Chapter 3: Observations: Surface and Atmospheric Climate Change


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EXECUTIVE SUMMARY

3.1 Introduction

3.2 Changes in Surface Climate: Temperature

3.2.1 Background

3.2.2 Temperature in the Instrumental Record for Land and Oceans

3.2.2.1 Land-surface air temperature

   Maximum and minimum temperature, DTR, globe, NH, SH

3.2.2.2 Urban temperatures and the Urban Heat Island

3.2.2.3 Sea surface temperature and marine air temperature

3.2.2.4 Land and sea combined: globe, NH, SH, zonal means

(Need for IPCC series?)

3.2.2.5 Consistency between land and ocean surface temperature changes.

3.2.2.6 Variability on different time scales (which time scales?)

3.3 Changes in Surface Climate: Precipitation and Atmospheric Moisture

3.3.1 Background

3.3.2 Changes in large-scale Precipitation

3.3.2.1 Changes in snowfall

3.3.2.2 Urban areas

3.3.2.3 Ocean

3.3.3 Water Vapour

3.3.4 Evaporation

3.3.4.1 Land

3.3.4.2 Ocean

3.3.5 Soil Moisture, runoff and river discharge

3.3.6 Consistency among surface variables

Box: Apparent conflicts in trends of evaporation and pan evaporation

3.4 Changes in the Free Atmosphere

3.4.1 Temperature of the Upper Air: troposphere and stratosphere

3.4.1.1 Weather balloons/sondes

3.4.1.2 Satellites; MSU

3.4.1.3 Reanalyses

3.4.1.4 The tropopause/tropopause heights

3.4.1.5 Synthesis and comparison with the surface temperatures

Box: Vertical structure of temperature trends

3.4.2 Humidity

3.4.2.1 Radiosonde observations

3.4.2.2 Lower-tropospheric water vapour (incl. SSM/I)

3.4.2.3 Upper-tropospheric and lower-stratospheric water vapour

3.4.3 Clouds
3.4.3.1 Land
3.4.3.2 Ocean
3.4.3.3 Global
3.4.4 Radiation
3.4.4.1 Top of Atmosphere
3.4.4.2 Sunshine at surface
3.4.4.3 Relation with clouds
3.4.5 Surface heat budget

3.5 Changes in the Atmospheric Circulation
3.5.1 Surface or sea level pressure
3.5.2 Geopotential height
3.5.3 Storm tracks
3.5.4 Blocking
3.5.5 The stratosphere
Box on stratospheric-tropospheric relations and downward propagation
3.5.6 Winds, waves, surface fluxes

3.6 Patterns of Circulation Variability
Box: Defining all the indices
3.6.1 Teleconnections
3.6.2 El Niño-Southern Oscillation and Tropical/Extra-tropical Interactions
3.6.3 Decadal to Inter-decadal Pacific Oscillation, and the North Pacific Oscillation
3.6.4 The Northern Hemisphere, excluding the North Pacific Ocean
3.6.5 The Southern Hemisphere (SAM)
3.6.6 Other indices: Atlantic multi-decadal oscillation, Antarctic circumpolar wave.QBO?
3.6.7 Summary

3.7 Changes in the Tropics and Sub-Tropics
3.7.1 Monsoons
3.7.1.1 Asia
3.7.1.2 Australia
3.7.1.3 The Americas
3.7.1.4 Africa
3.7.2 The Hadley and Walker circulations (includes ITCZ, SPCZ, SACZ, Subtropical highs and drought)

3.8 Changes in Extreme Events
3.8.1 Background
Box: Extreme events and climate change
3.8.2 Evidence for changes in variability or extremes
3.8.2.1 Temperature
3.8.2.2 Precipitation
3.8.3 Evidence for changes in extreme weather or climate events
3.8.3.1 Tropical cyclones
3.8.3.2 Extratropical cyclones
3.8.3.3 Droughts and wet spells
3.8.3.4 Tornadoes, hail and other severe local weather

3.8.4 Summary

**Boxes: 3.8 Specific events:**
1) Floods in Europe summer 2002;
2) Heat wave in Europe summer 2003;
3) Drought in Australia, 2002-2003 EN;
4) Drought in SW USA, other?

Other possibilities (need to be exceptional events):
- Kenyan floods of 2002
- SW Asian droughts during 2000-2002
- Floods in Bangladesh

3.9 Synthesis: Consistency Across Observations

3.9.1 Consistency of Observed Trends
3.9.2 Consistency with the retreat of Glaciers, Sea Ice, and Snow Cover
3.9.3 Summary
3.9.4 Gaps and Uncertainties

References

Appendix: Techniques, Error Estimation, and Measurement Systems
Box: Adjustments to homogenize land observations
Box: Adjustments to homogenize marine observations
Box: Adjustments to homogenize precipitation and also solid/liquid issues
Box: Adjustments to homogenize radiosondes
Box: Changes in observing system impacts on reanalysis