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

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

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**Tara 2007**
Nicolaus et al. (2010, JGR)

**Barneo 2012**
Wang et al. (2014, JGR)
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
Radiation Station PS106

- **Transmitted**
  - Range: 0 to 80 W/m²
  - Dates: 09 Jun to 09 Jul

- **Albedo**
  - Range: 0 to 1
  - Dates: 09 Jun to 09 Jul

- **Transmittance**
  - Range: 0 to 0.3
  - Dates: 09 Jun to 09 Jul

Key Observations:
- **Early melt features**
- **Pond formation**
- **New snow and freezing**
Radiation Station PS106

Transmittance distribution (all stations)

Frequency [%]

Transmittance

ROV dives
Towards MOSAiC

**Mission**

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

Interdisciplinary projects
Improving models

**Realization**

Repeated spatial transects (ROV)
Distributed network
MOSAiC: Central Observatory

Nicolaus et al. (2010, CRST)
MOSAiC: Distributed Network
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