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Global Environmental Trends and Probable Impacts on the Coasts of South American Mid-Latitudes

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ABSTRACT

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This note indicates the conflicting evidence that is emerging concerning the rise in global CO_2 and the possible greenhouse effect. Holocene data, for example, suggest that cooling cycles are marked by higher volcanic activity and tectonism in the northern hemisphere, though reversed in the South. Changing centrifugal force distribution can also lead to alteration to the upwelling-downwelling ocean systems. Changing solar emissions have been ignored by model-workers. There is no evidence that the Antarctic ice sheet is likely to melt. This removes the "Sword of Damocles" from the coastal zone, but the changing wind systems, if a warming trend develops, would have important effects on the Atlantic mid-latitudes of South America.

ADDITIONAL INDEX WORDS: *Greenhouse effect, Holocene wind systems, longshore drift, sea-level rise, volcanism and climate.*

INTRODUCTION

During the last decade, there was wide-spread information about *Global Changes* and particularly the probable trends of our global climate. Unfortunately, both scientist and journalist generally interpreted the available information as catastrophic for future generations. It was implied that only human action could have generated such drastic, definitive changes in the environment. The alternative would be adaptation or death!

Concerning the coastal belt, this catastrophic change lead to the prediction of a large sea-level rise during the next century as a result of the greenhouse effect. According to this phenomenon, the atmosphere would become warmer and would melt the Antarctic ice-sheets, dumping large amounts of meltwater into the ocean and submerging many coastal cities around the world.

Much of the published information is contradictory. The scientific data are supposed to rely on "dangerous numbers" that come from mathematical models without enough basic information, or without even an adequate conceptual basis. Verification in models concerning long-term, geological processes involved in global changes is not possible (YOUNKER and BOAK, 1994).

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Some models pointed to a 3.5 m rise of sea level in the next century (HOFFMAN *et al.*, 1983; BARTH and TITUS, 1984). Other, perhaps more reliable, models pointed to a rise between 0.24 and 0.8 m by the year 2100 (THOMAS, 1985); and, others only 0.03 to 0.5 m by the year 2100 (LINGLE, 1985).

This paper attempts to open the dialogue about this very important and, according to the current publications, very contradictory material.

THE GREENHOUSE EFFECT

More than 99.98% of the energy involved in global exogenetic processes comes from the sun (RIABCHIKOV, 1976). It arrives in all wave-lengths, from ultraviolet to infrared, mobilizing the natural processes in the atmosphere, biosphere, and hydrosphere, even including several in the crustal lithosphere.

These processes transform the solar energy into heat and reradiate some of the infrared radiation to the atmosphere. Part of it is recycled in new exogenetic processes; another important part is released into outer space, and still another part is trapped in the atmosphere by aerosols and the molecules of some gases, such as H_2O, CO_2, methane and others. This heat remains in these molecules, increasing their kinetic energy. A growing concentration of these gases in the atmosphere, particularly CO_2, means an increasing amount of heat in the exogenetic global system. As is well known, this warming process is the famous greenhouse effect.

The CO_2 concentration in the atmosphere grew from less than 300 ppm (parts per million) since the beginning of this century, to nearly 340 ppm by 1980 (FLOHN, 1984). This generated widespread alarm concerning the possible warming of the atmosphere and the catastrophic consequences of that warming. This growth of CO_2 in the atmosphere coincided with the increasing use of fossil fuels. Thus, in an excessively simplistic cause/effect way, the idea was established that fossil fuel undoubtedly generated this condition (TITUS *et al.*, 1987), with the help of massive global deforestation (WOODELL *et al.*, 1983).

New scientific information weakens these arguments, NOVELLI *et al.* (1994) showed that atmospheric concentrations of CO (directly related to burning of fossil fuels) sampled in 27 localities around the world decreased at a yearly rate ranging between 6.1% (Northern Hemisphere) and 7.0% (Southern Hemisphere) from June 1991 to June 1993. These researchers considered that a possible chemical influence from the emissions of Pinatubo Volcano influenced this decrease. However, this volcano only erupted in June 1992 and the decrease in atmospheric CO began slowly in 1988 (Figure 2a in NOVELLI *et al.*, 1994).

The previous growth of atmospheric CO occurred at a yearly rate ranging between 1 and 2% (see Zander *et al.*, in NOVELLI *et al.*, 1994). In comparison, this current decrease is highly significant. More significant is its unknown origin. It invalidates the automatic and simplistic assumption that the burning of fossil fuels leads to the atmospheric CO growth, because during the last few years this combustion continues in a growing trend. In the same way, it invalidates the simplistic thesis that the extrapolation of the atmospheric CO_2 growth to the next 50 to 100 years will be at a similar rate to the use of fossil fuels.

Still there are insufficient data to understand the origin of the atmospheric CO and CO_2 oscillations. Perhaps there may exist an ocean/atmospheric exchange greater than that which is considered normal (FLOHN, 1984; BROECKER *et al.*, 1985; KERR, 1986; GONZALEZ and GALAN, 1990). In addition other processes, *i.e.* biogeochemical, the weathering of carbonate rocks (KASTING *et al.*, 1986; KUMP and GARRELS, 1986; BERNER, 1989) and the oxidation of organic matter in the soils, might play a more important part in the atmospheric behavior of CO_2 than previously suggested.

The global ocean contains around $1{,}370 \times 10^{15}$ metric tons of water (4.6 times larger than the whole biosphere, atmosphere and lithosphere). Its mean CO_2 concentration is 0.01% by weight, that is to say $1{,}370 \times 10^{11}$ tons; or 374×10^{11} tons of pure carbon. This amount is comparable to that of all the known deposits of fossil fuels on the earth (GONZALEZ and GALAN, 1990).

The models of global ocean/atmosphere interactions are still in their infancy (U.S. DEPARTMENT OF ENERGY, 1985). It is very possible that upwelling and downwelling dominate the ocean/atmosphere exchange of CO_2, controlling climatic change (FLOHN, 1984; BROECKER *et al.*, KERR, 1986).

In this sense, TAIRA (1986, 1987, 1988) showed that major Holocene volcanism and tectonism in the Northern Hemisphere climaxed during cold episodes. In contrast, however, he showed that major Holocene volcanism and tectonism in the South Hemisphere occurred during warm episodes. This researcher suggested a shift of the earth's gravity center, alternatively north and south, increasing the centrifugal forces in the involved hemisphere and leading to tectonic stress. In addition, he suggests a possibly important influence of the centrifugal forces on the ocean currents, leading to important changes in the global upwelling and downwelling. These changes would alter the CO_2 ratio between ocean and atmosphere, leading in turn to respective increases and decreases in their atmospheric concentration and in the nonanthropogenic greenhouse effect.

OTHER FACTORS AFFECTING ENVIRONMENTAL PROCESSES

There are other important factors interacting on secular environmental processes. Secular oscillation in the solar emission of energy has not been as widely considered as the greenhouse effect with reference to environmental trends. It is, however, a very important factor and should be carefully analyzed when making predictions of such trends into the next century. Secular oscillation is a key factor in important climatic episodes (SISCOE, 1978); for instance, the Medieval Climatic Optimum, the Medieval Ice Age and the last Little Ice Age, all during the present millennium. According to FAIRBRIDGE (1990), the tree rings of Sweden studied by BRIFFA and his co-workers pointed to natural environmental changes that were larger than those expected by the greenhouse effect during their lapse of growth. These changes coincide with episodes of special gravitational influences of the planets on the sun and on its energetic activity. A special gravitational episode began in 1990, with a 30 year duration and with episodes of high and low energetic emission. As FAIRBRIDGE said: "Let up hope the greenhouse will save us from the latter!"

In another way, GRIBBIN (1991) pointed out a correspondence between the duration of the Hale Hemicycle, generally known as the "sunspot cycle", and the climate. The mean amplitude of this so-called "cycle" is about 11 years, ranging from a maximum of 16 yr to a minimum of 7 yr, (in a major cycle of about 80/90 years). As FAIRBRIDGE (1990) and also GRIBBIN (1991) pointed out, there may possibly be a decrease of solar activity during the next decade, ". . . partially offsetting any rise in temperatures due to greenhouse effect."

THE ANTARCTIC AND SEA LEVEL

The above controversial data concerning the greenhouse effect and the inevitable global warming in the next century minimizes the possibility of littoral submergence by Antarctic meltwater. Littoral submergence would introduce the possibility of reduced energetic activity of the sun, perhaps leading to some episodes of global cooling, instead of a general global warming.

In addition, the new information also reduces the possibility of melting of the Antarctic ice sheets, as a "Damocles sword" on the ocean littoral. This approach would permit one to postulate several possible states of the Antarctic ice sheets during glacial and interglacial episodes. GONZALEZ (1988) indicates that Antarctic ice sheets could be in steady-state, without growth, during a glacial episode. BROECKER and DENTON (1989) point to evidence that Antarctic ice sheets would diminish during the late Pleistocene glacial maximum. Further, from the data shown by JACOBS (1992a,b), it is possible to suppose that Antarctic ice sheets grow during warm episodes.

These possibilities have not been considered in any past model of sea-level behavior. In addition, there is new data that cast new and serious doubts concerning these models. This new data indicates the possible existence of a large Arctic ice sheet during late Pleistocene glaciations (see HOLDEN, 1994). This ice sheet was perhaps as thick as 1,000 meters and extended from Canada to Norway. Doug MacAyeal, in HOLDEN (1994), remarked: "This isn't something that solves a problem, but rather inspires problems".

DISCUSSION

To forecast probable environmental trends of the South American mid-latitudinal environments and the Atlantic Coastline, it is necessary to consider the dynamics of the current and past periods (late Pleistocene and Holocene) and the general atmospheric circulation in these latitudes. Strong winds from west and southwest (Westerlies) occurred during cold episodes and strong winds from east and north-east (Easterlies) occurred during warm episodes (GONZALEZ, 1990). It would also be necessary to consider the theoretical trend towards a warm climate in the next century caused by the still controversial growth of the greenhouse effect.

Assuming that sea level would not be changing significantly as a result of significant warming, the most important element impacting the littoral would be the shift of South American high pressure cells to higher latitudes; this seems to have occurred during past warm episodes (CAVIEDES, 1972). That shift would lead to strong Easterlies at the mid-latitudes; in turn, it would generate possible changes in wave approach and littoral drift.

The current littoral drift in the Atlantic mid-latitudes is from south-to-north created by "traveller waves" from south Atlantic storms. A possible emplacement of high pressure cells at more southerly locations than today would impact on the littoral drift (GONZALEZ, 1994). Even with the possible growth of the "Easterlies", there could be a reverse of the littoral drift to north-to-south.

In any case, considering the difficulty of accepting a possible sea-level rise, the main factor affecting this coast would be sedimentary behavior. This behavior would be dominated by the new conditions of the general atmospheric circulation and by the crustal behavior in the main tectonic basins involved (GONZALEZ, 1994). In addition, on the main estuaries open to the east, there could be the possible development of a Bay-of-Fundy effect by the strongest Easterlies.

CONCLUSION

During the past decade, the available information on the CO_2 problem has been controversial (IDSO, 1982). It is possible that a duplication of the current concentration of CO_2 in the atmosphere will not significantly affect climate and sea level (LINGLE, 1985). Furthermore, one should not dismiss the possible impact of some unknown feed-back process of the CO_2 and the greenhouse effect on climate.

The information provided herein could perhaps be considered to indicate that a rise in sea-level will not occur. However, this information must be analyzed carefully eliminating the frequently postulated catastrophic assumption before a reasonably accurate future prediction can be formulated.

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