User and Expert-supported Validation and Evaluation Experiments for high-latitude permafrost landscapes: ESA DUE PERMAFROST (2009-2012) and ongoing EnMAP, PAGE21, and HGF-EDA programs

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The ESA Data User Element (DUE) Permafrost (2009-2012) created an Earth Observation service for permafrost-related applications with extensive involvement from the permafrost research community. The DUE Permafrost consortium produced time series on regional and circum-arctic scales of'Land Surface Temperature'(LST), 'Surface Soil Moisture' (SSM), 'Frozen/Thawed Surface Status' (Freeze/Thaw), and static products of 'Terrain', 'Land Cover' (LC), and 'Surface Waters'.

Most of the DUE Permafrost services are based on operationally available remote sensing products. However, permafrost landscapes are a challenge for qualitative and quantitative remote sensing. The land surface is highly heterogeneous characterized by patterned ground, disturbances, abundant small water bodies, and sharp moisture gradients. Only few error estimates or standard evaluation methods exist for remote sensing products from high-latitude terrestrial landscapes. An additional significant challenge in the evaluation of remote sensing products in high-latitude permafrost landscapes is the very sparse availability of ground data.

Ground-based evaluation of the operationally available remote sensing products is needed. International programs, such as the Global Terrestrial Network for Permafrost (GTN-P) initiated by the International Permafrost Association (IPA) as well as national programs such as the scientific preparation programs for two national satellite missions (hyperspectral EnMAP satellite mission, Tandem-L radar satellite mission (Helmholtz Alliance Remote Sensing and Earth System Dynamics HGF-EDA) provide ground data and evaluation experiments.

We will show examples of:

- Evaluation experiments of remote sensing products of 'Land surface temperature' (LST) and 'Frozen/ Thawed Surface Status' (Freeze/Thaw) using GTN-P data (ESA DUE Permafrost).
- Evaluation experiments of optical and microwave remote sensing products using the method of 'homogeneous measurement fields' (HGF-EDA, PAGE21, EnMAP).
- field-based spectral and BRDF measurements of vegetation at different scales collected in Alaska, Yamal (Western Siberia) and the Lena Delta (Arctic Siberia) (EnMAP).