Quantification of vapor flux in dune sediments using a precision meteo-lysimeter

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Soil water infiltration: Measurements, assessment and modeling

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CLIGRO

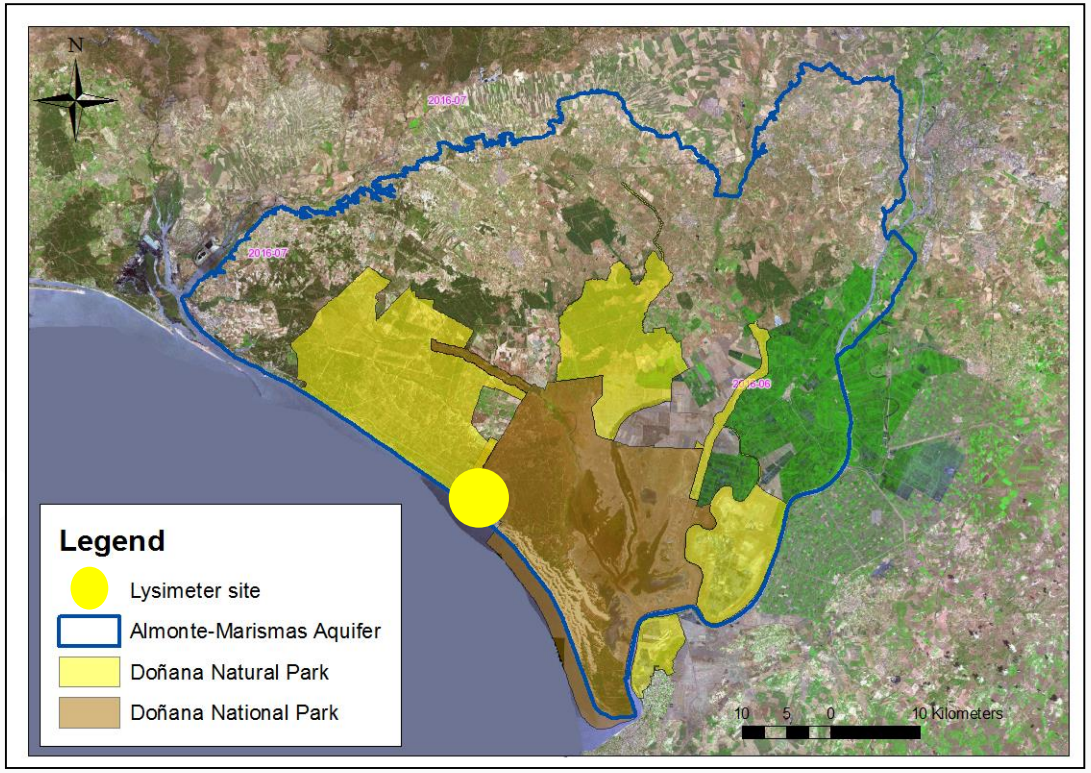
UNION EUROPEA
FONDO EUROPEO DE DESARROLLO REGIONAL
"Una manera de hacer Europa"

STUDY SITE

Southwest Spain: Doñana National Park => `protected wetland

Geography

- surrounded by 46 villages and towns =>1.5 Mio people
- Agriculture and Tourism



Geology

- dunes
- beaches
- marshes

Climate

- Sub-humid Mediterranean with Atlantic influence
- Average rainfall: 500-600 mm
- Average Temperature: 17-18ºC

Ortophoto from Junta de Andalucia webpage: http://www.ign.es/wms-inspire/pnoa-ma

Meteo Lysimeter Site Equipment

Weighting Lysimeter
(UMS AG, Munich, Germany)

- 1 m^2 area
- 1.5 m height
- 10 g weighting resolution

Six CS650 soil moisture sensors
(Campbell Scientific, Logan UT)

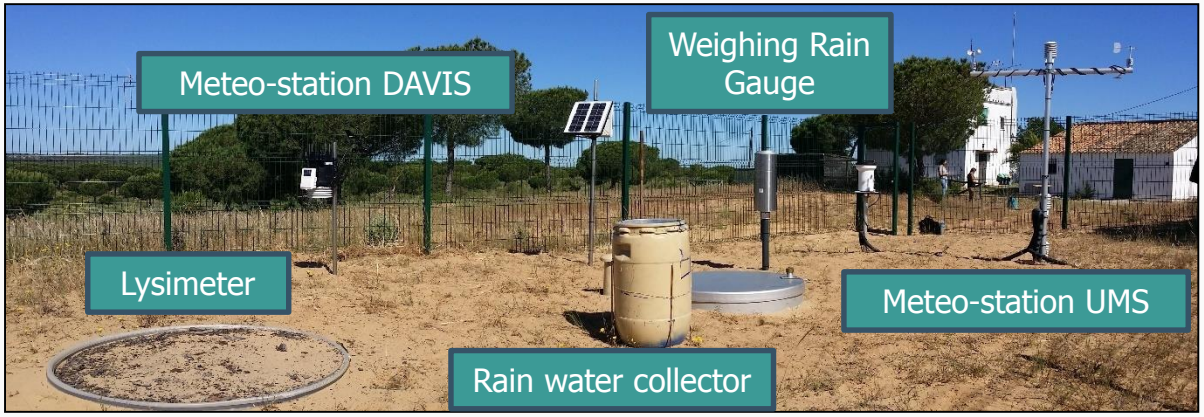
Depths (m)	
0.30	1.60
0.60	2.20
1.20	3

2 Automatic and Meteorological Stations
(Vantage PRO2 Davis, California, USA; UMS AG, Munich, Germany)

Weighing Rain Gauge (OTT pluvio1)

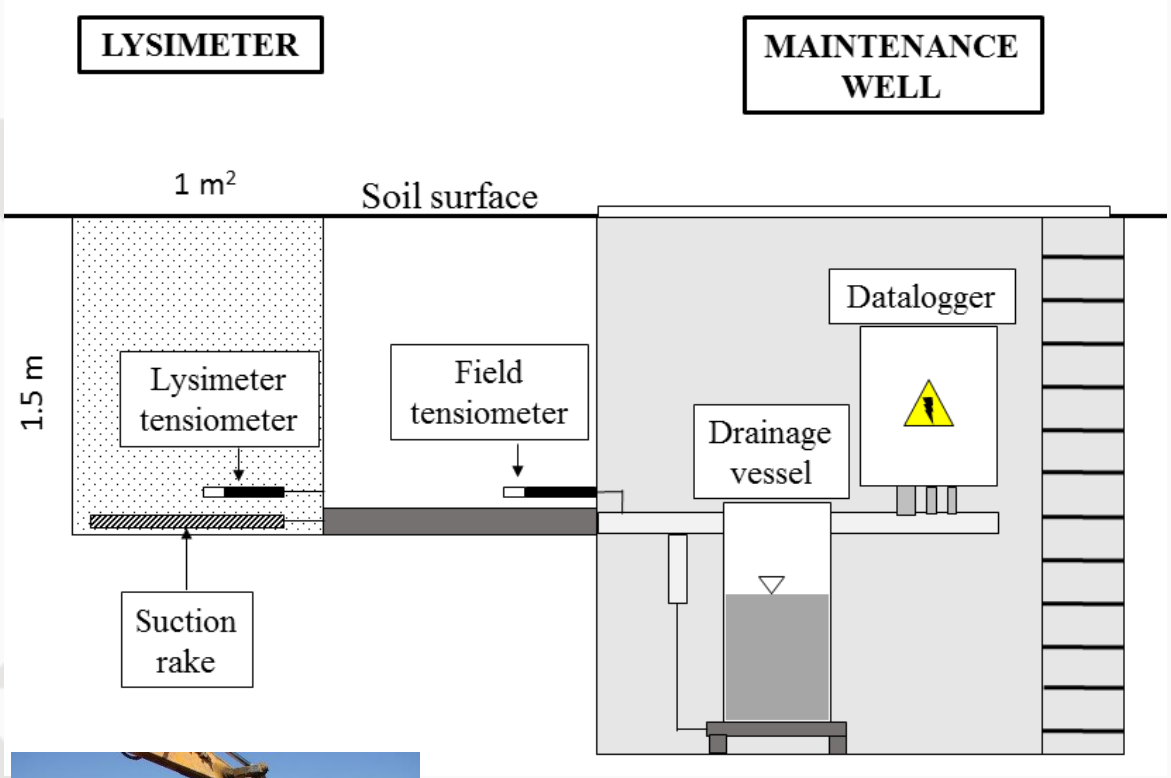
Rain water collector

Measured parameter	Time interval (minutes)
Soil mass lysimeter	1
Water mass drained from lysimeter	1
Soil water tension	10
Soil moisture	10
Wind direction	10
Wind velocity	10
Net radiation	10
Precipitation	10
Air humidity	10
Air and soil thermal profile	10
Soil bulk density	Once
Grain size distribution	Once
Mineralogy	Once
Metals content	Once



MATERIAL AND METHODS

METEO LYSIMETER



MATERIAL AND METHODS

✓Data Noise Filtration: AWAT (*Peters et al. 2014)*

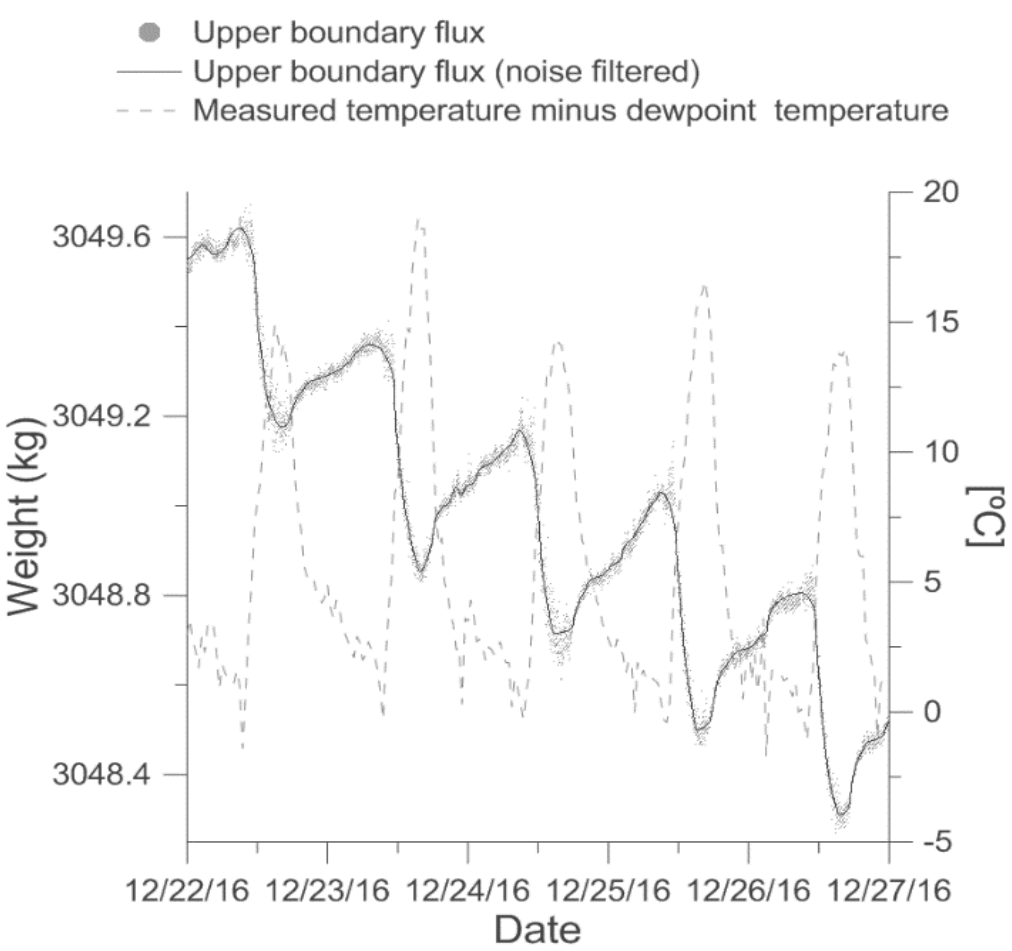
✓Hydrochemistry rain and drained water

✓Stable isotopes of rain and drained water

✓Sediment parameters (physical, mineralogical chemical)

RESULTS

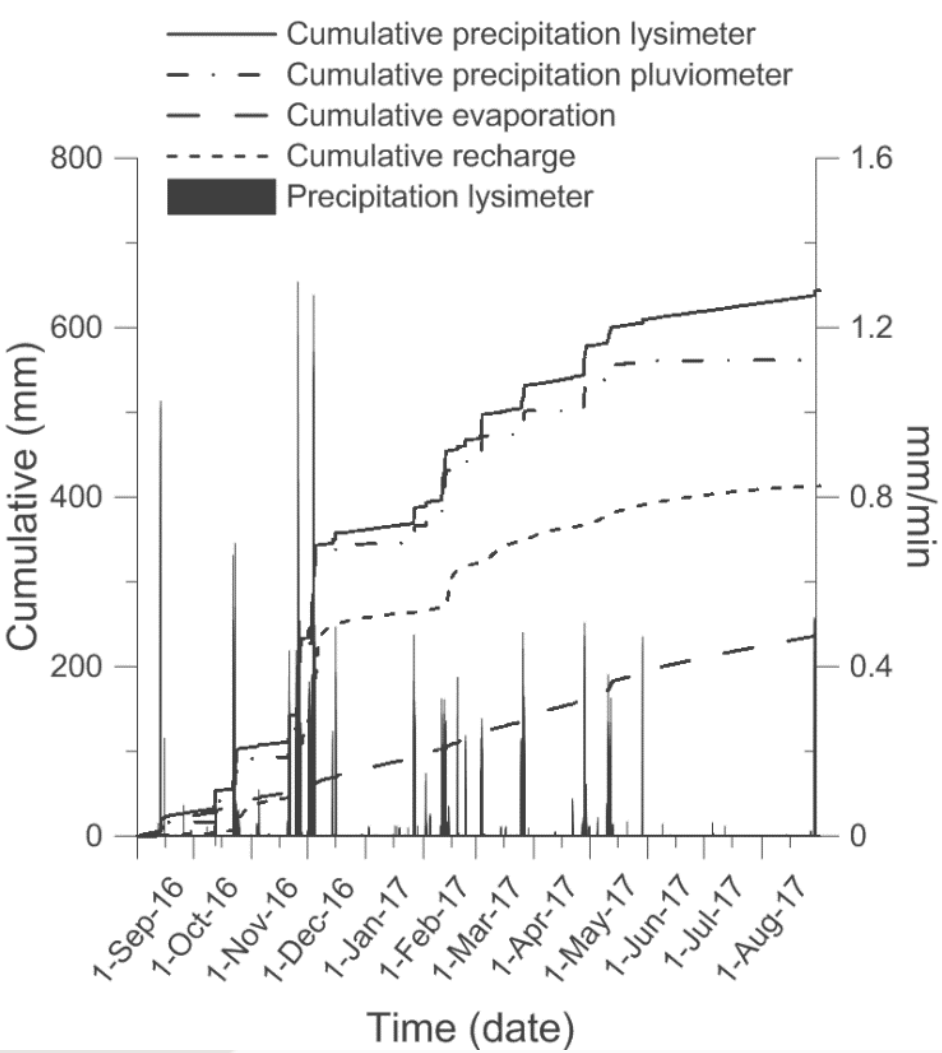
Dew and real evaporation



- ✓ Dew 0.3-0.5 mm/day
- ✓ Real evaporation 0.4-0.6 mm/day

RESULTS

Soilwater budget 2016/2017 in mm



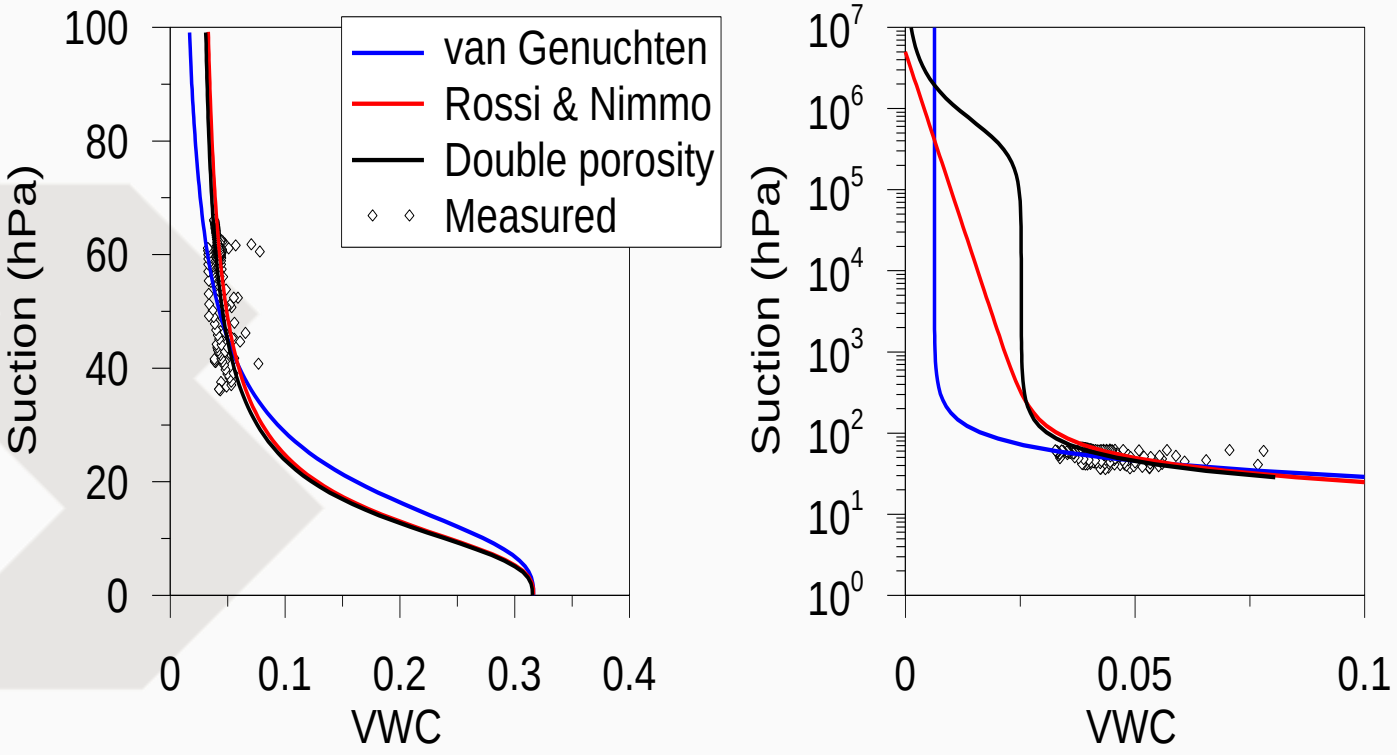
	2016/2017
$Prec._{lysimeter}$	644
$Prec._{pluviometer}$	566
Ev real	241
Recharge	413
Storage	-9.68 kg

✓ 64% recharge

Modelling results (Maarten Saaltink et al. in prep.)

- Software: **CODEBRIGHT** (Olivella et al., 1996)
- Solves balance equations for **water, air and energy** in an unsaturated medium
- One-dimensional vertical homogeneous domain of 1.4 m length, divided into 140 elements of 0.01 m
- Starts at November 25, 2015 and ends at October 4, 2017, which is the period with available meteorological data

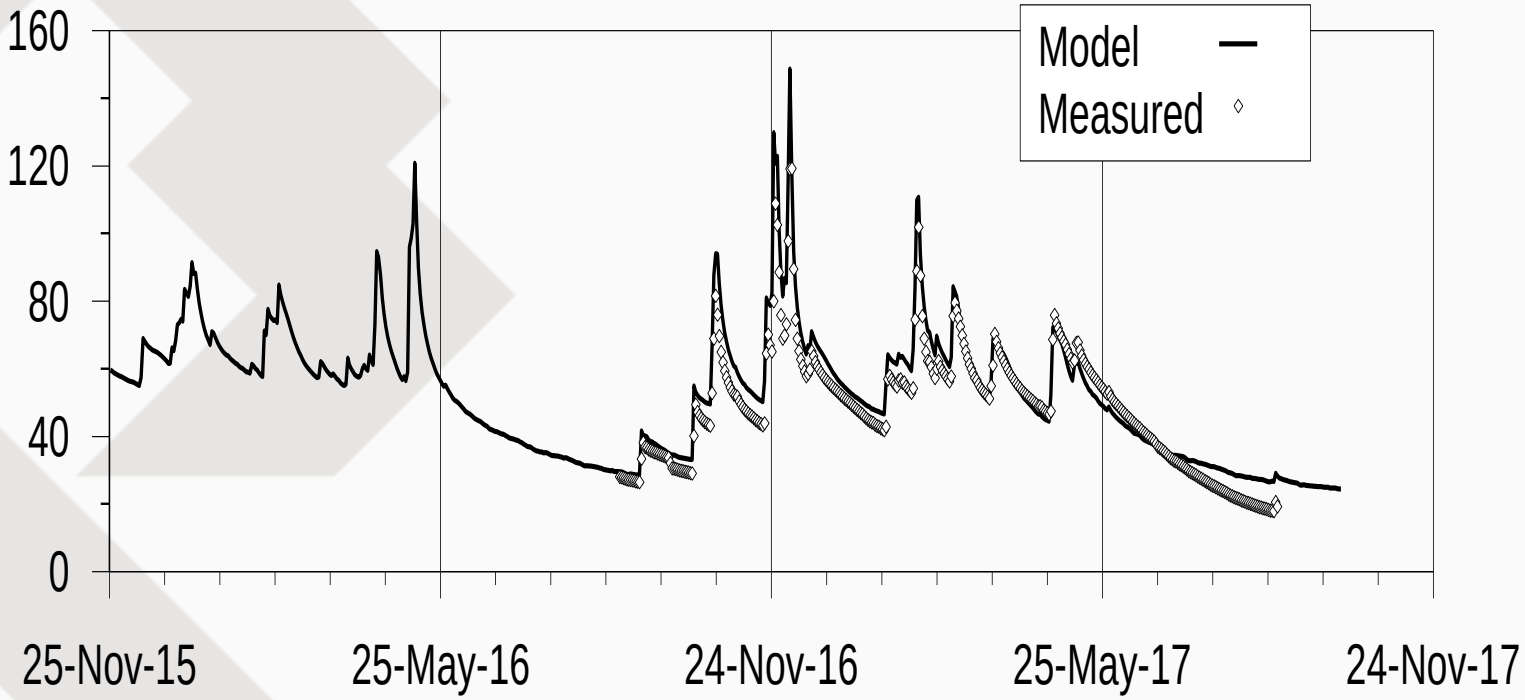
Modelling: retention curves



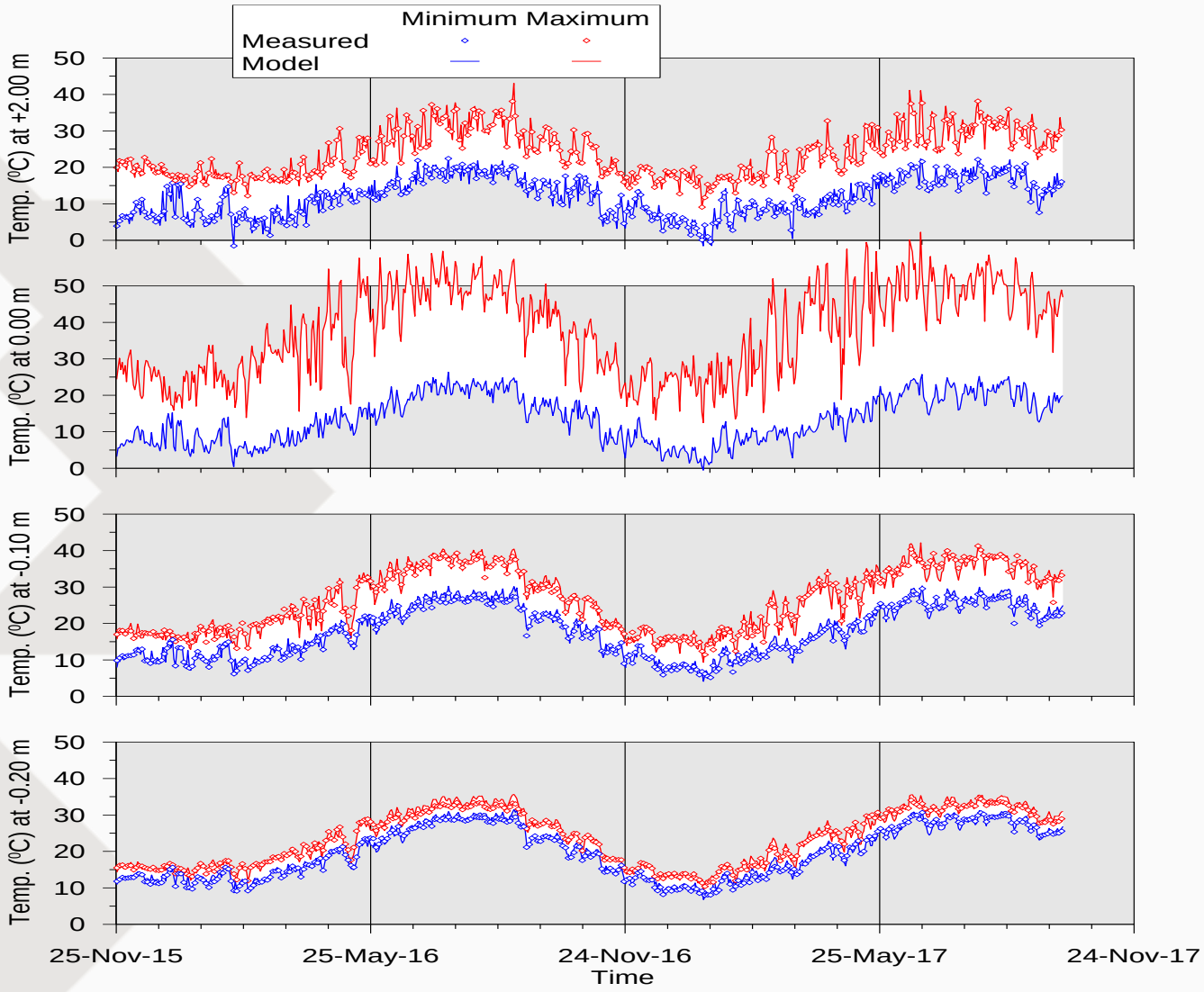
Retention curves used by the models together with suction and VWC (volumetric water content = ϕS_l), measured outside the lysimeter at a depth of 1.40 m. The three retention curves are plotted on an arithmetic (left) and logarithmic scale (right).

Modelling

Mass of water in the lysimeter

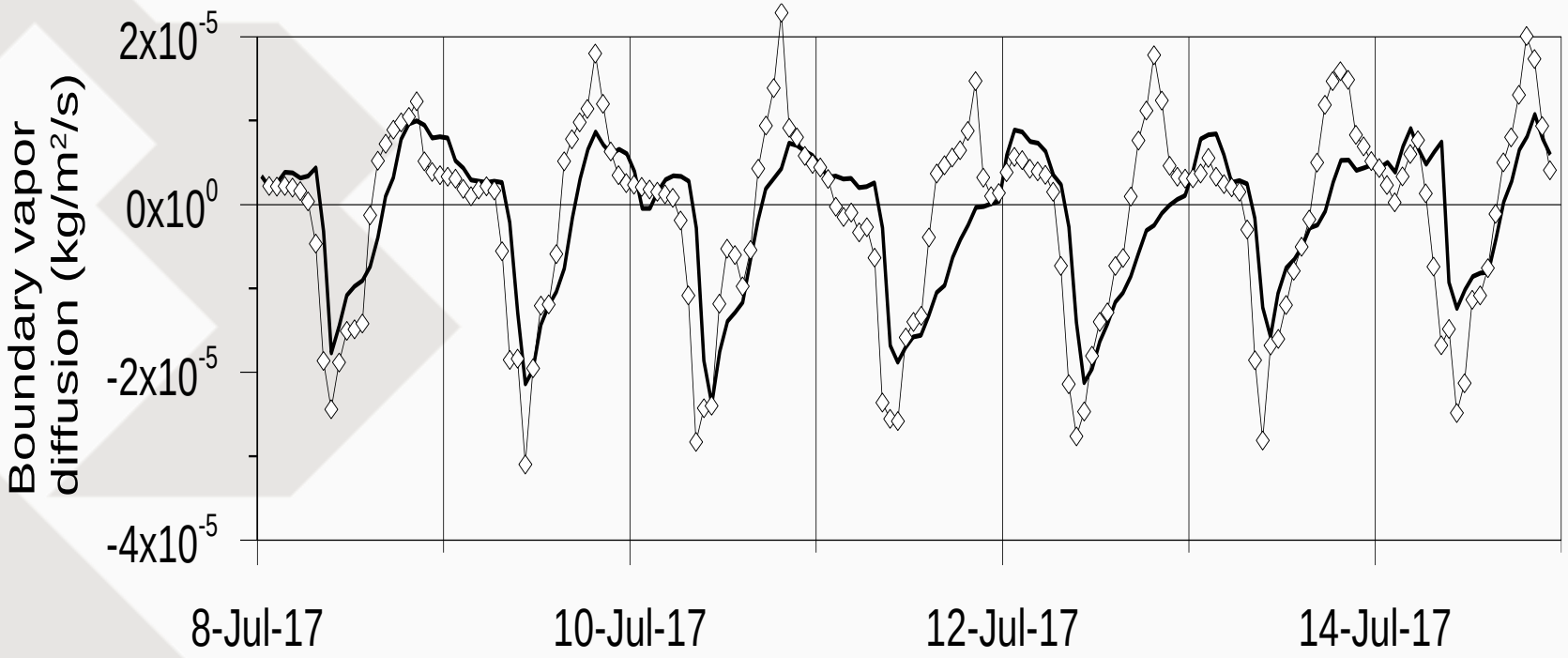


Modelling: Temperature profiles



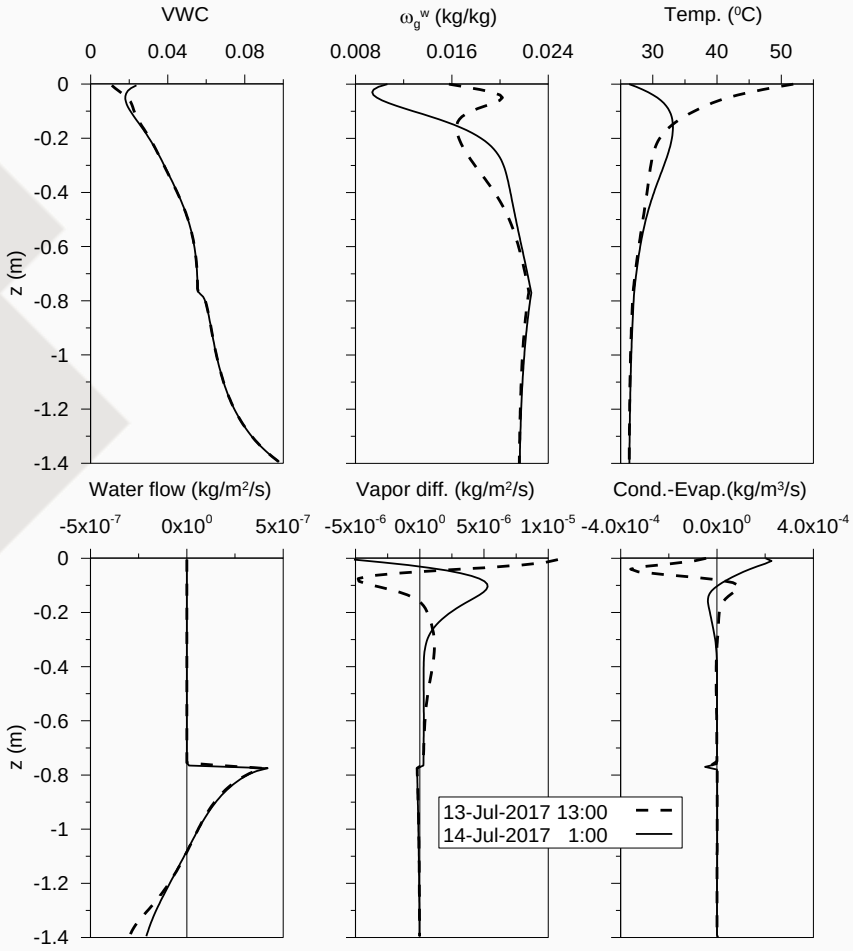
Modelling

Evolution of vapor diffusion at the boundary



Simulated profiles summer and winter (Maarten Saaltink et al., 2019)

Evolution of vapor diffusion at the boundary



Outlook

- Explore effect on different meteorological conditions on recharge rates
- Simulate climate change and impact on soil water balance
- Compare simple analytical approaches to calculate real evaporation
- Update the current infrastructure by 3 additional lysimeters equipped with humidity and suction sensor profiles in spring 2019

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Relevant Bibliography:

- Peters A, Nehls T, Schonsky H, Wessolek G (2014) Separating precipitation and evapotranspiration from noise - A new filter routine for high-resolution lysimeter data. Hydrology and Earth System Sciences, 18(3): 1189–1198