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Application of the complete CORINE land covers for modelling in WRF model

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NEMZETI KUTATÁSI, FEJLESZTÉSI ÉS INNOVÁCIÓS HIVATAL

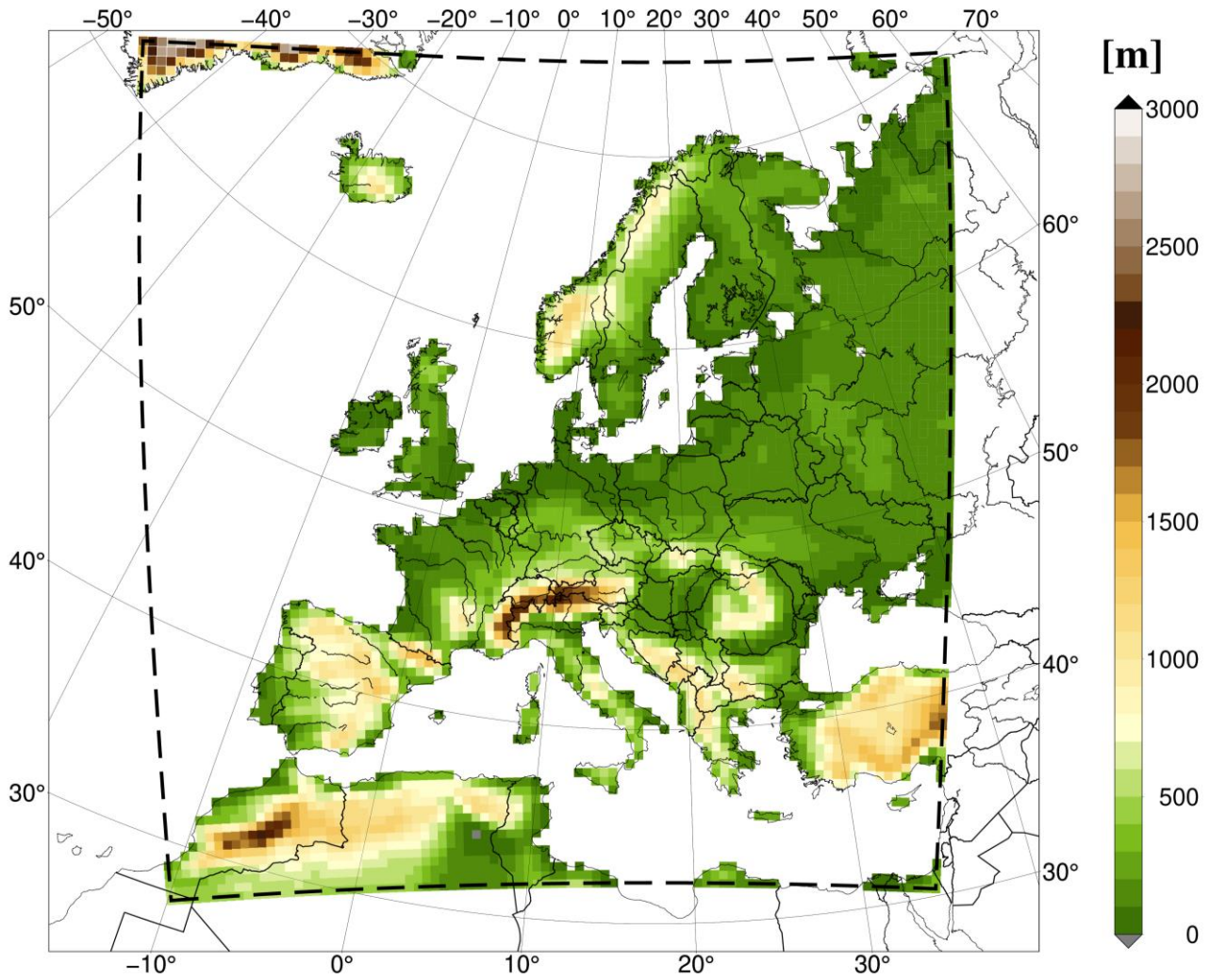
1. Introduction

Surface processes and land-atmosphere interactions are important in weather modelling as they affect the near-surface conditions. These determine the energy partitioning between heating of near surface air and moisture supply of the planetary boundary layer. Through these the near-surface temperature and the precipitation are affected as well. To taking these processes into account the model uses parameterization option, a Land Surface Model. For the better representation the more accurate surface properties are necessary.

In this study we present the complete integration of the CORINE 44 categories into the WRF model, together with the recategorization into USGS land use types. Along with the new land cover types vegetation parameters had be defined as well.

Four one-year runs were created with the WRF 4.2 model using the CORINE land cover database and were compared to the USGS dataset. The modelled area covers the whole European region with 50 km horizontal resolution. Here we present our results for the temperature and the precipitation.

The modelled area

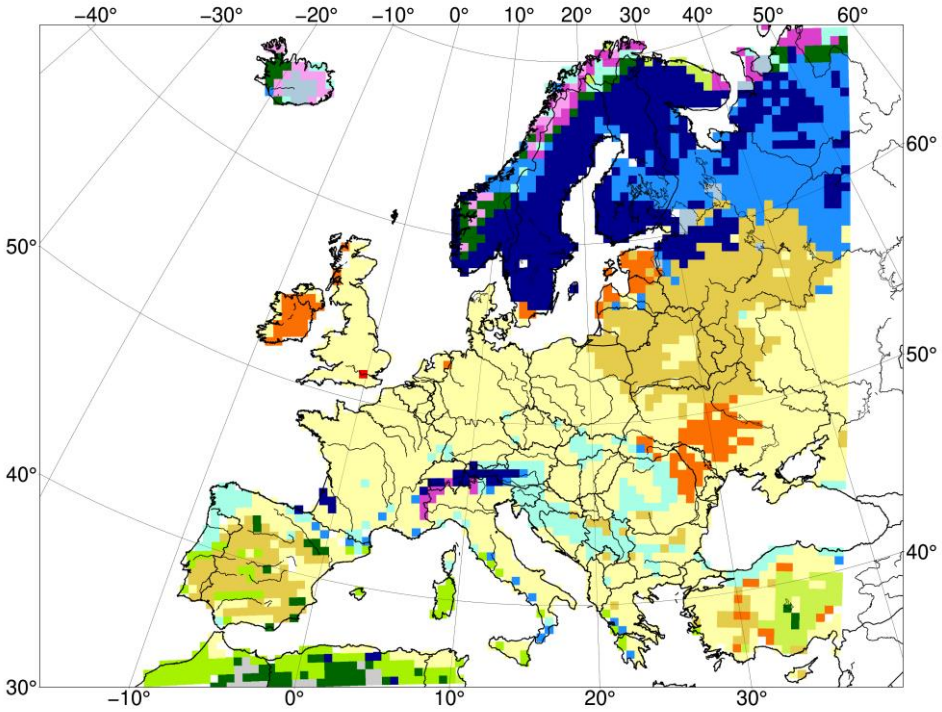


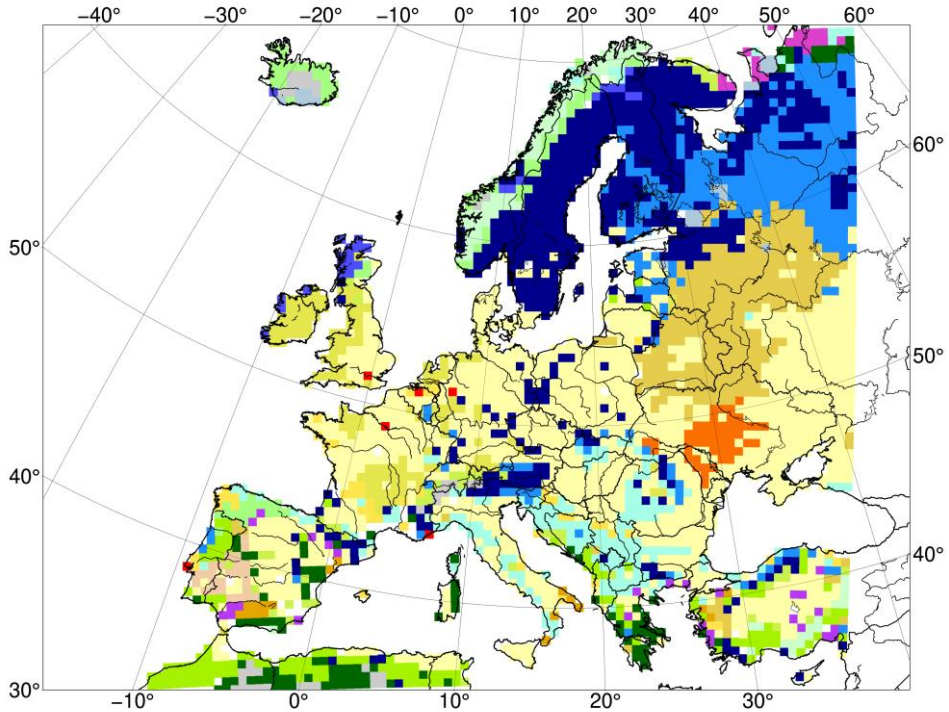
2. 50 km resolution

In the picture the dominant land use categories are shown in a 50 km x 50 km grid cell. The model counts the fluxes based on the ratio of all categories in a grid cell, thus making use of the 250 m resolution data base.

USGS
- available in WRF
- 1 km resolution
- 28 categories

CORINE
- CORINE 2012
- 250 m resolution
- 44 categories





- Urban
- Cropl./Grassl. Mosaic
- Grassland
- Mixed Shrubl./Grassl.
- Evergreen Needleleaf For.
- Barren or Sparsely Veg.
- Mixed Tundra
- Permanently irrigated l.
- Pastures
- Agro-forestry areas
- Sparsely veg. areas
- Dryl. Cropl. and Pasture
- Cropl./Woodl. Mosaic
- Shrubland
- Deciduous Broadleaf For.
- Mixed Forest
- Wooded Tundra
- Snow or Ice
- Olive groves
- Complex cultivation patt.
- Moors and heathland
- Peat bogs

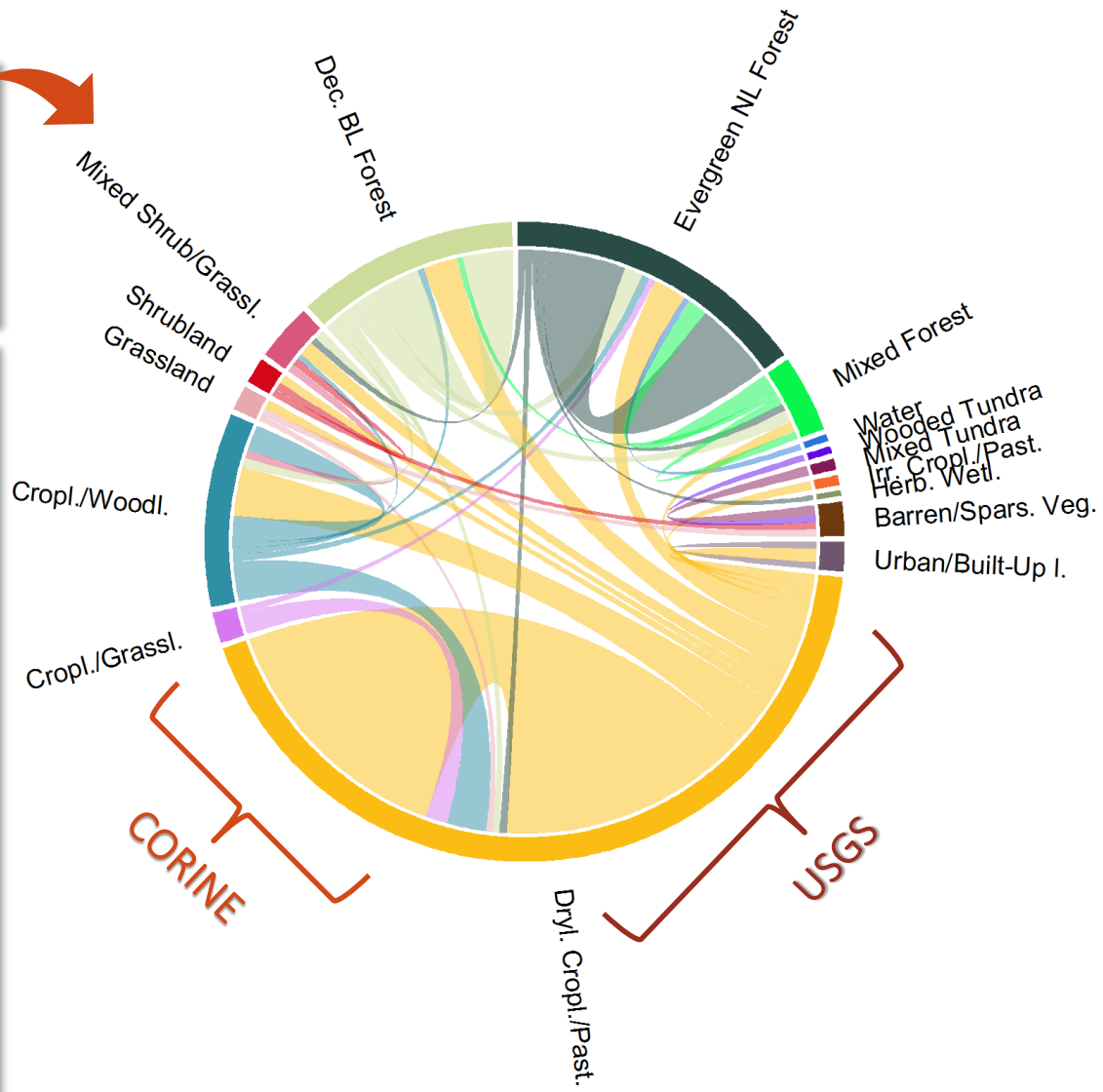
3. 2 km resolution

Overlap between *USGS* and *recategorized CORINE into USGS* land cover types by 2 km resolution only where the incidence number of the category pairs is more then 6250. The outer bands (with the same colour as the circle) represent the *USGS* land cover categories.
The marked CORINE part represents the proportion of all the *USGS* Dryland Cropland and Pasture category that has the same type in the *recategorized CORINE into USGS*.

The Dryland Cropland and Pasture is the most common land cover category in both database, in USGS 42.6% of all the grid cells has this category as the dominant type, in CORINE this ratio is 34.2%. Only 57.3% of the USGS Dryland Cropland and Pasture category has the same type according to the CORINE database. The rest of it converted into other categories, 11.1% into Cropland/Woodland Mosaic, 7.7% into Deciduous Broadleaf Forest, 7.5% into Evergreen Needleleaf Forest and 3% into Urban and Built-Up Land (*Category changes* ⇒).

In the CORINE the representation of the urban and built-up land cover types is more detailed. There is 1 urban and built-up category in the USGS database, on the other hand in the CORINE dataset there is an artificial surfaces group which contains 11 different types. Using the CORINE Land Cover database the ratio of the Urban and Built-up Land category increased from 0.8% to 2.7%. The largest part of the change came from Dryland Cropland and Pasture category, from the already mentioned 3%.

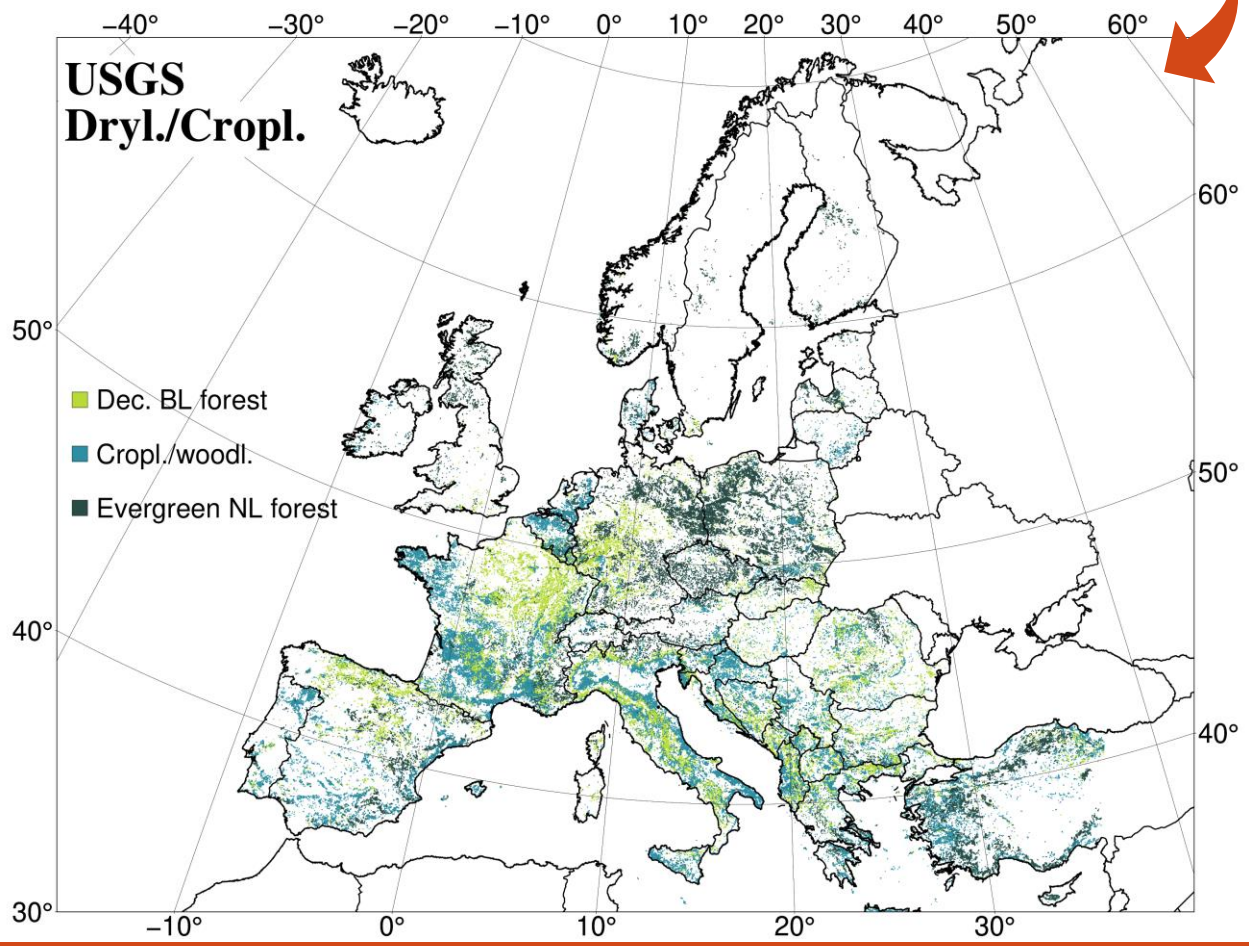
One other important change which effect we examined (*Results 2.* ⇒), 37.9 % of all the Cropland/ Woodland Mosaic grid cell converted into Dryland Cropland and Pasture.

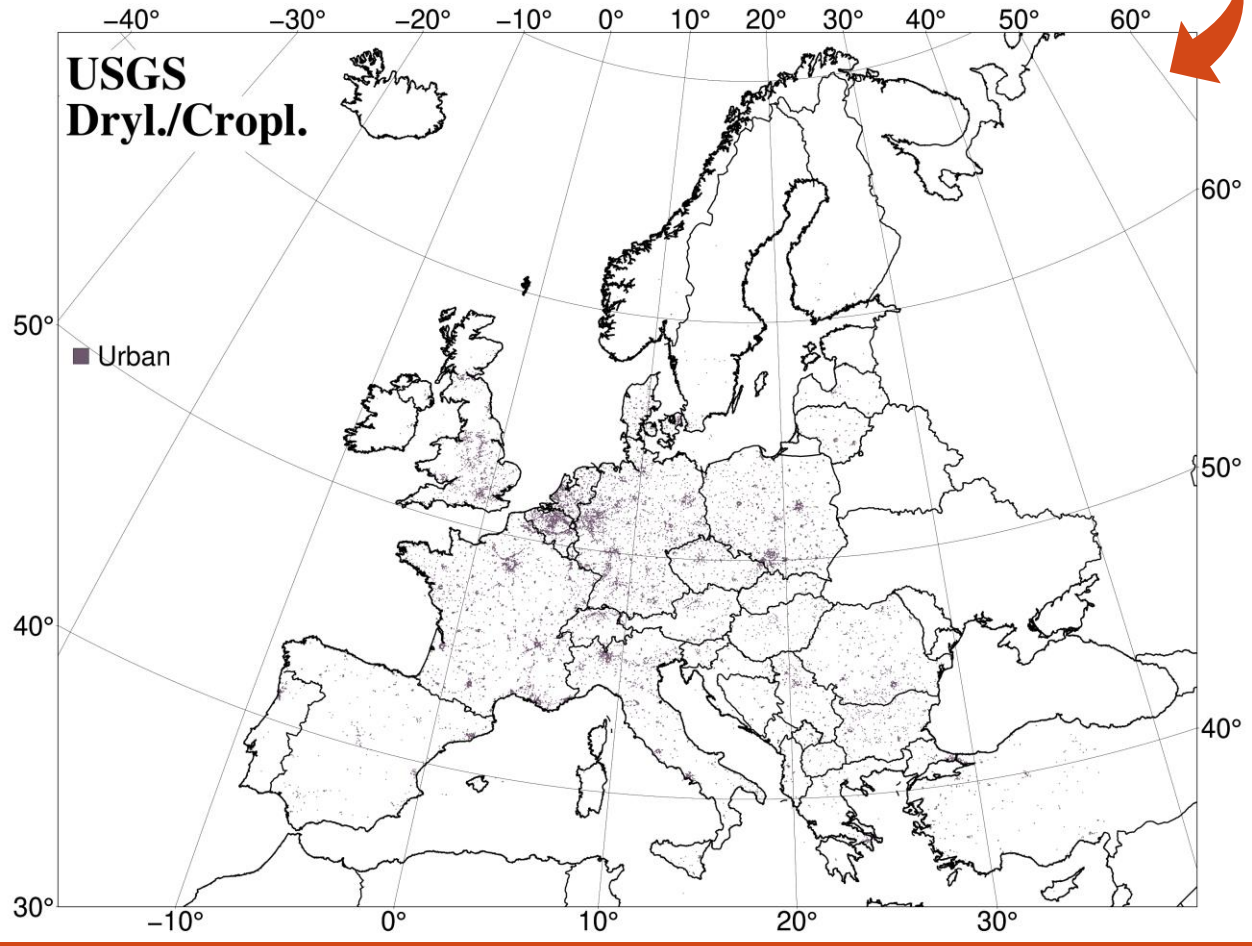


4. Category changes

The distribution of the *USGS* Dryland/ Cropland and Pasture category between *CORINE recategorized into USGS* Deciduous Broadleaf Forest, Cropland/ Woodland Mosaic and Evergreen Needleleaf Forest.

2 km x 2 km grid cells where the *USGS* Dryland/ Cropland and Pasture category changed into *CORINE recategorized into USGS* urban category.



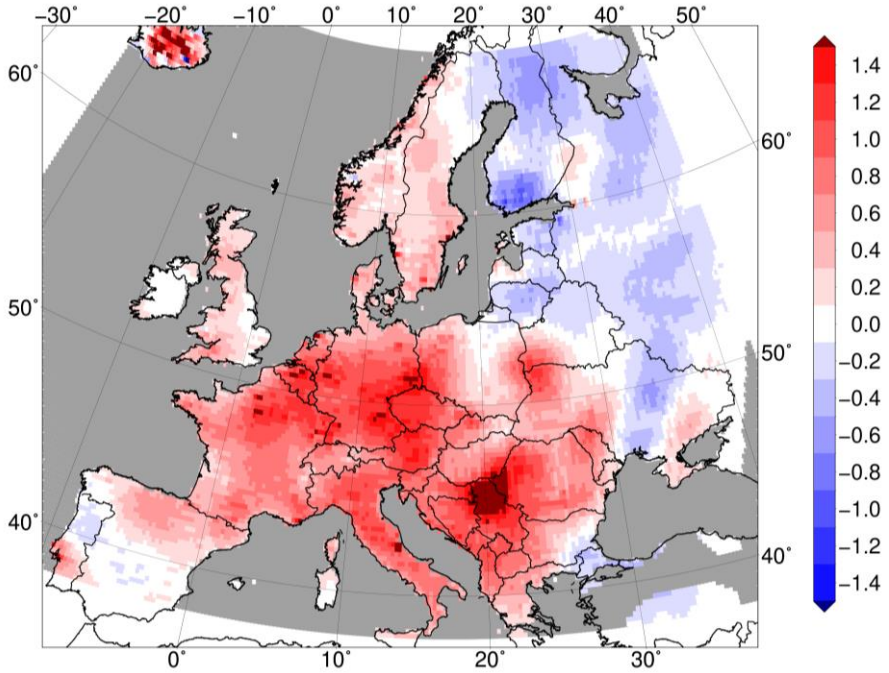


5. Results 1.

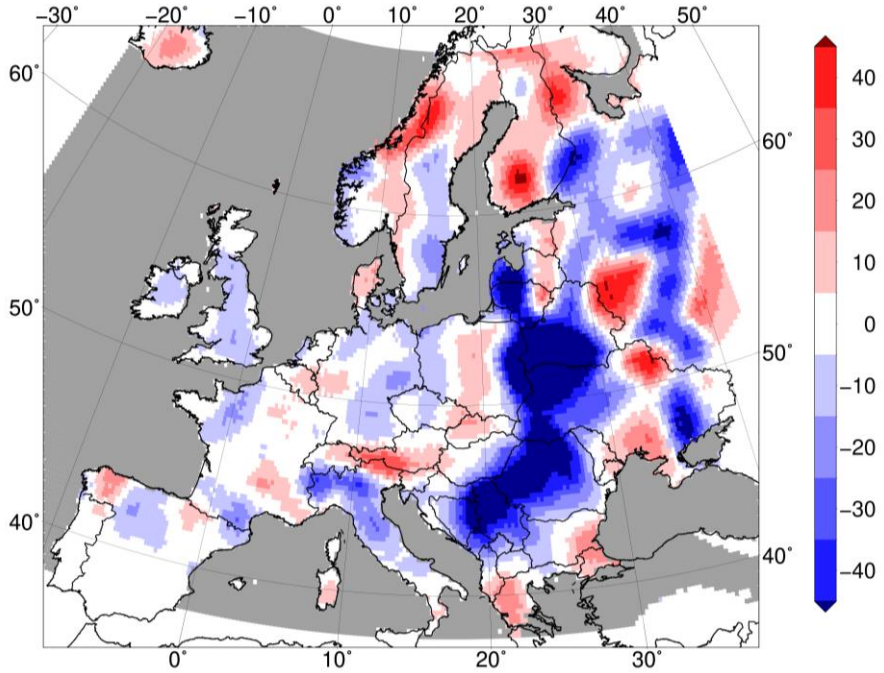
less precipitation → decreased soil moisture → decreased latent heat fluxes → increased sensible heat fluxes → elevated temperature

In Central Europe the m. avg. T diff. is over 1 °C, while the m. avg. maximum T diff. is over 2 °C. Generally maximum T differences are 30% larger than the avg temperatures. Local (isolated grid points) > 1.5 °C diff. is a result of the new urban land covers, as in those cells the latent heat fluxes are close to zero in the model which leads to larger sensible heat fluxes.

As a result of the different land cover types the surface energy balance changes. This leads to different moisture over a grid cell which can cause cloud and precipitation in other areas because of the advection. In this month there was less precipitation in East-Europe, as we can see the difference reached the monthly precipitation amount. The consequence of the dry July was a higher monthly average temperature in Serbia.



Difference in the monthly average 2 m temperature in July (CORINE-USGS parameter – USGS-reference) [°C]



Difference in the monthly precipitation amount in July (CORINE-USGS parameter – USGS-reference) [mm]

Model: WRF 4.2 (50 km resolution) (Skamarock et al., 2019)

Data: ERA5 Reanalysis (0,25° resolution) (Hersbach et al., 2020)

Simulations: Four one-year (2013) runs were created.

USGS-reference: USGS land cover database

CORINE2USGS converted*: CORINE land cover types recategorized into USGS land cover types (Pineda et al., 2004)

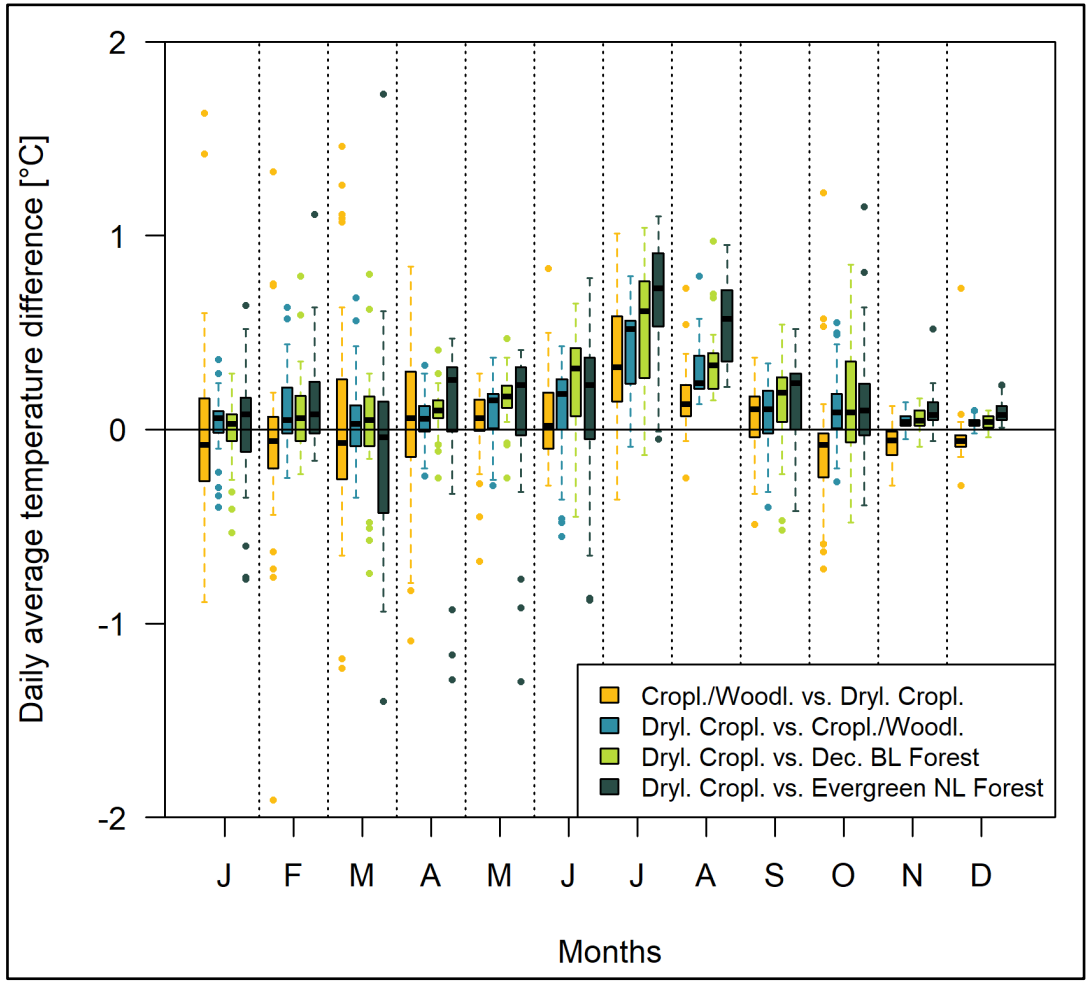
CORINE-USGS parameter*: CORINE categories with original vegetation parameters

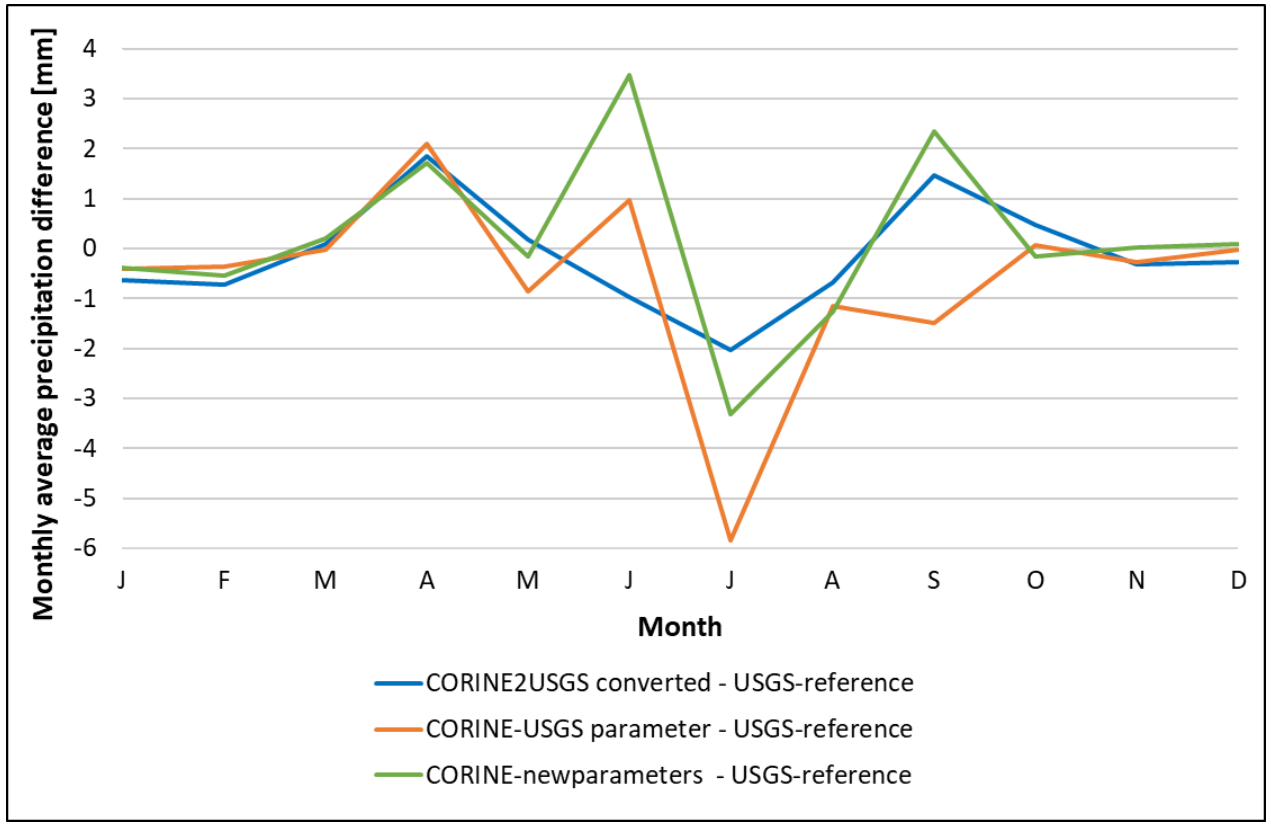
CORINE-newparameters*: CORINE categories with updated vegetation parameters

*USGS land cover dataset was used where CORINE was not available.

6. Results 2.

The effect of the land cover type change between the simulations appeared not only in the summer but from April when the evaporation has a greater impact.





CORINE2USGS converted – USGS reference

The daily average temperature difference only in grid cells where the listed land use type changes occured. The Dryland Cropland and Pasture change into some kind of forest type caused higher average daily temperature. The lower evaporation in evergreen forests caused larger sensible heat fluxes which led to increased temperature. In the case of deciduous forests the decreased soil moisture as the result of the higher evaporation was the reason for the increased temperature.

7. References

CORINE 2012 landcover dataset: © European Union, Copernicus Land Monitoring Service 2021, European Environment Agency (EEA)

Hersbach, H., Bell, B., Berrisford, P., et al. (2020) The ERA5 global reanalysis. Quarterly Journal of the Royal Meteorological Society 146: 1999–2049.

Pineda, N., Jorba, O., Jorge, J., & Baldasano, J. M. (2004) Using NOAA AVHRR and SPOT VGT data to estimate surface parameters: application to a mesoscale meteorological model. International journal of remote sensing 25(1): 129–143.

Skamarock, W. C., Klemp, J. B., Dudhia, J., Gill, D. O., Liu, Z., Berner, J., Wang, W., Powers, J. G., Duda, M. G., Barker, D. M. and Huang, X.-Y. (2019) A Description of the Advanced Research WRF Version 4. NCAR Technical Note NCAR/TN-556+STR 145 pp.

Acknowledgement

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