CEDAR

1991

Workshops

LTCS/CEDAR Workshop
June, 1991

The main theme of the 1991 LTCS workshop will be "variability". The following types of brief, informal, discussion-generating presentations are solicited:

[a.] Radar and optical analyses focusing on short-term variability, and where appropriate, interpretation in terms of gravity wave effects. The long-term goal is to better understand the role of gravity waves in the large-scale dynamics of the region above 100 km, to better understand the sources of gravity waves and their propagation characteristics, their interactions with tides, planetary waves, and the zonal mean flow, and to delineate seasonal/latitudinal climatological patterns of gravity wave fluxes into the thermosphere, and so on. The idea is to begin by quantifying the variability in lower thermosphere radar and optical data using spectral and filtering techniques, which will hopefully spawn theoretical and modeling studies to explain these results.

[b.] E-region penetration of magnetic storm effects. Significant E-region effects were observed during LTCS-1 which were not well reproduced by existing models. Further studies of this phenomena, whether for LTCS-1 or other periods, are solicited.

[c.] Planetary-wave (2-day, 4/5-day, 16-day, etc.) oscillations in the lower thermosphere and their implications.

[d.] Theory and modeling efforts focusing on the above problems.

Of course, any presentations, thoughts, LTCS experiment analyses, that fall within the purview of our lower thermosphere "coupling" interests are welcome at the workshop. Some time will also be allocated to discuss future directions, collaborative projects, and whether any AGU special topic sessions should be planned at this point.

For reference, please note the following existing calendar for LTCS experiments:

LTCS-1 21-25 Sept 87

LTCS-2 5-10 Dec 88

LTCS-3 30 May - 04 June 89

LTCS-4 12-17 Feb 90

LTCS-5 14-20 March 91 (CADITS/SUNDIAL)

LTCS-6 4-10 Dec 91 (CADITS/SUNDIAL) (possible UARS launch and IEEY)

LTCS-5 and LTCS-6 are 6-day joint campaigns with CADITS and SUNDIAL. A new capability to combine good E-region observations for LTCS goals and good F-region coverage for CADITS and SUNDIAL goals will be tested during these campaigns.

Accessing the CEDAR Data Base

The cedar machine at the High Altitude Observatory at NCAR is now open to the entire CEDAR community via internet or SPAN. The computer cedar is a UNIX SPARCsystem 470 with 32 MB of memory and 2 GB of disk space (in practice, closer to 1.5 GB). The space is split between the interactive MADRIGAL system provided by Millstone Hill (60 MB in /usr/madrigal), a large area for data files (745 MB in /usr/madrigal/files), user areas (365 MB in /home), and volatile storage space (240 MB in /d). We have about 9 GB of data on the NCAR mass storage system. Subsets to be analysed may be copied to the cedar disk scratch workspace or to /usr/madrigal/files. In addition, most geophysical indices will be on cedar permanently.

The workshop on Accessing the CEDAR Data Base will be given 2 times in the Damon Room (Monday PM and Friday AM), where we will have 8 graphics terminals set up for practice, and a Sun workstation for some demonstrations. We will show prospective users how to bring over data from the mass store system, how to use the interactive madrigal system (including generic plotting) developed by Millstone Hill, and how to use the batch programs developed by Roy Barnes at NCAR (which uses the NCAR plot package). Then we will let users try things out on the terminals.

Currently, we have about 23 persons registered on the cedar machine from the community. Persons without a separate login can use a guest account. We would like those of you who do not have accounts now, but intend to use the cedar machine later, to fill out the form below and send it in so we can set up logins for you. Please send the form to: Barbara Emery, HAO/NCAR, P. O. Box 3000, Boulder, CO 80307.

CEDAR Logins for the cedar machine

New User's Name:

Login Name (if different from last name, can give several choices):

Address:

Phone: FAX:

email:

If you already have a NCAR CRAY computer account, please provide the following information:

Cray account username:
Scientist number:
Project number:

Workshop on the

DEVELOPMENT OF A GIANT OPTICAL OBSERVATORY FOR ATMOSPHERIC STUDIES

Key Issues

18–19 June 1991

Annual CEDAR Meeting

Boulder, CO

Introduction

The development and refinement of sophisticated remote sensing technologies during the past three decades have contributed enormously to our knowledge of the atmosphere. The construction of major radar facilities, such as EISCAT, Millstone Hill, Arecibo, Jicamarca and the MU radar, has permitted researchers to study both the neutral and ionized atmosphere with unprecedented accuracy and resolution. At the time these facilities were built, each represented a major step forward in observational capabilities, and today these radars continue to play central roles in many atmospheric studies. Lidar technology has enjoyed a similar renaissance since the invention of the laser in 1961. The first lidars were built in the 1930s and 40s using mechanically modulated searchlights. Today, modern laser-based systems are used to probe composition and structure throughout the atmosphere from the troposphere into the lower thermosphere. The last five years have been a period of substantial growth in lidar capabilities and applications, principally because of advances in certain critical areas of laser technology. Perhaps the most important of these has been the development of high-power, ultrastable narrowband lasers, which are now being used in Doppler/temperature lidars for middle and upper atmosphere applications. The development of tunable solid-state lasers, which are rugged and reliable and can be used for ground-based, airborne and even satellite observations, has also been important. While the recent advances have been impressive, the accuracy, resolution and sensitivity of many lidar systems are still limited by signal levels.

The performance capabilities of most atmospheric radars and lidars are dictated by one simple parameter, the power aperture product of the system (PA = average transmitter power × effective area of receiving antenna). The largest radars have power aperture products on the order of 10^6 Wm^2. The largest lidars are quite modest by comparison, with values on the order of 10–30 Wm^2. Lidars can make useful measurements, even with small PA products, because the optical backscatter cross sections are usually very large. Even so, the performance and sensitivity of most lidar systems can be improved substantially if the PA product is increased.

A 1 1/2 day workshop has been organized for Tuesday, June 18 and Wednesday, June 19 at the 1991 CEDAR Meeting to assess the scientific rationale and technical feasibility of developing a giant optical observatory for atmospheric studies. The centerpiece of the observatory is a 10-meter class telescope and several advanced laser systems designed to study the structure, composition, dynamics and chemistry of the earth's atmosphere from the troposphere up into the thermosphere. The observatory would also include an appropriate complement of other important instruments such as radars, imagers, spectrometers, and perhaps *in situ* measurement capabilities using balloon and rocket probes. The large telescope, in combination with advanced high-power laser systems, would permit lidar measurements of winds, density, temperature and chemical composition with a sensitivity and resolution more than 1000 times better than those which can be achieved with the most powerful systems in operation today. Depending on the application, it would be possible to develop lidars with PA products ranging from 150 to more than 10^4 Wm^2. This capability would permit researchers to study atmospheric processes with unprecedented accuracy and precision. Because the telescope will be designed specifically for lidar applications and will be fully steerable, active experiments involving laser modification and chemical releases from satellites and rockets would open entirely new research areas and may even permit observations well into the thermosphere.

The facility would be located at a geophysically interesting site that has superb viewing conditions. Potential sites include (but are not limited to) Mt. Hopkins, AZ, Haleakala Crater, Maui, and Cerro Tololo, Chile. The facility would be operated much like the large astronomical observatories and atmospheric radars. Researchers would conduct observations either by using the equipment at the facility or perhaps by bringing their own lasers and detectors to the site and using the large telescope. A fraction of the observing time would be devoted to measurements directly related to global change, e.g., developing long-term data bases of important atmospheric constituents such as water vapor, ozone, carbon dioxide and methane.

The optical observatory workshop begins on Tuesday morning with the tutorial session **21st Century Research Challenges in Observational Atmospheric Science**. The first speaker, Dave Fritts from the University of Alaska, will discuss his perceptions of the key research issues facing the atmospheric dynamics discipline during the next 20 years. Guy Brasseur, Director of the Atmospheric Chemistry Division at NCAR, will discuss the important research problems in atmospheric chemistry. These two talks will help workshop participants identify some of the major scientific issues that can be investigated at the proposed observatory. Chet Gardner will end the session with a discussion of the potential measurement capabilities of the facility.

The main workshop activities will take place on Tuesday and Wednesday afternoons in nine separate sessions that will run serially. The sessions are designed to address specific issues related to various scientific and technical aspects of the observatory. The session titles and their leaders are listed below.

Tuesday PM June 18

- **Lower Atmosphere Lidar Requirements**
  Ed Browell, NASA Langley
- **Middle and Upper Atmosphere Lidar Requirements**
  John Meriwether, Geophysics Laboratory
- **Correlative Radar Instrumentation**
  Miguel Larson, Clemson University
- **Correlative Optical Instrumentation**
  Rick Niciejewski, University of Michigan
  Tim Killeen, University of Michigan

Wednesday PM June 19

- ***In situ* Balloon, Aircraft and Rocket Measurements**
  Bill Sharp, University of Michigan
- **Atmospheric Modification and Tracer Experiments**
  Mike Mendillo, Boston University
- **Telescope Performance Requirements**
  Russ Philbrick, Penn State University
- **Observatory Site Requirements**
  Craig Tepley, Arecibo Observatory
- **Planning the Next Step**
  Chet Gardner, University of Illinois

The portability and moderate cost of many lidars are distinct advantages for exploring the geographic variability of the atmosphere from remote sites or aircraft. However, researchers should have access to at least one major facility where sophisticated new technologies can be developed and tested and where mature techniques can be used to study atmospheric processes in exquisite detail. Presently, the giant optical observatory is only an idea. It can become a reality if we, as a community, are able to articulate compelling scientific and technical arguments for its construction.

Because the time allotted for each workshop is limited, it is important that the participants focus quickly on the key scientific and engineering issues. The following sections include a list of "strawman" questions to be considered in each workshop.

Chet Gardner
University of Illinois
(217) 333-4682

Lower Atmosphere Lidar Requirements ($Z \lesssim 25$ km)

There are numerous lower atmosphere parameters and constituents that can be monitored with lidar techniques. The optical facility should have the capability of routinely monitoring the most important of these parameters and constituents so that a long term data base, suitable for climatological studies related to global change, can be developed. The facility should also have the capability of monitoring periodically other constituents which are also important but less crucial to the climatological or global change issues. Listed below are several important atmospheric parameters and constituents.

1. Which of these should be monitored on a continuous basis? Why?
2. Which parameters should be monitored periodically? At what frequency should they be monitored? Why?
3. What accuracy, resolution and altitude range are desirable?
4. Are there any other constituents that should be considered?

Lower Atmosphere Lidar Requirements ($Z \lesssim 25$ km)

Parameter/Constituent	Altitude Range	Resolution		Accuracy	Measurement Frequency
		Δz(m)	Δt(s)		
Density – P					
Temperature – T					
Winds – u, v, w					
Water vapor – H_2O					
H_2O_2					
HO_2					
OH					
CO					
NO					
N_2O_2					
NO_2					
O_3					
CH_4					
non-methane hydrocarbons					
NH_3					
HNO_3					
Aerosols – size distribution, types/composition, optical properties, spatial properties					
Cloud types – frequency and content, optical and spatial properties					

Middle Atmosphere Lidar Requirements (25 km ≤ Z ≤ 100 km)

There are numerous lower atmosphere parameters and constituents that can be monitored with lidar techniques. The optical facility should have the capability of routinely monitoring the most important of these parameters and constituents so that a long term data base, suitable for climatological studies related to global change, can be developed. The facility should also have the capability of monitoring periodically other constituents which are also important but less crucial to the climatological or global change issues. Listed below are several important atmospheric parameters and constituents.

1. Which of these should be monitored on a continuous basis? Why?
2. Which parameters should be monitored periodically? At what frequency should they be monitored? Why?
3. What accuracy, resolution and altitude range are desirable?
4. Are there any other constituents that should be considered?

Middle Atmosphere Lidar Requirements (25 km ≤ Z ≤ 100 km)

Parameter/Constituent	Altitude Range	Resolution		Accuracy	Measurement Frequency
		Δz(m)	Δt(s)		
Density – P					
Temperature – T					
Winds – u, v, w					
Water vapor – H_20					
O_3					
CH_4					
OH					
Fe					
Mg					
medal ions					
aerosols					

Correlative Radar Instrumentation

Radar technology for atmospheric studies has reached an impressive level of maturity. Numerous active and passive techniques have been developed which can provide important correlative data to validate and complement the lidar measurements. Many of these systems are relatively low-cost (< $1–2M) and can make unique contributions to observing program of the facility. Listed below are several radar and radiometry systems which may be appropriate for deployment near the optical facility.

1. Which systems are absolutely essential for the proper interpretation and analysis of the lidar data? Why? What unique contributions can these systems make to the observing program?
2. What constituent or parameter measurements can these systems provide?
3. What are the accuracies, resolution and altitude range of the measurements?
4. Which systems can provide important redundant or correlative data that are highly desirable but not necessarily essential?
5. Are there any other radar based instruments that should be considered for deployment near the optical facility? Why?

Correlative Radar Instruments

Instrument	Measurements	Altitude Range	Resolution		Accuracy
			Δz(m)	Δt(s)	
ST radar	horizontal winds vertical winds				
MF radar	horizontal winds vertical winds				
Digisonde	electron profiles				
μ-wave radiometer	water vapor – H_2O temperature – T winds methane – CH_4				

Correlative Optical Instruments

Airglow emissions from the mesosphere and thermosphere can provide important information on the chemistry, dynamics and thermal state of the upper atmosphere. Recent advances in detector technology have resulted in substantial improvements in the temporal and spectral resolution of many airglow instruments. Various campaign studies during the past several years have shown that airglow observations can provide correlative data that is especially useful in interpreting lidar and radar measurements. Listed below are several airglow instruments which may be appropriate for deployment at the optical facility.

1. Which systems are absolutely essential for the proper interpretation and analysis of the lidar data? Why? What unique contributions can these systems make to the observing program?
2. What constituent or parameter measurements can these systems provide?
3. What are the accuracies, resolution and altitude range of the measurements?
4. Which systems can provide important redundant or correlative data that are highly desirable but not necessarily essential?
5. Are there any other optical instruments that should be considered for deployment near the facility? Why?

Correlative Optical Instruments

Instrument	Measurements	Altitude Range	Wavelength Range	Resolution		Accuracy
				$\Delta\lambda$(Å)	Δt(s)	
OH Imagers	I & T images (gravity wave λ_h and propagation direction)	87 ± 5 km				
O_2 Imagers	I & T images (gravity wave λ_h and propagation direction)	96 ± 5 km				
Michelson interferometer						
Fourier Transform Spectrometer						
Fabry-Perot interferometer (OH, OI, NaD)	I, T and winds	80–250 km				

In situ Balloon, Aircraft and Rocket Measurements

Although the optical facility is being designed primarily for remote sensing applications, there are certain constituents and parameters that can only be measured with *in situ* instruments or must be measured periodically *in situ* to insure the calibration of the remote sensing systems. The optical facility should have the capability of making certain *in situ* observations routinely from the ground and with balloon-sondes. It may also be highly desirable to make other more sophisticated *in situ* observations periodically on a campaign basis. Listed below are several parameters and constituents that can be measured *in situ.*

1. Which of these should be monitored on a routine basis? Why? How should they be monitored (i.e., balloon, aircraft, rocket)?
2. Which parameters and constituents should be monitored periodically on a campaign basis? Why? How should they be monitored (i.e., balloon, aircraft, rocket)?
3. What accuracy, resolution and altitude range are desirable?
4. Are there any other constituents that should be considered?
5. Is the capability to conduct *in situ* rocket observations near the optical facility absolutely essential, highly desirable or unimportant?

In situ Measurements

Parameter/Constituent	Altitude Range	Resolution		Accuracy	Measurement capability (ground, balloon, aircraft or rocket)
		Δz(m)	Δt(s)		
ion composition					
ion mobility					
particle density & size distribution					
E field					
μ-scale observations (P, T, winds, e^-)					
P, T, humidity					
CO_2					
O_3					
CH_4					
OH					

Atmospheric Modification and Tracer Experiments

Lasers are used routinely in the laboratory to photo-dissociate materials to study their chemistry and composition. Fluorescent tracers can be released into the upper atmosphere and tracked with imagers and lidars to study diffusion, turbulence and bulk motion as well as the influence of the earth's electric and magnetic fields. Atmospheric modification and chemical release experiments are relatively unexplored areas that could benefit substantially from the imaging and tracking capabilities designed into the optical facility. Listed below are several modification/tracer experiments that could be conducted at the optical facility.

1. What atmospheric modification and tracer experiments would be especially interesting to conduct considering the complement of instruments planned for the new facility?
2. What new science would we expect to learn from these experiments? What existing problems would these experiments help resolve?

Potential Experiments:

Laser photodissociation

Chemical releases from balloons, aircraft, rockets and satellites (chemical modification and tracers)

RF heating

Telescope Performance Requirements

Although the optical facility will be designed around a large (8–10 m diameter) fully steerable telescope, it is expected that one or more smaller telescopes (~ 1 m diameter) will be desirable or required for tropospheric applications. The basic design requirements of the large and perhaps smaller telescopes are dictated by the desired lidar measurement capabilities. The major design issues are listed below.

1. What numerical specifications are required?
2. What observational requirements drive the numerical requirements?

Large Telescope

Parameter	Value	Observational Driver
diameter		
focal length		
figure error		
wavelength coverage		
steering range		
steering speed		
pointing accuracy		
tracking accuracy		

Small Telescopes

Parameter	Value	Observational Driver
diameter		
focal length		
figure error		
wavelength coverage		
steering range		
steering speed		
pointing accuracy		
tracking accuracy		
number desired		
number required		

Site Requirements

Because the optical facility is being designed around a very large telescope and perhaps one or more smaller telescopes, it is essential that the site be selected so that weather does not compromise the lidar observations. Listed below are several criteria that should be considered in selecting the appropriate site for the facility. Also listed are several potential sites.

1. What is the appropriate priority ranking of the selection criteria?
2. Are there other additional criteria that should be considered? If so what is the priority ranking of the additional criteria?
3. Are there other sites that should be considered?
4. What are the geophysical attributes of the more desirable sites?

Site Selection Criteria:

1) Clear skies a high percentage (> 70%) of the time, smog-free
2) Geophysically interesting
3) High altitude (5,000–10,000 ft)
4) Reasonably accessible
5) Adequate infrastructure (hotels, service, etc.)
6) Rocket launch capabilities
7) Remote from major commercial flyways
8) Telecommunication facilities, satellite down link

Potential Sites

Name	Location (Lat., Long.)	Altitude	Cloud Cover Percentage	Geophysical Attributes
Haleakala, HI				
Mauna Kea, HI				
Mauna Loa, HI				
Mt. Hopkins, AZ				
Cerro Tololo, Chile				
Thule, Greenland				
Sondrestromfjord, Greenland				
Millstone Hill, MA				
Arecibo, PR				
Jicamarca, Peru				
Canary Islands				
Resolute Bay, Canada				
Pt. Barrow, AK				

WORKSHOP ON EQUATORIAL DYNAMICS

Third in a series of workshops (1988,1989), this year's agenda will deal with two main topics:

(1) Preliminary Results of the EQUIS/CRRES campaign (1990).

A half-day session devoted to results from rocket and groundbased studies of equatorial spread-F:

a) On 30 July and 2 August, EQUIS rocket flights were used for in-situ studies of fully developed ESF plumes.

b) On 10 August, an extraordinary natural ESF plume was investigated using a wide variety of groundbased radio and optical diagnostics.

c) On two nights (11 and 15 August), CRRES Active Experiments were conducted to test Rayleigh-Taylor instability mechanisms for ESF.

Time permitting, recent results of other equatorial observations will be presented.

(2) Future Campaign Plans. A second half-day session will be devoted to equatorial campaigns in 1992 and 1993.

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COORDINATED ANALYSIS OF THE THERMOSPHERE

June 1991 CEDAR Meeting

Tuesday, June 18, 1991 - Damon Room, NCAR

Workshop Schedule

1:30-1:35	Introductory Remarks	Maura Hagan
	On-Going Project Reports	
1:35-2:30	Thermospheric Seasonal Variability Studies	Fred Biondi Bela Fejer
2:30-3:00	Thermospheric Diurnal Variability Studies	Maura Hagan
3:00-3:30	Lower Thermosphere Studies	Roberta Johnson Rick Niciejewski
3:30-3:45	BREAK	
3:45-4:30	Thermospheric Density and Composition Studies	Geoff Crowley
4:30-5:00	General Discussion of On-Going Projects	Maura Hagan
	New Projects	
5:00-5:20	Thermospheric Neutral Wind Response to Magnetic Variability	Jeff Thayer
5:20-5:30	Ionospheric Modeling With Improved Empirical Solar EUV Irradiances	Kent Tobiska

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Attention CEDAR/CAT Participants:

Anyone interested in organizing and leading a new CAT project should contact Maura Hagan prior to Tuesday's session in order to be allotted time ($\approx$ 10 min) to present your ideas to the community.

CEDAR Workshop on the March, 1990 Storm

NCAR Damon Room, 1:30-3:30 pm, Wednesday, June 19

During the successful storm workshop held at last year's CEDAR Meeting, the March 20-21, 1990 period was the subject of a number of presentations. This storm was observed by five incoherent scatter radars during extended World Day operations, coherent scatter radars, Digisondes, polarimeters, Fabry Perot interferometers, and all sky imagers. This year our storm workshop will deal exclusively with this storm interval. The time is right to begin a coordinated multi-station study of this period. At the very least, we will review at our workshop the coverage and features present in the multi-site data. At best, by the end of the workshop, we will have a list of papers to be written, with authors and titles.

Below is a summary of available storm data and a preliminary agenda for the workshop.

Introduction	M. Buonsanto	1:30 pm	
location (instrument)	presenter(s)	time	comments
Xaanaaq, Sondrestrom, Goose Bay (Digisondes)	G. Crowley	1:35 pm	
EISCAT (incoherent scatter radar)			available
Goose Bay (coherent scatter radar)	M. Ruohoniemi & R. Greenwald	1:50 pm	
SABRE (coherent scatter radar)	M. Buonsanto	2:05 pm	
Millstone Hill (incoherent scatter radar)	M. Buonsanto	2:10 pm	
Millstone Hill (BU imager)	M. Mendillo J. Baumgardner, or D. Nottingham	2:20 pm	
Kyoto (incoherent scatter radar)			available
Arecibo (incoherent scatter radar)	M. Buonsanto B. Fejer (?)	2:30 pm 2:40 pm	
Jicamarca (incoherent scatter radar)	B. Fejer	2:50 pm	
Discussion		3:00 pm	

1991 CEDAR Workshop: The Modeling of Global Convection

Convenors: M. Ruohoniemi and R. Greenwald (JHU/APL)

June 19 3:45 - 5:45 pm NCAR Damon room

This workshop will consider the methods used to measure convection and to synthesize local measurements into global maps. The invited speakers have been asked to briefly review their experience in this field, and to contribute their thoughts on moving the studies forward in the CEDAR era. The presentations will be followed by an informal discussion. If a consensus can be reached, we will conclude with a summary of research topics and assignments.

Among the topics suggested for discussion are:

- the derivation of statistical models of high-latitude convection, including the application of indices to the parameterization of the global convection state, the uncertainties associated with the models, the proliferation of models, and the prospects for the merging of databases and the testing of modeling algorithims

- the real-time estimation of global- and meso- scale convection, the techniques, their scope, and their present limitations, and the design of coordinated experiments to improve this type of mapping

- the challenges presented by particularly variable or structured types of convection, including substorm processes and flow configurations in the cusp and Harang discontinuity

- the needs of the thermospheric modeling community in terms of the most useful convection parameters for the modeling of ionospheric coupling

Time	Speaker	Affiliation	Comment
3:45	M. Ruohoniemi	JHU/APL	Introduction
3:50	J. Holt	Millstone Hill	
4:02	R. Greenwald	JHU/APL	
4:14	B. Emery A. Richmond D. Knipp	NCAR USAF Academy	
4:38	J. Moses	Rice	
4:50	O. de la Beaujardiere	SRI	
5:00	All		Discussion
5:45	Adjourn		

CEDAR Workshop Announcement and Invitation to Participate

GLOBAL-SCALE MEASUREMENTS AND MODELLING APPROACHES TO INTERMEDIATE LAYERS

E. Szuszczewicz

NCAR Fleischmann Building, Wednesday , 2:00 - 4:00

The existence of intermediate, descending and transitional layers in the 100 - 160 km region of the ionosphere is becoming increasingly important in our studies of global-scale ionospheric dynamics and the coupling of electric fields, thermospheric winds, and molecular and metallic ion distributions. Our database is meager, and our theoretical descriptions of their global-scale cause-effect terms is in an equally primitive state.

You are invited to review and contribute to this subject area. We plan to present some recent experimental findings that draw attention to the possibility of long-term global-scale measurements of the layers. We plan also to present the associated comparisons of those data with the most recent version of the TIGCM. Initial discussions will focus on the relative roles of electric fields and meridional and zonal wind forces in the formation and transport of the layers. We will point to our measurement inadequacies and modelling limitations, as well as approaches to a global-scale modelling and measurement effort.

We invite modellers and experimentalists to contribute to the discussion, with special interest in improving the remote sensing capabilities of electric fields and thermospheric winds along with the challenges imposed by the accuracies and height resolutions necessary to uniquely unfold the contributing force terms. We invite contributions from those in our CEDAR community studying sodium layers in the D-region, with interest in understanding their relationship to the transitional and sporadic layers in the 100 - 160 km region. And we invite contributions from investigators focused on tidal modes in the mesosphere/lower thermosphere boundary region, with special interest in understanding the coupling mechanisms in this region and their influences on thermospheric wind structures at higher altitudes.

NEW CEDAR WORKSHOP:

Problems Related to Ionospheric Modelling and Observations (PRIMO)

I. Project Initiation Phase

a. Purpose of this new CEDAR Workshop is to identify, discuss, resolve (if possible) and publish unresolved problems in ionospheric modelling as related to observations.

b. To "kick-off" the new workshop the first unresolved problem will discuss the apparent discrepancy between calculated and observed peak electron densities in the daytime, midlatitude F-region ionosphere during high solar activity periods (F10.7 ~ 210 units). Model results seem to underestimate densities by 50%.

c. Conveners: Dave Anderson, Tim Fuller-Rowell and Jan Sojka.

d. Short invited talks will cover modelling results, assumed input parameters and observations to see if the sources of this apparent problem can be identified and resolved.

Auroral Arcs

Gary Swenson
NCAR Feischman Building
Thursday 1:45-3:30

A theme for this workshop is Proton Arc Emissions. This workshop will share the analysis of the proton arc observations and lack of N2 1PG relative relative to N2 emissions 1Neg

National Aeronautics and
Space Administration

NASA

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812
AC(205)544-2121

Reply to Attn of: ES55

June 11, 1991

TO: Participants in the June 1991 ATLAS 1 - CEDAR Workshop

FROM: Daniel Meléndez-Alvira

SUBJECT: The ATLAS 1 - CEDAR Coordinated Experiments Campaign

The first ATLAS 1 - CEDAR workshop was held during the June 1990 meeting to discuss a program of coordinated measurements during the flight of NASA's first ATMOSPHERIC LABORATORY FOR APPLICATIONS AND SCIENCE (ATLAS 1) mission now scheduled for March, 1992. The attached sheets give a brief summary of the ATLAS 1 instrument complement, measurements that will be made, and parameters to be inferred from the data. In short, the mission promises to provide a comprehensive database of thermospheric, ionospheric and mesospheric parameters which, if supported by a complementary set of measurements from the ground, would allow us to address many of the outstanding problems of the lower thermosphere and mesosphere, to make significant progress on some important ionospheric photochemical issues, and to test current global models of the thermosphere and ionosphere.

At the workshop held last year, chaired by Daniel Meléndez-Alvira, Marsha Torr, the ATLAS 1 mission scientist, gave an overview of the mission. Doug Torr reviewed the Imaging Spectrometric Observatory (ISO) and briefly discussed the science objectives and proposed studies. Brian Tinsley reviewed the Energetic Neutral Particle Precipitation (ENAP) investigation. At the end of the meeting a group discussion was held in which the community expressed interest in the ATLAS 1 - CEDAR campaign.

The main topics to be discussed at the workshop will be:

- Review of the ATLAS orbital parameters (nighttime in the Southern Hemisphere)

- Description of ATLAS 1 observing options
    - Twilight over the Southern United States
    - Daytime observations over the Northern United States and Canada

- Scientific Objectives
    - Merit of groundbased nighttime Northern Hemisphere airglow observations in conjunction with *in situ* nighttime shuttle observations in the Southern Hemisphere

- Discussion of the scientific objectives of the daytime overflights of ATLAS 1 of the radar and ionosonde observatories

- Modeling goals

Daniel Meléndez-Alvira

DMA/an
Attachments

WORKSHOP AGENDA

ATLAS 1 - CEDAR COORDINATED EXPERIMENTS

THURSDAY, JUNE 20, 1991
3:45 P.M.
NCAR, Chapman Room

Chairman: Dr. Daniel Meléndez-Alvira

3:45 P.M.	ATLAS Orbital Parameters and Observational Modes........	Doug Torr
4:00 P.M.	Proposed Optical Studies..	Doug Torr
4:15 P.M.	Correlative Radar and Ionosonde Measurements...............	Daniel Meléndez
4:30 P.M.	Planning and Discussion	

PROPOSED STUDIES

Photochemistry, energetics and dynamics of the thermosphere and ionosphere

Effects of energetic neutral particle precipitation on the mid-latitude thermosphere

Validation of the retrieval of thermospheric parameters from ground-based airglow measurements

Photochemical-dynamical coupling of the lower thermosphere/mesosphere

Mesospheric oxygen-hydrogen photochemistry

Photochemistry of metastable O, O_2 and OH

Photochemistry and dynamics of metallic species

ATLAS 1 - CEDAR COORDINATED EXPERIMENTS

NASA's first ATMOSPHERIC LABORATORY FOR APPLICATIONS AND SCIENCE (ATLAS 1) is scheduled for launch on March 10, 1992. The payload comprises the following instruments relevant to the objectives of CEDAR:

1. The Imaging Spectrometric Observatory (ISO) - a spectral imager
2. Atmospheric Emissions Photometric Imaging (AEPI)
3. Atmospheric Lyman-Alpha Emissions (ALAE)
4. Grille Spectrometer (GRILLE)
5. Atmospheric Trace Molecular Spectroscopy (ATMOS)
6. Millimeter Wave Atmospheric Sounder (MAS)
7. Solar Spectrum from 180 to 3200 Nanometers (SOLSPEC)
8. Space Experiments with Particle Accelerators (SEPAC)

This instrument complement will provide the following parameter database:

Upper Thermosphere/Ionosphere:

O, O_2, N_2, H, T_n

$O^+(^4S)$, $O^+(^2D)$, $O^+(^2P)$, O_2^+, N_2^+, NO^+, Ne, metallic species

Solar EUV and Photoelectron fluxes

Meridional Winds from peak height of Ne

Lower Thermosphere/Mesosphere:

O, O_2, N_2, O_3, NO, H, OH, H_2O, metallic species, Tn

Dynamics: through tracers CO and CO_2, and photometric imaging

ATLAS 1 ORBIT, LAUNCH VEHICLE AND MISSION DURATION

The payload will be launched on the shuttle Atlantis into a 57° inclination circular orbit at 296.3 km. The mission duration is projected to be 8 days.

ATLAS 1 MEASUREMENTS

All significant airglow emissions from 50 nm to 860 nm over the altitude range 50 to 300 km (ISO)

Microwave emissions below 100 km of O_3 and H_2O (MAS)

The solar EUV (ISO) and UV fluxes (SOLSPEC)

Solar absorption signatures by O_3, NO, H_2O, CO, CO_2 (GRILLE and ATMOS)

Gas cell absorption signatures of D (and H)

Spatial images of mesospheric and thermospheric airglow and aurora (AEPI)

Electron gun induced aurora (SEPAC)

THE ATLAS-CEDAR COORDINATED PROGRAM

ATLAS 1 and CEDAR will provide a comprehensive database of thermospheric, ionospheric and mesospheric parameters that would allow the community to address most of the unresolved problems of this region of the upper atmosphere. The basic neutral atmosphere can be reliably inferred from the *in situ* airglow measurements which extend from the EUV to the near infrared, using retrieval algorithms already developed and tested with ground-based measurements. The solar EUV and UV fluxes will be directly measured by the ISO and SOLSPEC respectively. The ISO will also provide well resolved altitude profiles of limb intensities, allowing the information content of height dependent sources of emission to be effectively utilized for the retrieval of both neutral and ionized constituents.

The vast information content of the ATLAS 1 and CEDAR spectroscopy database when coupled with detailed quantitative modeling, will allow many parameters to be reliably inferred. The recombination of O_2^+, and NO^+, for example, provide a means of measuring the concentrations of these ions. The concentrations of O^+ and N_2^+ are obtained from their resonance scattering signatures in the EUV and near-UV respectively. The electron density is derived from the sum of the ion concentrations, and must self-consistently satisfy the recombination rates of all the molecular ions.

Critical input from the CEDAR instruments would be ground-based measurements of neutral winds, which would be compared with those derived from the height of the F_2 layer peak inferred from the *in situ* airglow measurements; radar and ionosonde measurements of the electron density (and peak height and electron and ion temperatures) to verify the *in situ* results, and supporting spectroscopy and imager observations from the ground to provide temporal continuity, and to resolve temporal-spatial ambiguities in the spacecraft observations.

The ionospheric and thermospheric database acquired globally by the ATLAS instruments will be compared with that obtained from the ground during overflights of the CEDAR observatories and with the model values provided by the NCAR TIGCM, the Utah State global ionospheric model, the University of Alabama FLIP model and the London College TIGCM. Comparisons can also be made with empirical models such as the MSIS thermospheric and IRI ionospheric models respectively. The FLIP model will be used to provide semi-global plots as a function of altitude and time of electron and and ion temperatures, and flow velocities, which would be compared with the radar measurements. The FLIP model will utilize the ATLAS 1 thermospheric data base and solar EUV flux measurements to verify self-consistent determination of the electron densities as a function of altitude along the orbital track.

In addition to the thermospheric observations, the ISO instrument will spatially image all detectable mesospheric emissions on the limb. These will include: $O(^1S)$ 5577 Å, the Herzberg I and II, Chamberlain, O_2 atmospheric and OH Meinel bands from v'=4 to 9, which will provide the database for the study of mesospheric O, O_2, and OH^*. For the study of the oxygen-hydrogen chemistry, the dynamically controlled odd hydrogen reservoir molecule, H_2O, and O_3 will be measured by the GRILLE and ATMOS spectrometers. Deuterium in the lower thermosphere will be measured by ALAE and can be used to infer H if the D/H is assumed to be known, the hydroxyl radical in the lower mesosphere by the ISO, and NO in the mesosphere and thermosphere by several instruments

The AEPI will image a selection of lines or bands whose emission heights straddle the mesosphere, serving as dynamics tracers. These observations will be supplemented by measurements of the tracer constituents CO and CO_2 by the GRILLE and ATMOS. The CEDAR imager network would provide the corresponding view of the mesosphere from below.

For the study of metallic species, the ISO and AEPI will provide measurements of the vertical and horizontal distribution of emissions respectively. Critical data on the abundances of metallic neutrals, notably sodium, would be provided by the CEDAR lidars.

The above database will comprise the most complete set of measurements on key parameters acquired to date for the thermosphere/mesosphere system, and will allow the dynamical- photochemical coupling of the region, the photochemistry of $O(^1S)$, metastable oxygen, vibrationally excited OH, Ozone, odd hydrogen, and metallic species to be comprehensively studied. The thermospheric component of the database will provide the first comprehensive dataset on the vibrational distribution of N_2^+ together with simultaneous measurements of $O^+(^2D)$ which couples tightly into the N_2^+ chemistry. The fate of the $O^+(^2D)$ plays a significant role in determining the F2 layer electron density, and has never been measured in the F region previously.

Observing strategies will be the main focus of discussion because the nighttime component of the orbit occurs mainly in the Southern Hemisphere. The ISO will make measurements of the dayglow on 14 orbits, and several twilight crossings will occur over the southern United States. A program of groundbased twilight observations for neutral composition retrieval would provide a valuable component of the campaign. Anyone with the capability to make twilight observations of the 732, 630 and 391.4 nm emissions is encouraged to participate. Daytime overflights of radar and ionosonde stations will also be a primary objective of the campaign.

Coupling and Dynamics of Equatorial Regions (CADRE)

Dave Fritz
NCAR Main Seminar Room
Friday 8:30-12:30

There are two objectives of this CADRE Workshop:

To make participants and interested others aware of the present plans, campaign schedules, and anticipated instrument capabilities. This may be the best opportunity to do some detailed planning of correlative measurement components. There are a number of systems that are currently operating that will be providing data, this workshop will try to nail these down.

To present the campaign objectives in detail so that others that may have the resources to participate can see where they might best make a contribution. Most of the planning has been sketchy to date, but it is now time to prepare proposals that will allow for participation by those who are interested. With a little coordination we should be able to make this effort more successful for all.

GISMOS WORKSHOP
CEDAR meeting, June 21, 1991

GISMOS aims at understanding the magnetosphere ionosphere coupling processes. The workshop will focus on 3 main areas:

A. New data acquisition techniques
B. Boundaries
C. Plans

The participants who have agreed to contribute include:

- B. Showen -- Plasma lines, and how they can be used for velocity vector measurements, and field aligned current measurements

- M. Ruohoniemi -- Sondrestrom/Goose Bay Measurements

- B. Fejer -- Penetration electric fields

- O. de la Beaujardiere -- DMSP/Sondrestrom measurements of boundaries

- D. Knipp -- Global Mapping

- G. Crowley -- Goose Bay radar/Digisonde coordinated observations

- All participants -- Future observations and plans for analysis of existing data

The intent is to have a fairly informal workshop, where the presentations would not be more than 10 to 15 minutes long, and with ample time for discussions.

CADITS Workshop

Vincent B. Wickwar, CASS, Utah State University, Logan, UT, USA
Herbert C. Carlson, Jr., Geophysics Laboratory, Bedford, MA, USA

BACKGROUND

CADITS [Coupling And Dynamics of the Ionosphere-Thermosphere System] is the CEDAR (and STEP) project that focuses on the thermosphere and ionospheric F region. Significant aspects of the regular behavior or climatology of this system remain to be determined. Beyond that, much remains to be learned about its variability or weather. A major emphasis in this project is on how various forms of coupling affect this region. In addition to the coupling between neutral and ionized gases, this global system involves vertical coupling (from the mesosphere below and the magnetosphere, plasmasphere, and conjugate ionosphere above) and horizontal coupling (from distant latitudes and longitudes). The other major emphasis is on dynamics, because it is intimately related to much of the coupling.

The approach being taken includes comprehensive observations and extensive modeling. Many of the observations are synoptic, i.e., emphasizing the coordinated Incoherent-Scatter World Days, but special campaigns are also envisaged. Global synoptic observations are needed to determine the climatology, to detect long-term variability, and to provide a baseline for examining the shorter-term variability or weather. A comprehensive set of geophysical variables needs to be observed. Ground-based instruments that can make significant contributions include incoherent-scatter radars; Fabry-Perot and Michelson interferometers; HF sounders; HF and VHF radars; optical imagers; meridian-imaging spectrometers; spectrometers, low-resolution Fabry-Perot interferometers, and spatially scanning photometers; and meteor-wind and partial reflection radars.

The analysis of the observations will make extensive use of models. They provide a natural framework for relating the observations from many locations and for assessing our understanding. The most encompassing models are the three-dimensional, time-dependent global models, e.g., the NCAR thermosphere-ionosphere global circulation model and the USU time-dependent ionospheric model.

As might be surmised from this description, CADITS is closely related to several other CEDAR projects, including MLTCS for coupling to lower altitudes, GISMOS for high-latitude coupling, the project to determine neutral-atmosphere densities, SUNDIAL for interest in the F region, and CAT for overlapping interests in the analysis phase.

PURPOSE OF WORKSHOP

The purpose of this workshop is information exchange and planning for the future. It is intended for participants in CADITS and related CEDAR projects as well as people interested in the science. A partial agenda follows:

1) Status Report on Recent Campaigns

Review the CADITS aspects of the 25-29 June 1990 and 14-20 March 1991 coordinated world-day campaigns. (It would be particularly useful if short written descriptions were provided ahead of time to Vincent Wickwar. They could be duplicated and handed out, thereby minimizing discussion time.)

2) Future Campaigns

Discuss CADITS aspects of future observations including the scheduled 4-10 December 1991 campaign and dates for 1992 campaigns.

Discuss additional observations that are needed, e.g. ways of determining the neutral atmosphere.

Discuss incoherent-scatter radar operating modes--what are they and can changes be made to improve the data.

3) Coupling with other CEDAR Projects.

Update on aspects of other CEDAR projects that affect CADITS.

4) Present Research Results at Upcoming Meetings.