We construct fractionally integrated continuous-time GARCH models, which capture the observed long range dependence of squared volatility in high-frequency data. Since the usual Molchan-Golosov and Mandelbrot-van-Ness fractional kernels lead to problems in the definition of the model, we resort to moderately long memory processes by choosing a fractional parameter $d \in (-0.5,0)$ and remove the singularities of the kernel to obtain non-pathological sample paths. The volatility of the new fractional COGARCH process has positive features like stationarity, and its covariance function shows an algebraic decay, which make it applicable to econometric high-frequency data. In an empirical application the model is fitted to exchange rate data using a simulation-based version of the generalised method of moments.