Ph.D. Defense Announcement
Kyle Chudler
Monday, December 6, at 1:00 p.m. MT

Kyle Chudler
Ph.D. Defense

December 6, 2021
1:00 p.m. MT

Defense
ATS Large Classroom (101 ATS) or in Zoom (full meeting information below)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Steven Rutledge (Adviser)
Michael Bell
Eric Maloney
Steven Reising (Electrical and Computer Engineering)

Analysis of Convection and Precipitation in the West Pacific During the PISTON Field Campaign

In the tropics, convection and precipitation are important meteorological phenomena which impact the atmosphere both locally and globally. As meteorological observations over the open oceans where this precipitation occurs are typically scant or non-existent, ship-based field campaigns are required to study these precipitating systems in detail. The latest such project is the Propagation of Intraseasonal Oscillations (PISTON) field campaign, which took place in the western North Pacific in the late-summer and early-fall of 2018 and 2019. On board the PISTON ships was the SEA-POL weather radar. In addition to taking traditional radar measurements of precipitation intensity and velocity, SEA-POL's polarimetric measurements also provide insights into the size and shape of rain drops and other hydrometeors. By combining SEA-POL's unique measurements with other meteorological datasets, I present research which offers new insights into tropical convection in the Pacific warm pool.

First, I provide an overview of the variability in convection observed during the PISTON cruises, using an automated algorithm to identify, classify, and track precipitation features. I show that as feature size increases, occurrence frequency decreases, but rain volume contribution increases. The largest features occurred infrequently (present in 13% of radar scans) but contributed a large portion (56%) of the total rain volume. Conversely, small, isolated features were present in 91% of scans, but only contributed 11% of the total rain volume. Variability in feature morphology is then related to the environmental conditions they occurred in. I show that large, organized features were more common during periods of strong low-level southwesterly winds, during periods of enhanced low-level wind shear, as well as in the troughs of easterly waves. Easterly wave ridges, on the other hand, were associated with an increase in the number of small features.

Next, I examine a curious feature observed during PISTON, wherein SEA-POL regularly measured extreme values of differential reflectivity in the cores of small, isolated convection, owing to the presence of very large rain drops. I find that cells with high differential reflectivity (> 3.5 dB) were present in 24% of all radar scans, and were typically small, short lived, and shallow. High differential reflectivity was more often found on the upwind side of these cells, suggesting a size sorting mechanism. Differential reflectivity also tended to increase at lower altitudes, which I hypothesize to be due to continued drop growth and increasing temperature and the rain drops fall. Rapid vertical cross section radar scans, as well as transects made by a Learjet aircraft with on-board particle probes, are also used to analyze these cells, and support the conclusions drawn from statistical analysis.

Finally, I compare observations of precipitation from a spaceborne satellite precipitation radar (KuPR) to surface observations from SEA-POL. Over the 18 instances where KuPR and SEA-POL made concurrent measurements of precipitation, the average rain rate in KuPR was 50% lower than in SEA-POL, but the raining area was 113% higher. The net effect of these two differences of opposite sign was for KUPR to have 23% more rain volume than SEA-POL. The limited resolution of KuPR (5x5 km) causes it to underestimate rain rate in small convective cores, but also over-broaden raining features beyond their true extent. I also show that KuPR tends to slightly overestimate rain rate below the melting layer in stratiform rain, likely due to overcorrection of attenuation below radar bright bands. Using a statistical model to simulate KuPR rain volume, I show that KuPR would theoretically overestimate rain volume during trough phases of the easterly waves observed during and underestimate rainfall during ridge phases.

Topic: Ph.D. Defense: Kyle Chudler
Time: Dec 6, 2021 01:00 PM Mountain Time (US and Canada)

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