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Enclosed is please find one copy of our Annual Status Report for the period April 2, 1987 through April 1, 1988 for our contract NAS5-28135, *Visiting Scientist Program in Atmospheric Sciences.*

Sincerely,

Kevin Schmadel
Associate Director,
Atmospheric Sciences Program

Enclosure

A VISITING SCIENTIST PROGRAM IN ATMOSPHERIC SCIENCES FOR THE GODDARD SPACE FLIGHT CENTER

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FINAL REPORT - Contract NAS5-28135

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16. Abstract

Narrative report of sponsored research task activities during the contract period, April, 1984 - September, 1988. Research results are not given.

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PREFACE

The purpose of Contract NAS5-28135 between The Universities Space Research Association and The Goddard Space Flight Center was to provide Goddard with expert researchers to perform specified research tasks in collaboration with government scientists. The contract covered efforts for the time period April, 1984 through September, 1988. USRA was able to provide suitable research persons for each assigned task. Details of the conduct of the specific tasks are provided in the body of this Final Report. The Report does not, however, discuss details of research findings, for which reference should be made to publications by the individual scientists.

INTRODUCTION

This document is the Final Report for Contract NAS5-28135 between the Universities Space Research Association (USRA) and the NASA Goddard Space Flight Center.

Under this contract, USRA operated a visiting scientist program and conducts research in the atmospheric sciences and related areas at the Goddard Laboratory for Atmospheres (LA) and at designated off-base sites, as specified by task assignments, for the period April 2, 1984 through September 30, 1988. USRA visiting scientists and consultants performed research in mathematical analysis as applied to computer modeling of the atmosphere, development of atmospheric modeling programs, analysis of remotely sensed atmospheric, surface, and oceanic data and its incorporation into atmospheric models, development of advanced remote sensing instrumentation, and related research areas. This report details specific research efforts by task. The dates accompanying each task assignment show the period of the supported effort during the period of the contract.

USRA appreciates the opportunity this contract has afforded to participate in and contribute to the Goddard research program in the atmospheric sciences.

DETAILS OF RESEARCH PERFORMED ON EACH ASSIGNED TASK

TASK 1
April 2, 1984 - November 2, 1984

Dr. Dennis Reuter was the visiting scientist who performed research under this task assignment. He improved and extended the parameterization of long-wave radiative heat transfer in the stratospheric version of the GLAS GCM. November 2, 1984, Dr. Reuter terminated to accept a government research position. During his tour with USRA, Dr. Reuter presented papers at the 39th Annual Symposium on Molecular Spectroscopy, which was held in Columbus, Ohio, and also at workshops on remote sensing and Earth sciences held at Williamsburg, Virginia, and at the Jet Propulsion Laboratory.

TASK 2
April 2, 1984 - January 31, 1985

Dr. Richard L. Wobus performed theoretical research in remote sensing of the atmosphere and the Earth's surface using data from satellite-borne IR and microwave radiometers. He also investigated the design of sounders to improve the accuracy of soundings to obtain multi-level cloud and water vapor profiles. He was able to achieve more accurate parameterization of the carbon dioxide 15 micron band for the GLA GCM by using an improved regression method. He left USRA to join a private firm.

TASK 3
April 2, 1984 - January 6, 1985

Supported by this task, Dr. Noah Wolfson performed diagnostic studies of "significant" meteorological events during the periods of the First Global GARP Experiment (FGGE) and the post-FGGE period. He carried out extensive numerical prediction experiments using the GLAS models. Wolfson participated in the Remote Sensing workshop at Williamsburg and the Tenth Conference on Weather Forecasting and Analysis at Clearwater Beach, Florida.

TASK 4
April 2, 1984 - April 1, 1988

Dr. Stephen C. Bloom, as USRA visiting scientist, carried out research in areas of meteorological data analysis and assimilation, using the GLA 4th Order GCM and Optimum Interpolation systems.

His first research tasks involved the development of initialization techniques for the GLAS 4th Order GCM and the application of these techniques to diagnostic studies of the systematic short-term forecast errors of the GLAS GCM. He also performed research on vectorized methods. He authored a paper entitled "Experiments with a Three-Dimensional Statistical Objective Analysis Scheme Using FGGE Data" with Stephen Bloom (USRA) and Wayman Baker (NASA/GSFC) and others.

During the 1986-87 period, Bloom performed initial experiments with a diabatic initialization procedure and characterized the vertical structures in the GLA GCM that are needed to retain the Hadley Circulation after initialization. With Dr. Robert Atlas and others he authored the paper "Global Surface Wind and Flux Fields from Model Assimilation of SEASAT ..." which was submitted to the J. Geophys. Res.

A major accomplishment during 1987 was the development of a series of methods for assigning directions to the abundant scalar wind speed data over oceans. In February, 1988, Bloom presented a paper at the 3rd Conference on Satellite Meteorology and Oceanography at Anaheim, California -sponsored by the AMS.

TASK 5
April 2, 1987 - December 17, 1987

The Task Assignment for Task 5 was (a) to maintain and improve software systems that apply to correlation spectra and the spectral filter program, and (b) to carry out a study of the marine boundary layer, in particular, to study the air mass transformation over warm

water using MASEX and GALE data, to study the characteristics of the marine surface layer, and to study aircraft soundings from GALE. The assignment was carried out by Dr. Eueng-nan Yeh in collaboration with NASA/GSFC scientists, particularly Dr. S-H Chou.

Dr. Yeh, in collaboration with Dr. S-H Chou and Dr. David Atlas prepared a paper in 1984 on "Turbulence in a Convective Marine Atmospheric Boundary Layer." They found a greater importance of wind shear than had been previously noted. The paper was published in the Journal of the Atmospheric Sciences. In November, 1985, Yeh attended the GALE planning meeting (GALE="Genesis of Atlantic Lows Experiment") in Raleigh-Durham, North Carolina.

Yeh's studies of the marine boundary layer continued through 1985-87. He left USRA in December, 1987 and joined a company in the private sector.

TASK 6
April 2, 1984 - September 30, 1988

Dr. Li Peng was the USRA Visiting Scientist sponsored by Task 6. His research assignment was to carry out theoretical and numerical studies aimed toward an understanding of the dynamics of the tropical oscillations at intraseasonal and interannual time-scales; their origins, spatial and spectral structure, the responsible mechanisms, and the relationship between the multiple spatial and temporal scales of the oscillations.

Dr. Peng performed research in climate sensitivity to external radiative forcing, along with investigations of influences on the El Nino/Southern Oscillation. Much of this work was in collaboration with Dr. M. D. Chou and Dr. Alan Arking. In 1985-86, Peng developed an atmosphere-ocean coupled model to study the climate response to a projected carbon dioxide trend in the next hundred years. In 1986-87, in collaboration with Dr. K. Lau, Peng developed a theory for the origin of the 30-60 day oscillation in the tropical atmosphere. The model shows that under realistic conditions the development of an eastward moving 30-60 day wave is generally accompanied by smaller scale convective cells moving with a speed nearly equal to that of the wave, but in the opposite direction, i.e. westward. This is in agreement with the most recent observational studies using satellite data of smaller time interval - 3 hours. An eigenvalue analysis of a multilayer atmosphere-ocean system shows that there are two types of unstable modes. One is an essentially atmospheric mode excited by moist convection, and the other is the mode excited by the interaction between the atmosphere and the ocean. Both types of modes have similar baroclinic vertical structures.

Peng participated in the Conference on the Variability of the Atmosphere and the Oceans on Time Scales of a Month to Several Years

that was held in London in 1986, and the 4th Conference on Climate Variations held in Baltimore in March, 1987. He also attended the Sixth Conference on Atmospheric and Oceanic Waves and Stability, August 25-28, 1987, Seattle, Washington, and presented the results of the study on atmosphere-ocean unstable modes.

Publications include:
Chou, M.D., Peng, L, and A. Arking, 1984, "Climate Studies with a Multilayer Energy Balance Mode, Part III", J. Atmos. Sci, 41, 759-767.

Chou, M.D., Peng, L., and A. Arking, 1984, "Characteristics of Radiatively Forced Climate Changes in a Multilayer Energy Balance Model"

Peng, L., Chou, M.D., and A. Arking, 1985: "Climate Warming due to Increasing Atmospheric CO_2"

Lau, K., and L. Peng "Origin of Low Frequency (Interseasonal) Oscillations in the Tropical Atmosphere, Part I, Basic Theory"

TASK 7
April 2, 1984 - September 30, 1988

The purpose of Task 7 was to assist the Atmospheric Dynamics and Radiation Branch, Earth Science and Applications Division of NASA Headquarters. The principal in this effort was Dr. Robert Turner, who acted as a USRA consultant, with collaborating consultants Dr. Walter Frost and Dr. William Vaughan.

Dr. Frost collaborated with Dr. John Theon of NASA Headquarters on several papers dealing with atmospheric turbulence measurements and field studies of boundary layer models.

Dr. Turner carried out a comprehensive literature search on turbulent fluxes in the atmosphere. As another assignment, he collected data on meteorological services requirements and assisted in the planning and conduct of several major meetings of the AIAA. In 1987, he assisted in the preparation for the Tropical Rainfall Mapping Mission (TRMM) Symposium held at Tokai University, Tokyo, Japan, October 28-30, 1987 and provided assistance to Dr. Theon on NASA Center inputs to OFCM along with preparations for the AIAA 26th Aerospace Sciences Meeting, Jan 11-14, 1988, Reno, Nevada, and coordination with major participants. Recently, Turner has begun to work on planning for the 1989 Reno meeting. He acted as planner for the Natural Lightning Hazard Short Course held at the SimuFlite Training International Division, Dallas/Ft. Worth, in July, 1988, and handled all arrangements.

Dr. Vaughan provided assistance to Dr. Theon on the organization and administration of meetings.

June to September of 1987 Dr. K.R. Kimble collaborated with Dr. Wayman Baker of GLA on the application of artificial intelligence tools to problems in mesoscale modelling.

In March 1988, the travel of Prof. T. Sakata, one of Asia's foremost authorities on remote sensing, was sponsored from Japan to the United States. Dr. Sakata participated in several meetings and delivered a colloquium at Goddard.

In March 1988, Prof. K. Okamoto of the Japan Radio Research Laboratory visited ASA/GSFC to participate in the engineering meeting of the Tropical Rainfall Measuring Mission.

TASK 8
February 20, 1985 - February 19, 1987

Dr. Kenji Nakamura worked on this Task as a USRA Visiting Scientist from February 20, 1985 to October 29, 1985. It was a cooperative airborne meteorological experiment effort between Goddard/Wallops Flight Facility, and the Radio Research Laboratory (RRL) of Japan. The purpose of the program was to test methods of measuring rain from space. Four rain observation flights were carried out and the data were analyzed. A presentation entitled "Comparisons of Methods Using Data from an Airborne Dual-wavelength Radar" was given at the 23rd Conference on Radar Meteorology.

Dr. Toshiaki Kozu assisted Dr. Nakamura during November and December, 1986.

TASK 9
October 9, 1984 - September 30, 1988

This task supported an internship program designed to provide the opportunity for university researchers to become familiar with such Goddard research computing resources as the GLA global modeling programs. Other related efforts were also supported.

Under the sponsorship of Task 9, Dr. Cort Willmott and Dr. Clinton Rowe of the University of Delaware visited GSFC in 1984-5 and gained familiarity with the computing facilities and the GCM programs. Dr. Noah Wolfson traveled to GSFC from Tel Aviv University several times and collaborated with Dr. Robert Atlas and Dr. Eugenia Kalnay. Dr. Richard Pfeffer of Florida State University visited GSFC and conferred with Dr. Kalnay.

Vikram Mehta of Florida State University visited Goddard and worked with Dr. Y. Sud of GLA on the GLA-GCM to investigate various types of sea-surface temperature anomalies. Mehta also worked with Dr. M. Suarez at GLA in the development of a coupled atmosphere-ocean model. This work was part of Mehta's Ph.D. dissertation.

Dr. Sirpa Hakkinen was supported briefly under this task in her work on modeling air-sea-ice interactions. Her support continued under Task 24.

During the summer of 1988, Dr. T. O. Aro of the Department of Physics, University of Ilorin, Nigeria, visited GSFC under the sponsorship of the Internship Program and worked with Dr. Joel Susskind on analyses of satellite HIRS/MSU (High Resolution Infrared Sounder/Microwave Sounding Unit) to retrieve clear-air precipitable water data over the West Africa tropical region bounded by the Gulf of Guinea and the southern borders of the Sahel. At the end of his tour at Goddard, Dr. Aro returned to his home institution. Other senior visitors to Goddard during the summer of '88 whose visits were sponsored by Task 9 included Dr. Akio Arakawa, Dr. Noah Wolfson and Dr. Donald Johnson. During his recent stay at Goddard, Wolfson's research concentrated on finding the causes responsible for the initiation of the 1980 heat wave.

TASK 10
February 2, 1985 - September 10, 1986

Dr. Jeffrey Augenbaum was the Visiting Scientist under Task 10. Dr. Augenbaum engaged in a collaborative project with members of the Courant Institute of Mathematical Sciences of New York University to develop highly efficient methods for the numerical solution of the primitive equations that describe atmospheric motions. His papers included "A Factored Implicit Scheme for Numerical Weather Prediction" (with S. Cohn, D.Dee, E. Isaacson, and D. Marchesin) in Communications in Pure and Applied Mathematics 38, 503-517 (1985); "A Fully Implicit Scheme for Global Numerical Weather Prediction (with S. Cohn, D. Dee, E. Isaacson, and D. Marchesin) in the Reprint volume of the Seventh Conference on Numerical Weather Prediction, 1985; and "Eliminating Grid Orientation Errors in Alternating Direction Implicit Schemes" (with S. Cohn and D. Marchensin).

Augenbaum traveled to the NYU Currant Institute several times, and attended the 7th Conference on Numerical Weather Prediction in 1985 in Montreal, and the SIAM Conference on Parallel Processing which was held November, 1985 in Norfolk, Virginia. He left USRA in September, 1986 to accept a position in the Mathematics Department of the University of Connecticut.

TASK 11
February 11, 1985 three months

Under the sponsorship of Task 11, USRA assembled a committee of experts to examine the feasibility of developing a program at GSFC focused on the applications of high-speed vector or parallel processors to computational requirements of atmospheric research involving space-derived data.

TASK 12
June 15, 1985 - October 31, 1986

Dr. Gerard Szejwach joined the USRA staff of visiting scientists to perform research under Task 12. He developed and made use of a radiative transfer model to study the feasibility of inferring cloud structure and rain information from passive microwave measurements. Szejwach participated in the GALS experiment in February, 1986. In October, 1986, Dr. Szejwach left USRA to become Technical Head of the newly created European Organization for the Exploitation of Meteorological Satellites.

TASK 13
June 1, 1985 - August 31, 1985

Under the sponsorship of this task an independent laser scientist provided expertise to NASA, working with senior laser specialists at the University of Arizona.

TASK 14
May 20, 1986 - September 11, 1986

Dr. Hiroshi Tanaka traveled from Nagoya, Japan to GSFC in May, 1986 and returned to Japan in September, 1986. While at GSFC, working as a USRA visiting scientist, he implemented sub-grid-scale gravity wave parameterization in a general circulation model extending from the Earth's surface to the stratosphere.

TASK 15
January 1, 1987 - December 31, 1987

Dr. Louis Gonzalez, from Lille, France, worked at GSFC under USRA sponsorship to develop techniques and analysis routines for the Cloud Cover Pressure System. The analysis includes comparisons of cloud cover parameters retrieved from satellite observations at various resolutions with aircraft and ground-based measurements of the same parameters and at extremely high resolution.

TASK 16
November 3, 1986 - September 30, 1988

Dr. Daniel Rosenfeld performed research in collaboration with Goddard scientists to 1) study the evolution of convective rain cloud systems in various climatic regimes by means of weather radars; 2) develop the algorithms, perform the quality control, and process the data of a network of several weather radars around the world in tropical regions, as a major part of the ground-truth of NASA's Tropical Measuring Mission (TRMM).

Articles:

Rosenfeld, D., 1987: Objective method for analysis and tracking of convective cells as seen by radar, J. Atmos. Ocean. Tech., 4, 422-434.

Rosenfeld, D., and Y. Mintz, 1988: Evaporation of rain falling from convective clouds as derived from radar measurements. J. Appl. Meteor. (accepted).

Schlesinger, M.E., J. Oh, and D. Rosenfeld, 1988: A parameterization of the evaporation of rainfall. Mon. Wea. Rev. (in press).

Atlas, D., D. Rosenfeld, and D.A. Short, 1988: The estimation of convective rainfall by area integrals. Part I: The theoretical and empirical basis. Conference on Mesoscale precipitation: Analysis, Simulation, and Forecasting, MIT, Cambridge, MA., September 13-17, 1988 (accepted.)

Rosenfeld, D., D. Atlas, and D.A. Short, 1988: The estimation of convective rainfall by area integrals. Part II: The height area rainfall threshold (HART) method. ibid.

Seminars, Meetings:

Tropical Rainfall Measuring Mission Workshop, November, 1986, Washington, DC.

International Workshop on the Validation of Satellite-Derived Precipitation Measurements for the Global Precipitation Climatology Project of the World Climate Research Program, November, 1986, Washington, DC.

July 7-8, 1987: Visited Kennedy Space Center to adapt the weather radar for accurate rainfall measurements.

November, 1987: Conference on Radar Meteorology, Boston, MA

December, 1987: Participated in a collaborative research effort with the Australian Bureau of Meteorology Research Centre, which took place in Darwin, Australia, to perform quality control of the data gathered by meteorological doppler radar which NASA installed in Darwin.

TASK 17
May 4, 1987 - Sepbember 30, 1988

Dr. S. Moorthi was sponsored as USRA Visiting Scientist to design and develop an efficient, finite-difference, multi-level primitive equation atmospheric general circulation model (GCM) with realistic physics for the study of climate, air-sea interaction, etc.
Moorthi completed a version of the model with horizontal resolution 4 x 5 degrees latitude/longitude and 8 layers in the vertical. He developed a convective adjustment scheme and also a Revised Arakawa-Schubert cumulus parameterization scheme for use in GCMs.

In 1988, Dr. Moorthi completed version 4 of the model which includes the convective parameterization and has interactive cloudiness for the purpose of radiation calculation. This version of the model produces reasonable winter and summer climatology of the earth's atmosphere.

Moorthi participated in the AMS meeting held in Baltimore, Feb. 22-26, 1988. He also participated in the NASA Review of the Modeling, Data Analysis, and Instrument Development Research during July 27-29, 1987.

TASK 18
December 1, 1986 - July 5, 1988

Task 18 sponsored the start-up phase of the new USRA Center of Excellence in Space Data and Information Sciences (CESDIS) at Goddard. The first step was the organization, management, and convening of a committee of experts to study the establishment of CESDIS Membership of this committee included Dr. Barry Leiner, Dr. Jack Schwartz, Dr. Donald R. Johnson, Dr. Robert Kurucz, Dr. Anthony Hearn, Dr. Bruce W. Arden, Dr. Stephen E. Cohn, Dr. Barnard A. Galler, Dr. Shelton Alexander, Dr. Ethan Schreir. Several meetings were held, and by the end of 1987, the CESDIS project took shape.

A Call for Proposals was sent out to computer science departments throughout the country, and a search was conducted for a permanent CESDIS director by a search committee headed by Dean Robert Dorfman of the University of Maryland. During this formative period, the interim director was Prof. John Hopcroft, Head of the Computer Science Department at Cornell University. To guide the development of the Center, an executive committee was formed whose membership included Dr. Joel Moses, Dr. Louis Lanzerotti, Dr. Milton Halem, Dr. David Landgrebe, Dr. Ken Kennedy, and Dr. Jack Minker. In the Spring of 1988, Dr. Raymond Miller of The Georgia Institute of Technology accepted the position of Director of CESDIS.

A peer review was held of the over 80 proposals that were submitted in response to the Call for Proposals, and by the

conclusion of the Task, several outstanding programs had been selected for funding by the new Center. Work under this task came to an end when the contract between NASA and USRA supporting CESDIS was in place.

TASK 19
July 20, 1987 - September 30, 1988

Toshiaki Kozu was sponsored to develop software development and radar hardware modification for data acquisition and processing associated with an airborne rain measuring experiment conducted by the Communications Research Laboratory (old name: "Radio Research Laboratory") of Japan and NASA/GSFC, continuing the effort that had begun under Task 8 with Dr. Kozu. The Tropical Rainfall Measuring Mission (TRMM) project is a joint US-Japan space program for which the first spaceborne rain radar has been proposed. The feasibility study of the TRMM was conducted in 1987. Kozu contributed to this study mainly in the field of radar design with NASA and Japanese staff.

PUBLICATIONS:

T. Kozu et. al. "Observation of Oil Slicks on the Ocean by an X-band SLAR"' Proc. of IGARSS '87 Symposium, Ann Arbor, Mich., May 1987.

K. Okamoto, T. Kozu, K. Nakamura, and T. Ihara, "Tropical Rainfall Measuring Mission Rain Radar", First Symposium on Tropical Precipitation Measurements, B-08, Tokyo, Japan, October, 1987

T. Suitz, S. Yoshikado, T. Kuroso, T. Kozu, and T. Umehara, "Backscattering Coefficient of Rice Crops and Rice Fields by an X-Band Scatterometer", Twenty-First International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., October, 1987.

T. Kuzo, K. Nakamura, J. Awaka, and M. Takeuchi, "Development of Ku-Band FM-CW/Pulse-compression radar for rain observations on a slant path", Journal of Radio Research Laboratory, Japan, 34, 143, 95-113, Nov., 1987.

T. Kozu, J. Awaka, H. Fukuchi, and K. Nakamura, "Rain Attenuation ratios on 30/20 and 14/12 GHZ Satellite-to Earth Paths" Radio Science, vol. 23. No. 3, 409-418, May-June, 1988.

J. Awaka, T. Kozu, and K. Okamoto, "A feasibility study of rain radar for the Tropical Rainfall Measuring Mission: Determination of basic system parameters", J. of the Communications Research Laboratory, Japan, vol 35, No. 145, 111-133, July, 1988.

K. Okamoto, J. Awaka, and T. Kozu, "A feasibility study of rain radar for the Tropical Rainfall Measuring Mission: A case study of rain radar system", J. of the Communications Research Laboratory, Japan, vol. 35, No 145, 183-208, July, 1988.

During his tenure, Kozu attended
1. the International Symposium on Remote Sensing of the Environment (University of Michigan, Oct. 26-30, 1988) to present the paper "Backscattering Coefficient of Rice Crops and Rice Fields by an X-Band Scatterometer" as one of the authors.

2. the AMS 40th Anniversary Radar Meteorology Conference as a member of the panel "Airborne/Spaceborne Radar". Kozu also contributed to the panel report and the review paper.

3. the ISY Mission to Planet Earth Conference (Univ. of New Hampshire, Durham, NH, April 29-May 1, 1988) as the representative of N. Fugono, CRL, Japan, and served as a member of the working group for the global standard for observing systems.

4. the ERS-1 AO First Experiments Meeting (ESRIN, Frascati, Italy, May 2-6, 1988) as the representative of the PIs of the proposals from Japan.

TASK 20
June 1, 1987 - August 30, 1987

The visiting scientist supported under Task 20 was Insik Kang, a visitor from Korea.

During the summer of 1987, Kang performed research on the global angular momentum fluctuations in time scale of 50 days, with emphasis on the tropical influence. He attended the 6th Conference on Atmospheric and Oceanic Waves and Stability, August 25-28, Seattle, Washington and presented the paper "Influence of zonal mean flow changes on the stationary wave fluctuations."

TASK 21
August 1, 1987 - September 30, 1987

Under sponsorship of Task 21, Guiseppe Dalu investigated the optical properties of clouds in the IR utilizing the Nimbus-4 IRIS data and developed a theoretical framework to perform multiple scattering computations.

The following publication was submitted to the JCAM:
Prabhakara, Fraser, Dalu, Wu, Curran and Styles, "Thin Cirrus Clouds: Seasonal Distribution over Oceans Deduced from Nimbus-4 IRIS".

TASK 22
December 1, 1987 - September 30, 1988

The Task Assignment for Task 22 calls for analysis of hierarchy of tropical convection over the western Pacific using satellite derived cloud information and conventional meteorological data. This research was carried out by Tetsuo Nakazawa.

Nakazawa prepared the following articles for publication:
1. "Analysis of the super cloud cluster by Geostationary Meteorological Satellite IR 3-hourly data", October, 87. Submitted to the Proceedings of the International Symposium on Tropical Precipitation Measurements.

2. "Evidence of the existence and eastward motion of super clusters at the equator" (with Yoshi-Yuki Hayashi) November, 1987. Submitted to Monthly Weather Review of the AMS.

3. "Tropical super clusters under intraseasonal variations, November, 1987", published in Meteorological Research Report, 88-1, Division of Meteorology, Geophysical Institute, University of Tokyo, 76-86.
4. "Tropical cloud clusters within intraseasonal variations over the western Pacific" March, 1988. Submitted to the Journal of Meteorological Society of Japan.

5. "Dynamics of super cloud clusters, westerly wind bursts, 30-60 day oscillations and ENSO" by K.M. Lau, L. Peng, C.H. Sui, and T. Nakazawa. (Submitted to the Journal of Meteorological Society of Japan in August, 1988.

During his tenure, Nakazawa attended:
1. International Symposium on Tropical Precipitation Measurements, October, 1987, presented "Analysis of the super cloud cluster by GMS IR 3-hourly data."

2. Japan-US workshop on the El Nino - Southern Oscillational Phenomenon. Nov., 1987. Presented "Tropical superclusters under intraseasonal variations."

3. Jacob Bjerknes Symposium on air-sea interactions by the AMS. February, 1988. Presented "Analysis of eastward moving supercluster under intraseasonal variation in the tropics."

August 15, 1987 - October 1, 1987

Under the subcontract established by Task 23, Dr. Bruce Morton of Monash University (Australia) provided support to a study of bulk entrainment into cumuli growing through wind shear. An analysis was made of model computer runs to develop measures of the strength and vertical extent of organized pairs of vertical vortices within clouds which were then related the ambient wind shear state.

TASK 24
February 1, 1988 - June 30, 1988

Dr. Sirpa M. A. Hakkinen was sponsored by USRA to study air-sea-ice interactions, specifically heat exchange between ocean and atmosphere in the Norwegian-Greenland Seas, and the deep (bottom) water formation/water mass modification using numerically coupled ice-ocean models. Previously, Dr. Hakkinen was sponsored for a brief period under Task 9.

PUBLICATIONS:

Hakkinen, S., "A coupled dynamic-thermodynamic model of an ice-ocean system in the marginal ice zone," J. Geophys. Res., 92, 9469-9478 (1987)

Crowley, T.J., and S. Hakkinen, "A new mechanism for decreasing North-Atlantic deep water production rates during pleistocene," to appear in Paleoceanography (1988).

Hakkinen, S., "A note on deep water production via a 'chimney' formation in the ice edge regions," to appear in J. Geophys. Res. (1988)

Hakkinen, S. and L. P. Roed, "Models" in Polar Oceanography) (ed. W. O. Smith). Pergamon Press, 1988 (in preparation).

Hakkinen, S., and D. J. Cavalieri, "A study of surface heat fluxes in the Norwegian, Greenland and Barents Seas," submitted to J. Geophys. Res., 1988.

PRESENTATIONS:

IUGG Meeting, Vancouver, Canada, Aug 1 1987: "A coupled dynamic-thermodynamic model of an ice-ocean system - the marginal ice zone."

Woods Hole Oceanographic Institution, Sept., 1987 (invited):
"Ice-ocean interactions in the MIZ"

GFDL/Princeton University, Sept., 1987 (invited): "Modeling dynamic-thermodynamic interactions of an ice-ocean system"

CIRES, Boulder, September, 1987 (invited)
"A coupled ice-ocean model for the MIZ"

AGU Fall Meeting, San Francisco, December, 1987:
"A new mechanism for decreasing North Atlantic deep water production rates during the pleistocene"

Director's Seminar, NASA GSFC, April, 1988:
"Modeling deep water formation at the ice edge"

TASK 25
March 3, 1987 - September 30, 1988

The Task Assignment for Task 25 called for research to develop wavemeter techniques to measure and control the frequency of the pulsed solid state laser (alexandrite laser) used in the pressure temperature lidar (PR lidar). These efforts were carried out by Coorg R. Prasad.

Publication: "Laser wavelength measurement in the presence of speckles", Coorg R. Prasad, C. Laurence Korb and Geary K. Schwemmer, p. 253. Proceedings of the Fourteenth International Laser Radar Conference, Innichen-San Candido, Italy, June 20-24, 1988.

TASK 26
June 1, 1988 - September 30, 1988

Dr. Christian Kummerow's research project was to develop and test strategies to measure precipitation from space using microwave radiometry, and to develop radiative transfer models to simulate the three-dimensional structure of precipitation. A model was developed to combine both passive and active microwave sensor information.

Publications:

Kummerow, C., R. A. Mack and I. M. Hakkarinen, 1988: A Self Consistency approach to Improve Microwave Rainfall Estimates from Space. (Submitted to the J. Appl. Meteor.)

Negri, A.J., R. F. Adler, and C. Kummerow, 1988: False Color Display of Special Sensor Microwave/Imager (SSM/I) Data. (Submitted for cover of Bull. Amer. Meteorol. Soc.)

Conference Papers:

Kummerow, C., 1988: Rainfall estimates from airborne Multichannel Passive Microwave Radiometric Observations. Paper presented at International Radiation Symposium, Lille, France, 18 - 24 August.

Weinman, J.A., C. Kummerow and C.S. Atwater, 1988: An Algorithm to Derive Precipitation from a Downward Viewing Radar and a Multifrequency Passive Radiometer. Proceedings of IGARRS '88 Symposium, Edinburgh, Scotland, 13- 16 September, 29-234.

TASK 27
July 1 - August 30, 1988

Sponsored by Task 27, Dr. Insik Kang again visited Goddard to perform data analyses and modeling studies on empirical relationships between tropical convection and global angular momentum and NMC forecast experiments to assess extended range predictability. He collaborated with Dr. William Lau on research on the influence of tropical sea surface temperatures on the climate of the Western Pacific and Eastern Asia.

TASK 28
July 1 - September 30, 1988

Dr. Lee Miller visited Goddard Space Flight Center and worked on radar design engineering involving the specifications of the overall radar design of the ER-2 doppler radar. He collaborated with engineers at Goddard/Wallops.

TASK 29
September 26, 1988 - September 30, 1988

Dr. David Adamec was sponsored for several days at the end of September, 1988 prior to the onset of a new contract. His work was on mid-latitude ocean modeling in support of satellite altimetry and ocean color in collaboration with Dr. Tony Busalacchi.

TASK 30
September 19, 1988 - September 30, 1988

Dr. Joan Rosenfield joined Goddard as a USRA Visiting Scientist during this period, prior to the beginning of a new contract. She worked on stratospheric modeling in collaboration with Dr. Marvin Geller of NASA/GSFC.

INTRODUCTION

This document is the Annual Report for Contract NAS5-28135 between the Universities Space Research Association (USRA) and the NASA Goddard Space Flight Center.

Under this contract, USRA operates a visiting scientist program and conducts research in the atmospheric sciences and related areas at the Goddard Laboratory for Atmospheres (LA) and at designated off-base sites, as specified by task assignments. During the reporting period, April 2, 1987 to April 1, 1988, USRA visiting scientists performed research in mathematical analysis as applied to computer modeling of the atmosphere, development of atmospheric modeling programs, analysis of remotely sensed atmospheric, surface, and oceanic data and its incorporation into atmospheric models, development of advanced remote sensing instrumentation, and related research areas. This report details specific research accomplishments by task. The dates accompanying each task assignment show the period of the supported effort during the contract year.

The present contract is scheduled to terminate by October 1, 1988.

USRA appreciates the opportunity this contract has afforded to participate in and contribute to the Goddard research program in the atmospheric sciences.

TASK 4
April 2, 1987 - April 1, 1988

Stephen C. Bloom

TASK ASSIGNMENT:

Research in areas of meteorological data analysis and assimilation, using the GLA 4th Order GCM and Optimum Interpolation systems.

MAJOR ACCOMPLISHMENTS:

The major accomplishment during the past year was the development of a series of methods which can assign directions to scalar wind speed data over oceans. Such data are currently available in abundance (from the SMMR instrument on Nimbus-7 and SSMI instruments on DMSP satellites.) These assignment methods make varying use of GCM first guesses and assumptions about atmospheric balance. Preliminary work with the simplest of the assignment methods using the GLS Simulation System has been encouraging.

TRAVEL, SEMINARS:

February, 1988, Bloom attended the 3rd Conference on Satellite Meteorology and Oceanography at Anaheim, California - sponsored by the AMS, and presented the paper (with R. Atlas as coauthor): "Assimilation of Satellite Surface Wind Speed Data using the GLS Analysis/Forecast System".

This task was completed on April 1, 1988.

TASK 5
April 2, 1987 - December 15, 1987

Eueng-nan Yeh

TASK ASSIGNMENT:

A) Maintain and improve the software systems:

(1) Correlation spectra
(2) Spectral Filter program

B) Marine boundary layer study

(1) Air mass transformation over warm water: MASEX and GALE
(2) Characteristics of the marine surface layer
(3) Aircraft sounding from GALE

MAJOR ACCOMPLISHMENTS / PUBLICATIONS :

Spectral analysis of surface layer data collected during Mesoscale Air-Sea Exchange (MASEX) experiment indicated that the behavior of high-frequency spectra is consistent with local isotropy. In the inertial subrange, a 4/3 ratio is observed between velocity spectra normal to and those along the aircraft heading.

Due to the existence of various organized convection regimes in the surface layer, the shapes of the spectra and cospectra appear to vary with the sampling direction. The results from turbulent kinetic energy budget analysis imply that more energy is available for storm development over the ocean than over the land.

TASK 6
April 2, 1987 - April 1, 1988

Li Peng

TASK ASSIGNMENT:

The assignment is to carry out theoretical and numerical studies aiming toward an understanding of the dynamics of the tropical oscillations of intraseasonal and interannual time-scales; their origins, spatial and spectral structure, the responsible mechanisms, and the relationship between the multiple spatial and temporal scales of the oscillations.

MAJOR ACCOMPLISHMENTS / PUBLICATIONS:

An updated theory of the 30-60 day oscillation has been developed based on numerical experiments using a multi-layer model of the tropical atmosphere. The model shows that under realistic conditions the development of an eastward moving 30-60 day wave is generally accompanied by smaller scale convective cells moving with a speed nearly equal to that of the wave, but in the opposite direction, i.e. westward. This is in agreement with the most recent observational studies using satellite data of smaller time interval - 3 hours.

An eigenvalue analysis of a multi-layer atmosphere-ocean system shows that there are two types of interactive unstable modes. One is an essentially atmospheric mode excited by moist convection, and the other is the mode excited by the interaction between the atmosphere and the ocean. Both types of modes have similar baroclinic vertical structures.

TRAVEL / SEMINARS :

Peng attended the Sixth Conference on Atmospheric and Oceanic Waves and Stability, August 25-28, 1987, Seattle, Washington, and presented the results of the study on atmosphere-ocean unstable modes.

FUTURE GOALS:

Theoretical and numerical study of intraseasonal and interannual tropical oscillations in shear flow and the effect of these oscillations on extra-tropical flow.

This is an ongoing task.

TASK 7
April 2, 1987 - April 1, 1988

Robert E. Turner
William Vaughan
K.R. Kimble
And Others

TASK ASSIGNMENT

Assist the Atmospheric Dynamics and Radiation Branch, Earth Science and Applications Division, NASA Headquarters in collecting and assembling information, preparing documents and reports, and organizing meetings, workshops and reviews, and related activities.

MAJOR ACCOMPLISHMENTS

Preparation for the Tropical Rainfall Mapping Mission (TRMM) Symposium to be held at Tokai University, Tokyo, Japan, October 28-30, 1987.

Dr. Turner provided assistance to Dr. Theon on NASA Center inputs to OFCM along with preparations for the AIAA 26th Aerospace Sciences Meeting, Jan 11-14, 1988, Reno, Nevada, and coordination with major participants.

Dr. Vaughan provided assistance to Dr. Theon on organization and administration of meetings.

Dr. Kimble consulted on the application of artificial intelligence tools to problems in meso-scale computational fluid modelling of the atmosphere.

TRAVEL / SYMPOSIUMS

In March 1988, the travel of Prof. T. Sakata was sponsored from Japan to the United States. Prof. Sakata is one of the foremost authorities on remote sensing in Asia. He presented an important colloquium at NASA Goddard Space Flight Center and conferred with scientists there.

In March 1988, Prof. K. Okamoto of the Japan Radio Research Laboratory visited ASA/GSFC to participate in the engineering meeting of the Tropical Rainfall Measuring Mission. Prof. Okamoto consulted with colleagues including Dr. J. Theon, Dr. M. Geller, Dr. J. Simpson, and Dr. D. Atlas.

This is an ongoing task.

TASK 9
April 2, 1987 - April 1, 1988
(internship program)

TASK ASSIGNMENT:

This task supports an internship program which provides the opportunity for university researchers to become familiar with such Goddard research resources as the GLA global modeling programs.

ACCOMPLISHMENTS:

Vikram Mehta of Florida State University visited Goddard and worked with Dr. Y. Sud of GLA on the GLA-GCM to investigate various types of sea-surface temperature anomalies. Mehta also worked with Dr. M. Suarez at GLA in the development of a coupled atmosphere-ocean model. This work will be a part of Mehta's Ph.D. dissertation.

Dr. Sirpa Hakkinen was supported briefly under this task in her work on modeling air-sea-ice interactions. Her support was continued under Task 24 (q.v.).

Dr. Noah Wolfson traveled to Goddard from the University of Tel Aviv, and worked with Dr. Atlas on the evaluation of the predictive power of the GLA model and its implementation in the forecast of the Summer-of-1980 heat wave.

This is an ongoing task.

TASK 15
April 2, 1987 - October 6, 1987

L. Gonzalez

Develop techniques and analysis routines for the Cloud Cover Pressure System. The analysis includes comparisons of cloud cover parameters retrieved from satellite observations at various resolutions, with aircraft and ground-based measurements of the same parameters and at extremely high resolution. The routines provide statistics on the differences as a function of time, location, and cloud characteristics, and display the results in the form of tables and graphs.

TASK 16
April 2, 1987 - April 2, 1988

Daniel Rosenfeld

TASK ASSIGNMENT:

1. Study the evolution of convective rain cloud systems in various climatic regimes by means of weather radars.

2. Develop the algorithms, perform the quality control, and process the data of a network of several weather radars around the world in tropical regions, as a major part of the ground-truth of NASA's Tropical Measuring Mission (TRMM).

MAJOR ACCOMPLISHMENTS / PUBLICATIONS:

Rosenfeld, D., 1987: Objective method for analysis and tracking of convective cells as seen by radar, J. Atmos. Ocean. Tech., 4, 422-434.

Rosenfeld, D., and Y. Mintz, 1988: Evaporation of rain falling from convective clouds as derived from radar measurements. Journal of Applied Meteorology (accepted).

Schlesinger, M.E., J. Oh, and D. Rosenfeld, 1988: A parameterization of the evaporation of rainfall. Mon. Wea. Rev. (in press).

Atlas, D., D. Rosenfeld, and D.A. Short, 1988: The estimation of convective rainfall by area integrals. Part I: The theoretical and empirical basis. Conference on Mesoscale precipitation: Analysis, Simulation, and Forecasting, MIT, Cambridge, MA., September 13-17, 1988 (accepted.)

Rosenfeld, D., D. Atlas, and D.A. Short, 1988: The estimation of convective rainfall by area integrals. Part II: The height area rainfall threshold (HART) method. ibid.

TRAVEL / SEMINARS :

July 7-8, 1987: Visited Kennedy Space Center to adapt the weather radar for accurate rainfall measurements.

November, 1987: Conference on Radar Meteorology, Boston, MA

December, 1987: Participated in a collaborative research effort with the Australian Bureau of Meteorology Research Centre, which took place in Darwin, Australia, to perform quality control of the data gathered by meteorological doppler radar which NASA installed in Darwin.

April 11-12, 1988: Visited NASA/KSC for a meeting concerning improving the quality of the weather radar.

FUTURE GOALS:
1. Improve methods of rain measurement from spaceborne radar.
2. Find more accurate ways to derive rainfall amounts from conventional weather radar data.
3. Analyze rain enhancement projects with new powerful methods for physical and statistical evaluation.

This is an ongoing task.

TASK 17
May 4, 1987 - April 1, 1988

Shrivinas Moorthi

TASK ASSIGNMENT:

Design and develop an efficient, finite-difference, multi-level primitive equation atmospheric general circulation model (GCM) with realistic physics for the study of climate, air-sea interaction, etc.

MAJOR ACCOMPLISHMENTS / PUBLICATIONS

1. Version 3 of the model with horizontal resolution 4 x 5 degrees latitude/longitude and 8 layers in the vertical has been successfully completed. This version does not include any convective parameterization and assumes zonally uniform cloudiness (obtained from observation) for radiation calculation.

2. A convective adjustment scheme was coded and successfully tested.

3. Developed a "Revised Arakawa-Schubert cumulus parameterization scheme for use in GCMs". This is currently being documented as a NASA technical report. An expert version of this code has also been developed.

4. Version 4 of the model was successfully completed. This version includes the above convective parameterization and has interactive cloudiness for the purpose of radiation calculation. This version of the model produces reasonable winter and summer climatology of the earth's atmosphere. We are currently performing long-term simulation using this version of the model. The results are still being analyzed.

TRAVEL / SEMINARS

1. Gave a review seminar to Code 611, GMSB staff on Arakawa-Schubert cumulus parameterization.

2. Participated in the Eighth Conference on Numerical Weather Prediction (WP) of the AMS, held in Baltimore, Feb. 22-26, 1988.

3. Participated in the NASA Review of the Modeling, Data Analysis, and Instrument Development Research during July 27-29, 1987.

FUTURE GOALS:
1. Develop high resolution versions of the model (2 x 2.5 degrees and 1 x 1 1/4 degrees).
2. Apply the model for short range NWP experiments, particularly with reference to the monsoon problem.
3. Couple the atmospheric GCM with an oceanic GCM and study the ocean-atmosphere interaction and site effects on climate.

This is an ongoing task.

TASK 19
July 20, 1987 - April 1, 1988

Toshiaki Kozu

TASK ASSIGNMENT:

The tasks assigned are software development and radar hardware modification for data acquisition and processing associated with an airborne rain measuring experiment conducted by the Communications Research Laboratory (formerly Radio Research Laboratory) of Japan and NASA/GSFC. In addition, the experimental data is to be analyzed to test the accuracy of rain estimation algorithms.

MAJOR ACCOMPLISHMENTS:

1. Software development and hardware modification

The design of data acquisition software and the radar modification have been accomplished. Performance tests of new antennas to obtain high resolution and sensitivity were successfully made. Basic operational tests of the software were also completed. For the experiment scheduled for this fall, radar modification and software debugging are in progress.

2. TRMM feasibility study,

The Tropical Rainfall Measuring Mission (TRMM) project is a joint US-Japan space program for which the first spaceborne rain radar has been proposed. The feasibility study of the TRMM was conducted in 1987. Kozu contributed to this study mainly in the field of radar design with NASA and Japanese staff.

3. PUBLICATIONS:

T. Kozu et al. "Observation of Oil Slicks on the Ocean by an X-band SLAR" Proc. of IGARSS '87 Symposium, Ann Arbor, Mich., May 1987.

K. Okamoto, T. Kozu, K. Nakamura, and T. Ihara, "Tropical Rainfall Measuring Mission Rain Radar", First Symposium on Tropical Precipitation Measurements, B-08, Tokyo, Japan, October, 1987

T. Suitz, S. Yoshikado, T. Kuroso, T. Kozu, and T. Umehara, "Backscattering Coefficient of Rice Crops and Rice Fields by an X-Band Scatterometer", Twenty-First International Symposium on Remote Sensing of the Environment, Ann Arbor, Mich., October, 1987.

T. Kozu, K. Nakamura, J. Awaka, and M. Takeuchi, "Development of Ku-Band FM-CW/Pulse-compression radar for rain observations on a slant path", Journal of Radio Research Laboratory, Japan, 34, 143, 95-113, Nov., 1987.

TRAVEL / SEMINARS:

1. Attended the International Symposium on Remote Sensing of the Environment (University of Michigan, Oct. 26-30, 1988) to present the paper "Backscattering Coefficient of Rice Crops and Rice Fields by an X-Band Scatterometer" as one of the authors.

2. Attended the AMS 40th Anniversary Radar Meteorology Conference as a member of the panel "Airborne/Spaceborne Radar". Kozu also contributed to the panel report and the review paper.

3. Kozu attended the ISY Mission to Planet Earth Conference (Univ. of New Hampshire, Durham, NH, April 29-May 1, 1988) as the representative of N. Fugono, CRL, Japan, and served as a member of the working group for the global standard for observing systems.

4. Attended the ERS-1 AO First Experiments Meeting (ESRIN, Frascati, Italy, May 2-6, 1988) as the representative of the PI's of the proposals from Japan.

FUTURE GOALS:

1. Aircraft Experiment

Test flight and preliminary observation flight will be made this fall. Externally radar calibration is also planned in these flights. Preliminary data analysis and system debugging will be made this winter. The main experiment is scheduled for next spring. Detailed data analysis will test the validity and limitations of existing rainfall retrieval algorithms, and should lead to improved or new algorithms.

2. Studies on spaceborne rain radars

Studies to be made include the system design of TRMM radar, problems in pulse compression, rainfall retrieval algorithms from space, etc.

This is an ongoing task.

TASK 20
June 1, 1987 - August 30, 1987

Insik Kang

TASK ASSIGNMENT:

Global angular momentum fluctuations in time scale of 50 days: the tropical influence.

ACCOMPLISHMENTS / PUBLICATIONS:

The results obtained are the following:

1. Power spectrum of global angular momentum fluctuations (50 day peak found)
2. Association of 50-day fluctuation of global angular momentum fluctuations with regional (tropical) OLR and zonal wind fields.
3. The amplitude and preferred time scale of zonal mean wind at each latitude
4. Principal modes of zonal mean fluctuations such as [u], [v], and [OLR].
5. Seasonal cycle of zonal mean fields.
6. Intercomparison of NMC and ECMWF climatological data sets (just initiated).

TRAVEL / SEMINARS: ,

Travel to GFD Laboratory at Princeton in June, 1987 to obtain data to be used in the present research and to discuss the task with Dr. Isaac Held.

6th Conference on Atmospheric and Oceanic Waves and Stability, August 25-28, Seattle, Washington. Presented the paper "Influence of zonal mean flow changes on the stationary wave fluctuations."

FUTURE GOALS:

Continue this research in Korea, and organize the results obtained at NASA and the results obtained there into a publication.

TASK 21
April 2, 1987 - September 30, 1987

Giuseppe Dalu

TASK ASSIGNMENT:

Investigate the optical properties of clouds in the IR utilizing the Nimbus-4 IRIS data. Develop a theoretical framework to perform multiple scattering computations.

ACCOMPLISHMENTS / PUBLICATIONS:

A radiative transfer model has been developed to calculate radiances in a cloudy atmosphere utilizing multiple scattering by spherical ice and water particles. With the help of this model two types of optically thin clouds have been investigated.

The first type is the thin high altitude cirrus cloud, which is produced by intense convective storms. The IR interferometer Spectrometer (IRIS, flown on Nimbus-4) data show that extinction due to cloud particles at 12.6 micron is larger than that at 10.8 micron. Multiple scattering radiative transfer model simulations showed that this spectral signature can be explained by water or ice particles, provided that their size is smaller than the wavelength of radiation. The particular signature found (maximum temperature difference at a relatively low temperature, and the fact that such a signature was sensed by IRIS about 100 to 200 km away from the center of high altitude cold clouds, led to the conclusion that it was characteristic of optically thin cirrus clouds.

The second type is the boundary layer thin stratus cloud. The spectral signature of these clouds is revealed by the relative strength of the water vapor lines in the window region, that are shown by the high resolution IRIS spectral measurements. This signature is evident in regions where trade wind inversions prevail, and boundary layer thin cirrus cloud formation is most probable.

Prabhakara, Fraser, Dalu, Wu, Curran and Styles, Thin Cirrus Clouds: Seasonal Distribution over Oceans Deduced from Nimbus-4 IRIS. (Submitted to the J.C.A.M.)

TASK 22
December 1, 1987 - April 1, 1988

Tetsuo Nakazawa

TASK ASSIGNMENT:

Analysis of hierarchy of tropical convection over the western Pacific using satellite derived cloud information and conventionalmeteorological data.

MAJOR ACCOMPLISHMENTS / PUBLICATIONS

1. Analysis of the super cloud cluster by Geostationary Meteorological Satellite IR 3-hourly data., October, 87. Submitted to the Proceedings of the International Symposium on Tropical Precipitation Measurements.

2. Evidence of the existence and eastward motion of super clusters at the equator. (with Yoshi-Yuki Hayashi) November, 1987. Submitted to Monthly Weather Review of the AMS.

3. Tropical super clusters under intraseasonal variations, November, 1987, published in Meteorological Research Report, 88-1, Division of Meteorology, Geophysical Institute, University of Tokyo, 76-86.

4. Tropical cloud clusters within intraseasonal variations over the western Pacific. March, 1988. Submitted to the Journal of Meteorological Society of Japan.

TRAVEL / SEMINARS

1. International Symposium on Tropical Precipitation Measurements, October, 1987, presented "Analysis of the super cloud cluster by GMS IR 3-hourly data."

2. Japan-US workshop on the El Nino - Southern Oscillational Phenomenon. Nov., 1987. Presented "Tropical superclusters under intraseasonal variations."

3. Jacob Bjerknes Symposium on air-sea interactions by the AMS. February, 1988. Presented "Analysis of eastward moving supercluster under intraseasonal variation in the tropics."

FUTURE GOALS:

Examine the following fields:
1. Interannual and intraseasonal variability of the convection and circulation over the tropics.
2. Dynamical process for the SSCs and relationship between different time-space phenomena.
3. Analysis of the SSCs over the Atlantic by using GOES data.

This is an ongoing task.

TASK 24
February 1, 1988 - April 2, 1988

Sirpa M. A. Hakkinen

TASK ASSIGNMENT

To study air-sea-ice interactions, specifically heat exchange between ocean and atmosphere in the Norwegian-Greenland Seas, and the deep (bottom) water formation/water mass modification using numerically coupled ice-ocean models.

ACCOMPLISHMENTS / PUBLICATIONS

Hakkinen, S., "A coupled dynamic-thermodynamic model of an ice-ocean system in the marginal ice zone," Journal of Geophysical Research, 92, 9469-9478 (1987)

Crowley, T.J., and S. Hakkinen, "A new mechanism for decreasing North-Atlantic deep water production rates during pleistocene," to appear in Paleoceanography (1988).

Hakkinen, S., "A note on deep water production via a 'chimney' formation in the ice edge regions," to appear in Journal of Geophysical Research (1988)

Hakkinen, S. and L. P. Røed, "Models" in Polar Oceanography) (ed. W. O. Smith). Pergamon Press, 1988 (in preparation).

Hakkinen, S., and D. J. Cavalieri, "A study of surface heat fluxes in the Norwegian, Greenland and Barents Seas," submitted to Journal of Geophysical Research, 1988.

SEMINARS AND PRESENTATIONS:

IUGG Meeting, Vancouver, Canada, Aug 1 1987: "A coupled dynamic-thermodynamic model of an ice-ocean system - the marginal ice zone."

Woods Hole Oceanographic Institution, Sept., 1987 (invited): "Ice-ocean interactions in the MIZ"

GFDL/Princeton University, Sept., 1987 (invited): "Modeling dynamic-thermodynamic interactions of an ice-ocean system"

CIRES, Boulder, September, 1987 (invited) "A coupled ice-ocean model for the MIZ"

AGU Fall Meeting, San Francisco, December, 1987: "A new mechanism for decreasing North Atlantic deep water production rates during the pleistocene"

Director's Seminar, NASA GSFC, April, 1988: "Modeling deep water formation at the ice edge"

This is an ongoing task.

TASK 25
April 2, 1987 - April 1, 1988

Coorg R. Prasad

TASK ASSIGNMENT

Develop wavemeter techniques to measure and control the frequency of the pulsed solid state laser (alexandrite laser) used in the pressure temperature lidar (PT lidar).

MAJOR ACCOMPLISHMENTS OR PUBLICATIONS

The first step in this task was to measure the frequency of the pulsed tunable alexandrite laser. For this purpose a Fizeau wavemeter available with the PT Lidar group was used. The frequency stability of the alexandrite laser was found to be much worse than is acceptable for the lidar. During the period in question (March-April, 1988) Prasad was involved in making modifications to the alexandrite to improve its frequency stability in addition to measuring its frequency. This work included development and modifications of different types of flash lamp coupling reflectors, a heating system for temperature control of the laser rod, etc. Significant improvements in frequency stability of the laser have been observed.

FUTURE GOALS

The goal of this work is to control the frequency of the pulsed alexandrite laser to better than 0.005 cm^{-1} about the laser frequency of 13000 cm^{-1} using the wavemeter to measure and supply the correction signal.

This is an ongoing task.