Cover Page for Proposal Submitted to the National Aeronautics and Space Administration	NASA Proposal Number
	10-AURA10-0015

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
George Mount	**gmount@wsu.edu**	**509-335-3790**

Street Address (1)	Street Address (2)
Code 2910 - Spokane Street	

City	State / Province	Postal Code	Country Code
Pullman	**WA**	**99164-2910**	**US**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

Proposed Start Date	Proposed End Date	Total Budget	Year 1 Budget	Year 2 Budget	Year 3 Budget
01 / 01 / 2011	**12 / 31 / 2013**	**569,418.00**	**199,783.00**	**183,863.00**	**185,772.00**

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**		

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
041485301	**0REY0**	**916001108**	**2A**

Organization Name (Standard/Legal Name)	Company Division
Washington State University, Pullman	

Organization DBA Name	Division Number

Street Address (1)	Street Address (2)
240 FRENCH ADMINISTRATION BLDG	

City	State / Province	Postal Code	Country Code
PULLMAN	**WA**	**99164-0001**	**USA**

SECTION IV - Proposal Point of Contact Information

Name	Email Address	Phone Number
George Mount	**gmount@wsu.edu**	**509-335-3790**

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
Dan Nordquist	**ogrd@wsu.edu**	**509-335-9661**

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

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION VI - Team Members

Team Member Role	Team Member Name	Contact Phone	E-mail Address
PI	**George Mount**	**509-335-3790**	**gmount@wsu.edu**
Organization/Business Relationship		Cage Code	DUNS#
Washington State University, Pullman		**0REY0**	**041485301**
International Participation	U.S. Government Agency		Total Funds Requested
No			**0.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I	**Brian Lamb**	**509-335-5702**	**blamb@wsu.edu**
Organization/Business Relationship		Cage Code	DUNS#
Washington State University, Pullman		**0REY0**	**041485301**
International Participation	U.S. Government Agency		Total Funds Requested
No			**0.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I	**Joseph Vaughan**	**509-335-2832**	**jvaughan@wsu.edu**
Organization/Business Relationship		Cage Code	DUNS#
Washington State University, Pullman		**0REY0**	**041485301**
International Participation	U.S. Government Agency		Total Funds Requested
No			**0.00**
Team Member Role	Team Member Name	Contact Phone	E-mail Address
Co-I/Institutional PI	**Louisa Emmons**	**303-497-1491**	**emmons@ucar.edu**
Organization/Business Relationship		Cage Code	DUNS#
University Corporation For Atmospheric Research (UCAR)		**0SEF6**	**078339587**
International Participation	U.S. Government Agency		Total Funds Requested
No			**0.00**

PI Name : **George Mount**

Organization Name : **Washington State University, Pullman**

NASA Proposal Number

10-AURA10-0015

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION VII - Project Summary

The research described in this proposal focuses on the use of Aura and other satellite data products to further our understanding of regional air quality including the accuracy of emission inventories and the effects of long-range transport of air pollutants on air quality, particularly in the U.S. Pacific Northwest. This work will be performed collaboratively by Washington State University (WSU) and the National Center for Atmospheric Research (NCAR). Work will concentrate on using Aura data along with other satellite trace gas data sets to quantify and map emissions and quantify the impact of long-range transport and export of trace gases important to air quality. The research will emphasize the integration of satellite data with the AIRPACT-3 regional air quality forecast system which operates on a daily basis for the Pacific Northwest. The AIRPACT system is supported by the NW-AIRQUEST consortium which includes a broad range of clean air agencies, federal land managers, and research institutions with the mission to use sound science to support regional air quality management. The AIRPACT system employs meteorological forecasts from the WRF weather model and chemical transport modeling using the CMAQ photochemical grid model. Daily forecasts from the NCAR MOZART global chemical model, including assimilation of MOPITT CO retrievals, are used to set chemical boundary conditions for AIRPACT.

Primary project goals will be to (1) quantify the significance of long range transport of atmospheric trace gases and aerosols on AIRPACT performance and develop methods to integrate a suite of satellite products and global modeling to prescribe chemical boundary conditions for the region (2) apply satellite data products using a combination of inverse modeling methods and the AIRPACT framework to improve quantification of pollution emissions to better characterize air quality, and (3) continue our active participation as a member of the Aura science team. This research builds upon current work supported by NASA to enhance the AIRPACT decision support system using OMI and other satellite data products. The end products will be a better understanding of how long range transport affects regional air quality, new methods for integration of satellite products with global models to prescribe chemical boundary conditions for regional modeling, and improved emission inventories for anthropogenic, biogenic and wildfire emissions.

PI Name : **George Mount**	**NASA Proposal Number**
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

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 : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

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 : **George Mount**	**NASA Proposal Number**
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

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 : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION IX - Program Specific Data

Question 1 : Short Title:

Answer: Using Aura and a regional air quality model to improve emissions and investigate the impact of long range transport on air quality

Question 2 : Type of institution:

Answer: Educational Organization

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: Yes

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

Answer: No

Question 6 : Research Category:

Answer: 2) Data analysis/data restoration/data assimilation/Earth System modeling (including Guest Observer Activities)

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 : **George Mount**	**NASA Proposal Number**
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Cumulative Budget

Budget Cost Category	Funds Requested ($)			
	Year 1 ($)	Year 2 ($)	Year 3 ($)	Total Project ($)
A. Direct Labor - Key Personnel	52,065.00	54,148.00	56,313.00	162,526.00
B. Direct Labor - Other Personnel	46,119.00	48,056.00	50,074.00	144,249.00
Total Number Other Personnel	3	3	3	9
Total Direct Labor Costs (A+B)	98,184.00	102,204.00	106,387.00	306,775.00
C. Direct Costs - Equipment	15,000.00	0.00	0.00	15,000.00
D. Direct Costs - Travel	5,000.00	5,000.00	5,000.00	15,000.00
Domestic Travel	5,000.00	5,000.00	5,000.00	15,000.00
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	23,453.00	24,129.00	22,521.00	70,103.00
Materials and Supplies	3,500.00	3,500.00	3,500.00	10,500.00
Publication Costs	0.00	0.00	0.00	0.00
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	19,953.00	20,629.00	19,021.00	59,603.00
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	0.00	0.00	0.00	0.00
G. Total Direct Costs (A+B+C+D+E+F)	141,637.00	131,333.00	133,908.00	406,878.00
H. Indirect Costs	58,146.00	52,530.00	51,864.00	162,540.00
I. Total Direct and Indirect Costs (G+H)	199,783.00	183,863.00	185,772.00	569,418.00
J. Fee	0.00	0.00	0.00	0.00
K. Total Cost (I+J)	199,783.00	183,863.00	185,772.00	569,418.00
Total Cumulative Budget				569,418.00

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Mount，George	PI_TYPE	11,536.00	2	0	0	11,536.00	3,530.00	15,066.00
Lamb，Brian	CO-I	14,778.00	1			14,778.00	4,522.00	19,300.00
Vaughan，Joseph	CO-I	4,517.00	3			13,552.00	4,147.00	17,699.00
							Total Key Personnel Costs	52,065.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	Graduate Students	12			22,430.00	11,090.00	33,520.00
1	Undergraduate Students	5.75			5,520.00	110.00	5,630.00
1	Classified Staff - Cluster Support	4			5,336.00	1,633.00	6,969.00
3	Total Number Other Personnel					Total Other Personnel Costs	46,119.00

Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	98,184.00

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

C. Direct Costs - Equipment

Item No.	Equipment Item Description	Funds Requested ($)
1	Cluster upgrades, nodes and storage	15,000.00
	Total Equipment Costs	**15,000.00**

D. Direct Costs - Travel

	Funds Requested ($)
1. Domestic Travel (Including Canada, Mexico, and U.S. Possessions)	5,000.00
2. Foreign Travel	0.00
Total Travel Costs	**5,000.00**

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 : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2011	**12 / 31 / 2011**	**Project**	**1**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	3,500.00
2. Publication Costs	0.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	19,953.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
Total Other Direct Costs	23,453.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	141,637.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
Facilities and Administrative Costs	49.50	117,466.00	58,146.00
Cognizant Federal Agency: **U.S. Dept. of Health & Human Services, Wallace Chan, Director 415-437-7820**	**Total Indirect Costs**		58,146.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	199,783.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	199,783.00

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**Project**	**2**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Vaughan, Joseph	CO-I	4,517.00	3			14,094.00	4,313.00	18,407.00
Mount, George	PI_TYPE	11,536.00	2	0	0	11,998.00	3,671.00	15,669.00
Lamb, Brian	CO-I	14,778.00	1			15,369.00	4,703.00	20,072.00
							Total Key Personnel Costs	54,148.00

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	Graduate Students	12			23,327.00	11,625.00	34,952.00
1	Undergraduate Students	5.75			5,741.00	115.00	5,856.00
1	Classified Staff - Cluster Support	4			5,550.00	1,698.00	7,248.00
3	Total Number Other Personnel					Total Other Personnel Costs	48,056.00
						Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	102,204.00

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**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)	**5,000.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**5,000.00**

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 : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2012	**12 / 31 / 2012**	**Project**	**2**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	**3,500.00**
2. Publication Costs	**0.00**
3. Consultant Services	**0.00**
4. ADP/Computer Services	**0.00**
5. Subawards/Consortium/Contractual Costs	**20,629.00**
6. Equipment or Facility Rental/User Fees	**0.00**
7. Alterations and Renovations	**0.00**
Total Other Direct Costs	**24,129.00**

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	**131,333.00**

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
Facilities and Administrative Costs	**49.50**	**106,121.00**	**52,530.00**
Cognizant Federal Agency: **U.S. Dept. of Health & Human Services, Wallace Chan, Director 415-437-7820**	**Total Indirect Costs**		**52,530.00**

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	**183,863.00**

J. Fee

	Funds Requested ($)
Fee	**0.00**

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	**183,863.00**

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**Project**	**3**

A. Direct Labor - Key Personnel

Name	Project Role	Base Salary ($)	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
Mount, George	**PI_TYPE**	**11,536.00**	**2**	**0**	**0**	**12,478.00**	**3,818.00**	**16,296.00**
Vaughan, Joseph	**CO-I**	**4,517.00**	**3**			**14,658.00**	**4,485.00**	**19,143.00**
Lamb, Brian	**CO-I**	**14,778.00**	**1**			**15,983.00**	**4,891.00**	**20,874.00**
							Total Key Personnel Costs	**56,313.00**

B. Direct Labor - Other Personnel

Number of Personnel	Project Role	Cal. Months	Acad. Months	Summ. Months	Requested Salary ($)	Fringe Benefits ($)	Funds Requested ($)
1	**Graduate Students**	**12**			**24,260.00**	**12,187.00**	**36,447.00**
1	**Undergraduate Students**	**5.75**			**5,970.00**	**119.00**	**6,089.00**
1	**Classified Staff - Cluster Support**	**4**			**5,772.00**	**1,766.00**	**7,538.00**
3	**Total Number Other Personnel**					**Total Other Personnel Costs**	**50,074.00**
						Total Direct Labor Costs (Salary, Wages, Fringe Benefits) (A+B)	**106,387.00**

PI Name : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**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)	**5,000.00**
2. Foreign Travel	**0.00**
Total Travel Costs	**5,000.00**

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 : **George Mount**	NASA Proposal Number
Organization Name : **Washington State University, Pullman**	**10-AURA10-0015**

Proposal Title : **Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest.**

SECTION X - Budget

Start Date :	End Date :	Budget Type :	Budget Period :
01 / 01 / 2013	**12 / 31 / 2013**	**Project**	**3**

F. Other Direct Costs

	Funds Requested ($)
1. Materials and Supplies	3,500.00
2. Publication Costs	0.00
3. Consultant Services	0.00
4. ADP/Computer Services	0.00
5. Subawards/Consortium/Contractual Costs	19,021.00
6. Equipment or Facility Rental/User Fees	0.00
7. Alterations and Renovations	0.00
Total Other Direct Costs	22,521.00

G. Total Direct Costs

	Funds Requested ($)
Total Direct Costs (A+B+C+D+E+F)	133,908.00

H. Indirect Costs

	Indirect Cost Rate (%)	Indirect Cost Base ($)	Funds Requested ($)
Facilities and Administrative Costs	49.50	104,777.00	51,864.00
Cognizant Federal Agency: **U.S. Dept. of Health & Human Services, Wallace Chan, Director 415-437-7820**	Total Indirect Costs		51,864.00

I. Direct and Indirect Costs

	Funds Requested ($)
Total Direct and Indirect Costs (G+H)	185,772.00

J. Fee

	Funds Requested ($)
Fee	0.00

K. Total Cost

	Funds Requested ($)
Total Cost with Fee (I+J)	185,772.00

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References

Biographical Sketches
- George Mount
- Brian Lamb
- Joseph Vaughan
- Louisa Emmons

Current and Pending Support
- George Mount
- Brian Lamb
- Joseph Vaughan
- Louisa Emmons

Letters of Collaboration

Budget and Justification

Project Description

1.0 Introduction and Objectives

The research described in this proposal focuses on the use of Aura and related satellite data products to further the understanding of regional air quality and the effects of long-range transport of air pollutants on air quality, particularly in the US Pacific Northwest. This work will be performed collaboratively by Washington State University (WSU) and the National Center for Atmospheric Research (NCAR). The project will address both *research and analysis* and *applied sciences* in the Earth Sciences Research Program in the science focus area of *atmospheric composition*. We will contribute knowledge addressing the Earth Sciences Research question:

- *What are the effects of global atmospheric composition and climate changes on regional air quality?*

For Aura Science Team Activities (ROSES A15), this proposal responds to the solicitation goal:

- *using Aura data along with other satellite trace gas data sets to quantify and map emissions and quantify the impact of long-range transport and export of trace gases important to air quality.*

Satellite data will be used to improve emissions estimates in the AIRPACT-3 (Air Indicator Report for Public Access and Community Tracking, version 3) air quality forecast system and to estimate the effects of long-range transport (mainly from Asia) on the model output in the Pacific Northwest spatial domain. Primary project objectives will be to:

- quantify the significance of long range transport of atmospheric trace gases and aerosols on AIRPACT performance and develop methods to integrate a suite of satellite products and global modeling to prescribe chemical boundary conditions for the region,
- apply satellite data products using a combination of inverse modeling methods and the AIRPACT framework: (1) to improve quantification of pollution emissions to better characterize air quality, and (2) to quantify the significance of long range transport of atmospheric trace gases and aerosols on results from the AIRPACT air quality forecasting system, and for the Pacific Northwest, especially as regards boundary conditions, and
- continue our active participation (membership) in the Aura science team providing scientific input to the various trace gas analysis groups.

We plan to concentrate on the time period of 2007-2009 with particular focus on 2009. Choice of this period reflects: (1) modifications to the Aura/OMI standard product NO_2 algorithm which began in February 2009, (2) significant changes to the AIRPACT system in 2006, and (3) recognition that some satellite products have degraded during their orbital service. Results from retrospective analyses for this period will be used to develop new methods for incorporation into ongoing AIRPACT operations and to improve our understanding of regional air quality and atmospheric chemistry.

2.0 The AIRPACT Air Quality Forecast System

AIRPACT is an air quality forecast system operated daily by WSU for the Pacific Northwest and reporting to the public daily via the web (http://www.lar.wsu.edu/airpact-3). The AIRPACT system combines meteorology, emissions, and atmospheric chemistry using community modeling software including the Weather Research Forecast (WRF) meteorological model, the Sparse Matrix Operator Kernel Emissions (SMOKE) processing system, and the Community Multi-Scale Air Quality Model (CMAQ). WRF output fields are obtained from the University of Washington mesoscale meteorological forecast operations on a daily basis (http://www.atmos.washington.edu/mm5rt/, Mass et al., 2003). The WRF meteorological fields are processed using the MCIP program prior to use in CMAQ. CMAQ is a state-of-science 3-d chemical transport model which treats detailed gas phase photochemistry in AIRPACT using the SAPRC-99 chemical mechanism, a modal approach for particle dynamics, inorganic particle chemistry using ISOROPIA, secondary organic aerosol formation using SORGAM (Secondary Organic Aerosol Model; Schell et al., 2001), and cloud processing and aqueous chemistry of gas and aerosol pollutants (Byun and Schere, 2006). Wet and dry deposition of gases and aerosols are treated explicitly.

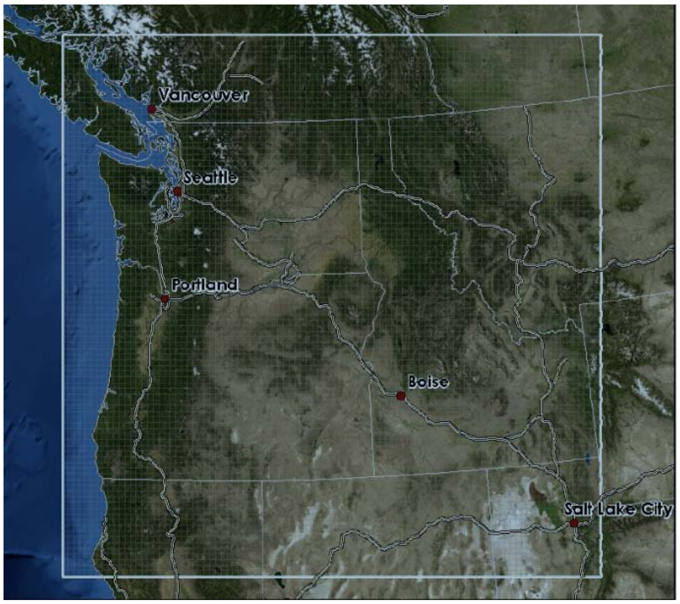

Figure 1. The AIRPACT-3 domain.

The AIRPACT-3 domain is shown in Figure 1 and uses 95 x 95 12 km x 12 km grid cells with 21 vertical layers from the surface to the tropopause. Five large urban areas are included in the domain: Seattle, Portland, Vancouver (BC, Canada), Boise, and Salt Lake City. Work is in progress to convert this domain to a higher resolution with 4 km x 4 km grid cells. Hourly, gridded emissions are simulated dynamically for each forecast using the SMOKE tool to process anthropogenic and biogenic emission categories (including the effects of temperature and solar radiation where appropriate). Area and non-road emissions are based on the 2002 EPA NEI with projections to 2005 using the EPA's Economic Growth Analysis System software. Updating of the emission inventory to 2010 is currently in progress. On-road emissions are generated using emission factors from the EPA MOBILE v6.2 model and state specific activity data and are adjusted for WRF-forecast temperature. Anthropogenic emissions over the provinces of British Columbia and Alberta, Canada are included from the 2000 Greater Vancouver Regional District inventory. Wildfire emissions have previously been obtained automatically from the US Forest Service BlueSky smoke dispersion forecast system (http://www.airfire.org/bluesky) utilizing ICS-209 reports to provide necessary inputs to SMOKE. However, this data stream is no longer available, and we are now implementing the new BlueSky Framework for accessing SMARTFIRE wildfires and emissions which are based upon a combination of ICS-209 reports and satellite fire detection products. Further details describing AIRPACT-3 and evaluation results are given in Chen et al. (2008).

The transport of air pollution into the domain of AIRPACT is of significant concern since the Pacific Northwest is a key receptor for long range transport of pollutants from Asia (Cooper et al., 2010; Reidmiller et al., 2009; Jaffe et al., 2004). Chemical boundary conditions (BC) have previously been set using monthly averaged diurnal patterns for each boundary grid cell based upon a decade of MOZART global chemical model results that were generated as part of a WSU/NCAR climate change/air quality research project supported through the EPA STAR grant program (Chen et al., 2009; Avise et al., 2009). Currently, we are implementing a new dynamic forecast where the global chemical transport model MOZART-4 (Model for Ozone and Related chemical Tracers, version 4) is being run in real-time to produce global chemical forecasts of the atmospheric composition of the troposphere (http://www.acd.ucar.edu/acresp/forecast/). These forecasts include the assimilation of near-real-time carbon monoxide (CO) retrievals from the MOPITT satellite instrument. Dr. Emmons is working with us to produce these forecasts, and to provide real-time boundary conditions to the regional AIRPACT-3 air quality forecast system for the Pacific Northwest. This work is supported through our current NASA project to enhance AIRPACT as a decision support system for our partners in the Northwest International Air Quality & Environmental Technology consortium (NW-AIRQUEST). The mission of the NW-AIRQUEST is to support effective air quality management using sound science and to foster collaboration among all of the partners to make effective use of measurement and modeling expertise and resources. WSU plays a lead technical role in NW-AIRQUEST. Membership in NW-AIRQUEST is international and includes: BC, Canada Ministry of Water, Lands and Air Protection Environment; Canada Greater Vancouver Regional District; Idaho Department of Environmental Quality; Lane Regional Air Pollution Authority; National Park Service, Pacific West Region; Oregon Department of Environmental Quality; Oregon Department of Forestry; Olympic Region Clean Air Agency; Puget Sound Clean Air Agency; Southwest Clean Air Agency; University of British Columbia; University of Washington; U.S. EPA Region 10; USDA Forest Service, Pacific Northwest Research Station; Washington Department of Ecology; and Washington State University.

2.1 Current Use of NASA Satellite Data Products with AIRPACT

NO_2

Substantial effort has been devoted by our group (with NASA support) to exploring the use of Aura/OMI NO_2 measurements for evaluation of the AIRPACT model. Those efforts have recently been submitted for publication (Herron-Thorpe et al., 2010) and are summarized below. [*Note: a large part of that work concentrated on comparison and analysis of the NASA and Royal Netherlands Meteorological Institute (KNMI) NO_2 data products derived from the basic OMI radiance measurements. That work will not be discussed here in any detail.*] Our goals in use of the OMI data were (1) to establish a record of OMI retrievals of tropospheric nitrogen dioxide over the Pacific NW for the AIRPACT-3 domain, (2) to evaluate the AIRPACT-3 results by comparison to OMI data, (3) to improve our understanding of emissions and atmospheric chemistry in the Pacific NW by understanding the differences between the OMI data and the AIRPACT-3 model data (interpreted with applicable OMI averaging kernels) to achieve a rigorous tropospheric column comparison, and (4) to share information about the OMI tropospheric nitrogen dioxide products that may be of use to other air quality scientists. Thus, the main thrust of our work has been to examine the spatial and temporal distribution of NO_2 over the model domain by comparing OMI retrieval results to the AIRPACT-3 model results.

We have found the OMI air quality data products to be very useful for identifying large biases in AIRPACT-3 modeled data.

We have concentrated on an 18-month time series of OMI and AIRPACT tropospheric NO_2 data. Overall, AIRPACT column densities were well correlated with cloud-free OMI retrievals for monthly averages without wildfires (r=0.75), but for months with wildfires, the correlation is quite poor ($r < 0.2$) with significant model over-prediction. Figure 2 shows results for January 2008 for (a) OMI NO_2, (b) AIRPACT NO_2 with appropriate KNMI averaging kernel applied, and (c) the difference between AIRPACT and OMI results. For this winter month there are clear differences in urban areas with AIRPACT overestimation of emissions and underestimation of mobile NO_2, e.g., along Interstate 84 in Idaho. Figure 3 shows the same types of results as in Figure 3, but for July 2007. The presence of wildfires is clear in the Figure 4 (b) AIRPACT summer results, but the fires are not visible in the Figure 3 (a) KNMI OMI plot of a monthly average results. Based upon these analyses, the conclusion is that the AIRPACT fire emissions inventory needs downward adjustment. Analysis of daily tropospheric NO_2 from OMI showed that AIRPACT can both over and under-predict fire emissions. However, fire emissions were consistently propagated in AIRPACT with infrequently updated burn area estimates for the entire fire season. This is inconsistent with actual variation in daily burned areas, where a fire will consume fuels and will only be smoldering in previous burn areas.

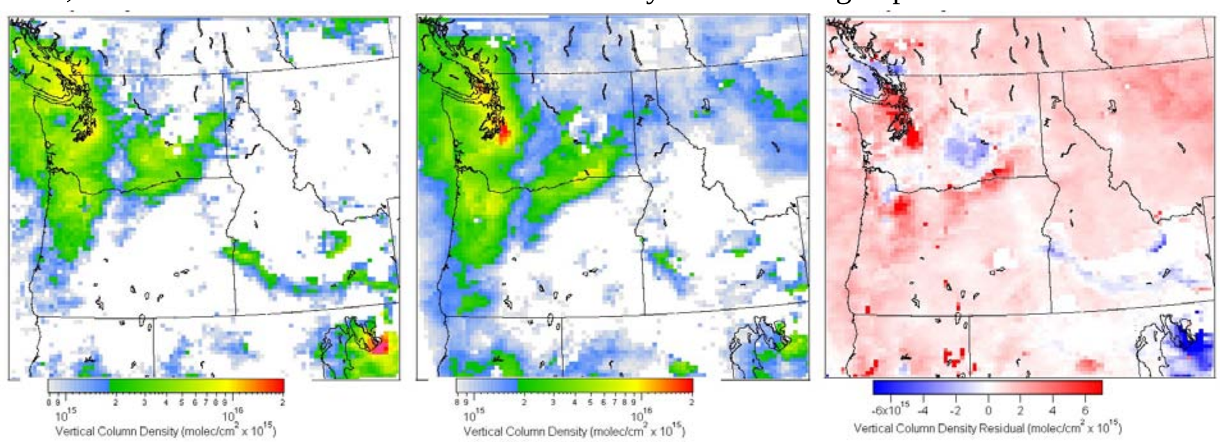

Figure 2. January 2008 results for tropospheric column NO_2 from: (a) OMI , (b) AIRPACT with appropriate KNMI averaging kernel applied, and (c) the difference between AIRPACT and OMI columns.

Generally, AIRPACT under-predicts mobile NO_2 sources and over-predicts rural NO_2. In the Vancouver, BC area, AIRPACT is generally lower than the OMI data product. Generally, we find AIRPACT over-predicts urban NO_2 in winter and is in reasonable agreement in the summer. An example for Portland, OR is shown in Figure 4. Figure 5 shows a 12-month average of the ratio of OMI (KNMI) tropospheric NO_2 to AIRPACT tropospheric vertical column NO_2 (with averaging kernel applied). Clear differences are apparent in the Puget Sound, Columbia Basin, Vancouver, and Salt Lake City regions. These differences are discussed in detailed in Thorpe et al. (2010).

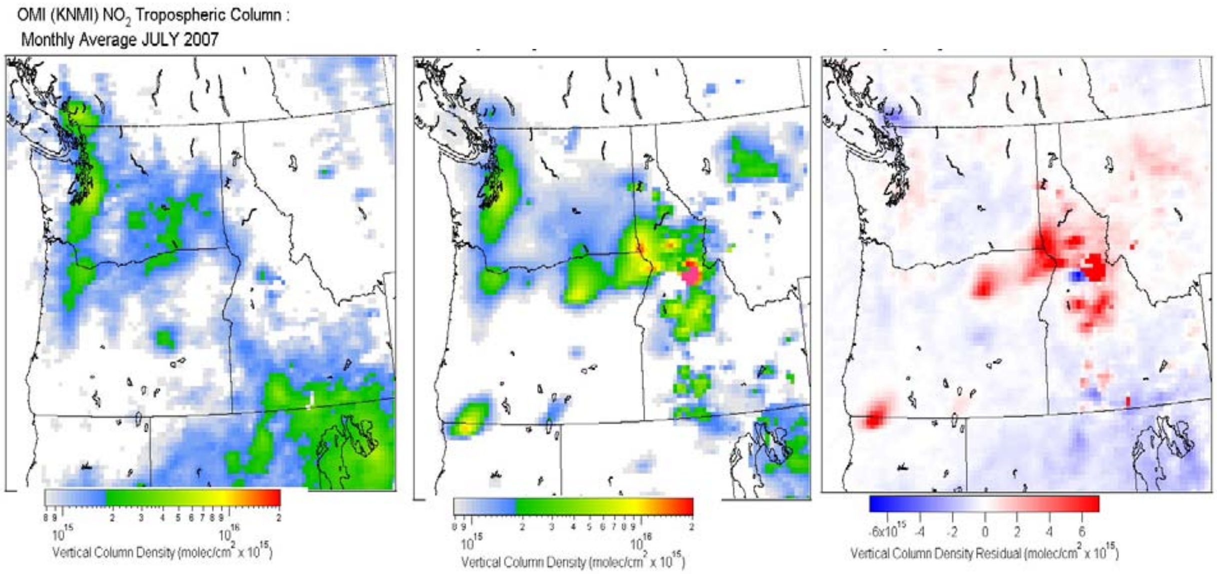

Figure 3. July 2007 results for tropospheric column NO_2 from (a) OMI, (b) AIRPACT with appropriate KNMI averaging kernel applied, and (c) the difference between AIRPACT and OMI columns.

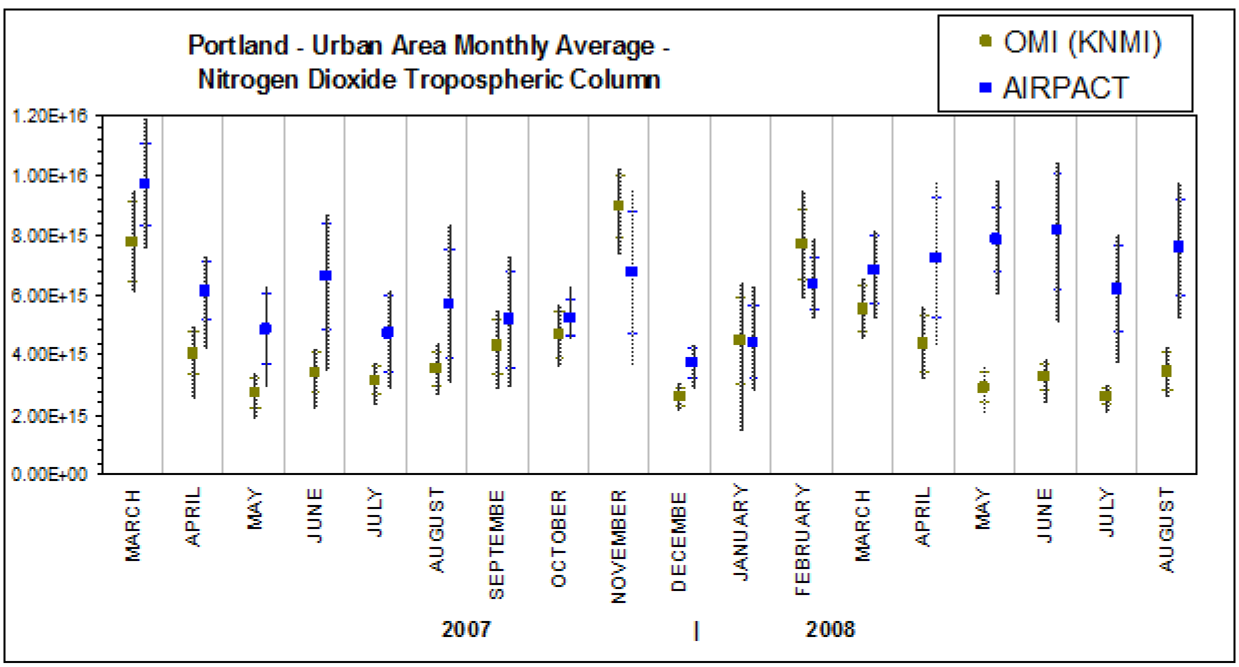

Figure 4. Monthly comparison of OMI and AIRPACT NO2 column densities for the Portland, OR urban area.

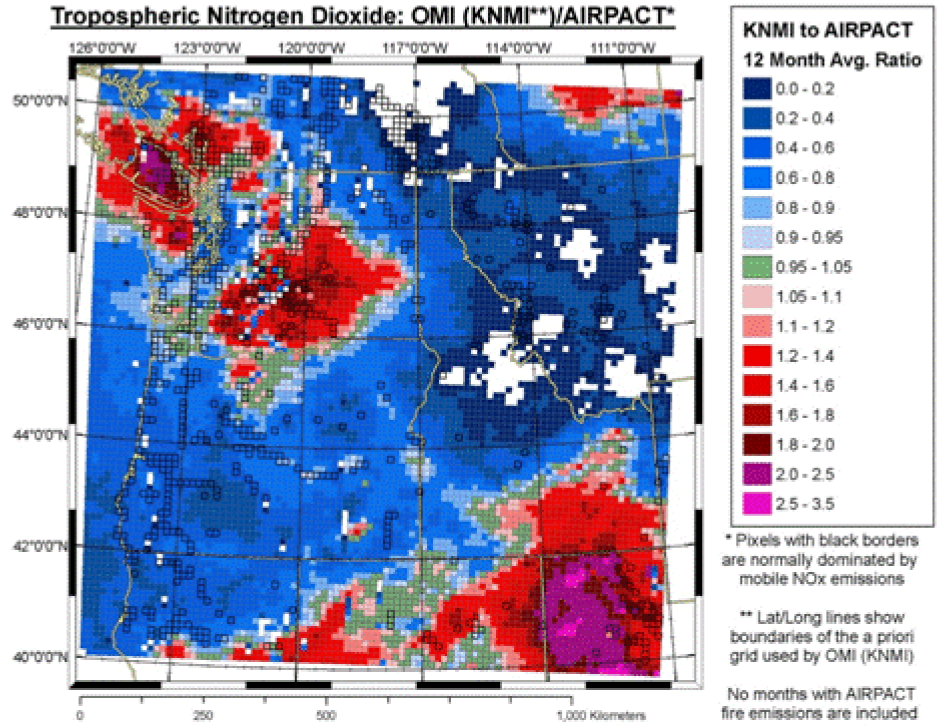

Figure 5. Annual average of ratio of OMI (KNMI) to AIRPACT vertical column tropospheric NO2.

O_3

We have investigated the use of tropospheric ozone data from Aura/OMI, using preliminary research results from Dr. Xiong Liu. These results clearly demonstrate the importance of transport on the AIRPACT results. Figure 6 shows a comparison of ozone from AIRPACT with OMI.

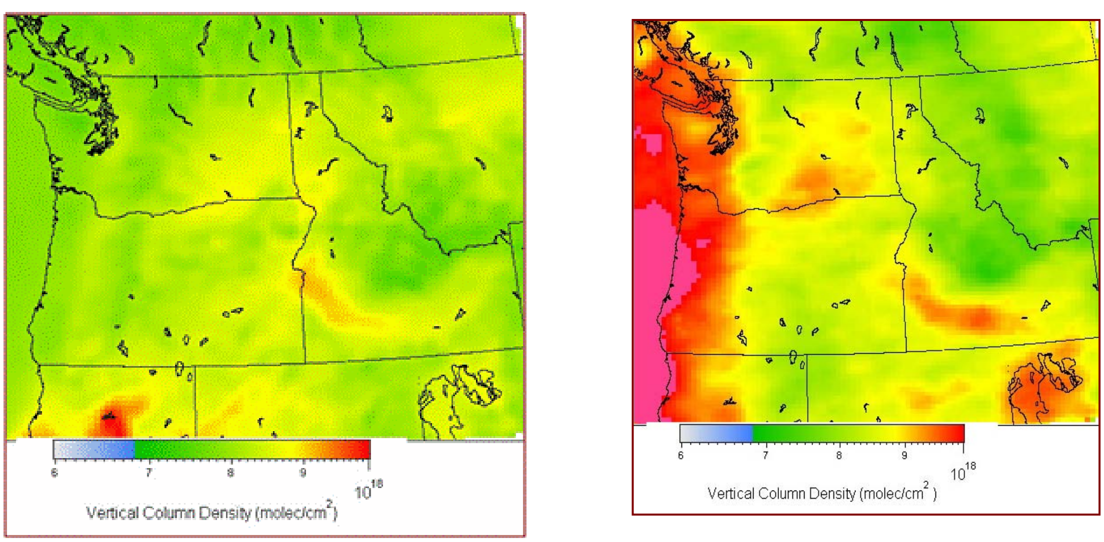

Figure 6. Comparison of AIRPACT ozone with Aura/OMI tropospheric ozone for July 2007: (left) AIRPACT tropospheric vertical column density ozone and (right) level 2 OMI tropospheric VCD ozone.

Figure 7 shows CO (a well known transport tracer) from AIRS compared to OMI tropospheric ozone for two days in July 2007. There is clearly an influx of both ozone and CO into the western boundary of the AIRPACT domain. As the OMI tropospheric ozone data product evolves, we plan to use that data product to analyze AIRPACT results, as well as to test use of the OMI ozone results for boundary conditions.

CO

One of the difficulties of regional air quality modeling is properly accounting for boundary conditions. The global measurements of carbon monoxide from MOPITT (the Measurements of Pollution in the Troposphere instrument onboard Terra) were used to improve boundary conditions of our air quality model. The MOPITT CO observations show high concentrations are frequently transported into the PNW from source regions in Asia. Since there is significant seasonal and inter-annual variability in the transported CO, air quality forecasts could be significantly improved with the incorporation of real-time information from MOPITT CO. The global chemical transport model MOZART-4 (Model of Ozone and Related chemical Tracers, version 4, Emmons et al., 2010) is currently being run in real-time, with the assimilation of MOPITT CO column retrievals (http://www.acd.ucar.edu/acresp/forecast/). Model output is saved every hour for use as boundary conditions in AIRPACT. The assimilation is performed with a sub-optimal extended Kalman filter (EKF), which uses a parameterized scheme for the error statistics in the assimilation cycle (Lamarque et al., 2004). The assimilation of the MOPITT retrievals for CO improves the model simulation, correcting for errors in emissions and transport in MOZART.

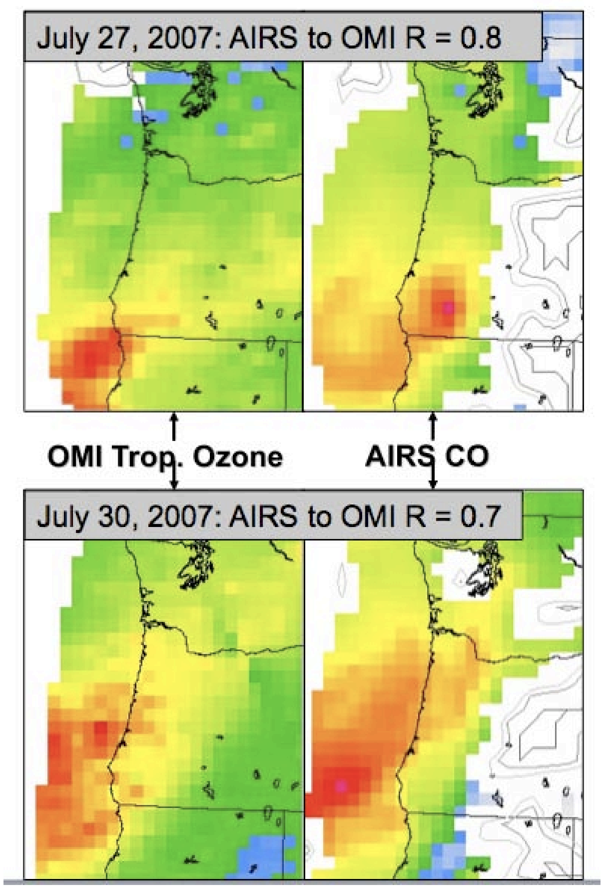

Figure 7. Correlation of OMI ozone and AIRS CO for two summer days along the western boundary of AIRPACT.

Aerosols

For aerosol retrieval, OMI uses a near UV method, similar to the prior TOMS aerosol retrieval, as the primary retrieval technique over land to determine aerosol optical depth. An example of a 9-day average of OMI near-UV AOD and AIRPACT AOD at 500 nm is shown in Figure 8 for a period of large regional wildfires. AIRPACT over-predicts aerosols relative to OMI. As discussed above in our NO_2 analyses, AIRPACT estimated hourly fire emissions but were not updated often enough, which resulted in the propagation of longer burning fires in the model. This is the reason such a large bias in AOD is seen in Figure 8. This is likely due primarily to over-estimation of emissions, particularly from wildfires, although other analyses show over-predictions of AIRPACT urban PM2.5, likely from over-estimation of primary particulate emissions from some anthropogenic sources.

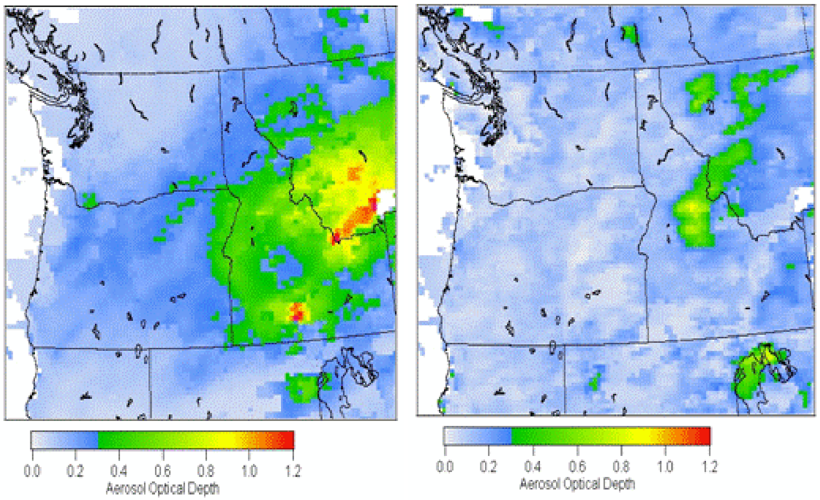

Figure 8. AIRPACT aerosol optical depth (left) and OMI UV Absorption. final aerosol optical depth (right) for August 1 – 9, 2007.

3.0 Research Plan

Our overall approach is to seek methods for combining satellite data products with model simulation results to improve our understanding of the effects of long range transport upon air quality and to improve the quality of emission inventories used in our regional model system. Because our AIRPACT system employs the WRF and CMAQ community models, the results from this work should be widely applicable for other regional modeling efforts. The combination of satellite products with the modeling system will involve different approaches for different aspects of this research.

To investigate long range transport and, in turn, improve treatment of chemical BC, we will continue the work we have underway to employ MOZART with assimilated CO as a foundation for identifying long range transport events and providing dynamic BC. However, we believe the work with CO is just a starting point and that we have the opportunity to develop a much more integrated approach that encompasses other trace gases and aerosols. We will take advantage of long term measurements by Jaffe at Cheeka Peak and now at Mt. Bachelor (see attached letter of collaboration) to employ robust correlations among transported species and apply these correlations via MOZART and selected satellite products. Our intent is to improve the dynamic BC provided by MOZART with BCs from additional satellite products while constraining the satellite-based BCs for the AIRPACT system by reference to Jaffe's monitoring results.

To improve emission inventories, we will extend the work underway using OMI NO2 to identify model biases that can be related primarily to emission inventories. This will include careful analysis of OMI NO2 for urban and rural areas and for wildfires as well as application of a novel inverse modeling approach recently described by Paton-Walsh et al. (2010) where satellite AOD was combined with modeling results in a kind of ratio approach to estimate wildfire emissions of CO and other species.

In addition to specific analyses aimed at long range transport and emission inventories, we will continue to compare satellite products for specific trace gases and aerosols with model simulation results as a way to improve the modeling system and to increase our understanding of regional atmospheric chemistry. We provide additional details in each of these areas in the following sections, beginning with a brief review of satellite products that are of particular value for the proposed research.

3.1 Proposed Satellite Data Products for Use with the AIRPACT Air Quality System

As a result of steady progress within NW-AIRQUEST during the past decade, we have a good understanding of the strengths and weaknesses of our relatively mature automated simulation systems for air quality management. We understand that the AIRPACT-3 photochemical simulations are more sensitive to boundary conditions (BC) than to initial conditions and that correct specification of emissions is also very important. However, with the exception of surface measurements provided by Jaffe and colleagues at Cheeka Peak along the Washington coast (e.g., Jaffe et al., 2003) and at Mt. Bachelor in the Oregon Cascades, there is a lack of observations that we can use to define boundary conditions, particularly along the Pacific coast. Thus, we seek to use available gas and aerosol satellite products to help define and update spatial and temporal patterns of chemical boundary conditions for the CMAQ model. We understand that satellite products will not give a complete suite of chemical boundary conditions. However we believe that use of satellite observations, such as for CO, can be used with correlations derived from more detailed surface measurements and/or from global chemistry models, such as MOZART, as surrogates for defining and updating boundary conditions.

Having conducted a variety of model evaluation exercises to document the accuracy of the AIRPACT system (Chen et al., 2008; also see the AIRPACT web site for automated model performance charts and tables), we have been hampered by the fact that the existing monitoring sites are quite sparse, mostly distributed along the urban I-5 corridor between Seattle and Portland, and mostly for ozone and PM2.5, less often for CO and especially for NOx. Thus, we believe that high resolution satellite observations, such as from the Aura/OMI sensor, will provide more highly resolved spatial information that can be coupled with fixed point continuous surface observations for a more comprehensive evaluation data set.

Given this understanding of where improvements are needed in our air quality system, our approach for this project will be to target specific satellite products and to employ these products to address the areas of weakness in our modeling systems. The planned data products we intend to make use of are listed below.

Aura/OMI NO_2: We already have substantial experience with OMI nitrogen dioxide. Unfortunately, much of that effort has gone into understanding the differences between the NASA standard NO_2 product and the KNMI Domino NO_2 product, both derived from the same OMI level 1b radiance measurements, rather than into understanding the differences between the AIRPACT model and the satellite observations. Our progress with understanding these differences between retrieval products is documented in Herron-Thorpe et al. (2010). For model/satellite comparisons, OMI is a particularly desirable instrument due to its wide swath (2600km) and relatively small pixel size (~ 12km x 24km at nadir). As a result of our work, we have come to general conclusions regarding AIRPACT NO_2, as described above, and we are now poised to apply OMI data for evaluation of AIRPACT-3 NOx emissions, for boundary condition adjustment, and for evaluation of long range transport. We propose detailed use of KNMI OMI NO_2 for modification of model emission inventories.

Aura/OMI O3, HCHO, SO2: OMI does not produce a standard tropospheric ozone product, although a research product is currently available on the web (http://acdbext.gsfc.nasa.gov/Data_services/cloud_slice/) that utilizes OMI/MLS residuals. Research tropospheric ozone products are becoming available from OMI (e.g. Liu et al., 2010), and as members of the Aura science team, we have access to those research products. Tropospheric ozone is arguably the most important tropospheric trace gas for AIRPACT, and as the OMI ozone data becomes available, we propose making use of that product for model modification. OMI also measures HCHO and SO_2. HCHO can be used as a surrogate for biogenic VOCs (Palmer et al., 2003; 2006), while use of SO2 modified to incorporate a local air mass factor (AMF) could be useful for measurements of power plant plumes. We will make use of these two data products to help constrain the AIRPACT model in the same way as described previously for NO2.

MOPITT CO: . With pixel size of 22 km horizontally, vertical resolution of 3 km and a functional return time of ~3 days, this product is sought to constrain AIRPACT-3 boundary conditions as well as for use in evaluation of AIRPACT-3 results. Retrievals of vertical profiles and total columns of CO are available from MOPITT since March 2000, and have been extensively validated (e.g., Emmons et al., 2009), and significant improvements made in the recently released Version 4 retrievals (Deeter et al., 2010). Observations of CO are valuable for identifying constant anthropogenic sources such as from traffic and power plants in urban areas, as well as episodic emissions from wildfires and agricultural burns. Dr. Emmons will conduct hindcast simulations with MOZART-4 including the assimilation of MOPITT CO for the studies in this project. Dr. Emmons will also assist this project in the interpretation and use of MOPITT CO retrievals. CO retrievals of vertical profiles and total columns are available since March 2000 through the present from the MOPITT instrument onboard the Terra satellite. These observations will be valuable for evaluating combustion emissions sources (traffic, domestic heating and cooking, wildfires, etc.). CO is also a good indicator of pollution transport pathways, due to its relatively long lifetime of a few weeks.

OMI, CALIOP, MODIS - aerosols: Aerosol type and height from lidar retrievals by CALIPSO are a high quality satellite source for high-resolution data on atmospheric aerosols. The addition of along-track CALIOP/CALIPSO data to the A-Train provides valuable information on general aerosol type and height that can be merged with OMI and MODIS AOD to better understand aerosol loading in the troposphere. OMI AOD is derived from near-UV measurements with a resolution of 13 km x 24 km at nadir and MODIS AOD is retrieved from 550 nm with a resolution of 10 km x 10 km. These two AOD products are very useful due to their wide swath and daily coverage. Although OMI AOD is only available for afternoons, MODIS AOD is available for mornings (Terra satellite) and afternoons (Aqua satellite). We will also use OMI's trace measurements of SO_2 and NO_2 to refine aerosol information from CALIOP and further characterize the aerosols found in the free troposphere where OMI AOD exceeds a determined threshold.

MetOp-A/IASI ESA/EUMETSAT NH3: Ammonia is an important molecule for aerosol formation, and the Pacific Northwest has many large dairies, particularly in Idaho and northern California (see Figure 3, Clarisse et al., 2009), that emit copious quantities of ammonia. In addition, ammonia volatilizes as a result of crop fertilization and we have conducted studies supported by USDA that shows significant loss of NH3 during fertilization periods. AIRPACT includes an ammonia emissions module based on measurements made at the WSU dairy (e.g., Rumburg et al., 2006). Verification of that module is important to understanding the effects of dairies on air quality. AIRPACT also includes NH3 and NO soil emissions that have been parameterized as a function of historical fertilizer sales within the region. Daily ammonia is now measured routinely by the IASI/MetOp satellite (Clarisse et al., 2009). Temporal averaging will be required for the data because of the low levels of NH3, but we anticipate use of that data can help evaluate the model emissions used in AIRPACT.

3.2 Evaluation of Long Range Transport of Pollutants and Incorporation in the Regional AIRPACT System

Improvements in satellite remote sensing techniques have resulted in the ability to observe major pollution events and observe their transport across large areas of the globe. Intercontinental transport of air pollutants across the North Pacific and the Gulf of Alaska is a robust phenomenon with maximum transport occurring in the troposphere in early springtime (e.g. Jacob et al., 1999; Oltmans et al., *2008;* Reidmiller et al., 2009.). These transport events can affect air quality for periods of days to months (e.g. Liu et al., *2005*). In particular, satellite imagery of trace gases (e.g., MOPITT CO, also AIRS in Figure 8) show strong sources of air pollutants in Asia/India that make their way across the Pacific Ocean and impact onto the coast of the US Pacific NW. East Asia has the fastest growing ozone precursor emissions globally and much of the springtime pollution is transported eastward towards western North America. Cooper et al (2010) show a strong increase in springtime ozone mixing ratios between 1995 and 2008 with the rate of increase in ozone mixing ratio greatest when measurements are more heavily influenced by direct transport from Asia. These authors state that it is possible that increasing emissions from emerging economies like China are outpacing reductions in the developed economies.

We have developed a method for use of MOZART with assimilated MOPITT CO to prescribe chemical BC for AIRPACT that are dynamically updated on a daily forecast basis. For this proposal, we want to continue this work to evaluate how well AIRPACT performs using these new dynamic BC and, in particular, we want to develop a more integrated approach for using multiple satellite products to continue to improve treatment of long range transport within AIRPACT. In addition, we also want to investigate how incoming polluted air masses interact with terrain to affect regional air quality.

As indicated above, we are just implementing the MOZART BC with assimilated CO into AIRPACT-3. We have conducted some preliminary analyses of these new BC with and without assimilated CO in comparison to monthly averaged BC that have been used previously in AIRPACT. However, more work is needed over a longer time frame to evaluate how these changes affect overall model performance in terms of CO, NOx, O3 and other species. We propose to continue this work using both ongoing forecast results as well as retrospective simulations developed for the other parts of this proposal.

A second aspect of this analysis will be to continue to look at correlations among species as way to integrate more species into the dynamic BC process. Because of issues with timing of various satellite data products, we anticipate that development of correlations among species that are tied to CO as a surrogate will be the most fruitful approach. So our overall approach will be to develop correlation relationships between CO and other satellite detected species including NO2, O3, SO2, and HCHO and then to first see if these correlations are matched within the MOZART model results and second to adjust MOZART-provided BC to reflect robust correlations. We will also take advantage of the extensive, long-term measurements that Jaffe and colleagues are collecting at Mt. Bachelor which emphasizes quantitative characterization of long range transport. Jaffe has identified a number of strong correlations among CO and other pollutants which, with assistance from Jaffe (see letter), we can compare to those obtained from similar correlations obtained from satellite observations. The sum of these satellite and ground based correlation analyses will be used to improve the dynamic BC provided by MOZART. An important part of this analysis will be to focus on how identified correlations may change with position along the western boundary and with time of year. It is well known that more pronounced long-range transport events occur during spring, so we might expect different correlation results during spring compared to other times of the year.

3.3 Evaluation and improvement of regional emission inventories

As indicated previously, we have conducted an initial analysis of the OMI NO2 tropospheric products in terms of inter-comparison of NASA and KNMI retrievals and in terms of inter-comparison with AIRPACT NO2 column densities. In the latter case, we have focused on biases in the model in the major urban areas within the region with the intent that these analyses will provide a foundation for developing methods to improve urban NOx emission estimates. We have also found that model estimates of wildfire NO2 are grossly overestimated compared to the OMI NO2 column densities. Finally, we have observed low level NO2 in agricultural areas that do not appear to agree with satellite retrieval data. We have also examined OMI SO2, HCHO, and CO satellite products in comparison to AIRPACT column densities and find that there is considerable scatter in these comparisons.

We propose to continue our investigation of satellite/model comparisons with an emphasis on understanding how the observed biases can be used to evaluate and improve the regional biogenic, anthropogenic and wildfire emission estimates. There are two levels to our approach. First, a simple bias analysis as shown for NO2 can be more thoroughly conducted for each trace gas species and for aerosols to fully document where discrepancies may exist in model emissions in terms of location or type of source and seasonal changes. Because of the spatial resolution of OMI products, we can filter these comparisons in terms of urban areas, agricultural or natural ecosystem areas and wildfire areas to assess these types of sources separately.

This initial bias analysis will provide the foundation for a second more specific analysis where inverse modeling methods will be used to infer correct emissions based upon satellite data products. In particular, we will investigate methods as described by Paton-Walsh et al. (2010) where excess AOD (above background levels) detected by MODIS were used with established correlations between AOD and CO, as well as other trace gases (Paton-Walsh et al., 2005) to estimate excess CO attributed to wildfires. These estimates, obtained on a regional, daily basis, were corrected using MOZART on a 1 deg x 1 deg gridded basis, to correct for CO that remained in the region for multiple days so that the emission estimates only account for fresh CO emissions. Corrections were also made to the excess AOD based upon ground-based sun photometer measurements of AOD. The results were then compared to fire emission estimates based upon a bottom-up calculation using area burned, fuel type, and emission factor. The method was also applied to estimate a number of other trace gas emissions from fires including ammonia, formaldehyde, and a number of other VOCs.

We anticipate that application of this method using the AOD from OMI and/or MODIS in conjunction with AIRPACT modeling results will be very useful for evaluation of current wildfire emissions used in AIRPACT. The fact that AIRPACT operates on a 12 km x 12 km grid should improve the application of this method compared to that based only on MOZART. For this investigation of regional wildfires, we will use fire data primarily from 2007 which is was an extreme fire year with more than 3 million acres burned in ID, OR and WA, although there were also fire events during 2008 (600,000 acres burned) and 2009 (100,000 acres burned).

We can use literature results such as given by Paton-Walsh et al. (2005) and Goode et al. (2000) to establish the correlation factors needed for this method, but we will also investigate the use of satellite derived correlations between AOD and CO, NO2, NH3, SO2, and HCHO where we carefully filter areas and days to examine fire dominated column densities.

It may also be possible to develop a variation of this excess AOD method for application to urban plumes and to agricultural areas. In the Pacific Northwest, this may be particularly useful since the major urban areas are relatively isolated such that urban plumes can be tracked individually. Similarly there are large expanses of agricultural areas in eastern Washington and Oregon and in southern Idaho, where we may be able to examine ammonia and soil NO (via NO2) emissions. The key, in either case, is to be able to first detect an excess signal of AOD or other excess species, identify useful correlations among a suite of species, and then track the source areas to account for multi-day residence times within the area of interest. Results from the first level of bias analyses will be quite useful for determining where and for what species, we might be able to apply an excess loading satellite/modeling method.

The bias analysis and excess level method will provide quantitative information regarding the quality of emission inventory data, but these analyses do not themselves lead explicitly to a revised emission inventory. To do this, we will either make ad hoc adjustments guided by the results of the emissions analyses, which might be appropriate for the wildfire emissions, or we will use a more sophisticated, objective approach based upon Kalman filter inverse modeling as described by Napelenok et al. (2008). These authors describe an approach where they used relationships between emissions and modeled ambient concentrations obtained from the decoupled direct method in three dimensions (DDM-3D) implemented within the framework of the Community Multi-scale Air Quality (CMAQ) regional model. These were coupled to SCIAMACHY NO2 retrievals to constrain the solution via the Kalman filter method. They found that emissions biases were different in urban and rural areas of the southeast and that the method suggested a decrease in urban emissions, but that rural region results were very sensitive to NOx processes in the upper troposphere and not solely to emissions. We have had discussions with Napelenok and colleagues at EPA about adopting this method for use in the AIRPACT system and will employ this approach for appropriate cases based upon our analyses.

3.4 Educational Development

As part of this proposal, we will work with Dr. Shane Brown in the Engineering Education Research Center (EERC) at WSU to develop curriculum that emphasizes correction of identifiable misconceptions in air quality science and related technical topics among university students. New technologies such as satellite remote sensing of trace gases and air quality modeling provide a unique point of entry for educators to teach science, technology, engineering, and mathematics (STEM) subjects. Subjects such as math and science are traditionally taught in a historical context or purely theoretically without real world application within the classroom. This can lead to less than optimal learning amongst students that may not regularly benefit from traditional rigorous pedagogy. Using teaching methods that use current technologies and that address important social issues is relevant to students and increases their interest. Engineering principles such as modeling and spectrometry can provide unique points of entry to discussing STEM concepts in the classroom. Furthermore, NASA products and air quality modeling easily lead to hands-on opportunities in the classroom that can help facilitate deeper student understanding of the material. They will be able to compare different major cities in the Pacific Northwest, using AIRPACT-3 air quality forecast products and NASA satellite retrieval maps.

The newly developed curriculum will focus on greenhouse gases and the sources of air pollution while identifying the effects of preconceptions and misconceptions on research and learning among environmental engineering students.

5.0 Management and Partner Contributions

Drs. George Mount, Brian Lamb, and Joseph Vaughan from WSU, and Dr. Louisa Emmons from NCAR will be co-investigators for this work. This collaboration continues our current joint efforts to employ satellite and global model output to enhance the AIRPACT forecast system. A graduate student will be supported as part of a PhD dissertation project. Dr. Mount (currently a member of the Aura science team) will be responsible for overall management of the project, Drs. Lamb and Vaughan will work on the model/satellite interactions incorporating and using satellite data products within the AIRPACT-3 air quality system, and Dr. Emmons will work on the MOZART global chemistry model to provide boundary conditions and expertise of non-Aura satellite data, e.g., MOPITT CO (Dr. Emmons is a member of the MOPITT science team).

6.0 Anticipated Impact and End Products

AIRPACT was one of the first numerical air quality forecast systems in the US and it continues to provide valuable information for clean air agencies and stakeholders in the Pacific Northwest as evident from the letter of support from members of NW-AIRQUEST. In addition, the development of the AIRPACT framework has proven to be a very strong foundation for a range of scientific research efforts including our current NASA project as described previously and a substantial program to assess the effects of global change upon regional air quality in the US (EPA STAR grants; Chen et al., 2009a,2009b, Avise et al., 2009). We currently have support from USDA to incorporate windblown dust within AIRPACT using the USDA Wind Erosion Prediction System (WEPS) and we anticipate that aerosol satellite products will be a valuable way to evaluate the performance of this part of AIRPACT. We also have support from EPA with collaboration from Caltech and NCAR to develop a new parameterization for pollen release from vegetation, including a pollen rupture mechanism, that is hypothesized to be a key factor in asthmatic attacks.

Thus AIRPACT is strong and active platform that provides an excellent opportunity to develop new methods for using satellite data products to improve our understanding of regional atmospheric chemistry and air quality. We anticipate that the research program described herein will lead to better methods for treating long range transport using a combination of satellite and global modeling methods and that our research will result in a better understanding of regional wildfire emissions as well as urban and rural anthropogenic emissions. In turn, the better treatment of long range transport and improved emissions will yield an overall improvement in our ability to manage air quality now and in the future. In particular, we expect significant synergy between this project and our ongoing assessment of the effects of global change upon regional air quality.

Specific end products for this work will be presented at various technical meetings and in the peer reviewed literature in terms of manuscripts describing results from our analysis of long range transport and the various analyses of regional emissions. We will incorporate all of the results of this work in the ongoing operation of AIRPACT with appropriate presentation of products on the AIRPACT web site.

6.0 Research Schedule

This is proposed as a 3 year program. The specific activities for each year include:

- Year 1: collect relevant satellite data for the year years 2007-2009 and compare with AIRPACT in the Pacific NW regional domain to determine where the differences are and begin to understand why those differences occur. Develop an integrated approach to quantification of the focus on bias analyses for the suite of pollutants entering the model domain over the PNW species, examine correlations, and excess levels as needed for improvement to emission estimates and building a complete picture of satellite air quality products in the domain. Begin work on merger of satellite and AIRPACT data. Use at least MOPITT CO data to understand for correlations in long-range transport into the AIRPACT domain and begin to understand how to set boundary conditions for the model from the satellite species. Examine the feasibility for application of the excess loading method to urban and agriculture sources. Conduct performance analyses related to the MOZART dynamic BC as newly implemented in AIRPACT.
- Year 2: complete wildfire emission estimates using the excess method approach and begin the application of the method to other source types. Continue to develop correlation analyses for long range transport products and identify those that could used to improve MOZART-provided BC.
- Year 3: Complete emission estimate analyses and incorporate results into new AIRPACT emission inventory. Conduct analysis of model performance using modified emissions. Complete incorporation of correlation analyses within MOZART provided BC and conducted performance analyses for AIRPACT. Examine long-range transport tracer behavior within the AIRPACT domain to help understand effects of long-range transport upon regional air quality.

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Five other significant publications:

Rahul Jain, Joseph Vaughan, Kyle Heitkamp, Charleston Ramos, Candis Claiborn, Maarten Schreuder, Mark Schaaf and Brian Lamb, Development of the ClearSky Smoke Dispersion Forecast System for Agricultural Field Burning in the Pacific Northwest, *Atmospheric Environment*, **41**:32, 6745-6761, 2007.

Kaufman, Y.J., D. Tanre, B.N. Holben, S. Mattoo, L.A. Remer, T.T. Eck, J. Vaughan, and B. Chatenet, 2002. Aerosol radiative impact on spectral solar flux at the surface, derived from Principal-Plane Sky Measurements. J. Atmos. Sci. 59, 635-646.

Vaughan, J.K., C. Claiborn, D. Finn, 2001. Dust event over the Columbia Plateau. J. Geophys. Res. 106, 18,381-18,402.

Claiborn, C., B.K. Lamb, A. Miller, J. Beseda, B. Clode, J. Vaughan, L. Kang, and C. Newvine (1998). Regional measurements and modeling of windblown agricultural dust: The Columbia Plateau PM_{10} Program, *J. Geophys. Res.* 103, 19753-19768.

LOUISA K. EMMONS

Atmospheric Chemistry Division, National Center for Atmospheric Research
P.O. Box 3000, Boulder CO 80307-3000 USA

EDUCATION

1986 B.S., Physics, Haverford College, Haverford, PA
1989 M.A., Physics, State University of New York, Stony Brook, NY
1994 Ph.D., Physics, State University of New York, Stony Brook, NY

PROFESSIONAL EXPERIENCE

2010-present **Scientist III**, Atmospheric Chemistry Division, National Center for Atmospheric Research (NCAR), Boulder, CO.
2006-2010 **Scientist II**, Atmospheric Chemistry Division, NCAR.
2003-2006 **Scientist I**, Atmospheric Chemistry Division, NCAR.
1999-2003 **Associate Scientist III**, **Scientific Visitor,** ACD, NCAR.
1994-1998 **Post-doctoral Research Fellow**, Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI.

SELECTED RECENT PUBLICATIONS

Emmons, L.K., Apel, E.C., Lamarque, J.-F., et al., Impact of Mexico City emissions on regional air quality from MOZART-4 simulations, *Atmos. Chem. Phys., 10*, 6195-6212, doi:10.5194/acp-10-6195-2010, 2010.

Paton-Walsh, C., Emmons, L.K., and Wilson, S.R., Estimated total emissions of trace gases from the Canberra Wildfires of 2003: a new method using satellite measurements of aerosol optical depth & the MOZART chemical transport model, *Atmos. Chem. Phys., 10*, 5739-5748, doi:10.5194/acp-10-5739-2010, 2010.

Apel, E.C., Emmons, L.K., Karl, T., et al., Chemical evolution of volatile organic compounds in the outflow of the Mexico City Metropolitan area, *Atmos. Chem. Phys., 10*, 2353-2375, 2010.

Randel, W. J., M. Park, L. Emmons, D. Kinnison, P. Bernath, K. A. Walker, C. Boone, and H. Pumphrey, Transport from the Asian Monsoon to the Stratosphere Observed in Satellite Measurements of Hydrogen Cyanide, *Science*, *328*, 611-613, 2010.

Pfister, G.G., Emmons, L.K., Edwards, D.P., Arellano, A., G Sachse, and Campos, T.: Variability of springtime transpacific pollution transport during 2000–2006: the INTEX-B mission in the context of previous years, *Atmos. Chem. Phys., 10*, 1345-1359, 2010.

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G. Mount

Name	***Supporting Agency***	***Total $***	***Effective***	
		Amount	*Expiration Dates*	*Title of Project*
Mount	NASA	$382,000	5/1/12	Ground based measurements of trace gases using MultiFunction DOAS in clean and polluted environments
Jobson, Lamb, Mount, et al	NSF	$812,000	8/31/10	Integrated Atm. Mobile Chemical Lab
Lamb, Mount, et al.	NASA	$912,000	9/2010	Effects of Climate Change on Air Pollution
Lamb, Mount (co-I):	NSF	$3.1M	6/2012	NSF IGERT
Cousins, Mount, Evans, Orr, Keller (co-pIs):	NSF	$729,000	6/2012	Acquisition of instrumentation to study stable isotopes of the carbon, nitrogen, and water biogeochemical cycles.

Current & Pending Support: Brian Lamb

Name	***Supporting Agency***	***Total $ Amount***	***Start/Stop Dates***	***Mo/yr***	***Title of Project***
Lamb, B.,Vaughan, O'Neill, Guenther, Mass	EPA	$900,000	2/7/2007-- 2/06/11	0.2	Impact of Climate Change on Regional Air Quality
Lamb, B.	USDA	$67,000	7/1/06 – 6/30/11	0.1	Pheromones in Forest Canopies
Lamb, B., J. Vaughan	Ecology	$63,000	7/1/10- 6/30/11	0.1	AIRPACT Air Quality Forecast System
Lamb, B., J. Vaughan	Idaho DEQ	$36,000	7/1/10 – 6/30/11	0.1	ClearSky Smoke Forecast System
Lamb, Vaughan, Mount, Mass, Emmons, Edwards	NASA	$900,000	10/1/06-9/30/10	0.2	Air Quality Decision Support System
Lamb & Pressley	NSF	$242,599	4/1/08 – 3/31/11	0.2	REU Site: Regional Atmospheric Chemistry: State-of-the-art Measurement and Modeling in the Pacific Northwest
Lamb, Chung, VanReken, Vaughan and Wagner	USDA	$354,788	5/15/09-5/14/12	0.2	Incorporation of the Wind Erosion Prediction System (WEPS) within a Comprehensive Regional Air Quality Model
Vaughan and Lamb	US Park Service	$12,000	1/1/2009- 8/15/2010	--	Mapping N and S Deposition in the Northwest
VanReken, Jobson, Pressley & Lamb	NSF	$299,865	7/1/2009 – 6/30/2011	0.1	CABINEX Forest Canopy Chemistry Field Program
Lamb et al.	NSF	$3M	8/15/2009 – 8/14/2014	0.75	IGERT: Nitrogen Systems Policy Oriented Integrated Research and Education (NSPIRE)
Strand, Larkin, Potter, Lamb	USDA Forest Service	$202,867	10/1/2009 – 9/30/2012	0.2	Investigation of Smoke Dispersion related to Prescribed Burns
Flagan, VanReken, Chung, and Lamb	EPA (accepted)	$266,938	10/1/2009- 9/30/2012	0.2	Climate Change Effects on Pollen and Asthma
Lamb et al.	USDA Forest Service	$187,063	5/1/2010 – 4/30/2013	0.2	Development and Evaluation of High Resolution Simulation Tools to Improve Fire Weather Forecasts
Proposals Pending					
Ham, Johnson, Pressley & Lamb	EPA (accepted)	$163,381	1/1/2010 – 12/31/2013	0.1	Ammonia from Feedlots: Measurements and Modeling
Lamb, VanReken, Jobson, Lamb, Chung, Herndon	NSF (accepted)	$170,000	4/112010- 3/31/2012	0.3	Urban Fluxes from Tianjin, China
Keller et al.	NSF (submitted)	$1.47M	1/1/2011 – 12/31/2015	0.25	Water Sustainability & Climate in the Pacific Northwest
Adam et al.,	NSF (submitted)	$4.5M	1/1/2011 – 12/31/2016	0.50	Regional-scale modeling of linkages and feedbacks among atmospheric, terrestrial, aquatic, and socio-economic processes that influence climate at the decadal scale

Barber et al.	USDA (submitted)			0.20	Integrated Adaptation and Mitigation Modeling Tool for Improved Management of Columbia River Basin Dryland Agriculture
Eigenbrode et al.	USDA (submitted)	$20M	1/1/2011 – 12/31/2016	1.0	Climate change and cereal cropping systems in the Pacific Northwest

Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

Investigator: Joseph K. Vaughan

Other agencies (including NSF) to which this proposal has been/will be submitted. none

Support: ☐ Current X Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Collaborative Research: Type 2: Understanding Biogeochemical Cycling in the Context of Climate Variability Using a Regional Earth System Modeling Framework

Source of Support: NSF

Total Award Amount: 3,621,581 Total Award Period Covered: 01/01/11 – 12/31/15

Location of Project: Wash St Univ.

Person-Months Per Year Committed to the Project. 3 Cal: X Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Using NASA Earth-Sun Science Products to Enhance a Comprehensive Air Quality Decision Support System in the Pacific Northwest

Source of Support: NASA

Total Award Amount: $900K Total Award Period Covered: 7/1/06-6/30/09, delayed/extended to 9/30/10

Location of Project: Washington State University

Person-Months Per Year Committed to the Project. 4 Cal: X Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Reducing Uncertainties in Smoke Emissions Modeling

Source of Support: NASA (via subcontract to WSU from STI)

Total Award Amount: $ 1.22M Total Award Period Covered: 2009-2012

Location of Project: Washington State University, Sonoman Tech, Inc, and USDA-FS Seattle

Person-Months Per Year Committed to the Project. 1/1/1 Cal: X Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: Incorporation of the Wind Erosion Predictions System (WEPS) within a Comprehensive Regional Air Quality

Source of Support: USDA

Total Award Amount: $365k Total Award Period Covered: 05/15/2009-05/14/2012

Location of Project: WERU lab at KSU, Manhattan, KS and LAR at WSU, Pullman, WA

Person-Months Per Year Committed to the Project. 0.5 Cal: X Acad: Sumr:

Support: X Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support

Project/Proposal Title: NW-AIRQUEST Agricultural Smoke Dispersion Forecast System—ClearSky

Source of Support: U.S. EPA via Region 10 Air Directors via NW-AIRQUEST consortium

Total Award Amount: $36K Total Award Period Covered: July 1, 2010 – June 30, 2011

Location of Project: LAR at WSU, Pullman, WA

Person-Months Per Year Committed to the Project. 2 Cal: X Acad: Sumr:

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY

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Louisa Emmons

In the event that an unanticipated overlap does occur, the level of effort would be adjusted, and/or additional personnel would be added, in concurrence with funding sources. Some projects may be ending as others are beginning.

Project Title: A Comprehensive Regional Air Quality Decision Support System in the Pacific Northwest

PI: Louisa Emmons

Time Committed to the Project: 1.2 person-months 0.0 person-months/year support by NSF base funds

Source of Support: Washington State University

Contact Information: Brian Lamb, (509) 335-5702, blamb@wsu.edu

Award Amount (or amount requested): $148,168.00 **Duration of Award:** 12/18/06-9/30/10

Award Status: Award

Project Title: Chemical Forecasting and Analysis for ARCTAS using MOPITT measurements and the Community Atmosphere Model with Chemistry (CAM-Chem)

PI: Louisa Emmons

Time Committed to the Project: 1.2 person-months 0.0 person-months/year support by NSF base funds

Source of Support: NASA

Contact Information: James Crawford, (202) 358-0915, James.H.Crawford@nasa.gov

Award Amount (or amount requested): $653,808.00 **Duration of Award:** 1/1/08-12/31/10

Award Status: Award

Project Title: Integration of Satellite Products into a Chemical Weather Forecasting System

PI: Gabriele Pfister

Time Committed to the Project: 0.0 person-months 1.2 person-months/year support by NSF base funds

Source of Support: NASA

Contact Information: David B. Considine, David.B.Considine@nasa.gov, (202) 358-2277

Award Amount (or amount requested): $300,000.00 **Duration of Award:** 11/1/09-10/31/12

Award Status: Award

Project Title: Integrating carbon monoxide and aerosol retrievals: Improving estimates of aerosol vertical distribution, carbon component & local radiative forcing

PI: David Edwards

Time Committed to the Project: 0.0 person-months 1.8 person-months/year support by NSF base funds

Source of Support: NASA

Contact Information: Lucia Tsaoussi, (202) 358-4471, Lucia.S.Tsaoussi@nasa.gov

Award Amount (or amount requested): $832,681.00 **Duration of Award:** 10/1/10-9/30/13

Award Status: Pending

Current and Pending Non-Base Support for Scientific Staff

Louisa Emmons

Project Title: Collaborative Research: Type 1: Chemistry and Climate over Asia: Understanding the Impact of Changing Climate and Emissions on Atmospheric Composition (L02170219)

PI: Mary Barth

Time Committed to the Project: 1.0 person-months 0.0 person-months/year support by NSF base funds

Source of Support: NSF

Contact Information: Jay Fein, GEO/AGS, (703) 292-8527, jfein@nsf.gov

Award Amount (or amount requested): $707,785.00 **Duration of Award:** 1/1/11-12/31/13

Award Status: Pending

Project Title: Establishing Boundary Conditions and Atmospheric Boundary Layer Depths for Eastern Texas Using Satellite Remote Sensing Observations

PI: Christine Wiedinmyer

Time Committed to the Project: 1.0 person-months 0.0 person-months/year support by NSF base funds

Source of Support: University of Texas

Contact Information: David Allen, allen@che.utexas.edu, 512-471-0049

Award Amount (or amount requested): $28,982.00 **Duration of Award:** 9/1/10-8/31/11

Award Status: Pending

UNIVERSITY OF WASHINGTON

28 July, 2010

To whom it may concern:

This letter describes future collaboration between my research group and the groups at WSU and NCAR on understanding ozone in the Pacific Northwest using satellite and in-situ observations, along with global and regional models. My research group currently makes observations at the Mt. Bachelor Observatory at 2.7 km elevation in central Oregon. This site has been used for 7 years to study long-range transport of pollutants and the background free troposphere. We are also in the process of expanding our observations in the free troposphere of the Pacific Northwest to other mountain top sites. This collaboration will involve sharing of data and model products to better understand the influence of the free troposphere on surface air quality. With the transition to lower air quality standards for ozone in the US, understanding the role of background air on surface air quality is becoming increasingly important.

Please contact me if you have any questions about this collaboration.

Sincerely

Daniel A. Jaffe

Dan Jaffe
Professor of Science and Technology (UW-Bothell)
Professor of Atmospheric Sciences (UW-Seattle)

Prof. Daniel Jaffe, University of Washington Bothell, 18115 Campus Way NE, Bothell, WA 98011-8246.
Telephone: 425-352-5357; Fax 425-352-5335; email: djaffe@u.washington.edu;
http://faculty.washington.edu/djaffe/

Northwest International AIR QUality Environmental Science and Technology Consortium
NW AIRQUEST

July 29, 2010

George Mount
Laboratory for Atmospheric Research
Department of Civil & Environmental Engineering
Sloan Hall 101, Spokane Street
Washington State University
Pullman, WA 99164-2910

Subject: Support for Satellite Products to Refine Emissions and Long-Range Transport Estimates in the Pacific Northwest

Dear Dr. Mount,

NW-AIRQUEST is writing in support of the proposal entitled "Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest." This proposal is submitted by Washington State University (WSU) and the National Center for Atmospheric Research (NCAR).

NW-AIRQUEST (Northwest International Air Quality Environmental Science and Technology) is a consortium of U.S. and Canadian federal, state, tribal, and local government agencies and universities in the Pacific Northwest that seeks to maintain and enhance a sound scientific basis for air quality management decisions in the region. NW-AIRQUEST collaboration enhances the effectiveness of individual members to align science and management needs with the air programs of its member organizations.

Past NASA-funded satellite and air quality projects by WSU, NCAR, and its partners have greatly benefited our NW-AIRQUEST air quality consortium organizations in the Pacific Northwest. These projects have led to a better understanding of air quality issues. The benefits include improved NO_2 emissions estimates; more refined land use maps for calculating pollutant emissions; web products that give air quality agencies better access to satellite, ground, model air quality products; and dynamic model boundary conditions. These boundary conditions better incorporate long-range transport into our daily regional air quality forecasts and retrospective regulatory modeling.

Recognizing the strengths of the NASA-ROSES project, EPA Region 10 on behalf of NW-AIRQUEST has submitted a proposal to the EPA Group on Earth Observations that makes satellite, ground observational, and model data more accessible and usable by air quality

NCAR

National Center for Atmospheric Research
Earth System Laboratory

WILLIAM RANDEL
Division Director
Atmospheric Chemistry Division (ACD)

P.O. Box 3000, Boulder, CO 80307-3000 USA
Phone: 303.497.1439 Fax: 303.497.1400
randel@ucar.edu www.acd.ucar.edu

July 28, 2010

Dr. George Mount
405 Spokane Street, Sloan 101
PO Box 642910
Washington State University
Pullman WA 99164-2910

Dear Dr. Mount:

I am pleased to submit for consideration NCAR proposal number 2010-564 entitled "Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest." Dr. Louisa Emmons is the NCAR Principal Investigator on this project. The total amount requested for NCAR is $59,603.

Should you have questions regarding the proposal, please contact the Principal Investigator, Dr. Emmons at (303) 497-1491. For administrative matters, contact the UCAR Sponsored Agreements Office, Ms. Virginia Taberski at (303) 497-2132.

Sincerely,

WJRandel

Dr. William Randel
Director, Atmospheric Chemistry Division

WASHINGTON STATE UNIVERSITY

College of Engineering and Architecture

July 28, 2010

Dr. George Mount
Department of Civil & Environmental Engineering
405 Spokane Street, Sloan 101
PO Box 642910
Pullman, WA 99164-2910

Dear George:

I'm writing to confirm my collaboration with you for the educational component of your proposal entitled: *Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of trace gases and aerosols in the Pacific Northwest*. The efforts you propose regarding enhanced educational activities related to the regional modeling and satellite analyses will be a valuable and useful addition to the type of work we have underway in engineering education. Curriculum development that utilizes NASA products and air quality modeling in the Pacific Northwest will be an engaging and relevant topic for our students here at Washington State University. It's a unique opportunity to develop new curriculum while identifying the effects of preconceptions and misconceptions on research and learning amongst engineering students. I look forward to working with you on this project.

Sincerely,

Shane Brown, PhD
Assistant Professor
Engineering Education

PO Box 642910, Pullman, WA 99164-2910
509-335-7847 · Fax: 509-335-7632 · shanebrown@wsu.edu

Budget Justification – WSU

Proposal: AURA Science Team Atmospheric Composition:

Project Duration: 01/01/2011 – 12/31/2013

Personnel

Position	Name	Monthly Salary[1]	Number of Months/Year	Total
PI	George Mount	$11,536	1.00	$36,012
Co-I	Brian Lamb	$14,778	1.00	$42,304
Co-I	Joseph Vaughan	$4,517	3.00	$46,130

[1] Current monthly salary. Total reflects a 4% increase each year.

The amounts for Mount and Lamb reflect their roles in providing overall project supervision and analysis. Co-I Vaughan is a Research Assistant Professor who has direct responsibility for the daily operation of AIRPACT and he will be involved in retrospective simulations and analyses of AIRPACT as outlined in the proposal.

Support is included for WSU staff (25% FTE for 4 mo/yr, $16,657 total) to assist with operation and maintenance of the LAR computer cluster which will be the primary computer resource for the research project.

Fringe Benefits

The fringe benefit rate for senior and staff personnel is 30.6%.

Students

We are requesting funding for a full time PhD student for the duration of the project. This student will be involved in all aspects of the satellite/model analyses. Associated costs include:

Salary:	$ 70,017
Qualified Tuition Reduction:	$ 28,914
Health Insurance:	$ 4,938
Benefits:	$ 1,050

Travel

Funds are requested for yearly NASA meetings to share methods and results with other research groups and members of the AURA science team and to present results at technical conference meetings, such as the AGU annual meeting in San Francisco. Three trips per year are proposed. Costs are estimated at approximately $1667/trip ($1000 airfare/trip, 3 days per diem at $222/day).

Goods & Services

Costs are included for updating the AIRPACT web site with new satellite/modeling products. This is estimated at $3500/yr for a web manager/support person.

Subcontract

Dr. Louisa Emmons, NCAR, will serve as co-I for this project and will assist with the retrospective MOZART global model simulations and MOPITT CO assimilation. She will also assist with overall project design and analyses. Support for Dr. Emmons will be provided via a subcontract from WSU to NCAR for the duration of the project ($59,603 total). Costs are included in the NCAR contract for a salary support and for travel for one meeting each year.

WSU Indirect Costs

Indirect costs are included at the required rate of 49.5% on modified total direct costs of $328,363 with tuition, equipment, and a portion of the NCAR subcontract excluded. Total indirect costs for the project will be $162,540.