

# MODELLED AND MEASURED ABL CHARACTERISTICS FOR THE CITY OF SOFIA

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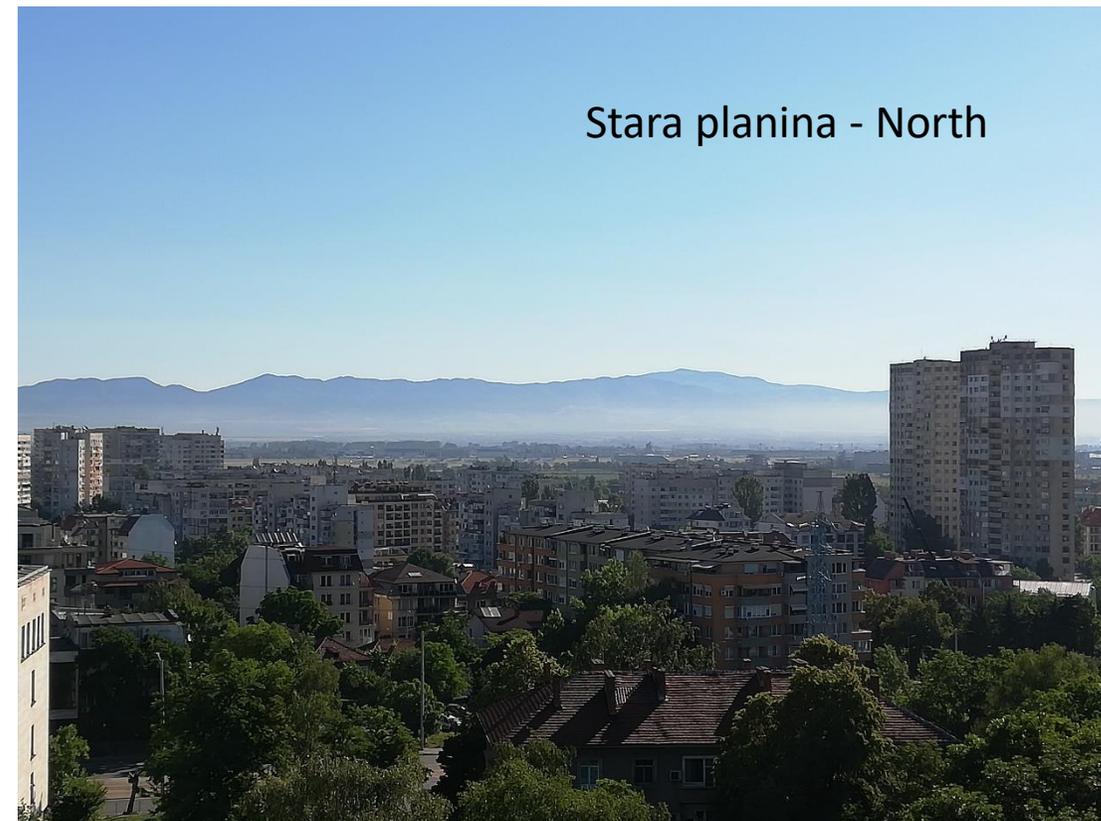
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# Motivation

The ABL height in Sofia valley is the main factor for air pollution episodes in Sofia in winter.

Even in a bright sunny day the ABL reaches only half way the height of the mountains.



**Goal:** Evaluation of model results against sodar measurements in complex terrain urban area; identify best model setup for Sofia

**ALONG WITH ABL HEIGHT OTHER  
METEOROLOGICAL PARAMETERS ARE  
ALSO IMPORTANT FOR AIR QUALITY AND  
SURFACE-ATMOSPHERE EXCHANGE IN  
FORECAST AND CLIMATE MODELS**

**Turbulence**

**Wind speed**

**Wind direction**

**Temperature**

**Profiles of all parameters**

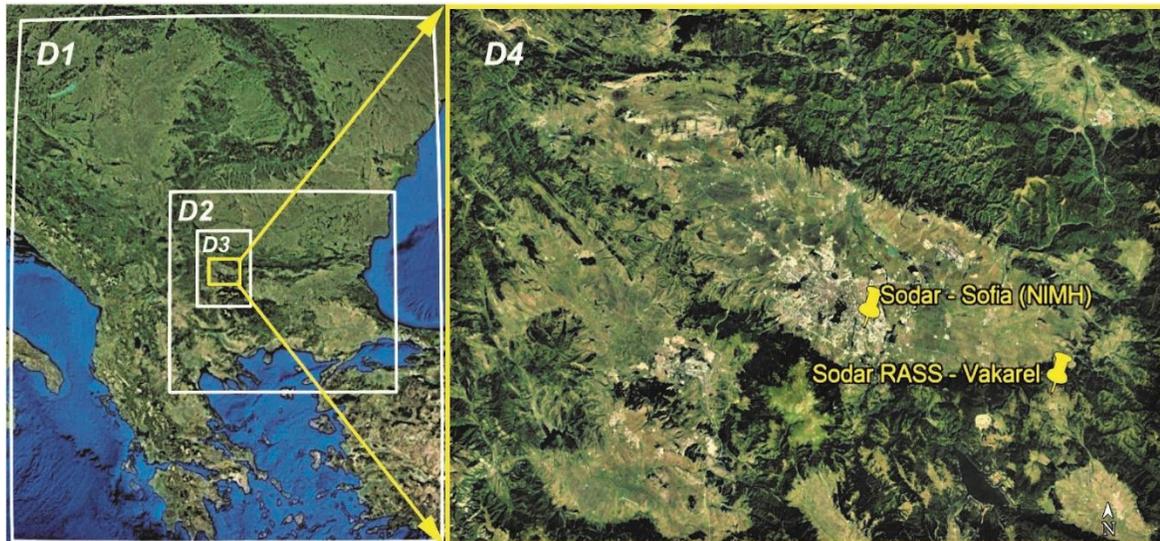
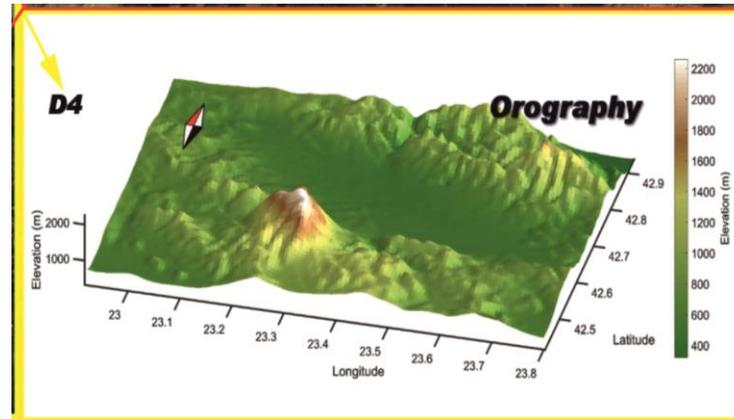
**Energy and material exchange with surface**

## **OUTLINE**

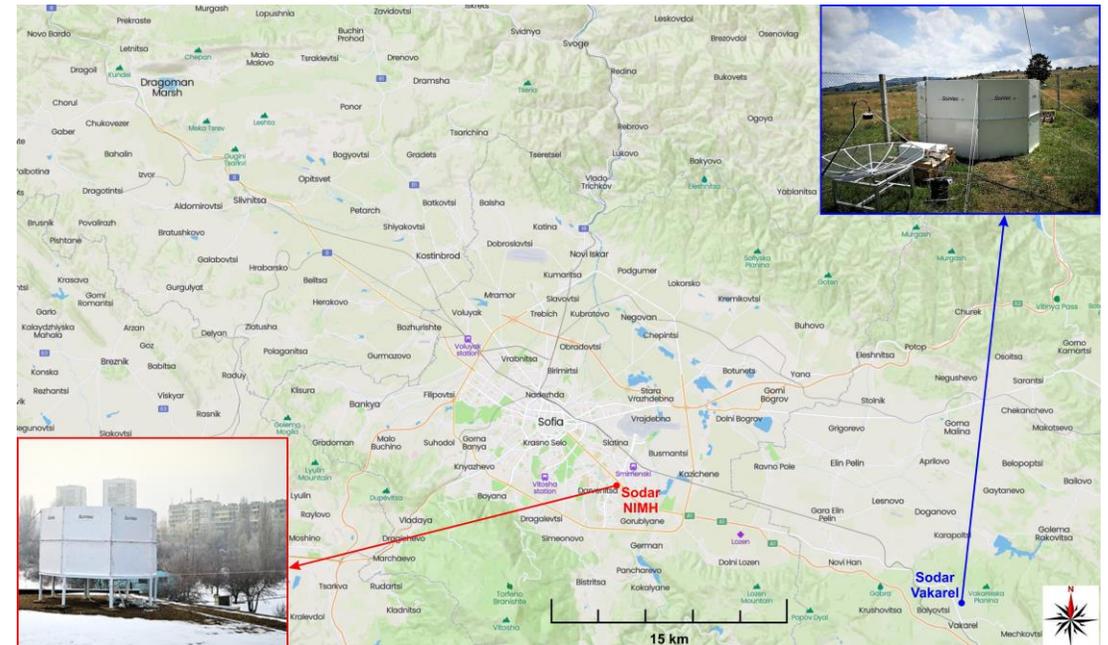
- Methods (model and observations)
- TKE
- Temperature
- Conclusions

# Question: How well WRF simulates the profiles of wind and turbulence?

D1 at 32 km,  
D2 at 8 km,  
D3 at 2 km,  
D4 at 500 m



## 2 MFAS SCINTEC sodars, one with RASS



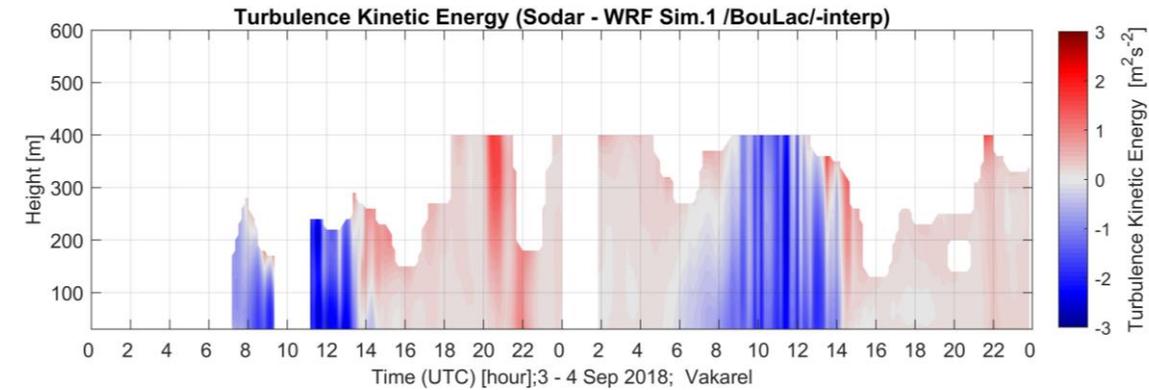
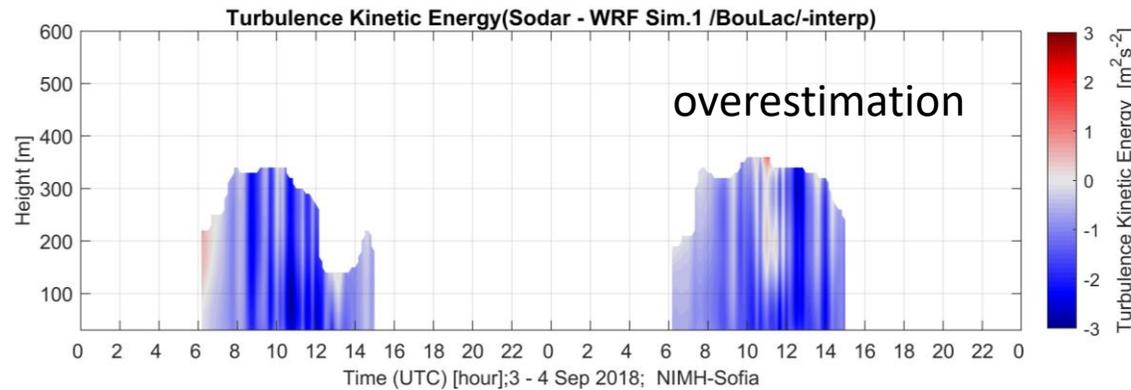
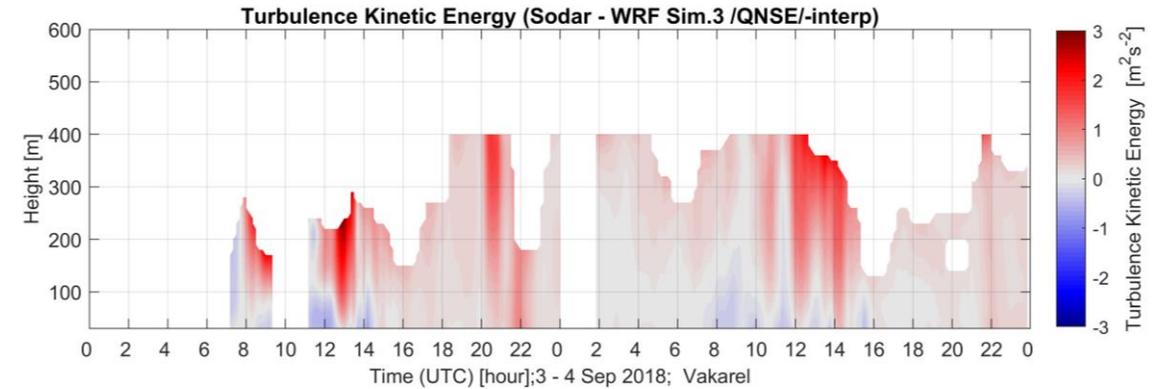
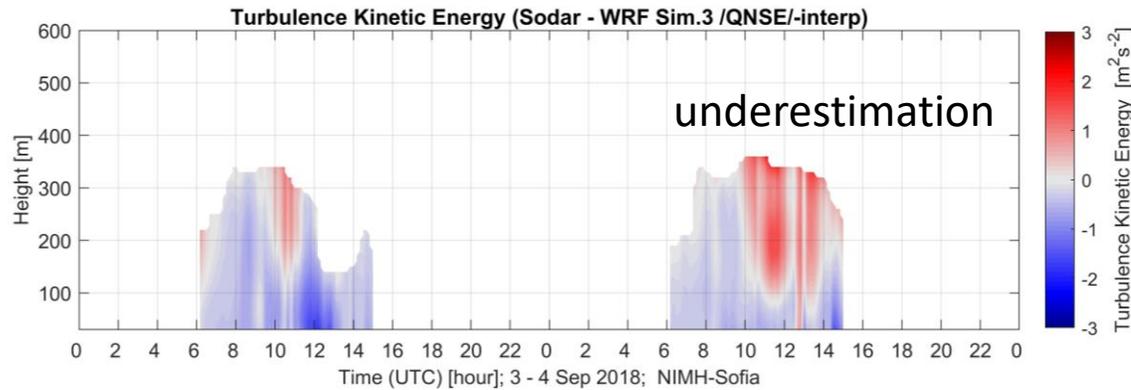
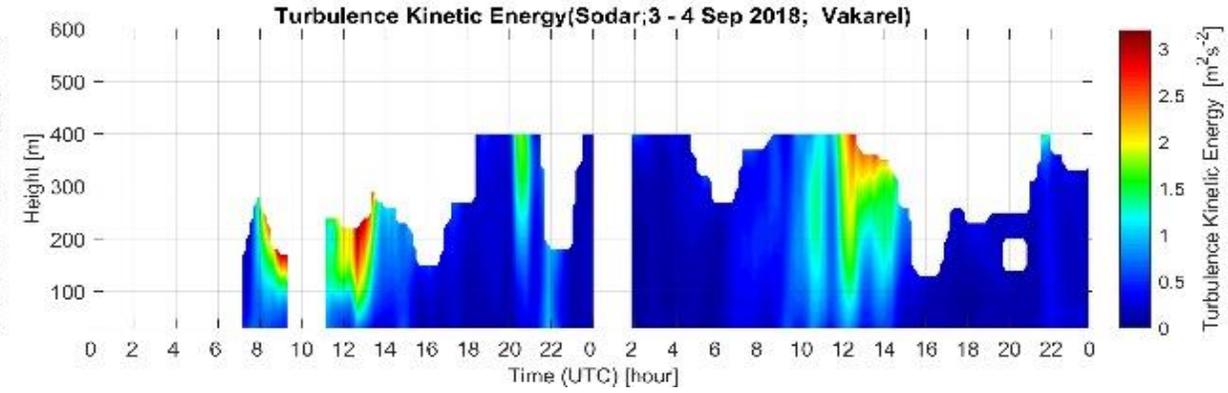
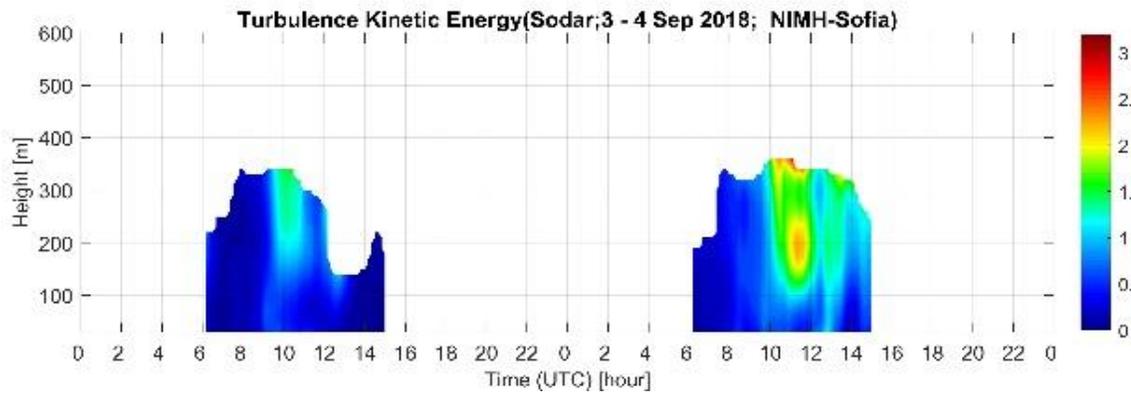
# WRF v. 3.9 setup

- 99 pressure-based terrain-following vertical levels from the surface to app. 50 hPa, **23** levels up to 500 m; **40** levels in 1000 m a.g.l.
- The initial and boundary conditions were derived from the 0.25-degree NCEP Final Operational Model Global Tropospheric Analyses datasets every 6 hours. This product comes from the Global Data Assimilation System and Data assimilation (fdda model option) was used for the outermost domain D1 for all vertical levels and for D2 above the first 10 model levels only. No data assimilation for D3 and D4.

# WRF physics package

- New version of Radiative Transfer Model - RRTMG parameterization for longwave and shortwave radiation computed every 10 minutes;
- Noah land surface model;
- Grell-Freitas cumulus parameterization for D1 and D2
- Lin, *et al.* microphysics
- Two PBL schemes with their corresponding surface schemes:
  - Bougeault and Lacarrere scheme, BouLac
  - Quasi-Normal Scale Elimination scheme, QNSE
- The period 3-4 September 2018 is presented here for illustration

# Measured (MFAS SCINTEC sodars) and modelled TKE



# Statistical indicators for BouLac ABL scheme, 3 - 4 Sep 2018

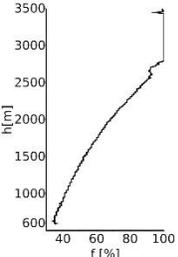
Corr. coefficient, standard deviation error (stde), standard deviation (SD), bias, mean value of model (mod) and observation (obs)

		count	r	stde	SD mod	SD obs	bias	mean mod	mean obs
Sofia Sim. 1	WD	3251	0.850	47.4	66.6	77.0	-7.4	358.9	6.3
	U	3251	0.735	2.3	2.3	3.4	0.4	-0.1	-0.5
	V	3251	0.662	2.0	1.6	2.7	-0.7	-0.8	-0.1
	TKE	2869	0.589	0.7	0.9	0.5	1.0	1.7	0.7
Vakarel Sim. 1	WD	9291	0.108	100.2	76.9	74.2	102.8	130.2	27.4
	U	9291	0.744	2.1	1.9	3.1	-0.1	-0.4	-0.3
	V	9291	0.583	2.9	2.7	3.5	0.3	0.1	-0.2
	TKE	6361	0.744	0.7	1.0	0.5	0.1	0.7	0.6
	T	6975	0.785	1.7	2.3	2.7	0.1	18.9	18.8

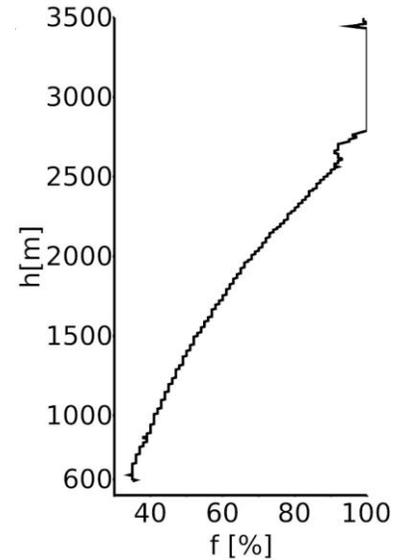
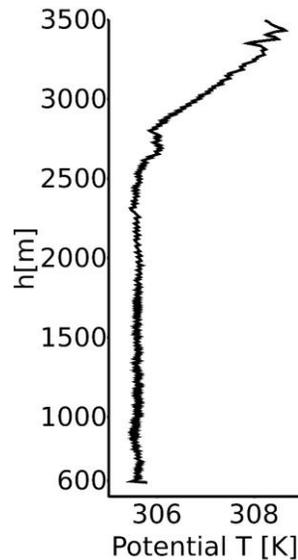
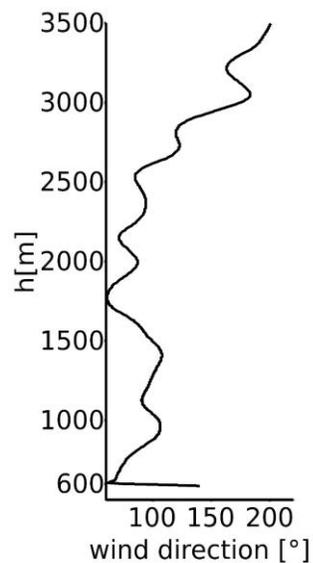
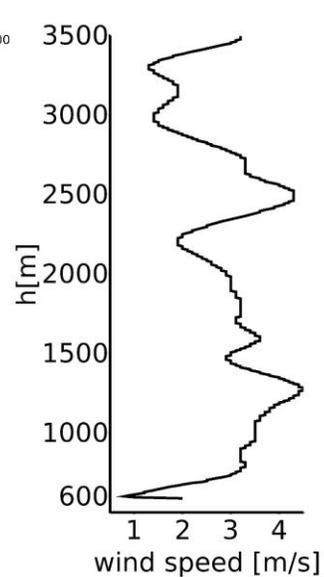
# Statistical indicators QNSE ABL scheme, 03 - 04 Sep 2018

Corr. coefficient, standard deviation error (stde), standard deviation (SD), bias, mean value of model (mod) and observation (obs)

		count	r	stde	SD mod	SD obs	bias	mean mod	mean obs
Sofia	WD	3251	0.710	65.8	59.2	77.0	24.5	30.8	6.3
	U	3251	0.575	2.8	2.4	3.4	-0.6	-1.1	-0.5
	V	3251	0.479	2.4	1.9	2.7	-0.9	-1.0	-0.1
	TKE	2869	0.307	0.5	0.3	0.5	0.0	0.7	0.7
Vakarel	WD	9291	0.469	80.6	72.1	74.2	67.7	95.1	27.4
	U	9291	0.601	2.5	2.1	3.1	-0.5	-0.9	-0.3
	V	9291	0.580	3.0	3.0	3.5	0.1	-0.1	-0.2
	TKE	6361	0.596	0.4	0.3	0.5	-0.3	0.2	0.6
	T	6975	0.761	1.8	2.2	2.7	0.0	18.7	18.8

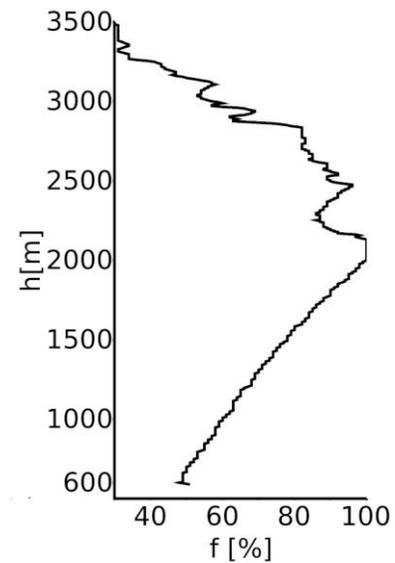
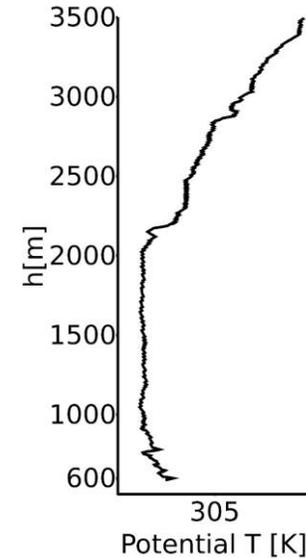
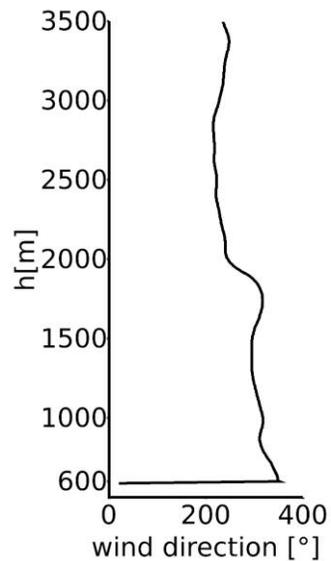
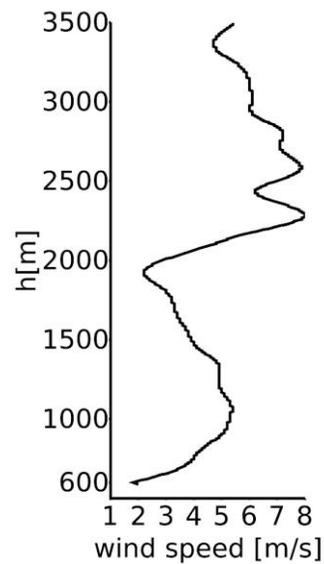


# TKE vs radiosonde profiles?



Sep 3, 2018

Increase of wind speed in the layer 200-400 a.s.l. on both days around 12 UTC

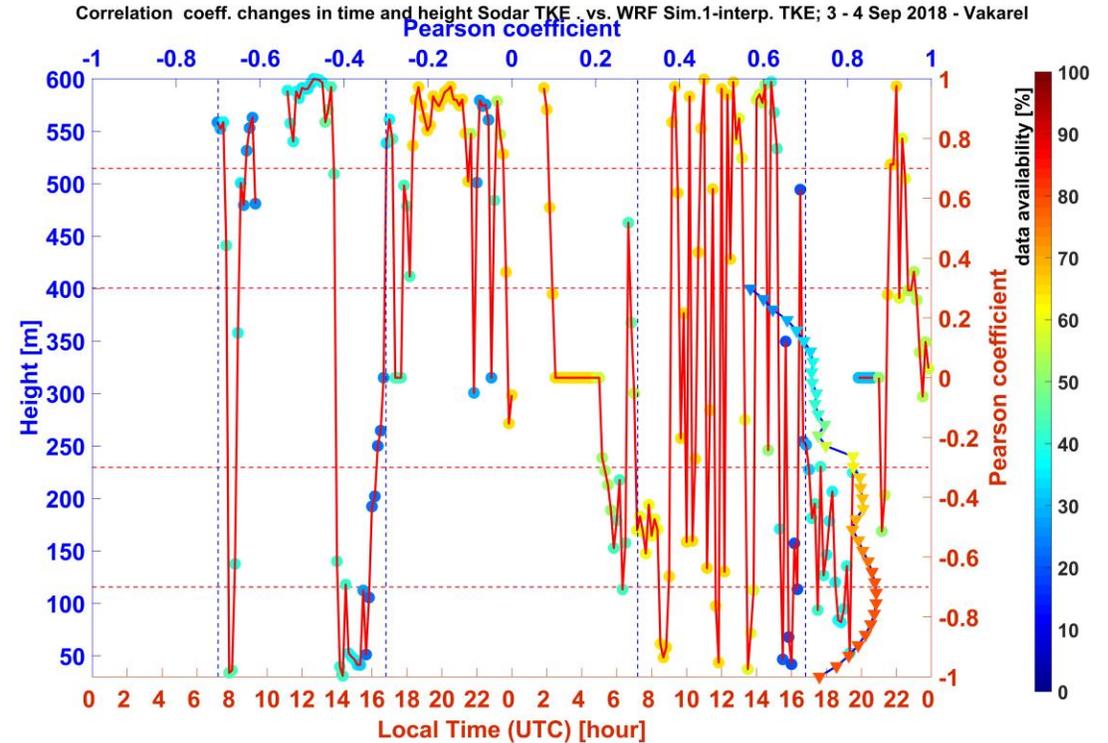
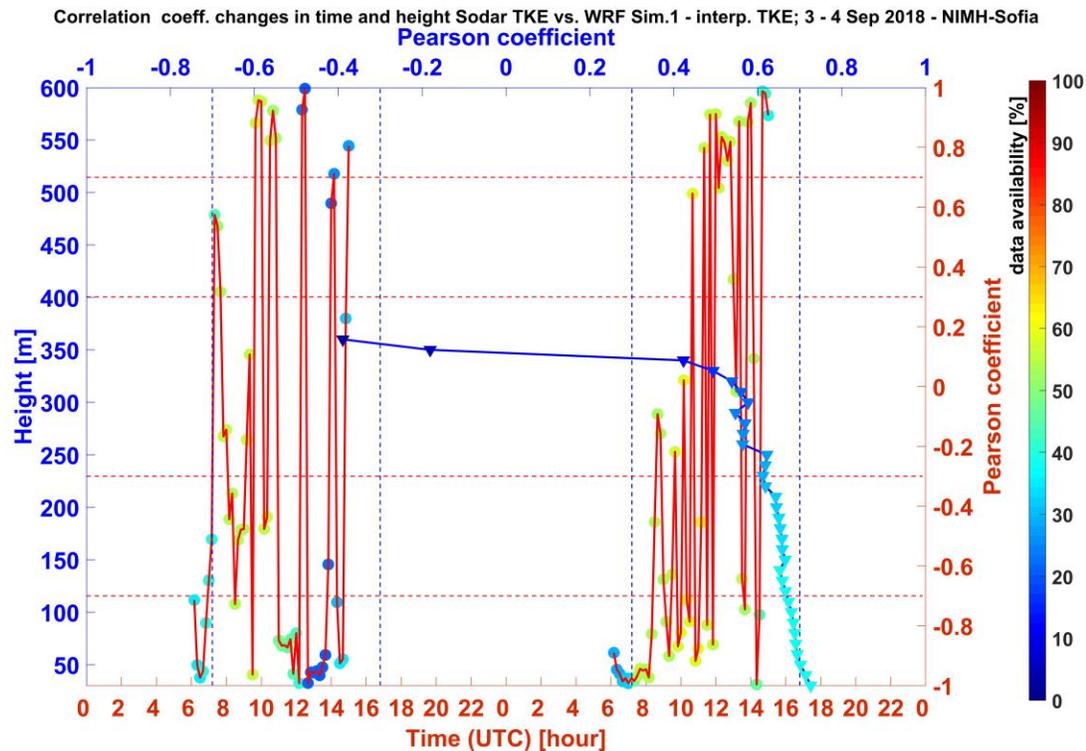


Sep 4, 2018

Spatial (top and left blue axes and blue line with colored triangles)  
Temporal (down and right red axes and line with colored dots)  
values of  $r$  for TKE (sodar vs WRF/BouLac)

## Sofia

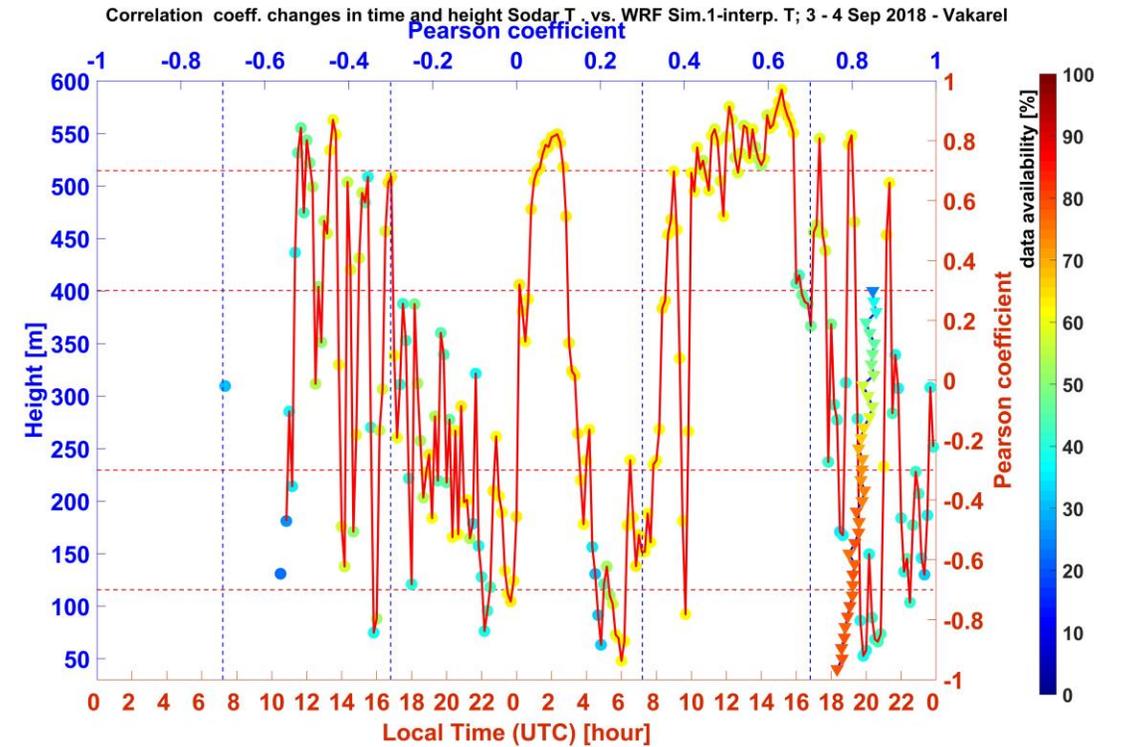
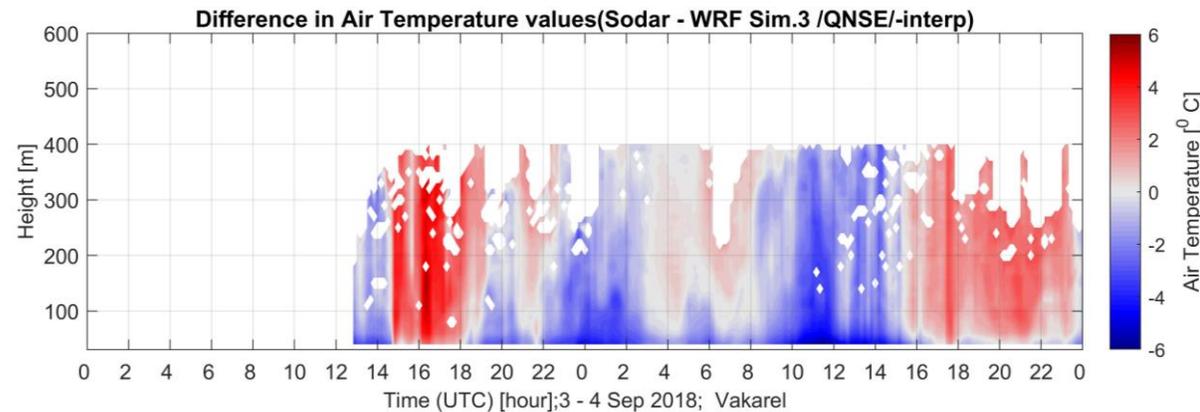
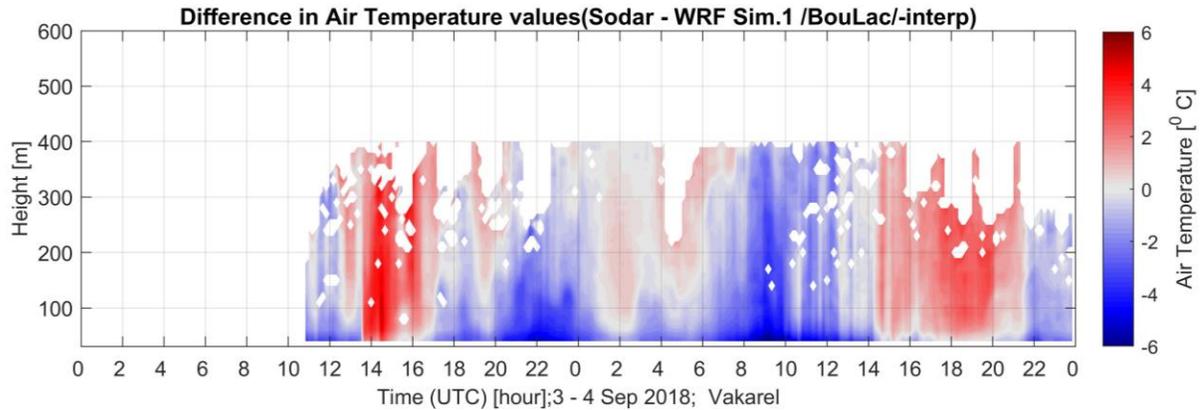
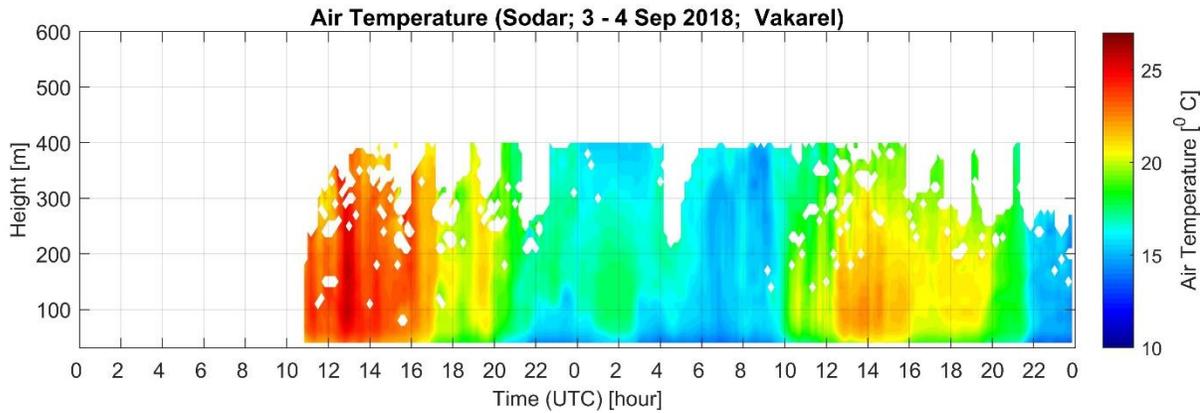
## Vakarel



The profile of  $r$  is in the range 0.5-0.7 in Sofia and in the range 0.7-0.9 at Vakarel

The correlation between model and obs. for TKE is better at noon than during transition periods

# Temperature



Both PBL schemes give good results for temperature profiles

The values in the vertical profile of  $r$  is between 0.7-0.9

Model is better correlated to measurements around midday than during transition hours

# Conclusions

WRF with BouLac ABL scheme simulates better TKE than WRF with QNSE ABL scheme and the results for the rural site are better than for the urban site

Both PBL schemes give similar good results for temperature profiles

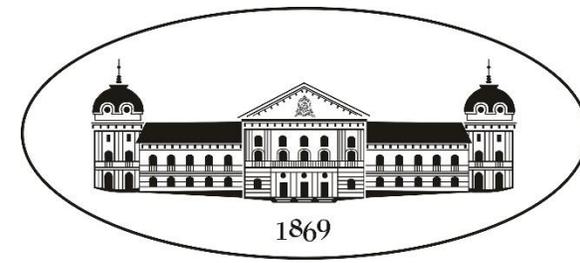
Compared to observations the model performed better at the rural site

- The profile of  $r$  is in the range 0.5-0.7 in Sofia and in the range 0.7-0.9 at Vakarel
- The correlation between model and obs. for TKE is better at noon than during transition periods
- The values in the vertical profile of  $r$  is between 0.7-0.9
- Model is better correlated to measurements around midday than during transition hours

# ACKNOWLEDGEMENTS

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*Thank you for your  
attention!*