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Interactive comment on "Greenhouse effect dependence on atmospheric concentrations of greenhouse substances and the nature of climate stability on Earth" *by* V. G. Gorshkov and A. M. Makarieva

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In our Final Response we would like to comment very briefly on the current trends in global change studies concerned with possible consequences of the projected global warming. It is the possibility of formulating a different point of view on these problems at an open scientific forum that encouraged us to submitting our paper (Gorshkov and Makarieva, 2002) to ACPD.

On Earth the major greenhouse substance (water) is characterised by a huge value of latent heat of evaporation. This means that, if the planet has an extensive liquid hydrosphere, the planetary greenhouse effect is strongly dependent on surface temperature via a positive feedback. It is clear therefore that the potential (Liapunov) func-

tion describing stability of surface temperature on Earth cannot have a form of a flat plateau, where any stationary temperature values are possible. As we showed in our work (Gorshkov and Makarieva, 2002) the stationary value of the modern favourable for life surface temperature is physically unstable. The corresponding potential function has two steep slopes towards two stable states of climate (at very high and very low temperatures) both of which are life-incompatible.

The two stable life-incompatible minima of the potential function have a clear physical meaning, corresponding to the solid phase of the major greenhouse substance (complete glaciation of the planet) and its gaseous phase (complete evaporation of the hydrosphere). In both state neither albedo, nor the greenhouse effect depend on surface temperature. The two potential minima can be continuously connected via one unstable maximum, which may fall on the intermediate regions of favourable for life temperatures. There are no other physically meaningful extrema of the potential function.

At present, numerous attempts are undertaken to forecast regional and global characteristics of a hypothetical climate corresponding to global warming caused by a given amount of additional atmospheric CO_2 (e.g. CO_2 doubling). We argue that results thus obtained are hardly reliable, as far as the proposed states of climate with several degrees global warming cannot be stationary, representing intermediate stages of a rapid transition of climate towards one of the two life-incompatible states. Studies forecasting and evaluating future changes of climatic zones, rise of sea level, changes in the biological communities induced by climate change etc. do not take into account the character of physical instability of the global mean surface temperature. Such studies implicitly assume the existence of the above discussed plateau of the potential function, which has been postulated by the contemporary global change science without any extensive theoretical investigations.

Mean global surface temperature of the planet is determined by the amount of absorbed solar radiation and magnitude of the greenhouse effect. Various physical ter-

ACPD

2, S236–S239, 2002

restrial and cosmic forcings could have driven the mean global surface temperature beyond the life-compatible limits over geologically short time periods. Meanwhile the existence of life on Earth represents a unambiguous testimony of the fact that the mean global surface temperature has remained within the rather narrow life-compatible limits during the documented period of more than 3.8 billion years.

The only available explanation of such a stability of favourable for life temperatures is the maintenance of certain non-random concentrations of major environmental constituents, in particular, atmospheric water vapour, clouds and CO_2 that determine the planetary greenhouse effect. Changes in the values of the absorbed solar radiation and greenhouse effect should be internally correlated and non-arbitrary, compensating for random changes of the mean global surface temperature. Physical processes on the Earth's surface and in the outer space do not contain information about the value of the optimal for life temperature, neither about intervals of temperature changes tolerated by life. Thus, physical processes cannot control the life-compatible global mean surface temperature on Earth.

Control of the life-compatible value of the global mean surface temperature can be performed by life itself, i.e. by the global biota, which comprises natural, undisturbed by humans biological communities forming a continuous cover on the planet's surface. This means that environmental concentrations of life-important substances are not arbitrary, but are formed and maintained by the Earth's biota at the optimal for life values. Values of biotically formed concentrations of atmospheric water vapour, cloudiness and CO_2 determine the surface temperature on Earth and ensure its stability. Such a control can be called biotic regulation of the environment and climate.

It is clear that the biotic regulation of the environment should have formed and perfected during billions of years of natural biological evolution. Artificial sorts of plants and breeds of animals recently selected by man, as well as all types of artificial or intensively exploited biosystems (arable lands, pastures, maricultures, managed forests, meliorated bogs etc.) are deprived of information necessary for performing the biotic

ACPD

2, S236–S239, 2002

control of the environment. Technological means of the modern civilisation are also inadequate for the task of global environmental control. This conclusion follows from the analysis of information fluxes processed by the global biota, which exceed the information processing capacity of the civilisation by 20 orders of magnitude (Gorshkov et al., 2000).

Thus, the only way to conserve stability of favourable for life climatic characteristics on a global scale is to ensure functioning of natural, undisturbed by humans natural biotic communities over globally significant territories. It follows that the current attitudes of the humanity towards natural biota should be seriously reconsidered, starting with urgent changes of current policies of forest exploitation and cultivation of biological resources of the world ocean.

References

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