Description for the general public

Aerosols and clouds are integral component of the Earth atmosphere, and they play an important role in weather and climate. However, the impact of aerosols and clouds on projected climate variations is still poorly understood (see reports of IPCC; the Intergovernmental Panel on Climate Change). This is because of a complexity of interactions among physical processes involved in the formation of clouds and the development of precipitation. In natural clouds, processes occurring at small scales (say, centimeters) affect what happens at larger scales – the scale of a single cloud (few kilometers) or a whole cloud field (tens and hundreds of kilometers). Processes occurring in small scales are labeled microphysics, whereas cloud characteristics at larger scales are called macroscopic properties. Most of microphysical processes, such as the diffusional growth of a cloud droplet in a homogeneous water vapor field or the gravitational collision-coalescence growth of cloud droplets, are well understood in isolation. In natural clouds, however, these processes interact and they occur in environments that vary in space and time. This is especially true for shallow convective clouds because of their limited vertical and horizontal extent, small cloud cover, and their fast evolution in space and time. Therefore their impact on cloud macroscopic properties is difficult to assess. Numerical models can simulate development of individual clouds at high resolution (say, tens of meters) and can simulate the impact once equipped with reliable representation of cloud microphysics and the simulation is capable to document macroscopic impacts with high fidelity.

The overall goal of the proposed research is to study the influence of microphysical processes on macroscopic properties of shallow warm convective clouds with the use of the state-of-the-art numerical model and a novel assessment methodology. We will use a model that applies a novel representation of aerosol and cloud microphysics (called the *super-droplet* method) that has been recently developed at the Institute of Geophysics (Faculty of Physics, University of Warsaw). The new microphysics is a unique method to represent all particles involved in cloud formation and rain development, aerosols, cloud droplets, and drizzle/rain drops. We will apply a novel methodology to provide a confident assessment of the effect of microphysics in simulations of a cloud field. The method, developed by Prof. Wojciech Grabowski from the U.S. National Center for Atmospheric Research can detect miniscule changes in macroscopic cloud field properties despite their large temporal fluctuations. The proposed project will not only advance our understanding of fundamental cloud physics processes, but will also help to develop improved representations of shallow convective clouds for modeling climate and climate change.