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Study on the interannual variability and long-term trend of summer precipitation in East Siberia

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In Eastern Siberia, there are great reaches of boreal forest, which play a great role in hydrological cycle and carbon cycle. Those boreal forest growths are closely related to interannual variability of summer precipitation. However, that in Eastern Siberia is poorly understood. In this study, I investigated dominant time-space patterns of interannual variability of summer precipitation in Eastern Siberia (90E-140E,50N-70N), using EOF (Empirical Orthogonal Function) analysis based upon daily precipitation grid data from 1979 to 2007. The association of the EOFs of monthly precipitation with atmospheric circulation water vapor transport (and its divergence) fields are additionally analyzed, using the global objective reanalysis data.

Analysis was made for the top three patterns of predominant patterns based on the contribution ratio of the EOFs. The first pattern (EOF1, contribution ratio: is 22.0%) represents the variation in the large area from central n to western region of Eastern Siberia (central Siberian highland) with that in opposite sign in southeast part of Eastern Siberia (far east Siberia). The second pattern (EOF2, contribution ratio: is 13.8%) represents a dipole-like pattern (in precipitation variability) between east and west part of Eastern Siberia. The third pattern (EOF3, contribution ratio: is 9.3%) represents pattern of summer precipitation variability in northeast in Eastern Siberia.

Those three variability patterns have been proved to occur as a result of interaction between the westerly waves along 60N with slight changes of trough (or ridge) system and water vapor field controlled by zonally-oriented water stationary vapor sources along 50-60N (possibly related to evapotranspiration from the boreal forest there) and by transport from the Arctic sea region.

In wet (dry) year in EOF1, deeper pressure trough (ridge) at around the Central Siberian Plateau (80E-120E) is likely to cause more (less) transport of water vapor from the Arctic sea (particularly from the Kara Sea). In wet (dry) year in EOF2, a pressure trough (ridge) at around western Central Siberian Plateau (80E) and a pressure ridge (trough) at around eastern Central Siberian Plateau (120E) is likely to cause more (less) water vapor transport from Laptev Sea (Arctic Sea) and less (more) transport from Kara Sea (Arctic sea). In wet (dry) year in EOF3, a pressure trough (ridge), remarkable only in a lower troposphere, extending from the Arctic Sea to Mongolia is likely to cause more (less) water vapor transport and convergence over regions of Verkhoyansk mountain Range and Mongolia.

Finally, geographical pattern (or classification) for interannual variations of precipitation has been deduced using the correlation analyses between the EOF patterns and gridded actual summer precipitation in Eastern Siberia: that is, the interannual variability of summer precipitation in western region of central Siberian plateau is relevant to EOF1 mode and that in Verkhoyansk Range on east bank of Lena River is relevant to EOF2 mode, and that in North Verkhoyansk Range is relevant to EOF3 mode. It has also been found that the summer precipitation amount in central Siberian plateau has shown increasing trend particularly since 1990s.

Keywords: precipitation, interannual variation and trend, East Siberia, water vapor transport, global warming, biosphere-atmosphere interaction