NASA-CR-194050

A GRANT
IN-36-CR
181668
4P

DEVELOPMENT OF AN AIRBORNE LASER INDUCED FLUORESCENCE SYSTEM FOR THE DETECTION OF ATMOSPHERIC TRACE GASES

NASA GRANT NAG-1-50
FINAL REPORT

Submitted To:
Dr. Edward Browell
Project Monitor
National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23665

Submitted By:
Dr. John Bradshaw
and Dr. Scott Sandholm
Georgia Institute of Technology
School of Earth and Atmospheric Sciences
Atlanta, Ga 30332

(NASA-CR-194050) DEVELOPMENT OF AN AIRBORNE LASER INDUCED FLUORESCENCE SYSTEM FOR THE DETECTION OF ATMOSPHERIC TRACE GASES Final Technical Report, 1 Mar. 1981 - 31 Jul. 1991 (Georgia Inst. of Tech.) 4 p

N94-70710

Unclas

Z9/36 0181668

Significant progress and achievements have been made during the ten years (3/81-3/91) of funded effort for this program. Three generations of airborne laser induced fluorescence sensors were successfully field deployed as participants in the CITE-I (both ground and two aircraft campaigns, the CITE-2, the ABLE-3A, the CITE-3, and the ABLE-3B Missions. The LIF NO sensor underwent favorable intercomparison in both CITE-I and CITE-2, as did the NO2 portion of the instrument during CITE-2. Data sets giving the distribution and partitioning of N_xO_y species were also successfully obtained in the Arctic and Subarctic during the ABLE-3A and ABLE-3B mission and in the south Atlantic during the CITE-3 mission.

These results of the Ga Tech participation in this program are contained in the following publications:

"Tropospheric Observations Related to N_xO_y Distributions and Partioning Over the Alaskan Arctic", S. Sandholm, J. Bradshaw, G. Chen, H. Singh, R. Talbot, G. Gregory, D. Blake, G. Sachse, E. Browell, J. Barrick, M. Shipman, S. Wofsy, R. Harris, and J. Hoell, Journal Geophys. Res. (submitted).

"Relationship of PAN to Active and Total Odd-Nitrogen at Northern High Latitudes: Influence of Reservoir Species on NO_x and O_3", H. Singh, D. Herth, K. Zahnle, D. O'Hara, J. Bradshaw, S. Sandholm, R. Talbot, P. Crutzen, and M. Kanakidous, Journal Geophys. Res. (submitted).

"Atmospheric Measurement of PAN and Other Organic Nitrates at High Latitude: Possible Sources and Sinks", H. Singh, D. O'Hara, D. Herth, J. Bradshaw, S. Sandholm, G. Gregory, G. Sachse, and D. Blake, Journal Geophys. Res. (submitted).

"Summertime Photochemistry in the Arctic Troposphere", D. Jacobs, S. Wofsy, P. Baklin, S. Fan, J. Bradshaw, S. Sandholm, G. Gregory, G. Sachse, M. Shipman, H. Singh, D. Blake, and R. Talbot, Journal Geophys. Res. (submitted).

"Influence of Natural Fires and Anthropogenic Emissions on Atmospheric Chemistry in Remote Areas", S. Wofsy, G. Sachse, G. Gregory, D. Blake, J. Bradshaw, S. Sandholm, H. Singh, J.

Barrick, R. Harriss, R. Talbot, M. Shipman, E. Browell, D. Jacob, and J. Logon, Journal Geophys. Res. (submitted).

"An Airborne Compatible Photofragmentation Two-Photon Laser-Induced Fluorescence Instrument for Measuring Background Tropospheric Levels of NO, NO_x, and NO_2", S. T. Sandholm, J.D. Bradshaw, K. S. Dorris, M. O. Rodgers, and D.D. Davis, Journal Geophys. Res., **95**, 10,148-10,155 (1990).

"Peroxyacetyl Nitrate Measurements During CITE 2: Atmospheric Distribution and Precursor Relationships", H.B. Singh, E. Condon, J. Vedder, D. O'Hara, B. A. Riley, B.W. Gandrud, J.D. Shetter, L. J. Salas, B. Huebert, G. Hubler, M. A. Carroll, D. L. Albritton, D. D. Davis, J. D. Bradshaw, S. T. Sandholm, M. O. Rodgers, S. M. Beck, G. L. Gregory, and P. J. LeBel. Journal Geophys. Res., **95**, 10,156-10,163 (1990).

"Ratios of Peroxyacetyl Nitrate to Active Nitrogen Observed During Aircraft Flight Over the Eastern Pacific Oceans and Continental United States", B. A. Ridley, J. D. Shetter, B. W. Gandrud, L. J. Salas, H. B. Singh, M. A. Carroll, G. Hubler, D. L. Albritton, D. R. Hastie, H. I. Schiff, G. I. Mackay, D. R. Karechi, D. D. Davis, J. D. Bradshaw, M. O. Rodgers, S. T. Sandholm, A. L. Torres, E. P. Condon, G. L. Gregory, and S. M. Beck, Journal Geophys. Res., **95**, 10,164-10,178 (1990).

"Measurements of the Nitric Acid to NO_x Ratio in the Troposphere", B. J. Huebert, S. E. Van Bramer, P. J. LeBel, S. A. Vay, A. L. Torres, H. I. Schiff, D. Hastie, G. Hubler, J. D. Bradshaw, M. A. Carroll, D. D. Davis, B. A. Ridley, M. O. Rodgers, S. T. Sandholm, and S. Dorris, Journal Geophys. Res., **95**, 10,180-10,193 (1990).

"Aircraft Measurements of NO_x Over the Eastern Pacific and Continental United States and Implications for Ozone Production", M. A. Carroll, D. R. Hastie, B. A. Ridley, M. O. Rodgers, A. L. Torres, D. D. Davis, J. D. Bradshaw, S. T. Sandholm, H. I. Schiff, D. R. Karecki, G. W. Harris, G. I. Mackay, G. L. Gregory, E. P. Condon, M. Trainer, G. Hubler, D. D. Montzka, S. Madronich, D. L. Albritton, H. B. Singh, S. M. Beck, M. C. Shipham, and A. S. Bachmeier, Journal Geophys. Res., **95**, 10,200-10,205 (1990).

"Observed and Model Calculated NO_2/NO Ratios in Tropospheric Air Sampled During the NASA GTE/CITE 2 Field Study", W. L. Chameides, D. D. Davis, J. Bradshaw, S. Sandholm, M. Rodgers, B. Baum, B. Ridley, S. Madronich, M. A. Carroll, G. Gregory, H. I. Schiff, D. R. Hastie, A. Torres, and E. Condon, Journal Geophys. Res., **95**, 10,206-10,235 (1990).

"An Intercomparison of Airborne Nitrogen Dioxide Instruments", G. L. Gregory, J. M. Hoell, Jr., M. A. Carroll, B. A. Ridley, D. D. Davis, J. Bradshaw, M. O. Rodgers, S. T. Sandholm, H. I. Schiff, D. R. Hastie, D. R. Karecki, G. I. Mackay, G. W. Harris, A. L. Torres, and A. Fried, Journal Geophys. Res., **95**, 10,090-10,103 (1990).

"An Intercomparison of Airborne Nitric Oxide Measurements: A Second Opportunity", Gerald L. Gregory, James L. Hoell, Jr., Arnold L. Torres, Mary Anne Carroll, Brian A. Ridley, Michael O. Rodgers, John Bradshaw, Scott Sandholm, and Douglas D. Davis, Journal Geophys. Res., **95**, 10,104-10,129 (1990).

"Free Tropospheric and Boundary Layer NO Measurements over the Eastern and Central North Pacific Ocean", D. Davis, J. Bradshaw, M. Rodgers, and S. Sandholm, Journal Geophys. Res., **92**, 2049 (1987).

"Net Ozone Photochemical Production Over the Eastern and Central North Pacific Ocean as Inferred from GTE/CITE I Observations During Fall 1983", W. Chameides, C. Hsu, J. Bradshaw, M. Rodgers, S. Sandholm, and D.D. Davis, G. Sachse and G. Gregory, Journal Geophys Res., **92**, 2153 (1987).

"Airborne Intercomparison of Nitric Oxide Measurement Techniques", Hoell, J. M. et al., G. Gregory, D. McDougal, A. Torres, D. Davis, J. Bradshaw, M. Rodgers, B. Ridley and M.A. Carroll, Journal Geophys. Res., **92**, 1995-2008 (1987).

"A Two-Photon Laser-Induced Fluorescence Instrument for the Detection of Atmospheric NO", J. Bradshaw, M. Rodgers, S. Sandholm, S. KeSheng, and D.D. Davis, Journal Geophys. Res., **90**, 12861 (1985).

"A Two-Wavelength Laser Induced Fluorescence (2-LIF). Field Instrument for Ground-Based and Airborne Measurements of Atmospheric OH", M.O. Rodgers, J.D. Bradshaw, S.T. Sandholm, and D.D. Davis, Journal Geophys. Res., **90**, p. 12819-12834 (1985).

"Sequential Two-Photon Laser-Induced Fluorescence: A New Technique for Detecting Hydroxyl Radicals", J. Bradshaw, M. Rodgers, and D.D. Davis, Applied Optics, **23**, 2134 (1984).

"An Intercomparison of CO, NO, and OH Measurement Techniques: Overview of Results, "Hoell, J. et al., D.D. Davis, J. Bradshaw, and M. Rodgers, Journal Geophys. Res., **89**, p. 11819, (1984).

"Single Photon Laser-Induced Fluorescence Detection of NO and SO_2 for Atmospheric Conditions of Composition and Pressure", J.D. Bradshaw, M.O. Rodgers, and D.D. Davis, Applied Optics, **21**, 2493 (1982).

"Sequential Two Photon Laser-Induced Fluorescence Detection of Hg Atoms", M.O. Rodgers, K. Liu, J.D. Bradshaw, and D.D. Davis, Optics Letters, **7**, 359 (1982).

"Sequential Two-Photon Laser-Induced Fluorescence: A New Method for Detecting Atmospheric Trace Levels of NO", J. Bradshaw and D.D. Davis, Optics Letters, **7**, 224 (1982).