Cedric Gillmann,

G. Golabek.

Venus: The role of surface volatile exchanges in evolving climate conditions on terrestrial planets

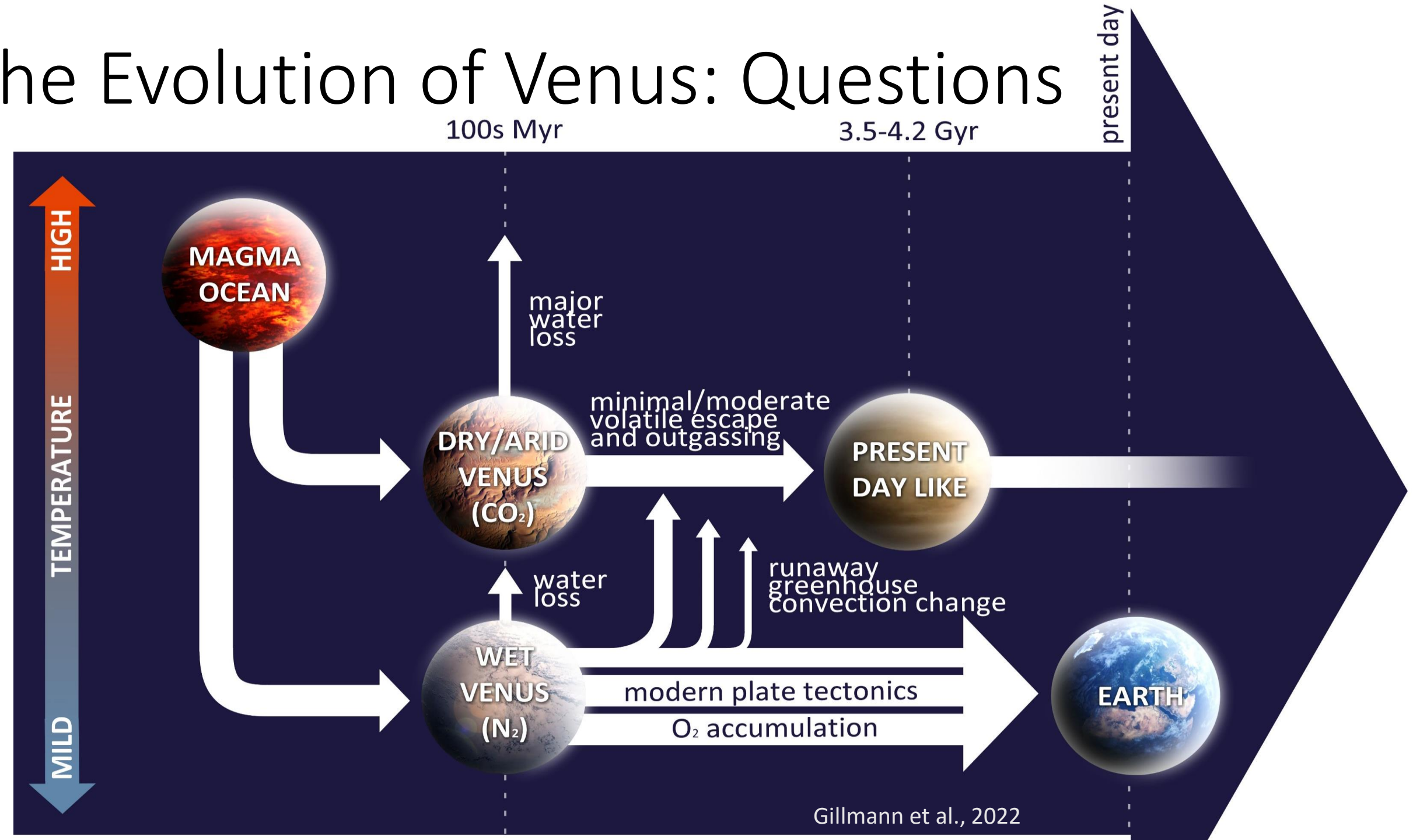
For more details, please read:

- **The long-term evolution of the atmosphere of Venus: processes and feedback mechanisms**

C. Gillmann, M. J. Way, G. Avice, D. Breuer, G. J. Golabek, D. Honing, J. Krissansen-Totton, H. Lammer, A.-C. Plesa, M. Persson, J. G. O'Rourke, A. Salvador, M. Scherf, M. Yu. Zolotov

http://arxiv.org/abs/2204.08540 (submitted to *Space Sci. Rev.*, 2022)

The Evolution of Venus: Questions



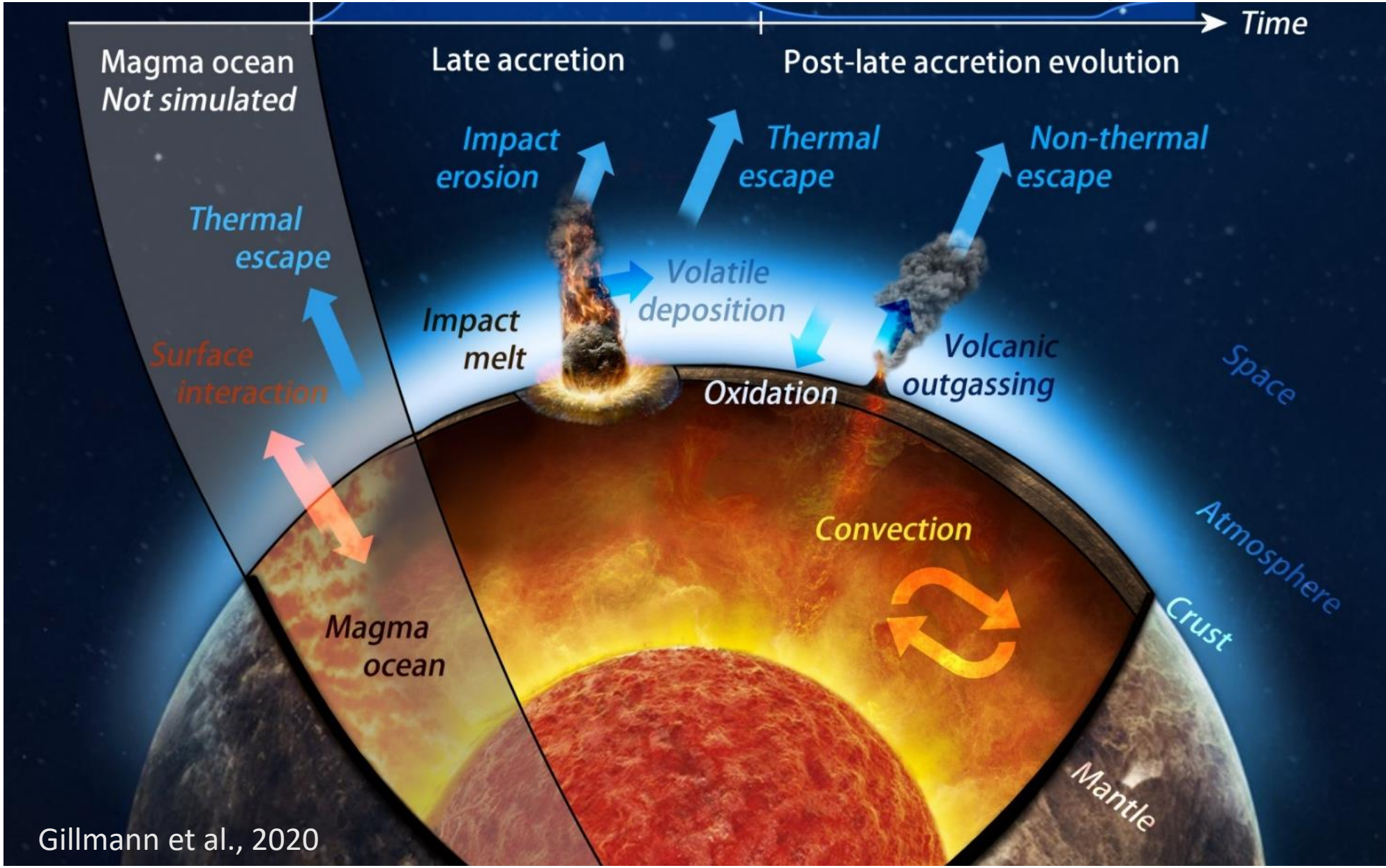
Gillmann et al., 2022

Evolution through volatile exchanges

Possibly simpler volatile exchanges than on Earth.

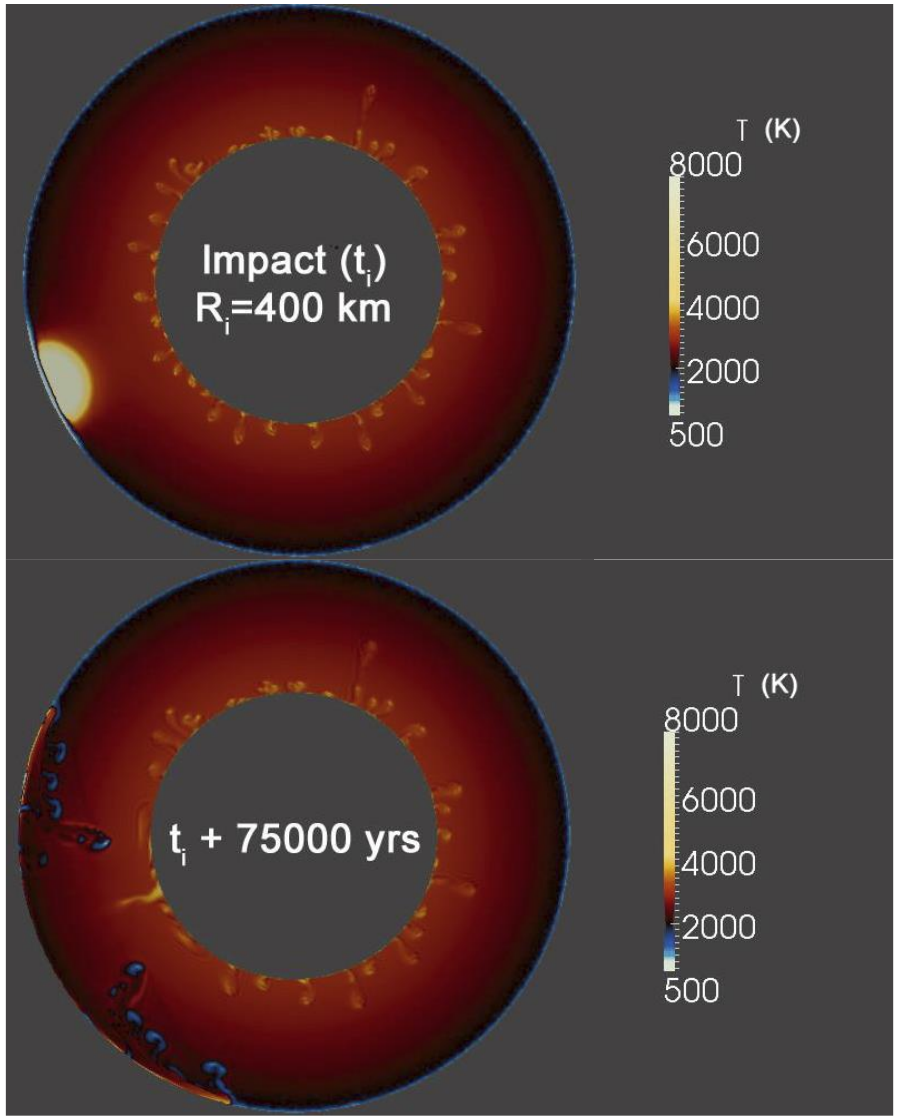
Water sources *on Venus:*
- *Volcanic outgassing*
- *Impactor delivery*

Water loss *on Venus:*
- *Impact erosion*
- *Thermal and non-thermal escape*
- *Surface oxidation / gas-solid reactions*

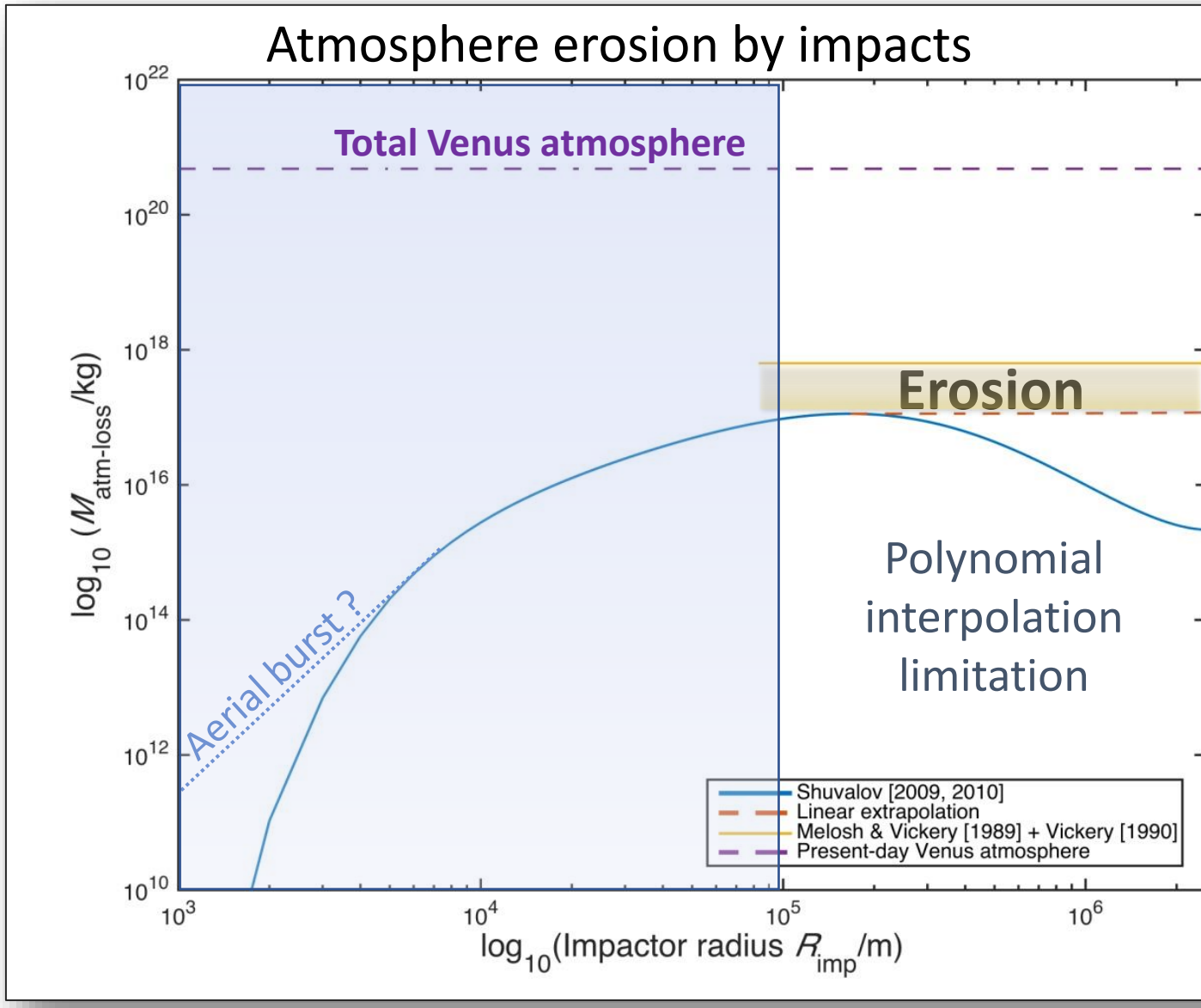


The effects of impacts

Melting by impact

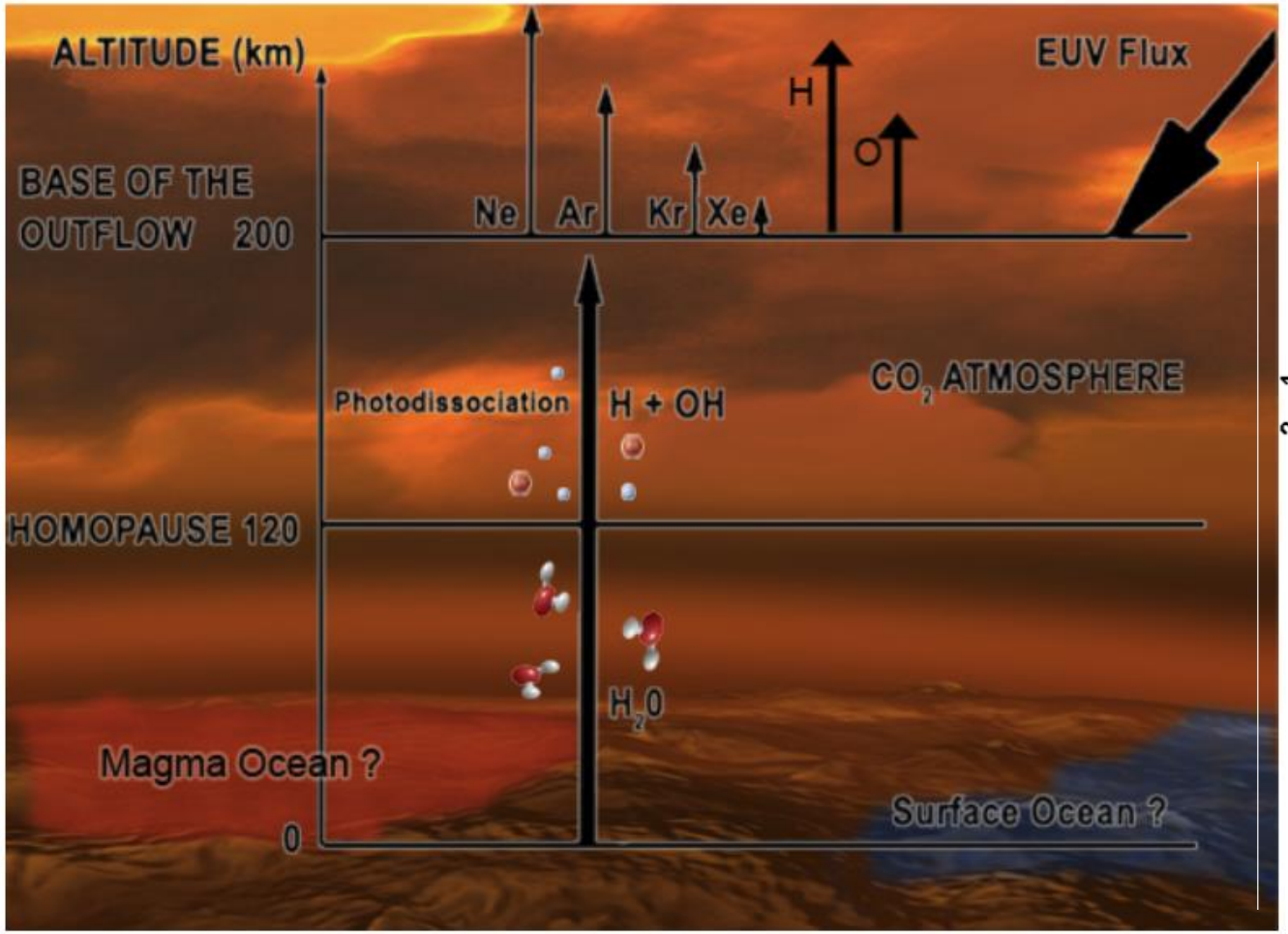


Atmosphere erosion by impacts

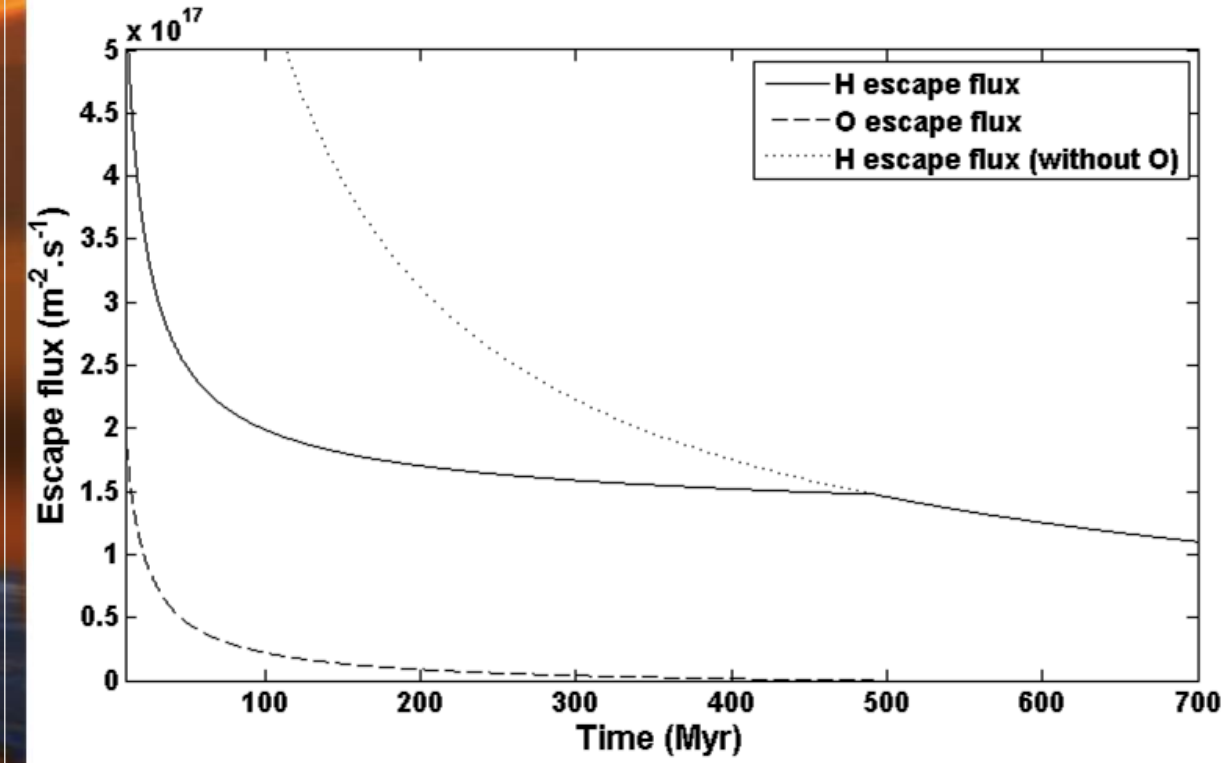


Thermal escape: efficient early on, and for H

- Removes water efficiently, but O remains and needs to be removed.

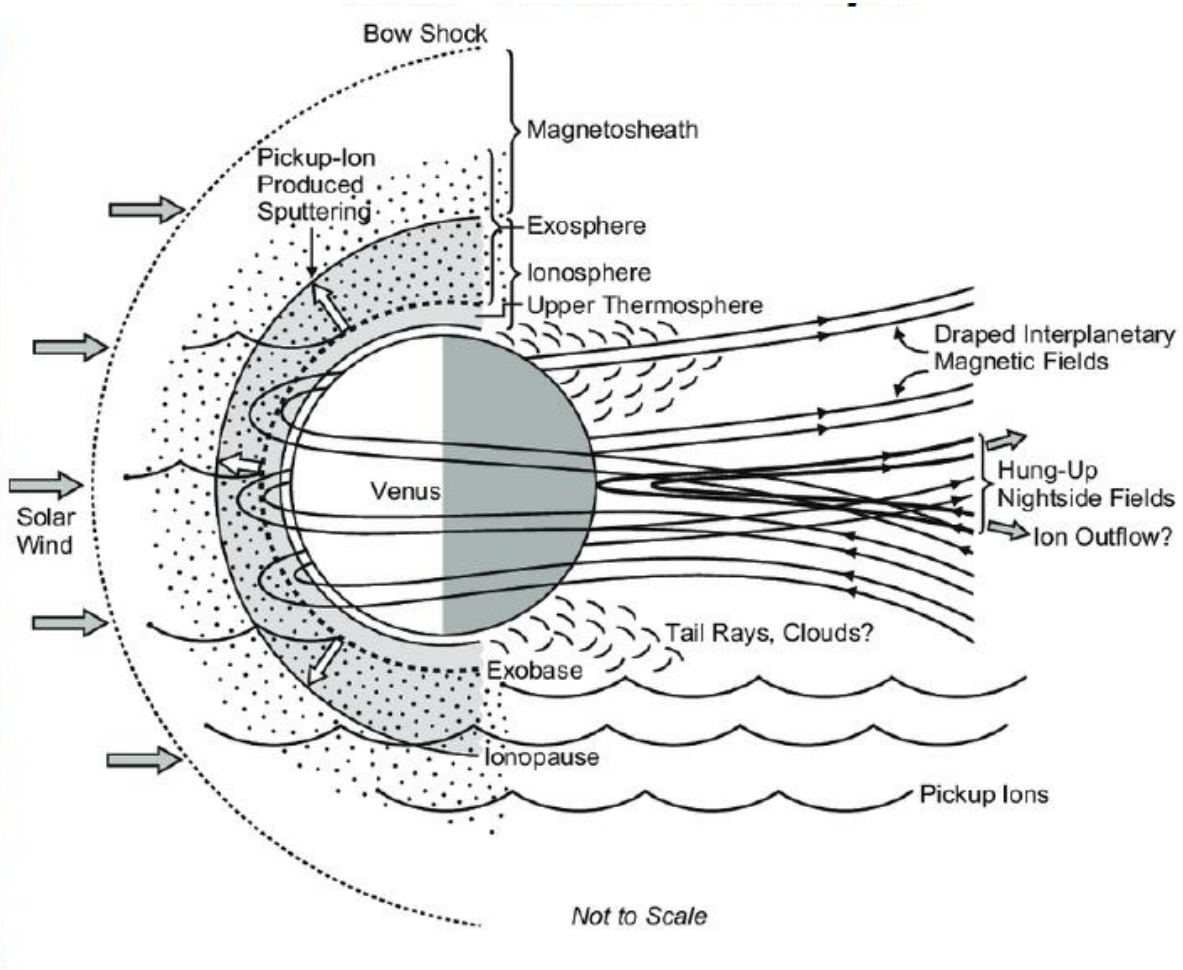


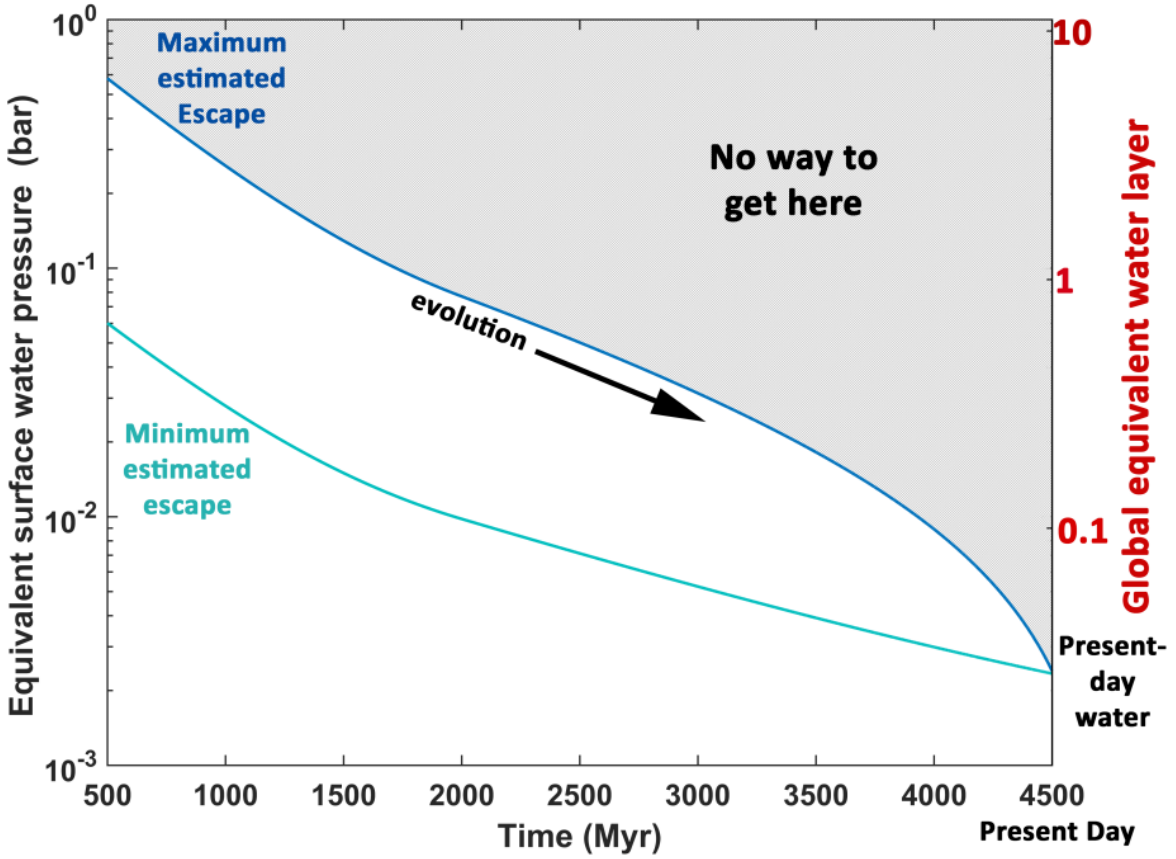
- H loss potentially high even late in the evolution of Venus, provided a significant water vapor atmosphere occurs.



Non-Thermal escape: a sink for O, but how much?

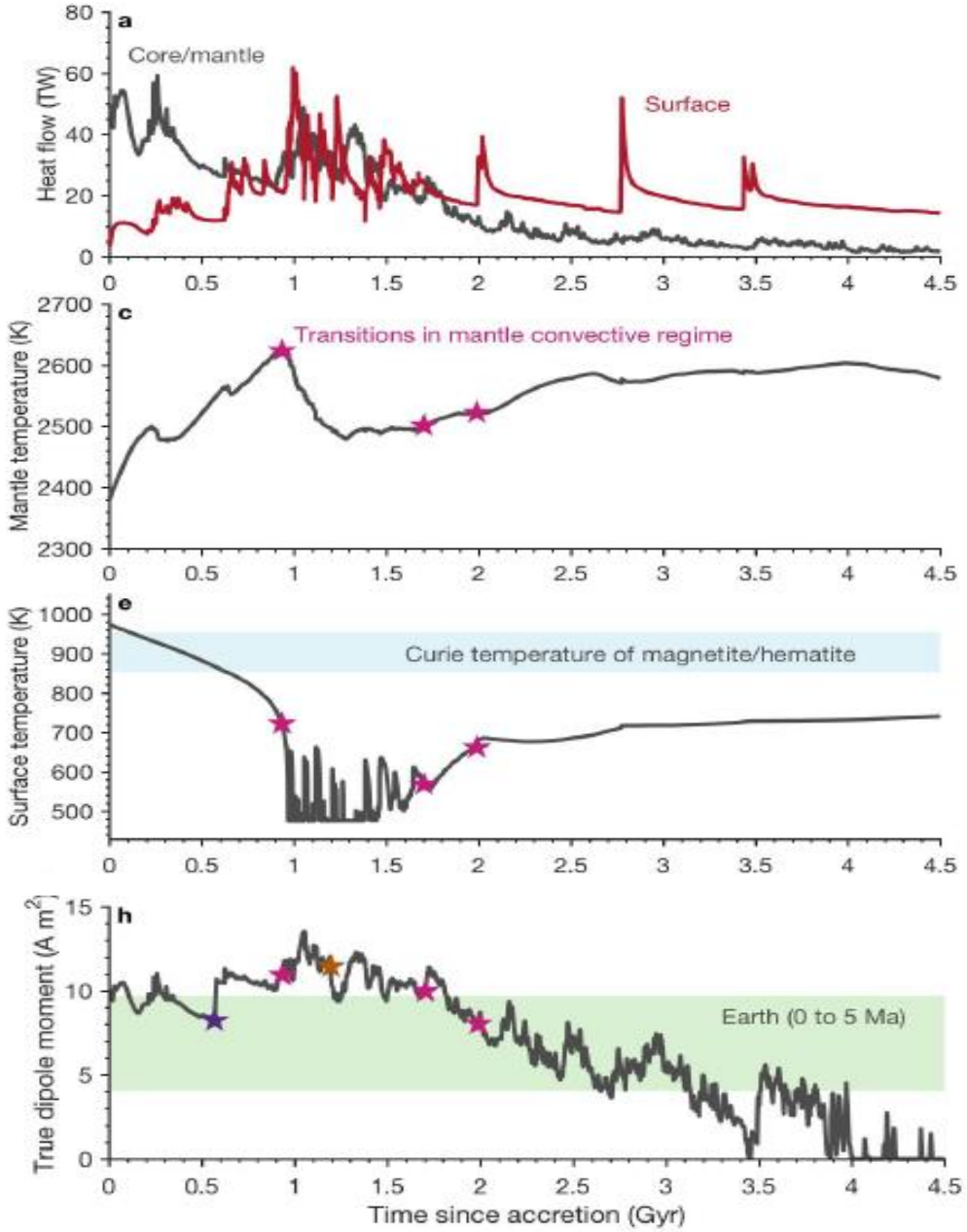
- How does it really evolve with time and a changing atmosphere?
- Recent work suggests very little oxygen loss this way.





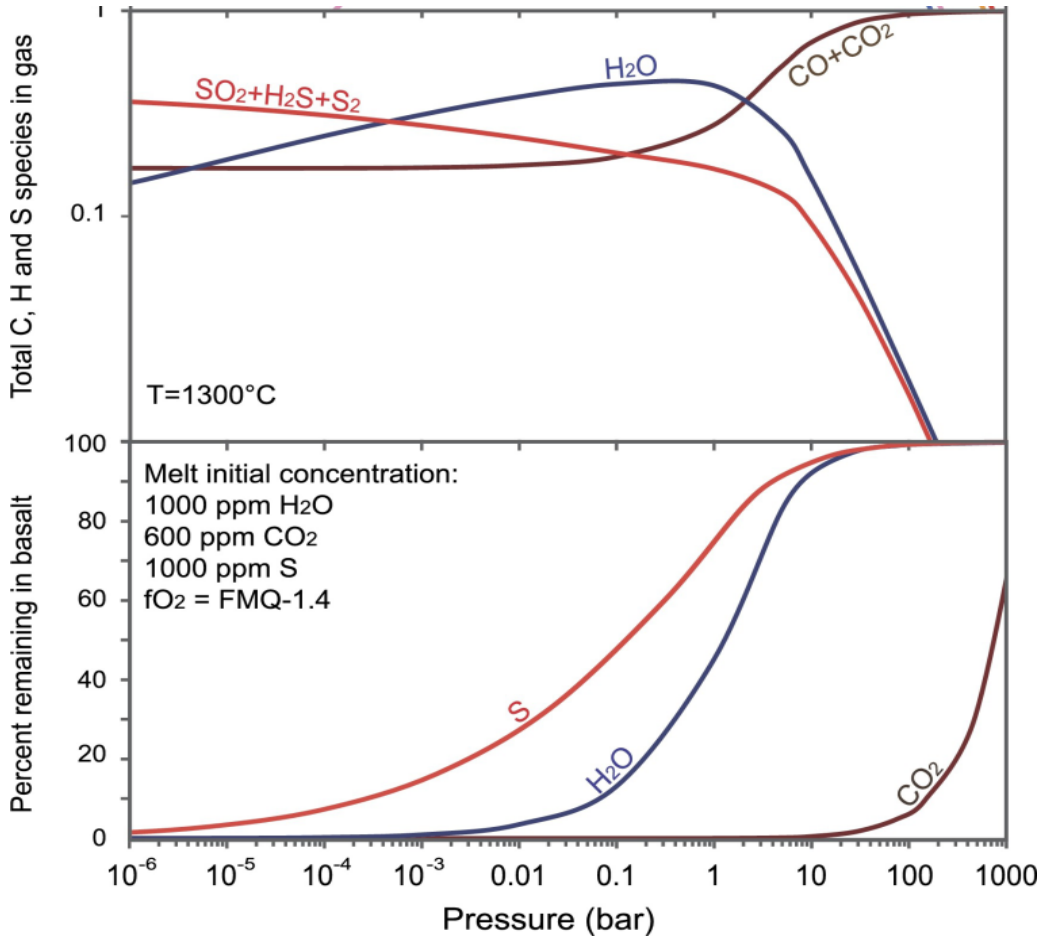
Russell et al. (2007)

Consequences of Mantle dynamics



For magnetic field generation, surface conditions, and volatile cycles.

Outgassing, mostly CO_2 on Venus?



Gaillard and Scaillet (2014)

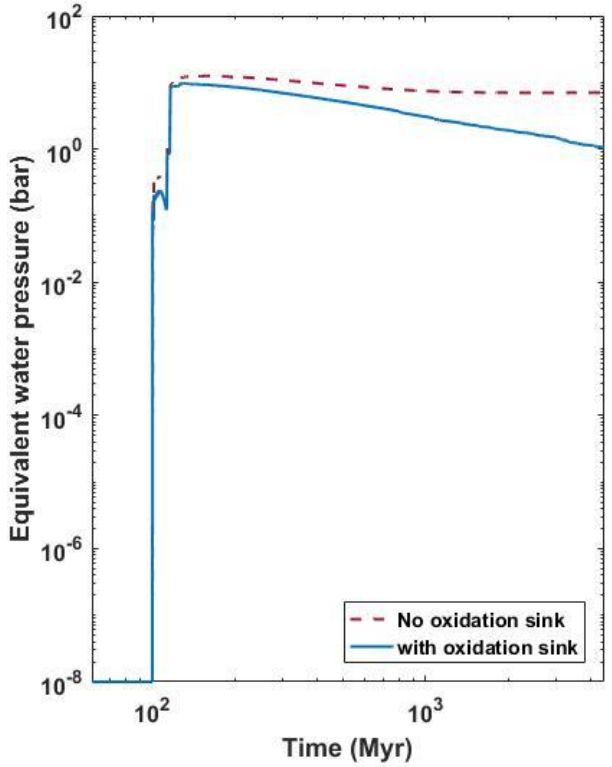
Consequences of volcanism

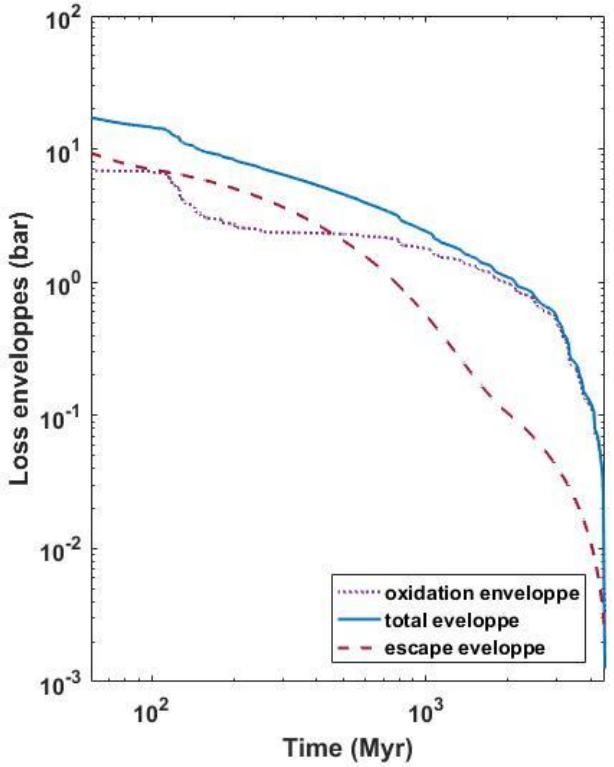
Volcanic production is estimated from Mantle dynamics modelling

A sink for Oxygen

- Fresh volcanic material can be oxydized to form Hematite/magmetite
- $2\ FeSiO_3 + ½\ O_2 \rightarrow Fe_2O_3 + 2\ SiO_2$
- Reaction is fast but produces only a thin coating

Filiberto et al. (2020)

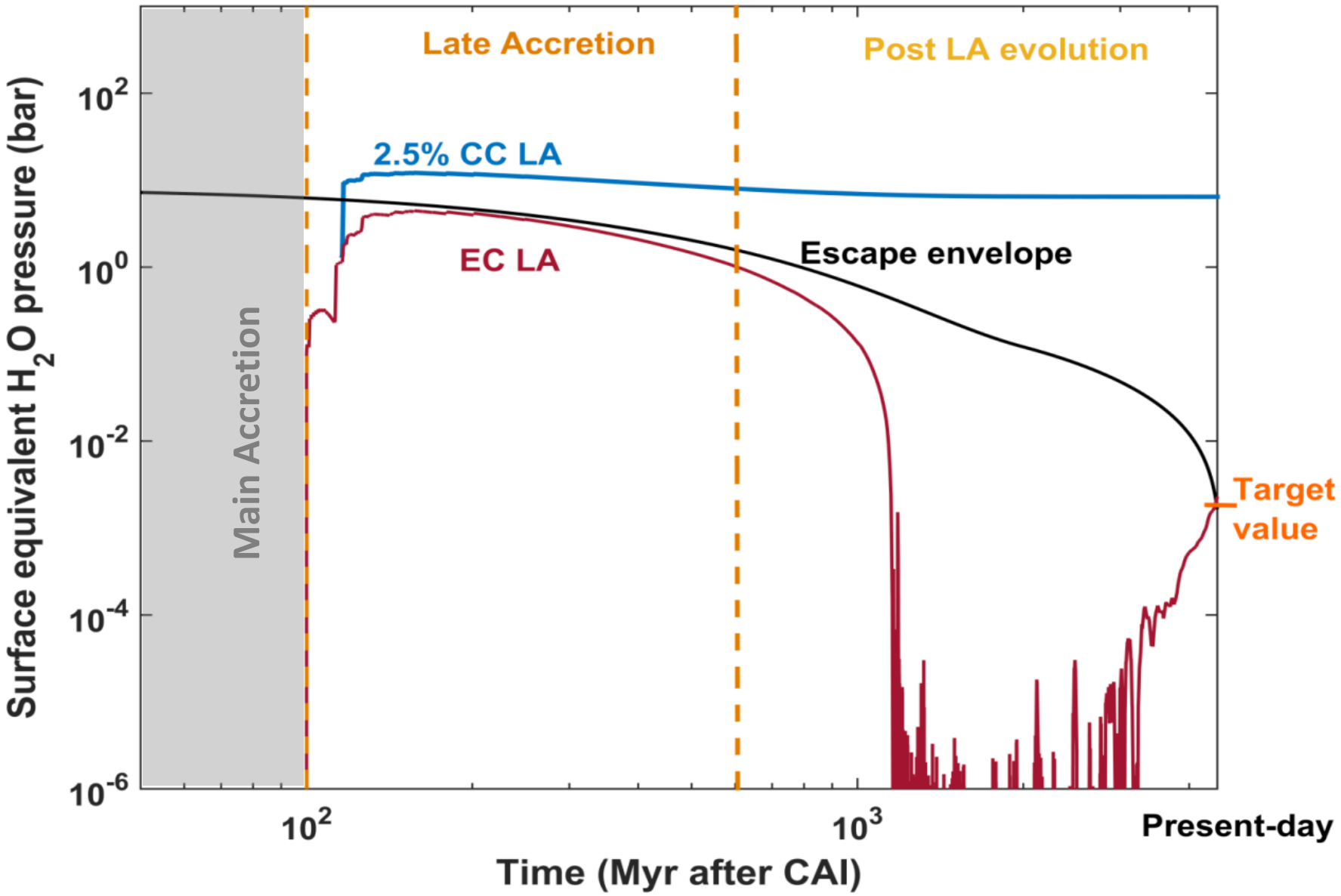




- Solid/gas oxidation is potentially more efficient than escape but still only accounts for a small total amount of O.
- The situation may be different with magma.

Combining the mechanisms

- Using realistic H_2O loss.
- Relatively dry material delivery is consistent.
- Depends on our understanding of volatile exchanges
- **CC: 8% H_2O**
- **EC: 0.1% H_2O**



Conclusions

- Volatile exchanges are critical.
- Late water rich environments become more and more difficult to reconcile with the present-day state.
- It is critical to understand the nature and abundance of volatiles released by volcanism.
- Surface observation is needed to understand the nature of the (sub)surface and conditions of past melting events

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