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The EarthCARE Doppler radar: forward modelling and performance estimation

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The 94 GHz EarthCARE radar (expected to be launched within three years) will be the first radar in space with Doppler capabilities. The retrieval of hydrometeor fall speeds and air motions from the radar signal will be extremely challenging due to a variety of complications. In EarthCARE configuration (height=395 km, beam-width=0.08°, PRF around 6000 Hz) the following caveats have to be accounted for: a) the high satellite speed matched to the finite antenna beam-width produces consistent Doppler fading ($\sigma_{Doppler} \approx 3.25$ m/s); b) Nyquist Doppler interval (4.5 m/s) can introduce relevant folding; c) non uniform beam filling conditions may cause biases in the mean Doppler velocity estimates; d) multiple scattering widens the Doppler spectrum and de-correlate the signal from the real mean velocity.
A forward Doppler radar simulator capable of accounting both for non uniform beam filling conditions and multiple scattering enhancements has been coupled to an instrument simulator in order to reproduce the signal at the antenna port. In this paper the EarthCARE radar simulator has been applied to a variety of scenarios (convective rain, drizzle, cirrus sedimentation). The performance of different standard Doppler moment estimators is discussed for the three different situations. In convective scenarios it will be utterly tough to extract useful velocity information from EarthCARE observations.