CESAR Observatory

of past, of present, of future yet to come

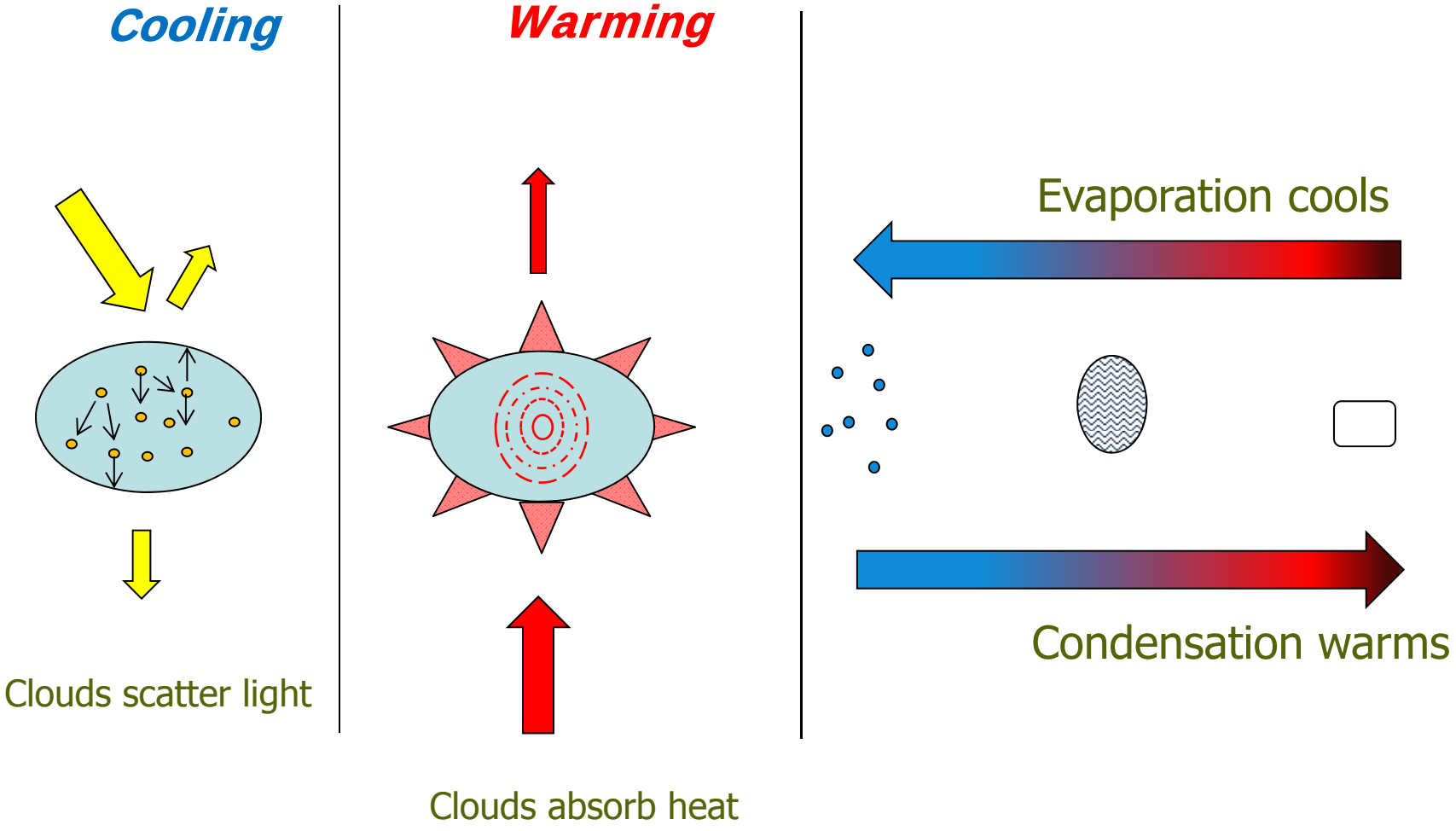
Herman Russchenberg

past

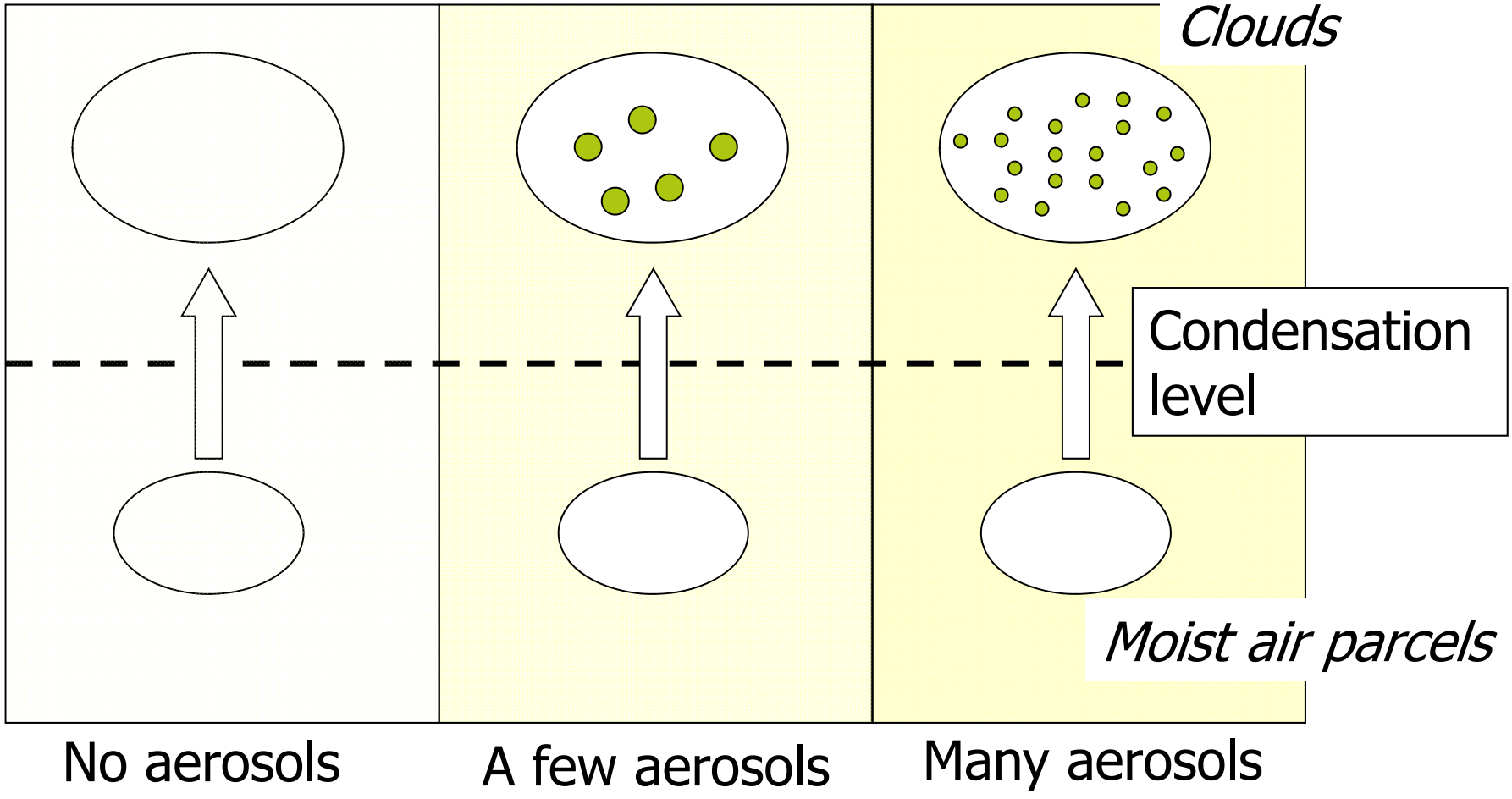
??? The role of the atmospheric water cycle in the climate system

We don't know what we don't know

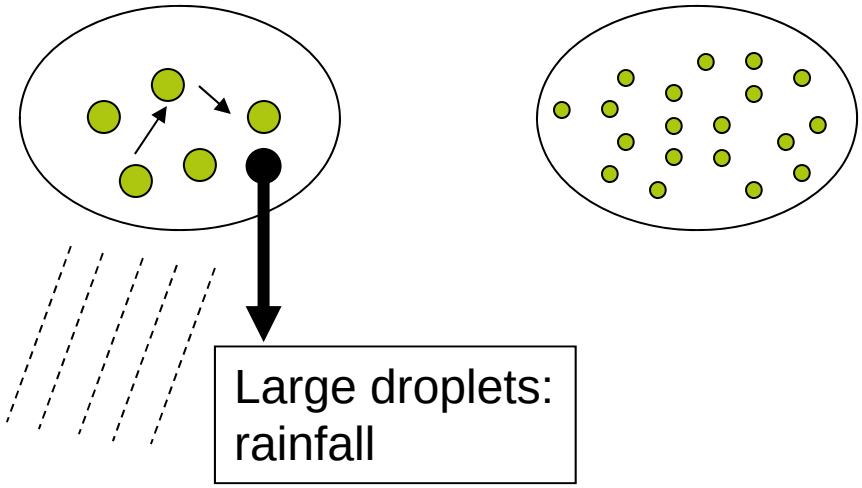
Example: clouds and climate



A bit about cloud formation



rainfall formation



More aerosols

↓

Delayed rainfall

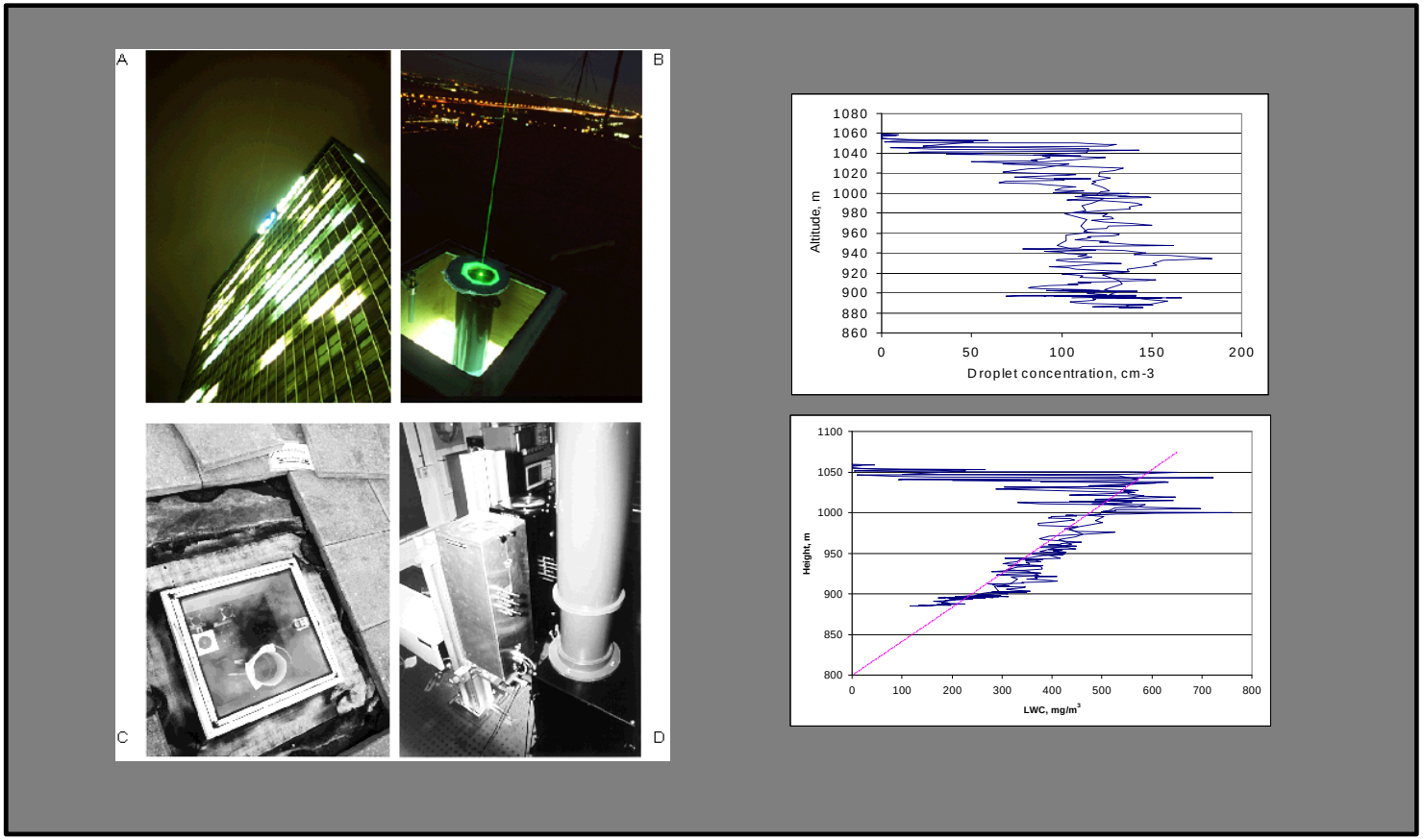
↓

Longer cloud lifetime

↓

Sustained impact
on radiation

Clara: clouds and radiation, 1996



CESAR Opening: 2002

KNMI
TU Delft
RIVM
TNO
ECN
WUR
UU
ESA
TUe

CESAR Objectives

- Validation of space-borne observations and retrieval products
- Atmospheric and land surface process studies
- Evaluation/validation/improvement of models
- New measurement techniques
- Training of young scientists at post-doc, PhD and master level.

Activities

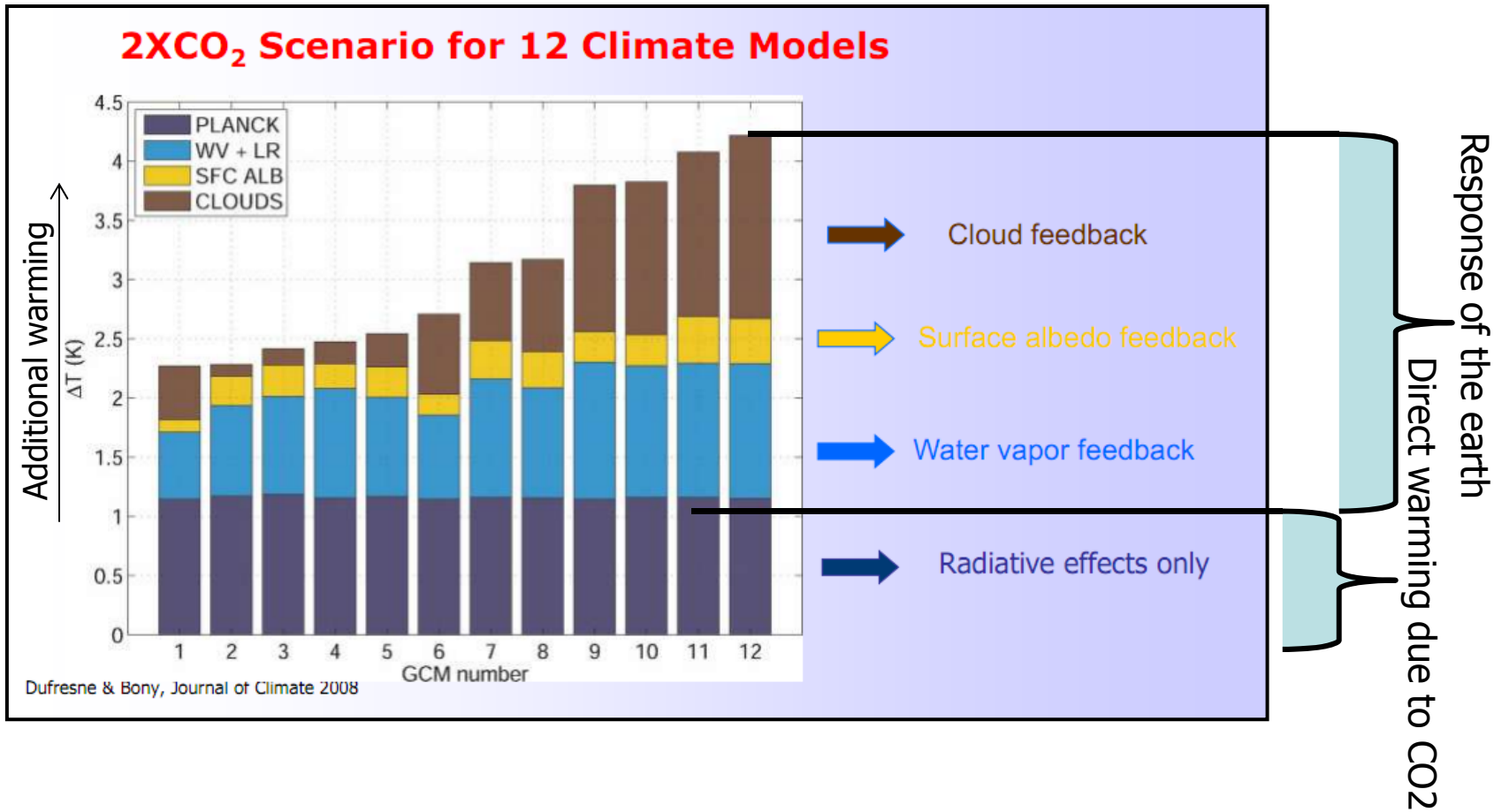
claracaprixcnn1cnn2bbccre
x02bbcdadelionsspedandelio
nseageaglesatlinkemepgopeu
caariesacalipsopilpsgablsloto
seurostranscomcarboeurope
nitroeuroperamshypactactrisi
cosingos

present

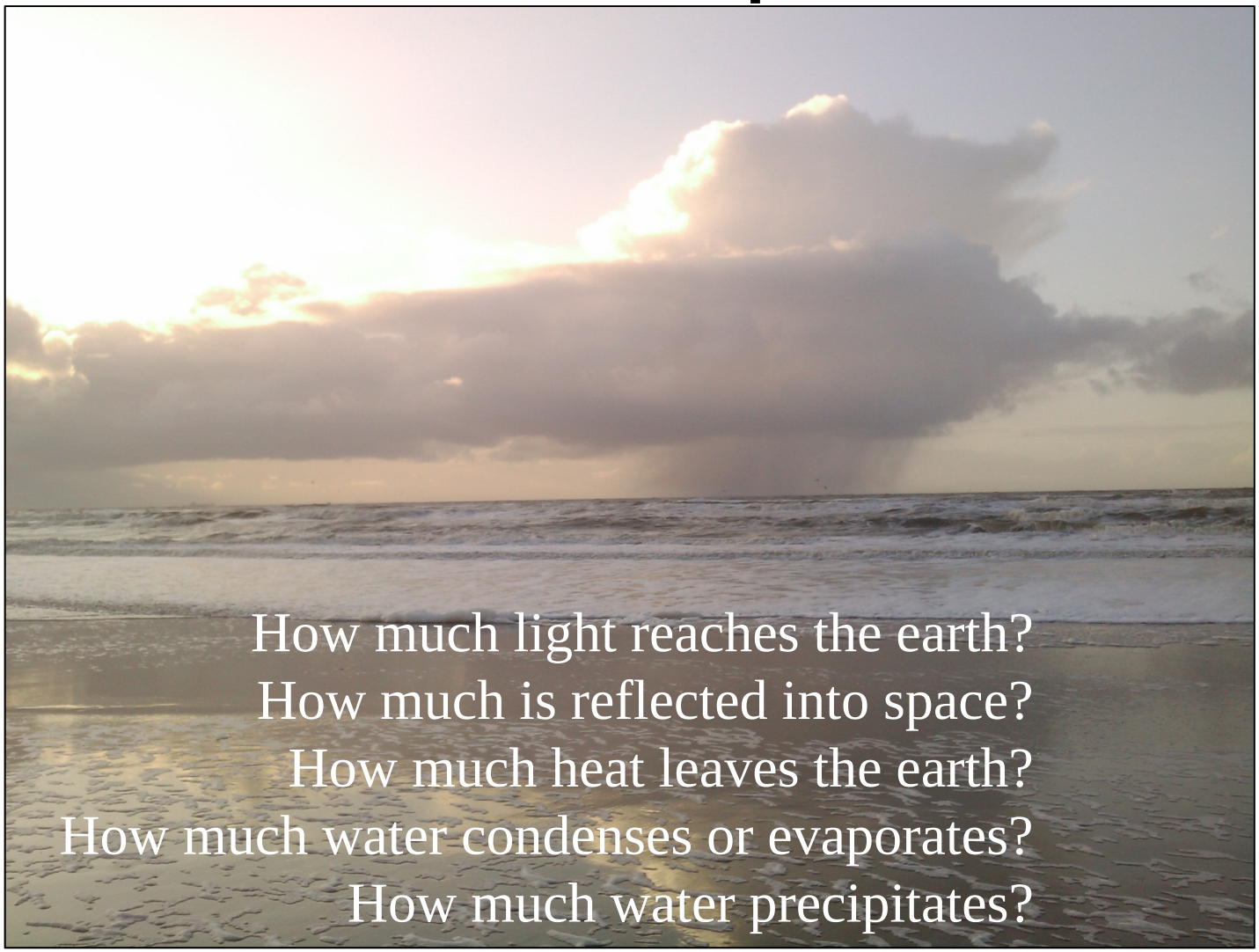
?? The role of the atmospheric water cycle in the climate system

We know what we don't know

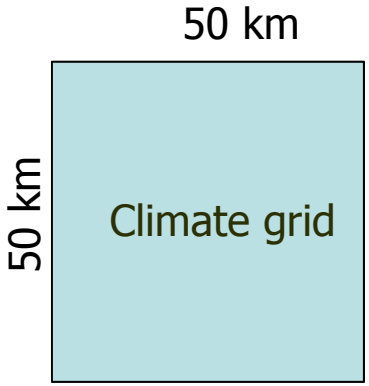
Global warming: state of the art



The cloud questions



Why are clouds so difficult?

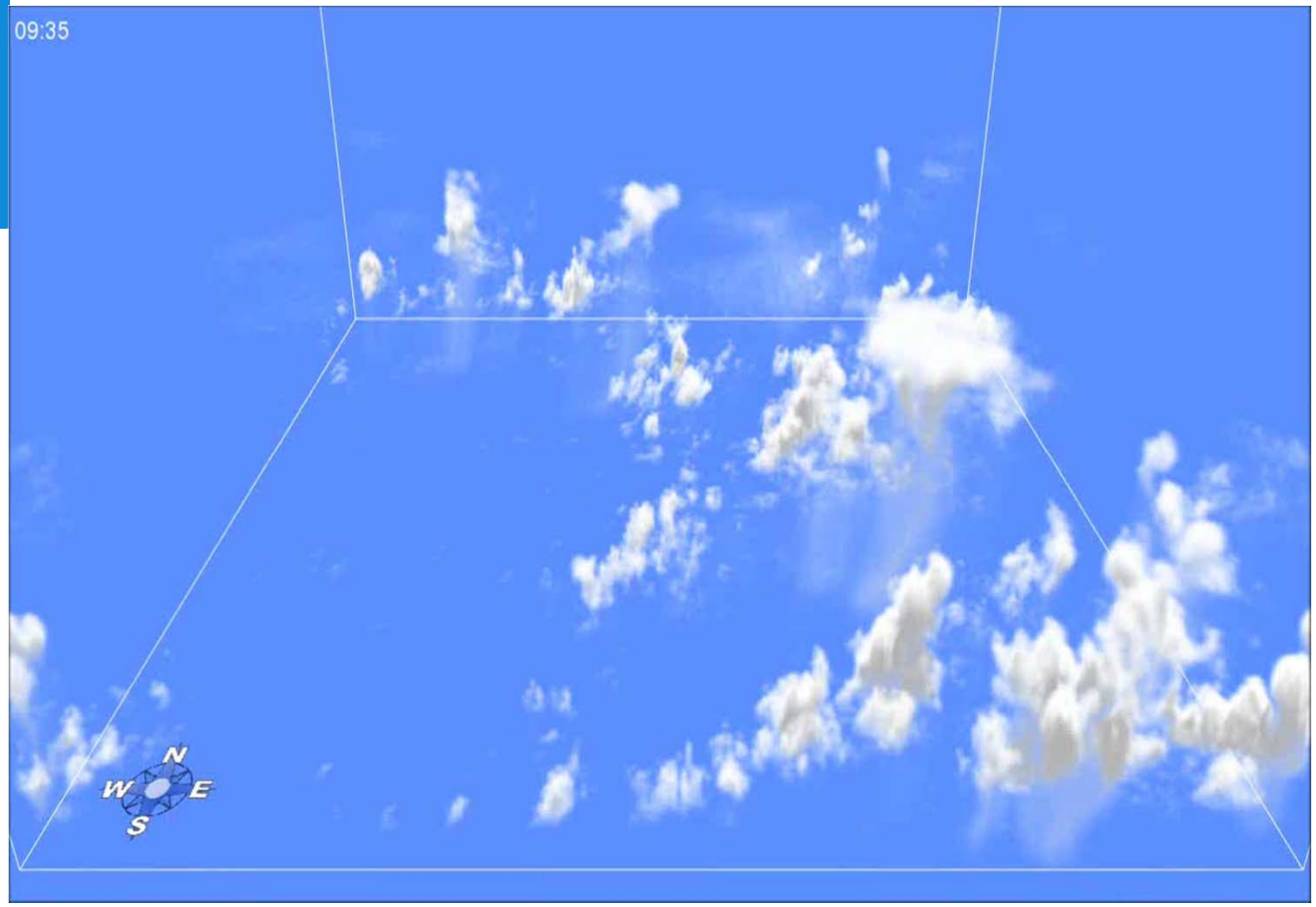


How to solve this problem?

Models

Observations

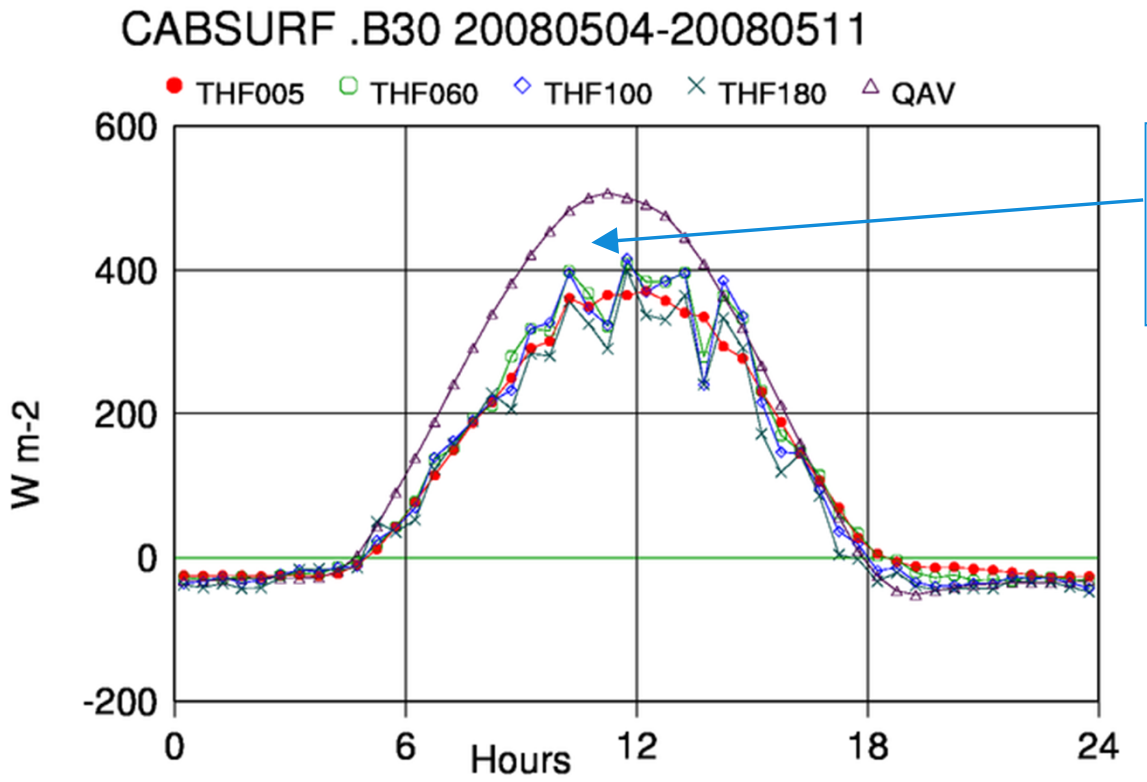
Cloud simulations



Courtesy of Harm Jonker, Stephan de Roode, Pier Siebesma, Jerome Schalkwijk, Gerwin de Haan

physics meets computer science

Surface energy budget at larger scales (from elevated levels)



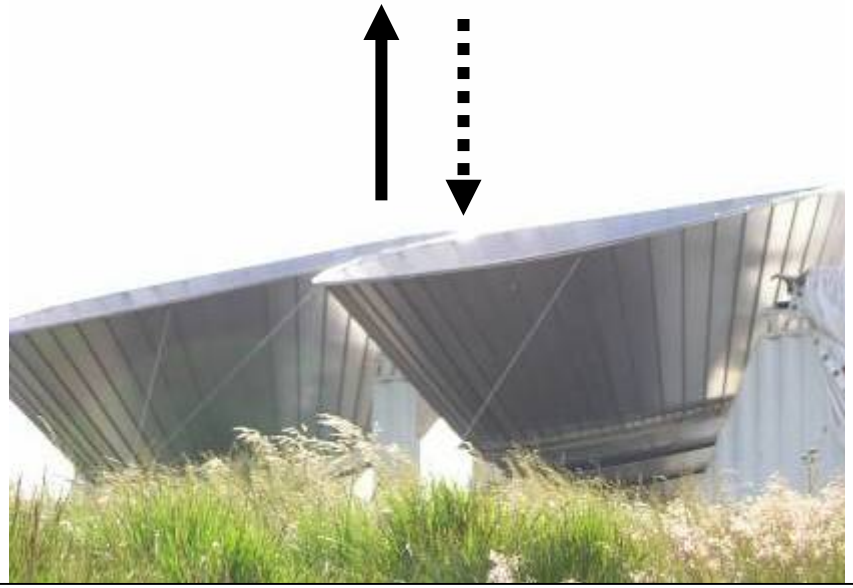
Imbalance is independent of height of flux observation.

- Mean diurnal variation of 8 comparable days
- THFxxx (Surface Total Heat Flux) = turbulent heat flux + Storage heat flux

How to measure clouds?

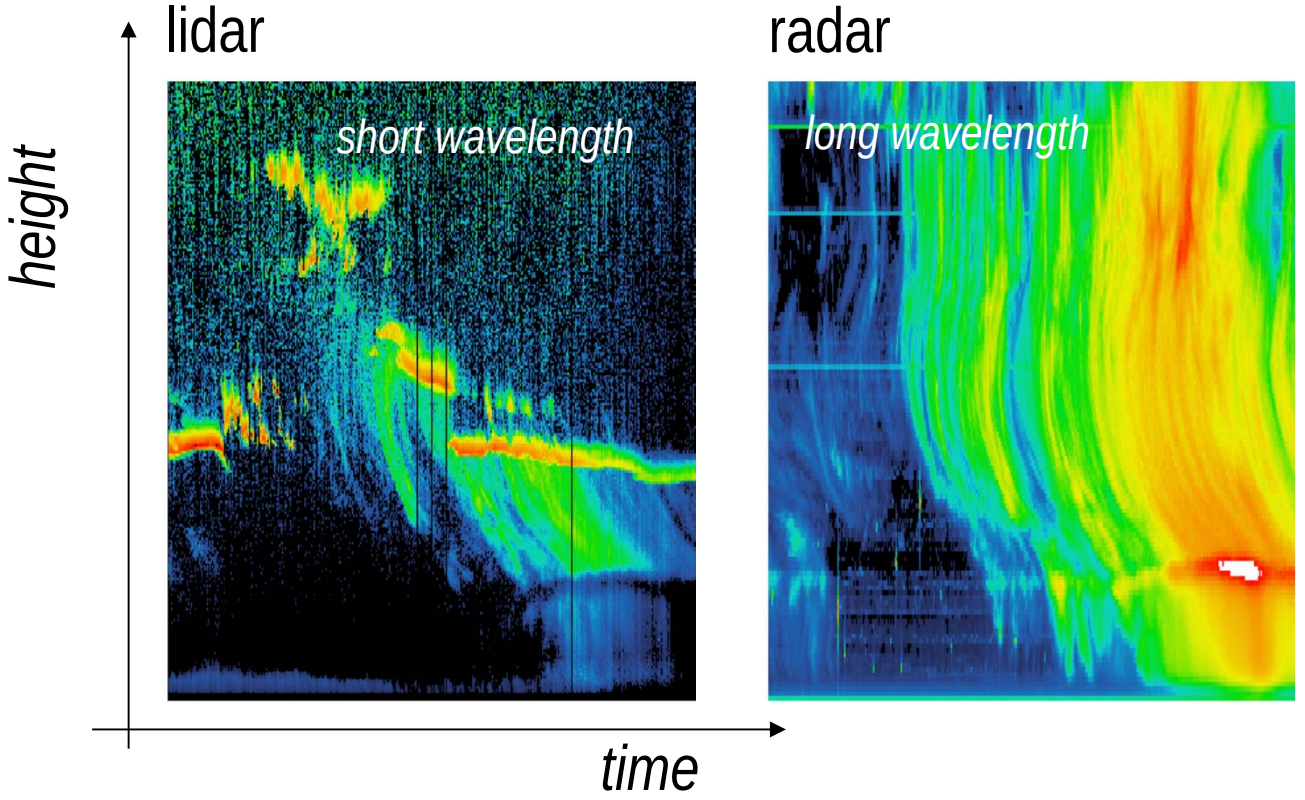
Atmospheric properties: gases, aerosols clouds, rainfall, wind, thermo-dynamics, radiation

Reflection properties of the atmosphere as function of time and place

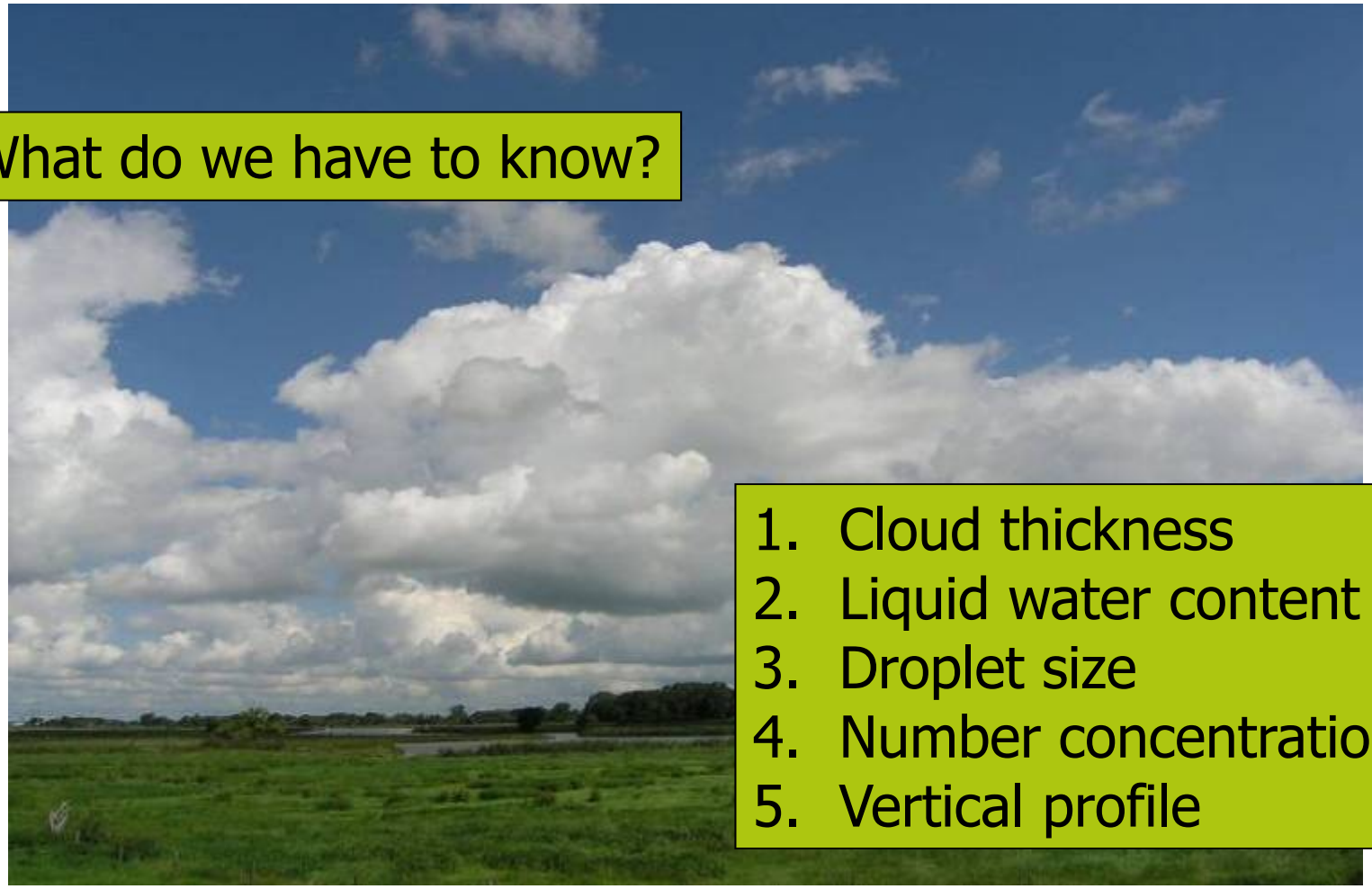


Why multi-sensor strategies?

Observation of light rain with different instruments



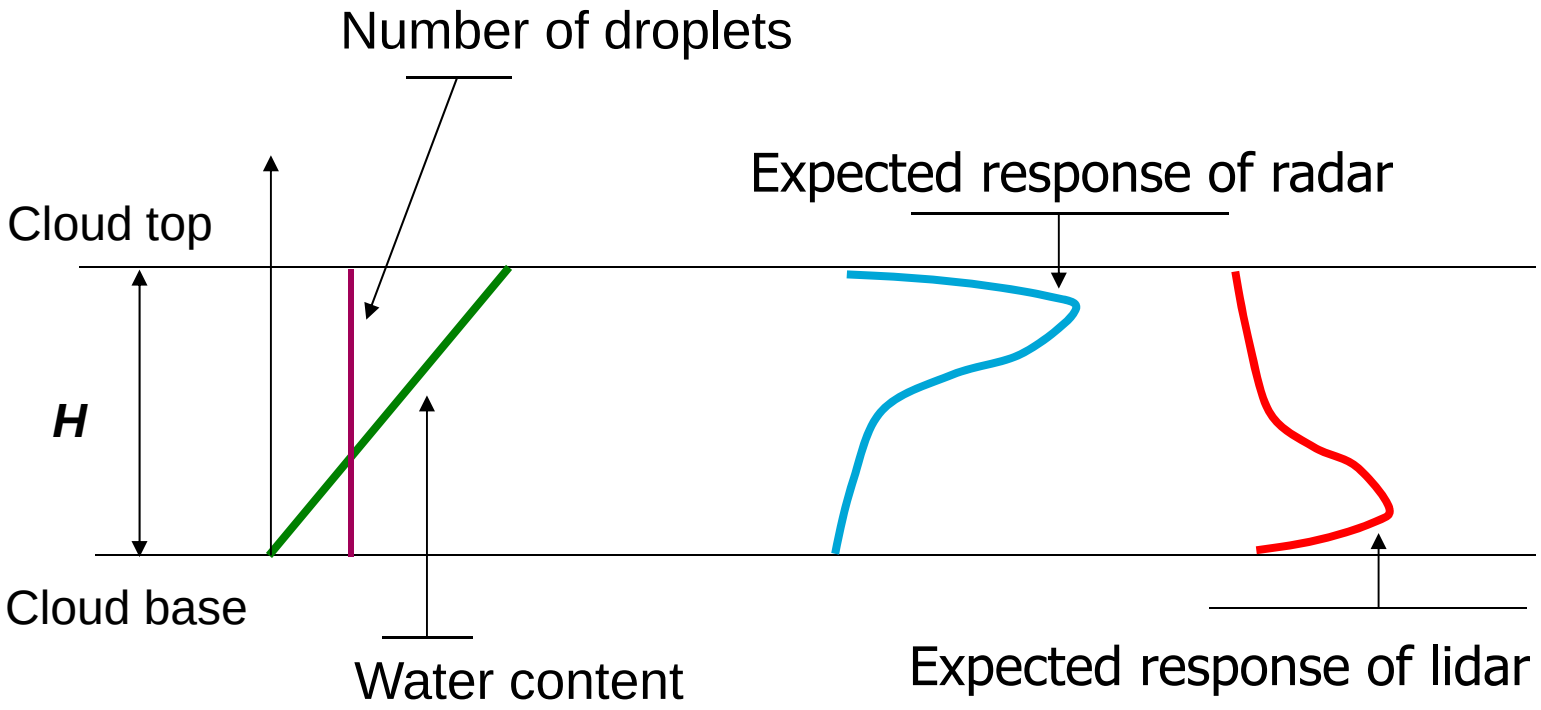
Case study: water clouds



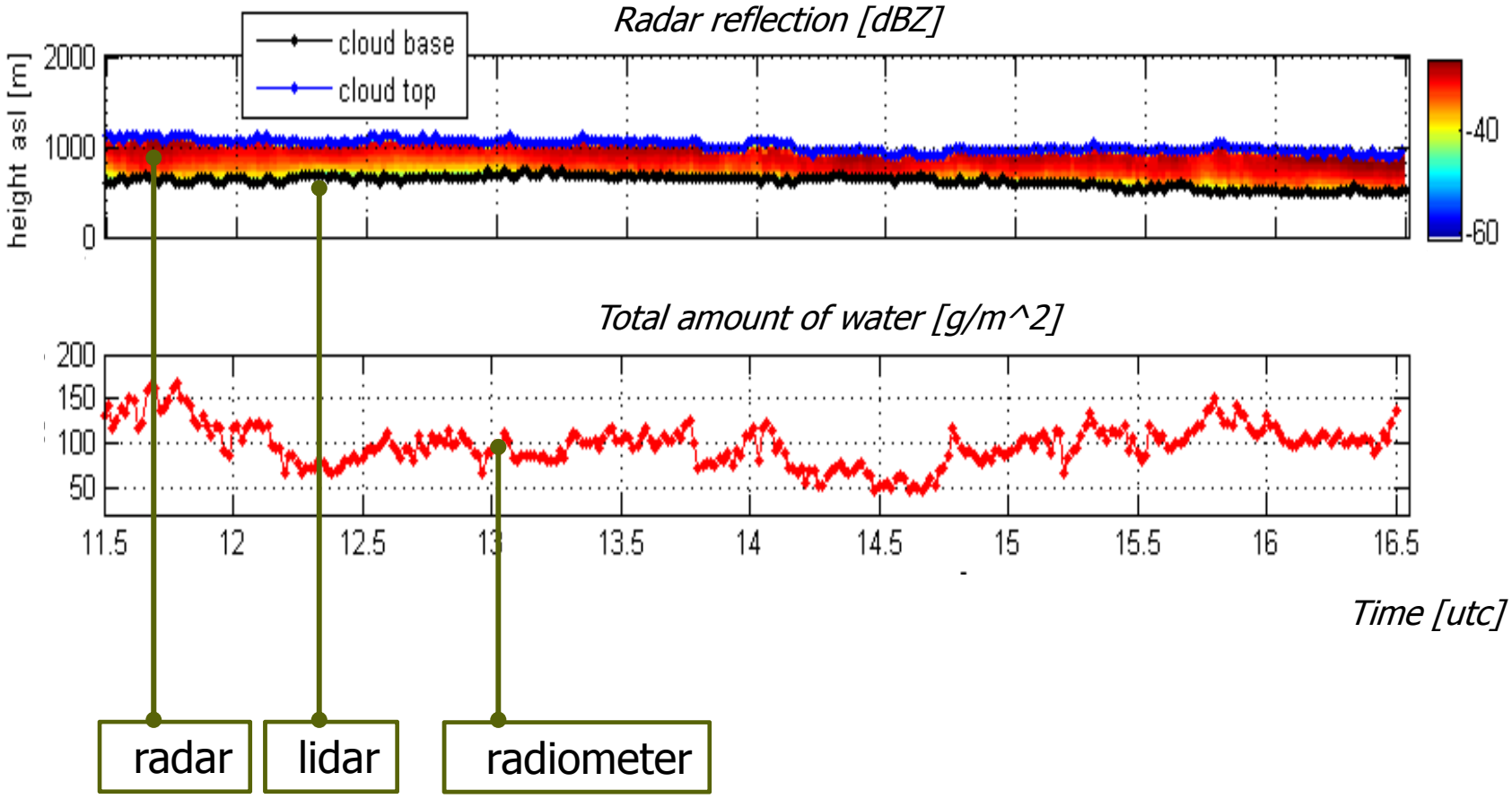
What do we have to know?

1. Cloud thickness
2. Liquid water content
3. Droplet size
4. Number concentration
5. Vertical profile

Assume a cloud model,



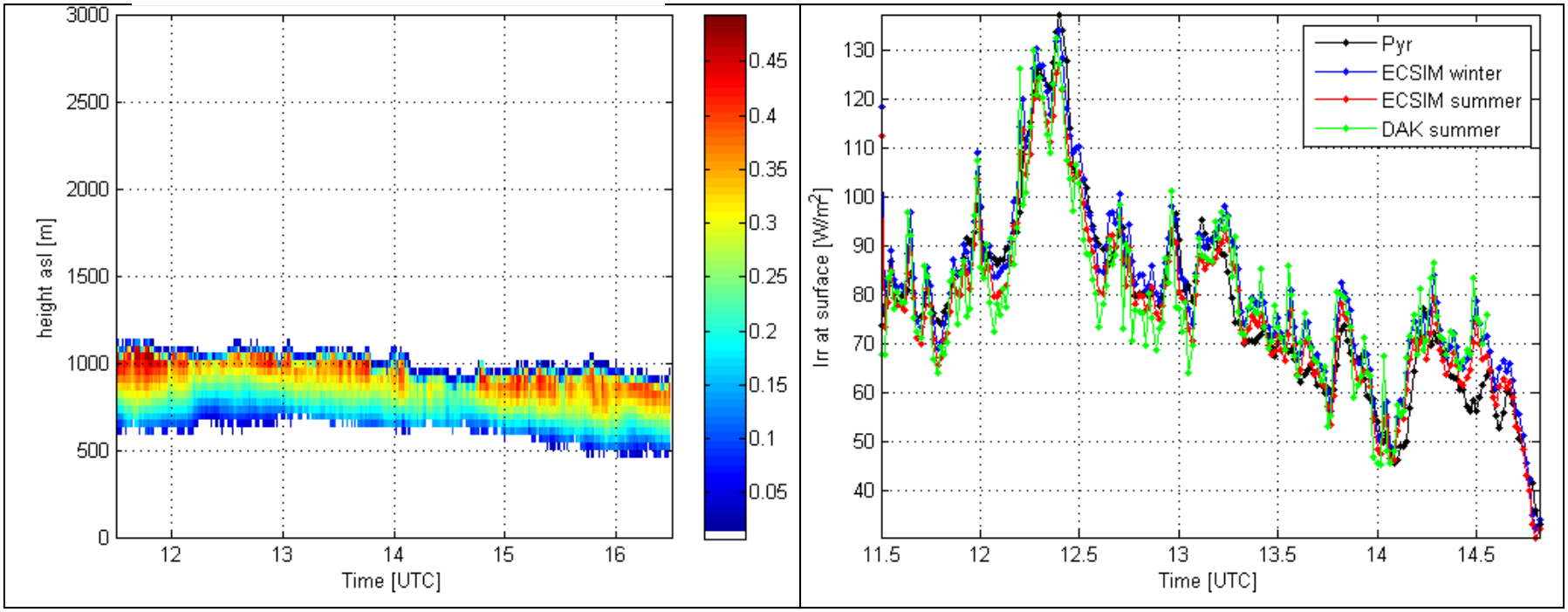
Inside stratocumulus



Clouds and their shadow

Distribution of water in the cloud [g/m^3]

Amount of sunlight at the surface [W/m^2]



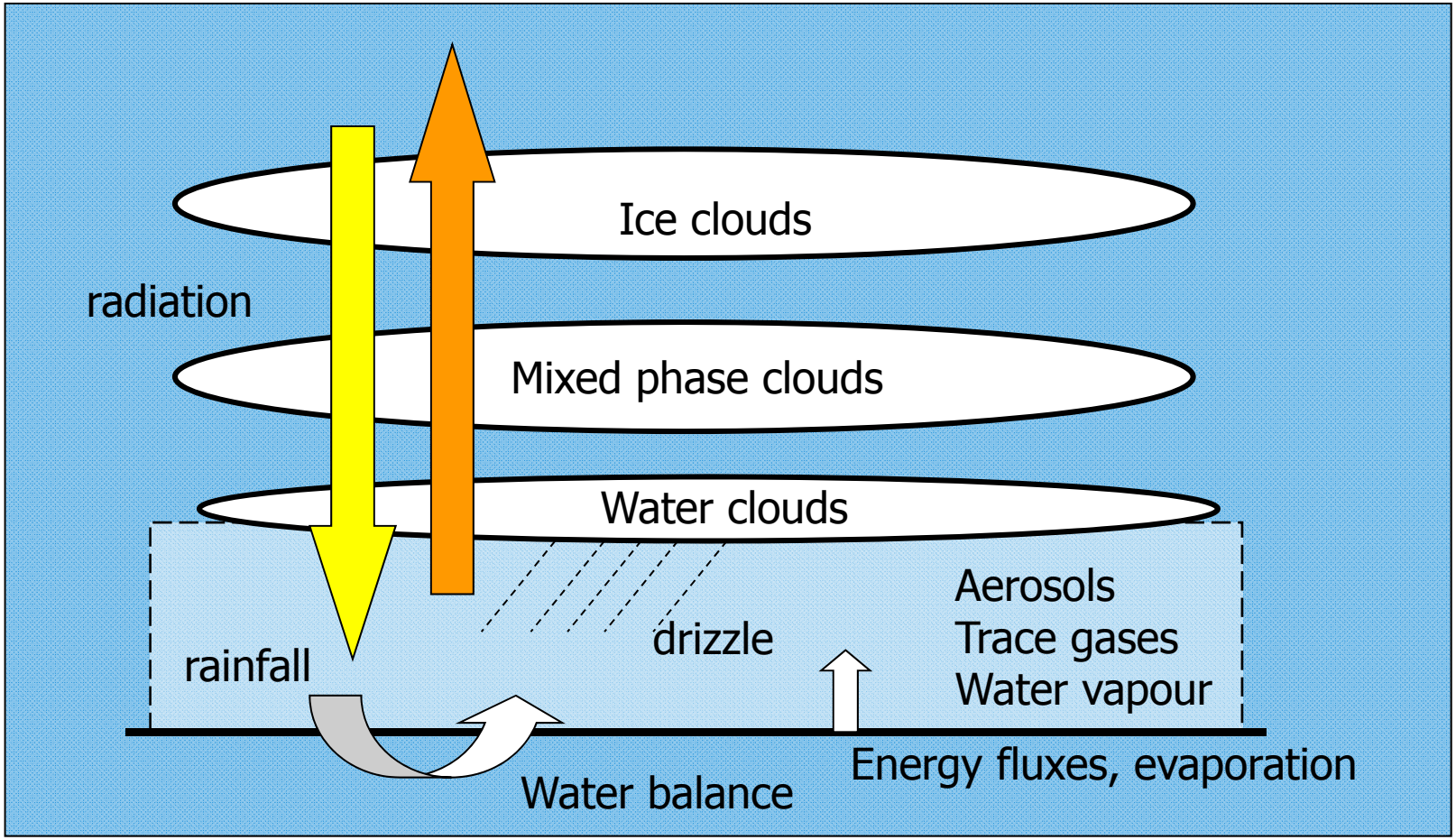
Courtesy of Christine Brandau, Simone Placidi, Dave Donovan, Wouter Knap

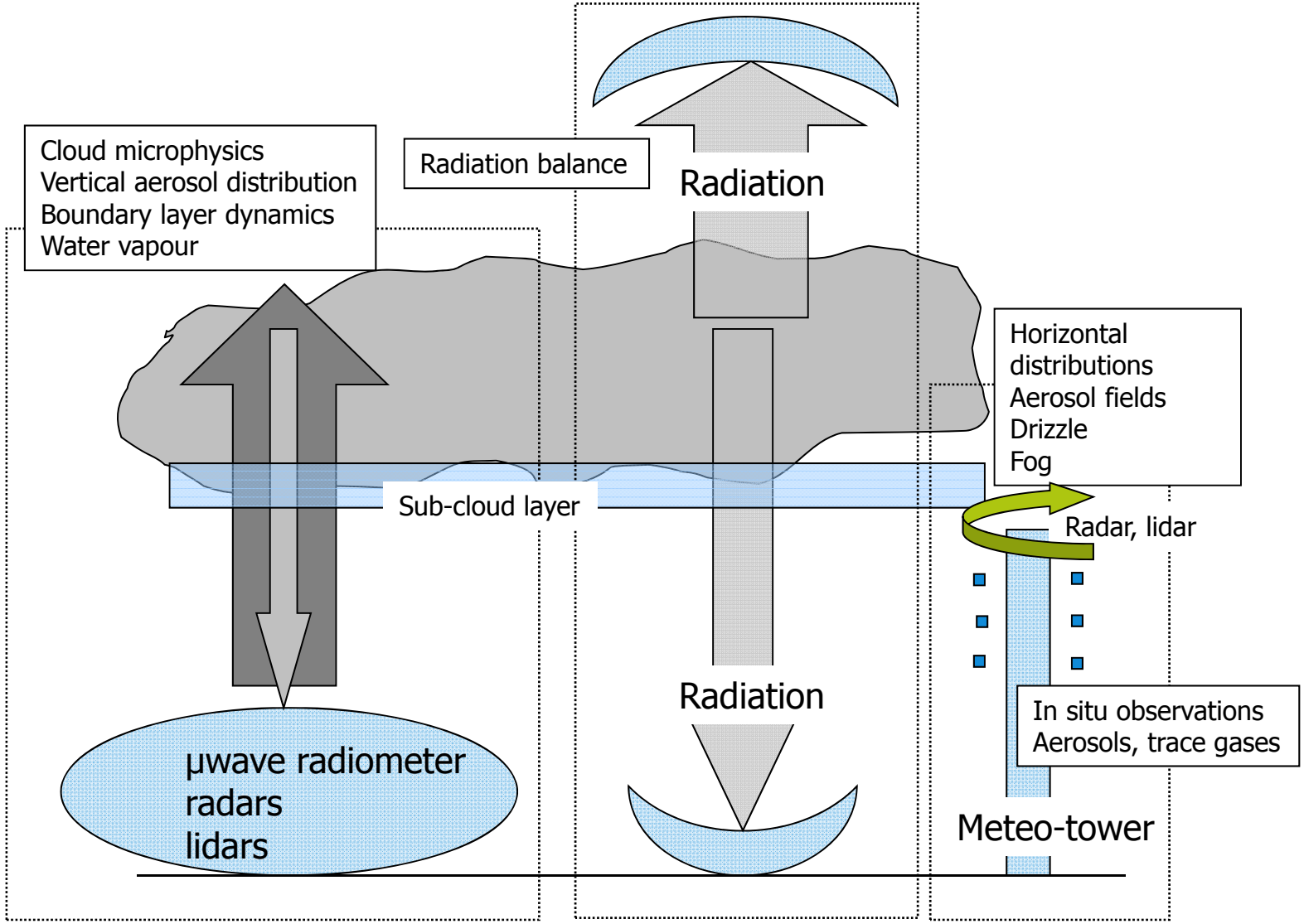
future

? The role of the atmospheric water cycle in the climate system

We know what we know

Atmospheric water cycle: put the content into its ***3D*** context




Cloud microphysics
Vertical aerosol distribution
Boundary layer dynamics
Water vapour
Radiation balance
Radiation
Horizontal distributions
Aerosol fields
Drizzle
Fog
Sub-cloud layer
Radar, lidar
Radiation
In situ observations
Aerosols, trace gases
µwave radiometer
radars
lidars
Meteo-tower

Tighter link observations - models

Models

Observations

What for?

Understanding

Climate change

World population

Urbanization

Curiosity

A final word

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