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Towards interior-atmosphere coupling on Venus: CO_2 and H_2O

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Here, we show the first results of coupling a grey atmosphere model (i.e., we assume that the absorption coefficients are constant and hence independent of frequency) considering only CO_2 and H_2O as greenhouse gases to the geodynamic code Gaia (Hüttig et al., 2013). The evolution of the atmospheric composition of a planet is largely determined by the partial melting and volcanic outgassing of the interior. In turn, the composition of the atmosphere dictates the surface temperature of the planet (due to processes like the greenhouse effect), which is an important boundary condition for crustal and mantle processes in the interior of a planet. Venus in particular has a thick atmosphere at present with an abundance of the greenhouse gas CO_2 and a small amount of water vapour. However, the surface conditions may have been much milder up to recent times (e.g., Way et al., 2016). Volcanic outgassing during the thermal history of Venus is thought to have significantly affected the planet's surface temperature and hence its global mantle evolution. Here, we calculate the outgassing of CO_2 and H_2O from the melt and then use the resulting partial pressures to calculate the surface temperature, which we then use as our boundary condition for the mantle convection. We compare our results to previous studies who employed similar coupled models to address the interaction between the interior and atmosphere of Venus (e.g., Noack et al., 2012; Gillmann & Tackley, 2014; Höning et al., 2021). Ultimately, we aim to consider more chemical species than CO_2 and H_2O to shed light on the Venus' interior and atmosphere evolution. Therefore, we also show preliminary results of outgassing models that consider chemical speciation of the entire C-O-H system, i.e., CO_2, H_2O, H_2, O_2, CO, and CH_4.