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# Methodology for assessing impacts of air quality

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*Wildfire Induced Air Pollution Mitigation & Assessment Symposium*

March 23, 2020

# Past Research I: Hydrogen Fuel

- **What are the requirements for the implementation of FCV?**
  - Infrastructure for hydrogen production and distribution for fuel cell vehicles
  - Hydrogen fuel cell vehicles adoption
- **How are emissions spatially distributed?**
- **What are the potential air quality impacts?**



# Past Research II: Biopower vs Biofuel

- **What are the biomass resources?**
  - Types of biomass available
  - Co-location of biomass installations with power and fuel infrastructure
- **How are biomass resources used?**
  - Biopower production
  - Biofuel production: bio CNG, Ethanol
- **What are the potential air quality and greenhouse gas impacts?**



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# Wildfires and Air Quality



- In 2018 Paradise, California fires produce air that ranks among the dirtiest in the world.
  - Wood smoke contains some of the same toxic chemicals that city pollution does.
  - Inhalation of minuscule particles from wood fires can nestle in the folds of lung tissue and do harm to the human immune system.
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# Challenge

Develop a state-of-the-art computational modeling framework to assess wildfire-induced air pollution (WIAP)

- Scalable
  - Time-resolved
  - Spatially resolved
  - Able to interface with changing meteorology and climate
  - Able to interface with health assessment models
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## *Climate Change Affected Australia's Wildfires, Scientists Confirm*



The Dunn Road fire burned in southeastern Australia in January. Sam Mooy/Getty Images

By **Henry Fountain**

March 4, 2020



Confirming what had been widely suspected, **researchers have found that human-caused climate change had an impact on** Australia's recent devastating **wildfires**, making the extremely high-risk conditions that led to widespread burning at least 30 percent more likely than in a world without global warming.

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# Multidisciplinary Challenge



Assessment and mitigation of wildfire-induced air pollution

- Fire Modeling
  - Electrical grid
  - Emission Modeling
  - Atmospheric Chemistry
  - Atmospheric Physics
  - Computational Sciences
  - Meteorology
  - Climate Change
  - Urban Design
  - Health Effects
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# Multidisciplinary Challenge



Assessment and mitigation of wildfire-induced air pollution

- Fire Modeling
  - Electrical grid
  - Emission Modeling
  - Atmospheric Chemistry
  - Atmospheric Physics
  - Computational Sciences
  - Meteorology
  - Climate Change
  - Urban Design
  - Health Effects
-

## *How the Coronavirus Crisis May Hinder Efforts to Fight Wildfires*



A grass fire near Knightsen, Calif., in 2019. Jose Carlos Fajardo/San Jose Mercury News, via Associated Press



By [Kendra Pierre-Louis](#)

March 20, 2020



In San Jose, Calif., just under 10 percent of the city's firefighters, some of whom also help battle the state's wildfires, this week found themselves either infected with the coronavirus or in quarantine.

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# Satellite Observations



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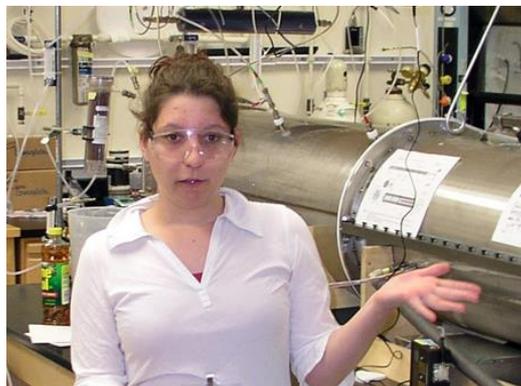
Atlantis over the Bahamas – International Space Station 7/10/2011

Photo courtesy of NASA's Marshall Space Flight Center

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# Chamber Studies

Aerosol Flow System  
Indoor chamber



UC Irvine

One Atmosphere Research  
Outdoor chamber



UNC

EUPHORE  
Outdoor smog chamber



Valencia, Spain

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# Computational Studies

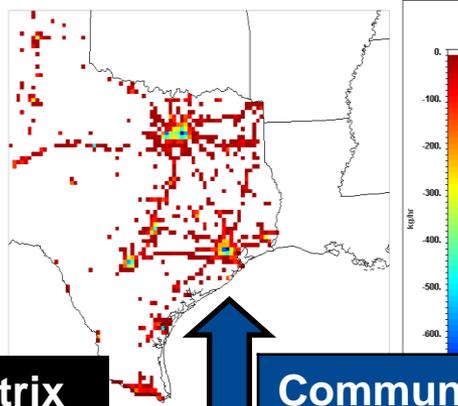


IBM 1401 computer circa 1960  
Photo courtesy of the IBM corporate archive

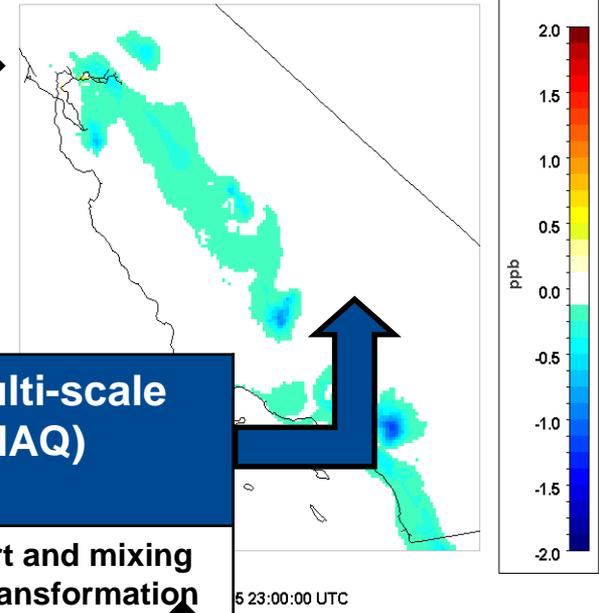
## Wildfires Scenarios



## Pollutant Emissions



## Air Quality Simulations

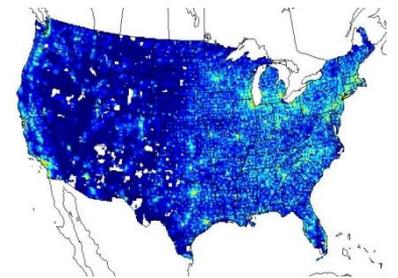


Baseline Emissions  
2005 EPA NEI



Sparse Matrix Operator Kernel Emissions (SMOKE) Model

Spatial Surrogates



Activity Profiles

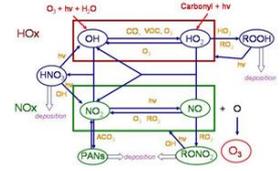


Community Multi-scale Air Quality (CMAQ) Model

- Dilution, transport and mixing
- Photochemical transformation



Meteorology

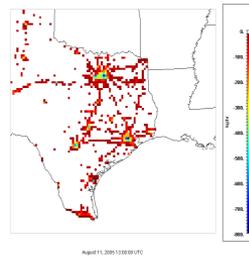


Chemistry

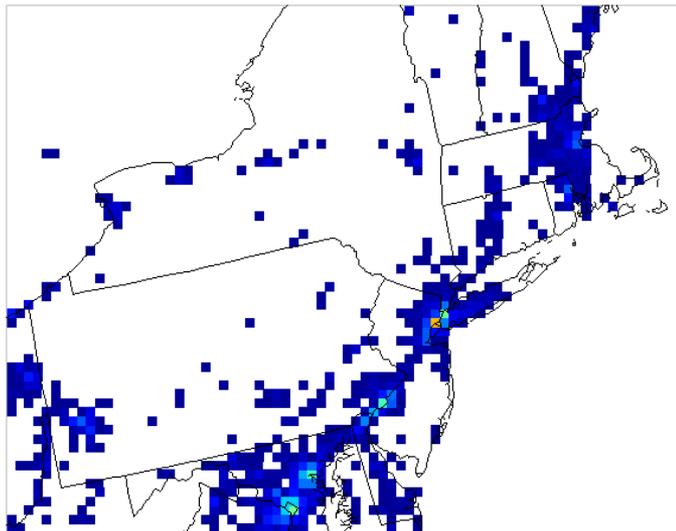
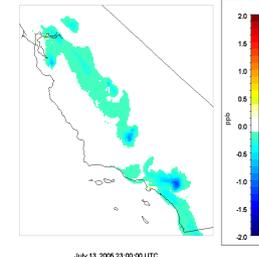
## Wildfires Scenarios



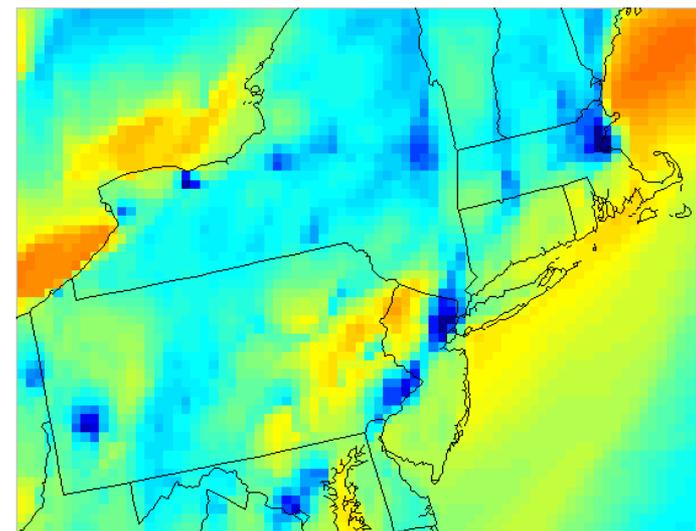
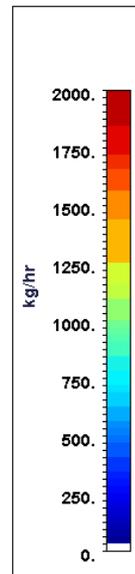
## Pollutant Emissions



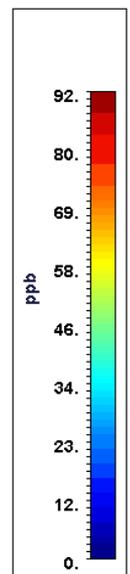
## Air Quality Simulations



Emissions of NO<sub>x</sub> over a 24 h period in 2005



Ozone concentration over a 24 h period in 2005



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# Software Resources



## SMOKE version 4.7

(Sparse Matrix Operator Kernel Emissions)

Emissions processing system designed to create gridded, speciated, hourly emissions



## CMAQ version 5.3.1

Community Multiscale Air Quality Modeling System

Predicts estimates of ozone, particulates, toxics and acid deposition

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# Hardware Resources



The HPC cluster is now the largest on campus with:

- 9900 64bit CPU cores
  - 55 TB aggregate RAM
  - 30 Nvidia GPUs
  - Quad Data Rate (40Gbs) Infiniband interconnects
  - 2 PB of storage
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# Thanks!



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