
[EJ] Evening Poster | P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS07] Mars and Mars system: results from a broad spectrum of Mars studies and aspects for future missions

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Unprecedented progress in being made in our understanding of the planet Mars, especially because of new data from the US, European, Russian, and Asian missions to Mars. Eight spacecraft are currently operating at Mars, with six in orbit (Odyssey, MRO, MAVEN, Mars Express, Mangalyaan and TGO) and two on the surface (MSL-Curiosity and MER-Opportunity), the largest number ever at any given time. In addition InSight Lander is on track for launch in 2018, and Mars 2020, ExoMars and the Emirates Mars Mission in 2020. All this is a clear demonstration of public's strong fascination with and commitment to Mars exploration and the resulting scientific bonanza. Synergistic investigations with ongoing or already completed missions along with modeling studies and earth-based observations are gradually revealing the nature of Earth's most closely resembling planet that took on a different evolutionary track. Morphology and variable phenomena seen on the surface (RSLs, for example) indicate the red planet may possibly be still active, and require a clear understanding of its current geologic and atmospheric state, climate evolution and habitability. Thus, this session is planned to discuss recent results from a broad spectrum of Mars studies encompassing the interior, surface, atmosphere, plasma environment, and the Mars system including its two satellites. Abstracts on instrumentation and future mission plans are also encouraged for this session, as both the presenters and the audience would greatly benefit from ensuing discussions and feedbacks.

[PPS07-P02] Quantitative evaluation of the cumulus convection schemes for the implementation into the Paleo Martian Global Climate Model

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Current Mars has a lot of fluvial traces, which are supposed to be made during the late Noachian and early Hesperian boundary (3.85-3.6 Ga). If these traces are created by the fluvial activity, the climate of early Mars should be 'warm and wet' enough for the long-term existence of liquid water on its surface. However, solar luminosity at that time would be weaker by 20-30 % of today's value and preclude early Mars from keeping clement climate ('Faint young Sun paradox'). Previous studies using 3-dimensional Mars Global Climate Models (MGCMs) have revealed that pure CO₂ atmosphere, even assuming 2~7 bars, was hard to reproduce the surface temperature above 273 K [e.g. *Kasting, 1991; Forget et al. 2013*].

We newly developed a 3-dimensional Paleo MGCM (PMGCM) with ancient ocean on its surface below a sea level of -2.54 km, including the absorptions of CO₂ / H₂O gases, CO₂ / H₂O ice clouds, thermodynamics of

land / ocean, and hydrological processes [*Kamada et al.*, submitting to *Icarus*]. This model reproduced the clement surface environment enough for liquid water on surface and could create the most of fluvial channels by hydrological processes. However, a part of fluvial channels in our model could not be reconciled with observed ones on current Mars (e.g. *Sabaea Terra*). Some explanations for these mismatches may be considered by 1) Noachian and early Hesperian boundary, the Tharsis rise had not finished or completed, which would enable wind system to transport water vapor towards the leeward regions such as *Sabaea Terra*, and/or 2) some of fluvial channels would have formed by glaciation.

Another possible reason is that our model has excluded the cumulus convection scheme, only included large-scale condensation process for the precipitation process. This process could be crucial for atmospheric stability and affect the distribution and the amount of precipitations on early Mars. Therefore, as the next step, we are newly introducing the cumulus convection scheme based on Kain-Fritsch scheme [*Kain and Fritsch*, 1993]. This scheme is appropriate for low-middle resolution GCMs to reproduce the cumulus lifetime including creation, developing, declining, and eliminating atmospheric instability by one cumulus in a grid. Another candidate is Relaxed Arakawa-Schubert scheme [*Moorthi and Suarez*, 1991] which is often introduced to terrestrial GCMs. However, it is not obvious whether this scheme could be adapted to early Mars, because it is based on several terrestrial empirical assumptions when calculating cloud-base mass flux which cannot be simply adopted to the CO₂ / H₂O atmosphere in our model.

In order to do the trade-off between those two schemes, we evaluate the differences of precipitation created by both schemes. First, we do the test in our model but under the present Earth conditions (1 atm, N₂ / O₂ atmosphere, present solar flux at 1 AU). We suppose that both schemes would show the similar results in precipitation distribution and amount as long as performed on present Earth models. Next, we change parameters such as surface pressures (wet CO₂ atmosphere of 0.5-2.0 bars), atmospheric compositions, and solar flux for early Mars as our PMGCM conditions. These results will provide the differences and the validity of those schemes to apply for early Mars. In this paper, we will provide a first summary of these results.