Forward-inverse modeling based on scalar and vector radiative transfer models for coupled atmosphere-surface systems and machine learning tools

Knut Stamnes1, Børge Hamre2, Snorre Stamnes3, Nan Chen1, Yongzhen Fan1, Wei Li1, Zhenyi Lin1, and Jakob Stamnes2

1Stevens Institute of Technology, Department of Physics, Hoboken, United States of America (kstamnes@stevens.edu)
2University of Bergen, Department of Physics and Technology, Bergen, Norway
3NASA Langley Research Center, MS 475, Hampton, VA 23681, USA

Reliable retrieval of atmospheric and surface properties from sensors deployed on satellite platforms rely on accurate simulations of the electromagnetic (EM) signal measured by such sensors. A forward radiative transfer (RT) model of the coupled atmosphere-surface system can be used to simulate how the EM signal responds to changes in atmospheric and surface properties. Realistic RT modeling is a prerequisite for solving the inverse problem, i.e. to infer atmospheric and surface parameters from the EM signals measured at the top of the atmosphere. The surface may consist of a soil-plant canopy, a snow/ice covered surface or an open water body (ocean, lake, river system). An overview will be provided of forward and inverse RT in such coupled atmosphere-surface systems. A coupled system consisting of two adjacent slabs separated by an interface across which the refractive index changes abruptly from its value in air to that in water/ice will be used as an example. Several examples of how to formulate and solve inverse problems involving coupled atmosphere-water systems will be provided to illustrate how solutions to the RT equation can be used as a forward model to solve practical inverse problems. Cloud screening, atmospheric correction, treatment of two-dimensional surface roughness, Earth curvature effects, and ocean bottom reflection for shallow water in coastal areas will be discussed, and the advantage of using powerful machine learning techniques to solve the inverse problem will be emphasized.

References


[3] Chen N., W. Li, C. Gatebe, T. Tanikawa, M. Hori, R. Shimada; T. Aoki, and K. Stamnes, New cloud mask algorithm based on machine learning methods and radiative transfer simulations, , 219,