New Radiative Transfer Code in the Oxford Venus GCM

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Venus models are at the stage of evolving from Simple General Circulation Models (SGCM) towards more complete and physically-based ones. The process is complex and challenging due to difficulties in reproducing the global atmosphere of Venus in a realistic numerical approach. The circulation of Venus's atmosphere is well known to exhibit strong super-rotation and a variety of enigmatic features which remain poorly understood. Previous work in Oxford has resulted in the development of a SGCM of its atmosphere, which is already capable of qualitatively reproducing some aspects of its meteorology.

In this work we adapt and extend the existing 3D time-dependent numerical circulation of the atmosphere to include a new physically-based radiative transfer formulation. This new parameterisation uses different approaches in the two main wavelength bands: solar radiation (0.1-5.5μm) and thermal radiation (1.7-250 μm). The general solar radiation calculation is based on the δ-Eddington approximation scheme (two-stream-type) with an adding layer method and represents absorption and scattering of sunlight by gas molecules and aerosols. For the thermal radiation case, we use a scheme based on the Net Exchange Rates matrix formalism of Eymet et al. (2009). This new scheme is first tested in a 1D grid configuration in the GCM code and the final radiative-convective equilibrium is analysed. A parameterisation with prescribed heating rates for the solar radiation (Crisp 1986) was investigated for a global grid, and the results are presented.

A new method to retrieve the zonal winds from temperatures fields based on cyclostrophic balance and an eddy diffusion parameterisation is proposed. The accuracy of this method is tested using temperature fields obtained by the Venus SGCM and its numerical stability is explored. This approach may be useful in reconstructing zonal velocity fields from spacecraft measurements of temperature in Venus's atmosphere.