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BRDF characteristics of tundra vegetation communities in Yamal, Western Siberia

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Satellite data from platforms with pointing capabilities (CHRIS/Proba, RapidEye) or from sensors with wide swath (AVHRR, MODIS, MERIS) is influenced by the bidirectional reflectance distribution function (BRDF). This effect can cause significant changes in the measured spectral surface reflectance depending on the solar illumination geometry and sensor viewing conditions.
The Environmental Mapping and Analysis Program (EnMAP), a German hyperspectral mission with expected launch in 2016, will provide high spectral resolution observations with a ground sampling distance of 30 meters. Since the EnMAP sensor has pointing capabilities, both spectral and directional reflection characteristics need to be taken into account for the algorithms development for vegetation parameters. The 'hyperspectral method development for Arctic VEGetation biomes' (hy-Arc-VEG) project is part of the national preparation program for the EnMAP mission. Within the EnMAP projcect hy-Arc-VEG we developed a portable field spectro-goniometer, named ManTIS (Manual Transportable Instrument for Spherical BRDF observations), for the in-situ measurements of anisotropic effects of tundra surfaces (national and international patent pending – DE 102011117713.6). The goniometer was designed for field use in difficult as well as challenging terrain and climate. It is therefore of low weight, without electrical devices and weatherproof. It can be disassembled and packed into small boxes for transport. The current off-nadir viewing capacity is matched to the EnMAP sensor configuration (up to 30°).
We carried out spectral field and goniometer measurements on the joint YAMAL 2011 expedition (RU-US-DE) organized by the Earth-Cryosphere Institute (ECI) in August 2011 on the Yamal Peninsula, northwestern Siberia, Russia. The field goniometer measurements (conducted under varying sun zenith angles) as well as field spectro-radiometrical measurements were carried out at the NASA Yamal Land Cover/Land Use Change (NASA Yamal-LCLUC) transects and réleves at Laboravaya (southern Yamal) and Vaskiny Dachi (central Yamal), and at the Circumpolar Active Layer Monitoring (CALM) site in Vaskiny Dachi. The LCLUC plots are Greening of the Arctic (GOA) sites established in 2007 by Walker et al. (2009). The Circumpolar Active Layer Monitoring (CALM) site was established by M. Leibman (ECI) in 1993.
BRDF processing for the tundra test sites demonstrate the mirror asymmetry in relative azimuth with respect to the principal plane. It also showed that the maximum scattering appears in the backward direction, but that there is no minimal forward scattering. Instead, the forward scattering is characterized by similar to higher reflectance values compared to the nadir position. Moreover, the analysis of the anisotropic behaviour of moss-dominated tundra types with 10 to 15% vascular plant cover show that the BRDF influence on vegetation indices (VI) of low-growing arctic vegetation communities can be up to 15% of the nadir value. The low sun elevation at the arctic latitudes prevents hotspot-effects, but a BRDF normalization still should be taken into account for the development of tundra-adapted vegetation indices.

Walker, D.A. et al. (2009): Data Report of the 2007 and 2008 Yamal Expeditions. AGC Data Report. 133.