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ACRANEB2 radiative transfer scheme - pushing the limits of broadband approach

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Well known dilemma of radiative transfer parameterizations in NWP and climate models is cost versus accuracy issue. Common approach is to use radiative transfer schemes with as many spectral bands as necessary for required accuracy, but because of computational cost they must often be used at reduced temporal and/or spatial resolution. However, variability of cloudiness field and its strong feedback with radiative forcing compromises overall model accuracy when such approach is used. Alternative solution is to employ cheaper broadband schemes which can be called at every model timestep and at every gridpoint, thus ensuring full feedback with clouds. Extreme example of this approach is ACRANEB radiation transfer scheme used in model ALADIN, which employs only single shortwave and single longwave spectral interval. Should such ultra-broadband approach have sufficient accuracy, it must deal with broadband saturation effect, double temperature dependency of longwave gaseous transmissions, and non-random spectral overlaps between various absorbing species. These issues were addressed successfully and sometimes with original methods in recently developed ACRANEB2 radiation transfer scheme. Its cornerstones are gaseous optical depths based on Malkmus band model with empirical broadband correction, linear correction of Planck weights with respect to temperature of emitting body, parameterization of non-random gaseous overlaps in absorptivity space, use of net exchanged rate formalism combining exact primary exchanges with approximate secondary ones, delta-two stream treatment of multiple scattering, interaction of scattering with saturation via idealized optical paths and parameterized saturation of shortwave cloud absorption. Longwave part of ACRANEB2 is comparable to RRTM in terms of accuracy and cost, while still keeping full interaction with model cloudiness.