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First shots of the climate revolution: An untold story

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This is an account of the history of the "climate revolution of the eighties", focusing on early discussions and, at times, fierce disputes about what's wrong with Planet Earth and why, and what to do about it through coordinated research.

The paper describes the genesis and initial planning of the Global Change program within the International Council of Scientific Unions, and the early split of participating scientists into two camps: one emphasizing the need for a truly global, widely interdisciplinary and basic-science oriented approach that views the Earth system as one single whole of strongly interacting parts; the other camp defending a much more restricted approach by focusing exclusively on that which has greatest and most immediate impact on society.

As a spin-off from the defeat of the "globalists" came the generation of yet another, ultimately international (and politically far less contested) program, centered on what today is called Space Weather—the study of solar-variability- and human-induced changes in the space environment of Earth, and the ensuing effects on technological and human systems in space, as well as the possible physical downward actions of these space perturbations on our more immediate environment of air, water, land and biota.

KEYWORDS

climate change, history, space weather, earth system, initial planning

Part I: Weather and climate on earth

After a 20-years lull, even a slight decrease, before 1975, the global temperature started rising again with gusto in correlation with the unrelenting increase of atmospheric CO_2 concentration. In the early eighties, concerned scientists started asking the question: If this global warming keeps going on at this rate, what will happen with the world food supply in the longer-term future?

NASA was finding itself under increasing pressure from politicians to do something "of more direct relevance" to voters than landing astronauts on the Moon or building a futuristic space station. At the same time, science in general was feeling the pressure from an increasingly powerful worldwide environmental movement to do something about this global warming threat. So, NASA decided to develop a program that it called Global Habitability (Tilford, 1984). Unfortunately, it was poorly designed from the scientific

FIGURE 1
Cover of the first edition of the book (Malone and Roederer, 1985) with all contributions to the 1984 Ottawa Symposium on the IGBP. The picture of the eruption of Alaska's St. Augustine volcano was chosen on purpose to emphasize the original global interdisciplinary character envisaged for the original proposal.

point of view and did not recognize the need for international scientific cooperation, essential for the success of any such an endeavor.

Scientists of the United States Academy of Sciences/National Research Council (NAS) became quite alarmed and, under the leadership of Herbert Friedman, co-chair of its Commission on Physical Sciences, established a study group which met in summer 1983 in Woods Hole, MA, to craft the proposal for an international cooperative program to be carried out under the leadership of the International Council of Scientific Unions (ICSU) in similar fashion as the tremendously successful International Geophysical Year (IGY; Korsmo, 2007) 30 years earlier.

The President of NAS, Frank Press, took personal interest in this project, and participated in the Woods Hole study. The final product was the proposal for an International Geosphere-Biosphere Program (IGBP) (Friedman et al., 1983). The Foreign Secretary of the NAS (Thomas Malone) and the Foreign Secretary of the American Geophysical Union (me) were designated to act as the initial coordinators of this US initiative. Because of a sudden illness of Tom Malone, I was designated to formally present the Woods Hole study report to the ICSU Council meeting in Warsaw a few weeks after the Woods Hole study.

In this proposal, the goal of the IGBP was defined as:

> "*…to describe and understand the interactive physical, chemical and biological processes that regulate the total Earth System, the unique environment that it provides for life, the changes that are occurring in this system, and the manner in which they are influenced by human activity.*"

ICSU approved the proposal and asked Tom Malone and me to lead a 2-year ground-laying study that included the organization of an international, truly interdisciplinary symposium, which took place in Ottawa in September 1984 and was a resounding success. Individual presentations were published speedily in book form (Figure 1; in Malone and Roederer, 1985).

A Planning Group was established by ICSU (Bolin et al., 1986), consisting of five Working Groups: WG1 Terrestrial Ecosystems and Atmospheric Interactions; WG2 Marine Ecosystems and Atmospheric Interactions; WG3 Geological Processes, Past, and Present; WG4 Upper Atmosphere and Near-Space Environment; and WG5 Remote Sensing. These groups worked diligently between the 1984 symposium and the ICSU 1986 General Assembly in Berne, Switzerland. Also, during that time, Malone and I realized that the Peoples Republic of China (PRC), so important for a future IGBP from the environmental point of view, seemed not yet fully integrated in the ICSU family. With the sponsorship of the Ford Foundation we organized a small delegation which visited the PRC in April 1984 to meet with authorities of the Chinese Academy of Science and Technology (CAST).

And during all this time a monumental fight had broken out—between the scientists themselves! There were two mutually warring factions worldwide.

One faction was comprised mainly of broad-minded *geophysicists* with expertise in relevant fundamental physical-chemical-biological processes relevant to planet Earth, who were fully aware of the immense complexities (Waldrop, 1984) and inherent unpredictability of this "terrestrial machine," in which "nothing was proportional to anything." Many were already aware of the new mathematical field of "Catastrophe Theory" (later called Complexity Theory). This group was also aware of how difficult it was to communicate such complexities to the lay public and to convey the lurking long-term danger to impatient, scientifically naïve politicians. At this early stage already, this group called the attention to the possibility of a much faster increase of the frequency of extreme events (not yet calculable in climate models of the time), than the predicted rise of global temperature.

The other faction included mainly traditional synoptic meteorologists, experts in weather and climate forecasting, and in crafting the emerging, still highly simplified and

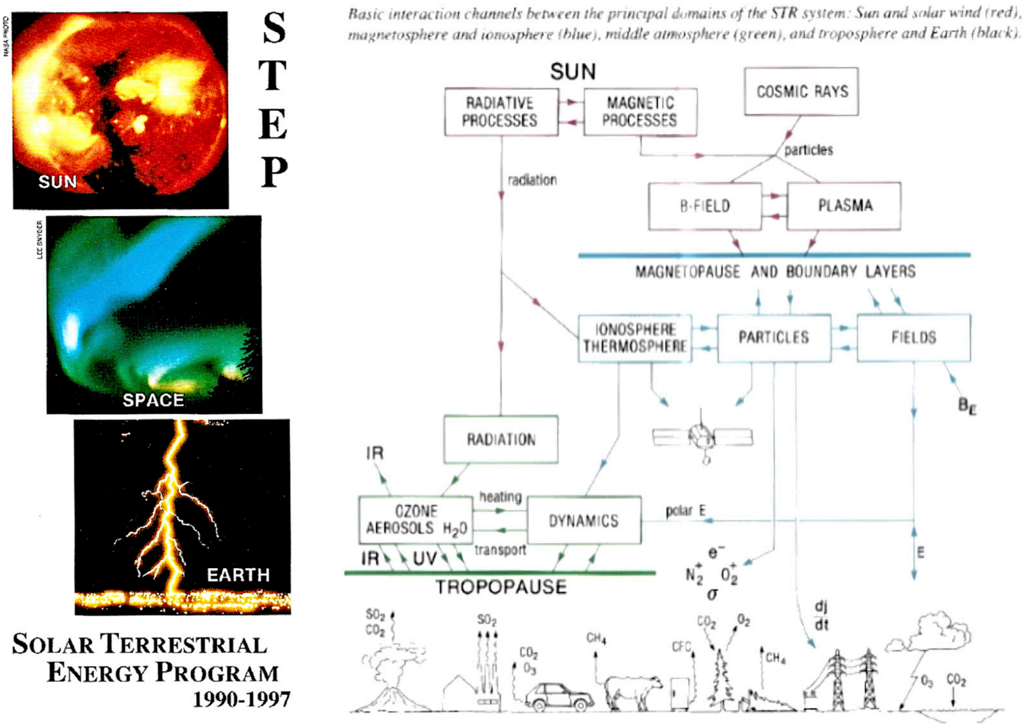

FIGURE 2
Brochure for the ICSU international Solar-Terrestrial Energy Program 1990–1997 (STEP), showing relevant domains and processes in the solar-terrestrial domain, with a sketch of the perturbations determining the "climate and weather in space" and its coupling to the Earth.

coarse-grained computer models. They were joined by environmental biologists, experts in marine, riparian and land ecological systems. All were well versed in relevant economic, hence political impacts of their profession. Environmentalists, a majority of whom were young enthusiasts not specifically trained in science, tended to allay themselves with this second group.

The first group viewed IGBP more as an intellectual challenge of *basic science*; their opponents instead considered it *applied* science focusing on problems of socio-economic impact. The all-encompassing target of the first group was the study of *Global Change* of the *total* earth system including the "new" regions of near-earth space populated by crucial technological systems (and, occasionally, people), whereas the target of the second group was *Global Warming* of the troposphere and its effects on the biosphere, including the anthroposphere.

ICSU had placed the IGBP planning activities under the general direction of the late Swedish meteorologist Bert Bolin who, with manners I have never witnessed in 27 years of participation in international scientific committees, tried to vociferously silence anyone who disagreed with his personal views of the IGBP. In Berne the ICSU formally launched the IGBP (Roederer, 1986a). The basic tenets of the IGBP shown above were preserved, but then came a severe blow to the original concept. Bolin's faction managed to include in the ground-laying document a conditional clause:

> "*Priority in the IGBP will fall on those areas that deal with key interactions and significant change, that most affect the biosphere, that are most susceptible to human perturbations, and that will most likely lead to practical predictive capability.*"

As a result, the entire subject of Working Group 4, near-space and its solar-caused perturbations, was thrown out of IGBP—including the WG itself. Despite having been the chairman of that group, miraculously I still remained on the IGBP Committee. I found it necessary to defend our Working Group's proposals and approach to the IGBP, and published some related articles (Roederer, 1986b, Roederer, 1987). This warfare also propagated right into the US Academy of Sciences, and Herb Friedman, a very mild-mannered person, bitterly complained and withdrew from direct personal involvement in this program, which now was taken over by several meteorologists, atmospheric scientists and environmental biologists who conducted another Woods Hole study to craft a plan for the US contribution to the IGBP (Eddy et al., 1986).

My good friend and colleague Valeria Troitskaya, representing the Soviet Academy of Sciences, and I were sort of standard-bearers of the "opposition" in the ICSU IGBP Committee until the ICSU meeting in Lisbon in 1989. My parting shots were given on the floor in a debate during the meeting (Roederer, 1989):

> "*What would the reaction of impatient politicians be if in a few years' time scientists came to the conclusion that global predictability of a chaotic, turbulent system like the atmosphere is basically impossible on the decadal timescale envisaged? . . . What if the real perturbations caused by greenhouse gas increases manifest themselves first on a much smaller spatial scale, say, as increases in regional variability and turbulence, which are not treatable in any of the current supercomputer global circulation models?*"

That was said in 1989 but, I submit, is still valid today. The rest is history. In 1988 the IGBP Committee had entered in negotiations with the intergovernmental World Meteorological Organization (WMO), and the Intergovernmental Panel on Climate Change (IPCC) was created, headed by—of course—Bert Bolin. It shared the no doubt well-deserved 2007 Nobel *Peace* Prize with former US Vice President Al Gore.

Part II: Weather and climate in space

Have the fields of geoscience tossed out of the IGBP in 1986 suffered? Not at all. One night even argue that this turned out beneficial for space physics! In the late eighties, under the initiative of Donald J. Williams the *international Solar-Terrestrial Energy Program* (STEP—Figure 2) got underway, organized by the ICSU Scientific Committee on Solar-Terrestrial Physics (SCOSTEP). It was based on the original vision of IGBP Working Group 4, and can be summarized as shown in the diagram of Figure 2. In this brochure one can read, for the first time in official print, the expression "*climate and weather in space*."

At the national level in the United States, two initiatives were launched that also developed a few years later into international cooperative programs. Already before the ICSU Assembly in Berne, the brand-new US Arctic Research Commission (ARC), of which I was the Vice Chairman at that time, adopted the original "Earth Systems" approach as one of the *Arctic Research Priorities* (Roederer, 1986c). It should be noted that this was a logical step: near-earth space indeed has its most significant and active coupling with the upper atmosphere in the polar cap regions. In addition, the first steps were taken in 1987 to establish an international Arctic Committee (now the Arctic Council; https://www.arctic-council.org), and on 1 October 1987, Soviet Union President Mikhail Gorbachev opened the vast Soviet Arctic to international research (Roederer, 1988b) calling the community to an international conference in Leningrad. In that conference, which took place December 12–15, 1988, the IGBP program played a fundamental role, but *with* a prominent place for upper atmospheric and near-earth space research, as originally envisaged by IGBP WG4.

The other development was not restricted to Arctic science. As a matter of fact, it led to an enduring world-wide program of basic and applied research in space physics. This story begins right after the 1986 ICSU Assembly in Berne. I had returned home to Alaska deeply concerned about possible consequences of the assault on near-earth space science prior to and during the ICSU meeting, and felt the obligation of doing something at the national level. Taking shameful advantage of now being the Chairman of ARC (a presidential commission with the Director of the NSF an ex-officio member), during its meeting coffee breaks I held conversations with NSF director Erich Bloch, filling him in on this problem. He encouraged me to write him a letter, of course not as Chairman of ARC but as director of the Geophysical Institute of the University of Alaska.

The letter, dated 6 August 1986, begins by defining the problem as: "how to place solar-terrestrial research (STR), a relatively new interdisciplinary field, into the framework of a funding agency such as the NSF." It then points out that STR has now entered a new phase of trying to understand how the solar-terrestrial system works as a single whole, and pointing out that:

> "*. . .near-earth space has become a crucial technological resource . . . yet the medium in which such earth-orbiting resources operate is hostile . . . Prediction of weather and climate in space is rapidly becoming an economic necessity . . .* "

The letter also addresses the fact that the solar activity-controlled outer regions of the geosphere play a role for life—significant in the long term because of their shielding effect from the constant solar-wind flow, but also more subtly in the short term through variations of the ozone layer. Finally, since this letter mainly addresses STR in the domestic arena, I also elaborated on the importance of the predictability of space disturbances for astronautics and the national defense systems.

As a result, NSF invited a small group of STR scientists (Louis Lanzerotti, Stamatios Krimigis, George Reid and myself) to make a formal presentation to NSF Director Bloch and Assistant Director William Merrell, in which it was decided that a proposal for action be submitted to organize a planning workshop. The proposal was approved quickly and the workshop took place at Washington University in August 1987.

And thus, the Geosphere Environment Modeling (GEM) program was born (Roederer, 1988a). A few years later it spun off the international *Space Weather Program*—in close connection with SCOSTEP but outside the ICSU organization (Roederer, 1988b). Today the US space weather central is located at NOAA, and also Europe has an active space weather network distributed among ESA Member States.

Part III: Lessons learned

My personal involvement in the early phase of the "Climate Revolution" and related consequences have taught me (and hopefully others too) some important lessons.

- The crucial importance of international cooperation not just for the advancement of geophysical research per se, but also for the advancement of science in general in developing countries.
- The crucial importance of engaging in interdisciplinary studies, because in the real world, everything is coupled with everything else.
- The importance of learning to communicate with the public and politicians in their language and not that of science.
- The fact that not all scientists are equal, that there are some who can bully and others who are so shy that they withdraw whenever confronted with debate.
- That to understand and propose practical solutions in climate research, whether terrestrial or space, a solid knowledge of physics and mathematics is imperative.

There is one lesson not yet learned enough concerning climate in space: That there is an equivalent of greenhouse gas pollution in the form of ever-increasing orbiting debris from past satellite and rocket missions, posing a fatal threat to technological activity and human habitability in space.

Finally, I would like to state a personal opinion: decreasing the anthropogenic generation of greenhouse gases, while necessary, is not sufficient. We are dealing with the integral Earth System as one single whole—of which a thin veneer, the anthroposphere, is being polluted not just by greenhouse gases but with sheer numbers of people—whether they drive cars or ride on oxen: it is the good old Second Principle of Thermodynamics that counts. Every bit of organization in whatever form out of disorganization costs $>$ (ln2) kT of energy. Ask the bit-coin miners.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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