GEM-Mars GCM: Update

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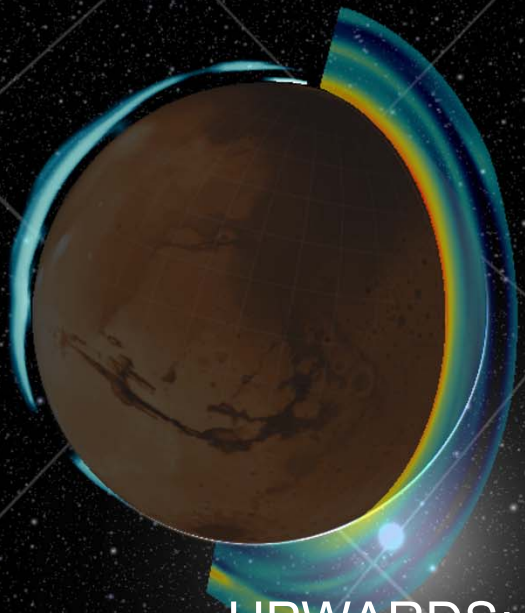

UPWARDS: From Mars Express to ExoMars
Madrid Feb 2018

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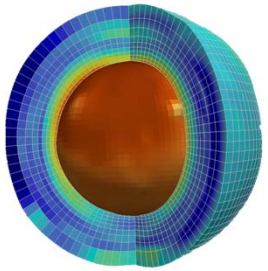
About GEM-Mars



- Model Highlights:
  - **Multi-scale** grid point model (**semi-Lagrangian**, semi-implicit scheme, hydrostatic/non-hydrostatic formulation), **high vertical resolution** (103 levels up to ~150 km)
  - Parameterizations for **CO_2 and H_2O cycles**, boundary layer, etc.
  - Active dust lifting, **radiatively active water ice clouds**
  - Gas-phase **chemistry**, non-condensable gas enrichment
  - Parameterizations for **gravity wave drag** (orographic and non-orographic)
- Full description and evaluation in **Neary and Daerden, Icarus, 2017**
  - Comparisons with **MCS, TES, REMS, MARCI**

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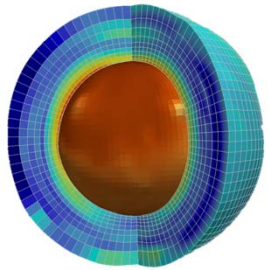
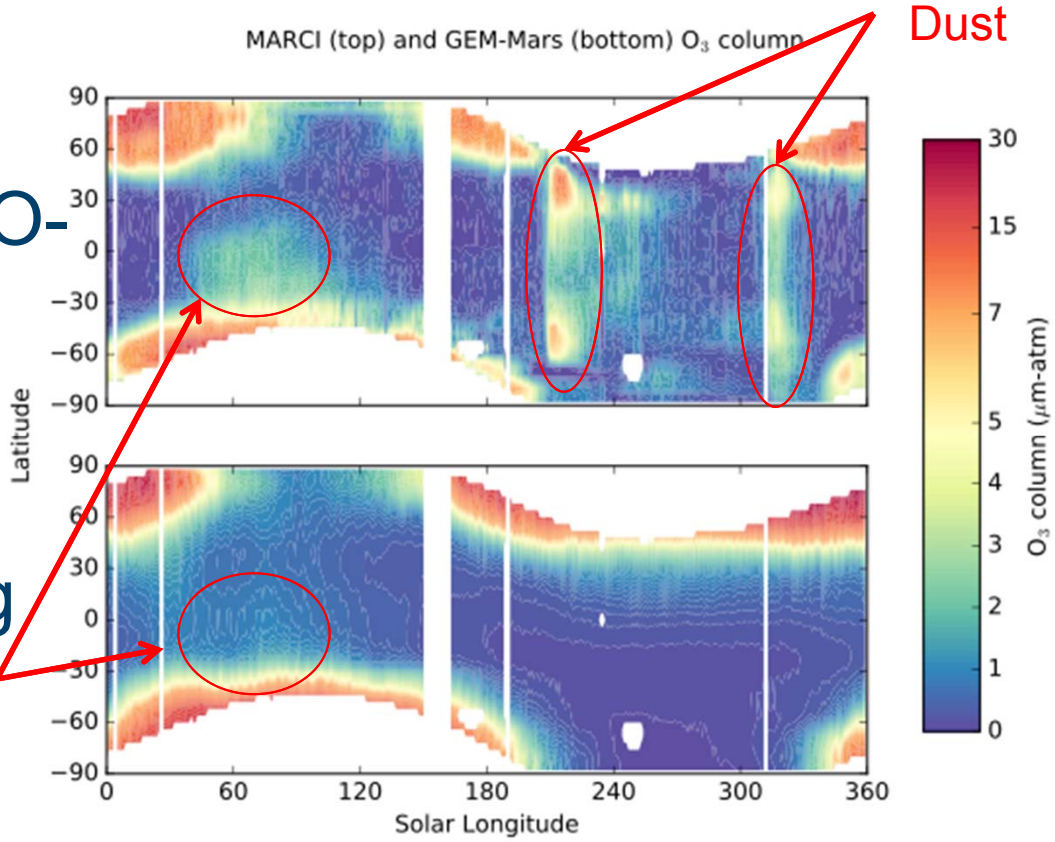
GEM-Mars Chemistry: Ozone

Neary and Daerden, 2017



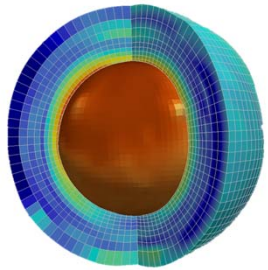
- Zonal average column ozone compared with MRO-MARCI (top)
- High latitude maximums reproduced, lacking the equatorial increase before the ACB



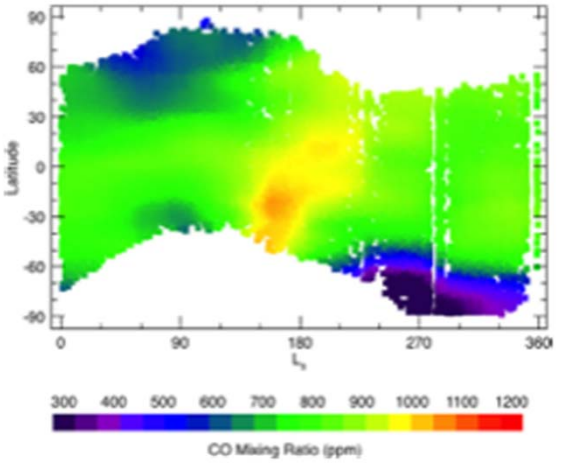
Stay tuned for an update: Daerden et al., in prep

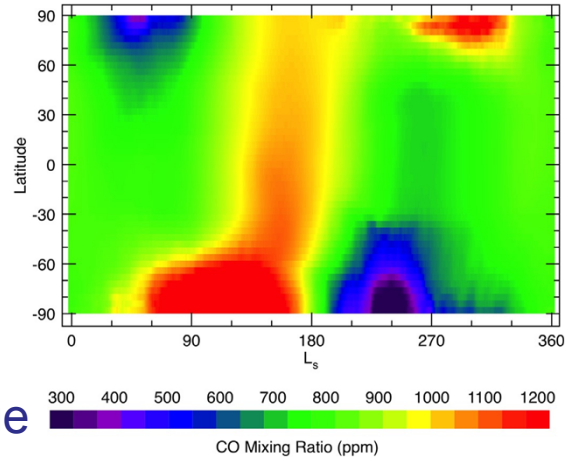
Non-condensable gases

Smith et al., 2018



- Seasonal cycle of CO compared with MRO-CRISM (top)
- Depletion/enhancement seen in summer/winter polar regions
- Breakup of south polar vortex results in “leaking” towards northern latitudes



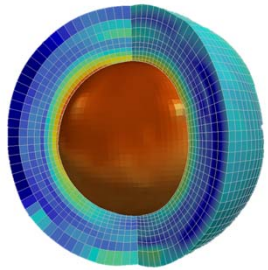


Model updates in this paper:

- New definition of north polar cap
- New formulation of non-condensable gas exchange

Water cycle

Smith et al., 2018



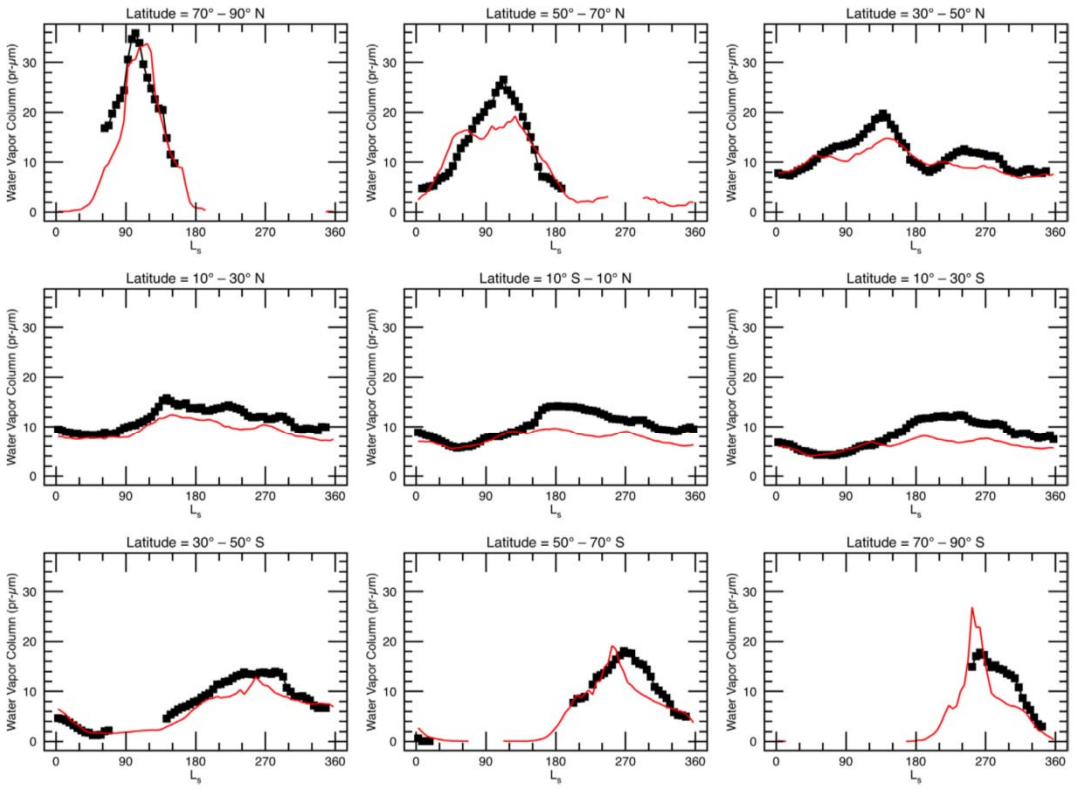
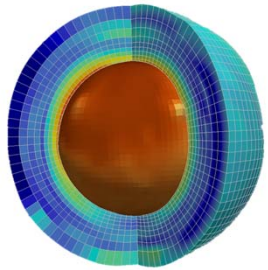
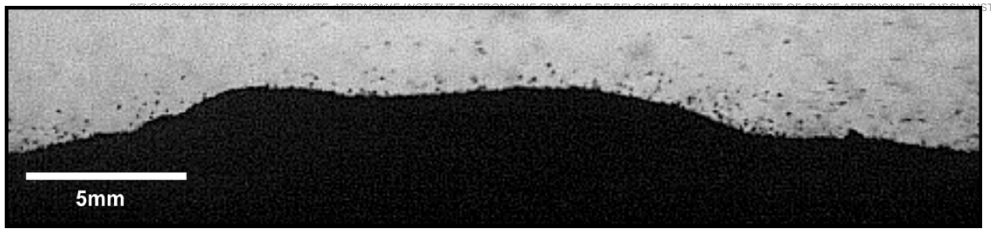


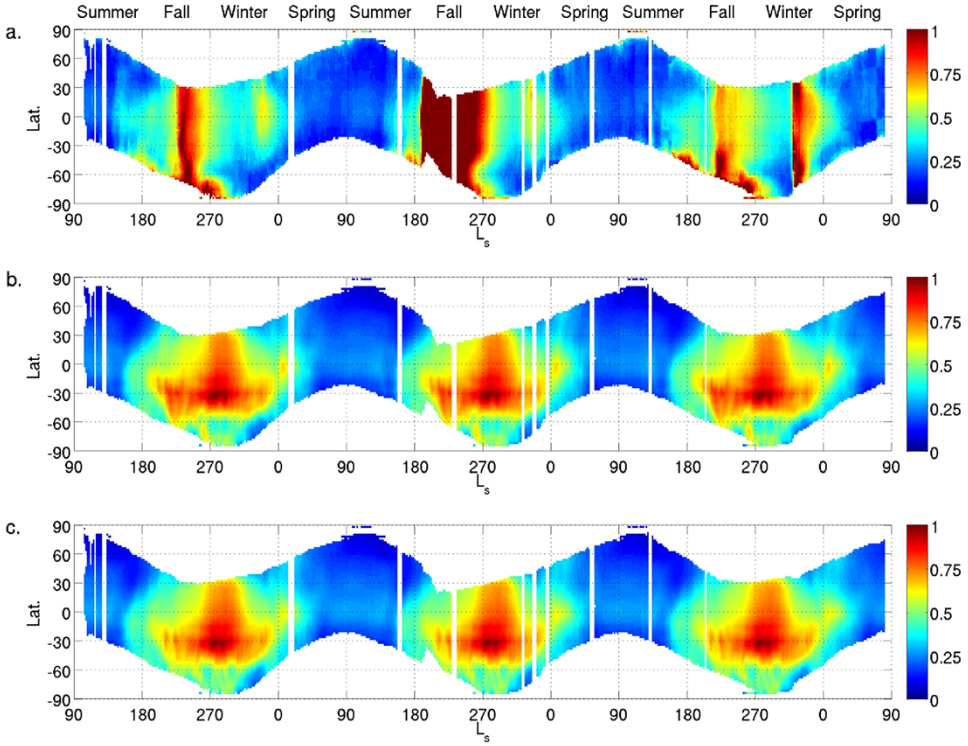
Fig. 14. Comparison of GEM-Mars model simulation of water vapor column abundance (red line) with CRISM retrievals (black points). The model output is averaged over the local times observed by CRISM (2:00–4:00 PM). The estimated uncertainty in the binned retrievals is 2 pr-μm. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

GEM-Mars (red) vs CRISM H_2O column for various latitudes

New dust threshold from experimentation (Musiolik et al., 2018)







Dust particles lifted at 0.38g (wind flowing from left to right)

TES dust optical depth

GEM-Mars with old wind stress threshold (which was ~40% lower than former lab measurements)

GEM-Mars with new threshold based on this work

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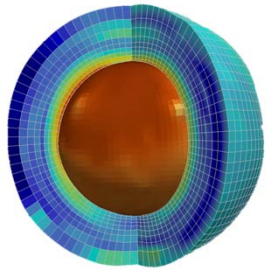
Preparing for NOMAD



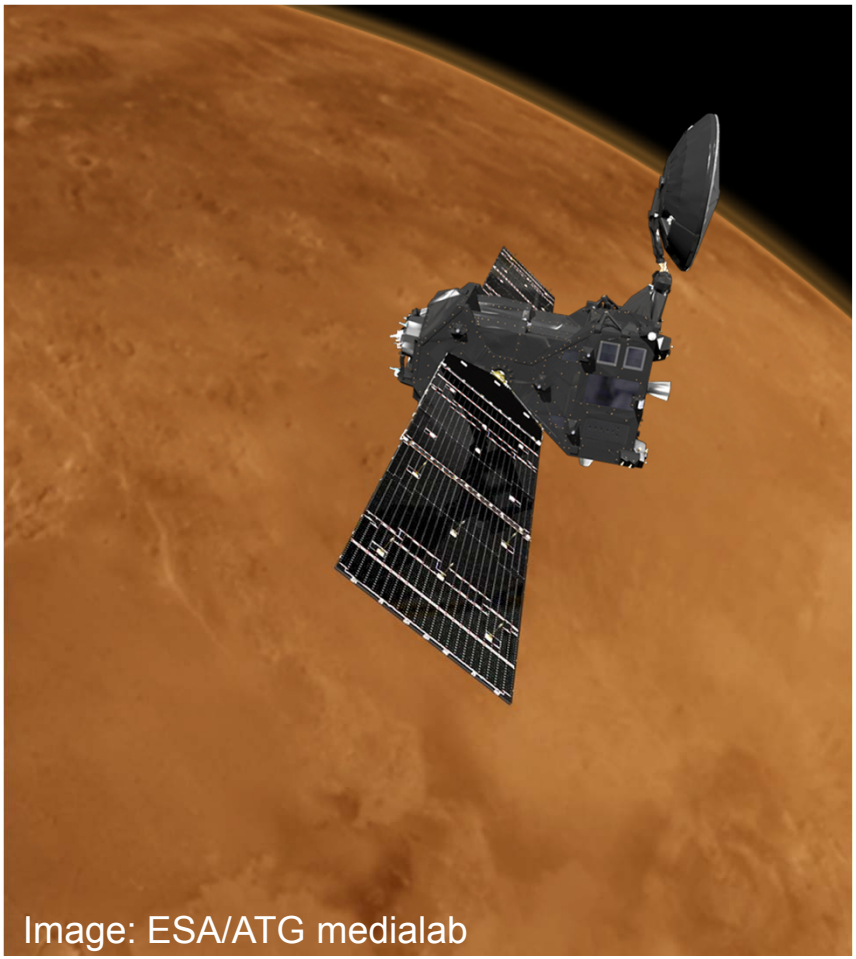


Image: ESA/ATG medialab

- Model atmosphere provided to retrieval teams (e.g. talk of A. Mahieux)
- Support for work on ozone gradients at terminator (talk of A. Piccialli)

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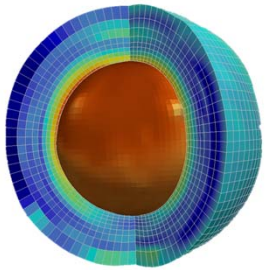
What else is new?



- Focus on **trace gases**:
  - New **KPP*** chemistry package (+1D model for testing)
    - Easy to add new species and reactions (e.g. HDO)
    - **Rosenbrock** solver
    - Higher **spectral resolution** in J-value calculation (important for H_2O +hv -> H + OH)
  - J-value calculation updated to include slant path, ice optical depth
  - Lower reaction rate for $O_2(a^1\Delta_g) + CO_2 \rightarrow O_2 + CO_2$
  - Addition of **120 tracers + new statistical method** for examining potential source regions of methane (Giuranna et al., submitted)

*Kinetic PreProcessor

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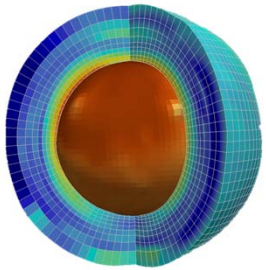
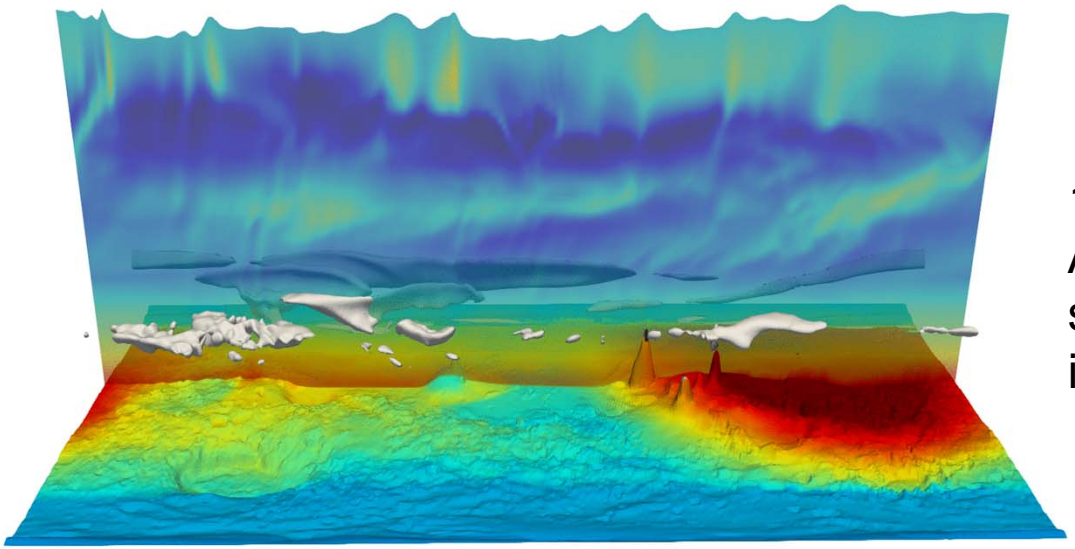
What else is new?



- Focus on **dynamics**:
  - high resolution simulations to examine waves and constrain GWD parameterisations



1° x1° GEM-Mars simulation: Animation of 1 sol at L_s 54° showing temperature and water ice clouds

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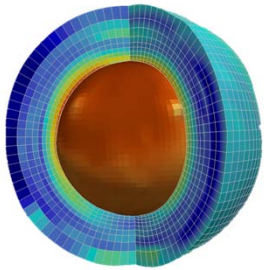
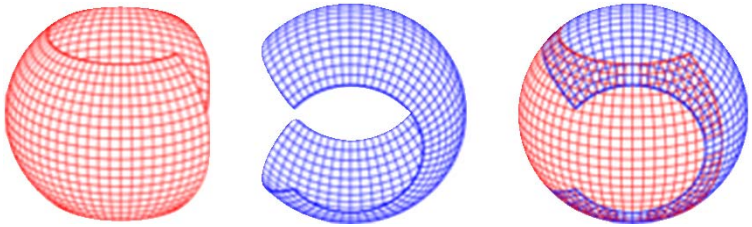
In the near future…



- New dynamical core (version 4.8LTS), collaboration with Environment Canada
  - Yin-Yang grid



  - Potential for 3DVAR data assimilation (collaboration with Canada and Poland)
- Microphysics (Daerden et al., 2010)
- Whole atmosphere GWD scheme (Yiğit et al., 2008)

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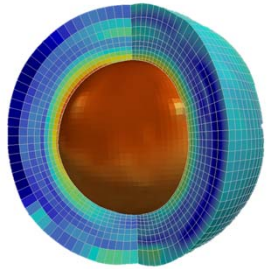
Thank you



For Miguel, one intriguing question…
What can a **multiscale** GCM tell us about waves in the Mars atmosphere?