Tropospheric Trace Species Observed with NAST-I During CRYSTAL-FACE

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NPOESS Airborne Sounder Testbed (NAST)

Infrared Interferometer Sounder (NAST-I)
- 3.5 – 16 micron @ 0.25 cm⁻¹

Microwave Radiometers (NAST-M)
- 54, 118 GHz

NADIR 2.6 km IFOV
- 20 km Altitude
- +/- 23 km Ground Coverage

Electronics, Control, Navigation, Processing, Recording

Proteus aircraft

NASA ER-2
NAST-I Data Products

Calibrated Brightness Temperature or Radiance Spectrum

NUMERICAL INVERSION

Retrievals (under clear sky conditions)
- Surface skin temperature and emissivity
- Atmospheric temperature and moisture profiles
- Atmospheric O$_3$ and CO abundances (preliminary)

Retrievals (under cloudy sky conditions)
- Cloud Parameters (i.e., cloud top pressure temperature, effective cloud amount, particle size, and optical thickness)
- Atmospheric profile above cloud
Flow Diagram for NAST-I O3 (or CO) Retrieval

1. **NAST-I Measured Raw Data**
   - Calibration
     - Calibrated Spectral Radiances
       - Total Noise Level
       - **Historical Training Data**
         - Radiance Simulation (OSS model)
           - EOFs & Reg. Coef.
             - PCA and Optimal Reg. Analyses
               - Statistical Reg. Retrieval
                 - Reg. Retrievals (Stage #1)
               - Simultaneous Matrix Inversion (SMI)
                 - SMI Retrievals (Stage #2)
               - **O3 (or CO) Physical Retrieval**
                 - All parameters fixed except O3 (or CO)
                   - O3 (or CO) Physical Retrievals using OSS fast transmittance model
                     - O3 (or CO) Physical Retrievals (Stage #3)
Linear Regression Methodology and Analyses (stage 1):
Regression retrieval obtained by using a linear statistical regression of radiance eigenvector amplitudes against atmospheric state parameters based on a historical radiosonde training database. Accurate temperature and water vapor profiles can be achieved from optimal regression (by minimization observed and retrieval simulated radiance).

Simultaneous Matrix Inversion Algorithm (stage 2):
Simultaneous matrix inversion achieved using eigenvector regression results as the first guess by iterating the radiative transfer calculations to achieve a solution which best fits the radiance observations (i.e., minimum discrepancy principle).

O₃ and CO Physical Fitting Algorithm (stage 3):
Final O₃ (or CO) retrieved using simultaneous matrix inversion parameters and by iterating the radiative transfer calculations (only O₃ or CO variable) to achieve a solution which best fits the observed radiance (in O₃ or CO spectral region).
NAST-I results show $O_3$ and CO column density (from 200 mb to surface) and their vertical cross sections. Temperature and water vapor mean profiles (in blue) are compared with a sonde (in red). NAST-I $O_3$ and CO mean profiles (in blue) are compared with ozone photometer (red) and Argus CO (red) observed from BW-57 (near Key West, FL), respectively.
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Conclusions and Future Work

- Day to day variations of the temperature, moisture, and trace species were shown in NAST-I retrievals, which are verified by radiosondes (or dropsondes) and BW-57 in-situ measurements.

- A preliminary O\textsubscript{3} and CO profile comparison between Proteus NAST-I retrievals and BW-57 in-situ measurements is satisfied in spite of spatial and temporal differences between Proteus and BW-57 aircrafts.

- Further forward and inversion analyses and detailed validations will be undertaken.

Acknowledgments. Ozone and Carbon monoxide in-situ data from BW-57 were kindly provided by Erik C. Richard (NOAA Aeronomy Laboratory and U. Colorado, CIRES) and Max Loewenstein (NASA Ames Research Center).