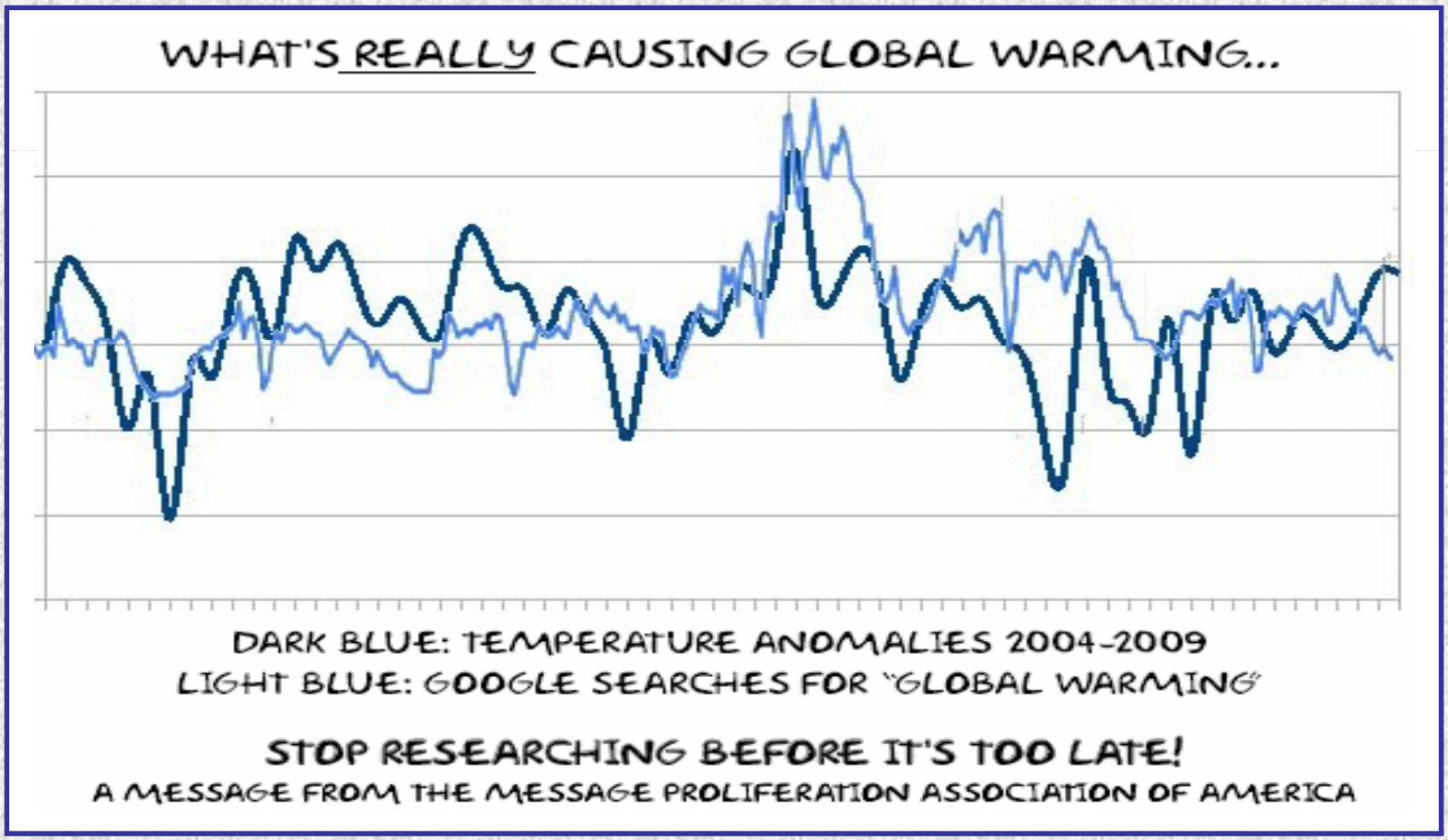
Importance of Reliable Continuous Records of the Earth Systems

Earth System Research Laboratory
Global Monitoring Annual Conference
May 18 2010

T. J. Blasing

"Ensuring Continuity and Reliability of Long Term Measurements."



We are:

CDIAC

Carbon Dioxide Information Analysis Center • http://cdiac.ornl.gov

Sponsored by:

U.S. DEPARTMENT OF ENERGY

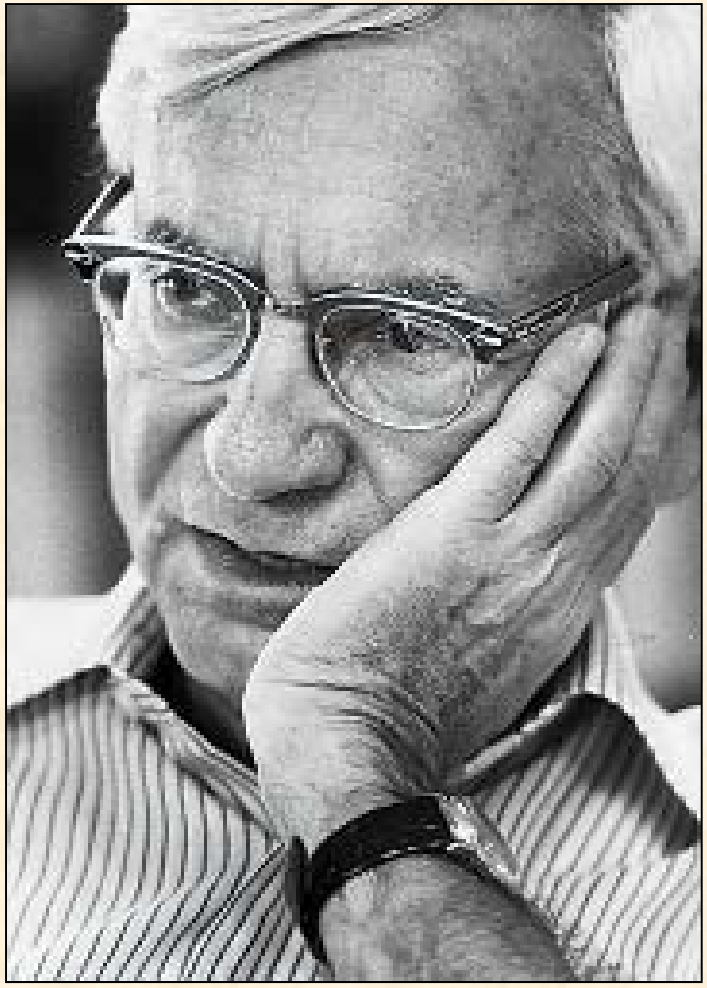
Office of Science

SERVING SCIENCE AND SOCIETY • DOE Biological and Environmental Research Program

Housed at:

We are here.

OAK RIDGE National Laboratory



1. Is Carbon Dioxide Increasing?

2. Are CO_2 changes anthropogenic?

3. Is the temperature increasing?

4. Are 1 and 3 related?

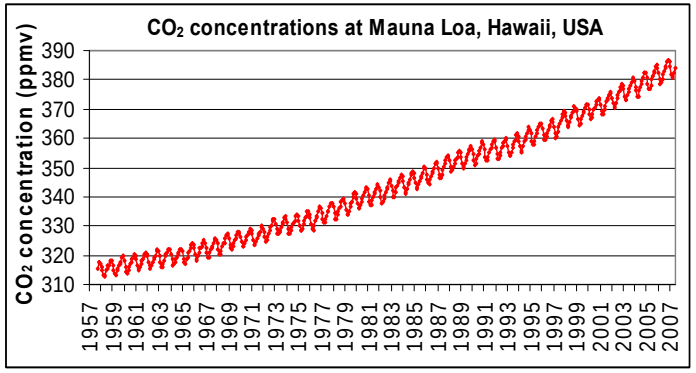
Beer's Law
M.N. Berberan-Santos, 1990.
J. Chem. Educ. 67, p 757

OAK RIDGE National Laboratory

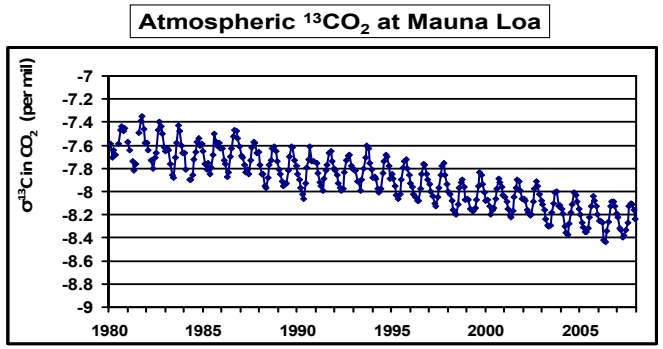
Documentation of Tropospheric CO_2 Increases

Charles David Keeling (1928-2005)

Dr. Keeling was the first to document, through continuous measurements, the current rise in atmospheric CO_2, its annual cycle and interannual variations



Isotopic signatures of fossil carbon are showing up in the atmosphere



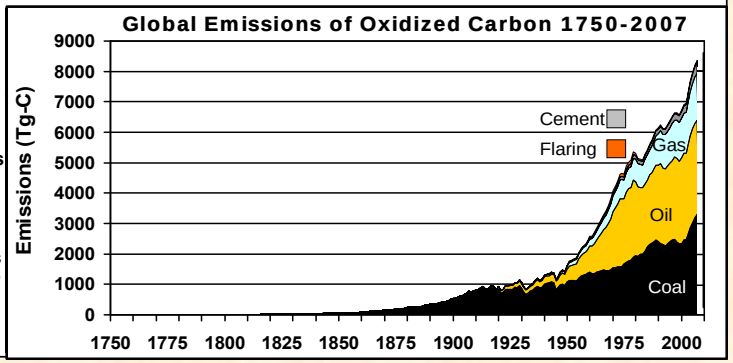
Documentation of Fossil-Carbon Emissions

Gregg Marland

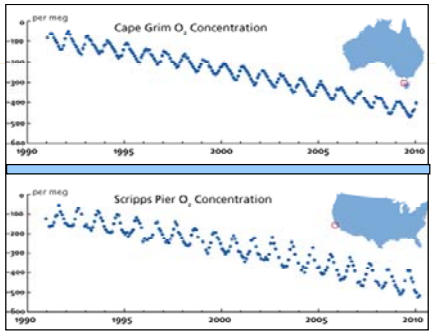
Tom Boden

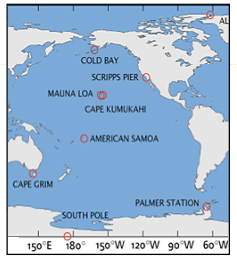
Bob Andres

Each year, CDIAC compiles time series' of global, regional and national fossil carbon emissions. Gregg Marland leads the effort, with contributions from Tom Boden and Bob Andres. The amount emitted is consistently about twice that needed to explain the Keeling Curve, above. The remaining carbon is taken up by the oceans and terrestrial biosphere.



Carbon dioxide increases are associated with matching drawdowns of atmospheric oxygen.

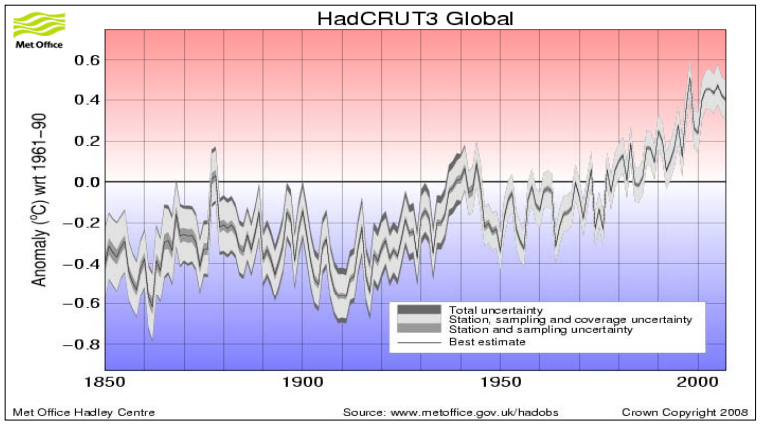


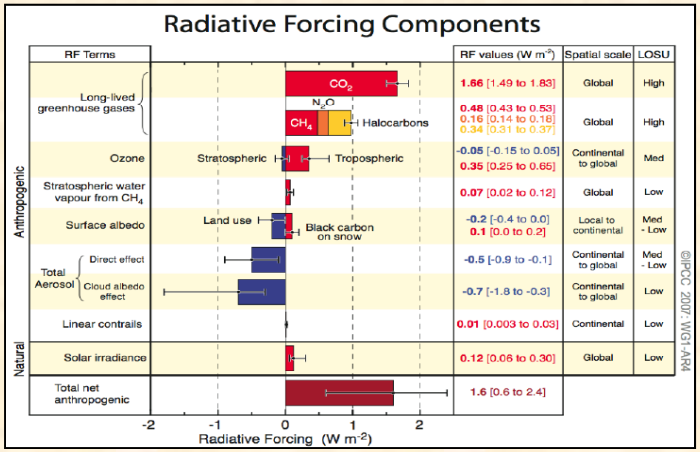


Documentation of Global Temperature Changes

Hubert H. Lamb (1913-1997)

Hubert Lamb, Founding Director of the Climate Research Unit at the University of East Anglia recognized the importance of a consistent time series of Earths near-surface temperature. His work led to a temperature record used by the Intergovernmental Panel on Climate Change (IPCC).





Data Gathering (providing good quality information)

- Quality Assurance (techniques, calibration, adjustments)
- Record keeping
- Consistent time series
- Independent redundant measurements/estimates

Data Management (preserving/displaying the information)

- Discovery of recorded mistakes
- Archiving of time series
- Presentation

Analysis (using the information)

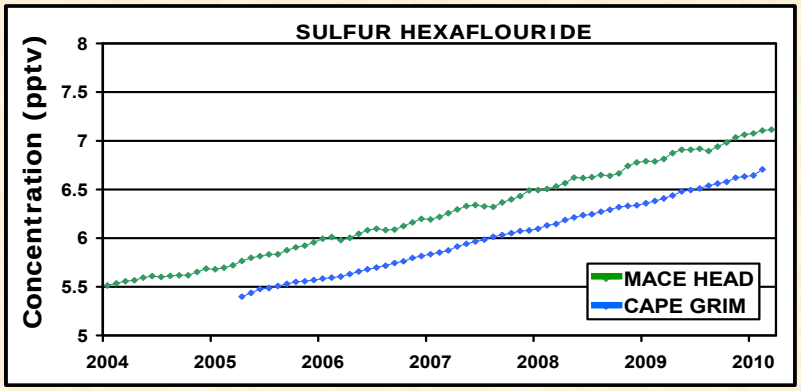
- Causes
- Effects

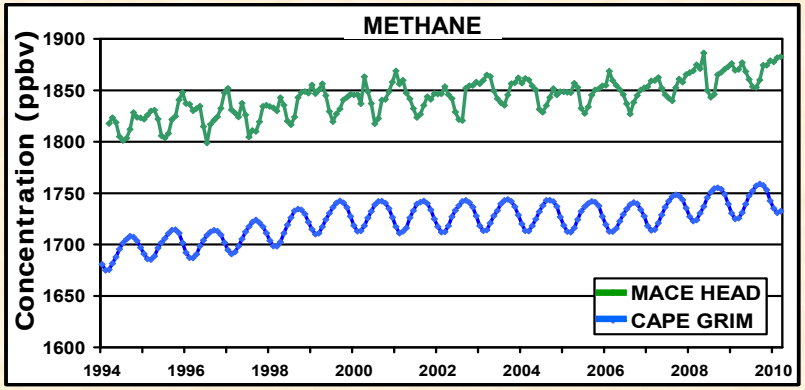
1. Is Carbon Dioxide Increasing?

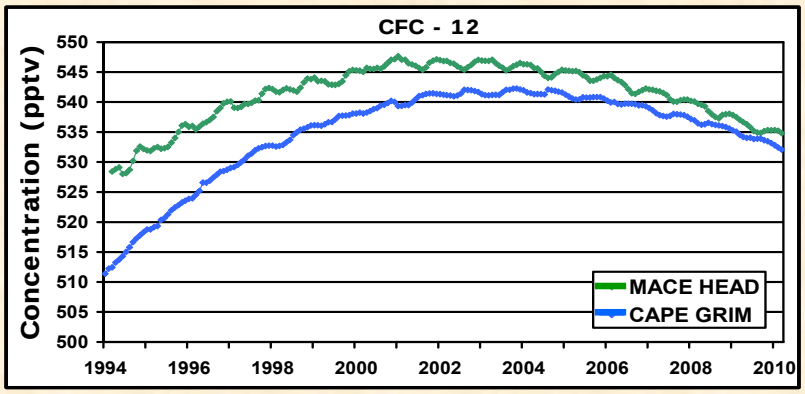
1. (revised) Are Greenhouse Gases Increasing?

Importance of redundant/corroborating data

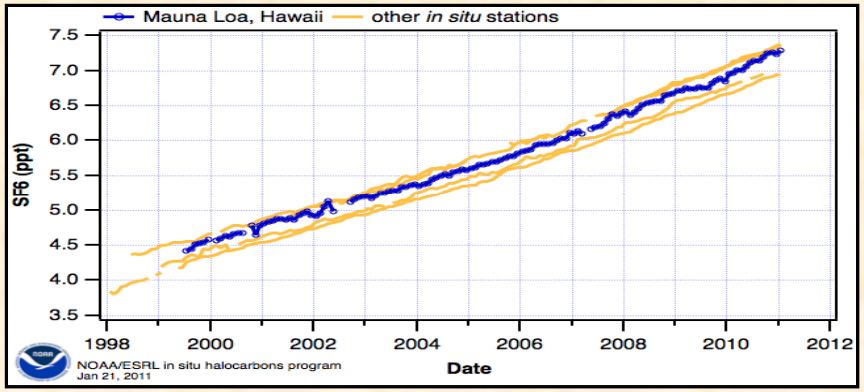
AGAGE

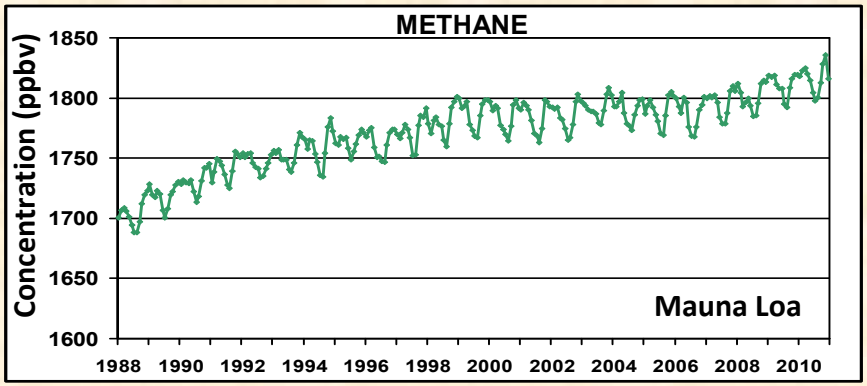


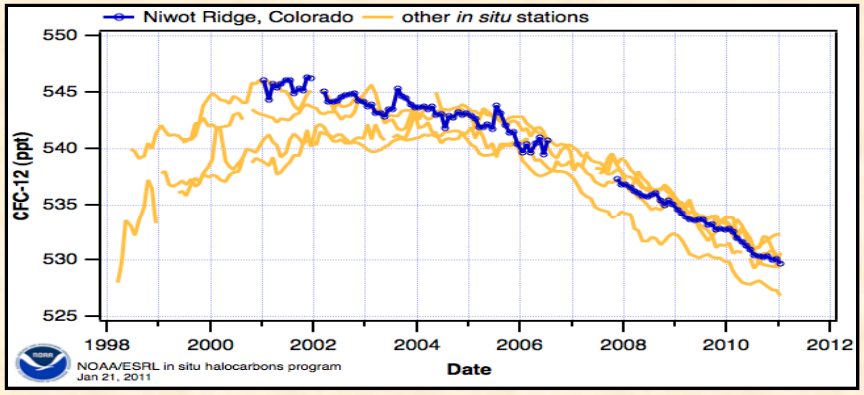


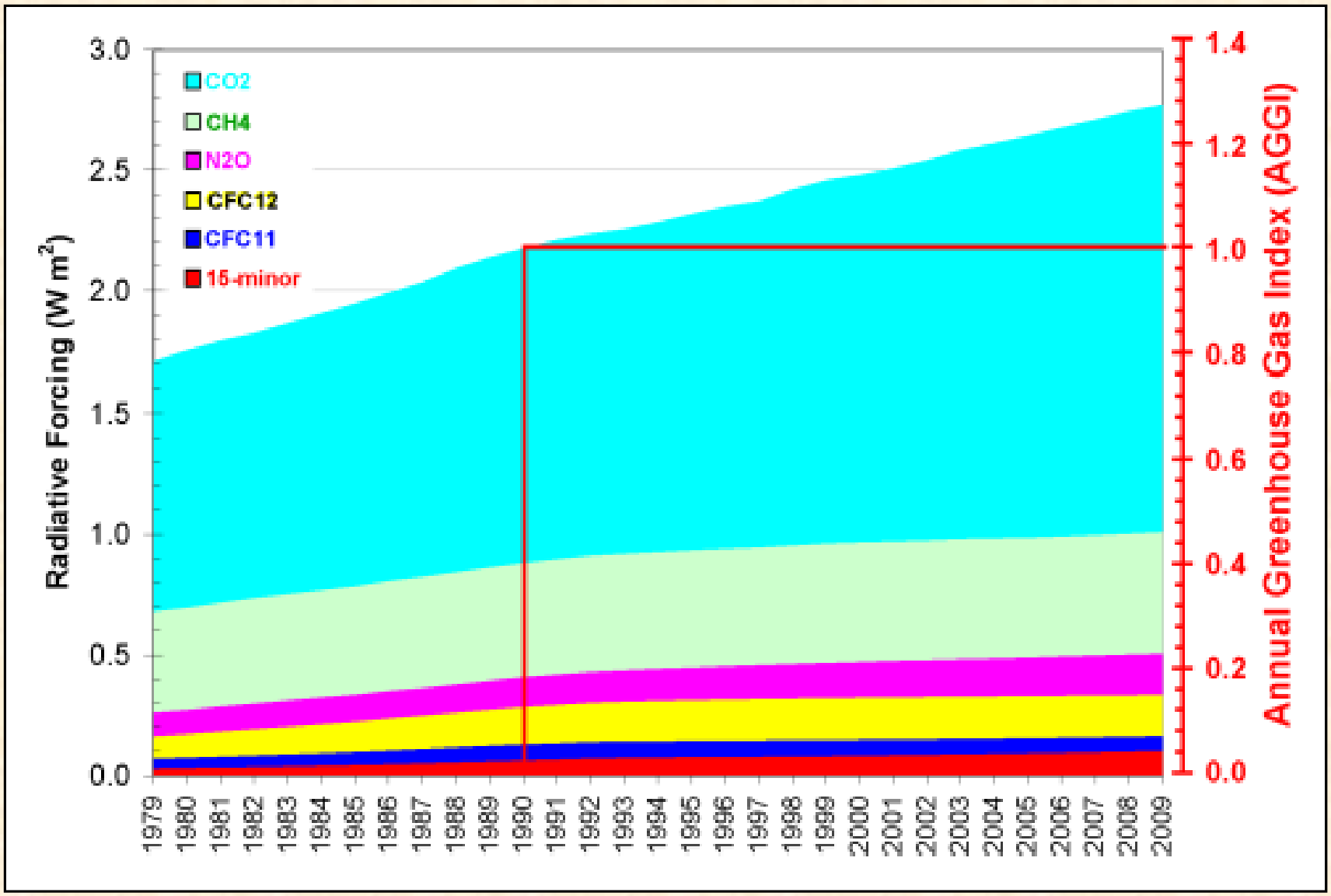


NOAA







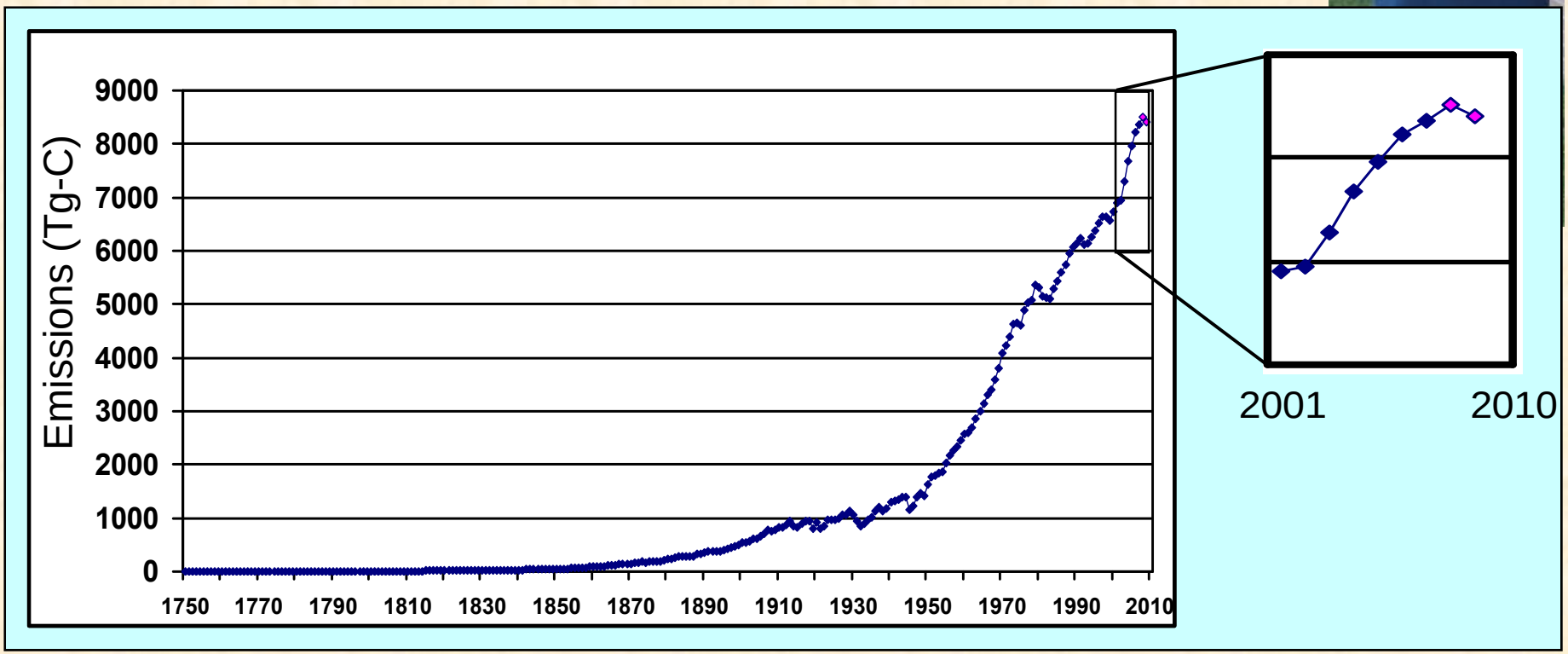

Radiative Forcing (W m^2)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
CO2
CH4
N2O
CFC12
CFC11
15-minor
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Annual Greenhouse Gas Index (AGGI)
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

2. Are CO_2 changes anthropogenic?

Analysis

Calculations of Global Emissions on an Annual Basis

reveal that we're not only making enough CO_2 to explain the atmospheric increase, but we're making about twice that much. ***This bounds the amount of CO_2 taken up by the atmosphere and oceans***. Because the calculations are made for each fuel type (solid, liquid, gas) ***isotopic composition can be estimated for comparison with changes in atmospheric concentrations.***



2. Are CO_2 changes anthropogenic?

Redundant data → Discovery of recorded mistakes

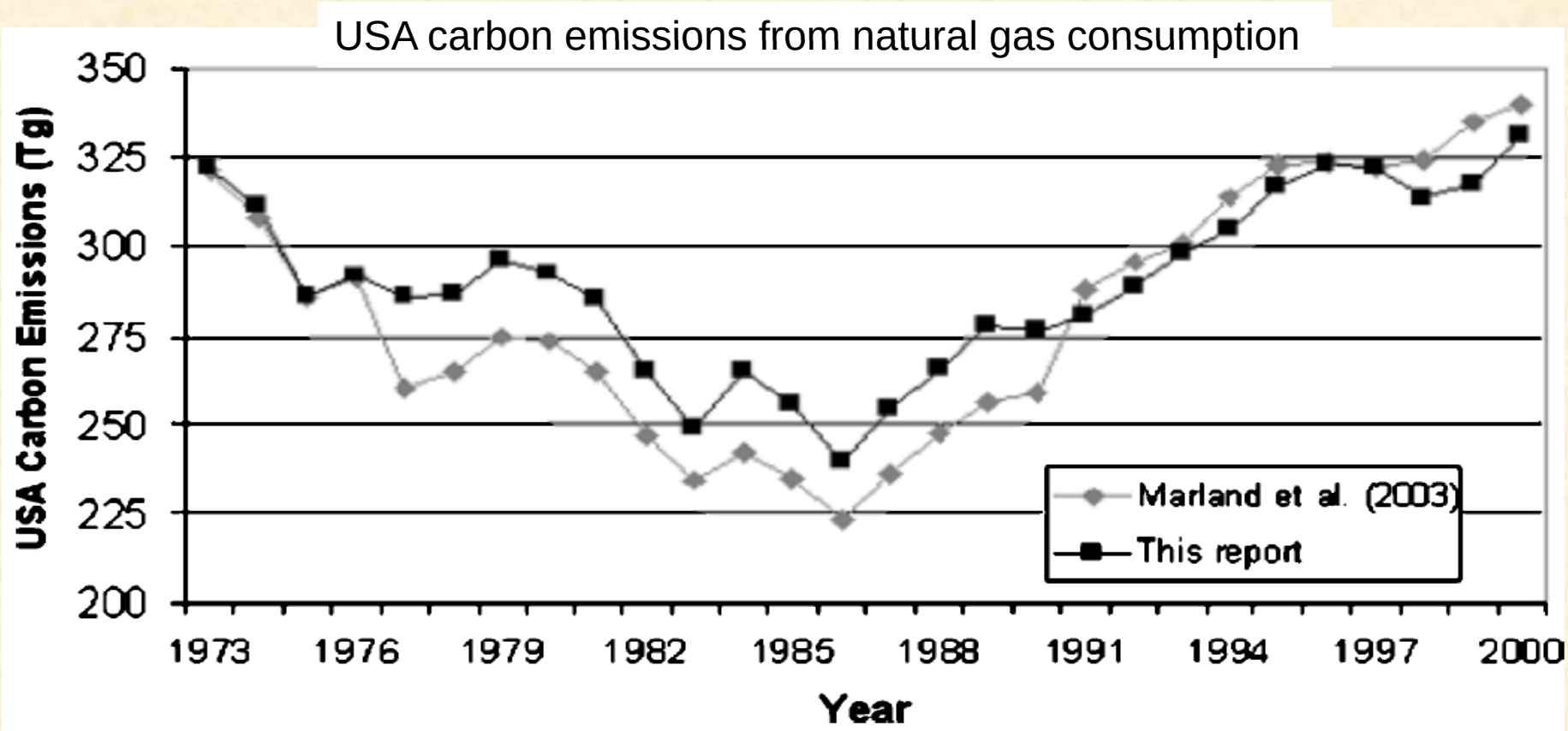


Fig 4. Comparison of the results of this paper for natural gas consumption with CDIAC (United Nations) data (Marland et al., 2003).

Fuel amount [Mg, m^3] • heat coefficient [MJ/amount] • carbon coefficient [g/MJ]

= carbon emissions [g-C]

2. Are CO_2 changes anthropogenic?

Redundant data → Discovery of recorded mistakes

Tellus (2005), 57B, 107–115
Printed in UK. All rights reserved

TELLUS

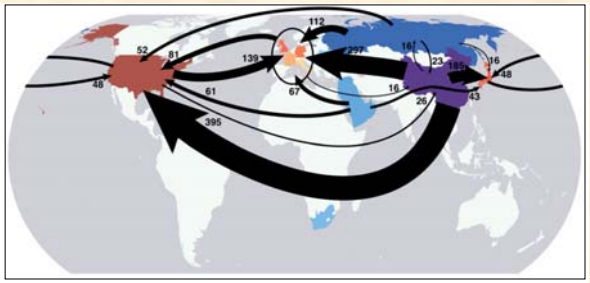
The annual cycle of fossil-fuel carbon dioxide emissions in the United States

By T. J. BLASING[1]*, C. T. BRONIAK[2] and G. MARLAND[1], [1]*Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6335, USA;* [2]*Department of Agricultural and Resource Economics, Oregon State University, Corvallis OR 97331, USA*

Another reason for the higher estimates presented here, particularly for 1976 to 1991, is an apparent problem in the United Nations (UN) energy data base for natural gas, on which the emissions estimates of Marland et al. (2003) are based. Post-1976 UN accounting apparently involved some **confusion of US conventions on "wet" gas (before natural gas liquids are separated out) and "dry" gas (after the liquid portion has been separated out)** and the **change in heating value that occurs during** this **"shrinkage".** After 1991 the problem was largely compensated by an accounting change in the calculation of "shrinkage" (see Fig. 4).

Analysis

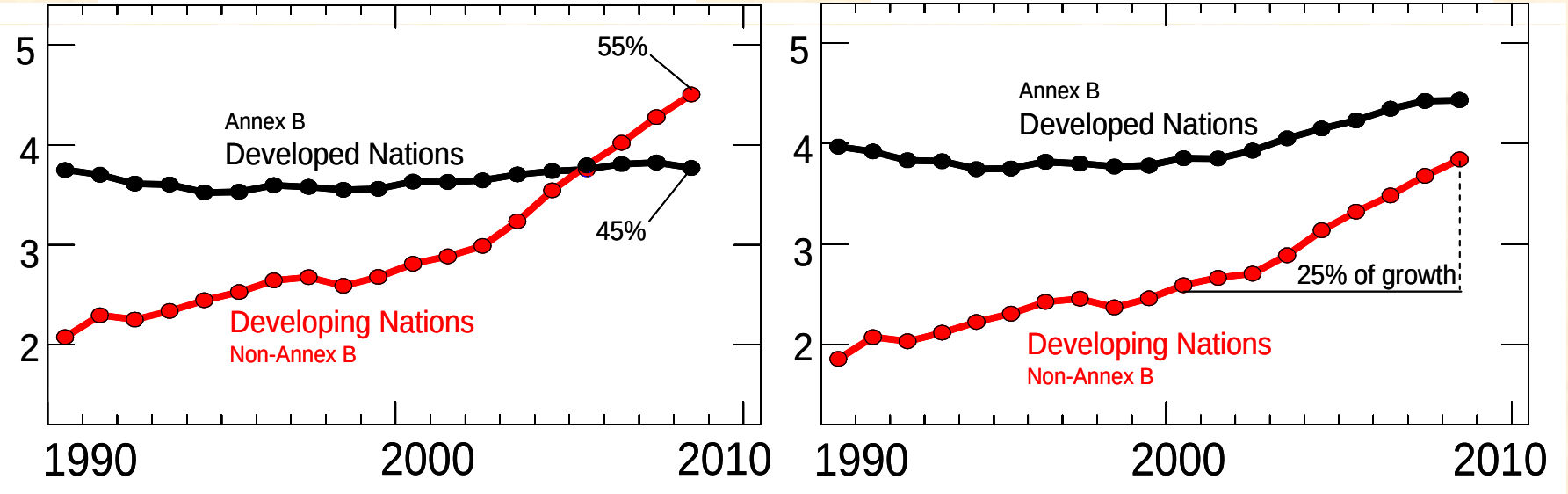
2. CO_2 changes are anthropogenic.



Transport of Embodied Emissions

Carbon emissions (PgC y^{-1})

attributed to *producers* | attributed to *consumers*



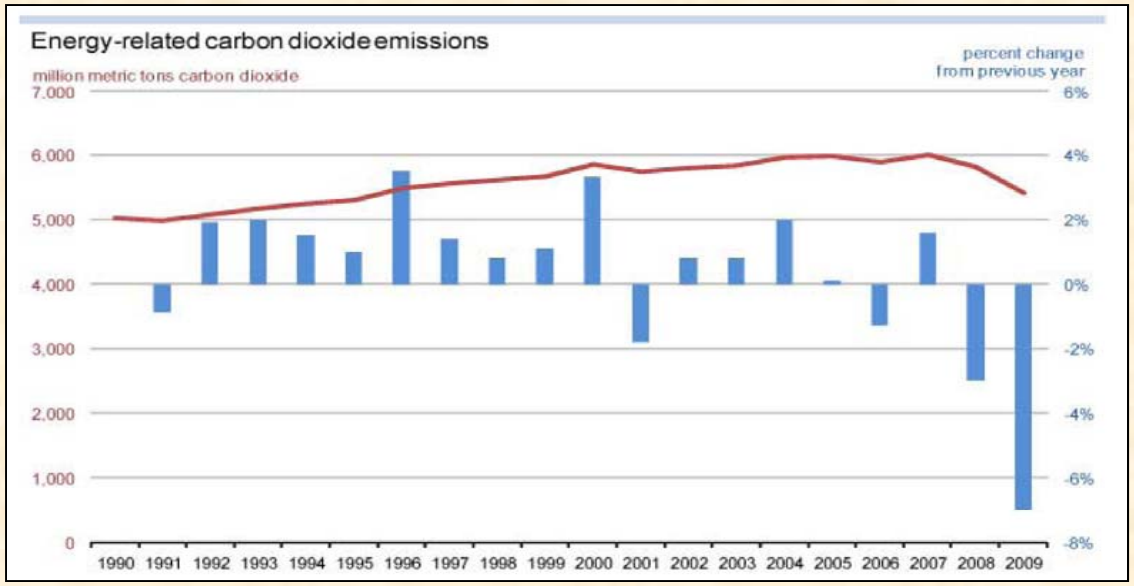
25% of the emissions growth in developing countries (2000-2008) is due to the manufacturing of products consumed in developed countries.

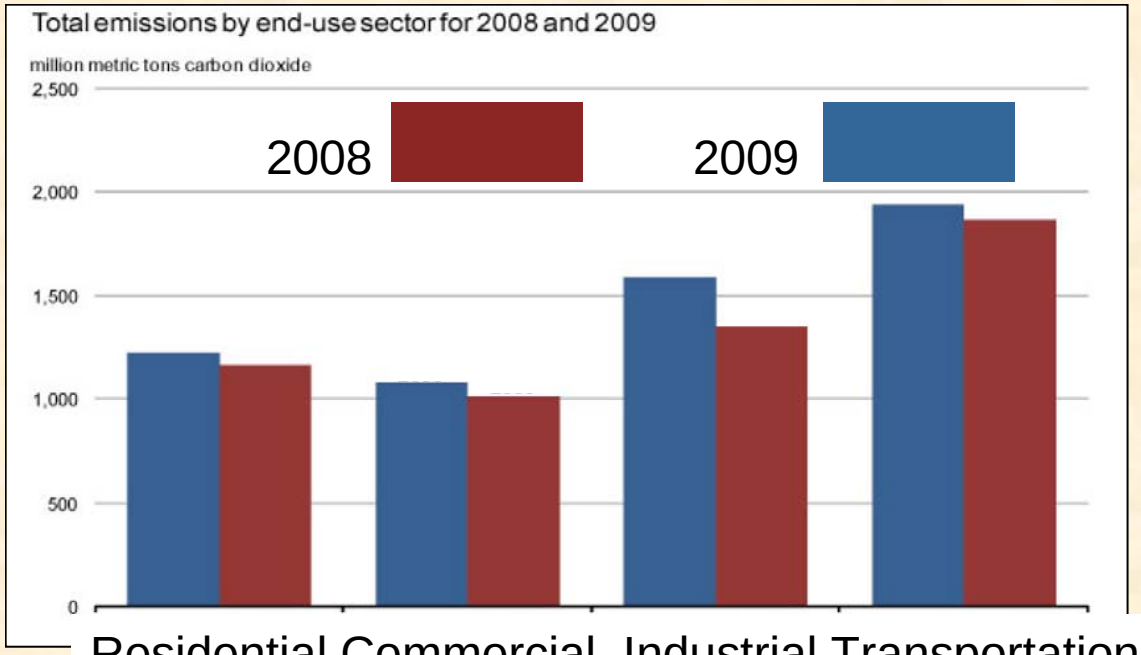
Global Carbon Project 2009; Le Quéré et al. 2009, Nature Geoscience; Data: Peters & Hetwich 2009; Peters et al. 2008; Weber et al 2008; Guan et al. 2008; CDIAC 2009

OAK RIDGE National Laboratory

2. CO_2 Changes are anthropogenic

Analysis

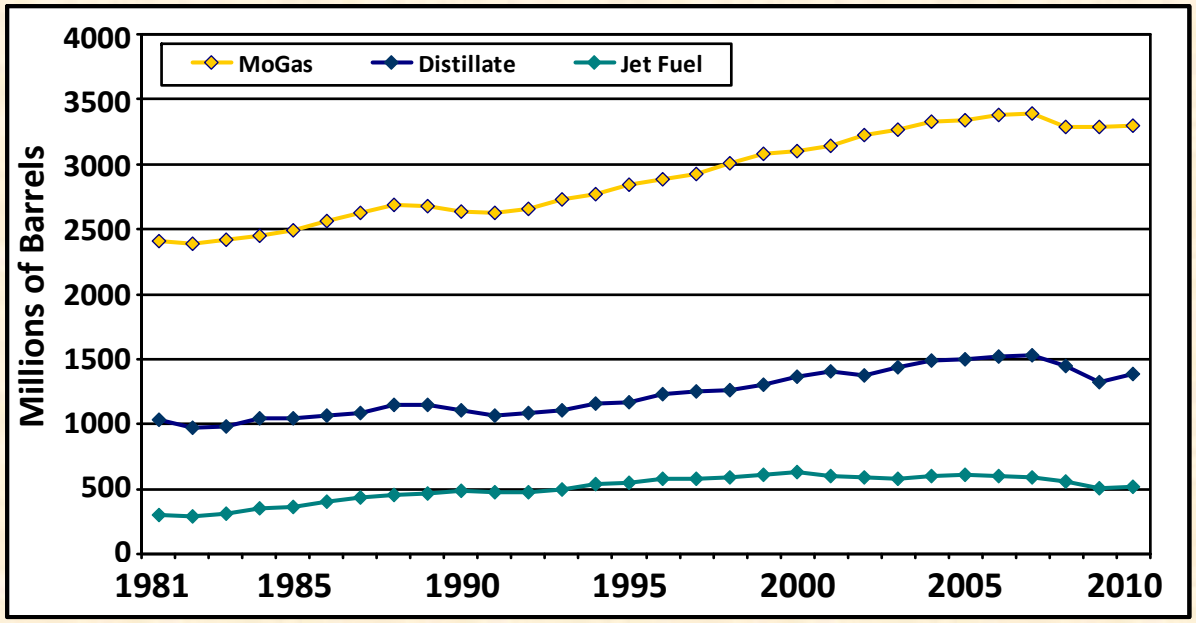


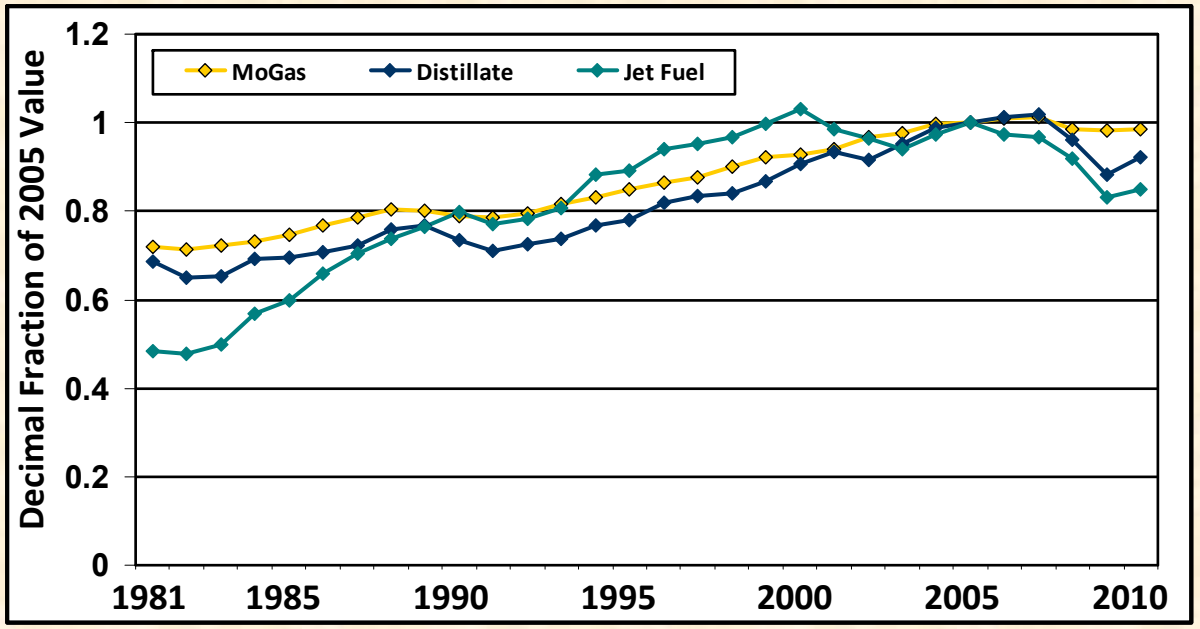


OAK RIDGE National Laboratory

2. CO_2 changes are anthropogenic.

Analysis





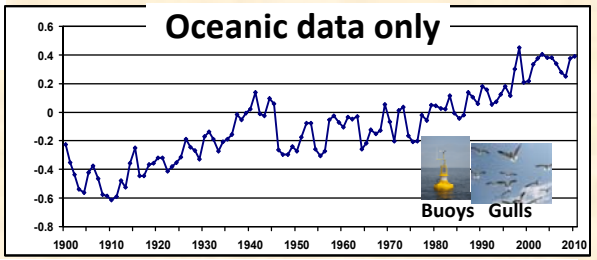
OAK RIDGE National Laboratory

3. Is the temperature increasing?

Importance of redundant/ corroborating data

Documentation of Global Warming

Hubert Horace Lamb (1913-1997)

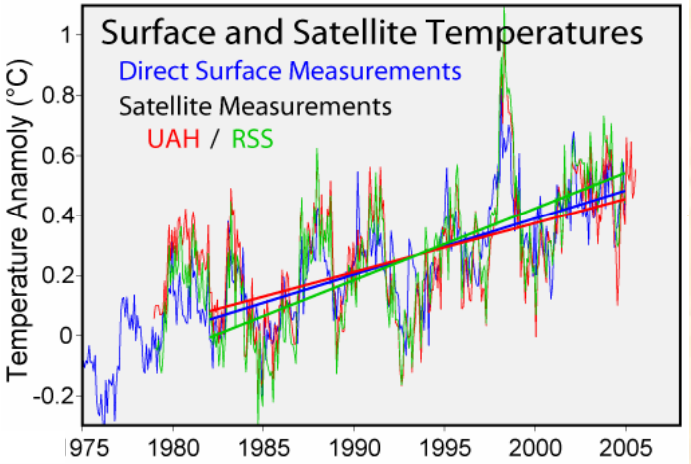


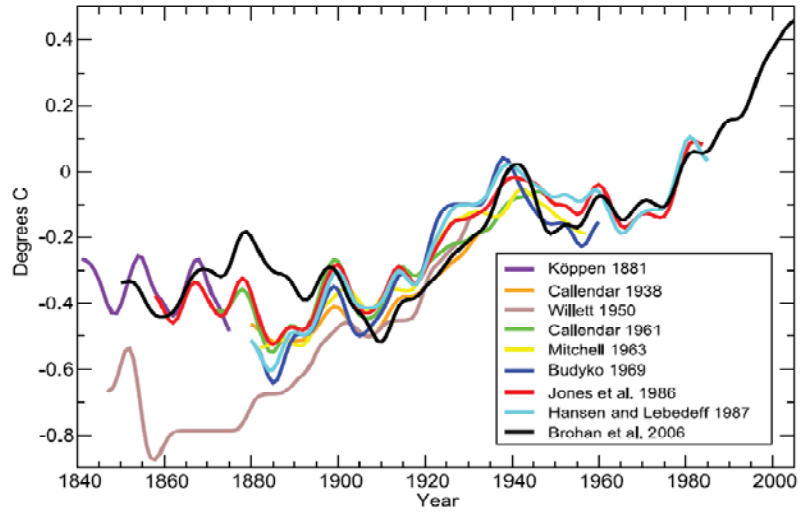
Met Office Hadley Centre

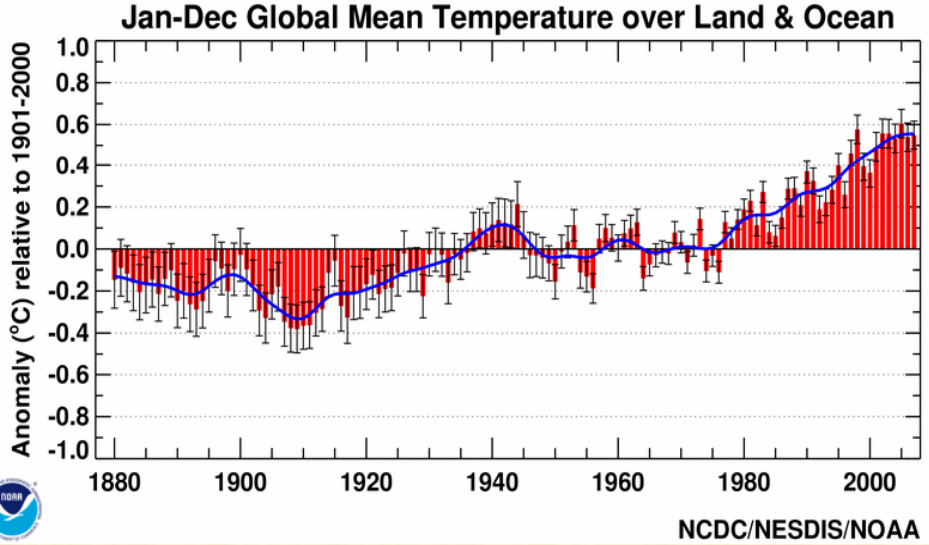
Source: www.metoffice.gov.uk/hadobs

RSS = **Remote Sensing Systems**

UAH = **University of Alabama, Huntsville**







3. Is the temperature increasing? Importance of redundant/corroborating data

http://www.usanpn.org/

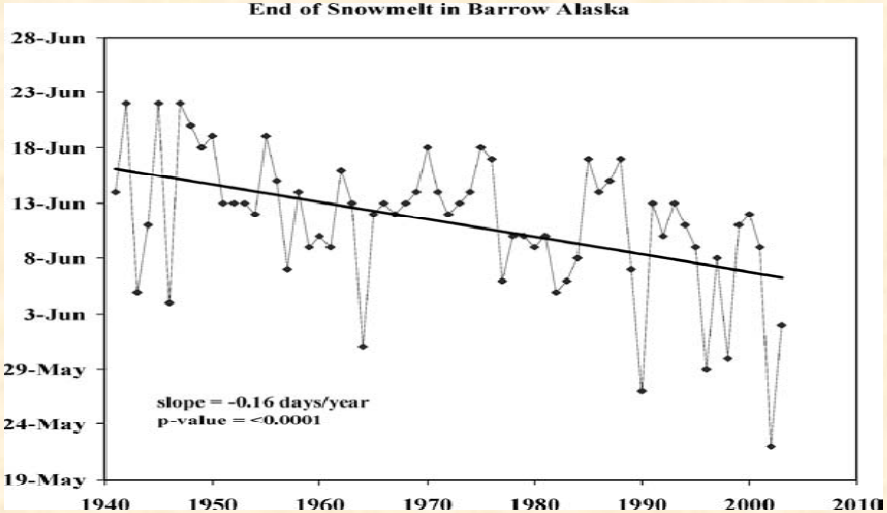
USA npn National Phenology Network

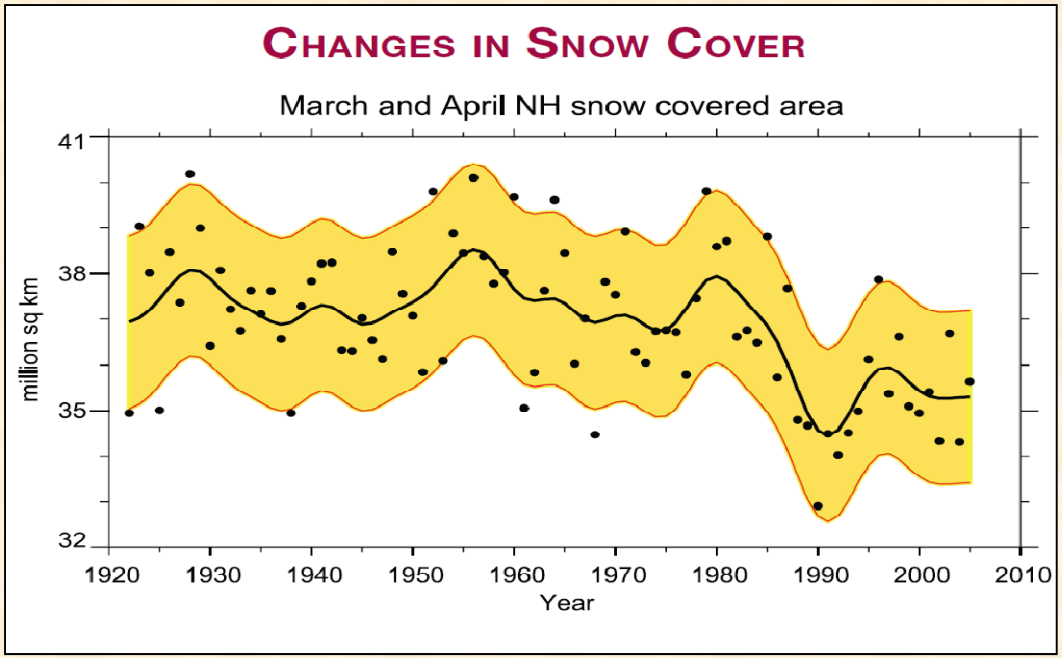





3. Is the temperature increasing?

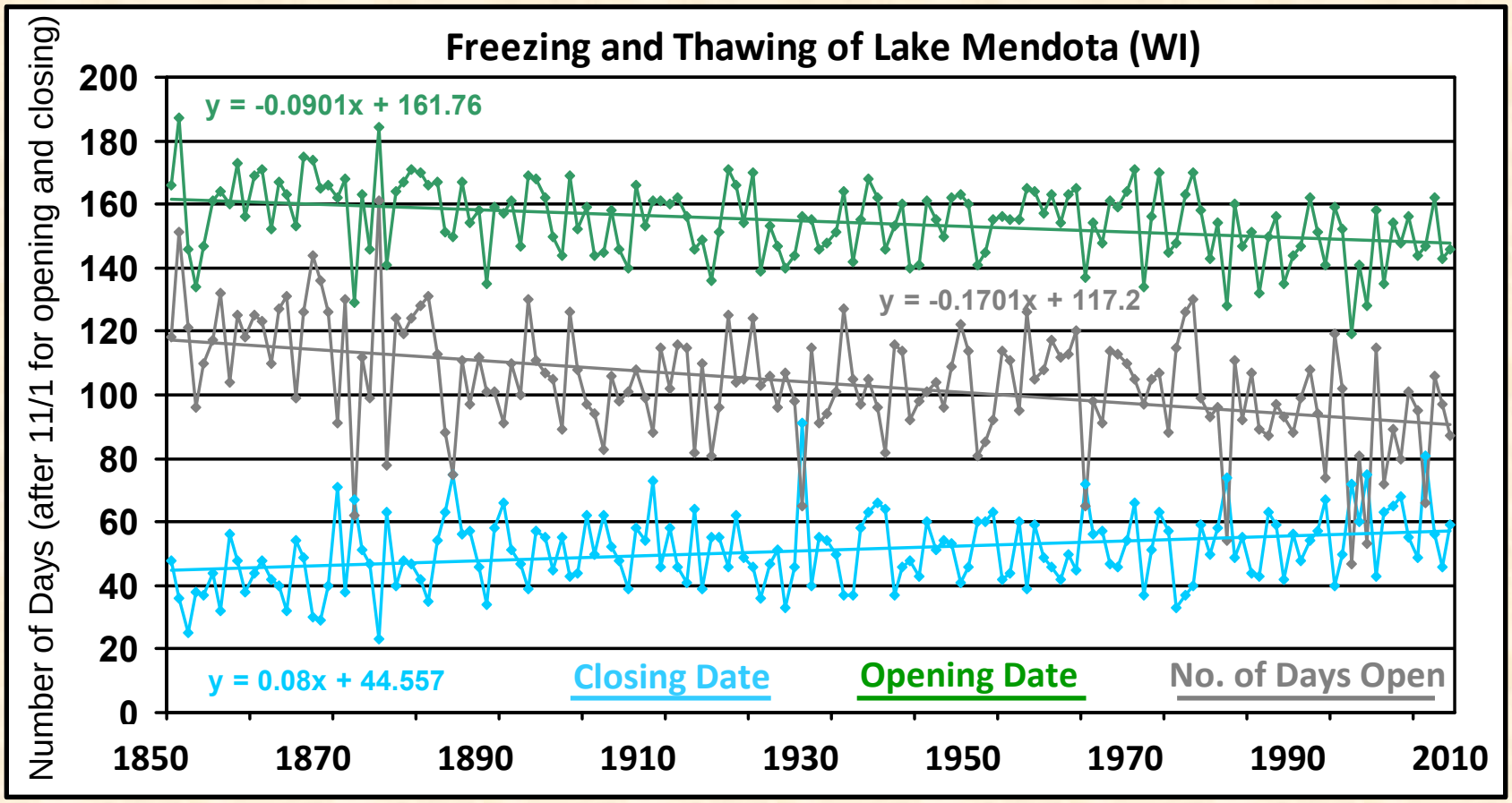
Importance of redundant/corroborating data





3. Is the temperature increasing?

Importance of redundant/corroborating data



OAK RIDGE National Laboratory

3. Is the temperature increasing?

Importance of Archiving

'Climategate': Scientists, Politicians War Over Hacked E-Mails

Do They Prove a Global Warming 'Conspiracy' or Honest Debate? The Heat Builds

Dec. 4, 2009

abc NEWS

In e-mails, science of warming is hot debate

By David A. Fahrenthold and Juliet Eilperin
Washington Post Staff Writer

Sunday, December 5, 2009

OAK RIDGE National Laboratory

3. Is the temperature increasing?

Importance of Archiving

>Dale,
>
> Ages ago there were two US DoE Technical Reports numbered 22 and
>27. One was for the NH and one was for the SH. They have years
>1985 and 1986. I'm sure you recall them.
>
> Did we send you the station data? I'm sure we did on mag tapes
>probably! Do you still have it? I can't see the two TRs or the
>datasets online, so apologies if they are. If they are not online can
>you see if you still have them somewhere and email them back to us.
>
> We have copies here, but we want to check whether they are the same
>as the one we sent you ages ago.
>
>
> When replying can you include the cc in the message.
>
>
>
>Cheers
>Phil
>
>
>
>Prof. Phil Jones
>Climatic Research Unit Telephone +44 (0) 1603
>592090
>School of Environmental Sciences Fax +44 (0) 1603 507784
>University of East Anglia
>Norwich, NR4 7TJ,
>UK Email p.jones@uea.ac.uk<mailto:p.jones@uea.ac.uk>

OAK RIDGE National Laboratory

3. Is the temperature increasing?

Importance of Archiving

At 19:53 04/12/2009, Kaiser, Dale Patrick wrote:
Dear Phil,

I spoke with Tom Boden about these databases and Tom has presented the summary below with regard to your questions about the station data.

Best wishes from all of us at CDIAC,

Dale

In 1991, when CDIAC updated the original gridded temperature anomalies through 1990 (i.e, NDP020/R1) CRU provided the underlying monthly mean temperature records from individual stations. The original release of the database (i.e., NDP020 with gridded anomalies through 1984) following the publication of TR027 in 1986 did not contain the individual station records. According to the documentation for NDP020/R1, the records for NH stations are corrected but the records for the SH are not and lack 5 expected stations (e.g., Lincoln College, New Zealand). These files have been, and remain, freely available since June 1993 from the CDIAC FTP server (see URLs below). Please realize we were still spinning 9-track tapes, 8mm tapes, and the like to satisfy data requests from the time of publication of the updates (October 1991) until June 1993.

ftp://cdiac.ornl.gov/pub/ndp020/jonesnh.dat

• • •

OAK RIDGE National Laboratory

3. Is the temperature increasing?

Importance of Archiving

The original data are there, the CRU temperature record can be reconstructed from original data

724640 383 1045 1428 PUEBLO USA

(data are in 0.1°C)

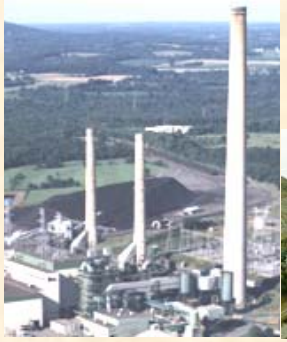
1889	-40	-4	68	121	154	204	244	243	170	118	6	57	112
1890	-4	14	63	103	153	207	247	222	176	103	50	27	113
• • •													
1973	-14	17	59	83	152	218	241	247	182	134	56	0	114
1974	-32	27	83	107	187	224	259	227	174	138	53	-18	119
1975	-2	8	47	96	154	211	249	241	178	126	35	25	114
1976	-6	46	36	107	153	208	248	225	177	91	22	6	109
1977	-24	34	56	123	185	234	253	234	197	121	48	22	124
1978	-38	-16	65	118	144	212	255	227	193	120	38	-44	106
1979	-88	13	62	110	142	205	247	221	197	129	21	11	106
1980	-21	29	48	91	146	227	268	244	194	113	49	51	120

OAK RIDGE National Laboratory

Analysis

CO_2 EMISSIONS AFFECT CO_2 EMISSIONS

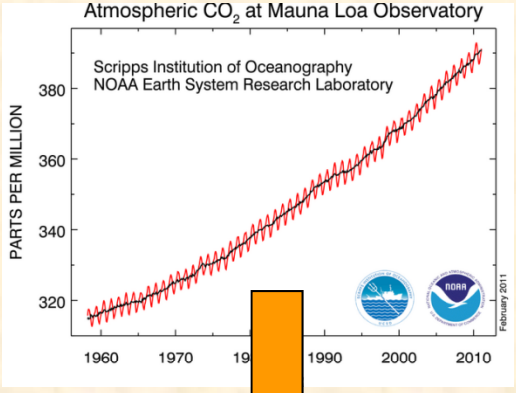
CO_2 Emissions



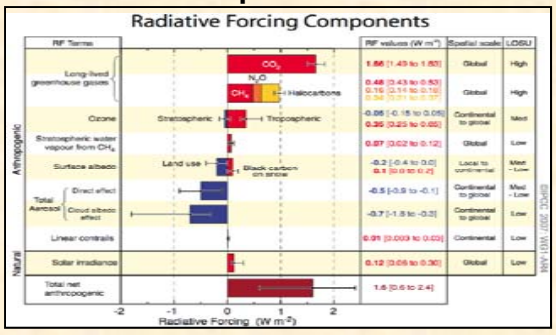
Energy Sources

Energy Needs

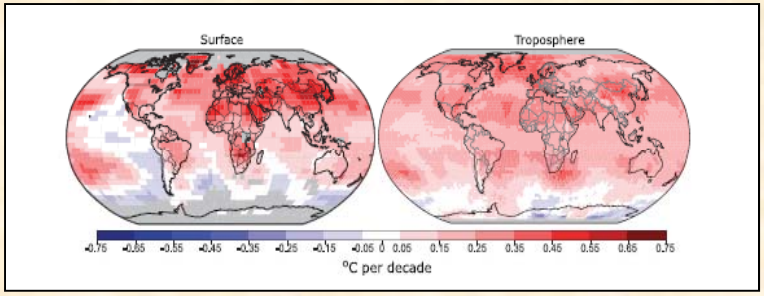
Atmospheric CO_2 Concentrations



Radiation Balance
Vertical Temperature Profile



General Atmospheric Circulation
Global Temperature Pattern
Global Precipitation Pattern



Analysis

Changes toward Earlier Streamflow Timing across Western North America

IRIS T. STEWART

Scripps Institution of Oceanography, La Jolla, California

DANIEL R. CAYAN

Scripps Institution of Oceanography, and U.S. Geological Survey, La Jolla, California

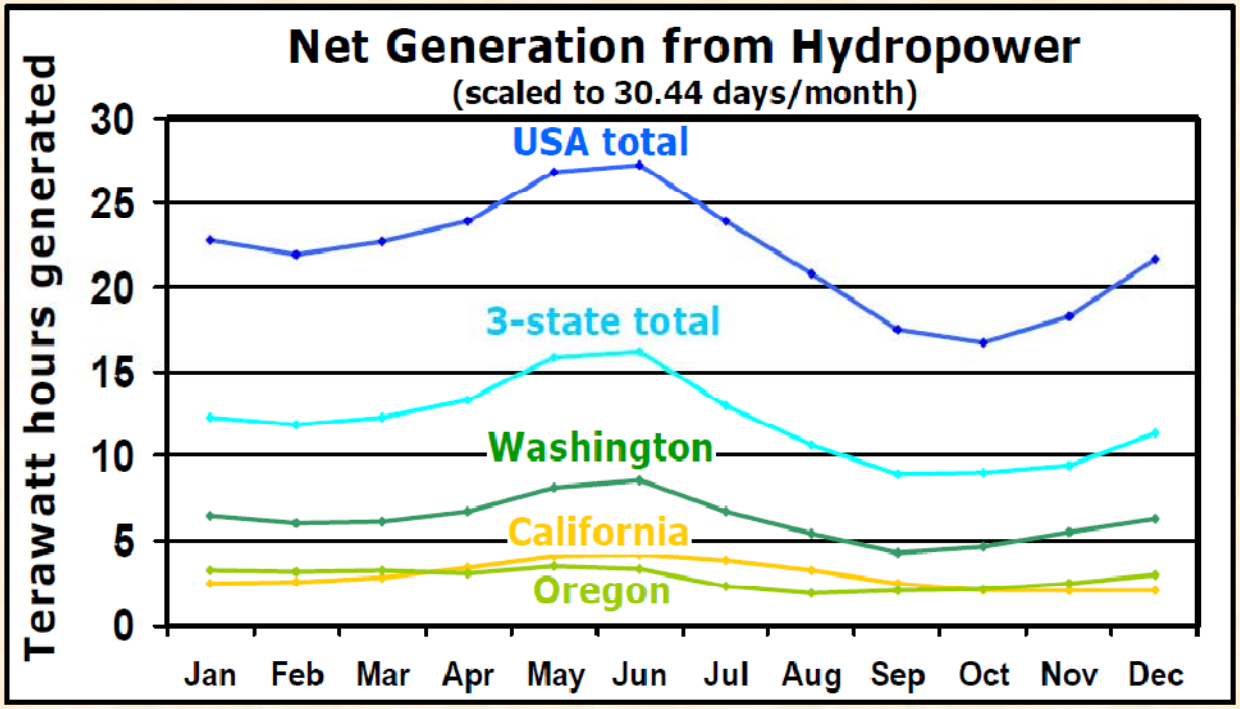
MICHAEL D. DETTINGER

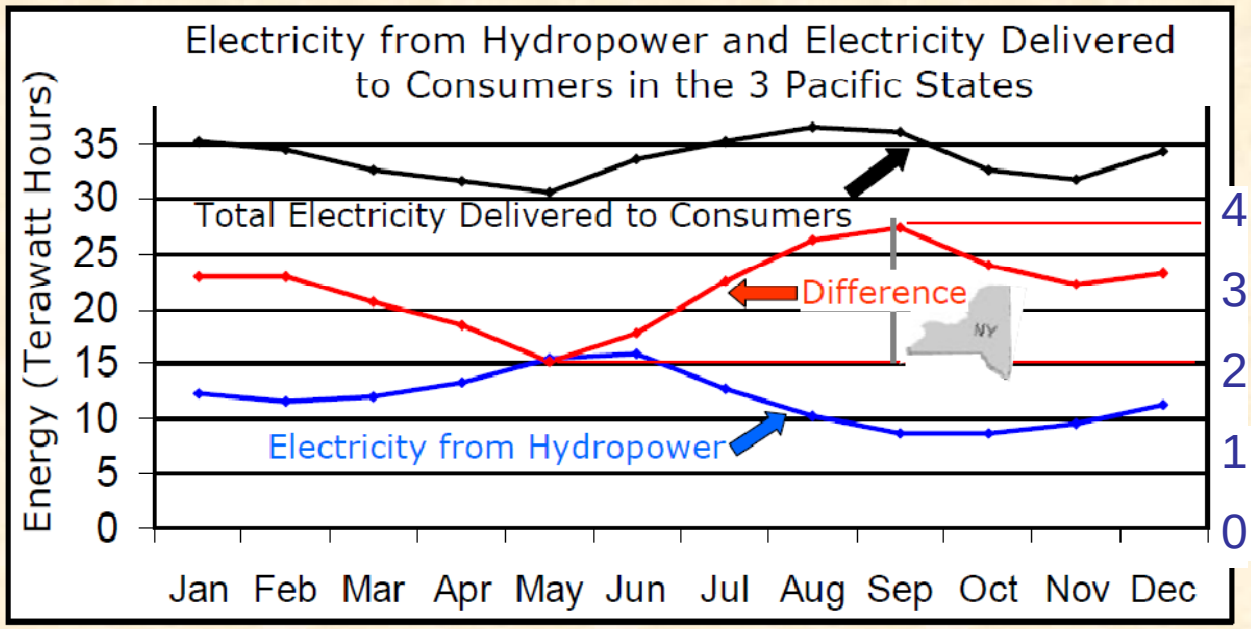
U.S. Geological Survey, and Scripps Institution of Oceanography, La Jolla, California

ABSTRACT

The highly variable timing of streamflow in snowmelt-dominated basins across western North America is an important consequence, and indicator, of climate fluctuations. Changes in the timing of snowmelt-derived streamflow from 1948 to 2002 were investigated in a network of 302 western North America gauges by examining the center of mass for flow, spring pulse onset dates, and seasonal fractional flows through trend and principal component analyses. Statistical analysis of the streamflow timing measures with Pacific climate indicators identified local and key large-scale processes that govern the regionally coherent parts of the changes and their relative importance.

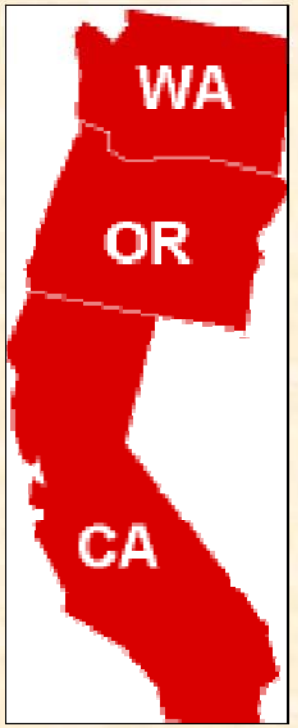
Widespread and regionally coherent trends toward earlier onsets of springtime snowmelt and streamflow have taken place across most of western North America, affecting an area that is much larger than previously recognized. These timing changes have resulted in increasing fractions of annual flow occurring earlier in the water year by 1–4 weeks. The immediate (or proximal) forcings for the spatially coherent parts of the year-to-year fluctuations and longer-term trends of streamflow timing have been higher winter and spring temperatures. Although these temperature changes are partly controlled by the decadal-scale Pacific climate mode [Pacific decadal oscillation (PDO)], a separate and significant part of the variance is associated with a springtime warming trend that spans the PDO phases.





Analysis

You heard it first on WGMD



OAK RIDGE National Laboratory