Global/Regional/Local-Scale Climate Change – A Reality Check

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Three Climate Change Hypotheses – Only One Of Which Can Be True

The climate issue, with respect to how humans are influencing the climate system, can be segmented into three distinct hypotheses:

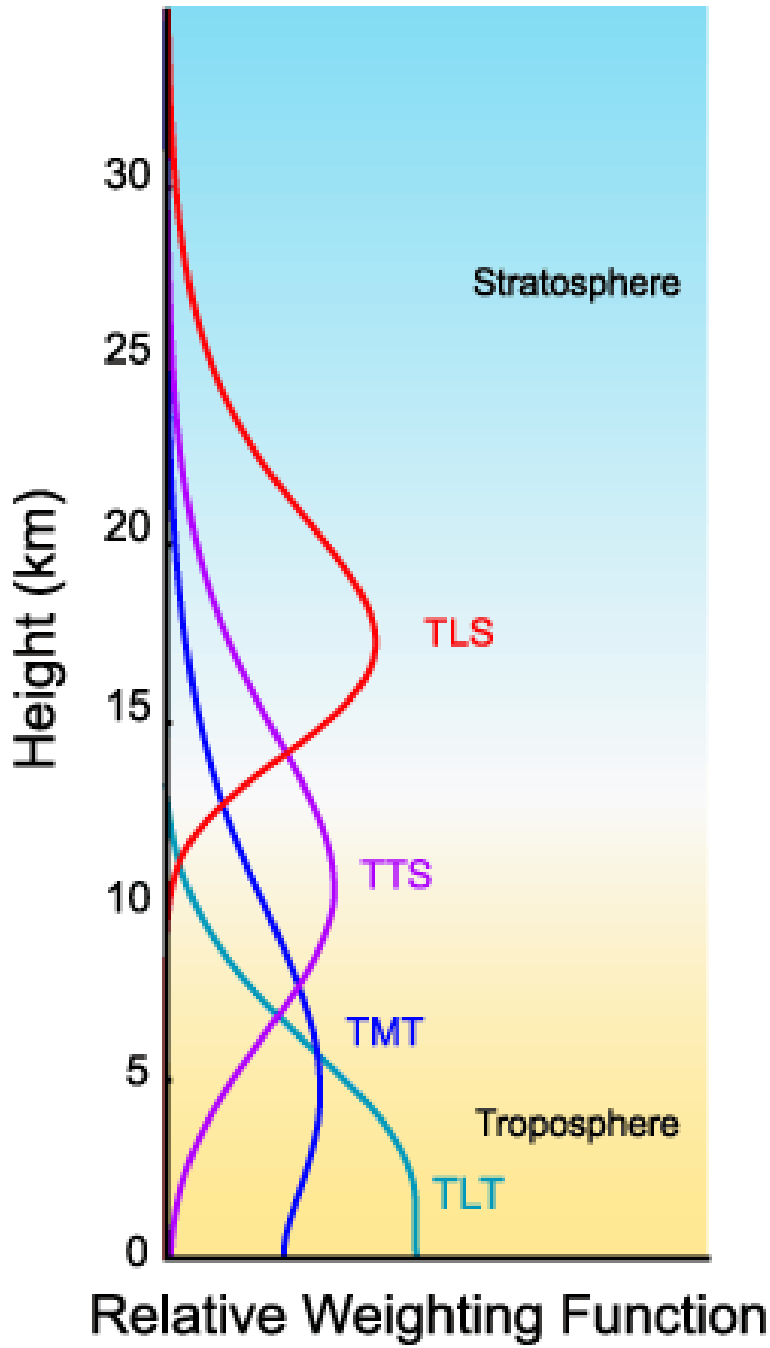
1. **The human influence is minimal and natural variations dominate climate variations on all time scales;**
2. **While natural variations are important, the human influence is significant and involves a diverse range of first-order climate forcings (including, but not limited to the human input of CO_2);**
3. **The human influence is dominated by the emissions into the atmosphere of greenhouse gases, particularly carbon dioxide.**

What Does the Data Tell Us?

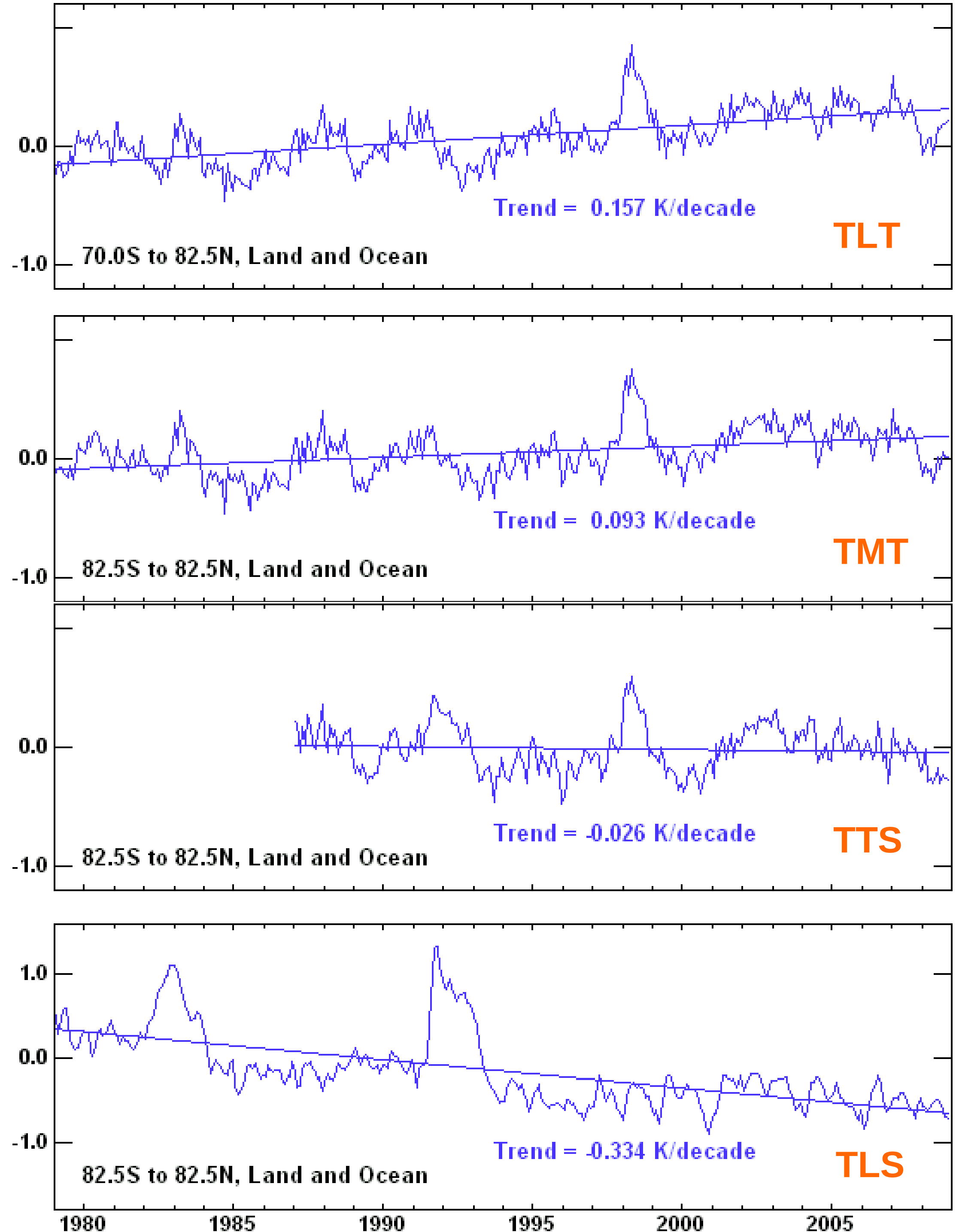
Vertical relative weighting functions for each of the channels discussed on this website. The vertical weighting function describes the relative contribution that microwave radiation emitted by a layer in the atmosphere makes to the total intensity measured above the atmosphere by the satellite.

The weighting functions are available at ftp.ssmi.com/msu/weighting_functions

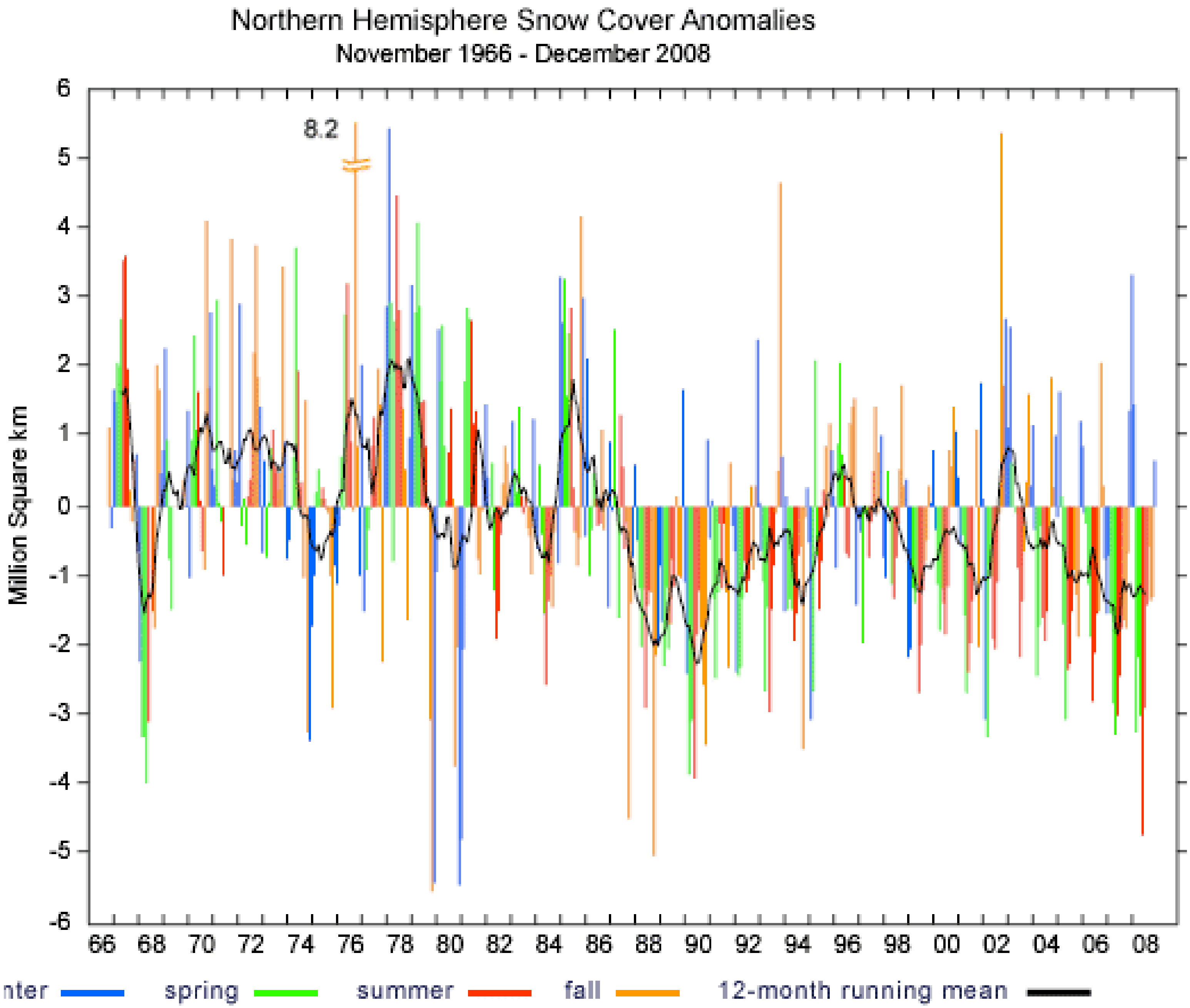
From: http://www.remss.com/msu/msu_data_description.html



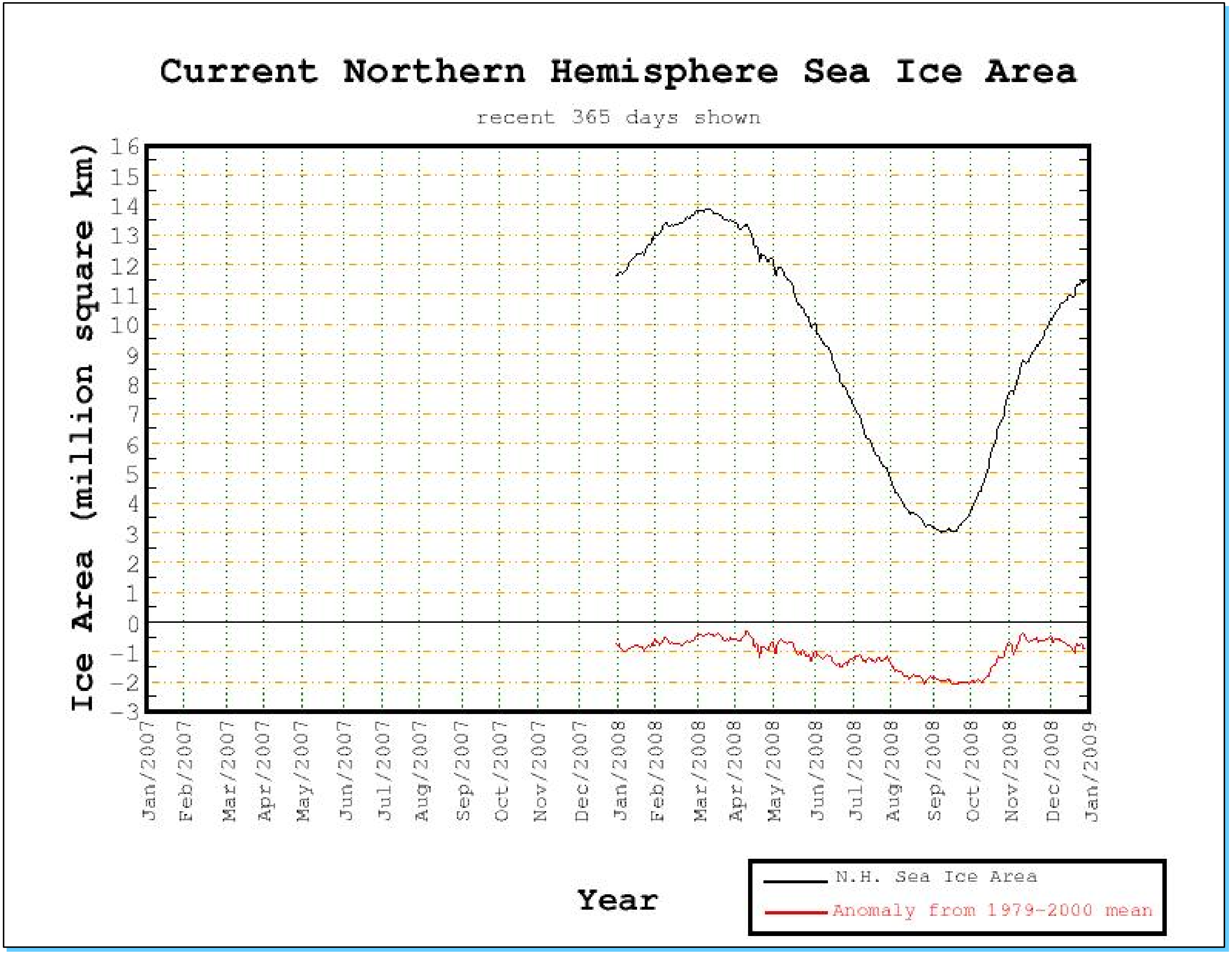
Global, monthly time series of brightness temperature anomaly for channels TLT, TMT, TTS, and TLS (from top to bottom). For Channel TLT (Lower Troposphere) and Channel TMT (Middle Troposphere), the anomaly time series is dominated by ENSO events and slow tropospheric warming. The three primary El Niños during the past 20 years are clearly evident as peaks in the time series occurring during 1982–83, 1987–88, and 1997–98, with the most recent one being the largest. Channel TLS (Lower Stratosphere) is dominated by stratospheric cooling, punctuated by dramatic warming events caused by the eruptions of El Chichon (1982) and Mt Pinatubo (1991). Channel TTS (Troposphere/Stratosphere) appears to be a mixture of both effects. From: http://www.remss.com/msu/msu_data_description.html



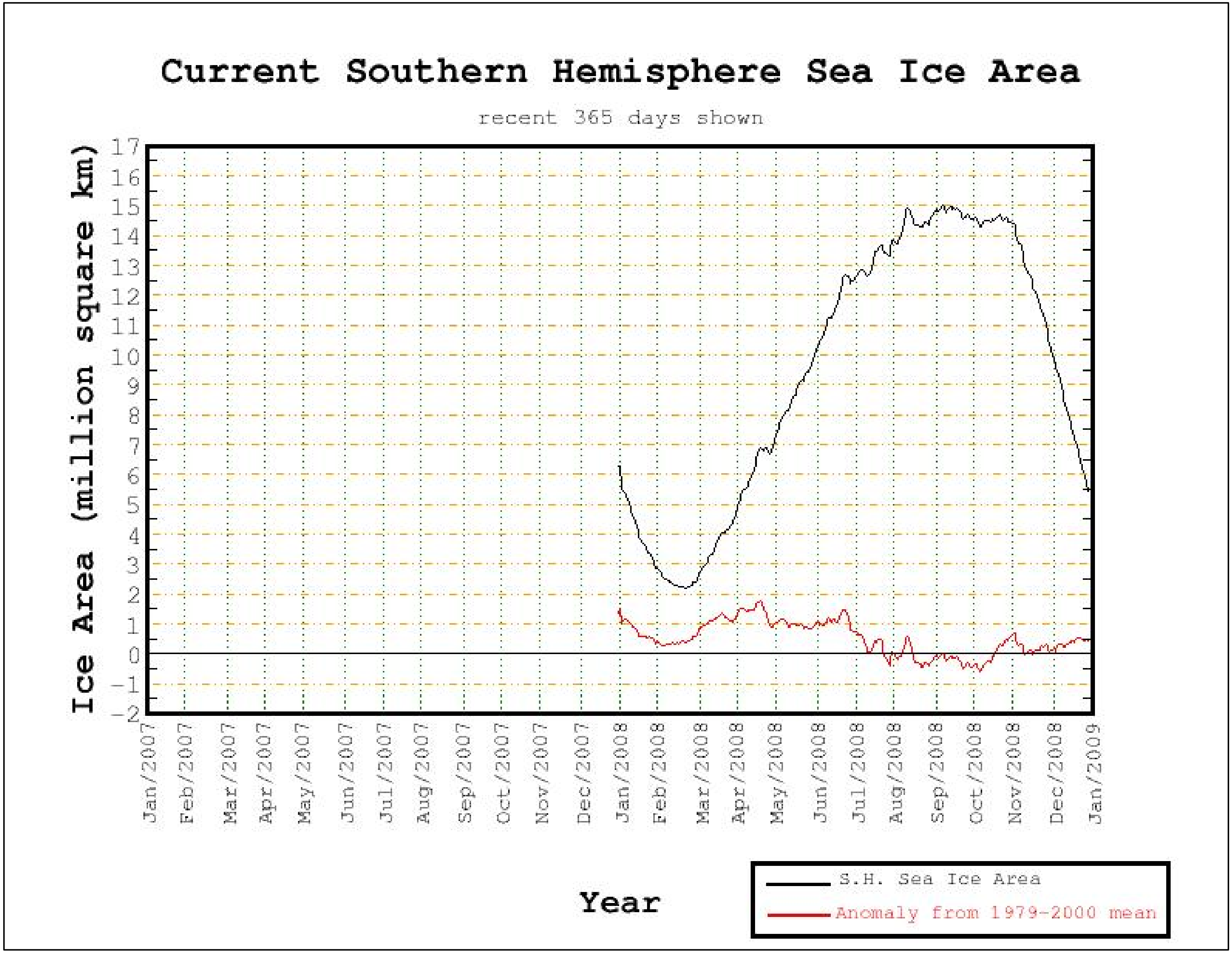
http://climate.rutgers.edu/snowcover/chart_anom.php?ui_set=0&ui_region=nhland&ui_month=12



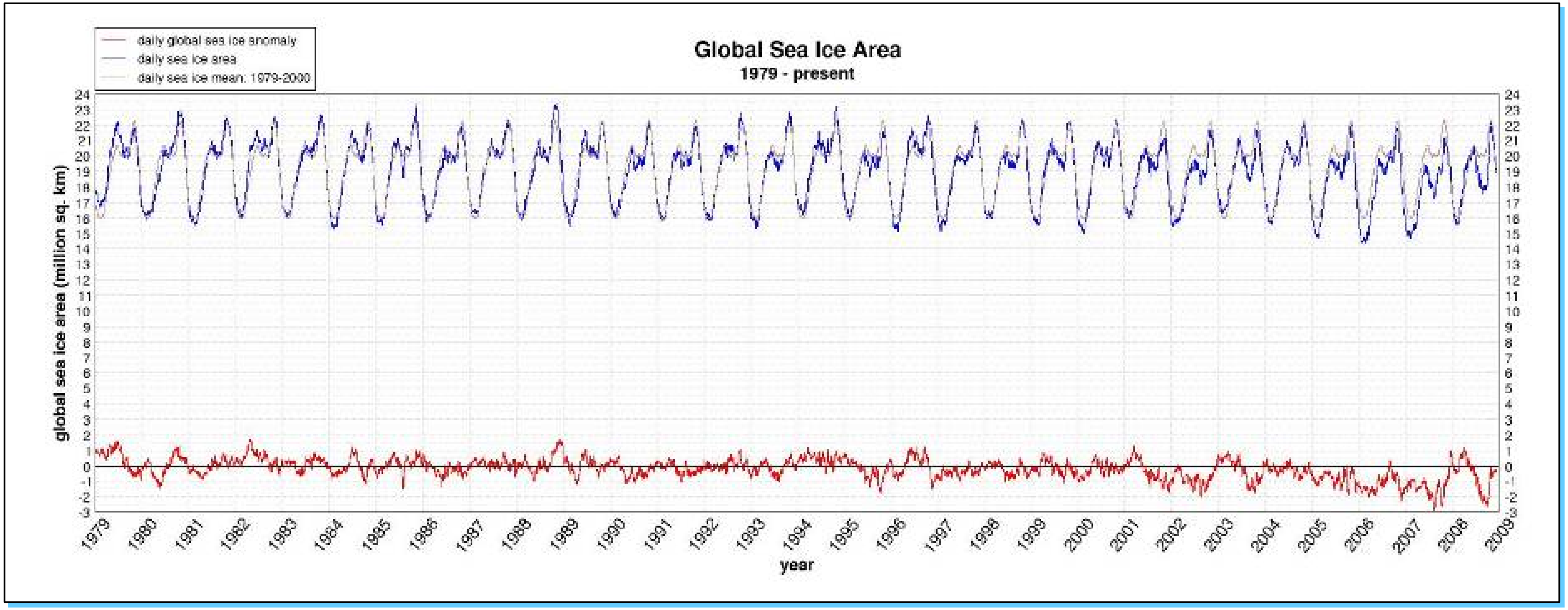
http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.365.jpg



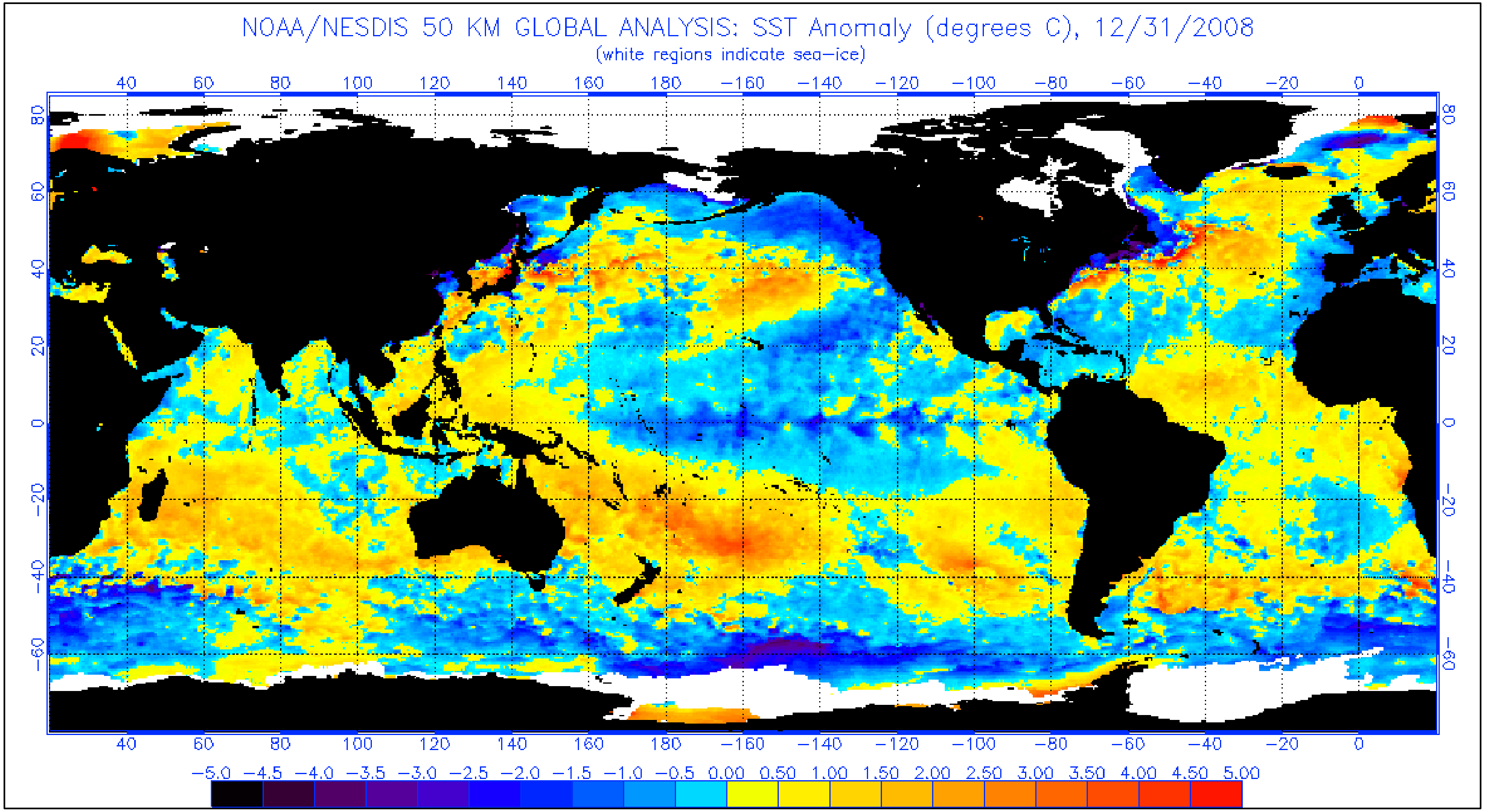
http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/current.365.south.jpg



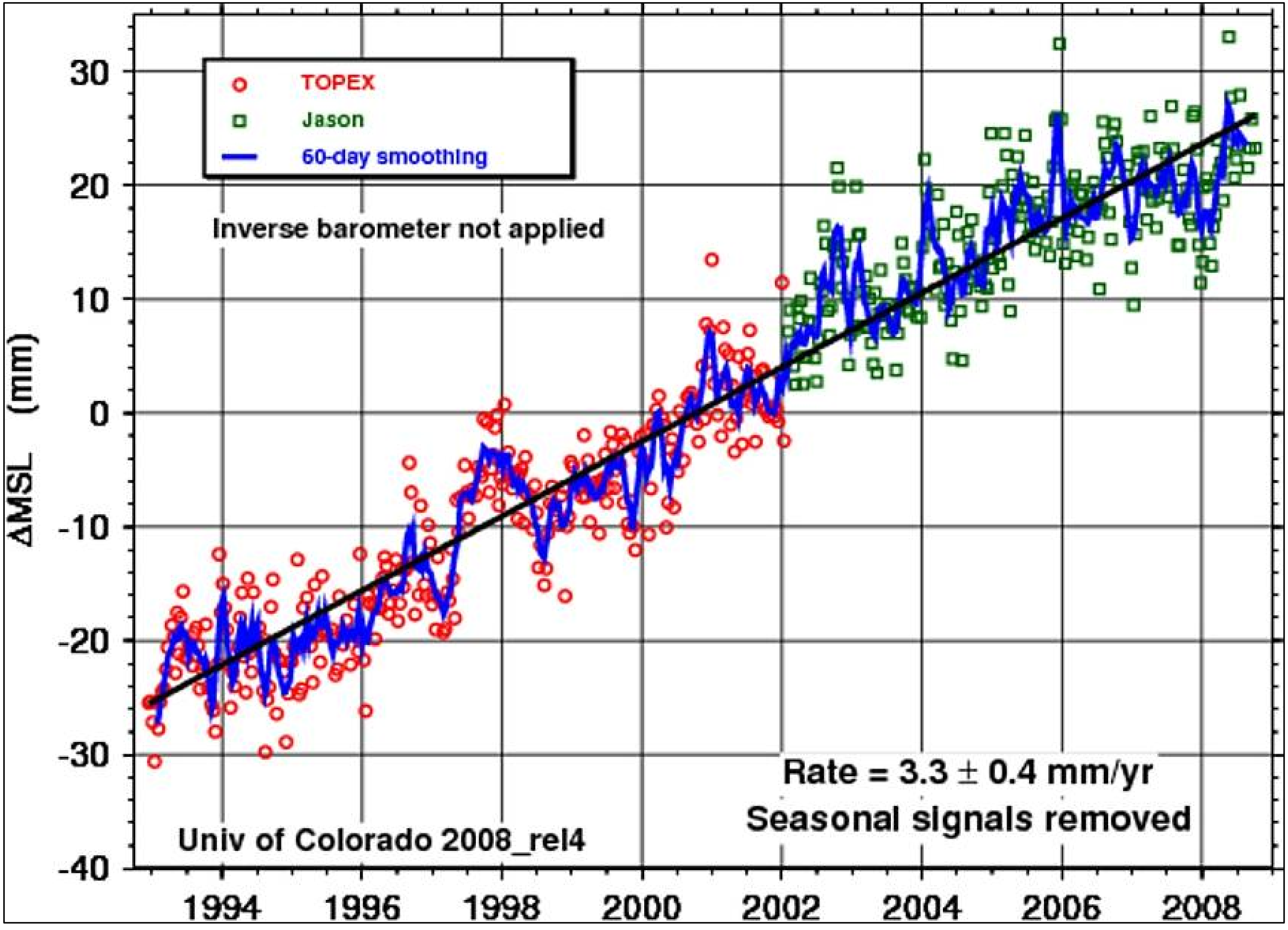
http://arctic.atmos.uiuc.edu/cryosphere/IMAGES/global.daily.ice.area.withtrend.jpg



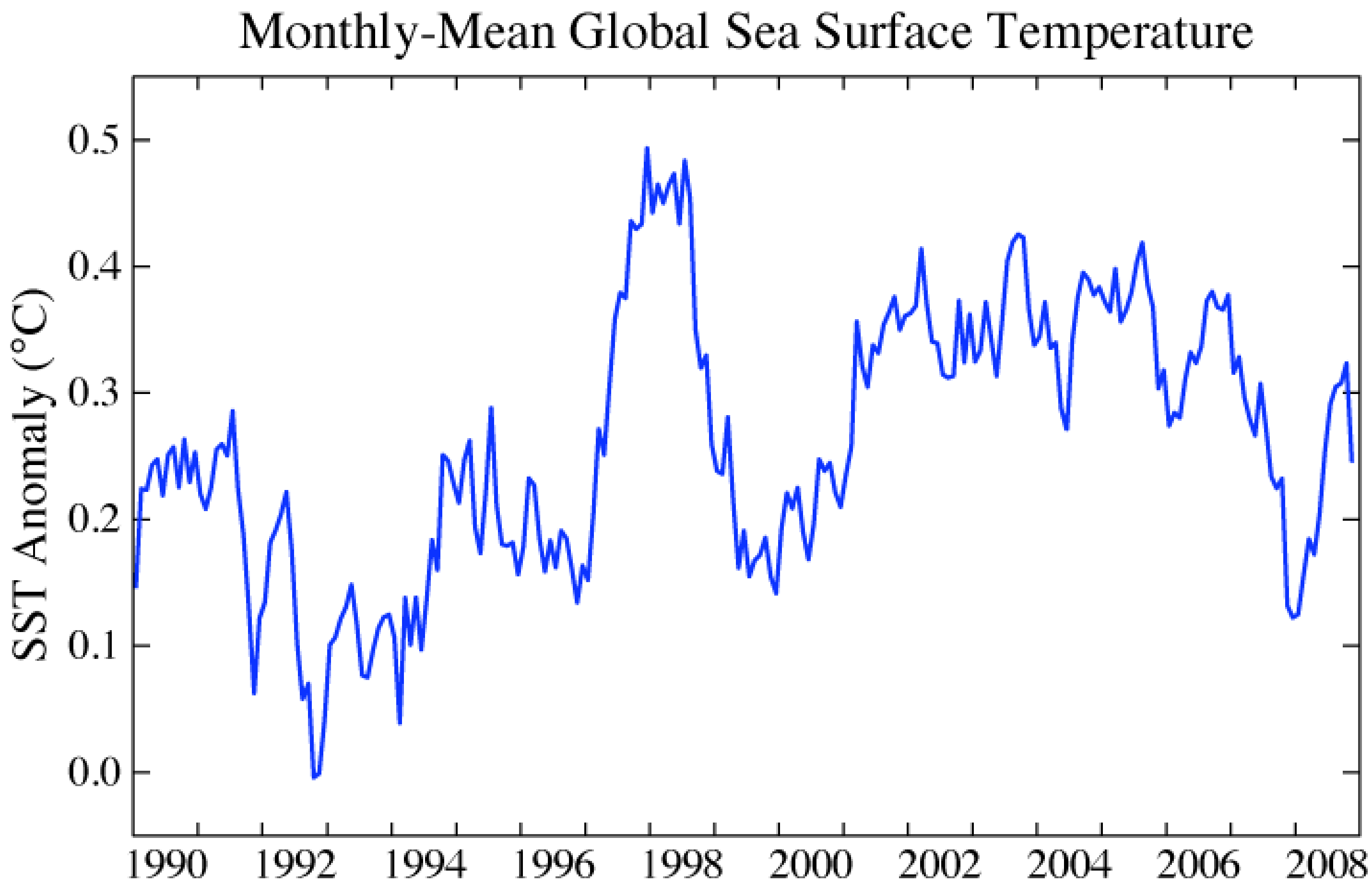
http://www.osdpd.noaa.gov/PSB/EPS/SST/data/anomnight.12.31.2008.gif



http://sealevel.colorado.edu/current/sl_noib_ns_global.jpg



http://data.giss.nasa.gov/gistemp/2008/Fig2b.gif



The data presents a complex variation in time that is not accurately simulated by the global models

Poor Microclimate Exposure at Many Climate Observing Sites

http://wattsupwiththat.wordpress.com/

Davey and Pielke 2005

http://climatesci.org/publications/pdf/R-274.pdf

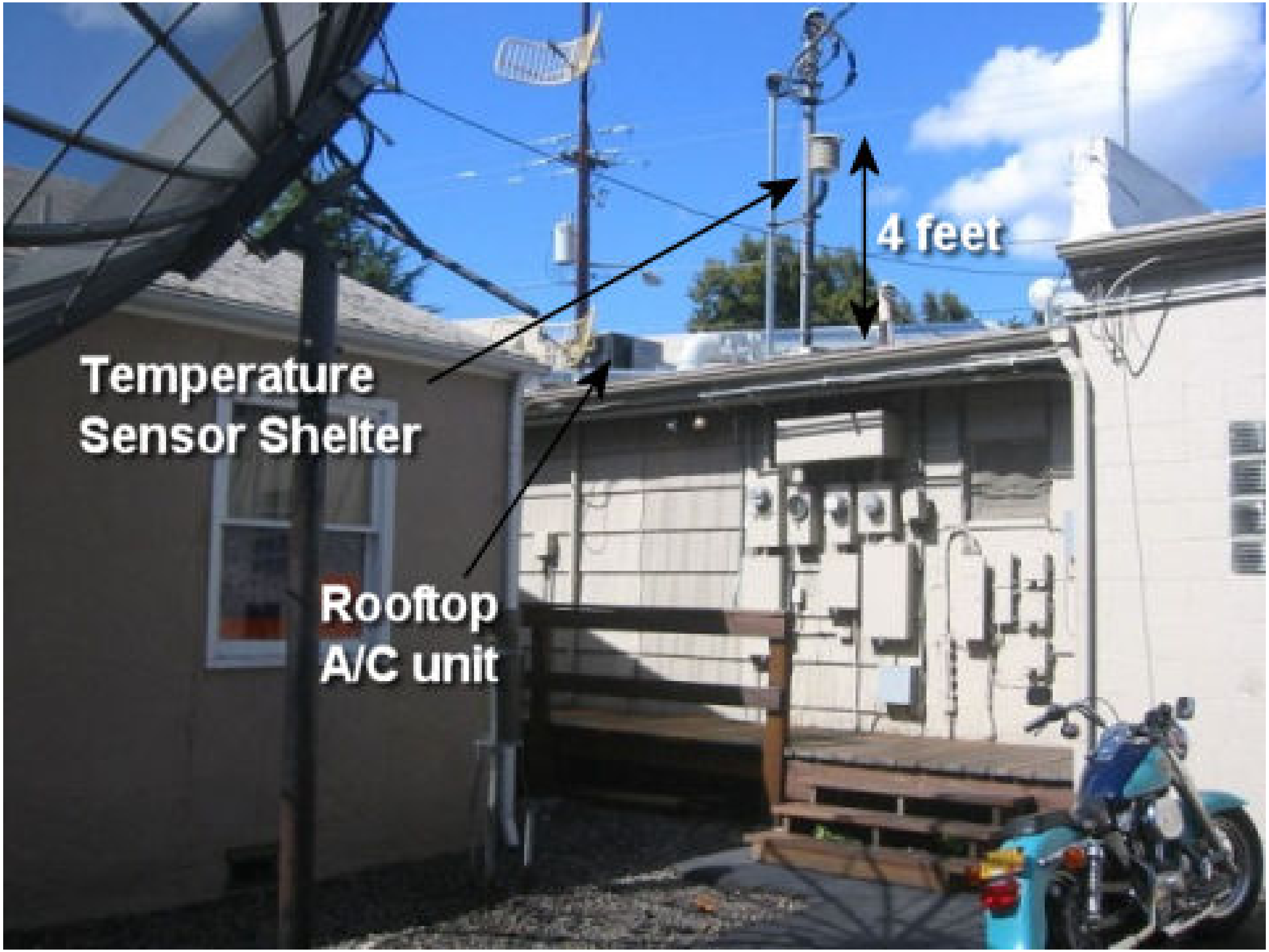
Fort Morgan site showing images of the cardinal directions from the sensor (from Hanamean et al. 2003)

http://wattsupwiththat.wordpress.com/category/weather_stations/

Santa Ana, Orange County CA site situated on the rooftop of the local fire department. See related article and photos at: http://wattsupwiththat.wordpress.com/ and http://sciencedude.freedomblogging.com/2008/08/07/urbanization-raises-the-heat-in-oc/

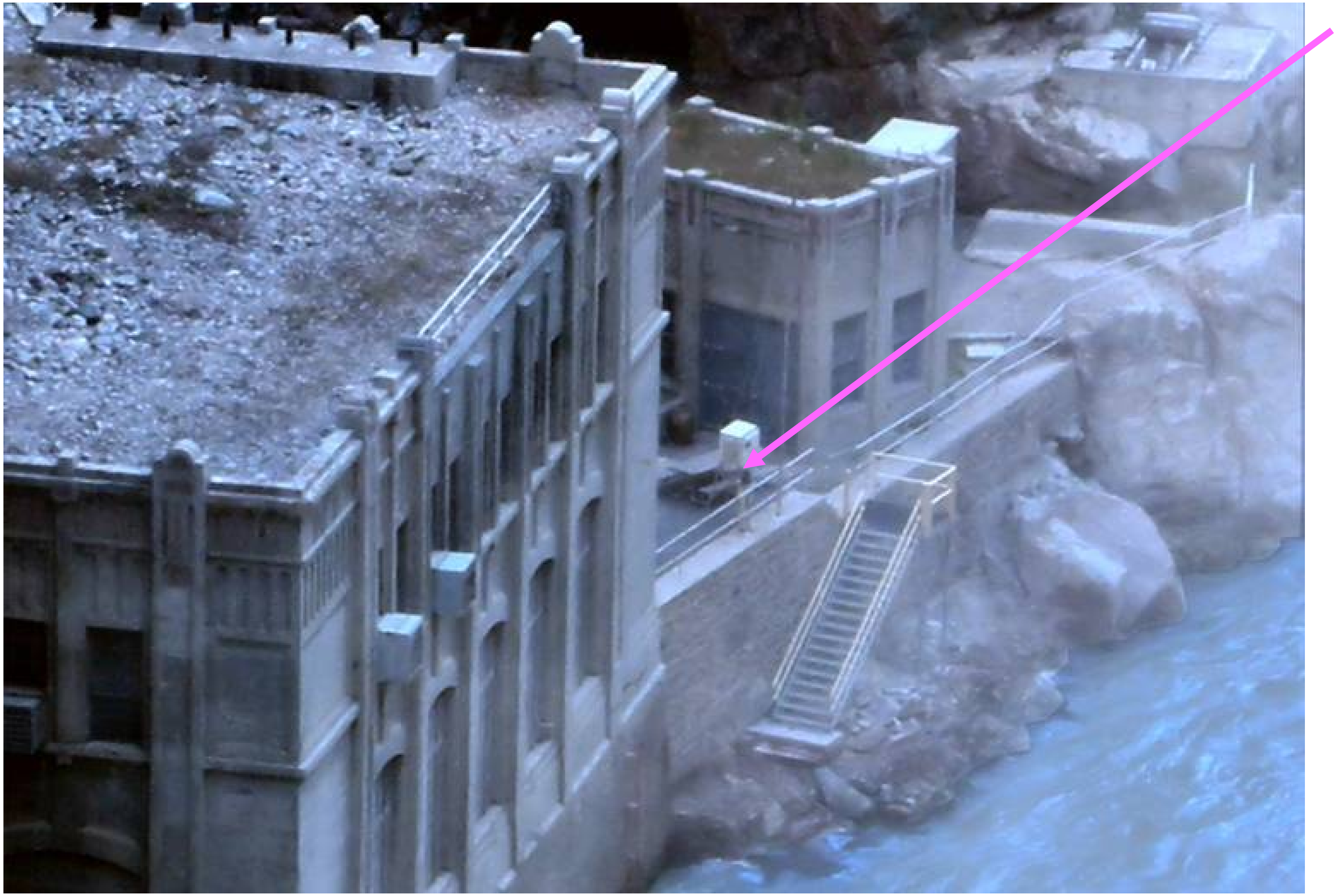
Photo taken at Roseburg, OR (MMTS shelter on roof, near a/c exhaust)

http://www.surfacestations.org/images/Roseburg_OR_USHCN.jpg



Buffalo Bill Dam, Cody WY shelter on top of a stone wall at the edge of the river. It is surrounded by stone building heat sinks except on the river side. On the river it is exposed to waters of varying temperatures, cold in spring and winter, warm in summer and fall as the river flows vary with the season. The level of spray also varies, depending on river flow.

http://wattsupwiththat.wordpress.com/2008/07/15/how-not-to-measure-temperature-part-67/



Lampasas, TX, 10 February 2008

http://gallery.surfacestations.org/main.php?g2_itemId=34296


Looking SSE
Pavement
SCREEN
Busy metro Road

Climate Reference Network Rating Guide:

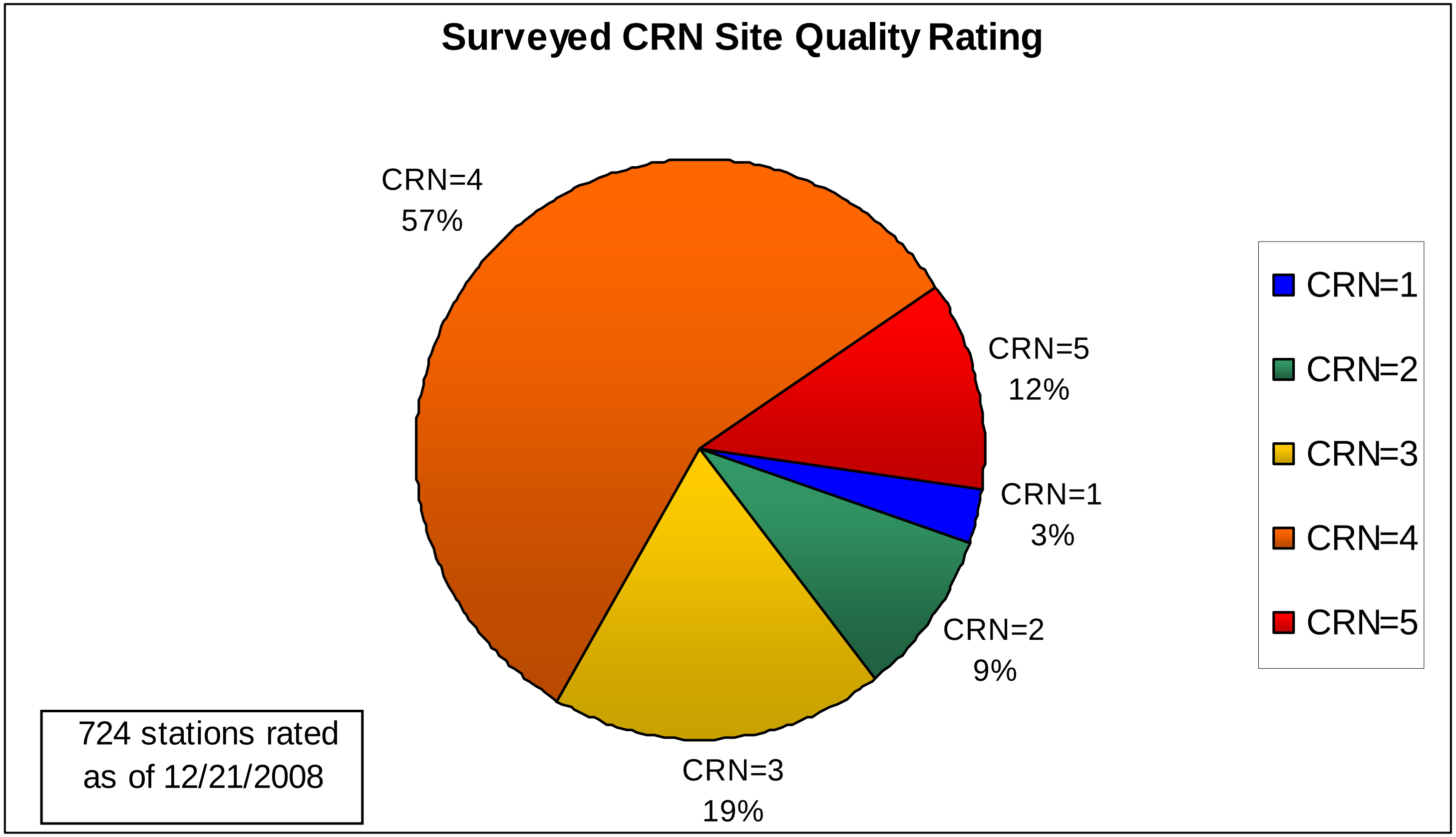
Class 1 **Flat and horizontal ground surrounded by a clear surface with a slope below 1/3 (<19deg). Grass/low vegetation ground cover <10 centimeters high. Sensors located at least 100 meters from artificial heating or reflecting surfaces, such as buildings, concrete surfaces, and parking lots. Far from large bodies of water, except if it is representative of the area, and then located at least 100 meters away. No shading when the sun elevation >3 degrees.**

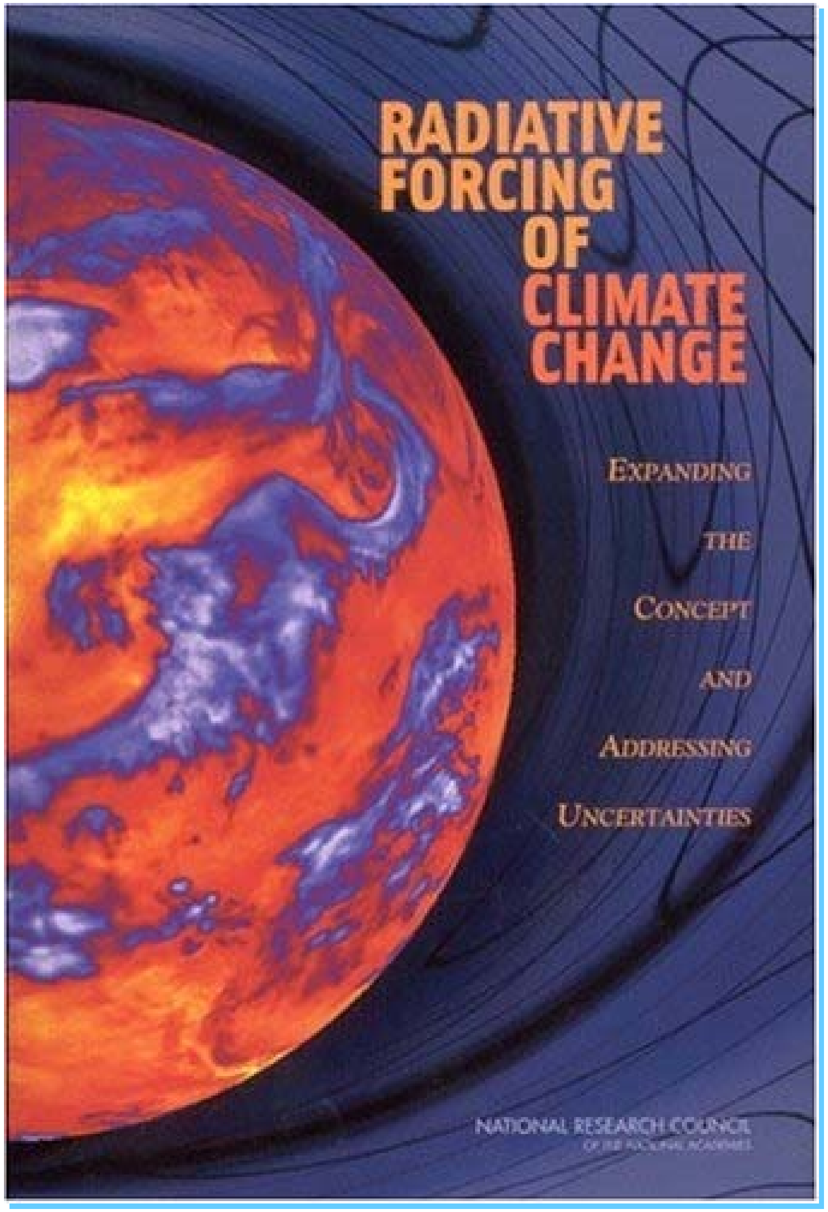
Class 2 **Same as Class 1 with the following differences. Surrounding vegetation <25 centimeters. No artificial heating sources within 30m. No shading for a sun elevation >5deg.**

Class 3 **(error 1C) - Same as Class 2, except no artificial heating sources within 10 meters.**

Class 4 **(error >= 2C) - Artificial heating sources <10 meters.**

Class 5 **(error >= 5C) - Temperature sensor located next to/above an artificial heating source, such a building, roof top, parking lot, or concrete surface."**





National Research Council 2005

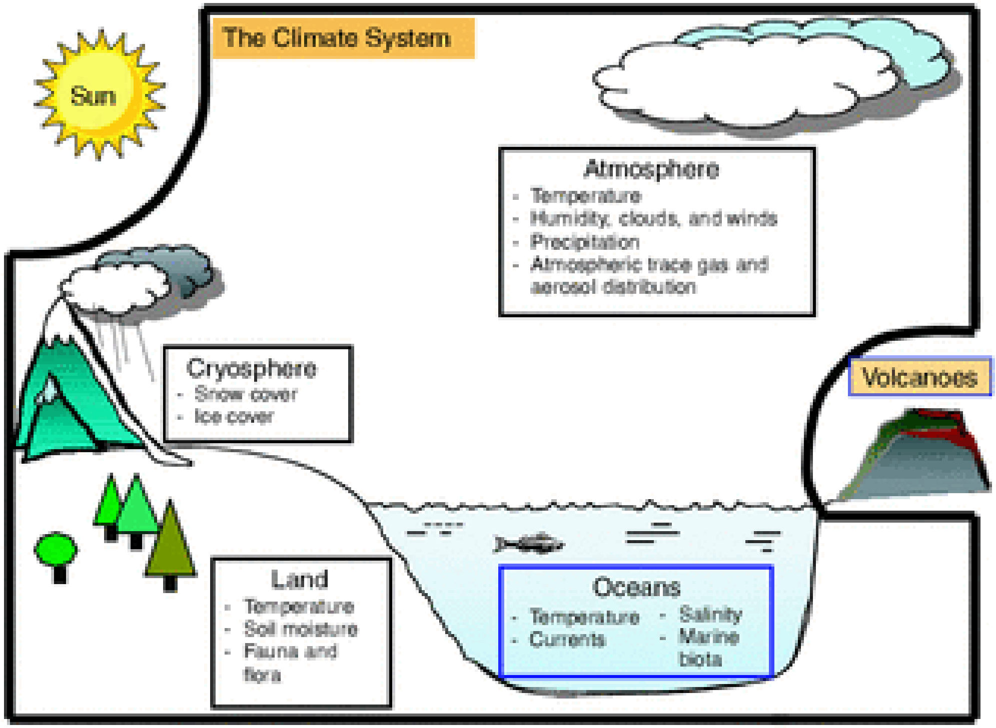


FIGURE 1-1 The climate system, consisting of the atmosphere, oceans, land, and cryosphere. Important state variables for each sphere of the climate system are listed in the boxes. For the purposes of this report, the Sun, volcanic emissions, and human-caused emissions of greenhouse gases and changes to the land surface are considered external to the climate system.

From: National Research Council 2005

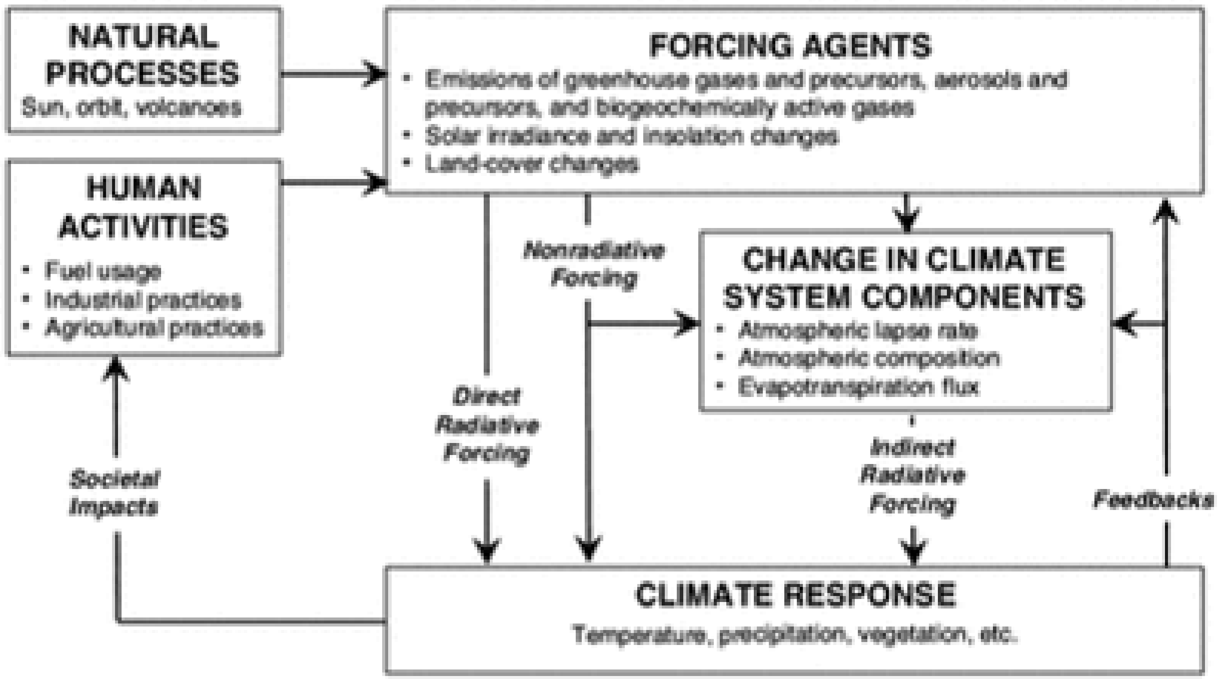


FIGURE 1-2 Conceptual framework of climate forcing, response, and feedbacks under present-day climate conditions. Examples of human activities, forcing agents, climate system components, and variables that can be involved in climate response are provided in the lists in each box.

From: National Research Council 2005

Despite all … [its] … advantages, the traditional global mean TOA radiative forcing concept has some important limitations, which have come increasingly to light over the past decade. The concept is inadequate for some forcing agents, such as absorbing aerosols and land-use changes, that may have regional climate impacts much greater than would be predicted from TOA radiative forcing. Also, it diagnoses only one measure of climate change – global mean surface temperature response – while offering little information on regional climate change or precipitation.

From http://www.nap.edu/openbook.php?record_id=11175&page=4

EXPANDING THE RADIATIVE FORCING CONCEPT (NRC 2005 Recommendations)

- → **Account for the Vertical Structure of Radiative Forcing**
- → **Determine the Importance of Regional Variation in Radiative Forcing**
- → **Determine the Importance of Nonradiative Forcings**
- → **Provide Improved Guidance to the Policy Community**

Determine the Importance of Regional Variation in Radiative Forcing

National Research Council Report

PRIORITY RECOMMENDATIONS

Use climate records to investigate relationships between regional radiative forcing (e.g., land use or aerosol changes) and climate response in the same region, other regions, and globally.

Determine the Importance of Regional Variation in Radiative Forcing

National Research Council Report

PRIORITY RECOMMENDATIONS

Quantify and compare climate responses from regional radiative forcings in different climate models and on different timescales (e.g., seasonal, interannual), and report results in climate change assessments.

Determine the Importance of Nonradiative Forcings

National Research Council Report

PRIORITY RECOMMENDATIONS

Improve understanding and parameterizations of aerosol-cloud thermodynamic interactions and land-atmosphere interactions in climate models in order to quantify the impacts of these nonradiative forcings on both regional and global scales.

Determine the Importance of Nonradiative Forcings

National Research Council Report

PRIORITY RECOMMENDATIONS

Develop improved land-use and land-cover classifications at high resolution for the past and present, as well as scenarios for the future.

Provide Improved Guidance to the Policy Community

National Research Council Report

PRIORITY RECOMMENDATIONS

Encourage policy analysts and integrated assessment modelers to move beyond simple climate models based entirely on global mean TOA radiative forcing and incorporate new global and regional radiative and nonradiative forcing metrics as they become available.

Global Climate Effects Occur with ENSOs for the following reasons:

1. Large Magnitude
2. Long Persistence
3. Spatial Coherence

Wu and Newell 1998

The 2005 National Research Council report concluded:

"regional variations in radiative forcing may have important regional and global climate implications that are not resolved by the concept of global mean radiative forcing.“

And furthermore:

"Regional diabatic heating can cause atmospheric teleconnections that influence regional climate thousands of kilometers away from the point of forcing."

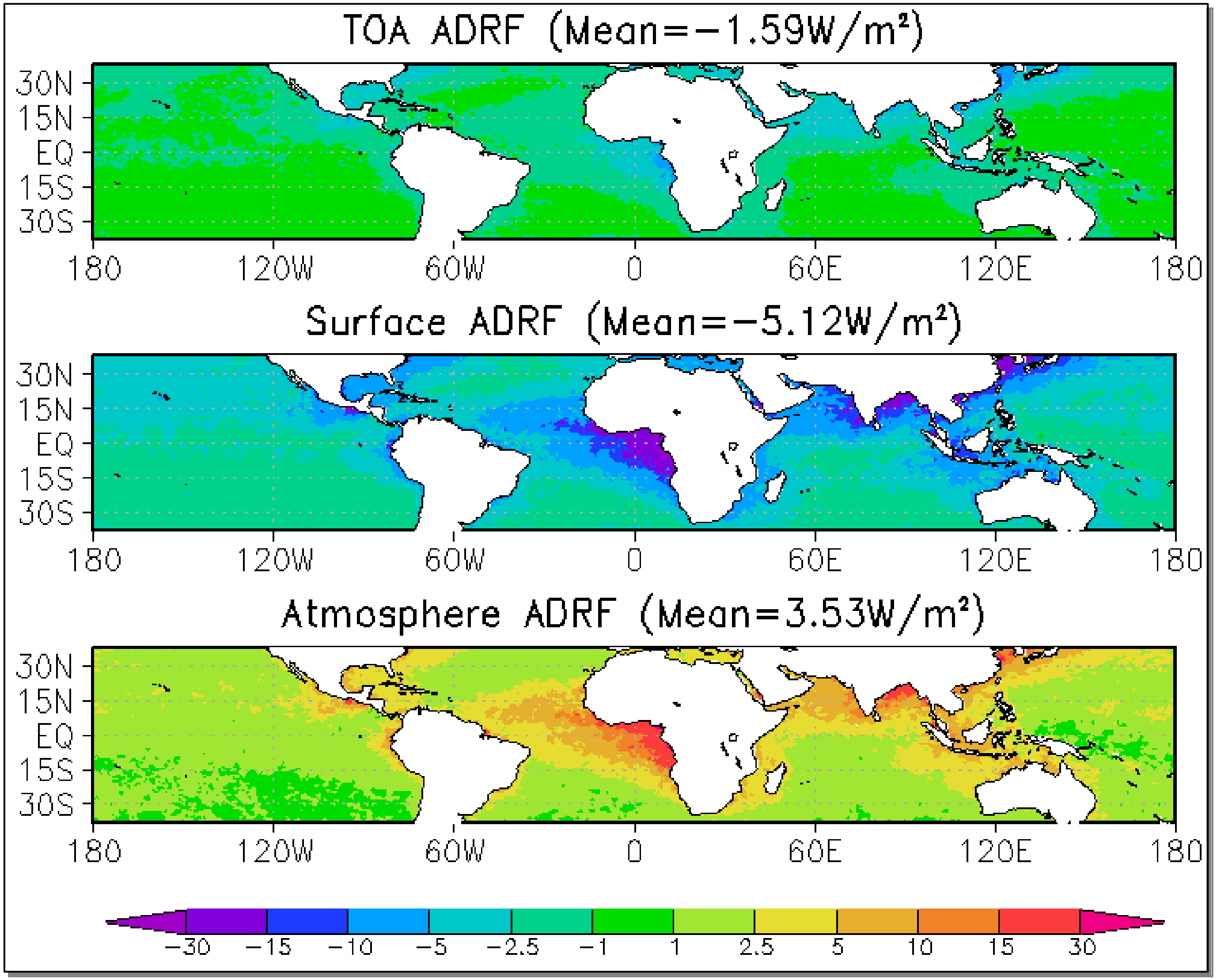
This regional diabatic heating produces temperature increases or decreases in the layer-averaged regional troposphere. This necessarily alters the regional pressure fields and thus the wind pattern. This pressure and wind pattern then affects the pressure and wind patterns at large distances from the region of the forcing which we refer to as teleconnections.

We should, therefore expect global climate effects from any human and natural climate forcing that has the same three characteristics.

The regional alteration in tropospheric diabatic heating has a greater influence on the climate system than a change in the globally-averaged surface and tropospheric temperatures.

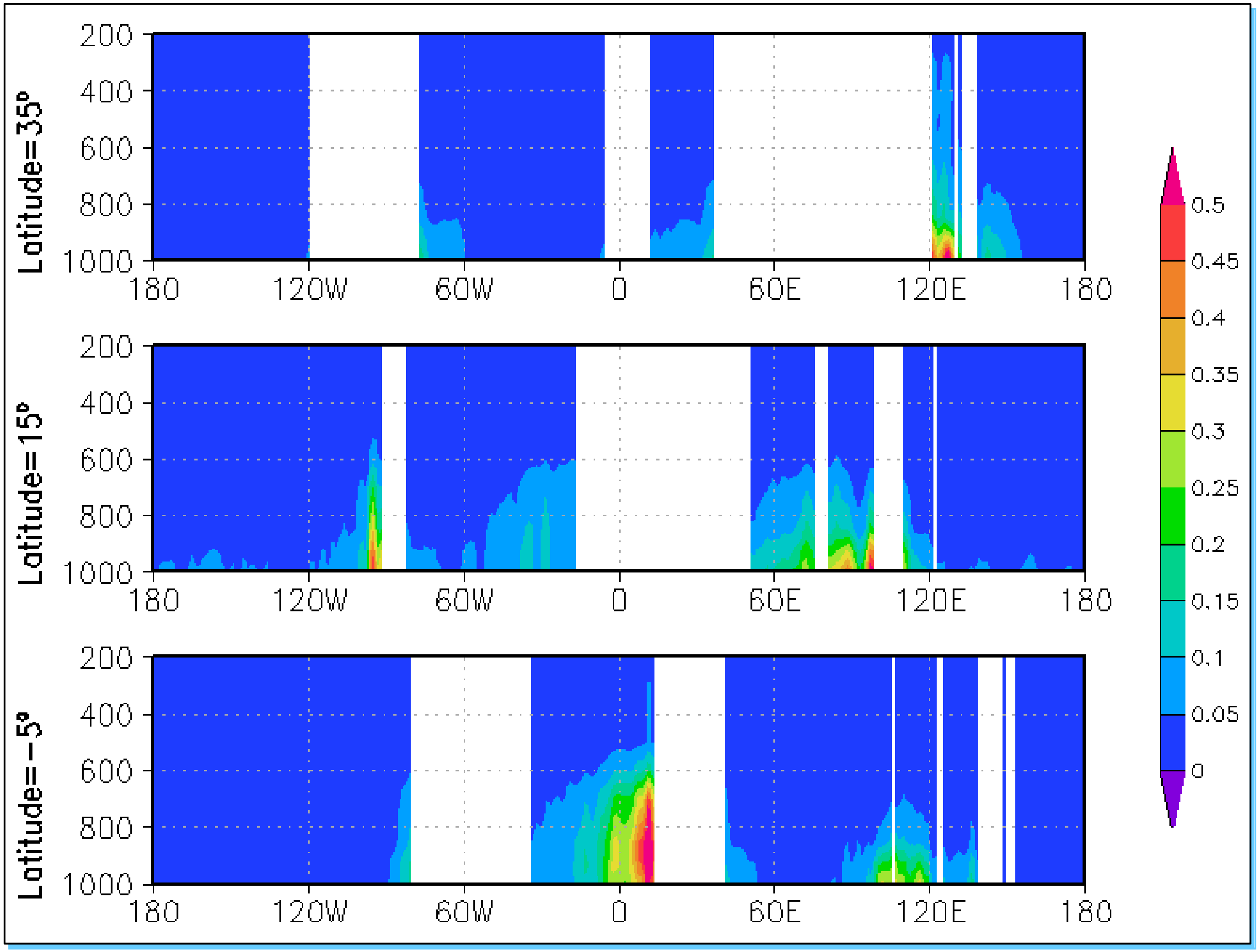
What is the importance of more heterogeneous climate forcings relative to more homogeneous climate forcing such as the radiative forcing of CO_2?

AN EXAMPLE FOR AEROSOL CLIMATE FORCING



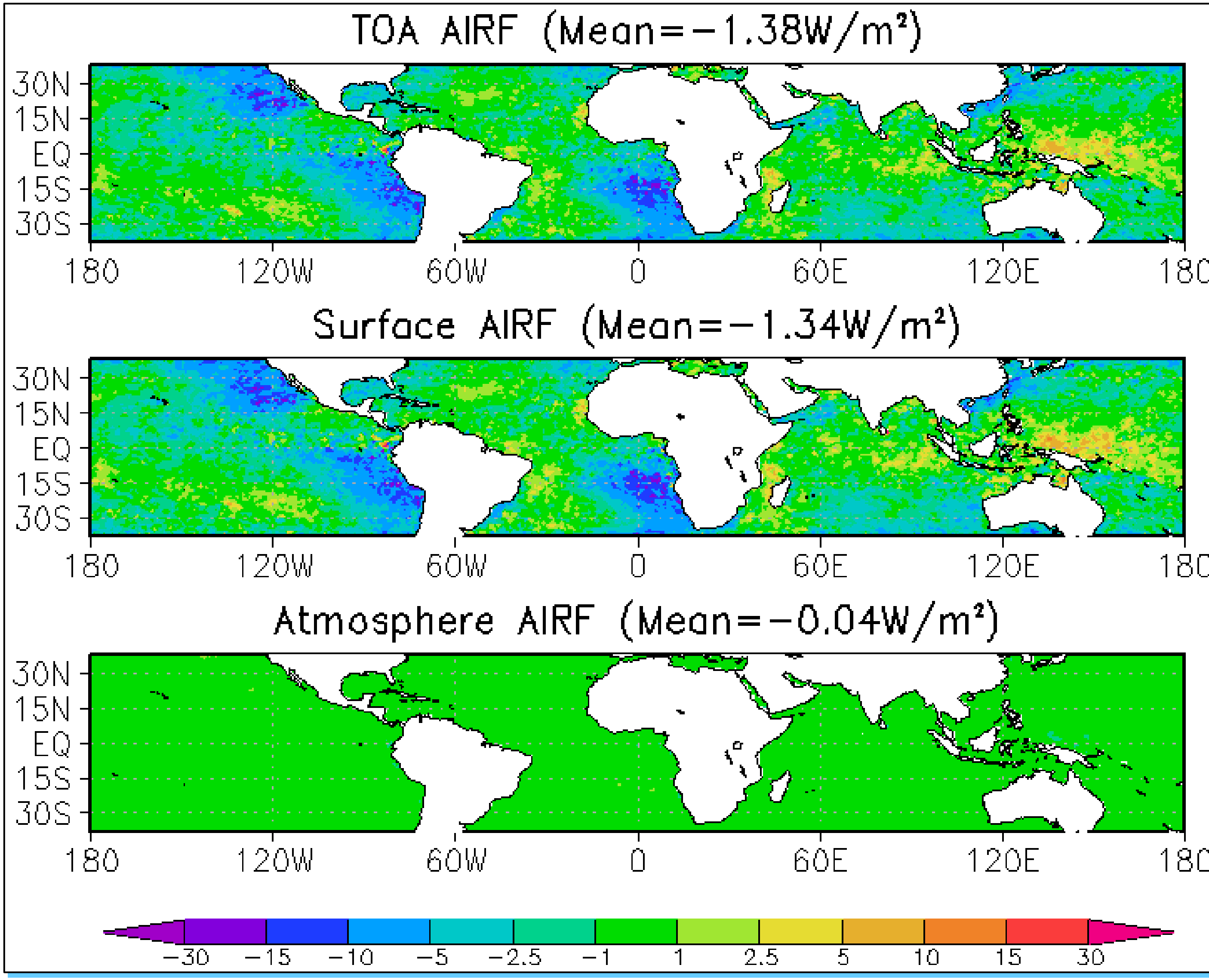
Shortwave aerosol direct radiative forcing (ADRF) for top-of atmosphere (TOA), surface, and atmosphere.

From: Matsui and Pielke 2006



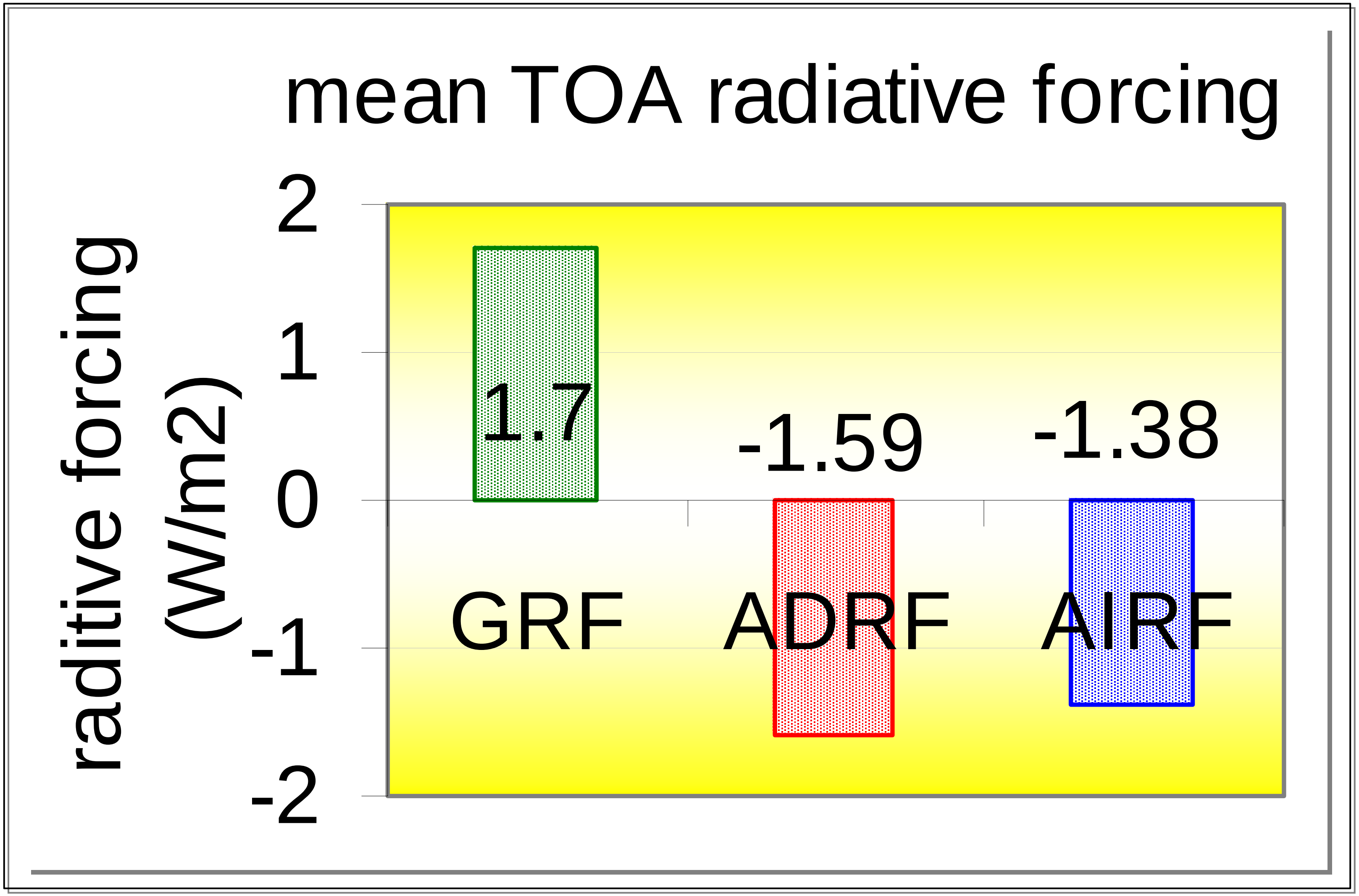
Vertical profile of atmospheric heating rate (K day^{-1}) due to shortwave ADRF. Vertical coordinate is pressure level (mb).

From: Matsui and Pielke 2006



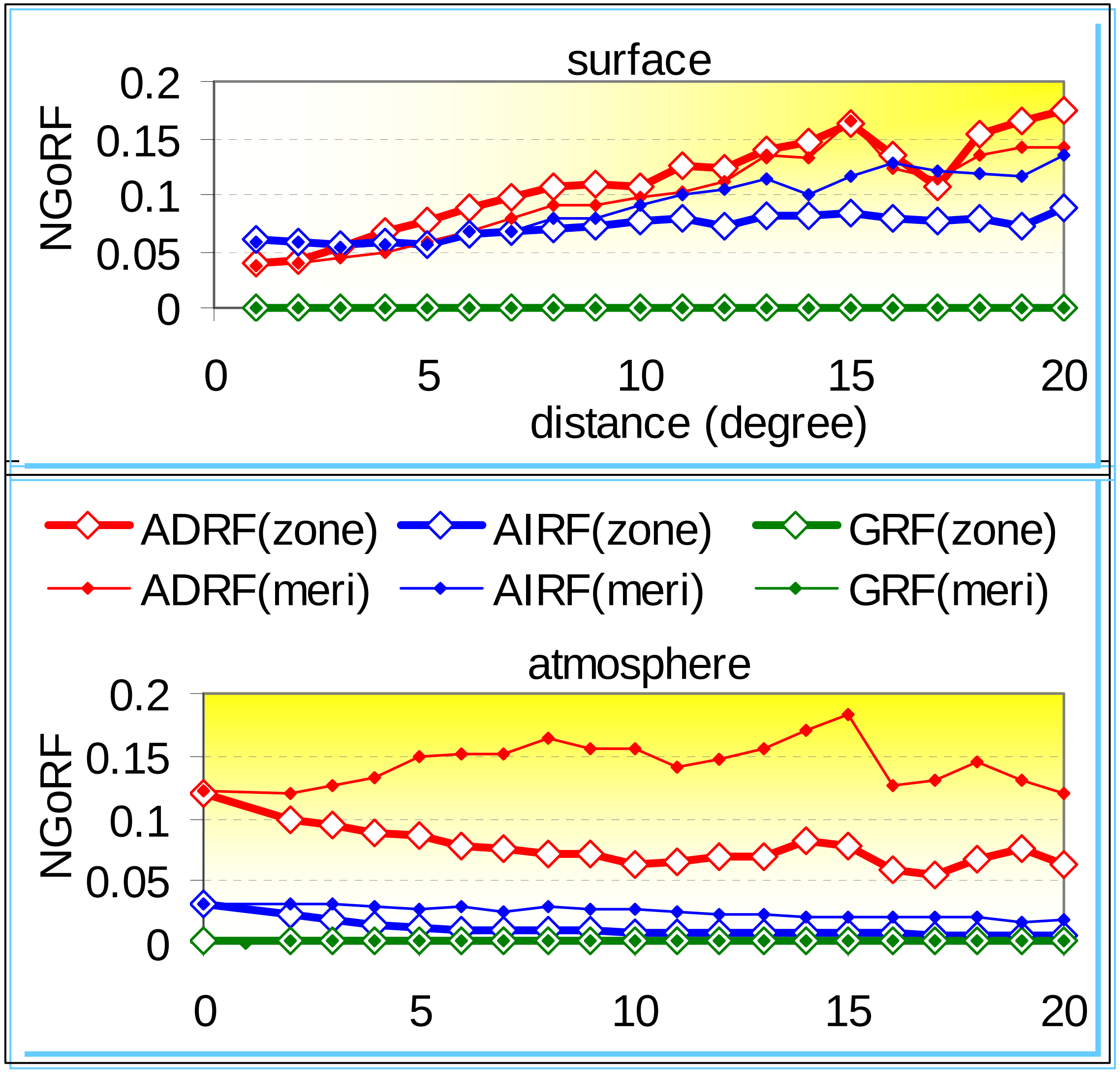
Shortwave aerosol indirect radiative forcing (AIRF) for top-of atmosphere (TOA), surface, and atmosphere.

From: Matsui and Pielke 2006



Comparison of Mean TOA radiative forcing between infrared GRF, shortwave ADRF, and shortwave AIRF.

From: Matsui and Pielke 2006

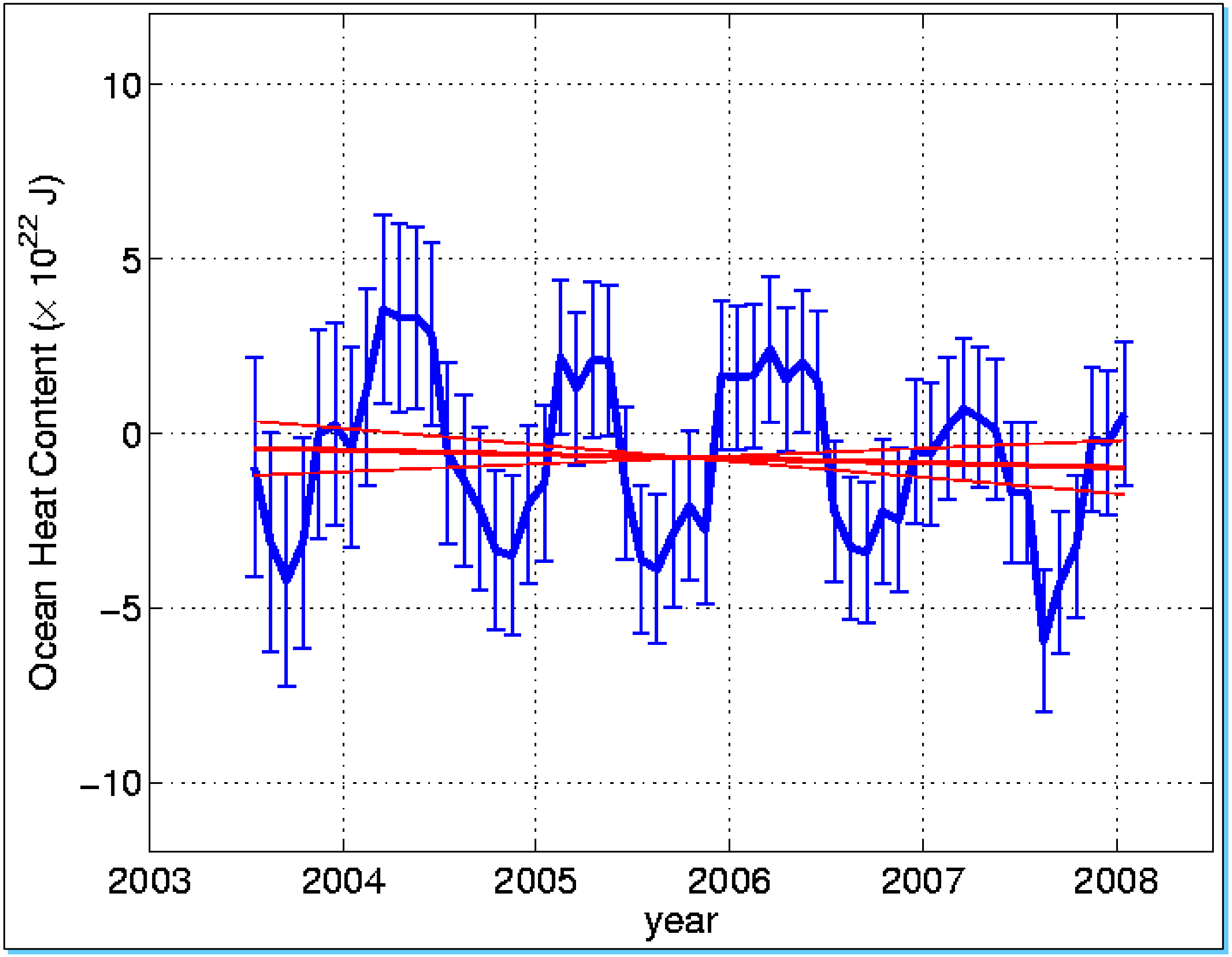


Comparison of the meridional and the zonal component of NGoRF between infrared GRF, shortwave ADRF, and shortwave AIRF for atmosphere and surface.

From: Matsui and Pielke 2006

In Matsui and Pielke Sr. (2006), it was found from observations of the spatial distribution of aerosols in the atmosphere in the lower latitudes, that the aerosol effect on atmospheric circulations, as a result of their alteration in the heating of regions of the atmosphere, is 60 times greater than due to the heating effect of the human addition of well-mixed greenhouse gases.

THE ASSESSMENT OF THE GLOBAL RADIATIVE IMBALANCE FROM CHANGES IN OCEAN HEAT CONTENT



Four-year rate of the global upper 700 m of ocean heat changes in Joules at monthly time intervals. One standard error value is also shown. (Figure courtesy of Josh Willis of NASA's Jet Propulsion Laboratory).

Global Radiative Forcing

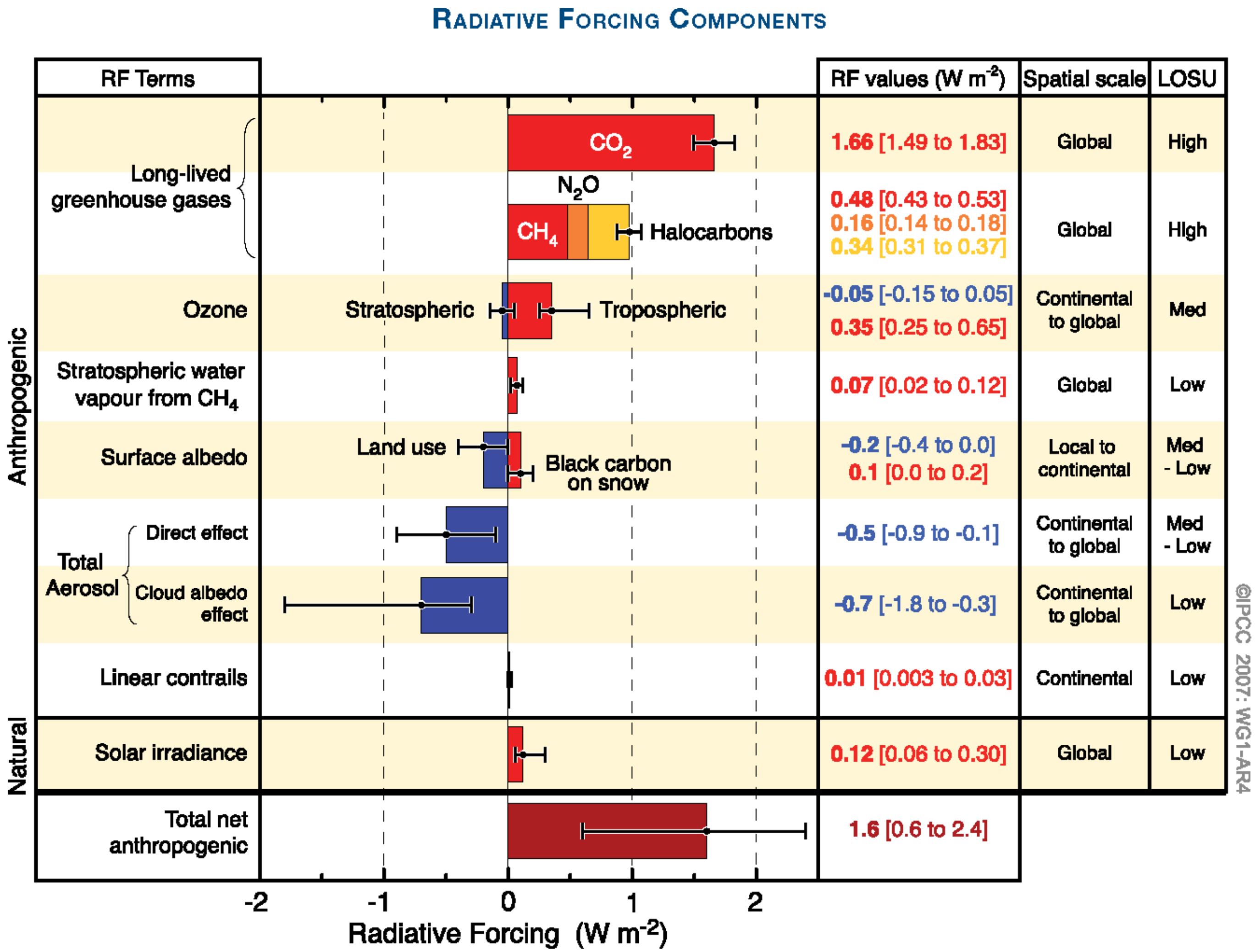


Figure SPM.2. *Global average radiative forcing (RF) estimates and ranges in 2005 for anthropogenic carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). The net anthropogenic radiative forcing and its range are also shown. These require summing asymmetric uncertainty estimates from the component terms, and cannot be obtained by simple addition. Additional forcing factors not included here are considered to have a very low LOSU. Volcanic aerosols contribute an additional natural forcing but are not included in this figure due to their episodic nature. The range for linear contrails does not include other possible effects of aviation on cloudiness. {2.9, Figure 2.20}*

2007 IPCC Total Radiative Forcing = 1.72 (0.66 to 2.7) Watts per meter squared

Best Estimate of Total Radiative Imbalance (1993-2005) = 0.33 (0.10 to 0.56) Watts per meter squared

If the IPCC Forcing is accepted as the current forcing, then the net global radiative feedbacks are negative!

IN CONCLUSION

1. **Solar forcing is spatially and temporally distributed across the Earth.**

2. **Natural and human effects alter the spatial and temporal distribution of this solar forcing.**

3. **The diabatic heating pattern that results is a major control on the weather at all time periods.**

FINALLY

There is a clear conflict of interest in the preparation of the IPCC and CCSP reports. The lead authors are individuals who are assessing their own research. There need to be new Committees convened which can provide a more objective assessment of climate, including the human role within it. Unless this is done, we are doomed to a continued repetition of the same information, which is misleading the public and policymakers in terms of what policy actions should be taken with respect to climate.


HONESTY BRAND
LOUISIANA ORANGES
GROWN PACKED BY
J. B. FASTERLING,
BURAS, LA.

Roger A. Pielke Sr. Weblog

http://climatesci.org

Roger A. Pielke Sr. Website

http://cires.colorado.edu/science/groups/pielke

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Background Photograph Courtesy of Mike Hollingshead

http://www.extremeinstability.com/index.htm

References

Davey, C.A. and R.A. Pielke Sr. 2005. Microclimate exposures of surface-based weather stations – implications for the assessment of long-term temperature trends. Bull. Amer. Meteor. Soc. 86(4):497–504 http://climatesci.org/publications/pdf/R-274.pdf

Hanamean, J.R. Jr., R.A. Pielke Sr., C.L. Castro, D.S. Ojima, B.C. Reed, and Z. Gao. 2003. Vegetation impacts on maximum and minimum temperatures in northeast Colorado. Meteorological Applications 10:203–215 http://www.climatesci.org/publications/pdf/R-254.pdf

Matsui, T. and R.A. Pielke Sr. 2006. Measurement-based estimation of the spatial gradient of aerosol radiative forcing. Geophys. Res. Letts. 33:L11813, doi:10.1029/2006GL025974 http://climatesci.org/publications/pdf/R-312.pdf

References (continued)

National Research Council. 2005. Radiative Forcing of Climate Change: Expanding the Concept and Addressing Uncertainties. Committee on Radiative Forcing Effects on Climate, Climate Research Committee. 224 pp. http://www.nap.edu/catalog/11175.html

Wu, Z.-X. and R.E. Newell. 1998. Influence of sea surface temperature of air temperature in the tropic. Climate Dynamics 14:275–290.