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TOWARDS AN ICE-FREE ARCTIC OCEAN IN SUMMERTIME

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Dividing the Arctic Ocean in two parts, the so-called Atlantic versus the Pacific sector, two distinct modes of variability appear for characterizing the Arctic sea-ice extent from 70°N up to 80°N in both sectors. The Atlantic sector seasonal sea-ice extent is characterized by a longer time scale than the Pacific sector with a break up melting season starting in May and reaching a peak in June-July, one month earlier than the Pacific sector of the Arctic Ocean revealing a faster time evolution and a larger spatial amplitude than the Atlantic sector. During recent years like 2007, sea-ice extent with sea-ice concentration above 15% retreated from 4 million km2 to about 1 million km2 in the Arctic Pacific sector between 70° and 80°N except for 2012 when most of the sea-ice melted away in this region. That explained most of the differences between the two extreme years 2007 and 2012. In the Atlantic sector, Arctic sea-ice retreated from 2 million km2 to nearly 0 during recent years including 2007 and 2012. The Atlantic inflow North of Svalbard and Franz Josef Land is more likely responsible for a northward retreat of the ice edge in that region. The important factor is not only that the Arctic summer sea-ice minimum extent decreased by 3 or 4 millions km2 over the past 10 years but also that the melting period was steadily increasing by one to two days every year during that period. An important factor concerns the strength of the freezing that can be quantified in terms of Freezing Degree Days FDD accumulated during the winter-spring season and the strength of the melting (MDD) that can be accumulated during the summer season. FDD and MDD have been calculated for the past 30 years all over the Arctic Ocean using ERA Interim Reanalysis surface temperature at 2m height in the atmosphere. It is clear that FDD decreased significantly by more than 2000 FDD between 1980 and 2012 which is equivalent to the sensible heat flux corresponding to more than a meter of sea-ice thickness. During the same period MDD increased steadily mainly due to an increase of the melting period rather than an increase in summer temperatures. Due to uncertainties in sea-ice thickness distribution, an estimated 66% up to 75% of sea-ice mass or volume melted away during recent summers compare to previous 20 or 30 years. How long would it take to melt away the 1/4 or 1/3 of Arctic sea-ice left in summer? A root mean square extrapolation based on the last 10 years summer sea-ice minimum extent would lead to an ice-free Arctic Ocean by 2035 but based on sea-ice volume decrease it could happen much sooner.