

“Urgent and unprecedented environmental and social changes challenge scientists to define a new social contract. This contract represents a commitment on the part of all scientists to devote their energies and talents to the most pressing problems of the day, in proportion to their importance, in exchange for public funding.”

Jane Lubchenco (NOAA)
From: Entering the Century of the
Environment- A New Social Contract for
Science, SCIENCE Vol. 279, Jan.1998

SUSTAIN THIS! MAKING MATH MATTER

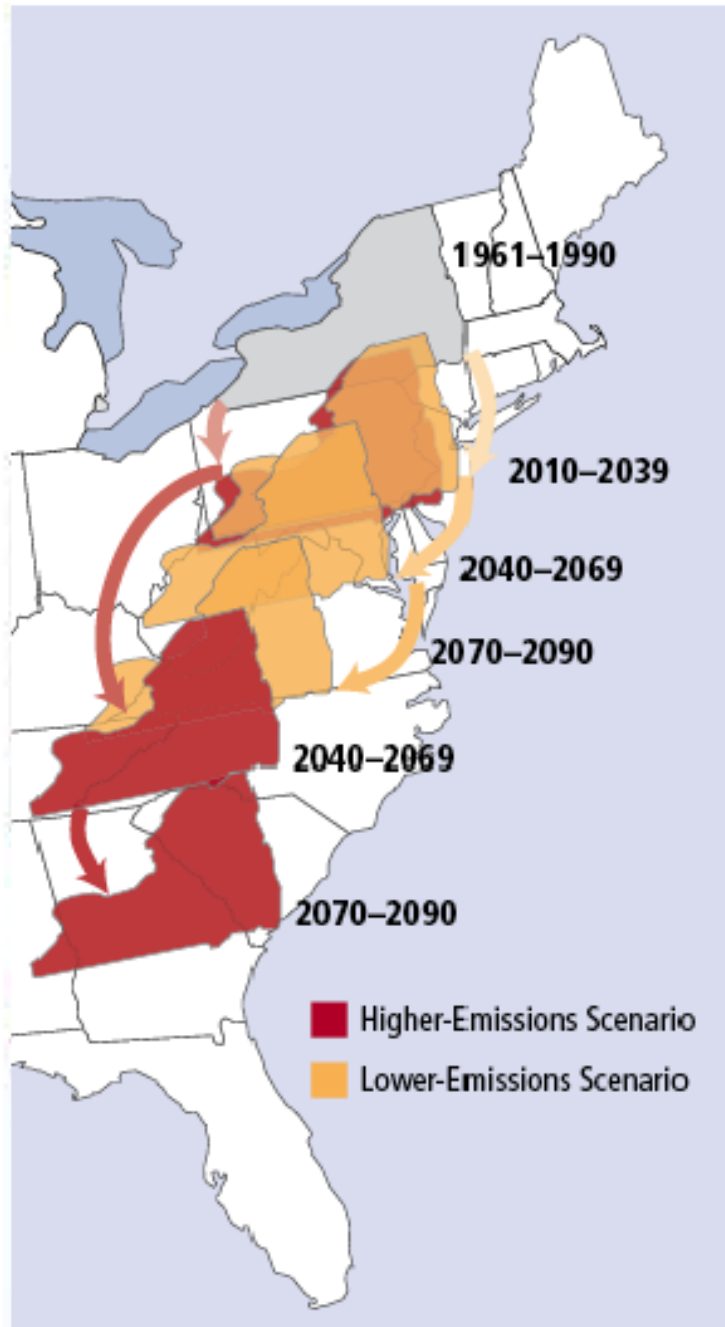
Thomas J. Pfaff
Ithaca College

Human activity is putting such a strain on the natural functions of Earth that the ability of the planet's ecosystems to sustain future generations can no longer be taken for granted.

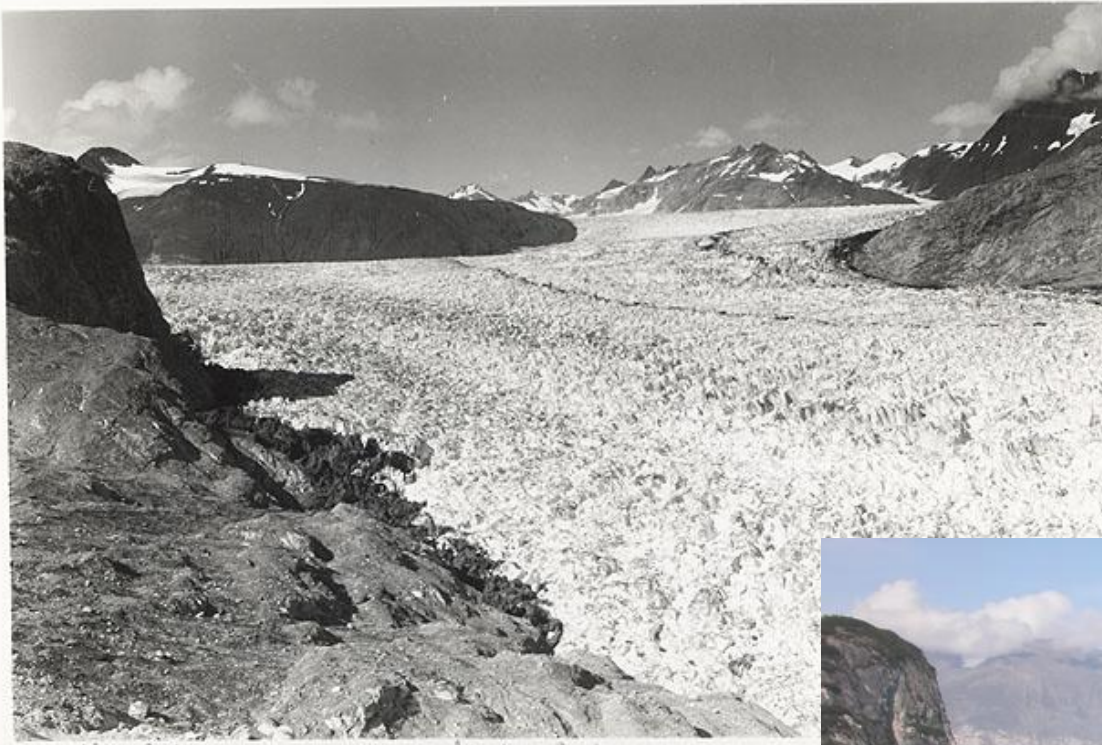
Millennium Ecosystem Assessment (2005)

<http://www.maweb.org/en/About.aspx>

Upstate New York



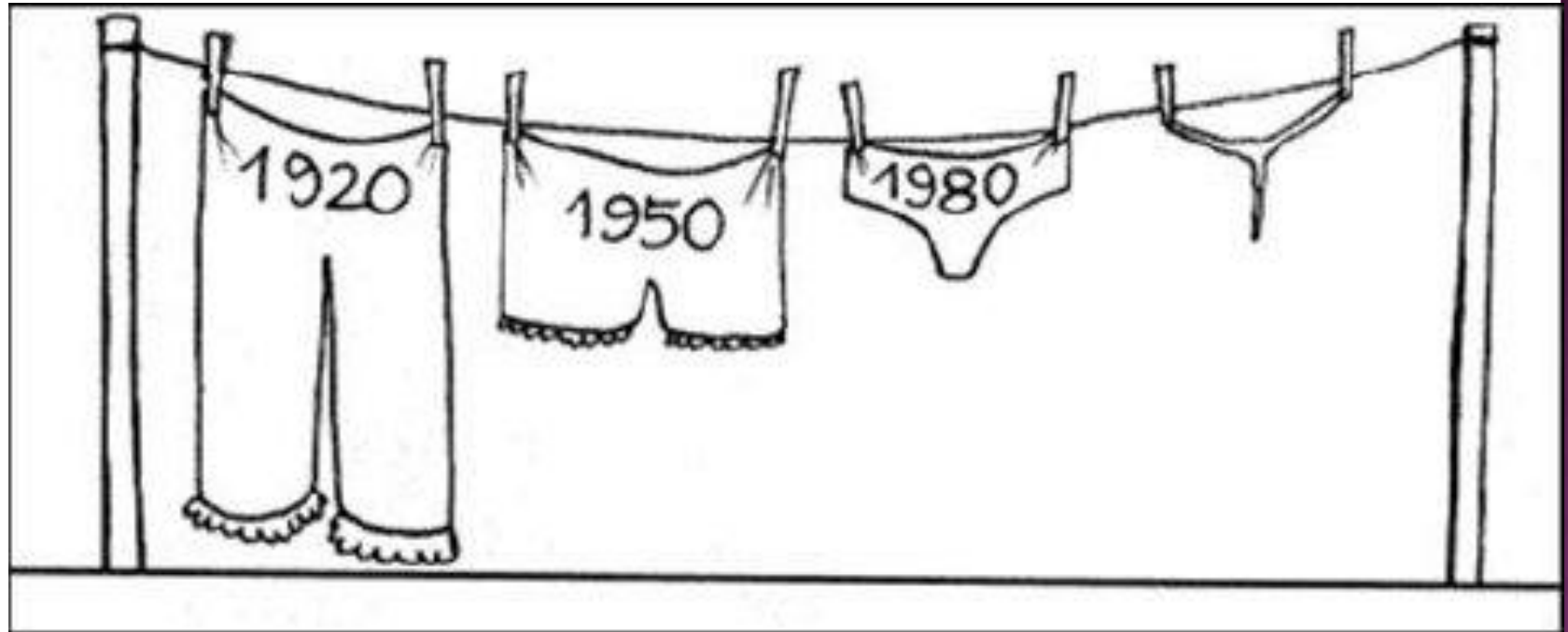
A Report of the Northeast
Climate Impacts
Assessment
Union of Concerned
Scientists (October 2006)
www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf



1941

2004





Certain current trends of population and habitation, wealth and consumption, technology and work, connectedness and diversity, and environmental change are likely to persist well into the coming century. . . . If they do persist, many human needs will not be met, life support systems will be dangerously degraded, and the numbers of hungry and poor will increase.

Our Common Journey: A Transition Toward Sustainability (1999)
U.S. National Academy of Sciences

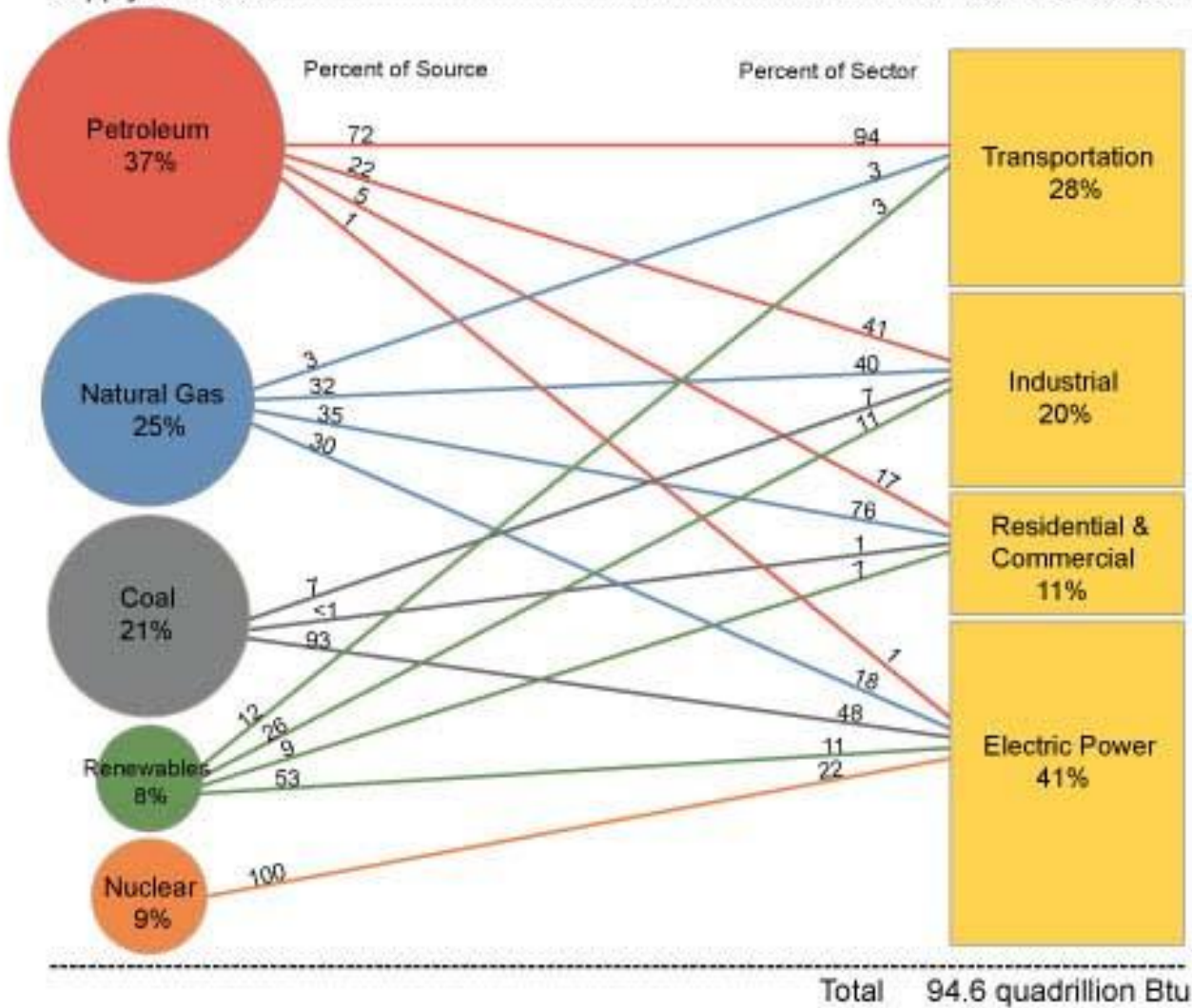
"By 2012, surplus oil production capacity could entirely disappear, and as early as 2015, the shortfall in output could reach nearly 10 million barrels per day," says the report, which has a foreword by a senior commander, General James N Mattis.

guardian.co.uk, Sunday 11 April 2010

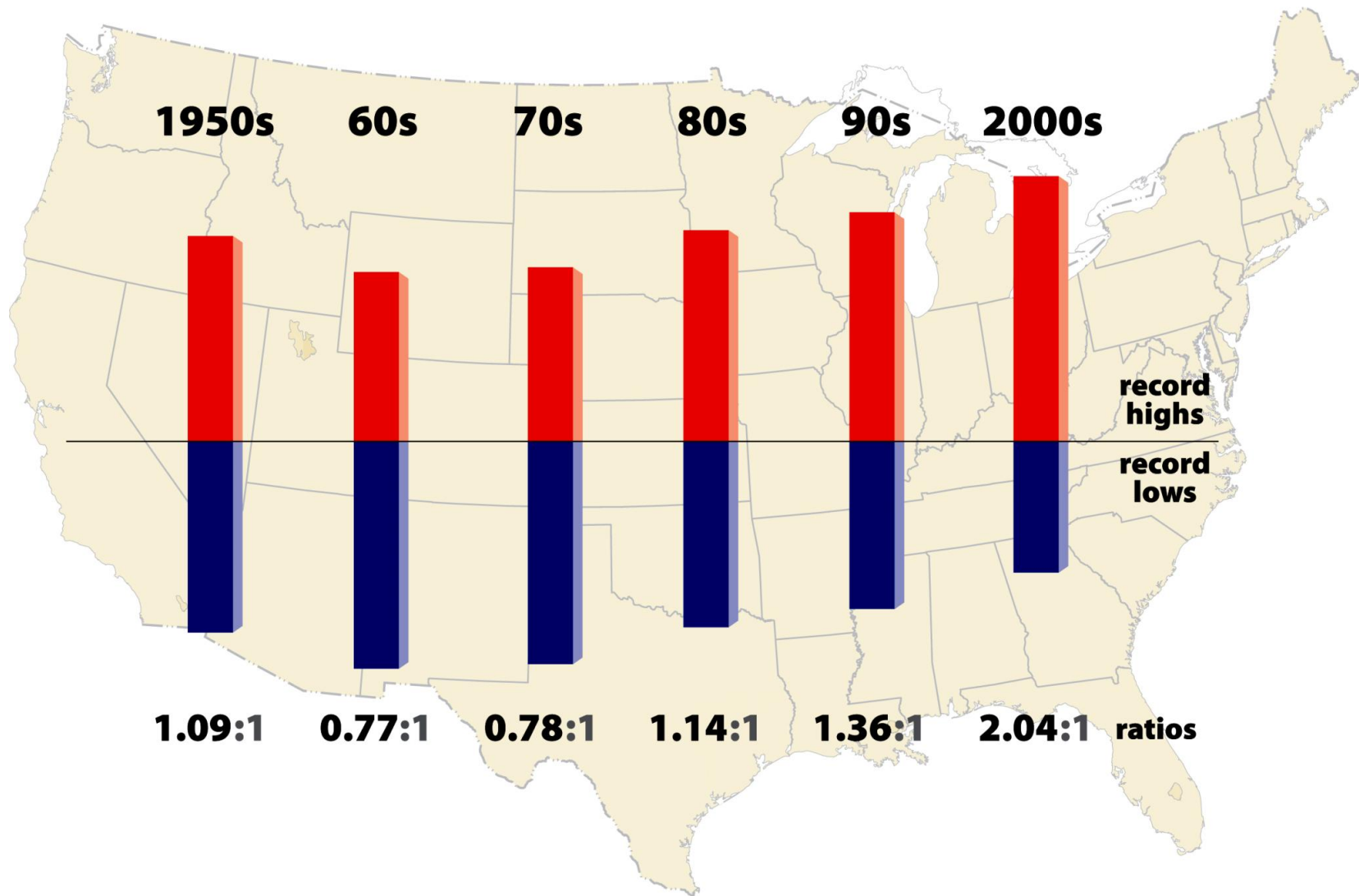
EXAMPLES

- ⦿ General/Liberal Education
- ⦿ Statistics
- ⦿ Calculus
- ⦿ Differential Equations/Modeling
- ⦿ Junior/Senior Projects

Supply Sources Demand Sectors



Source: Energy Information Administration, Annual Energy Review 2009

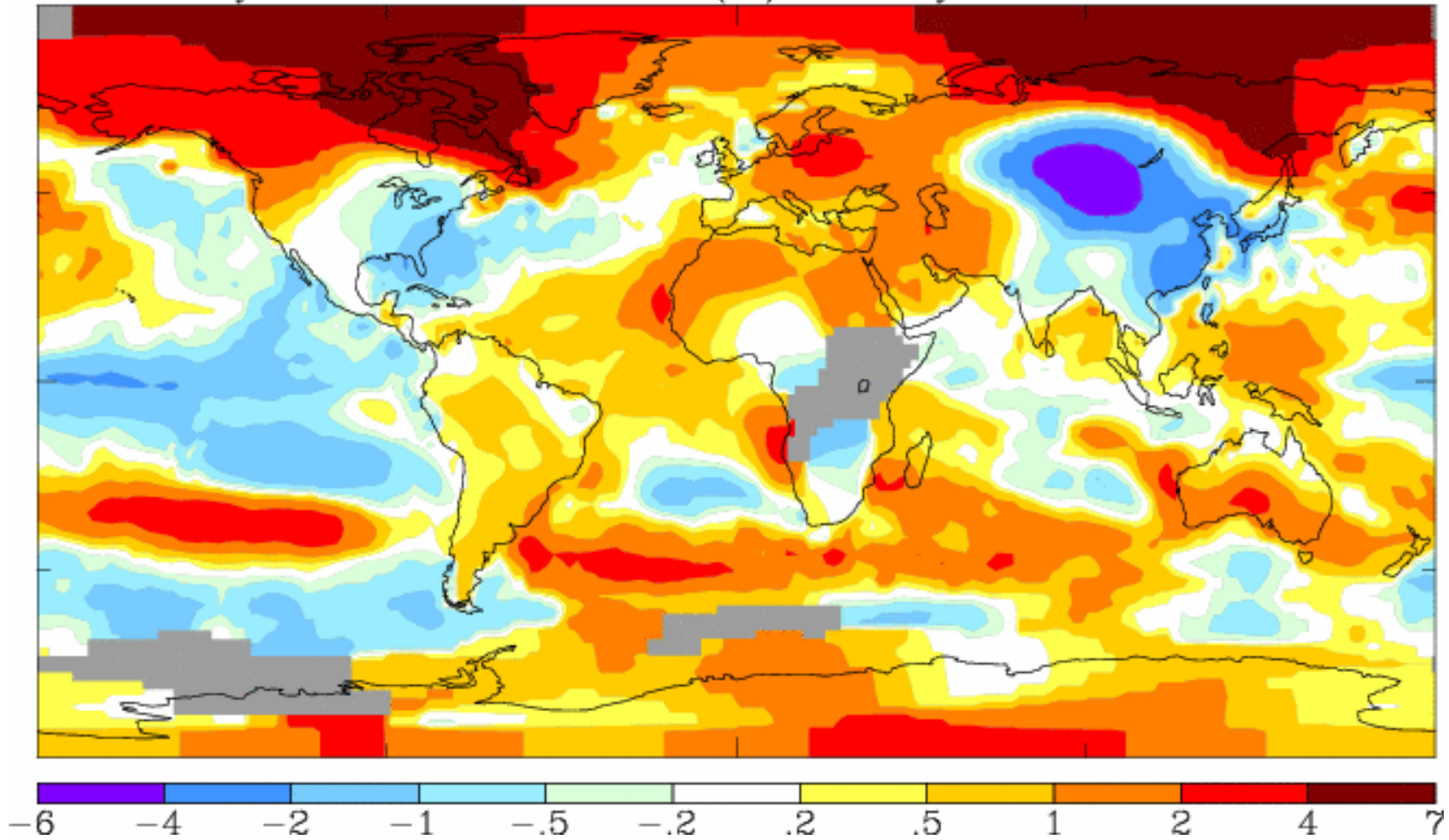


www2.ucar.edu/news/1036/record-high-temperatures-far-outpace-record-lows-across-us

January 2011

L-OTI(°C) Anomaly vs 1951-1980

.46



<http://data.giss.nasa.gov/gistemp/maps/>

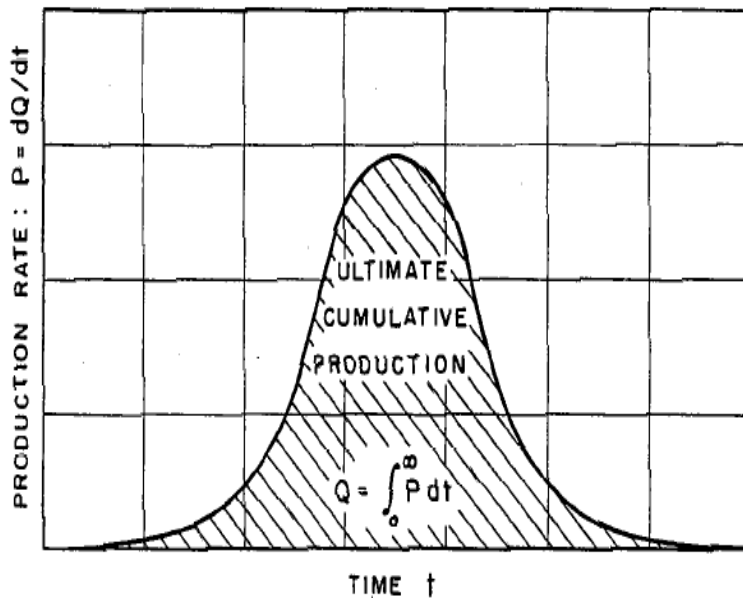


Figure 11 - Mathematical relations involved in the complete cycle of production of any exhaustible resource.

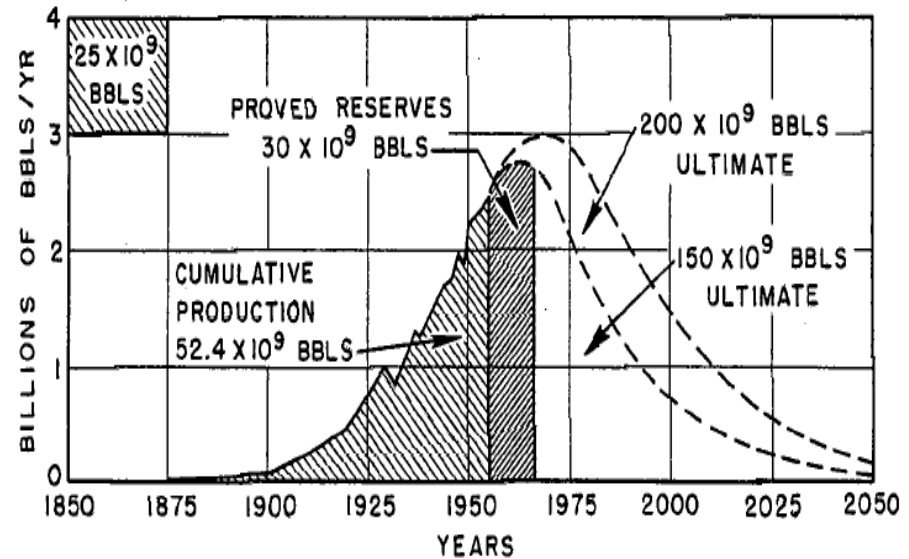
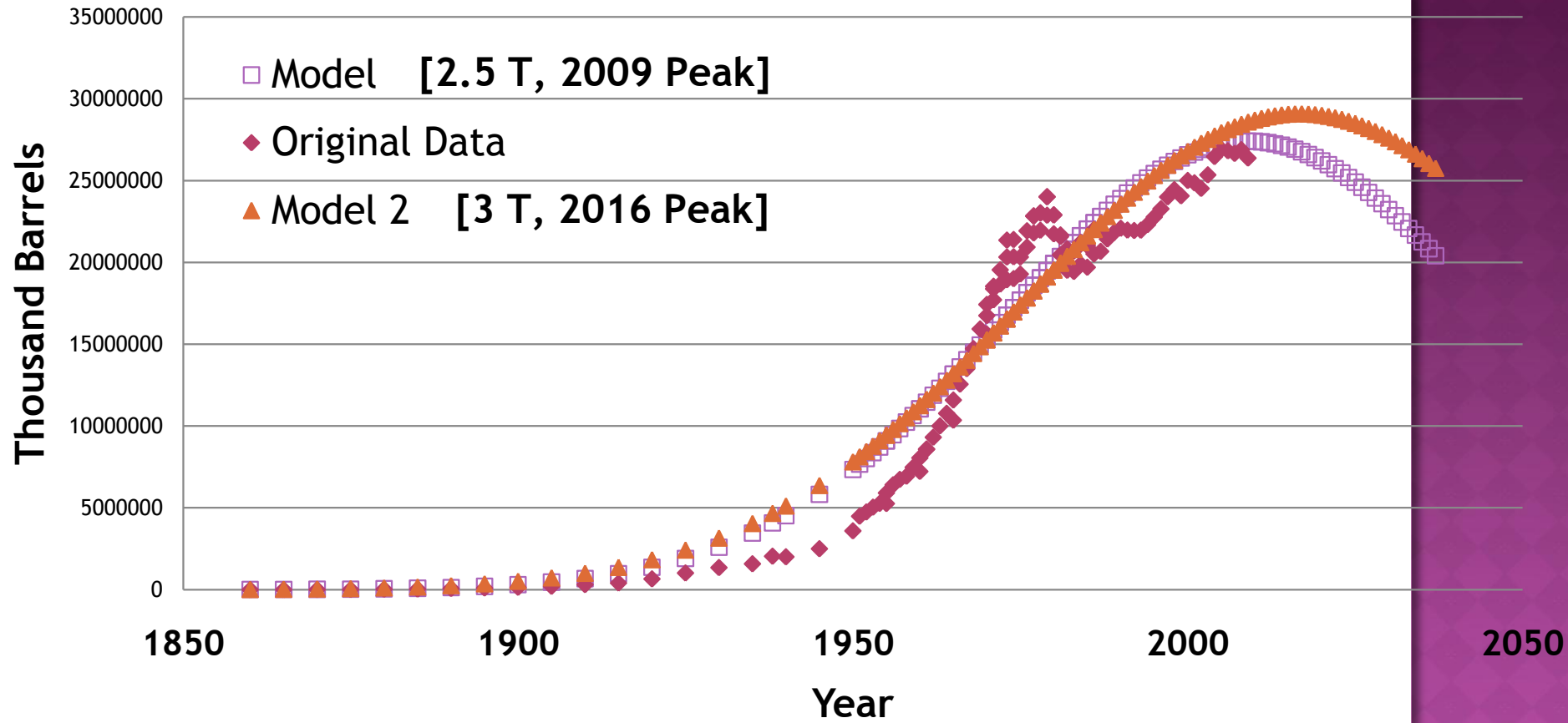
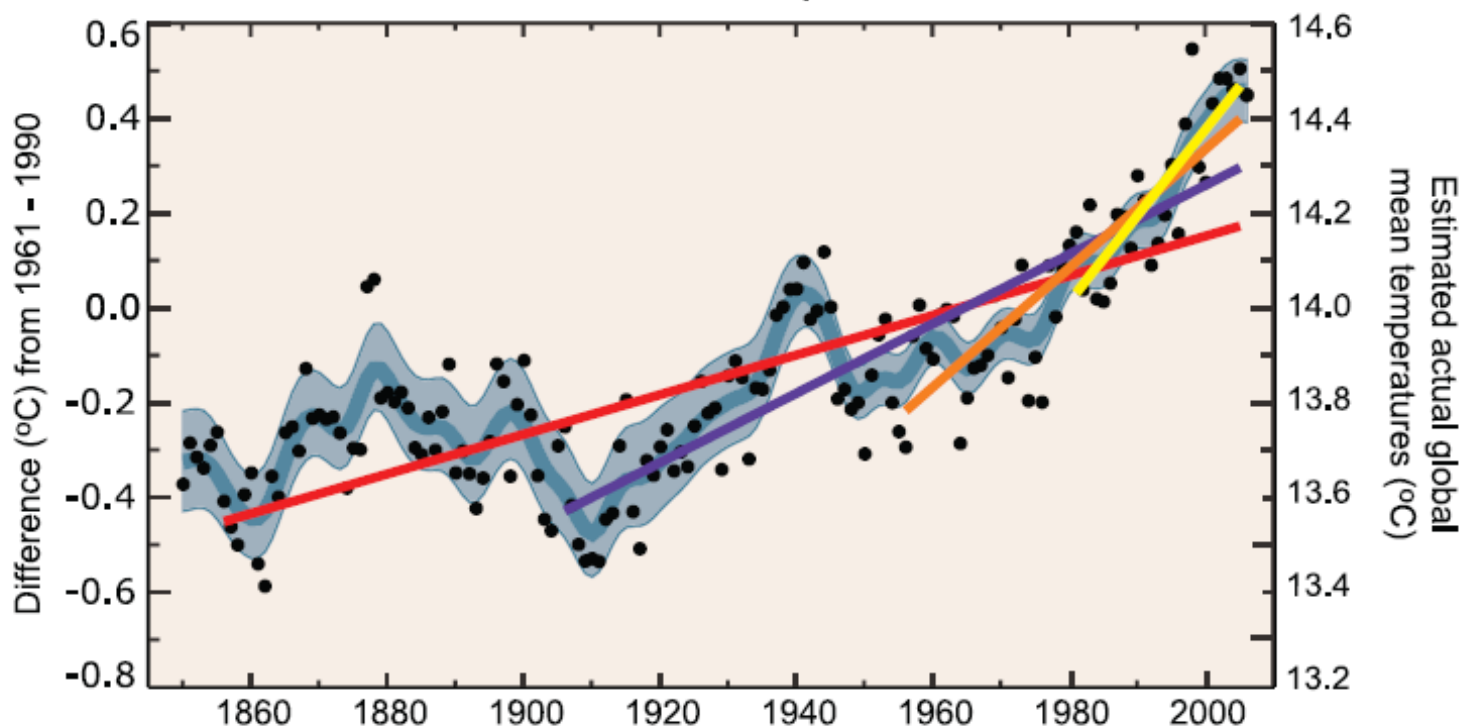


Figure 21 - Ultimate United States crude-oil production based on assumed initial reserves of 150 and 200 billion barrels.

M. King Hubbert's (1903-1989), chief consultant-general geology for shell development company, 1956 paper Nuclear Energy and the Fossil Fuels.

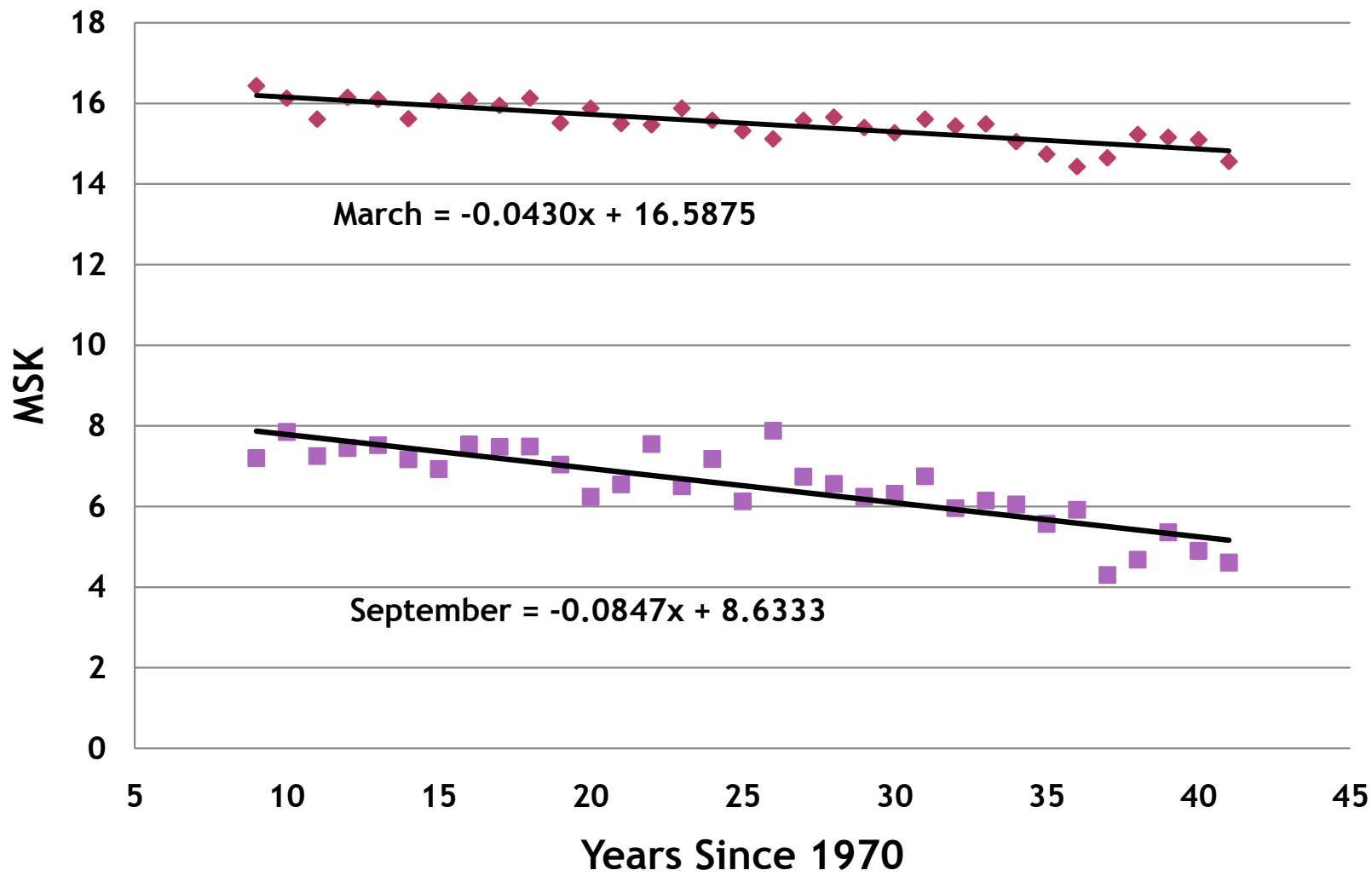


Global Mean Temperature

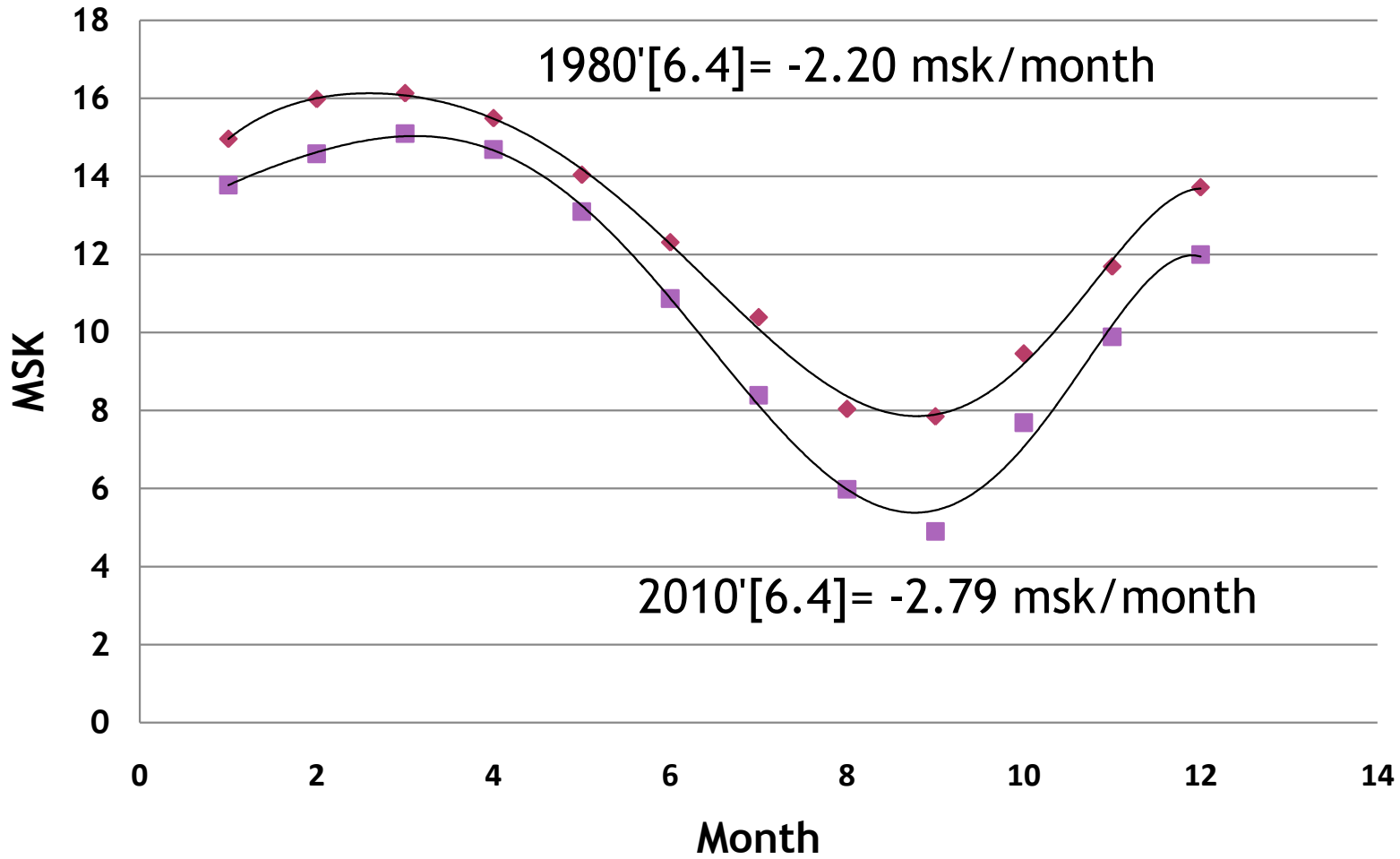


	Period Years	Rate °C per decade
● Annual mean		
— Smoothed series		
■ 5-95% decadal error bars		
	25	0.177±0.052
	50	0.128±0.026
	100	0.074±0.018
	150	0.045±0.012

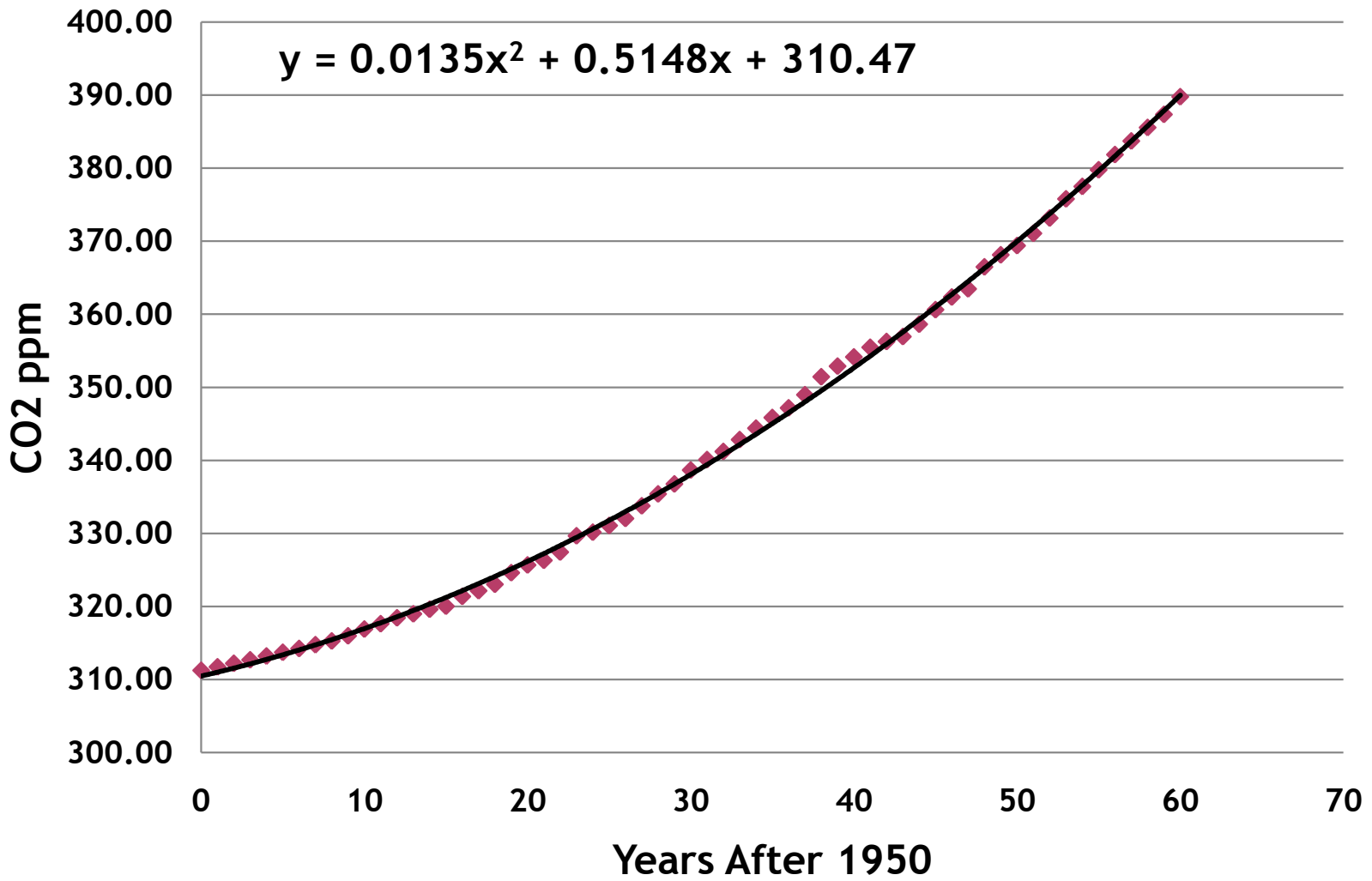
Arctic Sea Ice



Arctic Ice Extent



Atmospheric CO2



$$B(t)=0.222x^2-3.684x+16.376 \text{ MW x year after 1990}$$

$$B(25)=63.03\text{MW}$$

- At 25 years G.B. has generated 63.03 MW of solar energy.
- 25 years after 1990, G.B. solar generating capacity is 63.03 MW.

$$\text{In response to } B'(15)=2.976 \text{ MW/Yr}$$

- By the year 2005 G.B. solar generating capacity will be 10.9 MW.

2.2 Surplus Production Assessments

Biomass Dynamics Analyses

A nonequilibrium surplus production model incorporating covariates (ASPIC; Prager 1994, 1995) was applied to each stock using landings (and discards where available) and multiple survey indices of stock biomass. The model assumes logistic population growth, in which the change in stock biomass over time (dB_t/dt) is a quadratic function of biomass (B_t):

$$dB_t/dt = rB_t - (r/K)B_t^2$$

where r is intrinsic rate of population growth, and K is carrying capacity. For a fished stock, the rate of change is also a function of fishing mortality (F):

$$dB_t/dt = (r-Ft)B_t - (r/K)B_t^2$$

Biological reference points can be calculated from the production model parameters:

$$MSY = K r / 4$$

$$BMSY = K / 2$$

$$FMSY = r / 2$$

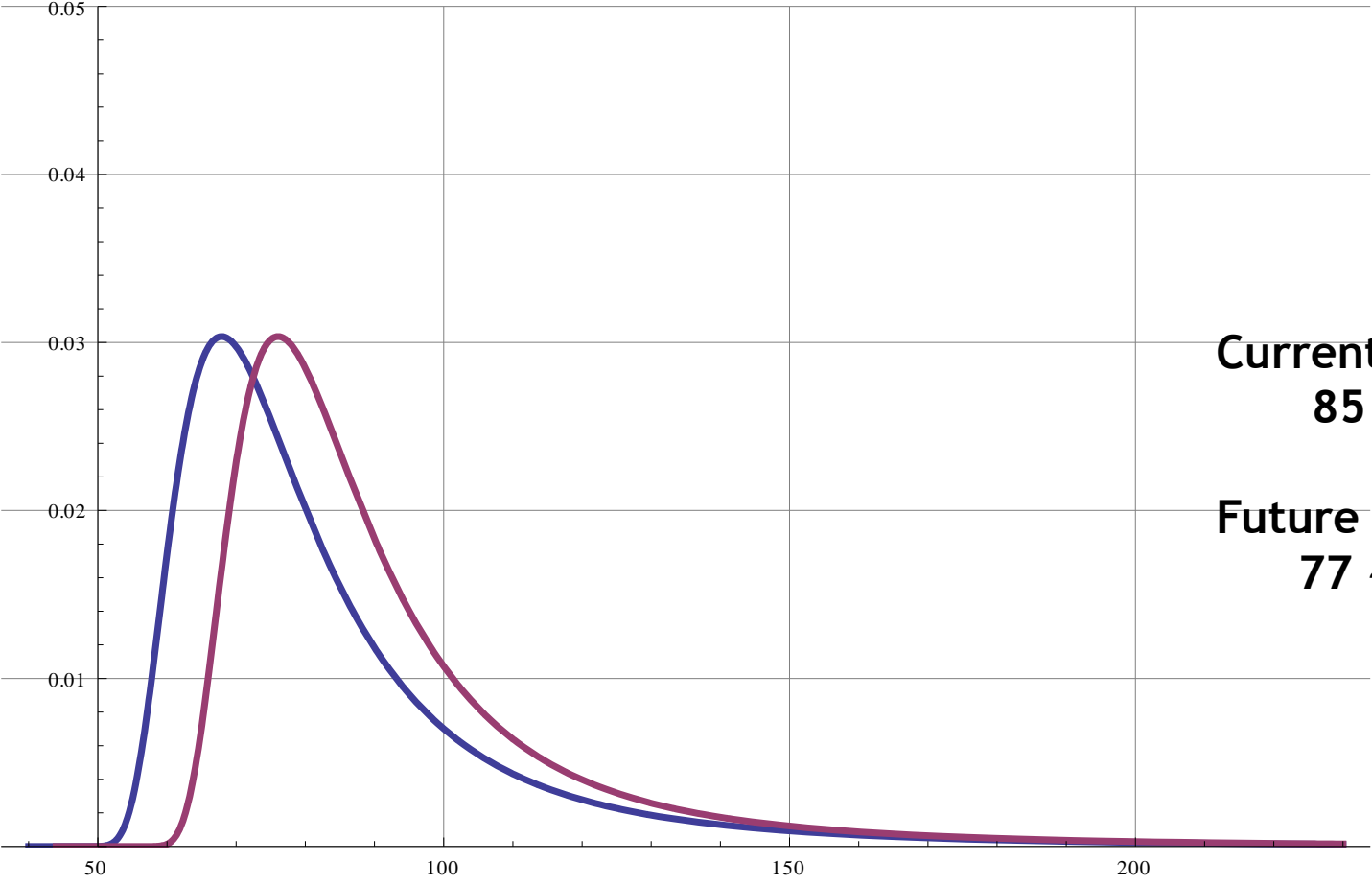
<http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0204/>

<http://www.ithaca.edu/mse>

K.K.TUNG'S TOPICS IN MATHEMATICAL MODELING

$$R \frac{\partial T}{\partial t} = Qs(y)(1 - \alpha(y)) - I(y) + C(\bar{T} - T)$$

WORK WITH ASHLEY BELL



**Current Median:
85 ~ Feb 23**

**Future Median:
77 ~ Feb 15**

WORK WITH BRIAN MCGAUVVRAN

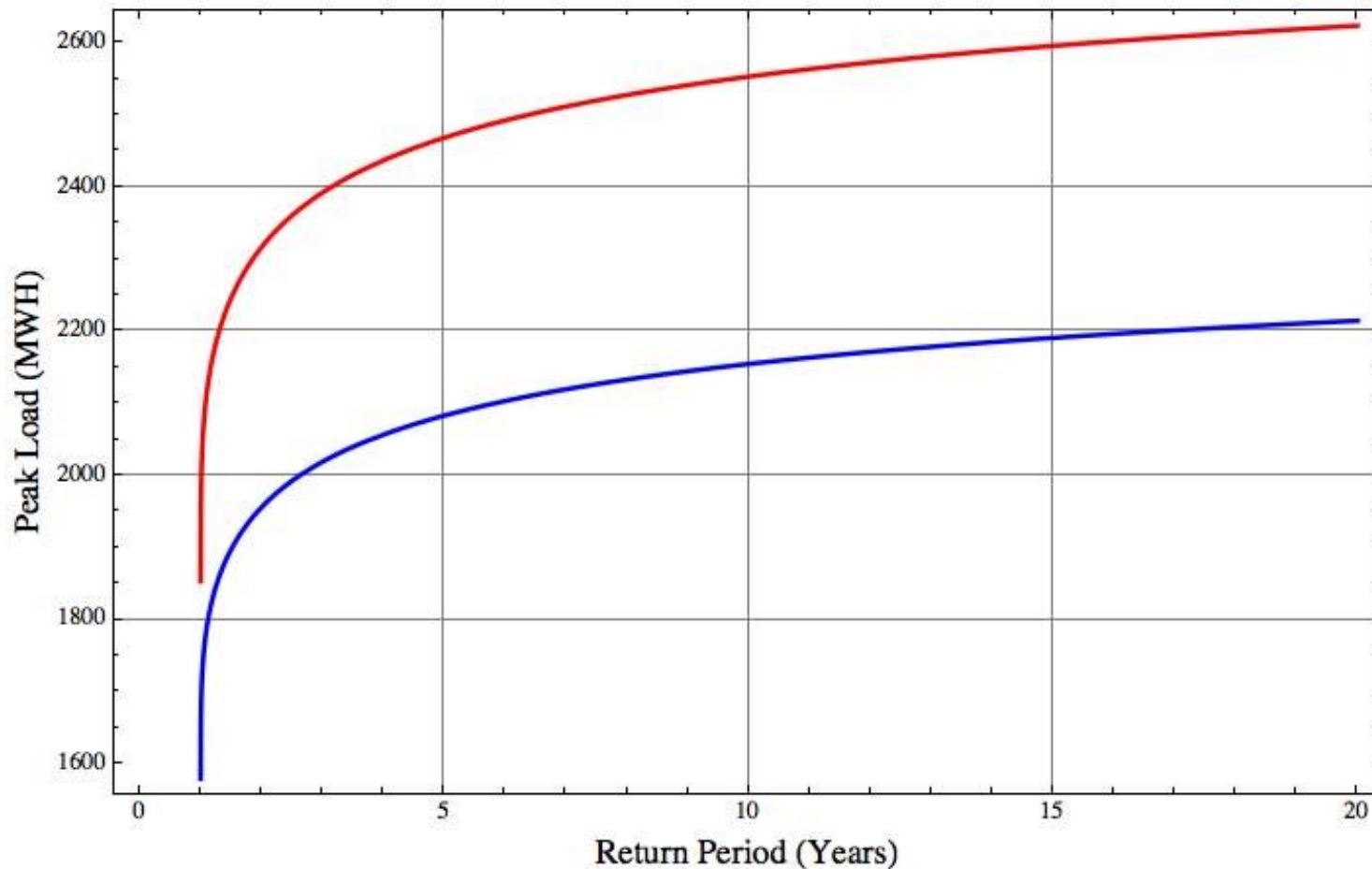
Observed Ithaca Maxima

Heat Index (°F)	Probability Above HI
100	73%
105	55%
110	38%
115	24%
120	14%
125	8%
130	4%

Predicted Ithaca Maxima

Heat Index (°F)	Probability Above HI
100	82%
105	70%
110	57%
115	43%
120	31%
125	22%
130	14%

WORK WITH SCOTT CONSTABLE



OPPORTUNITIES

- ◉ Simulation Data, R, Netcdf, NCAR
- ◉ www.ithaca.edu/tpfaff/sustainability.htm

RANDOM THOUGHTS

- QLvs Math vs Sustainability

RANDOM THOUGHTS

- QLvs Math vs Sustainability
- Extremes are Normal

RANDOM THOUGHTS

- ◉ QLvs Math vs Sustainability
- ◉ Extremes are Normal
- ◉ Inert Knowledge (information which one can express but not use)

Theoretical ideas should always find important applications within the pupil's curriculum. This is not an easy doctrine to apply, but a very hard one. It contains within itself the problem of keeping knowledge alive, of preventing it from becoming inert, which is the central problem of all education."

—Alfred North Whitehead 1929

*THANK
YOU!*

- www.ithaca.edu/tpfaff/sustainability.htm
- www.ithaca.edu/mse
- tpfaff@ithaca.edu
- Partly Supported by NSF DUE-0837721