GABLS4: a model intercomparison study in extremely stable condition

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22th Boundary Layers and Turbulence
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2. CAM5-IPHOC: Anning Cheng (Center for Weather and Climate Prediction, NOAA, US)
3. NCEP/GFS : Weizhong Zheng, Michael Ek (NOAA, US)
4. CMC : Ayrton Zadra (CMC, Canada)
5. WRF : Wayne Angevine (CIRES/NOAA,US) & D. Veron and A. Schroth (University of Delaware, US)
6. ARPEGE/AROME/ARP-CLIMAT : Eric Bazile, I. Beau (Meteo-France/CNRS, France)
7. LMDz : E. Vignon (LMD/LGGE, France)
8. MAR : Hubert Gallé (LGGE, France)
9. Méso-NH : M. A . Jimenez (UIB, Spain)
10. UKMO-SCM : J. Edwards (MetOffice)
11. RACMO: Peter Baas (TuDelft, Netherland)
12. HARMONIE-HARATU: Wim de Rooy (KNMI, Netherland)
13. CSIRO: Jing Huang (Australia)
14. COSMO: B. Goger and M. Rotach (Univ. of Innsbruck, Austria) not yet
15. COSMO: Matthias Raschendorfer (DWD, Allemagne) need to be confirmed
16. ICON: A. Eichorn, J. Schmidli (Univ. of Frankfurt) not yet

Participants

LES:

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2. PALM : B Maronga (IMC, Leibniz Universitat, Hannover, Germany)
3. MicroHH: B. Van Stratum, C. Van Heerwaarden, (MPI & Wageningen U.)
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5. SAM-LES : A Cheng (Center for Weather and Climate Prediction, NOAA, USA)
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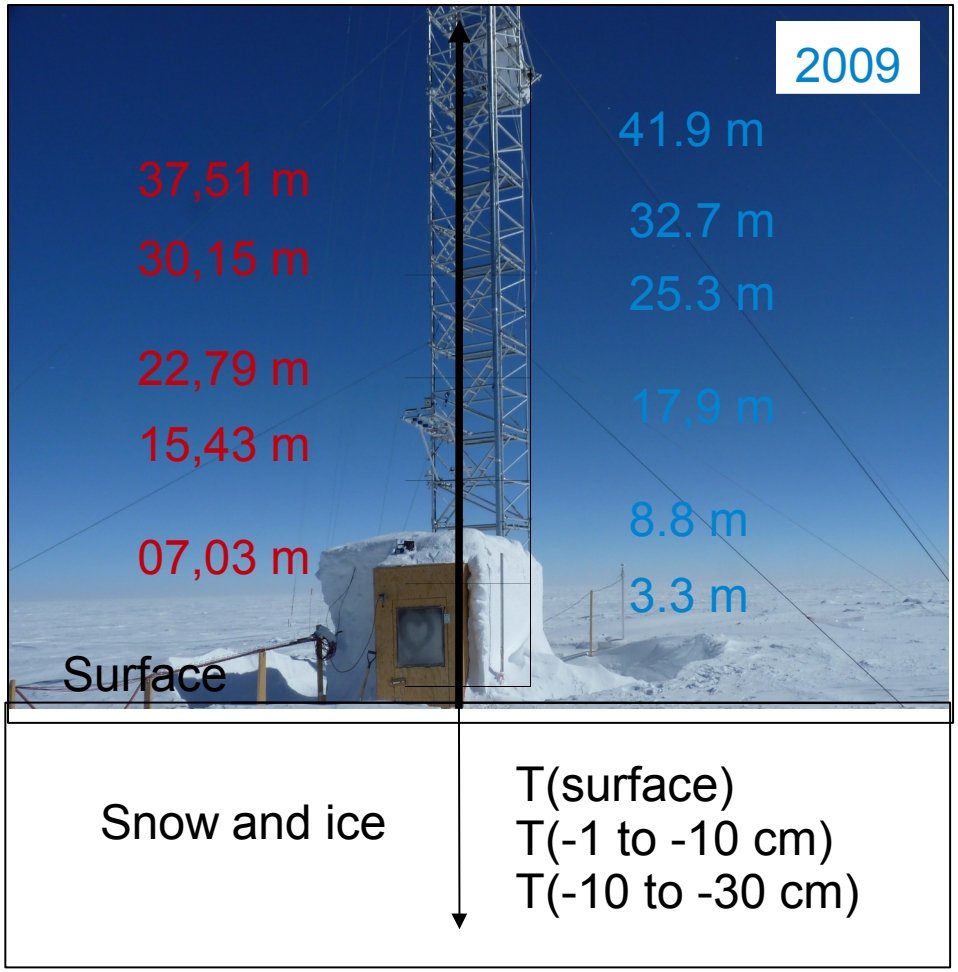
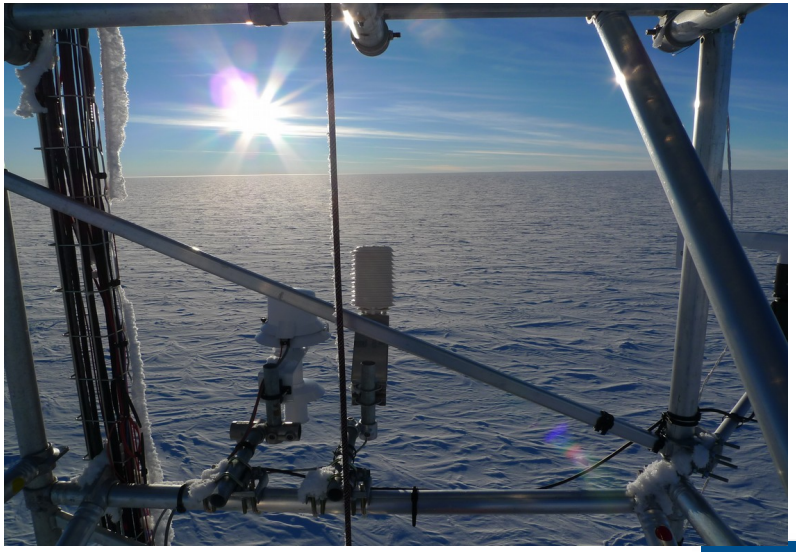
3. NCEP/GFS : Weizhong Zheng, Michael Ek (NOAA, US)
4. CMC : Ayrton Zadra (CMC, Canada)
5. IFS : E. Dutra, Irina Sandu (ECMWF)
6. LMDz : E. Vignon (LMD/LGGE, France)
7. UKMO-SCM : J. Edwards (MetOffice)

Observations: Antarctic Plateau Dome C / Concordia

« American » Tower



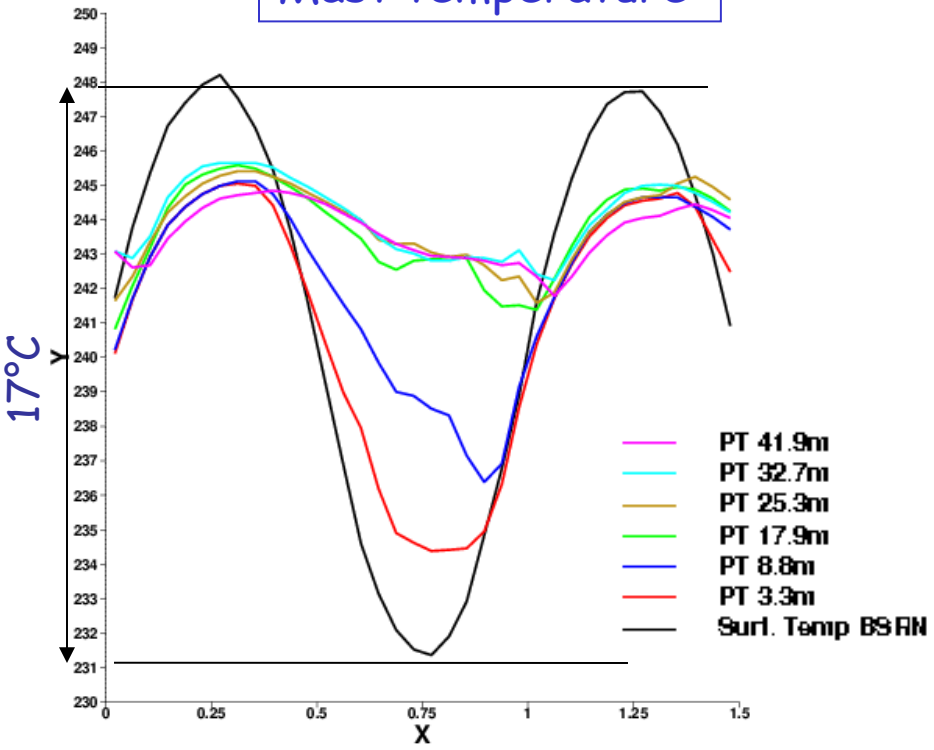
- High frequency parameters (10 Hz) from 6 ultra-sonic anemometers :
  3D Wind components and sonic temperature
- Low frequency parameters (30 min) : air temperature (ventilated and not ventilated), relative humidity, wind speed and direction (**Young**)
- 1 minute solar radiation components
- Sub and surface temperatures
- Radiometer HAMSTRAD (P. Ricaud)
- RS (1 or 2 per day)
- Alt=3233m



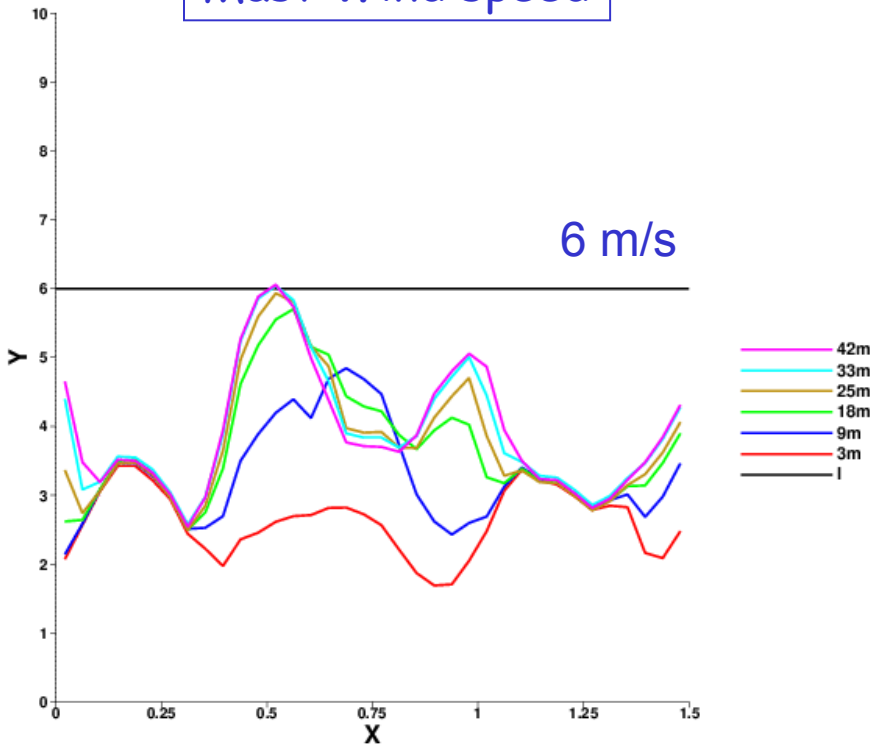
GABLS4

• Focus on very stable conditions with (Ri > 1), weak wind < 6 m/s, no cloud, strong radiative cooling ~ 1.5K/h (GABLS1 = 0.25K/h)

Mast temperature



Mast Wind speed



GABLS4

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strong radiative

< 6 m/s, no cloud,

Mast t

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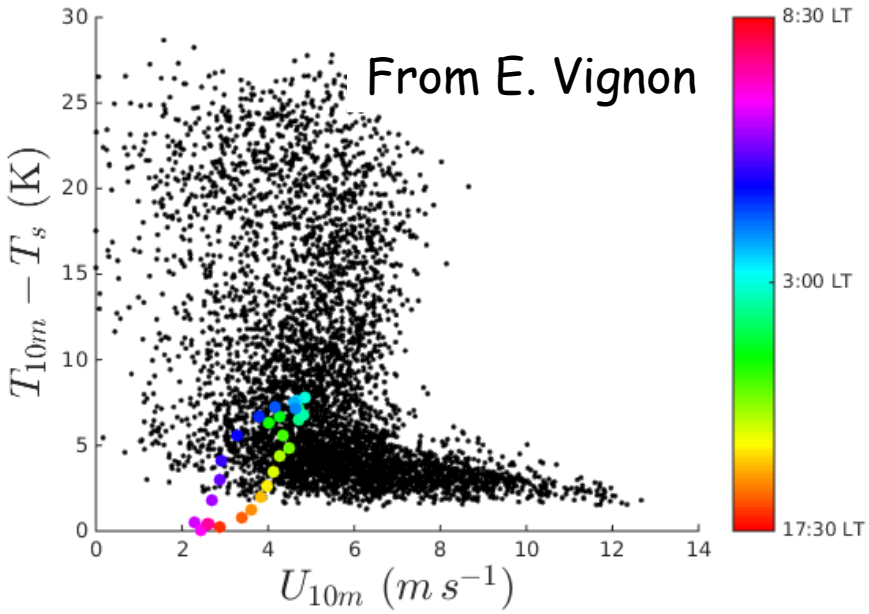
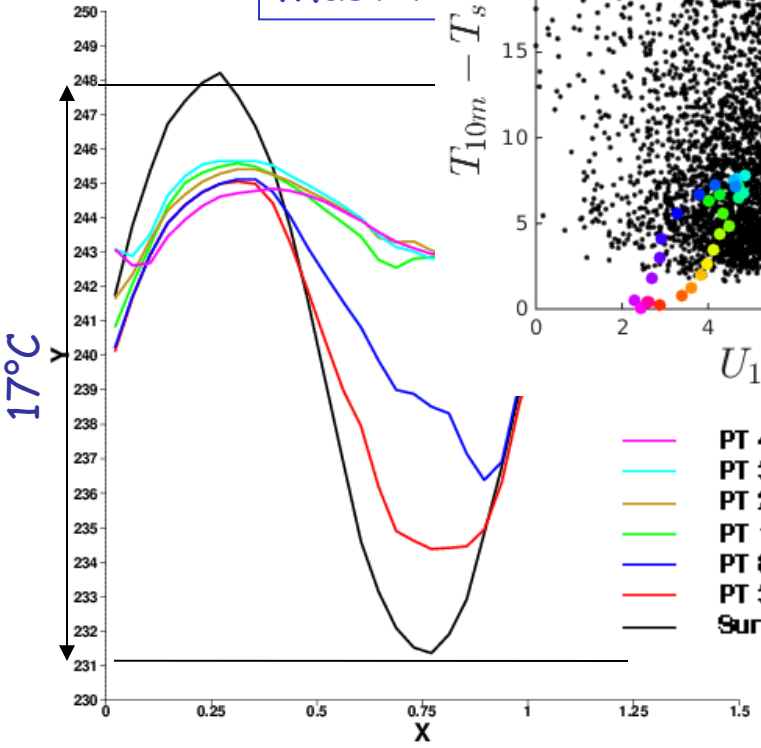
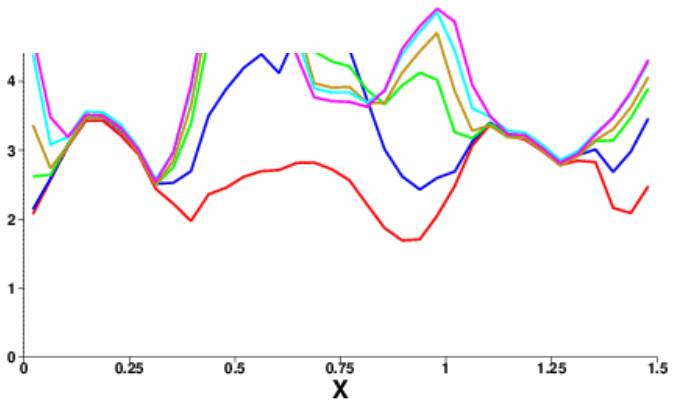
From E. Vignon



6 m/s

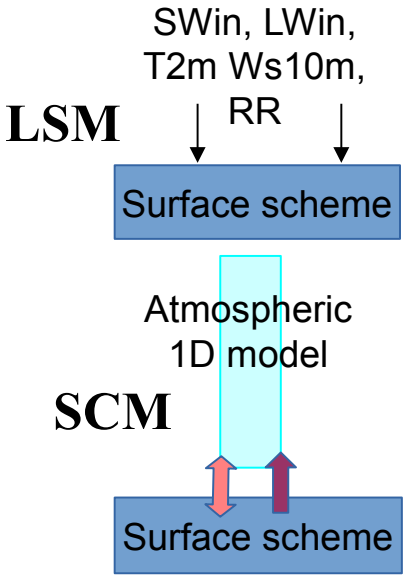
17°C

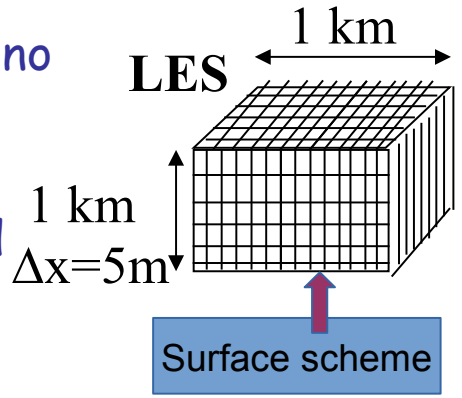




GABLS4: several steps & 3 intercomparisons

- **Stage 0:** LSM (snow scheme) driven by observations for 15 days
- **Stage 1:** SCM with all the physics and surface interaction: 36h forecast starting the 11th Dec 2009
- **Stage 2:** LES and SCM, stage1 atmospheric forcing but the surface temperature is prescribed.
- **Stage 3**: LES and SCM. "ideal GABLS4" or simplified: no radiation, no specific humidity, constant geostrophic wind, no advection, Ts prescribed.
- Can we use stage3 with the LES results to understand the SCM deficiencies in stage2 and 1 ?





Preliminary results

- 1st Workshop organized in Toulouse 20-22 May 2015

GewexNewsletter Vol25 August 2015

www.gewex.org/gewex-content/files_mf/1438893730Aug2015.pdf

Presentations and setup available on the GABLS4 website:
www.cnrm-game-meteo.fr/aladin/meshtml/GABLS4/GABLS4.html

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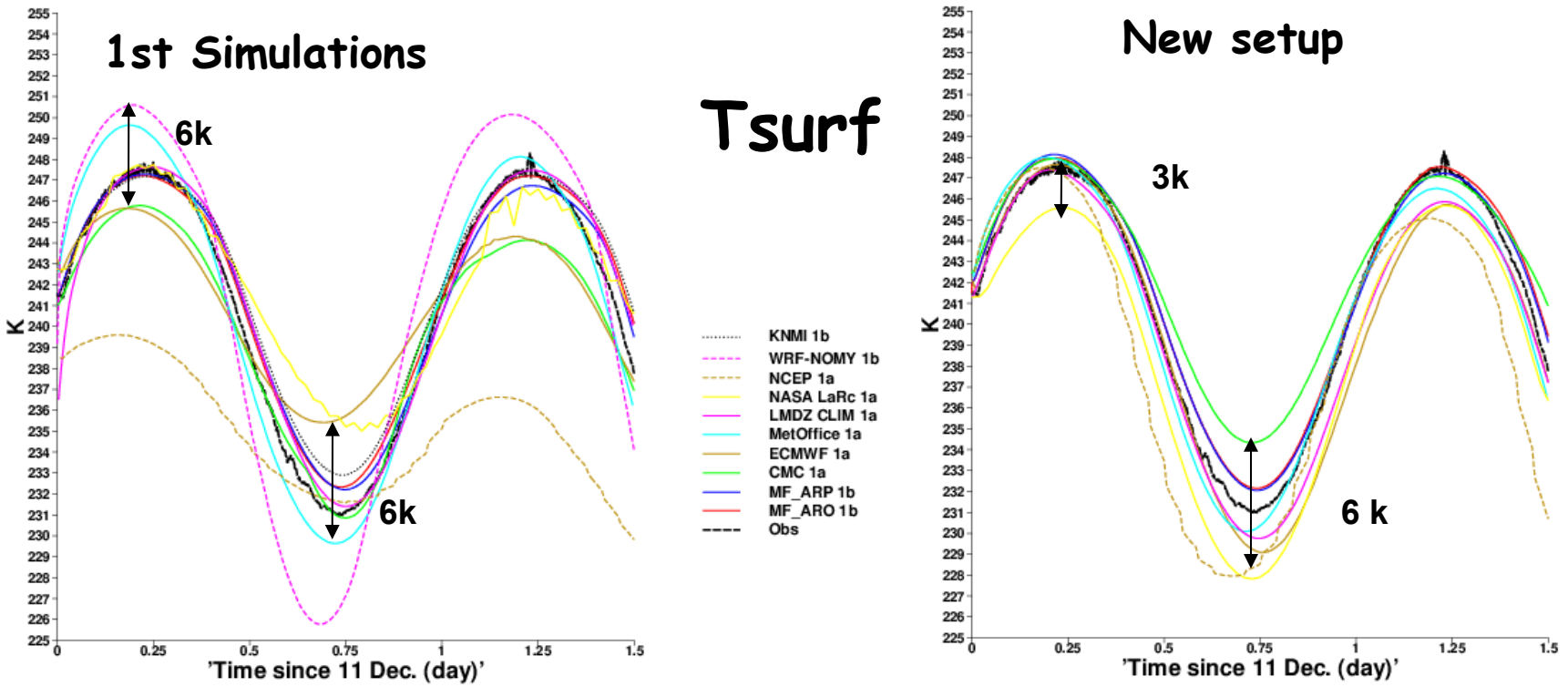
New setup for all the stages and for LSM, SCM and LES
- prescribed albedo=0.81, z0m=1mm, z0h/q=0.1mm, Emis=0.98 and snow inertia

and for SCM :
- a prescribed vertical grid with a first level at 2.5m and 17 levels below 100m (dz ~ 5m)

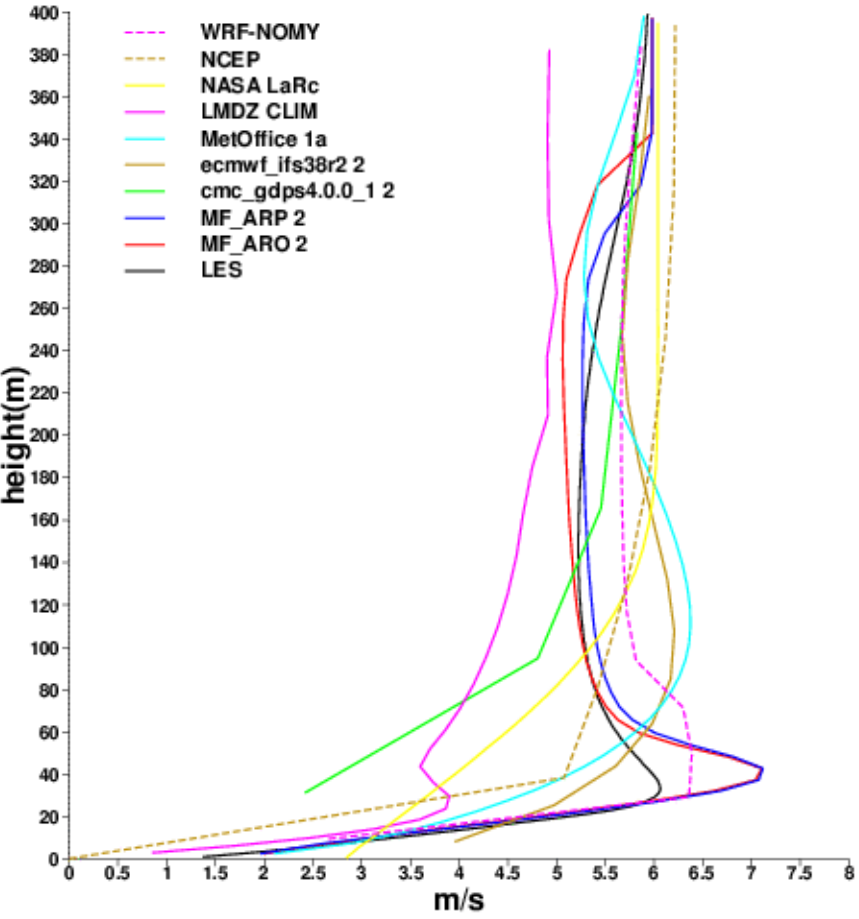
Impact of the new setup SCM stage1

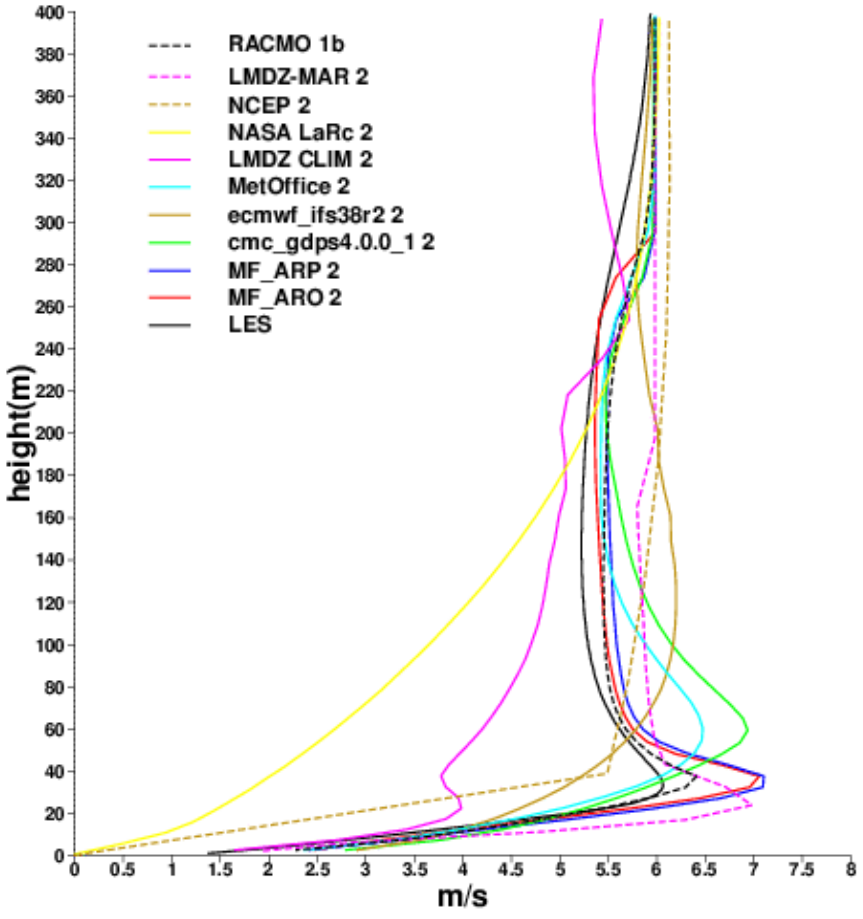


Less variability with the new simulations especially during day time (mainly due to the prescribed albedo). During night, for the Ts min, the variability is probably due to the turbulence scheme and/or to the surface layer

Impact of the new setup SCM

1st Simulations — Ws at 18h UTC — New setup





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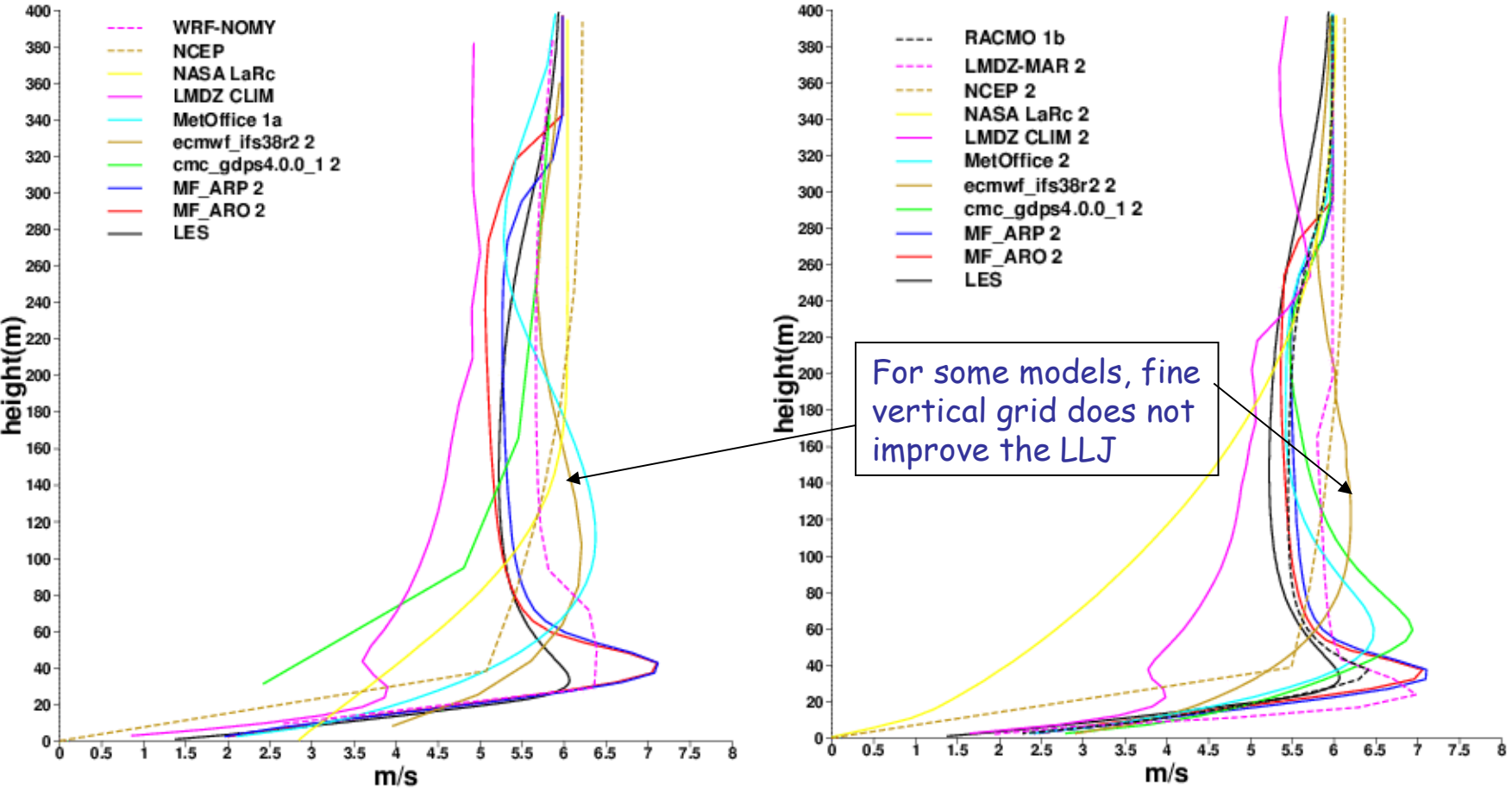
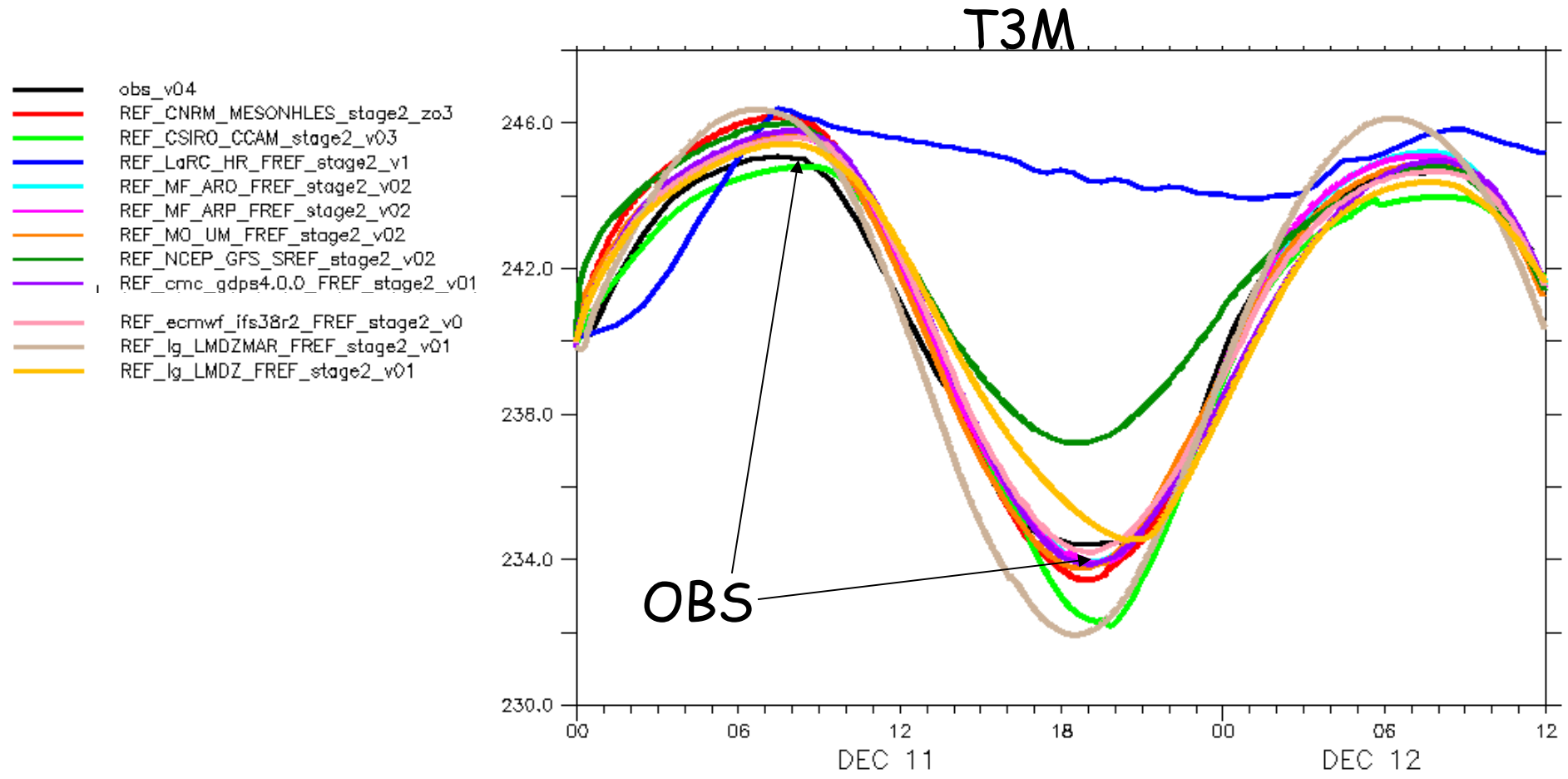


Comparison with the mast data : stage 2



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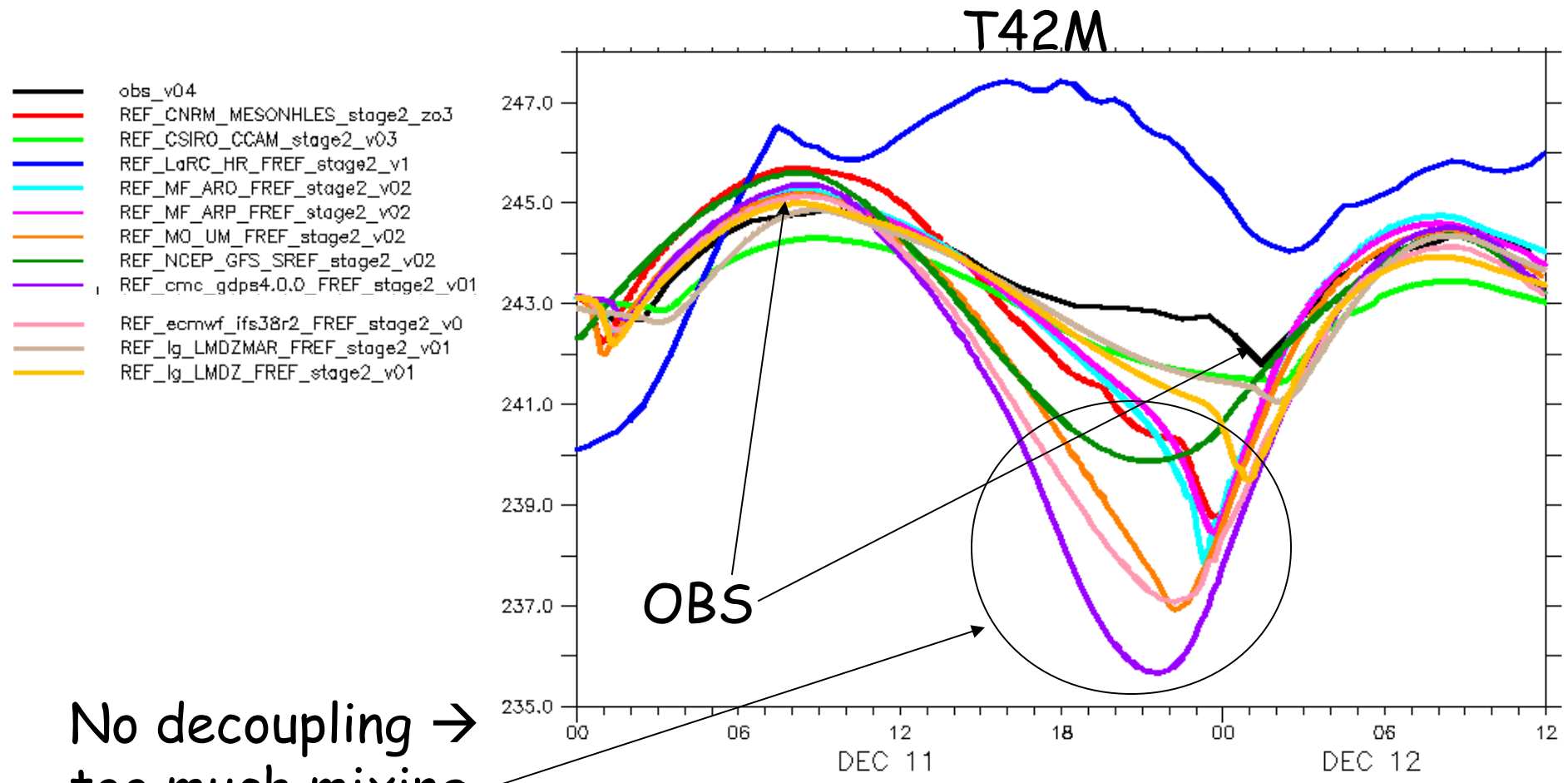
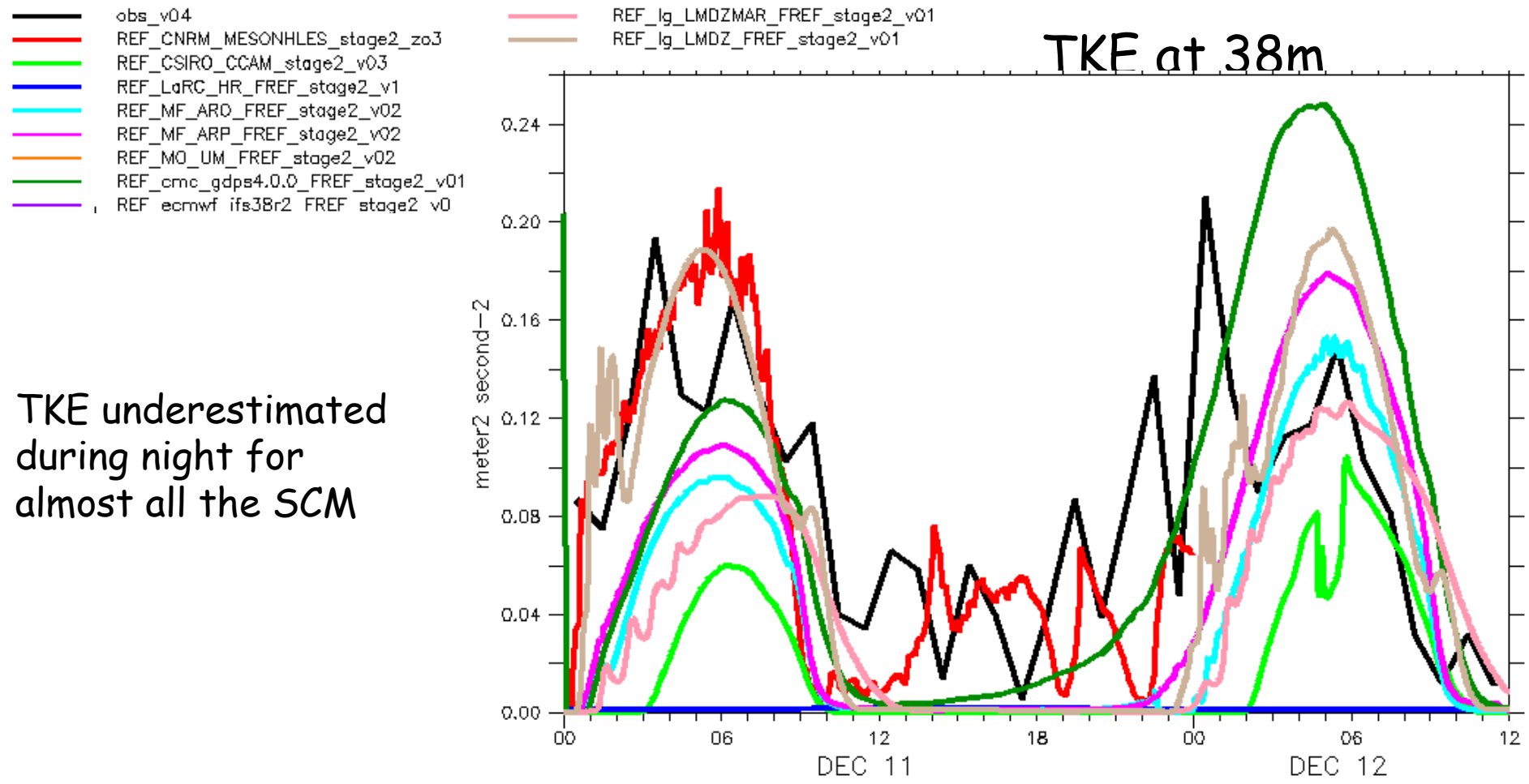


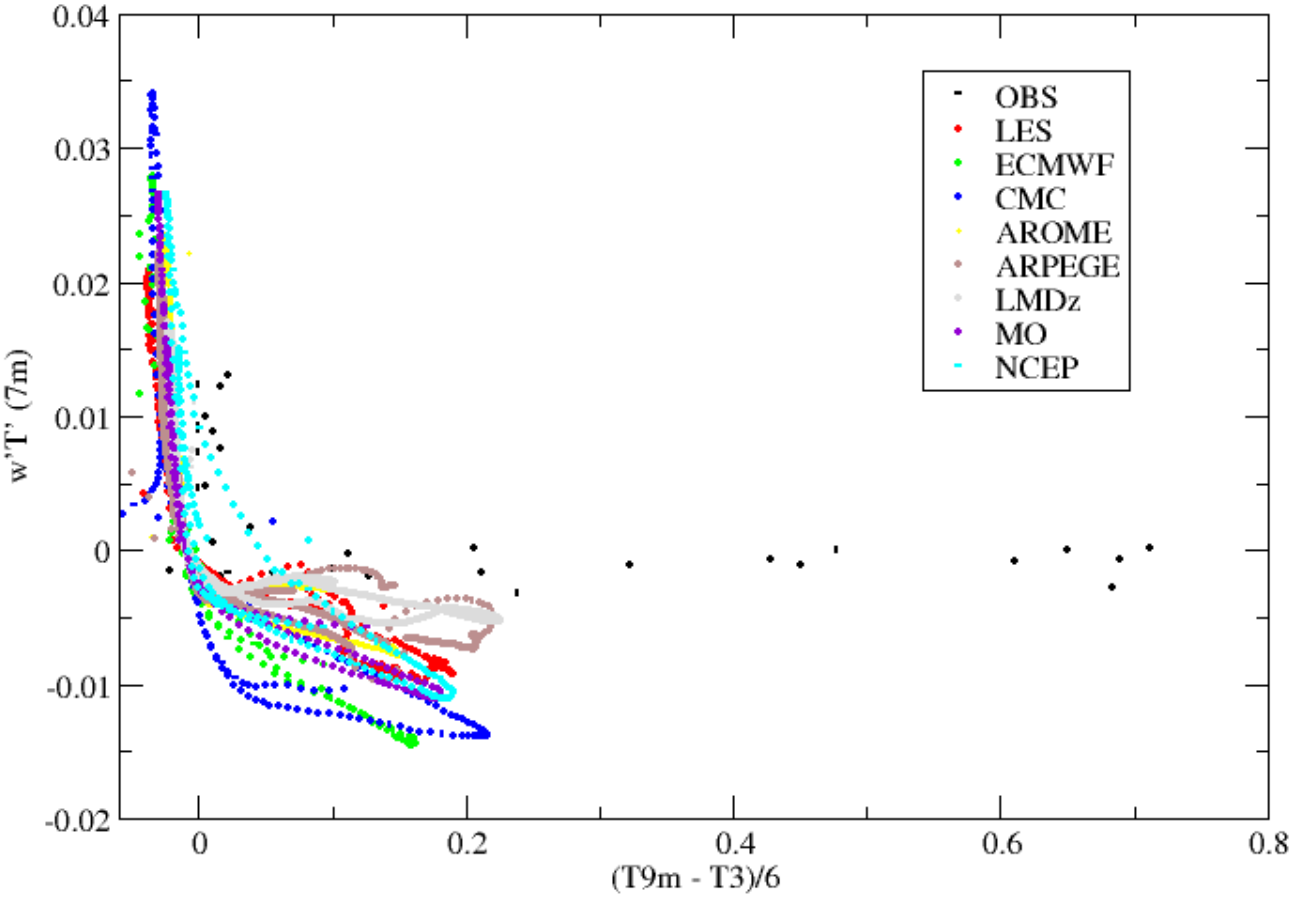
No decoupling → too much mixing

Comparison with the mast data : stage 2



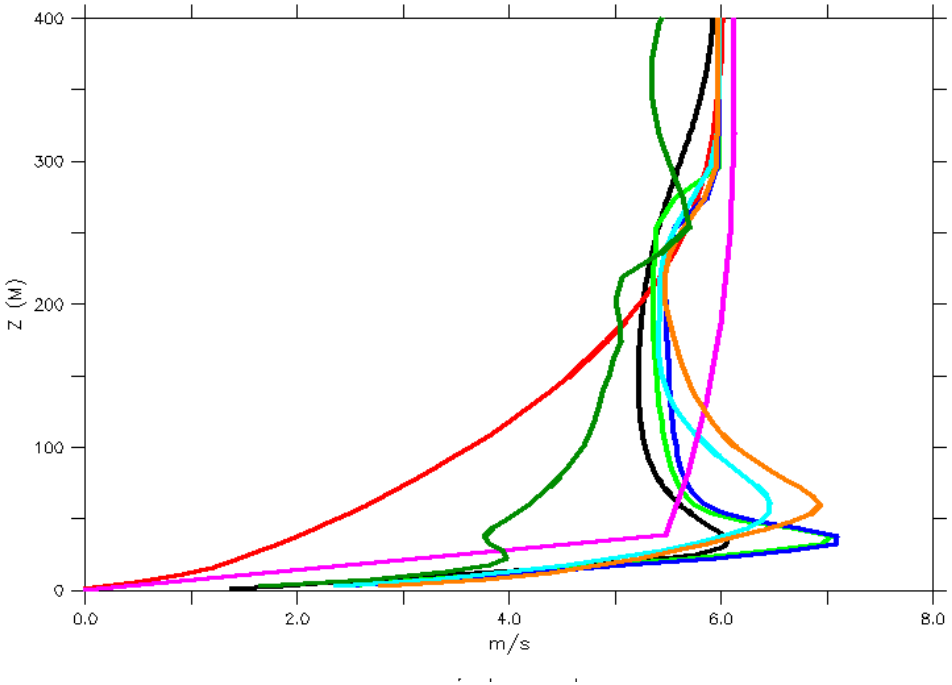
TKE underestimated during night for almost all the SCM

w'T' at 7m vs dT/dz : stage 2

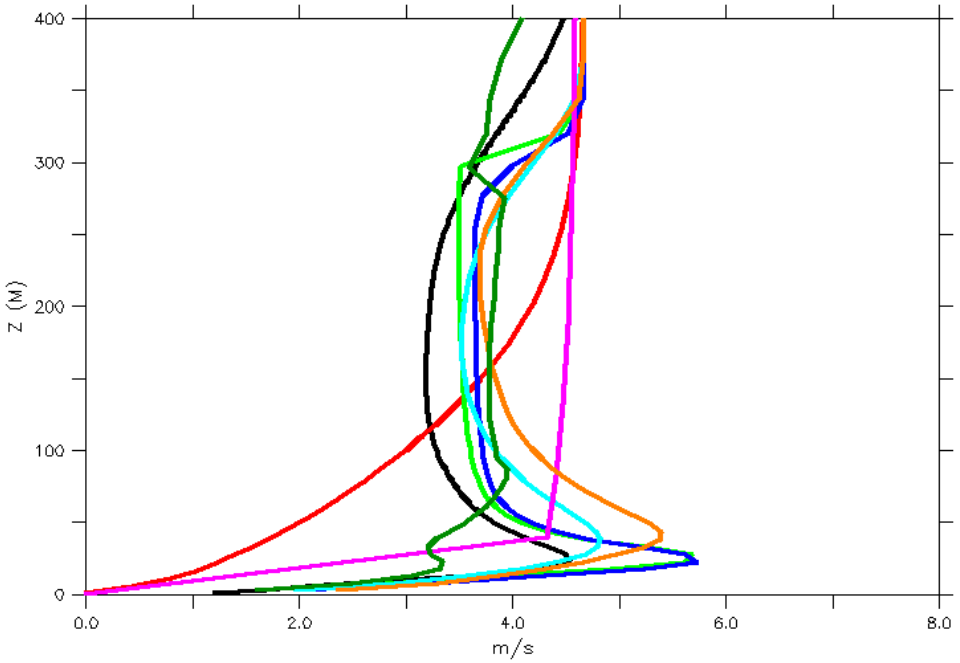


GABLS4 : comparison between stage2 & stage3

Stage 2 : WIND 18h

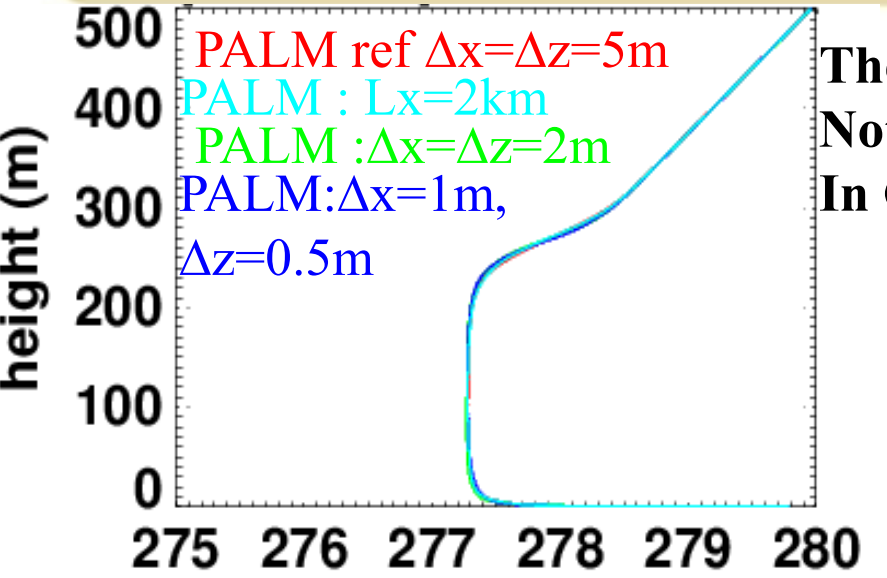


Stage 3 : WIND 18h

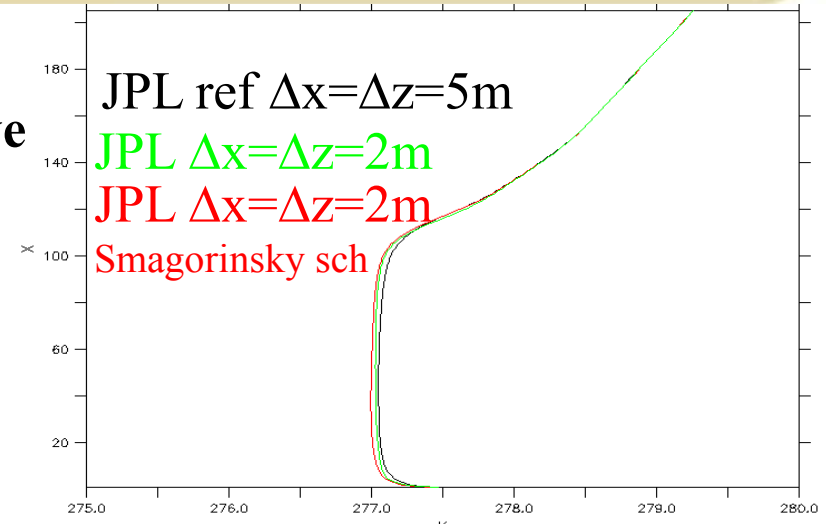


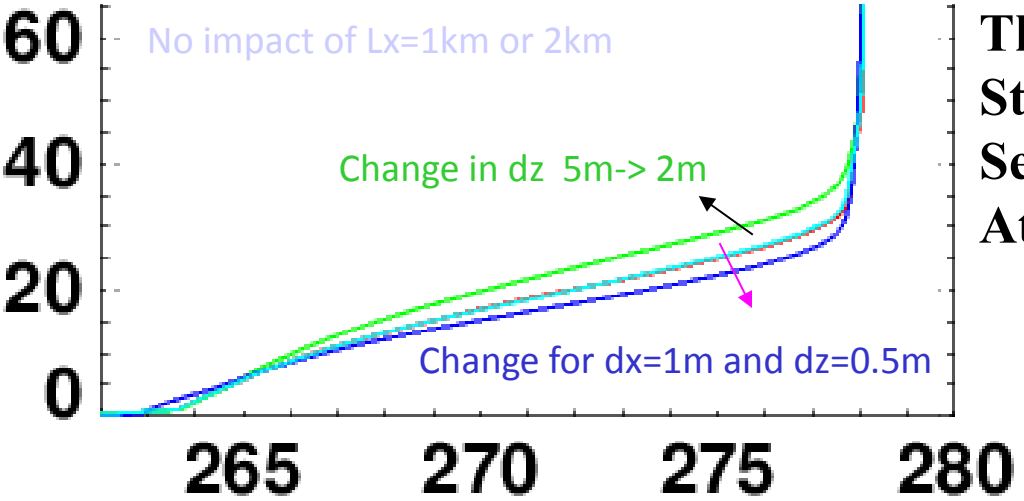
The « ideal case » or stage3 is representative to the real case and the differences between models are similar → comparison between SCM and LES on stage 3 will be very useful (several LES) but …

Sensitivity to the resolution: PALM & JPL

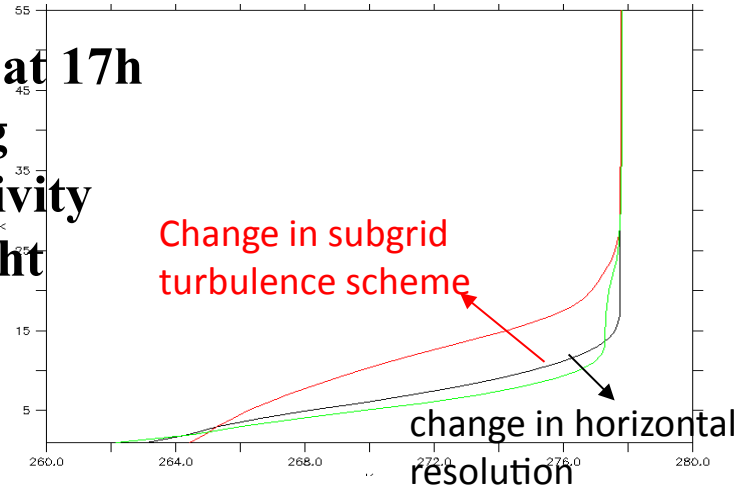


Theta at 5h
Not sensitive
In CBL

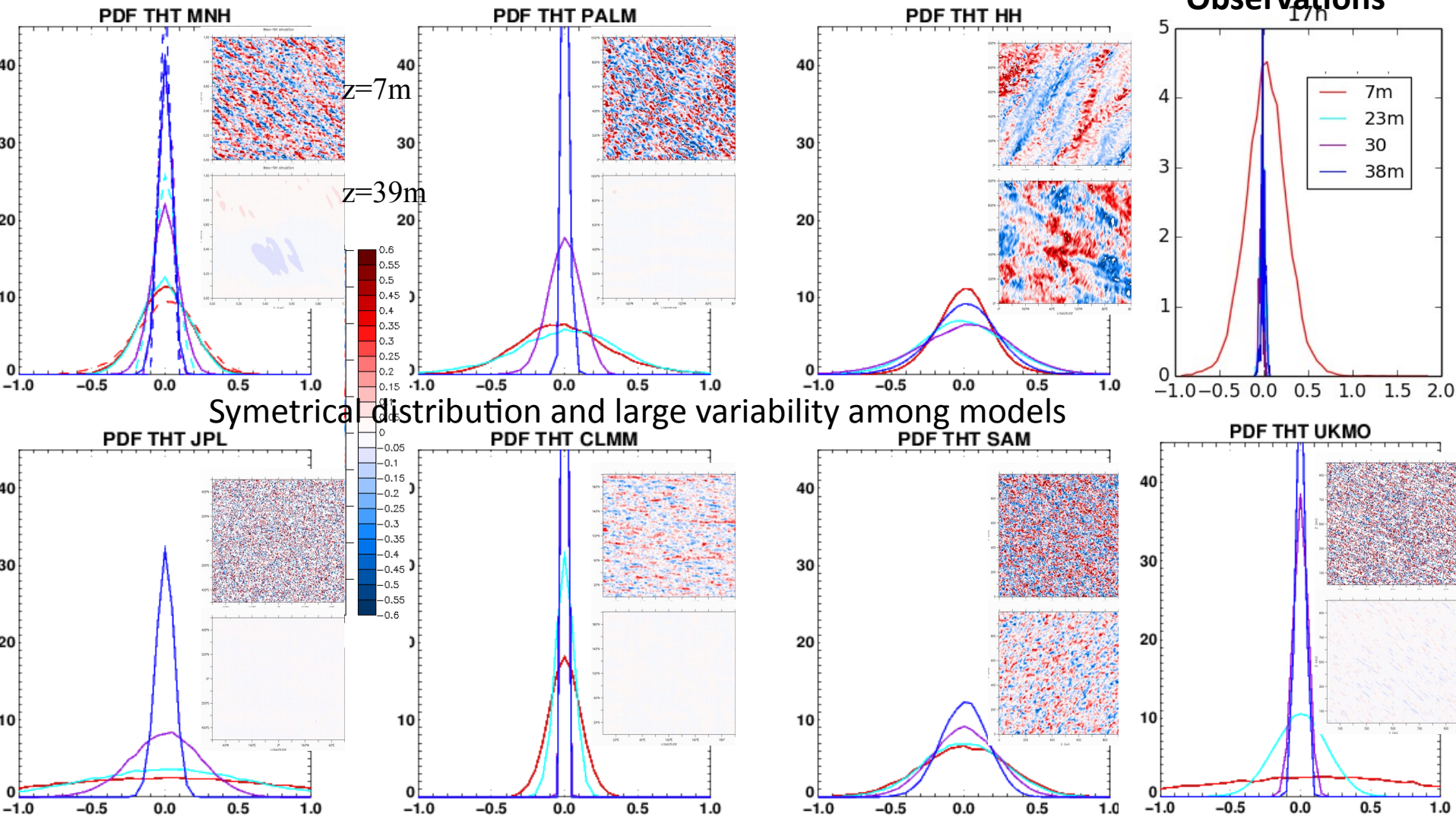




Theta at 17h
Strong
Sensitivity
At night



LES intercomparison: distributions at observed levels at 17h



Symetrical distribution and large variability among models

Conclusions

- New simulations for stage 1 & 2 with given albedo, roughness length, snow density, emissivity, model vertical grid => better comparison among models and less variability

- For the SCM, with the fine vertical grid, almost all the SCM have a LLJ but too high ..

- Large variability for the sensible heat flux and surface temperature between models for the LSM and SCM (not shown)

- Prescribing the surface temperature reduces the scatter among models → importance of surface interaction and the positive feedback

Perspectives

- For the LES and Stage 3 (simplified setup) very similar to more complex setup : good consistency with tower observations : but too large turbulence (reducing zo) and not strong enough stability at night (vertical and horizontal resolution ?).

- Large differences among LES models in term of horizontal distributions, spectra,... can we relate those differences to the subgrid scale schemes ?

- For the extreme stable case very high resolution is required dx=dz=1m ? Same for all the LES ? Effective resolution ?

- More diagnostics (using process diagram Bosveld et al (2014))comparison between 1D and LES with uncertainties : on going work ...

Acknowledgements

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www.cnrm.meteo.fr/aladin/meshtml/GABLS4/GABLS4.html