Influence of ice thickness and surface properties on light transmission through Arctic sea ice.
Why light transmission?

- Energy fluxes:
  - Sea ice  →  mass balance
  - Ocean   →  warming

- Light availability:
  → ecosystem
Light transmission through sea ice

- **Surface properties**
- **Ice thickness**
- **Transmission**

- Air
- Melt pond
- Sea ice
- Water
- Ridge
Typical sea ice sampling vs. ROV
Nereid Under-Ice (NUI)

- Light-fiber tether
- Piloted / autonomous
- Multiple sensors:
  - Radiometers \(\rightarrow\) light
  - Multibeam sonar \(\rightarrow\) ice topography
  - ...

Human Hair
Optical Fiber
Coordinated survey
- Optics
- Topography
- Drillholes
- Aerial image

28 July 2014
Results
72% of light variability are explained by ice draft and surface albedo.

Averages over larger footprints better describe the variability.

- Sea ice is not a homogenous slab.
- 1-D models have limited capabilities.
Spatial scales of variability

- Analysis of Variograms

Datapoints with a distance bigger than the range value are unrelated
## Typical length Scales

<table>
<thead>
<tr>
<th></th>
<th>Pole survey (~100 m)</th>
<th>All data (&gt;10 000 m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice draft</td>
<td>26.8 m</td>
<td>15.1 m</td>
</tr>
<tr>
<td>Albedo</td>
<td>8.4 m</td>
<td>10.6 m</td>
</tr>
<tr>
<td>Light transmission</td>
<td>8.4 m</td>
<td>16.6 m</td>
</tr>
</tbody>
</table>
Typical length Scales

- **On small scales** (<100m), light variability is associated with *melt pond* variability

- **On larger scales**, light variability is associated with *ice thickness* variability
$\rightarrow T_i = (1 - \alpha_i) \exp(-\kappa z_i)$
**Summary**

- **NUI ROV** enables comprehensive spatial surveys under ice

- **Spatial averages** of albedo and ice thickness determine **light transmittance**

- **Variability** of light-transmittance is driven by **melt-ponds** on small scale and by **ice-thickness** on larger scales.

- **Histograms** of optical properties of sea ice can be constructed **from distributions** of ice thickness and albedo

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Thank you!

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