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FINAL REPORT - NASA/NSG-1431

1. Neutral Constituent Measurements in the Stratosphere
2. Final Technical Report
3. Konrad Mauersberger
4. July 1, 1978 - Sept. 30, 1995
5. School of Physics and Astronomy, University of Minnesota
   116 Church St. S.E., Minneapolis, MN 55455
6. NSG 1431

Summary Highlights

During the period of this grant a large number of new results were discovered and researched in the lab as well as in the atmosphere. To highlight the most interesting accomplishments, a summary is presented below.

a) First measurement of an unusual isotope effect in ozone. A mass independent enrichment in the heavy isotopes was discovered. This isotope anomaly was later linked to the ozone formation process.

b) Precision measurement of the absorption cross sections at the 254 nm line (including the temperature dependence) and in the Chappuis- and Wulf bands.

c) First laboratory simulation of Polar stratospheric clouds. Identification of nitric acid trihydrates and their phase diagram of stability. Solubility of HCL in ice and NAT as well as other forms of PSC material.

d) First ozone collection in troposphere and stratosphere and precision measurement of the isotopes.

e) First identification of metastable electronic states of ozone: The two states are $^3A_2$ and $^3B_2$.

f) First identification of a mass independent isotope enrichment in stratospheric CO_2. This enrichment is initiated by the ozone isotope anomaly.

Relevant Publications as a Result of Grant NSG-1431

1. "Mass Spectrometer Beam System for Applications in the Stratosphere," K. Mauersberger, *Rev. Sci. Instrum. 48*, 1169 (1977).

2. "Further Laboratory Studies and Stratosphere Flight of a Mass Spectrometer Beam System," K. Mauersberger and R. Finstad, *Rev. Sci. Instrum. 50*, 1612 (1979).

3. "A Comparison of Ozone Measurements," K. Mauersberger, R. Finstad, S. Anderson, and D. Robbins, *Geophys. Res. Lett. 8*, 361 (1981).

4. "Calibration of a Mass Spectrometer Experiment for Ozone," S. Anderson and K. Mauersberger, *Rev. Sci. Instrum. 52*, 1025 (1981).

5. "Measurement of Heavy Ozone in the Stratosphere," K. Mauersberger, *Geophys. Res. Lett. 8*, 935 (1981).

6. "Mass Spectrometry in the Stratosphere," K. Mauersberger, *Adv. Space Res. 2*, 287 (1983).

7. "Precise Ozone Measurements Using a Mass Spectrometer Beam System," K. Mauersberger, S. Anderson, D. Murphy, and J. Morton, *Proceedings of Quadrennial Ozone Symposium, Halkidiki, Greece*, Sept. (1984).

8. "Operation of a Microchannel Plate Counting System in a Mass Spectrometer," D.M. Murphy and K. Mauersberger, *Rev. Sci. Instrum. 56,* 220 (1985).

9. "Results from the Balloon Ozone Intercomparison Campaign," E. Hilsenrath, J. Ainsworth, A. Holland, J. Mentall, A. Torres, W. Attmannspacher, A. Bass, W. Evans, W. Komhyr, K. Mauersberger, A. Miller, M. Proffitt, D. Robbins, S. Taylor, and E. Weinstock, *Atmospheric Ozone*, C. S. Zerefos, Editor, D. Reidel Publishing Co. (1984).

10. "A New Ozone Standard: The Vapor Pressure of Ozone at Liquid Argon Temperatures," K. Mauersberger, D. Hanson, and J. Morton, *Geophys. Res. Lett. 12*, 89 (1985).

11. "Precision Ozone Vapor Pressure Measurements," D. Hanson and K. Mauersberger, *J. Chem. Phys. 85*, 326 (1985).

12. "Measurement of the Ozone Absorption Cross-Section at the 253.7 nm Mercury Line," K. Mauersberger, J. Barnes, D. Hanson, and J. Morton, *Geophys. Res. Lett. 13*, 671 (1986).

13. "The Vapor Pressures of Solid and Liquid Ozone," David Hanson and Konrad Mauersberger, *J. Chem. Phys. 85*, 4669 (1986).

14. "Results from the Balloon Ozone Intercomparison Campaign (BOIC)," E. Hilsenrath, W. Attmannspacher, A. Bass, W. Evans, R. Hagemeyer, R. A. Barnes, W. Komhyr, K. Mauersberger, J. Mentall, M. Profitt, D. Robbins, S. Taylor, A. Torres, and E. Weinstock, *J. Geophys. Res. 91*, 13,137 (1986).

15. "Ozone Isotope Measurements in the Stratosphere," K. Mauersberger, *Geophys. Res. Lett. 14*, 80 (1987).

16. "Precision Ozone Calibration System Based on Vapor Pressures of Ozone," K. Mauersberger, D. Hanson, and J. Morton, *Rev. Sci. Instrum. 58*, 1063-1066 (1987).

17. "A Highly Sensitive Mass Spectrometer Detector System," D. Murphy and K. Mauersberger, *Int. J. Mass Spectrom. Ion Proc. 76*, 85-93 (1987).

18. "Ozone Vapor Pressure and Absorption Cross-Section Measurements: Introduction of an Ozone Standard," K. Mauersberger, D. Hanson, J. Barnes, and J. Morton, *J. Geophys. Res. 92*, 8480-8482 (1987).

19. "Temperature Dependence of the Ozone Absorption Cross-Section at the 253.7 nm Mercury Line," J. Barnes and K. Mauersberger, *J. Geophys. Res. 92*, 14861-14864 (1987).

20. "Upper Limit on the Rate Constant for Isotope Exchange Between Molecular Oxygen and Ozone at 298 K," S.M. Anderson, J. Morton, and K. Mauersberger, *Geophys. Res. Lett. 14,* 1258-1261 (1987).

21. "Vapor Pressures of HNO_3/H_2O Solutions at Low Temperatures," D. Hanson and K. Mauersberger, *J. Phys. Chem. 92*, 6167-6170 (1988).

22. "Laboratory Studies of the Nitric Acid Trihydrate: Implications for the South Polar Stratosphere," D. Hanson and K. Mauersberger, *Geophys. Res. Lett. 15*, 855-858 (1988).

23. "Solubility and Equilibrium Vapor Pressures of HCL Dissolved in Polar Stratospheric Cloud Materials: Ice and the Trihydrate of Nitric Acid", D. Hanson and K. Mauersberger, *Geophys. Res. Lett. 15*, 1507-1510 (1988).

24. "Oxygen Fractionation of Ozone Isotopes $^{48}O_3$ Through $^{54}O_3$ ", J. Morton, B. Schueler, and K. Mauersberger, *Chem. Phys. Lett. 154*, 143-145 (1989).

25. "Laboratory Measurements of Ozone Isotopomers by Tunable Diode Laser Absorption Spectroscopy", S.M. Anderson, J. Morton, and K.Mauersberger, *Chem. Phys. Lett. 156*, 175-180 (1989).

26. "Laboratory Studies of Heavy Ozone," J. Morton, J. Barnes, B. Schueler and K. Mauersberger, *J. Geophys. Res. 95*, 901-907 (1990).

27. "HCL/H_2O Solid Phase Vapor Pressures and Solubility in Ice", D. Hanson and K. Mauersberger, J. *Chem. Phys. 94*, 4700-4705 (1990).

28. "Near-Infrared Absorption Spectra of $^{16}O_3$ and $^{18}O_3$: Adiabatic Energy of the $^1A_2$ State?," S. Anderson, J. Morton and K. Mauersberger, *J. Chem. Phys. 93*, 3826-3832 (1990).

29. "Measurement of Isotopic Abundances in Collected Stratospheric Ozone Samples," B. Schueler, J. Morton and K. Mauersberger, *Geophys. Res. Lett. 17*, 1295-1298 (1990).

30. "Effect of Isotopic Substitution on the Visible Absorption Spectrum of Ozone," S. Anderson, J. Maeder and K. Mauersberger, *J. Chem. Phys. 94*, 6351-6357 (1991).

31. "Oxygen Isotope Fractionation in Stratospheric CO_2," M. Thiemens, T. Jackson, K. Mauersberger, B. Schueler and J. Morton, *Geophys. Res. Lett. 18*, 669-672 (1991).

32. "HCl Solubility in Solid Mixtures of Nitric Acid and Ice: Implications for the Polar Stratosphere," J. Marti, K. Mauersberger and D. Hanson, *Geophys. Res. Lett. 18*, 1861-1864 (1991).

33. "Das Ozonloch über dem Südpol," K. Mauersberger, *Die Geowissenschaften 9*, 352-356 (1991).

34. "Mass Spectrometric Investigations of Ozone Isotopes," K. Mauersberger, J. Morton, D. Schueler and S. Anderson, *Proceedings, Symposium on Inorganic Mass Spectrometry, Durango, CO*, Donald Rokop, Editor, 1991.

35. "Heavy Ozone Anomaly: Evidence for a Mysterious Mechanism," S. Anderson, K. Mauersberger, J. Morton and B. Schueler, *ACS Symposium Series 502, Isotope Effects in Gas-Phase Chemistry*, J. Kaye, Editor, Washington D.C., 1992.

36. "Laser Measurements of Ozone Absorption Cross Sections in the Chappuis Band," S.M. Anderson and K. Mauersberger, *Geophys. Res. Lett. 19*, 933-936 (1992).

37. "A Study of Atom Exchange Between $O_2(^1\Delta)$ and Ozone," S.M. Anderson, J. Morton, K. Mauersberger, Y.L. Yung and W.B. DeMore, *Chem. Phys. Lett. 189*, 581-585 (1992).

38. "Laboratory Simulations of PSC Particle Formation," J. Marti and K. Mauersberger, *Geophys. Res. Lett. 20*, 359-362 (1993).

39. "A Survey and New Measurements of Ice Vapor Pressure at Temperatures Between 170 and 250K, " J. Marti and K. Mauersberger, *Geophys. Res. Lett. 20*, 363-366 (1993).

40. "Rotational Structure in the Near-Infrared Absorption Spectrum of Ozone," S. Anderson, P. Hupola and K. Mauersberger, *J. Chem. Phys. 99*, 737-739 (1993).

41. "Multi-Isotope Study of Ozone: Implications for the Heavy Ozone Anomaly," K. Mauersberger, J. Morton, B. Schueler, J. Stehr, and S. Anderson, *Geophys. Res. Lett.*, 20, 1031-1034 (1993).

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43. "Evidence for Nitric Acid Pentahydrate Found Under Stratospheric Conditions," J. Marti and K. Mauersberger, *J. Chem. Phys.*, published, 1994.

44. "The Ozone Molecule: Isotope Effects and Electronic Structure," S. Anderson, K. Mauersberger and J. Morton, in *Current Problems and Progress in Atmospheric Chemistry; Advances in Physical Chemistry*, published, 1995.

45. "Ozone Absorption Spectroscopy in Search of Low-Lying Electronic States," S.M. Anderson and K. Mauersberger, *J. Geophys. Res.*, published, 1995.