# Evaluation of the coupled COSMO-CLM/DCEP with data from the Basel Urban Boundary Layer Experiment (BUBBLE)


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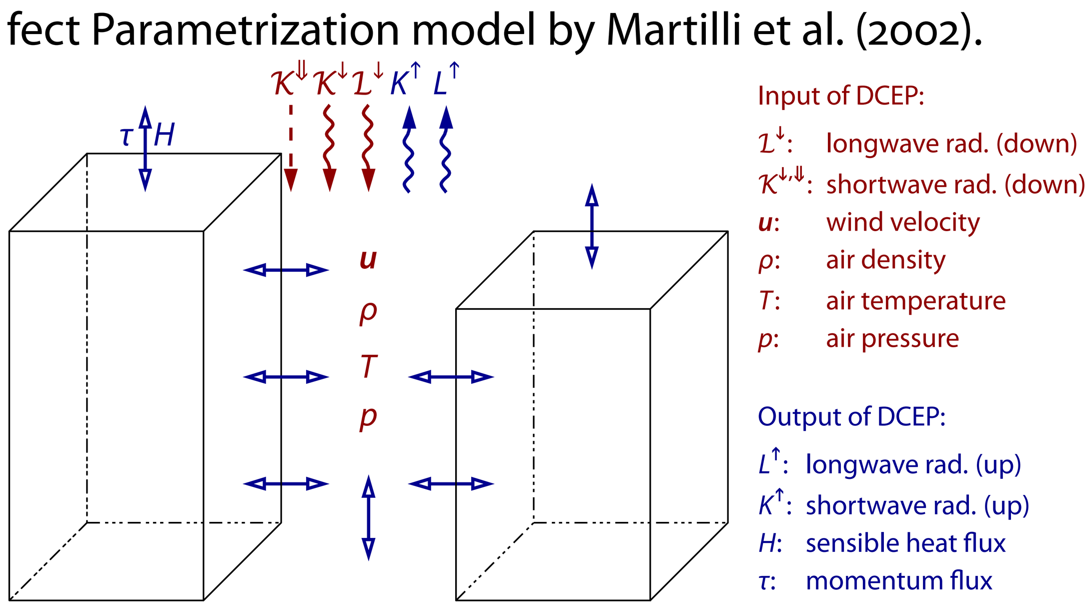
We evaluate the urban Double Canyon Effect Parametrization scheme (DCEP), fully online coupled to the regional climate and weather model COSMO-CLM (CCLM), with measurements from the Basel UrBan Boundary Layer Experiment (BUBBLE). Furthermore, the CCLM/DCEP simulations are compared with CCLM simulations with the default bulk scheme, which represents urban areas only by an increased roughness length and reduced vegetation parameters.


## 1. Mesoscale climate model CCLM and urban canopy scheme DCEP

The CCLM model is a non-hydrostatic limited-area regional climate model developed from the operational weather forecast Local Model (LM) of the German Weather Service (Steppeler et al. 2003) by the CLM-Community. Meanwhile it is used and further developed by several other weather services organized in the COnsortium for Small-scale MOdelling (COSMO).

DCEP (Schubert et al. 2012) is based on the Building Effect Parametrization model by Martilli et al. (2002).



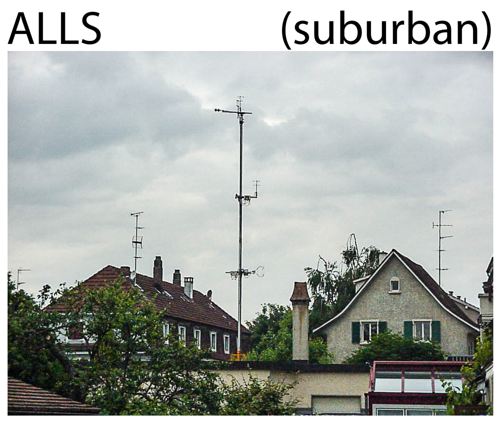

## 2. BUBBLE

The Basel UrBan Boundary Layer Experiment (BUBBLE) (Christen et al. 2004; Rotach et al. 2005) was conducted in 2001–2002. The aim of BUBBLE was to investigate in detail the boundary layer structure of the city of Basel and its surroundings by combining near-surface and remote sensing instrumentation. Basel is a mid-size town ($23\,\mathrm{km}^2$) and consists together with its surrounding of a built-up area of approximately $130\,\mathrm{km}^2$ ($30\,\mathrm{km}^2$ dense urban, $80\,\mathrm{km}^2$ suburban and $20\,\mathrm{km}^2$ industrial areas) and a population of 400 000.

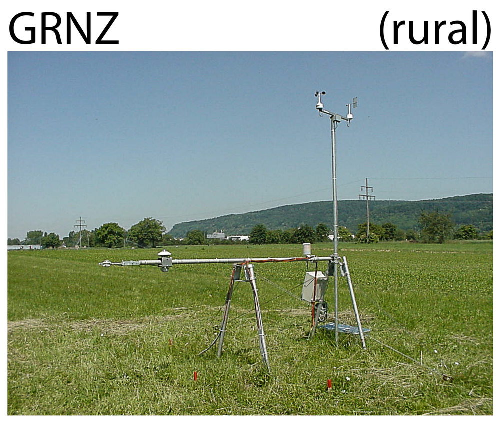
Sites discussed on this poster:

BSPR (urban)

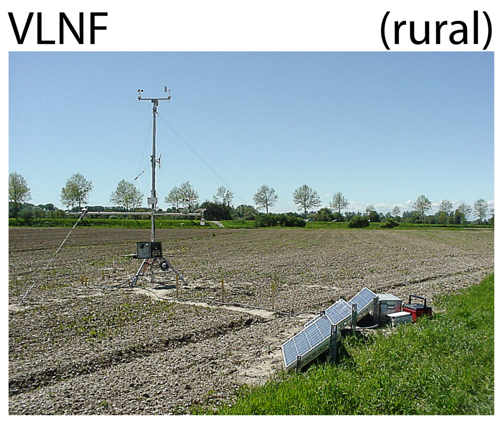
ALLS (suburban)



GRNZ (rural)



VLNF (rural)



Furthermore, the cloud cover measured at BBIN, and the air temperature profiles and wind profiles measured at the urban station BKLH are also included in the evaluation.

## 3. Building Parameters for Basel

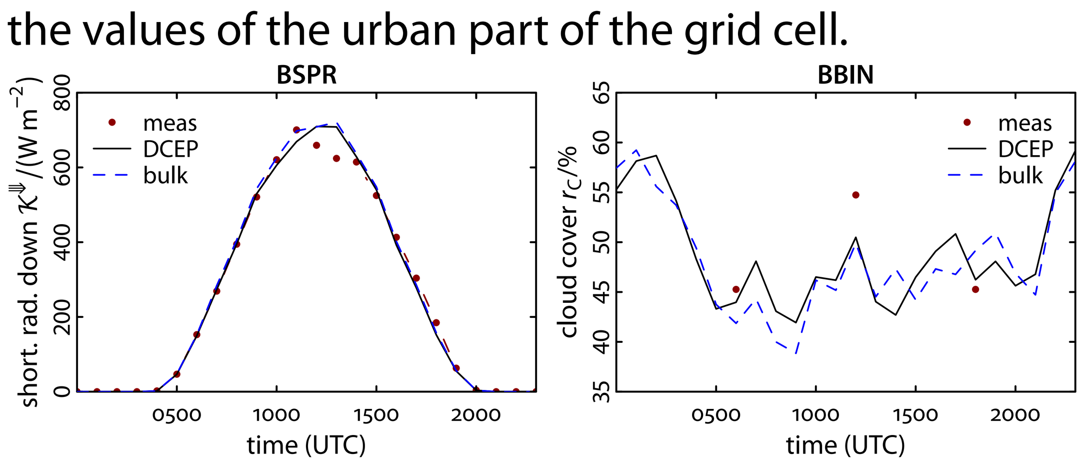
Specific urban input parameters for each mesoscale grid cell are derived for the area of Basel and its surroundings. To this end, detailed land-use data of the cantons of Basel-Stadt and Basel-Landschaft as well as the corine land-use data for France and Germany are used. Furthermore, building parameters for the area of the canton Basel-Stadt including the city of Basel, and municipalities Riehen and Bettingen are derived from a 3-d building data set in the 3-d shapefile format.

## 4. Set-up of simulation

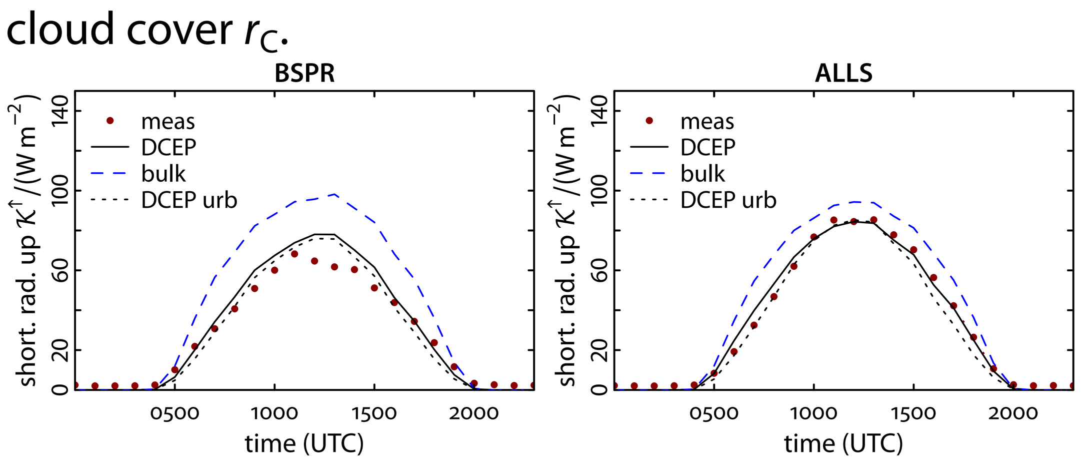
CCLM version 4.8_clm11 is used for one way nested grids of resolutions of approx. 25 km (Europe and Mediterranean region, without DCEP), 7 km (Central Europe, without DCEP), 2.8 km (Alpine region, with and without DCEP) and 1 km (centred around Basel with a domain size of approx. 300 km × 300 km, with and without DCEP) for 15 June 2002 0000 UTC through 10 July 2002 0000 UTC. The orography, monthly vegetation and soil parameters are provided by the preprocessor of CCLM (Smiatek et al. 2008). In the DCEP run, the preprocessor data in Basel is substituted with parameters that represent only the vegetated part of the grid cell.

## 5. Surface radiation budget

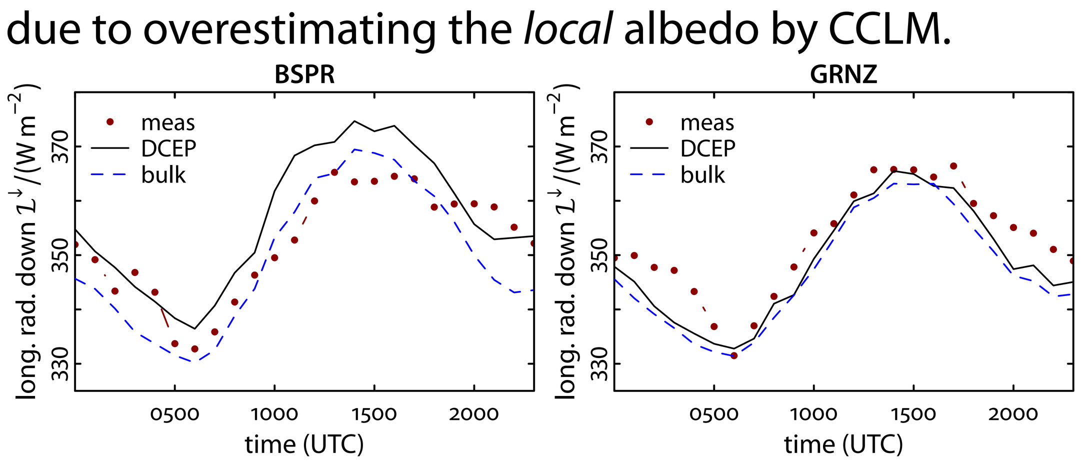
The measurements ("meas") are compared with simulations with DCEP or the bulk scheme. "DCEP only" shows the values of the urban part of the grid cell.



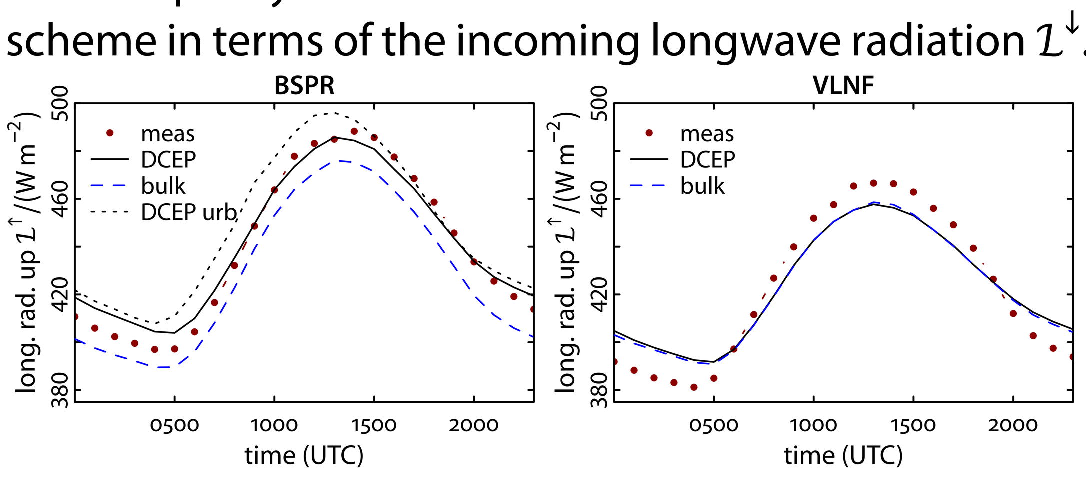

The shortwave irradiance $\mathcal{K}^{\Downarrow}$ is similar at all stations (measured and simulated) and is slightly overestimated at noon probably due to the underestimation of the cloud cover $r_C$.




With DCEP, the reflected shortwave radiation $\mathcal{K}^{\uparrow}$ is improved at urban and suburban sites due to a decrease of the albedo. $\mathcal{K}^{\uparrow}$ is overestimated at the rural stations due to overestimating the *local* albedo by CCLM.

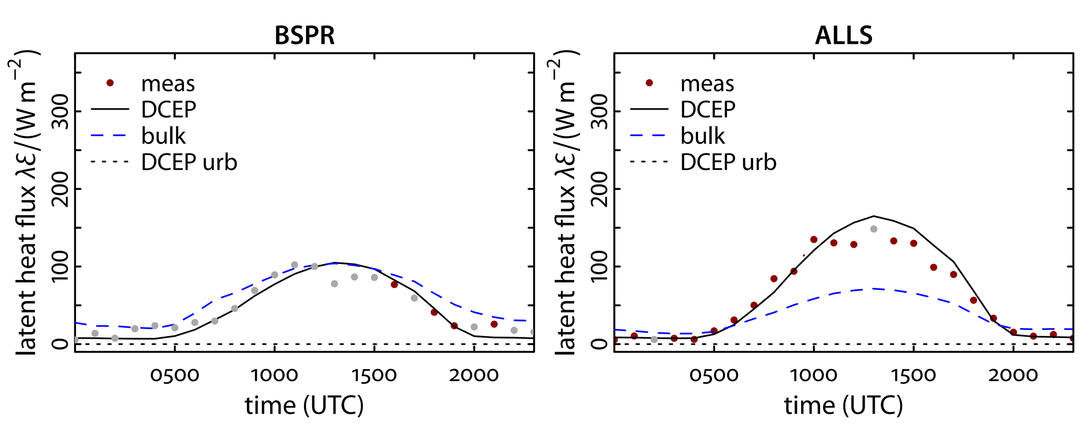



Similar quality of simulation with DCEP and the bulk scheme in terms of the incoming longwave radiation $\mathcal{L}^{\downarrow}$.

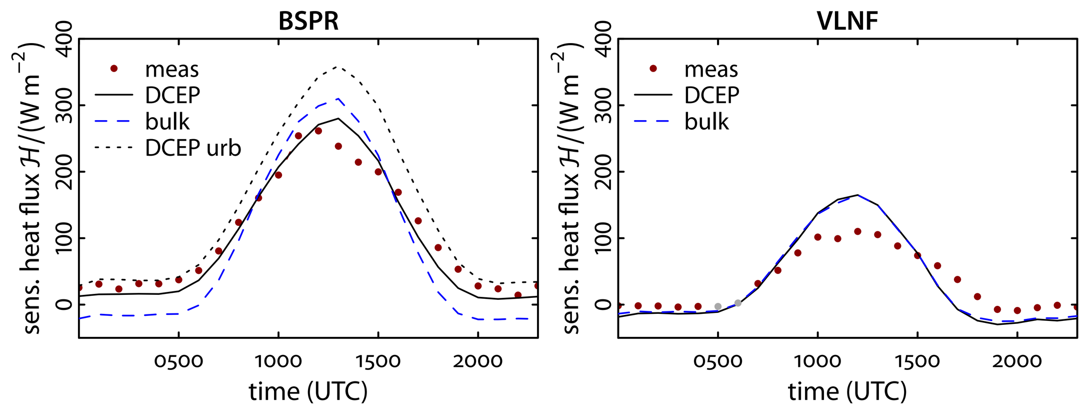



The simulated reflected and emitted longwave radiation $\mathcal{L}^{\uparrow}$ shows a good performance of CCLM/DCEP at BSPR. At night, $\mathcal{L}^{\uparrow}$ is overestimated due to too high surface temperatures.

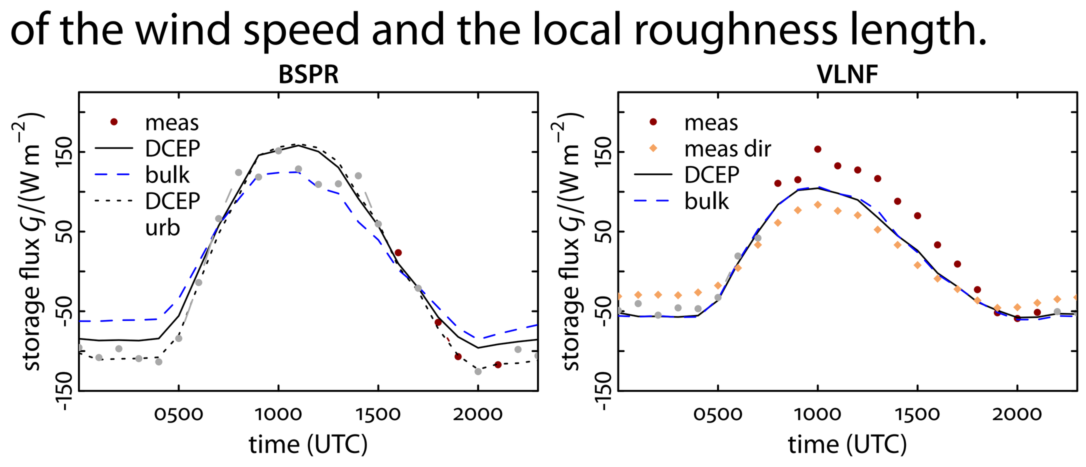
## 6. Surface energy budget




The latent heat flux $\lambda\mathcal{E}$ is slightly improved at the urban stations and clearly improved at the suburban ALLS with DCEP. At the rural stations, $\lambda\mathcal{E}$ is overestimated due to the *locally* different vegetation conditions.

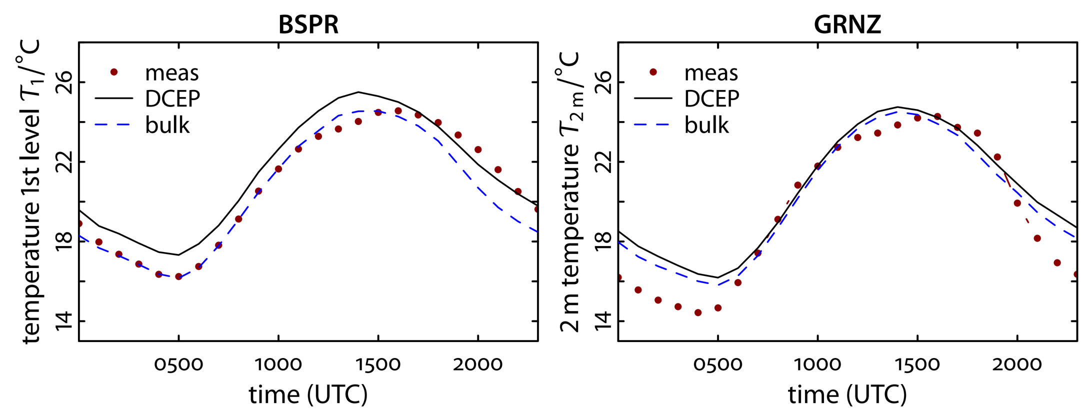



The sensible heat flux $\mathcal{H}$ is improved by DCEP at the urban stations and shows typical urban slightly positive values during nighttime. At the rural sites, $\mathcal{H}$ is overestimated at daytime probably due to the overestimation of the wind speed and the local roughness length.

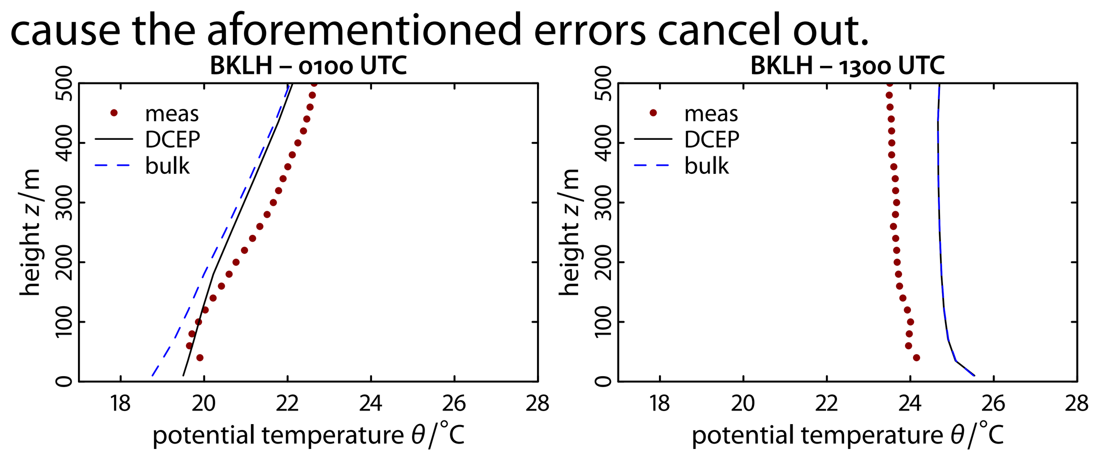



The storage flux $\mathcal{G}$ calculated as the residual of the energy budget is captured well at the urban sites. DCEP shows larger values during daytime and lower (in absolute terms larger) values during nighttime. The latter maintains a positive $\mathcal{H}$.

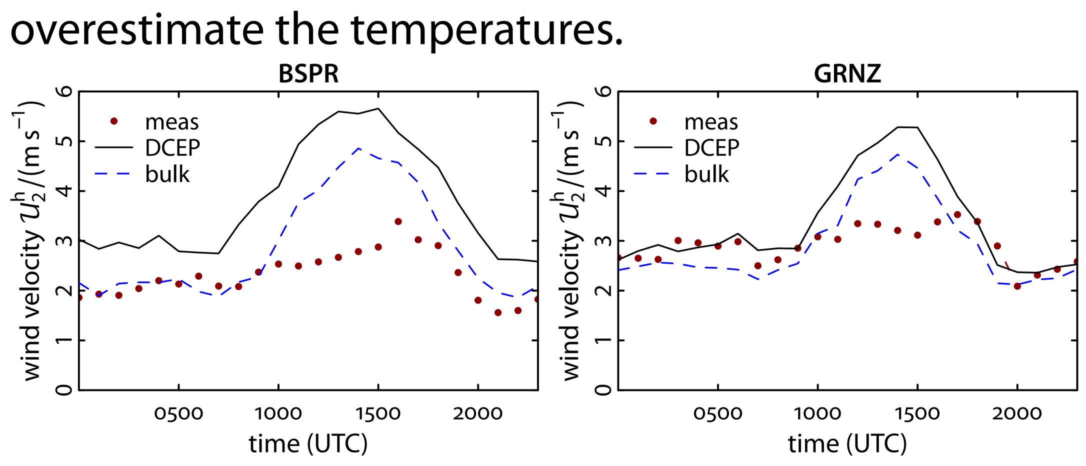
## 7. Air temperature and wind velocity



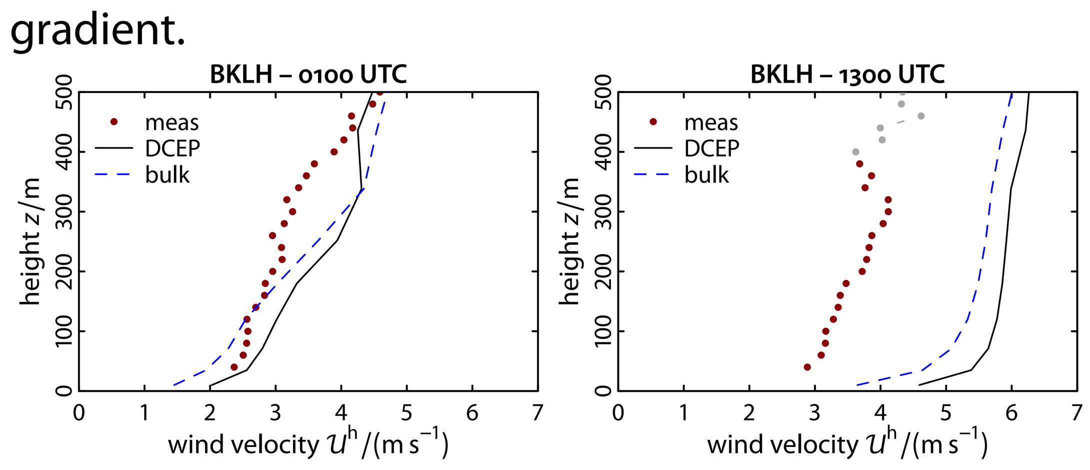

Especially during nighttime, the 2 m temperature $T_{2m}$ is overestimated at the rural stations by CCLM. Furthermore, the bulk scheme does not reproduce the urban heat island. Thus, the bulk scheme captures the lower air temperatures in the city better than DCEP only because the aforementioned errors cancel out.




With DCEP, a less stable lower boundary layer is simulated than with the bulk scheme in the city during nighttime due to the increased sensible heat flux at the surface, yet not as unstable as the measurements up to 100 m indicate. During daytime, both, the bulk and DCEP, overestimate the temperatures.




Both simulations overestimate the wind velocity, especially during daytime. The urban heat island simulated for the area of Basel with DCEP further increases the wind velocity in the city due to the urban/rural pressure gradient.




The behaviour of the wind speed near the surface is reproduced in the wind profiles. The measurements might have uncertainties of about $2\,\mathrm{m\,s^{-1}}$, though (Rotach et al. 2005).