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The comparison of ERS-2 satellite data, TDR-measurements and modeling of soil water content in the boreal forested area

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The feasibility of the ERS-2 SAR for monitoring the status of surface soil water content in the boreal forest was investigated at two sites, the Rudbäck catchment (0.18 km2) and the Hyytiälä test area (20kmx20 km), located in southern Finland. In the first phase, the existing soil water data was reassessed to allow a comparison of satellite data with ground truth data. During 1994-1995, the intensive soil water content measurements were carried out in the Rudbäck catchment. The area of the catchment is 0.18 km2, the growing stock is dominated by Norway spruce and the average cubic meter of solid timber is 211 m3/ha. The dominating soil type of the both sites is morain, with small areas of finer grained soils and peat. The open bedrock covers a large portion of the area. The soil layers are relatively thin, exclusive of the peat areas. The soil water content was measured with time domain reflectometer (TDR) at 30 m spacing interval inside the Rudbäck catchment while only one measurement site was available in Hyytiälä area. The data of both areas were classified based on soil data and growing stock and the soil water content data was analyzed separately for different classes.

One of the major problems in comparing the ground truth soil moisture data with satellite data is the natural small-scale mosaic variability of the landscape. The first area, the Rudbäck site, is well mapped with ground truth soil moisture measurements (70 points/ 0.18 km2) but the area is fractured and too small for satellite data resolution (covering appr. 25 satellite pixels). The other test area to be used in the study, the Hyytiälä site, has opposite situation: good satellite coverage but poor ground truth coverage.

Satellite data are very complex. We feel that the most reliable data are obtained in the areas with minor tree coverage. In densely forested areas, the backscattering coefficient, which reflects the moisture situation, is strongly affected by the foliage or underbrush moisture condition. Relative humidity and precipitation data explained some inconsistencies between satellite data and ground truth measurements but unfortunately not all. The study shows that in peat areas with a low tree density and a high soil moisture variation, the ground soil moisture measurements correspond satisfactorily with the satellite soil moisture data. In rocky and densely forested areas the signal of the soil moisture situation is blurred by external noises.

The soil moisture content based on satellite data varied from 10 vol-% to 28.5 vol-% while the average range measured with TDR method varied between 16.4 and 37.5 vol-% in the Rudbäck area. According to the land surface model simulations (ASTIM model) the smaller the growing stock density is, the drier the soil moisture condition is at the end of August (at soil moisture minimum). This phenomenon was affirmed with satellite data obtained from Hyytiälä. One point which also decreases the comparability between satellite and TDR data is the fact that TDR data represents the average moisture condition of the 0.2 m layer from the soil surface while satellite data represents the soil moisture content of 0-0.02 m layer. There might be more diurnal soil moisture variation in the vicinity of the soil surface than can be observed in the deeper layers.