LIAISE-NL: understanding Evapotranspiration over complex terrain
by integrating processes, scales and methodologies

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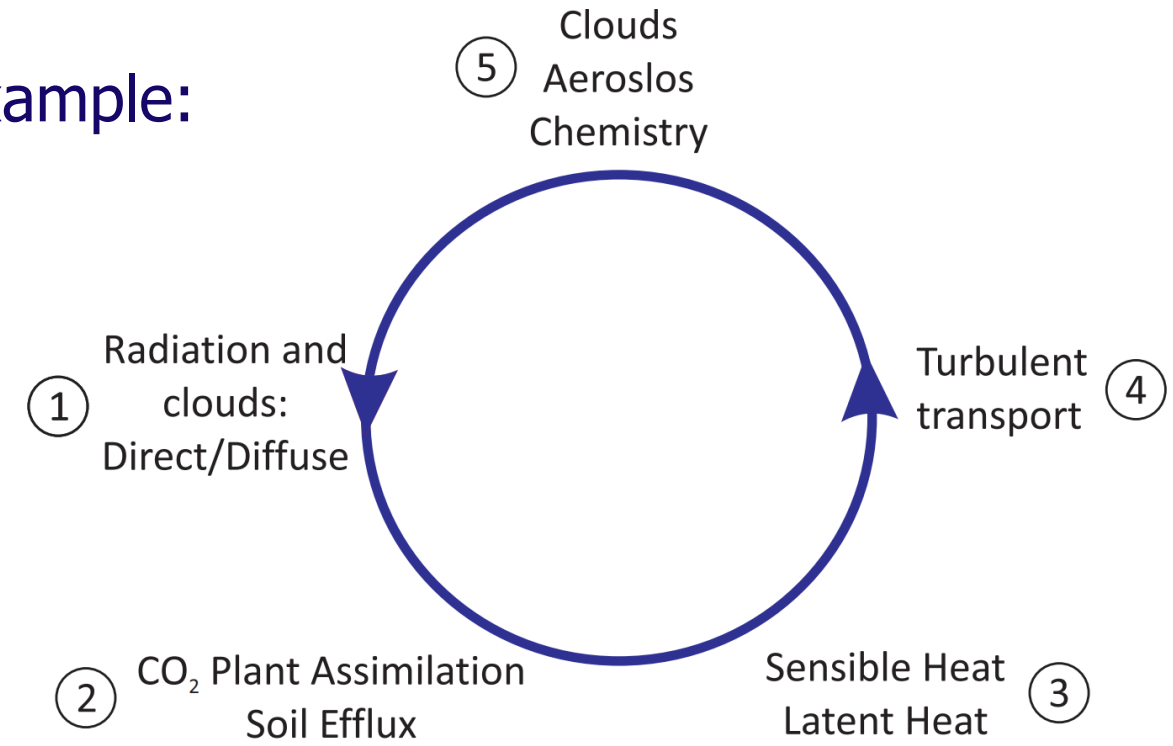
"Evapotranspiration and Boundary-Layer Clouds interact through biophysical processes across multiple spatiotemporal scales connecting Leafs to Clouds"

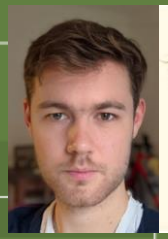
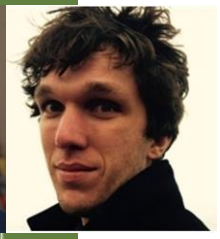
Example:



Jordi Vila

LIAISE-NL Team: innovative observation techniques and modelling

Distributed Temperature Sensing (DTS)

Spatiotemporal Radiation

Head coach

Number 10,
LIAISE integrator

On loan with team Atacama


Ecophysiology


Isotopologue Fluxes

Team captain,
Scintillometry

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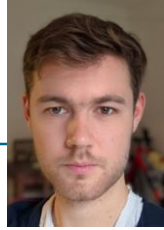
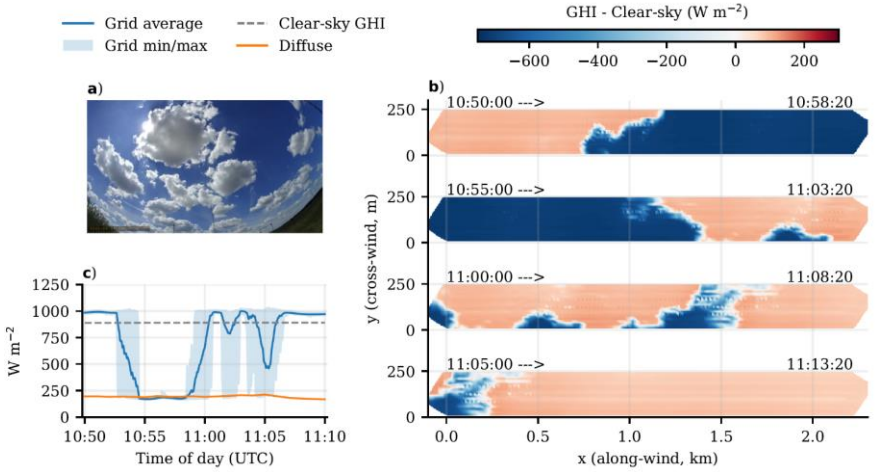
Universiteit Utrecht

TU Delft

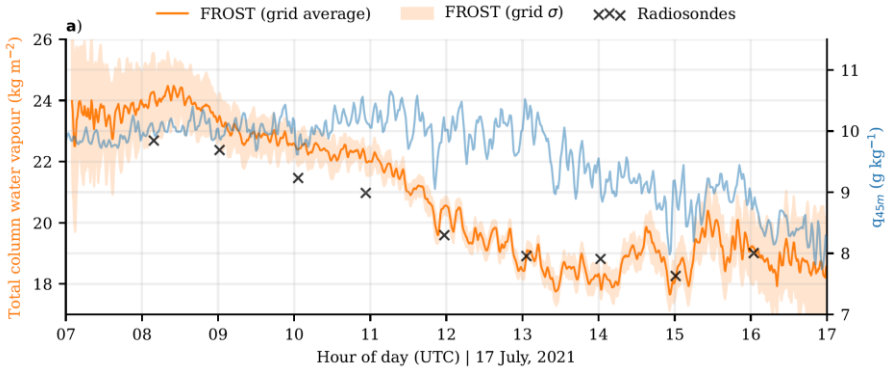


LIAISE-NL Team – Spatiotemporal radiometers

- FROST: Fast Response Optical Spectroscopy Time synchronized instrument (Heusinkveld et al., 2023)
- 18 wavelengths + 1 UV - Fast (>10Hz) - Spatial grid (5 locations) - Vertical profile through canopy (5 heights)



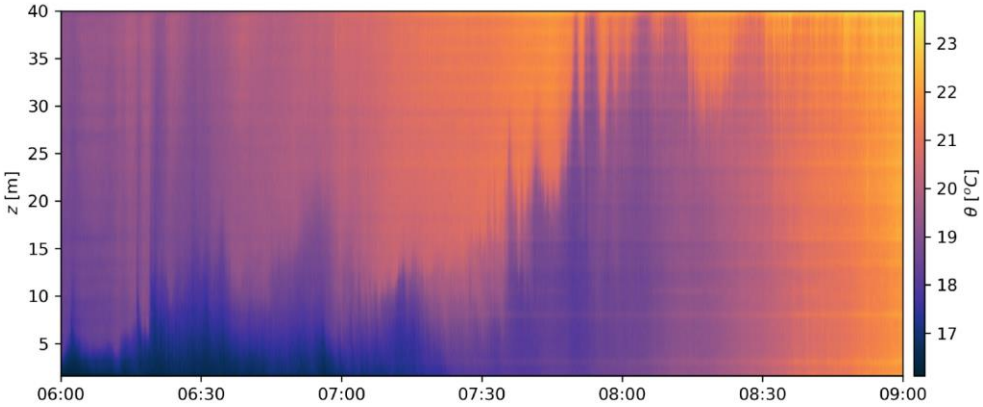
Spatial radiation patterns



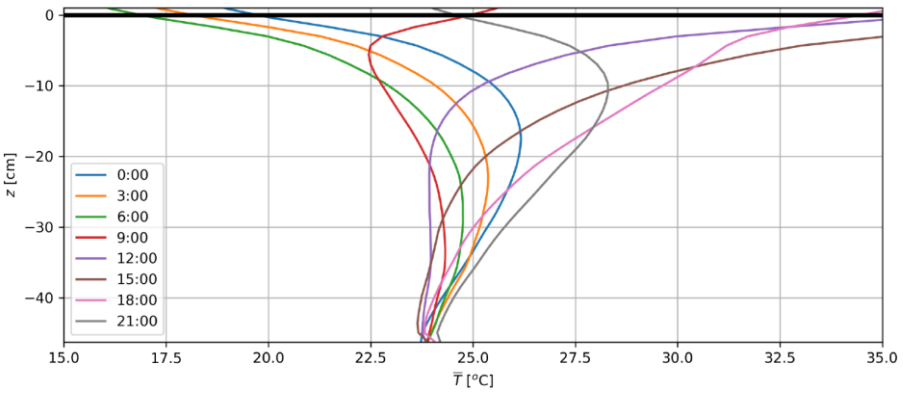
Total column water vapour

LIAISE-NL Team – Distributed Temperature Sensing (DTS)

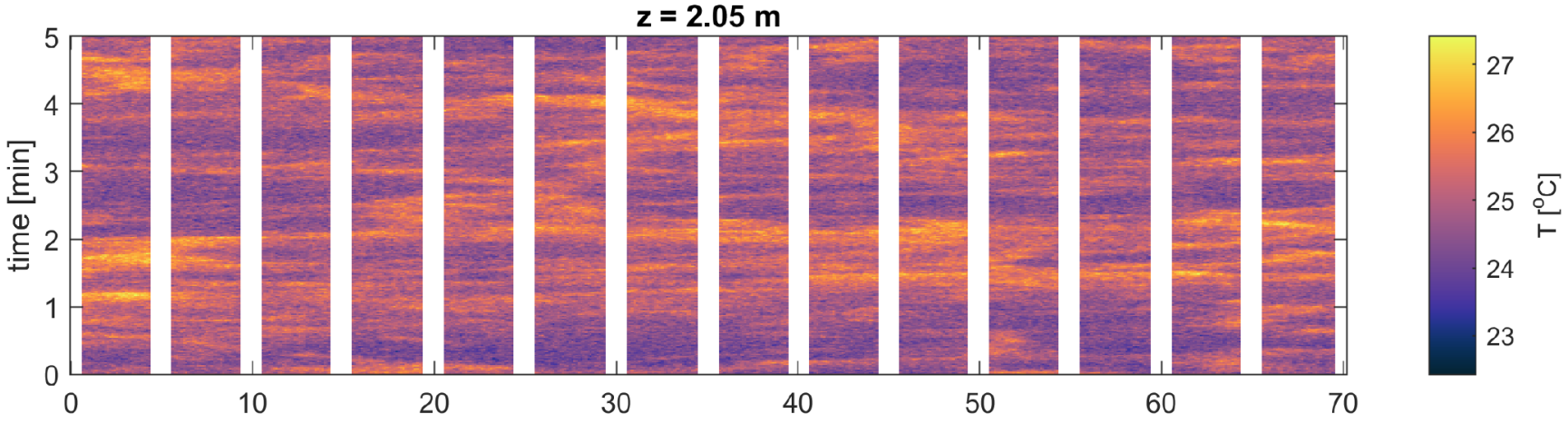
- Detailed temperature structures in horizontal and vertical
- First attempt with spatially distributed turbulence measurements



Vertical Profile 50m tower



Vertical Profile Soil



Horizontal Profile Turbulence

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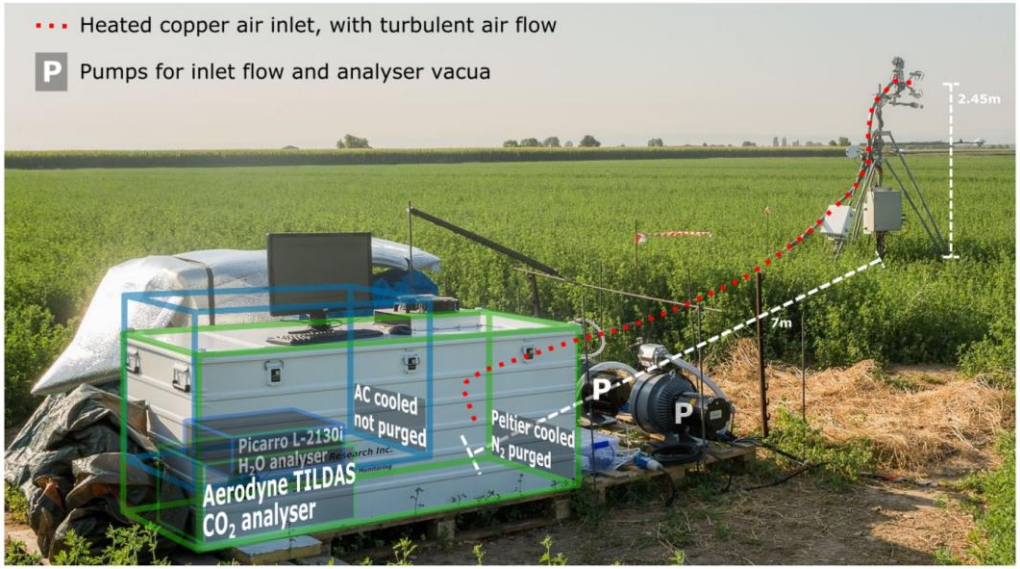
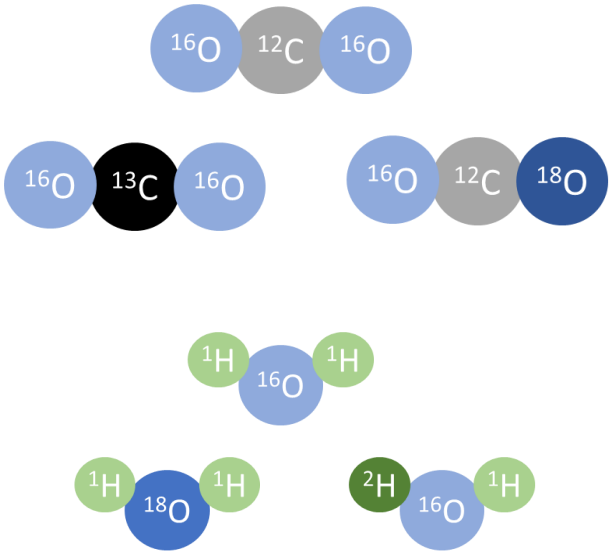
LIAISE-NL Team – Isotopologue fluxes

- **Motivation:** H_2O and CO_2 isotopologue fluxes bare information about the source area; constrain flux partitioning at a canopy level
- **Method:** Couple fast isotopologue measurements to flux technique (scintillometer combination method and Eddy Covariance)

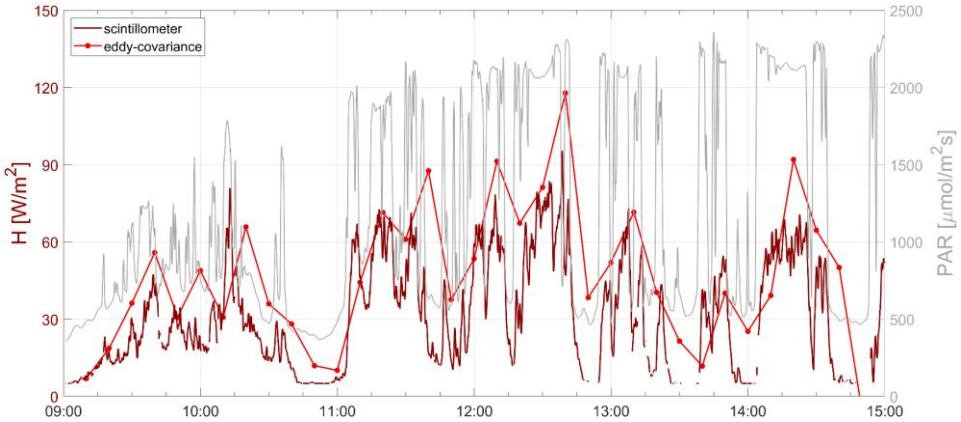




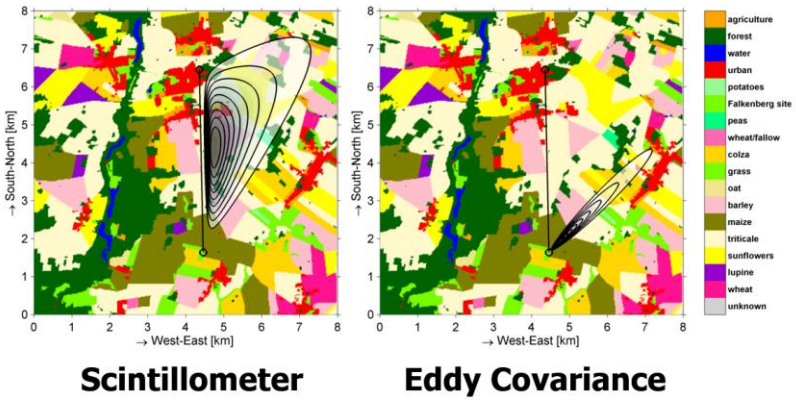
LIAISE-NL Team – Scintillometers

Short timescale *H* + u* with
a dual-beam Laser Scintillometer

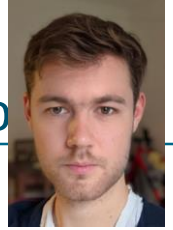
Landscape scale *H* + *L*$_v$*E* with
combined Optical and Microwave Scintillometers



PAR (6s) – Scintillometer (6s) – EC (30min)
(van Kesteren, 2013)



Footprint Scintillometer > EC



- Measurements of **stomatal conductance, transpiration and photosynthesis**
- **Photosynthesis parameters** (Vcmax, Jmax, Rd), light response curves
  → needed for photosynthesis **model parameters** (Farquhar, A-gs)

LI-6400XT leaf gas exchange

LIAISE league: all Teams

Team MF-CNRM

Team UKMO

Team UIB

Team IRTA

Team LIAISE-NL

Team SAFIRE

Team Juelich, CESBIO, ..

LIAISE-NL: Integrating processes, scales and methodologies

	t	X	Z		Observations
Leaf/Plant	$\sim s$	$10^{-1}m$	$10^{0}m$		chambers, DTS, plant characteristics
Field	$\sim$mins	$10^{2}m$	$10^{2}m$		EC, scintillometers, DTS lysimeters, isofluxes
Landscape	$\sim$hour	$10^{3}m$	$10^{3}m$		scintillometers, radiation patterns, radiosondes, aircraft
Regional	$\sim$hours	$10^{2}km$	$10^{3}m$		radiosondes, aircraft, satellite RS
~~**Global**~~	~~$\sim$days~~	~~$10^{4}km$~~	~~$10^{2}km$~~		Basin recharge

How much model complexity is needed?

Raupach and Finnigan, 1988

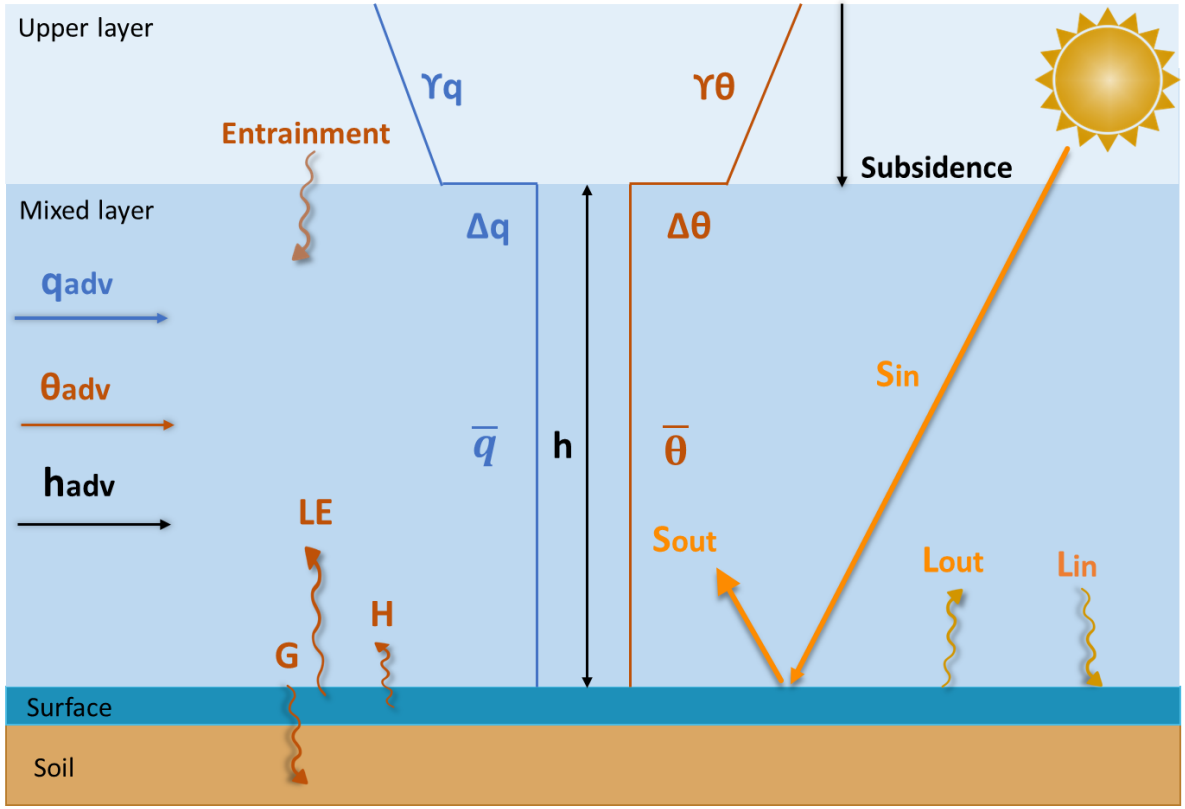
'Simple models are incorrect,

but useful, whereas

Complex models are correct

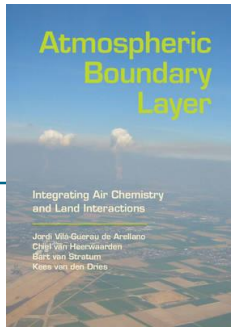
but useless'

Simple Model – CLASS (https://classmodel.github.io/)



CLASS (Chemistry Land-surface Atmosphere Soil Slab):

- 0D (space) - 1D (time) mixed layer model
- simple, conceptual
- Integrates soil – plant – surface - boundary layer



$$\frac{\delta\bar{\theta}}{\delta t} = \frac{\frac{H}{\rho c_p} + w_e \Delta\theta}{h} + \theta_{adv}$$

Land-Surface:

- Radiation Balance
- Surface Energy Balance:
  - Soil: 2 layers, force-restore method
  - Surface: Penman-Monteith, resistance formulation fluxes
  - Plants: Farquahar/A-gs
- Surface layer: MOST

Boundary layer:

- mixed layer equations (advection terms if needed):

$$\frac{\delta\bar{\theta}}{\delta t} = \frac{\frac{H}{\rho c_p} + w_e \Delta\theta}{h} + \theta_{adv} \qquad \frac{\delta h}{\delta t} = w_e + Div\left(\overrightarrow{U_h}\right) h + h_{adv}$$

CLASS workflow

Model set-up heavily constrained by data:

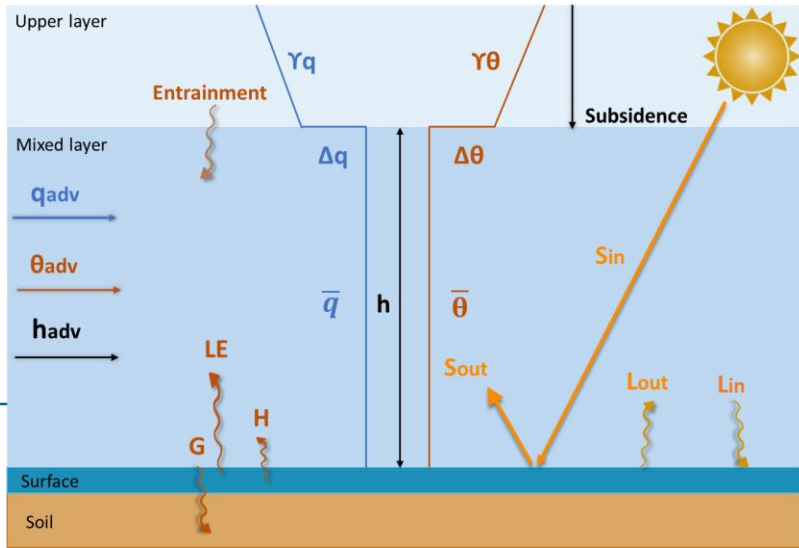
- Ecophys: LAI, veg-cover, A_{max}, V_{cmax}, J_{cmax}, ...
- Surface: soil moisture, soil type, roughness parameters,...
- Boundary Layer initial profiles

Prescribe external processes (data, ERA, WRF):

- Advection
- Subsidence

Experiment:

- Bypass a process with prescribed values
- Add additional process
- ...



CLASS in LIAISE-NL team

Mary-Rose Mangan (LIAISE):

- Influence of scale (local, landscape, regional) on BL development
- Processes controlling ET tendency
- Data driven

Raquel Gonzalez (LIAISE)

- Upscaling leaf traits to canopy scale
- Case-study: effect of cloud on radiation on ecophysiology
- Future: isotopologues in CLASS
- Data driven

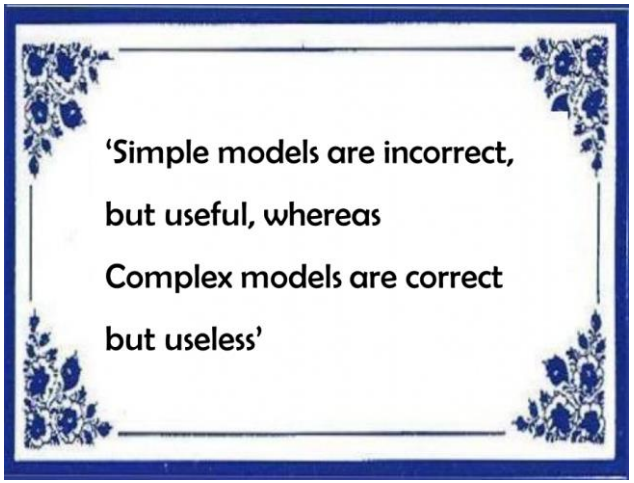
Francisca Aguirre (Atacama)

- Boundary layer effects on E-regime of a salt-water lagoon
- Data + WRF driven

Conclusions:

In understanding Evapotranspiration over complex terrain:

- Connect Scales
- Connect Measurements and Models
- Connect Disciplines – Meteorology/Hydrology/Biology
- Connect Soil – Plant – Land-Surface – Boundary-Layer
- Connect local and non-local



Thank you

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