

The Advanced Ultra-high Resolution Optical and Radiofrequency (AURORA) Pathfinder

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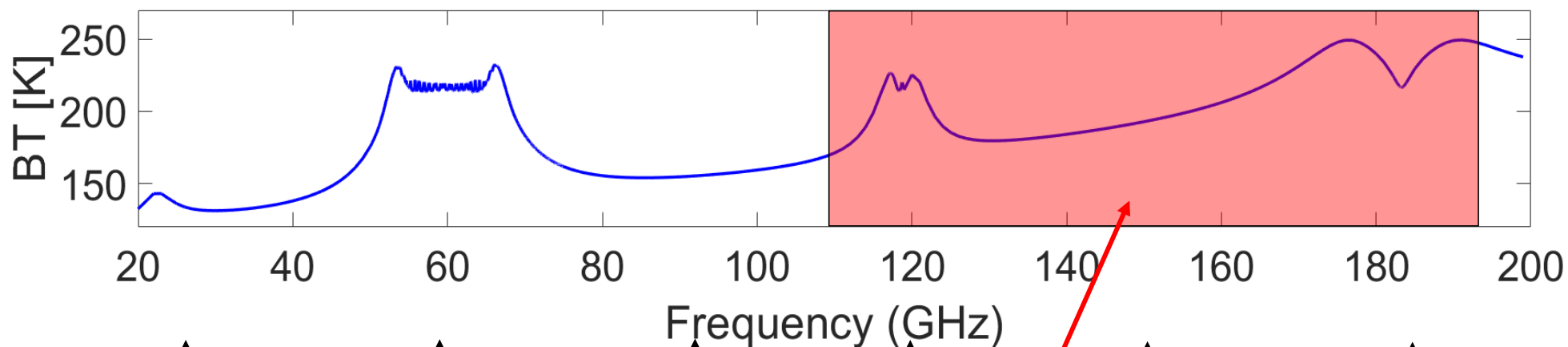
Acknowledgements



- **FY24 IIP & DSI NASA ESTO:** “The Advanced Ultra-high Resolution Optical RAdiometer (AURORA) Pathfinder” – *PI: Gambacorta, NASA GSFC*
- **FY23 NASA ESTO, HQ & NOAA:** “The Westcoast & Heartland Hyperspectral Microwave Sensor Intensive Experiment (WH²yMSIE) – *PI: Gambacorta, NASA GSFC*
- **FY22 NOAA BAA:** Developing the NOAA Next Generation Hyperspectral Microwave Sensor (HyMS): Instrument Concept and Demonstration of Benefits for the NOAA Mission – *PI: Gambacorta, NASA GSFC*
- **FY22 NOAA BAA:** “Developing a Hyperspectral SounderSat Prototype” – *PI: Brown, JPL*
- **FY21 PBL DSI:** “Hyperspectral CoSMIR (CoSMIR-H)” – *PI: Kroodsmma, NASA GSFC*
- **FY21 PBL DSI:** “A Combined Passive-Active, Multi-Sensor Approach to Earth’s Planetary Boundary Layer (PBL) Sounding – *PI: Gambacorta, NASA GSFC*
- **FY21 NOAA:** “Airborne Microwave Spectrometer for NOAA Gulfstream G550” – *PI: Brown, JPL*
- **FY21 IIP:** “Photonic Integrated Circuit in Space: The Hyperspectral Microwave Photonic Instrument (H) – *PI: Gambacorta, NASA GSFC.*
- **FY20 ACT:** “Ultra-Wideband Photonic Spectrometer for PBL Sensing” - *PI: Phase Sensitive Innovations*



Enabling Improved PBL Science Through Hyperspectral Microwave Measurements



Total Precipitable Water
 Total Cloud Liquid Water
 Light Precipitation
 Surface Temperature
 Surface Emissivity
 Surface Wind Vector
 Sea Ice Concentration
 Snow Depth
 Snow Water Equivalent
 Bare Surface Soil Moisture

Temperature

Surface
 Temperature
 Precipitation

Temperature

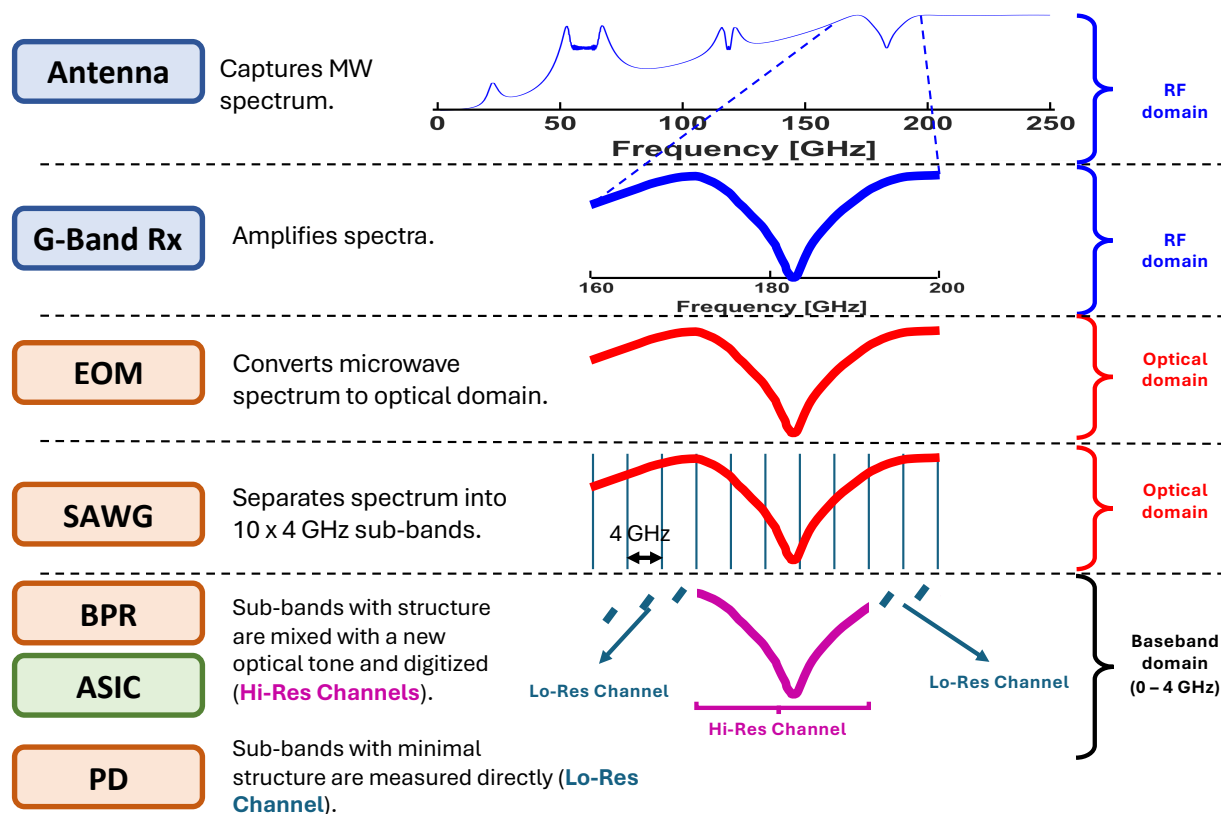
Surface
 Temperature
 Hydrometeors
 Water Vapor

Water Vapor
 Hydrometeors

Advanced Ultra-High Resolution Optical Radiometer
 (AURORA) Pathfinder



Building on The Success of The Hyperspectral Microwave Photonic Instrument (HyMPI)



A Sounder + Imager in One Instrument

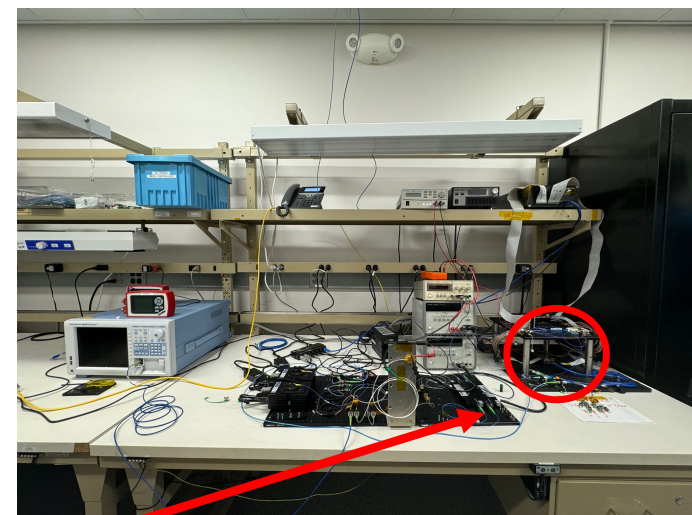
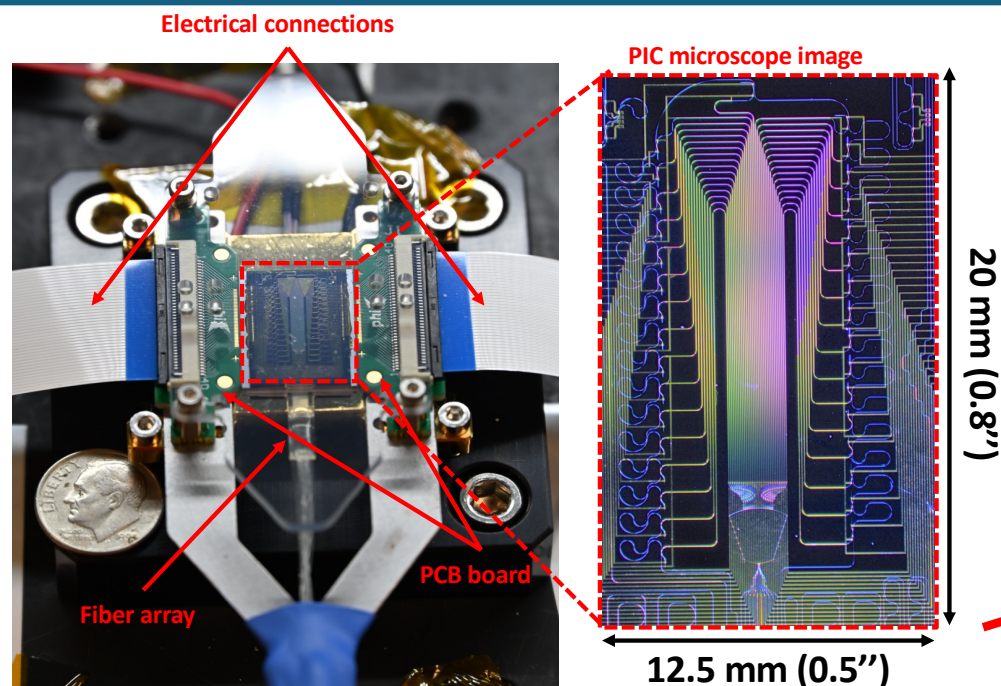
- HyMPI is a modular design, with simultaneous 40 GHz coverage
- Can be applied to multiple parts of the spectrum to obtain full, contiguous coverage of the MW thermal domain
- Paired with ASICs - “PICASIC” - it enables full, contiguous, hyperspectral resolution coverage in entire thermal domain



Title: “Serial Arrayed Waveguide”

Gambini et al., 2024, <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=860670>

HyMPI's Serial Arrayed Waveguide Grating - SAWG



NASA GSFC, Bldg.33 P. 5321

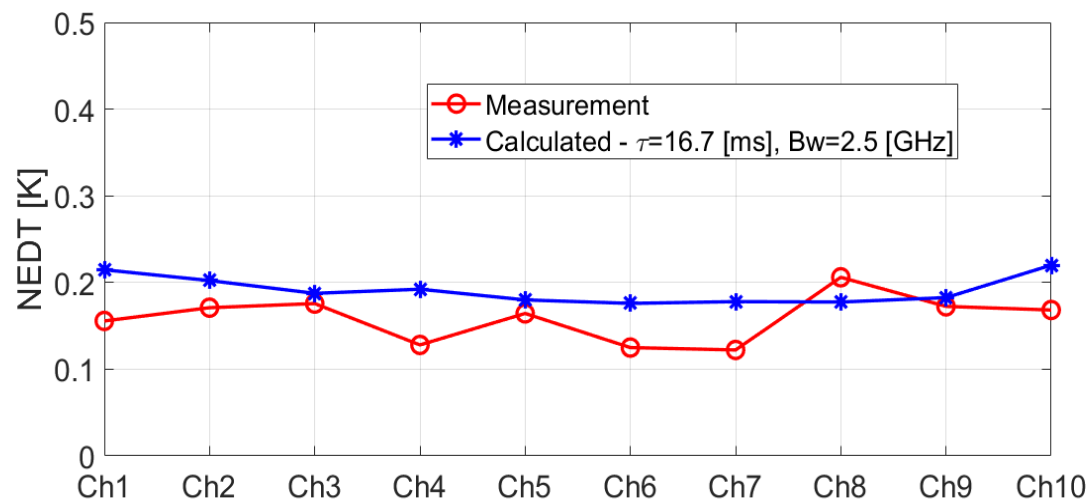


US Patent 11852864

Title: "Serial Arrayed Waveguide Grating"

Gambini et al., 2024, <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=10380670>, doi: 10.1109/JLT.2024.33495

Leveraging HyMPI's TRL Maturity to achieve Science Quality Measurements

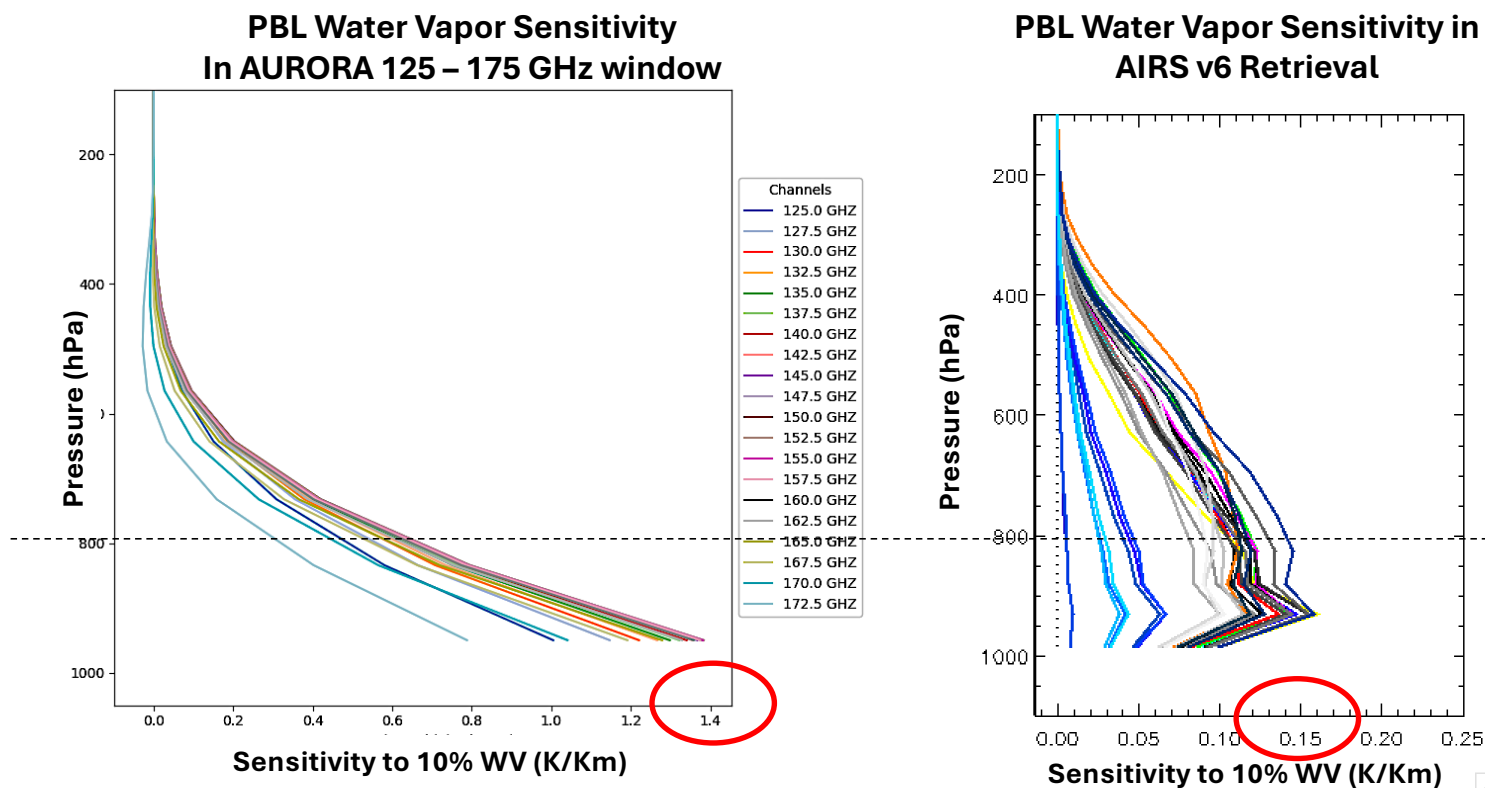


- PICs NeDT Lab measurements are within specifications: **TRL = 4**
- The Photonic Integrated Circuit module adds negligible noise to the front-end
- Low noise front end + PIC will enable science quality measurements



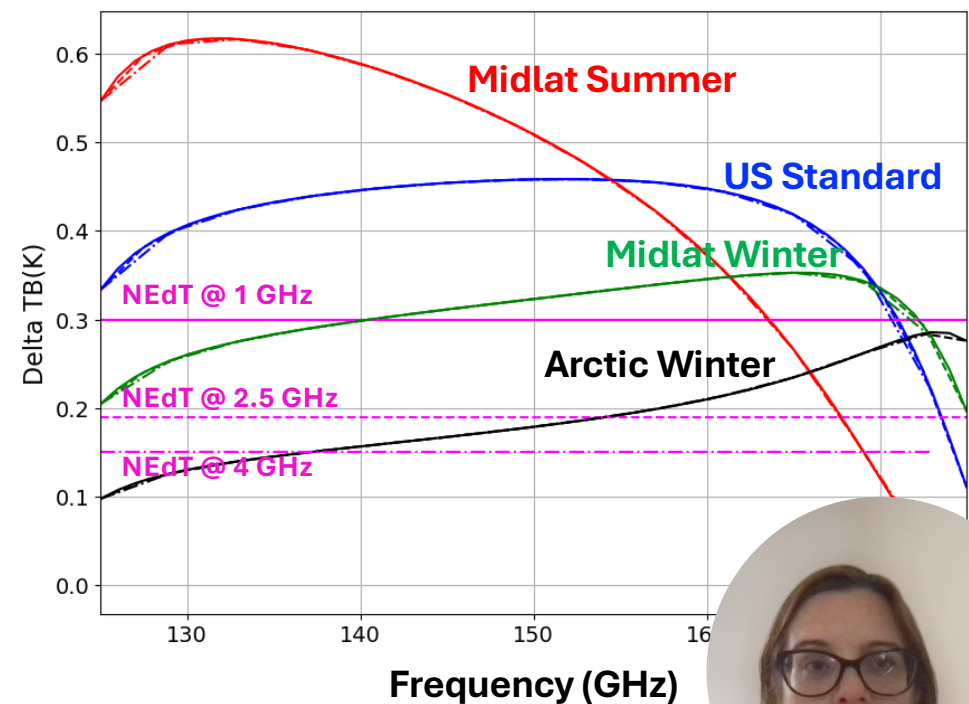
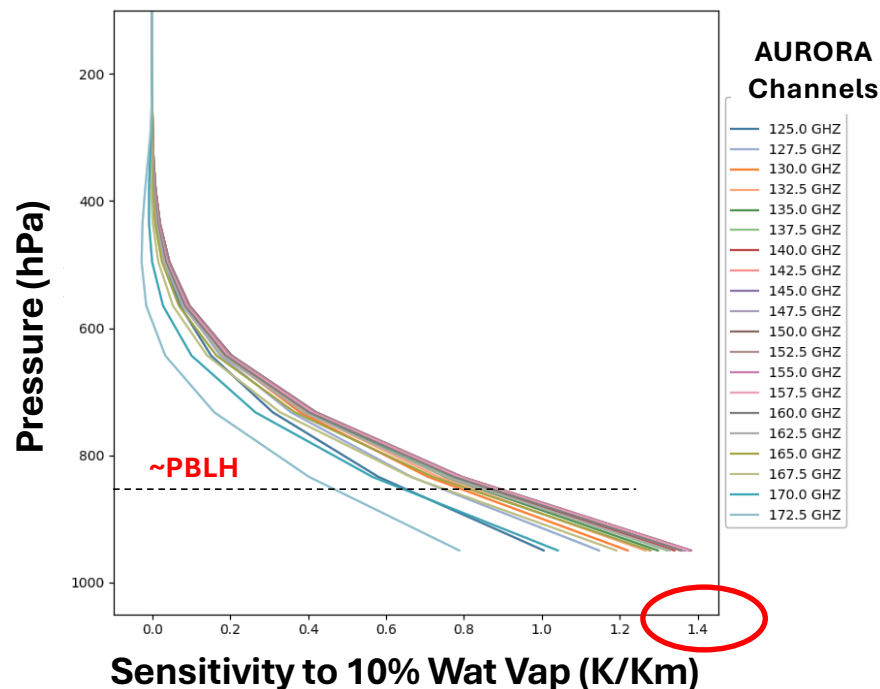
Ref.: Gambini *et al.*, DOI: [10.1109/JLT.2024.3349932](https://doi.org/10.1109/JLT.2024.3349932); V. Torres *et al.*, in submission, 2025.

Harnessing Enhanced PBL Information Content In Unexplored HMW “Window” Domain through PIC technology



Gambacorta et al., 2023, doi: 10.1109/JSTARS.2023.3269697, <https://ieeexplore.ieee.org/abstract/document/107761>

Groundbreaking Science Requires High Performing Technology: Instrument Noise Tolerance Study

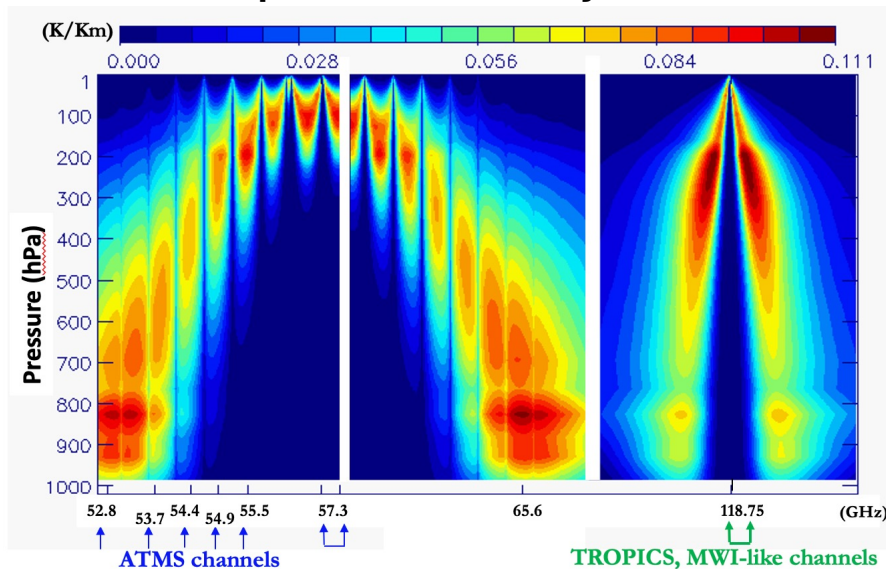


AURORA PICs will measure the broadband window region: 125 GHz – 175 GHz to achieve a global PBL product

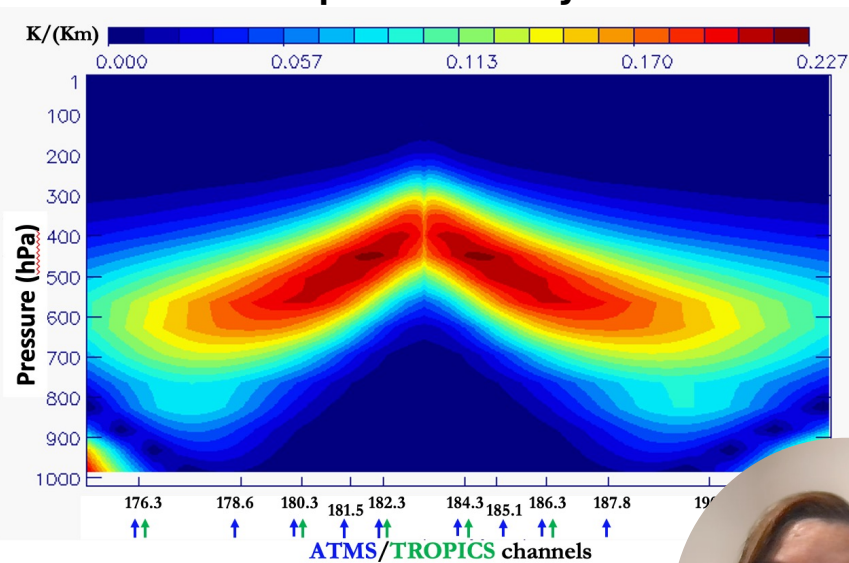


Filling The Gap in Information Content Left by the Program of Record

Temperature Sensitivity Functions



Water Vapor Sensitivity Functions

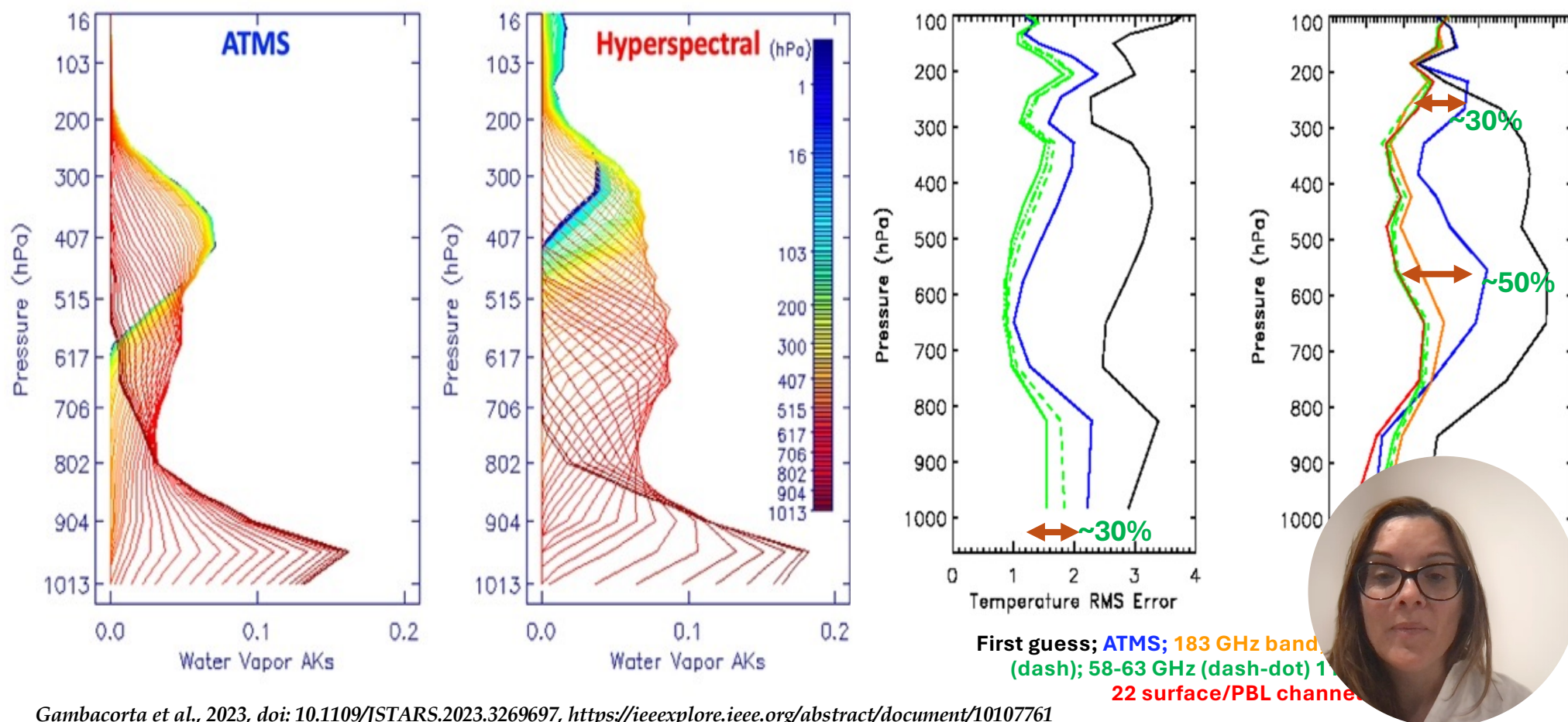


AURORA ASICs will measure the atmospheric absorption lines to achieve a PBL + free tropospheric product

Gambacorta et al., 2023, doi: 10.1109/JSTARS.2023.3269697, <https://ieeexplore.ieee.org/abstract/document/10107761>

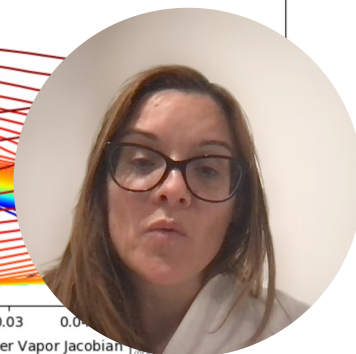
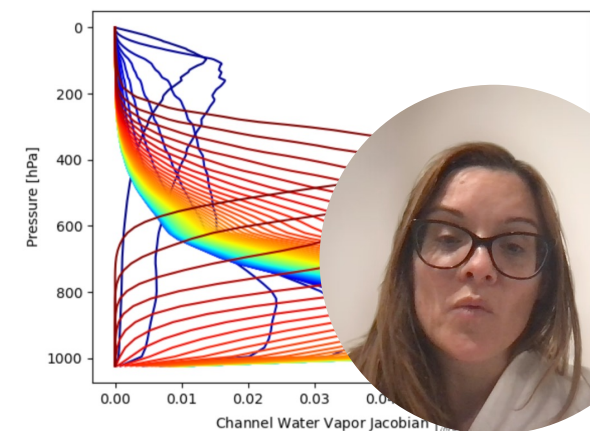
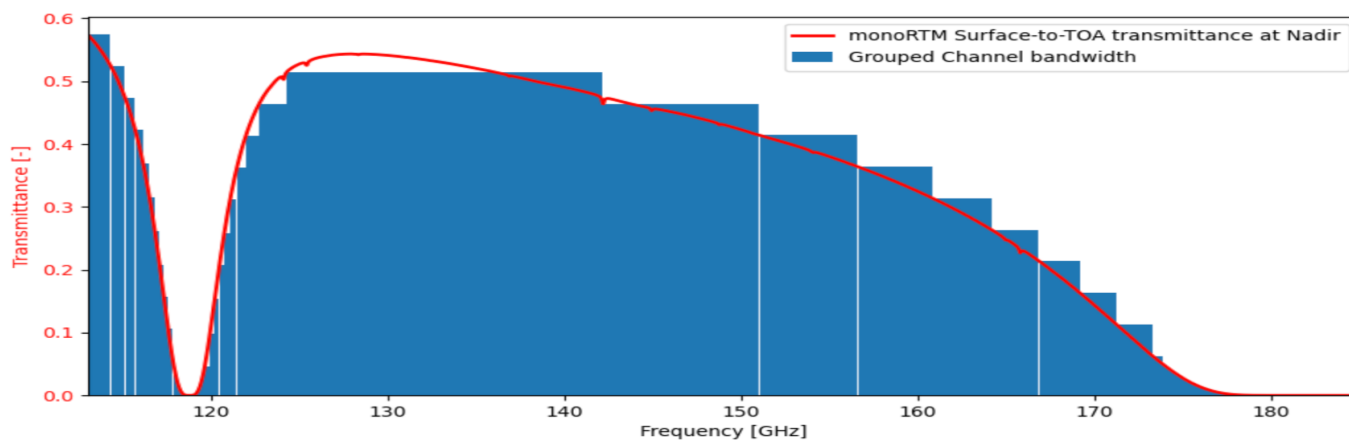
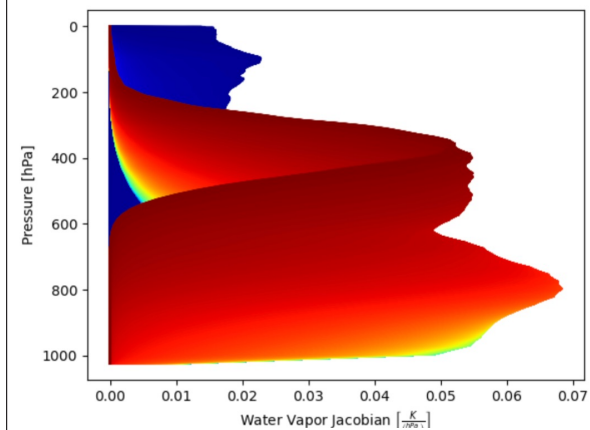
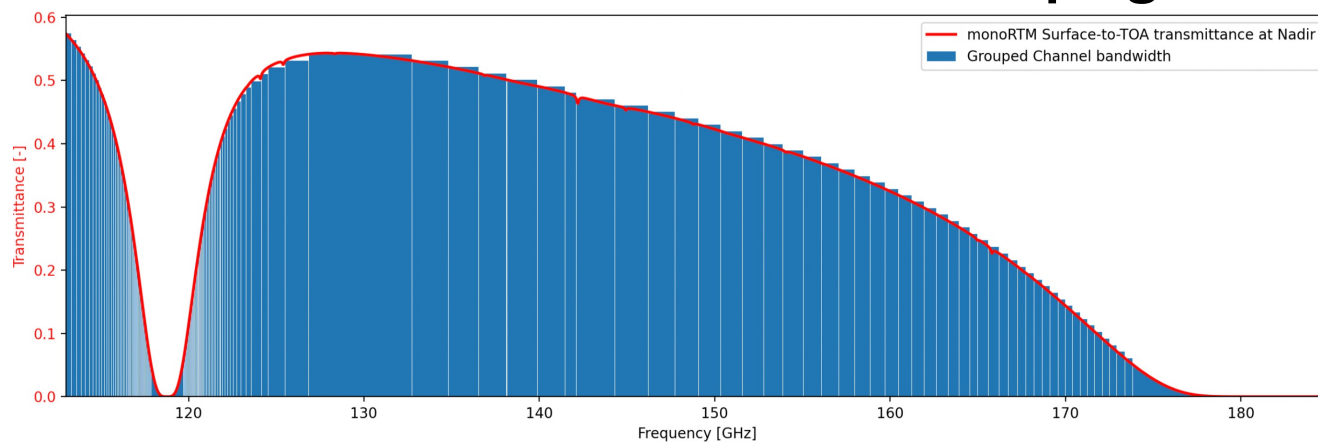


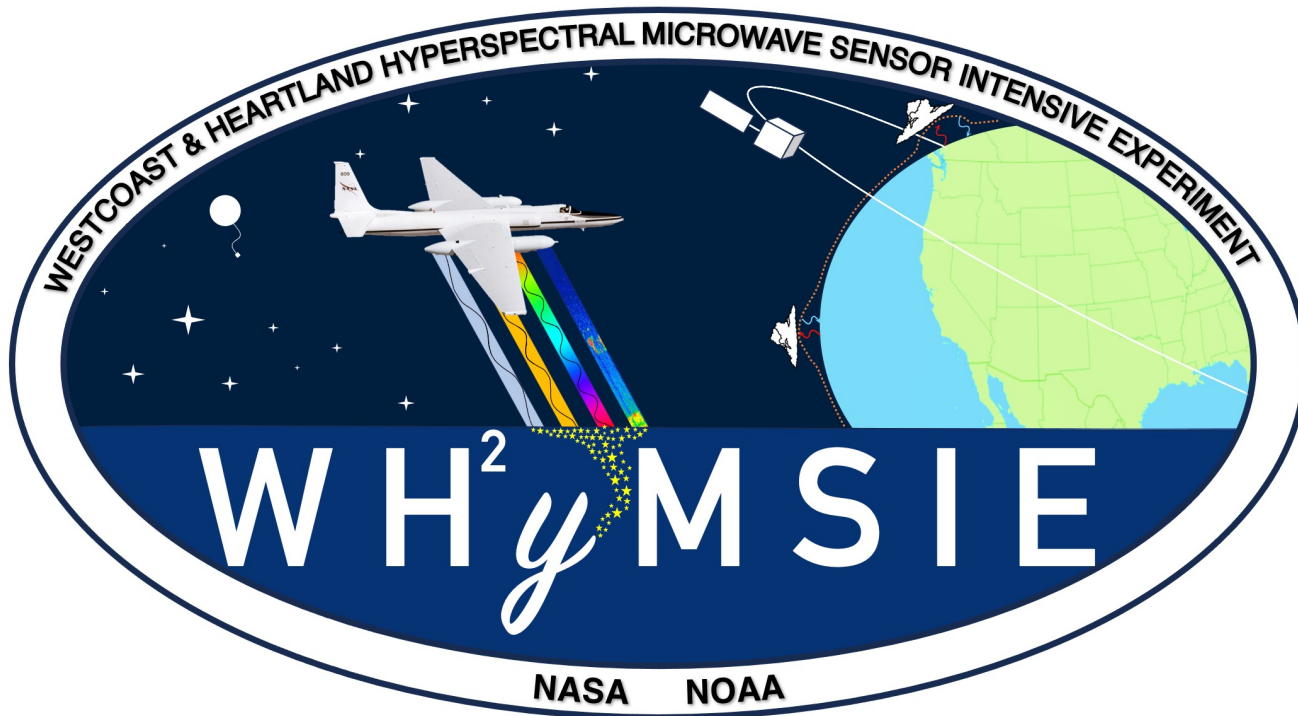
Photonics + ASICs: Up to 50% Improvement in product performance



Gambacorta et al., 2023, doi: 10.1109/JSTARS.2023.3269697, <https://ieeexplore.ieee.org/abstract/document/10107761>

Applications: AURORA Pathfinder Will Enhance Numerical Weather Prediction – Channel Grouping & PC Scores Trade Study



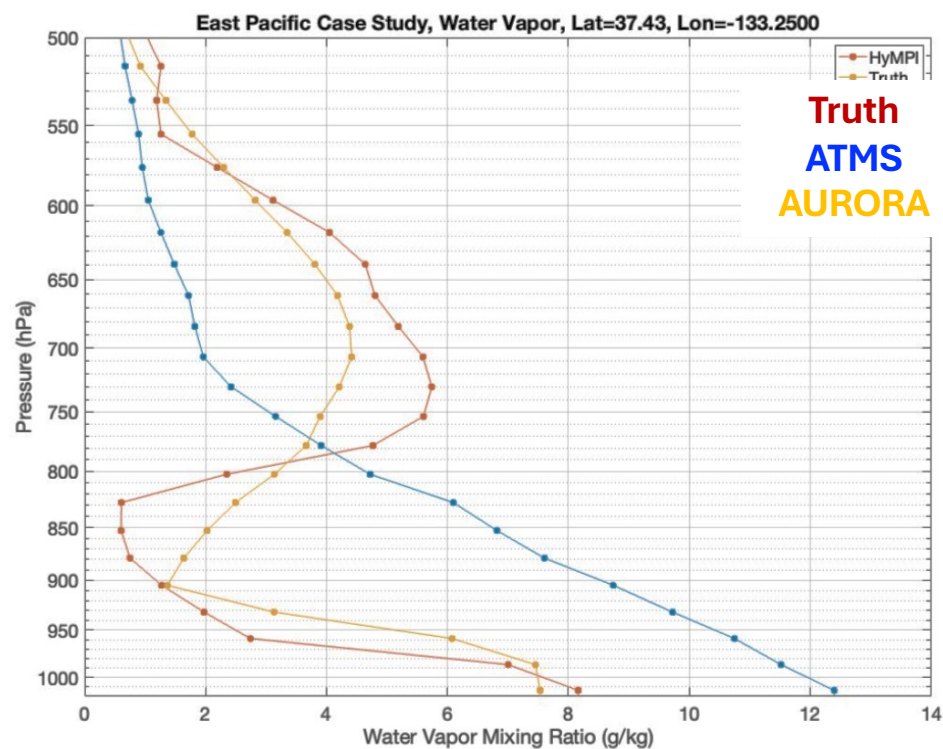
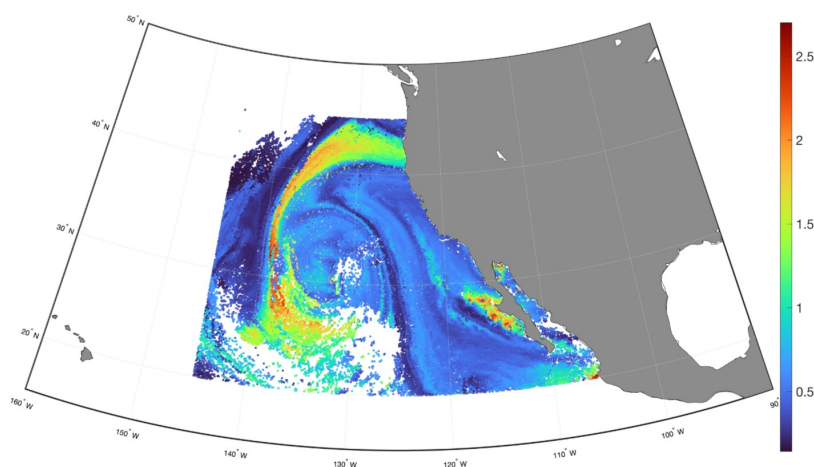


<https://earth.gsfc.nasa.gov/climate/campaigns/WHyMSIE>

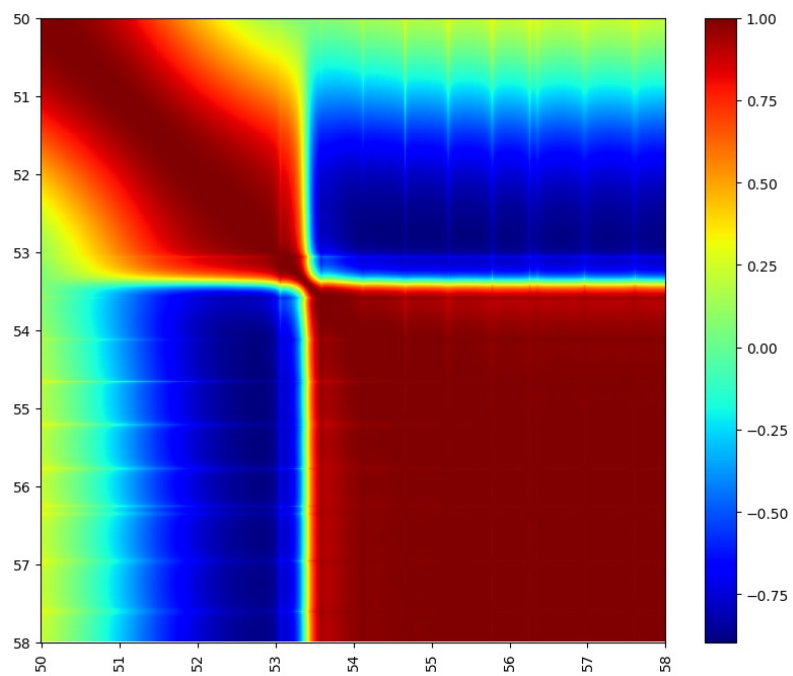


Back up slides

Applications: AURORA Pathfinder Will Enable PBL, Convection and Extreme Weather Measurements



50-58 GHz band



175-191 band

