Monte Carlo simulations of clear twilights in aerosol & molecular atmospheres

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Abstract
Sky colors during clear civil twilights depend on (1) molecular scattering, (2) extinction by tropospheric aerosols, and (3) ozone absorption. Molecular scattering alone cannot produce the most vivid twilight colors near the solar horizon, which also require aerosol scattering and absorption. Haze aerosols’ effects on twilight sky colors at larger scattering angles, including near the antisolar horizon, are not well understood. To analyze this color range, we compare 3D Monte Carlo simulations of skylight spectra from the MYSTIC model with hyperspectral measurements of clear twilight skies made over a wide range of aerosol optical depths.

Conclusions
Our combined measurements and simulations indicate that: (a) the purest antisolar twilight colors would occur in a purely molecular, multiple-scattering atmosphere, (b) the most vivid solar-sky colors require at least some turbidity, and (c) large changes in ozone concentrations only serve to shift twilight chromaticity curves along the Planckian locus.