Spectral Light Transmittance through Arctic Sea Ice

Background
- Light transmittance through sea ice has important impacts on both the ocean heat content and the ice associated ecosystem.
- We investigate the solar shortwave radiation transmitted through snow and sea ice and its spatio-temporal variability.
- We aim to deduce surface topography and sea ice draft from the spectral transmittance and combine these data sets for upscaling onto the aggregate scale.

Light transmittance
- Comparison between First Year Ice (FYI) and Multi Year Ice (MYI) off Alert, Canada (Last Ice Area project).
- Light transmittance is determined using measurements of transmitted irradiance under the sea ice and of incoming irradiance at the surface.
- Very low transmittances of 0.2 – 1.0% through FYI and < 0.1% through MYI.

Research goal
- Development of an algorithm that uses the spectral transmittance data to yield information about the surface topography and the under-ice structure.
- Multiplicative exponential function fit for light transmission: \( \tau = \exp\left(-\left(\kappa_{snow}(\lambda) + \kappa_{ice}(\lambda) + \kappa_{bio}(\lambda)\right)\right) \)
- Statistical approach: calculate normalized difference indices (NDI).
- Generate synthetic spectra from surface topography and ice draft using a radiative transfer model.

Methods
- Spectral radiance (7°) and irradiance (90° cos) are obtained using a Remotely Operated Vehicle (ROV).
- Sea ice draft is measured by a single-beam altimeter / multi-beam profiling sonar mounted on the ROV.
- Snow thickness is derived from a Magna Probe and a Terrestrial Laser Scanner (TLS) which emits laser pulses in the near infrared (1550 nm).

Snow thickness
- Snow thickness distribution and temporal change can be derived from TLS scans.
- Snow thickness is measured using a Magna Probe.

Ice draft
- Level FYI has a continuous thickness of about 1.5 m and structured MYI has thicknesses up to 5.5 m.

Combined data set
- Merge snow thickness, ice draft, and light transmittance on same coordinate system.
- Allows detailed analyses of how snow and sea ice influence the light transmittance.

Snow thickness
- Light transmittance through snow and sea ice (colored dots) and symbolized snow thickness (red) and ice draft (green).