

## RESPONSES TO QUESTIONS ABOUT CLIMATE CHANGE

Last week, the three of us, an oceanographer, an economist, and a meteorologist, provided testimony at a hearing of the Maryland General Assembly on the science behind the goals for reducing greenhouse gas emissions included in the Global Warming Solutions bill. We thought it would be helpful for us to summarize for the broader public our answers to the following questions we were asked

*Aren't there large numbers of scientists who disagree that global warming is occurring or poses a serious risk?* Not really, the overwhelming views of bona fide climate and environmental scientists are consistent with the reports of the Nobel Prize-winning Intergovernmental Panel on Climate Change (IPCC). The IPCC concluded that evidence of global warming is "unequivocal" and that increases in temperature are predominantly due to increases in atmospheric greenhouse gases resulting from human emissions.

The IPCC projected with high confidence that unless greenhouse gas concentrations are stabilized, warming will continue, causing increased heat waves, heavy rainfall in some areas and droughts in others, and much greater rates of sea level rise, with profound consequences for biodiversity, water and food supplies, and coastal zones.

*Hasn't the Earth, in fact, been experiencing a recent global cooling trend despite the increase of greenhouse gases in the atmosphere?* Following the record high global temperatures of 1998 temperatures dropped for a few years and this was touted by skeptics as evidence against human-induced global warming. But global warming does not mean that each year will be warmer than the previous year.

The same factors that have always caused year-to-year variations are still at play, particularly the alternative warming and cooling associated with the El Niño conditions in the Pacific Ocean. One has to examine the unequivocal warming trend over longer periods. The fact remains that twelve of the last 13 years rank among the 13 warmest years recorded since regular temperature readings began in 1850.

*Hasn't the Earth experienced dramatic warming and cooling periods in the past?* Yes, of course, it has, for example cooling periods that allowed massive glaciers to grow and warming periods during which most of these glaciers melted. These cycles are caused by the slow changes of the Earth's orbit and tilt, which change the seasonal cycle of energy received from the sun. Those small changes are magnified by feedbacks in the system, including the release of greenhouse gases from the warming ocean. The differences in the present situation are that (1) this warming is being driven mainly by increases in greenhouse gases; (2) unlike previous warming periods this one is caused by humans; (2) we are already in a very warm, interglacial period; and (3) potential additional warming just in the 21<sup>st</sup> century will take us to temperatures not experienced for more than 3 million years.

*Couldn't the observed global warming result from of increased sunspot activity rather than an increase in greenhouse gases?* Variations in solar activity do affect climate and a general increase in activity probably contributed to warming during the 20<sup>th</sup> century, but the IPCC estimated this effect to be about 7% of the net effect of human activities on warming.

*Doesn't the exhaling of carbon dioxide by the ever-increasing population of humans contribute to its increase in the atmosphere?* Despite our large numbers, human exhalation of carbon dioxide is just a fraction of a percent of the total respiration of all animals, plants and microbes on earth. Furthermore,

it is part of a closed system—the amount of carbon dioxide we exhale cannot be greater than the carbon we put into our bodies by eating plants, which take their carbon from the atmosphere via photosynthesis, or by eating animals that eat plants.

Indirectly, though, the increase in the human population and, particularly, the increased per-capita consumption of resources is the primary driver of increased greenhouse gas concentrations. Energy and materials consumed by this expanding population result in large quantities of carbon dioxide released into the atmosphere by burning of fossil fuels long buried in the earth or by clearing forests and disturbing soils.

*How do we know the present temperature is optimal? Wouldn't a warmer world be better?* It depends, of course, on where you live: agricultural might certainly be easier in Canada in a warmer world. But analysis of the economic effects of a warmer world (which would also have very different patterns of wet and dry regions) generally show that the costs outweigh the benefits.

The rapidity of climate change also poses problems. If California loses a large part of its water resource as snowfall decreases in the Sierra Nevada mountains, where will we grow the nation's produce? If millions of people farming the Sahel must leave because of drought, where will they live? In addition, we have to think not only of human troubles, but of the world's natural systems that support us, and which can't as easily pick up and move.

*Why are such dramatic reductions in emissions required?* The IPCC demonstrated that reductions in global greenhouse gas emissions of 50-85% would be required by 2050 in order to avoid raising global temperatures to the point where large number of species would become extinct, economic impacts would be severely negative, and irreversible changes such as melting of the polar ice sheets would be initiated.

To have any chance of achieving such large reductions, we must start now, first to eliminate the growth in our greenhouse gas emissions and then to return emissions to 1990 levels by 2020. For Maryland, that would require at least a 25% reduction from our 2006 emission levels. Fortunately, this could be done using conservation measures and existing technologies, while the deeper reductions after 2020 will require development and refinement of new technologies.

*But wouldn't reductions of emissions in Maryland alone have an insignificant effect on global warming?* Of course, Maryland's emissions are only 0.3% of the world total. However, on a per capita basis we emit twice the greenhouse gases than the average European and four times the average Chinese. Unless technologically advanced societies take action to slow global warming there is little chance that developing nations will. Further, states that move fast will have the advantages of developing green industries whose products the world will need as we all move to limit emissions. That's why 25 other states have developed or are developing climate action plans.

*Wouldn't we drive up energy prices and hurt the economy and consumers, particularly small businesses and households with low income, by aggressive efforts to reduce greenhouse gas emissions?* The extent to which energy prices are affected by policy depends on the extent to which the energy sector remains dependent on carbon-based sources. Efficiency improvements and transition towards renewable energy can cut cost, lower energy bills, and reduce susceptibility to shocks that may come from international energy markets and extreme weather events

Without efforts to wean the economy from carbon-based fuels, the poor, the elderly, and small businesses will continue to feel the impacts from rising fuel shortages and from climate change most. For example, during heat waves, the elderly are disproportionately hit, as are the poor. During power outages and water restriction periods, small farms and small businesses can lose a significant share of their output, and thus lose in the market place, compared to larger, more diversified, better capitalized operations.

Investing in efficiency and alternative energy will be more economical than continuing to invest in technologies of which we know that they are not sustainable, provide new business opportunities, and secure our standard of living.

The scientific rationale for addressing climate change now has grown increasingly strong. While there may be legitimate concerns about how Maryland's Global Warming Solutions act is crafted, uncertainty about the reality of climate change or the seriousness of its consequences is not among them.

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