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On-orbit Performance of the Thermospheric Wind and Temperature Instrument on the NASA ICON Mission

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Abstract: The MIGHTI instrument was launched October 2019 on the NASA ICON Explorer mission. This presentation will discuss the performance of the MIGHTI wind sensor and techniques used for calibration and monitoring instrument drifts. © 2021 The Author(s)

1. Introduction

The Michelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI) is one of the instruments on the NASA-sponsored Ionospheric Connection (ICON) Explorer mission. ICON investigates the extreme variability of the Earth's ionosphere with a unique combination of sensors in low-Earth orbit. Since late 2019 MIGHTI has been measuring neutral wind and temperature altitude profiles over an altitude range not accessible to in-situ probes. MIGHTI is a limb viewing instrument that uses the Doppler Asymmetric Heterodyne Spectroscopy (DASH) technique for wind measurements via the atomic oxygen red and green airglow emission lines, and an infrared multi-color photometer technique to measure atmospheric temperature. The wind is determined by measuring the phase of interference fringes produced by a field-widened monolithic interferometer imaging the Earth's limb. In this presentation we discuss the on-orbit performance of the MIGHTI wind sensors, their validation with concurrent ground-based measurements, methods for on-orbit calibration, and techniques used to monitor instrument drifts. A further discussion of MIGHTI's wind results with an emphasis on geophysics can be found in the paper by Englert *et. al*. in this conference [1]. Additional details on the MIGHTI instrument can be found in Englert *et. al.* [2] details on the design and construction of the MIGHTI interferometers can be found in Harlander *et. al.* [3], and details on the wind retrieval algorithm can be found in Harding *et. al.* [4].

2. Early Orbit Results

MIGHTI obtains the horizontal components of the vector line-of-sight winds by utilizing two identical sensors, one oriented in azimuth at 45 degrees with respect to the spacecraft velocity (MTA) and the other oriented at 135 degrees (MTB). With this orientation, a common volume of the Earth's limb is viewed in perpendicular directions separated in time by ~7 minutes as the spacecraft orbits. Figure 1 shows the fringe patterns obtained from both MTA and MTB viewing the Earth's limb. The red and green fringe patterns are produced by the same interferometer in each instrument. A dichroic beamsplitter between the interferometer and the CCD images the red and green fringes onto adjacent areas of the CCDs. Beneath the red fringe patterns are the infrared channels that are used to determine the atmospheric temperature.

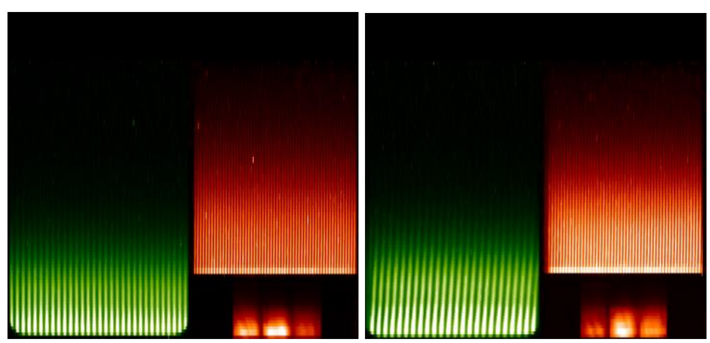

Fig.1 Daytime atmospheric fringe patterns obtained by MTA (left) and MTB (right). Path difference is imaged along the horizontal dimension and altitude is along the vertical and shows the expected variation in limb brightness with altitude.

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Figure 2 compares fringe patterns obtained for MTA during thermal vacuum testing and on-orbit using MIGHTIs on-board Ne (red) and Kr (green) calibration lamps. Note that the prelaunch (colors) and the post-launch (black) measurements were separated in time by over three years due to delays in the launch, however, except for a small shift in phase, the fringes are nearly identical.

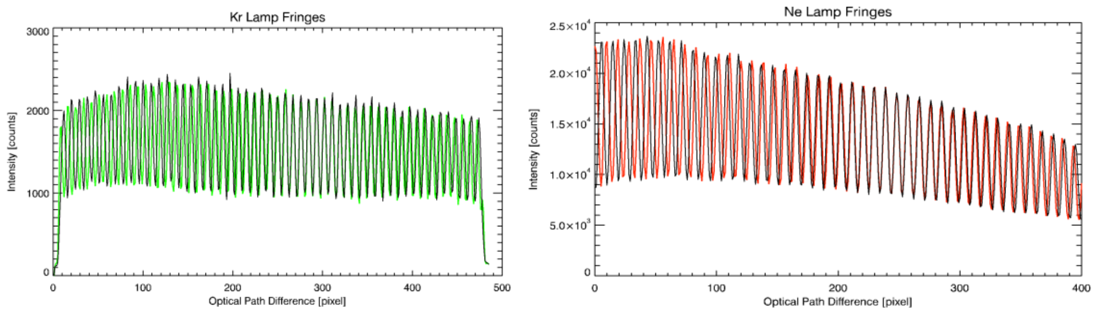

Fig. 2. MTA Calibration lamp fringes taken before launch (red, green) and after launch (black). MTB is similar. The non-ideal fringe visibility is primarily due to the thermal width of the calibration lamps.

3. Instrument calibration

One of the most challenging aspects of operating interferometers in space is monitoring and correcting for thermal drifts of the fringes. The MIGHTI interferometers are by design thermally compensated [3] and are in holders that are thermally controlled to within 0.2° C. A number of calibration measurements are required to monitor the remaining instrument drifts. On-board calibration lamps are used to measure and correct for long- and short-term fringe drifts. The short-term drifts are due to day/night thermal cycling of the instrument and are therefore periodic with orbit. Long-term drifts are seasonal, periodic with spacecraft precession cycle but also have a non-periodic component, likely due to mechanical "settling" of the interferometer, the imaging elements, or the mechanical mount of the CCD detector. Interferometer path difference drift and drifts associated with mechanical motion of the optics or detector have different fringe signatures and are monitored and corrected separately.

4. Comparison with ground-based measurements

Figure 3 shows a comparison of MIGHTI wind and coincident ground-based measurements. The top panel is for red line winds with Fabry-Perot measurements from Makela *et. al.* [5]. The bottom panel is for green line winds with meteor radar measurements from Harding *et. al.* [6]. In both cases attempts have been made to account for the different viewing geometries of the limb viewing MIGHTI measurements and the upward looking ground-based measurements.

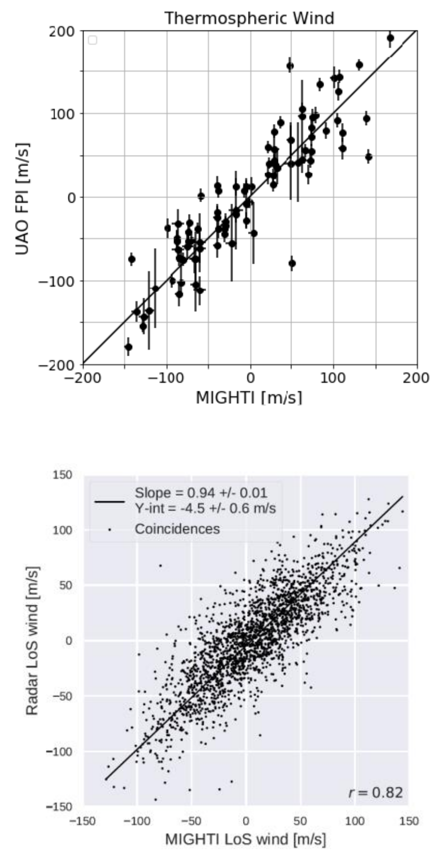

Fig. 3. Comparison of MIGHTI and ground-based wind measurements.

5. Acknowledgements

ICON is supported by NASA's Explorer's Program through contracts NNG12FA45C and NNG12FA42I.

6. References

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