SF 424

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Application for Federal Assistance SF-424

* 1. Type of Submission:	* 2. Type of Application:	* If Revision, select appropriate letter(s):
❍ Preapplication	● New	
● Application	❍ Continuation	* Other (Specify)
❍ Changed/Corrected Application	❍ Revision	

* 3. Date Received: 11/27/2024
4. Applicant Identifier: LERO1992

5a. Federal Entity Identifier:
5b. Federal Award Identifier:

State Use Only:

6. Date Received by State:
7. State Application Identifier:

8. APPLICANT INFORMATION:

* a. Legal Name: The Regents of the University of Colorado

* b. Employer/Taxpayer Identification Number (EIN/TIN): 84-6000555
* c. UEI: SPVKK1RC2MZ3

d. Address:

* Street1: 3100 Marine Street Room 481, 572 UCB
Street2:
* City: Boulder
County/Parish: Boulder
* State: CO: Colorado
Province:
* Country: USA: UNITED STATES
* Zip / Postal Code: 80309-0001

e. Organizational Unit:

Department Name: CIRES
Division Name:

f. Name and contact information of person to be contacted on matters involving this application:

Prefix: Dr.
* First Name: Leidy
Middle Name:
* Last Name: Romero Alvarez
Suffix:

Title: Research Associate

Organizational Affiliation: CIRES

* Telephone Number: (505) 333-8399
Fax Number:

* Email: leidy.romeroalvarez@colorado.edu

Application for Federal Assistance SF-424

*** 9. Type of Applicant 1: Select Applicant Type:**

H: Public/State Controlled Institution of Higher Education

Type of Applicant 2: Select Applicant Type:

Type of Applicant 3: Select Applicant Type:

* Other (specify):

*** 10. Name of Federal Agency:**

DOC NOAA - ERA Production

11. Catalog of Federal Domestic Assistance Number:

11.459

CFDA Title:

Weather and Air Quality Research

*** 12. Funding Opportunity Number:**

NOAA-OAR-WPO-2025-28603

* Title:

FY2025 Weather Program Office Research Programs Announcement - Air Quality Research and Forecasting (AQRF)

13. Competition Identification Number:

Title:

14. Areas Affected by Project (Cities, Counties, States, etc.):

File Name:

*** 15. Descriptive Title of Applicant's Project:**

Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration

Attach supporting documents as specified in agency instructions.

File Name:

Application for Federal Assistance SF-424

16. Congressional Districts Of:

* a. Applicant: CO-002
* b. Program/Project: CO-002

Attach an additional list of Program/Project Congressional Districts if needed.

17. Proposed Project:

* a. Start Date: 08/01/2025
* b. End Date: 07/31/2028

18. Estimated Funding ($):

* a. Federal	930,652.00
* b. Applicant	0.00
* c. State	0.00
* d. Local	0.00
* e. Other	0.00
* f. Program Income	0.00
* g. TOTAL	930,652.00

*** 19. Is Application Subject to Review By State Under Executive Order 12372 Process?**

❍ a. This application was made available to the State under the Executive Order 12372 Process for review on [ ].

❍ b. Program is subject to E.O. 12372 but has not been selected by the State for review.

● c. Program is not covered by E.O. 12372.

*** 20. Is the Applicant Delinquent On Any Federal Debt? (If "Yes", provide explanation in attachment.)**

❍ Yes ● No

21. *By signing this application, I certify (1) to the statements contained in the list of certifications and (2) that the statements herein are true, complete and accurate to the best of my knowledge. I also provide the required assurances** and agree to comply with any resulting terms if I accept an award. I am aware that any false, fictitious, or fraudulent statements or claims may subject me to criminal, civil, or administrative penalties. (U.S. Code, Title 218, Section 1001)**

☑ ** I AGREE

** The list of certifications and assurances, or an internet site where you may obtain this list, is contained in the announcement or agency specific instructions.

Authorized Representative:

Prefix:
* First Name: Autumn
Middle Name:
* Last Name: Coleman
Suffix:
* Title: Proposal Analyst
* Telephone Number: 303-492-5692
Fax Number:
* Email: autumn.coleman@colorado.edu

* Signature of Authorized Representative: Autumn Coleman
* Date Signed: 11/27/2024

BUDGET INFORMATION - Non-Construction Programs

OMB Approval No. 4040-0006
Expiration Date 02/28/2025

SECTION A - BUDGET SUMMARY						
Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1 . Weather and Air Quality Research	11.459			$930,652.00		$930,652.00
2 .						$0.00
3 .						$0.00
4 .						$0.00
5. Totals				$930,652.00		$930,652.00

SECTION B - BUDGET CATEGORIES					
6. Object Class Categories	GRANT PROGRAM, FUNCTION OR ACTIVITY				**Total (5)**
	(1) Weather and Air Quality Research	(2)	(3)	(4)	
a. Personnel	$66,390.00	$68,994.00	$67,469.00		$202,853.00
b. Fringe Benefits	$27,087.00	$28,713.00	$28,639.00		$84,439.00
c. Travel	$6,415.00	$7,213.00	$7,033.00		$20,661.00
d. Equipment	$0.00	$0.00	$0.00		$0.00
e. Supplies	$0.00	$0.00	$0.00		$0.00
f. Contractual	$0.00	$0.00	$0.00		$0.00
g. Construction	$0.00	$0.00	$0.00		$0.00
h. Other	$176,974.00	$177,124.00	$179,378.00		$533,476.00
i. Total Direct Charges (*sum of 6a-6h*)	$276,866.00	$282,044.00	$282,519.00		$841,429.00
j. Indirect Charges	$33,115.00	$27,938.00	$28,170.00		$89,223.00
k. TOTALS (*sum of 6i and 6j*)	$309,981.00	$309,982.00	$310,689.00		$930,652.00
7. Program Income					

Standard From 424A (Rev. 7-97)
Prescribed by OMB Circular A-102

SECTION C - NON-FEDERAL RESOURCES					
(a) Grant Program		(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS
8 . Weather and Air Quality Research					$0.00
9 .					$0.00
10 .					$0.00
11 .					$0.00
12. TOTAL (sum of lines 8-11)					
SECTION D - FORECASTED CASH NEEDS					
13. Federal	**Total for 1st Year**	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
	$309,981.00	$77,495.25	$77,495.25	$77,495.25	$77,495.25
14. Non-Federal					
15. TOTAL (*sum of lines 13 and 14*)	$309,981.00	$77,495.25	$77,495.25	$77,495.25	$77,495.25
SECTION E - BUDGET ESTIMATES OF FEDERAL FUNDS NEEDED FOR BALANCE OF THE PROJECT					
(a) Grant Program		FUTURE FUNDING PERIODS (Years)			
		(b) First	(c) Second	(d) Third	(e) Fourth
16 . Weather and Air Quality Research		$309,982.00	$310,689.00		
17 .					
18 .					
19 .					
20. TOTAL (*sum of lines 16-19*)		$309,982.00	$310,689.00		
SECTION F - OTHER BUDGET INFORMATION					
21. Direct Charges: 841,429			22. Indirect Charges: 89,223		
23. Remarks: The F&A rate for off-campus research is 26% of MTDC per DHHS agreement dated 7/23/2024.					

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FORM **CD511** U.S. DEPARTMENT OF COMMERCE
(REV 1-05)

CERTIFICATION REGARDING LOBBYING

Applicants should also review the instructions for certification included in the regulations before completing this form. Signature on this form provides for compliance with certification requirements under 15 CFR Part 28, 'New Restrictions on Lobbying.' The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of Commerce determines to award the covered transaction, grant, or cooperative agreement.

LOBBYING

As required by Section 1352, Title 31 of the U.S. Code, and implemented at 15 CFR Part 28, for persons entering into a grant, cooperative agreement or contract over $100,000 or a loan or loan guarantee over $150,000 as defined at 15 CFR Part 28, Sections 28.105 and 28.110, the applicant certifies that to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying.' in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

Statement for Loan Guarantees and Loan Insurance

The undersigned states, to the best of his or her knowledge and belief, that:

In any funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this commitment providing for the United States to insure or guarantee a loan, the undersigned shall complete and submit Standard Form-LLL, 'Disclosure Form to Report Lobbying,' in accordance with its instructions.

Submission of this statement is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required statement shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure occurring on or before October 23, 1996, and of not less than $11,000 and not more than $110,000 for each such failure occurring after October 23, 1996.

As the duly authorized representative of the applicant, I hereby certify that the applicant will comply with the above applicable certification.

* NAME OF APPLICANT
The Regents of the University of Colorado

* AWARD NUMBER
NOAA-OAR-WPO-2025-28603

*PROJECT NAME
Improving Smoke Predictions in NOAA’s Rapid Refresh Forecast

Prefix: * First Name: Autumn Middle Name:
* Last Name: Coleman Suffix:
* Title: Proposal Analyst

*** SIGNATURE:**
Autumn Coleman

*** DATE:**
2024-11-27

ASSURANCES - NON-CONSTRUCTION PROGRAMS

OMB Approval No. 4040-0007
Expiration Date 02/28/2025

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee- 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis- Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327- 333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93- 205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

19. Will comply with the requirements of Section 106(g) of the Trafficking Victims Protection Act (TVPA) of 2000, as amended (22 U.S.C. 7104) which prohibits grant award recipients or a sub-recipient from (1) Engaging in severe forms of trafficking in persons during the period of time that the award is in effect (2) Procuring a commercial sex act during the period of time that the award is in effect or (3) Using forced labor in the performance of the award or subawards under the award.

* SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	* TITLE
Autumn Coleman	Proposal Analyst
* APPLICANT ORGANIZATION	* DATE SUBMITTED
The Regents of the University of Colorado	11-27-2024

Standard Form 424B (Rev. 7-97) Back

Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS- Smoke) Model Through Advanced Fuel Moisture lntegration

Notice of Funding Opportunity: NOAA-OAR-WPO-2025-28603

Competition Priority: AQRF-3: Improved spatial and temporal estimates of anthropogenic and natural pollutant emissions, including smoke from wildland fires and small fires and other potential sources of model biases, using NOAA satellite remote sensing and other data sources and through improved representation of emission physics coupled to the land surface model.
Project Period: August 1st, 2025 – July 31st, 2028

Lead Pl: Johana Romero Alvarez, Research Associate, Cooperative Institute for Research in Environmental Sciences (CIRES) at University of Colorado Boulder. NOAA, Global Systems Laboratory, 325 Broadway, Boulder, CO 80305
(505) 333-8399, leidy.romeroalvarez@colorado.edu
Lead Pl - Authorized Institutional Representative: Autumn Coleman, Proposal Analyst, CIRES, University of Colorado Boulder, 216 UCB, Boulder, CO 80309-0001
303-492-5692, Autumn.coleman@colorado.edu

Co-Pl: Timothy Juliano, Project Scientist II, NSF, NCAR, 303-497-8424, tjuliano@ucar.edu **Co-Pl – Authorized lnstitutional Representative:** Tina Campbell, Program Administrator III, NSF NCAR , 3090 Center Green Dr., Boulder, CO 80301. 303.497.2871, Campbell@ucar.edu

Co-ls: Pedro Jimenez Munoz, Project Scientist III, NSF, NCAR 303-497-8201, jimenez@ucar.edu; Ravan Ahmadov, Physical Scientist, NOAA Global Systems Laboratory, ravan.ahmadov@noaa.gov

Collaborators: Jordan Schnell (CIRES, NOAA/GSL}, Eric James (NOAA/GSL}, Haiqin Li (CIRES, NOAA/GSL}, Jianping Huang (NOAA/NWS/EMC}.

Budget Summary Table:

Organization	Year 1	year 2	year 3	Total
University of Colorado Boulder	$135,482	$135,390	$136,517	$407,389
NOAA GSL	$40,017.31	$40,017.31	$39,309	$119,343.62
Subaward: NCAR	$174,499	$174,592	$174,172	$523,263
Total	$349,998.31	$349,999.31	$349,998	$1,049,995.62

Starting Readiness Level: RL 5 **Ending Readiness Level: RL 7**

*1f this proposal is funded, the University of Colorado requests that the award not be linked to or sent via the Cooperative Agreement (Award NA22OAR4320151}

B. Abstract

Title: Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration

Project goal: Improve wildland smoke emissions in NOAA's RRFS-Smoke model by integrating a Fuel Moisture Content (FMC) product with meteorological and land surface data to enhance fire weather predictions and refine the emissions framework. Additionally, integrate the UFS Community Fire Behavior Model (UFS CFBM) into RRFS-Smoke while minimizing performance overhead.

Problem opportunity statement: Wildland smoke emissions are essential inputs to smoke modeling, driven by weather and fuel characteristics. However, operational models often rely on previous-day emissions, simplifying meteorological factors like precipitation and ignoring critical aspects such as FMC and wildfire dynamics, significantly limiting forecast accuracy.

Methodology/Activities to be performed: (i) Integrate an FMC product into RRFS-Smoke to enhance fire weather predictions and refine the emissions framework. (ii) Develop combustion phase-specific emissions based on literature-derived FMC thresholds. (iii) Incorporate UFS CFBM to enable simultaneous PM2.5 smoke predictions from the CFBM and the enhanced RRFS-Smoke framework.

Primary Project Products/Outputs: (i) Preprocessing software for model-ready FMC data. (ii) An enhanced Hourly Wildfire Potential (HWP) index incorporating FMC for better predictions in moisture-sensitive areas. (iii) A dynamic emissions module using FMC, HWP, fuel types, and emission factors to improve smoke estimates. (iv) An integrated RRFS-Smoke/CFBM system accounting for wildfire behavior-driven smoke emissions.

Expected Results, Outcomes, and Benefits: We will advance NOAA's smoke modeling by improving plume injection accuracy, smoke-weather interactions, and emissions predictions, increasing forecast reliability. These advancements will benefit wildfire management, air quality planning, and support the integration of advanced tools into operational systems. Accounting for CFBM-predicted smoke emissions will further strengthen RRFS-Smoke capabilities.

Intended Beneficiaries and Recipients: Our outputs focus on smoke prediction and aim to benefit a wide range of stakeholders, including forecasters, firefighters, aviation professionals, federal and state air quality agencies, and researchers. These groups rely on HRRR-Smoke and RRFS-Smoke products to make informed and effective decisions.

C. Problem/Opportunity Statement

Introduction to Wildfires and Smoke. In recent decades, wildland fires, or "wildfires", have become more frequent and intense, leading to deadly, costly events, elevated PM2.5 levels, and stronger smoke-radiation-cloud feedback. Notable examples include California's 2020 August Complex fire and Canada's 2023 wildfire season. As climate change intensifies these events, accurate emissions estimates are critical to assess air pollution, human exposure, and fire-meteorology interactions.

Wildfire smoke consists of carbonaceous aerosols from the incomplete combustion of fuels, influenced by fuel type, moisture content, and combustion phase. As a wildfire evolves and spreads through various ecosystems, these factors, along with fuel arrangement and ignition patterns, determine the biomass consumed and the type of combustion (i.e., flaming or smoldering) (Urbanski et al., 2022). Pre-ignition pyrolysis, flaming combustion, and smoldering release aerosols with distinct properties. Smoldering emits higher particulate matter (PM) due to lower combustion efficiency. Dense, moisture-laden fuels promote smoldering, while drier, smaller fuels encourage flaming combustion, resulting in complex smoke profiles that vary with ecosystem conditions (Chen et al., 2007, 2010; Urbanski et al., 2008). The modified combustion efficiency (MCE) is a key indicator of the combustion phase, with values above 0.9 indicating flaming combustion and below 0.9 indicating smoldering combustion (Akagi et al., 2011). For certain chemical species, the emission factor (EF), defined as the fraction of fuel mass burned, depends on MCE at high values, while others stabilize at a minimum EF with little or no dependence beyond this threshold (Fiddler et al., 2024).

Wildfire Smoke Modeling Forecasting. Numerical weather prediction (NWP) models are commonly used to forecast wildfire smoke evolution, employing two primary approaches for estimating emissions. The first approach is satellite-based, typically using fire radiative power (FRP) as a proxy for estimating smoke production. FRP represents the radiant energy released by a fire and is linearly correlated with biomass consumption (Wooster, 2002). The second approach calculates emissions interactively by incorporating a fire behavior model into the NWP system, allowing direct calculation of fuel consumption and its link to smoke emissions. Smoke is represented in both methods usually as either a simple tracer, like PM2.5 (PM less than 2.5 microns in diameter), or as a complex mixture of aerosol types that may undergo chemical transformation (e.g., secondary organic aerosol).

Since 2016, NOAA's HRRR-Smoke model has provided critical smoke forecasts for CONUS using a 3 km grid resolution. Recognized for its efficiency, the model uses satellite-derived FRP data to estimate emissions with a constant EF and a prescribed combustion state partition (Ahmadov et al., 2017). In this approach, smoke is treated as a passive tracer, with emissions and plume rise parameterized (Freitas et al., 2007, 2010). This enables NWP physics to simulate smoke transport, evolution, and radiation impacts. However, its reliance on daily persistence oversimplifies the complex interactions between meteorology and fire behavior, limiting forecasting accuracy. Forecasting methods incorporating meteorological variables and fire weather indices promise to improve short-term predictions of fire activity and smoke emissions (Giuseppe et al., 2017; Graff et al., 2020; Peterson & Wang, 2013; Romero-Alvarez et al., 2024).

Similarly, measurements and laboratory experiments indicate that smoke production varies significantly with factors such as fuel type (e.g., Prichard et al., 2020) and combustion state (e.g., (McMeeking et al., 2009). Increased fuel moisture content (FMC) reduces combustion efficiency, shortens the flaming phase, and extends the smoldering phase before ignition (Chen et al., 2010). As a result, EFs are heavily influenced by the combustion state. As shown in Table 1, PM2.5 emissions per kilogram of fuel consumed during the smoldering phase can be more than double those of the flaming phase. However, operational systems often approximate or overlook these factors, leading to biases in smoke production predictions.

Vegetation type	EF flaming		EF smoldering	
	Mean	SD	Mean	SD
Conifer forest	19	10.5	28.0	16.7
Hardwood forest	9.4	5.0	37.7	20.8
Mixed-wood forest	14.6	4.0	17.6	5.1
Shrublands	9.3	5.1	36.6	21.1
Shrublands and grasslands	10.7	6.5	36.7	20.4
Grasslands	13.3	8.2	38.1	0

Table 1. *Emission factors for flaming and smoldering phases obtained using the U.S. Forest Service Smoke Emissions Reference Application (SERA, https://depts.washington.edu/nwfire/sera/). Units are in g PM2.5 per kg^{-1} of dry matter. Highlighted values show large differences for conifer forests and grasslands.*

The Community Fire Behavior Model (CFBM). A recent UFS development relevant to this proposal is the implementation of a state-of-the-art fire behavior model in the Unified Forecast System (UFS), known as the CFBM (Jimenez y Munoz et al., 2024). CFBM is based on the WRF-Fire model, originally developed at NCAR and implemented in the Weather Research and Forecasting (WRF) system. Developed under a NOAA project (award number NA22OAR4590514, performance period August 1, 2022 – July 31, 2025) led by co-PI Jimenez, CFBM utilizes high-resolution fuel and topography data from Landscape Fire and Resource Management Planning Tools (LANDFIRE) and NASA's Shuttle Radar Topography Mission, respectively. This data enables explicit computation of 2D fire spread and fuel consumption using semi-empirical parameterizations, facilitating two-way feedback between fire evolution and atmospheric conditions. In CFBM, the 2D fire grid is refined relative to the atmospheric grid, adding minimal computational overhead once parallelization is fully implemented at the conclusion of the ongoing NOAA WPO project. Currently, CFBM treats smoke PM2.5 as a tracer, with a mass production rate equivalent to 2% of the fuel consumed (EF = 20 g PM2.5/kg fuel). This is notably lower than the EF used in U.S. Forest Service tools, such as the Fire Emission Production Simulator (EF = 66.8 g/kg; (Anderson et al., 2004)). However, the use of a constant EF oversimplifies the complexity, as studies show PM2.5 EFs vary significantly with fuel characteristics (Prichard et al., 2020). To address this limitation, a NOAA project funded by JPSS (award number NA21OAR4310383, with a performance period ending in September 2025) is actively investigating the relationship between FMC, combustion states, and smoke production, with the goal of implementing an initial capability.

Balancing Accuracy and Computational Efficiency. For an operational modeling system, such as HRRR-Smoke, addressing these challenges requires balancing computational cost and simulation accuracy. While physics-based models can represent smoke production accurately, they are computationally intensive and impractical for operational use. Conversely, simplified empirical models are computationally efficient but sacrifice accuracy. Coupled fire-weather models (e.g., Clark et al., 2004; Coen et al., 2013; Jimenez y Munoz et al., 2024; Mandel et al., 2011), like the CFBM, offer a middle ground, balancing accuracy and cost effectively for both research and operational applications.

The RRFS-Smoke Model. Recently, NOAA's Global Systems Laboratory (GSL), Environmental Modeling Center (EMC), and partners developed an experimental forecast model called RRFS-Smoke, based on the Rapid-Refresh Forecasting System (RRFS) weather model. The new model introduces key advancements over HRRR-Smoke, including improved fire plume rise and dry and wet removal parameterizations (see https://rapidrefresh.noaa.gov/RRFS-SD/ and https://rapidrefresh.noaa.gov/monet_rrfs_verif/ for model output and verification).

A major improvement in RRFS-Smoke over the HRRR-Smoke model is the incorporation of **hourly FRP data from the RAVE emissions product**, **which offers improved temporal resolution compared to traditional polar-orbiting satellite data** (Li et al., 2022). This product combines temporally resolved FRP from the Advanced Baseline Imager (ABI) (Schmit et al., 2017) onboard the Geostationary Operational Environmental Satellite (GOES) with high spatial resolution (375 m) FRP from the Visible Infrared Imaging Radiometer Suite (VIIRS) (Csiszar et al., 2014; Giglio et al., 2016) on the Joint Polar Satellite System (JPSS) satellites.

The emissions module uses the previous day's fire location, which has been proven to be a key component in providing reliable next-day fire spread forecasts in machine learning models (Huot et al., 2022; Thapa et al., 2024; Wang et al., 2022). **Additionally, an Hourly Wildfire Potential (HWP) index (James et al., 2024; under review) predicts fire weather potential at each model timestep using meteorological variables such as a wind gust diagnostic, solar radiation, 2-m dewpoint depression, precipitation, and soil moisture. The HWP modulates smoke emissions and FRP at each timestep, which in turn determines the fire heat flux** (Romero-Alvarez et al., 2024). The fire heat flux is a key parameter to estimate the plume injection height. Note that plume rise is updated hourly within the model.

Figure 1 shows how the diurnal patterns of satellite FRP and estimated HWP align closely, displaying consistency in day-to-day variations where increases in FRP generally coincide with rises in HWP, and vice versa. It also highlights the decline in fire activity following precipitation events after August 9.

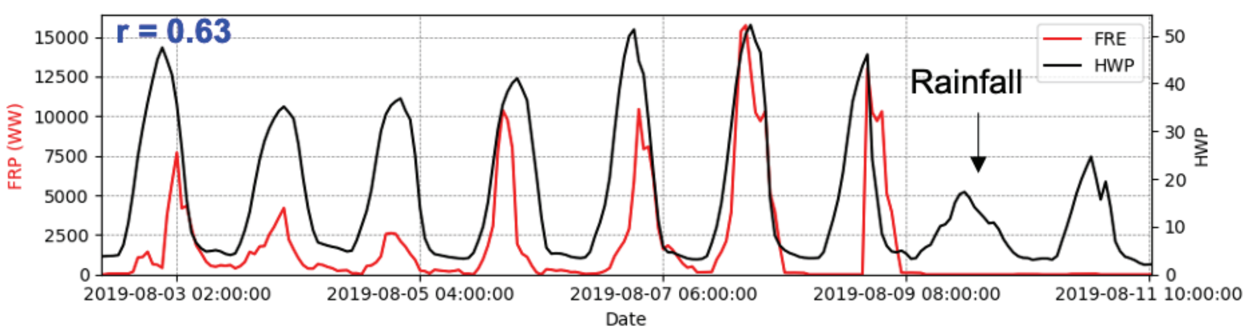


Figure 1. *Satellite RAVE FRP and forecasted HWP comparison for the Williams Flats fire. Note that FRP is the sum of values within the fire area, while HWP represents the average value for the pixels with FRP observations within the fire area.*

Compared to the traditional persistence approach, the current FRP/HWP smoke emission method in RRFS-Smoke reduced mean biases in RRFS-Smoke by 8% across the CONUS domain and by 22% in EPA Region 10, during the 2019 Western wildfires (see Figure 2 for a PM2.5 time series example at Spokane E Broadway, Washington State, impacted by the Williams Flats Fire that burned from August 2-10).

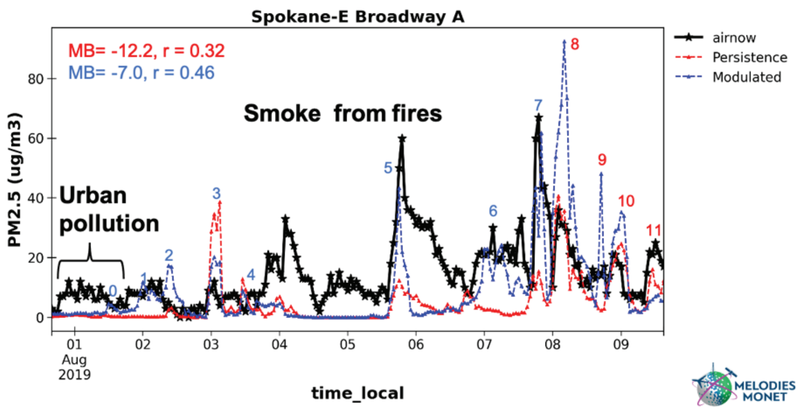


Figure 2. *Time series comparing observed PM2.5 concentrations from AirNow with smoke PM2.5 simulations from RRFS-Smoke using two methods: the persistence and the modulated persistence approach (HWP-informed FRP). The numbered points indicate cases where one approach performed better, with the modulated persistence approach capturing 7 out of 11 smoke peaks. Note that no meteorological DA was used here. PM2.5 included only smoke for wildfires.*

However, high HWP values do not always correspond to large FRP values (see Figure 1, Aug 3–5), indicating the influence of additional factors such as fuel FMC, type, and/or load. **Omitting variables like FMC can lead to overestimates of fire activity or failures to detect fire danger in areas with rapidly drying fuels.** For example, HWP might indicate high fire potential in regions with relatively high FMC, resulting in false alarms or failure to identify fires where vegetation is drying rapidly. Additionally, weak HWP values may lead to underestimations of smoke production and FRP, leading to lower-than-expected forecasts for plume height and smoke transport distances. **These discrepancies underscore the importance of incorporating FMC data into the HWP framework to classify wildfire potential under fire-prone conditions more accurately.** Incorporating such metrics could significantly enhance fire danger forecasting and assessments of landscape flammability (Mcnorton & Di Giuseppe, 2024).

FMC retrievals. Achieving accurate measurements of FMC has been a longstanding challenge. However, our team has recently developed a dynamic, CONUS-wide dead and live FMC product gridded at 375 x 375 m resolution.

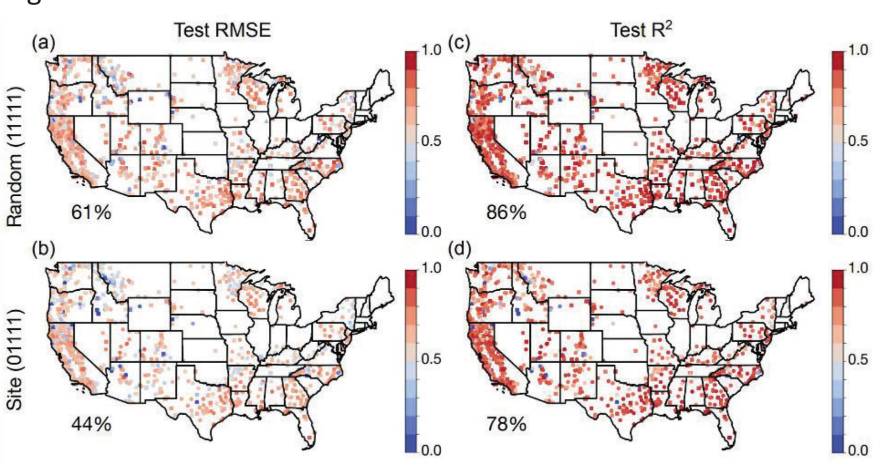


Figure 3*: Daily skill scores of the 10 h dead FMC product for (a,b) root-mean square error (RMSE) and (c,d) coefficient of determination (R^2) for (a,c) random and (b,d) site splits. Red (blue) means better (worse) skill relative to climatography. The figure is adopted from Schreck et al. (2023; Fig. 7).*

The product combines meteorological and land surface data from NOAA's HRRR model, VIIRS, and GOES retrievals, along with the XGBoost machine learning model (Chen et al., 2016), enabling the estimation of the diurnal evolution of FMC. It provides 10-hour (h) dead and live FMC estimates, expressed as the proportion of water relative to the total dry mass of vegetation, at satellite overpasses (Schreck et al., 2023). The 10 h classification refers to the fuel's response time to moisture changes and its diameter (e.g., small dead vegetation materials such as branches, twigs, and plant debris). This product has demonstrated significant improvements over climatology at most CONUS sites (see Figure 3). Demonstration is available at (https://www.arcgis.com/apps/dashboards/df67eb22d5f34b6e9808beed2d4c7f51).

Project objectives. This collaborative project, led by PI Johana Romero with co-PI Juliano and co-I Jiménez at NCAR, adopts a two-step strategy to enhance RRFS-Smoke emissions.

1. **Enhancing the HWP/FRP Method:** We will retrain the HWP index to incorporate live and dead Fuel Moisture Content (FMC) data, vegetation types, and fuel load. Vegetation-specific FMC thresholds will be established to link FMC with combustion phases (smoldering and flaming), guiding the development of a dynamic emissions framework.
2. **Integrating the CFBM into RRFS-Smoke:** The CFBM will be integrated into RRFS-Smoke, enabling seamless interaction with the enhanced emissions framework. This integration will allow simultaneous activation of FRP/HWP-based and CFBM emissions, fully leveraging the UFS-based architecture of RRFS-Smoke.

These advancements aim to refine NOAA's wildfire smoke modeling by incorporating detailed fuel, meteorological, and land surface data, resulting in more accurate emissions forecasting.
Our team's extensive and complementary expertise with RRFS-Smoke, CFBM, and their UFS foundation uniquely positions us to execute this project. PI Johana Romero brings significant experience in supporting the development of the smoke component into RRFS. Her key contributions include advancing the RRFS-Smoke/Dust emissions pre-processor and optimizing workflows for satellite-based fire emissions and smoke cycling. Johana's work has seamlessly connected GSL research with EMC experimentation, enabling the transition of RRFS-Smoke/Dust to NOAA's WCOSS2 HPC platform. Additionally, her postdoctoral research on biomass burning emissions, using HRRR-Smoke and WRF-Chem, tackled inventory uncertainties impacting air quality forecasts. **Co-PI Juliano and co-I Jimenez have extensive experience with NWP model development for a number of applications, including WRF-Fire and CFBM, with co-I Jimenez being the lead developer of the CFBM**. With this background, we anticipate a smooth and successful integration of the proposed UFS fire enhancements.

D. Methods and Activities

To effectively address our proposed research objectives, we outline the collaborative activities shown in Figure 4. Some of these tasks will be carried out concurrently, as they are independent. Detailed methods and activities for these tasks are provided in the following subsections.

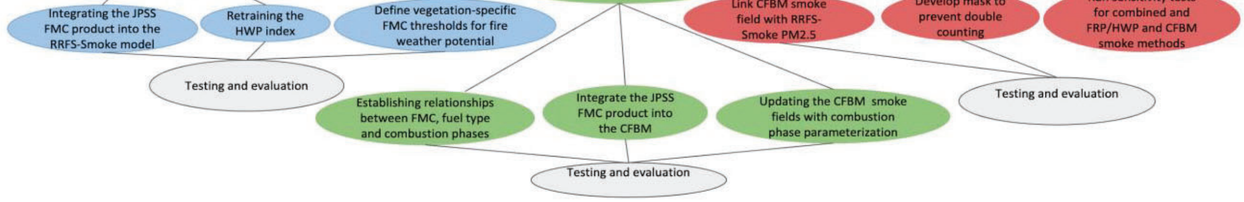


Figure 4. *Flowchart for the proposed activities*

Task 1: Refine the HWP/FRP method for estimating smoke emissions in RRFS-Smoke

The goal of this task is to **integrate the gridded FMC product with the RRFS-Smoke system**. Currently, RRFS-Smoke's preprocessing tool interpolates satellite FRP data onto predefined CONUS and North American grids that include Alaska and Central America. Since the FMC product is gridded at a fixed resolution in Lambert Conformal projection and provided in NetCDF format, we will apply our interpolation routine to align FMC data with the initial CONUS grid. This **FMC data will then inform the RRFS-Smoke emissions module to (i) improve the predictability of the HWP index and (ii) improve PM2.5 smoke emissions estimation.**

For (i), we **will retrain the HWP index following a similar machine-learning framework (James et al., 2024) to establish a mathematical relationship between the HWP index and new inputs, including live and dead FMC data, vegetation type, and fuel load from LANDFIRE**. The fire activity (FRP) data will be sourced from the RAVE dataset, with a focus on the years 2023 and 2024. The impact of FMC on the HWP will be assessed by comparing fire events and predicted HWP for the 2019 and 2020 fire seasons, using FRP counts from the RAVE database.

We will establish vegetation-specific FMC thresholds for fire weather potential by analyzing historic fire and non-fire detected areas across various fuel types, considering live and dead FMC levels, HWP maps, fuel amounts, and FMC climatology, following methodologies described in McNorton & Di Giuseppe (2024). This will allow us to better define wildfire potential levels (e.g., "extreme," "high," "moderate," etc.) tailored to the moisture dynamics of specific vegetation types. Live FMC is primarily influenced by vegetation health and environmental factors such as evapotranspiration (Jolly et al., 2014); while dead FMC is more responsive to immediate weather conditions. This responsiveness is particularly critical for smaller fuels, such as 1 h and 10 h fuels. While our analysis focuses on these smaller fuels, we recognize that larger fuels, such as 100 h and 1000 h fuels, play an essential role in smoldering and are less sensitive to rapidly changing weather conditions (Matthews, 2014). **The live FMC product is currently undergoing testing, with plans to continue its evaluation and move toward implementation**. Additionally, the product is being demonstrated in real time at https://fmc.ral.ucar.edu/ , and efforts are in progress to secure resources for its transition to operational use.

For (ii), since RRFS-Smoke forecasts HWP at each time step within a forecast cycle**, we will update the HWP subroutine to incorporate FMC, enabling it to be read at model initialization and dynamically estimated over the forecast lead time** (up to 60 hours). **The diurnal evolution of dead FMC during the forecast period will be predicted using land surface model parameters and meteorological variables, such as relative humidity and soil moisture, which are effective predictors** (Schreck et al., 2023). Algorithms for this prediction will need to be defined to ensure accurate FMC estimation. In contrast, live FMC will remain static during the forecast period. The predicted diurnal evolution of FMC will be verified against the JPSS FMC product. Additional tests will be conducted to ensure seamless integration of FMC predictions into HWP calculations.

The current HWP formulation relies solely on meteorological parameters. We anticipate that this new framework, with inline FMC-informed HWP, will enhance smoke emissions estimates by better modulating FRP and smoke emissions.

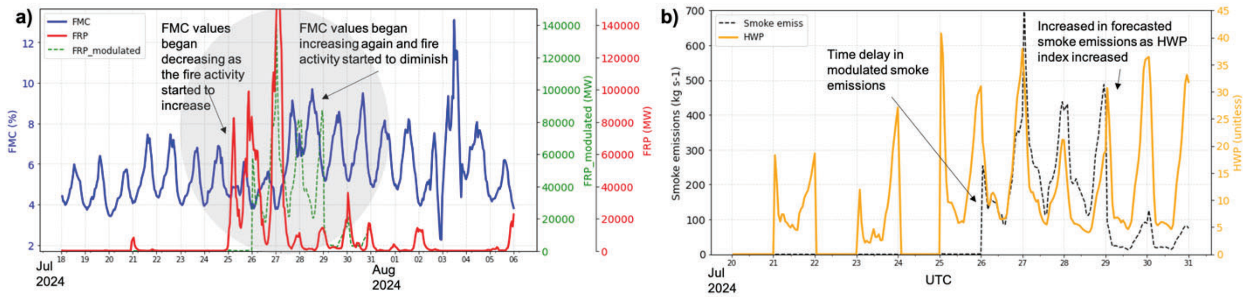


Figure 5. *Time series comparison for the Park Fire 2024 showing: (a) Satellite FRP, model FRP, and FMC; and (b) model HWP and modulated smoke emissions. The modeled parameters correspond to the 00z cycle with a lead time of 24 hours. Note the differing time axes. Additionally, there is a time delay in the forecasted and modulated smoke emissions due to the model's reliance on previous day satellite fire detections, as fires are not directly ignited in the model but depend on satellite observations.*

Figure 5a demonstrates an expected negative correlation between decreases in FMC (blue) and fire activity, as indicated by satellite FRP (red), during the onset of the 2024 Park Fire in California. The figure also highlights variability in forecasted FRP (green) estimated using the current RRFS-Smoke emissions framework, which generally aligns with observed increases in fire activity (red). However, Figure 5b reveals that sustained high HWP index values lead to significantly larger than observed predicted smoke emissions (orange) on the 28th–29th, while actual fire activity appears reduced (red line Figure 5a). This discrepancy is likely due to an increase in the 10 h FMC, potentially caused by an overnight rise in relative humidity, as small fuels (such those represented in the 10 h FMC) are highly responsive to immediate changes in weather conditions. The impact of fire on FMC will not be included in this framework (i.e., one-way coupling only). Additionally, while there are no current plans to extend the JPSS FMC product to include 100 and 1000 h fuels, these components remain areas for potential exploration if time allows.

We will conduct retrospective RRFS-Smoke simulations focused on the Williams Flats fire, August 2019, and other significant Western U.S. wildfires observed during FIREX-AQ to assess the accuracy of the new approach for predicting FRP and fire emissions, air quality impacts, aerosol loading, and the vertical structure of smoke, ensuring a comprehensive evaluation of our enhancements. The NOAA Model Analysis Tool Suite (MATS, https://esrl.noaa.gov/gsd/mats/) and Model and Observation Evaluation Toolkit (MONET, https://www.arl.noaa.gov/research/surface-atmosphere-exchange-home/tools-and-products/monet/) will be used to evaluate the meteorology and aerosol fields.

Task 2. Linking FMC with combustion phases

The current RRFS-Smoke model does not simulate fire ignition or spread but relies on satellite-detected fires, maintaining fire activity throughout the forecast period (up to 60 hours) based on vegetation type. Fire intensity (e.g., FRP) and duration are adjusted by the HWP. Emission factors (EFs) are static, with weights for smoldering and flaming assigned by fuel type, and higher EF values allocated to tundra areas rich in organic soil. Groundwork from Task 1 will enable the use of FMC to dynamically inform EF selection during runtime. **Lookup tables with FMC thresholds will be derived from literature on controlled burns of biomass, soil samples (e.g., Chen et al. (2007); Chen et al. (2010)), and living vegetation (e.g., May et al. (2019)), as well as more recent**

field measurements (e.g., Reisen et al. (2018) and Fiddler et al. (2024) and LANDFIRE fuel types. These resources provide critical insights into how FMC impacts PM2.5 emissions during combustion, aligning with findings that fuel type significantly influences burning behavior and emissions (Garg et al., 2024). We anticipate that cross-referencing modeled FMC with literature-derived thresholds will enable more realistic EF selection and better integration of emissions with plume rise by allowing dynamic classification of combustion phases during runtime.

The system will also incorporate the fire age parameter in RRFS-Smoke, which tracks active fire pixels over 24 hours to adjust EFs. Additionally, the framework will inform the plume rise scheme on the vertical allocation of the smoke emissions. Smoldering emissions typically remain in the lowest model layer, whereas flaming emissions are lofted to higher altitudes due to heat-driven buoyancy. It is important to note that this framework does not account for the fire's dynamic influence on FMC. While the framework primarily employs 10 h FMC, it provides a foundation for future refinements.

Distinguishing between flaming and smoldering combustion phases in air quality modeling remains challenging due to the complexity and variability of fire behavior across landscapes (Andreae, 2019). The type of fuel burned (e.g., vegetation, woody debris) plays a critical role in determining the dominance of smoldering or flaming phases (Fiddler et al., 2024). Fuel moisture further influences the prevalence of either phase (Fiddler et al., 2024; Gkatzelis et al., 2024). Moreover, it is well-established that smoldering and flaming emissions can occur simultaneously within a plume (Gkatzelis et al., 2024). By integrating FMC with fuel type, the proposed framework acknowledges these processes while addressing the computational constraints of operational air quality models. This approach represents a significant step toward overcoming current limitations by leveraging the extensive range of emission factors documented in measurement studies for different combustion phases, rather than relying on the static values traditionally used in most models. We will compare our findings with the values summarized in the review by Andreae (2019) and Prichard et al. (2020).

As in Task 1, testing will focus on Western U.S. fires observed during the 2019 FIREX-AQ campaign, as it provides ground-truth data for smoke mass fluxes derived from airborne lidar and in situ measurements, as well as measured EFs (Gkatzelis et al., 2024) and burning state (Fiddler et al., 2023). Additionally, the 2019 wildfire season was considered low-fire 2019 presenting contrasting moisture conditions due to heavy spring rains that resulted in wetter-than-normal grasslands and forests. Testing will also consider the very dry 2020 season, which led to widespread fires. The MONET tool will be used to verify PM2.5 as well as Aerosol Optical Depth (AOD) using satellite retrievals from the Moderate Resolution Imaging Spectroradiometer (MODIS). After testing and evaluating retrospective runs, we will real-time test and evaluation following the same framework currently used on RRFS-Smoke. NOAA GSL will provide HPC computing and storage resources to support this development.

To prepare for Task 3, **we will align the CFBM smoke production with the new approach in RRFS-Smoke**. First, we will connect the gridded FMC product with the CFBM, and, specifically, the parameterization of the rate of spread (ROS; Rothermel, 1972). In CFBM, the Fire National Unified Operational Prediction Capability (NUOPC) initializes the fire grid. Since the CFBM sets the FMC field during initialization, it is in this part of the code where we will integrate the FMC retrievals. Similar to Task 1, we will utilize standard interpolation routines to interpolate the FMC retrievals onto the fire grid, which is refined relative to the atmospheric grid. Then, we will verify these code modifications using idealized simulations in a controlled environment. For our present WPO project, we have developed a simplified testing framework that allows us to run the CFBM in a standalone mode with offline atmospheric data. We will use this framework to verify that the gridded FMC field is read in properly and passed to the FBM, thus affecting the fire ROS. Finally, we will adjust the CFBM EFs in each grid cell in a similar way as proposed for RRFS-Smoke; that is, based on fuel type following Prichard et al. (2020) and adjusted for FMC. We note that fuel load is already implicitly accounted for in CFBM since it computes emissions directly from the mass of fuel burned.

Task 3. Enable simultaneous activation of FRP/HWP and FBM smoke

Under this task, we aim to link the CFBM's smoke PM2.5 field with the RRFS-Smoke PM2.5 field such that both can be active within the same simulation. It is important to note that the CFBM will be exclusively used for wildfires. The main benefit of this approach is to allow the CFBM model to produce smoke emissions based on the simulated fire evolution. In this way, smoke PM2.5 emissions can evolve more physically based on atmospheric conditions, topography, and fuel conditions. We aim to provide user flexibility to consider the smoke PM2.5 field from only RRFS-Smoke or from a combined RRFS-Smoke/CFBM approach. **In the future, we expect this capability to be useful for real-time forecasting when using an extended fire domain that covers a large fraction of CONUS.**

To complete this task, the CU CIRES, NOAA, and NCAR teams will coordinate closely. It will be important to prevent double counting of smoke emissions if the CFBM is active over a region. A logical way to address this is to develop a new 2D array to mask grid cells where the CFBM emits smoke. This masked array will then be exchanged with the Aerosol NUOPC because this is the part of the UFS code that handles smoke generation for RRFS-Smoke. As a first test, we will use a single fire subdomain and mask the entire region. Since the CFBM will not be active outside of the fire subdomain, this will guarantee that we are not double counting. If time allows, we will explore other options, such as using a minimum radius threshold computed from the CFBM's level-set function. This will require careful consideration of spatiotemporal discrepancies between emissions predicted by the CFBM and those detected by the FRP/HWP approach in RRFS-Smoke.

We propose to use the Williams Flats fire and other significant Western U.S. wildfires observed during FIREX-AQ to develop, test, and evaluate the coupling of the CFBM with RRFS-Smoke. Smoke PM2.5 production from the CFBM will be compared to that from the RRFS-Smoke HWP method. Our previous simulations with RRFS-Smoke with the updated HWP approach will serve as our baseline. For each FIREX-AQ case of interest, we will conduct a series of sensitivity simulations with both the RRFS-Smoke HWP and the CFBM smoke emission methods active and using the same domain setup as in Task 2. First, we plan to use a constant value for the FMC based on the fire area-averaged FMC from our gridded dynamic FMC product or local Remote Automatic Weather Stations. This simulation will also use the current CFBM setting of a constant smoke PM2.5 EF. This is how the CFBM is typically run at the time of writing. The second simulation will use the dynamic FMC product as the initial lower boundary condition while keeping the EFs the same. In this way, we can isolate the direct impact of FMC on fire spread and therefore on smoke emissions. The third simulation will be the same as the second one, except we will activate CFBM's fuel moisture model to evolve the FMC field from the initial condition imposed by our gridded dynamic product. The fuel moisture model allows for evolving atmospheric conditions to influence the FMC online during the simulation. The fourth simulation will be the same as the third one, except we will impose spatially variable EFs (based on fuel type) as described in Task 2. The final simulation will be the same as the fourth one, except we will adjust the EFs based on an FMC threshold for smoldering versus flaming combustion.

It will be important to thoroughly verify and validate our CFBM developments with the FIREX-AQ measurements to understand both the direct and indirect impacts of FMC on smoke PM2.5 emissions in the CFBM, and also to directly evaluate the potential benefit of producing smoke emissions in the CFBM versus RRFS-Smoke for a particular fire. We anticipate that coupling the CFBM with RRFS-Smoke will lead to a more realistic representation of smoke emissions. The key benefit of this coupling is that the CFBM explicitly computes the fire evolution, based on two-way fire-atmosphere feedbacks, and therefore does not have to rely on assumed relationships between meteorological parameters and smoke emissions, such as what is currently done with the FRP/HWP approach. Because we will initialize the CFBM with an accurate FMC field from our dynamic product, and update the FMC field online with the fuel moisture model, critical FMC-fire spread-smoke emissions interactions will be included. It is also important to note that the additional cost incurred by adding the CFBM is minimal, thus enhancing the benefit of representing the fire spread and thus emissions more comprehensively.

E. Project Products/Outputs

Our proposed enhancements aim to advance NOAA's wildfire smoke emissions representation and improve smoke forecasting. The primary development work for this proposed project will involve improving the FRP/HWP smoke emissions method within RRFS-Smoke by integrating a novel dead and live FMC product into the HWP algorithm. A second key element is the integration of CFBM smoke with the FRP/HWP-informed method. Given our team's complementary and extensive experience with RRFS-Smoke, CFBM, and their UFS foundation, we anticipate a smooth integration of UFS fire enhancements. Key outcomes of our model enhancements include:

1. Improved fire weather predictions, particularly in fuel-limited environments such as grasslands and shrublands, were fuel drying drives fire activity.
2. Enhanced FRP/HWP-based emissions methods in RRFS-Smoke through FMC integration, refining the HWP index and modulating the diurnal cycle of FRP and smoke emissions.
3. Improved smoke PM2.5 emission estimates using FMC thresholds as proxies for fire combustion states.
4. Public availability of the improved emission framework's subroutines via UFS GitHub repositories.

Progress will be shared through scientific conferences, meetings, and journal publications. The ultimate goal is to implement the enhanced FRP/HWP-FMC-based emissions framework into the next-generation RRFS v2 operational forecast system.

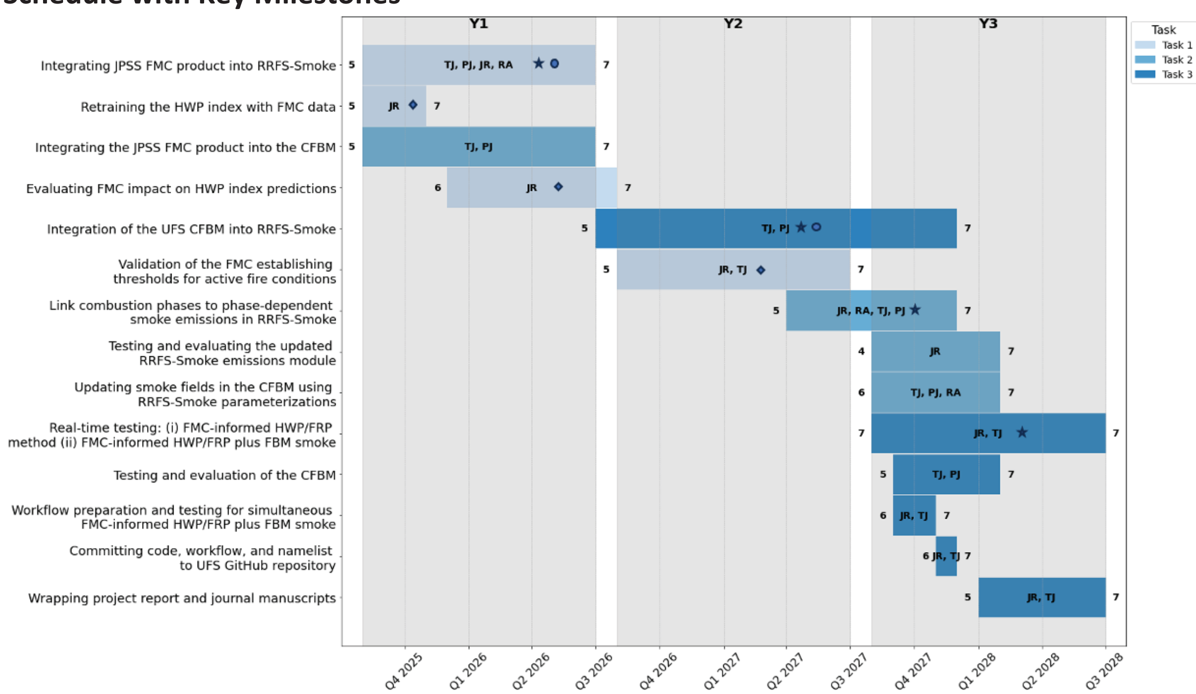
The FMC product has been running in real-time since early 2023. The experimental RRFS-Smoke model, which uses FRP/HWP-based emissions methods, is also evaluated in real-time, and the HWP index is currently under peer review (James et al., 2024). Based on our team's expertise, we classify the project's starting point at RL-5, as FMC and combustion state impacts on smoke

PM2.5 generation in RRFS-Smoke have yet to be implemented and tested. We aim to reach RL-6 by Year 2, following post-emissions enhancements and initial CFBM integration. By Year 3, we target achieving RL-7, laying the groundwork for broader community model implementation.

F. Project Impacts/Benefits, Outcomes, & Recipients

Wildfires in the U.S. impact millions every year, posing direct threats and broader health risks from smoke. Dynamic FMC, essential for predicting fire danger and smoke emissions, is frequently neglected in current forecasting models. Our proposed enhancements aim to elevate NOAA's modeling capabilities by integrating dynamic FMC and refining smoke emissions predictions. We will aim to include the first product of this proposal 'an enhanced FRP/HWP-FMC-based emissions method' into the next generation RRFS v2 operational implementation operated by NOAA/EMC and NOAA/NCO. We anticipate that these improvements will enhance the representation of emissions diurnal cycle and the accuracy of smoke transport, enabling more realistic simulations of interactions between smoke and weather and improving our ability to manage and mitigate the impacts of wildfires.

G. Schedule with Key Milestones



JR= Johana Romero; TJ= Timothy Juliano; PJ= Pedro Jimenez

Additional support: Jordan Schnell ★ ; Haiqin Li ● ; Eric James ◆

Figure 6. *Project schedule with key Milestones*

H. Outreach and Education

To maximize the impact of our research, we will actively disseminate findings through multiple initiatives. Model development updates will be shared at community meetings, such as the American Geophysical Union (AGU) and American Meteorological Society (AMS) annual gatherings. Code updates will be contributed to relevant GitHub repositories, including the UFS repositories hosting the CFBM. Additionally, we plan to publish two open-access, peer-reviewed articles to ensure broad accessibility. A project website will also be developed to provide updates, documentation, and links to resources.

Our findings will be shared with NOAA and NCAR branches through ongoing collaborations. To cultivate the next generation of Numerical Weather Prediction (NWP) modelers, we will support undergraduate and graduate students through mentoring and hands-on training opportunities. These internships, offered through the NOAA Global Systems Laboratory (GSL)/CIRES Internship Project, will be open to all students (https://ciresdiversity.colorado.edu/projects/cires-gsl-internship-project).

I. Diversity, Equity, Inclusion, and Accessibility (DEIA)

In line with our strong commitment to diversity, equity, inclusion, and accessibility (DEIA), this proposed project creates an inclusive research environment, focuses on building partnerships with diverse communities, and ensures fair access to opportunities and outcomes. Our team reflects these values, including early- and mid-career scientists from different genders and nationalities, many of whom bring unique perspectives as individuals who speak English as a second language. The RRFS-Smoke project also addresses the urgent need for wildfire forecasting in Central America and the northern tip of South America—regions heavily affected by wildfires and lacking advanced forecasting tools. The enhanced RRFS-Smoke forecasts will be accessible to both domestic and international users through a public website as current experimental RRFS-Smoke-Dust.

J. Data and/or Software Management Plan

The Global Forecast System (GFS) analysis, Rapid Refresh (RAP) analysis, and RAVE (Regional Advanced Baseline Imager and Visible Infrared Imaging Radiometer Suite Emission) fire emissions will serve as input data for RRFS in this project. These datasets are readily available on NOAA's High-Performance Storage System (HPSS). Retrospective run results will also be stored on HPSS, and raw outputs will be shared with the community upon reasonable request, free of charge for internet delivery. Verification results will be made publicly accessible via NOAA's Model Analysis Tool Suite (MATS) website (https://esrl.noaa.gov/gsd/mats/). Additionally, model outputs from real-time testing, including improved smoke emissions, FRP, HWP, FMC, smoke forecasts, meteorology, and aerosol fields, will be available online.

We will use GitHub to manage the project's code, leveraging its platform for version control and collaboration. All code updates will be contributed to the UFS community GitHub repository (https://github.com/ufs-community/) through Pull Requests (PRs). Submitted PRs will be reviewed by UFS code managers and collaborators, with follow-up commits made to address feedback and comments.

Reference List

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K. Curriculum Vitae (CV)

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Education

- **Ph.D.** Environmental Science, University of East Anglia, UK, July 2020
- **M.S.** Climate Change, University of East Anglia, UK, August 2013
- **B.S.** Environmental Engineering, Universidad de la Salle, Bogotá, Colombia, 2007

Employment

- **04/2022 – Present**: Research Scientist I, CIRES at CU Boulder; NOAA GSL
- **10/2019 – 03/2022**: Postdoctoral Researcher, Chemistry Department, University of Colorado Boulder

Activities relevant to this proposal

- **10/2020 - Present:** key member in the development of NOAA's RRFS-Smoke-Dust model
- **03/2023 - Present:** Collaborating with EPIC on the implementation of Smoke and Dust components into the UFS Short-Range Weather (SRW) Application. Active member of the release committee, representing RRFS-Smoke

Awards

- **Team Member of the Month**, NOAA/Global Systems Laboratory: "Outstanding contributions to the implementation of the smoke forecasting capability within the Rapid-Refresh Forecasting System (RRFS)," May 2024

Publications

- Laura H. Thapa, Pablo E. Saide, Jacob Bortnik, Melinda T. Berman, Arlindo da Silva, David A. Peterson, Fangjun Li, Shobha Kondragunta, Ravan Ahmadov, Eric James, J**ohana Romero-Alvarez**, Xinxin Ye, Amber Soja, Elizabeth Wiggins, Emily Gargulinski. **Forecasting daily fire radiative energy using data-driven methods for air quality forecasting.** (2024) JGR Atmospheres. https://doi.org/10.1029/2023JD040514
- Wei-Ting Hung, Barry Baker, Patrick C. Campbell, Youhua Tang, Ravan Ahmadov, **Johana Romero-Alvarez**, Haiqin Li, Jordan Schnell. **Fire Intensity and Spread Forecast (FIRA): A machine learning-based fire spread prediction model for air quality forecasting applications.** (Submitted, GeoHealth)
- Eric James, Ravan Ahmadov, **Johana Romero-Alvarez**, Georg Grell, Ivan Csiszar. **An hourly wildfire potential index for predicting sub-daily fire activity based on rapidly updating convection-allowing model forecasts.** (Submitted, WAF)
- M. M. Bela, N. Kille, S. A. McKeen, **J. Romero-Alvarez**, R. Ahmadov, E. James, G. Pereira, C. Schmidt, R. B. Pierce, S. M. O'Neill, X. Zhang, S. Kondragunta, C. Wiedinmyer, R. Volkamer. **Quantifying Carbon Monoxide Emissions on the Scale of Large Wildfires**. (2022) GRL. https://doi.org/10.1029/2021GL095831

- Natalie Kille, Kyle J. Zarzana, **Johana Romero Alvarez**, Christopher F. Lee, Jake P. Rowe, Benjamin Howard, Teresa Campos, Alan Hills, Rebecca S. Hornbrook, Ivan Ortega, Wade Permar, I Ting Ku, Jakob Lindaas, Ilana B. Pollack, Amy P. Sullivan, Yong Zhou, Carley D. Fredrickson, Brett B. Palm, Qiaoyun Peng, Eric C. Apel, Lu Hu, Jeffrey L. Collett Jr., Emily V. Fischer, Frank Flocke, James W. Hannigan, Joel Thornton, and Rainer Volkamer. **The CU Airborne Solar Occultation Flux Instrument: Performance Evaluation during BB-FLUX**. (2022) ACS Earth Space Chem. https://doi.org/10.1021/acsearthspacechem.1c00281
- Min Deng, Rainer Volkamer, Zhien Wang, Jefferson Snider, Natalie Kille, and **Leidy Romero-Alvarez. Wildfire Smoke Observations in the Western United States from the Airborne Wyoming Cloud Lidar during the BB-FLUX Project. Part II: Vertical Structure and Plume Injection Height.** (2022) Journal of Atmospheric and Oceanic Technology. https://doi.org/10.1175/JTECH-D-21-0093.1
- **J**ake P. Rowe, Kyle J. Zarzana, Natalie Kille, Tobias Borsdorff, Manu Goudar, Christopher F. Lee, Theodore K. Koenig, **Johana Romero-Alvarez**, Teresa Campos, Christoph Knote, Nicolas Theys, Jochen Landgraf, and Rainer Volkamer. **Carbon Monoxide in Optically Thick Wildfire Smoke: Evaluating TROPOMI Using CU Airborne SOF Column Observations.** (2022) ACS Earth Space Chem. https://doi.org/10.1021/acsearthspacechem.2c00048
- **Johana Romero-Alvarez**, Aurelia Lupașcu, Steve Dorling, Claire E. Reeves, Tim Butler. **Exploring the Factors Leading to the Ozone Build-Up in the East of England During a Brief Heat Wave.** (Submitted, Science of the Total Environment)
- **Johana Romero-Alvarez**, Aurelia Lupașcu, Douglas Lowe, Alba Badia, Scott Archer-Nicholls, Steve Dorling, Claire E. Reeves, and Tim Butler. **Sources of surface O3 in the UK: tagging O3 within WRF-Chem**. (2022). ACP. https://doi.org/10.5194/acp-22-13797-2022

Selected presentations

1. **Romero, Johana**, Ahmadov, Ravan, […] et al**. High-Resolution Smoke Simulations within NOAA's Rapid-Refresh Forecasting System: Verification for the 2019 Fire Season Using the FIREX-AQ and Satellite Data.** AGU Fall Meeting 2023 (Oral)
2. LD Anderson, J Schnell, **J Romero**, […] et al. **Using Hourly Wildfire Potential Index and Satellite Data to Estimate the Impact of Changing Combustion Conditions on the Composition of Wildfire Emissions**. AGU Fall Meeting 2023 (Oral)
3. Sean Youn, Janaina M. Nascimento, Jordan Schnell, **Johana Romero**, […] et al. **Applying the Visible Energy Fraction (VEF) to Investigate Nighttime Variations in Fire Combustion Phase**. AGU Fall Meeting 2022 (Poster)
4. **Romero-Alvarez,** J., N. Kille, K. J. Zarzana, J. Rowe, E. James, G. Grell, R. Volkamer, and R. Ahmadov. **Evaluation of Top-Down Biomass Burning Emission Estimates Using Aircraft Measurements at Fire-Event Scale**. AGU Fall Meeting, 2021 (Oral)
5. Volkamer, R., L. J. **Romero-Alvarez**, […] et al. **Ecosystem on Fire: How do Smoke Emissions Relate to Heat Produced from Large Wildfires?** AMS 2021 (Invited Talk)
6. Rowe, J. P., K. J. Zarzana, N. Kille, T. K. Koenig, C. F. Lee, **J. Alvarez-Romero**, et al. **Towards Global Emission Fluxes from Wildfires: An Error Assessment of Aerosol Optical Properties on Inert and Reactive Trace Gas Retrievals in Optically Thick Plumes**. AGU Fall Meeting, 2020 (Online, Oral)

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Education and Training

Millersville University, Millersville	Meteorology	BS 2013
University of Wyoming, Laramie	Atmospheric Science	MS 2015
University of Wyoming, Laramie	Atmospheric Science	PhD 2018
NSF NCAR Research Applications Lab	Atmospheric Science	Postdoc 2019-2020

Appointments

2023-present:	Project Scientist II, Research Applications Laboratory, NSF NCAR
2020-2023:	Project Scientist I, Research Applications Laboratory, NSF NCAR
2016-2018:	Graduate Teaching Assistant, University of Wyoming
2013-2018:	Graduate Research Assistant, University of Wyoming
2010-2013:	Undergraduate Research Assistant, Millersville University

Publications and Conference Presentations – All relevant in last 3 years (2024-2022)

2024

Juliano, T. W., F. Szasdi-Bardales, N. P. Lareau, K. Shamsaei, B. Kosović, N. Elhami-Khorasani, E. P. James, and H. Ebrahimian, 2024. Brief communication: The Lahaina Fire disaster – How models can be used to understand and predict wildfires. Nat. Hazards Earth Syst. Sci., 24, 47–52.

Roberts, M., N. P. Lareau, **T. W. Juliano**, K. Shamsaei, H. Ebrahimian, and B. Kosović, 2024. Sensitivity of simulated fire-generated circulations to fuel characteristics during large wildfires. Journal of Geophysical Research: Atmospheres, 129(6), e2023JD040548.

Szasdi-Bardales, F., K. Shamsaei, N. P. Lareau, **T. W. Juliano**, B. Kosović, H. Ebrahimian, and N. Elhami-Khorasani, 2024. Integrating dynamic wildland fire position input with a community fire spread simulation: A case study of the 2018 Camp Fire. Fire Safety Journal, 143, 104076.

2023

Juliano, T. W., N. Lareau, M. E. Frediani, K. Shamsaei, M. Eghdami, K. Kosiba, J. Wurman, A. DeCastro, B. Kosović, and H. Ebrahimian, 2023: Toward a better understanding of wildfire behavior in the wildland-urban interface: A case study of the 2021 Marshall Fire, Geophysical Research Letters, 50, e2022GL101557.

Turney, F. A., **et al.**, 2023: Sensitivity of burned area and fire radiative power predictions to containment efforts, fuel density, and fuel moisture using WRF-fire. Journal of Geophysical Research: Atmospheres, 128, e2023JD038873.

Shamsaei, K., **T. W. Juliano**, M. Roberts, H. Ebrahimian, N. P. Lareau, E. Rowell, and B. Kosović, 2023: The Role of Fuel Characteristics and Heat Release Formulations for Coupled Fire Atmosphere Simulation. Fire, 6(7), 264.

Shamsaei, K., **T. W. Juliano**, M. Roberts, H. Ebrahimian, B. Kosović, N. P. Lareau, and E. Taciroglu, 2023: Coupled fire-atmosphere simulation of the 2018 Camp Fire using WRF-Fire, International Journal of Wildland Fire, 32(2), 195–221.

2022

Juliano, T. W., P. A. Jiménez, B. Kosović, T. Eidhammer, G. Thompson, J. Fast, L. Berg, and A. Motley, and A. Polidori, 2022: Smoke from 2020 United States wildfires responsible for substantial solar energy forecast errors, Environ. Res. Lett., 17, 034010.

Juliano, T. W., B. Kosović, P. A. Jiménez, M. Eghdami, S. E. Haupt, and A. Martilli, 2022: "Gray zone" simulations using a three-dimensional planetary boundary layer parameterization in the Weather Research and Forecasting model, Mon. Wea. Rev., 150, 1585–1619.

DeCastro, A. L., **T. W. Juliano**, B. Kosović, H. Ebrahimian, and J. K. Balch, 2022: A computationally efficient method for updating fuel inputs for wildfire behavior models using Sentinel imagery and random forest classification. Remote Sens., 14, 1447.

Other Relevant Publications and Conference Presentations

2021

Juliano, T. W., et al., 2023: Combining a Coupled Fire-Atmosphere Model and Radar Measurements: A Case Study of the 2021 Marshall Fire in Colorado (Invited Presentation). 103rd American Meteorological Society Annual Meeting, Denver, CO.

Eghdami, M., **T. W. Juliano**, P. A. Jiménez, B. Kosović, M. Castellnou, R. Kumar, and J.Vila-Guerau de Arellano, 2023: Characterizing the Environmental Controls on the 2021 Santa Coloma de Queralt Pyroconvective Event using WRF-Fire, Journal of Advances in Modeling Earth Systems, 15, e2022MS003288.

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Education and Training

Complutense University of Madrid	Physics	BS 2001
Complutense University of Madrid	Physics	MS (DEA) 2005
Complutense University of Madrid	Physics	PhD 2009

Appointments

2022-present: Project Scientist III, Research Applications Laboratory, NSF NCAR
2017-2022: Project Scientist II, Research Applications Laboratory, NSF NCAR
2014-2017: Project Scientist I, Research Applications Laboratory, NSF NCAR
2012-2014: Project Scientist, Renewable Energy Division of CIEMAT
2007-2012: Research Scientist, Renewable Energy Division of CIEMAT
2002-2006: PhD fellowship, Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas.

Publications and Conference Presentations – All relevant in last 3 years (2024-2022)

2024

Jimenez Munoz, P.A., M. Frediani, M. Eghdami, D. Rosen, M. Kavulich, and T. W. Juliano: The Community Fire Behavior Model for coupled fire-atmosphere modeling: Implementation in the Unified Forecast System. Geosci. Mod. Dev. Discuss. https://doi.org/10.5194/gmd-2024-124.

Jimenez, P.A., A. Islas, M. Duda, D. Rosen, and J. Dudhia, 2024: Coupling the Community Fire Behavior model to WRF. WRF/MPAS workshop. Oral. June 26, 2024. Boulder CO. WRF / MPAS Users Workshop

Lee, J.A., **P. A. Jimenez,** R. Kumar, and C. He, 2024: Impact of direct insertion of SMAP soil moisture retrievals in WRF-Chem for dust storm events in the western U.S., Atmos. Environ., 321, 120349.

2023

Jimenez, P.A., B. Kosovic, M. Frediani, T.W. Juliano, M. Eghdami, D. Rosen, U. Turuncoglu, and R. Ahmadov, 2023: Implementing a fire behavior model in the Unified Forecast System. Oral presentation. Second Symposium on Community Modeling and Innovation. AMS General Conference, Denver, CO.

Jimenez, P.A., J. Schreck, T. Brummet, B. Petzke, E. James, J.C. Knievel, and B. Kosovic, 2023: Towards high spatio-temporal fuel moisture content retrievals over the contiguous U.S. and Alaska based on VIIRS and ABI instruments. Poster. AGU Annual Meeting 2023, 13 Dec 2023, San Francisco, CA, USA.

Jimenez, P.A., 2023: Real-time dead and live fuel moisture content retrievals. Oral presentation. 4th Annual Colorado Utilities Wildfire Summit. Tri-State Generation and Transmission, Inc, CO.

Turney, F.A., P.E. Saide, **P.A. Jimenez**, D. Munoz-Esparza, E.J. Hyer, D.A. Peterson, M.E.

Frediani, T.W. Juliano, A.L. DeCastro, B. Kosovic, X. Ye, L.H. Thapa, 2023: Sensitivity of burned area and fire radiative power predictions to containment efforts, fuel density, and fuel moisture using WRF-Fire. JGR-Atmospheres, 128, e2023JD038873.

Schreck, J.S., W. Petzke, **P.A. Jimenez**, T. Brummet, J.C. Knievel, E. James, B. Kosovic, D.J. Gagne, 2023: Machine learning and VIIRS retrievals for skillful fuel moisture content monitoring in wildfire management. Remote Sensing, 15, 3372.

Eghdami, M., T.W. Juliano, **P.A. Jimenez**, B. Kosovic, M. Castellnou, R. Kumar, and J. Vila-Guerau de Arellano, 2023: Characterizing the Role of Moisture and Smoke on the 2021 Santa Coloma de Queralt Pyroconvective Event Using WRF-Fire. *JAMES*, 15, e2022MS003288.

2022

Jimenez,P.A., J.Schreck, T.Brummet, B.Petzke, E.James, J.Knievel, B.Kosovic, 2022: Monitoring fuel moisture content over the contiguous U.S. and Alaska based on VIIRS. Poster presentation. Session: Engaging Low-Earth-Orbiting (LEO) Users to Build on Past Successes and to Set the Path for a Sustainable Future. AGU Fall meeting.

Other Relevant Publications and Conference Presentations

2022

Juliano, T.W., **P.A. Jimenez**, B. Kosovic, T. Eidhammer, G. Thompson, L.K. Berg, J. Fast, A. Motley, and Andrea Polidori, 2022: Smoke from 2020 United States wildfires responsible for substantial solar energy forecast errors. Environmental Research Letters, 17, 034010

2021

Kosovic,B., T.W. Juliano, A. DeCastro, M. Frediani, A. Siems-Anderson, **P. Jimenez**, D. Munoz-Esparza, J. C. Knievel, M. Eghdami, 2021: Wildfires and weather, subchapter 1.4 in Extreme Weather Forecasting. Editors: Marina Astitha and Efthymios Nikolopoulos, Springer, pp 31-86.

2019

Ferrero, E., S. Alessandrini, B. Anderson, E. Tomasi, **P. Jimenez** and S. Meech, 2019: Lagrangian simulation of smoke plume from fire and validation using ground-based lidar and aircraft measurements. Atmospheric Environment, 213, 659-674.

2018

Jimenez, P.A., D. Munoz-Esparza and B. Kosovic, 2018: A high resolution coupled fire atmosphere system to minimize the impacts of wildland fires: applications to the chimney Tops II wildland event. Atmosphere, 9, 197. https://doi.org/10.3390/atmos9050197

Munoz-Esparza, D. B. Kosovic, **P.A. Jimenez** and J. Coen, 2018: An accurate fire-spread algorithm in the Weather Research and Forecasting model using the level-set method.

Jimenez, P. A., B. Kosovic, J. Cowie, D. Munoz-Esparza, A. Anderson, Amy DeCastro, B. Petzke, J. Boehnert, K. Sampson, W. Mahoney and J. Knievel: Description and evaluation of the Colorado Fire Prediction System (CO-FPS). Oral. AGU Fall meeting 12 Dec 2018, Washington, D.C.

Jimenez, P.A., D. Munoz-Esparza and B. Kosovic: A high resolution coupled fire-atmosphere forecasting system to minimize the impacts of wildland fires: Applications of the Colorado Fire Prediction System (CO-FPS) during the management of the Chimney Tops 2 fire. Oral.

12 Fire and Forest Meteorology, AMS. May 17, 2018, Boise, ID.

2017

Jimenez, P.A., B. Kosovic, D. Munoz-Esparza, A. Anderson, B. Petzke, J. Boehnert, J. Cowie, J. Exby, K. Sampson, R. Sharman, B. Brown and W. Mahoney: The Colorado Fire Prediction System: system description and evaluation. Oral. WRF Users' Workshop, June 14, 2017, Boulder, CO.

Ravan Ahmadov

Education

- Ph.D. in Atmospheric Physics, Moscow State University, 2004
- M.S. in Astrophysics, Baku State University, 2000
- B.S. in Physics, Baku State University, 1998

Research Experience

- June 2023 - current: Physical Scientist at NOAA/GSL Earth Prediction Advancement Division (EPAD)
- May 2022 - May 2023: Senior Research Scientist affiliated with NOAA/GSL/EPAD
- 2016 – 2022: CIRES Scientist III affiliated with NOAA/GSL/EPAD
- 2009 – 2016: CIRES Research Scientist II affiliated with NOAA/CSL
- 2005 – 2009: Post-doctoral researcher, Max-Planck Institute for Biogeochemistry, Germany

Research Interests

- Ai quality modeling and forecasting.
- Fire Weather and Atmospheric Composition
- Wildland Fire Processes: Wildland fire emissions and plume rise, Smoke transport, mixing, and chemistry, The impact of smoke on radiation and microphysics.
- Coupled Meteorology-Chemistry Models

Model Development & Research to Operations (R2O) at CIRES and NOAA

- Contributed to the development of HRRR-Smoke, operational at NCEP since 2020 (HRRR-Smoke).
- Collaborating on NOAA's next-generation RRFS-Smoke-Dust model (RRFS-SD).

Awards

- CIRES Outstanding Performance Award (2021)
- 2019 Joint Polar Satellite System Esprit De Corps Award (2019)
- Colorado Governor’s Award for High Impact Research (2014)
- Colorado Governor’s Award for High Impact Research (2012)

Selected Publications

- Thapa L., […], **Ahmadov R**. et al. Forecasting daily fire radiative energy using data driven methods for air quality forecasting. JGR Atmospheres. https://doi.org/10.1029/2023JD040514
- Li, Y., Tong, D., Ma, S., Freitas, S. R., **Ahmadov, R**., et al.: Impacts of estimated plume rise on PM2.5 exceedance prediction during extreme wildfire events: a comparison of three schemes (Briggs, Freitas, and Sofiev), Atmos. Chem. Phys., 23, 3083–3101, https://doi.org/10.5194/acp-23-3083-2023, 2023.

- Anderson, L. D., Dix, B., Schnell, J., Yokelson, R., Veefkind, J. P., **Ahmadov, R**., & de Gouw, J. (2023). Analyzing the impact of evolving combustion conditions on the composition of wildfire emissions using satellite data. GRL, 50, e2023GL105811.
- Langford A., Senff C., Alvarez R., Aikin K., **Ahmadov R.**, et al. Were Wildfires Responsible for the Unusually High Surface Ozone in Colorado During 2021? JGR Atmospheres. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022JD037700
- Jones. T., **Ahmadov R.**, James E.: Assimilation of aerosol optical depth into the Warn-on-Forecast System for Smoke (WoFS-Smoke). JGR Atmospheres. DOI10.1029/2022JD037454
- Thapa L., […], **Ahmadov R**. et al.: Heat flux assumptions contribute to overestimation of wildfire smoke injection into the free troposphere. Commun Earth Environ. 3, 236 (2022).
- Chow F., […], **Ahmadov R**. High-resolution smoke forecasting for the 2018 Camp Fire in California. Bull Amer Meteorol Soc., 2022. https://doi.org/10.1175/BAMS-D-20-0329.1
- Kumar A., Pierce B., **Ahmadov R**. et al.: WRF-Chem retrospective aerosol predictions during FIREX-AQ with GOES-16 fire radiative power-based emissions and plume rise. Atmos. Chem. Phys. 22, 10195–10219, 2022.
- Zhang L., […], **Ahmadov R**., et al. Development and evaluation of the Aerosol Forecast Member in the NCEP's GEFS-Aerosols v1. Geoscientific Model Dev., 15, 5337–5369, 2022.

L. Current and Pending Support

Investigator Name: Dr. Johana Romero Alvarez
Other agencies to which this proposal has been/will be submitted: N0NE

Pending Support

Project/Proposal Title: **Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration**
Source of Support (w/Grant#): National Oceanic & Atmospheric Administration (NOAA-OAR-WPO-2025-28603)
Proposed Award Amount: $1,049,996
Total Award Period Covered: 08/2025-07/2028
Months of Your Time Committed to the Project: 8.92 (2026), 8.98 (2027), 8.51 (2028)
Total: 26.41

Project/Proposal Title: Enhancing Regional Air Quality Forecasting with AI Fire models
Source of Support (w/Grant#): National Oceanic & Atmospheric Administration (NOAA-OAR-WPO-2025-28603)
Proposed Award Amount: $747,124
Total Award Period Covered: 08/2025-07/2028
Months of Your Time Committed to the Project: 1.0 (2026), 1.0 (2027), 1.0 (2028),
Total: 3.0

CURRENT AND PENDING SUPPORT

In the event an unanticipated overlap does occur, the level of effort would be adjusted and/or additional personnel would be added, in concurrence with funding sources.

Principal Investigator: Juliano, Timothy DATE: October 2024

CURRENT SUPPORT

Project Title: Fighting Wildfires under Climate Change: A Data-Informed Physics-Based Computational Framework for Probabilistic Risk Assessment and Mitigation, and Emergency Response Management Source of Support: University of Nevada Reno / NSF-ENG-CMMI/Civil, Mechanical and Manufacturing Innovation, Contract #: UNR2112 Total Award Amount: $318668 Total Award Period/Duration: 09/01/2020 – 08/31/2025 Person-Months: 2.16

Project Title: Numerical Simulations of Cold Air Outbreaks Using a Multi-Scale Modeling Framework Source of Support: University of Wyoming / DOE/Department of Energy, Contract #: 1004790 Total Award Amount: $573,657 Total Award Period/Duration: 09/01/2020 – 08/31/2025 Person-Months: 1.75

Project Title: Examining the influence of heterogeneous forest canopy on shallow convection at the third ARM Mobile Facility (AMF3) site Source of Support: DOE/Department of Energy, Contract #: DE-SC0024033 Total Award Amount: $627,548 Total Award Period/Duration: Person-Months: 2.02

Project Title: NCARs CY24 participation in Observationally driven Resource Assessment with Coupled models (ORACLE) Source of Support: Pacific Northwest National Laboratory-Battelle Memorial Institute / DOE/Department of Energy, Contract #: 721249 Total Award Amount: $464,350 Total Award Period/Duration: 01/01/2024 – 12/31/2024 Person-Months: 4.05

Project Title: Characterizing and Understanding Atmospheric Boundary Layer Fluxes, Structure and Cloud Property Evolution in Arctic Cold Air Outbreaks Source of Support: University of Colorado Boulder / National Science Foundation, Total Award Amount: $0 Total Award Period/Duration: 09/30/2023 – 09/29/2028 Person-Months: 0.21 Y1, 0.2 Y2-5

Project Title: RAPID: Tuning and Assessing Lahaina Wildfire Models with AI Enhanced Data Source of Support: University of Hawaii / National Science Foundation, Total Award Amount: $0 Total Award Period/Duration: 01/01/2024 – 12/31/2024 Person-Months: 0.23

PENDING SUPPORT

Proposal Title: Observationally driven Resource Assessment with CoupLEd models (ORACLE) Source of Support: Pacific Northwest National Laboratory-Battelle Memorial Institute / Department of Energy Total Award Amount: $1,615,000 Total Award Period/Duration: 10/01/2022 – 09/30/2025 Person-Months: 4.73 Y1, 4.03 Y2, 5.07 Y3

Proposal Title: Understanding Cloud Transitions in Arctic Cold-Air Outbreaks Using a Multiscale Modeling Framework Source of Support: National Science Foundation - GEO – OPP Total Award Amount: $734,872 Total Award Period/Duration: 06/01/2025 – 06/30/2028 Person-Months: 1.96 Y1-3

Proposal Title: Influence of spatial heterogeneity in subcanopy exchange processes on shallow convection at the third ARM Mobile Facility (AMF3) site Source of Support: Washington State University / Department of Energy Total Award Amount: $319,860 Total Award Period/Duration: 04/01/2025 – 03/31/2028 Person-Months: 3.28 Y1, 3.29 Y2, 3.28 Y3

Proposal Title: Assessing Climate-Induced Shifts in Flood Risk Across the Southeast U.S.: A Multi-Modeling Approach to Understanding Mesoscale Convective Systems, Tropical Cyclones, and Urbanization Impacts: University of Wyoming / Department of Energy Total Award Amount: $287,331 Total Award Period/Duration: 04/01/2025 – 03/31/2028 Person-Months: 1.94 Y1, 1.95 Y2, 1.94 Y3

Proposal Title: Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration (THIS PROPOSAL) Source of Support: University of Colorado CIRES / DOC-NOAA-OAR-WPO/Weather Program Office Total Award Amount: $523,263 Total Award Period/Duration: 08/01/2025 – 07/31/2028 Person-Months: 2.88 Y1, 2.71 Y2, 2.65 Y3

Proposal Title: In-field Forecasting, Nowcasting and Meteorological Support for NURTURE Source of Support: University of Oklahoma / NASA Total Award Amount: $155,696 Total Award Period/Duration: 01/01/2026 – 12/31/2028 Person-Months: 1.04 Y1, 3 Y2, 1.04 Y3

CURRENT AND PENDING SUPPORT

"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."

Principal Investigator: Jimenez Munoz, Pedro DATE: October 2024

CURRENT SUPPORT

Project Title: Real-time fuel moisture content estimations at high spatio-temporal resolution based on reflectances from VIIRS and GOES-R ABI Source of Support: Joint Polar Satellite System; Contract # NA21OAR4310383 Total Award Amount: $509,810 Total Award Period Covered: 04/01/2021 – 09/30/2025 Person-Months Committed to the Project: 2.13

Project Title: Implementing a state-of-the-science fire behavior model in the Unified Forecast System Source of Support: DOC-NOAA-OAR-WPO/Weather Program Office; Contract # NA22OAR4590514 Total Award Amount: $1,049,514 Total Award Period Covered: 08/01/2022 – 07/31/2025 Person-Months Committed to the Project: 5.14

Project Title: DEVELOPMENT AND IMPLEMENTATION OF MAGEN RAPID REFRESHING FORECASTING CAPABILITY Source of Support: Government of Israel Ministry of Defense / DOD-USAF/United States Air Force; Contract # 4441320108 Total Award Amount: $1,735,175 Total Award Period Covered: 03/01/2024 – 02/28/2026 Person-Months Committed to the Project: 1.33

PENDING SUPPORT

Proposal Title: Improved numerical weather prediction of dust impacts on solar surface irradiance: building capacity with probabilistic forecasting and assimilation of aerosol optical depth retrievals Source of Support: Dubai Electricity & Water Authority Total Award Amount: $399,881 Total Award Period Covered: 12/01/2023 – 11/30/2025 Person-Months Committed to the Project: 2.31 Y1-2

Proposal Title: Advice for using the MAD-WRF model for short-term solar surface irradiance predictions in cloudy conditions Source of Support: Dubai Electricity & Water Authority Total Award Amount: $327,628 Total Award Period Covered: 03/01/2023 – 08/31/2024 Person-Months Committed to the Project: 2.3

Proposal Title: Collaborative Research: SRS RN: GREENPATHS - Great Lakes Regional Energy and Environmental Network for Progress and Acceleration Towards Human Sustainability Source of Support: University of Illinois - Discovery Partners Institute / National

Science Foundation Total Award Amount: $1,234,948 Total Award Period Covered: 09/01/2024 – 08/31/2029 Person-Months Committed to the Project: .52 Y1, 1.03 Y2-3, .41 Y4-5

Proposal Title: Fuel moisture content impacts on wildland fire emissions, aerosol effects, and air quality Source of Support: NASA Total Award Amount: $541,396 Total Award Period Covered: 03/01/2025 – 02/29/2028 Person-Months Committed to the Project: 3.17 Y1, 2.42 Y2, 2.31 Y3

Proposal Title: Technology Transfer of Kuwait Renewable Energy Prediction System Source of Support: Kuwait Institute for Scientific Research Total Award Amount: $99,204 Total Award Period Covered: 01/01/2024 – 09/30/2024 Person-Months Committed to the Project: 0.46

Proposal Title: Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration (THIS PROPOSAL) Source of Support: University of Colorado CIRES / DOC-NOAA-OAR-WPO/Weather Program Office Total Award Amount: $523,263 Total Award Period Covered: 08/01/2025 – 07/31/2028 Person-Months Committed to the Project: 2.77 Y1, 2.54 Y2, 2.42 Y3

Proposal Title: Development of two-way coupling between fire behavior modeling with dynamic biomass burning emissions and air quality within the UFS Source of Support: NOAA - Oceanic and Atmospheric Research Total Award Amount: $1,049,775 Total Award Period Covered: 08/01/2025 – 07/31/2028 Person-Months Committed to the Project: 3.95 Y1, 3.42 Y2, 3.41 Y3

Proposal Title: Understanding the three-dimensional cloud variability and associated cloud radiative effects and their representation in general circulation models based on multiyear retrievals from CALIPSO and CloudSat Source of Support: NASA - Science Mission Directorate Total Award Amount: $641,654 Total Award Period Covered: 06/01/2025 – 05/31/2028 Person-Months Committed to the Project: 3.46 Y1-3

Proposal Title: Optimal fire initialization and rate of spread propagation for fire behavior simulations with UFS Source of Support: NOAA - Oceanic and Atmospheric Research Total Award Amount: $899,693 Total Award Period Covered: 08/01/2025 – 07/31/2028 Person-Months Committed to the Project: 3.46 Y1, 3.01 Y2, 3.03 Y3

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research
Global Systems Laboratory
325 Broadway – David Skaggs Research Center
Boulder, Colorado 80305-3328

Date: November 7, 2024
Memorandum for: WPO
From: Jennifer Mahoney, Director, Global Systems Laboratory
Subject: Letter of Proposal Support

The Global Systems Laboratory (GSL) supports the submission of *Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration,* involving Johana Romero Alvarez as Principal Investigator, submitted in response to funding opportunity NOAA-OAR-WPO-2025-28603:FY2025 Weather Program Office Research Programs. This effort is in alignment with the GSL, OAR, and NOAA missions. This work is well aligned with GSL's Strategic Goal #2, more specifically with the improvement of fire weather and atmospheric composition. It recognizes the shortcomings of methodologies used to specify fuel moisture and smoke emissions and proposes venues for improvement. These improvements should result in better forecasts of smoke in the RRFS context and will be usable in MPAS-based configurations.

In the event that the proposed research is funded, NOAA/OAR/GSL will provide infrastructure such as general office space, administrative support, and technical support needed for current Cooperative Institute staff affiliated with GSL to successfully complete the proposed activity. The associated federal hosting costs to support the GSL infrastructure for the three-year proposal are $119,343.62. Infrastructure costs support the following:

- IT Support and Services, which includes: IT security integrity and Assessment & Authorization (A&A) Controls; personnel access and enhanced security controls for high performance computing systems; maintenance and upkeep of necessary IT facilities; scientific data collection and distribution; IT user services such as GitHub, SSL Certificates, etc.; IT system and software upgrades and installation; system, network and facility monitoring; and system administration support systems and individual users.
- Administration and Management Support, which includes: Budget management; tracking and accounting; acquisition and property management; cooperative institute and contract administration and management; facility services and maintenance including rent, electricity, gas, water, telephones, etc.

Costs per year according to these two categories are outlined in the table below:

	Year 1	Year 2	Year 3	Total
IT Support and Services	$25,094.86	$25,094.86	$24,651	$74,840.72
Administration and Management	$14,922.46	$14,922.46	$14,658	$44, 502.92
Total	**$40,017.31**	**$40,017.31**	**$39,309**	**$119,343.62**

Sincerely,

ALEXANDER.CURTIS.R AYMOND.1391497423

Digitally signed by ALEXANDER.CURTIS.RAYMOND.1 391497423
Date: 2024.11.20 13:20:38 -07'00'

Curtis Alexander, Deputy Director, signing for
Jennifer Mahoney
Director, Global Systems Laboratory

Dear Representative,

On behalf of the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC) Regional Air Quality Modeling Team, I am writing to express strong support for the proposal titled, **"Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration."**

NOAA/NWS/NCEP/EMC and Dr. Ravan Ahmadov's group at the Earth Prediction Advancement Division, Global Systems Laboratory (GSL), have a longstanding collaborative relationship focused on developing and enhancing the National Air Quality Forecasting Capability (NAQFC) and providing vital numerical guidance for air quality forecasting nationwide. We currently work together on a variety of initiatives, including the development and enhancement of the RRFS-Smoke prediction system and fire emissions modeling.

Dr. Ahmadov's proposal is closely aligned with NOAA's mission to advance air quality forecasting by employing innovative approaches to improve the simulation of air quality processes, enhance fire emissions modeling, and refine forecast products. EMC, in response to the transition to new innovative approaches, is committed to collaborating closely with Dr. Ahmadov should the proposal be funded. It is important to note that this collaboration will not require funding support from the proposal for activities at EMC.

Our collaborative efforts may include the following:

- Providing operational NAQFC forecast products necessary for applying Advanced Fuel Moisture Integration to refine the RRFS-Smoke prediction system.
- Contributing to the preparation and submission of publications and conference presentations to disseminate project results.

These joint activities between EMC and the team from the Earth Prediction Advancement Division, GSL, will significantly enhance the capabilities of NOAA's RRFS-Smoke system, improving forecast products and strengthening their utility in providing air quality guidance to the public. We are excited about the opportunity to collaborate with GSL on developing the RRFS-Smoke system through Advanced Fuel Moisture Integration and strongly encourage the proposal's consideration for funding.

Sincerely,

Jianping Huang, Ph.D.
Physical Scientist and Project Lead
National Air Quality Forecasting Capability
National Oceanic and Atmospheric Administration
National Weather Service / National Centers for Environmental Prediction
Environmental Modeling Center (EMC), Physics and Dynamics Division

Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration
Johana Romero Alvarez
University of Colorado Boulder

Organization	Year 1	year 2	year 3	Total
University of Colorado Boulder	$135,482	$135,390	$136,517	$407,389
NOAA GSL	$40,017.31	$40,017.31	$39,309	$119,343.62
Subaward: NCAR	$174,499	$174,592	$174,172	$523,263
Total	$349,998.31	$349,999.31	$349,998	$1,049,995.62

BUDGET JUSTIFICATION

PERSONNEL

Salaries for all named personnel are based upon current University of Colorado Boulder (CU Boulder) academic and staff salary scales and estimated in accordance with institutional base salary policy. All personnel budget calculations include salary range adjustments and merit increases as applicable for each year of support in accordance with University policy.

Salary for 12 months at 74.34% effort is requested in year 1, 74.86% effort in year 2, and 70.93% effort in year 3 for the Principal Investigator, Johana Romero Alvarez. The PI will be responsible for integrating the FMC product into RRFS-Smoke and refining the current fire weather-informed top-down emissions method in RRFS-Smoke. This work involves: i) developing a dynamic prediction method for FMC during model forecasts and ensuring seamless integration of FMC predictions into HWP calculations; ii) establishing relationships between FMC, fuel types, and combustion phases (smoldering and flaming); and iii) modifying the RRFS-Smoke emissions module to account for FMC's influence on combustion phases and, consequently, on the emission factor selection.

Position Title & Name	Current Yearly Salary (merit Inflation of 3.2% annually, 4% Jan 2025)	% of time applied to project	Throughout the project, how many working months will that effort be applied.	Total months of effort assigned to this project	Salary amount assigned to project
PI, Johana Romero Alvarez	$84,300	See above	36 months	26.41 months	$202,853

FRINGE BENEFITS

Fringe benefits are calculated on requested salary per the University's federally negotiated Rate Agreement with the Department of Health and Human Services (DHHS) dated 7/23/2024. The Fixed rate for the period 7/1/2024-6/30/2025 is 40% of salary for full time professional & research personnel.

Fringe Benefit rates are Fixed for the period 7/1/2024-6/30/2025 and Provisional thereafter until new rates are established. As rates are renegotiated yearly, an inflation rate of 2% has been included in the fringe benefit cost estimation to account for inevitable rate fluctuations that will occur throughout the project period. Inflation is included to provide an accurate estimate of potential fringe benefit costs, just as inflation is estimated for other direct costs. When salary is charged to the project, the actual Fixed or Provisional rate at that time will be applied.

Position Title & Name	Salary amount assigned to project	% Rate for Benefits	Benefits amount assigned to project
PI, Johana Romero Alvarez	$202,853	40%	$84,439

UNIVERSITY OF COLORADO BOULDER - FRINGE BENEFITS COMPONENTS TO FY2025

FY2025 Fringe Benefits - Projected by Employee Group	FT Prof & Perm Classified
Dental Insurance	1.4%
Disability Insurance	0.4%
FICA Contribution	11.7%
Health Insurance	38.3%
Life Insurance	0.2%
Medicare	3.7%
Other Retirement Plans	18.0%
PERA	13.5%
RTD/ECOPASS	0.1%
Back Up Care	0.0%
Annuitants Insurance	1.0%
Unemployment Compensation Claims	0.0%
Workers' Compensation Insurance	1.8%
CO FAMLI	1.3%
	91.4%

ADD BENEFITS RECORDED AS SALARY	
Termination Annual Leave	2.6%
Termination Sick Leave	0.2%
Parental Leave	0.5%
TOTAL FRINGE BENEFIT EXP - SCH B-1	94.8%
FY2023 (Over)Under Recovery to be Carried Forward to FY2025 - Sch A-2	5.2%
Total Fringe Benefit Costs - Adjusted	100.0%
FY2025 RATE CALCULATION	**40.0%**

TRAVEL
Domestic
Travel funds are requested for the PI to attend the AGU conference in each year of the project. Additionally, travel funds are requested for the PI to attend two other scientific conferences in each year of the project. Conference attendance will support the dissemination of this project's research results. The cost of travel is calculated for 5 days and includes airfare, lodging, per diem, and ground transportation. CIRES standard practice for TBD conference travel is to budget a 5-day trip, where there are 5 days per diem and 5 nights lodging, to support a trip that has 4 full conference days with 2 travel days, where the travel days only allow for partial per diem. The cost of airfare and ground transportation is based on estimated costs. Lodging and per diem costs are based on rates as established by the GSA for the planned destinations. When the destination is unknown, Washington, DC is used as the basis for calculations. A 2.3% yearly inflation is included.

Domestic	**Cost/ Person**	**# Days**	**Year 1**	**Year 2**	**Year 3**	**Total**
PI travel to AGU Conference yr 1 - Dec 2025, New Orleans, LA						
Airfare	$500		$500	$0	$0	$500
Lodging	$157	5	$785	$0	$0	$785
Per Diem	$80	5	$400	$0	$0	$400
Ground Transportation	$50	5	$250	$0	$0	$250
PI travel to AGU Conference yr 2 - Dec 2026, San Francisco, CA						
Airfare	$500		$0	$512	$0	$512
Lodging	$272	5	$0	$1,391	$0	$1,391
Per Diem	$92	5	$0	$471	$0	$471
Ground Transportation	$50	5	$0	$256	$0	$256
PI travel to AGU Conference yr 3 - Dec 2027, Washington D.C.						
Airfare	$550		$0	$0	$576	$576
Lodging	$196	5	$0	$0	$1,026	$1,026
Per Diem	$92	5	$0	$0	$481	$481
Ground Transportation	$50	5	$0	$0	$262	$262
Other scientific conferences - Washington D.C used for planning						
Airfare	$550		$1,100	$1,125	$1,151	$3,376
Lodging	$196	5	$1,960	$2,005	$2,051	$6,016
Per Diem	$92	5	$920	$941	$963	$2,824
Ground Transportation	$50	5	$500	$512	$523	$1,535
Subtotal Domestic Travel			**$6,415**	**$7,213**	**$7,033**	**$20,661**
Total Travel			**$6,415**	**$7,213**	**$7,033**	**$20,661**

OTHER DIRECT COSTS

Publication Costs:
Publication costs for article processing page charges of $2,616 are requested for dissemination of the research results in a refereed scientific journal in year 3 of the project.

Funds are requested to cover the costs of abstract publication fees for AGU and other scientific conferences in each year of the project. The AGU rate of $70/person/conference was used for planning purposes. The abstract publication costs will support dissemination of this project's research results at the conferences.

Subawards:
NCAR: Dr. Juliano's primary responsibilities for this project includes helping to integrate an FMC product into the RRFS-Smoke system, including the emissions module, helping to integrate the UFS FBM into RRFS-Smoke, aiding in model configuration and analysis of model simulations, and project management. Dr. Jimenez Munoz's primary responsibilities for this project includes leading integration of an FMC product into the RRFS-Smoke system, including the emissions module, leading integration of the UFS FBM into RRFS-Smoke, and aiding in model configuration and interpretation of model results.

Other Costs:
Funds are requested to cover AGU and other scientific Conference Registration Fees in each year of the project. The AGU rate of $755/person/conference was used for planning purposes. Conference attendance will be to present this project's research results.

FACILITIES AND ADMINISTRATION (F&A) COSTS

Facilities and administration (F&A) costs are charged according to the University's federally negotiated rate agreement. The F&A cost rate for off-campus research is 26% of Modified Total Direct Cost (MTDC), predetermined for the period 7/1/2020 - 6/30/2023; provisional thereafter per HHS agreement dated 7/23/2024. MTDC consists of all salaries and wages, benefits, materials, supplies, travel, and up to the first $25,000 of subcontracts. MTDC shall exclude tuition, capital equipment, participant support costs, and the portion of subcontracts that exceed $25,000.

F&A has been calculated by applying the 26% rate described above to an MTDC base of $343,166, totaling F&A costs for the project period of $89,223. The total direct costs of the project are $841,429.

INFLATION RATES

The University of Colorado's current budget planning parameters include an annual inflation factor of 3.2% for salaries of investigators (with a 4% increase used for 1/1/2025). Other direct costs, such as travel, can be inflated at 2.3% per year.

UNIVERSITY OF COLORADO
SUMMARY BUDGET TABLE:

Personnel	$	202,853
Fringe	$	84,439
Travel	$	20,661
Supplies	$	0
Other	$	533,476
Indirect	$	89,223
Total:	$	930,652

INTERNAL COST ESTIMATION

Office of Contracts and Grants
UNIVERSITY OF COLORADO **BOULDER**

Title: Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration

Principal Investigator: Johana Romero-Alvarez
Co-Principal Investigator(s):

Duration: 8/1/2025 - 7/31/2028						Year 1	Year 2	Year 3	Total
A. Salaries and Wages									
PI: Johana Romero-Alvarez									
74.34% time yr1, 74.86% time yr 2, 70.93% time yr 3						66,390	68,994	67,469	202,853
Total Salaries and Wages						66,390	68,994	67,469	202,853
B. Fringe Benefits					***Rate***				
PI: Johana Romero-Alvarez					*40.00%*	27,087	28,713	28,639	84,439
Total Fringe Benefits						27,087	28,713	28,639	84,439
Total Salaries and Wages and Fringe Benefits						93,477	97,707	96,108	287,292
D. Travel									
Domestic	*Cost*	*No. Days*	*No. People*	*No. Trips*					
PI travel to AGU Conference yr 1 - Dec 2025, New Orleans, LA									
Airfare	*$500*		*1*	*1*		500	0	0	500
Lodging	*$157*	*5*	*1*	*1*		785	0	0	785
Per Diem	*$80*	*5*	*1*	*1*		400	0	0	400
Ground Transportation	*$50*	*5*	*1*	*1*		250	0	0	250
PI travel to AGU Conference yr 2 - Dec 2026, San Francisco, CA									
Airfare	*$500*		*1*	*1*		0	512	0	512
Lodging	*$272*	*5*	*1*	*1*		0	1,391	0	1,391
Per Diem	*$92*	*5*	*1*	*1*		0	471	0	471
Ground Transportation	*$50*	*5*	*1*	*1*		0	256	0	256
PI travel to AGU Conference yr 3 - Dec 2027, Washington D.C.									
Airfare	*$550*		*1*	*1*		0	0	576	576
Lodging	*$196*	*5*	*1*	*1*		0	0	1,026	1,026
Per Diem	*$92*	*5*	*1*	*1*		0	0	481	481
Ground Transportation	*$50*	*5*	*1*	*1*		0	0	262	262
Other scientific conferences - Washington D.C used for planning									
Airfare	*$550*		*1*	*2*		1,100	1,125	1,151	3,376
Lodging	*$196*	*5*	*1*	*2*		1,960	2,005	2,051	6,016
Per Diem	*$92*	*5*	*1*	*2*		920	941	963	2,824
Ground Transportation	*$50*	*5*	*1*	*2*		500	512	523	1,535
					Subtotal Domestic Travel	*6,415*	*7,213*	*7,033*	*20,661*
Total Travel						6,415	7,213	7,033	20,661
F. Other Direct Costs									
Publication Costs - article processing page charges in peer reviewed scientific journal						0	0	2,616	2,616
Publication Costs -abstract fees (AGU rate used for estimate)						210	215	220	645
Subcontracts	*Number of Subs*:*	1							
	**Subs to other CU campuses are not included in this total, but should be detailed below.*								
	**Update MTDC formula as applicable for each year if subaward costs are less than $25,000 in Year 1.*								
Subcontractor 1 [NCAR]						174,499	174,592	174,172	523,263
Other Direct Costs									
Conference Registration Fees - AGU rate used for estimate	*$755*		*1*	*3*		2,265	2,317	2,370	6,952
Total Other Direct Costs						176,974	177,124	179,378	533,476
G. Total Direct Costs						**276,866**	**282,044**	**282,519**	**841,429**
H. Facilities and Administration (F&A) Costs					*IDC Exclusions*	*149,499*	*174,592*	*174,172*	*498,263*
Research	Off-Campus		IDC Base:		MTDC	127,367	107,452	108,347	*343,166*
Predetermined for the period 7/1/22-6/30/23:									
Provisional thereafter per HHS agreement dated 07/23/2024.					26%	33,115	27,938	28,170	*89,223*
I. Total Costs						309,981	309,982	310,689	*930,652*
K. Total Amount Requested from Sponsor						309,981	309,982	310,689	*930,652*

Should this proposal be selected for funding, we request that a financial assistance agreement (e.g. grant, subaward, etc.) be awarded to the University Corporation for Atmospheric Research (UCAR). The National Center for Atmospheric Research (NCAR) is a Federally Funded Research Development Center (FFRDC), sponsored by the National Science Foundation (NSF) and managed by UCAR. The proposed scope of work outlined in the proposal narrative will be performed by NCAR. All staff performing effort within NCAR are UCAR employees, not federal employees.

NSF NCAR Proposal 2024-0799 – Budget Justification

Proposed Total Budget: $523,263

A. Personnel: $194,821

The salary budget includes direct labor charges for time worked only. Personnel are budgeted at 100 % worktime against their proposed work effort. Salaries are calculated based on the anticipated effort/time staff will contribute to the project and adjusted for non-work time for holidays, paid time off, etc., which is charged to the fringe benefit category. A 4% escalation is applied to salaries each fiscal year, beginning October 1, allowing for anticipated annual merit increases and/or reclassifications per approval of our cognizant audit agency.

Name & Position Title	Annual Salary	% of Time	# of Months	Salary Request
Timothy Juliano, PI	Year 1: $128,329	24%	2.88	$30,850
	Year 2: $133,462	22.5%	2.71	$30,155
	Year 3: $138,803	22%	2.65	$30,696
	TOTAL	**22.6%**	**8.24**	**$91,701**
Pedro Jimenez Munoz	Year 1: $154,102	22.5%	2.77	$35,563
	Year 2: $160,266	21%	2.54	$33,902
	Year 3: $166,679	20%	2.42	$33,655
	TOTAL	**21%**	**7.73**	**$103,120**

Dr. Timothy Juliano, Project Scientist II, will serve as NSF NCAR's PI and charge approximately 2.88 months in Year 1, 2.71 months in Year 2, and 2.65 months in Year 3 of this project. Dr. Juliano's primary responsibilities for this project include helping to integrate an FMC product into the RRFS-Smoke system, including the emissions module, helping to integrate the UFS FBM into RRFS-Smoke, aiding in model configuration and analysis of model simulations, and project management.

Dr. Pedro Jimenez Munoz, Project Scientist III, will serve as Co-I and charge approximately 2.77 months in Year 1, 2.54 months in Year 2, and 2.42 months in Year 3 of this project. Dr. Jimenez Munoz's primary responsibilities for this project include leading the integration of an FMC product into the RRFS-Smoke system, including the emissions module, leading integration of the UFS FBM into RRFS-Smoke, and aiding in model configuration and interpretation of model results.

B. Fringe Benefits: $118,232

Name & Position Title	Annual Salary	Salary Request	% Rate	$ Fringe
Timothy Juliano, PI	Year 1: $128,329 Year 2: $133,462 Year 3: $138,803	$30,850 $30,155 $30,696	56.0% 56.0% 56.0%	$17,276 $16,887 $17,190
	TOTAL	**$91,701**	**56.0%**	**$51,353**
Pedro Jimenez Munoz	Year 1: $154,102 Year 2: $160,266 Year 3: $166,679	$35,563 $33,902 $33,655	56.0% 56.0% 56.0%	$19,915 $18,985 $18,847
	TOTAL	**$103,120**	**56.0%**	**$57,747**

The salary budget includes a full-time employee benefit rate of 56.0% for non-work time of vacation, sick leave, holidays, and other paid leave, as well as standard staff benefits. NSF NCAR's negotiated indirect cost rate agreement (NICRA) with NSF, outlining our fringe and other indirect rates, is provided at the end of this narrative document.

C. Travel: $10,783

A total of $10,783 is requested for domestic travel, which includes 3 total trips over the duration of the project. Unless otherwise noted, the point of origin for all trips is Boulder, Colorado. The following are the basis for NSF NCAR's travel cost estimates:

- 3% annual escalation of all travel costs beginning Year 2
- For roundtrip **Airfare** costs, a search for comparable flights between Denver International Airport (DIA) and the closest major airport near the travel destination conducted using NSF NCAR's web-based travel system, Concur.
- FY2024 GSA rates for domestic travel **Lodging** (per night) and M&IE **Per Diem.** Lodging rates include any associated taxes and fees. Per Diem includes a reduced 75% rate for first and last days of travel
- Current U.S. Department of State rates for foreign travel **Lodging** and M&IE **Per Diem**, including a reduced 75% per diem rate for first and last days of travel.
- For **Ground Transportation** costs, NSF NCAR's average prior travel rates for taxi, rail, bus, airport parking, etc. for both domestic and foreign locations, as applicable
- For **Mileage**, a total of 90 miles to/from DIA (45 miles each way) at a rate of $0.67 per mile, based on the current IRS standard mileage rates, is applied for each traveler on all trips involving airfare.
- For **Car Rental** costs, a search for an intermediate car to be picked up/dropped off at the destination airport conducted using NSF NCAR's web-based travel system, Concur. Unless otherwise noted, car rentals are shared among travelers.
- For **Registration** fees, an online search for the most recent in-person registration rate available for the given conference

Domestic Travel: $10,783

Travel Summary *(#s in italics = base unit costs)*

Destination	Purpose	# of Travelers	Airfare	Lodging	Per Diem	Ground Trans.	Mileage	Car Rental	Regist. / Misc.	Total
New Orleans, LA	AGU 2025	1	*$391*	*$188*	*$80*	*$100*	*$30*		*$875*	$3,077
			$391	$1,130	$520	$100	$61	$0	$875	
Trip 1 Y1										
San Francisco, CA	AGU 2026	1	*$432*	*$326*	*$92*	*$100*	*$30*		*$875*	$4,145
			$445	$2,017	$616	$103	$63	$0	$901	
Trip 2 Y2										
Washington, D.C.	AGU 2027	1	*$312*	*$235*	*$92*	*$100*	*$30*		*$875*	$3,561
			$331	$1,497	$634	$106	$65	$0	$928	
Trip 3 Y3										
										$10,783

$3,077 is requested in Year 1 for 1 person for 7 days/6 nights to travel to New Orleans, LA to attend the AGU Conference.

$4,145 is requested in Year 2 for 1 person for 7 days/6 nights to travel to San Francisco, CA to attend the AGU Conference.

$3,561 is requested in Year 3 for 1 person for 7 days/6 nights to travel to Washington, D.C. to attend the AGU Conference.

D. Equipment: None

E. Supplies: None

F. Contractual: None

G. Construction: None

H. Other: None

Publication Costs: $6000

A total of $6000 is budgeted for publication(s) in Year 2 and one in Year 3 The estimated cost is based upon published rates and PI's previous journal costs. The publications will be used for publishing, sharing, and communicating the scientific findings of this project.

Computer Services: $20,720

Scientific and computing support costs have been allocated to this project through the Computer Service Center (CSC), in accordance with OMB circulars and NSF NCAR management policy. The FY2024 NSF NCAR Research IT (NRIT) CSC rate is applied to staff within NSF NCAR at a rate of $7.48 per labor hour, with Approximately 2,770 RAL CSC hours are allocated for this project.

Data Management Storage and Processing: None

I. Total Direct Charges: $341,424

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A.	Personnel	$194,821
B.	Fringe	$109,100
C.	Travel	$10,783
D.	Equipment	$0
E.	Supplies	$6000
F.	Contractual	$
G.	Construction	$
H.	Other	$20,720
TOTAL DIRECT		**$341,424**

J. Indirect Charges: $181,839

Indirect Costs are applied to all modified total direct costs (MTDC). Excluded from MTDC are items of equipment, participant costs, service center rates such as computing services, machine shop, data storage, etc., and individual subaward and subcontract amounts more than $50,000 per fiscal year. (In anticipation of the updated OMB Uniform Guidance effective 10-1-24 and in alignment with our approved rate agreement with the U.S. National Science Foundation (NSF), subawards and subcontracts have been budgeted with indirect costs capped at the first $50,000 per subaward/subcontract each fiscal year. UCAR will work with our cognizant agency to update the MTDC methodology based upon the updated Uniform Guidance.) The provisional FY2024 rate for Indirect Costs is 56.7%. Cognizant Agency: U.S. National Science Foundatn (NSF).

A.	Personnel	$194,821
B.	Fringe	$109,100
C.	Travel	$10,783
E.	Supplies	$6000
H.	Other	$20,720
TOTAL (MTDC)		$320,704
Multiplied by		56.7%
TOTAL INDIRECT		**$181,839**

A copy of NSF NCAR's most recent negotiated indirect cost rate agreement (NICRA) is provided at the end of this narrative document.

UCAR Management Fee: None

K. Totals – Direct and Indirect Charges: $523,263

<u>**Standard Information:**</u>

1. The U.S. National Science Foundation National Center for Atmospheric Research (NSF NCAR) is operated by the University Corporation for Atmospheric Research (UCAR), UEI# YEZEE8W5JKA3, under the sponsorship of the National Science Foundation (NSF). NSF, our cognizant audit agency, approves UCAR rates annually. Budgets include provisional rates, which are subject to review and approval of NSF. Out year rates are estimated based on current provisional rates and are subject to change.

2. The salary budget includes direct labor charges only for time worked. The employee benefit rate includes direct charges for non-work time of vacation, sick leave, holidays and other paid leave, as well as standard staff benefits. The casual benefit rate applies to casual employees who do not receive the full benefit package.

3. Indirect Costs are applied to all modified total direct costs (MTDC). Items excluded from MTDC are equipment, participant costs, service center rates such as computing services, machine shop, data storage, etc. and individual subcontract amounts in excess of $50,000 per fiscal year. (In anticipation of the updated OMB Uniform Guidance effective 10-1-24 and in alignment with our approved rate agreement with the U.S. National Science Foundation (NSF), subawards and subcontracts have been budgeted with indirect costs capped at the first $50,000 per subaward/subcontract each fiscal year. UCAR will work with our cognizant agency to update the MTDC methodology based upon the updated Uniform Guidance.)

4. The budget may include a charge for scientific computing and networking support in accordance with 2 CFR 200, OMB Uniform Guidance and NSF NCAR management policy allocating the costs of scientific computing system infrastructure.

5. Non-NSF and NSF Grant research at NSF NCAR is monitored by our sponsor, the U.S. National Science Foundation, in accordance with criteria and guidelines approved by NSF/Division of Atmospheric and Geospace Sciences (AGS).

For funds provided by direct agreement with UCAR, contractual arrangements should be made with Ms. Anna Thomas, Manager, UCAR Contracts, 3090 Center Green Drive, Boulder, CO 80301-2252, Phone (303) 497-2005, Fax (303) 497-8501. Please refer to NSF NCAR's proposal number on all correspondence with UCAR.

Rev. 8/8/24

UCAR

UCAR Proposal Budget Detail

Proposal #	2024-0799	
Proposal Title:	Improving Smoke Predictions in NOAA's Rapid Refresh Forecast System with Smoke (RRFS-Smoke) Model Through Advanced Fuel Moisture Integration	
UCAR Entity:	NCAR	
Period of Performance:	08-01-2025 -	07-31-2028
Principal Investigator	Timothy	Juliano

			Unit / Rate	Effort Year 1	Effort Year 2	Effort Year 3	Year 1 University of Colorado CIRES	Year 2 University of Colorado CIRES	Year 3 University of Colorado CIRES	Cumulative Grand Total
Salaries	Regular Salaries	Proj Scientist III	Hours	480.00	440.00	420.00	35,563	33,902	33,655	103,120
		Proj Scientist II	Hours	500.00	470.00	460.00	30,850	30,155	30,696	91,701
	Subtotal Salaries						66,413	64,057	64,351	194,821
Fringe Benefits		Regular Benefits @	56.00 %				37,191	35,872	36,037	109,100
	Subtotal Fringe Benefits						37,191	35,872	36,037	109,100
	Total Salaries and Benefits						103,604	99,929	100,388	303,921
Materials and Supplies		Publication / Page Charges					0	3,000	3,000	6,000
	Subtotal Materials and Supplies						0	3,000	3,000	6,000
Travel		Domestic - AGU Conference (New Orleans, LA)					3,077			3,077
		Domestic - AGU Conference (San Francisco, CA)						4,145		4,145
		Domestic - AGU Conference (Washington, DC)							3,561	3,561
	Subtotal Travel						3,077	4,145	3,561	10,783
	Modified Total Direct Costs (MTDC)						106,681	107,074	106,949	320,704
Indirect Costs		NCAR Indirect Cost Rate (MTDC)	56.70 %				60,488	60,711	60,640	181,839
	Total Indirect Costs						60,488	60,711	60,640	181,839
MTDC Costs that Include Indirect Costs	Computing Service Center	Computing Service Center	$7.48 / hr				7,330	6,807	6,583	20,720
	Subtotal MTDC Costs that Include Indirect Costs						7,330	6,807	6,583	20,720
	Total MTDC + Applied Indirect Costs						174,499	174,592	174,172	523,263
	Total Funding To UCAR						174,499	174,592	174,172	523,263

COLLEGES AND UNIVERSITIES RATE AGREEMENT

EIN:
ORGANIZATION:
University of Colorado Boulder
914 Broadway, 90 UCB
Boulder, CO 80309

Date: 07/23/2024
FILING REF.: The preceding agreement was dated 06/15/2023

The rates approved in this agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions in Section III.

SECTION I: INDIRECT COST RATES

RATE TYPES: FIXED FINAL PROV. (PROVISIONAL) PRED. (PREDETERMINED)

	EFFECTIVE PERIOD				
TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
FINAL	07/01/2018	06/30/2020	54.00	On-Campus	Organized Res.
PRED.	07/01/2020	06/30/2021	54.00	On-Campus	Organized Res.
PRED.	07/01/2021	06/30/2023	56.50	On-Campus	Organized Res.
FINAL	07/01/2018	06/30/2020	26.00	Off-Campus	Organized Res.
PRED.	07/01/2020	06/30/2023	26.00	Off-Campus	Organized Res.
FINAL	07/01/2018	06/30/2020	49.00	On-Campus	Instruction
PRED.	07/01/2020	06/30/2021	49.00	On-Campus	Instruction
PRED.	07/01/2021	06/30/2023	47.50	On-Campus	Instruction
FINAL	07/01/2018	06/30/2020	26.00	Off-Campus	Instruction
PRED.	07/01/2020	06/30/2023	26.00	Off-Campus	Instruction
FINAL	07/01/2018	06/30/2020	33.50	On-Campus	Other Spons Act
PRED.	07/01/2020	06/30/2023	33.50	On-Campus	Other Spons Act
FINAL	07/01/2018	06/30/2020	14.40	Off-Campus	Other Spons Act
PRED.	07/01/2020	06/30/2023	14.40	Off-Campus	Other Spons Act
FINAL	07/01/2018	06/30/2020	40.00	All	LASP (1)
PRED.	07/01/2020	06/30/2021	40.00	All	LASP (1)
PRED.	07/01/2021	06/30/2023	43.00	All	LASP (1)
FINAL	07/01/2018	06/30/2020	10.00	Off-Campus	IPA (2)
PRED.	07/01/2020	06/30/2023	10.00	Off-Campus	IPA (2)
PROV.	07/01/2023	Until Amended			Use same rates and conditions as those cited for fiscal year ending June 30, 2023.

*BASE

Modified total direct costs, consisting of all direct salaries and wages, applicable fringe benefits, materials and supplies, services, travel and up to the first $25,000 of each subaward (regardless of the period of performance of the subawards under the award). Modified total direct costs shall exclude equipment, capital expenditures, charges for patient care, rental costs, tuition remission, scholarships and fellowships, participant support costs and the portion of each subaward in excess of $25,000. Other items may only be excluded when necessary to avoid a serious inequity in the distribution of indirect costs, and with the approval of the cognizant agency for indirect costs.

(1) Lab for Atmospheric and Space Physics (LASP)
(2) Intergovernmental Personnel Act Agreements.

ORGANIZATION: University of Colorado Boulder
AGREEMENT DATE: 07/23/2024

SECTION I: FRINGE BENEFIT RATES**

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
FIXED	7/1/2024	6/30/2025	31.00	All (A)	Regular Faculty
FIXED	7/1/2024	6/30/2025	40.00	All, except LASP (A)	FT Professional Exempt, Research Faculty & Permanent Classified
FIXED	7/1/2024	6/30/2025	14.60	All (A)	PT Professional Exempt, Research Faculty & Temporary Classified
FIXED	7/1/2024	6/30/2025	11.40	All (A)	Student Faculty
FIXED	7/1/2024	6/30/2025	16.50	All (A)	Athletic Director and Coaches
FIXED	7/1/2024	6/30/2025	35.70	All (A)	Police Officers
FIXED	7/1/2024	6/30/2025	38.90	LASP (A)	FT Professional Exempt, Research Faculty, Permanent Classified
FIXED	7/1/2024	6/30/2025	25.60	LASP (B)	Leave Rate for All Eligible Employee Classifications
FIXED	7/1/2024	6/30/2025	1.80	All (A)	Hourly
PROV.	7/1/2025	Until Amended			Use same rates and conditions as those cited for fiscal year ending June 30, 2025

** DESCRIPTION OF FRINGE BENEFITS RATE BASE:

(A) Salaries and wages including vacation, holiday, sick leave pay and other paid absences.

(B) Salaries and wages excluding vacation, holiday, sick leave pay and other paid absences.

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:
The fringe benefits are charged using the rate(s) listed in the Fringe Benefits Section of this Agreement. The fringe benefits included in the rate(s) are listed below.

TREATMENT OF PAID ABSENCES:
Except for LASP employees, vacation, holiday, sick leave pay and other paid absences are included in salaries and wages and are charged to Federal projects as part of the normal charge for salaries and wages. Separate charges for the cost of these absences are not made.

For LASP, the cost of vacation, holiday, sick leave pay, and other paid absences are included in a leave benefit rate which is applied to salaries and wages for budgeting and charging purposes for Federal projects, and are not included in direct charges for salaries and wages. Charges for salaries and wages must exclude those paid to LASP for periods when they are on vacation, holiday, or sick leave, or are otherwise absent from work.

Off-campus activity shall be defined as those activities which, because of location where work is performed, do not incur physical plant operations and maintenance costs. Projects partially performed off-site are apportioned between their on-site components. If 50% or more of the indirect cost rate base costs of the project are determined to be on-site, the entire project is considered on-site. If less than 50% of the indirect cost rate base costs are determined to be on-site, the entire project is considered off-site. This rate agreement updates the facilities and administrative cost rates only.

Fringe Benefits include Health, Dental and Life Insurance, Disability Insurance, Annuitants' Insurance, FICA Contribution, PERA, Medicare, Workers' Compensation, Unemployment Compensation Claims, Other Retirement Plans, RTD Bus Pass/ECOPASS, Back Up Care, FAMLI, Parental Leave, and Termination Vacation & Sick Leave Pay.

Equipment means tangible personal property (including information technology systems) having a useful life of more than one year and a per-unit acquisition cost which equals or exceeds $5,000.

NEXT PROPOSALS DUE DATE:
A fringe benefit rate proposal based on actual costs for fiscal year ended 06/30/2024, will be due no later than 12/31/2024. FY2022 F&A rate proposal is currently under review.

This rate agreement updates fringe benefits rates only.

ORGANIZATION: University of Colorado Boulder
AGREEMENT DATE: 07/23/2024

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its indirect cost pool as finally accepted: such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as indirect costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES:

This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from indirect to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES:

If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES:

The rates in this Agreement were approved in accordance with the authority in Title 2 of the Code of Federal Regulations, Part 200 (2 CFR 200), and should be applied to grants, contracts and other agreements covered by 2 CFR 200, subject to any limitations in A above. The organization may provide copies of the Agreement to other Federal Agencies to give them early notification of the Agreement.

E. OTHER:

If any Federal contract, grant or other agreement is reimbursing indirect costs by a means other than the approved rate(s) in this Agreement, the organization should (1) credit such costs to the affected programs, and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of indirect costs allocable to these programs.

BY THE INSTITUTION:

University of Colorado Boulder

DocuSigned by:
Todd Haggerty
98FBAB6DC8A64A4...
(SIGNATURE)

Todd Haggerty
(NAME)

CFO and Vice Chancellor for Finance and Business Strategy
(TITLE)

7/24/2024
(DATE)

ON BEHALF OF THE GOVERNMENT:

DEPARTMENT OF HEALTH AND HUMAN SERVICES
(AGENCY)

Arif M. Karim -S Digitally signed by Arif M. Karim -S Date: 2024.07.24 09:25:40 -05'00'
(SIGNATURE)

Arif Karim
(NAME)

Director, Cost Allocation Services
(TITLE)

07/23/2024
(DATE)

HHS REPRESENTATIVE: Lucy Siow
TELEPHONE: (415) 437-7820

NATIONAL SCIENCE FOUNDATION

2415 Eisenhower Avenue
Alexandria, VA 22314

Division of Institution and Award Support
(703) 292-8244 VOICE

November 27, 2023

Geoff Cheeseman
Director, UCAR Budget and Planning
University Corporation for Atmospheric Research
P. O. Box 3000
Boulder, CO 80307-3000

Dear Mr. Cheeseman:

We have completed our review of the indirect cost proposal and supporting financial data submitted to the National Science Foundation (NSF) for your fiscal year ended September 30, 2022.

The enclosed rate agreement indicates the rates approved by this office. Please indicate your concurrence with these rates by signing, dating and returning a copy of the agreement to my attention at the above address. The rates included in the agreement may not be used until the agreement has been ratified through signatures from both your organization and NSF.

Should you wish to appeal any of the indirect cost pool adjustments NSF made as part of this rate negotiation, you may follow the dispute resolution procedures contained in Chapter XII of the NSF Proposal & Award Policies and Procedures Guide (PAPPG). These may be found online at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papp.

Per the rates that have been established, the organization will not be required to submit a new indirect cost rate proposal until the end of your FY 2023. This proposal should be submitted to this office within 6 months after the end of the organization's fiscal year and should follow NSF's current submission procedures (https://www.nsf.gov/bfa/dias/caar/docs/idcsubmissions.pdf). If you have any questions concerning the contents of this letter or the rate agreement, please contact James Deans at jdeans@nsf.gov or at (703) 292-2636.

Sincerely,

Meghan A. Benson
Dr. Meghan A. Benson
Lead Analyst, Indirect Cost Rates
Cost-Analysis and Pre-Award Branch (CAP)
Division of Institution and Award Support

Enclosure: Rate Agreement

NATIONAL SCIENCE FOUNDATION

OFFICE OF BUDGET, FINANCE & AWARD MANAGEMENT
Division of Institution and Award Support

NON-PROFIT ORGANIZATION
NEGOTIATED INDIRECT COST RATE AGREEMENT (NICRA)

EIN #: 84-0412668

NSF INS CODE: 4062600000

ORGANIZATION:
University Corporation for Atmospheric Research (UCAR)
P. O. Box 3000
Boulder, CO 80307-3000

DATE: November 27, 2023

FILING REF: The preceding agreement was dated December 12, 2022.

The indirect cost rates contained herein are for use on grants, contracts, and other agreements with the Federal Government to which 2 CFR Part §200 apply, subject to the terms and conditions of Section II of this agreement. The rates were negotiated by the National Science Foundation and the subject organization in accordance with the authority contained in applicable regulations.

SECTION I: RATES

FY 2022 - FINAL

Rate Description	Effective Period	Rate	Base
UCAR			
UCAR G&A	10/01/21 – 09/30/22	13.29%	(a)
UCAR Community Programs (UCP) G&A			
Onsite	10/01/21 – 09/30/22	35.03%	(b)
Offsite	10/01/21 – 09/30/22	21.54%	(b)
NCAR			
NCAR G&A			
Onsite	10/01/21 – 09/30/22	56.47%	(b)
Offsite/NWSC	10/01/21 – 09/30/22	44.92%	(b)
Fringe Benefits			
Full Benefits	10/01/21 – 09/30/22	57.47%	(c)
Reduced Benefits	10/01/21 – 09/30/22	9.24%	(c)

FY 2024 - PROVISIONAL

Rate Description	Effective Period	Rate	Base
UCAR			
UCAR G&A	10/01/23 – 09/30/24	13.10%	(a)
UCAR Community Programs (UCP) G&A			
Onsite	10/01/23 – 09/30/24	36.00%	(b)
Offsite	10/01/23 – 09/30/24	23.20%	(b)
NCAR			
NCAR G&A			
Onsite	10/01/23 – 09/30/24	56.70%	(b)
Offsite/NWSC	10/01/23 – 09/30/24	46.10%	(b)
Fringe Benefits			
Full Benefits	10/01/23 – 09/30/24	56.00%	(c)
Reduced Benefits	10/01/23 – 09/30/24	8.70%	(c)

SECTION I: RATES (cont'd)

Rate Application Bases

(a) Total direct costs of each entity, excluding equipment, participant support, Intergovernmental Personnel Assignments (IPAs), subaward or subcontract costs and other direct costs that are in excess of $25,000 per year, plus entity G&A before the allocation of UCAR G&A. The UCAR G&A rate is part of the National Center for Atmospheric Research (NCAR) and UCAR Community Program (UCP) rates and is generally not proposed separately on grant, contract, or cooperative agreement proposal budgets.

(b) Total direct costs, excluding equipment, participant support, Intergovernmental Personnel Assignments (IPAs), subaward or subcontract costs, and other direct costs that are in excess of $25,000 per year.

(c) Direct salaries and wages excluding paid absences. The Reduced Benefit rate is applicable to the salaries of student assistants, student visitors and other hourly staff that work "on call." The Full Benefit rate is applicable to the salaries of "regular" employees.

Fringe Benefits: Fringe benefits consist of: Payroll Taxes, Group Life and Major Medical Insurances, Retirement Contributions (TIAA/CREF), Unemployment Insurance, Worker's Compensation, Disability Insurance, Severance, Educational Assistance, Travel Accident Insurance, Transportation Benefits (RTD Bus Passes), and Employee Wellness. Fringe Benefits also include the costs of Paid Time Off (holiday, vacation, sick leave and other "non-work" time).

cont'd

SECTION II: GENERAL TERMS

A. LIMITATIONS: Use of the rates contained in this agreement is subject to any applicable contractual or grant limitations. Acceptance of these rates agreed to herein is predicated upon the conditions: (1) that no costs other than those incurred by the contractor or grantee were included in its indirect cost proposal and that such costs are legal obligations of the contractor or grantee, (2) that the same costs that have been treated as indirect costs have not been claimed as direct costs, and (3) that similar types of costs have been accorded consistent treatment.

B. AUDIT: All costs, direct and indirect, Federal and non-Federal are subject to audit. Adjustments to amounts resulting from audit of cost allocation plan or indirect rate proposal upon which the negotiation of this agreement was based will be compensated for in subsequent negotiation.

C. ACCOUNTING CHANGES: The rates contained in this agreement are based on the accounting system in effect at the time the proposal was prepared and the rates were negotiated. Changes to the method of accounting which effect the amount of reimbursement resulting from the use of these rates require the prior approval of this office. Failure to obtain such approval may result in subsequent cost disallowances.

D. RATE TYPES:
   1. Provisional/Final Rate: Within six (6) months after fiscal year end, a final indirect cost rate proposal must be submitted based on actual costs. Billings and charges to federal grants and contracts must be adjusted if the final rate varies from the provisional rate. If the final rate is greater than the provisional rate and there are no funds to cover the additional indirect costs, the organization may not recover all indirect costs. Conversely, if the final rate is less than the provisional rate, the organization will be required to pay back the difference to the funding agency.

   2. Predetermined Rate: Predetermined rates are applicable to a current or future period and are based upon an estimate of the costs to be incurred during the period. A predetermined rate is not subject to adjustment.

E. NOTIFICATION TO FEDERAL AGENCIES: Copies of this document may be provided to other Federal offices as a means of notifying them of the rates agreed to herein.

SECTION III: ACCEPTANCE

BY THE ORGANIZATION:

University Corporation for Atmospheric Research (UCAR)
(Organization)

DocuSigned by:
Erika Smith
7A7DDB066E374DA
(Signature)

Erika Smith
(Name)

CFO
(Title)

11/28/2023
(Date)

ON BEHALF OF THE FEDERAL GOVERNMENT:

National Science Foundation
(Agency)

MEGHAN A BENSON
Digitally signed by MEGHAN A BENSON
Date: 2023.11.27 15:16:55 -05'00'
(Signature)

Meghan A. Benson
(Name)

Lead Analyst, Indirect Cost Rates
Cost-Analysis and Pre-Award Branch
(Title)

November 27, 2023
(Date)

NSF Negotiator: James P. Deans
Telephone: 703-292-2636

UCAR
UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

April 28, 2023

The National Science Foundation
Division of Institution and Award Support
Attn: CAP Branch – Indirect Cost
2415 Eisenhower Avenue
Alexandria, Virginia 22314

Dear Ms. Meghan Benson:

Enclosed for review and approval are UCAR's proposed **FY 2024 Aircraft Maintenance Rates (AMR), Service Center Rates** (Computer Service Center (CSC) and Machine Shop), **User Rates** (System User Rates (SUR) and Core Hour Rate), and **Data Management Services Rates** (data processing and storage).

Please note in FY 2024 the addition of three new System User Rates for instrumentation operated by the Atmospheric Chemistry and Modeling Laboratory (ACOM). These instruments are available to the community, and are listed in the Project Requests Online (PRESTO) platform.

As with previous rate submissions, the attached summary page has an approval line for the NCAR/Facilities Section Head signature. If you have any questions regarding these FY 2024 proposed rates, please do not hesitate to contact me: (303) 497-1116 or charliem@ucar.edu.

Sincerely,

Charlie Mitchell
Assistant Director, NCAR Budget & Planning

cc: K. Spencer (NSF)
S. Ruth (NSF)

UCAR CFO
UCAR Budget & Planning
NCAR Administrators

UCAR President's Council:
A. Busalacchi E. Joseph
A. Swofford (interim) W. Kuo

Section 11
National Center for Atmospheric Research
Proposed Rate Summary

1. Aircraft Maintenance Rate

Aircraft Maintenance Rate (AMR)	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
C-130 Aircraft	$1,204 /Hour	$648 /Hour	$69 /Hour
GV Aircraft (Gulfstream HIAPER)	$3,226 /Hour	$3,781 /Hour	$5,556 /Hour

2. Service Center Rates

Computing Service Centers	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
Climate and Global Dynamics (CGD)	$7.44 /Hour	N/A /Hour	N/A /Hour
Atmospheric Chemistry Observations & Modeling (ACOM)	$8.31 /Hour	N/A /Hour	N/A /Hour
High Altitude Observatory (HAO)	$6.36 /Hour	N/A /Hour	N/A /Hour
NCAR Research IT (NRIT)	N/A /Hour	$8.01 /Hour	$7.48 /Hour
Mesoscale & Microscale Meteorology (MMM)	$7.03 /Hour	$6.50 /Hour	N/A /Hour
Research Applications Laboratory (RAL)	$7.17 /Hour	$7.75 /Hour	N/A /Hour

Machine Shop			
Machine Shop Rate	$87 /Hour	$88 /Hour	$90 /Hour

3. System User Rates

Earth Observing Laboratory (EOL)	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
ISFS	$289 /Day	$271 /Day	$271 /Day
ISS	$1,650 /Day	$1,689 /Day	$1,689 /Day
Dropsonde Data System	$820 /Day	$893 /Day	$908 /Day
Calibration Lab / Wind Tunnel	$346 /Day	$968 /Day	$968 /Day
S-Pol Radar	$6,253 /Day	$9,132 /Day	$9,132 /Day
HCR	$2,213 /Day	$5,313 /Day	$5,313 /Day
MPD	$934 /Day	$1,722 /Day	$1,722 /Day
HAIS	$309 /Day	$599 /Day	$849 /Day
C-130 Aircraft	$5,594 /Day	$11,738 /Day	$11,738 /Day
Gulfstream Aircraft (HIAPER)	$20,885 /Day	$10,759 /Day	$10,759 /Day
Mechanical Design	$949 /Day	$923 /Day	$923 /Day
Machine Shop	$683 /Day	$315 /Day	$315 /Day

Comp. & Information Systems Lab (CISL)	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
Rate Per Core Hour	$0.0062 /Hour	$0.0060 /Hour	$0.0056 /Hour
Rate per 100 Core Hours	$0.62 /100 Hours	$0.60 /100 Hours	$0.56 /100 Hours
GPU Rate	N/A /Hour	N/A /Hour	$1.30 /Hour

High Altitude Observatory (HAO)	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
Vacuum Tunnel	$955 /Day	$988 /Day	$1,038 /Day

Atmospheric Chemistry Observations & Modeling (ACOM	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
TOGA-TOF	N/A /Day	N/A /Day	$573 /Day
2 Channel Chemi Luminescence Instrument	N/A /Day	N/A /Day	$157 /Day
Fast Ozone (non-HAIS)	N/A /Day	N/A /Day	$363 /Day

4. Data Management Services Rate (DMSR)

Assume data preservation commitment of 5 years *(include set-up costs*)*

Comp. & Information Systems Lab (CISL) - DMPSR	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
Processing Services*: Vol < 5 TB	$874.00 /Project	$938.00 /Project	$1,084.00 /Project
Processing Services: 5 TB <= Vol <10 TB	$1,311.00 /Project	$1,407.00 /Project	$1,626.00 /Project
Processing Services: 10 TB <= Vol < 25 TB	$2,622.00 /Project	$2,814.00 /Project	$3,252.00 /Project
Processing Services*: 25 TB <= Vol < 50 TB	$4,370.00 /Project	$4,960.00 /Project	$5,420.00 /Project
Processing Services: 50 TB <= Vol < 100 TB	$6,555.00 /Project	$7,035.00 /Project	$8,130.00 /Project
Processing Services: 100+ TB <= Vol	$8,740.00 /Project	$9,380.00 /Project	$10,840.00 /Project
CISL Storage Services Rate**	$45.00 /TB/Yr (ea.)	$45.00 /TB/Yr (ea.)	$45.00 /TB/Yr (ea.)

Comp. & Information Systems Lab (CISL) - DMPSSUR	FY 2022 Actual	FY 2023 Submitted	FY 2024 Proposed
Processing Services*: Vol < 5 TB	N/A /Project	$1,876.00 /Project	$2,168.00 /Project
Processing Services: 5 TB <= Vol <10 TB	N/A /Project	$2,814.00 /Project	$3,252.00 /Project
Processing Services: 10 TB <= Vol < 25 TB	N/A /Project	$5,628.00 /Project	$5,628.00 /Project
Processing Services*: 25 TB <= Vol < 50 TB	N/A /Project	$9,380.00 /Project	$6,504.00 /Project
Processing Services: 50 TB <= Vol < 100 TB	N/A /Project	$14,070.00 /Project	$16,260.00 /Project
Processing Services: 100+ TB <= Vol	N/A /Project	$18,760.00 /Project	$21,680.00 /Project
CISL Storage Services Rate**	N/A /TB/Yr (ea.)	$75.00 /TB/Yr (ea.)	$75.00 /TB/Yr (ea.)

**Processing Services costs assume estimated data volume is known at the time of proposal and current SE-II fully loaded salary midpoint.*
***All projects may be assessed the Processing Services fee plus the storage rate.*

APPROVED:

Sarah L. Ruth, Ph.D.
Section Head, NCAR and Facilities Section

Section 11
National Center for Atmospheric Research
Proposed Service Center Rates

Computing Service Centers (CSC)	Actual FY 2022	Submitted FY 2023	Proposed FY 2024
Climate & Global Dynamics			
Operating Expenses	$1,312,448	N/A	N/A
Worktime Hours	176,450	N/A	N/A
CGD CSC Rate/Hour	**$7.44**	**N/A**	**N/A**
Atmospheric Chemistry Observations & Modeling			
Operating Expenses	$709,338	N/A	N/A
Worktime Hours	85,336	N/A	N/A
ACOM CSC Rate/Hour	**$8.31**	**N/A**	**N/A**
High Altitude Observatory			
Operating Expenses	$559,085	N/A	N/A
Worktime Hours	87,953	N/A	N/A
HAO CSC Rate/Hour	**$6.36**	**N/A**	**N/A**
NCAR Research IT (NRIT) Rate (CGD, ACOM, HAO)			
Operating Expenses	N/A	$3,047,266	$8,915,030
Worktime Hours	N/A	$380,424	1,192,516
NRIT CSC Rate/Hour	**N/A**	**$8.01**	**$7.48**
Mesoscale & Microscale Meteorology			
Operating Expenses	$716,625	$732,915	N/A
Worktime Hours	101,932	112,740	N/A
MMM CSC Rate/Hour	**$7.03**	**$6.50**	**N/A**
Research Applications Laboratory			
Operating Expenses	$1,845,258	$2,052,394	N/A
Worktime Hours	257,336	264,825	N/A
RAL CSC Rate/Hour	**$7.17**	**$7.75**	**N/A**
Machine Shop			
Operating Expenses	$350,339	$528,884	$473,881
Number of Hours	4,037	5,984	5,246
Machine Shop Rate/Hour	**$87**	**$88**	**$90**

Section 11
National Center for Atmospheric Research
Proposed Aircraft Maintenance Rates (AMR)

Aircraft Maintenance Rates (AMR)	**Actual FY 2022**	**Submitted FY 2023**	**Proposed FY 2024**
C-130 Aircraft			
Operating Expenses	$6,235	$130,882	$17,263
Number of Hours	5	202	250
C-130 AMR Rate/Hour[1]	**$1,204**	**$648**	**$69**

[1] Actual aircraft flight hours are dependent on NSF approved deployments and the deployment schedule. Additionally, revenue and expenditures are not always realized in the same fiscal year.

GV Aircraft Maintenance Rate (AMR)	**Actual FY 2022**	**Submitted FY 2023**	**Proposed FY 2024**
Operating Expenses[2]	$1,168,824	$786,448	$805,620
Number of Hours	219	208	145
GV Rate/Hour[2]	**$3,226**	**$3,781**	**$5,556**

[2] The operating expenses for 2022 and component include COVID relief funding received in 2022 to offset the aircraft not flying due to the pandemic.

Section 11
National Center for Atmospheric Research
Proposed System User Rates

Earth Observing Laboratory (EOL)	Actual FY 2022	Submitted FY 2023	Proposed FY 2024
Systems User Rates (SUR)			
ISFS			
Operating Expenses	$1,510,514	$1,407,857	$1,414,620
Number of Systems	20	20	20
Number of Days[1]	261	260	261
ISFS Rate/Day[2]	**$289**	**$271**	**$271**
ISS/MISS/GAUS/MGAUS			
Operating Expenses	$1,722,965	$1,756,554	$1,763,316
Number of Systems	4	4	4
Number of Days[1]	261	260	261
ISS Rate/Day[2]	**$1,650**	**$1,689**	**$1,689**
ISS / GAU combined in FY 2007.			
Dropsonde Data System			
Operating Expenses	$641,852	$696,802	$710,964
Number of Systems	3	3	3
Number of Days[1]	261	260	261
Dropsonde Data System Rate/Day[2]	**$820**	**$893**	**$908**
Calibration Lab / Wind Tunnel			
Operating Expenses	$90,176	$251,789	$252,648
Number of Systems	1	1	1
Number of Days[1]	261	260	261
Calibration Lab Rate/Day[2]	**$346**	**$968**	**$968**
S-Pol Radar			
Operating Expenses	$1,631,967	$2,374,320	$2,383,452
Number of Systems	1	1	1
Number of Days[1]	261	260	261
S-Pol Rate/Day[2]	**$6,253**	**$9,132**	**$9,132**
HIAPER Cloud Radar (HCR)			
Operating Expenses	$577,536	$1,381,380	$1,386,693
Number of Systems	1	1	1
Number of Days[1]	261	260	261
HCR Rate/Day[2]	**$2,213**	**$5,313**	**$5,313**
MicroPulse DIAL (MPD)			
Operating Expenses	$1,218,233	$1,343,541	$1,797,768
Number of Systems	5	3	4
Number of Days[1]	261	260	261
MPD Rate/Day[2]	**$934**	**$1,722**	**$1,722**
HIAPER Aircraft Solicitation Instrumentation (HAIS)			
Operating Expenses	$726,507	$1,245,920	$1,772,644
Number of Systems	9	8	8
Number of Days[1]	261 #	260	261
HAIS Rate/Day[2]	**$309**	**$599**	**$849**
C-130 Aircraft			
Operating Expenses	$1,460,086	$3,051,880	$3,063,618
Number of Days[1]	261	260	261
C-130 Aircraft Rate/Day[2]	**$5,594**	**$11,738**	**$11,738**
GV (HIAPER) Gulfstream Aircraft			
Operating Expenses	$5,450,962	$2,797,340	$2,808,099
Number of Days[1]	261	260	261
GV Aircraft Rate/Day[2]	**$20,885**	**$10,759**	**$10,759**
Mechanical Design			
Operating Expenses	$569,915	$479,960	$385,445
Number of FTEs	2.3	2	1.6
Number of Days[1]	261	260	261
Mechanical Design Rate/Day[2]	**$949**	**$923**	**$923**
Machine Shop			
Operating Expenses	$410,209	$409,500	$312,417
Number of FTEs	2.3	5	3.8
Number of Days[1]	261	260	261
Machine Shop Rate/Day[2]	**$683**	**$315**	**$315**

This represents an add on user rate for non-NSF users, for recovery of base funded supervisory and support staff.

[1] For all SUR rates, the number of working days in a year is 5 days per week for 52 weeks in a year, per NSF-AGS.
[2] For all SUR rates, duration and complexity of field programs may affect the required size of the base funded field crew.
Subject to NSF Program Official approval, the SUR can be adjusted to reflect lower or higher labor requirements.

Comp. & Information Systems Laboratory (CISL)	Actual FY 2022	Submitted FY 2023	Proposed FY2023[4]
Core Hours			
Operating Expenses	$20,532,908	$19,022,642	$19,783,547
Estimated Core Hours	3,300,000,000	3,151,425,000	3,510,825,000
CISL Core Hour Rate	**$0.0062**	**$0.0060**	**$0.0056**
CISL Core Hour Rate per 100 Core Hours	**$0.62**	**$0.60**	**$0.56**
CISL GPU Hour Rate	**N/A**	**N/A**	**$1.30**

[4] In FY23/FY24, the estimated Core Hours are based on the current best estimate of Derecho deployment and the overlap of machines. The rate includes Cheyenne Core and Derecho Core. 1 Derecho GPU hour is equal to 230 Derecho core-hours.

High Altitude Observatory (HAO)	Actual FY2022[5]	Submitted FY2023	Proposed FY2024
Vacuum Tunnel			
Operating Expenses	$ 249,288	$ 256,766	$ 270,923
Number of Days	261	260	261
Vacuum Tunnel Rate/Day	**$955**	**$988**	**$1,038**

[5] In FY23 no NSF funds were spent on vacuum tunnel O&M.