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The story of the Grand Modern Maximum: How did the solar magnetic field evolve during the 20th century?

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The 20th century marks a period of exceptionally high solar activity, now termed the Grand Modern Maximum. Sunspot activity increased from a low level at the beginning of the century to a maximum during the solar cycle 19, then settled to a slightly lower level during cycle 20-23, and reduced to a significantly lower level during the ongoing cycle 24.

Solar coronal holes are sources of high-speed solar wind streams, which cause persistent geomagnetic activity especially at high latitudes. One can estimate seasonal solar wind speeds at 1 AU for the last 100 years using high-latitude geomagnetic measurements, and thereby obtain information on the long-term evolution of the most important structures of the solar large-scale magnetic field, in particular on persistent coronal holes. We find that the centennial evolution of solar wind speed at 1 AU is different for equinoxes and solstices, reflecting differences in the evolution of polar coronal hole extensions and isolated low-latitude coronal holes. Equinoctial solar wind speeds had their centennial maximum in 1952, during the declining phase of solar cycle 18, verifying that polar coronal holes had exceptionally persistent extensions just before the peak of the Grand Modern Maximum of solar activity. This verifies the solar dynamo model for the most active period of solar activity. On the other hand, solstice speeds due to large low-latitude coronal holes had their centennial maximum during the declining phase of solar cycle 23. A similar configuration of seasonal speeds (coronal holes) as in cycle 23 was not found earlier, not even during the less active cycles of early 20th century. Therefore, the exceptional occurrence of persistent, isolated low-latitude coronal holes in cycle 23 is not related to the low level of sunspot activity but to the demise of the Grand Modern Maximum.