



COLLEGE OF THE ENVIRONMENT
UNIVERSITY of WASHINGTON



CAARE

COASTAL ATMOSPHERIC AEROSOL
RESEARCH AND ENGAGEMENT





Street flooding in Alameda, California on Monday, Jan. 9, 2023. (John Baskett)



Science

Scientists warn Earth warming faster than expected – due to reduction in ship pollution

Leading climate scientist James Hansen says 'global warming will accelerate'



Nicole Mortillaro · CBC News · Posted: Nov 03, 2023 8:52 AM PDT | Last Updated: November 7, 2023

What are we
studying &
why?

What are we doing in the research?

Spraying

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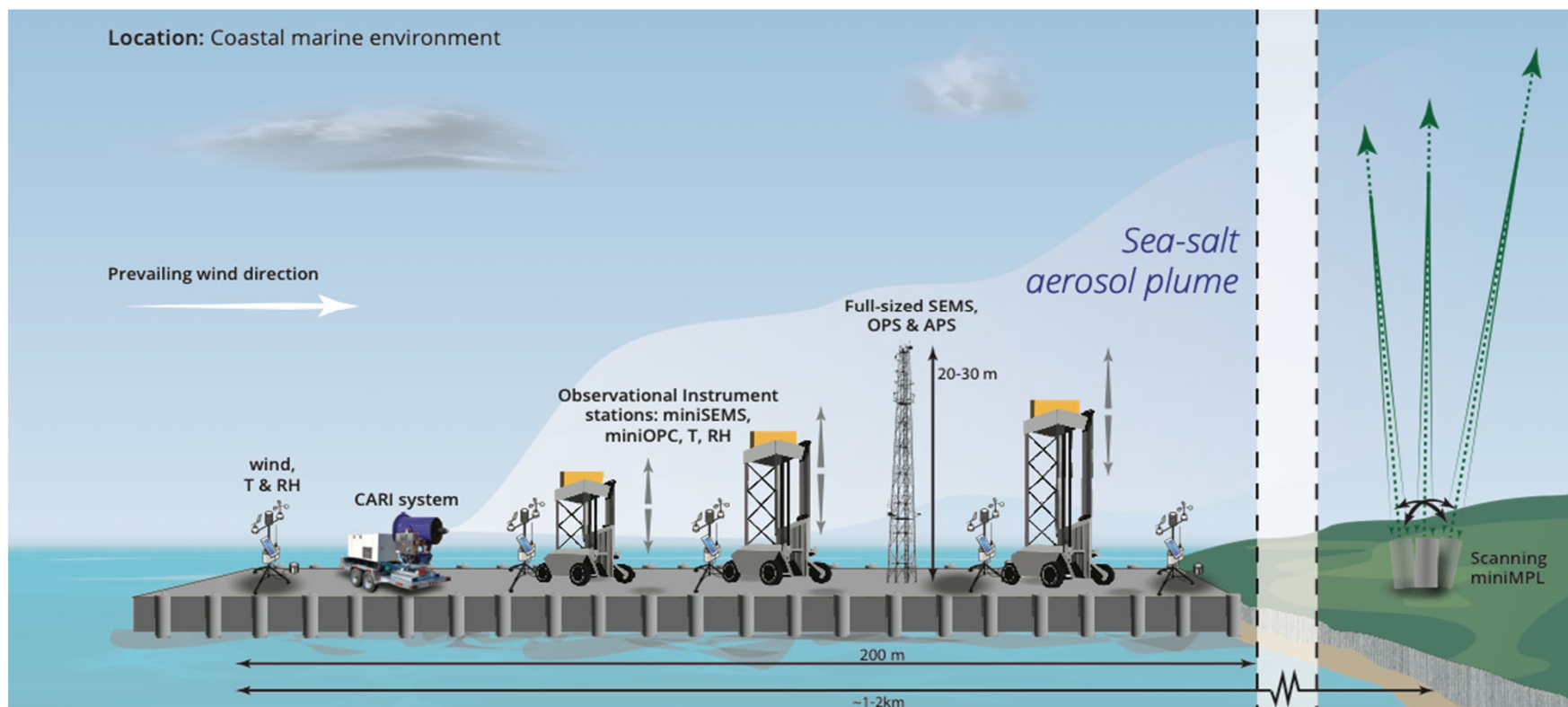
Measuring

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Modeling

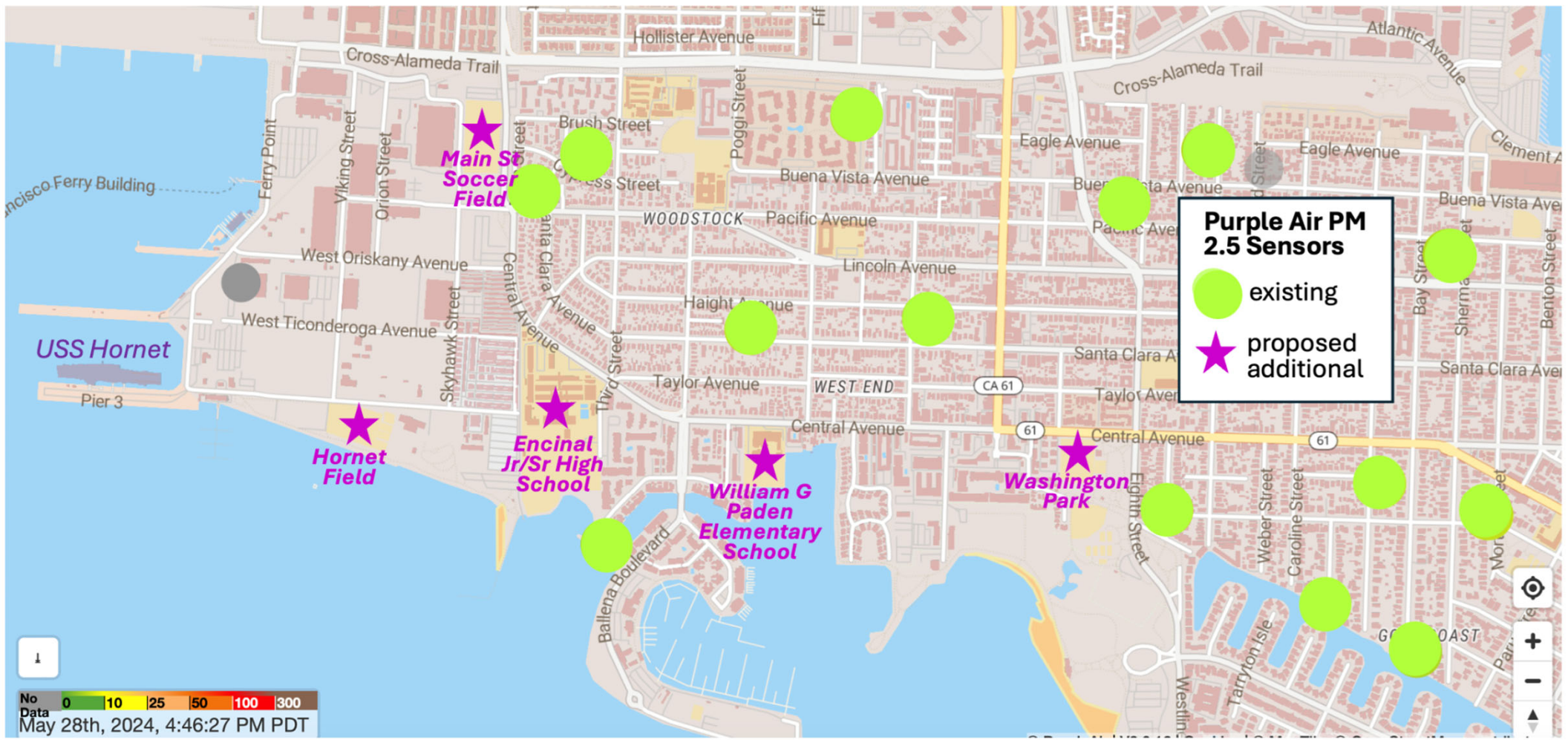
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**Why are we at the
USS Hornet Sea, Air
and Space Museum
in Alameda?**

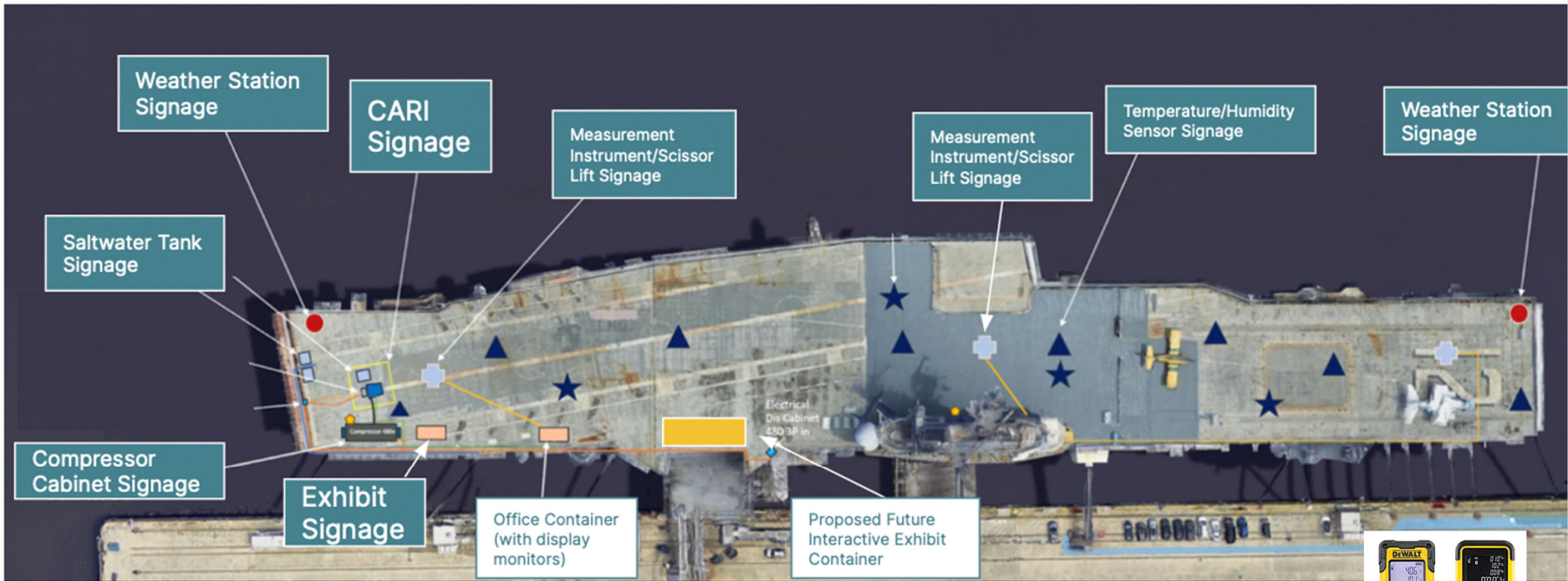
- Marine meteorology
- Operational support
- Local to our research partner SRI
- *Opportunity to engage people directly with the research*





CAARE at the USS Hornet Sea, Air and Space Museum

- Interactive tours
- Student field trips
- Community workshops, focus on vulnerable and underrepresented communities
- Visiting scientists and government agencies
- Outreach scientist visits to schools and local groups
- *Global Youth Workshop in conjunction with Youth Science Fair*



Hornet Flight Deck Content

Learning about weather and climate, engaging with research



Coastal Atmospheric Aerosol Research and Engagement

The University of Washington Marine Cloud Brightening Program is a group of scientists and engineers from around the world who are studying how clouds in the sky react to tiny particles in the air called aerosols. The scientists are studying what happens when aerosols mix into clouds and the impact this has on our climate.

The program is researching how aerosols from pollution make clouds a stronger mirror for sunlight so that the Earth is heated a little bit less by the sun. They are investigating if it might be possible to someday reduce climate warming by producing the same cloud effect with natural sea-salt particles from the ocean. They want other scientists and all of society to have access to the results of their research. They hope this will inspire further science and better our understanding of the Earth's changing climate and our options for improving its stability in the coming decades.



Climate Change



The Earth is protected by a thin layer called the atmosphere. Because of things that humans do, the environment inside Earth's protective shield is changing. By burning fossil fuels like oil and gas to power things like cars and electricity, or by cutting down trees to make room for more farm animals, humans have released gases into the atmosphere and lowered Earth's ability to absorb them. These gases are called greenhouse gases because, like a greenhouse, they trap heat energy in the Earth's atmosphere, changing the climate and weather in different ways.



While a greenhouse is great for growing vegetables, it is not good for our planet. It leads to extreme weather like heat waves, droughts and floods that affect life for plants, animals and people around the world. One of the biggest problems with climate change is that these extremes are more than our ecosystems can handle, meaning many living things on the planet are now at risk. To help our planet, the world must stop putting more greenhouse gases into the atmosphere by changing the way we produce energy, food, buildings, clothing and more and also find ways of taking greenhouse gases out of the atmosphere. But climate change is moving fast and we may need more ways to address it.

Clouds, Aerosols and Climate



Clouds in the sky act like mirrors for the sun, reflecting sunlight back into space. By reflecting sunlight away from the Earth, clouds cool down areas directly below them and across the planet. Aerosols are also in the sky floating in the air like clouds. Aerosols are much smaller than clouds, though. They are tiny particles that come from natural sources like the spray of the ocean or from human sources like pollution from ships, cars and factories.

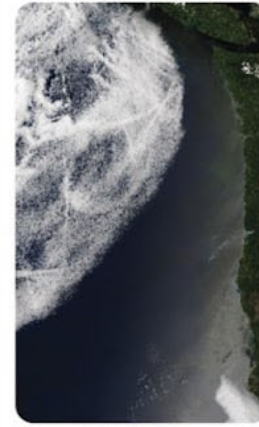
Sometimes, clouds and aerosols mix together. When aerosols mix into clouds, especially clouds floating over the ocean, they can make the clouds brighter. Brighter clouds are stronger mirrors for the sun, so they reflect more sunlight back into space. This means that the clouds have a stronger cooling effect on the Earth.

Today, particles from human pollution are mixing with clouds to create this cooling effect. This is keeping the planet cooler than it would otherwise be, but we do not know by exactly how much. Because pollution particles are bad for human health, the world is reducing this kind of pollution very quickly. The world will lose some of the cooling from clouds as we do this, but we do not yet know how much.

Marine Cloud Brightening

When big ships cross the ocean, they sometimes leave streaks of brightened clouds behind them. Scientists figured out that these streaks are from aerosols that come out of a ship's smokestack and mix into clouds, making the clouds more reflective. This gives scientists an idea: could we spray salt from sea water to natural source of aerosols that mix with clouds into the air from ships to brighten low-lying ocean clouds and reduce climate warming? This idea is called marine cloud brightening.

There is still a lot of research to be done before we will know if marine cloud brightening is possible, or if it would be a good idea. Scientists are being very careful and patient as they research this topic. Clouds over the ocean are important to the atmosphere, our weather and rain. Scientists need to know how brightening clouds could affect local and global areas before they try to do this. That is why many scientists have recommended finding out more about marine cloud brightening so we can learn if it could be a safe and helpful way to reduce climate warming.



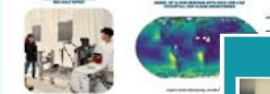
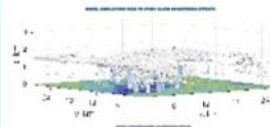
Our Research

The Marine Cloud Brightening Program, led by scientists who study the atmosphere, hopes to do three important things:

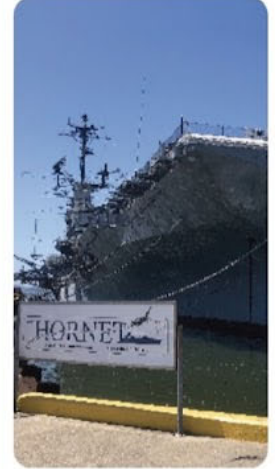
1. Understand the way that pollution aerosols are changing clouds over the ocean right now.
2. Find out whether sea salt aerosols could be safely used to reduce climate warming while greenhouse gas levels are reduced in the atmosphere.
3. Understand the benefits, risks and usefulness of purposefully using aerosols to reduce climate warming with different methods of marine cloud brightening.



The research that is being done here, on the flight deck, is to measure how small sea salt particles are mixed into the air and lifted up towards the clouds. We are doing this, and hoping to help answer those three questions above, with a new tool we have developed called the Cloud Aerosol Research Instrument, or CARI, that can create very small sea salt particles. Instruments along the flight deck are being used to measure the particles created by CARI as they travel through the air.



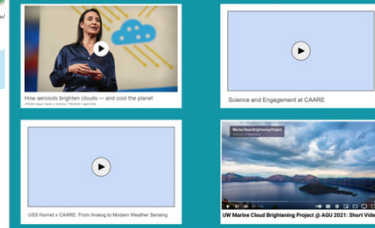
Engaging with Society



Onboard the USS Hornet Sea, Air and Space Museum, the Marine Cloud Brightening Program is conducting some of its most important research in a way that other scientists and the public (you!) can experience too. The site you are visiting is called the Coastal Atmospheric Aerosol Research and Engagement (CAARE) facility and is a place for scientists to do important scientific research and for visitors to learn and engage.

The Marine Cloud Brightening Program hopes that CAARE can play an important role in educating the public about cloud and aerosol science and the potential opportunities that clouds may offer to manage

CAARE Exhibit Theater



Educational Content

Learning about weather, engaging with research

Interactive Experiences

