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The effects of mineral aerosol deposits on the BRDF (bidirectional reflectance distribution function) of sea ice for the calibration of satellite remote sensing products: an experimental and modelling study.

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Knowledge of the albedo in the cryosphere is essential to monitor a range of climatic processes that have an impact on a global scale. Optical Earth Observation satellites are ideal for the synoptic observation of expansive and inaccessible areas, providing large datasets used to derive essential products, such as albedo. The application of remote sensing to investigate climate processes requires the combination of data from different sensors. However, although there is significant value in the analysis of data from individual sensors, global observing systems require accurate knowledge of sensor-to-sensor biases. Therefore, the inter-calibration of sensors used for climate studies is essential to avoid inconsistencies, which may mask climate effects. CEOS (Committee on Earth Observing Satellites) has established a number of natural Earth targets to serve as international reference standards, amongst which sea ice has great potential. The reflectance of natural surfaces is not isotropic and reflectance varies with the illumination and viewing geometries, consequently impacting satellite observations. Furthermore, variations in the physical properties (sea ice type, thickness) and the light absorbing impurities deposited in the sea ice have a strong impact on reflectance. Thus, the characterisation of the bi-directional reflectance distribution function (BRDF) of sea ice is a fundamental step toward the inter-calibration of optical satellite sensors.

This study provides a characterisation of the effects of mineral aerosol and black carbon deposits on the BRDF of three different sea ice types. BRDF measurements were performed on bare sea ice grown in an experimental ice tank, using a state-of-the-art laboratory goniometer. The sea ice was "poisoned" with concentrations of mineral dust and black carbon varying between 100 and 5 000 ng g-1 deposited uniformly in a 5 cm surface layer. Using measurements from the experimental facility, novel information about sea ice BRDF as a function of sea ice type, thickness and light-absorbing impurities was derived using a radiative-transfer model (PlanarRad). This extensive characterisation of the multi angular reflectance of sea ice reveals the importance of BRDF for the validation and calibration of Earth Observation satellite sensor data.