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On the role of spatially inhomogeneous diabatic effects upon the evolution of Mars' annular polar vortex

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Evolution of Mars' annular polar vortex is not similar to that of its counterpart on Earth and is characterized by a potential vorticity (PV) low in the vicinity of the winter pole, rather than PV monotonically increasing towards the pole. A number of persistent asymmetric high-PV patches around the central low are also typical for the Mars' polar vortex. By using the simplest vertically averaged model of the Mars atmosphere, where the diabatic processes of radiative relaxation and latent heat release due to spatially inhomogeneous CO_2 deposition are added, with simple relaxational parameterizations, it is shown that these latter combined can account for the observed, formally unstable, with patches of high potential vorticity, structure of the polar vortex. The parametrization of inhomogeneous deposition is new, and includes dependence on the concentration of condensation nuclei, which are otherwise considered as a passive tracer. The study consists in linear stability analysis of the zonally and time averaged Mars' winter polar vortex, and the use of thus identified unstable modes for initialization of high-resolution numerical simulations of their nonlinear evolution in different configurations: adiabatic and diabatic with only radiative relaxation, only deposition, and both radiative relaxation and deposition, in order to identify the role of each process.