The Satellite Era Cyclicity of Arctic Sea Ice Area Extent

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Abstract

Arctic sea ice is a key component of the Arctic hydrologic cycle. This cycle is connected to land and ocean temperature variations and Arctic snow cover variations, spatially and temporally. Arctic temperature variations from historical observations shows an early 20th century increase (i.e. warming), followed by a period of Arctic temperature decrease (i.e. cooling) since the 1940s, which was followed by another period of Arctic temperature increase since the 1970s that continues into the two decades of the 21st century. Evidence has been accumulating that Arctic sea ice extent can experience multi-decadal to centennial time scale variations as it is a component of the Arctic Geohydrological System. We investigate the multi-satellite and sensor daily values of area extent of Arctic sea ice since SMMR on Nimbus 7 (1978) to AMSR2 on GCOM-W1 (2019). From the daily time series we use the first year-cycle as a wave-pattern to compare to all subsequent years-cycles, currently to 30 June 2019, and constitute a derivative time series. In this time series we find the emergence of a multi-decadal cycle, showing a relative minimum during the period of 2007 to 2014, and subsequently rising. This may be related to an 80-year cycle (hypothesis). The Earth's weather system is principally driven the solar radiation and its variations. If the multi-decadal cycle in Arctic sea ice area extent that we interpret continues, it may be linked physically to the Wolf-Gleissberg cycle, a factor in the variations of terrestrial cosmogenic isotopes, ocean sediment layering and glacial varves, ENSO and Aurora. Our hypothesis and results give more evidence that the multi-decadal variation of Arctic sea ice area extent is controlled natural physical processes of the Sun-Earth system.

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[1] Ref. Akasofu, S. (2010) On the recovery from the Little Ice Age. Natural Science, 2, 1211-1224. doi: 10.4236/ns.2010.211149.

[2] Ref. Muskett, R. (2011) Non-stationary drivers of polar sea ice area. Natural Science, 3, 351-358. doi: 10.4236/ns.2011.35047.

[3] Ref. Muskett, R. (2012) Multi-Satellite and Sensor Derived Trends and Variation of Snow Water Equivalent on the High-Latitudes of the Northern Hemisphere. International Journal of Geosciences, Vol. 3 No. 1, 2012, pp. 1-13. doi: 10.4236/ijg.2012.31001.

[4] Ref. Muskett, R. (2013) MODIS-Derived Arctic Land-Surface Temperature Trends. Atmospheric and Climate Sciences, Vol. 3 No. 1, 2013, pp. 55-60. Doi: 10.4236/acs.2013.31008.

Acknowledgements

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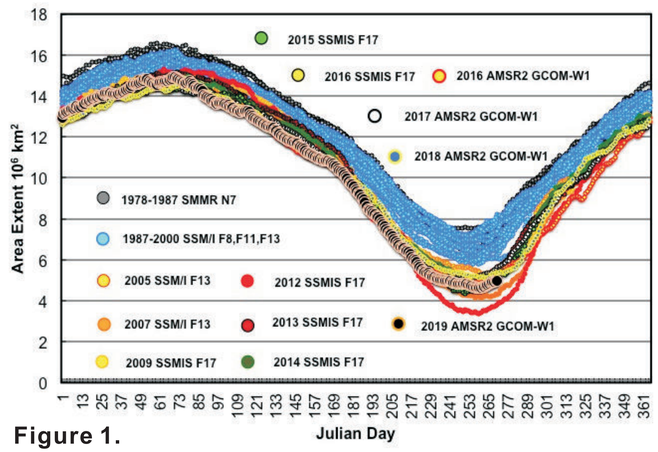

Figure 1.

Figure 1 illustrates the daily sea ice area extent time series, algorithmic retrievals, of the satellites and microwave sensors.

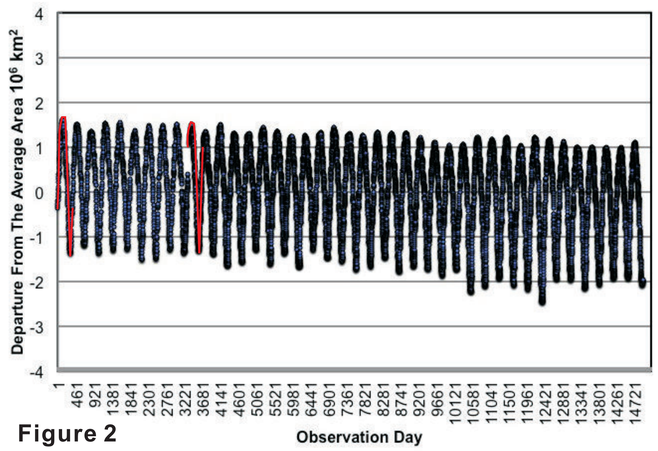

Figure 2

Figure 2 illustrates the daily departure of the area extent from the entire series average, from first to last. The average is re-computed for every new-day retrieval added.

The Red curves are wavelets beginning annual cycle, one for the SMMR series and the other for the SSMI - AMSR2 series. We difference the wavelets against the Departure Series to derive the Cycle Anomaly shown in Figure 4..

Figure 3 illustrates the Power Spectrum of the daily time series of daily area extent. Arrows with numbers (years) point to significant Cycles in the spectrum.

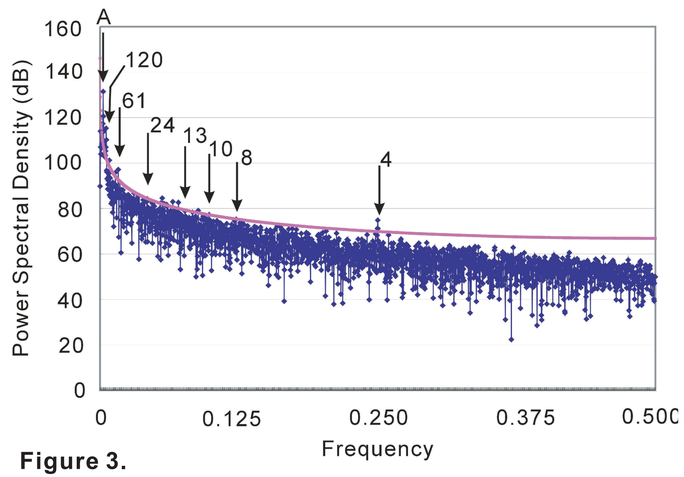

Figure 3.

Figure 4 illustrates the Cycle Anomaly of the daily area extent series.

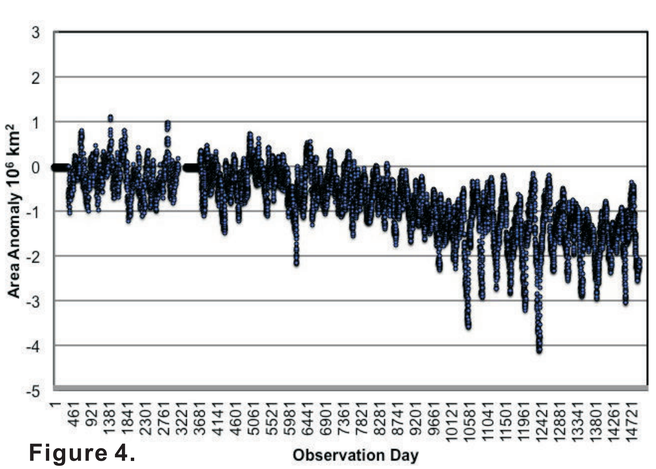

Figure 4.