

Warfighting in a Climate Warming World - Implications for U.S National Security Policies

2007 Joint Service Power Expo
Power and Energy Independence for the
Warfighter

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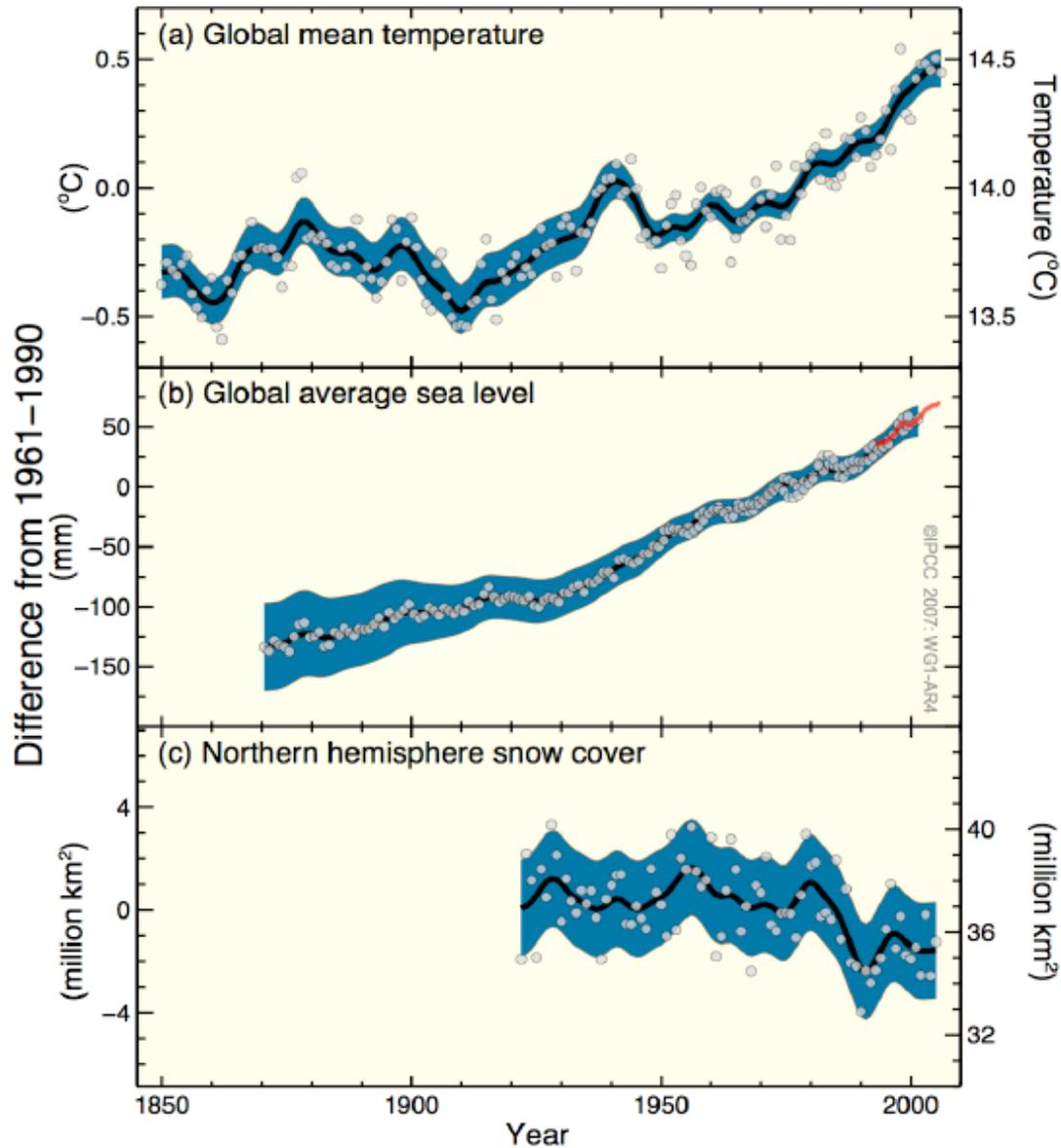
Positive proof of global warming.



18th
Century 1900 1950 1970 1980 1990 2006

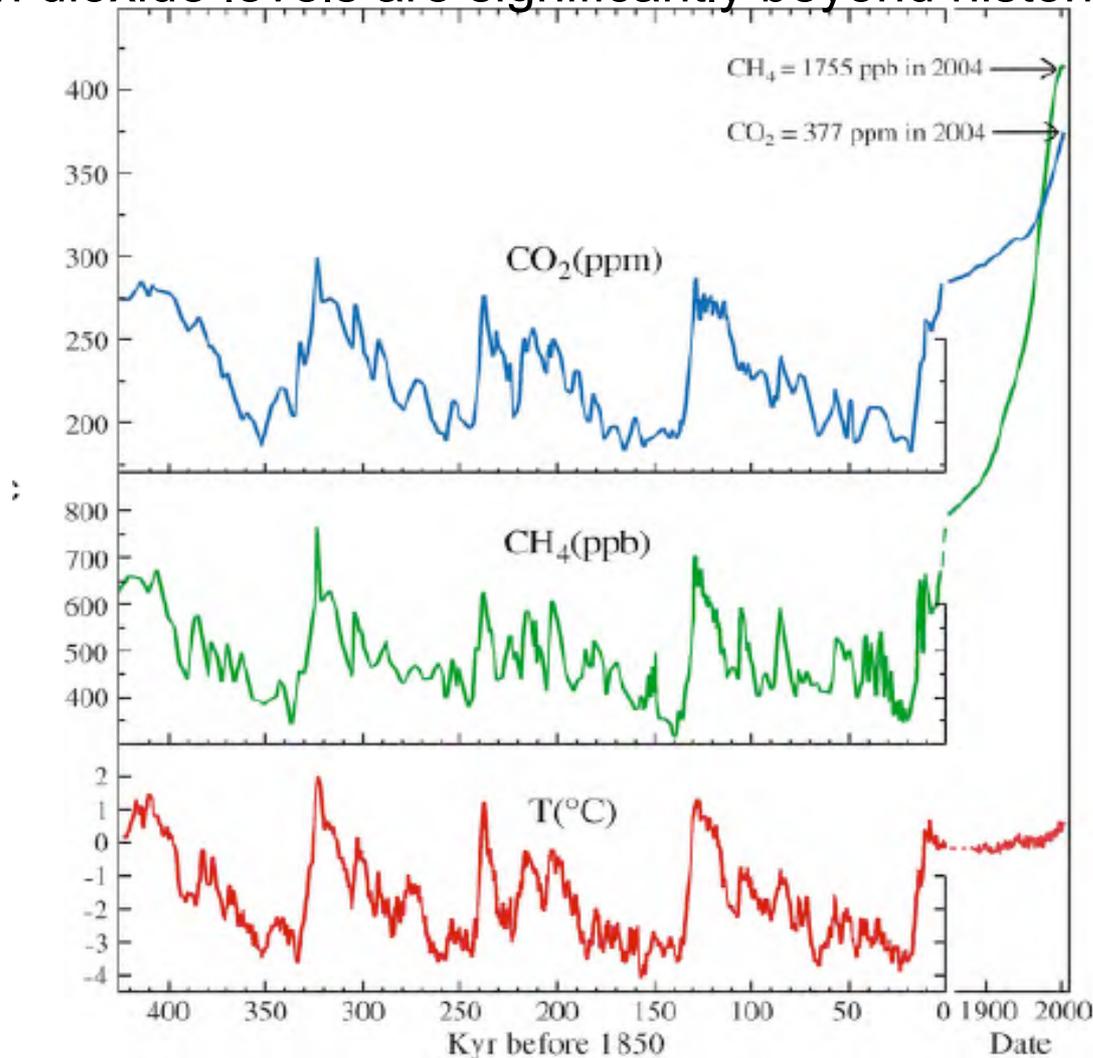
In the last 150 Years

- Temperatures have risen
- Sea level is higher
- Snow cover is down



In the last 400,000 years

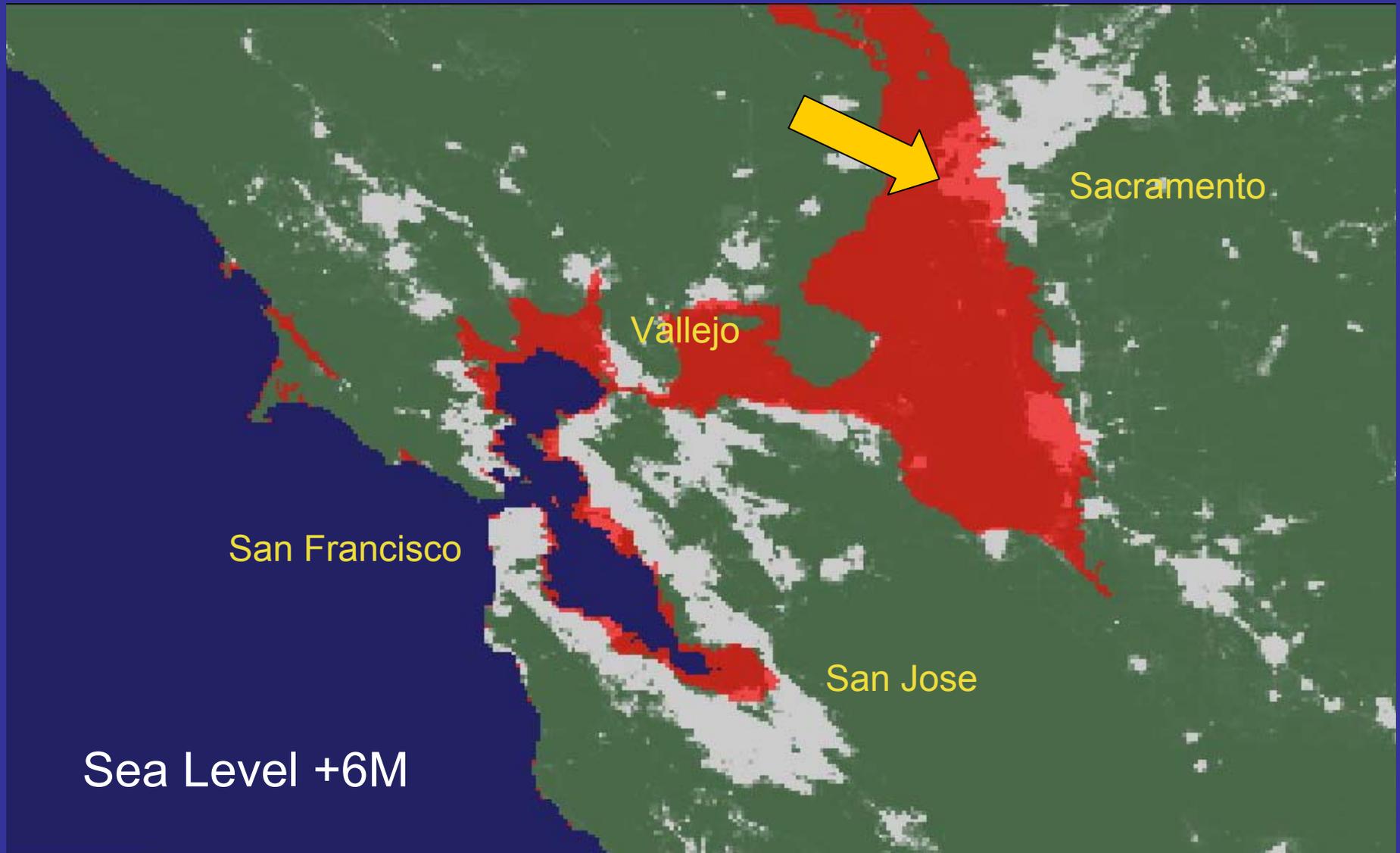
- Temperatures are at the upper end of historical variability, but
- Carbon dioxide levels are significantly beyond historical levels



CO₂, CH₄ and
estimated global
temperature (Antarctic
 $\Delta T/2$
in ice core era)
0 = 1880-1899 mean.

Source: Hansen, *Clim.
Change*, 68, 269, 2005.

You think Katrina was bad; Here's where I
Live under a 6m storm surge!



Report of the United Nations Intergovernmental Panel on Climate Change

Fourth major assessment since 1990

2500+ scientific expert reviewers

800+ contributing authors and

450+ Lead authors from

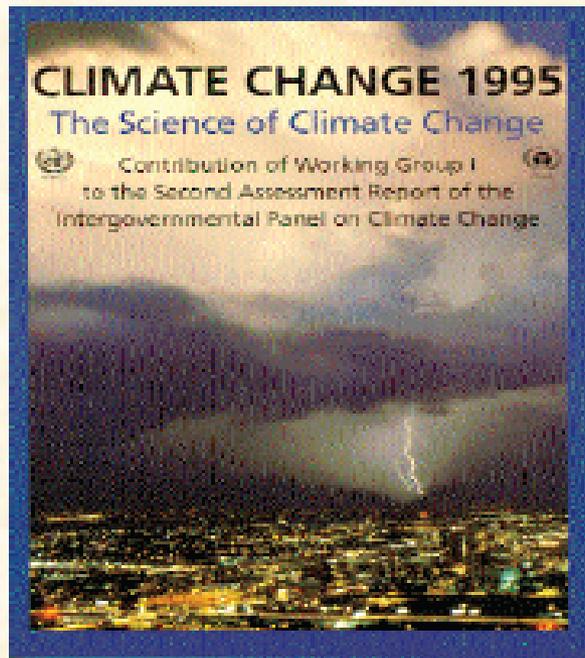
130+ countries

6 years work

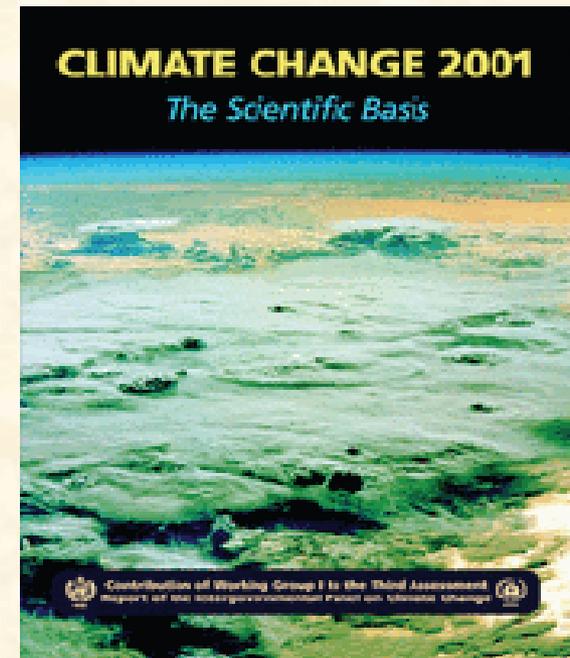
4 volumes

1 report

Detection and attribution conclusions of IPCC Second and Third Assessment Reports (1995, 2001)



“The balance of evidence suggests a discernible human influence on global climate”



“There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities”

Climate Change 2007: The Physical Science Basis

Working Group I Contribution to the IPCC Fourth Assessment Report

Direct Observations of Recent 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.

Observed sea ice September 1979



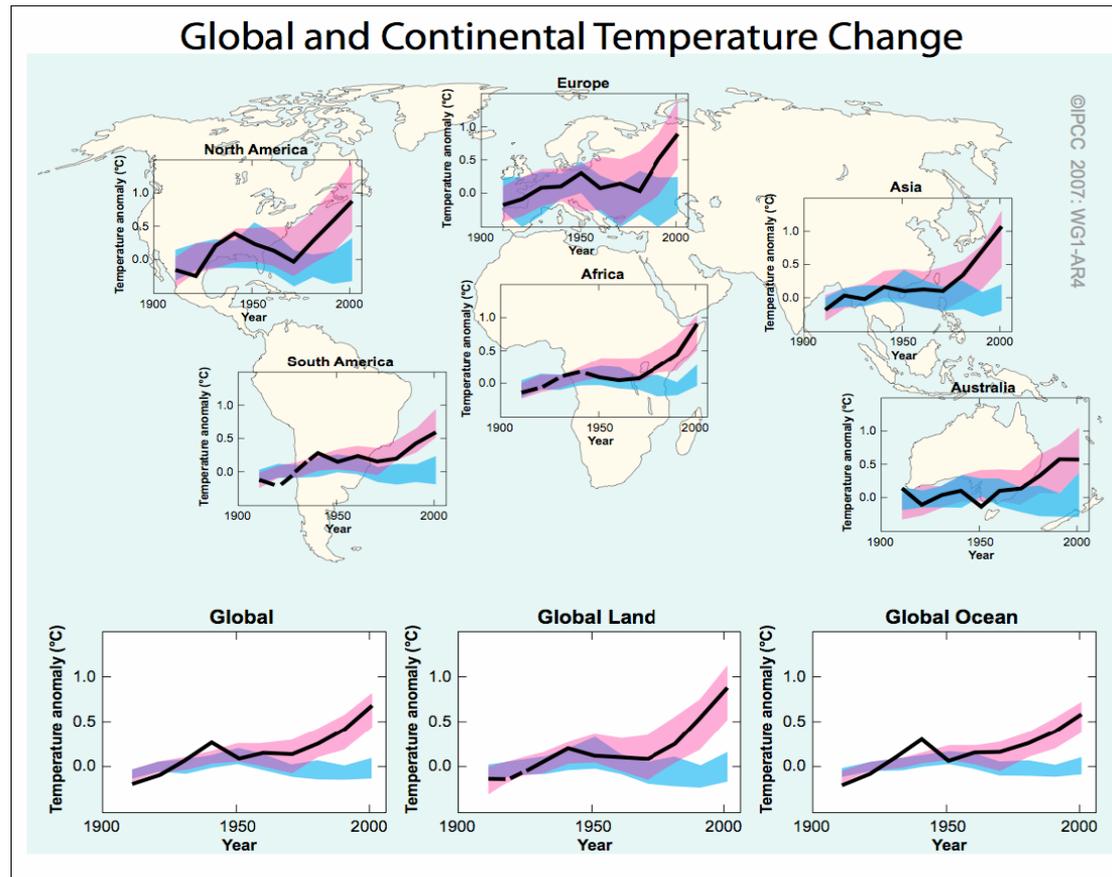
Observed sea ice September 2003



Climate Change 2007: The Physical Science Basis Working Group I Contribution to the IPCC Fourth Assessment Report

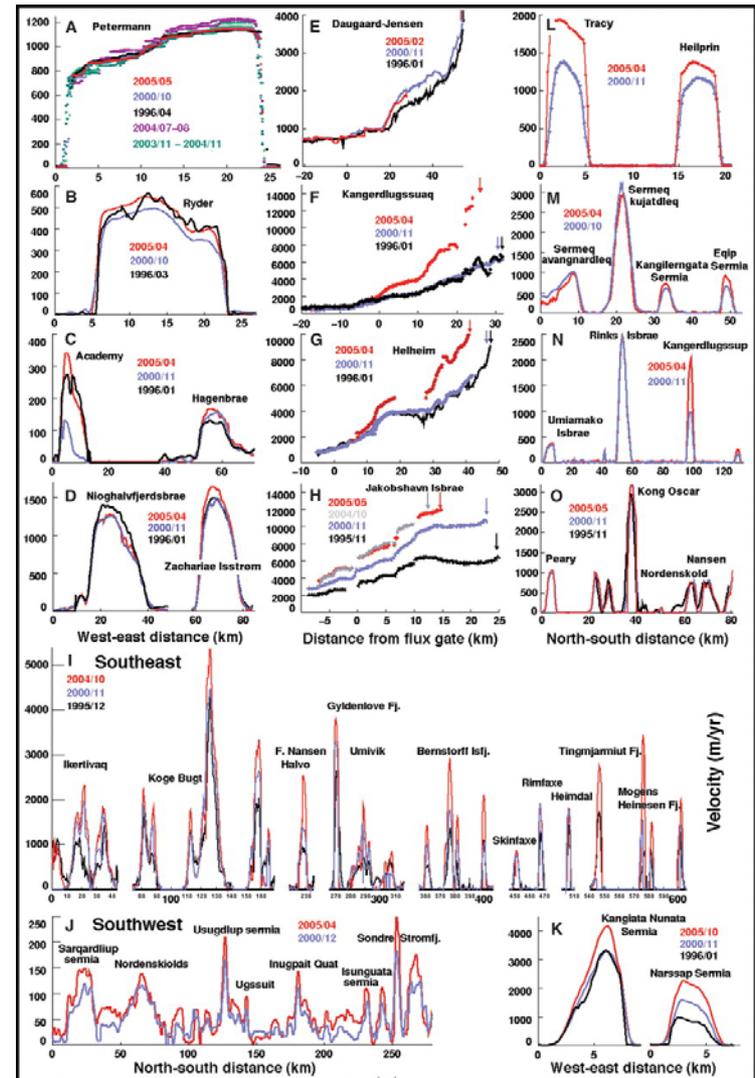
Human and Natural Drivers of Climate Change

The understanding of **anthropogenic** warming and cooling influences on climate has improved since the Third Assessment Report (TAR), leading to **very high confidence** that the globally averaged net effect of human activities since 1750 has been **one of warming**, with a radiative forcing of $+1.6$ [$+0.6$ to $+2.4$] $W m^{-2}$.



Limitations of the UN Study

- Data behind the UN study were frozen two years ago.
- The problem is actually worse.
- Greenland is melting faster than we expected



E. Rignot et al., Science 311, 986 -990 (2006)

Recent DOD Studies

- Defense Science Board Task Force on DOD Energy Strategy. Chartered May 2, 2006.
- National Security and the Threat of Climate Change, The CNA Corporation, Gordon Sullivan, Chair, April 16, 2007.
- Reducing DOD Fossil-Fuel Dependence, JASON, September 2006, JSR-06-135.
- An Abrupt Climate Change Scenario and Its Implications for United States National Security, Peter Schwartz and Doug Randall, Global Business Network, October, 2003.

What's the Threat?

- Cost of fuels
- Availability of fuels
- Operational flexibility
- Deployability
- Strategic Balance
- Sustainability

Yes, but What's the Real Threat?

The Good News

- No extended world-wide shortage of fossil fuels for ~ 25 years.
- DOD fuel consumption is < 2% of total U.S. domestic fuel consumption.
- DOD fossil fuel spending is only 2.5-3% of the national defense budget.

The Bad News

- The world will need as much oil in the next 25-30 years as has been produced over the last 150 years.
- DOD fuel consumption is 93% of U.S. Government use.
- Mobility fuels = vast majority of DOD fuels use.
- JP-8 cost is up 2.8X since 2004= >\$4B/year

More Bad News

- Current logistics supply chain designed when “behind the front lines” meant “safe.” Today = Iraq, IEDs, etc.
- Air-to Air = \$20-25 per gallon.
- Army theater = \$100-600 per gallon.
- Ethanol and Hydrogen unsuitable?
- But 62% of DOD fuel use is CONUS.

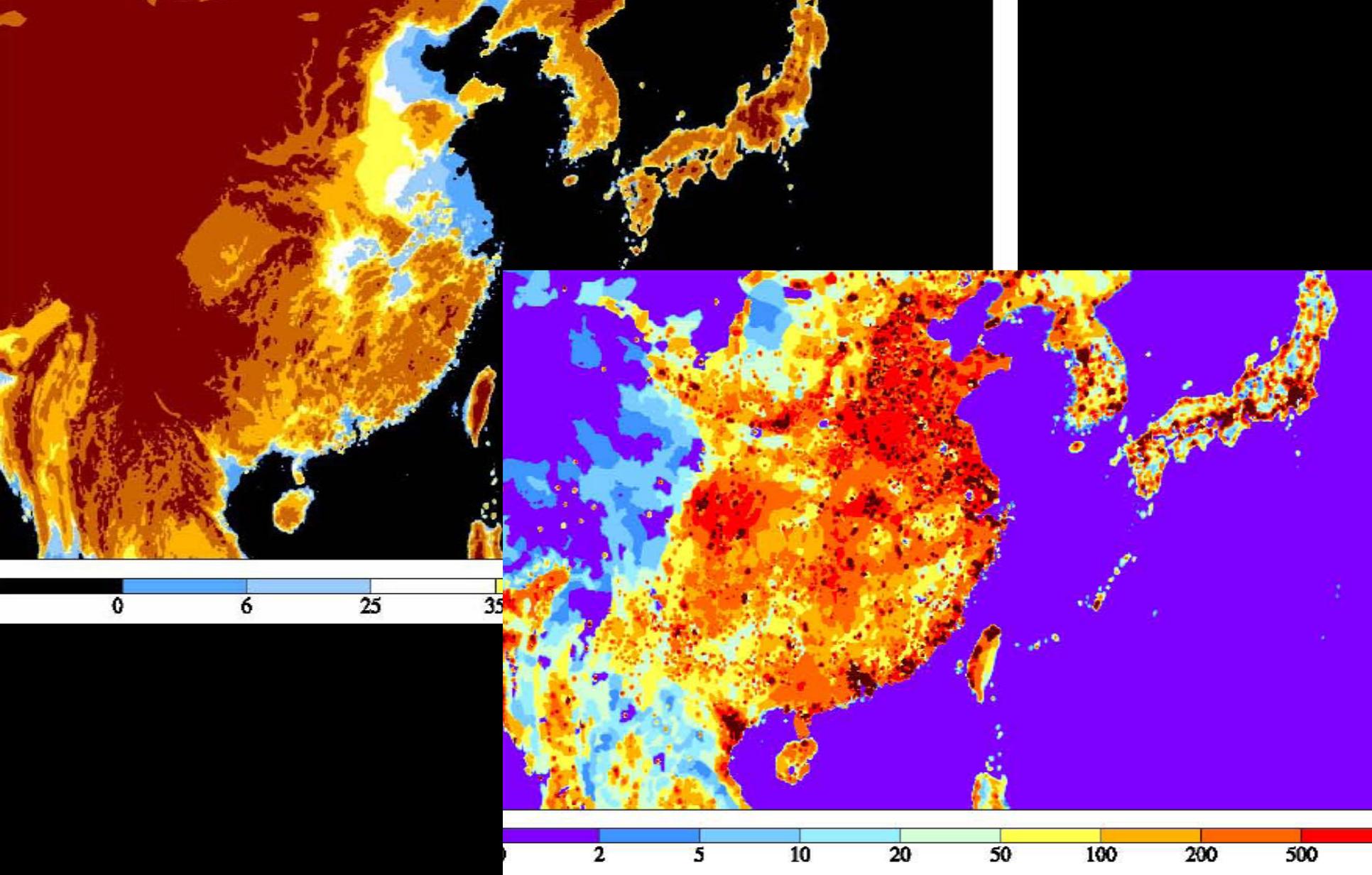
What's the Real Threat?

- Massive population displacements due to loss of land mass.
 - China, India, Bangladesh, Myanmar
 - Persian Gulf
 - Vietnam, Thailand
 - Indonesia, Phillipines
- Impacts on water availability, growing seasons
- Geographical range of infectious disease

Complete melting of Greenland glaciers = 6.55 meter sea rise

Complete melting of all glaciers = 80.32 meter sea rise

USGS Fact Sheet 002-00 January, 2000



93 million Chinese (~7%) at risk in 6m storm surges.

Loss of Land Mass ~ China

- 93 million people in China could be displaced by a 6 meter sea-level rise.
- In terms of loss of territory, loss of lives, economic disruption, and long term effects, global warming can be compared to nuclear war.

Region (total population in millions, 2000)	Population Under Water (for given sea level rise)			
	<i>6m</i>	<i>25 m</i>	<i>35m</i>	<i>75m</i>
United States (283)				
East Coast	9	41	51	70
West Coast	2	6	9	19
China + Taiwan (1275+23)	93	224	298	484
India + Sri Lanka (1009+19)	46	146	183	340
Bangladesh (137)	24	109	117	130
Indonesia + Malaysia (212+22)	23	72	85	117
Japan (127)	12	39	50	73
Western Europe (454)	26	66	88	161

Hansen

Sea-level rise in Regions of Importance to the U.S. Military

- Norfolk, Virginia
- Florida
- Gulf Coast
- Carolinas
- Hawaii



Dover

Ocean City

Hampton

Virginia Beach

Norfolk

Sea Level +1M



Dover

Ocean City

Hampton

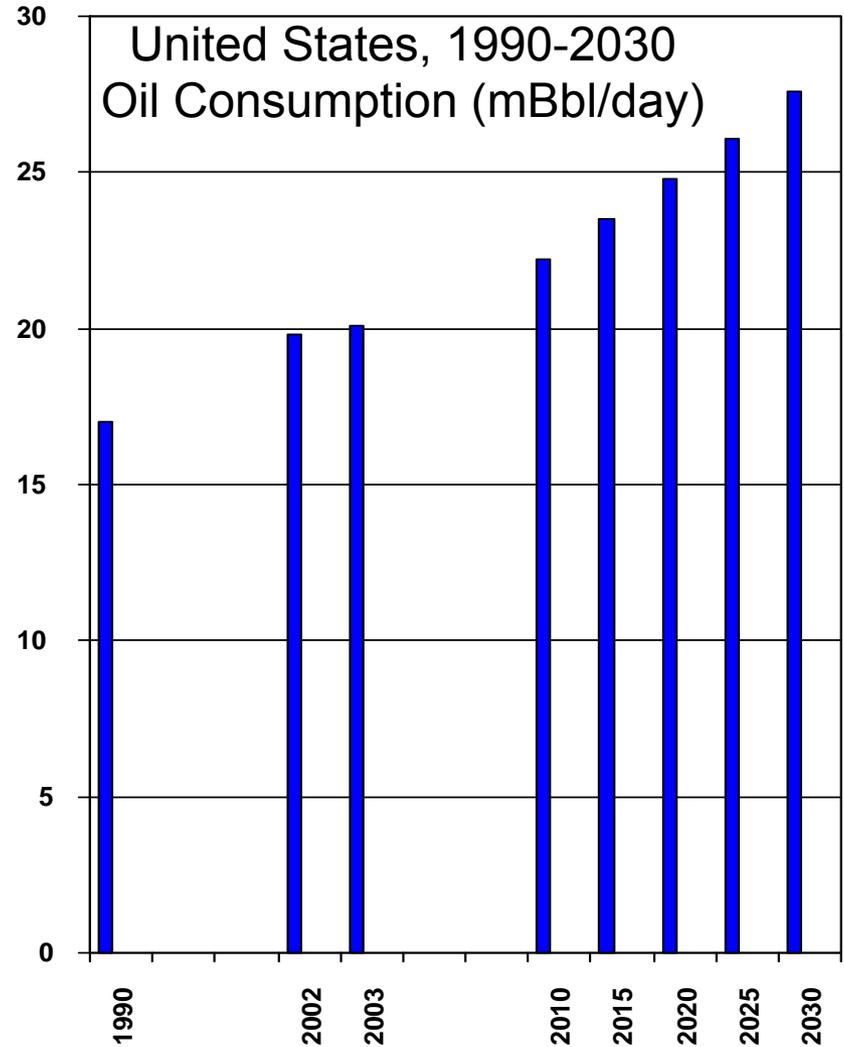
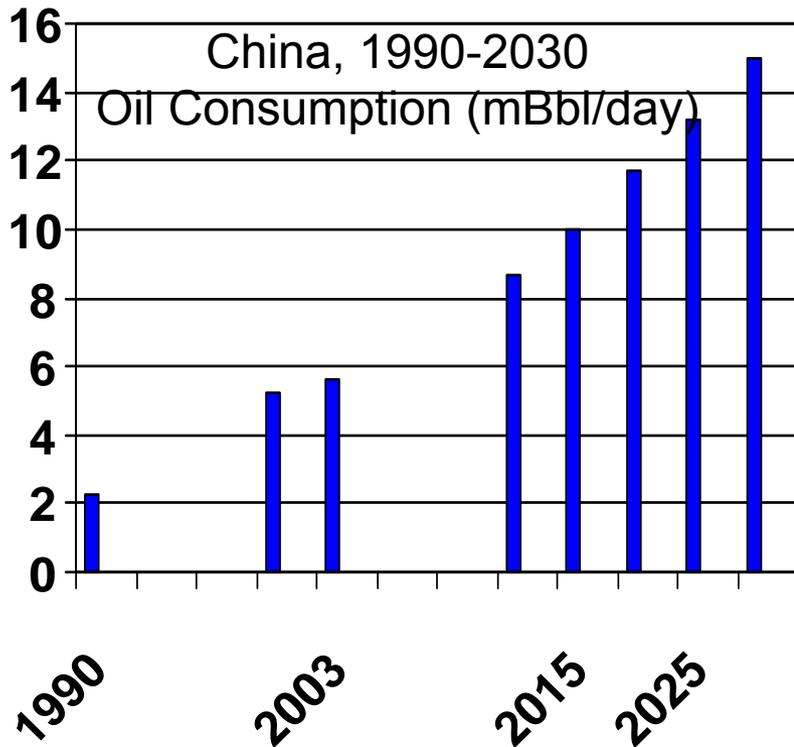
Virginia Beach

Norfolk

Sea Level +6M

Strategic Oil Supply

EIA International Energy Annual 2006
Reference Case



Expectations

- The U.S. Military as a microcosm of U.S. society
- Preserving the American way of life;
Preserving American values
- Domestically, American support of the U.S. Military depends on consistency with U.S. values.

Expectations

- The realization of climate warming and its actual early physical manifestations will come to have an impact on the U.S. military as well as on other sectors of American endeavor.
- While in battle the U.S. military could well be exempted from the constraints of climate warming, but during periods of low intensity conflict or relative peace, the U.S. military could well be expected to do its share to reduce these impacts.

National Security can drive innovation in energy supply

An Historical Precedent

The U.S. Synthetic Fuels Corporation was
created as an amendment (January 15,
1979) to the Defense Production Act of
1950

What the U.S. Military is Already Doing

- Army
- Navy
- Air Force
- Marines

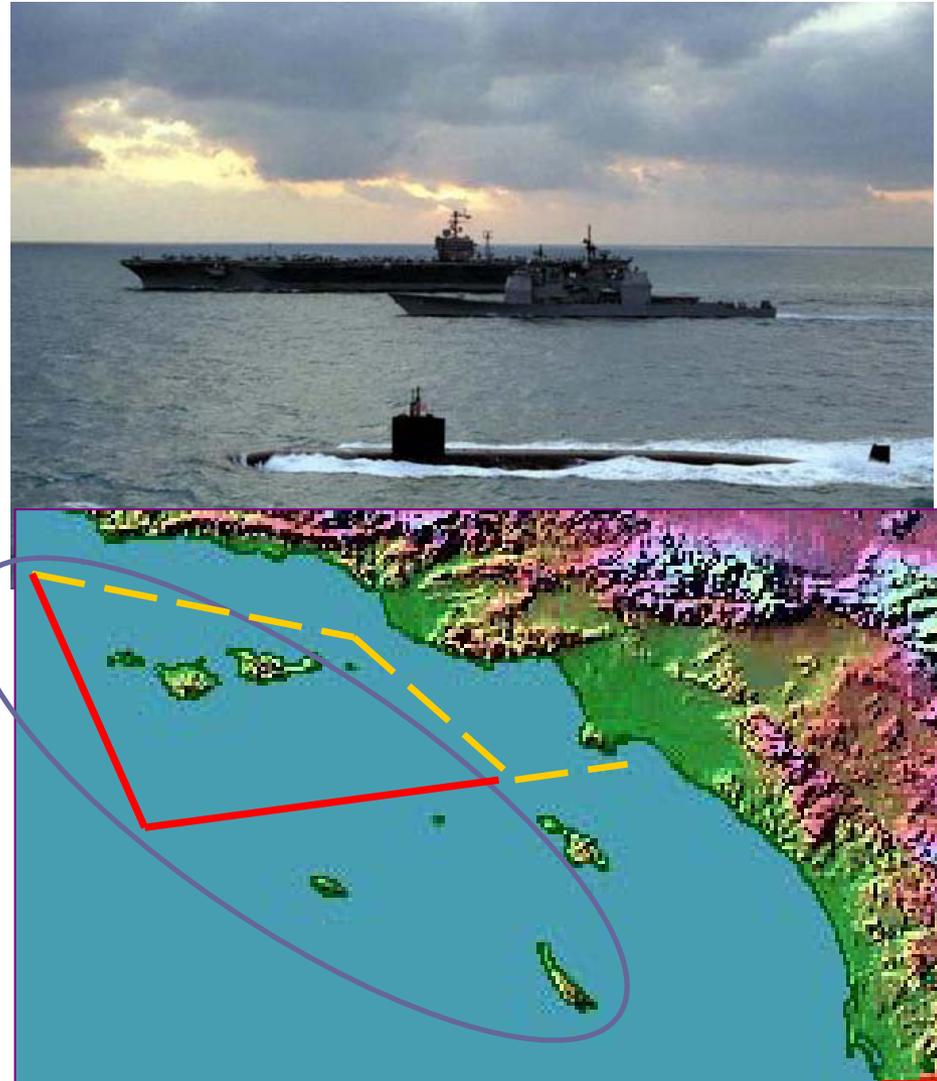
Ft. Bliss Ethanol Pump



M-13 SIP ISSUE

(Pt Mugu Ship Channel)

- **Feb 1998 Navy proposal to establish working group to study speed reduction as alternative to moving channel.**
 - CARB establishes working group(June 1998) Participation by Navy, Shipping Industry, Ports, USEPA
- **Dec 2000 Final Report**
 - Relocated commercial channel increases estimated 2010 SIP NOx pollution by 1.3 tons per day (greater steaming distance of relocated channel)
 - Estimated 2010 SIP NOx reductions ranging from 3.9-10.7tons per day from speed reduction in existing channel
 - All exceed M-13 target and are feasible for shipping industry
- **Marine vessel emission reduction/Navy operations can co-exist**



“Unleash us from the tether of
Fuel.” Lt.Gen. James Mattis, USMC

“Commit to hybrid electric architecture for
Tactical Wheeled Vehicles (TWV)”

“Long term commitment to manufactured
liquid hydrocarbon fuels from domestically
abundant feedstocks.”

Key Actions, Naval Research Advisory Committee Report, April 2006.

“Flying Out In Front: *The Air Force Is Taking The Lead On Synthetic Fuel; Will You Follow Us? Asks Michael Wynne*”

Dallas Morning News □ January 27, 2007 □ Pg. 21



Strategic Supply

Oil prices and availability are still being determined by geo-politics, especially Middle Eastern politics, not raw supply.

Saudi Arabia can and does dampen Iranian adventurism by reducing the price of oil.

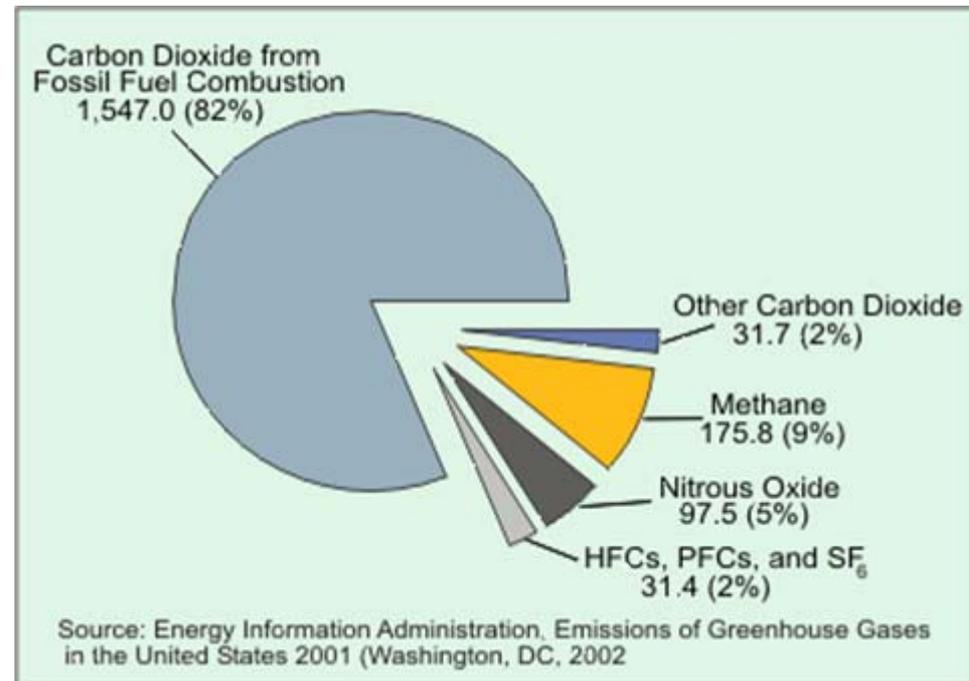
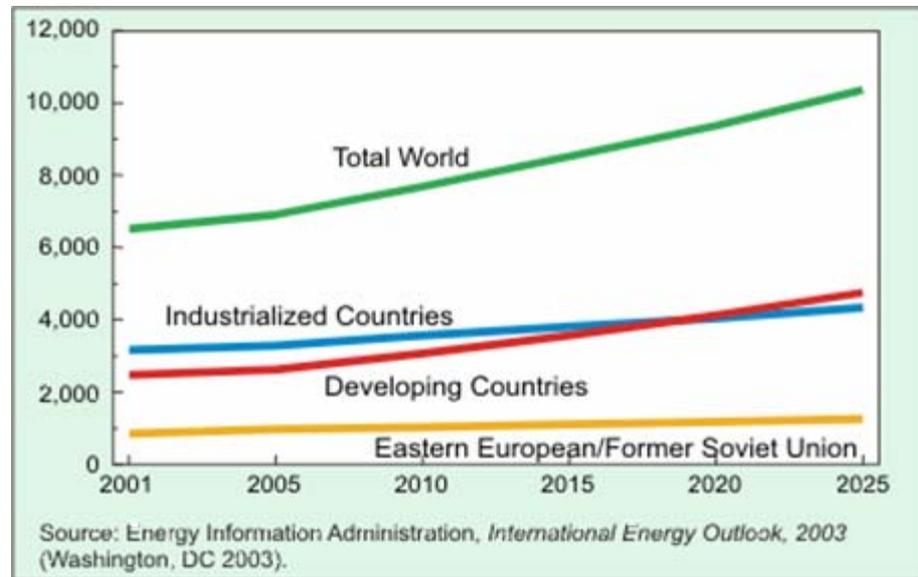
“Yes, some time next decade demand may indeed start to bump up against supply, but the price of oil today is as much political as it is supply and demand.” John Mauldin, 1-12-07

Strategic Supply is Important

- But coal to liquids makes carbon problem worse.
- 50% Coal-To-Liquids efficiency leads to 2X more CO₂ emissions than from petroleum diesel.
- Must be coupled to Carbon Capture and Storage, e.g. carbon sequestration ~ injecting CO₂ into the ground.
- Large scale demo of carbon sequestration, possibly at one or major U.S. military bases.

Carbon, carbon, carbon

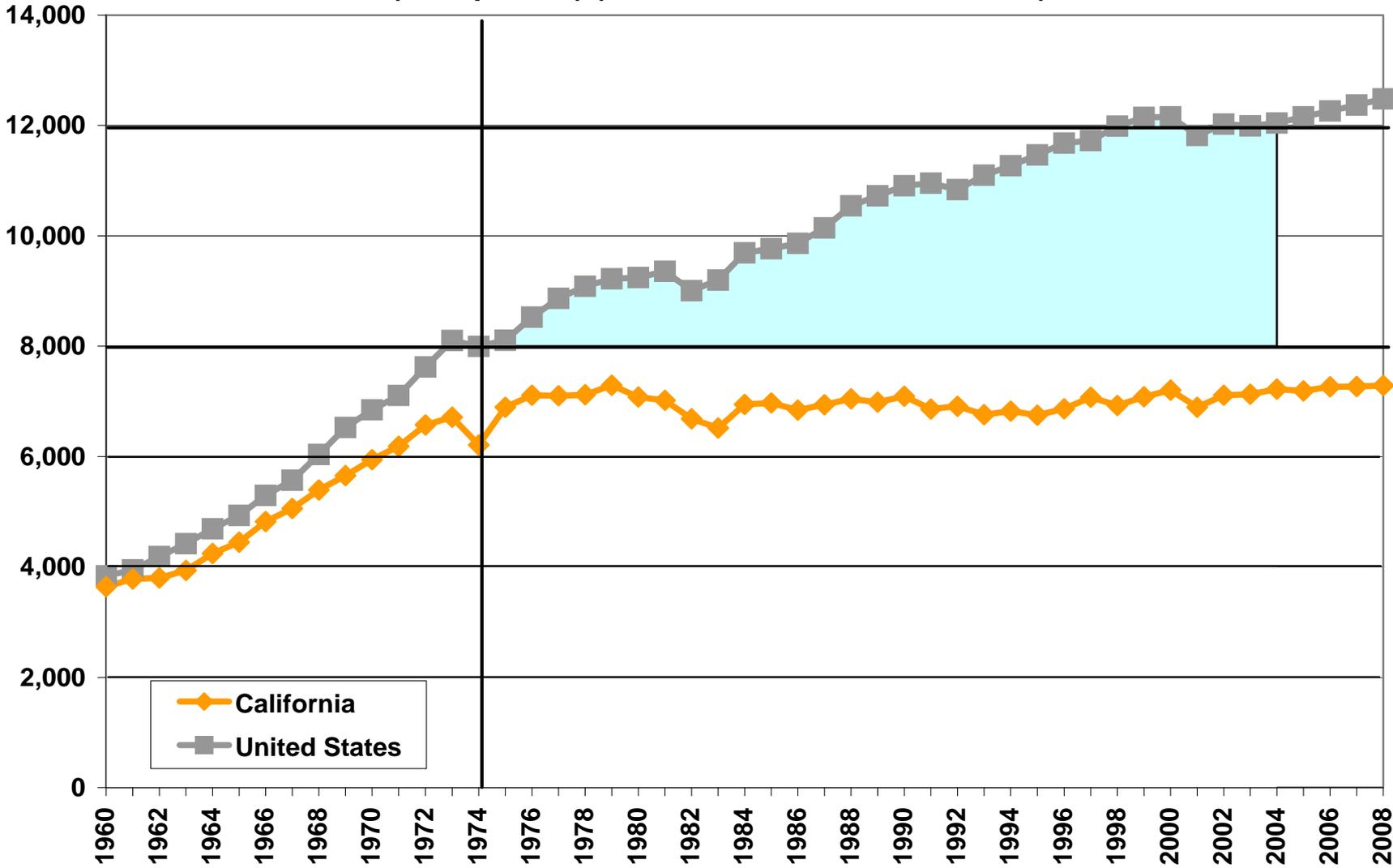
World Carbon Dioxide Emissions by Region, 2001-2025
(Million Metric Tons of Carbon Equivalent)



U.S. Anthropogenic Greenhouse Gas Emissions by Gas, 2001
(Million Metric Tons of Carbon Equivalent)

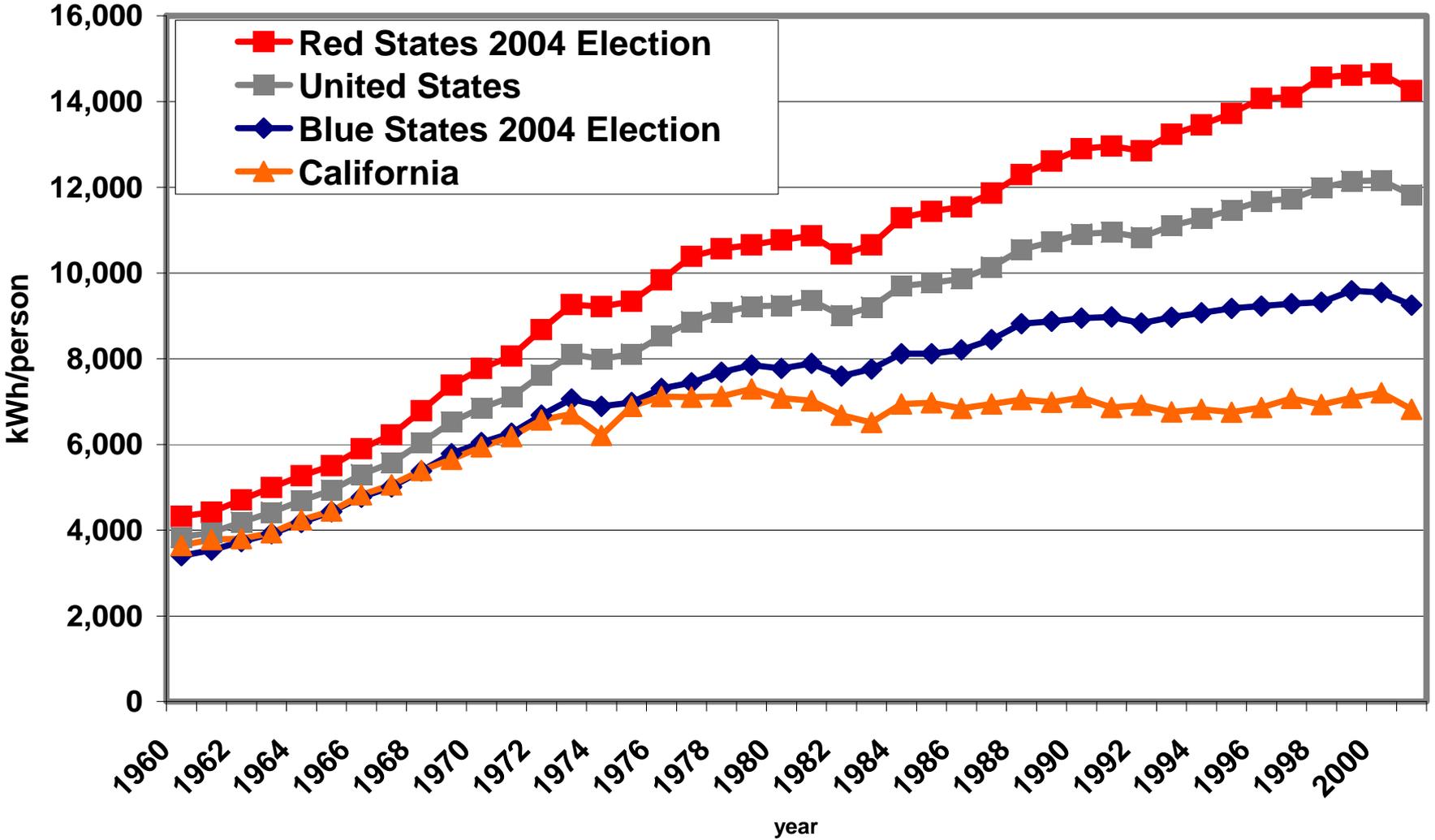
California Electricity Consumption

Per Capita Electricity Sales (not including self-generation)
(kWh/person) (2005 to 2008 are forecast data)



Red States and Blue States

Per Capita Electricity Consumption



Conclusions

- The cost of fuels is already becoming a burden to the U.S. military.
- Global warming will become an increasing factor in U.S. military planning.
 - DSB Study
 - CNA Study
 - Global Business Network study
- To make a difference, reducing carbon emissions will be key.

Backup slides

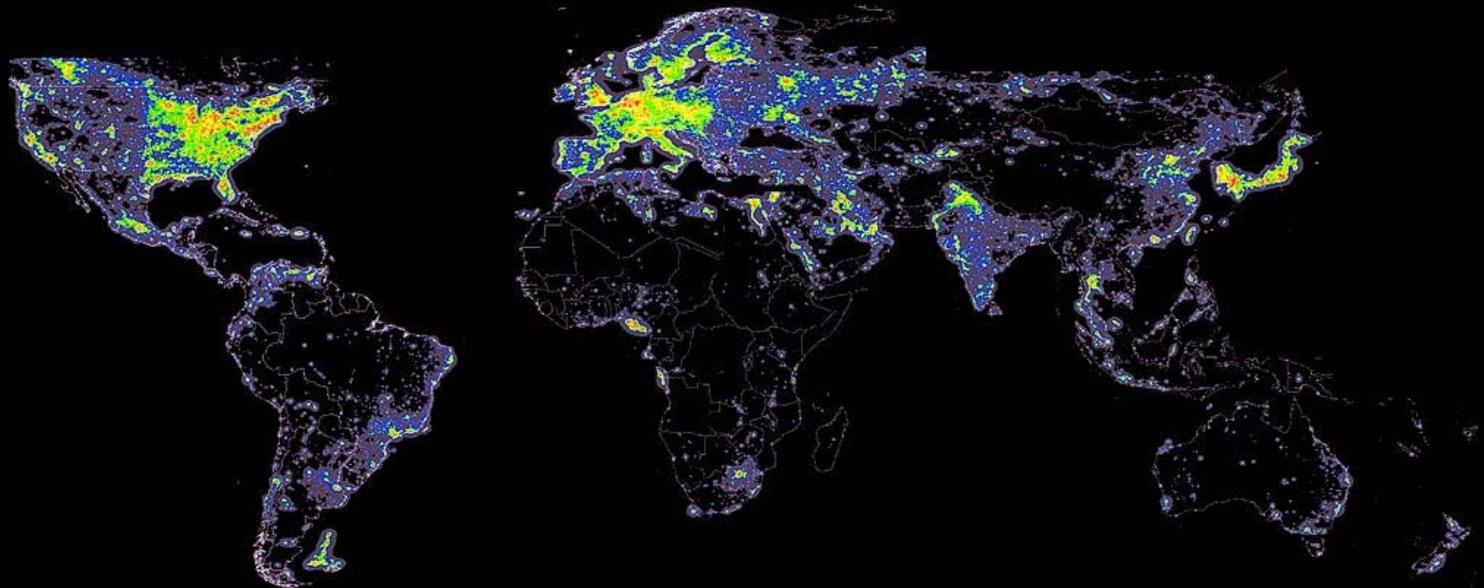
Sustainability ~ a Military Definition

- “The ability to maintain the necessary level and duration of operational activity to achieve military objectives.
- Sustainability is a function of providing for and maintaining those levels of ready forces, materiel, and consumables necessary to support military effort.”

Sustainability is Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. 1987

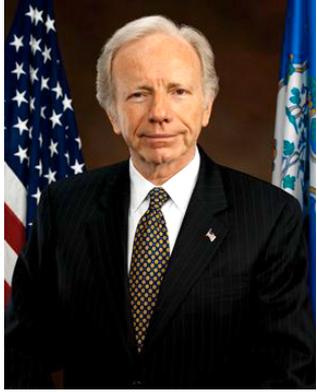
– World Commission on Environment and Development (the Brundtland Commission)

espacial.com



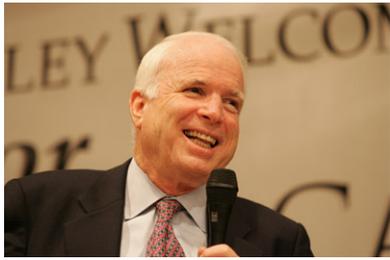
Loss of Land Mass ~ China

- Western China is not under government control like the eastern and coastal regions of China.
- Western China lives as though the central government does not exist.



Senator Joseph I. Lieberman

- Still, it is my strong hope that having addressed issues of conventional energy supply through this legislation, we will turn, in the very near future, our urgent attention to the most pressing issues - the clear and inextricable linkage between energy supply and national security, the resulting urgent need for aggressive development of a portfolio of alternative and renewable fuels and conservation strategies, and the need to take comprehensive steps to set mandatory caps on greenhouse gas emissions. Solving these problems – and soon – is a responsibility that we have to today's public as well as our children and grandchildren, an obligation that we will not have fulfilled when this legislation passes. - *July 29, 2005*



Senator John McCain

- Global warming is a serious threat. There is overwhelming evidence that increasing amounts of carbon dioxide and other greenhouse gases are heating up the Earth's climate and that inaction could be disastrous. - January 8, 2003
- The status quo is a strong and stubborn force. People and institutions are averse to change, even when that change is critical for their own well-being, and that of their children and grandchildren. If the scientists are right and temperatures continue to rise, we could face environmental, economic, and national security consequences far beyond our ability to imagine. If they are wrong and the Earth finds a way to compensate for the unprecedented levels of greenhouse gases in the atmosphere, what will we have accomplished? Cleaner air; greater energy efficiency, a more diverse and secure energy mix, and U.S. leadership in the technologies of the future. There is no doubt; failure to act is the far greater risk.— January 30, 2007