QUANTIFYING WATER FLUXES WITHIN SOIL-PLANT-ATMOSPHERE CONTINUUM SYSTEM USING HYDROMETRIC MEASUREMENTS AND STABLE ISOTOPES TECHNIQUES

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OUTLINES

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BACKGROUND

925M PEOPLE HUNGER

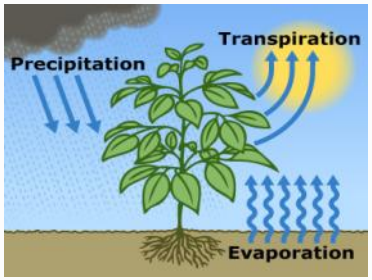
PLANT FOR FOOD

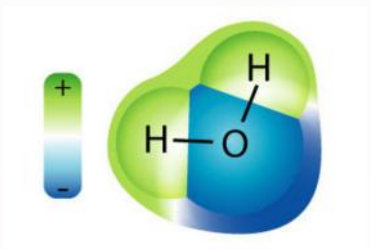
BEST PRACTICE AGRICULTURE → WATER → POPULATION

WUE IN IRRIGATION

QUANTIFYING WATER FLUXES WITHIN SPAC

ENVIRONMENTAL ISOTOPES AND HYDROMETRIC MEASUREMENTS





OBJECTIVE

The objective of this study is to quantify water fluxes within soil-plant-atmosphere system using hydrometric measurements and stable isotopes techniques. Moreover, the evaporation flux has been partitioned into soil evaporation, transpiration and interception fluxes.

STUDY AREA

THE NETHERLANDS
NORTH SEA
Wadden Sea
GRONINGEN
FRIESLAND
DRENTHE
NORTH HOLLAND
FLEVOLAND
OVERIJSSEL
GELDERLAND
UTRECHT
SOUTH HOLLAND
NORTH BRABANT
ZEALAND
LIMBURG
BELGIUM
GERMANY
IJsselmeer
Markermeer
Delfzijl
Ems
Leeuwarden
Groningen
Assen
Heerenveen
Emmen
Den Helder
Alkmaar
Zaanstad
Lelystad
Zwolle
Haarlem
AMSTERDAM
Almere
Almelo
Apeldoorn
Enschede
Katwijk
Leiden
Hilversum
Amersfoort
Utrecht
The Hague / 's-Gravenhage
Delft
Rotterdam
Arnhem
Lek
Nether Rhine
IJssel
Haringvliet
Merwede
Waal
Dordrecht
Nijmegen
Rhine
Meuse
's-Hertogenbosch
Eastern Scheldt
Breda
Tilburg
Middelburg
Flushing
Western Scheldt
Eindhoven
Venlo
Antwerp
Scheldt
Maastricht
Heerlen
Provincial capitals in red
A Wikipedia map

UNESCO-IHE
Botanic Ga
© 2010 Tele Atlas
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 Aerodata International Surveys
Google
Pointer 52°00'27.70" N 4°21'51.34" E elev 1 m
Streaming 100%
Eye alt 970 m

METHOD AND EQUIPMENTS

Literature Review → Preparation Setup → Equipments, Lysimeters, Detailed Planning

Data Collection

- Historical Data
- Hydrometric Measurements
- Sampling for Isotopes
- Soil Properties
- Climate
- Percolation
- Soil Moisture, EC, Temperature
- Deuterium
- Oxygen 18

→ Water Balance, Penmann-Monteith

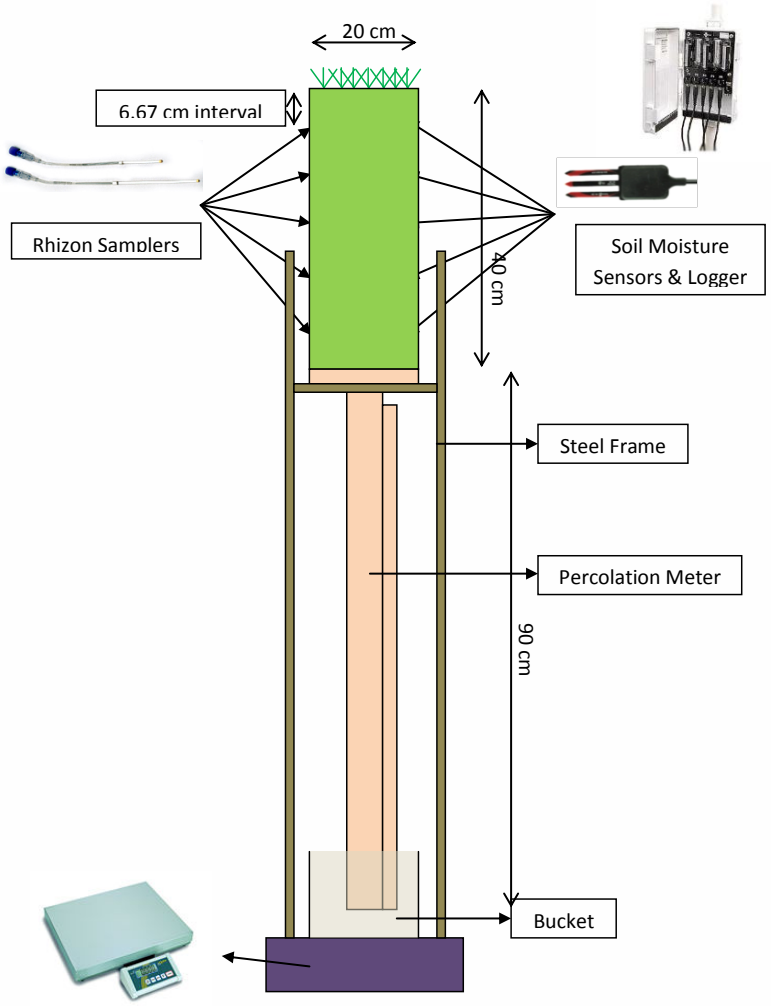
→ Data Processing and Analysis

→ **Conceptual Modelling**

- Hydrus 1D
- Isotope Mass Balance

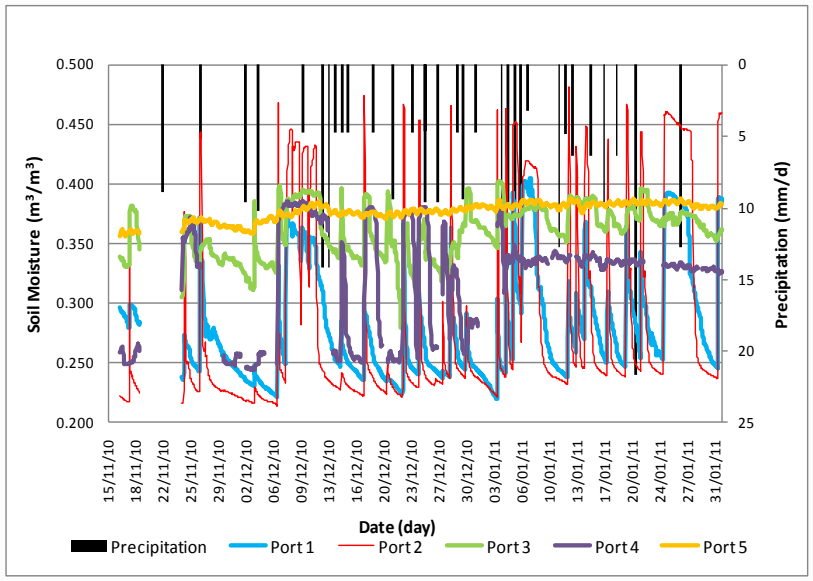
→ Evaporation Comparison (Water Balance, Penmann-Monteith, HYDRUS, Isotope Mass Balance)

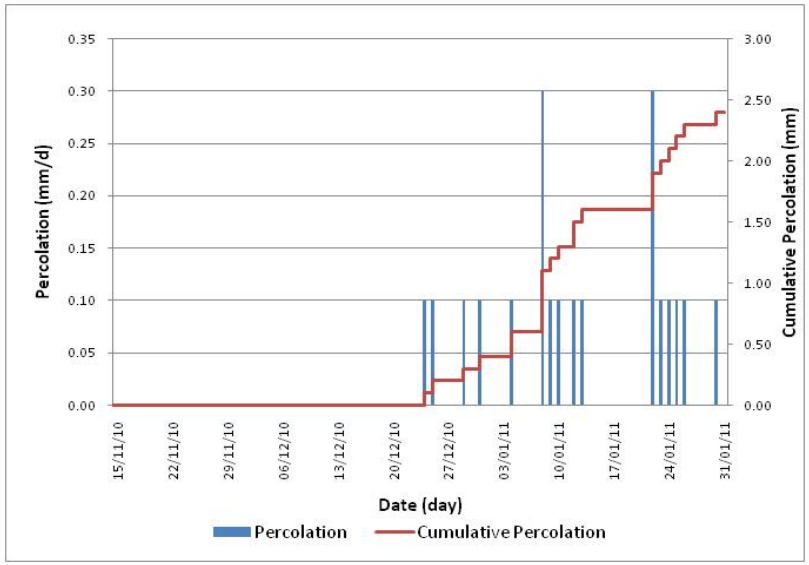
→ Quantifying Water Fluxes within SPAC System

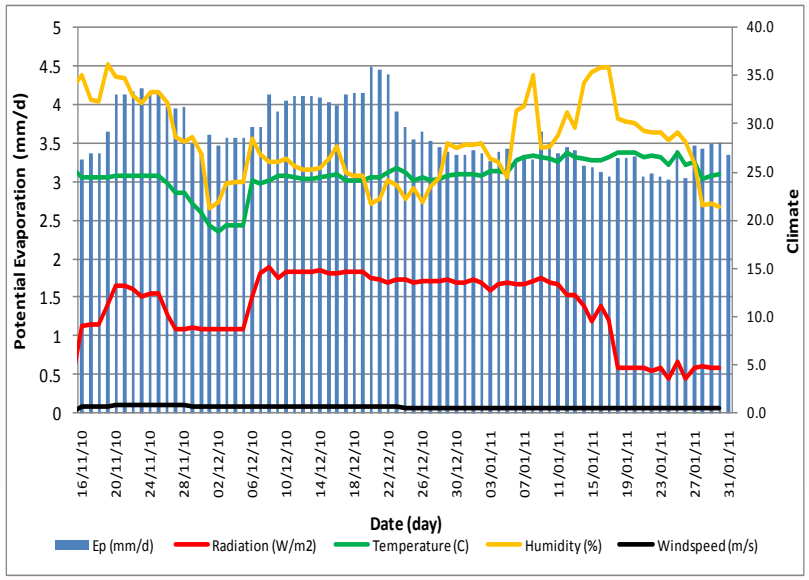


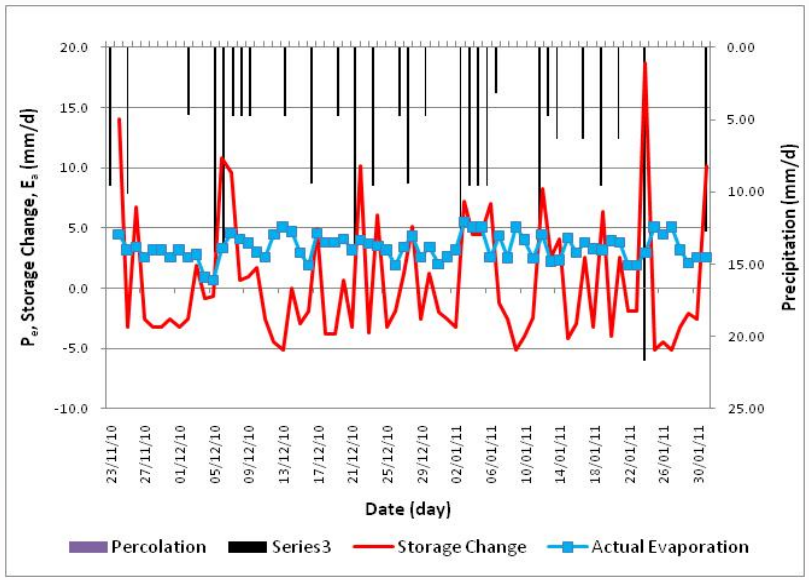
MEASUREMENTS RESULTS

(Ep=3.2 mm/d, Ea=3.0 mm/d))

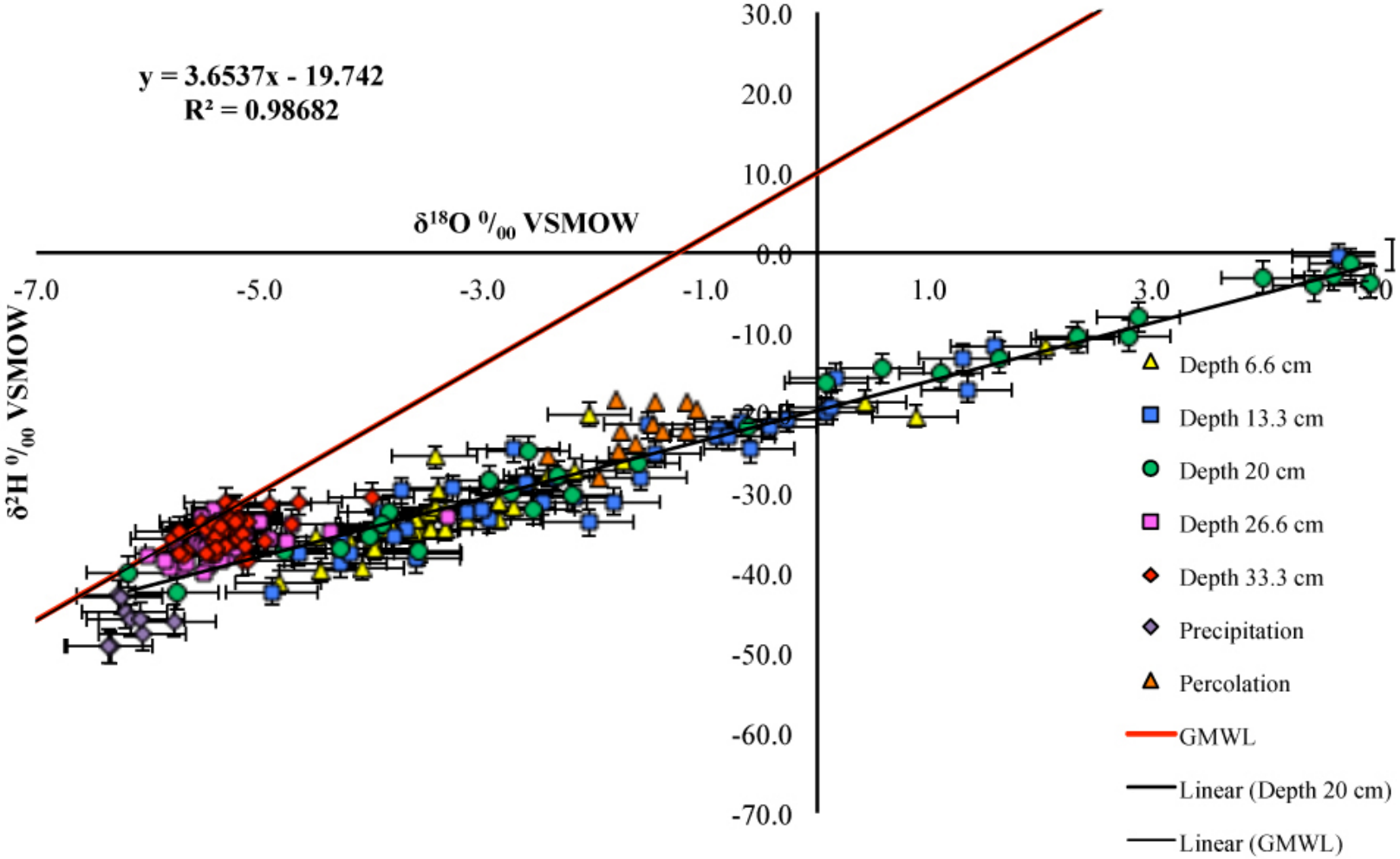








ISOTOPES MEASUREMENTS RESULTS



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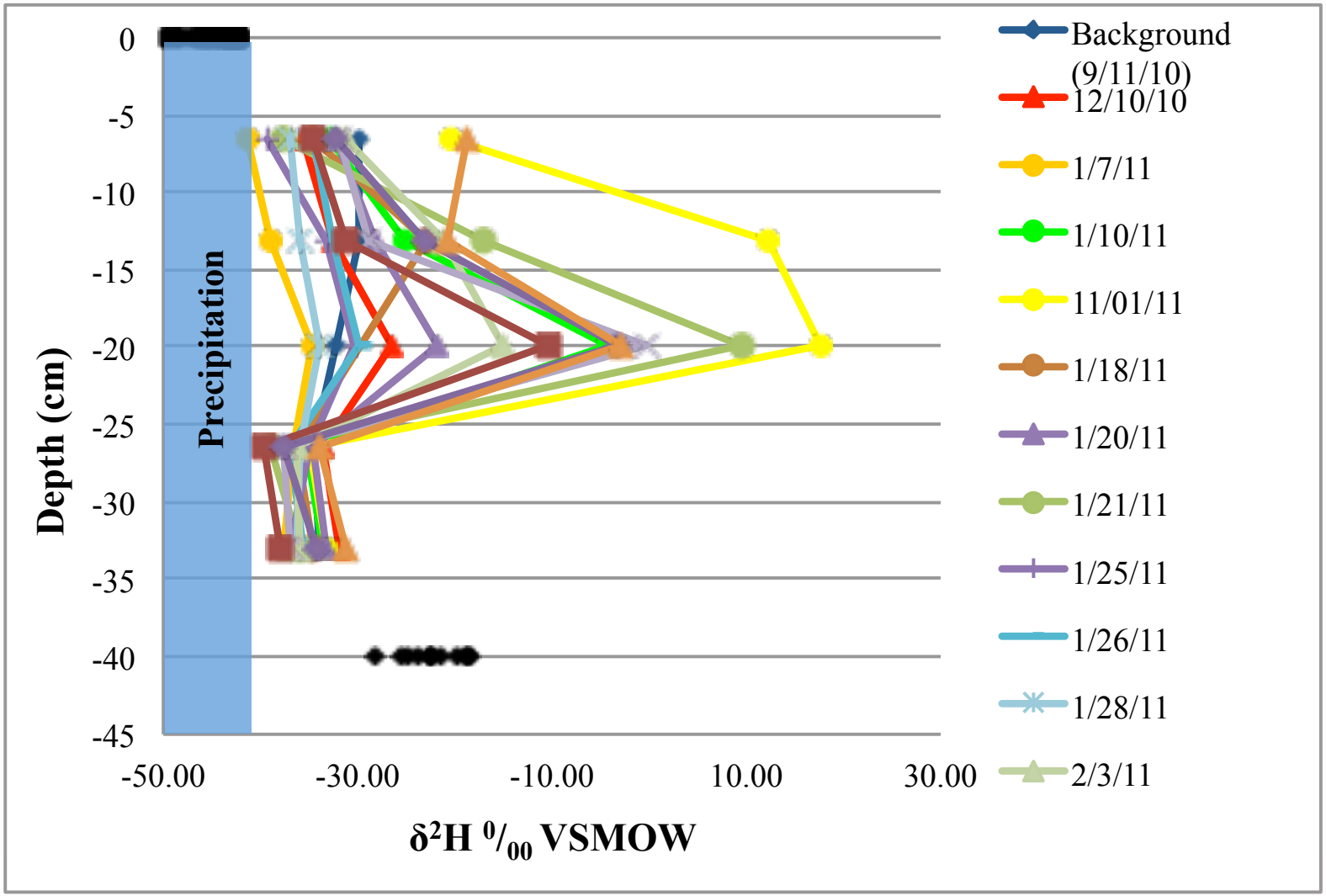
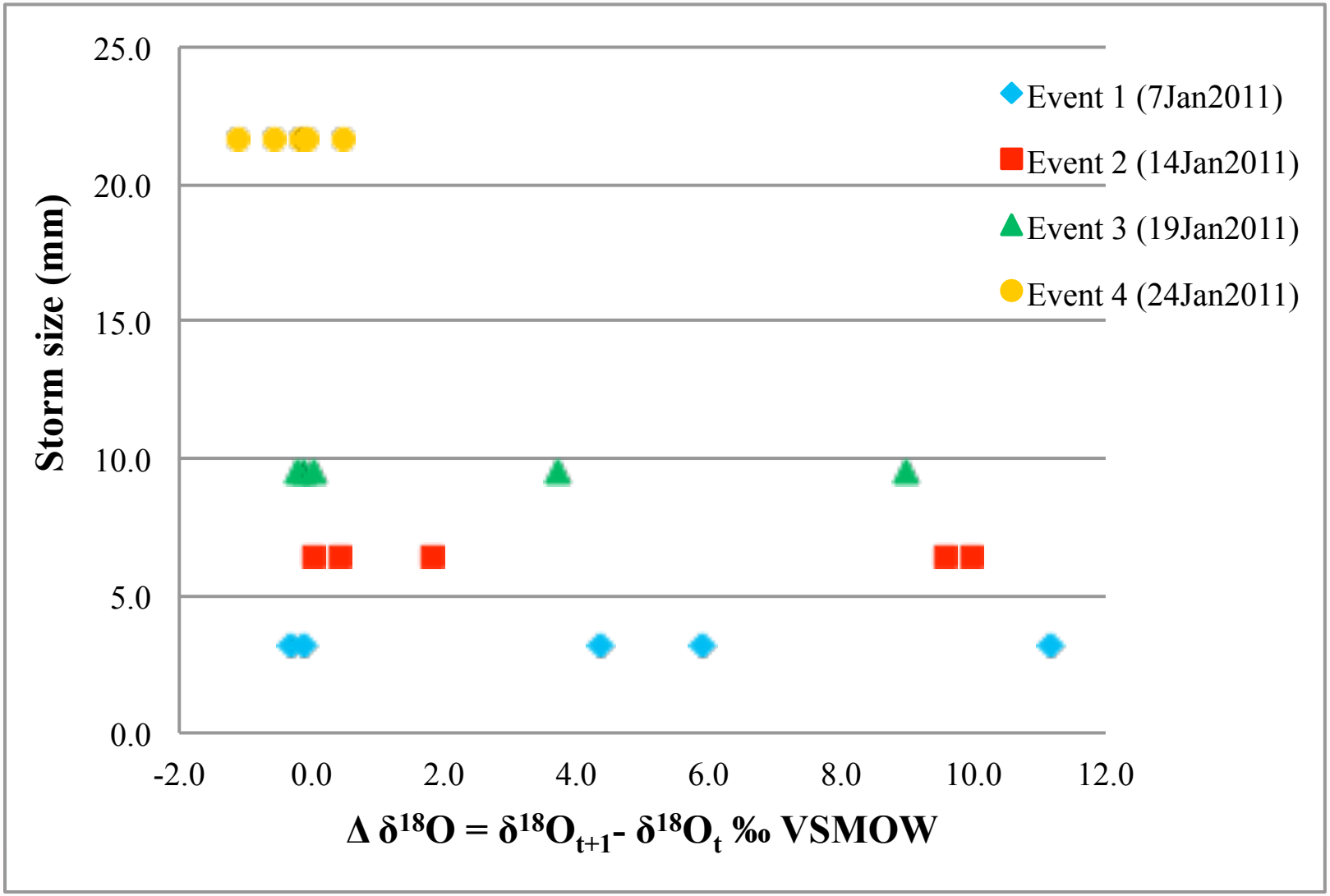


ISOTOPES RESULTS



ISOTOPE MASS BALANCE

The water taken out by plant root for transpiration is not affected by isotopes fractionation until the water leaving the plant from stomata.

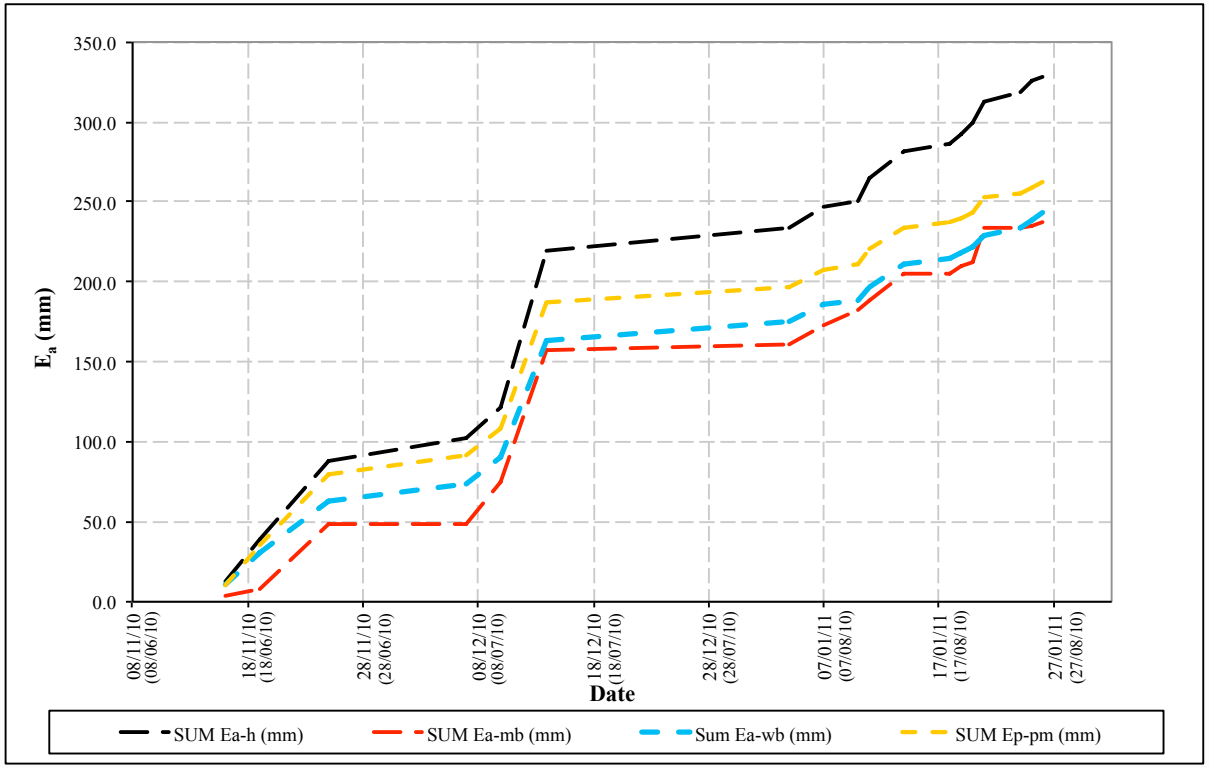
In contrast, the water evaporate from soil is affected by isotopes fractionation.

Since the grass also intercepts rain water, the precipitation value needs to be adjusted for interception -> net precipitation.

ISOTOPE MASS BALANCE

This net precipitation is the input for our lysimeter and is assumed to have the same isotopic concentration as the precipitation since the interception will not play a significant role in isotope water for lower vegetation type.

EVAPORATION COMPARISON



Methods	SUM E (mm)	$\overline{E}$ (mm/d)	$\overline{E_s}$ (mm/d)	$\overline{E_t}$ (mm/d)	$\overline{E_i}$ (mm/d)
Penman-Monteith	262.4	3.2	-	-	-
Water balance	243.1	3.0	-	-	-
HYDRUS-1D	328.1	4.0	1.2	2.5	0.3
Isotope mass balance (exclude E_i)	237.3	2.9	0.4	2.5	
Isotope mass balance (include E_i)	213.4	2.6	0.35	2.25	0.3

CONCLUSIONS

- A combination of hydrometric measurements technique and isotopes approach is able to do direct measurements of the water fluxes components.
- Isotope mass balance revealed to be a useful tool to partition soil evaporation, interception and transpiration fluxes
- Interception flux proved to be an important flux in evaporation processes since the interception flux may have the same value as soil evaporation flux.

CONCLUSIONS

- The most evaporation flux is produced by transpiration (78% from total evaporation)

Fluxes	Total Flux (mm)	Av Flux (mm/d)	E_s (mm/d)	E_t (mm/d)	E_i (mm/d)
Precipitation	242.6	2.96			
Percolation	2.3	0.03			
Evaporation (IMB)	237.3	2.9	0.35	2.25	0.3

THANKS FOR YOUR ATTENTION