Detecting Soil Thawing in Siberia with ERS Scatterometer and SAR

K. Boehnke and V. R. Wismann

Institute for Applied Remote Sensing, Bahnhofstrasse 54, 22880 Wedel, Germany
ifars compuserve.com
http://ourworld.compuserve.com/homepages/ifars

Abstract

Based on multi-temporal radar backscatter measurements obtained from the ERS-1 scatterometer at various incidence angles, a method was developed for monitoring the state (frozen/thawed) of the upper layer of the soils in arctic to temperate climate regions. In spring and to some lesser extent in fall, the normalized radar cross section (NRCS) data show distinct variations which can be attributed to thawing and freezing soils. When liquid water in soil freezes, the dielectric constant of the soil falls dramatically. This process is reversed in spring when the soil thaws and expresses itself as a dramatic increase in NRCS. The application of a change detection algorithm to the average radar cross sections derived from ERS scatterometer data for the Siberian test site reveals maps of the state of the soils for the years 1992 - 1996. The signatures detected in these maps are well represented in air temperature reanalyses and SSM/I derived snow cover maps.

Depending on the geographical position, an additional strong decrease in NRCS, within only one week, is detected at the time of initial snow melt. This behavior is investigated in detail for a location in Northern Siberia. Here, the NRCS time series derived from the scatterometer is compared to a time series of ERS SAR images. Precisely, the diversity encountered in an ERS scatterometer resolution cell and the representativeness of the ERS scatterometer data for the soil thawing process are investigated.

While on the 50 km scale the NRCS measured by both instruments agree well, the ERS SAR images reveal a very inhomogeneous radar cross section within the scatterometer resolution cell during the snow melt phase. Areas where wet snow persists and melt water runoff or infiltration is inhibited have low NRCS, whereas the NRCS of regions that are exposed is up to 10 dB higher. During this phase of the freeze/thaw cycle, single point in situ measurements are shown to be non-representative of the situation encountered by the scatterometer.