Estimation of Marine Boundary Layer Heights over the Western North Pacific using GPS Radio Occultation Profiles

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The second method (MG-BA) defines the MBLH as the altitude of the minimum gradient of bending angle. The third method (BP-Ref) estimates the MBLH by finding the break point in a refractivity profile. The final method (MG-Ref) is similar to the MG-BA, but uses refractivity instead of bending angle.

Because not all the cases had a clear MBLH, we examined their temperature and water vapor pressure profiles and identified their MBLHs with a confidence parameter (CP) of 1 to 3. When a sounding exhibited a clear temperature inversion and a sharp-decreasing moisture profile, it was assigned by a CP of 3 (Fig. 2).

In order to fairly evaluate the performance of each method, we only choose cases with a clear MBLH (CP=3). Figure 3 presents scattered diagrams with linear regression of the MBLHs estimated from the four methods against those determined from the radiosonde observations. It is clear that the MBLHs estimated by the MXP-BA, with the best slope (~0.99) and the highest R^2 (~0.7), have the best fit with those from the sounding observations among the four methods (Fig. 3a). The MG-BA (Fig. 3b) also reliably estimates the MBLH, but its R^2 (~0.44) is lower than that of the MXP-BA. The BP-Ref (Fig. 3c) overestimates the MBLH with a low R^2 (~0.2), while the MG-Ref (Fig. 3d) underestimates the MBLH with an even lower R^2. It suggests that the MXP-BA, among the four chosen methods, provides the best estimate of MBLH at locations where nearby radiosonde stations indicate a clear MBLH.

The MXP-BA method is therefore applied to compute the average MBLH over the entire WNP. Figure 4 shows that the MBLH is significantly higher in winter than in summer over the WNP, and the mean MBLHs in the spring and autumn (Figs. 4b, d) fall between those of the winter and summer. In order to examine why this is the case, we further use nine years (2007-2015) of GPS data to calculate the correlation coefficient (CC) between MBLH and three other variables, including Oceanic Niño Index (ONI) (Fig. 5a), sea surface temperature (SST) (Fig. 5b), and the stability of lower atmosphere (SB) (Fig. 5c). We found that the MBLH is more correlated with the stability of lower atmosphere than the other two variables. The higher MBLH in winter is because winter exhibits a larger temperature difference between the WNP ocean surface and the lower atmosphere than does summer. Moreover, many regions with high MBLHs in winter are approximately located within the paths of the Kuroshio Current and the North Equatorial Current. When these warm ocean currents flow under relatively colder air, favorable conditions for convection develop, resulting in a higher MBLH.