How does the chemistry as well as the temperature - and therefore detectable features - change for a planet, if it is closer or further away from its host star? We build a grid of mini-Neptune atmospheres models (planets of 10 Earth masses with a solar composition atmosphere), to explore these questions. We also explore hotter and colder stars, where the different energy distribution will influence the chemistry in the upper atmosphere [1].

**METHODS**

- **Thermal structure:** We adopt a gray atmosphere in hydrostatic equilibrium. The absorption of stellar irradiation (shortwave) and the subsequent reemission (longwave) are treated separately [2].
- **Chemistry:** Our 1D model takes into account the effect of photochemistry induced by stellar irradiation, considering equilibrium and disequilibrium chemistry [3].
- At low pressures, the incident UV photons dominate the photochemistry.
- Large concentrations of H and OH are produced from H2O photolysis, followed by a destruction of H2 due to its reaction with the produced OH.
- CO abundance is set by thermochmical equilibrium, except high in the atmosphere where it combines with OH, forming CO2.
- CO2 decreases its abundance above this level due to its dissociation, which is higher for planets around stars with higher emission of UV flux.

**RESULTS**

- When a planet orbits further away from its star, it cools and therefore the major chemical reactions taking place and the atmospheric composition change, while different spectral types imply different fluxes (specially UV) that affect the photochemistry.
- The stellar spectral energy distribution (shown in Fig. 1) influences how much of the star’s light gets reflected and absorbed. For cool stars (M, $T_{eff}$=3600K), most of the energy received at a planet’s orbit gets absorbed, therefore the planet is hotter than the same planet receiving the same radiation from a hotter (F, $T_{eff}$=7000K) star.
- CH4 is more stable at lower T, therefore its abundance increases when going from hot to cool planets. Its abundance also increases with decreasing stellar UV.
- In our models, the atmospheres of the hottest planets in the grid are dominated by H, H2, O, H2O and CO (see Fig. 3).
- For cool planets in our grid, CH4 is a major constituent in atmospheres of planets orbiting K and M stars.
- H replaces H2 as the major gas in the high atmosphere for high UV flux - shown in the atmosphere of planets around stars with high emission of UV flux and when going to smaller semimajor axis (see Fig. 3).

**REFERENCES**


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