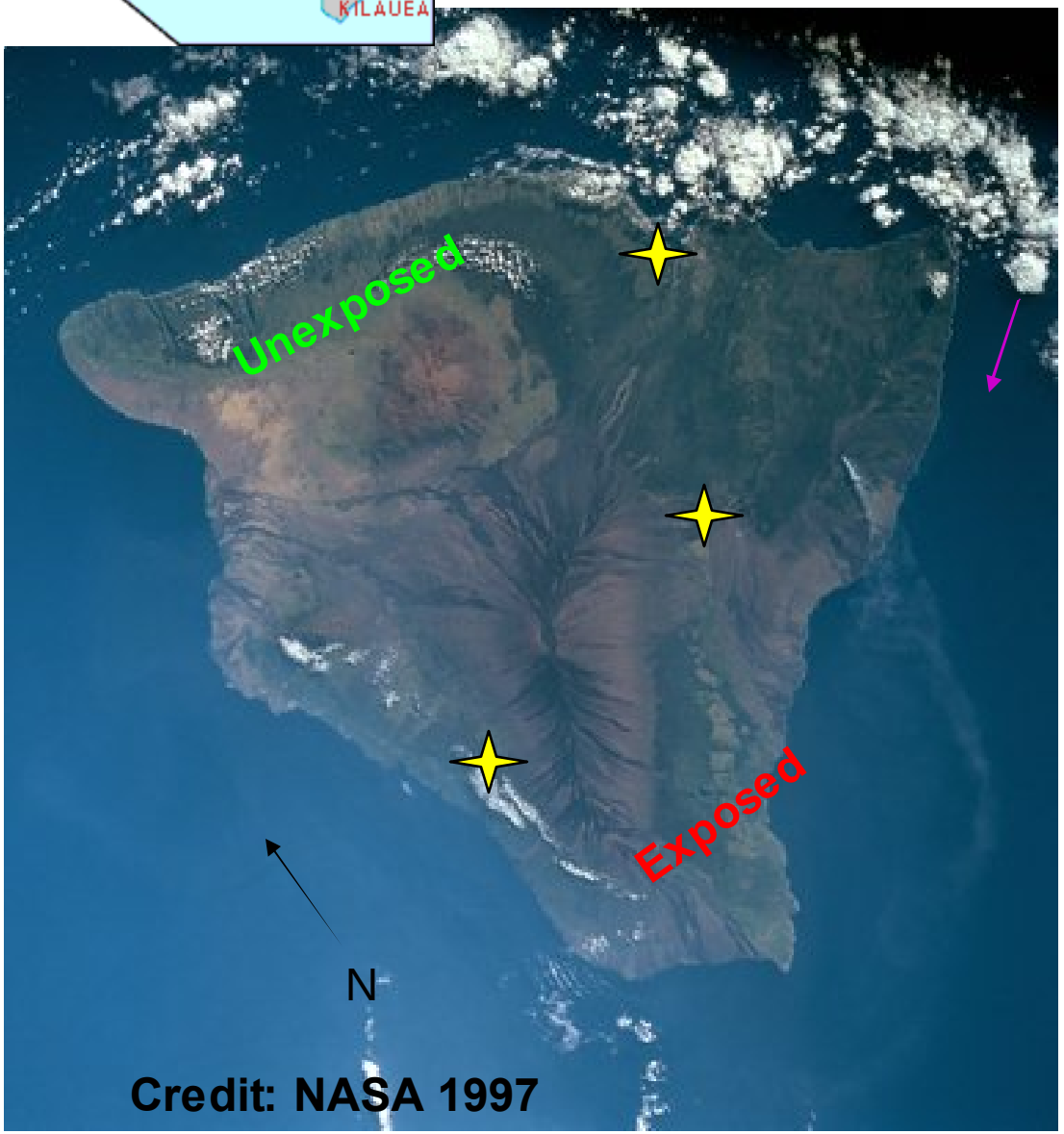
Volcanic air pollution in Hawai`i: Research, politics and policy

Bernadette Longo, PhD, RN
Orvis School of Nursing, University of Nevada-Reno
Anne Rossignol, DSc
Department of Public Health, Oregon State University
Anita Grunder, PhD
Department of Geosciences, Oregon State University

Kilauea Volcano – Hawai`i

Location & Meteorology



The BIG ISLAND of Hawai`i

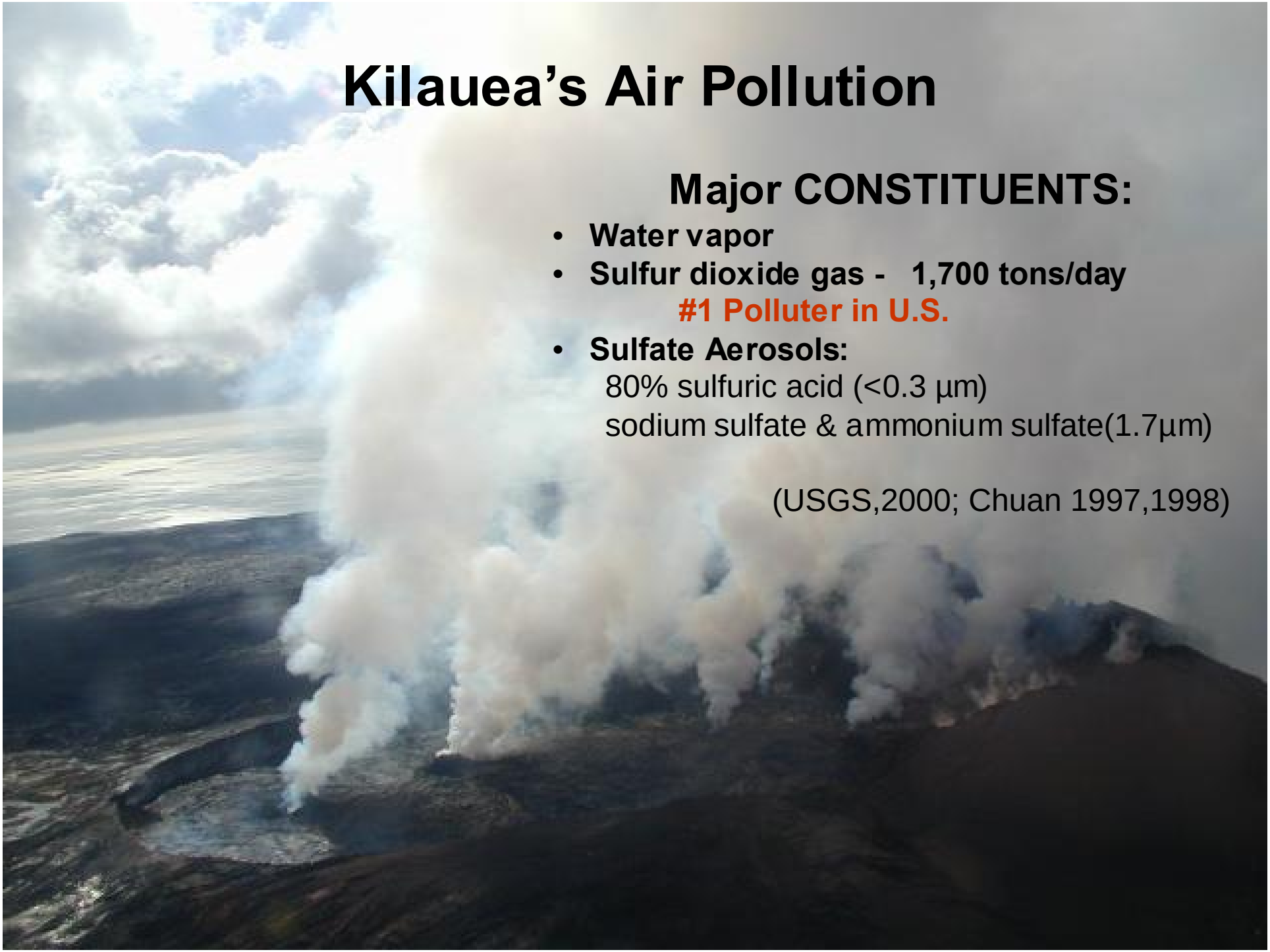
Pacific Trade winds carry the volcanic plume

Exposed areas

Unexposed areas

Existing Air Monitors in 2003

The People & Industry



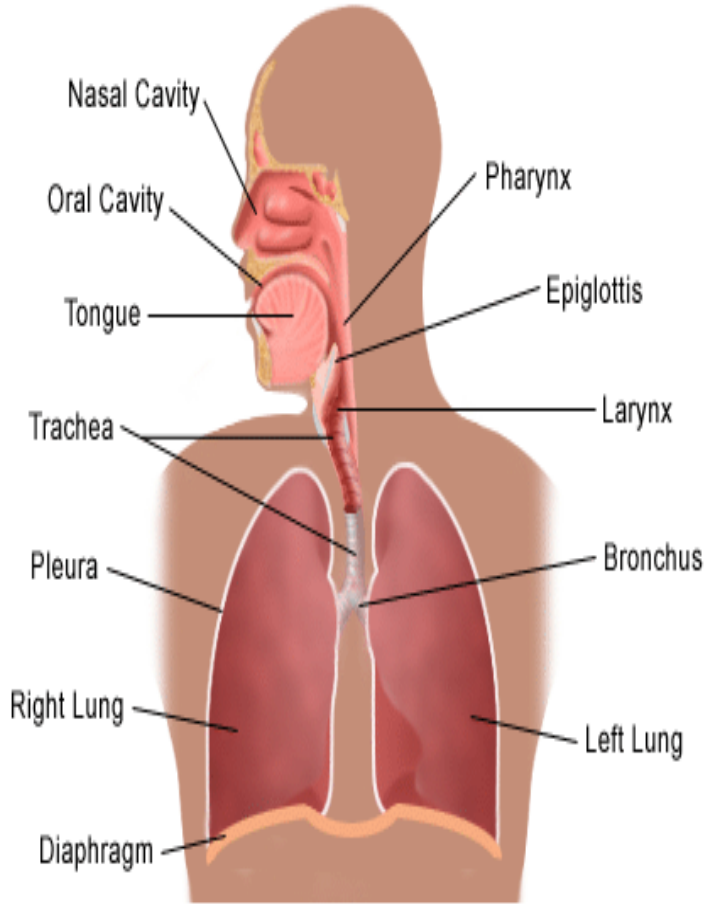
Kilauea's Air Pollution

Major CONSTITUENTS:

- **Water vapor**
- **Sulfur dioxide gas - 1,700 tons/day**
  #1 Polluter in U.S.
- **Sulfate Aerosols:**
  80% sulfuric acid (<0.3 µm)
  sodium sulfate & ammonium sulfate(1.7µm)

(USGS,2000; Chuan 1997,1998)

Sulfur Pollution & Health



SO_2 Gas

- Irritant (respiratory, dermal)
- bronchoconstriction
- Threshold in healthy individuals
- Non-threshold: pre-existing illness

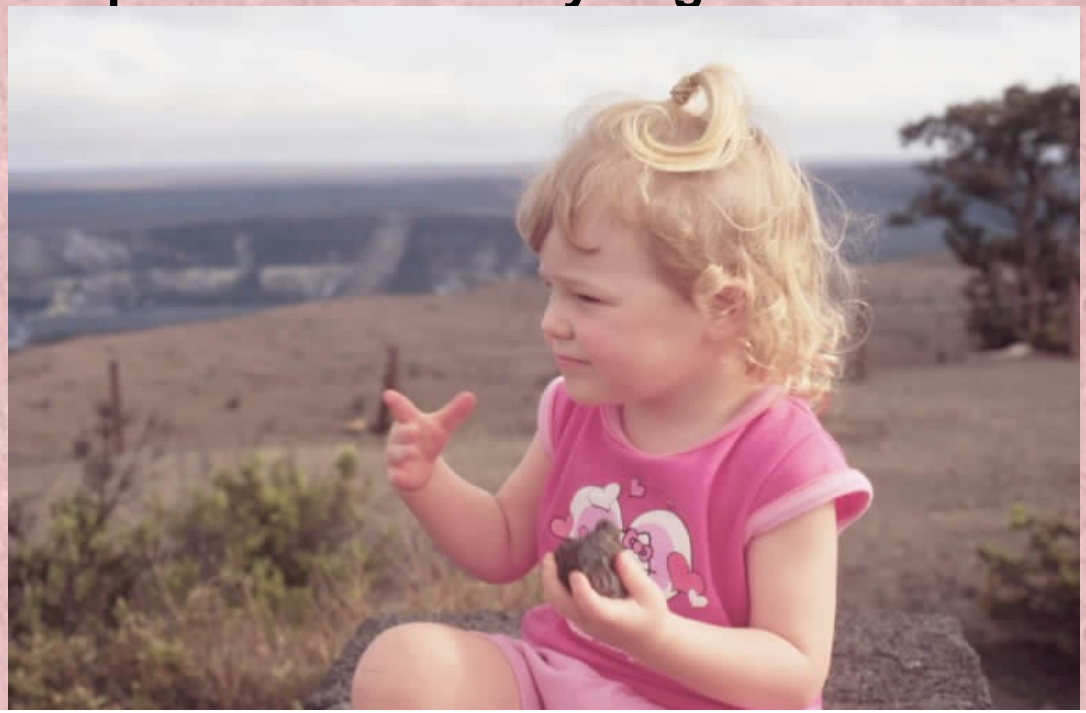
Sulfate aerosols ($PM_{2.5}$ µm)

- Irritant (respiratory, dermal)
- Alters lung defenses
- Everyone at risk
- Bronchitis
- Cardiac effects associated with fine $PM_{2.5}$

(Holgate et al., 1999)

Are certain population groups particularly vulnerable?

- those who are **inherently more sensitive** to air pollutants: unborn or very young children
- those who **develop increased sensitivity** because of increased age, certain diseases, or environmental and socio-economical factors
- those who are **exposed to unusually large amounts** of air pollutants



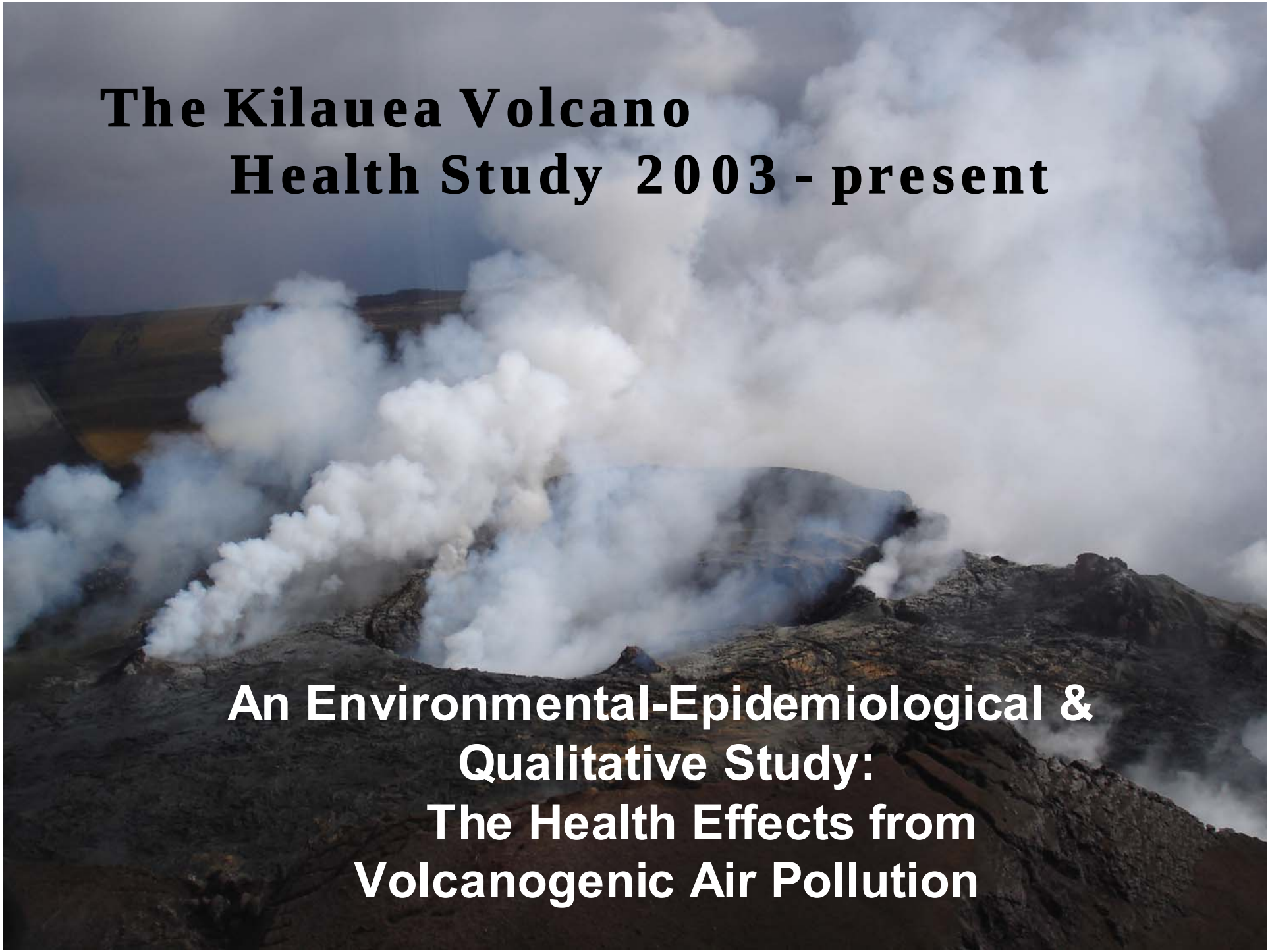
Early Assessment & Politics

CDC Report (1983) retrospective study for outpatient visits & admissions. No evidence of respiratory effects. Recommended surveillance by the State & air monitoring stations. (Roper et al., 1992)

CDC & State (1996) retrospective study for ER visits & admissions. Significant findings for asthma & COPD. Improved air sampling was recommended. (Mannino, 1996)

Other Research

- Focused on acute respiratory effects in asthmatic populations in Hawai`i
- No data on population health at any degassing volcano existed

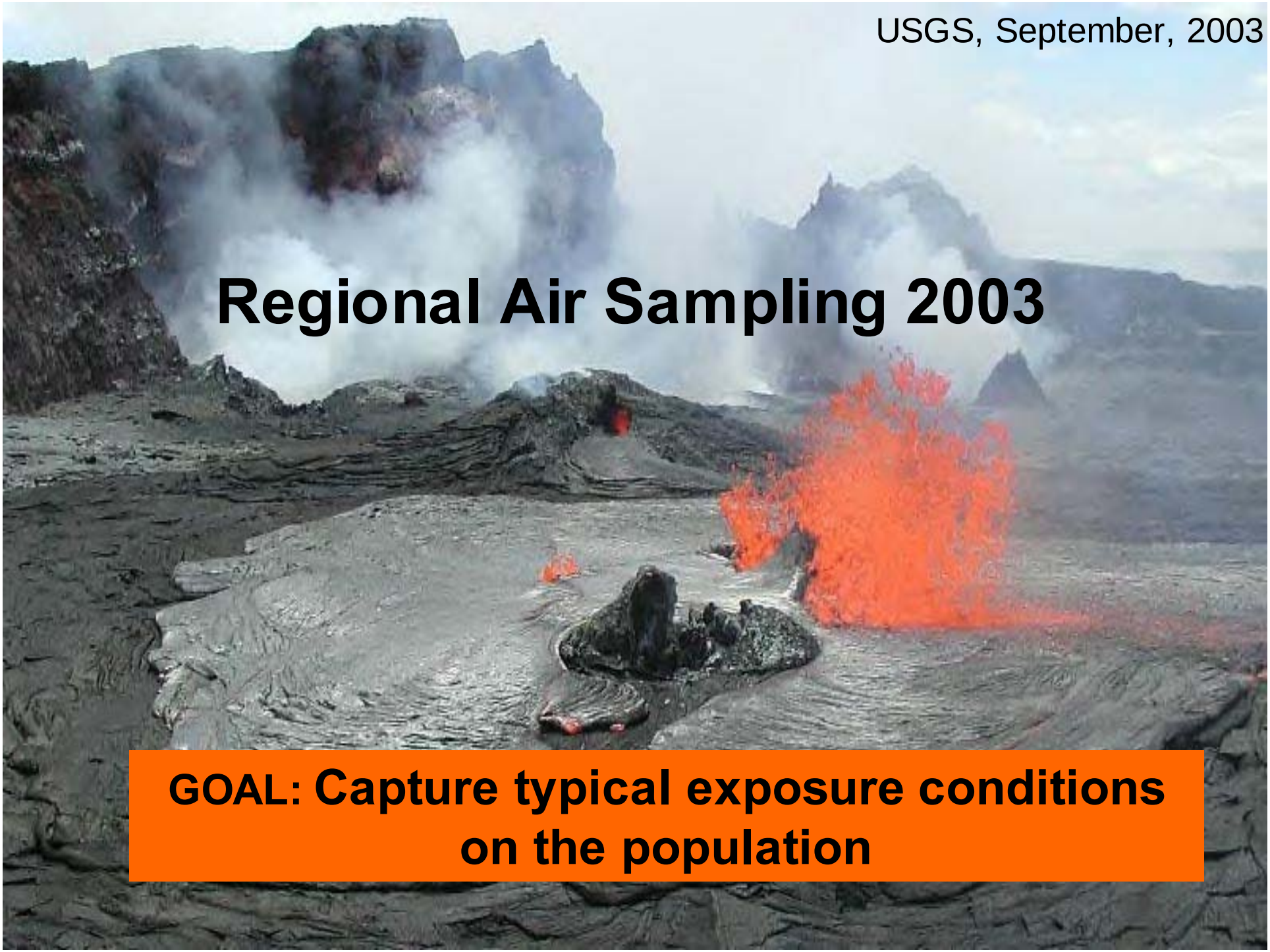


The Kilauea Volcano Health Study 2003 - present

An Environmental-Epidemiological & Qualitative Study: The Health Effects from Volcanogenic Air Pollution

Community Involvement from the start!

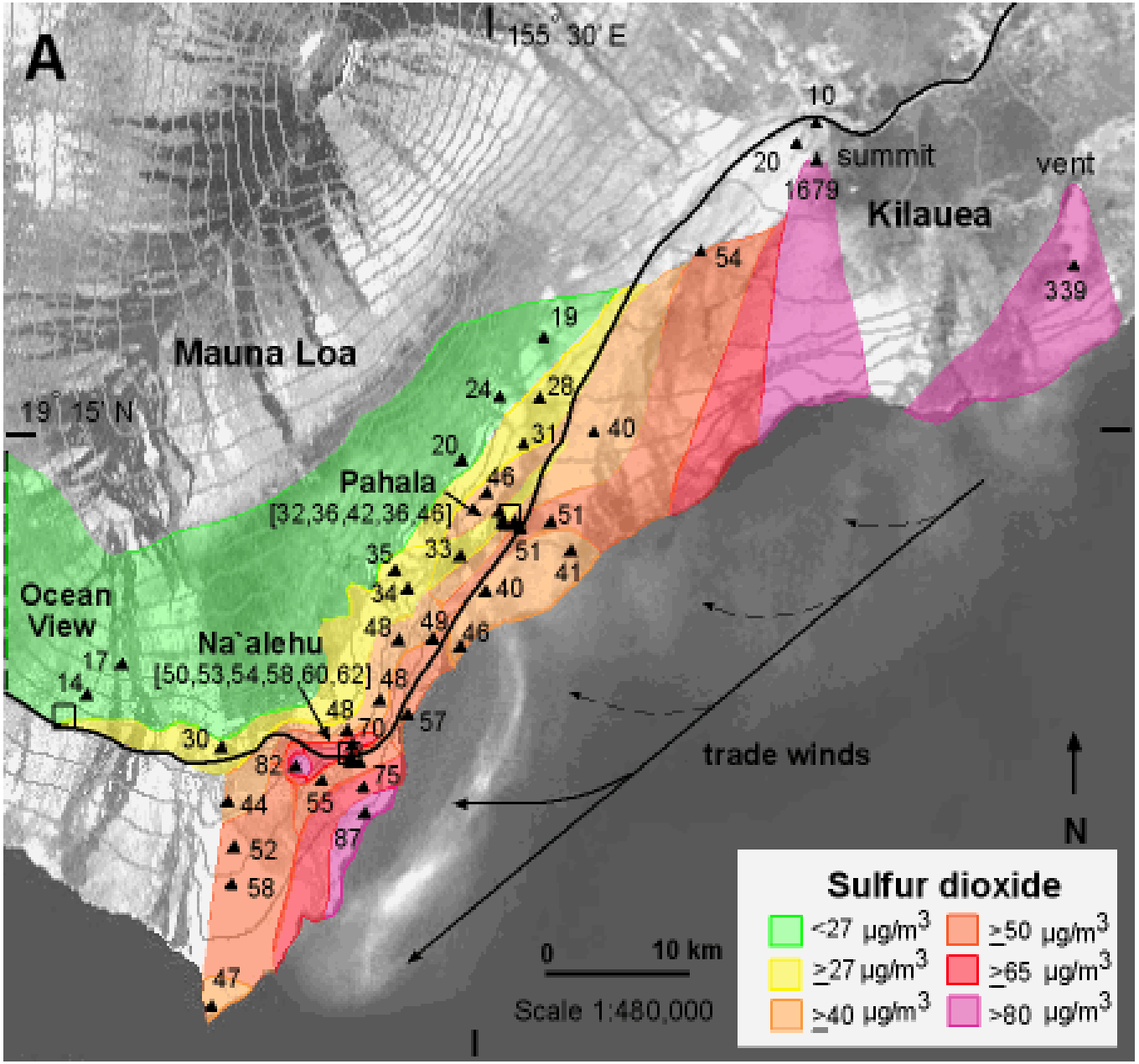
- The volcanologists at the Hawaiian Volcano Observatory
- Key community members
- Collaboration with the health professionals and institutions (the local doctor!)
- Schools – “scientist in the classroom”
- Senior Citizens



Regional Air Sampling 2003

GOAL: Capture typical exposure conditions on the population

Sulfur dioxide Concentrations 2003



Kau average = 17.8 ppbv

25 times higher than background

U.S. ATSDR

Acute MRL = **10 ppbv**

W.H.O. Guidelines

annual = **50 µg/m³** 19 ppbv

! New (2006) 24-hour 20 µg/m³ (~7.5 ppbv)

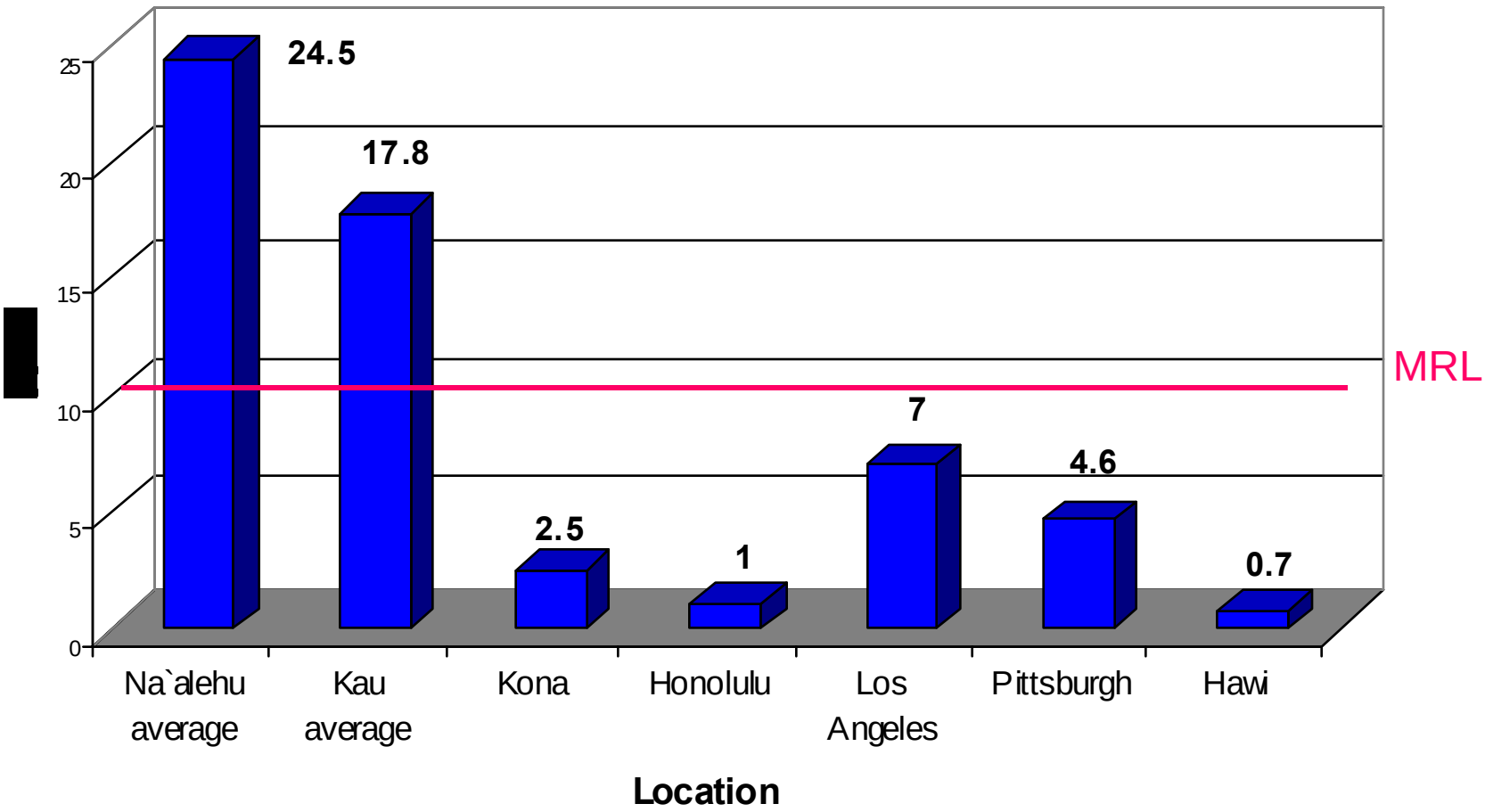
U.S. EPA standards

annual = **80 µg/m³**

Hot spot:

Na`alehu

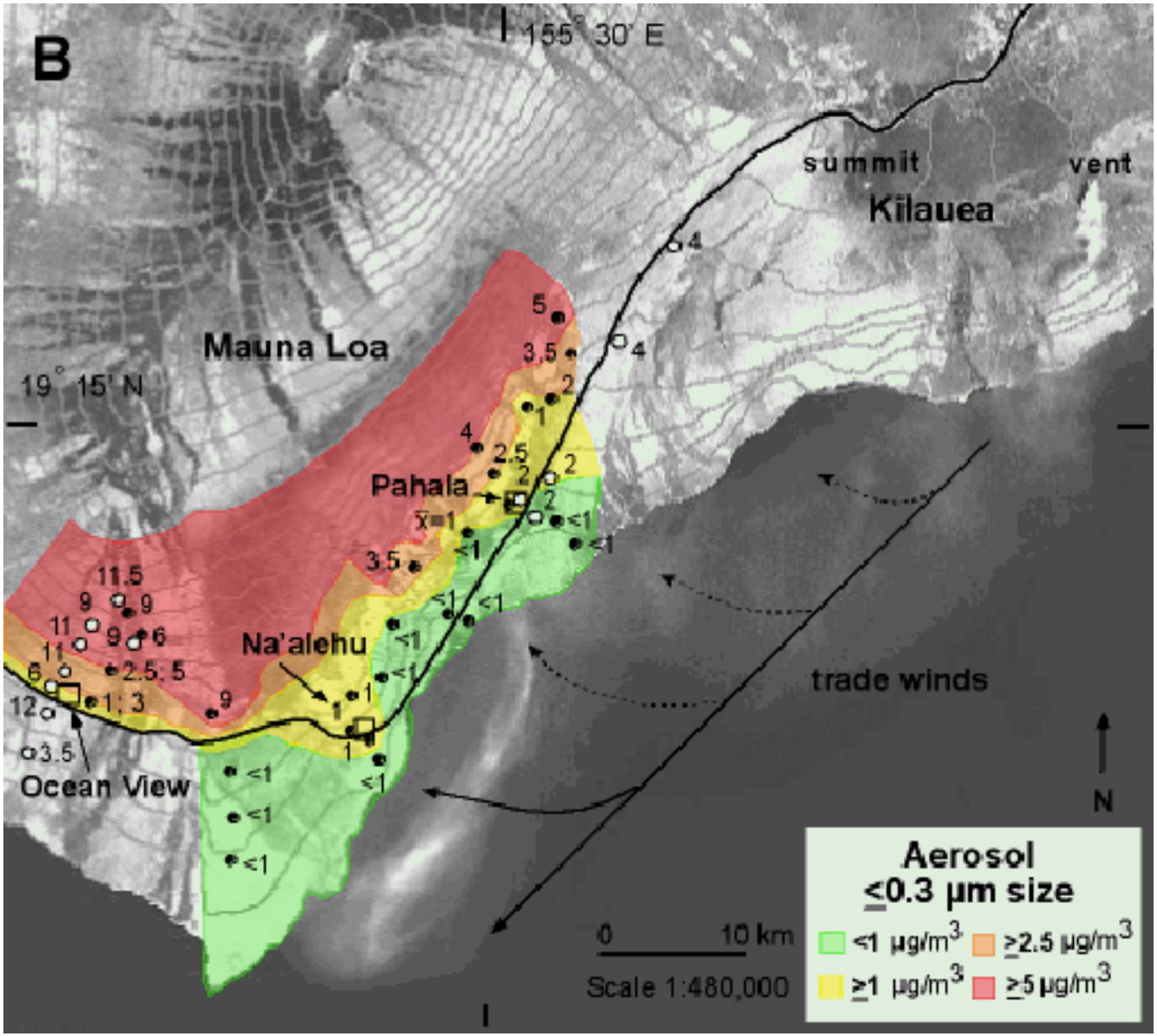
How did Kau compare?



SO_2 Penetration Indoors

I/O Ratio	Indoor ppbv	Location
0.69= **69%**	16.8	School cafeteria
0.59	12.3	School classroom
0.56	13.1	Plantation house
0.68	13.3	Plantation house
0.15	3.2	Modern house
0.71 **71%**	14.1	Hospital dayroom
0.65	11.7	Hospital clinic
0.69	9.8	School classroom
0.23	2.8	Modern house

Volcanic Fine Sulfate Concentrations 2003



Kau District
2 to 40 times higher
than background

Sulfate "Event"
≥ 5 µg/m³
(Lioy & Waldman 1989)

Hot Spot: Ocean View

Sharing the data & recommendations

- First – peer review
- Informed the residents
- Informed the State Health Department
- Informed community representatives
- Informed the public - Publish

- Journal of GEOLOGY
- Letters
- Air Quality Division, Big Island Health Officer, Director of Health
- Mayor, State representatives
- Published, the press

The Politics

Within 1 month of publication:

House Concurrent Resolution HCR 141

"URGING THE DEPARTMENT OF HEALTH to ACTIVELY MONITOR LEVELS OF SULFUR DIOXIDE AND ESTABLISH A VOG INDEX advisory PROGRAM FOR THE PUNA AND KA'U AREAS OF THE ISLAND OF HAWAII."

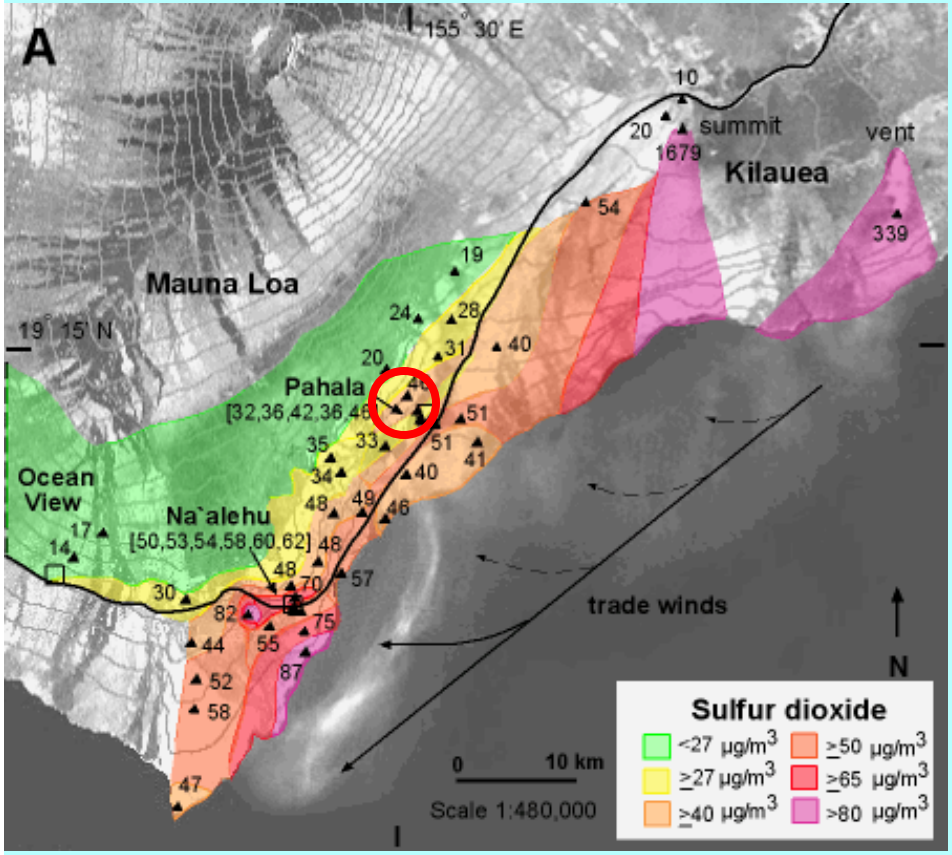
TWENTY-THIRD LEGISLATURE, 2005

Introduced by State Representative

Josh Green, M.D.

6th Representative District

The Air Monitors



- We had recommended
  - SO_2 in Na'alehu
  - $PM_{2.5}$ in Ocean View
- First - placed in Pahala and operation began April 2007
- Key to identify a temporal pattern in the air pollution
- Second - will be in a community near the vent – exposed when the wind changes.

Current - Phase II

- Release of the epidemiological survey in the journal of **Public Health**:

Significantly increased odds: cough, phlegm, rhinorrhea, sore/dry throat, sinus congestion, wheezing, eye irritation, and bronchitis in the exposed population.

Statistically significant: Blood pressure (BP) elevation and faster pulse rate.

Air Pollution + Smoking

Our study found that smokers (current and former) were most affected by the volcanic air pollution.

Chronic bronchitis = OR 7.96 (95%CI 2.16-29.39)

cough along with phlegm, for 3 or more months in at least 2 consecutive years

Other Laws for Health

2006 – Act 295 Hawaii became the 14th state to become **smoke free** for workers and with a revision – for public places!

2006 – Act 316, S.B. 2961 C.D. 1

Cigarette Tax Increase

Uses the monies to fund programs to promote health!

Health Promotion & Treatment Efforts

- *Community involvement in health*
- Smoking Cessation program (American Lung Association of Hawaii)
- Prevention of smoking initiation – needs development!
- Posters in health care facilitates: joint efforts of our research team & local clinicians
- Health Fair Screenings, including spirometery
- Air quality improved in local hospital & ER

Continued Research

College of Health and Human Sciences
University of Nevada, Reno
Orvis School of Nursing

Funded Grant from the University of Nevada-Reno

- Retrospective medical record review
- Continued community assessments

The Broad Impact

500 million *people live near Earth's 600 active volcanoes*

Most are in the Pacific!

About 50 volcanoes erupt each year

Long-term residency in active volcanic areas may adversely influence cardiorespiratory health in adults.

University of Nevada, Reno
Statewide • Worldwide

OSU Oregon State University

The summit of Kilauea Volcano