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Title: *The impact of a non-uniform land surface on the radiation environment over an Arctic fjord – a study with a 3D radiative transfer model*

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This paper addresses the influence of land topography and cover on 3D radiative effects under clear and overcast skies in the Arctic coastal environment, in particular in the Hornsund fjord region, Spitsbergen. The authors focus on the impact of a nonuniform surface on the spatial distribution of solar fluxes reaching the fjord surface as well as remote sensing of cloud optical thickness and aerosol over the fjord.

The analysis is based on Monte Carlo simulations of solar radiation transfer over a heterogeneous surface for selected channels of MODIS. The simulations showed a considerable impact of the land surrounding the fjord on the solar radiation over the fjord. The biggest differences between atmospheric transmittances over the fjord surface and over the ocean were found for a cloud optical thickness tau(555 nm)=12, low solar zenith angle theta, high cloud base and snow-covered land. For tau(550 nm)=12, theta=53^o, cloud base height 1.8 km and wavelength lambda=469 nm, the enhancement in irradiance transmittance over the fjord was 0.19 for the inner fjords and 0.10 for the whole fjord. In the case of clear skies, the highest enhancement in irradiance transmittance over the fiord was found for relatively high aerosol optical thickness (tau_{aer}(550 nm)>0.3), weakly absorbing aerosols, high solar zenith angle (theta=53^o), high land albedo and channel 3 (569 nm) of the MODIS radiometer: > 0.06 for the whole fiord and >0.11 for the vicinity of sun-lit cliffs.

For the mouth and central part of the fjord the error due to the use of channel 2 of the MODIS radiometer (lambda=858 nm) for cloud optical thickness retrieval waso, cloud optical thickness retrieved solely from MODIS channel 2). However, near the shoreline (up to 2 km from it), especially over the inner fjords, the cloud optical thickness was then overestimated by >3 for teta(550 nm)=5 and by >5 for teta(550 nm)=20. In the case of aerosol optical thickness retrieval, the error due to highly reflective land surrounding the fiord is much bigger. Unless a local 3D algorithm is implemented, channels 569 and 858 nm of MODIS should not be used for retrievals of aerosol optical thickness over the water in the coastal regions of the Arctic. The expected errors would exceed 100%. In lateral fiords the error reaches even several hundred percent.