A comparison of exoplanet retrieval tools

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In recent years, spectroscopic observations of transiting exoplanets have begun to uncover information about their atmospheres including atmospheric structure and composition, and indications of the presence of clouds. Spectral retrieval is the leading technique for interpretation of exoplanet transmission spectra. Whilst several atmospheric models and retrieval algorithms have been successfully employed, as yet the different model suites have mostly been used in isolation and so it is unknown whether results from each are comparable. As we approach the launch of the *James Webb Space Telescope* in 2020, and looking further ahead to the recently-selected *ARIEL* mission, we are entering a new data-rich era in the field of exoplanet atmospheres and so it is important that the tools that will be used to interpret these data are properly verified. We here present a comparative study of three retrieval code suites: *TauREX*; *NEMESIS*; and *CHIMERA*, and dem- onstrate that they produce comparable results for both forward and retrieval models.

We compared output transmission spectra for simple model atmospheres including only a single spectrally active gas, with isothermal temperature profiles, then moved on to comparing more realistic planet models, including simple clouds and combinations of spectrally active gases. Excellent agreement was obtained between the three forward models for the cases we tested. We then took each of the more realistic model planets and binned the spectra down to a resolution of R=100 over the wavelength range of 0.5–10 μm. These spectra were cross-retrieved between the three algorithms to assess whether spectra generated with one model can be accurately retrieved using the others. We find that in the majority of cases the cross retrievals produce the correct result, demonstrating that our retrieval codes have been successfully benchmarked against each other.

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