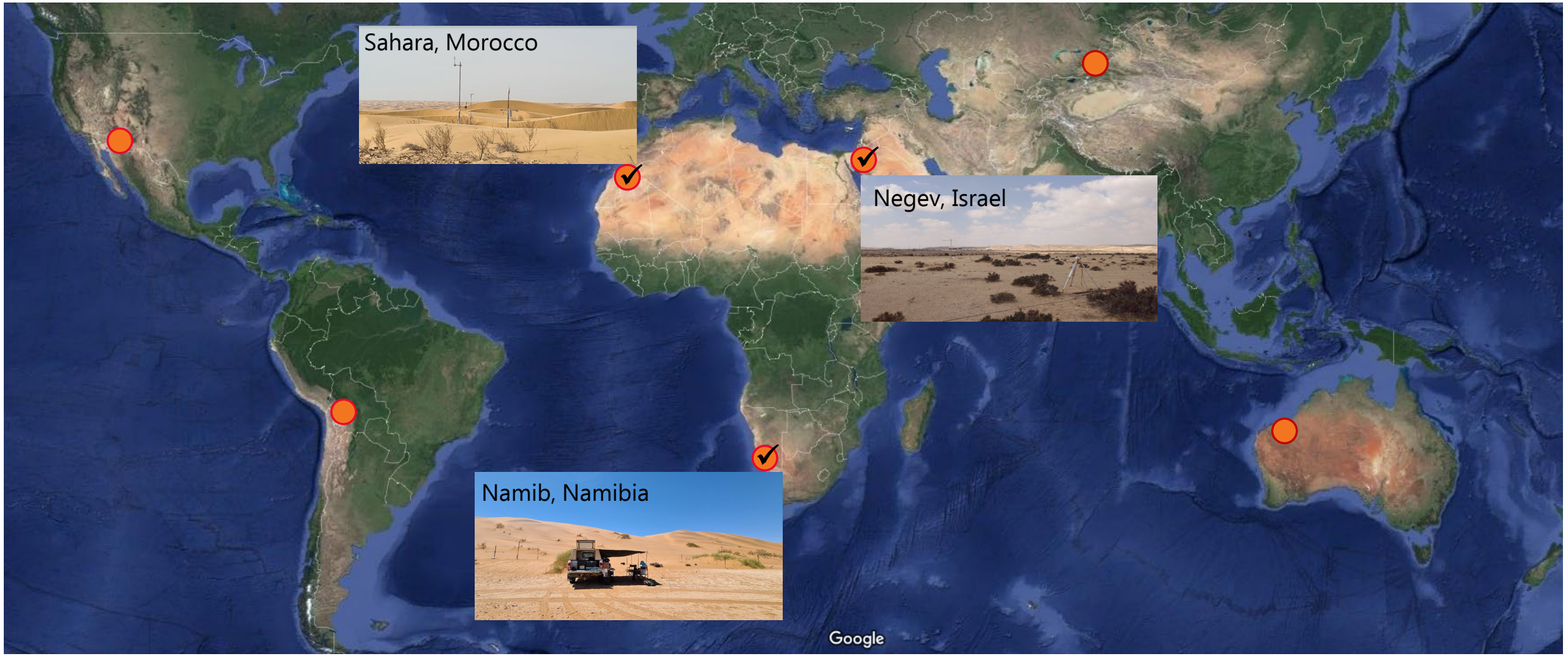
The Sahara, Morocco ✓





What's next?

Towards a global assessment of non-rainfall water input dynamics in deserts



What's next?

Towards a global assessment of non-rainfall water input dynamics in deserts

Thank you!