Aspect sensitivity of clear-air measured by coherent radar imaging

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Aspect sensitivity of refractivity irregularities in the clear-air was examined with multiple-receiver coherent radar imaging (CRI) of the MU VHF atmospheric radar in Japan. The so-called aspect angle, which is a measurement of aspect sensitivity, was estimated. Two CRI parameters retrieved by the Capon method were utilized to estimate the aspect angle: brightness width from vertical radar beam, and direction of arrival (DOA) of echo center from oblique radar beam. Differing from previous studies with CRI, however, a mitigation of radar beam weighting effect on the CRI brightness distribution was made before estimating the two CRI parameters.

To mitigate the radar beam weighting effect, the intensity distribution of the radar beam was described with a Gaussian function, and moreover, the standard deviation of the Gaussian function, defined as the radar beam width, was recommended to be adaptive to signal-to-noise ratio (SNR) of data as well as off-beam direction angle. Such kind of adaptable beam width has been proposed in our previous study to be able to yield a more reliable CRI brightness.

Observations showed that the aspect angles obtained from the modified brightness width of vertical beam were larger than those of without modification, and they were very close to the values derived from the DOA of 1^{o}-oblique radar beam, suggesting consistent results of the two approaches around the zenith. Moreover, the aspect angle derived from DOA varied with radar beam direction, which is similar to that suggested by some other methods such as comparison of echo powers of two different oblique radar beams. However, the DOA-approach yielded a larger aspect angle in the lower-SNR condition, as compared with the method of comparison of echo powers. Such characteristic of aspect angle gives a benefit: altitudinal variation of aspect sensitivity is more explicit and so the layers with high aspect sensitivity can be identified more clearly. This study has shown an application of adaptable radar beam width, and recommended a feasibility of improving the measurements of atmospheric parameters with CRI after removing the radar beam weighting effect from the CRI brightness.

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