Impact of the 11-year Solar Cycle at the Earth's Surface

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The surface response to the 11-year solar cycle signal over the Atlantic / European sector has been an interesting but controversial research topic. There is evidence for 11-year variability in the North Atlantic Oscillation (NAO), a pattern of pressure anomalies that essentially govern the behavior of the NH mid-latitude jet-stream and hence much of the weather that arrives over Europe. However, skeptics point to the fact that the signal appears to be present in some periods but not others, and suggest the signal may be a random artifact. Analysis of long datasets is therefore required, and a better understanding of the influence mechanism(s) that might explain why it is evident in some periods and not others. An analysis of an extended dataset back to 1660 will be described, that shows an 11-yr signal in mean sea level pressure, related sea surface temperatures and patterns of atmospheric blocking. We confirm the presence of an 11-yr signal throughout the data period, but the amplitude and lag of the response exhibits decadal variations. Mechanisms will be discussed in terms of solar influence via UV changes and their effect on stratospheric temperatures and wind structures. The surface response to this stratospheric forcing is generally synchronous with the 11-year irradiance forcing. An additional mechanism is proposed, involving atmosphere-ocean coupling, that results in a peak response that lags the forcing by ~3-4 years. The overall observed signal is the result of a mixture of these mechanisms and appears to depend on both the amplitude of the solar forcing and the strength of the ocean feedback process which itself exhibits decadal-scale variability.