Light Transmission Through Arctic Sea Ice
- Large-Scale Studies on Seasonality and Spatial Variabilty -

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Field measurements

Expedition ARK-XXVI/3 (TransArc, Aug-Oct 2011)

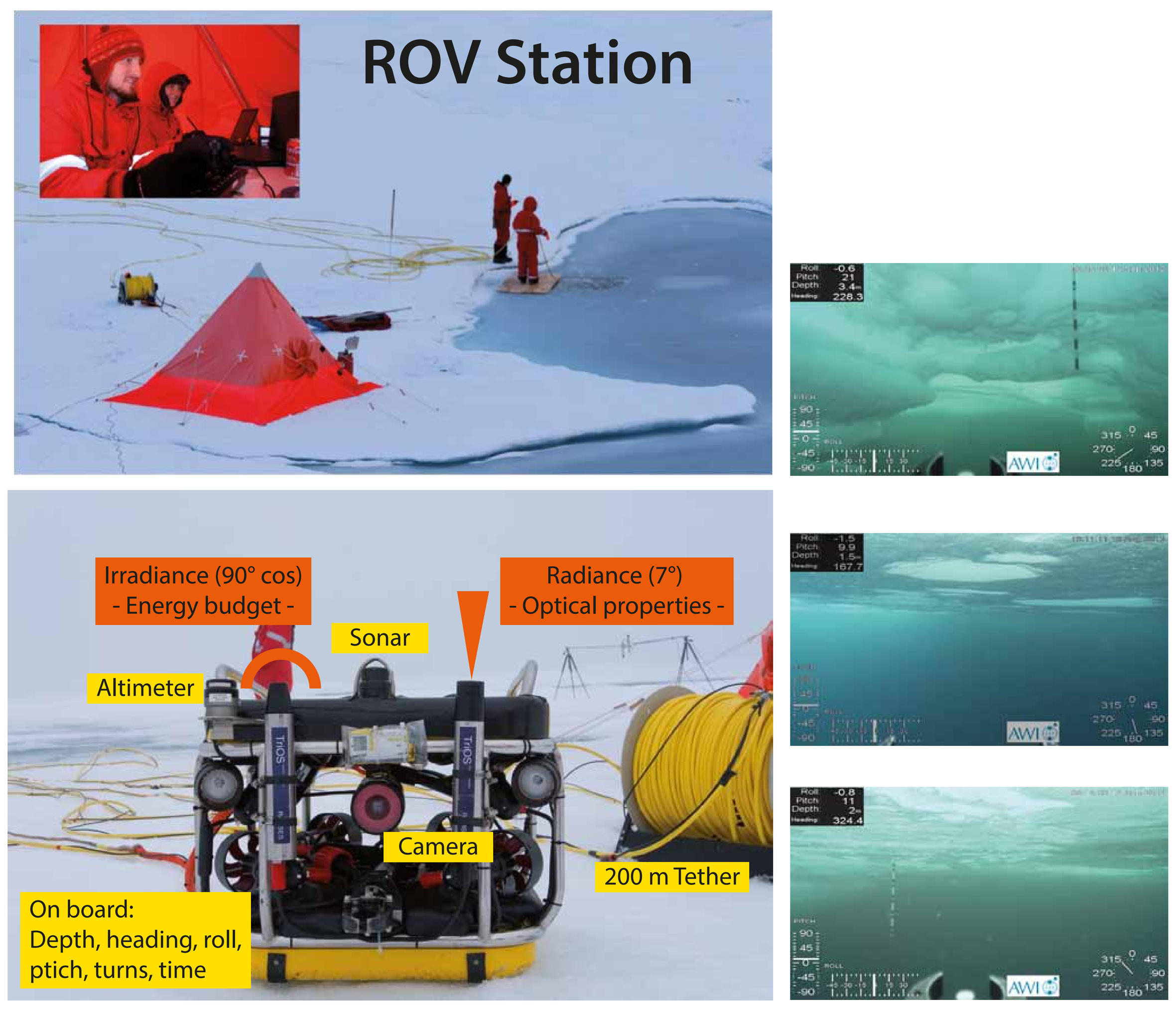


Figure 1: Left: Set up and instrumentation for under-ice transects of spectral radiation using a Remotely Operated Vehicle (ROV) operated directly from the sea ice. **Right**: Impressions from under the sea ice, photographs taken by the ROV. Markers are 1 m long.

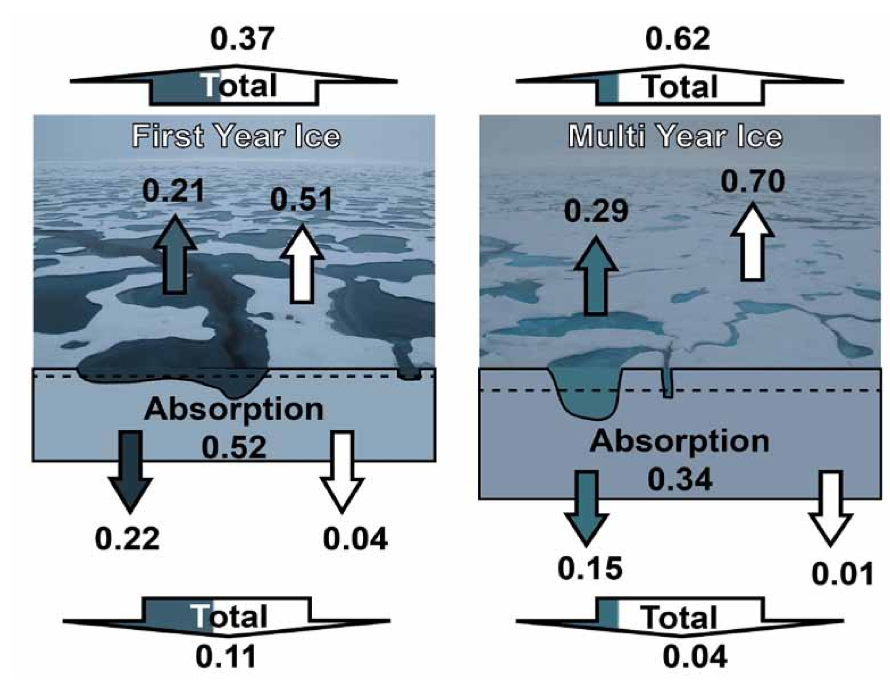


Figure 2: Resulting parameterization of broadband albedo (arrows up, Perovich et al., 1996), transmittance (arrows down), and absorption.

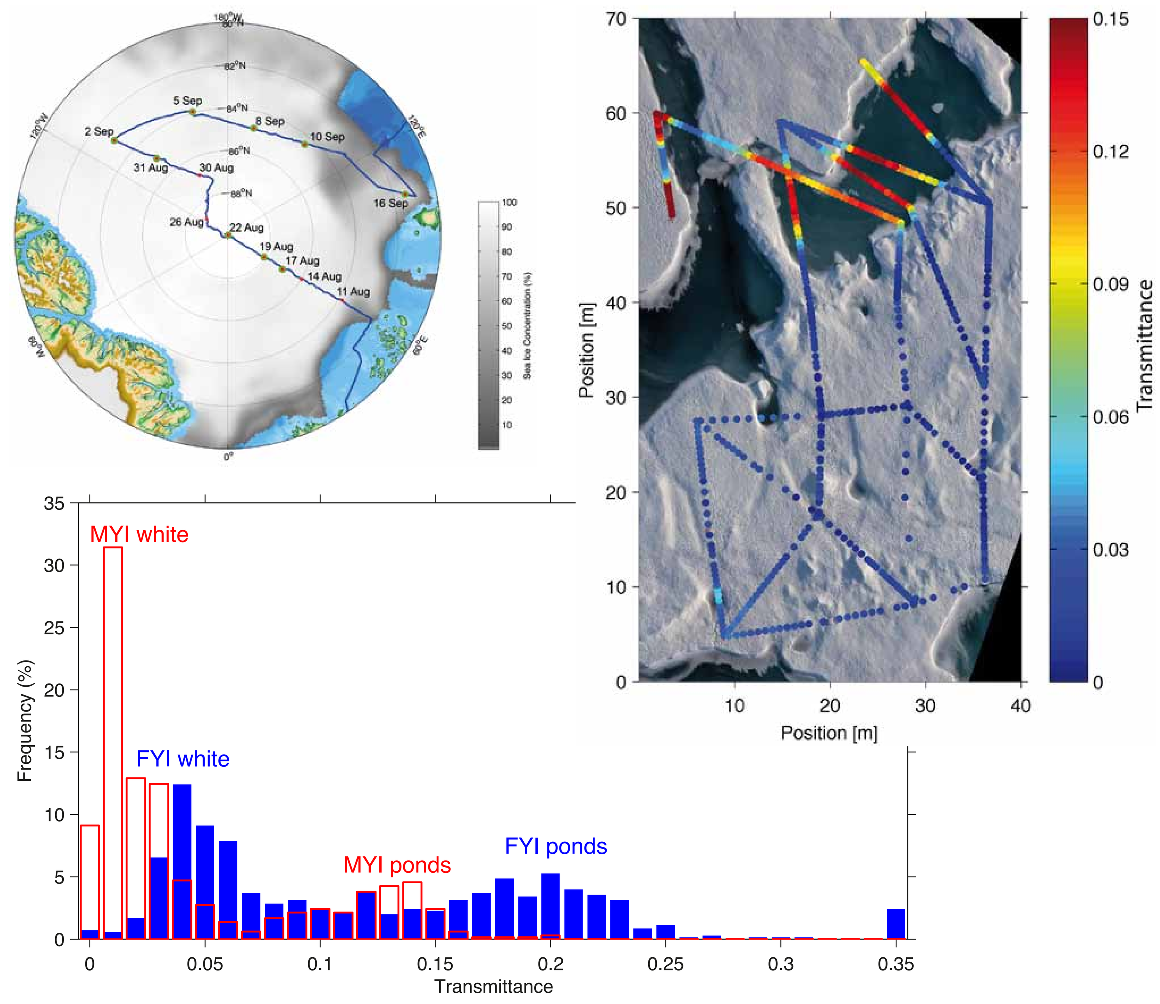


Figure 3: Top left: Cruise track with ice stations (red dots) and ROV operations (green dots). **Top right**: Exemplary results of total transmittance from ROV transects. **Bottom**: Histogram showing different transmittance modes for different ice types and surface freatures.

Introduction

Arctic sea ice has declined and become thinner and more seasonal during the last decade. One consequence of this is that the surface energy budget of the Arctic Ocean is changing.
Solar light transmitting into and through sea ice is of critical importance for the state of sea-ice and the timing and amount of primary production.
The light field in and under sea ice is highly variable: horizontally, vertically, and over seasons.
At the same time, observations of light transmittance through sea ice are still sparse, because the under-ice environment is difficult to access and high quality measurements are challenging.
Furthermore, it is necessary to generalize measurements in order to obtain Arctic-wide estimates of light conditions and energy budgets.

Results

It was possible to derive the first Arctic-wide estimates of light transmission through summer sea ice. Using ROV-based spectral radiation measurements it was possible to derive a simple parameterization for light transmission through different sea-ice and surface types.

During summer, light transmission through First Year Ice (FYI) is almost three-times larger than through Multi Year Ice (MYI).

Absorption is 50% larger in FYI than in MYI.

Arctic-wide and seasonal extrapolation allow quantification of regional and temporal variability, particularily important during spring and autumn.

Perspectives

Include additional (existing and planned) data sets of spectral radiation measurements under sea ice for different seasons and regions. Most important are observations in May/June, when greatest changes are expected.

Derive decadal changes and trends through extension of the satellite-data analyses into the past.

Improve and generalize the given parameterization and include more results on optical properties of sea ice.

Merge spatial data sets (ROV) with seasonal data sets (drifting observatories, buoys) of snow and sea-ice optics, mass and energy balance.

Upscaling & Seasonality

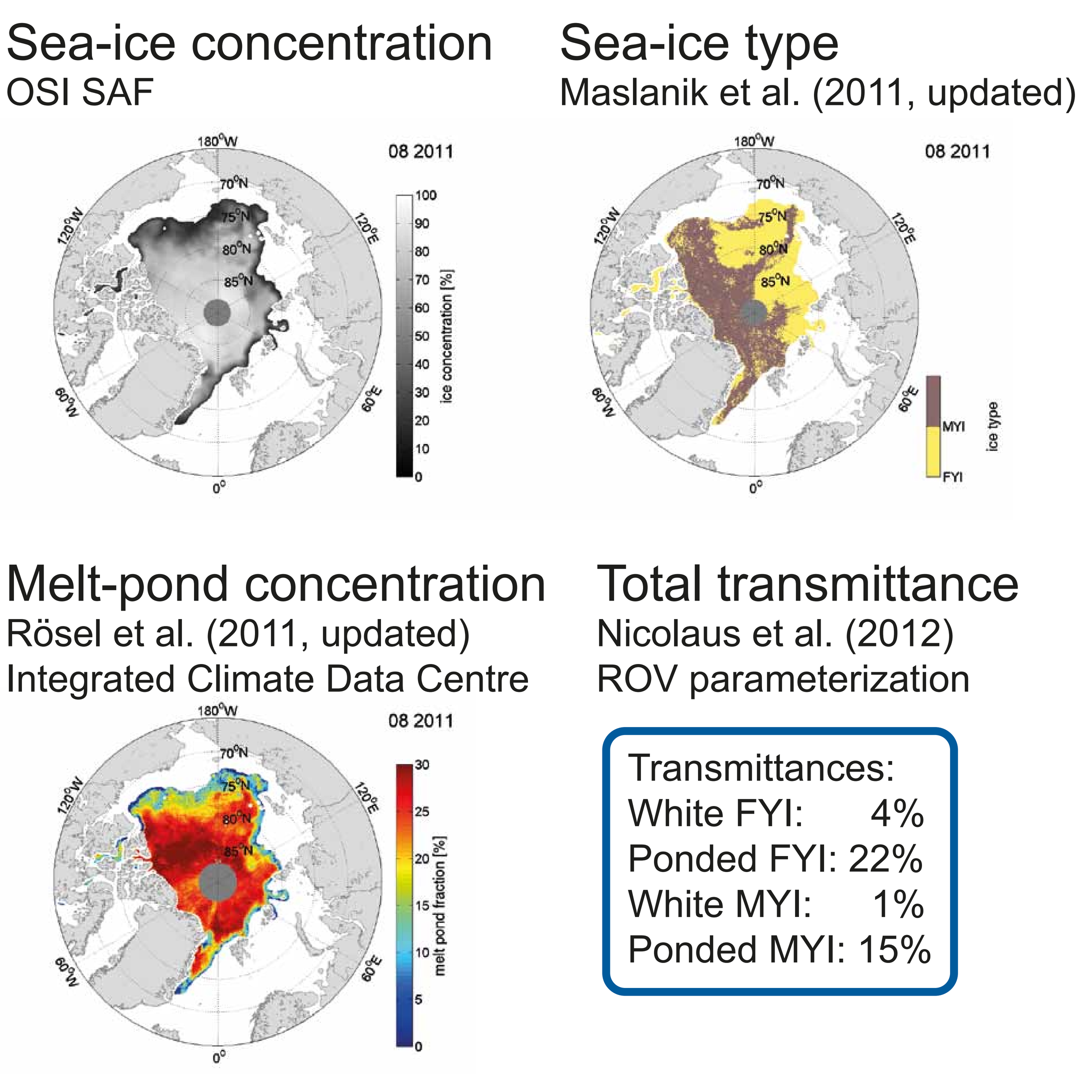


Figure 4: Input data sets and parameterization for the Arctic-wide upscaling for August 2011.

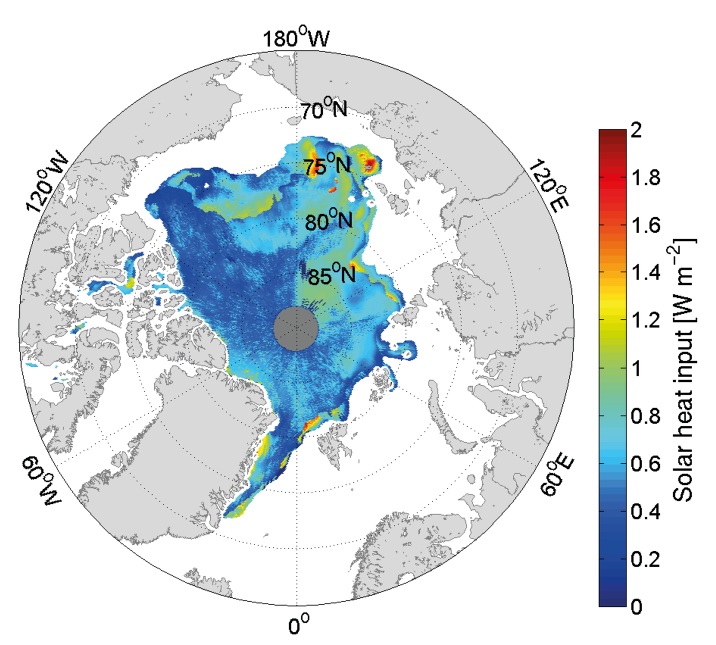
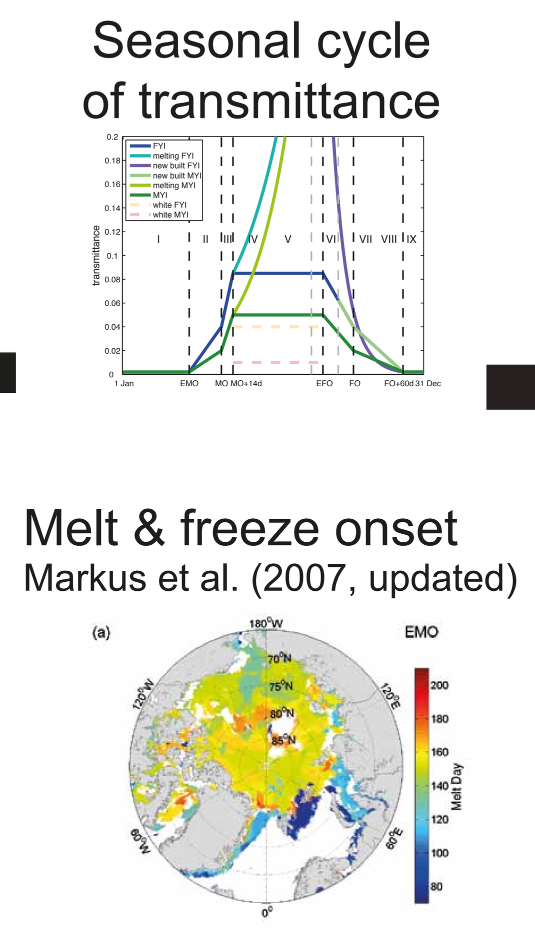


Figure 5: Monthly mean solar irradiance under sea ice (ice covered area only) for August 2011.



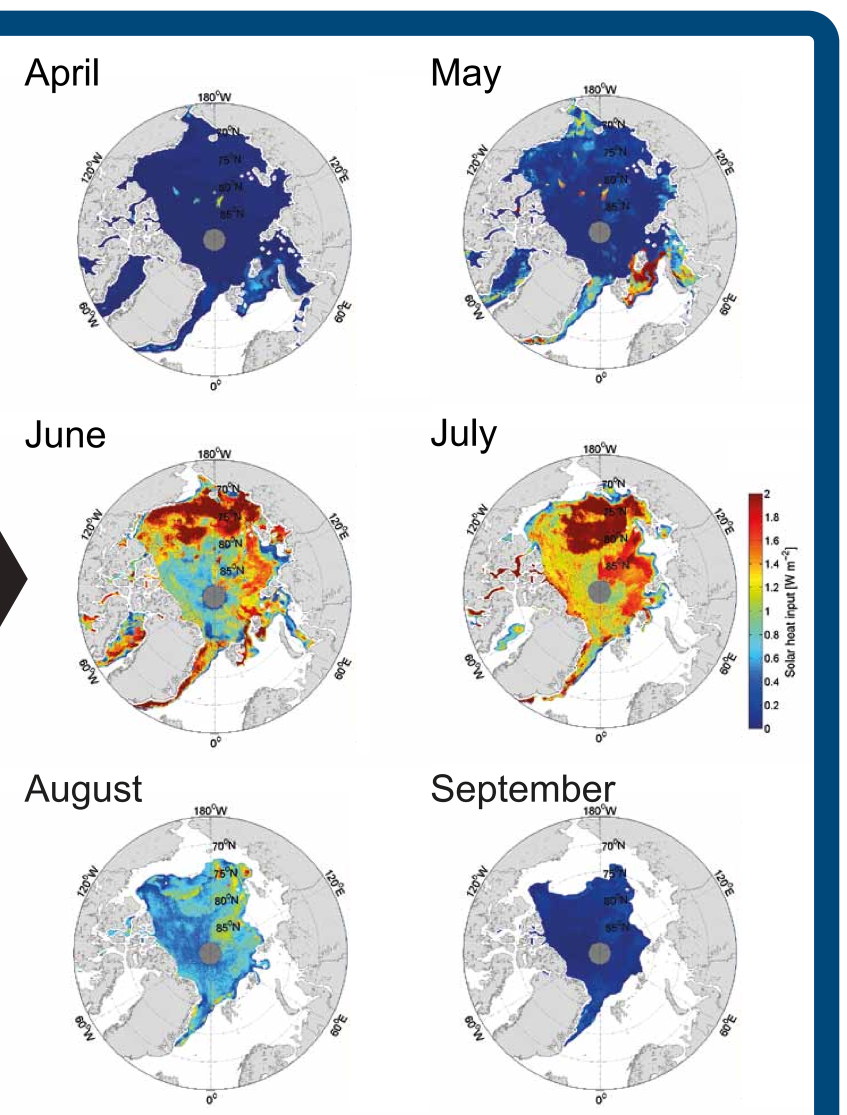


Figure 6: Monthly mean solar irradiance under sea ice from April to September 2011.

References

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Acknowledgements

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