

Contents

Foreword by Ellen R. Stofan, Former NASA Chief Scientist vii

Preface ix

1 The Age of Wonder: Learning the Earth, Oceans and Sky 1

440 BC TO ~1760. HERODOTUS, HUYGENS, HALLEY, HUTTON, JEFFERSON, FRANKLIN

2 Planets and Greenhouses 17

1760 TO ~1870. LOMONOSOV, HERSCHEL, HUMBOLDT, FOURIER, ADHEMAR, AGASSIZ, FERREL, FITZROY, TYNDALL, EBELMEN, CROLL, THOMSON, CHAMBERLIN, EKHOLM, CHALLENGER

3 The Age of Numbers: Calculation of Planetary Climates 39

1870 TO ~1930. SCHIAPARELLI, STEFAN, CHRISTIANSEN, ROSSE, LANGLEY, ARRHENIUS, LANGLEY, READE, CHAMBERLIN, EKHOLM, STONEY, TEISSERENC DE BORT, GODDARD, SIMPSON, MILANKOVITCH

4 Feeling the Heat 63

1920 TO 1963. BRETZ, CALLENDAR, KUIPER, DOLLFUS, KEELING. DUST BOWL, DUST DEVILS, WORLD WAR II, ICE CORES, RADIO TELESCOPES, COMPUTERS

5 First Contact: The Dawn of Planetary Exploration 83

1960 TO 1979. SAGAN, POLLACK, MANABE, OPIK, LEIGHTON, MURRAY, LORENZ, LOVELOCK, BUDYKO, SELLERS. MARINERS 2-10, VENERAS 4-8, PIONEER VENUS. VENUS GREENHOUSE. MARS CLIMATE STABILITY

6 Return of the Ice 111

1975 TO 1989. KASTING, MCKAY. DEEP SEA CORES. VIKING - A WET MARS? VENUS' LOSS OF WATER. TITAN - FRIGID GREENHOUSE AND ANTIGREENHOUSE. GIANT PLANETS. DAISYWORLD. NUCLEAR WINTER. TRITON

7 Mars Attracts 133

1990 TO 2000. ICE CORES, TITAN'S OCEAN? DEATH OF THE DINOSAURS. MAGELLAN - CLIMATE DRIVES TECTONICS? PINATUBO. PATHFINDER. SNOWBALL EARTH. METEORITES FROM MARS. MARS GLOBAL SURVEYOR

8 A New Millennium 161

1994 TO 2004. HUBBLE. MARS ODYSSEY, SPIRIT, OPPORTUNITY. VENUS GLOW. PRESENT-DAY CLIMATE CHANGE ON MARS. METHANE ON MARS. TITAN CLOUDS. WIDESPREAD ICE ON MARS. EARTH CLOUD CLIMATE CONTROVERSIES

9 Dune Worlds 187

2004 TO 2012. TITAN VALLEYS, SEAS OF SAND. VENUS' VARIATIONS. SPIDERS ON MARS. EARTH'S CHANGING TUNE. SNOW ON MARS. TITAN'S SEAS OF METHANE. DECODING MARS' LAYERS. TITAN'S CYANIDE CLOUDS

10 Looking Ahead 221

2012 TO 2020. SATURN STORM, IAPETUS DAISYWORLD. TITAN HABOOBS. BIOSPHERIC FEEDBACKS, SAHARAN DUST IN THE AMAZON. MARS GULLIES, DUST STORMS, INTERANNUAL VARIABILITY. PLUTO. FUTURE MISSIONS

11 Worlds Beyond: Exoplanet Climate 249

THE HABITABLE ZONE. DETECTION OF LIGHT AND HEAT FROM EXTRASOLAR PLANETS. FIRST DETECTION OF ATMOSPHERES ON EXOPLANETS. NUMERICAL MODELING OF EXTREME CLIMATES. MANY EXOPLANETS TIDALLY LOCKED WITH PERMANENT NIGHT- AND DAYSIDES. MULTIPLE PLANET SYSTEMS DISCOVERED. PLANET IN THE HABITABLE ZONE OF PROXIMA CENTAURI, OUR NEAREST STAR

12 Conclusions 265

Glossary 271

Further Reading 275

Bibliography 281

Index 313