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A review of the Synopsis of the PhD dissertation by A. Yu. Karavayskiy "Dielecric models of the mineral soils with account of phase transitions of the soil water" (Specialty: Physics of Condensed Matter – 01.04.07)

The dissertation by A. Yu. Karavayskiy is devoted to a very important scientific and practical problem of investigation of the hydro physical processes in different soils associated with phase transitions of water below- and above freezing temperatures. Thawing of soils in the Tundra regions may potentially have huge effects on the Earth environment (by releasing methane, in particular). This explains significant interest and attention to investigation of corresponding processes which are inevitably related to the phase transitions of free- and bounded water in the soils. The dissertation represents significant contribution to this area of research.
Global monitoring of huge and sparsely populated Tundra regions can be done only by remote sensing means using, in particular, radars and radiometers. Measurements at L-band (1.4 GHz) are particularly popular due to their sensitivity to soil moisture. This explains focus on this frequency range in this work. However, other frequencies which can be used by airplane-mounted radars are also of significant interest. In fact the results of the dissertation, as it follows from available publications by the author and corresponding research groups with his participation, cover frequencies starting from 50 MHz. Such relatively low frequencies appeared to be of significant interest to a particular approach to the remote sensing of soil moisture which is currently pursued in the National Oceanic and Atmospheric Administration (NOAA) in the USA.

Interaction of electromagnetic waves with environment is totally determined by a complex, frequency dependent dielectric constant of corresponding media. There exist different models of dielectric constant of soils, however they all are applicable to GHz range and usually do not take into account phase transitions of water. The dissertation by A. Yu. Karavayskiy fills in this significant gap. The author not only performed measurements and tabulated the data, however provided their physical interpretation. Moreover, he developed models for the complex dielectric constant of the soils of particular types. These models include as input parameters gravimetric content of water in the soil, density of the substrate, temperature, and content of clay what makes them very convenient to use. One of the models developed by A. Yu. Karavayskiy

implemented and used in our research group in NOAA. It is important that the models were verified independently by comparing the results obtained with the soil samples not used for the model development. It is also acknowledged in the current scientific literature that these models ensure higher accuracy of the dielectric constant calculations as compared, for example, with well-known and broadly used Dobson's model.

In my mind the dissertation by A. Yu. Karavayskiy is a solid work and is in full compliance with national and international standards of PhD-level work and he certainly deserves the PhD title in specialty Physics of Condensed Matter.

Should there are any questions I can be reached by email <alexander.voronovih@noaa.gov> or, after shut down due to COVID 19 is over, by phone 303-497-6464.

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I acknowledge that Alexander Voronovich signed this document in my presence on April 14th 2020

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