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Batchvarova, Ekaterina; Gryning, Sven-Erik

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The ability of mesoscale meteorological models - driving chemical transport models - to predict the vertical profiles of meteorological parameters – COST728 evaluation study

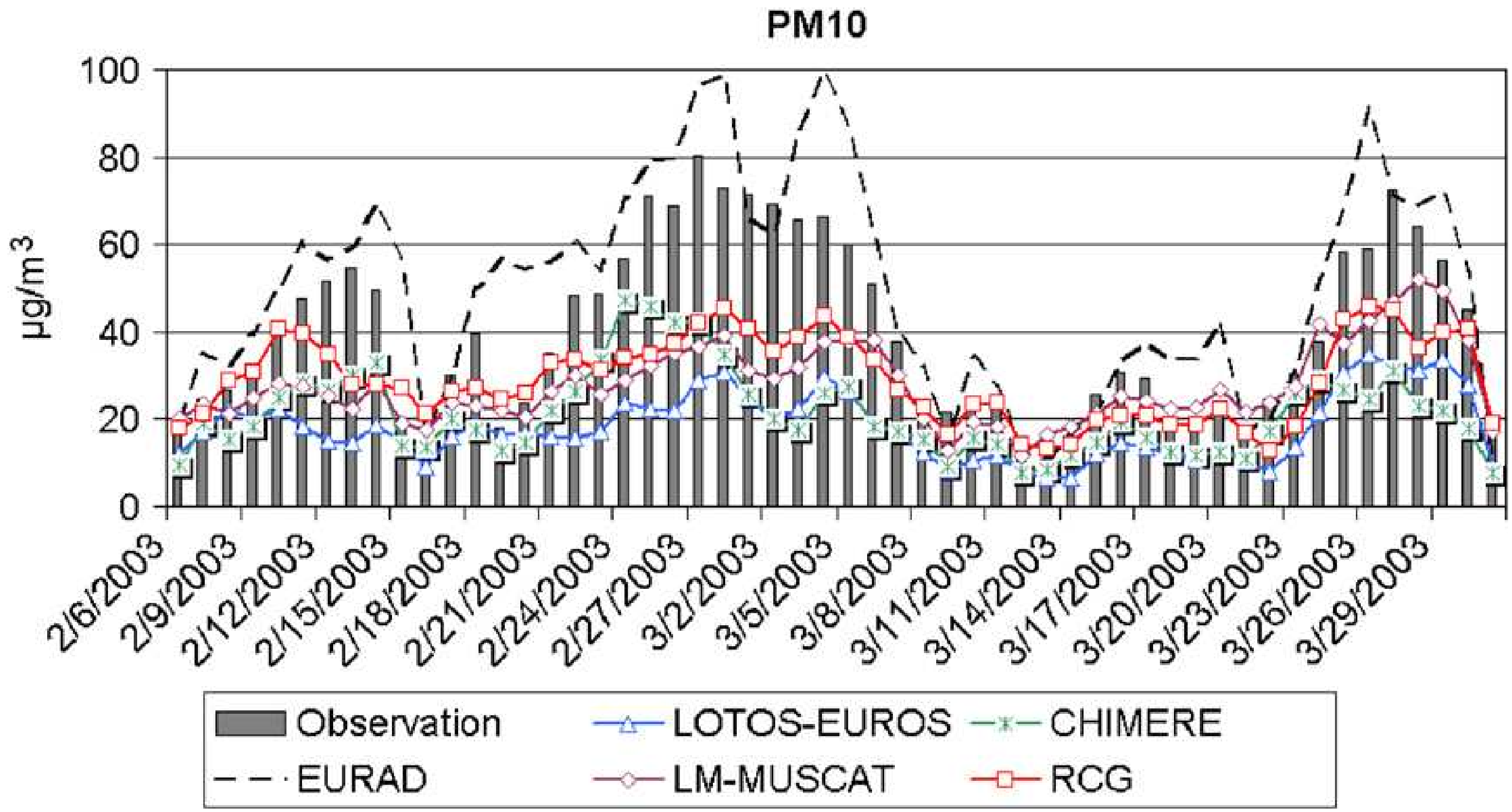
Ekaterina Batchvarova[1]

Sven-Erik Gryning[2]

[1]National Institute of Meteorology and Hydrology, Sofia, Bulgaria

[2]Risø DTU, Roskilde, Denmark

Daily mean PM_{10} concentrations averaged over the area



It can be seen that the models generally underpredict the PM_{10} concentration during episodes, and there is a wide scatter between the models.

All models predict and use different Atmospheric Boundary-Layer height. How is this related to observations? The ABL height is a parameter defined in different way in the fields of temperature, humidity, wind, aerosol. The different measuring techniques correspond also to diverse definitions.

Therefore the discussions within COST728 concluded that modeled and measured profiles of meteorological parameters are to be compared rather than ABL height.

Model evaluation

We note that we can have a perfect model without an exact match with the measurements.

How close is close enough to be within the limits of representativiness?

In other words when will it be worthwhile to look for improvements in the models and when are the model predictions within the statistical range given by the representativiness of the measurements.

The mean square relative error, ε

$$\varepsilon^2 = \frac{\sigma_{x,T}^2}{\langle x \rangle^2} = \frac{2\sigma_x^2}{\langle x \rangle^2}\frac{\tau}{T}$$

depends on the averaging time T of the parameter x.

$\sigma_{x,T}^2 / \langle x \rangle^2$ - is the mean-square relative error when integrating over duration T

τ - is the integral time scale of the parameter.

For the wind speed: $$\varepsilon^2 = \left(\sigma_{u,T} / \langle u \rangle\right)^2$$

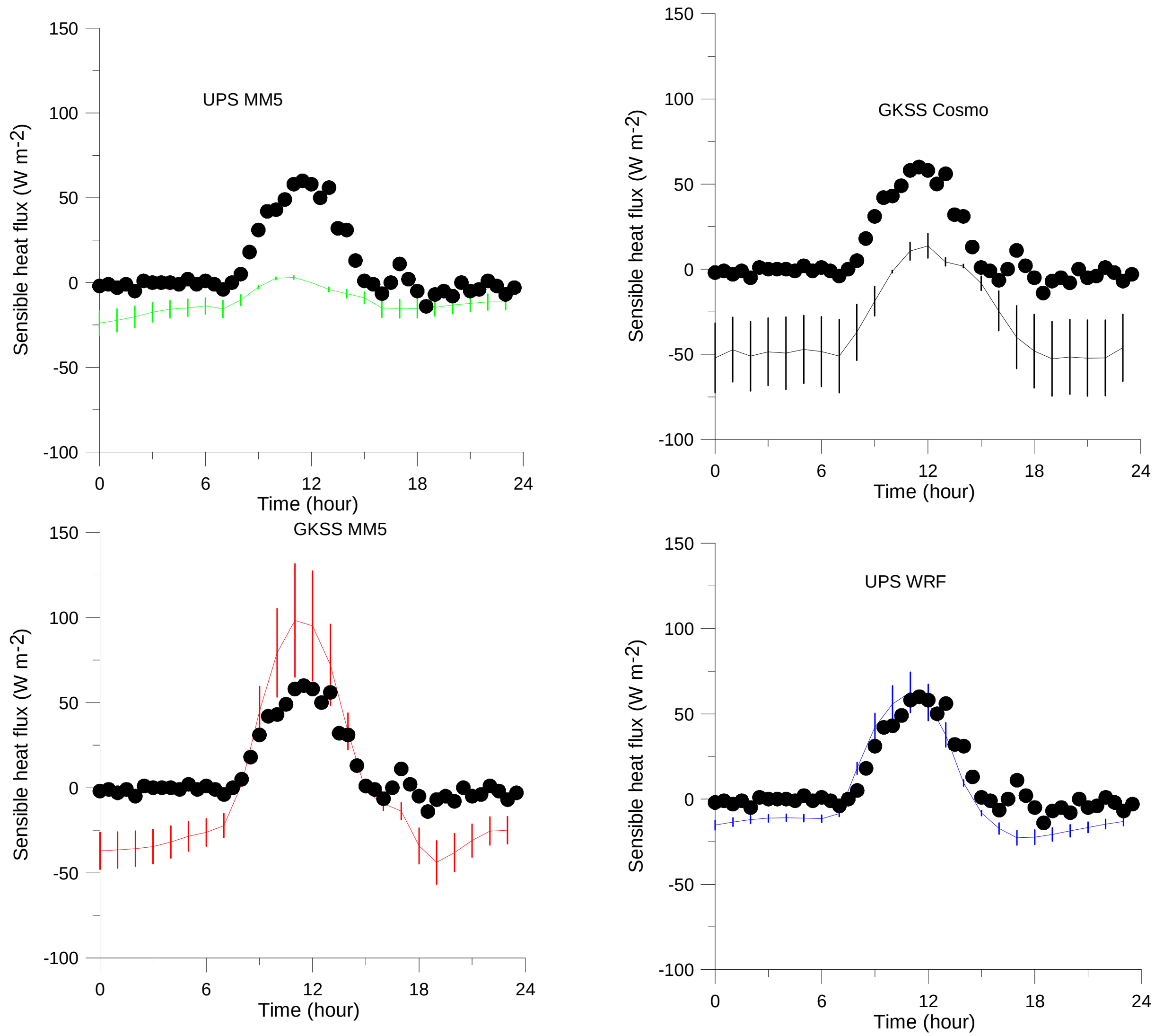
For the sensible heat flux: $$\varepsilon^2 = \left(\sigma_{w\theta,T} / \langle w\theta \rangle\right)^2$$

Sreenivasan et al, 1978 suggest to determine the relative error for wind speed and sensible heat flux for a given averaging time T as follows:

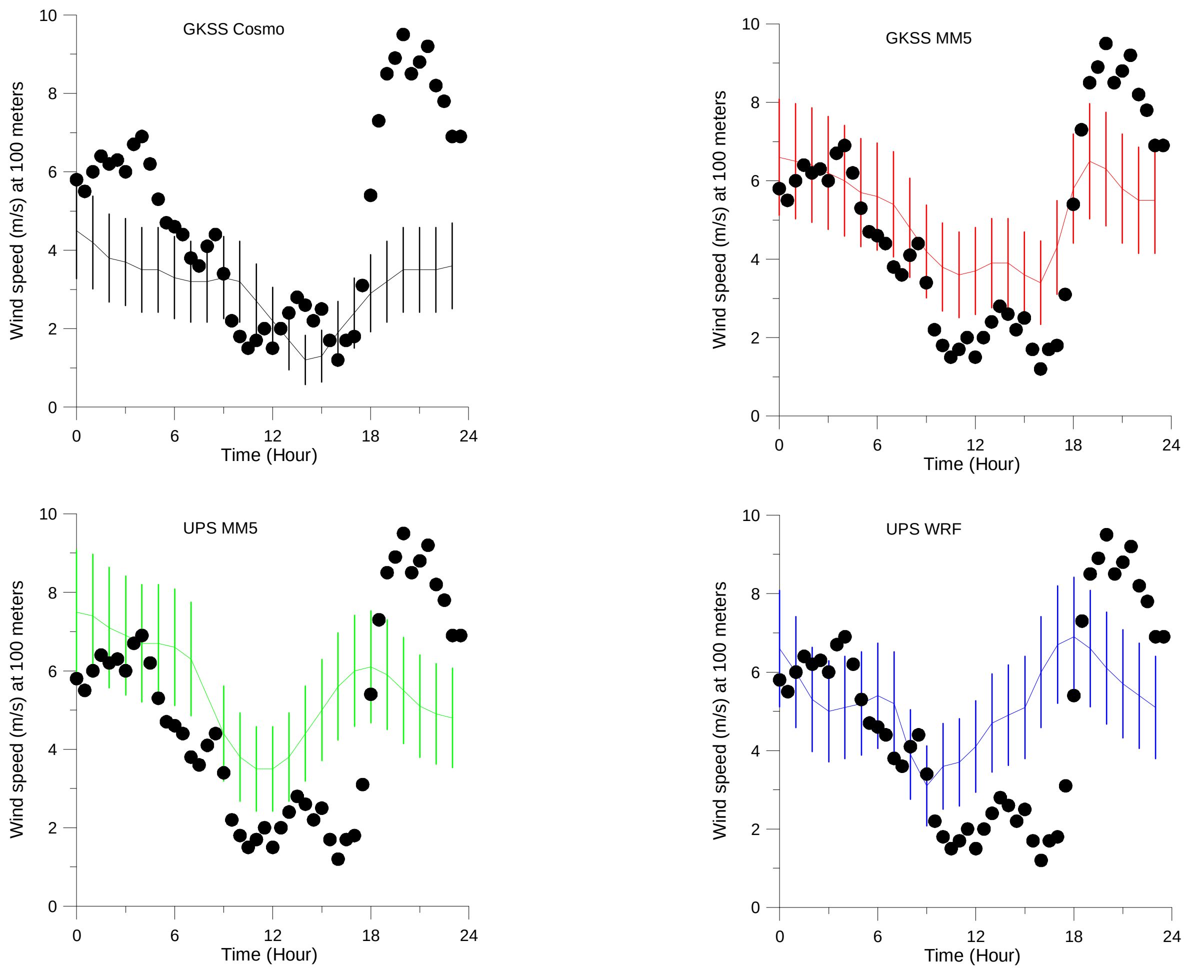
$$\sigma_{u,T} = \sqrt{12}\sqrt{\frac{z}{T\,u}}\,u \qquad \sigma_{w\theta,T} = 8\sqrt{\frac{z}{T\,u}}\,w\theta$$

The method is used in Batchvarova and Gryning, 2009 to associate an uncertainty interval for the model predictions, based on averaging time (in a simplified calculation the uncertainty interval is found to be 2/3 of the sensible heat flux value and   for the wind speed).

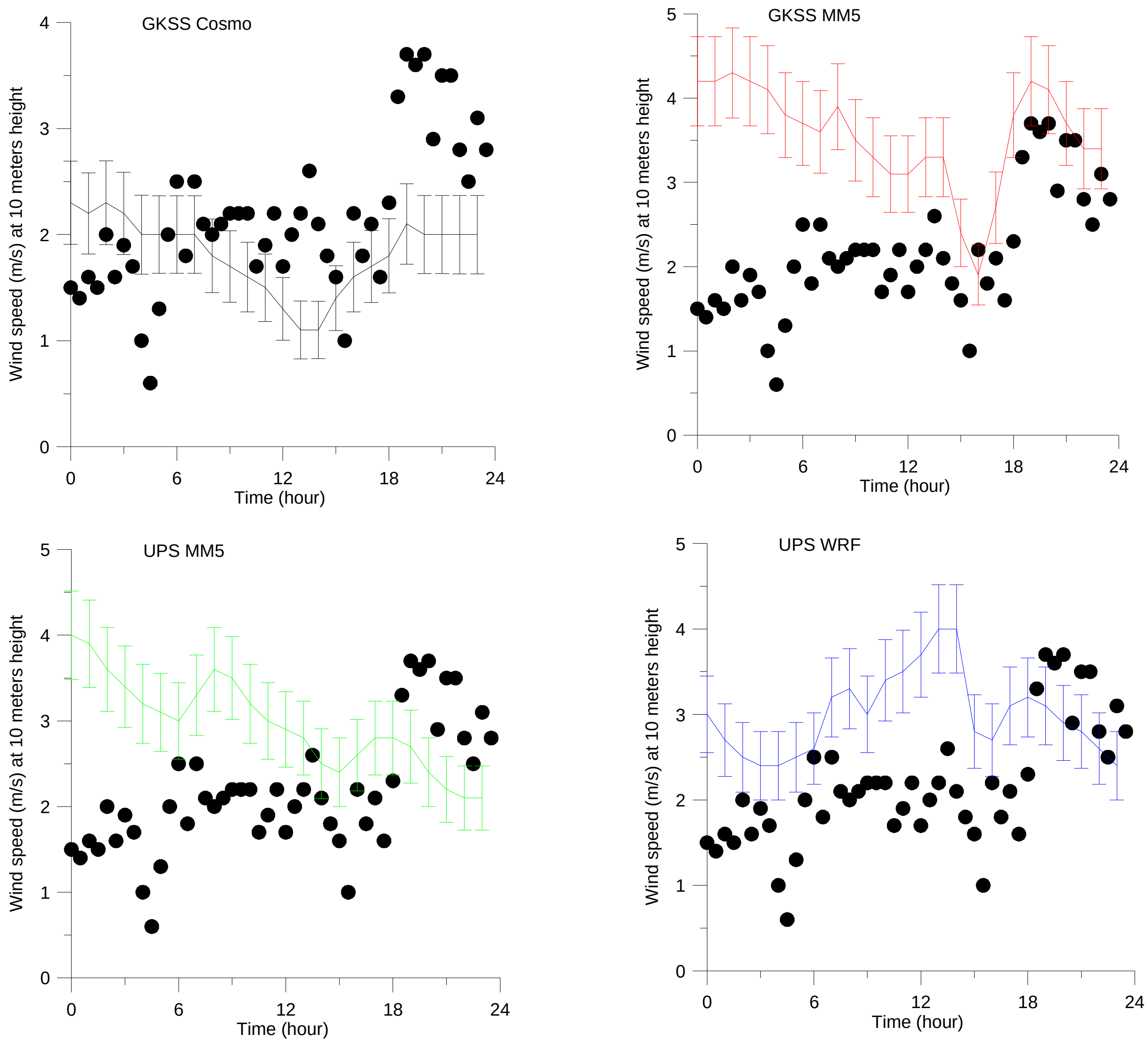
Lindenberg: sensible heat flux at 2.4 meter over grassland



Lindenberg: wind speed at 100 meters over grassland



Lindenberg: wind speed at 10 meters over grassland



Conclusions:

Progress in model developments is based on comparison with data.

It is essential to evaluate the models on profile measurements, not just traditional surface measurements

The representativiness of the measurements should be taken into account in any model evaluation against measurements.

The representativiness is a function of the length scale of turbulence (height in the surface layer) and averaging time of the measurements (as a first rough approximation)

We note that we can have a good model without an exact match with the measurements.

In other words a model cannot be improved if the measuremenst fall within the statistical range.

Acknowledgements

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