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Spatially-resolving the terminator: Variation of Fe, temperature and winds in WASP-76b across planetary limbs and orbital phase

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Exoplanet atmospheres are inherently three-dimensional systems in which thermal/chemical variation and winds can strongly influence spectra. Recently, the ultra-hot Jupiter WASP-76b has shown evidence for condensation and asymmetric Fe absorption with time. However, it is unclear whether these asymmetries are driven by chemical or thermal differences between the two limbs, as precise constraints on variation in these have remained elusive due to the challenges of modelling these dynamics in a Bayesian framework as well as the procurement of such high quality observations. To address this we develop a new model, HyDRA-2D, capable of simultaneously retrieving morning and evening terminators with day-night winds, and use this on recent high-precision terminator observations of WASP-76b with ESPRESSO/VLT. We explore variations in Fe, temperature profile, winds and opacity deck with limb and orbital phase. In this talk I will show that with HyDRA-2D we find Fe is more prominent on the evening for the last quarter of the transit. On the other hand the morning shows a lower abundance with a wider uncertainty, driven by degeneracy with the opacity deck and because the stronger evening signal dominates the overall spectrum. We also constrain a trend of higher temperatures for the more irradiated atmospheric regions, and a higher wind speed for the last quarter of the transit than the first. This new spatially- and phase-resolved treatment is statistically favoured by 4.9 over traditional 1D-retrievals, and thus demonstrates the power of such modelling for robust constraints with current and future facilities.