Meteorological factors controlling year-to-year variability in the spring onset of snow melt in the Arctic Ocean

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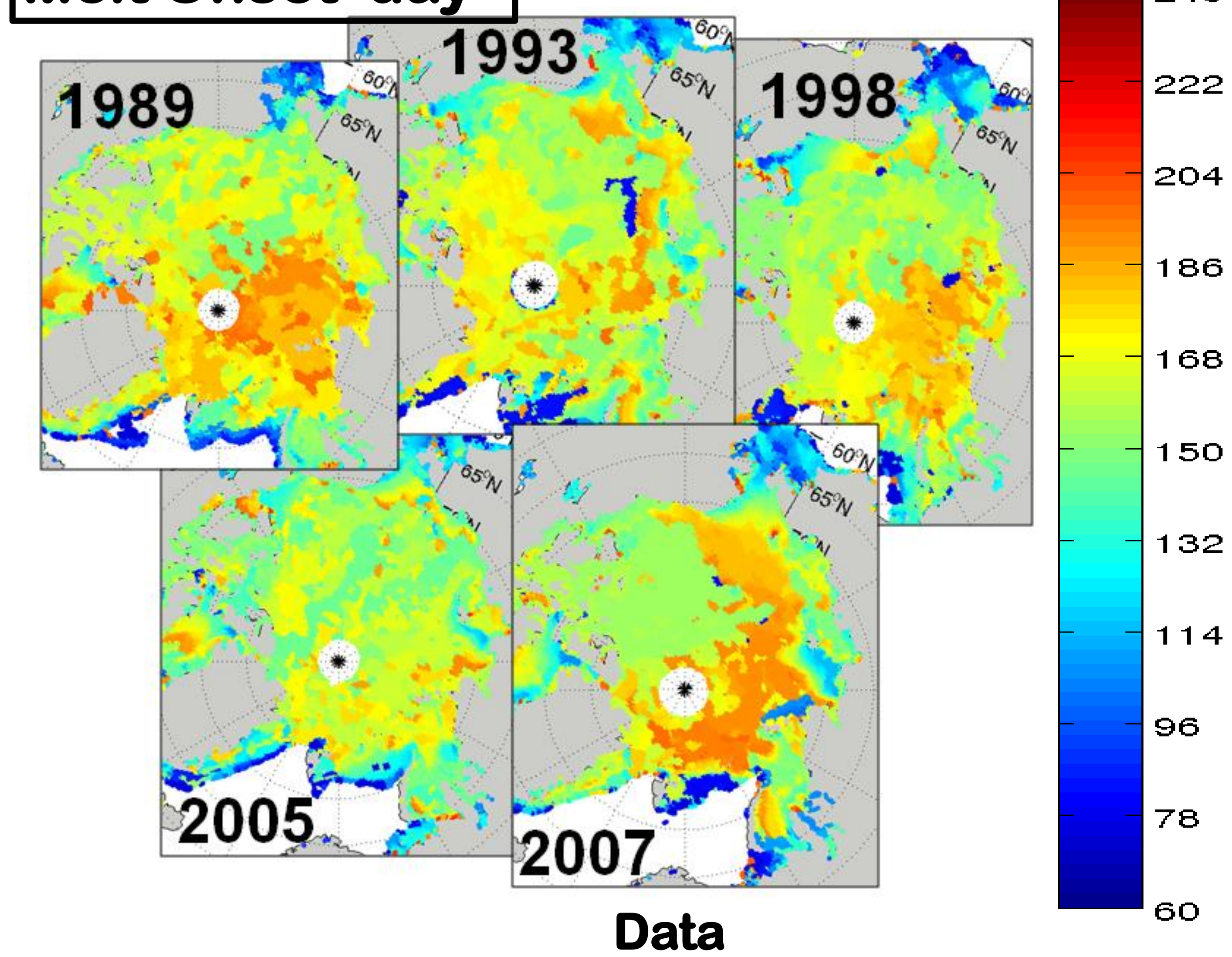
Melt Onset day



MOTIVATION and OBJECTIVES

Spring onset of snow melt is an important moment as it initiates the positive feedback between the surface melt and the albedo. Hence, the melt onset (MO) affects the total ablation during the summer.

We study the role of meteorological factors that directly control the onset of snow melt: radiative and turbulent surface fluxes. Our objectives are to quantify statistically:
- the effect of the surface fluxes on the year-to-year variations in the melt onset day;
- the most pertinent time scale for the flux anomalies;
- the regional differences in the «flux – melt onset» relationships within the entire maritime Arctic;
- the link between synoptic-scale meteorological conditions and flux anomalies prior to the melt onset;

Data

Period of study years 1989-2008

ERA Interim reanalysis

surface LW and SW downward radiation, SW absorbed and turbulent fluxes of latent and sensible heat

Meteorological conditions during spring: Sea Level Pressure, 10 meter winds, total cloud cover, total column water vapor

SSM/I Melt Onset date

derived from brightness temperature (Thorsten et al., 2009) is the beginning of the continuous surface melt. Spatial resolution about 25x25 km, northward limit at 87°N. Only SSM/I pixels with the entire time series (1989-2008) are taken into account

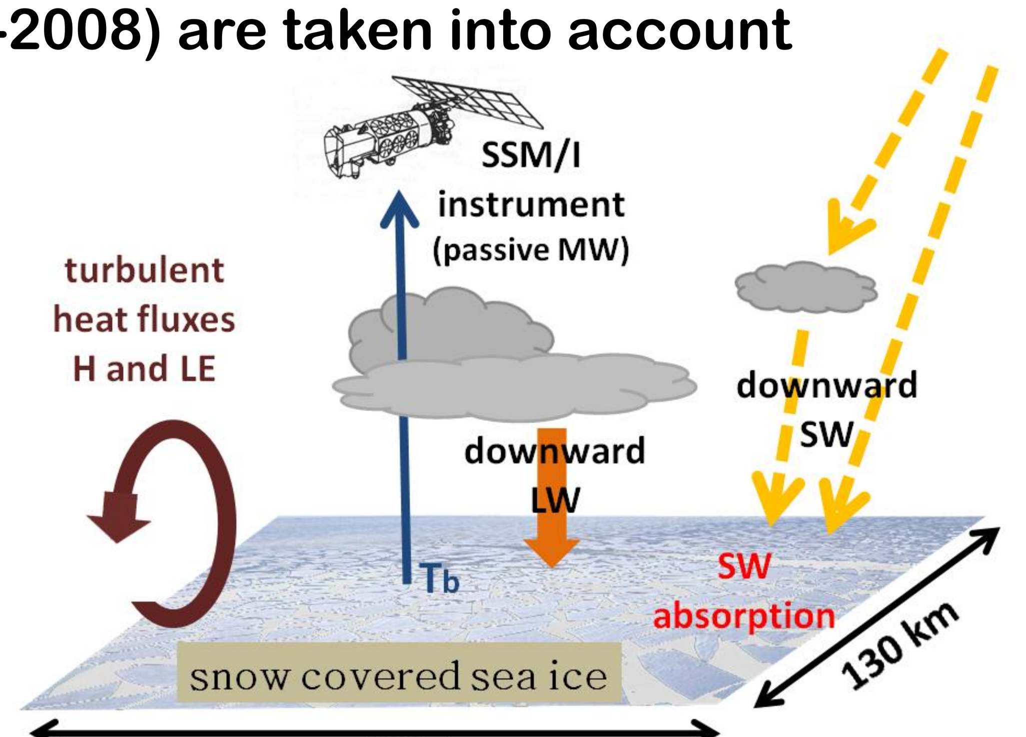


Figure 1. Schematic formulation of the study

METHODOLOGY

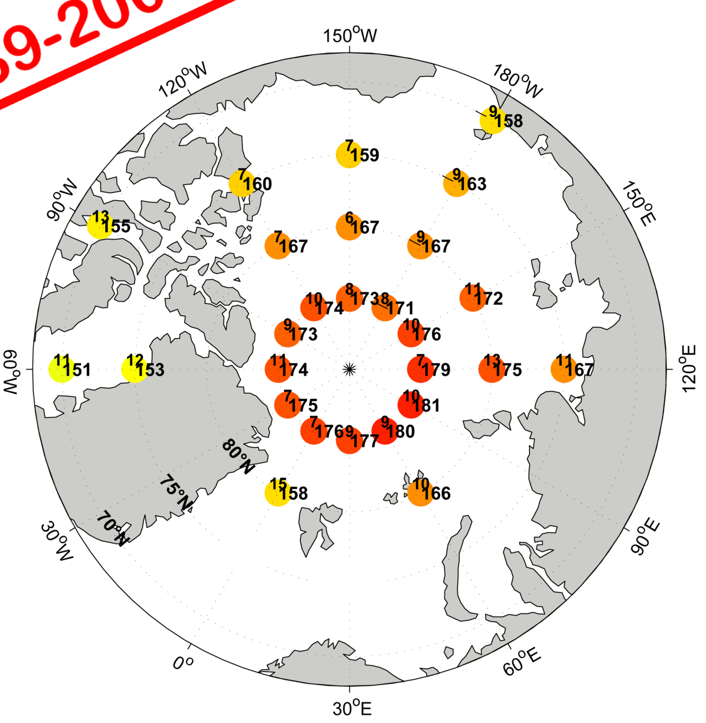


Figure 2. 20-year average MO day (large numbers) within 130km radius of marked locations and y-to-y standard deviation in days (small numbers in the upper corner)

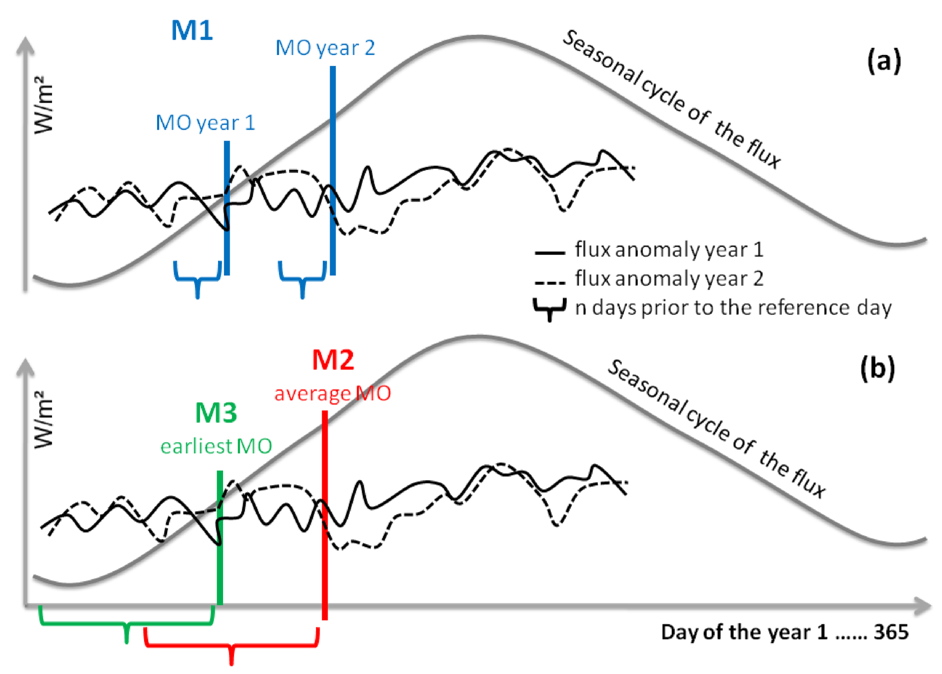


Figure 3. Schema of three methods (M1, M2 and M3) to determine the anomaly of flux prior to the reference day

Thee methods for flux averaging are applied: the n-day average flux anomaly before the exact MO date (M1), before the 20-year average MO date (M2) and before the earliest MO date within 20-years (M3), **Figure 3.**

n-day period: 3, 7, 14, 20, 30, 45 and 60 days.

For each year the **MO date is the average of all SSM/I pixels within 130km radius around a given location.**

RESULTS

- In the Beaufort and Laptev Seas, the relationships are strongest for anomalies 20-30 days prior to the melt onset, which correspond to May.
- Anomaly in the downward LW radiation controls the MO timing in the whole study region.
- Positive anomalies in the downward LW radiation dominate over the simultaneous negative anomalies in the downward shortwave radiation.
- The anomalies in downward radiative fluxes are consistent with the total column water vapor, sea level pressure, and 10-m wind direction.
- Turbulent fluxes affect the MO timing but not as strongly as the LW radiation. Stronger winds increase the correlations between turbulent fluxes and MO timing.

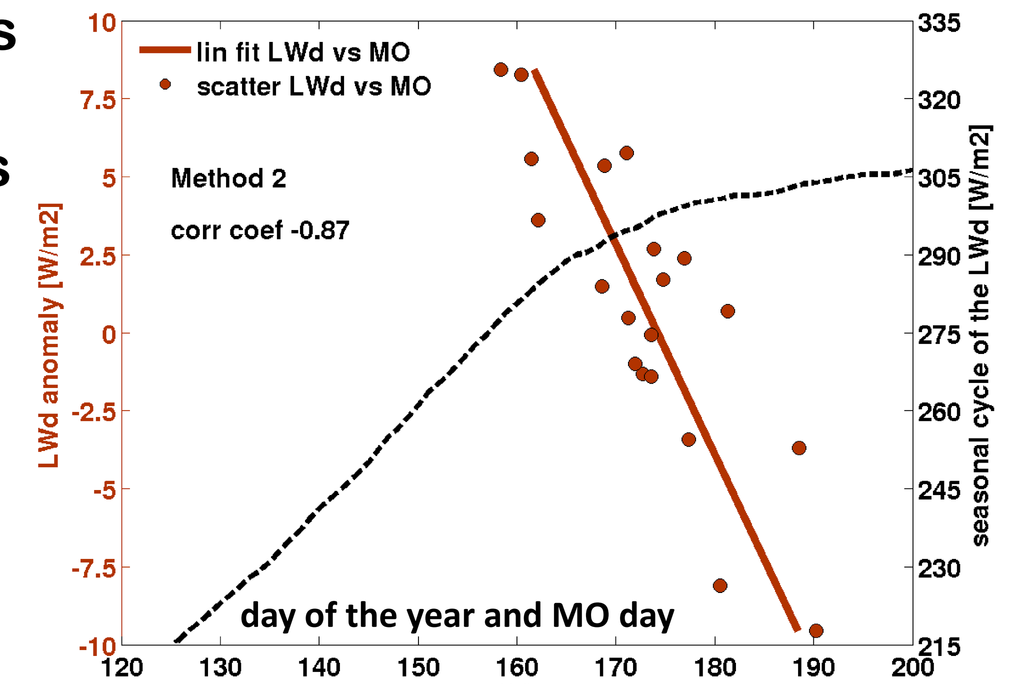


Figure 4. Relationship between MO timing and preceding 20-day average downward LW flux anomaly, M2.

Table Best results of the linear regression sudy

location	Flux	method	time scale in days	corr coef flux vs MO date
30˚E 85°N	LWd	M3	20	-0.76
60˚E 85°N	Sshf	M1	7	-0.65
120˚E 85°N	LWd	M1	7	-0.73
150˚E 85°N	DF	M1	3	-0.61
180˚E 85°N	LWd	M1 and M2	14 and 30	-0.65
210˚E 85°N	LWd	M2	20	-0.72
240˚E 85°N	LWd	M2	20	-0.8
270˚E 85°N	LWd	M2	20	-0.87
60˚E 80°N	Net	M3	10	-0.69
150˚E 80°N	LWd	M1	3	-0.68
210˚E 80°N	LWd	M1	3	-0.69
240˚E 80°N	DF	M2	30	-0.68
120˚E 75°N	Net	M2	20	-0.83
210˚E 75°N	Slhf	M1	30	-0.7
240˚E 75°N	Net	M2	20 , 30	-0.75

References

Thorsten M, Stroeve J.C., Miller J., Recent changes in Arctic sea ice melt onset, freeze up and melt season length. 2009. JGR 114.