

**Answers to the questions raised by A.N. Illarionov during his talk
«Anthropogenic Factors in Global Warming: Some Questions» at the World
Climate Change Conference 2003 prepared from material of the IPCC Third
Assessment Report (TAR) by attending scientists¹ and presented to the
conference by Bert Bolin, chair emeritus of IPCC:**

- 1) *What was the actual level of Carbon Dioxide concentration in the atmosphere in 1980-2000?*

Atmospheric CO₂ concentrations rose from 338 ppm in 1980 to 368 ppm in 2000. Values for the period 1980 to 2000² are based only on direct measurements of air samples, whereas the data before 1980 are from direct measurements as well as proxy data, i.e. ice core and firn data.

- *) *The forecast is alarming. What is the basis for it?*

The projections for the temperature rise for the 21st century as shown in Fig. 9-1b³ are generated by sophisticated models and are based on a well defined set of socio-economic assumptions about the development of technology and society⁴. It is to be noted, that the latter assumptions contain no explicit measures such as the Kyoto Protocol to limit the anthropogenic emissions of green house gases.

- 2) *What are the parameters of the model of temperature anomalies? And how were they derived? Why are there such fluctuations in anthropogenic forcing observations?*

The figures⁵ refer to temperature changes calculated by complex climate models. Such models make use of many parameters. The models are able to reproduce the manifestation of the current climate and are validated as described and summarized in TAR (2001). Fig. 2-4a) shows the climate that is computed if only natural effects such as solar variation and volcanic eruptions are included, but ignoring any effects from anthropogenic emissions. Fig. 2-4b) shows the climate that is computed if only anthropogenic GHG and aerosol emissions are included, but ignoring any natural effects. Fig. 2-4c) shows the climate if natural and anthropogenic effects are both included. Since only the last figure succeeds in fitting the actual observations, human induced increases in atmospheric GHG concentrations must be included in an explanation of the observed warming. These findings were important to warrant the following carefully derived statement: "There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities" (SYR TAR, 2001)⁶.

- 3) *Can we explain the temperature variation by CO₂ concentration in the atmosphere in the past 1000 years?⁷*

Atmospheric concentrations of GHGs such as CO₂ and CH₄ remained relatively constant during preindustrial times⁸. The temperature changes during the preindustrial period are due

¹ Among those scientists were Bert Bolin (Sweden), Andreas Fischlin (Switzerland), John M.R. Stone (Canada), Michel Petit (France), David Warrilow (UK), Jean-Pascal van Ypersele (Belgium), Michael Grubb (UK) and numerous others

² Fig. 9-1a SYR TAR, 2001 resp. WGI TAR SPM, 2001 Figs. 2a & 5b

³ SYR TAR, 2001, p. 140 resp. WGI TAR SPM, 2001 Figs. 1b & 5d

⁴ SR ES, 2000

⁵ SYR TAR, 2001 Fig. 2-4, p.50 resp. WGI TAR, 2001 Fig. 12-7

⁶ p.51 and WGI SPM TAR, p. 5

⁷ Speaker highlights six periods of nearly linear warming (6 regression lines) since year 1000 and emphasizes that those periods do not correlate with any significant changes in atmospheric CO₂ concentrations.

⁸ SYR TAR, 2001 Figs. 2-3, p. 49 and Fig. 9-1a, p. 138

to natural effects such as solar variations, volcanic eruptions, and random climate variability. The uncertainty in the data increases the further back in time we go, as earlier data are based on indirect measurements such as widths of tree rings. Direct temperature measurements date only from around 1840. The six warming periods shown on the graph⁹ never exceeded a change of $\sim 0.3^{\circ}\text{C}$ and never extended beyond half of a century. On the other hand the increase during the last century is $\sim 0.6^{\circ}\text{C}$ and has lasted for most of the 20th century. As has been pointed out above (Q2), the course of temperature during the 2nd half of the 20th century can not be explained unless the effects of anthropogenic GHGs emissions are included as well¹⁰.

- 4) *Can we explain the temperature variation by CO₂ concentration in the atmosphere in the past 140 years?*¹¹

Yes, given we include other effects as well. The response of the climate system to the smooth increase in CO₂ is a slow and considerably delayed increase in the global mean temperature. The observed variations during the last 140 years is not only brought about by anthropogenic emissions, but also by natural effects such as changes in the solar radiation, volcanic eruptions, and natural random variability (see also answers to Q2).

- 5) *Can we explain the temperature variation by CO₂ emissions of anthropogenic character?*

Yes, given we include natural effects as well. It is crucial to understand the inertia of the climate system, i.e. emissions are not reflected instantly in changes of the temperature. Thus we can expect further changes from emissions we have already made. The temperature variation as measured in the last 140 years is a combination of the influence of several factors, both natural and anthropogenic (see also answers to Q2).

- 6) *Other factors explaining temperature variation? Volcanic activity? Whether to include into the model?*

Yes, natural effects such as volcanic eruptions have, are, and will be of importance for any explanation on climate variation. They have been considered by the scientific community and were thus included in the analysis of past temperature anomalies as reported in the TAR. Moreover, this analysis not only included volcanic eruptions, but also those from changing solar activity in addition to the human-induced effects from anthropogenic emissions of CO₂, CH₄, and sulfate aerosols¹².

- 7) *Other factors explaining temperature variation? Long-term cycles? Whether to include into the model?*

The temperature variations over thousands of years are primarily the result of changes in the Earth's orbit and other natural factors like solar activity. But, these changes do not explain the recently observed, rapid warming and are expected to be insignificant in the next several thousand years.

- 8) *Is the modern "global warming" unique in the last 5'000 years?*

Yes. The extent, magnitude, and rate of change as observed during the last 140 years appears

⁹ see previous footnote

¹⁰ conf. TAR, 2001

¹¹ The speaker emphasizes decrease in temperature during 60's and 70's, and stresses the point that these decreases do not correspond with the concurrent increase in CO₂ emissions.

¹² Incidentally, climate models can now reproduce the climatic effects from the Pinatubo eruption in 1991, which strengthens their credibility.

to be unprecedented. The figure¹³ shows data on isotope ratios, which require further computations to derive temperature estimates. Moreover, they are from Greenland and are not representative for the global picture. In this context it is worth-noting that "the projected rate of warming is very likely to be without precedent during at least the last 10'000 years" (SYR TAR, 2001)¹⁴.

- 9) *Can we achieve the Kyoto protocol targets, providing the share of the Annex 1 countries' (include. Russia, not include. USA and Australia) in the world's CO2 emissions is rapidly falling?*¹⁵¹⁶

Yes, given the most recent emissions¹⁷, this appears still to be possible. With or without the US and Australia the declining share of industrialized countries in global emissions is not relevant for complying with the targets of the 1st commitment period because these are defined only for industrialized countries¹⁸. Longer-term global reductions would of course require additional countries to be included for subsequent commitment periods.

- 10) *And finally: How much does it cost?*

This depends on the level of stabilization aimed for and must be seen relative to the size of the concurrent GDP¹⁹. For instance, stabilization at 550ppm²⁰ reduces global GDP in 2050 for all but one scenario by 1% or less, compared to the case without any constraint²¹. Added up across the whole century this represents many trillions of dollars, but has negligible impacts on the projected economic growth²².

¹³ Grootes *et al.*, 1993

¹⁴ Q 3.1 p. 61

¹⁵ To answer the question, we reformulated it in the following way: *Can we achieve the Kyoto protocol targets while Annex 1 countries' (including Russia, but not US and Australia) aggregated emissions' share is rapidly falling?*

¹⁶ The speaker draws attention to the fact that the aggregated CO₂ emissions stabilize or decline anyway, i.e. without mitigation, while only a limited number of Parties responsible for only ~30% of total global emissions have reduction commitments.

¹⁷ By 2000 alone for CO₂ the Annex I emissions were by at least 5% below the base year levels and without US and Australia by more than 15%.

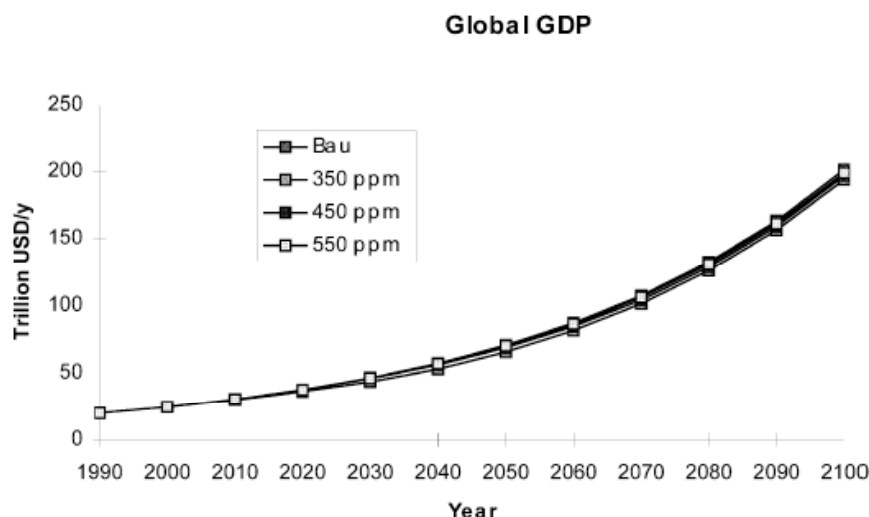
¹⁸ The aggregated Kyoto Protocol target is 5% reduction relative to base year (typically 1990) emission levels as described in Art. 3.1.

¹⁹ compare Fig. 7-3, p. 119 with Fig. 7-4, p. 120 from SYR TAR, 2001

²⁰ Stabilization at 550 ppm CO₂ would allow cumulative global emissions of around 1'000 Gt C total over 1990-2100. This averages about 9 Gt C/a, 50% above current global fossil fuel emissions, and about 100 times the amount of carbon in Russia's proven petroleum reserves.

²¹ WGIII TAR, 2001 sections 2.5.2, 8.4.1, 8.4.3 & 10.4.6; see also Fig. 8-18

²² Azar, C. & Schneider, S., 2002. Ecological Economics.



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