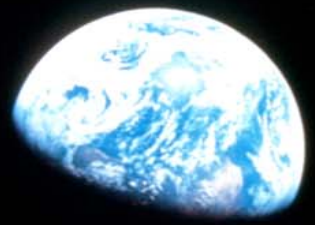
Risk Assessment:
Climate Change, Insurance, and Utilities



Utility Executive Leadership Institute (UELI) 2007

Pinehurst Resort, North Carolina

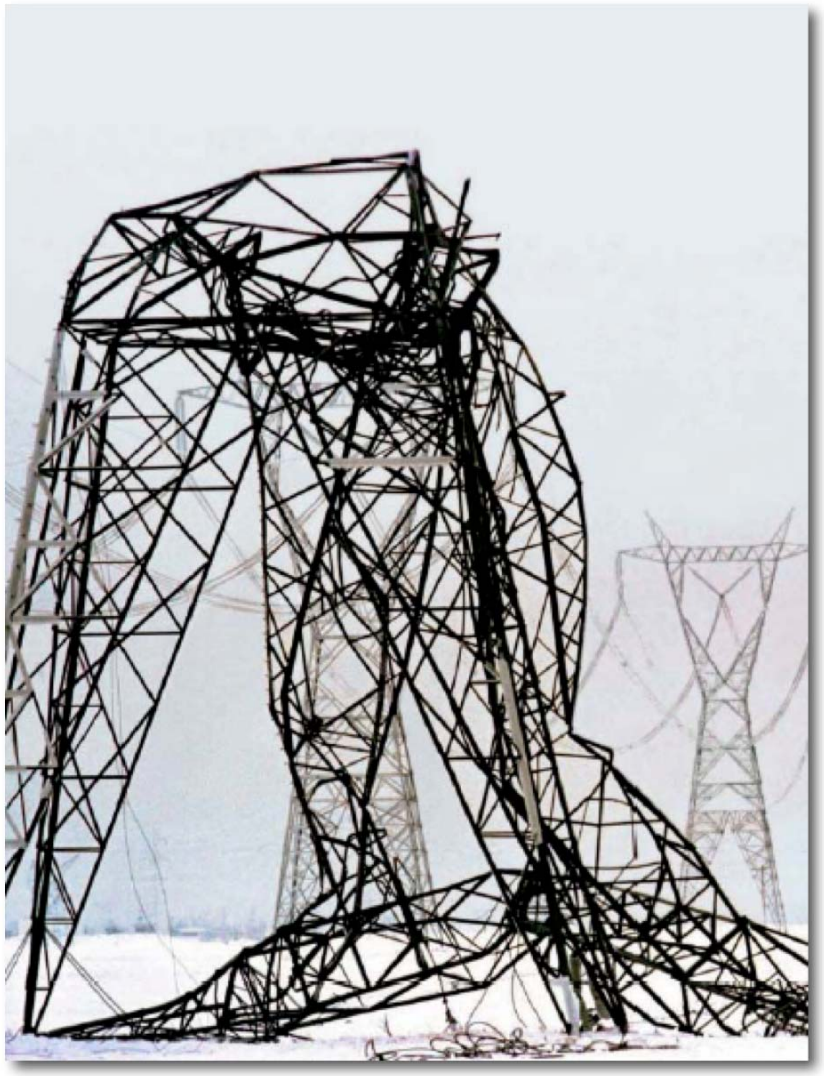
August 10, 2007

Evan Mills, Ph.D.
Staff Scientist
University of California
U.S. Department of Energy
Lawrence Berkeley National Laboratory

Our atmosphere is as thin —– in proportion to the Earth's diameter —– as a film of condensation on a small steel ball.

Variability is a fact of life; but the dice are loaded

Managing Risks for Utilities
(costs of impacts *and* adaptation)



Why Utilities, Insurance, and Climate Change?

- Electric and water utilities are insured (or self-insured, reinsured)
- Both sectors are weather- and climate-sensitive, and have to cope with shareholder, customer, regulator perceptions of the climate problem
- Both can be instrumental in climate solutions
- Both can work *together* on risk-management and new business opportunities

Roadmap

- State of the Science
  - fingerprints & forecasts
  - focusing on aspects most relevant to energy and water utilities
- Implications for Insurers & Utilities
- Managing Risks & Capturing Opportunities

State of the Science: Fingerprints

The Scientific Consensus

http://www.ipcc.ch

Intergovernmental Panel on Climate Change
TAR - 1300 Authors; 1100 Reviewers
Unanimously adopted by 100+ nations (*including* U.S.)

IPCC's Latest Characterization of Climate Change

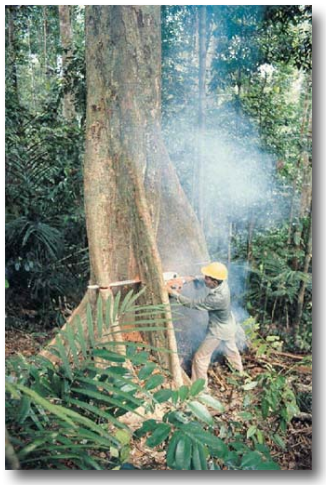
"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level."

- ***IPCC Fourth Assessment Report (2007)***

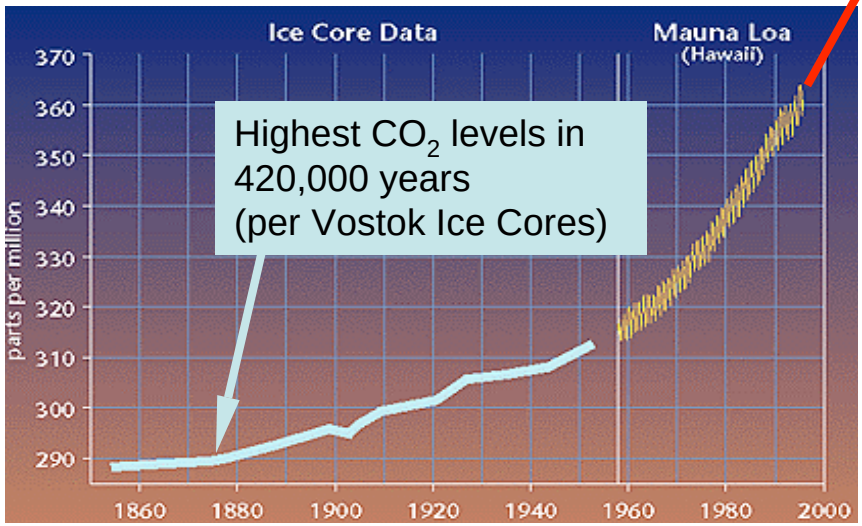
http://www.ipcc.ch

The Primary Human Influence is Fossil Fuels Combustion

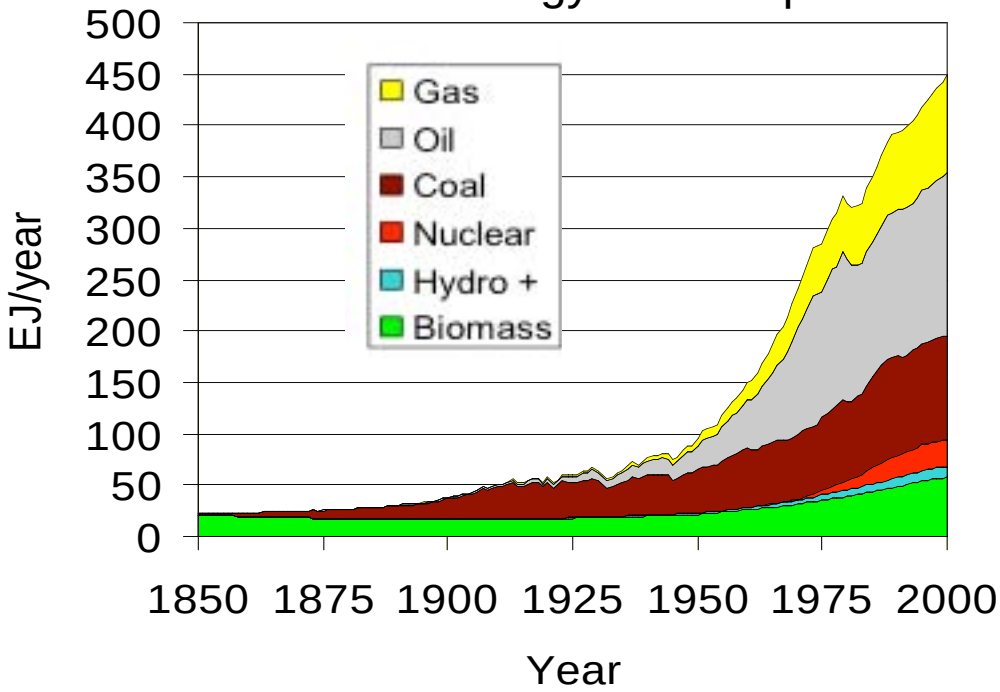
(Second is Deforestation)



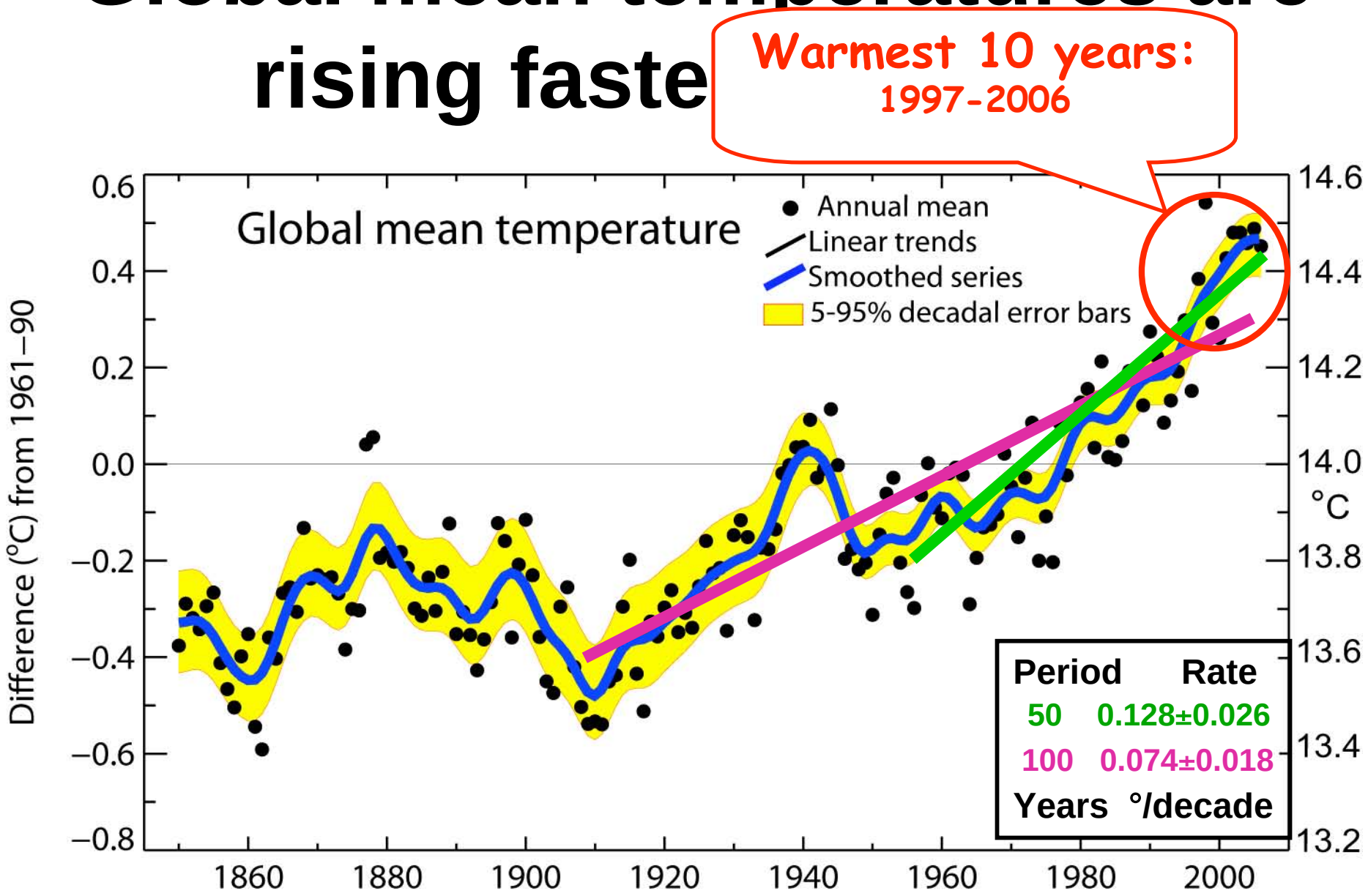
World Carbon Dioxide Concentrations



World Energy Consumption



Global mean temperatures are rising faste



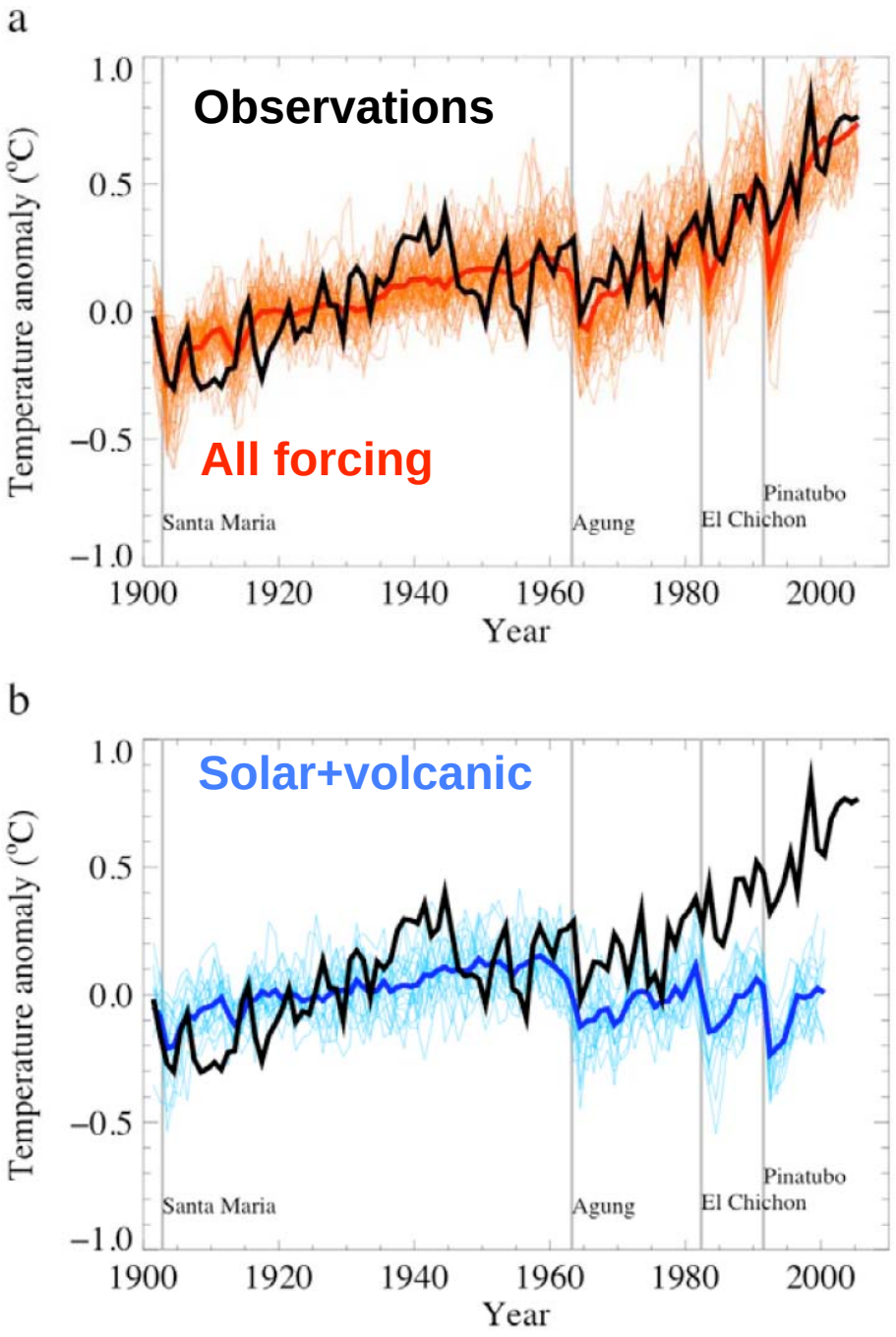
Source: IPCC 4th Assessment (2007)

Attribution

- Observed changes are consistent with:

☑ expected responses to human activity

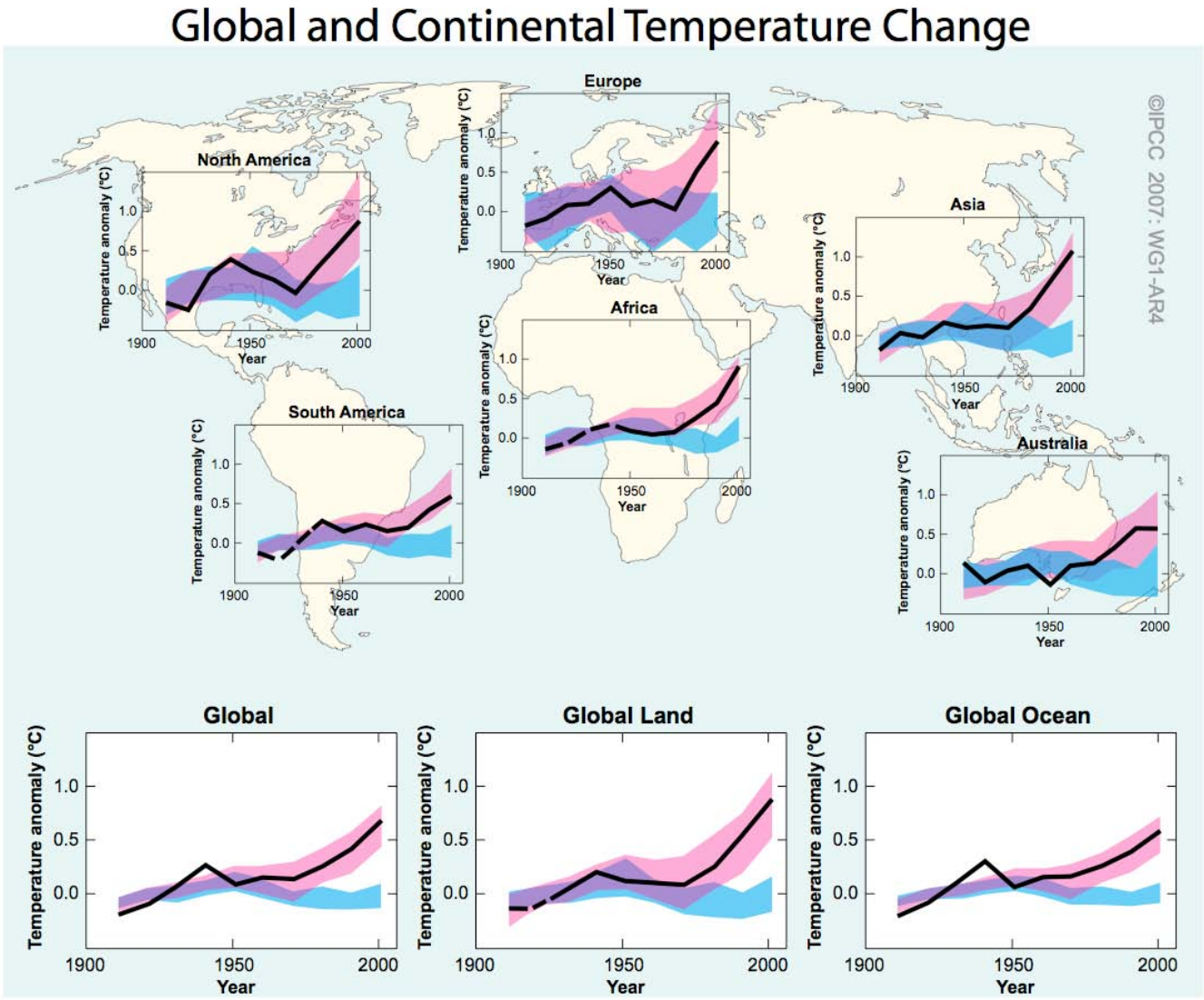
☒ inconsistent with alternative explanations



Source: IPCC 4th Assessment (2007)

Human Activity is Main Driver of Observed Temperature Changes

Warming shows a significant human contribution over the past 50 years in **all** regions

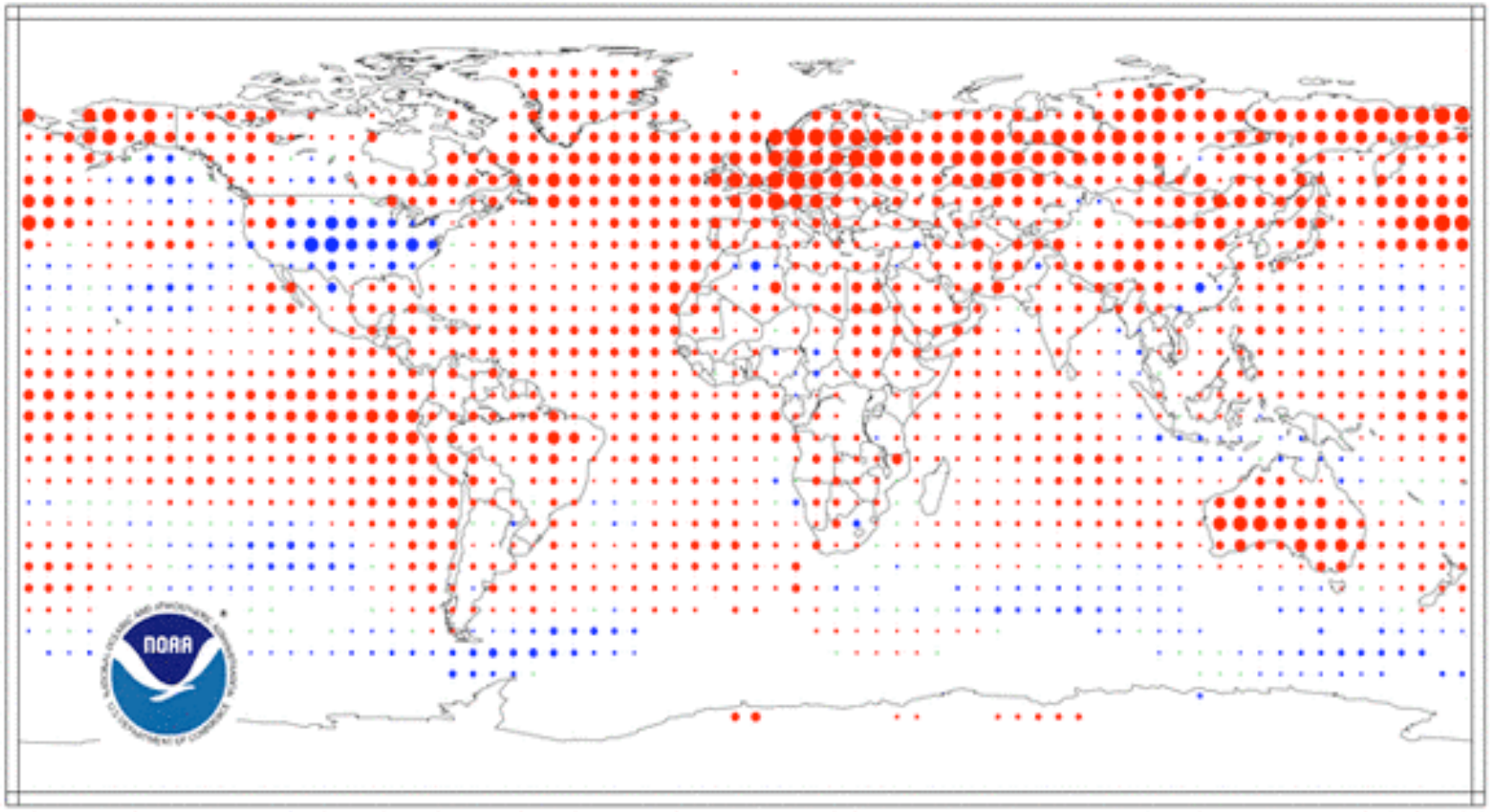


Source: IPCC 4th Assessment (2007)

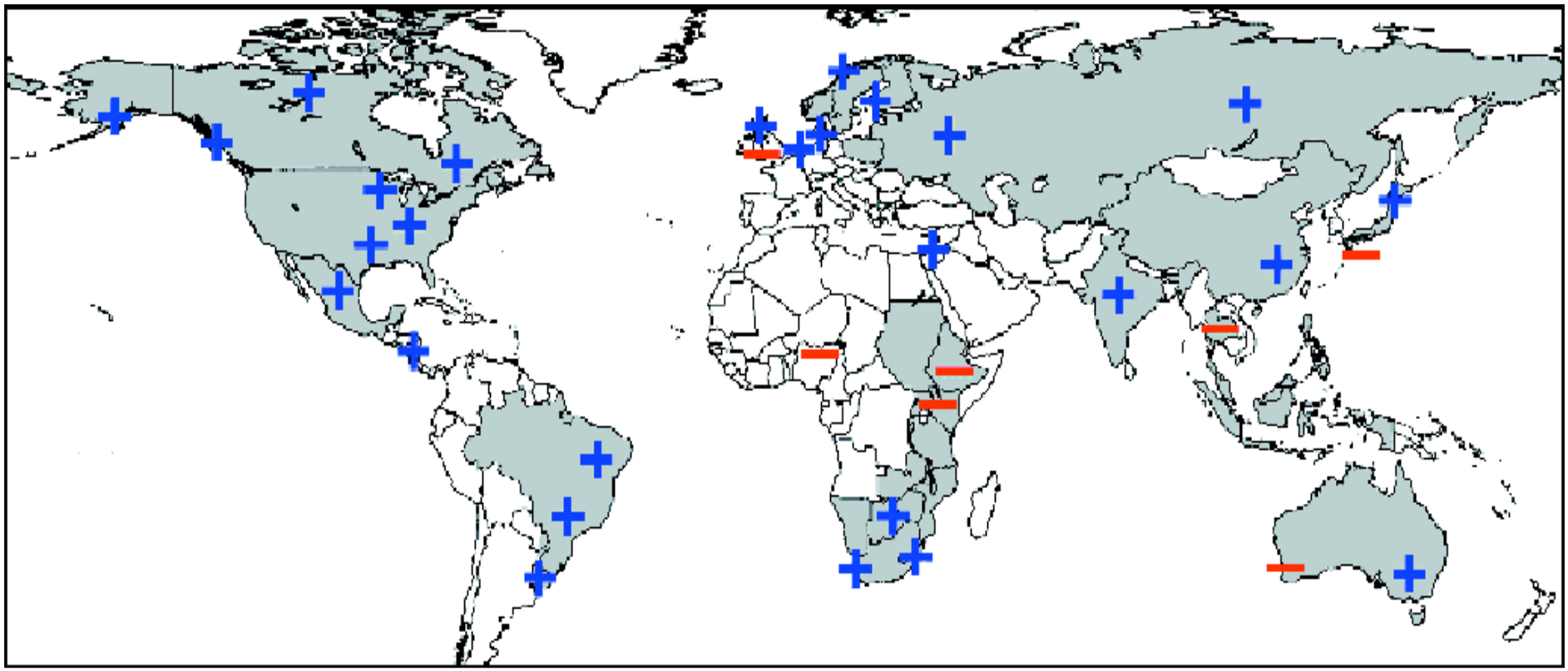
September 2006 Temperature Anomalies

(with respect to a 1961-1990 base period)

National Climatic Data Center/NESDIS/NOAA



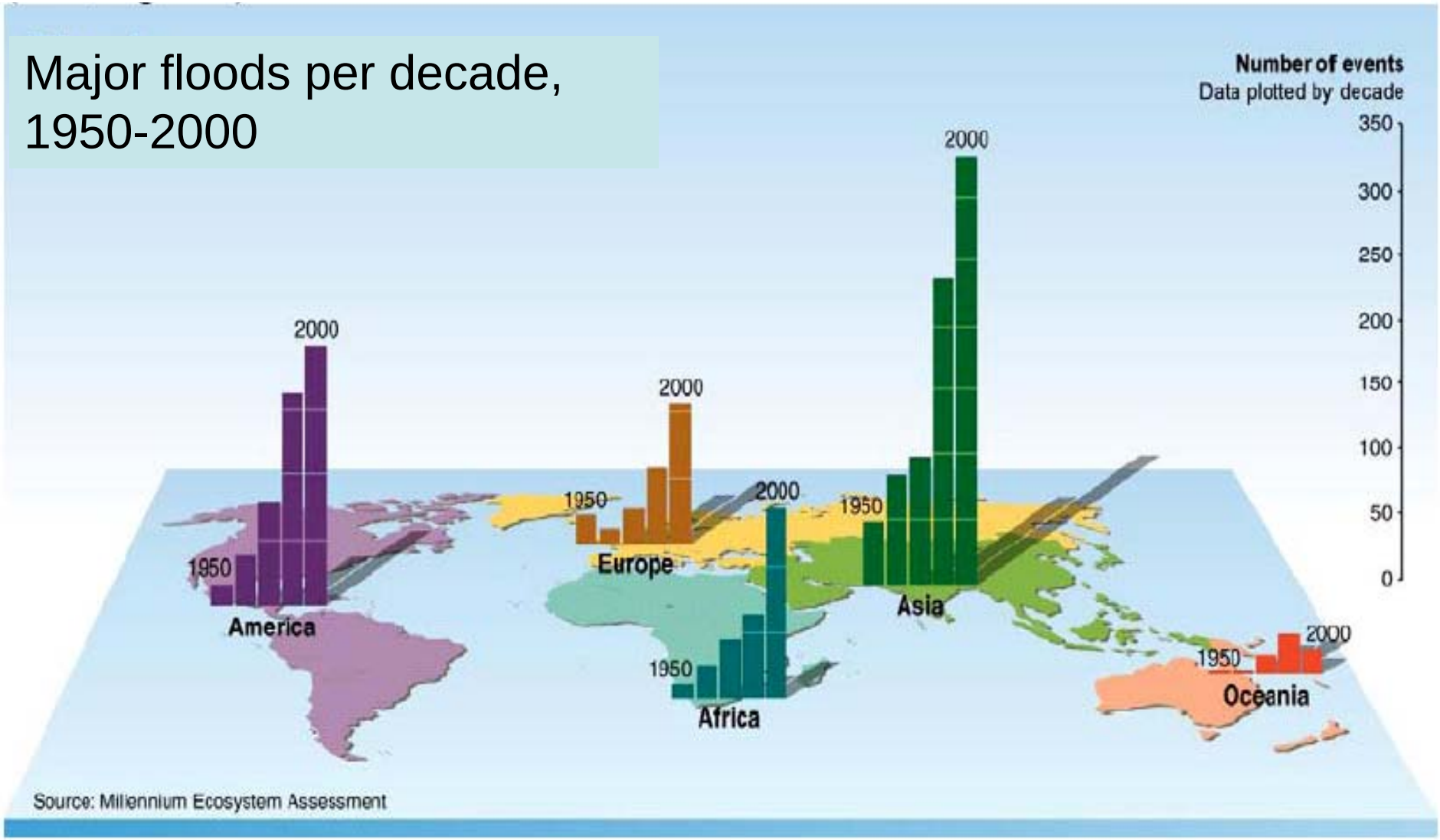
Fingerprints.... Torrential Rain



Regions of observed disproportionate changes in heavy (95th %-ile) and very heavy (99th %-ile) precipitation

Source: IPCC 4th Assessment (2007)

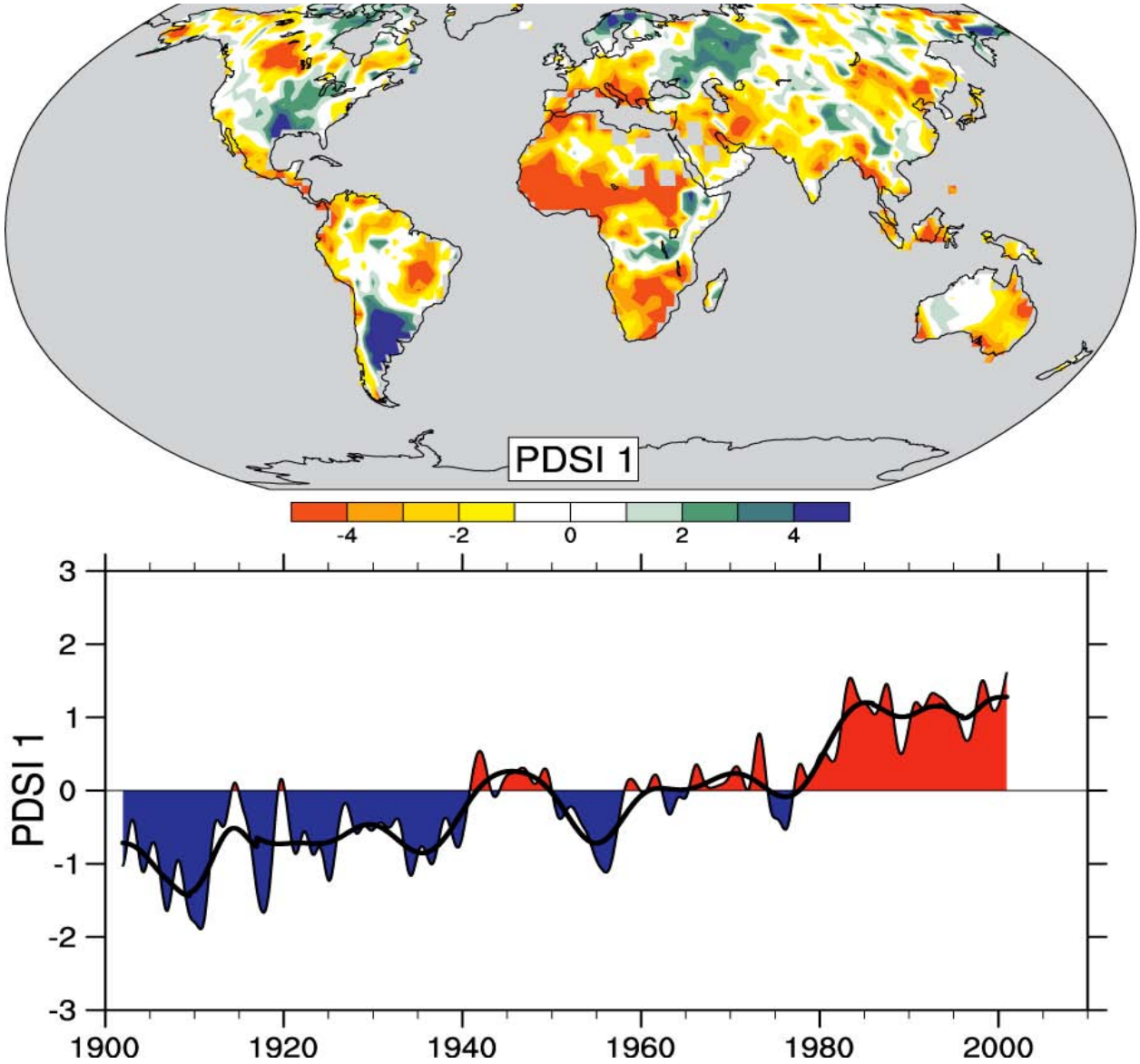
Fingerprints.... Floods



There's a consistent 50-year upward trend in every region except Oceania.

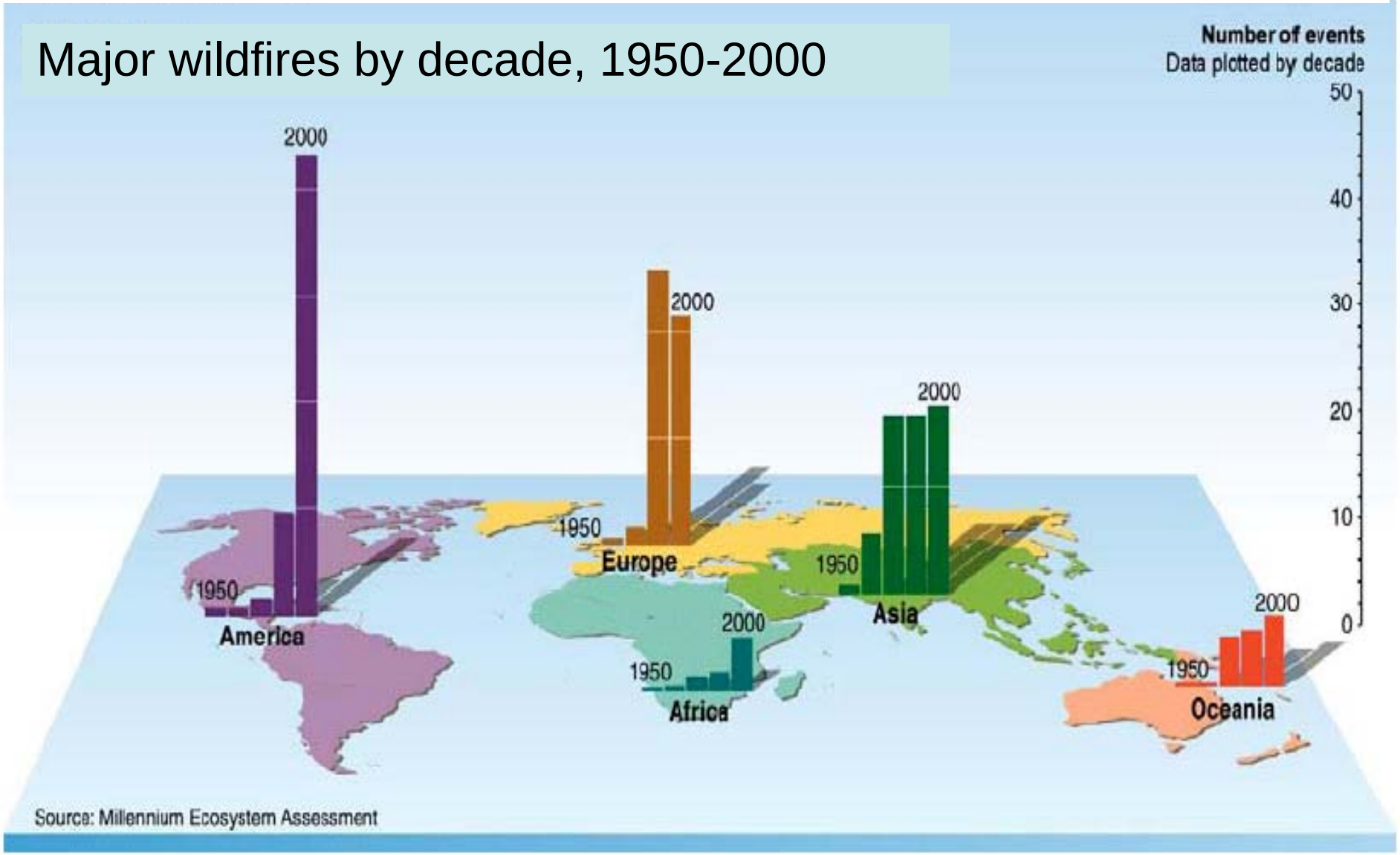
Fingerprints.... Drought

Change in Palmer Drought Severity Index (PDSI) for 1900 to 2002



Source: IPCC 4th Assessment (2007)

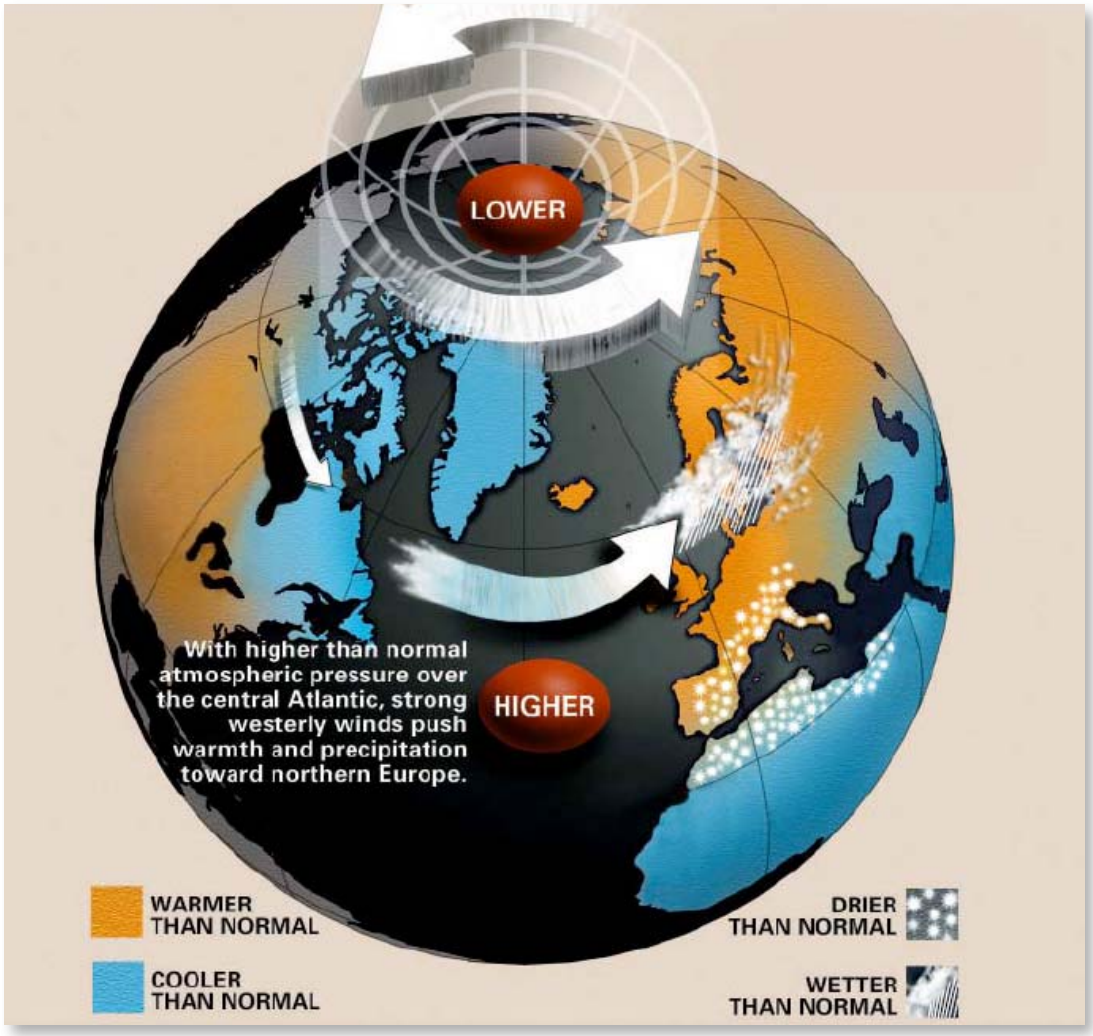
Fingerprints.... Wildfire



The trend has been sharply upward everywhere.

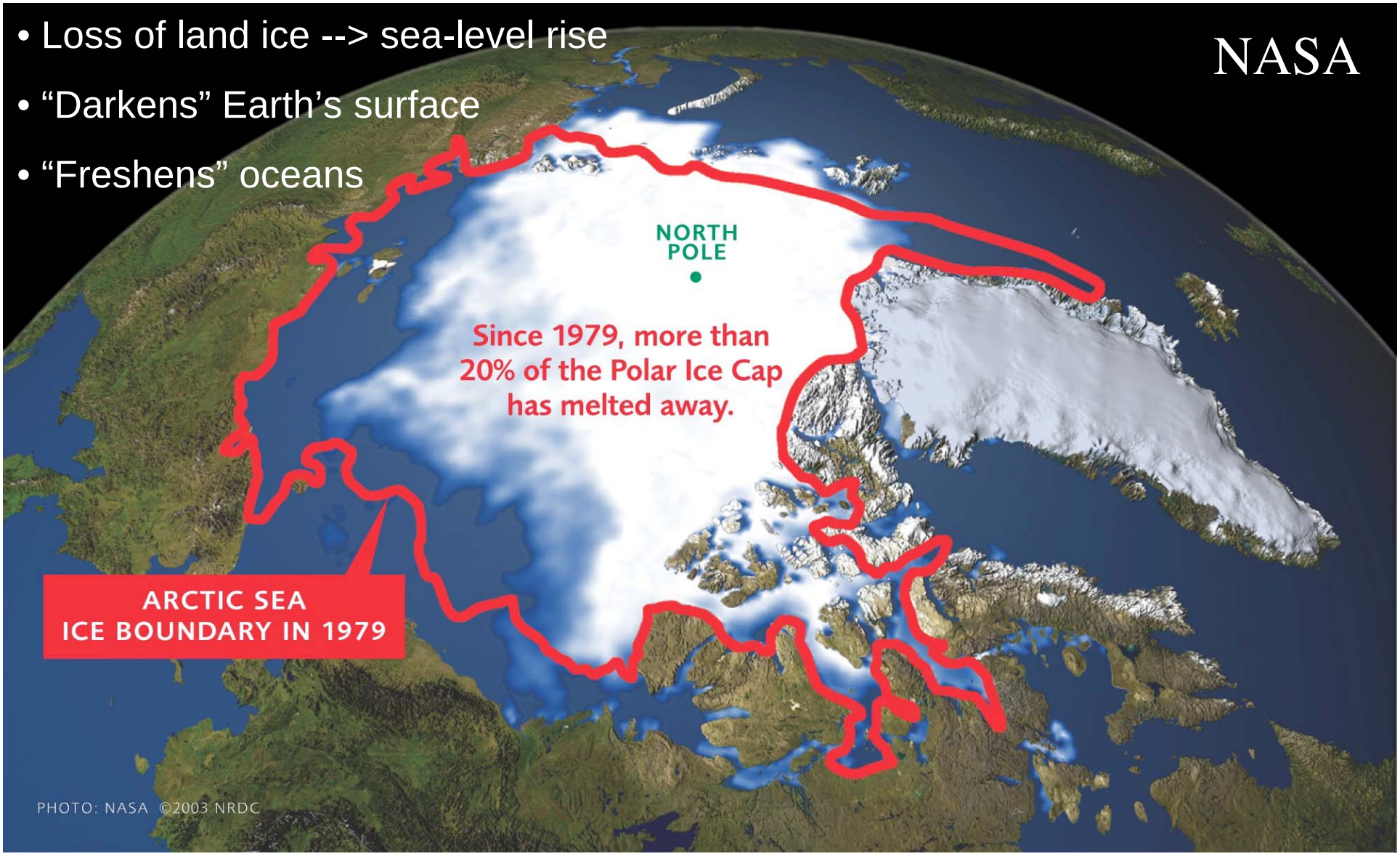
Fingerprints.... Storms

- Climate change is affecting storm tracks, winds and temperature patterns
- Human-induced forcing has likely contributed



Source: IPCC 4th Assessment (2007)

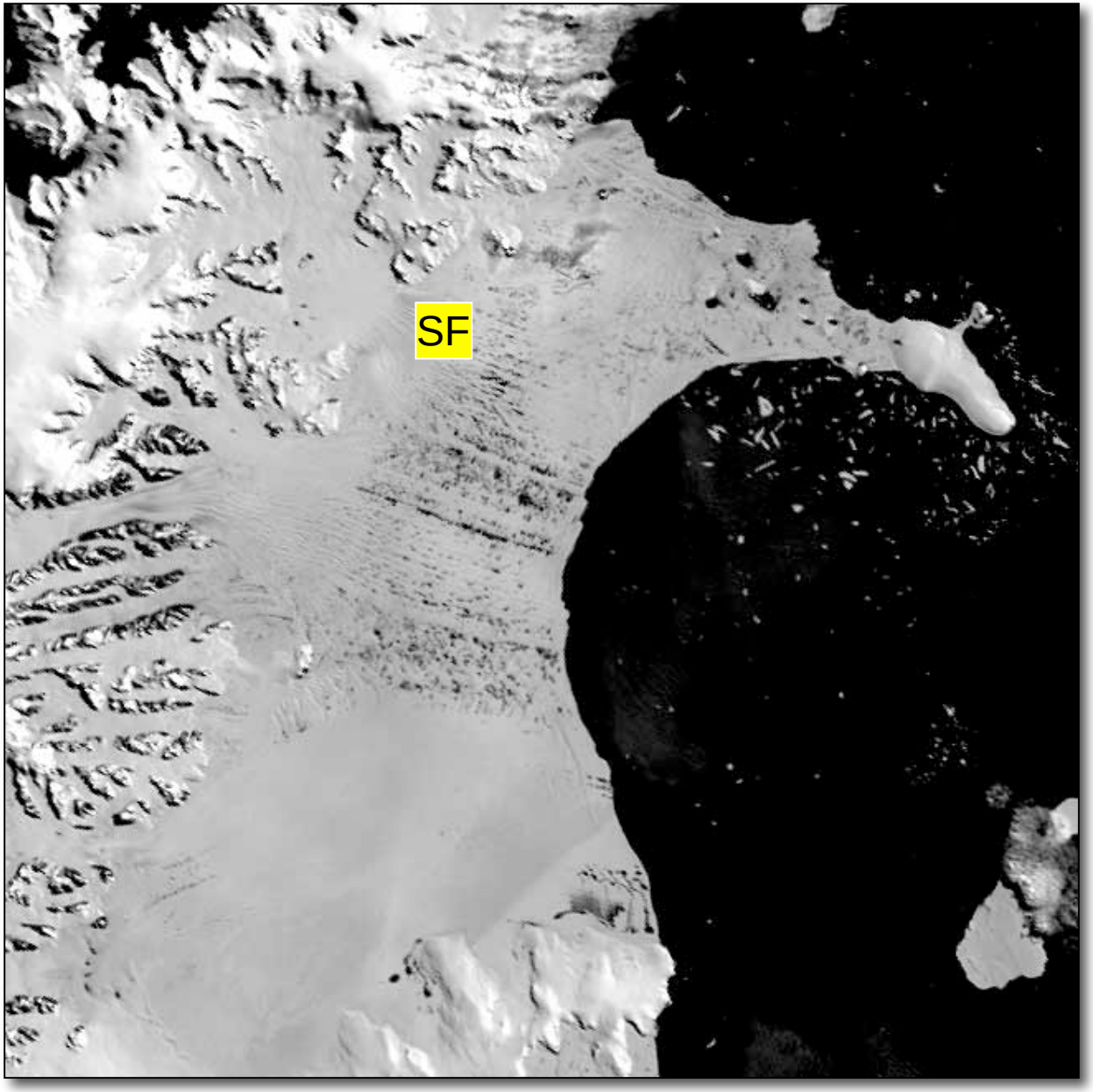
Fingerprints: Loss of Ice & Snow Cover (Summer -7.4% per decade)



Harvard Expedition to North Pole ... free water ....

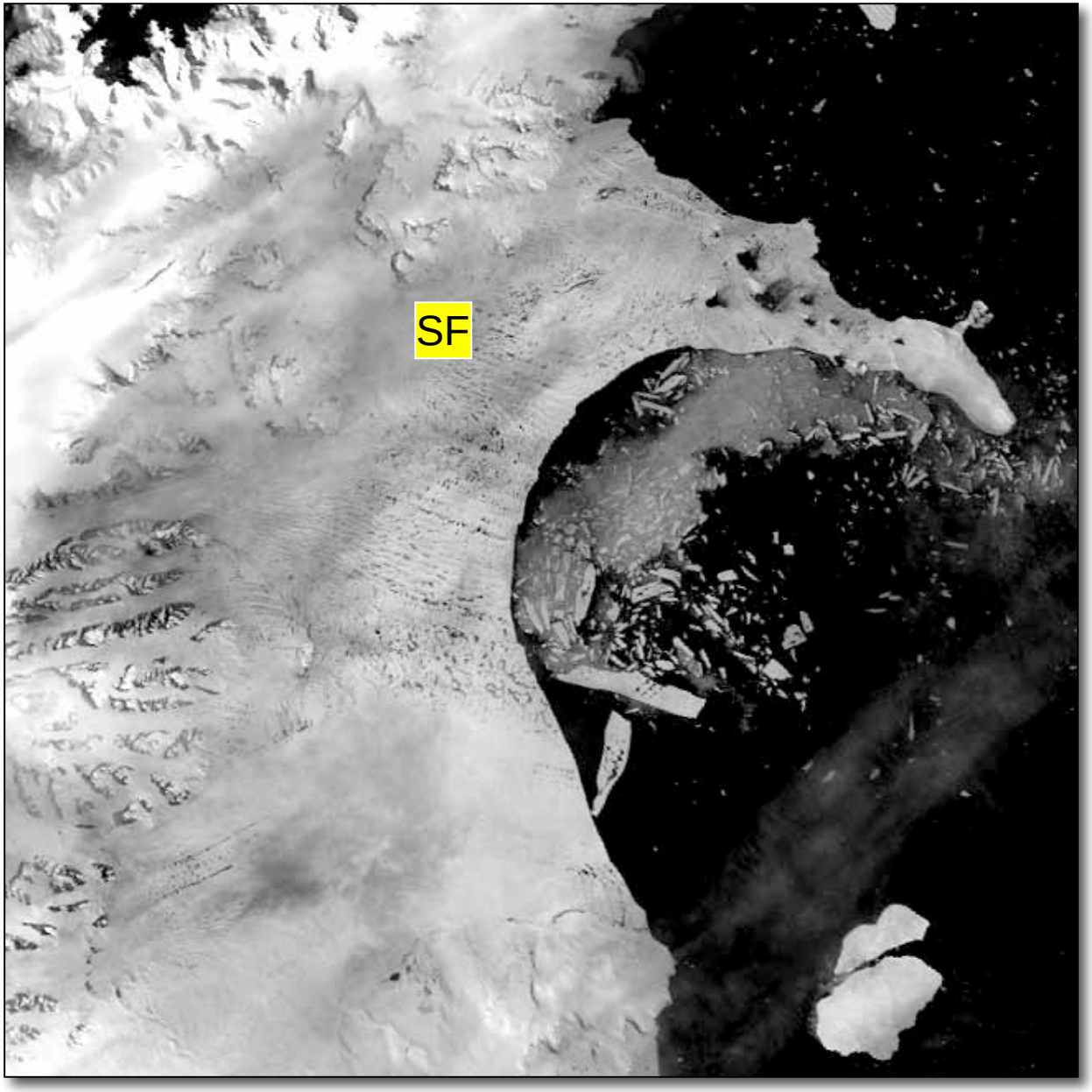
Source: James McCarthy, Harvard

Larsen-B Ice Sheet
Image NASA
©2006 Google
Pointer 87°32'33.79" S 86°21'17.38" E
Streaming 100%
Eye alt 8466.64 km

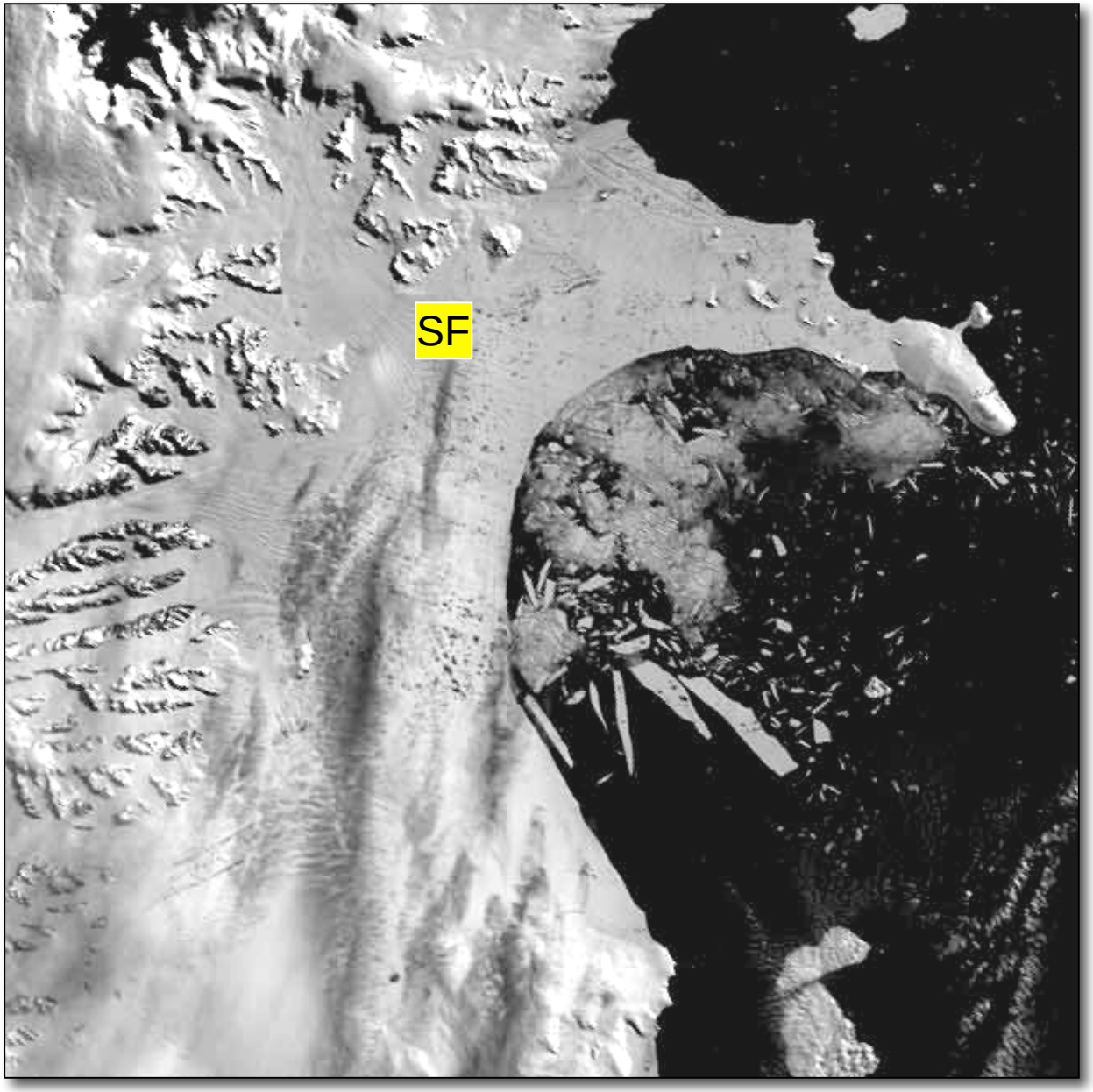


Jan 31
2002

Larsen B
Ice Shelf



Feb 17



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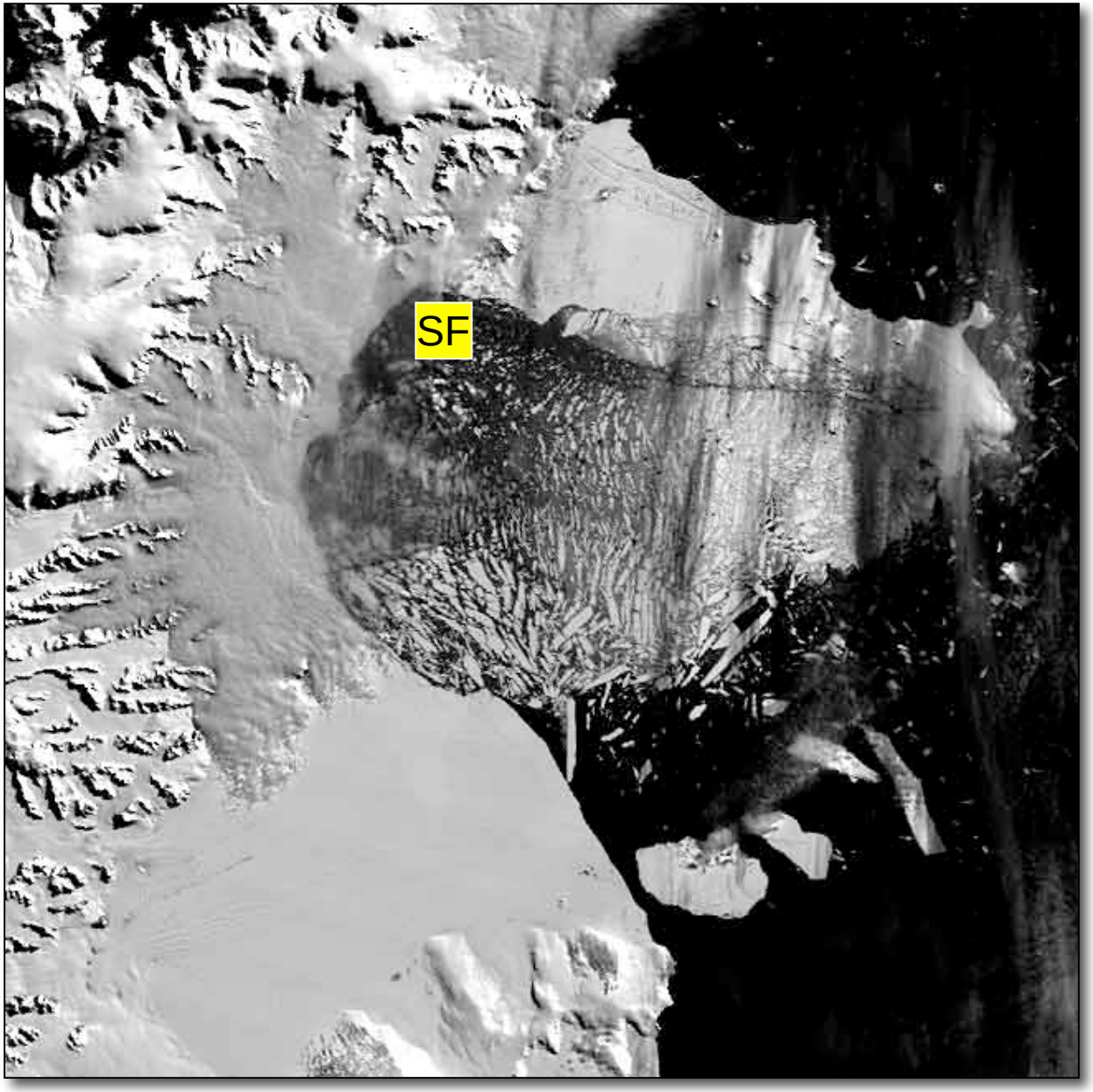


March 5

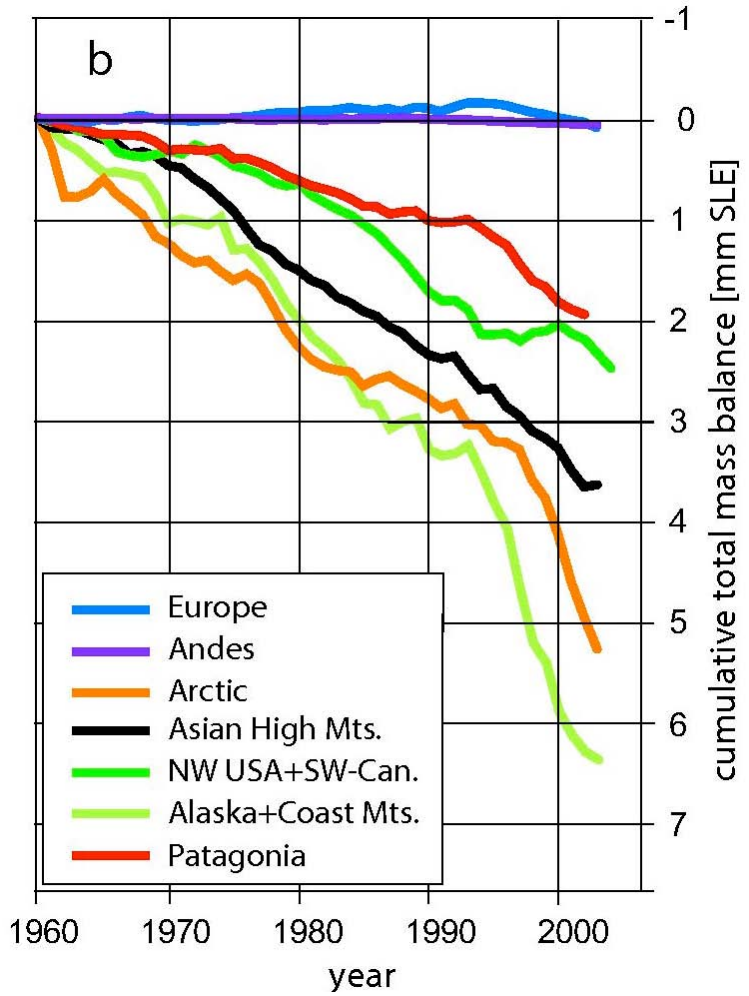
1255 square miles [24x San Francisco]

650 feet thick [4.3 Lake Tahoes]

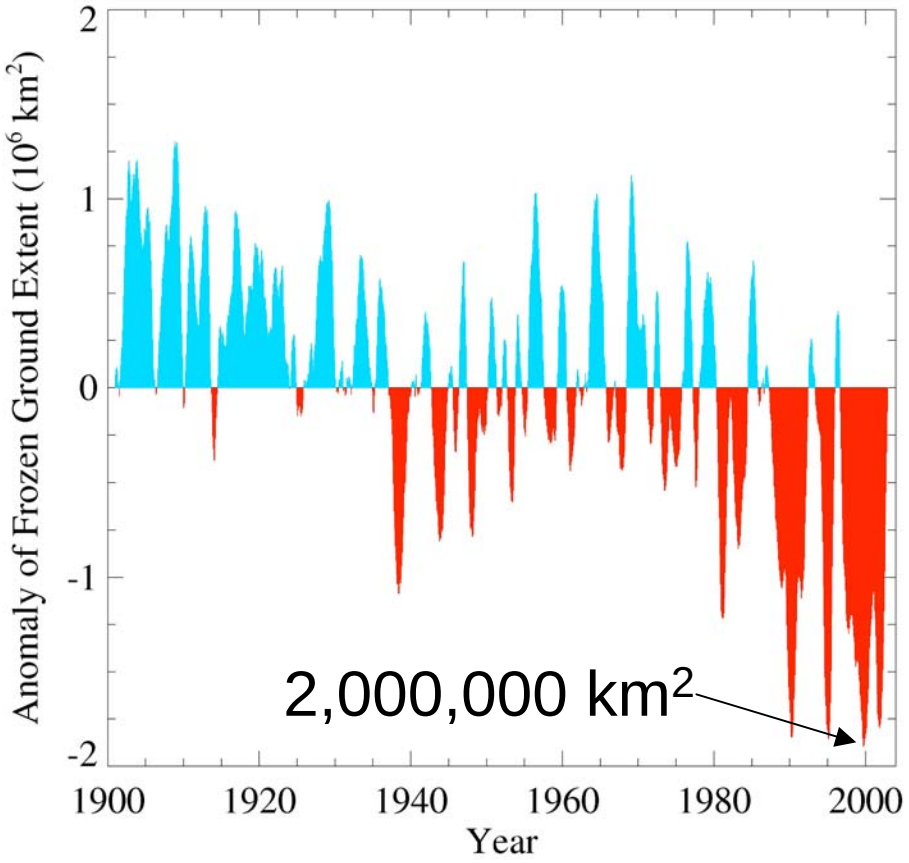
720 billion tons

Subsequent 8x increase in outflow glacier speed

Fingerprints ... Glaciers & frozen ground are receding



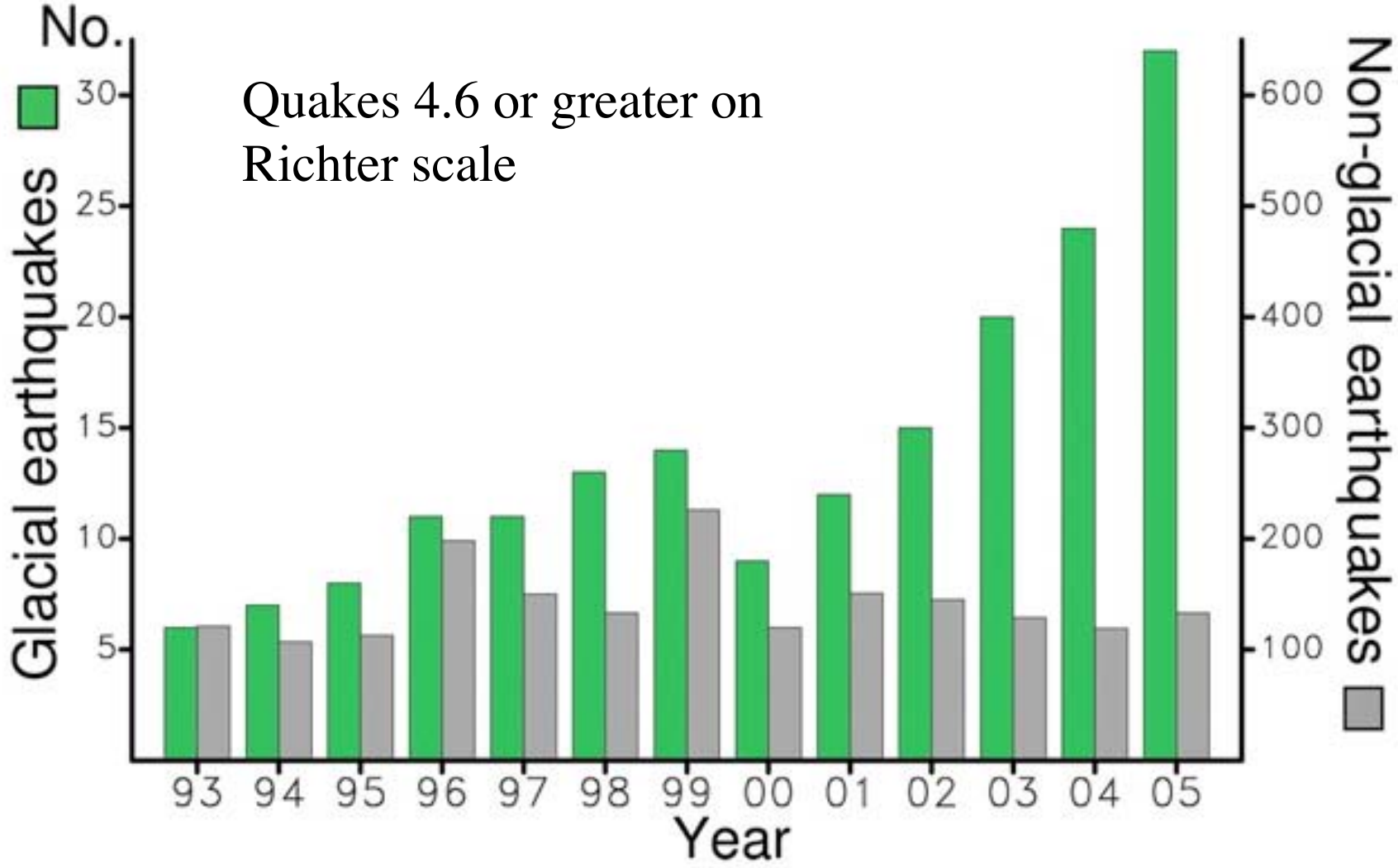
Accelerating **since early 1990s**



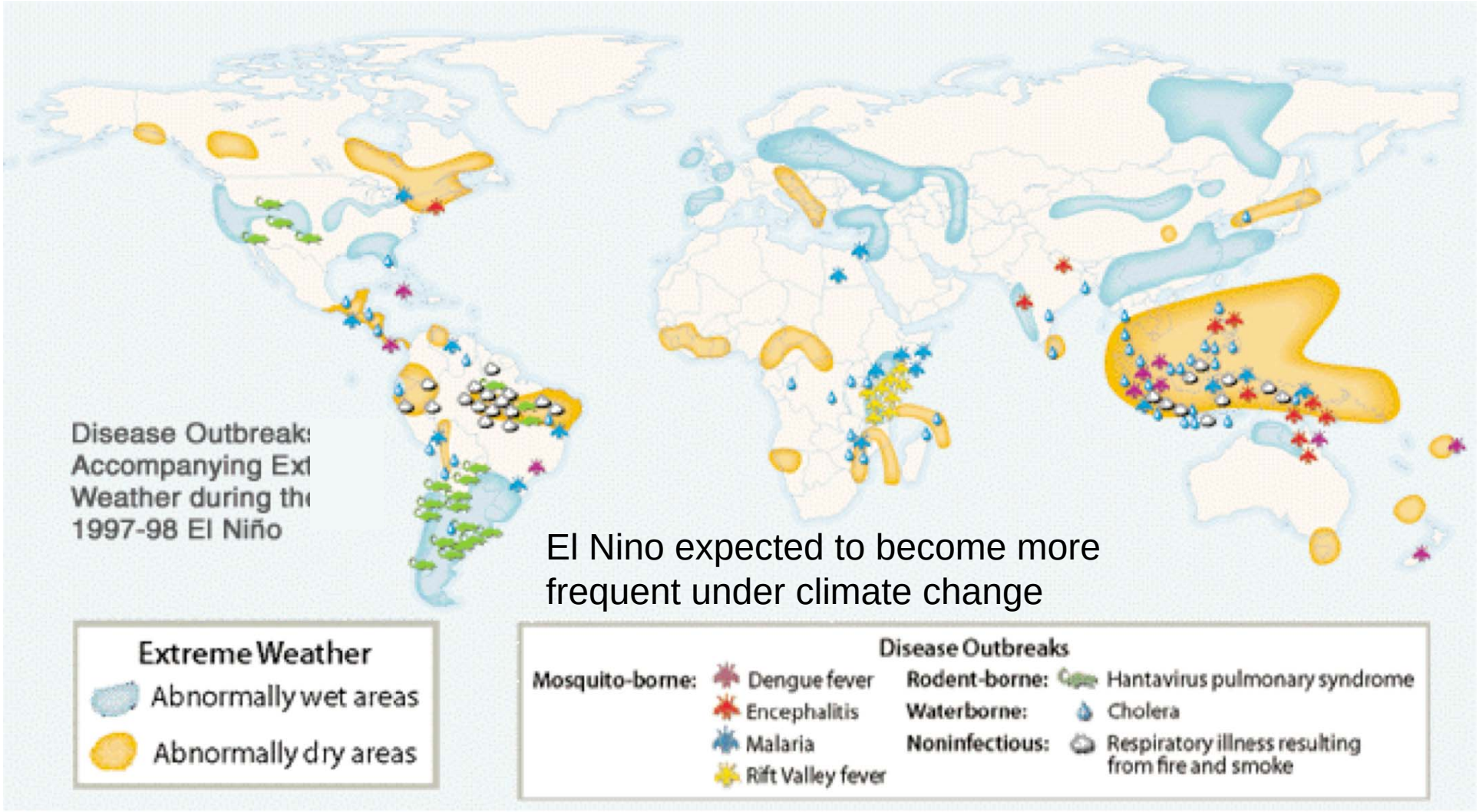
Area of seasonally frozen ground in the northern hemisphere has decreased by 7% from 1901 to 2002

Source: IPCC 4th Assessment (2007)

Fingerprints ... Glacial Earthquakes



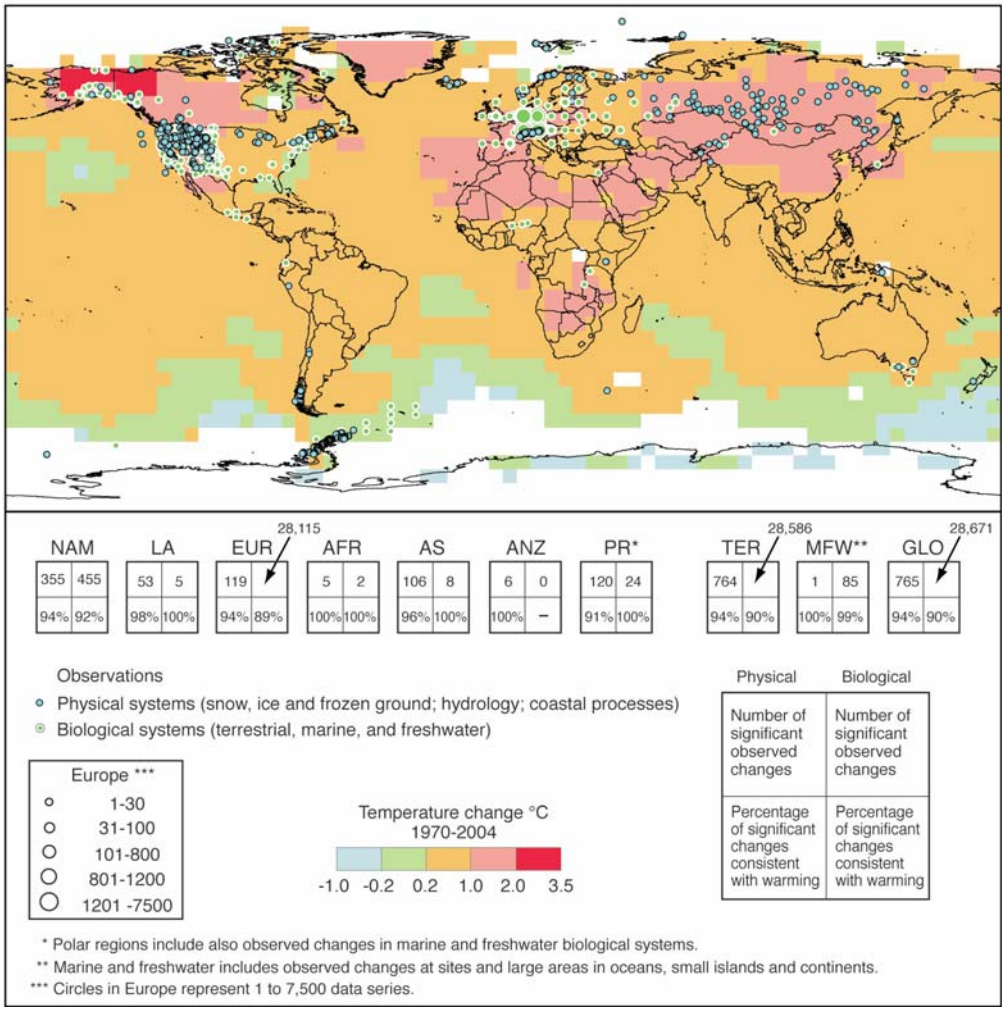
Correlation of Disease Clusters with the 1997-1998 El Nino Weather Extremes



Source: Epstein, Harvard Medical School, *Science*

Overwhelming Correlations
Synthesis of Scientific Literature on Observed Changes 1970-2004

- 577 studies reviewed
- 765 observed **physical** changes (94% consistent with warming)
- 28,671 observed **biological** changes (90% consistent with warming)

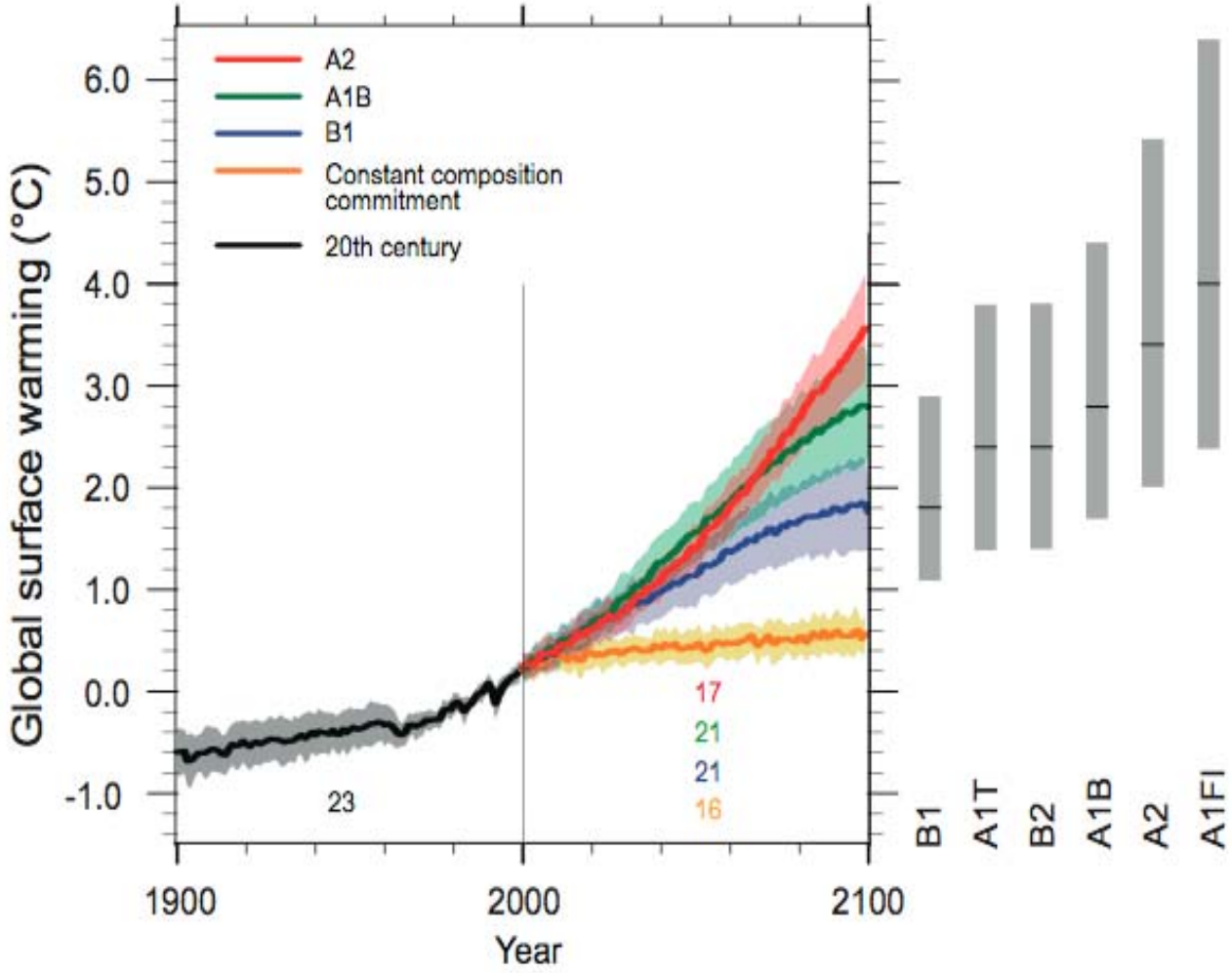


Source: IPCC 4th Assessment (2007)

State of the Science: Forecast

IPCC (2007) Projections of Future Changes in Climate

Best estimate for low scenario (B1) is 1.8°C (*likely* range is 1.1°C to 2.9°C), and for high scenario (A1FI) is 4.0°C (*likely* range is 2.4°C to 6.4°C).



Source: IPCC 4th Assessment (2007)

IPCC Change in Runoff: 2041-2060 (Average of 12 models -- Western US results are among the more robust)

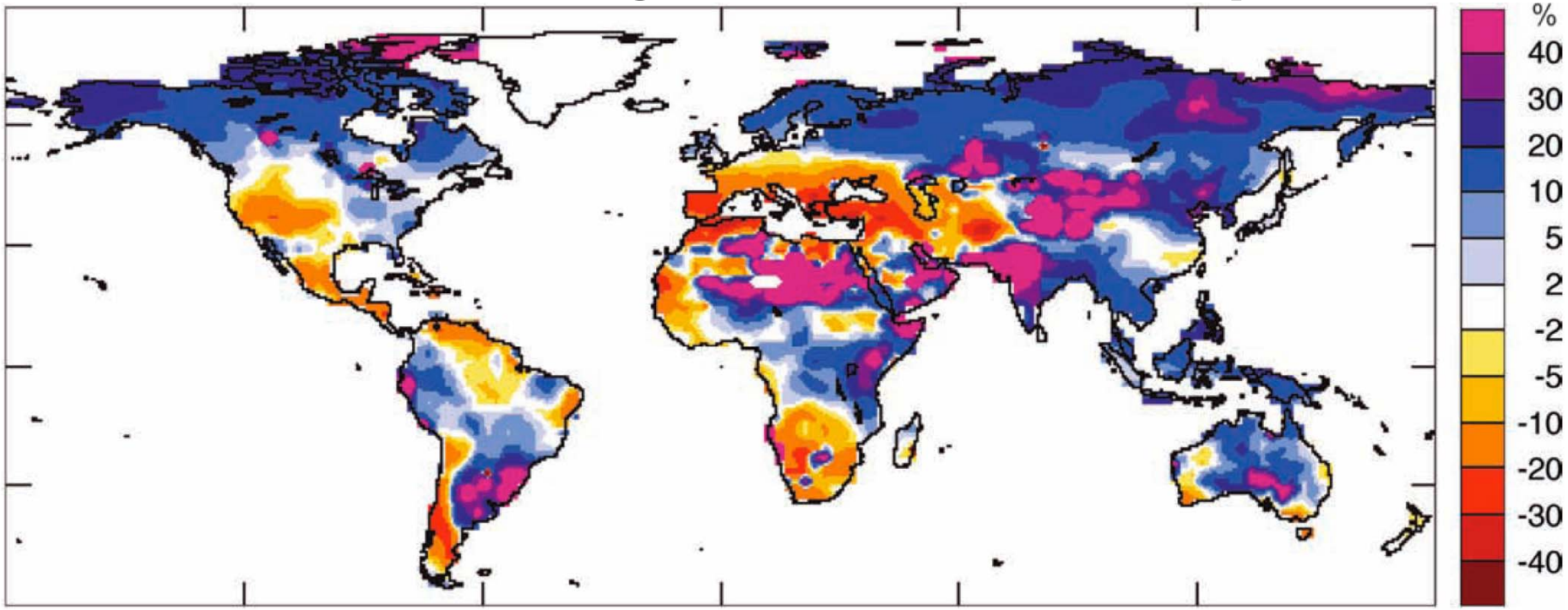


Figure 3.4. *Change in annual runoff by 2041-60 relative to 1900-70, in percent, under the SRES A1B emissions scenario and based on an ensemble of 12 climate models (Milly et al., 2005).*

Proportion of land area in extreme drought predicted to increase from 1-3% to 30% by 2090s. Drought duration expected to increase six-fold.

Source: IPCC 4th Assessment (2007)

Change in Recurrence of 100-year Droughts

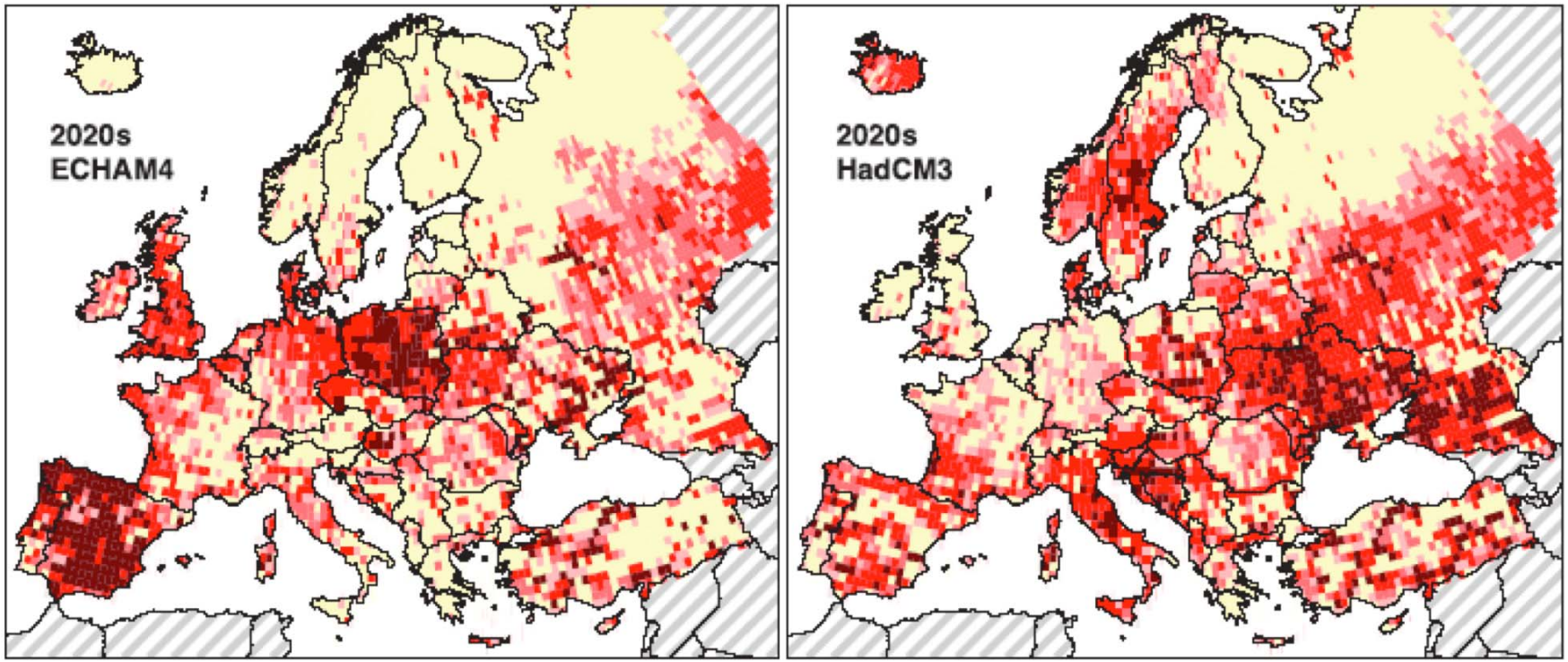


Figure 3.6. *Change in the recurrence of 100-year droughts, based on comparisons between climate and water use in 1961 to 1990 and simulations for the 2020s and 2070s (based on the ECHAM4 and HadCM3 GCMs, the IS92a emissions scenario and a business-as-usual water-use scenario). Values calculated with the model WaterGAP 2.1 (Lehner et al., 2005b).*

Source: IPCC 4th Assessment (2007), Ch 3

The Consensus

- **Human-induced climate change is here**: we've been studying this for over a century
- The climate consensus, is about as good as it ever gets in science.
  - It's about like that for:
    - Human evolution
    - Health consequences of tobacco smoke
- One can quibble with specific points, but not with the systematic observed pattern of evidence
- Uncertainties are explicit; and are shrinking
- No alternate theory has been advanced

Open Questions

- Not the existence of human-induced climate change, or lack thereof, but rather:
  - How much?
  - How fast?
  - Smooth versus abrupt change
  - Feedbacks
    - Positive
    - Negative
  - Geography of impacts; downscaling
  - Gaps in models (especially cryosphere)
  - Attribution of *Impacts*
  - Society's ability to adapt
  - Costs of mitigation and adaptation
  - Policy pathways

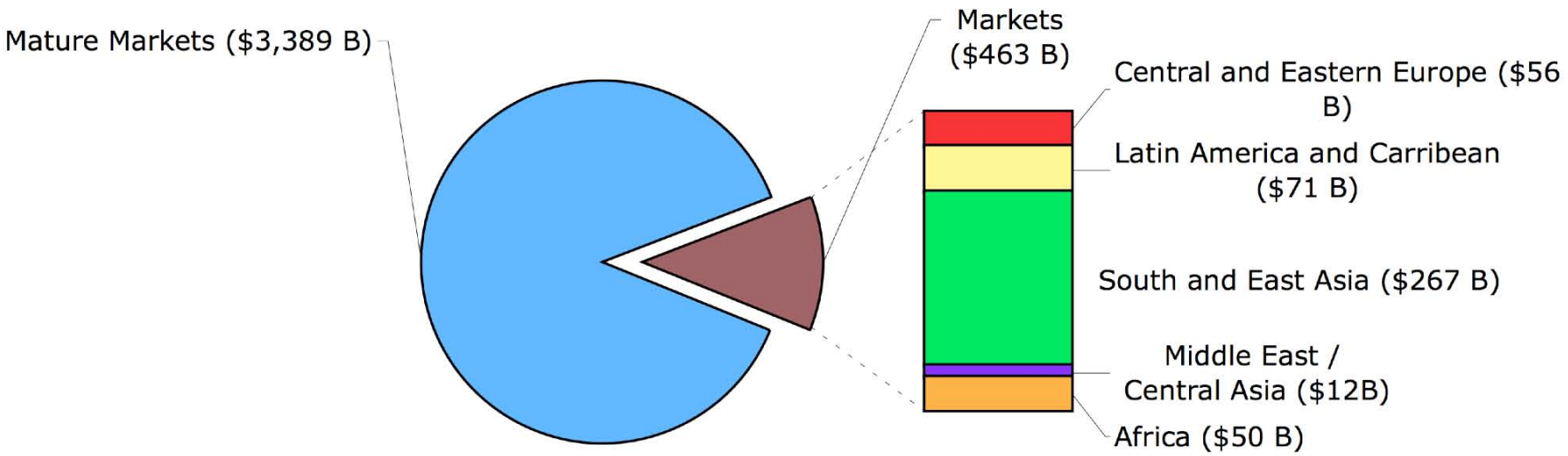
Donuts Exist Despite the Holes

Source: Krispy Creme

Risks for Insurers & Utilities

$3.8 *Trillion*
World Insurance Market

- World's biggest industry
- Important to all other business segments
- Major player in financial markets
- Enormous political influence

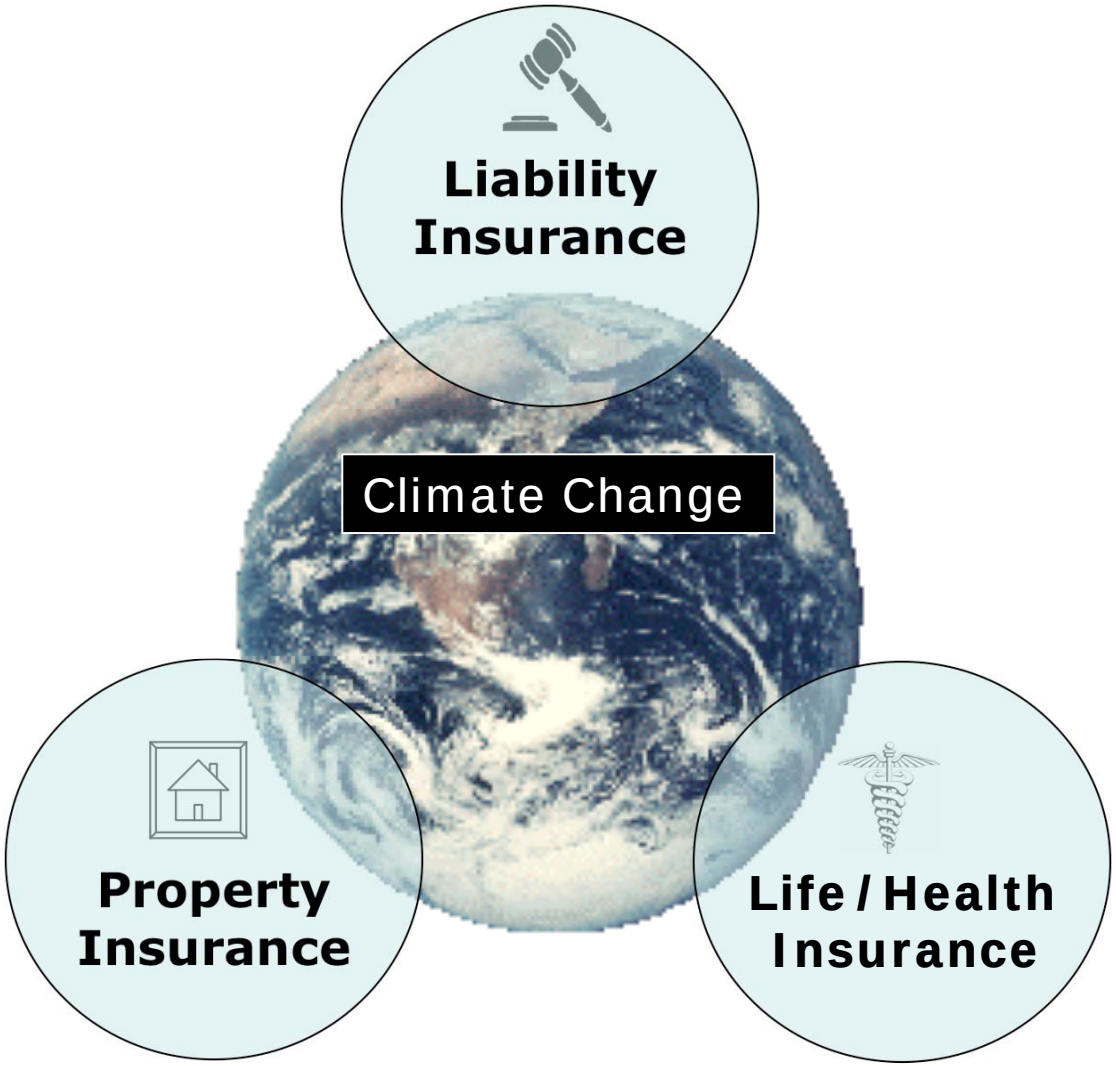


Source: Swiss Re, Sigma

Climate Change: Intersection with insurance

Insurers are....

- integrators
- risk managers
- vulnerable
- selective
- potentially part of solution



Anticipated Losses

- Property damage
- Mold/moisture
- Forest products
- Agricultural losses
- Fisheries
- Business interruption
- Roadway

- Injury
- Infectious diseases
- Heat stress
- Respiratory
- Pollutant releases
- Food poisoning
- Mental health
- Nutrition/water

- Products
- Negligence
- Nuisance
- Fiduciary
- Tort / BI
- Environmental
- Roadway liability insurance

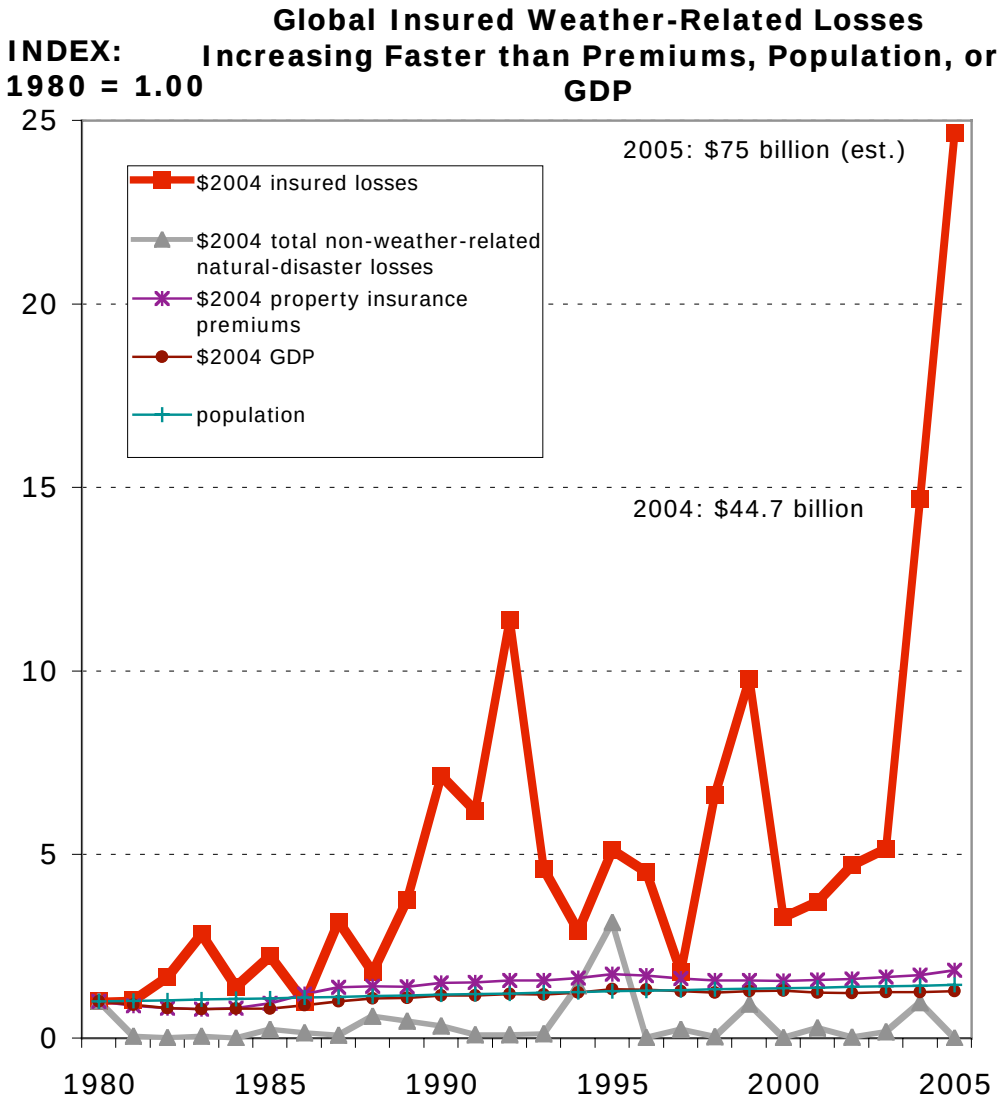
“We'd be out of our minds if we wrote weather insurance on the opinion global warming would have no effect at all.”

- Warren Buffett
2006 annual Shareholder meeting

Uncertainty: **Physical ➡ Financial**

Non-climate factors play a role, but…

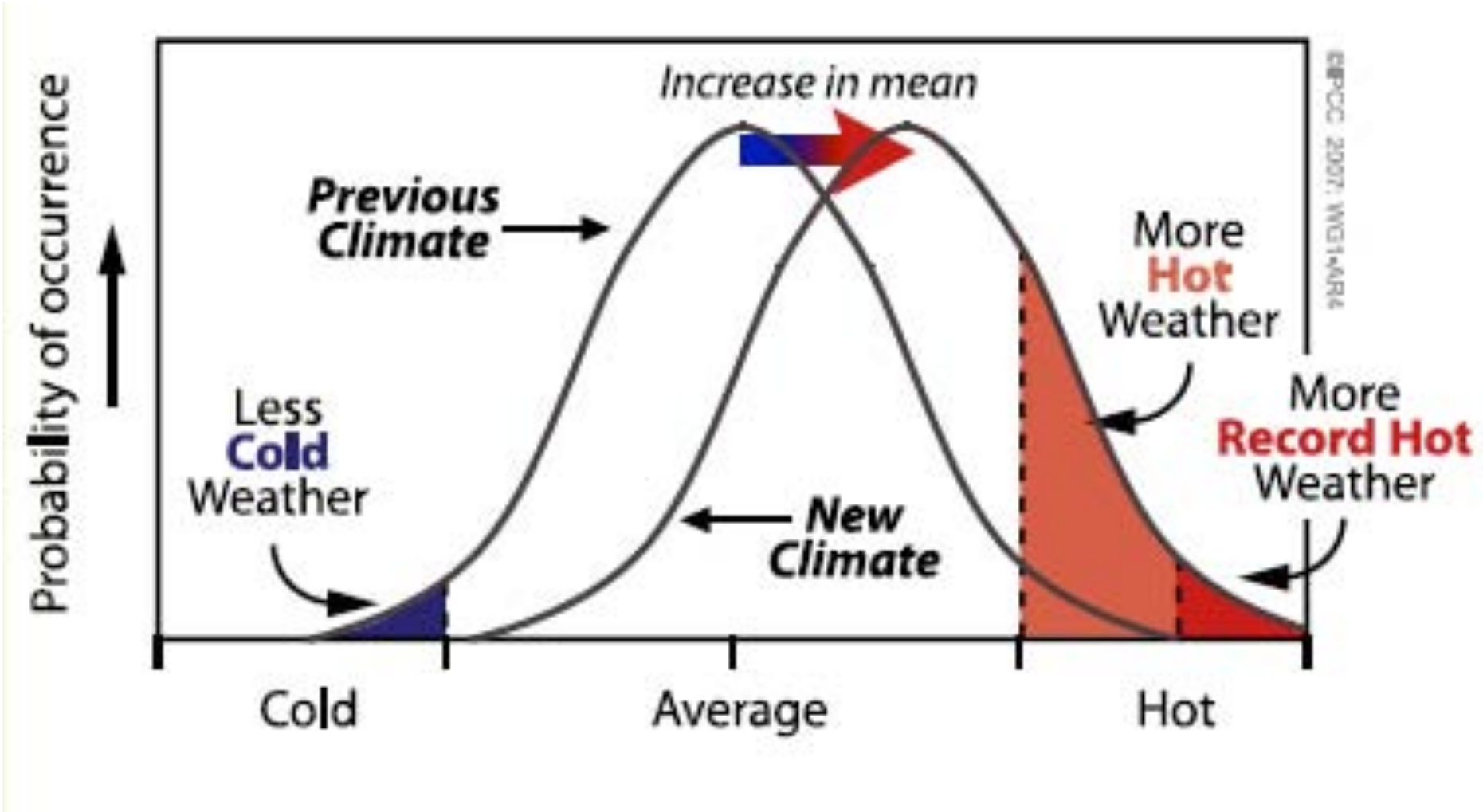
- Trends *consistent* with observed change
- Why are non-weather losses growing more slowly?
- Would have been even worse without prevention efforts



Notes: All economic values inflation-adkusted to 2004 levels. Losses from Munich Re NatCat Service; premiums from Swiss Re, *Sigma*. Values for 2005 are LBNL estimates.

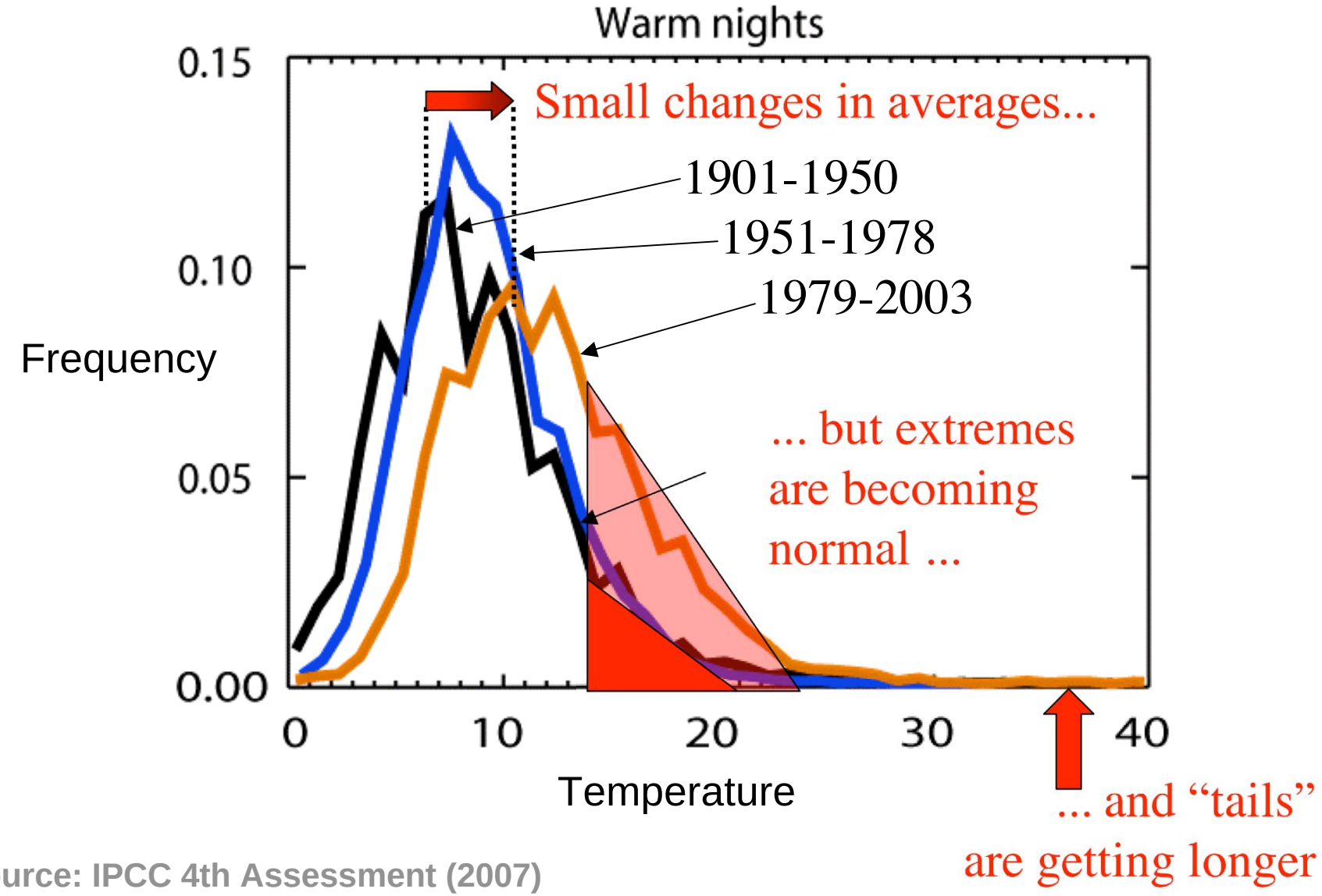
Source: E. Mills Science 309, 1040 -1044 (2005)

Changes in Averages vs. Extremes



Source: IPCC 3rd Assessment (2001)

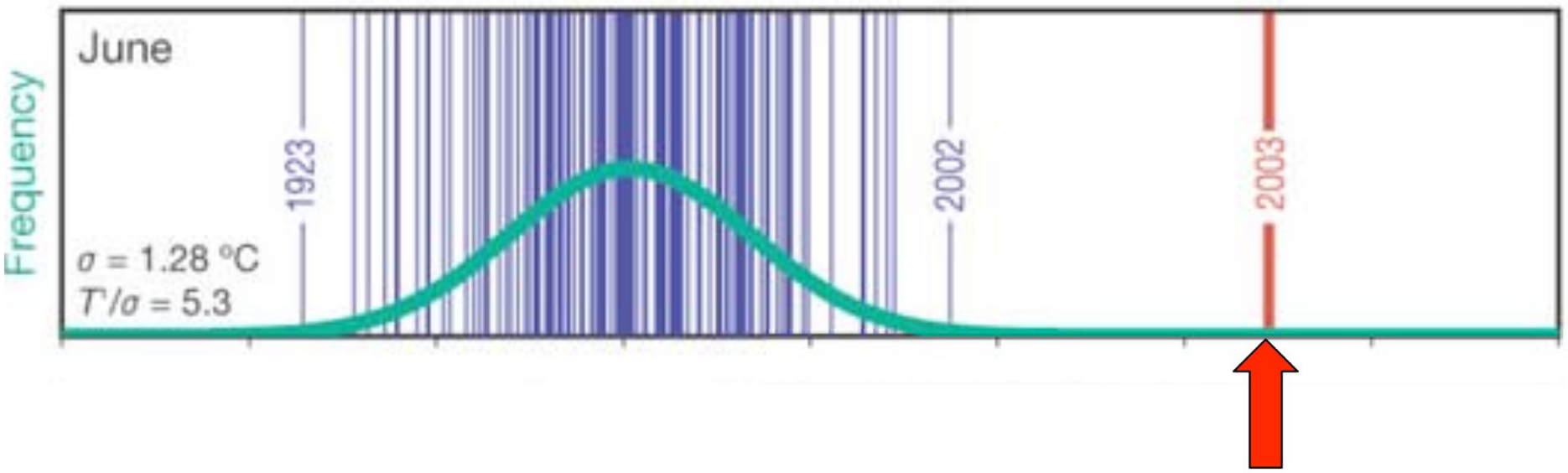
Extremes Shift *More* Than Avg's.



Source: IPCC 4th Assessment (2007)

Rare Extremes Cause Most of the Damages & Insured Losses

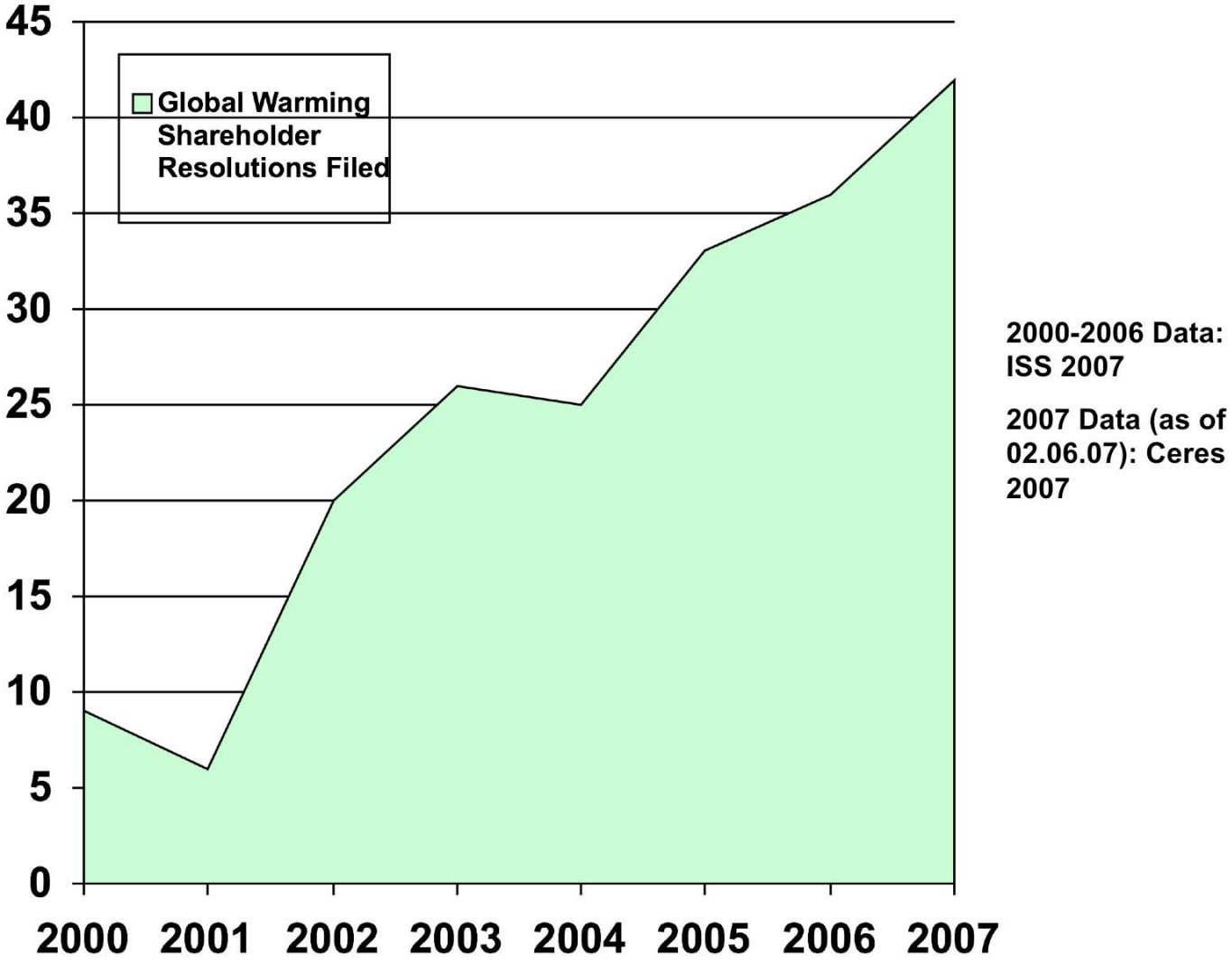
The European heat wave of Summer 2003



Event was "six-sigmas" outside of norm.
16°F above average in France and Germany
was a 1-in-10,000 event to 1-in-46,000 event

Source: Schar et al, *Nature*, v. 427, 2004.

Shareholder Resolutions Link Business Atmosphere to Climate Change Liability



www.bestreview.com

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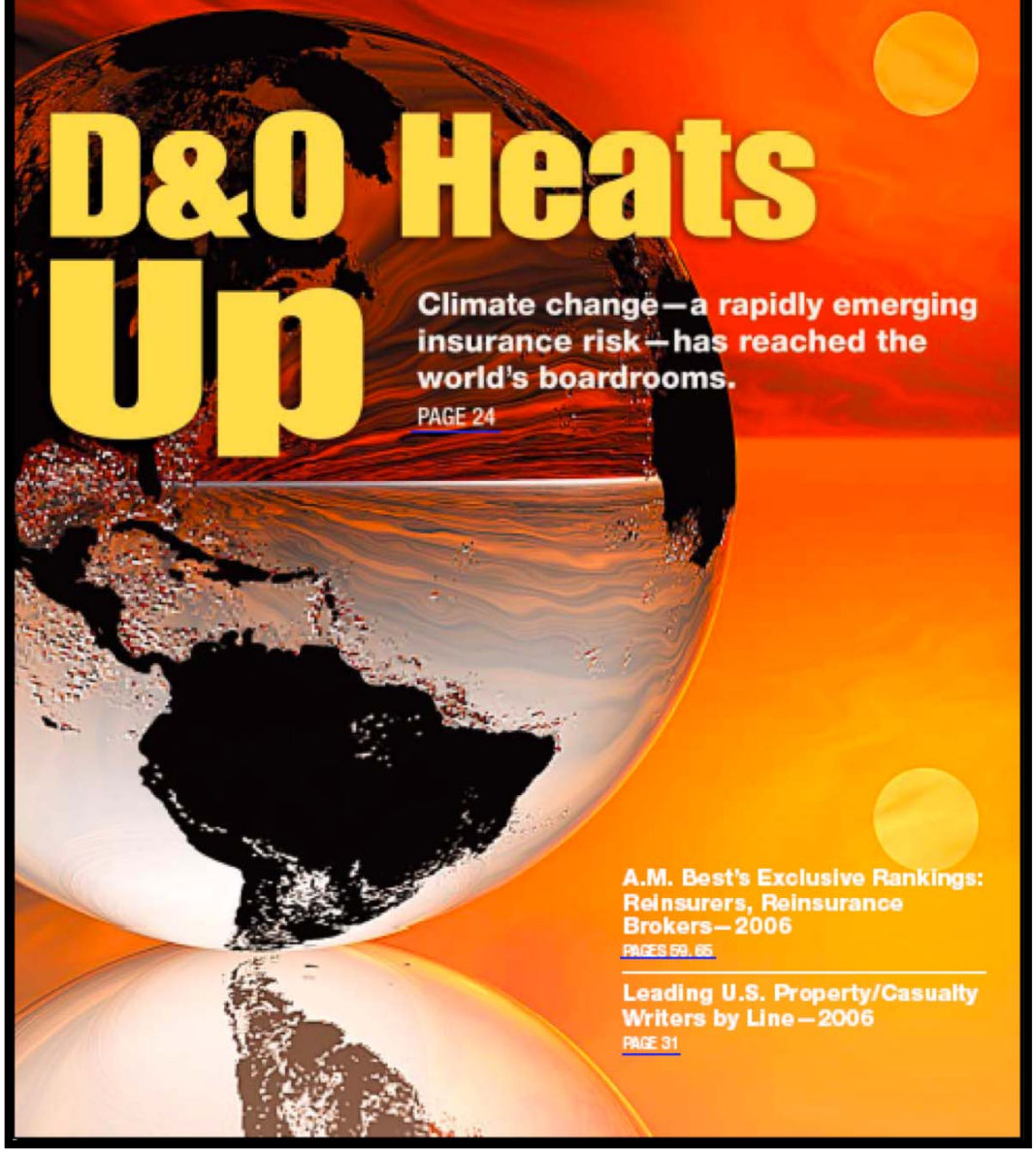

D&O Heats Up

Climate change—a rapidly emerging insurance risk—has reached the world's boardrooms.

PAGE 24

A.M. Best's Exclusive Rankings: Reinsurers, Reinsurance Brokers—2006

PAGES 59, 65

Leading U.S. Property/Casualty Writers by Line—2006

PAGE 31

www.propertyandcasualtyinsurancenews.com

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LAST CALL!

National Underwriter Property & Casualty Insurance Agency of the Year 2007

Award Entries Due By July 6

See Page 3

Top Stories of The Week

Bush Opposition Leaves TRIA Extension In Doubt

The White House threw cold water on legislation providing a long-term extension of the Terrorism Risk Insurance Act, while small insurers voiced concern over mandatory coverage for all types of attacks. ▶Page 6

State Regulator Cleared For Private NAIC Sessions

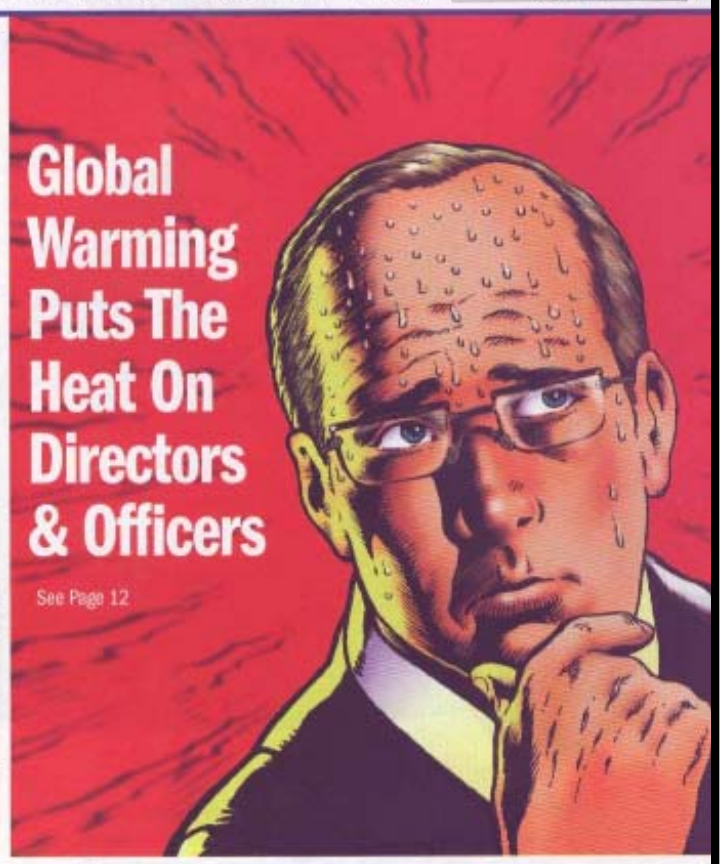
In the first ruling of its kind, North Dakota's attorney general has upheld the legality of the nation's insurance regulators barring the public from certain meetings of their national association. ▶ Page 8

Katrina Battle Heats Up

The legal battle between a major insurer and a high-profile plaintiff attorney over Katrina claims expanded on three new fronts. ▶ Page 10

'Woman Of The Year' Offers Career Advice

APIW's 2007 "Insurance Woman of the Year," H. Elizabeth Mitchell, president of Platinum Underwriters Re, shares some of the secrets of her success for those trying to make it in the industry. ▶ Page 30



Global Warming Puts The Heat On Directors & Officers

See Page 12

**********AUTO**3-DIGIT 947
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EVAN MILLS 06712
LAWRENCE BERKELEY NATL LAB

FRAUD REVIEW

Insurers Go Hi-Tech To Combat Crooks

ROGUE AGENTS!

Dishonest Producers Play Shell Games With Their Clients

Business Insurance

February 5, 2007

www.businessinsurance.com

ANOTHER APPEALS COURT RULES CASH BALANCE PLANS DON'T DISCRIMINATE / PAGE 3

FINANCIAL GUARANTEE INSURER PAYS $75 MILLION TO SETTLE FINITE CHARGES / PAGE 3

RADIO STATION RISK MANAGERS TO INCREASE ON-AIR OVERSIGHT AFTER CONTEST TRAGEDY / PAGE 3

In Brief

Mich. court rejects same-sex benefits

Michigan's 2004 marriage amendment prohibits public employers in the state from offering health benefits to employees' same-sex domestic partners, the Michigan Court of Appeals has held. [illegible] Court of Appeals, the three-state panel held that public employer plans that recognize domestic partnership agreements for the purpose of providing benefits "would totally distort the plain language of the amendment."

Bias claims up in 2006: EEOC

A total of 75,768 discrimination charges were filed with the U.S. Equal Employment Opportunity Commission in fiscal year 2006,

See IN BRIEF page 22

U.N. climate report stirs liability fears

Scientific testimony may fuel lawsuits on global warming

By ROBERTO CENICEROS

The publication of a U.N. report last week linking human activity to global warming could be enough to cause immediate liability problems for industrial companies, but it does increase the chances of more claims flowing through to insurance policies in the future, some experts say.

The report, which links the burning of fossil fuels with more extreme climate conditions, may increase the likelihood that commercial policyholders and their liability insurers will have to fund more defenses against alleg[illegible] claims that global warming played a role in causing Hurricane Katrina, which damaged the homeowners' properties.

The lawsuit, which [illegible] brought [illegible] to get thrown out and didn't represent a "first shot across the bow" for potentially responsible liability for global warm-related losses, said Dave Oakleaf, president of American Risk Management Resources Network L.L.C., a Madison, Wis.-based environmental wholesale brokerage.

In addition, last year then-Connecticut Attorney General Richard Blumenthal sued several Japanese and U.S. auto manufacturers, said G. Andrew Lundberg, a policyholder attorney at Latham & Watkins L.L.P. in Los Angeles.

The lawsuit alleged that the

Marsh reaps $3.9B with Putnam deal

[illegible] investment firm sale will sharpen focus, boosts war chest

By SALLY ROBERTS

NEW YORK—[illegible] Inc.'s sale of Putnam Investments, its asset management unit, to [illegible] will make [illegible] a stronger and more focused, analysts say.

[illegible] Inc., a Milwaukee-based unit of Marsh & McLennan Cos., Inc., New York, agreed [illegible] to pay $3.9 billion in cash, repurchase stock, make acquisitions and focus on building its core insurance and consulting businesses, according to analysts.

[illegible] of MMC must [illegible] analysts noted although they disagree as to the likelihood of such a deal.

At the end of 2006, Putnam, which MMC acquired in 1970, had $192 billion in mutual fund and institutional assets under management, generating about [illegible] of MMC's total revenues in 2006.

MMC has been under pressure [illegible] following a host of regulatory and legal issues that have affected both Putnam and MMC's brokerage unit, Marsh Inc.

In 2003 and 2004, Putnam entered into agreements with U.S. Securities and Exchange Commission and state authorities in Massachusetts regarding excessive short-term trading by former Putnam employees in Putnam mutual funds. Putnam paid a total [illegible]

June 3, 2007, 5:13 pm

What Insurers Should Do About Climate Change

Getty Images

Insurers are likely to soon take a leadership role in reducing the risks of climate change as companies become more liable for damage related to it. The authors of a study jointly published by the Stanford Environmental Law Journal and the Stanford Journal of International Law sketch out several ways that companies who disproportionately contribute to global warming could be held responsible for its damage as the science of global warming becomes clearer.

The most common example is owners of property damaged by a warmer world's extreme weather suing companies that disproportionately emitted greenhouse gases. As well as paying out on insurance covering such liability claims, insurers will have to pay for several kinds of damage related to global warming, the authors say. They'll have to pay for car crashes on wet roads and ski resorts that insure themselves against warm winters short on snow.

"The insurance industry, perhaps more than any other institution, has the power to set the stage for enduring and significant contributions to solving the problem of global climate change," say environmental consultant Christina Ross, government scientist Evan Mills and environmental-law expert Sean B. Hecht.

Considerations for Utilities

[insurance, self-insurance, reinsurance]

- **Infrastructure repair, redesign, fortification** [property]
- **Service provision & lost revenues**
  - Changes in demand for energy and water
  - Failure to deliver [contingent business interruption]
  - Eroded water quality [product liability]
- **Liability**
  - As providers of services [general liability]
  - As emitters [various liability]
  - As impacted businesses [directors and officers liability]
- **Reputation**
  - Part of problem or solution?
  - Preparedness in the eyes of public, customers, shareholders, regulators
- **Risk profiles of climate responses**
- **Insurance availability & affordability**

Availability & Affordability

- Exodus of insurers from coasts (*and* elsewhere)
- Quiet “hollowing out” of insurance
- Customers “going Bare”: 9 utilities (10% of membership) left in OIL Mutual Ins. Co. May 2007
  - Paid $100 million in fees to leave
  - CEO says “It was a stunning blow”
- Rand Report on commercial insurance in FL
  - In 2005: one insured paid $250k for $38m coverage
    In 2006: paid $940k for $5m coverage, i.e. a ~29-fold bump in the “cost of risk”

Physical Impacts to Watch For

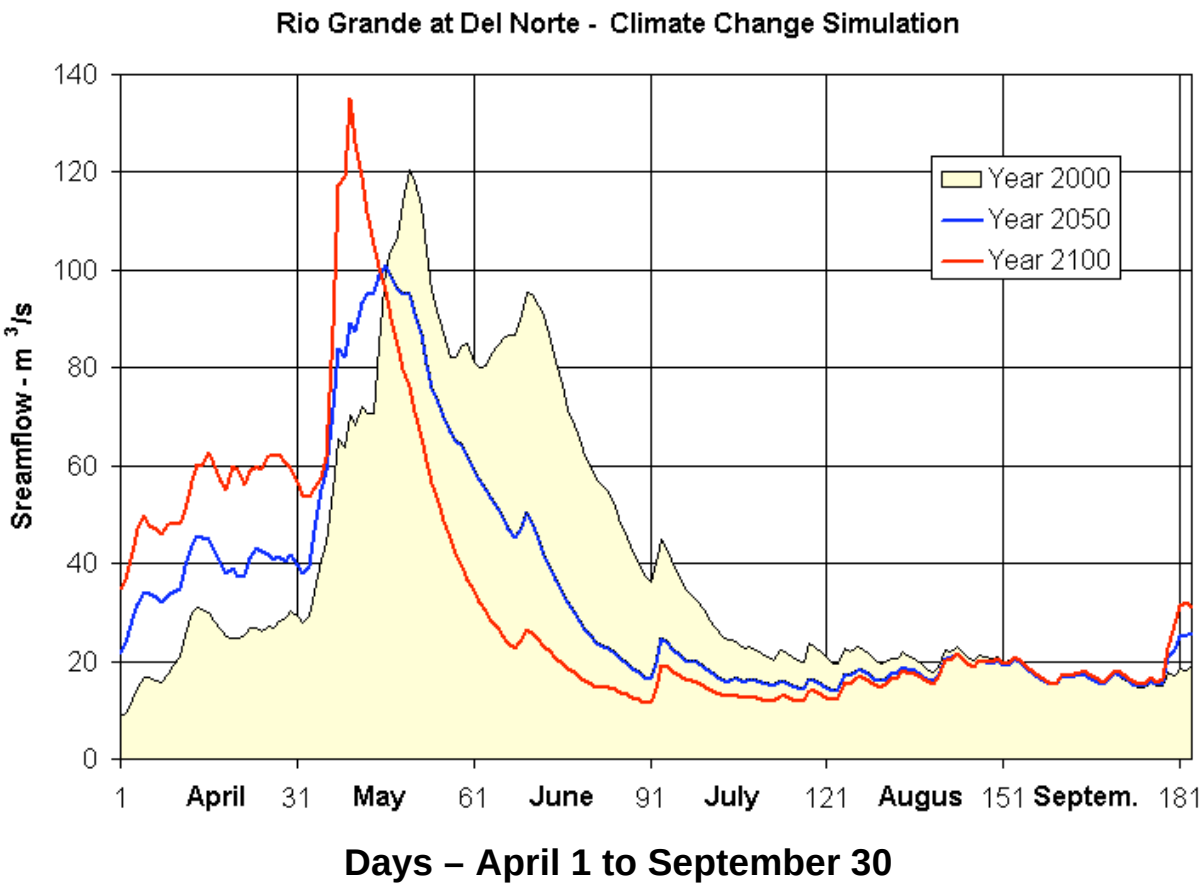
- **Elevated temperatures** - peak demand (water & energy); increased T&D ("I^2R") losses; loss of cooling water; erosion of water quality; increased evaporation
- **Sea level rise** - infrastructure inundation; corrosion; wastewater; salt-water intrusion into drinking water
- **Reduced lake levels** - hydro output; water avail./qual.
- **Storm -- Precipitation, flood, lightning** - infrastructure damage & power outages; siltation of reservoirs; water quality (turbidity, nutrients, pathogens, toxins, algal blooms, bacteria, acidification, fertilizers and pesticides)
- **Drought** - reduced hydro output; water supply-demand; water quality (reduced dilution, increased salinity)
- **Subsidence & permafrost melt** - damaged pipelines, generators; transmission networks; groundwater quality

Climatic Shifts in Hydrograph

Fingerprints

- Percent of precipitation falling as rain (*vs* snow) increased at 74% of U.S. stations
- April snow equivalent down 15-30% in western North America
- Stream-flow peaking 1-4 weeks earlier (western US mountains)
- Earlier river-ice breakup

Forecasts



Source: Brian H. Hurd
Dept of Agricultural Economics and Agricultural Business, New Mexico State University

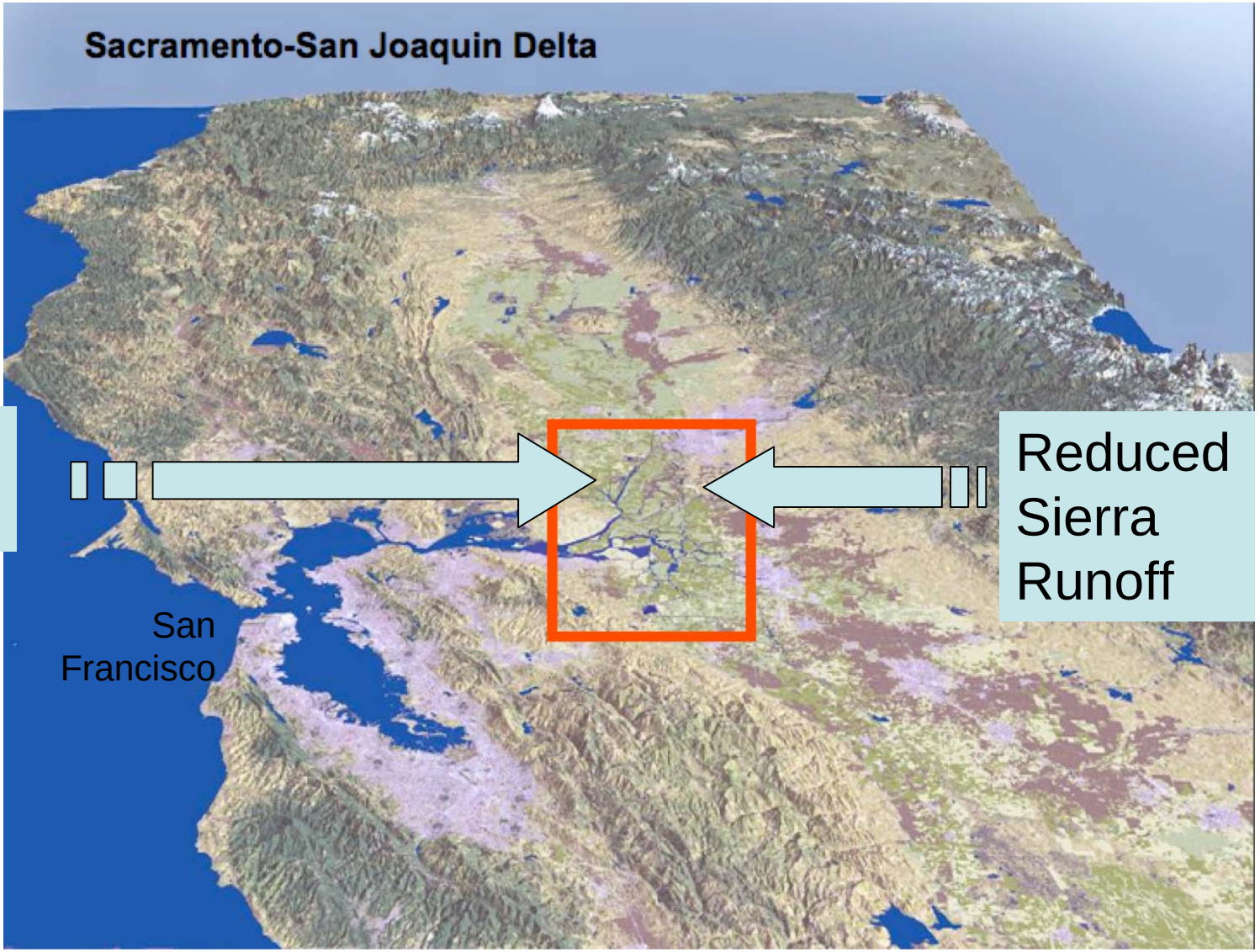
Tanzania: Drought >> Blackouts

1990

Mt. Kilimanjaro

2000

Water Quality: California

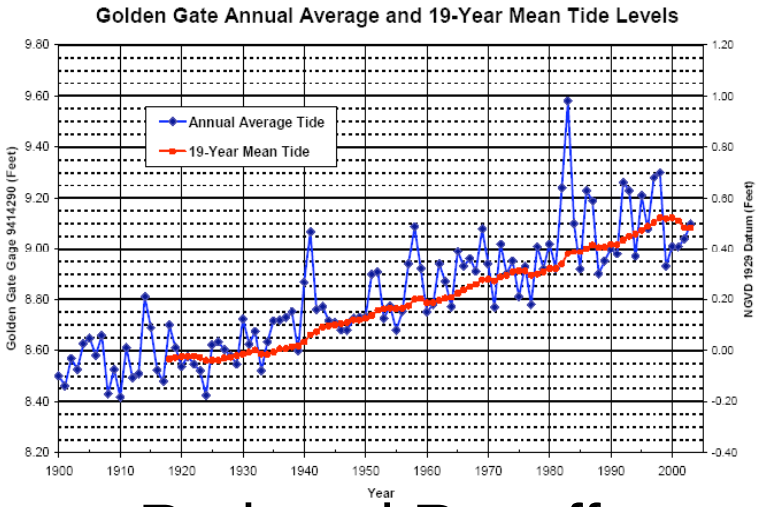


Sea-level Rise

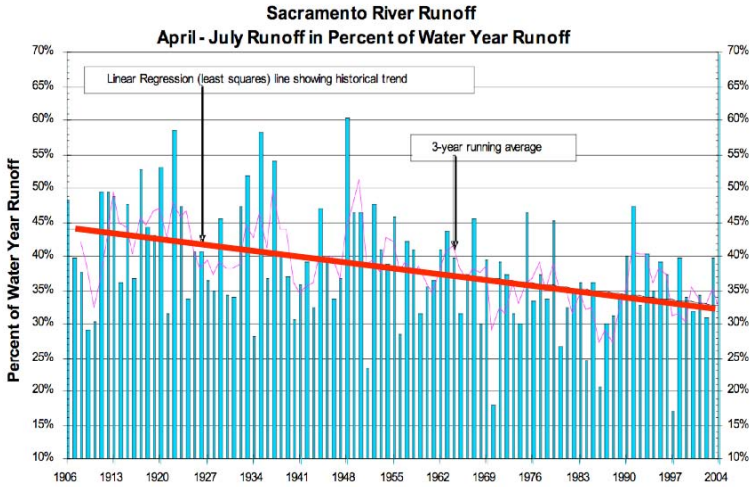
Reduced Sierra Runoff

Rising Salinity

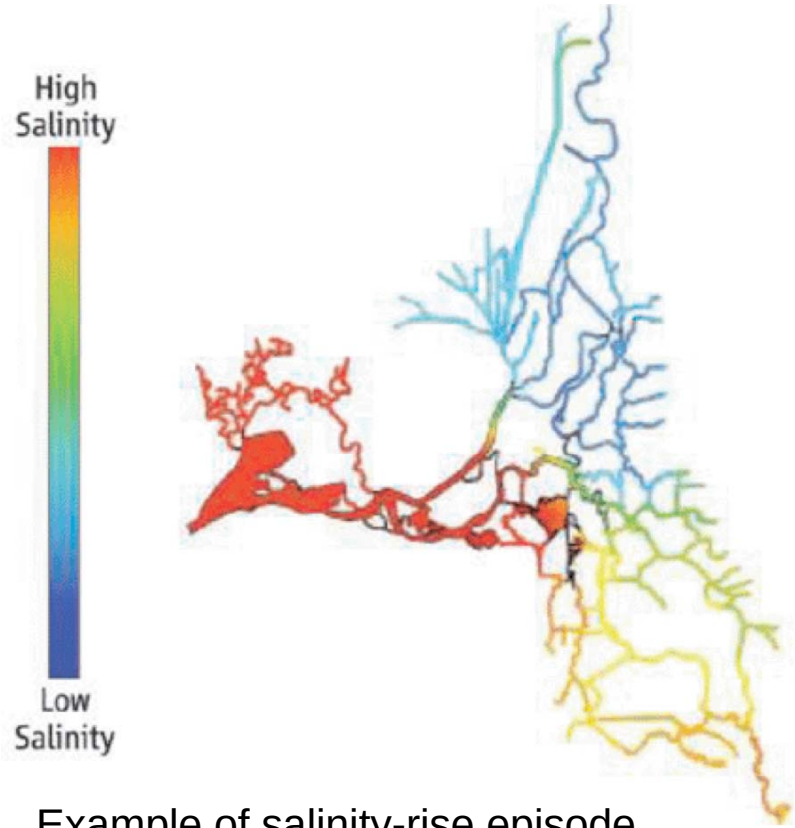
Sea-level Rise



Reduced Runoff



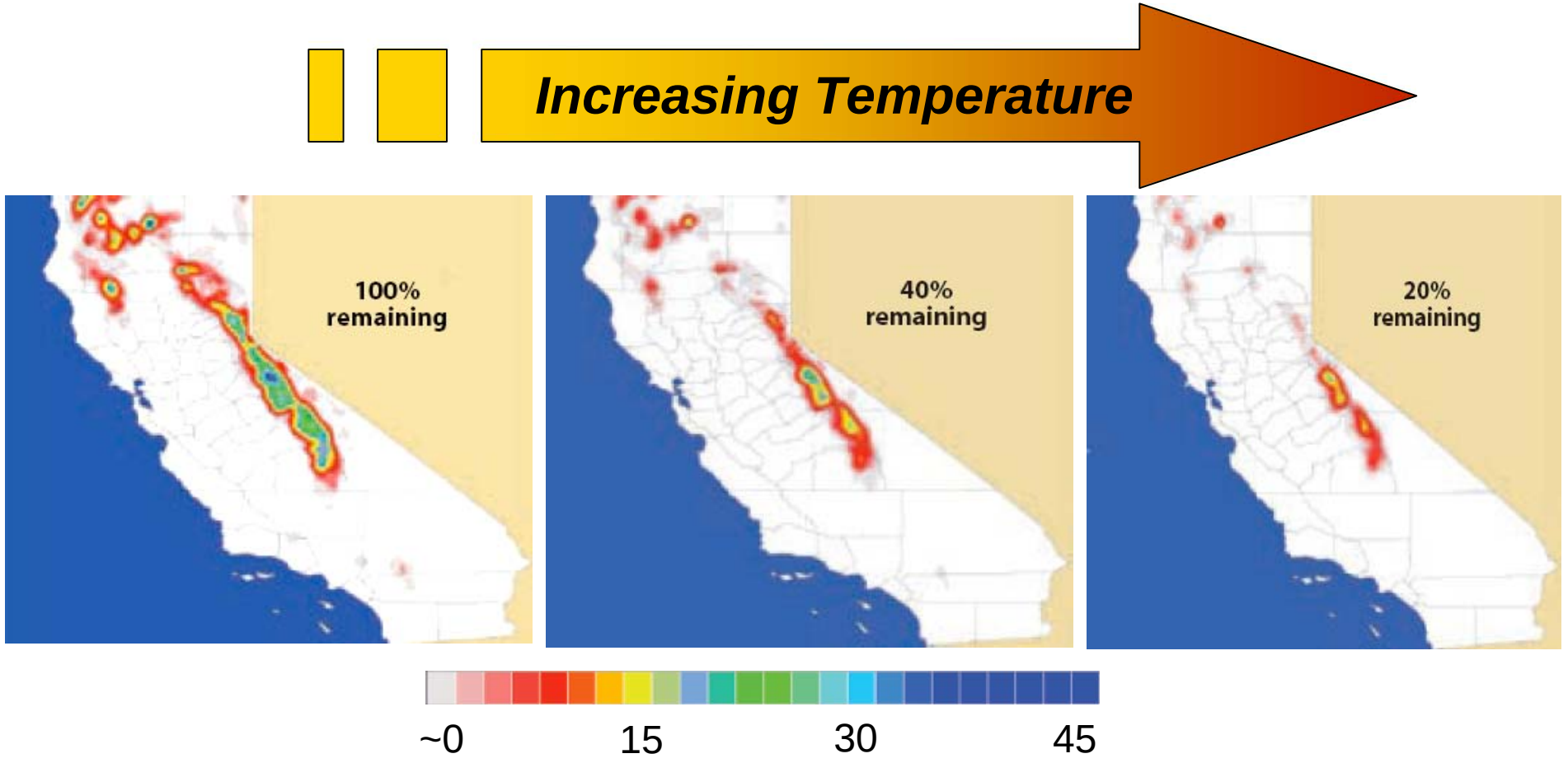
Salt Water Intrusion (California Delta)



Example of salinity-rise episode during drought of 1992 (*Science* 2007)

http://baydeltaoffice.water.ca.gov/climatechange.cfm

Forecast Decrease in Sierra Nevada Snowmelt

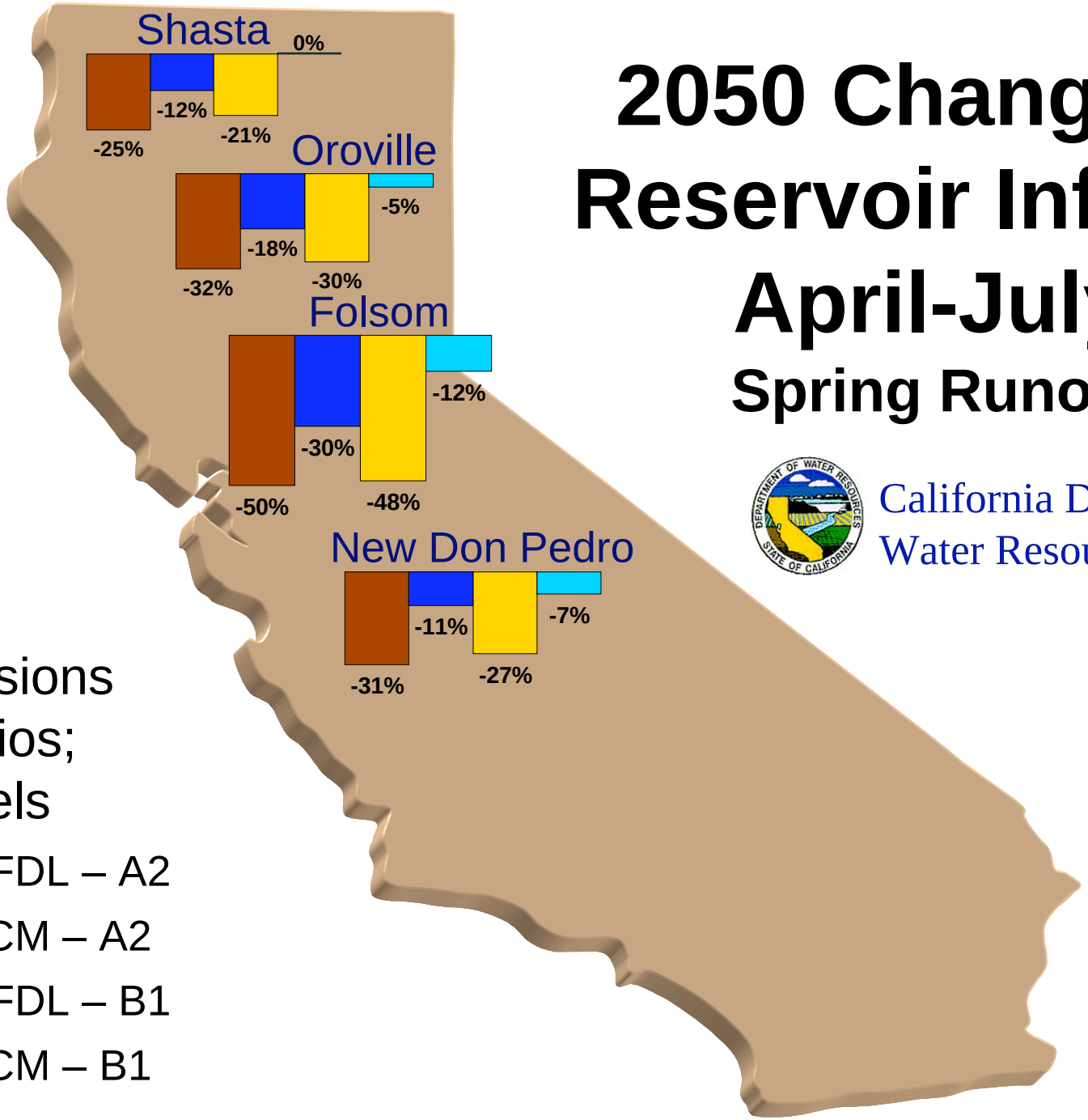


April 1 snow water equivalent (inches)

Hayhoe et al. "Emissions pathways, climate change, and impacts on California", *PNAS* (2004)

2050 Change in Reservoir Inflows April-July

Spring Runoff



California Department of Water Resources

2 emissions scenarios;
2 models

- GFDL – A2
- PCM – A2
- GFDL – B1
- PCM – B1

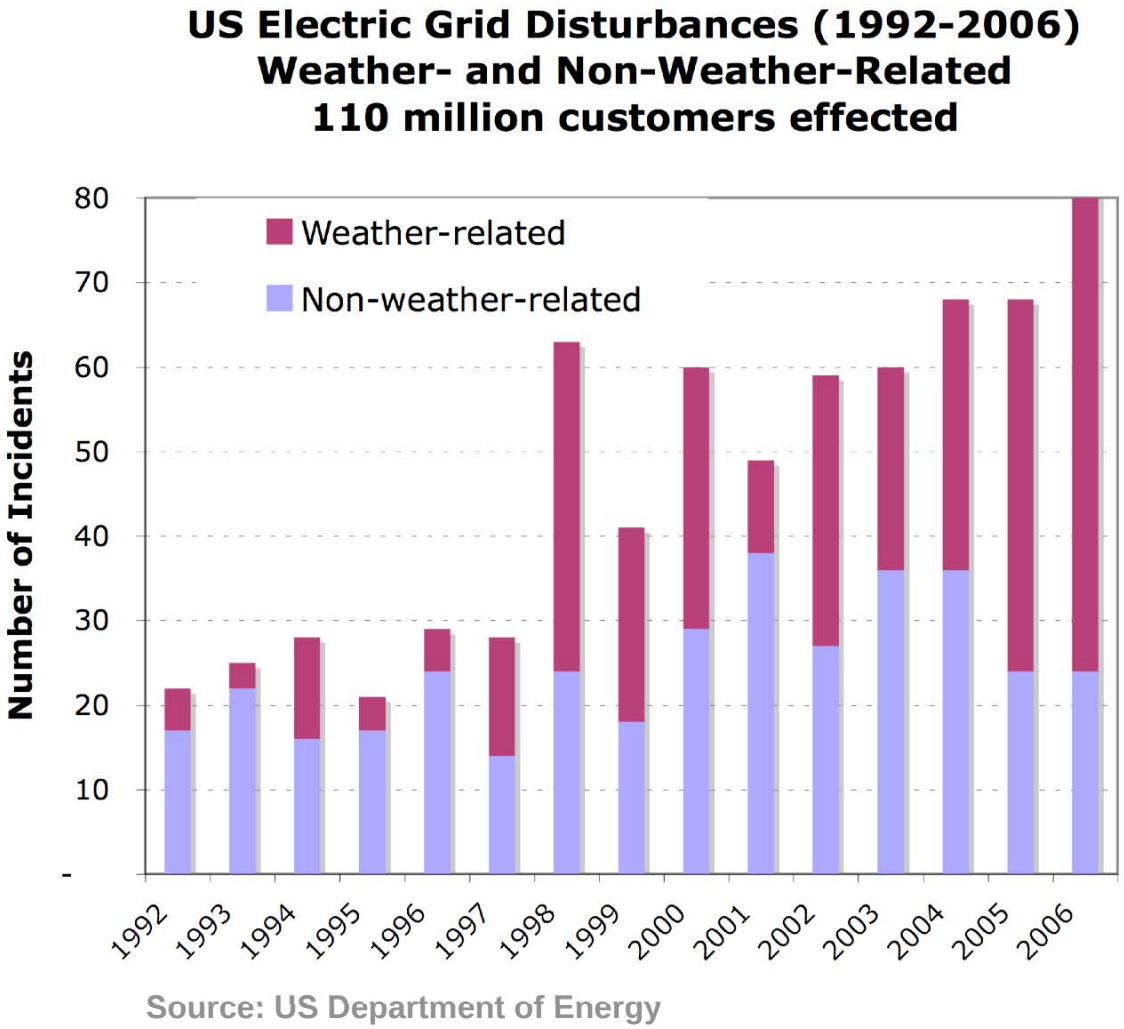
Sea-level Rise = 10 feet = half of Greenland melting

(Source:
Harvard University)

Sea-level Rise = 10 feet = half of Greenland melting

(Source:
Harvard University)

U.S. Power Outages



Source: US Department of Energy

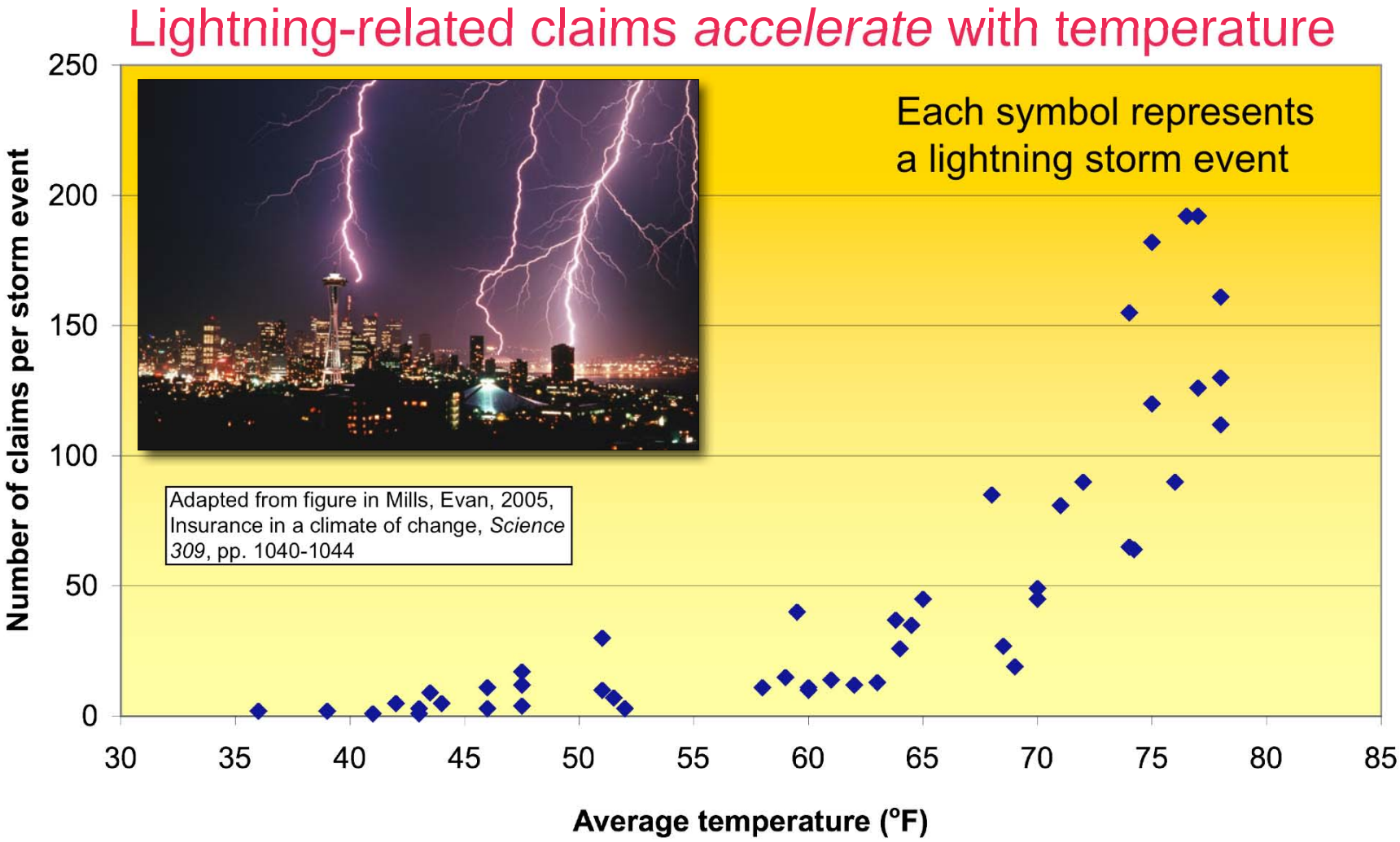
Power outages were a factor in slowness of draining New Orleans following Hurricane Katrina.

U.S. economy total cost:
~$80B/year

Average cost to utilities
$49 million/storm; max.
$890 million (EEI)

RMS Scenario:
$2.7B for NY

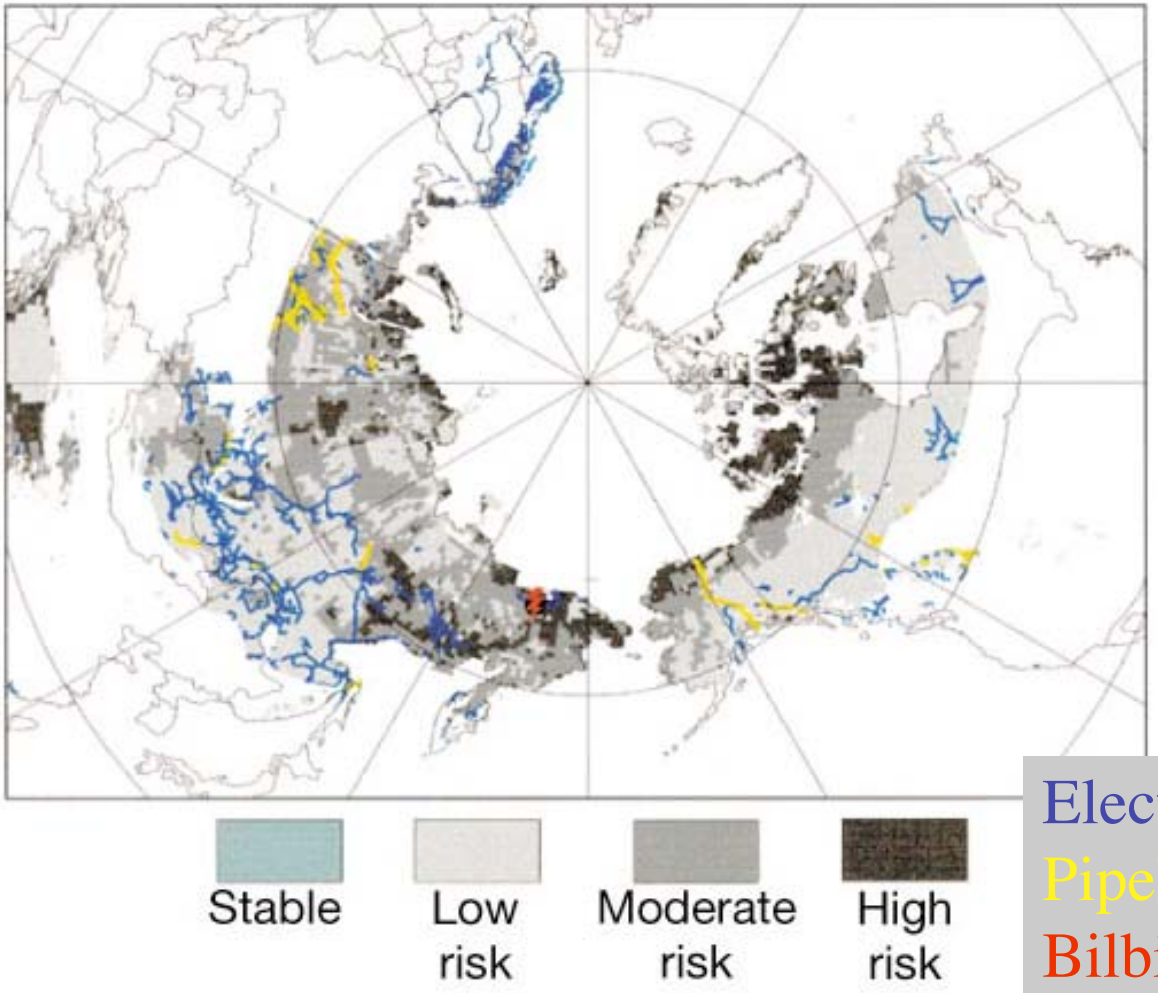
Temperature-Related Insurance Loss Experience

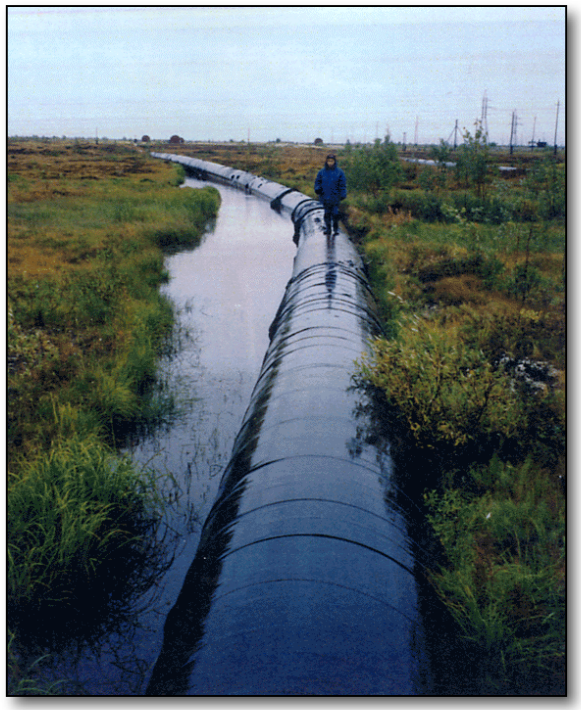


Source: Hartford Steam Boiler Inspection and Insurance Co.

Permafrost Melt Hazard Potential

Settlement of *several meters* is possible





Electrical transmission
Pipelines
Bilbino nuclear station

Nelson, et al. 2001 (*Nature*)

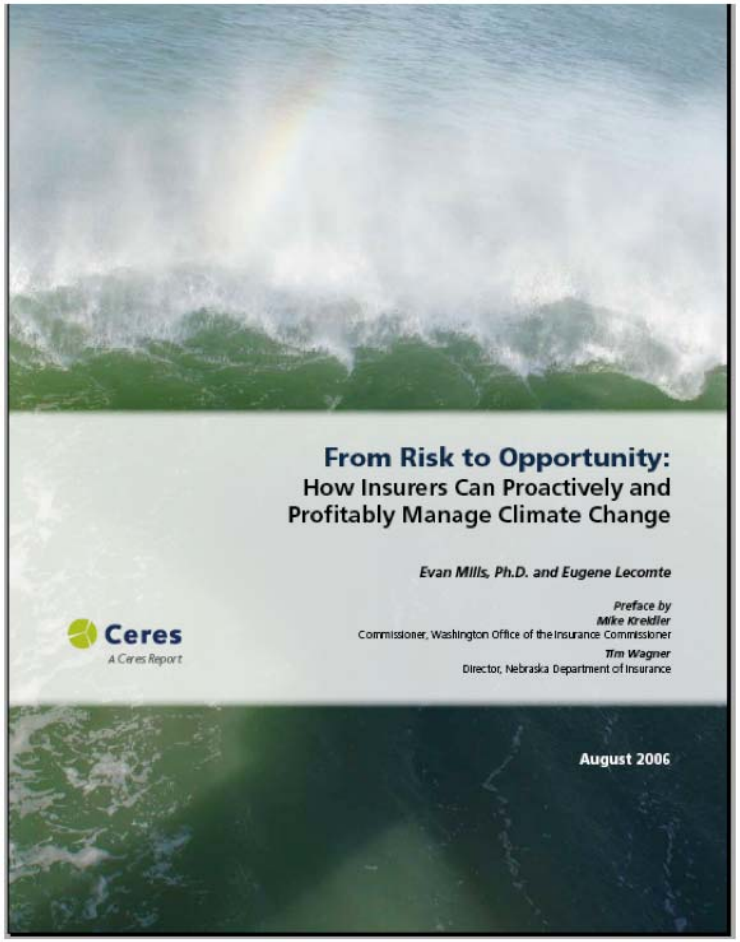
Managing Risks
&
Capturing Opportunities

From Risk … to Opportunity

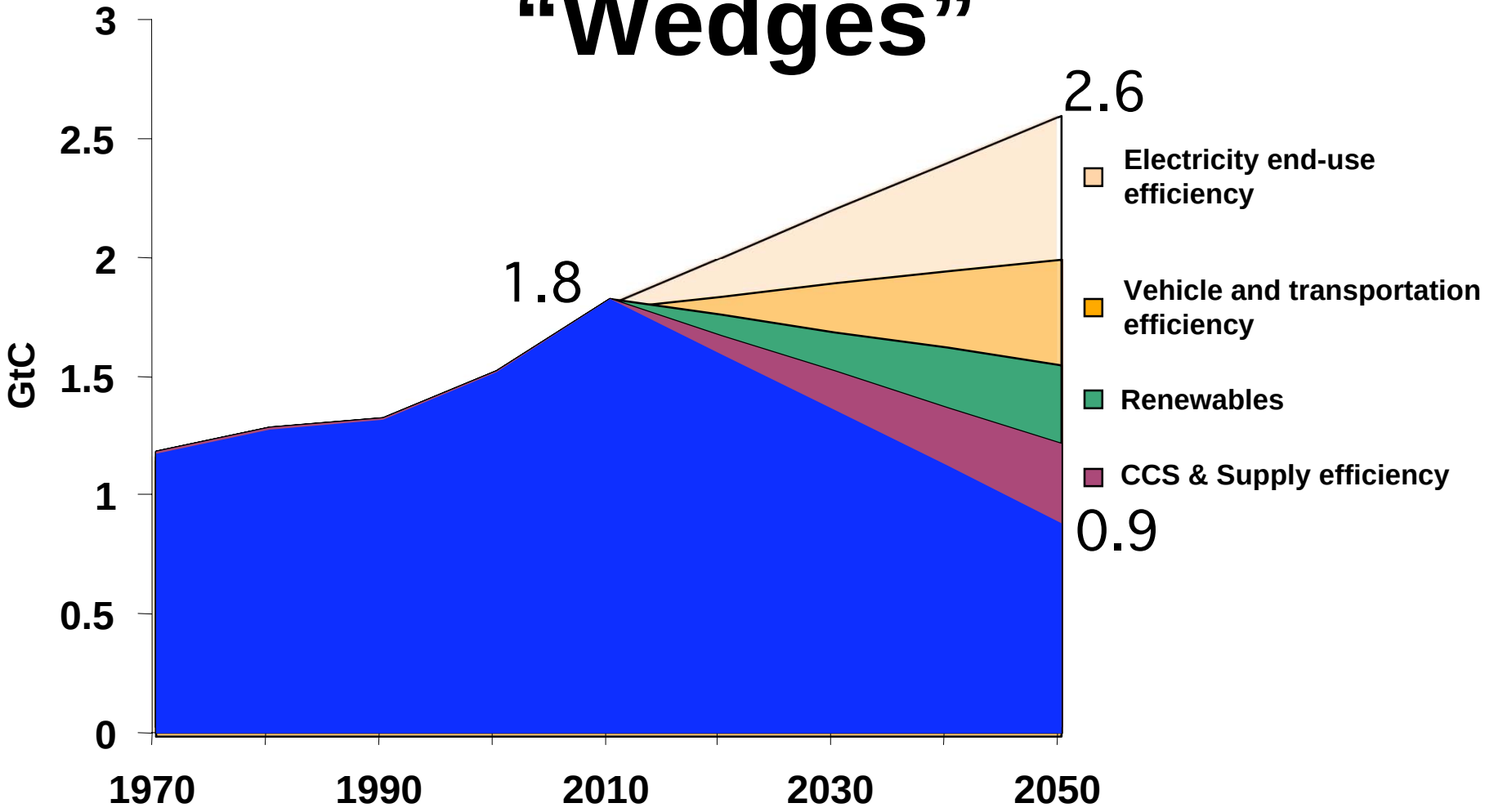
The insurance sector has a key role to play in ***helping to mitigate the effects*** *of climate change … and by* ***developing new products and solutions*** *that can support emerging greenhouse-gas and renewable energy markets.*

- Marsh & McLennan

Ceres Report: 25 strategies; ~220 examples; ~120 insurers

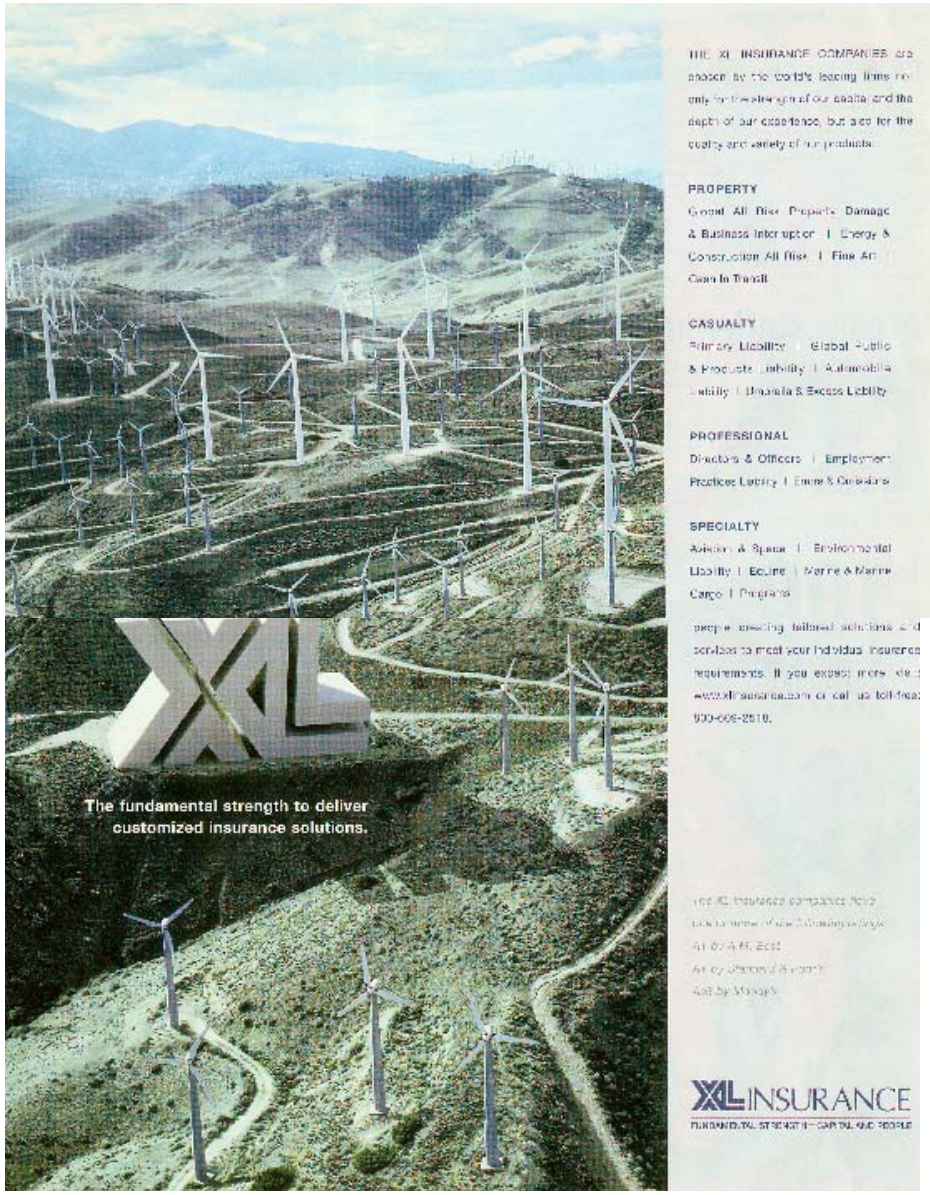


Cutting U.S. Emissions in Half with Climate-Stabalization "Wedges"



After Pacala and Socolow (*Science*)

More Business!



Promoting Loss Prevention

- ***Institute for Business and Home Safety's*** "Fortified… for safer living" stds.
  - Wind-resistant rigid foam panel walls and multi-glazed windows
  - Ice-dam resistant
  - Mold resistant
  - Water-resistant insulation

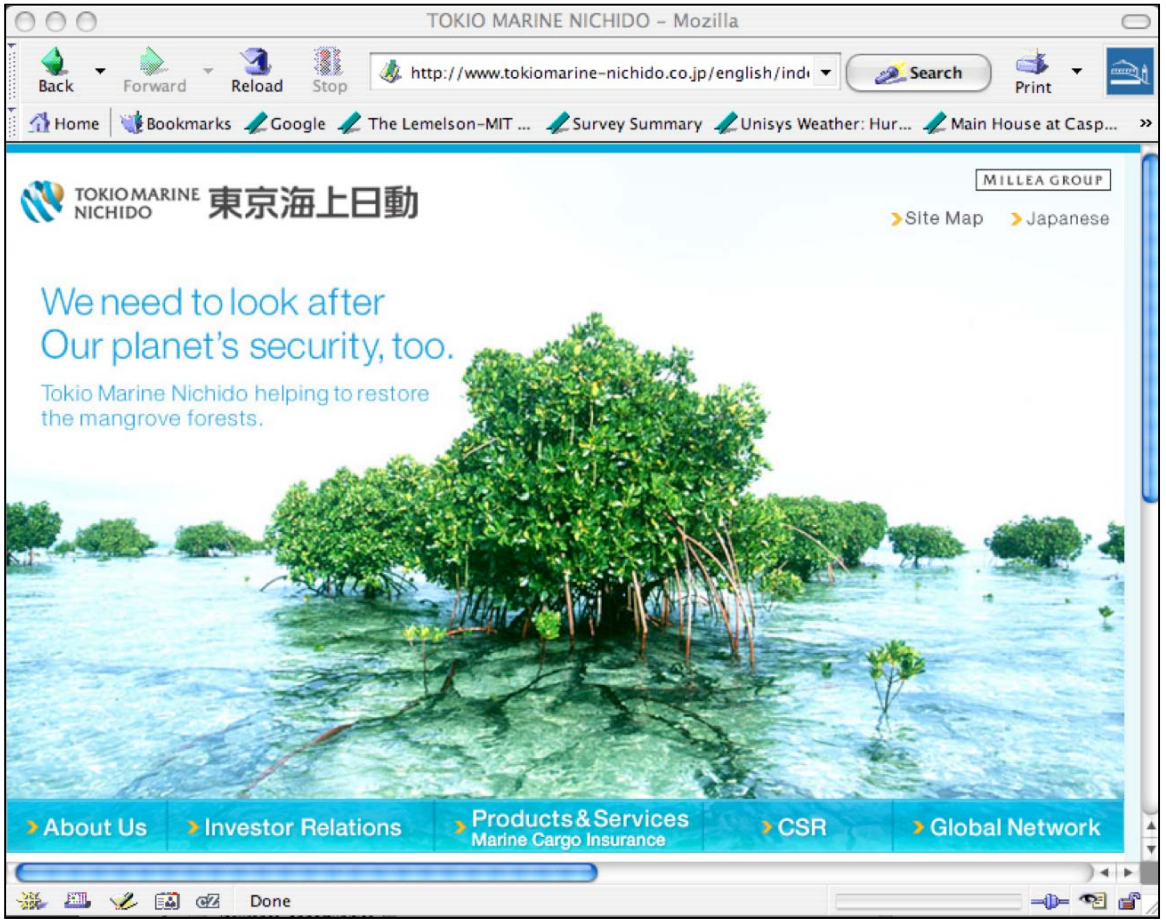
BASF Home - Patterson NJ

Some insurers are giving premium credits...,

why not combine with utility rebates??

Financing Solutions

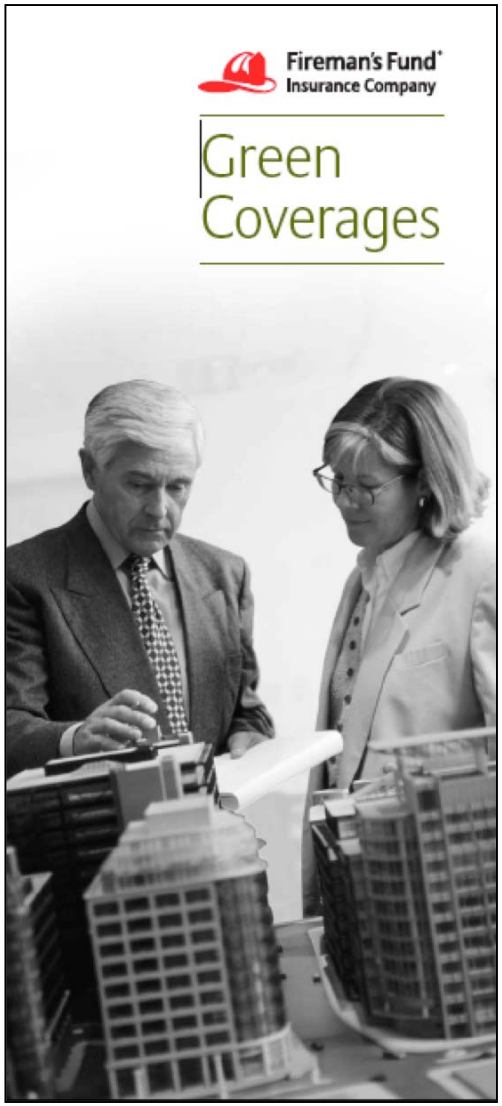
- ***Tokio Marine & Nichido*** has reforested 7,500 acres of mangroves in Indonesia, Thailand, Philippines, Myanmar and Vietnam. 5,000 more acres in progress



Source: http://www.tokiomarine-nichido.co.jp/english/index.html

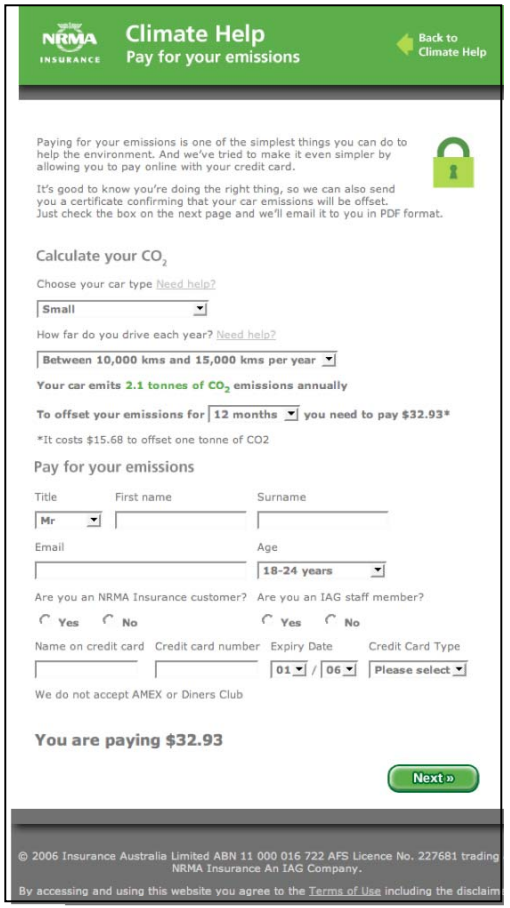
Crafting Innovative Insurance Products

- ***Fireman's Fund***: first-ever "Green-Buildings Insurance"
  - Premium credits for green features
  - Rebuild green after loss
  - Talking with utilities....
- ***Lloyds***: Energy Savings Insurance
- ***Munich Re***: geothermal performance insurance
- ***Various***: weather derivatives



Providing New Customer Services

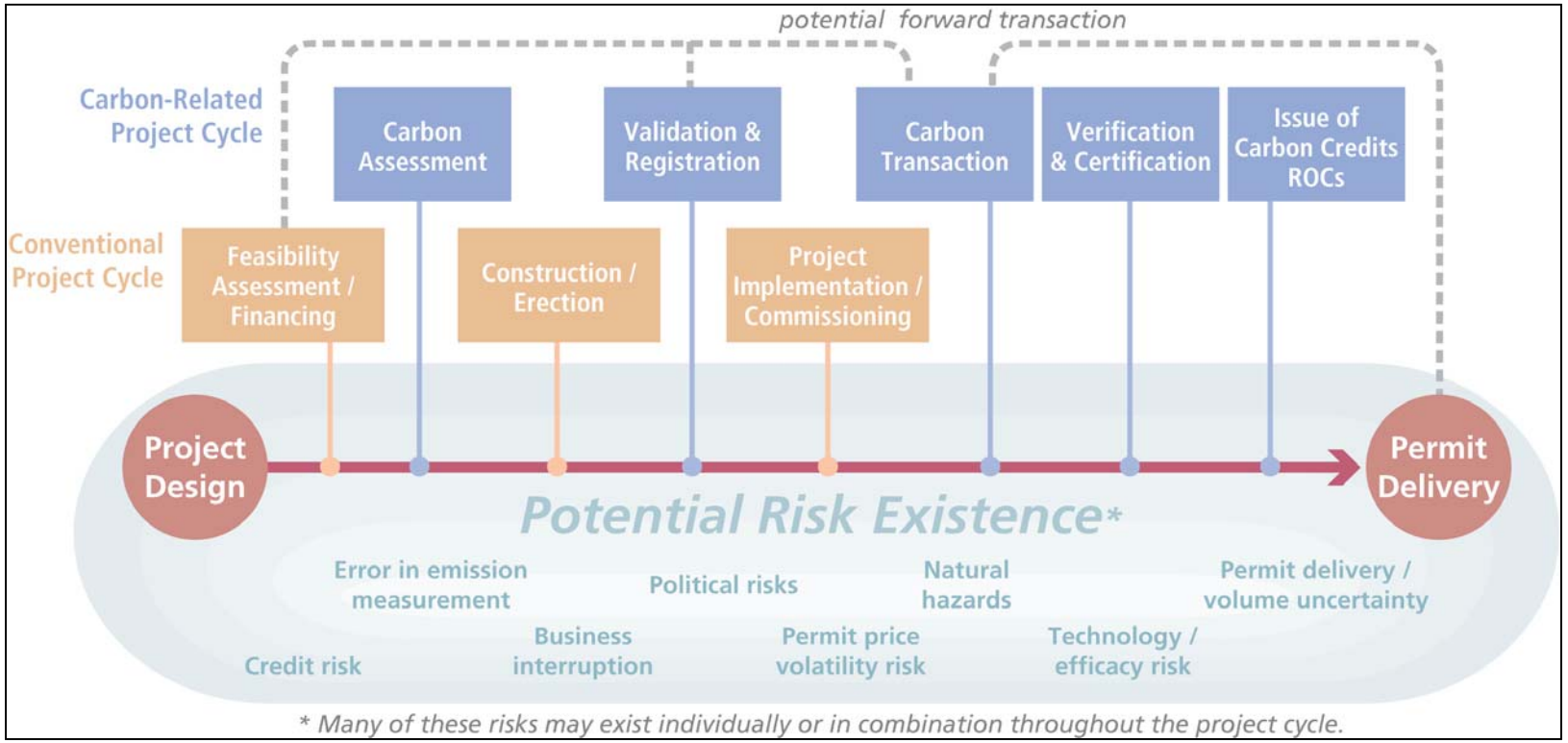
- ***Insurance Australia Group*** offering on-line automobile carbon-offset service for customers



Source: http://www.climatehelp.com.au/

Participating in Carbon Markets

- ***AIG***, ***Marsh***, others offering carbon project risk-management consulting services; insurance

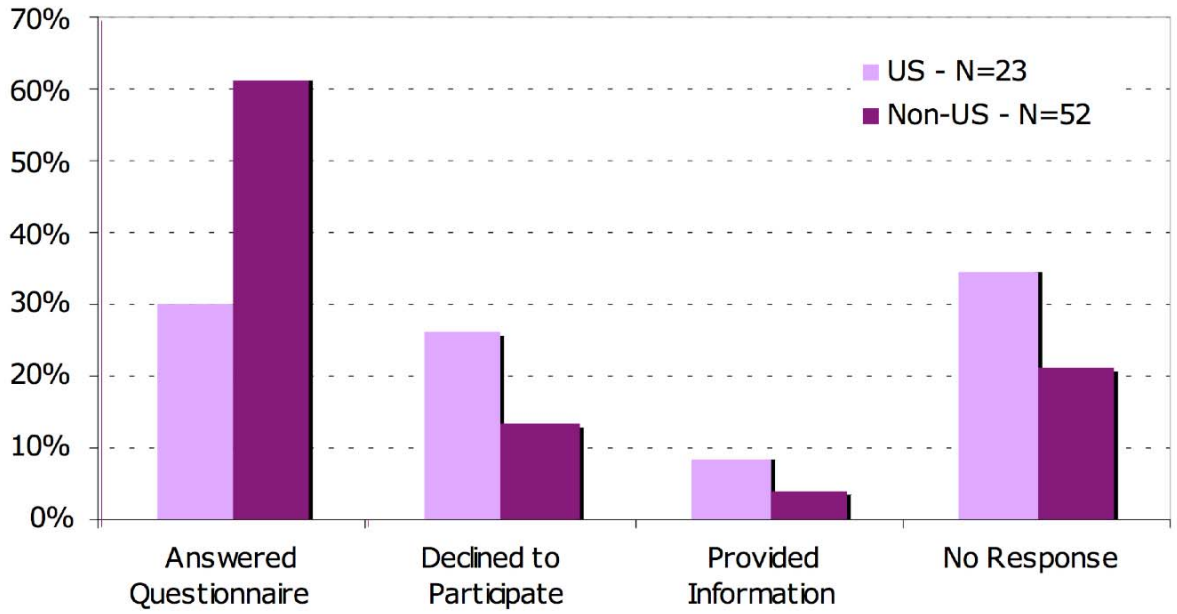


Source: Marsh. 2004. “Responding to Climate Change Risks and Opportunities.”

Leading by Example

Carbon Disclosure Project

Insurers' responses: ***AIG, Aon, Marsh & McLennan, MBIA, Safeco, St. Paul Travelers, Unum Provident***



Swiss Re's "Gherkin" building (London)

- Energy efficiency
- Daylighting
- Natural ventilation

Source: http://www.cdproject.net/

Sustainable Asset Management

- ***Munich Re:*** membership in sustainable investment indices; screens its own investments
- ***Allianz:*** endorsed the Ceres/INCR "Call to Action"
- ***Gerling:*** Select 21 Fund includes energy and environmental criteria in the selection of securities

Ethical Index Constituent Certificate

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Milan, 04-01-2005

Michele Calcaterra, CEO

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e-mail: info@e-cpartners.com Web: www.e-cpartners.com Bloomberg: <ECPS> go

Risks Are Also Associated with Responses *to* Climate Change

- Emissions reductions: supply- and demand-side
  - Green buildings
  - Nuclear power
  - Hydrogen energy
  - Renewable energy
  - Carbon capture & storage
  - Carbon offsets/trading
- Comparative risk assessments needed

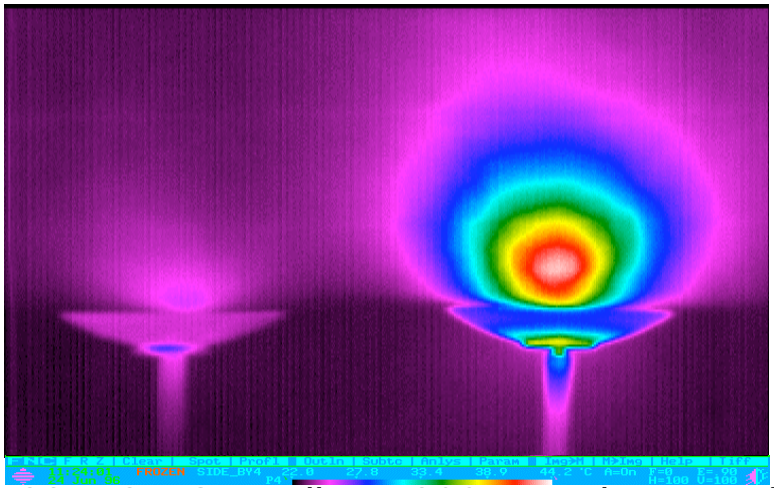
Carbon Capture & Storage (CCS)

- Lake Nyos - 1986 (Cameroon): Natural CO_2 leak killed 1800 people, 3500 farm animals

Win-Win Solutions:

Boston Edison

Fire-causing halogen lamps v CFLs

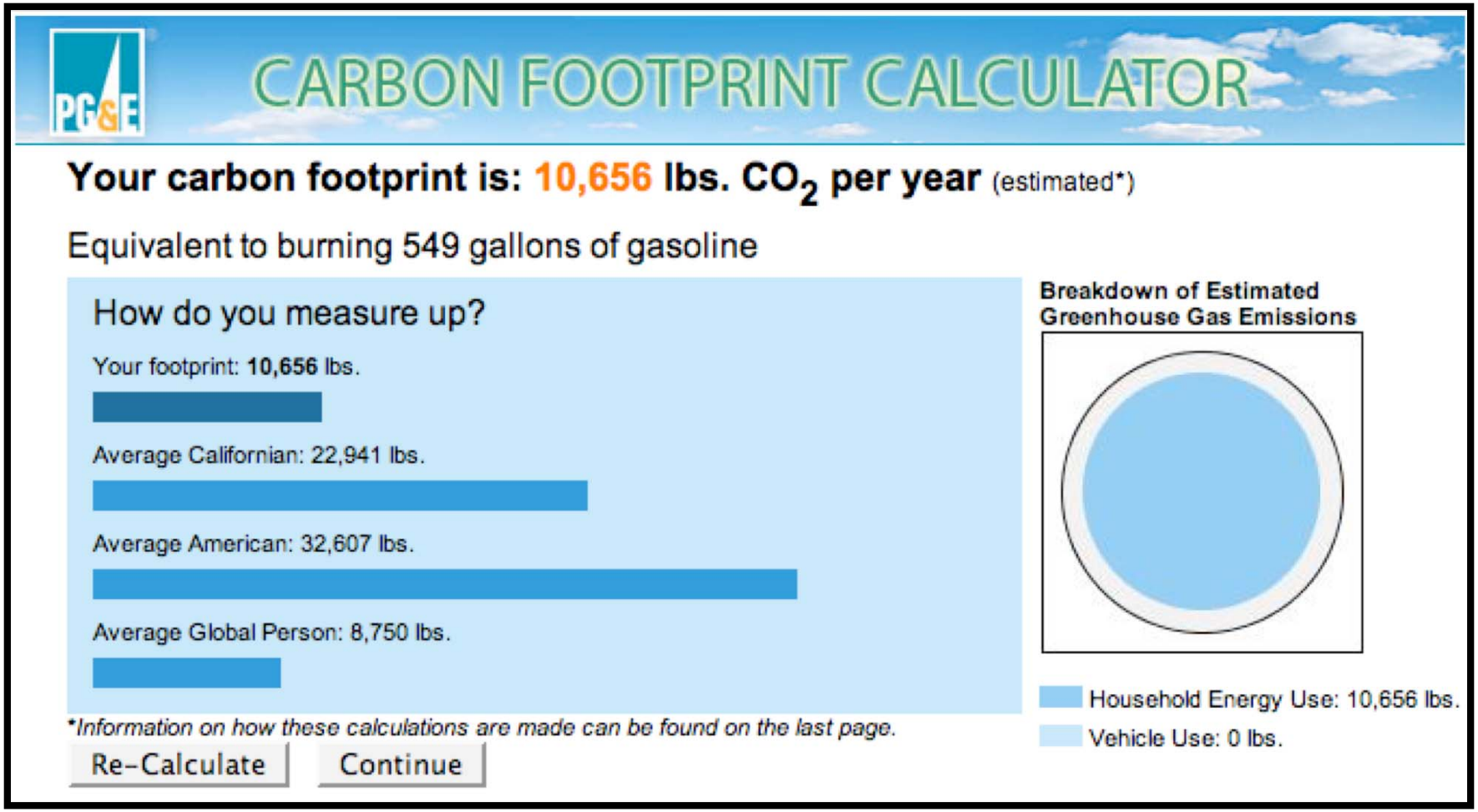


38W 2D CF Bulb 300 W Halogen Bulb

PG&E

Direct-current data centers

Making Lemonade: Energy



Making Lemonade: Water

Insurer-Utility Partnerships?

1. Efficiency
2. Risk assessment & management: customer-facing analysis, services
3. Energy-carbon performance assurance
4. Synergisms between energy/water management and risk management

Thank You

http://insurance.lbl.gov

Thank You

http://insurance.lbl.gov