M.S. Defense Announcement
Zachary Bruick
Monday, March 25 at 3:30pm

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March 25, 2019
3:30pm

Defense
ATS Large Classroom (101 ATS)

Post Defense Meeting
Riehl Room (211 ACRC)

Committee:
Kristen Rasmussen (Advisor)
Russ Schumacher
Chandra Venkatachalam (Electrical and Computer Engineering)

CHARACTERISTICS OF HAILSTORMS AND ENSO-INDUCED EXTREME STORM VARIABILITY IN SUBTROPICAL SOUTH AMERICA

Convection in subtropical South America is known to be among the strongest anywhere in the world. Severe weather produced from these storms, including hail, strong winds, tornadoes, and flash flooding, causes significant damages to property and agriculture within the region. These insights are only due to the novel observations produced by the Tropical Rainfall Measuring Mission (TRMM) satellite since there are the limited ground-based observations within this region. Convection is unique in subtropical South America because of the synoptic and orographic processes that support the initiation and maintenance of convection here. Warm and moist air is brought into the region by the South American low-level jet from the Amazon. When the low-level jet intersects the Andean foothills and Sierras de Córdoba, this unstable air is lifted along the orography. At the same time, westerly flow subsides in the lee of the Andes, which provides a capping inversion over the region. When the orographic lift is able to erode the subsidence inversion, convective initiation occurs and strong thunderstorms develop. As a result, convection is most frequent near high terrain. Additionally, convection in this region often remains stationary for many hours by back-building over the high terrain, as the low-level jet continues to orographically lift unstable air over the mountains. This thesis expands the TRMM-based findings on convection in this region in two separate studies: (1) Examination of the El Nino-Southern Oscillation (ENSO)-induced convective variability and (2) Characteristics and environmental conditions supporting hailstorms. The first study uses 16 years of TRMM and reanalysis data to identify how El Nino and La Nina affect storm occurrence and characteristics in this region. While the frequency of storms does not vary greatly between ENSO phases, El Nino conditions tend to promote deeper storms with stronger convection, with more robust synoptic environments supporting convective initiation and maintenance. The second study focuses on the characteristics of the powerful hailstorms that frequent subtropical South America. Using TRMM precipitation radar and microwave imager data, hailstorms are investigated based on their probability of containing hail. Results from this study show that hailstorms have an extended diurnal cycle, often occurring in the overnight hours relative to other locations around the world. High-probability hailstorms tend to be taller and larger than storms that contain low probabilities of hail. They also tend to be supported by strong synoptic forcing, including enhanced lower- and upper-level jet streams, an anomalously warm and moist surface, and increased instability. These conditions can be forecast days in advance, which will help promote readiness and preparation for these damaging storms. Overall, these two studies further the knowledge of convection in subtropical South America, providing new information for short- and long-term forecasts of convection and context to the results of the recent RELAMPAGO field campaign.