A grid of self-consistent MSG (MARCS - StaticWeather - GGchem) cool stellar, substellar, and exoplanetary model atmospheres

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Self-consistent MSG (sub-)stellar and exoplanetary model atmospheres

We present an extension of the classical MARCS grid of stellar atmosphere models (*Gustafsson et al. 2008, A&A 486, 951*) to lower temperatures, ranging from T_{eff} = 3000 K down to 300 K, hereby including the temperature range of the coolest stars, sub-stellar objects of type M, L, T, and Y, as well as exoplanets in the temperature range from ultra-hot Jupiters to Earth-like planets.

The new code is a self-consistent merging of an updated version of the classical **MARCS** code with updated numerical methods and input data and iterative calls to the cloud formation code **Static-Weather** (*Helling & Woitke 2006, A&A 455, 325*) and the chemical equilibrium code **GGchem** (*Woitke et al. 2018, A&A 614, A1*), hence the name MSG.

The basic grid of MSG models is described in *Jørgensen et al. 2024 (arXiv 2407.093972, A&A in press)*. Details about the irradiated MSG models are presented in the poster by *Flavia Amadio, Azzurra D'Alessandro et al.* at the present conference, and further work on the cloud formation part is presented in *Beatriz Campos Estrada 2024 (submitted to A&A)*. Work on the non-equilibrium part of the code, as well as several other applications and improvements are in progress and will be expanded upon in the coming months and years with the major aim of deepening our understanding of the interaction between atmospheric structure and biological processes (see also the announcement of two postdoc positions in the box below).

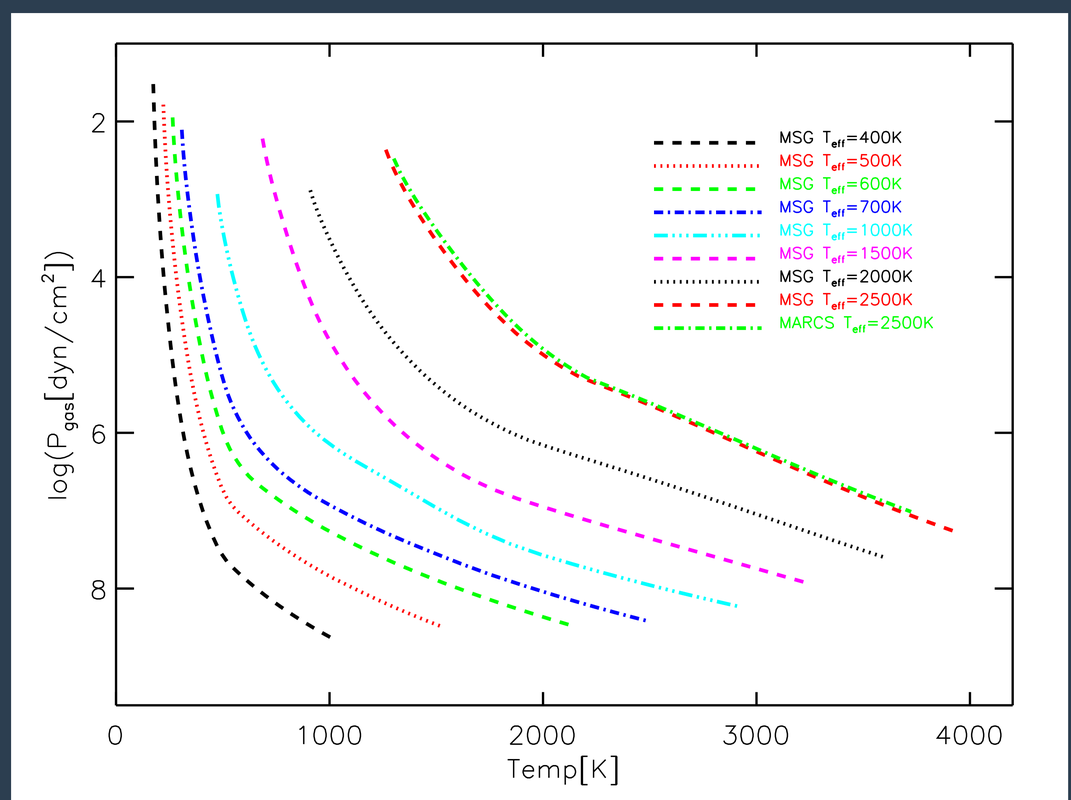

Figure: The temperature versus gas pressure structure of basic MSG models from effective temperature 400K to 2500K (plus for comparison also the coolest classical MARCS model from the Gustafsson et al. 2008 MARCS-grid).

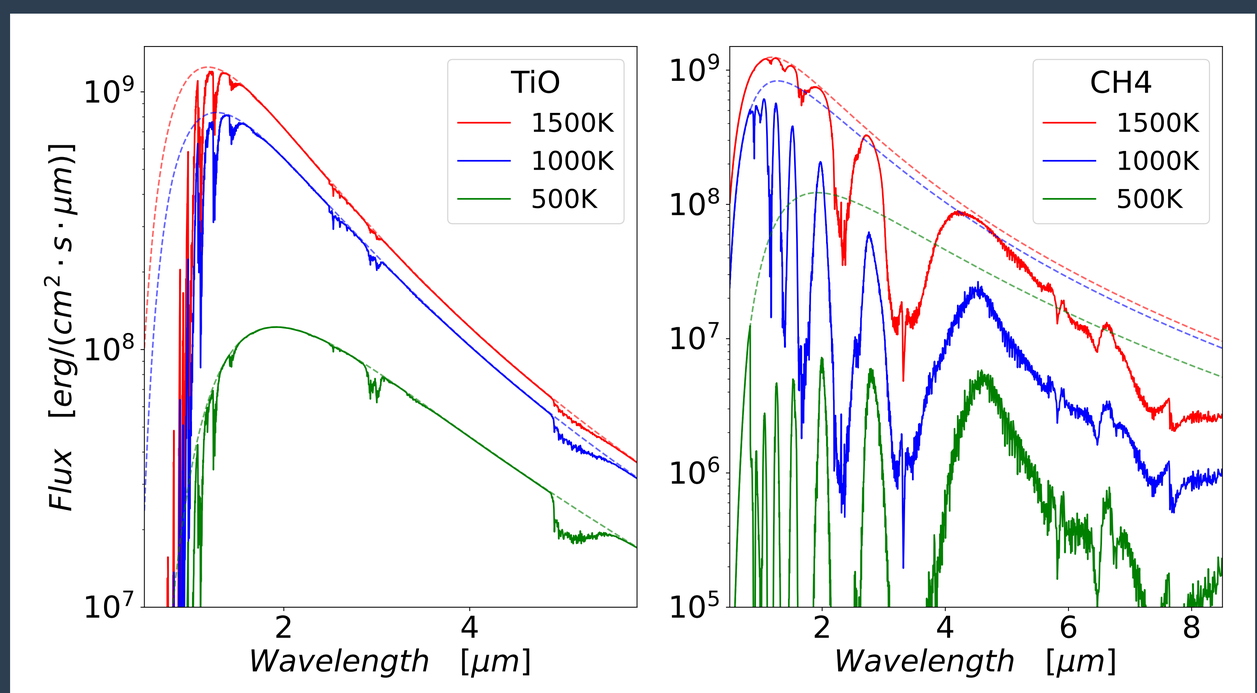

Figure: The model spectra of TiO (left) and CH4 (right) for MSG models of Teff = 1500K (red), 1000K (blue) and 500K (green), computed by allowing the opacity from only TiO or CH4 in the spectrum computation (but all sources in the model computation). Remark that for the coolest models (and the plotted resolution) the combined spectra do not at any place reach even close to the model continuum (the dashed curves), which is the continuum that should be used in abundance analyses.

Two available postdoc positions at the Niels Bohr Institute on:

The imprint of life on exoplanetary atmospheres

Deadline: 9th of September 2024; Start: 1st of November 2024 or soon thereafter.
The aim of the two positions is to increase our understanding of the interaction between life and the surrounding atmosphere of habitable exoplanets, and how it can be characterized from spectral modelling and observations. Applicants with knowledge and interest in atmospheric modelling, non-equilibrium chemistry, and basic biological processes, will be preferred. Further information at www.cels.nbi.ku.dk/english/openings. To apply for the position, please go to https://employment.ku.dk/faculty/?show=162260

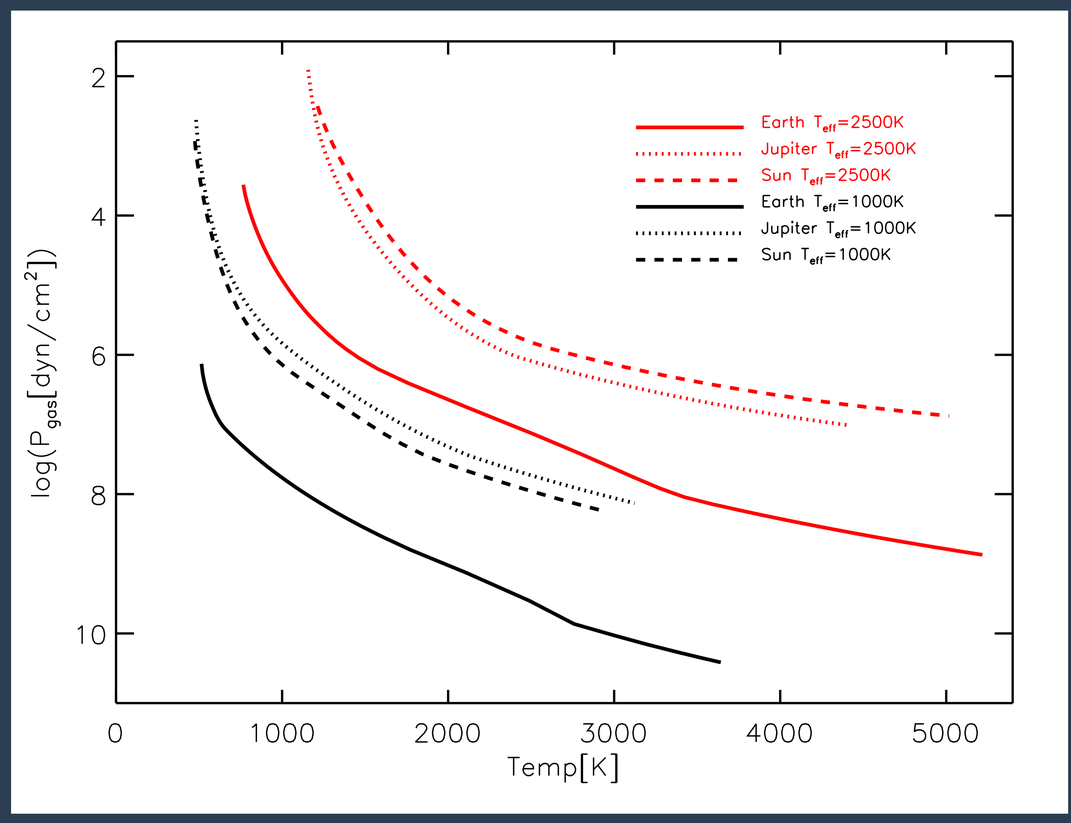

Figure: The T - Pg structure of models at Teff = 1000K (black) and 2500K (red), with respectively solar, Jupiter-like and Earth-like chemical atmospheric compositions. All models are for log(g) = 4.5.

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