



Increasing Polar Sea Ice Area Secular Balance from 1979 through 2007 from Satellite Observations

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Since October 1978, the satellites of the Defense Meteorological Satellite Program, now operated by NOAA, have been acquiring multi-channel passive microwave data globally on a daily basis. Algorithms (Bootstrap and NASA Team) developed at the NASA Goddard Space Flight Center with these observations have been providing estimates of the sea ice area and extent of the north and south polar regions. Sea ice area and extent are vital parameters in the energy balance and climate system of Earth. Recently, *Overland et al. (2008)* highlighted the discordance of the polar sea ice area changes. The Arctic sea ice area has been decreasing, where as the Antarctic sea ice area has been increasing during the satellite observation period. Now covering more than 30 years, the daily satellite observations dataset can be explored for variations and secular trends, lending insight for appraisal of the forcing mechanisms.

The polar sea ice area, the area sum of the Arctic and Antarctic sea ice regions, forms a harmonic sinusoidal signal in the daily time series from 1978 to the present. Forcing on sea ice area (growth and decay) comes from solar radiation, infrared radiation under cloudy-sky conditions, ocean kinematics and heat transfer, and surface winds acting on daily, seasonal, interannual, decadal and longer time scales (e.g. *Mazzarella, 2007*).

The Arctic sea ice area sinusoid contains two dominant low-order trends: a linear (secular) and quadratic trend. The quadratic trend shows that 1979 through 1990 was a positive period (increase) of Arctic sea ice area. From 1990 through 1997, the quadratic trend assumed a period of no increase or decrease in trend. Following 1997 through 2007, the quadratic trend entered a negative period (decrease) of Arctic sea ice area. The secular trend on the other hand indicates that Arctic sea ice area has been decreasing by $17,996 \pm 3,587 \text{ km}^2/\text{yr}$ from 1979 through 2007. The Antarctic sea ice area sinusoid in contrast contains a dominant secular trend indicating its sea ice area has been increasing by $24,311 \pm 5,359 \text{ km}^2/\text{yr}$ from 1979 through 2007. The sum of the Arctic and Antarctic secular trends shows that the polar sea ice area has been increasing by $6,103 \pm 2,332 \text{ km}^2/\text{yr}$ from 1979 through 2007, during the period of satellite observations. The quadratic trend over the full time series suggests the existence of a sinusoid with a 60-year period. This is consistent with the 60-year solar modulation of global surface air temperatures, to which Earth's atmospheric circulation is coupled.

References:

Mazzarella, A. 2007. The 60-year solar modulation of global air temperature: The Earth's rotation and atmospheric circulation connection. *Theor. Appl. Climatol.*, 88, 193-199, doi: 10.1007/s0074-005-0219-z.

Overland, J., J. Turner, J. Francis, N. Gillett, G. Marshall, and M. Tjernstrom. 2008. The Arctic and Antarctic: Two faces of climate change. *EOS Trans. of the Am. Geophys. Union*, 89 (19), 177 (179).