APPENDIX 1: THE LABORATORY IN THE NEWS

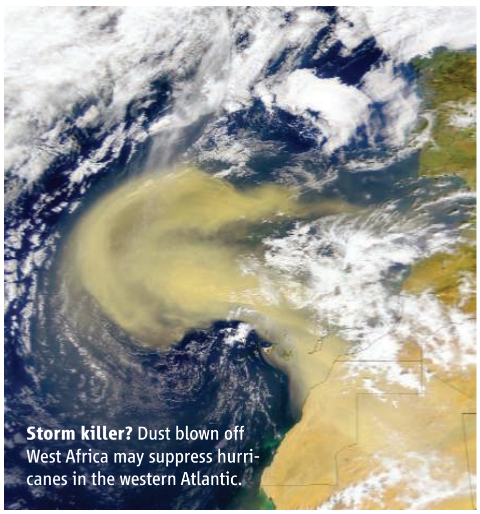
The following pages contain news articles and press releases that describe some of the Laboratory's activities during 2007.

METEOROLOGY

A Dose of Dust That Quieted An Entire Hurricane Season?

The 2006 hurricane season was looking grim. Three hurricanes had ripped across Florida during the 2004 season. Four hurricanes, including Katrina, had ravaged the Gulf Coast in 2005. Now meteorological signs were unanimous in foretelling yet another hyperactive hurricane season, the eighth in 10 years. But the forecasts were far off the mark. The 2006 season was normal, and no hurricanes came anywhere near the United States or the Caribbean.

Now two climatologists are suggesting that dust blown across the Atlantic from the Sahara was pivotal in the busted forecasts. The dust seems to have suppressed storm activity over the southwestern North Atlantic and Caribbean by blocking some energizing sunlight, they say. "I think they're on to something," says hurricane researcher Kerry Emanuel of the Massachusetts Institute of Technology in Cambridge. Dust "might play a big role" in year-to-year fluctuations in hurricane activity.



Storm killer? Dust blown off West Africa may suppress hurricanes in the western Atlantic.

CREDIT: SEAWIFS PROJECT/NASA/GSFC; NASA

As the 2006 season approached, conditions looked propitious for another blustery hurricane season. In particular, there was no sign of El Niño, whose Pacific warming can reach out to the Atlantic and alter atmospheric circulation to suppress hurricanes there. But, unremarked by forecasters, an unusually heavy surge of dust began blowing off North Africa and into the western Atlantic at the 1 June beginning of the official hurricane season. Two weeks later, the surface waters of the western Atlantic began to cool compared with temperatures in the previous season.

Climatologists William Lau of NASA's Goddard Space Flight Center in Greenbelt, Maryland, and Kyu-Myong Kim of the University of Maryland, Baltimore County, in Baltimore argue in the 27 February issue of *Eos* that the arrival of the thick dust and the subsequent cooling were no coincidence. The dust blocked some sunlight and cooled the surface, they say. That cooling went on to trigger a shift toward less favorable conditions for the formation and intensification of storms in the western Atlantic, they argue. As a result, no storm tracks crossed where nine had passed the previous season.

Lau and Kim find that historically, El Niño's influence on Atlantic storms has in fact prevailed in the eastern tropical Atlantic, as it may have done last year when it put in a surprise appearance beginning in August. But in the west, near the Caribbean and the United States, dust has been the dominant external influence, they found. "We're not denying El Niño had an impact," says Lau, but "maybe we have neglected an equally important factor, if not a more important factor."

Many hurricane researchers are intrigued but cautious. "The authors have an intriguing hypothesis," says Christopher Landsea of the National Hurricane Center in Miami, Florida, but "there's not much evidence that there is a direct cause and effect going on here." And if dust were involved, it would have been more complicated than a simple cooling, says Jason Dunion of the National Oceanic and Atmospheric Administration's Atlantic Oceanographic and Meteorological Laboratory in Miami. The dust comes in a layer of air whose extreme dryness and high winds are thought to discourage storm development and intensification as well.

If dust is a major factor in the Atlantic, it will only complicate forecasting the severity of hurricane seasons. Anticipating the arrival of El Niño is proving tricky enough. Predicting far-traveled Saharan dust months ahead—both the necessary North African dryness and the dust-carrying winds—could be formidable.

–RICHARD A. KERR

SCIENCESCOPE

Broad Institute Given $100 Million

The already well-heeled Broad Institute in Cambridge, Massachusetts, this week announced a $100 million gift from a wealthy direct marketer to conduct research on severe mental illnesses such as bipolar disorder and schizophrenia. The funding from the Stanley Medical Research Institute will allow the Broad—a joint venture between the Massachusetts Institute of Technology and Harvard University—to create an interdisciplinary center that will draw on the universities' expertise in neuroscience and genomics. That center, located within the Broad Institute, will be led by Edward Scolnick, a former National Institutes of Health researcher and president of Merck Research Laboratories. The money from the Stanley Institute, founded by the family of Theodore and Vada Stanley, will help Broad researchers apply "the most advanced genomic tools" to the biology of mental illness, says Harvard Provost Steven Hyman.

–ANDREW LAWLER

Ganging Up on Jupiter

A NASA probe heading to Pluto and a European Space Agency (ESA) spacecraft on its way to a comet will team up in coming weeks in an unusual effort to observe Jupiter. ESA's Rosetta, launched in 2004 and currently in the neighborhood of Mars, will examine the ring of electrically charged particles around the gas giant planet that may stem from volcanic eruptions on its moon Io. Meanwhile, NASA's New Horizons mission (below) sped past Jupiter last week after leaving Earth in January 2006. As the probe uses the planet's gravity to slingshot its way to Pluto, the onboard instruments are monitoring the Jupiter system.

The roughly simultaneous observations from the two probes could provide a unique set of data on the planet. "We couldn't pass up this opportunity to study Jupiter's meteorology,

rings, aurorae, satellites, and magnetosphere," says New Horizons principal investigator S. Alan Stern of Southwest Research Institute in Boulder, Colorado. The joint effort augurs well for future international cooperation in space science: Stern takes over as NASA's science chief next month. –ANDREW LAWLER

Article published Mar 9, 2007

African dust casts big damper

Its impact on storms is more far-ranging than suspected

By CATHY ZOLLO
H-T SCIENCE WRITER
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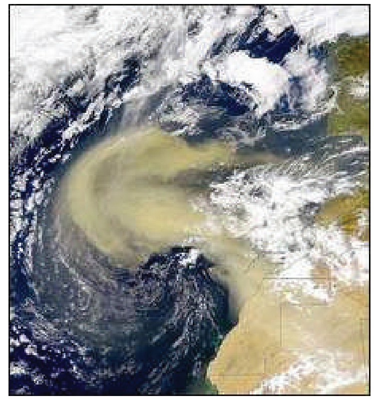
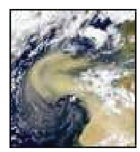


SEAWIFS PROJECT / NASA
Satellite image provided by NASA of a massive sand storm blowing off the northwest African desert has blanketed hundreds of thousands of square miles of the eastern Atlantic ocean.

More photos



NASA / 2000
A satellite image shows a sandstorm from northwest Africa in 2000 blanketing hundreds of thousands of square miles of the Atlantic.

Something so remote as drought in Africa, the cause of suffering for millions, could stifle hurricanes in the Atlantic in more ways than scientists first thought.

The recent findings will likely change the way forecasters look at whole seasons and individual storms.

Scientists have known for a few years that the dust, driven skyward by desert heat and blown to the Atlantic, chokes storms that are building off the African coast.

Now, they have discovered that the dust has a much wider effect on storms, smothering the development of storms as far away as the Caribbean.

The findings, reported in a recent issue of Eos, a publication of the American Geophysical Union, showed that the dust creates a cooling effect on western Atlantic waters.

The dust starts what scientists call a feedback loop, first cooling the Atlantic by shielding it from the sun.

The cooler water then cools the air above, causing it to sink, creating wind at the surface. That wind amplifies the cooling effect through evaporation and by causing water at the surface to mix with deeper, even cooler water.

The effect, which scientists called dramatic, is greatest in the western Atlantic and Caribbean.

William Lau, chief of the Laboratory of the Atmospheres at NASA's Goddard Space Flight Center in Greenbelt, Md., and Kyu-Myong Kim, of Goddard's Earth Sciences and Technology Center at the University of Maryland, made the discovery.

Looking back 25 years, they found that the effect of the dust is stronger than that of El Niño for keeping storms down in the western Atlantic and Caribbean.

"When we move to the eastern Atlantic, the effect is comparable," Lau said.

The sinking air that the cooler water creates has its own storm-dampening effect. Building tropical storms need rising air to grow. Sinking cold air: another wet blanket.

Though the African dust invasion of the Atlantic is an annual event in June, July and August, its intensity varies year to year, depending on drought conditions in Africa.

Rains in Africa's Sahel, south of the Sahara, determine how much plant cover there will be for the coming year.

It also reveals how much dust might get kicked up in the atmosphere the following year and ride easterly winds to the Atlantic.

Amato Evan, a climate scientist at the University of Wisconsin at Madison, also looked at decades of dust data and found that years with more dust tend to mean fewer hurricanes.

His work partially answered questions about why long-range forecasters were fooled by the 2006 season. They called for an above-average season, and it was average in number and a relief for Florida, with no hurricane making landfall here or on any U.S. coast.

"There might be kind of a threshold where you pump enough dust over the ocean and you are really going to kill the hurricanes," Evan said.

Scientists don't yet have a good idea how much dust will roll off Africa during the 2007 season, but Phil Klotzbach, lead author of the seasonal hurricane forecast put out by the William Gray team at Colorado State University, said he is already considering the dust and its effects for the team's forecast that is updated in April.

So far, they are calling for an active season with 14 named storms, seven hurricanes, three of them intense, with winds greater than 110 mph.

About half of the systems that become tropical storms in any season begin as easterly waves. Those are areas of unstable air that literally weave north and south as they move from Africa to the Atlantic.

A little bit farther west, the waves enter a massive mid-Atlantic pool of warm water that forecasters call the tropical storm genesis zone. This is where each year a handful out of about a hundred waves find the conditions to become hurricanes.

The other half of the storms that form in a given year grow up in the western Atlantic, Caribbean and Gulf of Mexico.

In years when there is a lot of dust, fewer hurricane form in both places.

Though scientists don't yet know whether global warming or deforestation add to a dust cycle, they say the dust seems to increase or decrease for decades at a time and could point to another reason for decades- long cycles of warmer and cooler Atlantic waters.

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Published online: 24 April 2007; | doi:10.1038/news070423-6

Every cloud has an invisible halo

Unseen particles may confuse climate models.

Philip Ball

Clouds are bigger than they look, according to new measurements by atmospheric scientists in Israel and the United States. They say that clouds are surrounded by a 'twilight zone' of diffuse particles, invisible to the naked eye, extending for tens of kilometres around the cloud's visible portion.

Clouds have unseen portions that stretch for many kilometres.

AddStyle

These vast, sparse haloes of droplets may have been overlooked in atmospheric studies, the researchers say. And they think that this could have skewed attempts to understand how clouds influence climate.

Clouds are one of the biggest sources of uncertainty in efforts to measure and predict global warming. They have two opposite effects: increasing warming by absorbing heat radiated from the planet's surface (which is why cloudy nights are warmer), while offsetting this by reflecting sunlight back into space from cloud tops.

Most atmospheric scientists now think that clouds have an overall global cooling effect. Measurements of warming trends therefore have to take into account whether the skies are cloudy or not, and model forecasts of future warming may hinge on whether they predict more or less cloudiness.

Cloudy distinction

Such modelling studies typically try to distinguish between cloudy and cloud-free regions of the atmosphere. But the new results show that this distinction is less clear-cut than has been thought, say Ilan Koren of the Weizmann Institute of Science in Rehovot, Israel, and his colleagues, who publish their discovery in *Geophysical Research Letters*[1].

> **"Right now there is a discrepancy between what global models predict for aerosol effects and what satellites measure."**
>
> Lorraine Remer
> NASA Goddard Space Flight Center

Clouds are formed when floating solid particles called aerosols — dust, for example — act as 'seeds' on which water droplets grow. Aerosols reflect light, and do so more strongly as they grow by accumulating water. The large droplets in clouds reflect most visible light, which is what makes clouds look white and opaque.

Koren and his colleagues first demonstrated that it is relatively easy to see from digital photographs that clouds are surrounded by an invisible haze, made up of these water-coated, or humidified, aerosols. If the parts of the photo containing visible white stuff are masked out, the surrounding haze comes into view.

This haze extends far further than anyone has ever imagined. "People may have seen these extended haloes anecdotally," says Koren's colleague Lorraine Remer of the NASA Goddard Space Flight Center in Greenbelt, Maryland. "But thanks to a new generation of instruments, the satellite observations have got much better, and we can look on larger scales, with more sensitivity and at finer resolution."

Satellite images of clouds over the Atlantic Ocean show that the sky's reflectance — a measure of how much humidified aerosol it contains — falls very gradually with increasing distance from the edge of a cloud, and is still declining at least 20-30 kilometres away, Koren's team says.

Into the twilight zone

To study these twilight zones further, the researchers studied several years' worth of images collected by a global network of ground-based lightmeters called AERONET, usually used to monitor the brightness of the Sun.

Sudden dips in the light detected by these instruments are automatically logged as indicating the passage of a cloud. Koren and colleagues discovered that it can take well over an hour for light levels to recover fully after a cloud has passed, indicating that their haloes are very broad.

Not all clouds will have a big twilight zone, the researchers say. For example, the halo might be tightly reined in around the sharp-edged white cumulus clouds that form when moist, warm air rises and cools. But they estimate that for typical global cloud coverage, the halo could encompass as much as two-thirds of the sky usually classed as cloud-free.

Remer says that some climate models might already include these extended cloud haloes — they should 'grow' them automatically if they do a good job of capturing the humidity variations of the air. But other, simpler, models might neglect the effect.

As a result, Remer suspects that the overall cooling effect of aerosols may have been underestimated. But she admits that it is too early to say whether that is really the case, or how significant an impact it might have on climate predictions.

"Right now there is a discrepancy between what global models predict for aerosol effects and what satellites measure," she says. "This might be part of the reason for that."

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References

1. Koren I., *et al*. *Geophys. Res. Lett.*, **34**. L08805 (2007).

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Story from news@nature.com:
http://news.nature.com//news/2007/070423/070423-6.html

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MEDIA ADVISORY: M07-68

NASA MEDIA TELECONFERENCE ON UPCOMING CLIMATE, OZONE EXPEDITION

WASHINGTON -- Scientists planning NASA's largest Earth science expedition of the year will hold a media teleconference on Wednesday, June 27, at 2 p.m. EDT to discuss the upcoming Tropical Composition, Cloud and Climate Coupling (TC4) field campaign.

The TC4 study will tackle challenging questions about Earth's ozone layer and climate using coordinated observations from satellites and high-flying NASA airplanes. Researchers will study how chemical compounds in the air are transported to the stratosphere, the area of the atmosphere that contains most of Earth's ozone. They will investigate how this vertical transport of water and chemicals affects climate-influencing cirrus clouds, and the chemistry of the upper atmosphere, of which ozone is an important component. The campaign will be based out of San Jose, Costa Rica, starting in mid-July.

Briefing participants are:

-- Michael Kurylo, TC4 program scientist, NASA Headquarters, Washington
-- Hal Maring, TC4 program scientist, NASA Headquarters
-- **David Starr**, TC4 mission scientist, NASA Goddard Space Flight Center, Greenbelt, Md.
-- Brian Toon, TC4 mission scientist, University of Colorado, Boulder

washingtonpost.com
Friday, August 10, 2007

Does African Dust Affect Atlantic Hurricanes?

Storm scientists are taking a closer look at whether giant dust clouds from the Sahara could join the El Niño phenomenon as a leading indicator of the ferocity of Atlantic hurricane seasons.

Scientists are intrigued by preliminary research showing a direct correlation between the sandy plumes and tropical cyclones.

"What we've seen is: more dust, fewer hurricanes," said **William Lau**, chief of the Laboratory for Atmospheres at NASA's Goddard Space Flight Center.

The busy and damaging hurricane seasons of 2004 and 2005, which rattled global energy and insurance markets, have heightened interest in storm forecasting and in research on factors that make tropical cyclones either spin into monster storms or wither and die at sea.

El Niño, a warming of eastern Pacific waters, has become a dominant storm indicator because it can flatten an Atlantic hurricane season by increasing the wind shear that can rip apart cyclones.

National Aeronautics and Space Administration

FEATURE

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R.I.P. TOMS: NASA Ozone Instrument Laid to Rest After Three Decades **08.15.07**

During its almost 30-year lifespan, the Total Ozone Mapping Spectrometer (TOMS) program provided unique and valuable information that shaped public policy and international perspectives on the environment. The instrument was important because its data established the geographical extent of the "ozone hole" over the Antarctic, and monitored its year-to-year evolution.

With the recent decommissioning of the last of the three TOMS instruments, Earth Probe TOMS, the TOMS program closed on May 30, 2007. The legacy TOMS leaves behind will not be forgotten.

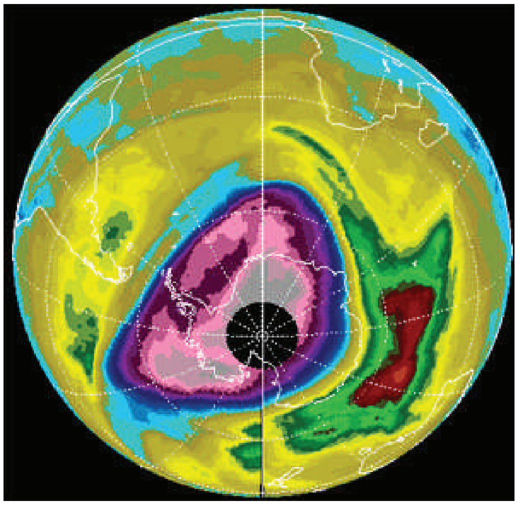

Image right: The ozone hole over the arctic in the year 2000, as seen by Earth Probe TOMS. *Click image to enlarge.* **Credit:** NASA

The TOMS program began with the launch of TOMS Flight Model No. 1 on the Nimbus-7 spacecraft on October 24, 1978. NASA scientists originally designed the instrument to study weather patterns by mapping global ozone. They quickly realized that some of the data collected by TOMS was much more significant than they initially had imagined.

The instrument gave scientists a tool for studying ozone in the upper and lower atmosphere in a way that had never been done before, more frequently and with far greater detail. The TOMS instrument captured a vast number of images of the ozone daily, which allowed scientists to constantly monitor changes in the ozone. The capability to measure long-term trends with the TOMS instrument series has been critical to international ozone assessment activities.

Ozone that surrounds the Earth in the upper atmosphere acts as protection from the sun’s harmful ultraviolet rays. A thinning of the upper ozone layer would put people at greater risk for skin cancer, cataracts and impaired immune systems. Ozone in the lower atmosphere, close to Earth’s surface, is a pollutant that causes damage to lung tissue and plants.

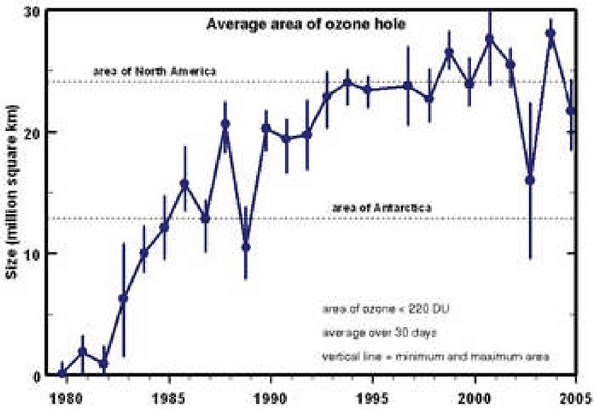

Image left: A graph of the size of the ozone hole from 1979 to 2004. *Click image to enlarge.* **Credit:** NASA

TOMS measured the Earth’s ozone levels by calculating the amount of ultraviolet light scattered from the Earth’s surface and atmosphere back into space. Since the ozone layer absorbs ultraviolet light, areas in which less ultraviolet light was recorded indicated the presence of more ozone.

"TOMS was unique because it was a total ozone mapper. It measured ozone on every spot on the Earth every day. That is why it was so valuable, it saw everything," said Richard McPeters, the principal investigator for Earth Probe TOMS, at NASA’s Goddard Space Flight Center, Greenbelt, Md. McPeters worked on TOMS from the earliest days of the program.

The data from the TOMS instrument were critical to the detection of long-term damage to the ozone layer over long periods of time, including above heavily populated areas. These discoveries led to the passage of the Montreal Protocol in 1987, an international agreement restricting the production of ozone-depleting chemicals.

Image right: The Earth Probe TOMS instrument before its launch in 1996. **Credit:** NASA

TOMS data were also key in confirming the destruction of the ozone at the South Pole each year, the "ozone hole," which is now an annual occurrence.

A new TOMS instrument on the Russian spacecraft Meteor-3 replaced TOMS/Nimbus-7 after 14 years of service. TOMS/Meteor-3 was the first significant U.S. instrument to fly aboard a Russian spacecraft and provided a main source of ozone data until it stopped working in 1994.

The final leg of the TOMS program was launched in July of 1996. This TOMS instrument, aboard the Earth Probe spacecraft, was placed at a lower altitude than its predecessors. The lower orbit allowed Earth Probe TOMS to provide better resolution for viewing smaller phenomena, like volcanoes, forest fires and sources of pollution. This instrument took almost

200,000 measurements daily, covering nearly the entire planet.

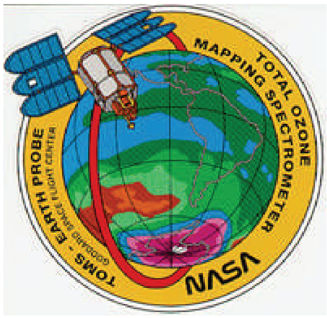

Image left: The official Earth Probe TOMS mission patch. **Credit:** NASA

Earth Probe TOMS also kicked off collaboration between Goddard and Capitol College of Laurel, Md. Students from Capitol College's Space Operations Institute worked with the TOMS Flight Operations Team at Goddard to redesign the Earth Probe TOMS ground control system. A few years later, the TOMS control center was moved to the Capitol College campus and the students took over the full operation of the instrument with periodic supervision by the team at Goddard.

Edward Chang, the contracting officer's technical representative from Goddard, says that even though the TOMS mission has ended, the collaboration between NASA and Capitol College continues. The college took the lead in decommissioning Earth Probe TOMS on May 30, 2007.

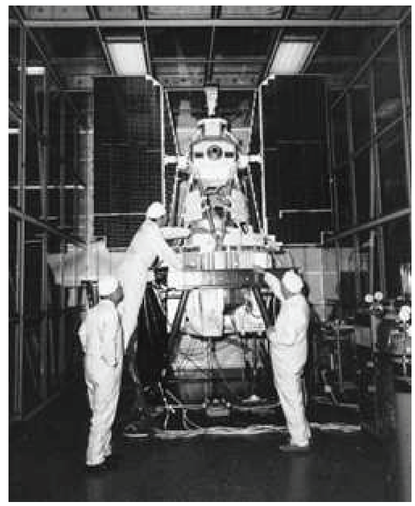

Image right: The Nimbus-7 spacecraft, which carried the first TOMS instrument, before its launch in 1978. *Click image to enlarge.* **Credit:** NASA

Following failure of the transmitter in late 2006, TOMS was no longer able to send its data back to the scientists on the ground, so continuing to operate the instrument was useless. The spacecraft will remain in its current orbit, but with all fuel and other energy sources cut off. It will take 37 years for the spacecraft to re-enter the atmosphere.

The Ozone Monitoring Instrument, a more advanced spectrometer that flies on the Aura satellite, has taken over the work done by the TOMS program. Launched in 2004, this instrument was created through collaboration between Goddard and the Netherlands Agency for Aerospace Programs working with the Finnish Meteorological Institute. Like TOMS, the Ozone Monitoring Instrument records total ozone and other atmospheric data related to ozone chemistry and climate.

TOMS delivered some of the most critical and influential environmental data ever recorded, documenting the long-term decline of global ozone levels and the emergence and development of the Antarctic ozone hole. It allowed the world to view and understand ozone in a new way, helping to shape international environmental perspectives and policy.

The program's legacy, according to McPeters, lies in the incredibly detailed information TOMS provided for examining changes in the ozone layer. "People got used to being able to view the Earth the way TOMS viewed it, seeing a global image of the ozone in high resolution every day. At this point, as a result of TOMS, that view is now considered a necessity."

Related Links:

+ The TOMS Program
+ AURA's Ozone Monitoring Instrument
+ NASA's Ozone Hole Watch

Laura Spector
Goddard Space Flight Center

Find this article at:
http://www.nasa.gov/centers/goddard/news/topstory/2007/toms_end.html

Aug. 27, 2007

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RELEASE: 07-181

SCIENTISTS SEE FIRST SIGNS OF LONG-TERM CHANGES IN TROPICAL RAINFALL

WASHINGTON - NASA scientists have detected the first signs that tropical rainfall is on the rise, using the longest and most complete data record available.

The international scientific community assembled a 27-year global record of rainfall from satellite and ground-based instruments. The researchers found the rainiest years between 1979 and 2005 occurred primarily after 2001. The wettest year was 2005, followed by 2004, 2003, 2002 and 1998. The study appeared in the August 1 issue of the American Meteorological Society's Journal of Climate. The rainfall increase was concentrated over tropical oceans, with a slight decline over land.

"When we look at the whole planet over almost three decades, the total amount of rain falling has changed very little. But in the tropics, where nearly two-thirds of all rain falls, there has been an increase of 5 percent," said lead author **Guojun Gu**, a research scientist at NASA's Goddard Space Flight Center in Greenbelt, Md.

Climate scientists predict that a warming trend in Earth's atmosphere and surface temperatures would produce an accelerated recycling of water between land, sea and air. Warmer temperatures increase the evaporation of water from the ocean and land and allow air to hold more moisture. Eventually, clouds form that produce rain and snow.

"A warming climate is the most plausible cause of this observed trend in tropical rainfall," said co-author **Robert F. Adler**, senior scientist at Goddard's Laboratory for Atmospheres. Adler and Gu are now working on a detailed study of the relationship between surface temperatures and rainfall patterns to investigate the possible link further.

Obtaining a global view of our planet's rainfall patterns is a challenge. Only since the satellite era have regular estimates of rainfall over oceans been available to supplement the long-term, but land-limited record from rain gauges. Recently, the many different land- and space-based data have been merged into a global record: the Global Precipitation Climatology Project, organized under the World Climate Research Program.

Using this global record, the scientists identified a small upward trend in overall tropical rainfall since 1979. To assess whether this pattern was a long-term trend rather than natural year-to-year variability, they removed the effects of the two natural phenomena that change rainfall: the El Niño -Southern Oscillation and large volcanic eruptions.

El Niño is a cyclical warming of the ocean waters in the central and eastern tropical Pacific that generally occurs every three to seven years and alters weather patterns worldwide. Volcanoes that loft debris into the upper troposphere and stratosphere create globe-circling bands of aerosol particles that slow the formation of precipitation by increasing the number of small cloud drops and temporarily shielding the planet from sunlight. The result lowers surface temperatures and evaporation that fuels rainfall. Two such eruptions - El Chicon in Mexico and Mount Pinatubo in the Philippines - occurred during the 27-year period.

The scientists found that during El Niño years, total tropical rainfall did not change significantly, but more rain fell over oceans than usual. During the two years following each volcanic eruption, overall tropical rainfall was reduced by about 5 percent. With these effects removed from the rainfall record, the long-term trend appears more clearly in the rainfall data both over land and over the ocean.

According to Adler, evidence for the rainfall trend is holding as more data come in. The latest numbers for 2006 show another record-high year for tropical rainfall, tying 2005 as the rainiest year. Adler's research group at NASA produces the Global Precipitation Climatology Project's monthly rainfall updates.

"The next step toward firmly establishing this initial indication of a long-term tropical rainfall trend is to continue to lengthen and improve our data record," said Adler, who is project scientist of the Tropical Rainfall Measuring Mission (TRMM), a joint effort between NASA and the Japan Aerospace Exploration Agency. The satellite's three primary instruments are providing the most detailed view of rainfall ever provided from space. Since 1997, Adler's group has been incorporating the mission's rainfall data into the global rainfall record.

NASA plans to extend the success of monitoring rainfall over the tropics to the entire globe with the Global Precipitation Measurement mission, scheduled for launch in 2013. This international project will measure both rain and snow around the world.

Sept. 13, 2007

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RELEASE: 07-192

NASA KEEPS EYE ON OZONE LAYER AMID MONTREAL PROTOCOL'S SUCCESS

WASHINGTON - NASA scientists will join researchers from around the world to celebrate the 20th anniversary of the Montreal Protocol, an international treaty designed to reduce the hole in Earth's protective ozone layer. The United Nations Environment Programme will host the meeting from Sept. 23 to 26 in Athens, Greece. NASA scientists study climate change and research the timing of the recovery of the ozone layer.

"The Montreal Protocol has been a resounding success," said **Richard Stolarski**, a speaker at the symposium from NASA's Goddard Space Flight Center, Greenbelt, Md. "The effect can be seen in the leveling off of chlorine compounds in the atmosphere and the beginning of their decline."

Since the Montreal Protocol was signed on Sept. 16, 1987, more than 100 nations have agreed to limit the production and release of compounds, notably human-produced chlorofluorocarbons, known as CFCs. CFCs and a list of other compounds are known to degrade the layer of ozone in the stratosphere that shields life from the sun's ultraviolet radiation. That process gives rise to the ozone hole above Antarctica.

Today, space-based instruments aboard NASA's Aura satellite monitor the chemical make-up of the atmosphere and collect data that will help researchers better understand ozone chemistry through computer models. While the data show that average chlorine levels are beginning to decline, springtime ozone depletion in the polar regions continues to be a prominent atmospheric feature.

"The goal now is to ensure that CFCs and other emissions continue to fall to below the levels that produce an ozone hole," said Goddard's **Anne Douglass**, the deputy project scientist for Aura. "This won't happen until about 2070."

NASA and National Oceanic and Atmospheric Administration scientists announced in 2006 that the hole was the largest ever observed, at 10.6 million square miles. The size of the hole will approach its annual peak in late September. Researchers at the symposium will discuss 20 years of scientific progress, as well as how best to monitor the atmosphere to ensure the goals of the treaty are realized.

In addition to the current satellite measurements, NASA research efforts use data collected on the ground, in the air and from previous missions.

Data from past satellite observations have been essential to understanding ozone depletion. NASA's Total Ozone Mapping Spectrometer, or TOMS, was one of NASA's signature ozone research achievements. TOMS launched in 1978 and was decommissioned in May 2007.

"The TOMS images of the Antarctic ozone hole caused worldwide alarm and thus played a key role in the Montreal Protocol and other international agreements to phase out the offending chemicals from our environment," said Goddard's **Pawan Bhartia**, project scientist for the mission. In addition, measurements from the Stratospheric Aerosol and Gas Experiment, along with the Microwave Limb Sounder and the Halogen Occultation Experiment aboard the Upper Atmospheric Research Satellite, were important to scientists' understanding of ozone.

Scientists collect atmospheric composition data from ground-based monitoring stations around the world. Researchers have collected measurements since 1978 for nearly all compounds identified in the Montreal Protocol. The data come from coastal monitoring stations used in previous missions and as part of the NASA-sponsored Advanced Global Atmospheric Gases Experiment.

Airborne instruments have been a critical piece of the scientific search to find the cause of ozone depletion, and they remain central to NASA's research efforts today.

Data from NASA's Airborne Antarctic Ozone Experiment in 1987 "provided the smoking gun measurements that nailed down the cause of the ozone hole being the increase of CFCs combined with the unique meteorology of the

Antarctic," Stolarski said. Since then, NASA has sponsored several airborne field campaigns that have furthered understanding of the chemical processes controlling ozone.

These measurements are key for researchers working to predict the future of the global ozone layer. The differences between loss and recovery of ozone at the poles and in non-polar regions are complex. "Such complexity has led to heated debates over the timing and extent of recovery," said Ross Salawitch, an atmospheric chemist at the Jet Propulsion Laboratory, Pasadena, Calif.

The modern focus in ozone research also has shifted to include the effects of climate change. "Twenty years ago we went out of our way to separate ozone depletion from climate change," Salawitch said. "After a decade of looking at data, the community realizes they are linked in subtle but profoundly important ways."

From The Oregonian, September 19, 2007

Clouds of mystery

Scientists suspect glowing wisps show that global warming is changing Earth's atmosphere Wednesday, September 19, 2007
MICHAEL MILSTEIN
The Oregonian Staff

Relaxing in the hot tub behind his Warrenton home one evening in June, Brad Hill spotted a strange wiry cloud unlike any he had ever seen.

It glowed electric blue. As the sun fell below the horizon, the tendril grew brighter and brighter.

Scientists strongly suspect that such curious clouds, now expanding around the planet and growing brighter, are one of the most visible signs yet that global warming is altering Earth's atmosphere.

They're known as noctilucent, or night-shining, clouds. They resemble normal cirrus clouds but build mysteriously in summer about 50 miles higher in the sky. They were first reported in the late 1800s and seem to be proliferating with the rise of greenhouse gases.

Sky watchers used to see noctilucent clouds only at northern latitudes such as in Canada and Scandinavia but now spot them more often as far south as Oregon. Oregonians from Bend to the coast reported the clouds this summer, when they appeared especially bright.

The clouds are too wispy to see during the day. They show up only after dusk, when the sun has set but sunlight from over the horizon still illuminates the upper atmosphere, where the clouds hover near the edge of space.

"It's really not a normal sunset color at all," said Hill, a paragliding instructor who watches the sky constantly. He was so captivated it took him 10 minutes to realize that he should snap photos of the cloud he saw in June.

Many researchers suspect the clouds are spreading because, though greenhouse gases hold more heat in the lower atmosphere, they deflect more heat away from the highest reaches of the atmosphere. That causes it to cool and helps ice crystals coalesce into the clouds. The same greenhouse gases may also move extra water into the atmosphere's upper fringe, adding to the luminous wisps.

The clouds have attracted so much attention that NASA launched a new satellite last spring to probe them and the mesosphere, the little-studied layer of atmosphere where the clouds form.

"If indeed we're doing something to change the atmosphere so far above Earth, then we need to understand what it is," said James Russell, a professor at Hampton University in Virginia. He is the lead scientist for the satellite mission, called Aeronomy of Ice in the Mesosphere, or AIM.

The satellite carries newly designed equipment to look into the mesosphere, which is too high for planes or weather balloons to reach but too low for most satellites, which begin to burn up as they drop into it.

Last month, the satellite looked down onto a flotilla of the clouds as huge radar dishes in Greenland and Alaska looked up, collecting some of the most detailed data yet. Researchers are analyzing the data for clues about what's behind the clouds' formation.

They know the clouds require three key ingredients: water vapor to form the ice that makes the clouds; seed particles such as dust for the ice to build upon; and cold temperatures to drive the formation of ice.

"They're increasing in number, and they're occurring at lower latitudes," said Scott Bailey, a Virginia Tech professor who is deputy lead scientist for AIM. "The fact that they were not here at all 120 years ago, and now they are is itself a sign something is changing up there."

The upper atmosphere where the clouds build is usually very dry, because water gets caught by an extremely cold underlying layer of air called the tropopause. But methane, a potent greenhouse gas that has doubled in concentration since the Industrial Revolution, can make it through -- with water hitching a ride.

Once the methane passes into the upper atmosphere, sunlight helps break it down into water molecules, moistening the otherwise dry environment and contributing to the clouds, researchers say.

About 60 percent of methane emissions come from human sources, but concentrations in the atmosphere appear to have leveled off in recent years.

Exhaust from rockets, such as those that loft the space shuttle, also add water to the upper atmosphere. That helps create noctilucent clouds shortly after launches. But those clouds last only about a day, so that wouldn't explain the clouds appearing at other times, Bailey said.

At the same time, colder temperatures may help freeze more of the water to make clouds. The upper atmosphere appears to be cooling a few degrees per decade. That's because carbon dioxide, the greenhouse gas that catches and holds heat near the Earth, does the opposite in the upper atmosphere -- catching the heat and releasing it into space.

That lowers temperatures, making it easier to form bigger ice particles that make the clouds appear brighter.

Levels of carbon dioxide, released by burning fossil fuels, are at their highest point in the atmosphere in hundreds of thousands of years.

Solar cycles also shrink or expand the clouds by alternately cooling and heating the upper atmosphere as energy from the sun rises and falls every 11 years. That may have amplified this summer's display.

But the clouds are growing still brighter and more widespread over and above those cycles, said Jeffrey Thayer, a professor of aerospace engineering at the University of Colorado, Boulder.

Researchers differ on how clear the evidence is for increasing amounts of water or lower temperatures in the upper atmosphere, but almost all agree the clouds are spreading.

Occurring more often

Data from past satellites that tracked the clouds show they occur 50 to 60 percent more often now than 28 years ago, said **Matthew DeLand**, a scientist at Science Systems and Applications Inc. who works with NASA. "We definitely see increasing trends at all latitudes. There are places that 20 years ago you didn't have people seeing the clouds where now they do."

Ice in the clouds forms around tiny dust particles. It's unclear where they come from, but they may be the leftovers of dust particles arriving from space.

Noctilucent clouds were first recorded in 1885, just after the massive volcanic eruption of Krakatoa in Indonesia in 1883. Some scientists suspect the blast shot extra water, and possibly dust particles, into the upper atmosphere, briefly accelerating the clouds' emergence as rising levels of methane and carbon dioxide took hold over the longer term.

Common clouds in the lower atmosphere can help offset global warming by reflecting sunlight away from Earth. Noctilucent clouds remain much too thin and wispy to have a similar effect, with particles more than 1,000 times smaller than usual cirrus clouds, Thayer said.

But if the strangely glowing clouds continue to brighten and expand, they might begin to have a broader influence.

Hill Heat

Science Policy Legislation Action

Hurricanes and Climate Change: What's Resolved and What Remains To Be Resolved?

on Friday, September 21, 2007

Is there a scientific basis for anticipating that human-induced climate warming does and/or will affect hurricanes in some way, over and above natural climate variability? Do observations and model simulations support that expectation, or are there issues with data and observations that make the task of sorting out linkages more difficult? If the latter, what are the observational and data issues that continue to make this a challenging scientific problem? What do we know now that we did not know two years ago? What role do model simulations play in helping to sort out linkages, if any, between global warming and hurricanes, in the absence of data/observation or the presence of unreliable data/observations? How can we best develop a coordinated national effort to provide urgently required information for planning, community response and infrastructure development.

Moderator

- Dr. Anthony Socci, Senior Science Fellow, American Meteorological Society

Speakers

- Dr. Kerry Emanuel, Professor of Atmospheric Science, Massachusetts Institute of Technology, Cambridge, MA
- Dr. William K. M. Lau, Chief, Laboratory for Atmospheres, NASA/Goddard Space Flight Center, Greenbelt, MD
- Dr. Greg Holland, Director, Mesoscale and Microscale Meteorology Division, Earth and Sun Systems Laboratory, National Center for Atmospheric Research, Boulder, CO
- Dr. Gabriel Vecchi, Research Oceanographer, Climate diagnostics Group, Geophysical Fluid Dynamics Lab/NOAA, Princeton, NJ.
- Thomas R. Knutson, Research Meteorologist, Climate Dynamics and Prediction Group, Geophysical Fluid Dynamics Lab/NOAA, Princeton, NJ.

Overview of Hurricanes and Climate Change (a.k.a. global warming)

The understanding of climate change, including its effects on hurricanes, rests on three essential scientific techniques: theory, observation, and computational modeling. Each of these three approaches has unique strengths and limitations. In this talk, I will discuss the application of each of these to understanding the effect of climate change on hurricane activity and demonstrate that while each approach is compromised by uncertainties, taken together they present a persuasive picture of increasing hurricane risk as the climate warms.

Notes:

The science of hurricanes and climate rests on all three of observations, theory, and computer models.

There's no significant trend in the number of storms recorded per year, nor do we know what determines that number.

Tropical cyclone power dissipation. There's a strong correlation between cyclonic power dissipation and sea-surface temperature before 1987, then the record is highly variable.

We no longer fly planes into storms in the western Pacific. We can't do everything with satellites.

Good correlation in the Atlantic. Since the 1980s Atlantic hurricane strength has doubled.

Paleotempestology: Jeff Donnelley, Jon Woodruff, Phil Lane, WHOI. May be able to show longer record of changing hurricane activity.

We have the theory of potential intensity. Observed potential intensity has gone up dramatically since 1990.

What is causing SST changes in the northern hemisphere? The tropical Atlantic's SST changes are consistent with the entire northern hemisphere SST.

You can explain a lot of the difference between Atlantic SST and global mwan temperatures by aerosol forcing.

There are beginnings of downscaling techniques to seed GCMs with fledgling cyclonic storms. Their preliminary results show decreases overall, some increases. Decrease in frequency but increase in intensity and rainfall. But they predict less change than we have already observed over the past 50 years.

Rainfall Extremes, Saharan Dust, Tropical Cyclones and Climate Change

Trends in tropical rainfall are more readily detectable in the form of changes in rainfall characteristics, rather than in rainfall total. From satellite data, we find that in the tropics there is a strong positive trend in extreme heavy and very light rains, coupled to a negative trend in moderate rain. Climatologically over tropical oceans, a large portion (over 60%) of most extreme heavy rainfall (top 5%) can be identified with those coming from tropical cyclones. Over the Atlantic, the contribution of tropical cyclones to heavy rain events has almost doubled in the last quarter century. Over the Pacific basin, the increase is lesser at about 10%. The differences in the basin may be related to the percentage change in the warm pool (SST> 28 ºC) areas in both oceans. Overall, tropical cyclones appear to be feeding more extreme rainfall events in the tropics in recent decades.

Saharan dust can affect tropical cyclones development, and may be a factor contributing to long-term hurricane statistics and possibly in seasonal hurricane forecasts. The Saharan Air Layer (SAL) can suppress tropical cyclogenesis through entrainment of hot, dry air into a developing cyclone, increasing stability and denying the developing system of its moisture supply. Saharan dust may also pre-condition the Atlantic, cooling the ocean surface through attenuation of solar radiation, during the early hurricane season. Additionally, differential radiative heating of the atmosphere by Saharan dust may induce changes in the large-scale circulation over the West Africa and Atlantic region. All these effects may provide a feedback on the coupled ocean-atmosphere system over the Atlantic, modulating the seasonal statistics of hurricanes. Analyses of satellite data and historical records show a more (less) active hurricane season is generally associated with less (more) Saharan dust over the Atlantic.

Global Warming and Hurricane Activity

The past century has seen North Atlantic hurricanes occurring in three periods of relatively stable frequency separated by sharp upward transitions. Each period has experienced 50% more hurricanes than the previous one and each was associated with a distinct change in eastern Atlantic sea surface temperatures (SSTs). After taking account of missing cyclones in earlier periods due to poor observing systems, we have experienced an 80-100% increase in hurricane frequency over since the early 1900s. Natural variability has contributed to some of the observed changes, but the compelling conclusion is that the overall increase has been substantially influenced by greenhouse warming. Superimposed on this increasing hurricane frequency is a completely independent oscillation in the proportions of major and minor hurricanes (compared to all storms). This oscillation has no distinguishable net trend and may arise largely from internal oscillations of the climate system. The period of enhanced major hurricane activity during 1945-1964 arose entirely from this oscillation. Unfortunately, the period since 1995 has experienced a double-whammy of a sharp increase in both numbers of hurricanes and the proportion of major hurricanes.

This heightened hurricane activity is unlikely to decrease in the future and we may see further increases. If so, current planning, building and coastal levee systems may prove to be inadequate, leading to more New Orleans-type disasters. The National Hurricane Research Initiative is designed to provide us with the tools to assess this future threat, to develop improved forecast and community response approaches, and to establish coastal planning approach to minimize the potential for future disasters. It is an initiative of critical national importance, which deserves strong and urgent support.

Long-term changes in Tropical Cyclone Activity: Looking Forward and Looking Back

To understand how human-induced climate change influences global and Atlantic tropical cyclone activity it is essential to have accurate records of past tropical cyclone variations and to model future climate conditions. The ways that tropical cyclones are measured have evolved over time, thereby influencing the homogeneity of the record. Statistical techniques can help, however, to estimate these deficiencies in the century-scale record. To project future conditions, global climate models (GCMs) – though not perfect – are our best tools. Although current computing power prevents GCMs from explicitly representing tropical cyclones, GCMs do indicate robust changes in many of the large-scale environmental conditions that are known to influence tropical cyclone activity, such as the thermodynamic structure of the atmosphere and vertical wind shear. Analyses of climate models and reconstructions of past tropical cyclone records indicate:

- Observational evidence for century-scale changes in tropical cyclone activity is mixed, depending on the metric chosen, on the statistical correction applied to the data and on the time interval being examined.
- Climate model projections of the Atlantic and East Pacific response to global warming exhibit mixed changes in cyclone-relevant parameters, with both an increase in thermodynamic potential intensity of tropical cyclones and an increase in vertical wind shear. More refined methods are needed to understand the detailed response of tropical cyclones to these environmental changes.
- Outside of the Atlantic and East Pacific, projected changes to both the thermodynamic potential and the wind shear indicate conditions more favorable to tropical cyclone activity under global warming.
- Although questions remain about the detailed response of tropical cyclone activity to human-induced climate change, we have relatively much greater confidence in the projected response of other large-scale climate conditions to increasing greenhouse gases (e.g., global warming, surface temperatures over land warm faster than over ocean, Arctic sea ice reduction, increase in ocean heat content, etc.).

Estimating how many tropical storms we missed before satellite observations, based on ship tracks. We have real observation gaps during WWI and WWII.

Model results show temperatures and wind shear increasing in most areas, not pointing in a clear direction for potential intensity. In the West Pacific and Indian Ocean, however, the trends all point toward increased cyclonic frequency.

Modeling the Response of Atlantic Hurricanes to Climate Variability and Change

A pressing question concerning ongoing global warming is whether human-caused warming of the planet has had any discernible impact on Atlantic hurricane activity. Confidence in any such a link is currently hampered by both data quality issues for the hurricane observational record and by limited work specifically targeting this question from a modeling perspective. Based on existing studies to date:

- Observed data, including consideration of data problems, give conflicting indications on whether there have been significant increases in Atlantic tropical storm and hurricane numbers. U.S. land-falling numbers have not increased. Models have not yet reproduced some reported long-term (~100 yr) increasing trends in basin-wide numbers.
- High resolution models consistently project increasing hurricane intensities and rainfall rates for the late 21st century, but whether there will be more or fewer hurricanes remains uncertain.
- A new modeling approach reproduces many important aspects of Atlantic hurricane activity observed since 1980, and thus shows promise as a tool for both understanding past variations and for making more reliable projections of future hurricane activity.

Biographies Dr. Kerry Emanuel is a professor of atmospheric science at the Massachusetts Institute of Technology, where he has been on the faculty since 1981, after spending three years as a faculty member at UCLA. Professor Emanuel's research interests focus on tropical meteorology and climate, with a specialty in hurricane physics. His interests also include cumulus convection, and advanced methods of sampling the atmosphere in aid of numerical weather prediction. He is the author or co-author of over 100 peer-reviewed scientific papers, and three books, including Divine Wind: The History and Science of Hurricanes, recently released by Oxford University Press and aimed at a general audience, and What We Know about Climate Change, published by the MIT Press.

Dr. William Lau is currently the Chief of the Laboratory for Atmospheres at NASA, Goddard Space Flight Center, and Adjunct Professor at Department of Meteorology U. of Maryland. His research work spans three decades and covers a wide range of topics including climate dynamics, tropical and monsoon meteorology, ocean-atmosphere interaction, and climate variability and change.

Dr. Lau has received numerous awards for his research and his scientific leadership, including among others, the AMS Meisinger Award in 1997; the John Lindsay Award,1998; the NASA Exceptional Science Achievement Award, 1991; the William Nordberg Award (GSFC highest award in Earth Sciences), 2002. He is a Goddard Senior Fellow, a fellow of the American Meteorological Society since 1988, and a fellow of the American Geophysical Union, 2007. Dr. Lau has published over 190 refereed papers, book Chapters in refereed journals. He is the principal author of a book "Intraseasonal Variability in the Tropical Ocean-Atmosphere System", published in 2006. Dr. Lau received his B. Sc. in Physics and Mathematics from the University of Hong Kong, and his Ph.D. in Atmospheric Sciences from the University of Washington, Seattle.

Dr. Greg Holland is currently Director of the Mesoscale and Microscale Meteorology Division at the National Center for Atmospheric Research in Boulder, where he is involved scientifically with hurricane landfall, genesis and climate related work. He is a fellow of the American Meteorological Society as well as the Australian Meteorological and Oceanographic Society. Dr. Holland has several areas of research interests which have carried through to applications and include improved forecasting of tropical cyclone motion, scale interactions associated with cyclogenesis, establishment of field facilities, establishment of programs on coastal impacts of tropical cyclones and the development of Unmanned Aerial Vehicles (UAVs).

Dr. Holland has authored or co-authored more than 120 peer-reviewed scientific journal articles and book chapters, as well as dozens of planning documents, scientific prospectuses and workshop papers. He has given several hundred invited talks worldwide, as well as many contributed presentations at national and international conferences on hurricanes and related. He has also convened several national and international workshops, and served on several national and international committees and science-planning initiatives.

Dr. Gabriel Vecchi is a Research Oceanographer at the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey, where he has been working since 2003. GFDL, which is part of the National Oceanic and Atmospheric Administration (NOAA), is one of the world's leading climate modeling centers. Dr. Vecchi received a B.A. in Mathematics from Rutgers University, and an M.S. in Oceanography, an M.S. in Applied Mathematics and a Ph.D. in Oceanography from the University of Washington. His scientific research focuses on the interactions between the atmosphere and oceans on timescales from weeks to centuries. His recent research has focused on understanding long-term changes to tropical circulation and variability, including characterizing changes relevant to the possible impact of climate change on hurricanes.

Dr. Vecchi currently serves on the Climate Variability and Predictability (CLIVAR) Indian Ocean Panel, and is an Associate Editor of the Journal of the Atmospheric Sciences. His awards include the Presidential Early Career Award for Scientists and Engineers (PECASE), the American Geophysical Union's Editor's Citation for Excellence in Refereeing for Geophysical Research Letters, and the Cook College, Rutgers University Marine Sciences Student of the Year. He has over 30 publications in peer-reviewed science journals or book chapters.

Thomas R. Knutson has been a Research Meteorologist at the Geophysical Fluid Dynamics Laboratory (GFDL) in Princeton, New Jersey since 1990. GFDL, which is part of the National Oceanic and Atmospheric Administration, is one of the world's leading climate modeling centers. Mr. Knutson has authored several modeling studies in major scientific journals on the potential impact of climate change on hurricanes. He now leads a project at GFDL aimed at simulating past and future Atlantic hurricane activity using regional high-resolution models.

He currently serves on the World Meteorological Organization (WMO) Expert Team on Climate Impacts on Tropical Cyclones, and was a major contributor to the December 2006 WMO "Statement on Tropical Cyclones and Climate Change". He is a member of a U.S. Climate Change Science Program (CCSP) committee developing an assessment report on "Weather and Climate Extremes in a Changing Climate," the AMS Climate Variability and Change Committee, and is an Associate Editor of the Journal of Climate. Mr. Knutson has over 30 publications in peer-reviewed science journals or book chapters.

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Tags hurricanes

http://www.nasa.gov/centers/goddard/news/topstory/2007/newman_montreal.html

FEATURE

Montreal Protocol Selects Goddard's Paul Newman as Scientific Assessment Panel Co-Chair

10.25.07

The 191 nations of the Montreal Protocol have selected Dr. Paul A. Newman, an atmospheric physicist in the Atmospheric Chemistry and Dynamics Branch at Goddard Space Flight Center, as co-chair of their Scientific Assessment Panel. The Montreal Protocol is the historic international agreement that protects the Earth's ozone layer.

Image right: Dr. Paul A. Newman **Image Courtesy:** Ilias Anagnostopoulos

The 1987 Montreal Protocol established three panels to periodically provide updates on matters related to the ozone layer. As co-chair of the Scientific Assessment Panel, Newman is specifically charged with providing assessments of the science related to the ozone layer, ozone-depleting substances, climate and ozone interactions, and ultraviolet radiation at the Earth's surface.

"I'm really honored by my selection," said Newman. "First, it's still a very important task as ozone begins to show the first signs of recovery, and second, because my colleagues have entrusted me with the continuations of this work."

Newman's background and experience has more than prepared and him for this prestigious position. He graduated from Seattle University with a bachelor of science in physics and a minor in mathematics. He completed his doctorate in physics at Iowa State University.

For 17 years Newman has been with NASA, where his principal area of research has been stratospheric dynamics and chemistry. Newman has participated in and led more than 15 NASA aircraft field campaigns, including trips to Costa Rica, Sweden, Norway, and Alaska. During the SAGE III Ozone Loss and Validation Experiment (SOLVE) in 2000, Newman directed the first flight of the NASA ER-2, a civilian version of the U-2 spy plane, over Russia since the famous shoot-down of Gary Powers in May 1960 at the height of the Cold War.

Newman has also spent time researching the Antarctic ozone hole during his career with NASA. In the summer of 2006, he published a new prediction of the recovery of the Antarctica ozone hole.

In addition to Newman, the committee includes Ayité-Lô Nohende Ajavon of Université de Lomé in Togo, John Pyle of Cambridge University, U.K., and A.R. Ravishankara of the U.S. NOAA Earth Sciences Research Laboratory.

Lynn Chandler
Goddard Space Flight Center

National Aeronautics and Space Administration

FEATURE

Print This Close Window

Local Sources Major Cause of U.S. Near-Ground Aerosol Pollution **11.16.07**

A new NASA study estimates that most ground-level particulate pollution in the United States stems from regional sources in North America and only a small amount is brought to the country from other parts of the world.

Image right: A cloud of pollution hangs over the Eastern United States in this image captured in July 2002 by NASA's Moderate Resolution Imaging Spectroradiometer (MODIS). The majority of such haze originates locally in North America, and only a small amount is imported from other continents, new research suggests. + Larger image Credit: Jacques Descloitres, MODIS Land Rapid Response Team, NASA/GSFC

Researchers using an innovative global aerosol tracking model have for the first time produced a global estimate of sources and movements of aerosols near the ground where they can affect human health and run afoul of environmental regulations. Previously, researchers studying aerosols moving between continents focused primarily on tracking a single type of aerosol, such as dust or black carbon, or measuring their quantities throughout the atmosphere. This left gaps in understanding where ground-level particulate pollution comes from.

"This is the first study to comprehensively consider the origin, composition and type of fine particles over the United States and connect them to both domestic and foreign sources." said Mian Chin, an atmospheric scientist at NASA's Goddard Space Flight Center, Greenbelt, Md., and lead author of the study.

Aerosols are airborne particles that arise from both human sources such as burning fossil fuels, and natural sources such as fires, dust and volcanoes. They are also a major source of near-ground pollution. Since 1970, particulate matter has been regulated in the United States by the Clean Air Act. A more recent concern has been aerosols that arrive here from distant shores carried by the wind.

Chin and colleagues set out to investigate how much and what type of aerosols made the intercontinental journey in 2001. The team employed the help of a computer model using known air chemistry and wind patterns to trace a region's aerosols – everything from fossil fuel and biofuel combustion, biomass burning, and volcanic sources, desert dust and sea salt – back to their sources.

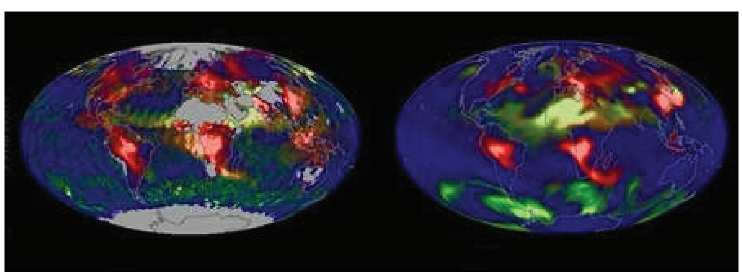

Image left: Aerosols in Earth's atmosphere can be a major source of pollution worldwide, and include fine aerosols such as pollution and smoke (red) and coarse aerosols such as dust and sea-salt (green). The left image shows aerosol levels on April 13, 2001 as seen by a NASA satellite. The map at right is a computer simulation of the same day showing that the model accurately estimates the transport of aerosols between continents. + Larger image Credit: NASA

"Using the model, we followed the path of aerosols to find out how much is local and how much is from outside a region," Chin says.

Chin and colleagues estimate that between 65-70 percent of surface particulate matter in the eastern U.S. originates from regional pollution aerosols from fuel combustion in North America. The report was in the Nov. 1 edition of the European Geosciences Union's Atmospheric Chemistry and Physics.

They also found that 30-40 percent of fine particulates in the western U.S. come from local pollution sources. The model results estimated that just 2-6 percent of U.S. surface fine particulates come from fuel combustion particles emitted outside of North America, including Asia and Europe. About 50 percent of surface fine particulate matter in the western U.S. stems from a natural source: dust transported from Asia or from local deserts and organic aerosols from vegetation.

"Our results indicate that controlling regional pollution emissions will be the most effective and most responsible way to manage U.S. air quality," Chin says.

Kathryn Hansen
Goddard Space Flight Center

Find this article at:
http://www.nasa.gov/vision/earth/environment/particulate_pollution.html