Solar radiation becomes polarized when scattered by molecules, aerosols, and cloud particles in the Earth's atmosphere. Therefore measurements of the polarization state of radiation can be used to improve remote sensing of the atmosphere. Recently, several instruments have been developed which measure polarization, these are ground based polarimeters, airborne instruments (e.g. RSP), and satellite instruments (e.g. POLDER, GOSAT, SCIAMACHY, and GLORY). The analysis of those measurements requires radiative transfer codes that handle polarization. The Monte Carlo model MYSTIC allows the calculation of polarized radiances in 3D-domains including inhomogeneous clouds and complex topography. For limb sounding applications or simulations during twilight the model can be run in spherical geometry. To simulate the measurements of polarized Fourier transform spectrometers (e.g. TANSO-FTS on GOSAT) a new method has been developed which allows very efficient simulations of high spectral resolution radiance spectra.

The algorithms for polarized radiative transfer will be presented. Furthermore simulations for various types of instruments will be shown: for ground based all sky imagers, for multi-directional and multi-spectral radiometers as well as for high spectral resolution Fourier transform spectrometers. In particular the sensitivity of the polarization characteristics with respect to cloud inhomogeneity, cloud size distribution, and ice crystal shape is investigated.