Ref.#: At_27
karolina.stanislawska@fmi.fi

ABSTRACT

Genetic programming for heat flux estimation in polar regions

Karolina Stanislawska[1]
[1]*Finnish Meteorological Institute, Polar Meteorology and Climatology, Finland,*

A proper description of the heat exchange between the atmosphere and Earth surface is crucial to understand the Earth heat budget. The problem of an accurate description of the heat flux is a challenge in weather and climate models. In the models this process of high local variability must be described (parameterized) by variables resolved by model grid. Classical approaches to this parameterization, such as the bulk method, tend to make idealized assumptions and too far reaching generalizations. This causes a problem especially in polar regions, where the atmospheric boundary layer is very often stably stratified, with little turbulence. The lack of turbulence causes the heat exchange depend on other processes and these interconnections are not enough described by known models. Therefore a need of alternative ways of defining these relationships arises. In this study genetic programming (GP), a branch of evolutionary computation is used to obtain models that describe the heat flux as a function of different atmospheric variables. The variables include those present in classical methods, such as surface-air temperature difference and wind speed, but also introduce new possibly important factors, such as short- and longwave solar radiation. GP is a method of biologically inspired computing that evolves a population of solutions and chooses best individuals in each generation, mimicking the process of natural evolution of species. The process of GP evolution begins with generating a population of random combinations of defined variables and operators. Then, generation by generation, the individuals in the population are mutated and crossed over, analogously to how the nature does. In each generation the individuals are assessed according to their fitness, and the best performing ones form a new generation. What is important, GP uses domain-specific language to define variables, operators and the fitness function: no transformations to “method-specific” representations are needed. The models or equations are thus explicit at each stage of the evolution. For heat flux problem, the individuals have a form of mathematical equations. The evolution is driven by information coming from two datasets from Arctic and Antarctic sea ice zones. The results obtained present better performance compared to the known parameterizations. They are also considered conceptually novel from the point of view of meteorology, as their evolved form is usually significantly different from the equations used for flux estimation so far. This brings a possibility for a new approach to heat flux estimation and opens the door for applications in weather and climate models.