Probabilistic Attenuation Correction in Multiple Radar Network

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Conventional radar systems with high power transmitters at S-, or C-band have long coverage areas. On the other hand, dense radar network systems with low power transmitters at X-, or Ku-band has been proposed (Junyent et al. , *J. Atmos. Oceanic Technol.*, 27, 2010, pp.61–78.) (S. Shimamura et al., 144, 36th Conference and Radar Meteorology, Breckenridge CO USA, Sep., 2013) which can infill observation gaps in low altitudes because of the earth curvature and have good accuracy and resolution. A weather radar, especially with transmitting short-wavelength pulses, is impacted by precipitation attenuation seriously. Various methods for precipitation attenuation correction have been developed in the literature. Hitschfeld and Bordan (1954) assumed exponential approximation for *k-Z* relationship and solved the propagation differential equation. The Hitschfeld-Bordan (HB) solution is relatively stable at C-band, but not so at X-, or Ku-band due to fluctuation in measured reflectivity values. A network based attenuation correction technique in a multiple radar network has been suggested (Chandrasekar and Lim, *J. Atmos. Oceanic Technol.*, 25, 2008, 1755–1767). In this paper, we suggest a probabilistic technique for precipitation attenuation correction based on the HB solution in a dense radar network.

The HB method can obtain an analytic solution by solving a differential equation on each ray. In the proposed attenuation correction method, however, the HB solutions can be regarded as probabilistic values with Gaussian distribution, and a weighted-average value can be obtained by weighting with the inverse of variances of HB solutions σ_{HB}^2 which can be calculated from variance of measured radar reflectivity σ_Z^2. The standard deviation of measured reflectivity σ_Z depends on some radar parameters. σ_{HB}^2 can be regarded as uncertainty of HB solution and the inversed σ_{HB}^2 value can used as a weight value.

The attenuation correction method is evaluated by two-dimensional simulation at Ku-band as well as a network of X-band observations from CASA IP-1 experiment. The following describes the simulation process. A three-radar network at Ku-band is described here, and their locations have a regular triangle with 20 kilometers' sides(shown in Fig.1 (a)). The specification of radars is based on a Ku-band broadband radar (BBR (E. Yoshikawa et al., Development and initial observation of high-resolution and volume-scanning radar for meteorological application, IEEE Trans. Geosci. RemotoSens., vol. 48. no. 5, 2010.)). Only a case can be introduced here that an isolated precipitation core like as convective rain is assumed at the center of the triangle (shown in Fig.1 (b)). HB solutions can be calculated from measured reflectivity including attenuation and fluctuation. Some overestimated areas can be found behind the core viewed from the nodes. Fig.2 (a) shows estimated result which can be similar to true value. In Fig.2 (b), error values can be within 1 dB.

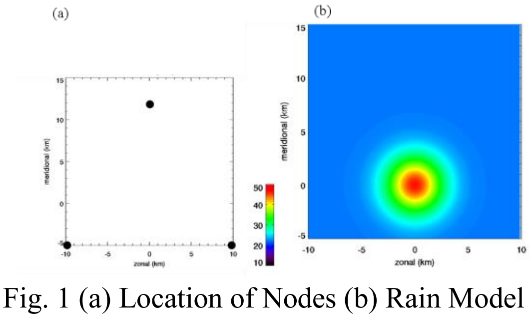

Fig. 1 (a) Location of Nodes (b) Rain Model

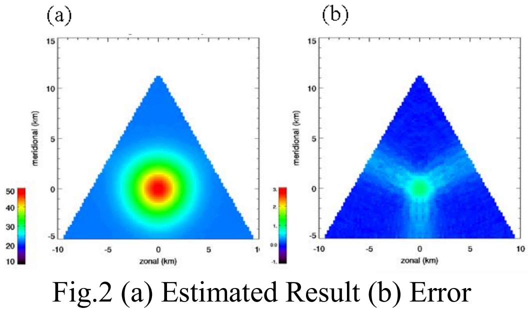

Fig.2 (a) Estimated Result (b) Error