Cover Page for Proposal Submitted to the National Aeronautics and Space Administration

NASA Proposal Number

10-AURA10-0016

NASA PROCEDURE FOR HANDLING PROPOSALS

This proposal shall be used and disclosed for evaluation purposes only, and a copy of this Government notice shall be applied to any reproduction or abstract thereof. Any authorized restrictive notices that the submitter places on this proposal shall also be strictly complied with. Disclosure of this proposal for any reason outside the Government evaluation purposes shall be made only to the extent authorized by the Government.

SECTION I - Proposal Information

Principal Investigator	E-mail Address	Phone Number
Annmarie Eldering	**Annmarie.Eldering@jpl.nasa.gov**	**818-354-4941**

Street Address (1)	Street Address (2)
4800 Oak Grove Dr	**MS 183-601**

City	State / Province	Postal Code	Country Code
Pasadena	**CA**	**91109-8001**	**US**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

Proposed Start Date	Proposed End Date	Total Budget	Year 1 Budget	Year 2 Budget	Year 3 Budget
02 / 01 / 2011	**01 / 31 / 2014**	**765,700.00**	**261,000.00**	**251,500.00**	**253,200.00**

SECTION II - Application Information

NASA Program Announcement Number	NASA Program Announcement Title
NNH10ZDA001N-AURA	**Atmospheric Composition: Aura Science Team**

For Consideration By NASA Organization *(the soliciting organization, or the organization to which an unsolicited proposal is submitted)*
Earth Science

Date Submitted	Submission Method	Grants.gov Application Identifier	Applicant Proposal Identifier
08 / 02 / 2010	**Electronic Submission Only**		**16076**

Type of Application	Predecessor Award Number	Other Federal Agencies to Which Proposal Has Been Submitted
New		

International Participation	Type of International Participation
No	

SECTION III - Submitting Organization Information

DUNS Number	CAGE Code	Employer Identification Number (EIN or TIN)	Organization Type
095633152	**23835**	**951643307**	**2A**

Organization Name (Standard/Legal Name)	Company Division
Jet Propulsion Laboratory	

Organization DBA Name	Division Number
JET PROPULSION LABORATORY	

Street Address (1)	Street Address (2)
4800 OAK GROVE DR	

City	State / Province	Postal Code	Country Code
PASADENA	**CA**	**91109-8001**	**USA**

SECTION IV - Proposal Point of Contact Information

Name	Email Address	Phone Number
Annmarie Eldering	**Annmarie.Eldering@jpl.nasa.gov**	**818-354-4941**

SECTION V - Certification and Authorization

Certification of Compliance with Applicable Executive Orders and U.S. Code

By submitting the proposal identified in the Cover Sheet/Proposal Summary in response to this Research Announcement, the Authorizing Official of the proposing organization (or the individual proposer if there is no proposing organization) as identified below:

- certifies that the statements made in this proposal are true and complete to the best of his/her knowledge;
- agrees to accept the obligations to comply with NASA award terms and conditions if an award is made as a result of this proposal; and
- confirms compliance with all provisions, rules, and stipulations set forth in the two Certifications and one Assurance contained in this NRA (namely, (i) the Assurance of Compliance with the NASA Regulations Pursuant to Nondiscrimination in Federally Assisted Programs, and (ii) Certifications, Disclosures, and Assurances Regarding Lobbying and Debarment and Suspension.

Willful provision of false information in this proposal and/or its supporting documents, or in reports required under an ensuing award, is a criminal offense (U.S. Code, Title 18, Section 1001).

Authorized Organizational Representative (AOR) Name	AOR E-mail Address	Phone Number
Karen Piggee	**Karen.R.Piggee@jpl.nasa.gov**	**818-354-9154**

AOR Signature *(Must have AOR's original signature. Do not sign "for" AOR.)*	**Date**

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION VI - Team Members

Team Member Role	Team Member Name	Contact Phone	E-mail Address
PI	**Annmarie Eldering**	**818-354-4941**	**Annmarie.Eldering@jpl.nasa.gov**
Organization/Business Relationship		Cage Code	DUNS#
Jet Propulsion Laboratory		**23835**	**095633152**
International Participation	U.S. Government Agency		Total Funds Requested
No	**Other**		**499,300.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I	**Jeff McQueen**	**301-763-8000 x 7226**	**jeff.mcqueen@noaa.gov**
Organization/Business Relationship		Cage Code	DUNS#
National Weather Service		**1QHX8**	**879835593**
International Participation	U.S. Government Agency		Total Funds Requested
No	**National Oceanic and Atmospheric Administration (NOAA)**		**195,000.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I	**Gregory Osterman**	**818-354-3641**	**Gregory.Osterman@jpl.nasa.gov**
Organization/Business Relationship		Cage Code	DUNS#
Jet Propulsion Laboratory		**23835**	**095633152**
International Participation	U.S. Government Agency		Total Funds Requested
No	**Other**		**71,400.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I	**Youhua Tang**	**301-763-8000 x 7250**	**youhua.tang@noaa.gov**
Organization/Business Relationship		Cage Code	DUNS#
I.M. Systems Group, Inc.		**0RS46**	**622827525**
International Participation	U.S. Government Agency		Total Funds Requested
No	**National Oceanic and Atmospheric Administration (NOAA)**		**0.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Collaborator	**Xiong Liu**	**617-496-2136**	**xliu@cfa.harvard.edu**
Organization/Business Relationship		Cage Code	DUNS#
Smithsonian Institution/Smithsonian Astrophysical Observatory		**1PPP1**	**003261823**
International Participation	U.S. Government Agency		Total Funds Requested
No			**0.00**

PI Name : **Annmarie Eldering**

Organization Name : **Jet Propulsion Laboratory**

NASA Proposal Number

10-AURA10-0016

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION VII - Project Summary

Surface-level ozone causes serious health impacts in humans and damages crops and terrestrial ecosystems. High concentrations of ozone are due to a combination of photochemistry, dynamics, and background or long range transport of pollutants. As discussed in the NESCAUM report (NESCAUM, 2006), "Scientific studies have uncovered a rich complexity in the interaction of meteorology and topography with ozone formation and transport." Different regions have different characteristics, and the situation for the Northeastern United States has been described in the following manner: At nighttime, a temperature inversion forms, isolating ozone above the inversion layer, so it is not chemically destroyed or deposited. Because winds are often much stronger above the inversion layer, this aloft ozone can be transported long distances. The next morning, as the boundary layer breaks up, the aloft ozone can be mixed down to the surface and contribute to rapidly increasing concentrations. We define ##nighttime aloft ozone## as the high ozone concentrations that can be found in the region of the atmosphere between the nocturnal boundary layer and the top of the daily mixing layer that serves as an ozone reservoir throughout the night. In polluted environments, the entrainment of nighttime aloft ozone in the morning may be as important as chemical ozone production during the day (Athanassiadis et al., 2002). In national parks close to polluted regions, such as Yosemite and Great Smoky Mountains, the ozone frequently exceeds 90 ppb and overnight transport of ozone substantially contributes to these elevated concentrations (Mueller, 1994; Burley and Ray, 2007).

To help protect human health and ecosystems, regional-scale atmospheric chemistry models are used to forecast high ozone events and to design emission control strategies to decrease the frequency and severity of ozone events. Despite the importance of nighttime aloft ozone, regional-scale atmospheric chemistry models do not simulate the surface nighttime ozone concentrations well (Sokhi et al., 2006; O'Neill et al., 2006) and nor do they sufficiently capture the nighttime ozone transport patterns (Gilliland et al., 2008). Fully characterizing the importance of the processes has been hampered by limited measurements of the vertical distribution of ozone and ozone-precursors. The main focus of this proposal is to begin to utilize remote sensing data sets to characterize the impact of nighttime aloft ozone to air quality events.

Our specific objectives are:
*** Characterize nighttime aloft ozone using remote sensing data and sondes.**
*** Evaluate the ability of the Community Multi-scale Air Quality (CMAQ) model and the National Air Quality Forecast Capability (NAQFC) model to capture the nighttime aloft ozone and its relationship to air quality events.**
*** Analyze a set of air quality events and determine the relationship of air quality events to the nighttime aloft ozone.**

To achieve our objectives, we will utilize the ozone profile data from the NASA Earth Observing System (EOS) Tropospheric Emission Spectrometer (TES) and other sensors, ozonesonde data collected during the Aura mission (IONS), EPA AirNow ground station ozone data, the CMAQ continental-scale air quality model, and the National Air Quality Forecast model. The EOS TES instrument measures in the infrared, allowing it to produce nighttime ozone profiles, unlike other remote sensing ozone measurements. This proposal is a collaborative effort of remote sensing experts, and air quality scientists with knowledge of CMAQ and the NAQFC. Many of the barriers to success in this research area (lack of familiarity between the communities, remote sensing data with appropriate sensitivity, mathematical tools for quantitative comparison of remote sensing measurements and models) have been removed, allowing progress and success of the proposed work.

This work is proposed to be conducted as Fundamental Research.

PI Name : **Annmarie Eldering**	**NASA Proposal Number**
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION VIII - Other Project Information

Proprietary Information

Is proprietary/privileged information included in this application?
Yes

International Collaboration

Does this project involve activities outside the U.S. or partnership with International Collaborators?
No

Principal Investigator	Co-Investigator	Collaborator	Equipment	Facilities
No	**No**	**No**	**No**	**No**

Explanation :

NASA Civil Servant Project Personnel

Are NASA civil servant personnel participating as team members on this project (include funded and unfunded)?
No

Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year	Fiscal Year
Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs	Number of FTEs

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION VIII - Other Project Information

Environmental Impact

Does this project have an actual or potential impact on the environment?	Has an exemption been authorized or an environmental assessment (EA) or an environmental impact statement (EIS) been performed?
No	**No**

Environmental Impact Explanation:

Exemption/EA/EIS Explanation:

PI Name : **Annmarie Eldering**	**NASA Proposal Number**
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION VIII - Other Project Information

Historical Site/Object Impact

Does this project have the potential to affect historic, archeological, or traditional cultural sites (such as Native American burial or ceremonial grounds) or historic objects (such as an historic aircraft or spacecraft)?

Explanation:

PI Name : **Annmarie Eldering**	**NASA Proposal Number**
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION IX - Program Specific Data

Question 1 : Short Title:

Answer: Nighttime Ozone - Impact on Air Quality

Question 2 : Type of institution:

Answer: NASA Center (including JPL)

Question 3 : Will any funding be provided to a federal government organization including NASA Centers, JPL, other Federal agencies, government laboratories, or Federally Funded Research and Development Centers (FFRDCs)?

Answer: Yes

Question 4 : Is this Federal government organization a different organization from the proposing (PI) organization?

Answer: No

Question 5 : Does this proposal include the use of NASA-provided high end computing?

Answer: No

Question 6 : Research Category:

Answer: 9) Earth System Science applications and decision support

Question 7 : Team Members Missing From Cover Page:

Answer:

Question 8 : This proposal contains information and/or data that are subject to U.S. export control laws and regulations including Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR).

Answer: No

Question 9 : I have identified the export-controlled material in this proposal.

Answer: N/A

Question 10 : I acknowledge that the inclusion of such material in this proposal may complicate the government's ability to evaluate the proposal.

Answer: N/A

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Cumulative Budget

Budget Cost Category	Funds Requested ($)			
	Year 1 ($)	Year 2 ($)	Year 3 ($)	Total Project ($)
A. Direct Labor - Key Personnel	39,200.00	41,200.00	41,600.00	122,000.00
B. Direct Labor - Other Personnel	0.00	0.00	0.00	0.00
Total Number Other Personnel	0	0	0	0
Total Direct Labor Costs (A+B)	39,200.00	41,200.00	41,600.00	122,000.00
C. Direct Costs - Equipment	11,000.00	0.00	0.00	11,000.00
D. Direct Costs - Travel	8,500.00	5,500.00	5,500.00	19,500.00
Domestic Travel	8,500.00	5,500.00	5,500.00	19,500.00
Foreign Travel	0.00	0.00	0.00	0.00
E. Direct Costs - Participant/Trainee Support Costs	0.00	0.00	0.00	0.00
Tuition/Fees/Health Insurance	0.00	0.00	0.00	0.00
Stipends	0.00	0.00	0.00	0.00
Travel	0.00	0.00	0.00	0.00
Subsistence	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Number of Participants/Trainees				0
F. Other Direct Costs	162,200.00	165,700.00	167,200.00	495,100.00
Materials and Supplies	0.00	0.00	0.00	0.00
Publication Costs	0.00	2,000.00	2,000.00	4,000.00
Consultant Services	0.00	0.00	0.00	0.00
ADP/Computer Services	0.00	0.00	0.00	0.00
Subawards/Consortium/Contractual Costs	97,200.00	98,700.00	100,200.00	296,100.00
Equipment or Facility Rental/User Fees	0.00	0.00	0.00	0.00
Alterations and Renovations	0.00	0.00	0.00	0.00
Other	65,000.00	65,000.00	65,000.00	195,000.00
G. Total Direct Costs (A+B+C+D+E+F)	220,900.00	212,400.00	214,300.00	647,600.00
H. Indirect Costs	40,100.00	39,100.00	38,900.00	118,100.00
I. Total Direct and Indirect Costs (G+H)	261,000.00	251,500.00	253,200.00	765,700.00
J. Fee	0.00	0.00	0.00	0.00
K. Total Cost (I+J)	261,000.00	251,500.00	253,200.00	765,700.00
Total Cumulative Budget				765,700.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2011	**01 / 31 / 2012**	**Project**	**1**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Eldering, Annmarie	PI_TYPE	0.00				10,200.00	6,100.00	16,300.00
Osterman, Gregory	CO-I	0.00				14,400.00	8,500.00	22,900.00
							Total Key Personnel Costs	39,200.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
0	Total Number Other Personnel					Total Other Personnel Costs	0.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	39,200.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2011	**01 / 31 / 2012**	**Project**	**1**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
1	compuer with 5 TB storage	11,000.00
	Total Equipment Costs	11,000.00

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	8,500.00
2. Foreign Travel	0.00
Total Travel Costs	8,500.00

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		0.00
2. Stipends		0.00
3. Travel		0.00
4. Subsistence		0.00
Number of Participants/Trainees:	Total Participant/Trainee Support Costs	0.00

PI Name : **Annmarie Eldering**	**NASA Proposal Number**
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2011	**01 / 31 / 2012**	**Project**	**1**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	0.00
2. Publication Costs	0.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	97,200.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
8 . Other: **Jeff McQueen/ NOAA**	65,000.00
Total Other Direct Costs	162,200.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	220,900.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MPS (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	5,800.00
ADC (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	15,800.00
Gen (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	18,500.00
Cognizant Federal Agency: None		**Total Indirect Costs**	40,100.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	261,000.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	261,000.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2012	**01 / 31 / 2013**	**Project**	**2**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Eldering, Annmarie	PI_TYPE	0.00				10,700.00	6,400.00	17,100.00
Osterman, Gregory	CO-I	0.00				15,100.00	9,000.00	24,100.00
							Total Key Personnel Costs	41,200.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
0	Total Number Other Personnel					Total Other Personnel Costs	0.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	41,200.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2012	**01 / 31 / 2013**	**Project**	**2**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**5,500.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**5,500.00**

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		**0.00**
2. Stipends		**0.00**
3. Travel		**0.00**
4. Subsistence		**0.00**
Number of Participants/Trainees:	**Total Participant/Trainee Support Costs**	**0.00**

PI Name : Annmarie Eldering	NASA Proposal Number
Organization Name : Jet Propulsion Laboratory	10-AURA10-0016

Proposal Title : Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2012	01 / 31 / 2013	Project	2

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	0.00
2. Publication Costs	2,000.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	98,700.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
8 . Other: Jeff McQueen/ NOAA	65,000.00
Total Other Direct Costs	165,700.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	212,400.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MPS (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	5,800.00
ADC (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	15,500.00
Gen (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	17,800.00
Cognizant Federal Agency: None		Total Indirect Costs	39,100.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	251,500.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	251,500.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2013	**01 / 31 / 2014**	**Project**	**3**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Eldering, Annmarie	PI_TYPE	0.00				10,800.00	6,400.00	17,200.00
Osterman, Gregory	CO-I	0.00				15,300.00	9,100.00	24,400.00
							Total Key Personnel Costs	41,600.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
0	Total Number Other Personnel					Total Other Personnel Costs	0.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	41,600.00

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2013	**01 / 31 / 2014**	**Project**	**3**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
	Total Equipment Costs	**0.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	**5,500.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**5,500.00**

E. Direct Costs - Participant/Trainee Support Costs

		Funds Requested ($)
1. Tuition/Fees/Health Insurance		**0.00**
2. Stipends		**0.00**
3. Travel		**0.00**
4. Subsistence		**0.00**
Number of Participants/Trainees:	**Total Participant/Trainee Support Costs**	**0.00**

PI Name : **Annmarie Eldering**	NASA Proposal Number
Organization Name : **Jet Propulsion Laboratory**	**10-AURA10-0016**

Proposal Title : **Nighttime Tropospheric Ozone Impacts and Relationship to Air Quality**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
02 / 01 / 2013	**01 / 31 / 2014**	**Project**	**3**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	0.00
2. Publication Costs	2,000.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	100,200.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
8 . Other: **Jeff McQueen/ NOAA**	65,000.00
Total Other Direct Costs	167,200.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	214,300.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
MPS (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	5,800.00
ADC (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	15,400.00
Gen (reported as Direct Costs per NASA Prime Contract)	0.00	0.00	17,700.00
Cognizant Federal Agency: None		**Total Indirect Costs**	38,900.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	253,200.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	253,200.00

Contents

1 Scientific/Technical/Management

Surface-level ozone causes serious health impacts in humans and damages crops and terrestrial ecosystems. High concentrations of ozone are due to a combination of photochemistry, dynamics, and background or long range transport of pollutants. As discussed in the NESCAUM report (NESCAUM, 2006), "Scientific studies have uncovered a rich complexity in the interaction of meteorology and topography with ozone formation and transport." Different regions have different characteristics, and the situation for the Northeastern United States has been described in the following manner: At nighttime, a temperature inversion forms, isolating ozone above the inversion layer, so it is not chemically destroyed. Because winds are often much stronger above the inversion layer, this aloft ozone can be transported long distances. The next morning, as the boundary layer breaks up, the aloft ozone can be mixed down to the surface and contribute to rapidly increasing concentrations. We define "nighttime aloft ozone" as the high ozone concentrations that can be found in the region of the atmosphere between the nocturnal boundary layer and the top of the daily mixing layer that serves as an ozone reservoir throughout the night. In polluted environments, the entrainment of nighttime aloft ozone in the morning may be as important as chemical ozone production during the day (Athanassiadis et al., 2002). In national parks close to polluted regions, such as Yosemite and Great Smoky Mountains, the ozone frequently exceeds 90 ppb and overnight transport of ozone substantially contributes to these elevated concentrations (Mueller, 1994; Burley and Ray, 2007).

To help protect human health and ecosystems, regional-scale atmospheric chemistry models are used to forecast high ozone events and to design emission control strategies to decrease the frequency and severity of ozone events. Despite the importance of nighttime aloft ozone, regional-scale atmospheric chemistry models do not simulate the surface nighttime ozone concentrations well (Sokhi et al., 2006; O'Neill et al., 2006) and nor do they sufficiently capture the nighttime ozone transport patterns (Gilliland et al., 2008). Fully characterizing the importance of the processes has been hampered by limited measurements of the vertical distribution of ozone and ozone-precursors. The main focus of this proposal is to begin to utilize remote sensing data sets to characterize the impact of nighttime aloft ozone to air quality events.

Our specific objectives are:

- *Characterize nighttime aloft ozone using remote sensing data and sondes.*
- *Evaluate the ability of the EPA's Community Multi-scale Air Quality (CMAQ) model and NOAA's National Air Quality Forecast Capability (NAQFC) model to capture the nighttime aloft ozone and its relationship to air quality events.*
- *Analyze a set of air quality events and determine their relationship to the nighttime aloft ozone.*

To achieve our objectives, we will utilize the ozone profile data from the NASA Earth Observing System (EOS) Tropospheric Emission Spectrometer (TES) and other sensors, ozonesonde data collected during the Aura mission, EPA AirNow ground station ozone data, the CMAQ air quality model, and the National Air Quality Forecast model. The EOS TES instrument observes in the infrared, allowing it to obtain profiles of nighttime ozone in the troposphere, unlike other remote sensing ozone measurements. The sensitivity of TES to nighttime ozone will be described in more detail in a later section. This proposal is a collaborative effort of remote sensing experts, and air quality scientists with knowledge of

CMAQ and the NAQFC. Many of the barriers to success in this research area (lack of familiarity between the communities, remote sensing data with appropriate sensitivity, mathematical tools for quantitative comparison of remote sensing measurements and models) have been removed, allowing progress and success of the proposed work, as described in more detail in section 1.3.

The proposed work is directly responsive to the objectives of the Aura Science Team call, specifically, the request to use 'Aura data to better merge the activities of the atmospheric composition research community and air quality monitoring activities of other agencies within the United States'. In addition, we are aligned with the Applied Sciences objectives of this call, teaming with NOAA scientists to integrate remote sensing data into the evaluations of their tools for decision making and forecast.

1.1 Objectives and Expected Significance

1.1.1 Objectives

- **Objective 1**: Characterize nighttime aloft ozone using remote sensing data and sondes. We will focus our analysis on TES data collected in the summers of 2005 - 2009. We have global survey data collected over that period, which provides daytime and nighttime measurements.

- **Objective 2**: Evaluate the CMAQ and NAQFC air quality models' ability to capture the nighttime aloft ozone and its relationship to air quality events in the United States. By comparing CMAQ/NAQFC data to TES remote sensing measurements, we can evaluate how well the daytime and nighttime aloft ozone features are captured in CMAQ/NAQFC. This can be performed with standard North America CMAQ and NAQFC runs and with new CMAQ hemispheric runs that cover the Pacific Ocean, North America, and out into the Atlantic Ocean.

- **Objective 3**: Analyze a set of air quality events that show signs of entrainment of the residual layer or long range transport and determine the relationship to the nighttime aloft ozone. From the larger set of CMAQ/NAQFC runs, we will select several episodes that show signs of entrainment of the residual layer or long range transport. For these episodes, we will perform a detailed analysis of CMAQ/NAQFC and all potential remote sensing data (TES ozone and CO, OMI ozone (column and profile), MOPITT CO, ozonesonde data) and available in situ measurements. Our goal is to use the remote sensing data and the modeling tools to quantify the contribution of nighttime ozone during high ozone events in order to improve air quality forecasting and management.

1.1.2 Expected Significance

This work is focused on exploiting remote sensing data to study the 'effects of global atmospheric composition on regional air quality', which is directly aligned with the Atmospheric Composition Focus Area emphasis. Our collaborative effort of NASA and NOAA scientists gathers the expertise in remote sensing, air quality modeling, and air quality analysis that is needed to address these questions. The importance of transport and ozone in the free troposphere on local air quality has become increasingly important in recent years. The proposed work will allow us to evaluate the air quality model's ability to simulate ozone above the boundary layer and study transport events. This will lead to increased confidence when using the model for scientific, forecasting or regulatory purposes. In addition, this work is significant in that it the close teaming of NASA and the NOAA/NCEP air quality forecasting group will allow for advances in the use of remote sensing data in the routine work of air quality modeling. This is the ultimate goal for NASA measurements, to be utilized and have a positive impact on societally relevant science and applications.

1.2 Technical Approach and Methodology

1.2.1 Background

The prediction and control of air pollution has improved drastically over the last few decades. While the obvious ingredients of air pollution have been controlled, there are still challenges related to the long-range transport of pollutants and pollution precursors. Meteorology and topography are involved in the complex transformations that underlie air pollution. This striking interplay and its role in pollution episodes on the East Coast of the United States are described in the NESCAUM report "**The Nature of the Ozone Air Quality Problem in the Ozone Transport Region (OTR): A Conceptual Description**" "*The evolution of severe ozone episodes in the eastern U.S. often begins with the passage of a large high pressure area from the Midwest to the middle or southern Atlantic states, where it assimilates into and becomes an extension of the Atlantic (Bermuda) high pressure system. During its passage east, the air mass accumulates air pollutants emitted by large coal-fired power plants and other sources located outside the OTR. Later, sources within the OTR make their own contributions to the air pollution burden. These expansive weather systems favor the formation of ozone by creating a vast area of clear skies and high temperatures*." The report continues, "*The relative influences of the transport pathways and local emissions vary by hour and day during the course of an ozone episode and between episodes."* Figure 1-1 illustrates a nighttime ozonesonde profile with elevated aloft ozone, the key phenomenon that we would like to explore.

Much of the knowledge about this phenomenon has come from aircraft data, large combined field campaigns such as the Texas Air Quality studies, ozonesondes and ground based field experiments such as the New England Air Quality Study, The Regional Atmospheric Measurement, Modeling, and Prediction Program, based out of the University of Maryland. The work of NARSTO (formally North American Research Strategy for Tropospheric Ozone) (NARSTO Synthesis Team, 2000) also documented how a number of processes lead to long-range transport of air pollution. Field campaigns were critical to the NARSTO work, where regional scale meteorological patterns were documented, and a conceptual picture of pollution transport was described.

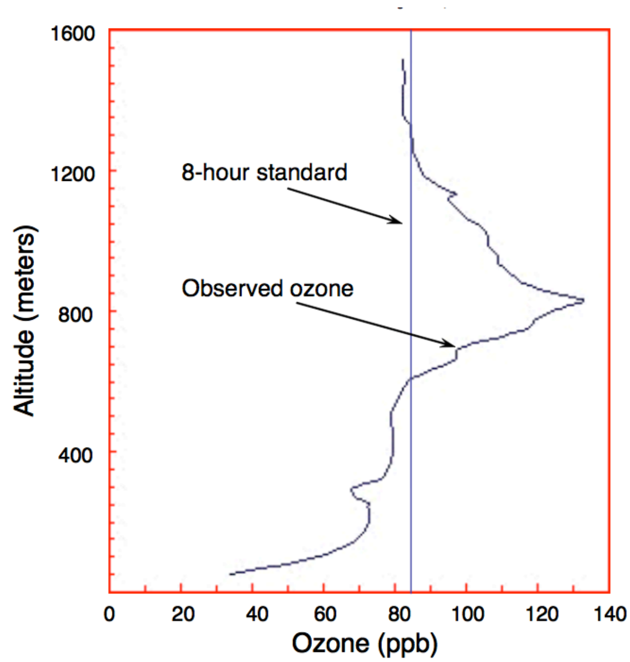

Figure 1-1 – Observed vertical ozone profile measured above Poughkeepsie, NY at about 4 a.m. EST on July 14, 1995 (in the NESCAUM report, from Zhang and Rao, 1999)

While the NESCAUM report is focused on how long-range transport plays a role in the ozone episodes of the east coast of the US, others have

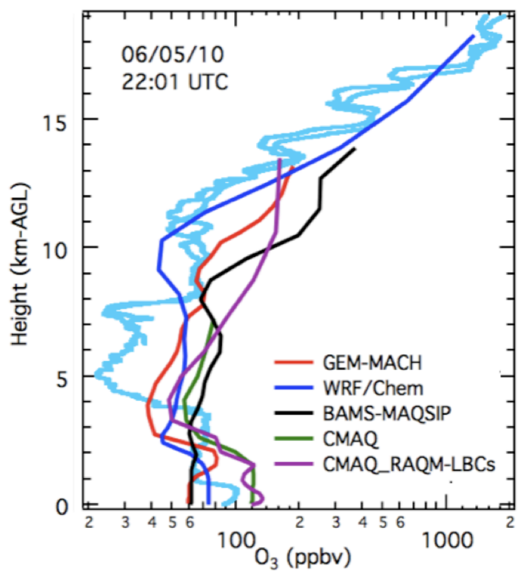

Figure 1-2: CalNex ozonesonde profiles (cyan) measured at Joshua Tree compared to a range of models, including CMAQ (green line)

investigated how long-range transport can contribute to air pollution episodes of Houston. Data from many platforms (including satellite data) combined with model analysis showed ozone in the Houston area could be attributed to sources in the Midwestern US or from recirculated local pollution (Pierce et al, 2009). That study also showed that ozone in the Dallas/Ft Worth area could come from the Great Lakes area as well as from Houston. McMillan et al, 2010 used satellite and ground based data with models to show that CO originating from fires in the Pacific Northwest was transported to the Houston area in August 2006 during the Texas Air Quality Study II.

In addition, the CalNex 2010 (CalNex, 2008) field experiment was developed to better understand atmospheric emissions and processes over California and the eastern Pacific coastal region. CalNex was joint field study with the California Air Resources Board (CARB) and the California Energy Commission (CEC). State-of-the-art instrumentation to make chemical and meteorological measurements was deployed by NOAA, NASA, DOE and several universities and other institutions. California was chosen as the focus of the mission due to its leadership in air pollution regulation. The recent tightening of the EPA standard for ozone has created a demand for a much greater understanding of transport processes. In California, this means determining when ozone aloft and/or offshore might be affecting local California air quality conditions. Over the San Joaquin Valley for instance, Parrish et al. (2010) emphasized the importance of the air layer between the nocturnal boundary layer and the top of the daily mixing layer that serves as an ozone reservoir throughout the night. Ozone reservoir layers existing at night can enhance the accumulation of surface ozone on the following day. However, the understanding of these ozone reservoir layers and their effects on the daily ozone accumulations is limited. The CalNex experiment identified the model limitations in capturing these ozone profiles (Fig. 1-2). Strong ozone gradients just above the boundary layer and mid-troposphere are not predicted by the CMAQ forecasts (green lines), nor any of the other models run during the experiment. These air quality models typically predict very smooth ozone profiles with height compared to observations.

While advances have been made in our understanding of the contribution of long-range transport to ozone events, through ground-based measurements, field campaigns, and improved modeling capability, there is still relatively little integration of remote sensing measurements of the amount of ozone aloft, in daytime or nighttime, in this assessment of ozone events. This is where the newest generation of remote sensing instruments can make a significant contribution to the investigations of the air pollution community.

Specifically, as described in the sections below, the tropospheric ozone profiles of TES, which are made during night and day, can provide new quantification of the ozone aloft. Only infrared measurements such as TES can profile ozone in the troposphere at night, and TES typically has sensitivity to the ozone layers of interest, as described below. TES measurements can be used in evaluation of the CMAQ model and the NAQFC model, and also in detailed analysis of specific air pollution episodes, to investigate the impact of nighttime ozone aloft on ozone episodes. For some episodes, additional daytime remote sensing data can be brought to bear to understand the context and evolution.

1.2.2 TES measurements

TES is a Fourier Transform Spectrometer that was launched on the Earth Observing System Aura satellite on July 15, 2004 (Beer et al., 2001). TES provides global profiles of ozone, CO, as well as water vapor, HDO, and temperature among others. Figure 1-3 shows an example of the spatial pattern of TES 'Global Survey' (GS) measurements for a 16 day repeat cycle in August 2006. TES GS measurements are made every other day, providing profile measurements for over 3000 locations over the globe in about 27 hours. The latitudinal coverage of TES has been modified over the course of the mission; currently global survey data are collected from 50N to 30S to preserve lifetime. Since September 2004, the continental United States has been regularly sampled by TES GS observations. Individual profiles from TES GS observations are spaced approximately 180 km apart, but they provide both daytime and nighttime observations with coverage across North America and coastal oceans. During science and validation campaign periods, TES is capable of taking observations with better spatial resolution made over smaller geographic regions. These special observations (SO) provide profiles spaced about 45 km apart, primarily during the daytime. In the Spring/Summer 2006 and the summers of 2007 and 2008, extensive TES SO campaigns were carried out over North America. During February-March 2006, nighttime special observations were taken as well.

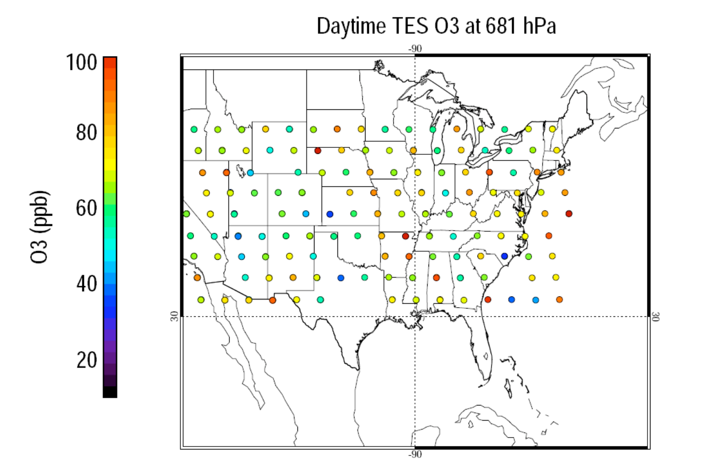

Figure 1-3: TES daytime observations of ozone over North America during a 16 day repeat cycle in August 2006. Nighttime O3 coverage is similar for the TES global survey.

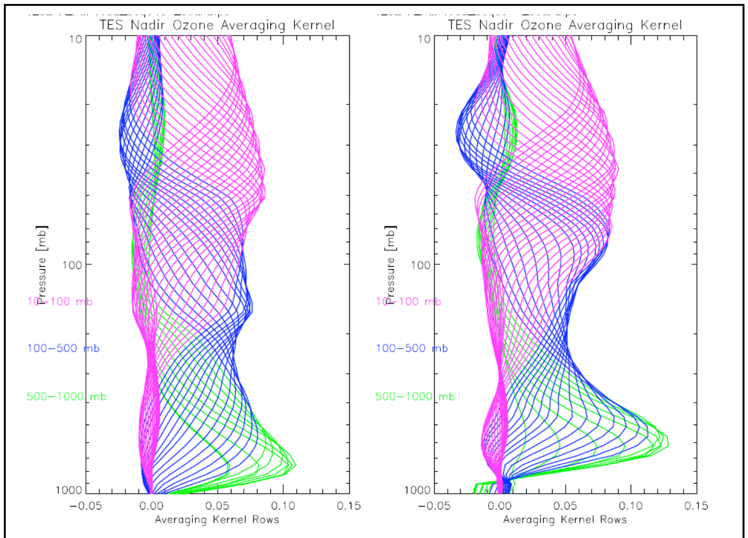

Figure 1-4: A plot of TES averaging kernels for daytime (left) and nighttime (right) observations showing instrument sensitivity to ozone over the United States.

TES can typically distinguish two vertical layers in the troposphere for ozone, and CO measurements are sensitive to one layer in the troposphere, centered at about 600mb. Typical averaging kernels for both daytime and nighttime ozone observations from TES are shown in Figure 1-4. The TES averaging kernel provides a means of quantifying the sensitivity of the TES measurement to ozone in the atmosphere. Detailed discussion of TES averaging kernels can be found in Worden et al, (2007) or in the TES Data User's Guide (Osterman et al, 2009). The averaging kernels in Figure 1-4 show TES sensitivity in the lower troposphere for both observations, with some sensitivity in the free troposphere during the day. If enough ozone is present or if thermal contrast is good, TES can resolve upper and lower tropospheric ozone. The TES ozone observations have been validated against numerous data sources (ozonesondes, aircraft measurements, other satellite data sets, see Boxe et al, 2009, Nassar et al, 2008, Richards et al, 2008, Osterman et al, 2008). The ozone profiles show a positive bias of 3-10 ppbv for the TES v002 data (Nassar et al, 2008). Ozone from more recent TES data versions has been shown to be largely consistent with v002. Over the Northern hemisphere, the region of focus for this study, the bias is usually at a maximum near 200mb. This bias is persistent over time, and should not impact the spatial analysis. We will have to account for the bias when making comparisons to model runs and other remote sensing measurements. An example of TES ozone as a function

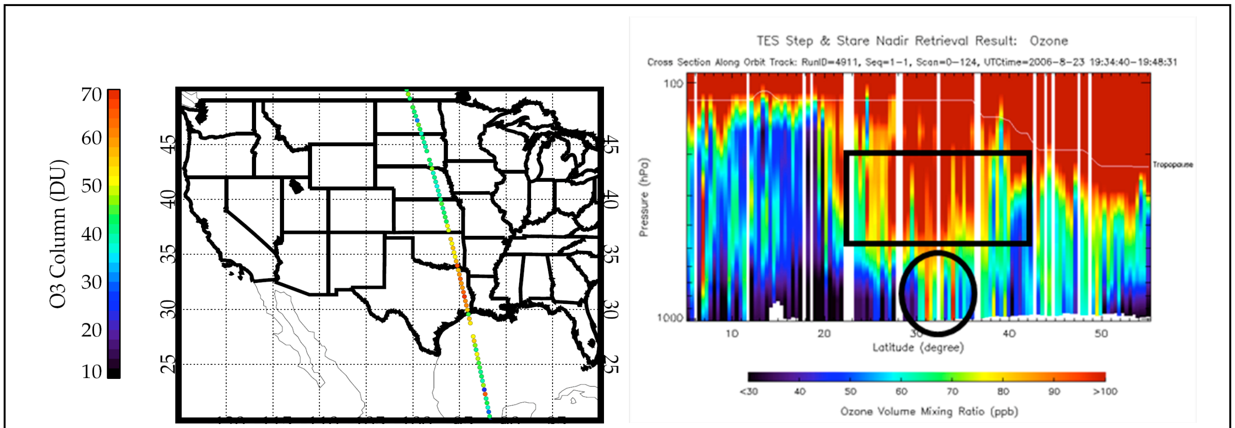

Figure 1-5: TES curtain plot showing high ozone in the middle/upper troposphere and in the lower troposphere over East Texas in August 2006. Map shows location of TES observations and the tropospheric ozone column measured by TES.

of latitude from a TES special observation is shown in Figure 1-5. This "curtain" plot shows a broad area of enhanced ozone in the middle/upper troposphere over Texas and the Gulf of Mexico and a smaller area over east Texas in the lower troposphere. TES data can provide information on these broad (in latitude) ozone features such as that seen in Figure 1-5. As mentioned above, the vertical sensitivity of TES is good enough to often resolve broad "layers" in the troposphere like the upper and lower tropospheric features seen in Figure 1-5.

1.2.3 EPA CMAQ model

The Community Multi-scale Air Quality (CMAQ) model is a regional-scale chemical transport model that explicitly simulates advection, dispersion, gas, aqueous, and mixed-phase chemistry, aerosol thermodynamics and microphysics and dry and wet deposition (Byun and Schere, 2006). We will employ the most recent public release of CMAQ (version 4.7.1), which has been extensively evaluated (Foley et al., 2009). In addition to the advancements available in

CMAQv4.7.1, we will use several recently developed improvements necessary for accurate simulation of nighttime aloft ozone.

- On-line simulation of nitrogen oxide produced during lightning – recent work suggests that this source accounts for 80% of NO_x in the upper troposphere (Cooper et al., 2009) and contributes significantly to upper troposphere ozone production (Allen et al., 2009).
- Advanced treatment of oxidized nitrogen in the upper troposphere including HNO_3 uptake on ice particles (Schauble et al., 2009), HO_2 uptake on aerosols (Mao et al., 2010), and improved chemical specificity for alkyl and peroxy acetyl nitrates (Henderson et al., 2009).
- Replaced the standard CMAQ photolysis calculations with the temperature and pressure dependant photolysis rates as implemented in the most recent version (4.6) of the Tropospheric Ultraviolet and Visible (TUV) Radiation Model .
- Improved characterization of organic nitrates in the lower troposphere, including advanced treatment of isoprene nitrate formation, nighttime oxidation of isoprene by nitrate radical, and cycling of OH during isoprene oxidation (Paulot et al., 2009; Xie et al., 2009, Archibald et al., 2010).
- A potential vorticity scheme to parameterize the flux of stratospheric ozone to the troposphere (Mathur et al., 2008).

Compared to other regional-scale chemical transport models, we are uniquely positioned to investigate nighttime ozone chemistry in the free troposphere because our configuration of CMAQ includes (1) a more accurate simulation of the free troposphere chemistry and photolysis and (2) process analysis tools that can be used to attribute the daily maximum ozone either to transport or local production. Figure 1-6 is an example of CMAQ nighttime surface ozone over the United States.

CMAQ has been applied to simulate spatial domains from the northern hemisphere at 108 km horizontal resolution to urban scale features in Houston, Texas at 1 km horizontal resolution. For this application we will use 12 km horizontal resolution domain that includes the continental United States. This spatial scale is commensurate with the TES resolution. Also, by including the entire continental US, we have a high number of TES global survey instances to compare with CMAQ, and enough area in the spatial domain to investigate back-trajectories and overnight transport of ozone. Comparison of the CMAQ version 4.7.1 (including the improvements described above) to the remote sensing data will focus on the year 2006. This is a year with a large set of special observations from TES to supplement the global survey measurements, and a year for which CMAQ has been exercised extensively. Through our established working relationship with EPA scientists, CMAW model data will be provided for this work.

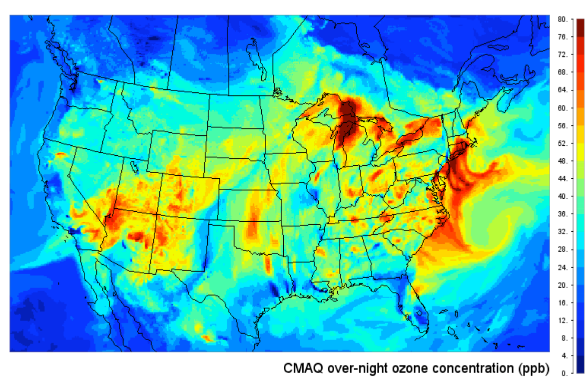

Figure 1-6: Nighttime surface ozone calculated by CMAQ over the continental US.

1.2.4 National Air Quality Forecast Model (NOAA)

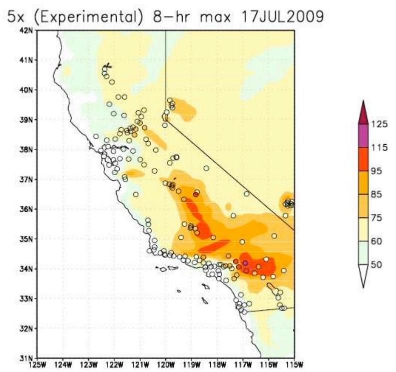

Figure 1-7 NAQFC model output compared to ground-based measurements for a California ozone episode.

The National Air Quality Forecast Capability (NAQFC, Otte, et al. 2005) is based on the CMAQ V4.6 system, and used to produce twice per day 48 hour predictions of ozone and other pollutants to aid state and local air quality agencies in their daily forecasts of pollutant conditions. The NAQFC is run at the National Oceanic and Atmospheric Administration (NOAA), National Weather Service (NWS) super computer facility and is driven by the North American Model (NAM) Weather Research and Forecasting (WRF) Non-hydrostatic Multiscale (NMM) at 12 km horizontal resolution. CMAQ predictions are configured with the Carbon Bond-5 gas-phase and AERO-4 aerosol chemicals with 22 vertical layers. Real-time outputs are produced on the National Digital Gridded Database (NDGD) and the National Centers for Environmental Prediction (NCEP) web-based visualization systems.

Model performance is evaluated in near real-time with the EPA AIRNOW ozone and particulate matter (PM2.5) surface network over the Continental U.S., Hawaii and Alaska model domains. Model error time-series over various regions are produced and displayed on the NCEP web page with its Forecast Verification System (FVS) software. This software will be used to evaluate meteorological and NAQFC model performance using the surface and upper-air profiles provided by TES. In addition, model horizontal plots with surface observations overlaid (Fig. 1-7) are useful for evaluating areas of poor performance. The NCEP real-time forecast and verification page showing these capabilities is available at : http://www.emc.ncep.noaa.gov/mmb/aq.

The NAQFC model has been run for the 2008 and 2009 period, and that will be the focus of comparisons against TES. TES Global Survey data and a limited number of special observations are available for this analysis. We will examine geographic areas that are believed to have high levels of tropospheric ozone, particularly at night. We will also perform comparisons over a wider area to evaluate the model's ability to simulate free tropospheric ozone.

1.2.5 Other remote sensing datasets

The TES ozone profiles are a critical element of this proposal, as they are the only tropospheric nighttime remote sensing ozone profile. But, when we start to examine some air quality episodes in detail, we will want to study events over a few days, so it will be valuable to bring in additional datasets.

The OMI ozone profile research product that Xiong Liu has developed will be a valuable source of information. The OMI measurements have a broad swath, so they can provide information on ozone in the region of interest. The OMI footprint is 13 by 24km at nadir, and measurements must be taken in daylight. Dr. Liu has developed an optimal estimation retrieval of ozone, and has shown that there are 0 to 1.5 degrees of freedom in the troposphere (Liu et al. 2010). The retrievals have the most sensitivity in the latitude band from 30N to 30S, and in that region, the estimated error in the troposphere is about 2 DU. Retrievals for June to August of 2006 are available now, which is what is needed for the case studies in this proposal. Averaging kernels and all of the ancillary data that is needed for proper model comparisons are available for the OMI data. The OMI data will be a good complement to the TES observations, as the OMI data can help determine if CMAQ is capturing the horizontal structure of the ozone field, while TES has more power in investigating the vertical structure.

In addition to comparing CMAQ ozone to remote sensing measurements, we will examine CO, a key emissions tracer. Evaluation of CO will be valuable for analysis of transport in the model. We will be less focused on the absolute concentrations, which are strongly impacted by emission factors, and more focused on the spatial structure of the field and how it compares to the measurements. There are two sources of data that will be studied – the TES profiles of CO, which are coincident with the ozone measurements, and the MOPITT CO measurements, which are taken earlier in the day from the Terra spacecraft, at approximately 10:30am local time. The TES and MOPITT CO data have similar sensitivity and error characteristics (Luo et al, 2007; Ho et al., 2009). MOPITT has a larger footprint (22x22 km at nadir), but like OMI, has a broad swath, so it can provide data over the region of interest. The standard MOPITT products include the ancillary data needed for model comparisons.

The work required to integrate these datasets into the analysis is manageable. TES CO data is formatted just like the TES O_3 data, so no new tools will be required. TES colleagues have worked extensively with the MOPITT CO product, so we will be able to start with their tools for reading and manipulating the data. We have worked closely with Dr. Xiong Liu, and are confident that he can provide the needed code for reading the OMI data, and we can revise it to interface with the next steps.

1.2.6 TES/CMAQ Comparisons

The TES team at JPL has extensive experience in using TES data to compare to chemical model results. TES data has been used in work with the Texas Commission on Environmental Quality (CAMx model) and many studies using GEOS-Chem results. When doing comparisons between TES and profile results from models or between TES and ozonesondes, the TES observation operator must be applied to the model to take into account the observed vertical resolution (Worden et al, 2007). An example of this is shown in Figure 1-8, which shows a monthly mean comparison of TES data to CMAQ results off the coast of California for July 2008. The TES data showed that CMAQ was overestimating the amount of ozone in the lower troposphere over the Pacific during that time. Many of the tools are in place at JPL to perform these types of comparisons. Our plan for the proposed work will be to do a systematic comparison to the EPA CMAQ and NOAA NAQFC model, focusing on regions where the models are known to have problems. These comparisons can be done for both daytime and nighttime model results.

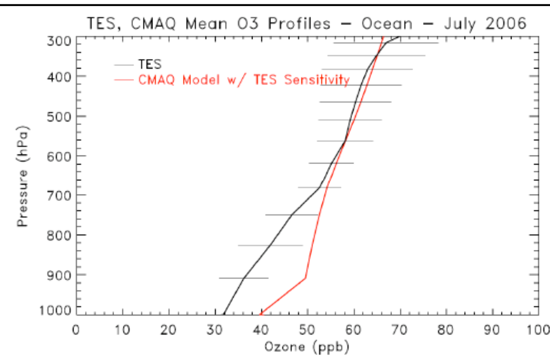

Figure 1-8: Comparison of monthly mean ozone off the coast of California from TES and the CMAQ model. The TES observation operator has been used on the model results to take into account TES vertical sensitivity.

The methods used to compare TES and CMAQ/NAQFC can be readily adapted for any remote sensing dataset with averaging kernels. As described in section 1.2.5, MOPITT products and Dr. Liu's ozone retrieval from OMI have the needed ancillary data, and will be compared to CMAQ/NAQFC with the same methodology that is applied to TES.

1.3 Applied Research and Innovative Applications

Our project is highly relevant to the Applied Sciences portion of the call, as well as the main solicitation goals. We are relevant to the Applied Sciences portion because we have a team that brings together NASA researchers and NOAA scientists to examine the ability of NASA satellite data to evaluate regional chemical models (CMAQ/NAQFC). The CMAQ model is used widely by federal agencies (EPA) and state air quality agencies to understand sources and sinks of pollution as well as developing mitigation strategies. The work of evaluating results from these critical modeling tools that are used by NOAA, EPA and others air quality agencies will have a significant effect on their policy-relevant work and analysis. The evaluation aspect of the proposed work will allow the modeling teams at NOAA/NCEP to quantify strengths and/or weaknesses in the ability to model ozone above the boundary layer. As described further in section 1.4, this project has a unique collaborative team, and will made significant advances in the utilization of remote sensing data for air quality applications.

The proposal team has experience on applying NASA data to air quality problems. Dr. Gregory Osterman has the credentials required for the applied sciences work, having developed a network with EPA and NOAA colleagues and performing an analysis using TES and CMAQ results in California during 2008. He participated in the Texas Air Quality Study II and has a current collaboration the Texas Commission on Environmental Quality. The proposed work responds to the applied research aspects of the Aura proposal call by using remote sensing data to evaluate the CMAQ and NAQFC air quality models' ability to capture the nighttime aloft ozone and its relationship to air quality events in the United States. Through our close collaboration with the NOAA co-I's we will be able to meet the expectations of representing feedback from the application community to the Aura Science Team, and to aid our EPA and NOAA colleagues in communicating the appropriate role of remote sensing data in their work to their management. By the end of this work, the NOAA researchers will have gained experience in using TES and OMI data to perform these model/data intercomparisons independently of the NASA researchers, which will enable applications and value in decision making activities.

1.4 Perceived Impact to State of Knowledge

The work proposed here, where NASA remote sensing data will be used to assess the state of the art air quality models (CMAQ/NAQFC) and investigate some specific air pollution episodes, will be a significant advance for the field. Historically, there has been a missing connection between the atmospheric composition remote sensing community and the air pollution community. In the field of aerosol measurements, there has been some history of connection of remote sensing and air quality scientists, but this has not yet been achieved with trace gas measurements. There has been a barrier to integrating remote sensing trace gas measurements with air quality science because of the sensitivity characteristics of most remote sensing measurements. Specifically, the barriers have been a lack of familiarity between different communities, the lack of appropriate sensitivity of remote sensing measurements, and the absence of tools to quantitatively compare remote sensing measurements and models.

Through NASA Applied Sciences program activities, interactions and professional conferences, and collaborative research problems, our team has established a dialogue, and we have a clear vision of a way to effectively use remote sensing data in the analysis of air quality science and the evaluation of air quality models. This is an important step past a previous barrier.

Previous generations of remote sensing measurements of ozone (ie TOMS, GOME) were used to quantify the total ozone columns, and through a variety of differencing techniques, a tropospheric ozone residual. While this data was useful for qualitative comparisons, one of the limitations was that there is no quantitative determination of the measurement's sensitivity to the ozone in the troposphere. Analysis has shown that most residual techniques are primarily responsive to upper tropospheric ozone. The Aura measurements, TES in particular, have unprecedented sensitivity in the troposphere, and the optimal estimation techniques that are applied to the data provide a quantitative estimate of the sensitivity of the remote sensing measurements to the layers of the atmosphere (see Figure 1-2 and accompanying text). These quantitative sensitivity estimates allow us to overcome another previous barrier.

The third barrier has also been overcome, as we have now developed a comprehensive understanding of how to use TES data and other remote sensing data in conjunction with atmospheric models. Basically, by using the estimates of sensitivity, we can put the remote sensing and model data on the same basis, and compare them in an appropriate and quantitative way. By applying the averaging kernels of remote sensing data to model output, the model data are then transformed into quantities that one would see from remote sensing measurements. This is a critical, and now available, step for this work to succeed.

1.5 Relevance to Element Programs and Objectives in the NRA

This work is focused on exploiting remote sensing data to 'effects of global atmospheric composition on regional air quality', which is directly aligned with the Atmospheric Composition Focus Area emphasis. Our collaborative effort of NASA and NOAA scientists gathers the expertise in remote sensing, air quality modeling, and air quality analysis that is needed to address these questions.

This proposal is responsive to the specific objectives of the Aura Science Team call. The fourth objective of the call seeks to use 'Aura data along with other satellite trace gas data sets to ….. quantify the impact of long-range transport and export of trace gases important to air quality', and the sixth objective seeks to use 'Aura data to better merge the activities of the atmospheric composition research community and air quality monitoring activities of other agencies within the United States'. Our proposed work is directly aligned with these objectives.

In addition, the work proposed here "supports applied science research and enables practical applications of Earth science products and knowledge," as specifically requested in the Applied Research and Innovative Applications section of the call.

1.6 Work Plan

Year 1:

- CMAQ results from the EPA model will be contributed to the team prior to the beginning of the proposed work. This will be done as part of a current collaboration between JPL and EPA.
- NOAA deliver existing CMAQ and AQ forecast modeling runs to JPL. Initial visualization provided. Transfer tools to read and extract data to the JPL postdoc.
- NOAA creates paired model/sonde database, and model/ground-based dataset.
- JPL postdoc identifies TES measurements that correspond to model data.
- JPL postdoc works with NOAA to create dataset of paired TES/model data. JPL postdoc applies TES observation operator to data.

Year 2:

- Continue analysis of CMAQ/NAQFC data, adding sondes and ground-based data to intercomparisons.
- NOAA/JPL to examine CMAQ/NAQFC data for episodes of interest (where there is meteorological conditions that should be conducive to ozone aloft).
- For identified episodes, examine CMAQ/NAQFC and TES data – is there evidence of ozone aloft? Are the model and remote sensing data in agreement?
- Perform back trajectory analysis with Hysplit to further elucidate development of ozone episodes.
- Anticipating updates to CMAQ/NAQFCmodels, begin to rework analysis compared to TES

Year 3:

- Continue analysis of CMAQ/NAQFC models
- For a set of the episodes, gather additional, relevant remote sensing data (TES CO, MOPITT CO, OMI daytime O3 columns, OMI daytime NO2 columns).
- Perform detailed analysis of identified ozone episodes
- Ensure that NOAA collaborators understand tools and techniques to compare models and remote sensing datasets.

1.6.1 Key Milestones

The Schedule in Figure 1-9 shows the workflow and key tasks.

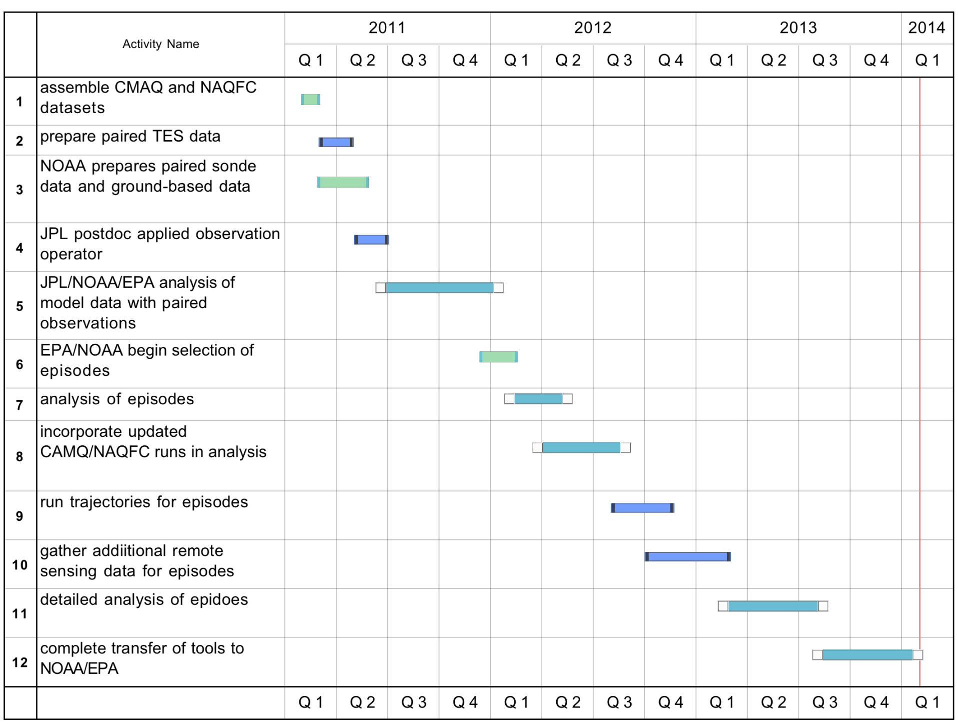

FIgure 1-9: Workflow for the project. JPL tasks are marked in blue, NOAA in green, and the joint work in cyan.

1.6.2 Management Structure

Dr. Annmarie Eldering of JPL is the PI of the proposed investigation. She is solely responsible for the quality and direction of the proposed research and the proper use of all awarded funds. She is also responsible for all technical, management, and budget issues and is the final authority for this task. The Co-Is report to and take direction from the PI and will provide all the management data needed to ensure that the she can effectively manage the entire task.

Since the team is dispersed, telecons will be held on a regular basis (roughly every two weeks), to discuss results. The postdoctoral scholar and Dr. Tang will carry out the majority of the data analysis, so the telecons will be an important for all of the team members to see results and discuss the statistics and data analysis.

1.6.3 Contributions of Principal Investigator and Key Personnel

Principal Investigator

The PI, Annmarie Eldering, will provide the overall direction and structure for the activity. She will be the advisor of the postdoctoral scholar, and provide mentoring and direction to teach the postdoc about the TES data and the tools that are already in existence. She will lead the telecons and coordinate the activities of the team members.

Key Personnel

Dr. Gregory Osterman of JPL, Co-I, will lead the postdoc in the comparison of the TES and CMAQ data. He has developed this capability at JPL, and will mentor the postdoc in utilizing the toolset.

Dr. Osterman has well established working relationships with EPA scientists. Although EPA policy prevents them from being names co-I's on this proposal, he anticipate continued discussion with them on this science topic and the research area.

Dr. Jeff McQueen, of NOAA, will provide the NCEP FVS software to NASA, work with the postdoc to couple the TES profiles to the FVS system and produce evaluation statistics and analyses to assess model improvements.

Dr. Youhua Tang, of NOAA, has performed detailed analysis of NAQFC runs and ozonesondes, and will conduct NAQFC sensitivity runs for verifying the mechanism driving ozone aloft, and evaluate the potential of using this result to improve the existing air quality prediction.

1.6.4 Collaborators and Consultants

Dr. Xiong Liu, of Harvard-Smithsonan Center for Astrophysics, will provide his retrievals of ozone profiles from OMI measurements. He will provide guidance to the team as we adapt the TES/CMAQ comparison code to work with OMI data.

1.7 Data Sharing

The air quality model runs that are needed for this work are very large files (80 GB for a 48 model run, if full 3D fields are archived). Therefore, we will purchase a computer that is only for this project, with a large amount of storage (such as a quad core machine with 4 TB of disk storage). In addition, a 2 TB external drive will be purchased, and the postdoc will use the portable drive for the initial transfer of data while visiting colleagues at NOAA/NCEP. In addition, in the third year of the project, we will transfer the algorithms for reading remote sensing data and applying the averaging kernels to our colleagues at NOAA.

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3 Biographical Sketch

3.1 Principal Investigator

Annmarie Eldering
Jet Propulsion Laboratory
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RELEVANT EXPERIENCE:

Dr. Annmarie Eldering is a full time staff member of the Jet Propulsion Laboratory, California Institute of Technology as well as an adjunct Professor at UCLA (Atmospheric and Oceanic Sciences, JIFRESSE). Since joining the staff at JPL, she has developed methods of characterizing stratospheric sulfuric acid aerosols from infrared solar occultation measurements, cloud characterizations from infrared satellite measurements, the integration of multi-sensor data sets to study water vapor and clouds, and studies of tropospheric pollution with TES measurements. In 2006, she became the acting Deputy PI of the TES experiment, and since September of 2009 she has been the PI of TES. In those roles, she has became knowledgeable about all aspects of the TES instrument operations and data processing to produce L1B, L2, and L3 products.

EDUCATION:

Ph.D., Environmental Engineering Science, Caltech, Pasadena, CA 1994
M.S., Environmental Engineering Science, Caltech, Pasadena, CA 1989
B.E., Chemical Engineering, Cooper Union, New York, NY, 1988

PROFESSIONAL EXPERIENCE:

2/07 – present:	**(**Deputy) Section Manger, Earth Atmospheric Science Section
5/06 – present:	**(**Deputy) PI**,** Tropospheric Emission Spectrometer Expt.
5/06 – 1/07	Group Supervisor, Tropospheric Emission Spectrometer Group
10/99–5/06:	Research Scientist, Earth Remote Sensing Science Section, JPL
1997–present:	Adjunct Assistant Prof., JIFRESSE & Dept. of Atmospheric & Oceanic Sciences, UCLA
1994-1997	Assistant Professor, University of Iowa, Civil and Environmental Engineering Dept.

SELECTED REFEREED PUBLICATIONS:

Choi, Y., J. Kim, **A. Eldering**, G. Osterman, Y.L. Yung, Y. Gu, K.N. Liou (2009) Lightning and anthropogenic NOx sources over the United States and the western North Atlantic Ocean: Impact on OLR and radiative effects, *Geophys. Res. Lett.* 36,L17806, doi:10.1029/2009GL039381

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3.2 Co-Investigators

Gregory Ben Osterman
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Education:

Ph.D. in Physics, University of Texas at Dallas, Richardson, Texas, 1994.
MS in Physics, Texas Tech University, Lubbock, Texas, 1990.
BS in Physics, Texas A&M University, College Station, Texas, 1987.

Professional Experience:

September, 2009 – Present: Scientist – Jet Propulsion Laboratory
September, 2005 – September, 2009: Senior Member Technical Staff – Jet Propulsion Laboratory
January, 2001 – September, 2005: Member Technical Staff – Jet Propulsion Laboratory
September, 1998 – January, 2001: Research Scientist – Jet Propulsion Laboratory
September, 1995 – September 1998: Postdoctoral Researcher – California Institute of Technology.
May - September, 1995: Research Scientist – University of Texas at Dallas.
January - May, 1995: Visiting Assistant Professor, East Carolina University – Greenville, NC.

Current Work Responsibilities

Currently work as a member of the JPL Tropospheric Emission Spectrometer (TES) and Orbiting Carbon Observatory-2 (OCO-2) Science Teams. Primary TES responsibilities include:

- **Air Quality Applications Lead**: Responsible for developing collaborations for using and understanding TES data with groups in the air quality modeling/forecasting community. Developed collaborations with agencies such as the Texas Commission on Environmental Quality, Environmental Protection Agency and University of Houston.
- **Validation Lead: Responsible** for coordinating the effort to validate TES Level 2 products. This required working with a variety of different groups in the atmospheric chemistry community and keeping current on different instruments and experimental campaigns that might provide validation data for TES.
- **Operational Support Product Lead:** Responsible for providing and maintaining the support data needed by the TES Level 2 operational production software. This required developing content and formatting the support files for use by the software. It also required extensive interaction with the engineering team developing the TES software.

Selected Publications and Documents:

Osterman, G.B. et al. (2008), Validation of Tropospheric Emission Spectrometer (TES) Measurements of the Total, Stratospheric and Tropospheric Column Abundance of Ozone, *J. Geophys. Res.*, 113, D15S16, doi:10.1029/2007JD008801, May 7, 2008.

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Mr Jeffery T. McQueen	**NOAA/National Center for Environmental Prediction**
Program Responsibilities: • Principal Investigator • Subject Matter Expert • Software Development and Management	Physical Scientist NOAA - NWS – National Centers for Environmental Prediction 5200 Auth Road Camp Springs, MD 20746 (301) 763-8000, Ext. 7226; fax: 763-8545

Summary: Mr. McQueen has over 25 years of related experience in meteorology, software development and management and mesoscale numerical modeling and data assimilation in support of hydrodynamics, transport and dispersion. Mr. McQueen is a principal scientist for the NOAA NCEP Air Quality Forecast System and Homeland Security Plume Dispersion Forecasting System which are widely used. He also developed and coded mesoscale modeling boundary layer capabilities which are principle forcings for atmospheric transport, dispersion and air-chemistry modeling. In addition to over 10 years of experience in air-quality related research, Mr. McQueen is widely recognized for his expertise in mesoscale numerical weather prediction and hazards prediction modeling. He also leads efforts to produce probabilistic air quality and dispersion products from the NCEP Short Range Ensemble Forecast.

Education:

M.S., 1985, Atmospheric Sciences, The Colorado State University, Fort Collins, CO
B.A., 1982, Environmental Science, University of Virginia, Charlottesville, VA
Graduate classes in Computer Science, 1986-87, Johns Hopkins University, Columbia, MD

Resume: Mr. McQueen, NOAA/NWS National Center for Environmental Prediction, Environmental Modeling Center, Air Quality and dispersion modeling program Leader. Currently, Mr. McQueen leads efforts to develop, test, implement and maintain the NCEP air quality and dispersion modeling systems and to develop, implement and maintain a) the generation of guidance products from the air quality and dispersion systems, b) their distribution to users and c) tools to monitor status and quality of the system and its products. Also, Mr. McQueen led the evaluation of model physics diversity versus initial condition breeding to improve the spread and accuracy of SREF products. In 2003, Mr. McQueen and his staff have established test capability for ozone and particulate matter by driving EPA's CMAQ model with atmospheric fields from the NCEP North American Model (NAM) l fields. Mr. McQueen has also chaired the Weather Research and Forecasting (WRF) Model Science Board and is a member of the WRF Model Atmospheric Chemistry and Ensemble Working Groups and OFCM Atmospheric Transport and Dispersion Joint Action Group.

Mr. McQueen's research interests include mesoscale modeling, air quality and atmospheric dispersion modeling, short range ensemble forecast systems, and use of physical parameterizations and coupled models (e.g., boundary layer, land-surface) to quantify atmospheric dispersion uncertainties.

Professional Experience:

Air Quality Program Leader, Environmental Modeling Center, NWS/NCEP, Camp Springs, MD, 2003-
NWP Program Leader, Office of Science and Technology, NWS, Silver Spring, MD, 2000-2003.
Meteorologist, Air Resources Laboratory, NOAA, Silver Spring, MD, 1991 to 2000.
Research Meteorologist, NASA/GSFC, Greenbelt, MD, 1985-1990.

Publications: Over 50 scientific papers including:

McQueen, J.T., P. C. Lee, M. Tsidulko, G. DiMego, T. Otte, J. Pleim, G. Pouliout, J. Young, D. Kang, P. M. Davidson, and N. Seaman, 2005: Update to and Recent Performance of the NAM-CMAQ Air Quality Forecast Model at NCEP operations. *17th Conference on Numerical Weather Prediction. Amer. Meteo. Soc.* 12A.2, Washington, D.C.,. 9 pp. http://ams.confex.com/ams/pdfpapers/94666.pdf

McQueen, J.T., R.A. Valigura, and B.J.B. Stunder, 1997: Evaluation of the Regional Atmospheric Modelling System for estimating nitric acid pollution deposition onto the Chesapeake Bay. Atmos. Environ. 31, 3803-3819.

McQueen, J.T., R.R. Draxler, and G.D. Rolph, 1995: Influence of grid size and terrain resolution on wind field predictions from an operational mesoscale model. J. Appl. Meteor., 34, 2166-2181.

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Background

- Dr. Tang has a PhD degree in and 15 years of relevant work experience in atmospheric modeling with a focus on regional air quality and mesoscale meteorological models. He is familiar with regional models including CMAQ, WRF/CHEM, WRF-NMM/ARW, MM5, RAMS, and STEM. His scientific interests were focused on gas/aerosol chemistry and physics, aerosol and cloud radiative impacts on photochemistry, Emission analysis and pollutant long-range transport while also supporting other related researches, such as mercury, CO_2, COS, data assimilation, and IPCC assessment on uncertainty of aerosol predictions.

Recent/Relevant Work Experience

Support Scientist III, NOAA/ NCEP/EMC Dec 2006 - Present

Support NOAA/NCEP's operational air quality forecast system (WRF-NMM/CMAQ system) by making pre-implementation testing, model improvement and post verification. Develop the inline regional air quality model under NOAA Environmental Modeling System framework

Assistant Research Scientist, Center for Global and Regional Environmental Research, University of Iowa Sep 2000 – Dec 2006

Research Associates of National Research Council at NOAA Oct 1999 – Sep 2000

Education

- Ph.D. Institute of Atmospheric Physics, Chinese Academy of Sciences, July 1999
- MS Department of Atmospheric Sciences, Nanjing University, China, July 1996
- BS Department of Atmospheric Sciences, Nanjing University, China, July 1993

Selected Publications:

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Tang, Y., et al., Multi-scale Simulations of Tropospheric Chemistry in the Eastern Pacific and US West Coast during Spring 2002, *Journal of Geophysical Research, 109, D23S11, doi:10.1029/2004JD004513*, 2004.

4 Current and Pending Support

4.1 Current Awards

Annmarie Eldering

Name of Principal Investigator on Award	Award/Project Title	Program Name/ Sponsoring Agency/ Point of Contact telephone and email	Period of Performance/Total Budget	Commitment (Person-Months per Year)
Annmarie Eldering	EOS Aura TES	Program Manager – Ken Jucks	9/2009 – 9/2011	6 (0.5 FTE)

Gregory Osterman

Name of Principal Investigator on Award	Award/Project Title	Program Name/ Sponsoring Agency/ Point of Contact telephone and email	Period of Performance/Total Budget	Commitment (Person-Months per Year)
Gregory Osterman	OCO-2 Validation Team at JPL	Program Manager – Ken Jucks	3/2010-9/2012	9.6 (0.8 FTE)
Gregory Osterman	Improving the Characterization of Pollution Transported into Texas	University of Houston – Xun Jiang xjiang4@mail.uh.edu	June 1, 2010 – February 1, 2011	2.4 (0.2 FTE)

4.2 Pending Awards

None

5 Budget Justification

5.1 Budget Narrative

The proposed work leverages off of expertise at JPL and NOAA. The proposal assumes that funding will begin early in calendar year of 2011. A postdoc must be hired quickly, and then the project will kick off with data collection and collaboration meetings. The postdoc and PI will travel to NOAA to gather model runs, learn some of the existing data analysis tools, and to refine details of the analysis plan. The postdoc will then work on gathering the TES data that is paired with the model runs. To achieve these objectives, the postdoc is full time on the project, the PI will focus one month a year (about three hours a week), and the JPL co-I, Greg Osterman, will focus 0.15 wy, so he has adequate time to mentor the postdoc. NOAA will also contribute a significant fraction of time (0.5 for Dr. Tang, who is a NOAA contractor), as they will have a significant amount of data preparation to perform, with the NAQFC model runs, and the comparisons to sondes and ground based data. Mr McQueen will contribute his effort in kind. The second year of proposed work builds on the first, but shifts from general CMAQ comparisons to the identification of specific episodes. The levels of efforts of all participants remain the same. The third year all of the analysis, will be finalized, we make sure that the NOAA team members have tools that they can use with remote sensing data independently of JPL, and we ensure that publications are completed. Again, the levels of effort remain constant.

5.1.1 Personnel and Work Effort

Table 5-1. Summary of Personnel and Work Efforts

Name	Organization	Role	Work Commitment		
			Year 1	Year 2	Year 3
Dr. Annmarie Eldering	JPL	Principal Investigator	.08	.08	.08
Dr. Gregory Osterman	JPL	Co-Investigator	.15	.15	.15
Dr. Jeff McQueen (in-kind $$)	NOAA	Co-Investigator	.05	.05	.05
Dr. Youhua Tang	NOAA contractor	Co-Investigator	.50	.50	.50
TBD - postdoc	Caltech/JPL	postdoc	1	1	1

5.1.2 Facilities and Equipment

5.1.2.1 Jet Propulsion Laboratory

The JPL PI and co-I are members of the TES team, and have access to the TES computing cluster, as will the postdoc. The TES cluster hosts a copy of all of the TES L2 data products, as well as licenses for IDL and standard compilers. The computer that we will purchase, with the large storage, will be integrated into the cluster, so our project can take advantage of the L2 data products and the IDL toolset.

5.1.2.2 NOAA

NOAA/NCEP has two IBM supercomputers, and each of them is equipped with 4992 IBM Power6 (p575 @ 4.7GHz) processors, 19712 GB physical memory and 320 TB disk space.

5.1.3 Rationale and Basis of Estimate

The Nighttime Tropospheric Ozone: Impacts and Relationship to Air Quality cost proposal was prepared using JPL's Pricing System and the current internally published Cost Estimation Rates and Factors, dated October 2009.

The derivation of the cost estimate is a grassroots methodology based on the expert judgment from a team of experienced individuals who have performed similar work. The team provides the necessary relevant experience to develop a credible and realistic cost estimate. The cognizant individuals identify and define the products and the schedule needed to complete the tasks for each work element. Then they generate the resource estimates for labor, procurements, travel, and other direct costs for each work element. The resource estimates are aggregated and priced using JPL's Pricing System. JPL's process ensures that lower level estimates are developed and reviewed by the performing organizations and their management who will be accountable for successfully completing the proposed work scope within their estimated cost.

JPL Cost Accumulation System

Introduction

All costs incurred at the Laboratory, including JPL applied burdens, are billed to the Government as direct charges at the rates in effect at the time the work is accomplished.

Multiple Program Support

The Multiple Program Support (MPS) rate applies costs for program management and technical infrastructure. Cost estimates and system application tools will apply the composite rate to all project direct hours charged to projects managed by JPL.

Allocated Direct Costs

Allocated Direct Cost (ADC) rates contain cost elements benefiting multiple work efforts, including Project Direct, MPS, and Support and Services activities. Rate applications for cost estimates are specific to the given category as stated below:

1) Engineering and Science (E&S)
2) Procurement: Purchase Order, Subcontract, Research Support Agreement (RSA)
3) General and Administrative (G&A): Basic, RSA
4) Specialized G&A applications: Remote Site

The accounting process fully distributes these costs to the respective project/task(s).

Employee Benefits

All costs of employee benefits are collected in a single intermediate cost pool, which is then redistributed to all cost objectives as a percentage of JPL labor costs, including both straight-time and overtime. Functions and activities covered by this rate include paid leave, vacations, and other benefits including retirement plans, group insurance plans, and tuition reimbursements.

For this proposal the estimated costs have been derived in the same manner as stated above. However, presentation of the estimated costs in the required tables has been adapted in the following ways:

1. The costs for Employee Benefits are included in the Direct Labor costs stated in this proposal.
2. Engineering and Science ADC and Procurement ADC along with MPS costs are displayed in the "Indirect" category in the Other Direct Costs section.
3. G&A is shown in the Facilities and Administrative Costs section.
4. JPL's forecasted labor rates equal an hourly laboratory-wide average for each job family and are further broken down by career level within the job family. Labor cost estimates apply the family average or family average career level rate to the estimated work hours. An actual individual's labor is considered discrete and confidential information and is only released on an exception basis and only if a statement of work identifies that specific individual as the only one able to perform a task. The use of family average or family average career level rates is consistent with the JPL CAS disclosure statement and the Cost Estimating Rates and Factors CDRL published in response to a requirement in NASA prime contract NAS7-03001 I-10 (d) (1).

The proposed budget of the NRA proposal also covers labor costs for serving on NASA peer-review panels and advisory committee at the request of NASA discipline scientists or program managers.

5.2 Budget Details – Year 1

Direct Labor – Year 1

- Dr. Annmarie Eldering is the PI and will oversee all aspects of the proposed work. Dr. Eldering will coordinate the overall activities of the team, through telecons, face-to-face meetings, and email exchanges. Time Commitment is 0.08 wy. ($10,200 requested salary with $6,100 fringe benefits)
- Dr. Gregory Osterman will serve as a Co-Investigator on this effort. Dr. Osterman will mentor the postdoc, and teach the postdoc how to use the analysis tools for TES/model comparison. Time Commitment is 0.15 wy. ($14,400 requested salary with $8,500 fringe benefits).

Other Direct Costs – Year 1

Subcontracts/Subawards

- Desktop Network Chargebacks (calculated at $5.08/hr.): All JPL computers are subject to a monthly service charge that includes hardware, software, and technical support. ($2.2K)

Consultants

- There are no consultants required for this task.

Equipment

- In the first year, a multiprocessor computer with 5 TB of storage will be purchased. This will be linked to the existing computer cluster, but the large storage will be needed because of the large data files from the model runs. The cost estimate is based on recent purchases of similar machines ($11K).

Services

- Caltech IA for Post-doctoral Fellow to be named. The postdoctoral scholar will perform a large fraction of the hands on work, identifying the remote sensing data that can be compared to the model data, and performing the analysis. Time Commitment is 1.0 wy ($95K)

Supplies and Publications

- There are no supplies and publications in the first year.

Travel

- The PI and postdoc will travel together early in the first year to meet with the collaborators on the East Coast ($6K).
- The postdoc, and possibly the JPL co-I, will attend one of the key air quality conferences (either Conference on Air Quality or EPA Air Quality Conference ($2.5K).

Other

- Multiple Program Support (MPS) $5.8.

Facilities and Administrative (F&A) Costs – Year 1

- Allocated Direct Costs (ADC) $15.8K.
- Applied General ADC $18.5K.

Other Applicable Costs – Year 1

- Government Co-I, NOAA, Mr. Jeff McQueen (in-kind) and Dr. Youhua Tang – 0.5 wy ($65K).

Total Estimated Costs for Year 1: $261,000

5.3 Budget Details – Year 2

Direct Labor – Year 2

- Dr. Annmarie Eldering is the PI and will oversee all aspects of the proposed work. Dr. Eldering will coordinate the overall activities of the team, through telecons, face-to-face meetings, and email exchanges. Time Commitment is 0.08 wy. ($10,700 requested salary with $6,400 fringe benefits)
- Dr. Gregory Osterman will serve as a Co-Investigator on this effort. Dr. Osterman will mentor the postdoc, and teach the postdoc how to use the analysis tools for TES/model comparison. Time Commitment is 0.15 wy. ($15,100 requested salary with $9,000 fringe benefits).

Other Direct Costs – Year 2

Subcontracts/Subawards

- Desktop Network Chargebacks (calculated at $5.08/hr.): All JPL computers are subject to a monthly service charge that includes hardware, software, and technical support. ($2.2K)

Consultants

- There are no consultants required for this task.

Equipment

- There are no major equipment purchases necessary in the second year.

Services

- Caltech IA for Post-doctoral Fellow to be named. The postdoctoral scholar will perform a large fraction of the hands on work, identifying the remote sensing data that can be compared to the model data, and performing the analysis. Time Commitment is 1.0 wy ($96.5K)

Supplies and Publications

- Publication and Documentation: Miscellaneous publication and documentation charges ($2K).

Travel

- The postdoc will travel to meet with the collaborators on the East Coast ($3K).
- The postdoc, and possibly the JPL co-I, will attend one of the key air quality conferences (either Conference on Air Quality or EPA Air Quality Conference ($2.5K).

Other

- Multiple Program Support (MPS) $5.8K.

Facilities and Administrative (F&A) Costs – Year 2

- Allocated Direct Costs (ADC) $15.5K.
- Applied General ADC $17.8K.

Other Applicable Costs – Year 2

- Government Co-I, NOAA, Mr. Jeff McQueen (in-kind) and Dr. Youhua Tang – 0.5 wy between the two collaborators ($65K).

Total Estimated Costs for Year 2: $251,500

5.4 Budget Details – Year 3

Direct Labor – Year 3

- Dr. Annmarie Eldering is the PI and will oversee all aspects of the proposed work. Dr. Eldering will coordinate the overall activities of the team, through telecons, face-to-face meetings, and email exchanges. Time Commitment is 0.08 wy. ($10,800 requested salary with $6,400 fringe benefits)
- Dr. Gregory Osterman will serve as a Co-Investigator on this effort. Dr. Osterman will mentor the postdoc, and teach the postdoc how to use the analysis tools for TES/model comparison. Time Commitment is 0.15 wy. ($15,300 requested salary with $9,100 fringe benefits).

Other Direct Costs – Year 3

Subcontracts/Subawards

- Desktop Network Chargebacks (calculated at $5.08/hr.): All JPL computers are subject to a monthly service charge that includes hardware, software, and technical support. ($2.2K)

Consultants

- There are no consultants required for this task.

Equipment

- There are no major equipment purchases necessary in the third year.

Services

- Caltech IA for Post-doctoral Fellow to be named. The postdoctoral scholar will perform a large fraction of the hands on work, identifying the remote sensing data that can be compared to the model data, and performing the analysis. Time Commitment is 1.0 wy ($98K)

Supplies and Publications

- Publication and Documentation: Miscellaneous publication and documentation charges ($2K).

Travel

- The postdoc will meet with the collaborators on the East Coast ($3K).
- The postdoc, and possibly the JPL co-I, will attend one of the key air quality conferences (either Conference on Air Quality or EPA Air Quality Conference ($2.5K).

Other

- Multiple Program Support (MPS) $5.8K.
- .

Facilities and Administrative (F&A) Costs – Year 3

- Allocated Direct Costs (ADC) $15.4K.
- Applied General ADC $17.7K.

Other Applicable Costs – Year 3

- Government Co-I, NOAA, Mr. Jeff McQueen (in-kind) and Dr. Youhua Tang – 0.5 wy ($65K).

Total Estimated Costs for Year 3: $253,200

National Oceanographic and Atmospheric Administration (NOAA)
National Weather Service/National Center for Environmental Predictions (NCEP)
W/NP2 WWBG, Rm 201
5200 Auth Road
Camp Springs, MD 20746

" ***Night time Trophospheric Ozone Impacts and Relationahip to Air Quality*** "

Budget submitted to

NAS/JPL

July 28, 2010

Starting Date:	October 1, 2011
Amount Requested:	Year 1: $65,000
Duration:	12 months

Submitted by: ______________________________
Jeffery T. McQueen, Principal Scientist

Approved by: ______________________________
Stephen J. Lord, Director,
NCEP/Environmental Modeling Center

Technical Contact: J.T. McQueen, Principal Scientist, 301-763-8000, Ext. 7226;
FAX:(301)763-8545; email: Jeff.Mcqueen@noaa.gov
Business Contact: Steven J. Lord, 301-763-8000, Ext. 7200,
FAX:(301)763-8545; email: Stephen.Lord@noaa.gov

2. Budget

National Oceanographic and Atmospheric Administration (NOAA)
National Weather Service/National Center for Environmental Predictions (NCEP)
To
NASA/JPL

Project Dates: 10/1/2010—9/30/2011

DIRECT COSTS		10/1/2010 9/30/2011
Salaries (Category I)		
Admin Support/contract management (T.Braun, J. Etter)		$2,400
Web Support Technician (R. Firestone)		$750
Total Salary and Wages		
Domestic and Foreign Travel		$1,000
Publication Costs		
Fringe Benefits (refer to Budget Notes)		
Subcontract		$60,850
Direct Labor Hours		
	Youhua Tang (data/model analysis)	624 hrs
	Perry Shafran (Data ingest support)	83 hrs
	TOTAL Labor Hours:	707
TOTAL PROJECT COSTS		$65,000

NCEP Budget Notes

Note: NCEP fringe benefits and indirect costs are included in Category I salaries.
Full costs are to be recovered by the NWS. Billing/payment method should be the Treasury's on-line payment and Collection system (IAC System). Overhead rate 24.19%.

Personnel		
	% time	**Charges/total hours**
Y. Tang	30%	624 h
P. Shafran*	10%	83 h
Jeff McQueen	10%	Gratis
Total	50%	707 h $60,815.

* Detailed budget with overhead breakout available from Julie Etter, NCEP/EMC.

National Weather Service
National Centers for Environmental Prediction
Environmental Modeling Center

Dr. Annmarie Eldering
NASA/Jet Propulsion
4800 Oak Grove Dr
MS 183-601
Pasadena, CA 91109-8001

Dr. Stephen Lord
Director
NOAA/NWS/NCEP/EMC
5200 Auth Road
Camp Springs, MD20746

Phone 301-763-8000
Fax 301-763-8545

REGARDING: NASA ROSES-2010 AURA Science Team Solicitation

Dear Dr. Eldering:

Thank you for your invitation to participate in your project: *"Nighttime Trop Ozone Impacts and Relationship to Air Quality"* that you are developing in response to the NASA ROSES-2010 Aura Science Team solicitation. I accept your offer and commit my staff to participate in this project.

I am director of the NOAA/NWS/NCEP Environmental Modeling Center. We request funding of $65,000 per year for three years to support ~~two~~ one contractor~~s~~ for supporting the tasks outlined in the proposal.

Sincerely,

Stephen Lord
NOAA/NWS/NCEP/EMC Director

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, California 91109

Detailed Budget (Basis of Estimate)

11 NRA/ROSES 5YR Ver 15.3

PROPOSAL TITLE: Proposal Title

PROGRAM: Program Name

		CY 2011	CY 2012	CY 2013	CY 2014	CY 2015		CY 2011	CY 2012	CY 2013	CY 2014	CY 2015
A. DIRECT COMPENSATION	JPL LABOR CLASS.	2,080	2,080	2,080	2,120	2,080		$k	$k	$k	$k	$k
	Y Eldering	0.08	0.08	0.08	-	-						
	Y Osterman	0.15	0.15	0.15	-	-						
	Y Name (Co-I 2)	-	-	-	-	-						
	Y Name (Co-I 3)	-	-	-	-	-						
	Y Name (Co-I 4)	-	-	-	-	-						
	Y Name (Co-I 5)	-	-	-	-	-						
	N -	-	-	-	-	-						
	N -	-	-	-	-	-						
	N -	-	-	-	-	-						
	SUBCONTRACTOR WORKHOURS	-	-	-	-	-						
	Estimated Group Sup/Secr'y Hours ==>	0.01	0.01	0.01	-	-						
	TOTAL WORKYEARS, A1	0.24	0.24	0.24	-	-						
	LABOR COST SUBTOTAL						A2	26.2	27.5	27.8	-	-
	APPLIED FRINGES COSTS						A3	13.0	13.6	13.8	-	-
	JPL DIRECT COMPENSATION						TOTAL A	39.2	41.1	41.6	-	-
	Y Jeff McQueen	65.0	65.0	65.0	-	-						
	Y Name (Gov't Co-I 2)	-	-	-	-	-						
B. TRAVEL	DESTINATION	Cost/Trip										
	1 collaboration meeting (postdoc and staff)							6.0	3.0	3.0	-	-
	2 AO conference							2.5	2.5	2.5	-	-
							TOTAL TRAVEL B	8.5	5.5	5.5	-	-
C. SERVICE	(LIST BY TYPE)											
	1 0							-	-	-	-	-
	2 0							-	-	-	-	-
	3 0							-	-	-	-	-
	4 Name (Caltech IA Co-I)							-	-	-	-	-
							TOTAL SERVICES C	-	-	-	-	-
D. PROCUREMENTS	(LIST BY TYPE, e.g. CONTRACT LABOR, CONSULTANTS, MATERIALS & SUPPLIES, EQUIP., etc.)											
D1 CONTRACTS/	1 0							-	-	-	-	-
	2 postdoc							95.0	96.5	98.0	-	-
	3 Name (University Co-I 1)							-	-	-	-	-
	4 Name (University Co-I 2)							-	-	-	-	-
CHARGEBACKS	5 *Chargebacks calculated at $5.08/Hour (FY10 dollars) - Autocalc*							2.2	2.2	2.2	-	-
							TOTAL CONTRACTS D1	97.2	98.7	100.2	-	-
D2 CONSULTANTS	4 0							-	-	-	-	-
	5 0							-	-	-	-	-
							TOTAL CONSULTANTS D2	-	-	-	-	-
							TOTAL CONTRACTS AND CONSULTANTS D1+D2	97.2	98.7	100.2	-	-
D3. PO's EQUIP.	1 computer with storage (Over $5k)							11.0	-	-	-	-
	2 0 (Over $5k)							-	-	-	-	-
	2 0 (Over $5k)							-	-	-	-	-
	3 Misc. (Remainder)							-	-	-	-	-
							TOTAL PO - EQUIPMENT D3	11.0	-	-	-	-
D4 SUPPLIES	4 0							-	-	-	-	-
	5 0							-	-	-	-	-
	6 Publication Costs							-	2.0	2.0	-	-
							TOTAL PO - SUPPLIES D4	-	2.0	2.0	-	-
							TOTAL PO D3+D4	11.0	2.0	2.0	-	-
							TOTAL PROCUREMENTS - D	108.2	100.7	102.2	-	-
E. FACILITIES	(LIST AS EITHER NEW CONSTRUCTION OR MODIFICATION - IF C OF F FUNDED, DO NOT INCLUDE)											
	1 0							-	-	-	-	-
	2 0							-	-	-	-	-
							TOTAL FACILITIES E	-	-	-	-	-
F. MULTIPLE PROGRAM SUPPORT (MPS)							F	5.8	5.8	5.8	-	-
G. TOTAL DIRECT COST							(SUM A THROUGH F) G	161.7	153.2	155.1	-	-
H. ALLOCATED DIRECT COSTS (ADC)												
	H1. APPLIED ENG & SCI (Labor) ADC						H1	11.4	11.6	11.6	-	-
	H2. APPLIED CONTRACTS ADC						H2	3.4	3.8	3.6	-	-
	H3. APPLIED PURCHASE ORDERS (PO) ADC						H3	1.0	0.2	0.2	-	-
I. COSTS SUBTOTAL							(SUM A THROUGH H) I	177.5	168.7	170.5	-	-
	I1. APPLIED GENERAL ADC						I1	18.5	17.8	17.7	-	-
J. TOTAL COSTS (with Gov't Co-I)							(I + I1) J	261.1	251.5	253.2	-	-