Chasing the Great American 2017 Total Solar Eclipse: Coronal Results from NASA's WB-57F High-Altitude Research Aircraft

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Abstract Text:

Total solar eclipses present rare opportunities to study the complex solar corona, down to altitudes of just a few percent of a solar radius above the surface, using ground-based and airborne observatories that would otherwise be dominated by the intense solar disk and high sky brightness. Studying the corona is critical to gaining a better understanding of physical processes that occur on other stars and astrophysical objects, as well as understanding the dominant driver of space weather that affects human assets at Earth and elsewhere. For example, it is still poorly understood how the corona is heated to temperatures of 1-2 MK globally and up to 5-10 MK above active regions, while the underlying chromosphere is 100 times cooler; numerous theories abound, but are difficult to constrain due to the limited sensitivities and cadences of prior measurements. The origins and stability of coronal fans, and the extent of their reach to the middle and outer corona, are also not well known, limited in large part by sensitivities and fields of view of existing observations.

Airborne observations during the eclipse provide unique advantages; by flying in the stratosphere at altitudes of 50 kft or higher, they avoid all weather, the seeing quality is enormously improved, and additional wavelengths such as near- IR also become available due to significantly reduced water absorption. For an eclipse, an airborne observatory can also follow the shadow, increasing the total observing time by 50% or more.

We present results of solar coronal measurements from airborne observations of the 2017 Great American Total Solar Eclipse using two of NASA's WB-57 high-altitude research aircraft, each equipped with two 8.7" telescopes feeding high-sensitivity visible (green-line) and medium-wave IR (3-5 μm) cameras operating at high cadence (30 Hz) with ~3 arcsec/pixel platescale and ±3 R_sun fields of view. The aircraft flew along the eclipse path, separated by ~110 km, to observe a summed ~7.5 minutes of totality in both visible and NIR, enabling groundbreaking studies of high-speed wave motions and nanojets in the lower corona, the structure and extent of coronal fans, and constraints on a potential primordial dust ring around the Sun. We review the mission, and the results of analysis on the visible and IR coronal measurements.