

# *Comparison of 1D turbulence models for the flat, stratified boundary layer*

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# Outline

**-Motivations**

**-The test-case (using ARPS) : GABLS1**

**-Turbulence model predictions as computed from a 1D model**

**-Comparison between GABLS1 and the 1D model predictions**

**-Conclusions**





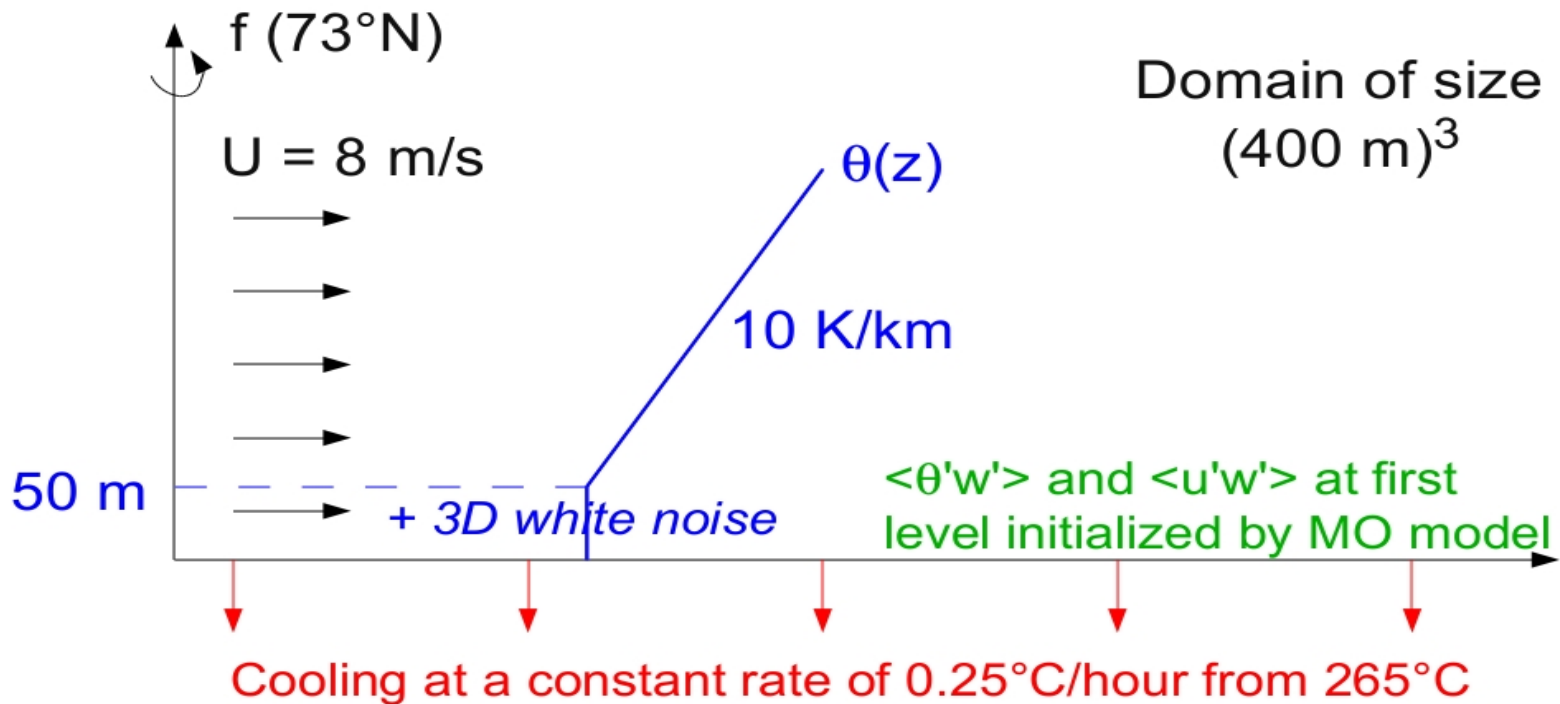
# Motivations

Mis-representation of turbulent processes in the stable atmosphere boundary layer in NWP models

while a minor change in the turbulent diffusivity may have a major change on large circulation circulation (Bryan 1987, Viterbo et al. 1999).

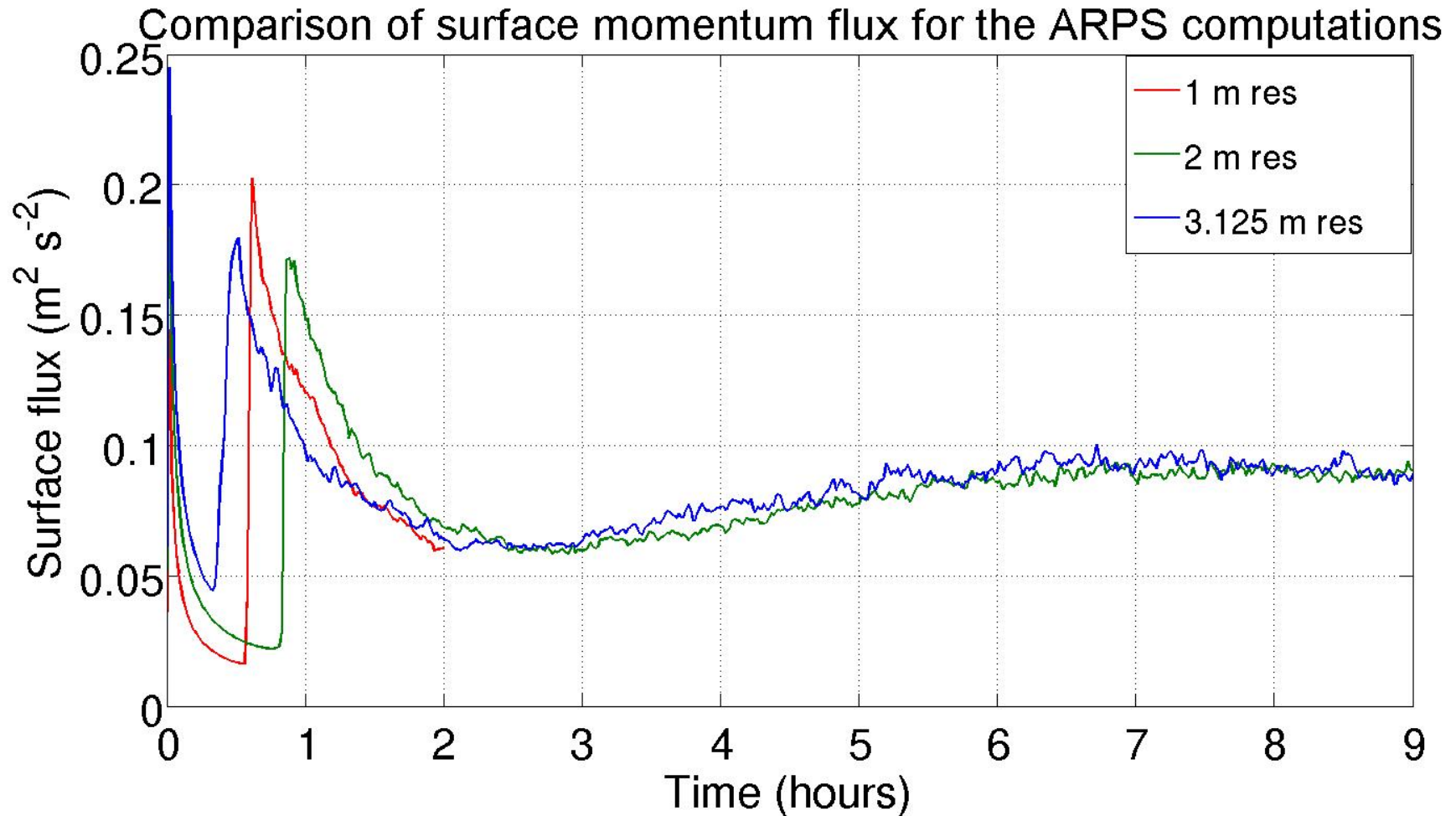
**Motivation of the present study : improve the turbulence model of BOLAM**

# The GABLS1 test-case: design



Computations with ARPS at resolutions 3.125 m, 2 m, 1 m

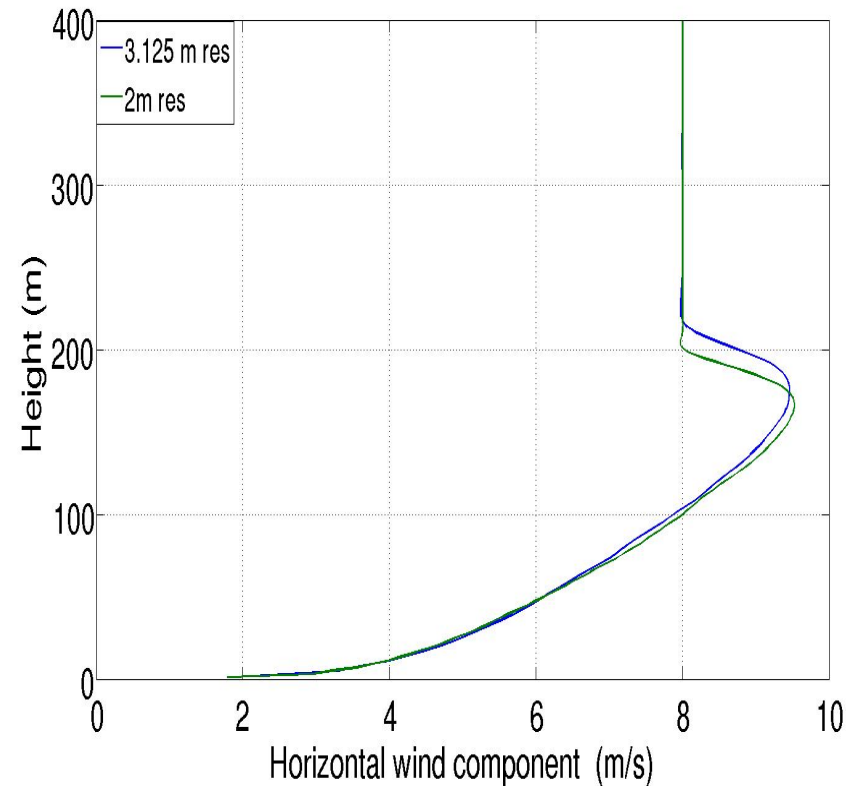
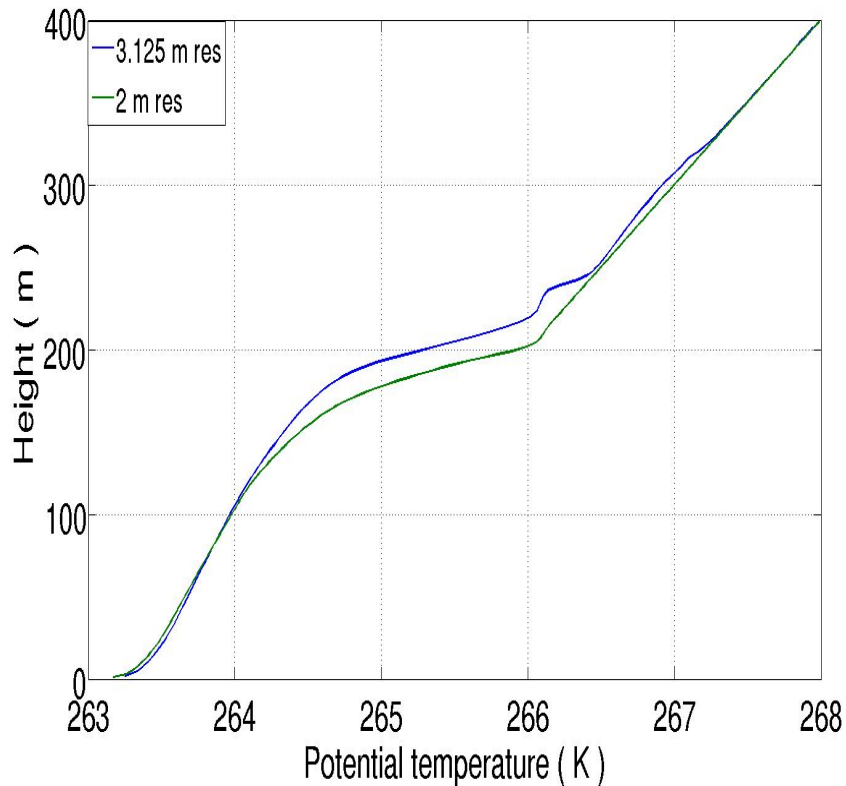
# The test-case: main results



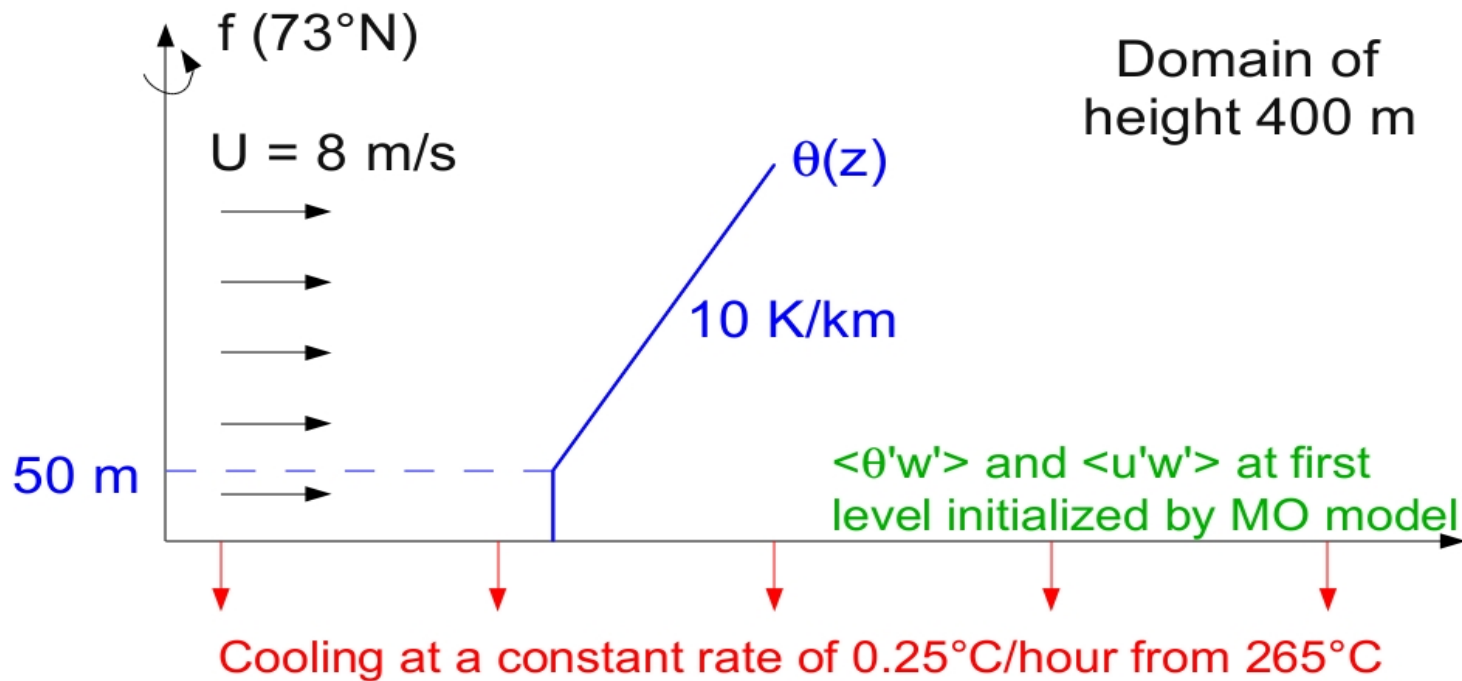


# The test-case: main results

ARPS results with resolutions 3.125 m and 2 m



# Turbulence model predictions as computed from a 1D model: *the 1D model*



Solve the 1D equations for  $\langle U(z) \rangle$ ,  $\langle V(z) \rangle$  and  $\langle \theta(z) \rangle$   
with three different turbulence models for  $\langle u'w' \rangle$  and  $\langle \theta'w' \rangle$

# Turbulence model predictions as computed from a 1D model: *the turbulence models*

- Blackadar model (1962):

- $\langle u'w' \rangle = -K_m dU/dz$
- $K_m = L (\alpha TKE)^{1/2}$ ,  $L$  : mixing length,  $\alpha=0.17$
- $1/L = (1/Kz + 1/L_0) f(Ri)$ ,  $K$  : von Karman constant,  $L_0 = 100m$
- Prognostic equation for TKE

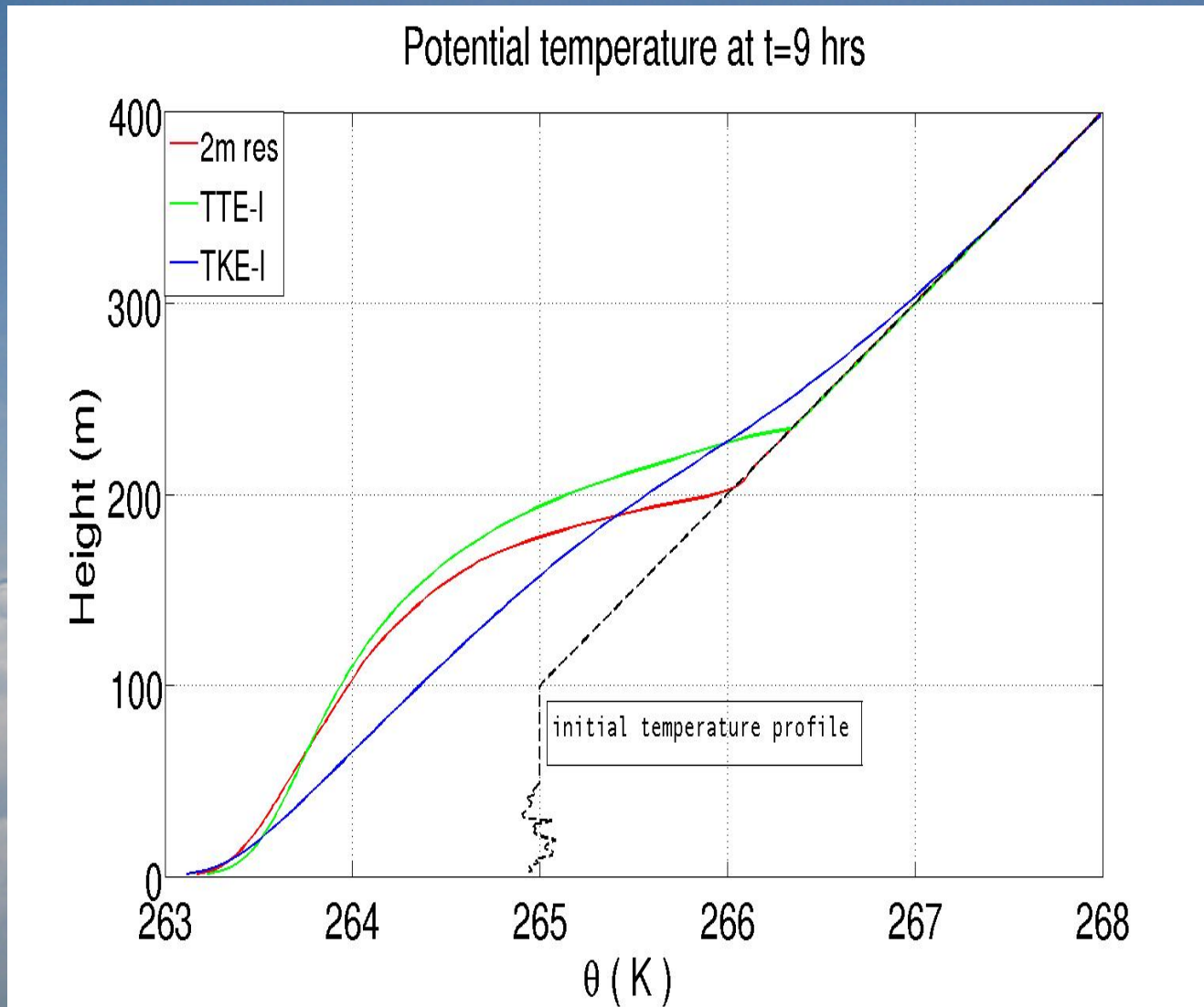
- Mauritsen et al (2007) model:

- the fluxes are expressed as a function of the total (kinetic + potential) energy
- mixing length model :  $1/L = 1/Kz + f/C_f \tau^{1/2} + N/C_N \tau^{1/2}$

- Blackadar model with Mauritsen et al. (2007) mixing length

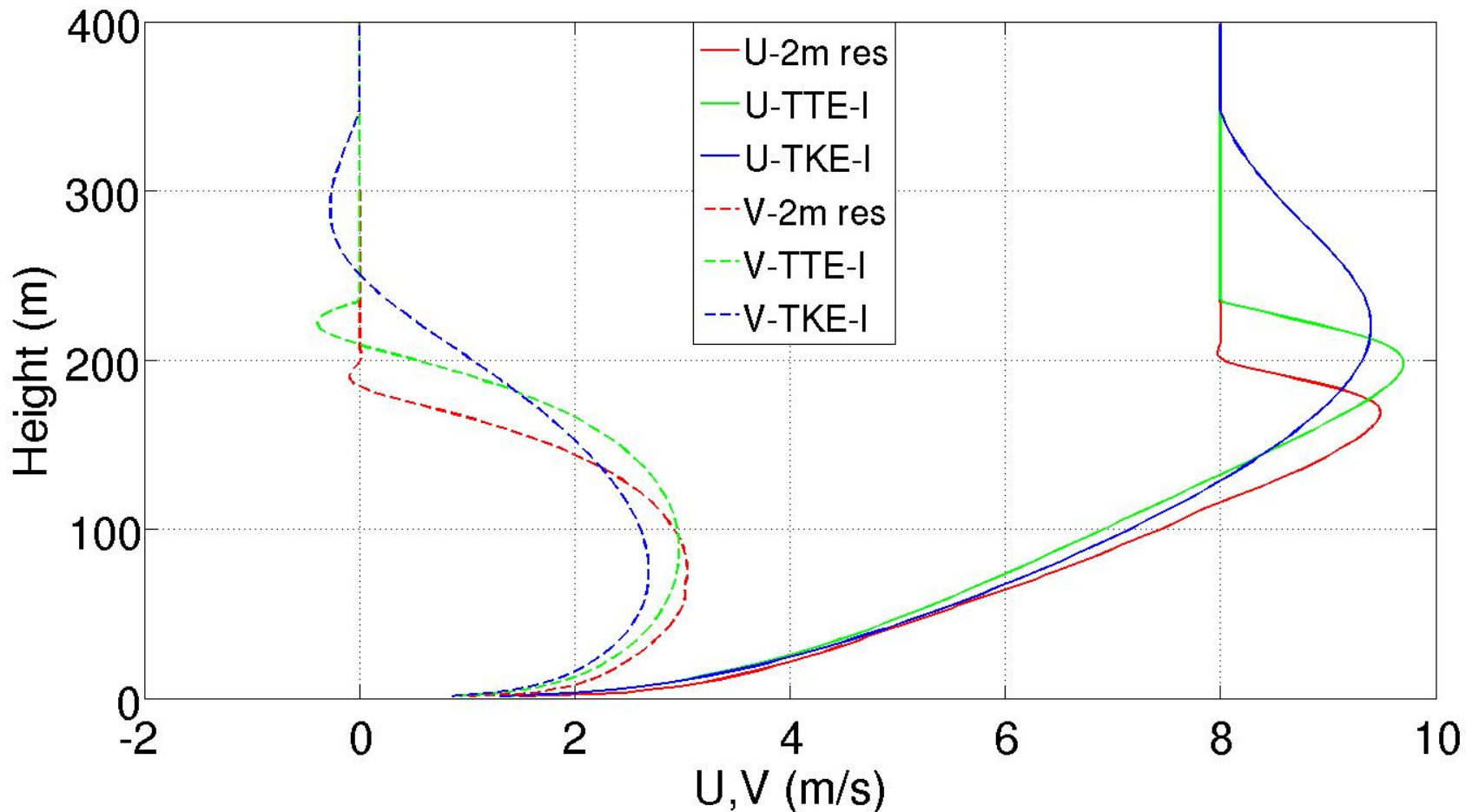


# Comparison between GABLS1 data and the 1D model predictions



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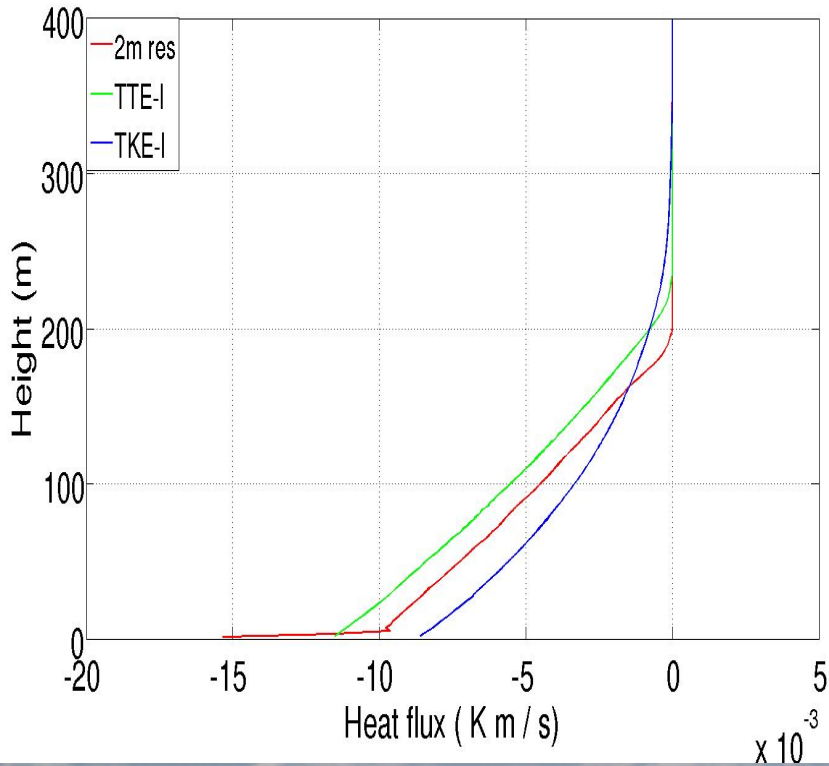
Mean wind components at t=9 hrs



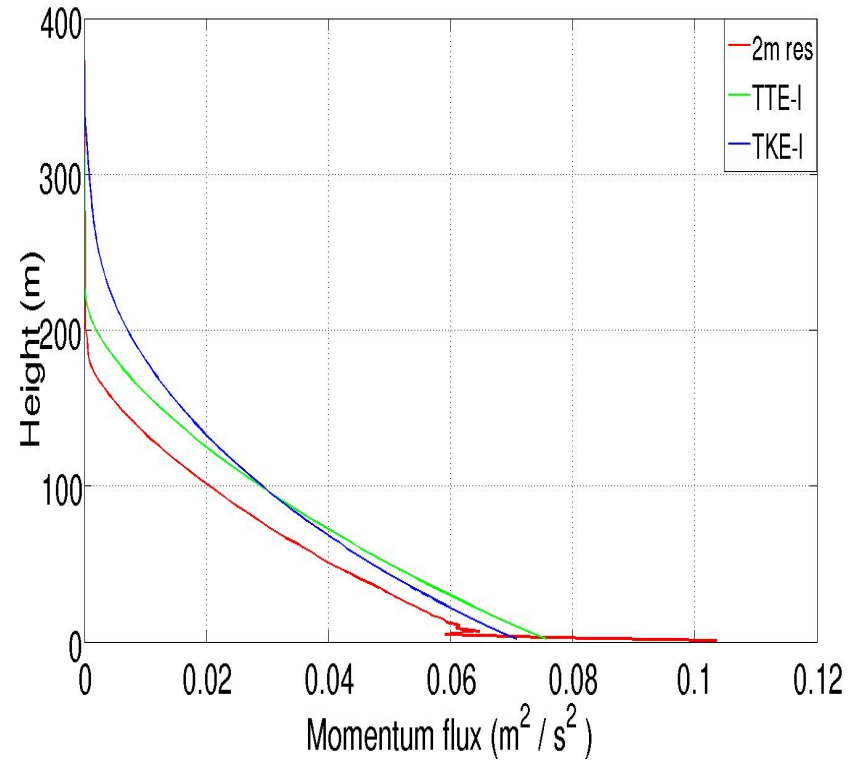


# Comparison between GABLS1 data and the 1D model predictions

Heat flux, averaged over the last hour

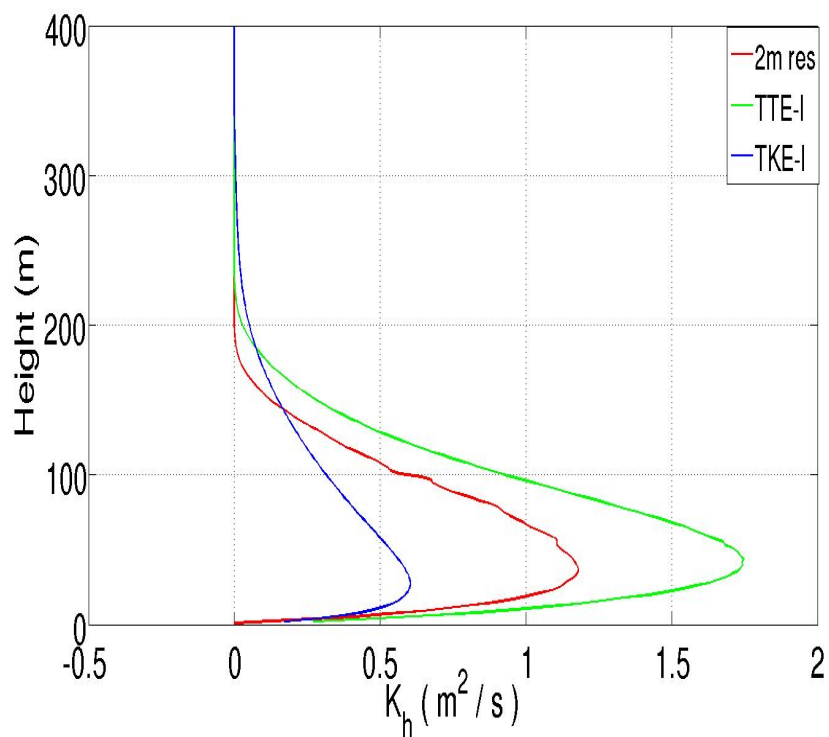


Modulus of momentum fluxes, averaged over the last hour

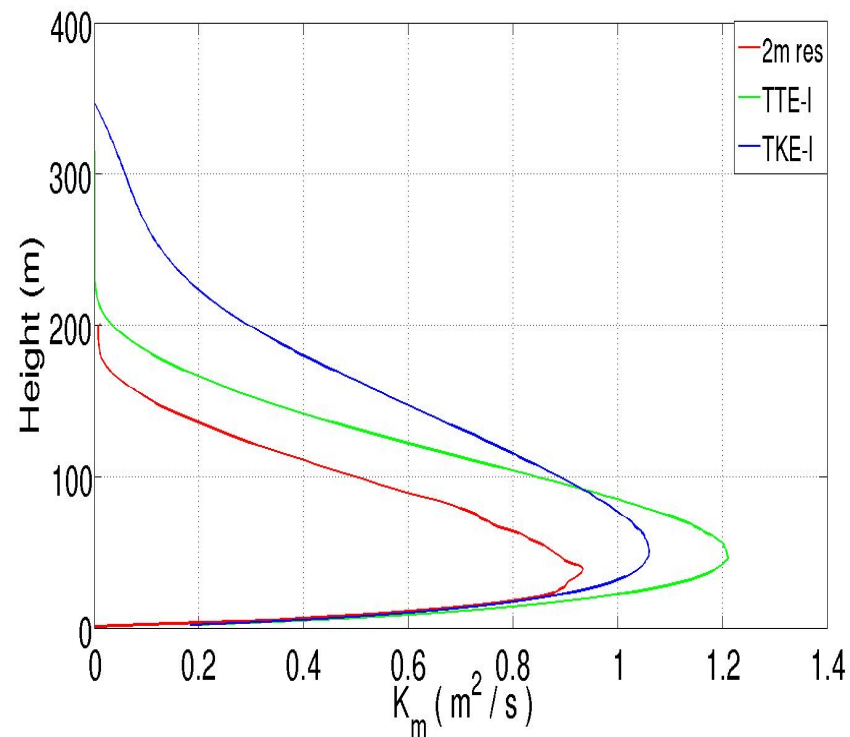


# Comparison between GABLS1 data and the 1D model predictions

Thermal diffusion coefficient  $K_h$



Momentum diffusion coefficient  $K_m$





# Conclusions

- Mise en place de deux outils permettant d'évaluer des modèles de turbulence sous-maille : un modèle 1D et le code ARPS, pour le cas-test GABLS1.
- Objectif : améliorer « à moindre coût » la paramétrisation du modèle de recherche BOLAM.
- Perspectives :
  - \* modification de BOLAM : introduction du modèle de longueur de mélange de Mauritsen et al. (2007) (et de la loi  $Pr(Ri)$  obtenue avec ARPS) → run « off-line » de BOLAM.
  - \* participation à GABLS4 pour le site « Dôme C ».