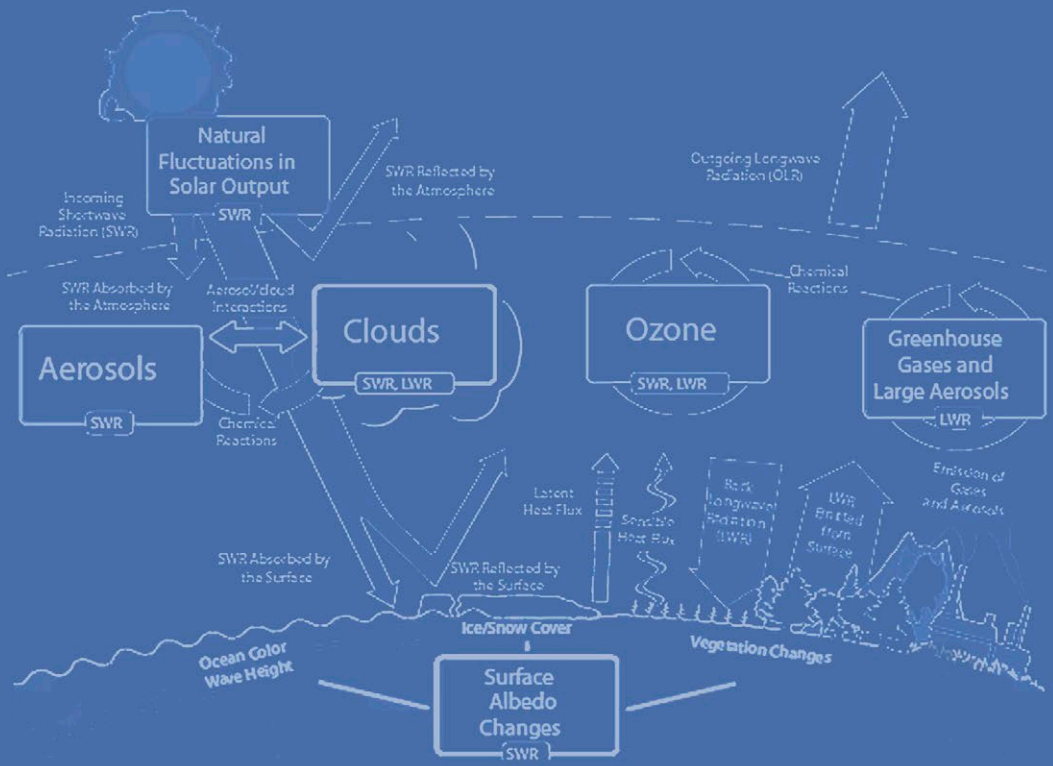
UN CC:Learn

The One UN Climate Change Learning Partnership

Resource Guide for Advanced Learning on



THE SCIENTIFIC FUNDAMENTALS OF CLIMATE CHANGE

Acknowledgements

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Specific inputs were provided by: Amir Delju and Roberta Boscolo, WMO; Ned Guttman, University of Tennessee; Charles Davies, UNEP; Cristina Rekakavas, Angus Mackay, Achim Halpaap, Amrei Horstbrink, Ilaria Gallo and Junko Taira, UNITAR.

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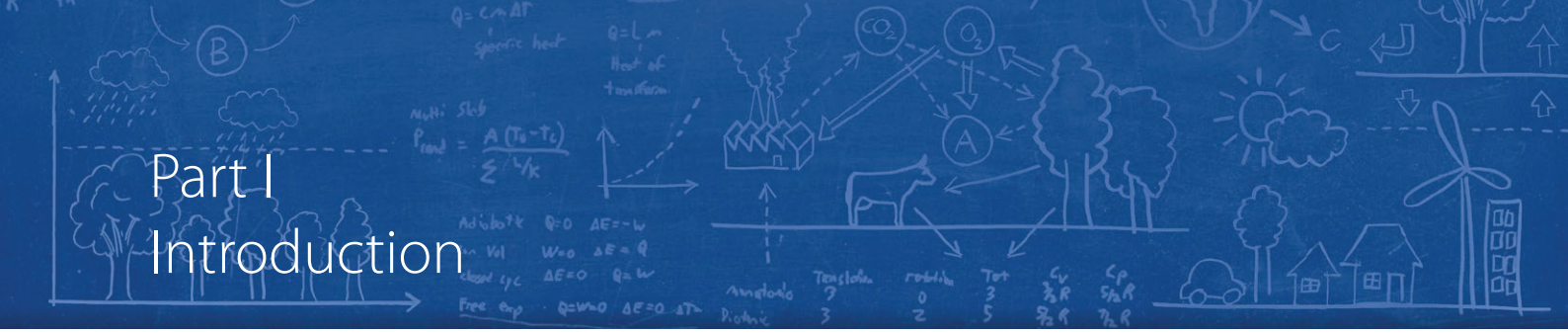
We Are Boq, Lda.



Part I
Introduction

1.1 About the Series of Resource Guides for Advanced Learning

This Guide is part of a series developed through UN CC:Learn[1] to facilitate access to existing state-of-the-art materials relevant for climate change learning on particular topics. The Guides are written from the perspective of a learner who perhaps understands the basics of a topic but is seeking to obtain a more advanced understanding by gaining quick access to the most relevant learning materials. The Guides cover selected climate change topics that have been identified as a priority from a country perspective.

The learning resources presented in this Guide are drawn primarily from within the UN and partners to UN CC:Learn. Learning resources published by other recognized international and other organizations are provided in the Annex. UN CC:Learn is not responsible for the content of these third-party resources and their mention does not imply that these have been endorsed or recommended by UN CC:Learn.

1.2 How to Use this Resource Guides for Advanced Learning

This Resource Guide for Advanced Learning is organised into three parts. Part I provides basic orientation for readers, including a brief introduction to the subject area and an outline of the specific learning topics to be covered. Part II lists available written learning resources as well as a number of training courses currently being offered, organised by learning topic. For each selected learning resource a hyperlink is provided through to Part III of the Guide, which provides more detailed factsheets and further links to source material. Readers are advised to: (A) start by reading Part I; (B) select a preferred learning topic; (C) identify the relevant learning resources for that topic under Part II; and (D) click on the relevant hyperlinks to access the factsheets.

1.3 Target Groups for this Resource Guide for Advanced Learning

This Resource Guide for Advanced Learning has been designed to inform the following target groups interested in learning about the basics of climate change:

- Decision-makers in the public and economics sector responsible for developing and implementing policies, programmes or projects;
- National and local government officials participating in or using climate change science;
- Non-governmental organizations (NGOs) involved in the development and implementation of climatological programmes;
- Climate assessment and risk managers and facilitators;
- Interested citizens/youth/students.

1 UN CC:Learn is a partnership of more than 30 multilateral organizations supporting countries to design and implement systematic, recurrent and results-oriented climate change learning. UN CC:Learn Partners to date include: CEB, EMG, FAO, GEF, IDB, IFAD, ILO, IMO, ITU, OCHA, UNAIDS, UNDP, UNECA, UNEP, UNESCAP, UNESCO, UNESCWA, UNFCCC, UNFPA, UNHABITAT, UNICEF, UNIDO, UNISDR, UNITAR, UNSSC, UNU, UN WOMEN, UNWTO, UPU, WFP, WHO, WMO, WTO, World Bank.

1.4 Introduction to the Scientific Fundamentals of Climate Change

The climate system is a complex, interactive system consisting of the atmosphere, land surface, snow and ice, oceans and other bodies of water, and living elements. The climate system evolves in time under the influence of its own internal dynamics and due to changes in external factors that are called forcings. External forcings include natural phenomena such as volcanic eruptions and solar variations, as well as human-induced changes in atmospheric composition and land morphology. Solar energy powers the climate system. There are three fundamental ways to change the energy balance of the Earth: 1) by changing the incoming solar energy; 2) by changing the fraction of solar energy that is reflected; and 3) by altering the energy that returns to space from the Earth. Incoming solar energy is changed by, for example, changes in the Earth's orbit or by changes in the sun itself. Changes in cloud cover, vegetation, and particles in the air, for example, can change reflected energy. Energy that is returned to space can be changed, for example, by changes in greenhouse gas concentrations. Climate, in turn, responds directly to such changes, as well as indirectly, through a variety of feedback mechanisms.

Climate change science seeks to understand the physical, chemical, biological and geological processes, and the interactions among these processes, that produce climate. The scales of interest range from local to global and from weeks or months to millions of years. Changes in climate, both temporally and spatially, are detected by examining observational evidence from instruments and indicators such as tree rings, fossils, glaciers and sea ice, plant pollen, and sea level. One of the goals of the scientists is to predict future climates based on natural phenomena and to project future climates based on assumptions of future human activities. These predictions and projections are determined as the output of climate models and may be used to develop strategies for mitigating the effects of climate change and for adapting to the expected changes.

1.5 Learning Topics Featured in this Resource Guide for Advanced Learning

Many organizations have developed learning materials on the theme of scientific fundamentals of climate change. However, given the wealth of existing resources, interested learners can face difficulties in identifying specific materials that match their needs. This Guide aims at facilitating access to learning by providing a "guided tour" to materials that are already available, focusing mainly on those available from within the UN system. These have been selected according to specific learning topics identified in consultation with the UN CC:Learn partners, further refined through the application of the following criteria:

- Universality: the resources featured in this package are relevant for interested learners regardless of their specific background and experiences;
- United Nations: the resources have been produced primarily by UN agencies, especially by agencies with specific expertise in the field of climate change science[2];
- Quality: the resources are comprehensive and of high quality;
- State-of-the-art: given the developments in the field, resources are recent and up-to-date;
- Learning component: the resources selected are designed to promote learning activities.

Learning Topic 1: Climate and the Factors Shaping the Earth's Climate

Climatology is the study of climate, its variations and extremes, and its influences on a variety of activities including (but far from limited to) human health, safety and welfare. Climate, in a narrow sense, can be defined as the average weather conditions for a particular location and a relatively long period of time.

2 Selected publications from other relevant international and other organizations have been referenced in Annex 1.

Climate can be described in terms of statistical descriptions of the tendencies and variability of relevant variables such as temperature, precipitation, atmospheric pressure, humidity and winds, or through combinations of elements, such as weather types and phenomena, that are typical of a location or region, or of the world as a whole, for any time period.

To understand climate change, it is crucial to use a scientific definition of climate, understand the difference between weather and climate, and to study changes in the state of the climate that persist for an extended period. It is also important to understand how the natural factors such as latitude, altitude, reflectivity of the Earth's surface, distance from the sea and external forcing such as solar radiation, which are beyond human control, contribute to the highly complex system of the climate and lead to climate patterns.

A climate pattern is a recurring characteristic of the climate. Climate patterns exist over many time scales. For instance the glacial and interglacial periods within ice ages last tens of thousands of years, while monsoons repeat each year. They may come in the form of a regular cycle, like the diurnal cycle or the seasonal cycle, a periodic event, like El Niño, or a highly irregular event, such as a volcanic winter. Since the nineteenth century, attempts were made to classify global climates in many ways and provide atlases which showed maps of temperature and precipitation around the world. Today, some of these atlases may contain maps of atmospheric pressure, prevailing winds, ocean currents and extent of sea ice throughout the year. These atlases with more detailed classifications are used by many countries in climate sensitive sectors such as agriculture and water management.

Go to Resources

Learning Topic 2: Historical Climate Variations

In most parts of the world there is nothing unusual about changeable weather. Seasonal contrasts, too, are perfectly usual and, indeed, to be expected. Further, no two years are alike and no two decades necessarily follow exactly the same pattern of changing weather. From the study of the factors governing climate and their expression in regional patterns we realize that there is no reason to suppose that the climate, or the characteristic regional weather, of one decade, will necessarily be the same as the climate of another decade. The likelihood of variability would be even greater if we looked at longer time spans or contrasted decades farther apart in time. Until well into the twentieth century it was widely believed that weather changes were no more than fluctuations around an average and that over a long enough time-span one could define average weather, or the 'normal' climate, for any place on Earth. This belief must now be questioned. Meteorological records of the past 150 years, for example, show that conditions characteristic of the mid-twentieth century differ noticeably from those of the mid-nineteenth century. To such data historical records and improved geological techniques must be added to provide an even clearer picture of the changing climate. These historical variations in climate may be due to natural internal processes or external forcing, or to persistent anthropogenic changes to the composition of the atmosphere or in land use.

Go to Resources

Learning Topic 3: Meteorological Consequences of Climate Variability and Change

The viewpoint of synoptic climatology (looking at an entire weather situation in a given time and location) is to regard climate essentially as the product of atmospheric circulation and weather conditions. Weather phenomena such as heavy rains, heatwaves and extreme events are meteorological manifestations of climate variability and change. These are mainly caused by changes in the distribution of mean annual total precipitation, minimum and maximum temperature, humidity, evaporation and solar radiation.

Variation in these parameters is a matter of great social and economic importance. How human activities are dominated by climate has driven our search for better knowledge of how it functions. It started with how daily weather events affected agriculture and has extended now to how wider features of the global climate can influence commerce and trade around the world.

Go to Resources

Learning Topic 4: The Human Contribution to Climate Variability

Continued expansion of man's activities on Earth may cause significant regional and even global changes of climate. In the context of climate change, global warming has been more in focus than other issues. It refers to the global-average temperature increase that has been observed over the last one hundred years or more. To many politicians and the public, the term carries the implication that mankind is responsible for that warming. In the early 1980s, international organizations called for global cooperation to explore the possible future course of global climate and to take this new understanding into account in planning for the future development of human society. Increasing concentrations of greenhouse gases were expected to cause a significant warming of the global temperature in the next century. WMO-UNEP established the Intergovernmental Panel on Climate Change (IPCC) which assesses uncertainties and gaps in our present knowledge with regard to climate change and its potential impacts, and provides suggestions for a plan of action over the short term to fill these gap.

Go to Resources

Learning Topic 5: Global Emission Scenarios and Climate Change

In order to determine the impact of climate change in the future, it is key to understand the concentrations of greenhouse gases and other pollutants in the atmosphere to which climate is sensitive, in the years to come. These concentrations depend on their emissions from various sources, natural as well as man-made. Emissions scenarios describe future releases into the atmosphere of greenhouse gases, aerosols, and other pollutants and, along with information on land use and land cover, provide inputs to climate models. They are based on assumptions about driving forces such as patterns of economic and population growth, technology development, and other factors. Levels of future emissions are highly uncertain, and so scenarios provide alternative images of how the future might unfold. They assist in climate change analysis, including climate modelling and the assessment of impacts, adaptation, and mitigation.

Go to Resources

Part II
Guide to Learning Resources and Training Courses

1 written resources

Learning Topic 1
Climate and the Factors Shaping the Earth's Climate

Written Resources

Introduction to Climate Change: Lecture Notes for Meteorologists WMO No. 926

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

These lecture notes are intended to enhance familiarity with the broad scope of topics related to climate change. In particular, chapter 1 defines climate and describes radiation processes and the climate system. It also discusses components of the climate system (atmosphere, land surface, ice, and the biosphere). Chapter 2 describes natural variability of climate, basic forcing mechanisms, and the interaction of climate system components. Both chapters describe several patterns resulting from the factors that shape the climate and the interaction of the components of the climate system.

Guide to Climatological Practices WMO No. 100

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Guidance Document/Handbook

Relevance

This publication is designed to provide guidance and assistance to WMO Members in developing national activities linked to climate information and services. Chapter 1 defines climate and briefly describes the climate system. Chapter 4 discusses measures for describing climate (averages, variability and extremes). Chapter 6 depicts many examples of how to visually display climate patterns.

Climate Change Science Compendium

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document is a review of some 400 major scientific contributions to our understanding of Earth Systems and climate. The background section of chapter 1 describes interactions among the components of the climate system. Chapter 2 describes patterns of ice and glacier coverage of the Earth. Chapter 3 describes patterns of ocean circulations.

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document provides a comprehensive assessment of the physical science basis of climate change. It describes progress in understanding of the human and natural drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate change. Chapter 1 starts with a description of the Earth's climate system.

2 written resources

Learning Topic 2
Historical Climate Variations

Written Resources

Introduction to Climate Change: Lecture Notes for Meteorologists WMO No. 926

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

These lecture notes are intended to enhance familiarity with the broad scope of topics related to climate change. In particular, chapter 2 discusses the natural temporal variability of several climate characteristics and patterns.

Guide to Climatological Practices WMO No. 100

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Guidance Document/Handbook

Relevance

This publication is designed to provide guidance and assistance to WMO Members in developing national activities linked to climate information and services. Chapter 4 discusses measures used to portray historical variations of climate characteristics, and some of the problems with the data used to determine historical features. Chapter 6 depicts many examples of how to visually display historical perspectives.

Climate Change Science Compendium

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document is a review of some 400 major scientific contributions to our understanding of Earth Systems and climate. Chapters 2-4 show graphs of temporal trends of several climate characteristics.

The Global Climate 2001-2010: A Decade of Climate Extremes WMO No. 1119

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This publication, covering the first decade of the 21st century, aims at providing a decadal perspective of global climate variability and change. It includes information of and trends in temperatures, precipitations and ice/snow cover over time.

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document provides a comprehensive assessment of the physical science basis of climate change. It describes progress in understanding of the human and natural drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate change. Chapters 2, 3, 4 and 5 put current climate characteristics into historical perspective. Timescales from days to decades are considered for chapters 2 to 4, and from centuries to many millennia for chapter 5.

3 written resources

Learning Topic 3
Meteorological Consequences of Climate Variability and Change

Written Resources

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This publication focuses on the relationship between climate change and extreme weather and climate events ("climate extremes"), their impacts and implications for the society as well as the strategies to manage the associated risks. In particular, chapter 3 focuses on changes in extremes of atmospheric weather and climate variables, related large-scale phenomena, and collateral effects on the physical environment such as droughts, floods, coastal impacts, landslides. Chapter 4 explores how changes in climate translate into extreme impacts on human and ecological systems.

Guide to Climatological Practices WMO No. 100

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Guidance Document/Handbook

Relevance

This publication is designed to provide guidance and assistance to WMO Members in developing national activities linked to climate information and services. Chapter 2 describes in detail observation practices so that users of data can better determine the impacts on the climate system of changes in characteristics and patterns. Chapters 4 and 5 discuss analysis techniques that are used to determine impacts, and chapter 6 offers many display tools.

WMO Statement on the Status of the Global Climate in 2014 WMO No. 1152

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This publication provides an overview of the status of the global climate in 2014. It reports on anomalies in temperatures and precipitations, snow/ice cover, and oceans level. It highlights significant climate and weather events that occurred in 2014 at the national and regional levels.

The Global Climate 2001-2010: A Decade of Climate Extremes WMO No. 1119

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This publication aims at providing a decadal perspective of global climate variability and change. It highlights the incidence of various weather phenomena such as heatwaves, extreme precipitation events, and severe storms, across the planet over the course of the 2001–2010 decade.

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document provides a comprehensive assessment of the physical science basis of climate change. It describes progress in understanding of the human and natural drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate change. In particular, chapters 2, 3, 4, 5, as well as 13 describe observed changes to the climate system, both globally and regionally.

4
written resources

Learning Topic 4
The Human Contribution to Climate Variability

Written Resources

Land Use, Land-Use Change, and Forestry

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Analytical/Technical Document

Relevance

This report examines how humans are changing the natural rate of exchange of carbon between the atmosphere and the terrestrial biosphere through land use, land-use change, and forestry (LULUCF) activities.

Our Planet: Climate for Life

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Other

Relevance

By presenting different efforts to limit greenhouse gas emissions from human activities, particularly through initiatives aimed at promoting protected areas and protecting biodiversity, this publication shows a wide range of examples of how countries are taking climate change into account in planning for their future development.

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This publication focuses on the relationship between climate change and extreme weather and climate events ("climate extremes"), their impacts and implications for the society as well as the strategies to manage the associated risks. In particular, chapter 3 discusses persistent anthropogenic changes in the composition of the atmosphere and in land use influencing the climate. Chapter 5 to 8 focus on approaches to disaster risk management and adaptation to climate change for the promotion of more sustainable and resilient future.

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document provides a comprehensive assessment of the physical science basis of climate change. It describes progress in understanding of the human and natural drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate change. In particular, chapters 6, 7, 8 and 10 concern the relationships between human activity and climate.

Atlas of Our Changing Environment - A Manual

Go to Factsheet

General Audience(s)

Technical Staff/Practitioners

Type of Material

Guidance Document/Handbook

Relevance

This manual provides geographic information system (GIS) and remote sensing practitioners with a step-by-step approach for communicating the scientific findings of time-series satellite imaging studies to a wide range of audiences, which can be used to provide evidence of environmental changes due to human activities.

5 written resources

Learning Topic 5
Global Emission Scenarios and Climate Change

Written Resources

Introduction to Climate Change: Lecture Notes for Meteorologists WMO No. 926

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

These lecture notes are intended to enhance familiarity with the broad scope of topics related to climate change. In particular, chapter 7 covers scenarios.

The Emissions Gap Report 2014: A UNEP Synthesis Report

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Analytical/Technical Document

Relevance

This report focuses on the global carbon emissions budget for staying within the 2°C temperature target and provides estimates of the emissions gap to reach this objective in 2025 and 2030. In particular, chapter 2 and 3 provide several emission scenarios, including business-as-usual emission levels and the analysis of expected global emissions by 2020 under several cases of pledge implementation.

Carbon Dioxide Capture and Storage

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Analytical/Technical Document

Relevance

This publication discusses the potential of carbon dioxide (CO2) capture and storage (CCS) as an option for reducing atmospheric emissions of CO2 from human activities. In particular, chapter 2 discusses major sources of CO2 and future emissions.

Bridging the Emissions Gap

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners

Type of Material

Analytical/Technical Document

Relevance

This report examines the gap between expected greenhouse gas emissions in 2020 according to country pledges and the reductions needed to limit temperature rise and climate change.

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

Analytical/Technical Document

Relevance

This document provides a comprehensive assessment of the physical science basis of climate change. It describes progress in understanding of the human and natural drivers of climate change, observed climate change, climate processes and attribution, and estimates of projected future climate change. In particular, chapter 9 describes climate models, both global and regional, and focuses on their evaluation. Climate System Scenario Tables from the report are listed in Annex II.

2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands

Go to Factsheet

General Audience(s)

Technical Staff/Practitioners

Type of Material

Guidance Document/Handbook

Relevance

This document provides methods to support countries in estimating anthropogenic emissions and removals of greenhouse gases from wetlands and drained soils.

Renewable Energy Sources and Climate Change Mitigation - Special Report of the Intergovernmental Panel on Climate Change

Go to Factsheet

General Audience(s)

Decision Makers; Technical Staff/ Practitioners; General Public

Type of Material

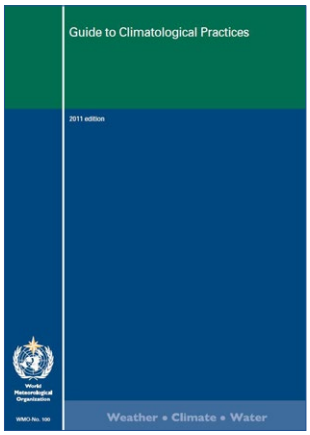
Analytical/Technical Document

Relevance

This publication addresses the potential of renewable energy for the mitigation of climate change. In particular, chapter 10 investigates how such technologies may contribute to varying GHG emission reduction scenario.

Part III
Factsheets

Guide to Climatological Practices WMO No. 100



Organization(s)
WMO

Language(s)
English, French, Spanish, Russian, Arabic, Chinese

General Audience(s)
Decision Makers, Technical Staff/Practitioners

Year of Publication
2011

Type of Material
Guidance Document/Handbook

Go to Document

Value of Learning Resource

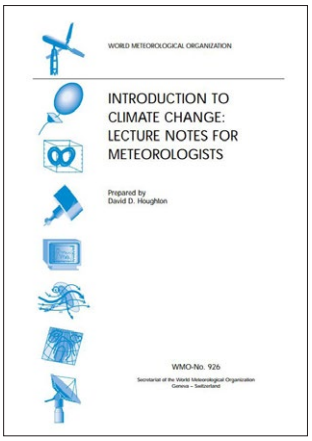
This guide provides, in a convenient form for all concerned with the practice of climatology, information about those practices and procedures that are of the greatest importance for the successful implementation of their work. It describes basic principles and modern practices important in the development and implementation of all climate services, and outlines methods of best practice in climatology. It is intended to describe concepts and considerations, and provides references to other technical guidance and information sources, rather than attempting to be all-inclusive in the guidance presented.

Structure and Content

- **Chapter 1**
  States the purpose and the scope of this guide. The publication is primarily designed to provide guidance and assistance to World Meteorological Organization (WMO) members in developing national activities to promote climate information and services. This first chapter includes information on climatology and its scope, the organization and functions of a national climate service, and international climate programmes.
- **Chapter 2**
  This chapter on observations follows the sequence of specifying the elements needed to describe the climate and the stations at which these elements are measured, instrumentation, siting of stations, network design and network operations.
- **Chapter 3**
  Looks at the importance, purpose and practices of managing data.
- **Chapter 4**
  Concentrates on descriptive statistics, the tool used to reduce to a comprehensible form the properties of an otherwise large amount of data.

- **Chapter 5**
  Concentrates on statistical methods and should be used in conjunction with chapter 4. Both chapters are intended to describe basic concepts rather than to provide detailed specifics of complex subjects.
- **Chapter 6**
  Describes the dissemination of climate information to the public or a specific user. This involves strong partnerships among National Meteorological or Hydro-meteorological Services (NMHS) and stakeholders, including government agencies, private interests and academia, for the purpose of interpreting and applying past climate information for decision-making, for sustainable development, and for the improvement of climate information products, predictions and outlooks.

Introduction to Climate Change: Lecture Notes for Meteorologists WMO No. 926



Organization(s)
WMO

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2002

Type of Material
Analytical/Technical Document

Go to Document

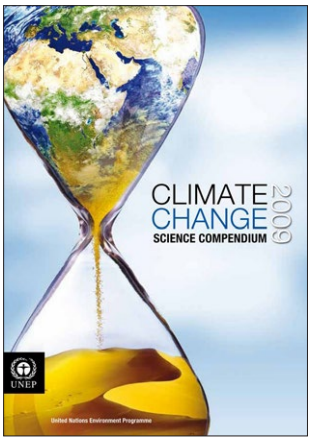
Value of Learning Resource

These lecture notes are intended to enhance familiarity with the broad scope of topics related to climate change. They provide material on the science of climate change assuming that the users already have a basic understanding of atmospheric processes, the hydrological cycle, and cloud physics along with some understanding of air chemistry, hydrology, and oceanography.

Structure and Content

- **Chapter 1**
  Reviews the characteristics and physical processes of the climate system.
- **Chapter 2**
  Discusses climate variability from natural causes.
- **Chapter 3**
  Discusses climate variability from human activity.
- **Chapter 4**
  Describes numerical climate models.
- **Chapter 5**
  Focuses on climate predictability.
- **Chapter 6**
  Presents important requirements for observations needed to identify and understand climate change.
- **Chapter 7**
  Describes progress in the isolation and analysis of recent climate change.
- **Chapter 8**
  Gives examples of climate change impacts.

Climate Change Science Compendium



Organization(s)
UNEP

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2009

Type of Material
Analytical/Technical Document

Go to Document

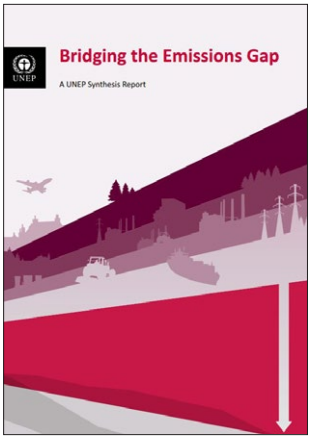
Value of Learning Resource

This document is a review of some 400 major scientific contributions to our understanding of Earth Systems and climate that have been released through peer-reviewed literature or from research institutions since the close of research for consideration by the IPCC Fourth Assessment Report.

Structure and Content

- **Earth Systems**
  Stresses that the Earth System behaves as a single, self-regulating system comprised of physical, chemical, biological, and human components.
- **Earth's Ice**
  Describes the trends of ice coverage on the Earth and the impacts of these trends.
- **Earth's Oceans**
  Describes the relationships among increased temperature, sea level rise, increased acidification, and changing oceanic circulation and nutrient supplies.
- **Earth's Ecosystems**
  Reports on the increasing confidence and better quantification of the impacts of climate change on the marine and terrestrial ecosystems.
- **Systems Management**
  Describes possible ways of mitigating the effects of climate change.

Bridging the Emissions Gap



Organization(s)
UNEP

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners

Year of Publication
2011

Type of Material
Analytical/Technical Document

Go to Document

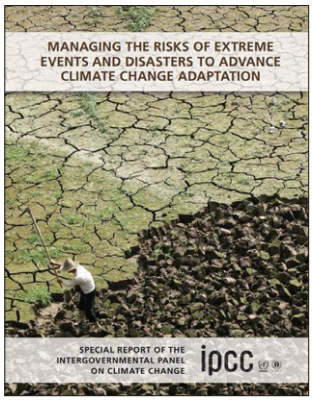
Value of Learning Resource

This report examines the gap between expected greenhouse gas emissions in 2020 according to country pledges and the reductions needed to limit temperature rise and climate change. It answers the questions 1) Is it possible to bridge the emissions gap by 2020?, 2) What is the emissions gap in 2020?, and 3) How can the gap be bridged?

Structure and Content

- **Chapter 1**
  Reviews and summarizes the latest studies of the gap.
- **Chapter 2**
  Provides updated emissions, scenarios consistent with temperature targets, national emission reduction pledges, and the estimated gap.
- **Chapter 3**
  Presents results from global mitigation scenarios, and options and emission reduction potentials by sector.
- **Chapter 4**
  Describes international baseline emissions and projections; targets, goals, measures, and abatement potential; and policies.

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation - Special Report of the Intergovernmental Panel on Climate Change



Organization(s)
IPCC

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2012

Type of Material
Analytical/Technical Document

Go to Document

Value of Learning Resource

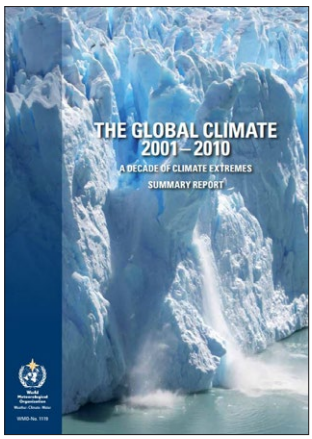
The report analyses the relationship between climate change and extreme weather and climate events, the impacts of such events, and the strategies to manage the associated risks. In particular, it contributes to frame the challenge of dealing with extreme weather and climate events as an issue in decision making under uncertainty, analyzing response in the context of risk management.

Structure and Content

- **Chapter 1**
  Frames the issue of extreme weather and climate events as a challenge in understanding and managing risk. It characterizes risk as emerging from the overlap of a triggering physical event with exposure of people and assets and their vulnerability.
- **Chapter 2**
  Explores the determinants of exposure and vulnerability in detail, concluding that every disaster has social as well as physical dimensions.
- **Chapter 3**
  Provides an assessment of the scientific literature on observed and projected changes in extreme weather and climate events, and, where possible, their attribution to causes.
- **Chapter 4**
  Assesses observed and projected impacts, considering patterns by sector as well as region.
- **Chapter 5**
  Assess experience and theory in adaptation to extremes and disasters, focusing on issues and opportunities at the local scale.
- **Chapter 6**
  Assess experience and theory in adaptation to extremes and disasters, focusing on issues and opportunities at the national scale.
- **Chapter 7**
  Assess experience and theory in adaptation to extremes and disasters, focusing on issues and opportunities at international scale.

- **Chapter 8**
  Assesses the interactions among sustainable development, vulnerability reduction, and disaster risk, considering both opportunities and constraints, as well as the kinds of transformations relevant to overcoming the constraints.
- **Chapter 9**
  Includes a series of case studies.

The Global Climate 2001–2010: A Decade of Climate Extremes - Summary Report WMO No. 1119



Organization(s)
WMO

Language(s)
Arabic, Chinese, English, French, Spanish, Russian

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2013

Type of Material
Analytical/Technical Document

Go to Document

Value of Learning Resource

This document covers the first decade of the 21st century and intends to provide a decadal perspective of climate variability and change. A decadal perspective makes it possible to assess trends and anticipate the future. The document can also inform efforts to develop operational climate services that provide information and forecasts for decision-making in agriculture, health, disaster risk, water resources and other sectors.

Structure and Content

- **Chapter 1: Climate Variability and Climate Change**
  Discusses the difference between natural climate variability and human-caused climate change.
- **Chapter 2: The Warmest Decade**
  Highlights that the period 2001–2010 was the warmest decade on record since modern meteorological records (starting around the year 1850), this being valid also for both land-only and ocean-only surface temperatures.
- **Chapter 3: Hot and Cold Extremes**
  Stresses that human influence has probably increased the maximum temperatures of the most extreme hot nights and days and the minimum temperatures of cold nights and cold days, as well as that it is more likely than not that human-induced climate change has increased the risk of heat waves.
- **Chapter 4: Precipitation, Floods and Droughts**
  Highlights that, because warm air can hold more moisture, it is likely that climate change has influenced the occurrence and intensity of extreme precipitation events. Greater warmth also speeds up the hydrological cycle, which should contribute to both heavier rainfall and increased evaporation. It highlights floods were the most frequently experienced extreme event over the course of the decade.
- **Chapter 5: Severe Storms**
  Underlines that 2001–2010 was the most active decade since 1855 for tropical cyclones in the North Atlantic Basin. In other regions, cyclone activity was generally at average or below-average levels.

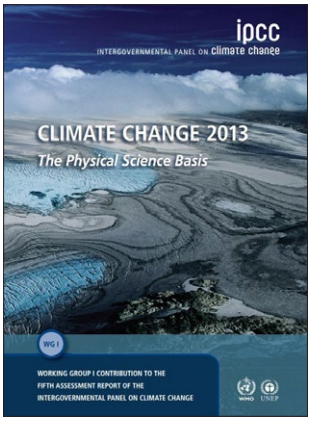
- **Chapter 6: Shrinking Ice and Rising Seas**
  Notes that the record warmth of the decade 2001–2010 was accompanied by the melting of ice caps, sea ice and glaciers and the thawing of permafrost.
- **Chapter 7: Conclusion**
  Notes that natural climate variability is clearly important, but there is also evidence that human influence has substantially increased the likelihood of some events occurring.

Additional Information

To learn more about the 2001–2010 decade of extremes, including the detailed results of the WMO survey of countries, the complete technical report is available at:

http://library.wmo.int/opac/index.php?lvl=notice_display&id=15112

The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change



Organization(s)
IPCC

Language(s)
Arabic, Chinese, English, French, Spanish, Russian

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2013

Type of Material
Analytical/Technical Document

Go to Document

Value of Learning Resource

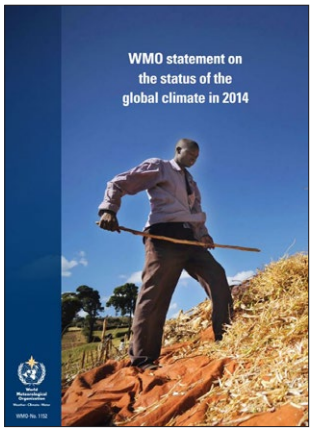
The document provides a comprehensive and robust assessment of the physical science basis of climate change. It builds upon the Working Group I contribution to the IPCC's Fourth Assessment Report in 2007 and incorporates subsequent new findings from the "Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation", as well as from research published in the extensive scientific and technical literature. The assessment considers new evidence of past, present and projected future climate change based on many independent scientific analyses from observations of the climate system, paleoclimate archives, theoretical studies of climate processes and simulations using climate models.

Structure and Content

- **Chapter 1**
  Introduction: focuses on concepts and definitions, examines several of the key indicators for a changing climate and shows how the current knowledge of those indicators compares with the projections made in previous assessments.
- **Chapter 2**
  Observations: Atmosphere and Surface: assesses the scientific literature on atmospheric and surface observations and identifies the most likely changes in physical climate variables or climate forcing agents.
- **Chapter 3**
  Observations: Ocean: summarizes the observational evidence of change in the ocean, with an emphasis on basin- and global-scale changes relevant to climate.
- **Chapter 4**
  Observations: Cryosphere: describes the current state of the cryosphere and its individual components, with a focus on recent improvements in understanding of the observed variability, changes and trends.
- **Chapter 5**
  Information from Paleoclimate Archives: assesses the information on past climate obtained prior to the instrumental period, using data from various paleoclimatic archives and modelling of past climate.

- **Chapter 6**
  Carbon and Other Biogeochemical Cycles: summarizes the scientific understanding of atmospheric budgets, variability and trends of the three major biogeochemical greenhouse gases, CO2, CH4 and N2O, their underlying source and sink processes and their perturbations caused by direct human impacts, past and present climate changes as well as future projections of climate change.
- **Chapter 7**
  Clouds and Aerosols: considers observations, theory and models to assess how clouds and aerosols contribute and respond to climate change.
- **Chapter 8**
  Anthropogenic and Natural Radiative Forcing: discusses radiative forcing from natural and anthropogenic components during the industrial period, presenting values for 2011 relative to 1750, and projected values through 2100.
- **Chapter 9**
  Evaluation of Climate Models: focuses on the climate models used in the report.
- **Chapter 10**
  Detection and Attribution of Climate Change: from Global to Regional: assesses the causes of the observed changes and uses understanding of physical processes, climate models and statistical approaches.
- **Chapter 11**
  Near-term Climate Change: Projections and Predictability: assesses the scientific literature describing expectations for near-term climate (present through mid-century) as well as atmospheric composition and air quality projections through to 2100.
- **Chapter 12**
  Long-term Climate Change: Projections, Commitments and Irreversibility: assesses long-term projections of climate change for the end of the 21st century and beyond.
- **Chapter 13**
  Sea Level Change: considers changes in global mean sea level, regional sea level, sea level extremes, and waves.
- **Chapter 14**
  Climate Phenomena and their Relevance for Future Regional Climate Change: assesses the scientific literature on projected changes in major climate phenomena and more specifically their relevance for future change in regional climates, contingent on global mean temperatures continue to rise.

WMO Statement on the Status of the Global Climate in 2014 WMO No. 1152



Organization(s)
WMO

Language(s)
Arabic, Chinese, English, French, Spanish, Russian

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2015

Type of Material
Analytical/Technical Document

Go to Document

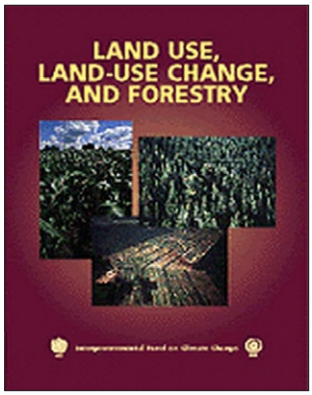
Value of Learning Resource

The document provides an overview of the status of the global climate in 2014. It highlights that 2014 was the warmest year since modern instrumental measurements began in the mid-1800s, as well as that global-average sea-surface temperatures for 2014 were warmer than for any previous year on record. This statement also highlights extremes that occurred in 2014 at the national and regional levels.

Structure and Content

- **Chapter 1: Temperatures**
  Presents an assessment of the global temperature for 2014, observing that the global-average near-surface temperature for 2014 was comparable to the warmest years since instrumental record.
- **Chapter 2: Rain, Snow and Ice**
  Provides information on rain, snow and ice for 2014, highlighting that global average precipitation in 2014 was close to the long-term average, while variations were recorded in terms of snow and ice cover.
- **Chapter 3: Oceans**
  Provides information on oceans for the year 2014, highlighting areas where sea-surface temperatures were much warmer than average, and notes that global-average sea level reached record or near-record levels.
- **Chapter 4: Regional Analysis**
  Provides climatic information for 2014 by region - Africa, Asia, South America, North America, Central America and the Caribbean, South-West Pacific, and Europe.
- **Chapter 5: Tropical Cyclones**
  Provides information on tropical cyclones, highlighting that 78 tropical storms were recorded globally during 2014.
- **Chapter 6: Greenhouse Gases and Ozone-Depleting Substances**
  Provides a concise summary of atmospheric levels of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) as well as ozone-depleting gases.

Land Use, Land-Use Change, and Forestry



Organization(s)
IPCC

Language(s)
Arabic, Chinese, English, French, Spanish, Russian

General Audience(s)
Decision Makers; Technical Staff/Practitioners

Year of Publication
2000

Type of Material
Analytical/Technical Document

Go to Document

Value of Learning Resource

This report examines several key questions relating to the exchange of carbon between the atmosphere and the terrestrial pool of aboveground biomass, below-ground biomass, and soils. Given that humans are changing the natural rate of exchange of carbon between the atmosphere and the terrestrial biosphere through land use, land-use change, and forestry activities, the report aims to support the Parties to the Kyoto Protocol by providing relevant scientific and technical information to describe how the global carbon cycle operates and what the broad-scale opportunities and implications of afforestation, reforestation, and deforestation (ARD) and additional human-induced activities are, now and in the future.

Structure and Content

- **Chapter 1: Global Perspective**
  Provides an overview of our present understanding of the fundamental natural processes at work, for an analysis of the opportunities, limitations, and implications of actions related to land use and land-use change.
- **Chapter 2: Implications of Different Definitions and Generic Issues**
  Describes the components of the global carbon cycles and the issues to be considered in accounting for carbon fluxes to and from the atmosphere.
- **Chapter 3: Afforestation, Reforestation, and Deforestation (ARD) Activities**
  Focuses on delineating issues related to the implementation of Article 3.3 of the Kyoto Protocol on GHG emissions from land-use change and forestry activities.
- **Chapter 4: Additional Human-Induced Activities-Article 3.4**
  Addresses the implications of including - as adjustments to assigned amounts under the Kyoto Protocol - the effects of activities related to land use, land-use change, and forestry (LULUCF) other than those covered by Article 3.3.
- **Chapter 5: Project-Based Activities**
  Discusses issues related to projects that are based on land use, land-use change, and forestry, which are important means of mitigating GHG emissions, providing guidance and information for policymakers.
- **Chapter 6: Implications of the Kyoto Protocol for the Reporting Guidelines**
  Analyses the extent to which the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories can be used to report changes in carbon stocks, GHG emissions, and their associated activities under the Kyoto Protocol, indicating where improvements may be needed.

Our Planet: Climate for Life

Organization(s)
UNEP

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2014

Type of Material
Other

Go to Document

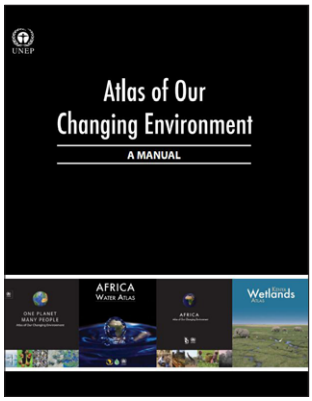
Value of Learning Resource

By presenting different efforts to limit greenhouse gas emissions from human activities, particularly through initiatives aimed at promoting protected areas and protecting biodiversity, this publication shows a wide range of examples of how countries are taking climate change into account in planning for their future development.

Structure and Content

- **Pride turns to Vision**
  Highlights Gabon's initiatives in developing a green economy.
- **The Ocean: Too Important to Ignore**
  Describes how green-blue growth is important for managing climate change and maintaining the world's ecosystem.
- **Promise of Changes**
  Provides information on Australia's commitment to protect the Great Barrier Reef.
- **Crucibles for Change**
  Presents the potential of the green schools and green youth ambassadors projects in Indonesia.
- **Going Green with Blue Carbon**
  Describes the commitment of Abu Dhabi to develop ecosystem-based management for the city and its people.
- **Ocean of Difference**
  Focuses on the challenges of Pacific countries to take actions for the oceans.
- **Combating Climate Change, Naturally**
  Highlights how protected areas can help to mitigate climate change.
- **Building Momentum**
  Stresses the necessity to take climate actions and the need for a new international agreement.
- **Chickens, Eggs, Biodiversity and Land**
  Describes the impact of land degradation on biodiversity, climate change, agricultural production and security.
- **Getting Ready**
  Highlights the growing value of reducing emissions from deforestation and forest degradation (REDD) programmes.
- **Protecting Biodiversity, Protecting Carbon**
  Discusses how protected areas can contribute to reducing carbon dioxide emissions.

Atlas of Our Changing Environment – A Manual



Organization(s)
UNEP

Language(s)
English

General Audience(s)
Technical Staff/Practitioners

Year of Publication
2014

Type of Material
Guidance Document/Handbook

Go to Document

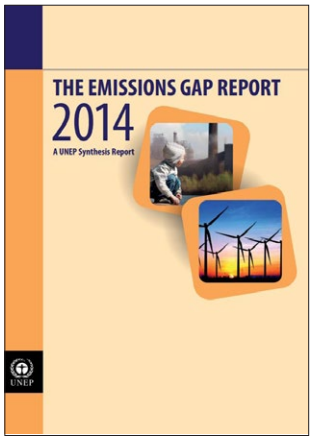
Value of Learning Resource

This booklet is a manual for geographic information system (GIS) and remote sensing practitioners, providing a step-by-step approach for communicating the scientific findings of time-series satellite imaging studies to a wide range of audiences. It focuses on the identification, production and presentation of time series sets of satellite images which graphically show environmental change. It aims to make the scientific evidence compelling enough to stimulate sound environmental policy-making. Background in remote sensing and GIS is needed.

Structure and Content

- **Introduction**
  Explains the purpose of the manual and highlights possible challenges.
- **Part 1: General Guidelines - "What is needed"**
  Introduces the preparatory, production and delivery phases and the resources required for mapping.
- **Part 2: Technical Specifications – "How to do it"**
  Presents technical details concerning maps, ground photos, references, design, layout and printing.

The Emissions Gap Report 2014: A UNEP Synthesis Report



Organization(s)
UNEP

Language(s)
Arabic, Chinese, English, French, Spanish, Russian

General Audience(s)
Decision Makers; Technical Staff/Practitioners

Year of Publication
2014

Type of Material
Analytical/Technical Report

Go to Document

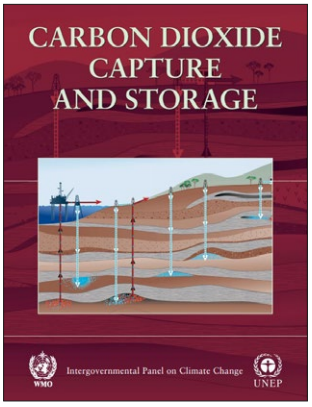
Value of Learning Resource

This report provides an analysis of the global carbon emissions budget for staying within the 2°C temperature target. It also provides estimates of the emissions gap in 2025 and 2030 and describes the current and projected levels of global greenhouse gas emissions as well as the role of energy efficiency measures for emission reductions.

Structure and Content

- **Chapter 1: Introduction**
  Introduces the focus of the report and provides background information.
- **Chapter 2: What Emission Levels will Comply with Temperature Limits?**
  Reviews estimates of recent global emission levels and trends, examines business-as-usual emission levels that would theoretically be reached if no further action were taken to reduce emissions and presents the levels of emissions that are consistent with limits to global temperature increases.
- **Chapter 3: Emissions Pledges and the Emissions Gap**
  Analyses expected global emissions by 2020 under several cases of pledge implementation, projects 2025 and 2030 emission levels based in 2020 estimates, estimates the 2025 and 2030 emissions gaps and evaluates the progress of major economies in achieving their 2020 pledges.
- **Chapter 4: Improving Energy Efficiency and Reaping Development and Climate Benefits**
  Shows that energy efficiency improvements not only reduce greenhouse gas emissions and energy consumption, but also positive impacts on development.

Carbon Dioxide Capture and Storage



Organization(s)
IPCC

Language(s)
Arabic, Chinese, English, French, Russian, Spanish

General Audience(s)
Decision Makers; Technical Staff/Practitioners

Year of Publication
2005

Type of Material
Analytical/Technical Document

Go to Document

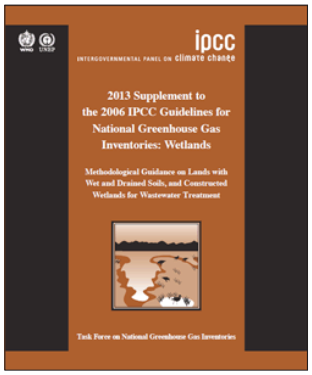
Value of Learning Resource

This report provides a broad range of information for policymakers, scientists and engineers in the field of climate change and reduction of CO2 emissions on carbon dioxide capture and storage (CCS). It shows that the potential of CO2 capture and storage is considerable, and the costs for mitigating climate change can be decreased compared to strategies where only other climate change mitigation options are considered.

Structure and Content

- **Chapter 1: Introduction**
  Outlines the general framework for the assessment and provides a brief overview of carbon dioxide capture and storage (CCS) systems.
- **Chapter 2: Sources of CO2**
  Characterizes the major sources of CO2 that are technically and economically suitable for capture, in order to assess the feasibility of CCS on a global scale.
- **Chapter 3: Capture of CO2**
  Describes different types of CO2 capture systems as well as risk, cost and legal aspects.
- **Chapter 4: Transport of CO2**
  Focuses on methods of CO2 transport.
- **Chapter 5: Underground Geological Storage**
  Describes geological storage mechanisms, their security and site-selection criteria.
- **Chapter 6: Ocean Storage**
  Illustrates several approaches to release CO2 into the ocean with an analysis of biological impacts and risk.
- **Chapter 7: Mineral Carbonation and Industrial Uses of Carbon Dioxide**
  Identifies the definition, sources and life cycle assessment of metal oxides and emission reduction potential.
- **Chapter 8: Costs and Economic Potential**
  Provides potential scenarios of CCS deployment and economic impacts of different storage times.
- **Chapter 9: Implications of Carbon Dioxide Capture and Storage for Greenhouse Gas Inventories and Accounting**
  Examines the implications of CCS for greenhouse gas inventories and emissions accounting.

2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands



Organization(s)
IPCC

Language(s)
English

General Audience(s)
Technical Staff/Practitioners

Year of Publication
2014

Type of Material
Guidance Document/Handbook

Go to Document

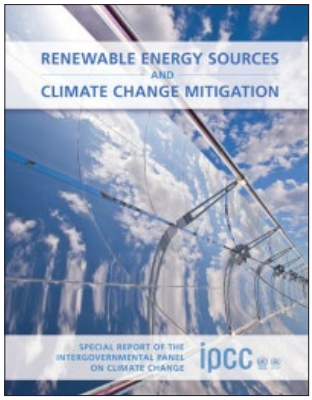
Value of Learning Resource

This guidance document is designed to assist countries in compiling complete national inventories of greenhouse gases to include significant land-use and management activities occurring in lands with wet and drained soils, and constructed wetlands for wastewater treatment. It provides methods for estimating anthropogenic emissions and removals of greenhouse gases. The document extends the content of the "2006 IPCC Guidelines for National Greenhouse Gas Inventories" by filling gaps in the coverage and providing updated information reflecting scientific advances, including updating of emission factors.

Structure and Content

- **Chapter 1: Introduction**
  Explains on how to use the document.
- **Chapter 2: Drained Inland Organic Soils**
  Provides guidance on estimating GHG emissions and removals from drained inland organic soils in all land-use categories.
- **Chapter 3: Rewetted Organic Soils**
  Provides new guidance and emission factors for organic soils that have been drained for forestry, crop production, grazing, peat extraction or other purposes, and have subsequently been rewetted to re-establish water saturation.
- **Chapter 4: Coastal Wetlands**
  Provides guidance on estimating emissions and removals of GHG associated with specific activities on managed coastal wetlands that may or may not result in a land use change.
- **Chapter 5: Inland Wetland Mineral Soils**
  Provides guidance on estimating and reporting GHG emissions and removals from managed lands with Inland Wetland Mineral Soils (IWMS).
- **Chapter 6: Constructed Wetlands for Wastewater**
  Provides guidance on estimating CH4 and N2O emissions from constructed wetlands and semi-natural treatment wetlands used for wastewater treatment.
- **Chapter 7: Cross-cutting Issues and Reporting:**
  Provides guidance on reporting and cross-cutting issues, including, for instance, uncertainties and quality control.

Renewable Energy Sources and Climate Change Mitigation
Special Report of the Intergovernmental Panel on Climate Change



Organization(s)
IPCC

Language(s)
English

General Audience(s)
Decision Makers; Technical Staff/Practitioners; General Public

Year of Publication
2012

Type of Material
Analytical/Technical Document

Go to Document

Value of Learning Resource

This publication provides policymakers, the private sector, academic researchers and civil society with information on the future potential of renewable energy for the mitigation of greenhouse gas emissions. It covers six key renewable energy technologies, as well as their integration into present and future energy systems. It also takes into consideration the environmental and social consequences associated with these technologies, cost and strategies to overcome technical obstacles to their application and implementation.

Structure and Content

- **Chapter 1: Renewable Energy and Climate Change**
  Provides an introduction, key statistics on renewable energy and options for mitigation.
- **Chapter 2: Bioenergy**
  Analyses resource potential, technical applications, status of market and environment/social impacts for bioenergy.
- **Chapter 3: Direct Solar Energy**
  Analyses resource potential, technical applications, status of market and environment/social impacts for direct solar energy.
- **Chapter 4: Geothermal Energy**
  Analyses resource potential, technical applications, status of market and environment/social impacts for geothermal energy.
- **Chapter 5: Hydropower**
  Analyses resource potential, technical applications, status of market and environment/social impacts for hydropower.
- **Chapter 6: Ocean Energy**
  Analyses resource potential, technical applications, status of market and environment/social impacts for ocean energy.
- **Chapter 7: Wind Energy**
  Analyses resource potential, technical applications, status of market and environment/social impacts for wind energy.

- **Chapter 8: Integration of Renewable Energy into Present and Future Energy Systems**
  Discusses the current and future integration of renewable energy technologies into energy distribution systems, particularly in the transport, buildings, industry and agricultural sectors.
- **Chapter 9: Renewable Energy in the Context of Sustainable Development**
  Analyses the social, environmental and economic impacts of renewable energy sources.
- **Chapter 10: Mitigation Potential and Costs**
  Investigates how renewable energy technologies may contribute to varying GHG emission reduction scenarios.
- **Chapter 11: Policy, Financing and Implementation**
  Describes the current trends in renewable energy support policies, as well as trends in financing and investment in renewable energy technologies.

ANNEX 1
Selected Non UN Written Resources and Training Courses

1

Learning Topic 1
Climate and the Factors Shaping the Earth's Climate

Introduction to Climatology

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2008)

This module provides an overview of climatology, the study of climate. It is intended for a wide range of users, from forecasters and scientists to those in business and government as well as the general public — in short, anyone interested in learning about climatology. Chapter 1 discusses the difference between weather and climate and defines climatology. Chapters 2 through 5 examine the drivers that combine to create the climate regions of the world — from those at the mesoscale (local) level to those at the synoptic-scale (continental) and global-scale levels. Examples include locally dominant winds, air masses, fronts, ocean currents, Earth's rotation around the sun, and latitude. Each discussion of a climate driver has an 'example/exploration' segment, where the information is applied to several cities. Chapter 6 examines climate zones and classifications of the world's climate. The module also discusses the sources and uses of climate information, and some of the limitations of this information. Some familiarity with basic meteorology is useful although not required. The material is available in English both as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=499

Climate Change: Fitting the Pieces Together

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects. It is intended for anyone interested in learning about climatology. The first section describes some of the natural influences of climate. Included are descriptions of orbital mechanics, continental drift, ocean currents, greenhouse gases, and the carbon cycle. Some familiarity with basic meteorology is useful although not required. The material is available both in English and in Spanish both as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=522

Climate Variability and Change Lectures

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2014)

This module aims to deliver scientific knowledge for the provision of local climate services. Various climate variability and change topics are covered, with an emphasis on developing skills for effectively communicating with the public. Topics addressed include the difference between climate and weather; statistical techniques used in climate studies; dynamics, physical mechanisms, and impacts of climate variability phenomena; the science behind and limitations of climate prediction products; the physical and feedback mechanisms involved in global climate change; and global climate change impacts on quality of human life, biological habitats, and natural resource availability. The material is available as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=1034

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Learning Topic 2

Historical Climate Variations

Climate Change: Fitting the Pieces Together

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects. It is intended for anyone interested in learning about climatology. The first section describes some of the natural influences of climate. Included are graphics of historical patterns of carbon dioxide, and temperature. The second section presents historical changes of temperature, sea level, snow and ice, rain and drought, and ecosystems. Some familiarity with basic meteorology is useful although not required. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=522

Monitoring the Climate System with Satellites

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module explores the benefits of monitoring the climate system with satellites. Firstly, it reviews how satellites observe key atmospheric elements and features that are found in a variety of climate cycles and are important for studying long-term climate trends. Secondly, it explores events at the different scales (from seasonal to long-term) and the contributions that satellites make to improving their understanding, monitoring, and prediction. Finally, it discusses the challenges involved in monitoring climate with satellites, including the need for continuous, stable, high-resolution, and validated measurements that are coordinated with the world's satellite operators. The material is available in English and French as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=895

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Learning Topic 3

Meteorological Consequences of Climate Variability and Change

Climate Change: Fitting the Pieces Together

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects. It is intended for anyone interested in learning about climatology. Section 4 discusses global and regional effects of climate change on weather, temperature, precipitation, sea level rise, and extreme weather. Some familiarity with basic meteorology is useful although not required. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=522

Coastal Climate Change

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2011)

This module provides an overview of the impacts coastal regions are experiencing and may continue to experience as a result of Earth's changing climate. A video series within the module demonstrates effective strategies for communicating climate science. The material is available in English both as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=772

Climate Change and Regional Impacts

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This short module provides an overview of the different effects climate change produces in different regions of the United States. In addition to discussing impacts already being experienced, the module presents information on how climate scientists use specialized models and statistical techniques to estimate how regional climates are likely to change in the future. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=972

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Learning Topic 4

The Human Contribution to Climate Variability

Climate Change: Fitting the Pieces Together

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects. It is intended for anyone interested in learning about climatology. Section 2 discusses the human contribution to climate change in terms of carbon dioxide, methane, nitrous oxide, and fluorinated gases. The last section discusses adaptation and mitigation strategies. Some familiarity with basic meteorology is useful although not required. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=522

Climate Change and Sea Level rise

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module looks at how increasing temperatures due to climate change have affected sea level rise and what effects scientist expect in the future, given rising GHG emissions. The various mechanisms of sea level rise are discussed, as well as the tools and research used to study this topic. Section 5 highlights potential impacts. Section 6 discusses how countries and communities are preparing for future increases in sea levels. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=974

Climate Change and Extreme Weather

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses how a changing climate can also lead to changes in extreme weather events on the local scale. The role of natural variability is also explained. The module describes how climate change can have both positive and negative effects, depending on the situation, location, and the vulnerability of the population. While research on climate change and extreme events is still relatively new, the module discusses what changes scientists think are likely if greenhouse gas emissions continue to rise. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=973

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Learning Topic 5

Global Emission Scenarios and Climate Change

CO2 Emissions from Fuel Combustion: Highlights

(International Energy Agency, 2014)

This document presents information on the level and growth of CO2 emissions, their source and geographic distribution. It covers more than 140 countries and regions and provides an estimation of CO2 emissions and its driving forces from 1971 to 2012.

https://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2014.pdf

Climate Change: Fitting the Pieces Together

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2012)

This module discusses climate change, particularly as it is currently being affected by increasing concentrations of greenhouse gases emitted by human activities. It also covers signs of climate change, how scientists study climate, the current thinking on future changes, and what can be done to minimize the effects. It is intended for anyone interested in learning about climatology. Sections 3 and 5 discuss climate models, future projections and scenarios, and future impacts. Some familiarity with basic meteorology is useful although not required. The material is available both in English and in Spanish as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=522

Satellite Monitoring of Atmospheric Composition

(COMET Program, University Corporation for Atmospheric Research (UCAR) and National Oceanic and Atmospheric Administration – National Weather Service (NOAA NWS), United States, 2011)

Satellite monitoring of atmospheric composition provides important information for a number of applications, including stratospheric ozone monitoring, long-range pollutant transport, biomass burning, air quality monitoring and forecasting, and climate change. This module provides an overview of the use of satellites in these application areas, the measurement techniques used, and the development of related operational services. In addition, the module covers a short history of European and U.S. satellite missions, as well as a look at future missions planned for monitoring atmospheric composition. The material is available as a print version and as an audio/visual online web-based interactive format; registration is required.

https://www.meted.ucar.edu/training_module.php?id=985

Regional and Global Climate

(U.S. Geological Survey (USGS), United States, 2012)

This Global Climate Change Viewer web application provides basic visualization of climate change scenario data sets. It is a user-friendly, interactive interface that summarizes simulated future changes in temperature and precipitation for each country. Users can visualize global and country-specific spatial patterns of change, compare present-day simulations with observations, and display the distribution of climate change for a given country. The application web page includes documentation for describing in detail the methods and data sets used to create the data displayed.

http://regclim.coas.oregonstate.edu/

About UN CC:Learn

UN CC:Learn is a partnership of more than 30 multilateral organizations supporting countries to design and implement systematic, recurrent and results-oriented climate change learning. At the global level, the partnership supports knowledge-sharing, promotes the development of common climate change learning materials, and coordinates learning interventions through a collaboration of UN agencies and other partners. At the national level, UN CC:Learn supports countries in developing and implementing national climate change learning strategies. Through its engagement at the national and global levels, UN CC:Learn contributes to the implementation of Article 6 of the UNFCCC on training, education and public awareness-raising, and the 2012-2020 Doha Work Programme. Funding for UN CC:Learn is provided by the Swiss Government and UN partners. The Secretariat for UN CC:Learn is hosted by the UN Institute for Training and Research (UNITAR). For further information please contact: uncclearn@unitar.org.

www.uncclearn.org

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