THE MICROWAVE TEMPERATURE PROFILER PERFORMANCE IN RECENT AIRBORNE CAMPAIGNS

Boon Lim[1], Michael Mahoney[1], Julie Haggerty[2] and Richard Denning[1]

[1]Jet Propulsion Laboratory, California Institute of Technology
[2]National Center for Atmospheric Research

ABSTRACT

The JPL developed Microwave Temperature Profiler (MTP) has recently participated in GloPac, HIPPO (I to V) and TORERO, and the ongoing ATTREX campaigns. The MTP is now capable of supporting the NASA Global Hawk and a new canister version supports the NCAR G-V. The primary product from the MTP is remote measurements of the atmospheric temperature at, above and below the flight path, providing for the vertical state of the atmosphere. The NCAR-MTP has demonstrated unprecedented instrument performance and calibration with ±0.2 K flight level temperature error. Derived products include curtain plots, isentropes, lapse rate, cold point height and tropopause height.

***Index Terms*—**Microwave radiometry, Atmospheric measurements, Airborne instruments

1. INTRODUCTION

The JPL Microwave Temperature Profiler (MTP) has been a work-horse instrument participating in 59 campaigns over the last 3 decades spanning 7 aircraft platforms. The MTP performs measurements of the 50-60 GHz oxygen complex, is the only airborne instrument performing vertical profiling measurements above the flight level. The vertical state of the atmosphere, including the cold point and the lapse rate, is critical to understanding chemical processes in the tropical transition layer (TTL). MTPs perform measurements critical to understanding the transport of trace gases into the stratosphere and their impact on climate change and global warming. The last 5 years has seen the MTP [1] upgraded for use on the NASA Global Hawk (GH) supporting GloPac (2010) and ongoing ATTREX (2011-2014), and a new canister NCAR-MTP design [2] for use on the G-V supporting HIPPO (2009-2011) and TORERO (2012). MTP is an invaluable companion instrument for Upper Atmospheric Composition Observations (UACO) and will also support SEAC4RS in 2013. The following shows a sampling of the data collected from the various campaigns and the impact of the improved hardware on the NCAR-MTP.

2. AIRBORNE TROPICAL TROPOPAUSE EXPERIMENT (ATTREX)

Figure 1 shows the MTP first installed on the GH during GloPac (2010). The data unit is housed within the body of the GH, with the sensor unit external in a fairing. The MTP for the GH is the same as the ER-2 version with an upgraded communications computer to take advantage of the high

Figure 1. (Left) MTP sensor unit and data unit (Right) Installed MTP with external fairing

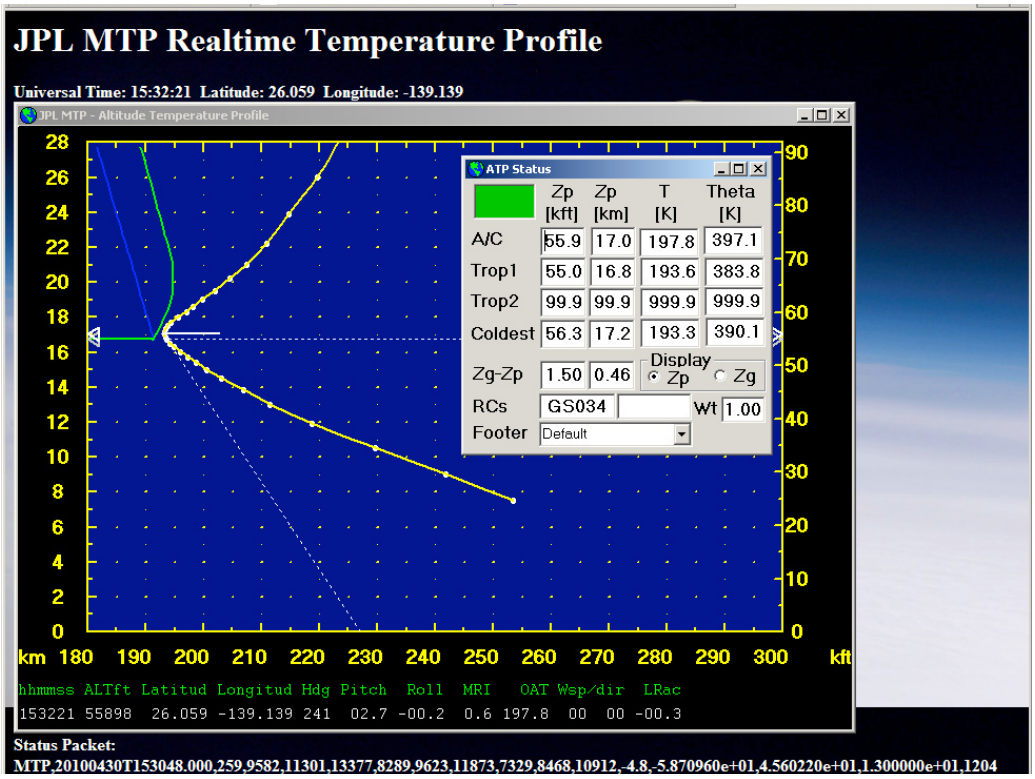
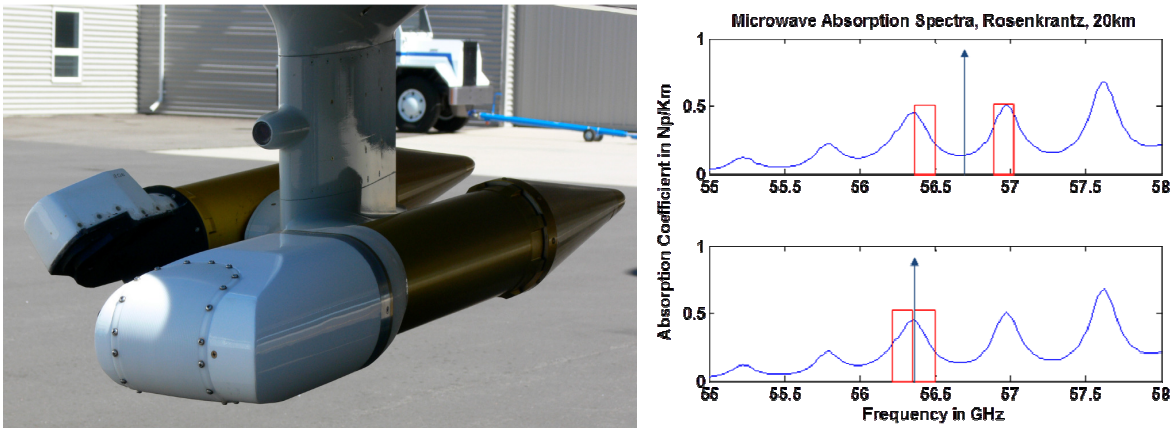


Figure 2. Real time temperature profile retrievals demonstrated during GloPac

speed 'ethernet-like' data link available. MTP data can be transmitted to the ground in real-time via the Iridium or Ku-band satellite downlink and retrievals performed on the fly to support aircraft operations. Figure 2 shows a sample screen with various real time products available including the cold-point temperature and the tropopause height.

3. NCAR-MTP IMPROVEMENTS

The primary hardware difference between the current JPL-MTPs and the newer NCAR-MTP [2] is the upgrade to the mixer hardware allowing for intermediate frequency (IF) measurements at baseband, as opposed to the 'split-line' measurements as shown in Figure 3. The measurement is now sensitive ONLY to a single oxygen complex line and not the combination of two, hence the sideband are sensitive to the same portion of the atmosphere. This results in significantly improved performance, with ±0.2 K flight level temperature error [3]. The canister configuration allows for compatibility with any aircraft that is capable of supporting such systems allowing for quicker installation and qualification.



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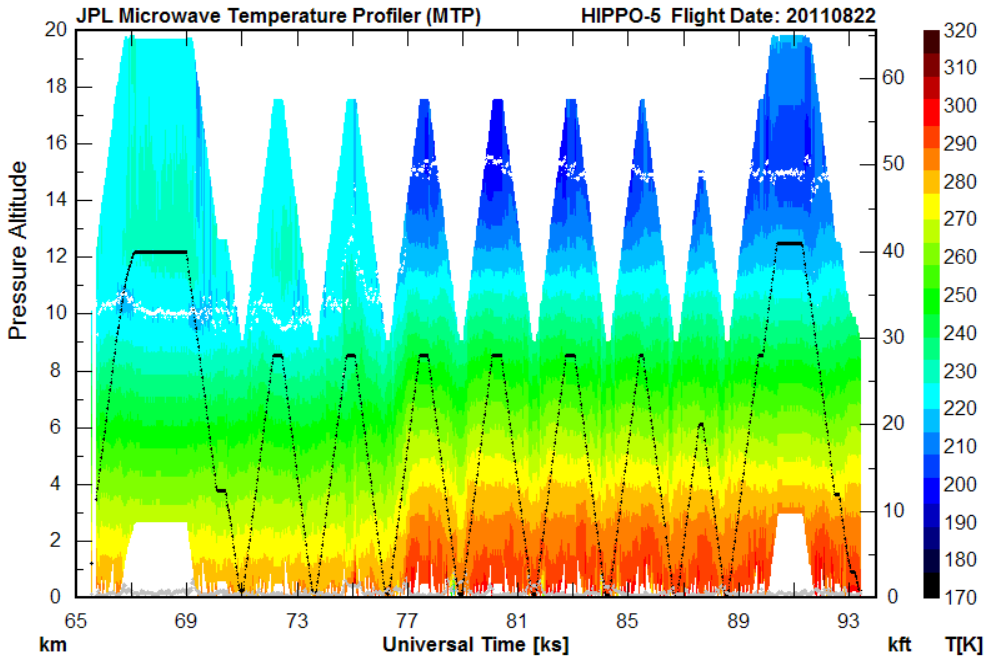

Figure 4. HIPPO-V flight from Anchorage, Alaska to Kona, Hawaii

4. HIAPER POLE TO POLE OBSERVATIONS (HIPPO)

HIPPO measured cross sections of atmospheric concentrations approximately pole-to-pole, from the surface to the tropopause, five times during different seasons over a three year period (2009-2011). The NCAR-MTP provided color-coded temperature curtain plots, demonstrating the capability of profiling up to ±10 km from the flight level. Figure 4 shows a result from HIPPO-V with the flight level in black and tropopause in white. The cooling of the atmosphere is apparent as the aircraft travels from Alaska to Hawaii, with the tropopause moving from 10 km to 15 km. Measurements from the HIPPO campaign were calibrated using a novel method [4] utilizing the avionics temperature with an appropriate correction for Mach Number [5].

5. TROPICAL OCEAN TROPOSPHERE EXCHANGE OF REACTIVE HALOGEN SPECIES AND OXYGENATED VOC (TORERO)

The MTP is used to identify occurrences of the double tropopause from thermal lapse rate measurements. Figure 5 shows the comparisons with complimentary ozone

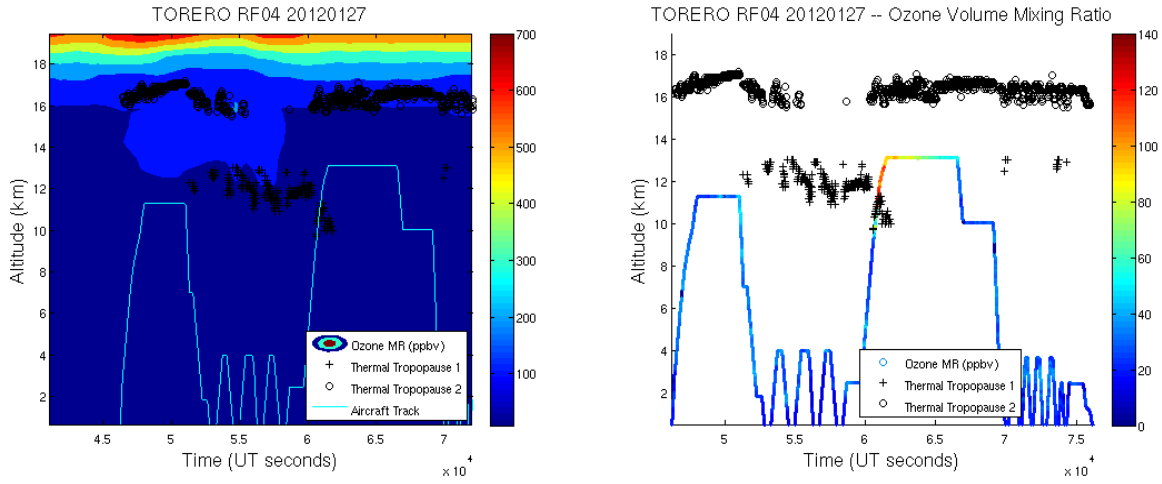

Figure 5. (Left) RAQMS ozone is elevated in the thermal tropopause (Right) In situ measurements of Ozone volume mixing ratio are consistent with MTP double tropopause

instruments [6]. The product also has value to other species, including water vapor and carbon monoxide.

6. CONCLUSION

The MTP continues to build upon its 3 decade long legacy of providing temperature profiles above and below the flight level, upgrading to be capable of performing measurements on the Global Hawk and canister equipped aircraft. MTP is currently involved in 3 missions - ATTREX, SEAC4RS and MPEX.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

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