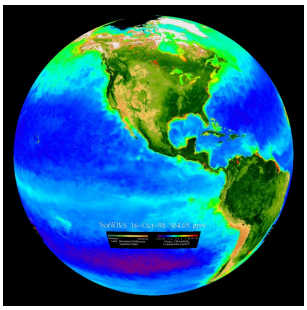
Science On a Sphere®
National Oceanic and Atmospheric Administration

# Biosphere SeaWIFS with Carbon Dioxide Levels (ppm)

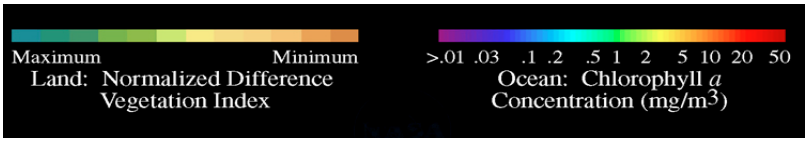
## Description



Media Preview

"The purpose of the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project is to provide quantitative data on global, ocean bio-optical, properties to the Earth science community. Subtle changes in ocean color signify various types and quantities of marine phytoplankton (microscopic marine plants), the knowledge of which has both scientific and practical applications." - **SeaWiFS website**. The SeaWiFS Project collects, processes, and distributes data received from an ocean color sensor orbiting the Earth on a satellite. The orbiting sensor can view every square kilometer of cloud-free ocean every 48 hours, providing global information on the oceans. The satellite observations can be used to derive the concentration of microscopic marine plants, phytoplankton, based on the color of the ocean. Greener water signifies an abundance of phytoplankton, while bluer water indicates less.

This is of interest to scientists because it is thought that marine plants remove carbon from the atmosphere, similar to plants on land. The ability to continuously monitor biological activity with SeaWiFS helps scientists to understand the role of the ocean in the global carbon cycle, as well as other interactions between the ocean and the atmosphere. The oceans are shaded based on the chlorophyll (green pigment in plants) concentration as indicated on the color bar below. The lands are shaded to depict the vegetation. Green areas have abundant vegetation, yellow areas have little vegetation, and brown areas have no vegetation. As an addition to this dataset, another version is available that has the Carbon Dioxide record from NOAA's Mauna Loa Observatory included in the images. A second version of SeaWiFS is also available with the land as a still image, showing only the changes in the ocean through the year.




## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**NASA Goddard Space Flight Center**

Dataset Developer
**NASA Goddard Space Flight Center**

Visualization Developer
**NASA Goddard Space Flight Center**

Contact

Directory
**FTP Link**

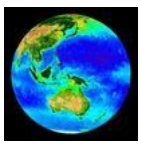
KML
**KML File**

Keywords
**Ocean, SeaWiFS, carbon, vegetation**

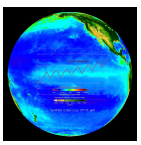
## Notable Features

- Shading on land depicts amount of vegetation
- Shading on ocean depicts concentration of chlorophyll

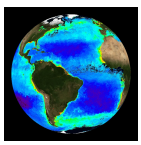
## Related Datasets



Biosphere SeaWIFS



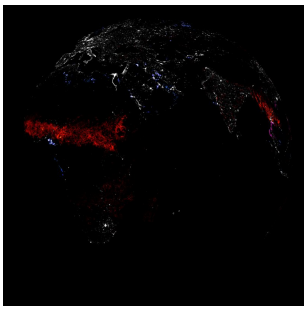
Biosphere with Carbon Dioxide concentration measured at Mauna Loa



SeaWIFS with Land Background

# Colored Night Lights

## Description



Media Preview

This visualization uses the same database as the nighttime side of the **Hot Topo** visualization. The data was recorded by the Defense Meteorological Satellite Program, DMSP, in the National Geophysical Data Center. The Earth Observation Group in the NGDC maintains the archived data, performs research on the data, and makes products utilizing the data available. The data was collected using polar orbiting satellites that provide full cover of the globe twice a day. The satellites have an Operation Linescan system which allows them to detect low levels of visible-near infrared radiance at night. With this data, it is possible to detect clouds illuminated by moonlight, lights from cities and towns, industrial sites, gas flares, fires, lightning, and aurora. The Nighttime Lights of the World data set was complied from DMSP data spanning October 1994 - March 1995.

This particular visualization shows only the lights generated from electricity. The oceans are shaded a very dark blue and the land is shaded a slightly lighter blue so that they can be distinguished. All of the lights are bright white. Areas of high economic prosperity and/or population are generally the areas that are well illuminated. Most of the coast lines are well highlighted, as it seems people like to live by the water. The Nile River in Africa it outlined by the lights that border it. In the United States, it is visible that the eastern half of the country is more densely populated than most other areas. Major highways can be identified by the lights along them.

Special colorized versions of these maps can also be used to detect power outages. This is done by comparing an annual composite image against data from one night. The lights in the composite image are shaded red, the visible data from the one night is shaded green and the thermal data from the one night is shaded blue. The result is clouds show up blue, lights that are on during both time periods show up yellow, lights that were on only on the single night show up green and lights that were on in the composite image, but not the one night show up red. Any widespread area that is red suggests a power outage. Two images from August 30, 2005, right after Hurricane Katrina hit, are available to display on the sphere as a picture in a picture. The first is a black and white image of the lights from August 30 and the second is the same image, but colorized to highlight the widespread power outages.

There are three additional variations of the nighttime lights map. The first dataset is the nighttime lights merged with the **Blue Marble** dataset. The new dataset shows the Earth with daytime and nighttime views of the Earth, to demonstrate how only half of the Earth is illumintated at one time. The second dataset is similar to the original nighttime lights dataset, but the lights have been colorized based on the light source. The white represents lights generated from electricity, the red shading shows fires, the pink shading indicates light from squid fishing boats, and the blue spots are gas flares from oil rigs. The third variation is two maps, one with electric lights from 1992, the second with electric lights from 2002. By comparing the two images, viewers can see areas of growth and decline.

There are also additional updates to this dataset. The first is a color composite of three years - 1992, 2000, 2008 - of DMSP nighttime lights. Each year has been assigned to one of the primary colors: 1992 = blue, 2000 = green, 2008 = red. The contrast has been enhanced to show all the detected lights, including the dim lighting often detected in populated rural areas. Locations that had bright lighting in all three years are white. There are many rural areas in India and elsewhere that have a bronze color, indicating that they had no detected lighting in 1992 and dim lighting detected in both 2000 and 2008. Notice the areas of blue lighting in several parts of the Former Soviet Union, the result of collapse and loss of lighting in the mid-1990's. The second is similar, but only compares two years - 1992 and 2009 - of DMSP nighttime lights. In this dataset, purple represents a decrease in light levels, white represents no change in light levels and yellow represents an increase in light levels. Both of these datasets are available with and without country borders. For more information about the comparision dataset, visit **here**.

## Notable Features

- Nile River outlined by lights
- Eastern U.S. highly populated
- Major highways outlined by lights

## Related Datasets

## Details

Category
**Land**

Audio
**No**

Dataset Source
**DMSP**

Dataset Developer
**NOAA NGDC Earth Observations Group**

Visualization Developer
**NOAA NGDC Earth Observations Group**

Contact
**Beth Russell**

Directory
**FTP Link**

Keywords
**Land, nighttime lights, DMSP, NGDC**

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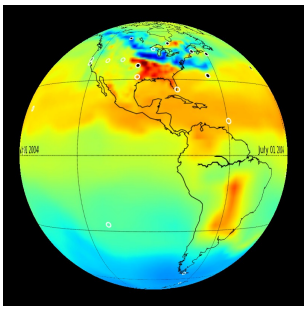
# CarbonTracker (2004 Carbon Plumes)

## Description



**Media Preview**

"NOAA encourages science that adds benefit to society and the environment. CarbonTracker does both." said retired Navy Vice Admiral Conrad Lautenbacher, Ph.D., undersecretary of commerce for oceans and atmosphere and NOAA administrator. CarbonTracker was developed in the Earth System Research Laboratory in the Carbon Cycle Greenhouse Gases group and is a system to keep track of carbon dioxide uptake and release at the Earth's surface over time. CarbonTracker as a scientific tool will, together with long-term monitoring of atmospheric CO2, help improve the understanding of how carbon uptake and release from land, ecosystems, and oceans are responding to a changing climate, increasing levels of atmospheric CO2 (the CO2 fertilization effect), and other environmental changes, including human management of land and oceans. **NOAA's CarbonTracker website**

This data set shows the distribution of carbon dioxide in the atmosphere for every day of the year 2004, allowing the large variations in CO2 from day-to-day (often called 'carbon weather') to be illustrated along with season-to-season changes. The data set also shows black and white dots at every location and time that NOAA ESRL and collaborators collect samples of air to analyze the contents for CO2 and multiple other gases. These are the locations for which we know the mixing ratios of CO2 exactly. The rest of the globe is filled in by a computer model driven by our best knowledge of the surface sources and sinks (fossil fuel and biomass burning emissions, biospheric and ocean uptake or release) of CO2 that are across the globe. The CO2 plumes can be seen moving across the globe, illustrating the importance of monitoring CO2 globally, not just locally. The large variations in CO2 concentration from season to season are due to the plant life. During the winter season, plants and trees respire CO2 as they shed leaves and stop growing or decay, adding much CO2 to the atmosphere. This process reverses during spring and summer, when they have plenty of access to sunlight and grow leaves and flowers, or increase their size substantially. This time of year is very well visible in the movie: in July the NH shows intense blue colors especially over the mid-latitude regions where forests and crops are soaking up CO2 in great amounts. The large change in CO2 between the seasons caused by plant activity is sometimes referred to as the 'breathing' of the planet. In the tropics, intense red areas are visible especially during July, August and September. This is due to the burning of biomass. Some of this is natural, such as dry grasses on the savannas burning, but most of it is man-made as people burn fields to prepare them for another year of production, or burn forests to make way for new agricultural lands.

## Notable Features

- Seasonal variations in the level of CO2 over land
- Intense concentration of CO2 in the tropics due to biomass burning
- High levels of CO2 emitted from cities (best visible in January)

## Related Datasets

(None)

## Details

Category
**Atmosphere**

Audio
**No**

Dataset Source
**NOAA/ESRL GMD Carbon Cycle Greenhouse Gases group**

Dataset Developer
**NOAA/ESRL GMD Carbon Cycle Greenhouse Gases group**

Visualization Developer
**Mike Biere, NOAA/GSD**

Contact
**Peter Wouters**

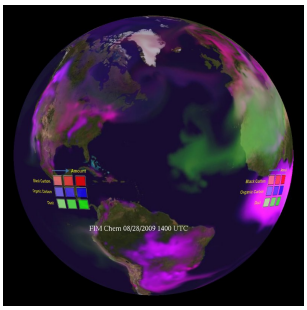
Directory
**FTP Link**

Keywords
**CarbonTracker, climate change, carbon dioxide**

Science On a Sphere®
National Oceanic and Atmospheric Administration

# FIM Chem Model - Three Aerosol Species

## Description



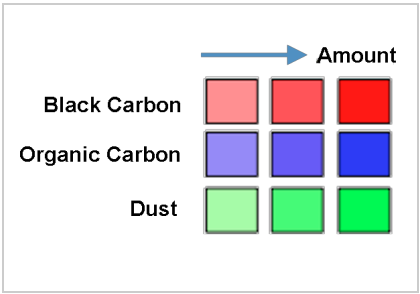

**Media Preview**

The Flow Following Finite Volume Icosahedral Model (FIM) was developed by NOAA to produce weather forecasts. In fact, weather forecasts from the FIM model are available for SOS **here**. Building upon the success of the FIM model, the FIM-Chem model was created. The FIM-Chem is the FIM model with chemistry and aerosol modules added. Aerosols are one of the biggest uncertainties in climate models due to their varied affects on radiation and cloud physics. The FIM-Chem allows researchers to forecast and study the behavior of aerosols in the atmosphere, leading to the potential for better Earth system modeling for climate prediction.

In this dataset, the FIM-Chem model is used to trace the presence of three aerosols from August 27, 2009 through September 7, 2009. Green shading is dust, red shading is black carbon aerosols and blue is organic carbon aerosols. When there are multiple aerosols present in one location, the color for the aerosols is combined. The two types of carbon often occur together, though in different proportions. Areas of anthropogenic emissions tend to have a redder color while areas of burning, such as wildfires, tend to have a more purplish-pink color because the ratio of organic carbons to black carbons varies for the two emissions sources. Wildfires have a high ratio of organic carbon to black carbon.

During the time period of this dataset there were wildfires in California, Alaska and British Columbia and biomass burning in Sub-Equatorial Africa and the Amazon region. The white shading is from the presence of all three aerosols. This can be seen in southern Europe where the anthropogenic emissions from Europe are mixing with the dry, dusty air in the Sahara.

Another **FIM Chem dataset** is available for SOS that shows the ash dispersion after the Iceland Volcano erupted in April 2010.




## Details

Category
**Atmosphere**

Audio
**No**

Dataset Source
**NOAA FIM-Chem Model**

Dataset Developer
**NOAA FIM-Chem Model**

Visualization Developer
**Steve Albers, NOAA/GSD**

Contact
**Georg Grell**

Directory
**FTP Link**

Keywords
**Atmosphere, aerosols, FIM, model, black carbon, organic carbon, dust**

## Notable Features

- Areas of anthropogenic emissions tend to have a redder color while areas of burning, such as wildfires, tend to have a more purplish-pink color
- Areas where all three aerosols are present have a white color.
- During the time period of this dataset there were wildfires in California, Alaska and British Columbia and biomass burning in Sub-Equatorial Africa and the Amazon region

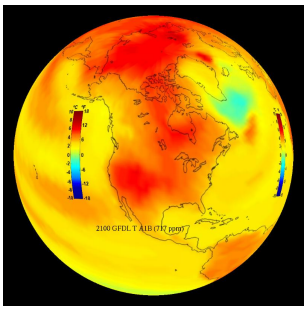
## Related Datasets

(None)

Science On a Sphere®
National Oceanic and Atmospheric Administration

# GFDL a1b Temp Change 1870-2100

## Description



Media Preview

"The Intergovernmental Panel on Climate Change (IPCC) was established by WMO and UNEP to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. It is open to all members of the UN and of WMO." - **from www.ipcc.ch** In an effort to better visualize the future of climate change, the IPCC releases assessment reports on the current state of the atmosphere and what the future could hold. Models from various atmospheric and oceanic organizations are included in these reports in order to establish a broad understanding of the science. Data from three of the IPCC models following temperature change from 1870 - 2100 have been formatted for Science On a Sphere®.

The models available on SOS are the **Climate Model 2.1, developed by the Geophysical Fluid Dynamics Laboratory;** the Community Climate System Model 3.0, developed by the National Center for Atmospheric Research; and the Hadley Centre HadCM3, developed by the United Kingdom Meteorology Office. All three models have similar forcing agents. For the past data they use the 20th Century Model 20C3M, which takes into account the historical record of greenhouse gases, sulfate aerosol concentrations, volcanic aerosol optical depths, and historical solar irradiation. For the future, there are two variations. Each model is available using the Special Report on Emissions Scenarios, SRES, A1B scenario, which assumes:

- Rapid economic growth
- A global population that reaches 9 billion in 2050 and then gradually declines.
- The quick spread of new and efficient technologies.
- A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide.
- A balanced emphasis on all energy sources

In addition, each model is also available using the more ecologically friendly SRES B1 scenario, which assumes:

- Rapid economic growth as in A1, but with rapid changes towards a service and information economy.
- Population rising to 9 billion in 2050 and then declining as in A1.
- Reductions in material intensity and the introduction of clean and resource efficient technologies.
- An emphasis on global solutions to economic, social and environmental stability.

Even though the all the models use the same inputs, the results vary because each of the three models have differing dynamics and physics parameterizations. In all of the models for the A1B scenario, CO2 production increases until it reaches 717ppm in the year 2100. For the B1 scenario, CO2 production increases until it reaches 621 ppm in the year 2100. The temperatures displayed in the datasets are all a comparison to temperatures in 2000. Blue tones on the visualization represent temperatures cooler than those in 2000, while red tones represent temperatures warmer than those in 2000.

In addition to the six model runs, there is a also a dataset has frames from the A1B and B1 scenario as modeled by GFDL for 2025, 2050, 2075, and 2100 in order to compare and contrast the differences between the two scenarios.

## Notable Features

| Model and Scenario | Global Mean Warming | North America Mean Warming |
|---|---|---|
| GFDL B1 | 2.7F (1.5C) | 4.32F (2.4C) |
| GFDL A1B | 5.22F (2.9C) | 8.82F (4.9C) |
| CCSM B1 | 2.52F (1.4C) | 3.24F (1.8C) |
| CCSM A1B | 4.86F (2.7C) | 7.56F (4.2C) |
| HAD B1 | 3.42F (1.9C) | 5.4F (3.0C) |
| HAD A1B | 6.66F (3.7C) | 10.26F (5.7C) |

*Note: Global Mean Warming and North America Mean Warming are the difference between decadal averages for 1990-2000 and 2090-2100.*

## Details

Category
**Models/Simulations**

Audio
**No**

Dataset Source
**Geophysical Fluid Dynamics Laboratory**

Dataset Developer
**Geophysical Fluid Dynamics Laboratory**

Visualization Developer
**Nikki Prive, NOAA/GSD**

Contact
**Dan Pisut, NOAA/NESDIS**

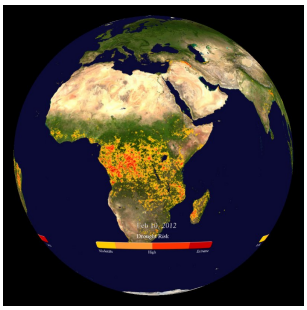
Directory
**FTP Link**

KML
**KML File**

Keywords
**Models and Simulations, CO2, global warming, temperature, GFDL, NCAR, UKMET**

# Real-time: Drought Risk

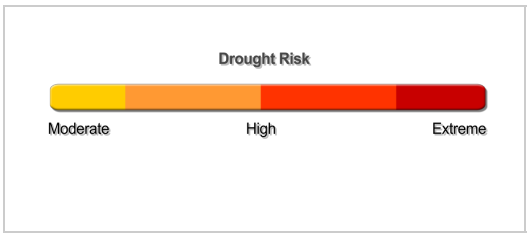
## Description



Media Preview

Satellites can detect the difference between rock, grassland, and forests because these surfaces emit energy differently back into space. By measuring these differences and observing the patterns of vegetation --or its lack of growth--NOAA scientists can monitor how droughts are changing across the world through time.

This global drought risk composite is derived from the Normalized Difference Vegetation Index datasets developed by NOAA from measurements of the AVHRR sensor onboard the POES satellite. By monitoring vegetation health, moisture and thermal conditions, scientists are able to identify areas that are considered to be vegetatively stressed due to drought. An important note is that the drought imagery is based solely on the analysis of vegetation health and stress, not soil moisture conditions. But this index serves as a reliable proxy measurement for drought worldwide. Areas of desert and snow cover are not included in the analysis. Yellow areas indicate areas under moderate drought conditions; red indicates areas experiencing extreme drought conditions. A number of other datasets are also being derived from NDVI, including risk indexes for wildfires and malaria. This dataset is updated weekly.




## Details

Category
**Land**

Audio
**No**

Dataset Source
**NOAA**

Dataset Developer
**NOAA Visualization Lab**

Visualization Developer
**NOAA Visualization Lab**

Contact
**NOAA Visualization Lab**

Directory
**FTP Link**

Keywords
**Land, drought, seasons**

## Notable Features

- Location and intensity of drought changes with the seasons
- Drought Risk is updated weekly

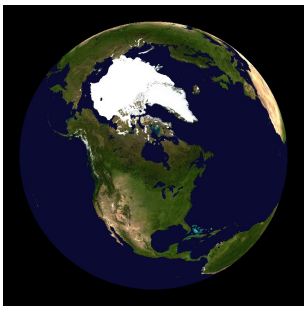
## Related Datasets

(None)

Science On a Sphere®
National Oceanic and Atmospheric Administration

# September Sea Ice Levels from 1987 - 2010

## Description



Media Preview

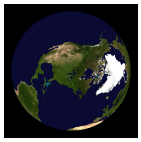
Sea ice is simply ocean water that has frozen. At least 15% of the ocean is covered by sea ice some part of the year. This means that on average, sea ice covers almost 10 million square miles (about 25 million square kilometers) of the Earth. Sea ice concentrations are monitored closely by scientists because changing sea ice concentrations can have a huge impact on the rest of the globe. Global warming is amplified in polar regions. Because of this, monitoring changes in sea ice can be a good indicator of climate change. The National Snow and Ice Data Center monitors sea ice concentrations using a satellite data record that begins in 1978. The Special Sensor Microwave/Imager (SSM/I) is the current monitoring instrument. The sea ice concentration dataset is on a 25km cell size grid covering both Arctic and Antarctic polar regions.

There are three different sea ice concentration datasets available for Science On a Sphere. The first is sea ice concentration every ten days from 1987 - 2010. Sea ice concentration for every six days is available from 2005 - 2007. These datasets show the growth and decay of sea ice concentration throughout the year. In the Arctic, the maximum coverage occurs in March and the minimum coverage occurs in September usually. The opposite is true for Antarctic, where the minimum occurs in March and the maximum occurs in September. An interesting point to note in the long dataset is that the extent of sea ice in the Arctic is shrinking, while the Antarctic sea ice is not trending downward. The third dataset shows only Septembers from 1987 - 2010. September was chosen to highlight the change in the Arctic minimum sea ice concentration through time. The decrease in sea ice coverage is apparent in this dataset.

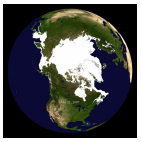
## Notable Features

- Seasonal change of sea ice
- Shrinking of Artic sea ice concentration, especially in summers
- The disappearancee of the Odden, a thumb-shaped sea ice feature east of Greenland, which often is visible prior to the late 1990's
- The minimum sea ice concentration in 2007 shattered the previous minimum sea ice record set in 2005 by 23% and contained 39% less ice than the 1979 to 2000 average.

## Related Datasets



Weekly Sea Ice July 2005 - August 2007 (over EV)



Weekly Sea Ice from 1987 - 2009 (every 10 days)

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**National Snow and Ice Data Center**

Dataset Developer
**Florence Fetterer, Matt Savoie; NSIDC**

Visualization Developer
**Mike Biere, NOAA/GSD**

Contact
**Florence Fetterer, Matt Savoie**

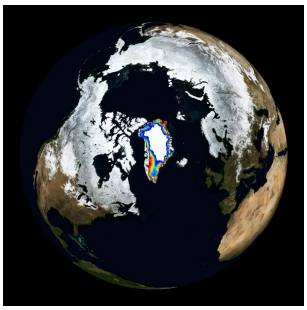
Directory
**FTP Link**

Keywords
**Ocean, sea ice concentration, climate change**

Science On a Sphere®
National Oceanic and Atmospheric Administration

# Greenland Melting Trends

## Description



Media Preview

Changes in the climate around Greenland can have a world-wide effect. According to Dr. Konrad Steffen, professor of geography at the University of Colorado and director of the NOAA joint institute CIRES, "For every degree (F) increase in the mean annual temperature near Greenland, the rate of sea level rise increases by about 10 percent." As Greenland warms, the ice that covers it melts and flows into the oceans. In order to study melting trends on Greenland, researchers at NASA developed a "melt index" which is the number of days that melting occurred multiplied by the melting area. There is a steady increase in the melt index from 1988 through present. In fact, in 2006 Greenland experienced more days of melting snow and at higher altitudes than the average over the past 18 years that have been studied. **See full story**

Scientists are tracking these trends because it will help them understand how fast the ice is melting, the speed of glacier flow, how much melt water is entering the ocean, and how the Earth's energy budget is changing. Melting ice can have a large impact on the amount of radiation that is either absorbed or reflected back to space. Because ice and snow are white, they generally do a good job of reflecting sunlight and radiation back to space. However, there is a difference between dry snow and wet, melting snow. Dry snow reflects 85% of sunlight back to space, while wet snow and even refrozen snow only reflect 50-60% of sunlight back to space. This means that as the area of wet or refrozen snow increases, the amount of sunlight being absorbed is also increasing. The color scheme is this dataset represents the number of melting days. Blue is 10 melting days and red is 60 or more melting days. This visualization starts in 1989 and goes through 2006.

## Notable Features

- Blue = 10 melting days, red = 60 melting days
- 2006 has the most melting days and at the highest latitudes

## Related Datasets

(None)

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**NASA Goddard Space Flight Center**

Dataset Developer
**NASA Goddard Space Flight Center**

Visualization Developer
**NASA Goddard Space Flight Center**

Contact
**NASA Goddard Space Flight Center**

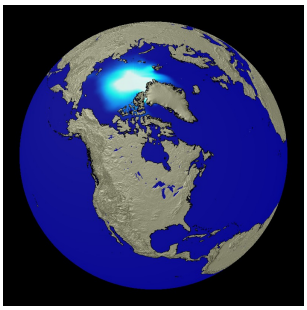
Directory
**FTP Link**

Keywords
**Oceans, sea ice, Greenland, sea level, climate change**

Science On a Sphere®
National Oceanic and Atmospheric Administration

# GFDL Sea Ice Model 1861 - 2100

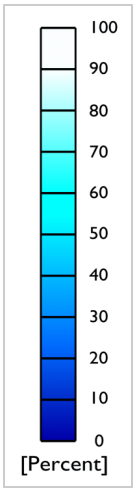
## Description



Media Preview

In the coming decades, the Arctic region is projected to warm at about twice the rate of the global average according to the scientists at NOAA's Geophysical Fluid Dynamics Laboratory. This is not good news for the Arctic sea ice. In fact, the concentration of sea ice in the northern latitudes has been decreasing over the past 30 years and this trend is expected to continue as the climate changes. The disappearance of sea ice can have a major impact globally. Melting sea ice can disturb the global ocean conveyor belt, impact sea life and the fishing industry, and change the Earth energy budget. Sea ice cools the climate because it is reflective and so returns much of the sun's warming back to space. As the ice melts, more of this energy is absorbed in the darker ocean water. The temperature increases as more sunlight is absorbed rather than reflected. This is a positive feedback loop because as temperature rises, more sea ice melts causing increased absorption which leads to rising temperatures.

In order to better understand how the climate is changing and the extent of the impact on the Arctic sea ice, scientists create models designed to simulate what has happened and what is likely to happen in the future. The model output for this dataset comes from GFDL's CM2.1 coupled model. The simulation of past years takes into account the historical record of greenhouse gases, volcanic aerosols, black and organic carbon aerosols, sulfate aerosols, ozone, solar irradiance, and land surface changes. For the future, they use the SRES A1B scenario from the Intergovernmental Panel on Climate Change, which assumes a mid-level increase in 21st century greenhouse gas levels. This simulation shows the change in the average sea ice concentration for August, September, and October. The sea ice in the Arctic is at a minimum during these months. Rather than steadily decline, the sea ice is projected to go through periods of small and large changes. In fact, it is thought that the melting of the sea ice could accelerate through the 21st century, with very little summer sea ice remaining by the year 2100.




For more information go to the **GFDL Research Highlight**

## Details

Category
**Models/Simulations**

Audio
**No**

Dataset Source
**NOAA Geophysical Fluid Dynamics Laboratory**

Dataset Developer
**Michael Winton, Keith Dixon, Remik Ziemlinski, NOAA GFDL**

Visualization Developer
**Remik Ziemlinski, Michael Winton, Keith Dixon, NOAA GFDL**

Contact
**Nikki Prive, NOAA/GSD**

Directory
**FTP Link**

Keywords
**Models and Simulations, CO2, sea ice, climate change GFDL**

## Notable Features

- The loss of sea ice concentration is greatest through the 21st century
- The decline is not steady, but goes through periods of small and large changes
- Bright white = 100% ice, dark blue = 0% ice

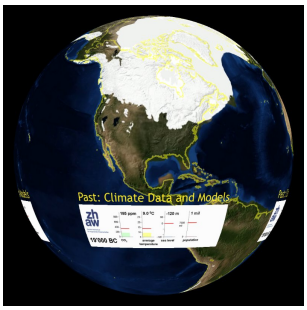
## Related Datasets

(None)

Science On a Sphere®
National Oceanic and Atmospheric Administration

# Blue Marble 19,000BC to 10,000AD

## Description




Media Preview

The Earth has been through many changes and continues to change today. To better understand these changes, the Zürich University of Applied Sciences created a **simulation** using past climate data, observations, and computer models. The simulation starts 21,000 years ago and ends 8,000 years in the future, showing the changes in ice concentration, sea level, and vegetation. 19,000BC was chosen as the start date because this was the last glacial maximum, when the Earth's ice sheets were at their maximum extension. As seen in the animation, much of northern Europe and North America were covered in ice in 19,000BC. The labels for the animation include information about carbon dioxide concentration, average temperature, sea level and population. The red line indicates the current levels. The yellow borders on the map represent the current coastlines. The data from 19,000BC to 2,000AD includes the most up-to-date paleoclimate data that is available. A list of sources can be found **here**. Some notable events in the past simulation include:

- The North Sea quickly forms around 8,000BC, creating the British Isles
- "Mega-Lake Chad" forms in the present-day Saraha Desert and is surrounded by lush landscapes around 7,000BC
- The ice pulls back and North America and Europe are largely ice free, starting in 6,500BC
- The lush vegetation across Northern Africa and the Arabian peninsula retreats in 2,000BC

For the time frame from 2,000AD to 3,000AD, a computer model based on the IPCC A2 scenario was used. This scenario assumes a complete cessation of carbon dioxide emissions in 2100. More details on the model used can be found **here**. In this part of the simulation the time steps change from a frame every 500 years as used in the first part of the animation, to a frame every 50 years to show the rapid changes that are modeled. The northern ice cap quickly disappears and the ice on Greenland and Antarctica begins to melt steadily. By the year 3,000AD, there is predicted 6m (19ft) sea level rise. The simulation continues from 3,000AD to 10,000 AD in 500 year time steps in a fictional scenario of worldwide glacier meltdown and shows the impacts this would have on the coasts.

The Zurich University of Applied Sciences has also made this animation available for Google Earth:

- **Blue Marble 19,000BC to 3,000AD for Google Earth**
- **Blue Marble 3,000AD to 10,000AD for Google Earth**

## Notable Features

- 19,000BC – 2,000AD simulated from Paleo-climate data
  - 500 year time steps
- 2,000AD – 3,000AD modeled from IPCC A2 scenario
  - 50 year time steps
- 3,000AD – 10,000AD created from a fictional scenario of worldwide glacier meltdown
  - 500 year time steps

## Related Datasets

(None)

## Details

Category
**Models/Simulations**

Audio
**No**

Dataset Source
**Zurich University of Applied Science**

Dataset Developer
**Adrian Meyer, Karl Rege - Institute of Applied Information Technology, Zurich University of Applied Science**

Visualization Developer
**Adrian Meyer, Karl Rege - Institute of Applied Information Technology, Zurich University of Applied Science**

Contact
**info.init@zhaw.ch**

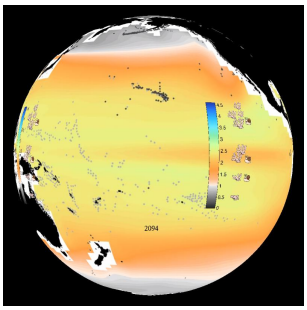
Directory
**FTP Link**

Keywords
**Models and Simulations, climate change, snow and ice cover, sea level rise, vegetation**

Science On a Sphere®
National Oceanic and Atmospheric Administration

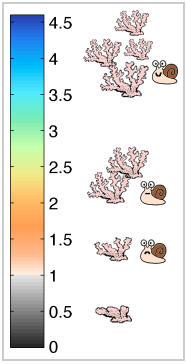
# Ocean Acidification Saturation State

## Description



Media Preview

Ocean acidification is a consequence of humankind's release of carbon dioxide emissions to the atmosphere. Excess carbon dioxide enters the ocean, reacts with water, decreases ocean pH (i.e., makes seawater less basic), and lowers carbonate ion concentrations. Organisms such as corals, clams, and some plankton use carbonate ions to create their shells and skeletons. Decreases in carbonate ion concentration will make it difficult for these creatures to form hard structures. Ocean acidification may cause some organisms to die, reproduce less successfully, or leave an area. Other organisms such as seagrass and some plankton species may do better in oceans affected by ocean acidification. Ocean ecosystem diversity and ecosystem services may therefore change dramatically from ocean acidification.

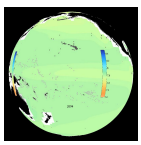



These datasets shows computer model simulations of surface ocean pH and aragonite saturation state from 1895-2094, with continents and coral reefs marked. (aragonite saturation state, sometimes called ?ar, is commonly used to track ocean acidification because it is a function of carbonate ion concentration.) These datasets show surface ocean pH and aragonite saturation state changes over time. Aragonite is one of the more soluble forms of calcium carbonate but it is widely used by marine calcifiers. Each successive frame shows, in 6-month increments beginning with January 1885 and ending with July 2094, the low-pass filtered monthly mean ?ar or pH of the surface ocean as modeled by the Community Climate System Model 3.1 (CCSM3.1 Doney SC et al. 2009. Skill metrics for confronting global upper ocean ecosystem-biogeochemistry models against field and remote sensing data. JOURNAL OF MARINE SYSTEMS 76(1-2): 95-112). The model simulation is driven with atmospheric emissions based on records of atmospheric carbon dioxide levels, for past dates, and the A2 IPCC SRES scenario for future dates (approx. 850 ppm atmospheric CO2 by 2100). Low-pass filtration removes seasonality and interannual variability with a period of less than 10 years. White indicates no data. A **plain-language script for docents** is included to help them introduce visitors to ocean acidification and to these particular data.

## Notable Features

- Dark gray dots show cold-water coral reefs, medium gray dots show warm-water coral reefs
- The Saturation legend shows how decreasing saturation will affect sea life

## Related Datasets



Ocean Acidification pH

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**Based on Feely et al. (2009)**

Dataset Developer
**Sarah R. Cooley, Woods Hole Oceanographic Institution**

Visualization Developer
**Sarah R. Cooley, Woods Hole Oceanographic Institution**

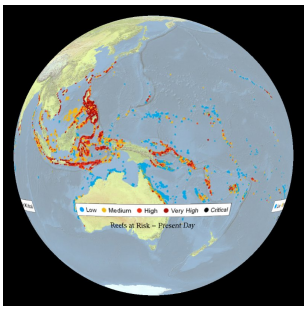
Contact
**Richard A. Feely**

Directory
**FTP Link**

Keywords
**Ocean, acidification, coral, climate change**

# Reefs at Risk

## Description




Media Preview

From tourism to disease prevention, it's clear that reefs offer much more than recreation. According to the newly released **Reefs at Risk Revisited** report, coral reefs:

- Support more than 275 million people worldwide.
- Protect coastlines in more than 100 countries - helping defend against storms and erosion.
- Accounts for 15% of gross domestic product in more than 20 countries.
- Hold the potential to fight disease - including treatments for cancer, HIV, malaria, and other diseases.

Yet coral reefs today face serious threats. The new report finds that approximately 75% of world's coral reefs are currently threatened by local and global pressures. Local pressures pose the most immediate threat - especially from overfishing and destructive fishing, which is particularly widespread in Southeast Asia. Global threats from climate change and alterations in ocean chemistry (i.e. ocean acidification) are compounding the pressures on reefs. Climate change is causing ocean temperatures to rise, which, in turn, is leading to wide-spread coral bleaching.

This dataset for SOS looks at the present state of coral reefs and then into the future. The present image shows the threat category for coral reefs due to local activities such as overfishing and destructive fishing, marine-based pollution, coastal development, and watershed-based pollution. The projected images in 2030 and 2050 show local threats combined with projections of thermal stress and ocean acidification using a "business as usual" greenhouse gas emissions scenario. According to the report, left unchecked, combined local and global pressures will push 90 percent of coral reefs to threatened status (all non-blue colors) in less than 20 years (by 2030) and nearly all reefs will be threatened by 2050.

**Image Details**

Reefs are assigned their threat category from the integrated local threat index as a starting point. Threat is raised one level if reefs are at high threat from either thermal stress or ocean acidification, or if they are at medium threat for both. If reefs are at high threat for both thermal stress and acidification, the threat classification is increased by two levels. The analysis assumes no increase in future local pressure on reefs, and no reduction in local threats due to improvements in management.

Low Medium High Very High Critical

## Notable Features

- At present, local human activities, coupled with past thermal stress, threaten an estimated 75 percent of the world's reefs.
- By 2030, estimates predict more than 90% of the world's reefs will be threatened by local human activities, warming, and acidification, with nearly 60% facing high, very high, or critical threat levels.
- By 2050, estimates predict nearly all of the reefs will be threatened, with 75% facing high, very high, or critical threat levels.

## Related Datasets

(None)

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**World Resources Institute**

Dataset Developer
**World Resources Institute**

Visualization Developer
**NOAA Pacific Services Center**

Contact
**NOAA Pacific Services Center**

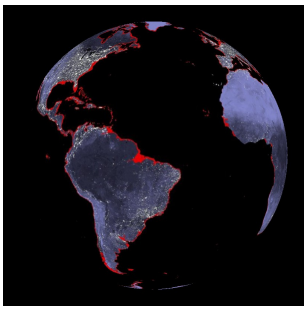
Directory
**FTP Link**

Keywords
**Ocean, coral reefs, climate change, fisheries, water**

Science On a Sphere®
National Oceanic and Atmospheric Administration

# Impact of 6 meter Sea Level Rise (red)

## Description



Media Preview

There are many questions surrounding climate change. One big question is how the changing climate will affect the oceans. The sea level has been steadily rising since 1900 at a rate of 1 to 2.5 millimeters per year. In fact, since 1992 new methods of satellite altimetry using the TOPEX/Poseidon satellite indicate a rate of rise of 3 millimeters per year. The Fourth Assessment Report from the IPCC states that "there is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate, after a period of little change between AD 0 and AD 1900. Sea level is projected to rise at an even greater rate in this century. " - **Fourth Assessment Report on Sea Level Rise** Sea level can rise by two different mechanisms with respect to climate change. The first is the expansion of the sea water as the oceans warm due to an increasing global temperature. The second mechanism is the melting of ice over land, which then adds water to the ocean. The IPCC Fourth Assessment Report predicts that total global-average sea level rise from 1990 - 2100 will be 7 - 15 inches for low emission scenarios and 10 - 23 inches for high emission scenarios.

There are two Science On a Sphere datasets that demonstrate rising sea levels and show the changes in the Earth's appearance as the sea levels rise. The first dataset starts with sea level 150 meters below its present level. The areas that appear white are land that would be uncovered if the sea level was below the current level. The animation proceeds in 10 meter increments, increasing up to 80 meters above the current sea level. Current land masses that would be covered by the rising sea level are shaded black. The National Snow and Ice Data Center predicts that if both Antarctica and Greenland, the world's largest ice sheets, both melted completely, the sea level would rise more than 70 meters. The second dataset shows the sea level rising meter by meter from current sea level up to 6 meters above sea level. The land that would be covered by water is shaded red to show the drastic decrease in land as the waters rise. The same dataset is also available with black shading for land covered by water.

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**John C. Kostelnick, College of Mathematics and Natural Sciences, Haskell Indian Nations University**

Dataset Developer
**John C. Kostelnick, College of Mathematics and Natural Sciences, Haskell Indian Nations University**

Visualization Developer
**NASA Goddard Space Flight Center**

Contact
**NASA Goddard Space Flight Center**

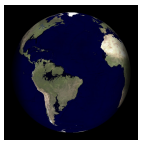
Directory
**FTP Link**

Keywords
**Ocean, sea level, climate change**

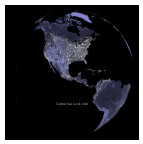
## Notable Features

- Shading in either red or black represents land that would be covered by rising sea levels
- Much of the eastern United States disappears when levels rise above current level

## Related Datasets



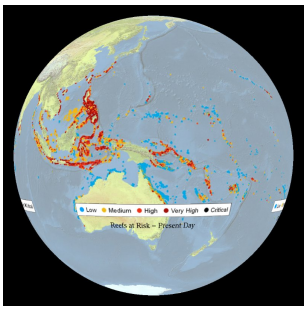
**Sea level Changing in every 10 meters from SMM**



**Impact of 6 meter Sea Level Rise (black)**

# Reefs at Risk

## Description




Media Preview

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Yet coral reefs today face serious threats. The new report finds that approximately 75% of world's coral reefs are currently threatened by local and global pressures. Local pressures pose the most immediate threat - especially from overfishing and destructive fishing, which is particularly widespread in Southeast Asia. Global threats from climate change and alterations in ocean chemistry (i.e. ocean acidification) are compounding the pressures on reefs. Climate change is causing ocean temperatures to rise, which, in turn, is leading to wide-spread coral bleaching.

This dataset for SOS looks at the present state of coral reefs and then into the future. The present image shows the threat category for coral reefs due to local activities such as overfishing and destructive fishing, marine-based pollution, coastal development, and watershed-based pollution. The projected images in 2030 and 2050 show local threats combined with projections of thermal stress and ocean acidification using a "business as usual" greenhouse gas emissions scenario. According to the report, left unchecked, combined local and global pressures will push 90 percent of coral reefs to threatened status (all non-blue colors) in less than 20 years (by 2030) and nearly all reefs will be threatened by 2050.

**Image Details**

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Low Medium High Very High Critical

## Notable Features

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- By 2030, estimates predict more than 90% of the world's reefs will be threatened by local human activities, warming, and acidification, with nearly 60% facing high, very high, or critical threat levels.
- By 2050, estimates predict nearly all of the reefs will be threatened, with 75% facing high, very high, or critical threat levels.

## Related Datasets

(None)

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**World Resources Institute**

Dataset Developer
**World Resources Institute**

Visualization Developer
**NOAA Pacific Services Center**

Contact
**NOAA Pacific Services Center**

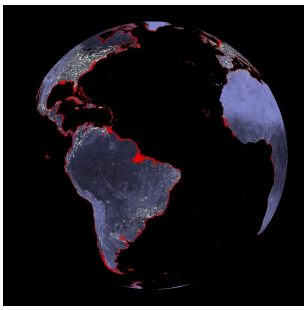
Directory
**FTP Link**

Keywords
**Ocean, coral reefs, climate change, fisheries, water**

Science On a Sphere®
National Oceanic and Atmospheric Administration

# Impact of 6 meter Sea Level Rise (red)

## Description



Media Preview

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There are two Science On a Sphere datasets that demonstrate rising sea levels and show the changes in the Earth's appearance as the sea levels rise. The first dataset starts with sea level 150 meters below its present level. The areas that appear white are land that would be uncovered if the sea level was below the current level. The animation proceeds in 10 meter increments, increasing up to 80 meters above the current sea level. Current land masses that would be covered by the rising sea level are shaded black. The National Snow and Ice Data Center predicts that if both Antarctica and Greenland, the world's largest ice sheets, both melted completely, the sea level would rise more than 70 meters. The second dataset shows the sea level rising meter by meter from current sea level up to 6 meters above sea level. The land that would be covered by water is shaded red to show the drastic decrease in land as the waters rise. The same dataset is also available with black shading for land covered by water.

## Details

Category
**Ocean**

Audio
**No**

Dataset Source
**John C. Kostelnick, College of Mathematics and Natural Sciences, Haskell Indian Nations University**

Dataset Developer
**John C. Kostelnick, College of Mathematics and Natural Sciences, Haskell Indian Nations University**

Visualization Developer
**NASA Goddard Space Flight Center**

Contact
**NASA Goddard Space Flight Center**

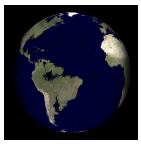
Directory
**FTP Link**

Keywords
**Ocean, sea level, climate change**

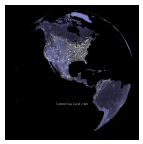
## Notable Features

- Shading in either red or black represents land that would be covered by rising sea levels
- Much of the eastern United States disappears when levels rise above current level

## Related Datasets



**Sea level Changing in every 10 meters from SMM**



**Impact of 6 meter Sea Level Rise (black)**