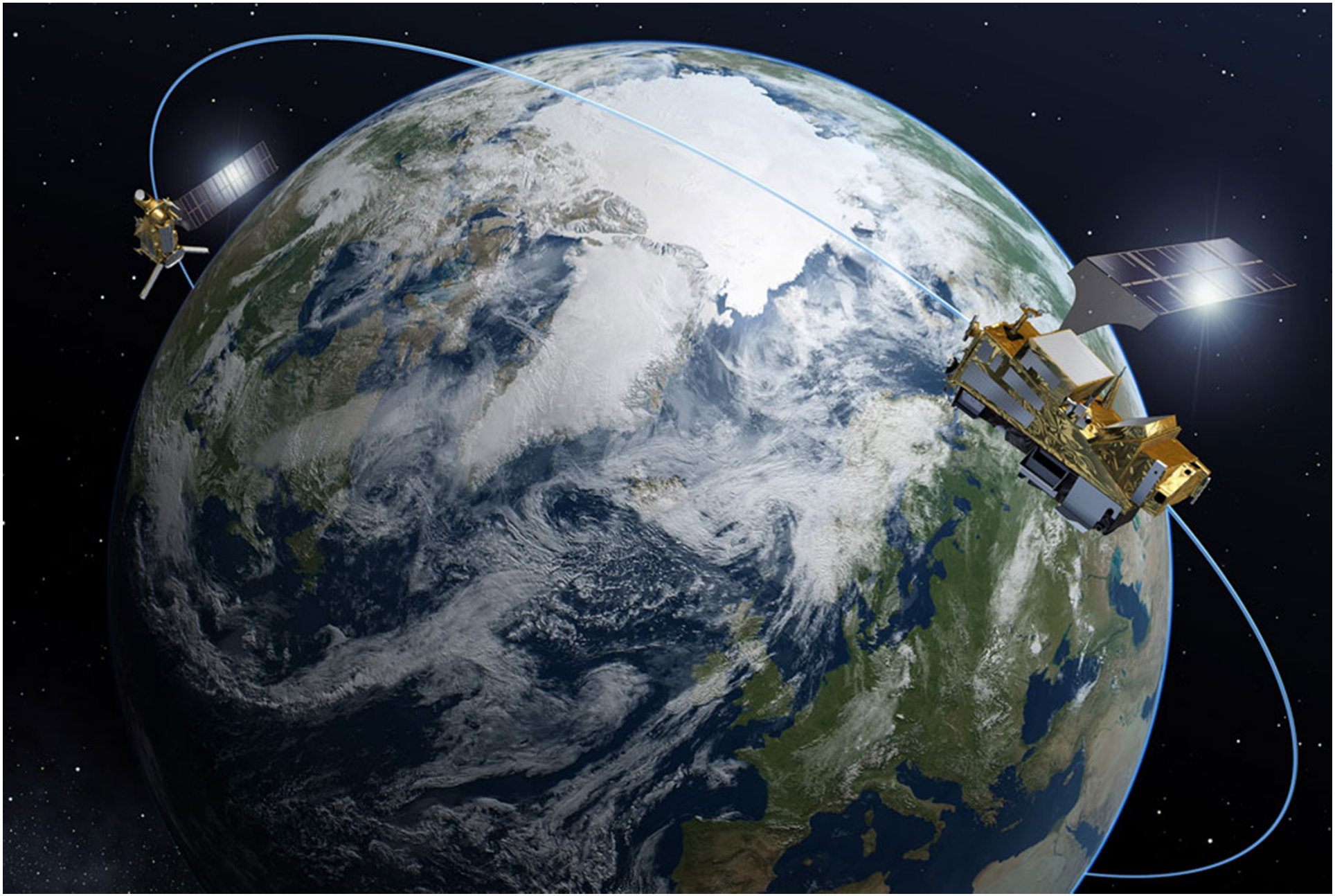
The Confusion over Global Warming: Is It Getting Hotter or Isn't It?

Jack Fishman
Department of Earth & Atmospheric Sciences
Center for Environmental Science
Saint Louis University
St. Louis MO

Presentation to the Air Quality Advisory Committee
East-West Gateway Council of Governments
St. Louis, MO
May 24, 2016

No Wonder the Public is Confused!

- https://www.youtube.com/watch?v=ZCSnKNoyWtw



Sources of Error in Satellite Temperature Measurements

- Orbital Decay
- Overlapping Data Records
- Stratospheric Contamination

Orbital Decay:

Satellites Lose Altitude Over Time which Alters "Equator Crossing Time" over their Operational Lifetime

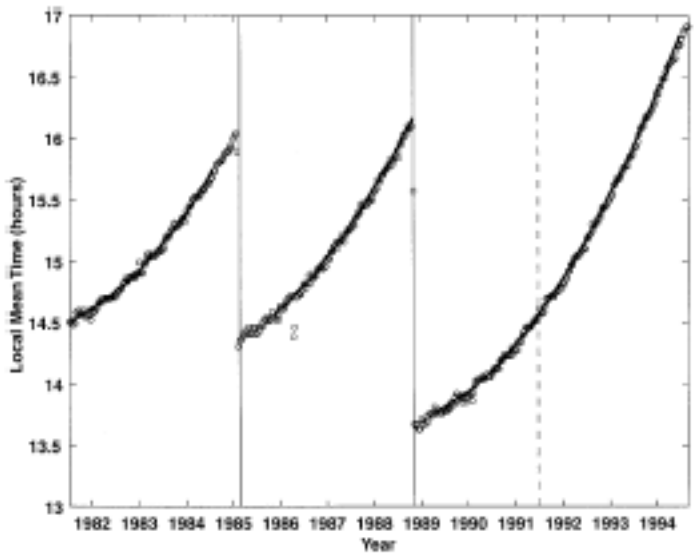
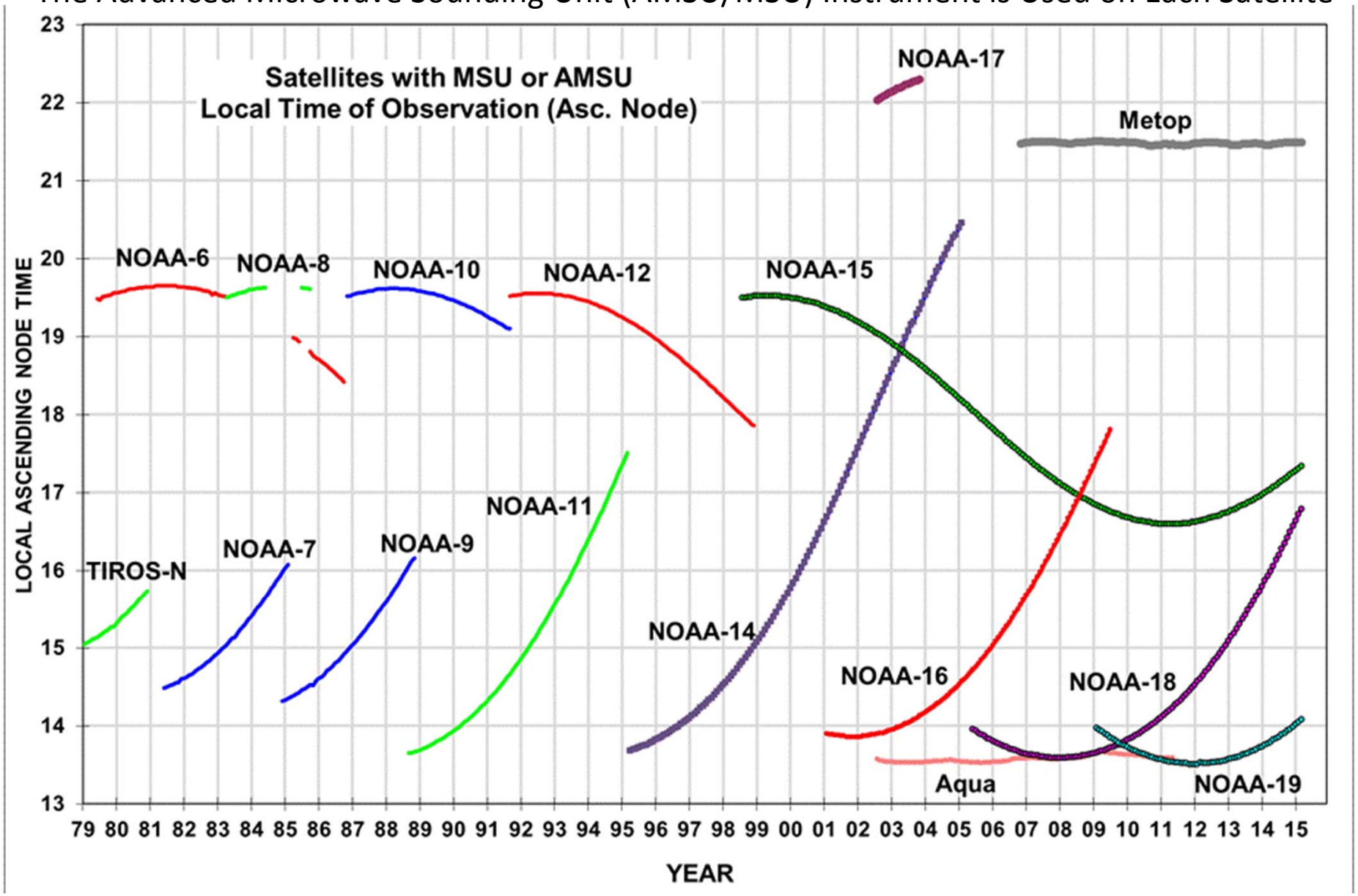


Fig. 1. Equatorial crossing time for NOAA-7, NOAA-9, and NOAA-11. Solid lines are based on antenna-pointing ephemeris computed by propagating NORAD two-line orbital elements for each satellite using SatTrak software, version 3.1 (Bester Tracking Systems, Emeryville, CA). Individual points are the mean t_m for each decade computed using Eqs. (12)–(15) for all pixels within ±1 degree of the equator and scan angles within 0.2 rad of nadir. Solid vertical lines mark transitions between satellites, and the dashed vertical line marks the eruption of Mt. Pinatubo.

Overlapping Measurements and Cross-Calibration

Temperature Measurements Have Been Made from Nearly 20 Different Satellites since 1979

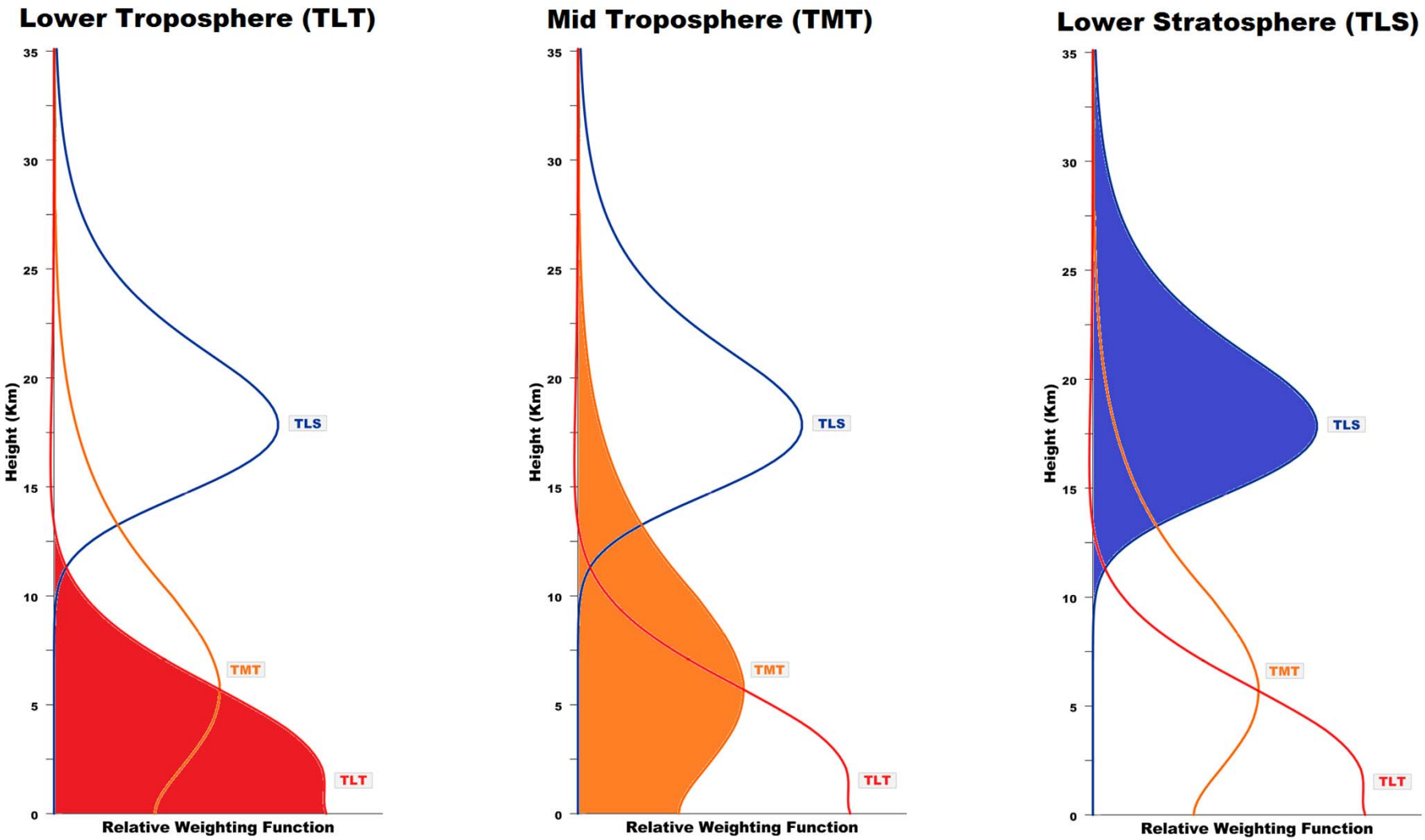
The Advanced Microwave Sounding Unit (AMSU/MSU) Instrument is Used on Each Satellite



Satellites Do Not Measure Surface Temperature!

They Measure Microwave Radiation Emitted from Different Regions of the Atmosphere

Relative Weighting Versus Altitude For Atmospheric Temperature Datasets



Satellites Measure Microwave Radiation Emitted from Different Regions of the Atmosphere:

AMSU has 15 Channels

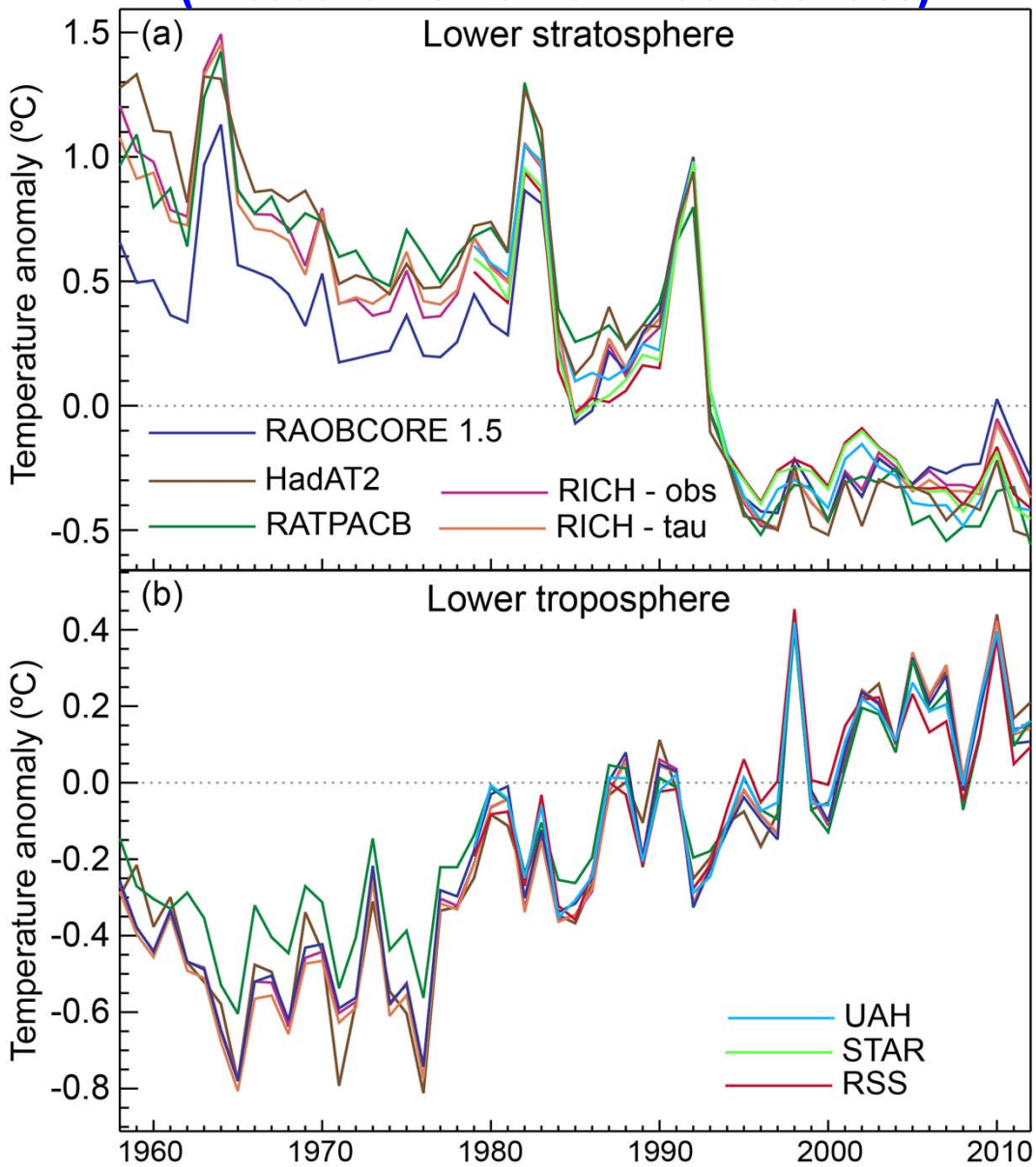
Table Channel Characteristics and Specifications of AMSU-A

Chan. #	Channel Frequency (MHz)	# bands	Nominal Bandwidth (MHz)	Nominal Beamwidth (degrees)	NEDT (K) (Spec.)	Polarization at nadir (See Note 1)	Function	Instrument Component
1	23,800	1	270	3.3	0.30	V	Water Vapor Burden	A2
2	31,400	1	180	3.3	0.30	V	Surface Temperature	A2
3	50,300	1	180	3.3	0.40	V	Surface Temperature	A1-2
4	52,800	1	400	3.3	0.25	V	Surface Temperature	A1-2
5	53596115	2	170	3.3	0.25	H	Tropospheric Temp	A1-2
6	54,400	1	400	3.3	0.25	H	Tropospheric Temp	A1-1
7	54,940	1	400	3.3	0.25	V	Tropospheric Temp	A1-1
8	55,500	1	330	3.3	0.25	H	Tropospheric Temp	A1-2
9	f_0=57,290.344	1	330	3.3	0.25	H	Stratospheric Temp	A1-1
10	$f_0$217	2	78	3.3	0.40	H	Stratospheric Temp	A1-1
11	$f_0$322.248	4	36	3.3	0.40	H	Stratospheric Temp	A1-1
12	$f_0$322.222	4	16	3.3	0.60	H	Stratospheric Temp	A1-1
13	$f_0$322.210	4	8	3.3	0.80	H	Stratospheric Temp	A1-1
14	$f_0$322.24.5	4	3	3.3	1.20	H	Stratospheric Temp	A1-1
15	89,000	1	<6,000	3.3	0.50	V	Cloud Top/Snow	A1-1

Although the Lower Troposphere is Warming,

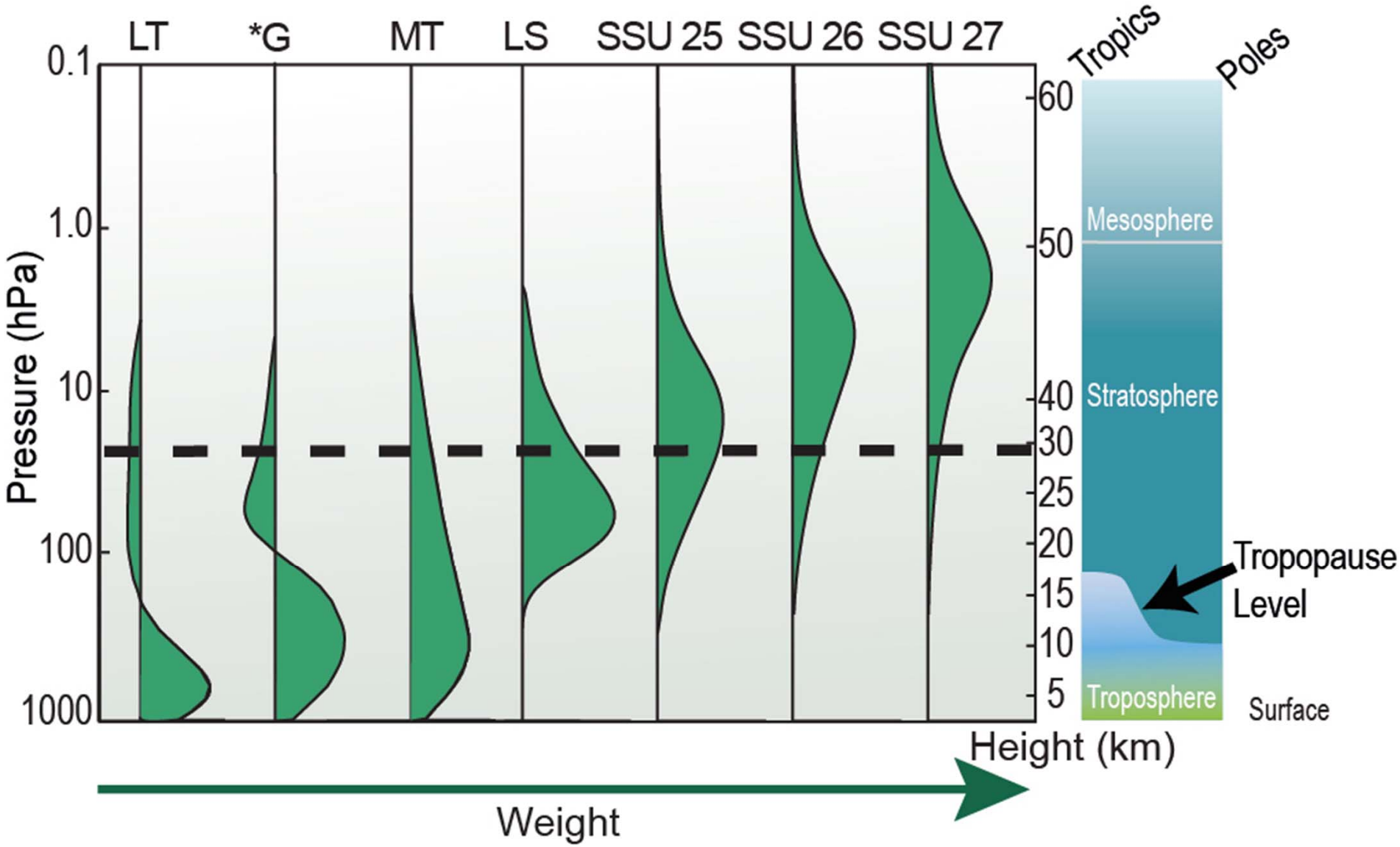
The Lower Stratosphere is Cooling!

(Measurements from Radiosondes)

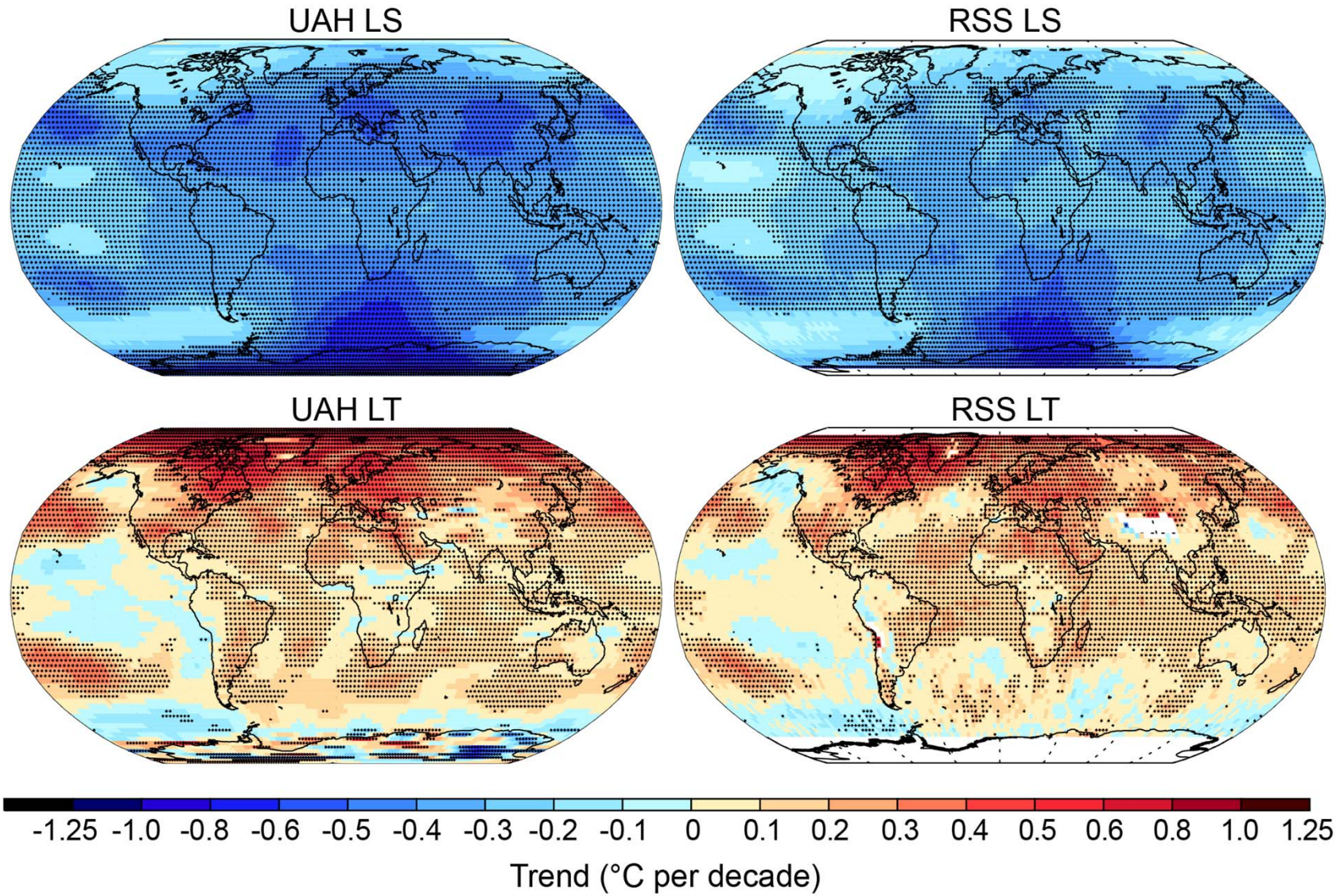


It is Critical that "Troposphere" and "Stratosphere" is Defined Consistently:

Height of Tropopause is Dependent on Latitude and Existing Synoptic Conditions at Time of Measurement



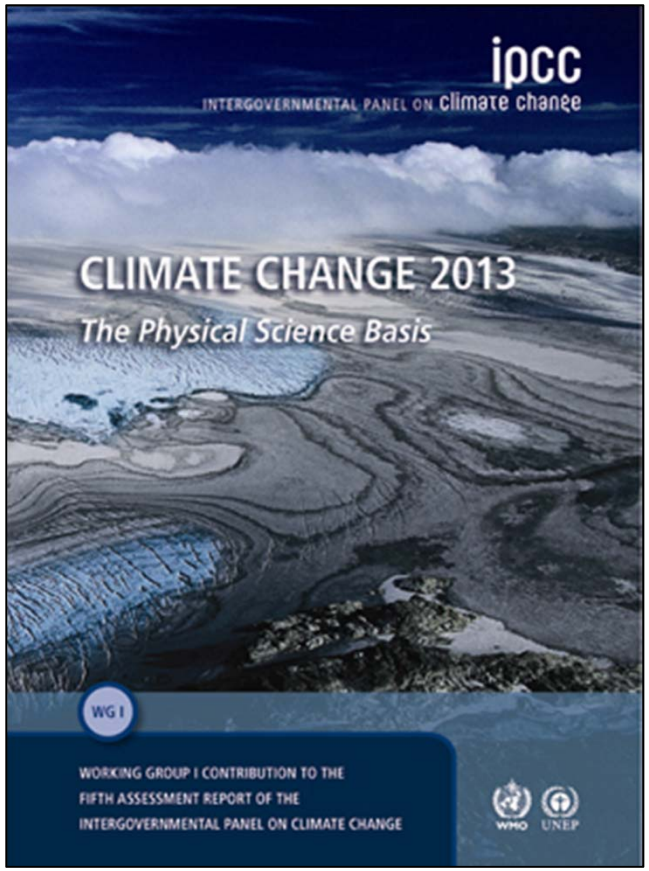
After Careful Analysis of UAH and Other Satellite Datasets, It was Found that they Are in Good Agreement



UAH: University of Alabama – Huntsville RSS: Remote Sensing System

Much of the Information about Global Climate Change Comes IPCC Reports

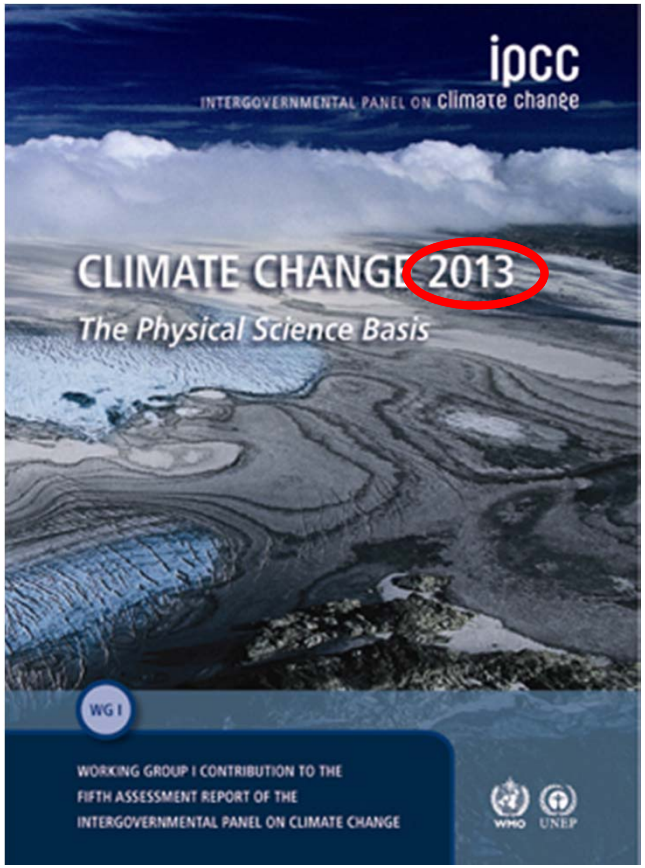
Intergovernmental Panel of Climate Change:
Contributions from 259 Authors



5th Assessment in 2013 (AR5)
(previous ones in 1990, 1995, 2001 and 2007)

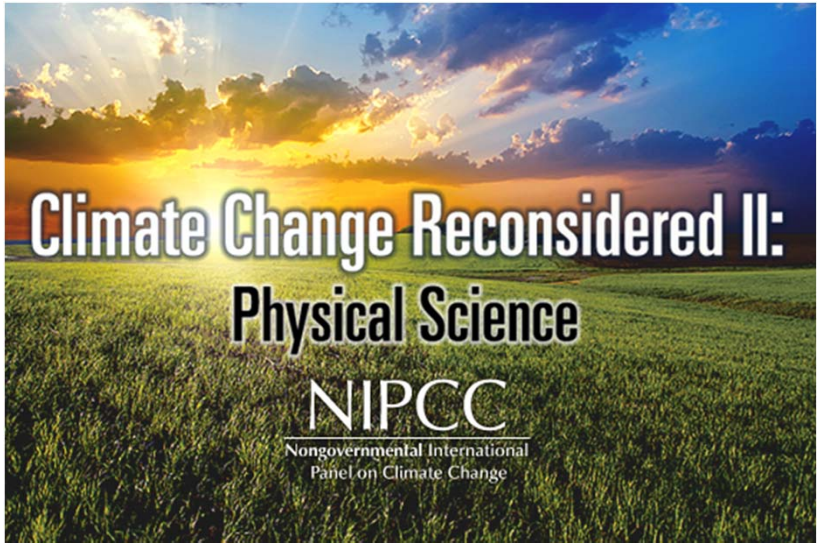
Information Summarizing the Two Sides of the Climate "Debate" Can Be Found in these Reports

Intergovernmental Panel of Climate Change (IPCC)



5th Assessment in 2013 (AR5)
(previous ones in 1990, 1995, 2001 and 2007)

Funded by the Heartland Institute



"The Holy Father is being **misled by 'experts'** at the United Nations who have proven unworthy of his trust. Though Pope Francis' heart is surely in the right place, he would do his flock and the world a disservice by putting his moral authority behind the United Nations' unscientific agenda on the climate."

John Bast, President of the Heartland Institute
New York Times, April 27, 2015

Who Wrote These Reports?

(from their respective websites)

The IPCC Report

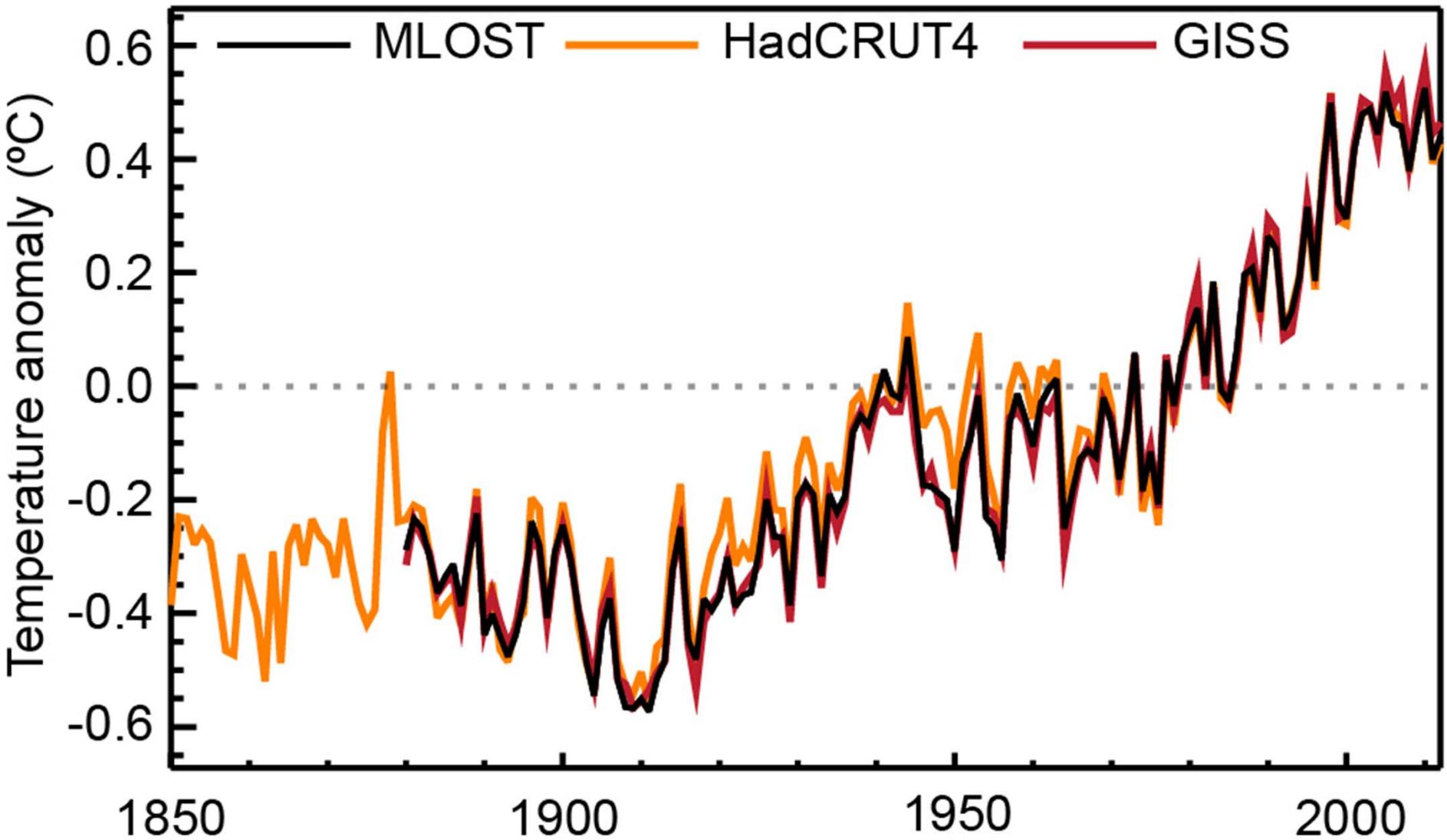
- Over **1000** nominations from **63** countries
- **209** Lead Authors and **50** Review Editors from **39** countries
- Over **600** Contributing Authors from **32** countries
  - Over **2 million** gigabytes of numerical data from climate model simulations
  - Over **9200** scientific publications cited
- **The First Order Draft Expert Review**
  21,400 comments from **659** Expert Reviewers from **47** countries
- **The Second Order Draft Expert and Government Review**
  54,677 comments from **1089** Expert Reviewers from **55** countries

The NIPCC Report

This report is produced by the Nongovernmental International Panel on Climate Change (NIPCC), a joint project of three organizations: Center for the Study of Carbon Dioxide and Global Change, Science & Environmental Policy Project, and The Heartland Institute. Three lead authors – Craig D. Idso, Robert M. Carter, and **S. Fred Singer*** – assembled and worked closely with nearly 50 chapter lead authors, contributors, and reviewers from 15 countries. This volume was subjected to the common standards of peer-review.

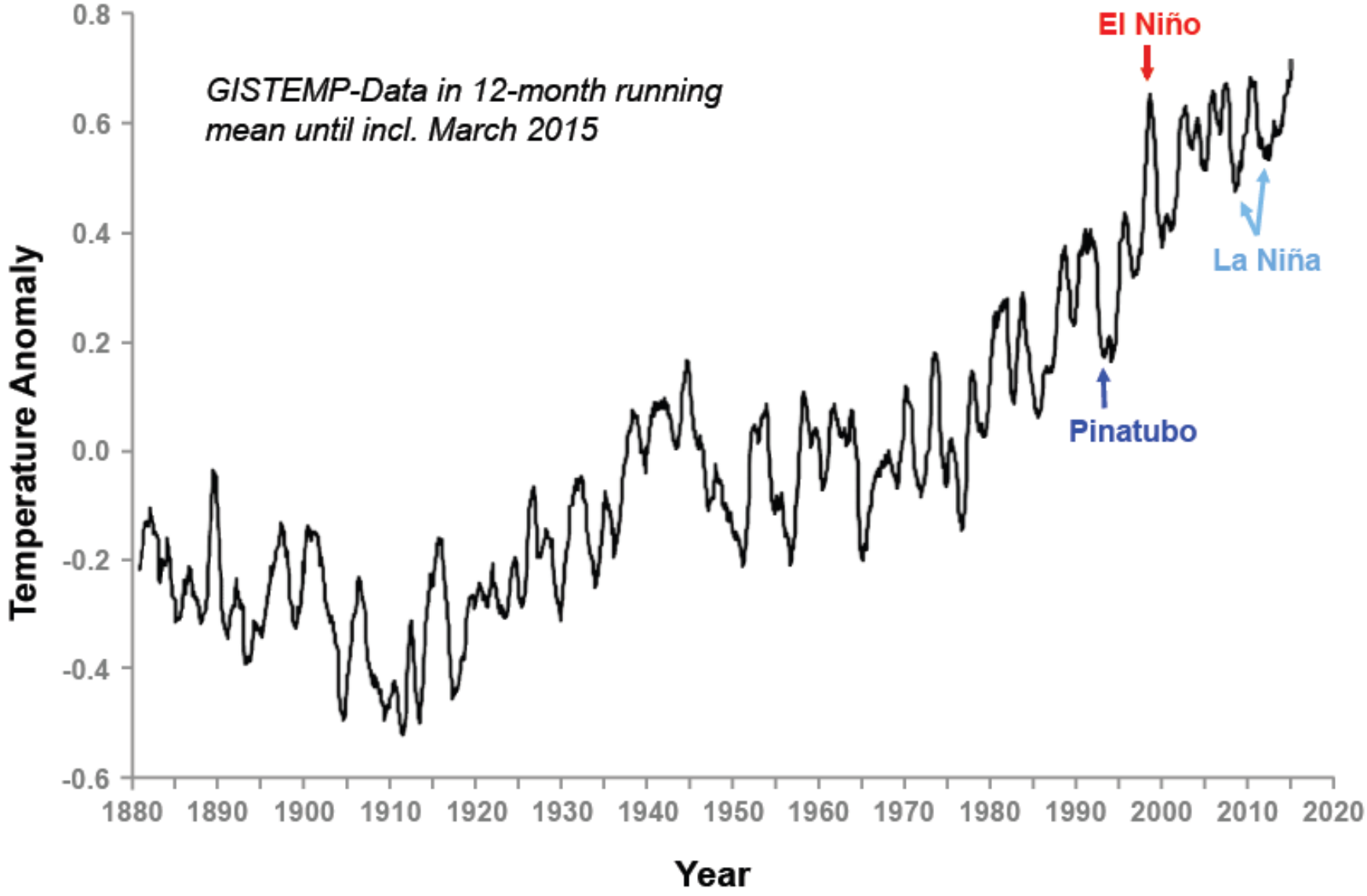
*In 1995, as President of the Science and Environmental Policy Project (a think tank based in Fairfax, Virginia) S. Fred Singer was involved in launching a publicity campaign about "The Top Five Environmental Myths of 1995," a list that included the U.S. Environmental Protection Agency's conclusion that secondhand tobacco smoke is a human carcinogen.

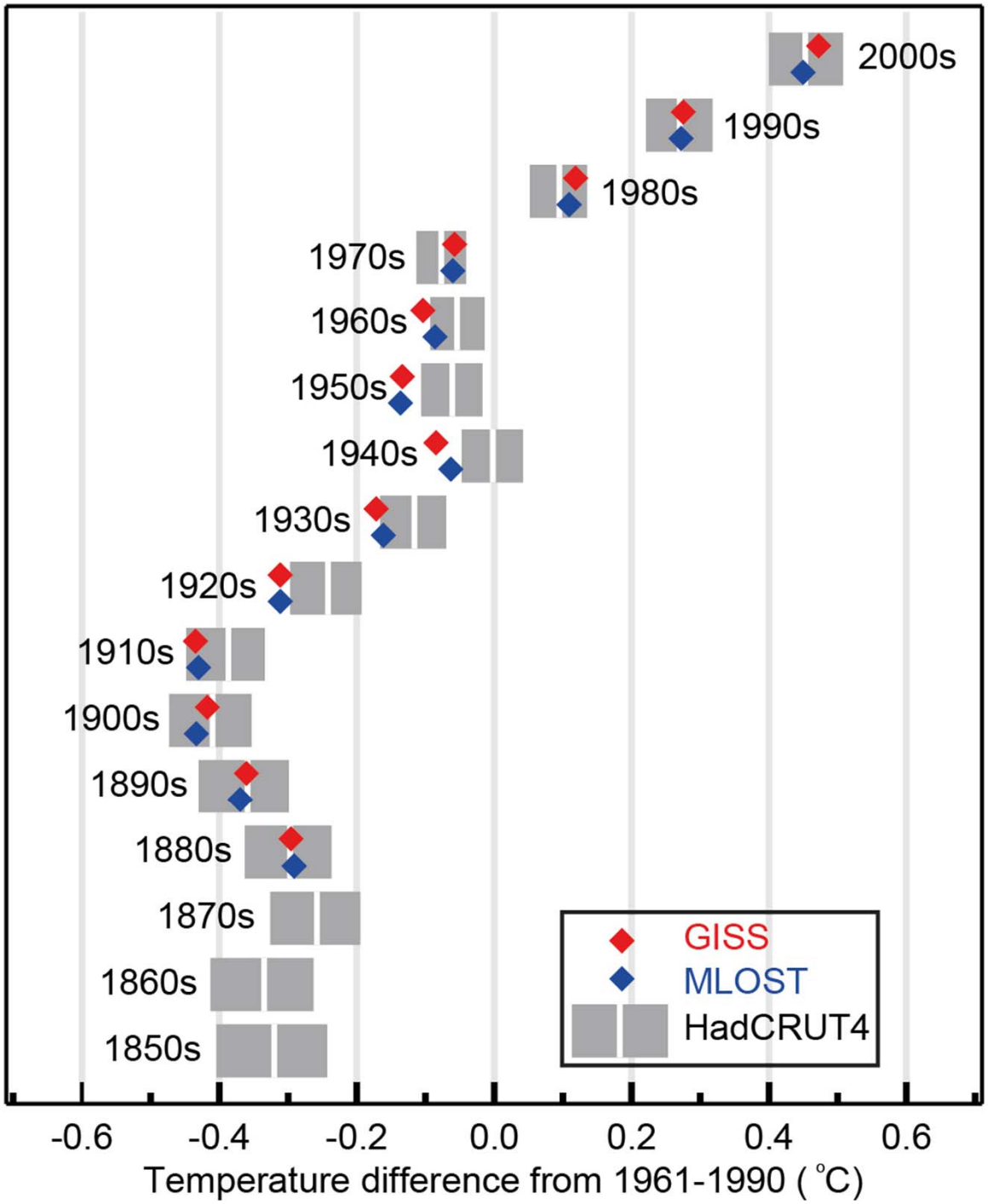
Surface Temperature Analyses of NOAA, NASA and UK Met Center is Excellent Agreement



MLOST: Merged Land-Ocean Surface Temperature (NOAA)
HadCRUT4: Hadley Center Climate Research Unit Dataset #4 (UK Met Office)
GISS: Goddard Institute of Space Studies (NASA)

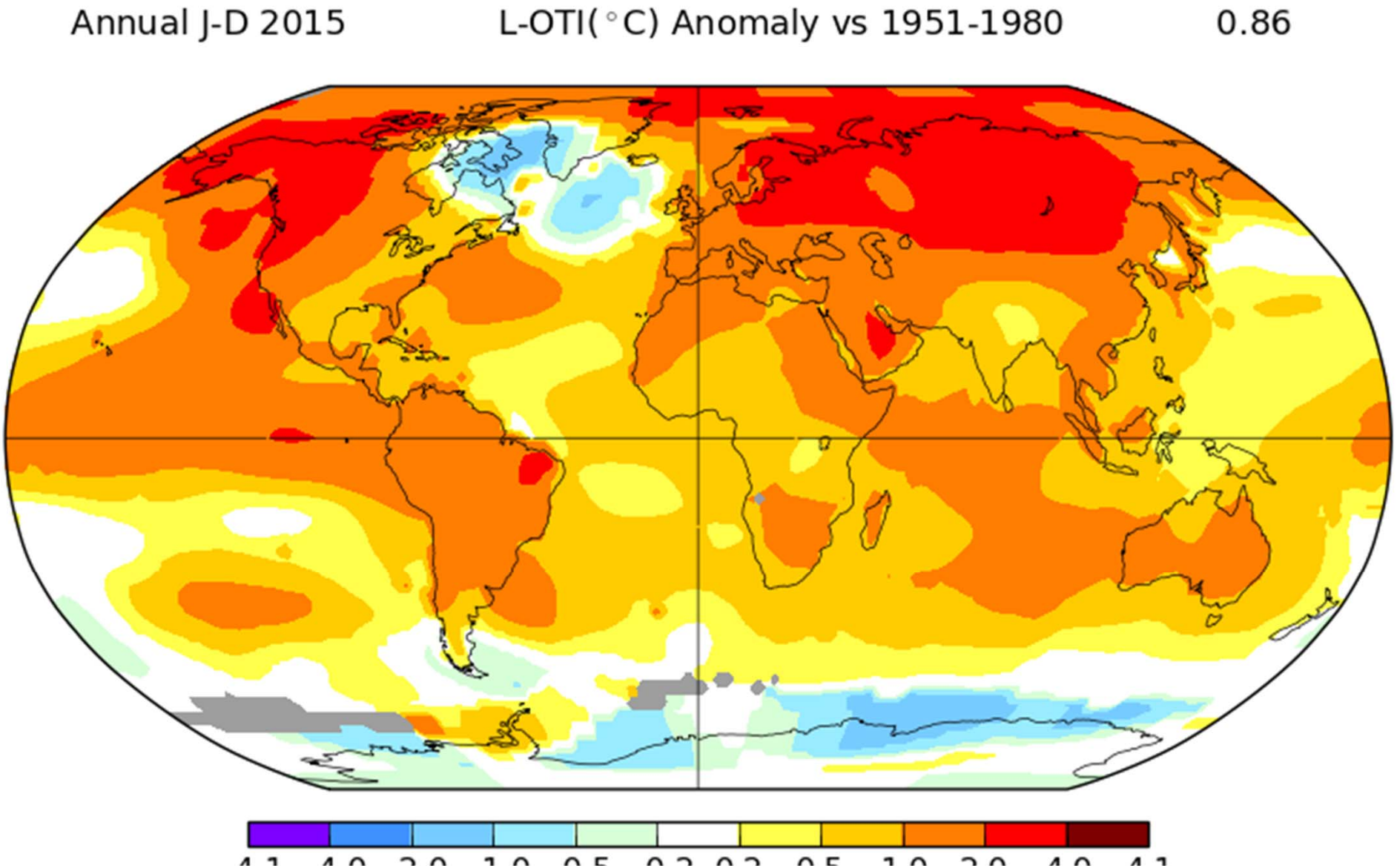
Global Temperature since 1880



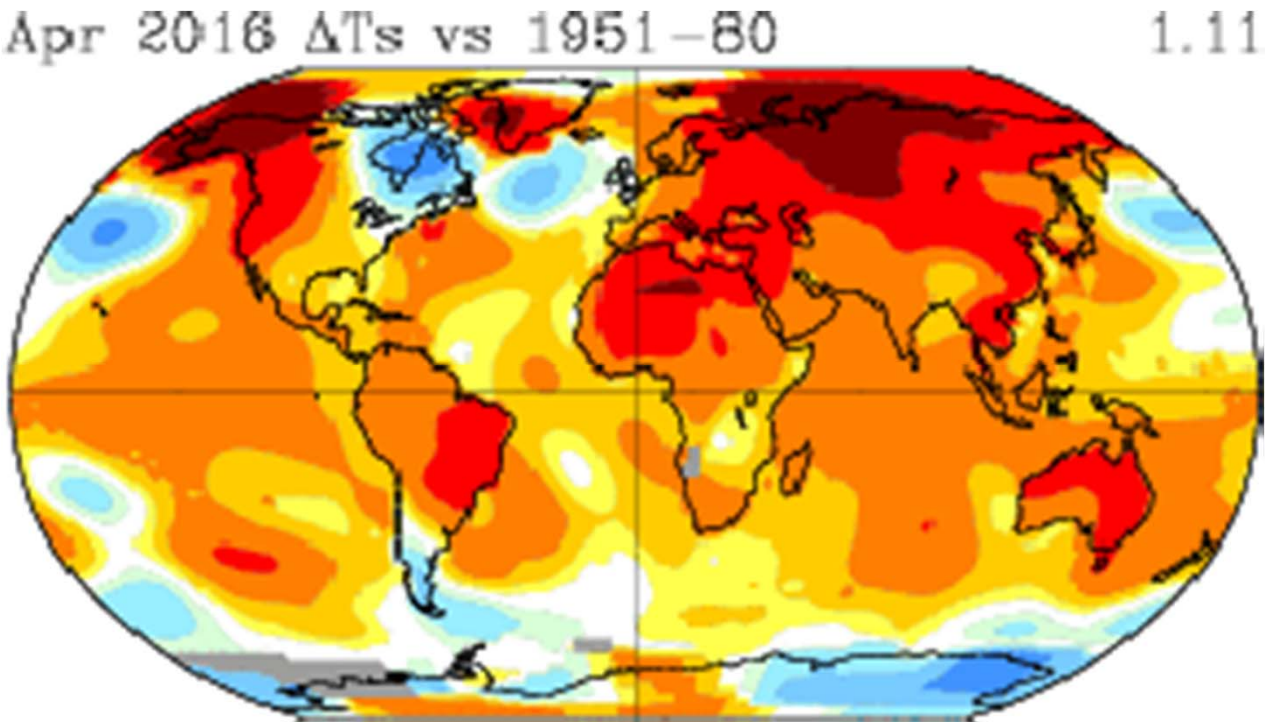

2000s
1990s
1980s
1970s
1960s
1950s
1940s
1930s
1920s
1910s
1900s
1890s
1880s
1870s
1860s
1850s
GISS
MLOST
HadCRUT4
-0.6
-0.4
-0.2
0.0
0.2
0.4
0.6
Temperature difference from 1961-1990 (°C)

Temperature Anomaly for 2015

(Source: NASA GISS)

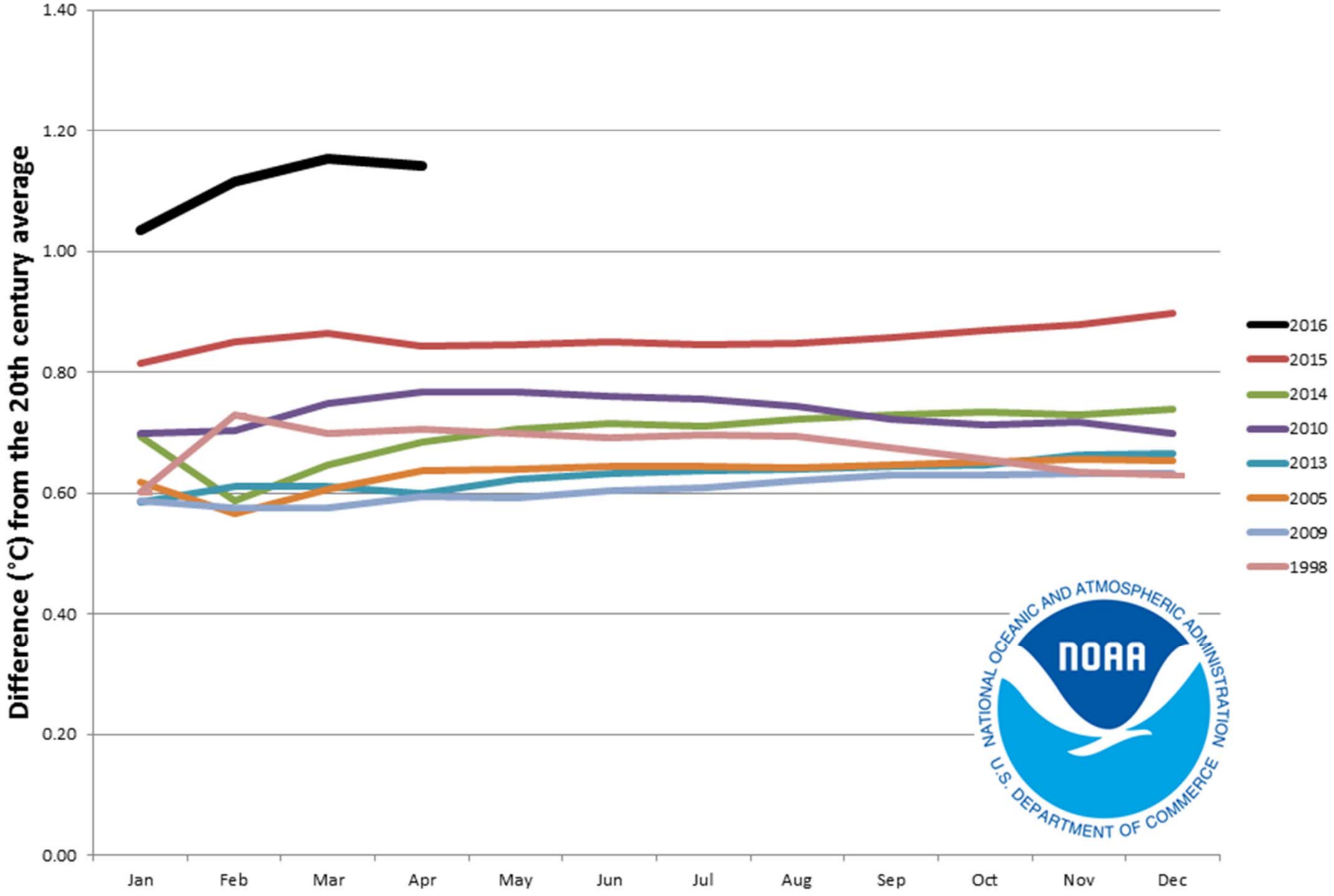


Temperature Anomaly for April 2016
(Source: NASA GISS)



Year-to-Date Global Temperature

for 2016 and the other seven warmest years on record

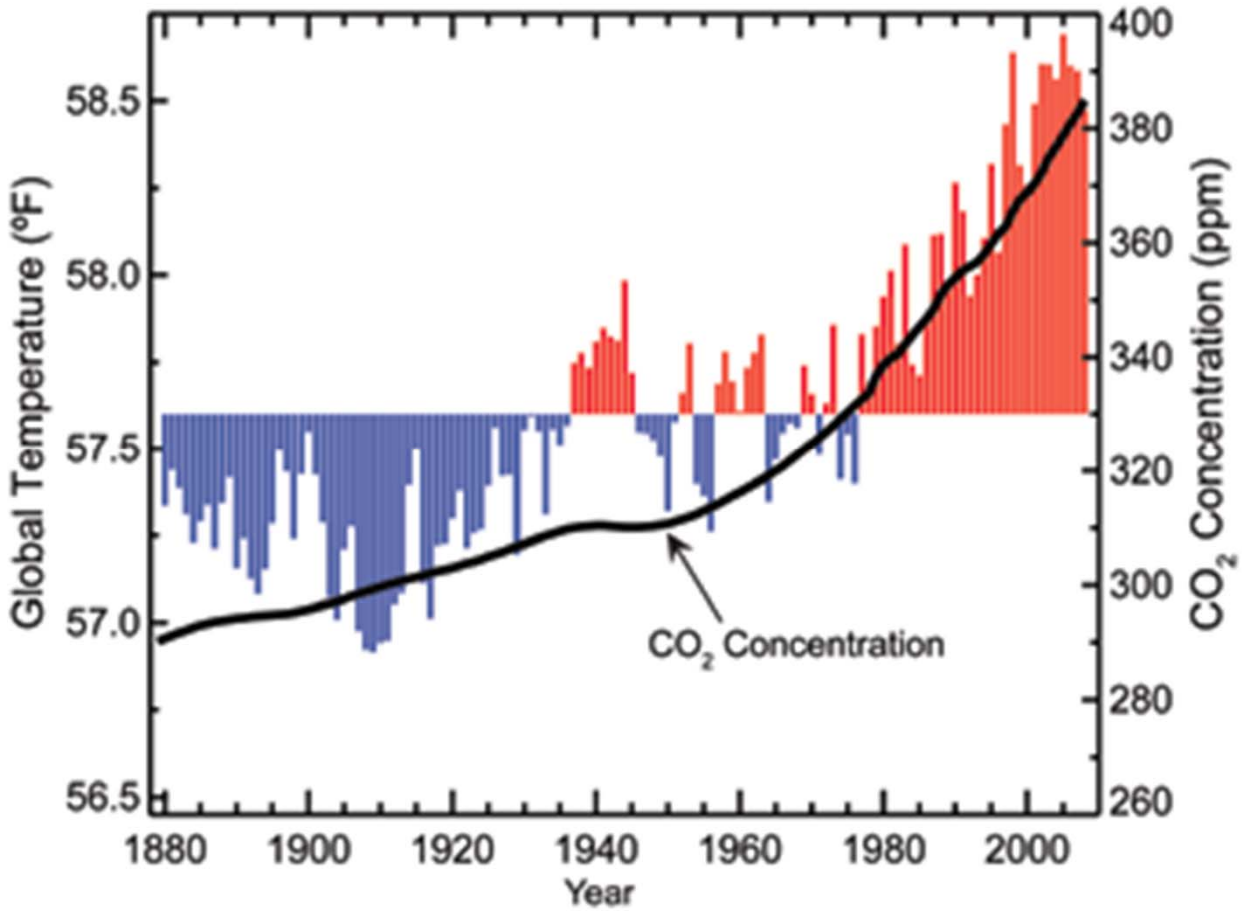


Climate Statistics for April 2016

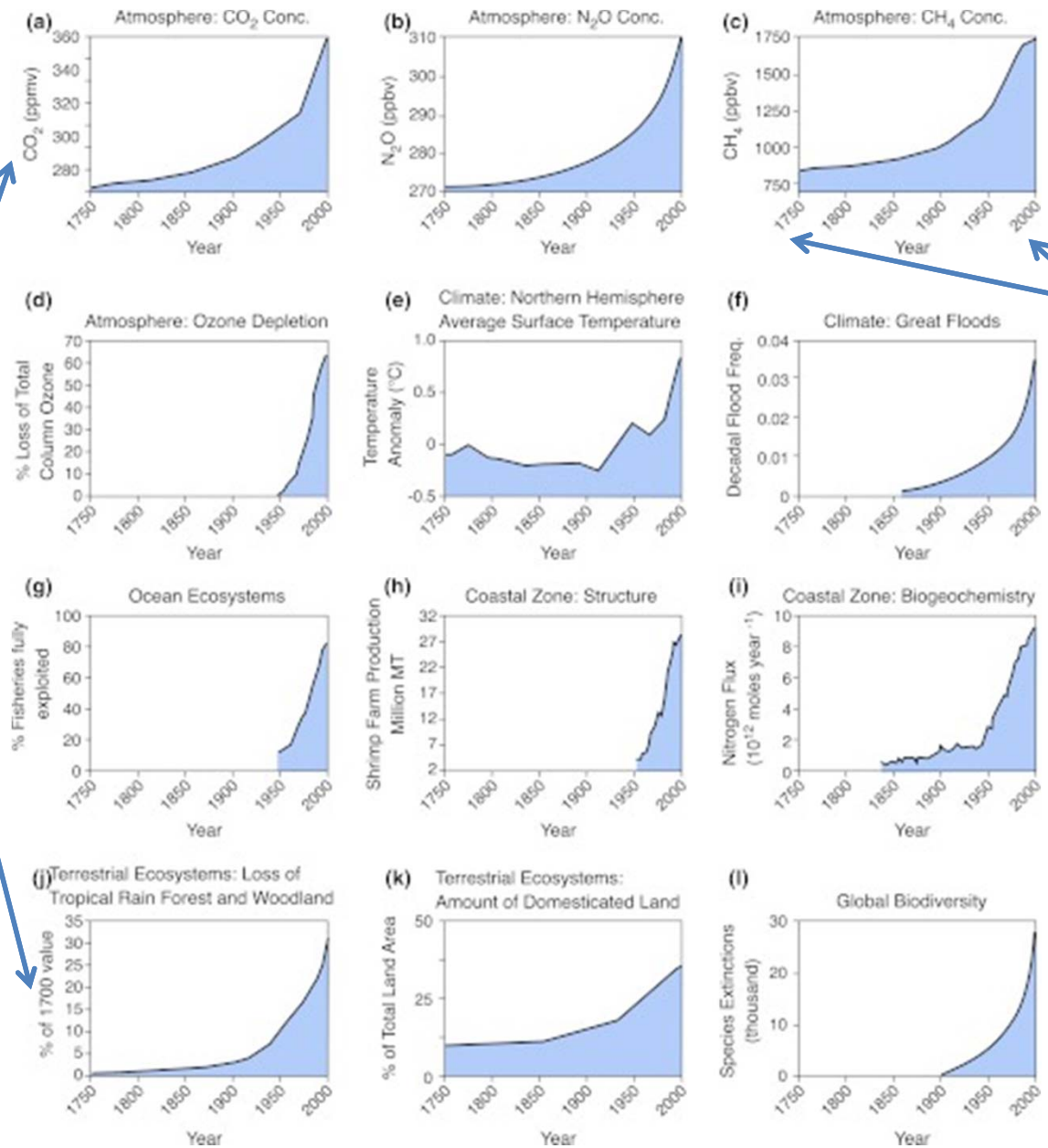
(Source: NOAA)

APRIL	ANOMALY		RANK (OUT OF 137 YEARS)		RECORDS		
	°C	°F			YEAR(S)	°C	°F
Global							
Land	+1.93 ± 0.11	+3.47 ± 0.20	Warmest	1st	2016	+1.93	+3.47
			Coolest	137th	1905	-0.86	-1.55
Ocean	+0.80 ± 0.14	+1.44 ± 0.25	Warmest	1st	2016	+0.80	+1.44
			Coolest	137th	1911	-0.55	-0.99
Land and Ocean	+1.10 ± 0.13	+1.98 ± 0.23	Warmest	1st	2016	+1.10	+1.98
			Coolest	137th	1909	-0.53	-0.95
Northern Hemisphere							
Land	+2.08 ± 0.14	+3.74 ± 0.25	Warmest	1st	2016	+2.08	+3.74
			Coolest	137th	1905	-1.10	-1.98
Ocean	+0.81 ± 0.13	+1.46 ± 0.23	Warmest	1st	2016	+0.81	+1.46
			Coolest	137th	1911	-0.54	-0.97
Land and Ocean	+1.29 ± 0.13	+2.32 ± 0.23	Warmest	1st	2016	+1.29	+2.32
			Coolest	137th	1905	-0.62	-1.12
Southern Hemisphere							
Land	+1.53 ± 0.13	+2.75 ± 0.23	Warmest	1st	2016	+1.53	+2.75
			Coolest	137th	1891, 1908	-0.78	-1.40
Ocean	+0.80 ± 0.15	+1.44 ± 0.27	Warmest	1st	2016	+0.80	+1.44
			Coolest	137th	1911	-0.54	-0.97
Land and Ocean	+0.91 ± 0.14	+1.64 ± 0.25	Warmest	1st	2016	+0.91	+1.64
			Coolest	137th	1911	-0.54	-0.97

A First-Order Analysis Certainly Seems to Support that there is a Relationship between Increasing GHG concentrations Increasing Temperatures



Global-scale changes in the Earth System as a result of the dramatic increase in human activity (~1750 - present)



Variable Y-Axis
(These will change during the video)

Trace Gases

Same X-Axis
1750-2000

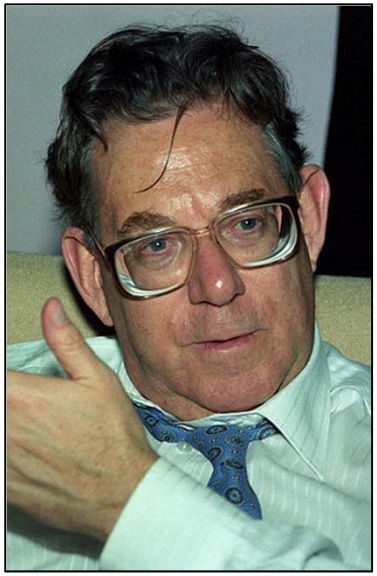
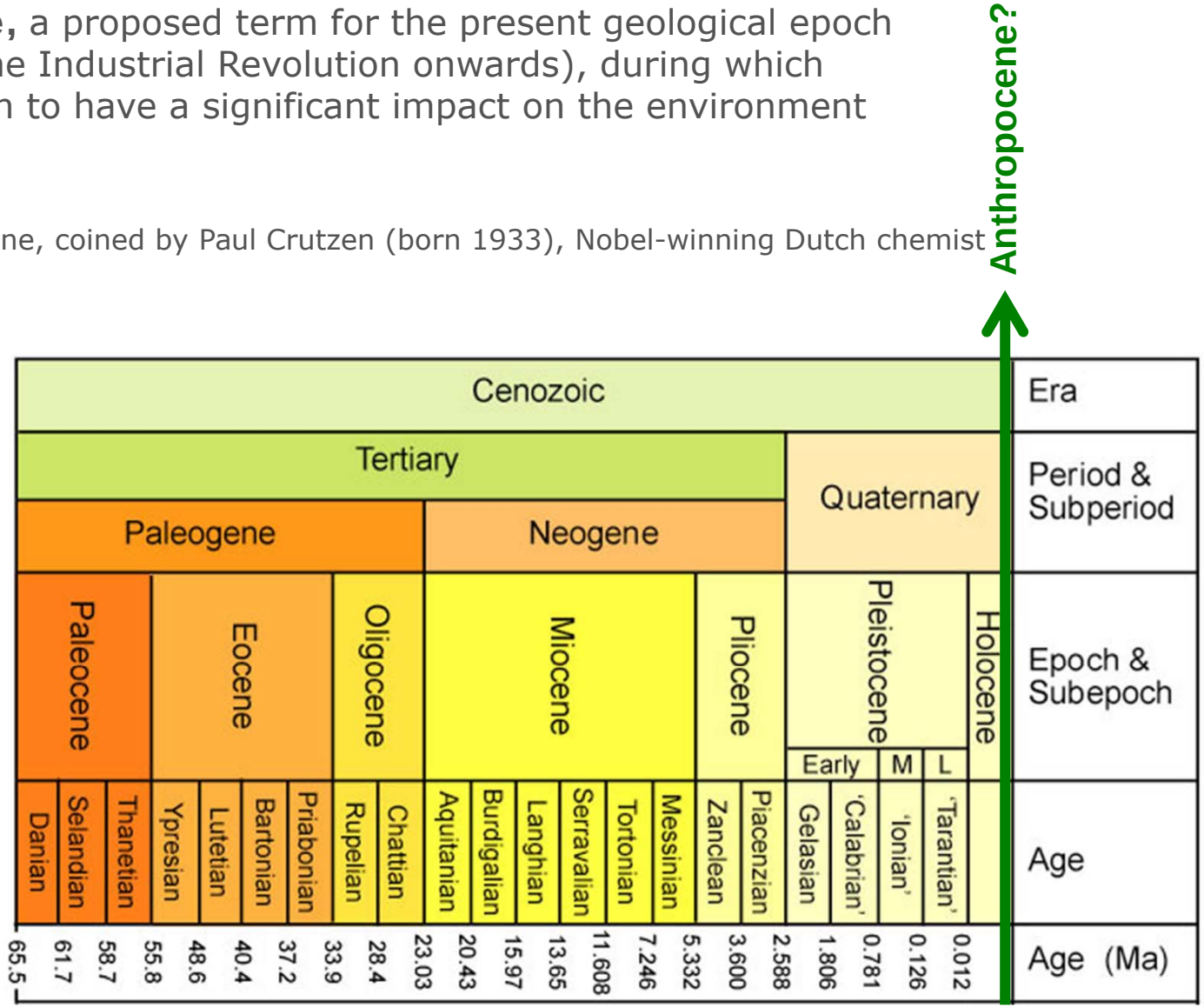
Other Geophysical Parameters

Anthropocene

/ænˈθrɒpəˌsiːn/

Noun

1. **the Anthropocene,** a proposed term for the present geological epoch (from the time of the Industrial Revolution onwards), during which humanity has begun to have a significant impact on the environment

Word Origin

C21: from anthropo- and -cene, coined by Paul Crutzen (born 1933), Nobel-winning Dutch chemist