Simulations of a Doppler Radar for monitoring wake vortices in rainy weather

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Wake vortices are associated to the generation of lift when an aircraft is flying. During the take-off and landing phases, wake vortices are hazardous if encountered by other flying aircrafts. In order to ensure flight safety and increase airports capacity as a constraining minimum distance between successive aircrafts has been defined to avoid them, wake vortex monitoring in real time has emerged as one of the key challenge in air traffic management. In this paper, the potential use of an X band Doppler radar for detecting and monitoring wake vortices in rainy weather is assessed by simulation. The Doppler signature measured by an X band radar in presence of a wake vortex in rainy weather is simulated accounting for the backscattering of each individual raindrop in the volume surrounding wake vortices. Starting from a given DSD and a homogeneous repartition of the raindrops in still air, their trajectory is computed assuming a generic air flow induced vortex and a simple model of drag. The descent velocity of the vortex due to the local reduction of buoyancy in the vortices is also taken into consideration in the computation of the trajectory. A scheme for computing the radar signals from the raindrops within wake vortices is described. The X band radar signatures in scanning mode are computed for raindrops in each concerned radar cell. According to the simulation results, the Doppler spectrum width of the raindrops disturbed by wake vortices is extended, thus providing a mean to identify the potential location of wake vortices in the scanned area and therefore to localize the hazards. The potentiality of this tool for the design of inversion algorithms from wake vortices signatures will also be addressed.