## Lessons from arms control for monitoring and verifying a climate treaty

### An urgent challenge:

The Obama Administration enters history having promised in forceful terms that it will come to grips with climate change. Unfortunately, it will need to do so on a crash basis, if it is to be able to reinsert the United States into a negotiating process that has a fixed time line: the period between now and the Copenhagen Conference, which is to take place in December 2009. In fact, if this timetable holds, the administration has much less time than that, since it must formulate its position and begin a process of selling that position domestically and internationally, through intensive bilateral and multilateral diplomacy, and because it must do this well before the formal opening date of the conference.

There is another reason why unusual urgency must apply: we have lost eight years of analysis and scientific work which ought to have been pushed forward by the Federal Government, but which, instead was blocked and distorted at every possible point. Meanwhile, all available information strongly indicates that processes associated with climate change are moving faster than anticipated, even so recently as the estimates put forward in the findings of the IPCC. The time for organizing a coherent and effective response to climate change is narrowing, and it is not hyperbole to say that this next period of several years is our last, best, chance to get it done. That is not only true because of the natural facts, but because of political realities : the new Administration must create a domestic foundation for its approach in the next eighteen months at most, or see the issues swept up in the vortex of the mid-term Congressional elections , two years hence.

### Objectives of this essay:

The question of how to monitor global climate conditions is under review by scientists operating in the reactivated MEDEA system, and the question of how to monitor compliance with a post-Kyoto agreement is under review by scientists and scholars from various disciplines, as part of a process organized by the National Academy of Science. I am a participant in both venues. Obviously, I leave the scientific and technological dimensions of these issues to those who are versed in them. Instead, I have been attempting to add value by describing the possible elements of a treaty, the relationship of those elements to the larger issues of climate change, and the forms of measurement that are likely in order to support the political dimension of a global effort to constrain climate change.

This effort on my part is merely a stop-gap, pending the full engagement of officials from within the Obama administration. But the hope is to help overcome the inertia of the past, and encourage first movement towards full engagement with the problems of the future. Here, therefore, is a first cut at some basic ideas about monitoring. I draw here very heavily upon experience I garnered during thirty years of active engagement in the field of arms control, where progress also depended on the ability to monitor compliance: “Trust, but verify,” in President Reagan’s memorable phrase.

I address these ideas to the scientists and technologists who are operating in the NAS and MEDEA frameworks. The design of a monitoring system will depend on their kind of knowledge of the phenomena that must be dealt with; their knowledge of systems of measurement and their shortcomings; and their knowledge of ways to create “work-arounds” where neither existing or future

means cannot directly settle problems. They also have the responsibility of speaking truth to power, by declaring the limits of what can be monitored by any means, and therefore the limits of what can be built into a treaty that must be considered subject to verification.

I want to emphasize that there is no way to mechanically transpose concepts from arms control to climate change negotiations. The scales and time lines of the phenomena to be measured are too different. Nevertheless, I am convinced that the generic problem of monitoring arms control agreements is similar to that of monitoring climate change treaties, and that experience in the former can shed a great deal of light on the latter. I have therefore organized my ideas in the form of short commentaries below the generic issues, which appear in bold.

**Relationship between what can be monitored and what can be negotiated.**

There is a tendency for scientists to ask to be told what will be in a treaty on climate change that will require monitoring and verification. Fair enough. But it is important to realize that the 'vocabulary' of this treaty is interactive with the 'vocabulary of science." Science will determine what must be brought under international agreement, and science will also determine whether direct or indirect systems of measurements exist to track compliance and to measure results. These operate together as major boundaries: what is needed, bounded by what is possible. Somewhere within this "space" diplomacy will determine what can be agreed upon internationally, and politics will determine what can be tolerated domestically.

In an ideal outcome, what science tells us must be our goals will successfully be translated into codified agreements. Science will also determine that these agreements produce observables that can be measured within limits that provide ongoing knowledge of effectiveness; this process will turn out to be accomplishable by means that can be negotiated into a universal treaty: and this treaty will be in a form that the Senate will ratify. That is a very tall order, but it is similar to the design requirements for arms control agreements that have been successfully negotiated, including agreements designed to be universal – like the Nuclear Non-Proliferation Treaty.

**Possible Elements of a treaty, requiring verification:**

Certainly, a new agreement will focus on carbon dioxide, with the objective of putting into place agreed **national** limits, to be accomplished by reductions at agreed rates to agreed levels. Other gases may also be constrained, based on the precedent established in Annex A of the Kyoto Protocol: i.e. methane, NOX, HFCs, PFCs and SF6. Provisions may also exist relating to carbon sinks represented by forests, and with that will come a need for monitoring that can that can take into account both deforestation and reforestation. There is growing interest in soil carbon as a sink – but, even if disputes about the potential of soil carbon are resolved, its inclusion in an agreement will very much depend on an ability to measure baselines and to monitor changes in those base lines, on a national basis.

**The Principle of Monitoring linked to Enforcement:**

Decisions regarding an approach to climate change – if they are to be meaningful – will have very powerful economic consequences around the globe. Where there is money, there is dishonesty: and the propensity to cheat will grow in proportion to the economic stakes. It follows, therefore, that a post-Kyoto agreement must be capable of being enforced. For it to be enforceable, however, it must first be subject to monitoring: a principle accepted as a basic design feature of a climate treaty, starting with the Kyoto agreement itself, which incorporated an elaborate mechanism for this purpose (article 18, and see http://unfccc.int/kyoto_protocol/compliance/introduction/items/3024.php. This principle was later re-emphasized ("stringent" monitoring) by international consensus as part of the findings of the Bonn 2001 Conference on Climate Change.

**Difference Between Monitoring and Verification**

In the arms control world, monitoring is the process of measuring observable indicators of compliance by parties to an agreement. There are almost always ambiguities in the information produced by the measuring systems, especially if there is any room for disagreement between the parties concerning the precise meaning of the provisions of a treaty. It turns out that language is never precise enough to reduce ambiguities to zero.

Verification is essentially a judgment-call by the President as to the meaning of available information: it is the president's assessment as to whether the totality of information, despite ambiguities or disagreements, adds up to confidence that compliance is taking place or to reasonable cause for suspicion of non-compliance. Roughly speaking, monitoring is the provenance of scientists, technicians and intelligence analysts: verification is, ultimately however a political act. I doubt that this distinction is understood as yet among those who will be responsible for negotiating a new climate treaty, but I believe that it will inevitably be recognized by them as unavoidable if a treaty is to deal with uncertainty.

**Dealing with uncertainty:**

Arms control agreements would all be highly verifiable, if this were an ideal world. In such a world, monitoring systems would be able to measure the performance of other parties to an agreement with sufficiently high precision to reduce uncertainty for decision-makers. In the real world, uncertainty is endemic, and can be reduced only by the potential accuracy of monitoring systems, but these will exercise a profound influence on the general structure of agreements, and on the politics surrounding them.

Strategic nuclear arms agreements negotiated during the 60's, 70s and 80s were based on numerical limits applied to launchers for strategic nuclear weapons: i.e. missile launch sites on land, sea and air-based platforms. Nothing was simple about monitoring any of these platforms, especially when taking into account the possibility of deliberate concealment. Even assuming a perfect count, once ballistic missiles were deployed with multiple re-entry vehicles (MRVs and MIRVS), there was at first no way to constrain the total number of warheads deployed on active ballistic missiles, especially if various types of missiles could carry a variable number of such warheads, per choice. Similarly, one could account with

some accuracy for the number of bombers in the inventory of another country, but not for the number of weapons carried on board. Keeping in mind the capability of one such weapon to destroy an entire city, the consequences of these monitoring problems were not trivial.

Other agreements, however, presented much greater levels of ambiguity. At the far extreme in this regard, the Biological Weapons Convention has always been regarded as not directly verifiable, because of the possibility for concealing production and related facilities in non-distinctive installations, and because of the possibility for making militarily significant quantities of biological agents as a byproduct of normal civilian activities.

To deal with such problems, negotiations incorporated a repertoire of devices: counting rules that would associate warheads to missiles at an agreed ratio; agreements not to interfere with "national technical means" of monitoring; agreements for on-site inspection – including by human observers and by instrumentation; agreements on technical performance limits (tested flight range for missiles as a discriminator between strategic and non-strategic delivery systems; radiated energy levels and other parametric restraints on radars for anti-ballistic missile systems).

**Global and sovereign-scale limits and monitoring:**

The capacity to design and then manage an effective international treaty on climate change will exist within a larger set of requirements: namely, the capacity to monitor the actual status and rate of change in critical systems that drive climate on a global basis. In both cases – monitoring the state of the climate on a global scale and measuring compliance on a national scale -- measurements will have to occur against a base-line of agreed data. Sensor requirements for monitoring these two systems (international, legally driven vs. global, physically driven) overlap but are not congruent. Both must be designed in such a manner as to provide the means not only to gauge where the planet is, but where it is going and at what rate. The interface between these two systems represents the feasibility of the treaty impacting international behavior. One of the critical areas of overlap will require an ability to gauge behavior of nations and groupings of nations, as contributors to global phenomena.

**Risk and monitoring compliance:**

Given the imperfection of agreements, and in view of uncertainties regarding compliance, the negotiation of these compacts always involved readiness to assume risk: the risk that cheating could proceed undetected to the point where the party engaged in this activity would acquire a serious advantage over the United States. In the nuclear age, cheating scenarios could be imagined which might endanger the physical existence of the United States. Readiness to accept this much risk could only be justified on certain grounds: (1) that the world would be even more dangerous for us if we were not to constrain the growth of military threat by negotiation; (2) that monitoring would with a high degree of certainty uncover cheating at a point sufficiently early to permit a timely response by the United States; and (3) that cheating would not exceed a margin beyond which one would regret having negotiated an agreement, or having complied with it.

Monitoring therefore involved considerations of time and response. The same could be said for monitoring the provisions of a climate change agreement. That is, activities by parties to the agreement that violate its terms must be detectable in time to catch abuses before fruition. I am not sure what this means when considering the primary element of such an agreement --- limiting greenhouse gases— except that the time-scale would appear to be rather generous. On the other hand, political decisions to cheat are made in a very limited period of time, and once made lead to a sequence of events that may take a long time to accumulate, but which may be extremely difficult to reverse from the moment of decision onwards.

**Managing disputes about compliance:**

In the end, no arms control treaty could ever be regarded as perfectly defended against deliberate cheating by one of the parties. And no monitoring system could be regarded as perfectly reliable. Therefore all agreements contained one or more provisions for dealing with unsettled dissatisfactions: a mechanism for dealing with compliance issues through diplomatic channels; sunset or renewal clauses; possibilities for amendment; and the ultimate sanction of withdrawal on grounds of threat to national security. Abrogating agreements, however, carried major consequences and therefore was not considered except as a last resort, in the event that negotiations were to fail. Typically, negotiations would involve both claims and counterclaims of non-compliance. These disagreements would involve the text of agreements, the negotiating history underlying the texts, and even the possibility of differing parallel interpretations based on linguistic differences. Such will certainly be the case in future disagreements over compliance with provisions of a climate treaty.

**Classified vs. unclassified**

Monitoring and verification provisions will have to be an integral part of an effective climate treaty that has universal application and the force of international law. The great challenges here will be conceptual and political in equal measure. On the conceptual side, agreement for assessing compliance will have to depend on unclassified information --- much of it scientifically derived from open source sensors that already exist, and from inspection systems including onsite inspections, and deployed sensors. The poorest, least advanced party to a climate agreement must have equal access to this kind of data, and there will have to be very broad consensus that the measuring systems are dependable enough to sustain the primary requirement that the treaty be monitorable and enforceable. Indeed, if it cannot be monitored, there is no way to enforce it.

The classified world will be of the utmost importance behind the scenes, in shaping opinion within the US government as to compliance by other parties. The President will need the best intelligence he can get, from any source, to help guide policy. Moreover, translation of classified data into unclassified information will also be vital. Civilian satellites are dying out rapidly, as they reach and exceed the end of their expected service lives. Moreover, many of these systems are not scheduled to be replaced… therefore science will continue to be at least partially dependent upon streams of converted classified information. In any event, classified archives continue to hold some of the most dramatic evidence of

the scope and rate of climate change, as manifested by observable phenomena such as the retreat of glaciers and polar ice cover.

It is no exaggeration to predict that the demands of environmental science for data will become factors in the utilization of national technical systems – in contrast to the present status of environmental science as gleaner of leftovers from national security missions. There will be costs for environmental monitoring and it would be a waste of time to embark upon negotiations for a global climate change treaty without planning now for expenditures of this type. Arms control became possible when it was realized that **existing** capabilities for measuring the Soviet Union's military capacity could be used for purposes of negotiating to constrain it. Climate change can only be brought under control by negotiated agreements if there can be a similar reapplication of national security systems.

**Enforcement:**

Enforcement depends upon the availability of measurement, in forms that can be used to support diplomacy: which means, with some exceptions, unclassified information. Nations can always withdraw from agreements as a matter of sovereign right, but it is usually done under cover of an assertion that national security will otherwise be jeopardized. Withdrawal of the United States from a climate change agreement would almost certainly mean that the entire structure would collapse. We will be more inclined, therefore, to find proportionate ways to deal with compliance issues. For this purpose, it may be that trade agreements offer a better model than arms control. Trade agreements can generate scalable menus of punitive actions, rather than the all-or-nothing act of abrogation. Monitoring trade agreements and penalties that can be exacted under their terms is a relatively attainable goal. But scaling punitive actions will require a sense of the consequences of behavior in violation of climate agreements – and that is a technically as well as a politically demanding problem.

It will be necessary to back up enforcement of global treaties by making violations of them actionable as crimes on the basis of national law and perhaps international convention as well. Illegal manufacture and use of substances such as the chloroflourides, etc., are an example of the need for criminal action that can be carried to the level of individuals. Prosecution requires detection, and detection will require instrumentation. So, it follows that a necessary evolution of international law will depend on scientific agreement about monitoring.

**The United States as an object of monitoring:**

One signal distinction between the use of systems for monitoring a climate treaty and the use of these systems for all other purposes, is that the United States itself must be an object of scrutiny – just like any other signatory. US intelligence may not be used, however, as a means to collect against the United States, unless under extraordinary circumstances the legality of which can be debatable, even in the face of a presidential order ( e.g. collection against US persons – corporation and individuals -- through electronic means). The United States itself must be prepared to accept any method that it expects other parties to an agreement to find acceptable.

Arms control history shows that this is not easy to do. There will be privacy concerns, and industrial objections to methods of surveillance that will be required to gauge compliance with a climate agreement. The US chemical, biological and pharmaceutical firms were resistant to the kinds of inspection measures that would be needed to monitor compliance with bans on the production and storage of agents for use in chemical and biological warfare.

**Conclusion:** The role of scientists in developing concepts for monitoring a climate agreement is a subset of their larger role in devising methods to monitor climate dynamics on a global scale. I think the basic questions look something like this:

- What parameters must be measured, with what degree of accuracy, using what means, in order to have a data stream that improves our knowledge of climate dynamics, and changes attributable to human intervention – including interventions designed to influence the process?
- In quantitative terms, what must nations agree to accomplish in order to produce – as the aggregate result of their behavior--a stated outcome for climate, also expressed in quantitative terms?
- What must be measured, with what degree of accuracy, and by what means in order to determine the overall fidelity of signatory states to their commitments under a treaty?
- To what extent is it possible to conduct these measurements using unclassified sources of information? To what extent is it unavoidable to resort to classified sources for this purpose? Can ways be found to express such information in surrogate, unclassified form that would be acceptable to world science?
- Where remote sensing systems cannot entirely do the job, what additional forms of monitoring – including methods such as inspection and terrestrially based sensors – would be needed to determine compliance by signatories?

**Caveat:**

I have assumed here that the focus of diplomatic efforts will be on negotiating a successor to the Kyoto agreement, in the form of a treaty open to universal subscription, which will incorporate binding requirements on signatories – and which also, in the end, will acquire the force of international law, with impact on all states whether they signatories or not. A full- scale treaty is not the only possible outcome of the effort to negotiate constraints on climate change. Agreements can take a variety of other forms, some of them bilateral or only partially multilateral (eg., there is talk about an agreement only among the largest Co2 emitters, for example ). For any outcome, however, monitoring will be needed if the results are to be enforceable.

Leon Fuerth

January 25, 2009