TESS observations of the WASP-121 b phase curve

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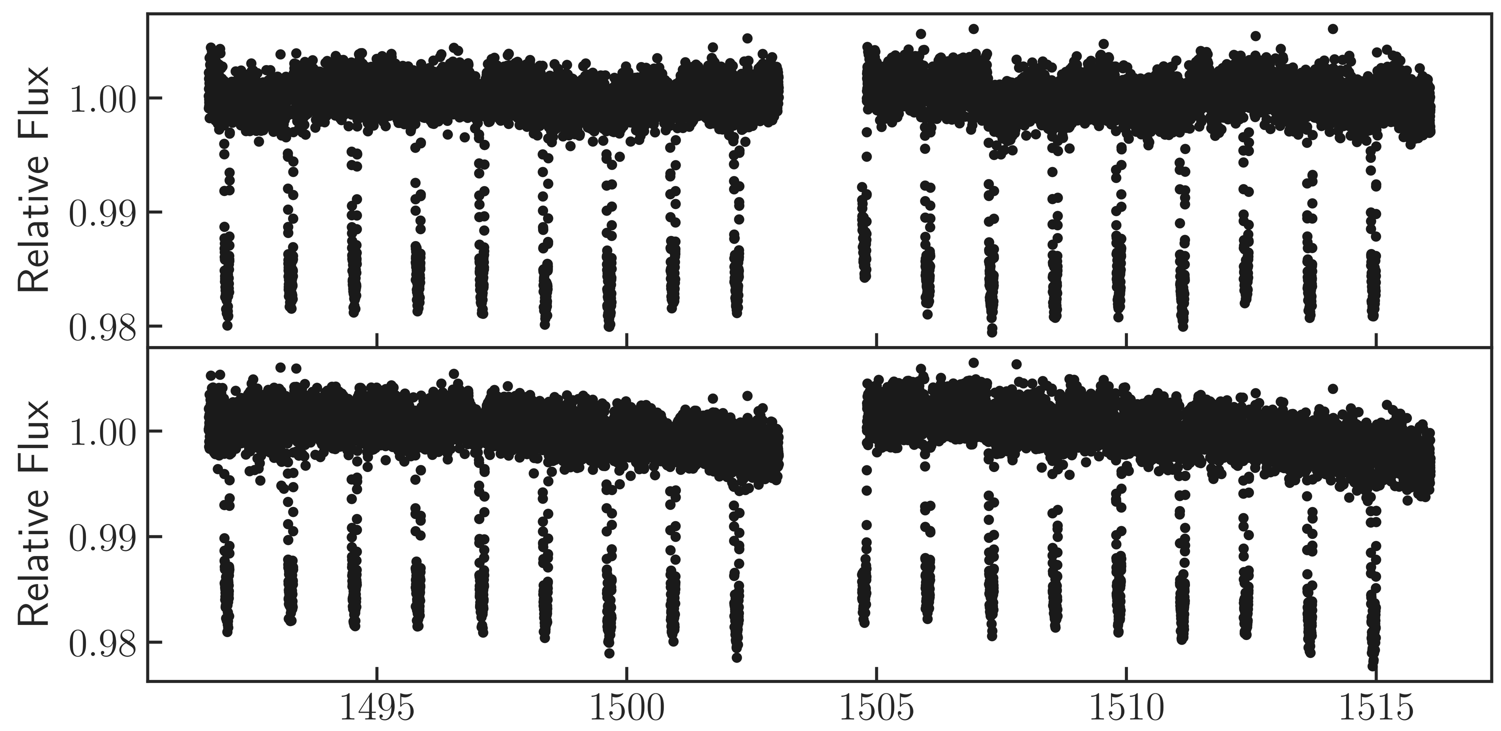
Introduction

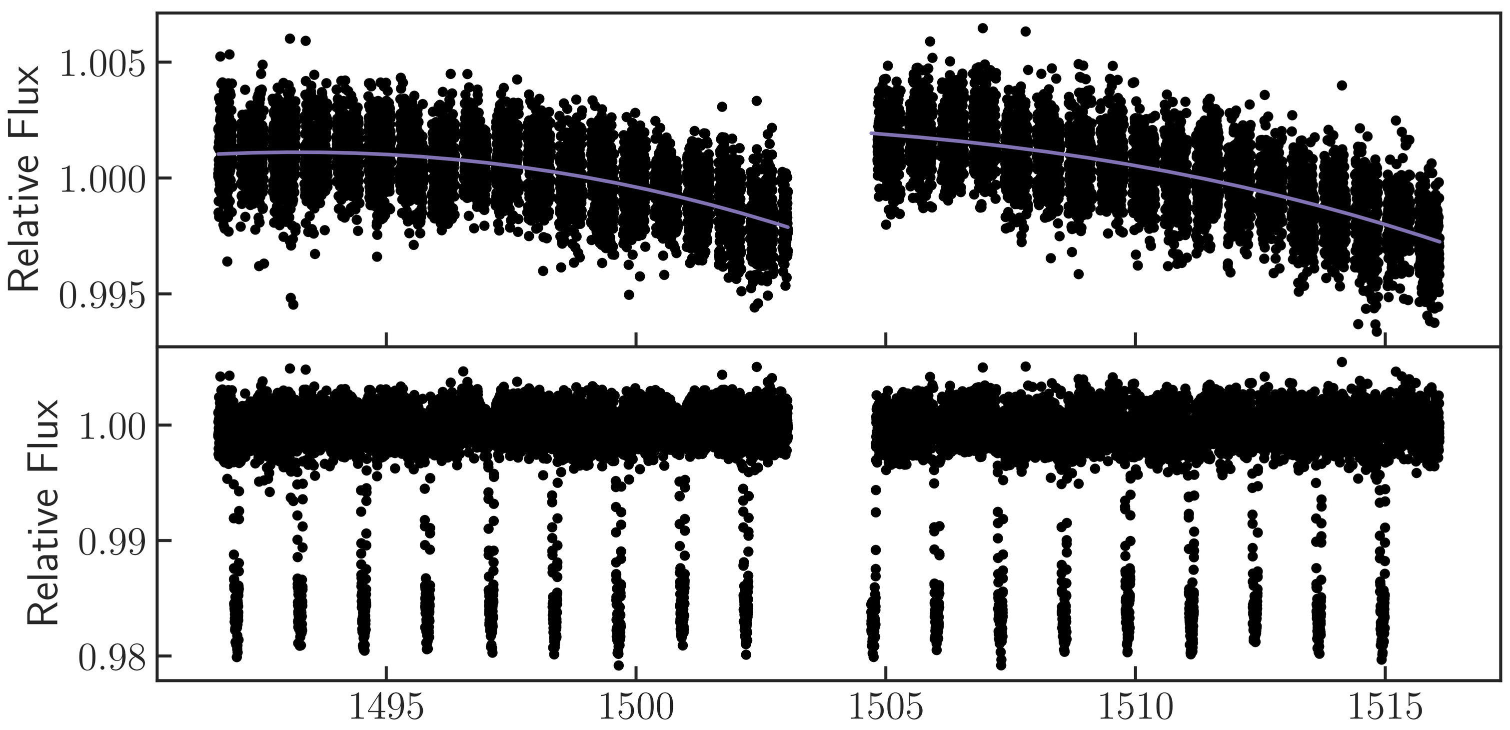
We study the first red-optical phase curve of the ultra-hot Jupiter WASP-121b (Delrez+2016) as observed by the Transiting Exoplanet Survey Satellite (TESS) during its Sector 7 observations. Given its short orbital period of 1.275 days, inflated state, and bright, F-type host star, WASP-121b has a high potential for detailed atmospheric characterization.

Modeling the TESS data

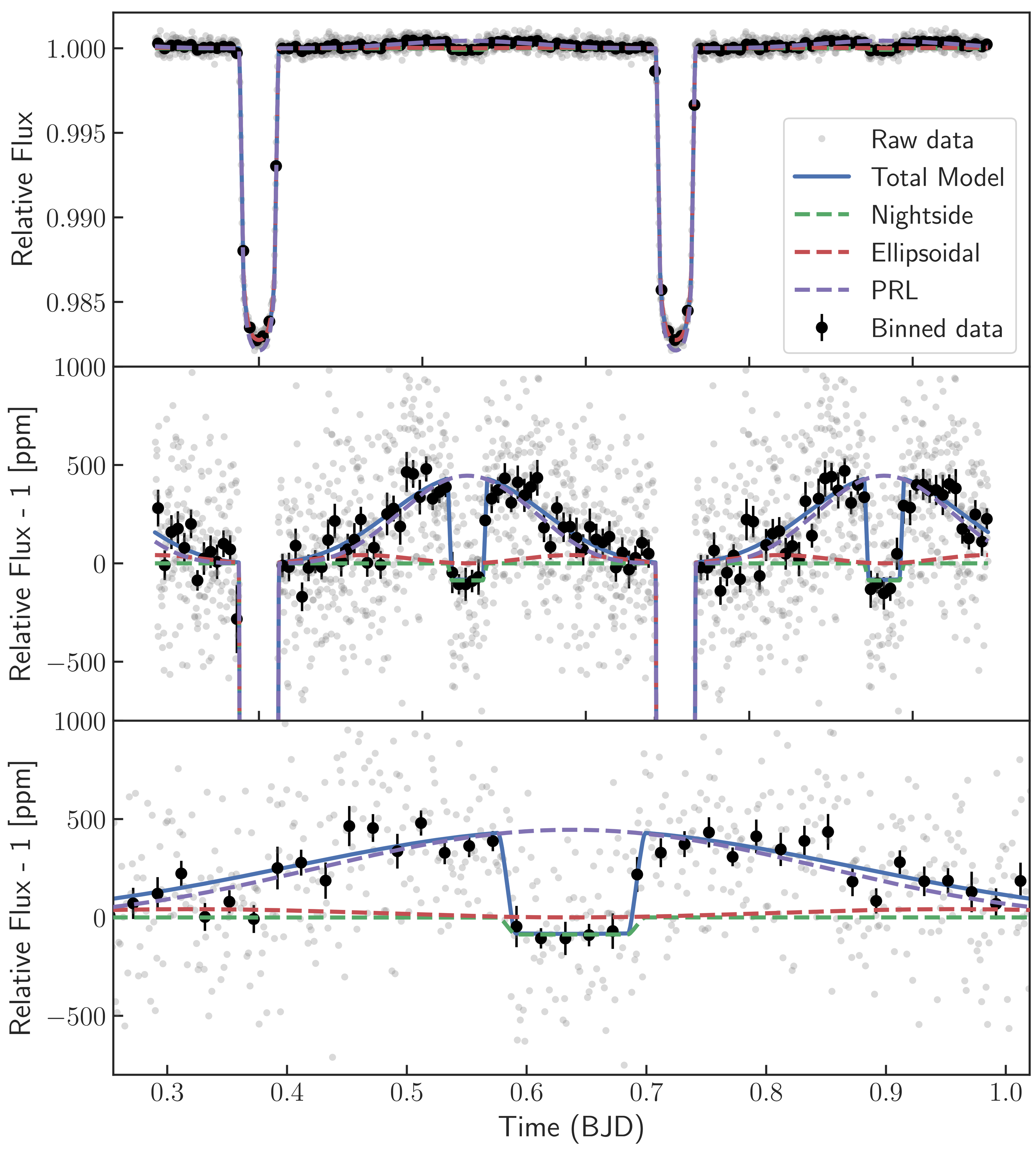
PDC (top) and SAP (bottom) light curves of WASP-121:



Masked (top) and detrended (bottom) light curves:



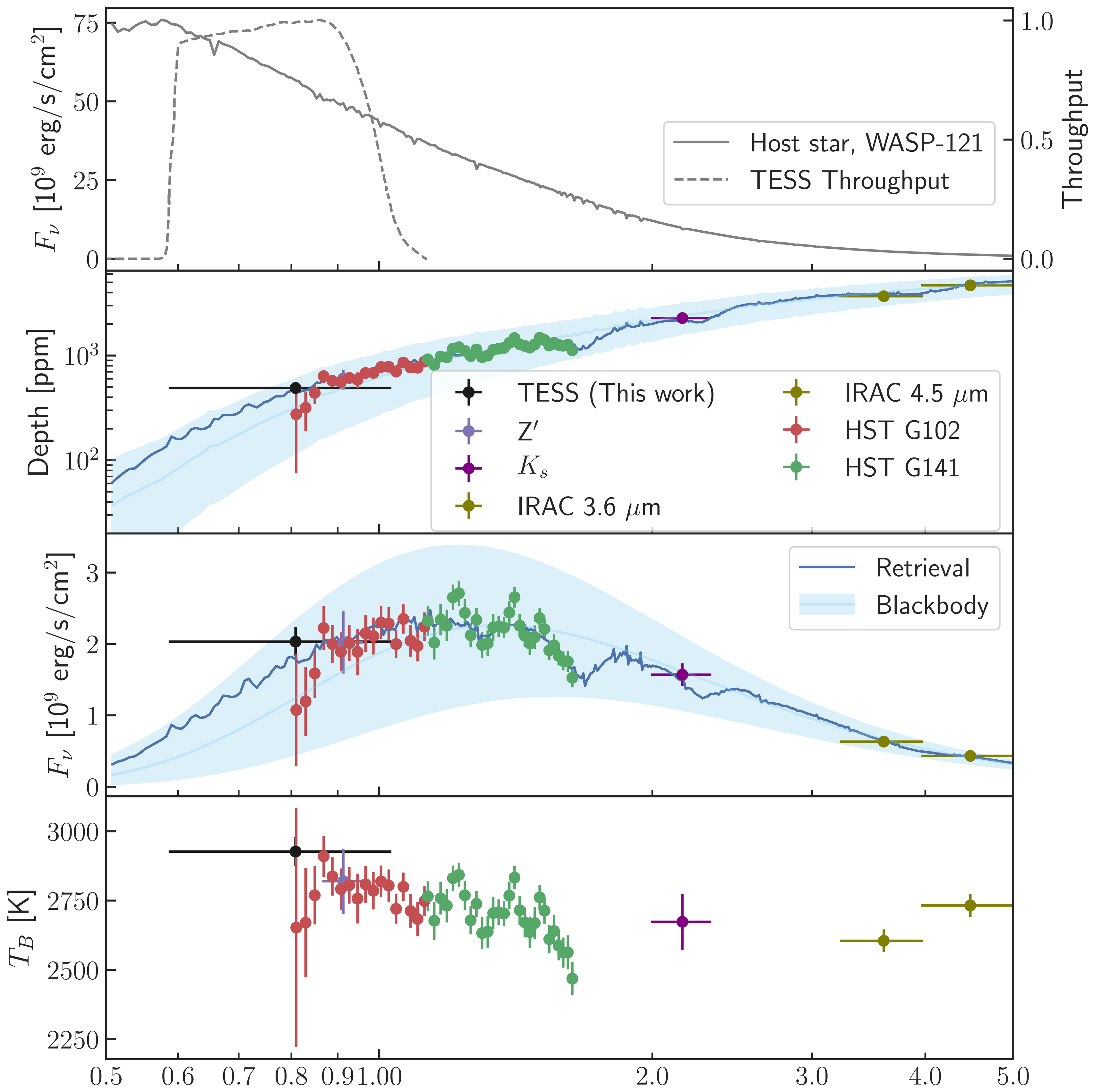
Characterization of the phase curve using `allesfitter` (Günther & Daylan 2019) including the primary and secondary transits, ellipsoidal variations, thermal and reflected components:



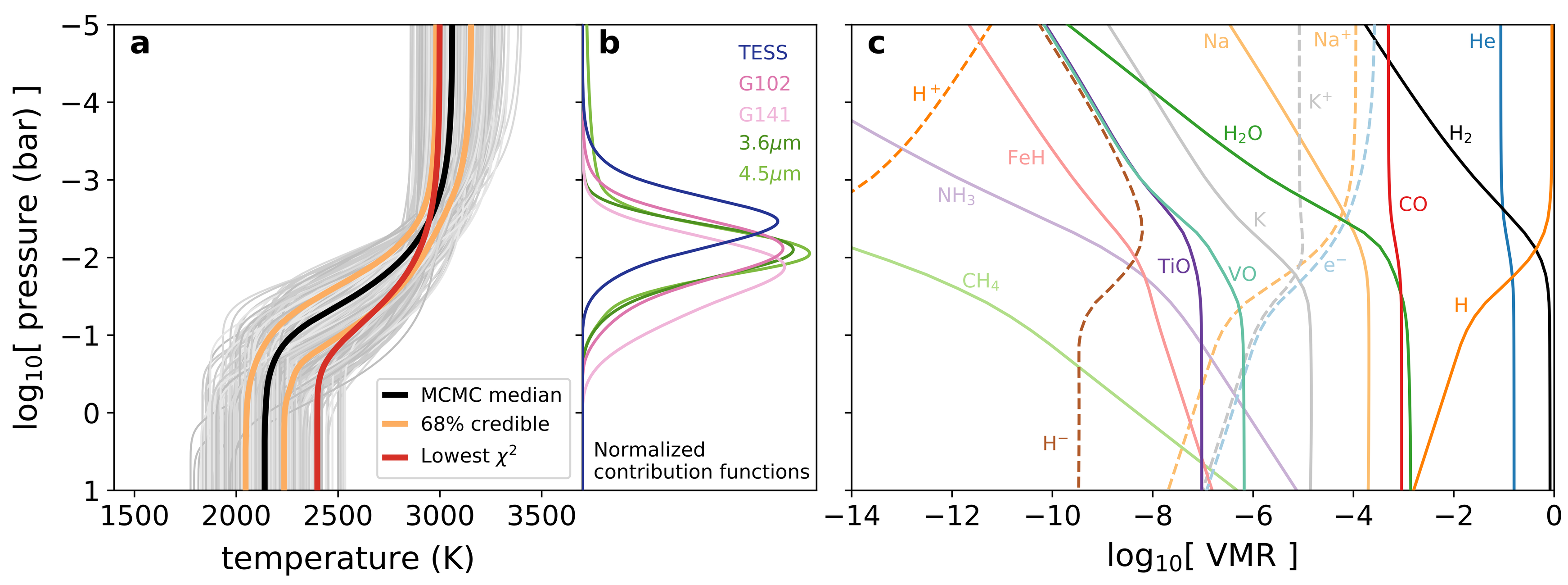
We measure a dayside and nightside emission of 530 ± 50 ppm and 90 ± 40 ppm, respectively, and find no significant phase offset between the secondary and the atmospheric modulation.

Atmospheric retrieval

We model WASP-121b's dayside atmosphere using ATMO (Amundsen+2014) via one-dimensional radiative transfer, exploiting all available data (Delrez+2016, Evans+2017, Kovacs&Kovacs2019, Garhart+2019, Evans2019):



Having a bluer passband than other datasets, TESS data are more sensitive to lower pressures in the atmosphere. The atmospheric retrieval confirms the previously-suspected temperature-pressure inversion, moves the inversion to lower pressures and the pre-inversion temperature up by ~ 150 K:



The resulting Carbon and Oxygen abundances are consistent with the Solar abundances.

Conclusion

The retrieval tied to the TESS data confirms the contribution of H^- to the optical opacity of the atmosphere at low pressures and infers a high (i.e., 10^{-24} cm^2/molecule) level of TiO and VO, which may be causing the temperature inversion. Our findings are consistent with a low albedo and heat recirculation efficiency. Future HST and JWST observations of WASP-121b will benefit from this red-optical light curve measured by TESS, in determining the characteristics of WASP-121b' stratosphere.