AI

Annex I: Observational Products

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AI.1 Introduction

The purpose of this annex is to document observational datasets used by Working Group I in the Sixth Assessment Report. This includes details of the types and versions of datasets, the time period they cover, the chapters in which they appear, and citations and (where available) web links to the data.

This list includes those observational datasets that contribute to values reported in the text or in figures, unless they are citing a specific result from a paper (as opposed to an ongoing dataset for which that paper is a reference).

Reanalyses are within the scope of this annex, but historical climate model simulations are not. Proxy datasets are also outside the scope of this annex.

Datasets which are updated regularly on an operational basis are shown as ending in 2020, even if no 2020 data have yet been published at the time of writing.

Datasets are sorted alphabetically according to the dataset name or, if there is no formal name, the name of the responsible institution or lead author.

Table AI.1 | Observational products used by Working Group I in the Sixth Assessment Report.

Name	Version	Type	Resolution (Time and Space)	Section(s)	Time Period	Citation, Link and DOI (Where Available)
NOAA-CIRES 20th Century Reanalysis (20CR)	2c	Reanalysis	3-hourly 2° × 2°, 24 vertical levels	2.4.1	1851–2014	Compo et al. (2011) www.esrl.noaa.gov/psd/data/20thC_Rean/
NOAA-CIRES 20th Century Reanalysis (20CR)	3	Reanalysis	3-hourly 0.5° × 0.5°	2.3.1 3.3.3 3.7.1	1851–2020	Slivinski et al. (2019) www.esrl.noaa.gov/psd/data/20thC_Rean/
Finland Climate (Aalto)		In situ	Daily 0.1° × 0.1°	10.2.1	1961–2010	Aalto et al. (2016) www.csc.fi/-/paituli
ACORN-SAT Australian temperature data	2.1	In situ	Daily Point-based	Atlas 6.2	1910–2020	Trewin et al. (2020) www.bom.gov.au/climate/data/acorn-sat/
AERONET AOD Level 2.0	3	Remote sensing	Monthly Point-based	2.2.6	1995–2020	Giles et al. (2019) https://aeronet.gsfc.nasa.gov/data_push/AOT_Level2_Monthly.tar.gz
Advanced Global Atmospheric Gases Experiment (AGAGE)		In situ	Up to 36 times per day Point-based	2.2.3 2.2.4 5.2.2 5.2.3	1978–2020	Prinn et al. (2018) http://agage.mit.edu/data
Australian Gridded Climate Data (AGCD)		In situ	Daily 0.05° × 0.05°	Atlas 6.2	1900–2020	Jones et al. (2009); Evans et al. (2020) www.bom.gov.au/climate/maps/rainfall
AIRS specific humidity	RetStd-v5	Remote sensing	Monthly 1° × 1°	3.3.2	2003–2010	Susskind et al. (2006); Tian et al. (2013) https://esgf-node.llnl.gov/search/obs4mips/
AIRS-6 climate data products		Remote sensing	Various	2.3.1	2002–2020	Susskind et al. (2014) http://disc.sci.gsfc.nasa.gov/AIRS/data-holdings
Energy balance reconstruction (Allan)		Remote sensing	Monthly 10° × 10°	7.2.2	1985–2012	Allan et al. (2014) http://met.reading.ac.uk/~sgs02rpa/research/DEEP-C/GRL/
AMOC dataset		In situ, reanalysis	Monthly Regional time series	3.5.4	2004–2017	Smeed et al. (2018)
Advanced Microwave Scanning Radiometer 2 (AMSR2)		Remote sensing	3-hourly	8.3.1	2012–2019	Kummerow et al. (2015) https://lance.nsstc.nasa.gov/amsr2-science/data/level2/rainocean/
Aqua's Advanced Microwave Scanning Radiometer for Earth Observing System (AMSR-E)		Remote sensing	5.4–56 km	8.3.1	2002–2011	Kawanishi et al. (2003)
Arctic sea ice thickness from submarine transects		In situ	Intermittent Track-based	2.3.2	1975–2000	Rothrock et al. (2008)
Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation (APHRODITE's) Precipitation		In situ	Daily 0.05° × 0.05°	8.3.2 10.2.1 10.6.3	1900–2020	Kamiguchi et al. (2010); Yatagai et al. (2012)

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Name	Version	Type	Resolution (Time and Space)	Section(s)	Time Period	Citation, Link and DOI (Where Available)
Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation Monsoon Asia (APHRO-MA)	V1808	In situ	Daily 0.5°	Cross-Chapter Box (CCB) 10.4	1961–2014	Yasutomi et al. (2011) http://aphrodite.st.hirosaki-u.ac.jp/products.html
Asian Precipitation – Highly-Resolved Observational Data Integration Towards Evaluation Monsoon Asia (APHRO-MA)	V1101	In situ	Daily 0.5°	10.6.3	1956–2005	Yatagai et al. (2012) http://aphrodite.st.hirosaki-u.ac.jp/products.html
Advanced Scatterometer (ASCAT)		Remote sensing	Daily 25 km	8.3.1	2006–2016	Wagner et al. (1999)
Cross-calibrated multi-platform wind dataset (Atlas)		Remote sensing, in situ	6-hourly 25 km	2.3.1	1987–2020	Atlas et al. (2011) www.remss.com/measurements/ccmp/
Australian vineyard data		In situ	Annual Point-based	2.3.4	Varies by site	Webb et al. (2011)
AVISO sea level observations		Remote sensing	Monthly 0.25°	9.2.4	1995–2020	Legeais et al. (2018) www.aviso.altimetry.fr/en/data/products/ocean-indicators-products/mean-sea-level.html
Beaune grape harvest dates		In situ	Annual Point-based	2.3.4	1354–2018	Labbé et al. (2019) www.euroclimhist.unibe.ch/en/
Berkeley Earth surface air temperature		In situ	Monthly 1° × 1° (or equivalent equal-area grid)	1.3.6 1.4.1 1.4.2 1.6.1 FAQ 1.2 2.3.1 CCB 2.3 3.3.1 3.7.3 10.3.3 10.6.4 Box 10.3 CCB 10.4 Atlas	1750–2020	Rohde and Hausfather (2020) www.berkeleyearth.org
Berlin City Measurement Network		In situ	1-minute	Box 10.3	Ongoing	www.geo.fu-berlin.de/en/met/service/stadtmessnetz/index.html
Bermuda Atlantic Time-series Study Data		In situ	Point-based	2.3.3	1988–2016	Bates et al. (2014); Bates and Johnson (2020) http://bats.bios.edu/bats-data/
Czech Republic precipitation (Bližňák)		In situ	10 min 0.01° × 0.01°	10.2.1	2002–2011	Bližňák et al. (2018)
Boulder stratospheric water vapour		In situ	Profiles approx. monthly Point-based	2.2.5	1980–2010	Hurst et al. (2011)
BUCL (Birmingham)		In situ	Hourly	Box 10.3	2013–2020	Chapman et al. (2015)
Global temperature data (Callendar)		In situ	Annual Global time series	1.3.3	1880–1935	Callendar (1938); Hawkins and Jones (2013)
Cyprus precipitation (Camera)		In situ	Daily 0.01° × 0.01°	10.2.1	1980–2010	Camera et al. (2014)
CAMS atmospheric composition reanalysis		Reanalysis	3-hourly 1° × 1°	7.3.3	2003–2018	Inness et al. (2019) http://atmosphere.copernicus.eu
Data of CARIACO ocean time-series program in the Cariaco Basin		In situ	Point-based	5.3.2	1996–2017	Bates et al. (2014) http://imars.marine.usf.edu/cariaco
CCU 'IKI-Monitoring' satellite data archive		Remote sensing	Daily Resolution varies	Atlas	1984–2020	Loupian et al. (2015)

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Community Emissions Data System (CEDS)		In situ	Monthly 50 km (nominal)	6.2.1	1750–2014	Hoesly et al. (2018) www.globalchange.umd.edu/ceds/
CERA-20C reanalysis		Reanalysis	3-hourly 125 km, 91 levels	10.3.3	1901–2010	Laloyaux et al. (2018) www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/cera-20c
CERES EBAF	Ed2.8	Remote sensing	Monthly 1°× 1°	3.8.2	2000–2018	Loeb et al. (2009, 2012) https://esgf-node.llnl.gov/search/obs4mips/
CERES EBAF	Ed4.0	Remote sensing	Monthly 1°× 1°	7.2.2 9.2.1	2000–2016	Loeb et al. (2017, 2020) http://ceres-tool.larc.nasa.gov/ord-tool/jsp/EBAF4Selection.jsp
NCEP Climate Forecast System Reanalysis (CFSR)		Reanalysis	Hourly T382 (approx. 38 km)	2.3.1 8.3.2	1979–2010	Saha et al. (2010) https://cfs.ncep.noaa.gov/cfsr/
High-resolution Gridded Daily Meteorological Dataset over Sub-Saharan Africa (Chaney)		Reanalysis	Daily 0.1° × 0.1°	10.2.1	1979–2005	Chaney et al. (2014)
Cheng ocean heat content		In situ	Monthly Ocean basin	2.3.3	1960–2020	Cheng et al. (2017)
Global mean sea level reconstruction (Church and White)		In situ, remote sensing	Monthly Global time series	2.3.3	1880–2009	Church and White (2011)
Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)	2.0	Remote sensing	Daily, monthly 0.25° × 0.25°	10.2.1	1981–2018	Funk et al. (2015) www.chc.ucsb.edu/data/chirps
CLIMATER		In situ	Daily Point-based	Atlas 5.2	1874–2020	Bulygina et al. (2014)
China Land Surface Air Temperature (CLSAT)		In situ	Monthly Point-based	2.3.1	1900–2020	Xu et al. (2018)
CPC Merged Analysis of Precipitation (CMAP)		Remote sensing	Monthly 2.5° × 2.5°	3.3.3 Atlas	1979–2020	Xie et al. (2007a) www.esrl.noaa.gov/psd/data/gridded/data.cmap.html
Copernicus Marine Environment Monitoring Service (CMEMS) ocean pH		In situ	Annual Global mean	2.3.3	1985–2020	Gehlen et al. (2020) https://marine.copernicus.eu/access-data/ocean-monitoring-indicators
CMEMS global mean sea level		Remote sensing	10-day Global time series	2.3.3	1993–2020	Ablain et al. (2019)
China Mean Surface Temperature (CMST)		In situ	Monthly 5° × 5°	2.3.1	1854–2020	Sun et al. (2021)
A gridded daily dataset over China CN05.1	5.1	In situ	Daily 0.25° × 0.25°	10.2.1	1961–2005	Wu and Gao (2013)
COBE Sea Surface Temperature	2	In situ	Daily 1° × 1°	2.4.3 2.4.5 3.7.6 3.7.7	1845–2020	Hirahara et al. (2014) https://ds.data.jma.go.jp/tcc/tcc/products/elnino/cobesst/cobe-sst.html
Bootstrap Sea Ice Concentrations From Nimbus-7 SMMR and DMSP SSM/I-SSMIS (Comiso)	3	Remote sensing	Monthly 25 km	2.3.2 3.4.1	1979–2020	Comiso (2017) https://nsidc.org/data/nsidc-0079
CORA Ocean Heat Content	5.2	In situ	Monthly Global time series	2.3.3	1950–2020	Cabanes et al. (2013) www.coriolis.eu.org/Science2/Global-Ocean/CORA
Co-WIN (Hong Kong)		In situ	15-minute	Box 10.3	2007–2020	Hung and Wo (2012)
Cowtan and Way global temperature	2.0	In situ	Monthly 5° × 5°	1.3.6 2.3.1 3.3.1	1850–2020	Cowtan and Way (2014) http://www-users.york.ac.uk/~kdc3/papers/coverage2013/series.html
Climate Prediction Center (CPC) Niño indices		In situ	Monthly Regional time series	2.4.2 2.4.3	1950–2020	www.cpc.ncep.noaa.gov/data/indices/ Derived from ERSSTv5

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Climate Prediction Centre (CPC) Precipitation		In situ	Hourly 2.0° × 2.5° Daily 0.25° × 0.25°	10.2.1	1948–2006	Higgins et al. (2000); Xie et al. (2007b); Chen et al. (2008)
CPC teleconnection indices (AAO, AO, NAO, PNA)		In situ	Daily Regional means	2.4.1	1950–2020 (1979–2019 for AAO)	www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_ao_index/teleconnections.shtml
CPC Unified Gauge-Based Analysis of Global Daily Precipitation		In situ, remote sensing	Daily 0.5° × 0.5°	8.3.1	1979–2019	Xie et al. (2010) https://psl.noaa.gov/data/gridded/data.cpc.globalprecip.html
CloudSat Cloud Profiling Radar (CPR)		Remote sensing	1.5 km horizontal, 0.5 km vertical	8.3.1	2006–2019	Tanelli et al. (2008)
CRU TS	4.02	In situ	Monthly 0.5° × 0.5°	3.3.2 3.3.3 3.7.3 5.2.1	1901–2017	Harris et al. (2014) https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.02/
CRU TS	4.03	In situ	Monthly 0.5° × 0.5°	10.6.2	1901–2017	Harris et al. (2014) https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.03/
CRU TS	4.04	In situ	Monthly 0.5° × 0.5°	2.3.1 8.3.2 Box 8.1 10.3.3 10.3.4 10.4.2 10.6.3 10.6.4 Box 10.3 CCB 10.4 Atlas	1901–2020	Harris et al. (2020) https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.04/
CRUTEM	4	In situ	Monthly 5° × 5°	10.6.4 Atlas	1850–2020	Jones et al. (2012) https://crudata.uea.ac.uk/cru/data/temperature/
CRUTEM	5	In situ	Monthly 5° × 5°	Atlas	1850–2020	Osborn et al. (2021) https://crudata.uea.ac.uk/cru/data/temperature/
Cryosat Arctic sea ice thickness data		Remote sensing	Monthly 25 × 25 km	2.3.2 9.4.1	2011–2020	Kwok and Cunningham (2015); Bamber et al. (2018) http://nsidc.org/cryosphere/sotc/sea_ice.html https://science-pds.cryosat.esa.int/
CSIR-ML6 air-sea CO_2 fluxes	2019	In situ	Monthly 1° × 1°	5.2.1	1982–2015	Gregor (2019) https://doi.org/10.6084/m9.figshare.7894976
CSIRO atmospheric gas measurements		In situ	Monthly Point-based	2.2.3 5.2.3	1976–2019	Langenfelds et al. (2002); Francey et al. (2003); Kirschke et al. (2013)
CSIRO global mean sea level		Remote sensing	Monthly 1° × 1°	2.3.3	1993–2020	Church and White (2011)
CSIRO ocean heat content		In situ	Annual Global	2.3.3	1950–2020	Domingues et al. (2008); Wijffels et al. (2016)
Mexican climate (Cuervo-Robayo)		In situ	Monthly 30 arcsec	10.2.1	1910–2009	Cuervo-Robayo et al. (2014)
3D-VAR regional reanalysis (Dahlgren)		Reanalysis	6-hourly 0.2° × 0.2°	10.2.1	1989–2010	Dahlgren et al. (2016)
Global sea level reconstruction (Dangendorf)		In situ, remote sensing	Monthly Regional means	1.2.1 2.3.3	1900–2015	Dangendorf et al. (2017, 2019)
DCNet (Washington)		In situ	Hourly	Box 10.3	Ongoing	Hicks et al. (2012)
Ethiopian precipitation (Dinku)		In situ	Sub-monthly 0.1° × 0.1°	10.2.1	1983–2013	Dinku et al. (2014)
Data of DYFAMED station in the Ligurian Sea		In situ	Point-based	5.3.2	1991–2016	Merlivat et al. (2018) http://dyfbase.obs-vlfr.fr/

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Eastern China spring phenology index		In situ	Annual Point-based	2.3.4	1834–2009	Ge et al. (2014)
European Climate Assessment & Dataset (ECA&D)		In situ	Daily Point-based	10.6.4	1775–2020	Klein Tank et al. (2002) www.ecad.eu/
EDGARv4.3.2	2019	In situ	Monthly 0.1° × 0.1°	6.7.1	1970–2012	Janssens-Maenhout et al. (2019) http://edgar.jrc.ec.europa.eu/overview.php?v=432_GHG&SECURE=123
EN4 ocean subsurface profiles		In situ	Monthly Point-based	2.3.3	1900–2020	Good et al. (2013) www.metoffice.gov.uk/hadobs/
E-OBS	V19.0	In situ	Daily 0.1° and 0.25°	10.3.3 10.6.4 Atlas 8.2	1950–2020	Cornes et al. (2018) www.ecad.eu/
ERA 20th Century (ERA-20C) reanalysis		Reanalysis	3-hourly Approx. 125 km, 128 vertical levels	2.3.1 3.3.3 3.7.1	1900–2010	Hersbach et al. (2015); Poli et al. (2016) www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-20c
ERA-5		Reanalysis	Hourly 30 km, 137 vertical levels	1.4.1 2.3.1 3.3.1 3.3.2 3.3.3 3.7.1 3.8.2 CCB 3.1 8.3.2 11.4.3 Box 11.4 Atlas	1979–2020	Hersbach et al. (2020) www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5
ECMWF ERA-Interim reanalysis		Reanalysis	6-hourly T255 spectral (approx. 80 km), 60 vertical levels	2.3.1 3.3.3 3.7.1 8.3.2 10.3.3	1979–2019	Dee et al. (2011) www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era-interim
ECMWF ERA-Interim reanalysis – Land		Reanalysis	6-hourly T255 spectral (approx. 80 km), 60 vertical levels	10.2.1	1979–2010	Balsamo et al. (2015)
NOAA ERSST sea surface temperature	5	In situ	Monthly 2° × 2°	2.4.2 2.4.3 2.4.5 3.7.3 3.7.6 3.7.7 9.2.1 CCB 9.2 Atlas	1880–2020	Huang et al. (2017) www.ncdc.noaa.gov/data-access/marineocean-data/extended-reconstructed-sea-surface-temperature-ersst-v5
ESA CCI sea surface temperature	L4-GHRSST-SSTdepth-OSTIA-GLOB	Remote sensing	Monthly 0.05° × 0.05°	3.8.2	1992–2010	Merchant et al. (2014a, b) ftp://anon-ftp.ceda.ac.uk/neodc/esacci/sst/data/
ESA CCI Soil Moisture	L3S-SSMV-COMBINED-v4.2	Remote sensing	Monthly, 0.25° × 0.25° Daily, global images	3.8.2 8.3.1	1979–2016	Y.Y. Liu et al. (2012); Dorigo et al. (2017); Gruber et al. (2017) ftp://anon-ftp.ceda.ac.uk/neodc/esacci/soil_moisture/data/
European Station for Time series in the Ocean Canary Islands (ESTOC)		In situ	Point-based	5.3.2	1995–2018	González-Dávila et al. (2010) http://data.plocan.eu/thredds/catalog/aggregate/public/ESTOCInSitu/EMSOservices/Biogeochemistry/catalog.html
Alpine precipitation grid dataset (EURO4M-APGD)	1.0	In situ	Daily 0.04° × 0.04°	10.2.2	1971–2008	Isotta et al. (2014)
FLO1K flow metrics dataset		In situ	Annual 1 km	2.3.1	1960–2015	Barbarossa et al. (2018)

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Fogt SAM reconstruction		In situ	Monthly index	2.4.1	1865–2005	Fogt et al. (2009) http://polarmet.osu.edu/ACD/sam/sam_recon.html
Global mean sea level reconstruction (Frederikse)	2018	In situ	Annual Global time series	2.3.3	1958–2014	Frederikse et al. (2018)
Global mean sea level reconstruction (Frederikse)	2020	In situ	Annual Global time series	2.3.3	1900–2018	Frederikse et al. (2020)
GHCN precipitation	2	In situ	Monthly 5° × 5°	3.3.2 3.8.1 3.8.2	1900–2014	Jones and Moberg (2003) www.esrl.noaa.gov/psd/data/gridded/data.ghcngridded.html
Global Historical Climatology Network (GHCN) – Monthly	4	In situ	Monthly Point-based	2.3.1 3.8.2 10.3.3	1880–2020	Menne et al. (2018) www.ncdc.noaa.gov/ghcnm/
GHCNDEX		In situ	Monthly 2.5° × 2.5°	2.3.1	1951–2020	Donat et al. (2013b) www.climdex.org
Global albedo change (Ghimire)		In situ	Monthly 1° × 1°	2.2.7	1700–2005	Ghimire et al. (2014)
GISTEMP	4	In situ	Monthly 2° × 2°	1.3.6 2.3.1 3.7.3 CCB 3.1 10.6.4 Box 10.3	1880–2020	Lenssen et al. (2019) https://data.giss.nasa.gov/gistemp/
Glacier Thickness Database (GlaThiDa)	3.0.1	In situ	Annual Point-based	9.5.1	1935–2018	GlaThiDa Consortium (2019) www.gtn-g.ch/data_catalogue_glathida/ doi:10.5904/wgms-glathida-2019-03
GLDAS		Reanalysis	Monthly 1° × 1°	3.4.2 8.3.1	1951–2010	Rodell et al. (2004) https://hydro1.gesdisc.eosdis.nasa.gov/data/GLDAS/GLDAS_NOAH10_M.2.0/
Global Carbon Project		In situ	Global Spatial average	5.2.1 5.2.2	1959–2020	Friedlingstein et al. (2020); Saunois et al. (2020) www.globalcarbonproject.org/
Global Ocean Data Analysis Project (GLODAP)	2	In situ	Point-based	5.2.1	1972–2020	Olsen et al. (2019) www.glodap.info/
Global Space-based Stratospheric Aerosol Climatology (GloSSAC)	1.0	Remote sensing	Monthly 5° zonal means	2.2.2 7.3.2	1979–2016	Thomason et al. (2018) https://eosweb.larc.nasa.gov
Ghana Meteorological Agency (GMet) precipitation	1.0	In situ	Monthly 0.5° × 0.5°	10.2.1	1990–2012	Aryee et al. (2018)
GOME global total ozone (GTO) dataset		Remote sensing	Monthly 1° × 1°	2.2.5	1996–2020	Coldewey-Egbers et al. (2015) www.esa-ozone-cci.org/?q=node/163
GOME GSG ozone dataset		Remote sensing	Monthly 5° zonal means	2.2.5	1995–2020	Weber et al. (2018a) www.iup.uni-bremen.de/gome/wfdoas/merged/
GOSAT	2019	Remote sensing	Hourly–monthly	5.2.1	2009–2017	Yoshida et al. (2013) www.gosat.nies.go.jp/en/recent-global-ch4.html
Global Precipitation Climatology Centre (GPCC)	8	In situ	Monthly 0.25° × 0.25°	1.2.1 2.3.1 3.3.3 3.7.3 8.3.1 8.3.2 Box 8.1 10.3.3 10.4.2 10.6.3 10.6.4 11.6.2 Atlas	1981–2020	Becker et al. (2013); Schneider et al. (2017) ftp://ftp.dwd.de/pub/data/gpcc/html/fulldata-monthly_v2018_doi_download.html

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Global Precipitation Climatology Project (GPCP)	2.3	Remote sensing, in situ	Monthly 2.5° × 2.5°	2.3.1 3.3.2 3.3.3 3.7.3 3.8.2 8.2.3 8.3.1 9.2.1 10.4.2 Atlas	1979–2020	Adler et al. (2018) www.esrl.noaa.gov/psd/data/gridded/data.gpcp.html
Gravity Recovery and Climate Experiment (GRACE)		Remote sensing	3 days 400 m	2.3.2 8.3.1	2002–2017	Tapley et al. (2004); Wouters et al. (2019) https://gracefo.jpl.nasa.gov/data/grace-fo-data/
GRID-Sat		Remote sensing	15-minute 4 km	8.3.1	1994–2016	Inamdar and Knapp (2015)
The Oceanic sink for anthropogenic CO_2 from 1994 to 2007 – the data (Gruber)		In situ	1° × 1°	5.2.1		Gruber et al. (2019) www.nodc.noaa.gov/archive/arc0132/0186034/1.1/data/0-data/
Global Streamflow Indices and Metadata Archive (GSIM)		In situ	Daily Point-based	2.3.1	1806–2016	Do et al. (2018)
GSMaP		Remote sensing	Hourly 0.1°	10.3.3	2007–2020	Kubota et al. (2020)
GEWEX Water Vapour Assessment (G-VAP)		Reanalysis, remote sensing	Monthly 2° × 2°	2.3.1	1988–2009	Schröder et al. (2018) http://gewex-vap.org/
HadAT	2	In situ	Monthly 5° latitude by 10° longitude	Atlas	1958–2012	Thorne et al. (2005) www.metoffice.gov.uk/hadobs/hadat/
HadCRUT	5	In situ	Monthly 5° × 5°	1.2.1 1.3.6 1.4.1 1.6.1 2.3.1 CCB 2.3 3.3.1 3.6.1 3.8.1 CCB 3.1 Box 10.3	1850–2020	Morice et al. (2021) www.metoffice.gov.uk/hadobs/
HadCRUT	4	In situ	Monthly 5° × 5°	3.3.1 FAQ 3.1 8.2.3 10.3.3 10.6.4	1850–2020	Morice et al. (2012) www.metoffice.gov.uk/hadobs/hadcrut4/
HadEX	2	In situ	Monthly 3.75° × 2.5°	2.3.1	1901–2010	Donat et al. (2013a) www.climdex.org
HadEX	3	In situ	Monthly 1.875° × 1.25°	CCB 3.2 11.1.4 11.3.2 11.4.3 11.6.2	1901–2020	Dunn et al. (2020) www.metoffice.gov.uk/hadobs/hadex3/
HadGHCND		In situ	Daily 3.75° × 2.5°	Atlas	1950–2014	Caesar et al. (2006) www.metoffice.gov.uk/hadobs/hadghcnd/
HadISD	2.0.2. 2017f	In situ	Sub-daily Point-based	2.3.1	1973–2020	Dunn et al. (2012, 2016) www.metoffice.gov.uk/hadobs/hadisd/
HadISDH	1.0.0. 2019f	In situ	Monthly 5° × 5°	2.3.1	1973–2020	Willett et al. (2014, 2020) www.metoffice.gov.uk/hadobs/hadisdh/

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Hadley Centre Sea Ice and Sea Surface Temperature dataset (HadISST)	1	In situ, remote sensing	Monthly 1° × 1°	2.4.3 2.4.5 3.5.1 3.7.3 3.7.6 3.7.7 3.8.1 7.4.4 9.2.1	1871–2020	Rayner et al. (2003) www.metoffice.gov.uk/hadobs/hadisst/
Hadley Centre HadNMAT2 night marine air temperature	2	In situ	Monthly 5° × 5°	CCB 2.3	1880–2010	Kent et al. (2013) www.metoffice.gov.uk/hadobs/hadnmat2/
Hadley Centre Sea Level Pressure (HadSLP)	2r	In situ, reanalysis	Monthly 5° × 5°	3.3.3	1850–2020	Allan and Ansell (2006) www.metoffice.gov.uk/hadobs/hadslp2/
Hadley Centre HadSST sea surface temperature	4	In situ	Monthly 5° × 5°	9.2.1 Atlas	1850–2020	Kennedy et al. (2019) www.metoffice.gov.uk/hadobs/
HadUK-Grid	1.0	In situ	Daily 0.009° × 0.009°	10.2.1	1862–2019	www.metoffice.gov.uk/climate/uk/data/haduk-grid/haduk-grid
Hawaii Ocean Time-series Data		In situ	Point-based	2.3.3	1988–2018	Dore et al. (2009) http://hahana.soest.hawaii.edu/hot/hot-dogs/interface.html
Global mean sea level reconstruction (Hay)		In situ	Annual Global mean	2.3.3	1901–2010	Hay et al. (2015)
Boulder stratospheric water vapor (Hegglin)		In situ		2.2.5	1980–2010	Hegglin et al. (2014)
Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite data record (HOAPS4)		Remote sensing	6-hourly 0.5° × 0.5°	2.3.1	1987–2014	Andersson et al. (2010, 2017) https://wui.cmsaf.eu/safira/action/viewDoiDetails?acronym=HOAPS_V002 doi:10.5676/EUM_SAF_CM/HOAPS/V002
Glacier and ice sheet dataset (Hugonnet)		Remote sensing	Annual Point-based	2.3.2	2000–2019	Hugonnet et al. (2021)
Central European high-resolution gridded daily datasets (HYRAS)	1.0	In situ	Daily 0.5° × 0.5°, 0.25° × 0.25°	10.2.1	1951–2006	Frick et al. (2014)
IAGOS airborne ozone data		In situ	Intermittent	2.2.5 6.3.2	1994–2020	Cohen et al. (2018); Cooper et al. (2020); Gaudel et al. (2020) www.iagos-data.fr/ doi:10.25326/20
ICESat sea ice thickness data		Remote sensing	Intermittent 25 × 25 km	2.3.1	2003–2008	Kwok et al. (2009) http://nsidc.org/cryosphere/sotc/sea_ice.html
International Comprehensive Ocean–Atmosphere Data Set (ICOADS)	3.0	In situ	Frequency varies, point-based Monthly, 1° × 1°	2.3.1	1662–2019	Freeman et al. (2017) https://icoads.noaa.gov/
IFREMER4	4	Remote sensing	Daily 0.25° × 0.25°	9.2.1	1992–2017	de Boyer Montégut et al. (2004); Bentamy et al. (2017)
Integrated Global Radiosonde Archive (IGRA)		In situ	Point-based	8.3.1	1900–2019	Durre et al. (2006) https://data.noaa.gov/dataset/dataset/integrated-global-radiosonde-archive-igra-version-2
IMBIE Greenland and Antarctic ice sheet mass		Remote sensing	Regional aggregate	2.3.2 9.4.1 9.4.2	1992–2017	The IMBIE Team (2018, 2019, 2021)
Indian Monsoon Data Assimilation and Analysis (IMDAA)		Reanalysis	Sub-daily 0.11° × 0.11°	10.2.1	1979–2016	Mahmood et al. (2018)
Indian Institute of Tropical Meteorology (IITM) all-India rainfall		In situ	Monthly Time series	10.6.3	1871–1993	Parthasarathy et al. (1994)
IPRC subsurface temperature data		In situ	Monthly 1° × 1°	2.3.3	2005–2020	http://apdrc.soest.hawaii.edu/projects/Argo/data/gridded/On_standard_levels/index-1.html

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ISAS-15 temperature and salinity gridded fields		In situ	Monthly 1° × 1°	2.3.3	2002–2015	Gaillard et al. (2016); Kolodziejczyk et al. (2017) www.seanoe.org/data/00412/52367/
Ocean heat content (Ishii)		In situ	Annual Time series	2.3.3 9.2.2	1955–2020	Ishii et al. (2017)
JAMSTEC Database for time series stations K2 and S1		In situ	Point-based	5.3.2	1997–2018	Wakita et al. (2017) www.godac.jamstec.go.jp/catalog/data_catalog/metadataDisp/JAMSTEC_K2_S1?lang=en
Jena-MLS air–sea CO_2 fluxes	2018	In situ	Daily 4° × 5°	5.2.1	1982–2017	Rödenbeck et al. (2013, 2014) www.bgc-jena.mpg.de/CarboScope/?ID=oc
Global mean sea level reconstruction (Jevrejeva)		In situ	Annual Global time series	2.3.3	1807–2009	Jevrejeva et al. (2014)
JMA-TRANSCOM		Reanalysis	Monthly 1° × 1°	3.6.1 3.8.2	1985–2008	Gurney et al. (2003)
Japanese Ocean Flux Data Sets with Use of Remote Sensing Observations (JOFURO3)	3	Remote sensing	Daily 0.25° × 0.25°	8.3.1	1988–2013	Tomita et al. (2017)
Belgium precipitation (Journée)		In situ	Daily 4 km^2	10.2.1	1981–2010	Journée et al. (2015)
Japan Meteorological Agency JRA-55 reanalysis		Reanalysis	3-hourly TL319 (approx. 55 km), 60 vertical levels	2.3.1 3.3.3 3.7.1 3.8.2 8.3.2 10.3.3 CCB 10.4	1958–2020	Kobayashi et al. (2015); Harada et al. (2016) https://jra.kishou.go.jp/JRA-55/index_en.html
JRA-25		Reanalysis	6-hourly T106 (approx. 120km)	10.3.3	1979–2004	Onogi et al. (2007) https://jra.kishou.go.jp/JRA-25/index_en.html
Kadow global temperature dataset		In situ	Monthly 5° × 5°	1.4.1 1.6.1 2.3.1 CCB 2.3 3.3.1 CCB 3.1	1850–2020	Kadow et al. (2020)
Kaplan Extended SST dataset	2	In situ	Monthly 5° × 5°	2.4.3 2.4.5 Atlas	1856–2019	Kaplan et al. (1998) www.esrl.noaa.gov/psd/data/gridded/data.kaplan_sst.html
Greenland Ice Sheet discharge (King)		Remote sensing	Annual Regional time series	9.4.1	1985–2018	King et al. (2020) https://datadryad.org/stash/dataset/doi:10.5061/dryad.qrfj6q5cb doi:10.5061/dryad.qrfj6q5cb
Kyoto cherry blossom data		In situ	Annual Point-based	2.3.4	801–2020	Aono and Saito (2010) http://atmenv.envi.osakafu-u.ac.jp/aono/kyophenotemp4/
LAI3g		Remote sensing	Monthly 0.5° × 0.5°	3.6.1 3.8.2	1982–2011	Zhu et al. (2013)
LandFlux-EVAL		In situ	Monthly	3.8.2 8.3.1	2000–2004	Mueller et al. (2013) www.iac.ethz.ch/groups/seneviratne/research/LandFlux-EVAL
Landsat Global Land Survey (GLS) database		Remote sensing	Daily Global images	8.3.1	1972–2019	Gutman et al. (2013)
LAQN (London)		In situ	15-minute	Box 10.3	1993–2019	www.londonair.org.uk
LDEO Global Ocean Surface Water Partial Pressure of CO_2 Database		In situ	Point-based	5.3.2	1957–2018	Takahashi et al. (2014) www.nodc.noaa.gov/ocads/oceans/LDEO_Underway_Database/NDP-088_V2018.pdf
LEGOS sea level budget		Remote sensing	Monthly Global time series	2.3.3	1993–2020	Blazquez et al. (2018)

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Combined satellite and station data (Maidment)		Remote sensing, in situ	10-day 0.0375° × 0.0375°	10.2.1	1983–2012	Maidment et al. (2014)
Marshall SAM index		In situ	Monthly Regional means	2.4.1	1957–2020	Marshall (2003) www.nerc-bas.ac.uk/icd/gjma/sam.html
Princeton MEaSUREs		Reanalysis, remote sensing, in situ	Monthly 0.5° × 0.5°	8.3.1	1950–2019	Pan et al. (2012)
Multivariate ENSO Index (MEI)		In situ	Monthly	5.2.3	1977–2017	Wolter and Timlin (1998) www.esrl.noaa.gov/psd/enso/mei/
Historical greenhouse gas concentrations for climate modelling (Meinshausen)		In situ	Monthly 15° zonal means	2.2.3	1850–2014	Meinshausen et al. (2017) www.climatecollege.unimelb.edu.au/cmip6
MERRA Reanalysis	1	Reanalysis	3-hourly 0.5° × 0.66°	8.3.2	1979–2016	Rienecker et al. (2011)
MERRA-2 reanalysis	2	Reanalysis	Hourly 0.5 × 0.66°, 72 vertical levels	2.3.1 3.3.3 8.3.2	1980–2020	Gelaro et al. (2017) https://gmao.gsfc.nasa.gov/reanalysis/MERRA-2/
MERRA-2 reanalysis – Land	2	Reanalysis	6-hourly 0.5° × 0.66°, 72 vertical levels	8.3.1	1980–2020	Reichle (2012) http://gmao.gsfc.nasa.gov/pubs/office_notes
METROS (Tokyo)		In situ	15-minute	Box 10.3	2000–2005	Takahashi et al. (2011)
MIROC4-ACTM emission flux data	2018	Reanalysis	Monthly 1° × 1°	5.2.2	1996–2016	Patra et al. (2016, 2018); Saeki and Patra (2017) https://ebcrpa.jamstec.go.jp/~prabir/data/co2l2r84/s042_FaChOt_srcdf1/ https://ebcrpa.jamstec.go.jp/~prabir/data/ch4l2r53/gcp2019/ https://ebcrpa.jamstec.go.jp/~prabir/data/n2ol2r84/s037_edgman1/
MISR Component Global Aerosol Product	V4, Level 3	Remote sensing	Yearly 0.5° × 0.5° grid	2.2.6	2000–2020	Garay et al. (2017) https://cmr.earthdata.nasa.gov/search/concepts/C43677715-LARC.html
MOCCA (Ghent)		In situ	15-minute	Box 10.3	2016–2020	Vandemeulebroucke et al. (2019); Caluwaerts et al. (2020)
NASA Merged Ozone Data (MOD)	8.6	Remote sensing	Monthly 5° zonal means	2.2.6	1970–2020	Frith et al. (2017) https://acd-ext.gsfc.nasa.gov/Data_services/merged/index.html
MODIS Aerosol Optical Depth 550nm	MYD08_M3	Remote sensing	Monthly 1° × 1°	2.2.6	2003–2011	Platnick et al. (2003) https://ladsweb.modaps.eosdis.nasa.gov/search/order
MODIS NDVI/EVI vegetation greenness index	6	Remote sensing	16-day 1 km	5.2.1	2000–2018	Myneni et al. (2015) doi:10.5067/MODIS/MCD15A2H.006
Moderate Resolution Imaging Spectro-radiometer (MODIS)	MCD12Q1	Remote sensing	Annual 500 m	8.3.1	2001–2019	Loveland and Belward (1997)
MPI-SOMFFN air–sea CO_2 fluxes	2016	In situ	Monthly 1° × 1°	3.8.2 5.2.1	1982–2015	Landschützer et al. (2016) www.nodc.noaa.gov/ocads/oceans/SPCO2_1982_2015_ETH_SOM_FFN.html
Ozone Multi-sensor Reanalysis (MSR)	2	Reanalysis	6-hourly 1° × 1°	2.2.5	1970–2019	Braesicke et al. (2018); Chipperfield et al. (2018); Weber et al. (2018b, 2020) www.temis.nl/protocols/O3global.php
Multi-Source Weighted-Ensemble Precipitation dataset (MSWEP)		Reanalysis, remote sensing, in situ	3-hourly 0.25° × 0.25°	8.3.1	1979–2015	Beck et al. (2017) https://wald.anu.edu.au/data_services/data/mswep-multi-source-weighted-ensem%C2%ADble-pre%C2%ADcip%C2%ADi%C2%ADta%C2%ADtion/
MTE Gross Primary Productivity	May12	Reanalysis	Monthly 0.5° × 0.5°	3.8.2	1982–2011	Jung et al. (2011)

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Northern Hemisphere Blended Snow Cover Extent and Snow Mass Time Series (Mudryk)		Remote sensing, in situ	Monthly Time series	2.3.2 3.4.2 9.5.3	1980–2018	Mudryk et al. (2020) http://data.ec.gc.ca/data/climate/scientificknowledge/climate-research-publication-based-data/northern-hemisphere-blended-snow-extent-and-snow-mass-time-series/
NASA global mean sea level	4.2	Remote sensing	10-day Global time series	2.3.3	1993–2020	Beckley et al. (2016)
NASA Team Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS Passive Microwave Data	1	Remote sensing	Monthly 25 km	3.4.1	1979–2019	Cavalieri et al. (1996) https://nsidc.org/data/nsidc-0051
NCEI Ocean Heat Content		In situ	Annual 1° × 1°	2.3.3 9.2.2 9.3.2	1955–2020	Levitus et al. (2012) www.ncei.noaa.gov/access/global-ocean-heat-content/
NCEP-NCAR Reanalysis		Reanalysis	Daily and monthly 2.5° × 2.5°	3.7.1 3.8.2 10.3.3	1980–2020	Kalnay et al. (1996) www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.html
New Zealand temperature and rainfall datasets		In situ	Daily Point-based	Atlas 6.2	1870–2020	NIWA (2020)
NIWA $d^{13}C$-CO_2	2019	In situ	Monthly	5.2.1	1957–2015	Turnbull et al. (2017)
NOAA atmospheric gas measurements		In situ	Time resolution depends on gas Point-based	2.2.3 2.2.4 3.6.1 5.1.2 5.2.1 5.2.2 5.2.3	Varies depending on gas	Masarie and Tans (2004); Montzka et al. (2009, 2015); Hall et al. (2011); Dlugokencky and Tans (2019) www.esrl.noaa.gov/gmd/ccgg/
NOAA ESRL MLO Carbon dioxide		In situ	Monthly Point-based	3.6.1	1980–2014	Zeng et al. (2014) www.esrl.noaa.gov/gmd/ccgg/trends/data.html
NOAA Global Temp	5	In situ	Monthly 5° × 5°	1.3.6 10.6.4	1880–2020	Huang et al. (2020) www.ncdc.noaa.gov/data-access/marineocean-data/noaa-global-surface-temperature-noaaglobaltemp
NOAA Global Temp – Interim		In situ	Monthly 5° × 5°	1.4.1 1.6.1 2.3.1 3.3.1 CCB 2.3 CCB 3.1	1850–2020	Vose et al. (2021)
NOAA Merge ozone data (SBUV)	8.6	Remote sensing	Daily 5° zonal means	2.2.5	1978–2020	Wild et al. (2016) ftp://ftp.cpc.ncep.noaa.gov/SBUV_CDR/
NOAA reconstructed snow cover dataset		Remote sensing, in situ	Monthly Hemispheric time series	3.4.2 9.5.3	1915–1997	Brown (2002); Brown and Robinson (2011) https://nsidc.org/data/g02131
NOAA Climate Data Record of Sea Ice Concentration	3.0	Remote sensing	Monthly 25 km	2.3.2	1979–2020	Peng et al. (2013) https://nsidc.org/data/g02202
NOAA STAR satellite temperature	3.0	Remote sensing	Monthly 2.5° × 2.5°, 3 vertical layers	2.3.1	1979–2020	Zou and Wang (2011) www.star.nesdis.noaa.gov/smcd/emb/mscat/
National Oceanography Centre (NOC) surface flux and meteorological dataset	2.0	In situ	Monthly 1° × 1°	2.3.1	1973–2014	Berry and Kent (2011) http://badc.nerc.ac.uk/data/nocs_flux/
African Rainfall Climatology (Novella and Thiaw)	2.0	Remote sensing	Daily 0.1° × 0.1°	10.2.1	1983–2010	Novella and Thiaw (2013)
National Sea and Ice Data Center (NSIDC) sea ice index	3	Remote sensing	Daily 25 km	2.3.2	1978–2020	Fetterer et al. (2017) https://nsidc.org/data/G02135/versions/3

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NASA Water Vapor Project MEaSUREs (NVAP-M)		Remote sensing	Daily 1°	2.3.1	1988–2008	Vonder Haar et al. (2012) https://public.satproj.klima.dwd.de/data/GVAP_data_archive/v1.0/TCWV/long/
NYCMET-NET (New York)	2.0.0	In situ	15-minute	Box 10.3	Ongoing	http://nycmetnet.ccny.cuny.edu
OAFlux		Remote sensing	Daily 0.25° × 0.25°	2.3.1 9.2.1	1987–2019	Yu et al. (2008) http://oaflux.whoi.edu/
Ocean Colour Climate Change Initiative (OC-CCI)	4.2	Remote sensing	Daily 4 km	2.3.4	1997–2019	Sathyendranath et al. (2019) https://climate.esa.int/en/projects/ocean-colour/
Ocean Satellite Oceanographic Datasets for Acidification (OCEAN SODA-ETHZ)		Remote sensing	Monthly 1°	2.3.3	1985–2018	Gregor and Gruber (2021) doi:10.25921/m5wx-ja34
NOAA Optimum Interpolation SST (OISST)	2	In situ, remote sensing	Daily 0.25° × 0.25°	2.4.3	1981–2020	Reynolds et al. (2002); Banzon et al. (2016) www.ncdc.noaa.gov/oisst
OSISAF/ CCI sea ice concentration	450	Remote sensing	Monthly 25 km	2.3.2 3.4.1	1979–2015	Lavergne et al. (2019) http://osisaf.met.no/p/ice/
USA temperature (Oyler)		In situ	Daily 30-arcsec	10.2.1	1948–2012	Oyler et al. (2015)
Swiss Alps (Panziera)		Remote sensing	Sub-daily 0.01° × 0.01°	10.2.1	2005–2017	Panziera et al. (2018)
Gridded dataset of hourly precipitation in Germany (Paulat)		In situ	Hourly 0.06° × 0.06°	10.2.1	2001–2004	Paulat et al. (2008)
Portland State University (PDX) CH_4, $d^{13}C$-CH_4	2017	In situ	Daily–monthly	5.2.2	1977–2010	Rice et al. (2016)
PERSIANN-CDR		Remote sensing	Daily 0.25° × 0.25°	10.2.1	1982–2020	Ashouri et al. (2015) www.ncdc.noaa.gov/cdr/atmospheric/precipitation-persiann-cdr
Philadelphia plant data		In situ	Annual Point-based	2.3.4	1840–2010	Panchen et al. (2012)
PIOMAS Arctic sea ice reanalysis	2.1	Reanalysis	Monthly 4°–5°	7.2.2	1979–2020	Zhang and Rothrock (2003); Schweiger et al. (2011) http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/
PMEL ocean heat content		In situ	Annual Global time series	2.3.3	1950–2011	Lyman and Johnson (2014)
PROMICE Greenland Ice Sheet discharge		Remote sensing	Annual Regional time series	9.4.1	1986–2018	Mankoff et al. (2019) http://promice.org/PromiceDataPortal
PROMICE ice sheet mass balance		Remote sensing	Annual Regional time series	9.4.1	1995–2019	Colgan et al. (2019) http://promice.org/PromiceDataPortal
Purkey and Johnson ocean heat content		In situ	Annual Global mean	2.3.3	1981–2010	Purkey and Johnson (2010)
High Resolution Gridded Data for India (Rajeevan)	1.0	In situ	Daily 1° × 1°	10.6.3	1951–2003	Rajeevan et al. (2006)
Randolph Glacier Inventory	6	Remote sensing	Decametric shape files of glacier outlines, global 0.5° global grid of glacierized area	2.3.2 9.5.1	1955–2014	Scherler et al. (2018) www.glims.org/RGI/rgi60_dl.html
RAOB-CORE radiosonde dataset	1.7	In situ	Monthly 10° × 5°, 12 vertical levels	2.3.1 3.3.1	1958–2020	Haimberger et al. (2012) www.univie.ac.at/theoret-met/research/raobcore/
Global mean sea level reconstruction (Ray and Douglas)		In situ	Annual Global time series	2.3.3	1900–2010	Ray and Douglas (2011)

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Name	Version	Type	Resolution (Time and Space)	Section(s)	Time Period	Citation, Link and DOI (Where Available)
REGEN global precipitation	1	In situ	Daily 1° × 1°	10.3.2	1950–2016	Contractor et al. (2020) https://researchdata.ands.org.au/rainfall-estimates-gridded-v1-2019/1408744 doi:10.25914/5ca4c380b0d44
RICH radiosonde dataset	1.7	In situ	Monthly 10° × 5°, 12 vertical levels	2.3.1 3.3.1	1958–2020	Haimberger et al. (2012) www.univie.ac.at/theoret-met/research/raobcore/
Antarctic ice mass balance (Rignot)		Remote sensing	Annual Regional average	2.3.2	1979–2017	Rignot et al. (2019)
ROCADA daily dataset Romania	1.0	In situ	Daily 0.1° × 0.1°	10.2.1	1961–2013	Dumitrescu et al. (2016)
MSG-based gridded datasets of clouds, precipitation and radiation (Roebeling and Holleman)		Remote sensing	Daily 0.27° × 0.27°	10.2.1	2005–2019	Roebeling and Holleman (2009)
ROM SAF radio occultation climate data record		Remote sensing	Monthly 5° latitude bins, 200 m vertical resolution	2.3.1	2001–2020	Gleisner et al. (2020) www.romsaf.org
Arctic permafrost layer temperature (Romanovsky)		In situ	Annual Site-based	2.3.2	1977–2020	Romanovsky et al. (2020)
Israel precipitation (Rostkier-Edelstein)		Reanalysis	Seasonal 0.02° × 0.02°	10.2.1	1991–2009	Rostkier-Edelstein et al. (2014)
Remote Sensing Systems (RSS) precipitation and water vapour	7	Remote sensing	2 per day 0.25° × 0.25°	2.3.1 3.3.2	1987–2020	Wentz (2013) www.remss.com/measurements/rain-rate/
Remote Sensing Systems RSS satellite temperature	4.0	Remote sensing	Monthly 2.5° × 2.5°, 5 vertical layers	2.3.1	1979–2020	Mears and Wentz (2017) www.remss.com/measurements/upper-air-temperature/
Rutgers University/NOAA snow cover extent dataset	V01r01	Remote sensing	Weekly 100–200 km	2.3.2 9.5.3	1966–2020	Estilow et al. (2015) https://climate.rutgers.edu/snowcover/
SAFRAN temperature and precipitation for France		Reanalysis	Hourly 8 km^2	10.2.1	1958–2008	Vidal et al. (2010)
SAT1 NASA satellite ozone data		Remote sensing	Daily 1° × 1°	2.2.5	2004–2020	Ziemke et al. (2019) https://acd-ext.gsfc.nasa.gov/Data_services/cloud_slice/new_data.html
SAT2 NASA satellite ozone data		Remote sensing	Daily 1° × 1°	2.2.5	2004–2020	Heue et al. (2016)
SAT3 NASA satellite ozone data		Remote sensing	Daily 1° × 1°	2.2.5	2004–2020	Leventidou et al. (2018)
Scripps atmospheric CO_2 data		In situ	Weekly Point-based	1.2.1 2.2.3 5.2.1	1958–2019	Keeling et al. (2001, 2005) http://scrippsco2.ucsd.edu/data/atmospheric_co2/
SeaWIFS FAPAR Data	V2010.0	Remote sensing	Monthly 1 km	2.3.4	1998–2017	Gobron (2018) https://fapar.jrc.ec.europa.eu/Home.php
Norwegian seNorge2 precipitation	2.0	In situ	Daily 0.008° × 0.008°	10.2.1	1957–2019	Lussana et al. (2018)
Merged Precipitation in China (Shen)		In situ	Hourly 0.01° × 0.01°	10.2.1	2015	Shen et al. (2018)
The Surface Ocean CO_2 Atlas (SOCAT)	6	In situ	Point-based	5.2.1	1957–2020	Bakker et al. (2016) www.socat.info/
Southern Oscillation Index (SOI)		In situ	Monthly Regional time series	2.4.2	1876–2020	Troup (1965) www.bom.gov.au/climate/current/soihtm1.shtml
Spain02	5.0	In situ	Daily 0.1° × 0.1°	10.2.1	1948–2002	Herrera et al. (2016)

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Arosa stratospheric ozone data (Staehelin)		In situ	Time resolution varies Point-based	2.2.5	1926–2020	Staehelin et al. (2018)
STAMMEX		In situ	Daily 0.1°, 0.25° and 0.5°	8.3.1	1931–2000	Zolina et al. (2014)
State University of New York (SUNY) radiosonde dataset		In situ	Monthly 10° × 10°	2.3.1	1958–2020	Zhou et al. (2021)
Stratospheric Water and Ozone Satellite Homogenized (SWOOSH)	2.5	Remote sensing	Monthly 2.5° zonal mean, 12 vertical levels	2.2.5	1984–2020	Davis et al. (2016) https://data.nodc.noaa.gov/cgi-bin/iso?id=gov.noaa.ncdc:C00958
Tibetan plateau growing season		In situ	Annual Point-based	2.3.4	1960–2014	B. Yang et al. (2017)
Merged TM4NO2A tropospheric NO_2 dataset		Remote sensing	Monthly 0.25°	6.3.3	1996–2016	Georgoulias et al. (2019) www.temis.nl/airpollution/no2.php
Tropospheric Ozone Assessment Report (TOAR) surface ozone database		In situ	Hourly Point-based	6.3.2	1970–2020	Schultz et al. (2017); Tarasick et al. (2019) www.igacproject.org/activities/TOAR
Tohoku Univ. N_2O, $d^{15}N$, ^{15}Na	2018	In situ	Irregular	5.2.3	1950–2000	Ishijima et al. (2007)
TOST composite ozonesonde product		In situ	Monthly 5° × 5° × 1 km	2.2.5 6.3.2	1965–2012	Tarasick et al. (2010); Liu et al. (2013); Gaudel et al. (2018)
TRMM Precipitation Radar 3A25	7	Remote sensing	Monthly 0.5°	8.3.1	1997–2014	Iguchi et al. (2000)
TRMM GPOF	GPOF	Remote sensing	Daily 0.25° × 0.25°	8.3.1	1997–2015	Stocker et al. (2018)
TRMM Microwave Imager (TRMM TMI)	TMI	Remote sensing	3 day 0.25° × 0.25°	8.3.1	1997–2015	Wentz et al. (2001)
TRMM Multi-Satellite Precipitation Analysis	7.0	Remote sensing	3-hourly 0.25° × 0.25°	10.2.1	1997–2018	Huffman et al. (2007); TRMM (2011); Z. Liu et al. (2012) https://disc.gsfc.nasa.gov/datasets/TRMM_3B42_7/summary
Tropical Rainfall Measuring Mission Precipitation Radar (TRMM PR)	PR	Remote sensing	Monthly 0.5° × 0.5°	8.3.1	1997–2015	Haddad et al. (1997)
TWIN (Taipei)		In situ	Hourly	Box 10.3	2004–2020	Chang et al. (2010)
University of Alabama at Huntsville (UAH) satellite temperature	6.0	Remote sensing	Monthly 3 vertical layers	2.3.1	1979–2020	Spencer et al. (2017) www.nsstc.uah.edu/climate/
UC Berkeley, N_2O, $d^{15}N$, ^{15}Na	2018	In situ	Event	5.2.3	1900–1995	Park et al. (2012)
University of Colorado global mean sea level		Remote sensing	Monthly Global time series	2.3.3	1993–2017	Nerem et al. (2018)
UCAR/ NOAA radio occultation data		Remote sensing	Monthly 5° latitude bands	2.3.1	2002–2020	Steiner et al. (2020)
University of California at Irvine (UCI) atmospheric gas measurements		In situ	Several sampling periods per year Point-based	2.2.3	1984–2020	Simpson et al. (2012) http://cdiac.ornl.gov/tracegases.html
UEA-SI air–sea CO_2 fluxes	2015	In situ	Monthly 2.5° × 2.5°	5.2.1	1985–2011	Jones et al. (2015) doi:10.1594/PANGAEA.849262
UHH sea ice product		In situ, remote sensing	Monthly Area average	2.3.2	1850–2020	Doerr et al. (2021) www.fdr.uni-hamburg.de/record/8559#.YEtN09xxXIU doi:10.25592/uhhfdm.8525
UrBAN (Helsinki)		In situ	Sub-hourly	Box 10.3	2004–2020	Wood et al. (2013) http://urban.fmi.fi
Global temperature dataset (Vaccaro)		In situ	Monthly 5° × 5°	2.3.1	1850–2020	Vaccaro et al. (2021)

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W5E5 bias-adjusted reanalysis	1.0	Reanalysis	Daily 0.5° × 0.5°	Atlas	1979–2016	Lange (2019) https://dataservices.gfz-potsdam.de/pik/showshort.php?id=escidoc:4855898 doi:10.5880/pik.2019.023
Sea ice data (Walsh)		Remote sensing, in situ	Monthly	2.3.2	1850–2020	Walsh et al. (2017)
WASWind marine wind data		In situ	Monthly 4° × 4°	2.4.4	1950–2011	Tokinaga and Xie (2011) https://climatedataguide.ucar.edu/climate-data/waswind-wave-and-anemometer-based-sea-surface-wind
WCRP/Palmer global sea level		Remote sensing, in situ	Monthly Global time series	2.3.3	1901–2018	WCRP Global Sea Level Budget Group (2018); Palmer et al. (2021)
Wegener Centre radio occultation dataset		Remote sensing	Monthly 0.1 km vertical resolution	2.3.1	2001–2020	Angerer et al. (2017)
Global mean sea level reconstruction (Wenzel and Schröter)		In situ	Monthly Global time series	2.3.3	1900–2009	Wenzel and Schröter (2014)
WFDE5	1.0	Reanalysis	Hourly 0.5°	10.3.3	1979–2018	Cucchi et al. (2020)
WMO Global Atmosphere Watch greenhouse gas measurements		In situ	Annual Point-based and global means	2.2.3	1984–2020	Tsutsumi et al. (2009); WMO (2019) https://gaw.kishou.go.jp/publications/global_mean_mole_fractions
World Ocean Atlas (WOA)	2018	In situ	Monthly 1° × 1°	3.5.1	2009	Levitus et al. (2012); Locarnini et al. (2019); Zweng et al. (2019) www.nodc.noaa.gov/OC5/woa18/woa18data.html
World Ozone and UV Data Center (WOUDC) ozone dataset		In situ	Monthly Global and zonal means	2.2.5	1964–2020	Fioletov et al. (2002) https://woudc.org/
Global Earth Observation for Integrated Water Resource Assessment (Earth2Observe) Water Resources Reanalysis v2 (WRR2)	2	Reanalysis	Monthly 0.5° × 0.5°	8.3.1	1979–2012	Schellekens et al. (2017)
Brazil gridded met data 1980–2013 (Xavier)		In situ	Daily 0.25° × 0.25°	10.2.1	1980–2013	Xavier et al. (2016) http://careyking.com/data-downloads/
Chile precipitation (Yang)		In situ	Daily 0.04° × 0.04°	10.2.1	2009–2014	Z. Yang et al. (2017) www.climatedatalibrary.cl/SOURCES/
Ocean heat content and thermosteric sea level reconstruction (Zanna)		In situ	Annual Global means	2.3.3	1871–2017	Zanna et al. (2019)

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References

Aalto, J., P. Pirinen, and K. Jylhä, 2016: New gridded daily climatology of Finland: Permutation-based uncertainty estimates and temporal trends in climate. *Journal of Geophysical Research: Atmospheres*, **121(8)**, 3807–3823, doi:10.1002/2015jd024651.

Ablain, M. et al., 2019: Uncertainty in satellite estimates of global mean sea-level changes, trend and acceleration. *Earth System Science Data*, **11(3)**, 1189–1202, doi:10.5194/essd-11-1189-2019.

Adler, R.F. et al., 2018: The Global Precipitation Climatology Project (GPCP) monthly analysis (New Version 2.3) and a review of 2017 global precipitation. *Atmosphere*, **9(4)**, 138, doi:10.3390/atmos9040138.

Allan, R. and T. Ansell, 2006: A new globally complete monthly historical gridded mean sea level pressure dataset (HadSLP2): 1850–2004. *Journal of Climate*, **19(22)**, 5816–5842, doi:10.1175/jcli3937.1.

Allan, R.P. et al., 2014: Changes in global net radiative imbalance 1985–2012. *Geophysical Research Letters*, **41(15)**, 5588–5597, doi:10.1002/2014gl060962.

Andersson, A. et al., 2010: The Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data – HOAPS-3. *Earth System Science Data*, **2(2)**, 215–234, doi:10.5194/essd-2-215-2010.

Andersson, A. et al., 2017: Hamburg Ocean Atmosphere Parameters and Fluxes from Satellite Data – HOAPS 4.0. Satellite Application Facility on Climate Monitoring. Retrieved from: https://doi.org/10.5676/eum_saf_cm/hoaps/v002.

Angerer, B. et al., 2017: Quality aspects of the Wegener Center multi-satellite GPS radio occultation record OPSv5.6. *Atmospheric Measurement Techniques*, **10(12)**, 4845–4863, doi:10.5194/amt-10-4845-2017.

Aono, Y. and S. Saito, 2010: Clarifying springtime temperature reconstructions of the medieval period by gap-filling the cherry blossom phenological data series at Kyoto, Japan. *International Journal of Biometeorology*, **54(2)**, 211–219, doi:10.1007/s00484-009-0272-x.

Aryee, J.N.A. et al., 2018: Development of high spatial resolution rainfall data for Ghana. *International Journal of Climatology*, **38(3)**, 1201–1215, doi:10.1002/joc.5238.

Ashouri, H. et al., 2015: PERSIANN-CDR: Daily Precipitation Climate Data Record from Multisatellite Observations for Hydrological and Climate Studies. *Bulletin of the American Meteorological Society*, **96(1)**, 69–83, doi:10.1175/bams-d-13-00068.1.

Atlas, R. et al., 2011: A Cross-calibrated, Multiplatform Ocean Surface Wind Velocity Product for Meteorological and Oceanographic Applications. *Bulletin of the American Meteorological Society*, **92(2)**, 157–174, doi:10.1175/2010bams2946.1.

Bakker, D.C.E. et al., 2016: A multi-decade record of high-quality CO_2 data in version 3 of the Surface Ocean CO_2 Atlas (SOCAT). *Earth System Science Data*, **8(2)**, 383–413, doi:10.5194/essd-8-383-2016.

Balsamo, G. et al., 2015: ERA-Interim/Land: A global land surface reanalysis data set. *Hydrology and Earth System Sciences*, **19(1)**, 389–407, doi:10.5194/hess-19-389-2015.

Bamber, J.L., R.M. Westaway, B. Marzeion, and B. Wouters, 2018: The land ice contribution to sea level during the satellite era. *Environmental Research Letters*, **13(6)**, 63008, doi:10.1088/1748-9326/aac2f0.

Banzon, V., T.M. Smith, T.M. Chin, C. Liu, and W. Hankins, 2016: A long-term record of blended satellite and in situ sea-surface temperature for climate monitoring, modeling and environmental studies. *Earth System Science Data*, **8(1)**, 165–176, doi:10.5194/essd-8-165-2016.

Barbarossa, V. et al., 2018: Data Descriptor: FLO1K, global maps of mean, maximum and minimum annual streamflow at 1 km resolution from 1960 through 2015. *Scientific Data*, **5**, 1–11, doi:10.1038/sdata.2018.52.

Bates, N.R. and R.J. Johnson, 2020: Acceleration of ocean warming, salinification, deoxygenation and acidification in the surface subtropical North Atlantic Ocean. *Communications Earth & Environment*, **1(1)**, 33, doi:10.1038/s43247-020-00030-5.

Bates, N.R. et al., 2014: A Time-Series View of Changing Ocean Chemistry Due to Ocean Uptake of Anthropogenic CO_2 and Ocean Acidification. *Oceanography*, **27(1)**, 126–141, doi:10.5670/oceanog.2014.16.

Beck, H.E. et al., 2017: MSWEP: 3-hourly 0.25° global gridded precipitation (1979–2015) by merging gauge, satellite, and reanalysis data. *Hydrology and Earth System Sciences*, **21(1)**, 589–615, doi:10.5194/hess-21-589-2017.

Becker, A. et al., 2013: A description of the global land-surface precipitation data products of the Global Precipitation Climatology Centre with sample applications including centennial (trend) analysis from 1901–present. *Earth System Science Data*, **5(1)**, 71–99, doi:10.5194/essd-5-71-2013.

Beckley, B. et al., 2016: Global Mean Sea Level Trend from Integrated Multi-Mission Ocean Altimeters TOPEX/Poseidon Jason-1 and OSTM/Jason-2 Version 4.2. PO.DAAC, CA, USA, Retrieved from: https://doi.org/10.5067/GMSLM-TJ142.

Bentamy, A. et al., 2017: Review and assessment of latent and sensible heat flux accuracy over the global oceans. *Remote Sensing of Environment*, **201**, 196–218, doi:10.1016/j.rse.2017.08.016.

Berry, D.I. and E.C. Kent, 2011: Air–Sea fluxes from ICOADS: the construction of a new gridded dataset with uncertainty estimates. *International Journal of Climatology*, **31**, 987–1001, doi:10.1002/joc.2059.

Blazquez, A. et al., 2018: Exploring the uncertainty in GRACE estimates of the mass redistributions at the Earth surface: Implications for the global water and sea level budgets. *Geophysical Journal International*, **215(1)**, 415–430, doi:10.1093/gji/ggy293.

Bližňák, V., M. Kašpar, and M. Müller, 2018: Radar-based summer precipitation climatology of the Czech Republic. *International Journal of Climatology*, **38(2)**, 677–691, doi:10.1002/joc.5202.

Braesicke, A.P. et al., 2018: Update on Global Ozone: Past, Present and Future. In: *Scientific Assessment of Ozone Depletion: 2018*. Global Ozone Research and Monitoring Project – Report No. 58, World Meteorological Organization (WMO), Geneva, Switzerland, pp. 3.1–3.74, https://csl.noaa.gov/assessments/ozone/2018/downloads/.

Brown, R.D., 2002: Reconstructed North American, Eurasian, and Northern Hemisphere Snow Cover Extent, 1915–1997, Version 1. National Snow & Ice Data Center (NSIDC), Boulder, CO, USA, Retrieved from: https://dx.doi.org/10.7265/N5V985Z6.

Brown, R.D. and D.A. Robinson, 2011: Northern Hemisphere spring snow cover variability and change over 1922–2010 including an assessment of uncertainty. *The Cryosphere*, **5(1)**, 219–229, doi:10.5194/tc-5-219-2011.

Bulygina, O.N., N.N. Korshunova, and V.N. Razuvaev, 2014: Specialized datasets for climate research [in Russian]. *Trudy of VNIIGMI-WDC*, **177**, http://meteo.ru/publications/125-trudy-vniigmi/trudy-vniigmi-mtsd-vypusk-177-2014-g/518-spetsializirovannye-massivy-dannykh-dlya-klimaticheskikh-issledovanij.

Cabanes, C. et al., 2013: The CORA dataset: Validation and diagnostics of in-situ ocean temperature and salinity measurements. *Ocean Science*, **9(1)**, 1–18, doi:10.5194/os-9-1-2013.

Caesar, J., L. Alexander, and R. Vose, 2006: Large-scale changes in observed daily maximum and minimum temperatures: Creation and analysis of a new gridded data set. *Journal of Geophysical Research: Atmospheres*, **111(D5)**, D05101, doi:10.1029/2005jd006280.

Callendar, G.S., 1938: The artificial production of carbon dioxide and its influence on temperature. *Quarterly Journal of the Royal Meteorological Society*, **64(275)**, 223–240, doi:10.1002/qj.49706427503.

Caluwaerts, S. et al., 2020: The urban climate of Ghent, Belgium: A case study combining a high-accuracy monitoring network with numerical simulations. *Urban Climate*, **31**, 100565, doi:10.1016/j.uclim.2019.100565.

Camera, C., A. Bruggeman, P. Hadjinicolaou, S. Pashiardis, and M.A. Lange, 2014: Evaluation of interpolation techniques for the creation of gridded daily precipitation (1 × 1 km^2); Cyprus, 1980–2010. *Journal of Geophysical Research: Atmospheres*, **119(2)**, 693–712, doi:10.1002/2013jd020611.

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Cavalieri, D.J., C.L. Parkinson, P. Gloersen, and H.J. Zwally, 1996: Sea ice concentrations form Nimbus-7 SMMR and DMSP SSM/I passive microwave data, Version 1. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center, Boulder, CO, USA. Retrieved from: https://nsidc.org/data/nsidc-0051/versions/1.

Chaney, N.W., J. Sheffield, G. Villarini, and E.F. Wood, 2014: Development of a High-Resolution Gridded Daily Meteorological Dataset over Sub-Saharan Africa: Spatial Analysis of Trends in Climate Extremes. *Journal of Climate*, **27(15)**, 5815–5835, doi:10.1175/jcli-d-13-00423.1.

Chang, B., H.Y. Wang, T.Y. Peng, and Y.S. Hsu, 2010: Development and evaluation of a city-wide wireless weather sensor network. *Journal of Educational Technology & Society*, **13(3)**, 270–280, doi:10.1172/jci37539.as.

Chapman, L. et al., 2015: The Birmingham Urban Climate Laboratory: An Open Meteorological Test Bed and Challenges of the Smart City. *Bulletin of the American Meteorological Society*, **96(9)**, 1545–1560, doi:10.1175/bams-d-13-00193.1.

Chen, M. et al., 2008: Assessing objective techniques for gauge-based analyses of global daily precipitation. *Journal of Geophysical Research: Atmospheres*, **113(D4)**, D04110, doi:10.1029/2007jd009132.

Cheng, L. et al., 2017: Improved estimates of ocean heat content from 1960 to 2015. *Science Advances*, **3(3)**, e1601545, doi:10.1126/sciadv.1601545.

Chipperfield, M.P. et al., 2018: On the Cause of Recent Variations in Lower Stratospheric Ozone. *Geophysical Research Letters*, **45(11)**, 5718–5726, doi:10.1029/2018gl078071.

Church, J.A. and N.J. White, 2011: Sea-level rise from the late 19th to the early 21st Century. *Surveys in Geophysics*, **32**, 585, doi:10.1007/s10712-011-9119-1.

Cohen, Y. et al., 2018: Climatology and long-term evolution of ozone and carbon monoxide in the upper troposphere–lower stratosphere (UTLS) at northern midlatitudes, as seen by IAGOS from 1995 to 2013. *Atmospheric Chemistry and Physics*, **18(8)**, 5415–5453, doi:10.5194/acp-18-5415-2018.

Coldewey-Egbers, M. et al., 2015: The GOME-type Total Ozone Essential Climate Variable (GTO-ECV) data record from the ESA Climate Change Initiative. *Atmospheric Measurement Techniques*, **8(9)**, 3923–3940, doi:10.5194/amt-8-3923-2015.

Colgan, W. et al., 2019: Greenland ice sheet mass balance assessed by PROMICE (1995–2015). *GEUS Bulletin*, **43**, doi:10.34194/geusb-201943-02-01.

Comiso, J.C., 2017: Bootstrap Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I-SSMIS, Version 3. NASA National Snow and Ice Data Center Distributed Active Archive Center, Boulder, CO, USA. Retrieved from: https://nsidc.org/data/nsidc-0079.

Compo, G.P. et al., 2011: The Twentieth Century Reanalysis Project. *Quarterly Journal of the Royal Meteorological Society*, **137(654)**, 1–28, doi:10.1002/qj.776.

Contractor, S. et al., 2020: Rainfall Estimates on a Gridded Network (REGEN) – a global land-based gridded dataset of daily precipitation from 1950 to 2016. *Hydrology and Earth System Sciences*, **24(2)**, 919–943, doi:10.5194/hess-24-919-2020.

Cooper, O.R. et al., 2020: Multi-decadal surface ozone trends at globally distributed remote locations. *Elementa: Science of the Anthropocene*, **8(1)**, 23, doi:10.1525/elementa.420.

Cornes, R.C., G. van der Schrier, E.J.M. van den Besselaar, and P.D. Jones, 2018: An Ensemble Version of the E-OBS Temperature and Precipitation Data Sets. *Journal of Geophysical Research: Atmospheres*, **123(17)**, 9391–9409, doi:10.1029/2017jd028200.

Cowtan, K. and R.G. Way, 2014: Coverage bias in the HadCRUT4 temperature series and its impact on recent temperature trends. *Quarterly Journal of the Royal Meteorological Society*, **140(683)**, 1935–1944, doi:10.1002/qj.2297.

Cucchi, M. et al., 2020: WFDE5: bias-adjusted ERA5 reanalysis data for impact studies. *Earth System Science Data*, **12(3)**, 2097–2120, doi:10.5194/essd-12-2097-2020.

Cuervo-Robayo, A.P. et al., 2014: An update of high-resolution monthly climate surfaces for Mexico. *International Journal of Climatology*, **34(7)**, 2427–2437, doi:10.1002/joc.3848.

Dahlgren, P., T. Landelius, P. Kållberg, and S. Gollvik, 2016: A high-resolution regional reanalysis for Europe. Part 1: Three-dimensional reanalysis with the regional HIgh-Resolution Limited-Area Model (HIRLAM). *Quarterly Journal of the Royal Meteorological Society*, **142(698)**, 2119–2131, doi:10.1002/qj.2807.

Dangendorf, S. et al., 2017: Reassessment of 20th century global mean sea level rise. *Proceedings of the National Academy of Sciences*, **114(23)**, 5946–5951, doi:10.1073/pnas.1616007114.

Dangendorf, S. et al., 2019: Persistent acceleration in global sea-level rise since the 1960s. *Nature Climate Change*, **9(9)**, 705–710, doi:10.1038/s41558-019-0531-8.

Davis, S.M. et al., 2016: The Stratospheric Water and Ozone Satellite Homogenized (SWOOSH) database: a long-term database for climate studies. *Earth System Science Data*, **8(2)**, 461–490, doi:10.5194/essd-8-461-2016.

de Boyer Montégut, C., G. Madec, A.S. Fischer, A. Lazar, and D. Iduicone, 2004: Mixed layer depth over the global ocean: An examination of profile data and a profile-based climatology. *Journal of Geophysical Research: Oceans*, **109(C12)**, C12003, doi:10.1029/2004jc002378.

Dee, D.P. et al., 2011: The ERA-Interim reanalysis: configuration and performance of the data assimilation system. *Quarterly Journal of the Royal Meteorological Society*, **137(656)**, 553–597, doi:10.1002/qj.828.

Dinku, T., K. Hailemariam, R. Maidment, E. Tarnavsky, and S. Connor, 2014: Combined use of satellite estimates and rain gauge observations to generate high-quality historical rainfall time series over Ethiopia. *International Journal of Climatology*, **34(7)**, 2489–2504, doi:10.1002/joc.3855.

Dlugokencky, E. and P. Tans, 2019: Trends in atmospheric carbon dioxide, National Oceanic and Atmospheric Administration. National Oceanic and Atmospheric Administration (NOAA) Global Monitoring Laboratory (GML). Retrieved from: www.esrl.noaa.gov/gmd/ccgg/trends/global.html.

Do, H.X., L. Gudmundsson, M. Leonard, and S. Westra, 2018: The Global Streamflow Indices and Metadata Archive (GSIM) – Part 1: The production of a daily streamflow archive and metadata. *Earth System Science Data*, **10(2)**, 765–785, doi:10.5194/essd-10-765-2018.

Doerr, J., D. Notz, and S. Kern, 2021: UHH Sea Ice Area Product (Version 2019_fv0.01). Retrieved from: http://doi.org/10.25592/uhhfdm.8559.

Domingues, C.M. et al., 2008: Improved estimates of upper-ocean warming and multi-decadal sea-level rise. *Nature*, **453(7198)**, 1090–1093, doi:10.1038/nature07080.

Donat, M.G. et al., 2013a: Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset. *Journal of Geophysical Research: Atmospheres*, **118(5)**, 2098–2118, doi:10.1002/jgrd.50150.

Donat, M.G. et al., 2013b: Global Land-Based Datasets for Monitoring Climatic Extremes. *Bulletin of the American Meteorological Society*, **94(7)**, 997–1006, doi:10.1175/bams-d-12-00109.1.

Dore, J.E., R. Lukas, D.W. Sadler, M.J. Church, and D.M. Karl, 2009: Physical and biogeochemical modulation of ocean acidification in the central North Pacific. *Proceedings of the National Academy of Sciences*, **106(30)**, 12235–12240, doi:10.1073/pnas.0906044106.

Dorigo, W. et al., 2017: ESA CCI Soil Moisture for improved Earth system understanding: State-of-the art and future directions. *Remote Sensing of Environment*, **203**, 185–215, doi:10.1016/j.rse.2017.07.001.

Dumitrescu, A., M.-V. Birsan, and A. Manea, 2016: Spatio-temporal interpolation of sub-daily (6 h) precipitation over Romania for the period 1975–2010. *International Journal of Climatology*, **36(3)**, 1331–1343, doi:10.1002/joc.4427.

Dunn, R.J.H., K.M. Willett, D.E. Parker, and L. Mitchell, 2016: Expanding HadISD: quality-controlled, sub-daily station data from 1931. *Geoscientific Instrumentation, Methods and Data Systems*, **5(2)**, 473–491, doi:10.5194/gi-5-473-2016.

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Dunn, R.J.H. et al., 2012: HadISD: a quality-controlled global synoptic report database for selected variables at long-term stations from 1973–2011. *Climate of the Past*, **8(5)**, 1649–1679, doi:10.5194/cp-8-1649-2012.

Dunn, R.J.H. et al., 2020: Development of an Updated Global Land In Situ-Based Data Set of Temperature and Precipitation Extremes: HadEX3. *Journal of Geophysical Research: Atmospheres*, **125(16)**, e2019JD032263, doi:10.1029/2019jd032263.

Durre, I., R.S. Vose, and D.B. Wuertz, 2006: Overview of the Integrated Global Radiosonde Archive. *Journal of Climate*, **19(1)**, 53–68, doi:10.1175/jcli3594.1.

Estilow, T.W., A.H. Young, and D.A. Robinson, 2015: A long-term Northern Hemisphere snow cover extent data record for climate studies and monitoring. *Earth System Science Data*, **7(1),** 137–142, doi:10.5194/essd-7-137-2015.

Evans, A., D.A. Jones, R. Smalley, and S. Lellyett, 2020: *An enhanced gridded rainfall analysis scheme for Australia*. Bureau Research Report – 41, Bureau of Meteorology (BOM), Australia, www.bom.gov.au/research/publications/researchreports/BRR-041.pdf.

Fetterer, F., K. Knowles, W.N. Meier, M.H. Savoie, and A.K. Windnagel, 2017: Sea Ice Index, Version 3. National Snow & Ice Data Center (NSIDC), Boulder, CO, USA. Retrieved from: https://dx.doi.org/10.7265/N5K072F8.

Fioletov, V.E., G.E. Bodeker, A.J. Miller, R.D. McPeters, and R. Stolarski, 2002: Global and zonal total ozone variations estimated from ground-based and satellite measurements: 1964–2000. *Journal of Geophysical Research: Atmospheres*, **107(D22)**, ACH 21-1–ACH 21-14, doi:10.1029/2001jd001350.

Fogt, R.L. et al., 2009: Historical SAM variability. Part II: Twentieth-century variability and trends from reconstructions, Observations, and the IPCC AR4 models. *Journal of Climate*, **22(20)**, 5346–5365, doi:10.1175/2009jcli2786.1.

Francey, R.J. et al., 2003: The CSIRO (Australia) measurement of greenhouse gases in the global atmosphere. In: *Baseline Atmospheric Program Australia 1999–2000* [Tindale, N.W., N. Derek, and P.J. Fraser (eds.)]. Bureau of Meteorology (BOM) and CSIRO Atmospheric Research, Australia, pp. 42–53, www.cmar.csiro.au/e-print/open/baseline_1999-2000.pdf.

Frederikse, T., S. Jevrejeva, R.E.M. Riva, and S. Dangendorf, 2018: A consistent sea-level reconstruction and its budget on basin and global scales over 1958–2014. *Journal of Climate*, **31(3)**, 1267–1280, doi:10.1175/jcli-d-17-0502.1.

Frederikse, T. et al., 2020: The causes of sea-level rise since 1900. *Nature*, **584(7821)**, 393–397, doi:10.1038/s41586-020-2591-3.

Freeman, E. et al., 2017: ICOADS Release 3.0: a major update to the historical marine climate record. *International Journal of Climatology*, **37(5)**, 2211–2232, doi:10.1002/joc.4775.

Frick, C. et al., 2014: Central European high-resolution gridded daily data sets (HYRAS): Mean temperature and relative humidity. *Meteorologische Zeitschrift,* **23(1),** 15–32, doi:10.1127/0941-2948/2014/0560.

Friedlingstein, P. et al., 2020: Global Carbon Budget 2020. *Earth System Science Data*, **12(4)**, 3269–3340, doi:10.5194/essd-12-3269-2020.

Frith, S.M., R.S. Stolarski, N.A. Kramarova, and R.D. McPeters, 2017: Estimating uncertainties in the SBUV Version 8.6 merged profile ozone data set. *Atmospheric Chemistry and Physics*, **17(23)**, 14695–14707, doi:10.5194/acp-17-14695-2017.

Funk, C. et al., 2015: The climate hazards infrared precipitation with stations – a new environmental record for monitoring extremes. *Scientific Data*, **2(1)**, 150066, doi:10.1038/sdata.2015.66.

Gaillard, F., T. Reynaud, V. Thierry, N. Kolodziejczyk, and K. von Schuckmann, 2016: In Situ–Based Reanalysis of the Global Ocean Temperature and Salinity with ISAS: Variability of the Heat Content and Steric Height. *Journal of Climate*, **29(4)**, 1305–1323, doi:10.1175/jcli-d-15-0028.1.

Garay, M.J., O. Kalashnikova, and M.A. Bull, 2017: Development and assessment of a higher-spatial-resolution (4.4 km) MISR aerosol optical depth product using AERONET-DRAGON data. *Atmospheric Chemistry and Physics*, **17(8)**, 5095–5106, doi:10.5194/acp-17-5095-2017.

Gaudel, A. et al., 2018: Tropospheric Ozone Assessment Report: Present-day distribution and trends of tropospheric ozone relevant to climate and global atmospheric chemistry model evaluation. *Elementa: Science of the Anthropocene*, **6(39)**, doi:10.1525/elementa.291.

Gaudel, A. et al., 2020: Aircraft observations since the 1990s reveal increases of tropospheric ozone at multiple locations across the Northern Hemisphere. *Science Advances*, **6(34)**, eaba8272, doi:10.1126/sciadv.aba8272.

Ge, Q., H. Wang, J. Zheng, R. This, and J. Dai, 2014: A 170 year spring phenology index of plants in eastern China. *Journal of Geophysical Research: Biogeosciences*, **119(3)**, 301–311, doi:10.1002/2013jg002565.

Gehlen, M. et al., 2020: Ocean acidification [in "The Copernicus Marine Service Ocean State Report, Issue 4"]. *Journal of Operational Oceanography*, **13(sup1)**, s64–s67, doi:10.1080/1755876x.2020.1785097.

Gelaro, R. et al., 2017: The Modern-Era Retrospective Analysis for Research and Applications, Version 2 (MERRA-2). *Journal of Climate*, **30(14)**, 5419–5454, doi:10.1175/jcli-d-16-0758.1.

Georgoulias, A.K., R.J. van der A, P. Stammes, K.F. Boersma, and H.J. Eskes, 2019: Trends and trend reversal detection in 2 decades of tropospheric NO_2 satellite observations. *Atmospheric Chemistry and Physics*, **19(9)**, 6269–6294, doi:10.5194/acp-19-6269-2019.

Ghimire, B. et al., 2014: Global albedo change and radiative cooling from anthropogenic land cover change, 1700 to 2005 based on MODIS, land use harmonization, radiative kernels, and reanalysis. *Geophysical Research Letters*, **41(24)**, 9087–9096, doi:10.1002/2014gl061671.

Giles, D.M. et al., 2019: Advancements in the Aerosol Robotic Network (AERONET) Version 3 database – automated near-real-time quality control algorithm with improved cloud screening for Sun photometer aerosol optical depth (AOD) measurements. *Atmospheric Measurement Techniques*, **12(1)**, 169–209, doi:10.5194/amt-12-169-2019.

GlaThiDa Consortium, 2019: Glacier Thickness Database 3.0.1. World Glacier Monitoring Service, Zurich, Switzerland. Retrieved from: https://dx.doi.org/10.5904/wgms-glathida-2019-03.

Gleisner, H., K.B. Lauritsen, J.K. Nielsen, and S. Syndergaard, 2020: Evaluation of the 15-year ROM SAF monthly mean GPS radio occultation climate data record. *Atmospheric Measurement Techniques*, **13(6)**, 3081–3098, doi:10.5194/amt-13-3081-2020.

Gobron, N., 2018: Terrestrial Vegetation Activity [in "State of the Climate in 2017"]. *Bulletin of the American Meteorological Society*, **99**, S62–S63, doi:10.1175/2018bamsstateoftheclimate.1.

González-Dávila, M., J.M. Santana-Casiano, M.J. Rueda, and O. Llinás, 2010: The water column distribution of carbonate system variables at the ESTOC site from 1995 to 2004. *Biogeosciences*, **7(10)**, 3067–3081, doi:10.5194/bg-7-3067-2010.

Good, S.A., M.J. Martin, and N.A. Rayner, 2013: EN4: Quality controlled ocean temperature and salinity profiles and monthly objective analyses with uncertainty estimates. *Journal of Geophysical Research: Oceans*, **118(12)**, 6704–6716, doi:10.1002/2013jc009067.

Gregor, L., 2019: Global surface ocean pCO_2 from CSIR-ML6 (version 2019a). figshare. Retrieved from: https://dx.doi.org/10.6084/m9.figshare.7894976.v1.

Gregor, L. and N. Gruber, 2021: OceanSODA-ETHZ: a global gridded data set of the surface ocean carbonate system for seasonal to decadal studies of ocean acidification. *Earth System Science Data*, **13(2)**, 777–808, doi:10.5194/essd-13-777-2021.

Gruber, A., W.A. Dorigo, W. Crow, and W. Wagner, 2017: Triple Collocation-Based Merging of Satellite Soil Moisture Retrievals. *IEEE Transactions on Geoscience and Remote Sensing*, **55(12)**, 6780–6792, doi:10.1109/tgrs.2017.2734070.

Gruber, N. et al., 2019: The oceanic sink for anthropogenic CO_2 from 1994 to 2007. *Science*, **363(6432)**, 1193–1199, doi:10.1126/science.aau5153.

Gurney, K.R. et al., 2003: TransCom 3 CO_2 inversion intercomparison: 1. Annual mean control results and sensitivity to transport and prior flux information. *Tellus, Series B: Chemical and Physical Meteorology*, **55(2)**, 555–579, doi:10.1034/j.1600-0889.2003.00049.x.

Gutman, G., C. Huang, G. Chander, P. Noojipady, and J.G. Masek, 2013: Assessment of the NASA–USGS Global Land Survey (GLS) datasets. *Remote Sensing of Environment*, **134**, 249–265, doi:10.1016/j.rse.2013.02.026.

Downloaded from https://www.cambridge.org/core. IP address: 13.58.4.169, on 10 Jul 2024 at 03:15:08, subject to the Cambridge Core terms of use, available at https://www.cambridge.org/core/terms. https://doi.org/10.1017/9781009157896.015

Haddad, Z.S. et al., 1997: The TRMM Day-1 Radar/Radiometer Combined Rain-Profiling Algorithm. *Journal of the Meteorological Society of Japan. Series II*, **75(4)**, 799–809, doi:10.2151/jmsj1965.75.4_799.

Haimberger, L., C. Tavolato, and S. Sperka, 2012: Homogenization of the Global Radiosonde Temperature Dataset through Combined Comparison with Reanalysis Background Series and Neighboring Stations. *Journal of Climate*, **25(23)**, 8108–8131, doi:10.1175/jcli-d-11-00668.1.

Hall, B.D. et al., 2011: Improving measurements of SF_6 for the study of atmospheric transport and emissions. *Atmospheric Measurement Techniques*, **4(11)**, 2441–2451, doi:10.5194/amt-4-2441-2011.

Harada, Y. et al., 2016: The JRA-55 Reanalysis: Representation of atmospheric circulation and climate variability. *Journal of the Meteorological Society of Japan. Series II*, **94(3)**, 269–302, doi:10.2151/jmsj.2016-015.

Harris, I., P.D. Jones, T.J. Osborn, and D.H. Lister, 2014: Updated high-resolution grids of monthly climatic observations – the CRU TS3.10 Dataset. *International Journal of Climatology*, **34(3)**, 623–642, doi:10.1002/joc.3711.

Harris, I., T.J. Osborn, P. Jones, and D. Lister, 2020: Version 4 of the CRU TS monthly high-resolution gridded multivariate climate dataset. *Scientific Data*, **7(1)**, 109, doi:10.1038/s41597-020-0453-3.

Hawkins, E. and P.D. Jones, 2013: On increasing global temperatures: 75 years after Callendar. *Quarterly Journal of the Royal Meteorological Society*, **139(677)**, 1961–1963, doi:10.1002/qj.2178.

Hay, C.C., E. Morrow, R.E. Kopp, and J.X. Mitrovica, 2015: Probabilistic reanalysis of twentieth-century sea-level rise. *Nature*, **517(7535)**, 481–484, doi:10.1038/nature14093.

Hegglin, M.I. et al., 2014: Vertical structure of stratospheric water vapour trends derived from merged satellite data. *Nature Geoscience*, **7**, 768, doi:10.1038/ngeo2236.

Herrera, S., J. Fernández, and J.M. Gutiérrez, 2016: Update of the Spain02 gridded observational dataset for EURO-CORDEX evaluation: assessing the effect of the interpolation methodology. *International Journal of Climatology*, **36(2)**, 900–908, doi:10.1002/joc.4391.

Hersbach, H. et al., 2015: ERA-20CM: a twentieth-century atmospheric model ensemble. *Quarterly Journal of the Royal Meteorological Society*, **141(691)**, 2350–2375, doi:10.1002/qj.2528.

Hersbach, H. et al., 2020: The ERA5 global reanalysis. *Quarterly Journal of the Royal Meteorological Society*, **146**, 1999–2049, doi:10.1002/qj.3803.

Heue, K.P. et al., 2016: Trends of tropical tropospheric ozone from 20 years of European satellite measurements and perspectives for the Sentinel-5 Precursor. *Atmospheric Measurement Techniques*, **9(10)**, 5037–5051, doi:10.5194/amt-9-5037-2016.

Hicks, B.B., W.J. Callahan, W.R. Pendergrass, R.J. Dobosy, and E. Novakovskaia, 2012: Urban Turbulence in Space and in Time. *Journal of Applied Meteorology and Climatology*, **51(2)**, 205–218, doi:10.1175/jamc-d-11-015.1.

Higgins, R., W. Shi, E. Yarosh, and R. Joyce, 2000: *Improved United States Precipitation Quality Control System and Analysis*. NCEP/Climate Prediction Center ATLAS No. 7, National Oceanic and Atmospheric Administration (NOAA)/ National Weather Service (NWS), Camp Springs, MD, USA, www.cpc.ncep.noaa.gov/research_papers/ncep_cpc_atlas/7/index.html.

Hirahara, S., M. Ishii, and Y. Fukuda, 2014: Centennial-Scale Sea Surface Temperature Analysis and Its Uncertainty. *Journal of Climate*, **27(1)**, 57–75, doi:10.1175/jcli-d-12-00837.1.

Hoesly, R.M. et al., 2018: Historical (1750–2014) anthropogenic emissions of reactive gases and aerosols from the Community Emissions Data System (CEDS). *Geoscientific Model Development*, **11(1)**, 369–408, doi:10.5194/gmd-11-369-2018.

Huang, B. et al., 2017: Extended Reconstructed Sea Surface Temperature, Version 5 (ERSSTv5): Upgrades, Validations, and Intercomparisons. *Journal of Climate*, **30(20)**, 8179–8205, doi:10.1175/jcli-d-16-0836.1.

Huang, B. et al., 2020: Uncertainty Estimates for Sea Surface Temperature and Land Surface Air Temperature in NOAAGlobalTemp Version 5. *Journal of Climate*, **33(4)**, 1351–1379, doi:10.1175/jcli-d-19-0395.1.

Huffman, G.J. et al., 2007: The TRMM Multisatellite Precipitation Analysis (TMPA): Quasi-Global, Multiyear, Combined-Sensor Precipitation Estimates at Fine Scales. *Journal of Hydrometeorology*, **8(1)**, 38–55, doi:10.1175/jhm560.1.

Hugonnet, R. et al., 2021: Accelerated global glacier mass loss in the early twenty-first century. *Nature*, **592(7856)**, 726–731, doi:10.1038/s41586-021-03436-z.

Hung, T.K. and O.C. Wo, 2012: Development of a Community Weather Information Network (Co-WIN) in Hong Kong. *Weather*, **67(2)**, 48–50, doi:10.1002/wea.1883.

Hurst, D.F. et al., 2011: Stratospheric water vapor trends over Boulder, Colorado: Analysis of the 30 year Boulder record. *Journal of Geophysical Research: Atmospheres*, **116(D2)**, D02306, doi:10.1029/2010jd015065.

Iguchi, T., T. Kozu, R. Meneghini, J. Awaka, and K. Okamoto, 2000: Rain-Profiling Algorithm for the TRMM Precipitation Radar. *Journal of Applied Meteorology*, **39(12)**, 2038–2052, doi:10.1175/1520-0450(2001)040<2038:rpaftt>2.0.co;2.

Inamdar, A.K. and K.R. Knapp, 2015: Intercomparison of Independent Calibration Techniques Applied to the Visible Channel of the ISCCP B1 Data. *Journal of Atmospheric and Oceanic Technology*, **32(6)**, 1225–1240, doi:10.1175/jtech-d-14-00040.1.

Inness, A. et al., 2019: The CAMS reanalysis of atmospheric composition. *Atmospheric Chemistry and Physics*, **19(6)**, 3515–3556, doi:10.5194/acp-19-3515-2019.

Ishii, M. et al., 2017: Accuracy of Global Upper Ocean Heat Content Estimation Expected from Present Observational Data Sets. *SOLA*, **13**, 163–167, doi:10.2151/sola.2017-030.

Ishijima, K. et al., 2007: Temporal variations of the atmospheric nitrous oxide concentration and its $\delta^{15}N$ and $\delta^{18}O$ for the latter half of the 20th century reconstructed from firn air analyses. *Journal of Geophysical Research: Atmospheres*, **112(D3)**, D03305, doi:10.1029/2006jd007208.

Isotta, F.A. et al., 2014: The climate of daily precipitation in the Alps: development and analysis of a high-resolution grid dataset from pan-Alpine rain-gauge data. *International Journal of Climatology*, **34(5)**, 1657–1675, doi:10.1002/joc.3794.

Janssens-Maenhout, G. et al., 2019: EDGAR v4.3.2 Global Atlas of the three major greenhouse gas emissions for the period 1970–2012. *Earth System Science Data*, **11(3),** 959–1002, doi:10.5194/essd-11-959-2019.

Jevrejeva, S., J.C. Moore, A. Grinsted, A.P. Matthews, and G. Spada, 2014: Trends and acceleration in global and regional sea levels since 1807. *Global and Planetary Change*, **113**, 11–22, doi:10.1016/j.gloplacha.2013.12.004.

Jones, D.A., W. Wang, and R. Fawcett, 2009: High-quality spatial climate datasets for Australia. *Australian Meteorological and Oceanographic Journal*, **58**, 233–248, doi:10.22499/2.5804.003.

Jones, P.D. and A. Moberg, 2003: Hemispheric and Large-Scale Surface Air Temperature Variations: An Extensive Revision and an Update to 2001. *Journal of Climate*, **16(2)**, 206–223, doi:10.1175/1520-0442(2003)016<0206:halssa>2.0.co;2.

Jones, P.D. et al., 2012: Hemispheric and large-scale land-surface air temperature variations: An extensive revision and an update to 2010. *Journal of Geophysical Research: Atmospheres*, **117(D5)**, D05127, doi:10.1029/2011jd017139.

Jones, S.D., C. Le Quéré, C. Rödenbeck, A.C. Manning, and A. Olsen, 2015: Data and Code archive for the interpolation of surface ocean carbon dioxide. PANGAEA. Retrieved from: https://doi.org/10.1594/pangaea.849262.

Journée, M., C. Delvaux, and C. Bertrand, 2015: Precipitation climate maps of Belgium. *Advances in Science and Research*, **12(1)**, 73–78, doi:10.5194/asr-12-73-2015.

Jung, M. et al., 2011: Global patterns of land-atmosphere fluxes of carbon dioxide, latent heat, and sensible heat derived from eddy covariance, satellite, and meteorological observations. *Journal of Geophysical Research: Biogeosciences*, **116(3)**, 1–16, doi:10.1029/2010jg001566.

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Kadow, C., D.M. Hall, and U. Ulbrich, 2020: Artificial intelligence reconstructs missing climate information. *Nature Geoscience*, **13(6)**, 408–413, doi:10.1038/s41561-020-0582-5.

Kalnay, E. et al., 1996: The NCEP/NCAR 40-Year Reanalysis Project. *Bulletin of the American Meteorological Society*, **77(3)**, 437–472, doi:10.1175/1520-0477(1996)077<0437:tnyrp>2.0.co;2.

Kamiguchi, K. et al., 2010: Development of APHRO_JP, the first Japanese high-resolution daily precipitation product for more than 100 years. *Hydrological Research Letters*, **4**, 60–64, doi:10.3178/hrl.4.60.

Kaplan, A. et al., 1998: Analyses of global sea surface temperature 1856–1991. *Journal of Geophysical Research: Oceans*, **103(C9)**, 18567–18589, doi:10.1029/97jc01736.

Kawanishi, T. et al., 2003: The Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E), NASDA's contribution to the EOS for global energy and water cycle studies. *IEEE Transactions on Geoscience and Remote Sensing*, **41(2)**, 184–194, doi:10.1109/tgrs.2002.808331.

Keeling, C.D. et al., 2001: *Exchanges of atmospheric CO_2 and $^{13}CO_2$ with the terrestrial biosphere and oceans from 1978 to 2000. I. Global Aspects*. SIO Reference No. 01-06, **6(10),** 813–823, Scripps Institution of Oceanography, San Diego, CA, USA, 28 pp.

Keeling, C.D. et al., 2005: Atmospheric CO_2 and ^{13}CO2 Exchange with the Terrestrial Biosphere and Oceans from 1978 to 2000: Observations and Carbon Cycle Implications. In: *A History of Atmospheric CO_2 and its effects on Plants, Animals, and Ecosystems* [Ehleringer, J.R., T. Cerling, and M.D. Dearing (eds.)]. Springer, New York, NY, USA, pp. 83–113, doi:10.1007/0-387-27048-5_5.

Kennedy, J.J., N.A. Rayner, C.P. Atkinson, and R.E. Killick, 2019: An ensemble data set of sea-surface temperature change from 1850: the Met Office 1 Hadley Centre HadSST.4.0.0.0 data set. *Journal of Geophysical Research: Atmospheres*, **124**, 7719–7763, doi:10.1029/2018jd029867.

Kent, E.C. et al., 2013: Global analysis of night marine air temperature and its uncertainty since 1880: The HadNMAT2 data set. *Journal of Geophysical Research: Atmospheres*, **118(3)**, 1281–1298, doi:10.1002/jgrd.50152.

King, M.D. et al., 2020: Dynamic ice loss from the Greenland Ice Sheet driven by sustained glacier retreat. *Communications Earth & Environment*, **1(1)**, 1, doi:10.1038/s43247-020-0001-2.

Kirschke, S. et al., 2013: Three decades of global methane sources and sinks. *Nature Geoscience*, doi:10.1038/ngeo1955.

Klein Tank, A.M.G. et al., 2002: Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. *International Journal of Climatology*, **22(12)**, 1441–1453, doi:10.1002/joc.773.

Kobayashi, S. et al., 2015: The JRA-55 Reanalysis: General Specifications and Basic Characteristics. *Journal of the Meteorological Society of Japan. Series II*, **93(1)**, 5–48, doi:10.2151/jmsj.2015-001.

Kolodziejczyk, N., A. Prigent-Mazella, and F. Gaillard, 2017: ISAS temperature and salinity gridded fields. SEANOE. Retrieved from: https://dx.doi.org/10.17882/52367.

Kubota, T. et al., 2020: Global Satellite Mapping of Precipitation (GSMaP) Products in the GPM Era. In: *Satellite Precipitation Measurement: Volume 1* [Levizzani, V., C. Kidd, D.B. Kirschbaum, C.D. Kummerow, K. Nakamura, and F.J. Turk (eds.)]. Springer, Cham, Switzerland, pp. 355–373, doi:10.1007/978-3-030-24568-9_20.

Kummerow, C., R. Ferraro, and D. Duncan, 2015: NRT AMSR2 L2B Global Swath Goddard Profiling Algorithm 2010: Surface Precipitation, Wind Speed Over Ocean, Water Vapor over Ocean and Cloud Liquid Water over Ocean. NASA Global Hydrology Center DAAC, Huntsville, AL, USA. Retrieved from: https://dx.doi.org/10.5067/AMSR2/A2_RainOcn_NRT.

Kwok, R. and G.F. Cunningham, 2015: Variability of arctic sea ice thickness and volume from CryoSat-2. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, **373**, 2045, doi:10.1098/rsta.2014.0157.

Kwok, R. et al., 2009: Thinning and volume loss of the Arctic Ocean sea ice cover: 2003–2008. *Journal of Geophysical Research: Oceans*, **114(C7)**, C07005, doi:10.1029/2009jc005312.

Labbé, T. et al., 2019: The longest homogeneous series of grape harvest dates, Beaune 1354–2018, and its significance for the understanding of past and present climate. *Climate of the Past*, **15(4)**, 1485–1501, doi:10.5194/cp-15-1485-2019.

Laloyaux, P. et al., 2018: CERA-20C: A Coupled Reanalysis of the Twentieth Century. *Journal of Advances in Modeling Earth Systems*, **10(5)**, 1172–1195, doi:10.1029/2018ms001273.

Landschützer, P., N. Gruber, and D.C.E. Bakker, 2016: Decadal variations and trends of the global ocean carbon sink. *Global Biogeochemical Cycles*, **30(10)**, 1396–1417, doi:10.1002/2015gb005359.

Lange, S., 2019: WFDE5 over land merged with ERA5 over the ocean (W5E5). V. 1.0. GFZ Data Services. Retrieved from: https://dx.doi.org/10.5880/pik.2019.023.

Langenfelds, R.L. et al., 2002: Interannual growth rate variations of atmospheric CO_2 and its $\delta^{13}C$, H_2, CH_4, and CO between 1992 and 1999 linked to biomass burning. *Global Biogeochemical Cycles*, doi:10.1029/2001gb001466.

Lavergne, T. et al., 2019: Version 2 of the EUMETSAT OSI SAF and ESA CCI sea-ice concentration climate data records. *The Cryosphere*, **13(1)**, 49–78, doi:10.5194/tc-13-49-2019.

Legeais, J.-F. et al., 2018: An improved and homogeneous altimeter sea level record from the ESA Climate Change Initiative. *Earth System Science Data*, **10(1)**, 281–301, doi:10.5194/essd-10-281-2018.

Lenssen, N.J.L. et al., 2019: Improvements in the GISTEMP Uncertainty Model. *Journal of Geophysical Research: Atmospheres*, **124(12)**, 6307–6326, doi:10.1029/2018jd029522.

Leventidou, E. et al., 2018: Harmonisation and trends of 20-year tropical tropospheric ozone data. *Atmospheric Chemistry and Physics*, **18(13)**, 9189–9205, doi:10.5194/acp-18-9189-2018.

Levitus, S. et al., 2012: World ocean heat content and thermosteric sea level change (0–2000 m), 1955–2010. *Geophysical Research Letters*, **39(10)**, L10603, doi:10.1029/2012gl051106.

Liu, G. et al., 2013: A global tropospheric ozone climatology from trajectory-mapped ozone soundings. *Atmospheric Chemistry and Physics*, **13(21)**, 10659–10675, doi:10.5194/acp-13-10659-2013.

Liu, Y.Y. et al., 2012: Trend-preserving blending of passive and active microwave soil moisture retrievals. *Remote Sensing of Environment*, **123**, 280–297, doi:10.1016/j.rse.2012.03.014.

Liu, Z., D. Ostrenga, W. Teng, and S. Kempler, 2012: Tropical Rainfall Measuring Mission (TRMM) Precipitation Data and Services for Research and Applications. *Bulletin of the American Meteorological Society*, **93(9)**, 1317–1325, doi:10.1175/bams-d-11-00152.1.

Locarnini, R.A. et al., 2019: World Ocean Atlas 2018, Volume 1: Temperature [Mishonov, A. (ed.)]. National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS), Silver Spring, MD, USA, 43 pp., www.ncei.noaa.gov/data/oceans/woa/WOA18/DOC/woa18_vol1.pdf.

Loeb, N.G. et al., 2009: Toward optimal closure of the Earth's top-of-atmosphere radiation budget. *Journal of Climate*, **22(3)**, 748–766, doi:10.1175/2008jcli2637.1.

Loeb, N.G. et al., 2012: Observed changes in top-of-the-atmosphere radiation and upper-ocean heating consistent within uncertainty. *Nature Geoscience*, **5(2)**, 110–113, doi:10.1038/ngeo1375.

Loeb, N.G. et al., 2017: Clouds and the Earth's Radiant Energy System (CERES) Energy Balanced and Filled (EBAF) Top-of-Atmosphere (TOA) Edition-4.0 Data Product. *Journal of Climate*, **31(2)**, 895–918, doi:10.1175/jcli-d-17-0208.1.

Loeb, N.G. et al., 2020: New Generation of Climate Models Track Recent Unprecedented Changes in Earth's Radiation Budget Observed by CERES. *Geophysical Research Letters*, **47(5)**, e2019GL086705, doi:10.1029/2019gl086705.

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Loupian, E., M.A. Burtsev, S.A. Bartalev, and A. Kashnitskii, 2015: IKI center for collective use of satellite data archiving, processing and analysis systems aimed at solving the problems of environmental study and monitoring [in Russian]. *Current Problems In Remote Sensing Of The Earth From Space*, **12(5)**, 263–284, http://d33.infospace.ru/d33_conf/sb2015t5/263–284.pdf.

Loveland, T.R. and A.S. Belward, 1997: The IGBP-DIS global 1km land cover data set, DISCover: First results. *International Journal of Remote Sensing*, **18(15)**, 3289–3295, doi:10.1080/014311697217099.

Lussana, C. et al., 2018: seNorge2 daily precipitation, an observational gridded dataset over Norway from 1957 to the present day. *Earth System Science Data*, **10(1)**, 235–249, doi:10.5194/essd-10-235-2018.

Lyman, J.M. and G.C. Johnson, 2014: Estimating Global Ocean Heat Content Changes in the Upper 1800 m since 1950 and the Influence of Climatology Choice. *Journal of Climate*, **27(5)**, 1945–1957, doi:10.1175/jcli-d-12-00752.1.

Mahmood, S. et al., 2018: Indian monsoon data assimilation and analysis regional reanalysis: Configuration and performance. *Atmospheric Science Letters*, **19(3)**, e808, doi:10.1002/asl.808.

Maidment, R.I. et al., 2014: The 30 year TAMSAT African Rainfall Climatology And Time series (TARCAT) data set. *Journal of Geophysical Research: Atmospheres*, **119(18)**, 10619–10644, doi:10.1002/2014jd021927.

Mankoff, K.D. et al., 2019: Greenland Ice Sheet solid ice discharge from 1986 through 2017. *Earth System Science Data*, **11(2)**, 769–786, doi:10.5194/essd-11-769-2019.

Marshall, G.J., 2003: Trends in the Southern Annular Mode from Observations and Reanalyses. *Journal of Climate*, **16(24)**, 4134–4143, doi:10.1175/1520-0442(2003)016<4134:titsam>2.0.co;2.

Masarie, K.A. and P.P. Tans, 2004: Extension and integration of atmospheric carbon dioxide data into a globally consistent measurement record. *Journal of Geophysical Research: Atmospheres*, **100(D6)**, 11593–11610, doi:10.1029/95jd00859.

Mears, C.A. and F.J. Wentz, 2017: A Satellite-Derived Lower-Tropospheric Atmospheric Temperature Dataset Using an Optimized Adjustment for Diurnal Effects. *Journal of Climate*, **30(19)**, 7695–7718, doi:10.1175/jcli-d-16-0768.1.

Meinshausen, M. et al., 2017: Historical greenhouse gas concentrations for climate modelling (CMIP6). *Geoscientific Model Development*, **10(5)**, 2057–2116, doi:10.5194/gmd-10-2057-2017.

Menne, M.J., C.N. Williams, B.E. Gleason, J.J. Rennie, and J.H. Lawrimore, 2018: The Global Historical Climatology Network Monthly Temperature Dataset, Version 4. *Journal of Climate*, **31(24)**, 9835–9854, doi:10.1175/jcli-d-18-0094.1.

Merchant, C.J. et al., 2014a: Sea surface temperature datasets for climate applications from Phase 1 of the European Space Agency Climate Change Initiative (SST CCI). *Geoscience Data Journal*, **1(2)**, 179–191, doi:10.1002/gdj3.20.

Merchant, C.J. et al., 2014b: ESA Sea Surface Temperature Climate Change Initiative (ESA SST CCI): Analysis long term product version 1.0. NERC Earth Observation Data Centre, 24th February 2014. Retrieved from: https://doi.org/10.5285/878bef44-d32a-40cd-a02d-49b6286f0ea4.

Merlivat, L. et al., 2018: Increase of dissolved inorganic carbon and decrease in pH in near-surface waters in the Mediterranean Sea during the past two decades. *Biogeosciences*, **15(18)**, 5653–5662, doi:10.5194/bg-15-5653-2018.

Montzka, S.A., B.D. Hall, and J.W. Elkins, 2009: Accelerated increases observed for hydrochlorofluorocarbons since 2004 in the global atmosphere. *Geophysical Research Letters*, **36(3)**, L03804, doi:10.1029/2008gl036475.

Montzka, S.A. et al., 2015: Recent trends in global emissions of hydrochlorofluorocarbons and hydrofluorocarbons: Reflecting on the 2007 Adjustments to the Montreal protocol. *Journal of Physical Chemistry A*, **119(19)**, 4439–4449, doi:10.1021/jp5097376.

Morice, C.P., J.J. Kennedy, N.A. Rayner, and P.D. Jones, 2012: Quantifying uncertainties in global and regional temperature change using an ensemble of observational estimates: The HadCRUT4 data set. *Journal of Geophysical Research: Atmospheres*, **117(D8)**, D08101, doi:10.1029/2011jd017187.

Morice, C.P. et al., 2021: An Updated Assessment of Near-Surface Temperature Change From 1850: The HadCRUT5 Data Set. *Journal of Geophysical Research: Atmospheres*, **126(3)**, e2019JD032361, doi:10.1029/2019jd032361.

Mudryk, L. et al., 2020: Historical Northern Hemisphere snow cover trends and projected changes in the CMIP6 multi-model ensemble. *The Cryosphere*, **14(7)**, 2495–2514, doi:10.5194/tc-14-2495-2020.

Mueller, B. et al., 2013: Benchmark products for land evapotranspiration: LandFlux-EVAL multi-data set synthesis. *Hydrology and Earth System Sciences*, **17(10)**, 3707–3720, doi:10.5194/hess-17-3707-2013.

Myneni, R., Y. Kynazikhin, and T. Park, 2015: MCD15A2H MODIS/Terra+Aqua Leaf Area Index/FPAR 8-day L4 Global 500m SIN Grid V006 [Data set]. NASA EOSDIS Land Processes DAAC. Retrieved from: https://doi.org/10.5067/MODIS/MCD15A2H.006.

Nerem, R.S. et al., 2018: Climate-change–driven accelerated sea-level rise detected in the altimeter era. *Proceedings of the National Academy of Sciences*, **115(9)**, 2022–2025, doi:10.1073/pnas.1717312115.

NIWA, 2020: *Ministry for the Environment Atmosphere and Climate Report 2020: Updated Datasets supplied by NIWA*. National Institute of Water & Atmospheric Research (NIWA), Wellington, New Zealand, 36 pp., www.mfe.govt.nz/publications/environmental-reporting/ministry-environment-atmosphere-and-climate-report-2020-updated.

Novella, N.S. and W.M. Thiaw, 2013: African rainfall climatology version 2 for famine early warning systems. *Journal of Applied Meteorology and Climatology*, **52(3)**, 588–606, doi:10.1175/jamc-d-11-0238.1.

Olsen, A. et al., 2019: GLODAPv2.2019 – an update of GLODAPv2. *Earth System Science Data*, **11(3)**, 1437–1461, doi:10.5194/essd-11-1437-2019.

Onogi, K. et al., 2007: The JRA-25 Reanalysis. *Journal of the Meteorological Society of Japan. Series II*, **85(3)**, 369–432, doi:10.2151/jmsj.85.369.

Osborn, T.J. et al., 2021: Land Surface Air Temperature Variations Across the Globe Updated to 2019: The CRUTEM5 Data Set. *Journal of Geophysical Research: Atmospheres*, **126(2)**, e2019JD032352, doi:10.1029/2019jd032352.

Oyler, J.W., A. Ballantyne, K. Jencso, M. Sweet, and S.W. Running, 2015: Creating a topoclimatic daily air temperature dataset for the conterminous United States using homogenized station data and remotely sensed land skin temperature. *International Journal of Climatology*, **35(9)**, 2258–2279, doi:10.1002/joc.4127.

Palmer, M.D., C.M. Domingues, A.B.A. Slangen, and F. Boeira Dias, 2021: An ensemble approach to quantify global mean sea-level rise over the 20th century from tide gauge reconstructions. *Environmental Research Letters*, **16(4)**, 044043, doi:10.1088/1748-9326/abdaec.

Pan, M. et al., 2012: Multisource Estimation of Long-Term Terrestrial Water Budget for Major Global River Basins. *Journal of Climate*, **25(9)**, 3191–3206, doi:10.1175/jcli-d-11-00300.1.

Panchen, Z.A., R.B. Primack, T. Aniśko, and R.E. Lyons, 2012: Herbarium specimens, photographs, and field observations show Philadelphia area plants are responding to climate change. *American Journal of Botany*, **99(4)**, 751–756, doi:10.3732/ajb.1100198.

Panziera, L., M. Gabella, U. Germann, and O. Martius, 2018: A 12-year radar-based climatology of daily and sub-daily extreme precipitation over the Swiss Alps. *International Journal of Climatology*, **38(10)**, 3749–3769, doi:10.1002/joc.5528.

Park, S. et al., 2012: Trends and seasonal cycles in the isotopic composition of nitrous oxide since 1940. *Nature Geoscience*, **5(4)**, 261–265, doi:10.1038/ngeo1421.

Parthasarathy, B., A.A. Munot, and D.R. Kothawale, 1994: All-India monthly and seasonal rainfall series: 1871–1993. *Theoretical and Applied Climatology*, **49(4)**, 217–224, doi:10.1007/bf00867461.

Patra, P.K. et al., 2016: Regional Methane Emission Estimation Based on Observed Atmospheric Concentrations (2002–2012). *Journal of the Meteorological Society of Japan. Series II*, **94(1)**, 91–113, doi:10.2151/jmsj.2016-006.

Patra, P.K. et al., 2018: Improved Chemical Tracer Simulation by MIROC4.0-based Atmospheric Chemistry-Transport Model (MIROC4-ACTM). *SOLA*, **14**, 91–96, doi:10.2151/sola.2018-016.

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https://doi.org/10.1017/9781009157896.015

Paulat, M., C. Frei, M. Hagen, and H. Wernli, 2008: A gridded dataset of hourly precipitation in Germany: Its construction, climatology and application. *Meteorologische Zeitschrift*, **17(6)**, 719–732, doi:10.1127/0941-2948/2008/0332.

Peng, G., W.N. Meier, D.J. Scott, and M.H. Savoie, 2013: A long-term and reproducible passive microwave sea ice concentration data record for climate studies and monitoring. *Earth System Science Data*, **5(2)**, 311–318, doi:10.5194/essd-5-311-2013.

Platnick, S. et al., 2003: The MODIS cloud products: algorithms and examples from Terra. *IEEE Transactions on Geoscience and Remote Sensing*, **41(2)**, 459–473, doi:10.1109/tgrs.2002.808301.

Poli, P. et al., 2016: ERA-20C: An Atmospheric Reanalysis of the Twentieth Century. *Journal of Climate*, **29(11)**, 4083–4097, doi:10.1175/jcli-d-15-0556.1.

Prinn, R.G. et al., 2018: History of chemically and radiatively important atmospheric gases from the Advanced Global Atmospheric Gases Experiment (AGAGE). *Earth System Science Data*, **10(2)**, 985–1018, doi:10.5194/essd-10-985-2018.

Purkey, S.G. and G.C. Johnson, 2010: Warming of Global Abyssal and Deep Southern Ocean Waters between the 1990s and 2000s: Contributions to Global Heat and Sea Level Rise Budgets. *Journal of Climate*, **23(23)**, 6336–6351, doi:10.1175/2010jcli3682.1.

Rajeevan, M., J. Bhate, J.D. Kale, and B. Lal, 2006: High resolution daily gridded rainfall data for the Indian region: Analysis of break and active monsoon spells. *Current Science*, **91(3)**, 296–306, www.jstor.org/stable/24094135.

Ray, R.D. and B.C. Douglas, 2011: Experiments in reconstructing twentieth-century sea levels. *Progress in Oceanography*, **91(4)**, 496–515, doi:10.1016/j.pocean.2011.07.021.

Rayner, N.A. et al., 2003: Global analyses of sea surface temperature, sea ice, and night marine air temperature since the late nineteenth century. *Journal of Geophysical Research: Atmospheres*, **108(D14)**, 4407 doi:10.1029/2002jd002670.

Reichle, R.H., 2012: *The MERRA-Land Data Product*. GMAO Office Note No. 3 (Version 1.2), Global Modeling and Assimilation Office (GMAO), Greenbelt, MD, USA, 38 pp., http://gmao.gsfc.nasa.gov/pubs/office_notes.

Reynolds, R.W., N.A. Rayner, T.M. Smith, D.C. Stokes, and W. Wang, 2002: An Improved In Situ and Satellite SST Analysis for Climate. *Journal of Climate*, **15(13)**, 1609–1625, doi:10.1175/1520-0442(2002)015<1609:aiisas>2.0.co;2.

Rice, A.L. et al., 2016: Atmospheric methane isotopic record favors fossil sources flat in 1980s and 1990s with recent increase. *Proceedings of the National Academy of Sciences*, **113(39)**, 10791–10796, doi:10.1073/pnas.1522923113.

Rienecker, M.M. et al., 2011: MERRA: NASA's Modern-Era Retrospective Analysis for Research and Applications. *Journal of Climate*, **24(14)**, 3624–3648, doi:10.1175/jcli-d-11-00015.1.

Rignot, E. et al., 2019: Four decades of Antarctic Ice Sheet mass balance from 1979–2017. *Proceedings of the National Academy of Sciences*, **116(4)**, 1095–1103, doi:10.1073/pnas.1812883116.

Rodell, M. et al., 2004: The Global Land Data Assimilation System. *Bulletin of the American Meteorological Society*, **85(3)**, 381–394, doi:10.1175/bams-85-3-381.

Rödenbeck, C. et al., 2013: Global surface-ocean pCO_2 and sea–air CO_2 flux variability from an observation-driven ocean mixed-layer scheme. *Ocean Science*, **9(2)**, 193–216, doi:10.5194/os-9-193-2013.

Rödenbeck, C. et al., 2014: Interannual sea–air CO_2 flux variability from an observation-driven ocean mixed-layer scheme. *Biogeosciences*, **11(17)**, 4599–4613, doi:10.5194/bg-11-4599-2014.

Roebeling, R.A. and I. Holleman, 2009: SEVIRI rainfall retrieval and validation using weather radar observations. *Journal of Geophysical Research: Atmospheres*, **114(D21)**, D21202, doi:10.1029/2009jd012102.

Rohde, R.A. and Z. Hausfather, 2020: The Berkeley Earth Land/Ocean Temperature Record. *Earth System Science Data*, **12(4)**, 3469–3479, doi:10.5194/essd-12-3469-2020.

Romanovsky, V.E. et al., 2020: Terrestrial Permafrost [in "State of the Climate in 2019"]. *Bulletin of the American Meteorological Society*, **101(8)**, S265–S271, doi:10.1175/bams-d-20-0086.1.

Rostkier-Edelstein, D. et al., 2014: Towards a high-resolution climatography of seasonal precipitation over Israel. *International Journal of Climatology*, **34(6)**, 1964–1979, doi:10.1002/joc.3814.

Rothrock, D.A., D.B. Percival, and M. Wensnahan, 2008: The decline in arctic sea-ice thickness: Separating the spatial, annual, and interannual variability in a quarter century of submarine data. *Journal of Geophysical Research*, **113(C5)**, C05003, doi:10.1029/2007jc004252.

Saeki, T. and P.K. Patra, 2017: Implications of overestimated anthropogenic CO_2 emissions on East Asian and global land CO_2 flux inversion. *Geoscience Letters*, **4(1)**, 9, doi:10.1186/s40562-017-0074-7.

Saha, S. et al., 2010: The NCEP Climate Forecast System Reanalysis. *Bulletin of the American Meteorological Society*, **91(8)**, 1015–1058, doi:10.1175/2010bams3001.1.

Sathyendranath, S. et al., 2019: An Ocean-Colour Time Series for Use in Climate Studies: The Experience of the Ocean-Colour Climate Change Initiative (OC-CCI). *Sensors*, **19(19)**, 4285, doi:10.3390/s19194285.

Saunois, M. et al., 2020: The Global Methane Budget 2000–2017. *Earth System Science Data*, **12(3)**, 1561–1623, doi:10.5194/essd-12-1561-2020.

Schellekens, J. et al., 2017: A global water resources ensemble of hydrological models: the eartH2Observe Tier-1 dataset. *Earth System Science Data*, **9(2)**, 389–413, doi:10.5194/essd-9-389-2017.

Scherler, D., H. Wulf, and N. Gorelick, 2018: Global Assessment of Supraglacial Debris-Cover Extents. *Geophysical Research Letters*, **45(21)**, 11798–11805, doi:10.1029/2018gl080158.

Schneider, U. et al., 2017: Evaluating the hydrological cycle over land using the newly-corrected precipitation climatology from the Global Precipitation Climatology Centre (GPCC). *Atmosphere*, **8(3)**, 52, doi:10.3390/atmos8030052.

Schröder, M. et al., 2018: The GEWEX Water Vapor Assessment archive of water vapour products from satellite observations and reanalyses. *Earth System Science Data*, **10(2)**, 1093–1117, doi:10.5194/essd-10-1093-2018.

Schultz, M.G. et al., 2017: Tropospheric Ozone Assessment Report: Database and Metrics Data of Global Surface Ozone Observations. *Elementa: Science of the Anthropocene*, **5**, 58, doi:10.1525/elementa.244.

Schweiger, A. et al., 2011: Uncertainty in modeled Arctic sea ice volume. *Journal of Geophysical Research: Oceans*, **116(C8)**, C00D06, doi:10.1029/2011jc007084.

Shen, Y., Z. Hong, Y. Pan, J. Yu, and L. Maguire, 2018: China's 1 km Merged Gauge, Radar and Satellite Experimental Precipitation Dataset. *Remote Sensing*, **10(2)**, 264, doi:10.3390/rs10020264.

Simpson, I.J. et al., 2012: Long-term decline of global atmospheric ethane concentrations and implications for methane. *Nature*, **488(7412)**, 490–494, doi:10.1038/nature11342.

Slivinski, L.C. et al., 2019: Towards a more reliable historical reanalysis: Improvements for version 3 of the Twentieth Century Reanalysis system. *Quarterly Journal of the Royal Meteorological Society*, **145(724)**, 2876–2908, doi:10.1002/qj.3598.

Smeed, D.A. et al., 2018: The North Atlantic Ocean Is in a State of Reduced Overturning. *Geophysical Research Letters*, **45(3)**, 1527–1533, doi:10.1002/2017gl076350.

Spencer, R.W., J.R. Christy, and W.D. Braswell, 2017: UAH Version 6 Global Satellite Temperature Products: Methodology and Results. *Asia-Pacific Jouurnal of Atmospheric Science*, **53(1)**, 121–130, doi:10.1007/s13143-017-0010-y.

Staehelin, J., P. Viatte, R. Stübi, F. Tummon, and T. Peter, 2018: Stratospheric ozone measurements at Arosa (Switzerland): History and scientific relevance. *Atmospheric Chemistry and Physics*, **18(9)**, 6567–6584, doi:10.5194/acp-18-6567-2018.

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Steiner, A.K. et al., 2020: Consistency and structural uncertainty of multi-mission GPS radio occultation records. *Atmospheric Measurement Techniques*, **13(5)**, 2547–2575, doi:10.5194/amt-13-2547-2020.

Stocker, E.F., F. Alquaied, S. Bilanow, Y. Ji, and L. Jones, 2018: TRMM Version 8 Reprocessing Improvements and Incorporation into the GPM Data Suite. *Journal of Atmospheric and Oceanic Technology*, **35(6)**, 1181–1199, doi:10.1175/jtech-d-17-0166.1.

Sun, W. et al., 2021: The Assessment of Global Surface Temperature Change from 1850s: The C-LSAT2.0 Ensemble and the CMST-Interim Datasets. *Advances in Atmospheric Sciences*, **38(5)**, 875–888, doi:10.1007/s00376-021-1012-3.

Susskind, J., J.M. Blaisdell, and L. Iredell, 2014: Improved methodology for surface and atmospheric soundings, error estimates, and quality control procedures: the atmospheric infrared sounder science team version-6 retrieval algorithm. *Journal of Applied Remote Sensing*, **8(1)**, 1–34, doi:10.1117/1.jrs.8.084994.

Susskind, J. et al., 2006: Accuracy of geophysical parameters derived from Atmospheric Infrared Sounder/Advanced Microwave Sounding Unit as a function of fractional cloud cover. *Journal of Geophysical Research: Atmospheres*, **111(D9)**, D09S17, doi:10.1029/2005jd006272.

Takahashi, K., T. Mikami, and H. Takahashi, 2011: Influence of the Urban Heat Island Phenomenon in Tokyo on the Local Wind System at Nighttime in Summer. *Journal of Geography (Chigaku Zasshi)*, **120(2)**, 341–358, doi:10.5026/jgeography.120.341.

Takahashi, T. et al., 2014: Climatological distributions of pH, pCO_2, total CO_2, alkalinity, and $CaCO_3$ saturation in the global surface ocean, and temporal changes at selected locations. *Marine Chemistry*, **164**, 95–125, doi:10.1016/j.marchem.2014.06.004.

Tanelli, S. et al., 2008: CloudSat's Cloud Profiling Radar After Two Years in Orbit: Performance, Calibration, and Processing. *IEEE Transactions on Geoscience and Remote Sensing*, **46(11)**, 3560–3573, doi:10.1109/tgrs.2008.2002030.

Tapley, B.D., S. Bettadpur, M. Watkins, and C. Reigber, 2004: The gravity recovery and climate experiment: Mission overview and early results. *Geophysical Research Letters*, **31(9)**, L09607, doi:10.1029/2004gl019920.

Tarasick, D. et al., 2019: Tropospheric Ozone Assessment Report: Tropospheric ozone from 1877 to 2016, observed levels, trends and uncertainties. *Elementa: Science of the Anthropocene,* **7**, 39, doi:10.1525/elementa.376.

Tarasick, D.W. et al., 2010: High-resolution tropospheric ozone fields for INTEX and ARCTAS from IONS ozonesondes. *Journal of Geophysical Research: Atmospheres*, **115(D20)**, D20301, doi:10.1029/2009jd012918.

The IMBIE Team, 2018: Mass balance of the Antarctic Ice Sheet from 1992 to 2017. *Nature*, **558(7709)**, 219–222, doi:10.1038/s41586-018-0179-y.

The IMBIE Team, 2020: Mass balance of the Greenland Ice Sheet from 1992 to 2018. *Nature*, **579(7798)**, 233–239, doi:10.1038/s41586-019-1855-2.

The IMBIE Team, 2021: Antarctic and Greenland Ice Sheet mass balance 1992–2020 for IPCC AR6 (Version 1.0) [Data set]. UK Polar Data Centre, Natural Environment Research Council, UK Research & Innovation, doi:10.5285/77B64C55-7166-4A06-9DEF-2E400398E452.

Thomason, L.W. et al., 2018: A global space-based stratospheric aerosol climatology: 1979–2016. *Earth System Science Data*, **10(1)**, 469–492, doi:10.5194/essd-10-469-2018.

Thorne, P.W. et al., 2005: Revisiting radiosonde upper air temperatures from 1958 to 2002. *Journal of Geophysical Research: Atmospheres*, **110(D18)**, D18105, doi:10.1029/2004jd005753.

Tian, B. et al., 2013: Evaluating CMIP5 models using AIRS tropospheric air temperature and specific humidity climatology. *Journal of Geophysical Research: Atmospheres*, **118(1)**, 114–134, doi:10.1029/2012jd018607.

Tokinaga, H. and S.-P. Xie, 2011: Wave- and Anemometer-Based Sea Surface Wind (WASWind) for Climate Change Analysis. *Journal of Climate*, **24(1)**, 267–285, doi:10.1175/2010jcli3789.1.

Tomita, H., T. Hihara, S. Kako, M. Kubota, and K. Kutsuwada, 2019: An introduction to J-OFURO3, a third-generation Japanese ocean flux data set using remote-sensing observations. *Journal of Oceanography,* **75(2),** 171–194, doi:10.1007/s10872-018-0493-x.

Trewin, B. et al., 2020: An updated long-term homogenized daily temperature data set for Australia. *Geoscience Data Journal*, **7(2)**, 149–169, doi:10.1002/gdj3.95.

TRMM, 2011: TRMM (TMPA) Rainfall Estimate L3 3 hour 0.25 degree x 0.25 degree V7 (TRMM_3B42). Goddard Earth Sciences Data and Information Services Center (GES DISC), Greenbelt, MD, USA. Retrieved from: https://doi.org/10.5067/TRMM/TMPA/3H/7.

Troup, A.J., 1965: The 'southern oscillation'. *Quarterly Journal of the Royal Meteorological Society*, **91(390)**, 490–506, doi:10.1002/qj.49709139009.

Tsutsumi, Y., K. Mori, T. Hirahara, M. Ikegami, and T.J. Conway, 2009: *Technical Report of Global Analysis Method for Major Greenhouse Gases by the World Data Center for Greenhouse Gases*. GAW Report No. 184, World Meteorological Organization (WMO), Geneva, Switzerland, 23 pp., https://library.wmo.int/index.php?lvl=notice_display&id=12631#.YbnYdWhKiUk.

Turnbull, J.C. et al., 2017: Sixty years of radiocarbon dioxide measurements at Wellington, New Zealand: 1954–2014. *Atmospheric Chemistry and Physics*, **17(23)**, 14771–14784, doi:10.5194/acp-17-14771-2017.

Vaccaro, A. et al., 2021: Climate Field Completion via Markov Random Fields: Application to the HadCRUT4.6 Temperature Dataset. *Journal of Climate*, **34(10)**, 4169–4188, doi:10.1175/jcli-d-19-0814.1.

Vandemeulebroucke, I., K. Calle, S. Caluwaerts, T. De Kock, and N. Van Den Bossche, 2019: Does historic construction suffer or benefit from the urban heat island effect in Ghent and global warming across Europe? *Canadian Journal of Civil Engineering*, **46(11)**, 1032–1042, doi:10.1139/cjce-2018-0594.

Vidal, J.-P., E. Martin, L. Franchistéguy, M. Baillon, and J.-M. Soubeyroux, 2010: A 50-year high-resolution atmospheric reanalysis over France with the Safran system. *International Journal of Climatology*, **30(11)**, 1627–1644, doi:10.1002/joc.2003.

Vonder Haar, T.H., J.L. Bytheway, and J.M. Forsythe, 2012: Weather and climate analyses using improved global water vapor observations. *Geophysical Research Letters*, **39(15)**, 1–6, doi:10.1029/2012gl052094.

Vose, R.S. et al., 2021: Implementing Full Spatial Coverage in NOAA's Global Temperature Analysis. *Geophysical Research Letters*, **48(4)**, e2020GL090873, doi:10.1029/2020gl090873.

Wagner, W., G. Lemoine, and H. Rott, 1999: A Method for Estimating Soil Moisture from ERS Scatterometer and Soil Data. *Remote Sensing of Environment*, **70(2)**, 191–207, doi:10.1016/s0034-4257(99)00036-x.

Wakita, M., A. Nagano, T. Fujiki, and S. Watanabe, 2017: Slow acidification of the winter mixed layer in the subarctic western North Pacific. *Journal of Geophysical Research: Oceans*, **122(8)**, 6923–6935, doi:10.1002/2017jc013002.

Walsh, J.E., F. Fetterer, J.S. Stewart, and W.L. Chapman, 2017: A database for depicting Arctic sea ice variations back to 1850. *Geographical Review*, **107(1)**, 89–107, doi:10.1111/j.1931-0846.2016.12195.x.

WCRP Global Sea Level Budget Group, 2018: Global sea-level budget 1993–present. *Earth System Science Data*, **10(3)**, 1551–1590, doi:10.5194/essd-10-1551-2018.

Webb, L.B., P.H. Whetton, and E.W.R. Barlow, 2011: Observed trends in winegrape maturity in Australia. *Global Change Biology*, **17(8)**, 2707–2719, doi:10.1111/j.1365-2486.2011.02434.x.

Weber, M. et al., 2018a: Total ozone trends from 1979 to 2016 derived from five merged observational datasets – the emergence into ozone recovery. *Atmospheric Chemistry and Physics*, **18(3)**, 2097–2117, doi:10.5194/acp-18-2097-2018.

Weber, M. et al., 2018b: Stratospheric ozone [in "State of the Climate in 2017"]. *Bulletin of the American Meteorological Society*, **99(8)**, S51–s54, doi:10.1175/2018bamsstateoftheclimate.1.

Weber, M. et al., 2020: Stratospheric ozone [in "State of the Climate in 2019"]. *Bulletin of the American Meteorological Society*, **101(8)**, S81–S83, doi:10.1175/ bams-d-20-0104.1.

Wentz, F.J., 2013: *SSM/I Version-7 Calibration Report*. RSS Technical Report 011012, Remote Sensing Systems (RSS), Santa Rosa, CA, USA, 44 pp.,

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http://images.remss.com/papers/rsstech/2012_011012_Wentz_Version-7_SSMI_Calibration.pdf.

Wentz, F.J., P. Ashcroft, and C. Gentemann, 2001: Post-launch calibration of the TRMM microwave imager. *IEEE Transactions on Geoscience and Remote Sensing*, **39(2)**, 415–422, doi:10.1109/36.905249.

Wenzel, M. and J. Schröter, 2014: Global and regional sea level change during the 20th century. *Journal of Geophysical Research: Oceans*, **119(11)**, 7493–7508, doi:10.1002/2014jc009900.

Wijffels, S., D. Roemmich, D. Monselesan, J. Church, and J. Gilson, 2016: Ocean temperatures chronicle the ongoing warming of Earth. *Nature Climate Change*, **6(2)**, 116–118, doi:10.1038/nclimate2924.

Wild, J.D., S.-K. Yang, and C.S. Long, 2016: Ozone Profile Trends: An SBUV/2 Perspective. *Quadrennial Ozone Symposium 2016, Edinburgh, 2–9 September 2016*.

Willett, K.M., R.J.H. Dunn, J.J. Kennedy, and D.I. Berry, 2020: Development of the HadISDH.marine humidity climate monitoring dataset. *Earth System Science Data*, **12(4)**, 2853–2880, doi:10.5194/essd-12-2853-2020.

Willett, K.M. et al., 2014: HadISDH land surface multi-variable humidity and temperature record for climate monitoring. *Climate of the Past*, **10**, 1983–2006, doi:10.5194/cp-10-1983-2014.

WMO, 2019: The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2018. *WMO Greenhouse Gas Bulletin*, **15**, 1–8, https://library.wmo.int/index.php?lvl=notice_display&id=21620#.Ybiw12jMKUk.

Wolter, K. and M.S. Timlin, 1998: Measuring the strength of ENSO events: How does 1997/98 rank? *Weather*, **53(9)**, 315–324, doi:10.1002/j.1477-8696.1998.tb06408.x.

Wood, C.R. et al., 2013: An Overview of the Urban Boundary Layer Atmosphere Network in Helsinki. *Bulletin of the American Meteorological Society*, **94(11)**, 1675–1690, doi:10.1175/bams-d-12-00146.1.

Wouters, B., A.S. Gardner, and G. Moholdt, 2019: Global Glacier Mass Loss During the GRACE Satellite Mission (2002–2016). *Frontiers in Earth Science*, **7**, 96, doi:10.3389/feart.2019.00096.

Wu, J. and X.-J. Gao, 2013: A gridded daily observation dataset over China region and comparison with the other datasets. *Chinese Journal of Geophysics*, **56(4)**, 1102–1111, http://en.igg-journals.cn/article/doi/10.6038/cjg20130406.

Xavier, A.C., C.W. King, and B.R. Scanlon, 2016: Daily gridded meteorological variables in Brazil (1980–2013). *International Journal of Climatology*, **36(6)**, 2644–2659, doi:10.1002/joc.4518.

Xie, P., P.A. Arkin, and J.E. Janowiak, 2007a: CMAP: The CPC merged analysis of precipitation. *Advances in Global Change Research*, **28**, 319–328, doi:10.1007/978-1-4020-5835-6_25.

Xie, P., M. Chen, and W. Shi, 2010: CPC unified gauge-based analysis of global daily precipitation. *24th Conference of Hydrology, Atlanta, 16–21 January 2010*.

Xie, P. et al., 2007b: A Gauge-Based Analysis of Daily Precipitation over East Asia. *Journal of Hydrometeorology*, **8(3)**, 607–626, doi:10.1175/jhm583.1.

Xu, W. et al., 2018: A new integrated and homogenized global monthly land surface air temperature dataset for the period since 1900. *Climate Dynamics*, **50(7)**, 2513–2536, doi:10.1007/s00382-017-3755-1.

Yang, B. et al., 2017: New perspective on spring vegetation phenology and global climate change based on Tibetan Plateau tree-ring data. *Proceedings of the National Academy of Sciences*, **114(27)**, 6966–6971, doi:10.1073/pnas.1616608114.

Yang, Z. et al., 2017: Merging high-resolution satellite-based precipitation fields and point-scale rain gauge measurements - A case study in Chile. *Journal of Geophysical Research: Atmospheres*, **122(10)**, 5267–5284, doi:10.1002/2016jd026177.

Yasutomi, N., A. Hamada, and A. Yatagai, 2011: Development of a Long-term Daily Gridded Temperature Dataset and Its Application to Rain/Snow Discrimination of Daily Precipitation. *Global Environmental Research*, **15**, 165–172, www.chikyu.ac.jp/precip/data/Yasutomi2011GER.pdf.

Yatagai, A. et al., 2012: APHRODITE: Constructing a Long-Term Daily Gridded Precipitation Dataset for Asia Based on a Dense Network of Rain Gauges. *Bulletin of the American Meteorological Society*, **93(9)**, 1401–1415, doi:10.1175/bams-d-11-00122.1.

Yoshida, Y. et al., 2013: Improvement of the retrieval algorithm for GOSAT SWIR XCO_2 and XCH_4 and their validation using TCCON data. *Atmospheric Measurement Techniques*, **6(6)**, 1533–1547, doi:10.5194/amt-6-1533-2013.

Yu, L., X. Jin, and R.A. Weller, 2008: *Multidecade Global Flux Datasets from the Objectively Analyzed Air-sea Fluxes (OAFlux) Project: Latent and sensible heat fluxes, ocean evaporation, and related surface meteorological variables*. OAFlux Project Technical Report (OA-2008-01), Woods Hole Oceanographic Institution (WHOI), Woods Hole, MA, USA, 64 pp.

Zanna, L., S. Khatiwala, J.M. Gregory, J. Ison, and P. Heimbach, 2019: Global reconstruction of historical ocean heat storage and transport. *Proceedings of the National Academy of Sciences*, **116(4)**, 1126–1131, doi:10.1073/pnas.1808838115.

Zeng, N. et al., 2014: Agricultural Green Revolution as a driver of increasing atmospheric CO_2 seasonal amplitude. *Nature*, **515(7527)**, 394–397, doi:10.1038/nature13893.

Zhang, J. and D.A. Rothrock, 2003: Modeling Global Sea Ice with a Thickness and Enthalpy Distribution Model in Generalized Curvilinear Coordinates. *Monthly Weather Review*, **131(5)**, 845–861, doi:10.1175/1520-0493(2003)131<0845:mgsiwa>2.0.co;2.

Zhou, C., J. Wang, A. Dai, and P.W. Thorne, 2021: A New Approach to Homogenize Global Subdaily Radiosonde Temperature Data from 1958 to 2018. *Journal of Climate*, **34(3)**, 1163–1183, doi:10.1175/jcli-d-20-0352.1.

Zhu, Z. et al., 2013: Global data sets of vegetation leaf area index (LAI)3g and fraction of photosynthetically active radiation (FPAR)3g derived from global inventory modeling and mapping studies (GIMMS) normalized difference vegetation index (NDVI3G) for the period 1981 to 2. *Remote Sensing*, **5(2)**, 927–948, doi:10.3390/rs5020927.

Ziemke, J.R. et al., 2019: Trends in global tropospheric ozone inferred from a composite record of TOMS/OMI/MLS/OMPS satellite measurements and the MERRA-2 GMI simulation. *Atmospheric Chemistry and Physics*, **19(5)**, 3257–3269, doi:10.5194/acp-19-3257-2019.

Zolina, O. et al., 2014: Precipitation Variability and Extremes in Central Europe: New View from STAMMEX Results. *Bulletin of the American Meteorological Society*, **95(7)**, 995–1002, doi:10.1175/bams-d-12-00134.1.

Zou, C.-Z. and W. Wang, 2011: Intersatellite calibration of AMSU-A observations for weather and climate applications. *Journal of Geophysical Research: Atmospheres*, **116(D23)**, D23113, doi:10.1029/2011jd016205.

Zweng, M.M. et al., 2019: World Ocean Atlas 2018, Volume 2: Salinity [Mishonov, A. (ed.)]. National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS), Silver Spring, MD, USA, 50 pp., www.ncei.noaa.gov/data/oceans/woa/WOA18/DOC/woa18_vol2.pdf.

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