ATMOSPHERIC CHEMISTRY OF HOT EARTH-LIKE EXOPLANETS. I. THE MAJOR VOLATILE ELEMENTS H, C, N, O AND S

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Introduction: The Kepler and COROT missions and Earth-based observations are now discovering super-Earth exoplanets. Some of these, such as CoRot-7b, are very hot [1]. Here we report results for an Earth-like planet hot enough to vaporize the atmosphere + hydrosphere + crust. Our results will be useful for spectroscopic studies of the atmospheres of hot super-Earths.

Methods: We computed the chemical equilibrium composition of a system with elemental abundances of the terrestrial atmosphere + hydrosphere + crust (continental & oceanic) mixed together in their observed proportions from 500 – 6000 K as a function of pressure. Calculations were done with a Gibbs energy minimization code and used compositions from [2].

Results: Here we discuss results for the major volatile elements H, C, N, O, and S at 100 bars total pressure (Fig. 1). In [3], we give results for lithophiles (Na, K, Fe, Si, Mg, Al, Ca, and Ti).

Hydrogen and Oxygen: Water vapor is the major H-bearing gas. As temperature increases, water vapor thermally dissociates into OH, O_2, H_2, O, and H. Dioxygen O_2 is a major gas and forms by thermal decomposition of oxides, silicates, H_2O and CO_2. Formation of Fe_3O_4 and Fe_2O_3 cause the sharp changes in the O_2 abundance at 2400 K and 1700 K.

Carbon, Nitrogen, Sulfur: Carbon is found entirely in the gaseous phase. It is primarily CO_2 at low temperatures and CO at high temperatures. CO and CO_2 have equal abundances at ~3765 K. Nitrogen is entirely in the gaseous phase as N_2 at lower temperatures. At temperatures >3100 K, N_2 reacts with free oxygen in the gas and forms NO. Sulfur is mainly present as SO_2.

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References: [1] Legér, A., et al. 2009 *A&A*, 506, 287. [2] Lodders, K. & Fegley, B. 1998. *The Planetary Scientist's Companion*. [3] Schaefer, L. & Fegley, B. 2010. *MAPS*, abstract, this meeting.

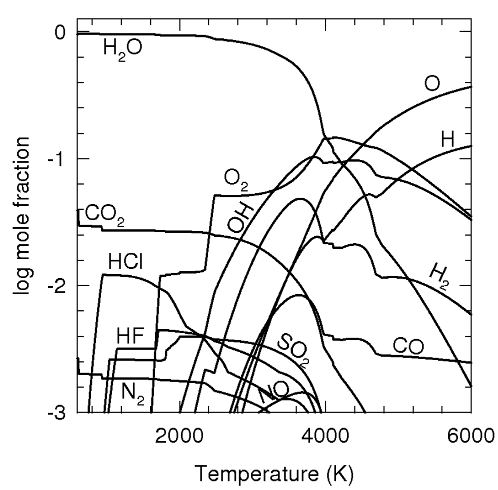

Figure. 1. Atmospheric chemistry of an Earth-like exoplanet as a function of temperature at a total pressure of 100 bars.