LAISE NLDE overview

- **Wageningen University and Research (WUR)**:
  - Meteorology and Air Quality Group (MAQ)
  - Horticulture & Product Physiology (HPP)
- **Utrecht University (UU)**:
  - Institute for Marine and Atmospheric research Utrecht (IMAU)
  - Copernicus Institute for Sustainable Development
- **Technical University Delft (TUD):**
  - Hydrology group – Civil Engineering
- **Forschungszentrum Jülich (FZJ)**

LIAISE

LAISE NLDE overview

Oscar Hartogensis, **Mary-Rose Mangan (PhD)** (WUR):

- Scintillometers
- Network of cheap multi-band radiometers (tentative) - Wouter Mol (PhD)

Miriam Coenders (TUD):

- Distributed Temperature Sensing (DTS)

Thomas Roeckmann, **Robbert Moonen (PhD)**, Getachew Agmuas (UU)

- High frequency isotope instruments to measure isotope fluxes of H2O and CO2

Alexander Graf (FZJ)**:**

- Gradient-elevator

Arnold Moene (WUR), **Kevin van Diepen (PhD)**, **Raquel Gonzalez (PhD)**, Elias Kaiser (WUR) and **Hugo de Boer** (UU):

- Eco-physiology: measurements (Hugo) + modeling (Arnold)

Jordi Vila, Raquel Gonzalez (PhD), **Kim Faassen (PhD)** (WUR)

- In-situ analysis during campaign
- Impact of Fire: before, during and after

LAISE

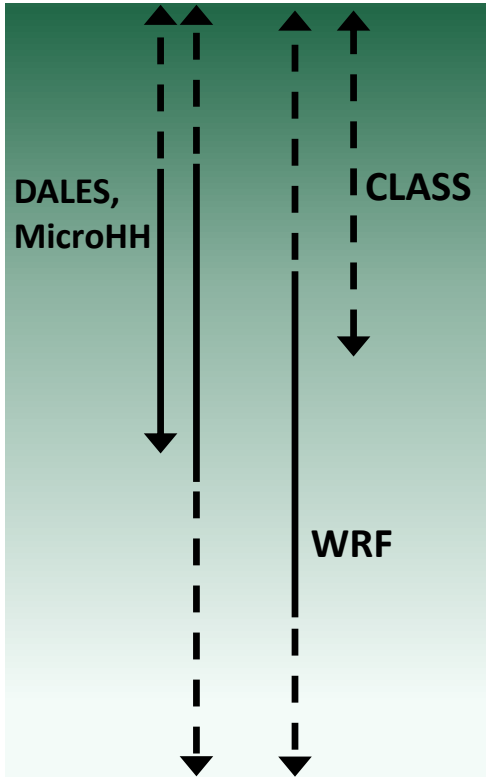
LAISE NLDE overview

	t	X	Z
Leaf/Plant	~s	$10^{-1}m$	$10^{0}m$
Field	~mins	$10^{2}m$	$10^{2}m$
Landscape	~hour	$10^{3}m$	$10^{3}m$
Regional	~hours	$10^{2}km$	$10^{3}m$
Global	~days	$10^{4}km$	$10^{2}km$

Observations

- LiCor-6400
- EC, Scintillometers, H2O/CO2 isotopes, gradient elevator, DTS
- Scintillometers (long path)
- Radiosondes, aircraft, satellite RS
- Radiosondes, satellite RS

Modelling



- Connecting processes over spatiotemporal scales
- Special attention to H2O – CO2 link

LAISE NLDE overview

La Cendrosa:

Scintillometry + LES (WUR)

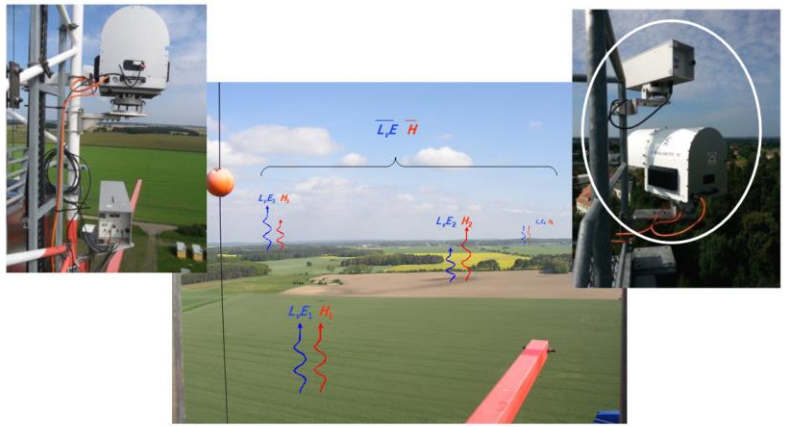
Scintillometry

- Wageningen University and Research (WUR):
  - Meteorology and Air Quality Group (MAQ)

- **Oscar Hartogensis (PI)**
- Mary-Rose Mangan (PhD)

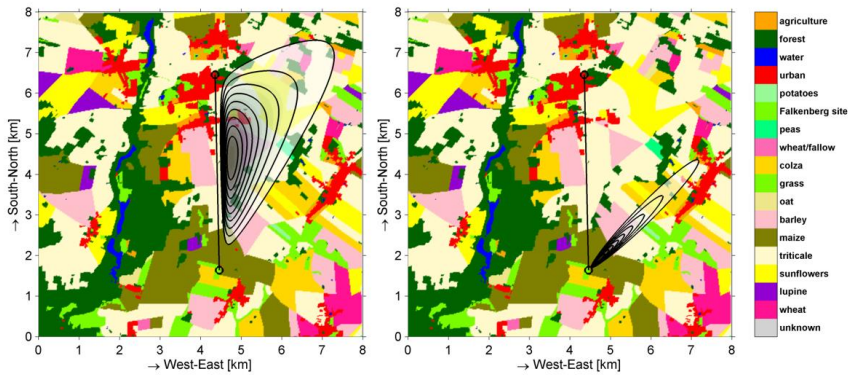
Scintillometry (WUR)

Long-path (~km) – Optical Microwave Scintillometer (OMS):



Landscape scale $H + L_vE$ with combined:

- Optical Large Aperture Scintillometer (LAS) and
- Microwave Scintillometer (MWS)

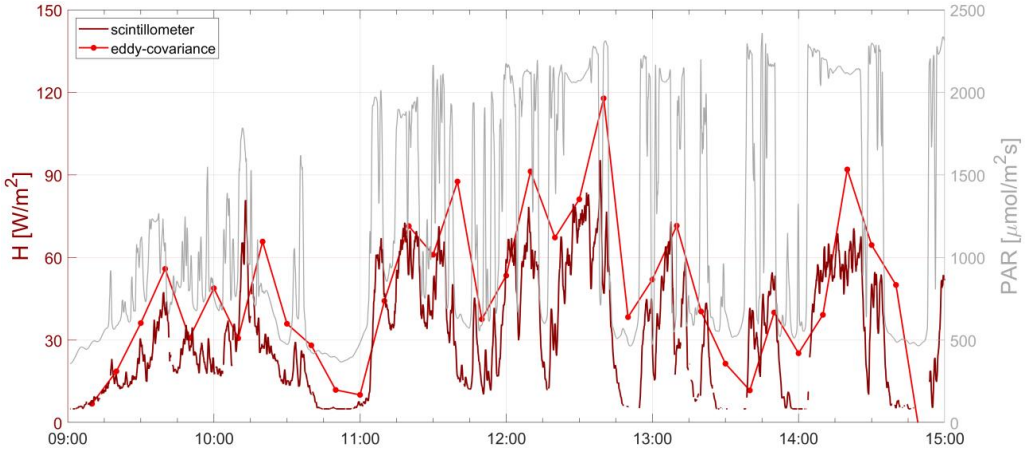


Scintillometer **Eddy Covariance**

Short-path (~100m) – Laser Scintillometer:

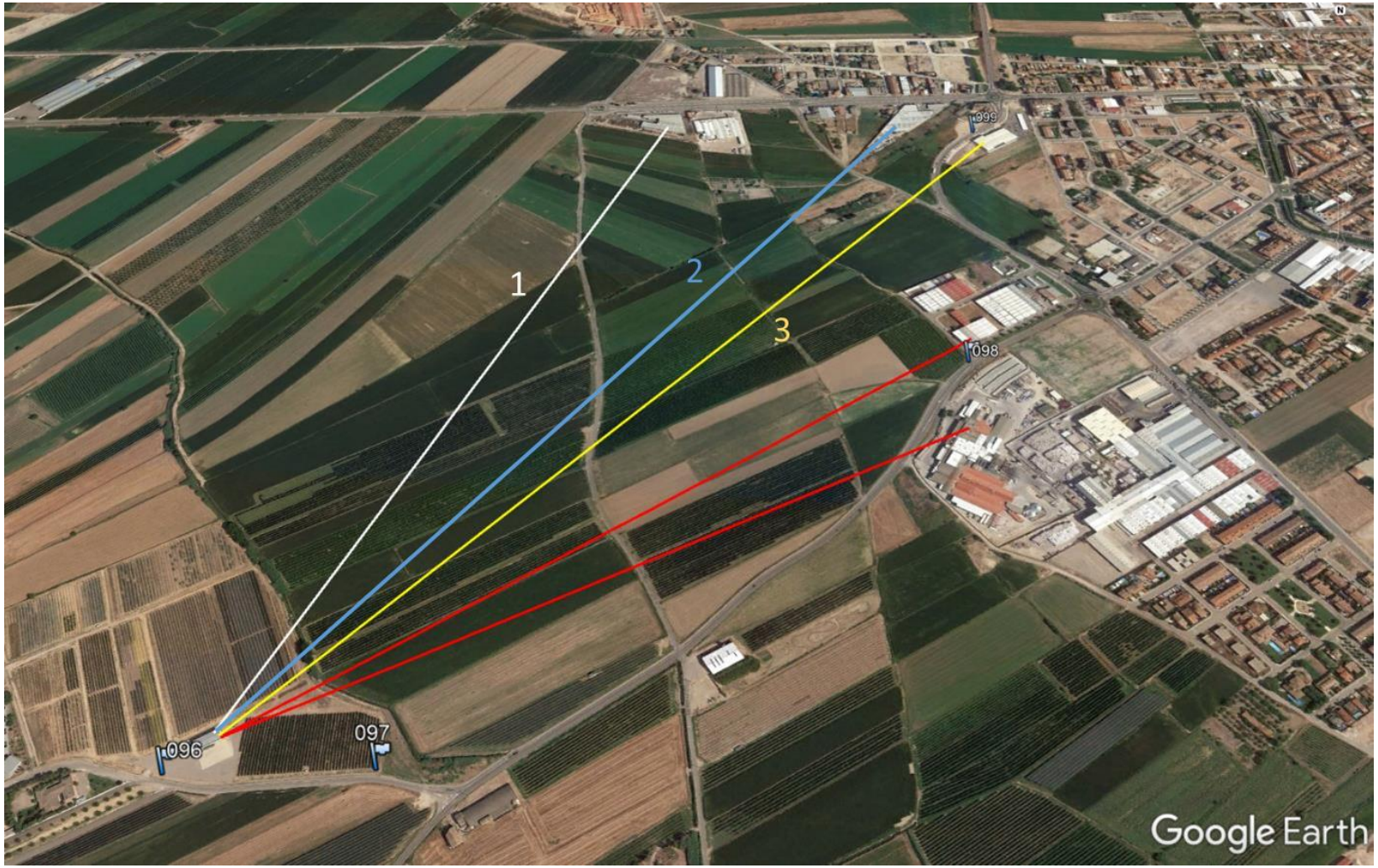
1-min $H + L_vE + F_{CO2}$ at field-scale with:

- dual-beam Laser Scintillometer and
- scalar turbulence measurements



Scintillometry (WUR)

OMS1 – IRTA site (near Mollerussa) - mixed-agriculture:



- Landscape scale ET
- Inter-comparison ET methods

Scintillometry (WUR)

OMS2 – Lake Ivars (near La Cendrosa) – open-water:

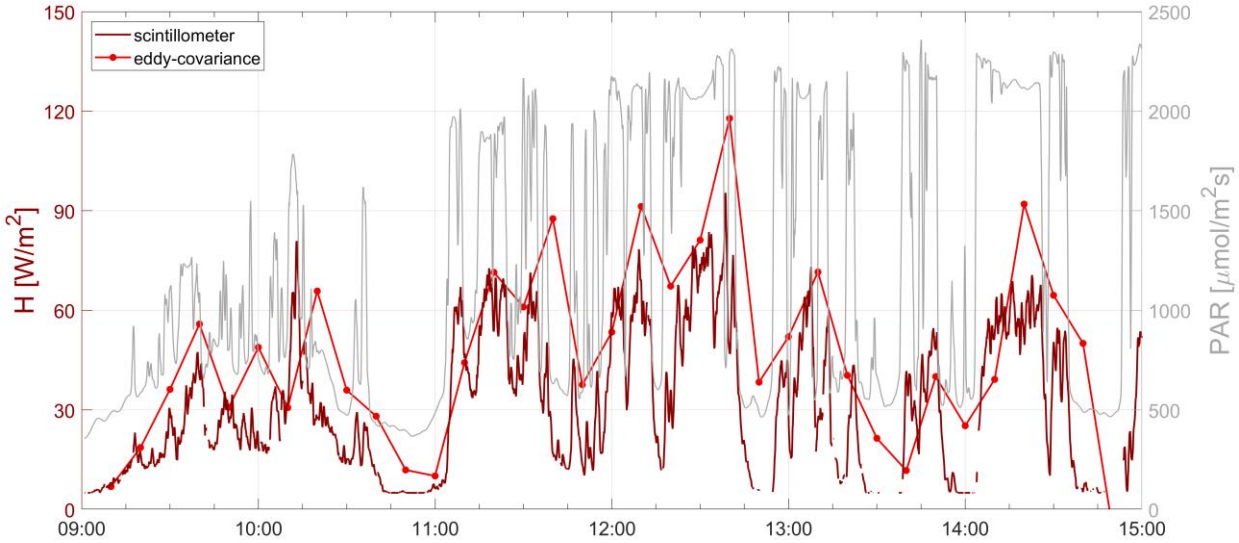
- Open-water Evaporation
- Applicability of MOST
- Catamaran EC from MF as reference

Scintillometry (WUR)

Laser scintillometer:

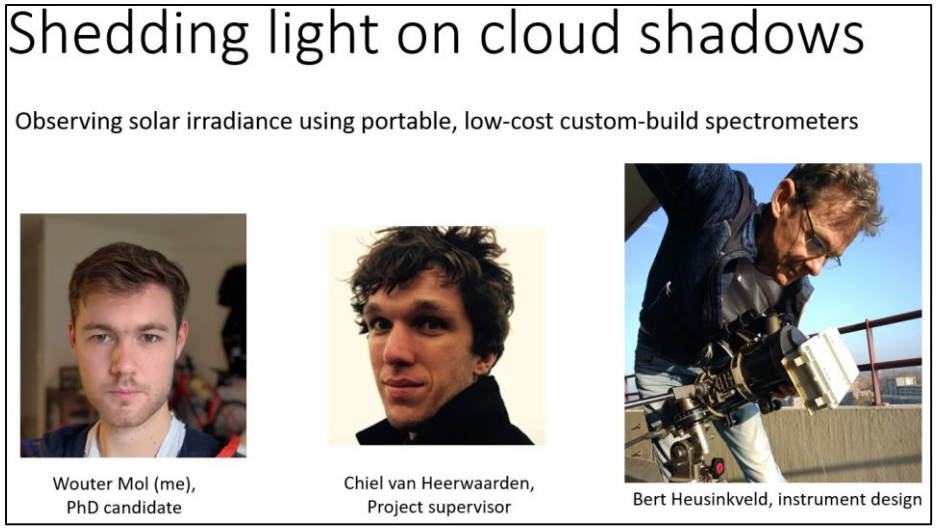
1-min $H + L_vE + F_{CO2}$ at field-scale with:

- dual-beam Laser Scintillometer and
- scalar turbulence measurements



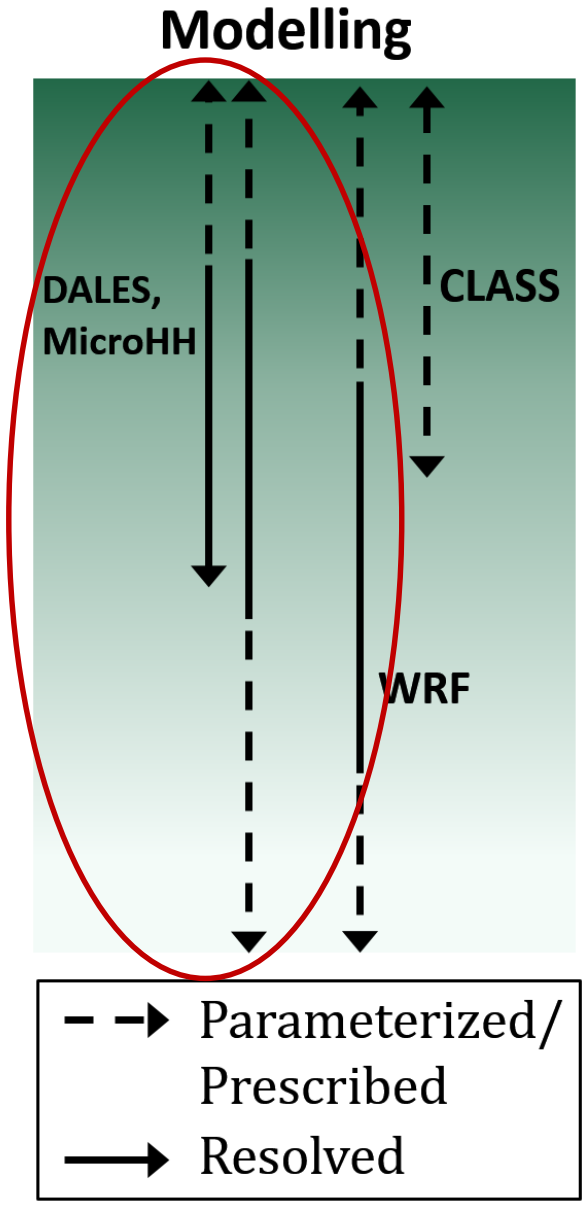
- Vegetation response to irradiance fluctuations (**clouds**)
- Combine with fast response H2O/CO2 **isotope** measurements → isotope-fluxes
- Reconstruct path averaging of turbulence with **DTS**

Network of multi-band radiometers (WUR - tentative)



- **Interaction clouds with solar irradiance**
- Grid of many (~100) **low-cost** spectrometers
- **18 wavelengths + 1 UV**
- **Fast** (>10Hz)
- Design and testing phase
- Main campaign: FESSTVaL, Germany (June)
- **LIAISE (tentative):**
  - Testing at lower latitude, different climate
  - Test in-canopy deployment

LES studies (WUR)



- **Idealized studies:** blending height and internal BL at wet-dry transitions
- **Realistic cases:** development of internal BL and regional circulations in the LIAISE study area

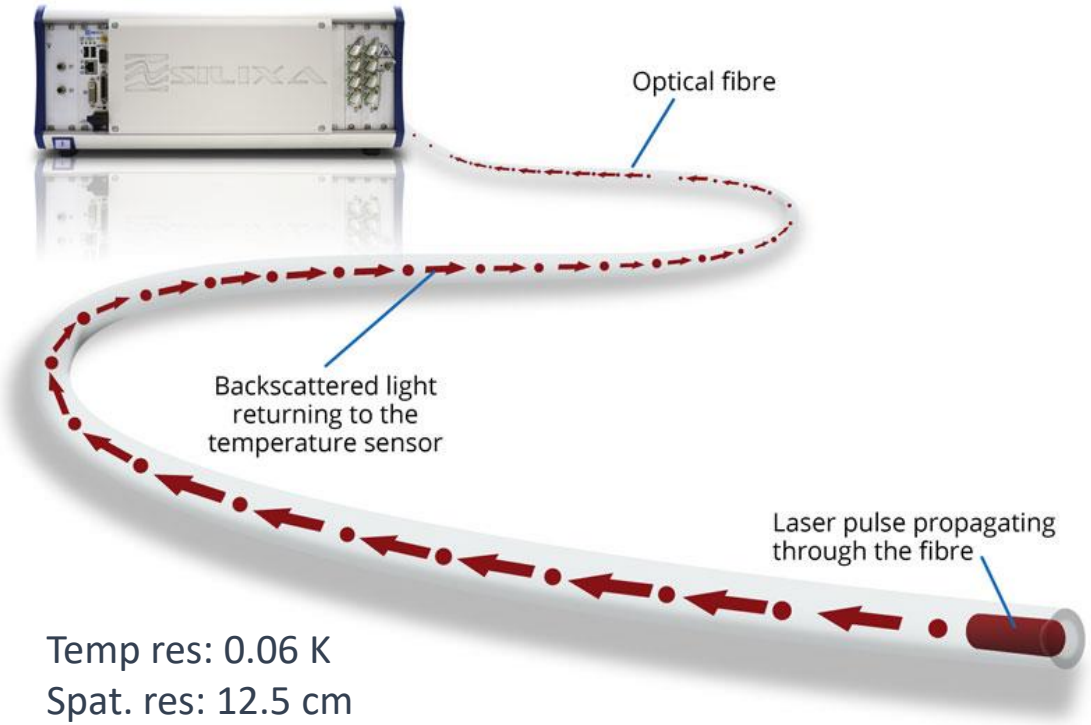
Distributed Temperature Sensing – (TUD)

Distributed Temperature Sensing (DTS)

- Technical University Delft (TUD):
  - Hydrology group – Civil Engineering
- **Miriam Coenders (PI)**
- …

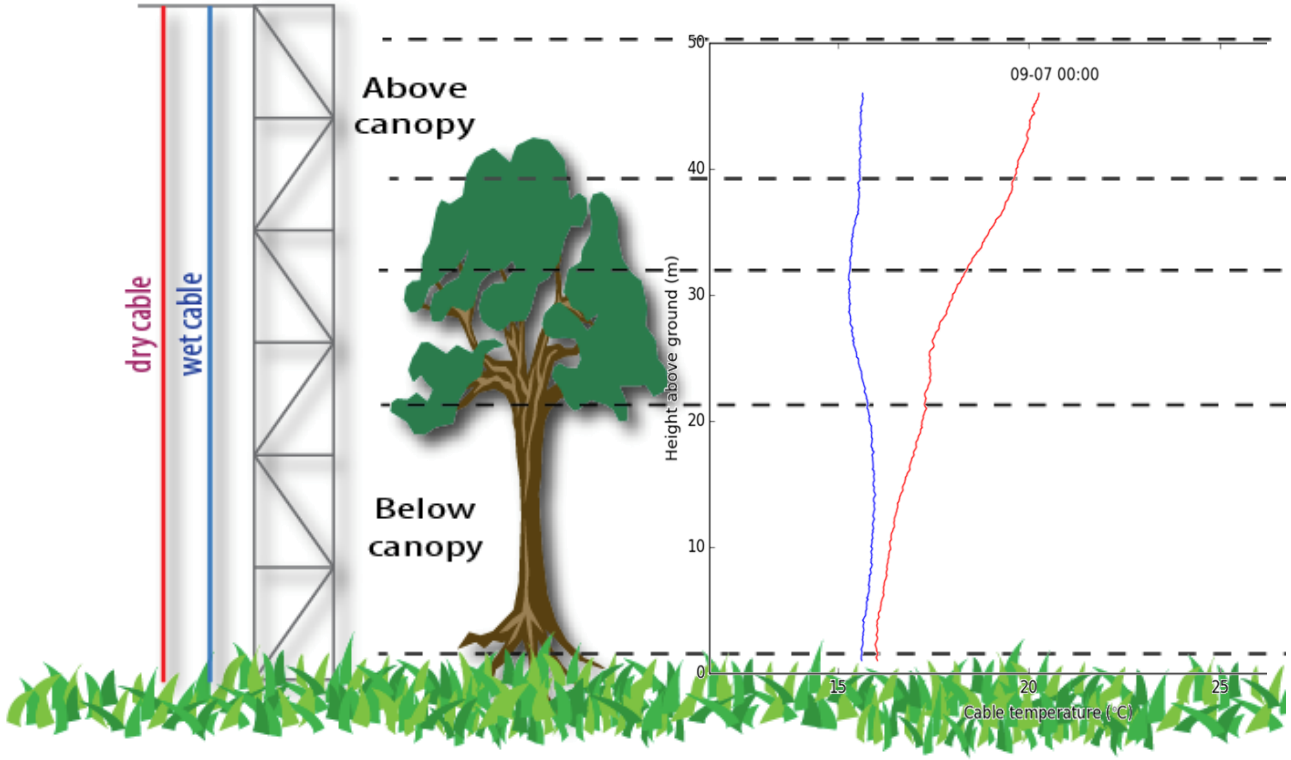
Distributed Temperature Sensing – (TUD)

- Technology:



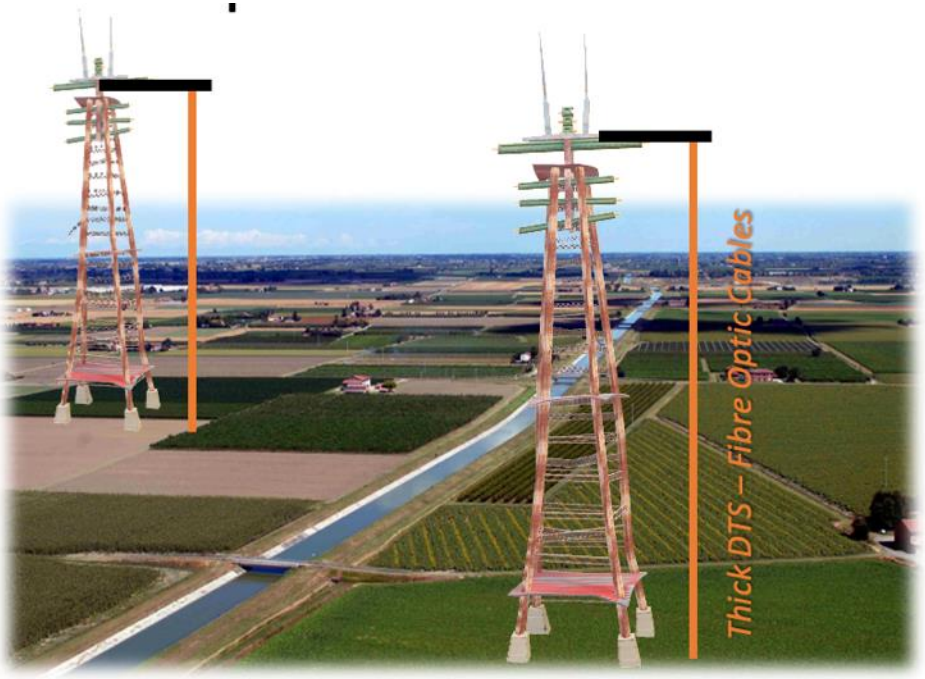
- Temp res: 0.06 K
- Spat. res: 12.5 cm
- Cable lengths: up to 1.5 km

- Measuring temperature gradients:

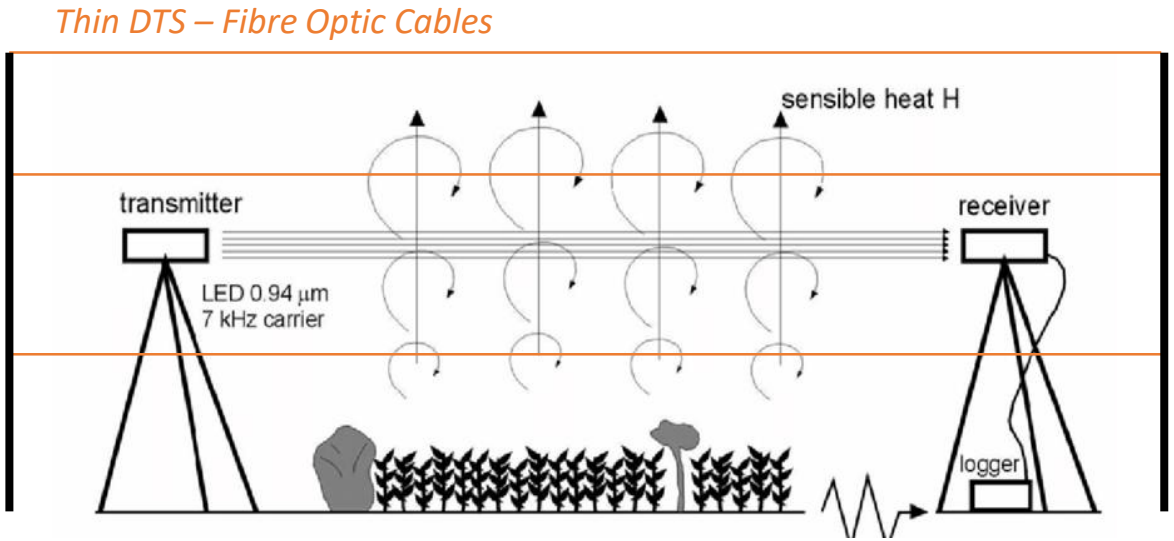


Research questions

1. How do the temperature gradients differ over a dry landscape versus a wet (irrigated) landscape?



2. Can DTS complement the scintillometer in order to detect spatial differences in evaporation along the observation path of the scintillometer?



Isotope Fluxes – (UU- IMAU)

Fast response H2O/CO2 isotope measurements

- Utrecht University (UU):
  - Institute for Marine and Atmospheric research Utrecht (IMAU)

- **Thomas Röckmann (PI)**
- Robbert Moonen (PhD)
- Getachew Agmuas (PostDoc)

Isotope Fluxes - (UU- IMAU)

Goal: Measurement and interpretation of

isotope fluxes (isofluxes) of H_2O and CO_2

to distinguish plant and surface contributions

Couple fast isotope measurements to flux technique (scintillometer ← WU)

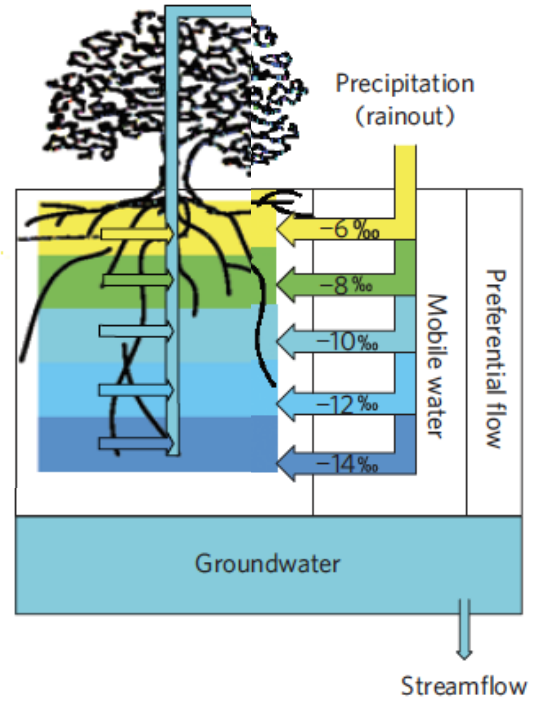
Instruments: fast water isotope analyzer (Picarro), fast CO_2 isotope analyzer (Aerodyne)

Team: Robbert Moonen (PhD student), Getachew Agmuas (PostDoc), Thomas Röckmann (PI)

Isotope Fluxes - (UU- IMAU)

Relevant processes:

- Surface water gets isotopically enriched by soil evaporation
- Plants access water from deeper layers
- Leaf water gets enriched by transpiration close to evaporation site
- CO_2 exchanges isotopes with H_2O in leaves
- ^{12}C preferentially assimilated during photosynthesis
- Isotope effects during diffusion into/out of stomata
- Respiration releases ^{13}C-depleted CO_2
- Non-surface processes, e.g. entrainment & advection



Brooks et al., Nat Geo, 2009, modified

Isotope processes incorporated in models by WUR team
(Vila-Guerau de Arellano, et al., 2019)

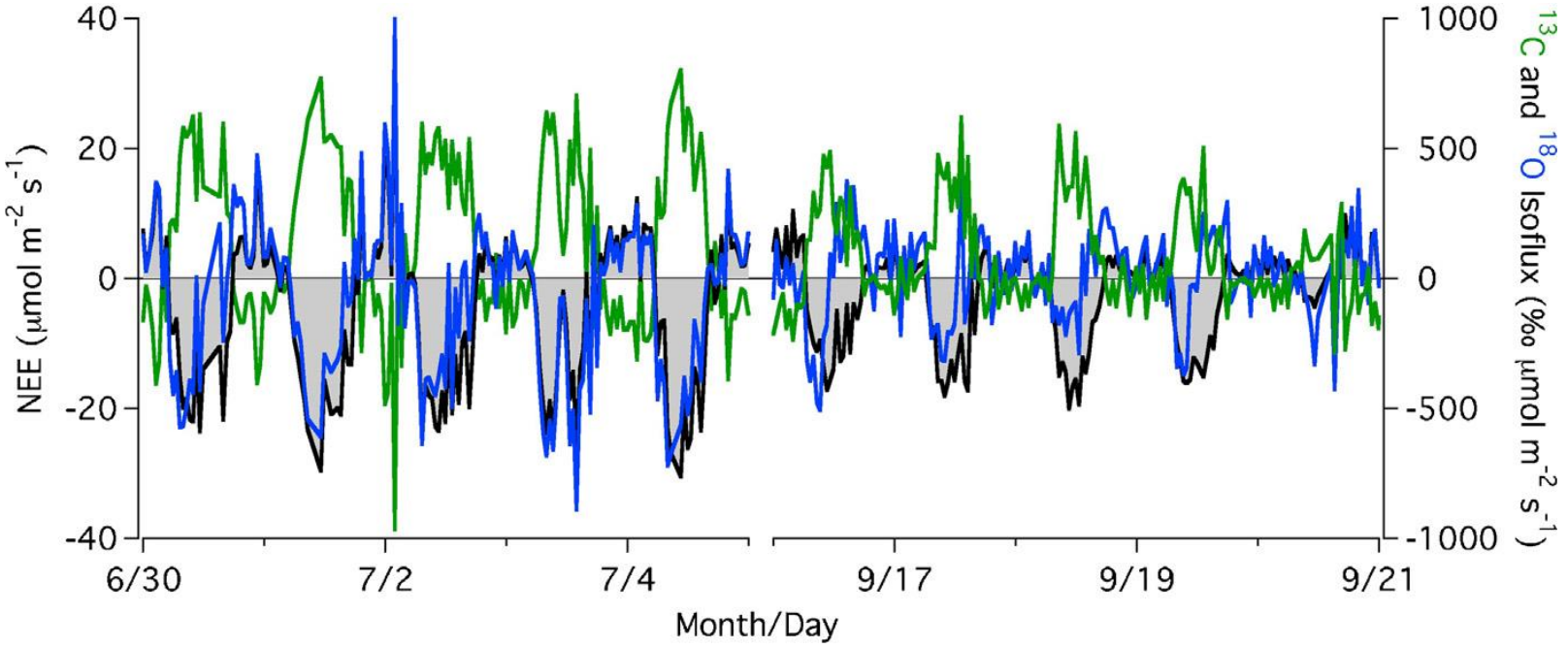
Isotope Fluxes - (UU- IMAU)

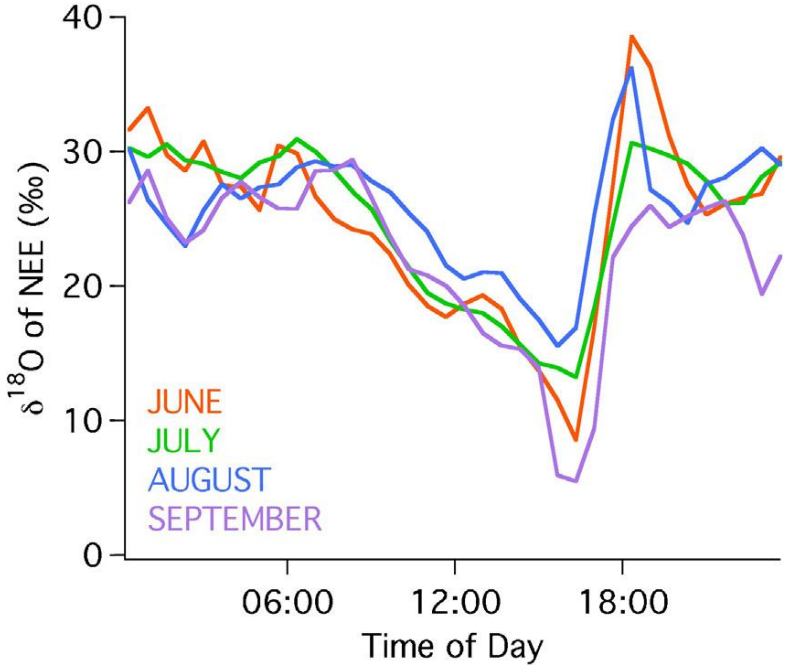
Example CO_2: (Wehr et al., 2013)

CO_2 flux and ^{13}C flux are strongly anti-correlated

(preferential uptake of ^{12}C)

CO_2 flux and ^{18}O flux is more correlated, but variable





Diurnal cyle:

Leaf water gets enriched in ^{18}O over day

CO_2 exchanges with leaf water

$C^{18}O^{16}O$) gradient between atmosphere and stomata decreases (compared to $C^{16}O^{16}O$)

Gradient Elevator – (FZJ)

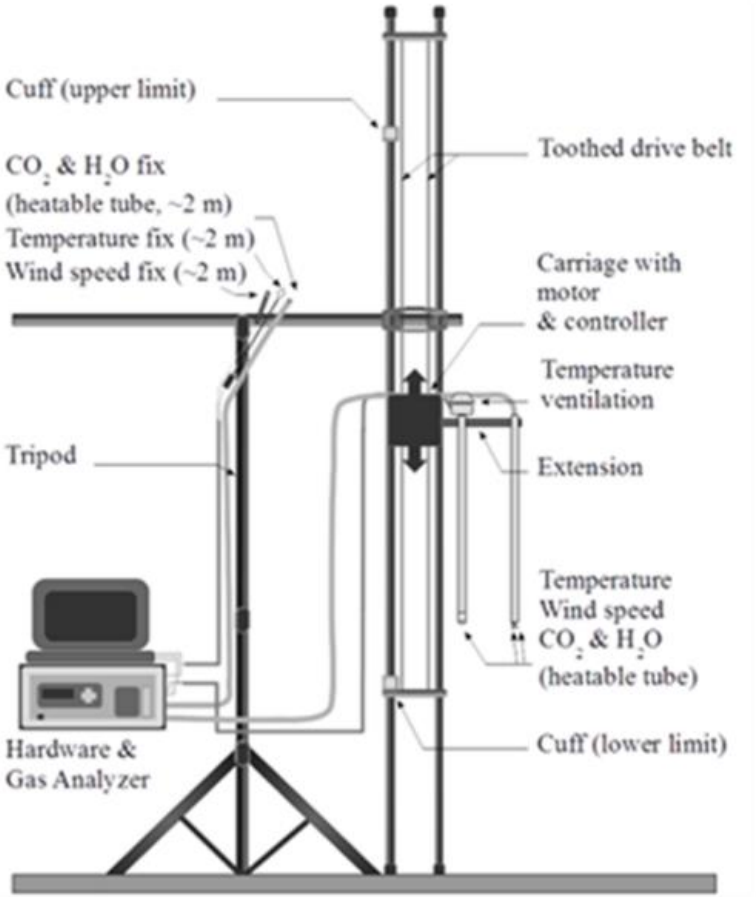
Gradient Elevator

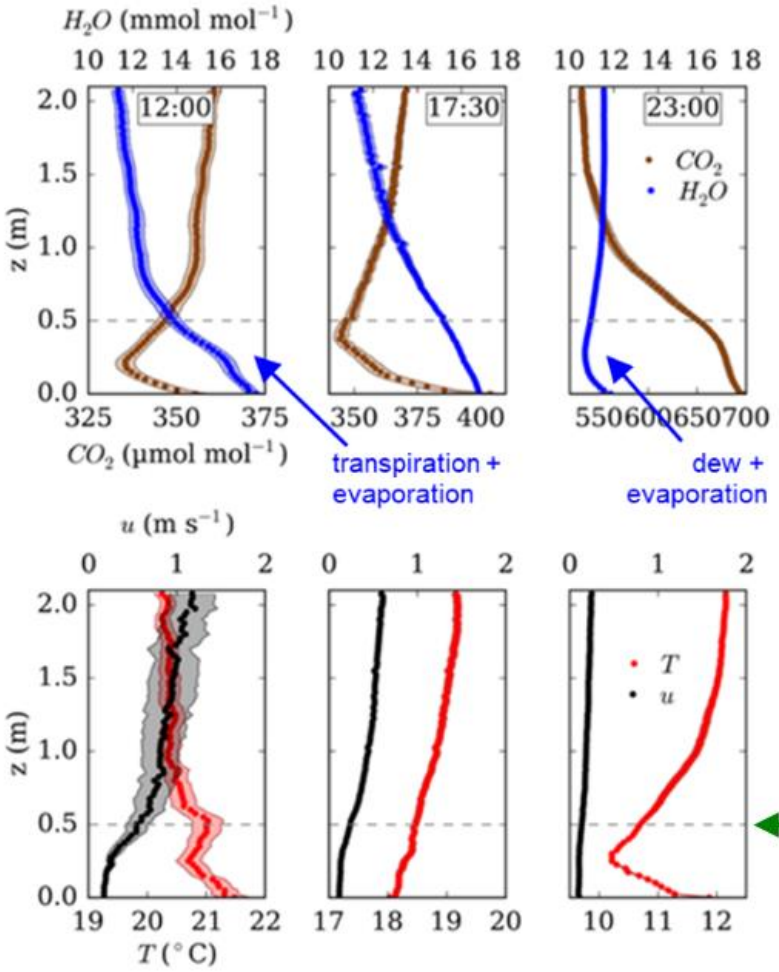
- Forschungszentrum Jülich (FZJ)

- **Alex Graf (PI, remote supervision) - FZJ**
- Jan Vanderborght (remote supervision) - FZJ, KU Leuven
- MSc student (operation, tentative) - KU Leuven
- Oscar Hartogensis, Mary-Rose Mangan (operation) - WUR

Gradient Elevator – (FZJ)

Elevator-based mini profiler for CO_2, humidity, temperature and wind speed





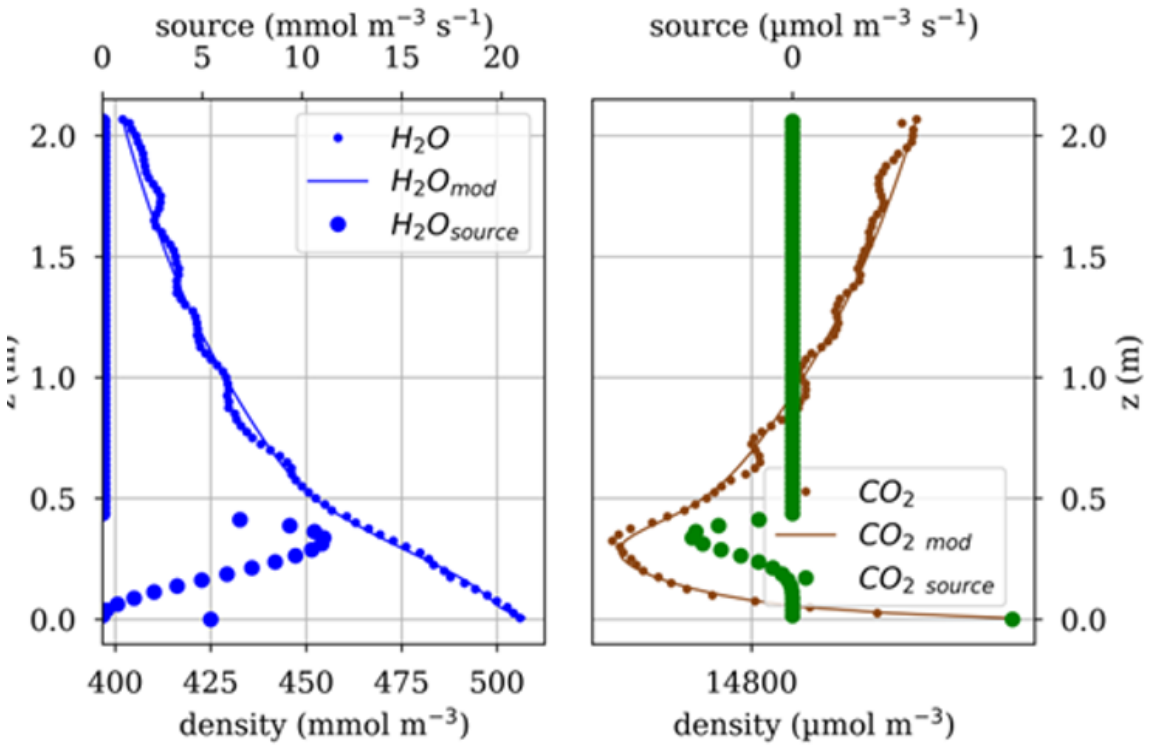
Canopy top

Ney and Graf (2018), Boundary-Layer Meteorol 166:449-473, https://doi.org/10.1007/s10546-017-0316-4

Vila et al. (2020), Biogeosciences 17:4375-4404, https://doi.org/10.5194/bg-17-4375-2020

Gradient Elevator – (FZJ)

Elevator-based mini profiler for CO_2, humidity, temperature and wind speed



measured H_2O and CO_2 concentration profiles at 2018-5-7 12:00..12:30 UTC together with profiles according to a fitted source strength and turbulence model, and the source strength profiles yielding this best fit.

a) research questions:

Identify sources and sinks of e.g. latent and sensible heat between canopy top and soil surface

b) the tools/equipment:

see previous slide. Measurements happen at 20 s^{-1} while continuously moving up and down, profiles are averaged over 30 min to suppress turbulent fluctuations (but raw data are stored)

c) strategy and possible challenges:

Operation supervised and fragile => selected half-hours only. Source / sink identification works well qualitatively but the actual source model inversion still needs improvements

d) potential interactions with other partners:

Maybe stitching together with higher profiles? Interested in any other E vs. T partitioning estimates for comparison.

Ecophysiology Measurements + Modelling – (UU + WUR)

Ecophysiology Team:

- Utrecht University (UU) : Copernicus Institute for Sustainable Development
- Wageningen University and Research (WUR):
  - Meteorology and Air Quality (MAQ)
  - Horticulture & Product Physiology (HPP)

- **Hugo de Boer** (PI) – UU
- Arnold Moene (PI), Raquel Gonzalez (PhD), Kevin van Diepen (PhD) – WUR-MAQ/HPP
- Elias Kaiser (PI) – WUR-HPP

LI-6400XT leaf gas exchange

Leaf gas exchange (CO_2 and water) with portable photosynthesis system

- 2x Li-Cor LI6400XT
- 1x Red/Blue LED light source leaf chamber (6400-02B)
- 1x Leaf chamber fluorometer (6400-40)
- Batteries and charger for field use, but prefer running on mains or car battery

Type of measurements

- Diurnal leaf gas exchange: measurements taken by hand, typically every 2-10 minutes.
- Measurements of stomatal conductance, transpiration and photosynthesis
- Photosynthesis parameters (V_{cmax}, J_{max}, R_d), light response curves and leaf fluorescence (stress)

Research aims

- **Aim 1:** Obtain specifies-specific photosynthesis parameters for model parametrization (light and CO_2 response curves, V_{cmax}, $J_{max,}$ A_{max} and stomatal delays) in irrigated and non-irrigated sites.
- **Aim 2:** Measure diurnal patterns in (leaf-level) stomatal conductance, photosynthesis and transpiration in irrigated and non-irrigated sites.

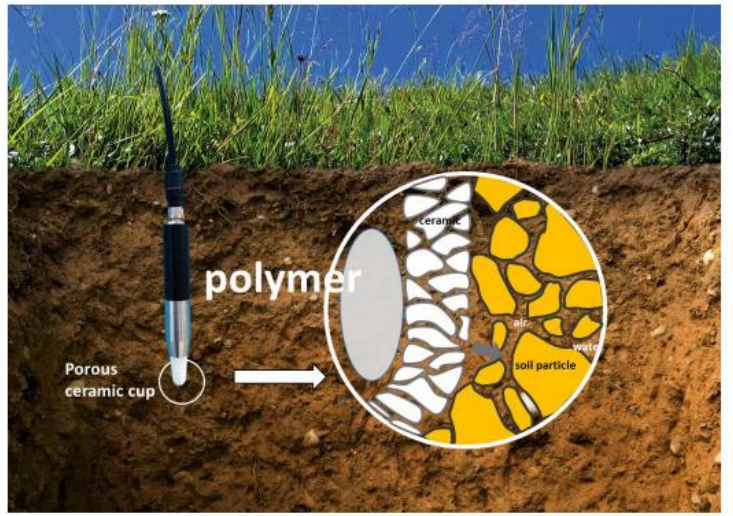
Full range polymer tensiometer

Water potential in the unsaturated soil (soil moisture tension)

- 3x UGT tensiometer
- 1x data logger (RS485 digital protocol)

Type of measurements

- Near-continuous measurements of unsaturated soil water potential
- Range fully saturated down to 1500 kPa (pF 4.2)
- Depending on soil type, this translates to VSWC of 5% (sand) to 25% (clay)



Research aims:

- Aim 3: Link diurnal patterns in stomatal conductance to changes in the gradient of soil water potential (SWP) to atmospheric vapor pressure deficit (VPD).
- Aim 4: Observe diurnal changes in SWP across a rooting depth profile and possibly hydraulic redistribution in non-irrigated sites.

Ecophysiology Modelling + Measurements – (WUR+UU)

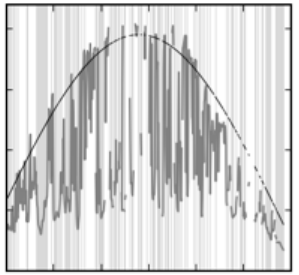
Ecophysiology Team:

- Wageningen University and Research (WUR):
  - Meteorology and Air Quality (MAQ)
  - Horticulture & Product Physiology (HPP)
- Utrecht University (UU) : Copernicus Institute for Sustainable Development

- **Arnold Moene** (PI), Raquel Gonzalez (PhD), Kevin van Diepen (PhD) – WUR-MAQ/HPP
- Hugo de Boer (PI) – UU
- Elias Kaiser (PI) – WUR-HPP

Photosynthesis under varying light

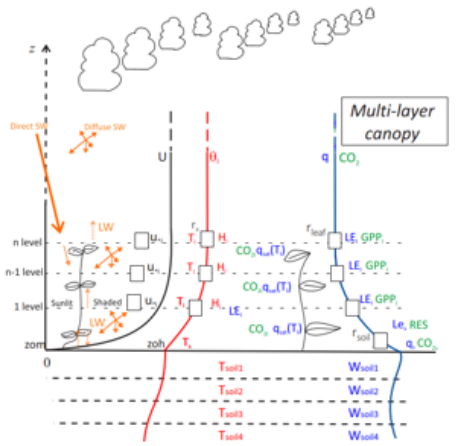
- How does photosynthesis and water-use efficiency at field level react to rapid transitions in light intensity?
  - Cloud-induced variations
  - Variations due to leaf-fluttering
  - Effect of time constants in photosynthesis process
- Essential observations:
  - LI-6400 XT
  - arrays of PAR-sensors (O(20) sensors within and above canopy)
  - field-level CO_2 observations
  - (soil respiration?)



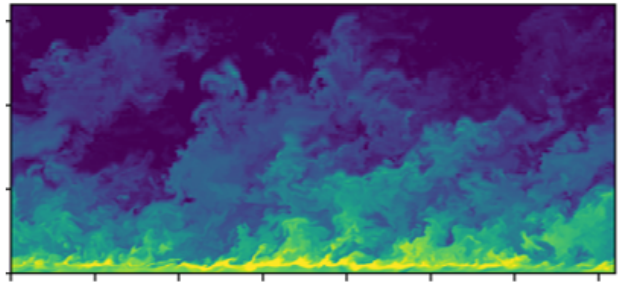
People involved:
Elias Kaiser & Sarah Berman (WU-HPP)
Arnold Moene (WU-MAQ)
PhD student: Kevin van Diepen (WU-HPP)

Isotopologue fluxes for source-partitioning

- How do canopy and soil contribute to above-canopy fluxes of H_2O and CO_2 at short time scales
  - Source partitioning through isotopologue fluxes
  - Implementation of leaf-scale + soil-level isotopologues fluxes in large eddy simulation model to interpret observations
- Observations:
  - Scintillometry (Hartogensis)
  - Fast-response isotopologue observations (Hartogensis + Röckmann)



courtesy: Jordi Vila



People involved:
Jordi Vila & Arnold Moene (WU-MAQ)
Thomas Röckmann (Utrecht University)
PhD student: Raquel Gonzalez Armas (WU-MAQ)

WAGENINGEN
UNIVERSITY & RESEARCH

Flying Team + Fire! – (WUR)

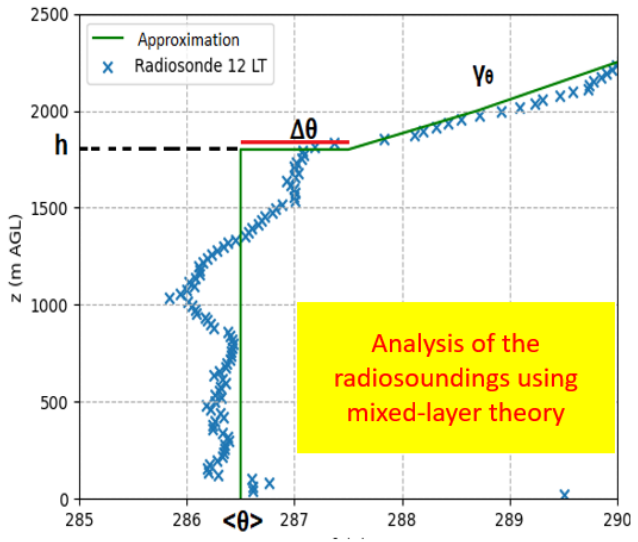
Analysis during campaign + Impact of Fire

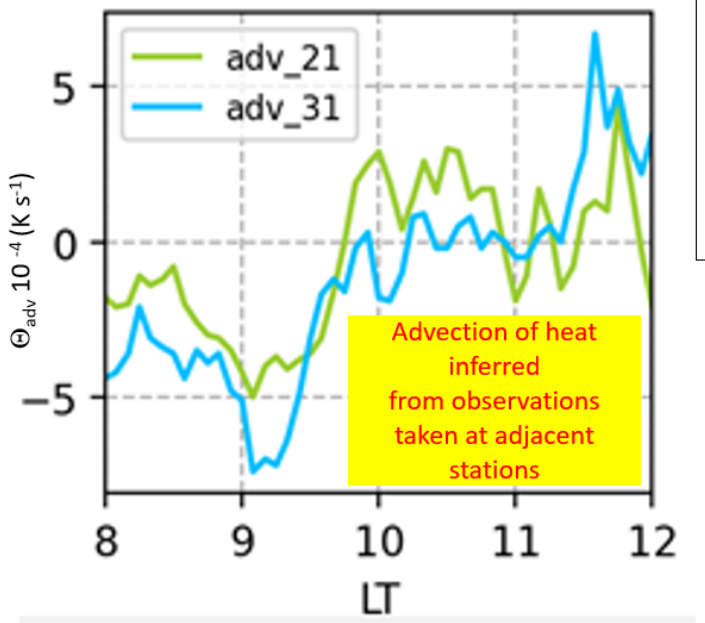
- Wageningen University and Research (WUR):
  - Meteorology and Air Quality Group (MAQ)
  - Soil Geography and Landscape (SGL)
- **Jordi Vila (PI)**
- Kim Faassen, Raquel González Armas (PhD) – Flying Team
- Marc Castellnou (PhD), Cathelijne Stoof (co-PI) - Fires

Flying Team – (WUR)

Support experimentalists and analysis in-situ observations/design numerical experiments

Kim Faassen, Raquel González Armas and Jordi Vilà (Flying team)





Tasks:

- Support the experimentalists: deployment DTS, measurements of stomatal aperture, etc.

Analysis and design of numerical experiments:

- Compile and analysis in-situ observations to do a selection of days: Golden days.
- Initial design of numerical experiments and validation with observations
- Formulating hypothesis and research questions based on initial observational and modelling analysis
- Initial classification, based on the observations, on coupling and interaction between biophysical processes occurring at different scales

Potentially formulation of research questions related to PhD topics

Fire! – (WUR)

Impact of fire above the surface and in the atmosphere: before, during and after

Marc Castellnou, Cathelijne Stoof and Jordi Vila

50 ha fires will be fast:

- Rate of 100 ha/h
- Fireline intensity around 6000 kw/m

Research questions:

- To observe how radiative and surface energy balance are modified during and after the fire
- To observe if the fire plume reaches the boundary-layer top and its effect in the entrainment zone
- To determine changes in the small scales of the wind due to the bidirectional interaction between the turbulence and fire
- To observe changes of the isotope composition in and around the fire plume

Experiment design:

- 2 fires about 50 ha each (one after the other the same day), both ignited around same time (morning)
- We can drive the fire in order to fulfil the observations needed for the ongoing research

Resources provided by Fire brigade Generalitat:

- Burns will be carried out by fire service resources
- They can provide helicopters as platforms for sensors
- They can provide a basecamp (tents, servers, network and facilities) for the experiments