

Photochemical Escape of Oxygen and Carbon from Early Mars

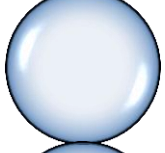
Jinjin Zhao and Feng Tian



CENTER FOR EARTH SYSTEM SCIENCE
TSINGHUA UNIVERSITY

2/12/2015

Outline

-  **Background**
-  **Previous Work**
-  **Model Description**
-  **Main Results**
-  **Future Work**

Non-thermal escape from Mars

O,C,N ...

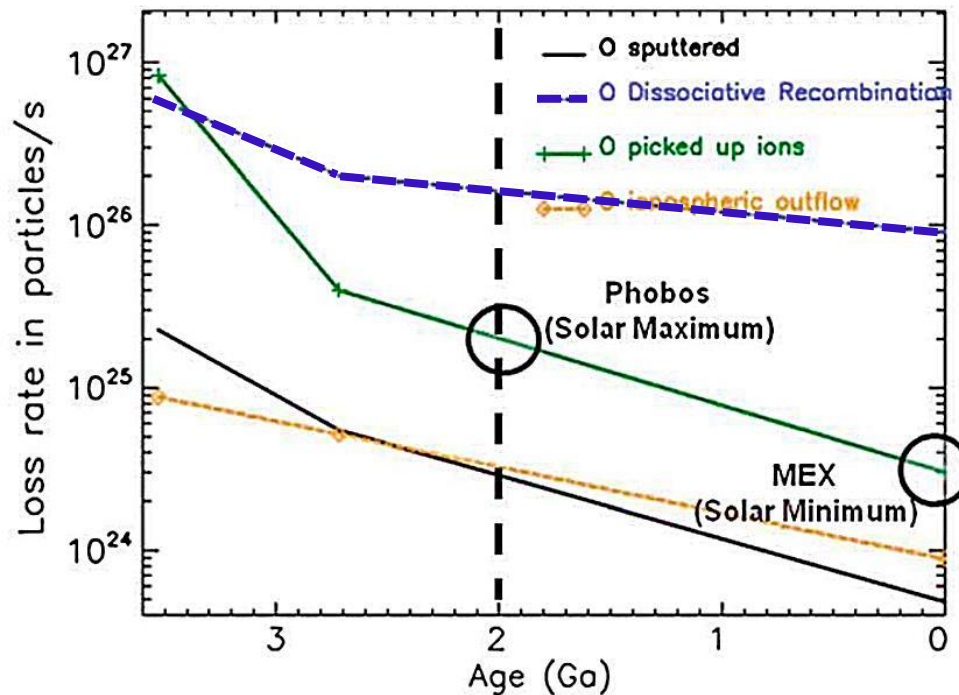
So Heavy~

Temperature is very low~

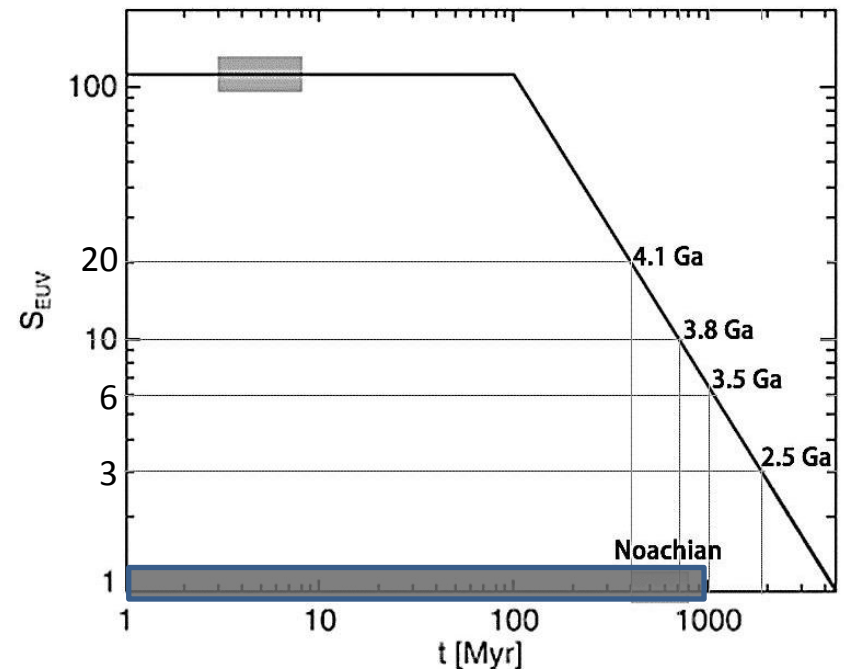


Could not escape from thermal process~

I need more energy to escape!



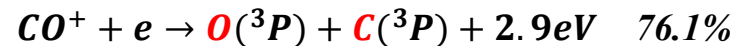
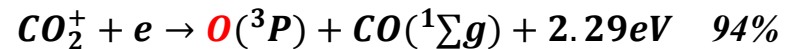
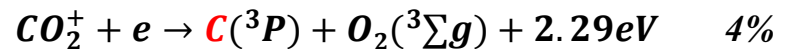
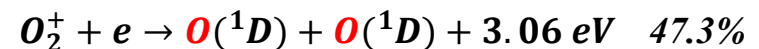
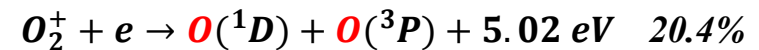
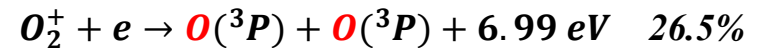
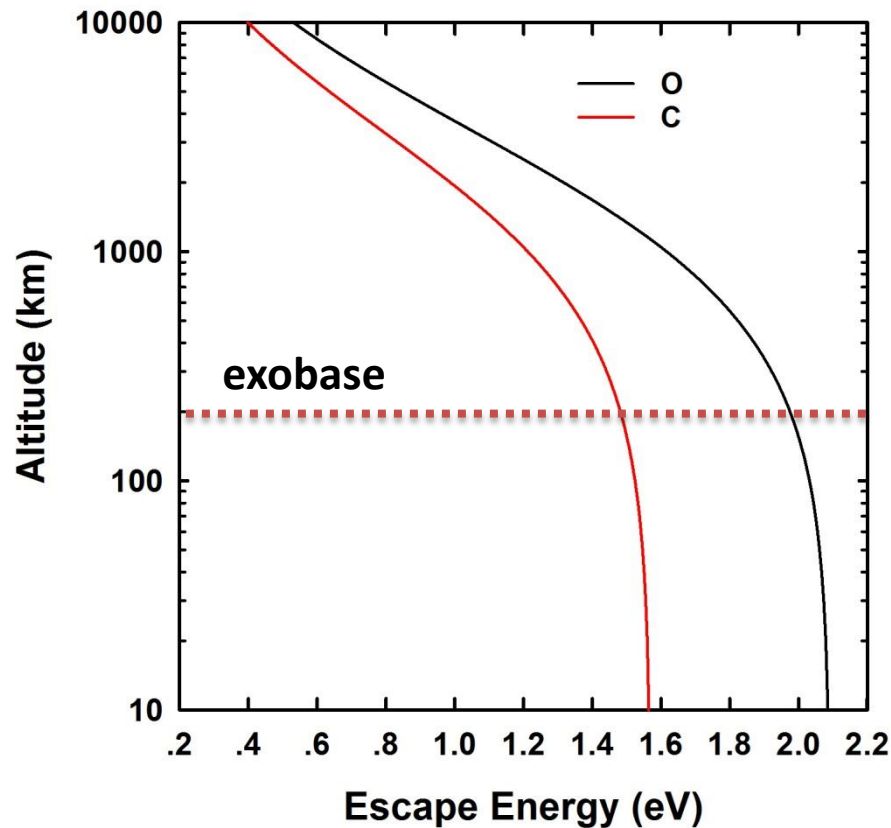
Chassefière et al. (2013, JGR)



Lammer, Chassefière et al.
(2012, Space Science Reviews)

Dissociative Recombination (DR)

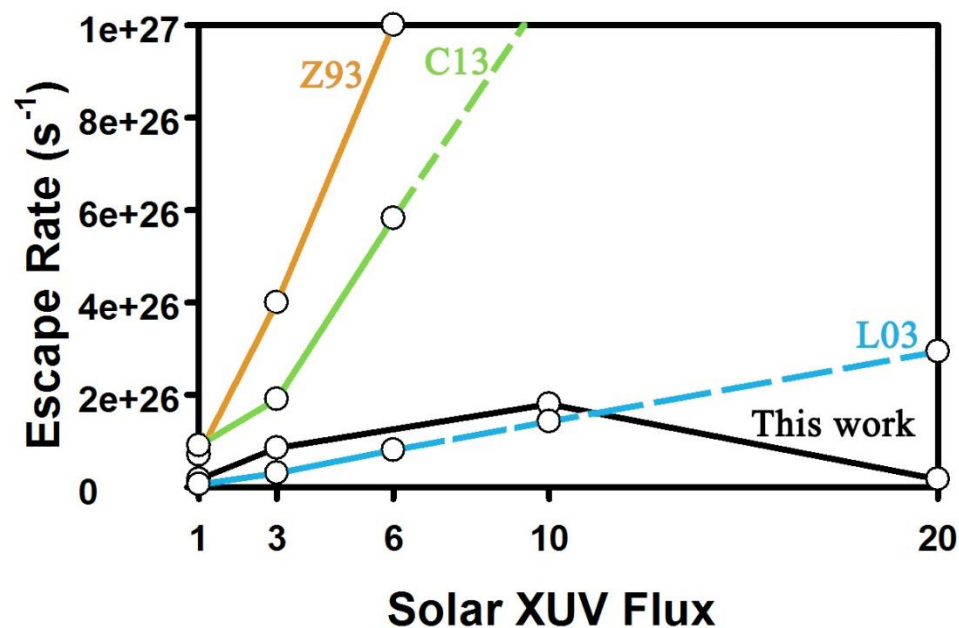
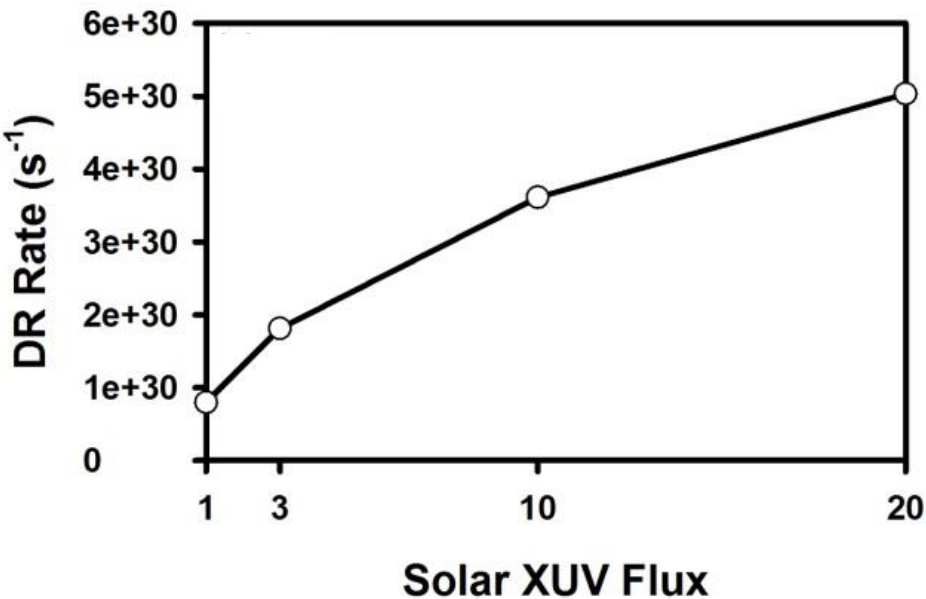
Energetic particles



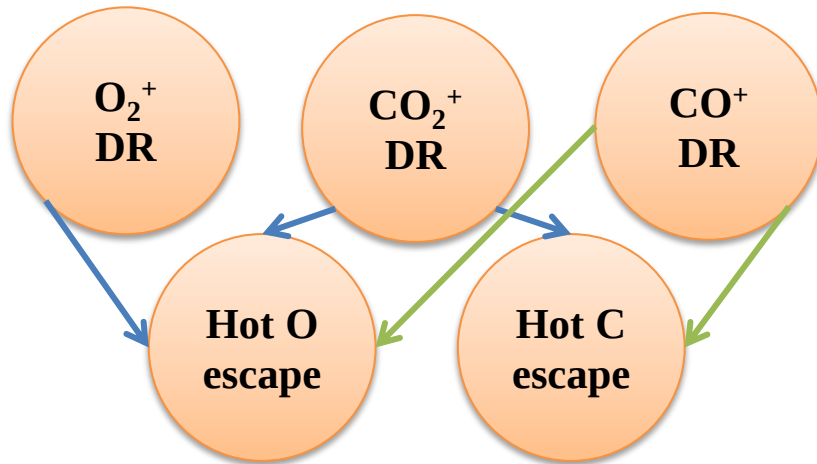
**1D Model**

Photochemical escape of oxygen from early Mars

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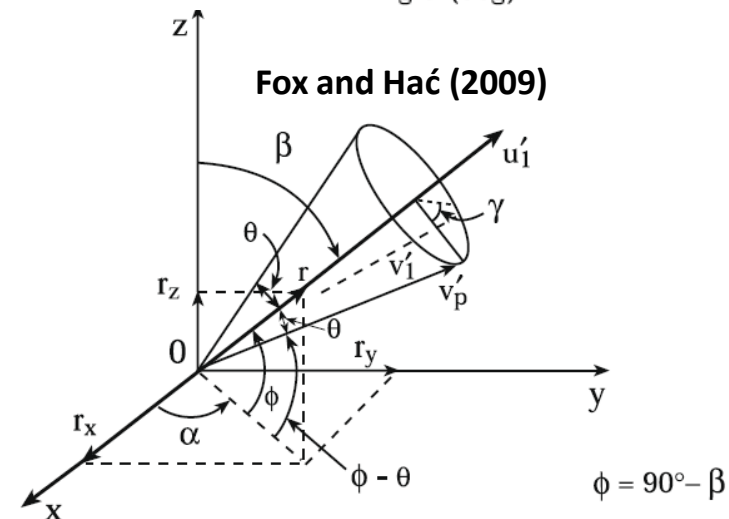
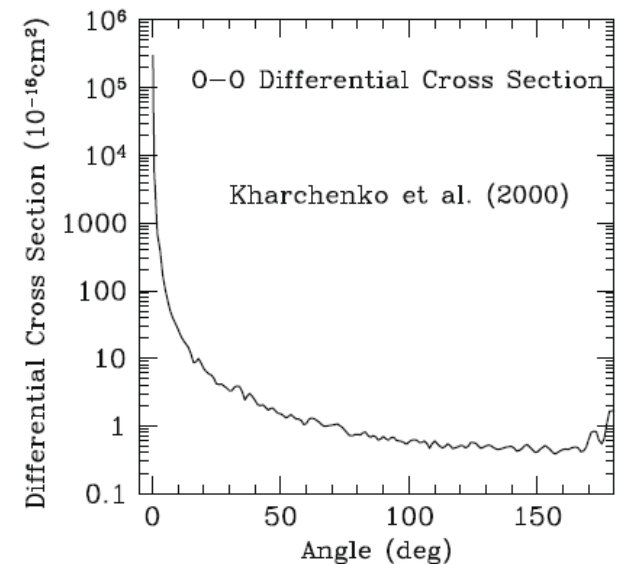
3D Monte Carlo Model



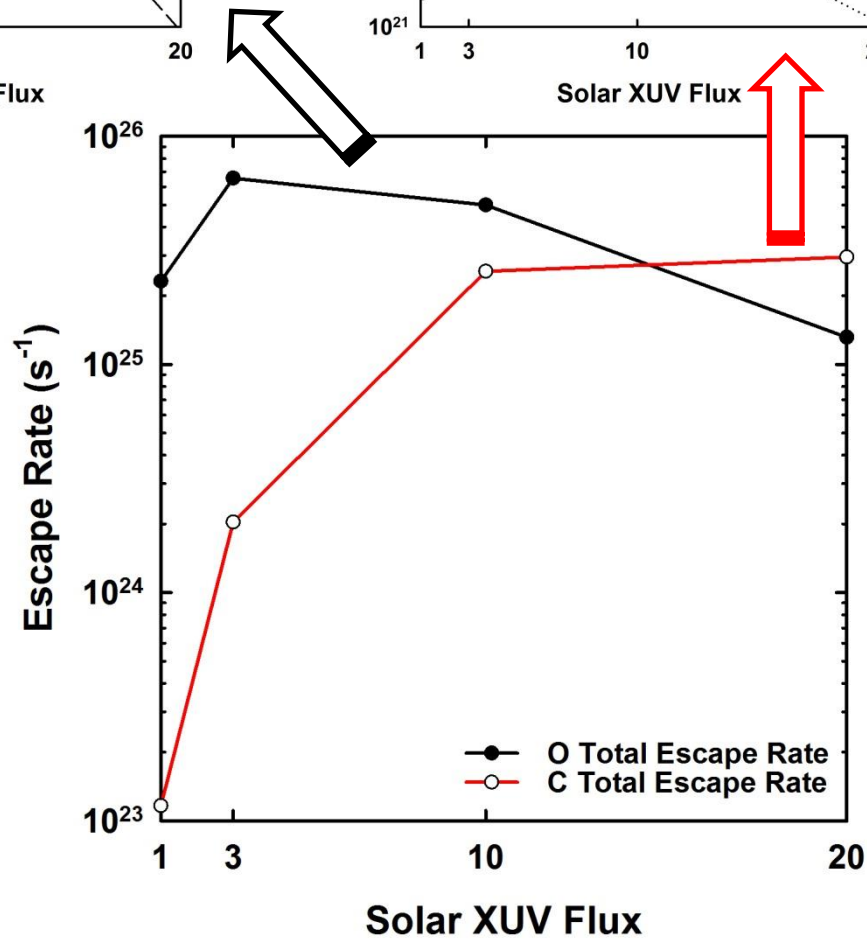
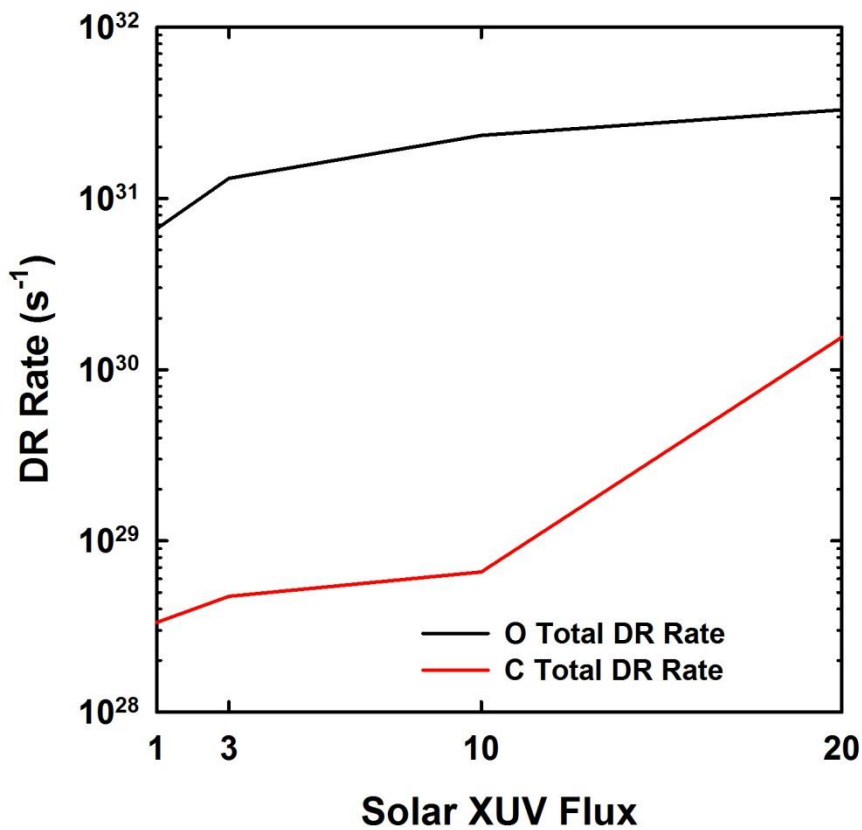
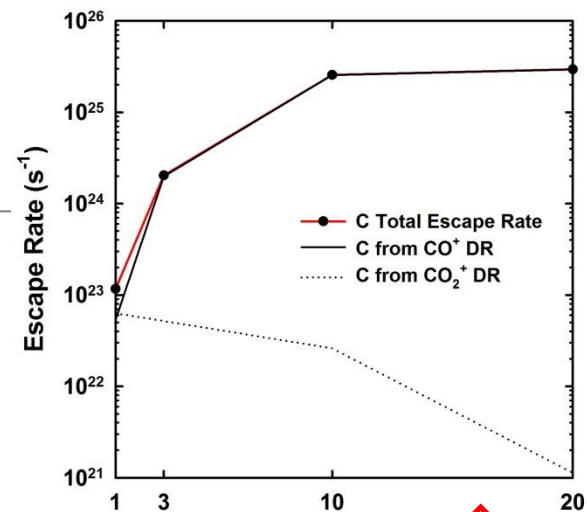
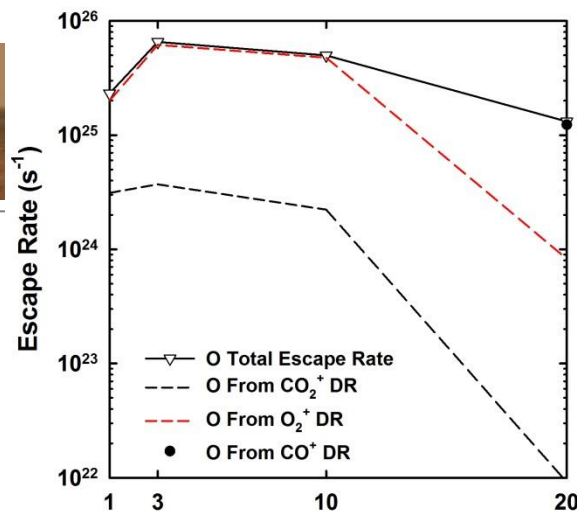
Grid: 20% mean free path or 1km

Background species: O,C,CO₂,CO

Total Cross Section: 6.4,9.0,20,18 ($\times 10^{-15}$) cm²



Results



Main Conclusions

Photochemical escape of O and C from early Mars

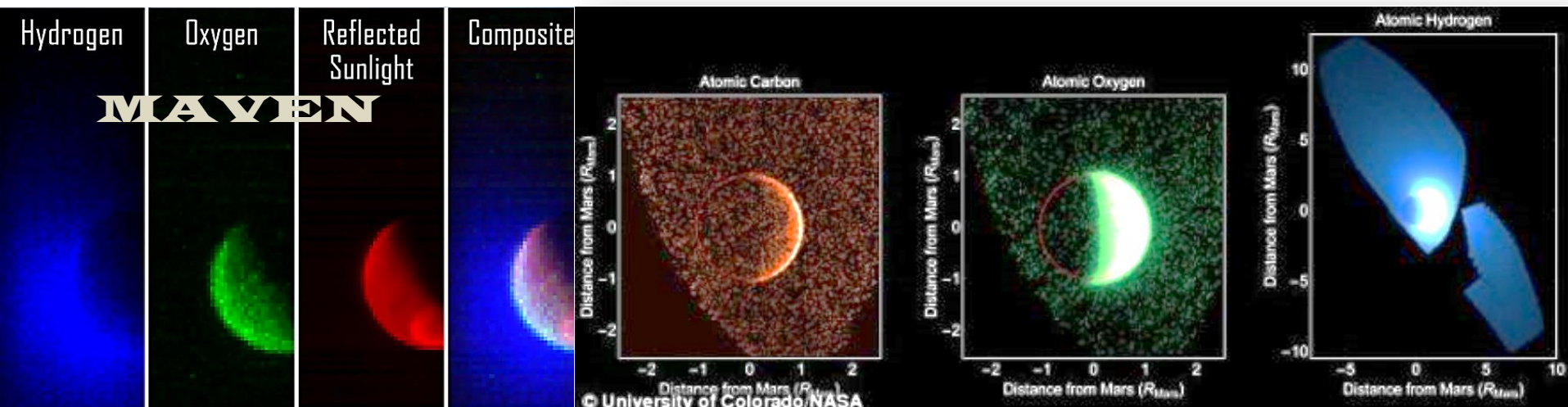
**Less
important
than
previously
thought**

**~1m
global
layer
water**

**~1.6 bar
CO₂**

Future Work

- Martian Corona: Oxygen, Carbon
- Martian Atmospheric Evolution
- Atmospheres of Exoplanets



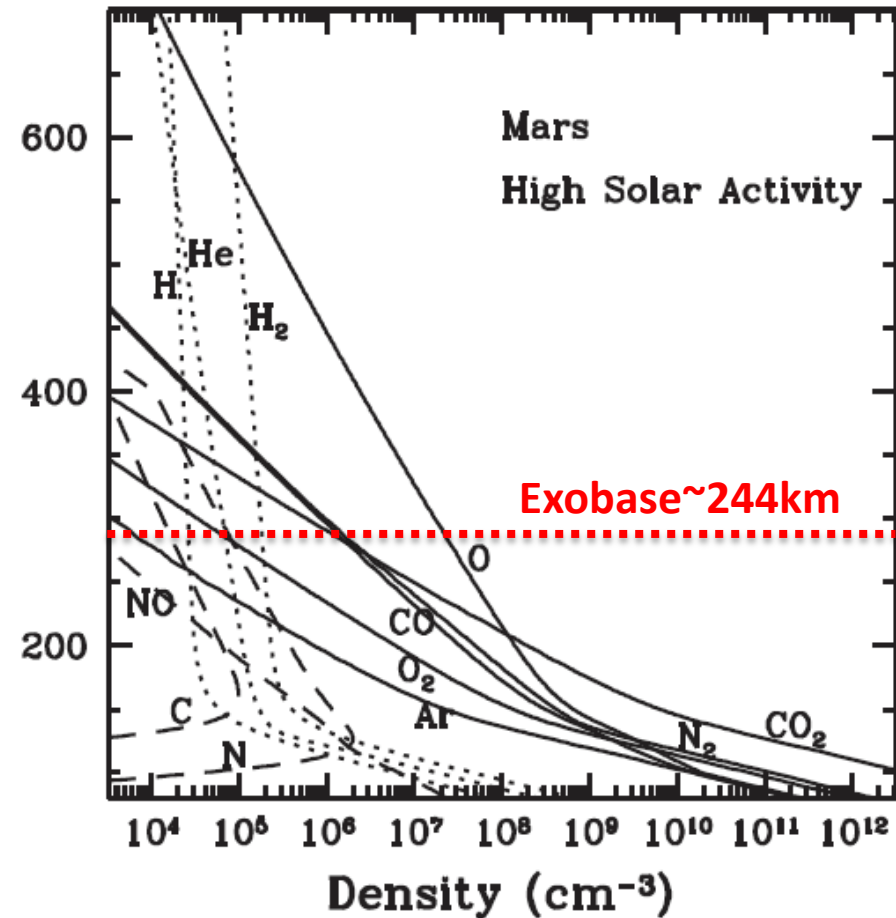
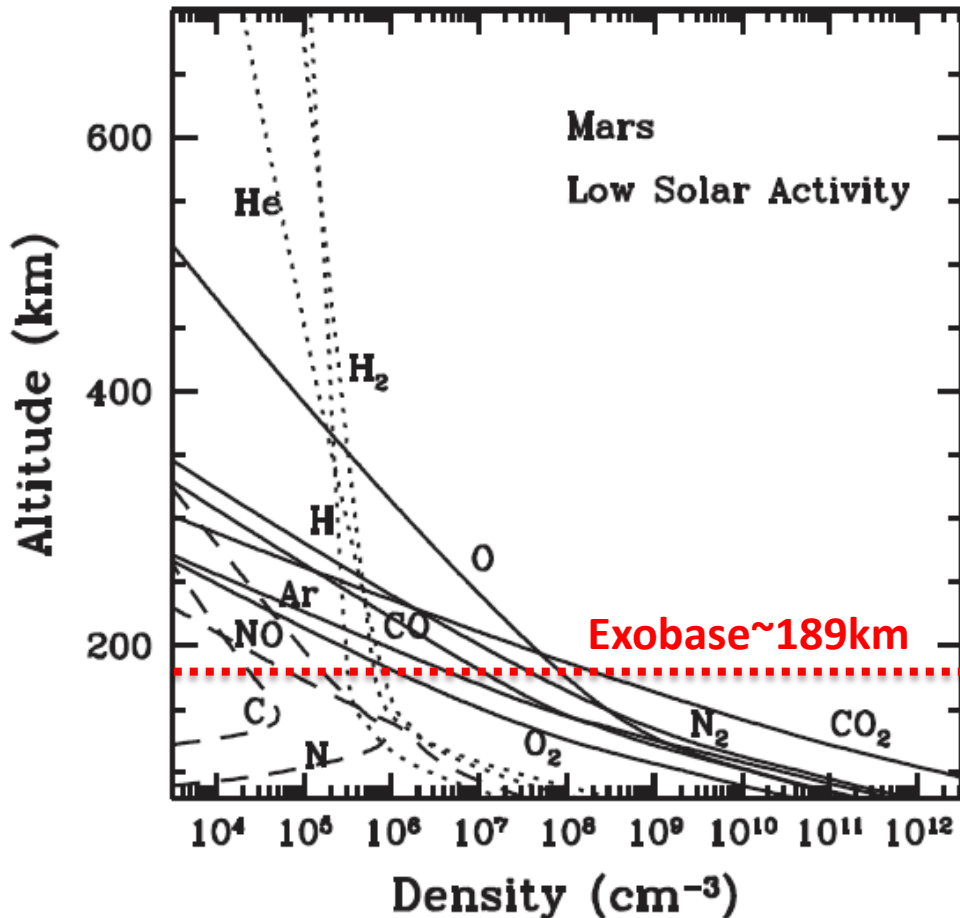
**Thanks
for your
attention!**



*Happy
Spring
Festival*

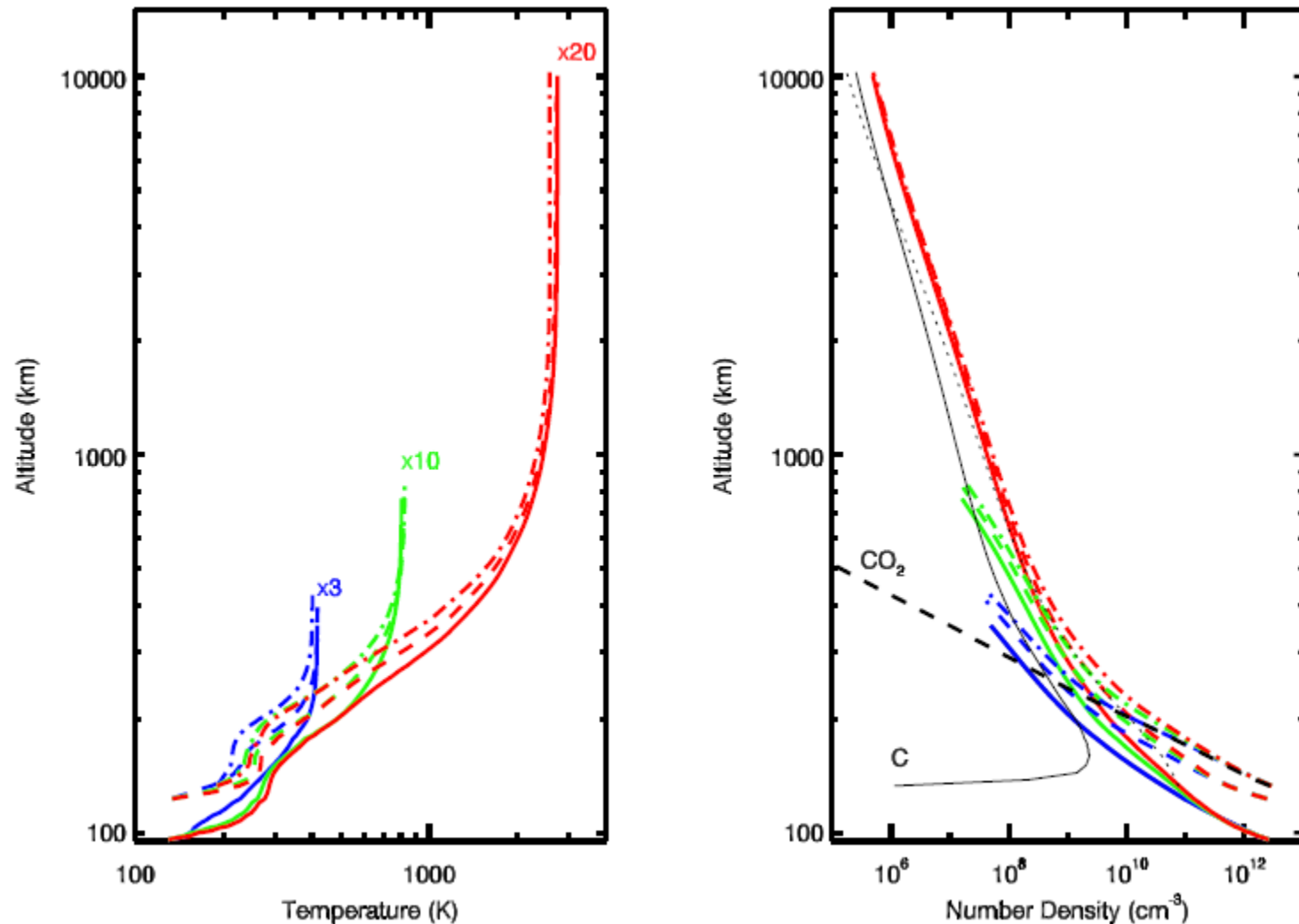
*****2015*****

Density distribution (Neutrals)



Fox and Hac' (2014, ICARUS)

Temperatures and Number Densities



Tian et al. (2009, GEOPHYSICAL RESEARCH LETTERS)