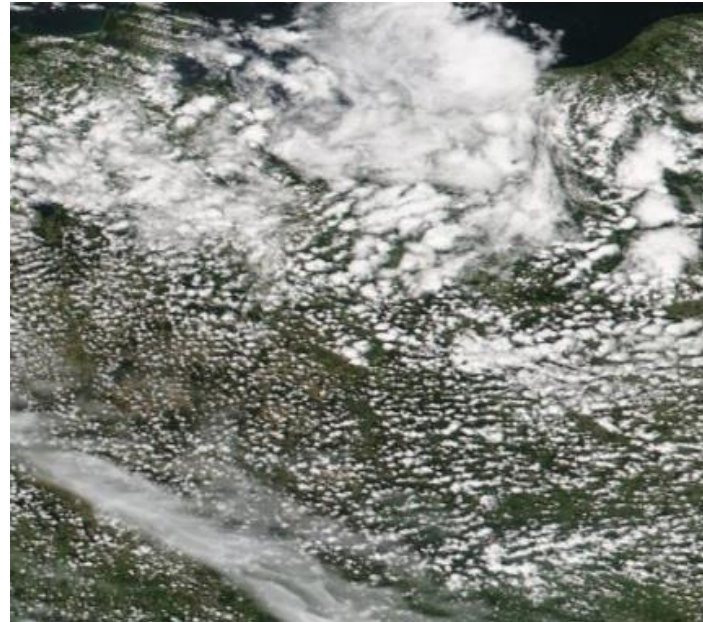


MODIS Aqua

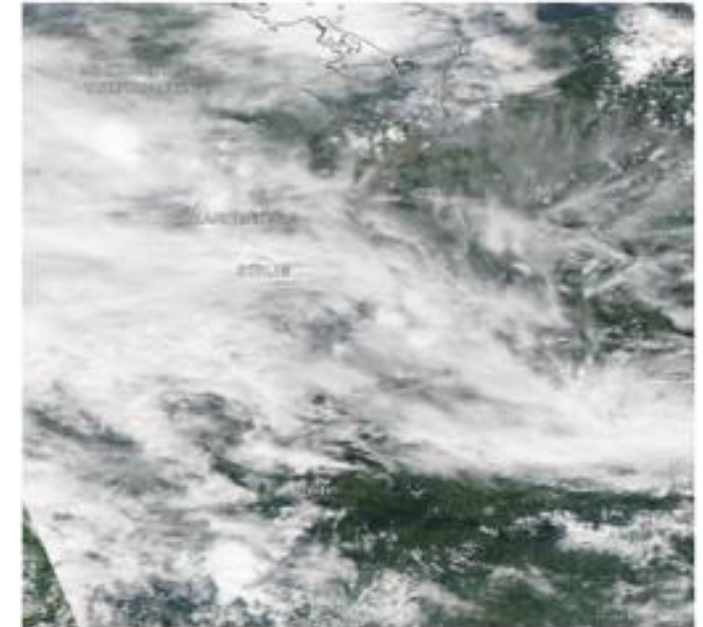
14.6.2021



27.6.2021



29.6.2021



Evaluating ICON-LEM simulations with observations from the FESSTVaL campaign

Maike Ahlgrimm (DWD), Eileen Päsche (DWD), Mirjana Sakradzija (LMU), Chiel van Heerwarden (U Wageningen)

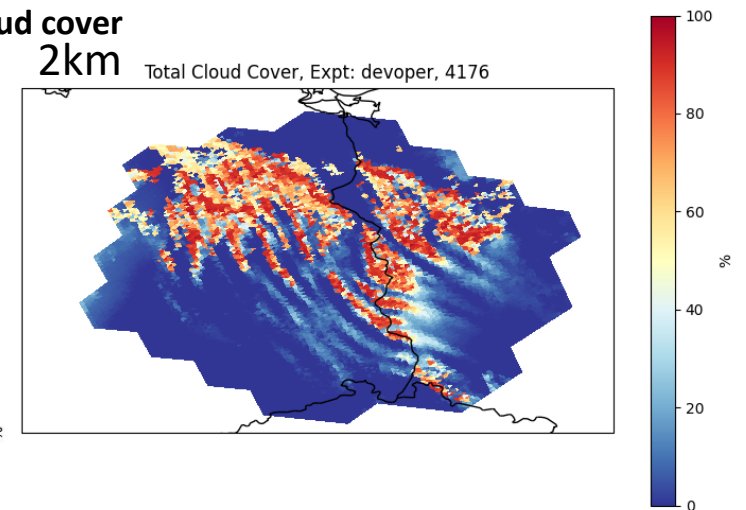
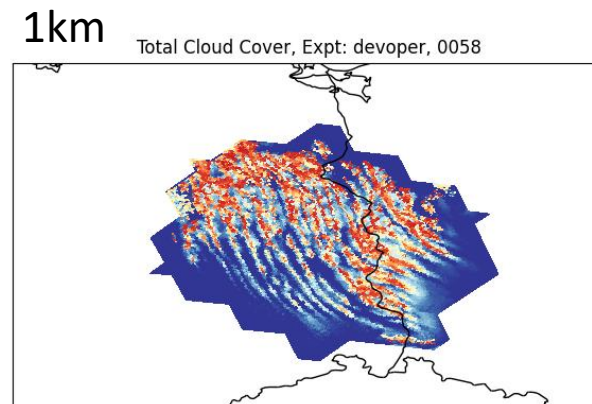
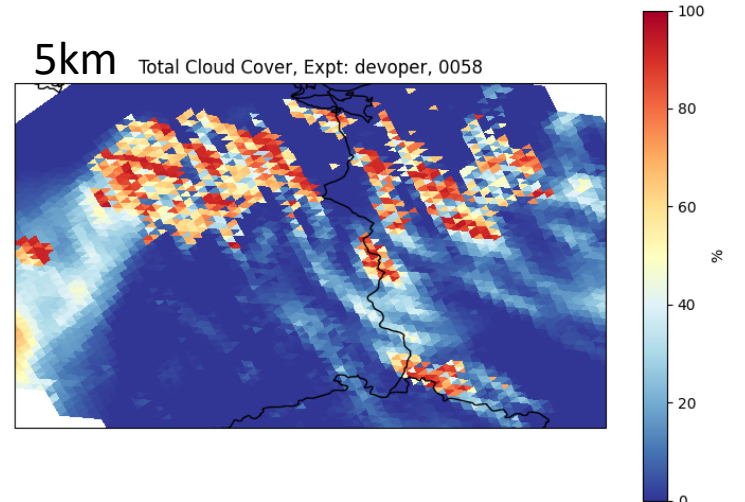
DKRZ levante: `/pool/data/fesstval/`

- All fields needed for experiments:
 - Grids, extpar
 - Initial data
 - Boundary forcing
- Sample run scripts for levante, NEC, Atos
- NWP setups at various resolutions: 1, 2, 5km (EU)
- LEM setups for nesting: **650, 325, 125, 75m** (D2)
- D2 runs
- Shell scripts to retrieve basic obs data (buggy)
- Python scripts to plot quick views

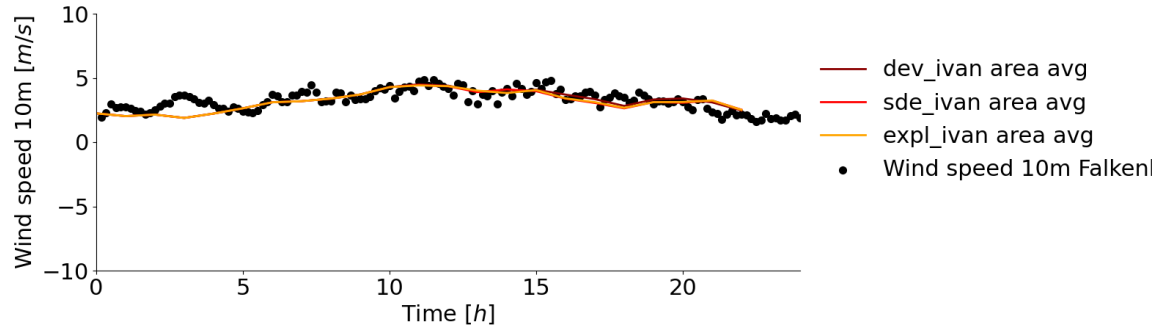
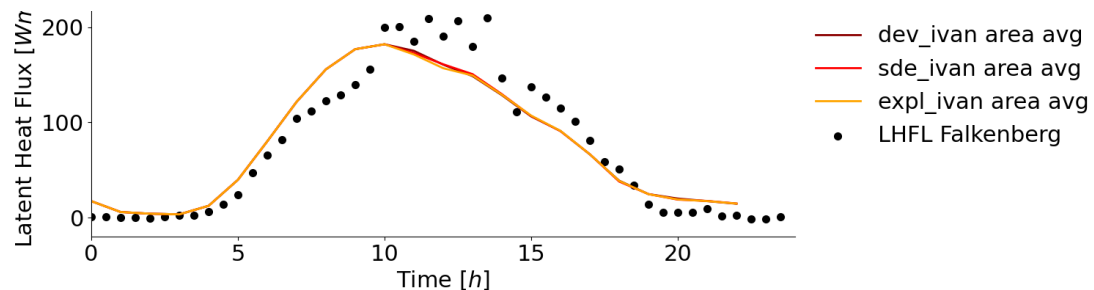
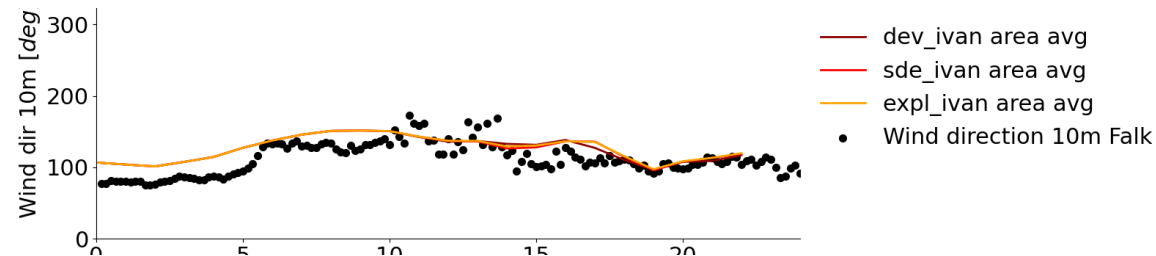
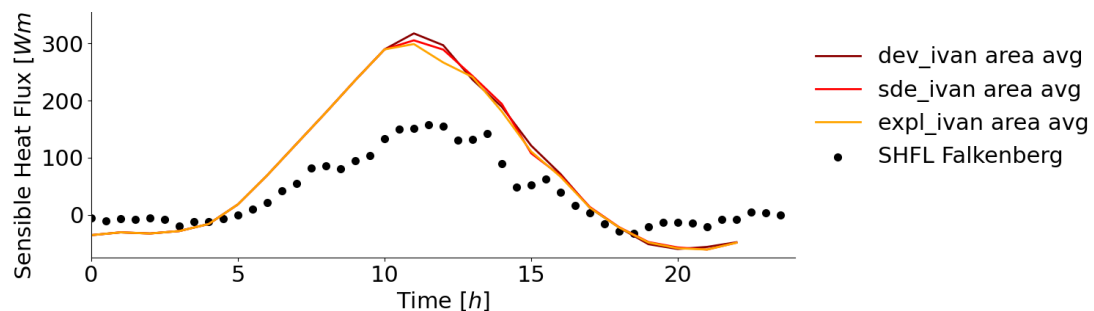
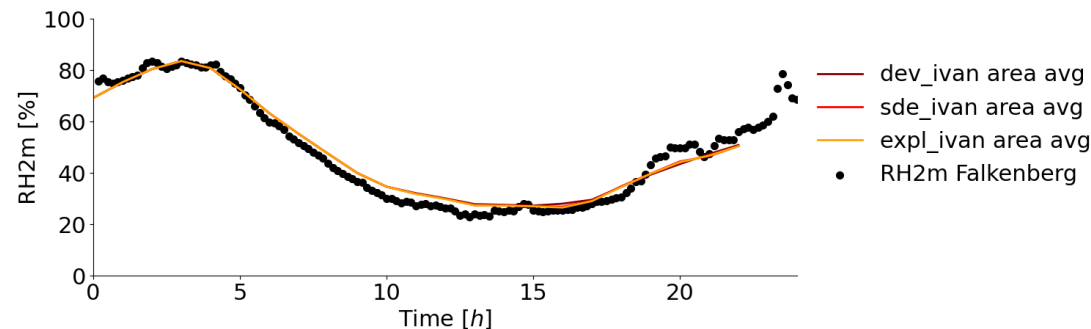
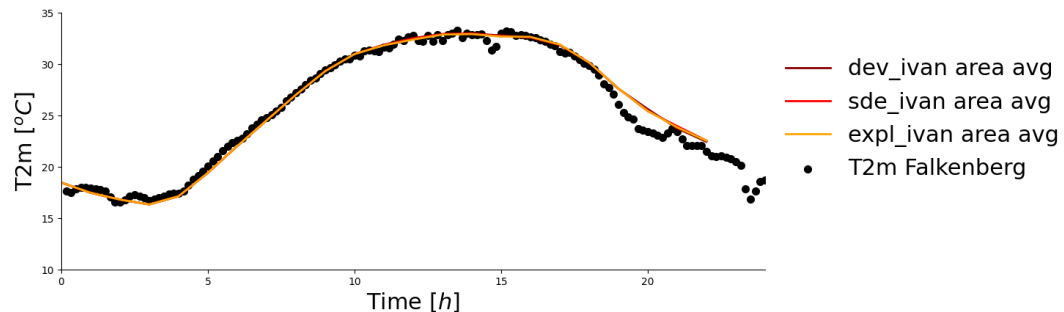
Questions? Ask me!



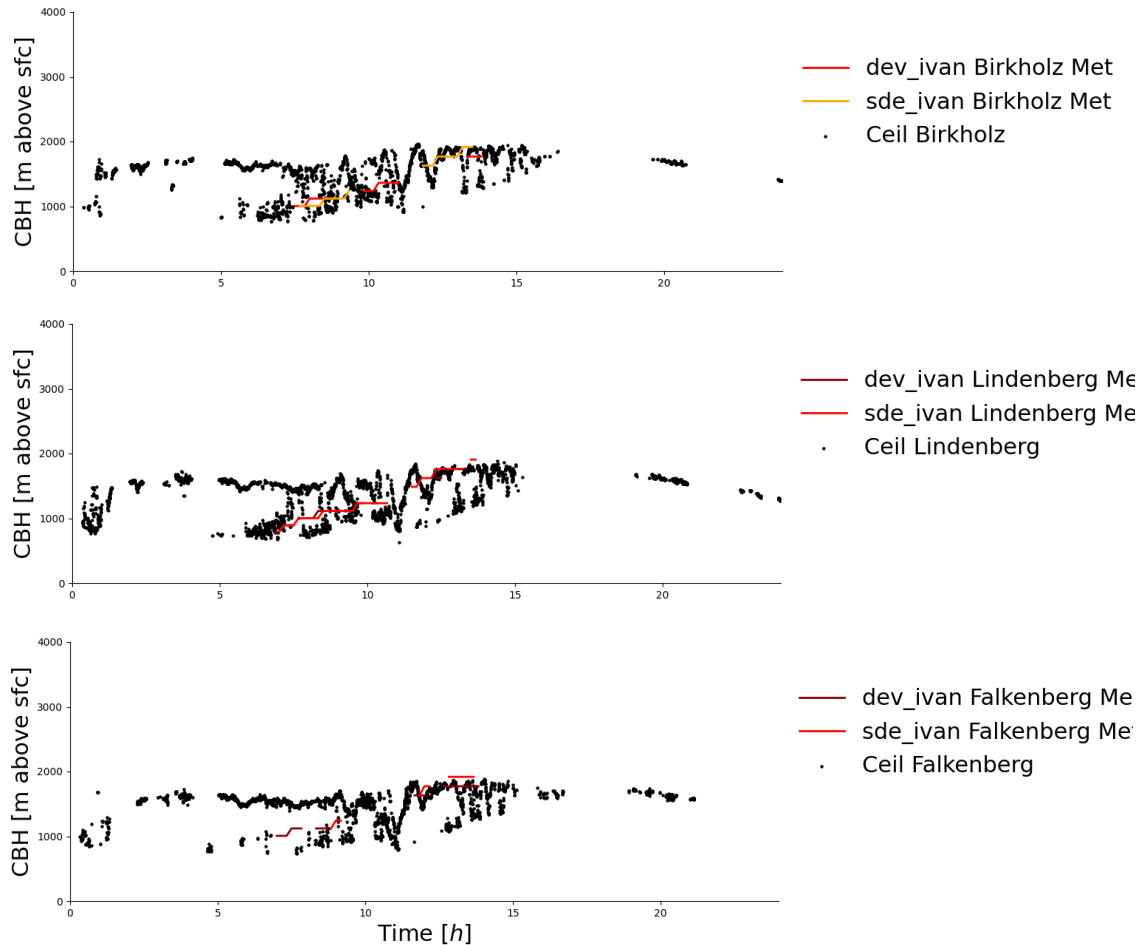
20210617, 11:36UTC, Total cloud cover



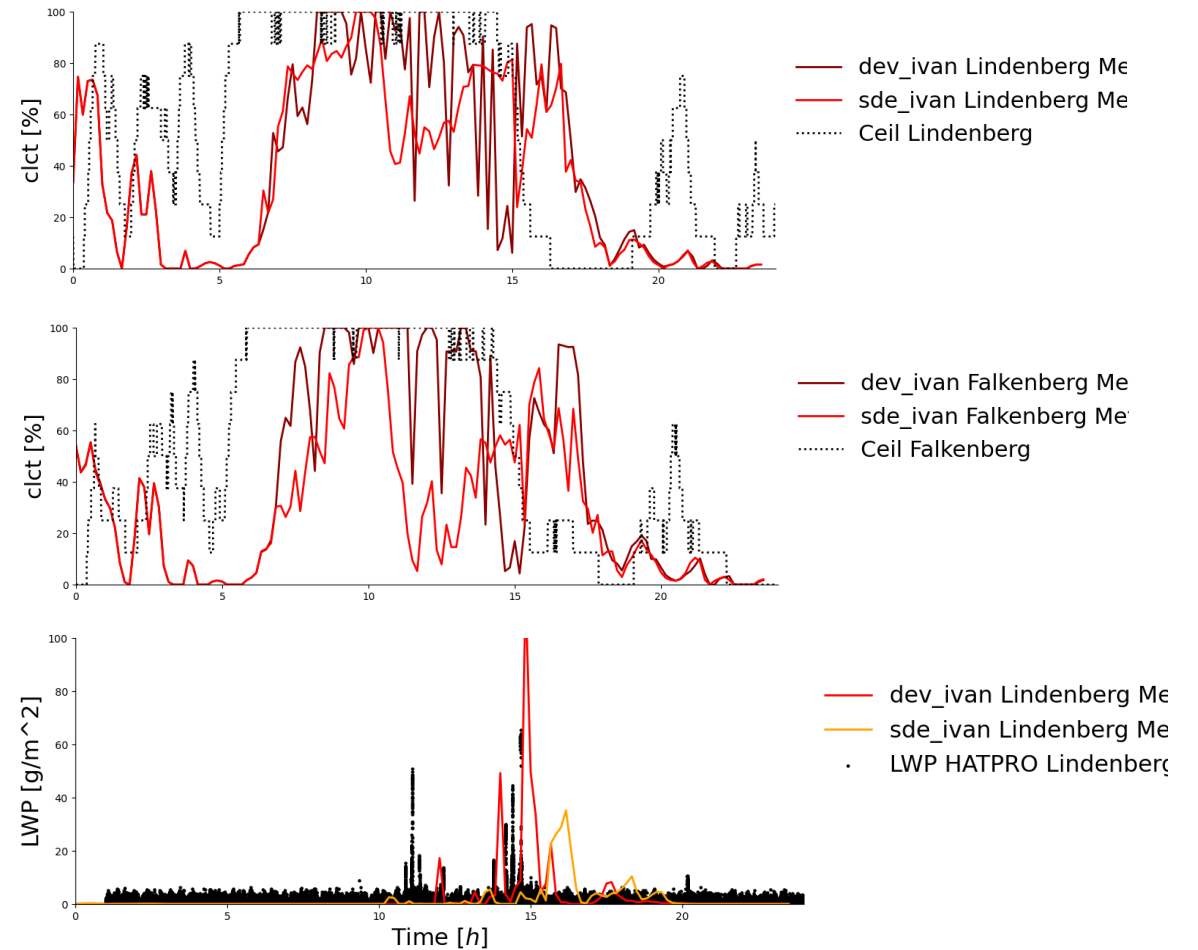
20210617, 2km LAM, comparing three model versions differing in shallow convection at Falkenberg, model output averaged over an area containing all three “supersites”



Cloud base from ceilometer at three supersites
20210613, 2km, 2 model versions, nearest gridpoint



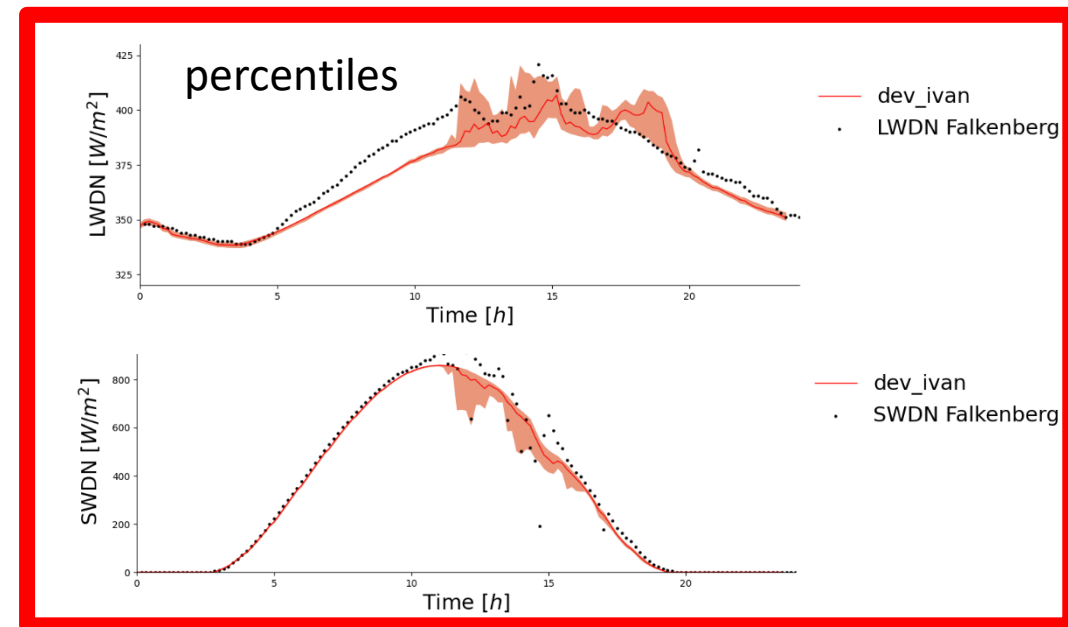
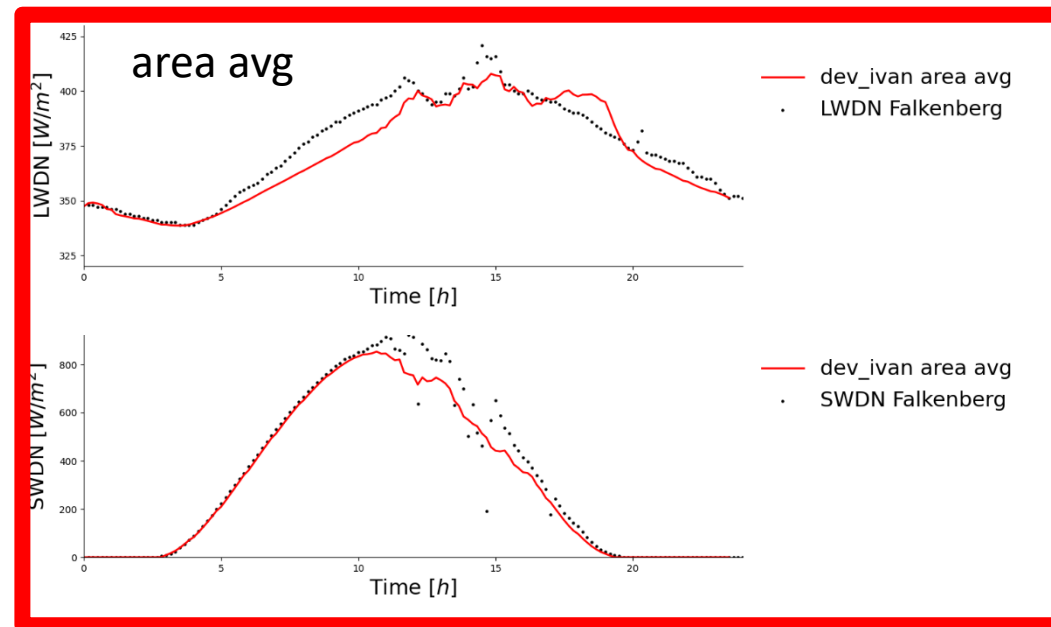
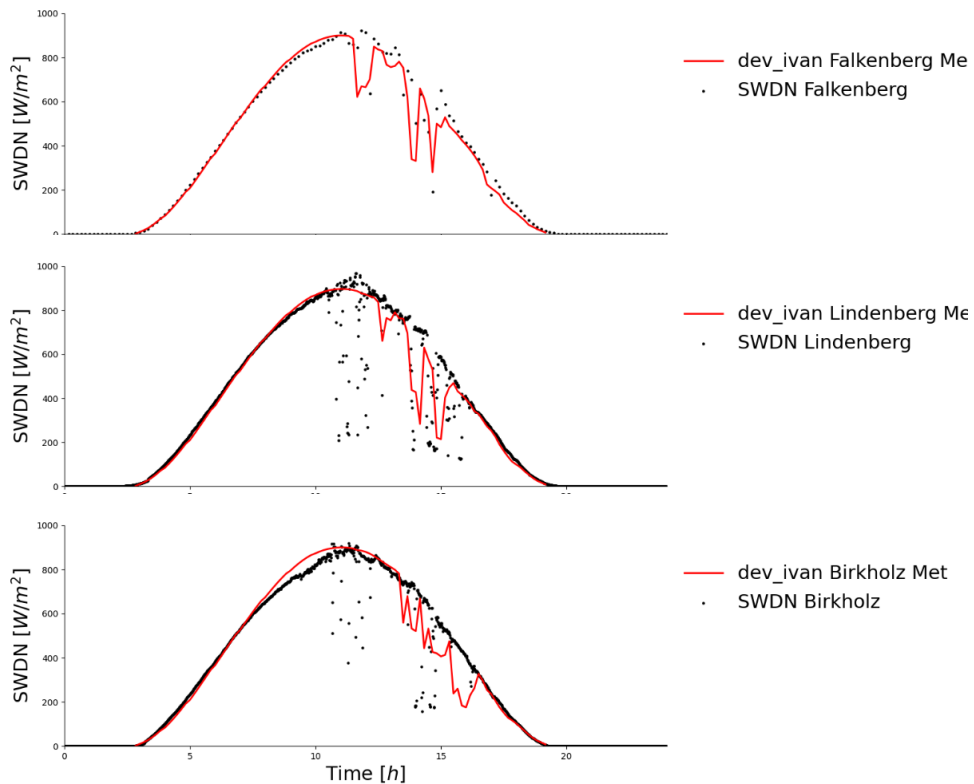
Cloud cover (octa) from ceilometer,
Falkenberg, Lindenberg vs. 2 model versions



Radiation

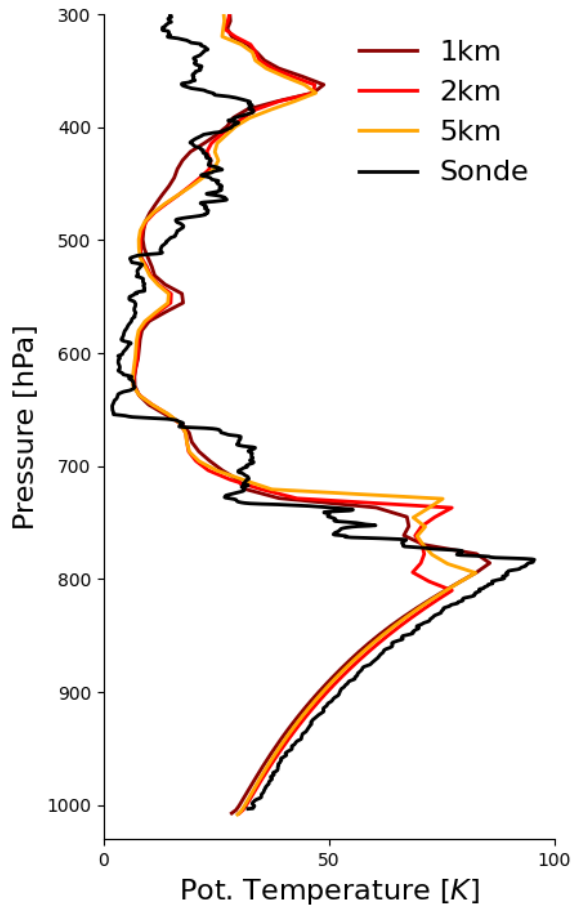
Point output using meteogram – not all variables included

Meteogram



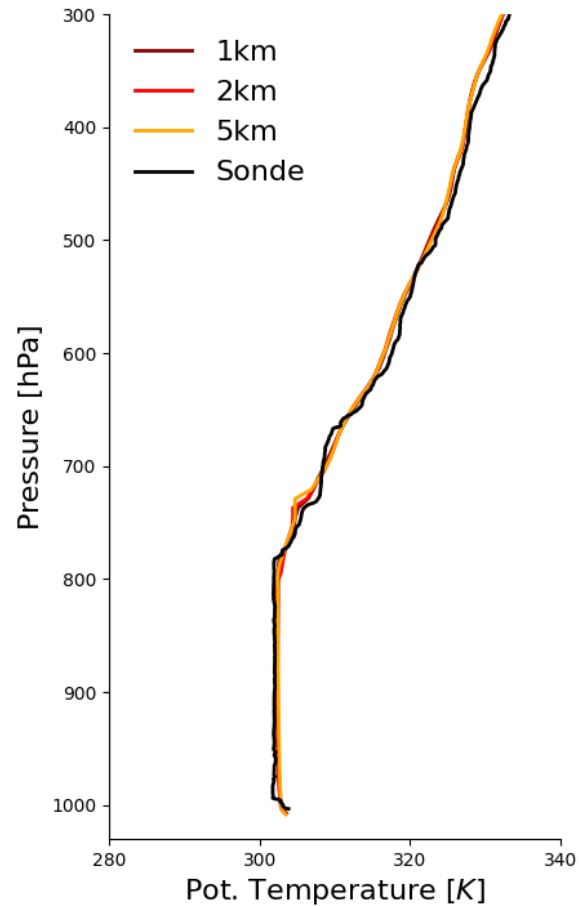
RH

12UTC Falkenberg, 20210617



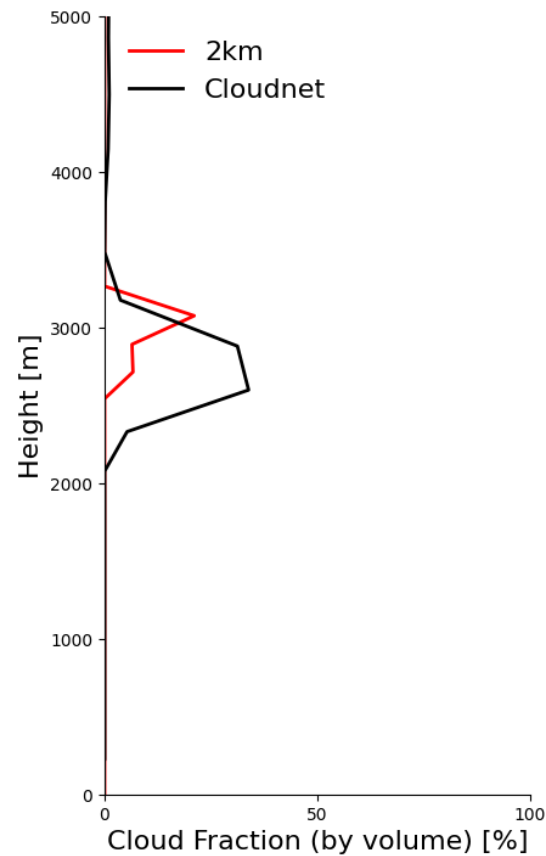
pot. temperature

12UTC Falkenberg, 20210617



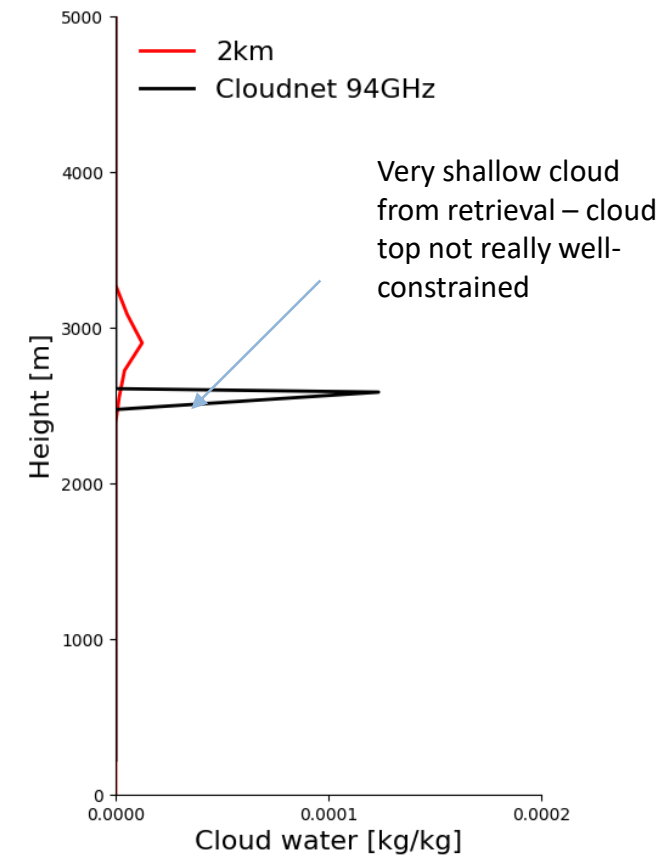
hourly Cloudnet product cloud fraction

14UTC Lindenberg, 20210617



Cloudnet condensate (94GHz radar)

14:10UTC Lindenberg, 20210617



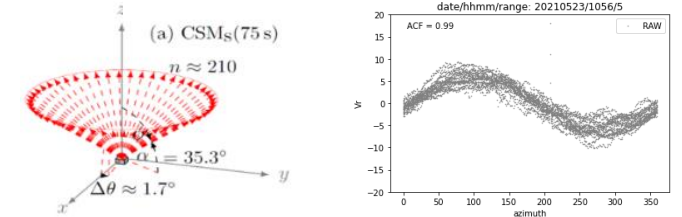
Work by Eileen Päsche, Claudia Becker, Frank Beyrich DWD Lindenberg

➤ turbulence kinetic energy (TKE)

$$TKE = \frac{3}{2} (\overline{\sigma_L^2} + \overline{\sigma_t^2} - \overline{\sigma_e^2})$$

correction terms

$$\overline{\sigma_L^2} \sim \int_0^{2\pi} \langle v_r'^2 \rangle d\theta \quad , \text{Kropfli (1985)}$$



➤ dissipation rate ϵ

$$\sigma_t^2 = \epsilon^{2/3} F(\Delta y_k) \quad \overline{D_a}(\psi_l) = \epsilon^{2/3} A(l\Delta y_k)$$

structure function based on real measurements

$$\overline{D_a}(\psi_l) \sim \int_0^{2\pi} \langle [v_r'(\theta_m + \psi_l) - v_r'(\theta_m)]^2 \rangle d\theta$$

mit: $\psi_l = l \Delta\theta$

$$\sigma_e = \sqrt{[\overline{D_L}(\psi_l) - \epsilon^{2/3} A(\Delta y_k)]/2}$$

$$\equiv \sqrt{\frac{\overline{D_L}(\psi_l) A(l\Delta y_k) - \overline{D_L}(\psi_l) A(\Delta y_k)}{2[A(l\Delta y_k) - A(\Delta y_k)]}}$$

(based on Kolmogorov theory)

➤ integral scale of turbulence L_V

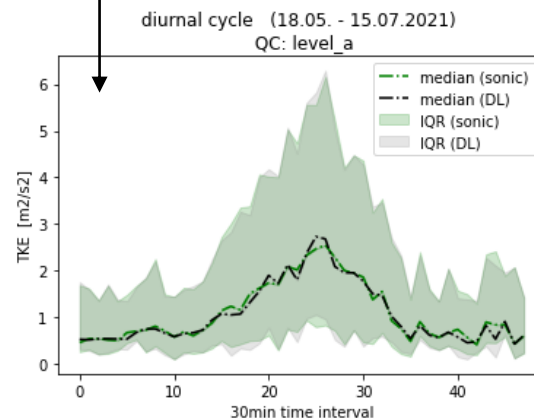
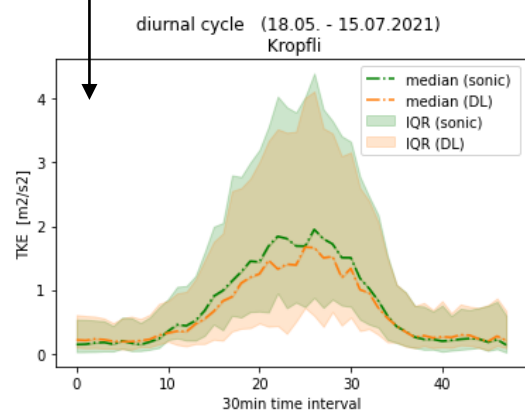
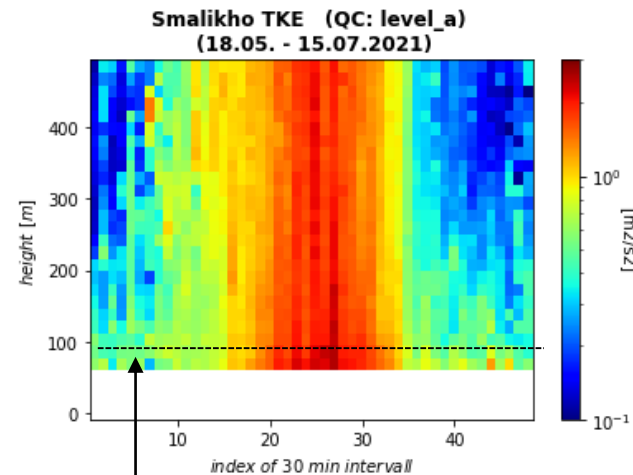
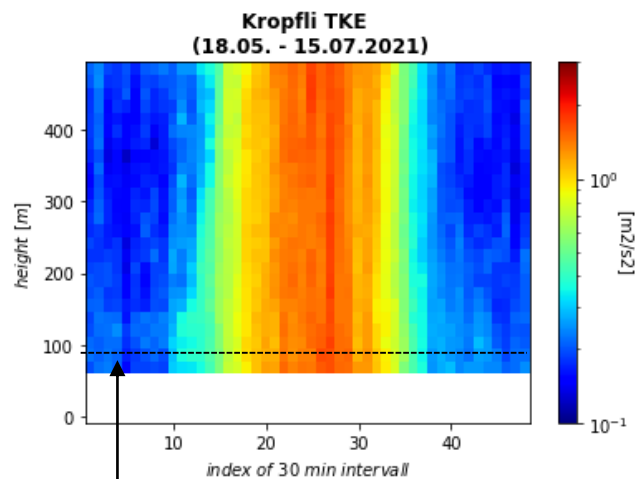
$$L_V \sim TKE^{3/2} / \epsilon$$

➤ momentum fluxes $\langle uw \rangle, \langle vw \rangle$

$$\langle uw \rangle + j \langle vw \rangle \sim \int_0^{2\pi} \langle v_r'^2 \rangle \exp(j\theta_m - wdir) d\theta$$

$$TKE = \frac{3}{2} (\overline{\sigma_L^2} + \overline{\sigma_t^2} - \overline{\sigma_e^2})$$

correction terms (Smalikho and Banakh, 2017)

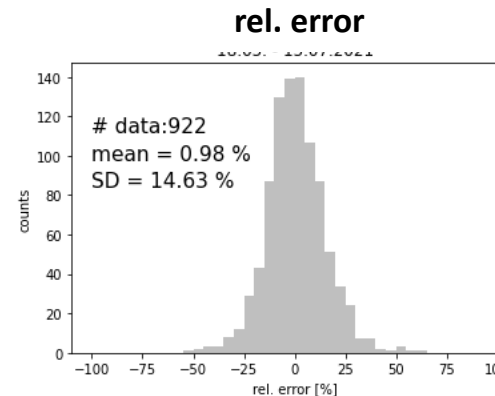
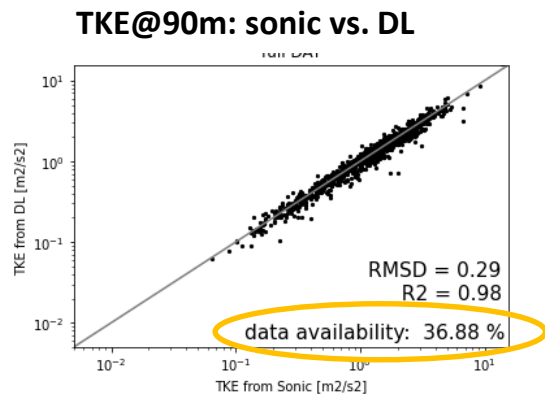
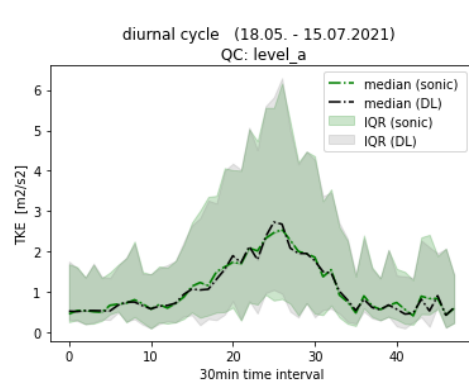


mean diurnal cycle, 18.05. – 15.07.2021

- good agreement with sonic data at 90m height during the diurnal cycle

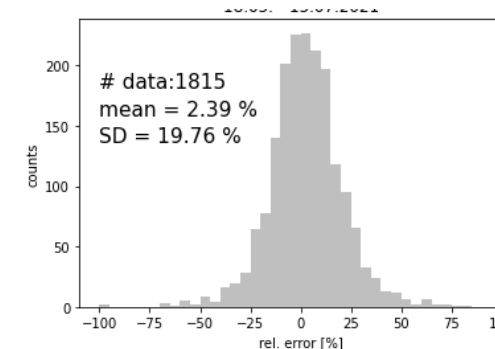
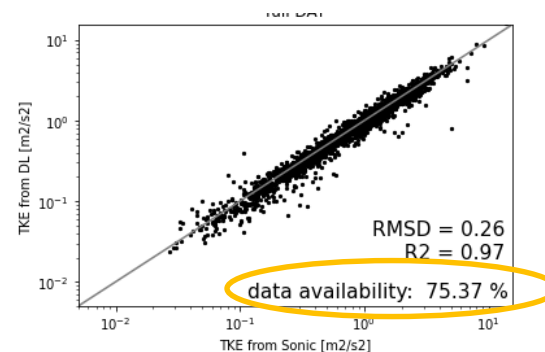
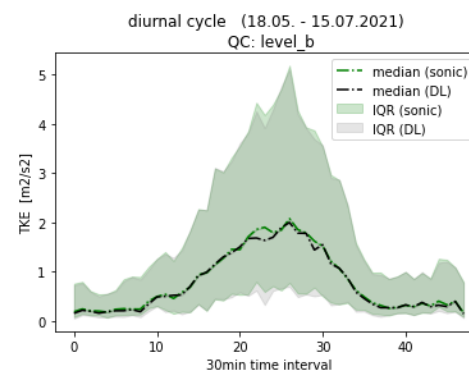
- use of quality flag depends on the demands on the data quality

QC:
turb_flag_lev_a



- small error & low data availability

QC:
turb_flag_lev_b



- high data availability & large error

What **proportion** of the TKE is **subgrid-scale** (and therefore parameterized) vs. **grid-scale** in the model?

Nested ICON LEM simulations (forced by D2) with 650, 325, 150, 75m resolution.

→ Right in the middle!

Calculating the **grid-scale** TKE from 75m run

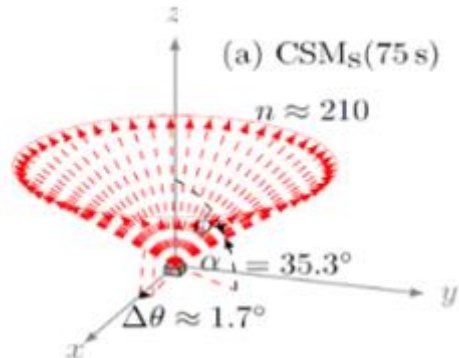
What is an appropriate spatial scale to average over?

8x8 grid points (~600m)

Subgrid scale

NWP setup with **Turbdiff**: is prognosed

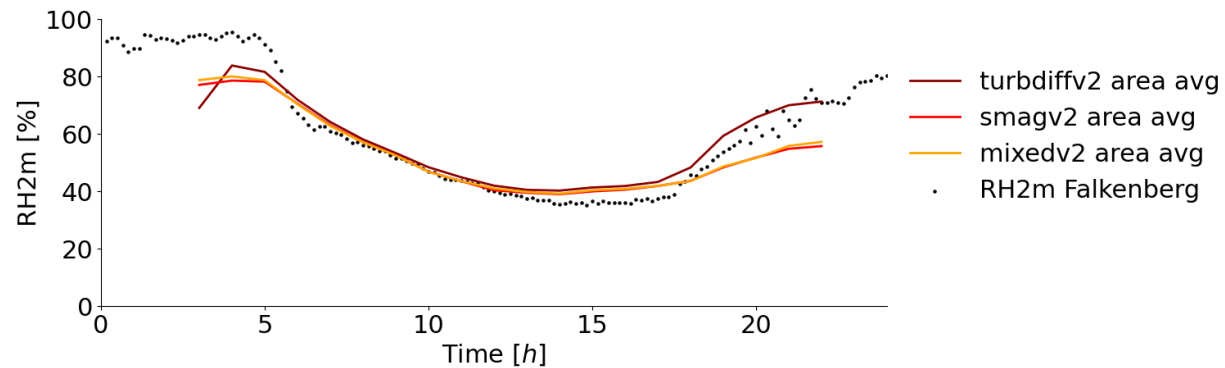
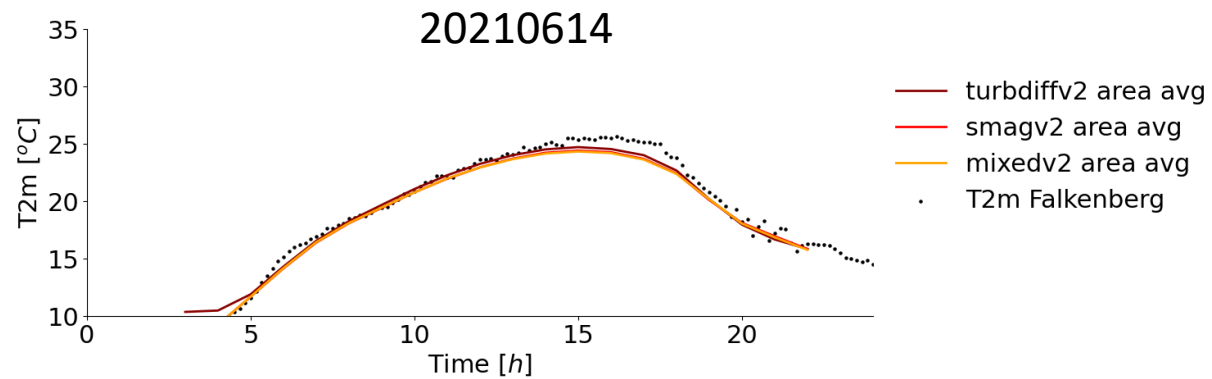
LES setup with **Smagorinsky**: needs to be diagnosed



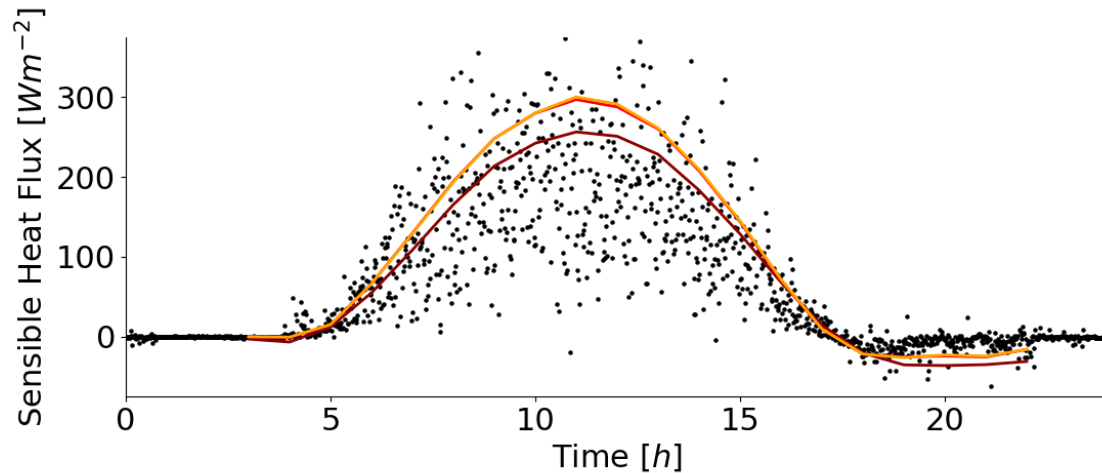
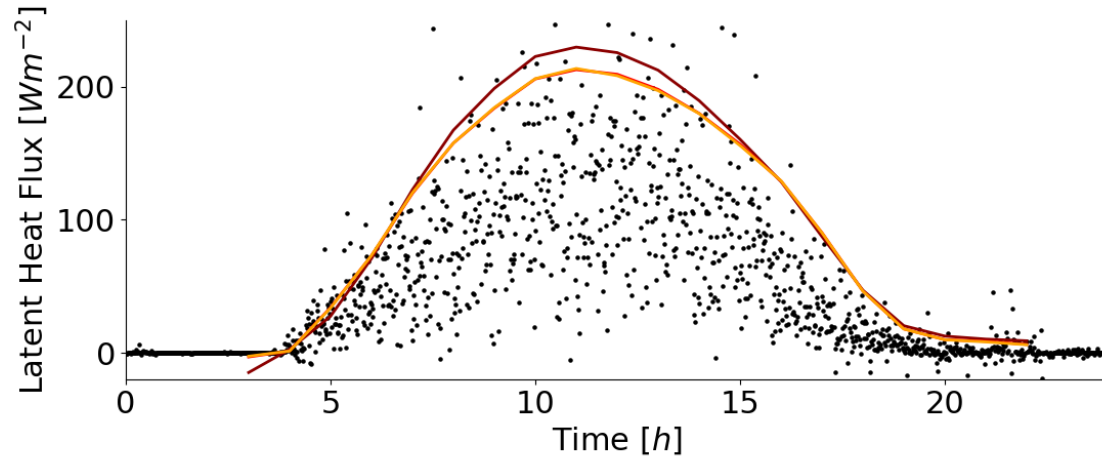
Turbdiff on all domains, **Smagorinsky** on all domains, Turbdiff on DOM01, Smagorinsky on DOM2-4 (“mixed”)

Innermost domain (DOM04), simulation start 03UTC

Evening transition appears to be worse with Smagorinsky



IGNORE THE BLACK DOTS!

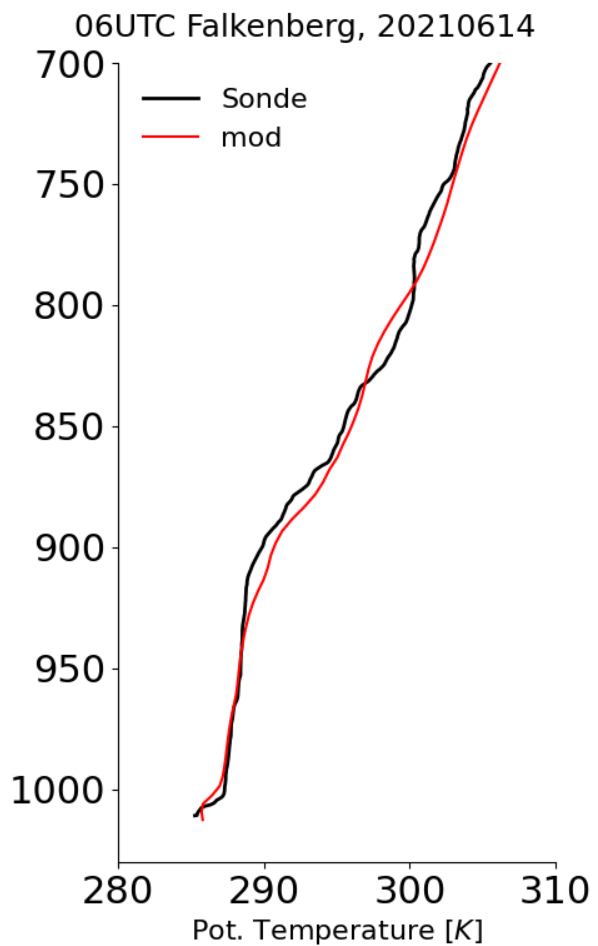


Smagorinsky has more sensible, less latent heat flux compared to Turbdiff. Transfer scheme?

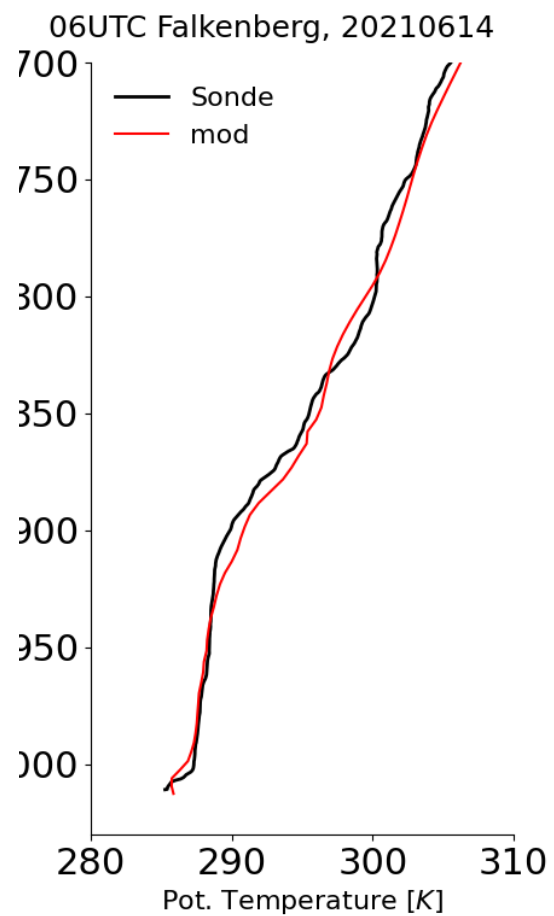
Impact on BL growth?

turbdiffv2

06UTC

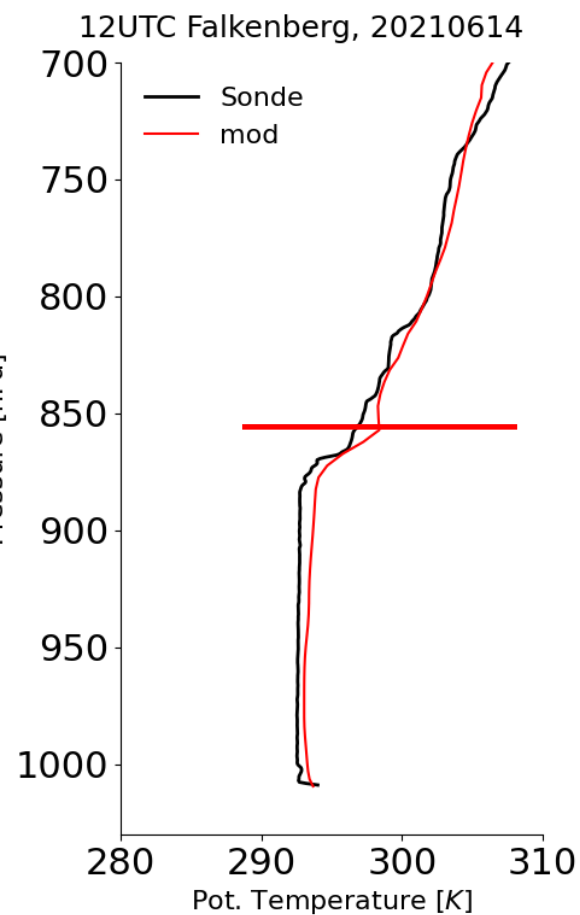


smagv2

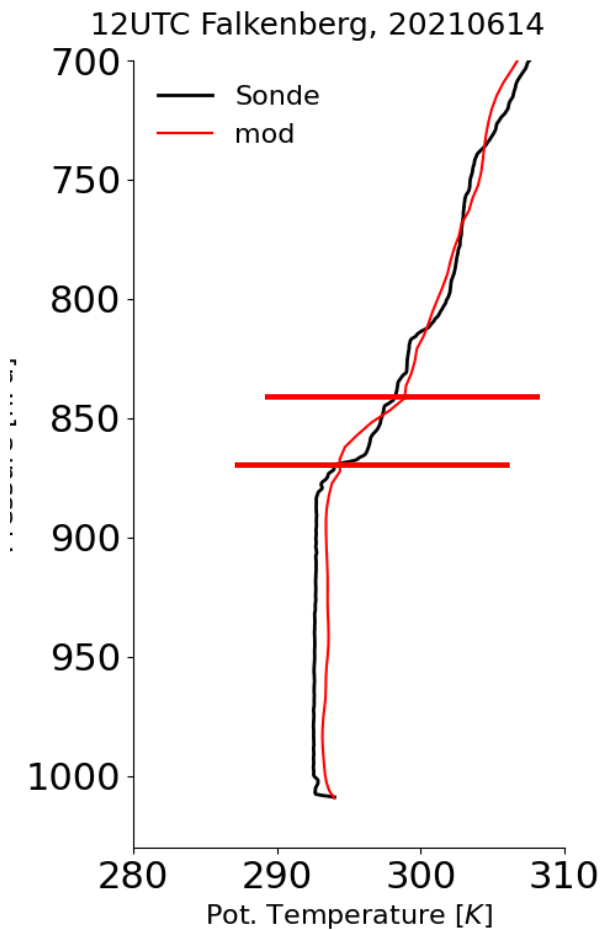


turbdiffv2

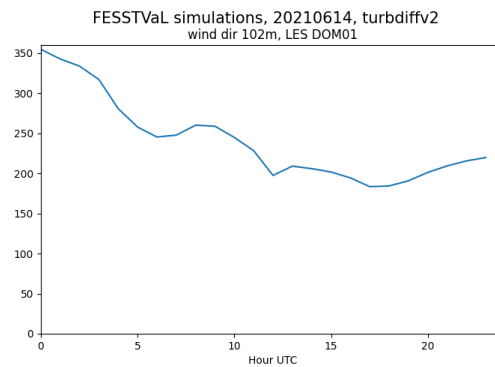
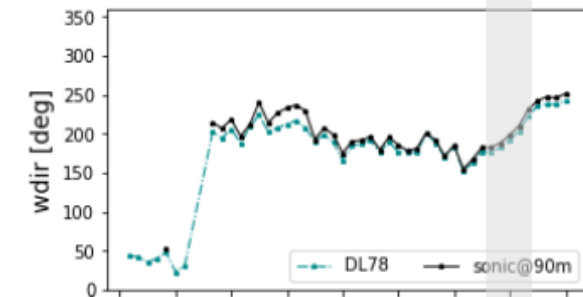
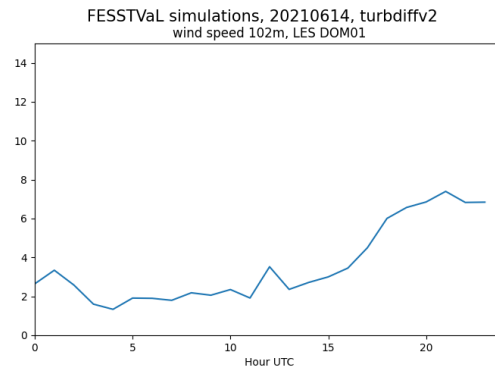
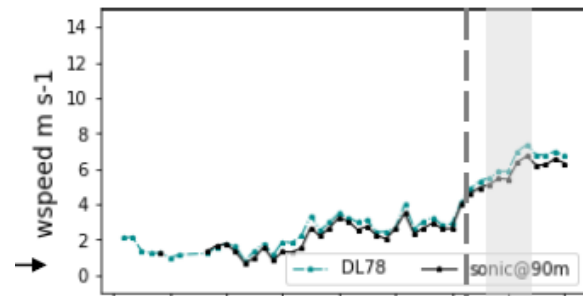
12UTC



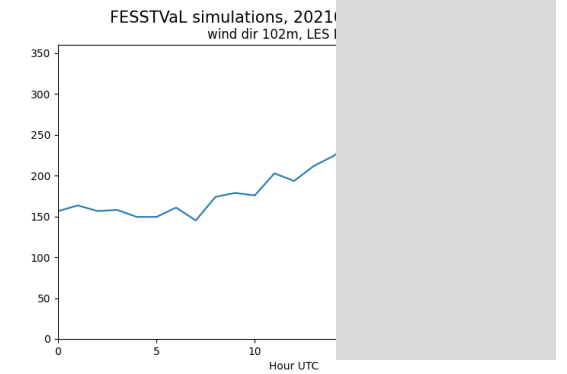
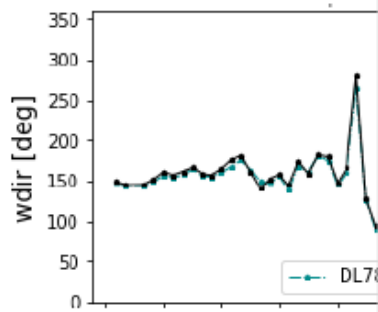
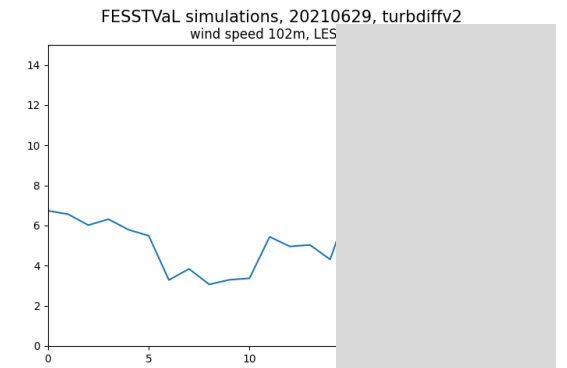
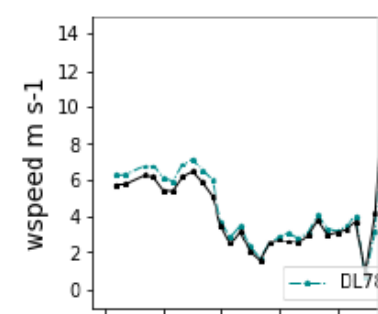
smagv2



20210614



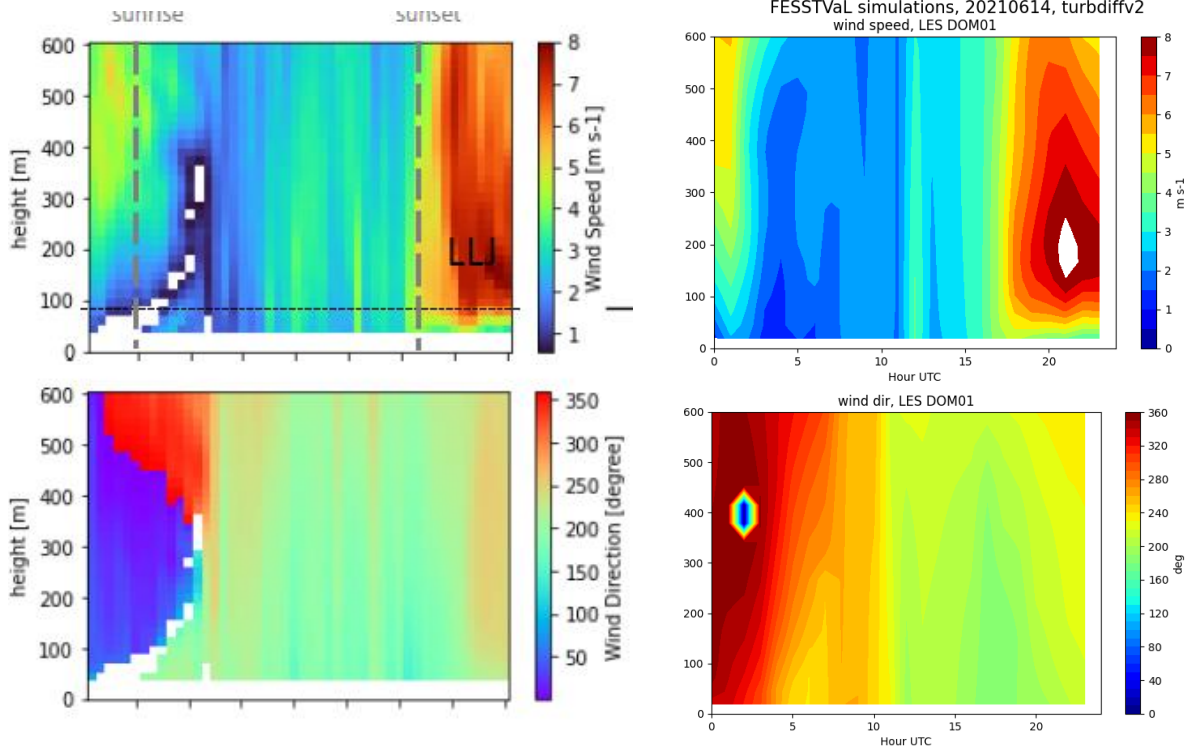
20210629



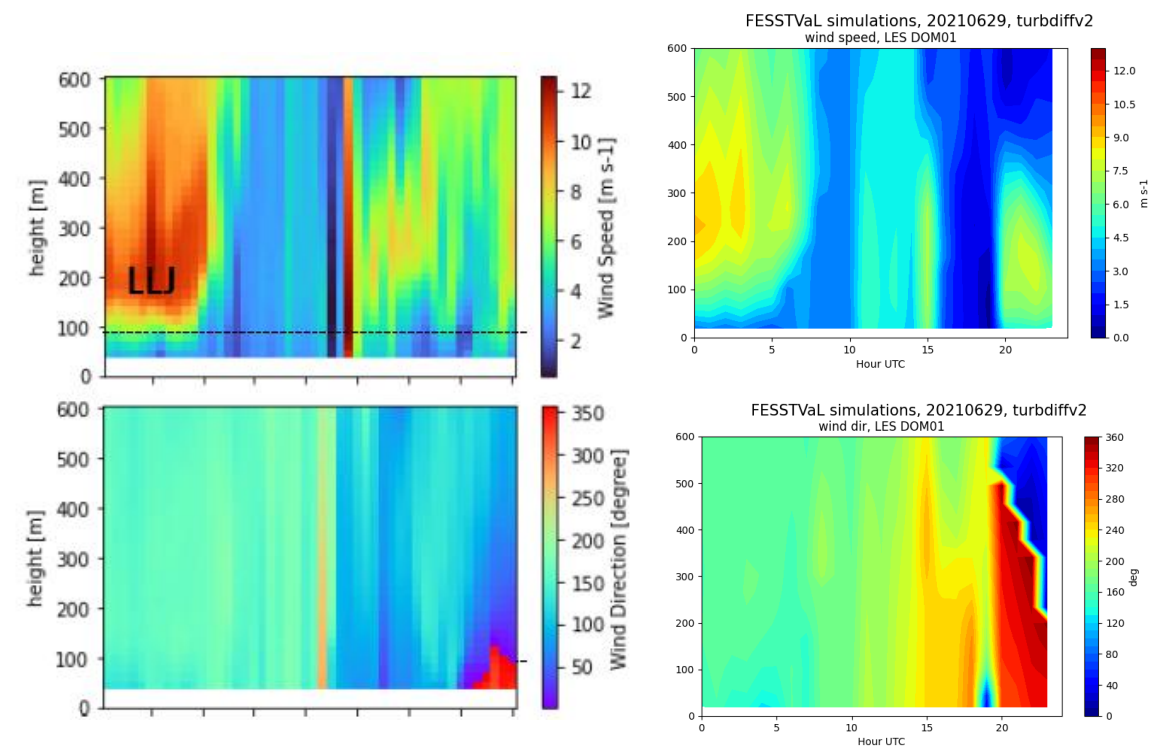
good agreement between DL product and sonic from mast

second half of the day not representative due to cold pools

20210614

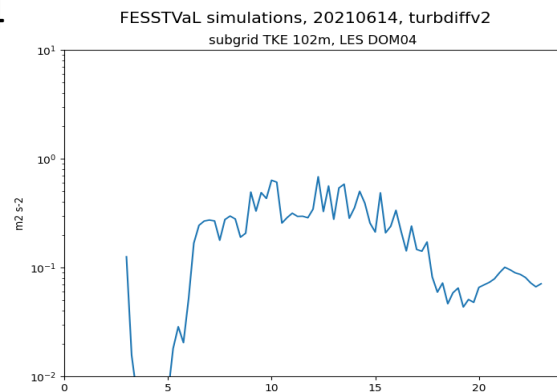
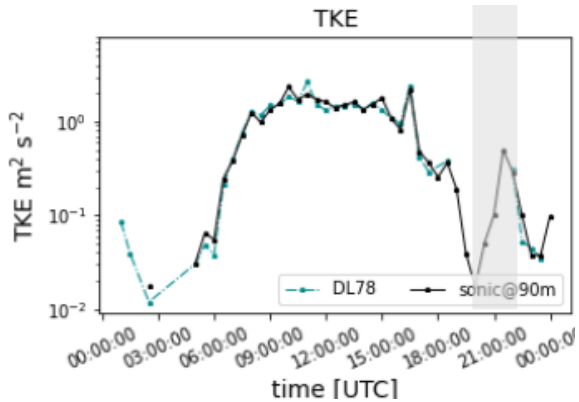


20210629

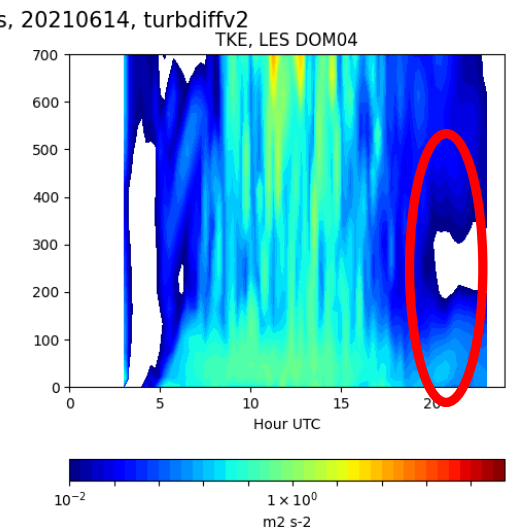
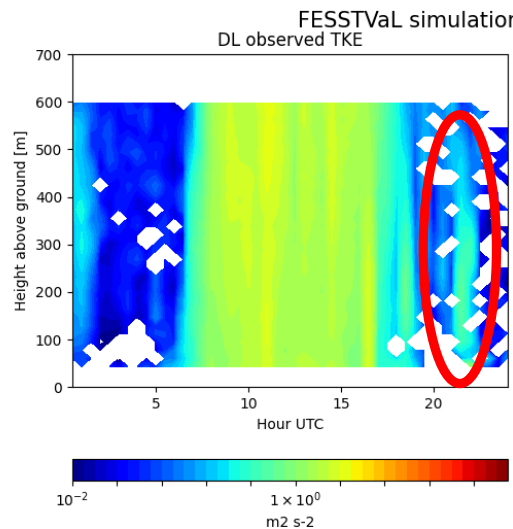
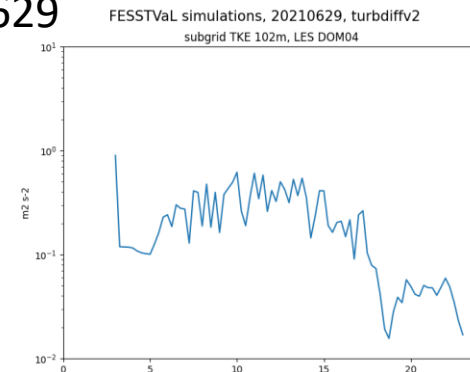
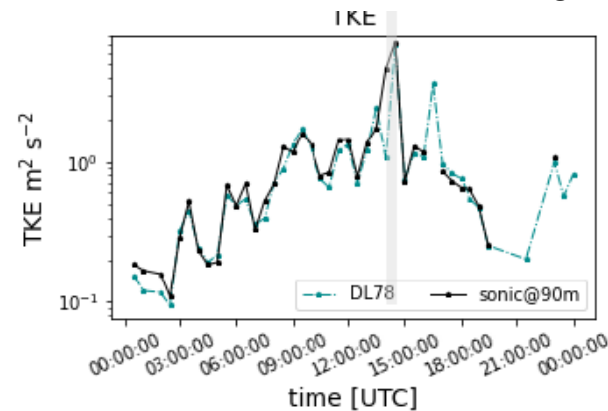


Interesting features: Low level jets!

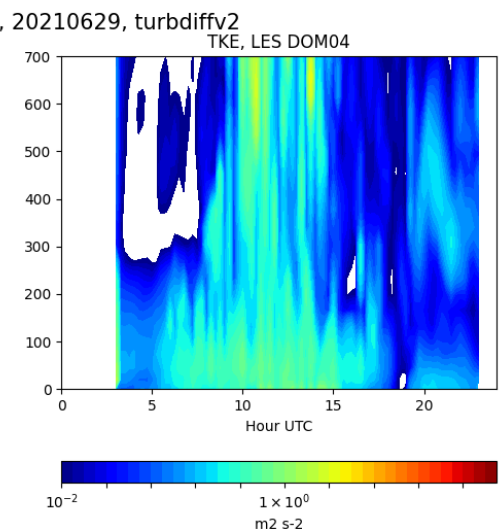
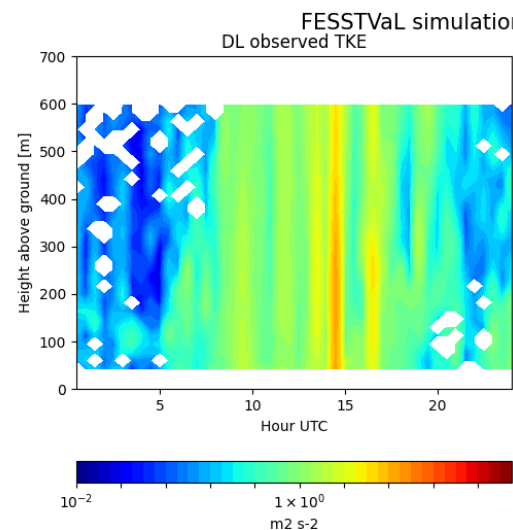
20210614



20210629



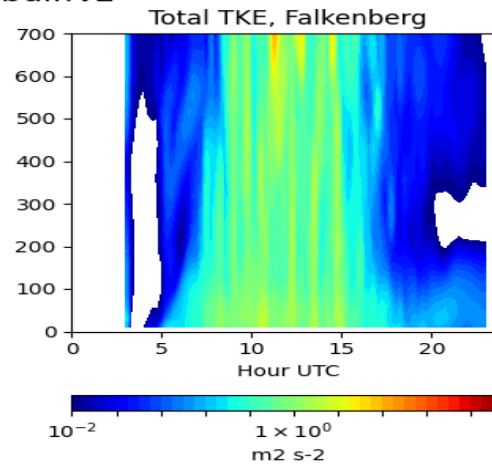
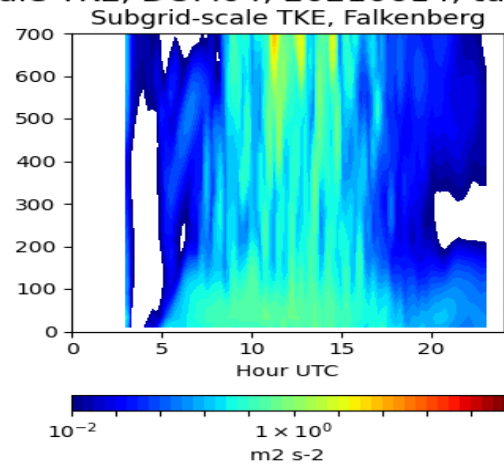
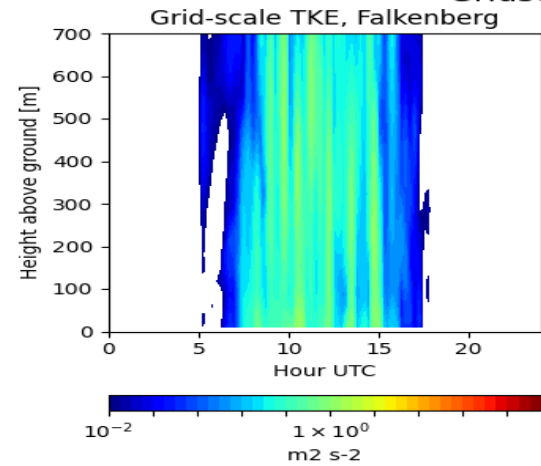
subgrid-scale TKE



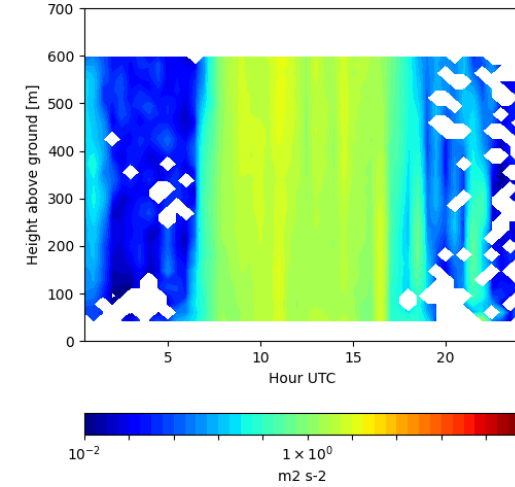
subgrid-scale TKE

20210614

Gridscale TKE, DOM04, 20210614, turbdiffv2

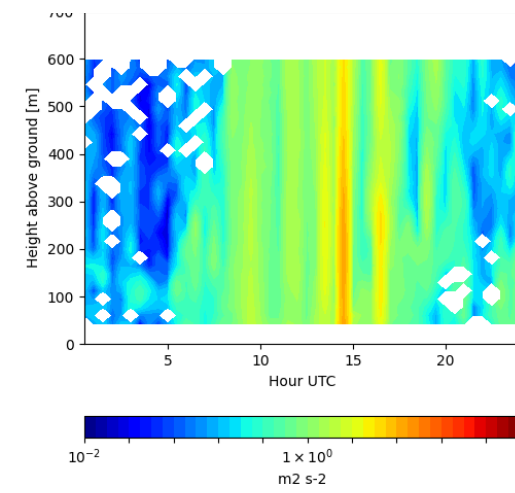
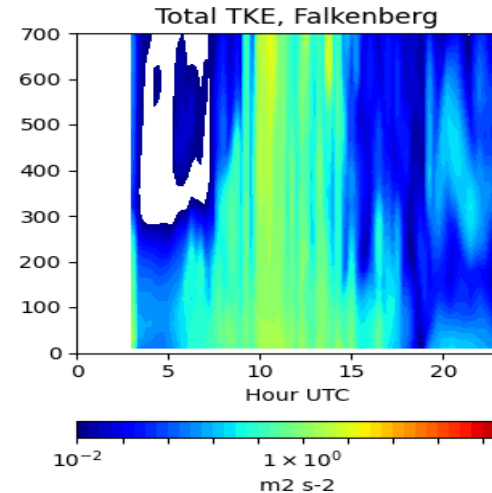
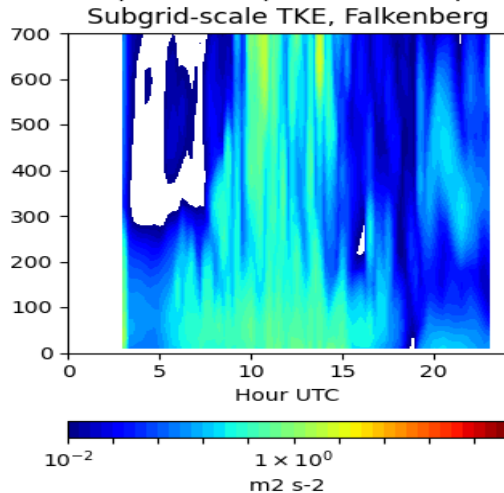
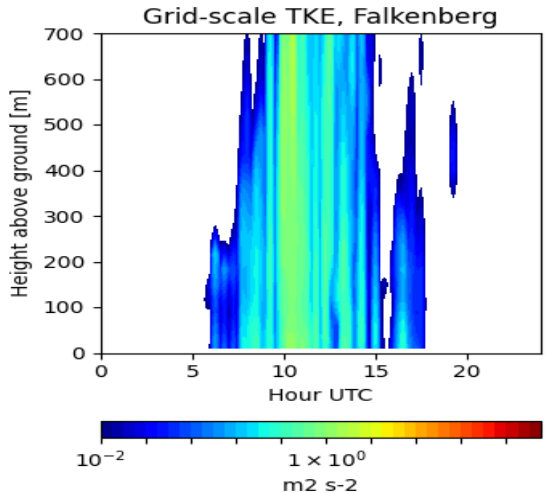


FESSTVaL simulations, 20210614. turbdiffv2
DL observed TKE



20210629

Gridscale TKE, DOM04, 20210629, turbdiffv2



grid-scale TKE

subgrid-scale TKE

total TKE

obs DL

- Why is absolute TKE value lower in model?
- Why is there so little TKE associated with jet in model (and only close to surface)?
- Why is there so much TKE associated with jet in the observations up to 500m? Which process generates TKE?
- Why does grid scale TKE profile shape not compensate for subgrid-scale shape?

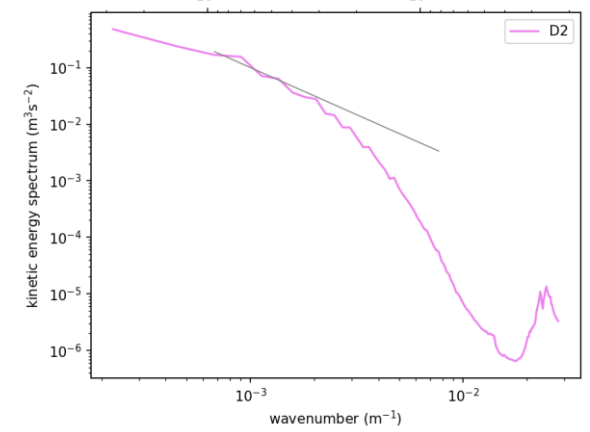
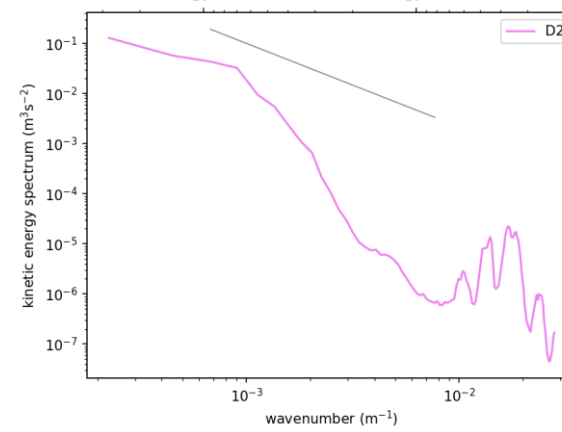
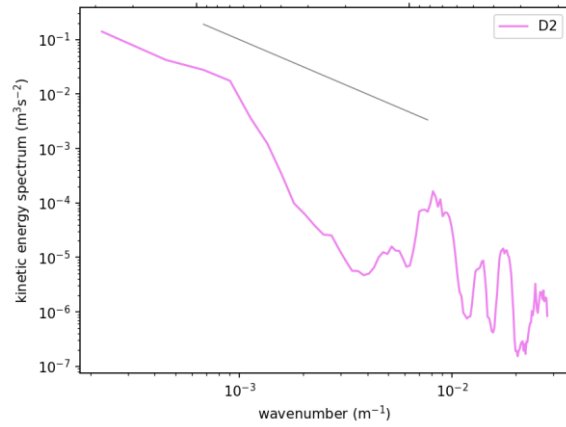
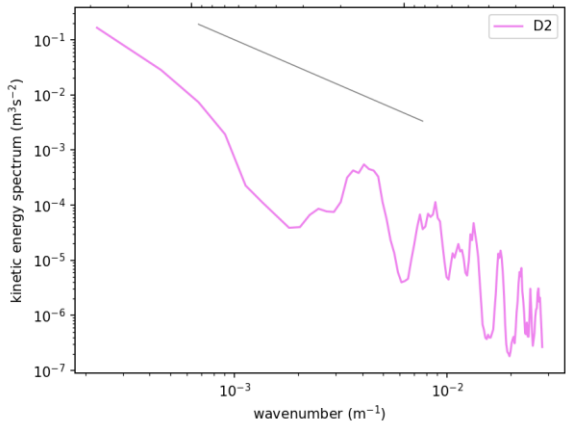
USE FESSTVaL!

Powerspectrum ICON-D2, 20210614
wavelength (km)

Powerspectrum ICON-D2, 20210614
wavelength (km)

Powerspectrum ICON-D2, 20210614
wavelength (km)

Powerspectrum ICON-D2, 20210614
wavelength (km)



Powerspectrum ICON-D2, 20210629
wavelength (km)

Powerspectrum ICON-D2, 20210629
wavelength (km)

Powerspectrum ICON-D2, 20210629
wavelength (km)

Powerspectrum ICON-D2, 20210629
wavelength (km)

