3D modeling of photochemical haze on the early Earth and exoplanets

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The atmosphere of Archean Earth (3.8-2.5 Ga) was likely rich in methane produced by methanogenic organisms [1]. When the CH_4/CO_2 ratio becomes higher than ~0.1, organic haze forms according to photochemical models and laboratory experiments laboratory experiments [2]. Paleosols from 2.7 Ga suggest the episodic formation of photochemical haze [3]. These episodes of haze formation could lead to glaciations [4] and could be at the origin of certain Archean glaciations (e.g. at 2.9 Ga). Organic haze are also of great astrobiological interest due to the associated of prebiotic molecules, and they could have played a key role in the origin of life on Earth [5]. Finally, many exoplanets appear to be covered in photochemical haze. During this presentation, we will present the first results from 3D modeling of photochemical mists on the primitive Earth. We are using a 3D climate model (the Generic Planetary Climate Model) coupled with a photochemistry module and a microphysical module. We describe the impact of atmospheric circulation on the distribution of haze, its consequences on climate and photochemistry. We will also present results for the application of this model to exoplanets (e.g. Trappist-1 planets and sub-Neptunes).

References

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