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Distinct Global Patterns of Strong Positive and Negative Shifts of Seasons over the Last 6 Decades

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ABSTRACT

Alterations of annual temperature cycles have profound implications on how the planet responds to global climate change. In this study, a high resolution global analysis of temperature cycle shifts and their development over time is presented. We show that over the last 63 years, phase shifts in the annual near surface temperature cycle exhibit large spatiotemporal variability. The calculated phase shifts comprise earlier onsets of seasons as well as delays with similar frequencies, depending on location. From 1978 to 2010 Eastern Europe experienced an advanced annual cycle of near-surface temperature of 3.2 days while Eastern Australia shows an opposite shift towards later seasons of 3.5 days in comparison to the preceding 30-year period from 1948 to 1977. The largest phase shifts of −5.5 days toward earlier seasons over land were found in Belarus and Northwest Russia. For the first time the developments of seasonal temperature shifts were generalized for large areas by using self-organizing feature map neural networks resulting into 4 significant global trends. The temperature phase shifts are also shown to have strong correlations with the timing of shrub foliation observed at 57 phenological stations across the USA. The findings have far-reaching, yet regionally distinct consequences on agriculture, animal life cycles, plant phenology, and regional weather phenomena that change with annual temperature cycles.

KEYWORDS

Climate Change; Temperature Phase Shift; Neural Networks; Phenology; Near-Surface Temperature

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