Sea ice modeling and knowledge about **black carbon impacts** can be improved by using a **snow model**

Towards dedicated snow over sea ice modeling: Comparison between ERA5 data and in-situ observations in Northeast Greenland

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RESEARCH QUESTIONS

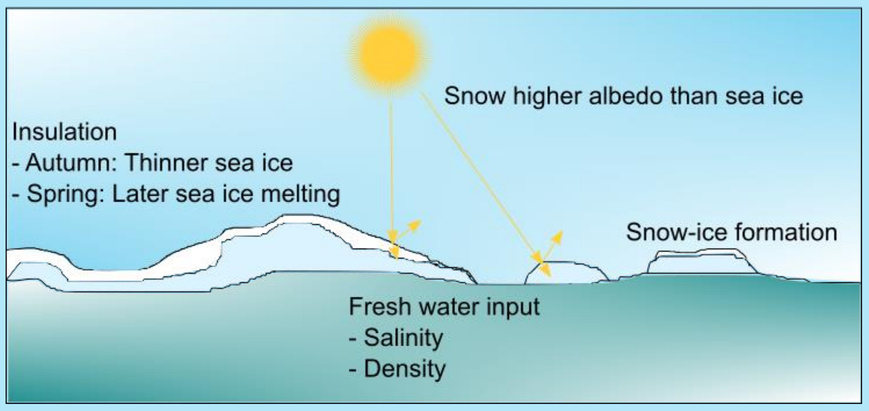
- In-situ observations vs reanalyses –
  Can atmospheric reanalyses be used to model snow characteristics over bedrock in Northeast Greenland?
- How can we improve snow characteristics in sea ice models?
- How does black carbon on snow over sea ice affect radiative properties, snow cover and sea ice evolution?
- Are MOSAiC observations able to improve simulations?

METHOD

Extend Crocus for usage over sea ice in the central Arctic and couple the snow model with a thermodynamic sea ice model (e.g. ICEPACK) along ice drift trajectories (Lagrangian simulations)

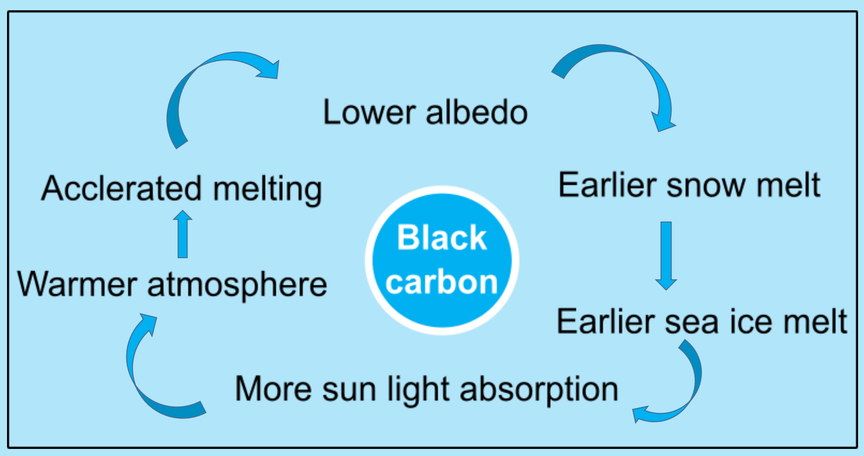
Why do we need a coupled snow-sea ice model?

- Snow is only rudimentarily represented in most current sea ice models
- Snow is an important factor:



Why is black carbon on snow/ on snow over sea ice important?

- Influences of BC on radiative budget:



- More BC in the future due to enhanced shipping in the Arctic?

ACTUAL STAGE

- Modification of Crocus for usage over Arctic bedrock
- Comparison of meteorological input data: ERA5 data and in-situ observations
- Several model runs forced by different ERA5 grid points close to in-situ location
- Comparison between outputs from in-situ and reanalysis data, find biases

NEXT STAGE

- Modification of Crocus (e.g. snow drift, sublimation, fresh snow density)
- Investigate the influence of black carbon on snow over bedrock and implicated radiation balance

The snow model Crocus

- 1-D snow model (Meteo-France)
- Multi-layer snowpack model
- Computes energy- and mass balance in snow
- Including time evolution of snow microstructure and metamorphism

Model forcing	
Air temperature	General meteorological variables
Near surface specific humidity	
Wind speed	
Wind direction	
Surface air pressure	
Rainfall rate	
Snowfall rate	
Longwave radiation downwards	Radiation
Direct shortwave radiation downwards	
Diffuse shortwave radiation downwards	
Aspect	Terrain
Slope	
Altitude	
Wet deposition coefficient	BC
Dry deposition coefficient	

Routines in Crocus

- Snowfall
- Update of snow layering
- Snow metamorphism
- Snow compaction
- Impact of wind drift
- Snow albedo, transmission of solar radiation
- Surface energy balance
- Update of temperature profile
- Snow melt
- Water flow and refreezing
  Snow sublimation/ hoar deposition

References:
Jacobi et al. (2015): Modeling the impact of black carbon on snowpack properties at an high altitude site in the Himalayas. In: The Cryosphere 9, 1685 - 1699.

Powell et al. (2005): The effects of snow depth forcing on southern ocean sea ice simulations. In: Journal of Geophysical Research: Oceans 110.

Interested in more information about the snow model Crocus?

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