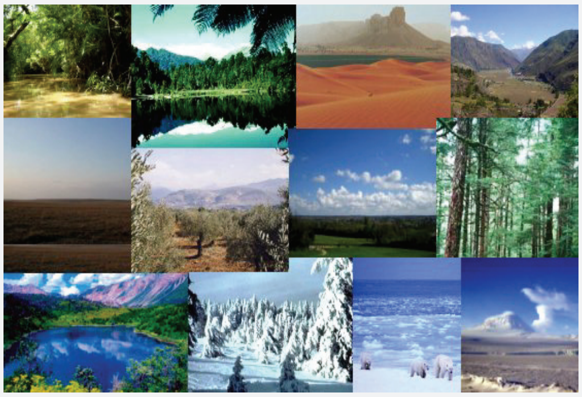
Climate Monitoring



The task of assessing the cycles of the Earth's climate is enormous, because so many variables affect and are affected by climate. Geographers, meteorologists, oceanographers, chemists, coastal morphologists, and wildlife biologists all help to refine the metrics and models for climate monitoring. However, this disciplinary diversity also creates challenges, since climate monitoring must be shared and synthesized across disciplines. For example, satellite geographers work with foresters to document changes in forest cover due to pine-bark beetle infestation. These same datasets–with some modification–are also useful to wildlife biologists to confirm species decline due to suspected habitat loss.

Climate researchers at the University of Maryland are pioneering a new generation of monitoring models, techniques, and products. These powerful tools are yielding more precise images of climate trends like shifting precipitation patterns and changes in hardwood forest cover. These researchers are also documenting the decline of fragile permafrost, the thinning of polar ice shelves, and new erosion patterns in densely populated river deltas. These data sets and graphical displays provide scientists and policy makers with critical tools for assessing Earth "health" and for adapting to climate change.

Philip Arkin is reworking years of global precipitation data to improve monitoring and modeling techniques. By synthesizing centuries of "almanac data" with new data on rainfall extent and location, Arkin is also improving rainfall predictions.

Charon Birkett works with NASA to monitor conditions of fresh water bodies such as lakes, rivers, and reservoirs. Her innovative approach scales down data gathering, providing critical regional information for local policy makers.

Ruth DeFries uses remote sensing data to examine the effect of land-use practices on ecological patterns, including the ability of endangered species to recover when habitat shifts.

Zhanqing Li tracks clouds to understand how the light they reflect contributes to climate. The albedo (reflectivity) effect he measures complicates climate change models.

Rachel Pinker monitors radiative fluxes–shifts in energy between the water, land, and atmosphere.

Ross Salawitch quantifies human effects on atmospheric composition, such as levels of stratospheric ozone. This work is important for both assessing ozone-layer recovery and improving our understanding of atmospheric chemistry.

Monitoring the Water Cycle: Will We Have Water Where We Need It?

Phil Arkin and Charon Birkett monitor different phases of the water cycle: Arkin studies precipitation patterns; Birkett tracks the levels of freshwater bodies.

Arkin reworks models of global precipitation patterns by accounting for differences between rain gauge observations, satellite-based estimates, and numerical models. How much rain and where will it fall can make or break an agriculture economy. Arkin's work on more than 17 years of global precipitation records resulted in massive "corrections" to precipitation models and to some climate models. Known as the Xie-Arkin observations, this data set helps scientists compare findings across different models. Xie-Arkin observations also help modelers develop regional versions of much-needed localized precipitation forecasts.

Work by Charon Birkett spurred NASA to monitor water levels of the world's lakes and reservoirs. Now, NASA's remote-sensing satellites pick up lake and river data. Understanding lakes, reservoirs, and rivers helps to develop accurate regional models for climate change. Changes in freshwater bodies can be a bellweather, especially in Africa where aridity means constant worry about in inadequate fresh water for personal use and agriculture.

Working with USDA and the Foreign Agriculture service, Birkett shared critical data on Lake Victoria, Africa's largest freshwater body and reservoir for the Nile. Water levels in Lake Victoria directly shape irrigation practices and flooding patterns in the Nile watershed.

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Monitoring Land Use and Habitat Reduction

Winner of a 2007 MacArthur Fellowship, Ruth DeFries uses remote sensing to examine the climate effects of shifting land-use patterns. For example, DeFries documented that deforestation in the tropics, despite huge conservation efforts, still contributes to climate change. DeFries has also indentified unexpected patchworks of agriculture and other land-use patterns in Central American national parks. Her maps reveal that habitat protection policies need to be reconsidered.

Wildlife biologists use work by DeFries. Her remote-sensing maps of Southeast Asia have been used to show that habitat loss is the primary reason for orangutan population decline. Similar work in Central and Latin American shows that despite protection of key tropical areas, habitat fragmentation curtails mating options for plants and animal.

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Improving Understanding about Clouds and Climate Change

Zhanqing Li researches the roles of clouds in climate by monitoring a plethora of cloud variables: coverage, density, color, water content, height, endurance, and location. According to Li, if researchers can "get clouds right," predictions about global climate change will be better.

Cloud characteristics are notoriously hard to monitor but essential for understanding the major, but often misunderstood, role of clouds in climate. For example, the albedo–or reflectivity–of clouds changes the flow of energy out from the earth, producing uncertainty in monitoring and modeling. Li works to create and improve methods for collecting and analyzing cloud data. For example, he developed a widely-applied algorithm to correct for difficulties in assessing albedo in high cirrus clouds.

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Energy Flows: Powerful but Unseen Engines of Climate

Understanding how energy moves from land and ocean surfaces into the atmosphere can help validate climate models and improve understanding of the Earth's water cycle. Rachel Pinker studies energy flows, known as "radiative fluxes," to understand the array of climate features caused by heat energy moving between land, sea, and the atmosphere. For example, the tradewinds are largely the result of these radiative fluxes.

Pinker uses satellite instruments to measure surface-to-atmosphere fluxes. Such an approach is important, because, unlike ground-based instruments, Earth-monitoring satellites can sample the globe widely and measure locations that are hard to monitor with surface instruments

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The Elusive Connection between Ozone Depletion and Climate Change

Ross Salawitch studies the connection between ozone depletion and climate change. Ozone depletion is caused primarily by ozone-reactive chemicals, like chlorofluorocarbons. However, as Salawitch shows, ozone recovery is impeded by cooling in the upper atmosphere caused largely by greenhouse gases like carbon dioxide. This information is important in monitoring recovery of the ozone layer, which is sometimes taken as a given because of the global ban on ozone-depleting substances. As Salawitch has confirmed, atmospheric temperature changes also complicate the ozone picture.

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