Creating the Nation's first BioPark

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Letter From the Desk of David Challinor
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The earth throughout its long history has been both warmer and colder than it is today. By studying ice cores and pollen grains found deep in bog cores, scientists can determine paleo-climate by mapping what trees grew where and when. In general, pollen grains are unique to tree species; therefore, if spruce/fir pollen grains are found in a core from a bog now surrounded by an oak/hickory forest, we can determine when tree species composition changed by the depth of the pollen grains in the bog. From this information past trends towards warmer or colder conditions in past millennia are plotted.

Paleoclimatologists have developed a climate sequence for the northern hemisphere going back almost 200,000 years. During this time the earth's temperature was, on average, considerably colder than it is today. We can only speculate on the causes of these temperature swings. Successive volcanic eruptions that hurl ejected tephra (laval dust) into the stratosphere might be one cause. If the dust was dense enough and remained at a critical altitude in the stratosphere, solar radiation could be reduced sufficiently to lower the earth's average temperature. This is but one of many natural phenomena that could account for the earth's temperature fluctuations.

Another such natural phenomenon is the presence or absence of sun spots, which may also cause a drop in global temperature. For example, during the Maunder Minimum or Little Ice Age, which coincided almost exactly with Louis XIV's reign in France (1643-1715), no sun spots were observed. Galileo's telescope (ca 1605) allowed astronomers to plot the movement of sun spots across the face of the sun as it rotates (once every 35 days at its poles and every 25 days at its equator). In the 1640's sun spots disappeared and were not seen again for roughly 70 years, during which interval Europe was especially cold. The Thames froze solid and Charles II held a huge Ice Fair on its surface the winter of 1683-84. Note too the number of skating scenes by the Dutch masters of this time. Today those canals freeze enough to skate on only at two- or three-year intervals. Scientists are still not clear on the relationship between solar flaring and global temperature, but they believe that the solar wind affects the earth's upper atmosphere enough to affect conditions on the earth's surface. Winters, however, seem to be getting warmer and the prediction that global temperature change is the principal environmental problem of the 1990's and beyond seems to becoming manifest.

Unlike past warming trends in the earth's atmosphere caused by natural phenomenon, the current one is almost certainly triggered by human activity, primarily the burning of fossil fuels, clearing of forests, and heavy use of nitrogen (N) fertilizer in farming. Such human action has increased the concentration of $CO_2$ and methane ($CH_4$) in the atmosphere by more than 25% and 100% respectively over the past 200 years. Annual increases are now running 0.4% for $CO_2$ and just under 1% for $CH_4$. Studies of air trapped in ice cores indicate that the percentage of these carbon gases remained relatively constant from the end of the Pleistocene (when the last ice age glaciers melted about 10,000 years ago) to the beginning of the industrial revolution in the early nineteenth century.

Not only has more $CO_2$ gas entered the atmosphere during this period, but nitrous oxide ($N_2O$), another greenhouse gas, has also increased dramatically! This gas originates as part of the earth's N cycle; it comprises roughly 80% of the air we breathe. But burning forests or crop residues, applying N fertilizer, and releasing raw sewerage into rivers and oceans all increase $N_2O$ release, which is now 50% more prevalent in our atmosphere than it was 50 years ago.

Also, there has been a 50% increase in the flow of sulphur (S) compounds aloft, again generated by human activities, especially as gaseous S from combustion of fossil fuels. Large areas of industrial activity emit roughly 70% of the total S in the air above them, mostly in the form of sulphur dioxide ($SO_2$) which, when exposed to water in the atmosphere, falls back to earth as acid rain.

Finally, sulphur emissions to the atmosphere have been shown to trigger significant changes in the concentration of cloud nuclei. Such changes have a potential impact on the optical properties of clouds, which in turn affect the physical climate below them.

Clearly we are fouling the air we breathe and assaulting the thin envelope of gases above, which protects life from dangerous ultraviolet radiation. This situation cannot continue without serious consequences for life on earth. Scientists' warnings have been met with skepticism by legislators, principally because evidence of global warming has been hard to confirm unequivocally. A few scientists have even challenged the warming evidence itself. Fortunately, such skeptics are becoming fewer and now there seems to be general agreement on climate warming even though the rate at which this is happening is still difficult to predict accurately.

Nonetheless, governments have taken action. The Montreal Protocol was upgraded in 1990 when 93 nations agreed to a rapid phasing out of CFC's, the release of which has been increasing faster than the release of $CO_2$. Molecule for molecule, CFC's produce 10,000 times the greenhouse effect of $CO_2$, depleting the ozone protecting us. Many nations have signed the Convention and their actions are one of the few success stories in the fight for better air. By the time you receive this letter, the last CFC's will have been produced in the United States. The original goal set in 1987 was to cut production in half by 2000, and production should cease globally by 2015. Not so encouraging is the effort to limit gasoline consumption for new cars. Any savings in $N_2O$ emissions due to more fuel-efficient auto engines has more than been lost by the proliferation of popular four-wheel drive station wagons and pickup trucks, which burn considerably more fuel per mile than small sedans. The federal abolition of speed limits will work against the attempt to cut back on emissions, and a long-term step towards nonpolluting cars received a setback when the auto manufacturers challenged the California directive that 3% of all new cars sold in that state would have to be nonpolluting (electric). California's current smog problem will only get worse. It will be interesting to see how much worse it must become before California's citizens accept constraints on their driving. My opinion is that smog must become <u>much</u> worse before real action is taken to curtail California driving and emissions and thus smog.

Humans cannot control volcanos or sun spot intensity, but we can curb man-induced harmful gas emissions to the atmosphere. There must be the political will to do so, but democracy as Americans practice it is not conducive to long-term solutions at the expense of short-term demands. I fear, therefore, that the drastic action needed to reverse the man-made attacks on the earth's atmosphere will not be taken, and within the next decade we can expect warmer winters (summer temperatures will change less drastically). Nights should be warmer, too. Climate models now suggest that droughts and forest fires and/or floods and storms will be more severe. We may have already experienced some manifestation of this prediction. Our responsibility is to reduce the climate change caused by human activity and let the globe return to its natural cycle of long-term change.

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