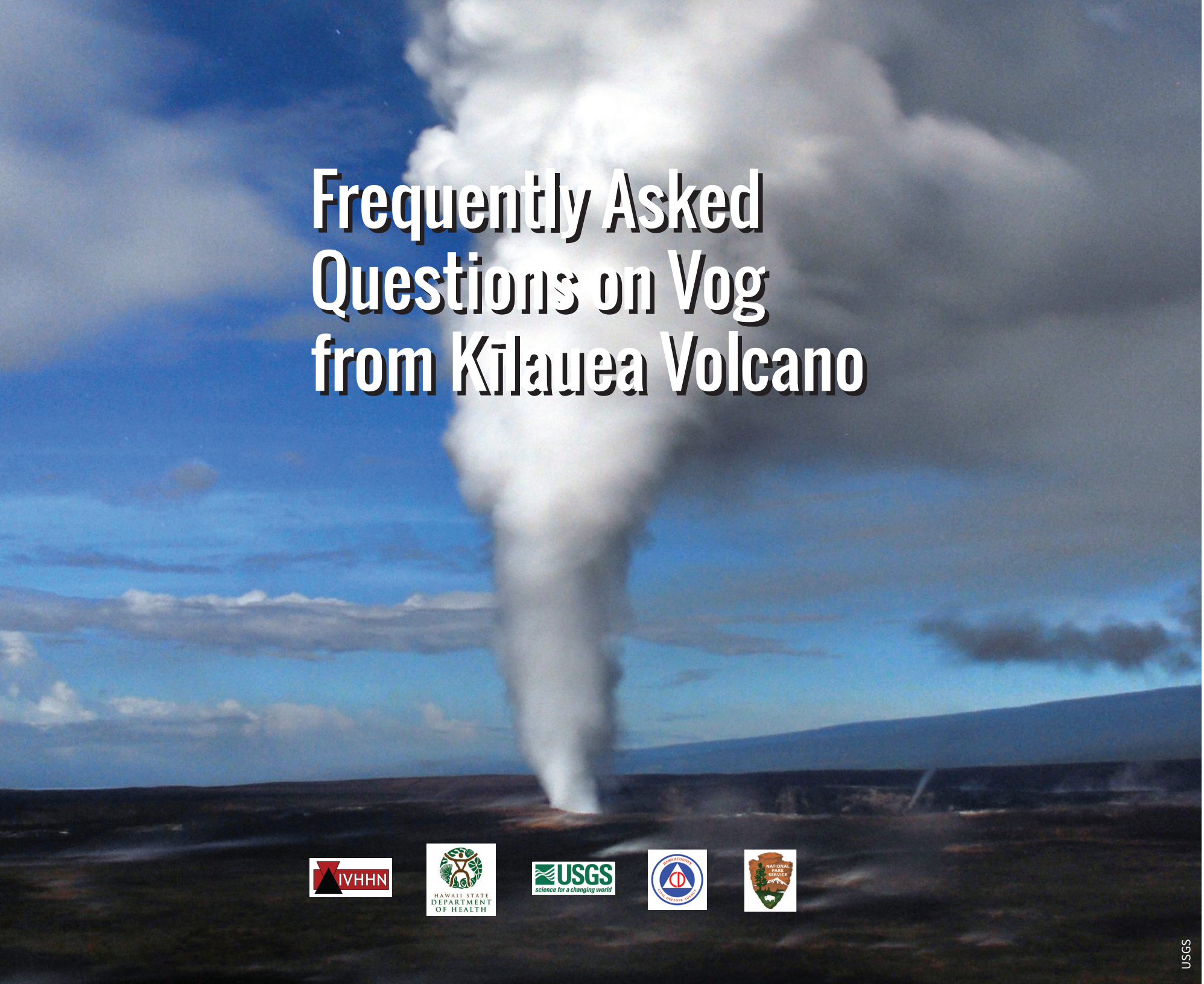
Frequently Asked Questions on Vog from Kīlauea Volcano



USGS

Vog shrouds Hilo Bay, 1/17/2010.

Introduction

Ongoing volcanic activity at the summit and East Rift Zone of Kīlauea Volcano, on the Island of Hawai‘i, creates the potential for airborne health hazards to residents and visitors. At the levels of volcanic emissions occurring over recent years, individuals with pre-existing respiratory conditions are the primary group at risk of experiencing health effects from vog exposures, but healthy people may also experience symptoms.

General information, advice, and data resources are provided in this fact sheet; however, it is very important to listen to your own body and take measures to protect yourself if you feel your health is being affected by vog.

What is vog?

The term ‘vog’ refers to the hazy air pollution caused by the volcanic emissions from Kīlauea Volcano, which are primarily water vapor (H_2O), carbon dioxide (CO_2), and sulfur dioxide (SO_2) gas. As SO_2 is released from the summit and east rift eruptive vents, it reacts in the atmosphere with oxygen, sunlight, moisture, and other gases and particles and, within hours to days, converts to fine particles, which scatter sunlight, causing the visible haze that is observed downwind of Kīlauea. Areas far downwind (e.g., the west side of Hawai‘i Island and other islands in the state) are mostly affected by the fine particles; however, areas closer to the eruptive vents, including the communities ranging from Ocean View to Hilo, can be exposed to both SO_2 gas and fine particles during periods of vog.

SO_2 is a colorless, irritating gas that has an acrid odor like fireworks or a struck match. It is also emitted from other sources, such as fossil fuel power plants and motor vehicles.

Fine particles consist of particulate matter less than 2.5 micrometers in diameter and are referred to as ‘$PM_{2.5}$’. These particles are smaller than the width of a human hair. $PM_{2.5}$ in vog is mainly composed of acid and neutral sulfate particles. Other sources of $PM_{2.5}$ include vehicle exhaust and smoke from fires.

Vog contains mostly SO_2 and acid particles, in contrast to urban, industrial, and other pollution sources, which also contain additional toxic contaminants, such as ozone and hydrocarbons.

What is laze?

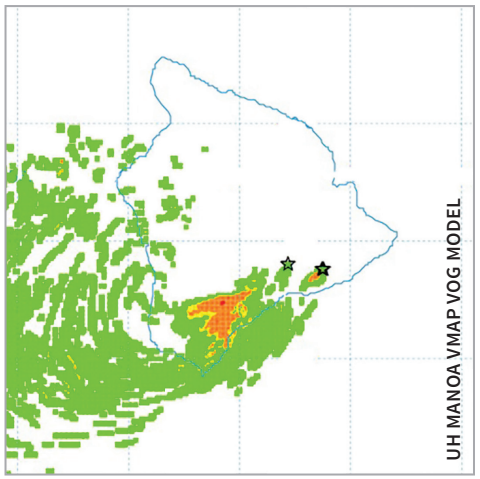
When molten lava flows into the ocean, it reacts vigorously with sea water to create large steam plumes laden with hydrochloric acid. These acidic ‘laze’ plumes mainly create a local hazard for people visiting the coastal entry. Inhaling or contacting acid gases and liquids can irritate the skin, eyes and respiratory tract, and may cause breathing difficulties, particularly for people with pre-existing respiratory diseases.

What is volcanic ash?

Volcanic ash is made of tiny rock and glass particles (less than 2 mm wide), which can be inhaled by people in downwind communities. Substantial volcanic ash emissions from Kīlauea have been rare in recent years. Rockfalls from the vent walls of Halema‘uma‘u Crater and spattering of the lava lake continue to produce minor, local ash emissions that do not generally pose a health hazard, so are not discussed further here.

How much vog is there and where does it go?

In any location, vog concentrations are primarily dependent on the amount of volcanic emissions, the distance from the source vents, and the wind direction and speed on a given day. In the Hawaiian Islands, the predominant wind direction is from the northeast (trade winds). Consequently, the areas southwest of Kīlauea are most frequently affected by vog on Hawai‘i Island. When trade winds are absent, which occurs most often during winter months, East Hawai‘i, the entire island, or the entire state can be impacted by vog.



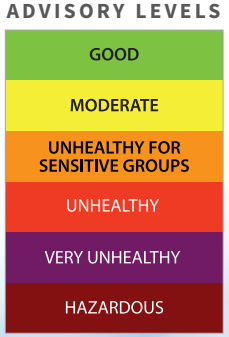
▲ Forecast of vog plume location on the Island of Hawai‘i during trade winds. Colors indicate health advisory levels.

Sulfur dioxide emissions from Kīlauea Volcano have decreased substantially since the beginning of the 2008 Halema‘uma‘u eruption, resulting in less vog for the island and state. In general, SO_2 and $PM_{2.5}$ are below levels considered to cause serious health effects for the general population. However, some individuals may experience symptoms from both $PM_{2.5}$ and SO_2 exposures, depending on location.

Levels of health concern for SO_2 and $PM_{2.5}$ concentrations over the last several years, as defined by the U.S. Environmental Protection Agency (EPA) and/or Hawaii Department of Health (HDOH):

- In areas close to the eruptive vents (e.g., Hawai‘i Volcanoes National Park (HVNP) and surrounds): under certain wind conditions, SO_2 can reach levels considered ‘unhealthy’ for the general population.
- Downwind areas relatively near Kīlauea (approximately ranging from Ocean View to Hilo): under certain wind conditions, SO_2 can reach levels considered ‘unhealthy for sensitive groups’.
- In most areas: $PM_{2.5}$ concentrations only occasionally reach levels considered ‘unhealthy for sensitive groups’.

The County of Hawai‘i, HDOH, USGS Hawaiian Volcano Observatory, and several other federal agencies worked together to form a short-term SO_2 color code advisory system, designed to alert people to volcanic SO_2 pollution on Hawai‘i Island. The same color code system is used by EPA for $PM_{2.5}$ 24-hour advisories. The advisory websites are listed on the back cover of this document.



Advisory levels color key ▶

What are the health effects of sulfur dioxide gas (SO_2) and fine particles ($PM_{2.5}$) from volcanic emissions?

Individuals vary in their sensitivity, and vog exposure may worsen symptoms for people who have pre-existing health conditions. Sensitive groups include:

- people with asthma or other respiratory conditions
- people with cardiovascular disease
- older adults
- infants and children
- new or expectant mothers

SO_2: Physically active asthmatics are most likely to experience serious health effects from SO_2. Even short-term exposures can cause narrowing of the airways (bronchoconstriction), causing asthma symptoms. Potential health effects increase as SO_2 levels and/or breathing rates increase. At SO_2 levels considered 'unhealthy' for the general population, even non-asthmatics may experience breathing difficulties. Short-term SO_2 exposure is connected to increased visits to emergency departments and hospital admissions for respiratory illnesses, particularly in the 'sensitive groups'. No one knows the long-term health effects of exposure to volcanic SO_2.

Short-term health symptoms include:

- eye, nose, throat, and/or skin irritation
- coughing and/or phlegm
- chest tightness and/or shortness of breath
- headache
- increased susceptibility to respiratory ailments
- some people also report fatigue and/or dizziness

$PM_{2.5}$: Both long- and short-term particle exposures have been linked to various health problems. High levels of particle pollution are linked to increased hospital admissions and emergency room visits, and even to death from existing heart or lung disease. Low levels of $PM_{2.5}$ are not considered as problematic for asthmatics as low levels of SO_2 gas.

Particle pollution can cause temporary health symptoms such as:

- eyes, nose and/or throat irritation
- coughing and/or phlegm
- chest tightness and/or shortness of breath

See **https://airnow.gov/index.cfm?action=particle_health.index** for more information.

Will staying indoors protect me from vog?

Staying indoors, with doors and windows closed, can help reduce vog exposures over a short time period (hours), depending on how well your house is sealed from the outside environment. Over the long term, outdoor air gradually seeps into a home, even if closed up. The house should be opened up again when vog levels decrease.

Air conditioning (AC) can provide comfort, but is not designed to filter out SO_2 gas or $PM_{2.5}$ from the air. However, AC dehumidifies the air, and some vog components may be pulled out of the air along with the moisture. During periods of vog, temporarily set the unit to the 'air recirculation' or 'closed vent' setting to prevent the unit from pulling outdoor air into the home.

Do room air cleaners work?

A room air cleaner can be effective in reducing levels of SO_2 and/or $PM_{2.5}$ from the air. People living close to the volcano are exposed to both SO_2 and $PM_{2.5}$, so they may want to seek protection by using a specialized air cleaner which has both a HEPA ($PM_{2.5}$) filter and an acid gas (SO_2) filter. Those living further from the eruptive vents can use an air cleaner designed to filter fine particles only (HEPA) since they are not exposed to substantial amounts of SO_2.

Quality room air cleaners can be expensive and are designed for a room that can be closed off from the rest of the house and the outdoors. Periodic filter replacement and other maintenance is required for air cleaners to perform as designed. For more information, see the EPA 'Guide to Air Cleaners in the Home': **https://www.epa.gov/indoor-air-quality-iaq/guide-air-cleaners-home**.

Should I use a respirator or face mask during vog episodes?

The HDOH does not recommend use of respirators by the general public to protect against volcanic gases. Short-term use of N95 masks can help protect against volcanic ash but not gases (like SO_2).

'Sensitive groups' such as children or people with pre-existing conditions should be especially cautious because N95 (or other) masks typically do not fit children and the breathing resistance caused by masks can worsen respiratory disorders.

Masks will not provide effective protection for people with beards or mustaches because they prevent a tight seal to the face.

Many common masks (including surgical masks) and bandanas will not provide substantial protection from $PM_{2.5}$ or SO_2.

Safe occupational use of respirators requires correct mask and/or filter cartridge selection, physician screening, annual fit testing and training on correct use, maintenance, and storage.

Are water catchment systems affected by vog?

Water from catchment systems in vog-prone areas can become acidic and leach harmful contaminants, such as lead, copper, and zinc, from roofing and plumbing materials, especially on older homes. Catchment water used for drinking or food preparation should be carefully monitored. Methods for adjusting water catchment pH include adding baking soda to the tank, or using an inline pH adjusting filter. Subsidized water testing for lead and copper is available through a special program: **http://health.hawaii.gov/sdwb/raincatchment/**.

Volcanic ash can also get into the water, causing contamination, and interfere with common water treatment methods such as filtration and chlorination. Guidelines for maintaining water catchment systems can be found at **http://www.ctahr.hawaii.edu/hawaiirain/guidelines.html**. For health and safety reasons, in general, the HDOH does not recommend using catchment water for drinking or preparing food. County water spigots can be used instead as a safer water supply.

Is it safe to visit the volcano if I have a respiratory condition?

At Hawai'i Volcanoes National Park (HVNP), elevated vog levels, and laze conditions at the coast, are most common when trade winds are absent. Current air quality and wind conditions can be checked online prior to visiting the park. People with pre-existing respiratory conditions should have their medications available when visiting the park, as SO_2 and other acid gas concentrations can reach unhealthy levels quickly, in some areas of the park. Pay attention to park warnings and follow park advisories.

Please see helpful **links** *on back cover*

What can I do to protect myself from vog?

Prepare for vog exposure:

- **Understand the hazard:** Get familiar with key air monitoring websites and the SO_2 and $PM_{2.5}$ advisory codes/levels.
- **Learn about wind conditions:** Be aware of winds that could carry vog to your area. This will help you to better track and predict when you might be affected by vog.
- **Keep medications handy:** If you have asthma or other respiratory conditions, keep your medication available and use as prescribed. If you don't have medications, but feel you might need them, call your doctor.

See links on back cover for wind and air monitoring websites

Protective actions when vog is a problem:

- **Seek medical assistance as necessary:** Assume that asthma could get worse during periods of high vog. If you are having asthma symptoms, such as trouble breathing, wheezing, increased coughing, or chest tightness, contact your doctor or seek other medical assistance.

- **Take care of yourself:**
  - **Do not smoke:** Also, avoid secondhand smoke.
  - **Stay hydrated:** Drink plenty of liquids to help loosen congestion. Warm or hot liquids in particular may help some people.
  - **Manage congestion or irritation:** Over-the-counter nasal sprays or eye drops can help reduce upper respiratory symptoms for some people.

- **Reduce your exposure to vog:**
  - **Limit strenuous activities:** Outdoor exercise or exertion increases your chances of being affected by SO_2 gas and/or $PM_{2.5}$. When vog levels are elevated, reduce strenuous activity, if possible.
  - **Stay indoors:** When vog levels rise, go indoors and close all doors and windows to the outside. Eliminate sources of indoor pollutants (e.g., smoking, candles/incense, and improperly vented fuel-burning stoves) and beware of becoming overheated as a result of closing up your house. If your house is not well-sealed, it may still offer some protection. Alternatively, consider visiting indoor areas that are better-sealed and/or have air conditioning (e.g., commercial buildings or businesses).
  - **Reduce indoor vog with an air cleaner:** If doors and windows in your house, or in one room of it, can be closed, the use of an appropriate air-cleaning device can help reduce the levels of both SO_2 and $PM_{2.5}$ (if you live near the source vents), or just $PM_{2.5}$ (if you live farther from the vents).
  - **Leave the area if appropriate:** If indoor areas have poor air quality, consider temporarily relocating to a less impacted part of the island.
  - **Restrict vog from entering your vehicle:** If driving through the dense volcanic plume near Hawai'i Volcanoes National Park, to minimize air infiltration, temporarily close your windows and vents, and turn your fan and air conditioner off.

For recommendations on what to do at specific SO_2 and $PM_{2.5}$ advisory levels see:

http://www.hiso2index.info/assets/FinalSO2Exposurelevels.pdf
and https://www.airnow.gov/index.cfm?action=pubs.aqguidepart

More Information

- **Vog dashboard** (comprehensive information including links below): **www.ivhhn.org/vog**
- **UH Mānoa VMAP Vog Forecast Model** (SO_2 and sulfate particle forecasts based on wind model): **http://weather.hawaii.edu/vmap/**
- **HDOH Hawai‘i short-term SO_2 monitoring and advisory** (SO_2 gas data from island-wide monitoring stations): **www.hiso2index.info/**
- **U.S. EPA AirNow current $PM_{2.5}$ conditions:** **www.airnow.gov** (select Hawaii State at top of page)
- **NPS HVNP air quality monitoring and advisory** (SO_2 and $PM_{2.5}$ data from within the National Park): **www.hawaiiso2network.com**

Acknowledgements

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