Title: **Research of atmospheric dynamics, climate and atmospheric chemistry across scales: from street level modelling to global phenomena**

Peter Huszár, Head of the Department of atmospheric physics, Faculty of Mathematics and Physics, Charles University

Atmospheric research at the Department of Atmospheric Physics, Charles University, covers a broad range of topics, focusing on atmospheric phenomena from the surface to the mesosphere and their mathematical-physical description from micro- to global scales. Key areas include numerical modeling of the climate system, weather forecasting incorporating radar and satellite data, and atmospheric chemistry. We also study small-scale flows, turbulence, urban climate, pollutant dispersion, and the predictability of atmospheric processes.

Regional climate modelling (RCM) has a longt tradition and the associated research focuses on scientific questions related to regional climate change, climate change scenarios and their uncertainties. Various methods for assessment of observed and simulated data are incorporated, including, climate classification schemes, analysis of extreme events, or functional data analysis. Within the WCRP CORDEX initiative we have been active mainly in the EURO-CORDEX branch contributing with regional climate simulations with the RegCM and WRF models. Along with the regional climate modelling activities, the atmospheric chemistry modelling has also strong foundations on the department and works closely with the RCM group focusing mostly on atmospheric chemistry-climate interactions, evolution of natural emissions and their impact on the regional air-quality within climate change, as well as on impact of anthropogenic emission policies with detailed analysis of the gas and particle phase chemical processes.

The emerging need for detailed climate/chemistry description and prediction over urban areas resulted in the formation micro-scale modeling group which focuses on the adaptation and application of the LES modeling technique for street-scale urban studies. We have collaborated on implementing the building surface model within the open LES model PALM. The urbanized PALM model was then used in numerous studies examining mainly the influence of urban greenery in the streets on heat stress and air quality. Most recently, in collaboration with a Norwegian group at the Nansen Center focus was given on the research and application of LES to provide high-resolution simulations and air quality scenarios for Prague and Bergen. The group also investigates the details of turbulent flow and air-pollution dispersion, such as the effect of the coherent structures, in street canyons using LES codes such as OpenFOAM or an in-house model ELMM, which is being actively developed by us.

Within the research of atmospheric dynamics, the gravity wave (GW) research group focuses on representation of internal gravity wave effects on atmospheric dynamics and transport processes in global climate and forecast models. We develop state-of-the-art methods for diagnosing the gravity wave effects in high-resolution simulations and reanalyses and produce numerical experiments with different configurations of the WRF model. We aim to rethink and advance our understanding of the climate impacts of gravity waves in the atmosphere and contribute to improving the way they are parameterized in climate models with a particular focus on the subgrid-scale orography parameterizations. Our group is actively involved in international research initiatives (APARC Gravity Wave Activity, DynVar, A-RIP, TEAMx). Along with the global climate effects of GWs, the overall development of the structure of middle atmosphere within the changing climate is also examined.

The theoretical aspects of predictability and non-linearity of the atmospheric processes are also investigated. Specifically, the error growth of initial conditions in multi-hierarchical systems with different spatio-temporal scales are examined. The intrinsic limits of weather predictability that results from error growth are also analyzed. Further the possibility of extending predictability beyond these limits by using slowly varying phenomena from the atmosphere-ocean interaction are explored.

This presentation provides an overview of the most up to date research activities the department is involved in within the indicated topics including possible pathways of future research.