The National Airborne Sounder Testbed-Interferometer (NAST-I): Existing Technology for New Science and Application

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Introduction

The National Airborne Sounder Testbed-Interferometer (NAST-I) is an existing ultraspectral infrared sounder flown on high-altitude aircraft that provides high spectral and spatial resolution measurements which continue to advance understanding of science critical for weather, climate, chemistry, and radiation applications. NAST-I provides high-spatial linear resolution equal to 13% of the aircraft altitude at nadir (i.e., 2.6 km IFOV on the ground from an aircraft altitude of 20 km), and high-spectral resolution (0.25 cm^{-1}) measurements within the spectral region of 645–2700 cm^{-1}. The NAST-I suborbital system serves as a spaceborne instrument simulator and pathfinder for future satellite capabilities and airborne science experiments.

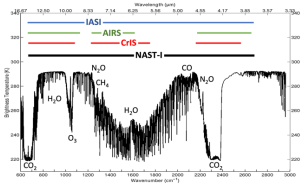
Presented herein are some groundbreaking capabilities of NAST-I measurements and corresponding geophysical retrievals and their potential benefits toward improved atmospheric state and composition characterizations needed for air quality, wildfire, and other science applications. As detailed, such capabilities could be of particular importance toward enhancing characterization and understanding of the planetary boundary layer (PBL).

NAST-I: Brief Description and Objectives

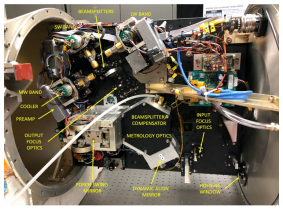
NAST-I was developed in 1997-1998; refurbished in 2009, 2016, & 2022.

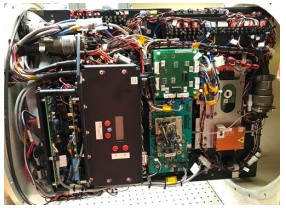
NAST-I Sensor Characteristics:

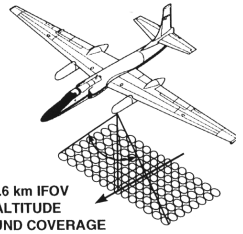
- Michelson interferometer (FTS).
- ~8500 spectral channels, ~650-2800 cm^{-1} at 0.25 cm^{-1} spectral resolution.
- Spatial resolution ~130 m/km flight altitude.
- Radiances ~0.5 K absolute accuracy with 0.1 K precision.



NAST-I spectral coverage encompasses all satellite IR sounders with a higher (or equivalent) spectral resolution and higher spatial resolution.







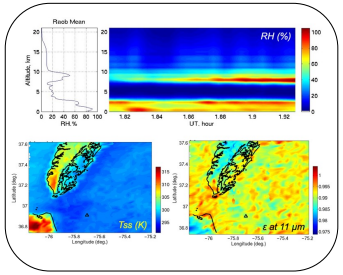
NAST-I Field Campaigns:

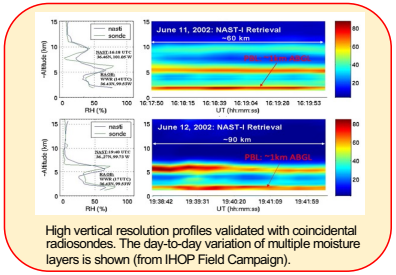
- Before AIRS launch (<2002): 9 missions collecting geophysical field state characterization for satellite remote sensing system risk mitigation (sensors and algorithms).
- After AIRS launch (>2002): 13 missions for advanced satellite remote sensor Cal/Val (e.g., Aqua AIRS, MetOp IASI, & SNPP/JPSS CrIS), and airborne science.
- The most recent field campaign: FIREX-AQ (August 2019).

Aircraft Accommodation:

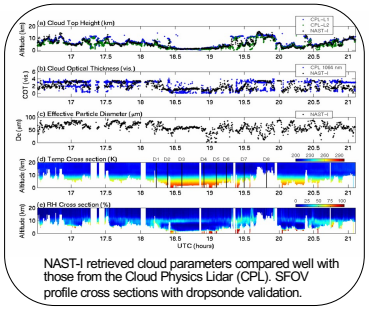
- ER-2 wing super pod (and nose cone)
- PROTEUS underbelly pod
- WB-57 underbelly pallet.

Select NAST-I Historical Results

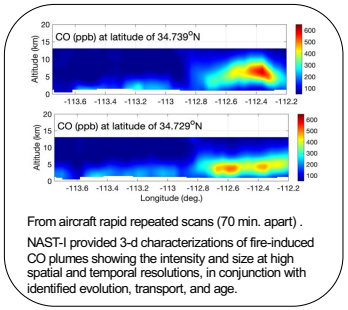




High vertical resolution profiles validated with coincidental radiosondes. The day-to-day variation of multiple moisture layers is shown (from IHOP Field Campaign).

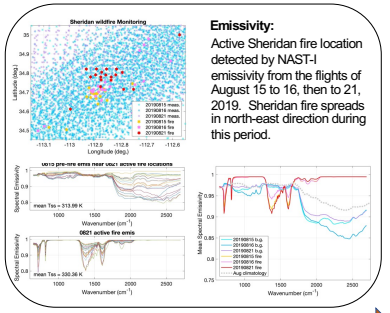


NAST-I retrieved cloud parameters compared well with those from the Cloud Physics Lidar (CPL). SFOV profile cross sections with dropsonde validation.



From aircraft rapid repeated scans (70 min. apart) .

NAST-I provided 3-d characterizations of fire-induced CO plumes showing the intensity and size at high spatial and temporal resolutions, in conjunction with identified evolution, transport, and age.



Emissivity:
Active Sheridan fire location detected by NAST-I emissivity from the flights of August 15 to 16, then to 21, 2019. Sheridan fire spreads in north-east direction during this period.

1998 (1st accurate profile ret.)
2001 (Surf temperature T_s & emissivity ε_ν ret.)

2002 (Water vapor evolution with a higher vertical resolution, & PBL)

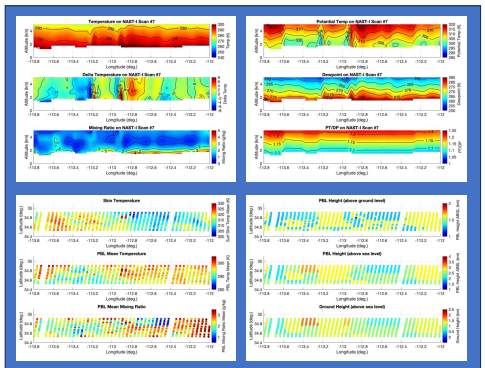
2005 (IR only SFOV ret.: thermodynamic & cloud parameters retrieved and validated)

2019 (Air quality: fire-induced CO plume evolution & transport)

2019 (Surface emissivity over the fire location.)

PBL Inferences Under evaluation with FIREX-AQ NAST-I Data (August 21, 2019)

Time evolution of surface skin temperature & PBL temperature and mixing ration distributions (over Sheridan wildfire location near 34.8 latitude & -112.85º longitude).
The PBL thermodynamic parameters are retrieved from NAST-I measurements, and PBL height is estimated.



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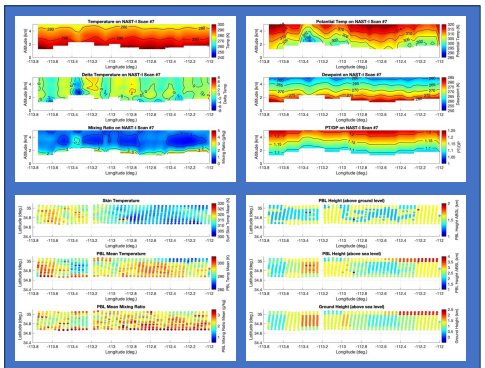

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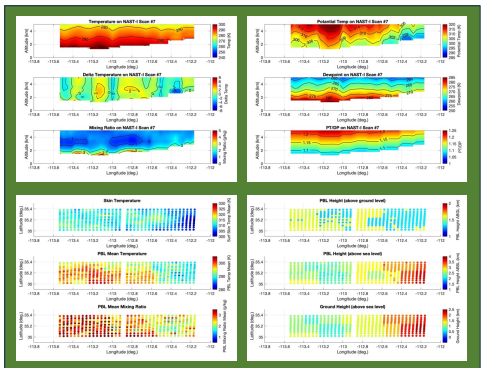

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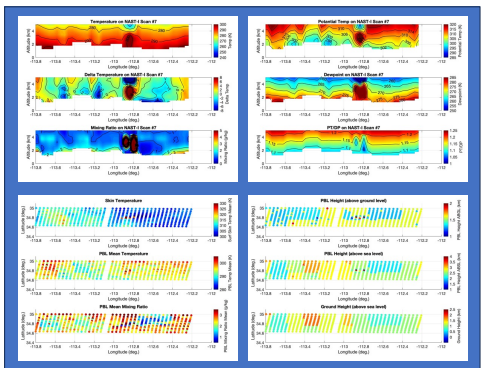
*Different latitude



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