



VARIABILITY OF ATMOSPHERIC METHANE INDUCED BY ADSORPTION IN THE REGOLITH



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➤ **Observations: Short scale time and space variations**



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- **The mechanisms that can induce **short term variations** of atmospheric CH₄ on Mars, apart from the seasonal enrichment over the winter poles characteristic of non-condensable gases, **are yet to be discovered.****



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- **Observations: Short scale time and space variations**
- The mechanisms that can induce **short term variations** of atmospheric CH₄ on Mars, apart from the seasonal enrichment over the winter poles characteristic of non-condensable gases, **are yet to be discovered.**
- Gough et al. (2009, this meeting) : adsorption/desorption in the regolith
⇒ seasonal variability of atmospheric methane

➤ Possible effects:

- Fate of a plume emitted by a local source in a virgin/equilibrated atmosphere: **adsorption in the regolith slows down its dispersion and increases the contrast between the peak area and its surroundings** ⇒ can it explain Mumma's et al. observations?
- How important is the “pseudo-leakage” term present in the mass balance equation?

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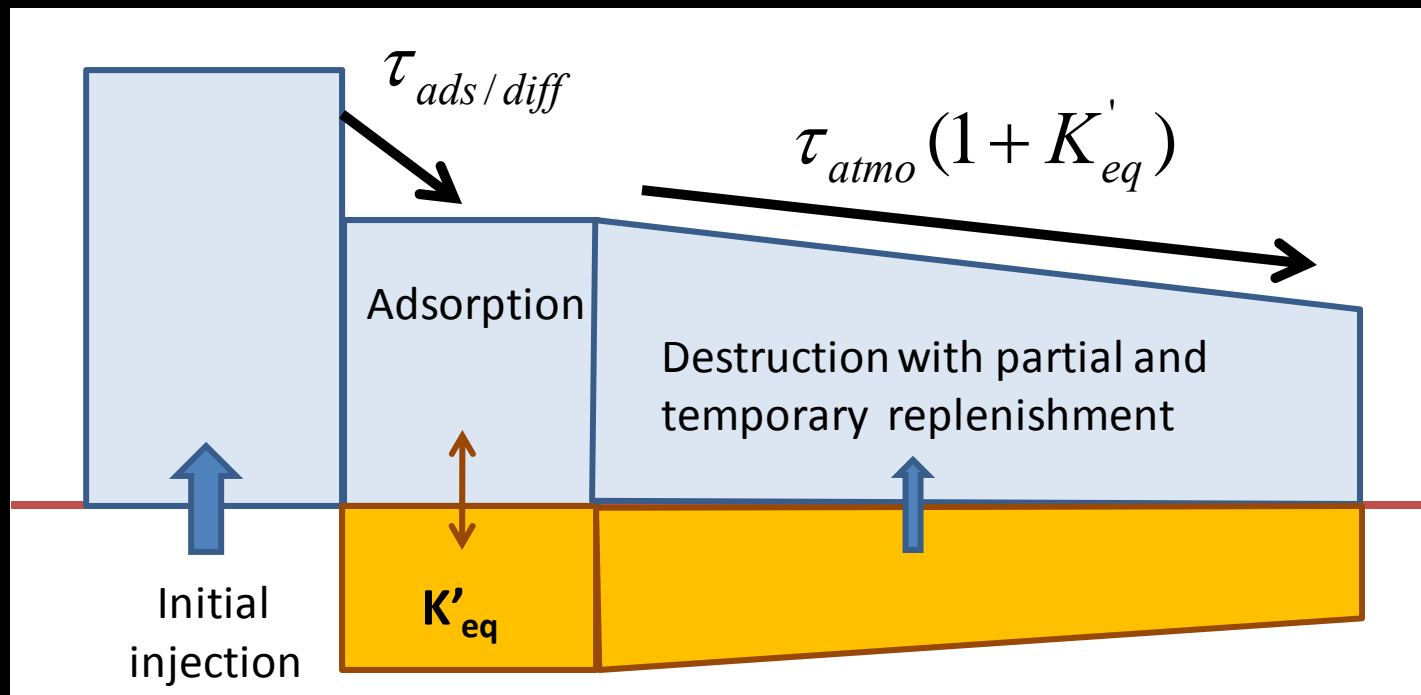
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$$M_{\text{ads}} = K'_{\text{eq}} M_{\text{atmo}}$$

$$M_{\text{atmo}} = \Phi \tau_{\text{atmo}} \left[1 - \exp\left(-\frac{t}{\tau_{\text{atmo}} (1 + K'_{\text{eq}})} \right) \right]$$

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 - **Total amount of adsorbed methane** stored in the regolith?

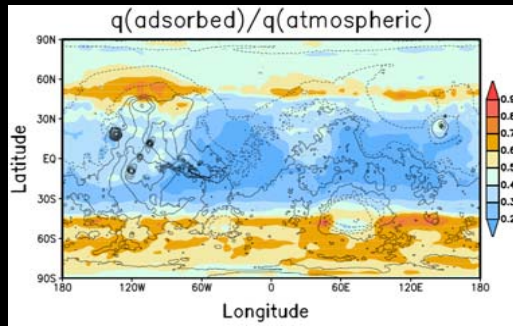
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 - **Time to reach equilibrium** with the regolith?
 - **Total amount of adsorbed methane** stored in the regolith?
 - Seasonal variations (once equilibrium is reached): **is the adsorption-diffusion kinetics fast enough?** are the **seasonal temperature variations and thermal skin depths large enough** to induce significant variations of the atmospheric column abundance of CH₄?

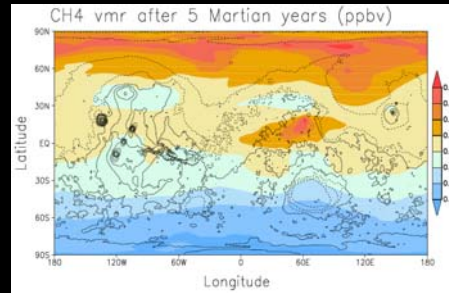
Model

- 3D simulations with a version of the LMDZ GCM that includes coupling with the subsurface (thermal coupling and transport)
- Takes into account the **kinetics and thermodynamics** of methane adsorption (taken from Gough et al., 2009)
- Free parameters : **thickness of the regolith, specific surface area, K_d value**
- Includes first-order loss rates (oxidation): set to 0 for now.
- Neither pore choking by subsurface ice nor the influence of co-adsorption are considered at this stage.

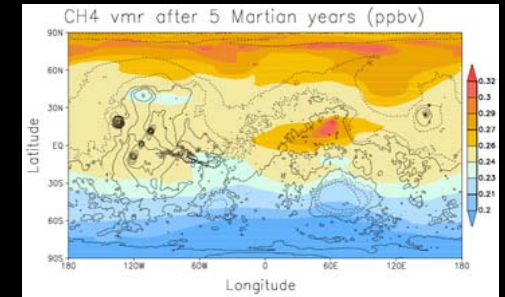
Results



K'_{eq}

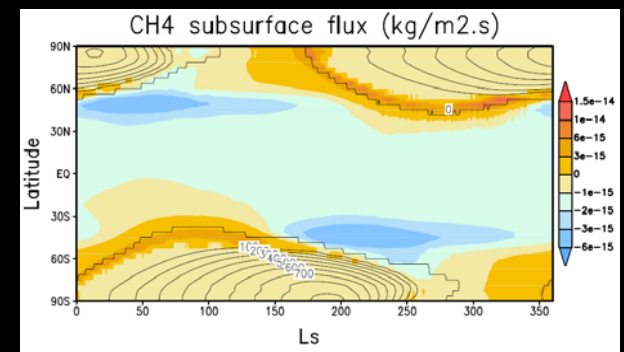
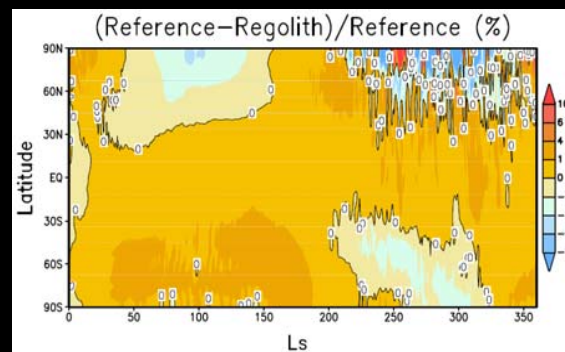
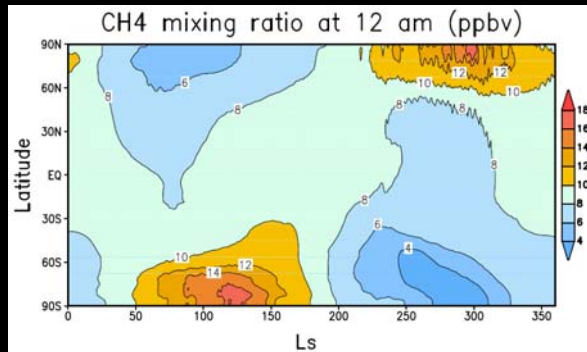


With regolith



Without regolith

Dispersion local source



Seasonal cycle ($\text{SSA} = 100 \text{ m}^2 \cdot \text{g}^{-1}$) : only a few % variations, no feature at low latitudes. Cannot explain the observations.