DOWNLOAD PDF CLIMATIC VARIATIONS AND VARIABILITY: FACTS AND THEORIES

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Climatic variability was the subject of the first Course, in that climatic changes represent one of the most exciting phenomenologies to study; in fact, even if the climate has changed many times in the past, so making it reasonable to asÂ- sume that it will do so in the future, it is still not easy to understand the above mentioned changes.

Many aspects of the global climate are changing rapidly, and the primary drivers of that change are human in origin. Evidence for changes in the climate system abounds, from the top of the atmosphere to the depths of the oceans. See Observed Change in the National Climate Assessment to learn more about the indicators of a warming world. According to the third U. The global warming of the past 50 years is primarily due to human activities, predominantly the burning of fossil fuels. National Climate Assessment documents climate change related impacts and responses for various sectors and regions, with the goal of better informing public and private decision making at all levels. National Climate Assessment Key Findings Global climate is changing and this is apparent across the United States in a wide range of observations. Some extreme weather and climate events have increased in recent decades, and new and stronger evidence confirms that some of these increases are related to human activities. Human-induced climate change is projected to continue, and it will accelerate significantly if global emissions of heat-trapping gases continue to increase. Impacts related to climate change are already evident in many sectors and are expected to become increasingly disruptive across the nation throughout this century and beyond. Climate change threatens human health and well-being in many ways, including through more extreme weather events and wildfire, decreased air quality, and diseases transmitted by insects, food, and water. Infrastructure is being damaged by sea level rise, heavy downpours, and extreme heat; damages are projected to increase with continued climate change. Water quality and water supply reliability are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods. Climate disruptions to agriculture have been increasing and are projected to become more severe over this century. Ecosystems and the benefits they provide to society are being affected by climate change. The capacity of ecosystems to buffer the impacts of extreme events like fires, floods, and severe storms is being overwhelmed. Ocean waters are becoming warmer and more acidic, broadly affecting ocean circulation, chemistry, ecosystems, and marine life. Planning for adaptation to address and prepare for impacts and mitigation to reduce future climate change, for example by cutting emissions is becoming more widespread, but current implementation efforts are insufficient to avoid increasingly negative social, environmental, and economic consequences. For a synopsis of the key findings from the Assessment, see the Highlights report or download the page Overview booklet. See the Intergovernmental Panel on Climate Change for more in-depth information on climate change and to view various assessments and technical reports. For general information on climate and climate change, visit www. See Analyses of Maximum Precipitation Estimates: Impacts of a Wetter Future for more information on a recent report about rising atmospheric concentrations of greenhouse gases and their effects on extreme precipitation events.

Chapter 2 : Climatic Variations and Variability: Facts and Theories : A.L. Berger :

If we are to understand both the mechanisms of climatic change and the spectrum of natural climatic variation, study of past climates is essential. Without it, formulation of analytical and.

Climatic shifts are known to be capable of effecting fill or clearance of channels and valleys: In addition to the alternation in some near-glacial areas between braiding during maximum cold and meandering during interglacial warmth, the recordâ€¦ The Earth system The atmosphere is influenced by and linked to other features of Earth, including oceans, ice masses glaciers and sea ice , land surfaces, and vegetation. Together, they make up an integrated Earth system, in which all components interact with and influence one another in often complex ways. Deciduous forest in fall coloration, Wasatch Mountains, Utah. Earth scientists and atmospheric scientists are still seeking a full understanding of the complex feedbacks and interactions among the various components of the Earth system. This effort is being facilitated by the development of an interdisciplinary science called Earth system science. A full understanding of the Earth system requires knowledge of how the system and its components have changed through time. The pursuit of this understanding has led to development of Earth system history, an interdisciplinary science that includes not only the contributions of Earth system scientists but also paleontologists who study the life of past geologic periods , paleoclimatologists who study past climates , paleoecologists who study past environments and ecosystems , paleoceanographers who study the history of the oceans , and other scientists concerned with Earth history. Because different components of the Earth system change at different rates and are relevant at different timescales, Earth system history is a diverse and complex science. Students of Earth system history are not just concerned with documenting what has happened; they also view the past as a series of experiments in which solar radiation, ocean currents, continental configurations, atmospheric chemistry, and other important features have varied. These experiments provide opportunities to learn the relative influences of and interactions between various components of the Earth system. Studies of Earth system history also specify the full array of states the system has experienced in the past and those the system is capable of experiencing in the future. Undoubtedly, people have always been aware of climatic variation at the relatively short timescales of seasons, years, and decades. Biblical scripture and other early documents refer to droughts , floods , periods of severe cold, and other climatic events. Nevertheless, a full appreciation of the nature and magnitude of climatic change did not come about until the late 18th and early 19th centuries, a time when the widespread recognition of the deep antiquity of Earth occurred. Naturalists of this time, including Scottish geologist Charles Lyell , Swiss-born naturalist and geologist Louis Agassiz , English naturalist Charles Darwin , American botanist Asa Gray , and Welsh naturalist Alfred Russel Wallace , came to recognize geologic and biogeographic evidence that made sense only in the light of past climates radically different from those prevailing today. Geologists and paleontologists in the 19th and early 20th centuries uncovered evidence of massive climatic changes taking place before the Pleistocene â€”that is, before some 2. For example, red beds indicated aridity in regions that are now humid e. Since the late 20th century the development of advanced technologies for dating rocks, together with geochemical techniques and other analytical tools, have revolutionized the understanding of early Earth system history. The occurrence of multiple epochs in recent Earth history during which continental glaciers, developed at high latitudes, penetrated into northern Europe and eastern North America was recognized by scientists by the late 19th century. Milankovitch proposed that the mechanism that brought about periods of glaciation was driven by cyclic changes in eccentricity as well as two other orbital parameters: Evidence for climate change All historical sciences share a problem: As they probe farther back in time, they become more reliant on fragmentary and indirect evidence. Earth system history is no exception. High-quality instrumental records spanning the past century exist for most parts of the world, but the records become sparse in the 19th century, and few records predate the late 18th century. Within strict geographic contexts , these sources can provide information on frosts , droughts, floods, sea ice, the dates of monsoons , and other climatic featuresâ€"in some cases up to several hundred years ago. Fortunately, climatic change also leaves a variety of signatures in the natural world. Paleoclimatologists study the traces of these effects, devising clever and subtle ways to obtain information about past climates. Most of the evidence of past climatic change is circumstantial, so paleoclimatology involves a great deal of investigative work. Wherever possible, paleoclimatologists try to use multiple lines of evidence to cross-check their conclusions. They are frequently confronted with conflicting evidence, but this, as in other sciences, usually leads to an enhanced understanding of the Earth system and its complex history. New sources of data, analytical tools, and instruments are becoming available, and the field is moving quickly. Climatic changes of the past â€" years, especially since the early s, are documented by instrumental records and other archives. These written documents and records provide information about climate change in some locations for the past few hundred years. Some very rare records date back over 1, years. Researchers studying climatic changes predating the instrumental record rely increasingly on natural archives, which are biological or geologic processes that record some aspect of past climate. These natural archives, often referred to as proxy evidence, are extraordinarily diverse; they include, but are not limited to, fossil records of past plant and animal distributions, sedimentary and geochemical indicators of former conditions of oceans and continents, and land surface features characteristic of past climates. Paleoclimatologists study these natural archives by collecting cores, or cylindrical samples, of sediments from lakes , bogs , and oceans; by studying surface features and geological strata; by examining tree ring patterns from cores or sections of living and dead trees; by drilling into marine corals and cave stalagmites ; by drilling into the ice sheets of Antarctica and Greenland and the high-elevation glaciers of the Plateau of Tibet , the Andes, and other montane regions; and by a wide variety of other means. Techniques for extracting paleoclimatic information are continually being developed and refined, and new kinds of natural archives are being recognized and exploited. Courtesy of Northwestern University Causes of climate change It is much easier to document the evidence of climate variability and past climate change than it is to determine their underlying mechanisms. Climate is influenced by a multitude of factors that operate at timescales ranging from hours to hundreds of millions of years. Many of the causes of climate change are external to the Earth system. Others are part of the Earth system but external to the atmosphere. Still others involve interactions between the atmosphere and other components of the Earth system and are collectively described as feedbacks within the Earth system. Feedbacks are among the most recently discovered and challenging causal factors to study. Nevertheless, these factors are increasingly recognized as playing fundamental roles in climate variation. The most important mechanisms are described in this section. Solar variability The luminosity, or brightness, of the Sun has been increasing steadily since its formation. Low solar luminosity during Precambrian time underlies the faint young Sun paradox , described in the section Climates of early Earth. Radiative energy from the Sun is variable at very small timescales, owing to solar storms and other disturbances, but variations in solar activity, particularly the frequency of sunspots , are also documented at decadal to millennial timescales and probably occur at longer timescales as well. See below Climatic variation and change since the emergence of civilization. A massive loop-shaped eruptive prominence is visible at the lower left. Nearly white areas are the hottest; deeper reds indicate cooler temperatures. NASA Volcanic activity Volcanic activity can influence climate in a number of ways at different timescales. A recent example is the eruption in the Philippines of Mount Pinatubo , which had measurable influences on atmospheric circulation and heat budgets. New England and Europe experienced snowfalls and frosts throughout the summer of Geological Survey Volcanoes and related phenomena, such as ocean rifting and subduction, release carbon dioxide into both the oceans and the atmosphere. Emissions are low; even a massive volcanic eruption such as Mount Pinatubo releases only a fraction of the carbon dioxide emitted by fossil-fuel combustion in a year. At geologic timescales, however, release of this greenhouse gas can have important effects. Variations in carbon dioxide release by volcanoes and ocean rifts over millions of years can alter the chemistry of the atmosphere. Such changeability in carbon dioxide concentrations probably accounts for much of the climatic variation that has taken place during the Phanerozoic Eon. See below

Phanerozoic climates. These movements have changed the shape, size, position, and elevation of the continental masses as well as the bathymetry of the oceans. Topographic and bathymetric changes in turn have had strong effects on the circulation of both the atmosphere and the ocean s. For example, the uplift of the Tibetan Plateau during the Cenozoic Era affected atmospheric circulation patterns, creating the South Asian monsoon and influencing climate over much of the rest of Asia and neighbouring regions. The locations over time of the present-day continents are shown in the inset. Scotese, The University of Texas at Arlington Tectonic activity also influences atmospheric chemistry, particularly carbon dioxide concentrations. Carbon dioxide is emitted from volcanoe s and vents in rift zones and subduction zones. Even the chemical weathering of rock constitutes an important sink for carbon dioxide. A carbon sink is any process that removes carbon dioxide from the atmosphere by the chemical conversion of CO2 to organic or inorganic carbon compounds. Carbonic acid, formed from carbon dioxide and water, is a reactant in dissolution of silicates and other minerals. Weathering rates are related to the mass, elevation, and exposure of bedrock. Tectonic uplift can increase all these factors and thus lead to increased weathering and carbon dioxide absorption. For example, the chemical weathering of the rising Tibetan Plateau may have played an important role in depleting the atmosphere of carbon dioxide during a global cooling period in the late Cenozoic Era. See below Cenozoic climates. Orbital Milankovich variations The orbital geometry of Earth is affected in predictable ways by the gravitational influences of other planets in the solar system. This variation occurs on a cycle of 41, years. In general, the greater the tilt, the greater the solar radiation received by hemispheres in summer and the less received in winter. These two processes create a 26,year cycle, called precession of the equinoxes , in which the position of Earth at the equinoxes and solstices changes. Today Earth is closest to the Sun perihelion near the December solstice, whereas 9, years ago perihelion occurred near the June solstice. These orbital variations cause changes in the latitudinal and seasonal distribution of solar radiation, which in turn drive a number of climate variations. Orbital variations play major roles in pacing glacial-interglacial and monsoonal patterns. Their influences have been identified in climatic changes over much of the Phanerozoic. For example, cyclothemsâ€"which are interbedded marine, fluvial, and coal beds characteristic of the Pennsylvanian Subperiod Carbon dioxide, methane , and water vapour are the most important greenhouse gases, and they have a profound effect on the energy budget of the Earth system despite making up only a fraction of all atmospheric gases. In general, greenhouse gas concentrations have been particularly high during warm periods and low during cold phases. A number of processes influence greenhouse gas concentrations. Some, such as tectonic activities, operate at timescales of millions of years, whereas others, such as vegetation, soil, wetland, and ocean sources and sinks, operate at timescales of hundreds to thousands of years. Human activitiesâ€"especially fossil-fuel combustion since the Industrial Revolution â€"are responsible for steady increases in atmospheric concentrations of various greenhouse gases, especially carbon dioxide, methane, ozone , and chlorofluorocarbons CFCs. Created and produced by QA International. Infrared IR radiation is then emitted from the surface. Feedback Perhaps the most intensively discussed and researched topic in climate variability is the role of interactions and feedbacks among the various components of the Earth system. The feedbacks involve different components that operate at different rates and timescales. Ice sheets, sea ice, terrestrial vegetation, ocean temperatures, weathering rates, ocean circulation, and greenhouse gas concentrations are all influenced either directly or indirectly by the atmosphere; however, they also all feed back into the atmosphere, thereby influencing it in important ways. At the same time, the transfer of water molecules from soil to the atmosphere is mediated by vegetation, both directly from transpiration through plant stomata and indirectly from shading and temperature influences on direct evaporation from soil. This regulation of latent heat flux by vegetation can influence climate at local to global scales. As a result, changes in vegetation, which are partially controlled by climate, can in turn influence the climate system. Vegetation also influences greenhouse gas concentrations; living plants constitute an important sink for atmospheric carbon dioxide, whereas they act as sources of carbon dioxide when they are burned by wildfires or undergo decomposition. These and other feedbacks among the various components of the Earth system are critical for both understanding past climate changes and predicting future ones.

Chapter 3 : Variability hypothesis - Wikipedia

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Theories and speculations on the nature of climate and climate variability cover a wide range, but there exists general agreement that the climatic system represents a complex structure of coupled.

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