HPC-Europa3 Transnational Access Programme

Main field: Earth Sciences & Environment

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"Integrated Modelling and Analysis of Influence of Land Cover Changes on Regional Weather Conditions/ Patterns"

The study aims to investigate influence of land cover changes (current vs. scenarios, including hypothetical ones) and its consequences on meteorology for cases of extreme (with heatwave, heavy rains and snowfall) meteorological situations and air quality/ atmospheric composition. The main focus is analysis of regional scale weather, but influence on metropolitan areas will be also studied.

Background information

It is known that land cover makes a significant influence on weather and climate in general by means of variety factors: albedo, roughness, process of photosynthesis, evapotranspiration, release of biogenic volatile organic compounds in plant canopy, energy fluxes and biogeochemical cycles between land and atmosphere, etc. Also anthropogenic contribution to land use/ land cover (LULC) change is tangible and has a profound effect on regional and local climate through replacement one type of vegetation to another or by urban landscape which is characterized by complicated geometry. Climate in turn, also effects on vegetation causing e.g. shifts of some forest species and changes in biodiversity. Thus, climate - LULC change interactions have plenty of apparent and latent interconnections and complexities and remain many researched problems, for example, how do temperate forests impact on local climate [1]. In context of climate change it is necessary to estimate possible effects of land cover change, which is mostly manmade, on weather. Some European countries are facing a problem of deforestation. For example, in Ukraine, during 2008-2017 large areas of forests were cut down, and only 16.3% from this area were reforested. A similar tendency also has been seen - reduction of green spaces in big cities.
The study will use the Enviro-HIRAM model [2] to perform simulations for extreme meteorological situations with current LULC and then to change it in order to estimate the consequences. Three case studies - heatwave and heavy rains in August 2010 and heavy snowfall in March 2013 – will be considered. Several scenarios of land cover changes will be considered, including hypothetical ones such as full deforestation, replacing by other vegetation type and gradually changing percentage of forested areas. The other study task is to be realized at higher resolution on local scale over the metropolitan area (Kyiv). This study will allow to reveal feedbacks between LULC changes and meteorological characteristics including chemical composition in the atmospheric boundary layer for the most frequent extreme weather events (heatwave and heavy precipitation) projected in future decades. The problem of deforestation or planned afforestation is relevant for many countries and not only Ukraine. Obtained estimation of the redistribution of meteorological parameters and atmospheric composition due to forest changes will give solid ground for decision-makers in planning adaptation measures to climate change and developing possible recommendations for national forestry service.
The proposed study is contribution to the PEEX Modelling-Platform research and development, and in particular, for online coupled integrated meteorology-chemistry-aerosols feedbacks and interactions in weather, climate and atmospheric composition multi-scale modelling [3]. Moreover, results of this study will benefit the PEEX programme and, in particular, the Impact on Society platform.

References:

[1] Climate Change and Land. IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems. Summary for policymakers. https://www.ipcc.ch/site/assets/uploads/2019/08/Fullreport-1.pdf

[2] Baklanov, A., Korsholm, U. S., Nuterman, R., Mahura, A., Nielsen, K. P., Sass, B. H., ... Gonzalez-Aparicio, I. (2017). Enviro-HIRLAM online integrated meteorology-chemistry modelling system: strategy, methodology, developments and applications (v7.2). Geoscientific Model Development,10(8), 2971-2999. https://doi.org/10.5194/gmd-10-2971-2017

[3] Mahura, A., Nuterman, R., Nerobelov, G., Sedeeva, M., Smyshlyaev, S., Savenets, M., Pysarenko, L., Krakovska, S., Ivanov, S., Michaelides, S., Ruban, I., Sassi, A.S., Makkonen, R., Baklanov, A., Petaja, T., Zilitinkevich, S., Kulmala, M. (2019): Integrated Multi-Scale Modelling for Meteorology-Chemistry-Aerosol Interactions. Report Series in Aerosol Science (Proceedings of The Center of Excellence in Atmospheric Science (CoE ATM)). No. 226. P.425–429.