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# Update of the Doubling-Adding KNMI (DAK) radiative transfer model

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Accurate radiative transfer calculations in the solar spectral range are an essential prerequisite for many applications in atmospheric science. Among these applications are: (i) remote sensing and retrieval development, for which radiances or Stokes parameters emerging at the top or bottom of the atmosphere have to be calculated, and their derivatives; (ii) climate forcing, for which fluxes (irradiances) at the top or inside the atmosphere have to be calculated; (iii) atmospheric physics studies for which profiles of fluxes throughout the atmosphere have to be calculated; (iv) atmospheric chemistry for which spectral actinic fluxes are needed.

The Doubling-Adding KNMI (DAK) model is an accurate and efficient line-by-line, multiple scattering, polarized radiative transfer model of the Earth's atmosphere in plane-parallel geometry. The doubling-adding principle with polarization was described by De Haan et al., Astron. Astrophys., vol. 183, 371-391 (1987). The model atmosphere may contain gas absorptions, and aerosol and cloud particle absorption and scattering. Since the 1990's DAK has been used for many satellite retrieval applications, e.g. cloud and aerosol remote sensing and ozone column retrievals. Recently the model was updated with several extensions to better serve the above applications. Some of these are unique innovations. The extensions are:
- Derivatives (or weighting functions) of radiances or Stokes parameters at top-of-atmosphere with respect to atmospheric composition are computed with analytical relations, for retrieval purposes.
- Pseudo-sphericity is included, to allow large solar zenith angles.
- k-distributions for gas absorptions are included to perform efficient broadband calculations of shortwave fluxes.
In this presentation we will show the basic principles of these extensions, and give sample results.