Assessing the Influence of Water Constituents on the Radiative Heating of Laptev Sea Shelf Waters

Maritana A. Soppa1, Vasileios Pefanis1, Sebastian Hellmann1, Jens Hölemann1, Markus A. Janout1, Fedor Martynov1, Birgit Heim4, Vladimir Rozanov5, Svetlana Loza1, Tilman Dinter1, Astrid Bracher1,5

Motivation

- Optically active water constituents → attenuation of light penetration → impact ocean heat content → potentially contribute to sea ice melting.
- Radiative heating of the Laptev Sea shelf and Lena River (Arctic Siberia, Fig. 1A) → river system with highest annual flux of dissolved organic carbon and silica to Arctic Ocean [1,2].
- Aim: to investigate influence of dissolved organic matter (CDOM) and total suspended matter (TSM) on radiative heating of Laptev Sea shelf waters.

Data and Methods

- Validation of MERIS Chl and a_{CDOM}(443) from C2RCC and CZX algorithms (Fig. 18, blue) + Evaluation of RTM SCIATRAN (Fig. 18, green) + Radiative Transfer simulations of radiative heating (Fig. 18, red).

- **In situ dataset:** vertically resolved a_{CDOM} spectra, SPM, Chl, temperature and salinity taken during August-September 2010 and 2011 by the TRANSFORM-XVII (2010) and TRANSFORM-XIX expeditions (Fig. 1A).

- **Simulations with RTM SCIATRAN:**
  - spectral RT calculations for a coupled atmosphere-ocean system [3];
  - atmosphere: thermal emission, absorption by several trace gases, Rayleigh scattering and scattering by aerosol and cloud particles.
  - ocean: scattering by water, TSM, absorption by water, CDOM, Chl and TSM.

- **Simulations:** spectrally scalar irradiance (E$_0$, W/m$^2$, 300 - 900 nm) for July at 76°N, 126°E, for 24 solar zenith angles and using MERIS imaging geometry information.

- input data: In situ and satellite Chl, CDOM, and TSM.

Absorbed Energy and Radiant Heat

- E$_{abs}$ (Fig. 3): incident solar radiation strongly absorbed in the first meters of the water column → increased rate of sea ice melt (dH/dt, mm/h) compared to clearer waters.

- Greater E$_{abs}$ by CDOM and TSM increased the radiant heating rate (RH, °C/day).

Spatial Distribution

- E$_{abs}$, ΔRH

- when TSM > 10 g/m$^2$ and Chl > 3 mg/m$^2$

- less direct relationship between E$_{abs}$ and a_{CDOM}

Validation of MERIS a_{CDOM}(443) and Chla

- a_{CDOM}(443): underestimation by C2RCC and small overestimation by CZX.

- Chl: overestimation by all four products, but at least using the Laptev Sea conversion factor for a_{CDOM} to Chl [4] of 7.8 (default is 21).

RT Evaluation

- Radiative processes are well implemented in the model.

Acknowledgements

This study was funded by the German Science Foundation (DFG) Trans Regio GR 594 “Arctic Amplification – TAE+ and Ineptis Climate Simulation – KA2C” (regional climate change). Additional funding was provided by the Federal Ministry of Economics and Technology (BMWi) and the German Aerospace Centre grant number 50 EE 1620. The long-term Russian-German TRANSDrift expedition in the Laptev sea region were supported by the German Federal Ministry of Education and Research and the Russian Ministry of Education and Science. ESA is acknowledged for the MERIS satellite data and the SNAP software. The NASA EOSDIS Physical Oceanography Distributed Active Archive Center (PO.DAAC) at the Jet Propulsion Laboratory, Pasadena, CA, is acknowledged for the SST data.

References


