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CONSIDERATIONS REGARDING GLOBAL WARMING AND CLIMATE CHANGE

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Abstract: The paper presents global considerations regarding the global warming and climate change. It also describes the green-house gases and gas concentrations that have increased over the industrial period. In the last part it tries to predict some implication due to the climate change in all the environment factors implied

Keywords: environment factors, global warming, climate change.

1. INTRODUCTION

The terms global warming and climate change are often used interchangeably, but the two phenomena are different. Global warming is the rise in global temperatures due to an increase of heat-trapping carbon emissions in the atmosphere.

Climate change, on the other hand, is a more general term that refers to changes in many climatic factors (such as temperature and precipitation) around the world. These changes are happening at different rates and in different ways. For example, the United States has become wetter over the 20th century, while the Sahel region of central Africa has become drier.

Infrared (IR) active gases, principally water vapor (H_2O), carbon dioxide (CO_2), and ozone (O_3), naturally present in the Earth's atmosphere, absorb thermal IR radiation emitted by the Earth's surface and atmosphere. The atmosphere is warmed by this mechanism and, in turn, emits IR radiation, with a significant portion of this energy acting to warm the surface and the lower atmosphere. As a consequence the average surface air temperature of the Earth is about 30° C higher than it would be without atmospheric absorption and reradiating of IR energy [1].

The principal greenhouse gas concentrations that have increased over the industrial period are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons CFC-11 (CCl_3F) and CFC-12 ($CC_{l2}F_2$) [2]. The observed increase of CO_2 in the atmosphere from about 280 ppm in the preindustrial era to about 364 ppm in 1997 (Figure 1) [3, 4] has come largely from fossil fuel combustion and cement production. For some greenhouse gases persistence can be estimated from "mean residence times," which are obtained with simple linear models and represent the time that would be required for removal of 63% of the anthropogenic excess of the material in the atmosphere, if anthropogenic sources were abruptly diminished to zero [5,6].

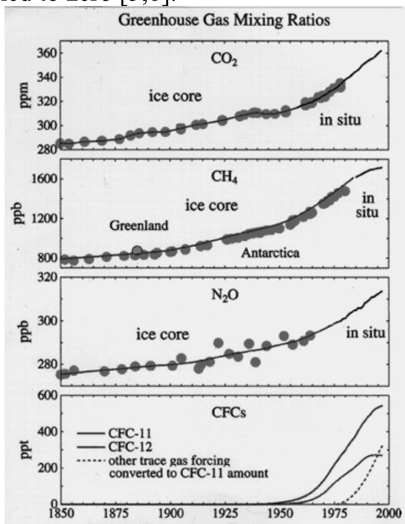

Figure. 1. Concentrations of principal anthropogenic greenhouse gases in the industrial era [3,4].

This approach yields a rough measure of the persistence in the atmosphere of anthropogenic additions of CH4 with an estimated mean residence time of 10 years [7, 8]; N_2O, 100 years and CFC-11 and CFC-12, 50 and 102 years.

Of the several anthropogenic greenhouse gases, CO_2 is the most important agent of potential future climate warming because of its large current greenhouse forcing, its substantial projected future forcing [9], and its long persistence in the atmosphere (see above). Understanding climate response to a specified forcing is one of the major challenges facing the climate research community. The equilibrium response of the nonlinear climate system depends in complex ways on various feedbacks, such as changes in water vapour concentration and cloudiness that can augment or diminish climate response from that which would occur in the absence of such feedbacks.

2. CLIMATE CHANGE AND CARBON DIOXIDE.

The most commonly considered indicator of climate change is the surface air temperature.

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Extensive efforts have been made to examine the trends in global and regional mean temperatures over time [10; 11; 12] and in the global patterns of temperature change [13. 14].

Worldwide temperature measurements, carefully screened with tools used to establish the effects of urbanization, have been used to estimate that global mean annual surface temperatures have increased between 0,3 and 0,.6° C during the last 150 years [15; 16]. However, it must be stressed that the increase has not been monotonic, with annual fluctuations in the global annual mean temperature equal to an appreciable fraction of the overall rise over this time period. No single explanation can account for this variability.

Although temperature is usually the first variable considered in assessments of global climate change, it is important to consider other data that integrate the state of the climate system over space and time. These include temperature proxy data (such as tree ring records), borehole temperature measurements in soil, permafrost, and ice sheets, and measurements of the mass balance of valley glaciers and ice caps. Several recent proxy temperature reconstructions have suggested that the warming during the twentieth century is greater than any seen in the last 400 to 600 years [17] and perhaps the last 1200 to 1500

Glaciers are present on every continent except Australia (Figure 2); they are thus excellent geographically dispersed regional indicators of climate change. The Earth's valley glaciers, ice caps, and ice fields and their associated outlet glaciers have generally been shrinking and receding during the last century. Studies in North America [18], South America [19], Europe [20], Iceland [21], Africa [22], and Asia have shown substantial recession of many of the ice caps and no tidewater, no surge-type glaciers [23] since the early nineteenth century.

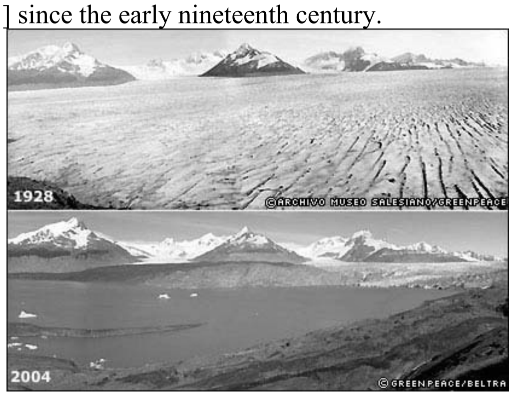

Figure 2. Glacial Change

The record of the past few thousand years is more difficult to piece together than the more recent record because fewer data are available. There is evidence from this period that climatic conditions were sometimes warmer and sometimes cooler than at present [2425].

It is clear from these records, and from many other studies of paleoclimate evidence throughout the geologic record, that the global climate system has been influenced by many factors in addition to greenhouse gases [6]. To evaluate geologic evidence for the influence of greenhouse gases, one must focus on records from periods when changes in atmospheric CO_2 were much larger than those that occurred during the millennia immediately preceding the recent increase in anthropogenic CO_2 production.

Larger natural variations in atmospheric CO_2 have been inferred from the geologic record of the more distant past [26]. Variations of 80-100 ppm, observed in analyses of gas bubbles trapped in glacier-ice cores, are correlated with the glacial ("ice age") and interglacial climatic oscillations of the latest Pleistocene and Holocene Epochs (Figure 3); [27]. Glacial periods are associated with low CO2 concentrations, and interglacial periods with high CO2 concentrations. Ice core methane profiles show a similar correlation with climate [28].

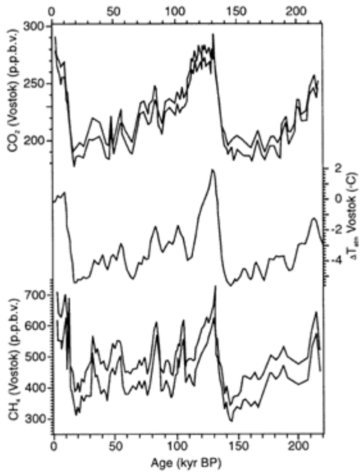

Figure 3. Carbon dioxide concentration (top), proxy temperature (middle), and methane concentration from analyses of ice cores from Vostok, Antarctica [29].

Still larger past variations in atmospheric CO2, including increases to concentrations several times higher than recent levels, have been estimated using geochemical models constrained by the sediment record [30]. During the last several hundred million years, these larger and slower CO2 changes can be correlated with general features of climate change [30,31].

Paleoclimate model simulations (using models similar in many ways to the models used in modern climate projections) support the importance of CO2 in explaining global mean temperatures in the geologic past [30, 32]. Model simulations have also shown the importance of changes in other climate controls, for example the configuration of Earth's orbit [25] and the geographical distribution and elevation of continental areas [33].

Significant gaps remain in understanding the relationships among these diverse climatic influences. However, the prevailing paradigm in paleoclimate research treats the radiative effects of atmospheric CO2 as an integral component in a complex system of many variables and interactive influences on global climate.

The complexity of the long-term coupling of CO2 and climate is enhanced by the extent to which climate variability is hypothesized to have influenced past atmospheric CO2 concentrations.

Glacial/interglacial CO2 variations during the Pleistocene epoch appear to have involved a combination of changes in global carbon cycling that were probably driven by some aspect of climate change [31, 34; 35, 36]. Likewise, for timescales of millions of years and longer, atmospheric CO2 appears to have been affected by the influence of climate on weathering and erosion rates.

Thus current interpretation of the geologic record suggests that greenhouse gases both respond and contribute to climate change. Atmospheric CO2 is viewed as one of many components of the climate system that interact in complex ways over a wide range of timescales. A change in one of these interactive components is likely to affect other aspects of the global climate system. This interactive relationship between CO2 and climate implies that the geologic record is not likely to reveal analogs of simple climate forcing by anthropogenic CO2 emissions [25, 36]. There is no known geologic precedent for large increases of atmospheric CO2 without simultaneous changes in other components of the carbon cycle and climate system.

3. PREDICTIONS REGARDING CLIMATE CHANGE FROM INCREASED GREENHOUSE GASES

Some of the predicted responses to increases in greenhouse gases include increases in mean surface air temperature, increases in global mean rates of precipitation and evaporation, rising sea level, and changes in the biosphere (Figure 4). Many of these predictions are based largely on computer models that simulate fundamental geophysical processes.

Most model simulations of Earth's climate indicate that an increase in the atmospheric concentration of a greenhouse gas will lead to an increase in the average surface air temperature of the Earth [37]. For example, the 18 model runs (using 7 independent models) quoted by Kattenberg et al. predict an equilibrium temperature increase of 2.0 ± 0.6° C for simulations using double the current level of atmospheric CO_2.

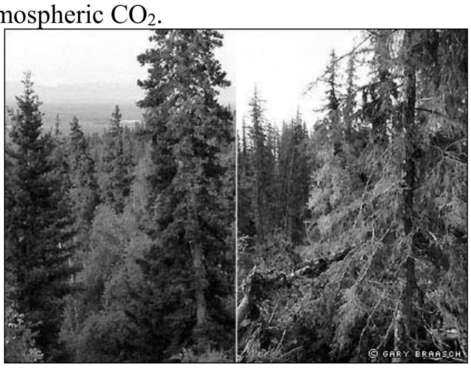

Figure 4. More pest invading due to warmer temperatures.

An increase in surface air temperature would cause an increase in evaporation and generally higher levels of atmospheric water vapor (Figure 5). The positive feedback associated with this leads to the expectation that an increase in surface air temperatures would lead to a more intense hydrological cycle, with more frequent heavy precipitation events [37].

Figure 5. No more snow

However, because of the coarse spatial resolution of present general circulation models, simulations of the regional and seasonal distribution of precipitation are poor.

Another possible consequence of greenhouse-gas-induced climate change is elevated sea level (Figure 6,7).

Figure 6. Vanishing Islands

The main factors that contribute to sea level rise are thermal expansion of ocean water and the melting of glaciers, both of which are in response to higher air temperatures. Although it has been well established that meltwater from the world's small glaciers has contributed to sea level rise during the last century [23], the mass balance of the ice sheets in Greenland and Antarctica is unknown.

However, recent geodetic airborne laser altimeter measurements indicate that between 1993 and 1998 the south-eastern part of the Greenland ice sheet thinned overall, with a thickening at a rate of 0.5 ± 0.7 cm/yr at elevations above 2000 m (not corrected for crustal motion) and a thinning at the low elevations at rates up to 1 m/yr [38].

Figure 7. Rising tides

Worldwide measurements from tidal gauges during the last 100 years indicate that mean sea level has risen between 10 and 25 cm (18 cm mean) [39, 40, 41]. This rate is greater than would be expected from the archaeological and geological record of sea level from the last two millennia [40]. Most modelling studies, including simulations of the combined effects of increasing greenhouse gases and aerosols, predict that the trend in rising sea level will continue in the future [40,41]. A possible biological effect may be seen in evidence that there has been an increase in the active growing season at high latitudes in the Northern Hemisphere.

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