Dorothy Holasek
[redacted]

April 18, 2022

Ref to: FEIS/Draft ROD
Rim Country 4FRI Objection
RESPONSIBSLE OFFICIALS AND FORESTS
Judith Palmer, Forest Supervisor, Apache Sitgreaves
Laura Jo West, Forest Supervisor, Coconino
Neil Bosworth, Forest Supervisor, Kaibab

NOTE: This version of my objection dated April 12, 2022 has the corrected salutation and responsible officials and forests as requested by the USFS

USFS
Reviewing Officer
Southwestern Regional Forester
333 Broadway Blvd. SE
Albuquerque, NM 87102

Dear Reviewing Officer:

The following is my response to the FEIS and the Draft ROD for Rim Country 4FRI. Because of the US Forest Service's history of altering my official comment in the 4FRI NEPA process by changing my submitted text to mean the exact opposite of what I submitted, I want all of my actual words to be printed in Rim Country 4FRI on line and hard copy public comments as written in this letter.

**SEQUESTERED NUCLEAR RADIATION**

**As in the DEIS, the most striking omission from the FEIS/DRAFT ROD is the fact that the four forests of the 4FRI are located entirely within the Radiation Exposure Compensation Act (RECA) counties of northern Arizona. This is an important omission because the FEIS/DRAFT ROD states that the "Rim Country area has not been significantly contaminated by radiological release events, nuclear power plant incidents, improvised nuclear devises, nuclear testing sites, or hazardous waste sites." This quote was taken out of context from the USFS Missoula Fire Science Laboratory study that was defining what a recent radiological event could look like. The Nevada Test Site discontinued atomic bomb testing in 1992. Therefore, the authors would not list it as a probable recent radiological event in the US**. Not only is this issue **NOT** "OUTSIDE THE SCOPE OF THIS ANALYSIS" as the USFS relegates it, it is a timely issue as there is currently support in the US Senate by Senator Sinema and by Senator Kelly to strengthen and extend the limit for downwinders to file under RECA for compensation for the cancers that resulted from the radioactive debris that fell on northern Arizona and other states. 4FRI and co-existing USFS burn programs will re-suspend the long lived radionuclides that are stored in the forests of northern Arizona such as CS-137 with a half life of 30 years, Strontium 90 with a half life of 28 years and Plutonium 239 with a half life of 24,400 years. The same radionuclides that claimed the lives of so many citizens in northern Arizona will be re-suspended into the atmosphere in the form of gases and particles once again to do their deadly harm.

The USFS in the the FEIS/Draft ROD again refers to the pamphlet that they created as an official source of scientific reference. It does not represent the "best available science" and should be removed from the USFS website. This pamphlet is full of falsehoods and without scientific basis, including that prescribed fire does not get hot enough to re-suspend the Cesium 137. The USFS has a history on this issue of quoting studies that have no relevant value to the issue at hand. Their latest attempt at this approach is to quote a study conducted at the USFS Fire Science Laboratory in Missoula, MT in which the researchers "doped" pine needles and peat with cesium chloride to study the dispersion of cesium in a burn chamber. The purpose of the study was to recreate the conditions of ***a recent radiological***

*event.* **The cesium 137 that is stored in the vegetation and duff of the 4FRI forests has had 60 years to be absorbed through the roots of the plants and incorporated throughout the entire biomass of the forest. The analog of cesium 137 is potassium and is, therefore, easily assimilated throughout the plant's cells. Strontium 90's analog is calcium. Plutonium 239 has no analog because it is a hideous creation of man. What is needed is a study of the amounts and kinds of radionuclides sequestered in the biomass of northern Arizona forests and to publish the methodology and results in peer reviewed literature, a request made by me and the entire board of Physicians For Social Responsibility Arizona Chapter back in 2012. It bears noting that the radioactive debris did not fall evenly and testing one plot of the forest does not necessarily represent another plot an acre away.**

**Unfortunately, the USFS in the FEIS/Draft ROD stated: "The Rim Country area has not been significantly contaminated by radiological release events, nuclear power plant incidents, improvised nuclear devises, nuclear testing sites, or hazardous waste sites. " This a quote was taken out of context from the USFS Missoula Fire Science Laboratory study that was defining what a recent radiological event could look like. The Nevada Test Site discontinued atomic bomb testing in 1992. Therefore, the authors would not list it as a probable recent radiological event in the US.**

**The amount of claims paid out under the Radiation Exposure Compensation Act to our citizens approaches $2.3 billion since its inception on 1990, the largest class action suit against a Federal agency in the history of our country.** It is statements that the forests of the Rim Country 4FRI have "not been significantly contaminated" published in the Rim Country FEIS/Draft ROD that makes me wonder who is assigned to respond to this issue. Because of the constant turnover of 4FRI staff, I will review some important concepts of this issue because the Rim Country FEIS/Draft ROD continues to quote a USFS pamphlet that does not represent the " best available science" as required by NEPA and other applicable Federal laws and executive orders.

The pamphlet referenced in the FEIS/Draft ROD which was written by the USFS incorrectly states that prescribed burns cannot get hot enough to re-suspend Cesium 137 into the atmosphere. CS-137 is the radionuclide that we worry about when the forests around Chernobyl catch on fire. It is a marker by which scientists can track the movement of smoke from wildland fire around the earth. A comparison graph of the Cesium 137 released from the Nevada atomic bomb tests (100 above ground explosions) makes Chernobyl and Fukushima look like mere pimples.

The USFS also incorrectly compared the cumulative exposure to medical x-rays and air travel to exposure to these radionuclides. Cesium 137, Strontium 90, and Plutonium 239 can lodge inside of the human body through breathing, eating, drinking or swallowing of saliva and continue to irradiate the surrounding tissue even after the person has died.

The USFS in the FEIS/ Draft ROD persists in citing the Cerro Grande fire in New Mexico, which was not located in a RECA county. The Cerro Grande fire was a prescribed fire that got out of control and nearly burned down the city of Los Alamos and the Los Alamos Nuclear Laboratories. The study was designed to determine whether the fire had reached the nuclear waste containers located outside the laboratories. It was not designed to determine the amounts and kinds of radionuclides that are still sequestered in out northern Arizona forests from the atomic bomb testing in Nevada during the 1950's and 1960's.

Apache, Coconino, Gila, Navajo and Yavapai counties are Radiation Exposure Compensation Act

(RECA) counties because they received the lion's share of radioactive debris from the atomic bomb tests. Residents that lived or worked in these counties during certain periods are eligible to receive $50,000 from the US Department of Justice for designated cancers.

The activities of Federal agencies that adversely effect the health of our citizens are covered in the :

National Environmental Policy Act
Executive Order 12890
Executive Order 13990
The Council of Environmental Quality
The USDA's Environmental Justice Program

The re-suspension of these radionuclides through the USFS burn programs constitutes an adverse effect on the health of our citizens. The USFS's practice of labeling an inconvenient issue as "outside the scope of this analysis" is not a legal statement and is in violation of the above Federal laws and executive orders.

The only radiation monitor in the state of Arizona is located at the Palos Verde Nuclear Power Station because it is mandated by Federal law.

CESIUM 137 HAS AN AFFINITY FOR THE SOFT TISSUES OF THE BODY. STRONTIUM 90 HAS AN AFFINITY FOR THE BONES AND TEETH. THAT IS WHY THE PHYSICIANS FOR SOCIAL RES PONSIBILITY SHARED THE NOBEL PRIZE FOR PEACE FOR STOPPING THE ATOMIC BOMB TESTING IN NEVADA. THEY FOUND STRONTIUM 90 IN BABY TEETH. PLUTONIUM HAS AN AFFINITY FOR THE LINING OF THE BONES. The following are the cancers covered under RECA for downwinder populations:

**multiple myeloma**
**brain cancer**
**esophageal cancer**
**ovarian cancer**
**salivary gland cancer**
**thyroid cancer**
**lymphomas (other that Hodgkins lymphoma)**
**breast cancer in females and males**
**gall bladder cancer**
**pancreatic cancer**
**small intestine cancer**
**urinary bladder cancer**
**bile duct cancer**
**colon cancer**
**liver cancer**
**pharynx cancer**
**stomach cancer**
**lung cancer**

## ENVIRONMENTAL JUSTICE

The USFS in the FEIS/Draft ROD states that "Based on minority status, and poverty data provided above, Coconino, Gila and Navajo counties appear most at risk for environmental justice issues". **Again, in this statement, the USFS left out Apache County, the poorest county in the state of**

**Arizona with a poverty rate of 35.9% and the 6th poorest county in the US. Low income and native Americans will bear the brunt of the deadly 2.5 micron smoke particles and the radionuclides that will hitch a ride on the smoke particles.** The native Americans of the southwest worked in the uranium mines and still live with uranium contaminated soil and water left as a result of mining the uranium for the atomic bombs. They were downwinders from the NTS atmospheric testing of the atomic bombs along with all the other northern Arizona citizens. And now, the USFS burn programs will inundate them with the same radionuclides all over again. The USFS acknowledges that impoverished populations with no access to electric power will not be able to practice protective averting behavior and simultaneously claims that they can give sufficient notice to the public before a prescribed burn so that downwind populations can protect themselves. The truth is, that staying inside with your windows and doors closed, room air cleaners running, air conditioning, oxygen tanks at the ready and bags packed for that condo in San Diego is expensive, impractical and unattainable for most citizens in northern Arizona, let alone the impoverished populations on the reservation with no power. In addition, the "best available science" shows that PM 2.5 easily enters closed doors and windows and easily enters our lungs and blood stream where they do their deadly damage to our organs. There is no such thing as effective averting behavior for our citizens.

Over a 20 year period, a Federal Agency plans to discharge into the air deadly substances and it is up to you as a citizen to protect yourself. As several USFS employees have told me, people just need to take responsibility for their own health.

**NET COST**

The USFS in the Rim Country FEIS/Draft ROD states that it will cost taxpayers $340 per acre to implement their plan. This does not include the cost to society from the deadly pm 2.5 smoke particles and the deadly substances that they will carry such as the radionuclides from the NTS atomic bomb blasts. The true net cost must include the cost to the health care system, absences from school and work, disability and early death of our citizens. The USFS has been provided by this author many articles warning of the deadly cost to society of any increase in PM 2.5. During the Smoke Conference in Albuquerque, the USFS listened to the guest pulmonologist from Santa Fe that explained in great detail how deadly PM 2.5 is on the human body. The USFS is well notified of these scientific studies and still insists on their burn programs.

ADEQ's air quality specialist requests that the FEIS/Draft ROD correct the language that describes the USFS smoke specialist as being "housed" in the ADEQ offices. The ADEQ states that they do not recommend that the USFS conduct prescribed burns, nor do they say that the smoke from the USFS burn programs is safe for downwind populations. ADEQ states that issuing the permits for the USFS to burn is intended only to attempt to identify meteorological conditions that would allow for the dispersal of smoke away from forested communities. The USFS states that it is not their job to provide air monitors for the Little Colorado River basin, it is ADEQ's. ADEQ states they cannot afford to place an air monitor on the Little Colorado River Basin and cannot find a secure location to place one. The USFS states that it would be too costly for the Office of Management and Budget to create a smoke complaint form and the USFS does not need to monitor the effects of their burn programs on downwind populations because ADEQ has a air quality complaint form. ADEQ has a skeleton staff to investigate air quality complaints.

**The USFS has to value human health before they can put a true dollar cost to society for their burn programs. In the meantime, the USFS sets aside funds to monitor the effects of their burn programs on goshawks and spotted owls.**

## OUTDATED LOG EXPORT LAWS

The USFS states that it is not protocol to approach the US Congress through the Secretary of Agriculture in order to change our outdated log export laws so that we can have a market for our small diameter trees. Yet, the USFS considered it protocol to write the Arizona Corporation Commission stating that their forest restoration plans would not succeed without the ACC mandating that power companies buy electricity generated by the burning of forest biomass. Finding a market for the small diameter trees has been a constant theme in the past 10 years both in and outside the stakeholders meetings. But not once has the USFS even talked about these outdated log export laws that, if changed, would provide a market to the orient for the small diameter logs. **The question is why?**

## OUR AIR TANKER FLEET

Another critical issue that the USFS states is "outside the scope of this analysis" is our skeleton air tanker fleet. The USFS in the Rim Country FEIS/Draft ROD suggests that part of the goal of their restoration program is to reduce catastrophic wildfires, providing graphic photos of burn scars and how devastating they are to the air, soil, water and carbon storage. But our skeleton air tanker fleet is beyond their control. Beyond whose control? The 4FRI team? The Apache Sitgreaves Forest, the Coconino Forest? The Tonto Forest? The Kaibab Forest? The USFS's? How can the public effectively communicate with the USFS through the NEPA process if they unilaterally announce that they can't talk about a subject that is crucial to the health of our forests and the health of our citizens and supremely relevant to the 4FRI NEPA process because the USFS announces that it is " outside the scope of this analysis". It begins to look like some kind of bizarre "simon says" game.

## MEAT GOAT GRAZING

The USFS in the Rim Country FEIS/Draft ROD states "Although goat grazing would assist in cleaning up some of the ladder fuels by eating the shrubs and saplings, goats would not take care of the dead an down component or be able to meet certain prescriptions or desired conditions." The USFS talks about a succession of first, second, third and maintenance burns of the same ground. Local residents have vivid memories of Rodeo -Chedeski and the Wallow burns sprouting tens of thousands of ponderosa pine saplings that meat goat grazing is ideal for. The USFS has already conducted prescribed burns in these burn scar areas. The truth is that the USFS is determined to burn at all costs, refusing to seriously considered no burn strategies.

## BLACK CARBON SOOT

I was unable to find any discussion in the Rim Country FEIS/Draft ROD about the black carbon soot that the USFS burn programs will produce. Early on in the 4FRI NEPA process, I spoke to an EPA scientist about the issues of PM 2.5. He pointed out to me that I needed to also educate myself about the catastrophic effect of black carbon soot landing on our snow and ice fields and changing the natural balance of the albedo effect on the earth's surface temperature. When the soot from the USFS burn programs lands on our snow and ice fields, it reduces the ability of these fields to reflect back into space the sun's radiation. This in turn, raises the temperature on the earth's surface and accelerates the melting of our snow and ice fields which in turn reduces the earth's ability to reflect back into space the sun's radiation. It becomes a feed back loop that accelerates until there is no stopping it.

**It is a terrifying reality that the very thing that the Forest Ecologists are dedicated to achieve, which is to "bring back fire into our forests" in order to *SAVE* our forests, is the very thing that will accelerate the death of our forests. Degrading the delicate albedo effect that is necessary to stabilize the earth's surface temperature should be enough to stop these USFS burn programs from continuing.**

**OVERVIEW**

**The Rim Country FEIS/Draft ROD is packed with incongruous rationalizations. It's as if the USFS bought a ticket on the train to " fire back in the forest " and nothing, and I mean nothing sways them. Not human health. Not the resultant albedo effect on our alpine snow and ice fields. Not the cost to society.**

**Climate scientists throughout the world predict that because of warmer temperatures , the prolonged drought, reduced snow pack and the resultant beetle kill in our ponderosa pine forests, the ponderosas will transition to a juniper/grassland savanna. These are forces beyond anything the USFS can mediate. What the USFS can do is "do no harm". They can choose to not engage in massive prescribed burns and managed wildfire programs.**

**I will never comprehend why the Fire Ecologist is the appointed person to address the issue of the assault on human health as a result of the USFS's burn programs. It should always have been a public health specialist. As a result, the human health issues of the 4FRI have been buried in the Fire Ecology Report. Human health should have been the priority one issue at the base of ever decision. The benefit/ risk rationalizations prevalent in this document should have been made transparent 10 years ago in the 4FRI NEPA process. By not informing our citizens of the true cost that the USFS is expecting them to endure, the USFS has violated the NEPA and other Federal laws and executive orders and set a precedent that it is acceptable for a Federal Agency to hide the truth from our citizens.**

**"It is a violation of the most fundamental human rights to impose risks (deaths) upon individuals without their consent. Human rights should not be sacrificed to the pursuit of a healthy economy, affluence, progress, science, or any other goal. The whole benefit versus risk doctrine is a profound violation of human rights".**

**Sincerely**

[redacted]

**Dorothy Holasek**

**Contents : 6 page letter + 2 pages reference citations + 11 pages hard copy references on Black Carbon Soot**

References

"Black Carbon Reduction of Snow Albedo", Nature Climate Change 2, 437-440(2012)

"Assessing the Climatic Benefits of Black Carbon Mitigation", Environmental Sciences, 6-21-10,107(26) 11703-11708

"Soot Climate Forcing Via Snow and Ice Albedos", Earth, Atmospheric and Planetary Sciences, 12-29-03, 101(2) 423-428

"Source Attribution of Black Carbon in Arctic Snow", Environ.Sci.Technol., 2009, 43, 11, 4016-4021

"Black Carbon in the Environment: Properties and Distribution". OSTI.GOV/ Book: Black Carbon in the Environment: Properties and Distribution

"Global and Regional Changes Due to Black Carbon", Nature Geoscience 1, 221-227 (2008)

"Biomass Burning Contribution to Black Carbon in the Western United States Mountain Ranges", European Geosciences Union 11 Nov

"Dating of Wines with Cesium-138: Fukushima's Imprint", Centre d Etudes Nucleaires de Bordeaus-Gadignon (CNRS/ Universite de Bordeaus) 7/2018

"Four Forest Restoration Initiative: Prescribed Burns and Radiation" online pamphlet http://www.fs.usda.gov/4fri

"What Smokey Bear Never Told You", Fire Ecology Curriculum Southwestern Region. www.fs.usda.gov

"Log Export Legislation", General Technical Report PN-GTR-624

"Forest Fires and Resuspension of Radionuclides Into the Atmosphere", American Journal of Environmental Sciences, (1): 1- (2012)

"Pulsed Redistribution of a Contaminant Following Forest Fire: Cesium-137 in Runoff", J. Environ. Qual. 32:2150-2159 (2003)

"Inter and Intra-continental Transport of Radioactive Cesium Released by Boreal Fires", Geophysical Research Letters, Vol. 33, L12806, dol:10.1029/2006 GL 026206, 2006

"Burning Radionuclide Question: What Happens To Iodine, Cesium and Chlorine in Biomass Fires?", The Science of Total Environment 187(1996) 93-103

"Chernobyl"s Nuclear Threat Returns: Forest Fires in the Ukraine Causes Radioactive Particles To Be Released Over Europe", Daily Mail (9/2018)

"Air Pollution Increases Death Risk in People With Diabetes, Heart Failure, Or Rheumatoid

Arthritis",Resp Environ Med. 2009 Mar; 66(3): 189-97

"Air Quality Linked to Cardiac Events, Heart Disease Patients Unaware", Reuters Health News (4/18) on line (4/18), Journal of American Heart Association, online (4/18)

"Heart Experts Warn of Air Pollution Dangers", Reuters (12/14); European Heart Journal, online (12/14)

"Air Pollution Linked to Changes in Heart Structure", The Guardian (8/3/18)

"Air Pollution May Shrink The Brain, Study Suggests", American Heart Association Journal Stroke, (4/23/15)

":Gene Altering Chemicals Found in Forest Fire Smoke", Pacific Northwest Laboratory, (5/2/09)

"Isocyanic Acid in the Atmosphere and Its Possible Link to Smoke Related Health Effects", Proceeding of National Academy of Sciences (5/31/11)

"Wildfires Ares Destroying Our Air Pollution Gains", https://www.outsideonline.com/2327376/wilddfires-are-making-bad air, National Proceedings of Academy of Sciences

"Health Effects and Economic Impacts of Fine Particle Pollution in Washington", Dept. of Ecology State of Washington, Pub # 09-021

"New Zealand's Air Gets Cleaner", Fairfax Stuff, stuff.co.nz, (5/16/14)

Large Air Tanker Fleet Size on USFS Exclusive Use Contracts (2000-1018), Graph

"Goat Grazing As a Wildfire Prevention Too: A Basic Review", I Forest, doi: 10 3832/ifor1112-007

"Goat Targeted Grazing", Arizona Cooperative Extension, (2/8/11)

"Paid to Graze...California Goat Grazier Fights Fires in Fields and Forests", The Stockman Grass Farmer/The Grazier's Edge, 2011

"The Poorest County In Every State", Wall Street Journal,1-23-18 (data from US Census Bureau American Community Survey and US Bureau of Labor Statistics)

"Pyrogenic Remobilization of Historic Lead Deposition" Flegal and Oldigie, Environ Science Technol 2011,45,15,6290-6295

Harvard's T. H. Chan School of Public Health, "Short Term Exposure To Air Pollution Linked To New Causes Of Hospital Admissions, Substantial Economic Cost", 11-27-19

RESEARCH ARTICLE | EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES | FREE ACCESS

# Soot climate forcing via snow and ice albedos

James Hansen and Larissa Nazarenko Authors Info & Affiliations

December 29, 2003 | 101 (2) 423-428 | https://doi.org/10.1073/pnas.2237157100




## Abstract

Plausible estimates for the effect of soot on snow and ice albedos (1.5% in the Arctic and 3% in Northern Hemisphere land areas) yield a climate forcing of +0.3 W/m$^2$ in the Northern Hemisphere. The "efficacy" of this forcing is ~2, i.e., for a given forcing it is twice as effective as $CO_2$ in altering global surface air temperature. This indirect soot forcing may have contributed to global warming of the past century, including the trend toward early springs in the Northern Hemisphere, thinning Arctic sea ice, and melting land ice and permafrost. If, as we suggest, melting ice and sea level rise define the level of dangerous anthropogenic interference with the climate system, then reducing soot emissions, thus restoring snow albedos to pristine high values, would have the double benefit of reducing global warming and raising the global temperature level at which dangerous anthropogenic interference occurs. However, soot contributions to climate change do not alter the conclusion that anthropogenic greenhouse gases have been the main cause of recent global warming and will be the predominant climate forcing in the future.




## References

1 Intergovernmental Panel on Climate Change (2001) *Climate Change 2001: The Scientific Basis*, eds.



# Source Attribution of Black Carbon in Arctic Snow

Dean A. Hegg*, Stephen G. Warren, Thomas C. Grenfell, Sarah J. Doherty, Timothy V. Larson, and
ıy D. Clarke

**View Author Information**

**Cite this:** *Environ. Sci. Technol.* 2009, 43, 11, 4016–4021
Publication Date: April 29, 2009
https://doi.org/10.1021/es803623f

**SUBJECTS:**
Redox reactions,


# Abstract

Snow samples obtained at 36 sites in Alaska, Canada, Greenland, Russia, and the Arctic Ocean in early 2007 were analyzed for light-absorbing aerosol concentration together with a suite of associated chemical species. The light absorption data, interpreted as black carbon concentrations, and other chemical data were input into the EPA PMF 1.1 receptor model to explore the sources for black carbon in the snow. The analysis found four factors or sources: two distinct biomass burning sources, a pollution source, and a marine source. The first three of these were responsible for essentially all of the black carbon, with the two biomass sources (encompassing both open and closed combustion) together accounting for >90% of the black carbon.


## Supporting Information

Locations of sample sites used in this analysis (Table S1 and Figure S1); Table S2, list of species used in the PMF analysis; Table S3, comparison of the black carbon values found in this study with some found in earlier studies; Figure S2, mean species concentrations by receptor region; Figure S3, bootstrap error analysis; and Figure S4, FLAMBE smoke data for April of 2007. This material is available free of charge via the Internet at http://pubs.acs.org.

# Black carbon in the environment: properties and distribution

## Abstract

Black carbon is derived largely from the incomplete combustion of fossil fuels, wood, and biomass, as well as from certain industrial processes such as the production of carbon black for automobile tires and printing inks. This book contains detailed descriptions of the physical and chemical properties of atmospheric black carbon - the soot, charcoal, and other particulate forms of impure carbon in the atmosphere - its contribution to air pollution in urban and nonurban settings, and its possible effects on climate.

Authors:
Goldberg, E D

Publication Date:
1985-01-01

OSTI Identifier:
5473086

Resource Type:
Book

Resource Relation:
Other Information: From review by H.E. Wright Jr., Univ. of Minnesota, in Environment, Vol. 28, No. 9(Nov 1986)

Country of Publication:
United States

Language:
English

Published: 23 March 2008

# Global and regional climate changes due to black carbon

V. Ramanathan & G. Carmichael

*Nature Geoscience* **1**, 221–227 (2008)



## Abstract

Black carbon in soot is the dominant absorber of visible solar radiation in the atmosphere. Anthropogenic sources of black carbon, although distributed globally, are most concentrated in the tropics where solar irradiance is highest. Black carbon is often transported over long distances, mixing with other aerosols along the way. The aerosol mix can form transcontinental plumes of atmospheric brown clouds, with vertical extents of 3 to 5 km. Because of the combination of high absorption, a regional distribution roughly aligned with solar irradiance, and the capacity to form widespread atmospheric brown clouds in a mixture with other aerosols, emissions of black carbon are the second strongest contribution to current global warming, after carbon dioxide emissions. In the Himalayan region, solar heating from black carbon at high elevations may be just as important as carbon dioxide in the melting of snowpacks and glaciers. The interception of solar radiation by atmospheric brown clouds leads to dimming at the Earth's surface with important implications for the hydrological cycle, and the

deposition of black carbon darkens snow and ice surfaces, which can contribute to melting, in particular of Arctic sea ice.



## References

1 Andreae, M. O. & Crutzen, P. J. Atmospheric aerosols: Bio-geochemical sources and role in atmospheric chemistry. *Science* **276**, 1052–1056 (1997).

Research article | 11 Nov 2011

# Biomass burning contribution to black carbon in the Western United States Mountain Ranges

Y. H. Mao[1,2], Q. B. Li[1,2], L. Zhang[1,2], Y. Chen[3], J. T. Randerson[3], D. Chen[1,2], and K. N. Liou[1,2]

[1]Department of Atmospheric and Oceanic Sciences, University of California, Los Angeles, CA 90095, USA

[2]Joint Institute for Regional Earth System Science and Engineering, University of California, Los Angeles, CA 90095, USA

[3]Department of Earth System Science, University of California, Irvine, CA 92697, USA

Received: 11 Apr 2011 – Discussion started: 03 May 2011 – Revised: 21 Oct 2011 – Accepted: 24 Oct 2011 – Published: 11 Nov 2011

**Abstract.** Forest fires are an important source to carbonaceous aerosols in the Western United States (WUS). We quantify the relative contribution of biomass burning to black carbon (BC) in the WUS mountain ranges by analyzing surface BC observations for 2006 from the Interagency Monitoring of PROtected Visual Environment (IMPROVE) network using the GEOS-Chem global chemical transport model. Observed surface BC concentrations show broad maxima during late June to early November. Enhanced potassium concentrations and potassium/sulfur ratios observed during the high-BC events indicate a dominant biomass burning influence during the peak fire season. Model surface BC reproduces the observed day-to day and synoptic variabilities in regions downwind of but near urban centers. Major discrepancies are found at elevated mountainous sites during the July-October fire season when simulated BC concentrations are biased low by a factor of two. We attribute these low biases largely to the underestimated (by more than a factor of two) and temporally misplaced biomass burning emissions of BC in the model. Additionally, we find that the biomass burning contribution to surface BC concentrations in the USA likely was underestimated in a previous study using GEOS-Chem (Park et al., 2003), because of the unusually low planetary boundary layer (PBL) heights in the GEOS-3 meteorological reanalysis data used to drive the model. PBL heights from GEOS-4 and GEOS-5 reanalysis data are comparable to those from the North American Regional Reanalysis (NARR). Model simulations show slightly improved agreements with the observations when driven by GEOS-5 reanalysis data, but model results are still biased low. The use of biomass burning emissions with diurnal cycle, synoptic variability, and plume injection has relatively small impact on the simulated surface BC concentrations in the WUS.



How to cite. Mao, Y. H., Li, Q. B., Zhang, L., Chen, Y., Randerson, J. T., Chen, D., and Liou, K. N.: Biomass burning contribution to black carbon in the Western United States Mountain Ranges, Atmos. Chem. Phys., 11, 11253–11266, https://doi.org/10.5194/acp-11-11253-2011, 2011.

Published: 04 March 2012

# Black-carbon reduction of snow albedo

Odelle L. Hadley & Thomas W. Kirchstetter

*Nature Climate Change* **2**, 437–440 (2012)



## Abstract

Climate models indicate that the reduction of surface albedo caused by black-carbon contamination of snow contributes to global warming and near-worldwide melting of ice[1,2]. In this study, we generated and characterized pure and black-carbon-laden snow in the laboratory and verified that black-carbon contamination appreciably reduces snow albedo at levels that have been found in natural settings[1,3,4]. Increasing the size of snow grains in our experiments decreased snow albedo and amplified the radiative perturbation of black carbon, which justifies the aging-related positive feedbacks that are included in climate models. Moreover, our data provide an extensive verification of the Snow, Ice and Aerosol Radiation model[1], which will be included in the next assessment of the Intergovernmental Panel on Climate Change[5].

RESEARCH ARTICLE | ENVIRONMENTAL SCIENCES | OPEN ACCESS

# Assessing the climatic benefits of black carbon mitigation

Robert E. Kopp and Denise L. Mauzerall Authors Info & Affiliations

June 21, 2010 | 107 (26) 11703-11708 | https://doi.org/10.1073/pnas.0909605107




## Abstract

To limit mean global warming to 2 °C, a goal supported by more than 100 countries, it will likely be necessary to reduce emissions not only of greenhouse gases but also of air pollutants with high radiative forcing (RF), particularly black carbon (BC). Although several recent research papers have attempted to quantify the effects of BC on climate, not all these analyses have incorporated all the mechanisms that contribute to its RF (including the effects of BC on cloud albedo, cloud coverage, and snow and ice albedo, and the optical consequences of aerosol mixing) and have reported their results in different units and with different ranges of uncertainty. Here we attempt to reconcile their results and present them in uniform units that include the same forcing factors. We use the best estimate of effective RF obtained from these results to analyze the benefits of mitigating BC emissions for achieving a specific equilibrium temperature target. For a 500 ppm $CO_2$e (3.1 W $m^{-2}$) effective RF target in 2100, which would offer about a 50% chance of limiting equilibrium warming to 2.5 °C above preindustrial temperatures, we estimate that failing to reduce carbonaceous aerosol emissions from contained combustion would require $CO_2$ emission cuts about 8 years (range of 1–15 years) earlier than would be necessary with full mitigation of these emissions.