# *2015 Haagen-Smit Clean Air Awards*


*Honoring Air Quality Achievements*

May 19, 2016

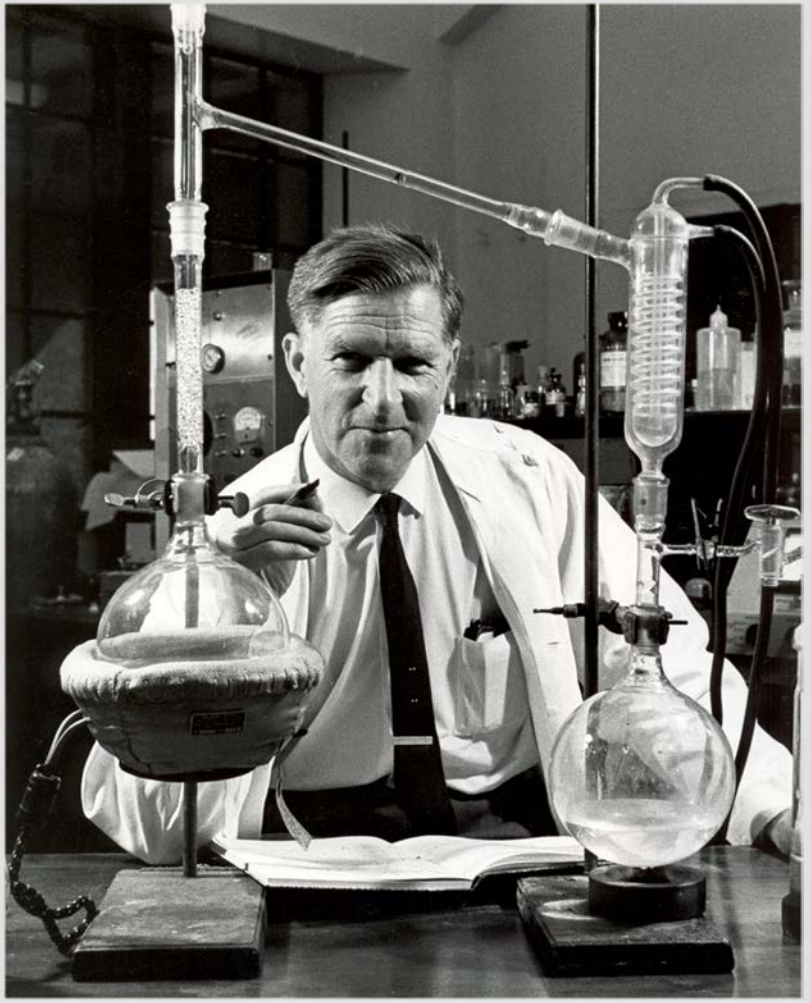
California Environmental Protection Agency
Air Resources Board

# DR. ARIE J. HAAGEN-SMIT
1900 – 1977


- The “father” of air pollution control
- Linked smog in southern California to automobiles
- ARB’s first Chairman in 1968
- Awarded the National Medal of Science in 1973

# DR. HAAGEN-SMIT

CALTECH OFFICE



# DR. HAAGEN-SMIT

## PLANT SCIENTIST

# LOS ANGELES 1968

## COVERED IN SMOG

# DR. HAAGEN-SMIT

## MOBILE LABORATORY

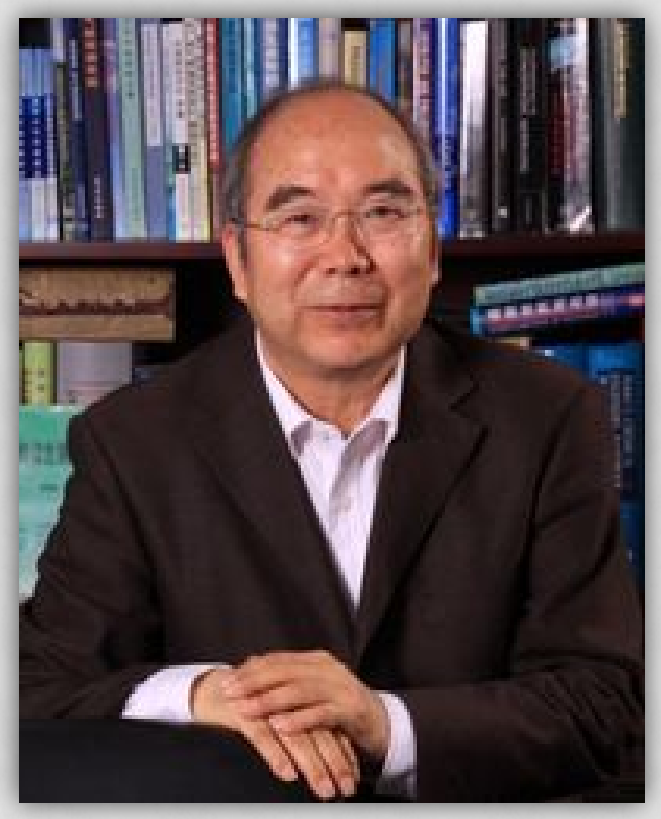
# CHAIR HAAGEN-SMIT

AIR RESOURCES BOARD MEETING

# BACKGROUND

- Awards began in 2001
- Two to three recipients selected each year
- Recognizes career contributions in improving air quality and climate change
- International nominations welcome

# JIMING HAO, Ph.D.
# INTERNATIONAL AIR POLLUTION CONTROL



- Professor and Dean in the School of the Environment, University of Tsinghua, China
- Leader and innovator in vehicle emissions identification and control
- Initiated clean vehicle program in multiple Chinese regions


DR. JIMING HAO

RESTORING BLUE SKIES FORUM - BEIJING

# BLUE SKY AND WHITE CLOUDS

THE TEMPLE OF HEAVEN, BEIJING, JUNE 12, 2015

# BEIJING OLYMPIC STADIUM – JULY 2008

## ONE MONTH BEFORE GAMES BEGAN

# DR. JIMING HAO

MEMBER OF THE ADVISORY COMMITTEE TO THE SHANGHAI EXPO 2010

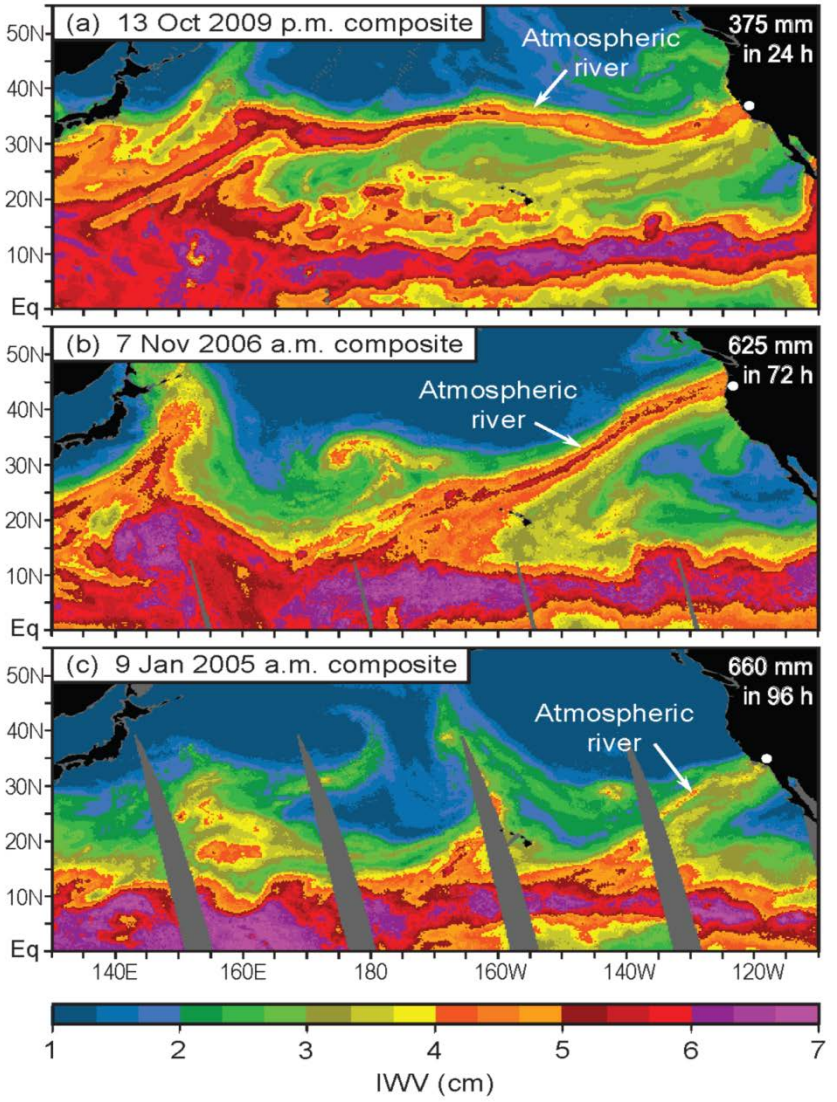
# KIMBERLY PRATHER, Ph.D.
## ATMOSPHERIC CHEMISTRY

- Professor of Atmospheric Chemistry, University of California, San Diego and Scripps Institute of Oceanography
- Director, Center for Aerosol Impacts on Climate and the Environment
- World-renowned expert in atmospheric aerosols

# CENTER FOR AEROSOL IMPACTS ON CLIMATE AND THE ENVIRONMENT

SCRIPPS INSTITUTION OF OCEANOGRAPHY, UC SAN DIEGO CHEMISTRY


NOAA'S PARTICLE ANALYSIS BY LASER MASS SPECTROMETRY INSTRUMENT ABOARD THE NASA WB-57 HIGH-ALTITUDE RESEARCH AIRCRAFT.




## NOAA'S ATMOSPHERIC RIVER INFORMATION WEB PAGE

IN FRONT OF PNNL G-1 AIRCRAFT TO STUDY CLOUD SEEDING.

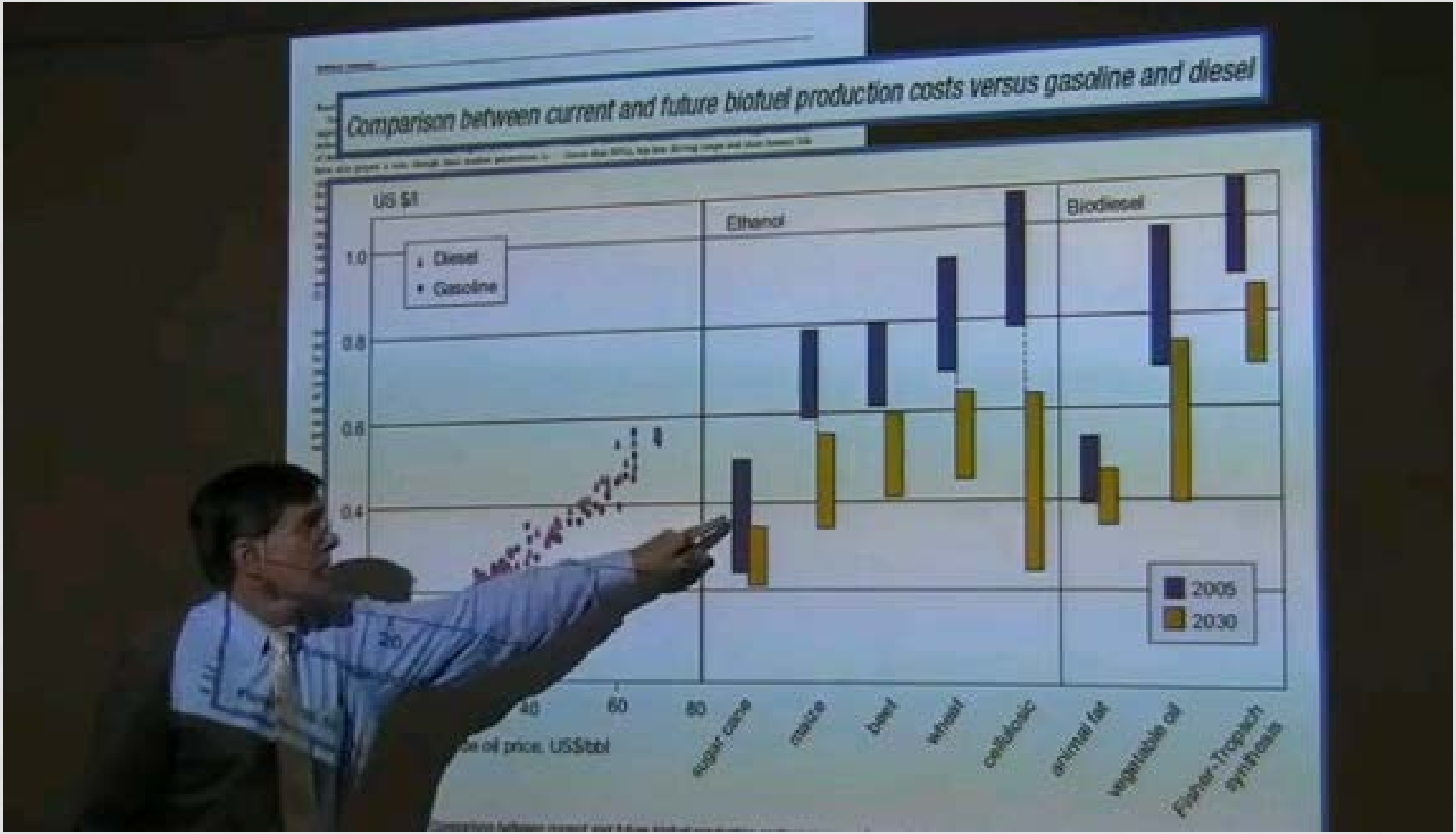
SCRIPPS INSTITUTION OF OCEANOGRAPHY

# MICHAEL PRATHER, Ph.D.
## CLIMATE CHANGE RESEARCH

- Professor of Earth System Science, University of California, Irvine
- Expert in scientific basis for international ozone and climate assessments
- Contributing and lead author in IPCC's Assessment Reports 1994-2014


PROFESSOR MICHAEL PRATHER

CONTRIBUTING AND LEAD AUTHOR IN IPCC'S ASSESSMENT REPORTS


Comparison between current and future biofuel production costs versus gasoline and diesel
US $/l
Ethanol
Biodiesel
Diesel
Gasoline
1.0
0.8
0.6
0.4
2005
2030
40
60
80
sugar cane
maize
beet
wheat
cellulosic
animal fat
vegetable oil
Fischer-Tropsch synthesis

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 86, NO. C8, PAGES 7210–7254, AUGUST 20, 1981

# Tropospheric Chemistry: A Global Perspective

JENNIFER A. LOGAN, MICHAEL J. PRATHER, STEVEN C. WOFSY, AND MICHAEL B. MCELROY

*Center for Earth Planetary Physics, Harvard University, Cambridge, Massachusetts 02138*

A model for the photochemistry of the global troposphere constrained by observed concentrations of $H_2O$, $O_3$, CO, $CH_4$, NO, $NO_2$, and $HNO_3$ is presented. Data for NO and $NO_2$ are insufficient to define the global distribution of these gases but are nonetheless useful in limiting several of the more uncertain parameters of the model. Concentrations of OH, $HO_2$, $H_2O_2$, NO, $NO_2$, $NO_3$, $N_2O_5$, $HNO_3$, $HO_2NO_2$, $CH_3O_2$, $CH_3OOH$, $CH_2O$, and $CH_3CCl_3$ are calculated as functions of altitude, latitude, and season. Results imply that the source for nitrogen oxides in the remote troposphere is geographically dispersed and surprisingly small, less than $10^7$ tons N $yr^{-1}$. Global sources for CO and $CH_4$ are $1.5 \times 10^9$ tons C $yr^{-1}$ and $4.5 \times 10^8$ tons C $yr^{-1}$, respectively. Carbon monoxide is derived from combustion of fossil fuel (15%) and oxidation of atmospheric $CH_4$ (25%), with the balance from burning of vegetation and oxidation of biospheric hydrocarbons. Production of CO in the northern hemisphere exceeds that in the southern hemisphere by about a factor of 2. Industrial and agricultural activities provide approximately half the global source of CO. Oxidation of CO and $CH_4$ provides sources of tropospheric $O_3$ similar in magnitude to loss by in situ photochemistry. Observations of $CH_3CCl_3$ could offer an important check of the tropospheric model and results shown here suggest that computed concentrations of OH should be reliable within a factor of 2. A more definitive test requires better definition of release rates for $CH_3CCl_3$ and improved measurements for its distribution in the atmosphere.

## 1. INTRODUCTION

The hydroxyl radical plays an important role in the photochemistry of the troposphere. Reaction with OH provides the dominant path for removal of a variety of atmospheric species including CO, $CH_4$, $C_2H_6$, $H_2$, $CH_3Cl$, $CH_3CCl_3$, $CH_3Br$, $H_2S$, and $SO_2$.

The chemistry of tropospheric OH is complex. Hydroxyl is produced by reaction of $O(^1D)$ with $H_2O$ [*Levy*, 1971, 1972], with $O(^1D)$ produced by photolysis of $O_3$ near 300 nm. In addition to the direct source, OH may be regenerated by a suite of reactions involving $HO_2$ and $H_2O_2$. Rates for these reactions vary appreciably in both time and space reflecting fluc-

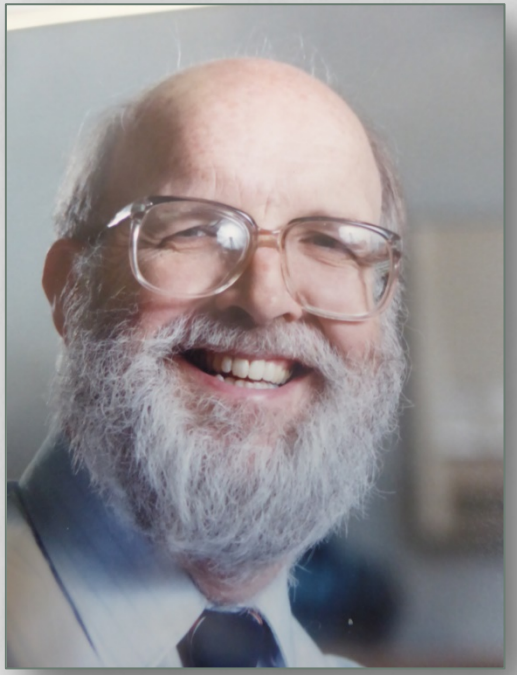
early models [e.g., *Levy*, 1972; *Wofsy et al.*, 1972; *Crutzen*, 1974] by a factor between 2 and 5. We shall argue here that the discrepancies suggested by such comparisons may be attributed to a combination of factors: lack of a global model for the troposphere, inadequate information on the distribution of gases such as NO and $NO_2$, uncertainties in rates for key reactions, uncertainty in release rates for $CH_3CCl_3$, and inadequacy of the data for atmospheric $CH_3CCl_3$. A more comprehensive analysis is given below.

An acceptable model for OH must be consistent with knowledge of budgets for other gases, in particular CO. Reaction with OH is the primary removal mechanism for atmo-

## MICHAEL PRATHER'S HIGHLY INFLUENTIAL PAPER

MORE THAN 1,400 CITATIONS SINCE 1981

# DONALD STEDMAN, Ph.D.
## EMISSIONS CONTROL TECHNOLOGIES
## (1945 – 2016)



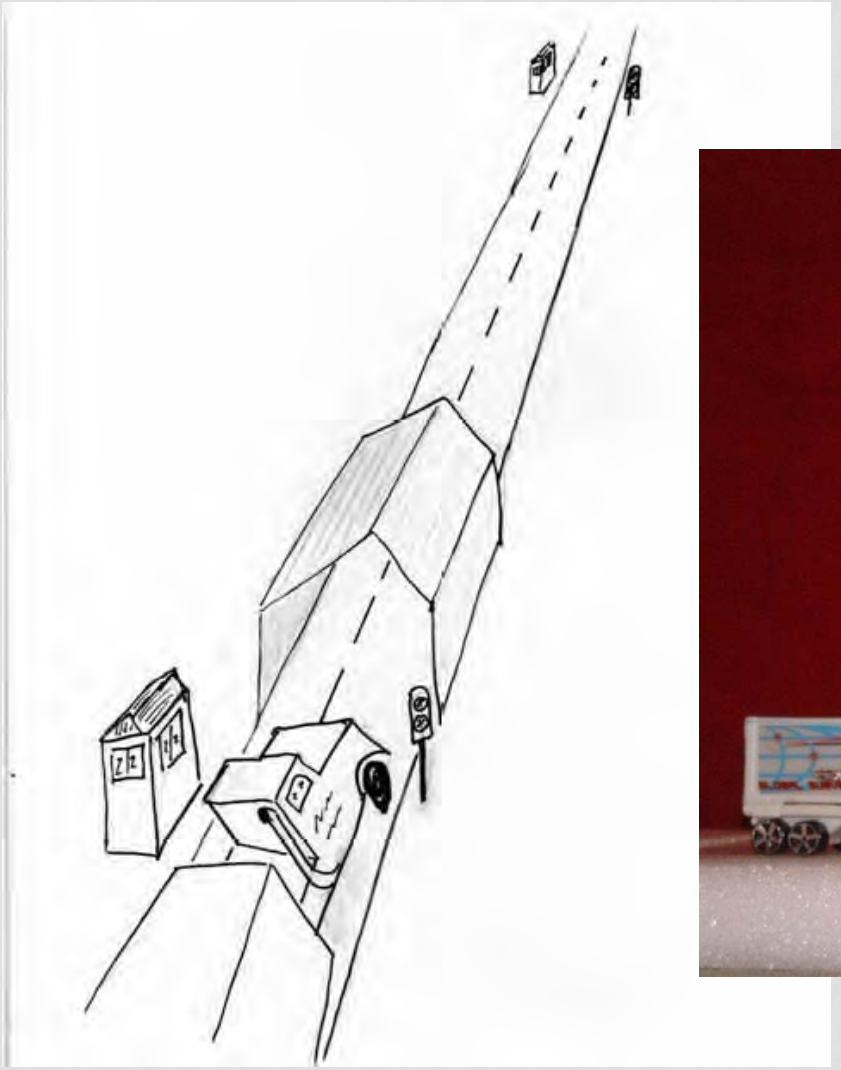
- Professor of Chemistry, University of Denver
- Leader in design and development of vehicle emissions testing devices
- Inventor of an on-road remote sensor for measuring in-use motor vehicle emissions

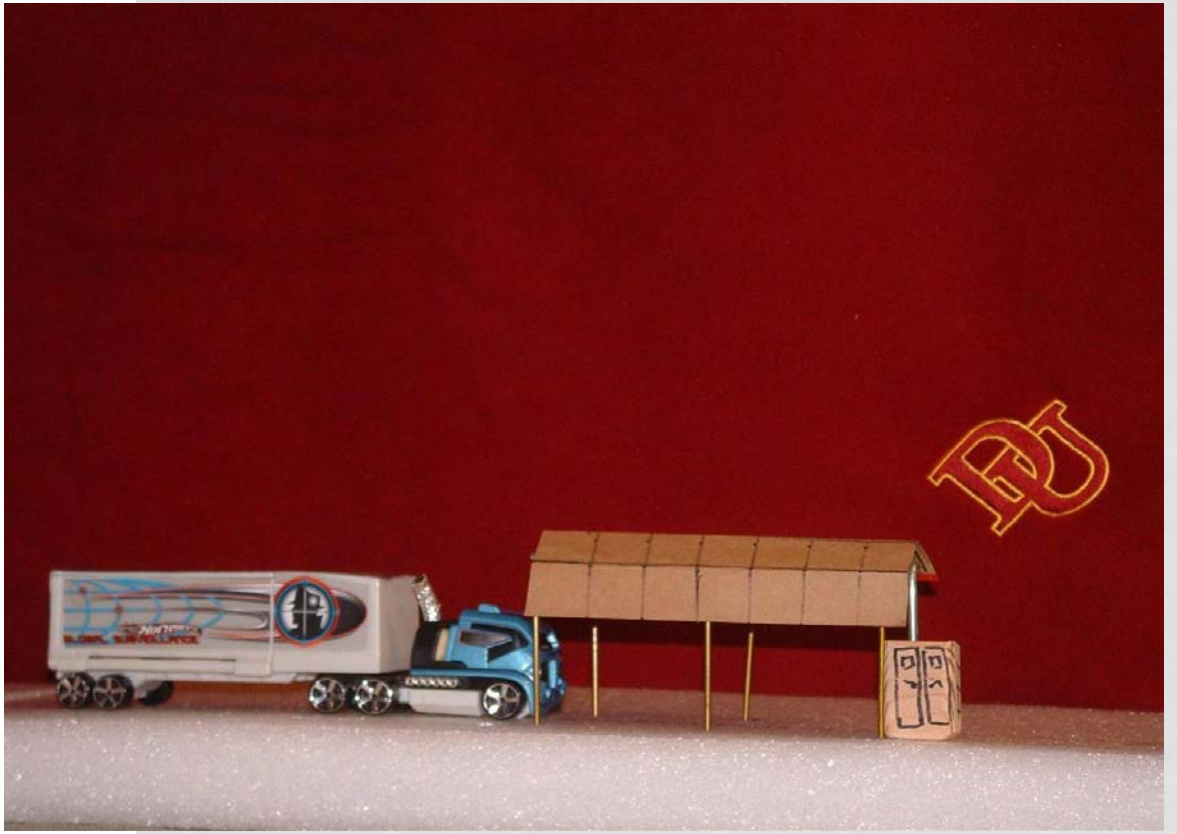

DU
gettyimages
Kathryn Scott Osler
161012021


# PROFESSOR STEDMAN

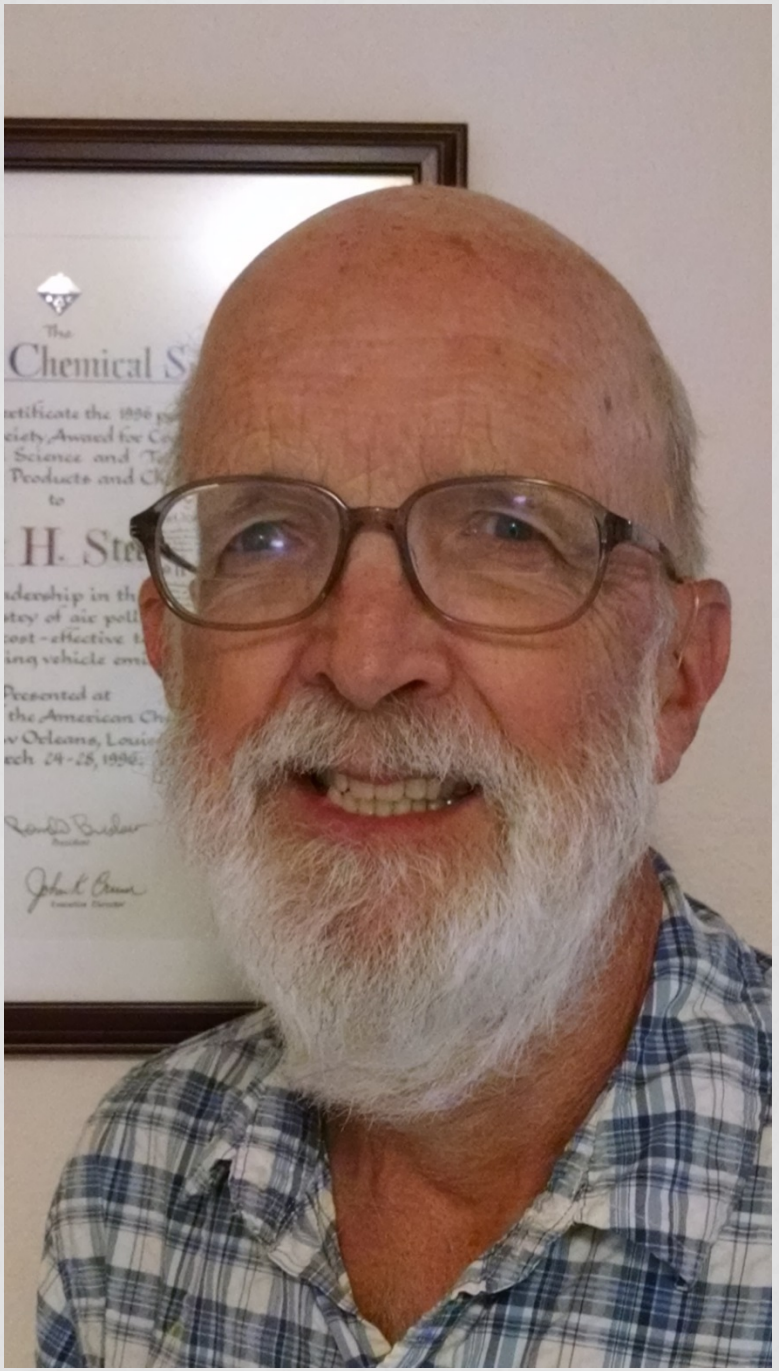
## ON-ROAD HEAVY-DUTY MONITORING SYSTEM (OHMS)

# How one of Don’s Ideas got Funding





System and method for quantifying the presence of components in the exhaust of commercial and/or heavy-duty vehicles. US Patent 8,429,957, D.H. Stedman, 2013.




DON
Donald Stedman
University of Denver

# THANK YOU!