TABLES FOR PUBLIC REVIEW

PREFACE

Preface Table 1**.** ***Note:*** Abbreviated terms --- Subscript 'S', refers to the Surface. Subscripts '2' and '4' refer to MSU data from channels 2 and 4. Subscript '2LT' refers to a modification of channel 2 data to focus more directly on the Lower Troposphere and reduce the influence of stratospheric temperatures on channel 2 data. Subscripts '850–300' and '100–50' are specific atmospheric layers sampled by radiosondes. Subscript '$*_G$' refers to a combination of channel 2 and channel 4 data derived by Fu and co-workers, applicable to global averages, and '$*_T$' refers to applicable tropical averages. For the model-observation comparisons, the observation-based definitions as listed in the Table were employed.

Terms for Layers of the Atmosphere Used in this Report

Common Term	**Abbrev. Term for the temperature of that layer**	**Main region of Influence**	**Approximate altitude. (For satellite products: altitude range of bulk (90%) of layer measured.)**	**Lower and upper pressure level boundaries**
Surface	T_S	Air: Just above surface Water: Shallow depth	Surface Air: Land: 1.5 – 2.0 m above surface; Ocean: ship deck-height (5 – 25 m) above surface. Surface Water: 1 – 10 m depth in ocean (SSTs)	Surface (or ~1000 hPa at sea level)
Lower Troposphere	T_{2LT}	Low to Mid-Troposphere	Surface – 8 km	Surface to 350 hPa
Troposphere (radiosonde)	$T_{(850\text{-}300)}$	Troposphere	1.5 – 9 km	850 – 300 hPa
Troposphere (satellite)	$T*_G$	Troposphere	Surface – 13 km	Surface – 150 hPa
Tropical Troposphere (satellite)	$T*_T$	Troposphere (tropics only)	Surface – 16 km	Surface – 100 hPa

Mid Troposphere to Lower Stratosphere	T_2	Mid and upper Troposphere to Low Stratosphere[1]	Surface – 18 km	Surface – 75 hPa
Lower Stratosphere (satellite)	T_4	Low Stratosphere	14 – 29 km	150 – 15 hPa
Lower Stratosphere (radiosonde)	$T_{(100\text{-}50)}$	Low Stratosphere	17 – 21 km	100 – 50 hPa

EXECUTIVE SUMMARY

Executive Summary Table 1: Summary of the most important global-scale climate forcing factors and their likely individual effects on global, annual-mean temperatures; based on Figure 1.3 (which gives temperature information) and Table 1.1 (which gives information on radiative forcing) in Chapter 1, and literature cited in Chapter 1. The stated effects are those that would be expected if the change specified in column 1 were to occur. The top two rows are the primary natural forcing factors, while the other rows summarize the main human-induced forcing factors. The relative importance of these different factors varies spatially and over time.

Forcing Factor	**Surface**	**Low to Mid Troposphere**	**Stratosphere**
Increased solar output	Warming	Warming	Warming
Volcanic eruptions	Cooling	Cooling	Short-term warming
Increased concentrations of well-mixed greenhouse gases (CO_2, CH_4, N_2O, halocarbons)	Warming	Warming	Cooling
Increased tropospheric ozone (O_3)	Warming	Warming	Slight cooling
Decreased stratospheric ozone	Negligible except at high latitudes	Slight cooling	Cooling
Increased loading of sulfate (SO_4) aerosol – sum of direct plus indirect effects	Cooling	Cooling	Negligible

Increased loading of carbonaceous aerosol (black carbon (BC) and organic matter (OM)) – sum of direct plus indirect effects	Regional cooling – possible global-mean cooling	Warming	Uncertain
Land use and land cover changes	Regional cooling or warming – probably slight global-mean cooling	Uncertain	Negligible

CHAPTER 1

Chapter 1 Table 1.1. Agents potentially causing an external radiative forcing of climate change in the 20th Century (based on Ramaswamy et al., 2001). See notes below for explanations.

Forcing agent	Nat. (N) or Anth. (A)	Solar pert.	Longwave pert.	Surface rad. effect	Tropos. rad. effect	Stratos. rad. effect	Geog. dis. (global G or localized, L)	Level of confidence
Well-mixed gases	A	(small)	Y	Y	Y	Y	G	High
Trop. ozone	A	Y	Y	Y	Y	(small)	L	Medium
Strat. ozone	A	Y	Y	(small)	Y	Y	L	Medium
Sulfate aero. (direct)	A	Y	-	Y	(small)	-	L	Low
Black carbon aero. (direct)	A	Y	(small)	Y	Y	-	L	Very low
Organic carbon aero.	A	Y	-	Y	(small)	-	L	Very low

(direct)								
Biomass burning aero. (direct)	A	Y	-	Y	Y	-	L	Very low
Indirect aerosol effect	A	Y	Y	Y	Y	(small)	L	Very low
Land-use	A	Y	(small)	Y	-	-	L	Very low
Aircraft contrails	A	(small)	(small)	(small)	(small)	-	L	Very low
Sun	N	Y	-	Y	(small)	Y	G	@Very low
Volcanic aero.	N	Y	Y	Y	(small)	Y	#	*

<u>Notes</u>:

Natural (N) and Anthropogenic (A) sources of the forcing agents. Direct aerosol forcing is to be contrasted with the indirect effects; the latter comprise the so-called first, second, and semi-direct effects. Y denotes a significant component, "small" indicates considerably less important but not negligible, while no entry denotes a negligible component. Forcings other than well-mixed gases and solar are spatially localized, with the degree of localization having considerable variations amongst the different agents, depending on their respective source locations. In addition, for short-lived species such as ozone and aerosols, the long-range meteorological transport plays an important role in their global distributions. Level of confidence is a subjective measure of the certainty in the quantitative estimate of the global-mean forcing.

 # Typically, the forcing becomes near-global a few months after an intense tropical eruption.

*** * In the case of volcanic aerosols, the level of confidence in the forcing from the most recent intense eruption, that of Mt. Pinatubo in 1991, is reasonably good because of reliable observing systems in place; for prior explosive eruptions, observations were absent or sparse which affects the reliability of the quantitative estimates for the previous volcanic events.**

@ Although solar irradiance variations before 1980 have a very low level of confidence, direct observations of the Sun's output from satellite platforms since 1980 are considered to be accurate (Lean et al., 2005). Thus, the forcing due to solar irradiance variations from 1980 to present are known to a much greater degree of confidence than from pre-industrial to present time.

CHAPTER 2

Chapter 2, Table 2.1 Dataset types and readiness for high quality climate monitoring related to the vertical temperature structure of the atmosphere. "Usage of Data" indicates the level of application of the dataset to the vertical temperature issue. "Understanding" indicates the level of confidence (or readiness) in the dataset to provide accurate information on this issue.

DATA SET SOURCE	Measured Variables	Usage of Data for Vertical Temperature	Understanding	Temporal Sampling	Geographic Completeness
Radiosondes (Balloons)	Upper Air Temperature			2x Day	
	Upper Air Humidity			2x Day	
	Upper Air Wind			2x Day	
Microwave Radiometers Space-based	Upper air Temperature			P	
	Sea Surface Temperature			P	
	Total Column Vapor (ocean)			P	
Surface-based sounders and profilers	Upper air Temperature			Hrly	
Infrared Radiometers Space-based	Upper Air Temperature			P, G	
	Land Surface Temperature			P, G	
	Sea Surface Temperature			P, G	
	Upper Air Humidity			P, G	
Visible and Infrared Radiometers	Radiative Fluxes			P, G	
GPS Satellites	Temperature			quasi-P	
Surface Stations Land	Land Surface Air Temperature			Hrly	
	Land Surface Air Humidity			Hrly	

Surface Instruments Ocean	**Sea Surface Temperature**			**Syn**	
	Marine Air Temperature			**Syn**	
Reanalyses	**All**			**Syn**	

: Adequate for long-term global climate variations

: Improvements or continued research needed for long-term global climate variations

: Problems exist or a lack of analysis to date inhibit long-term global climate variation studies

P: Polar orbiter, twice per day per orbiter per ground location

G: Geostationary, many observations per day per ground location

2x Day: Twice daily at site

Hrly: Up to several times per day, many report hourly

Syn: Synoptic or generally up to 8 times per day. (Buoys continuous

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Chapter 2, Table 2.2. Time scales and sources of global temperature variations.

Variation	**Description**	**Dominant Period**	**Approx. Magnitude**	Detectibility	**Effect on Trend Estimates**
Diurnal[1]	Warmer days than nights, due to earth's rotation on its axis affecting solar heating.	Daily (outside of polar regions)	Highly variable. Surface skin T changes up to 35K. Boundary layer changes <10K. Free tropospheric changes <1K. Stratospheric changes ~0.1-1 K.	Well detected in surface data. Poorly detected globally in the troposphere and stratosphere due to infrequent sampling (once or twice daily) and potential influence of measurement errors with their own diurnal signal. A few ground-based systems detect signal well.	Satellite data require adjustment of drift in the local equatorial crossing time of spacecraft orbits. Inadequate quantification of the true diurnal cycle hinders this adjustment. Different diurnal adjustments by different groups may partly account for differences in trend estimates.
Synoptic[2]	Temperature changes	1-4 days	Up to ~15K or more at middle	Well detected by observing	Not significant, but contributes to

Variation	**Description**	**Dominant Period**	**Approx. Magnitude**	Detectibility	**Effect on Trend Estimates**
	associated with weather events, such as wave and frontal passages, due to internal atmospheric dynamics.		latitudes, ~3K in Tropics.	systems designed to observe meteorological variability.	noise in climate data records.
Intraseasonal[3]	Most notably, an eastward-and vertically-propagating pattern of disturbed weather in the tropical Indo-Pacific ocean region, of unknown cause. Also, atmospheric “blocking” and wet/dry land surface can cause intra-seasonal variations at mid-latitudes.	40-60 days (Tropics), < 180 days (mid-latitudes)	1-2 K at surface, less aloft (tropics), larger in mid-latitudes.	Temperature signals moderately well detected, with tropical atmosphere limited by sparse radiosonde network and IR-based surface temperature limited by cloud. Reanalysis data are useful.	Not significant due to short duration, but may be important if character of the oscillation changes over time.
Annual[4]	Warmer summers than winters, and shift in position of major precipitation zones, due to tilt of the earth’s axis of rotation affecting solar heating.	Yearly	~2-30 K; greater over land than sea, greater at high than low latitudes, greater near the surface and tropopause than at other heights.	Well observed.	Trends are often computed from “anomaly” data, after the mean annual cycle has been subtracted. Changes in the nature of the annual cycle could affect annual-average trends.
Quasi-Biennial Oscillation (QBO)[5]	Nearly periodic wind and temperature changes in the equatorial stratosphere, due to internal	Every 23-28 months (average of 27 months because occasionally periods of up	Up to 10 K locally, ~0.5 K averaged over the tropical stratosphere.	Fairly well observed by equatorial radiosonde stations and satellites.	Like ENSO, can influence trends in short data records, but it is relatively easy to remove this signal.

Variation	**Description**	**Dominant Period**	**Approx. Magnitude**	Detectibility	**Effect on Trend Estimates**
	atmospheric dynamics.	to 36 months occur.)			
Interannual[6]	Multiannual variability due to interaction of the atmosphere with dynamic ocean and possibly land surfaces; most notably, ENSO. Can also be caused by volcanic eruptions.	ENSO events occur every 3-7 years and last 6-18 months; major volcanic eruptions, irregular but approximately every 5-20 years with effects lasting ~ 2 years.	Up to 3K in equatorial Pacific (ENSO), smaller elsewhere. Volcanic warming of stratosphere can exceed 5K in tropics cooling of surface <2K.	Fairly well observed, although the vertical structure of ENSO is not as well documented, due to sparseness of the tropical radiosonde network.	ENSO affects surface global mean temperatures by ±0.4K, and more in the tropical troposphere. Large ENSO events near the start or end of a data record can strongly affect computed trends, as was the case for the 1997-98 event. Changes in ENSO frequency or strength affect (and may be coupled with) long-term trends.
Decadal to interdecadal oscillations and shifts[7]	Like interannual, but longer time scales. Prominent example is the PDO/ Interdecadal Pacific Oscillation. Despite long time scale, changes can occur as abrupt shifts, for example, a warming shift around 1976. Others include regional changes in the North Atlantic, Pacific-North American,	Poorly known; 50-year PDO cycle suggested by 20th-century observations; others a decade or two; solar 11-year cycle detectable also.	Not well studied. The 1976-77 shift associated with a sharp warming of at least 0.2K globally, though difficult to distinguish from anthropogenic warming. 11-year cycle leads to stratospheric temperature changes of ~2K, and	Relatively large regional changes are well observed, but global expression is subject to data consistency issues over time and possible real changes.	Can account for a significant fraction of linear trends calculated over periods of a few decades or less regionally. Such trends may differ significantly from one such period to the next.

Variation	**Description**	**Dominant Period**	**Approx. Magnitude**	Detectibility	**Effect on Trend Estimates**
	Arctic, and the Antarctic oscillations. Some changes also caused by 11-year solar cycle.		interacts with the Quasi-Biennial Oscillation (QBO).		
Sub-centennial 60-80 year fluctuation or "Atlantic Multidecadal Oscillation"[8]	Fluctuates in instrumental and paleo data at least back to c.1600. Seems to particularly affect Atlantic sector. Possible interhemispheric component.	60-80 years	~ ±0.5C in parts of the Atlantic. Apparently detectable in global mean ~ ±0.1C	Detectable globally above the noise, clear in North Atlantic SST.	Effects small globally, but probably detectable in last few decades. Readily detectable over this period in North Atlantic Ocean where it clearly affects surface temperature trends and probably climate generally.
Centennial and longer variations[9]	Warming during 20th Century due to human influences, solar, and internal variability. Earlier changes included the "little ice age" and "medieval warm period."	None confirmed, though 1500 year Bond cycle possible.	20th century warming of ~0.6K globally appears to be as large or larger than other changes during the late Holocene.	Surface warming during 20th century fairly well observed; proxies covering earlier times indicated 20th century warmer than the past 5 centuries	Natural temperature variations occur on the longest time scales accessible in any instrumental record.

CHAPTER 3

Chapter 3, Table 3.1: Temperature datasets utilized in this report.

Our Name	*Name given by Producers*	*Producers*	*Web Page*
-- Surface –			
NOAA	ER-GHCN-ICOADS	NOAA's National Climatic Data Center (NCDC)	http://www.ncdc.noaa.gov/oa/climate/monitoring/gcag/gcag.html
GISS	Land+Ocean Temperature	NASA's Goddard Institute for Space Studies (GISS)	http://www.giss.nasa.gov/data/update/gistemp/graphs/
HadCRUT2v	HadCRUT2v	Climatic Research Unit of the University of East Anglia and the Hadley Centre of the UK Met Office.	http://www.cru.uea.ac.uk/cru/data/temperature
-- Radiosonde –			
RATPAC	RATPAC	NOAA's: Air Resources Laboratory (ARL), Geophysical Fluid Dynamics Laboratory (GFDL), and National Climatic Data Center (NCDC)	http://www.ncdc.noaa.gov/
HadAT2	HadAT2	Hadley Centre, UK	http://www.hadobs.org/
-- Satellite –			
Temperature of the Lower Troposphere			
T_{2LT-A}	TLT	University of Alabama in Huntsville (UAH)	http://vortex.nsstc.uah.edu/data/msu/t2lt
T_{2LT-R}	TLT	Remote Sensing System, Inc. (RSS)	http://www.remss.com/msu/msu_data_description.html
Temperature of the Middle Troposphere			
T_{2-A}	TMT	University of Alabama in Huntsville (UAH)	http://vortex.nsstc.uah.edu/data/msu/t2

T_{2-R} TMT Remote Sensing System, Inc. (RSS)
http://www.remss.com/msu/msu_data_description.html

T_{2-M} Channel 2 University of Maryland and NOAA/NESDIS (U.Md.)

Temperature of the Middle Troposphere minus Stratospheric Influences

T^*_G (global) $T_{(850\text{-}300)}$ University of Washington, Seattle (UW) and
T^*_T (tropics) NOAA's Air Resources Laboratory (ARL)

Temperature of the Lower Stratosphere

T_{4-A} TLS University of Alabama in Huntsville (UAH)
http://vortex.nsstc.uah.edu/data/msu/t4

T_{4-R} TLS Remote Sensing System, Inc. (RSS)
http://www.remss.com/msu/msu_data_description.html

-- Reanalysis –

US NCEP50 National Center for Environmental Prediction, NOAA and the National Center for Atmospheric Research
http://wesley.ncep.noaa.gov/reanalysis.html

European ERA40 European Center for Medium Range Forecasting
http://www.ecmwf.int/research/era

Chapter 3, Table 3.2 - Global temperature trends in ºC per decade from 1958 through 2004 (except for European which terminates September 2001) calculated for the surface or atmospheric layers by data source. The trend is shown for each, with the approximate 95% confidence interval (2 sigma) below in parentheses. The levels/layers, from left to right, go from the lowest to the highest in the atmosphere. Bold values are estimated to be statistically significantly different from zero (at the 5% level). A Student's t-test, using the lag-1 autocorrelation to account for the non-independence of residual values about the trend line, was used to assess significance (see Appendix for discussion of confidence intervals and significance testing).

	T_S	T_{2LT}	$T_{(850-300)}$	T^*_G	T_2	$T_{(100-50)}$	T_4
Surface:							
NOAA	**0.11** (0.017)						
GISS	**0.11** (0.021)						
HadCRUT2v	**0.13** (0.021)						
Radiosonde:							
RATPAC	**0.11** (0.022)	**0.13** (0.026)	**0.13** (0.030)	**0.13** (0.032)	**0.07** (0.030)	**-0.41** (0.093)	**-0.36** (0.082)
HadAT2	**0.12** (0.026)	**0.16** (0.036)	**0.14** (0.039)	**0.15** (0.041)	**0.08** (0.040)	**-0.39** (0.084)	**-0.38** (0.083)
Reanalyses:							
US	**0.12** (0.030)	**0.15** (0.046)	**0.17** (0.052)	**0.17** (0.057)	**0.13** (0.064)	-0.18 (0.232)	-0.18 (0.223)
European	**0.11** (0.027)	**0.15** (0.042)	**0.15** (0.042)	**0.14** (0.044)	**0.10** (0.040)	**-0.21** (0.128)	**-0.17** (0.134)

Chapter 3, Table 3.3 - Global temperature trends in ºC per decade from 1979 through 2004 (except for European which terminates September 2001) calculated for the surface or atmospheric layers by data source. The trend is shown for each, with the approximate 95% confidence interval (2 sigma) below in parentheses. The levels/layers, from left to right, go from the lowest to the highest in the atmosphere. Bold values are estimated to be statistically significantly different from zero (at the 5% level). A Student's t-test, using the lag-1 autocorrelation to account for the non-independence of residual values about the trend line, was used to assess significance (see Appendix for discussion of confidence intervals and significance testing).

	T_S	T_{2LT}	$T_{(850\text{-}300)}$	T^*_G	T_2	$T_{(100\text{-}50)}$	T_4
Surface:							
NOAA	**0.16** (0.035)						
GISS	**0.16** (0.043)						
HadCRUT2v	**0.17** (0.037)						
Radiosonde:							
RATPAC	**0.17** (0.050)	**0.13** (0.057)	**0.10** (0.065)	**0.11** (0.075)	0.02 (0.071)	**-0.70** (0.240)	**-0.65** (0.213)
HadAT2	**0.18** (0.050)	**0.14** (0.071)	**0.12** (0.075)	**0.12** (0.084)	0.03 (0.080)	**-0.63** (0.241)	**-0.64** (0.238)
Satellite:							
UAH		**0.12** (0.082)		**0.12** (0.089)	0.04 (0.078)		**-0.45** (0.421)
RSS		**0.19** (0.081)		**0.19** (0.089)	**0.13** (0.077)		-0.33 (0.382)
U.Md.					**0.20** (0.066)		
Reanalyses:							
US	**0.12** (0.074)	**0.12** (0.100)	**0.11** (0.101)	0.06 (0.106)	-0.04 (0.101)	**-0.76** (0.450)	**-0.74** (0.441)
European	**0.11** (0.060)	**0.11** (0.101)	0.10 (0.102)	**0.13** (0.106)	0.07 (0.096)	-0.31 (0.529)	-0.34 (0.493)

Chapter 3, Table 3.4 – Tropical (20^{o}N-20^{o}S) temperature trends in ºC per decade from 1979 through 2004 (except for European which terminates September 2001) calculated for the surface or atmospheric layers by data source. The trend is shown for each, with the approximate 95% confidence interval (2 sigma) below in parentheses. The levels/layers, from left to right, go from the lowest to the highest in the atmosphere. Bold values are estimated to be statistically significantly different from zero (at the 5% level). A Student's t-test, using the lag-1 autocorrelation to account for the non-independence of residual values about the trend line, was used to assess significance (see Appendix for discussion of confidence intervals and significance testing).

	T_S	T_{2LT}	$T_{(850\text{-}300)}$	T^*_G	T_2	$T_{(100\text{-}50)}$	T_4
Surface:							
NOAA	0.13 (0.149)						
GISS	0.13 (0.152)						
HadCRUT2v	0.12 (0.172)						
Radiosonde:							
RATPAC	**0.13** (0.068)	0.08 (0.119)	0.06 (0.136)	0.07 (0.153)	0.00 (0.140)	**-0.75** (0.362)	**-0.69** (0.289)
HadAT2	**0.15** (0.115)	0.05 (0.152)	0.03 (0.164)	0.02 (0.176)	-0.04 (0.170)	**-0.66** (0.304)	**-0.64** (0.307)
Satellite:							
UAH		0.05 (0.176)		0.09 (0.191)	0.05 (0.167)		**-0.37** (0.281)
RSS		0.15 (0.192)		0.18 (0.196)	0.14 (0.175)		-0.29 (0.303)
U.Md.					**0.19** (0.159)		
Reanalyses:							
US	0.03 (0.163)	0.05 (0.172)	0.04 (0.173)	-0.03 (0.183)	-0.10 (0.166)	**-0.89** (0.405)	**-0.83** (0.340)
European	0.03 (0.211)	0.00 (0.234)	-0.03 (0.249)	0.06 (0.255)	0.05 (0.232)	-0.03 (0.453)	-0.05 (0.423)

Chapter 3, Table 3.5 – Temperature trends in ºC per decade from the RATPAC and HadAT2 radiosonde datasets corresponding to the plots in Figure 3.7 (see figure caption for further details). Global and tropical trends are given for 1958 through 2004 and 1979 through 2004 (except for European which terminates September 2001). The HadAT2 dataset does not have temperatures for some of the levels, hence the empty table cells. The trend is shown for each vertical level (hPa), with the approximate 95% confidence interval (2 sigma) below in parentheses. Bold values are estimated to be statistically significantly different from zero (at the 5% level). A Student's t-test, using the lag-1 autocorrelation to account for the non-independence of residual values about the trend line, was used to assess significance (see Appendix for discussion of confidence intervals and significance testing).

Level (hPa)	1958-2004 RATPAC Global	1958-2004 HadAT2 Global	1958-2004 RATPAC Tropical	1958-2004 HadAT2 Tropical	1979-2004 RATPAC Global	1979-2004 HadAT2 Global	1979-2004 RATPAC Tropical	1979-2004 HadAT2 Tropical
20	**-0.41** (0.078)		**-0.49** (0.143)		**-0.91** (0.141)		**-0.95** (0.319)	
30	**-0.48** (0.091)	**-0.57** (0.100)	**-0.55** (0.179)	**-0.59** (0.204)	**-0.88** (0.234)	**-0.96** (0.249)	**-0.91** (0.522)	**-0.90** (0.586)
50	**-0.53** (0.120)	**-0.55** (0.119)	**-0.63** (0.224)	**-0.52** (0.232)	**-0.89** (0.330)	**-0.88** (0.346)	**-1.01** (0.568)	**-0.83** (0.591)
70	**-0.48** (0.110)		**-0.58** (0.222)		**-0.79** (0.261)		**-0.89** (0.451)	
100	**-0.23** (0.063)	**-0.25** (0.060)	**-0.18** (0.063)	**-0.27** (0.066)	**-0.43** (0.164)	**-0.43** (0.152)	**-0.36** (0.173)	**-0.51** (0.159)
150	-0.05 (0.061)	-0.04 (0.057)	0.05 (0.065)	-0.01 (0.064)	**-0.19** (0159)	-0.13 (0.140)	-0.10 (0.185)	-0.14 (0.158)
200	0.03 (0.047)	**0.05** (0.047)	**0.13** (0.079)	**0.11** (0.089)	-0.08 (0.113)	-0.05 (0.105)	-0.01 (0.204)	-0.02 (0.224)
250	**0.11** (0.037)		**0.15** (0.076)		0.08 (0.096)		0.09 (0.198)	
300	**0.14** (0.038)	**0.14** (0.044)	**0.18** (0.071)	**0.15** (0.084)	**0.12** (0.094)	**0.12** (0.094)	0.13 (0.181)	0.05 (0.208)
400	**0.15** (0.036)		**0.15** (0.063)		**0.13** (0.082)		0.11 (0.147)	
500	**0.14** (0.032)	**0.14** (0.040)	**0.14** (0.057)	**0.11** (0.063)	**0.09** (0.068)	**0.12** (0.074)	0.05 (0.124)	0.01 (0.135)
700	**0.13** (0.026)	**0.15** (0.035)	**0.13** (0.054)	**0.11** (0.064)	**0.09** (0.053)	**0.12** (0.066)	0.05 (0.123)	0.02 (0.129)
850	**0.12** (0.022)	**0.15** (0.029)	**0.08** (0.032)	**0.12** (0.051)	**0.08** (0.047)	**0.13** (0.060)	-0.01 (0.058)	0.06 (0.105)
Surface	**0.11** (0.022)	**0.12** (0.026)	**0.10** (0.031)	**0.11** (0.039)	**0.17** (0.050)	**0.18** (0.050)	**0.13** (0.068)	**0.15** (0.115)

CHAPTER 4

(no tables shown in Chapter 4)

CHAPTER 5

Chapter 5 Table 5.1: Acronyms of climate models referenced in this Chapter. All 19 models 1884 performed simulations of 20th century climate change ("20CEN") in support of the IPCC 1885 Fourth Assessment Report. The ensemble size "ES" is the number of independent 1886 realizations of the 20CEN experiment that were analyzed here.

	MODEL ACRONYM	COUNTRY	INSTITUTION	ES
1	CCCma-CGCM3.1(T47)	Canada	Canadian Centre for Climate Modelling and Analysis	1
2	CCSM3	United States	National Center for Atmospheric Research	5
3	CNRM-CM3	France	Météo-France/Centre National de Recherches Météorologiques	1
4	CSIRO-Mk3.0	Australia	CSIRO[1] Marine and Atmospheric Research	1
5	ECHAM5/MPI-OM	Germany	Max-Planck Institute for Meteorology	3
6	FGOALS-g1.0	China	Institute for Atmospheric Physics	1
7	GFDL-CM2.0	United States	Geophysical Fluid Dynamics Laboratory	3
8	GFDL-CM2.1	United States	Geophysical Fluid Dynamics Laboratory	3
9	GISS-AOM	United States	Goddard Institute for Space Studies	2
10	GISS-EH	United States	Goddard Institute for Space Studies	5
11	GISS-ER	United States	Goddard Institute for Space Studies	5
12	INM-CM3.0	Russia	Institute for Numerical Mathematics	1
13	IPSL-CM4	France	Institute Pierre Simon Laplace	1
14	MIROC3.2(medres)	Japan	Center for Climate System Research / NIES[2] / JAMSTEC[3]	3
15	MIROC3.2(hires)	Japan	Center for Climate System Research / NIES[2] / JAMSTEC[3]	1
16	MRI-CGCM2.3.2	Japan	Meteorological Research Institute	5
17	PCM	United States	National Center for Atmospheric Research	4
18	UKMO-HadCM3	United Kingdom	Hadley Centre for Climate Prediction and Research	1
19	UKMO-HadGEM1	United Kingdom	Hadley Centre for Climate Prediction and Research	1

[1] CSIRO is the Commonwealth Scientific and Industrial Research Organization. [2] NIES is the National Institute for Environmental Studies. 1889 [3] JAMSTEC is the Frontier Research Center for Global Change in Japan.

Chapter 5, Table 5.2: Forcings used in IPCC simulations of 20th century climate change. This Table was compiled using information provided by the participating modeling centers (see http://www-pcmdi.llnl.gov/ipcc/model.documentation). Eleven different forcings are listed: well mixed greenhouse gases (G), tropospheric and stratospheric ozone (O), sulfate aerosol direct (SD) and indirect effects (SI), black carbon (BC) and organic carbon aerosols (OC), mineral dust (MD), sea salt (SS), land use/land cover (LU), solar irradiance (SO), and volcanic aerosols (V). Shading denotes inclusion of a specific forcing. As used here, "inclusion" means specification of a time-varying forcing, with changes on interannual and longer timescales. Forcings that were varied over the seasonal cycle only are not shaded.

	MODEL	G	O	SD	SI	BC	OC	MD	SS	LU	SO	V
1	CCCma-CGCM3.1(T47)											
2	CCSM3											
3	CNRM-CM3											
4	CSIRO-Mk3.0											
5	ECHAM5/MPI-OM											
6	FGOALS-g1.0											
7	GFDL-CM2.0											
8	GFDL-CM2.1											
9	GISS-AOM											
10	GISS-EH											
11	GISS-ER											
12	INM-CM3.0											
13	IPSL-CM4											
14	MIROC3.2(medres)											
15	MIROC3.2(hires)											
16	MRI-CGCM2.3.2											
17	PCM											
18	UKMO-HadCM3											
19	UKMO-HadGEM1											

Chapter 5, Table 5.3: Forcings used in 20CEN experiments performed with the PCM, CCSM3.0, GFDL CM2.1, and GISS-EH models. Grey shading denotes 1901 a forcing that was included in the experimental design. Shading indicates a forcing that was not incorporated or that did not vary over the course of 1902 the experiment.

	PCM	CCSM3.0	GFDL CM2.1	GISS-EH
Well-mixed greenhouse gases	IPCC Third Assessment Report.	IPCC Third Assessment Report.	IPCC Third Assessment Report and *World Meteorological Organization* (2003).	CH_4, N_2O and CFC spatial distributions are fit to *Minschwaner et al*. (1998).
Sulfate aerosols (direct effects)	Spatial patterns of sulfur dioxide [SO_2] emissions prescribed over seasonal cycle. Year-to-year changes scaled by estimates of historical changes in SO_2 emissions.[1]	Sulfur cycle model using time and space-varying SO_2 emissions (*Smith et al*., 2001, 2005).[2]	Computed from an atmospheric chemistry transport model.[3]	Based on simulations of *Koch et al*. (1999) and *Koch* (2001).[4]
Sulfate aerosols (indirect effects)	Not included.	Not included.	Not included.	Parameterization of aerosol indirect effects on cloud albedo and cloud cover.[4]
Stratospheric ozone	Assumed to be constant up to 1970. After 1970 prescribed from a NOAA dataset.[1]	Assumed to be constant up to 1970. After 1970 prescribed from a NOAA dataset.[2]	Specified using data from *Randel and Wu* (1999).	Specified using data from *Randel and Wu* (1999).[4]
Tropospheric ozone	Computed from an atmospheric chemistry transport model. Held constant after 1990.[1]	Computed from an atmospheric chemistry transport model. Held constant after 1990.[2]	Computed from an atmospheric chemistry transport model.[3]	Computed from an atmospheric chemistry transport model (*Shindell et al*., 2003).[4]
Black carbon aerosols	Not included.	Present-day estimate of distribution and amount of black carbon, scaled by population changes over 20th Century.[2]	Computed from an atmospheric chemistry transport model.[3]	Based on simulations of *Koch et al*. (1999) and *Koch* (2001).[4]
Organic aerosols	Not included.	Not included.	Computed from an atmospheric chemistry transport model.[3]	Based on simulations of *Koch et al*. (1999) and *Koch* (2001).[4]
Sea salt	Not included.	Distributions held fixed in 20th Century at year 2000 values.[2]	Distributions held fixed at 1990 values.	
Dust	Not included.	Distributions held fixed in 20th Century at year 2000 values.[2]	Distributions held fixed at 1990 values.	
Land use change	Distributions held fixed at present-day values.	Distributions held fixed at present-day values.	*Hurtt et al*. (2006) global land use reconstruction history. Includes effect on surface albedo, surface roughness, stomatal resistance, and effective water capacity.	Uses *Ramankutty and Foley* (1999) and *Klein Goldewijk* (2001) time-dependent datasets. Effects on albedo and evapotranspiration included, but no irrigation effects.[4]
Volcanic stratospheric aerosols	*Ammann et al*. (2003).	*Ammann et al*. (2003).	"Blend" between *Sato et al*. (1993) and *Ramachandran et al. (2000).*	Update of *Sato et al*. (1993).
Solar irradiance	*Hoyt and Schatten* (1993).	*Lean et al*. (1995).	*Lean et al*. (1995).	Uses solar spectral changes of *Lean* (2000).

[1] See *Dai et al*. (2001) for further details.1904 [2] See *Meehl et al*. (2005) for further details.1905
[3] The chemistry transport model (MOZART; see *Horowitz et al*., 2003; *Tie et al*., 2005) was driven by meteorology from the Middle Atmosphere version of the1906 Community Climate Model ("MACCM"; version 3). "1990" weather from MACCM3 was used for all years between 1860 and 2000.1907 [4] See *Hansen et al*. (2005a) for further details.

Chapter 5, Table 5.4A: Summary statistics for global-mean temperature trends calculated from 49 1909 different realizations of 20CEN experiments performed with 19 different coupled models. 1910 Results are for four different atmospheric layers (T4, T2, T*G, and T2LT), the surface (TS), 1911 and differences between the surface and the troposphere (TS minus T*G and TS minus 1912 T2LT). All trends were calculated over the 252-month period from January 1979 to 1913 December 1999 using global-mean monthly-mean anomaly data. Results are in 1914 °C/decade. The values in the “Mean” column correspond to the locations of the red lines 1915 in the seven panels of Figure 5.3A. For each layer, means, medians and standard 1916 deviations were calculated from a sample size of *n* = 19, *i.e.*, from ensemble means (if 1917 available) and individual realizations (if ensembles were not performed). This avoids 1918 placing too much weight on results from a single model with a large number of 1919 realizations. Maximum and minimum values were calculated from all available realizations 1920 (*i.e.*, from a sample size of *n* = 49). 1921

Layer	Mean	Median	Std. Dev. (1σ)	Minimum	Maximum
T_4	-0.252	-0.281	0.194	-0.695	0.079
T_2	0.142	0.122	0.079	0.015	0.348
T^*_G	0.181	0.167	0.077	0.052	0.375
T_{2LT}	0.198	0.186	0.070	0.058	0.394
T_S	0.164	0.156	0.062	0.052	0.333
$T_S – T^*_G$	-0.017	-0.017	0.046	-0.110	0.083
$T_S – T_{2LT}$	-0.034	-0.031	0.030	-0.099	0.052

Chapter 5,Table 5.4B: As for Table 5.4A, but for tropical temperature trends (calculated from spatial 1923 averages over 20°N-20°S). 1924

Layer	Mean	Median	Std. Dev. (1σ)	Minimum	Maximum
T_4	-0.188	-0.189	0.152	-0.487	0.127
T_2	0.199	0.188	0.098	-0.013	0.481
T^*_T	0.238	0.213	0.105	0.007	0.558
T_{2LT}	0.215	0.194	0.092	0.006	0.509
T_S	0.155	0.144	0.067	-0.017	0.365
$T_S – T^*_T$	-0.083	-0.079	0.040	-0.194	0.017
$T_S – T_{2LT}$	-0.060	-0.053	0.028	-0.145	0.005

CHAPTER 6

(no tables shown in Chapter 6)

APPENDIX: STATISTICAL ISSUES REGARDING TRENDS

Table 1: Summary of the most important global-scale climate forcing factors and their likely individual effects on global, annual-mean temperatures; based on Figure 1.3 (which gives temperature information) and Table 1.1 (which gives information on radiative forcing) in Chapter 1, and literature cited in Chapter 1. The stated effects are those that would be expected if the change specified in column 1 were to occur. The top two rows are the primary natural forcing factors, while the other rows summarize the main human-induced forcing factors. The relative importance of these different factors varies spatially and over time.

Forcing Factor	**Surface**	**Low to Mid Troposphere**	**Stratosphere**
Increased solar output	Warming	Warming	Warming
Volcanic eruptions	Cooling	Cooling	Short-term warming
Increased concentrations of well-mixed greenhouse gases (CO_2, CH_4, N_2O, halocarbons)	Warming	Warming	Cooling
Increased tropospheric ozone (O_3)	Warming	Warming	Slight cooling
Decreased stratospheric ozone	Negligible except at high latitudes	Slight cooling	Cooling
Increased loading of sulfate (SO_4) aerosol – sum of direct plus indirect effects	Cooling	Cooling	Negligible
Increased loading of carbonaceous aerosol (black carbon (BC) and organic matter (OM)) – sum of direct plus indirect effects	Regional cooling – possible global-mean cooling	Warming	Uncertain
Land use and land cover changes	Regional cooling or warming – probably slight global-mean cooling	Uncertain	Negligible