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3D scene construction, radiative transfer, and radiative closure assessment for the EarthCARE satellite mission

H.W. Barker (1), T. Wehr (2), S. Kato (3), J.N.S. Cole (4), M. Shephard (5), D.P. Donovan (6), and R.J. Hogan (7)

(1) Environment Canada, Cloud Physics and Severe Weather Research Section, Toronto, Ontario, Canada (howard.barker@ec.gc.ca), (2) ESA, (3) NASA-Langley, (4) Environment Canada, (5) ACApps Inc., (6) KNMI, (7) U of Reading

Synergistic retrieval algorithms will be applied to EarthCARE's active and passive data thereby yielding profiles of cloud and aerosol properties for approximately 1 km x 1 km columns along the satellite's nadir ground-track. As with CloudSat, 1D radiative transfer models will operate on each of the ∼40,000 1 km columns in each orbit. EarthCARE's passive imager data will be interpolated to a joint standard grid (JSG) with horizontal grid-spacing of 1 km. A search algorithm, developed for this mission, will be applied to JSG imager data in order to construct, on a per orbit basis, a 3D domain of cloud and aerosol that encompasses the retrieved cross-section. Maximum cross-track size of the constructed domain is limited to the imager's swath width of 150 km. Through the domain construction process 2D fields of 1D fluxes can be averaged in a straight forward manner via the independent column approximation, to various desired domain sizes without having to perform additional 1D radiation calculations.

In addition to 1D RT approaches, 3D Monte Carlo radiative transfer algorithms will be applied to constructed domains. For the shortwave fluxes and radiances will be calculated. For the longwave only radiances will be computed because 1D fluxes are quite accurate and computation of 3D fluxes can be prohibitive. The length of the computational domains will be the entire Sun-up portion of each orbit for the shortwave and the entire orbit for the longwave. Constructed domains will include a central averaging sub-domain, over which Monte Carlo results will be reported, and adjacent buff-zones that will facilitate horizontal transport in and out of the averaging domain. The width of the averaging domain will not exceed 10 km and could be as small as 1 km. The width of the entire computational domain (averaging sub-domain + buffer-zones) will be less than 50 km.

Broadband radiances simulated by the Monte Carlo models will be compared to actual measurements made by EarthCARE's broadband radiometer (BBR). As BBR data will not be used for any retrievals, these comparisons will essentially constitute a continuous radiative closure experiment thereby allowing users a means of gauging the quality of the synergistic retrievals. Conversely, simulated top-of-atmosphere fluxes can be compared to estimated fluxes derived from application of angular direction models (ADMs) to BBR radiances. The relative merits of performing the closure using radiances and fluxes will be discussed. Errors injected into the closure experiment due to 3D scene construction, which can be expected to be scene dependent, will also be discussed. Results shown will be based on A-train data and data simulated by a cloud system-resolving model.