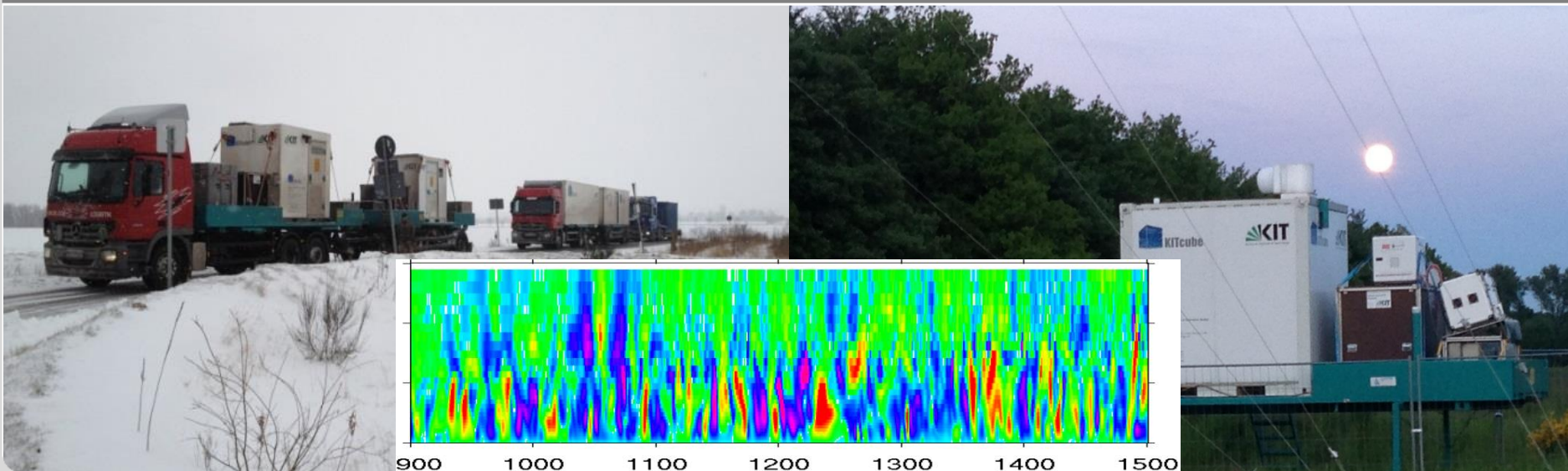


Very high-resolution modeling with COSMO focusing on land surface impacts

Leonhard Gantner, Norbert Kalthoff, Vera Maurer

Acknowledgements: Jürgen Helmert, Uli Blahak, DWD and Rieke Heinze, IMUK Hannover

Institute for Meteorology and Climate Research



Motivaton and Overview

Motivation:

In HD(CP)² runs with up to 100 m grid point distance are planned with ICON-LES

In NWP and climate applications coarser resolution is used

What is effect of resolution of land surface parameters?

Overview:

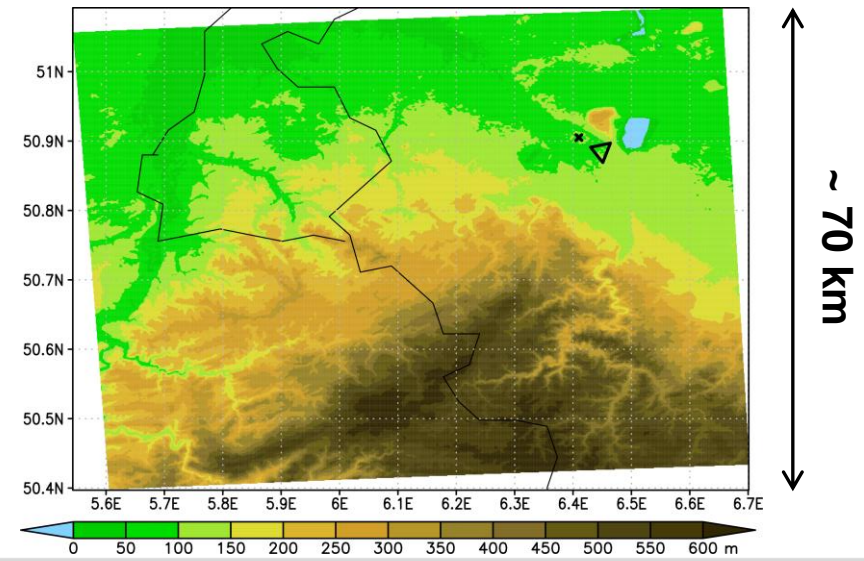
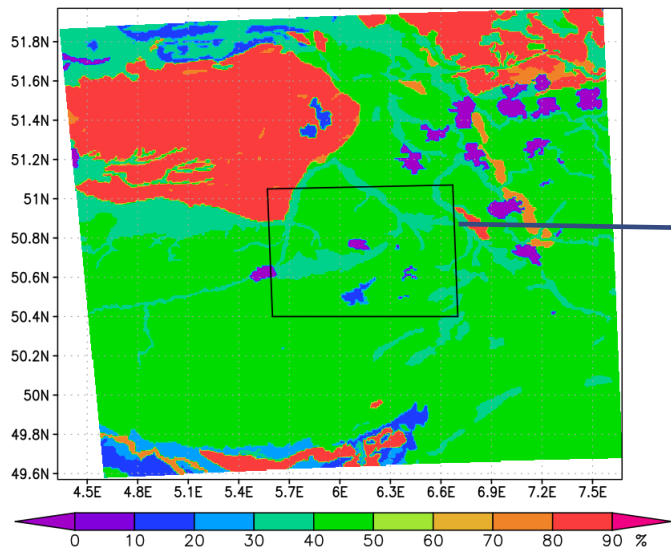
- Model setup
- HOPE campaign, part of HD(CP)² → www.hdcp2.eu
- Comparison of COSMO results with observations and PALM LES runs
- Results for sensitivity runs

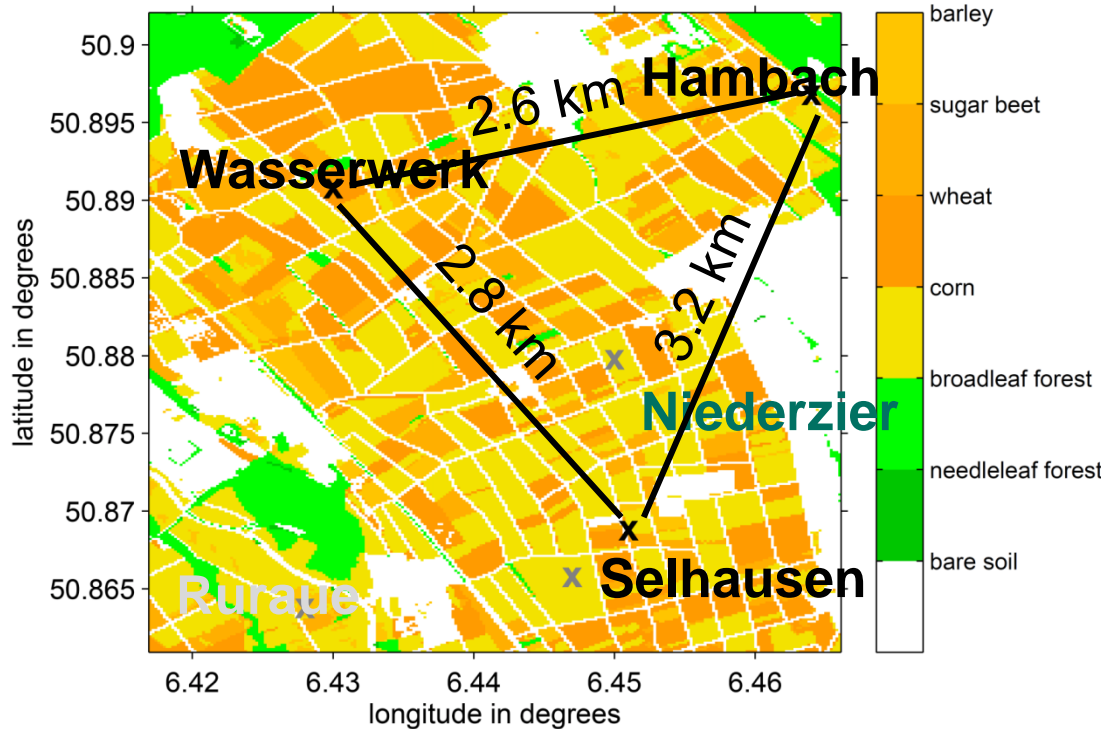
COSMO simulations: Model setup

- COSMO-DE analyses (0.025°) as initial and boundary conditions
- western part of Germany, covering HOPE area
- HWSD soil, using pedotransfer functions in TERRA

- COSMO 0.005° grid point distance (500 m)
- 4.5 – 7.5° E, 49.6 – 51.7° N, 80 vert. levs
- 21 h forecast starting at 0 UTC
- COSMO 0.001° GP distance (about 100m)
- 5.6 - 6.7°E, 50.4 – 51.05° N, 80 vert. levs
- 3d turbulence, Herzog (2002), fc 6 – 18 UTC
- Soil moisture from TERRA standalone runs
- Write some vars in part of domain every sec

fraction of sand





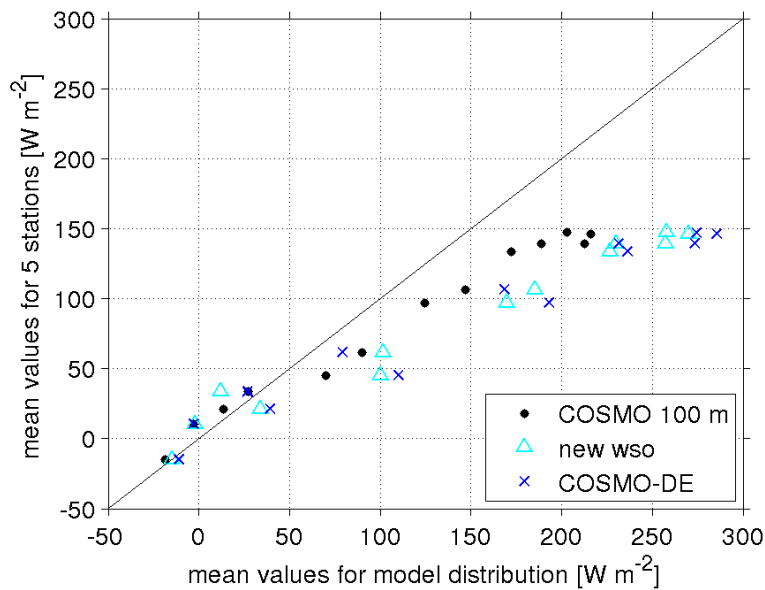
Doppler lidars at 3 locations

Veg. Data from
P. Shreshta, M. Sulis; Uni Bonn

- simultaneous vertical velocity measurements (w at 1 Hz) on six days with a convective BL
- days mostly without boundary layer clouds
- calculation of vertical velocity variances w'^2 and turbulence spectra

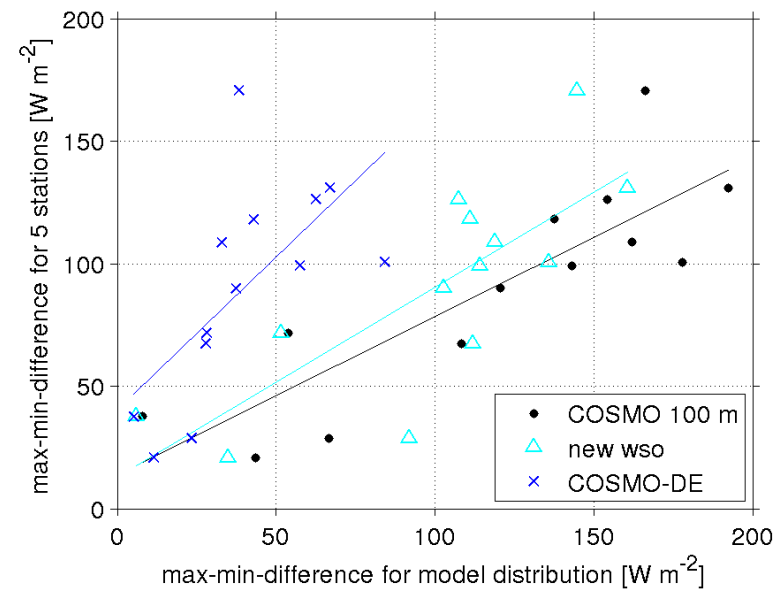
Sensible heat flux, HOPE area, 5 May 2013, every hour five measurement stations, high horizontal variability was observed

COSMO 100 with different soil initializations and COSMO-DE simulation results



Mean flux

Mean flux similar in COSMO-DE and COSMO 100



Range of fluxes

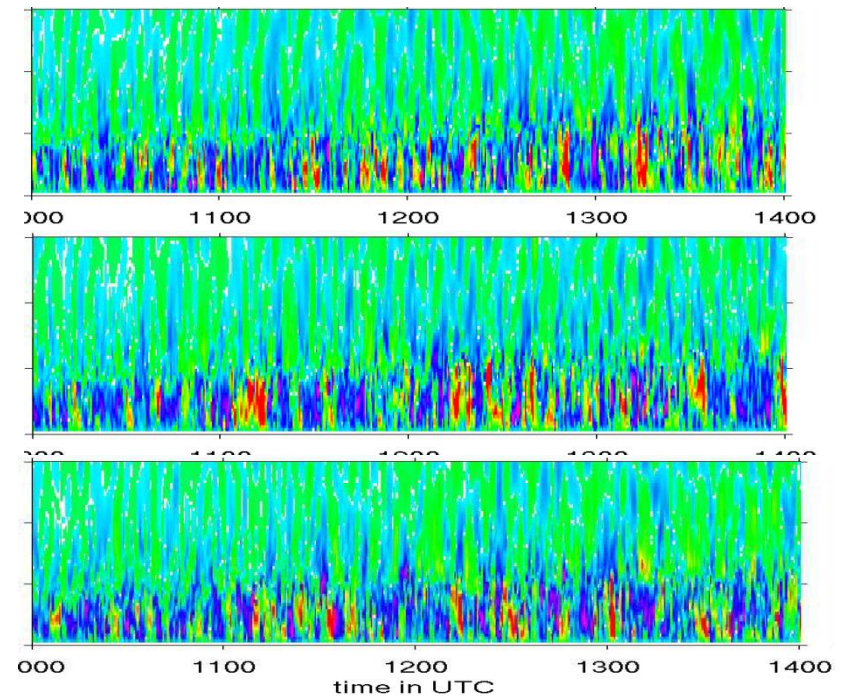
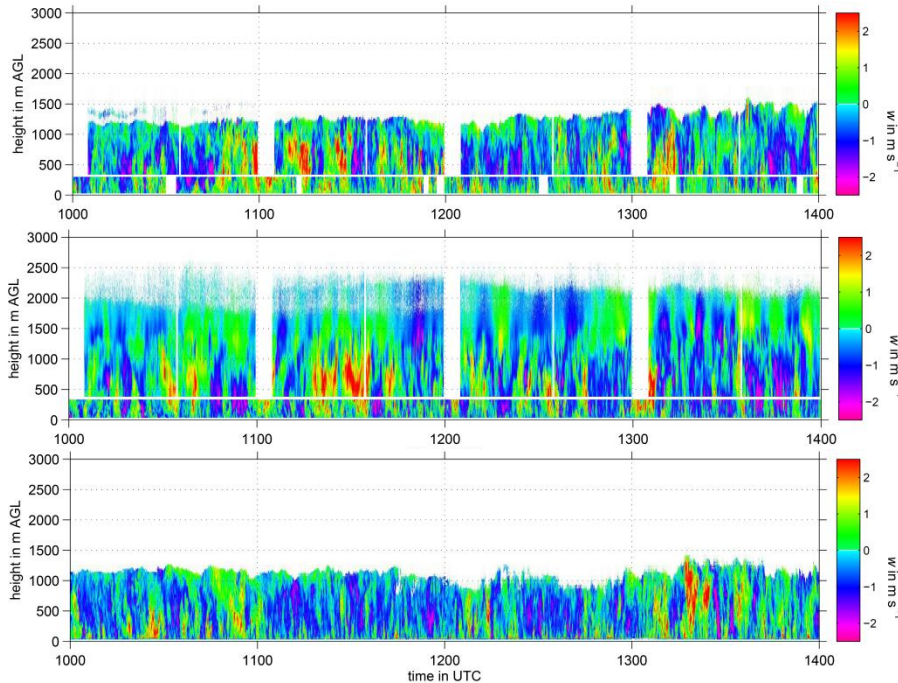
Horizontal variability improved in COSMO 100 m

Model comparison: vertical velocity

24 April

observations

PALM HPS



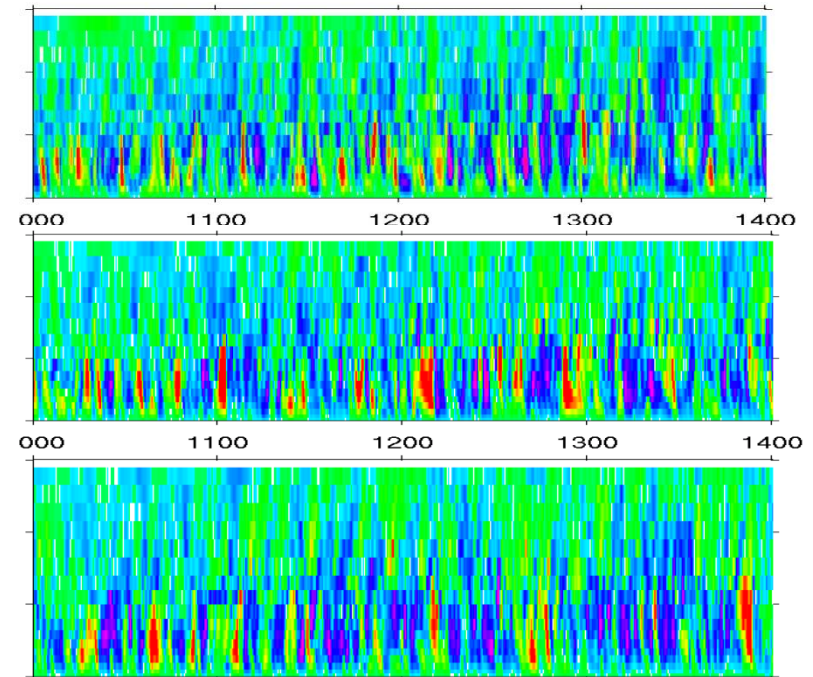
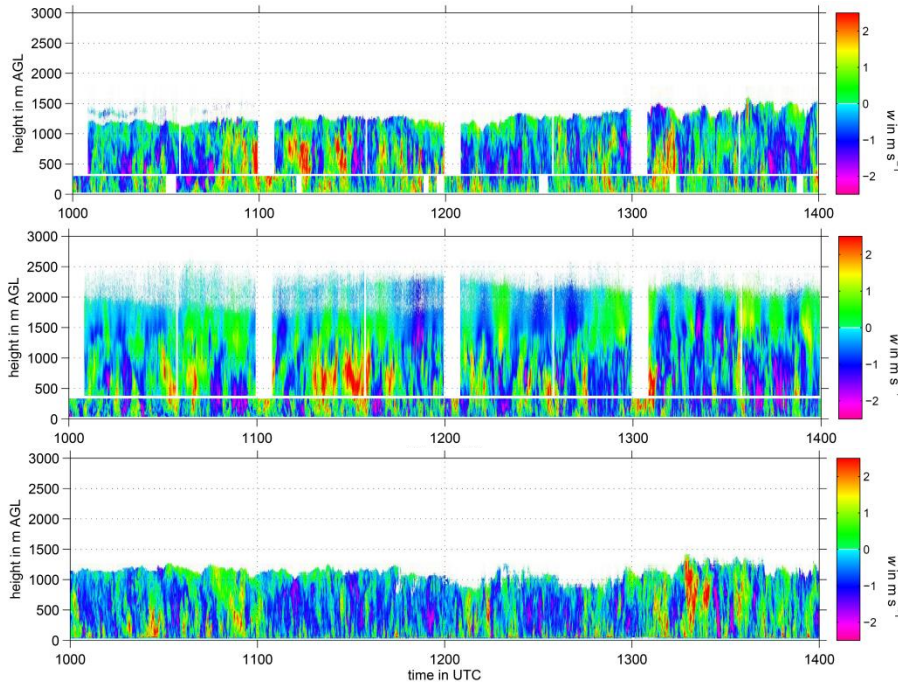
single-column output (30 s) at four „random“ locations → spatial differences are by chance!

Model comparison: vertical velocity

24 April

observations

COSMO



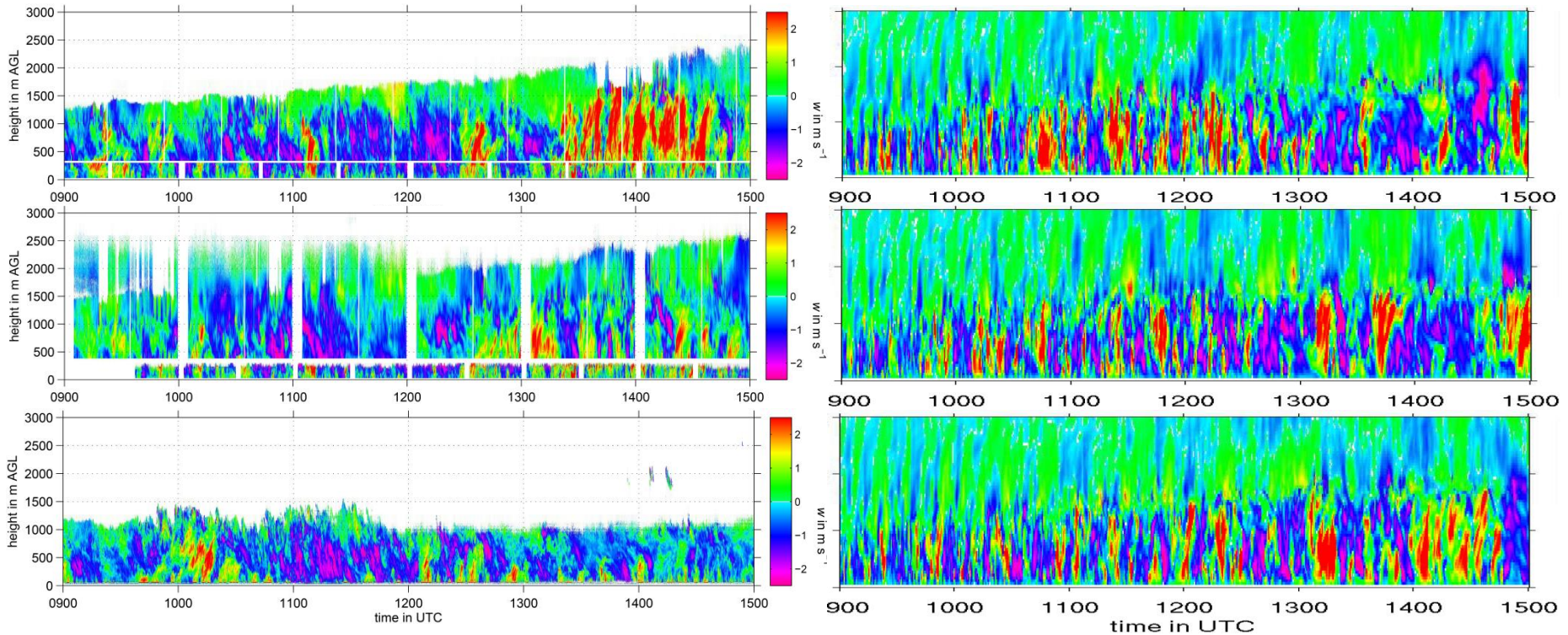
1-s output of u , v , w , T , q in HOPE domain with realistic orography and LAI, plant cover as well as soil types from common data base

Model comparison: vertical velocity

05 May

observations

PALM HPS

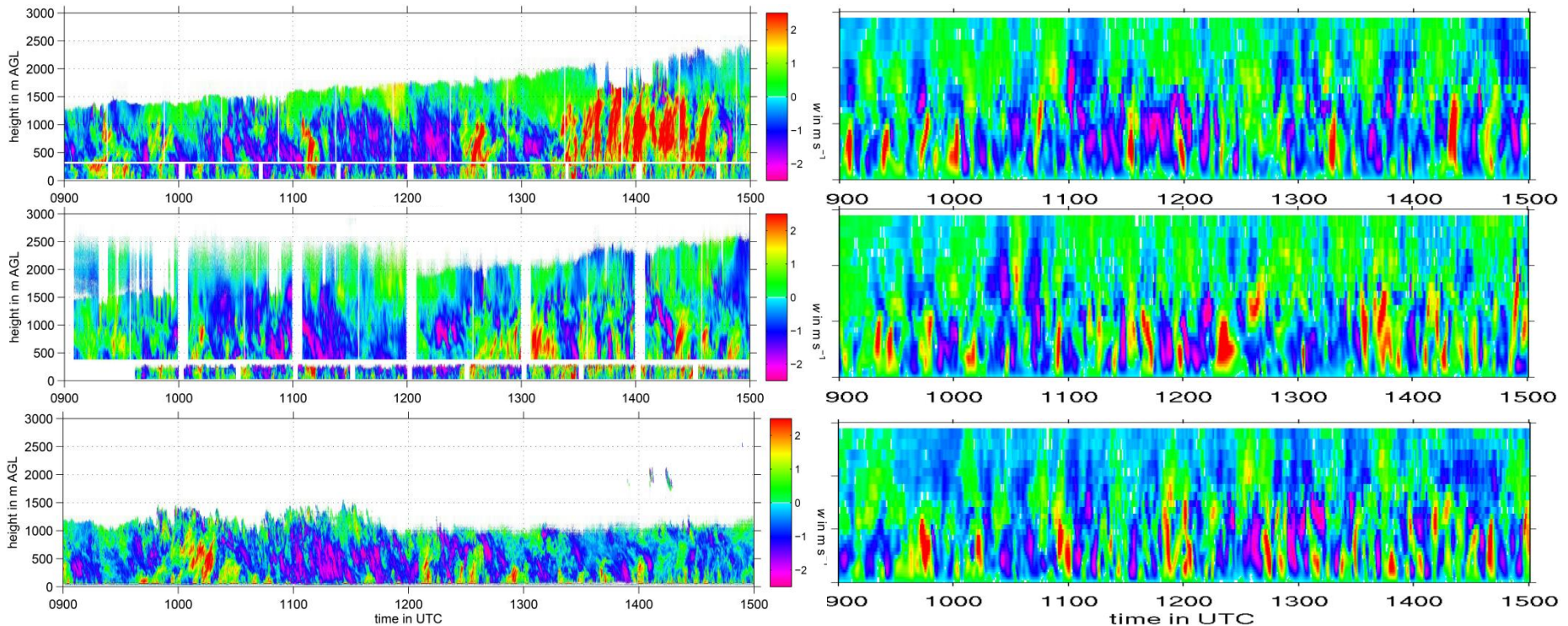


Model comparison: vertical velocity

05 May

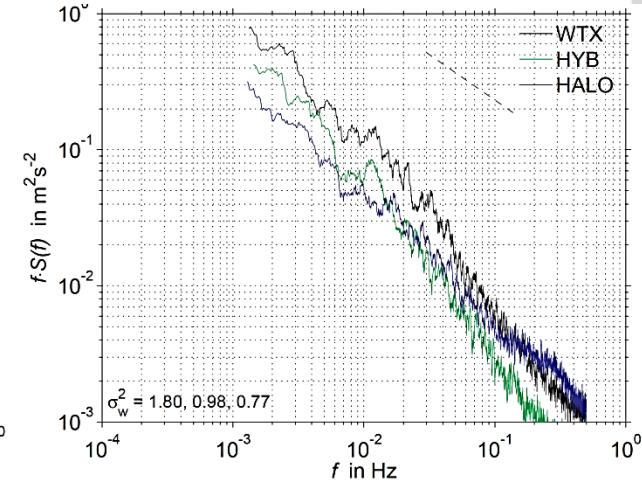
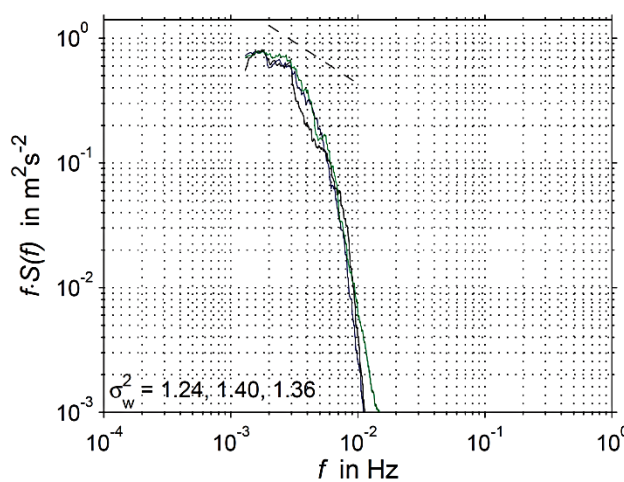
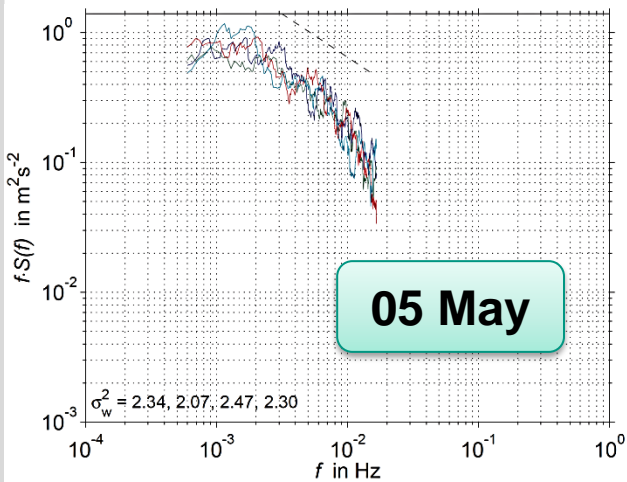
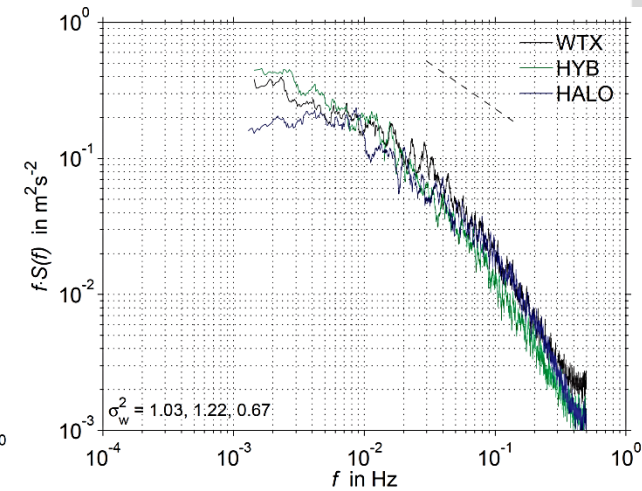
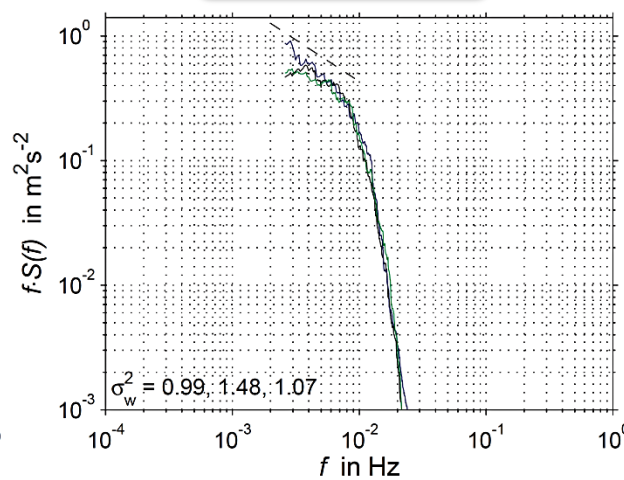
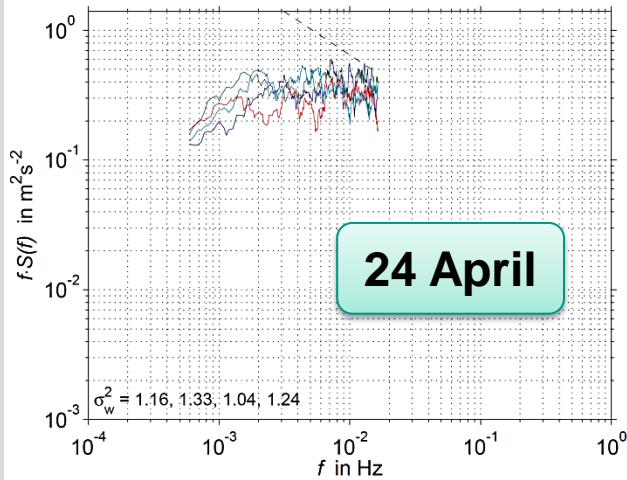
observations

COSMO



Model comparison

w @ 600 m



PALM

COSMO

observations

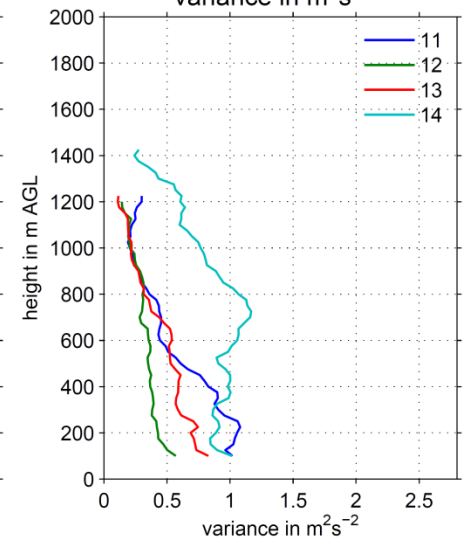
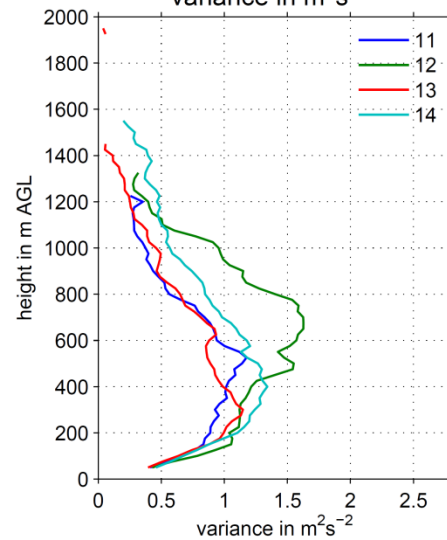
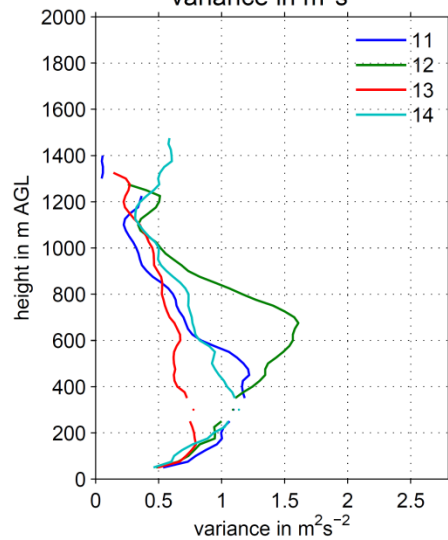
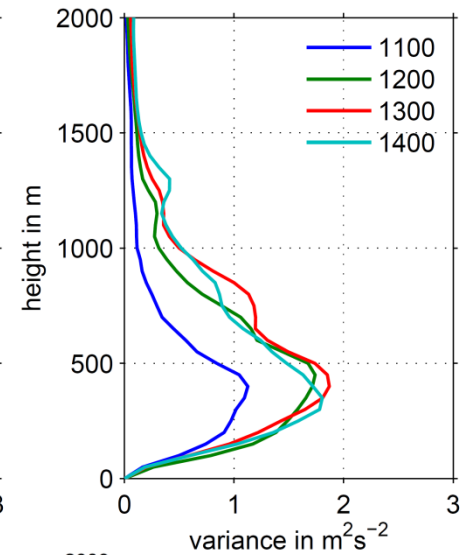
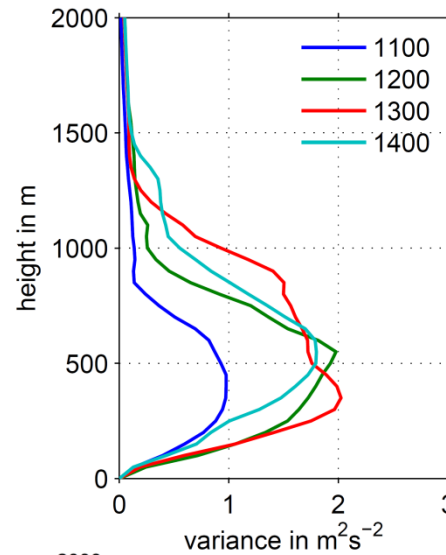
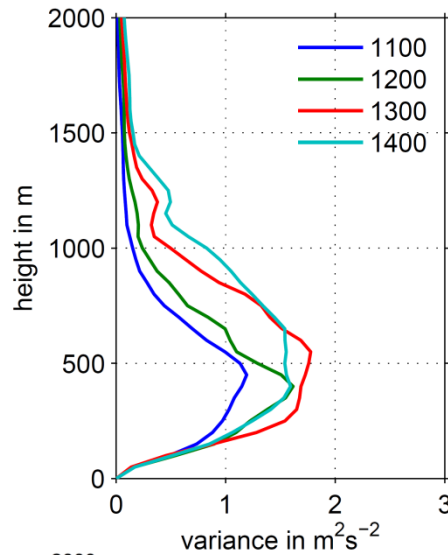
Model comparison

$\overline{w'^2}$ profiles

PALM
single-column
output

24 April

observations



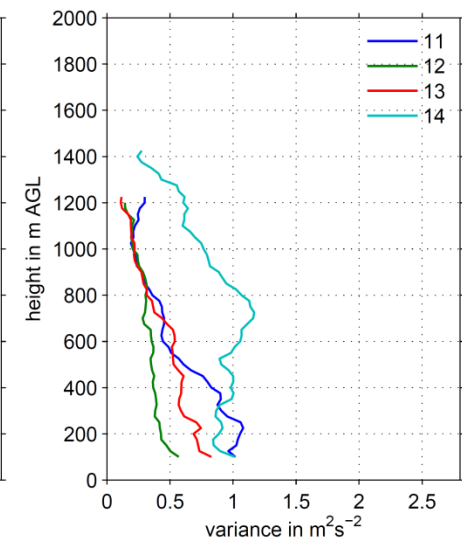
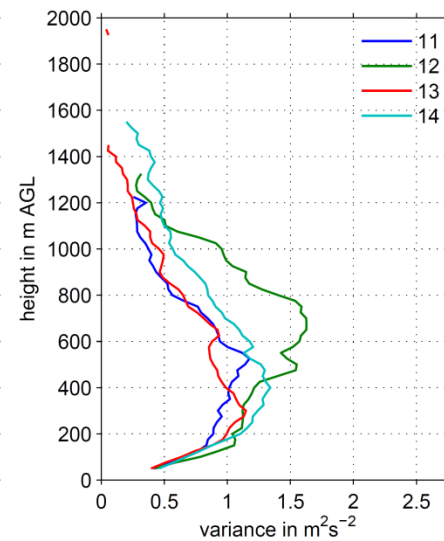
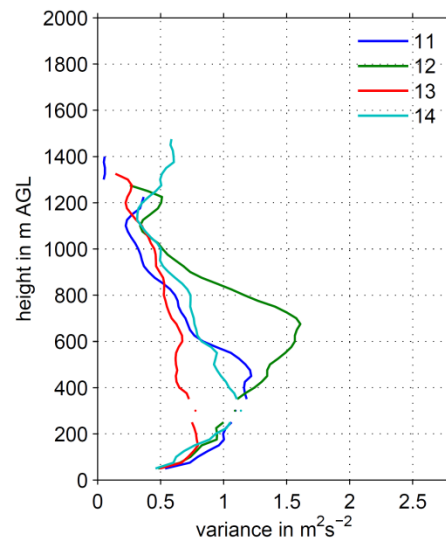
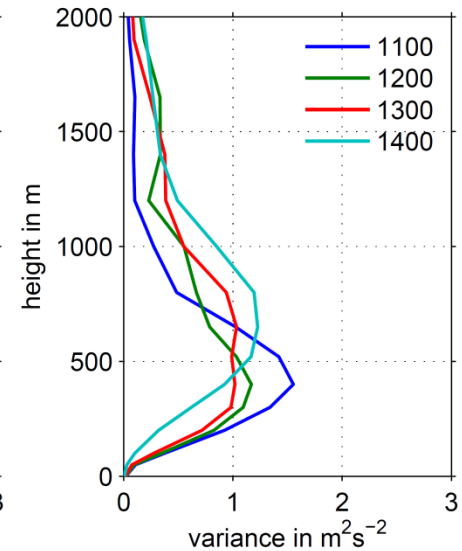
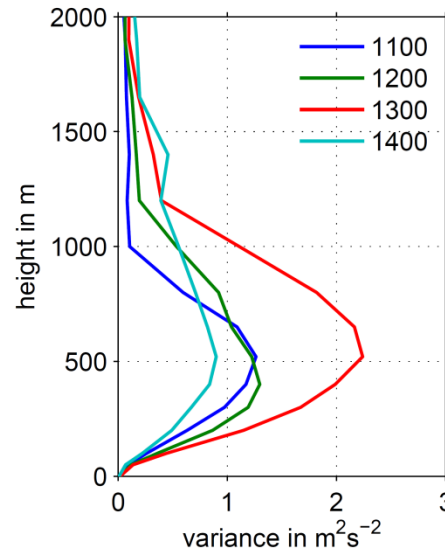
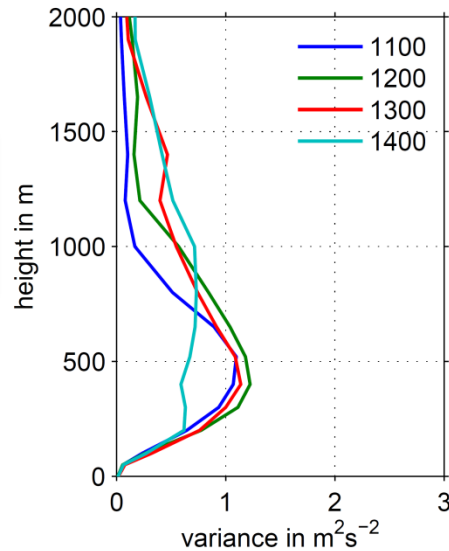
Model comparison

$\overline{w'^2}$ profiles

COSMO 100 m
single-column
output

24 April

observations



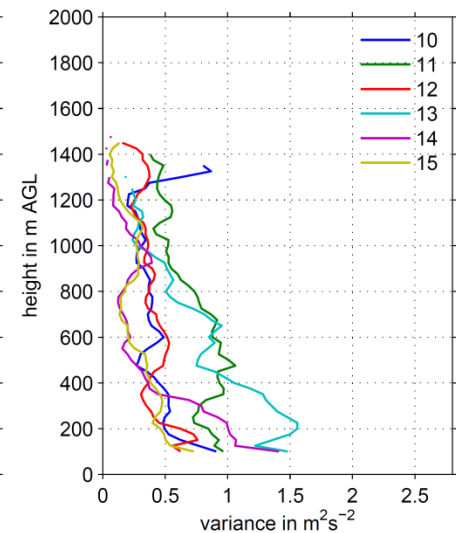
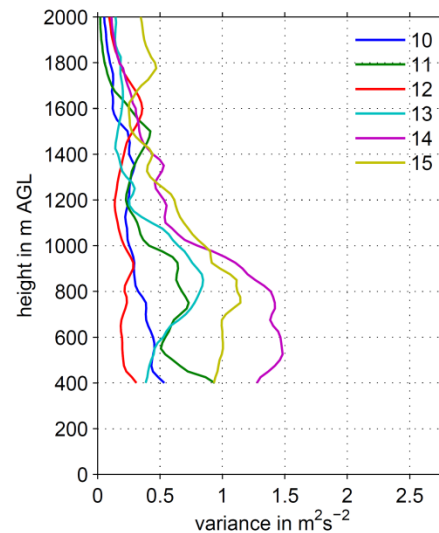
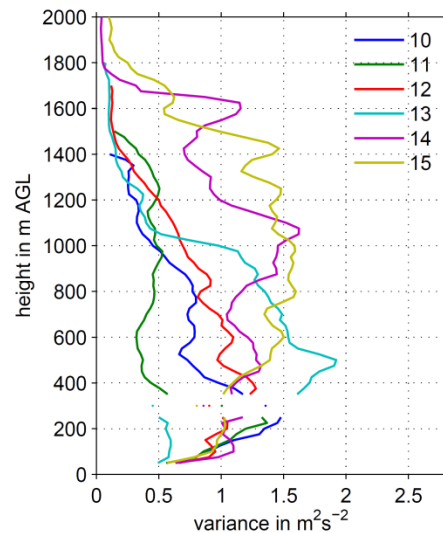
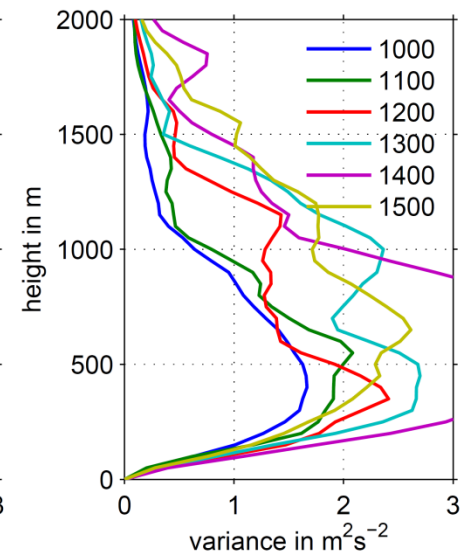
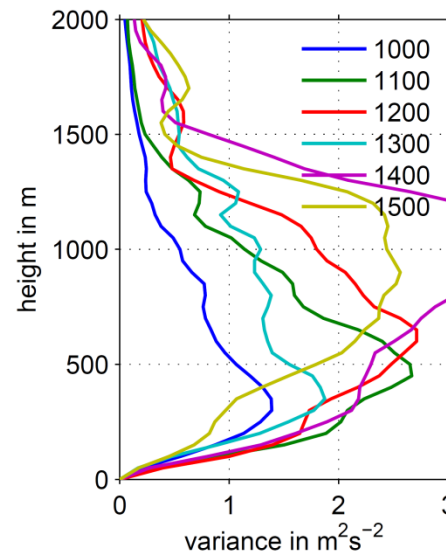
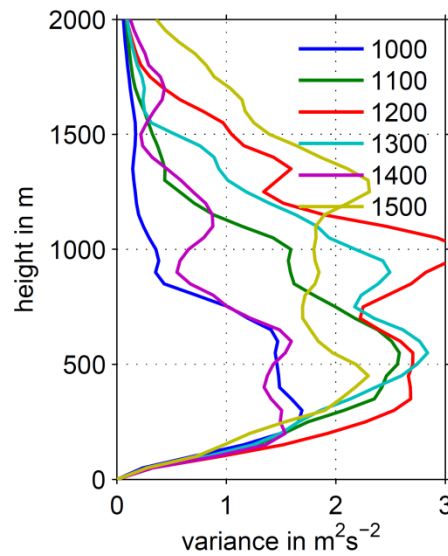
Model comparison

$\overline{w'^2}$ profiles

PALM
single-column
output

05 May

observations



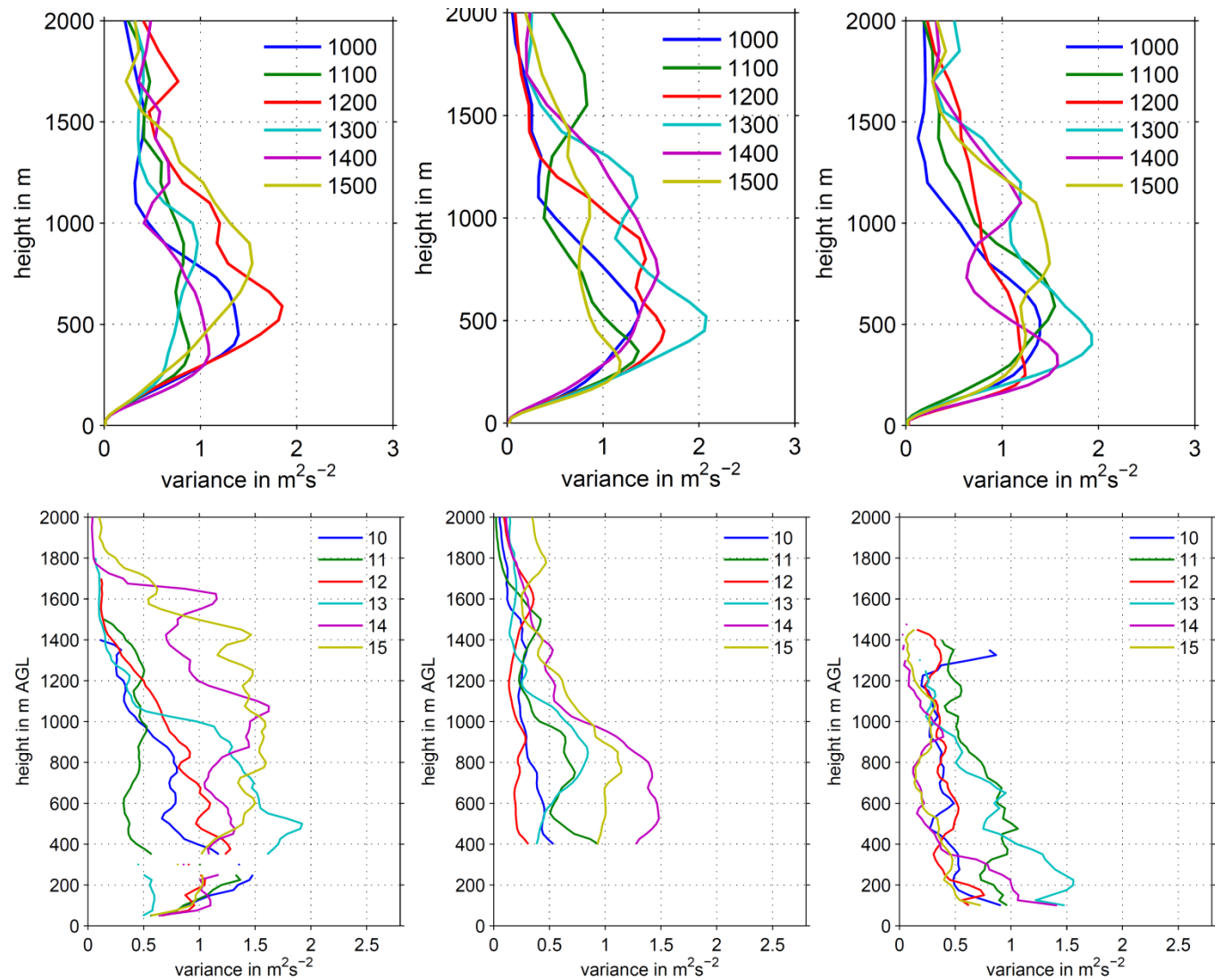
Model comparison

$\overline{w'^2}$ profiles

COSMO 100 m
single-column
output

05 May

observations



Sensitivity experiments

Investigate effect of resolution of soil and vegetation data

ref soil properties and vegetation 100 m grid

soi soil properties averaged 2500 m grid

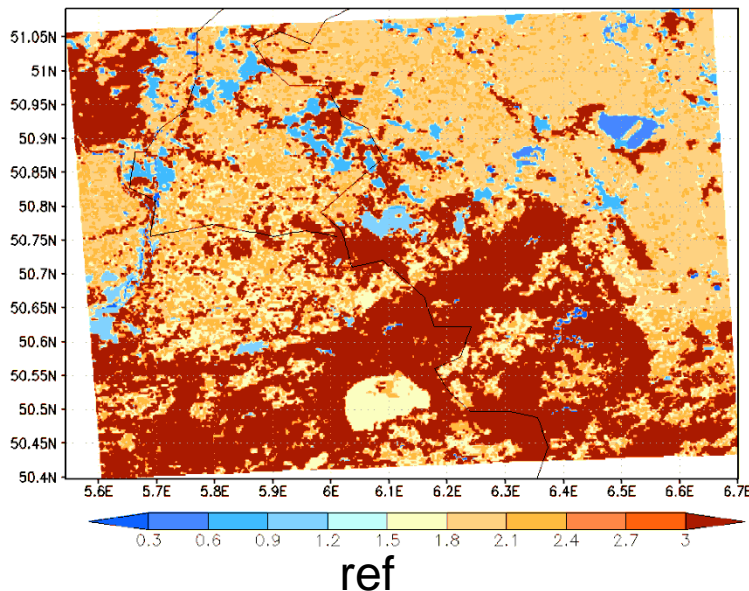
veg vegetation averaged 2500 m grid

soic soil properties constant

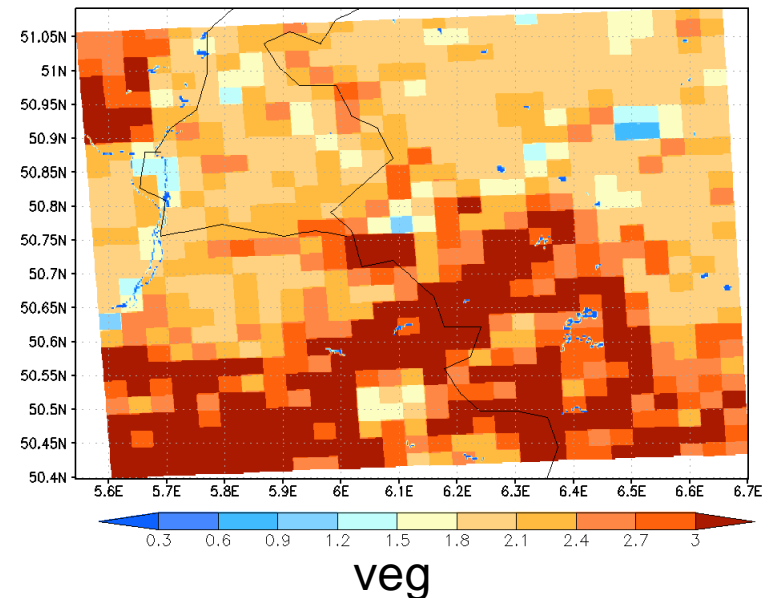
vegC vegetation constant

desoi soil moisture from COSMO-DE

Domain average land surface properties do not change, except for desoi



LAI

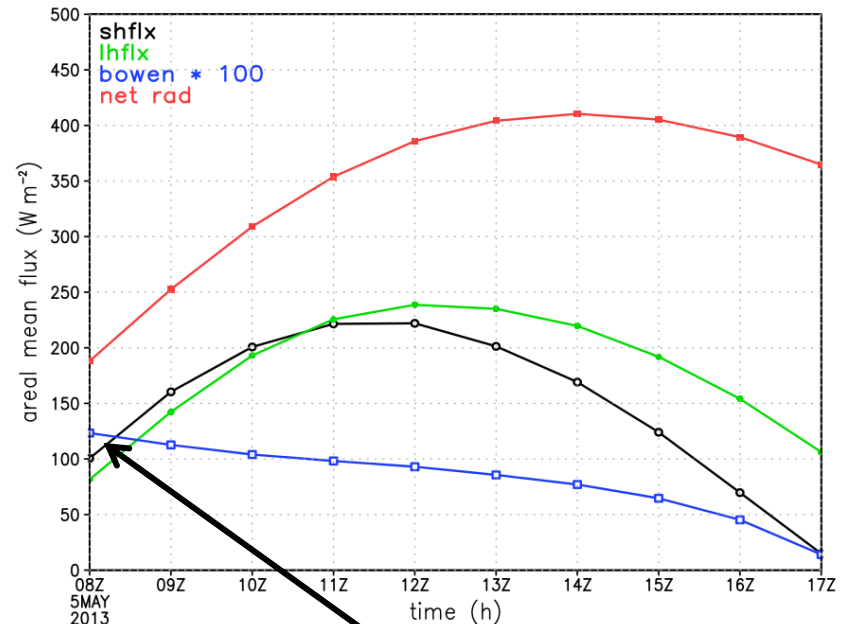
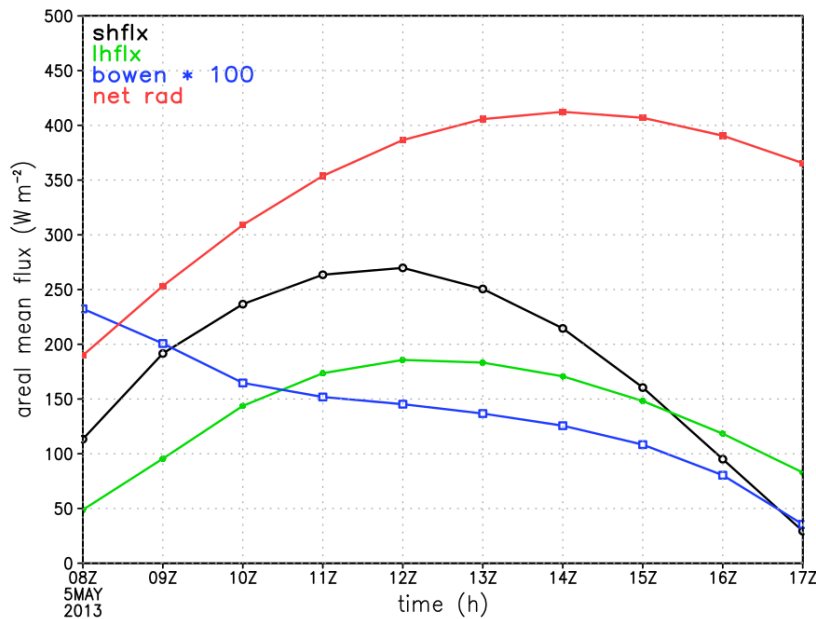


Soil-moisture initialization

05 May

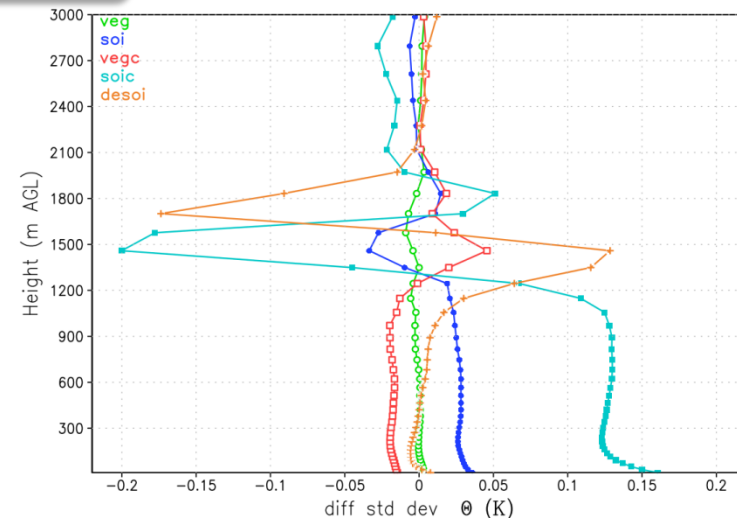
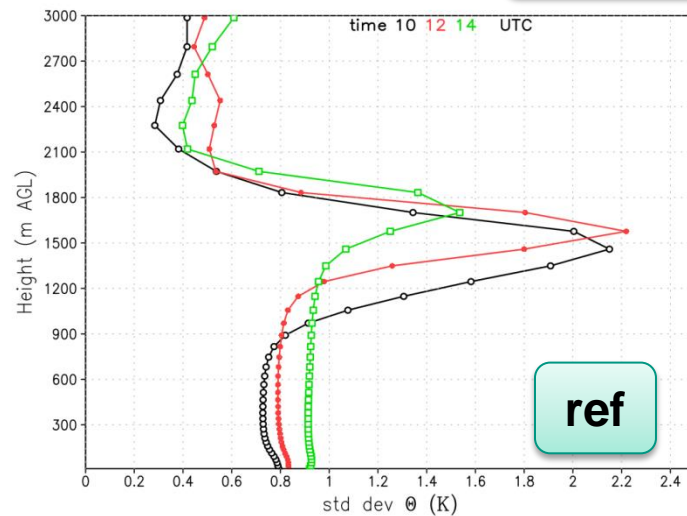
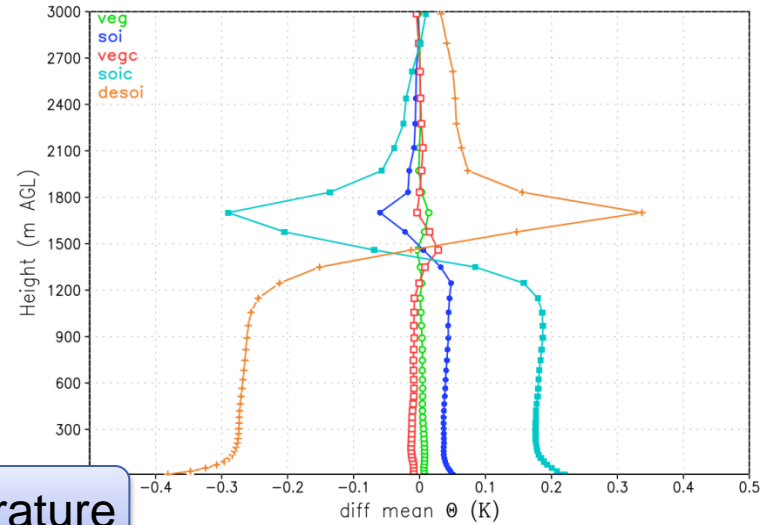
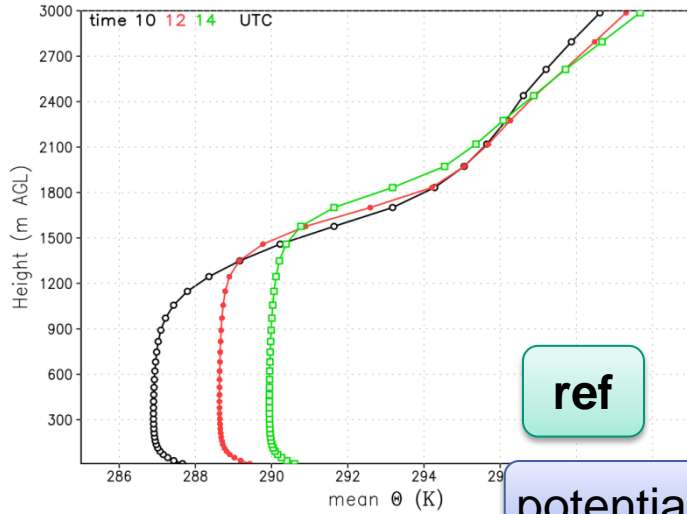
ref: soil moisture + temperature from TERRA standalone (HWSD!)

desoi: soil moisture from COSMO-DE



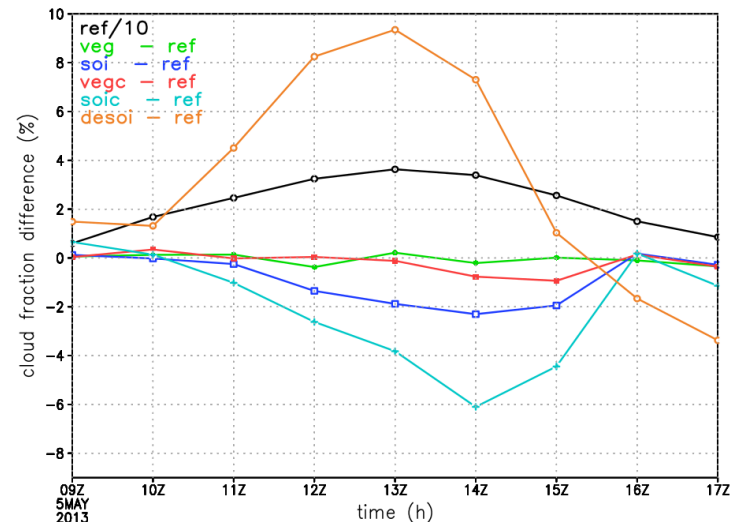
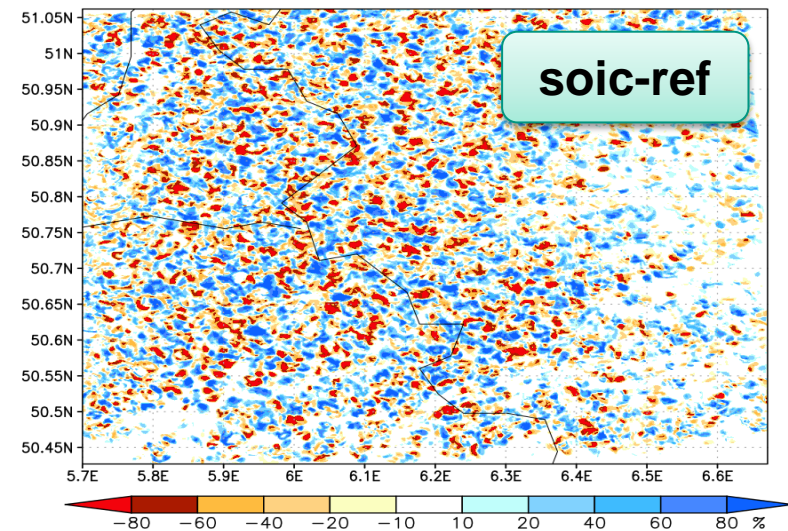
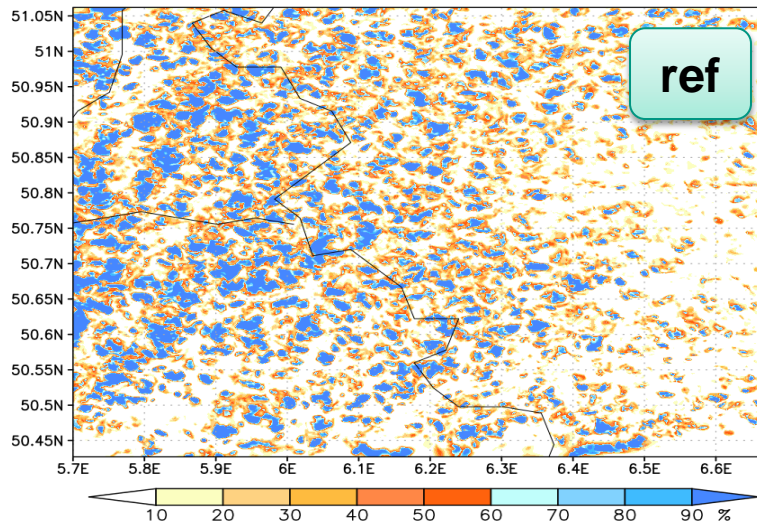
higher soil moisture
 → lower sensible heat flux / Bowen ratio

Sensitivity studies: Spatial mean and standard deviation for vertical profiles

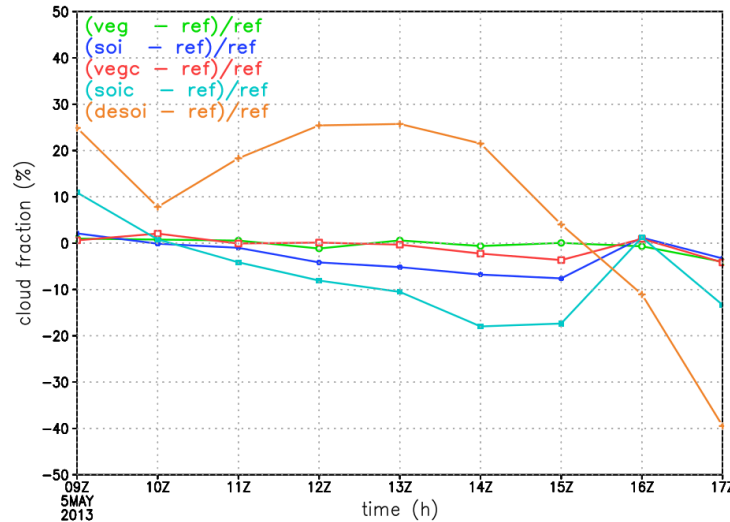


Cloud-cover differences

areal mean values



abs
diff



rel
diff

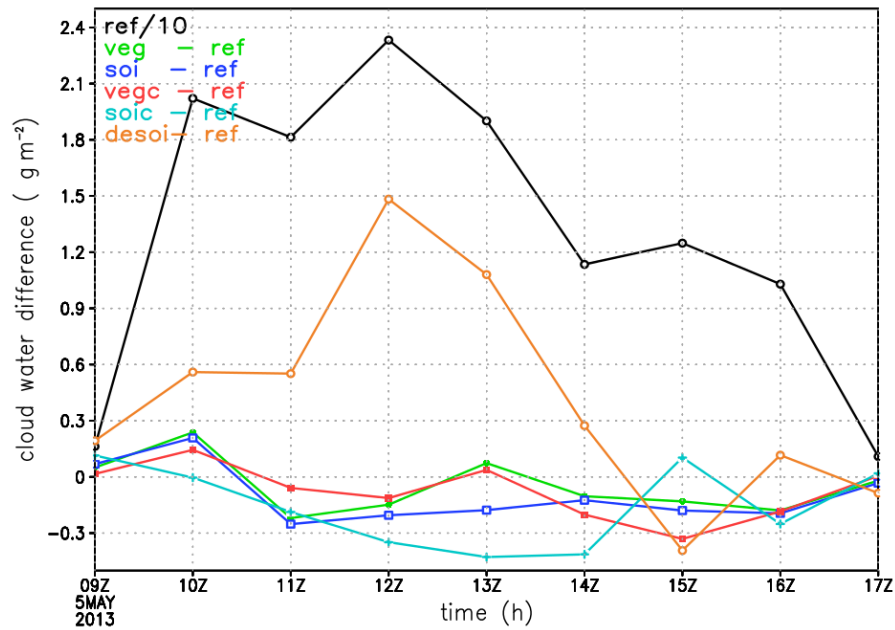
Summary

- COSMO runs in 0.001° (LES mode)
- Comparison of simulated flux and vertical velocity with measurements -
→ model can reproduce main structures
- Vertical velocity similar in PALM LES and COSMO 100 m
- There are smaller structures, which are still not resolved
- Sensitivity experiments show strong local variations
- Biggest differences for areal mean values in soic (constant soil) and desoi (soil moisture from COSMO-DE)

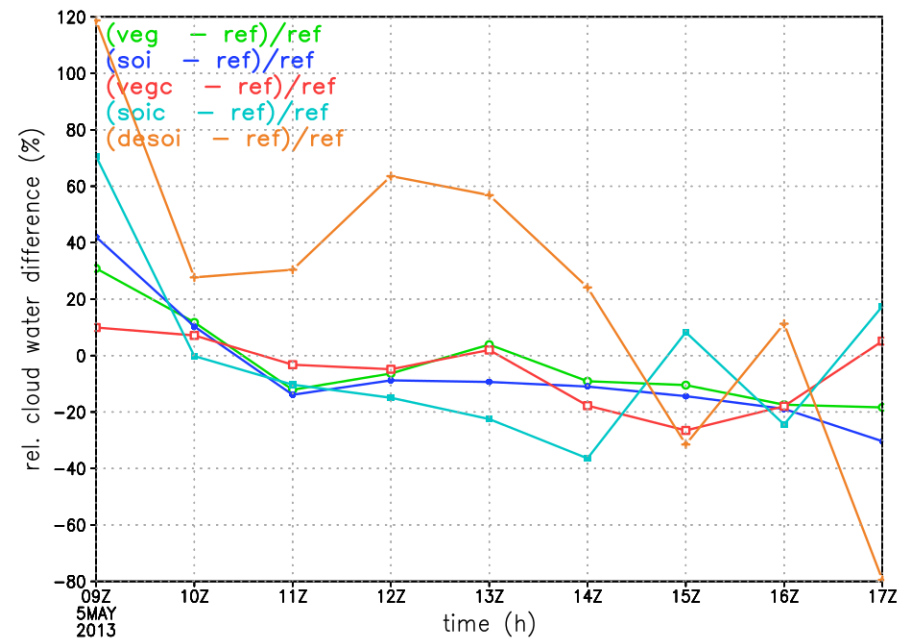
Thank you

Cloud water

abs diff



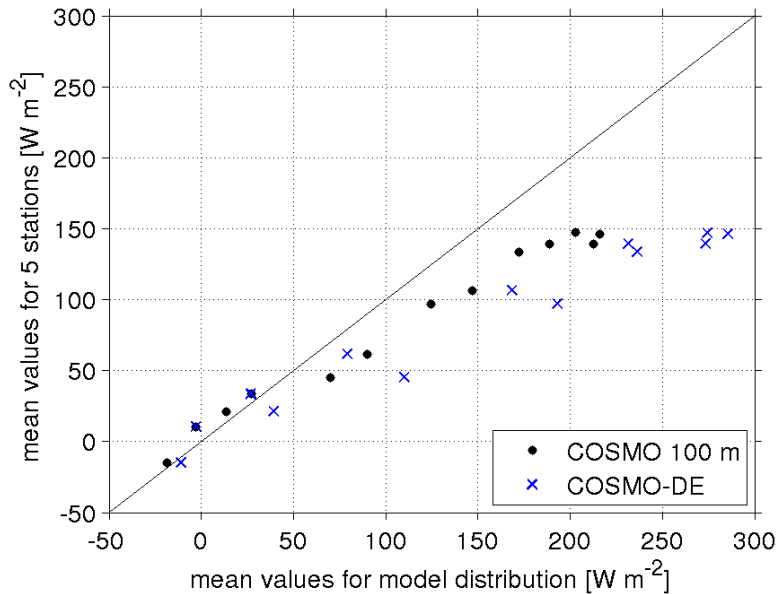
rel. diff



Sensible heat flux, HOPE area, 5. May 2013

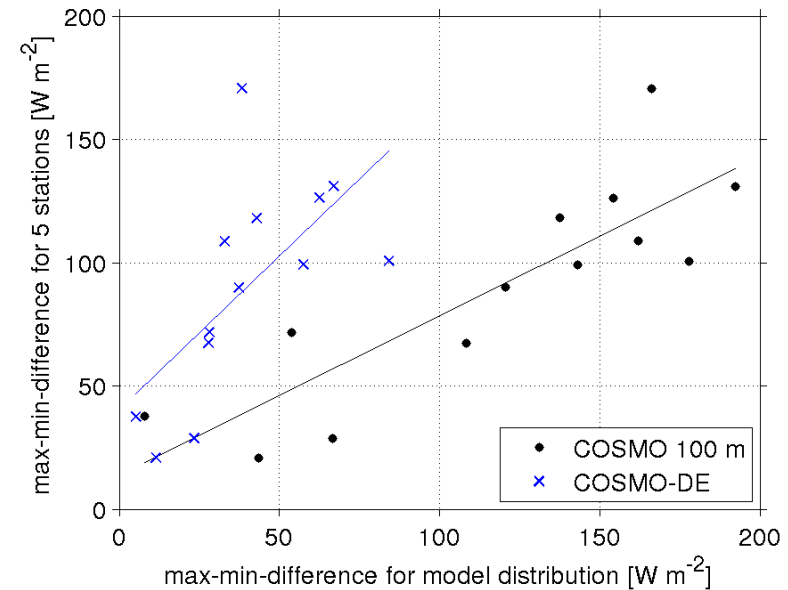
five measurement stations, high horizontal variability was observed

COSMO 100 and COSMO-DE simulation results



Mean flux

Mean flux similar in COSMO-DE and COSMO 100

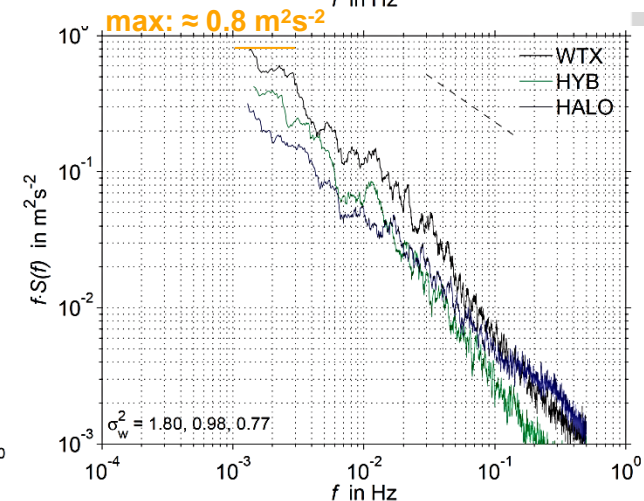
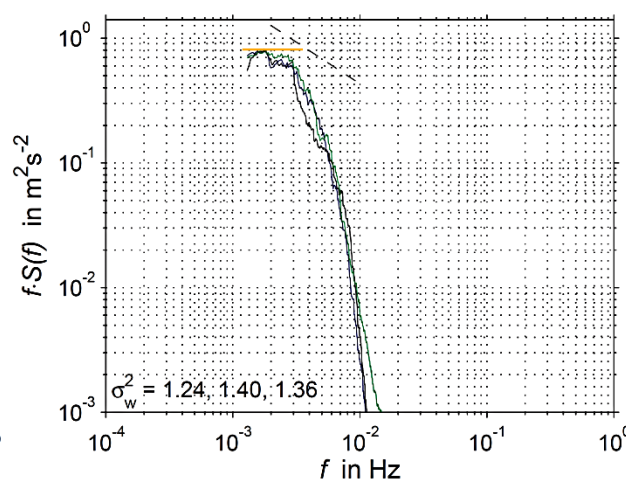
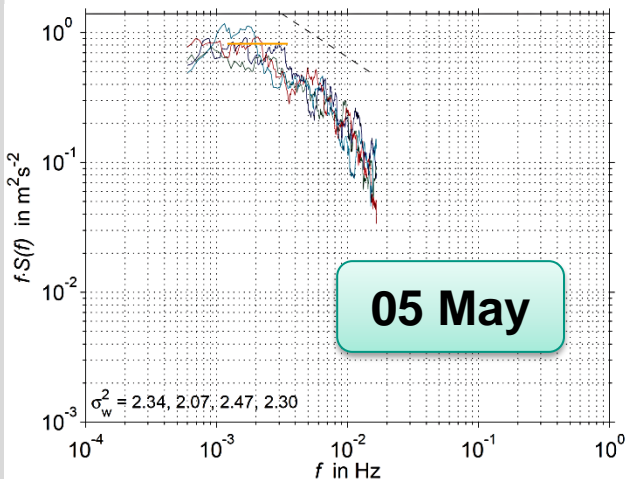
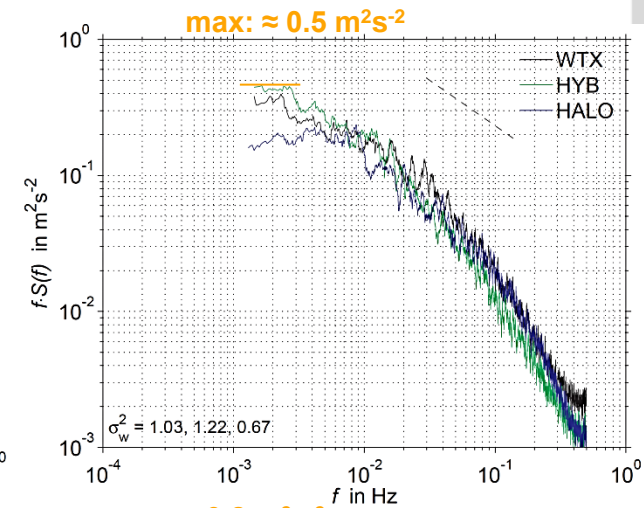
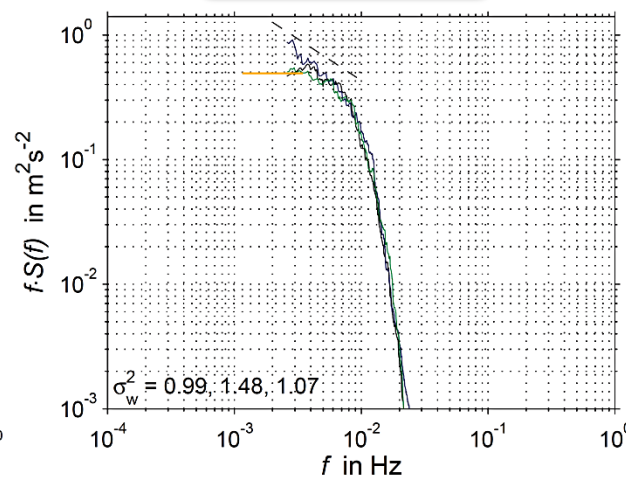
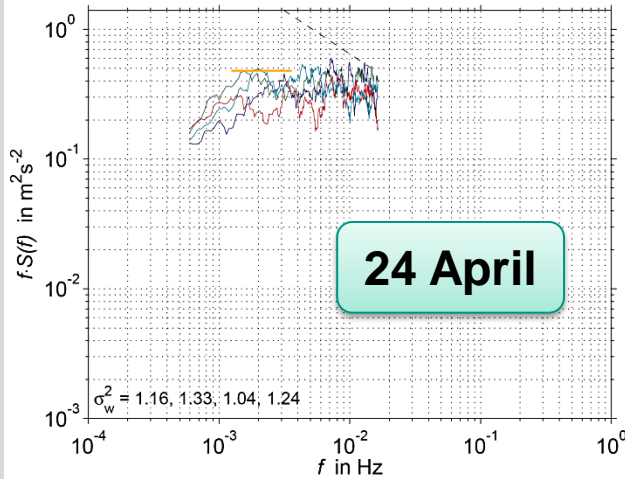


Range of fluxes

Horizontal variability improved in COSMO 100 m

Model comparison

w @ 600 m



PALM

COSMO

observations

Model comparison

$\overline{w'^2}$ profiles

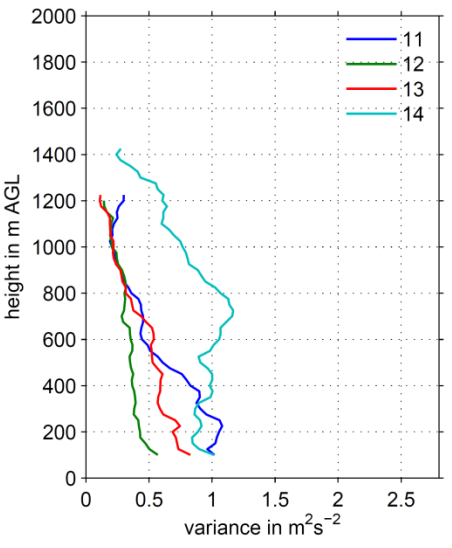
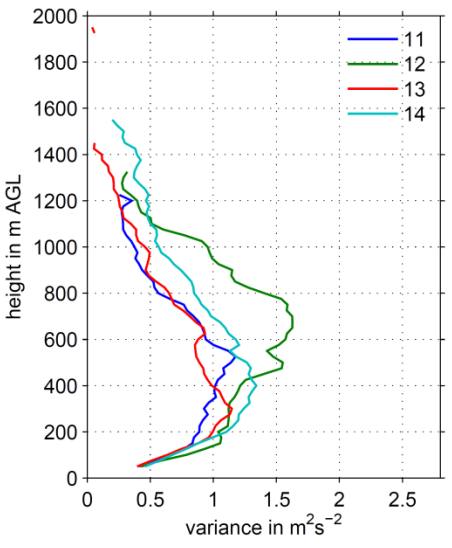
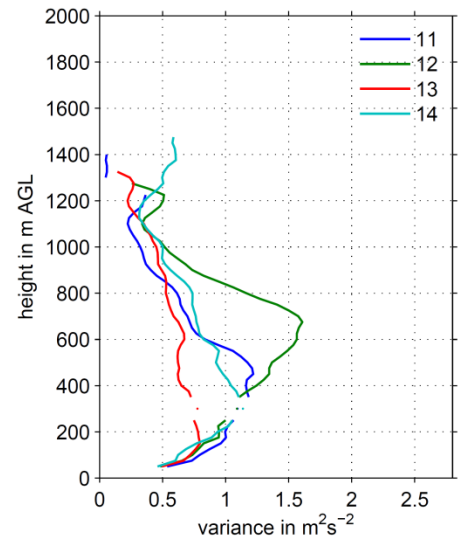
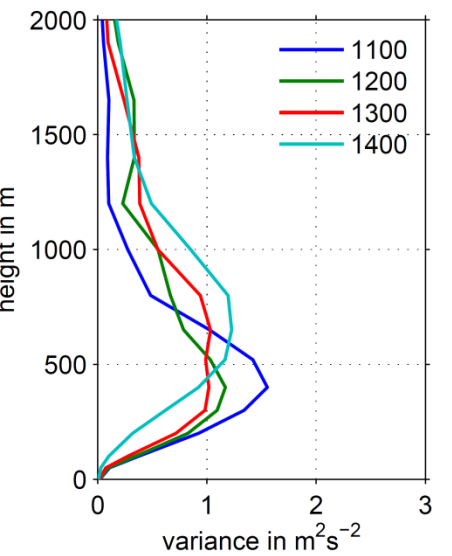
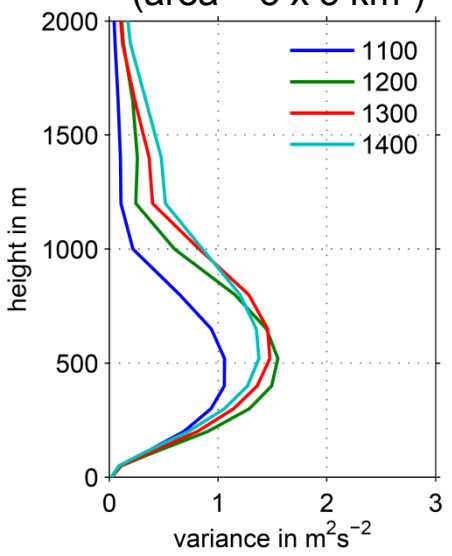
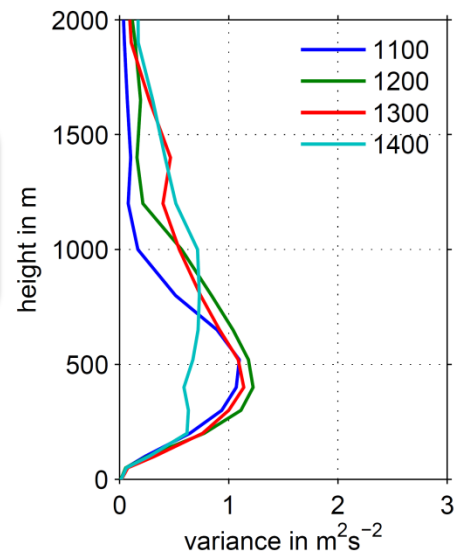
ensemble mean
(area $\approx 5 \times 5 \text{ km}^2$)



COSMO 100 m
single-column
output

24 April

observations



$\overline{w'^2}$ profiles

Model comparison

COSMO 100 m single-column output

05 May

observations

ensemble mean
(area $\approx 5 \times 5 \text{ km}^2$)

