Evaluation of Velocity measurement accuracy for Future Geostationary Spaceborne Doppler weather radar

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Geostationary Spaceborne Doppler weather radar (GSDWR) is a conceptual radar proposed by NASA and it was expected to improve the monitoring and predication of hurricanes or typhoons. And now lots of its technologies are still under research. One of the important researches for future GSDWR is the accuracy of velocity measurement from Geostationary orbit 36,000km far from the Earth which will affect a lot to the observation of hurricanes. Similar to GPM DPR before launching, lots of researches have been done on the velocity estimation and analysis. In this paper, we evaluate the velocity accuracy of GSDWR from two aspects: the characteristics of power spectrum and the accuracy of velocity measurement.

Firstly, we analyzed the factors of velocity estimation to determine the value of radar pulse repetition frequency (PRF). Then, according to the characteristics of weather echo signal and the parameters of GSDWR to build echo signal power spectrum model. Next, by weighting the spectrum, adding dithering and noise of weather echo, sampling, the power spectrum of GSDWR echo is finally simulated. Then based on the power spectrum, we analyzed the characteristics of echo power spectrum under different precipitation types. Finally, we used DFT method to get the Doppler velocity of GSDWR, then analyzed the velocity measurement error.

The results showed that, in the case of stratiform precipitation, power spectrum has been broadened, but it is not large, the spectrum shape is good and is still Gaussian. The errors of velocity estimation are mostly within 1m/s inside the area of precipitation while at the edge of precipitation the errors are larger, mostly can be up to 2~3m/s, and the maximum one can be more than 4m/s. In the case of convective precipitation, the power spectrum is broadened to a great extent, the spectrum distortion is serious. And there may have multiple velocity centers, spectrum becomes a non-Gaussian spectrum overlapped by multiple Gaussian spectra. In this case, the range of velocity errors depends on the size and intensity of convective monomers. For convective precipitation with high intensity, most of the errors are more than 5m/s, and the maximum one in those area with sharp changes of reflectivity can reach about 10m/s.

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