

THE ATMOSPHERE AND OCEAN

A Physical Introduction

Neil Wells

The Atmosphere and Ocean: A Physical Introduction

Neil Wells

Department of Oceanography, University of Southampton



Taylor & Francis
London and Philadelphia
1986

Contents

<i>Preface</i>		<i>v</i>
<i>Chapter 1.</i>	THE EARTH WITHIN THE SOLAR SYSTEM	1
1.1.	The Sun and its constancy	1
1.2.	Orbital variations in solar radiation	4
1.3.	Radiative equilibrium temperature	8
1.4.	Thermal inertia of the atmosphere	10
1.5.	Albedo	14
1.6.	The topography of the Earth's surface	18
<i>Chapter 2.</i>	COMPOSITION AND PHYSICAL PROPERTIES OF THE OCEAN AND ATMOSPHERE	25
2.1.	Evolution of the atmosphere and ocean	25
2.2.	Present-day composition of sea water	29
2.3.	Introduction to gases and liquids	31
2.4.	Hydrostatic equilibrium	39
2.5.	Adiabatic changes and potential temperature	42
2.6.	Vertical stability of the ocean and atmosphere	48
<i>Chapter 3.</i>	RADIATION, TEMPERATURE AND STABILITY	53
3.1.	Vertical variation of atmospheric constituents	53
3.2.	The attenuation of solar radiation	58
3.3.	Absorption of planetary radiation	65
3.4.	Vertical temperature profile and its relation to radiation	68
3.5.	The absorption of solar radiation in the ocean	75

<i>Chapter 4.</i>	WATER IN THE ATMOSPHERE	81
4.1.	Introduction	81
4.2.	The moist atmosphere	82
4.3.	Measurement and observation of water vapour	85
4.4.	Stability in a moist atmosphere	88
4.5.	Processes of precipitation and evaporation: the formation of clouds	93
4.6.	Macroscopic processes in cloud formation	105
<i>Chapter 5.</i>	GLOBAL BUDGETS OF HEAT, WATER AND SALT	110
5.1.	The measurement of heat budgets at the surface	110
5.2.	Observations of surface heat budgets	116
5.3.	The measurement of the water budget	126
5.4.	Observations of the water budget	128
5.5.	The salt budget of the ocean	132
5.6.	Temperature and salinity relations in the ocean	135
5.7.	Tracers in the ocean	143
<i>Chapter 6.</i>	OBSERVATIONS OF WINDS AND CURRENTS	150
6.1.	Measurement of winds and currents	150
6.2.	Climate and seasonal circulation	161
6.3.	Scales of motion in the atmosphere and ocean	176
6.4.	Time-dependent motion	181
<i>Chapter 7.</i>	THE INFLUENCE OF THE EARTH'S ROTATION ON FLUID MOTION	191
7.1.	An introduction to the Earth's rotation	191
7.2.	Inertial motion	195
7.3.	Pressure gradients and geostrophic motion	199
7.4.	Vorticity and circulation	207
7.5.	The atmosphere and ocean boundary layers	217
7.6.	Equatorial winds and currents	221
<i>Chapter 8.</i>	WAVES AND TIDES	229
8.1.	The spectrum of surface waves	229
8.2.	Wind waves and swell	233
8.3.	Long waves	241
8.4.	Internal waves	244
8.5.	Ocean tides	247
8.6.	Storm surges	254

<i>Chapter 9.</i>	ENERGY TRANSFER IN THE OCEAN-ATMOSPHERE SYSTEM	259
9.1.	Modes of energy in the ocean-atmosphere system	259
9.2.	The kinetic energy of the atmosphere and ocean	265
9.3.	Mechanisms of kinetic-energy transfer	268
9.4.	The general circulation of the atmosphere	276
9.5.	Models of the atmosphere and the ocean	283
<i>Chapter 10.</i>	CLIMATE VARIABILITY AND PREDICTABILITY	287
10.1.	Air-sea interaction: an introduction	287
10.2.	Seasonal anomalies of the ocean-atmosphere system	294
10.3.	Interannual fluctuations in the ocean-atmosphere system	298
10.4.	Long-term variations in the ocean-atmosphere system	304
10.5.	Mechanisms of climate change	310
10.6.	Perspectives in ocean and atmospheric science	317
<i>General reading</i>		325
<i>References</i>		327
<i>Index</i>		332