A Summary of MTP Results for ACCLIP

Julie Haggerty[1] and Janine Aquino[1]

[1]NSF NCAR

Revised July 2024 (Originally published March 2023)

Introduction

We summarize in this document the results for the Microwave Temperature Profiler (MTP) data obtained on the NSF/NCAR GV (NGV) during the ACCLIP field campaign. Its purpose is twofold: to present the final MTP data with comments on data quality for each flight, and to describe the use of in situ temperature measurements for MTP gain calculations. The header record in our production data files ('MP-files') provides a link to this document where users can obtain a summary of data quality and interesting features associated with each flight.

1 Results

Data Quality Overview

MTP collected good quality data and successful retrievals were achieved on all ACCLIP research flights except for RF01 and RF02. During these flights, the real-time transmission of aircraft attitude data via the IWG1 line was disrupted for most of the flight. Hence, variables that control the viewing orientation of the sensor were erroneous, and proper geolocation of measured radiances is not possible. For flights RF03 through RF14, raw data are of high quality and retrieval parameters indicate that derived temperature profiles are of generally good quality. Local radiosonde profiles provide a priori observations which serve as first-guess information in the MTP retrieval scheme. A comprehensive set of radiosonde data during ACCLIP provided good representation of the atmospheric conditions in most cases. Success of the retrieval is quantified by a metric known at the MRI; its value is given in the header line of each profile. The temperature curtain plots below show the MRI as a gray line at the bottom of the plot.

In the temperature curtain plots below, the color scale represents retrieved physical temperature. The gray line in the upper portion of the plots indicates the cold point in each retrieved temperature profile. The black line shows flight altitude, and the white dots indicate estimated tropopause height.

For portions of certain ACCLIP flights, users will notice that the tropopause height estimate fluctuates from scan-to-scan in a likely unrealistic way. This tends to happen especially during saw-tooth patterns (i.e., short-lived changes in aircraft altitude). We believe this is an artifact of the retrieval process combined with the observed small lapse rates in the tropopause region for these flights. Tropopause height from MTP is calculated by applying the WMO definition of the tropopause height to the retrieved temperature profile. During some flights, temperature profiles in the UT/LS region exhibited slowly changing lapse rates over a fairly deep vertical layer (in contrast to situations where the tropopause transition is marked by a sharper shift with a more dramatic change in lapse rate). Both the retrieved MTP profiles and radiosondes in the region contain such features. WMO defines the tropopause as the lowest level at which the temperature lapse rate decreases to 2 K/km or less (WMO, 1957). If this definition is applied to a retrieved temperature profile with a lapse rate near the 2 K/km threshold over a significant vertical layer, uncertainty in the MTP measurements and in the retrieval process will cause the assigned tropopause height to fluctuate more than it would if the transition occurred over a narrow vertical layer, i.e. the threshold may be met at different altitudes. The variation in estimated tropopause height with changes in aircraft altitude (e.g., sawtooth patterns) on some flights may be a result of the uncertainty in the retrieved profiles combined with the WMO

hard threshold applied to a deeper vertical transition region. An example is shown below in the latter part of RF13. Note variations in the estimated tropopause height on the order of 0.5 km as the aircraft changes altitude.

1.1 RF03

RF03 sampled the shedding air mass predicted by models, mapped out its horizontal extent by reaching a stratospheric air mass, and sampled vertical gradients using successive altitude changes in a saw-tooth pattern. MTP retrievals indicate the aircraft entered the stratospheric air mass at around 15.5 ks (note white dots indicating tropopause height below flight altitude). Retrieval quality is diminished in this flight segment (see gray line near the bottom), but is within acceptable limits. Tropopause height varies in a likely anomalous way during the sawtooth pattern for reasons explained above (Figure 1).

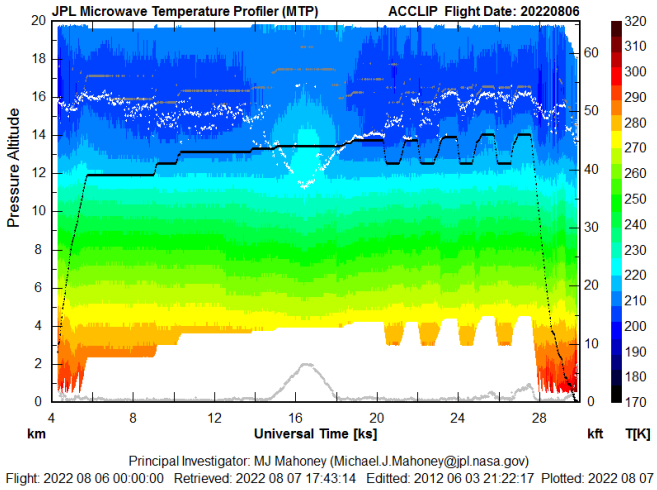

Figure 1: CTC Plot from Research Flight 3 on August 6, 2022

1.2 RF04

The GV sampled the same air mass from the previous flights. MTP retrievals are very good throughout this flight. Tropopause height of 15-16 km is well above flight altitude (Figure 2).

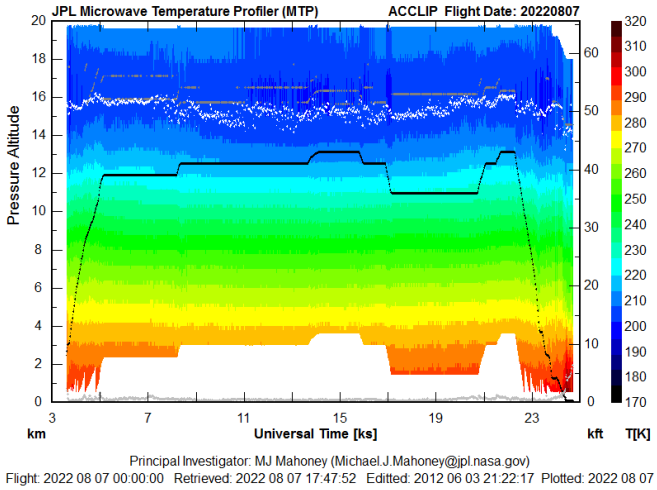

Figure 2: CTC Plot from Research Flight 4 on August 7, 2022

1.3 RF05

The GV sampled fresh and aged shedding air masses to the SE of Japan. MTP data quality is very good throughout this flight (Figure 3).

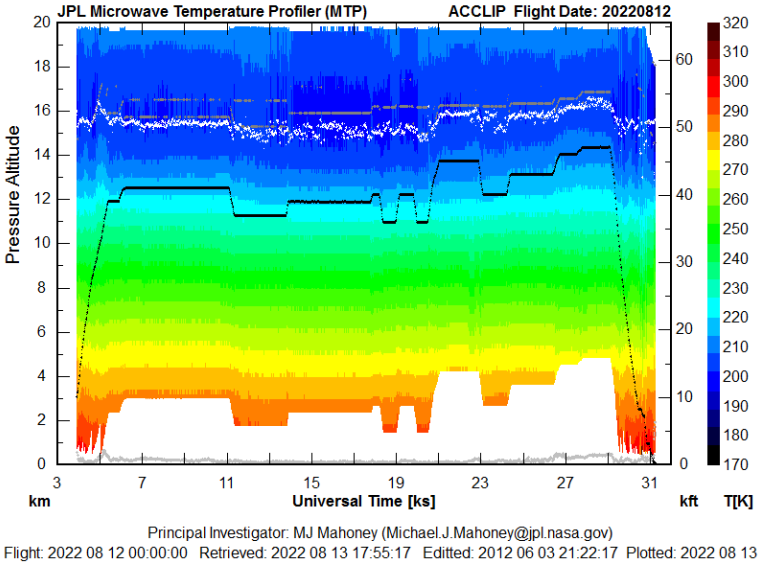

Figure 3: CTC Plot from Research Flight 5 on August 12, 2022

1.4 RF06

This flight sampled the interior of the UTLS anticyclone. MTP retrievals are of generally good quality with some uncertainty in estimated tropopause heights during ascents/descent between 9 and 12 ks (Figure 4).

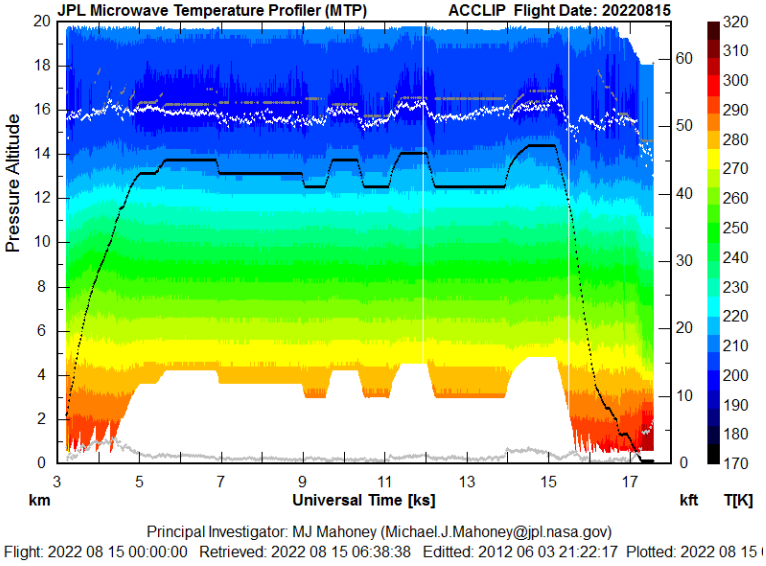

Figure 4: CTC Plot from Research Flight 6 on August 15, 2022

1.5 RF07

The GV sampled chemical and aerosol signatures within the monsoon anticyclone to the east and southeast of Japan. MTP retrieval quality is very good except for some uncertainty in estimated tropopause height associated with altitude changes after 26 ks (Figure 5).

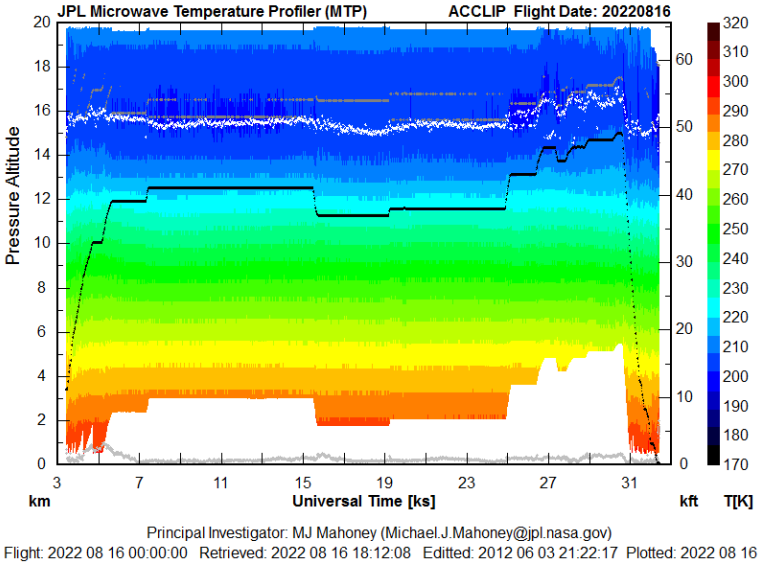

Figure 5: CTC Plot from Research Flight 7 on August 15, 2022

1.6 RF08

The GV sampled the "pre-shedding" air masses within the ASM anticyclone with repeated flight tracks. MTP retrievals during this flight are of excellent quality (Figure 6).

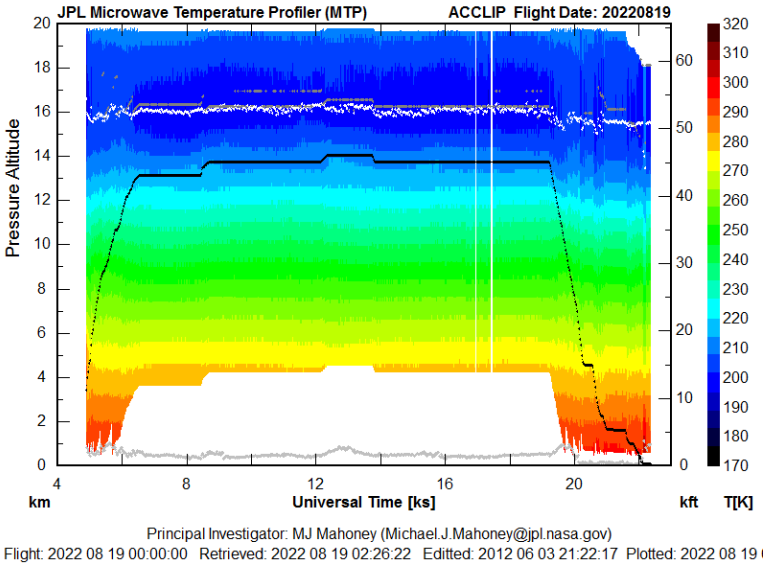

Figure 6: CTC Plot from Research Flight 8 on August 19, 2022

1.7 RF09

The GV sampled latitudinal gradients to 15N and conducted two deep descents to sample vertical gradients. The MTP data quality on this flight is good. Tropopause height estimates of ~16 km are fairly consistent during ascents/descents (Figure 7).

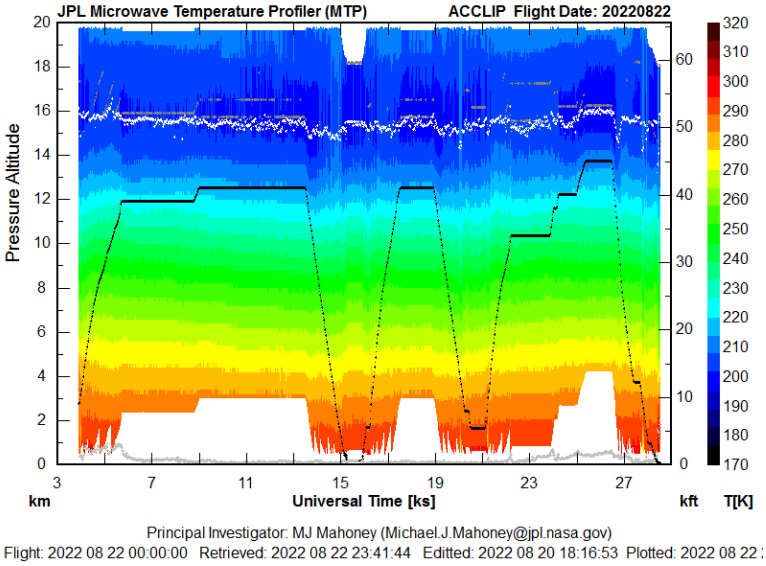

Figure 7: CTC Plot from Research Flight 9 on August 22, 2022

1.8 RF10

The GV sampled the anticyclone air mass over the western part of the flight domain at different altitudes. MTP retrievals are generally good, but display some anomalous variation due to altitude changes. (Figure 8).

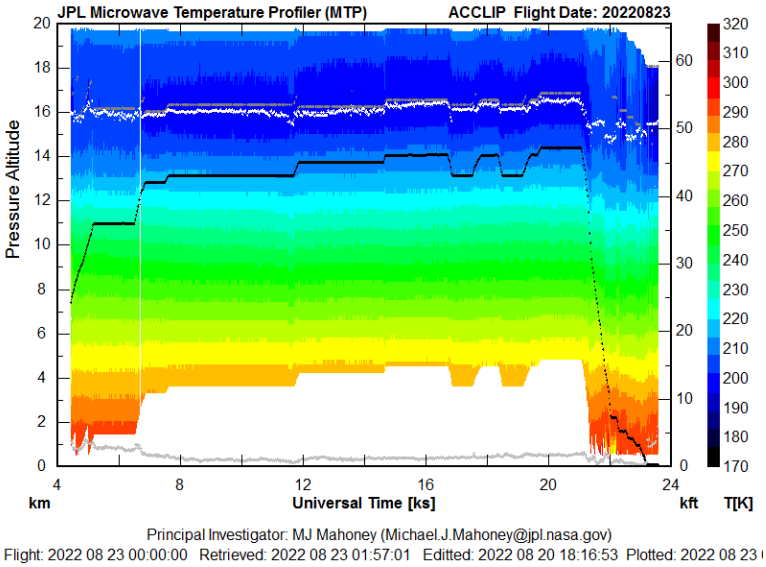

Figure 8: CTC Plot from Research Flight 10 on August 23, 2022

1.9 RF11

The GV sampled an elongated streamer of air shed from the ASM anticyclone, and conducted a stacked leg with the NASA WB-57. MTP retrievals are generally good with the exception of anomalous changes in the profiles due to altitude changes, especially near the tropopause (Figure 9).

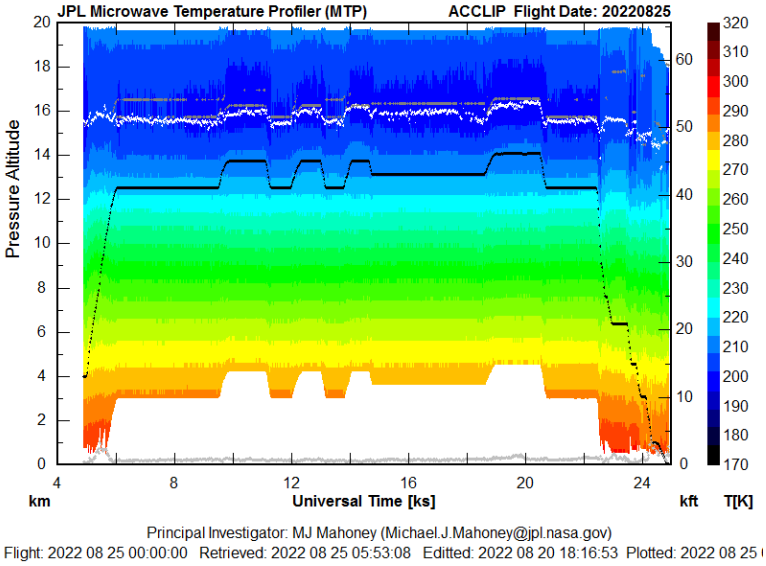

Figure 9: CTC Plot from Research Flight 11 on August 25, 2022

1.10 RF12

The GV sampled remnants of the monsoon air mass lingering in the flight domain. MTP retrievals are generally good with the exception of anomalous changes in the profiles due to altitude changes, especially near the tropopause (Figure 10).

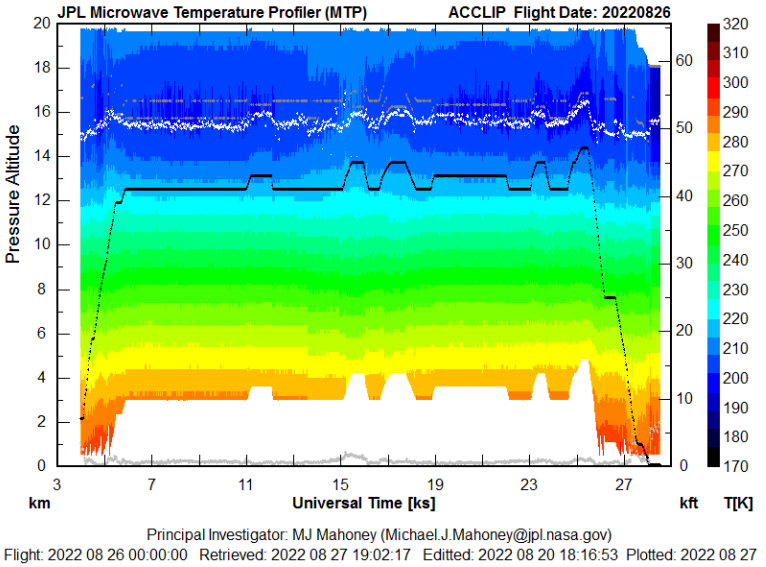

Figure 10: CTC Plot from Research Flight 12 on August 26, 2022

1.11 RF13

The GV sampled the early stages of a shedding event and captured outflow from a tropical mesoscale convective system. MTP retrievals are generally good with the exception of anomalous changes in the profiles due to altitude changes, especially near the tropopause (Figure 11).

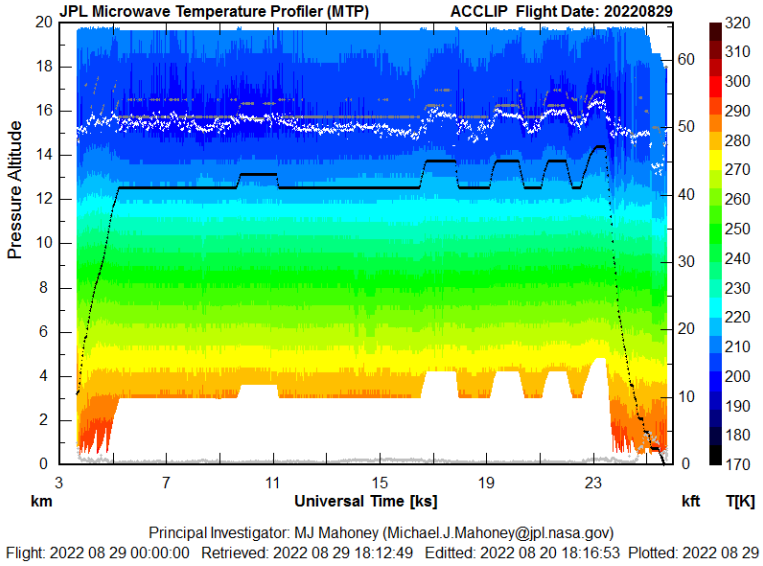

Figure 11: CTC Plot from Research Flight 13 on August 29, 2022

1.12 RF14

Osan to Anchorage flight. Retrieval quality diminished in the last half of the flight as the aircraft entered stratospheric air (Figure 12).

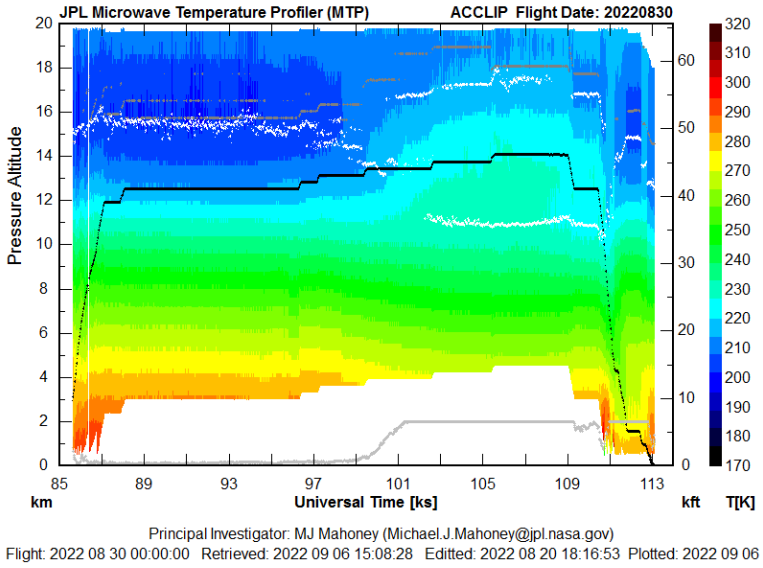

Figure 12: CTC Plot from Research Flight 14 on August 30, 2022