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FOREIGN TRIP REPORT

ORNL/FTR-3754

DATE: September 27, 1990

SUBJECT: Report of Foreign Travel of Gregg Marland, Staff Scientist, Carbon Cycle, Environmental Sciences Division

TO: Alvin W. Trivelpiece

FROM: Gregg Marland

PURPOSE: To participate in the conference "The Chemistry of the Global Atmosphere," the seventh international symposium of the Commission on Atmospheric Chemistry and Global Pollution of the International Association of Meteorology and Atmospheric Physics.

SITES VISITED:

9/5-11/90	Chemistry of the Global Atmosphere	Chamrousse, France	R. J. Delmas

ABSTRACT: The traveler attended the conference "The Chemistry of the Global Atmosphere," and presented a paper on the anthropogenic emission of carbon dioxide (CO_2) to the atmosphere. The conference included meetings of the International Global Atmospheric Chemistry (IGAC) programme, a core project of the International Geosphere/Biosphere Programme (IGBP) and the traveler participated in meetings on the IGAC project "Development of Global Emissions Inventories" and agreed to coordinate the working group on CO_2.

Papers presented at the conference focused on the latest developments in analytical methods, measurement, modeling, and understanding of atmospheric CO_2, CO, CH_4, N_2O, SO_2, NO_x, NMHCs, CFCs, and aerosols.

BACKGROUND INFORMATION

This trip involved attendance at a conference, "The Chemistry of the Global Atmosphere," the seventh international symposium of the Commission on Atmospheric Chemistry and Global Pollution (CACGP) of the International Association of Meteorology and Atmospheric Physics (IAMAP). The meeting was held at Chamrousse, a ski resort 30 km from Grenoble in southern France, and was chaired by Patrick Buat-Menard and Robert Delmas from Domaine du CNRS and the Laboratoire de Glaciologie, respectively. The conference followed by 2 years the sixth international symposium held in Peterbourgh, Canada, and was attended by 280 scientists from 27 countries. Attendance was roughly twice what organizers had originally anticipated, testifying to the increasing international interest in atmospheric chemistry.

The conference included sessions of the IGAC program, a core program of the IGBP. IGAC, chaired by R. A. Duce, University of Rhode Island, is designed to promote international cooperation in atmospheric chemical research, especially research applicable to global concerns. The IGBP was created by the International Council of Scientific Unions (ICSU) in 1988 as an international study of global change. One of the principal projects of IGAC was organized at this meeting and was of special interest to this participant. This project, under the guidance of Tom Graedel from AT&T Bell Laboratories, is the "Development of Global Emissions Inventories." The overall goals of IGAC, as expressed in its founding documents, are "to measure, understand, and thereby predict changes now and over the next century in the chemistry of the global atmosphere, with particular emphasis on changes affecting the oxidizing power of the atmosphere, the impact of atmospheric composition on climate, and the interactions of atmospheric chemistry with the biota." These goals were admirably served by this outstanding conference.

Appendix B of this report contains the full agenda of oral presentations. There were an additional 125 or so poster presentations. I have the book of abstracts and over 100 of the papers are being organized for a special issue of *The Journal of Atmospheric Chemistry*.

THE TRAVELER'S ROLE

I attended this conference in order to share results achieved, under DOE sponsorship, regarding the magnitude and distribution of CO_2 emissions to the global atmosphere—CO_2 being the principal greenhouse gas of current concern. I also hoped to learn the latest results of investigations of other greenhouse gases and their atmospheric interactions and, thus, to achieve better understanding of the full ramifications of the greenhouse effect and how society might deal with it. At the invitation of Tom Graedel, I attended the organizational meeting of the IGAC project "Development of Global Emissions Inventories" and was asked to organize an intercontinental working group on anthropogenic emissions of CO_2. My formal address will provide the foundation of this effort but the desire is to calculate emissions on a 1° latitude by 1° longitude grid and to have participation and cooperation of an international working group to ensure the accuracy and acceptance of the data. Comparable working groups will address CH_4, N_2O, CFCs, non-methane hydrocarbons, CO, NO_x SO_2, NH_3, aerosols, trace metals, and whatever other emissions might later be judged important.

TECHNICAL SUMMARY

Conference presentations were organized under five general headings: Paleo and Polar Atmospheric Chemistry, Tropical Atmospheric Chemistry, Global Emissions and Distributions, Multiphase Processes in Atmospheric Chemistry, and Chemistry of the Marine Atmosphere. Presentations came from scientists involved in field studies and data collection, modelers, and synthesizers, and covered a broad spectrum of data and ideas. I was intrigued and greatly educated by the many presentations on the rapidly evolving understanding of species such as dimethyl sulfide and hydroxyl but was particularly interested in discussions of CH_4, N_2O, and emissions related to biomass burning.

The atmospheric balance of N_2O was believed to be fairly well characterized until a 1988 paper by Muzio and Kramlich showed that N_2O measured in emissions from coal-fired power plants was, in fact, an artifact of the analytical technique and that N_2O emissions were actually extremely low. This left basic questions about the major sources responsible for measured increases in atmospheric N_2O and whether or not N_2O might be formed in the downstream portion of power plant plumes. Work reported at this meeting made clear that N_2O was not formed in plumes and that NO_2 emissions attributed to biomass burning were also a result of N_2O analytical problems. (N_2O emissions from soils are greater following a burn, especially when the soil is wetted.) The result is a four terragram source of N_2O which cannot be identified. Two different speakers suggested that NO_x emissions from fossil-fuel burning and subsequent nitrate deposition may be providing nitrogen fertilization which is partially converted to N_2O by reducing bacteria in forest soils, but the data are not conclusive.

The OH radical was suggested by one speaker as the most important trace species in the atmosphere. For many naturally and anthropogenically emitted species, the OH radical initiates chemical reaction chains which oxidize the trace gases and finally lead to their removal from the atmosphere. This is true, for example, of methane, and the impact of increasing emissions of methane, CO and NO_x is to increase the consumption rate of OH and hence, to alter the entire sequence of oxidative reactions in the atmosphere. A modeling study by Valentin and Crutzen showed very clearly how the mean lifetime of CH_4 is increasing as the oxidative balance of the atmosphere is altered. The lifetime of OH in the atmosphere is currently about 1.7 months.

Several intriguing presentations provided detailed measurements of methane emissions related to termites, a topic of considerable interest and disagreement over the last decade. The conclusion at this time seems to be that very high methane emissions can be measured from termites in glass bottles but that within the termite mounds or adjacent forest soils, there are generally large populations of methanotrophic bacteria so that net CH_4 emissions from the larger environment of termite mounds is small and perhaps even negative.

Formal presentations by the Soviet and Chinese attendees included atmospheric emissions data, but the data were presented in such a way as to be hard to read and/or hard to interpret. I initiated contacts with both of these gentlemen in hopes of obtaining further data on the magnitude and distribution of energy use. Reading of the Chinese graphs suggested that their estimates of CO_2 emissions for the 1980s match very well with ours and

when I introduced myself later, Dr. Yang commented that his group was in fact using our emissions coefficients.

In summary, this conference succeeded in assembling many of the best workers at the frontiers of atmospheric chemistry and left this participant feeling better attuned to recent developments with the suite of greenhouse gases other than CO_2. Personal and formal connections made with individuals and the IGAC program will facilitate both the utilization of our results by the international community and our ability to inject appreciation of the non-CO_2 greenhouse gases into our DOE work.

APPENDIX A

Trip Itinerary

9/3-4/90	Travel to Chamrousse, France
9/5-11/90	Chamrousse, France
9/12/90	Travel to Knoxville, Tennessee

APPENDIX B

7th International Symposium of the Commission on Atmospheric Chemistry and Global Pollution

5 - 11 SEPTEMBER 1990
CHAMROUSSE (France)

P R O G R A M M E

Support for this meeting is provided by :

France : - Centre National de la Recherche Scientifique/Institut National des Sciences de l'Univers
- Ministère de l'Environnement
- Météorologie Nationale
- Programme Interdisciplinaire de Recherche sur l'Environnement (PIREN)
- Ministère de la Recherche et de la Technologie
- Université Joseph-Fourier
- Conseil Général de l'Isère
- Ministère des Affaires Etrangères

USA : - NOAA
- NSF
- NASA

International : - CACGP
- WMO

WEDNESDAY SEPTEMBER 5, MORNING

Chairman : R.J. CHARLSON

8 H 30 Official opening of the Symposium

8 H 45 **R. DELMAS, P. BUAT-MENARD** : Introductory remarks

PALEO AND POLAR ATMOSPHERIC CHEMISTRY
PALEO/POLAR 1

9 H **A.L. DICK** : The sources, characteristics and removal mechanisms of Antarctic aerosols

9 H 20 **C.I. DAVIDSON and J.L. JAFFREZO** : Atmospheric sulfate, nitrate, and chloride as reflected in snowpits at Dye 3, Greenland

9 H 40 **M. DE ANGELIS, N.I. BARKOV and V.N. PETROV** : Change in continental aerosol sources over Antarctica during the last climatic cycle

10 H - 10 H 30 **PAUSE**

PALEO AND POLAR ATMOSPHERIC CHEMISTRY
PALEO/POLAR 2

10 H 30 **M. LEGRAND** : Methanesulfonic acid in Antarctic ice : impact of climatic variations as El Nino and glacial age

10 H 50 **A. MINIKIN and D. WAGENBACH** : The biogenic sulfur fraction of the coastal antarctic aerosol body

11 H 10 **J.M. PROSPERO, D.L. SAVOIE, E. SALTZMAN and R. LARSEN** : The seasonal cycles of nitrogen and sulfur species and of ^{7}Be and ^{210}Pb in aerosols at Mawson, Antarctica

11 H 30 **H.B. SINGH, D. HERLTH, D. O'HARA, J.D. BRADSHAW, S.T. SANDHOLM, R. TALBOT and G.L. GREGORY** : Reactive nitrogen in the high latitude troposphere (50° to 82° N)

11 H 50 **A. SIGG, T. STAFFELBACH and A. NEFTEL** : Gas phase measurements of hydrogen peroxyde in Greenland and their use for the interpretation of H_2O_2 ice core records

12H 10-14H 30 **LUNCH BREAK**

WEDNESDAY SEPTEMBER 5, AFTERNOON

Chairman : G. LAMBERT

PALEO AND POLAR ATMOSPHERIC CHEMISTRY
PALEO/POLAR 3

14 H 30 R.C. SCHNELL, S.D. SEWELL, W.T. STURGES and S.J. OLTMANS : Annual protolytic ozone destruction cycle in the Antarctic troposphere

14 H 50 M. SCHWIKOWSKI, U. BALTENSPERGER, H. GAGGELER, D. JOST, A. NEFTEL, U. SIEGENTHALER, K. GEIS, D. WAGENBACH and J. BEER : Transfer of atmospheric constituents into alpine snowfields

15 H 10 K. PFEILSTICKER and D. WAGENBACH : The seasonal cycle of nitrate in the Antarctic troposphere

15 H 30 K. VALENTIN and P.J. CRUTZEN : A two-dimensional, global photochemical study on the influences of increasing atmospheric methane concentrations on global tropospheric chemistry since the last glacial maximum

15 H 50 L.M. FRANCOIS and J.-C. GERARD : Modelling the phanerozoic evolution of atmospheric carbon dioxide and oxygen

16H 10-16H 40 PAUSE

16 H 40 R.J. DELMAS : *Keynote paper* : Paleoatmospheric composition records

TROPICAL ATMOSPHERIC CHEMISTRY
TROPIC 1

17 H 10 J.S. LEVINE, W.R. COFER III, R.P. RHINEHART, E.L. WINSTEAD, D.I. SEBACHER and S. SEBACHER : The effects of surface burning on biogenic emissions of CH_4, N_2O and NO

17 H 30 P.S. KASIBATLA, H. LEVY II, W.J. MOXIM and J.A. LOGAN : Impact of biomass burning on reactive nitrogen levels in the Tropics and sub-Tropics

17 H 50 S. LAL, S.V. RAMANI and B.H. SUBBARAYA : Biogenic trace gases in the tropical region

18 H 10 J.N. LOBERT, D.H. SCHARFFE, T.A. KUHLBUSCH, R. SEUWEN, W.M. HAO and P.J. CRUTZEN : Biomass burning as a source of atmospheric nitrogen containing compounds : an experimental study

18 H 40 END OF SESSION

19 H RECEPTION AND COKTAIL AT CHAMROUSSE CITY HALL

THURSDAY SEPTEMBER 6, MORNING

Chairman : M.O. ANDREAE

8 H 30 **H. SCHIFF** : *Keynote paper* : Instrumental developments in atmospheric chemistry

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 1

9 H C. LORIUS, D. RAYNAUD, J. JOUZEL, J. CHAPPELLAZ, J.M. BARNOLA : Ice core data, climate sensitivity and greenhouse warming

9 H 20 **A.M. THOMPSON** and R.W. STEWART : How well can we calculate tropospheric OH ?

9 H 40 **T. BERNTSEN** and I.S.A ISAKSEN : The OH feedback on methane

10 H - 10 H 40 **PAUSE**

TROPICAL ATMOSPHERIC CHEMISTRY
TROPIC 2

10 H 30 G. LAMBERT, M.F. LE CLOAREC, B. BONSANG, H. CACHIER, B. ARDOUIN and M.P. BREMOND : Global fluxes of atmospheric trace constituents from savanna burning

10 H 50 H. CACHIER, J. DUCRET, J.P. LACAUX, R. DELMAS, B. CROS and P. BUAT-MENARD : Particulate carbon in rain over the primary forest of northern Congo

11 H 10 R.A. DELMAS, J.P. TATHY and B. CROS : Atmospheric methane budget in tropical Africa

11 H 30 B. CROS, J. FONTAN, A. MINGA, D. NGANGA, M.O. ANDREAE and G. HELAS : Ozone in the intertropical region of Africa

11 H 50 J. SERVANT and A. KOUADIO : Organic acids in rainwaters collected in a tropical forest of Congo

12H 10-14H 30 **LUNCH BREAK**

THURSDAY SEPTEMBER 6, AFTERNOON

Chairman : J.M. PROSPERO

14 H 30	E. WOLFF : Posters Preview (Paleo-Polar)
14 H 45	H. CACHIER : Posters Preview (Tropics)

TROPICAL ATMOSPHERIC CHEMISTRY
TROPIC 3

15 H	E. SANHUEZA, M.C. ARIAS, L. DONOSO, N. GRATEROL, M. HERMOSO, J. ROMERO, A. RONDON and M. SANTANA : Rain chemical composition in the Venezuelan savannah region
15 H 20	P. ARTAXO and H.-C. HANSSON : Sources and size distribution of aerosol particles from the Amazone basin tropical rain forest
15 H 40	J. FISHMANN : Studies of tropospheric ozone over the tropical south Atlantic ocean
16 H	R. B. CHATFIELD, A. MARENCO and S. MADRONICH : Case studies of the formation and preservation of high tropical ozone due to agricultural burning in Africa and the global radiative consequences
16H 20-16H 50	PAUSE

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 2

16 H 50	H.J. DIGNON, J. E. PENNER, S.J. GHAN and J.J. WALTON : The global budget and cycle of carbononaceous soot aerosol
17 H 10	J. P. FRIEND : Some new views of the global cycles of chlorine and fluorine
17 H 30	J.M. PACYNA : Global emissions of major air pollutants from anthropogenic sources
17 H 50	G. MARLAND and T. BODEN : Carbon dioxide emissions from fossil fuel burning and cement manufacture
18 H 10	W. JAESCHKE, A. BANDY : Posters Preview : Instrumental developments on atmospheric chemistry
18 H 30	BOJKOV : WMO Global atmosphere watch
18 H 40	END OF SESSION

FRIDAY SEPTEMBER 7, MORNING

Chairman : T.E. GRAEDEL

8 H 30 C. JOHANSSON, A.M. THOMPSON, E. ATLAS : Poster Preview : Global

MULTIPHASE PROCESSES IN ATMOSPHERIC CHEMISTRY
MULTIPHASE 1

9 H N. CHAUMERLIAC and R. ROSSET : Wet chemistry parameterizations in a mesoscale meteorological model

9 H 20 J. LELIEVED : The role of clouds in tropospheric photochemistry

9 H 40 D. MÖLLER and G. MAUERSBERGER : The role of clouds in the tropospheric chemistry - model results

10 H-10 H 30 PAUSE

MULTIPHASE PROCESSES IN ATMOSPHERIC CHEMISTRY
MULTIPHASE 2

10 H 30 YU QIN and A. XIU : Numerical simulation of pollutants removal by precipitation

10 H 50 D. PAL and D.K. SINHA : On numerical model of acid rain formation : two-phase chemical kinetics approach

11 H 10 J.E. JONSON and I.S.A ISAKSEN : The role of liquid phase oxidation in tropospheric gas phase oxidation

11 H 30 G.J.H. ROELOFS : Microphysics and the chemistry inside cloud drops

11 H 50 P.K. QUINN and R.J. CHARLSON : Evidence for multi-phase desequilibrium of ammonia in the remote marine environment

12H 10-14H 30 LUNCH BREAK

FRIDAY SEPTEMBER 7, AFTERNOON

Chairman : G. BRASSEUR

14 H 30 F.C. FEHSENFELD : *Keynote paper* : Global inventories of terrestrial biogenic emissions

MULTIPHASE PROCESSES IN ATMOSPHERIC CHEMITRY
MULTIPHASE 3

15 H J. OGREN, K. NOONE, K. JOHANSSON, A. HALLBERG, S. FUZZI and J. LIND : Hydrogen peroxide partitioning in ambient clouds

15 H 20 H. OBERLINNINGER, H. PUXBAUM and W. WINTWARTER : Organic acids in radiation fogs observed in the Po Valley (Italy)

15 H 40 B. OBERHOLZER, J. COLLETT, J. STAEHELIN and A. WALDVOGEL : A multidisciplinary field experiment to study scavenging processes

16 H S. FUZZI : Presentation of a film entitled : Radiation fog processes - A field experiment in the Po Valley

16H 20-16H 50 PAUSE

16 H 50 S. FUZZI, M.C. FACCHINI and G. ORSI : Radiation fog processes in the Po Valley

MULTIPHASE PROCESSES IN ATMOSPHERIC CHEMISTRY
MULTIPHASE 4

17 H 10 T.E. GRAEDEL : Computer model study of chemistry in wetted aerosol particles

17 H 30 A.G. CLARKE and G.N. KARANI : Characterization of the carbonate content of atmospheric aerosol

17 H 50 N.R. JENSSEN, J. HJORTH, C. LOHSE, H. SKOV and G. RESTELLI : Products and mechanics of the NO_3 gas phase reactions with CH_3, SCH_3, CH_3SH and CH_3SSCH_3

18 H 10 G. BERGAMETTI - J. RUDOLPH : Posters Preview Marine

18 H 30 S. FUZZI, J. OGREN : Posters Preview Multiphase

18 H 45 END OF SESSION

SATURDAY SEPTEMBER 8, MORNING

Chairman : D. MÖLLER

8 H 30 **R.J. CHARLSON** : *Keynote paper* : Multiphase processes in the atmosphere

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 3

9 H **T.S. BATES**, B.K. LAMB and A.B. GUENTHER : Sulfur emissions to the atmosphere from natural sources

9 H 20 **J. LANGNER**, H. RODHE : Anthropogenic impact on the global distribution of atmospheric sulphate

9 H 40 **S. BEKKI** : Model predictions of sulfate aerosol layer changes

10 H-10 H 30 **PAUSE**

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 4

10 H 30 **K.S. LAW** and J.A. PYLE : Modelling the budgets of tropospheric trace gases

10 H 50 **I. LEVIN**, R. BOSINGER, P. BERGAMASCHI, V. HESSHAIMER, L. KATRUFF, D. TRAPP, W. WEISS, G. BONANI, M. SUTER and W. WOLFLI : Isotopic properties of global atmospheric methane

11 H 10 **G. BRASSEUR**, J.F. MULLER and C. GRANIER : The budget and three-dimensional distribution of carbon monoxide in the troposphere

11 H 30 **R.D. SAYLOR** and L.K. PETERS : The contribution and anthropogenic emissions to the global distribution of CO in the troposphere

11 H 50 **C. SPIVAKOVSKY**, J.A. LOGAN, J. DIGNON and E. GOTTLIEB : Constraints on the sources of CO derived from a 3-D model study

12 H 10-14 H **LUNCH BREAK**

SATURDAY SEPTEMBER 8, AFTERNOON

Chairman : R. DUCE

14 H - 17 H : SPECIAL SESSION

PRESENTATION OF THE INTERNATIONAL GLOBAL ATMOSPHERIC CHEMISTRY (IGAC) PROGRAMME

20 H - SYMPOSIUM BANQUET

SUNDAY SEPTEMBER 9

FREE ; EXCURSIONS

GROUP MEETINGS

MONDAY, SEPTEMBER 10, MORNING

Chairman : E. SANHUEZA

8 H 30 P. LISS : *Keynote paper* : The emission of trace gases from sea waterand their roles in atmospheric chemistry

CHEMISTRY OF THE MARINE ATMOSPHERE
MARINE 1

9 H M.O. ANDREAE, G. HELAS and G. SCHEBESKE : Dimethylsulfide and cloud condensation nuclei over the temperate South Atlantic

9 H 20

9 H 40 A.D. CLARKE : Aerosol physicochemistry in the remote Pacific troposphere

10 H - 10 H 30 PAUSE

CHEMISTRY OF THE MARINE ATMOSPHERE
MARINE 2

10 H 30 C. LECK : Do marine phytoplankton contribute to the atmospheric sulfur balance of northern Europe ?

10 H 50 R. STAUBES and H.W. GEORGII : Biogenic sulfur compounds in seawater and the marine atmosphere over the Atlantic Ocean

11 H 10 D.C. THORNTON, A.R. BANDY and R.G. RIDGEWAY : Sulfur gases in the Tropical marine atmosphere

11 H 30 B.C. NGUYEN, N. MIHALOPOULOS, A. GAUDRY, J.P. PUTAUD and L. GALLET : Effect of oceanic dimethylsulfide on the rain acidity in a remote marine area

11 H 50 A. PSZENNY, C. BROWN and C. FISCHER : Particle size distributions of methanesulfonate in the tropical Pacific marine boundary layer

12H 10-14H 30 LUNCH BREAK

MONDAY SEPTEMBER 10, AFTERNOON

Chairman : P. LISS

14 H 30 P. CRUTZEN : *Keynote paper* : Tropical atmospheric chemistry of biomass burning and cloud processes

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 5

15 H D. CUNNOLD, F. ALYEA, R. PRINN, R. RASMUSSEN, A. CRAWFORD, P. SIMMONDS and F. FRASER : Atmospheric inventories of the chlorocarbons from ten years of ALE/GAGE observations

15 H 20 M. PRATHER : Reporting requirements for the alternative CFCs : How can we monitor the global cycle of HCFCs ?

15 H 40 J. DIGNON and J.A. LOGAN : A global inventory of biogenic isoprene emissions

16 H T.E. GRAEDEL : The IGAC project for the development of global emission inventories

16H 20-16H 50 PAUSE

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 6

16 H 50 P. MIDDLETON : Use of North American inventories in regional studies : implications for global modeling applications

17 H 10 W.X. YANG and Z.L. CHEN : Trace gases emission fro agricultural biomass burning in China

17 H 30 J.L. GRAS : Southern ocean atmospheric nuclei - some observations

17 H 50 R.M. HARRISON and A.M.N. KITTO : Surface exchange of atmospheric nitrogen species including nitrous acid

18 H 10 E. ATLAS and S. SCHAUFFLER : Occurrence of alkyl nitrates in the global troposphere

18 H 30 END OF SESSION

TUESDAY SEPTEMBER 11, MORNING

Chairman : W.L. CHAMEIDES

CHEMISTRY OF THE MARINE ATMOSPHERE
MARINE 3

8 H 30 R. KOPPMANN, F.J. JOHNEN, C. PLASS and J. RUDOLPH : The lautudinal distribution of light nonmethane hydrocarbons over the Atlantic

8 H 50 H. AKIMOTO and F. SAKAMAKI : Nonmethane hydrocarfbon distributions in the western Pacific marine atmosphere

9 H 10 B. BONSANG, M. KANAKIDOU and I. BERTRAND : Simultaneous variations of the concentrations of non methane hydrocarbons, ozone and radioactive tracers during the "Oceano Nox" field campaign at the "Pointe de Penmarc'h".

9 H 30 P.D. NIGHTINGALE and P.S. LISS : The distributions and seasonal trends fo low molecular weight halocarbons in the southern North sea

9 H 50 P. CARLIER, P. FRESNET, S. PASHALIDIS, F. PETITET, M. TSETSI, V. LESCOAT, B. DUPONT, D. RITZ : Overview of the atmospheric field campaign at the "Pointe de Penmarc'h"

10H 10-10H 30 PAUSE

CHEMISTRY OF THE MARINE ATMOSPHERE
MARINE 4

10 H 30 T. BRAUERS, U. PLATT, H.P. DORN and R. NEUROTH : Nitrate free radicals in the marine troposphere

10 H 50 U. PLATT, G. LE BRAS, G. POULET, J.N. CROWLEY and G. MOORTGAT : Nighttime peroxy radical production reactions of NO, with organic compounds

11 H 10 B.J. HUEBERT, G. LEE and S. HOWELL : Measurements of Nitrate phase, concentration, and flux over the tropical Pacific ocean

11 H 30 G. HUBLER, D.D. MONTZKA, C. HAHN, R.B. NORTON, M.A. CARROLL, F.C. FEHSENFELD, B.A. RIDLEY, J.G. WALEGA, F.E. GRAHEK, S. SCHAUFFLER, E. ATLAS, B.J. HUEBERT, W.W. WARREN and J. MERRILL : Partitioning of total reactive odd nitrogen (NO_y) in the remote Pacific troposphere, MLOPEX 1988

11 H 50 G. GRAVENHORST, H. KREILEIN, M. MULLER, P. SCHAFER, A. IBROM and A. WARAGHAI : Estimation of NH_3 fluxes between the atmosphere and the ocean

12H 10-14 H LUNCH BREAK

TUESDAY, SEPTEMBER 11, AFTERNOON

Chairman : H. RODHE

CHEMISTRY OF THE MARINE ATMOSPHERE
MARINE 5

14 H J.M. PROSPERO, H. RODHE et al. : Sulfur and nitrogen cycling in the north Atlantic ocean atmosphere : a comparison of measurements and model results

14 H 20 R. ARIMOTO, R.A. DUCE, J.M. PROSPERO and D.L. SAVOIE : Trace element concentrations in aerosol particles from the North Atlantic

14 H 40 Y. BALKANSKI, D. JACOB, R. ARIMOTO and M.A. KRITZ : Transport of Radon 222 and Lead 210 over the Pacific Ocean

15 H M.A. SICRE, E.T. PLETZER, R.B. GAGOSIAN, A. SALIOT and J.C. MARTY : Assessment of marine and terrestrial regional signatures in aerosols over the Pacific Ocean

15 H 20 G.R. CARMICHAEL, Y. SUNWOO, V.R. KOTAMARTHI, H. KURITA and H. UEDA : the regional distribution of radiatively, biologically and photochemically imporetant trace species in the Pacific Rim region

15H 40-16H 10 **PAUSE**

GLOBAL EMISSIONS AND DISTRIBUTIONS
GLOBAL 7

16 H 10 W.L. CHAMEIDES : Hydrocarbons and NO, in urban, rural and remote tropospheric ozone photochemistry

16 H 30 A. MARENCO : Global and regional distribution of ozone and precursors in troposphere, from aircraft (Stratoz and Tropoz)

16 H 50 H. LEVY II, W.J. MOXIM and P.S. KASIBHATLA : The global distribution of reactive nitrogen : a synthesis of observation and numerical simulation

17 H 10 J.W. ELKINS, T.M. THOMPSON, J.H. BUTLER and B.D. HALL : The global budget of atmospheric nitrous oxide inferred from measurements obtained at NOAA/CMDL stations, in natural waters, and during combustion studies

17 H 30 P.H. ZIMMERMANN and P.J. CRUTZEN : The impact of industrial NO_x emissions on the net photochemical ozone production due to CH_4 and CO oxidation in the global troposphere calculated with a three-dimensional model

17 H 50 CLOSING OF THE SYMPOSIUM
CONCLUDING REMARKS

-END-

DATE FILMED

11 / 1 / 90