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HELMHOLTZ-ZENTRUM FÜR POLAR-
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Influence of snow depth and surface flooding on light transmittance through Antarctic sea ice

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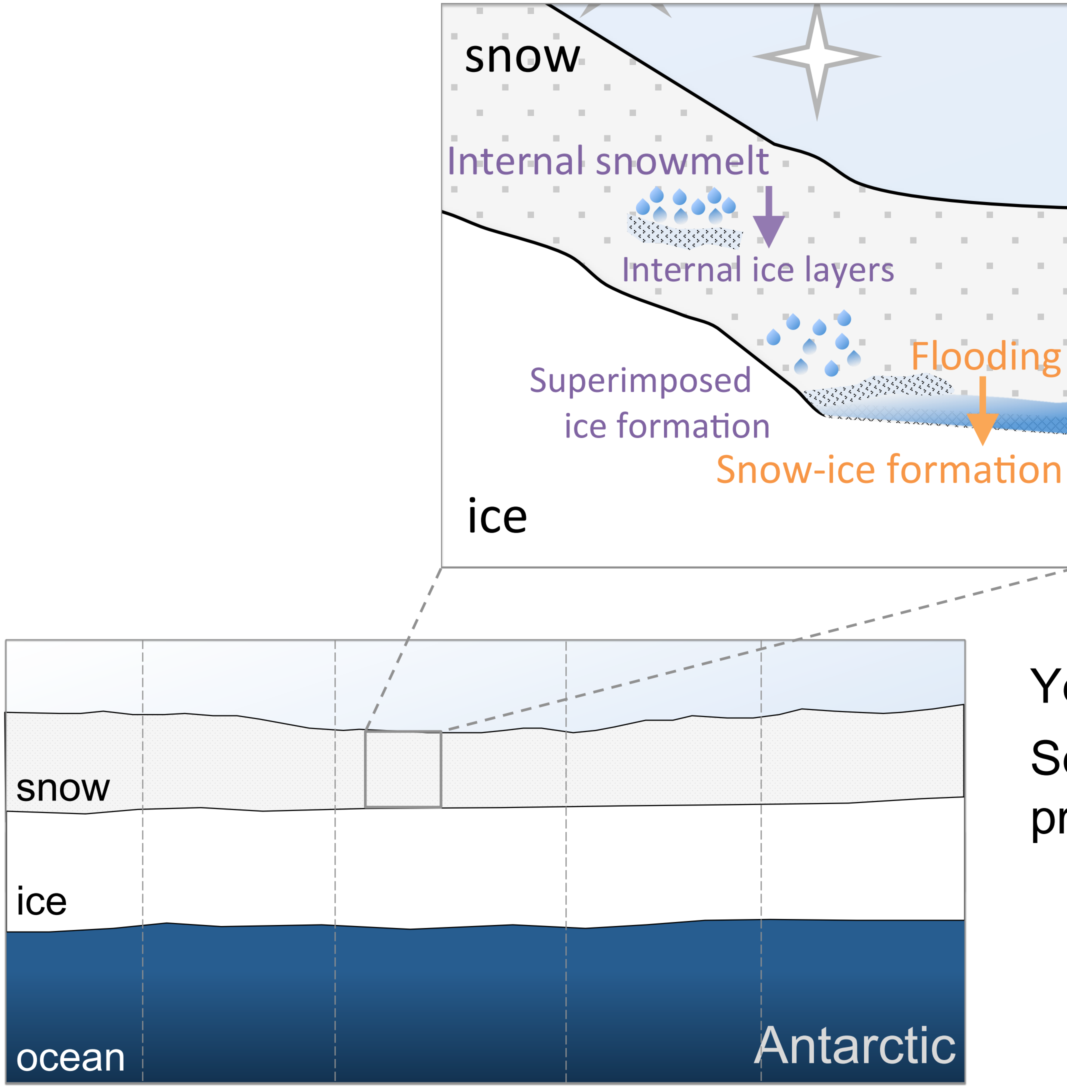
HELMHOLTZ | GEMEINSCHAFT

Temporal evolution of surface properties

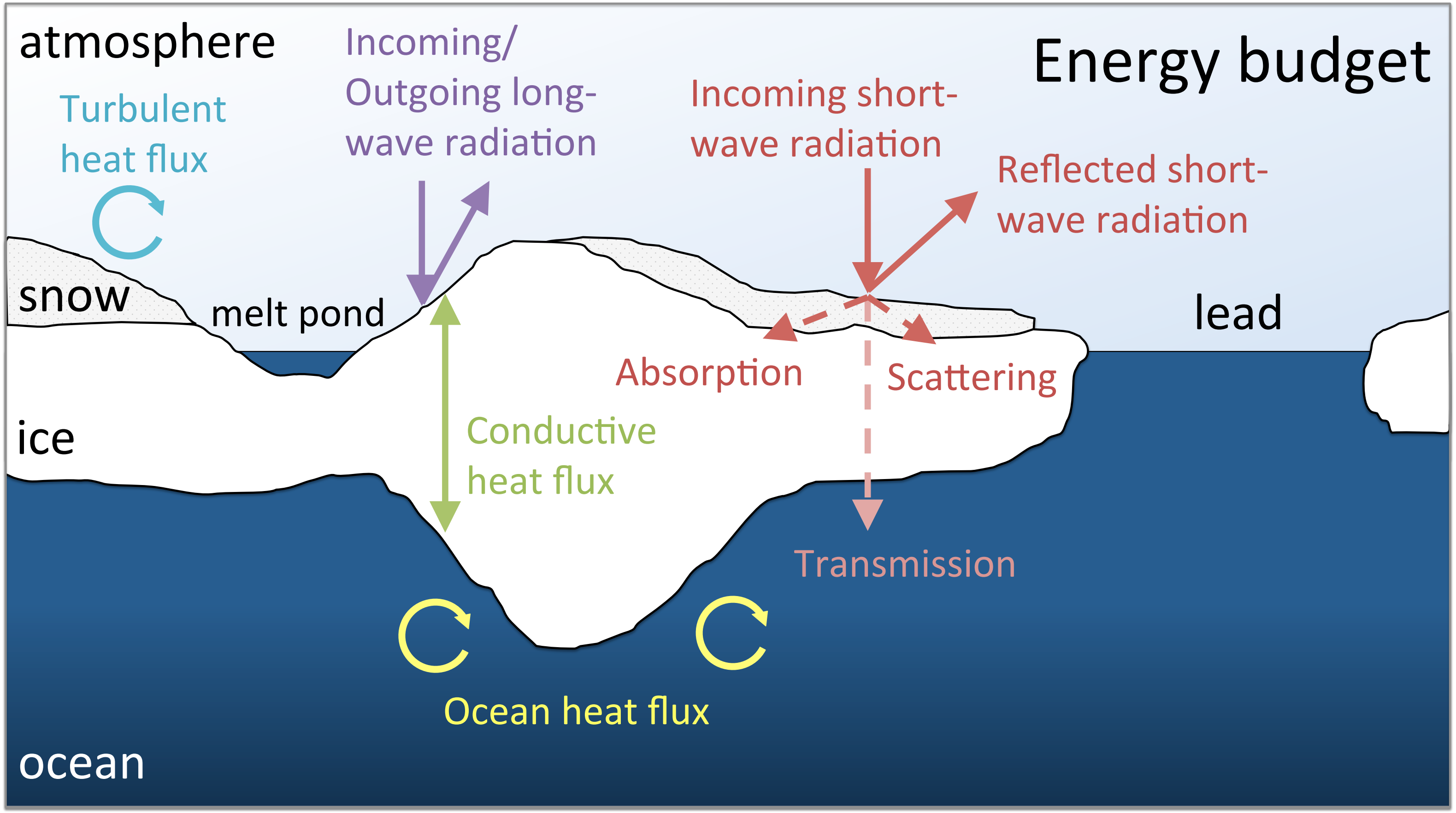


Year-round snow cover

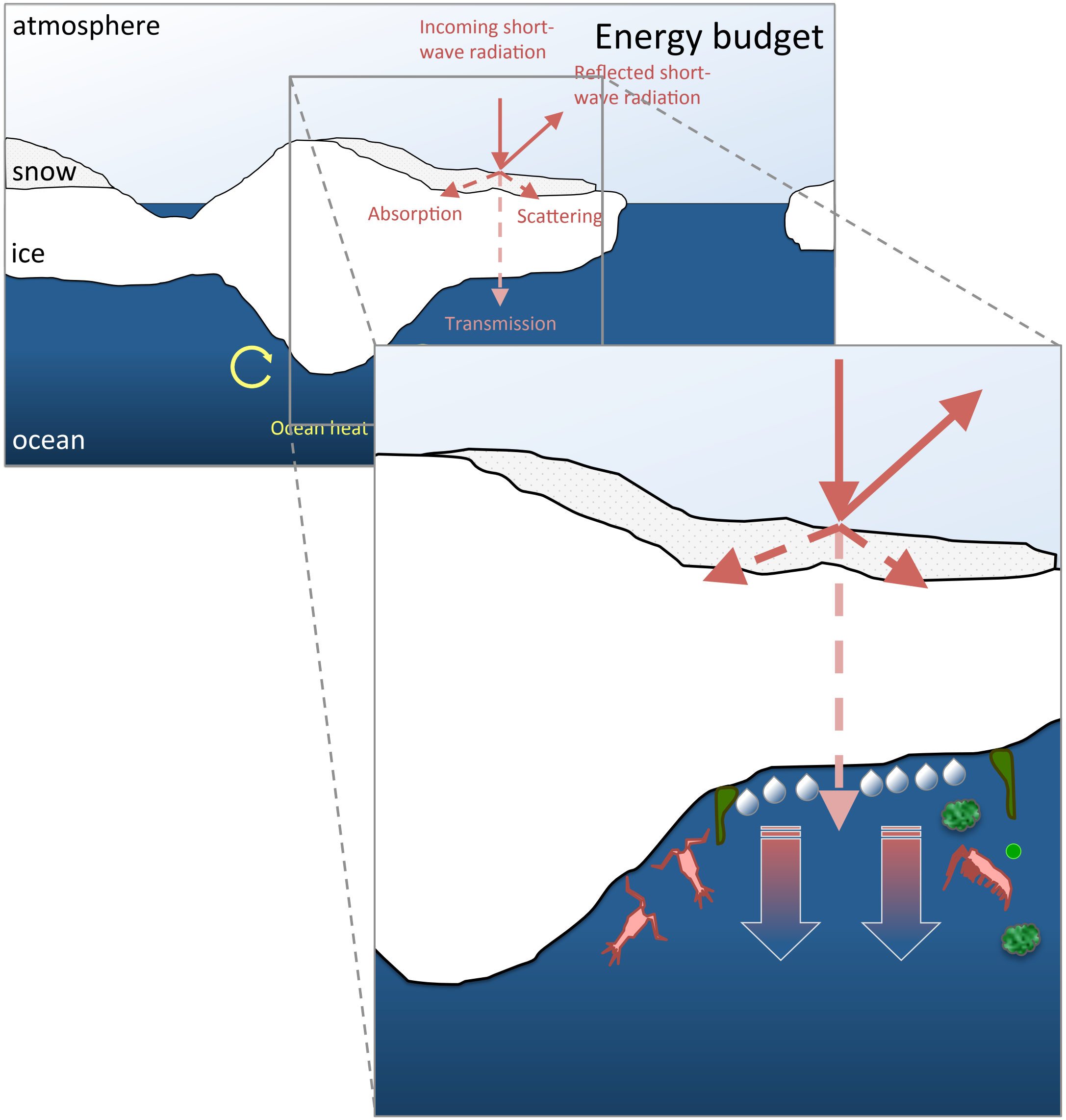
Seasonal changes in snow properties dominated by e.g.

- Diurnal freeze-thaw cycles
- Internal snowmelt

Surface energy budget



Importance of transmitted heat fluxes

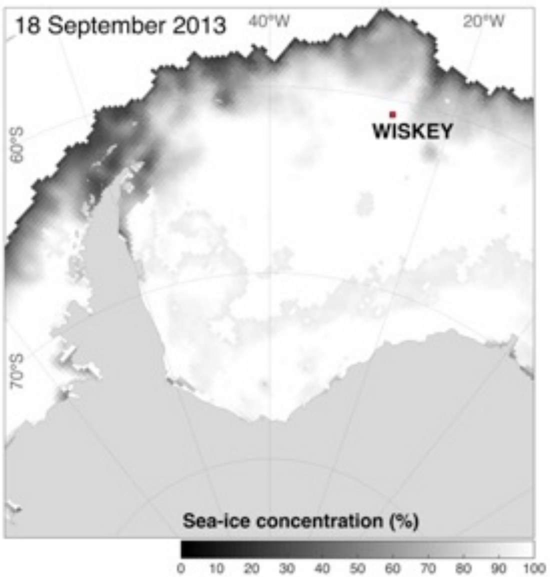


Mass budget of sea ice
bottom melt

Energy budget of the upper ocean
warming of the upper ocean

Under-ice ecosystem
changing habitat conditions for ice-associated organisms

Study side and measurements



WISKEY

= *Winter study on Sea ice and KEY species*
14 August to 16 October 2013

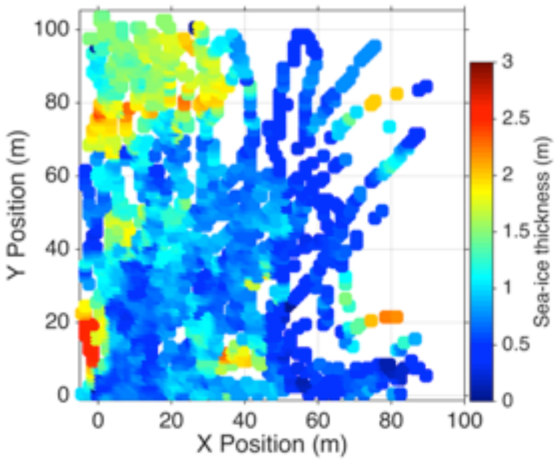
Measurements:

- Spectral solar radiation measurements: Remotely Operated Vehicle (ROV)
- Total sea-ice thickness: Multi-frequency electromagnetic induction (GEM-2)
- Snow depth: Magna Probe

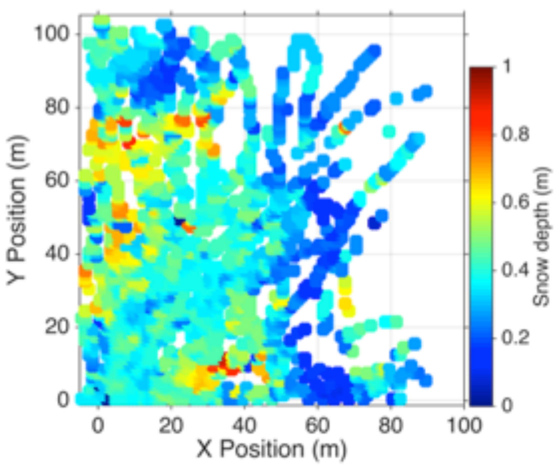
Arndt et al., 2017 (under review, JGR)

Physical properties of the pack ice floe

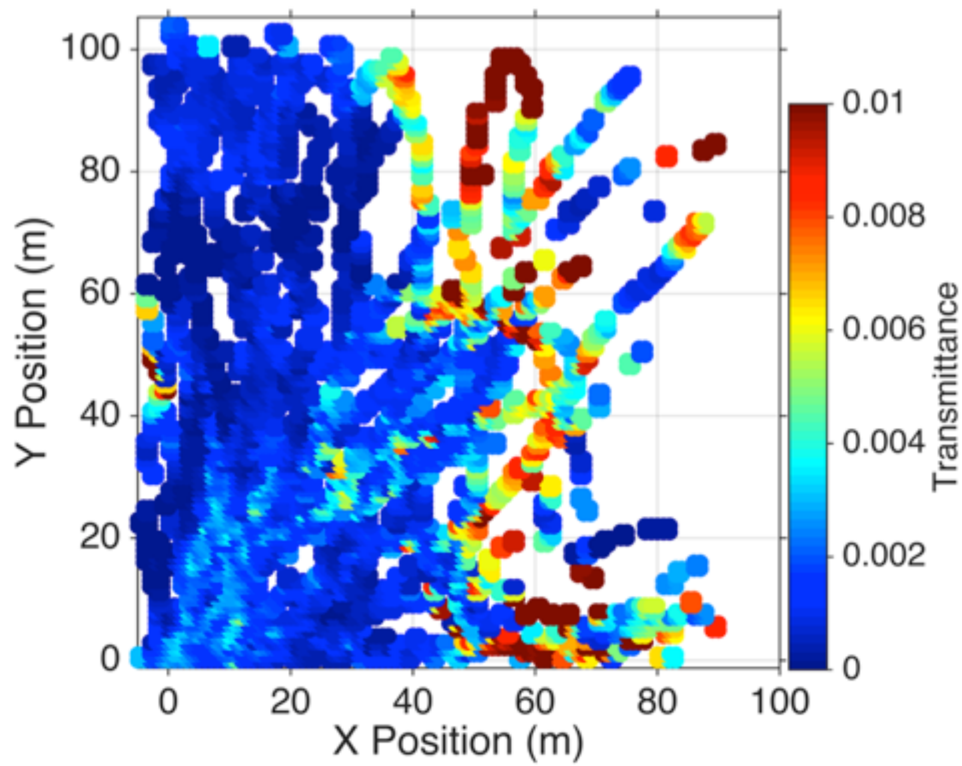
Sea-ice thickness, I:
mean(I) = 0.93 ± 0.45 m



Snow depth, S:
mean(S) = 0.39 ± 0.13 m



Transmittance, T:
mean(T) = 0.0024 (0.24%)
mode(T) = 0.0008 (0.08%)



Antarctic pack ice transmits less than 0.1% of the incoming solar radiation during early spring

Physical properties of the pack ice floe

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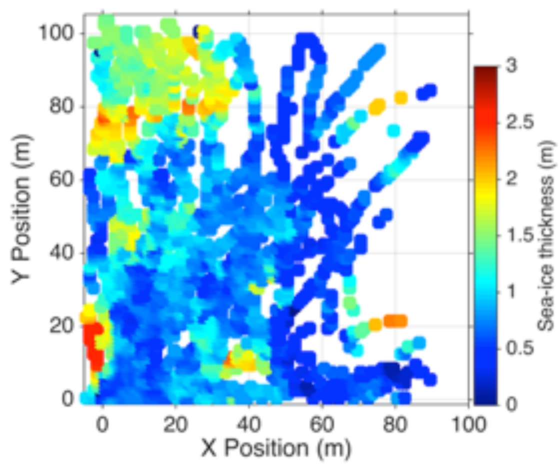

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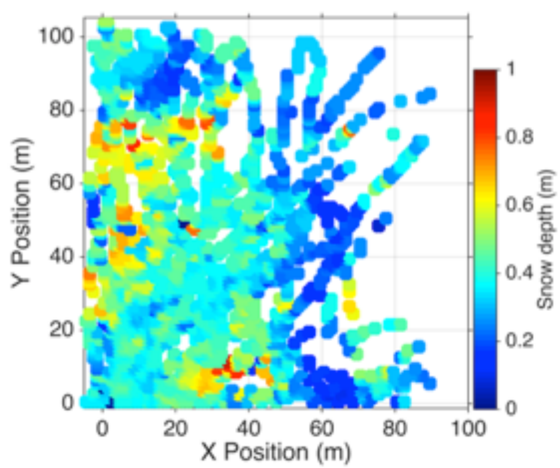
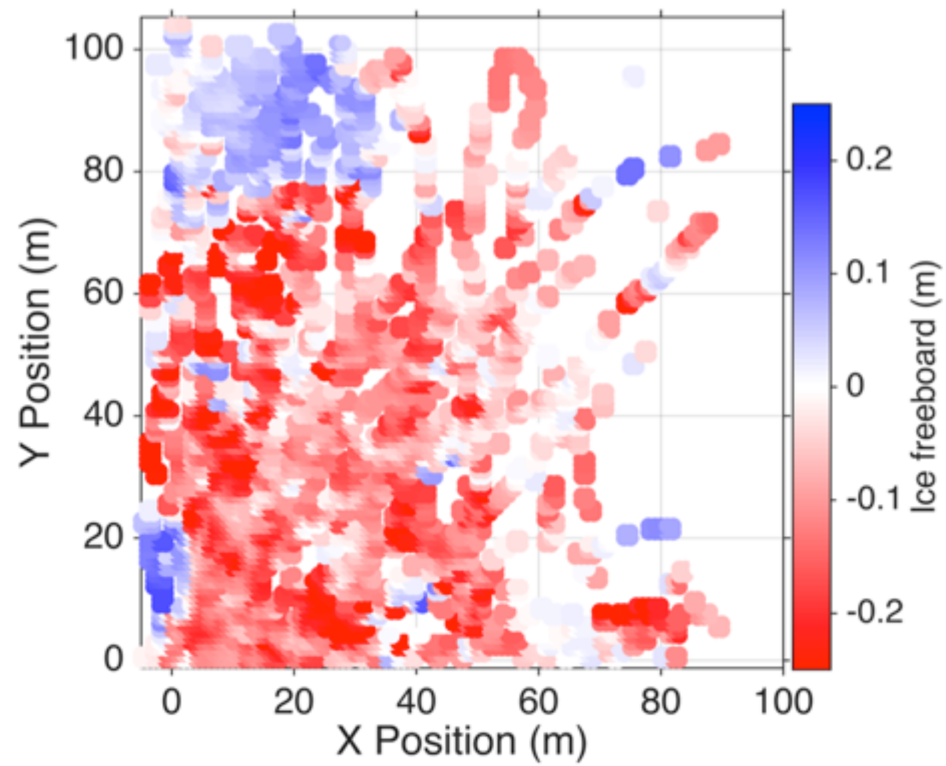
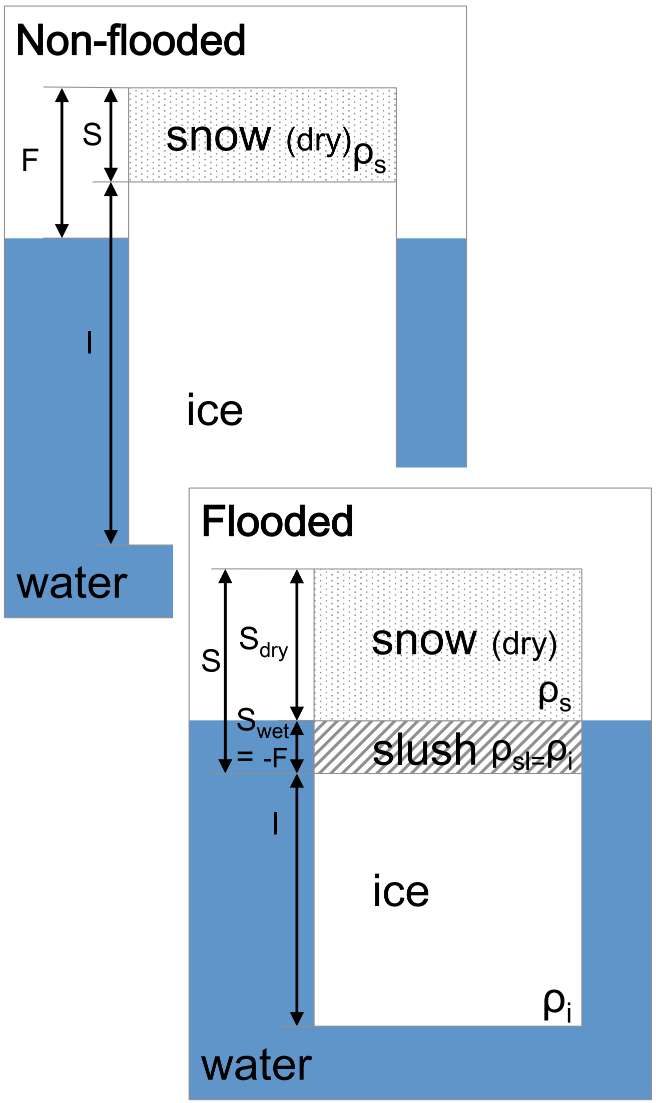


Ice freeboard, F:
mean(F) = -0.08 ± 0.10 m



Physical properties of the pack ice floe



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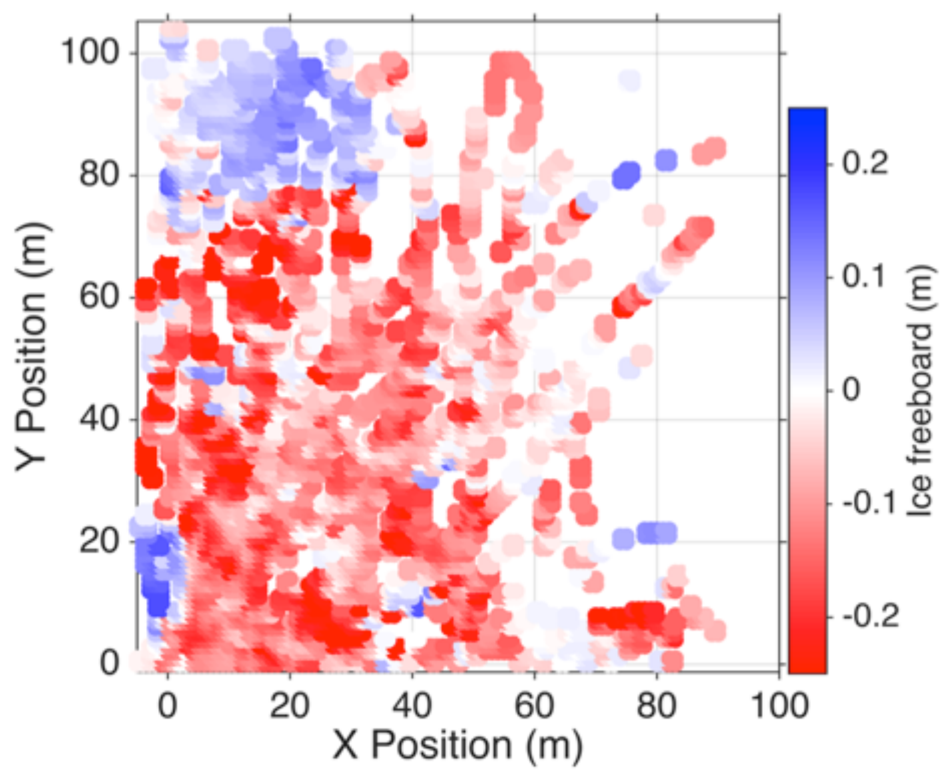
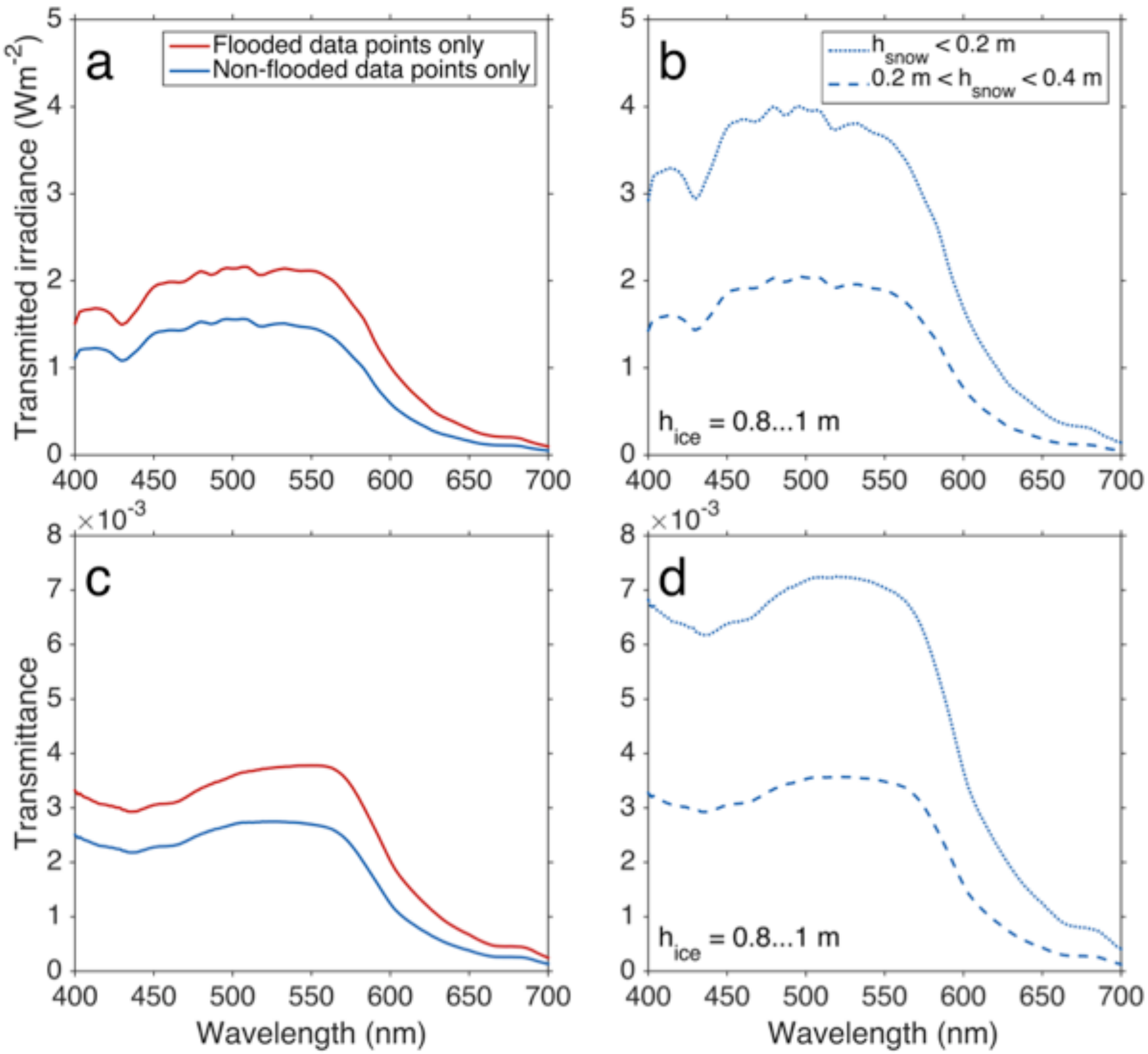


Spectral optical properties



Spectral optical properties

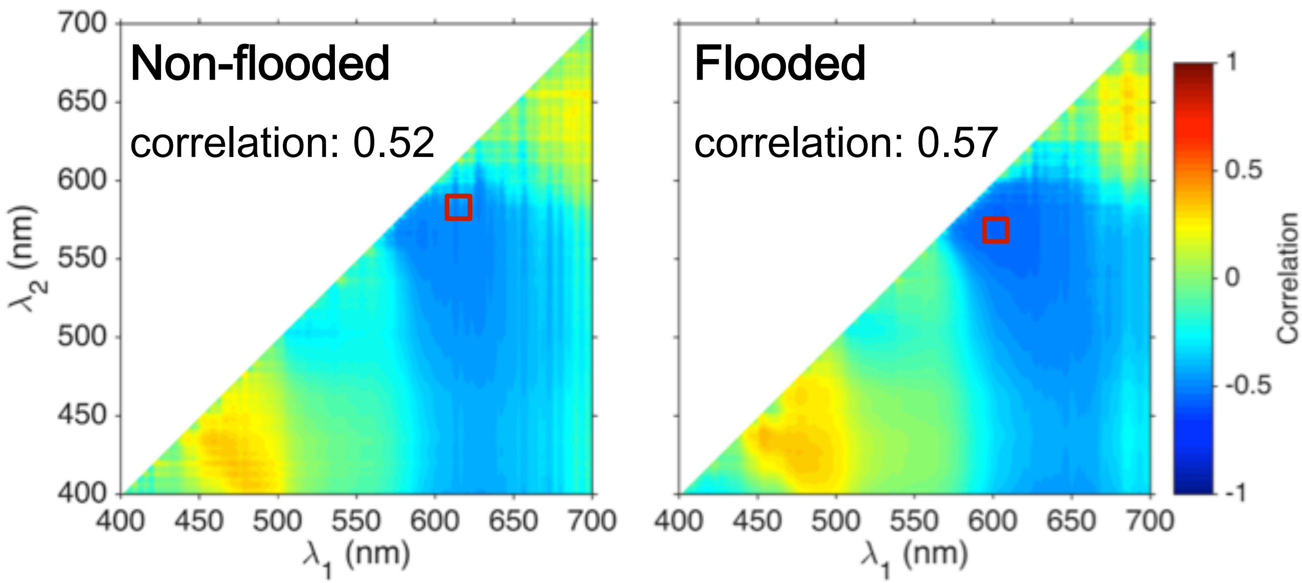
Normalized difference indices (NDI) of under-ice irradiance spectra:

$$NDI = \frac{E_d(\lambda_1) - E_d(\lambda_2)}{E_d(\lambda_1) + E_d(\lambda_2)}$$

λ_1, λ_2: wavelength pairs

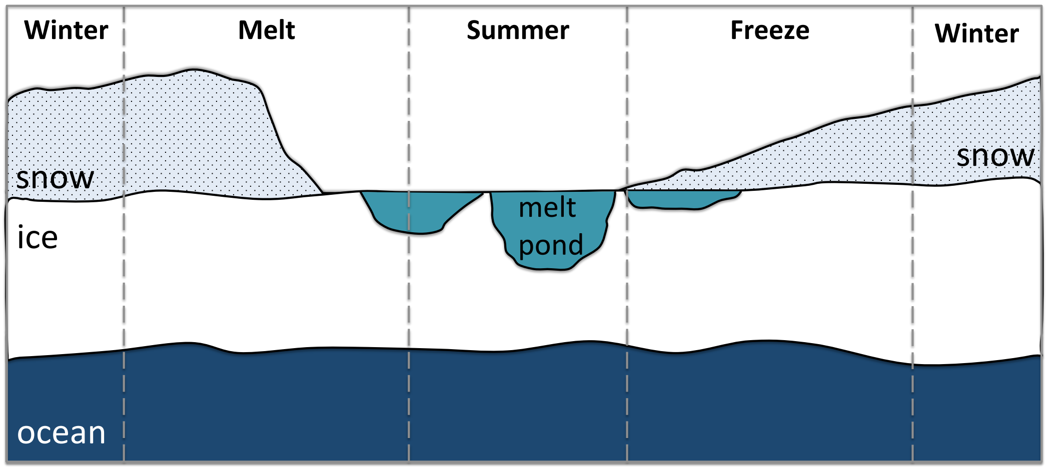
(Mundy et al., 2007)

Correlation surfaces of normalized difference indices (NDI) for snow depth



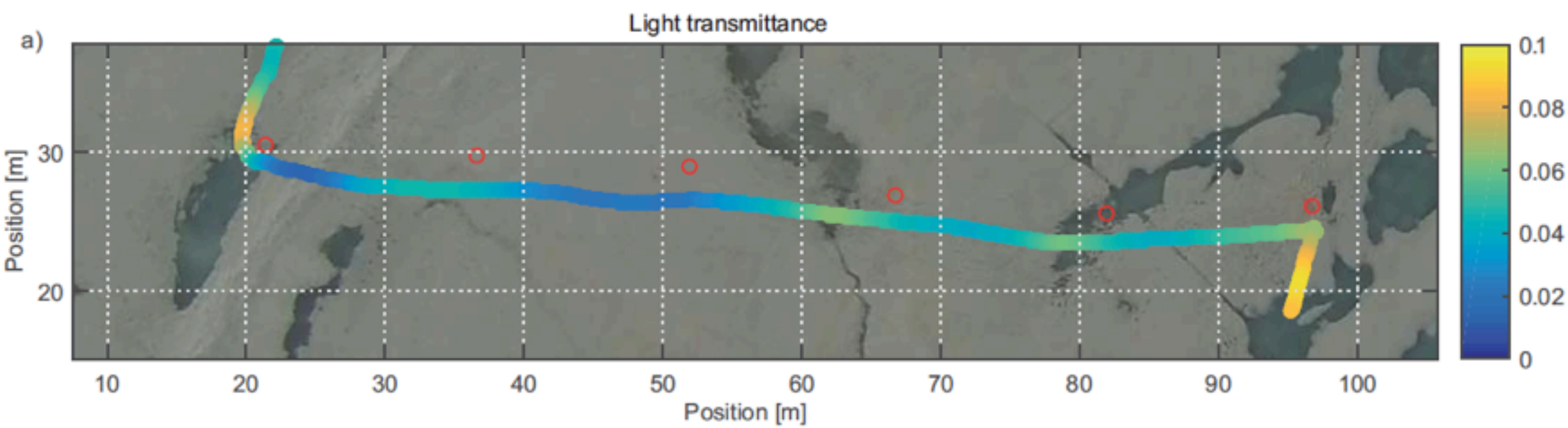
The heterogeneous snow on Antarctic pack ice obscures a direct correlation between the under-ice light field and snow depth

Comparison with Arctic studies



Optical properties highly correlated with **snow surface properties** (e.g. **melt ponds**)

Light transmittance significant higher (summer FYI: 0.09, summer MYI: 0.05)



Katlein, Arndt et al., 2015

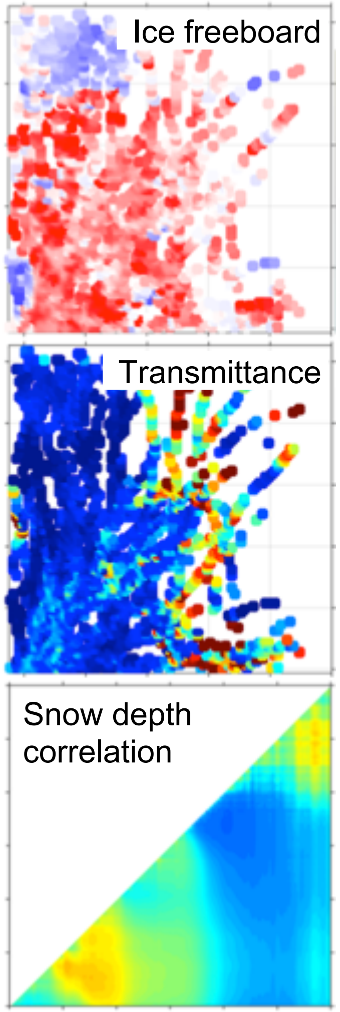
Conclusions

Antarctic pack ice transmits less than 0.1% of the incoming solar radiation during early spring

Ice freeboard and related flooding at the snow/ice interface dominates the spatial variability of the under-ice light regime

Limitation in the use of snow-NDI prevents estimating light transmission from snow depth and vice versa

In contrast to Arctic sea ice, the dependency of light transmittance of Antarctic sea ice on its surface properties is more obscure



Arndt et al., 2017 (under review, JGR)

Outlook

New field data sets for improved process understanding of the vertical snow layer

Comparison of relations of surface properties and (spectral) light transmittance in the Weddell Sea (WISKEY) with East Antarctic (e.g. SIPEX-2)

Antarctic-wide up-scaling approaches of the under-ice light field require more detailed field data and analysis

Application of existing Chlorophyll-*a* –NDI for Weddell Sea on WISKY data set to investigate spatial variabilities in Chlorophyll-*a* *(Meiners, Arndt et al., in prep.)*