







taurex-emcee: a TauREx 3.1 plugin for the emcee sampler

Andrea Bocchieri ¹, Quentin Changeat ², Lorenzo V. Mugnai ^{3,4,5}, and Enzo Pascale ¹

¹ Department of Physics, La Sapienza Università di Roma, Piazzale Aldo Moro 2, Roma, 00185, Italy ² European Space Agency (ESA), ESA Office, Space Telescope Science Institute (STScI), Baltimore, MD, 21218, USA ³ School of Physics and Astronomy, Cardiff University, Queens Buildings, The Parade, Cardiff, CF24 3AA, UK ⁴ Department of Physics and Astronomy, University College London, Gower Street, London, WC1E 6BT, UK ⁵ INAF, Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, Palermo, I-90134, Italy

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Summary

taurex-emcee is a plugin for the TauREx 3.1 atmospheric retrieval framework ([A. F. Al-Refaie et al., 2021](#)) that extends the choice of sampling methods available to the user. The plugin provides an interface to the [emcee](#) sampler ([Foreman-Mackey et al., 2013](#)), a popular affine-invariant ensemble sampler widely used in the astronomy community. Running the sampler to convergence is automated through the [autoemcee](#) package, which also supports parallelization with MPI. Thus, the taurex-emcee plugin allows users to easily launch parallelized retrievals of atmospheric spectra with emcee. This enables reliable, efficient, and fast retrievals, especially when coupled with TauREx's GPU-accelerated forward models ([A. Al-Refaie et al., 2020](#)).

taurex-emcee is released under the BSD 3-Clause license and is available on [GitHub](#). The plugin can be installed from the source code or from [PyPI](#), so it can be installed as `pip install taurex-emcee`. The documentation is available on [readthedocs](#), including a quick-start guide, a tutorial, a description of the software functionalities, and guidelines for developers. The documentation is continuously updated and is versioned to match the software releases.

Benchmark

Emcee vs MultiNest

Figures can be included like this:

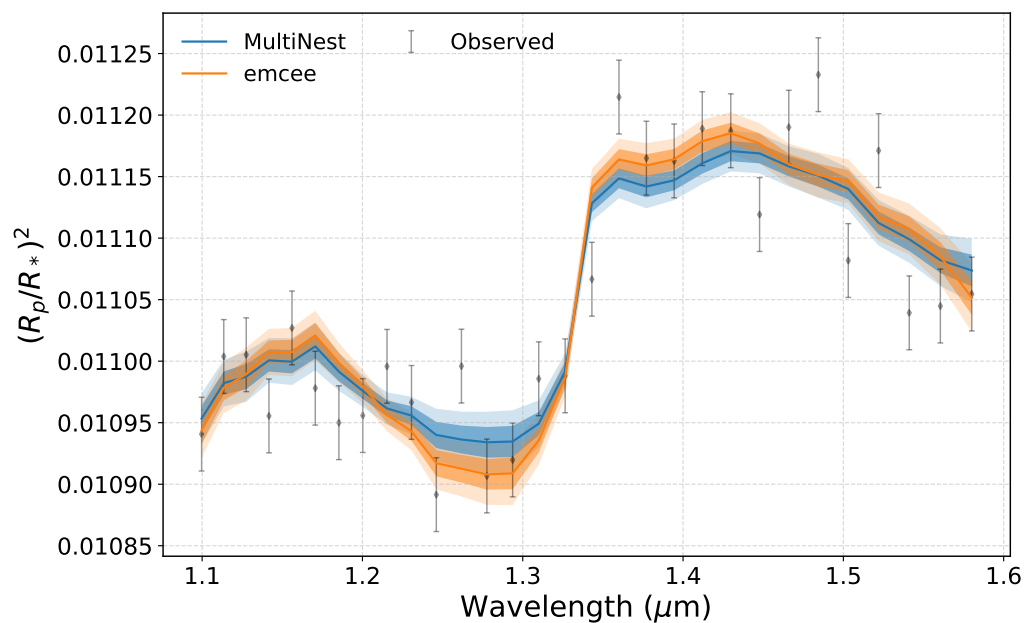


Figure 1: Caption for spectrum figure.

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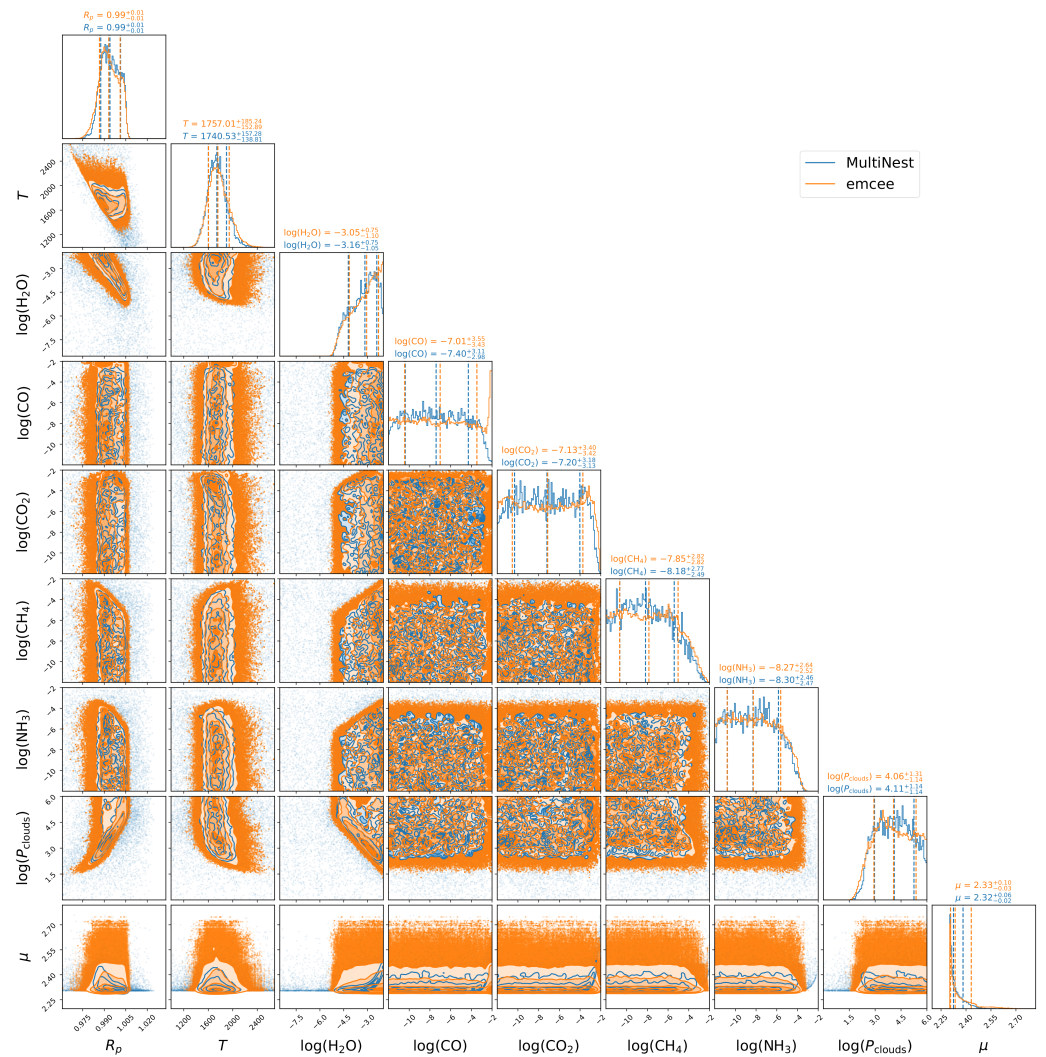


Figure 2: Caption for posteriors figure.

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Statement of need

Optimized sampling methods are a key component of any retrieval code. Nested samplers (F. Feroz et al., 2009; Farhan Feroz et al., 2019) are a powerful and robust sampling method, successfully applied to the retrieval of exoplanet atmospheric spectra (Barstow et al., 2020; Bocchieri et al., 2023; Changeat et al., 2020). TauREx 3.1 natively implements a suite of nested samplers, including the MultiNest sampler, or makes them available as plugins, such as the UltraNest sampler. The primary target of nested samplers is the efficient calculation of the Bayesian evidence, whilst the inference of the posterior is a by-product. This is regarded as a key advantage of nested samplers, as the evidence can be readily used for model selection. However, the evidence is not always required, and the interpretation of the posterior from nested samplers necessitates some care. Additionally, algorithmic assumptions of nested samplers may require to tailor the priors to explore the parameter space thoroughly.

Where the inference of the Bayesian posterior is the primary target, a well-established alternative to nested samplers are a family of Markov chain Monte Carlo methods known as

affine-invariant ensemble samplers (Goodman & Weare, 2010). The implementation in *emcee* (Foreman-Mackey et al., 2013) is a popular choice in the astronomy community, as it takes care of the heavy lifting of the sampling process, is well documented, and is straightforward to utilize. To date, the *emcee* sampler is not natively implemented in the TauREx 3.1 retrieval framework, nor elsewhere in other retrieval codes, to the knowledge of the authors. To fill this gap, we developed the *taurex-emcee* plugin, which interfaces the *emcee* sampler to TauREx. Key advantages of *taurex-emcee* are that it affords a more straightforward interpretation of the posterior and is more robust to the choice of priors. However, the current implementation is not intended to explore multimodal posteriors, for which nested samplers will inevitably be more efficient. Moreover, we caveat that it may require substantial computational time to sample high-dimensional parameter spaces with *emcee*, which can be mitigated by coupling *taurex-emcee* with TauREx’s GPU-accelerated forward models (A. Al-Refaie et al., 2020).

Acknowledgements

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