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Frequency-Dependent Phase Coherence and Phase Shift of Hemispheric Sunspot Activity: A New Look onto the North-South Asymmetry

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Traditionally, the north-south asymmetry of solar activity is determined by indices taking the total number or area of sunspots into account. This treatment is problematic, as the overall solar activity is known to be highly variable on multidecadal and centennial time scales. To overcome the corresponding difficulties, we propose to consider only the phases instead of the amplitudes of sunspot variability to derive a novel index. We apply wavelet analysis to show that these phases can be coherently defined on time scales between about 6 and 11 years. Parameters originated in phase synchronization analysis yield that the hemispheric sunspot dynamics is most coherent on time-scales of slightly less than ten years. We use the wavelet phases on the corresponding scale to estimate the temporally varying phase shift between the activity at both hemispheres. It is shown that this phase shift has been varying between roughly plus and minus ten months over the last 120 years. Long-term records of sunspot numbers are used as a natural surrogate to test for the significance of the observed variability.