



SAGE III

Stratospheric Aerosol and Gas Experiment

An Earth Science Mission on the International Space Station

Status of Utilization of Disturbance Monitoring Package in Data Products

Charles A. Hill

The DMP Guy

Marsha A. Larosee

Kevin R. Leavor

12 September 2023





SAGE III ISS

Status of Utilization of Disturbance Monitoring Package in Data Products

SAGE III/ISS Science Team Meeting at Georgia Tech

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12 September 2023

Utilization of DMP
in Data Products

Charles Hill

DMP Overview

What is it?

Where is it?

Defining Axes

How are we using it?

Product
Improvements

The Big Picture

Many Histograms...

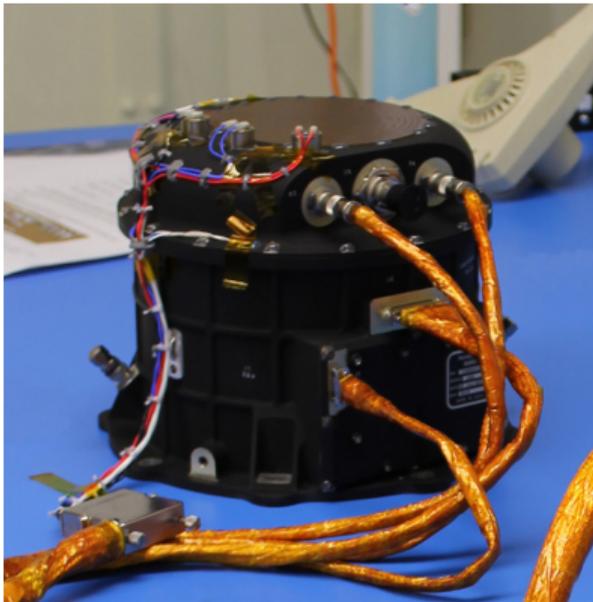
Life Without the
x-Axis

Summary

Questions



Disturbance Monitoring Package (DMP)



- ▶ The DMP is a Honeywell Miniature Inertial Measurement Unit comprised of three orthogonal ring laser gyros to measure angular rates in three orthogonal axes.
- ▶ The DMP's primary requirement was to flag periods when vibration conditions can negatively impact the science data product, but it **has been used successfully to correct the Level 1 transmission retrievals** for payload vibrations.
- ▶ **The DMP's x-axis gyroscope failed on 8 Aug 2023.** This was anticipated following a steady decline in the laser intensity over several months. *Is this a problem?*

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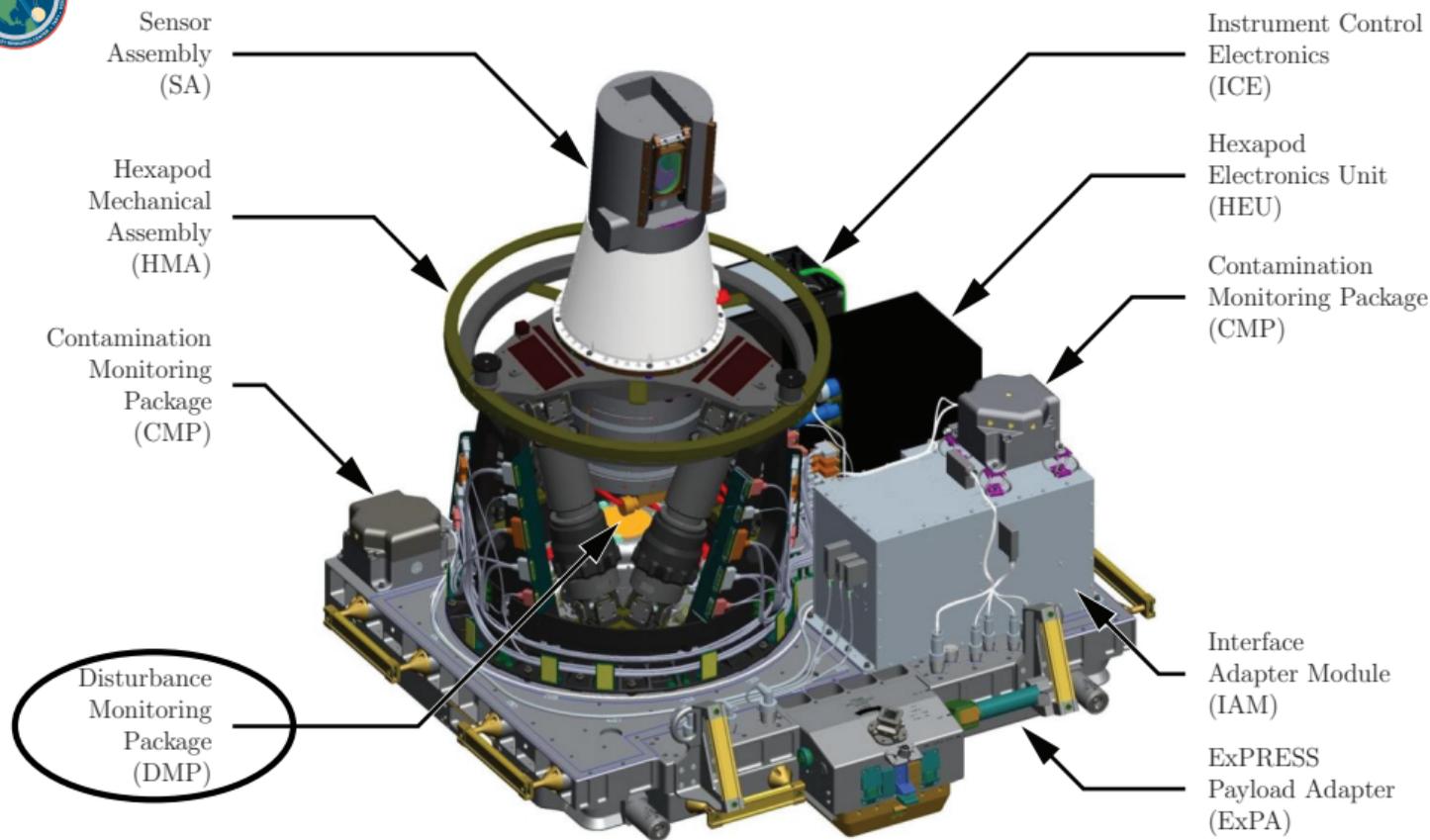
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SAGE III ISS



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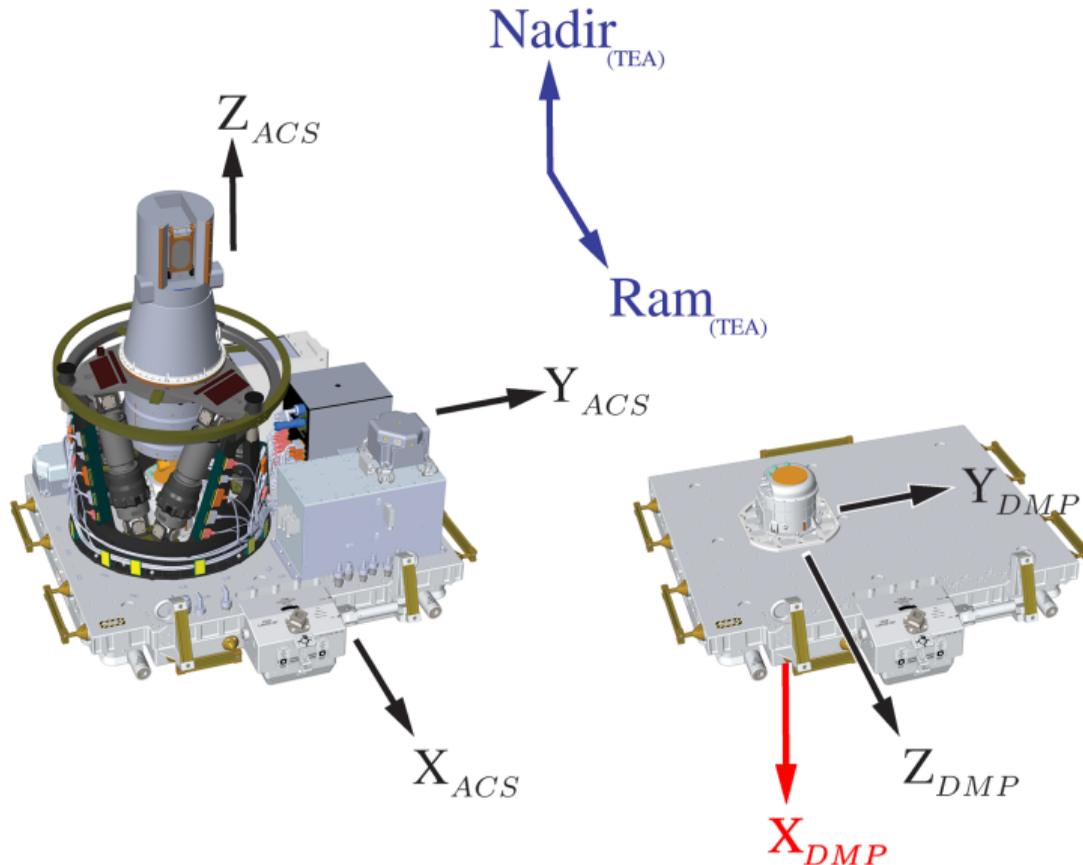
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Payload Axes



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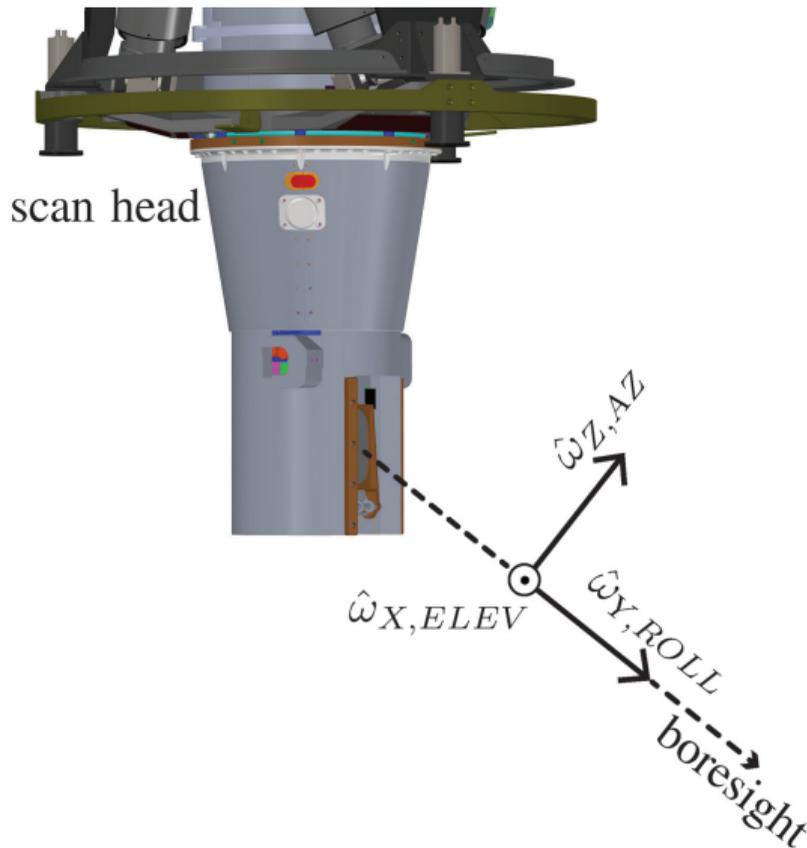
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SAGE III Boresight Coordinates



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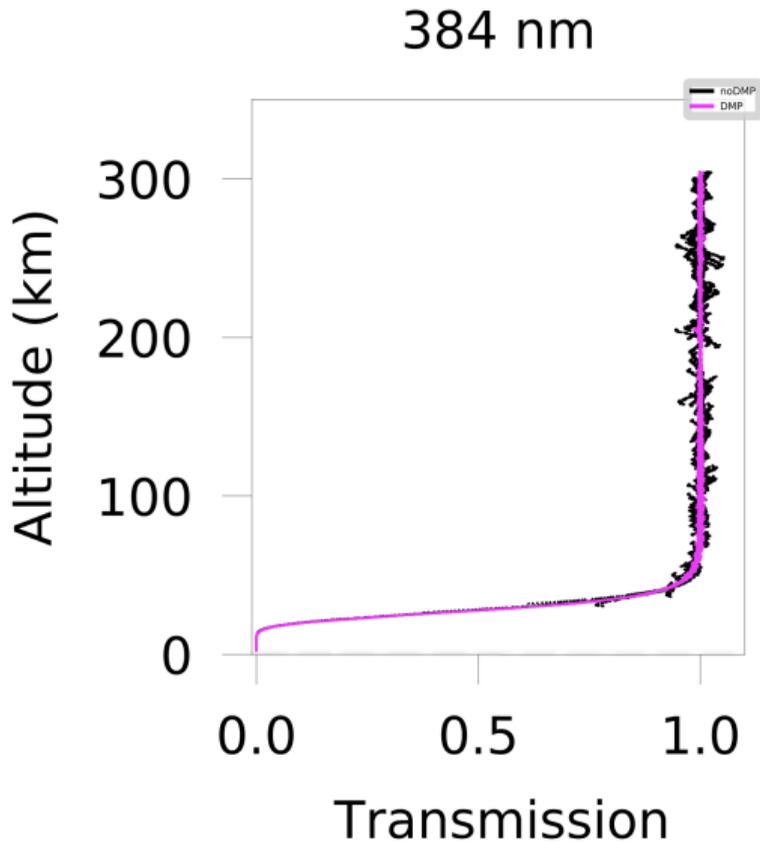
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Elevation Correction Improves Transmission Noise



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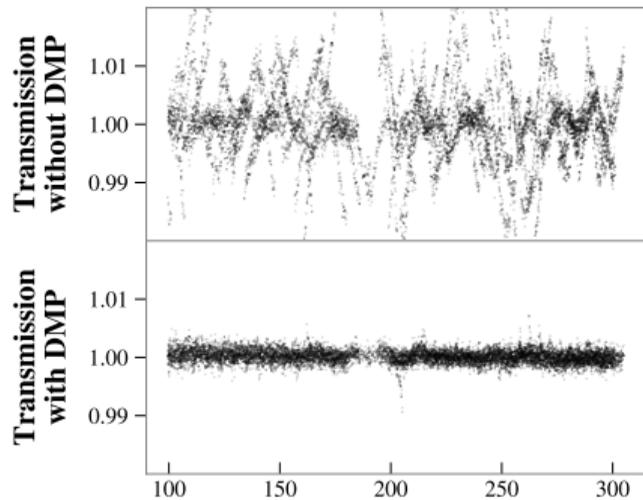
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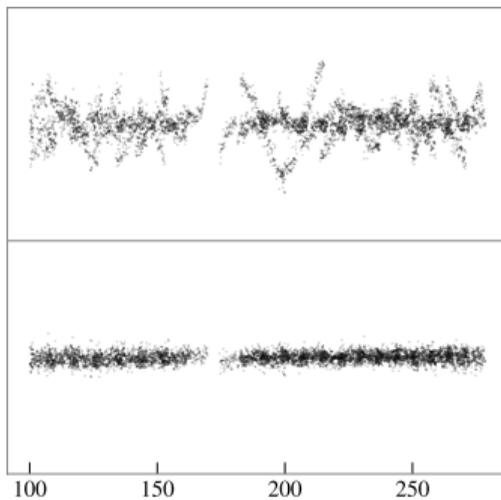
Questions

Elevation Correction Improves Transmission Noise

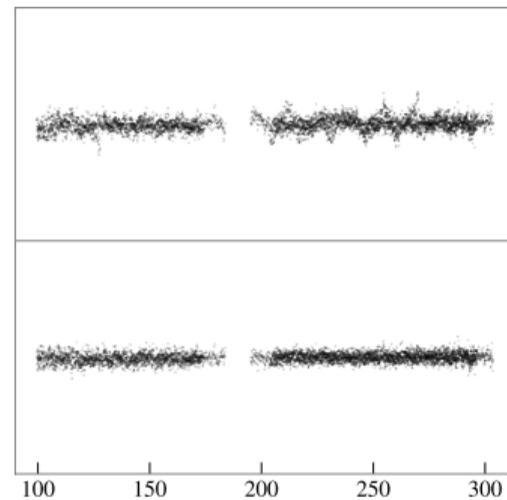
**High Disturbance
Event 2018051633SR**



**Medium Disturbance
Event 2017091637SS**



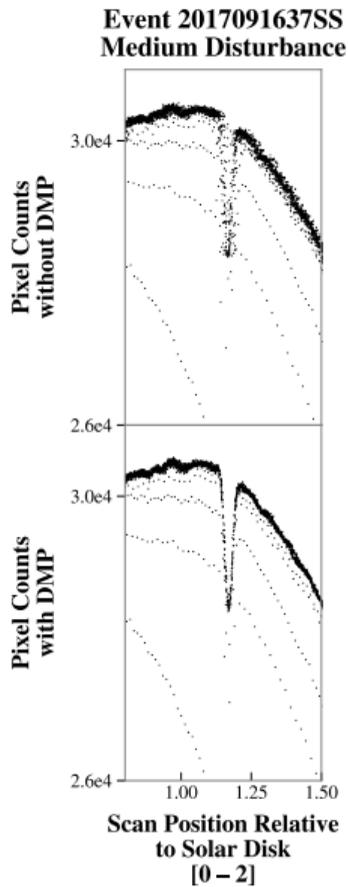
**Low Disturbance
Event 2019082825SR**



Altitude (km)



Elevation Correction Improves Transmission Noise



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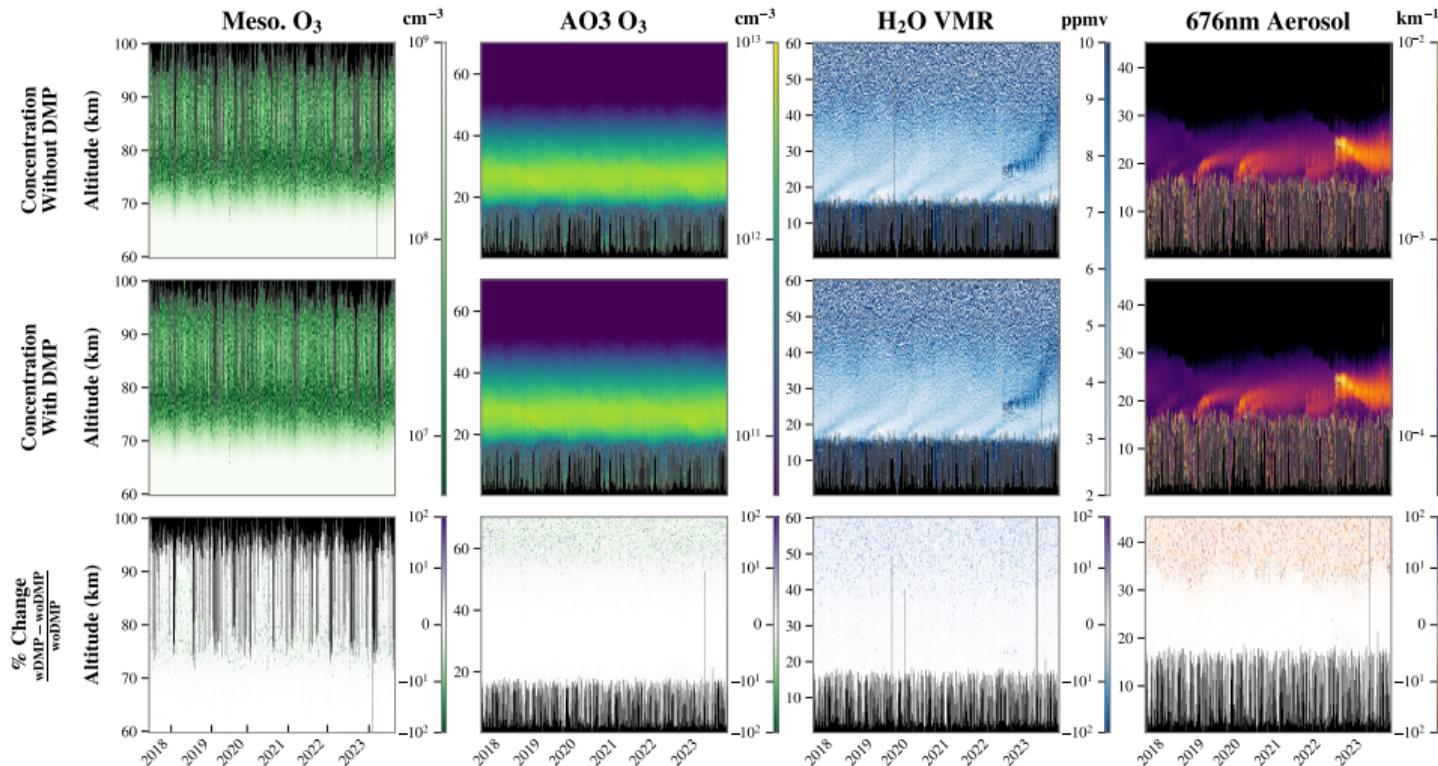
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DMP Doesn't Significantly Change Profiles



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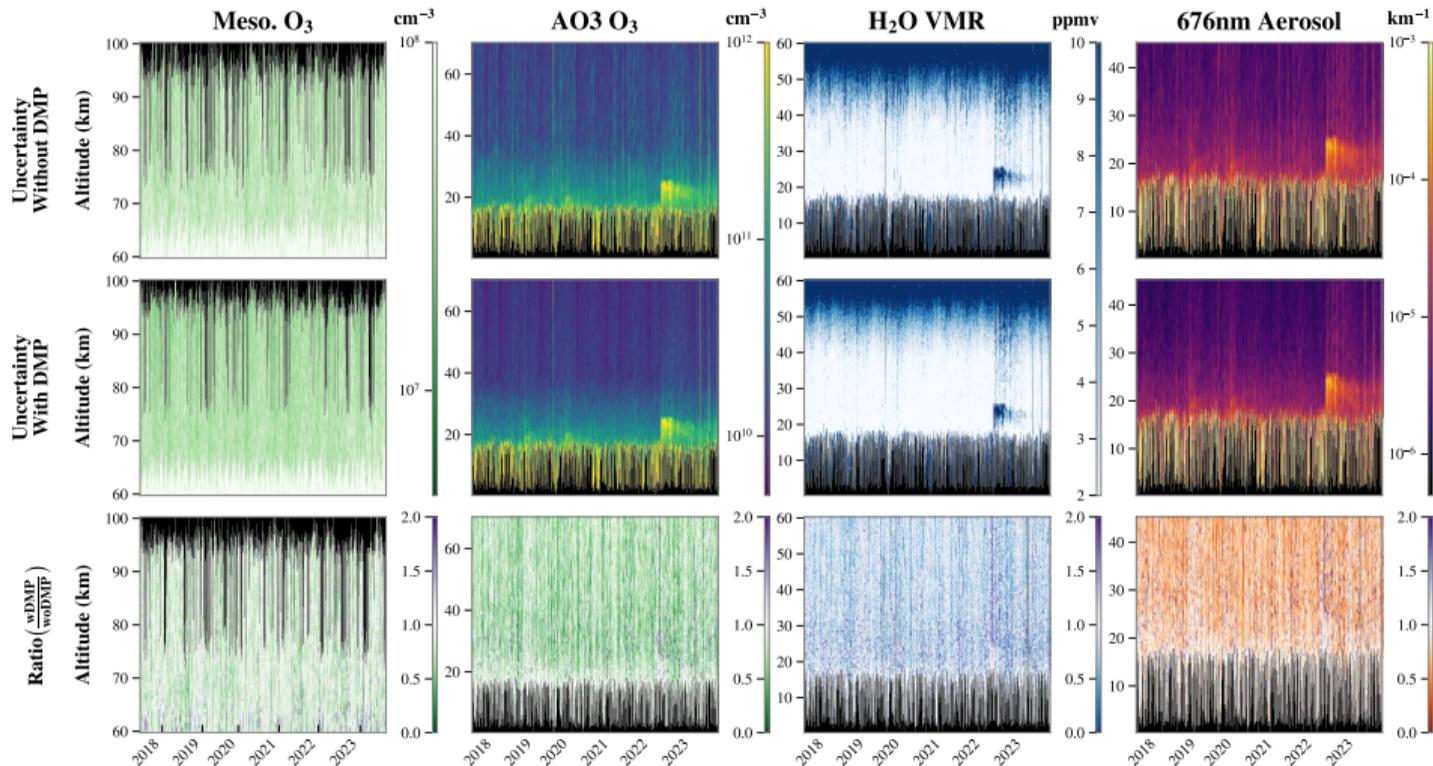
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DMP Correction Improves Uncertainties Significantly



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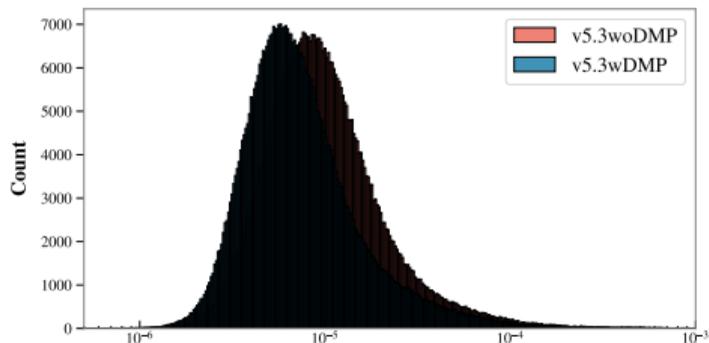
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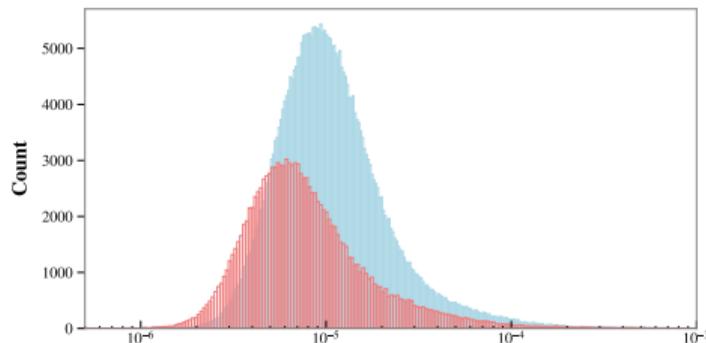
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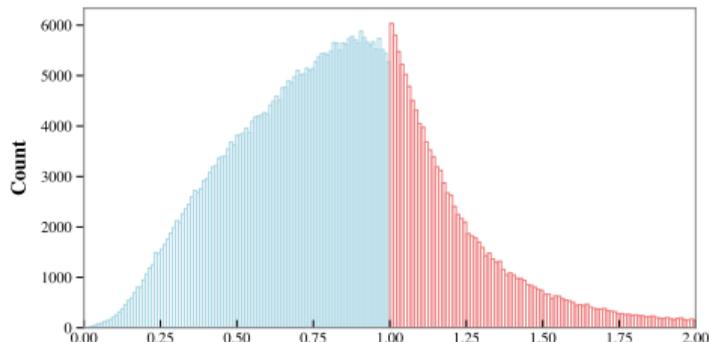
676 nm Aerosol Ext. Uncertainties at 20 km (± 2 km)



676nm Aerosol Uncertainty

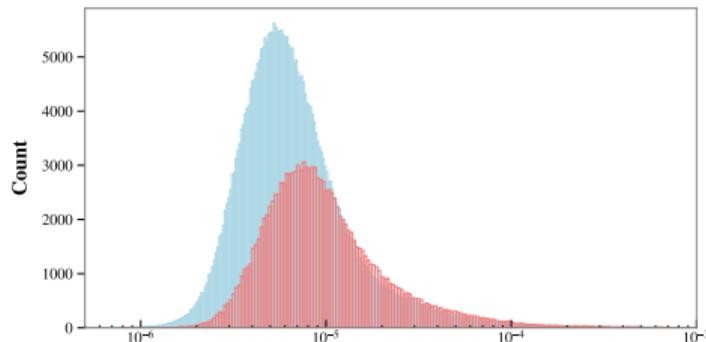


676nm Aerosol Uncertainty in v5.3 without DMP



Uncertainty Ratio ($\frac{v5.3wDMP}{v5.3woDMP}$)

□ < 1 □ > 1



676nm Aerosol Uncertainty in v5.3 with DMP

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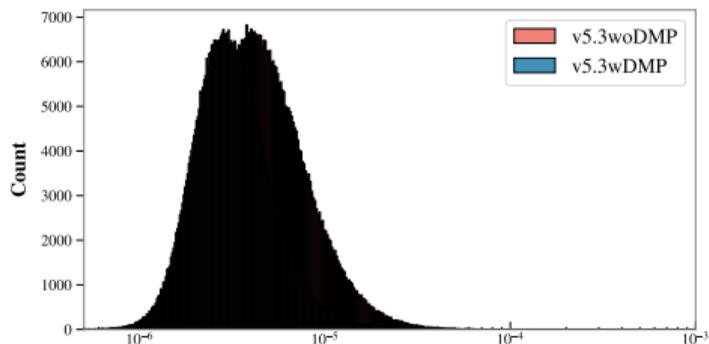
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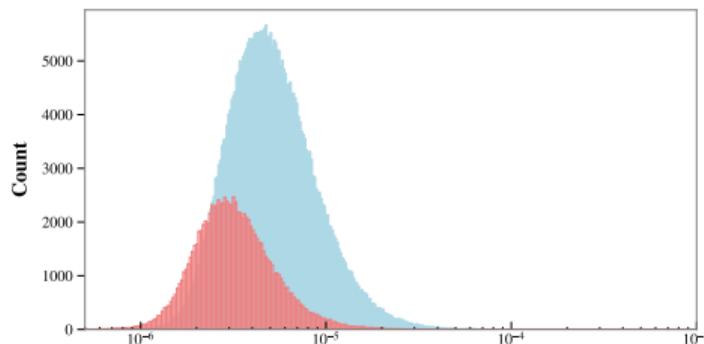
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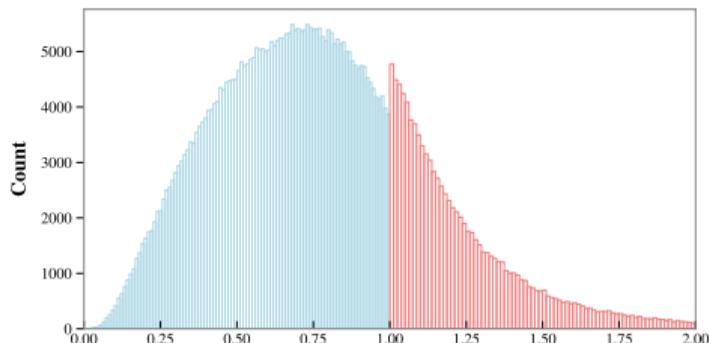
676 nm Aerosol Ext. Uncertainties at 30 km (± 2 km)



676nm Aerosol Uncertainty

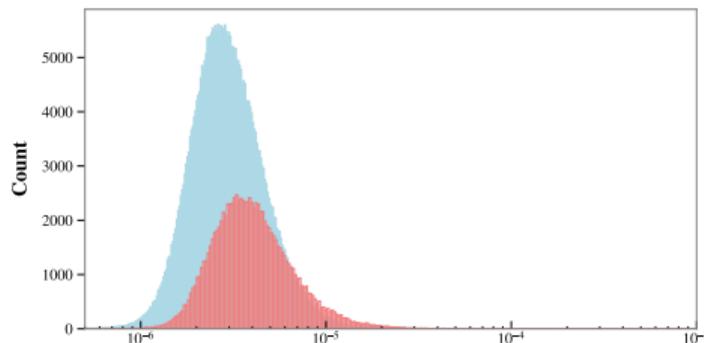


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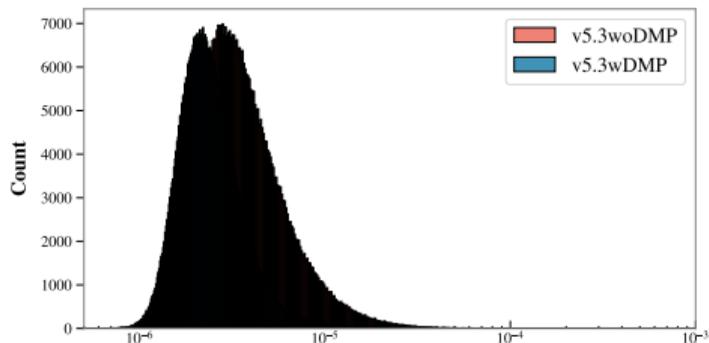
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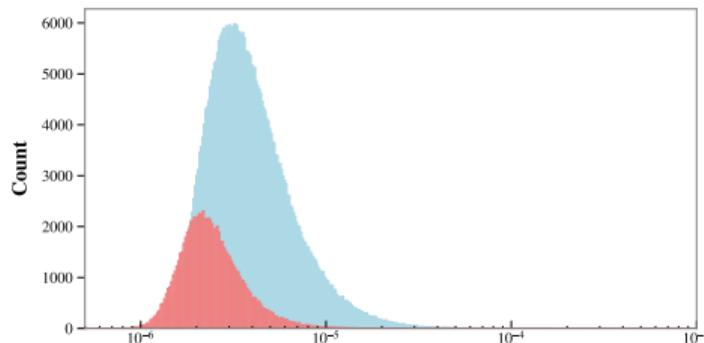
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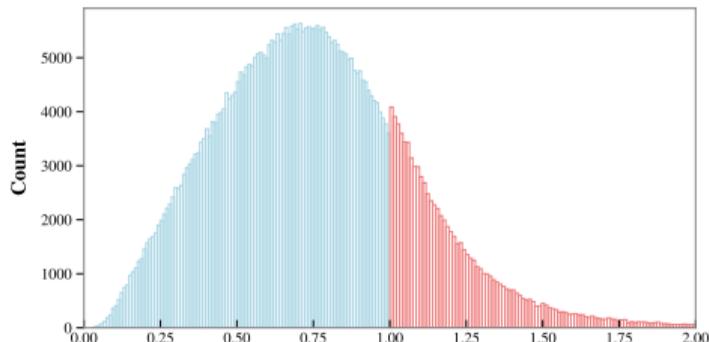
676 nm Aerosol Ext. Uncertainties at 40 km (± 2 km)



676nm Aerosol Uncertainty

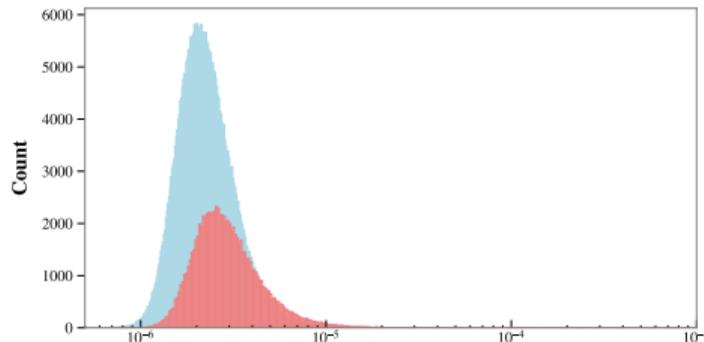


676nm Aerosol Uncertainty in v5.3 without DMP



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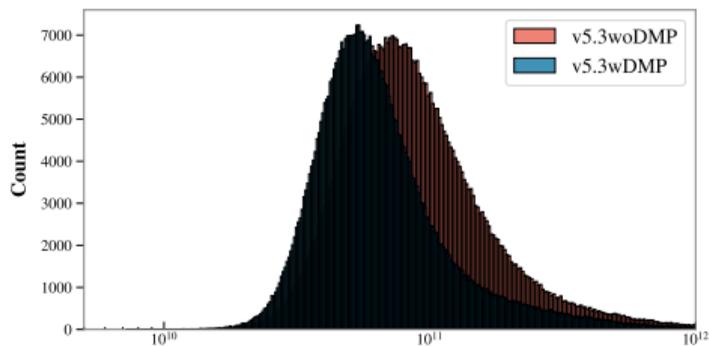
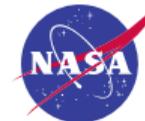
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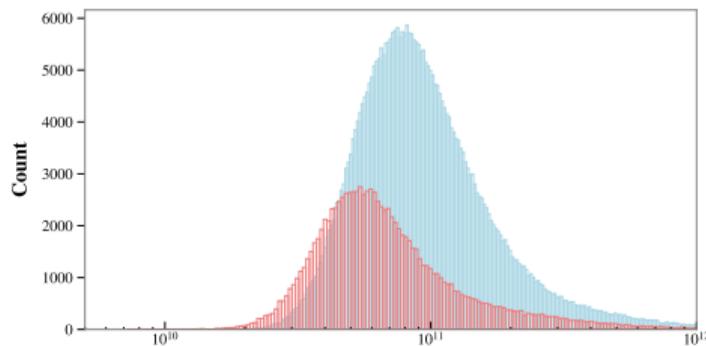
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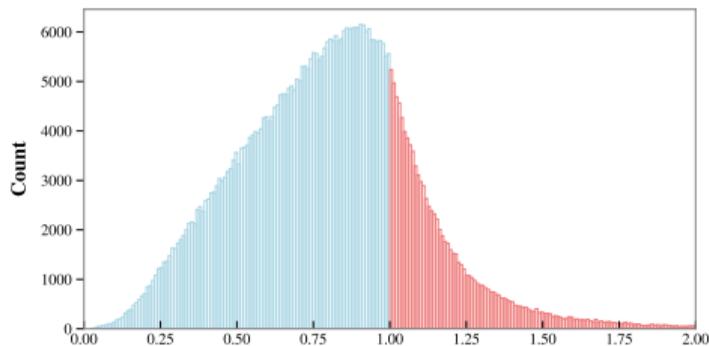
AO₃ Uncertainties at 20 km (± 2 km)



AO₃ O₃ Uncertainty

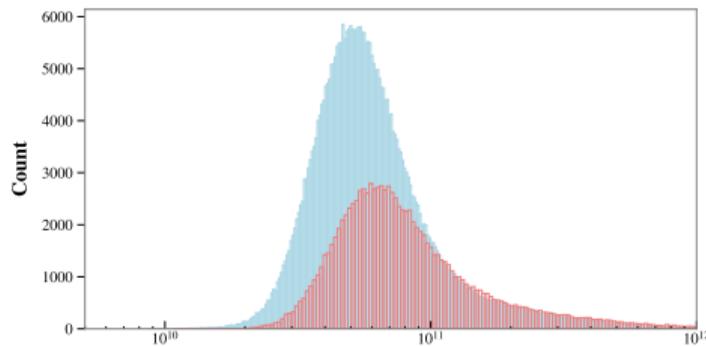


AO₃ O₃ Uncertainty in v5.3 without DMP



Uncertainty Ratio ($\frac{v5.3wDMP}{v5.3woDMP}$)

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AO₃ O₃ Uncertainty in v5.3 with DMP

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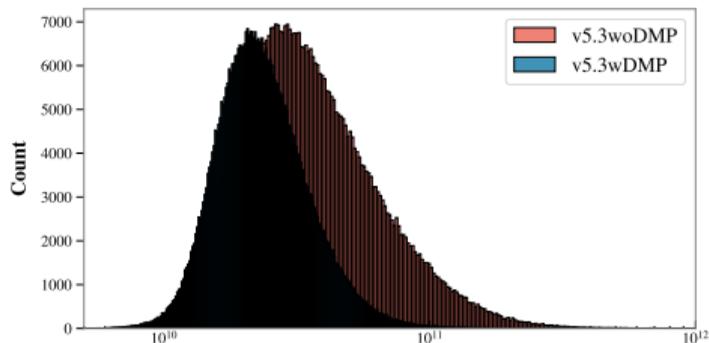
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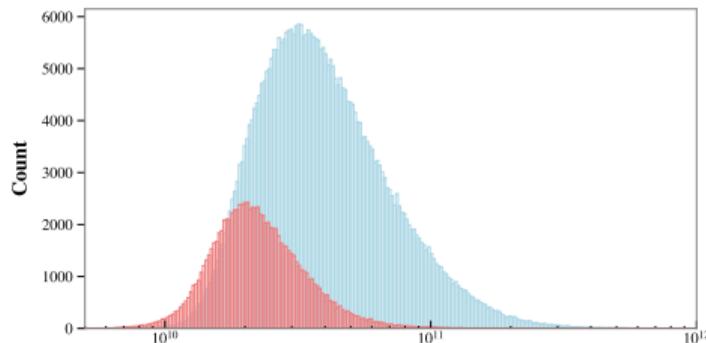
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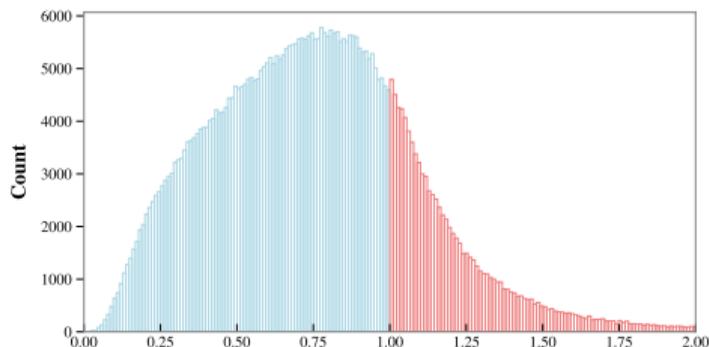
AO₃ Uncertainties at 30 km (± 2 km)



AO₃ O₃ Uncertainty

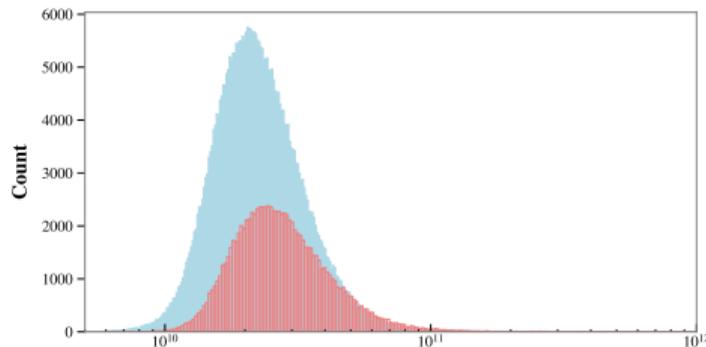


AO₃ O₃ Uncertainty in v5.3 without DMP



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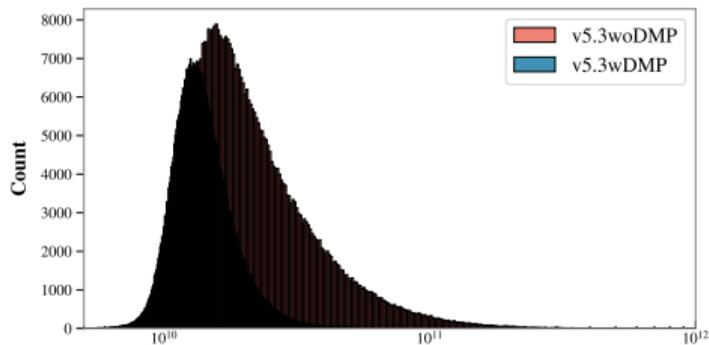
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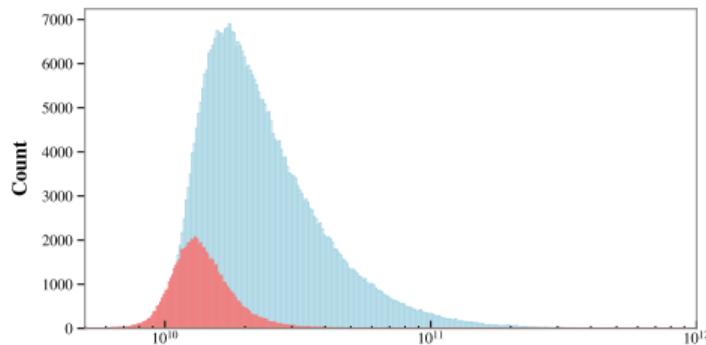
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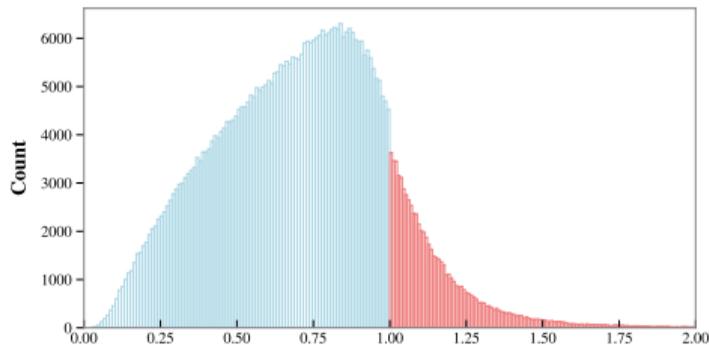
AO₃ Uncertainties at 40 km (± 2 km)



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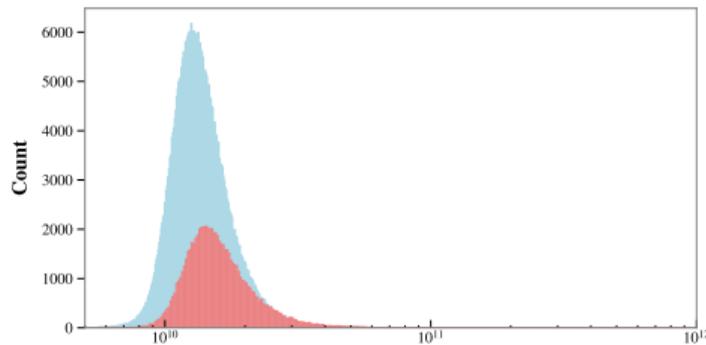


AO₃ O₃ Uncertainty in v5.3 without DMP



Uncertainty Ratio ($\frac{v5.3wDMP}{v5.3woDMP}$)

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AO₃ O₃ Uncertainty in v5.3 with DMP

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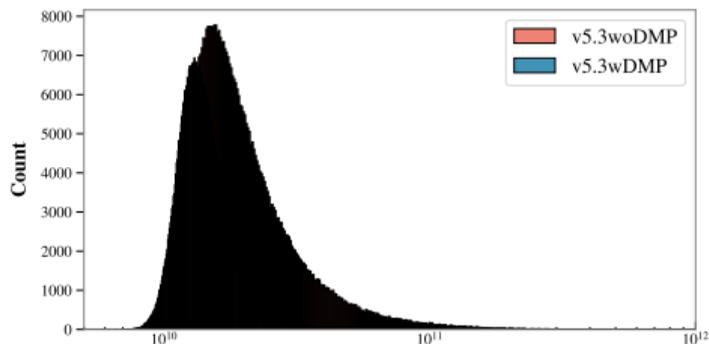
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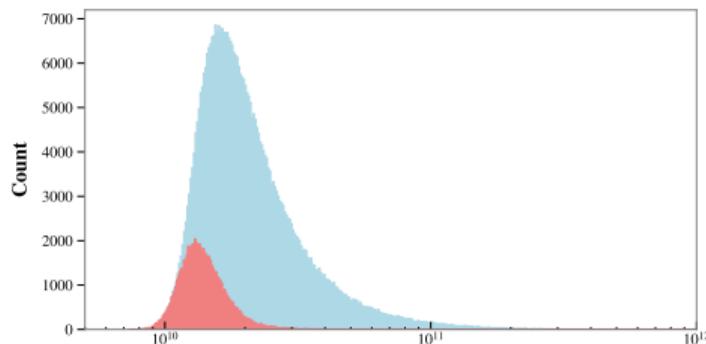
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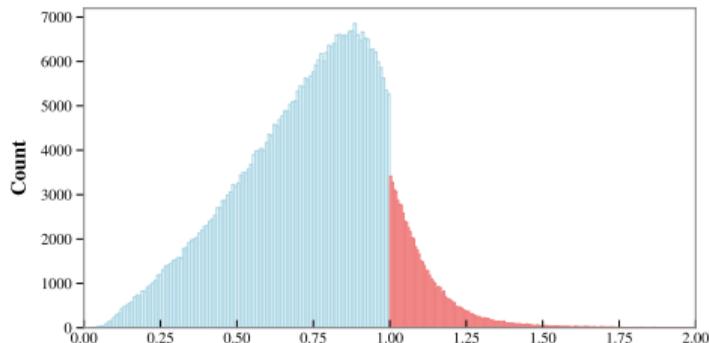
AO₃ Uncertainties at 50 km (± 2 km)



AO₃ O₃ Uncertainty

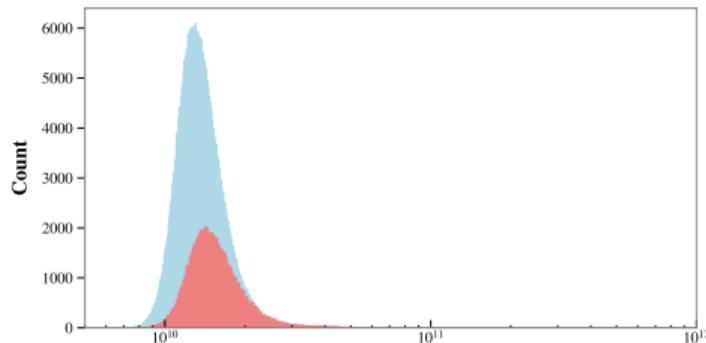


AO₃ O₃ Uncertainty in v5.3 without DMP



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AO₃ O₃ Uncertainty in v5.3 with DMP

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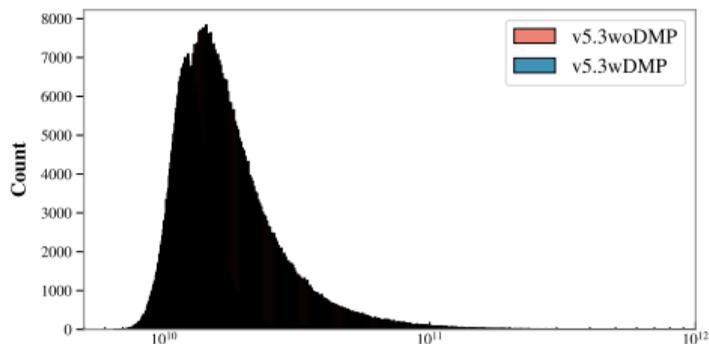
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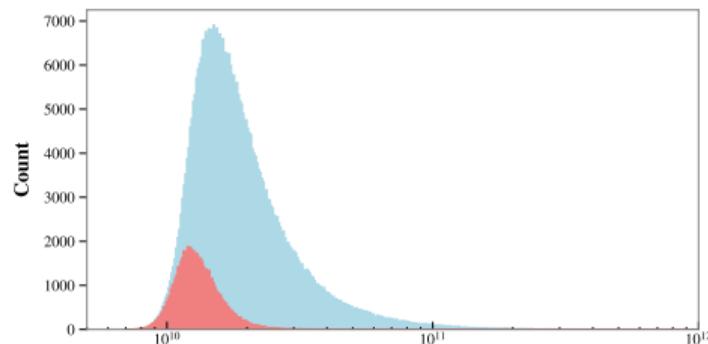
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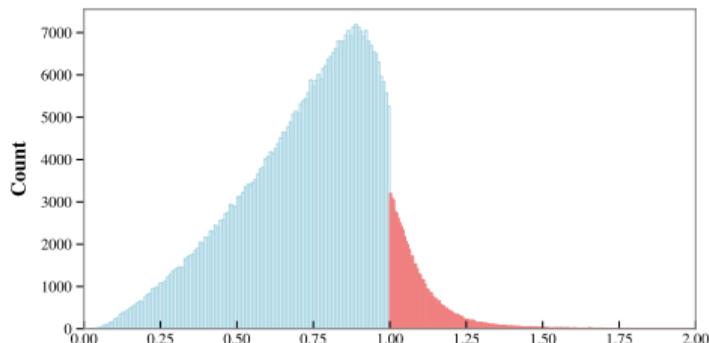
AO₃ Uncertainties at 60 km (± 2 km)



AO₃ O₃ Uncertainty

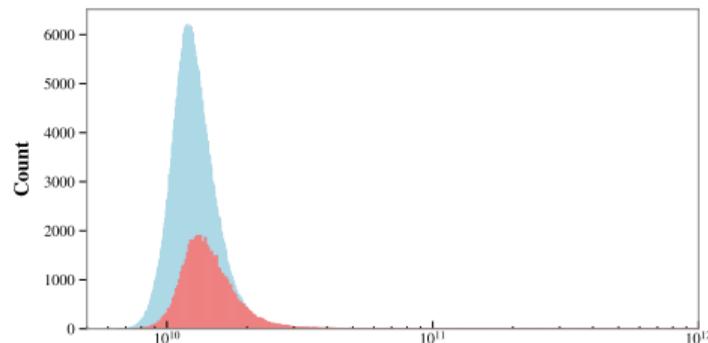


AO₃ O₃ Uncertainty in v5.3 without DMP



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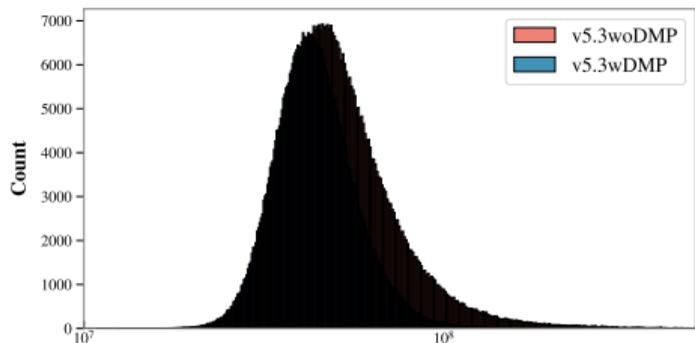
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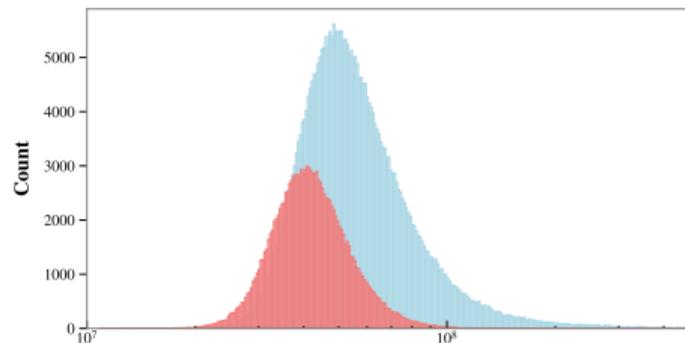
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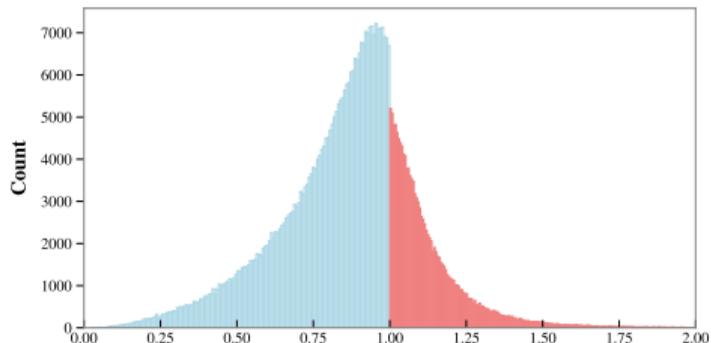
Meso. O₃ Uncertainties at 70 km (± 2 km)



Meso. O₃ Uncertainty

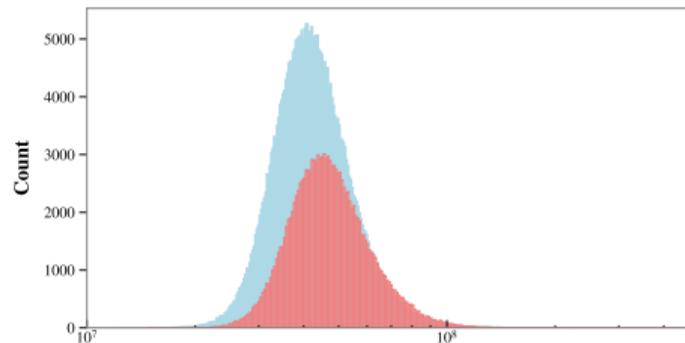


Meso. O₃ Uncertainty in v5.3 without DMP



Uncertainty Ratio ($\frac{v5.3wDMP}{v5.3woDMP}$)

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Meso. O₃ Uncertainty in v5.3 with DMP

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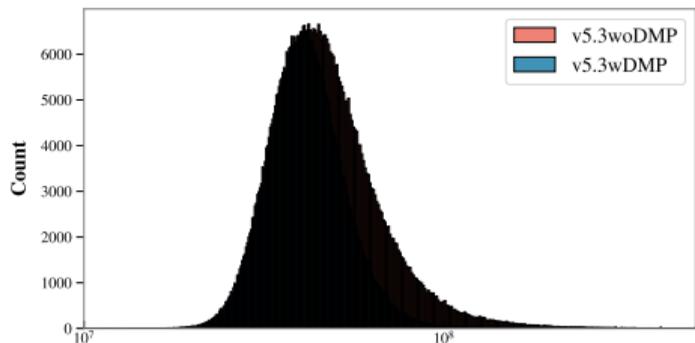
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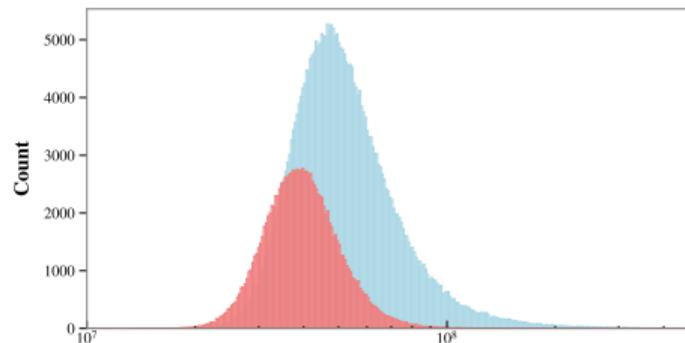
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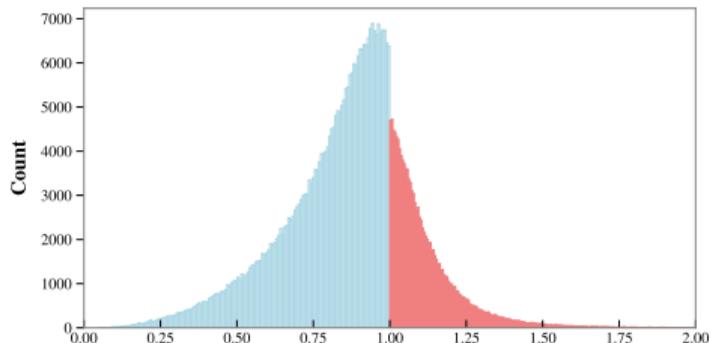
Meso. O₃ Uncertainties at 80 km (± 2 km)



Meso. O₃ Uncertainty

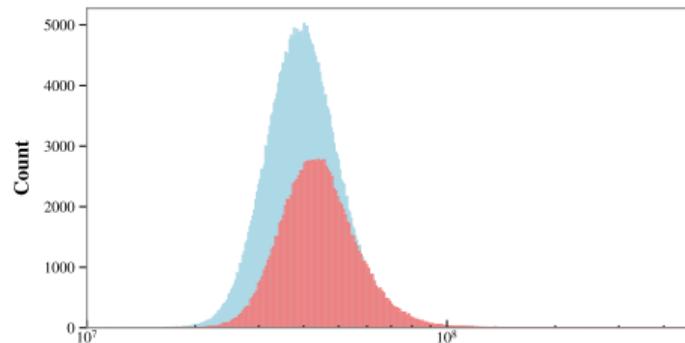


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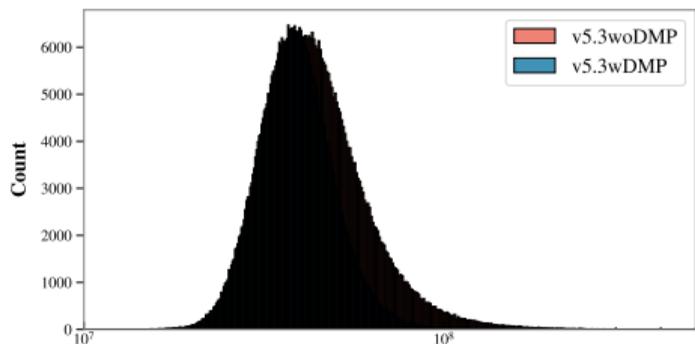
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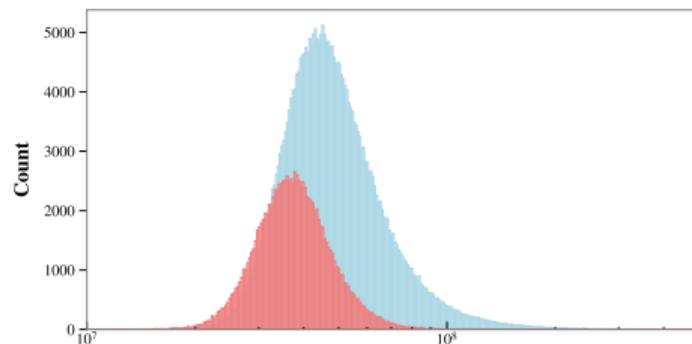
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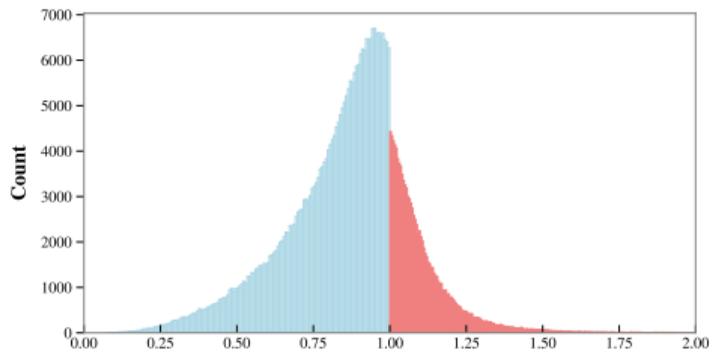
Meso. O₃ Uncertainties at 90 km (± 2 km)



Meso. O₃ Uncertainty

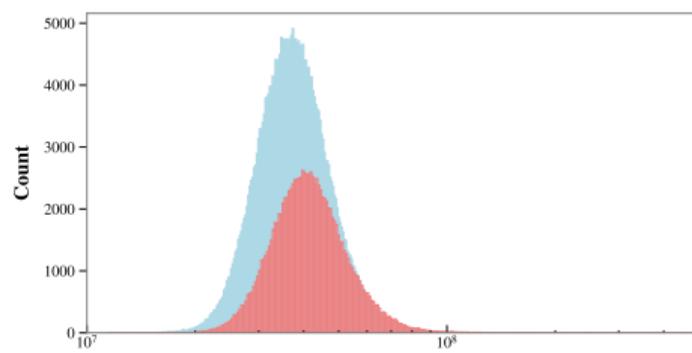


Meso. O₃ Uncertainty in v5.3 without DMP



Uncertainty Ratio ($\frac{v5.3wDMP}{v5.3woDMP}$)

□ < 1 □ > 1



Meso. O₃ Uncertainty in v5.3 with DMP

Utilization of DMP in Data Products

Charles Hill

DMP Overview

- What is it?
- Where is it?
- Defining Axes
- How are we using it?

Product Improvements

- The Big Picture
- Many Histograms...

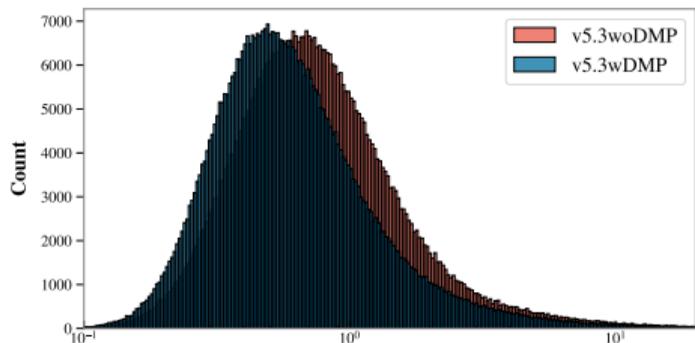
Life Without the x-Axis

Summary

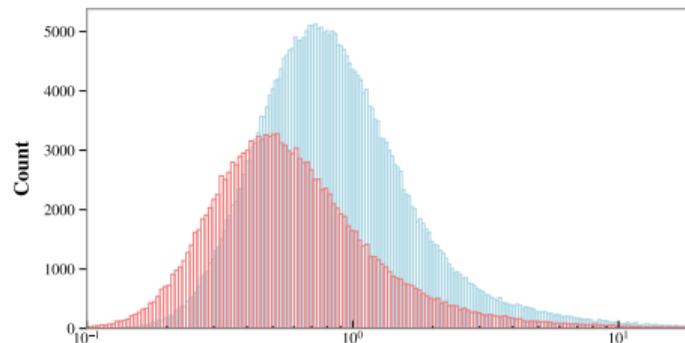
Questions



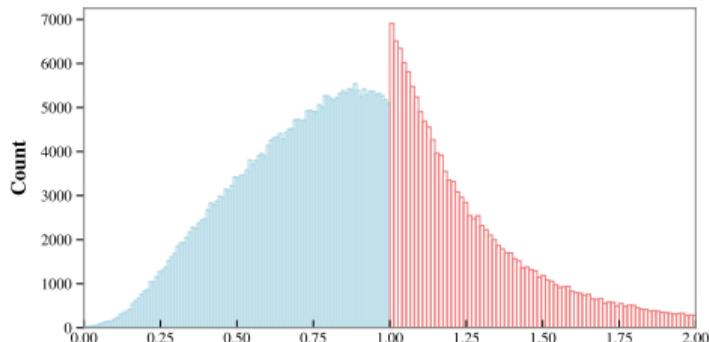
H₂O Uncertainties at 20 km (± 2 km)



H₂O VMR Uncertainty

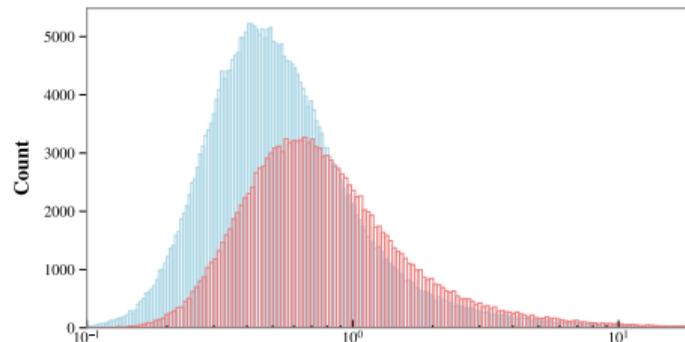


H₂O VMR Uncertainty in v5.3 without DMP



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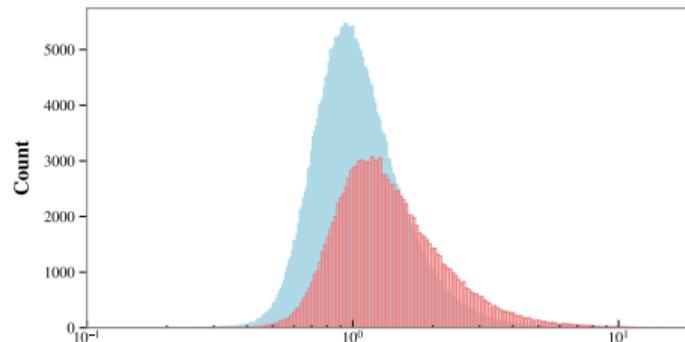
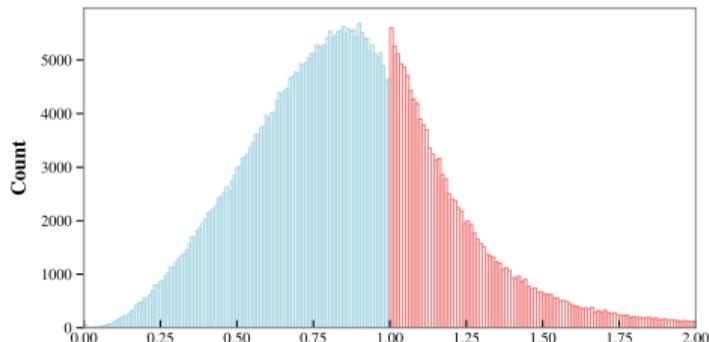
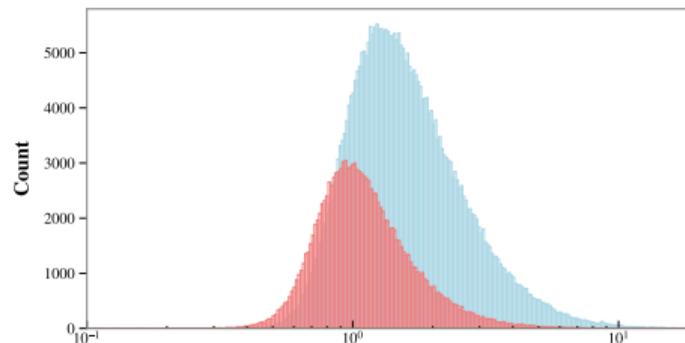
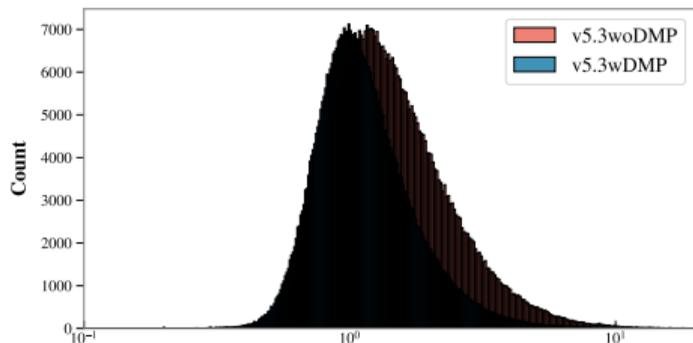
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H₂O Uncertainties at 30 km (± 2 km)



< 1 > 1

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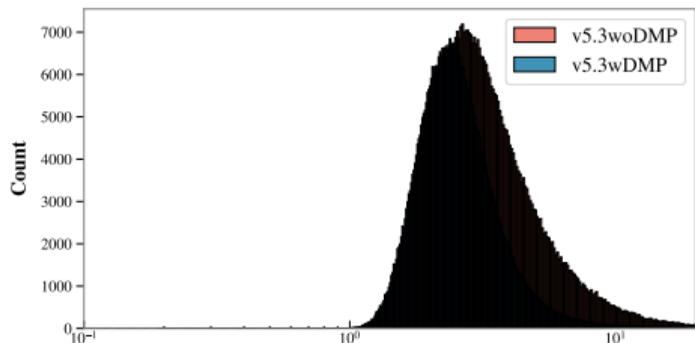
Life Without the
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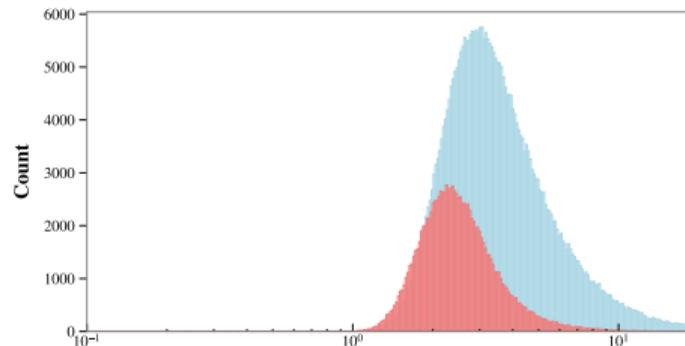
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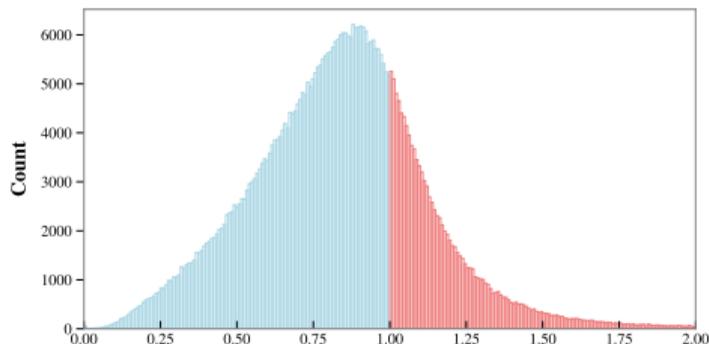
H₂O Uncertainties at 40 km (± 2 km)



H₂O VMR Uncertainty

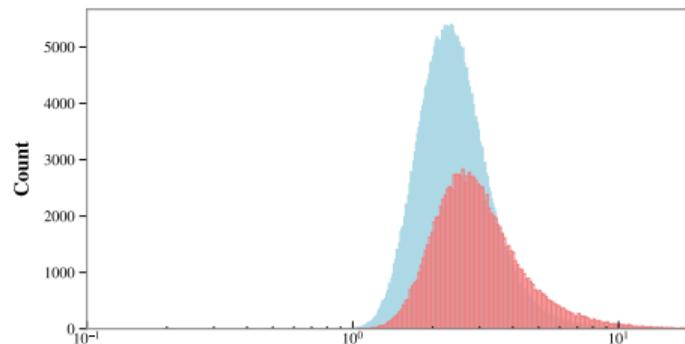


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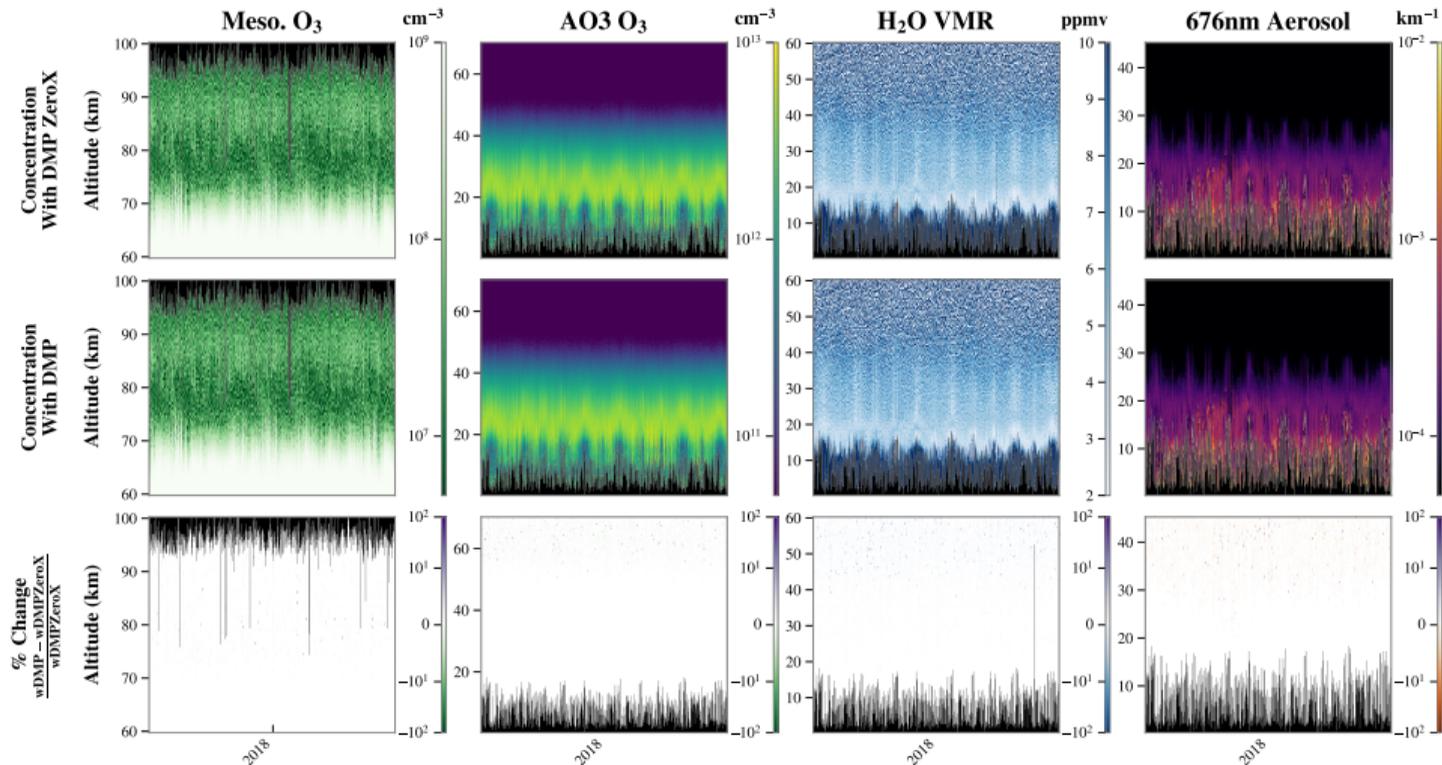
Life Without the x-Axis

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Simulated Loss of DMP x-Axis in 2018



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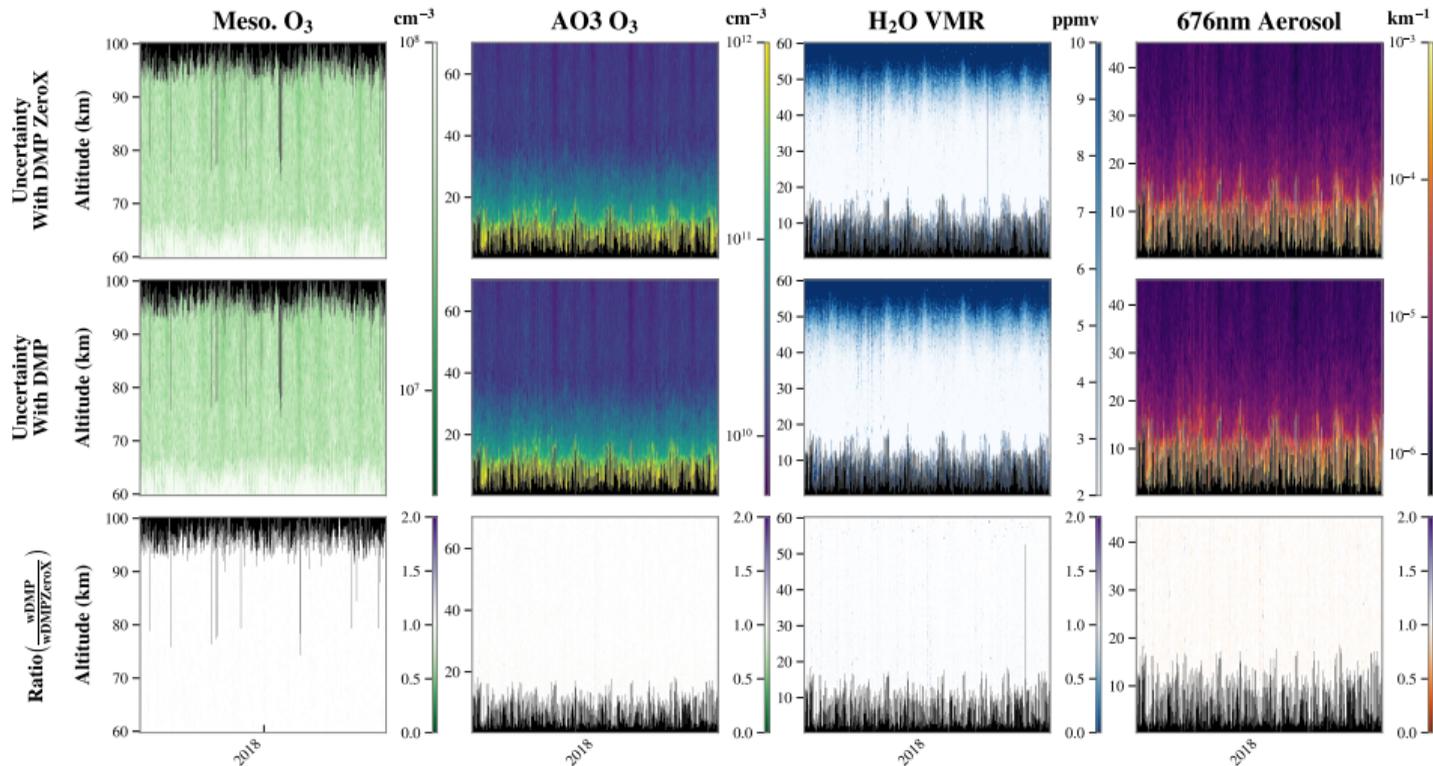
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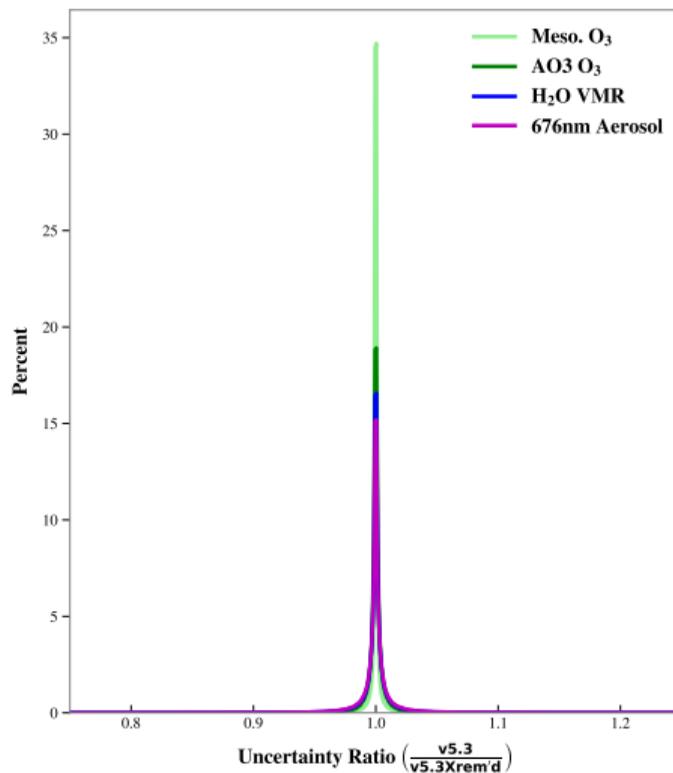
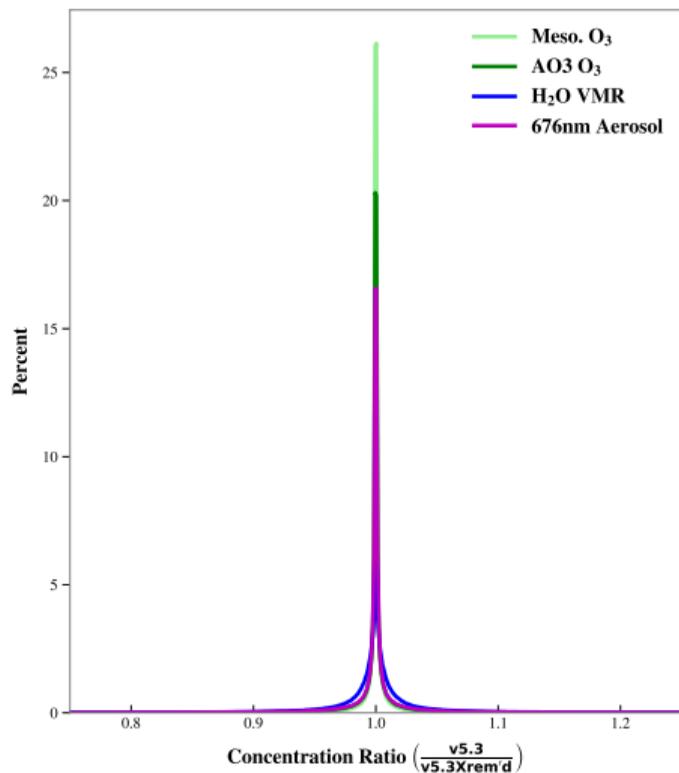
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DMP Utilization is a Success Story



- ▶ The DMP correction to the data product in v5.3 has significantly reduced the product uncertainties caused by ISS vibrations.
- ▶ Level 2 abundances and extinctions have not changed appreciably because of the robust handling of v5.2 binning statistics by the inversion algorithm team.
- ▶ The DMP x-axis gyroscope has failed.
 - The x-axis represents vibrations that are predominantly in the instrument's azimuthal direction and handled by the scan head.
 - The DMP team have shown that loss of the x-axis will not significantly affect the DMP correction to scan plane elevation.
 - **Loss of another axis would put an end to the DMP correction.**



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