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About inadequacy of the current radiation codes based on the correlated-k method and a new improved k-distribution technique

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A lot of k-distribution (KD) codes for GCMs, models of cloud evolution and other applications have been developed until the present. However, these codes are based on the correlated-k method, which has been developed more than a dozen years ago. Consequently, the present KD codes have the same well known difficulties in treatment of overlapping absorption by different species and in a cooling/heating rate simulation in the upper atmosphere. The worst thing is that in most codes the cloud/aerosol absorption is treated more coarsely than the gas absorption because of some problems in correlated-k method. It leads to essential errors in simulated fluxes and heating rates inside clouds, as shown already 10 years ago by Espinoza and Harshwardhan. Thus suitability of the present radiation codes is questionable, especially for simulation of interaction between the cloud media and radiation. It should be stressed that the correlated-k method can not overcome the above difficulties. A principal new KD technique is suggested, that can overcome all the above problems. E.g. the technique gives a possibility correctly to take into account correlation between water vapor and liquid water or ice absorption. It is shown that disregarding the above correlation in the present radiation codes can essentially distort simulated heating rates. Moreover the technique gives a possibility to generate codes that in 2-3 times faster than those published. Long/short-wave parameterizations, which are suitable for use in GCMs, are also presented. They have been created using 23 and 15 k-terms for the long/short-wave spectral regions, respectively, which is nearly half as many as other KD codes. Also will be briefly considered some effective line-by-line models for 'ab initio' calculations of the thermal/solar radiations in a scattering turbid plane-parallel atmosphere.