IOP5 – a golden day?

Boundary layer development and large scale influences

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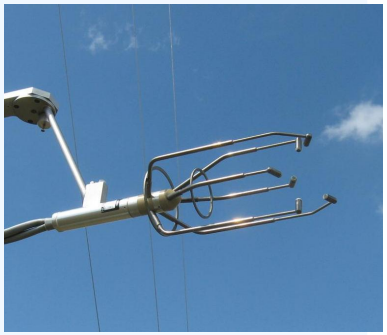
WAGENINGEN UR
For quality of life

Outline

- Research strategy
- Case
- Observations
- ML modeling
- Driving factors
- Continuation

Research Strategy
Boundary layer & aircraft data

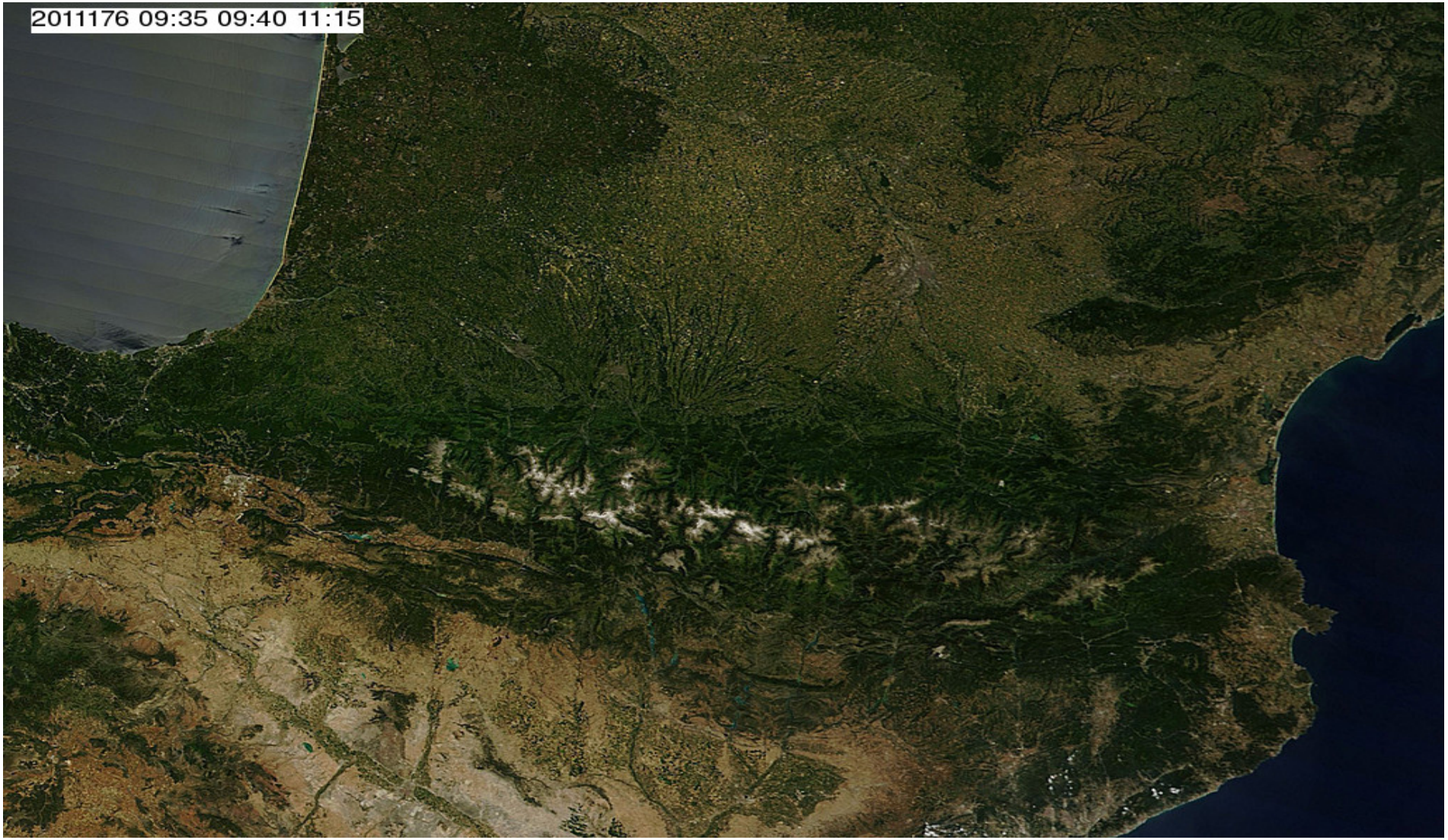
- case selection from observations
- First characterisation of case
  - observations
  - Mixed Layer model
  - identify main processes
- Modeling turbulence
  - DALES-model
- Back to observations
  - aircraft turbulent data



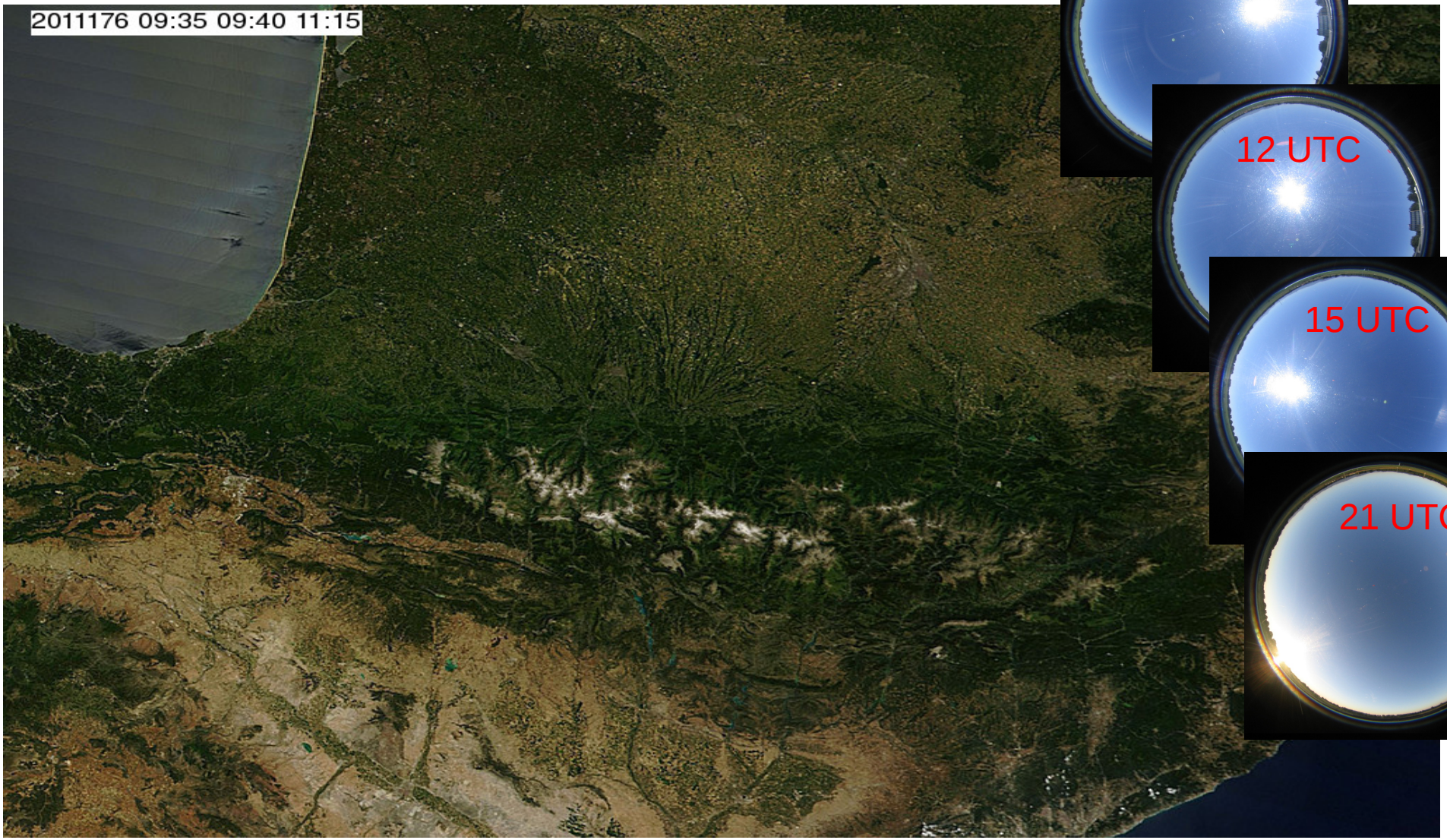
Case selection

- “Golden day”
- Good match for classical boundary layer theory
- A lot of BL measurements → IOP's
- Few disturbing factors

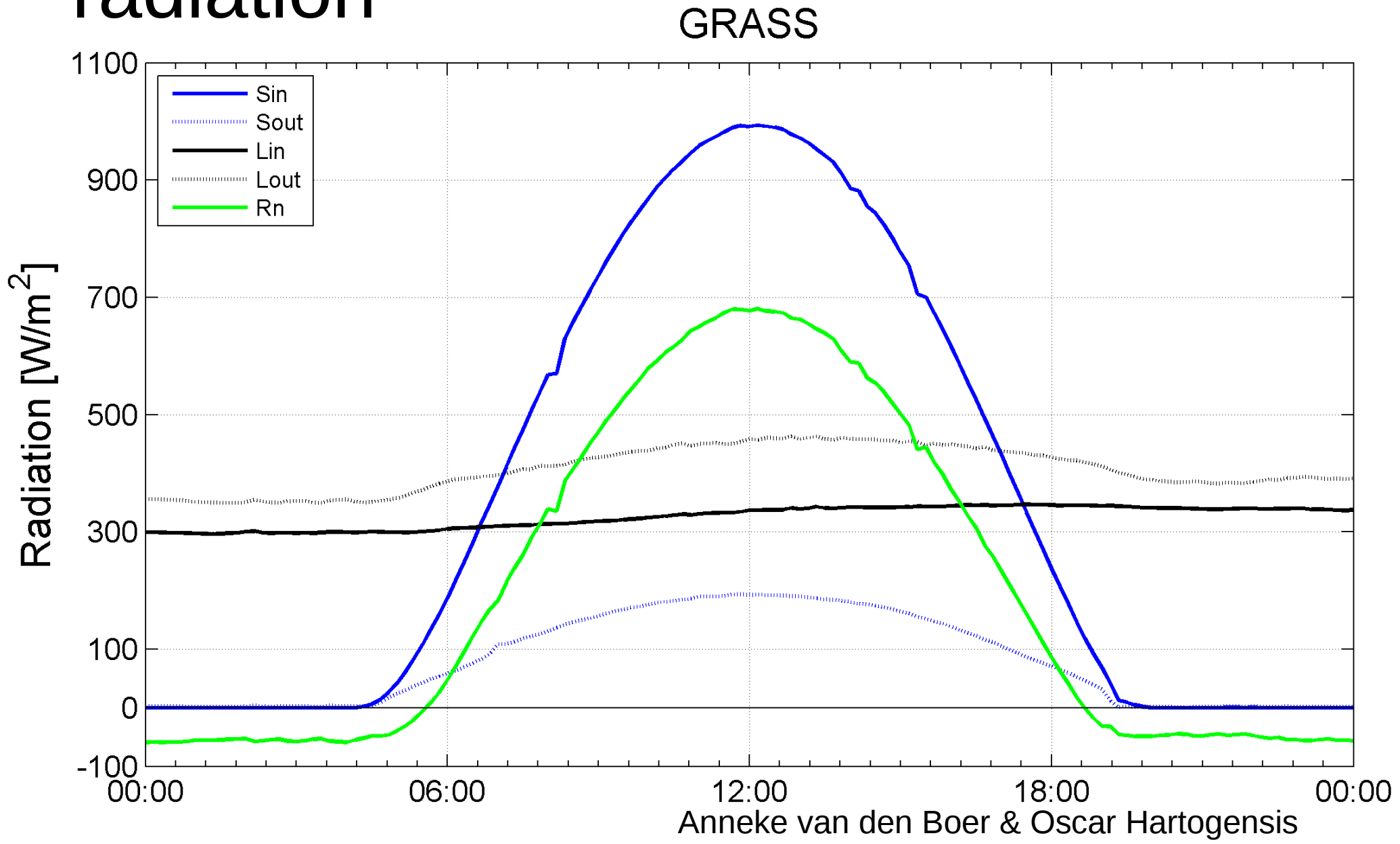
IOP5
a clear day



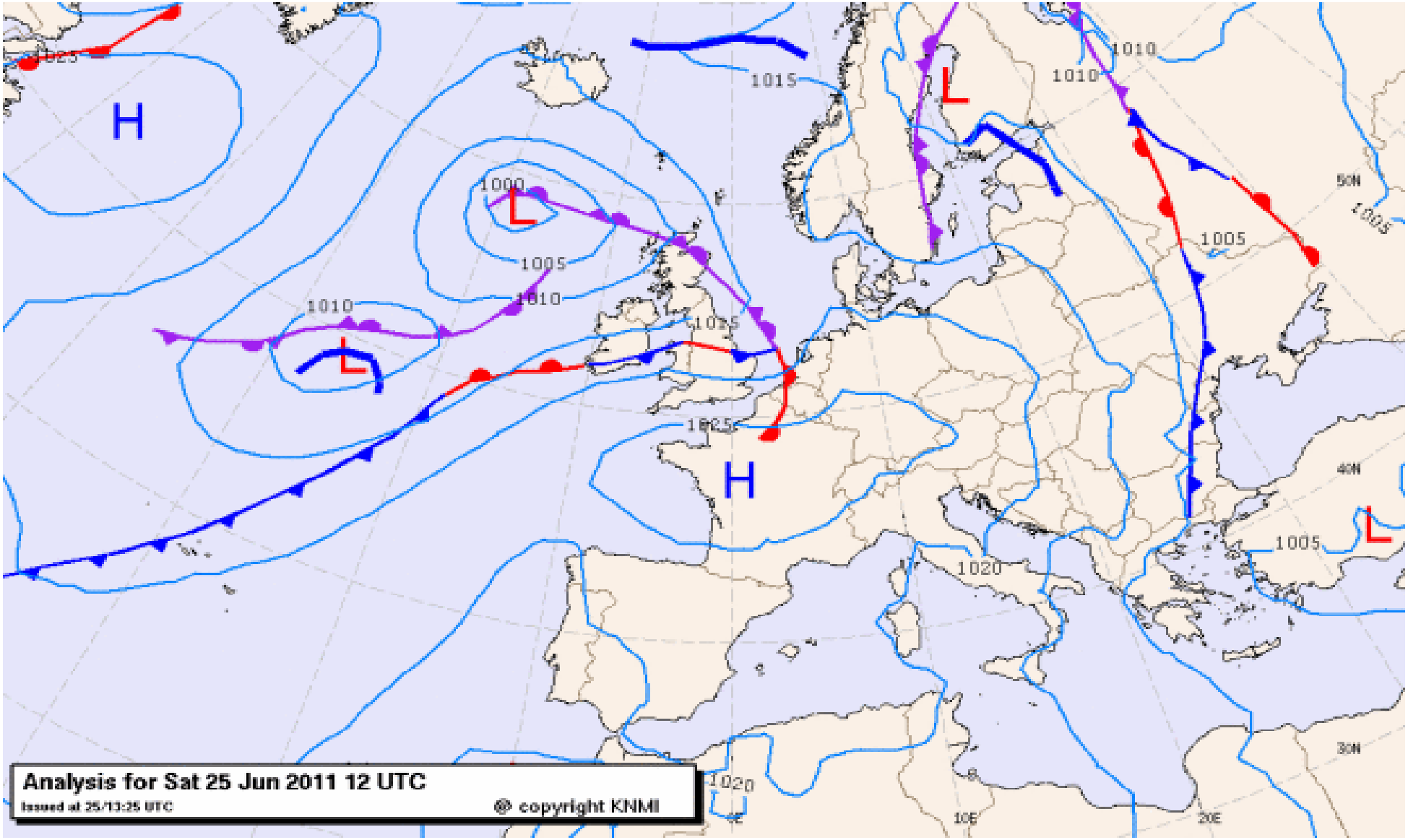
IOP5
a clear day



IOP5 radiation

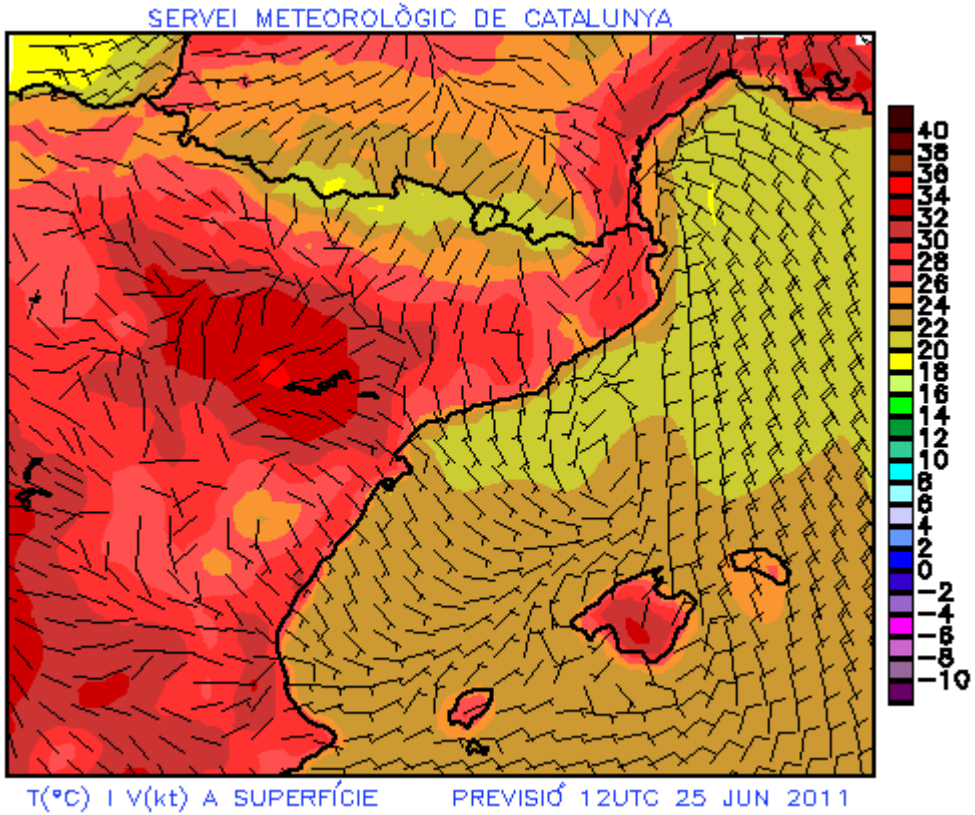


IOP5
synoptic scale



IOP5
synoptic scale - MM5

12 UTC



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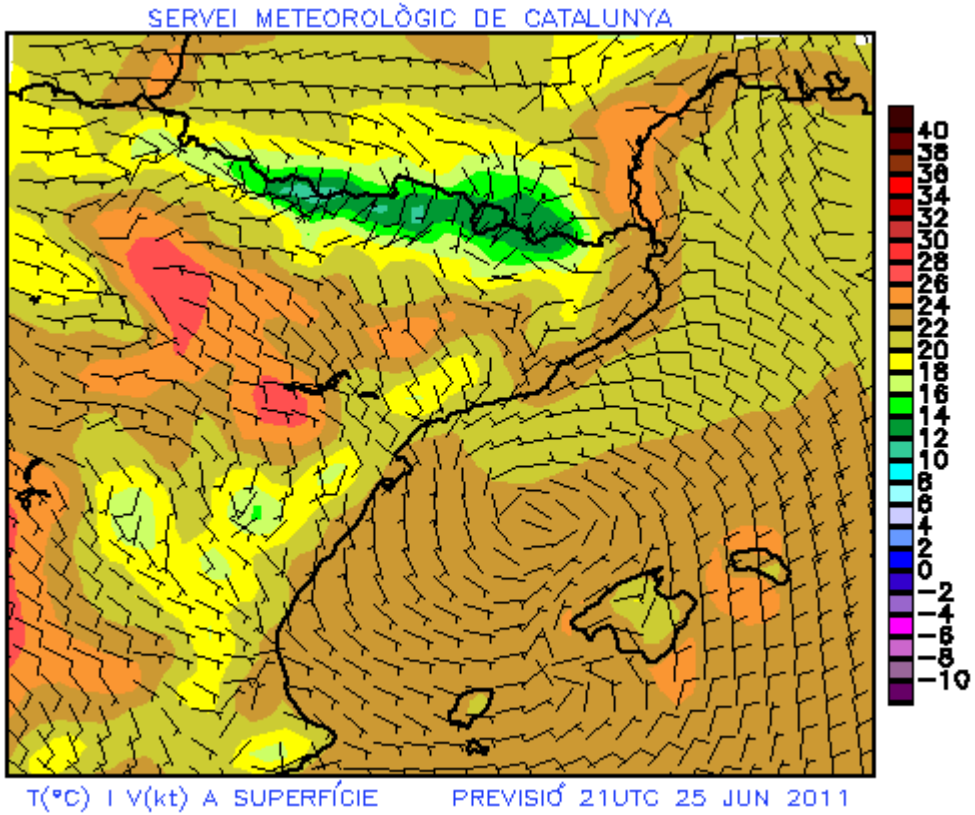
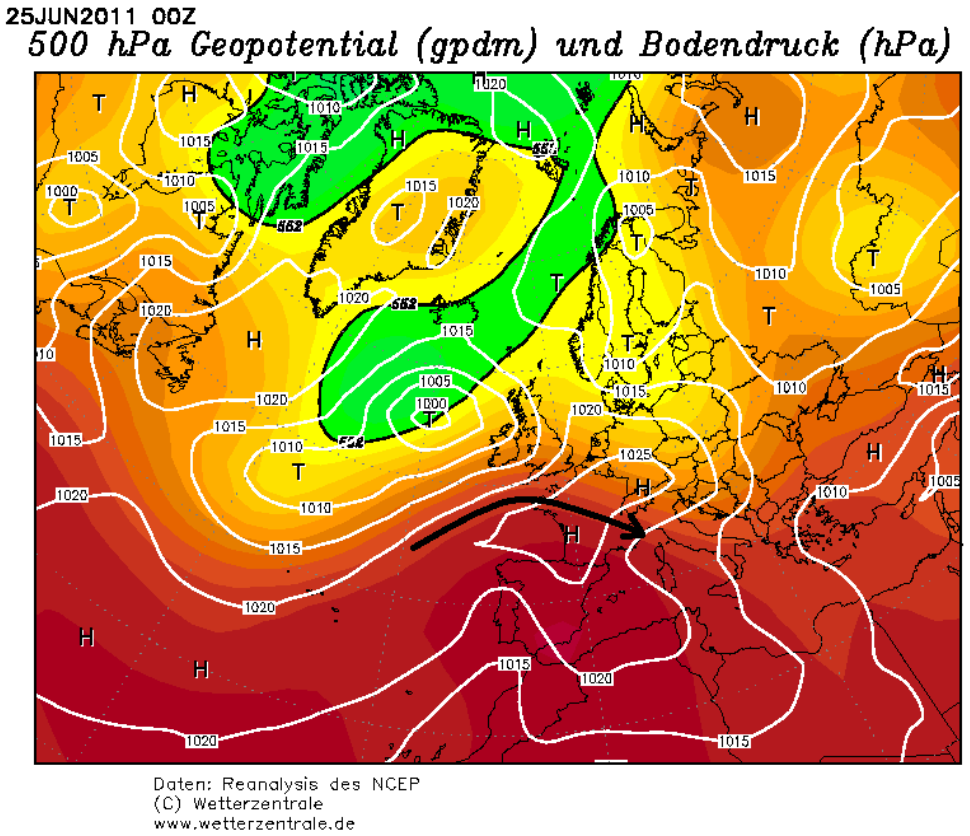
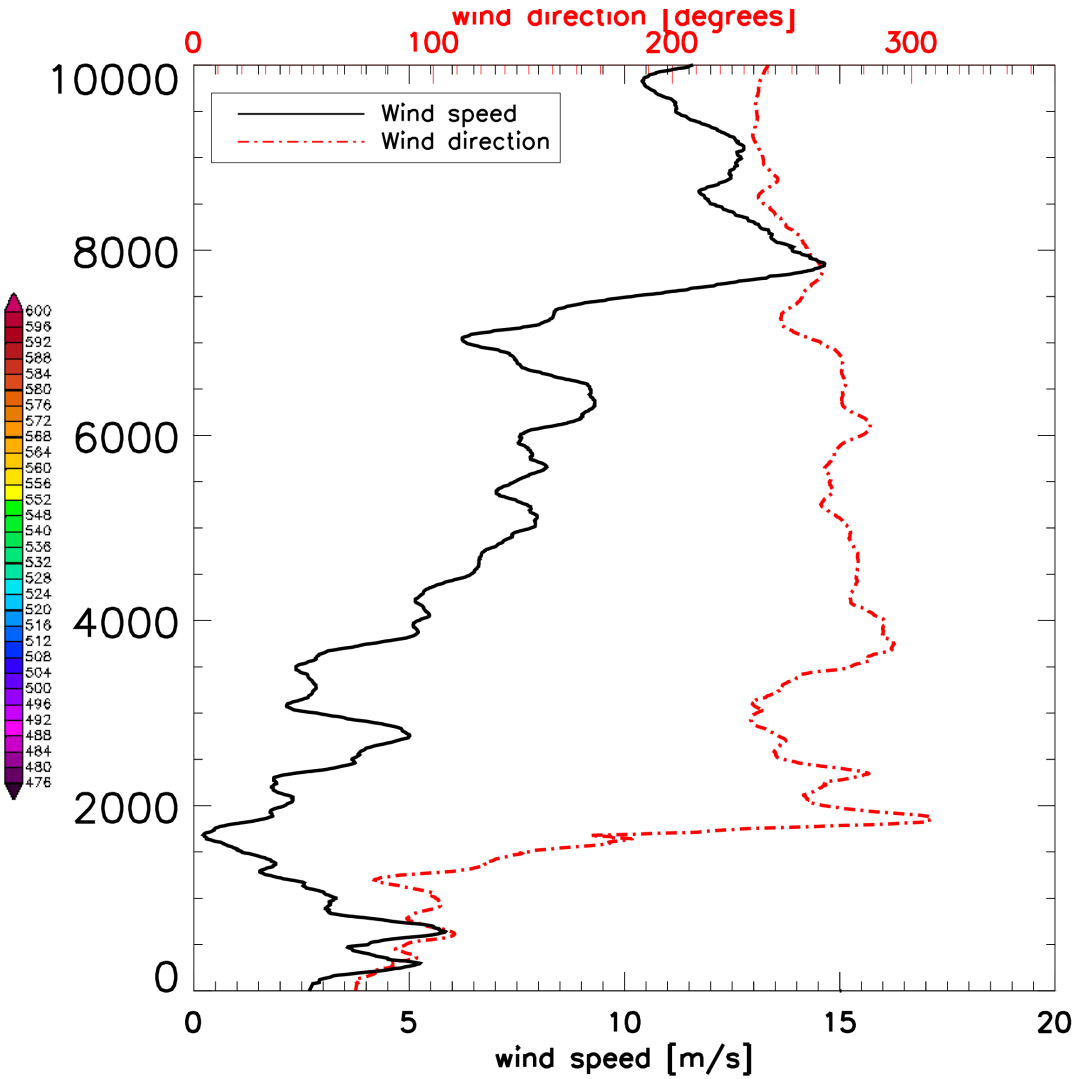


Joan Cuxart, BLLAST forecast

Upper air?





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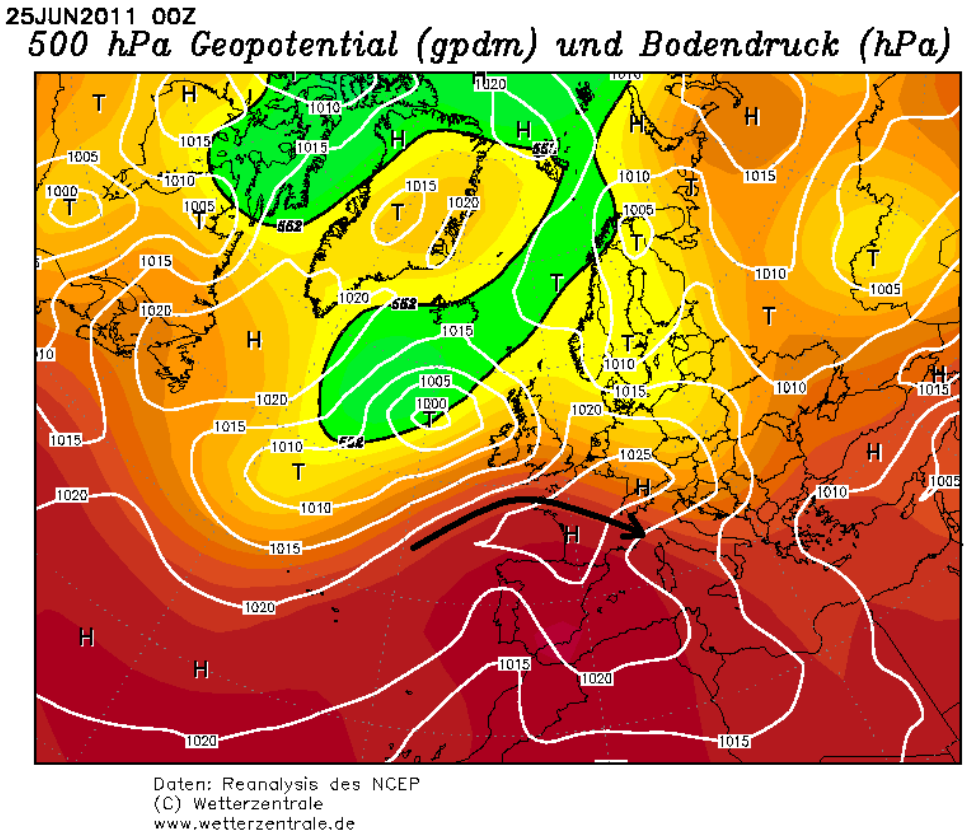
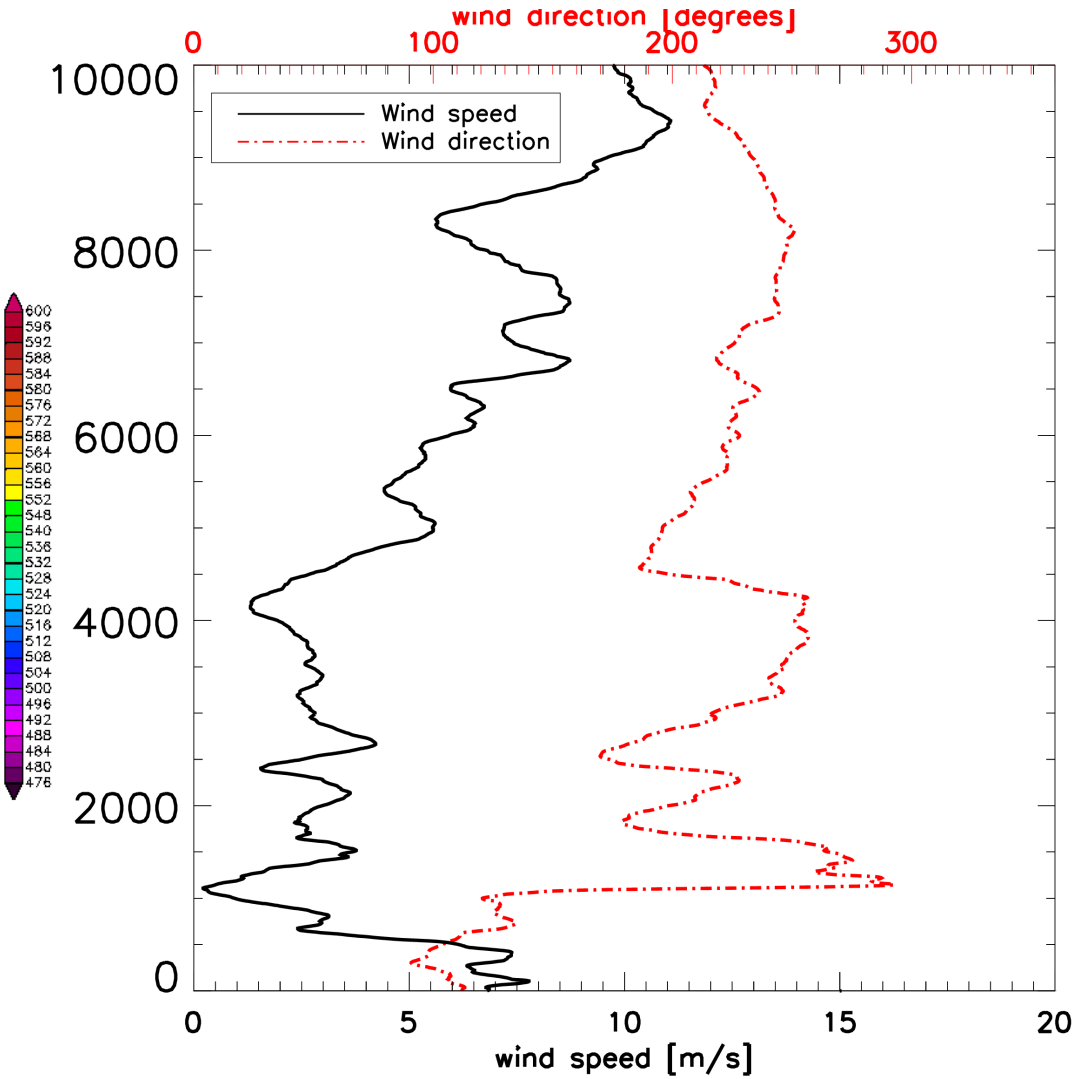
Upper air?





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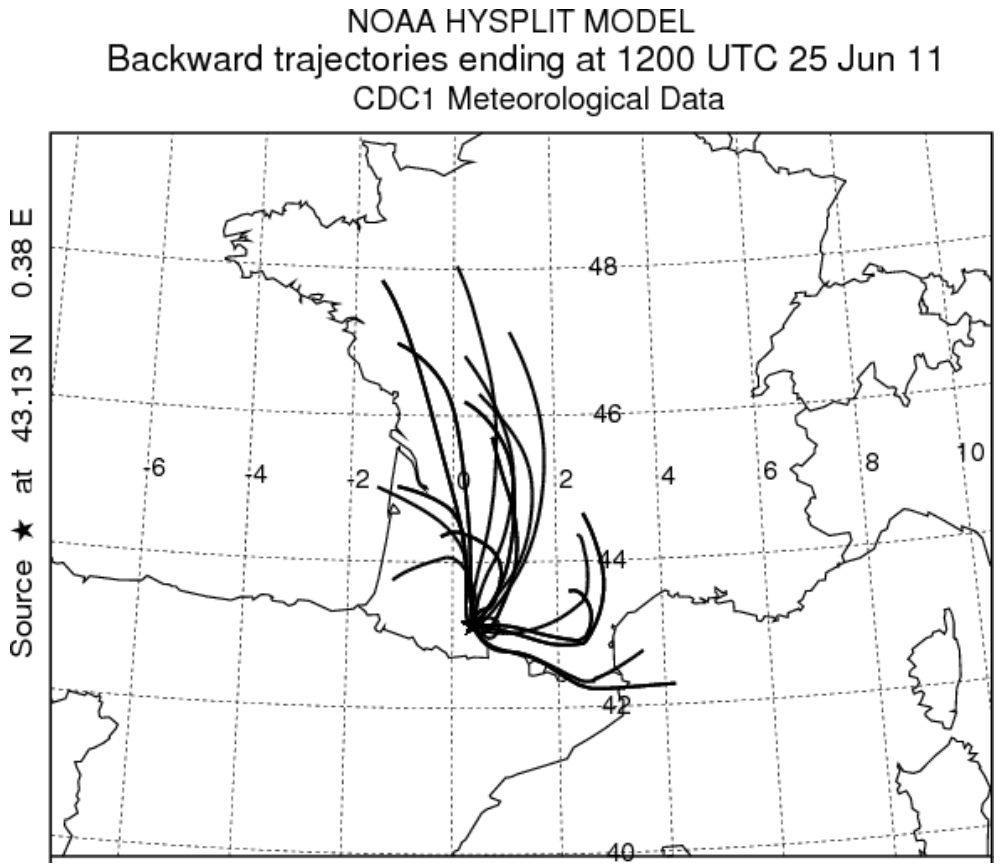
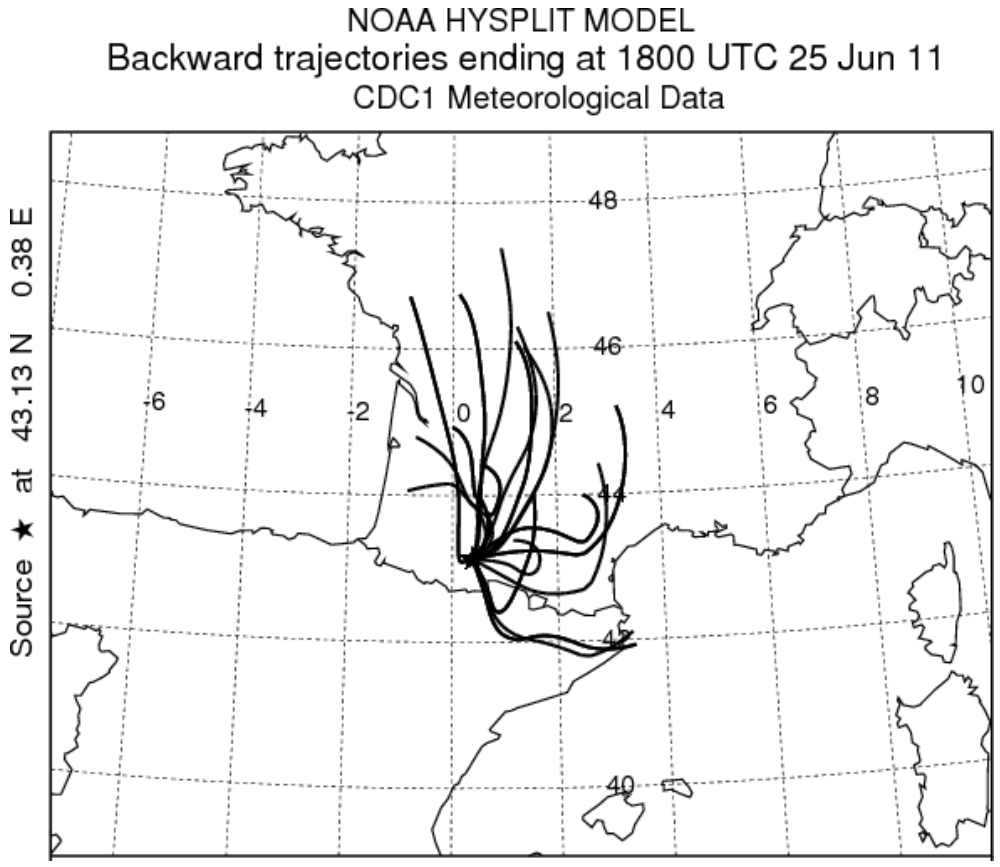
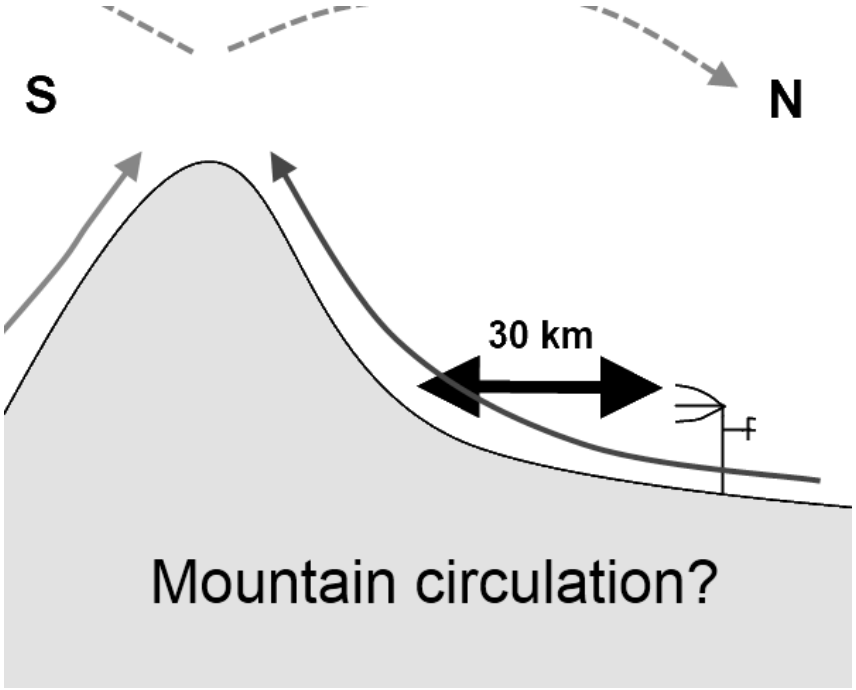
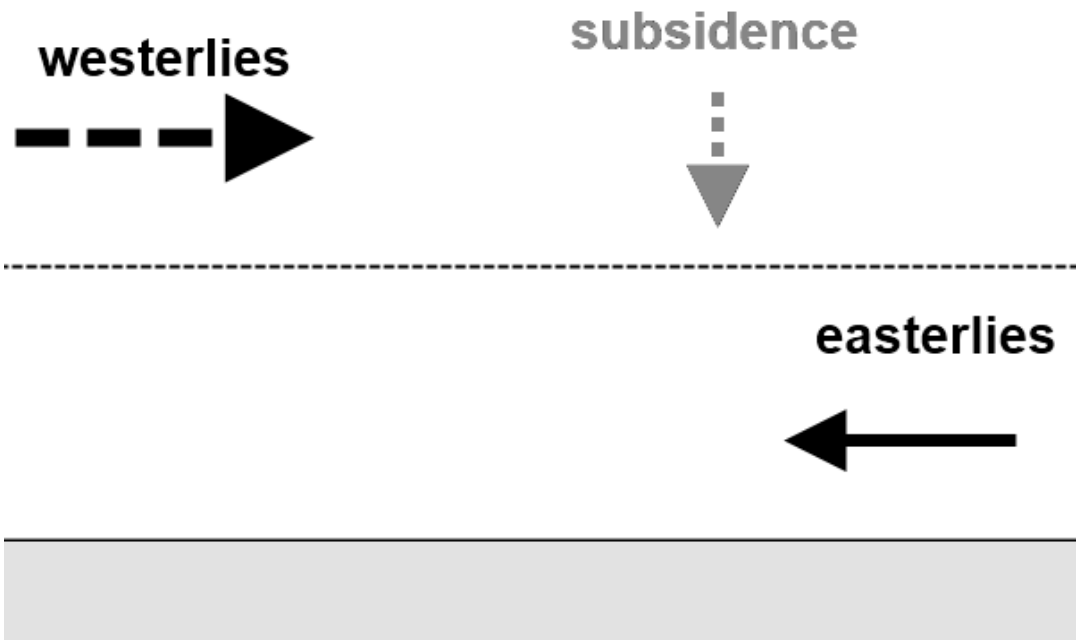
IOP5
synoptic scale - trajectories



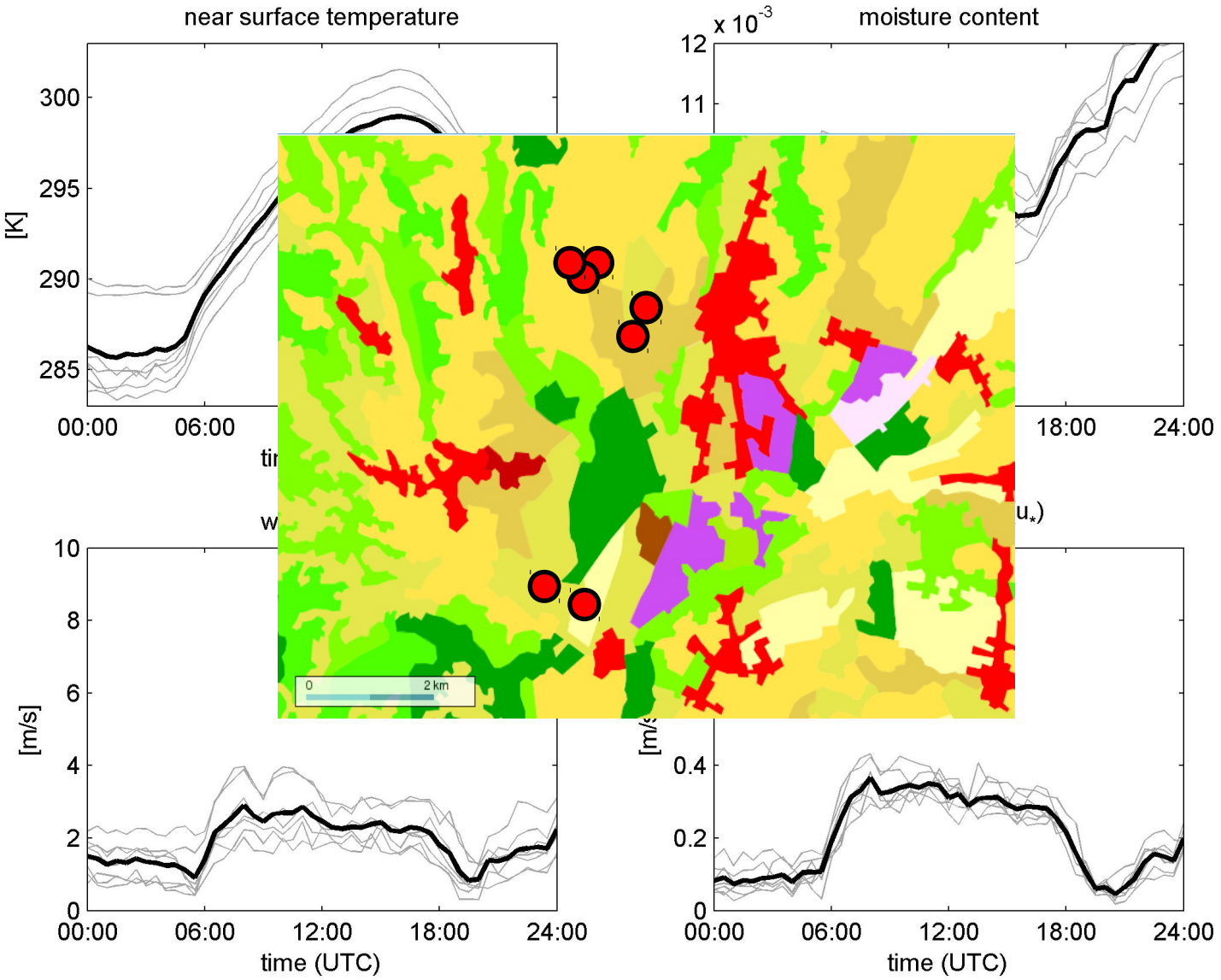


IOP5
Large scale influences

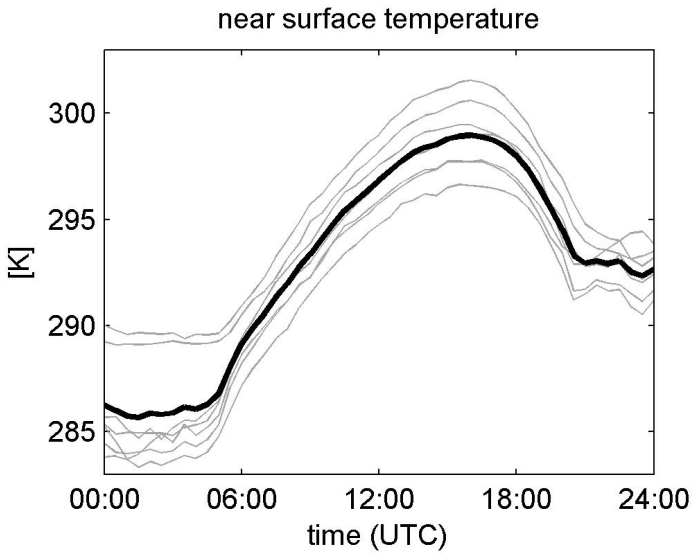


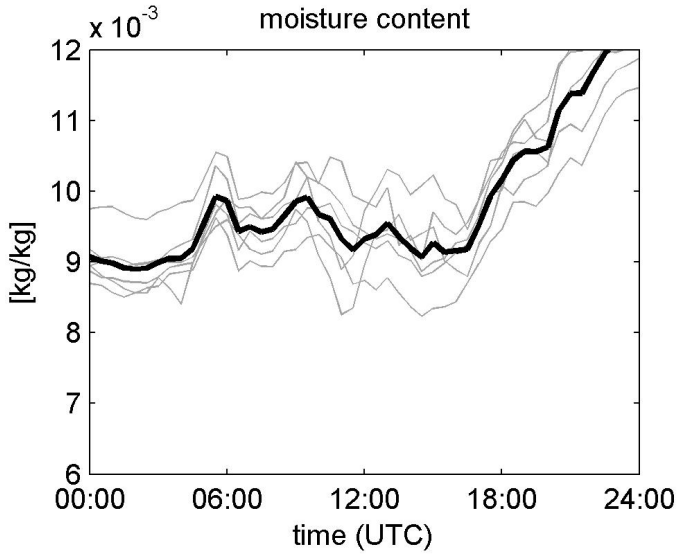


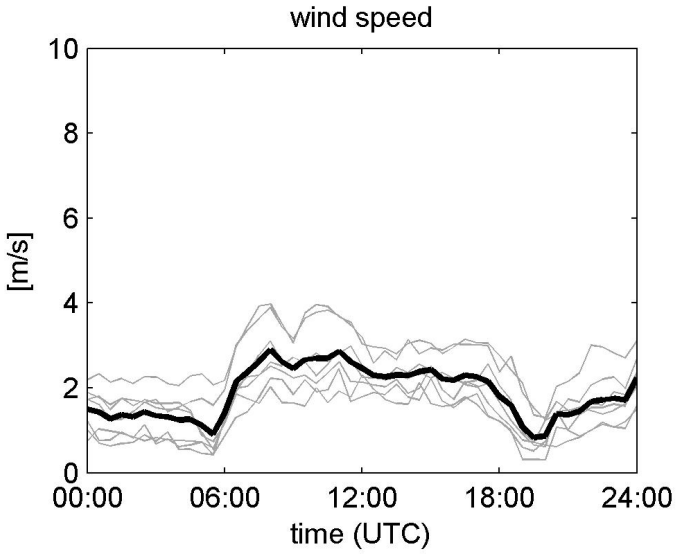
Surface measurements

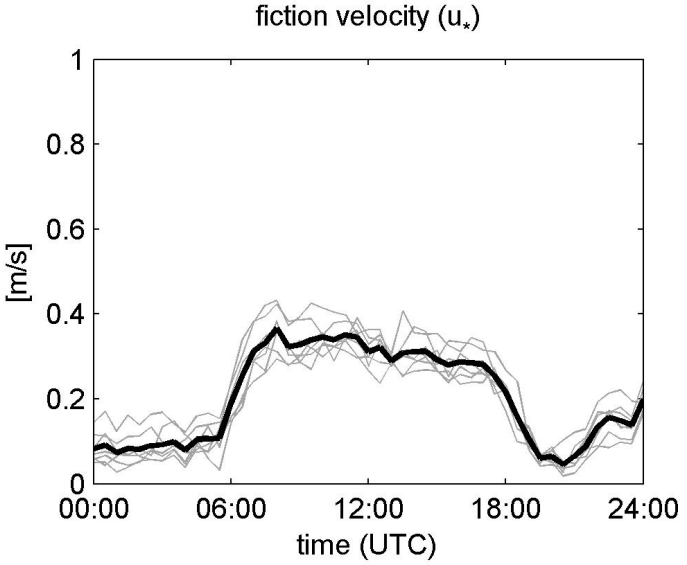


Surface measurements

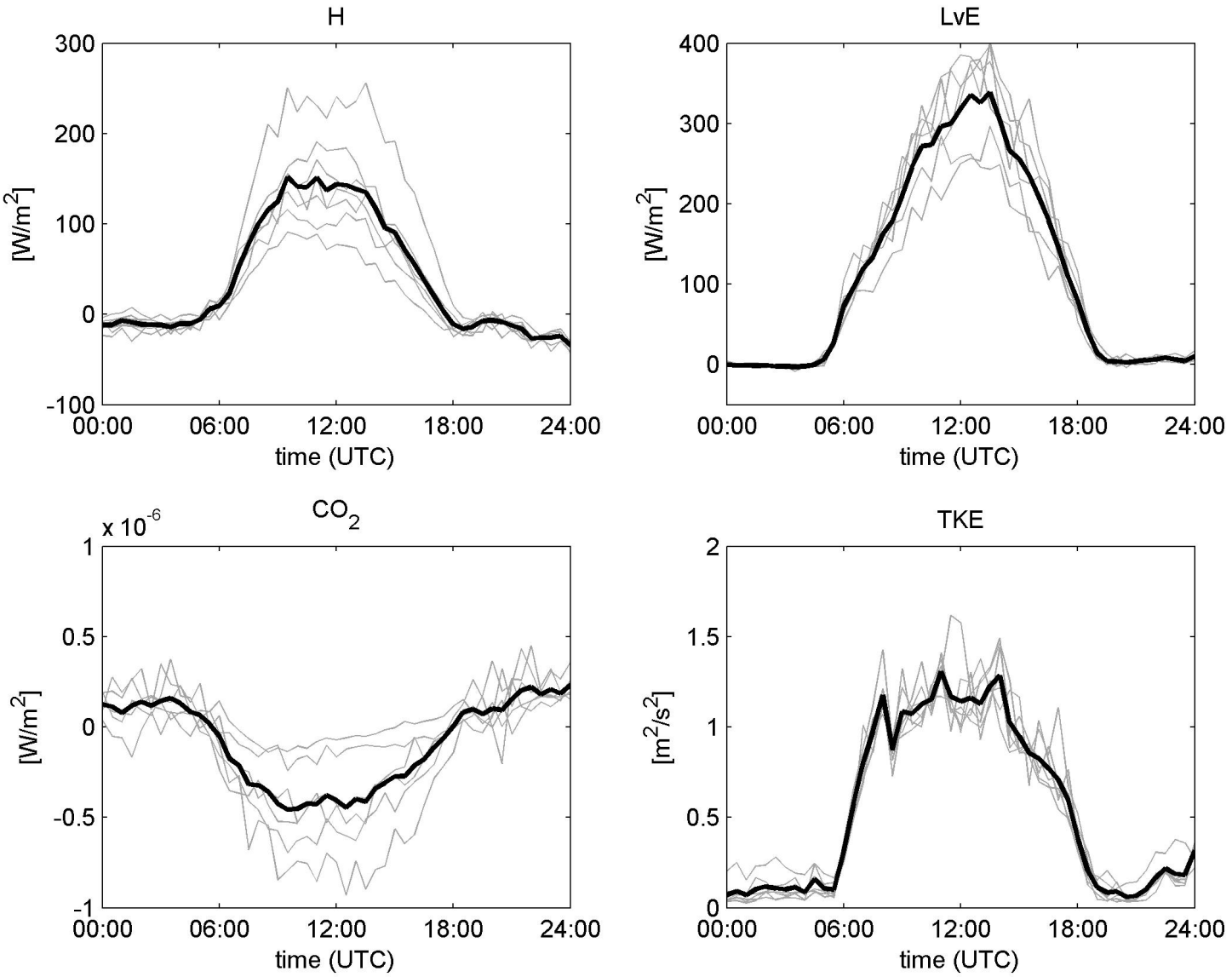




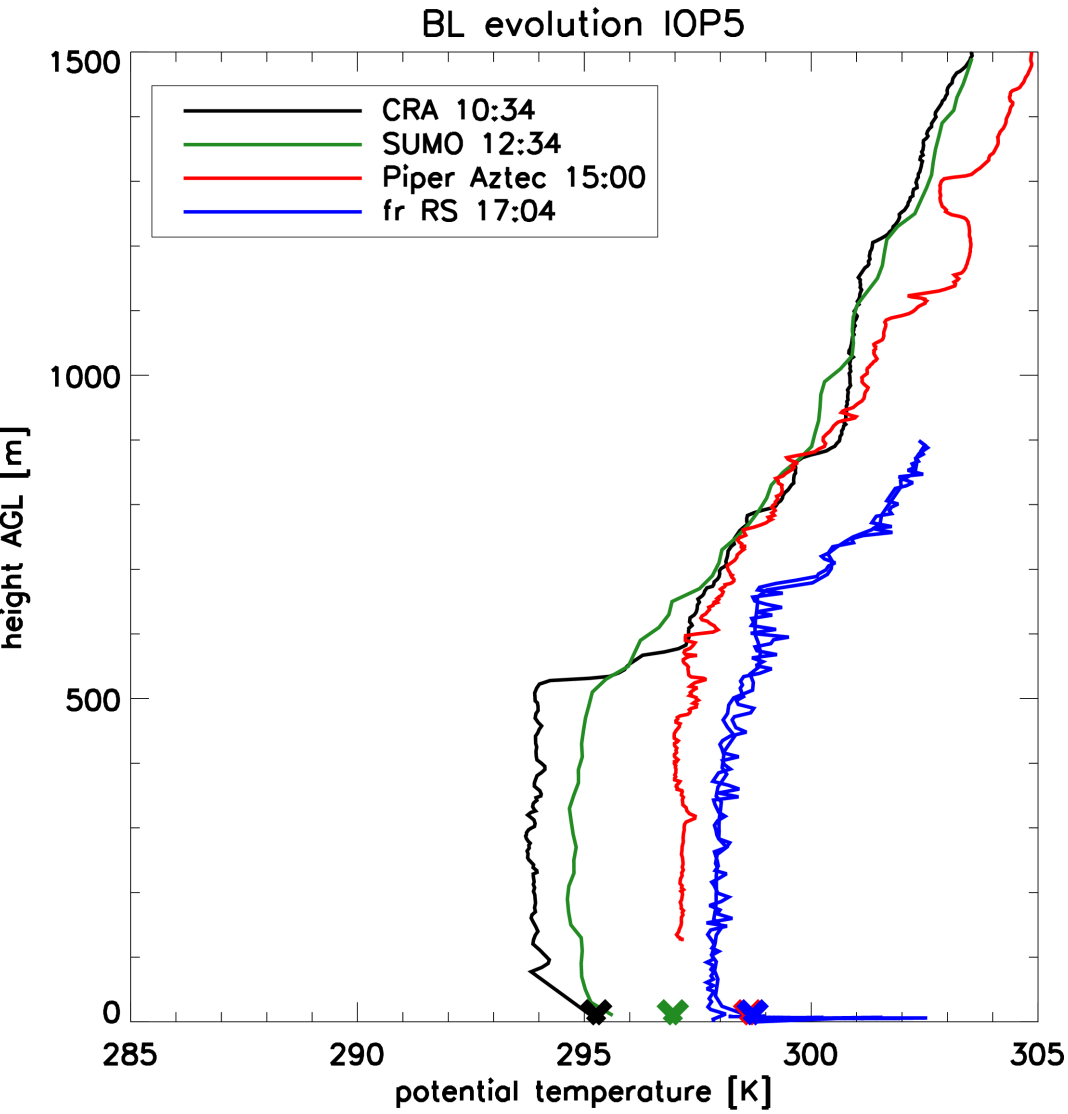


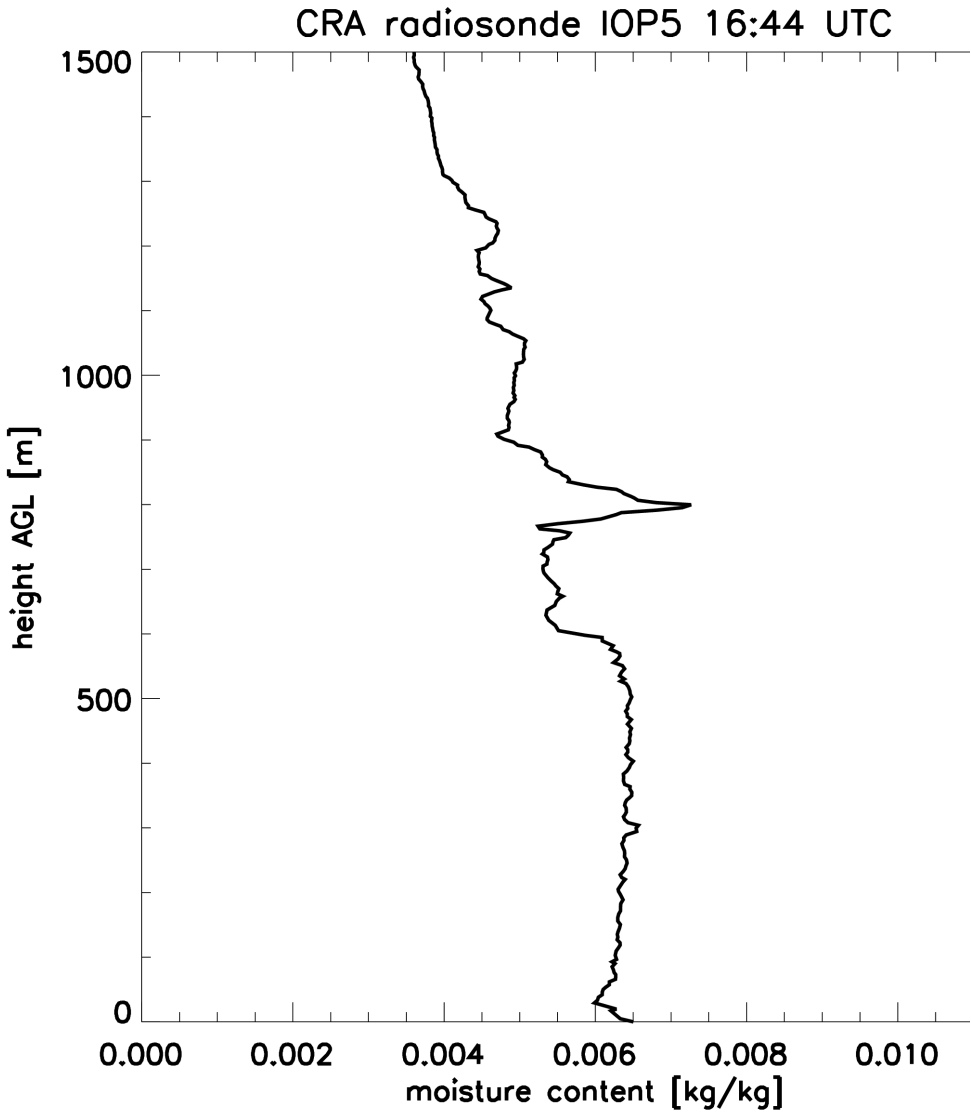


Surface measurements

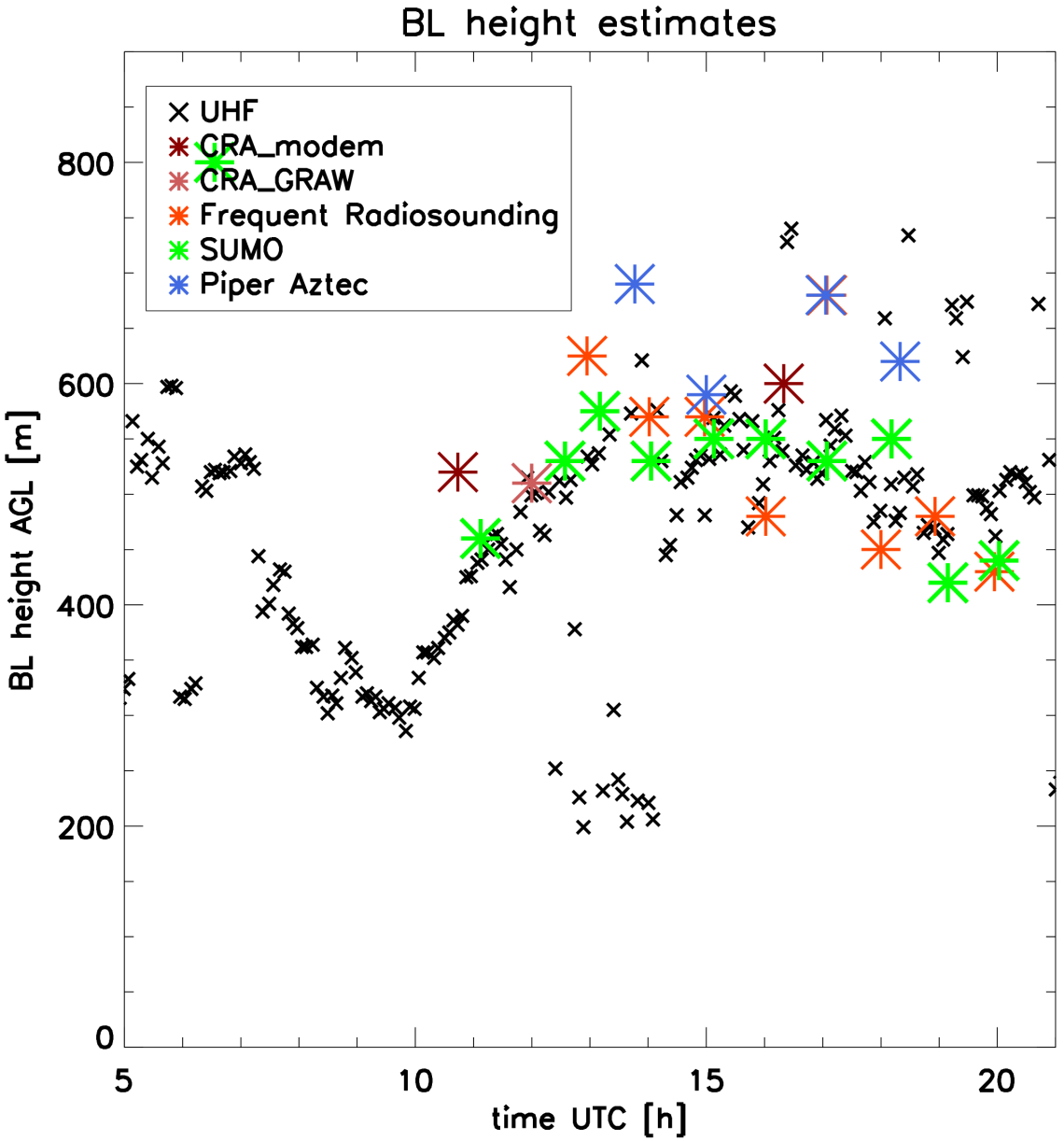


Vertical profiles





BL evolution



Modeling strategy

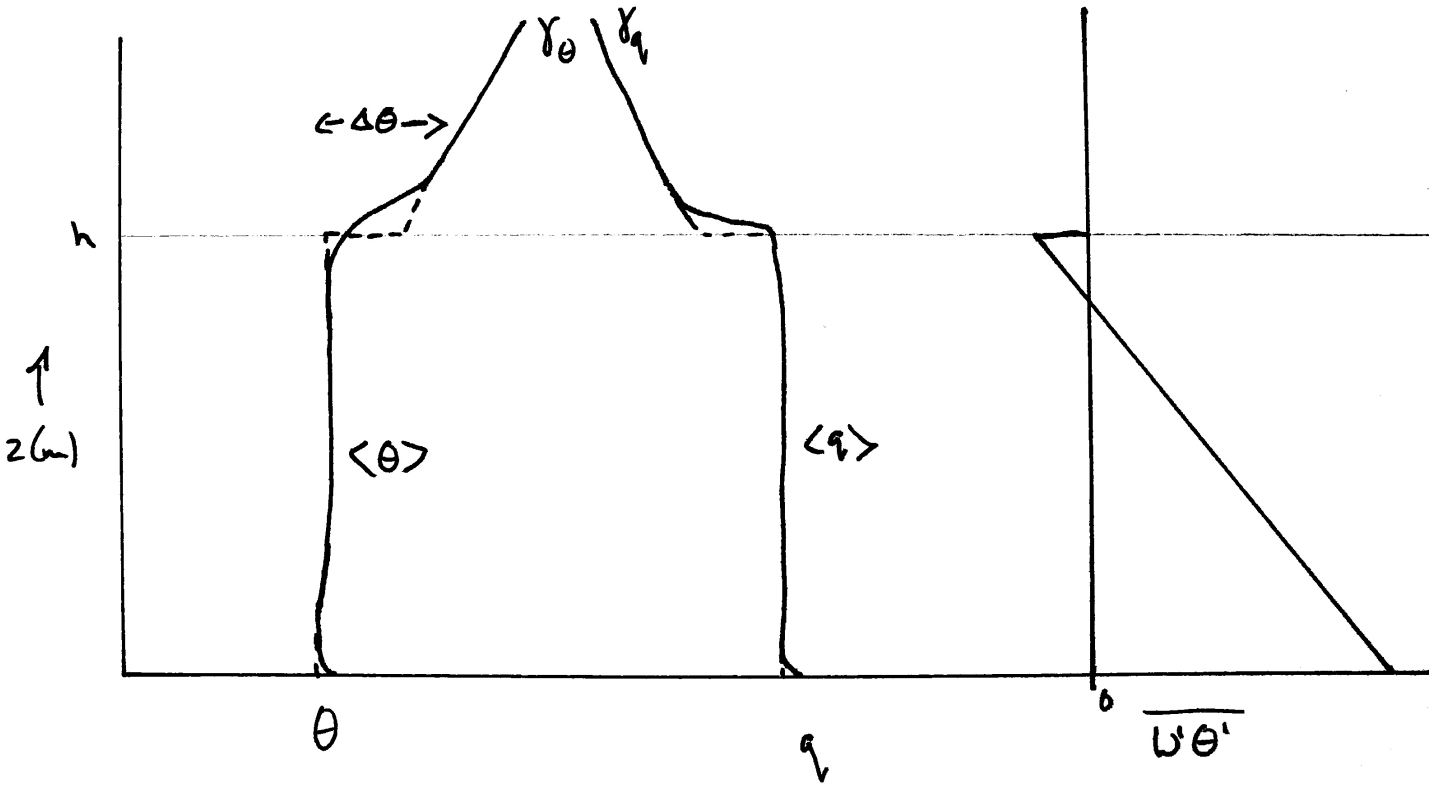
- Step-by-step reconstruction
- Initialize model with fluxes from observations
- Basic run
- Subsidence
- Advection
- Shear
- Surface heterogeity

Mixed layer

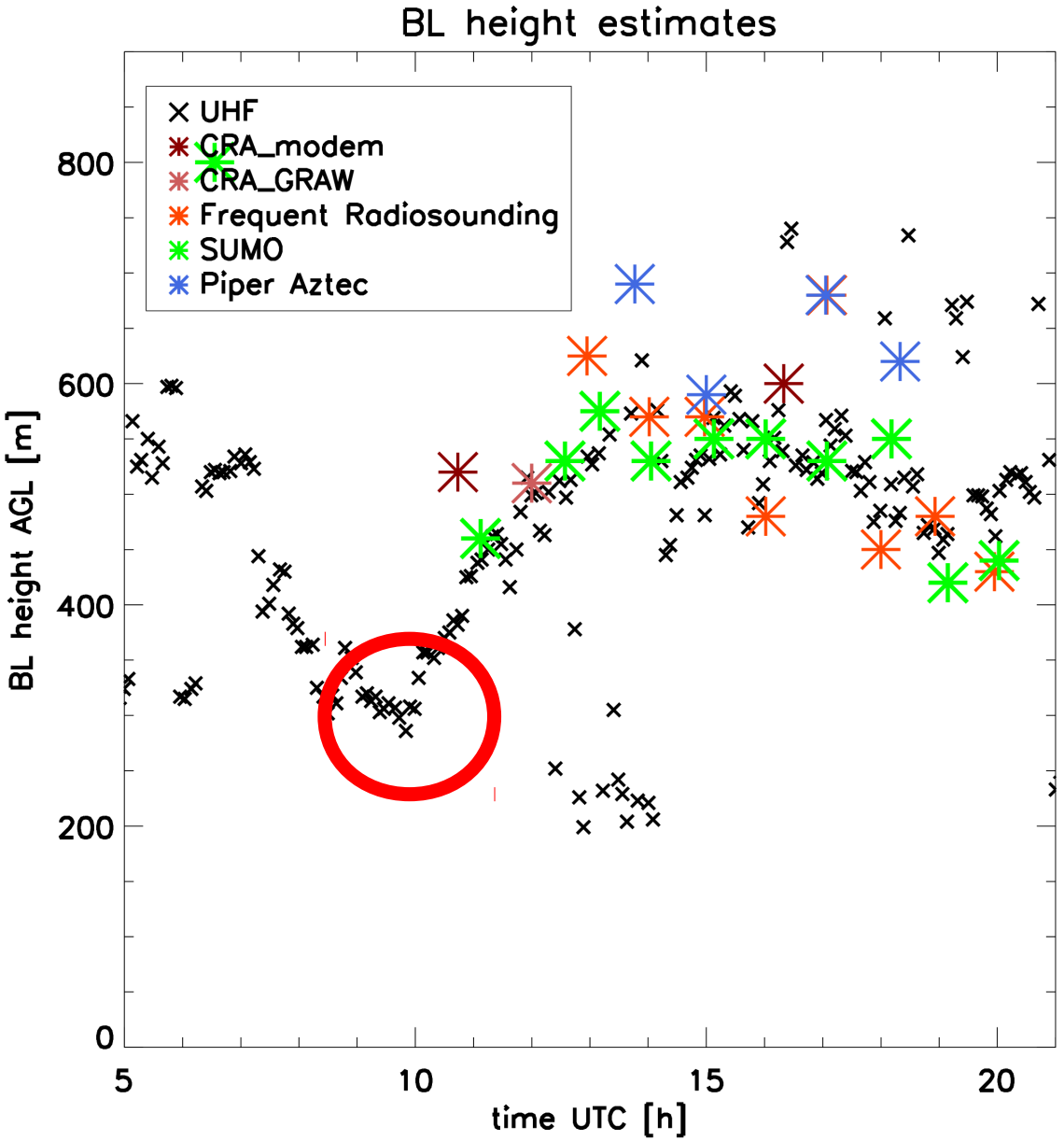
Les

ML model description

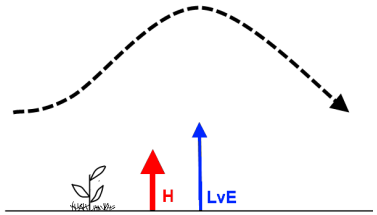
- from Tennekes and Driedonks, 1981
- Boundary layer simplification
- BL structure
  - Single layer
  - Jump
  - Upper air gradient
- Prescribe:
  - Initial state
  - Fluxes
  - (changes in boundary conditions)
- Useful tool to investigate BL processes

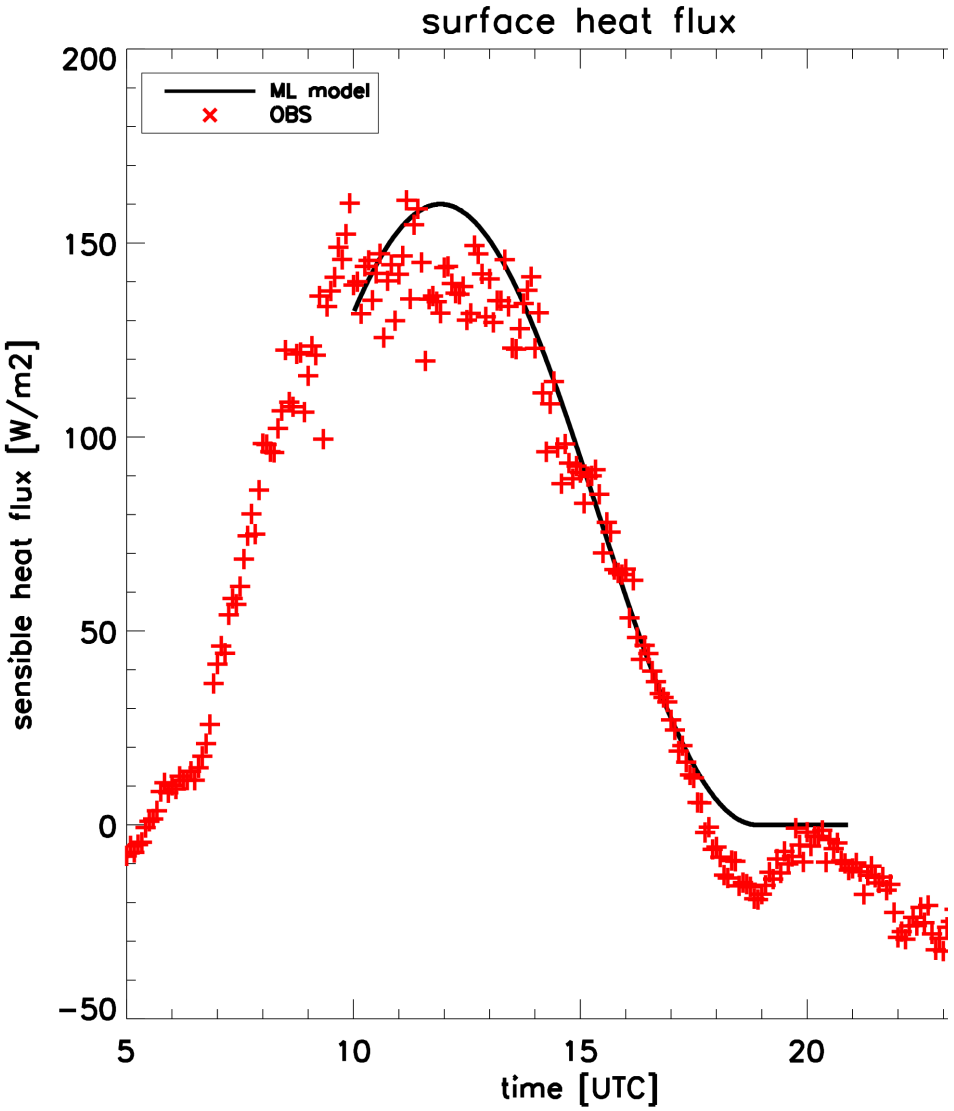


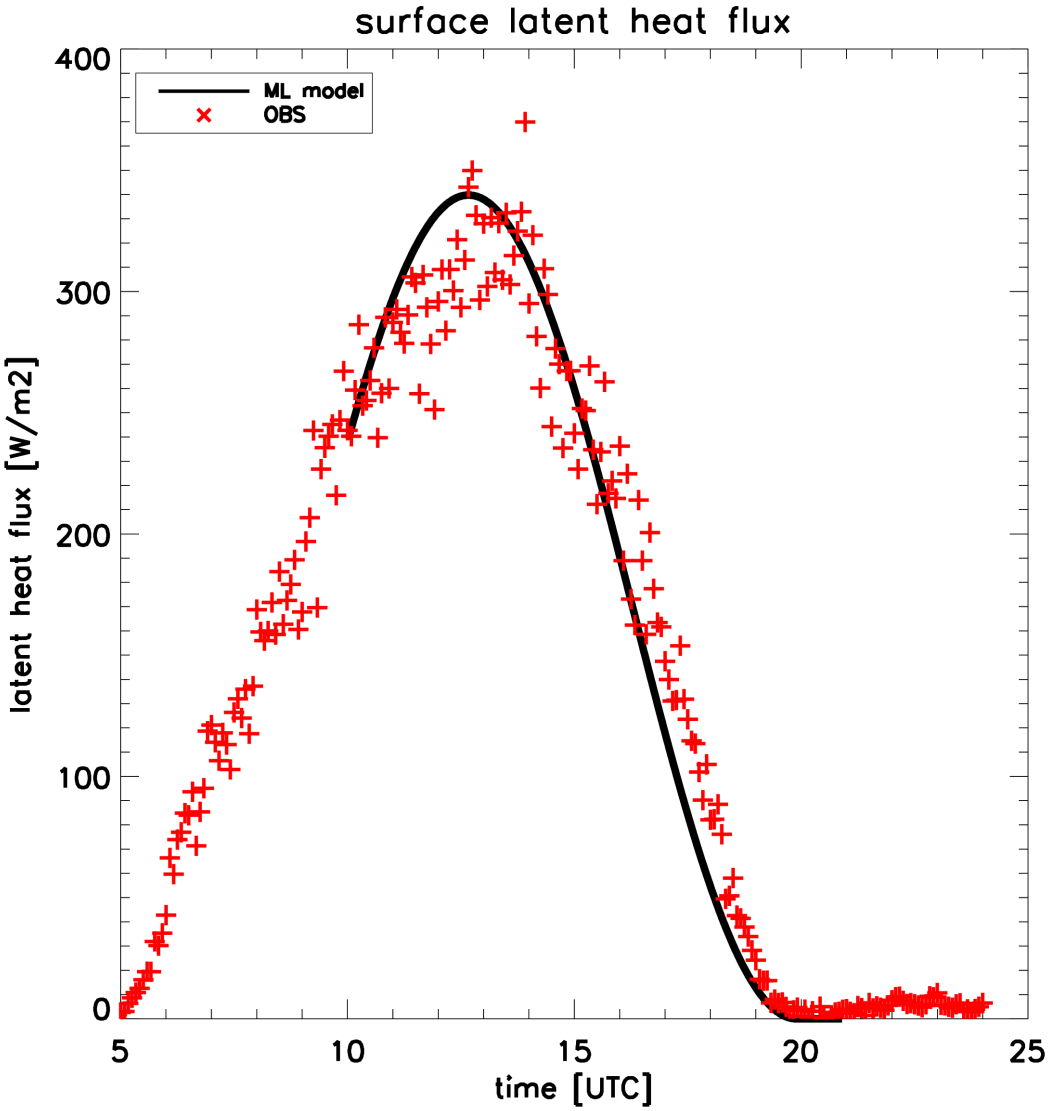
BL evolution



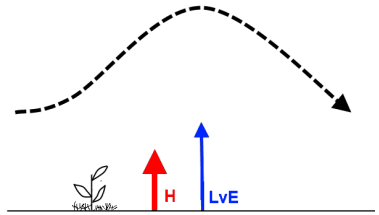
ML model initialisation fluxes

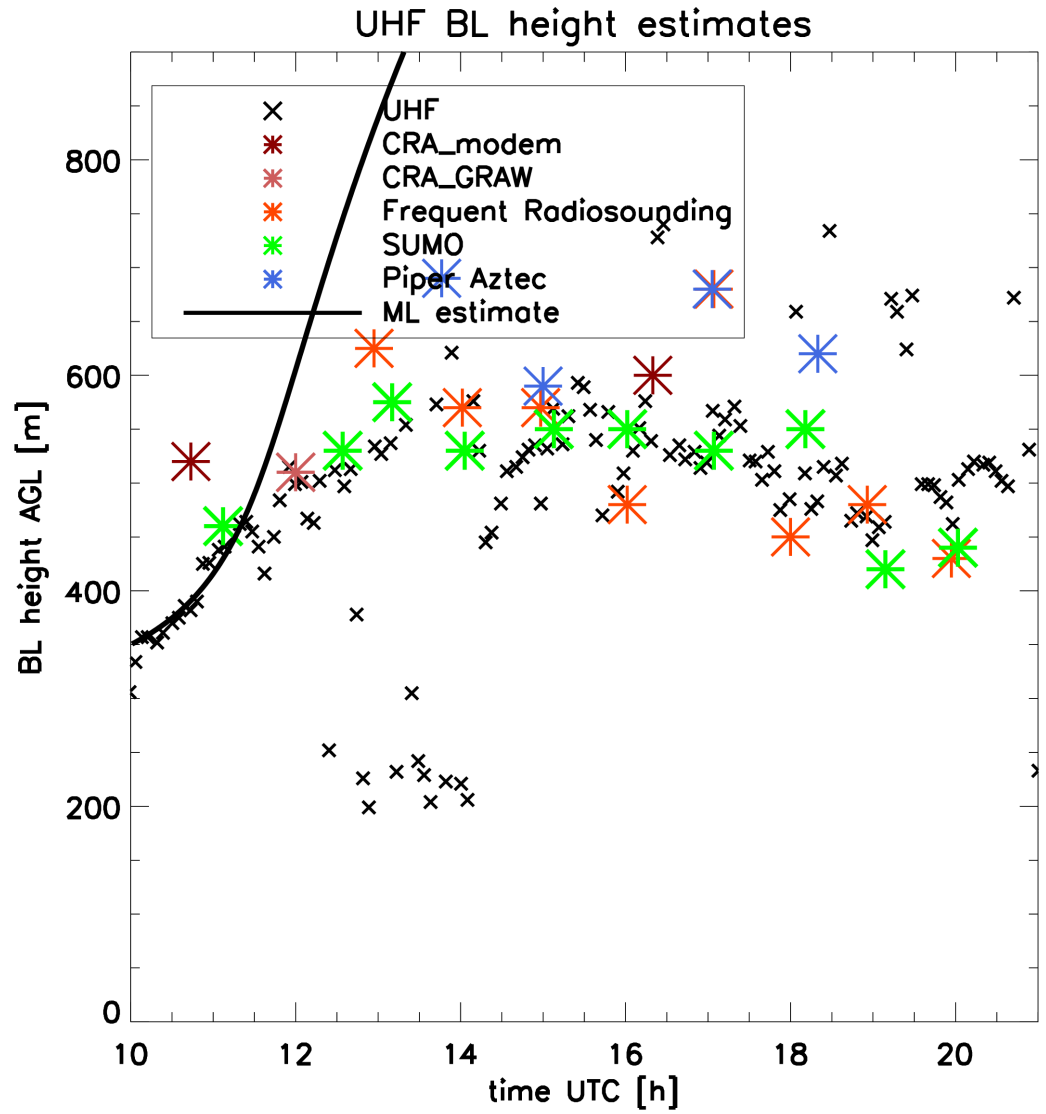


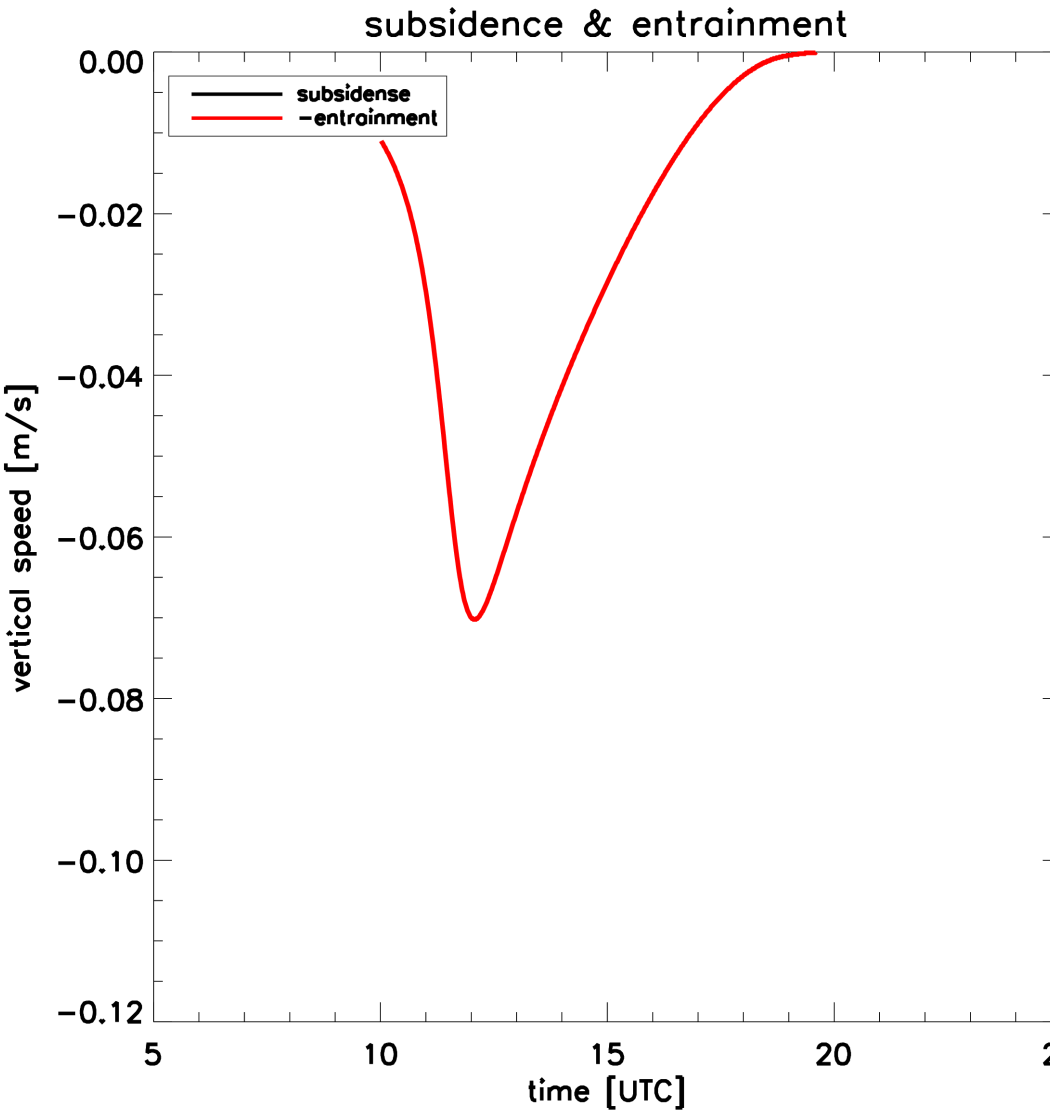




ML model basic run







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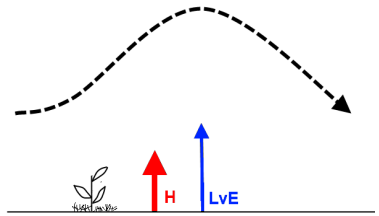
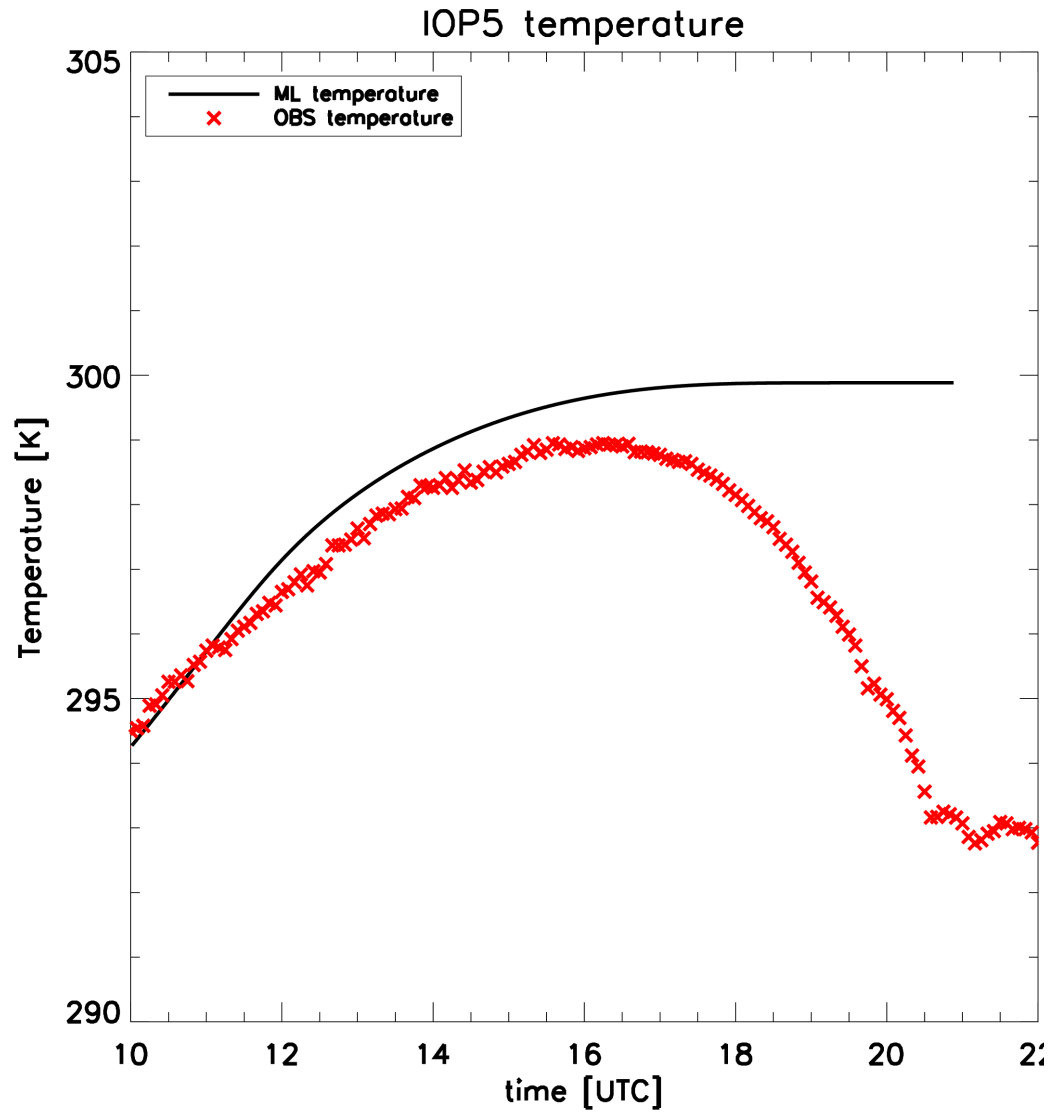
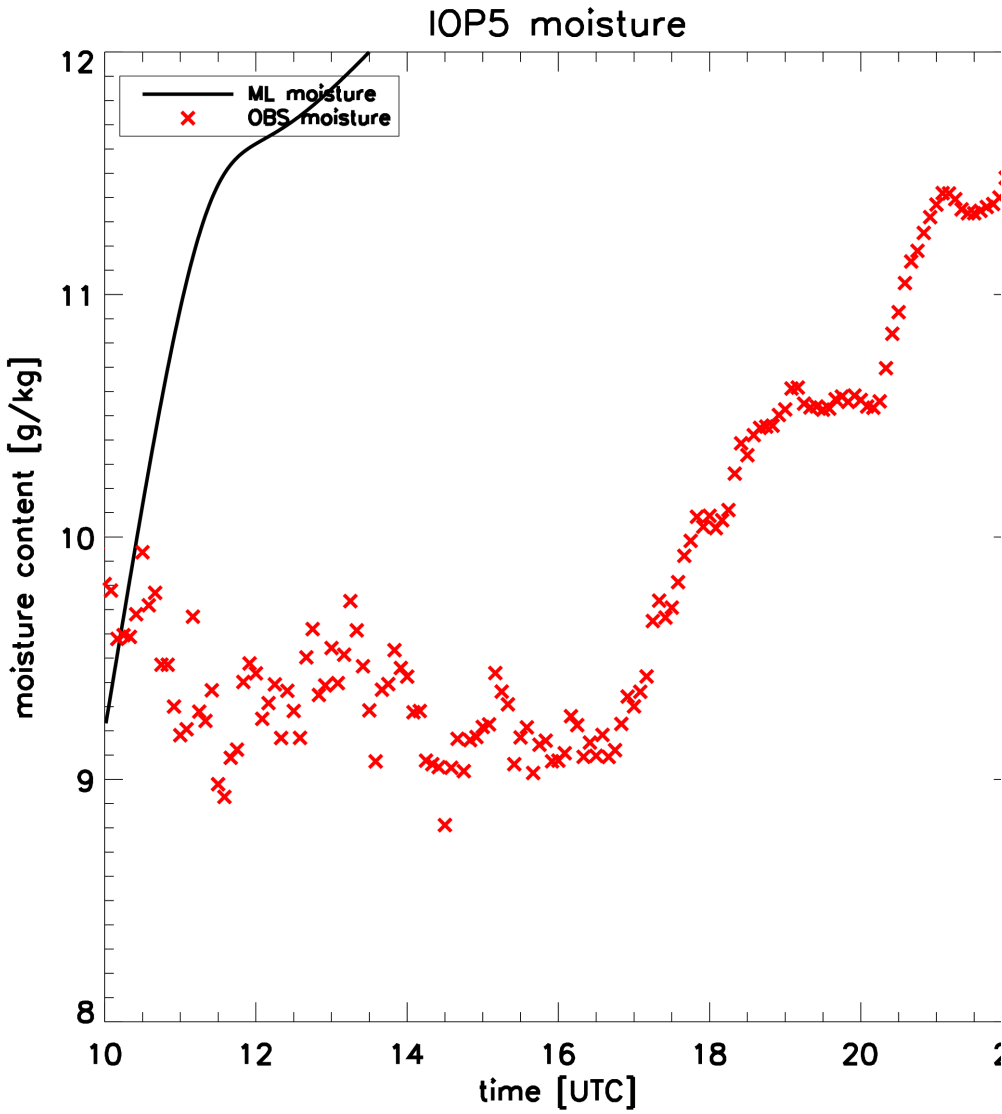
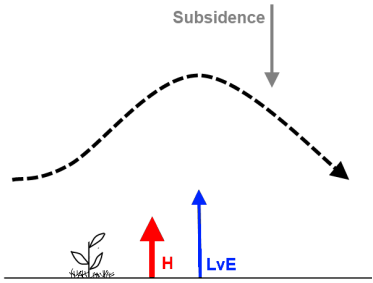
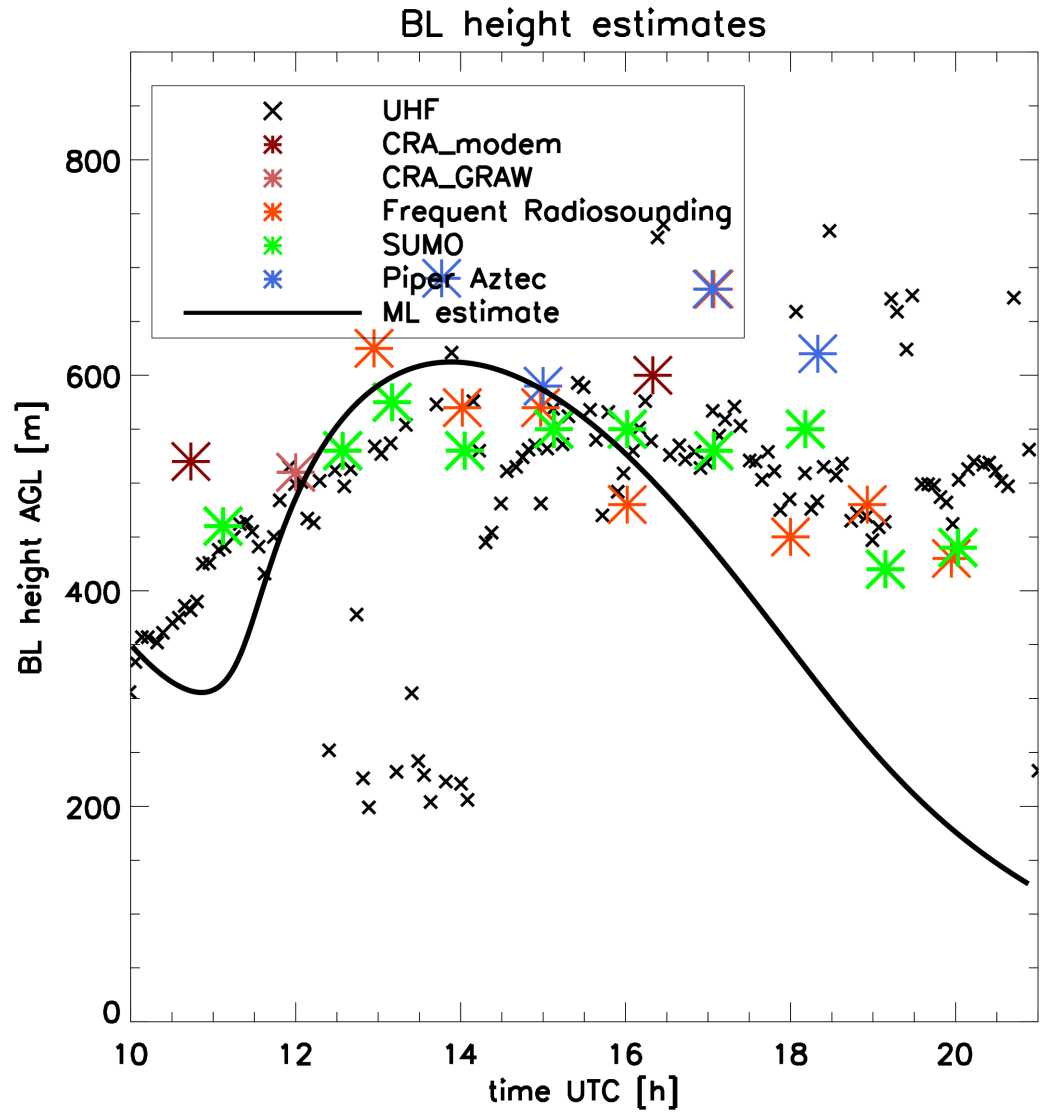


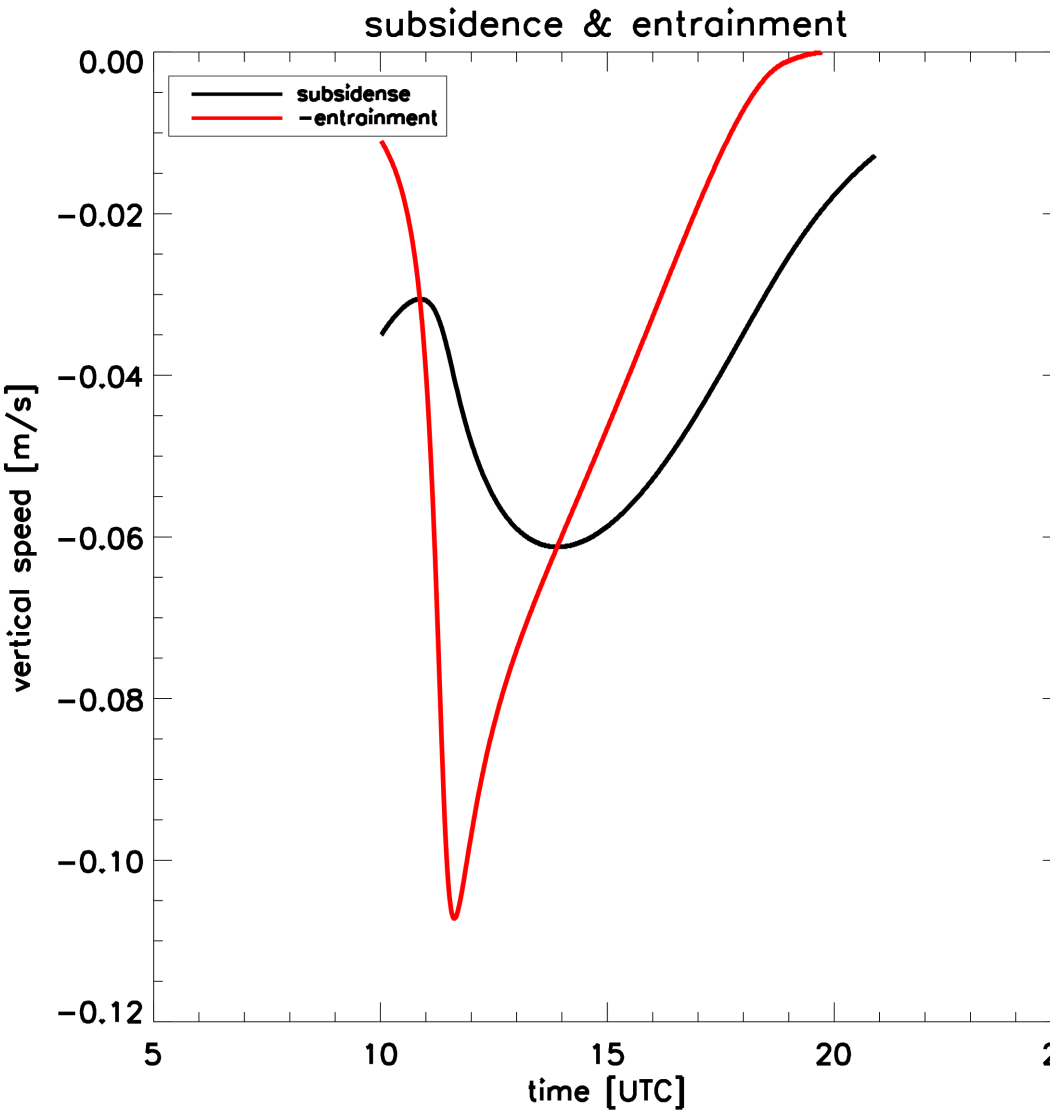




ML model subsidence







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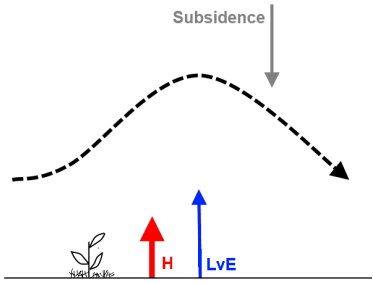
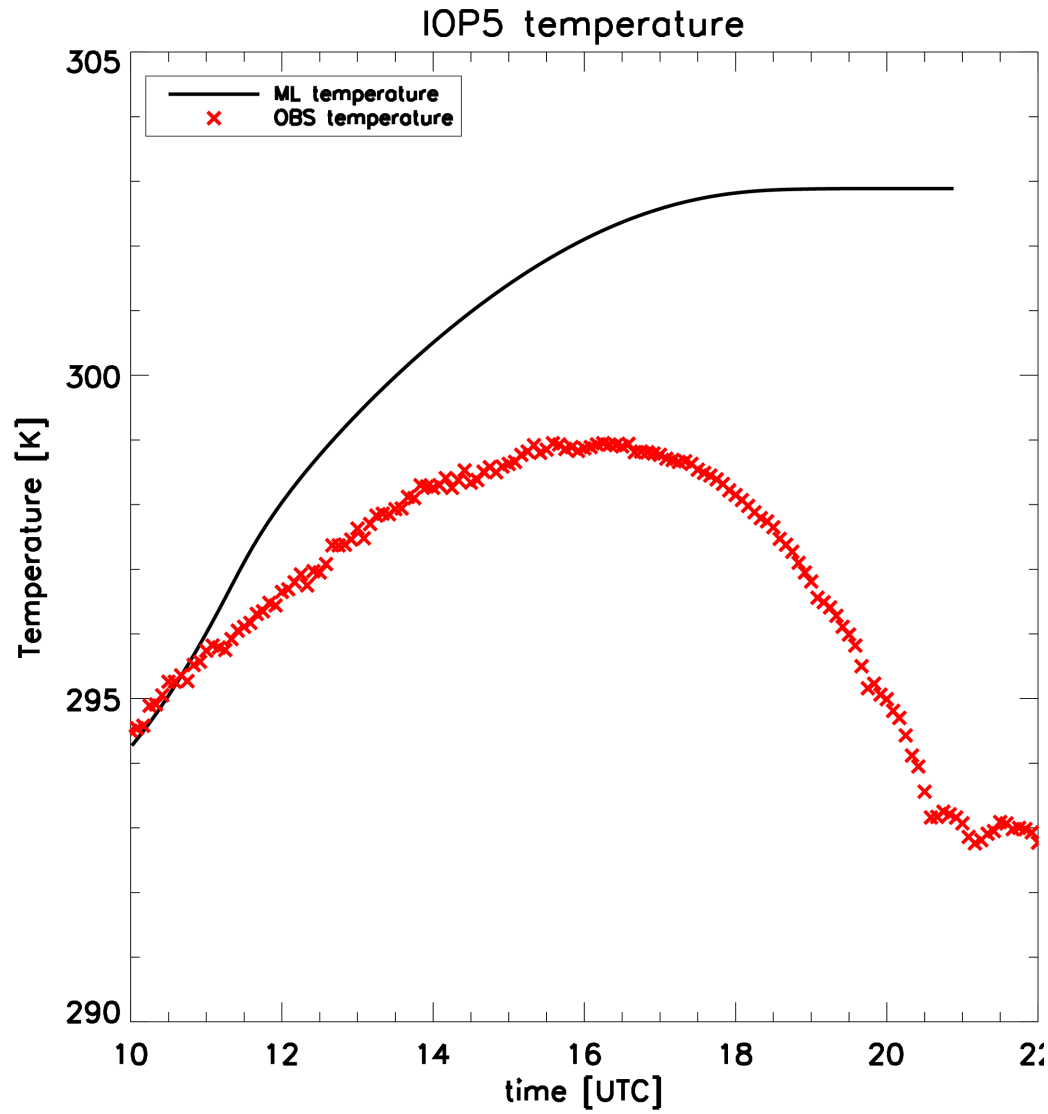
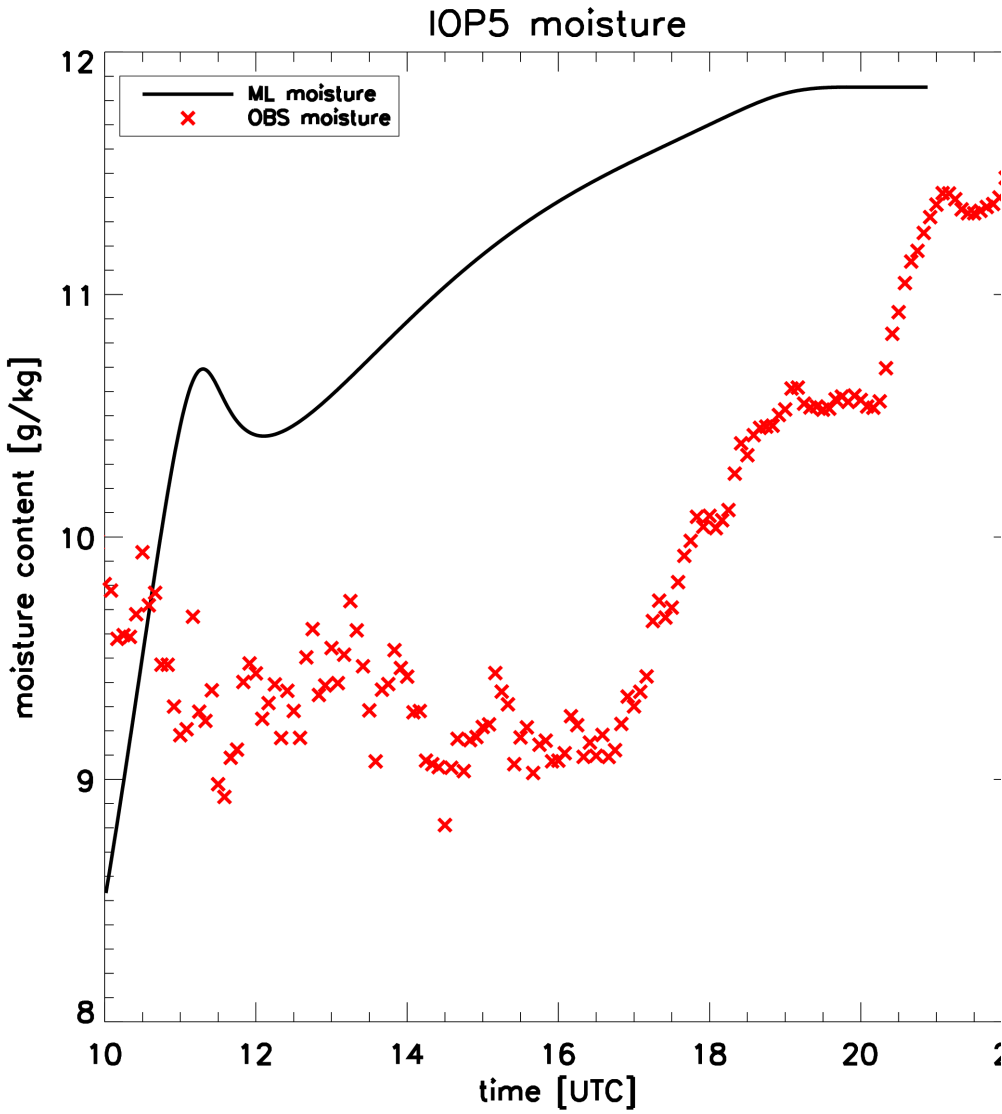
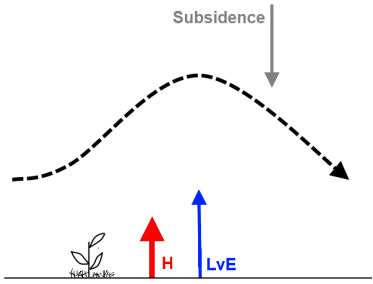
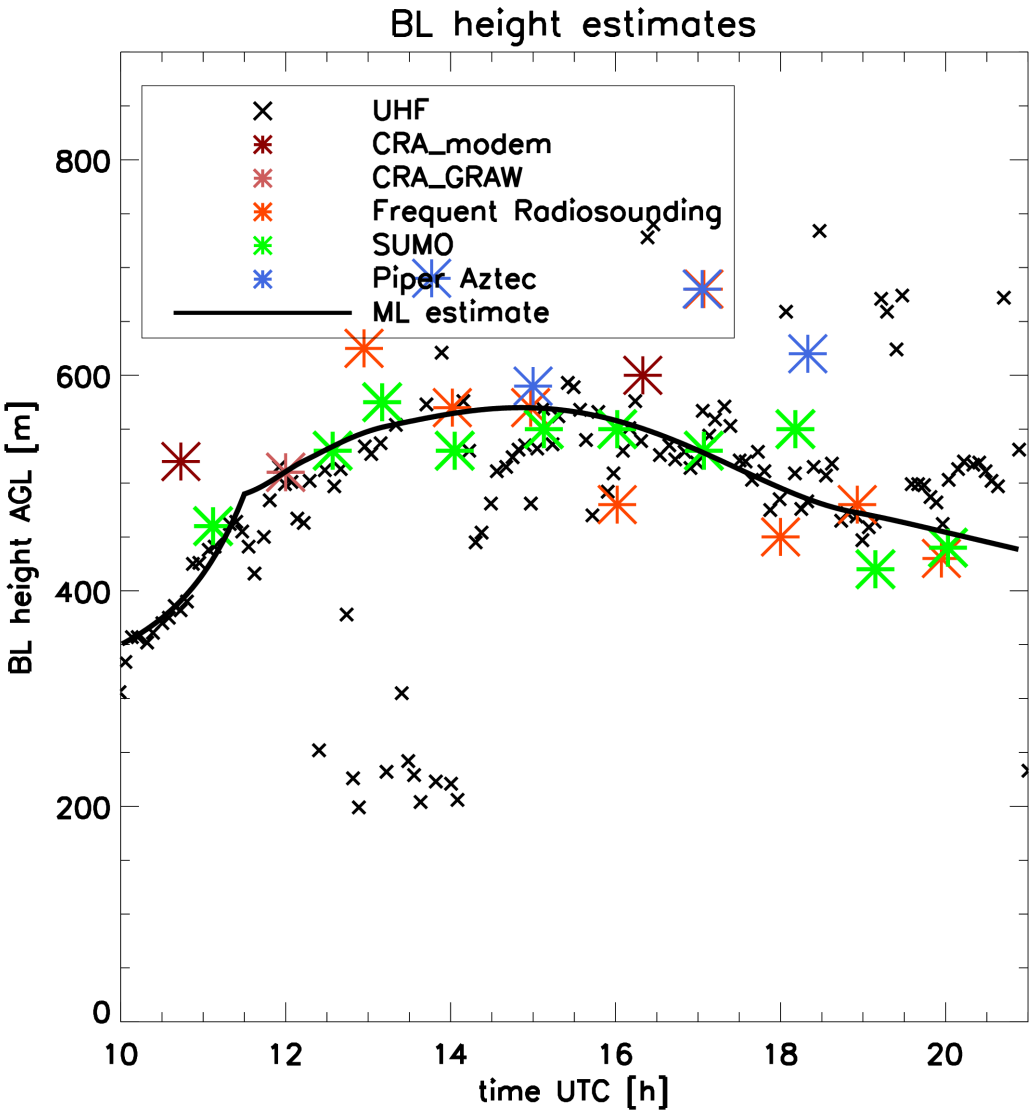


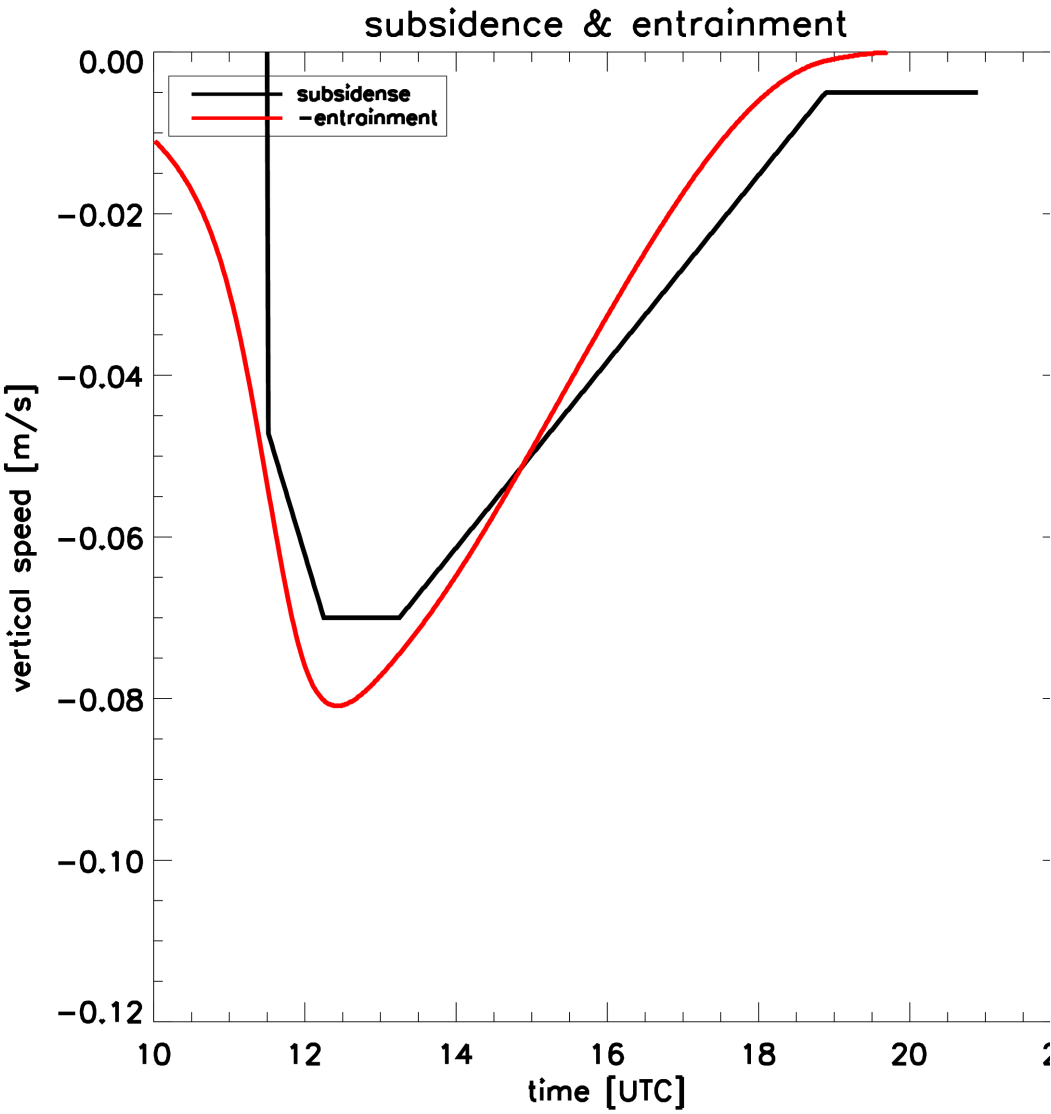




ML model prescribed subsidence







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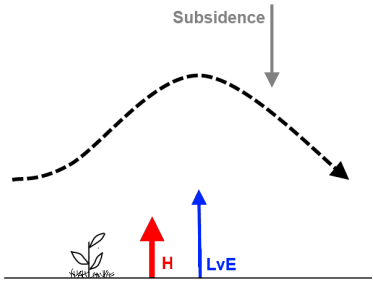
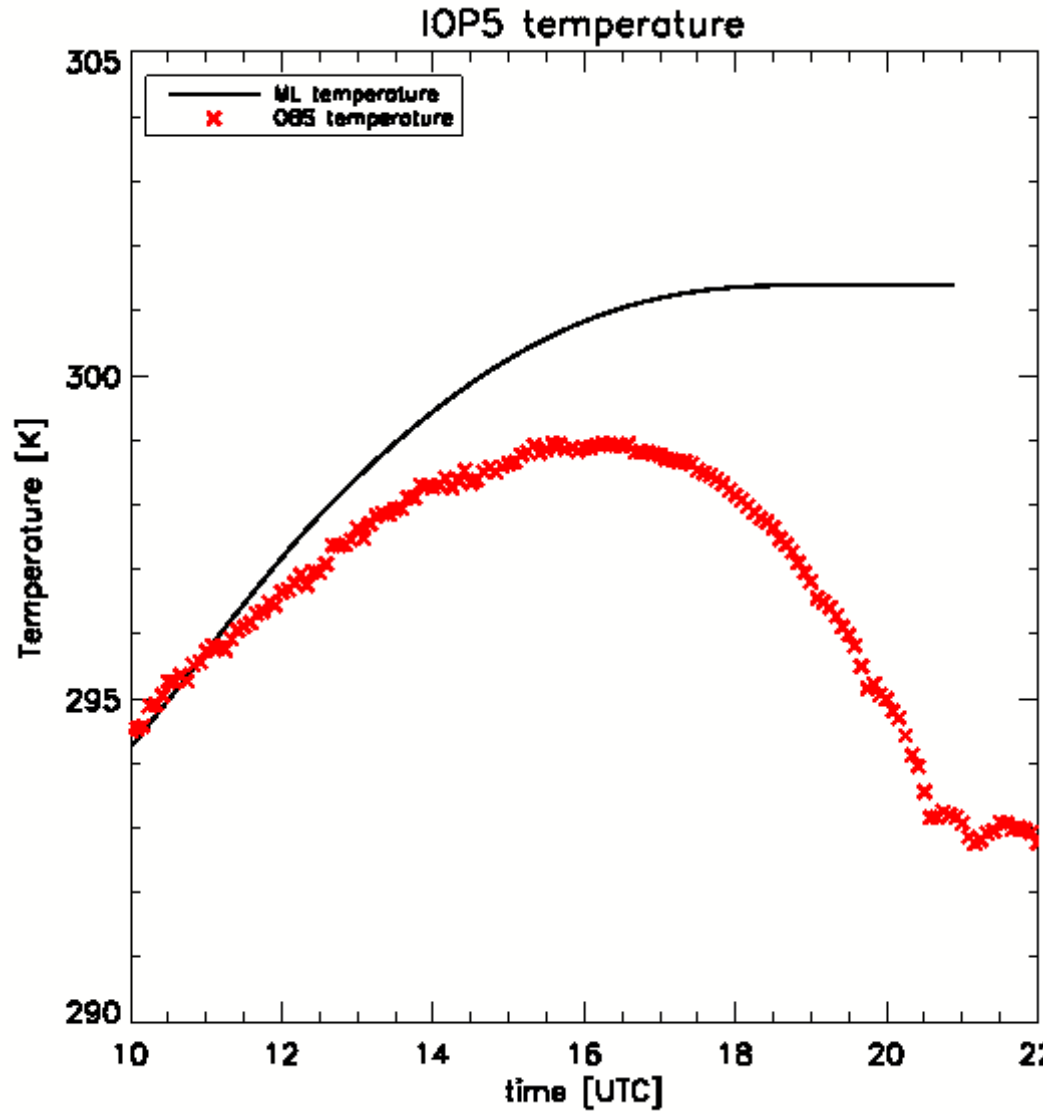
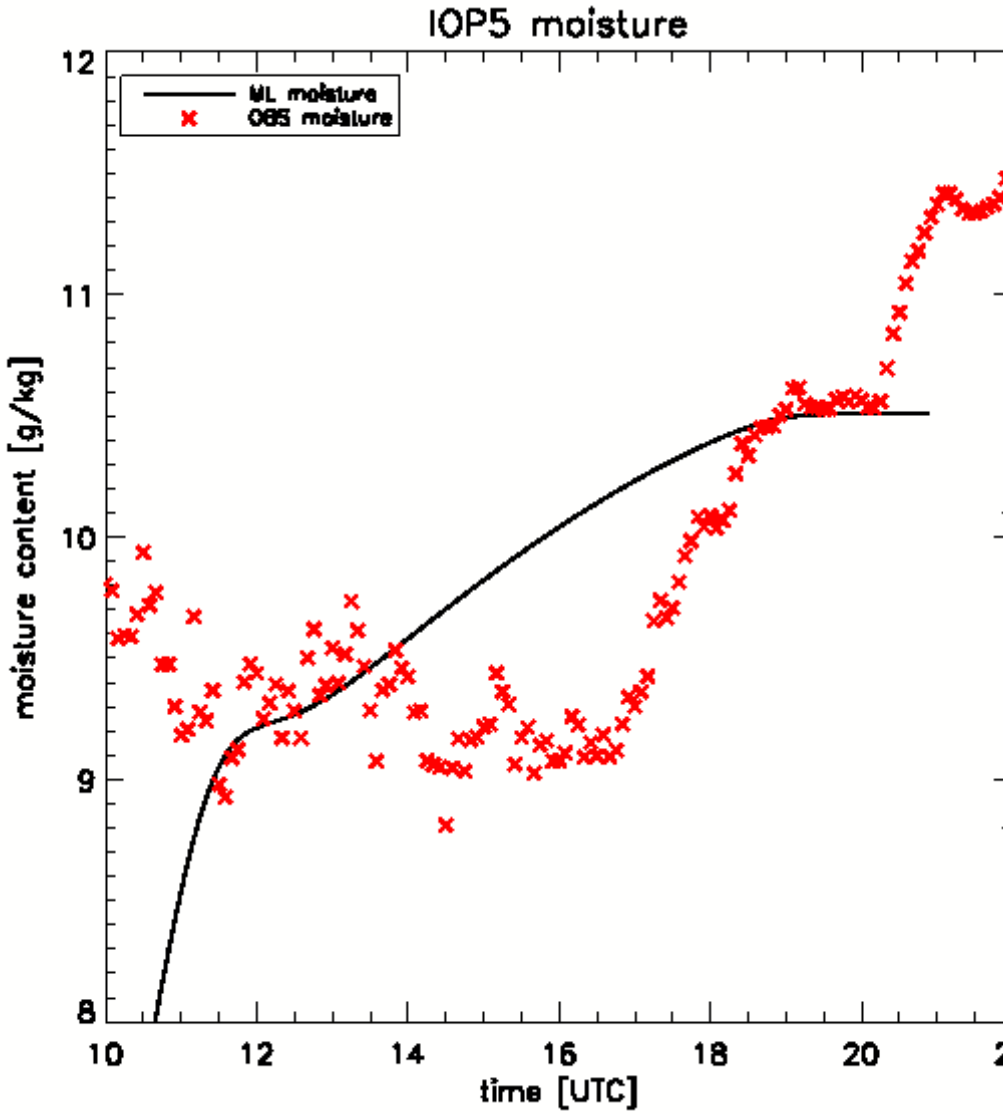
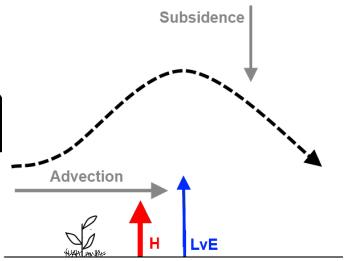
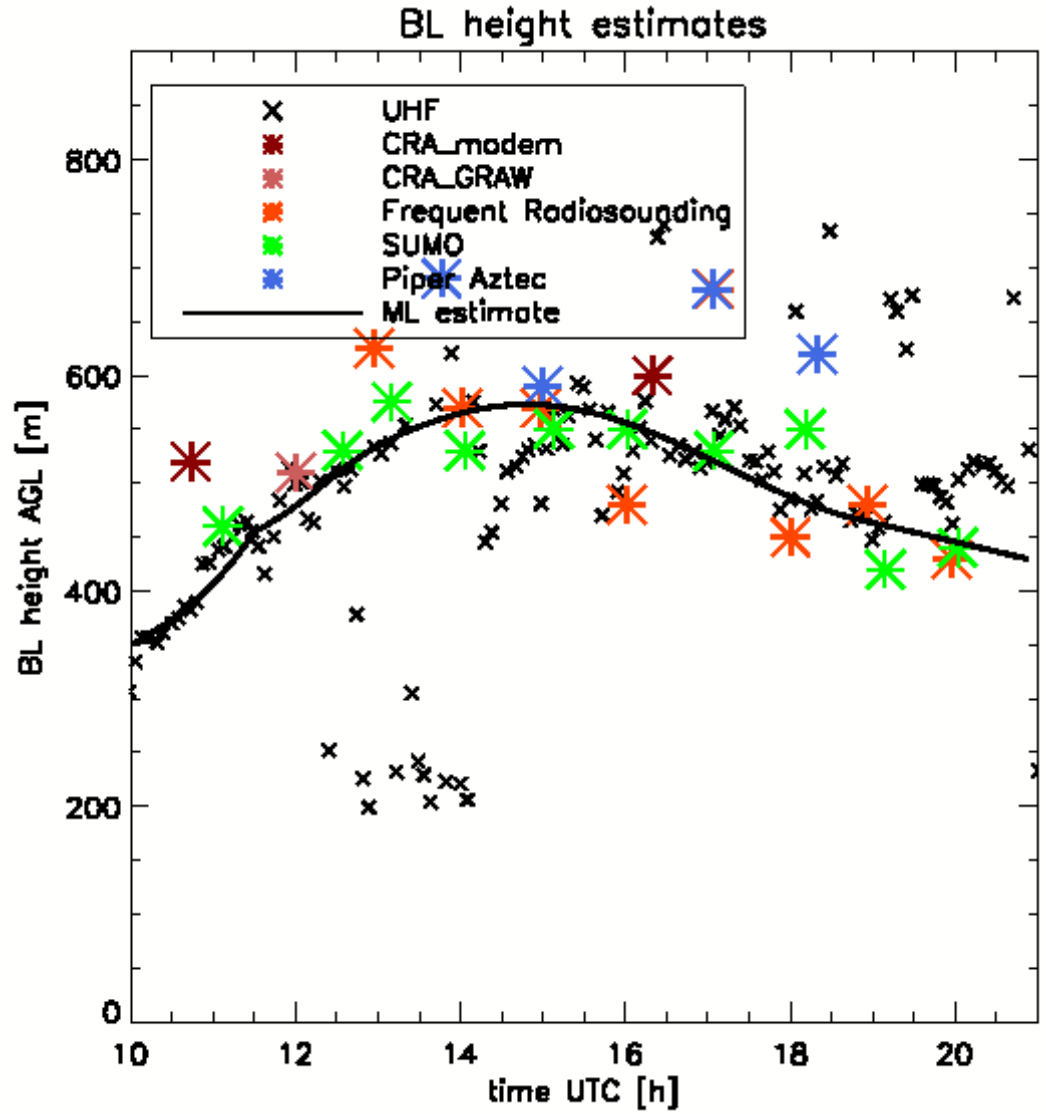


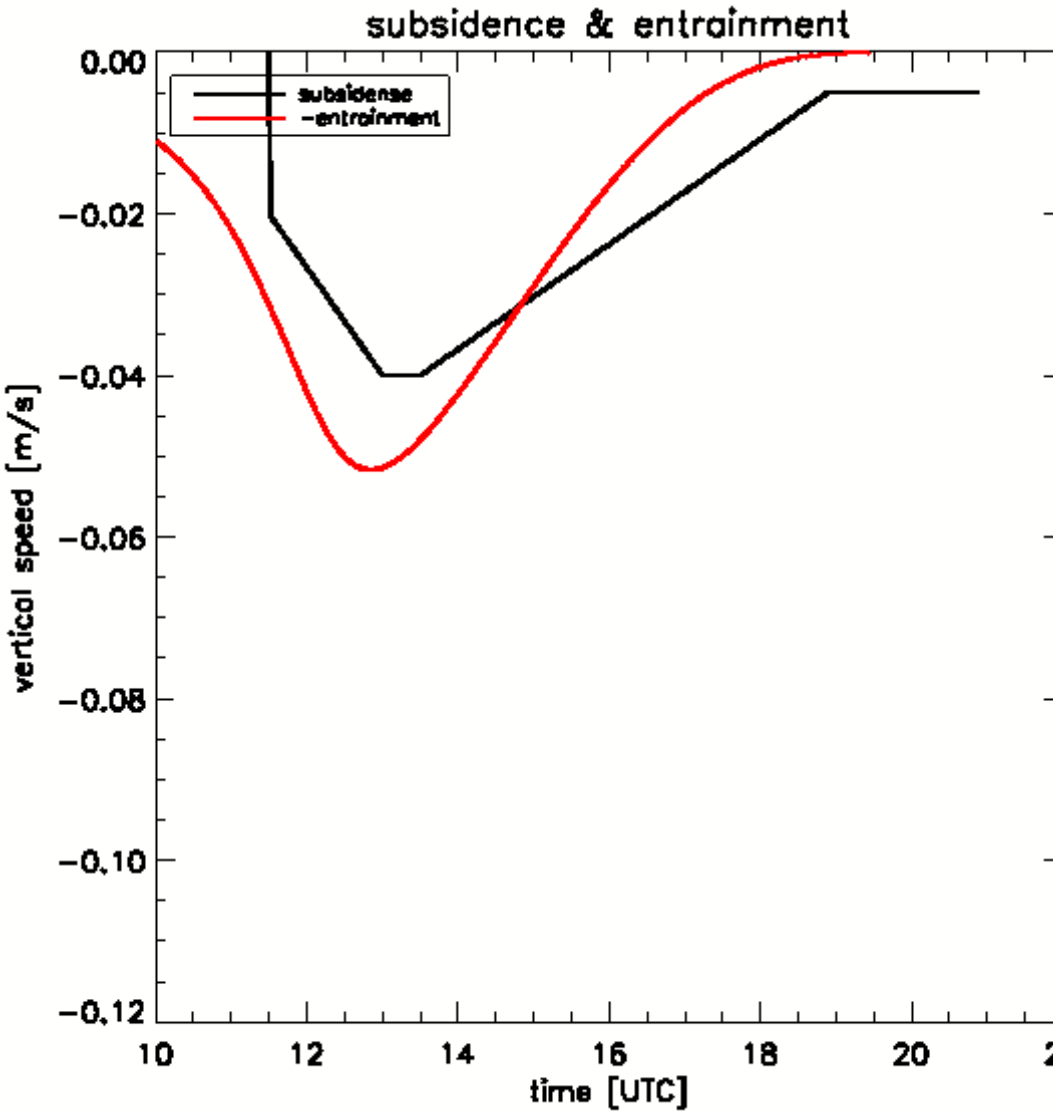




ML model - subsidence (-0.36 K/h + advection (-0.68 g/kg/h)







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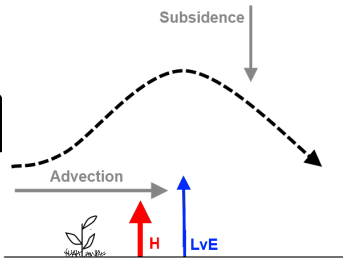
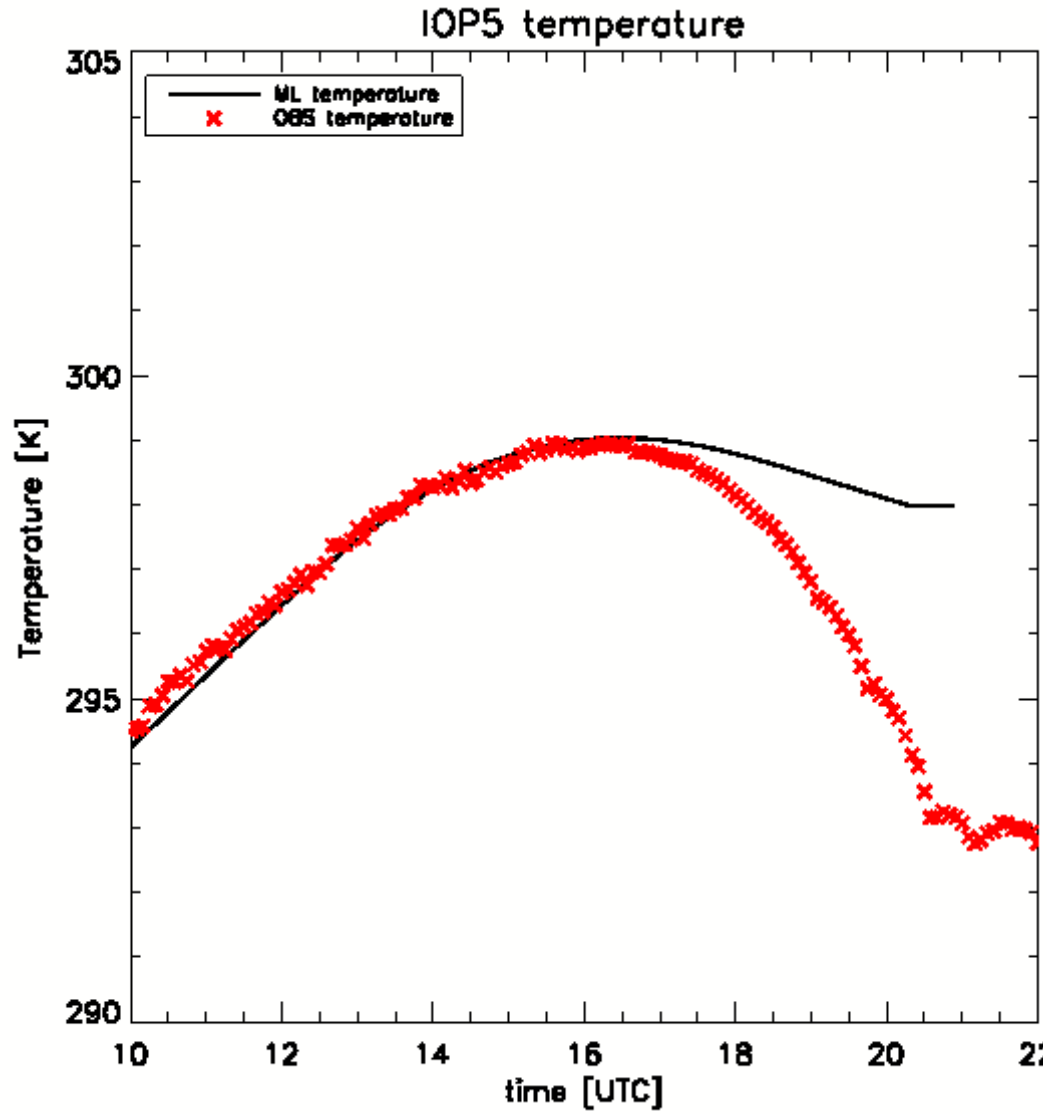
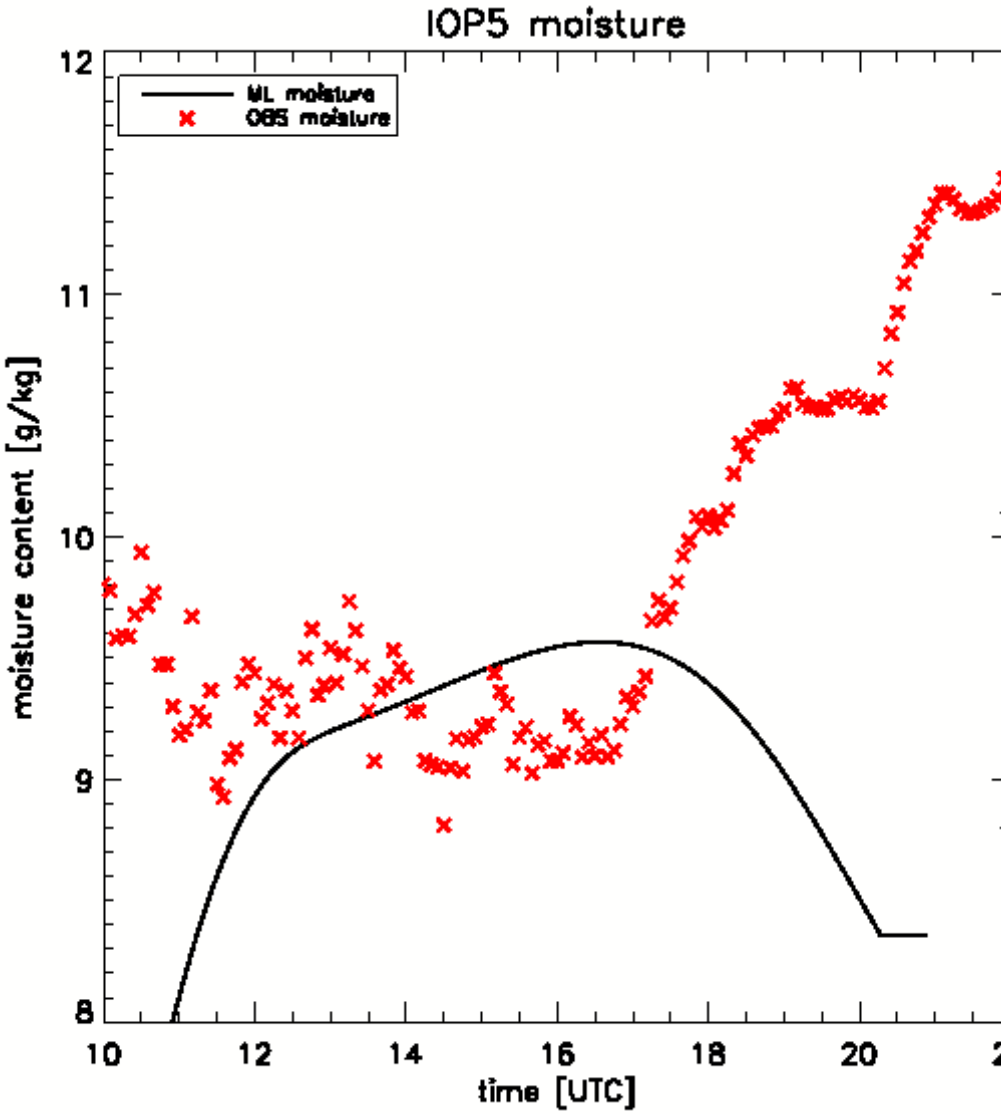
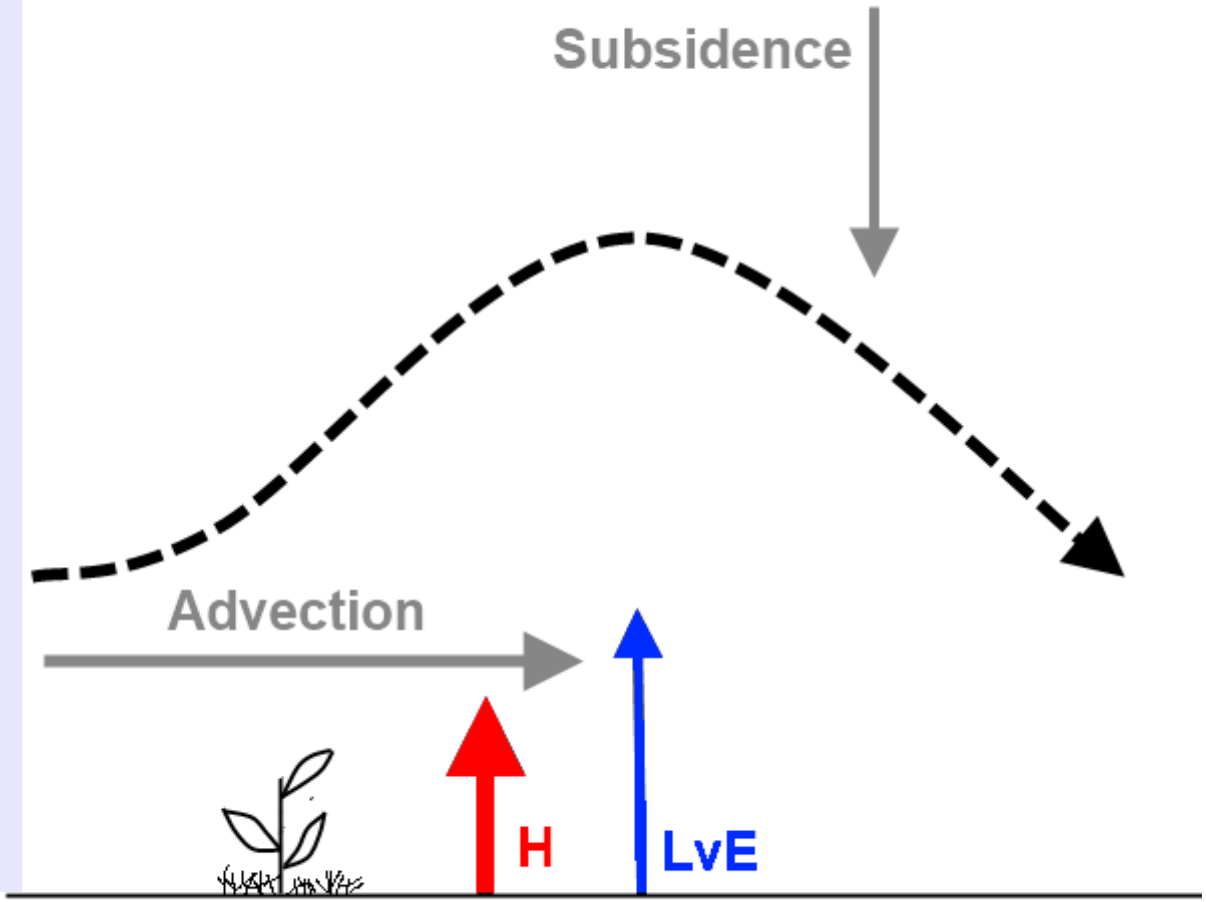






Case analysis driving factors

- Strong fluxes, low BL-height
- Early development is unclear
- Subsidence is important to reproduce BL evolution
- Some advection is needed to get BL parameters correct
- No prototype Boundary Layer
- Main influencing factors identified



Continuation:
LES modeling

- Use fluxes from measurements
- Use ML modeling as a base
- Try to reproduce the ML results
- Look at BL behaviour with subsidence
- Directional shear
- Surface heterogeneity
- Compare with turbulent data of aircrafts
- ...