Fog life cycle phase depending on LWP, cloud boundaries and vertical structure inside the cloud

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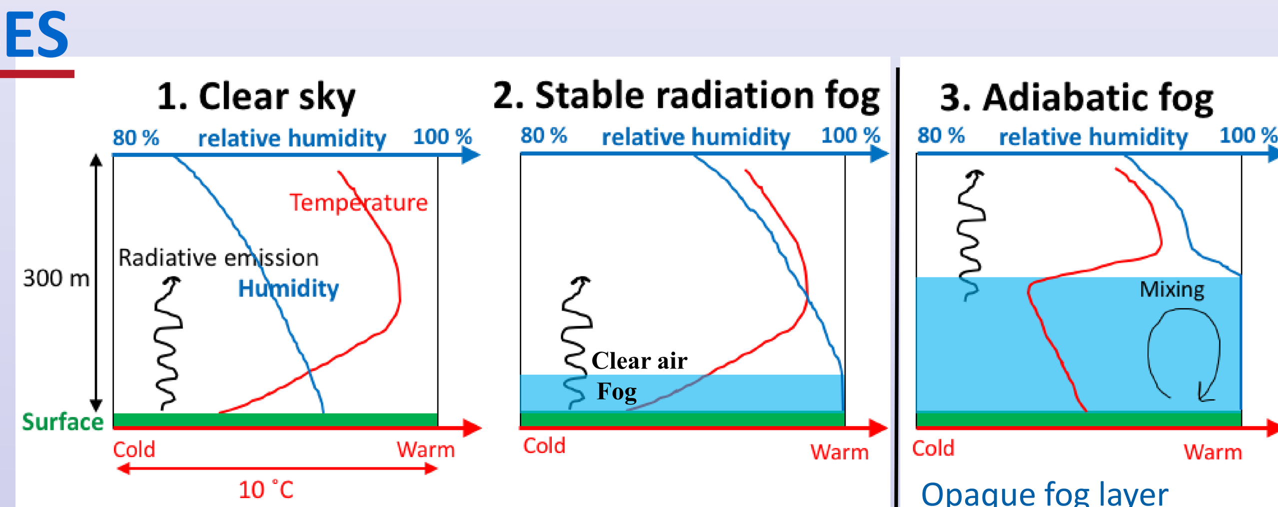
ACTRIS

STUDY OF FOG PROCESSES AND MONITORING OF LOCAL CONDITIONS ENABLE US TO UNDERSTAND HOW FOG EVOLVES FROM FORMATION TO DISSIPATION

1. FOG PROCESSES

FOG IMPACT ON NIGHTTIME THERMODYNAMICS



Opaque fog layer

Radiative cooling of the surface

–> Stable temperature profile (increasing with height)

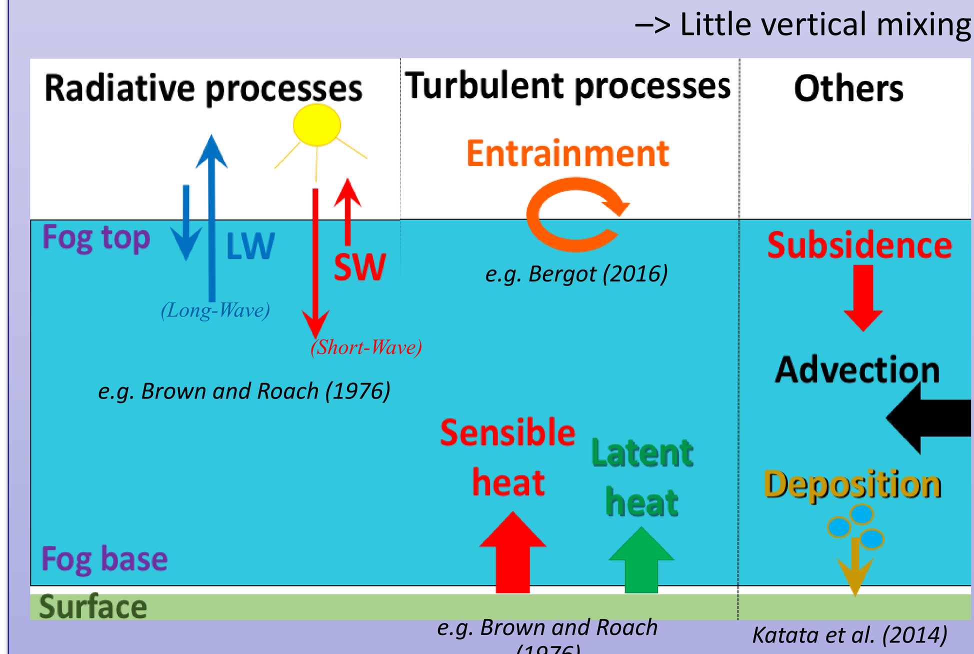
–> Little vertical mixing

–> Only fog top cools

–> Neutral temp. profile

–> Well-mixed fog layer

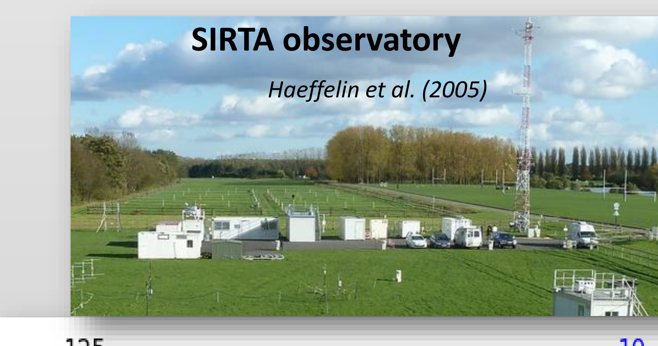
(Price, 2011)



COMPLEX BALANCE BETWEEN MANY PROCESSES GOVERNS FOG LIFE CYCLE

2. GROUND-BASED FOG OBSERVATIONS

REMOTE SENSING AT SIRTA / ACTRIS-CLOUDNET STATION ALLOWS TRACKING OF CLOUD BASE, CLOUD TOP AND LWP

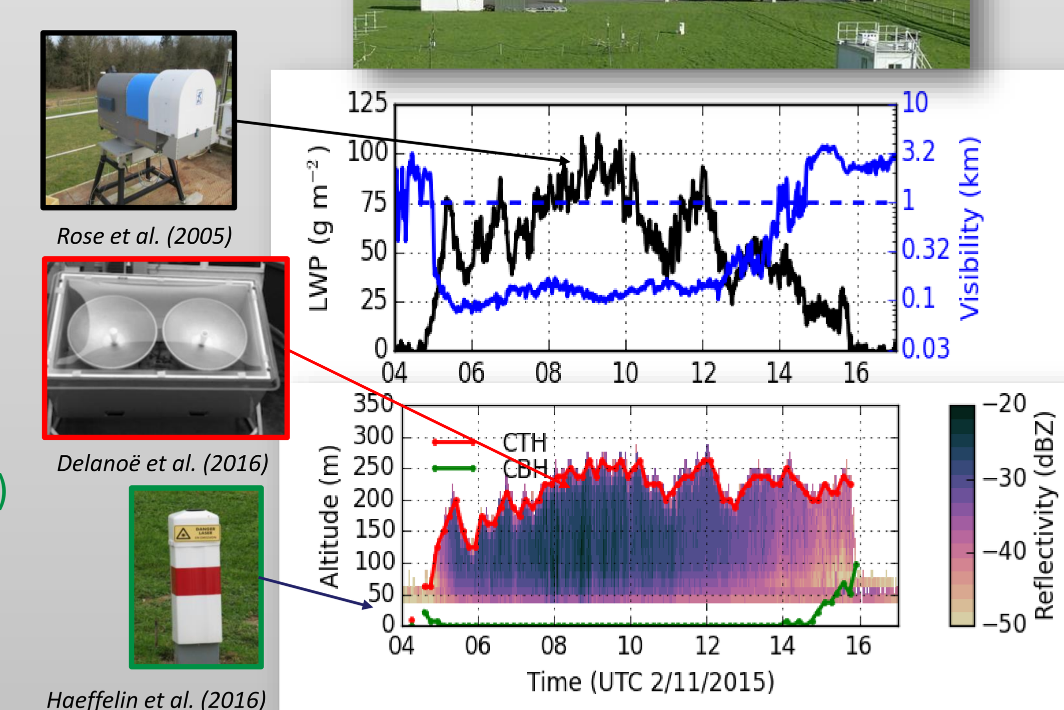


Collocated remote sensing instruments

- Microwave radiometer HATPRO (MWR):
  - Liquid water path (LWP):
  - Temperature and humidity profiles
- Cloud radar BASTA:
  - Reflectivity profile (sensitive to droplet sizes)
  - –> detect cloud top (CTH)
- Ceilometer: cloud base height (CBH)
- Sodar, UHF radar and Doppler Lidar

In-Situ measurements

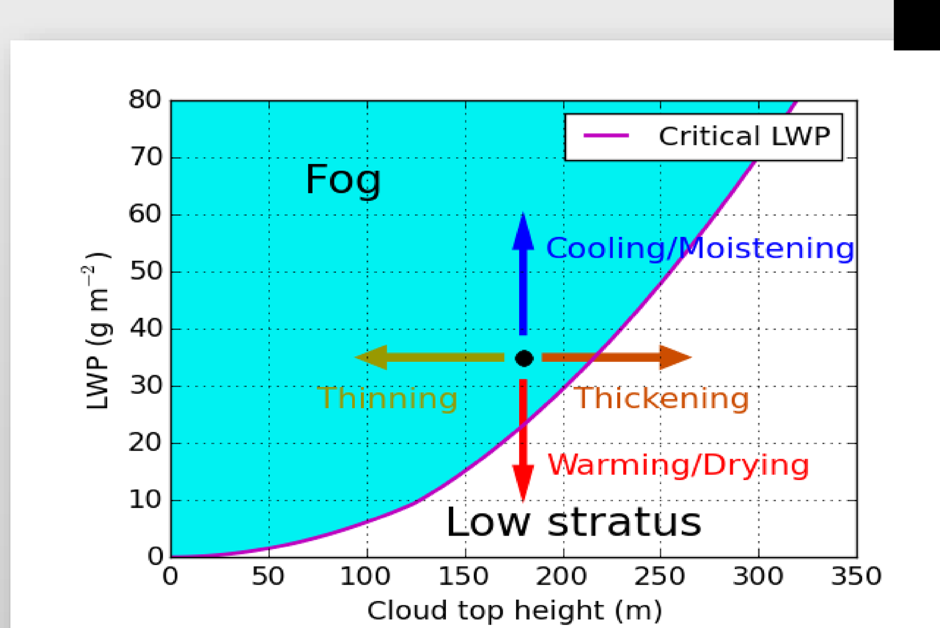
- Visibility meter
- Fog droplet size distribution
- Thermodynamics and dynamics profiles



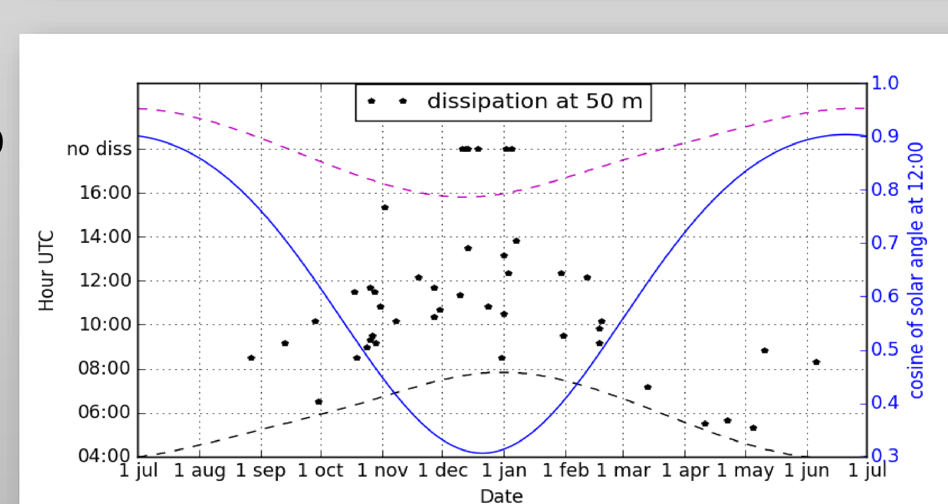
3. FOG DISSIPATION

FOG DISSIPATES WHEN LWP DROPS BELOW THE *CRITICAL LWP*

CRITICAL LWP IS DETERMINED BY CTH (AND TEMPERATURE).

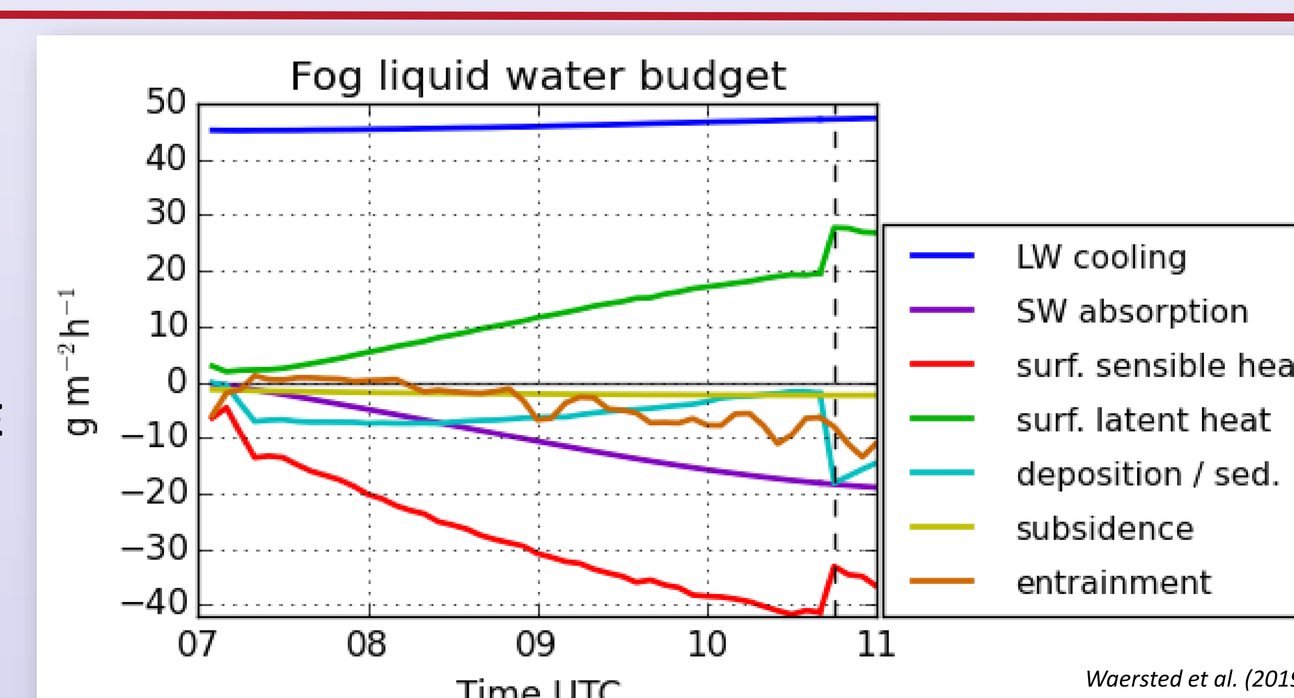


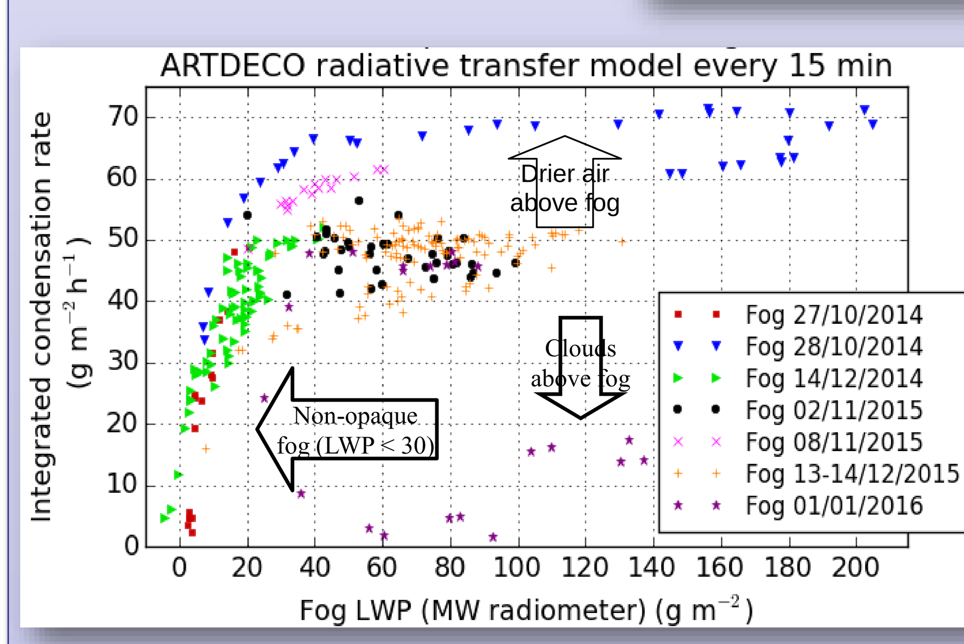
FOG DISSIPATION TIME IS SEASON DEPENDENT. CAN IT BE EXPLAINED BY PROCESSES WHOSE EFFECTS ON LWP DEPEND ON SOLAR ANGLE ?



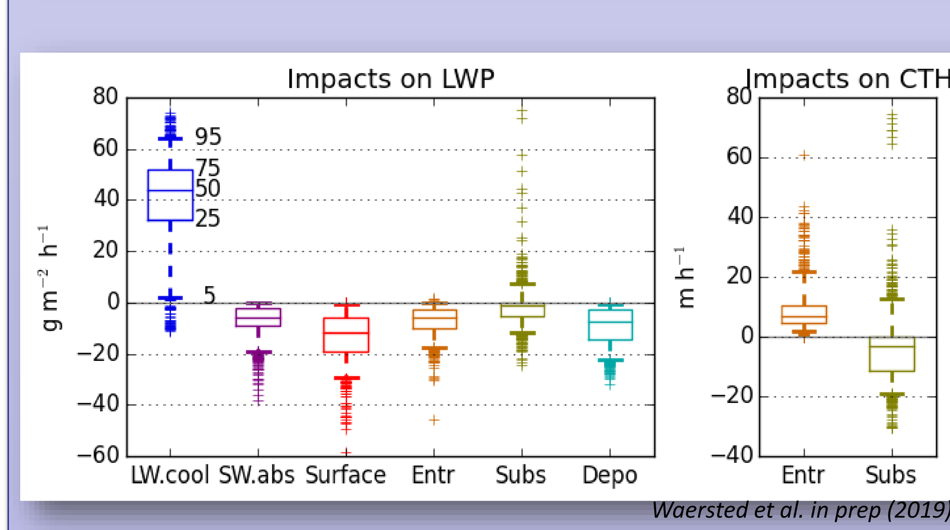
4. RELATIVE IMPORTANCE OF PROCESSES ON FOG DISSIPATION

CONTRIBUTION OF PROCESSES TO CHANGE IN FOG LIQUID WATER <u>BASED ON IDEALIZED LES</u> (DALES) SIMULATION OF RADIATIVE FOG (1 CASE).





CONTRIBUTION OF LW RADIATIVE PROCESSES TO CHANGE IN FOG LIQUID WATER <u>BASED ON RADIATIVE TRANSFER MODEL</u> SIMULATIONS OF RADIATIVE FOG (7 CASES).



CONTRIBUTION OF PROCESSES TO CHANGE IN FOG LIQUID WATER <u>BASED ON MEASUREMENTS</u> AND CONCEPTUAL MODEL (45 CASES).

VARIABILITY OF CONTRIBUTIONS: SENSITIVITY STUDY

LW: Main LWP source:
– 40–70 g m^{-2} h^{-1} for opaque fog
– Less for non-opaque fog (LWP < 30 g m^{-2})
– Strongly reduced by clouds above

SW: LWP loss of 5–15 g m^{-2} h^{-1} in winter day, increasing with fog thickness

Surface heat flux: Important for LWP loss after sunrise.
– Strongly sensitive to Bowen ratio
– Dry surface –> More sensible heat –> earlier dissipation (85 min in our test)

Entrainment: Sensitive to layer above fog top:
– Weak stratification –> earlier dissipation (90 min).
–- Dry air *directly* above –> earlier dissipation (70 min).

Subsidence weakly favours fog dissipation.

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