Development of a Fast Forward Model for the Infrared Atmospheric Sounding Interferometer

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The Infrared Atmospheric Sounding Interferometer (IASI) is a modern satellite sensor with 8461 channels and a spectral resolution of 0.25 wavenumber. It provides a wealth of information on atmospheric and surface properties. Due to the high spectral resolution, a large number of Radiative Transfer (RT) calculations through the inhomogeneous atmosphere are needed. Usually, only subsets of channels are used to perform physical inversions for atmospheric profiles. This paper presents a novel radiative transfer model based on principal component analysis. The Principal Component-based Radiative Transfer Model (PCRTM) predicts PC scores and associated derivatives with respect to various atmospheric and surface properties in PC space directly. Usually, less than 200 PCs are needed to regenerate the original radiance spectrum with accuracy better than instrument noise level. Therefore, the dimension of the spectrum is reduced by an order of magnitude for hyper spectral sensors with thousands of channels. The reduction in dimension and the fast RTM make the physical inversion algorithm very fast and efficient. Due to its significant savings in computational time, the approach uses information from all measured channels. There is no need to use only subset of channels. The parameterization of the PCRTM model is derived from properties of PC scores and instrument line shape functions. It is physical and accurate.