Earth's natural sunscreen

The role of Arctic sea ice in global solar heating

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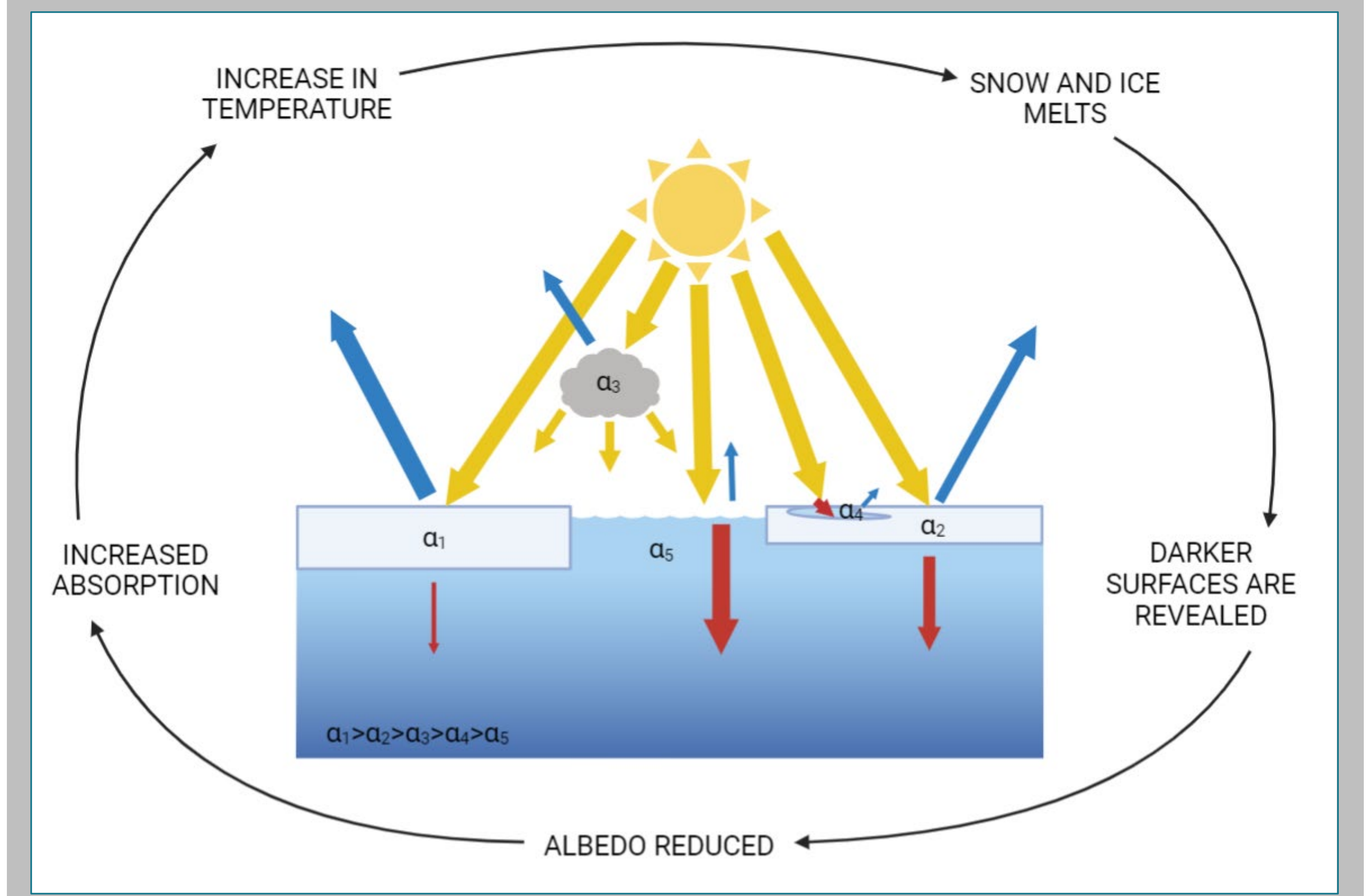
SEA ICE ALBEDO FEEDBACK

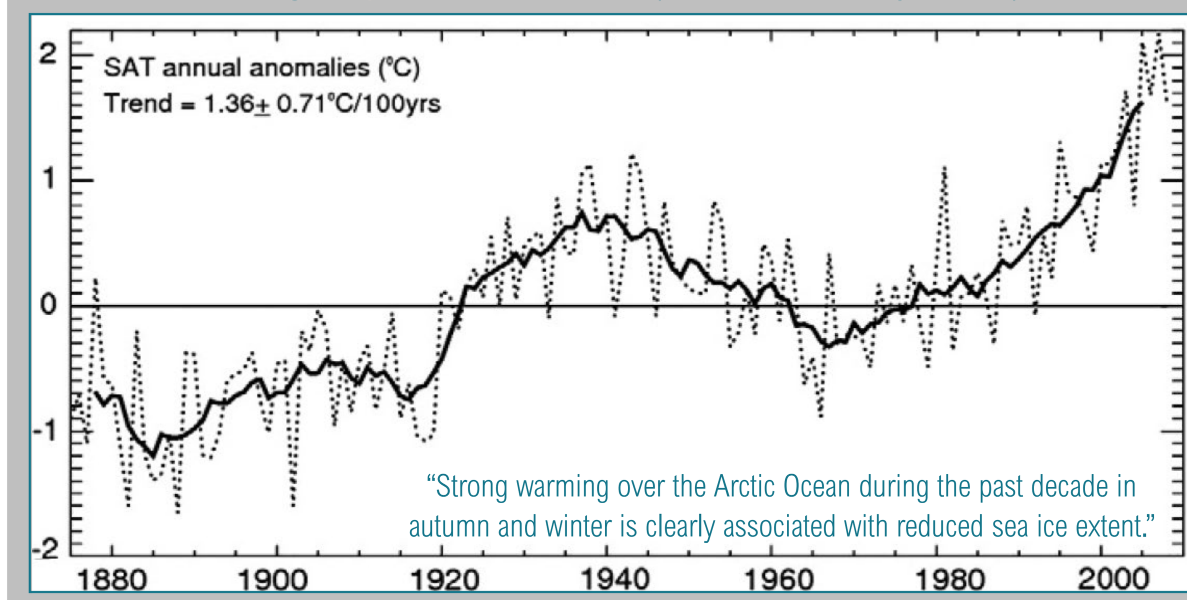


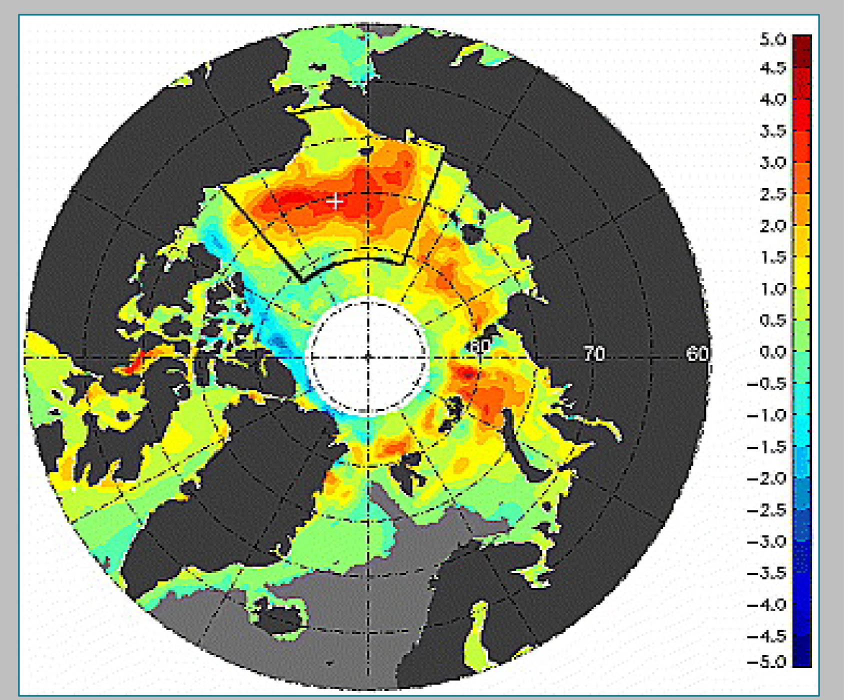
As the ice cover reduces, the amount of solar energy absorbed by the system increases causing a perturbation in the surface energy system resulting in the amplification of sea ice reduction.

EVIDENCE OF A WARMING ARCTIC

Changes in sea ice extent due to SIAF impact heat fluxes between the ocean and the atmosphere that contribute to the observed high variability in surface air temperature in the Arctic region, a phenomenon referred to as Arctic amplification (Serreze & Barry, 2011).

Time series of the annual surface air temperature anomalies (°C) for the region poleward of 59°N (Serreze & Barry, 2011).





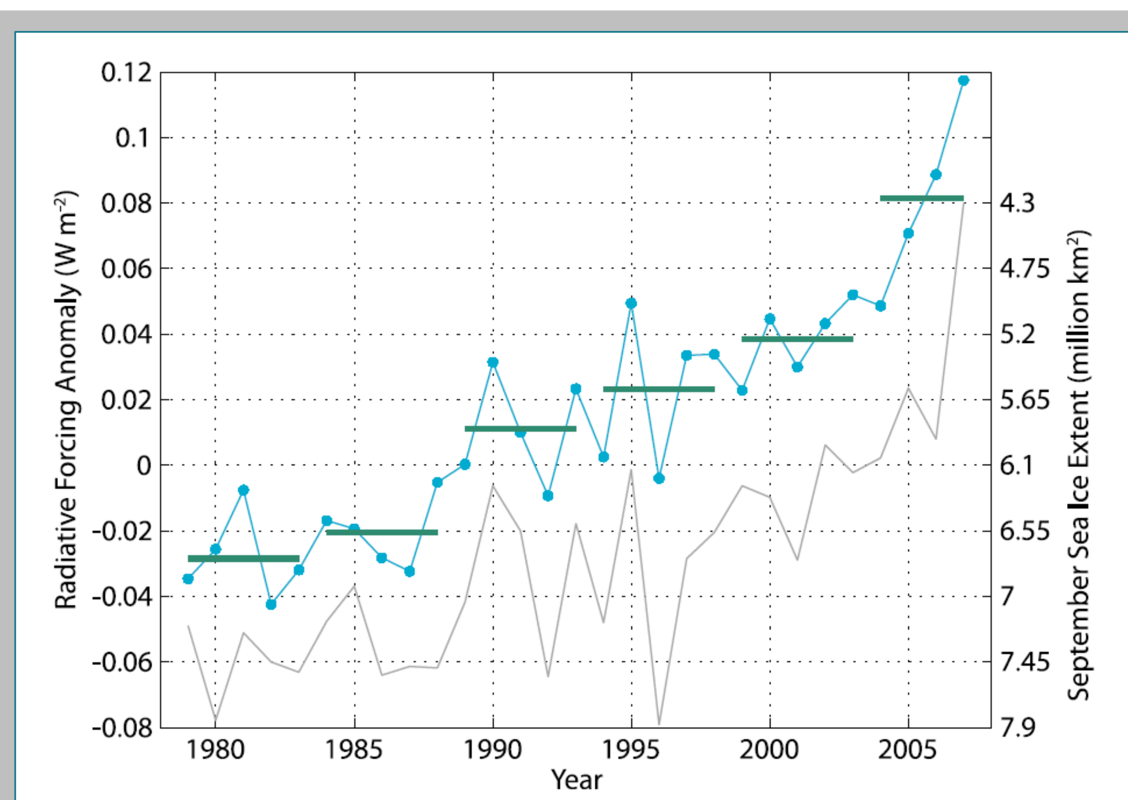
Map of the linear trend of annual solar heat input to the ocean, with units of percent per year (Perovich et al., 2007).

Total yearly solar heat input in the upper ocean, has increased as much as 4% per year, in the Chukchi Sea and adjacent areas (Perovich et al., 2007).

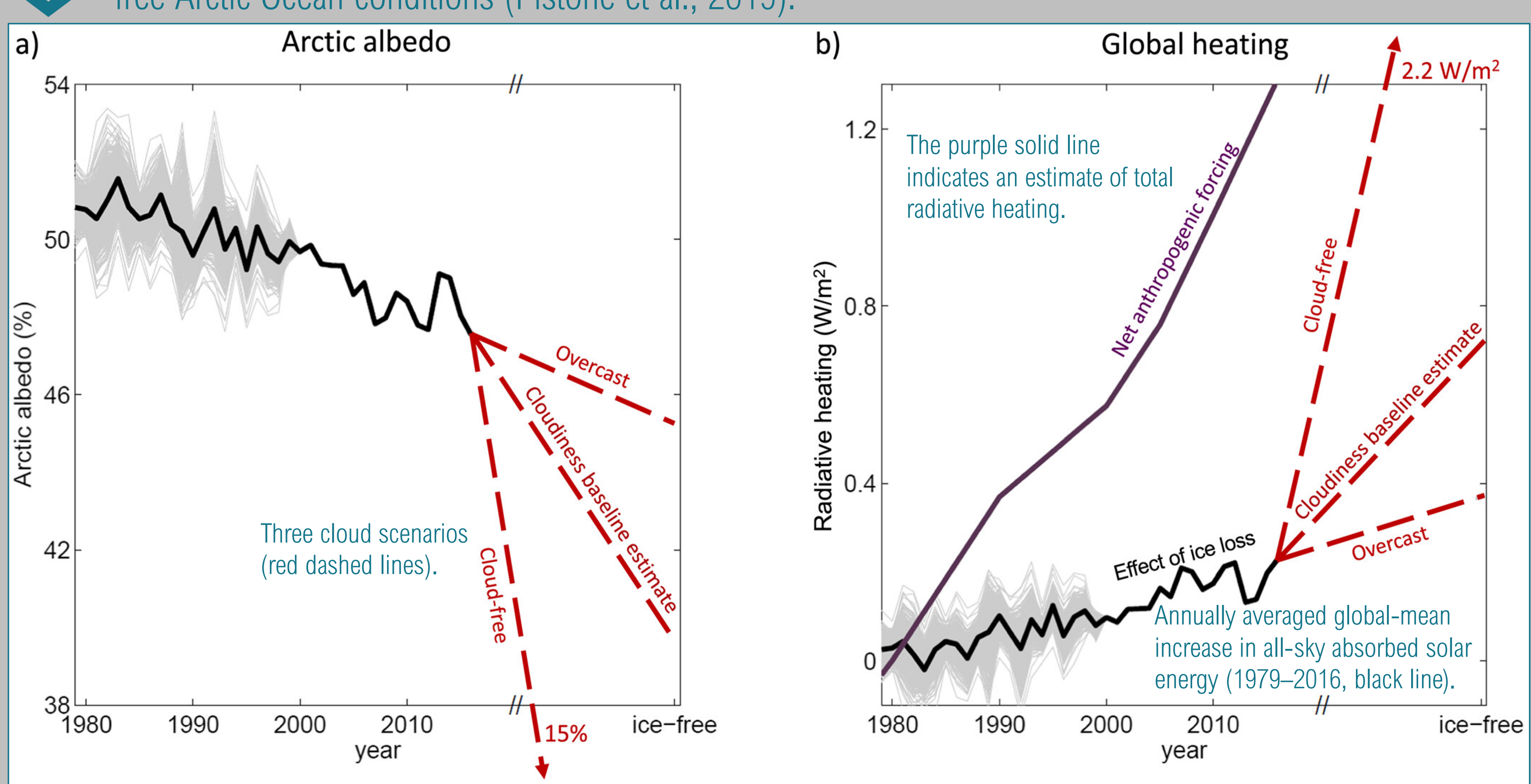
GLOBAL RADIATIVE FORCING

Studies show that the average global radiative forcing the past 40 years caused by sea ice loss is 0.1 W m^{-2}(Hudson, 2011). This heat input is reversely the primary driver of seasonal and interannual variations in ice retreat, due to a more mobile ice cover especially after 2000 (Kashiwase et al., 2017). However, with further retreat of Arctic sea ice due to SIAF, potential changes in could cover may inhibit the positive feedback and make the evaluation of radiative forcing more complex than we previously thought (Hudson, 2011, Serreze & Barry, 2011).

Globally and annually averaged radiative forcing anomalies (line with dots), together with 5-year averages (horizontal lines), caused by that year's anomalies in Arctic sea ice extent (grey line, right axis with inverted scale) (Hudson, 2011).



(a) Arctic albedo and (b) radiative heating from observed Arctic sea ice retreat and projections of ice-free Arctic Ocean conditions (Pistone et al., 2019).



FUTURE DIRECTIONS

Pistone et al., 2019 estimated that in the extreme future case of complete disappearance of the Arctic sea ice cover the annual-mean global-mean radiative heating would reach 0.71 W m^{-2} which is comparable to one trillion tons of additional CO_2 emissions. A more realistic ice-free scenario only during one month on summer, results in a forcing of about 0.3 W m^{-2}, equivalent to present-day anthropogenic forcing caused by halocarbons (Hudson, 2011). Despite that studies don't predict an ice-free Arctic within the 21st century, they forewarn a substantial acceleration of the global warming rate (Pistone et al., 2019).

References

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