

# Addressing Climate Change and Environmental Conservation

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Emerging Trends in Cloud Technology

September 2021



# Summary

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DEEP IN THE OCEAN  
TO THE SKIES



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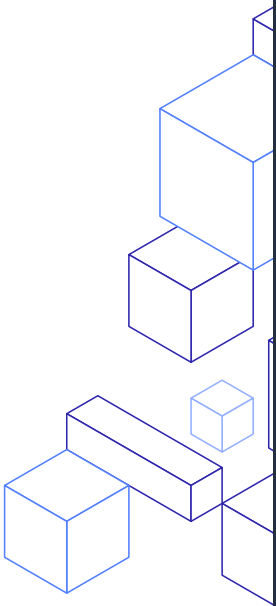
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# Introduction

## INTRODUCTION

### SIX TRENDS FROM DEEP IN THE OCEAN TO THE SKIES

## CONCLUSION

Climate change as an effect of greenhouse gas emissions is an emergency that affects all countries on all continents, disrupting national economies and affecting lives. People are experiencing the impacts of changing climate patterns, which are leading to rising sea levels, melting glaciers, and extreme weather events. Despite a temporary pause in the increase in emissions, due to the COVID-19 pandemic, they are expected to [return to highest levels](#) once people return to work, travel, and manufacturing.

To address climate change, countries adopted the [Paris Agreement](#) in 2015, in which 196 nations agreed to work to limit global temperature rise to well below 2 degrees Celsius above pre-industrial levels.

In all efforts to address climate change, it is essential to understand how changes in climate affect the planet, communities, and productive activities. Data is critical to measuring, modeling, and monitoring these changes. Governments, non-governmental organizations (NGOs), and businesses around the world worked to collect and generate datasets that support this goal. However, given the large size of most of this data and its complexity, only those with access to large compute storage and analytical capabilities can use those datasets. This limits the number of people, the diversity of thought and experience, and the experience at the table as we try to tackle this complex problem.

The [Amazon Sustainability Data Initiative \(ASDI\)](#) seeks to accelerate sustainability research and innovation by minimizing the cost and time required to acquire and analyze large sets of sustainability data. ASDI supports innovators and researchers with the data, tools, and technical expertise they need to drive sustainability and conservation initiatives.

From South America to Australia, ASDI is currently working with government and scientific organizations to identify, host, and deploy key datasets in the cloud, including weather observations, weather forecasts, climate projection data, satellite imagery, hydrological data, and air quality and ocean forecast data. These datasets are publicly available to anyone. Dataset categories in the ASDI catalog include weather, climate, water, agriculture, satellite imagery, altitude, air quality, energy, ecosystems, disaster response, and oceans. An example of a fundamental climate dataset is the [Global Daily Historical Climatology Network \(GHCN-D\)](#) from the [U.S. Office of National Oceanic and Atmospheric Administration \(NOAA\)](#), which contains daily measurements of precipitation, temperatures, and other weather conditions. This historical climatology is essential for analyzing trends in past meteorological conditions. Data from the Global Forecast System (GFS), NOAA's official weather forecasting system, is also available.



## INTRODUCTION



### SIX TRENDS FROM DEEP IN THE OCEAN TO THE SKIES

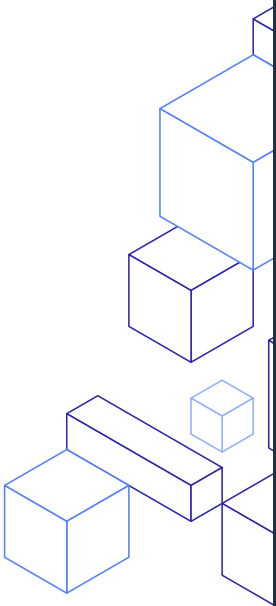


## CONCLUSION

Cloud-based technology is helping scientists and policymakers make better decisions to combat climate change and its derivative effects. For example, Dr. Werner Vogels, vice president and chief technology officer, Amazon, highlighted how agencies can model current second-by-second conditions against historic conflagrations—on the ground, rather than back in a central data center. By doing so, they might assess fire risk more accurately and better prevent and fight wildfires, such as the ones that consumed the Australian bush and the West Coast of the United States in 2020.

Here are six examples of how Amazon Web Services (AWS) customers are using cloud technology to address the derivative effects of climate change in the seas, forests, mountains, and cities.

1. Assessing the ocean's health by monitoring shark populations
2. Real-time monitoring of the melting of the Peruvian Andes glaciers
3. Digital Earth Africa: Enabling insights for better decision making
4. Helping to ensure a future for Tasmanian devils—in the cloud
5. Circumnavigating an ocean of data in remote Antarctica
6. Leveraging a dataset to foster climate innovation and study the impact of future climate conditions





# Six trends from deep in the ocean to the skies



## 1. Assessing the ocean's health by monitoring shark populations

“Two of the biggest problems preventing us from effectively managing the oceans are a deficit of essential data and time running out on fixing our oceans’ problems. We need to collect and process unprecedented datasets with a sense of urgency and efficiency to drive our oceans back to abundance.”

**Fernanda Ubatuba**

President and chief operating officer (COO) of OCEARCH

OCEARCH is a data-centric organization built to help scientists collect previously unattainable data about the ocean.

Ninety-five percent of the ocean remains unexplored, and the lack of data for those areas is detrimental to conservation efforts. The path to an abundant ocean requires uncovering the life history of our ocean's apex predators: the sharks. As balance keepers, sharks' lives, including their migratory and dietary habits, are key indicators of ocean health. However, the traditional methods to monitor sharks are expensive and inefficient, as they require catching, tagging, and tracking the sharks, which considerably limits the number of data points collected and their value.

OCEARCH enables large teams of collaborating scientists and experienced fishermen to collect critical data and makes these findings available to the public via open access. The organization collects satellite telemetry data on shark movements and then makes these data available via open source through [oearch.org](https://oearch.org) and the no-cost [OCEARCH Tracker App](#).

The data collected supports 180 scientists from 90 institutions worldwide who work to advance 23 distinct research projects. The collaborative environment provides access to





previously unattainable data about apex predators and helps determine overall ocean health, inform fisheries management for sustainability, and support public safety efforts.

In addition to supporting research, OCEARCH has a strong focus on building awareness and literacy in ocean conservation. Cloud computing enables the organization to store and share their data in a user-friendly format via the OCEARCH Tracker App, making the ocean data usable by ordinary people and students, as well as scientists. This democratizes access to ocean data and empowers people to work toward the goals of restoring the balance and abundance of the ocean.



The app allows millions of users to track sharks and other aquatic species in near-real time, learning alongside scientists as they conduct their research. To date, the OCEARCH Tracker has engaged with over 20 million unique users, bringing the ocean to everyone's day-to-day lives in a dynamic and engaging way.



## 2. Real-time monitoring of the melting of the Peruvian Andes glaciers

Peru contains about 68 percent of the Tropical glaciers mass, but in the last four decades it has lost a little over half of its glacier mass. The glacier inventory by the [Instituto Nacional de Investigación en Glaciares y Ecosistemas de Montaña or INAIGEM](#) reported this loss in 2018 caused by climate change-related temperature increases. Highly vulnerable human populations live in the Andean mountains, many of which face sudden floods from glacier avalanches and glacier lake outburst. In 1941, for example, a huge glacier lake outburst flood from Lake Palcacocha inundated the city of Huaraz, where close to 2,000 people died (Wegner, 2014). Similarly, a landslide from Mount Huascarán covered the city of Yungay resulting in over 20,000 people dead and only 400 survivors.



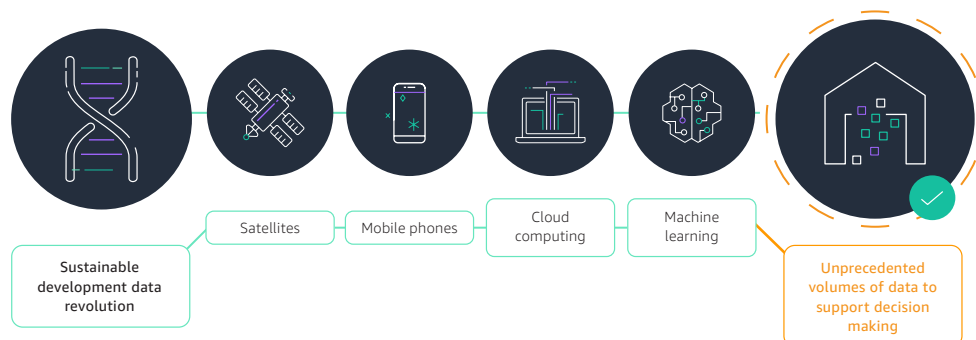
INAIGEM is a state-owned institute researching how to reduce the impact of future natural disasters, such as avalanches from glacier lakes across the Peruvian Andes. Their goal is to reduce the response time and provide advanced warning as soon as possible about future avalanches. In order to do so, INAIGEM implemented a real-time monitoring system of highly vulnerable glacier lakes.

They installed the first real-time monitoring system into the Palcacocha glacier lake cryospheric system in 2017. Palcacocha is a lake at 4,562 meters above sea level, formed by glacier retreat. This monitoring system uses a set of telecommunication antennas to transfer real-time data such as HD video of the lake, glaciers landscape, and climate data from an automatic weather station.

INAIGEM analyzes the recorded data using machine learning and artificial intelligence to generate avalanches detection tools. These tools optimize the early avalanche detection and use data such as speed, volume, mass, direction, and the impact over glacier lake to calculate the probability that the avalanche will generate big waves and flood that could produce damage to people living downhill. With early detection, they can help save more lives.



### 3. Digital Earth Africa: Enabling insights for better decision making



The sustainable development data revolution allows for the fusion of different technologies from satellites, mobile phones, cloud computing, and machine learning—making unprecedented volumes of data available to support decision making. Despite these advances, data availability, accessibility, quality, usability, disaggregation, timeliness, and capacity are still challenges for many countries. Several factors are helping unlock the vast potential for insights and information to address national development priorities. Operational satellites are providing routine global coverage; free and open data policies remove legal and cost barriers to data access; analysis ready data (ARD) is removing pre-processing burdens from users; computing and storage costs are decreasing; and cloud architectures are becoming more mainstream. In addition, the [Open Data Cube](#) (ODC) enables continental-scale analyses and web-service-driven visualizations over a complete time series of data.

[Digital Earth Africa](#) is enabling African nations to track changes across the continent in unprecedented detail by making Earth observation data more easily accessible. This will provide valuable insights for better decision making around prevention and planning in areas including flooding, droughts, soil and coastal erosion, agriculture, forest cover, land use and land cover change, water availability and quality, and changes to human settlements.

Digital Earth Africa is the technology enabler for global observations—helping data users across the continent gain fast access to petabytes of decision-ready satellite data. Users will be able to analyze critical data within minutes of it being available and use it to develop preventative and early warning systems to address sustainability challenges, such as land degradation over time, climate change patterns affecting agricultural production, and severe weather trends that lead to community displacement.

The project will leverage technology and services developed in Australia (implemented as Digital Earth Australia) and build upon the learnings from the Africa Regional Data Cube (ARDC). The ARDC, launched in May 2018, is a data management technology that builds capacity in African communities in support of their local and national needs framed around the United Nations Sustainable Development Goals (SDGs) and broader development priorities. The project focused on five different countries in Africa: Ghana, Kenya, Senegal, Sierra Leone, and Tanzania. It aimed to understand their data-related challenges and respond to these needs with improved access and use of geospatial data. Digital Earth Africa expands this approach and its goals to the entire African continent.





## 4. Helping to ensure a future for Tasmanian devils—in the cloud

Dr Carolyn Hogg has more than 25 years of experience in species conservation. She has worked on conservation projects for animals including koalas, humpback whales, and orange-bellied parrots, in places ranging from Australia to Hawaii and Alaska. As senior research manager for the Australasian Wildlife Genomics Group in the faculty of science at the University of Sydney, Carolyn's mission is to help protect rare species, often unique to the country.

**“Australia separated from the other continents more than 95 million years ago,” she explains. “More than 87 percent of our mammals, 93 percent of our reptiles, 94 percent of our frogs and 45 percent of our birds can only be found here in Australia. They are vital for biodiversity, and we have a responsibility to ensure their survival.”**

For the past decade Carolyn has been focusing on genomics research for the cross-governmental [Save the Tasmanian Devil Program \(STDP\)](#). The Tasmanian devil is a rare marsupial, found only on the island state of Tasmania. It is threatened not only due to manmade changes—from extreme climate events like the recent devastating bushfires, to habitat destruction, and vehicle collisions—but also by a contagious cancer that causes facial tumors and has reduced its population by more than 80 percent.

By using the genome of Tasmanian devils, Carolyn and her team can provide on-the-ground conservation managers with detailed scientific information and insights on how best to protect the species. Their work accelerated ever since using cloud computing at the University of Sydney in 2019, enabling them to speed up their research and also carefully, and more effectively, manage their funding.

Now, Carolyn's team is starting a new project to assemble and annotate the genomes of some of Australia's most threatened species. They will be sharing this genome data on the [AWS Public Dataset Program](#), an initiative designed to provide researchers anywhere in the world with fast, on-demand access to scientifically valuable, publicly available datasets, with the aim of accelerating scientific discovery.

By making the genomic data more easily available to researchers worldwide, they can help to intensify work to protect some of Earth's most endangered animals in Australia and beyond. “Australia has the worst mammal extinction rate in the world. We have lost more than 29 species over the past 200 years—that's 35 percent of all modern mammal extinctions,” says Carolyn. “The recent Australian bushfires have been catastrophic for our wildlife, pushing even more species to the brink of extinction.”



## 5. Circumnavigating an ocean of data in remote Antarctica

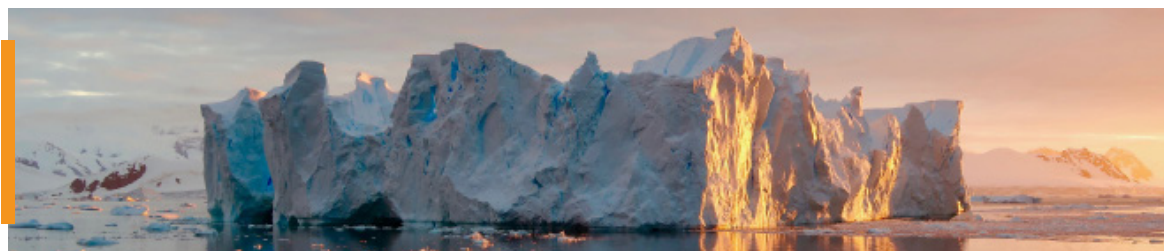
[Saildrone](#) builds and operates a fleet of unmanned surface vehicles (USVs) designed to collect high-resolution oceanographic and atmospheric data in remote oceans. Known as saildrones, each vehicle can stay at sea for up to 12 months, transmitting real-time data via satellite. The data collected informs climate models and extreme weather prediction, maritime domain awareness, maps and charts, and sustainable management of resources. Using clean, renewable wind and solar power, saildrones provide access to the world's oceans at a fraction of the cost of traditional ship-based methods while drastically reducing the carbon footprint of global ocean observation.

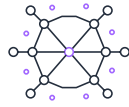
In 2019, Saildrone deployed a fleet of USVs on a mission to complete the first autonomous circumnavigation of Antarctica. The Southern Ocean is so inhospitable that even large ships avoid it in the winter. Nevertheless, eight months into its mission, the nimble and robust saildrone (SD 1020) returned safely home after surviving the Southern Ocean winter and streamed back vital new data from previously unsampled territory.

Saildrones carry a suite of [science-grade sensors](#) to collect meteorological and oceanographic data critical to understanding the changes taking place in the Antarctic ecosystem: air and sea temperature, wind speed and direction, barometric pressure, humidity, radiation, salinity, wave height and period, speed and direction of ocean currents, and air-sea carbon fluxes. This data provides the ground-based knowledge required to help scientists better understand and evaluate the models used to predict weather and climate but getting the data to scientists and researchers in a timely manner, especially from remote areas like the Southern Ocean, is a major data challenge.

SD 1020 spent nearly 200 days collecting some 20 variables at a one-second sample rate, generating an enormous amount of data. Downsampled data is available in real time to project collaborators, and researchers download the high-resolution raw data from the vehicle upon mission completion. Saildrone leverages cloud computing to both store and distribute real-time and high-resolution data.

Saildrone's open datasets, like that of the 2019 Antarctic Circumnavigation, are publicly available on the [Saildrone Data Portal](#). Members of the science community are invited to download the data, analyze it, and explore the capabilities of the Saildrone platform. Researchers can also use existing compute resources to access and analyze the data, without having to store their own copies.





## 6. Dataset to foster climate innovation and study the impact of future climate conditions



Through two cloud grants from the ASDI initiative to the [Earth System Grid Federation \(ESGF\)](#), cloud computing is enabling climate researchers worldwide to access and analyze the dataset used for the United Nation's Intergovernmental Panel on Climate Change's Sixth Assessment Report (IPCC-AR6). The report—scheduled to publish in May 2022—provides policymakers worldwide with the

latest assessment of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation.

The climate simulation dataset, also known as the [Coupled Model Intercomparison Project Phase 6 \(CMIP6\)](#) data archive aggregates the climate models created across approximately 30 working groups and 1,000 researchers working on IPCC-AR6. A portion of the CMIP6 data archive is now hosted in the first cloud-resident ESGF data node available to climate researchers. The initial subset of data represents CMIP6 model runs that climate scientists consider high value. By hosting the climate simulation dataset in the cloud, researchers can carry out their analysis in the cloud, eliminating the need for downloading and storing data replicas. Given the large size of these datasets, providing access to compute next to the data in the cloud helps democratize access and use of this data.

The ESGF data node allows users to search and discover the CMIP6 data right on the cloud, and to facilitate analysis of the data the ESGF team is making available sample Jupyter notebooks. A few groups have already benefited from this improved accessibility. Through this collaboration between ASDI and ESGF, CMIP6 data staged in the cloud is traceable to the reference ESGF datasets. In addition to supporting climate scientists, hosting the CMIP6 data is enabling a number of private sector companies to build products and services that help assess climate related risks and develop climate resilience.



# Conclusion

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Data provides policymakers, organizations, and companies worldwide the ability to prepare for climate change.

Climate data sourced from government agencies and academic institutions allows both public and private organizations to understand their exposure to climate hazards and to manage risk in their communities and take action to protect lives and the environment.

Global efforts to reduce greenhouse gas emissions and combat climate change must be accompanied by actions that provide a good understanding of the effects of the climate emergency. Around the world, monitoring of seas, forests, cities, changes in temperature, and melting of glaciers and polar caps is a priority, and initiatives that leverage cloud technology help gain understanding and information to change the course of the climate emergency.

