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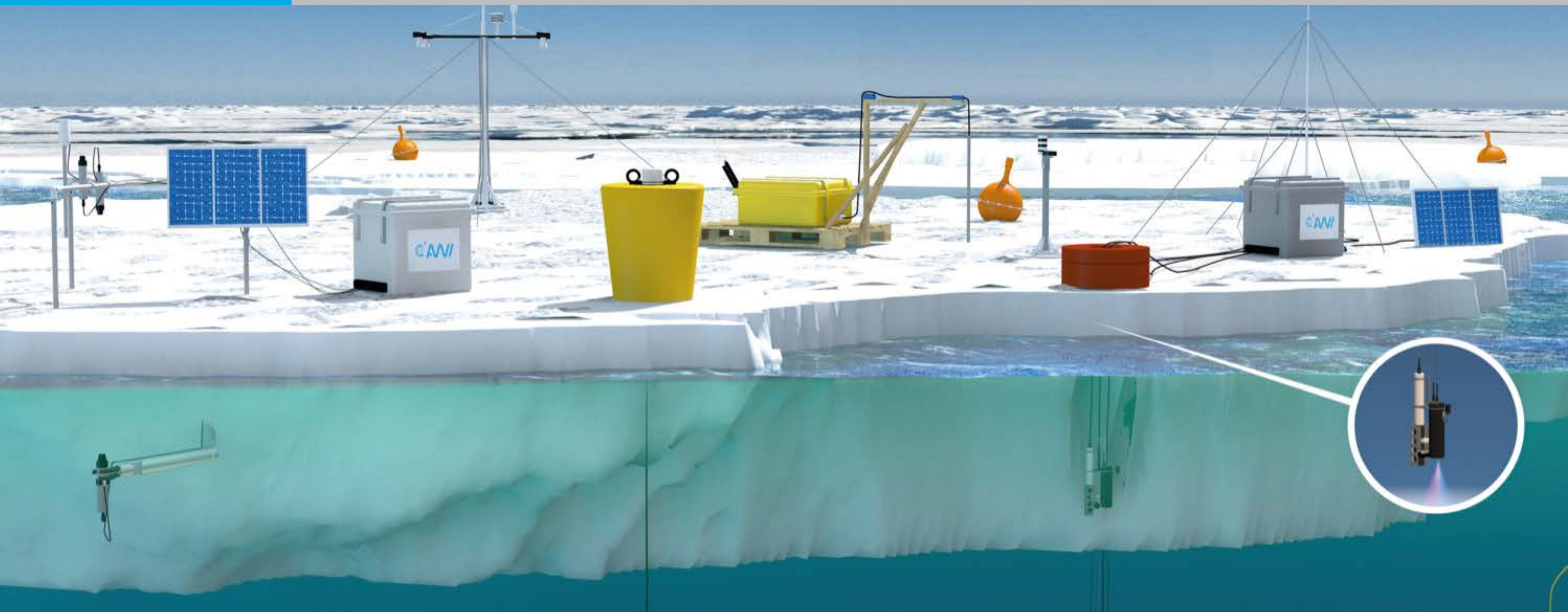

Seasonality of light transmittance through Arctic sea ice during spring and summer

13 Dec 2017

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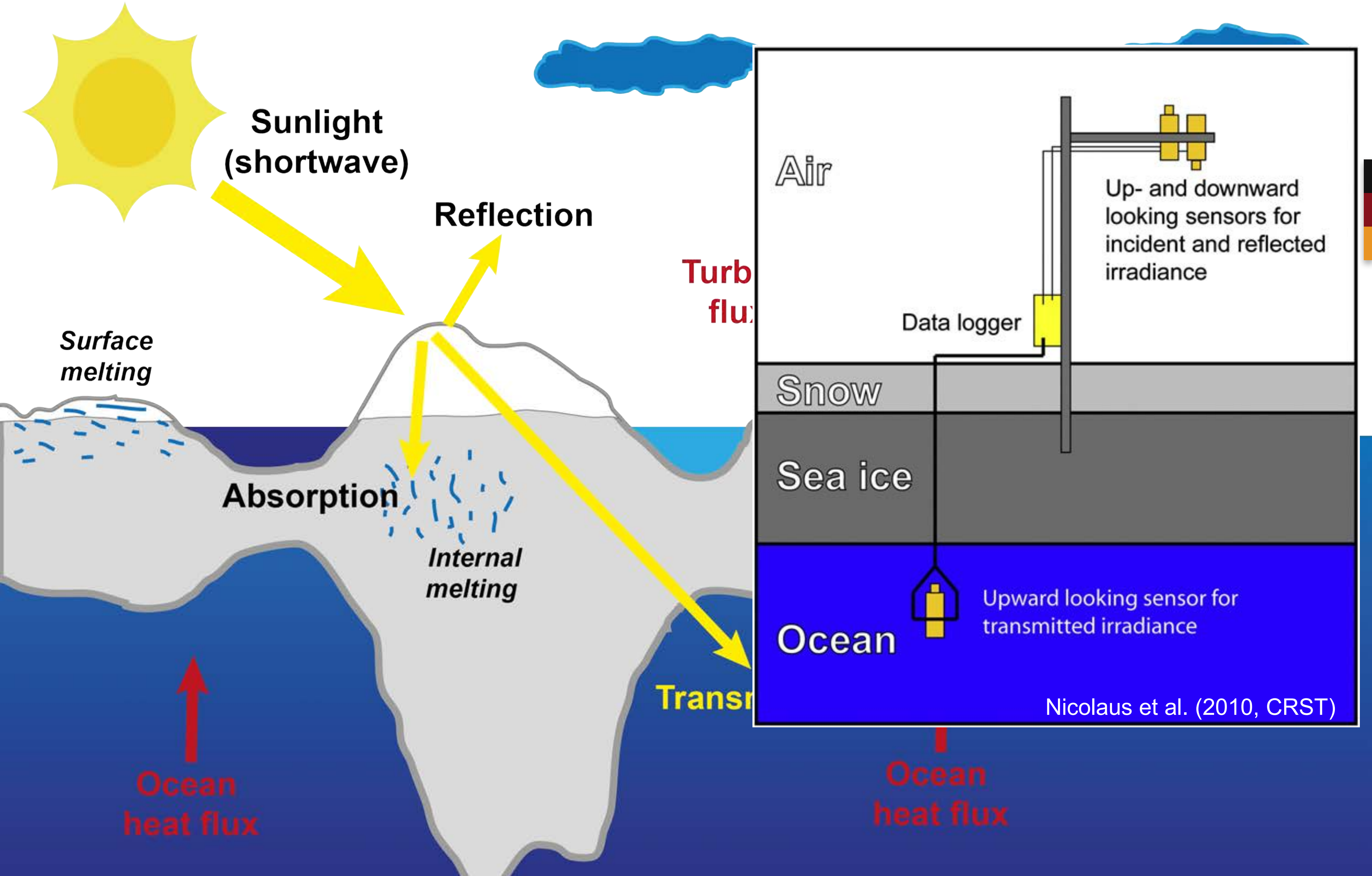
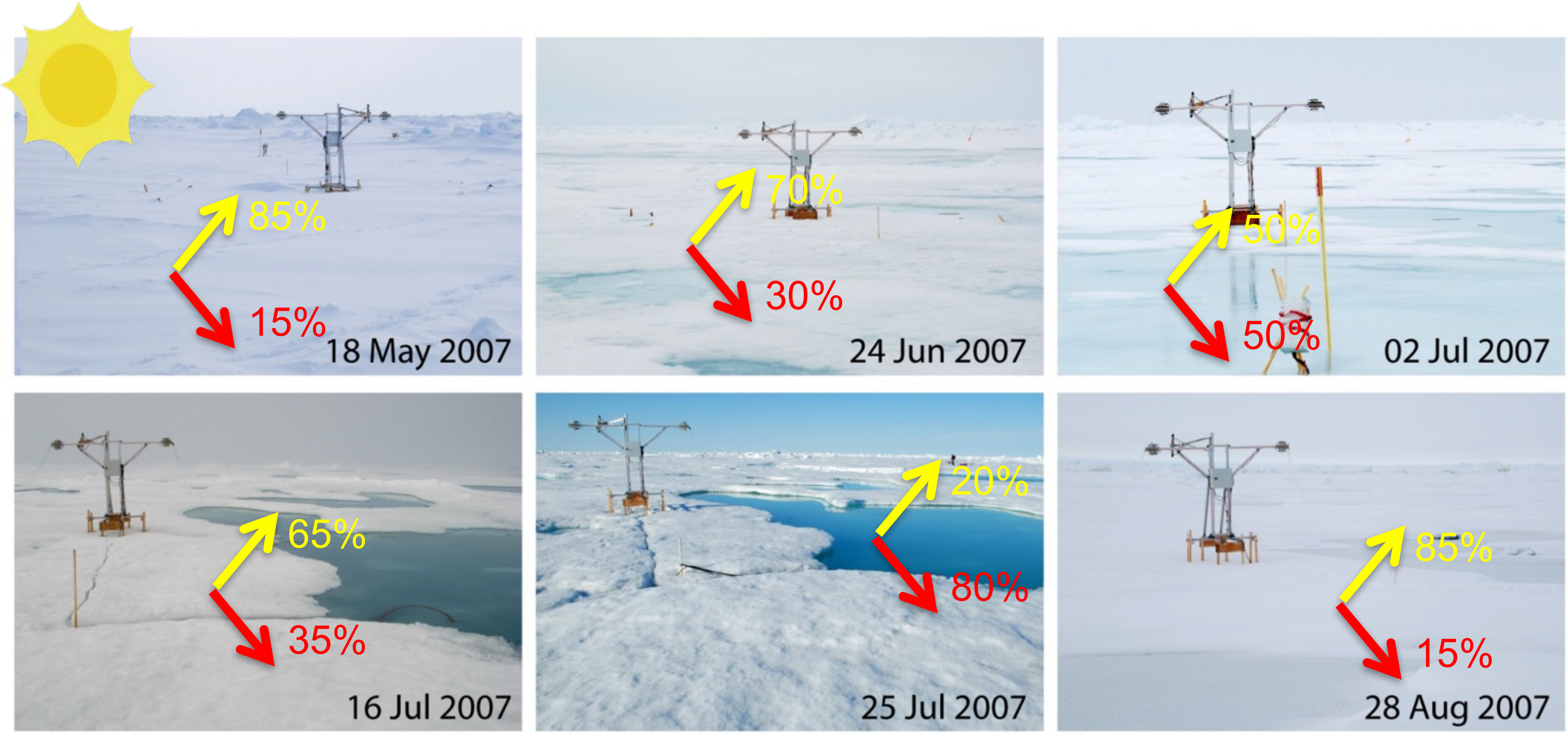
Sunlight and Sea Ice



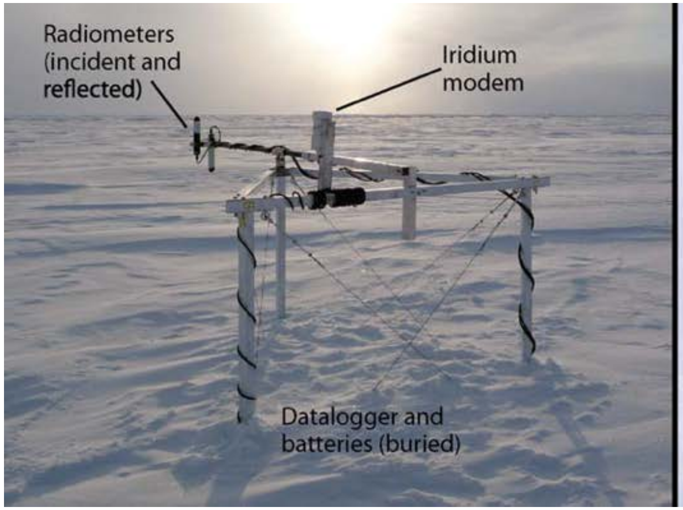
Seasonality from Tara 2007

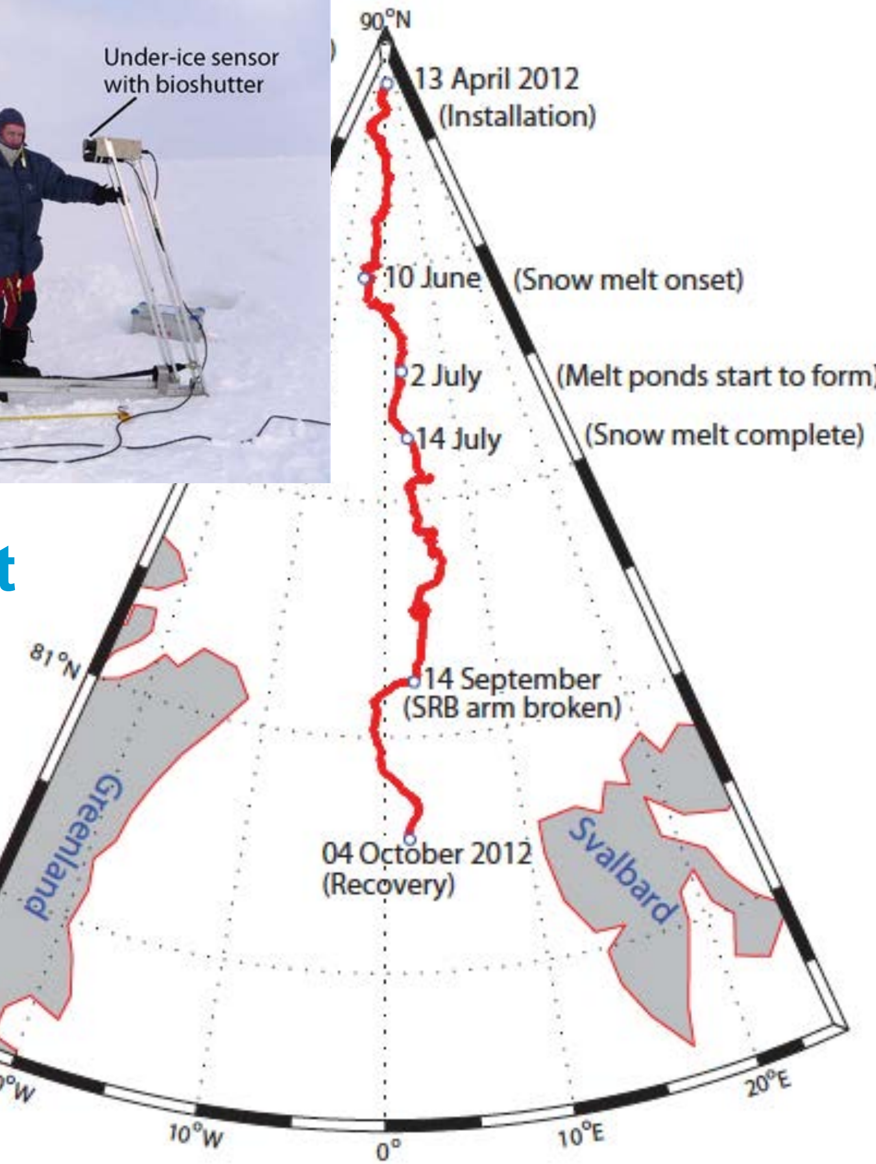


- Prototype transmittance and albedo time series
- Multi Year Ice conditions (ice: 2.0m, snow 0.2m)
- Strong spatial variability

Nicolaus et al. (2010, JGR)

Autonomous Drift 2012





From North Pole to Fram Strait

Ice thickness: 1.20 m

Snow depth: 0.40 m

Freeboard: -0.06 m

Wang et al. (2014, JGR)

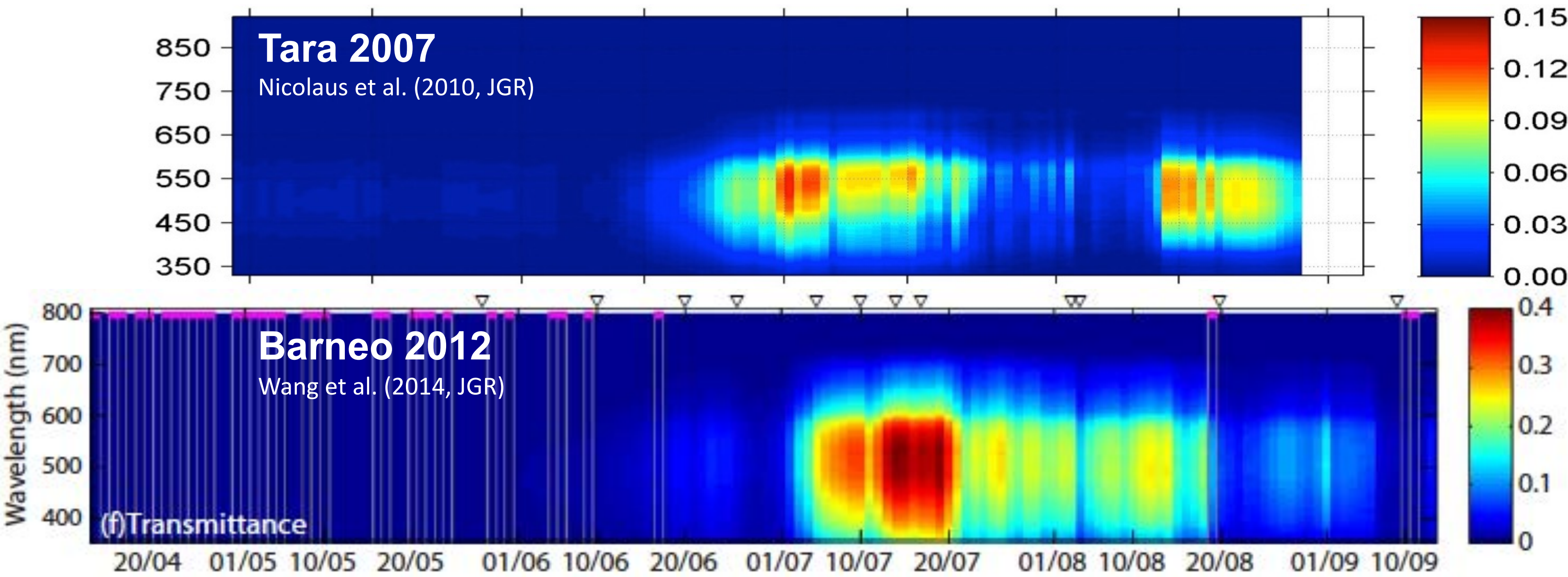
Transmittance Results

Energy budgets

- 2/3 of annual flux during melt season
- 2/3 of energy for observed bottom melt
- Max. integrated fluxes: 15 (Tara) 35 (Barneo) W/m2
- "Interruption" by snow fall events

Ecosystem interaction

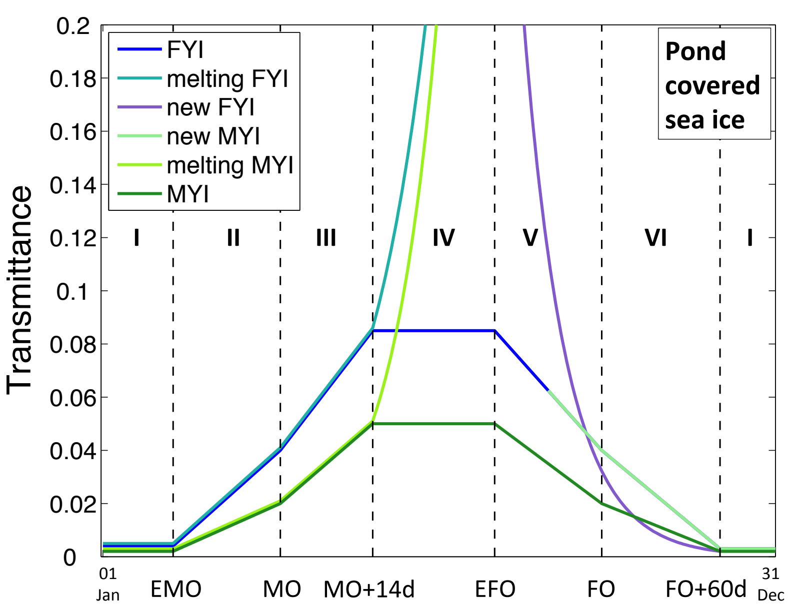
- Reduced transmittance
- Ocean warming

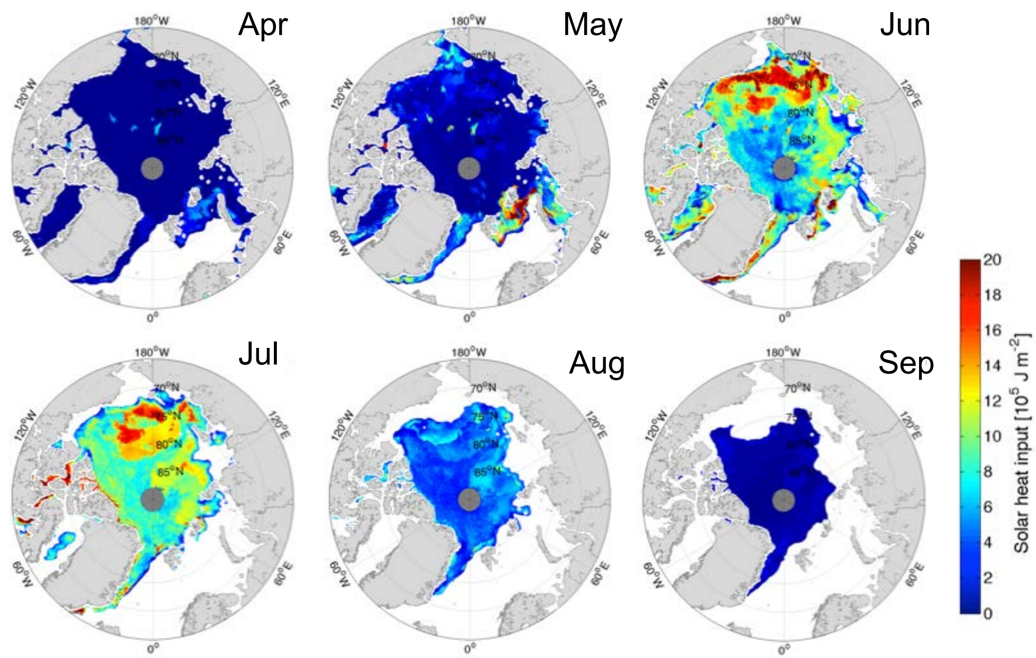


Arctic-wide Up-scaling

Results

- Transmitted short wave is of same order as ocean heat flux
- 96% of annual flux from May to August
- Highest fluxes in June
- Large uncertainties during melt season: 14 days => 25%





Arndt & Nicolaus (2014, Cryosphere)

Objectives

Characterize the variability of ice conditions

- New and thin ice, ridges, seasonal ice, melt ponds
- Towards distribution functions => spatial variability

Focus on key season: spring-summer transition

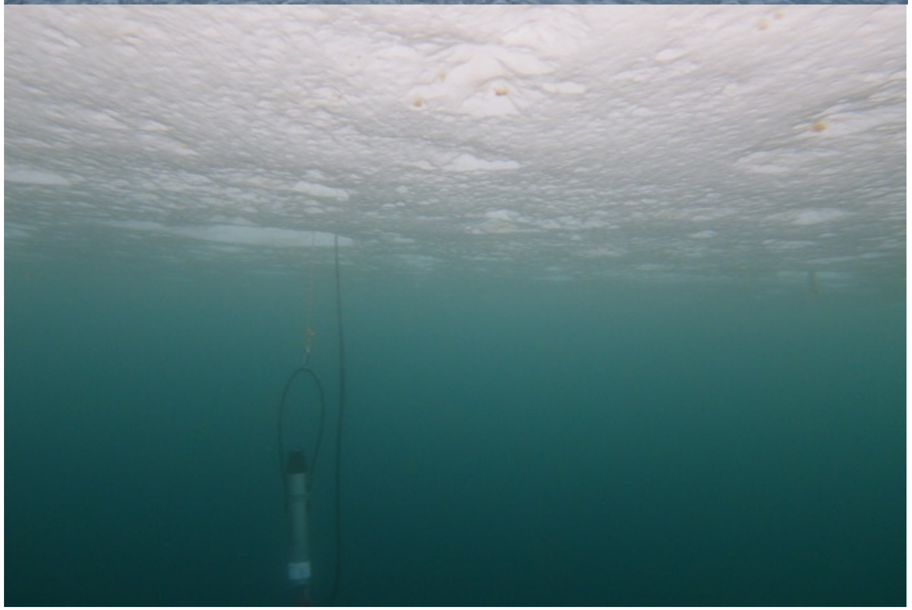
- Snow melt and melt pond formation
- Light transmission: atmosphere > snow > ice > ocean

Physical snow, ice and water properties

- Light transmission: atmosphere > snow > ice > ocean
- Scattering and radiative transfer
- Spectral properties and analysis

Ecosystem studies

- Biomass estimates
- Habitat conditions



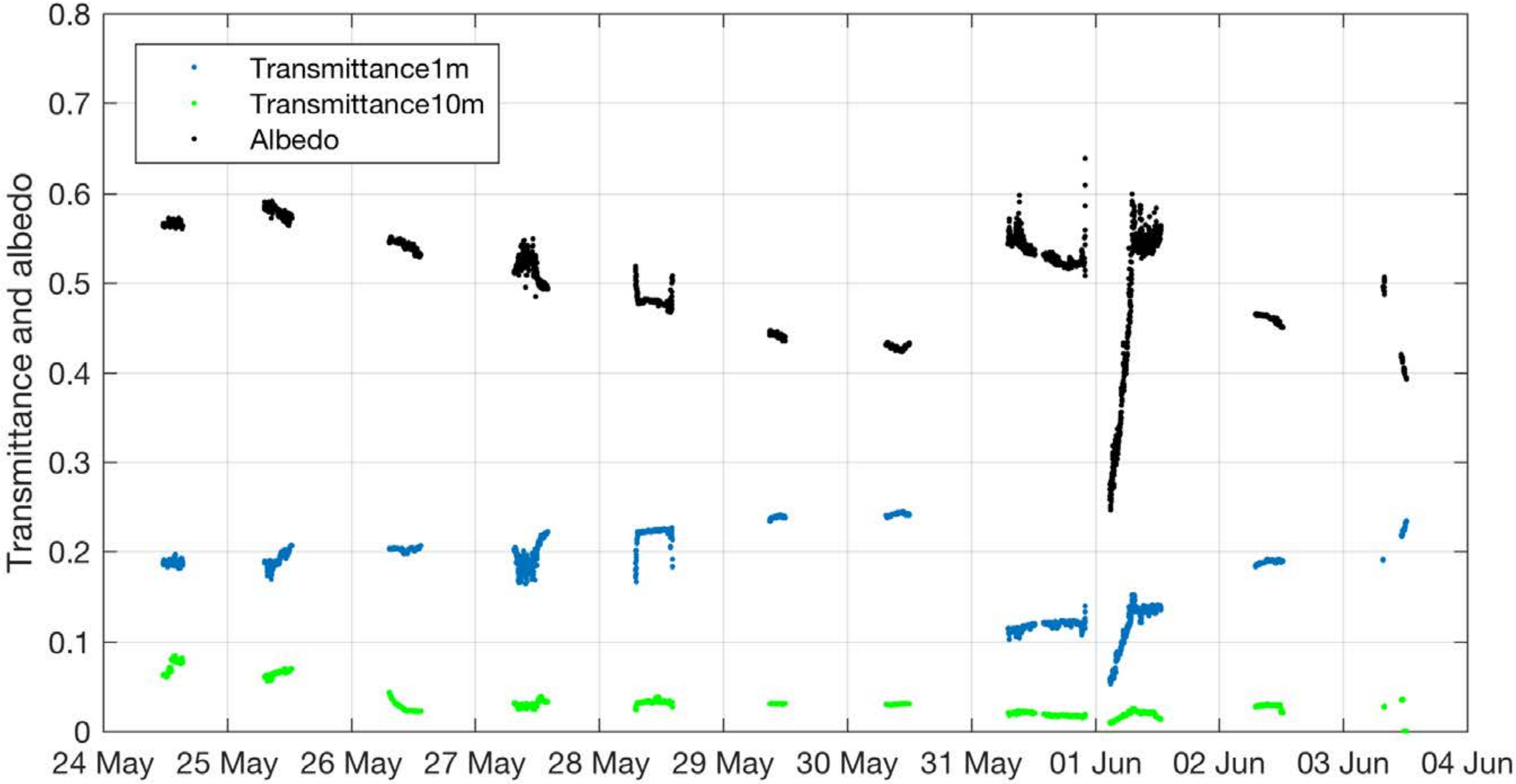
Conditions
- Drift north of Svalbard
- 24 May to 03 June 2015

Frozen lead (3 weeks old)
- Ice thickness 25 cm
- Snow depth 2 cm

5-Sensor Setup
- Surface albedo
- @ 1 m irradiance
- @ 10 m radiance
- @ 10 m irradiance

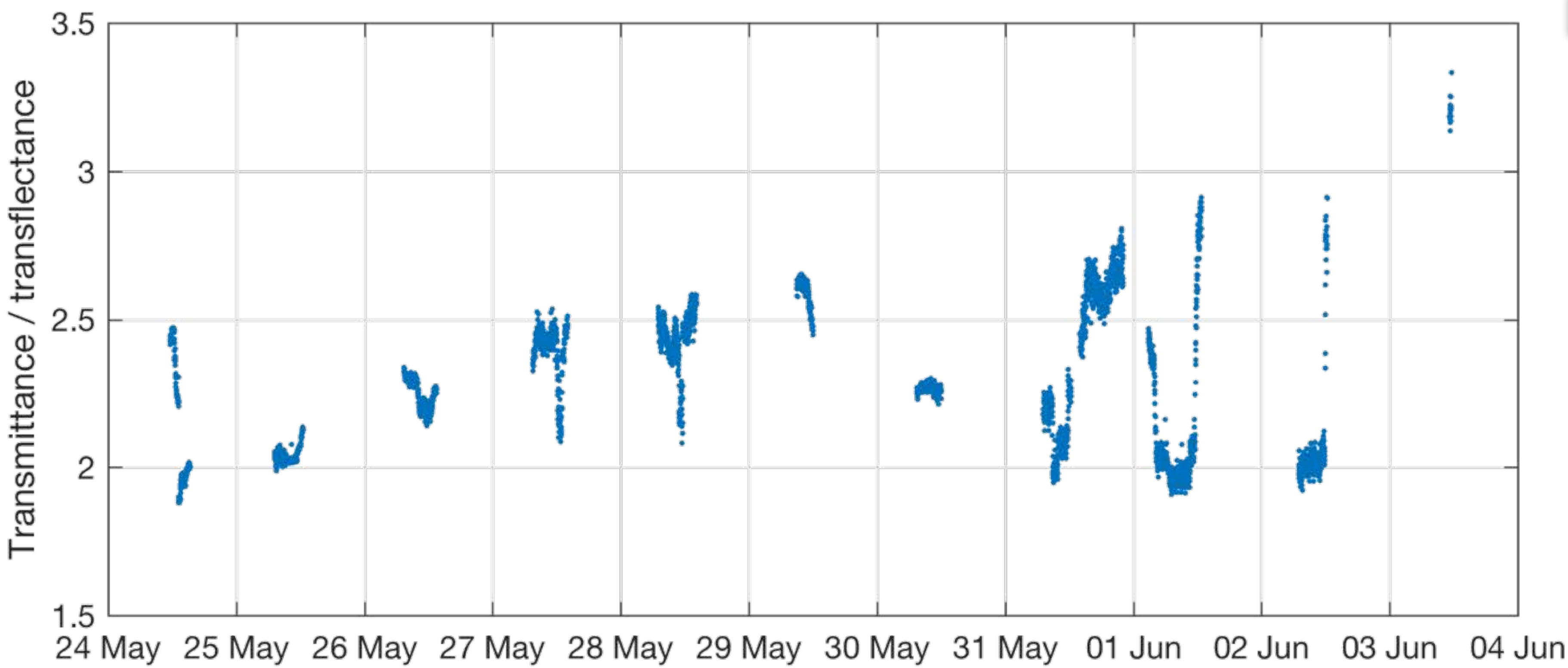
Main features

- Differences in 1m and 10m transmittance
- Bloom and snow fall

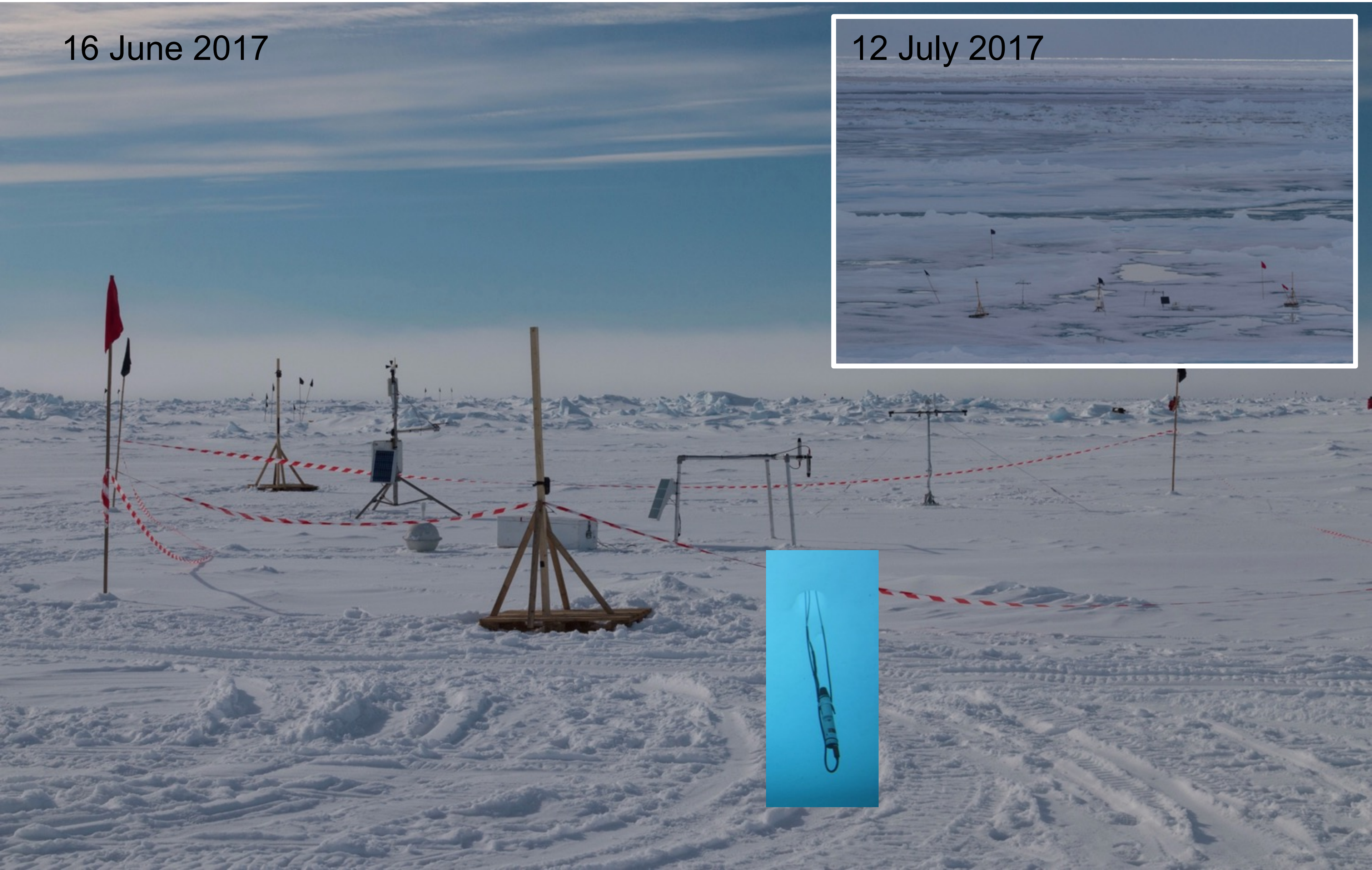


Effects of Phytoplankton Bloom

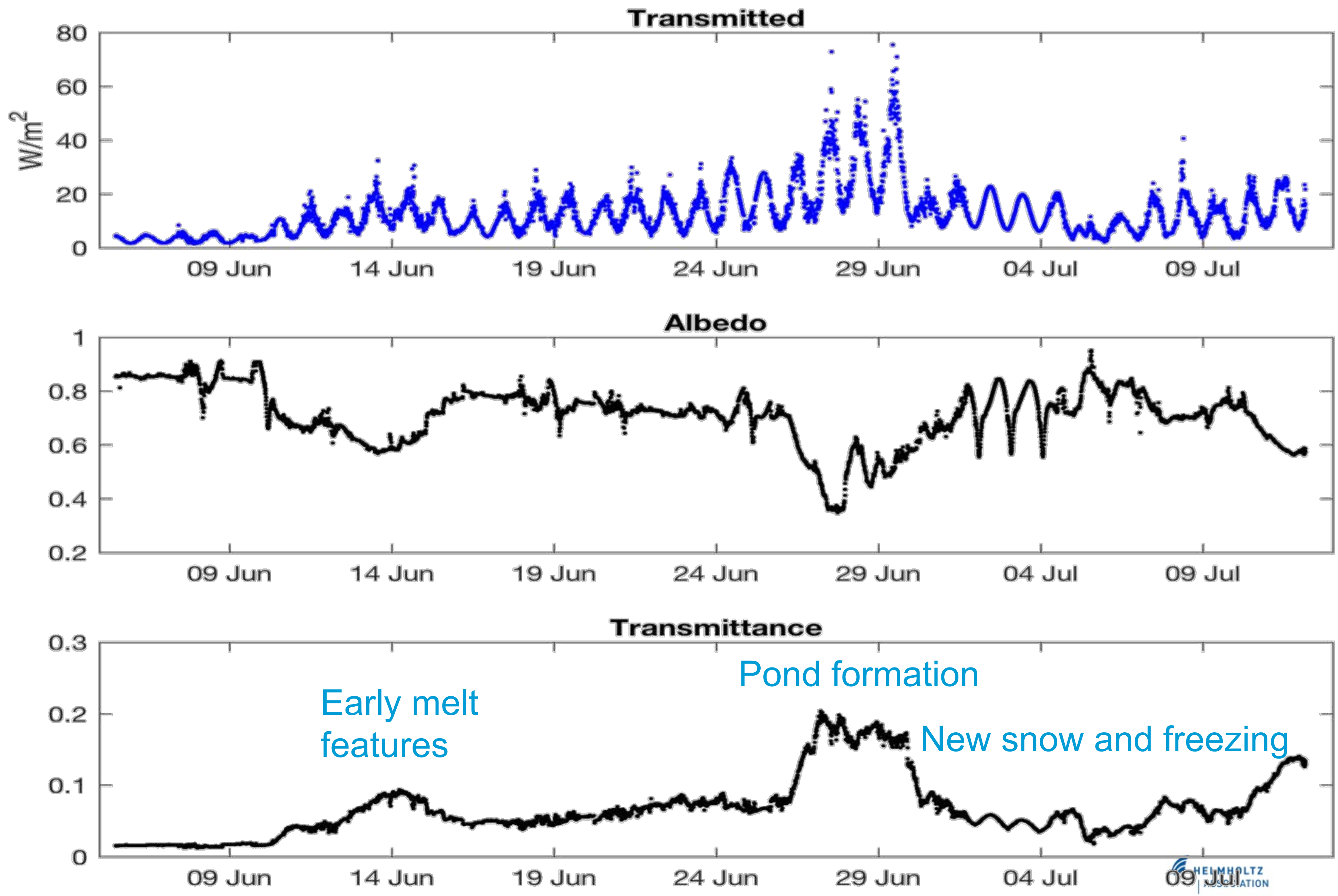
- Changing fractions of more direct and scattered light
- Decaying bloom after 30 May



PS106 Buoy Station



Radiation Station PS106



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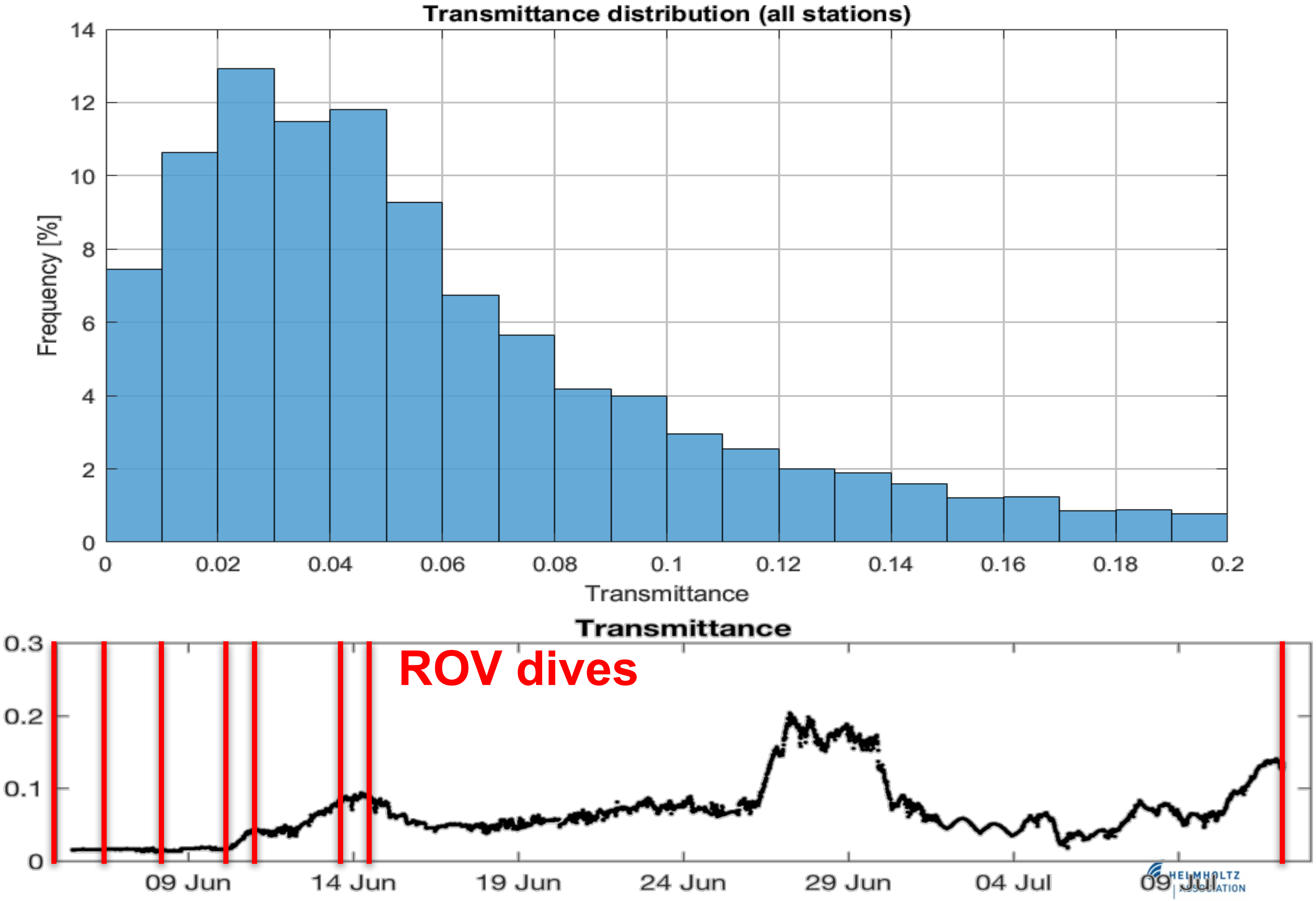
Radiation Station PS106



Towards MOSAiC

Mission

Full annual cycle
- Seasonality
- Spatial variability of all ice types

Interdisciplinary projects
Improving models

Realization

Repeated spatial transects (ROV)
Distributed network

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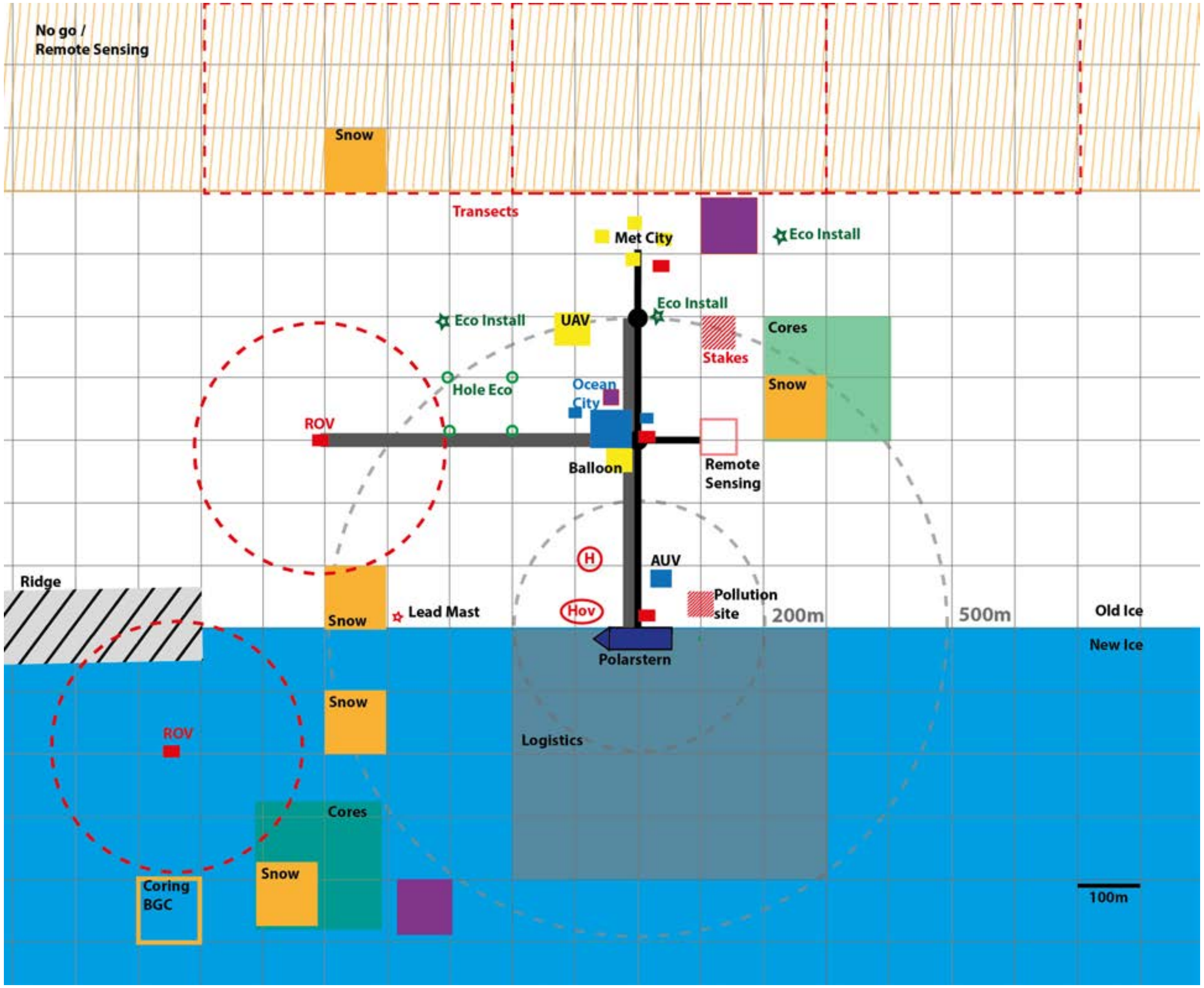
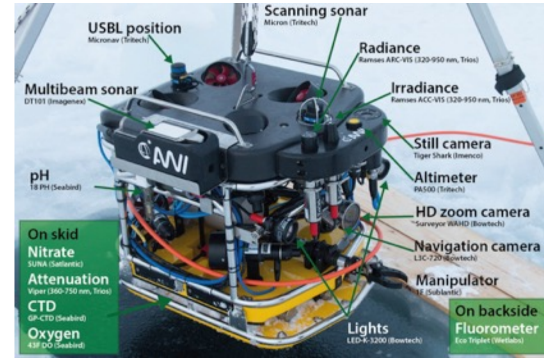
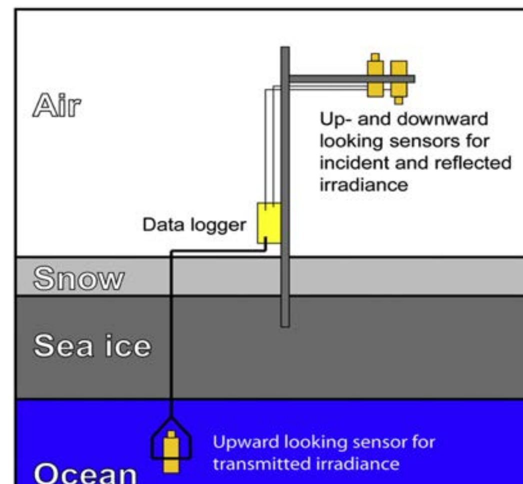
MOSAiC: Central Observatory

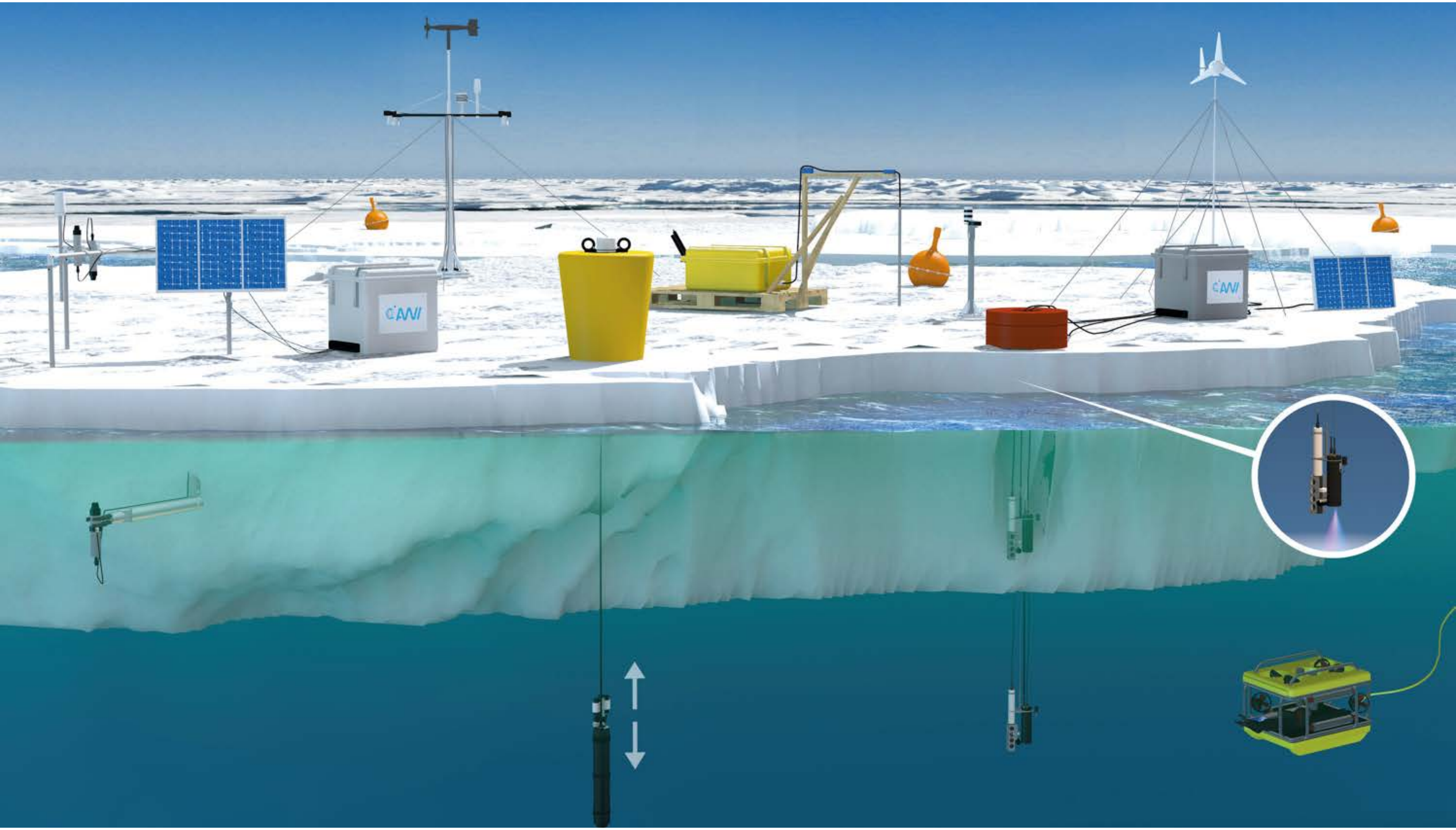






Nicolaus et al. (2010, CRST)

MOSAiC: Distributed Network



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Results and Next Steps

Improved understanding of seasonality

Technology: From prototypes to monitoring systems (distributed networks)

Interruptions by snow fall and freezing events

Role of different ice conditions (new/thin and old ice, ridges and ponds)

Improve up-scaling and model parameterization

Reduce uncertainties in key seasons (spring-summer transition)

Quantifying spatial variability

Include ROV transects and select different ice types

Importance of thin ice for aggregate scale studies => needs more focus

Include aerial data sets, e.g. photography => upscaling

Advanced studies of bio-physical interaction

Diurnal cycles and spectral features

Biomass estimates and habitat conditions