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Impact of boreal summer intraseasonal oscillation on heat wave occurrence in Asia and Europe during the summer of 2016

June-Yi Lee (1), Pang-Chi Hsu (2), Kyung-Ja ha (1), Hae-Jeong Kim (3), and Yoo-Rim Jung (3)

(1) Pusan National University, ICCP, Korea, Republic Of (juneyi@pusan.ac.kr), (2) Nanjing University of Information Science & Technology, Nanjing, China, (3) APEC Climate Center, Busan, Korea

The summer of 2016 was the earth's hottest summer on record since 1880. Especially, in August, the global mean temperature was 1.66 degree higher than normal and heat waves set records across Asia, Europe, and North America. This study proposes that boreal summer intraseasonal oscillation (BSISO) played an important role in heat wave outbreaks over many regions of the Northern Hemisphere (NH) extratropics in the summer 2016 in addition to other factors including global warming, atmosphere-land interaction, and Africa-Pakistan heavy rainfall. By utilizing the real-time multivariate BSISO indices recently proposed, it has been demonstrated that the two dominant BSISO modes significantly modulate occurrence probability and spatial distributions of extreme rainfall and heat wave over Asia and Europe depending on their phases. The BSISO1 represents the canonical northward propagating variability that often occurs in conjunction with the eastward propagating Madden-Julian Oscillation with quasi-oscillating periods of 30-60 days. The $BSISO_2$ represents the northward/northwestward propagating variability with periods of 10-30 days during primarily the pre-monsoon and monsoon-onset season. In August of 2016, BSISO1 was very active with amplitude up to 2 standard deviation and stayed at phase 7 state for about 20 days. During the phase 7 of BSISO1, extreme convective activity over the South China Sea and western North Pacific typically exerts significant global teleconnection leading to heat wave occurrence over East Asia including Korea and Japan, some part of Russia and Europe, and the western and eastern part of North America. In particular, anticyclonic circulation anomaly tends to be developed over East Asia inducing enhanced adiabatic and diabatic warming over Korea and Japan providing a favorable condition for extreme heat wave occurrence. The August of 2016 exhibited the typical global teleconnection pattern of BSISO1 associated with active convection over the western North Pacific with time scale of 40 days. We further note that the impact of BSISO on 2016 heat wave is quite different from that on 2010 case. During the August of 2010, $BSISO_2$ was more active than BSISO1 and stayed at phase 1 with about 20-day time scale. The phase 1 of $BSISO_2$ is mainly triggered by active convection over the western North Pacific and equatorial eastern Indian Ocean leading to heat wave occurrence over East Asia including central China, Korea and Japan and many part of Europe and Russia. This study implies that a better understanding of BSISO dynamics and its impact should contribute to advance in understanding and prediction of extreme rainfall and heat wave event over many part of the NH extratropics including Asia and Europe.