Use of multiple-antenna radar systems aboard moving high-altitude platforms has been proposed for measuring rainfall. The platforms contemplated in the proposal would be primarily spacecraft, but, in principle, the proposal could also apply to aircraft. The problem of measuring rainfall velocity from a moving platform is especially challenging because the velocity of the platform (especially in the case of a spacecraft) can be so large that it is difficult to distinguish between the rainfall and platform contributions to Doppler frequency shifts. Furthermore, nonuniform filling of radar beams can lead to biases in Doppler estimates. Although it might be possible to reduce these biases through improved data processing, a potential alternative is to use multiple antennas positioned at suitable along-track intervals.

The basic principle of the proposed systems is a variant of that of along-track interferometric synthetic-aperture radar systems used previously to measure ocean waves and currents. The simplest system according to the proposal would include two antennas that would perform cross-track scans as in a prior rainfall-measuring radar system. The antennas would be located at different along-track positions. The along-track distance between them would be chosen, in conjunction with the along-track velocity of the platform and the radar pulse-repetition frequency (PRF), such that this distance would equal the distance traveled by the platform between two successive pulses. (If necessary, the PRF could be adjusted to enforce this equality.) Thus, in effect, two sets of measurements would be performed at each platform position. Under this condition, extraction of the rainfall Doppler velocity without the platform contribution is substantially simplified and can be done with only minor modification of processing techniques traditionally used for ground-based Doppler radars.

This work was done by Stephen Durden, Simone Tanelli, and Paul Siqueira of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

Multi-Antenna Radar Systems for Doppler Rain Measurements
Use of multiple antennas would enable removal of platform Doppler contributions.

NRA’s Jet Propulsion Laboratory, Pasadena, California

Use of multiple-antenna radar systems aboard moving high-altitude platforms has been proposed for measuring rainfall. The platforms contemplated in the proposal would be primarily spacecraft, but, in principle, the proposal could also apply to aircraft. The problem of measuring rainfall velocity from a moving platform is especially challenging because the velocity of the platform (especially in the case of a spacecraft) can be so large that it is difficult to distinguish between the rainfall and platform contributions to Doppler frequency shifts. Furthermore, nonuniform filling of radar beams can lead to biases in Doppler estimates. Although it might be possible to reduce these biases through improved data processing, a potential alternative is to use multiple antennas positioned at suitable along-track intervals.

The basic principle of the proposed systems is a variant of that of along-track interferometric synthetic-aperture radar systems used previously to measure ocean waves and currents. The simplest system according to the proposal would include two antennas that would perform cross-track scans as in a prior rainfall-measuring radar system. The antennas would be located at different along-track positions. The along-track distance between them would be chosen, in conjunction with the along-track velocity of the platform and the radar pulse-repetition frequency (PRF), such that this distance would equal the distance traveled by the platform between two successive pulses. (If necessary, the PRF could be adjusted to enforce this equality.) Thus, in effect, two sets of measurements would be performed at each platform position. Under this condition, extraction of the rainfall Doppler velocity without the platform contribution is substantially simplified and can be done with only minor modification of processing techniques traditionally used for ground-based Doppler radars.

This work was done by Stephen Durden, Simone Tanelli, and Paul Siqueira of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

NPO-44018