Models of a Transient Lunar Atmosphere Billions of Years Ago Support the Possibility of Relic Water on the Moon

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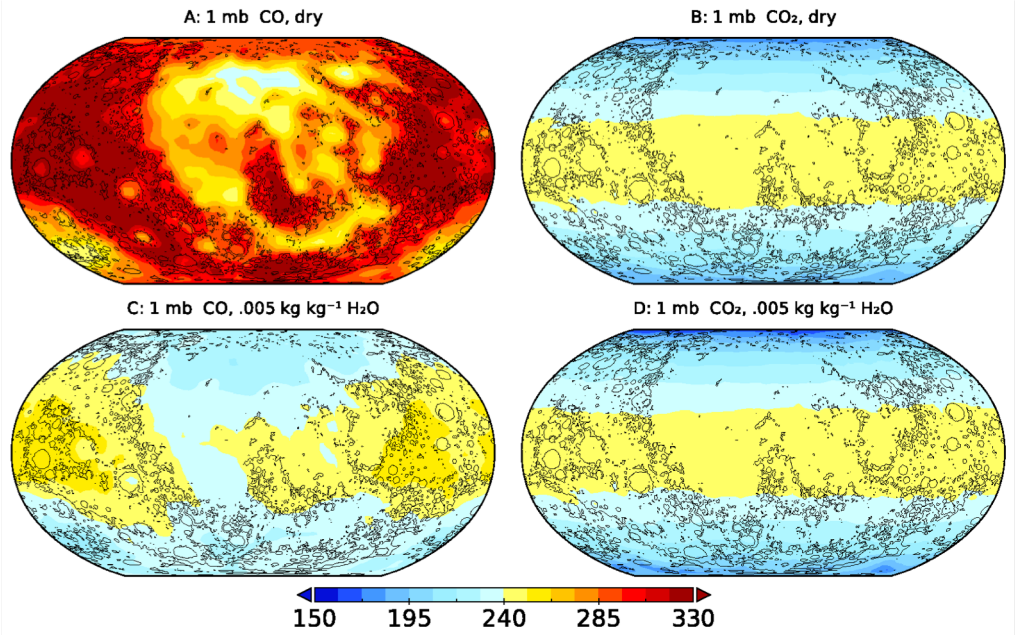
What is the science question? Could volcanic outgassing 3.5 billion years ago support an atmosphere on the moon, and where would volatiles like water collect?

What were your findings? We used a 3-D General Circulation Model combined with recent estimates of outgassing rates from the lunar maria (large dark planes formed by lava flows) to determine the climatological characteristics of the resulting atmosphere, which according to our chemistry model would predominantly consist of CO and/or CO_2 (depending on temperature). We confirm the atmosphere's short-term viability via suitable atmospheric escape calculations.

What was the impact? Preliminary results demonstrate that atmospheres as thin as ~1 millibar (1 bar = air pressure at sea level on earth) were viable and that transport and permanent cold trapping of volatiles in the permanently shadowed regions at the poles was possible.

What does it matter? Results support possibility of relic water resources at the lunar poles, which may provide resources for future human lunar missions.



Lower (2%) atmospheric temperature (K) for a pure CO (left) and a pure CO_2(right) 1-mbar atmosphere w/ and w/o water (below). Pure CO atmospheres are warmer because of the lack of radiative cooling during the lunar night.

Aleinov, I., Way, M., Harman, C. E., Tsigaridis, K., Wolf, E. T., & Gronoff, G. (2019). Modeling a transient secondary paleolunar atmosphere: 3-D simulations and analysis. *Geophysical Research Letters*, 46, 5107– 5116. https://doi.org/10.1029/2019GL082494