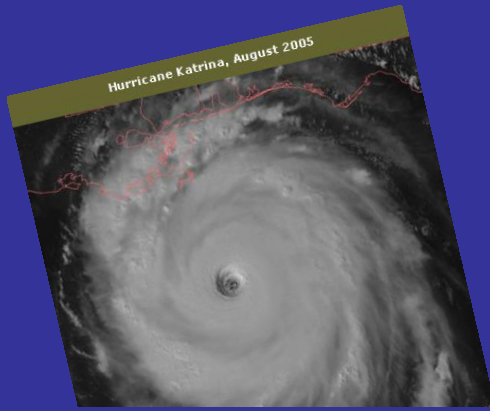
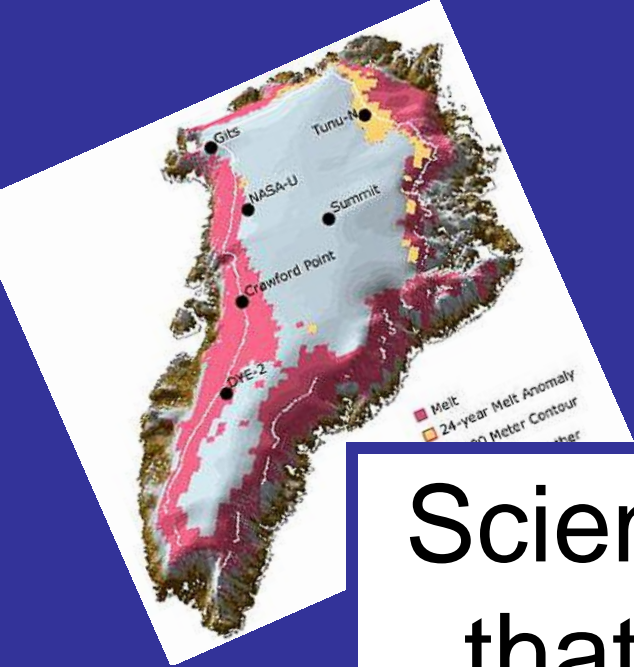
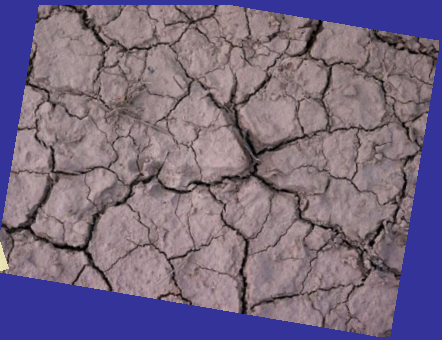


**Topic #1:
GLOBAL CHANGE:
THE SCIENCE &
THE ISSUES**



Science is demonstrating that this planet is more vulnerable than had previously been thought.
~ Richard Benedick



TROPICAL STORMS & HURRICANES

Are they increasing
in Magnitude and/or Frequency?

An important **GLOBAL CHANGE SCIENCE** question !



August,
6 years ago:

Hurricane Katrina

Could it happen again? Are such storms going to be more likely in the future?

<http://www.nhc.noaa.gov/#IRENE>

OBJECTIVES FOR TODAY'S CLASS:

- Gain an understanding of the huge scope of **Global Change scientific research:**
at UA, nationally, and internationally
- Get the big picture of what **GLOBAL CHANGE SCIENCE** is telling us: **“The Science Indicators”**
- Get the big picture of what is under discussion and debate regarding the **SCIENCE:** **“The Issues”**

Under Course Logistics:

- Learn how to navigate your **E-text** & our **class D2L site**

THE SCOPE OF GLOBAL CHANGE SCIENCE



GLOBAL CHANGE SCIENCE

“The one universal ever-operating law throughout has been the law of change . . .” ~ Laurence M. Gould

Earth has always been changing in:

Atmosphere (gases – composition, abundance, vertical structure)

Solid Earth (core, mantle, crust, plate tectonics, volcanism, surface processes)

Hydrosphere (liquid, gaseous, solid)

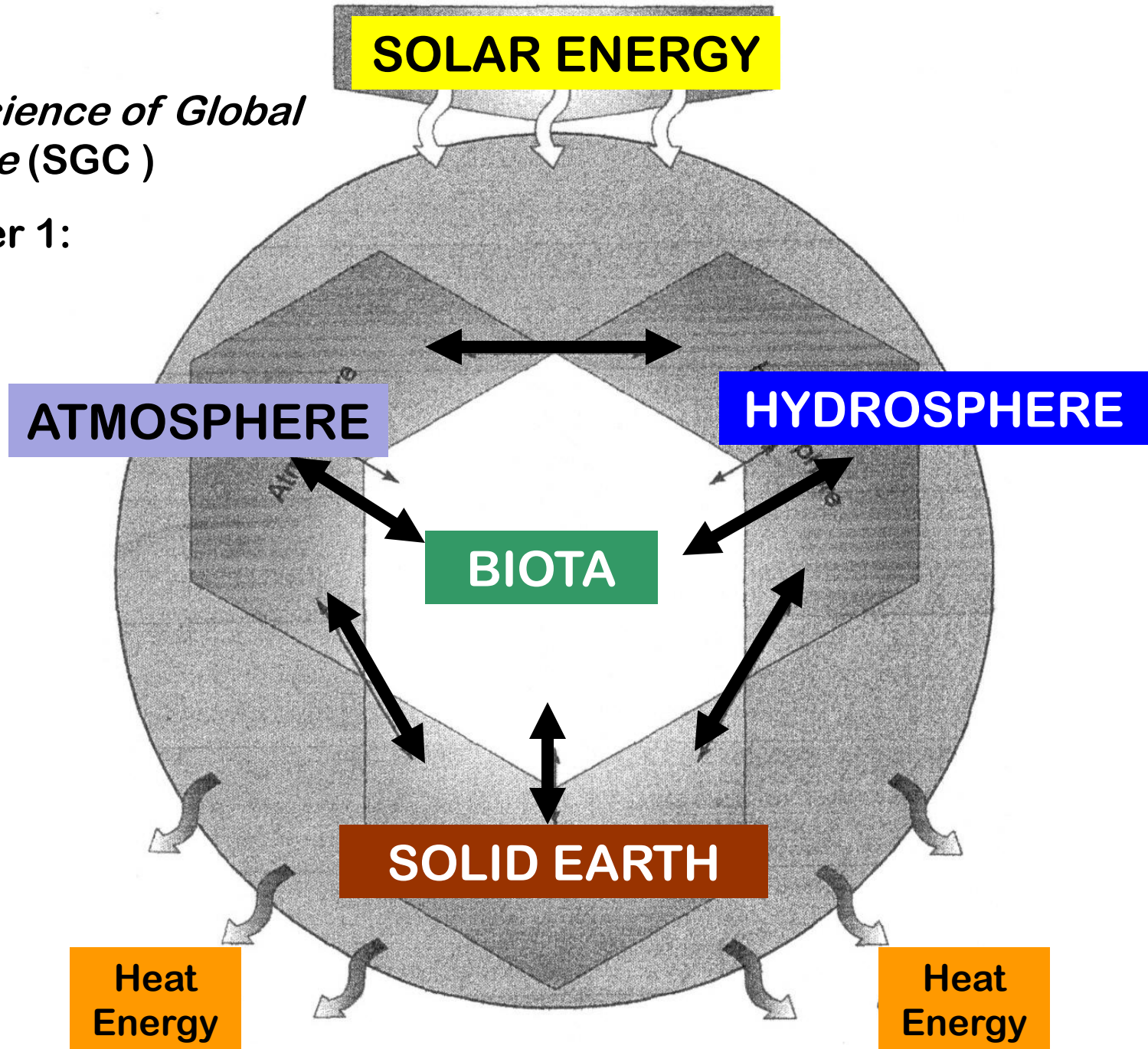
Biota (biosphere) (animal & plant life)

. . . .and in patterns and distribution of the above

From:

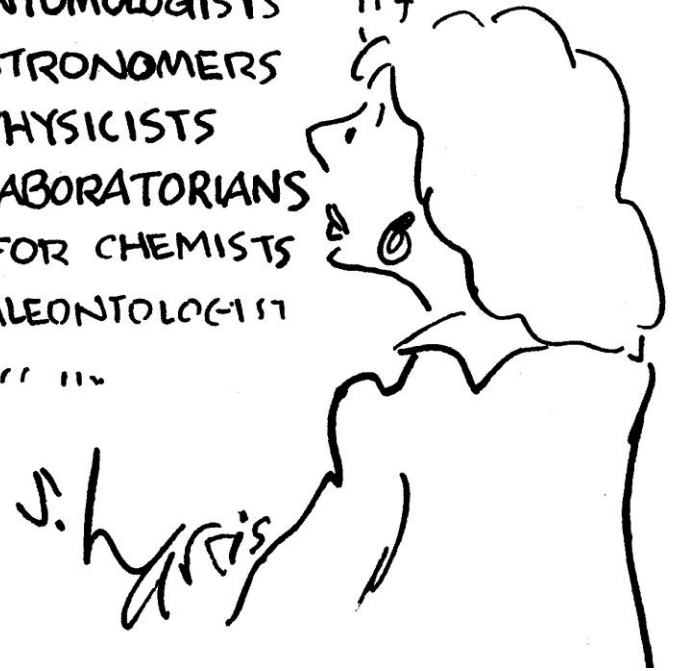
The Science of Global Change (SGC)

Chapter 1:



INTERDISCIPLINARY STUDIES

| | ROOM |
|------------------------------|------|
| CHEMISTRY FOR GEOLOGISTS | 127 |
| MATH FOR ARCHEOLOGISTS | 214 |
| PHYSICS FOR PSYCHOLOGISTS | 206 |
| BIOLOGY FOR MATHEMATICIANS | 319 |
| GEOLOGY FOR ENTOMOLOGISTS | 114 |
| BOTANY FOR ASTRONOMERS | |
| ANATOMY FOR PHYSICISTS | |
| PSYCHOLOGY FOR LABORATORIANS | |
| ANTHROPOLOGY FOR CHEMISTS | |
| TOPOLOGY FOR PALEONTOLOGISTS | |
| NUCLEAR PHYSICS III | |



Hence
studying global
change
requires an
interdisciplinary
approach

GLOBAL CHANGE SCIENCE IN ACTION

... at U of A ←

... Nationally

... Internationally

Your Teaching Team



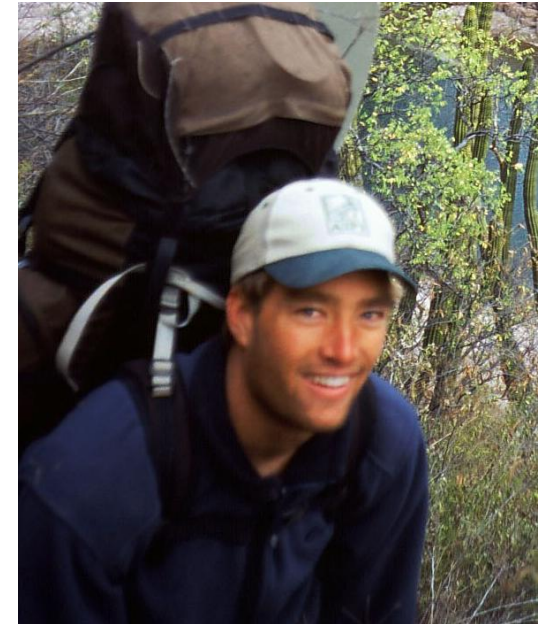
Katie Hirschboeck



Rebecca Franklin



Laura Marshall



Kanin Routson

How Global Change Science is done:

Many disciplines involved, e.g., at U of A:

Geosciences ← Rebecca

Hydrology & Water Resources
Atmospheric Sciences ← Dr H
Laboratory of Tree-Ring Research
School of Geography & Development

School of Natural Resources & Environment ← Laura

Plant Sciences
Udall Center for Studies in Public Policy
Soil & Water Science

Arid Lands Resource Sciences ← Kanin

Latin American Studies Center
Planetary Sciences
Optical Sciences Center
Electrical and Computer Engineering
Ecology & Evolutionary Biology
Anthropology

Economics & Agricultural Economics . . . etc. etc.



Institute of the Environment

Institute of the Environment (IE)

www.environment.arizona.edu

& The University of AZ's Committee on Global Change



The screenshot shows the homepage of the Institute of the Environment at The University of Arizona. The header includes the university logo and the institute's name. A navigation menu contains links for Home, About Us, Research Initiatives, Academic Programs, Funding Opportunities, People, Events, News, and Environmental Portal. A search bar is located below the navigation. The main content area features a 'Spotlight' section with an article titled '"Oh Earth, Wait for Me": Conversations about Art and Ecology' dated August 11, 2009. Below this is an 'Events' section listing a 'A Thousand-Year Record of Temperature Variations in Germany and Central Europe Based On Documentary Data' on Friday, September 11, 2009. A 'News' section at the bottom features a video titled 'Video: UA Solar Achievements in Science, Architecture and Art' dated September 1, 2009. A red box highlights the 'News' and 'Environmental Portal' links in the navigation menu.

Our Mission

The Institute of the Environment collaborates across The University of Arizona campus to understand, communicate, and solve the environmental challenges facing our world, nation, and state, as well as to help the people of Arizona seize opportunities created by these challenges.

ENVIRONMENT AND SUSTAINABILITY PORTAL

Your gateway to environmental research, education and sustainability at the University of Arizona

Home

Academics

Research

Campus Sustainability

Outreach

Students



Students Saving Slop

A student-led initiative is turning lemon peels, coffee grounds and other waste from UA dining areas into "Wildcat Compost" that will be on the shelves of nurseries around Tucson by next year.

[Read more](#)

Photo Credit: University of Arizona External Relations



Events

The Last Mountain
Wed., August 24, 2011
7:30 PM - 9:30 PM
Community Event

Advancing the Field and
Practice of Landscape-scale
Approaches to
Conservation, Resource
Management, and
Sustainability
Fri., August 26, 2011
12:00 PM - 2:00 PM
Talk

Fall 2011 SWES Department
Introductory Seminar
Mon. August 29, 2011

Environment in the News



August Southwest Climate Outlook Released

August 23, 2011 | CLIMAS
Forecasts call for slightly increased chances for below-average rain in September and increasing odds that La Niña conditions will return this winter.



Evidence Suggests La Niña Will Return This Winter

August 23, 2011 | CLIMAS
Mounting evidence points to a possible return of La Niña this fall. This is not good news for the Southwest, where severe to exceptional drought conditions already cover much of Arizona and New Mexico.

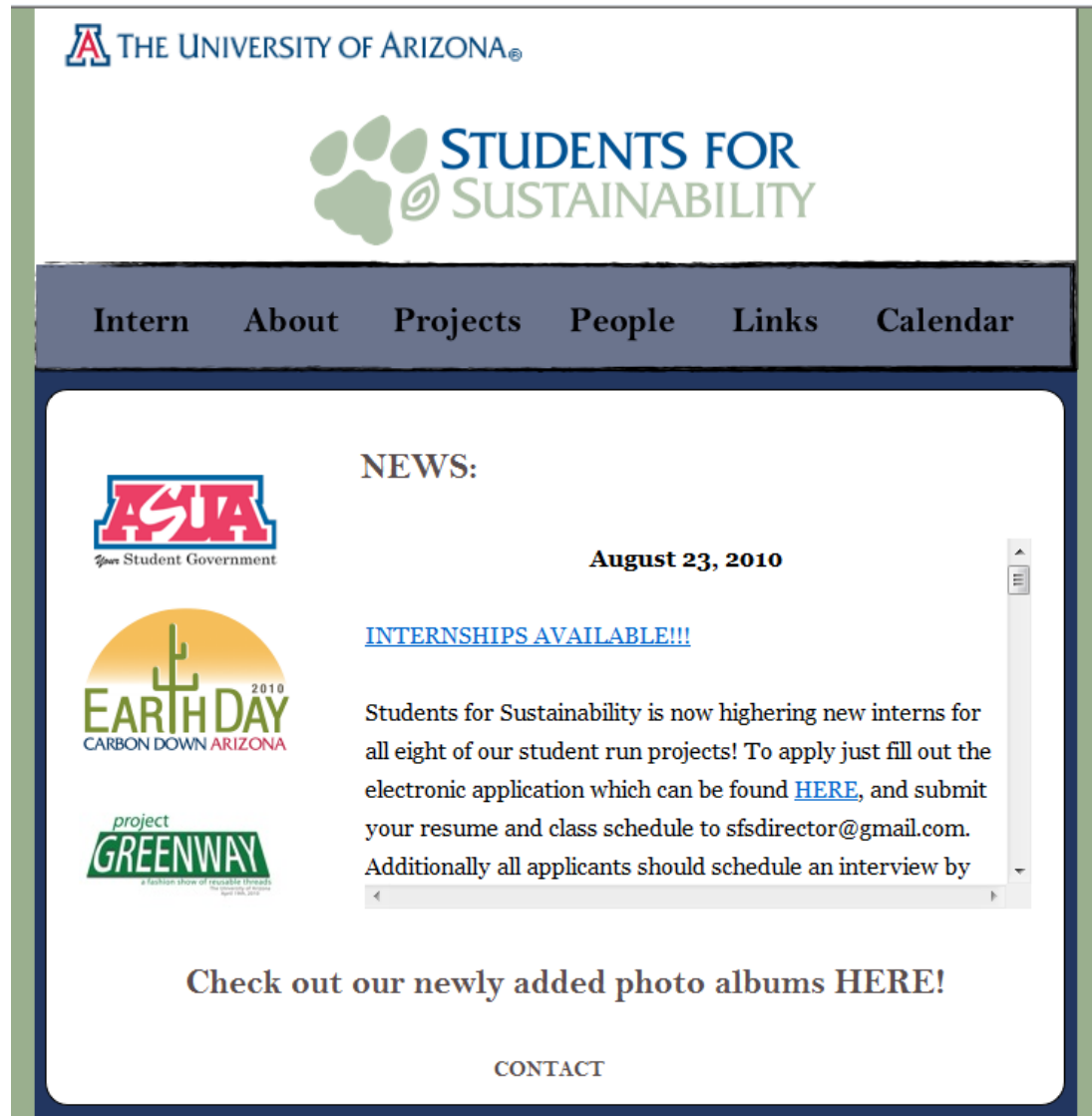
Stay informed, get involved

UA Environment Weekly 

Research Themes

- CLIMATE
- CULTURE and CREATIVE ARTS
- ECOSYSTEMS
- ENERGY
- ENGINEERING and DESIGN for SUSTAINABILITY
- FOOD and AGRICULTURE
- GOVERNANCE and POLICY
- HEALTH
- SCIENCE for SOCIETY
- WATER

ASUA SUSTAINABILITY COMMITTEE INTERNSHIP POSITIONS



The screenshot shows the website for ASUA Sustainability. At the top left is the University of Arizona logo. To its right is the ASUA logo with the text "ASUA Student Government". The main header features the "STUDENTS FOR SUSTAINABILITY" logo, which consists of a green paw print icon and the text "STUDENTS FOR SUSTAINABILITY". Below the header is a dark blue navigation bar with the following links: "Intern", "About", "Projects", "People", "Links", and "Calendar". The main content area has a "NEWS:" section with a date of "August 23, 2010". The news item is titled "INTERNSHIPS AVAILABLE!!!" and includes the text: "Students for Sustainability is now highering new interns for all eight of our student run projects! To apply just fill out the electronic application which can be found [HERE](#), and submit your resume and class schedule to sfsdirector@gmail.com. Additionally all applicants should schedule an interview by". To the left of the news text are three logos: ASUA Student Government, 2010 Earth Day Carbon Down Arizona, and Project Greenway. At the bottom of the page, there is a link to "Check out our newly added photo albums [HERE!](#)" and a "CONTACT" link.

<http://sustainability.asua.arizona.edu>

GLOBAL CHANGE SCIENCE IN ACTION

... at U of A

... **Nationally** ←

... Internationally

U.S. GLOBAL CHANGE RESEARCH PROGRAM



Integrating federal research on climate and global change

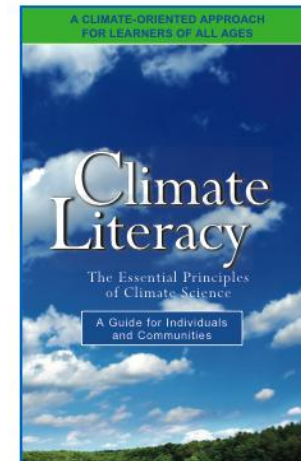
<http://www.globalchange.gov/>



Reports and Assessments



Annual Reporting to Congress



GLOBAL CHANGE SCIENCE IN ACTION

... at U of A

... Nationally

... **Internationally** ←

Intergovernmental Panel on Climate Change (IPCC)

<http://www.ipcc.ch/>



© © The Nobel Foundation

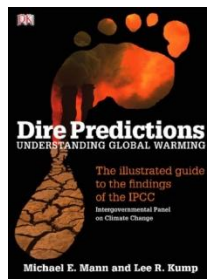
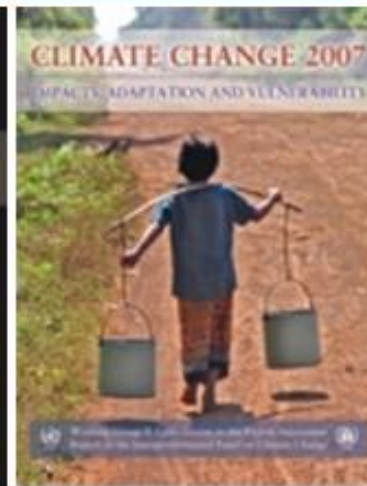
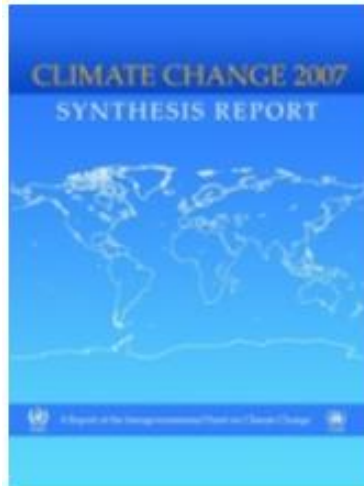
IPCC honoured with the
2007 Nobel Peace Prize

The AR4 Synthesis
Report

WG I
The Physical
Science Basis

WG II
Impacts, Adaptation
and Vulnerability

WG III
Mitigation of
Climate Change



“The illustrated guide to the findings of the IPCC”

**The Big Picture:
SCIENCE INDICATORS
POINTING TO GLOBAL
CHANGE**



THE BIG PICTURE: THE SCIENCE INDICATORS

1. **Climate Change is real:** change has happened, change is happening, change will continue to happen in the future
2. The **Earth is warming**
3. **Humans** are causing a significant portion of this recent warming
4. The warming **will continue**
5. Globally the **net result will be bad** for people, plants, and animals
6. There are **legitimate unresolved questions**
7. There are related -- but distinctly different -- **global change processes of great concern:**
specifically, **ozone depletion & biodiversity loss**

Indicators of a Warming World



Indicators of a Warming World

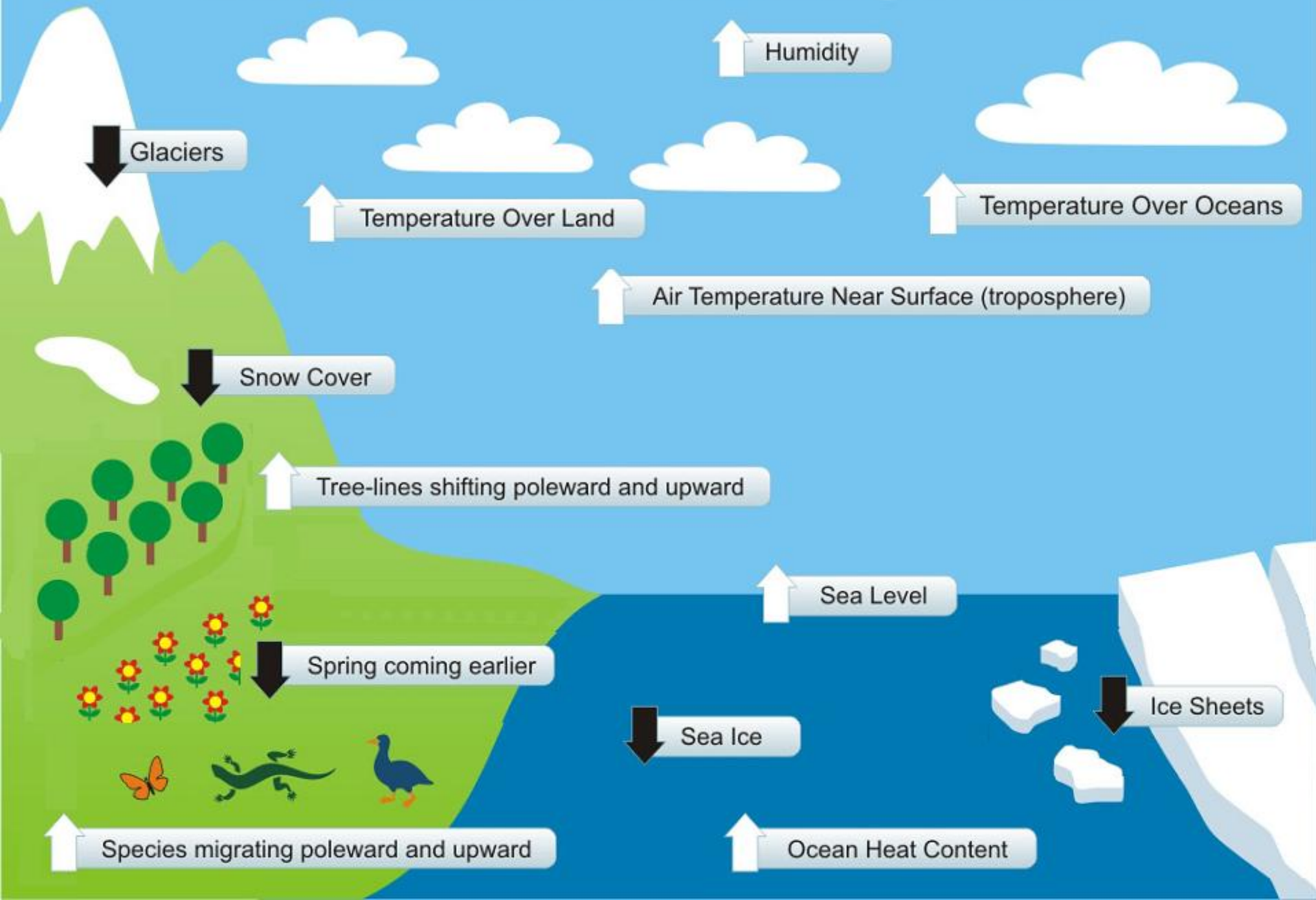
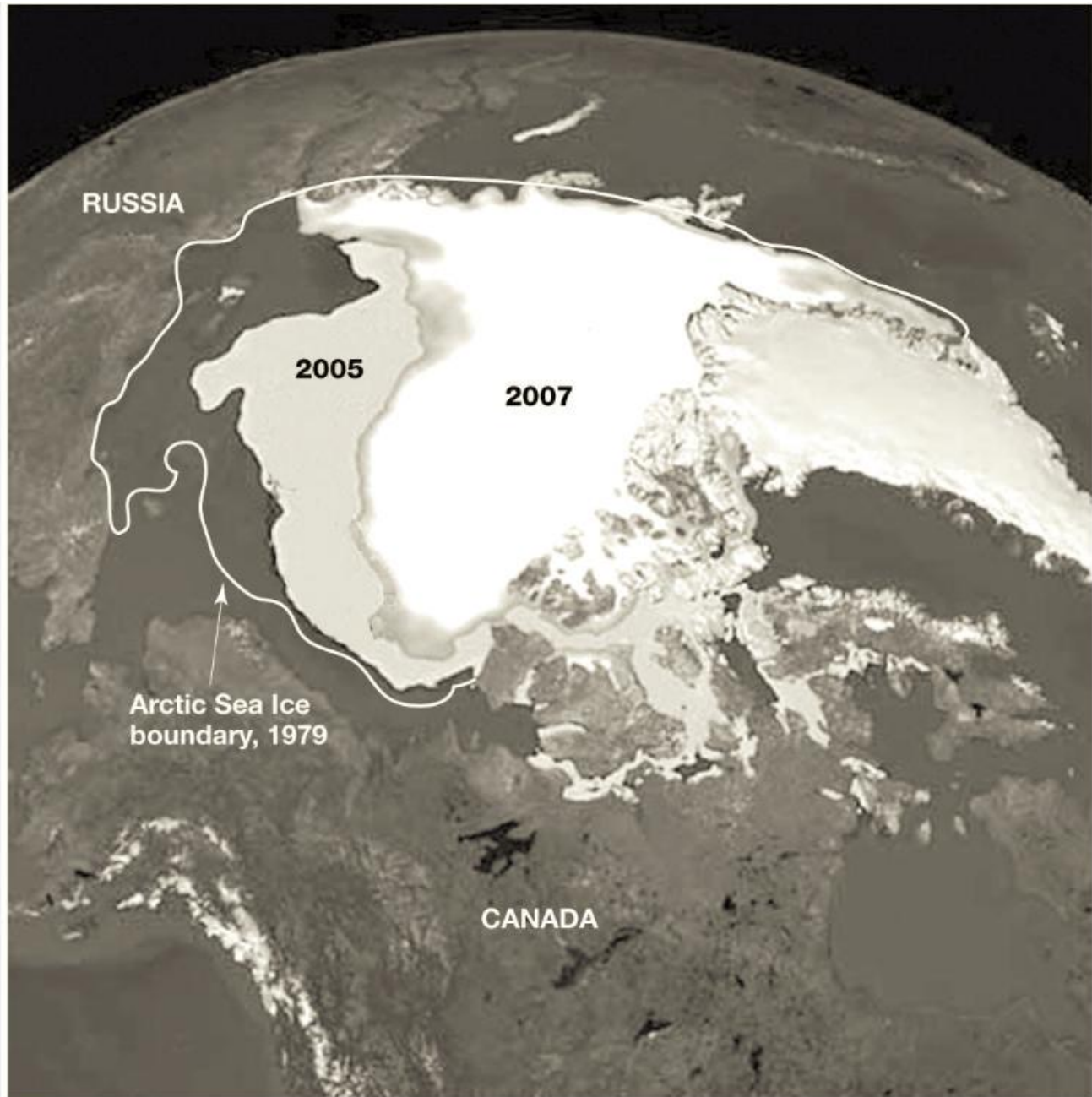


Fig 1-5 in SGC



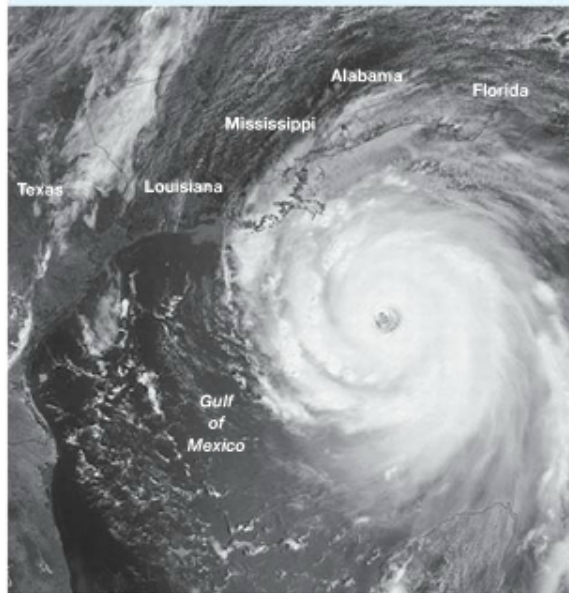
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A CLOSER LOOK

Are Hurricanes Getting Stronger with Time?

Hurricane Katrina (Box Figure 1-1) formed over the Bahamas on August 23, 2005. It crossed over Florida as a weak, Category 1 storm, then grew rapidly in strength as it drew energy from the unusually warm surface waters of the Gulf of Mexico. Within a few days, it had turned into a powerful Category 5 hurricane—the highest rating given to such storms—meaning that it had sustained winds over 155 mph, or 249 km/hr. On August 29, it slammed into the U.S. Gulf Coast as a Category 3 storm (111–130 mph). But it was still enormous in extent, with hurricane-force winds extending out more than 120 miles from its center. The low pressure at its center, combined with the onshore winds on the eastern side of the hurricane, caused a powerful storm surge of as much as 14 feet that overwhelmed the levees holding back Lake Pontchartrain and the southernmost outlets of the Mississippi River. The consequences for New Orleans were devastating. Large parts of the city were flooded, over 700 people were killed in New Orleans alone, and the nearby Mississippi Gulf Coast was similarly ravaged.



BOX FIGURE 1-1 Hurricane Katrina near peak strength, August 28, 2005. (Source: Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC.)

In that same year, 2005, two important papers were published in the prestigious journals *Nature* and *Science*. The first, by Kerry Emanuel of the Massachusetts Institute of Technology, suggested that warmer sea-surface temperatures induced by anthropogenic greenhouse gases might result in stronger hurricanes in the future. Hurricanes derive their tremendous power by tapping the energy present in surface water. Sunlight, combined with the strong winds generated by the hurricane, causes seawater to evaporate. When it recondenses as rain, its energy (or **latent heat**) is released, and this adds still more energy to the hurricane. Emanuel used existing meteorological datasets dating back to 1930 to show that these changes have actually been occurring, especially over the last 30 years.

The second paper, by Peter Webster of the Georgia Institute of Technology and his colleagues, provided additional evidence to support this hypothesis. Their key findings are shown in Box Figure 1-2. Many of the data for their analysis come from satellites, and so the record dates back only to 1972. Box Figure 1-2a shows sea-surface temperatures in various ocean basins. As one can see, they have all warmed by several tenths of a degree over this time period, consistent with the global average surface temperature data shown in Figure 1-4. Box Figure 1-2b shows the percentage of hurricanes of different categories over the entire globe per pentad. (A pentad is a period of 5 years.) The total number of hurricanes per pentad has remained roughly constant over this time period, so the *frequency* of hurricanes has not changed. But the percentage of the stronger Category 4 and 5 hurricanes has nearly doubled, suggesting that the *intensity* of hurricanes is increasing with time. This result is therefore consistent with Emanuel's independent analysis.

Whether or not this trend will continue into the future is unclear. The datasets used in both papers are too short to rule out the possibility that some decadal-scale natural cycle could account for the observed trend in hurricane strength. And Hurricane Katrina itself was not all that exceptional and cannot necessarily be attributed to global warming. Nevertheless, the combination of the two papers and the natural disaster really set the meteorological research community rocking. Large numbers of people live along tropical or subtropical coastlines that are affected by such storms. If stronger hurricanes are indeed to be expected in the future, many people will be concerned.

COURSE LOGISTICS: D2L Tour, Syllabus & FAQ & E-Text

The screenshot shows a D2L course page for GC170A Hirschboeck. The page layout includes a top navigation bar with links for My Home, D2L Email, Locker, Logout, D2L Help Pages, and University Libraries. Below this is a course-specific navigation bar with Course Home, Classlist, Chat, Discussions, GRADES, and Reading & RQ Schedule. The main content area is titled "GC 170A 'INTRODUCTION TO GLOBAL CHANGE'" and features a "COURSE TOOLS" section with various resource icons like Introduction to Global Change, class website, FAQ, checklist, Follow Up, movie, dropbox, assignment, self-test, quiz, and study guides. A "WELCOME!" section at the bottom contains a message from Dr. H. Callout boxes identify key elements: "D2L Help" and "UA Libraries" at the top; "Gradebook" in the course navigation; "Course Home" with a return link; "Reading & RQ Schedule" in the course navigation; "Semester-on-a-Page" in the course navigation; "Main GC 170A Course Tools here" pointing to the course tools grid; and "News & Announcements here" pointing to the welcome message.

<https://d2l.arizona.edu/>

ASSIGNMENTS FOR FRIDAY

- (1) D2L **CHECKLIST TOOL**
- (2) **Access the E-Text – read Chapt 1**
- (3) Register **your Clicker**
- (4) Read **the essay On Scientific Method**
(Password = **nats101gc**)
- (5) Take the 2 practice
SELF TESTS & Readiness Quizzes (RQ's)

The Big Picture: THE ISSUES





CLIMATE SUMMIT

WHAT IF IT'S
A BIG HOAX AND
WE CREATE A BETTER
WORLD FOR NOTHING?

- ENERGY INDEPENDENCE
- PRESERVE RAINFORESTS
- SUSTAINABILITY
- GREEN JOBS
- LIVABLE CITIES
- RENEWABLES
- CLEAN WATER, AIR
- HEALTHY CHILDREN
- ETC. ETC.



THE BIG PICTURE: THE ISSUES

1- **Global Climate Change** = How do we know it's happening and **what is causing it (human vs. natural)**? How will it affect regions, people, plants, animals? **Can we do anything about it?**

2- **Sustainability (ecological)** = How do we use our natural resources without depleting their stocks or irrevocably damaging ecosystems and the climate for future generations?

3- **Sustainability (economic)** = How can economic activity progress at a rate that meets (or surpasses) the needs of the planet and its population?

4. **Choices & Solutions** = Are (2) and (3) above at cross-purposes? What realistically effective actions can individuals and institutions take to address these issues?

WHAT'S CAUSING IT?

The most used “denier” arguments about the causes and effects of climate change

Climate's changed before

It's the sun

It's not bad

It's cooling

There is no consensus

Models are unreliable

Temp record is unreliable

Animals and plants can adapt

It hasn't warmed since 1998

And so forth.

**Is there REALLY
a “Human
Fingerprint” on
the observed
warming?**



From:

<http://www.skepticalscience.com/>

10 Indicators of a Human Fingerprint on Climate Change



How can we all live well and live within the means of one planet?

“This is the research question of the 21st century. If we are serious about sustainable development, there is no way around this question. If we do not design ways to live within the means of one planet, sustainability will remain elusive.”

The Global Footprint Network
<http://www.footprintnetwork.org/>



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