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Observational datasets used in climate studies (APPENDIX A)

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Abstract

Observations, including those from satellites, mobile platforms, field campaigns and ground based networks, provide the basis of knowledge on many temporal and spatial scales for understanding the changes occurring in Earth's climate system. These observations also inform the development, calibration, and evaluation of numerical models of the physics, chemistry, and biology being used in analyzing the past changes in climate and for making future projections. As all observational data collected by support from Federal agencies are required to be made available free of charge with machine readable metadata, everyone can access these products for their personal analysis and research and for informing decisions. Many of these datasets are accessible through web services.

Many long-running observations worldwide have provided us with long-term records necessary for investigating climate change and its impacts. These include important climate variables such as surface temperature, sea ice extent, sea level rise, and streamflow. Perhaps one of the most iconic climatic datasets, that of atmospheric carbon dioxide measured at Mauna Loa, HI, has been recorded since the 1950s. The U.S. and Global Historical Climatology Networks have been used as authoritative sources of recorded surface temperature increases, with some stations having continuous records going back many decades. Satellite radar altimetry data (for example, TOPEX/JASON1, 2 satellite data) have informed the development of the University of Colorado's 20+ year record of global sea level changes. In the United States, the USGS (U.S. Geological Survey) National Water Information System contains, in some instances, decades of daily streamflow records which inform not only climate but land-use studies as well. The U.S. Bureau of Reclamation and U.S. Army Corp of Engineers have maintained data about reservoir levels for decades where applicable. Of course, datasets based on shorter-term observations are used in conjunction with longer-term records for climate study, and the U.S. programs are aimed at providing continuous data records. Methods have been developed and applied to process these data so as to account for biases, collection method, earth surface geometry, the urban heat island effect, station relocations, and uncertainty (e.g., see Vose et al. 2012; Rennie et al. 2014; Karl et al. 2015).

Even observations not designed for climate have informed climate research. These include ship logs containing descriptions of ice extent, readings of temperature and precipitation provided in newspapers, and harvest records. Today, observations recorded both manually and in automated fashions inform research and are used in climate studies.

The U.S Global Change Research Program (USGCRP) has established the Global Change Information System (GCIS) to better coordinate and integrate the use of federal information products on changes in the global environment and the implications of those changes for society. The GCIS is an open-source, web-based resource for traceable global change data, information, and products.

Appendix A. Observational Datasets Used in Climate Studies

Climate Datasets

Observations, including those from satellites, mobile platforms, field campaigns and ground-based networks, provide the basis of knowledge on many temporal and spatial scales for understanding the changes occurring in Earth's climate system. These observations also inform the development, calibration, and evaluation of numerical models of the physics, chemistry, and biology being used in analyzing the past changes in climate and for making future projections. As all observational data collected by support from Federal agencies are required to be made available free of charge with machine readable metadata, everyone can access these products for their personal analysis and research and for informing decisions. Many of these datasets are accessible through web services.

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The U.S Global Change Research Program (USGCRP) has established the Global Change Information System (GCIS) to better coordinate and integrate the use of federal information products on changes in the global environment and the implications of those changes for society. The GCIS is an open-source, web-based resource for traceable global change data, information, and products. Designed for use by scientists, decision makers, and the public, the GCIS provides coordinated links to a select group of information products produced, maintained, and disseminated by government agencies and organizations. Currently the GCIS is aimed at the datasets used in Third National Climate Assessment (NCA3) and the USGCRP Climate and Health Assessment. It is to be updated for the datasets used in this report (The Climate Science Special Report, CSSR).

Satellite Temperature Datasets

A special look is given to the satellite temperature datasets because of controversies associated with these datasets. Satellite-borne microwave sounders such as the Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit (AMSU) instruments operating on NOAA polar-orbiting platforms make measurements of the temperature of thick layers of the atmosphere with near global coverage. Because the long-term data record requires the piecing together of measurements made by 16 different satellites, accurate instrument intercalibration is of critical importance. Over the mission lifetime of most satellites, the instruments drift in both calibration and local measurement time. Adjustments to counter the effects of these drifts need to be developed and applied before a long-term record can be assembled. For tropospheric measurements, the most challenging of these adjustments is the adjustment for drifting measurement time, which requires knowledge of the diurnal cycle in both atmospheric and surface temperature. Current versions of the sounder-based datasets account for the diurnal cycle by either using diurnal cycles deduced from model output (Mears and Wentz 2009; Zou et al. 2009) or by attempting to derive the diurnal cycle from the satellite measurements themselves (an approach plagued by sampling issues and possible calibration drifts) (Christy et al. 2003; Po-Chedley et al. 2015). Recently a hybrid approach has been developed, RSS Version 4.0 (Mears and Wentz 2016), that results in an increased warming signal relative to the other approaches, particularly since 2000. Each of these methods has strengths and weaknesses, but neither has sufficient accuracy to construct an unassailable long-term record of atmospheric temperature change. The resulting datasets show a greater spread in decadal-scale trends than do the surface temperature datasets for the same period, suggesting that they may be less reliable. In Figure A.1 shows annual time series for the global mean tropospheric temperature for some recent versions of the satellite datasets. These data have been adjusted to remove the influence of stratospheric cooling (Fu and Johanson 2005). Linear trend values are shown in Table A.1.

[INSERT FIGURE A.1 AND TABLE A.1 HERE]

TABLE

Table A.1. Global Trends in Temperature Total Troposphere (TTT) since 1979 and 2000 (in °F per decade).

Dataset	Trend (1979–2015) (°F/Decade)	Trend (2000–2015) (°F/Decade)
RSS V4.0	0.301	0.198
UAH V6Beta5	0.196	0.141
STAR V4.0	0.316	0.157
RSS V3.3	0.208	0.105
UAH V5.6	0.176	0.211
STAR V3.0	0.286	0.061

FIGURE

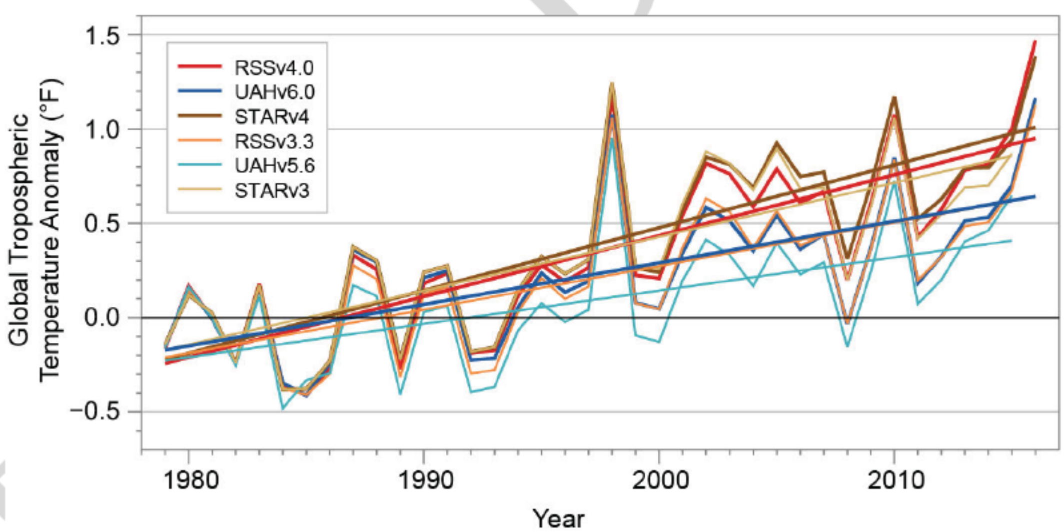

Figure A.1. Annual global (80°S–80°N) mean time series of tropospheric temperature for five recent datasets (see below). Each time series is adjusted so the mean value for the first three years is zero. This accentuates the differences in the long-term changes between the datasets. (Figure source: Remote Sensing Systems).

DATA SOURCES:

All Satellite Data are "Temperature Total Troposphere" time series calculated from TMT and TLS

(1.1*TMT) - (0.1*TLS). This combination reduces the effect of the lower stratosphere on the tropospheric temperature. (Fu, Qiang et al. "Contribution of stratospheric cooling to satellite-inferred tropospheric temperature trends." *Nature* 429.6987 (2004): 55-58.)

UAH. UAH Version 6.0Beta5. Yearly (yyyy) text files of TMT and TLS are available from

http://vortex.nsstc.uah.edu/data/msu/v6.0beta/tmt/tmtmonamg.yyyy_6.0beta5

http://vortex.nsstc.uah.edu/data/msu/v6.0beta/tls/tlsmonamg.yyyy_6.0beta5

Downloaded 5/15/2016.

UAH. UAH Version 5.6. Yearly (yyyy) text files of TMT and TLS are available from

http://vortex.nsstc.uah.edu/data/msu/t2/

http://vortex.nsstc.uah.edu/data/msu/t4/

Downloaded 5/15/2016.

RSS. RSS Version 4.0. ftp://ftp.remss.com/msu/data/netcdf/RSS_Tb_Anom_Maps_ch_TTT_V4_0.nc

Downloaded 5/15/2016

RSS. RSS Version 3.3. ftp://ftp.remss.com/msu/data/netcdf/RSS_Tb_Anom_Maps_ch_TTT_V3.3.nc

Downloaded 5/15/2016

NOAA STAR. Star Version 3.0.

ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/mscat/data/MSU_AMSU_v3.0/Monthly_Atmospheric_Layer_Mean_Temperature/Merged_Deep-Layer_Temperature/NESDIS-STAR_TCDR_MSU-AMSUA_V03R00_TMT_S197811_E201604_C20160513.nc

ftp://ftp.star.nesdis.noaa.gov/pub/smcd/emb/mscat/data/MSU_AMSU_v3.0/Monthly_Atmospheric_Layer_Mean_Temperature/Merged_Deep-Layer_Temperature/NESDIS-STAR_TCDR_MSU-AMSUA_V03R00_TLS_S197811_E201604_C20160513.nc

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