CLIMATE CHANGE RESEARCH AT THE SMITHSONIAN: SOME EXAMPLES

LAND

Smithsonian Tropical Research Institute: Forest Global Earth Observatories (ForestGEO)

The Forest Global Earth Observatories, headed by Stuart Davies, gather climate data at more than 50 forest plots worldwide in addition to conducting censuses of plants and animals, providing an unprecedented global network of long-term climate observations. Scientists analyze this extensive, high-resolution data set using statistical analyses and computer simulations to provide valuable climate predictions.
http://www.forestgeo.si.edu/group/Ecosystems+and+Climate

Smithsonian Environmental Research Center: BiodiversiTREE Program

The BiodiversiTREE project, led by John Parker, examines multiple environmental factors—including carbon dioxide flow—in large-scale forest plots, adding to our understanding of greenhouse gases on a regional scale and their effects on the changing climate. The project also helps us decipher how forests and their composition affect climatic variables like carbon storage.
http://www.serc.si.edu/about/biodiversitree.aspx

National Museum of Natural History: Climate and Floral Change at the Paleocene-Eocene Thermal Maximum (PETM)

Scott Wing uses fossil plants to examine ecosystem responses during a period of intense warming 55.8 million years ago, associated with a release of carbon dioxide equivalent to burning all remaining fossil fuels on the Earth today. The PETM is widely recognized by scientists as the best geological analog for human-induced climate change and had huge and lasting effects on terrestrial and marine ecosystems.
http://www.mnh.si.edu/ete/ETE_People_Wing_ResearchThemes_Wyoming.html

Smithsonian Conservation Biology Institute: Climate Change and Migratory Birds

Peter Marra and his colleagues at the Smithsonian Migratory Bird Center study the influences and seasonal interactions of long-distance migratory birds to determine the effects of climate change on these animals. This area has also been a blind spot in models of how the environment will respond to climate disturbances, and newly available data on many different species can inform both conservation and efforts to understand the effects of climate change on Northern Hemisphere ecosystems.
http://www.nature.com/nclimate/journal/v3/n2/full/nclimate1810.html

National Museum of Natural History: Arctic Cultures and Climate Change

Igor Krupnik is working with indigenous people of Alaska and the Bering Strait region to document their cultural knowledge and modern observations of the rapidly changing Arctic environment. Indigenous cultures have detailed and long-standing knowledge of sea ice, weather and climate, and general environmental change. Documenting that information is vital both for those cultures and for a general understanding of the changes currently affecting all aspects of human life in the north.
http://forces.si.edu/arctic/

National Air and Space Museum: Landscape Evolution in North African Deserts

Egypt's sandy southern desert used to be a much wetter and more habitable place. Ted Maxwell and his colleagues are examining that region's changing landscape to better understand the effects of climate change on the Earth's surface—for example, how and when sand dunes form. This information can be applied to research on other, more arid planets in our solar system, and it will also enhance our understanding of the causes and effects of desertification.
http://airandspace.si.edu/staff/ted-maxwell

National Museum of Natural History: Environmental Change: The Driver of Human Evolution

According to anthropologist Rick Potts, evidence of dramatic climate variability over the past 6 million years shows that a need to adapt to environmental change influenced the development of humanity's defining characteristics—such as using tools and walking on two legs. Humans' ability to adapt will continue to be tested as societies face unprecedented change in Earth's environment. Knowledge about climate change and its influence on evolution gives us a new perspective on how our species might adjust in the future.
http://humanorigins.si.edu/research/climate-research/effects

**National Air and Space Museum:** Urban Forest Dynamics

Using satellite data, Andrew Johnson investigates changes in urban vegetation cover and geographic patterns of urban land use over decades, leading to reliable measurements of changes in urban tree cover in the District of Columbia. This research provides new perspectives for management of urban resources and for understanding the role of human settlements in ecosystem processes—including how urban sprawl and land use can contribute to or help slow global climate change.
http://airandspace.si.edu/staff/andrew-johnston

National Museum of Natural History: Rapid Global Warming During the Carboniferous Ice Age and Its Effects on Tropical Vegetation

About 300 million years ago, Earth's climate cycles gradually became warmer and drier, culminating in the melting of nearly all the world's glaciers. William DiMichele's research shows that as a result, tropical vegetation experienced widespread extinction and wetlands a large-scale change in structure. Although climate shifts were gradual, the turnover in vegetation happened rapidly, indicating that ecosystems may change all at once when the climate reaches a tipping point.
http://paleobiology.si.edu/staff/individuals/dimichele.cfm

After Gordon et al., 2008
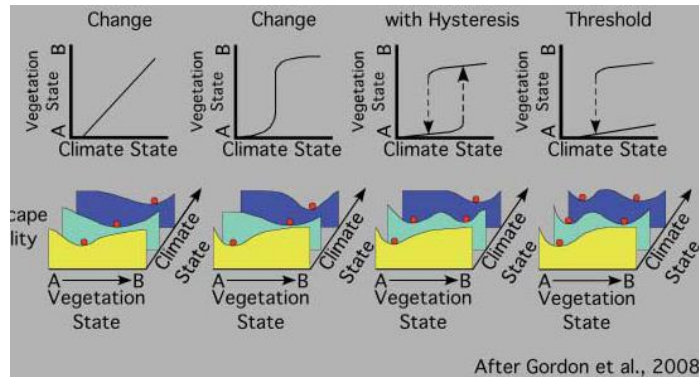
National Museum of Natural History: The Role of Oxygen and Carbon Dioxide in Deep-Time Insect Herbivory

A multi-institutional team led by Conrad Labandeira used insect damage in leaf fossils to demonstrate that climate change affected the amount of feeding on plants by insects (herbivory) during the Paleocene-Eocene Thermal Maximum (PETM)—a period 55.8 million years ago when global temperatures and atmospheric CO_2 levels rose significantly. This suggests that current warming that is influenced or caused by humans may also lead to a long-term increase in insect herbivory, a finding that has major implications for agriculture.
http://paleobiology.si.edu/staff/individuals/labandeira.cfm

National Museum of Natural History: Evolution of Early Human Ecosystems

Kay Behrensemeyer examines the evolution of early humans and their ecosystems in light of concurrent climate change in the Olorgesaillie Basin, Kenya. Through such research we can gain a better picture of how humanity has responded to climate change in the past and how such changes have affected us as a species—as well as the animals and environments on which we depend.
http://humanorigins.si.edu/research/hop-team/anna-k-kay-behrensmeyer

Museum Conservation Institute: Healthy Environments, Healthy Practices, and Healthy Collections

Maintaining world-class collections and operating iconic museums can run up a huge energy bill. The Museum Conservation Institute conducts research on reducing the energy requirements, and associated costs, of maintaining museum environments and on using conservation procedures and products with a smaller footprint, then measures the impact of these programs. Projects include work on temperature-control measures and energy savings in museum storage, and developing modular, reusable, efficient containers for shipping paintings.
http://www.si.edu/mci/english/research/conservation/healthy3.html

WATER

Smithsonian Environmental Research Center: Tennenbaum Marine Observatories Network (MarineGEO)

Emmett Duffy leads this initiative deploying the first global network of ocean observatories designed for the long-term study of marine ecosystems and monitoring physical ocean properties, such as temperature, salinity and pH, which are critical indicators of climate change and its effects. These globally coordinated data will allow scientists to comprehensively study environmental change across the oceans and around the world's coasts.
http://www.si.edu/marinegeo

Smithsonian Environmental Research Center: Global Change Research Wetland

The Smithsonian's Global Change Research Wetland is home to multiple long-term studies of an important ecosystem, tidal wetland, which few others have examined in terms of its contribution to climate change. Patrick Megonigal and colleagues measure the fluxes of CO_2, methane and other gases to understand how climate change will affect wetland stability. One project is the longest-running field experiment in the world measuring ecosystem responses to artificially elevated levels of CO_2.
http://www.serc.si.edu/labs/biogeochem/research_wetland.aspx

National Museum of Natural History: Deep Reef Observation Project (DROP)

Carol Baldwin and her partners deploy and retrieve underwater monitoring equipment to provide one of the most high-resolution data sets of ocean conditions, such as temperature and acidity. The project also studies biodiversity at different depths, including little-understood deep-water reef ecosystems below 700 meters. Such detailed studies are crucial for monitoring changes in marine biodiversity over time as a result of changing climate patterns.
http://ocean.si.edu/ocean-news/deep-reef-observation-project-drop

Smithsonian Environmental Research Center: Photobiology and Solar Radiation

Air pollution, greenhouse gas emissions and ozone fluctuations alter the composition of the atmosphere and affect the amount of solar radiation reaching the ocean. The Photobiology and Solar Radiation Lab, led by Patrick Neale, monitors incoming solar radiation, in particular increases in UVB radiation related to human influences on the atmosphere and ozone layer, and studies its effects on marine ecosystems in an effort to understand how different types of radiation affect aquatic life.
http://www.serc.si.edu/labs/photobiology/index.aspx

National Museum of Natural History/Smithsonian Environmental Research Center: Mangrove and Coral Reef Deposits in the Caribbean: Implications for Conservation under Climate Change

Healthy coral reefs and mangroves provide vital protection against the devastating impacts of sea-level rise. Marguerite Toscano's research looks at deposits from both of these ecosystems over time, establishing benchmarks for measuring their responses to climate change and determining how vulnerable they are in the face of these changes. This information can inform more sustainable use and management of these areas to limit loss of their critical functions.
http://paleobiology.si.edu/staff/individuals/toscano.html

National Museum of Natural History: Deep-Sea Temperature Changes during the Cretaceous "Supergreenhouse"

Brian Huber uses marine fossils to examine climate and the carbon cycle during a period of "supergreenhouse" warming about 90 million years ago during the Cretaceous Period. This research reveals how the ocean-atmosphere system worked at a time when surface waters not too far from the poles could be more than 80 degrees Fahrenheit. Understanding the linkages between climate factors and ocean circulation in the past will give us some idea of the magnitude of what could occur in the future due to human-induced climate change.
http://paleobiology.si.edu/staff/individuals/huber.html

SPACE

Smithsonian Astrophysical Observatory: Measuring Climate and Pollution Effects in the Atmosphere

Tropospheric Emissions: Monitoring of Pollution (TEMPO), a Smithsonian-led and NASA-funded satellite mission expected to launch in 2019, will monitor various atmospheric factors affecting climate (including ozone, aerosols and water vapor) at very high resolution. While TEMPO is primarily an air-quality mission, the data obtained will help scientists like Kelly Chance resolve some of the largest gaps in our knowledge of human contributions to climate change, including the poorly understood role of aerosols, which may have a greater impact than carbon dioxide in the next few decades.
http://www.si.edu/consortia/castlelectureseriesjune192013
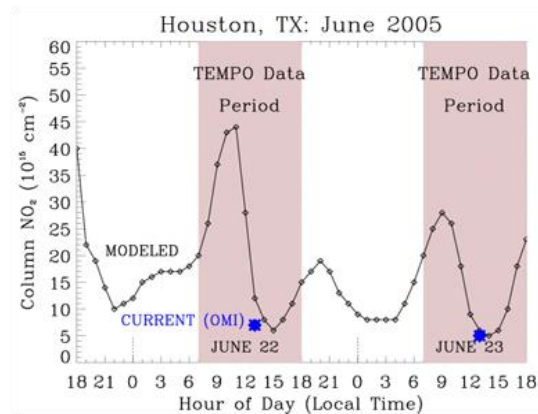
Smithsonian Astrophysical Observatory: The Role of Solar Wind in Space Weather and Climate

Changing levels of magnetic activity in the sun affect the "solar wind"—a cloud of charged particles that stream through space and impact the near-Earth environment in many ways, from short-term space weather to longer-term effects on the planet's climate. A solar-wind instrument calibrated and operated by the Smithsonian Astrophysical Observatory will launch on the Deep Space Climate Observatory (DSCOVR) mission in 2015 and will help researchers like Kelly Korreck monitor and understand the effects of the solar wind on the Earth.
http://www.nesdis.noaa.gov/DSCOVR/mission.html

Smithsonian Astrophysical Observatory: Light Radiation and Water Vapor in the Atmosphere

Understanding how water vapor scatters light is critical for correctly calibrating the instruments used to observe greenhouse gases in the atmosphere. Because it is difficult to replicate atmospheric conditions (especially the temperatures) in a lab, Smithsonian scientists such as Scott Paine are using the closest analog on the Earth's surface to obtain the correct measurements, setting up instruments at the Dome A project in Antarctica.
https://www.cfa.harvard.edu/~spaine/presentations/2011May24_SI_Climate_Change_Paine.pdf
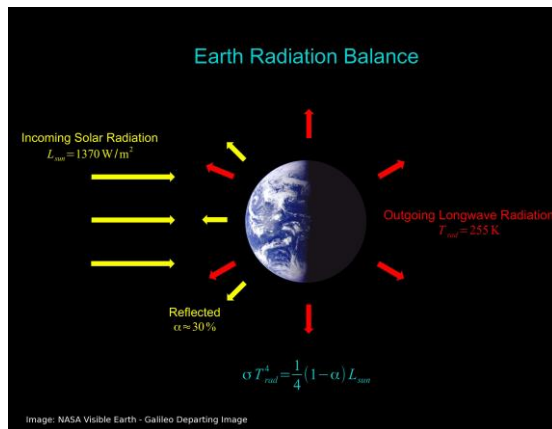
Smithsonian Astrophysical Observatory: High-Resolution Transmission Molecular Absorption (HITRAN) Database

Compiling decades' worth of observational data on the properties of atmospheric gases, the HITRAN database, overseen by Laurence Rothman, allows scientists from many different agencies to translate the raw observations from satellites and other instruments into a reliable understanding of what is happening in the atmosphere. The database is critical for researchers monitoring the trends of greenhouse gases, ozone depletion and pollution arising from both human activity and natural sources.
http://www.cfa.harvard.edu/hitran/

Smithsonian Tropical Research Institute: Climate Regulation Metric

Kristina Anderson-Teixeira and colleagues have created an index that combines information about the different ways, biogeochemical and biophysical, that ecosystems help regulate the climate. For example, forests influence climate both through their uptake and storage of carbon and in the way they reflect light and affect evaporation. This index reveals the total effect of specific ecosystems on temperature change and could lead to global standardized methods for evaluating greenhouse gas emissions and other climate factors.
http://www.stri.si.edu/english/scientific_staff/staff_scientist/scientist.php?id=72

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