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[1] ALFRED-WEGENER-INSTITUT
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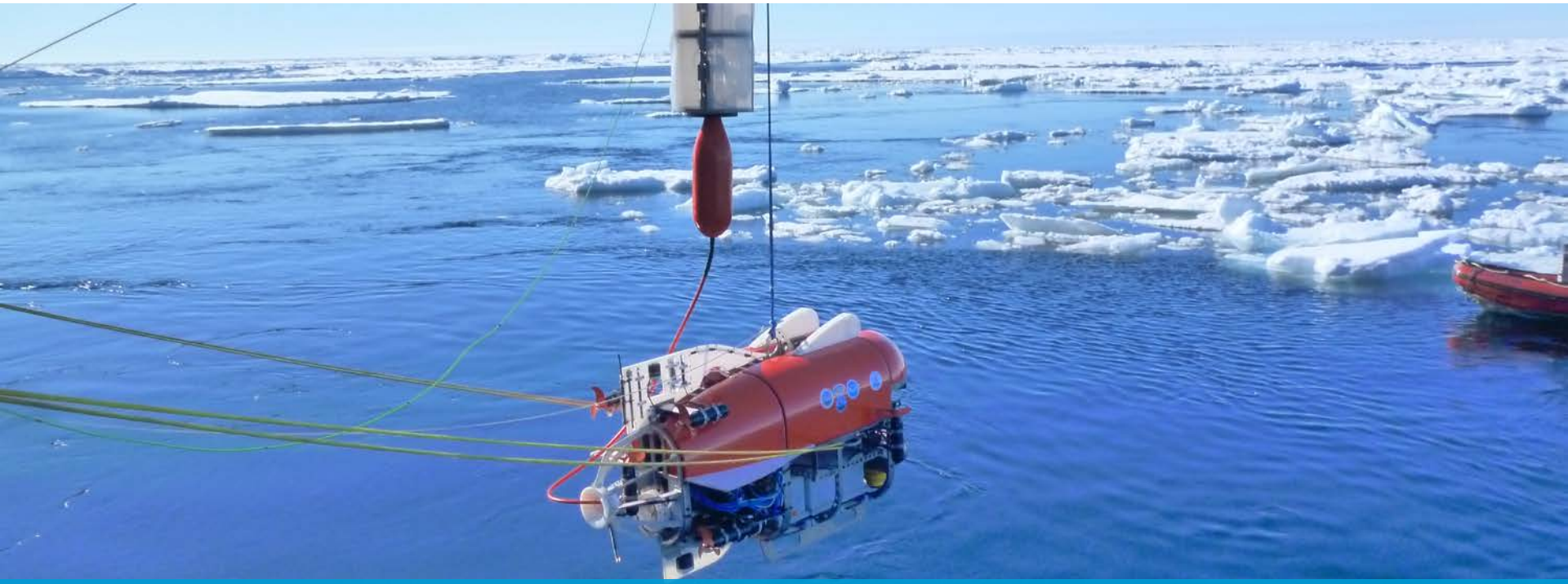

Influence of ice thickness and surface properties on light transmission through Arctic sea ice.

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[3] JOHNS HOPKINS WHITING SCHOOL of ENGINEERING

[4] CRREL

[5] Max Planck Institute for Marine Microbiology

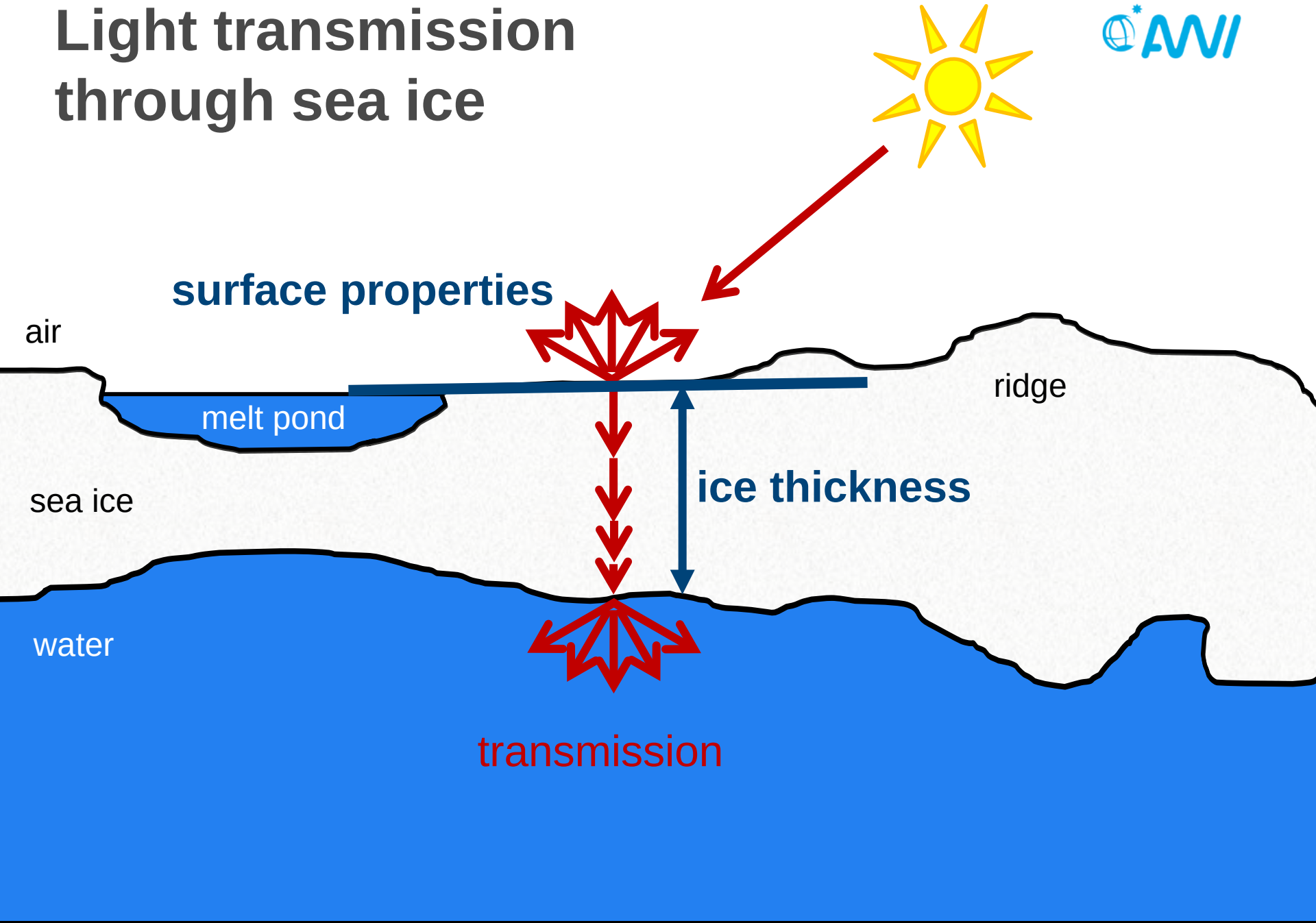
NSF NOAA POLMAR HELMHOLTZ GEMEINSCHAFT

Why light transmission?

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

- Light availability:
  → ecosystem

Light transmission through sea ice



Typical sea ice sampling vs. ROV

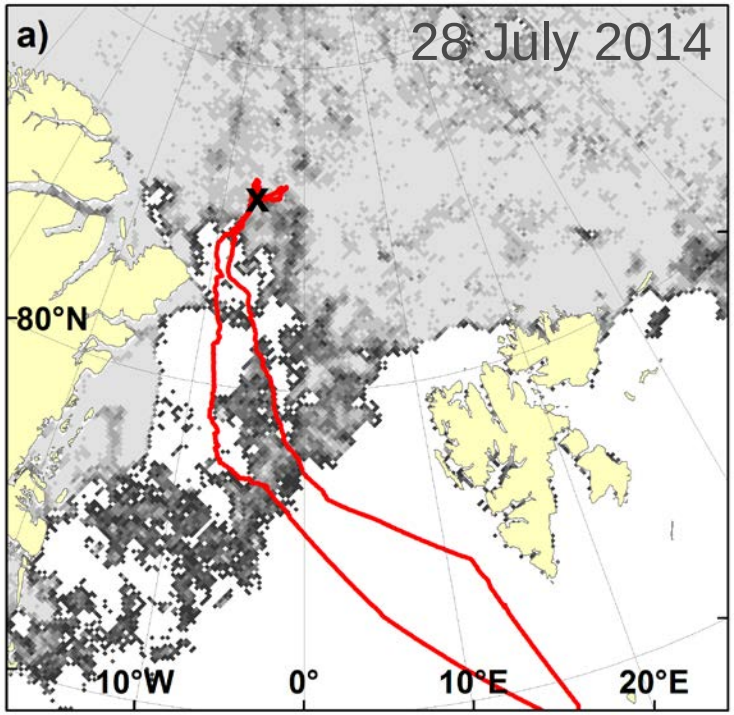
Nereid Under-Ice (NUI)

- Light-fiber tether
- Piloted / autonomous
- Multiple sensors:
  - Radiometers → light
  - Multibeam sonar → ice topography
  - …

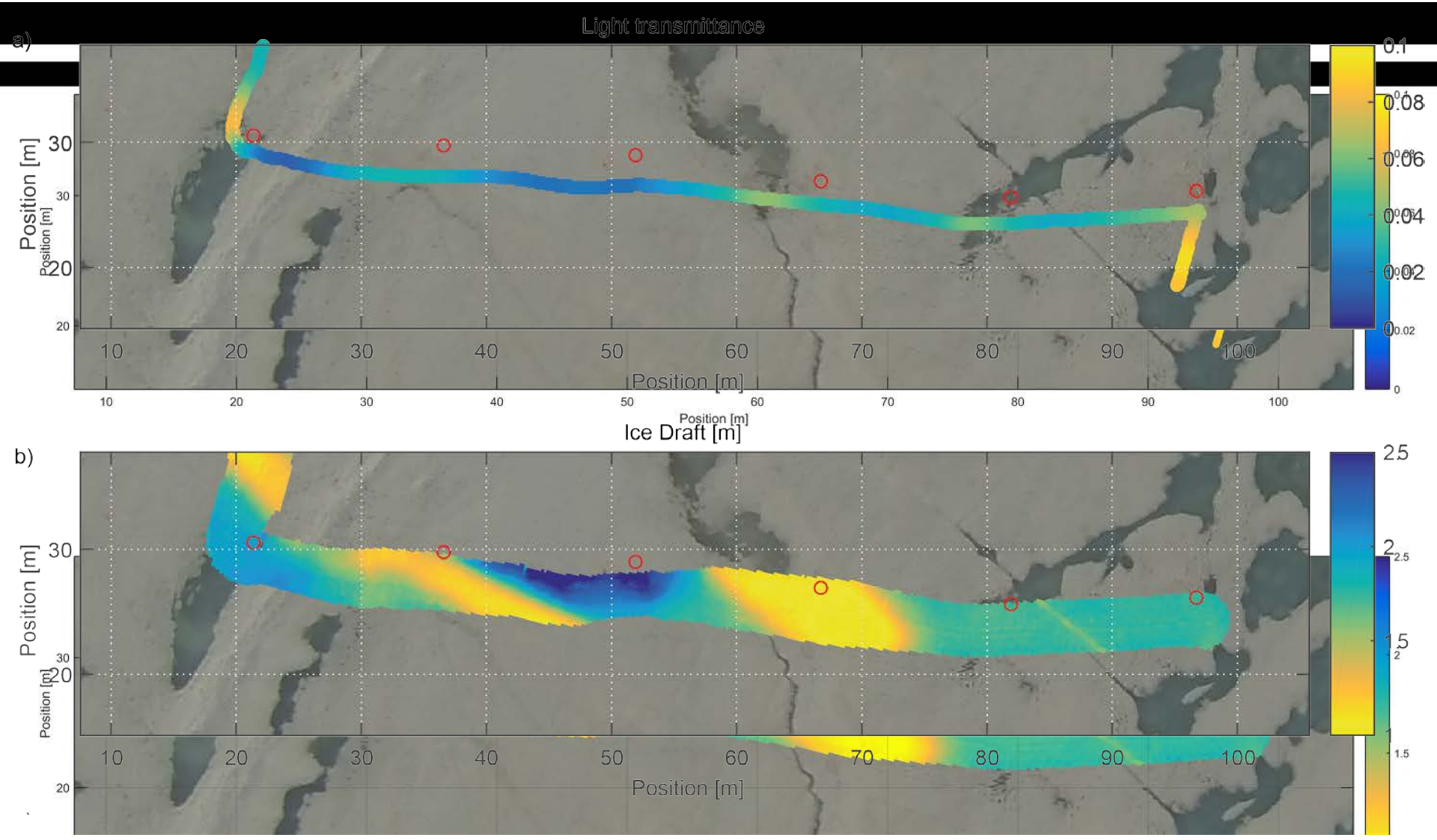
Coordinated survey

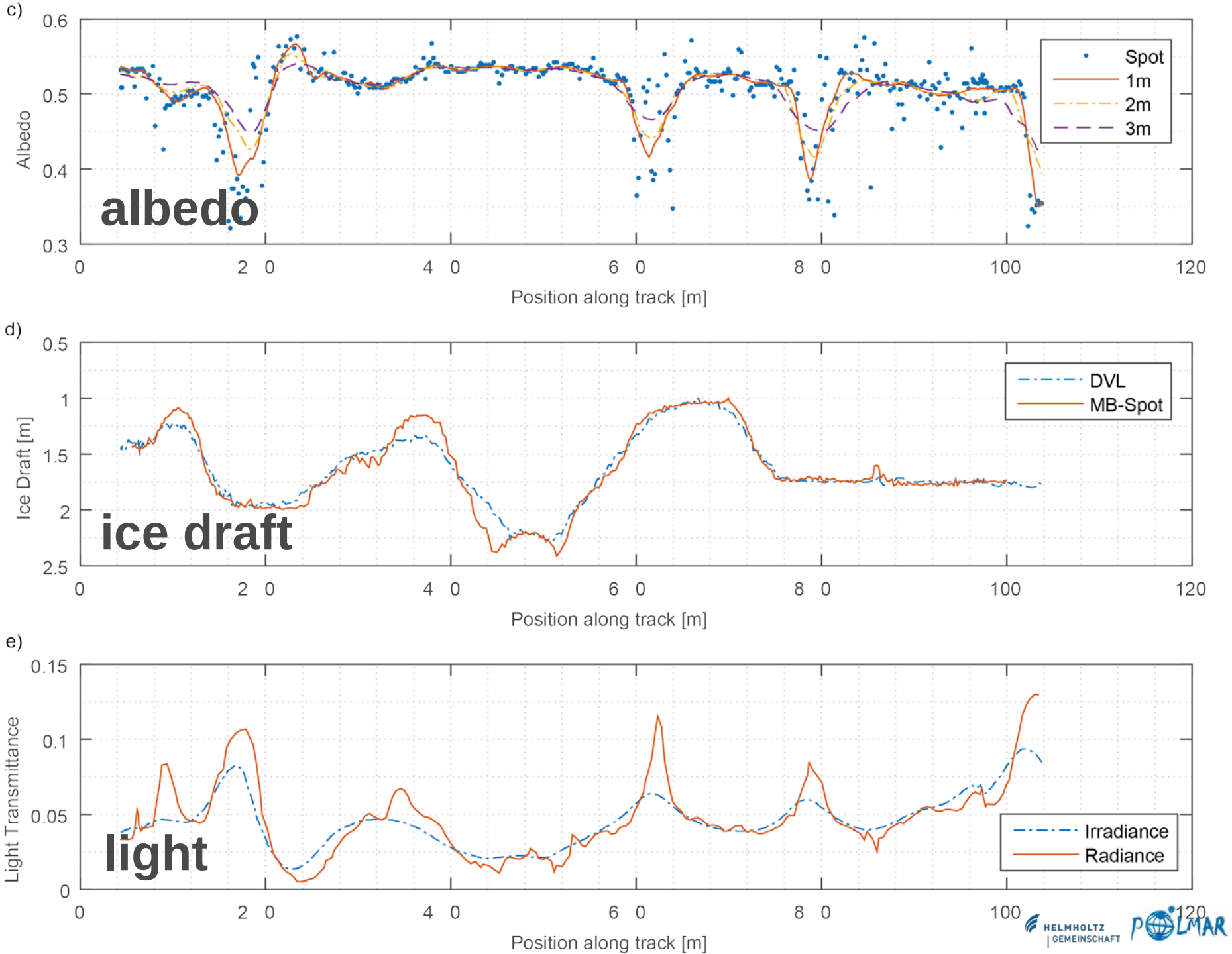
Pole survey

- Optics
- Topography
- Drillholes
- Aerial image



Results


Light transmittance
a)
Position [m]
Position [m]
Position [m]
Position [m]
Ice Draft [m]
b)
Position [m]
Position [m]


c)
Albedo
0.6
0.5
0.4
0.3
albedo
Spot
1m
2m
3m
0
20
40
60
80
100
120
Position along track [m]
d)
Ice Draft [m]
0.5
1
1.5
2
2.5
ice draft
DVL
MB-Spot
0
20
40
60
80
100
120
Position along track [m]
e)
Light Transmittance
0.15
0.1
0.05
0
light
Irradiance
Radiance
0
20
40
60
80
100
120
Position along track [m]

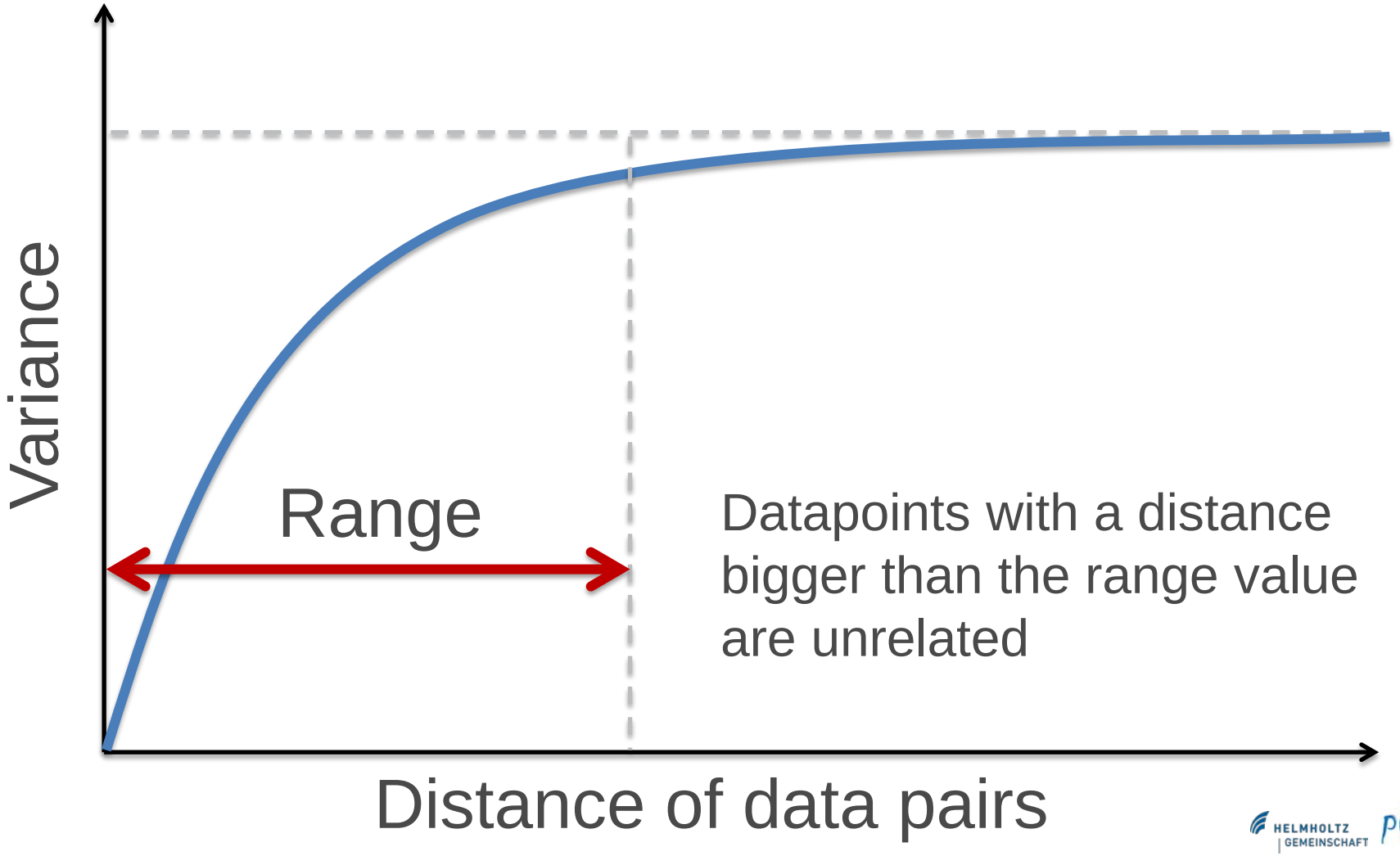
- 72% of light variability are explained by ice draft and surface albedo
- Averages over larger footprints better describe the variability

→**Sea ice is not a homogenous slab**

→**1-D models have limited capabilities**

Spatial scales of variablity

- Analysis of Variograms



Typical length Scales

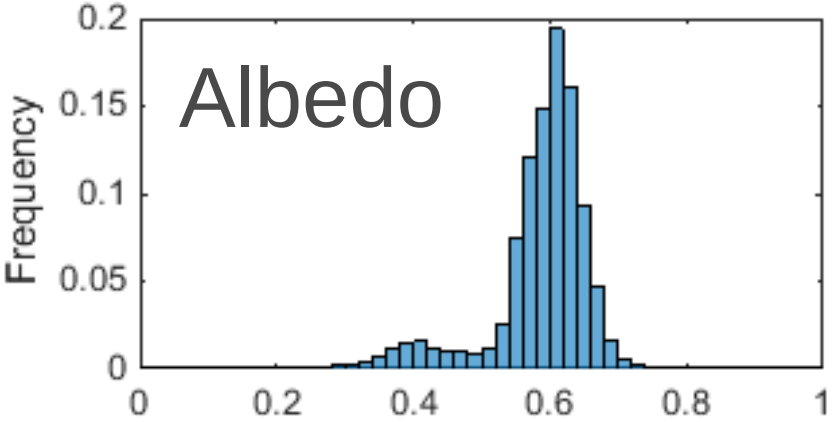
	Pole survey (~100 m)	All data (>10 000 m²)
Ice draft	26.8 m	**15.1 m**
Albedo	**8.4 m**	10.6 m
Light transmission	**8.4 m**	**16.6 m**

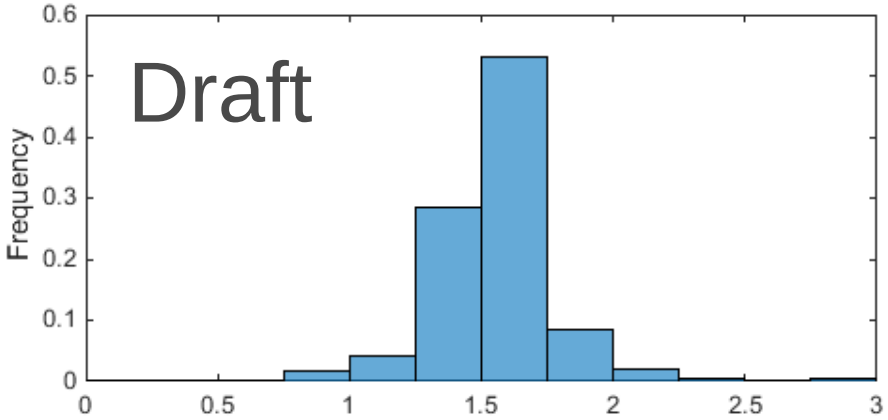
Typical length Scales

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

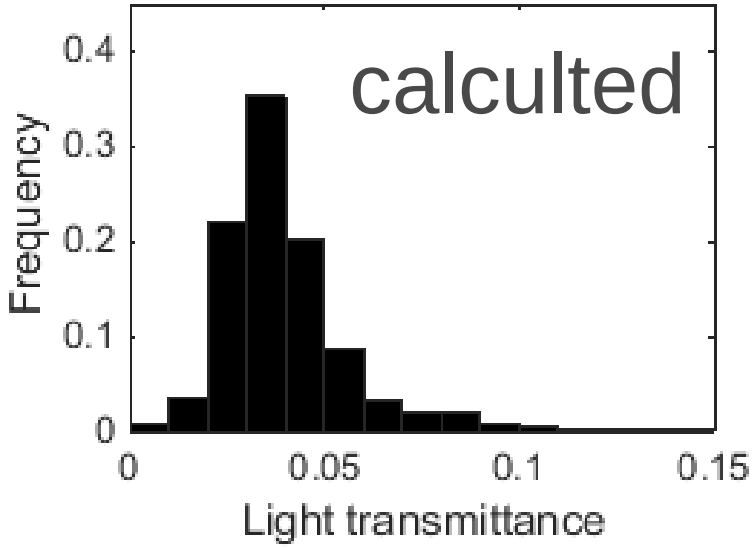
- On **larger scales**, light variability is associated with **ice thickness** variability

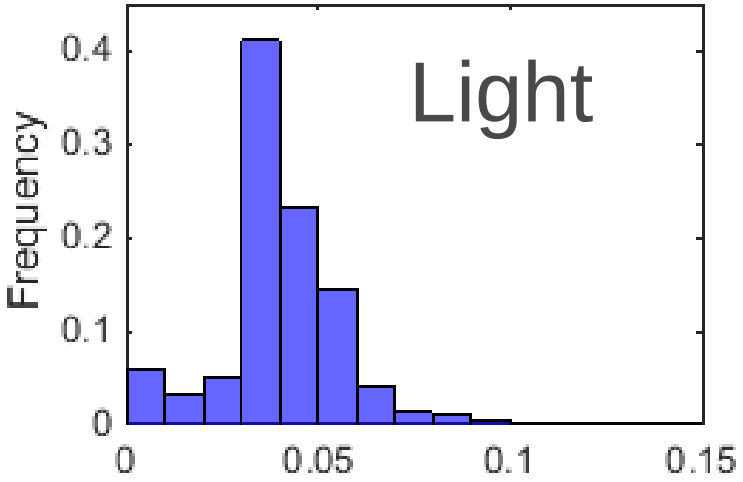
Histograms





$\rightarrow T_i = (1 - \alpha_i)\exp(-\kappa z_i)$





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

Katlein et al. 2015, submitted to JGR

Thank you!

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

- Polarstern crews & captain 2011, 2012, 2014
- WHOI NUI-Team:
  Mike Jakuba, Chris German, Louis Whitcomb, Stephen Elliot, Stefano Suman, Christopher McFarland, Chris Judge, John Bailey Sam Laney, Ted Maksym, and many more
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- AWI sea ice group

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