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Spatial variation of Methane and other trace gases detected on Mars: interpretation with a General circulation model

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Several teams have recently reported the detection of methane in the Martian atmosphere [1-3]. Although the detection is at the limit of the instrument capacities, one of the most surprising findings by some of these teams is the apparent strong spatial variations observed in spite of the fact that a gas like methane was expected to have a relatively long lifetime in the Martian atmosphere and thus be well mixed. To better quantitatively understand how such spatial variations can form on Mars, we have performed multiple realistic 3D general circulation model simulations in which gases with different sources, lifetime or sinks are released and transported in the Martian atmosphere. The main tool used for our study is the LMD General Circulation Model [4] which is designed to represent the details of the Martian climate circulation and tracer transport [5] with high accuracy.

Preliminary results: First, we find that gases with lifetime shorter than 10$ˆ7$s (˜100 sols) do exhibit strong spatial variations with a strong maximum near their localized source. Therefore gas with lifetime of a few tens of days or less released from a non global source should be expected to show large spatial (longitudinal) variations. Gases with longer lifetime tend to be well mixed after a while. However, spatial structures can be created if the source is not continuous, because the atmosphere is then far from being in equilibrium with the gases. For instance, after about two third of a year, a gas with a very long lifetime of 10${10}s (˜320 Earth years; like methane in theory) can be twice more abundant near its source than in the rest of the atmosphere. This suggest that remote observations could detect strong spatial variations not because the chemical lifetime of the gas is short, but because the sources are not constant in time

(local events, seasonal cycle, etc.).

Finally, after many years, we found that the main source of spatial variations for long lifetime gas is the seasonal CO2 cycle and the corresponding enrichment in the polar night as detected by [6] in the case of Argon.

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[6] Sprague et al. Science 306, pp1364 (2004)