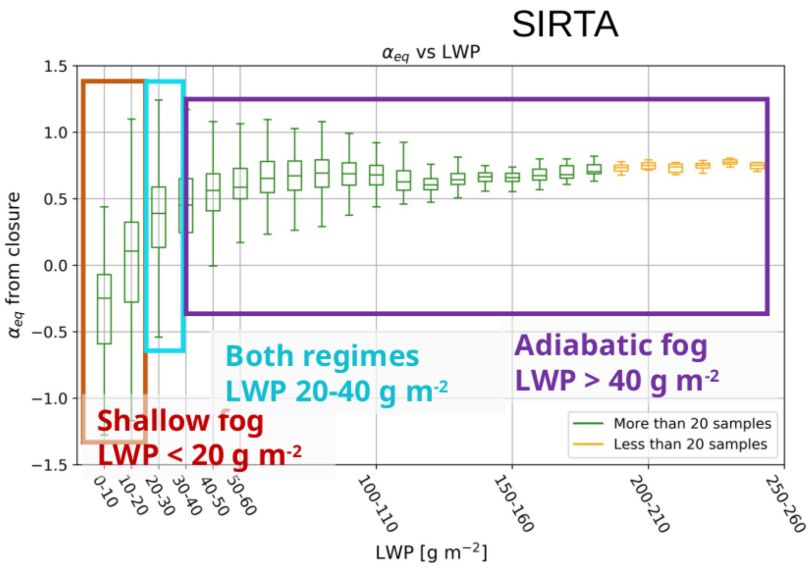
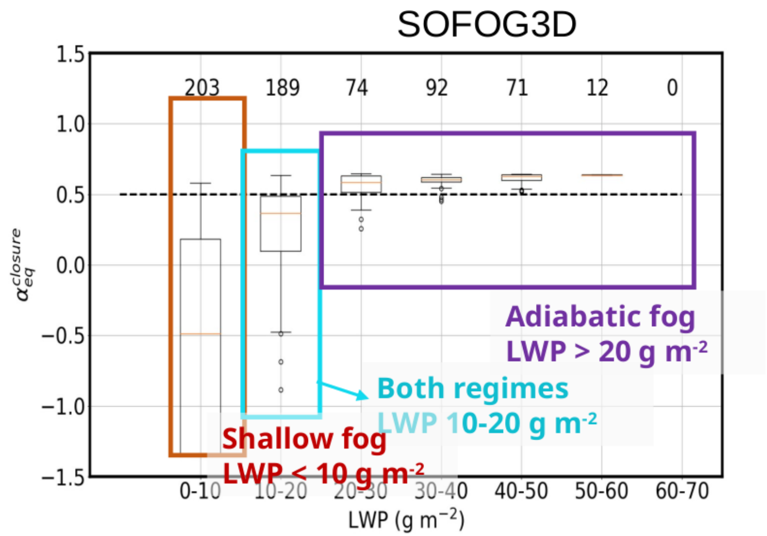
WP4 : Advanced process studies based on highly documented cases

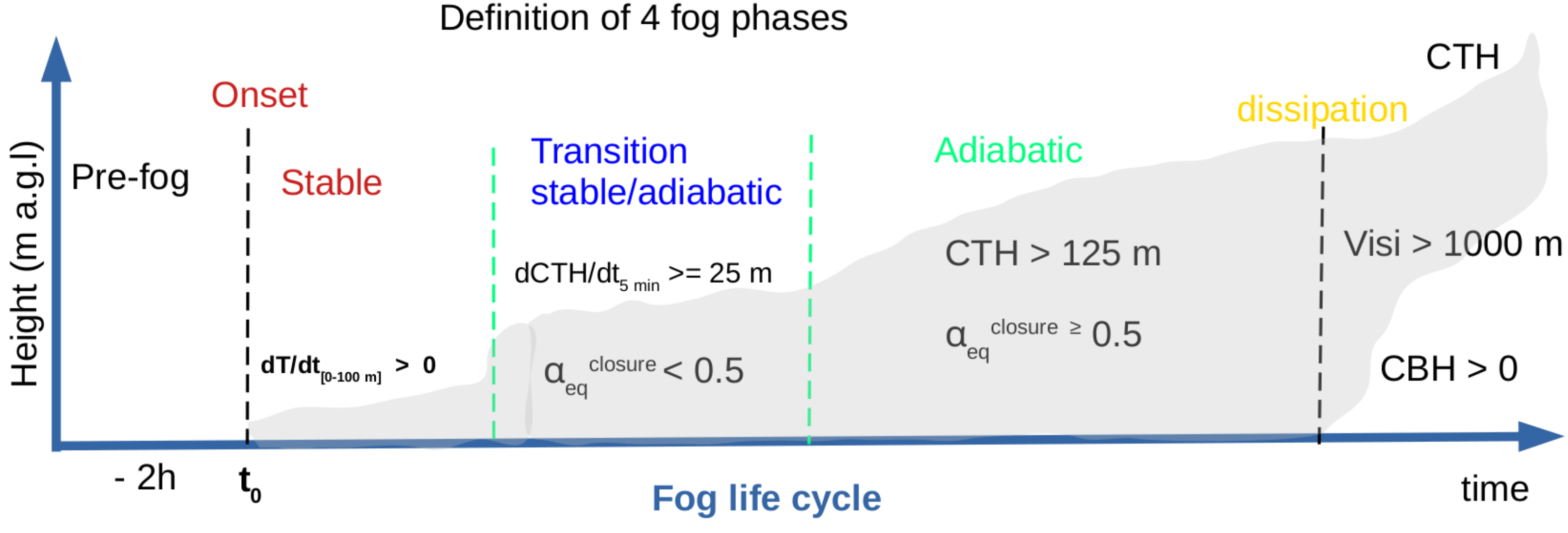
Task 4.1 : Transition thin/thick fog : *Cheikh*





Toledo et al., 2021

Definition of 4 fog phases



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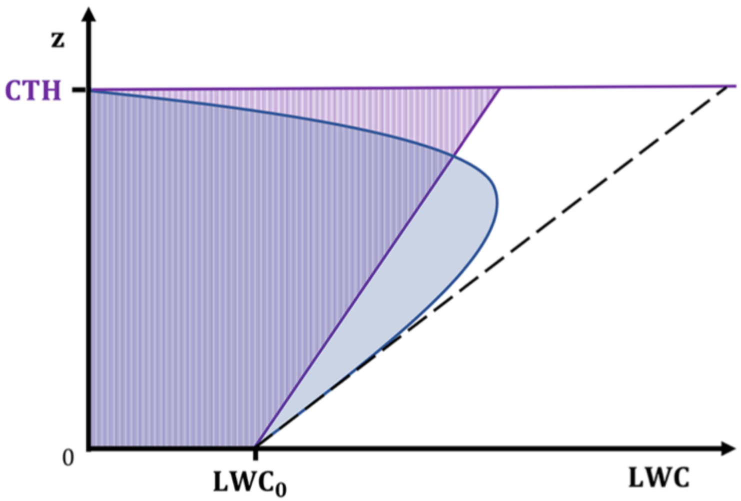
Task 4.1 : conceptual model reminder (if needed)



Fog LWP

$$LWC(z) = \int_0^z \alpha(z')\, dz' \cdot \Gamma_{ad}(T,P) + LWC_0$$

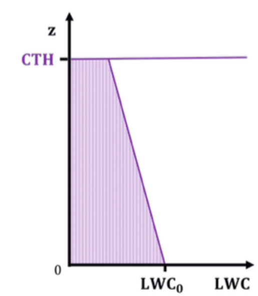
Conceptual Model LWP

$$LWC(z) = \alpha_{eq}\, \Gamma_{ad}(T,P)\, z + LWC_0$$

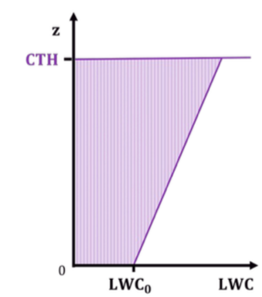
Adiabatic LWC (α_{eq}= 1)

$$LWC(z) = \Gamma_{ad}(T,P)\, z + LWC_0$$

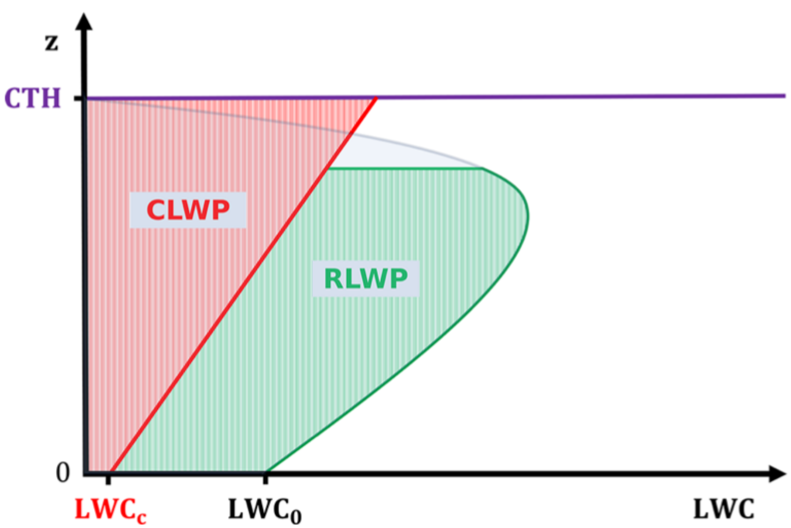
α_{eq}<0



α_{eq}>0



(b) Conceptual Model Critical and Reservoir LWP



Critical LWP (CLWP)

$$CLWP = \frac{1}{2}\alpha_{eq}\, \Gamma_{ad}(T,P)\, CTH^2 + LWC_c\, CTH$$

Reservoir LWP (RLWP)

$$RLWP = LWP - CLWP$$

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Task 4.1 : Transition thin/thick fog - *increasing turbulence*

α_{eq} : increases from negative or 0 to +0.5

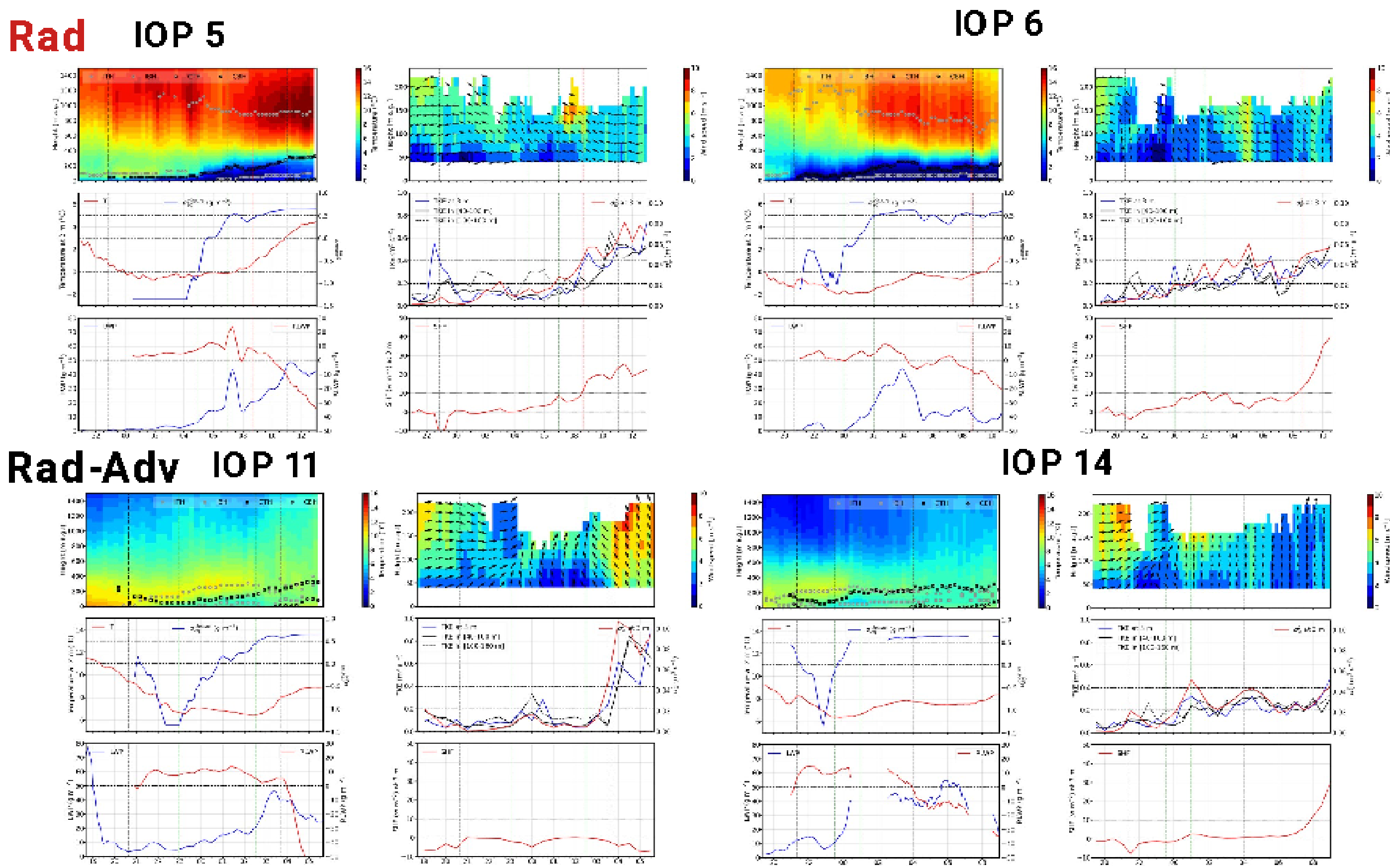
Transition time : lasts 1-2h (3h30 IOP5)

TKE: increases to 0.2-0.4 $m^2\ s^{-2}$

MWR: near surface T changes from inversion to adiabatic

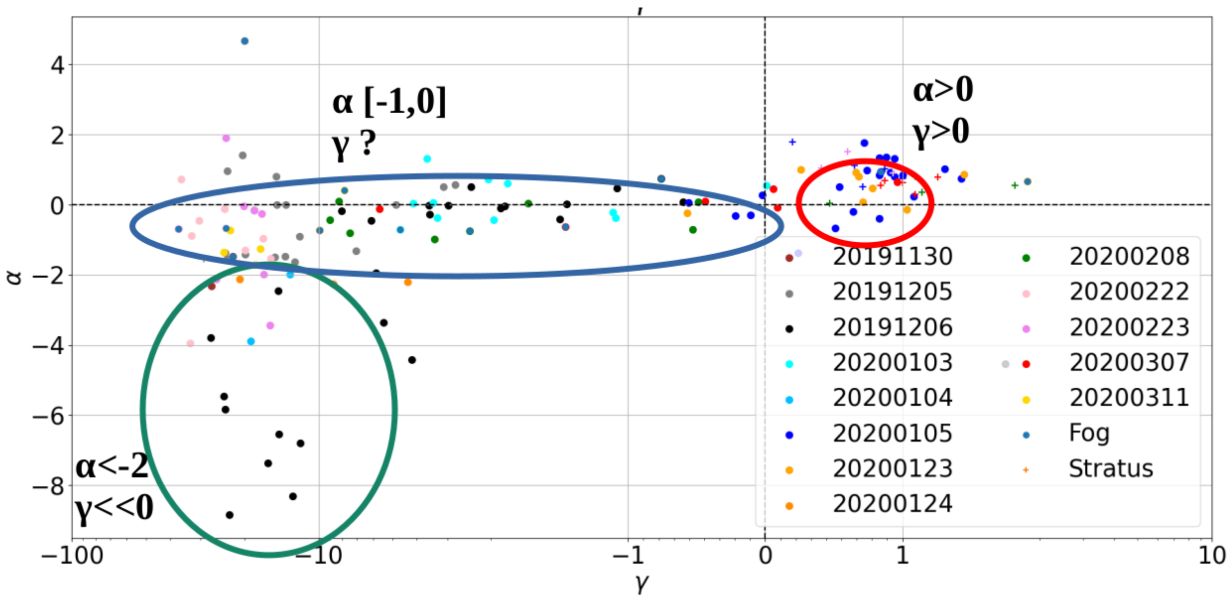
MWR: LWP reaches 10-20 gm^{-2}

Cloud Radar: reflectivity profile appears



Task 4.1 : Transition thin/thick fog – Entrainment at fog top (*Théophane)*

- Computation of the **real adiabaticity** ($\alpha = dLWC/dz_{norm}$) and **lapse** ($\gamma = dT/dz_{norm}$) rate fractions within the fog layer (activation and entrainment included). Conceptual model not designed for thin fog.
- Evaluation of different **thresholds** (TKE, Grad T, CTH) for the **transition** from optically thin to optically thick fog : OK for most of the thresholds except LWP
- Significant **vertical variability** between stable (High LWC values near the ground, $\alpha<0$ $\gamma<0$) and mature phases (more adiabatic LWC profile, $\alpha>0$ $\gamma>0$)
- **Transition to optically thick fog not linear**, highly dependant on non-local processes.
- **Correlation between α and γ** when fog is very **stable** ($\alpha<-2$) or **adiabatic** ($\alpha>0$)



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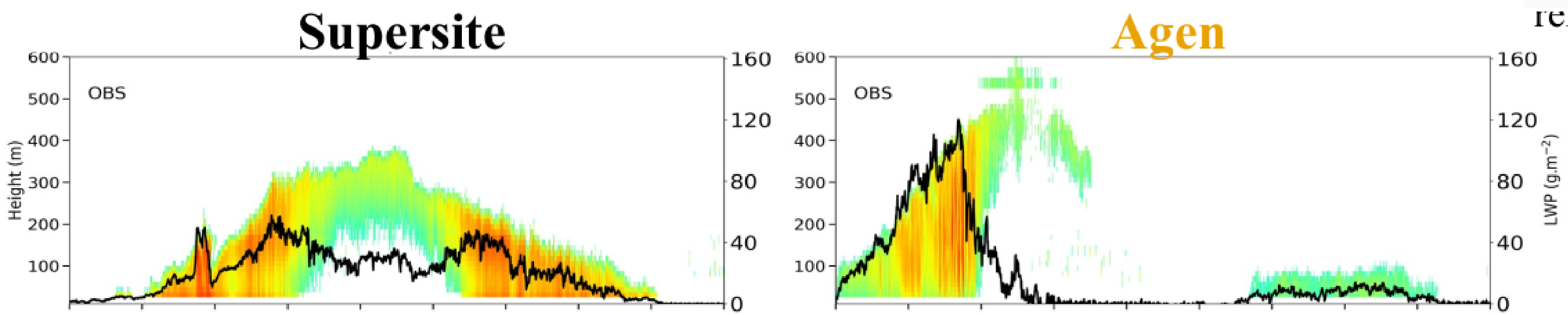
Task 4.2 : Stratus-to-fog transition : *Maroua*

- IOP5 very interesting to contrast between Supersite (stratus lowering) and Agen (stratus dissipation leading to radiative fog)

OBS



Thermal advection and then droplet settling appear the main mechanisms leading to the different scenarios (following Fathalli et al., 2022).

- The contrasted simulations MNH00h and MNH15h would help to confirm the main drivers

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Task 4.3 : Fog dissipation phase

Daytime dissipation

SHF: increases > 10 Wm^{-2}

TKE (thermal): increases > 0.4 $m^2\ s^{-2}$

Cloud Radar: CTH increases

CM: RLWP decreases, becomes negative, VIS increases

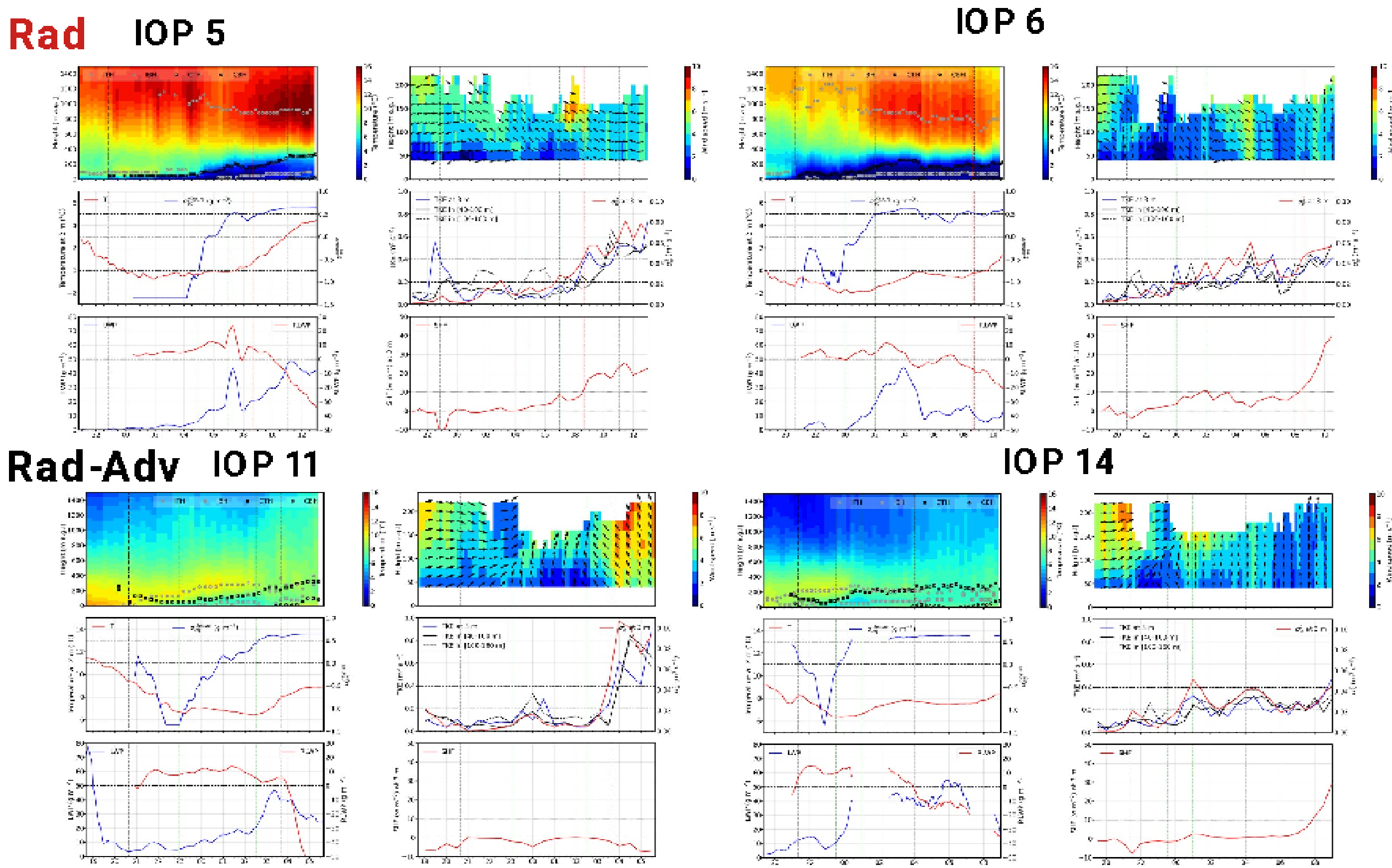
Nighttime dissipation

SHF: remains < 0 Wm^{-2}

TKE (mechanical): increases > 0.4 $m^2\ s^{-2}$

Cloud Radar: CTH increases

CM: RLWP decreases, becomes negative, VIS increases



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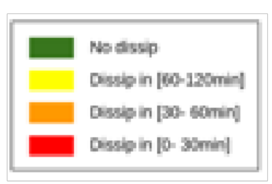
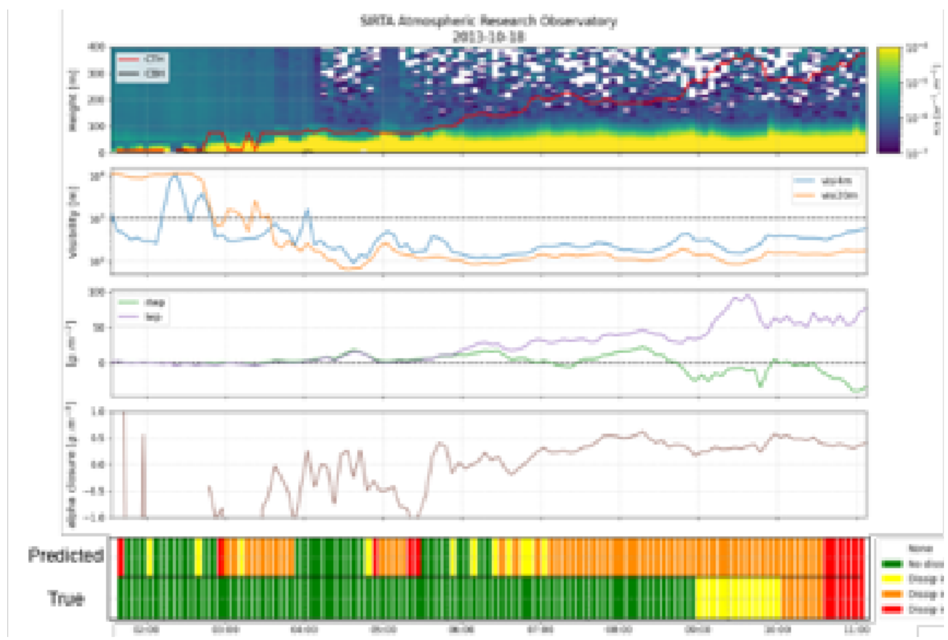
Future work

Applying results from SOFOG-3D: study of stable-adiabatic transition and dissipation on longer datasets (e.g. SIRTA, other ACTRIS station) with a particular focus on dynamics, thermodynamics, and turbulence. (DGA funded 1-yr postdoc)

Parafog v3: machine learning approach ingesting DCR, MWR, ALC, DL measurements to produce for transition and fog dissipation nowcasting. Realtime monitoring of fog evolution. New tool to monitor formation, transition, dissipation.

Machine learning
gradient boosting





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Future work

PhD CNRM : Contribution of a deep learning algorithm combining a set of innovative observations (ceilometer, microwave radiometer, cloud radar, wind lidar, etc.) with the large-scale information provided by the AROME nowcasting version (temperature and humidity advection, clouds, winds, etc...) to forecast fog events and evolution of their life cycle.
Direction : Pauline Martinet