Research on turbulence parameterisations in regional AQ modelling

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Overview

- Regional modelling in Croatia
- Turb. Parametrization schemes
- FLOSSII and CASES99
- LES data
- Evaluation
- Conclusions

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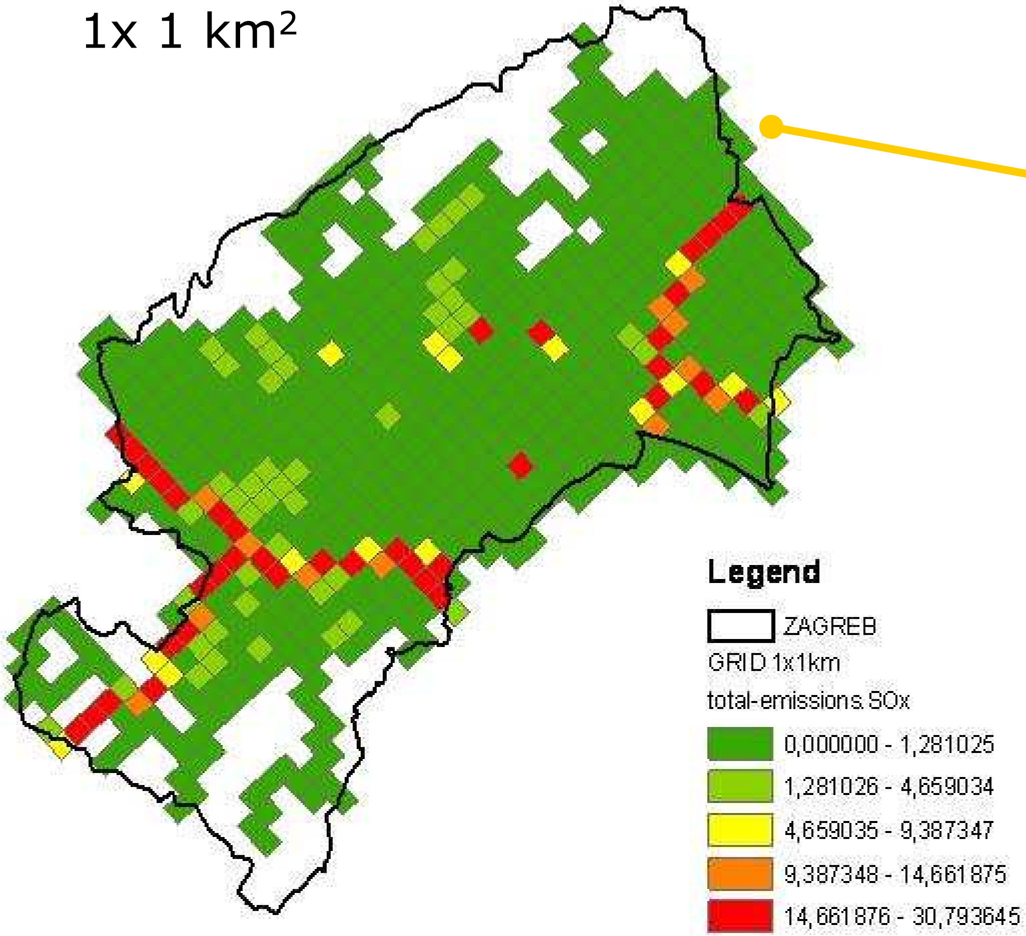
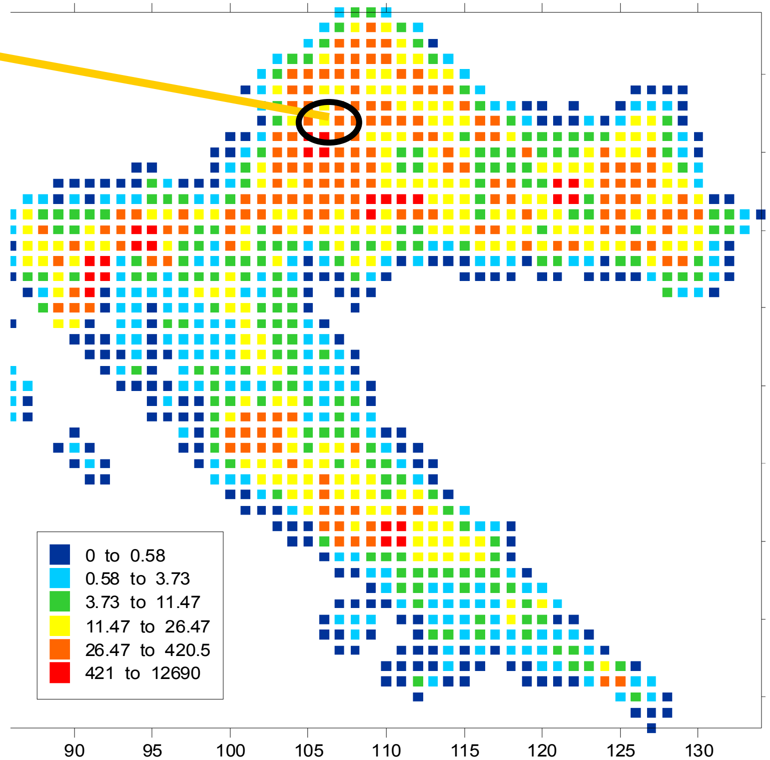
Regional modelling in Croatia

- EMEP/EMEP4HR model *(Jeričević et al., 2007; Kraljević et al., 2008)*
- Atm. transport and deposition of acidifying and eutrophying comp., photo-oxidants and PM over Europe.
- Vertical: 20 terrain-following layers reaching up to 100 hPa (1. model layer at 100 m~1/2 sgm. lay. at 50m)
- Input-3h NWP PARLAM-PS output *(Jakobsen et al., 1995; Simpson et al., 2003).*
- Emissions
- Objective-development of Croatian modelling capacities

Emissions

1x 1 km²





10x10 km²

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Turbulence parameterizations

- Vertical diffusion- K(z)
  - In SBL Blackadar scheme is used
  - In CBL O'Brien
  - New app. => aimed on K(z) improvement in SBL conditions
- ABL height parameterizations
  - SBL-based on K(z) profile
  - CBL- SHF distributed vertically ~ dry adiab. adj. => H height of corr. adiab. layer
  - New approach is based on R_{iB} number-not included in this presentation

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K(z) schemes-1.order schemes

- Blackadar (1979) in SBL and 'free' atmosphere

$$K(z) = \begin{cases} 1.1(Ri_C - Ri)l^2 \left|\Delta V_H / \Delta z\right| / Ri_C & Ri \le Ri_C \\ 0.001 & Ri > Ri_C \end{cases}$$

$$l = k \cdot z \qquad z \le z_m$$

$$l = k \cdot z_m \qquad z > z_m$$

- O'Brien (3rd order polynomial) in CBL

- New aproach: Grisogono scheme

$$K(z) = (K_{\max} e^{1/2} / z_{\max}) z \exp\left[-0.5(z / z_{\max})^2\right]$$

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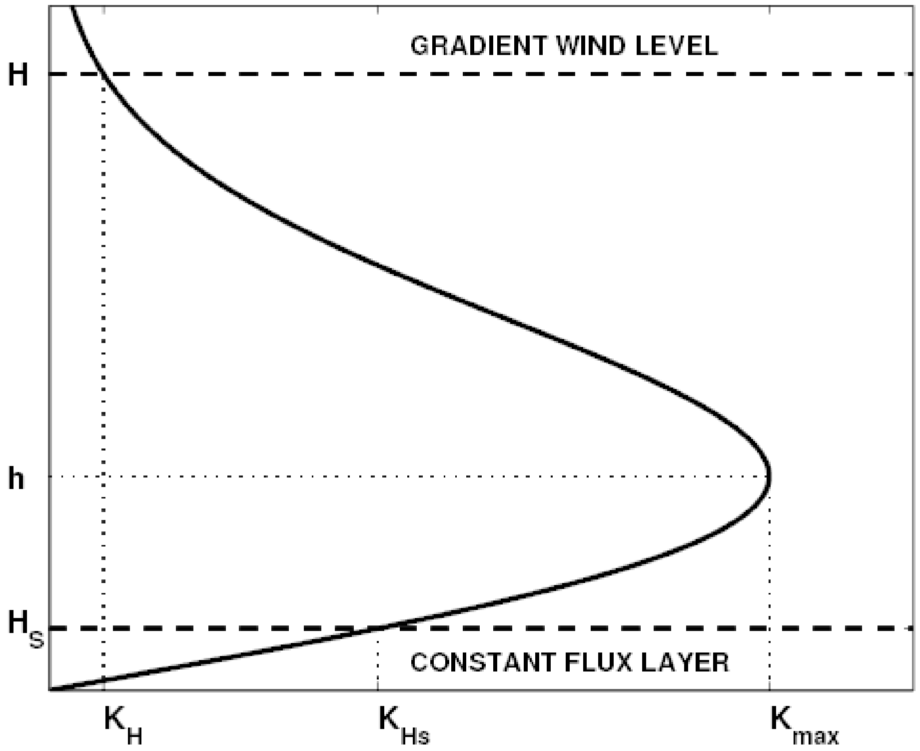
K(z) profiles



$$K_{max} = C(K) H u_* ,$$

$$h = H / C(h)$$

Main task to determine coefficients in Kmax and h

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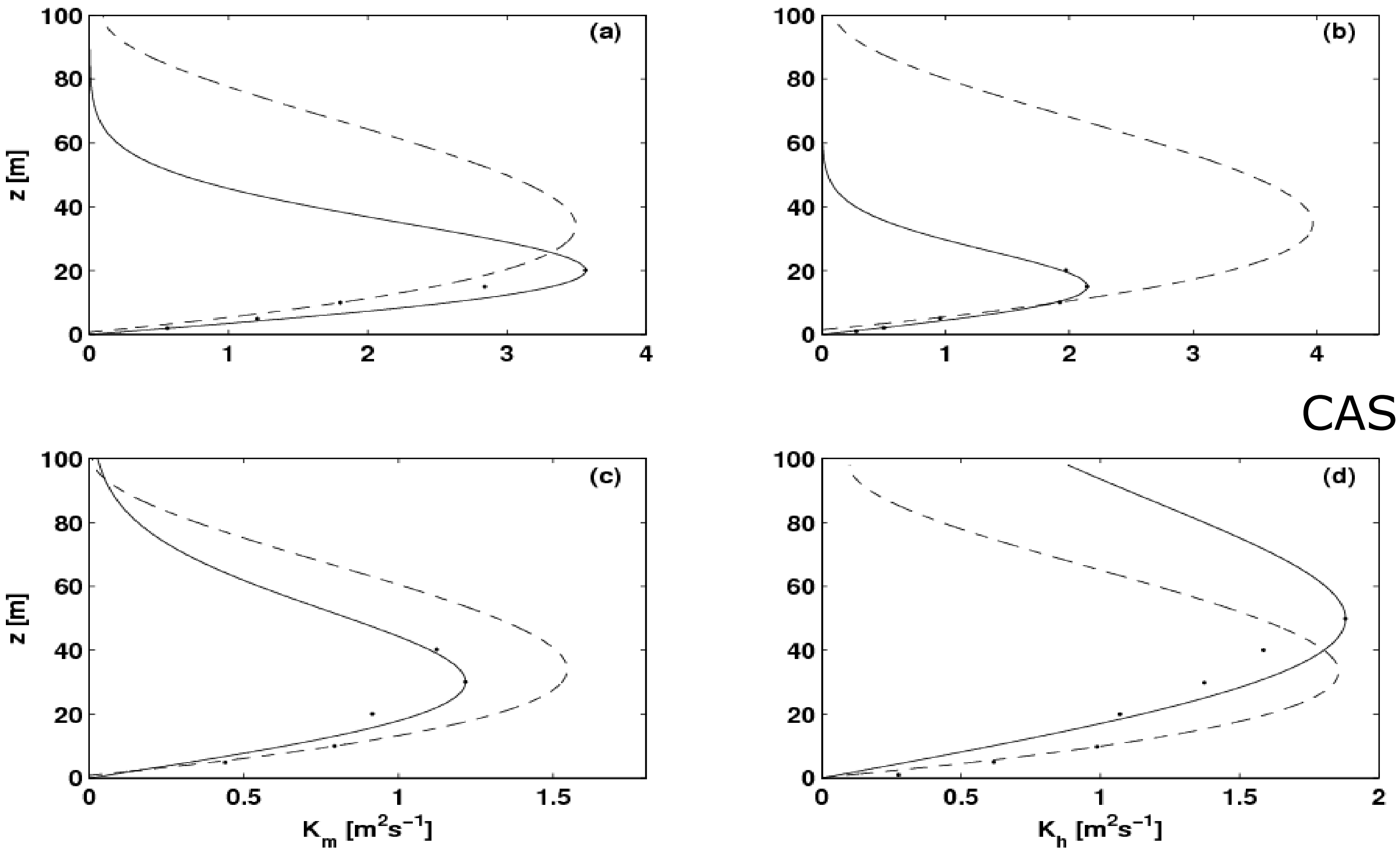
FLOSS II and CASES99 experiments-

(Jeričević and Večenaj, 2009 in BLM)

FLOSSII



CASES99

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LES data

- DATABASE64 *(Esau and Zilitinkevich, 2006.)-* **dynamic sub-grid scale closure model parameterizes TKE dissipation with Smagorinsky closure and a resolution of 64^3 gridpoints**
- ~ 140 runs of stable and neutral conditions, each case run 15h
- Boundary cond.~ initial T profile (neutral or with const. strat.), const. back. Vg, the surf. roughness length and surf. heat flux

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Empirical coefficients

- O’Brien, Blackadar and Grisogono schemes vs K profiles in the LES *(JV09, Jeričević et al. 2010 in ACP)*

	$C(K) \pm \sigma$	$C(z_{max}) \pm \sigma$
K_m (m^2s^{-1})	0.04 ± 0.02	0.32 ± 0.16
K_h (m^2s^{-1})	0.05 ± 0.02	0.21 ± 0.08

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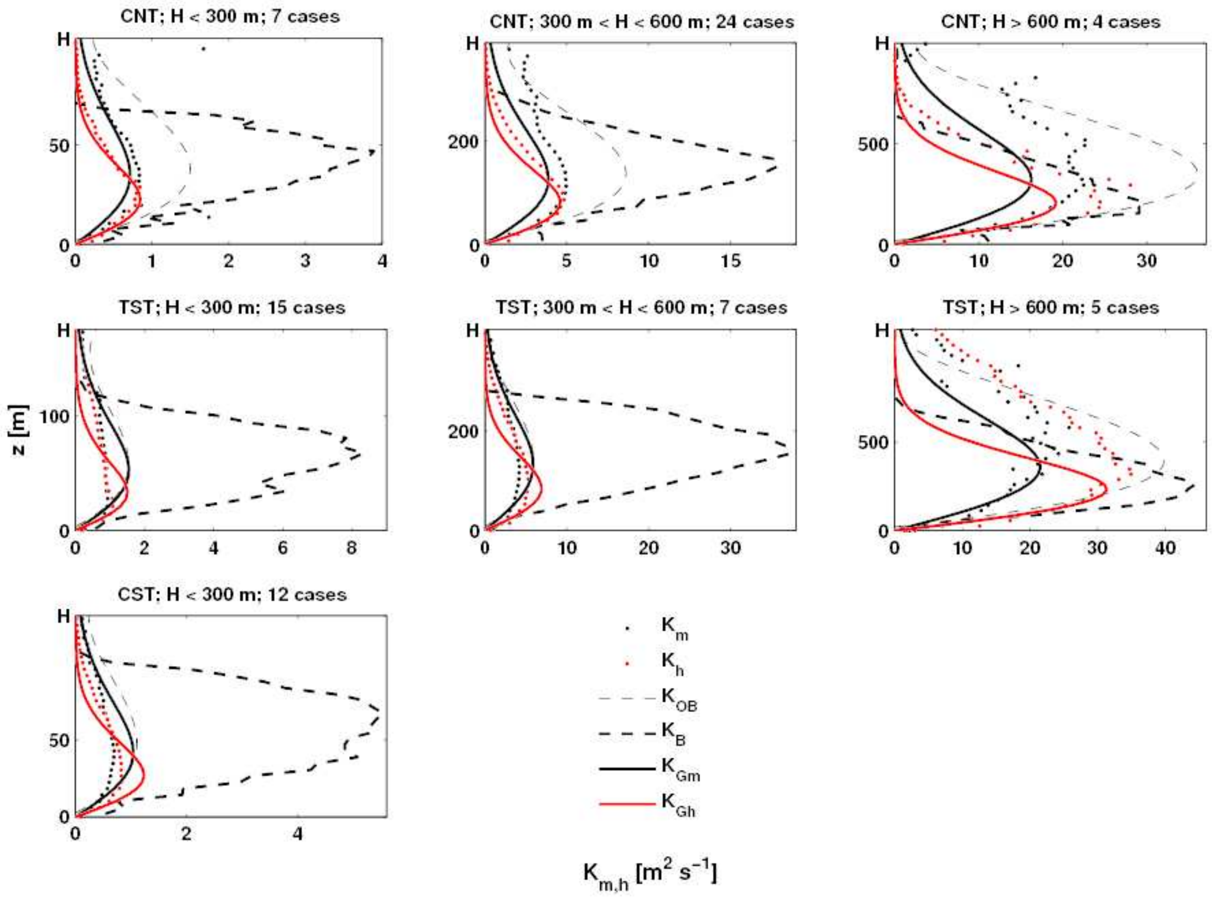
LES K(z) profiles



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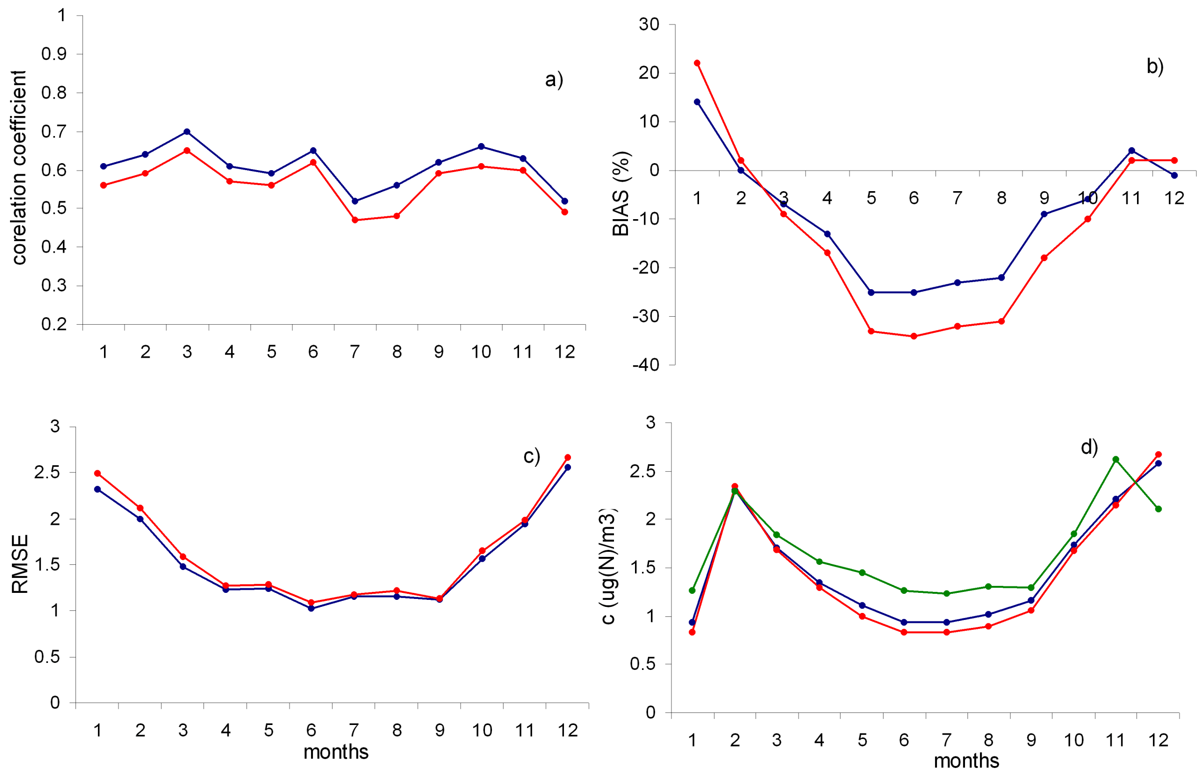
Evaluation in EMEP: NO_2



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K(z) scheme-higher order

- Scheme based on TTE

$$K(z) \approx \frac{2 f_\theta^2 E_k l}{C_\phi \sqrt{E}}$$

- f_θ non.-dim. heat flux
- l- disipation lenght
- C_ϕ empirical const from LES *(Mauritsen et al., 2007)*

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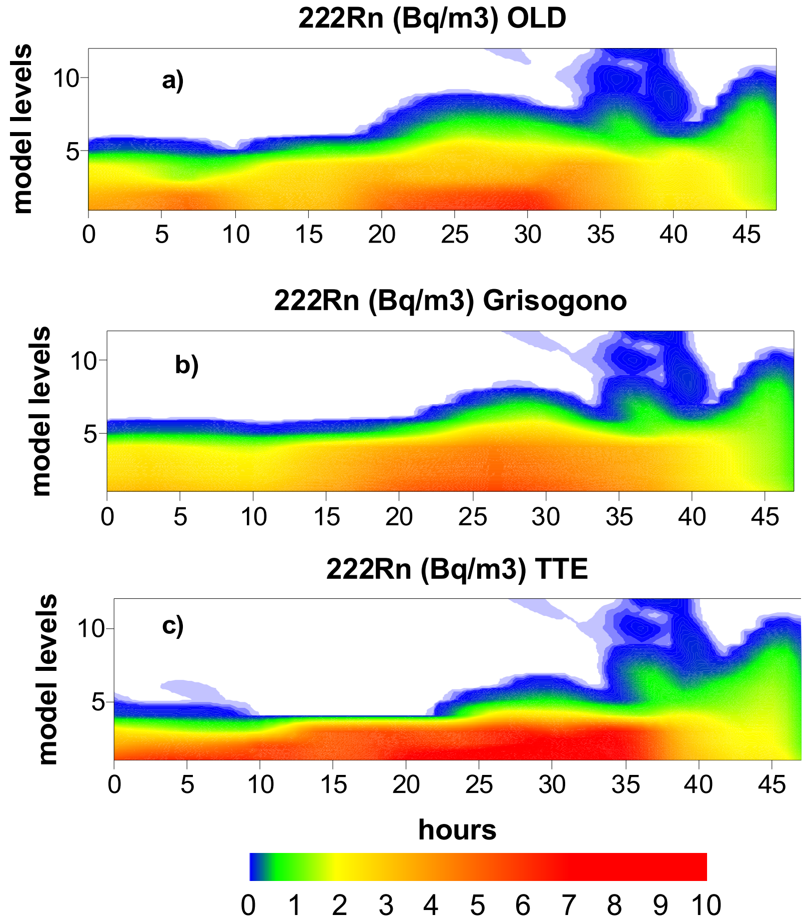
Case study:7-8 November 2006 Cabauw



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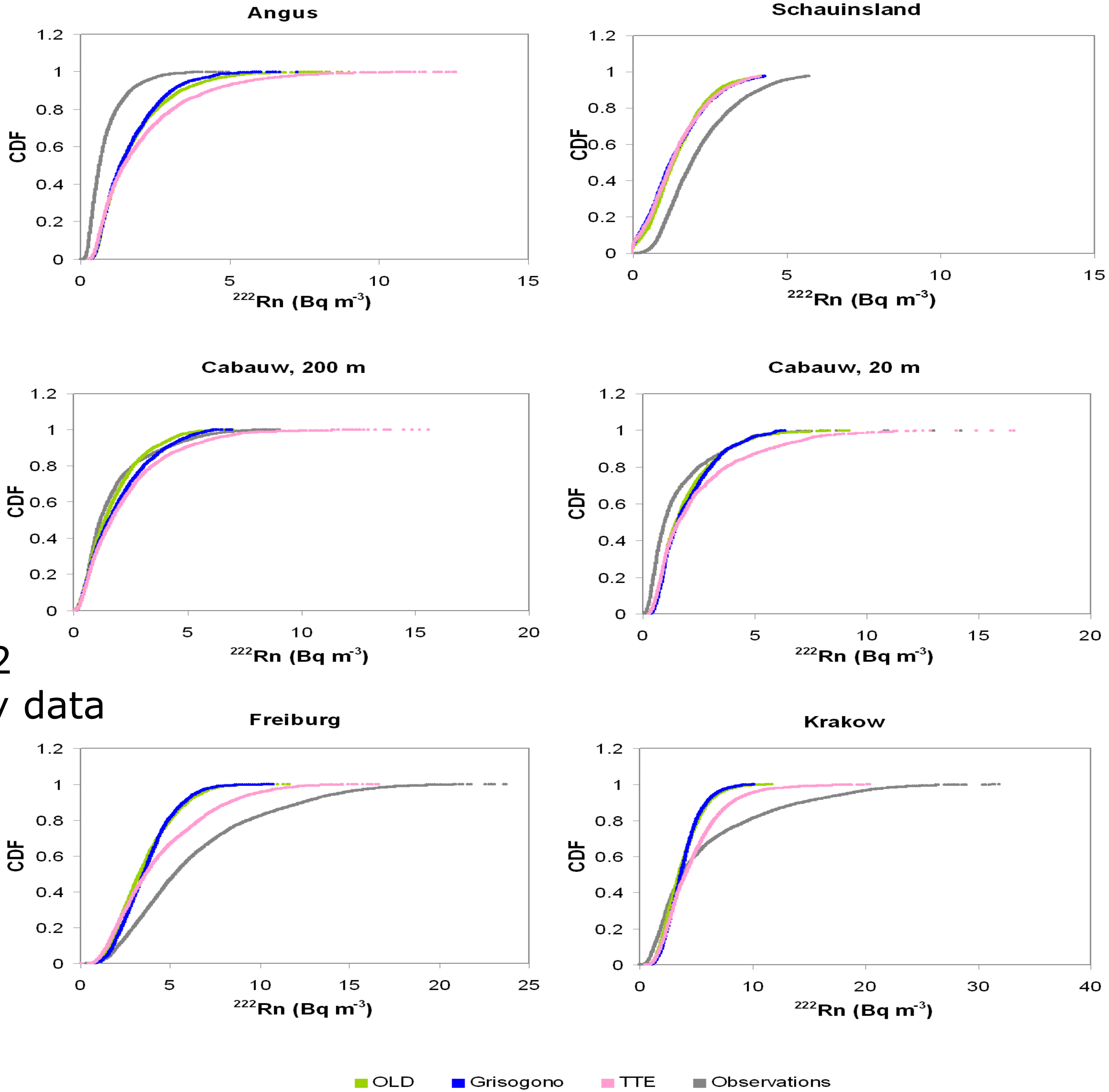
Rn222
hourly data



ABL-

0

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Conclusions

- Improvement proportional to the model robustnes with the Grisogono scheme is evident.
- TTE scheme tend to produce lower mixing ~higher surf. conc.
- The best results at Cabauw-representative for the model, flat terrain
- Further steps: empirical coeff. for CBL for Kh (inclusion of countergradient term) and Km => test in the EMEP and EMEP4HR model to test the effects of different met models/resolution/K(z) schemes on modelling results