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Model complexity in microwave remote sensing of soil moisture

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Microwave remote sensing of soil moisture has been an active area of research since the 1970s. While from a scientific point of view much progress has been made, there is still a lack of operational methods for retrieving soil moisture accurately enough to be of value for meteorology, hydrology and other applications. Nevertheless, given recent advances using operational radiometer (AMSR-E) and scatterometer (ASCAT) data and the approval of a dedicated soil moisture mission (SMOS), it is expected that within the next few years coarse-resolution soil moisture products (25-50 km) will finally become routinely available. On the other hand, scientific and technological breakthroughs are still a pre-requisite to make soil moisture monitoring at finer scales ($<$ 1 km) from Synthetic Aperture Radar (SAR) a reality. This presentation will address the question, why it has taken such a long period to reach this level, despite the relationship between soil moisture and microwave observations is generally strong for frequencies below about 10 GHz? While it is certainly true that past and current microwave sensors have not been optimal for soil moisture retrieval, it is also obvious that our lack of physical understanding of the interaction of microwaves with the Earth's surface has caused significant problems. In fact, it appears that the choice of the algorithm can have a similarly strong impact on the quality of the retrieved soil moisture product as the choice of instrument. One particular controversial question for algorithm developers is model complexity. Ideally, we would like to use models, which describe the physical reality in great detail, just based on theoretical considerations. However, any current spaceborne microwave sensor measures only a few independent variables. This creates a mismatch between the complexity of physical models and the dimension of the observation space. On these grounds it will be argued that more parsimonious retrieval approaches are more appealing than sophisticated ones.