Learning lessons from Amazonia to Ruisdael

Jordi Vilà
Meteorology and Air Quality Section
Wageningen University

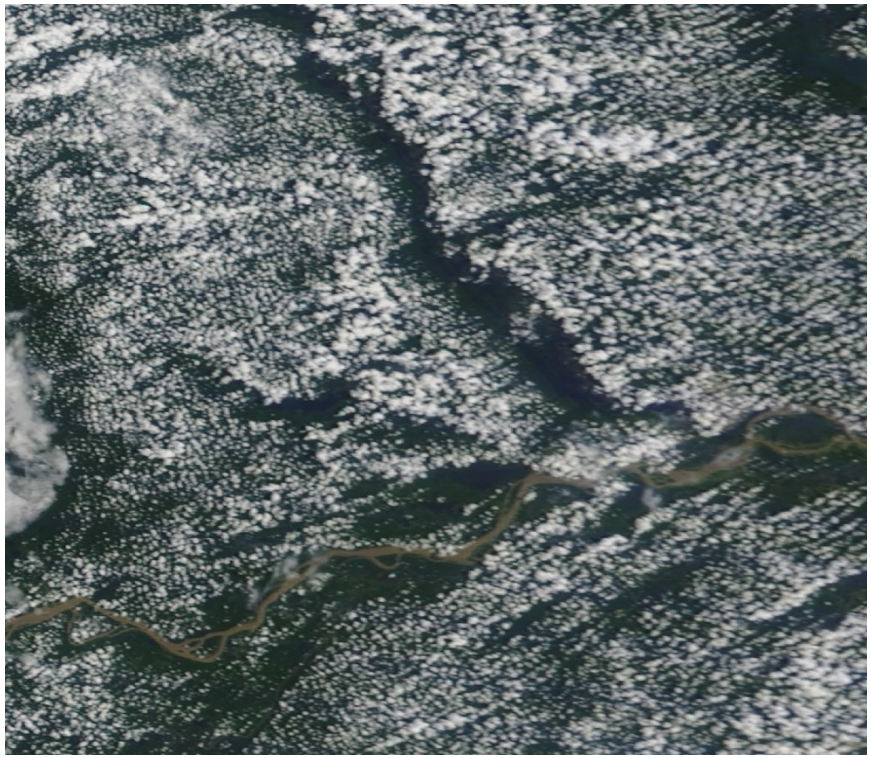
...we estimate reductions 21 per cent in the dry season precipitation respectively across the Amazon basin by 2050, due to less-efficient moisture recycling (Spracklen et al., 2012)

...rainforest transpiration enables an increase of shallow convection that moistens and destabilizes the atmosphere during the initial stages of the dry-to-wet season transition (Wright et al. 2017)

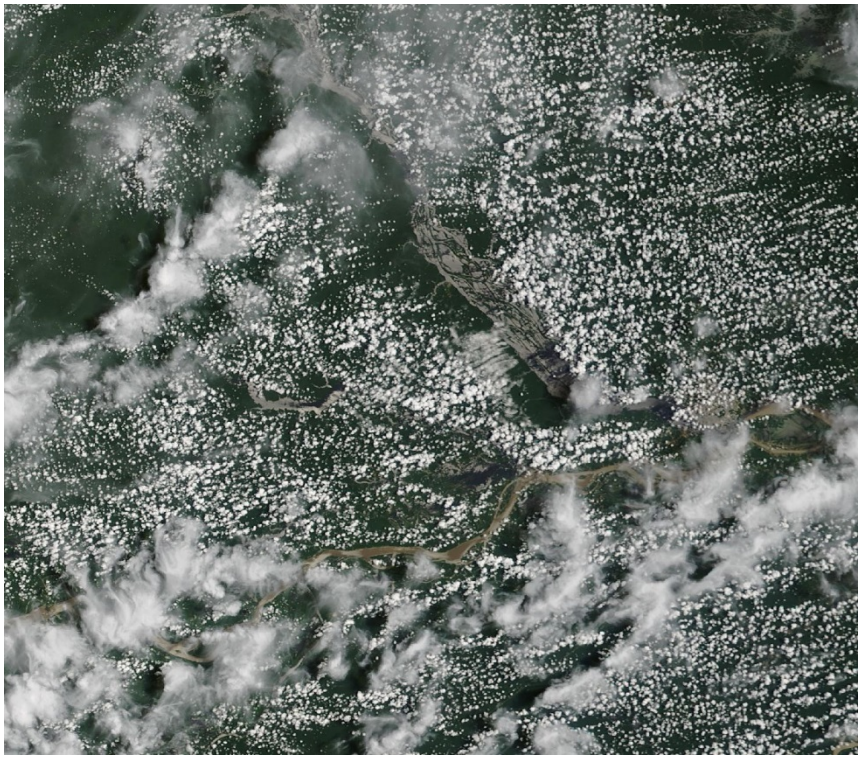
...The total drought response in the Amazon in our estimates is distributed between additional biomass burning and reduced net biomass (CO_2) exchange uptake (van der Laan-Luijkx et al., 2015)

The Green-White Amazonian Rainforest

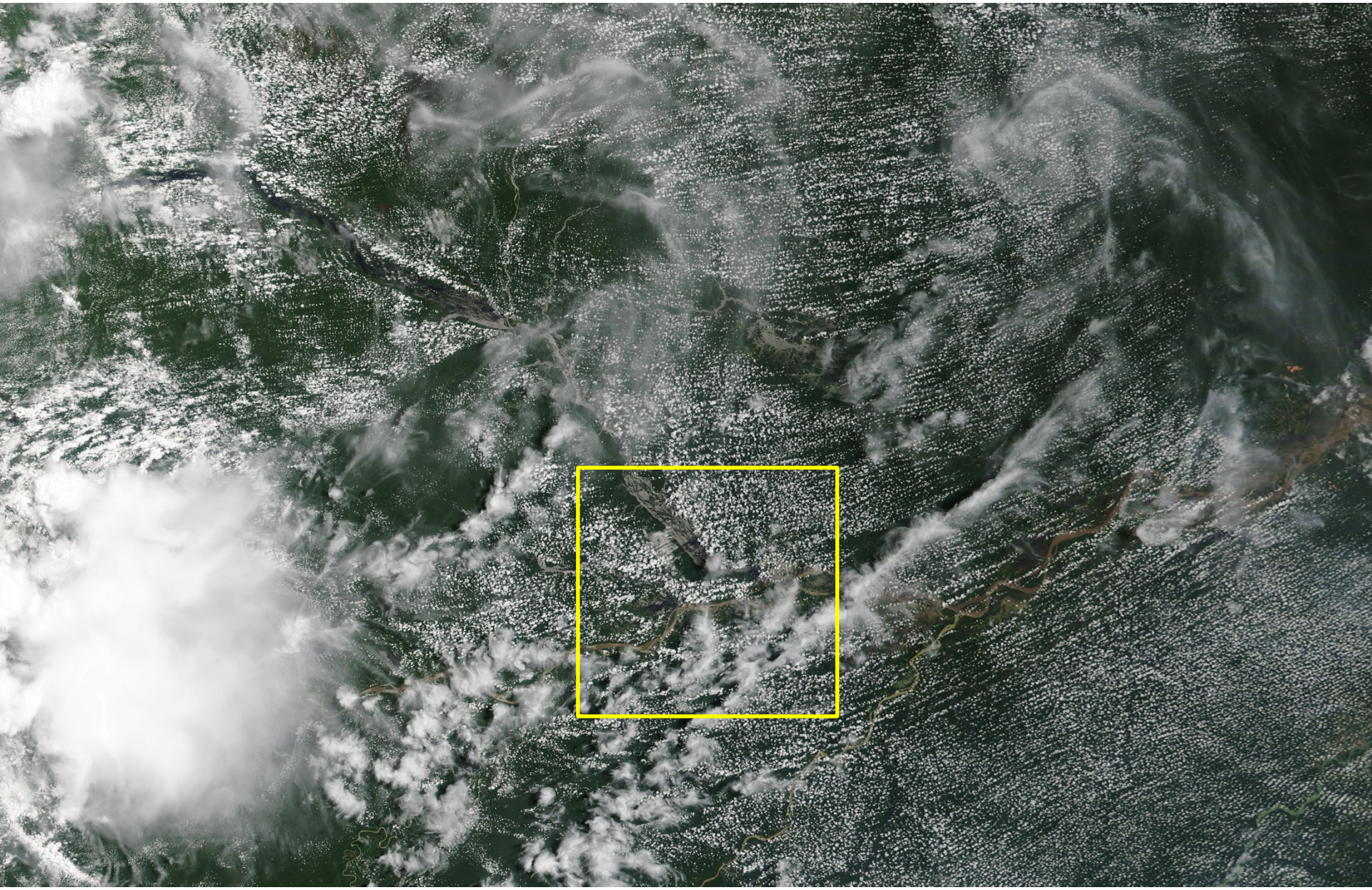
10-09-2014



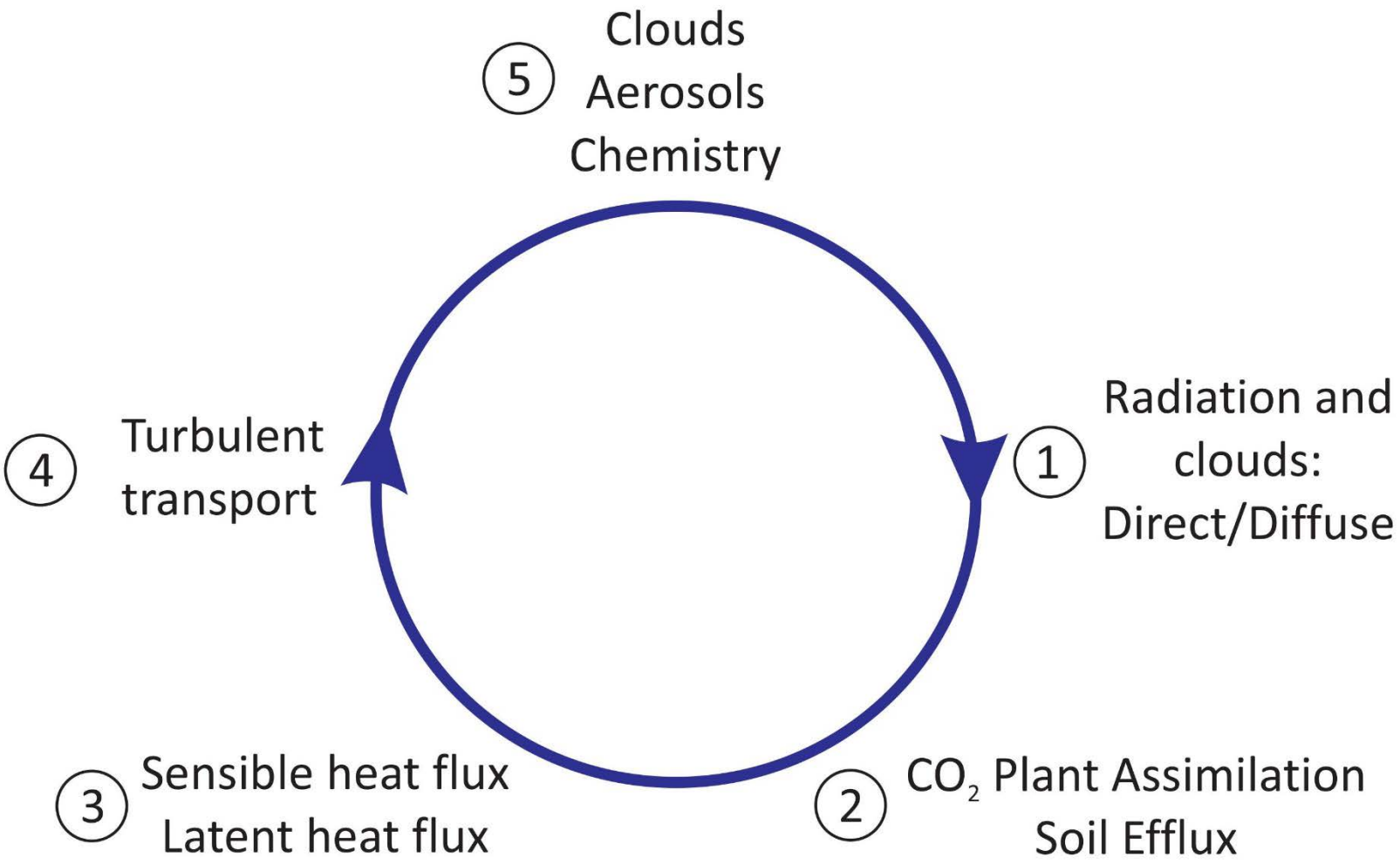
14-09-2014



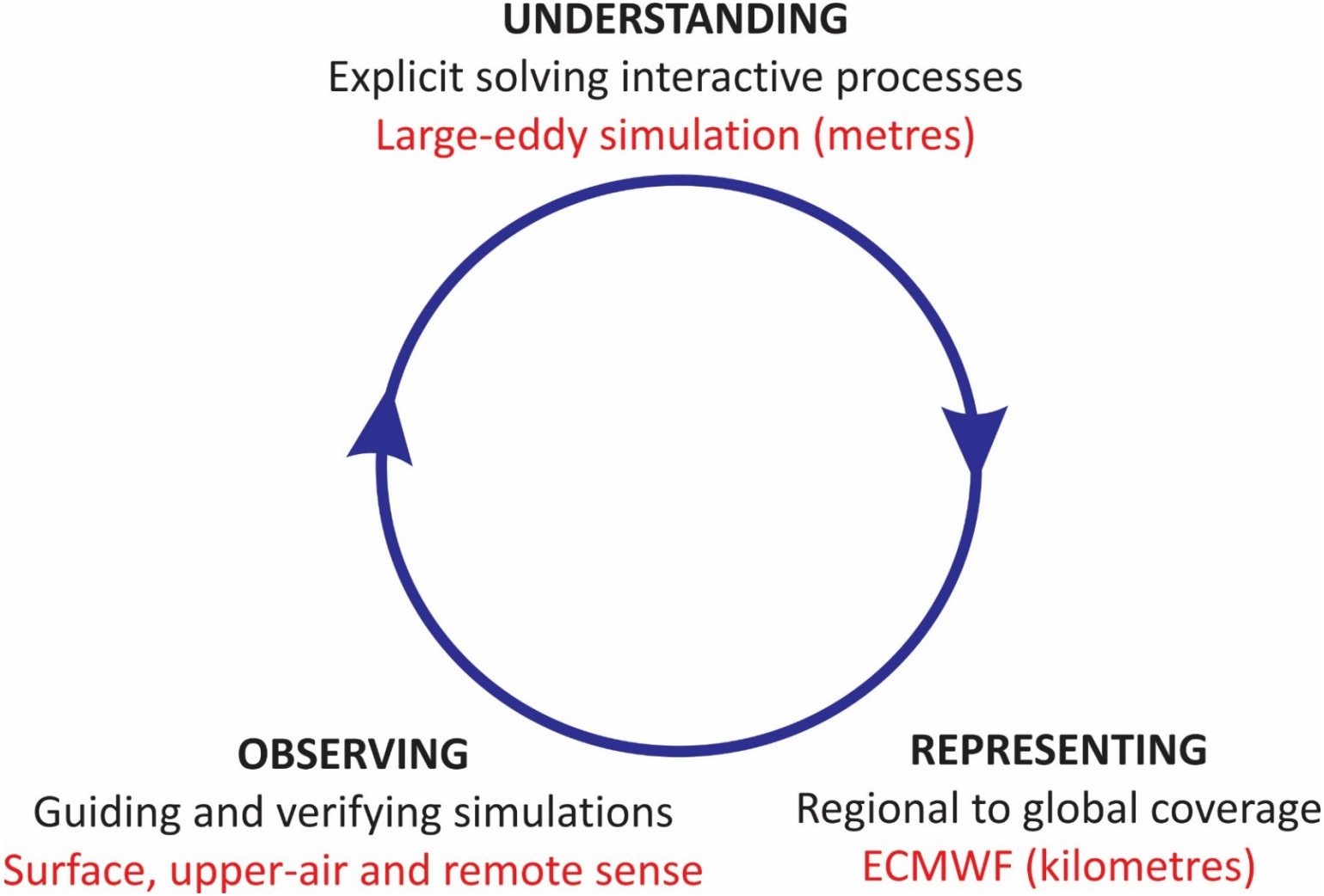
Understanding the energy, water and carbon cycles at the sub-daily and sub-kilometre scales

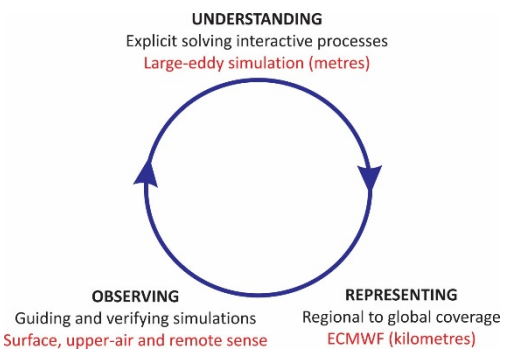


Biophysical processes interconnected to weather

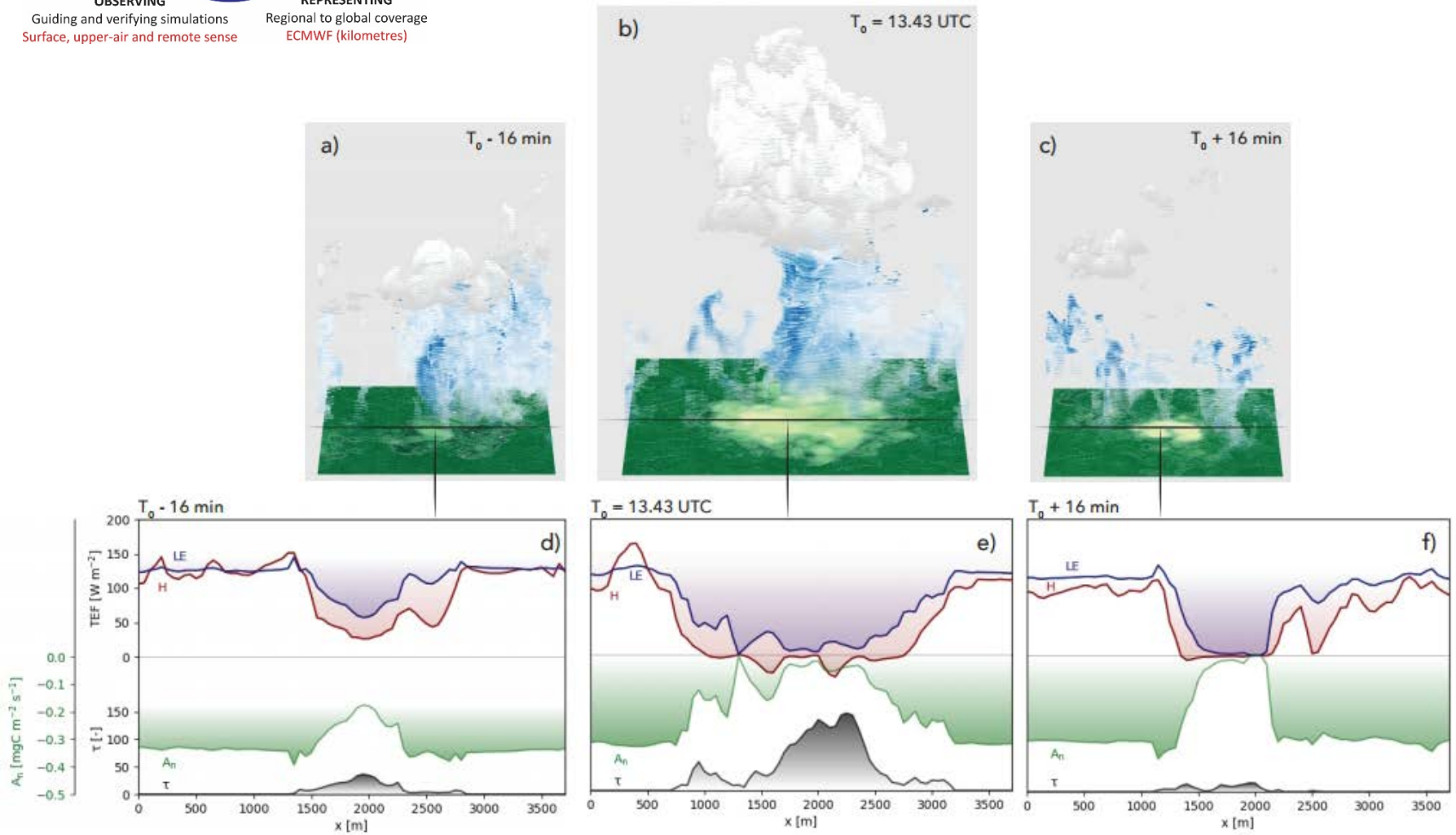


Research strategy: integrating methods



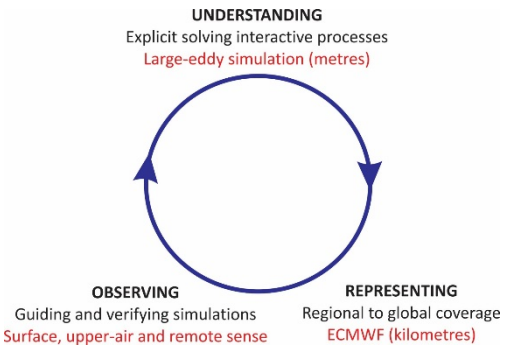


Understanding: Large-eddy simulation

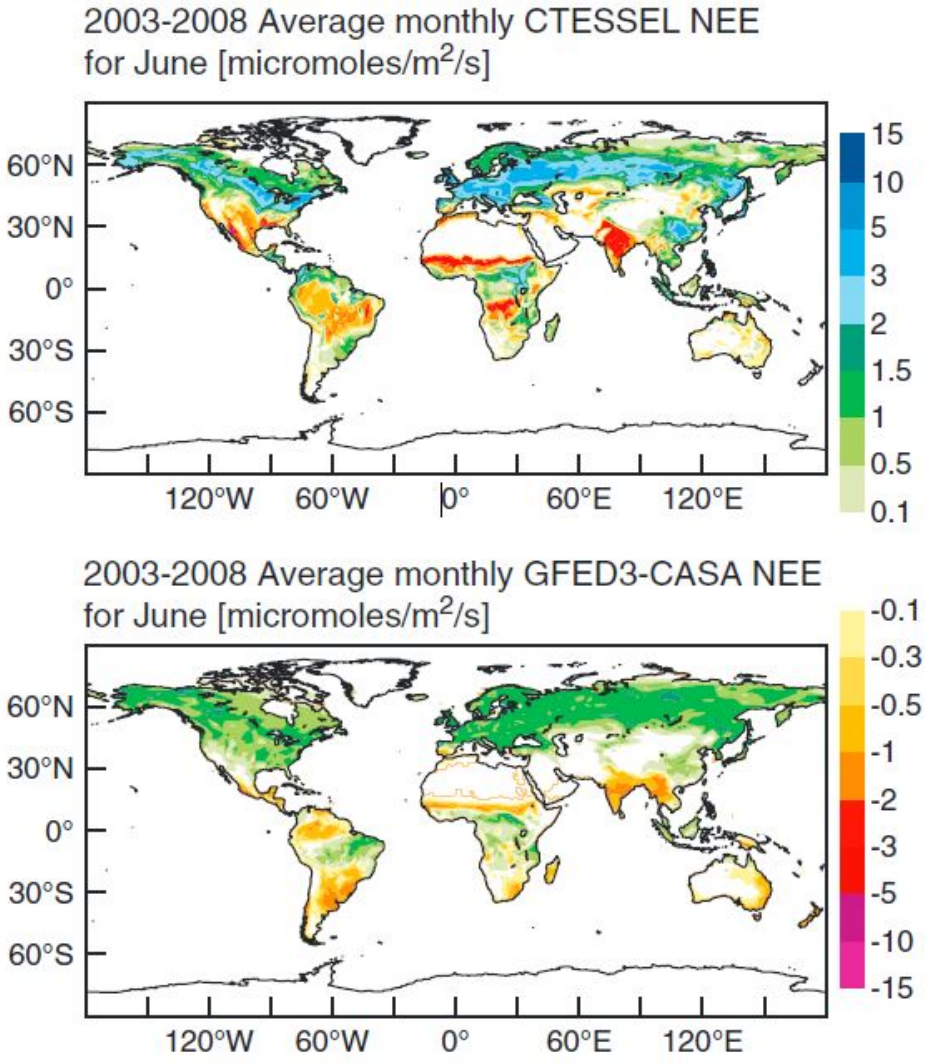


50 m x 50 m x 20 m

PhD thesis Sikma (2019)

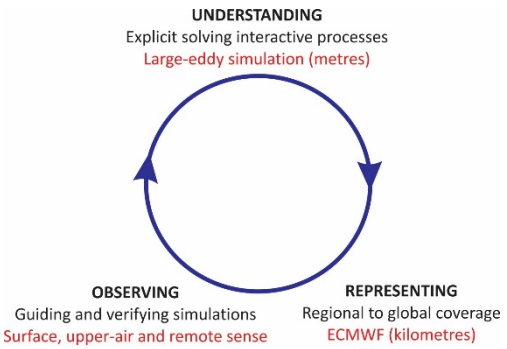


Representing:
ECMWF-Integrated Forecasting System

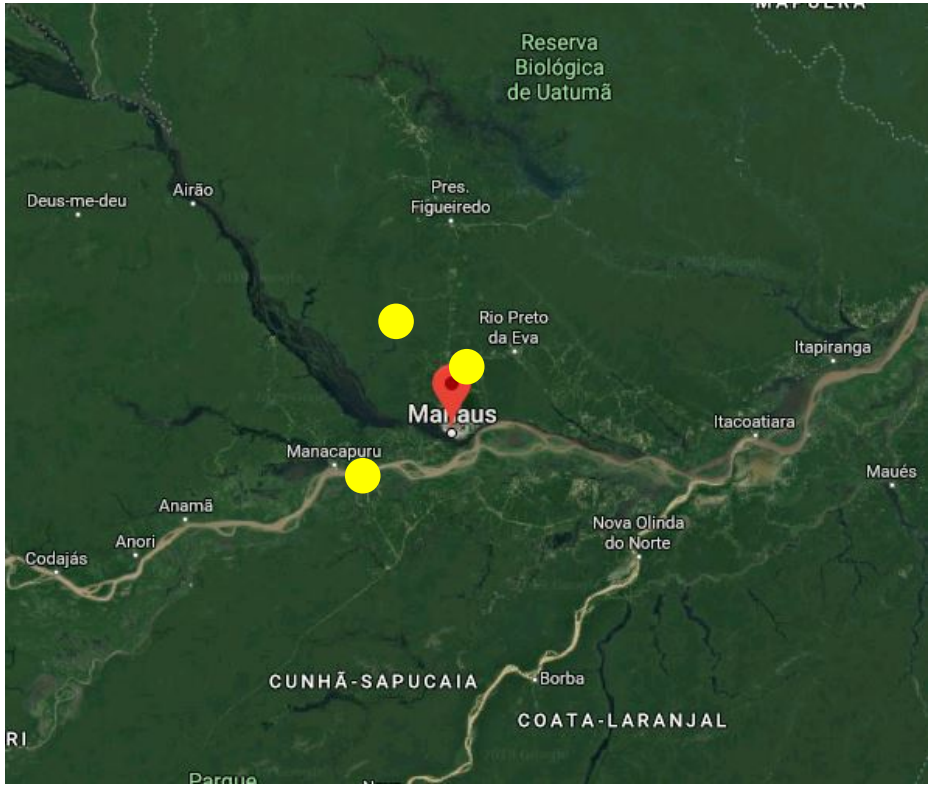


9 km x 9 km x 20 m

Bousseta et al. (2013)



Observations:
GoAmazon campaign September 2014

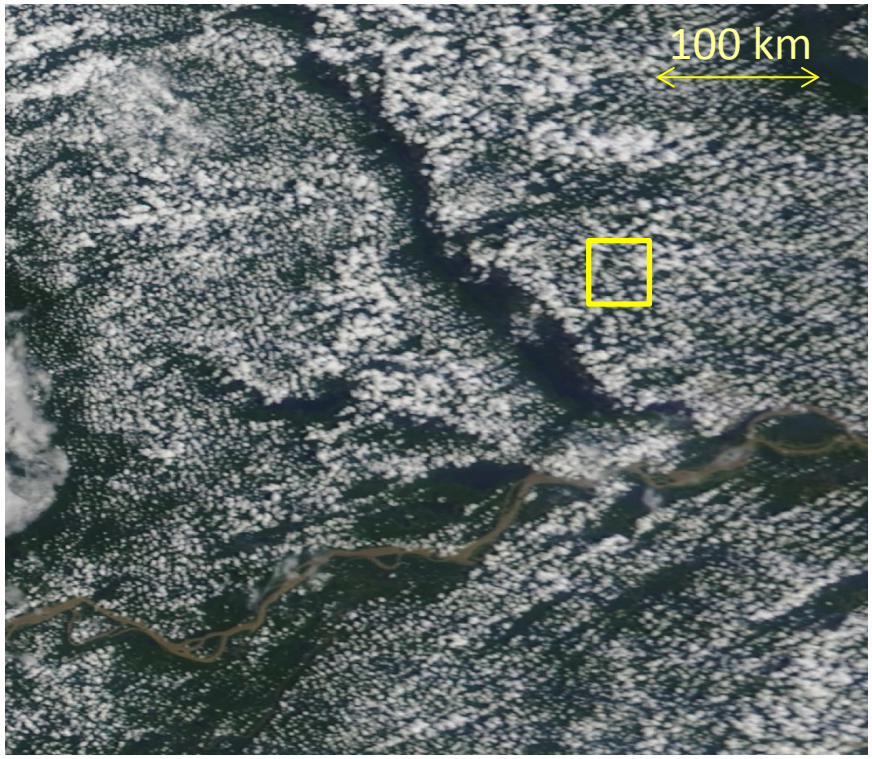


- Comprehensive 4D data set
- K34 tower (60 km NW Manaus)
  40 meter above the canopy
- Radiosoundings state variables
- ARM-Mobile facility:
  Cloud properties

(Martin et al., 2017)

Dry-to-wet season: September 2014

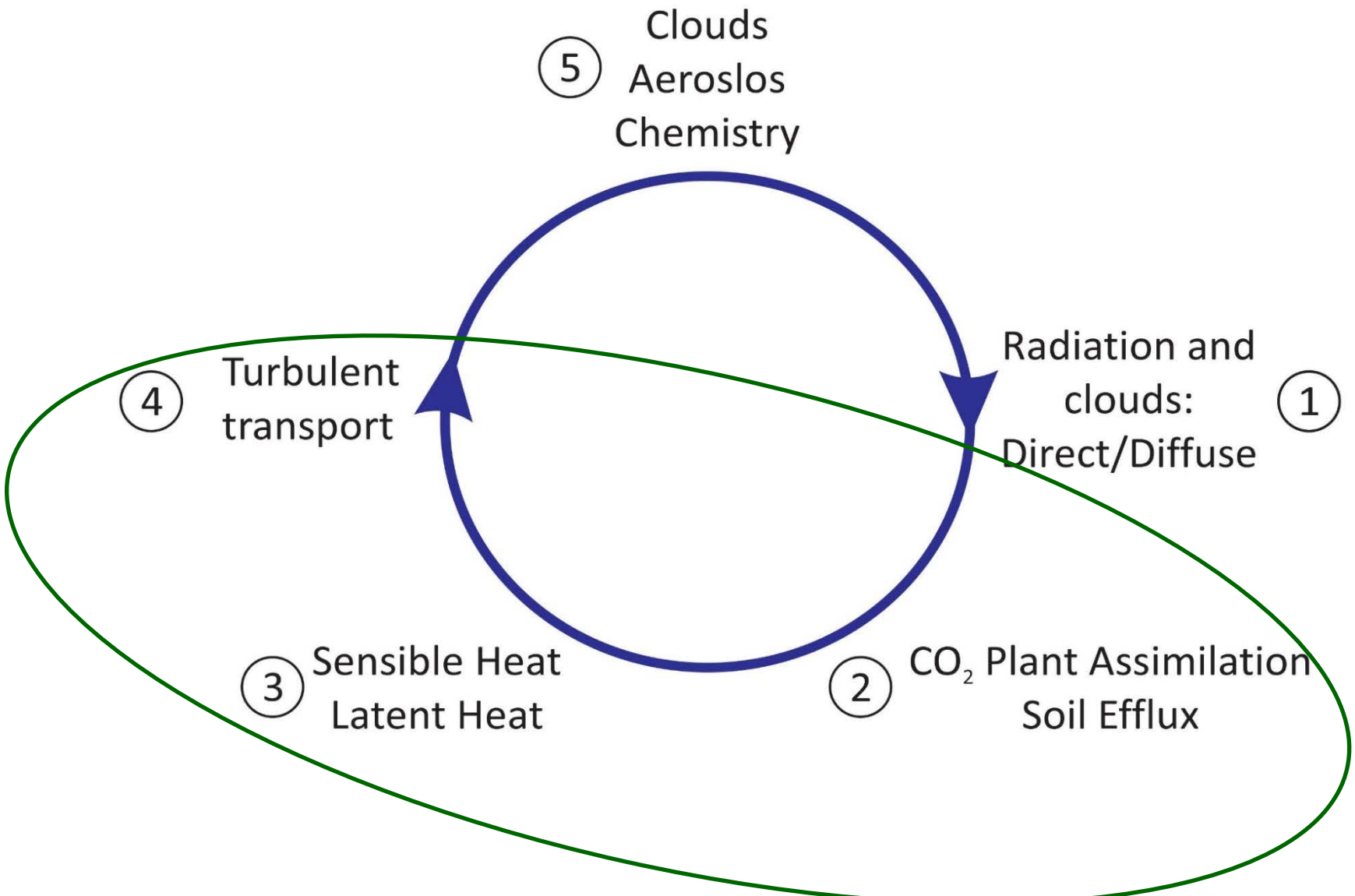
10-09-2014



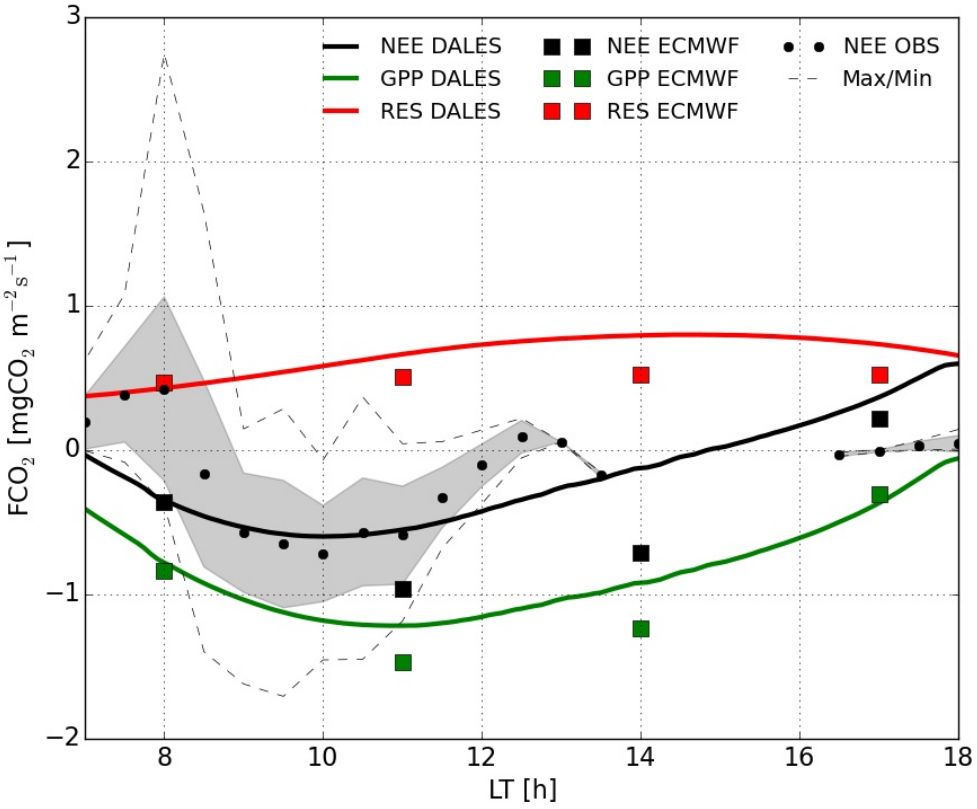
- For numerical experiment one representative day
  - DALES
  - ECMWF

- For observations, a monthly mean aggregate to study the variability, minimum and maximum values

Midday plant depression: fluxes CO_2 above the canopy

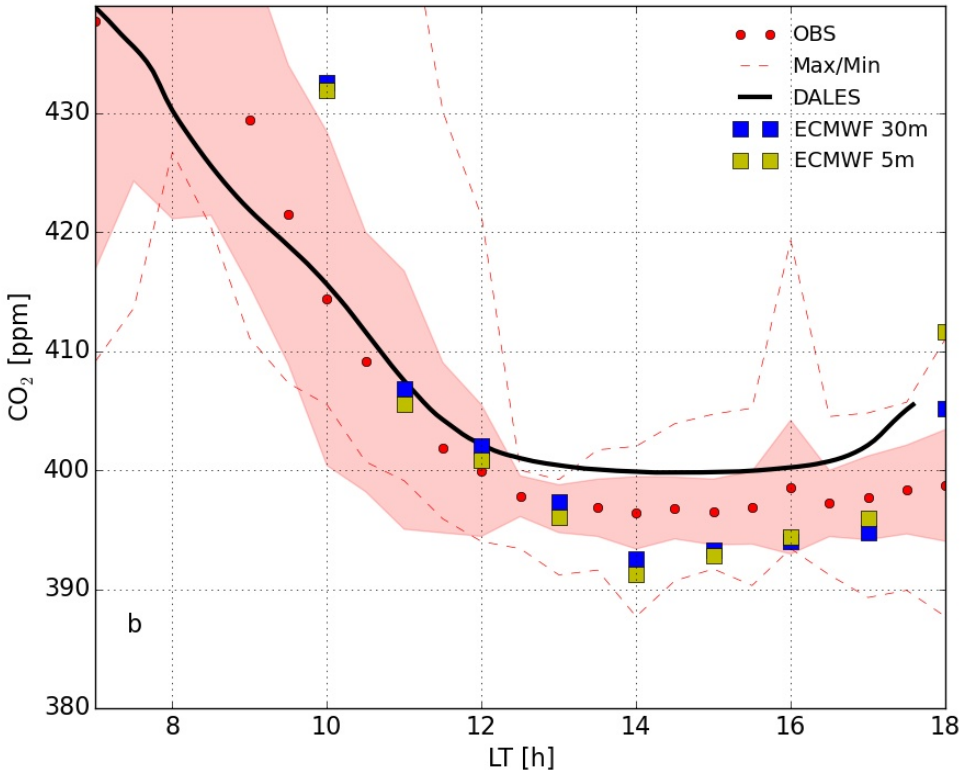


Midday plant depression: fluxes CO_2 above the canopy



- CO_2 assimilation and plant transpiration differs from morning to afternoon
- Hysteresis loop depends on soil moisture to water vapour pressure deficit (demand atmosphere)
- Similar timing onset shallow cumulus convection
- When does dial terrestrial update becomes a source or a skink?

CO_2 diurnal variability: Mixing ration above the canopy



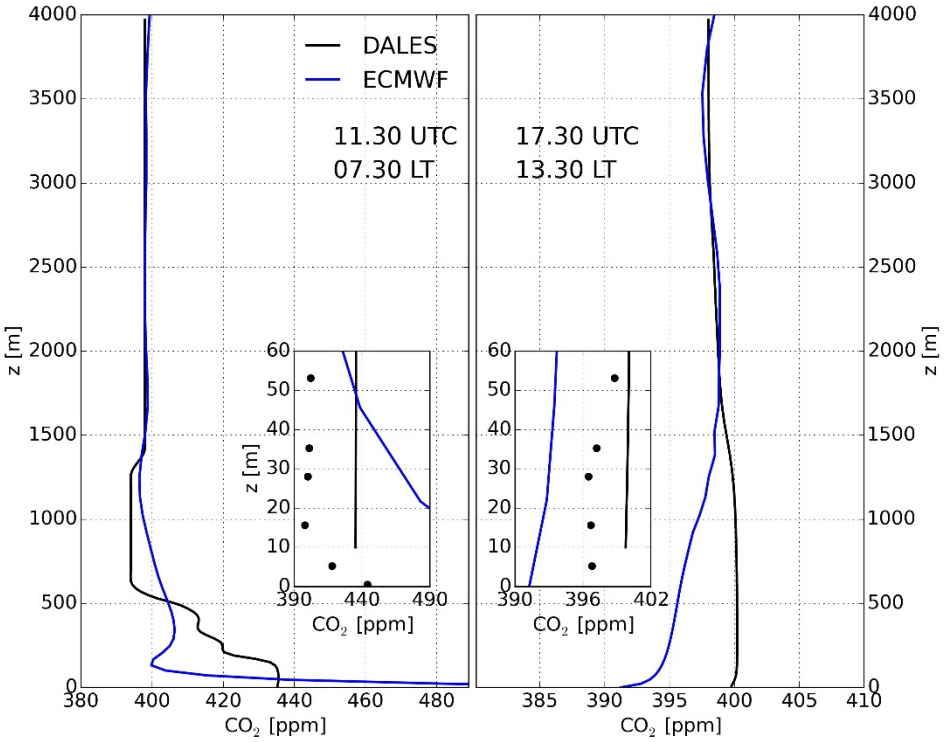
- CO2 diurnal variability depending on:

  - Local sources/sinks in the canopy

  - Entrainment residual layer and free troposphere

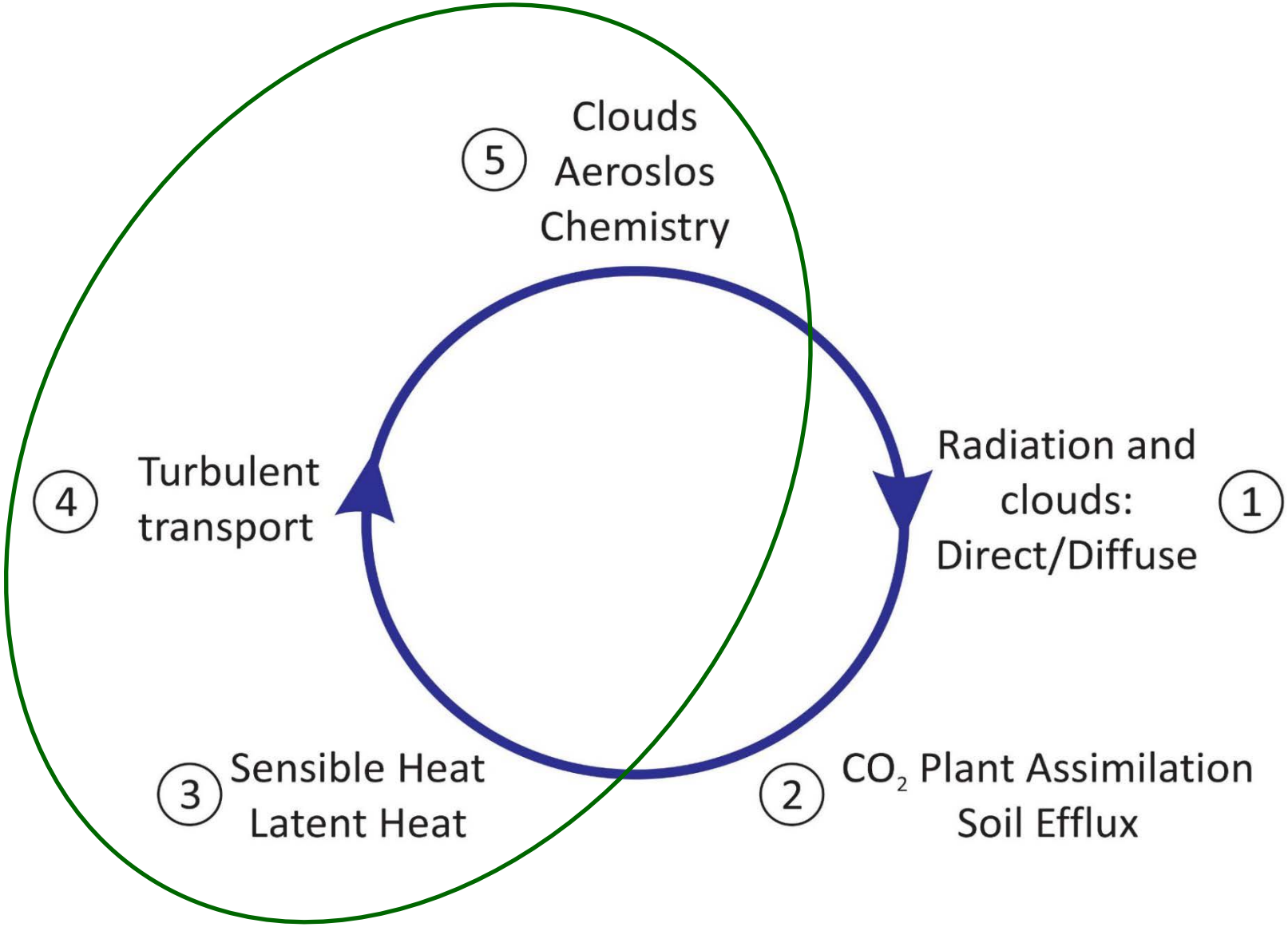
  - Large-scale transport

Interaction canopy-atmosphere: CO_2 vertical variability

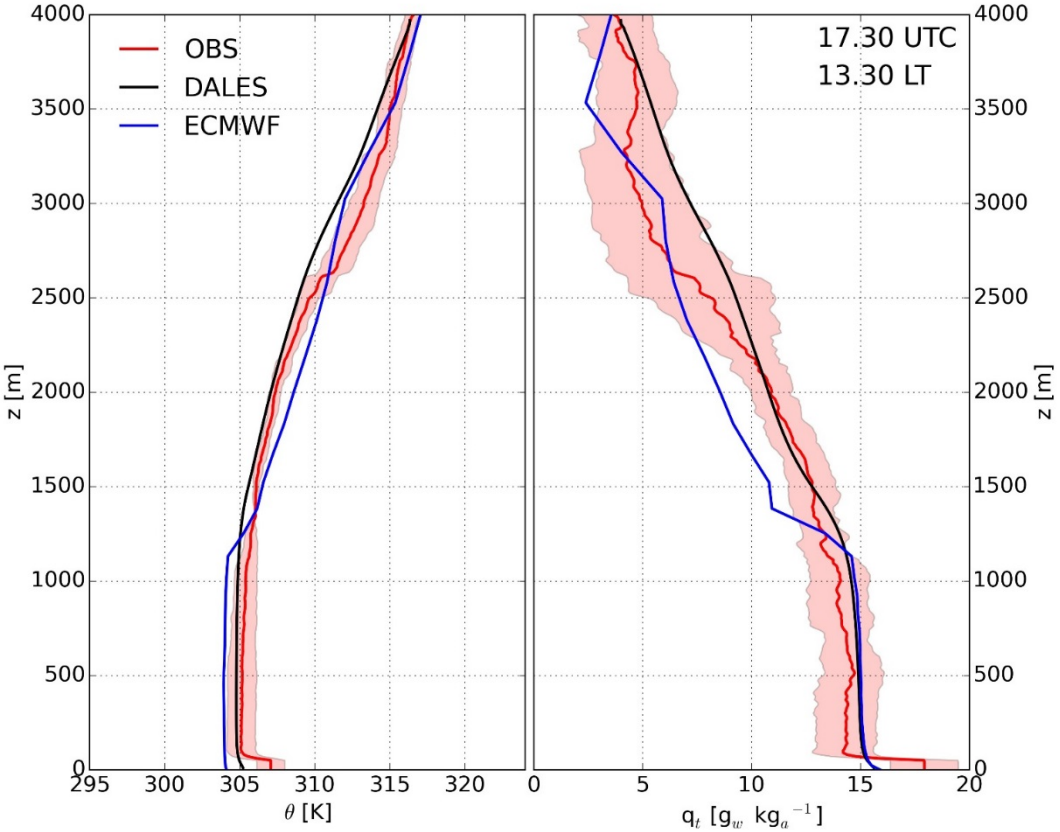


- CO_2 profiles in and in the roughness sublayer remains a challenge
- Disagreement between DALES and ECMWF in the sub-cloud layer
- Interaction between large-scale CO_2 spatial distribution and local sources and sinks

Transition dry-to-wet convection

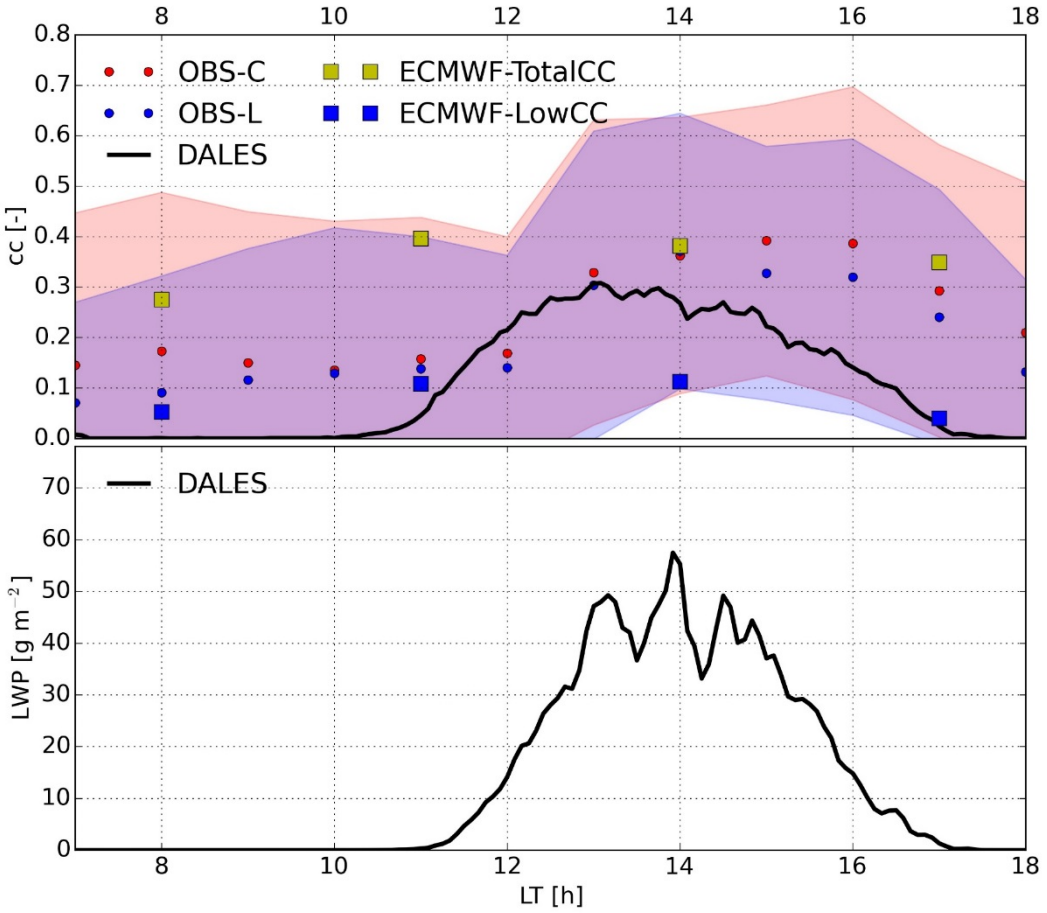


Moistening and destabilization above cloud base



- Thermodynamic profiles follow typical vertical structure shallow convection
- Small monthly observational variability during the month September
- Reduce moistening and destabilization above cloud base by ECMWF
- Impact in triggering deep convection

Cloud cover and liquid water path: Disentangling fog, shallow and deep convection



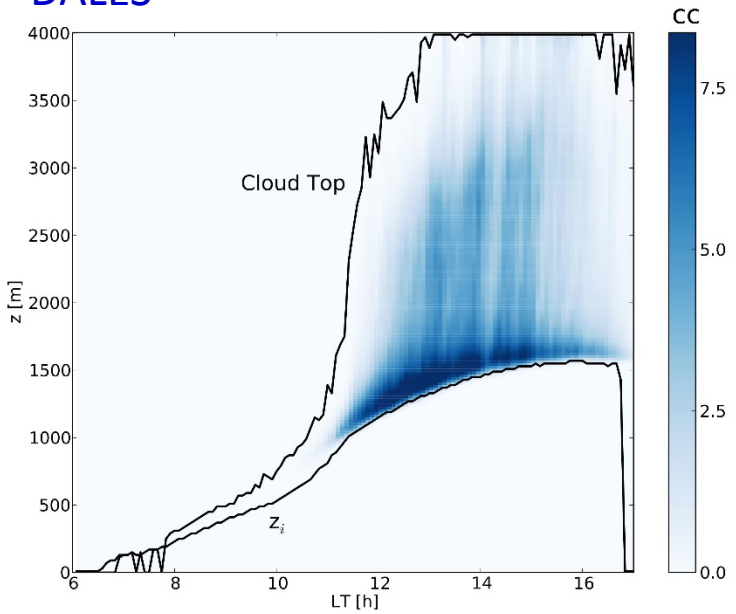
- DALES reproduces well the transition from clear to shallow cumulus

- Open challenges with respect to the morning fog and the transition from shallow to deep convection

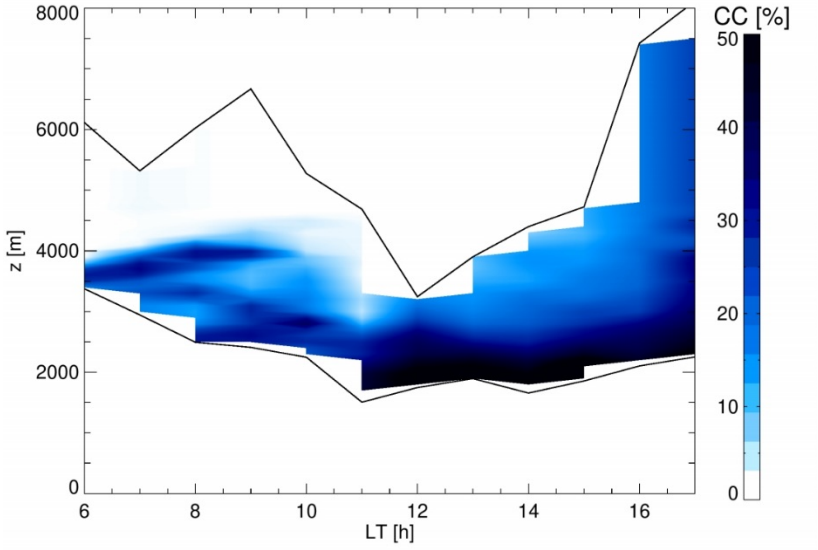
- Observing liquid water content by radar (small droplets, drizzle) with larger uncertainties

Cloud cover variation with height

DALES



OBSERVATIONS



- Possibility to compare the variation of cloud cover with height:
DALES versus radar observations
(W band + LIDAR)

- Similar vertical distribution
in the diurnal variation: from 10 to 15 LT

- Underestimation DALES compared to the observations...
But are we comparing the same?

Learning lessons with respect to the Ruisdael TestBed

- Coupling biochemical and physical processes

  - Advanced level on implementation of processes and verification
  - Not yet there in relation to microphysics, radiation and canopy-atmosphere interactions

- Interaction spatiotemporal scales

  - Ruisdael TestBed:

  Integrating large-scale weather/CO_2 and small spatiotemporal scales

- Moving forward on atmospheric sciences

  - Identifying gaps of knowledge on scientific topics:

  midday depression and transition shallow to deep convection

Ventilation CO2 by shallow convection