

The influence of climate change at high altitude and high latitude

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The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) has just published the current state of understanding of the Earth's climate system and the influence of human activities; the vulnerability of ecological systems and socio-economic sectors to climate change; and approaches to mitigate climate change by reducing emissions and enhancing sinks. The IPCC Reports were approved at a series of plenary meetings in 2007 (cf. www.ipcc.ch). Additionally, a special Synthesis Report, which addresses a series of policy-relevant questions, has been published.

The Earth's climate has been relatively stable since the last ice age. During this time modern society has evolved, and, in many cases, successfully adapted to the prevailing local climate and its natural variability. However, the Earth's climate is now changing. The Earth's surface temperature during the latest 100 years is clearly warmer than any other century during the last thousand years. In addition, there is evidence that precipitation patterns are changing, that sea level is increasing, that glaciers are retreating world-wide, that Arctic sea ice is thinning, and that the incidence of extreme weather events is increasing in some parts of the world.

The atmospheric concentrations of greenhouse gases have increased because of human activities, primarily due to the combustion of fossil fuels (coal, oil and gas), deforestation and agricultural practices since the beginning of the pre-industrial era. The concentrations are higher now than at any time during the last 650,000 years, the period for which there are reliable ice-core data. In addition, the combustion of fossil fuels has also caused the atmospheric concentrations of sulphate aerosols to have increased. Greenhouse gases tend to warm the atmosphere and, in some regions, primarily in the Northern Hemisphere, aerosols tend to cool the atmosphere.

The weight of scientific evidence suggests that the observed changes in the Earth's climate are, at least in part, due to human activities. Climate models that take into account the observed increases in the atmospheric concentrations of greenhouse gases, sulphate aerosols and the observed decrease in ozone in the lower stratosphere, in conjunction with natural changes in volcanic activity and in solar activity, simulate the observed changes in annual mean global surface temperature quite well. This, and our basic scientific understanding of the greenhouse effect, suggests that human activities are implicated in the observed changes in the Earth's climate.

Future emissions of greenhouse gases and sulphur dioxide are sensitive to the evolution of governance structures world-wide, changes in population and economic growth, the rate of diffusion of new technologies into the market place, energy production and consumption patterns, land-use practices, energy intensity, and the price and availability of energy. While different development paths can result in quite different greenhouse gas emissions, most projections suggest that greenhouse gas concentrations will increase

significantly during the next century in the absence of policies specifically designed to address the issue of climate change. IPCC Special Report on Emission Scenarios (SRES) reported that the atmospheric concentration of carbon dioxide would increase from today's level of about 365 ppmv (parts per million by volume) to between about 550 and 1000 ppmv by 2100.

Based on the range of climate sensitivities and the plausible ranges of greenhouse gas and sulphur dioxide emissions reported in the SRES, a number of climate models project that the global mean surface temperature would increase by about 1 to 6°C by 2100. The high estimates of projected warming arise because the lower projected emissions of sulphur dioxide result in less offset of the warming effect of the greenhouse gases. These projected global-average temperature changes would be greater than recent natural fluctuations and would also occur at a rate significantly faster than observed changes over the last 10,000 years.

Temperature changes are expected to differ by region with high latitudes projected to warm more than the global average, and land areas are projected to warm more than the oceans, and the northern hemisphere is projected to warm more than the southern hemisphere. However, the reliability of regional scale predictions is not regarded as large as global ones.

The majority of scientific experts believe that human-induced climate change is inevitable. The question is not whether climate will change in response to human activities, but rather how much, how fast and where. It is also clear that climate change will, in many parts of the world, adversely affect socio-economic sectors, with developing countries being the most vulnerable.

Decision-makers should realise that once carbon dioxide, the major anthropogenic greenhouse gas, is emitted into the atmosphere, it stays there for more than a century. This means that if policy formulation waits until all scientific uncertainties are resolved, and carbon dioxide and other greenhouse gases are responsible for changing the Earth's climate as projected by all climate models, the time to reverse the human-induced changes in climate and the resulting environmental damages, would not be years or decades, but centuries to millennia, even if all emissions of greenhouse gases were terminated, which is clearly not practical.

If actions are not taken to reduce the projected increase in greenhouse gas emissions, the Earth's climate is projected to change at a rate unprecedented in the last 10,000 years with adverse consequences for society, undermining the very foundation of sustainable development.