Precipitation Microphysics and Rainfall Retrieval in Three Typical Regions of Western Pacific

Wu Zuhang[1] and Wang Jing[2]

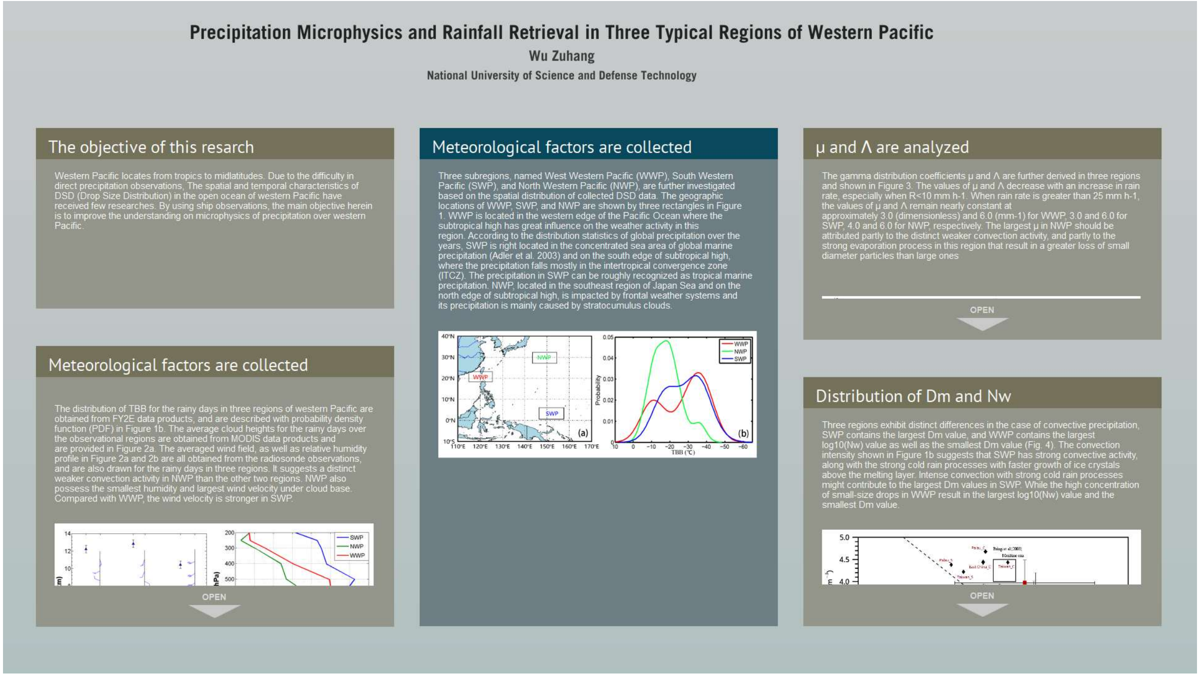
[1]College of Meteorology and Oceanography, National University of Defense Technology
[2]Organization Not Listed

November 23, 2022

Abstract

Raindrop size distribution (DSD) measurements were taken with an onboard OTT Particle Size Velocity (Parsivel) disdrometer over the western Pacific during a marine survey from June to July 2014. Three subregions named south western Pacific (SWP), west western Pacific (WWP) and north western Pacific (NWP) were separated for a comparative study of the variability of DSD. In addition to disdrometer data, FY2E, MODIS, NCEP FNL and radiosonde data sets are used to illustrate the dynamical and microphysical characteristics associated with summer season rainfall of western Pacific. The DSD characteristics of six different rain rates and two rain types (convective and stratiform) were studied. Histograms of normalized intercept parameter $log_{10}(N_w)$ and mass-weighted mean diameter D_m indicated largest $log_{10}(N_w)$ values in WWP while largest D_m values in SWP, and the convective clusters in three regions could be indentified between maritime-like and continental-like. The constrained relations between shape μ and slope Λ, N_w and D_m of gamma DSDs are derived. An inverse relation of the coefficients and exponents of Z-AR^b for convective rain were found in three regions. The $R(Z_H, Z_{DR})$ estimator is proved to be more accurate than Z–R relation algorithm. And the empirical relations between D_m and radar reflectivity factor in the Ku- and Ka-bands are also derived to improve the rainfall retrieval algorithms in the open sea of Pacific. Furthermore, the possible causative mechanisms for the significant DSD variability in three regions were investigated with respect to convective intensity, raindrop evaporation and other meteorological variables.

Precipitation Microphysics and Rainfall Retrieval in Three Typical Regions of Western Pacific



Wu Zuhang

National University of Science and Defense Technology

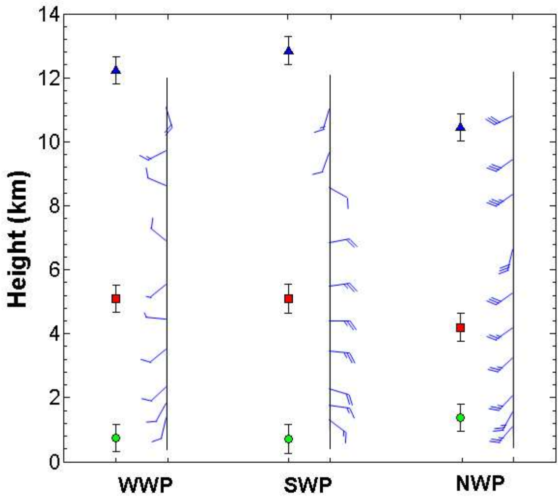
PRESENTED AT:

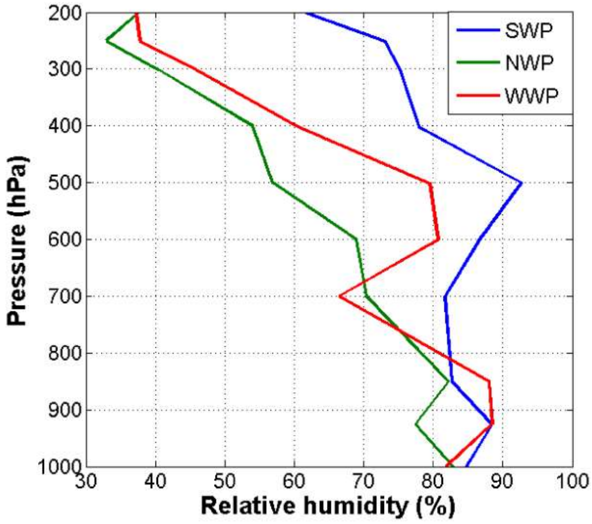
THE OBJECTIVE OF THIS RESARCH

Western Pacific locates from tropics to midlatitudes. Due to the difficulty in direct precipitation observations, The spatial and temporal characteristics of DSD (Drop Size Distribution) in the open ocean of western Pacific have received few researches. By using ship observations, the main objective herein is to improve the understanding on microphysics of precipitation over western Pacific.

METEOROLOGICAL FACTORS ARE COLLECTED

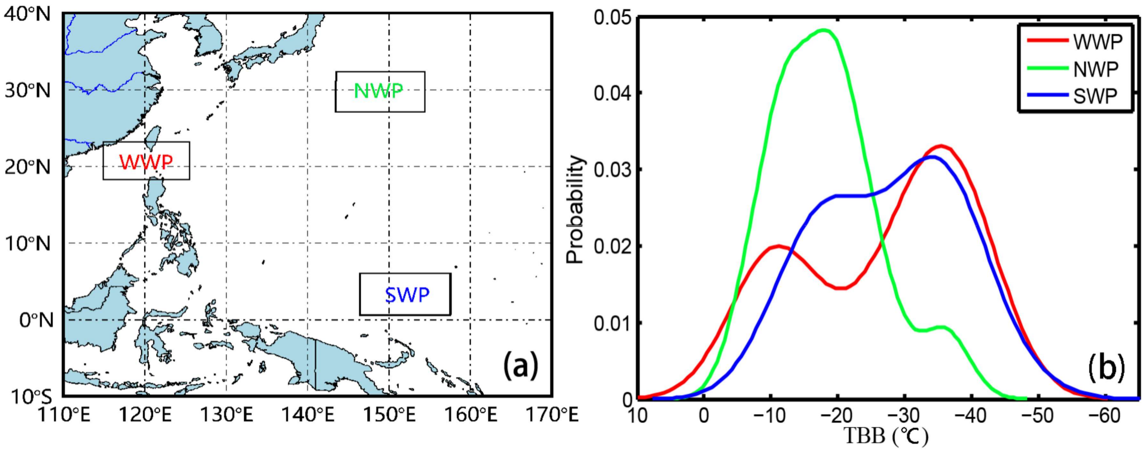
The distribution of TBB for the rainy days in three regions of western Pacific are obtained from FY2E data products, and are described with probability density function (PDF) in Figure 1b. The average cloud heights for the rainy days over the observational regions are obtained from MODIS data products and are provided in Figure 2a. The averaged wind field, as well as relative humidity profile in Figure 2a and 2b are all obtained from the radiosonde observations, and are also drawn for the rainy days in three regions. It suggests a distinct weaker convection activity in NWP than the other two regions. NWP also possess the smallest humidity and largest wind velocity under cloud base. Compared with WWP, the wind velocity is stronger in SWP.





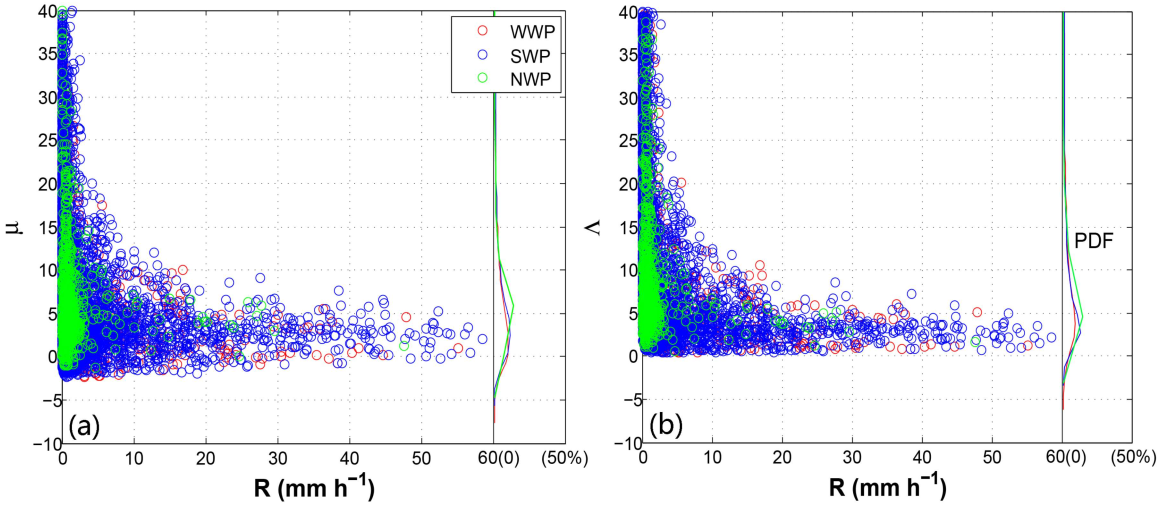
THREE TARGET AREAS ARE STUDIED

Three subregions, named West Western Pacific (WWP), South Western Pacific (SWP), and North Western Pacific (NWP), are further investigated based on the spatial distribution of collected DSD data. The geographic locations of WWP, SWP, and NWP are shown by three rectangles in Figure 1. WWP is located in the western edge of the Pacific Ocean where the subtropical high has great influence on the weather activity in this region. According to the distribution statistics of global precipitation over the years, SWP is right located in the concentrated sea area of global marine precipitation (Adler et al. 2003) and on the south edge of subtropical high, where the precipitation falls mostly in the intertropical convergence zone (ITCZ). The precipitation in SWP can be roughly recognized as tropical marine precipitation. NWP, located in the southeast region of Japan Sea and on the north edge of subtropical high, is impacted by frontal weather systems and its precipitation is mainly caused by stratocumulus clouds.



Μ AND Λ ARE ANALYZED

The gamma distribution coefficients μ and Λ are further derived in three regions and shown in Figure 3. The values of μ and Λ decrease with an increase in rain rate, especially when R<10 mm h-1. When rain rate is greater than 25 mm h-1, the values of μ and Λ remain nearly constant at approximately 3.0 (dimensionless) and 6.0 (mm-1) for WWP, 3.0 and 6.0 for SWP, 4.0 and 6.0 for NWP, respectively. The largest μ in NWP should be attributed partly to the distinct weaker convection activity, and partly to the strong evaporation process in this region that result in a greater loss of small diameter particles than large ones



DISTRIBUTION OF DM AND NW

Three regions exhibit distinct differences in the case of convective precipitation, SWP contains the largest Dm value, and WWP contains the largest log10(Nw) value as well as the smallest Dm value (Fig. 4). The convection intensity shown in Figure 1b suggests that SWP has strong convective activity, along with the strong cold rain processes with faster growth of ice crystals above the melting layer. Intense convection with strong cold rain processes might contribute to the largest Dm values in SWP. While the high concentration of small-size drops in WWP result in the largest log10(Nw) value and the smallest Dm value.