Science in Service of Society: Realizing the Promise of Climate Research

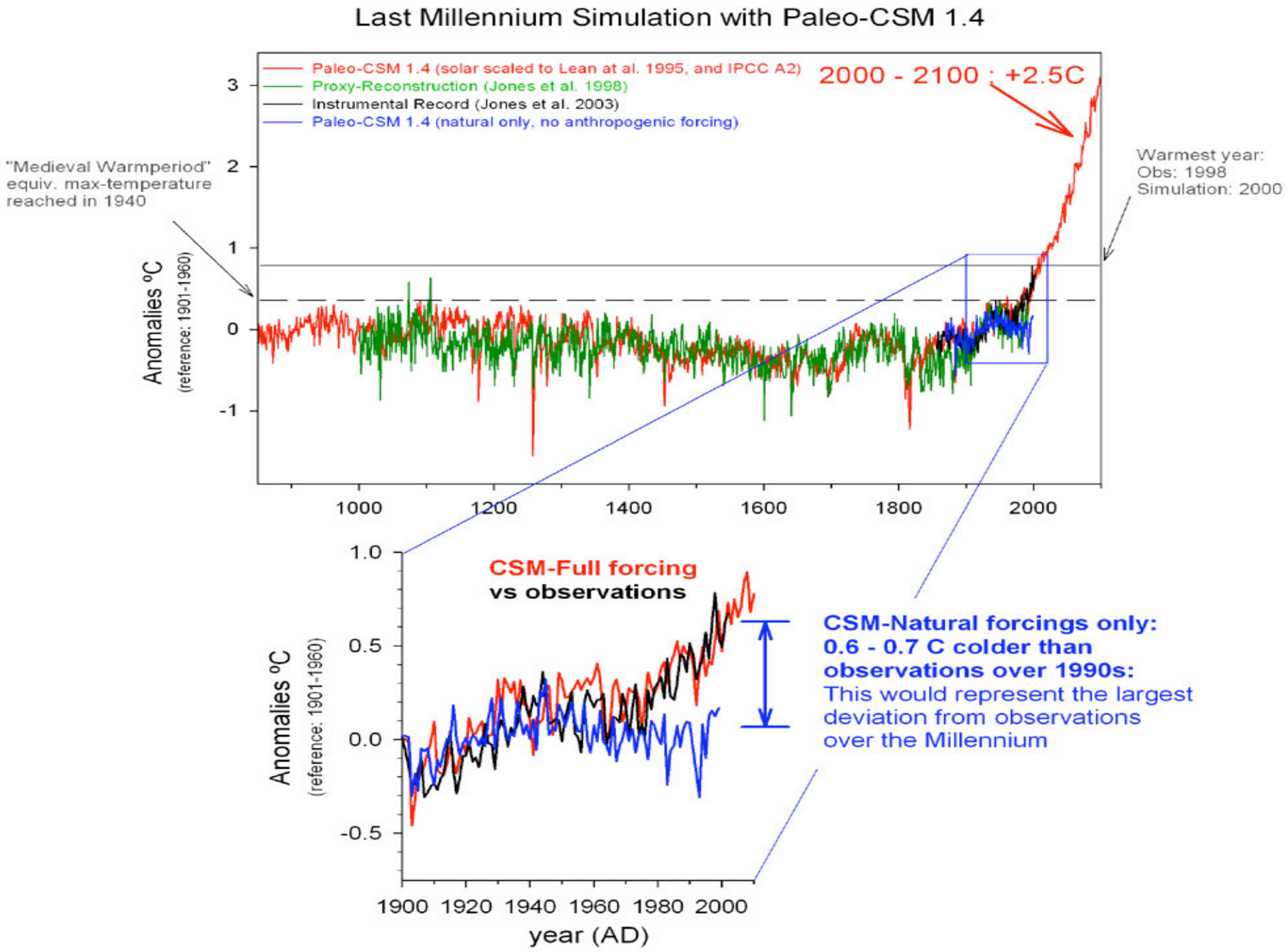
Raj Pandya
UCAR SOARS and
Community Building Program

CMMAP Meeting
January, 2008
UCLA

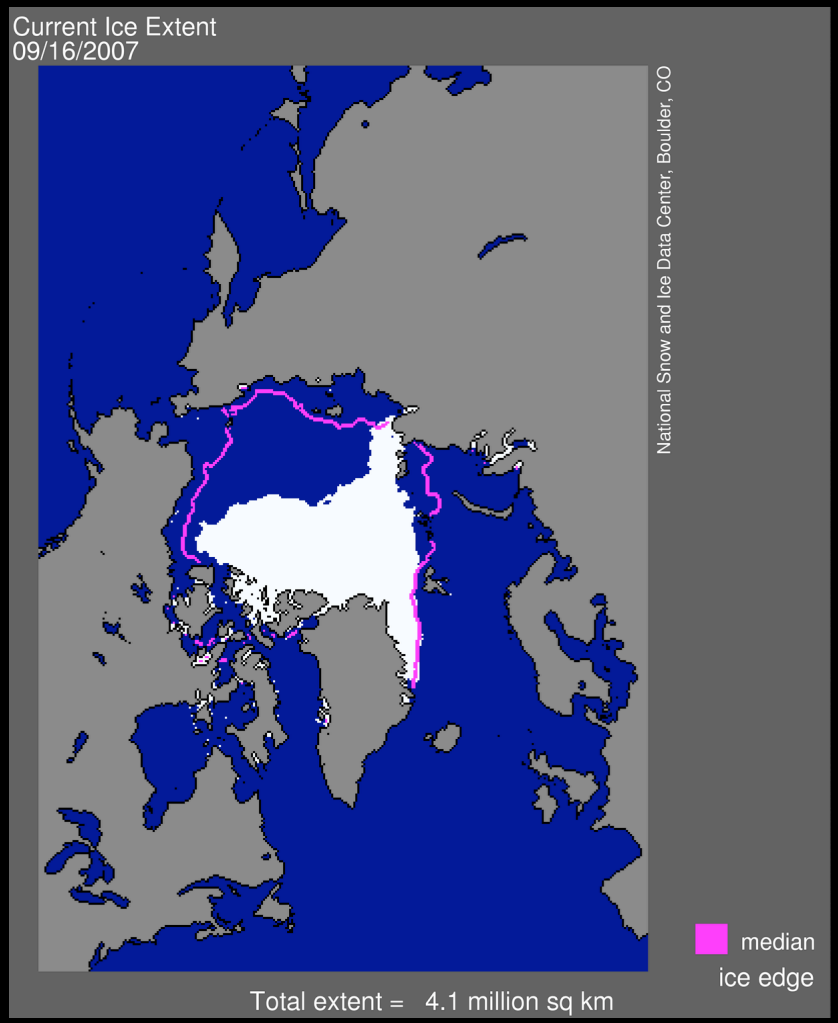
Overall Message

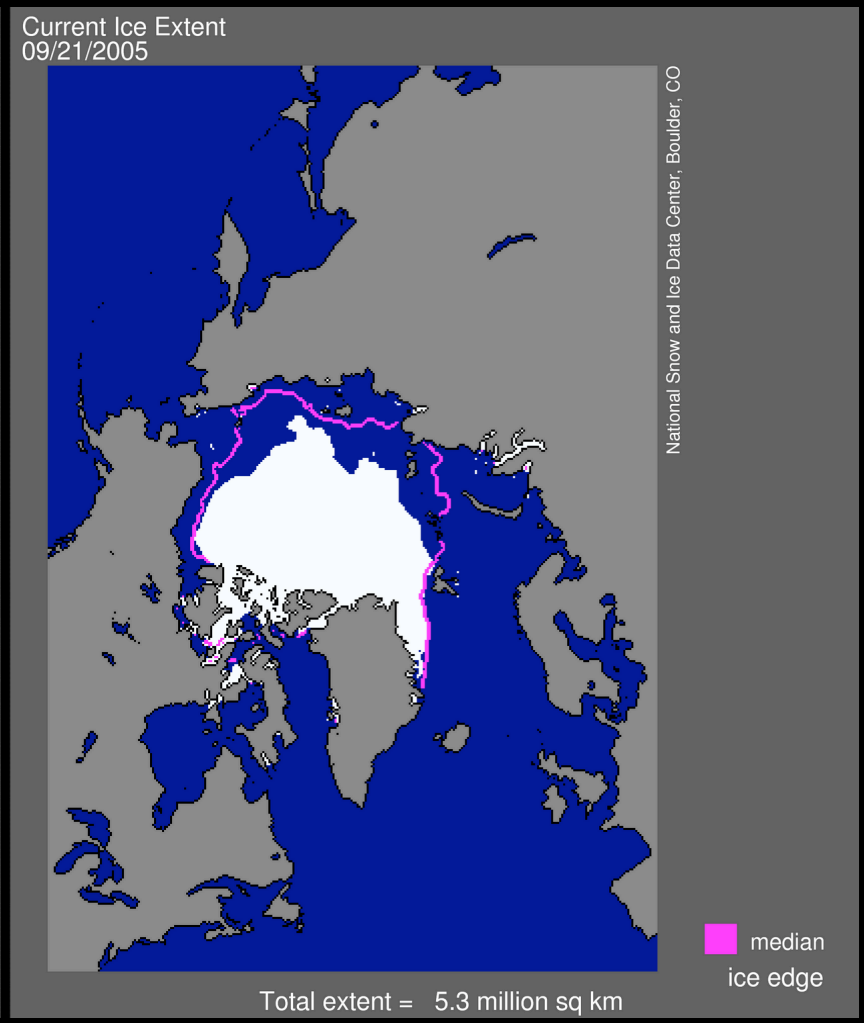
- We must connect ourselves and our science to broader societal issues of sustainability and education, for the health of our planet, our nation, and our field.
- We have an unprecedented opportunity to do that, right now, in climate

The Health of our Planet


Last Millennium Simulation with Paleo-CSM 1.4
Paleo-CSM 1.4 (solar scaled to Lean at al. 1995, and IPCC A2)
Proxy-Reconstruction (Jones et al. 1998)
Instrumental Record (Jones et al. 2003)
Paleo-CSM 1.4 (natural only, no anthropogenic forcing)
2000 - 2100 : +2.5C
"Medieval Warmperiod" equiv. max-temperature reached in 1940
Warmest year: Obs: 1998 Simulation: 2000
Anomalies °C (reference: 1901-1960)
3
2
1
0
-1
1000
1200
1400
1600
1800
2000
CSM-Full forcing vs observations
1.0
0.5
0.0
-0.5
1900 1920 1940 1960 1980 2000
year (AD)
CSM-Natural forcings only: 0.6 - 0.7 C colder than observations over 1990s:
This would represent the largest deviation from observations over the Millennium

Shrinking Arctic Ice





Historical relationship

“Cold is what makes my language, my culture, my identity. What am I going to do without cold?”

Oscar Kawagley, Yupiak

The Health of our Nation

Programme for International Student Assessment (PISA)

- International test of 15-year-old scholastic performance,
  - Implemented by Organisation for Economic Co-operation and Development .
- Measures ability to apply content to real-world contexts
- Administered in 2000, 2003, and 2006
- 2006 focused on science

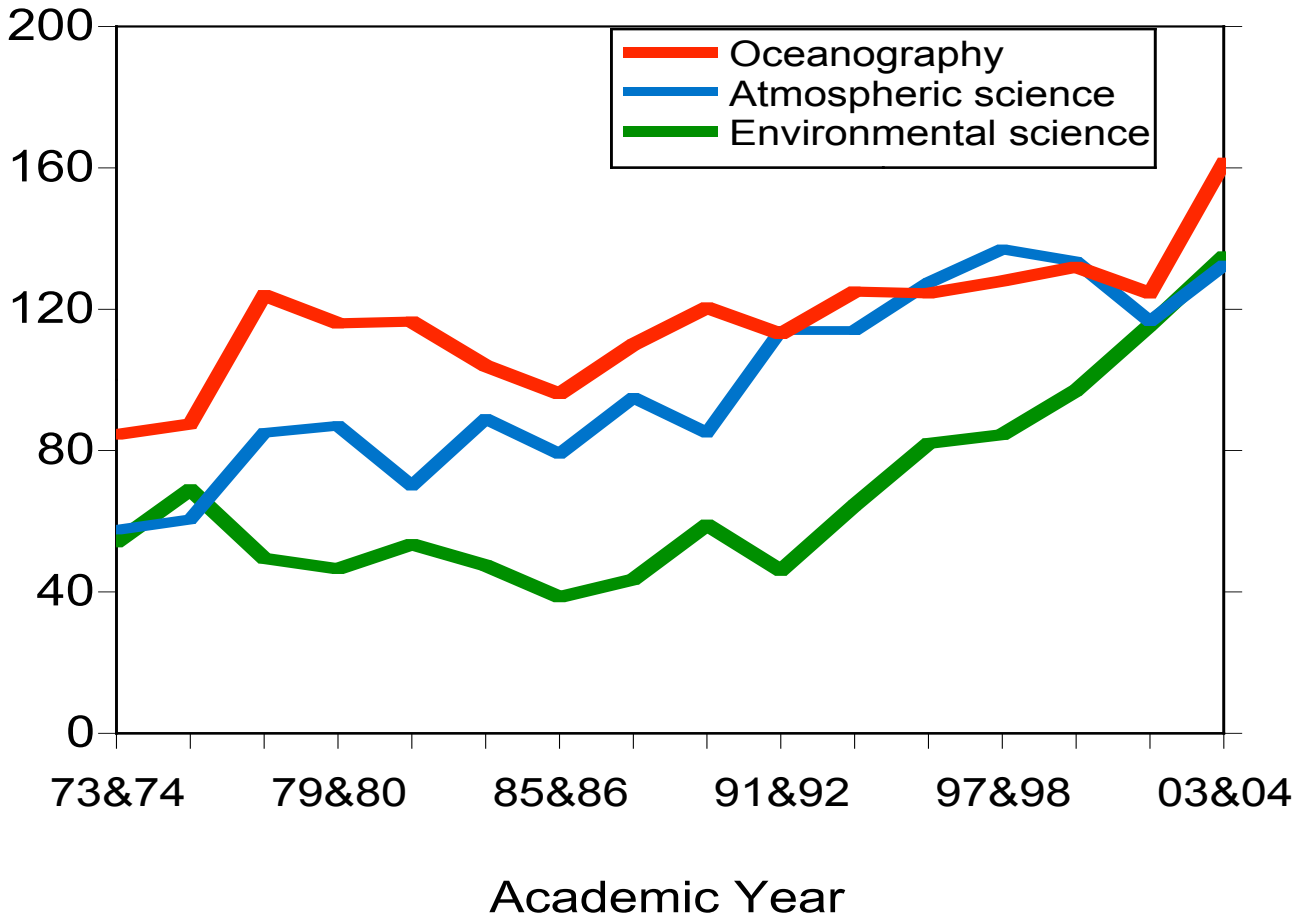
US Rankings in 2006

Reading Literacy	Mathematical Literacy	Scientific Literacy
1. Finland	1. Japan	1. Korea
2. Canada	2. Korea	2. Japan
3. New Zealand	3. New Zealand	3. Finland
4. Australia	4. Finland	4. United Kingdom
5. Ireland	5. Australia	5. Canada
6. Korea	6. Canada	6. New Zealand
7 United Kingdom	7. Switzerland	7. Australia
8. Japan	8. United Kingdom	8. Austria
9. Sweden	9. Belgium	9. Ireland
10. Austria	10. France	10. Sweden
11. Belgium	11. Austria	11. Czech Republic
12. Iceland	12. Denmark	12. France
13. Norway	13. Iceland	13. Norway
14. France	14. Liechtenstein	**14. United States**
15. United States	15. Sweden	15. Hungary
16. Denmark	16. Ireland	16. Iceland
17. Switzerland	17. Norway	17. Belgium
18. Spain	18. Czech Republic	18. Switzerland
19. Czech Republic	**19. United States**	19. Spain
20. Italy	20. Germany	20. Germany
21. Germany	21. Hungary	21. Poland
22. Liechtenstein	22. Russian Federation	22. Denmark
23. Hungary	23. Spain	23. Italy
24. Poland	24. Poland	24. Liechtenstein
25. Greece	25. Latvia	25. Greece
26. Portugal	26. Italy	26. Russian Federation
27. Russian Federation	27. Portugal	27. Latvia
28. Latvia	28. Greece	28. Portugal
29. Luxembourg	29. Luxembourg	29. Luxembourg

The health of our field

PhD degrees in atmospheric science, environmental science, and oceanography.

2 year averages 1973 & 74 through 2003 & 04.



AIP Statistical Research Center compiled from data collected by the National Center for Education Statistics.

Slide from Roman Czjuko

Ethnicity of Atmospheric Science PhDs (1973 to 2004)

- 3,166 Total PhDs
- 2,140 Total earned by US Citizens
- 30 Hispanic American PhDs
- 21 African American PhDs

Data from Roman Czujko, AIP Statistical Research Center

Why should we care?

- Global problems require global solutions
- Broader perspectives improve science
- Science should serve all communities
- Our future workforce depends on it
  - A majority-minority USA by 2050
- Need broadest and largest possible “brain pool”

PhD Job Market

- In 2003, 1.5% of PhDs in atmospheric science were unemployed, 6.3% “involuntarily out of field” up from 5.7% in 1999.
- Over 20% of post-docs in math, chemistry, and engineering report “other employment not available” as reason for their post-doc
- 13.5% of all post-docs are more than 6 years away from PhDs
- Increasing number of NCAR ASP post-docs go on to second temporary second positions

Too Many PhD's?

"No one who has come to the question with an open mind has been able to find any objective data suggesting general "shortages" of scientists and engineers. "

"Doctoral programs in many U.S. universities provide far less information to prospective and entering students about the career experiences of their recent graduates than do the law schools and business schools on the very same campuses."

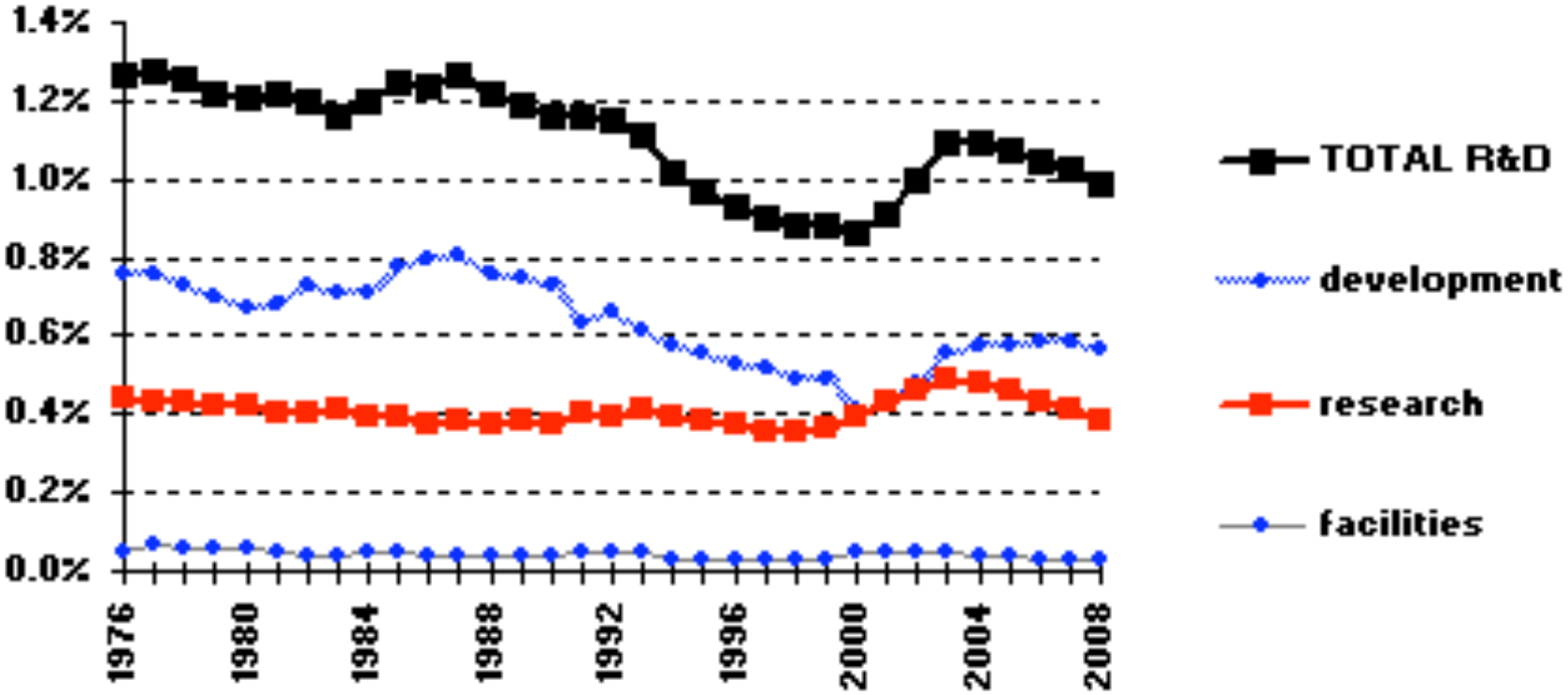
Michael S. Teitelbaum
Vice President, Alfred P. Sloan Foundation
Testimony to the Subcommittee on Technology and Innovation, Committee on Science and Technology, U.S. House of Representatives Washington, DC November 6, 2007

Dynamic modeling of the U.S. PhD and research funding systems

- University departmental needs drive intake of PhDs
- PhD admissions are insensitive to external labor market conditions
- Simulations of five years of research funding growth at 2% per year followed by stable funding produces a short-term increase in employment for recent PhDs, followed within a few years by declines in employment for recent PhDs

Charles A. Goldman and William F. Massy, The PhD Factory: Training and Employment of Science and Engineering Doctorates in the United States (Boston: Anker Publishing, 2001).

Trends in Federal R&D as % of GDP, FY 1976-2008



Source: AAAS analyses of R&D in annual AAAS R&D reports. FY 2008 figures are President's request. R&D includes conduct of R&D and R&D facilities. Data to 1984 are obligations from the NSF Federal Funds survey. GDP figures are from OMB, Budget of the U.S. Government FY 2008.

AAAS

Funding in Atmospheric and Related Sciences (FY08)

- NSF's research budget increases only 1.2 percent (instead of 8% for doubling in 10 years)
- NOAA's overall budget is $182 million below FY07, which was frozen at FY06
- DOE Office of Science budget received about half of its proposed increase, but close to half of that modest increase is for special congressional "earmarked" projects.
- The NASA Science Mission Directorate up 5.4 percent over the FY07 level (overall, NASA's earth science investment is down 35% in real dollars in last 4 years)

Challenges

- While our society increasingly depends on atmospheric science knowledge; it isn't clear that we are effectively connecting
  - US education is weakening, relative to the world
  - Science participation is lowest in the fastest growing demographic groups
  - Science degrees are focused on relatively scarce jobs in academe

Katrina – a missed connection

- Most expensive disaster in U.S. history—$300 billion
- Deadliest U.S. storm disaster since at least 1928
- Largest weather-related U.S. mass migration since the Dust Bowl (1930s)
- First near-total closure of U.S. city in modern times

Slide from Bob Henson


KEEP OUT
OR
BE SHOT
like a bomb hit it."
(AP PHOTO)
Victor H. Rivera-Monroy and Robert R. Twilley


Victor H. Rivera-Monroy and Robert R. Twilley

FOCUS THE NATION

Global Warming Solutions for America

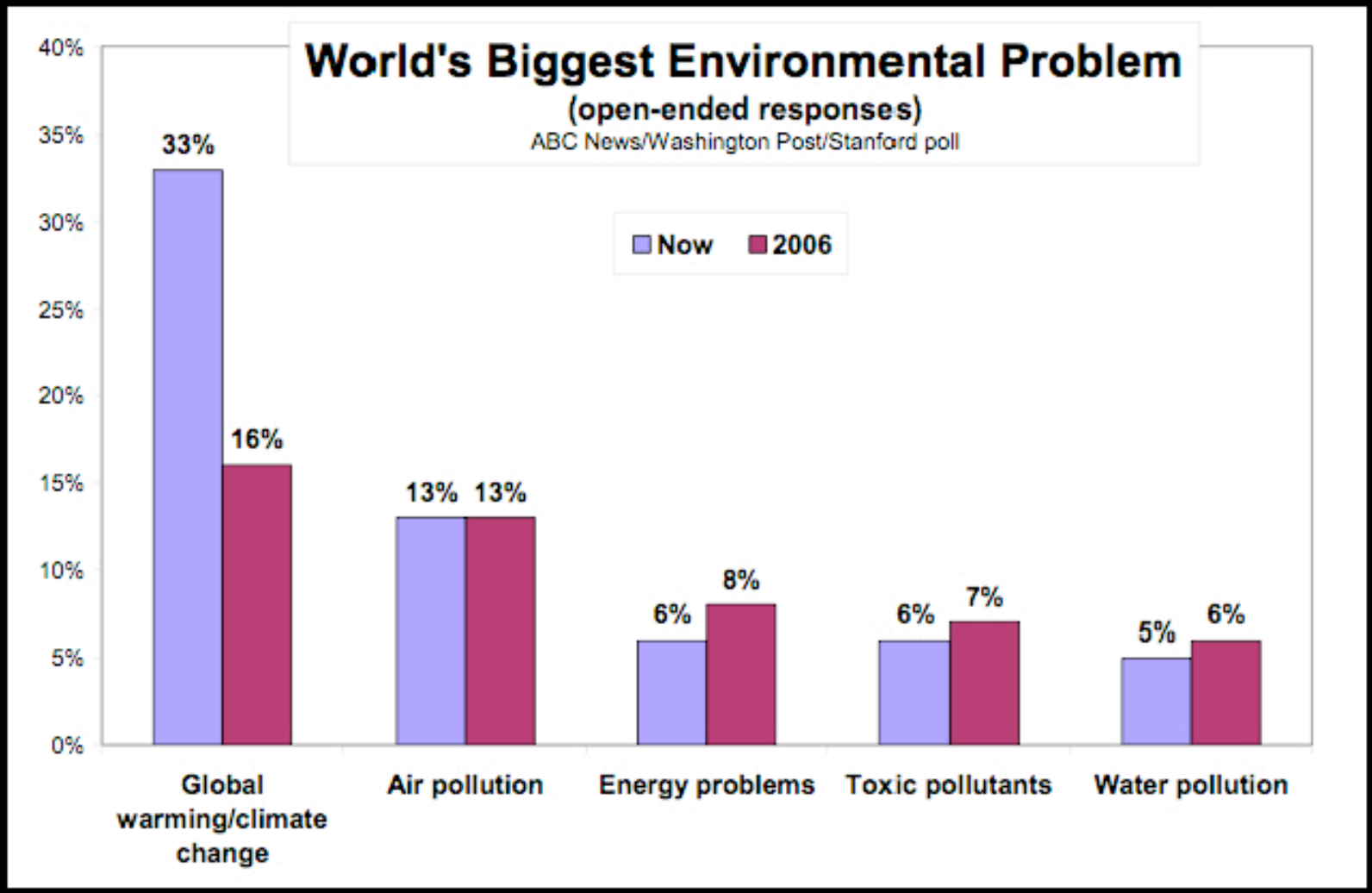
November 3rd, 2007 – National Day of Climate Action

STEP IT UP 2007

stopglobalwarming.org

All ten of the hottest years on record, globally, have occurred in the last fifteen years.

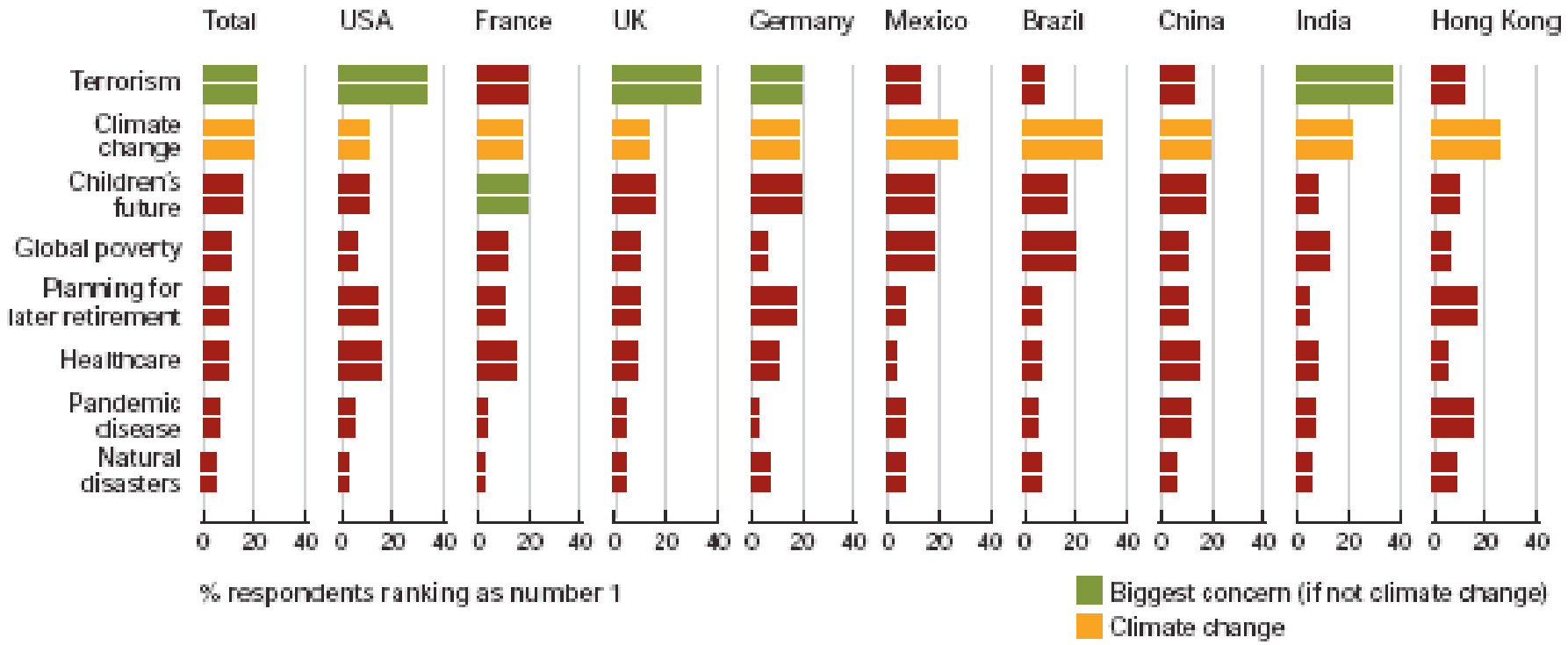
Where Is The Public?



ABC News/Washington Post/Stanford and OSU

Figure 3

Ranking of concern about the following list of world issues



A Changing Role for Atmospheric Science

- Old Conversation
  - About convincing people that “Its real, its human induced, its concerning”
- New Conversation
  - About helping people
  - Answers the questions, “what should we do about it?”
  - Places these concerns in context with other concerns

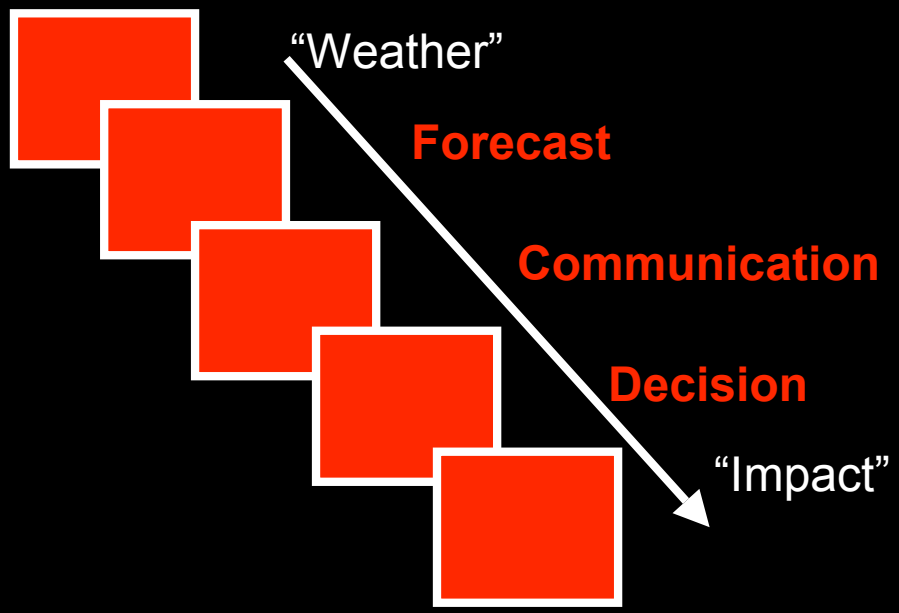
How can we adapt to this new role?

- Help our emerging atmospheric scientists to collaborate and contribute their expertise to societal issues
  - Attract and nurture diverse students
  - Provide opportunities in education & communication
  - Teach collaboration skills
  - Embed our curriculum in a larger context
  - Serve new communities

- “Communities of practice” can offer a framework to apply atmospheric sciences to societal problems

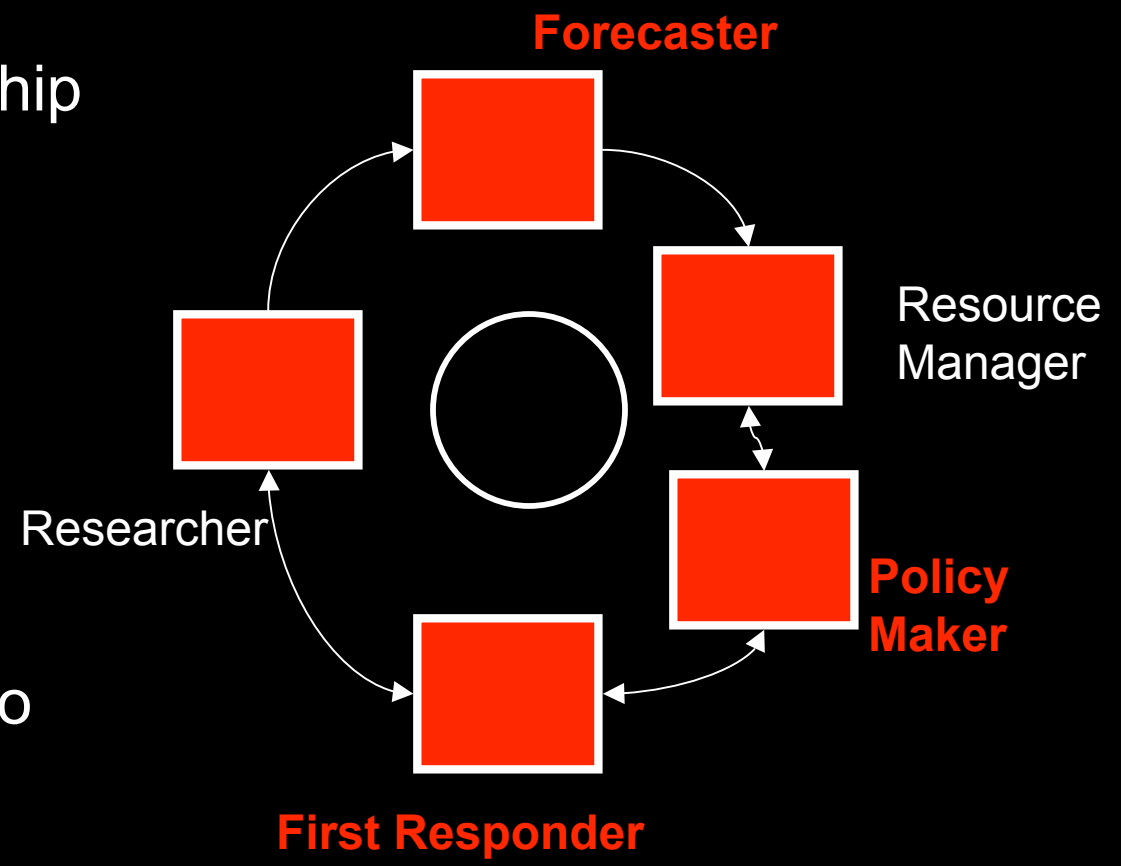
The value chain

- Weather information has little intrinsic value
- Most of the value of weather information is added or lost somewhere on the value chain
- Traditional “push” models of the value chain are problematic



Communities of Practice

- Evolve push relationship to a collaborative relationship between producers and users
- Learn to speak a common language
- Work collaboratively to integrate information



International Models

- In Britain, as in the United States, demand is growing within the private sector for climate expertise and for scientists able to bridge disciplinary boundaries.

- [In Germany] interest in basic climate science peaked several years ago….
  - Jochem Marotzke, a director of the Max Planck Institute for Meteorology in Hamburg
- "Yet a clear need is developing for detailed climate information for local governments…and there is a lot more work to be done before we can provide this information reliably".

Climate of opportunity, *Nature* 448, 618-619 (August 2007)

A Threat So Big, Academics Try Collaboration

NY Times, 25 December, 2007

"We want all the departments to contribute without thinking they own the initiative themselves."

ChangingClimates @ - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://changingclimates.colostate.edu/Home.html

GoodSearch

Gmail Remember The Milk SOARS UCAR SOARS Database My Meeting Maker Wx Outside Boulder forecast RAP Wx pandyawebshare Rock

CMMAP | ChangingClimates @

ChangingClimates @ Colorado State University

Home People Colloquium Courses Resources Poster

What, exactly, is causing Earth's climate to change, and how do we know? What difference will a few degrees more or less—or a little more rain or sunshine—make to our own lives? What will an altered climate mean to our students? What are we doing, and what more can we do, to prevent, minimize, and adapt to these changes and their effects?

Such questions are everybody's business. Indeed, they are driving research and teaching all over CSU: we are a key site for such research. But those of us who are concerned about climate change don't necessarily know each other, and the knowledge our research is producing isn't necessarily making its way to our students—or off campus to the larger community.

Changing Climates @ Colorado State is addressing these challenges. We are building a network of faculty and researchers from every CSU college whose interests and research coalesce around climate change. We are educating each other and ourselves. We are helping faculty across the curriculum add climate content to their courses. And in the next few years, we will be offering programs on the many aspects of climate change to the student body and the public.

SAHRA
Sustainability of semi-Arid Hydrology and Riparian Areas
Ensuring water in a changing world

Press Release 07-167

NSF Science and Technology Center Wins United Nations Prize

The UNESCO prize "rewards remarkable scientific research work on water usage in arid areas as well as areas subject to drought and also for the development of agriculture for the benefit of humanity and the environment."

What can you do

- Scientists and Engineers should "tithe" 10 percent of their time "working to increase the benefits of Science and Technology for the human condition."

- AAAS President John P. Holdren

Personal Actions

- Show **relevance** – applications related to modern, technologically savvy, increasingly urban and industrialized world.
- Contribute to **partnerships** between universities, community colleges, K-12 teachers and guidance counselors, families, and communities to address pipeline issues.
- Promote **mentoring** relationships among scientists, educators, and students.

Dr. Jacqueline E. Huntoon, Program Director for Diversity and Education, Geosciences Directorate, National Science Foundation

A Request

- At this meeting, devote 10% of your time and interest to the diversity, education, and outreach parts of the CMMAP project.
- There are opportunities to be involved all three recommended activities

Another way to say it…

As far as I can tell the last high profile scientist that aspired to reach out to the public was Carl Sagan. I think people tend to like and respect scientists but science has done a poor job with public relations in the last decade.

…we need more celebrity scientists to step up and spare us from the barrage of Brittany news.

Thank You

pandya@ucar.edu

EXPERT REPORT OF PATRICIA GURIN
Gratz, et al. v. Bollinger, et al., No. 97-75321 (E.D. Mich.)
Grutter, et al. v. Bollinger, et al., No. 97-75928 (E.D. Mich.)

SUMMARY AND CONCLUSIONS

A racially and ethnically diverse university student body has far-ranging and significant benefits for all students, non-minorities and minorities alike. Students learn better in a diverse educational environment, and they are better prepared to become active participants in our pluralistic, democratic society once they leave such a setting. In fact, patterns of racial segregation and separation historically rooted in our national life can be broken by diversity experiences in higher education. This Report describes the strong evidence supporting these conclusions derived from three parallel empirical analyses of university students, as well as from existing social science theory and research. Students learn more and think in deeper, more complex ways in a diverse educational environment.

"Global warming and the need to become a sustainable society are driving a new industrial economic revolution….Any time you have an industrial economic revolution, you create thousands of new jobs in disciplines that didn't exist before, and I think we're at the early stages of that."

Tom Kimmerer, executive director of the Association for the Advancement of Sustainability in Higher Education

7. What Should We Do Next?

- Project a More Positive Public Image of Science, Engineering, and Technology
- Mobilize at the Grass Roots

- Shirley Ann Jackson

The Quiet Crisis (BEST)

Slide from Jill Karsten

Recommendations

- Organize a national marketing campaign on the role of the Earth & Space Sciences in daily life and careers
- Begin aggressive efforts to increase required exposure to Earth & Space Science in high school
- Catalyze efforts to improve K-16 Earth Science teaching, especially in settings that serve underrepresented groups
- Mobilize and educate membership
- Enhance K-12 teacher preparation
- Link students with professional mentors and role models
- Catalyze policy/attitude changes

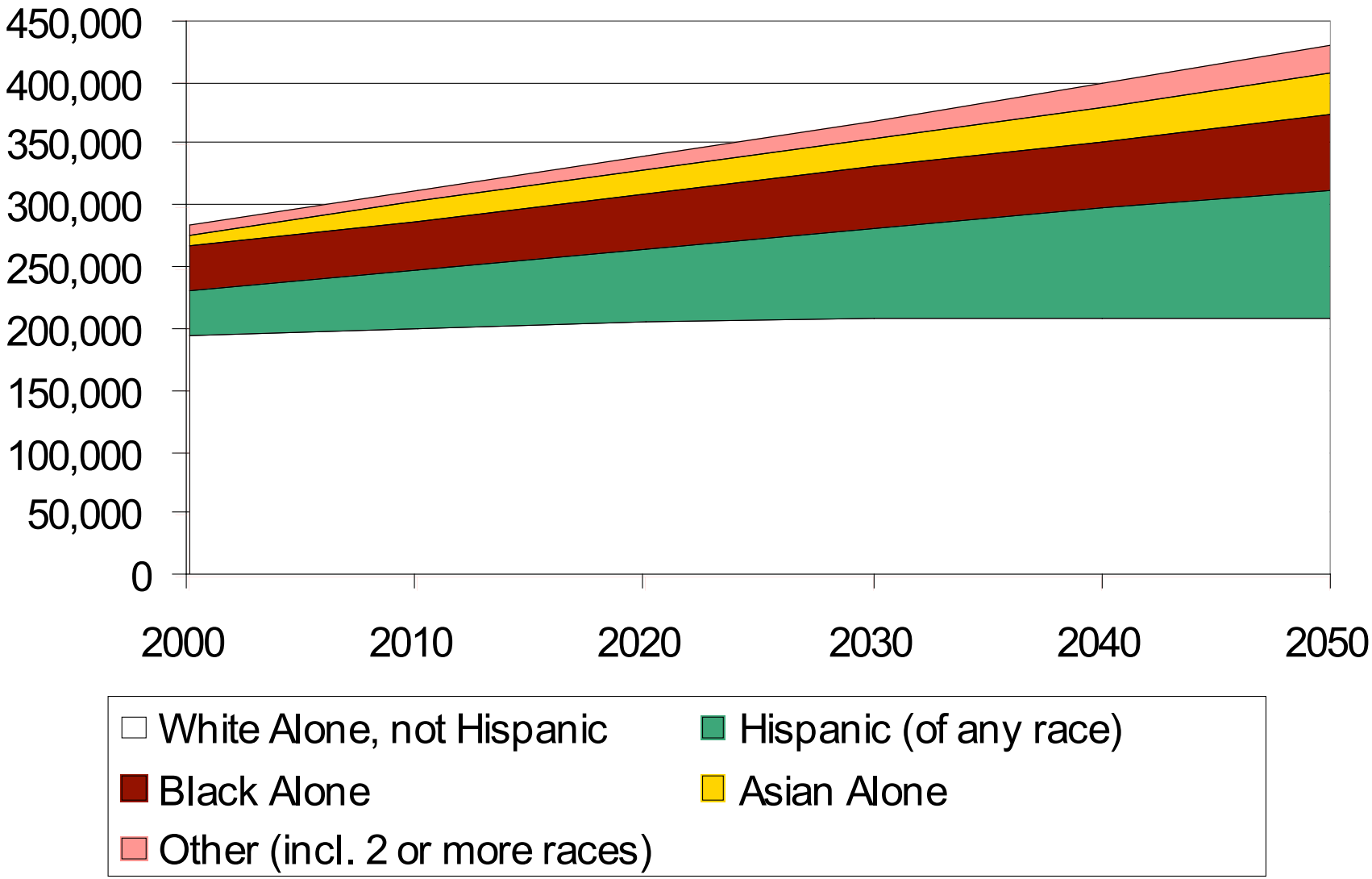
Recommendations

- Develop and scale up effective programs that support retention of students in the pipeline
- Mobilize the Earth & Space Scientific community to be involved locally
- Encourage rewards for outreach and service activities by academic faculty

Percentage of PhDs Earned by Women by Fine Field, Two-Year Averages

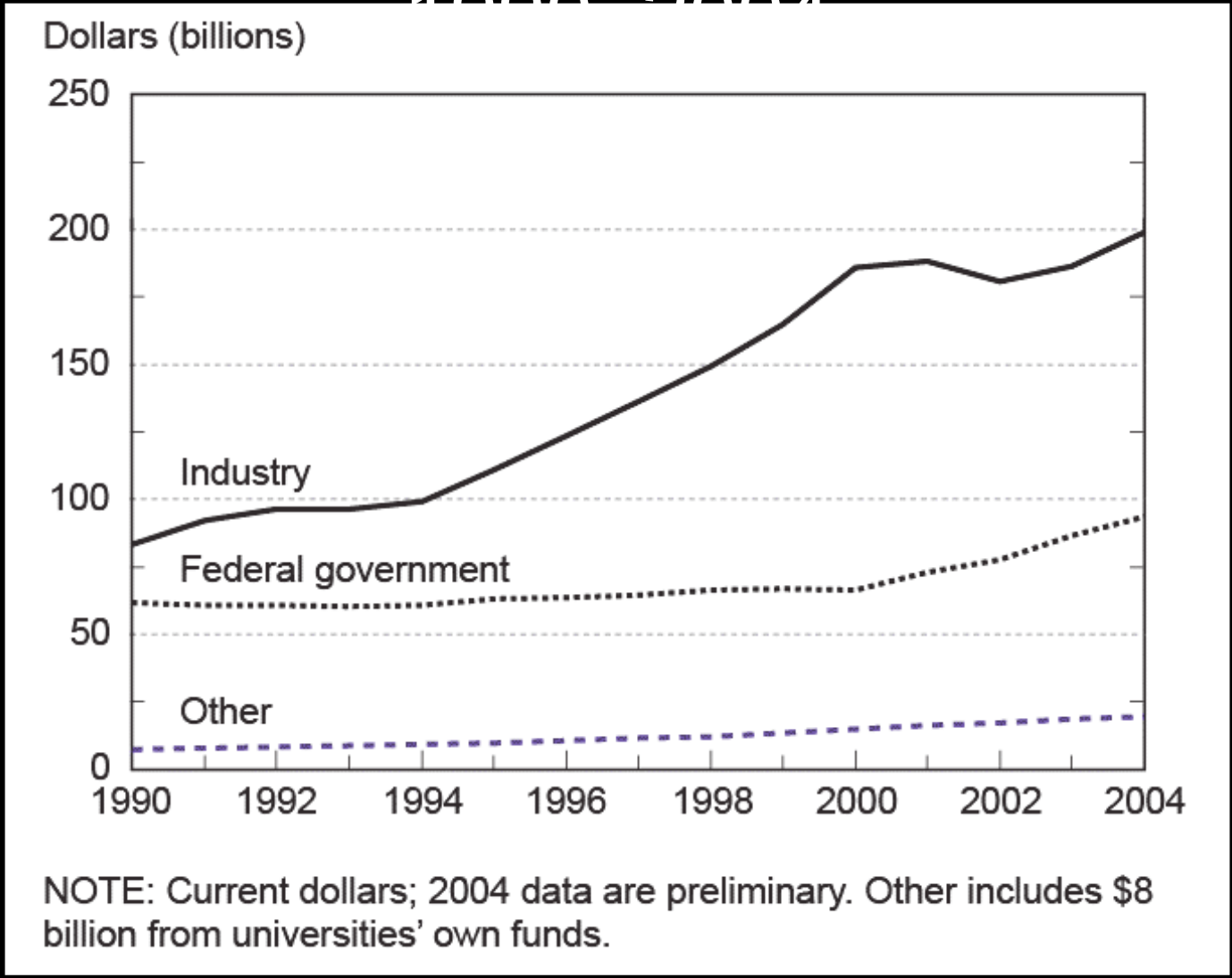
	1989-1990	2001-2002
Oceanography	26	39
Earth Sciences	19	29
Astronomy & Astrophysics	15	21
Atmospheric Sciences	14	25

Population Demographics 2000-2050



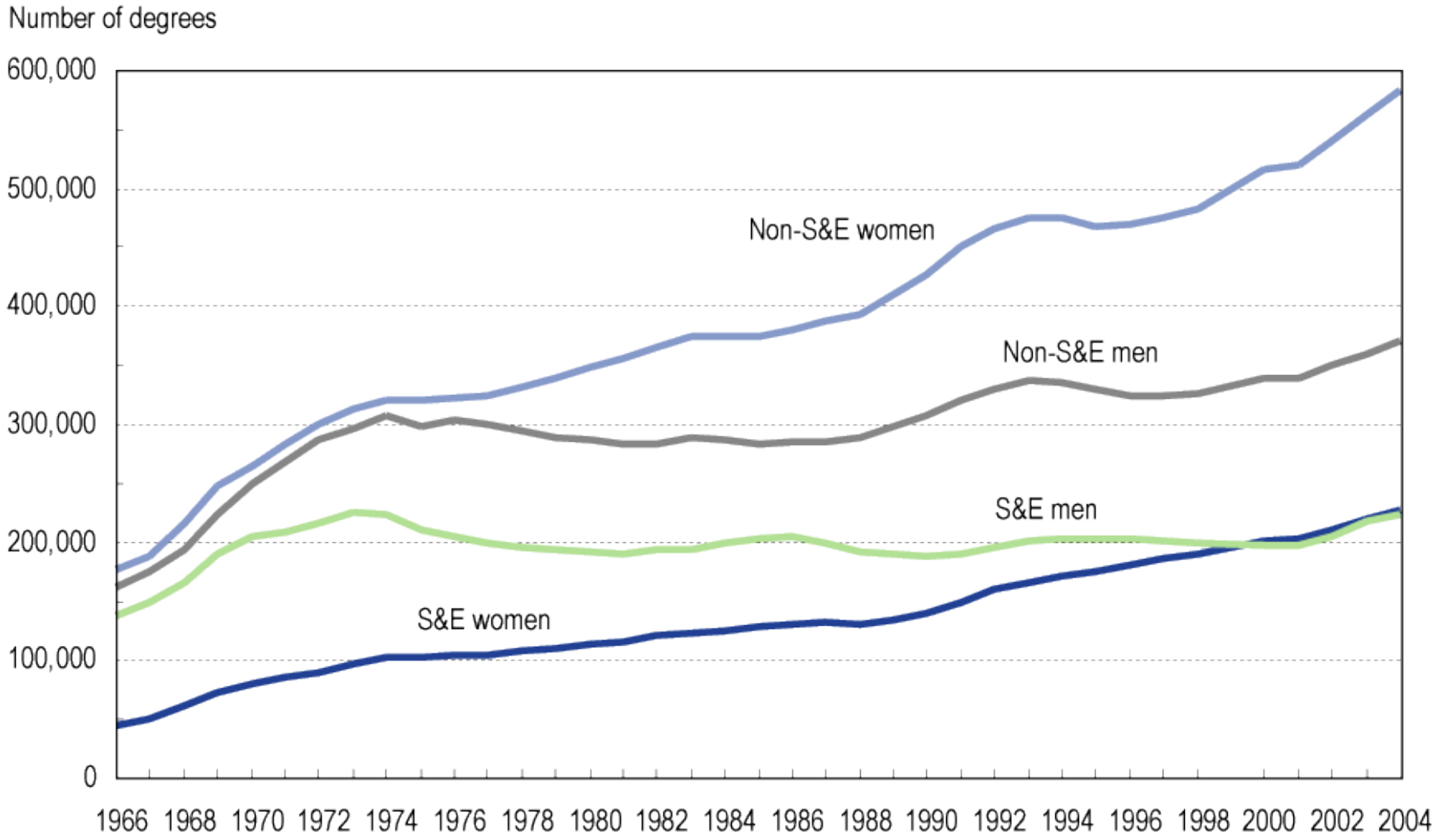
Source: U.S. Census Bureau, 2004, "U.S. Interim Projections by Age, Sex, Race, and Hispanic Origin," http://www.census.gov/ipc/www/usinterimproj/.

R&D expenditures by source of funds: 1990–2004

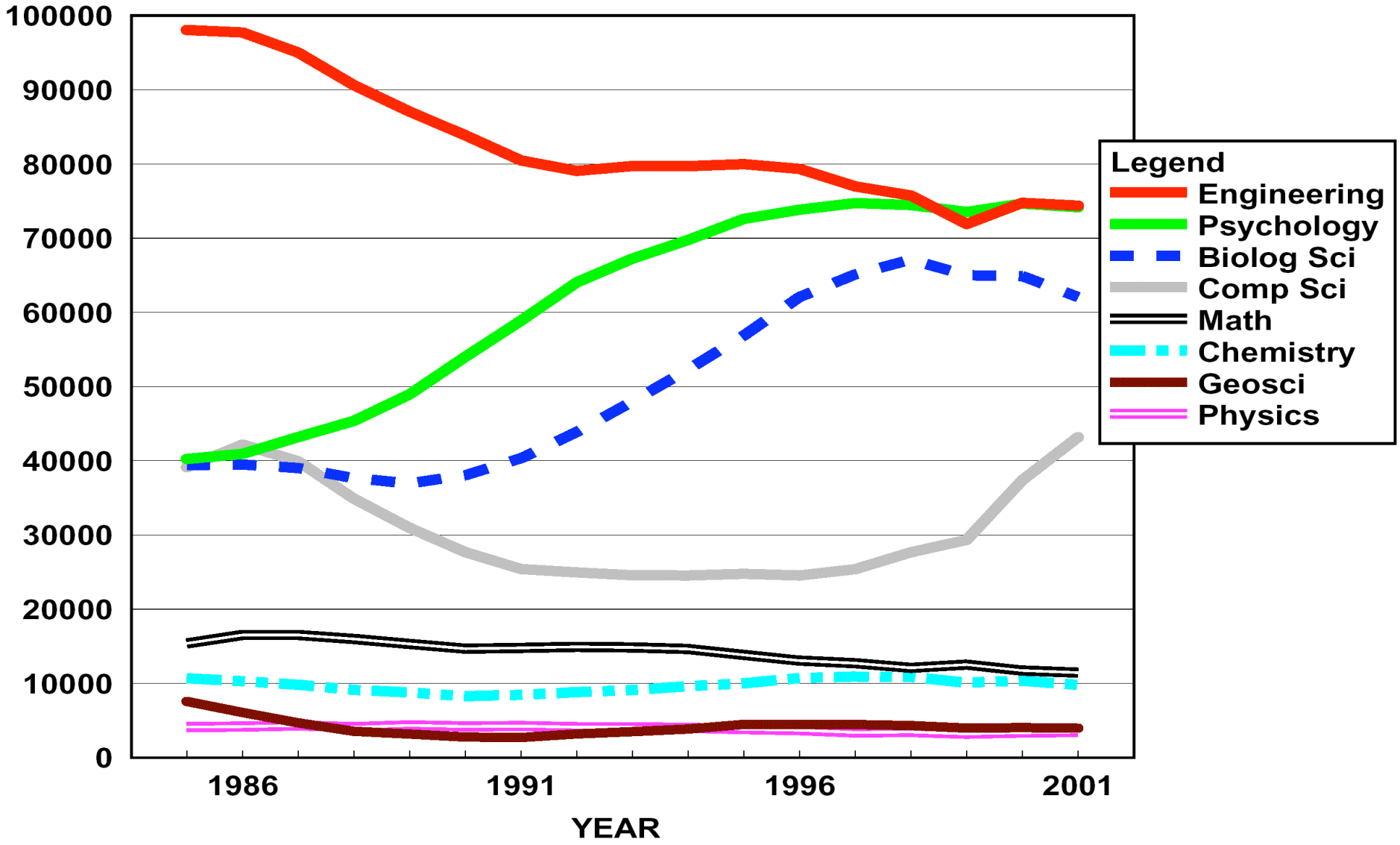


NOTE: Current dollars; 2004 data are preliminary. Other includes $8 billion from universities' own funds.

Bachelor's degrees awarded in S&E and non-S&E fields, by sex: 1966–2004



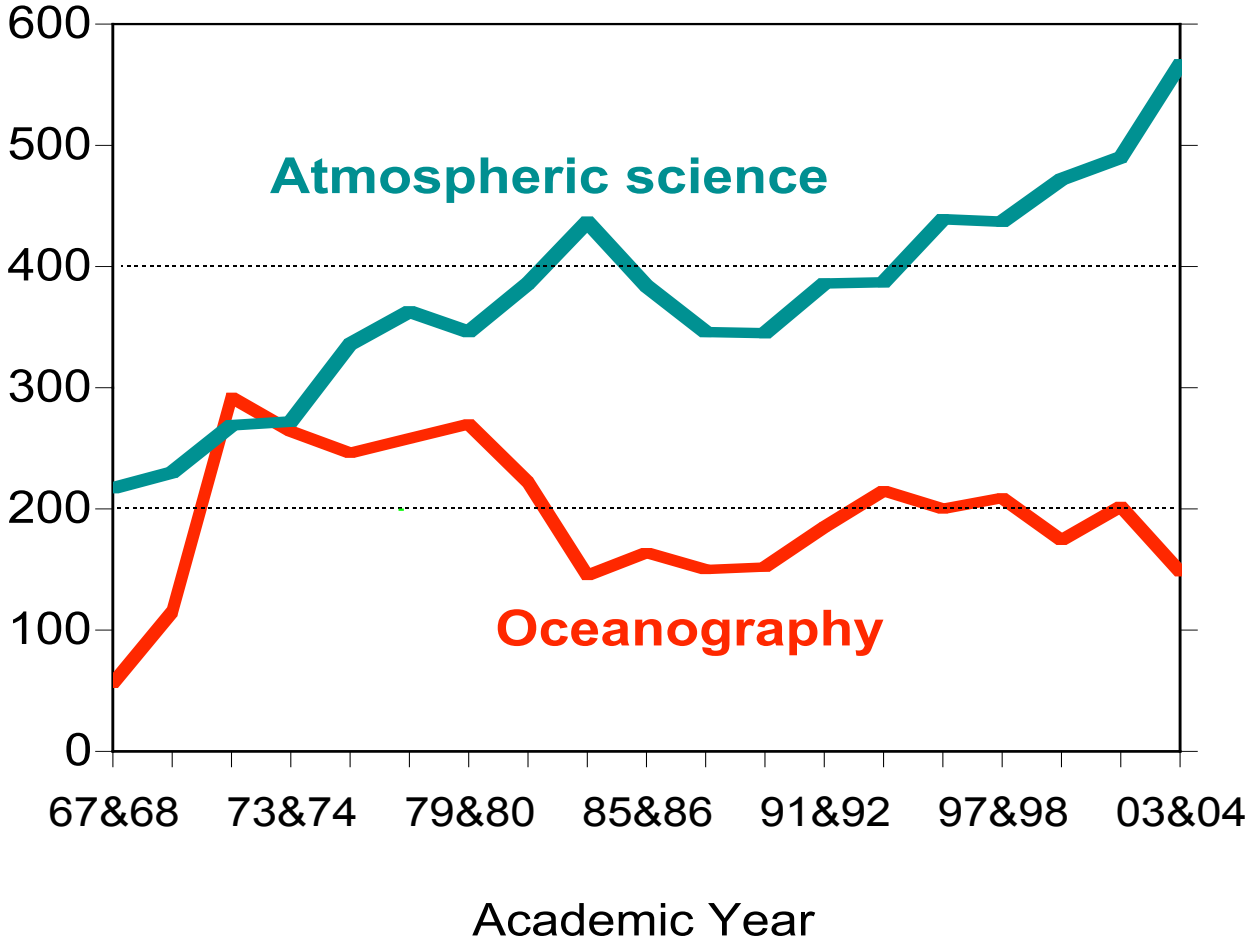
Total number of bachelor's degrees granted by discipline, 1985 to 2001



Source: AIP Statistical Research Center compiled data from NSF WebCASPAR Database System, February 2004

Bachelors degrees in atmospheric science and oceanography.

2 year averages 1967 & 68 through 2003 & 04.



AIP Statistical Research Center compiled from data collected by the National Center for Education Statistics.

Slide from Roman Czjuko

Demand for Meteorologists: Flat

- According to the Bureau of Labor Statistics (BLS), **number of employed meteorologists has been flat since mid-1990s** (right)
- Combined with previous graduation statistics: **during 1994-2004, supply of new meteorologists increased at least four times faster than the demand**
- **Future growth rate: less than 2%/year through 2014**, according to BLS
- **Spiegler** (August 2007 *BAMS*) **disagrees**, claiming **9,000 private-sector meteorologists by 2012**

Year	Number of Employed U.S. Meteorologists
1994	6,600
1996	**7,300**
1998	8,400
2000	6,900
2002	7,700
2004	**7,400**

Result: Low Pay; Or Else Go to Grad School

NACE data on U.S. College Degree Recipients in:	Class of 2006 Average Starting Salary
Computer Science	$50,744
Physics	**$45,120**
Geology	$45,091
Mathematics	$44,672
Chemistry	$39,804
Meteorology	**$35,211**
Environmental Science	$34,219
Secondary Education	$33,089
History	$33,071
Philosophy	$31,774
Marine Science	$31,643
English	**$31,385**

AMS/UCAR *Curricula* data on Fate of Met Graduates	Graduating Classes of 1997-99 (711 graduates)	Graduating Classes of 2003-05 (624 graduates)
Civilian Government	9.99%	7.69%
Military	9.85%	10.10%
Private Sector	**28.69%**	18.59%
Further Univ. Educ.	19.83%	**29.33%**
Univ. Employment	0.56%	0.48%
Other	4.36%	6.09%
Unknown	26.72%	27.72%

“Different kinds of thought and different kinds of abstraction may together give a better reflection of reality. Each is limited in its own way, but together they extend our grasp of reality further than is possible with one way alone.”

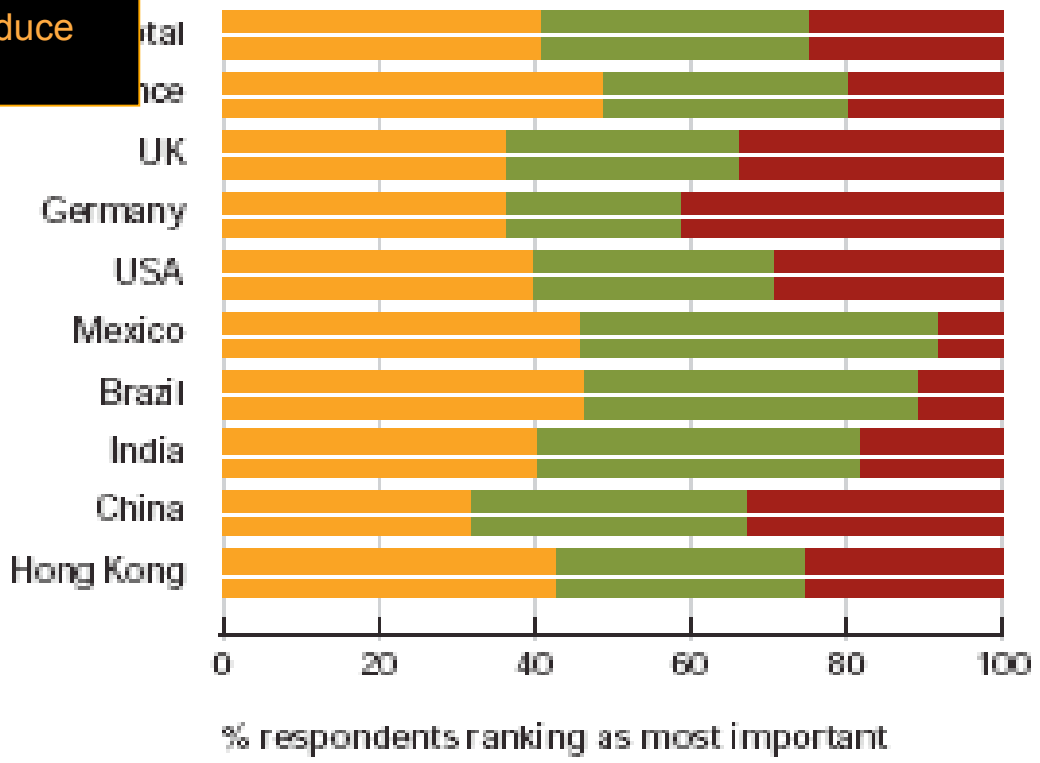
- David Bohm and David Peat, “Science, Order and Creativity”

We should make a big change to all of our lifestyles today to reduce climate change'

'the problem of climate change is impossible for us to try to stop'

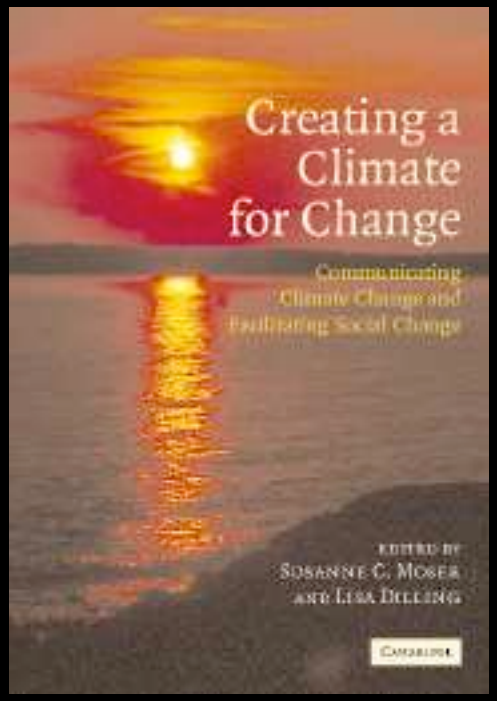
Figure 6

'Which best describes your view on how we should respond to climate change?'



'If we all act now we can help stop climate change for very little cost or disruption

Communicating about Climate Change



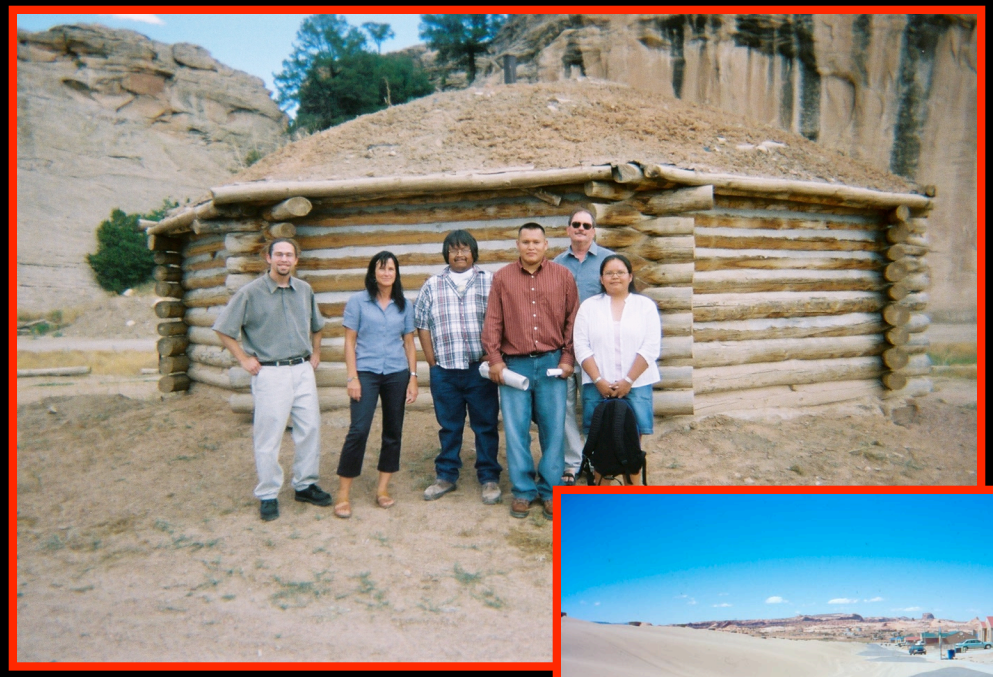
The first step is to move beyond debates over the science and focus debate instead on strategies for change. Accessible optimistic solutions that motivate and empower action are needed.

Lisa Dilling and Susi Moser, *Creating a Climate for Change: Communicating Climate Change and Facilitating Social Change*

Outline

- In spite of our increasing need for decisions that include scientific knowledge, there are some worrying indicators of a disconnect between science and society
  - Climate Change
  - Education in the US
  - Jobs for atmospheric science students
  - Budget
- There are opportunities for change
  - Societal attitudes
  - New academic partnerships

Reaching out to all Communities



Casey Thornbrugh

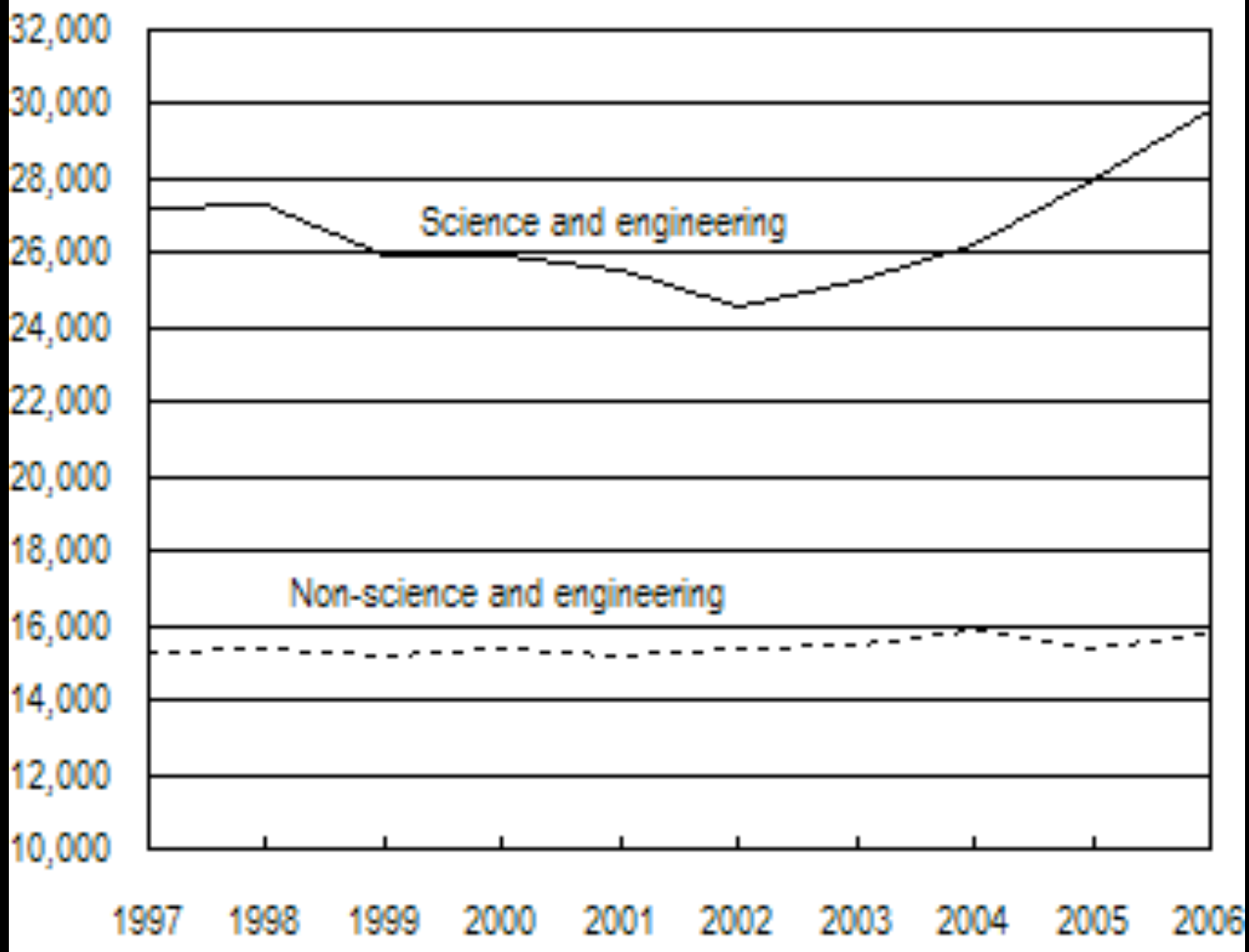
The Assessment of Sand Dune Mobility from 1980 through 2004 on the Moenkopi Plateau of the Navajo Nation

To keep the geoscience workforce responsive to society, increases are needed in the…

- ***visibility of geoscience and geoscientists,***
- ***awareness of geoscience-related issues (particularly in communities with diverse populations), and***
- ***diversity of geoscientists.***

Dr. Jacqueline E. Huntoon, Program Director for Diversity and Education, Geosciences Directorate, National Science Foundation

FIGURE 1. Doctorates awarded in science and engineering and non-science and engineering fields: 1997–2006



NOTE: See table 1 for fields of study included.

SOURCE: National Science Foundation/Division of Science Resources

Doctoral degrees awarded in S&E and non-S&E fields to U.S. citizens and permanent residents, by sex: 1966–2005