Investigation on heat transfer in the Laptev Sea with respect to regional climate change

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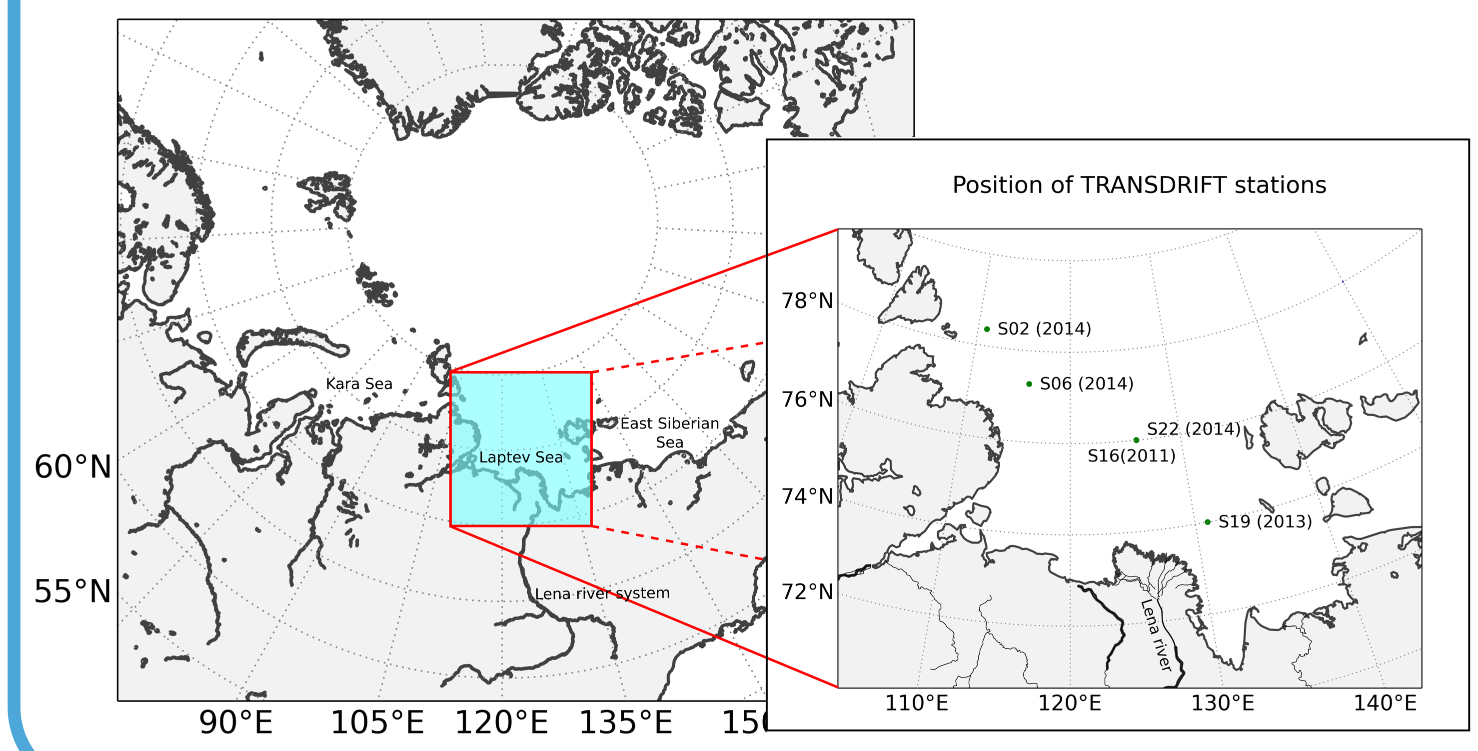
Objectives, Method and Background:

Background to Laptev Sea:
- is mainly influenced by Lena river system (carries high CDOM & SPM) -> extreme case-2 water
- due to increasing permafrost thawing under climate change CDOM & SPM loading is expected to increase here tremendously

Goal and first Objectives:
- ocean colour in combination with modelling to assess changes in radiation budget and heat transfer
  - What is the euphotic depth in the Laptev Sea under changing SZA and water constituents?
  - Can we use ocean colour to investigate the radiation budget in the Laptev Sea?

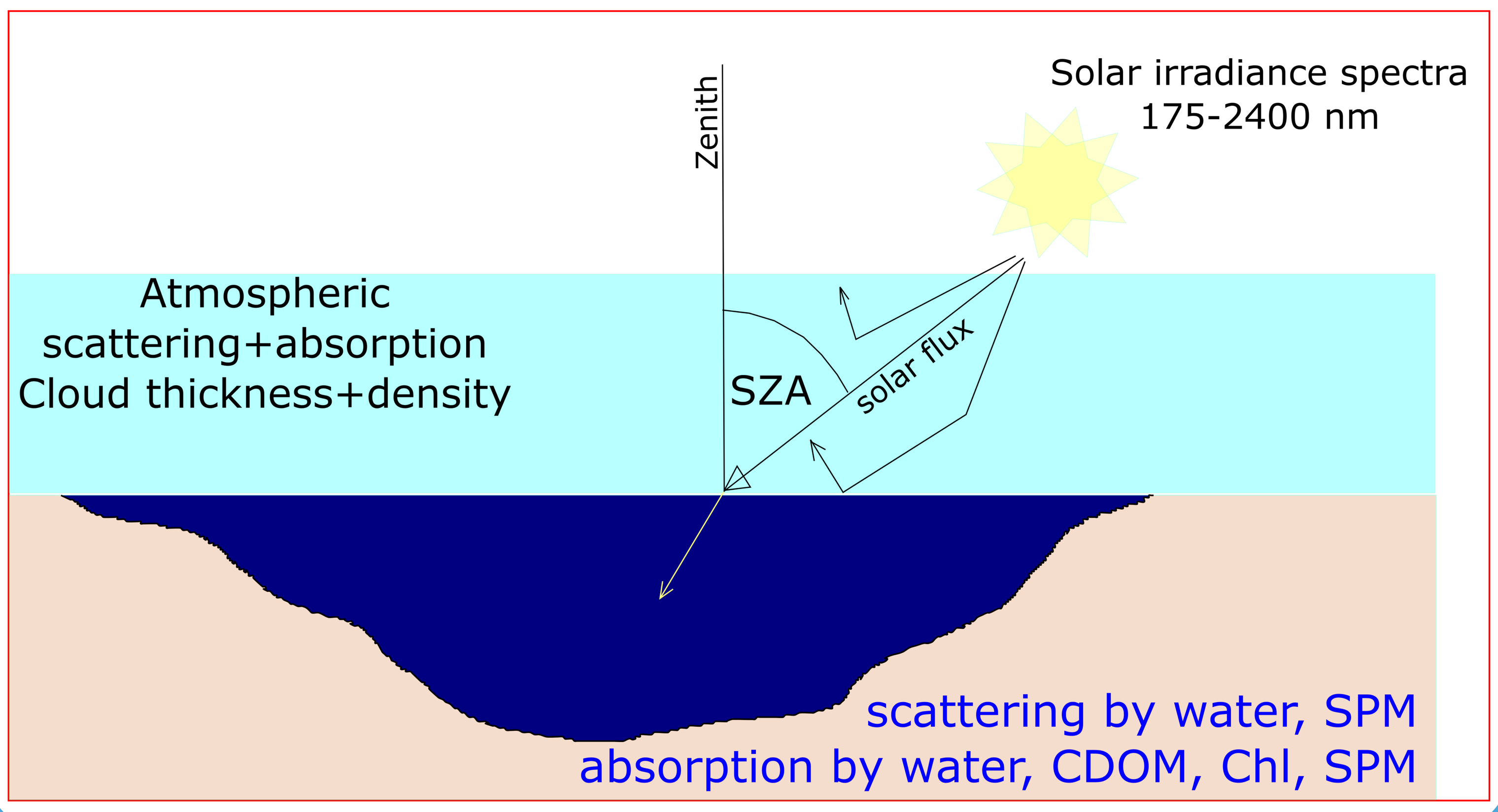
Investigation Area - Siberian Laptev Sea



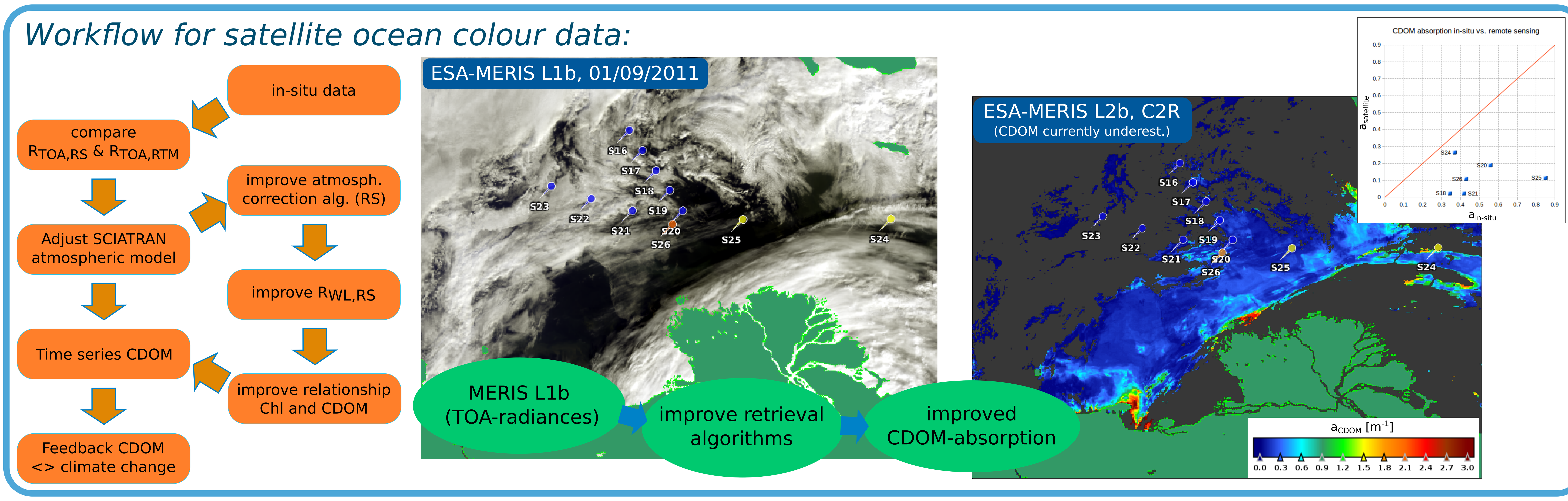
Methods for investigation:
- We use radiative transfer (RT) model SCIATRAN to calculate radiation budget and derive energy transfer at five representative stations which were sampled in situ for CDOM, CTD, SPM and Chl:
  - 2 in river plume (S16+S19)
  - 3 outside (S02, S06, S22)
- Preparation of satellite ocean colour data for multi-year assessment

Modelling software - SCIATRAN:

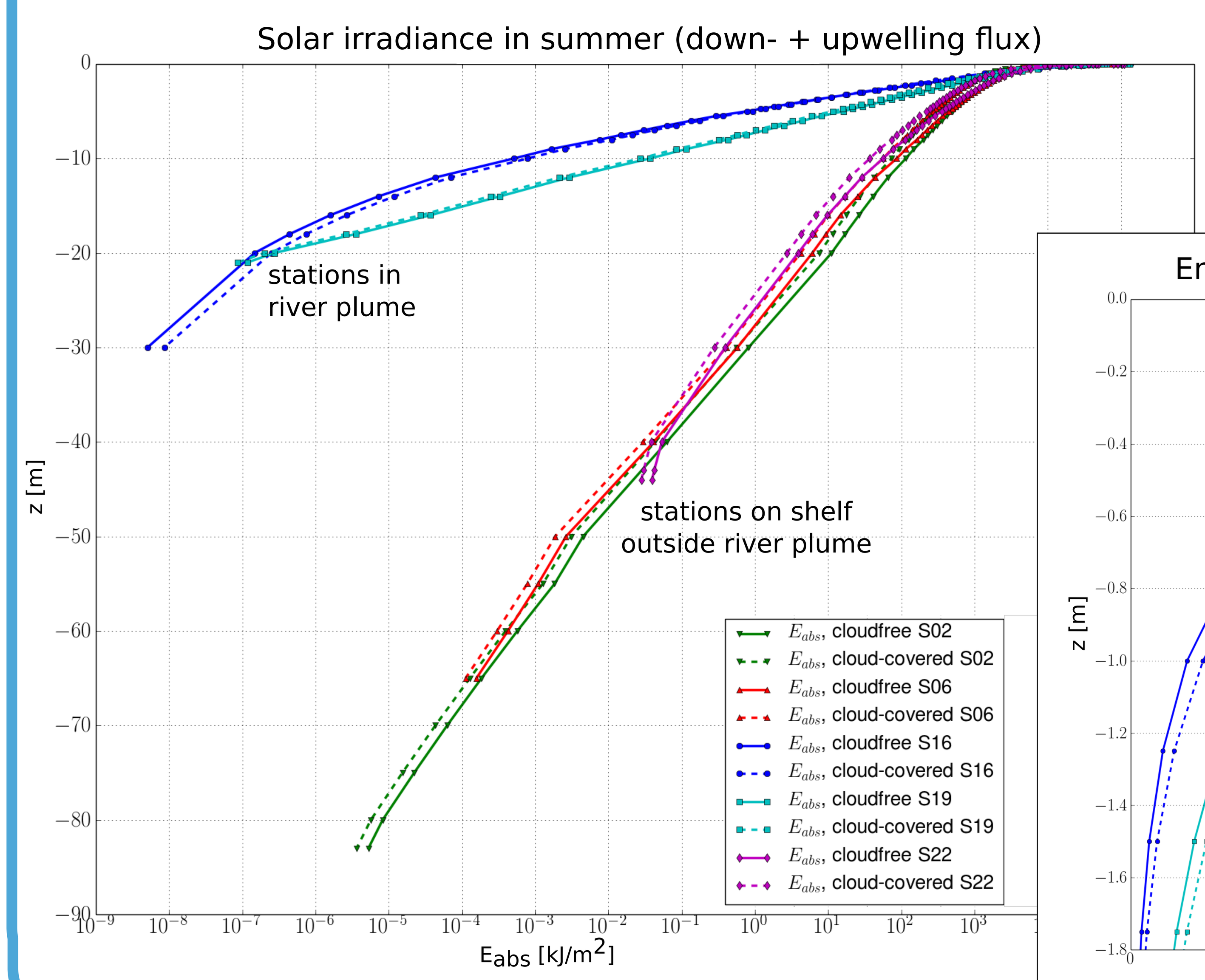
- spectral RT calculations from 175 to 4000 nm[Rozanov et al. 2002, 2014] for a coupled atmosphere-ocean system
- calculation of light field in ocean body with constituents Chlorophyll (Chl), coloured dissolved organic matter (CDOM) and inorganic suspended particulate matter (SPM) [Rozanov et al. 2014]
- atmosphere: spherical half space to allow solar zenith angles (SZA) up to 93°. Clouds, aerosols and common gaseous absorbers are considered in a freely layered model for the atmosphere.



Workflow for satellite ocean colour data:



First results on radiation budget:



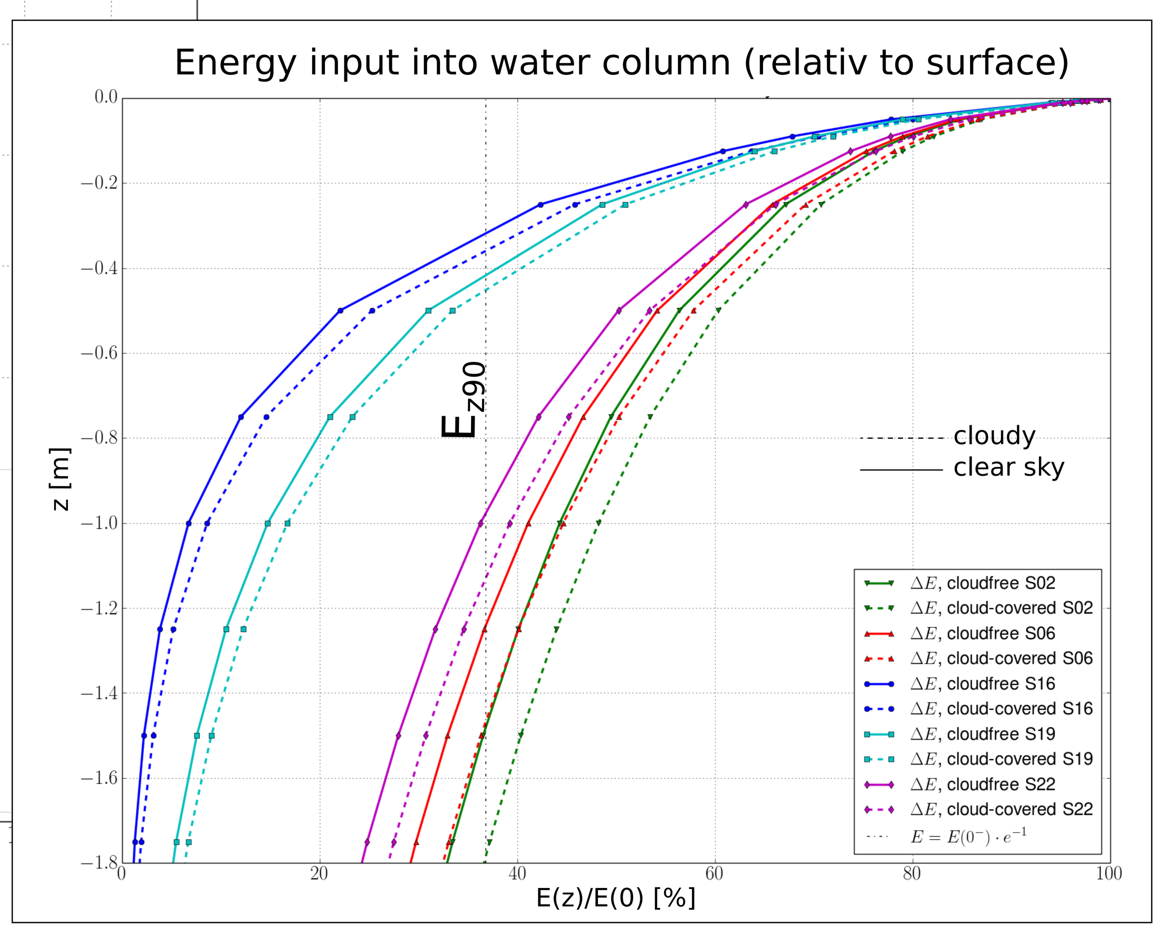
We investigated three major aspects:

1. Influence of solar elevation and the resulting first optical depth
2. Influence of cloud coverage
3. Influence of different values of CDOM-absorption

Tab. 1: First optical depth (z90) for different situations

	S02	S06	S22	S16	S19
Chl-conc. [mg/m^3]	*0.5*	*0.5*	*0.5*	1.12	5.04
SPM-conc. [g/m^3]	*1.0*	*1.0*	*1.0*	*1.0*	1.97
a_{CDOM}(440 nm) [m^{-1}]	0.087	0.183	0.430	2.030	2.396
z_{90} [m], 01/07, clear	1.45	1.21	0.95	0.30	0.39
z_{90} [m], 01/07, cloudy	1.78	1.45	1.11	0.33	0.43

1,0 - value set by suggestion, analysis not finished yet



Conclusion and Outlook:

CDOM absorption highly influences the underwater light field and availability in the Laptev Sea region. Our results clearly show the differences between extreme CDOM-rich Lena river waters and shelf water that rather bear typical absorption of case-2 waters.
Even for those stations outside the river plume the first optical depth is very shallow due to large SZA at this latitudes. This leads to a miscalculation of water constituents from satellite products. However, especially in this region remote sensing products are very important for time series analysis as in-situ is hampered due to difficulties in accessing this area.

In future, we plan to derive enhanced retrieval algorithms for RS based on improvements in biooptical models and atmospheric correction accounting for the special conditions of this environment.

References:
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