Observations: Atmosphere and Surface

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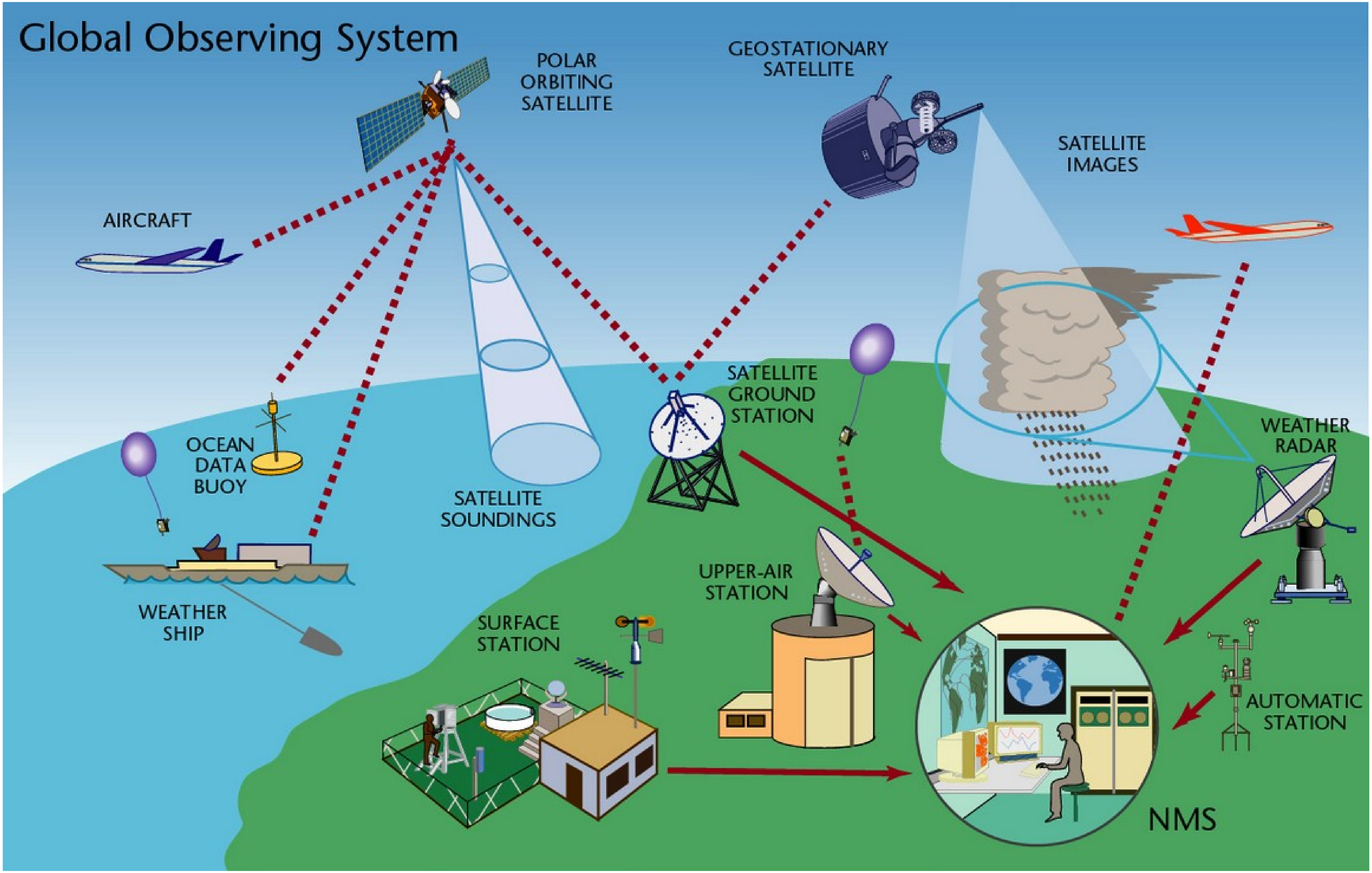
CHAPTER TOPICS

- ATMOSPHERIC COMPOSTION
- RADIATION BUDGETS
- TEMPERATURE
- HYDROLOGICAL CYCLE
- EXTREME EVENTS
- ATMOSPHERIC CIRCULATION AND INDICES OF VARIABILITY



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UNCERTAINTY

1) RECORDING ERROR/ INSTRUMENT ERROR

2) REPRESENTATION

3) PHYSICAL CHANGES IN INSTRUMENTS

4) DATA PROCESSING

ATMOSPHERIC COMPOSITION

- It is certain that atmospheric burdens of the well-mixed greenhouse gases (GHGs) targeted by the Kyoto Protocol increased from 2005 to 2011.

- Carbon dioxide (CO_2) 390.5 ppm in 2011 (40% greater than 1750)

- Nitrous oxide (N_2O) 324 ppb in 2011 (20% greater than 1750)

- Methane (CH_4) 1803 ppb in 2011 (150% greater than 1750)

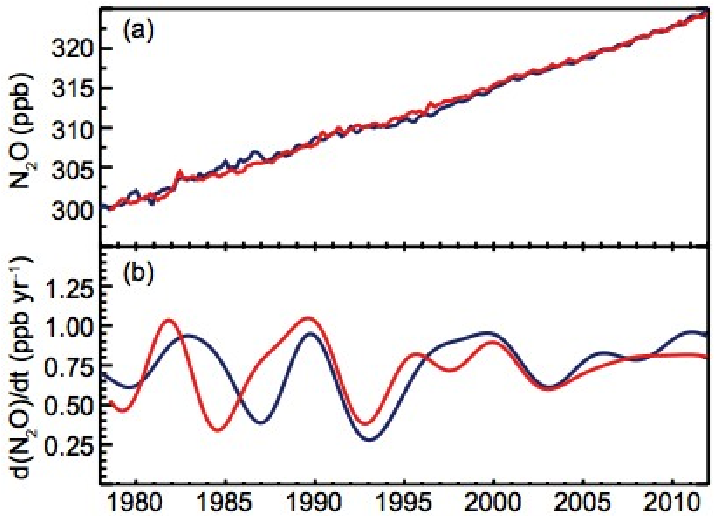


Figure 2.3 | (a) Globally averaged N_2O dry-air mole fractions from AGAGE (red) and NOAA/ESRL/GMD (blue) at monthly resolution. (b) Instantaneous growth rates for globally averaged atmospheric N_2O. Growth rates were calculated as in Figure 2.1.

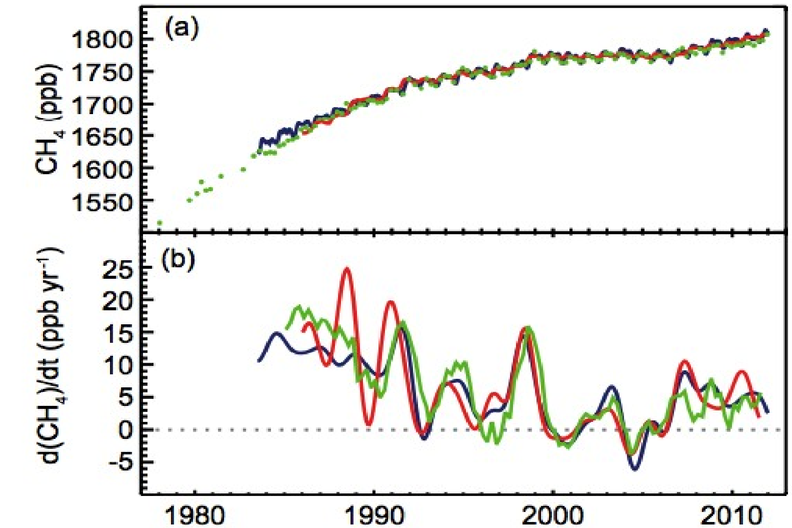


Figure 2.2 | (a) Globally averaged CH_4 dry-air mole fractions from UCI (green; four values per year, except prior to 1984, when they are of lower and varying frequency), AGAGE (red; monthly), and NOAA/ESRL/GMD (blue; quasi-weekly). (b) Instantaneous growth rate for globally averaged atmospheric CH_4 using the same colour code as in (a). Growth rates were calculated as in Figure 2.1.

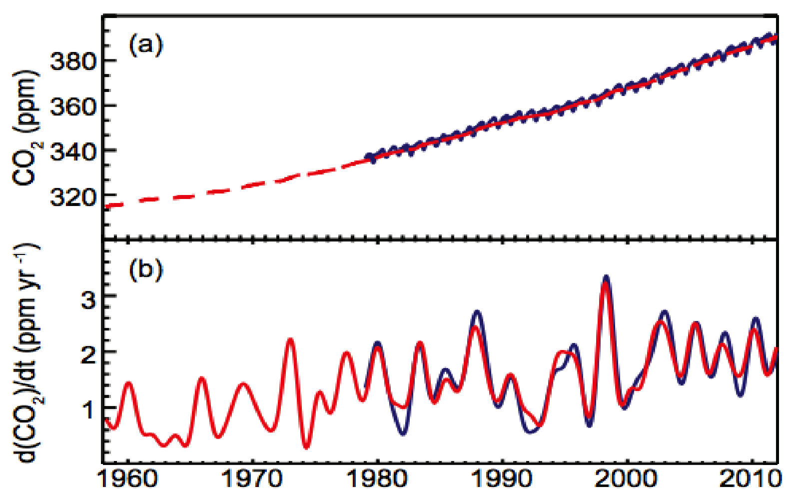


Figure 2.1 | (a) Globally averaged CO_2 dry-air mole fractions from Scripps Institution of Oceanography (SIO) at monthly time resolution based on measurements from Mauna Loa, Hawaii and South Pole (red) and NOAA/ESRL/GMD at quasi-weekly time resolution (blue). SIO values are deseasonalized. (b) Instantaneous growth rates for globally averaged atmospheric CO_2 using the same colour code as in (a). Growth rates are calculated as the time derivative of the deseasonalized global averages (Dlugokencky et al., 1994).

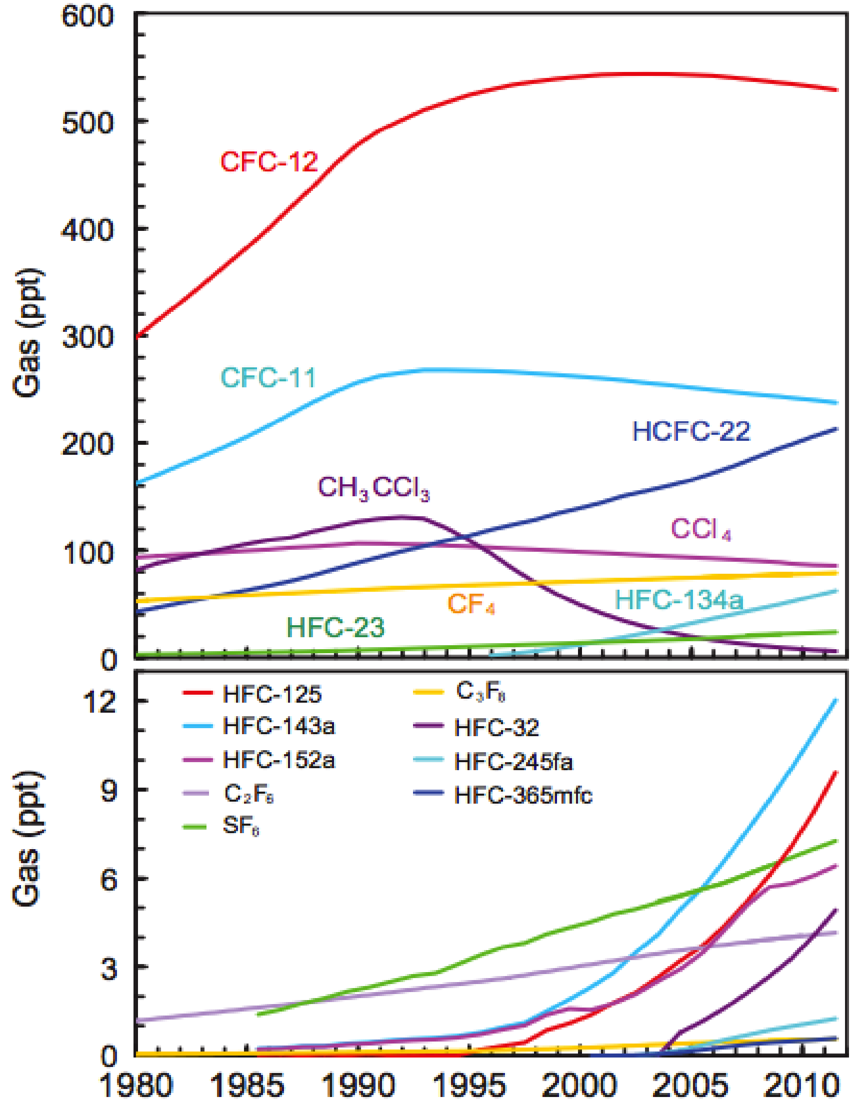
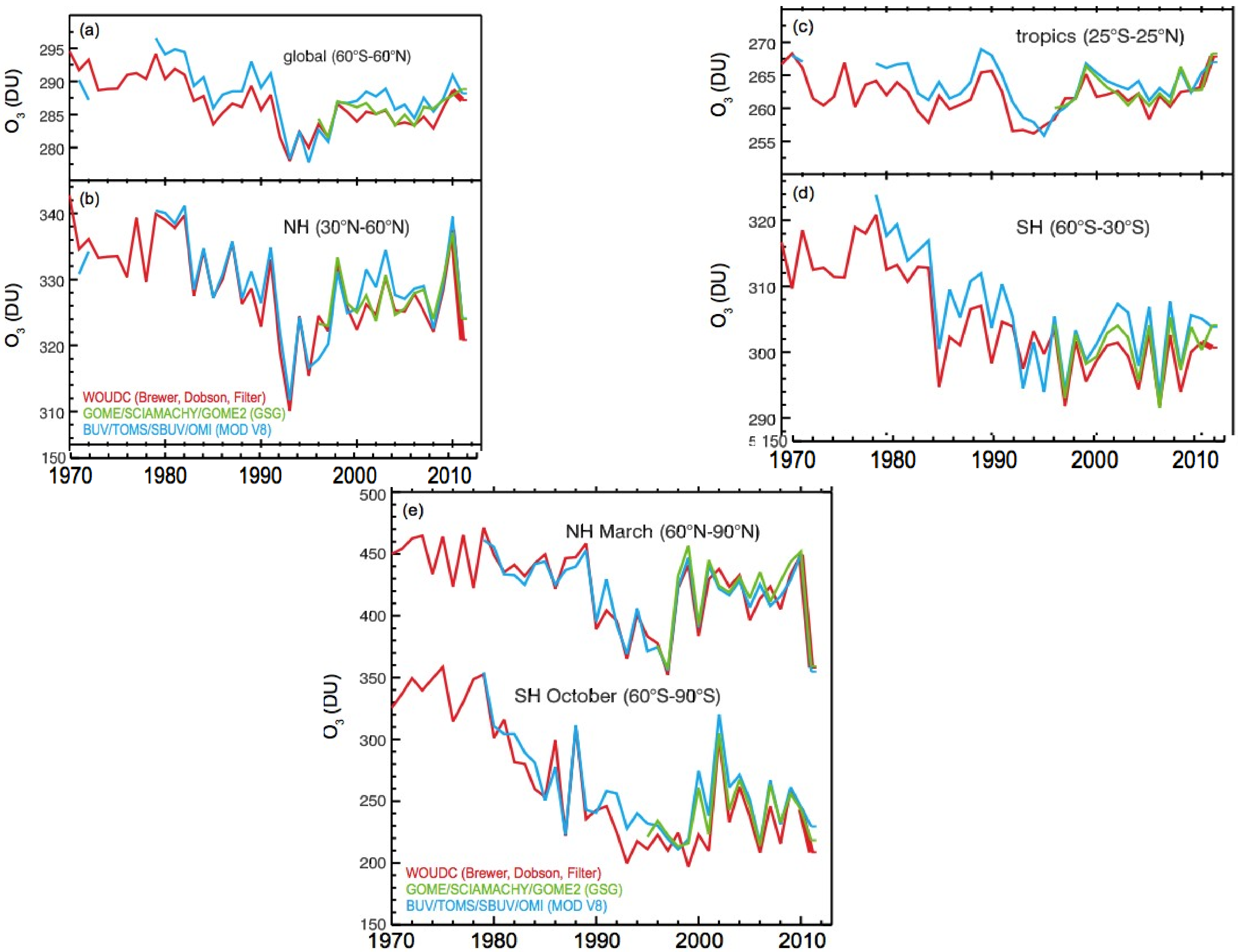


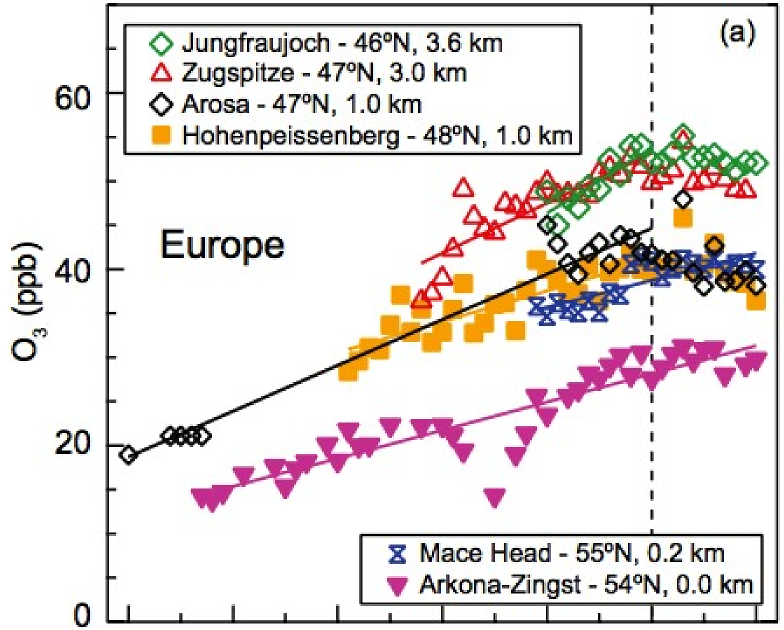
Figure 2.4 | Globally averaged dry-air mole fractions at the Earth's surface of the major halogen-containing well-mixed GHG. These are derived mainly using monthly mean measurements from the AGAGE and NOAA/ESRL/GMD networks. For clarity, only the most abundant chemicals are shown in different compound classes and results from different networks have been combined when both are available.

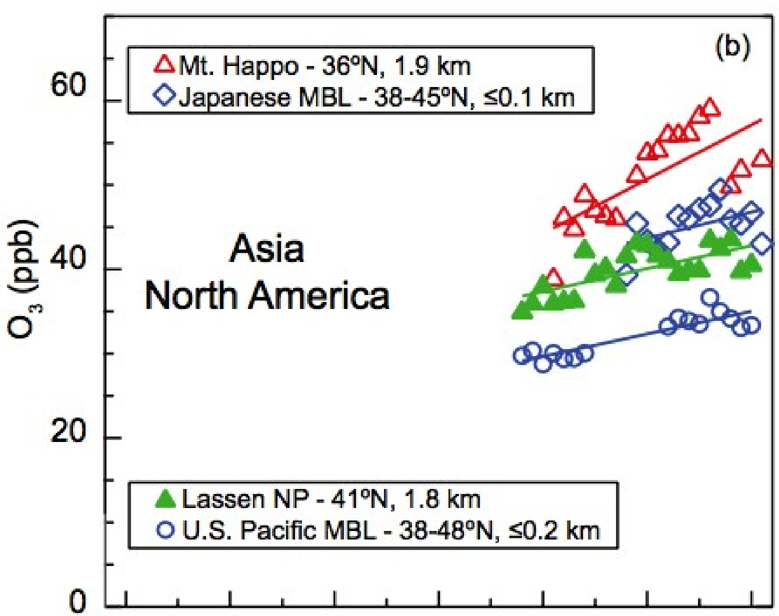
For ozone-depleting substances (Montreal Protocol gases), it is certain that the global mean abundances of major chlorofluorocarbons (CFCs) are decreasing

- It is certain that global stratospheric ozone has declined from pre-1980 values



- Confidence is *medium* in large-scale increases of tropospheric ozone across the Northern Hemisphere since the 1970s.
- Confidence is *low* in ozone changes across the Southern Hemisphere owing to limited measurements.





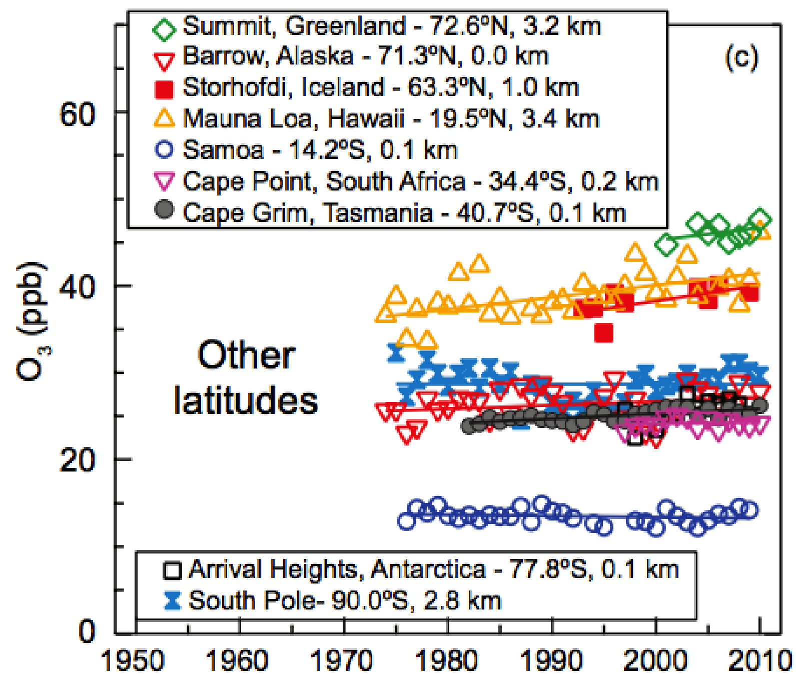


Figure 2.7 | Annual average surface ozone concentrations from regionally representative ozone monitoring sites around the world. (a) Europe. (b) Asia and North America. (c) Remote sites in the Northern and Southern Hemispheres. The station name in the

			2011 Global Annual Mean			Global Increase from 2005 to 2011		
Species	Lifetime (yr)	RE ($W\ m^{-2}\ ppb^{-1}$)	UCI	SIO[b]/AGAGE	NOAA	UCI	SIO[b]/AGAGE	NOAA
CO_2 (ppm)		1.37×10^{-5}		390.48 ± 0.28	390.44 ± 0.16		11.67 ± 0.37	11.66 ± 0.13
CH_4 (ppb)	9.1	3.63×10^{-4}	1798.1 ± 0.6	1803.1 ± 4.8	1803.2 ± 1.2	26.6 ± 0.9	28.9 ± 6.8	28.6 ± 0.9
N_2O (ppb)	131	3.03×10^{-3}		324.0 ± 0.1	324.3 ± 0.1		4.7 ± 0.2	5.24 ± 0.14
SF_6	3200	0.575		7.26 ± 0.02	7.31 ± 0.02		1.65 ± 0.03	1.64 ±0.01
CF_4	50,000	0.1		79.0 ± 0.1			4.0 ± 0.2	
C_2F_6	10,000	0.26		4.16 ± 0.02			0.50 ± 0.03	
HFC-125	28.2	0.219		9.58 ± 0.04			5.89 ± 0.07	
HFC-134a	13.4	0.159	63.4 ± 0.9	62.4 ± 0.3	63.0 ± 0.6	27.7 ± 1.4	28.2 ± 0.4	28.2 ± 0.1
HFC-143a	47.1	0.159		12.04 ± 0.07			6.39 ± 0.10	
HFC-152a	1.5	0.094		6.4 ± 0.1			3.0 ± 0.2	
HFC-23	222	0.176		24.0 ± 0.3			5.2 ± 0.6	
CFC-11	45	0.263	237.9 ± 0.8	236.9 ± 0.1	238.5 ± 0.2	−13.2 ± 0.8	−12.7 ± 0.2	−13.0 ± 0.1
CFC-12	100	0.32	525.3 ± 0.8	529.5 ± 0.2	527.4 ± 0.4	−12.8 ± 0.8	−13.4 ± 0.3	−14.1 ± 0.1
CFC-113	85	0.3	74.9 ± 0.6	74.29 ± 0.06	74.40 ± 0.04	−4.6 ± 0.8	−4.25 ± 0.08	−4.35 ±0.02
HCFC-22	11.9	0.2	209.0 ± 1.2	213.4 ± 0.8	213.2 ± 1.2	41.5 ± 1.4	44.6 ± 1.1	44.3 ± 0.2
HCFC-141b	9.2	0.152	20.8 ± 0.5	21.38 ± 0.09	21.4 ± 0.2	3.7 ± 0.5	3.70 ± 0.1	3.76 ± 0.03
HCFC-142b	17.2	0.186	21.0 ± 0.5	21.35 ± 0.06	21.0 ± 0.1	4.9 ± 0.5	5.72 ± 0.09	5.73 ± 0.04
CCl_4	26	0.175	87.8 ± 0.6	85.0 ± 0.1	86.5 ± 0.3	−6.4 ± 0.5	−6.9 ± 0.2	−7.8 ± 0.1
CH_3CCl_3	5	0.069	6.8 ± 0.6	6.3 ± 0.1	6.35 ± 0.07	−14.8 ± 0.5	−11.9 ± 0.2	−12.1 ± 0.1

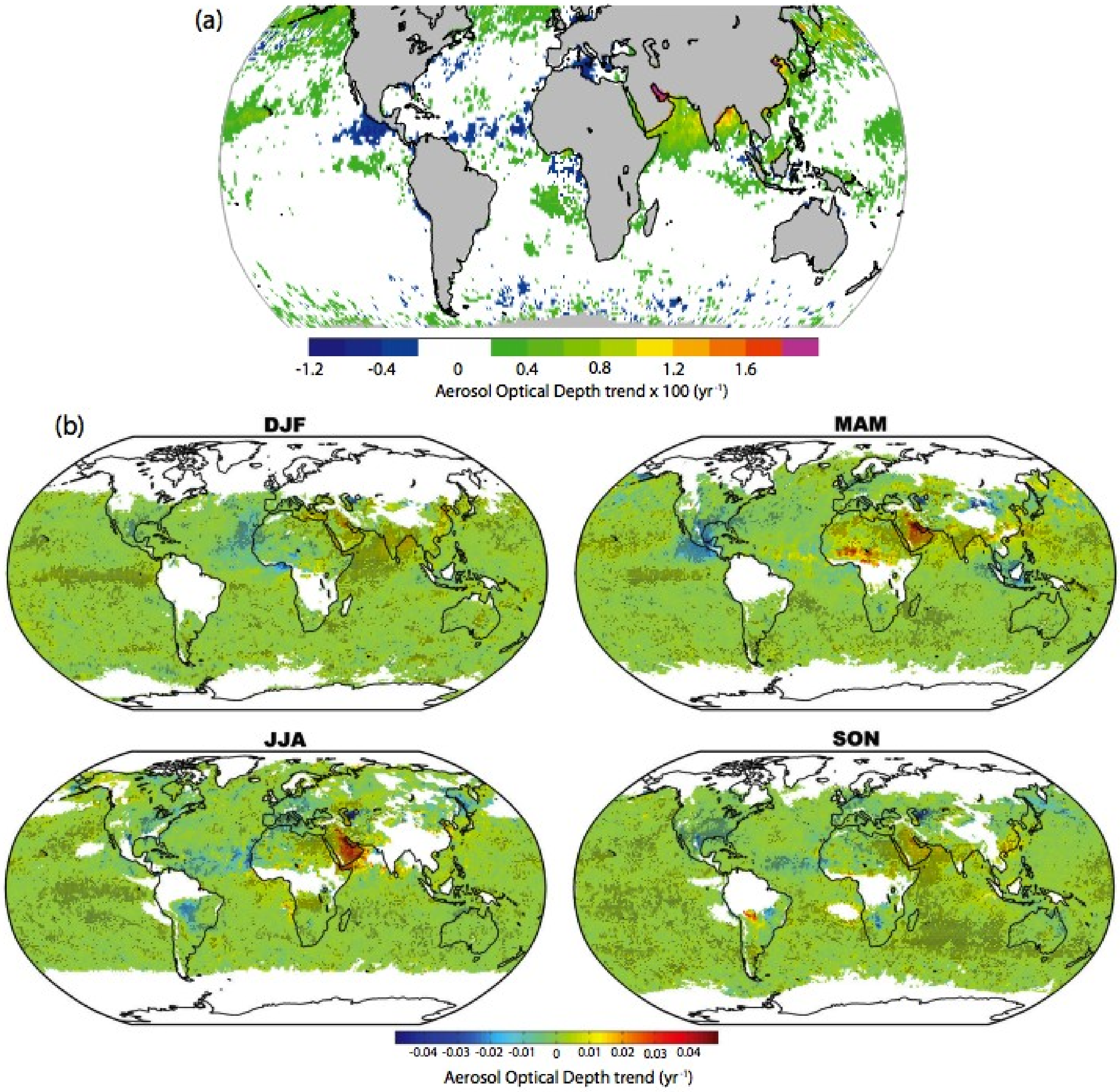


Figure 2.9 | (a) Annual average aerosol optical depth (AOD) trends at 0.55 µm for 2000–2009, based on de-seasonalized, conservatively cloud-screened MODIS aerosol data over oceans (Zhang and Reid, 2010). Negative AOD trends off Mexico are due to enhanced volcanic activity at the beginning of the record. Most non-zero trends are significant (i.e., a trend of zero lies outside the 95% confidence interval). (b) Seasonal average AOD trends at 0.55 µm for 1998–2010 using SeaWiFS data (Hsu et al., 2012). White areas indicate incomplete or missing data. Black dots indicate significant trends (i.e., a trend of zero lies outside the 95% confidence interval).

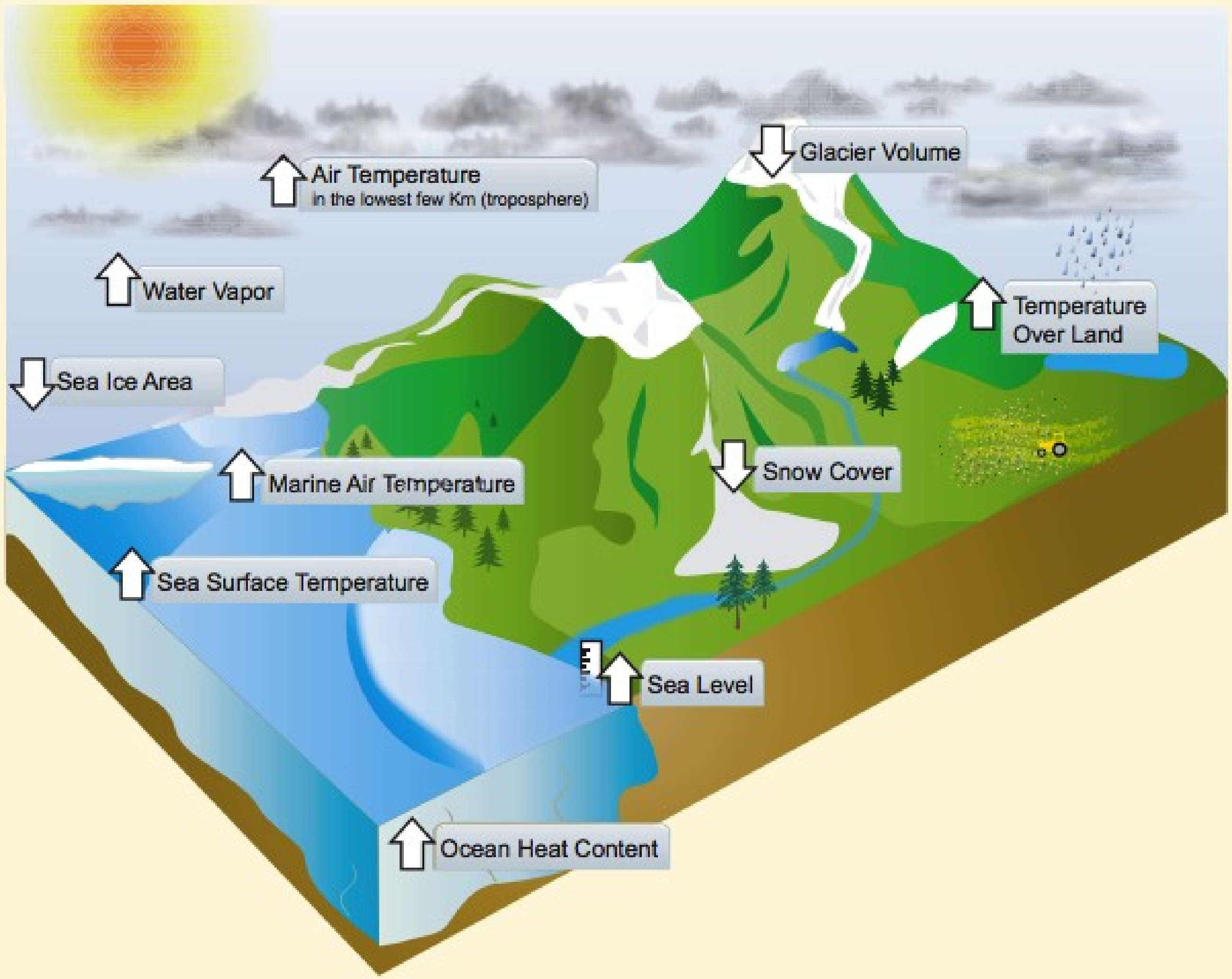
- It is *very likely* that aerosol column amounts have declined over Europe and the eastern USA since the mid 1990s and increased over eastern and southern Asia since 2000.

Aerosol variable	Trend, % yr^{-1} (1σ, standard deviation)	Period	Reference	Comments
Europe				
$PM_{2.5}$	–2.9 (1.31) –3.9 (0.87)[b]	2000–2009	(Adapted from Torseth et al., 2012) Regional background sites	13 sites available, 6 sites show statistically significant results. Average change was –0.37 and –0.52[b] mg m^{-3} yr^{-1}.
PM_{10}	–1.9 (1.43) –2.6 (1.19)[b]	2000–2009		24 sites available, 12 sites show statistically significant results. Average change was –0.29 and –0.40[b] mg m^{-3} yr^{-1} .
SO_4^{2-}	–3.0 (0.82) –3.1 (0.72)[b]	1990–2009		30 sites available, 26 sites show statistically significant results. Average change was –0.04 and –0.04[b] mg m^{-3} yr^{-1}.
SO_4^{2-}	– 1.5 (1.41) –2.0 (1.8)[b]	2000–2009		30 sites available, 10 sites show statistically significant results. Average change was –0.01 and –0.01[b] mg m^{-3} yr^{-1}.
PM_{10}	–1.9	1991–2008	(Barmpadimos et al., 2012) Rural and urban sites	10 sites in Switzerland. The trend is adjusted for change in meteorology—unadjusted data did not differ strongly. The average change was –0.51 mg m^{-3} yr^{-1}.
USA				
$PM_{2.5}$	–2.1 (2.08) –4.0 (1.01)[b]	2000–2009	Adapted from (Hand et al., 2011) Regional background sites	153 sites available, 52 sites show statistically significant negative results. Only 1 site shows statisticallly positive trend.
$PM_{2.5}$	–1.5 (1.25) –2.1 (0.97)[b]	1990–2009		153 sites available, 39 sites show statistically significant results.
PM_{10}	–1.7 (2.00) –3.1 (1.65)[b]	2000–2009		154 sites available, 37 sites show statistically significant results.
SO_4^{2-}	–3.0 (2.86) –3.0 (0.62)[b]	2000–2009		154 sites available, 83 sites show statistically significant negative results. 4 sites showed statistical positive trend.
SO_4^{2-}	–2.0 (1.07) –2.3 (0.85)[b]	1990–2009		103 sites available, 41 sites show statistically significant results.
Total Carbon	–2.5 to –7.5	1989–2008	(Hand et al., 2011) Regional background sites	The trend interval includes about 50 sites mainly located along the East and West Coasts of the USA; fewer sites were situated in the central part of the continent.
Arctic				
EBC[a]	–3.8 (0.7)[c]	1989–2008	(Hirdman et al., 2010)	Alert, Canada 62.3°W 82.5°N
SO_4^{2-}	–3.0 (0.6)[c]	1985–2006		
EBC[a]	Not sig.[c]	1998–2008		Barrow, Alaska, 156.6°W 71.3° N
SO_4^{2-}	Not sig.[c]	1997–2008		
EBC[a]	–9.0 (5.0)[c]	2002–2009		Zeppelin, Svalbard, 11.9°E 78.9° N
SO_4^{2-}	–1.9 (1.7)[c]	1990–2008		

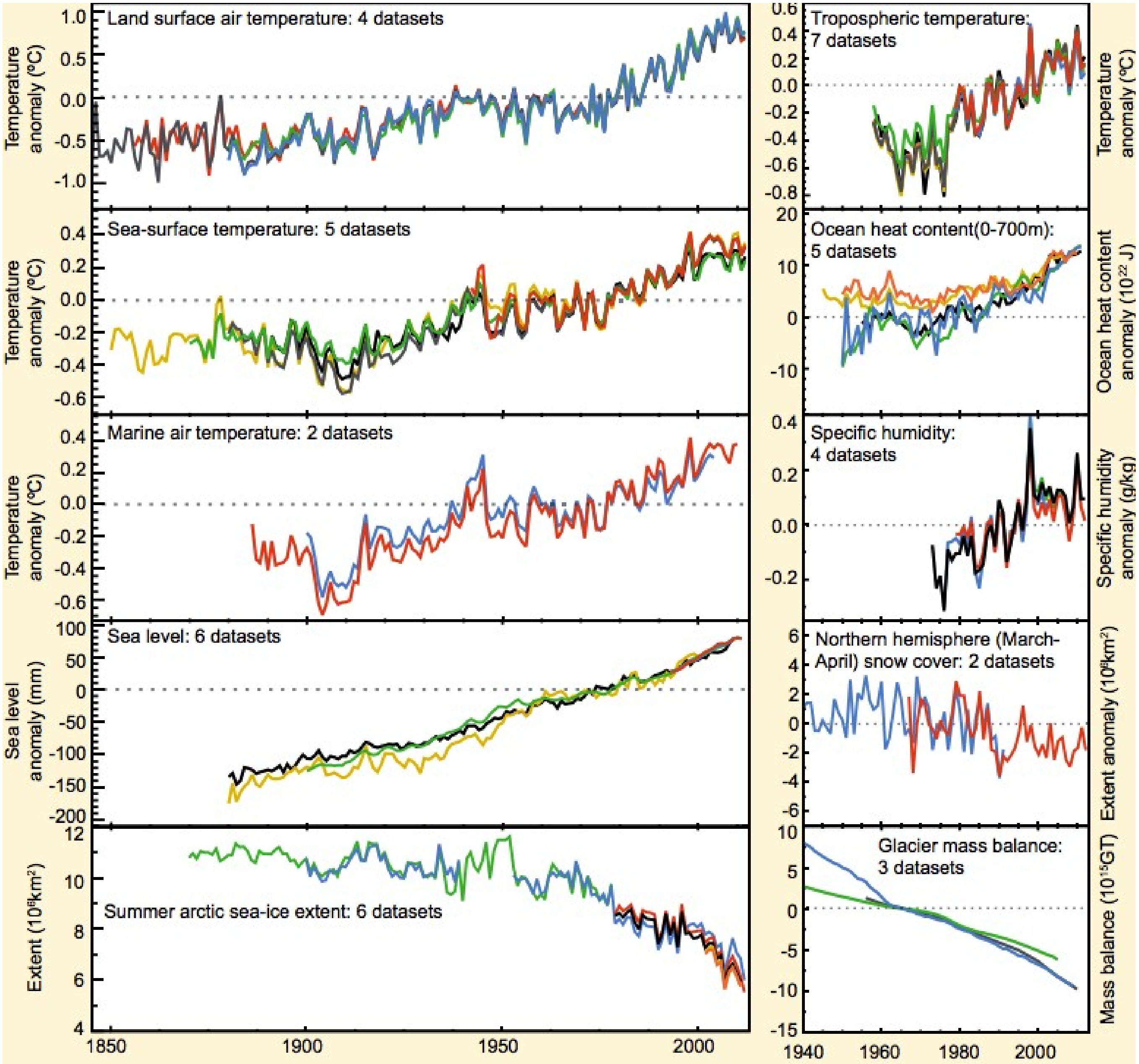
TEMPERATURE

- It is certain that Global Mean Surface Temperature has increased since the late 19th century.
- Each of the past three decades has been successively warmer at the Earth's surface than all previous decades in instrumental record.
- First decade of 21st century has been the warmest.

How do we know the Earth has warmed?



FAQ 2.1, Figure 1 | Independent analyses of many components of the climate system that would be expected to change in a warming world exhibit trends consistent with warming (arrow direction denotes the sign of the change), as shown in FAQ 2.1, Figure 2.



Land surface air temperature: 4 datasets
Temperature anomaly (ºC)
Sea-surface temperature: 5 datasets
Temperature anomaly (ºC)
Marine air temperature: 2 datasets
Temperature anomaly (ºC)
Sea level: 6 datasets
Sea level anomaly (mm)
Summer arctic sea-ice extent: 6 datasets
Extent (10^6km^2)
1850
1900
1950
2000
Tropospheric temperature: 7 datasets
Temperature anomaly (ºC)
Ocean heat content(0-700m): 5 datasets
Ocean heat content anomaly (10^{22} J)
Specific humidity: 4 datasets
Specific humidity anomaly (g/kg)
Northern hemisphere (March-April) snow cover: 2 datasets
Extent anomaly (10^6km^2)
Glacier mass balance: 3 datasets
Mass balance (10^{15}GT)
1940
1960
1980
2000

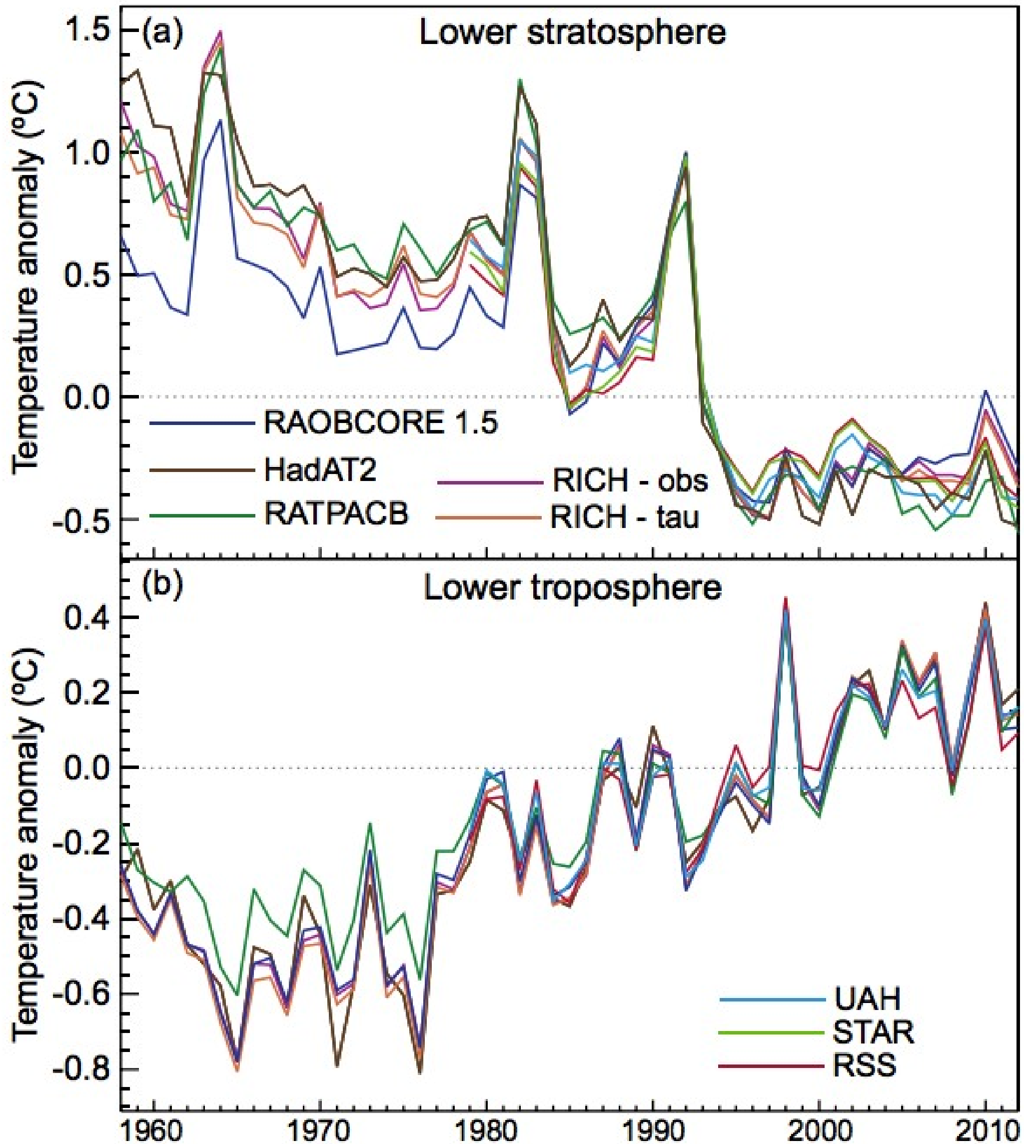


Figure 2.24 | Global annual average lower stratospheric (top) and lower tropospheric (bottom) temperature anomalies relative to a 1981–2010 climatology from different data sets. STAR does not produce a lower tropospheric temperature product. Note that the *y*-axis resolution differs between the two panels.

Global Annual Land-Surface Air Temperature

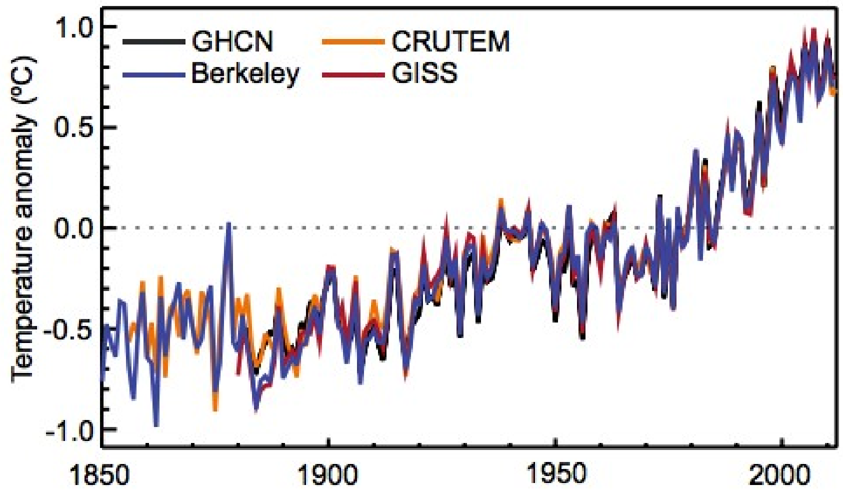


Figure 2.14 | Global annual average land-surface air temperature (LSAT) anomalies relative to a 1961–1990 climatology from the latest versions of four different data sets (Berkeley, CRUTEM, GHCN and GISS).

Table 2.4: | Trend estimates and 90% confidence intervals (Box 2.2) for LSAT global average values over five common periods.

Data Set	Trends in °C per decade				
	1880–2012	1901–2012	1901–1950	1951–2012	1979–2012
CRUTEM4.1.1.0 (Jones et al., 2012)	0.086 ± 0.015	0.095 ± 0.020	0.097 ± 0.029	0.175 ± 0.037	0.254 ± 0.050
GHCNv3.2.0 (Lawrimore et al., 2011)	0.094 ± 0.016	0.107 ± 0.020	0.100 ± 0.033	0.197 ± 0.031	0.273 ± 0.047
GISS (Hansen et al., 2010)	0.095 ± 0.015	0.099 ± 0.020	0.098 ± 0.032	0.188 ± 0.032	0.267 ± 0.054
Berkeley (Rohde et al., 2013)	0.094 ± 0.013	0.101 ± 0.017	0.111 ± 0.034	0.175 ± 0.029	0.254 ± 0.049

- It is *unlikely* that any uncorrected urban heat-island effects and land use change effects have raised the estimated centennial globally averaged LSAT trends by more than 10% of the report-ed trend.
- *Confidence* is *medium* in reported decreases in observed global diurnal temperature range (DTR), noted as a key uncertainty in the AR4.
- Based on multiple independent analyses of measurements from radiosondes and satellite sensors it is *virtually certain* that globally the troposphere has warmed and the stratosphere has cooled since the mid-20th century.

SEA SURFACE TEMPERATURE

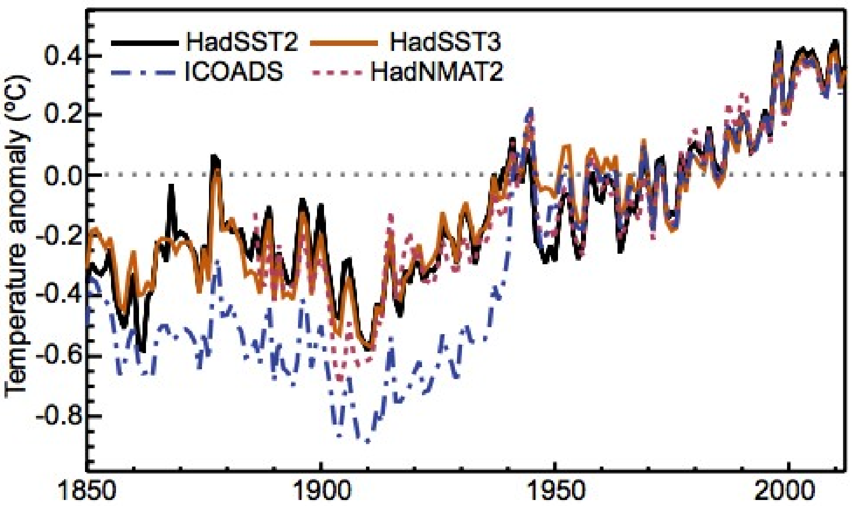


Figure 2.16 | Global annual average sea surface temperature (SST) and Night Marine Air Temperature (NMAT) relative to a 1961–1990 climatology from gridded data sets of SST observations (HadSST2 and its successor HadSST3), the raw SST measurement archive (ICOADS, v2.5) and night marine air temperatures data set HadNMAT2 (Kent et al., 2013). HadSST2 and HadSST3 both are based on SST observations from versions of the ICOADS data set, but differ in degree of measurement bias correction.

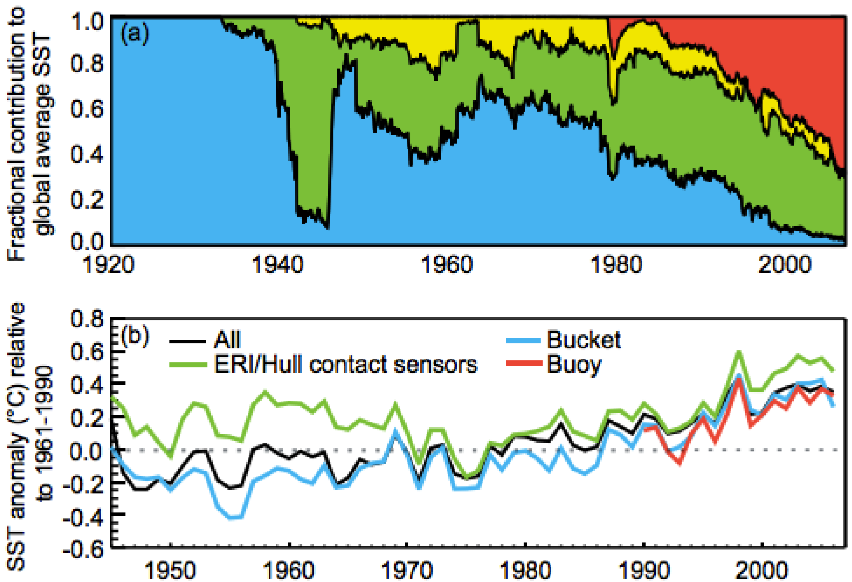


Figure 2.15 | Temporal changes in the prevalence of different measurement methods in the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). (a) Fractional contributions of observations made by different measurement methods: bucket observations (blue), engine room intake (ERI) and hull contact sensor observations (green), moored and drifting buoys (red), and unknown (yellow). (b) Global annual average sea surface temperature (SST) anomalies based on different kinds of data: ERI and hull contact sensor (green), bucket (blue), buoy (red), and all (black). Averages are computed over all 5° × 5° grid boxes where both ERI/hull and bucket measurements, but not necessarily buoy data, were available. (Adapted from Kennedy et al., 2011a.)

Table 2.6 | Trend estimates and 90% confidence intervals (Box 2.2) for interpolated SST data sets (uninterpolated state-of-the-art HadSST3 data set is included for comparison). Dash indicates not enough data available for trend calculation.

Data Set	Trends in °C per decade				
	1880–2012	1901–2012	1901–1950	1951–2012	1979–2012
HadISST (Rayner et al., 2003)	0.042 ± 0.007	0.052 ± 0.007	0.067 ± 0.024	0.064 ± 0.015	0.072 ± 0.024
COBE-SST (Ishii et al., 2005)	–	0.058 ± 0.007	0.066 ± 0.032	0.071 ± 0.014	0.073 ± 0.020
ERSSTv3b (Smith et al., 2008)	0.054 ± 0.015	0.071 ± 0.011	0.097 ± 0.050	0.088 ± 0.017	0.105 ± 0.031
HadSST3 (Kennedy et al., 2011a)	0.054 ± 0.012	0.067 ± 0.013	0.117 ± 0.028	0.074 ± 0.027	0.124 ± 0.030

Global Surface Temperature Anomalies and Trends

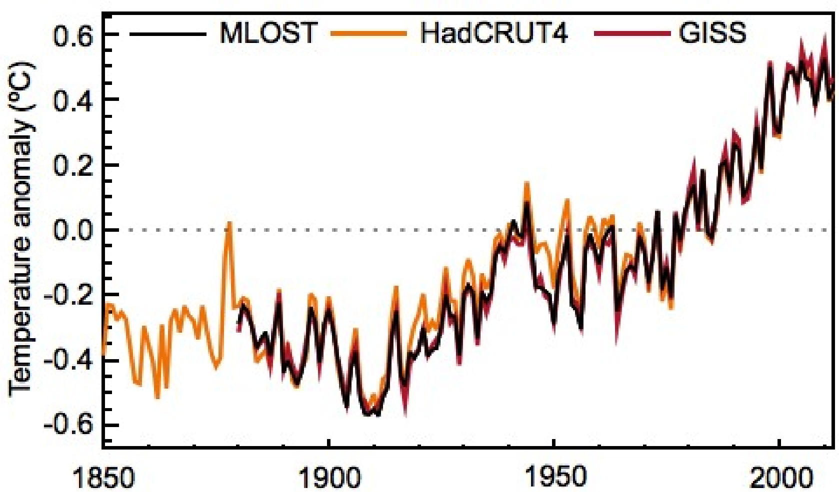


Figure 2.20 | Annual global mean surface temperature (GMST) anomalies relative to a 1961–1990 climatology from the latest version of the three combined land-surface air temperature (LSAT) and sea surface temperature (SST) data sets (HadCRUT4, GISS and NCDC MLOST). Published data set uncertainties are not included for reasons discussed in Box 2.1.

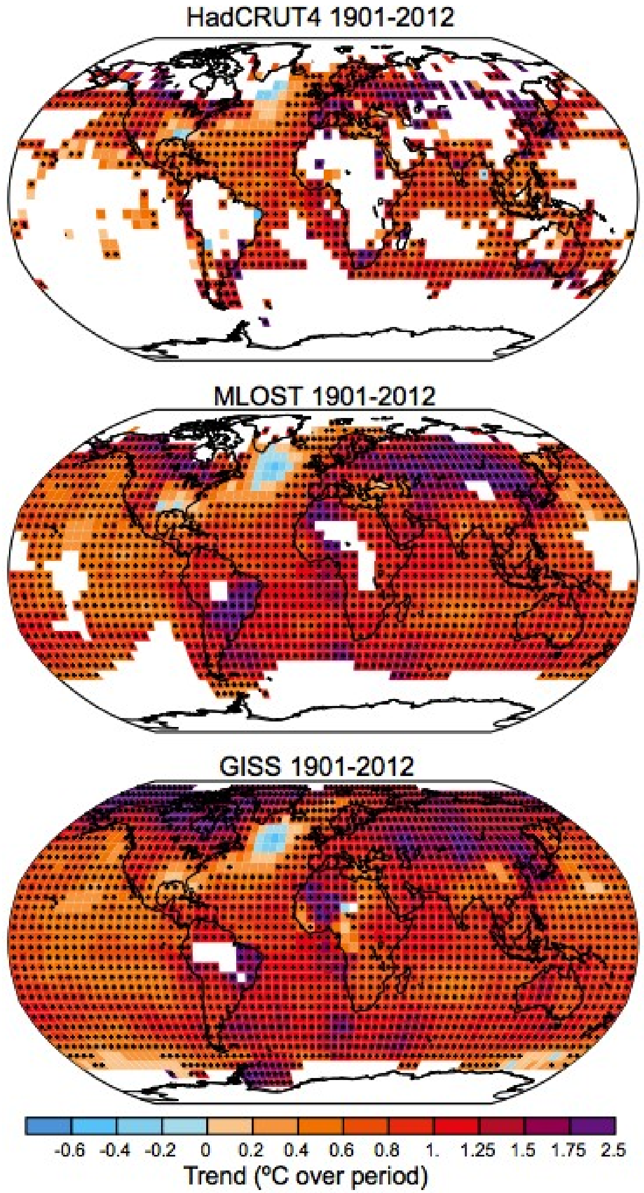


Figure 2.21 | Trends in surface temperature from the three data sets of Figure 2.20 for 1901–2012. White areas indicate incomplete or missing data. Trends have been

HYDROLOGICAL CYCLE

•*Confidence* in precipitation change averaged over global land areas since 1901 is *low* for years prior to 1951 and *medium* afterwards.

•Averaged over the mid-latitude land areas of the Northern Hemisphere, precipitation has *likely* <u>increased</u> since 1901 (*medium confidence* before and *high confidence* after 1951).

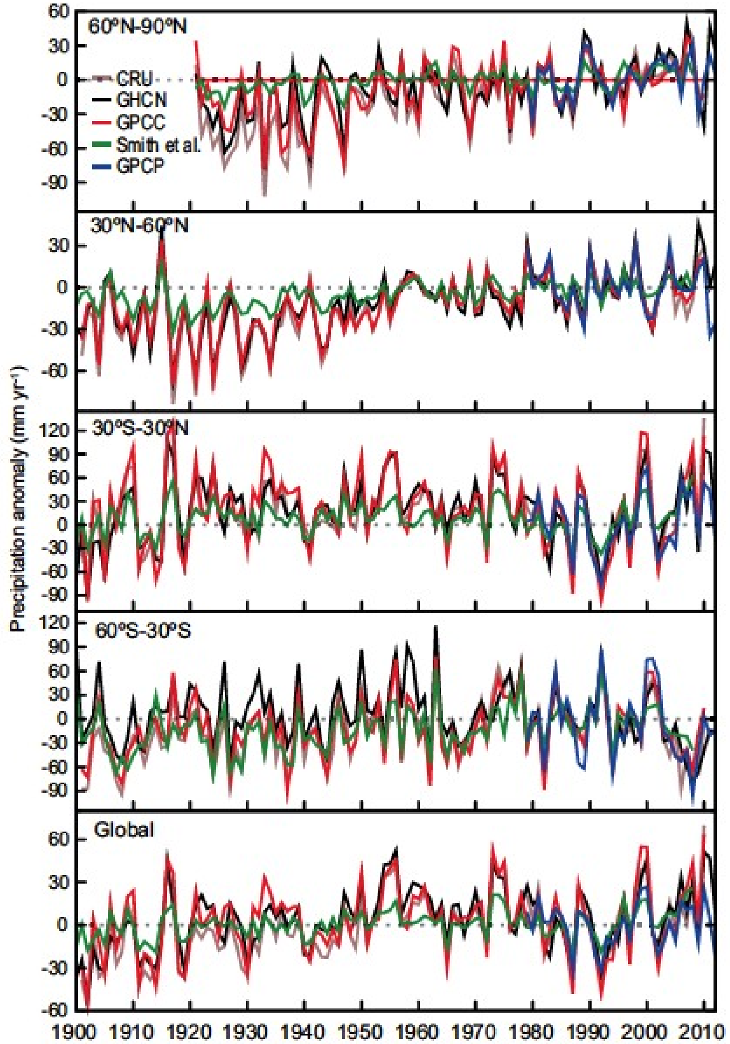
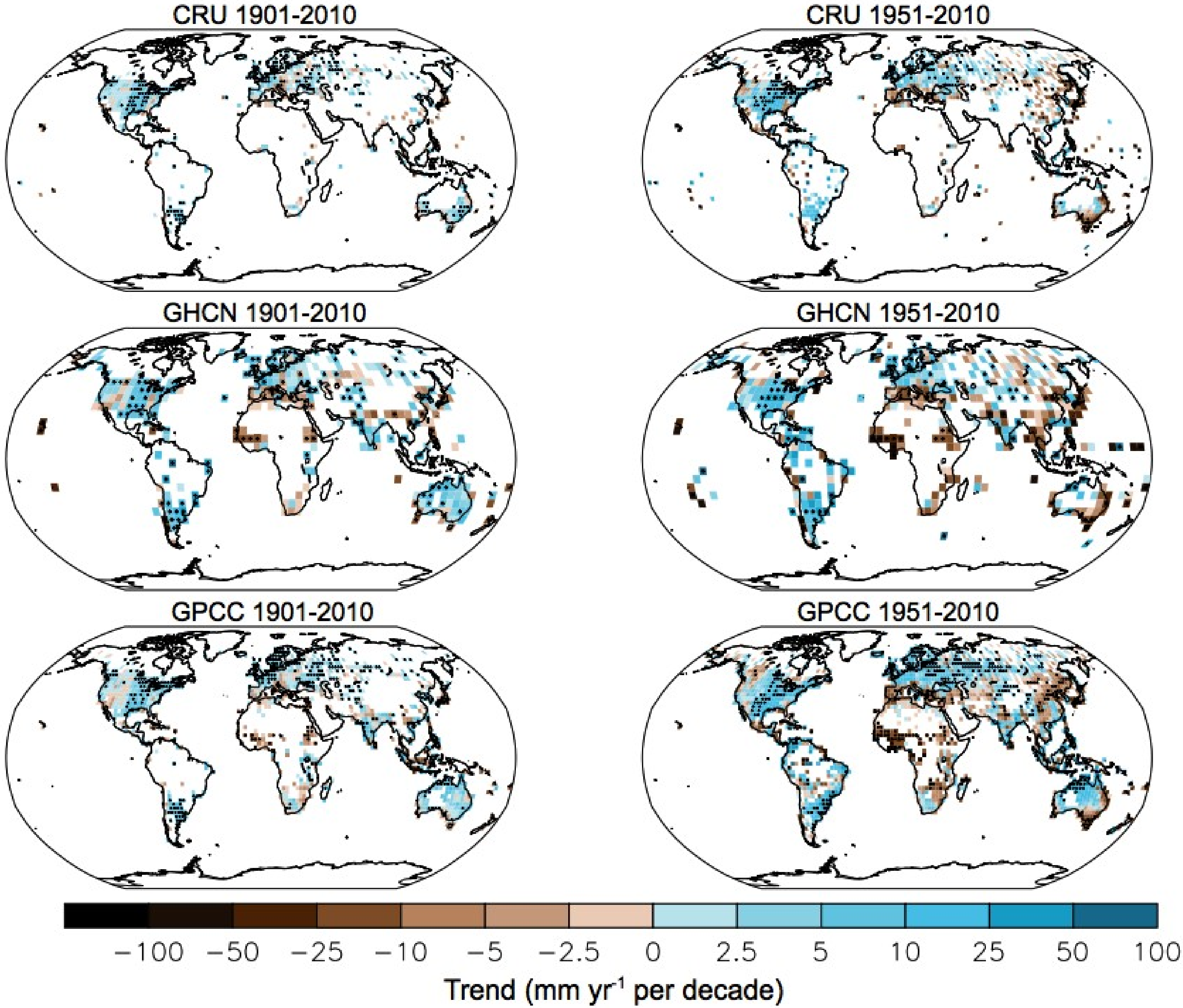


Figure 2.28 | Annual precipitation anomalies averaged over land areas for four latitudinal bands and the globe from five global precipitation data sets relative to a 1981–2000 climatology.

- Mid latitudes NH: overall increase
- High latitudes NH: increase
- Tropics: increase

Table 2.10 | Trend estimates and 90% confidence intervals (Box 2.2) for annual precipitation for each time series in Figure 2.28 over two periods. Dashes indicate not enough data available for trend calculation. For the latitudinal band 90°S to 60°S not enough data exist for each product in either period.

Data Set	Area	Trends in mm yr^{-1} per decade	
		1901–2008	1951–2008
CRU TS 3.10.01 (updated from Mitchell and Jones, 2005)	60°N–90°N	–	5.82 ± 2.72
	30°N–60°N	3.82 ± 1.14	1.13 ± 2.01
	30°S–30°N	0.89 ± 2.89	–4.22 ± 8.27
	60°S–30°S	3.88 ± 2.28	–3.73 ± 5.94
GHCN V2 (updated through 2011; Vose et al., 1992)	60°N–90°N	–	4.52 ± 2.64
	30°N–60°N	3.23 ± 1.10	1.39 ± 1.98
	30°S–30°N	1.01 ± 3.00	–5.15 ± 7.28
	60°S–30°S	–0.57 ± 2.27	–8.01 ± 5.63
GPCC V6 (Becker et al., 2013)	60°N–90°N	–	2.69 ± 2.54
	30°N–60°N	3.14 ± 1.05	1.50 ± 1.93
	30°S–30°N	–0.48 ± 3.35	–4.16 ± 9.65
	60°S–30°S	2.40 ± 2.01	–0.51 ± 5.45
Smith et al. (2012)	60°N–90°N	–	0.63 ± 1.27
	30°N–60°N	1.44 ± 0.50	0.97 ± 0.88
	30°S–30°N	0.43 ± 1.48	0.67 ± 4.75
	60°S–30°S	2.94 ± 1.40	0.78 ± 3.31

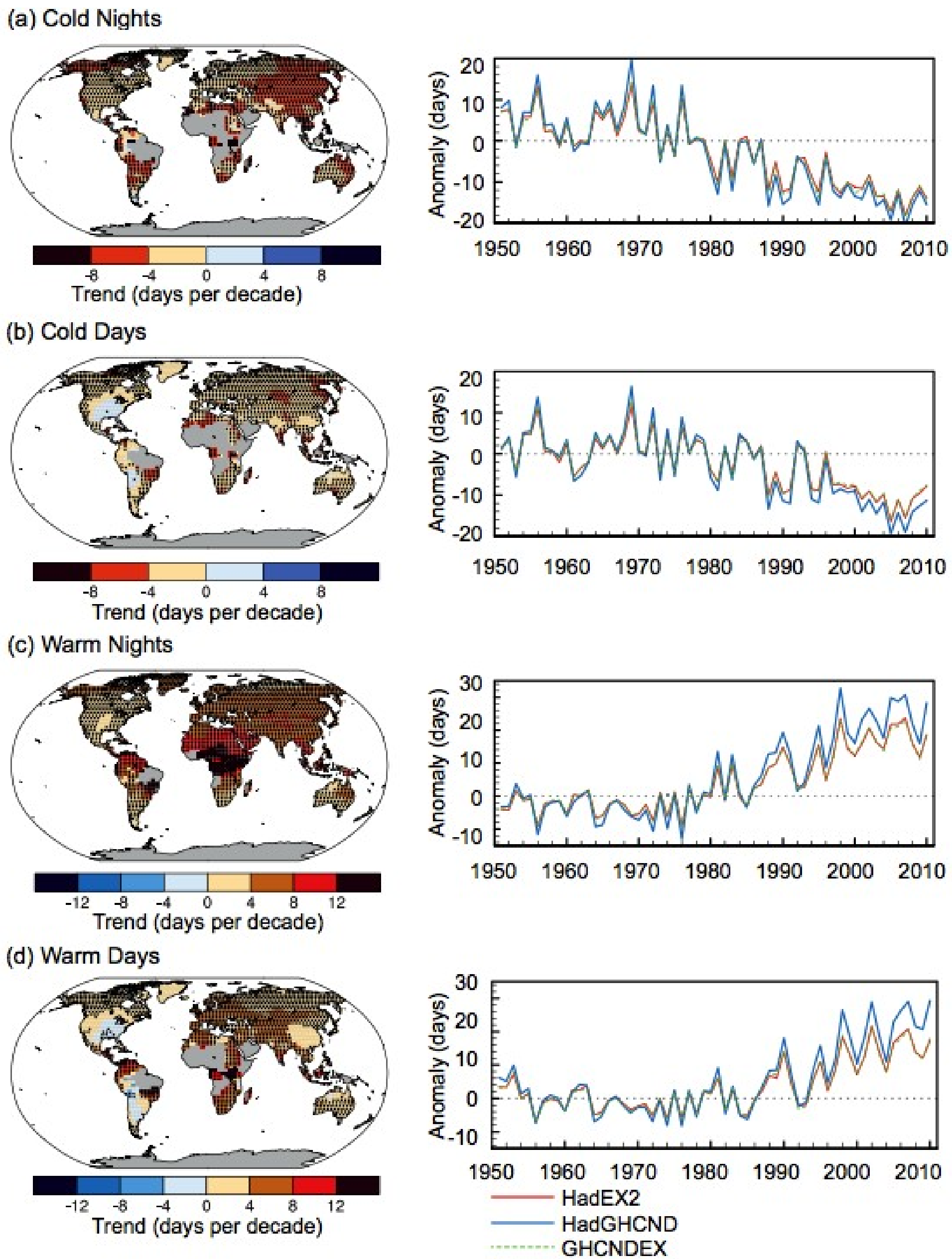

CRU 1901-2010
CRU 1951-2010
GHCN 1901-2010
GHCN 1951-2010
GPCC 1901-2010
GPCC 1951-2010
−100 −50 −25 −10 −5 −2.5 0 2.5 5 10 25 50 100
Trend (mm yr^{-1} per decade)

EXTREME EVENTS

Region	Warm Days (e.g., TX90p[a])	Cold Days (e.g., TX10p[a])	Warm Nights (e.g., TN90p[a], TR[a])	Cold Nights/Frosts (e.g., TN10p[a], FD[a])	Heat Waves / Warm Spells[g]	Extreme Precipitation (e.g., RX1day[a], R95p[a], R99p[a])	Dryness (e.g,. CDD[a]) / Drought[h]
North America and Central America	*High confidence*: *Likely* overall increase but spatially varying trends[1,2]	*High confidence*: *Likely* overall decrease but with spatially varying trends[1,2]	*High confidence*: *Likely* overall increase[1,2]	*High confidence*: *Likely* overall decrease[1,2]	*Medium confidence*: increases in more regions than decreases[1,3] but 1930s dominates longer term trends in the USA[4]	*High confidence*: *Likely* overall increase[1,2,5] but some spatial variation *High confidence*: *Very likely* increase central North America[6,7]	*Medium confidence*: decrease[1] but spatially varying trends ***High confidence*[b]: *Likely* decrease central North America[4]**
South America	***Medium confidence*[b]: Overall increase[8]**	***Medium confidence*[b]: Overall decrease[8]**	***Medium confidence*[b]: Overall increase[8]**	***Medium confidence*[b]: Overall decrease[8]**	*Low confidence*: insufficient evidence (lack of literature) and spatially varying trends but some evidence of increases in more areas than decreases[8]	***Medium confidence*[b]: Increases in more regions than decreases[8,9] but spatially varying trends**	*Low confidence*: limited literature and spatially varying trends[8]
Europe and Mediterranean	*High confidence*: *Likely* overall increase[10,11,12]	*High confidence*: *Likely* overall decrease[11,12]	*High confidence*: *Likely* overall increase[11,12]	*High confidence*: *Likely* overall decrease[10,11,12]	***High confidence*[b]: *Likely* increases in most regions[3,13]**	***High confidence*[b,c]: *Likely* increases in more regions than decreases[5,15,16] but regional and seasonal variation**	*Medium confidence*: spatially varying trends ***High confidence*[b]: *Likely* increase in Mediterranean[17,18]**

Africa and Middle East	*Low* to *medium confidence*[b,d]: limited data in many regions but increases in most regions assessed *Medium confidence*[b]: increase North Africa and Middle East[19,20] *High confidence*[b]: *Likely* increase southern Africa[21,22,23]	*Low* to *medium confidence*[b,d]: limited data in many regions but decreases in most regions assessed *Medium confidence*[b]: decrease North Africa and Middle East[19,20] *High confidence*[b]: *Likely* decrease southern Africa[21,22,23]	*Medium confidence*[b,d]: limited data in many regions but increases in most regions assessed *Medium confidence*[b]: increase North Africa and Middle East[19,20] *High confidence*[b]: *Likely* increase southern Africa[21,22,23]	*Medium confidence*[b,d]: limited data in many regions but decreases in most regions assessed *Medium confidence*[b]: decrease North Africa and Middle East[19,20] *High confidence*[b]: *Likely* decrease southern Africa[21,22,23]	*Low confidence*[d]: insufficient evidence (lack of literature) *Medium confidence*: increase in North Africa and Middle East and southern Africa[3,19,21,22]	*Low confidence*[d]: insufficient evidence and spatially varying trends *Medium confidence*[b]: increases in more regions than decreases in southern Africa but spatially varying trends depending on index[5,21,22]	*Medium confidence*[d]: increase[19,22,24] *High confidence*[b]: *Likely* increase in West Africa[25,26] although 1970s Sahel drought dominates the trend
Asia (excluding South-east Asia)	*High confidence*[b,e]: *Likely* overall increase[27,28,29,30,31,32]	*High confidence*[b,e]: *Likely* overall decrease[27,28,29,30,31,32]	*High confidence*[b,e]: *Likely* overall increase[27,28,29,30,31,32]	*High confidence*[b,e]: *Likely* overall increase[27,28,29,30,31,32]	*Medium confidence*[b,e]: Spatially varying trends and insufficient data in some regions *High confidence*[b,c]: *Likely* more areas of increases than decreases[3,28,33]	*Low* to *medium confidence*[b,e]: *Low confidence* due to insufficient evidence or spatially varying trends. *Medium confidence*: increases in more regions than decreases[5,34,35,36]	*Low* to *medium confidence*[b,e] *Medium confidence*: Increase in eastern Asia[36,37]
South-east Asia and Oceania	*High confidence*[b,f]: *Likely* overall increase[27,38,39,40]	*High confidence*[b,f]: *Likely* overall decrease[27,38,39]	*High confidence*[b,f]: *Likely* overall increase[27,38,39,40]	*High confidence*[b,f]: *Likely* overall decrease[27,38,39]	*Low confidence* (due lack of literature) to *high confidence*[b,f] depending on region *High confidence*[2]: *Likely* overall increase in Australia[3,14,41]	*Low confidence* (lack of literature) to *high confidence*[b,f] *High confidence*: *Likely* decrease in southern Australia[42,43] but index and season dependent	*Low* to *medium confidence*[b,f]: inconsistent trends between studies in SE Asia. Overall increase in dryness in southern and eastern Australia *High confidence*[b]: *Likely* decrease northwest Australia[25,26,44]

TEMPERATURE EXTREMES

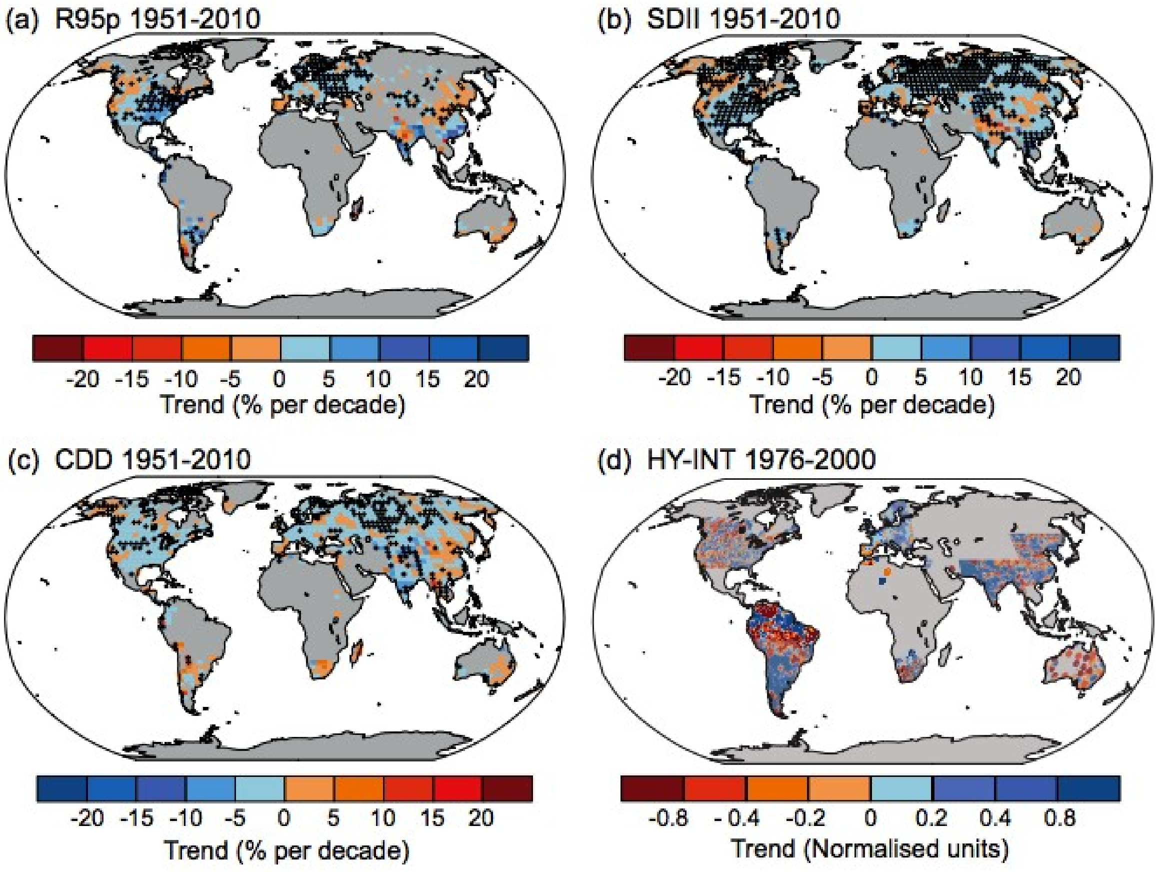


It is *very likely* that the numbers of cold days and nights have decreased and the numbers of warm days and nights have increased globally since about 1950.

PRECIPITATION EXTREMES

It is *likely* that since about 1950 the number of heavy precipitation events over land has increased in more regions than it has decreased.

Confidence is *low* for a global-scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th centu-ry, owing to lack of direct observations, methodological uncer-tainties and geographical inconsistencies in the trends.



(a) R95p 1951-2010
-20 -15 -10 -5 0 5 10 15 20
Trend (% per decade)
(b) SDII 1951-2010
-20 -15 -10 -5 0 5 10 15 20
Trend (% per decade)
(c) CDD 1951-2010
-20 -15 -10 -5 0 5 10 15 20
Trend (% per decade)
(d) HY-INT 1976-2000
-0.8 - 0.4 -0.2 0 0.2 0.4 0.8
Trend (Normalised units)