Spatial-temporal structures of intraseasonal precipitation oscillations over northern Eurasia during summer

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This study examines intraseasonal oscillations in summer precipitation over northern Eurasia using a multi-channel singular spectrum analysis (MSSA). For the analysis, a gauge-based daily gridded precipitation data set for the northern Eurasian domain is used. The analysis period extends June-August of 1979-2002 (23years). Empirical orthogonal function analysis is first performed on 8-day low-pass filtered precipitation records at 2.5 degree grid resolution in the northern Eurasian domain (50-70N, 40-140E). Then, the MSSA was carried out on the ten leading principal components (PCs). As a result, three quasi-periodic oscillations with timescales of 45 days, 15 days, and 9 days are identified, respectively.

Spatial-temporal structures of the precipitation oscillatory modes are defined by composite analysis based on reconstructed time series of spatial-temporal PCs obtained from the MSSA. A composite life cycle of each mode is classified into eight phase categories. The 45-day oscillation is characterized by a broad east-west contrastive pattern over the entire northern Eurasian domain which appears to be associated with quasi-stationary rainfall episodes persisting for about one to two weeks. On the other hand, the 15-day oscillation exhibits an east-west dipole pattern between western and eastern Siberia. This mode appears to dominate submonthly-scale dry (below normal rainfall) and wet (above normal rainfall) seesaw extreme events in the major Siberian river basins. The 9-day oscillation has a comparatively smaller spatial-scale and amplitude, and is localized in the southeastern part of northern Eurasia.

Connections between the precipitation oscillatory modes and mid- and high-latitude atmospheric circulation patterns are also explored. A similar composite method is applied to 500-hPa geopotential height anomalies over the Northern Hemisphere. A broad large-scale trough-ridge pattern (wavenumbers 3-4) prevails over the high-latitude North Atlantic and northern Eurasia associated with the 45-day oscillation. This wave appears to have both standing and slow eastward-propagating components. A circulation pattern responsible for the 15-day oscillation exhibits a wave train structure propagating from the North Atlantic into the North Pacific. The eastward propagation of this wave (wavenumbers 5-6) reflects the zonal displacements of Siberian rainfall anomalies. A comparatively smaller-scale (wavenumbers 6-7) wave train arcing through northern Eurasia develops at high-amplitude phases of the 9-day oscillation.