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NDSC Mobile Stratospheric Ozone Lidar

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Data Products

Ozone - vertical profile from 10 km - ~48 km

Temperature - vertical profile from ~ 10 km to >70 km

Aerosol lidar ratio - vertical profile from 10 km - ~ 30 km

Instrument Description

The Goddard Stratospheric Ozone Lidar has been a participant in the NDSC since its inception. It began development with funding from the NASA Upper Atmosphere Program in 1985. The instrument is housed in a 45' trailer allowing for transport around the world. The instrument is a combination Differential Absorption Lidar (DIAL), for the measurement of ozone; and a Raman and elastic backscatter lidar (for temperature and aerosol measurements).

The lidar instrument transmits two wavelengths, 308 nm from a XeCl excimer laser, and 351 nm from a XeF excimer laser. The repetition rate for each of the lasers is 200 Hz, and the lasers are triggered so that the pulses are transmitted 2.5 msec apart. This removes the potential for any optical cross-talk between the channels. Backscattered radiation is collected with a 30" Dall-Kirkham telescope; spectral separation is accomplished using beamsplitters and interference filters. Four return wavelengths are recorded: the two transmitted wavelengths and the N<sub>2</sub> Raman scattered radiation from each of the

transmitted beams - 332 nm and 382 nm. These channels were added in late 1991 after the eruption of Mt Pinatubo prevented a differential ozone retrieval using elastically scattered return signals. Each of the elastically scattered signals is further split to improve the dynamic range - roughly 2 - 5% is used to retrieve data in the lower stratosphere. The six signals are then amplified, discriminated and recorded using photon counting techniques.

The ozone measurement is a two wavelength differential absorption measurement; 308 nm is absorbed by ozone, and 351 nm is not. The Raman scattered 332 nm radiation includes an absorption signal from ozone, while the 382 nm radiation does not. The atmospheric ozone number density can be retrieved from the difference in slope between the absorbed and not absorbed lidar returns.

Temperature is extracted from the Raman and elastic returns from the XeF (351 nm) laser. A relative density profile is constructed using the 351 nm returns above 28 km, and the 382 nm return below. When the atmosphere is relatively clean - i.e. little or no volcanic aerosol present - this works well down to below 15 km. When there is a heavy loading of aerosol, however, this vibrational Raman technique breaks down and is not satisfactory for retrieving temperature at those altitudes.

Aerosol information is extracted from the ratio of the elastic return at 351 nm to the normalized Raman return at 382. This is, in essence, the lidar ratio; no assumption of the extinction to backscatter ratio is required as in single wavelength techniques.

For a discussion of these techniques in more detail please see the references in the accompanying Reference - Techniques list.

#### Measurement Campaigns

October - November, 1988	Table Mountain, CA	Informal Comp.
July - August, 1989	Table Mountain, CA	STOIC
March - May, 1990	Cannon AFB, NM	Balloon Comp.
June - July, 1991	Table Mountain, CA	Engineering
March, 1992	Table Mountain, CA	UARS Validation
July - August, 1992	OHP, France	NDSC Comp.
October - December, 1992	Lauder, NZ	UARS Validation
March, 1994 - April, 1995	Lauder, NZ	ASHOE-MAESA/NDSC
August, 1995 - February, 1996	MLO, Hawaii	NDSC/TOTE/VOTE/STRAT
February - March, 1997	Table Mountain, CA	STRAIT
June - July, 1997	OHP, France	NDSC
February - March, 1998	Ny Alesund, Svalbard	NDSC

#### References - Technique

"STROZ LITE: NASA Goddard Stratospheric Ozone Lidar Trailer Experiment," T. J. McGee, D. Whiteman, R. Ferrare, J. J. Butler, and J. F. Burris, *Optical Engineering*, 30, 31-39, 1991.

"Raman DIAL Measurements of Stratospheric Ozone in the Presence of Volcanic Aerosols," T. J. McGee, M. Gross, R. Ferrare, W. S. Heaps, and U. Singh, *Geophys. Res. Lett.*, 20, 955-958, 1993.

"An Improved Stratospheric Ozone Lidar", T.J. McGee, M. Gross, U.N. Singh, J. J. Butler, and P. Kimvilakani, *Opt. Engin.*, 34, 1421-1430, 1995.

"Measurements of Stratospheric Aerosols with a Combined Rayleigh/Raman Lidar", M. Gross, T. J. McGee, U. N. Singh, and P. Kimvilakani, *Appl. Opt.*, 34, 6915-6924, 1995.

"Temperature Measurements Made with a Combined Rayleigh-Mie/Raman Lidar," M. R. Gross, T. J. McGee, R. A. Ferrare, U. Singh, and P. Kimvilakani, *Applied Optics*, 24, 5987-5995, 1997.

#### References - Campaigns and Results

"Lidar Observations of Ozone Changes Involved by Sub-Polar Airmass Motion over Table Mountain, CA (34.4N)," T. J. McGee, P. Newman, R. Ferrare, D. Whiteman, J. Butler, J. Burris, S. Godin, and I. S. McDermid, *J. Geophys. Res.*, 95, 20, 527-20, 530, 1990.

"Measurement Intercomparison of the JPL and GSFC Stratospheric Lidar System," I. S. McDermid, S. M. Godin, L. O. Lindquist, T. D. Walsh, J. Burris, J. Butler, R. Ferrare, D. Whiteman, and T. J. McGee, *Applied Optics*, 29, 4671-4676, 1990.

"Comparison of Ozone Profiles from Ground-based Lidar, ECC Balloon Sonde, Rocoz-A Rocket Sonde, and SAGE-II Satellite Measurements," I. S. McDermid, S. M. Godin, R. A. Barnes, C. L. Parsons, A. Torres, M. P. McCormick, W. P. Chu, P. Wang, J. Butler, J. Burris, P. Newman, R. Ferrare, D. Whiteman, and T. J. McGee, *J. Geophys. Res.*, 95, 10,037-10, 042, 1990.

"Multi-Wavelength Profiles of Aerosol Backscatter Ratios over Lauder New Zealand, 24 November 1992", R. L. McKenzie, J. W. Rosen, N. T. Kjome, T. J. McGee, M. R. Gross, U.N. Singh, P. Kimvilakani, O. Uchino, and T. Nagai, *Geophys. Res. Lett.*, 21, 789-792, 1994.

"Lidar Measurements of Stratospheric Ozone During the STOIC Campaign," T. J. McGee, R. Ferrare, D. Whiteman, J. Butler, J. Burris, *J. Geophys. Res.*, 100, 9255-9262, 1995.

"Lidar Measurements of Stratospheric Temperature During STOIC," R. A. Ferrare, T. J. McGee, D. Whiteman, J. Burris, M. Owens and J. Butler, *J. Geophys. Res.*, 100, 9303-9312, 1995.

"Correlation of Ozone Loss with the Presence of Volcanic Aerosols," Thomas J. McGee, Michael Gross, Upendra Singh, Paul Newman, Gerard Megie, Sophie Godin, and Anne-Marie Lacoste, *Geophys. Res. Lett.*, 21, 2801-2804 1994.

"Comparison of Stratospheric Temperature from Several Lidars, Using NMC and MLS Data as Transfer References", J. D. Wild, M. E. Gelman, A. J. Miller, M. L. Chanin, A. Hauchecorne, R. Farley, P. D. Dao, G. P. Gobbi, A. Adriani, F. Congeduti, I. S. McDermid, T. J. McGee, E. F. Fishbein, *J. Geophys. Res.*, 100, 11105-11111, 1995.

"Comparison of STOIC 1989 Ground-Based Lidar, Microwave Radiometer, and Dobson Spectrophotometer Umkehr Ozone Profiles with Ozone Profiles from Balloon-Borne ECC Ozonesonde", W. D. Komhyr, B. J. Connor, I. S. McDermid, T. J. McGee, A. D. Parish, and J. J. Margitan, *J. Geophys. Res.*, 100, 9273-9282, 1995.

"Stratospheric Ozone Intercomparison Campaign (STOIC) 1989: Overview", J. J. Margitan, R. A. Barnes, G. B. Brothers, J. Butler, J. Burris, B. J. Connor, R. A. Ferrare, J. B. Kerr, W. D. Komhyr, M. P. McCormick, I. S. McDermid, C. T. McElroy, T. J. McGee, A. J. Miller, M. Owens, A. D. Parrish, C. L. Parsons, A. L. Torres, J. J. Tsou, T. D. Walsh, and D. Whiteman, *J. Geophys. Res.*, 100, 9193-9208, 1995.

"HALOE Ozone Channel Validation," C. Bruhl, S. R. Drayson, J. M. Russell, P. Crutzen, J. M. McInerney, P. N. Purcell, H. Claude, N. Gernandt, T. J. McGee, and I. S. McDermid, *J. Geophys. Res.*, 101, 10217-10240, 1996.

"Validation of UARS MLS Temperature and Pressure Measurements," E. F. Fishbein, R. E. Cofield, L. Froidevaux, R. F. Jarnob, T. Lunger, W. G. Read, Z. Shippony, J. W. Waters, I. S. McDermid, T. J. McGee, U. Singh, M. Gross, A. Hauchecorne, and M. E. Gelman, *J. Geophys. Res.*, 101, 9983-10016, 1996.

"A Validation of Temperature Measurements from the Halogen Occultation Experiment," M. E. Hervig, J. M. Russell, III, L. L. Gordley, S. R. Drayson, K. Stone, R.E. Thompson, M. E. Gelman, I. S. McDermid, A. Hauchecorne, P. Keckhut, T. J. McGee, U. Singh, and M. R. Gross, *J. Geophys. Res.*, 101, 10277-10286, 1996.

"Accuracy and Precision of Cryogenic limb Array Etalon Spectrometer (CLAES) Temperature Retrievals," J. C. Gille, P. L. Bailey, S. T. Massie, L. V. Lyjak, D. P. Edwards, A. E. Roche, J. B. Kumer, J. L. Mergenthaler, A. Hauchecorne, P. Keckhut, T. J. McGee, I. S. McDermid, A. J. Miller, U. Singh, R. Swinbank, *J. Geophys. Res.*, 101, 9583-9602, 1996.

"Stratospheric Temperature Measurements by Two Collocated NDSC LIDAR During UARS Validation Campaign," U. N. Singh, P. Keckhut, T. J. McGee, M. R. Gross, A. Hauchecorne, E. Fishbein, J. W. Waters, J. C. Gille, A. E. Roche, and J. M. Russell, *J. Geophys. Res.*, 101, 10287-10298, 1996.

"Lidar Measurements of Ozone at Lauder, NZ During ASHOE/MAESA," T. J. McGee, M. Gross, U. Singh, P. Kimvilikani, A. Matthews, G. Bodeker, B. Connor, J. J. Tsou, M. Proffitt, and J. Margitan, *JGR - Atmospheres*, 102, 13,283-13289, 1997.

"Comparison of Cryogenic Limb Array Etalon Spectrometer (CLAES) Ozone Observations with Correlative Measurements," P. L. Bailey, D. P. Edwards, J. C. Gille, L. V. Lyjack, S. T. Massie, A. E. Roche, J. B. Kumer, J. L. Mergenthaler, B. J. Connor, M. R. Gunson, J. J. Margitan, I. S. McDermid, and T. J. McGee, *J. Geophys. Res.*, 101, 9737-9756, 1996.

"Correlative Stratospheric Ozone Measurements with the Airborne UV DIAL System during TOTE/VOTE", W.B. Grant, M. A. Fenn, E.V. Browell, T. J. McGee, U. N. Singh, M. R. Gross, I. S. McDermid, P.-H. Wang, L. E. Deaver, and L. Froidevaux, *Geophys. Res. Lett.*, 25, 623- 626, 1998

"Lidar Temperature Measurements during the TOTE/VOTE Mission", J. Burris, Wm. Heaps, B. Gary, W. Hoegy, L. Lait, T. McGee, M. Gross, and U. Singh, *J. Geophys. Res.*, 103, 3505-3510, 1998.

OPAL: Network for the Detection of Stratospheric Change Ozone Profiler Assessment at Lauder, New Zealand. I. Blind Intercomparison, I. S. McDermid, J. B. Bergwerff, G. Bodeker, I. S. Boyd, E. J. Brinksma, B. J. Connor, R. Farmer, M. R. Gross, P. Kimvilakani, W. A. Matthews, T. J. McGee, F. T. Ormel, A. Parrish, U. Singh, D.P. J. Swart, J. J. Tsou, P. H. Wang, and J. Zawodney, *J. Geophys. Res.*, 103, 28,683-28692, 1998.

OPAL: Network for the Detection of Stratospheric Change Ozone Profiler Assessment at Lauder, New Zealand. II. Intercomparison of Revised Results, I. S. McDermid, J. B. Bergwerff, G. Bodeker, I. S. Boyd, E. J. Brinksma, B. J. Connor, R. Farmer, M. R. Gross, P. Kimvilakani, W. A. Matthews, T. J. McGee, F. T. Ormel, A. Parrish, U. Singh, D.P. J. Swart, and J. J. Tsou, *J. Geophys. Res.*, 103, 28,693-28,699, 1998.

STRAIT '97: An aerosol lidar and backscatter sonde intercomparison campaign at Table Mountain Observatory during February-March 1997, G. Beyerle, M. R. Gross, D. A. Haner, N. T. Kjöme, I. S. McDermid, T. J. McGee, J. M. Rosen, H.-J. Schaefer, and O. Schrems, Submitted to *J. Geophys. Res.*, July, 1998

DIAL Ozone Algorithm Intercomparison, S. Godin, A. Carswell, D. Donovan, H. Claude, W. Steinbrecht, S. McDermid, T. McGee, H. Nakane, D. Swaart, E. Brinksma, O. Uchino, P. Von der Gathen, and R. Neuber, In Press, *Applied Optics*, August, 1999.

NDSC Ozone Validation Campaign at OHP, France, G. Braathan, S. Godin, T. McGee, M. Gross, In Press, *JGR*, September, 1999.

Results of the 1998 Ny lesund Ozone Monitoring Comparison, W. Steinbrecht, R. Neuber, P. von der Gathen, P. Wahl, T. McGee, M. Gross, U. Klein, and J. Langer, *J. Geophys. Res.*, 104, 30,515 - 30,523, 1999.

Results from the 1995 Stratospheric Ozone Profile Intercomparison at Mauna Loa, R. D. McPeters, D. J. Hofmann, M. Clark, L. Flynn, L. Froidevaux, M. Gross, B. Johnson, G. Koenig, X. Liu, S. McDermid, T. McGee, F. Murcray, M. J. Newchurch, S. Oltmans, A. Parrish, R. Schnell, U. Singh, J. J. Tsou, T. Walsh and J. M. Zawodny, *J. Geophys. Res.*, 104, 30,505 - 30,514, 1999.