The Stability of Climate on Venus

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The high temperatures and pressures at the surface of Venus have led to the suggestion that surface/atmosphere interactions may play an important role in buffering CO2 and other volatiles [1]. If this is the case, perturbations to the atmospheric inventory of CO2 and other volatiles, caused by volcanic eruptions, may have a significant impact on the climate of Venus and upon the stability of the greenhouse effect. Before the return of detailed radar images of Venus’ surface by the Magellan spacecraft, estimates of the magnitude of volcanic source terms were relatively unconstrained. Recent work on the interpretation of the impact cratering record, however, have placed some plausible limits on the magnitude of the volcanic flux [2]. Fegley and Treiman [3] have shown that the surface temperature and pressure on Venus coincide approximately with the P-T equilibrium of the calcite-wollastonite mineral reaction. If this reaction is indeed buffering atmospheric CO2 at the surface of Venus, and if reaction rates are small on geologic timescales, it is of interest to assess the impact it may have on the greenhouse effect. Through buffering, surface mineral equilibria can produce important feedbacks with the greenhouse effect. A radiative-convective greenhouse model of Venus’ atmosphere that employs Rosseland mean absorption coefficients has been developed that couples the radiative properties of the atmosphere to the volatile abundances that are achieved through mineral equilibrium reactions. Perturbations to the model are considered by increasing the abundances of trace gases, and by calculating the new radiation field that results from constraining the pressure and temperature at the surface to those predicted by several candidate volatile buffering reactions. Results that have implications for possible alternate Venus climate regimes will be discussed.