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Comparing Models of an Exoplanet-Earth to Earthshine Observations

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Polarimetry is widely becoming recognized as a powerful technique for enhancing the contrast between a star and an exoplanet, and thus improving upon the direct detection of exoplanets. The real power of polarimetry, however, is in its ability to characterize the physical properties of these worlds. This is because the state of the polarization of the light from the planet is very sensitive to the composition and structure of the planetary atmosphere and surface, being affected by properties such as the mixing ratios of atmospheric absorbing gases, cloud optical thickness, cloud top pressure, cloud particle size, and surface albedo. Various groups have theoretically studied the optical linear polarimetric signals of Earth-like exoplanets as functions of both orbital phase and wavelength. This project aims to validate the accuracy of these theoretical models against the only known observations of an Earth-like planet thus far: Earthshine. Using atmospheric and surface data taken by the MODIS instrument aboard the Terra and Aqua satellites, as well as surface albedo spectra from the EcoStress Spectral Library, we created a detailed model of the Earth. Then, using this model data as input for three separate radiative transfer algorithms, we generate the flux and linear polarization spectra for the model exoplanet-Earth from the optical to near-infrared wavelengths. We compare the results from all three codes to each other and to observational linear spectropolarimetric data of the Earthshine obtained by a member of our group. We identify similarities and potential pitfalls between these codes in an effort to improve our future characterizations of Earth-like exoplanets.