INFLUENCE OF DETAILED MICROPHYSICS ON CLOUD FORMATION IN A MARS GCM. F. Daerden[1], C. Verhoeven[1], D. Moreau[1], J.W. Kaminski[2], J.C. McConnell[2], A. Akingunola[2], and N. Larsen[3] , [1]Belgian Institute for Space Aeronomy BIRA-IASB, Brussels, Belgium (Frank.Daerden@aeronomie.be), [2]Centre for Earth and Space Science, York University, Toronto, Canada, [3]Danish Meteorological Institute, Copenhagen, Denmark

Introduction: Ice cloud formation is calculated in Mars GCMs by a wide variety of methods, ranging from simple bulk condensation schemes to more detailed parameterizations, moment scaling methods, as well as full detailed microphysical descriptions. To understand the effects that different cloud condensation schemes may have on the actual calculation of ice cloud formation, cloud water uptake and their influences on the atmospheric environment and the global water cycle, an analysis of the two extremes in these approaches has been performed, i.e. the bulk condensation scheme vs a detailed microphysical description.

Bulk ice scheme versus detailed microphysics: The most recent version of the Global Mars Multiscale Model or GM3 [1] has an improved simulation of the water cycle on Mars including eddy and molecular diffusion, gravitational sedimentation, transport between the polar caps, regolith and atmosphere, and phase transitions between water vapor and bulk ice particles. The bulk cloud condensation scheme can be expected to overestimate the water uptake in clouds, because of the omission of a description of the availability of cloud condensation nuclei and by the negligence of the process of nucleation. Marsbox, a recently developed detailed microphysical model for Martian dust and ice clouds [2] is applied in an offline mode to estimate the possible influences of these approximations on the modeled cloud optical thickness and water content.

Marsbox: Marsbox is based on a state-of-the-art box model for terrestrial PSC and cirrus clouds [3,4]. The model is described in detail in Verhoeven et al (this workshop). The box model can be used in a vertically stacked mode and be driven by external GCM fields with a specific spatio-temporal resolution, an approach referred to as "offline mode".

Offline microphysical simulations: The box model is driven by offline GM3 fields of temperature, pressure, and total water budget with a time resolution of 1 sol-hour. The size-resolved dust distribution used in Marsbox is altitude-, latitude- and season-dependent, and consistent with the Conrath formula and MGS observations. The dust size distribution is assumed to be lognormal in the absence of ice particles, and the distribution parameters are estimated in consistency with available observations. The differences between the bulk condensation scheme and the microphysical scheme can be assessed approximately by driving the box model with the total GCM water budget (gas-phase + condensed phase) subtracted by the condensed water already present in the box model.

Sensitivity studies: In comparisons with observational data (TES, SPICAM) the differences between the GCM modeled clouds and the observations may be partly due to the approximate bulk condensation scheme, but also to biases in the modeled temperature and water budget. In fact it has been observed that cloud formation and water uptake are highly sensitive to these ambient fields [2]. An advantage of the offline application of a microphysical box model is that the box model can easily be driven by modified GCM fields. In a first approach this allows for an assessment of the sensitivities of the cloud formation on the GCM driving fields. But once the biases of the GCM fields are quantified using observational data, also a more realistic modeling approach can be performed by driving the box model with bias-corrected GCM fields, allowing for a more consistent comparison with observations of Martian ice clouds. Observations of TES will be used for such a study.

References:

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