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Derivation of soil surface roughness dynamics from multi temporal and multi parametric airborne PolSAR data

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Information on the spatial and temporal distribution of soil surface roughness states at field and even at the landscape scale is crucial for many hydrological applications. Many investigations have shown, that soil surface roughness, at the scale of 2-200 mm, plays an important role in numerous physical processes such as run off generation, infiltration, depressional storage capacity as well as lateral and vertical matter fluxes. Still, in recent modelling efforts, roughness is usually treated as a static parameter, leading to strong simplification and data uncertainty in the description of these physical processes and the derivation of hydrological quantities. However, this simplification is not only due to the lack of theoretical process knowledge but rather refers to the lack of appropriate input data to sufficiently describe roughness in such modelling efforts, since it is very complex to measure roughness under natural conditions.

To overcome the current limitations, the performance of three potential PolSAR roughness estimators is investigated to derive soil surface roughness dynamics under a wide range of natural surfaces. The presented study utilizes airborne C- and L-Band PolSAR data and intense photogrammetric in field roughness information collected on a weekly basis during the ESA founded AgriSAR 2006 campaign in the North-East of Germany over a whole agro-phenological cycle. To characterize in field soil surface roughness, the well established RMS-Height and Tortuosity Index were calculated. As potential roughness estimators (1) the Anisotropy (A), (2) the right-right left-left complex circular Coherence ($\rho|\mathrm{RRLL}|$) and (3) only the real part of the circular coherence

($\mathrm{Re}_{[\rho RRLL]}$) were correlated with the in field roughness information. However, only a good correlation was measurable between $\mathrm{Re}_{[\rho RRLL]}$ and the RMS-Height. During the correlation process it was obvious that values for all calculated PolSAR parameters with ks $<$ 0.27 cm are randomly distributed.

Final results in form of multi-temporal soil surface roughness maps showed only satisfying results due to several reasons:

- The presence and development of particular plants affected the derivation of soil surface roughness even under sparse vegetation.
- The calculated in field roughness indices did not allow an adequate separation of crusted or sealed soils with fresh harrowed soils .

However, for the derivation of soil surface roughness on bare fields the proposed approach is feasible and very promising. The potentials and implications of these findings for process-based hydrologic modelling will be discussed.