The contribution of cloud and radiation anomalies to the 2007 Arctic sea ice minimum

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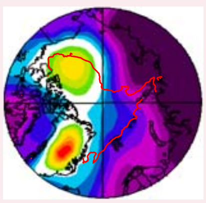
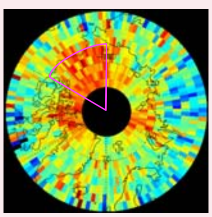
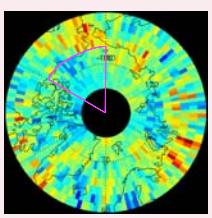
Quick Summary

Cloud decreases and downwelling shortwave radiation increases associated with an anticyclonic atmospheric circulation pattern contributed to the dramatic summer 2007 Arctic sea ice loss (F1).



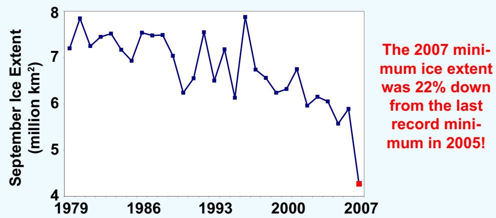




F1. Summer 2007 circulation and minimum ice extent (top), 2007-2006 summertime flux differences estimated from CloudSat and CALIOP (middle, bottom)

1. Dramatic Sea Ice Loss in 2007

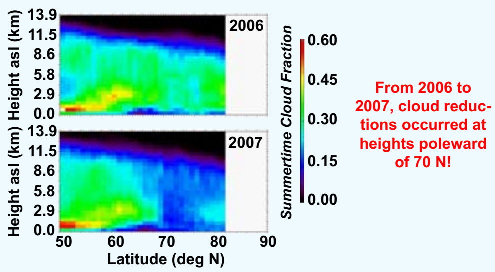
Although sea ice extent has been declining, the extent loss during summer 2007 was surprisingly large (F2, Stroeve et al., (2008)).



F2. September Arctic sea ice extent (credit: NSIDC)

2. 2007-2006 Clouds and Radiative Fluxes

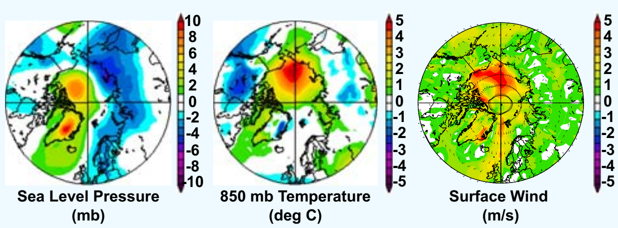
Cloudiness decreased by 16%, downwelling shortwave (longwave) radiation increased by 32 Wm^{-2} (-4 Wm^{-2}) in the Western Arctic (F1, F3). These radiation differences alone could lead to 0.3 m of surface melt OR warm the surface ocean by 2.4 K.



F3. Summertime Western Arctic cloudiness estimated from CloudSat and CALIOP

3. 2007 Arctic Atmospheric Circulation

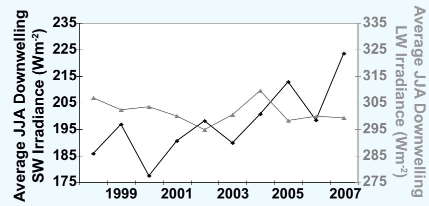
Cloud decreases resulted from a persistent anti-cyclonic circulation pattern (F4). In addition to reducing cloud cover, this pattern resulted in strong southerly winds that pushed ice into the Central Arctic and enhanced poleward atmospheric heat advection.

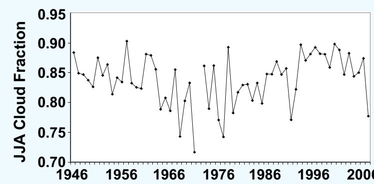


F4. Summer 2007 NCEP anomaly maps (Kalnay et al., 1996)

4. Historical Context for 2007 Loss

The 2007 clouds, radiative fluxes, and circulation patterns are anomalous in the recent past, but are not unprecedented (e.g., F5).





F5. Surface observations from Barrow, AK: ARM NSA downwelling fluxes (top), ISH cloud observations (bottom)

5. Implications and Future Work

In a warmer world with thinner ice, natural cloud and circulation variability will play an increasingly important role in controlling sea ice extent (Kay et al., GRL).

We are currently examining the potential for cloud-circulation-ice feedbacks during the 2007 sea ice loss, monitoring current Arctic ice, cloud, and circulation patterns, and evaluating the representation of atmospheric forcing on sea ice in NCAR's climate model.

References/Acknowledgements

Kalnay, E. et al. (1996), The NCEP/NCAR Reanalysis 40-year Project, *BAMS*, 77, 437-471.

Kay, J. E. et al., (in review), The contribution of cloud and radiation anomalies to the 2007 Arctic sea ice minimum, *GRL*.

Stroeve, J. et al. (2008), Arctic sea ice plummets in 2007, *EOS Transactions*, 89, 13.

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