Observations of snow cover processes on Antarctic sea ice from in-situ and model studies.

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Introduction: Snow on Antarctic sea ice

- Snow rules sea ice conditions (albedo, thermal insulation, …)
  (e.g. Lytle et al., 2000)

- Snow contributes to sea ice mass balance
  (e.g. Jeffries et al., 2001)

- Snow depth heavily affects results from satellite remote sensing
  (e.g. Ricker et al., 2015, Arndt et al., 2016)

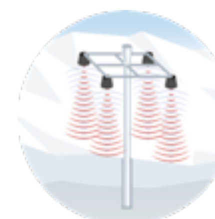
- Snow thickness in-situ measurements are sparse (in time and space)

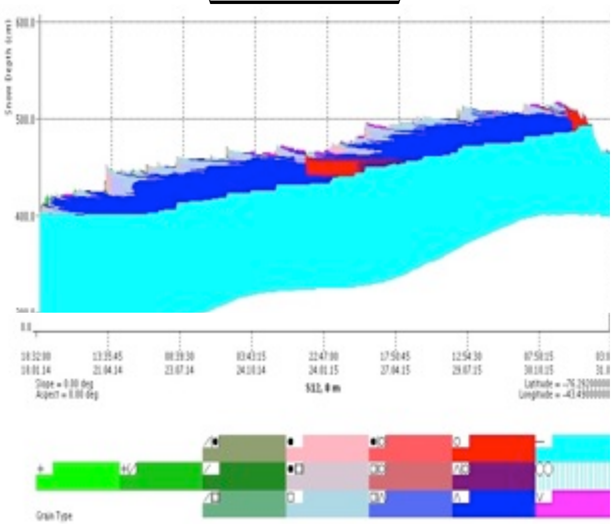
=> Strong need for Antarctic wide snow thickness product

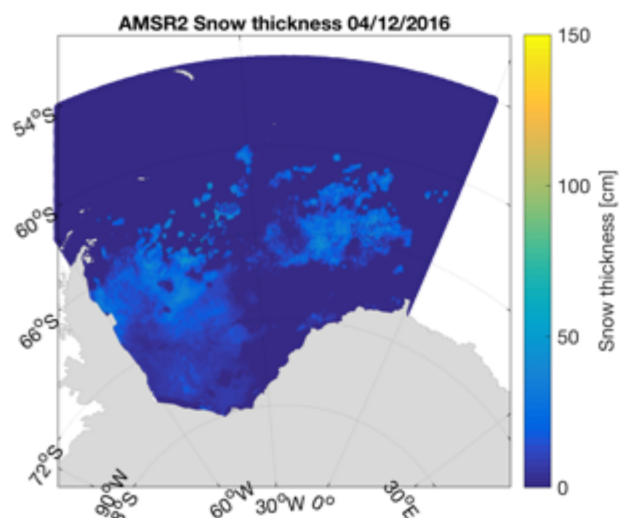
The SCASI Project

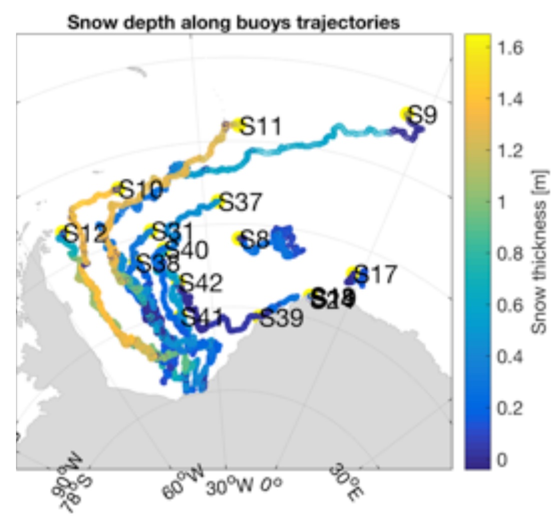
- German / Swiss Project
  (DFG & SNF funded)

Quantify the amount and distribution of snow on Antarctic sea ice, its physical properties and their evolution over time.

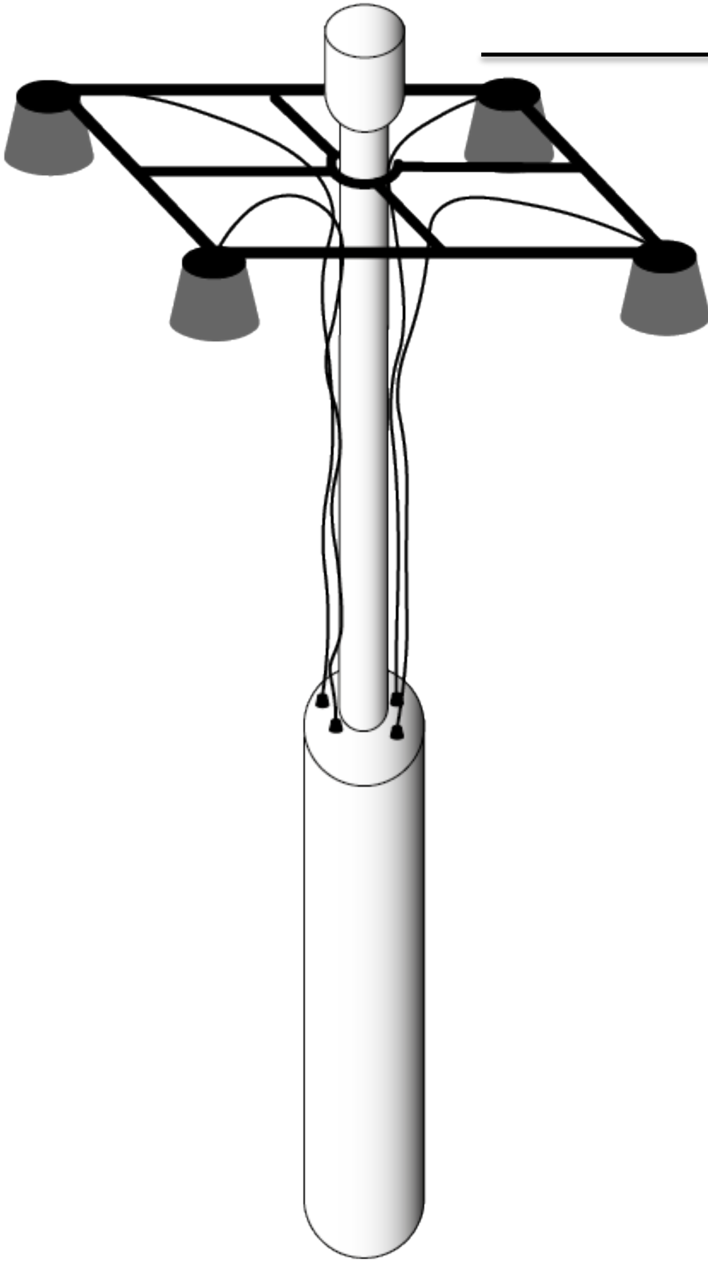








The Snow Buoy



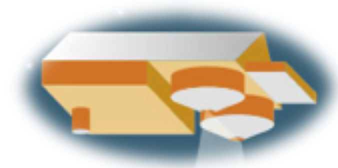
IRIDIUM antenna, temperature sensor

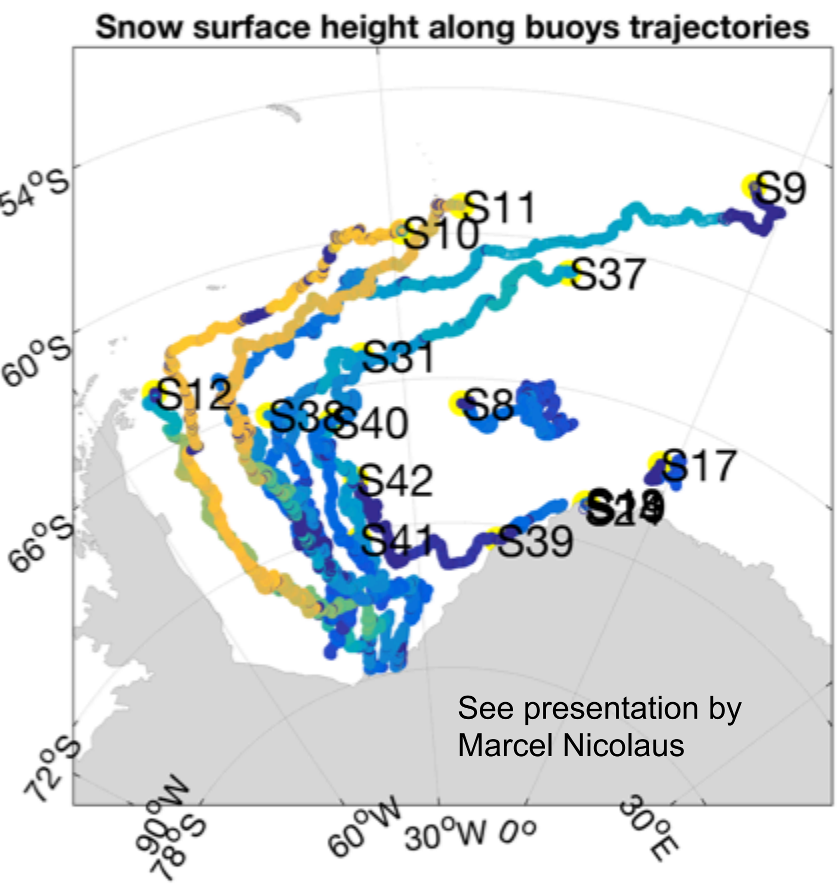
Four ultra sonic sensors

1.5 m mast

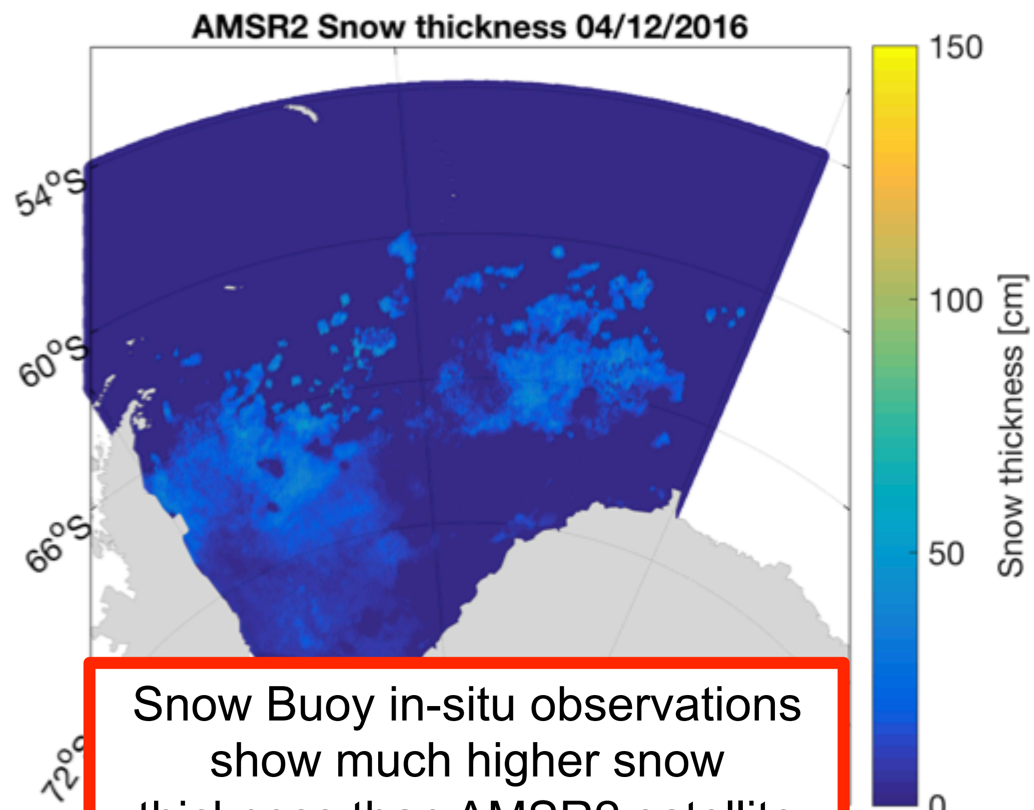
Electronics and batteries

Snow Buoy Overview



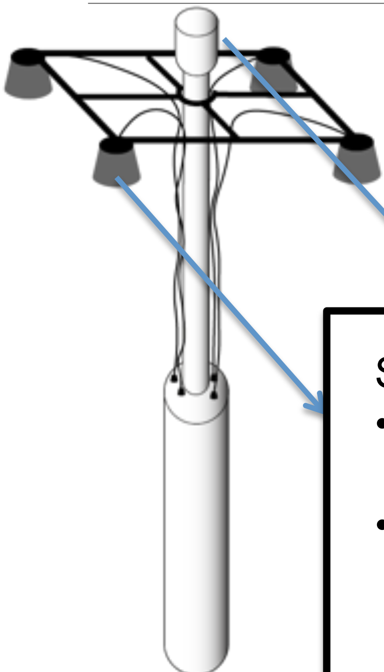


See presentation by
Marcel Nicolaus



Snow Buoy in-situ observations show much higher snow thickness than AMSR2 satellite observations.

SNOWPACK: Sea ice component



Air temperature from buoy
Initial snow and ice thickness
Snow accumulation

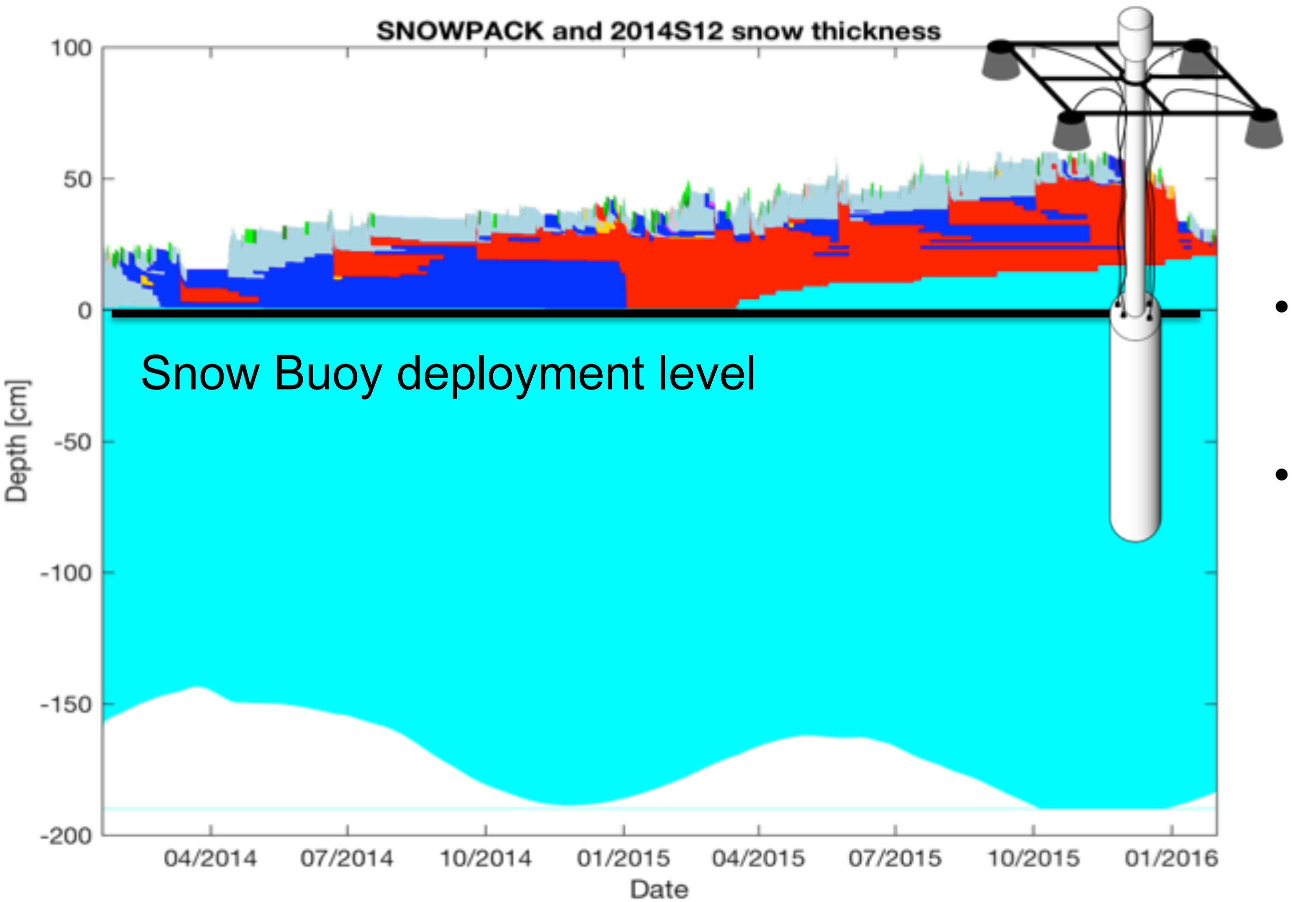
SNOWPACK adaptation for sea ice
- ECMWF Era-Interim
  - Radiation
  - Wind etc.
  - Precipitation
- Prescribed salinity
- Prescribed ocean heat flux
  - Sinus between 5-15 Wm^{-2}

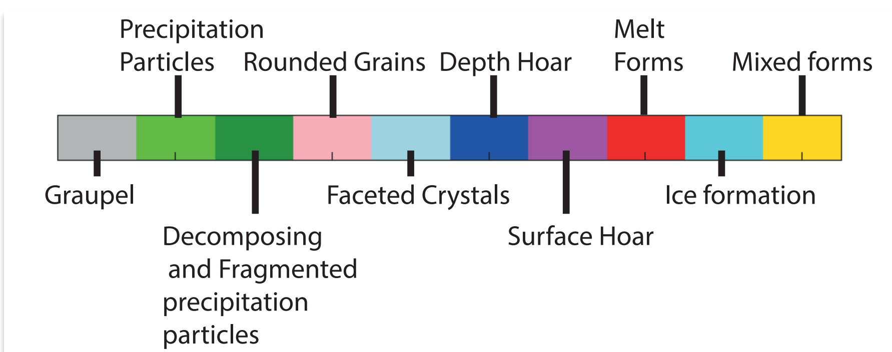
SNOWPACK:
- Well established numerical snow model (Bartel and Lehning, 2002)
- Recently developed sea ice branch:
  - 1D thermodynamic sea ice model including snow cover processes
- We combined the Snow Buoy with the new SNOWPACK branch

Main Outputs:
- Temperature
- Snow/Ice thickness
- Grain types

Snow and ice temperature from Ice Mass-balance Buoy

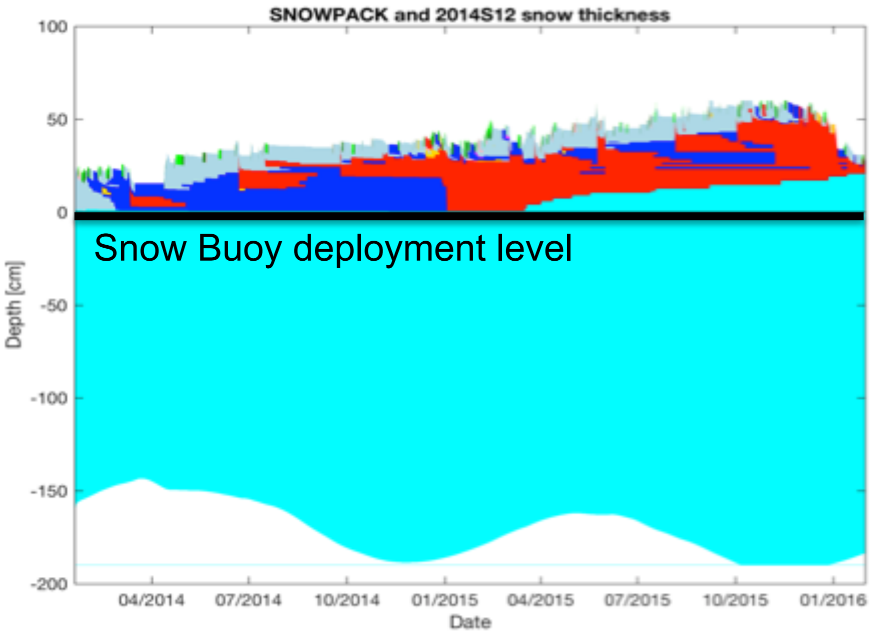
SNOWPACK: Exemplary result

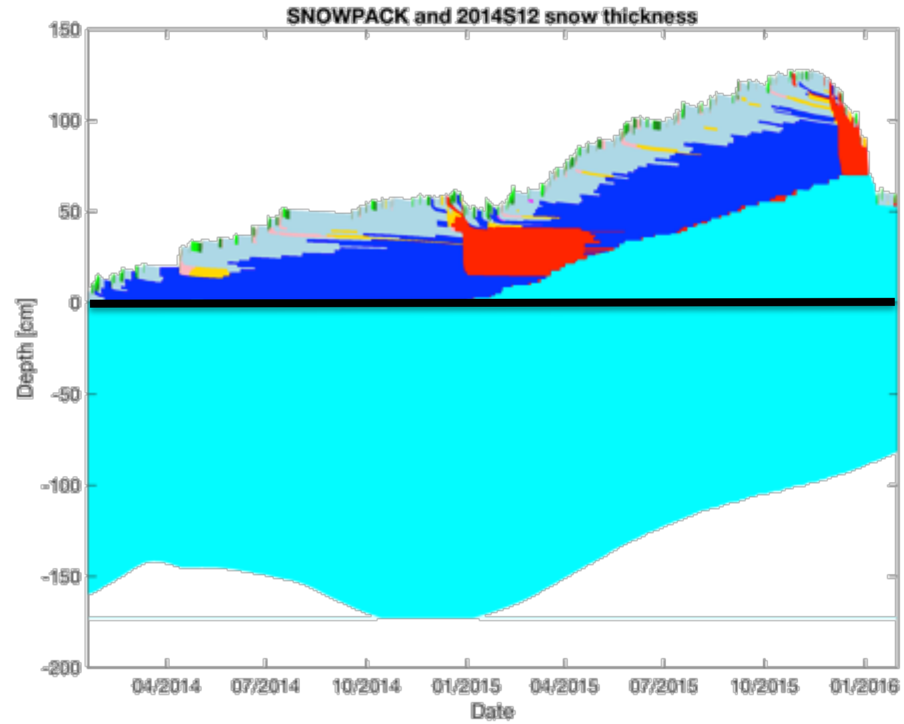




- Capable of modelling different snow types
- Results plotted corresponding to Snow Buoy measurements

SNOWPACK: Ocean heat flux



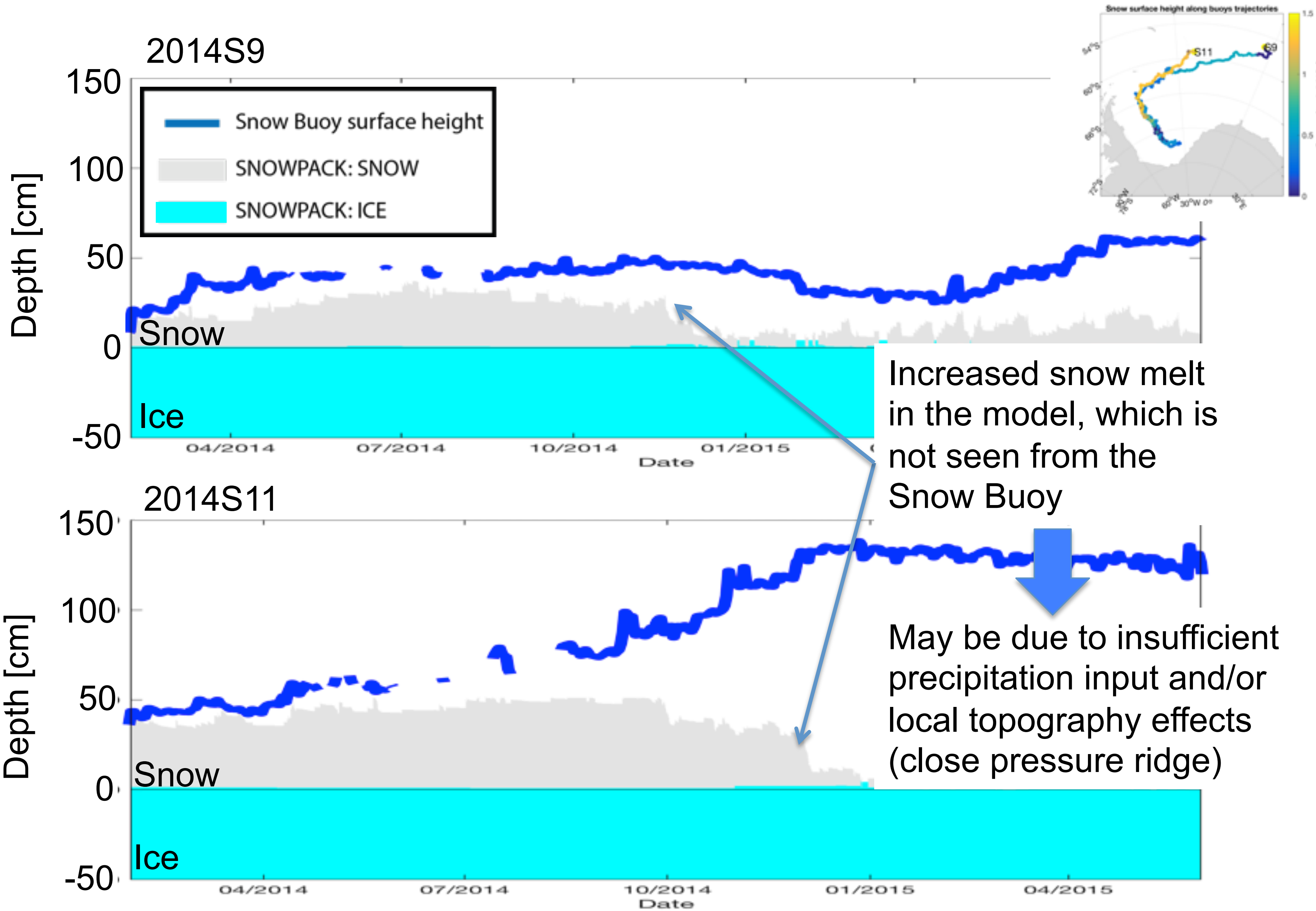


Ocean heat flux:
5 to 15 W/m^2

Ocean heat flux:
7 to 22 W/m^2

→ Ocean heat flux is still an essential concern

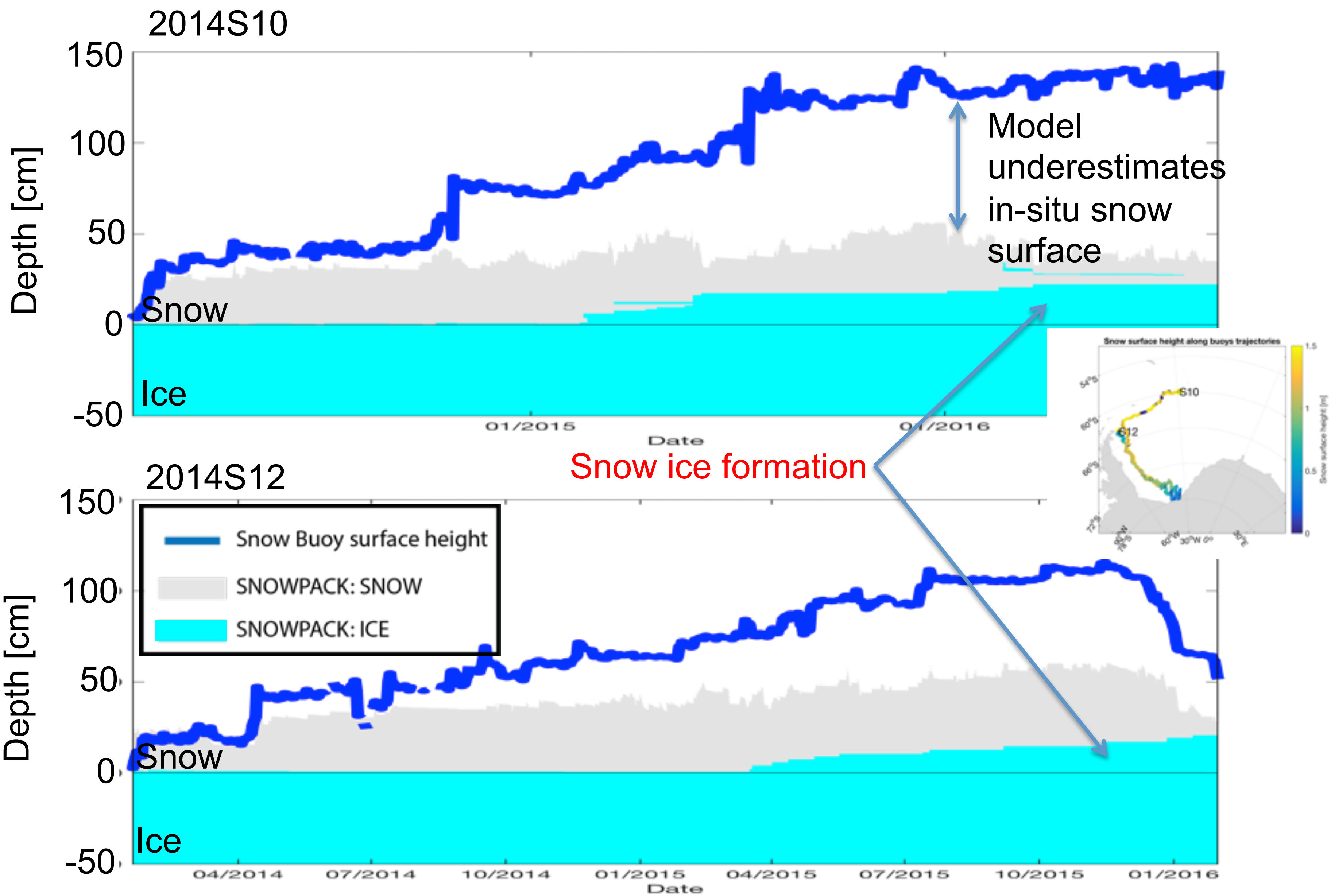
SNOWPACK: Snow melting in sea ice marginal zone



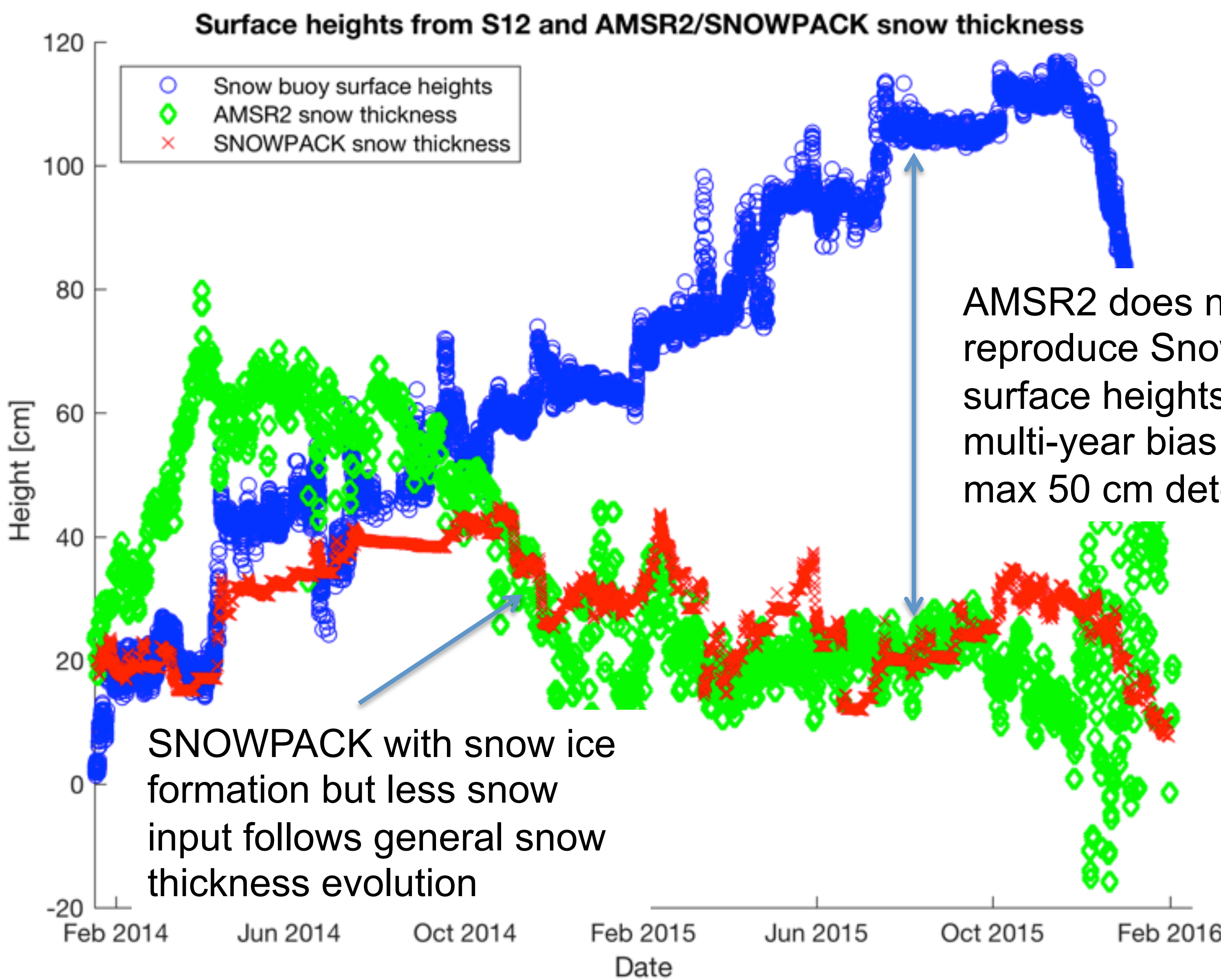
Increased snow melt in the model, which is not seen from the Snow Buoy

May be due to insufficient precipitation input and/or local topography effects (close pressure ridge)

SNOWPACK: Snow ice formation

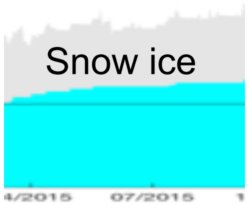


AMSR2 satellite snow product - comparison



Results and Conclusions

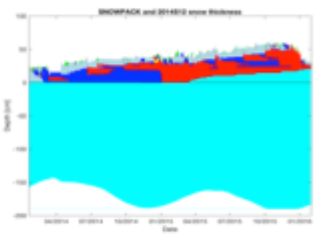
- In SNOWPACK a new sea ice model branch has been introduced
- It is capable of modelling snow on sea ice conditions
- Ocean heat flux is still a concern



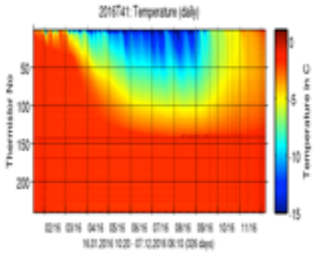
- Flooding and snow ice formation are present in the model and fit well with other observations
(Maksym & Markus, 2008)

- Flooding and snow ice formation explain the difference between space borne observations and in-situ observations

Outlook



Further study regarding grain type evolution and snow ice formation



Comparison to co-deployed Ice Mass-balance Buoy

Compare SMOS snow thickness retrieval to new results

Up-scaling to a Weddell Sea wide snow thickness product.