Lance Bosart, PI
Daniel Keyser, CoPI
Atmospheric and Environmental Sciences

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Phenomenological Studies of Cool-Season Extreme Weather Events over Central and Eastern North America on Intraseasonal Time Scales

Overview: We propose to investigate extreme weather events (EWEs), defined here as a category of high-impact weather events that are societally disruptive, geographically widespread, exceptionally prolonged, and climatologically infrequent, from a phenomenological perspective. It is hypothesized that planetary-scale wave amplification and breaking are necessary for the occurrence of EWEs, because the resulting high-amplitude flow patterns may lead to intense cyclogenesis and anticyclogenesis, and subsequently to downstream ridge amplification and blocking, which can modulate the positions of storm tracks and atmospheric rivers and establish synoptic-scale environments favorable for the occurrence of EWEs. The proposed research extends the ongoing NSF-supported investigation by the PI and Co-PI of high-impact weather events occurring over the eastern North Pacific and North America that are linked dynamically to western North Pacific tropical cyclones (TCs) through Rossby wave dispersion along the North Pacific jet stream (NPJ) by: (i) narrowing the focus on high-impact weather events occurring over the eastern North Pacific and North America to noteworthy cool-season EWEs occurring over central and eastern North America since 1979, and (ii) broadening the dynamical linkages between TCs and high-impact weather events to include antecedent disturbances of tropical, midlatitude, and polar origin that modulate the evolution of the NPJ on 10–20 day time scales prior to and during the occurrence of the class of EWEs specified in (i). The proposed extensions will be accomplished by: (i) determining the role of planetary-scale wave amplification and breaking in the subsequent occurrence of the aforementioned class of EWEs; (ii) investigating how cyclogenesis and anticyclogenesis, and subsequent downstream ridge amplification and blocking, establish synoptic-scale environments conducive to the occurrence of the aforementioned class of EWEs. These goals will be addressed by conducting multiscale investigations of EWEs using state-of-the-art global gridded reanalyses and, in conjunction with these multiscale investigations, identifying factors limiting predictability through the synoptic evaluation of the skill of several operational global models, including ensemble forecast products, for selected “hard-to-predict” cool-season EWEs occurring over central and eastern North America.

Intellectual merit: The proposed research will focus on noteworthy cool-season EWEs that have occurred over central and eastern North America in association with widespread heavy rainfall and extensive flooding and with strong extratropical cyclones, and will demonstrate dynamical linkages between Rossby wave amplification and breaking over the North Pacific, subsequent downstream baroclinic development and

associated upper-level flow amplification, and the occurrence of EWES over central and eastern North America. The outcome of the two EWE-related research projects may be expected to advance scientific understanding by: (i) investigating noteworthy cool-season EWEs that have occurred over central and eastern North America since 1979 from a contemporary synoptic-dynamic perspective; (ii) establishing a planetary-scale perspective and synoptic-dynamic context for understanding and interpreting the occurrence of the EWEs investigated in (i); (iii) assessing the predictability of selected “hard-to-predict” EWEs chosen from the EWEs investigated in (i); (iv) determining the factors that limit the predictability of the EWEs assessed in (iii).

Broader impacts: The expected advances in scientific understanding may be expected to: (i) enhance the specialized research training and advanced scientific education of the project-supported graduate students; (ii) enrich the teaching and scholarship of the PI and Co-PI in the area of synoptic-dynamic meteorology; (iii) translate into improved short- and medium-range forecasts of EWEs over central and eastern North America that are challenging to predict, thereby benefiting operational forecasters and emergency managers; (iv) contribute to an emerging community-wide research effort on the weather–climate intersection to improve projections of intraseasonal temperature and rainfall anomalies; and (v) facilitate the continual transfer of emerging research findings into the academic, governmental, and private sectors through weekly discussions of significant weather events conducted by the PI during the academic year and disseminated on the UAlbany map listserv, which comprises ~300 domestic and international members representing the diverse constituencies of the weather–climate enterprise.