Why Does the Positive Phase of NAO Pattern Appear Preferentially in the Declining Phase of the Solar Cycle?

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Several studies have examined the relation between different parameters of solar activity and variability in the Northern Hemisphere winter climate. While most studies indicate solar modulation of tropospheric and stratospheric circulation and surface temperature, opinions on the exact mechanism and the solar driver differ. Proposed drivers include, e.g., total solar irradiance (TSI), solar UV radiation, galactic cosmic rays, magnetospheric energetic particles etc. While some of these drivers are difficult to distinguish because of their closely similar variation over the solar cycle, other suggested drivers have clear differences in their solar cycle evolution. For example, geomagnetic activity and magnetospheric particle fluxes peak in the declining phase of the sunspot cycle, in difference to TSI and UV radiation which more closely follow sunspots. Using 13 solar cycles (1869-2009) we study winter surface temperatures and North Atlantic oscillation (NAO) during four different phases of the sunspot cycle: minimum, ascending, maximum and declining phase. We find significant differences in the temperature patterns between the four cycle phases. Surprisingly, the clearest pattern of the temperature anomalies is not found during sunspot maximum or minimum, but during the declining phase, when the temperature pattern closely resembles the pattern found during positive NAO. We find the same pattern during the low sunspot activity cycles of 100 years ago, suggesting that the pattern is largely independent of the overall level of solar activity.