CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization

CTBTO Spectrum

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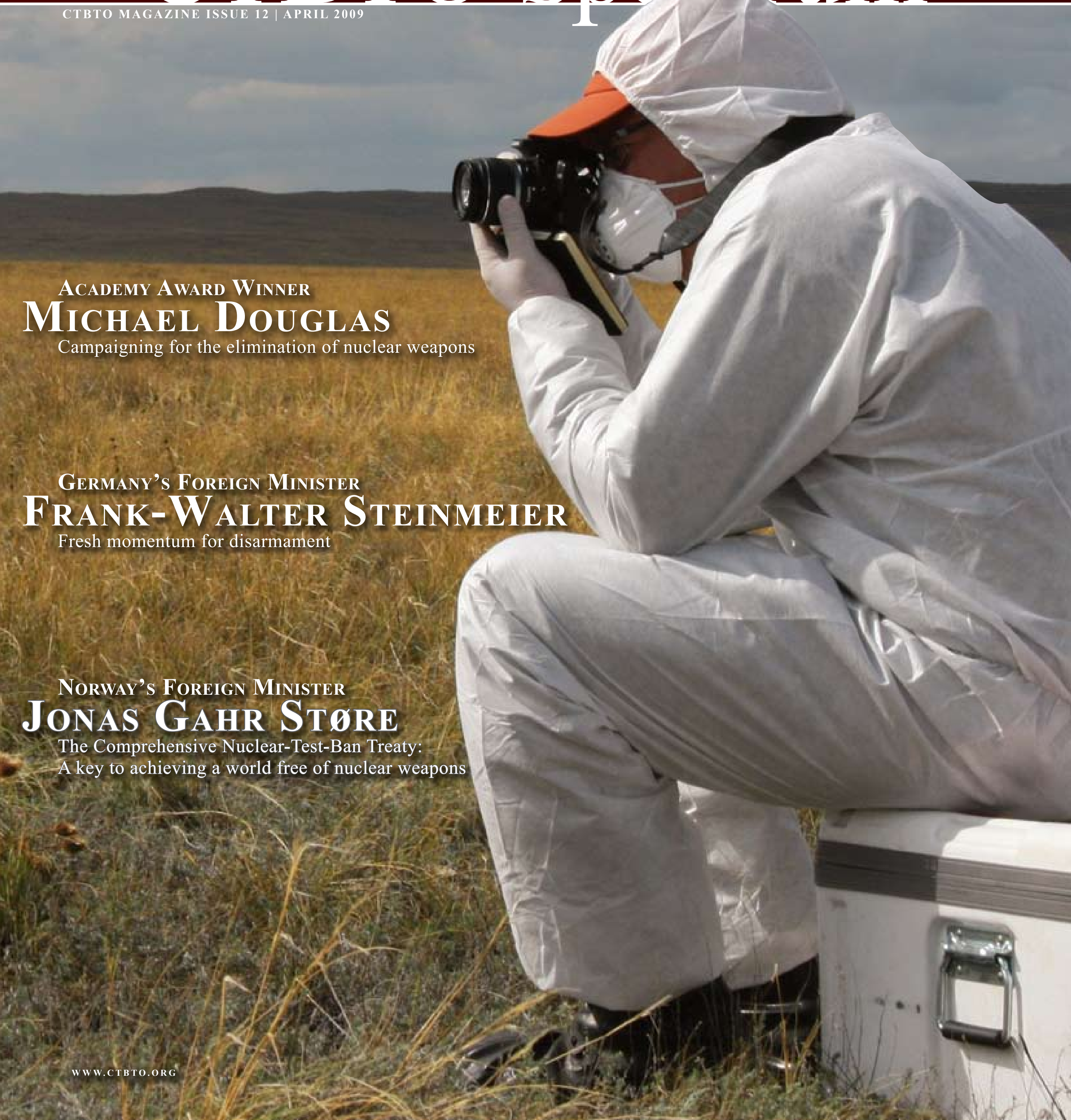


ACADEMY AWARD WINNER
MICHAEL DOUGLAS
Campaigning for the elimination of nuclear weapons

GERMANY'S FOREIGN MINISTER
FRANK-WALTER STEINMEIER
Fresh momentum for disarmament

NORWAY'S FOREIGN MINISTER
JONAS GAHR STØRE
The Comprehensive Nuclear-Test-Ban Treaty:
A key to achieving a world free of nuclear weapons

Cover designed by Todd Vincent

Cover photo taken by Kirsten Haupt (Integrated Field Exercise, Semipalatinsk, Kazakhstan, September 2008)

Inside this issue

Who we are

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans all nuclear explosions on Earth. It opened for signature on 24 September 1996 in New York.

The Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) consists of the States Signatories and the Provisional Technical Secretariat. The main tasks of the CTBTO are to promote signatures and ratifications and to establish a global verification regime capable of detecting nuclear explosions underground, underwater and in the atmosphere. The regime must be operational when the Treaty enters into force. It will consist of 337 monitoring facilities supported by an International Data Centre and on-site inspection measures.

Editorial

While the international community tries to cope with the ongoing global financial crisis, it is important not to forget another complex, volatile, and insufficiently regulated system: the nuclear non-proliferation and disarmament regime.

A fresh look at what can be done to secure and strengthen this larger regime is greatly needed, including necessary progress within the context of the Nuclear Non-Proliferation Treaty (NPT).

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) is an integral part of this regime. It is the last barrier against nuclear weapons development: it helps delineate between prohibited military and legitimate peaceful nuclear activities. It is also a key step towards nuclear disarmament and acts as a catalyst for other disarmament measures, such as deeper reductions in strategic and non-strategic nuclear arsenals and a Fissile Material Cut-Off Treaty. Very few measures are as mature and ready as the CTBT. An agreement on a CTBT in force will be crucial for success in the current NPT review cycle.

It is interesting that during the last decade, when the international non-proliferation and disarmament community was “sleepwalking” in the words of former UN Secretary-General Kofi Annan, remarkable progress was made on the CTBT.

Ten years ago, only 28 countries had ratified the Treaty. Today, 180 countries have signed and nearly 150 have ratified it.

In the last couple of years we have also seen positive momentum being generated in the United States. In 2007, the Reykjavik Revisited initiative, led by U.S. senior statesmen George Shultz, William Perry, Henry Kissinger and Sam Nunn, created a bipartisan platform on how to reach a nuclear-weapon-free world, including the CTBT’s entry into force. Three quarters of all former U.S. Secretaries of State and Defense support that platform.

Today, there is additional momentum through President Barack Obama and his administration’s strong support for the Treaty.

Over the last decade, significant progress has also been made in relation to the build-up of the CTBT’s verification regime. Ten years ago, no monitoring facilities had been certified. Today, 246 facilities have been certified as meeting the stringent standards of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), and can send data to the International Data Centre (IDC) in Vienna. The North Korean sub-kiloton nuclear test in October 2006 was successfully recorded and attributed by the CTBT’s International Monitoring System (IMS). Since then, an additional 60 facilities have been put in place and the capability of noble gas– the “smoking gun” of a nuclear explosion – has doubled. The data processing has been improved in general as well as specifically with regards to radionuclide data. Today, with the recent initial data provision by China, all five nuclear weapon States, as defined by the NPT, are sending data to the IDC. And on-site inspection capabilities have been improved through the Integrated Field Exercise in 2008.

This issue of CTBTO Spectrum tries to capture the momentum with regards to both political developments and verification build-up.

Academy Award-winning actor and producer and UN Messenger for Peace, Michael Douglas, explains why it is important that the United States ratifies the CTBT. Norway’s Foreign Minister, Jonas Gahr Støre, talks about the role the CTBT can play in helping to achieve a nuclear-weapon-free world. Germany’s Foreign Minister, Frank-Walter Steinmeier, expounds on the new momentum for nuclear disarmament, and the necessity of the CTBT’s swift entry into force. Deepti Choubey of the Carnegie Endowment argues that the remaining Annex 2 countries, whose ratifications are necessary for entry into force, should proceed with ratification rather than waiting for the United States to take action.

A number of articles explore the progress made over the last couple of years in the build-up of the IMS, on-site inspections and Atmospheric Transport Modelling. There are also future outlooks: Ola Dahlman, leader of the International Scientific Studies project to assess the readiness of the CTBT’s verification regime, details the importance of close cooperation between the scientific community and the CTBTO. And Raymond Jeanloz of the University of California at Berkeley lays out his vision for the democratization of monitoring data.

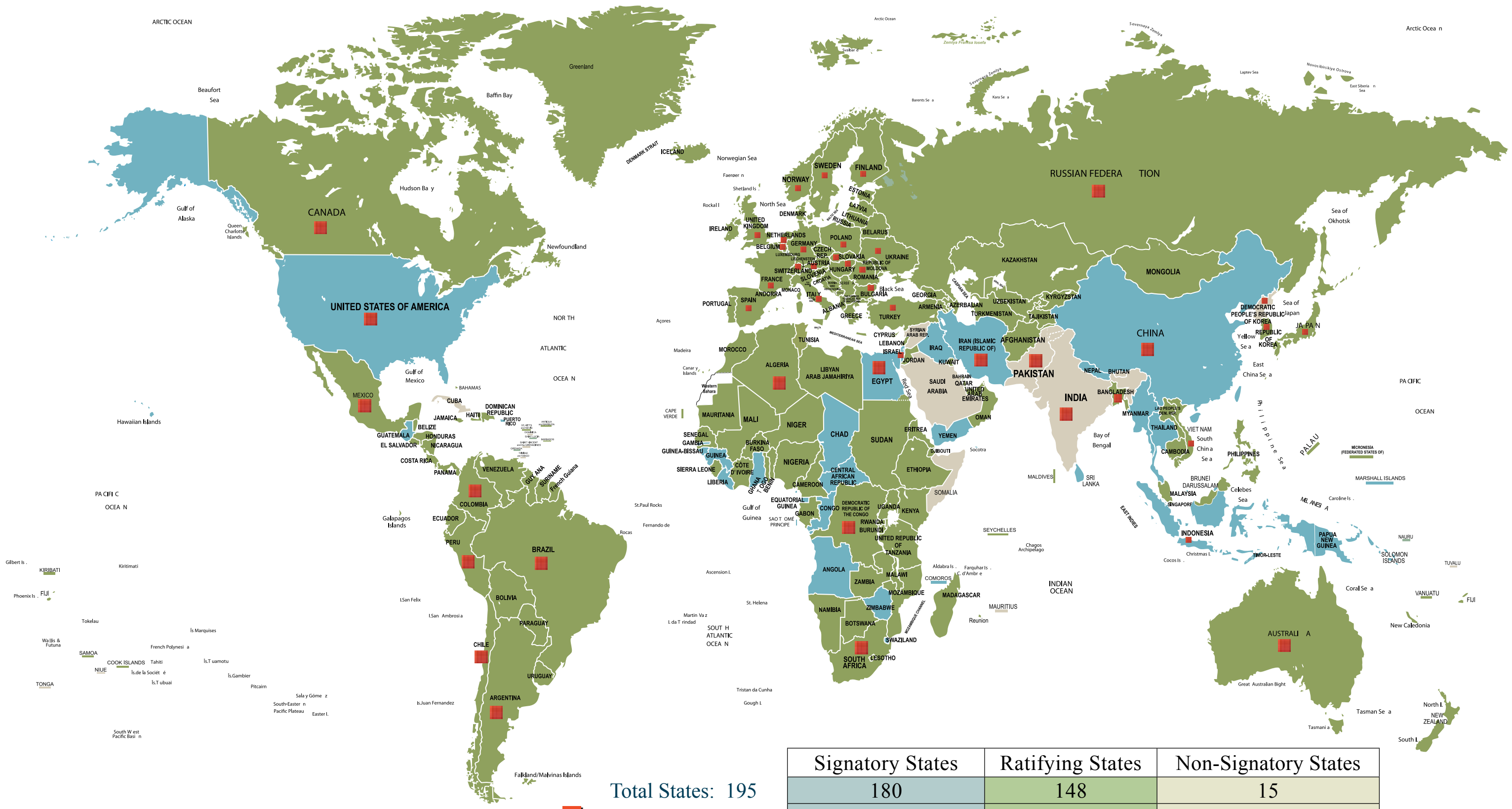
As with international financial markets, further regulation of the nuclear landscape is needed. We live in a complex world with economic, social, and political tensions, where clear-cut rules related to nuclear security and non-proliferation are imperative. The CTBT is one of these rules. It is already a de facto international norm with a verification regime that has proven its worth. I am confident that each country, when exploring how the CTBT can benefit national, regional and international security, will come to the conclusion that the Treaty is a powerful security- and confidence building measure.

It is time for all of us to go the extra mile so that this important instrument for international non-proliferation and disarmament can enter into force at last, and become fully operational.

Tibor Tóth
Executive Secretary
Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization

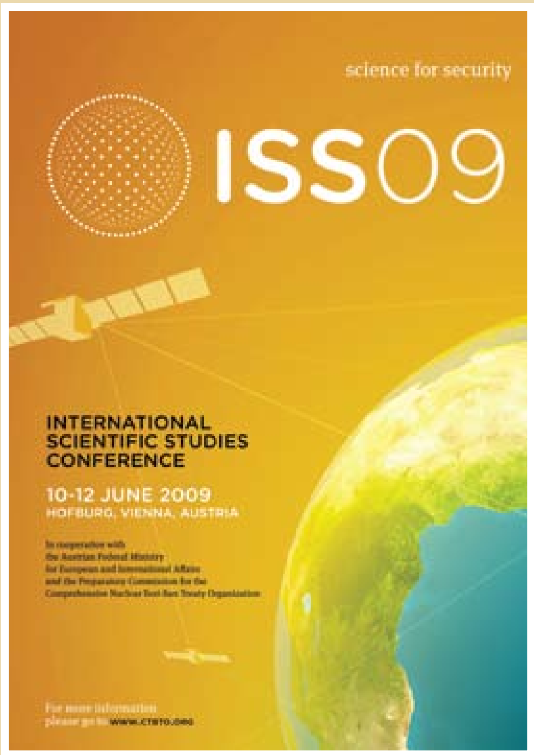
Treaty signatures and ratifications

CTBT signatures and ratifications as of 20 March 2009



Total States: 195
Annex 2 States: 44

	Signatory States	Ratifying States	Non-Signatory States
Total States: 195	180	148	15
Annex 2 States: 44	41	35	3



The International Scientific Studies (ISS) Conference

Provisional agenda:

Day One will address the capabilities of the verification regime. Evaluation results of the capability of the International Monitoring System to detect, locate and characterize events will be presented as well as the capabilities and the readiness to carry out an on-site inspection.

Day Two will be structured along the scientific disciplines with a key note lecture in each of the eight topic areas of the ISS project.

Day Three will address some broader issues:

1. A holistic perspective of the status of the verification regime today and key issues related to its further implementation.
2. Global capacity building.
3. Potential civil and scientific applications.
4. Science for Security: general issues related to science in support of our societies and our security.

Important dates

15 April 2009: Deadline for submitting abstracts to the poster session and requests for funding. Limited funds are available to cover attendance costs.

15 May 2009: Deadline for registration. No registration fee is charged.

Please visit www.ctbto.org for more information on the ISS Conference.

In the spotlight

Campaigning for the elimination of nuclear weapons

Annika Thunborg, Head of Public Information at the CTBTO, talks to Michael Douglas, the Academy Award-winning actor and UN Messenger of Peace

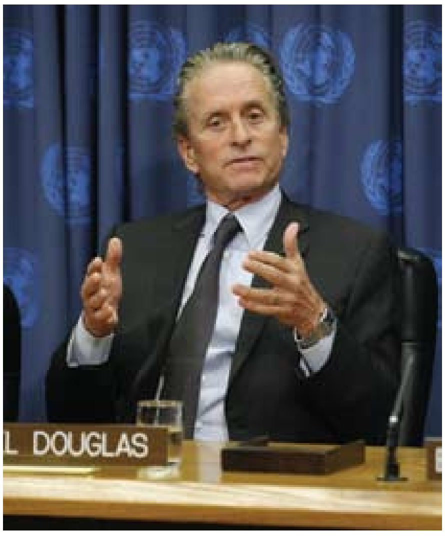
FROM LEFT TO RIGHT: **STEPHEN SMITH** (AUSTRALIAN FOREIGN MINISTER), **WILLIAM PERRY** (FORMER U.S. SECRETARY OF DEFENSE), **URSULA PLASSNIK** (FORMER AUSTRIAN FOREIGN MINISTER), **MICHAEL DOUGLAS** (UN MESSENGER OF PEACE), AND **BRUNO STAGNO UGARTE** (COSTA RICAN MINISTER OF FOREIGN RELATIONS) AT THE FOURTH MINISTERIAL MEETING IN SUPPORT OF THE CTBT'S ENTRY INTO FORCE, NEW YORK, SEPTEMBER 2008.

Q: *You are one of the world's most celebrated actors and film producers. You have also been the United Nations Messenger of Peace since 1998 and have campaigned tirelessly for the elimination of nuclear weapons. Could you share with us how you became engaged in the nuclear disarmament issue and how you became a UN Messenger of Peace?*

A: Do you know a scientist and philosopher named Buckminster Fuller? He was an American architect, author and inventor who devoted his life to the issue of humanity's chances of surviving successfully on Earth. I heard him speak a couple of times when I was at the University of California. Then I read one of his books, *Spaceship Earth*, which gave me a whole different perspective on the vulnerability of our planet and made me recognize that nuclear weapons were the largest evil in terms of their destructive powers. So I think that was the beginning of my interest in the issue, philosophically.

But let me elaborate a little on my background and my interests. When I was growing up in New York City, we used to have air raid drills. This was after Russia announced that it had conducted its first nuclear test in 1949. If there was a bright flash, you were supposed to get under your desk. Or they'd have fire drills and an alarm would ring and you'd all file down into the basement and lean up against the walls. I remember my father in California had a bomb shelter built in the back of his yard. At five or six years old, it was hard to grasp this thing, this white light. It was so powerful. And there was obviously a nightmare quality about it – a monster quality – which I think always haunted me. Even as a kid.

Later on, I produced and starred in *The China Syndrome*. Although it dealt specifically with nuclear energy/ nuclear power, I began to understand the ramifications and the half life of plutonium and how long it would stay with us. What was really an epiphany for me was when we had that accident at Three Mile Island in Harrisburg, Pennsylvania. It happened just 10 days after our movie opened. The movie script talked about a "China



MICHAEL DOUGLAS ADDRESSING PARTICIPANTS AT THE FOURTH MINISTERIAL MEETING.

Syndrome" or a meltdown and said it would destroy an area the size of Pennsylvania. That left a really lasting impression on me.

And then finally, I've been doing some homework about where my parents came from. My father came from Belarus and when I tried to find out where his town was, I discovered that it was basically eliminated because it was downwind from Chernobyl, which is on the Ukrainian border with Belarus. So it was a cumulative effect as far as where my interest in the nuclear disarmament issue comes from.

Q: *Is it this engagement that also made you interested in becoming a UN Messenger of Peace and taking this course forward on a larger level?*

A: Yes. There are so many issues to deal with in the world. I decided to really focus my energy particularly on this one. As an actor or "celebrity", it's easier to talk to politicians and diplomats in the world. They're more accessible to you. A lot of political leaders, who are unable to socialize like most people, watch movies. So there's a familiarity they have with actors. I've found sometimes that they're more comfortable with you and it's easier to reach them, because they feel like they know you before they've met you.

Q: *You grew up during the beginning of the Cold War and the nuclear arms race in the 1950s, when hundreds of nuclear tests were being conducted. Do you remember anything about the nuclear testing debate and was this something that affected you as well in terms of your subsequent interest in the ban on nuclear testing?*

A: Not at the time because I was fairly young. I was born in 1944, the year before nuclear weapons were first initiated and I certainly hope to see them eliminated in my lifetime.

In hindsight, as I began to understand the issue and more particularly, the health ramifications of all that nuclear weapon testing, this was something that made me interested in the issue. I guess the last real analysis in the States was about 10 years ago when they estimated around 100,000 cases of thyroid cancer caused by the fallout of nuclear testing. So there was certainly a health issue.

Q: *All the proponents of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) were very pleased that you participated in the Fourth Ministerial Meeting in support of the CTBT's entry into force in New York last September. During that meeting, you drew attention to some of the issues that are not so often covered in this debate, which is something you touched upon just now: the environmental and health aspects of the Treaty. So do you also think that the CTBT is important for human health and the environment?*

A: Yes, I think the CTBT's seismic monitoring stations have a tremendous effect on deterring and detecting any nuclear testing. But they can also detect any seismic activity in terms of tsunamis, like the tragedies that happened in Asia, in Indonesia and Thailand, a few years ago. Seismic data are really helpful for tsunami warning centres in terms of being able to monitor and detect tsunamis much more quickly and spread the message.

Q: *Yes, these are some of the important potential civil and scientific benefits of the Treaty and its verification regime, which I think will be expanded on a lot over the next few decades.*

If we go back to the CTBT, it bans all nuclear explosions on Earth - everywhere and by everyone. Nearly 150 countries have already ratified the Treaty, including all of Europe, most other U.S. allies, also Russia. But not the United States. Why, in your view, is the CTBT important?

A: For a number of reasons. I think it's a key part of the nuclear non-proliferation regime. If we can at least get all of the Big Five (the five nuclear weapon States: the U.S., Russia, the United Kingdom, France and China) to ratify, then we have a much better opportunity for the Treaty over the next couple of years. It will certainly help stop a nuclear arms race if it enters into force. It will be much more difficult to continue to build up arsenals if there is the inability to test. The CTBT will set a norm for the world which will make it extremely difficult for anybody, including those who have not signed, to continue testing.

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Biographical note

American Academy Award-winning actor/producer Michael Douglas is internationally recognized for his commitment to nuclear disarmament. He is a board member of the Ploughshares Fund, an organization that works to halt nuclear proliferation. Mr. Douglas is also a strong supporter of the Global Security Institute, which strives for the abolition of nuclear weapons. In 1998 he was appointed United Nations Messenger of Peace by UN Secretary-General Kofi Annan where his primary concentration is in the areas of nuclear non-proliferation and the control of small arms. ■

MICHAEL DOUGLAS UNDERSCORES HIS SUPPORT FOR THE CTBT'S EARLY ENTRY INTO FORCE.

This will apply even if we cannot get all the Annex 2 countries on board - and I think you've got to break these up after China between India and Pakistan and North Korea that are yet to sign. And Egypt and Indonesia, Iran, and Israel that are yet to ratify.

As far as the U.S. is concerned, I'm fairly optimistic. We've heard what President Obama has said and more recently what Secretary of State Clinton has said about the Treaty. I would hope that within the next couple of years, it will be ratified.

I'm hoping that the current terrible economic environment and the vulnerability that it has created will help expedite the Treaty's ratification. Nuclear security is as important as economic security. We who have been working on the nuclear disarmament issue for a long time are more optimistic than we've ever been before. There is a momentum. And the time is right to move ahead with Russia, too. Russia tried to approach us a few years ago on deeper reductions. Between the United States and Russia, we control over 90 percent of the weaponry in the world. And the economics are debilitating for Russia too in terms of maintaining its stockpiles.

The combination of a U.S. ratification of the CTBT and a dramatic reduction of weapons would be a great first start.

Q: *I know that you have lobbied on Capitol Hill before against the Reliable Replacement Warhead (RRW)[1]. If you were to talk to U.S. senators about the CTBT today, what would you say to persuade them to ratify the Treaty?*

A: I'd tell them that the CTBT is essential for reducing the arms race because it prevents nuclear proliferation to a large degree. I would advise them that the CTBT is strongly and clearly verifiable, which is very important. And unless we, the original signatories, ratify, we won't have much influence on the other countries that haven't yet done so. It would generally enhance worldwide monitoring capabilities if the CTBT went into effect so that we would be able to police the world much more effectively.

There's an argument that opponents of the Treaty make about the Stockpile Stewardship Program and about maintaining these stockpiles. Everything I've seen in defense is that there is enough ability to maintain the existing arsenal. I think there will be a debate. But based on what President Obama has accomplished in his first 30 days, which really nobody in our country has come close to except perhaps President Roosevelt, and knowing how clearly he's talked about the CTBT, I'm optimistic.

Q: *You talked about the other eight countries that haven't yet ratified the Treaty. Do you think that a U.S. ratification can have an impact on these other eight States?*

A: I certainly think it will limit their options. Let's look at India and Pakistan right now – and Israel – and Iran. U.S. ratification will certainly have an effect because it's going to strengthen the norm against testing and in a way, limit their further abilities to develop nuclear weapons. The irony is that the U.S. public has supported the CTBT all along. Back in 1997 when they last conducted a poll about the Treaty, over 70 percent of the country supported ratification. If it were approved by the U.S., it would carry some momentum with it. But regardless of whether some other countries approve the Treaty or not, a strong international norm against testing would severely limit what they could do. That alone would help other countries sign up. ■

[1] **RRW:** A proposal by the Bush administration for a new, advanced nuclear warhead design to provide a long-lasting, low maintenance nuclear force for the United States. The U.S. Congress denied funding for the project in 2009.

Fresh momentum for disarmament

by Frank-Walter Steinmeier, the German Federal Minister for Foreign Affairs

At the beginning of 2009, the prospects for a fresh start in disarmament and arms control look good. President Obama has taken office in Washington, and his administration places greater emphasis on disarmament and arms control than its predecessor, announcing concrete initiatives such as talks on a successor agreement to the START I Treaty with Russia to reduce the number of nuclear weapons. Moscow, too, is sending out encouraging messages – all this is new momentum for disarmament which we should use!

> **Notes & quotes**
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> "We unreservedly support the call by Messrs. Kissinger, Shultz, Perry and Nunn for a turnaround on nuclear policy, and not only in their country. This applies in particular to the following proposals: …America should ratify the Comprehensive Nuclear-Test-Ban Treaty."
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> Op-ed in the International Herald Tribune on 9 January 2009, *Toward a nuclear-free world: a German view*, by four German senior statesmen: Helmut Schmidt, Richard von Weizsäcker, Egon Bahr, and Hans-Dietrich Genscher.

New disarmament initiatives more important than ever

There are currently more reasons than ever before to launch new initiatives. There is a new sense of distrust that undermines the disarmament architecture so arduously constructed over many years. This holds true not only for conventional but also for nuclear disarmament: Iran still refuses to comply with its obligations to disclose its nuclear programme, while Syria's nuclear activities pose urgent questions, and North Korea is once again straying from the path of confidence-building. Not only are there new candidates aspiring to "The Bomb", but there are still too many nuclear warheads stored in the arsenals of the United States and Russia.

Senior statesmen in the U.S. and Germany call for nuclear-weapon-free world

A world free of nuclear weapons – in a joint article in 2007 George Shultz, William Perry, Henry Kissinger and Sam Nunn set out this ambitious goal. The four German "wise men" Helmut Schmidt, Richard von Weizsäcker, Egon Bahr and Hans-Dietrich Genscher further developed this idea in their reply at the start of this year. It is clear to all that if the vision of a nuclear-weapon-free world is to have a chance of becoming reality we must work hard on the details: preparations are well underway for next year's Review Conference for the Nuclear Non-Proliferation Treaty (NPT).

Germany continues to promote the CTBT's entry into force

Germany already put forward proposals to this end in 2007. Central to these is the entry into force of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). This agreement not only contains the further spread and development of nuclear weapons, but also sends an important message to those countries yet to join the NPT and the CTBT, that the nuclear weapon States, by not conducting any more nuclear tests, are demonstrating their commitment to comply with the NPT obligations. This is why I greatly welcome President Obama's announcement that he intends to submit the CTBT to the Senate for ratification.

CTBT key to nuclear non-proliferation

The CTBT's swift entry into force would represent a major step towards nuclear disarmament and non-proliferation and a cornerstone of the new stable security architecture which we must work on. Further steps such as a successor to START, the retention and enhancement of the Conventional Forces in Europe (CFE) Treaty, or negotiations on a treaty prohibiting the production of weapons-grade fissile material (the Fissile Material Cut-off Treaty or FMCT) must follow. We must be aware that new impulses in international security and disarmament policy will only be effective if all major players are willing to cooperate and agree on joint action. This also applies to the CTBT – a special responsibility is borne by those countries who must still ratify the Treaty so that it can finally enter into force. ■

Biographical note

Frank-Walter Steinmeier has been Germany's Foreign Minister since 2005 and the country's Deputy Chancellor since 2007. He is the Social Democratic Party's candidate for Chancellor in the 2009 parliamentary elections. During Gerhard Schröder's chancellorship, Steinmeier headed the Federal Chancellery where he was responsible for overall policy coordination within the Government. As Foreign Minister, Steinmeier has made disarmament and non-proliferation some of his key priorities. ■

The Comprehensive Nuclear-Test-Ban Treaty: A key to achieving a world free of nuclear weapons

by Jonas Gahr Støre, the Norwegian Minister of Foreign Affairs

A world free of nuclear weapons has been a longstanding objective of Norway's foreign policy. Considerable progress was made up to the 1990s, but the last ten years have been more discouraging. We have been confronted with serious proliferation challenges. There is a widespread perception that nuclear weapon States are not delivering on their disarmament obligations. And it has been difficult to strengthen the non-proliferation regime. In short, the first ten years of this century can be described as the lost decade.

Eliminating nuclear arms will enhance global security

Achieving a world free of nuclear weapons will require a reversal of recent years' setbacks and a renewed commitment to nuclear disarmament. Fortunately, there are signs in many countries of growing awareness, among politicians and the general public alike, that global security will be enhanced by the elimination of nuclear arms, and that the security of even the most powerful States will be better served in a world without these weapons.

Strong leadership crucial for promoting nuclear disarmament

In February last year, Norway hosted an international conference on nuclear disarmament that brought together some of the world's leading experts on nuclear issues. There was remarkable consensus on the advisability of moving towards the elimination of nuclear weapons. The crucial importance of the personal engagement of national leaders was underlined; strong leadership is vital in order to involve key stakeholders and build public support. The conference also agreed that taking disarmament seriously means taking concrete steps in that direction, such as the entry into force of the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

NPT must be strengthened

Nuclear weapons cannot be eliminated overnight. This will have to be a gradual process based on verified reductions over time. Our efforts should be anchored in the Nuclear Non-Proliferation Treaty (NPT), which has been a cornerstone of our collective security for more than 40 years. It has prevented the most alarming proliferation scenarios from becoming a reality. It has enabled non-nuclear weapon States to benefit from civilian nuclear applications. It has committed nuclear weapon States to disarm. However, despite its good record, the NPT is now under growing strain. We must develop a common vision of how to strengthen this vital treaty, and this should be the main objective for the NPT Review Conference in 2010. We cannot afford to repeat the failure of the 2005 Conference.

Legally binding CTBT is imperative

It is therefore of utmost importance that we develop a common approach to the nuclear threat. A legally binding and comprehensive ban on nuclear testing is crucial. This would effectively prevent the development of a new generation of nuclear weapons. It would enhance our common efforts to prevent horizontal nuclear proliferation and a new nuclear arms race. A legally binding CTBT is one of the preconditions for achieving a world free of nuclear weapons.

Norway has therefore on a number of occasions urged all remaining countries, whose ratification is necessary for entry into force, to ratify the CTBT, and has provided funding for activities to this end.

Importance of ratification by the United States

With the new U.S. administration there is now a new window of opportunity. Prior to his

Notes & quotes

"The Nonproliferation Treaty is the cornerstone of the nonproliferation regime, and the United States must exercise leadership needed to shore it up. So we will seek agreements with Russia to secure further reductions in weapons under START. We will work with this (Senate Foreign Relations) committee and the Senate toward ratification of the Comprehensive Test Ban Treaty, and we will dedicate efforts to revive negotiations on a verifiable, fissile material cut-off treaty."

Statement by U.S. Senator Hillary Clinton at the nomination hearings to be Secretary of State, 13 January 2009

election, President Barack Obama expressed strong support for the CTBT. Ratification by the United States would have a tremendous impact not only on the CTBT, but also on the NPT.

Meanwhile, pending entry into force, we must uphold the existing norm of non-testing. Norway expects all States that possess nuclear weapons to maintain their unilateral moratoria.

CTBT is verifiable

We must provide political and financial support to help the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) complete the International Monitoring System (IMS) and the other elements of the global verification regime. Indeed, much progress has been achieved in recent years. The assertion that the CTBT cannot be verified is not valid.

Reaching agreement on a legally binding ban on the production of fissile materials for weapons purposes is also essential in this respect. Such an agreement must be transparent and verifiable so that the international community can be confident that no nuclear warheads are being produced in secrecy. Likewise it is essential to make progress in the destruction of military stockpiles of fissile material, or the conversion of these materials for peaceful uses. Disarmament and peaceful use should go hand in hand.

United States and Russia must take the lead in nuclear disarmament

The number of nuclear warheads must be significantly reduced. Given the fact that the United States and Russia possess more than 95 percent of the world's nuclear weapons, they must take the lead. The bilateral United States –Russian START and SORT treaties, which limit the number of strategic and deployed arms, need to be replaced by new binding agreements on further cuts in strategic nuclear arsenals. And other nuclear weapon States will then have to follow suit.

We must reduce the salience of nuclear weapons in security policies. This could be done in a number of ways. Steps should be taken to reduce the operational status of deployed weapons in order to prevent accidental use. We should diminish the geographical scope of nuclear weapons by supporting the establishment of regional nuclear–weapon-free zones. We should encourage nuclear weapon States to provide assurances that they will not use or threaten to use nuclear weapons against non-nuclear weapon States, particularly States belonging to nuclear-free zones. We also need to reassess the role of deterrence.

Robust non-proliferation regime is essential

Total elimination of nuclear weapons will require a much more robust and credible non-proliferation regime than we have today. This will entail expansion of the regime and closure of the current loopholes. All nations must work towards this end, and assistance must be provided to countries that are not able to implement their non-proliferation obligations due to limited resources.

We will not make real progress on non-proliferation unless we ensure that all NPT States have the opportunity to benefit from nuclear energy and technology. However, the right to peaceful use must not undermine our non-proliferation efforts or human safety and environmental considerations.

IAEA nuclear fuel bank necessary

One way of providing opportunities for peaceful use while ensuring non-proliferation is through multilateral cooperation on handling the whole nuclear fuel cycle. As a first step, we should set up a fuel bank under the auspices of the International Atomic Energy Agency (IAEA) to supply nuclear fuel to all *bona fide* NPT States. Such a fuel bank would discourage a number of countries from developing their own fuel production capacity, which is both expensive and, more importantly, could increase proliferation. Norway has pledged US$ 5 million to such a bank.

We must overcome our differences. We must work across the traditional regional groupings, as Norway does in the Seven Nation Initiative *(please see explanation on page 11)*. We must involve civil society, academia and non-governmental organisations. We must forge new partnerships. We must work in innovative ways to achieve a positive and forward-looking outcome of the NPT 2010 Review Conference. These are challenging tasks, but I am confident that we can succeed. ■

Biographical note

Jonas Gahr Støre has served as Norway's Minister of Foreign Affairs since 2005. Prior to this he was the State Secretary and Chief of Staff at the Office of the Prime Minister. In addition to having held other positions within the Office of the Prime Minister earlier in his political career, Mr. Støre was also the Secretary General of the Norwegian Red Cross from 2003 to 2005 and the Chief of Staff at the World Health Organization from 1998 to 2000. ■

Perspectives

Don’t wait for the United States

by Deepti Choubey

After Republicans halted the ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) in 1999, the Bush administration treated it as a four letter word not to be uttered in its bilateral talks with both nuclear and non-nuclear weapon States. The time has come to put the CTBT back on the agenda of other nations and not just the United States.

Welcome change in U.S. policy on the CTBT

CTBT proponents are encouraged by the Obama administration’s declaration that it will seek ratification and then mount a full diplomatic effort to get hold-out States to do the same. This change in U.S. policy is welcome, but to assume that action by the Obama administration alone will guarantee the CTBT’s entry into force is a mistake. Both nuclear and non-nuclear weapon States as well as civil society must act now if Obama’s leadership is not to go to waste. Their efforts can increase the prospects of U.S. ratification and pressure CTBT laggards.

Republicans must be convinced of importance of ratification

Committed leadership from the Obama administration is essential, but insufficient for persuading Republican senators to vote for ratification. It is impressive that overall 148 countries have now ratified the CTBT -- a significant increase from the 51 who had done so when the Senate rejected it almost a decade ago. The number of outstanding Annex 2 States has halved from 18 to nine over the past 10 years. Nevertheless, senators concerned more about domestic political debates over the Reliable Replacement Warhead will not be swayed by this evidence of increasing international support against nuclear testing.

Indonesia expresses serious interest in ratifying

Almost counter-intuitively, senators are worried that the United States will ratify the CTBT and none of the remaining eight States will. The good news is that Indonesia has demonstrated solid political and financial support and recently declared that it is undertaking “serious preparations for the ratification of the CTBT.” This could happen before the Senate considers the Treaty itself.

A move by China would be important

China’s move, however, will be of far greater interest to senators. And China, too, will be watching American developments closely. Recalling the rivalry between the two nations when the CTBT opened for signature and China’s possible discomfort with being the last of the five nuclear weapon States recognized by the Nuclear Non-Proliferation Treaty (NPT) to ratify, China might do so just before the Senate. In its 2008 defense white paper, China emphasized its support for the CTBT to enter into force as soon as possible. This matters not only for China’s own ratification prospects, but also because of the role China might be willing to play in persuading hold-out States such as Pakistan, North Korea and Iran to ratify. A Chinese, rather than American, diplomatic effort may be more effective with these States.

Treaty would help create stability in South Asia

China’s ratification is a necessary precursor to addressing India and Pakistan. India has stated that it would not stand in the way of the Treaty entering into force. More recent assertions from India’s External Affairs Minister, Pranab Mukherjee such as “We will not sign the CTBT,” are worrying if they indicate a lasting change in policy. As there are Indian analysts advocating for the CTBT, there may be some hope for moderating the government’s position through efforts within India. With Pakistan’s ratification contingent

Notes & quotes

“Early US ratification would do much to encourage the few remaining states to follow suit, thereby finally enabling the treaty – concluded in 1996 – to take legal effect and ban all nuclear weapons test explosions.”

David Miliband, the U.K.’s Foreign Minister
The Guardian, 8 December 2008

on India, the push for the CTBT in South Asia will be a key test of what benefits the newly transformed U.S.-India strategic partnership will yield. States in favour of the CTBT must push India and Pakistan to agree to move if China and the U.S. do so. The CTBT is an important step to creating stability in a region badly in need of it.

Confidence- and security-building measure in the Middle East

The Middle East is another region where the actions of others will matter. The Olmert government in Israel has conveyed positive signals about CTBT ratification. U.S. ratification could trigger ratification by Israel. Evidence of Israeli ratification ahead of time, along with other progress on nuclear disarmament and, in particular, the resolution to create a zone free from nuclear weapons and other weapons of mass destruction in the Middle East[1], could spur Egypt to reconsider its position, which has hardened since 2000. As in South Asia, the ratification of the CTBT in the Middle East could help with security-building.

Iran's ratification could assuage concerns about its nuclear programme

Iran poses a different problem and requires a diverse selection of countries to promote the CTBT bilaterally. Countries aside from France, Germany and the United Kingdom, such as China and Russia, could frame the CTBT as a confidence-building measure. Ratification could assuage international concerns about Iran's nuclear programme. If Egypt is reluctant to ratify, the Iranians could make the CTBT an issue where they can demonstrate regional leadership. This would be a gambit with little cost as the Treaty would not enter into force until Egypt and other hold-outs like North Korea ratify.

Prominent statesmen can ensure prioritization of the CTBT

On all of these issues, other States and civil society have an important role to play as a conduit by which the intentions of other hold-out States can be determined and communicated. Bridge-building initiatives such as the International Commission on Nuclear Non-proliferation and Disarmament, launched by the Australian and Japanese governments in June 2008, can pressure governments to prioritize the CTBT. Their regional consultations over the next year will reveal which way the wind is blowing in the Middle East, South Asia and Northeast Asia. Through concerted government-to-government consultations, the Seven Nation Initiative[2] and the New Agenda Coalition[3] could also ensure that the CTBT rises to the top of the agenda. Uniquely influential are specific individuals such as US senior statesmen George Shultz, William Perry, Henry Kissinger and Sam Nunn, who can advance their vision of a world free of nuclear weapons, including interim steps such as the CTBT's entry into force, with senators directly.

Without a doubt, activities this year can create positive momentum and good will in advance of the 2010 NPT Review Conference. The CTBT will be high on the agenda of non-nuclear weapon States. Early progress on the CTBT, due to the initiative of other States and civil society, can be converted into the political capital needed to sustain efforts to shore up the nonproliferation regime.

Considering the progress of the last 10 years, it is not impossible to see the CTBT enter into force within the next decade. Doing so, however, will require everyone to play their part and no one can afford to wait. ■

Biographical note

Deepti Choubey is the deputy director of the Nonproliferation Program at the Carnegie Endowment for International Peace in Washington. She is responsible for establishing the program's priorities, conducting research and analysis, and leading the Carnegie International Nonproliferation Conference. Prior to joining the Carnegie Endowment in 2006, Ms. Choubey was director of the Peace and Security Initiative (PSI) for the Ploughshares Fund. ■

[1] The **Nuclear Non-Proliferation Treaty's 1995 resolution** NPT/CONF.1995/32/RES/1 called for a Middle East zone free of nuclear weapons as well as other weapons of mass destruction.

[2] The **Seven Nation Initiative** represents the strong commitment of Australia, Chile, Indonesia, Norway, Romania, South Africa and the United Kingdom to all three 'pillars' of the NPT - non-proliferation, disarmament and the peaceful uses of nuclear energy. It was launched in July 2005.

[3] The **New Agenda Coalition (NAC)**, composed of Brazil, Egypt, Ireland, Mexico, New Zealand, South Africa, and Sweden, seeks to build an international consensus to make progress on nuclear disarmament. The NAC was launched in June 1998 and played a crucial role in achieving the successful outcome of the 2000 NPT Review Conference.

Democratization of Monitoring

by Raymond Jeanloz

The International Monitoring System (IMS) is being successfully deployed, with more than 80 percent of its stations operational and an independent technical assessment of its capabilities – the International Scientific Studies (ISS) project – underway. Its sensitivity and reliability are also validated by non-IMS – even non-governmental – capabilities, from the global community of research seismologists to the commercial availability of high-resolution satellite imagery. It has also successfully confronted a real-world application in its definitive assessment of North Korea's sub-kiloton nuclear test of 9 October 2006.

It is time to capitalize on the momentum of this deployment by making plans for broadening global monitoring with more stations and a greater diversity of sensors, and by engaging a wider range of communities.

Potential civil and scientific applications

Expanded monitoring capability, with increased spatial density, improved sensitivity and diversified applications, offers significant opportunities. A case in point is the recent enhancement in tsunami warning, motivated by the tragic consequences of the Sumatra earthquake of 26 December 2004. Infrasound can be used to help monitor volcanic eruptions that threaten commercial flights, and bolides that continuously enter the atmosphere from space; and seismometers provide crucial information about earthquake hazards. These are all significant enhancements beyond the IMS's immediate responsibilities of nuclear test-ban monitoring.

Whether as part of the IMS or as separate deployments, one could envision far more extensive monitoring of the 3-D time-variable properties of the oceans, as well as the gases and aerosols of the atmosphere. The latter can greatly improve atmospheric modelling as well as environmental monitoring, in both cases of great benefit to society. It may even be possible to apply the astronomer's concept of a "guide star" by using controlled sources of sound to improve high-resolution spatial–temporal imaging of the oceans and atmosphere.

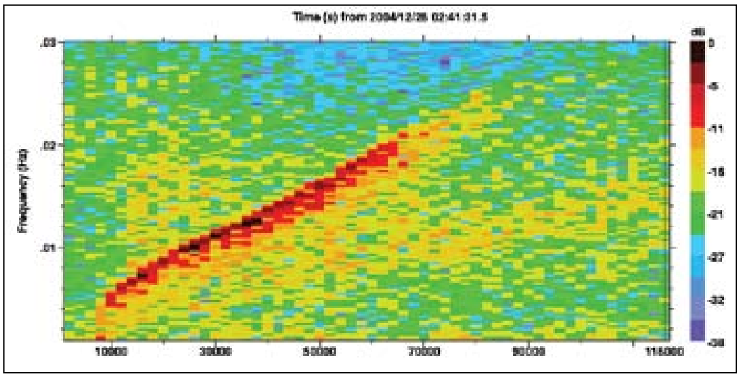
ERUPTION OF VOLCANO LOPEVI, VANUATU.

THE DEVESTATING FORCE OF A TSUNAMI.

Recognizing that micro-organisms can be lofted across oceans or continents on small particles, there is even a potential impact on public health with better characterization of disease transmission around the globe.

Treaty's technological opportunities

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) represents one of the most extensive and – from a technical perspective – most successful applications of science and technology in the realm of international treaties. It is this success that offers new opportunities as the technologies continue to develop, all the more so as capabilities that were once in the sole domain of nations or large institutions – overhead imagery, seismic records, near-instant global communication, and more – are becoming available to the world at large. It is barely an oversimplification to suggest that the



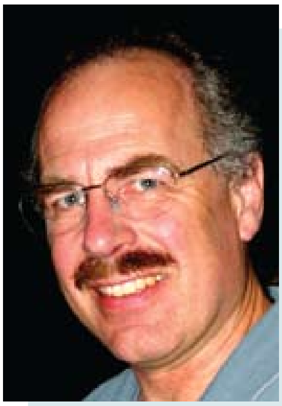
SPECTROGRAM OF THE 26 DECEMBER 2004 TSUNAMI RECORDED AT IMS HYDROPHONE STATION HA08 (DIEGO GARCIA, BRITISH INDIAN OCEAN TERRITORY) BETWEEN THREE AND 18 HOURS AFTER THE TSUNAMIGENIC EARTHQUAKE.

IMS is constantly checked: not only through the efforts of interested governments, but at least as much by the community of graduate students and other researchers monitoring the globe through their internet access to vast arrays of sensors and data banks.

Treaty monitoring must be left to the professionals, and there is no intention of suggesting inadequacies in this regard. To the contrary, non-specialists can be highly supportive of the professionals' efforts, a case in point being the academic community that has served to both validate and continuously improve IMS technical capabilities. The key will be to identify means by which interested outsiders can communicate with each other as well as with the Treaty professionals in improving global monitoring and enhancing its applications, all in a manner that is constructive of – and avoids undermining – the Treaty and its verification regime. One approach is through the scientific community's engagement in the ongoing ISS project. Another useful mechanism may be through a Treaty-monitoring "wiki," an internet-based forum that is publicly accessible but editorially controlled, for exploring new ideas about monitoring, exchanging open data and even discussing anomalous events.

In the end, the objective is to build on the success of the CTBT's IMS, both to expand monitoring of our global environment more broadly and to reaffirm the international norms represented by the Treaty's regime. ■

Biographical note



Raymond Jeanloz is Professor of Earth and Planetary Science and Astronomy at the University of California, Berkeley, where he conducts scientific research on planetary interiors and on materials at high pressures. Jeanloz also chairs the U.S. National Academy of Sciences' Committee on International Security and Arms Control that engages in scientist-to-scientist dialogue on topics ranging from nuclear weapons and non-proliferation to biological threats and counter-terrorism. ■

Notes & quotes

"I will begin working to build the necessary bipartisan support for US ratification of the Comprehensive Nuclear Test Ban Treaty, which would impose a worldwide ban on nuclear testing under the watch of a far-reaching verification regime. Winning approval of two-thirds of the Senate will be a long and difficult process. It will require the unyielding support of the Obama administration and my colleagues on both sides of the aisle. But success would be the single greatest arms control accomplishment for the new Senate and it would reestablish America's traditional leadership role on nonproliferation."

JOHN F. KERRY, U.S. SENATOR AND CHAIRMAN OF THE SENATE FOREIGN RELATIONS COMMITTEE,
THE BOSTON GLOBE, 13 JANUARY 2009

Verification highlight

Major progress over the last decade: The International Monitoring System nears completion

by Denise Brettschneider

ONE OF THE MOST REMOTE ISLANDS IN THE WORLD, TRISTAN DA CUNHA IN THE SOUTH ATLANTIC OCEAN: HOME TO THREE IMS STATIONS.

Universal condemnation of the nuclear tests conducted by India and Pakistan in May 1998 clearly reflected the broad international support for ending nuclear testing. The tests not only broke the *de facto* moratorium that had been in place since the Comprehensive Nuclear-Test-Ban Treaty (CTBT) opened for signature in 1996 but also led to fears of nuclear conflict in the region.

At that time, only a small number of the 337 monitoring facilities foreseen in the CTBT, which bans all nuclear testing on Earth, were in place. Yet the Treaty's International Data Centre (IDC) in Vienna was already receiving data from a number of primary seismic stations at the end of May 1998 when Pakistan exploded a series of underground nuclear devices in reponse to India's nuclear tests two weeks earlier.

Over the next few years, the verification capabilities of the CTBT's International Monitoring System (IMS) improved considerably as the network expanded around the globe. Its facilities are located in 89 countries – some in remote areas such as Antarctica, Tristan da Cunha in the South Atlantic and Siberia – in order to provide complete global coverage and ensure that no nuclear test goes undetected.

The 2002 report *Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty* by the U.S. National Academy of Sciences (NAS) stated: "Underground nuclear explosions can be reliably detected and can be identified as explosions, using IMS data down to a yield of 0.1 kilotons (100 tons) in hard rock if conducted anywhere in Europe, Asia, North Africa and North America."

The IMS uses seismic, hydroacoustic, infrasound and radionuclide technologies to monitor underground, the oceans and the atmosphere for any sign of a nuclear explosion.

DPRK announced nuclear test detected by many IMS stations

When the Democratic People's Republic of Korea (DPRK) declared that it had conducted a nuclear test on 9 October 2006, the IMS was able to demonstrate the extent to which its detection capabilities had progressed. The event, which had an estimated yield of well below one kiloton, was promptly detected and identified by 22 of the IMS's seismic stations. The seismic findings also allowed for the identification of a possible inspection area of less than 1,000 square kilometres, which is the maximum area allowed for an on-site inspection (OSI) under the Treaty. Within two hours, the Member States of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) received the first automatic analysis of the data, containing preliminary information on the time, location and magnitude of the event.

Radionuclide station registers high levels of radioactive noble gas

Two weeks later, the IMS's radionuclide noble gas station at Yellowknife, Canada – over 7,000 kilometres away from the DPRK - registered elevated levels of the noble gas, xenon-133, in the atmosphere. Since radioactive noble gases are a by-product of a nuclear explosion, noble gas monitoring enables verification of any violation of the CTBT.

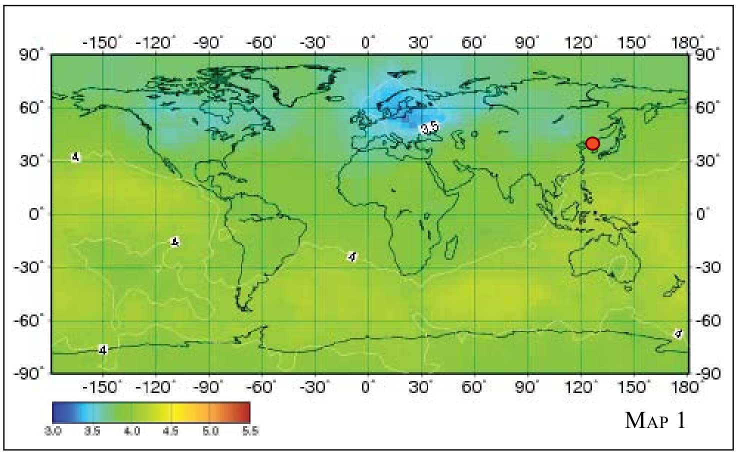
In order to locate the perpetrator of the announced explosion, atmospheric transport models were used to backtrack the dispersion of the gas. It was found to be consistent with a release from the location and time of the DPRK event, proving the ability of the IMS to detect such events from a great distance.

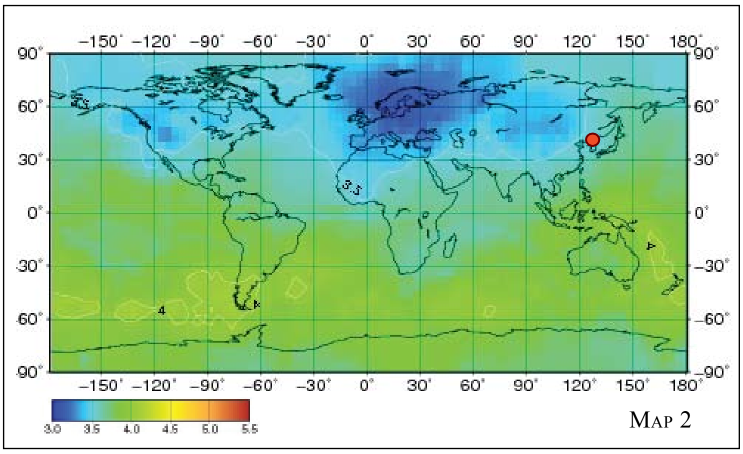
Although only 180 or 60 percent of the IMS stations had been installed in October 2006, the system exceeded the expectations of the Treaty negotiators in terms of sensitivity, reliability, precision, location and characterization.

Extensive network now spans the globe for evidence of nuclear tests

There have been considerable advances in the sciences and technologies relevant to the detection and location of nuclear tests over the last decade, with a corresponding increase in the build-up of IMS facilities. Noble gas technology, which was at an experimental stage in the 1990s, has significantly increased the ability to detect and identify nuclear explosions. The different technologies, such as the radionuclide/noble gas and seismic networks, complement each other to an extent not foreseen in the 1990s by increasing verification capabilities.

By the beginning of 2009, 264 stations and radionuclide laboratories had already been installed, creating a network that is far more extensive and sensitive than anything one country could establish alone. 246 of these monitoring facilities have been certified as meeting the CTBTO's stringent technical requirements and operational performance. Certified stations transmit data automatically and continuously to the IDC in Vienna, except for auxiliary stations, which send data upon request. In total, almost 90 percent of the IMS facilities were certified, operational or under construction by January 2009.





MAP 1 SHOWS THE AVERAGE DETECTION CAPABILITY OF THE IMS PRIMARY SEISMIC NETWORK ON 09 OCTOBER 2006. MAGNITUDE 4 (LIGHT GREEN TO GREEN) REPRESENTS AN EXPLOSION YIELD OF ROUGHLY 1 KILOTON. THE CAPABILITY OF THE SYSTEM WAS CLEARLY BETTER THAN THIS IN MANY PARTS OF THE WORLD.
MAP 2 SHOWS THE SITUATION ON 14 MARCH 2009. THE AVERAGE DETECTION CAPABILITY OF THE SYSTEM HAS BEEN FURTHER IMPROVED BY THE INCORPORATION OF DATA FROM PRIMARY SEISMIC STATIONS ADDED TO THE IMS NETWORK SINCE THE DPRK TEST, DEPICTED BY RED DOT.
THE COLOUR SCALE BELOW THE MAPS SHOWS THE DETECTION THRESHOLD, CALIBRATED TO BE CONSISTENT WITH THE REVIEWED EVENT BULLETIN (REB) PROCESSING PARAMETERS.

Verification highlight

Certifications have reached over 80 percent in several regions

In North America progress has been particularly encouraging, with certifications standing at 90 percent. In Latin America, 83 percent of the IMS stations have been certified, 80 percent in Australia, and 70 percent in Africa. Most stations in Europe have been certified, as have 50 percent of the planned stations for the Russian Federation, many of them over the last year. Another fifteen stations have either been installed in the Russian Federation or are being tested and evaluated for certification, with the installation of four of these stations having been completed between July and September 2008.

Increase in noble gas capabilities

At the time of the announced nuclear test in the DPRK, only ten out of the planned 40 stations with noble gas measuring technology were operating in test-mode. By January 2009, the noble gas capabilities of the radionuclide network had doubled. By 2013, all noble gas systems should be in place.

Major advances in data transmission

With the recent initial data provision by China, stations hosted by all five nuclear weapon States now transmit data to the IDC in Vienna. The volume of data has tripled since 2004 and a new global communications infrastructure for relaying the data has also been installed. Data analysis has also improved significantly through more sophisticated computers and software.

On-site inspections: a powerful deterrent to would-be Treaty violators

Two years after the IMS's capabilities were tested in October 2006, the Integrated Field Exercise in 2008 (IFE08) provided yet further proof of the CTBT's verifiability. The exercise demonstrated that the final element of the CTBT's verification regime, on-site inspections, promises to act as a strong and reliable deterrent to potential violators once the Treaty enters into force (*see page 21 for more information about the IFE08*).

INSIDE AN IN-GROUND VAULT AT AN AS104 ELEMENT, ESKDALEMUIR, SCOTLAND.

Seismic highlights

By the beginning of 2009, 80 percent of the network of 50 primary seismic and 75 percent of the planned 120 auxiliary stations had been certified - as many as 41 of them since October 2006. Another 27 seismic stations have already been installed or are under construction, including a primary seismic station in Turkmenistan in Central Asia.

Long-term quality monitoring is crucial

One of the most recent certifications was of primary seismic station PS37 at Ussuriysk in the Russian Far East, with North Korea to the South and China to the West, on 28 November 2008. As has been the case for many IMS stations, PS37 has been built from scratch. This involved an extensive site survey and the

Seismic Monitoring

The seismic network of primary and auxiliary stations monitors the Earth for underground explosions. The stations are equipped with seismic sensors, which measure waves generated by seismic events such as earthquakes or explosions. Measurements recorded at the stations help to identify the location, magnitude and nature of a seismic event.

installation of the equipment – much of which was imported from Canada and Austria – a lengthy process that required intensive preparation by the CTBTO. After certification, long-term quality monitoring ensures that high data quality standards and availability are maintained and that station performance is optimal.

The auxiliary seismic network's most recent certification

Auxiliary seismic station AS104 at Eskdalemuir in southern Scotland was certified on 17 February 2009. As well as detecting local and regional seismic disturbances, AS104 has a global monitoring capacity: it was designed to optimize the detection of seismic waves some 1000 km from the source. On 18 August 2000, the station detected the seismic waves generated by an explosion onboard the Russian nuclear submarine, *Kursk*, in the Barents Sea.

In the event of a catastrophic failure with one of the primary seismic stations in Europe, AS104 would temporarily transfer from its auxiliary role to act as a primary seismic station.

Hydroacoustic highlights

Ten of the eleven hydroacoustic stations have already been certified. All of these certifications have taken place since the late 1990s.

The ocean is one of the most inhospitable environments to work in and the station equipment must be of exceptional quality: it needs to withstand the huge pressure encountered in deep water, destructive waves near shore, strong currents and the sharp edges of undersea volcanic terrain, in addition to freezing temperatures and the saline corrosiveness of ocean waters. The underwater equipment is designed with longevity in mind: stations should last for up to 25 years.

WAKE ISLAND, NORTH PACIFIC OCEAN, HOST TO HYDROACOUSTIC STATION HA11 AND RADIONUCLIDE STATION RN77.

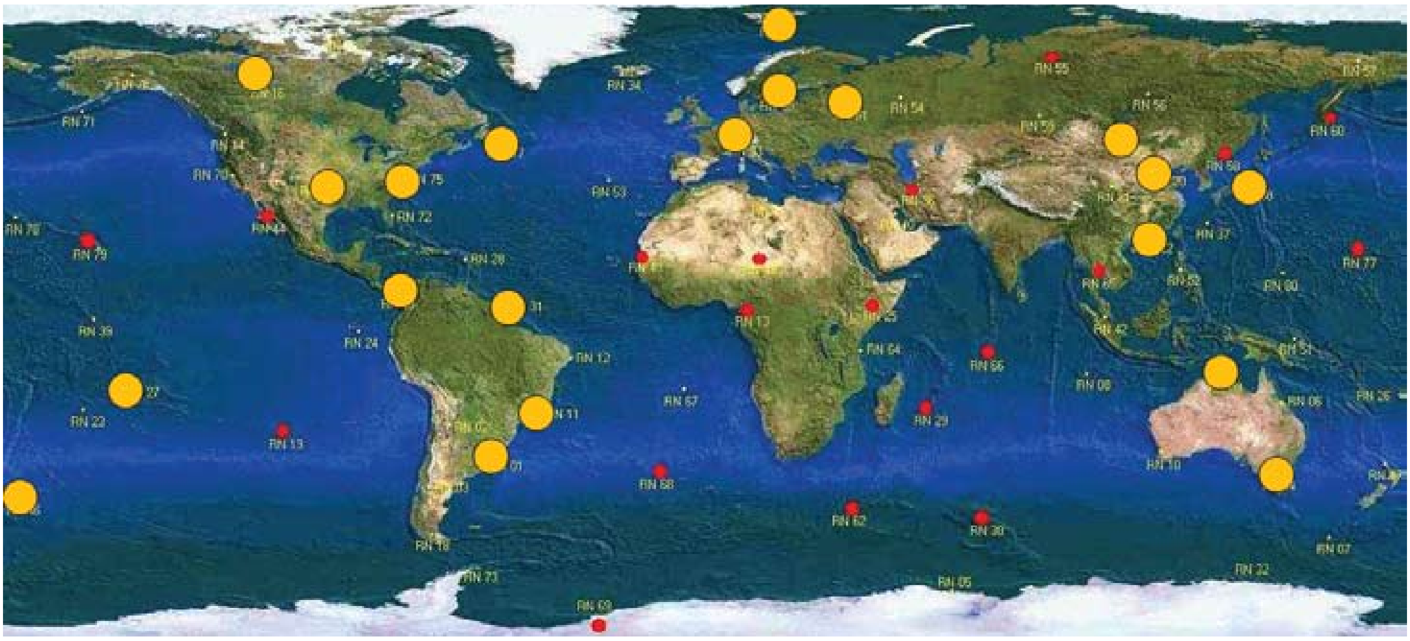
Hydroacoustic station at Wake Island, United States

When hydroacoustic station HA11 at Wake Island became the tenth station to be certified on 8 June 2007, it represented a milestone for the CTBTO: the network's capabilities have been enhanced to such an extent that the chances of an underwater nuclear explosion going unnoticed have been virtually eliminated.

Located in the middle of the North Pacific Ocean, Wake Island is administered by the United States. HA11's remoteness and specialized requirements all contributed to make it the most expensive station ever constructed by the CTBTO at a cost of about US$ 18 million. The US Air Force Technical Applications Center (AFTAC) has provided both financial support and technical expertise.

Hydroacoustic Monitoring

The IMS hydroacoustic network is comprised of hydrophone and T-phase (seismic) stations. These stations monitor the world's oceans for evidence of nuclear tests by measuring changes in water pressure caused by sound waves emanating from underwater explosions. Few stations are required because water is a highly efficient medium for the transmission of sound.



NOBLE GAS NETWORK. YELLOW CIRCLES DEPICT THE 20 RADIONUCLIDE STATIONS WITH NOBLE GAS EQUIPMENT INSTALLED AS OF MARCH 2009.
THE RED DOTS REPRESENT THE REMAINING STATIONS THAT ARE YET TO BE EQUIPPED WITH NOBLE GAS CAPABILITIES.
IN OCTOBER 2006 ONLY 10 OF THE PLANNED 40 STATIONS WERE OPERATING IN TEST-MODE.

Infrasound highlights

Since May 1998, 41 infrasound stations in 25 countries have been certified, meaning that almost 70 percent of the network's stations already comply with the CTBT's stringent requirements. Another five stations are currently under construction, bringing the target of 60 stations around the world even closer. None of these stations were in existence when the CTBT opened for signature.

The global distribution pattern of infrasound stations has resulted in a series of regional networks across North America, Latin America, Europe, Africa and Australia.

Six infrasound stations have been certified since October 2006. The most recent certifications were at IS45 at Ussuriysk in the Russian Federation, and at IS51 in Bermuda (British Overseas Territory), which both took place on 18 December 2008.

Infrasound Monitoring

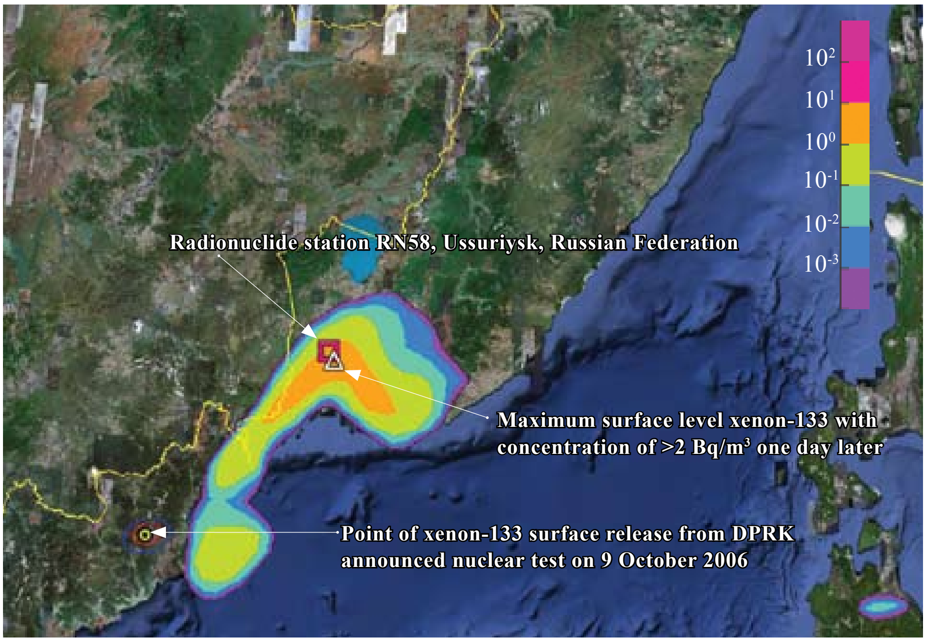
Infrasound is inaudible sound with frequencies below the human hearing threshold of 20 Hz. Sources of infrasound include nuclear tests, chemical explosions, sonic booms, severe weather, meteors, earthquakes, and volcanoes. Infrasound stations use infrasonic sensors to measure micropressure changes in the atmosphere generated by the propagation of infrasonic waves, which can be caused by atmospheric nuclear explosions or shallow underground explosions.

Infrasound station in Bermuda

Installing a monitoring station can be a challenging experience, especially in an area that is susceptible to hurricanes, like Bermuda. In order to ensure a constant data flow in the event of a hurricane or tropical storm, the CTBTO is working on emergency plans to prevent major damage to IS51. This will be achieved through the establishment of an additional virtual private network (VPN) link between the Central Recording Facility (CRF) and Vienna. What might constitute a potential danger for the maintenance of IS51, however, makes the station extremely interesting to the scientific community since it might contribute valuable data on hurricanes and tropical storms in the future.

Radionuclide highlights

A total of 55 radionuclide facilities in 26 countries have been certified over the last decade, with 15 of these certifications having



READINGS OF XENON-133 AT RN58 THE DAY AFTER THE DPRK ANNOUNCED TEST WOULD HAVE BEEN AT LEAST 500 TIMES HIGHER THAN THE CONCENTRATIONS ACTUALLY MEASURED AT YELLOWKNIFE, CANADA TWO WEEKS LATER.

PHOTO COURTESY OF ANDREAS BECKER, CTBTO.

taken place since the DPRK test. Five stations were certified in the Russian Federation in 2008, including RN56 in Peleduy in the middle of Siberia and RN60 in Petropavlovsk-Kamchatsky in the Russian Far East. RN60 is equipped with noble gas facilities and is strategically located to monitor the Pacific area. In addition, one radionuclide station was installed in the Russian Federation in 2008 and civil work contracts are underway for two more stations.

China hosts three radionuclide stations, which will transmit data to the IDC upon installation of a link to Vienna. China also contributes to the CTBTO by providing noble gas data to the International Noble Gas Experiment (INGE), which tests the detection and measuring of radionuclide noble gases.

Noble gas systems for Asia and Africa

RN58 at Ussuriysk, Russian Federation, has now been installed with noble gas equipment and would have played a crucial role in October 2006. According to the IDC's refined atmospheric transport calculations, RN58 would have picked up traces of xenon-133 from the DPRK announced test just one day later: readings would have been at least 500 times higher than the concentrations measured at Yellowknife, Canada two weeks later.

Radionuclide station RN13 in Edea, Cameroon, was certified on 30 November 2007 and will be the first IMS radionuclide station in Africa to be equipped with a noble gas detection system. Installation of noble gas equipment at RN13 is scheduled for 2009.

IMS expansion greatly reduces chances of nuclear test going undetected

When the CTBT's verification regime detected the DPRK's test, it added credence to the 2002 study by the U.S. National Academy of Sciences' conclusion that it would be very difficult for States with limited nuclear testing experience to avoid detection by testing weapons of one kiloton or less.

Given the considerable progress that has been achieved over the past decade and the experience gained, there is a very high probability today that States would be able to discover any nuclear test using data generated by the CTBT's verification regime and additional monitoring capabilities available to individual States. As the network of monitoring stations spanning the globe becomes more extensive, the chances of a nuclear test going unnoticed have decreased even further. ■

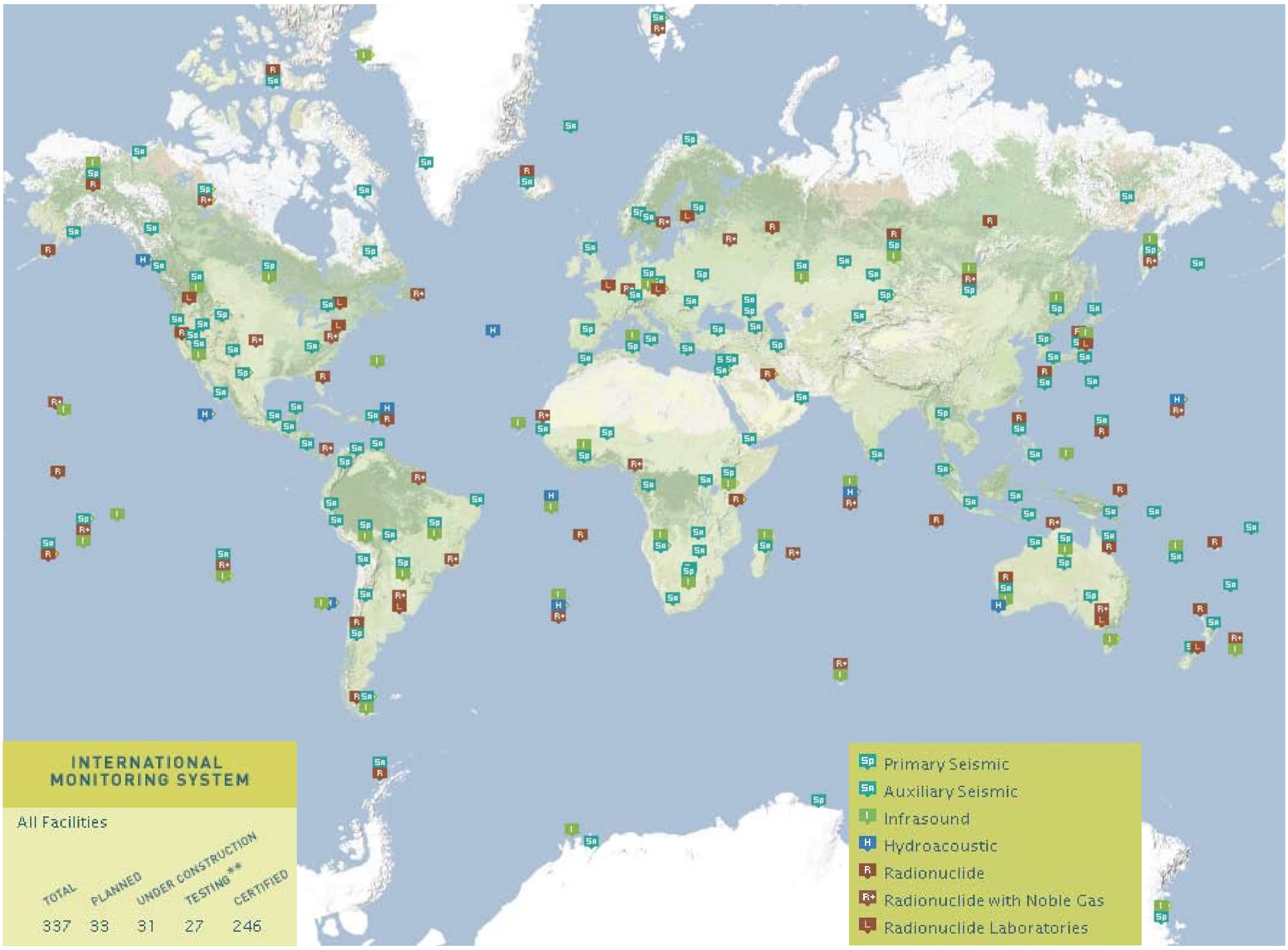
Denise Brettschneider is working as a writer and editor with the CTBTO's Public Information section. She has a number of years of editorial experience working for organizations in Kenya including the United Nations Educational, Scientific and Cultural Organization. ■

Radionuclide Monitoring

By collecting and analyzing the debris of a nuclear explosion, radionuclide technology can provide conclusive evidence that an explosion has been nuclear in nature and is therefore of crucial importance to the entire verification effort. Any potential violator would need to consider that any radioactive gases vented from a clandestine nuclear test would be detected by the IMS.

Status of certified IMS facilities

246 certified International Monitoring System (IMS) facilities as of 20 March 2009



Notes & quotes

"The CTBT is an important instrument for strengthening the international regime of nuclear non-proliferation and nuclear arms limitation. Russia has ratified the CTBT in year 2000, and has been consistently promoting its early entry into force. Observance of the nuclear tests' moratorium, however important it might be, is no substitute for legal obligations under the CTBT. We therefore urge all countries whose participation is vital for this Treaty's entry into force to sign and/or ratify it as soon as possible."

Sergey B. Ivanov, First Deputy Prime Minister, Russian Federation, speaking at the 45th Munich Security Conference, 6 February 2009

Verification science

Testing the Treaty's on-site inspection capabilities: The Integrated Field Exercise 08

by Oliver Meier and Andreas Persbo

INSPECTORS SEARCH FOR ANOMALIES IN THE SURROUNDINGS TO IDENTIFY THE LOCATION OF A POSSIBLE NUCLEAR EXPLOSION

The Integrated Field Exercise 2008 (IFE08) was a large-scale simulation conducted in September 2008 to assess the state of readiness of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization's (CTBTO) on-site inspection (OSI) regime. IFE08 demonstrated that the CTBTO's [1] efforts to lay the groundwork for future inspections are on the right track. Based on the exercise, it can be expected that the CTBTO will be able to conduct a successful OSI once the Treaty has entered into force. The biggest hurdle to finalizing future OSI procedures has been the absence of the United States and non-signatories like India and Pakistan from preparations.

[1] Once the Comprehensive Nuclear-Test-Ban Treaty enters into force, the Preparatory Commission will cease to exist and the CTBTO will become a fully operational.

An OSI is a strong deterrent to potential Treaty violators

On-site inspections add a crucial layer of security to the Treaty's verification regime. If an ambiguous event is detected by the International Monitoring System (IMS), any Member State may request an OSI to seek clarification as to whether a prohibited test has indeed taken place. The CTBTO's ability to conduct an inspection in a swift and effective manner once the Treaty has entered into force will thus act as a strong deterrent to a potential proliferator, who would think twice before conducting a clandestine nuclear test if inspectors have a high likelihood of finding the smoking gun of a Treaty violation.

Longest and hardest exercise to date

IIFE08 provided a realistic assessment of the CTBTO's preparations because, for the first time ever, virtually all OSI

A CRATER FORMED BY AN UNDERGROUND NUCLEAR EXPLOSION

INSPECTOR USING BINOCULARS TO LOOK FOR ANOMALIES ON THE GROUND.

VISUAL OBSERVATION IS AN IMPORTANT TECHNIQUE DURING THE INITIAL INSPECTION PHASE.

components were tested in combination. The four-week exercise, which involved more than 200 participants, was the longest and hardest of its kind to date. Members of the inspection team were faced with a tough and realistic scenario. The inspection team, which arrived in Kazakhstan's capital Almaty on 1 September 2008, had been briefed that a seismic event had been detected by IMS sensors at the former nuclear test site of the fictional state of Arcania. The Arcanian government denied any wrongdoing and claimed that an earthquake had triggered the event. Participants played out this scenario to the full and – as is to be expected in a real inspection – the relationship between the inspection team and Arcanian hosts fluctuated repeatedly between cooperation and confrontation.

Initial inspection phase

The choice of inspection area, which was located in a remote corner of the former Soviet Union test site, Semipalatinsk, ensured that equipment was tested under realistic conditions. IFE08 got off to a difficult start because of unexpectedly cold, wet and rainy weather. But inspection team members managed to move more than 50 tonnes of equipment within days to the base of operations and set up camp. The first 12 days were spent surveying the 1,000 square kilometre inspection area. During this initial inspection phase, inspectors primarily looked for anomalies that might be indicative of a nuclear test and tried to narrow down the search area. For example, they deployed 28 seismic sensors in the field, which covered 80 to 90 percent of the inspection area and picked up even small tremors, such as those that might be indicative of a collapsing cavity created by an underground nuclear test explosion.

Exercise continues to next level

By sending inspectors into an area in which the Soviet Union had conducted 458 nuclear tests between 1949 and 1991, a good deal of reality was injected into the exercise. This was particularly the case during the continuation phase of the inspection, which is used to investigate specific anomalies: instruments successfully located and identified cavities created by underground tests, even though some were over 20 years old. All in all, 10 different

OVER 50 TONNES OF EQUIPMENT WERE SHIPPED TO THE INSPECTION AREA.

inspection technologies were used successfully and more than 50 potential future inspectors received valuable training.

Opportunity to test the draft Operational Manual

The exercise was also useful in evaluating operational procedures for future OSIs. Finding the correct balance between the rights and obligations of inspectors and the inspected State Party will be crucial for the success of any real inspection. For the purpose of the exercise, the Member States developed a 178-page draft Operational Manual to guide the inspection team and inspected State Party officials. Many participants expect that the lessons learned during the exercise will infuse new life into diplomatic consultations on the Operational Manual, which will guide the conduct of any future, actual inspection.

IFE08 concludes successfully

The outcome of IFE08 confirms that more than 10 years of OSI preparations by the CTBTO have paid off. The basic capabilities needed to conduct an on-site inspection are in place. What is now needed is a realistic expectation that the Comprehensive Nuclear-Test-Ban Treaty (CTBT) will enter into force in the not-too-distant future. This would instill more urgency into discussions on the future OSI regime. One positive signal in this regard would be a quick revision by the Obama administration of the decision by George W. Bush to boycott discussions on OSI and withhold funding for all CTBTO activities related to OSI.

CTBT proves its verifiability

This OSI milestone testifies to the robustness of the burgeoning verification regime, which looks destined to become far more effective than most expected when the CTBT was negotiated. In any event, what occurred on the steppes of Kazakhstan should inspire confidence in the CTBTO's operational readiness by the time the Treaty becomes legally binding. ■

Biographical note

Dr. Oliver Meier is the international representative and correspondent of the Washington-based Arms Control Association, a nonpartisan organization dedicated to promoting public understanding of and support for effective arms control policies. He is also a researcher with the Institute for Peace Research and Security Policy at the University of Hamburg.

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Both authors participated as NGO observers in the IFEO8. ■

THE INSPECTION'S BASE CAMP WAS LOCATED OVER 150 KM AWAY FROM THE NEXT TOWN.

Secretariat snaphots

The International Scientific Studies (ISS) project: Facilitating scientific collaboration

by Ola Dahlman

Back in the 1970s, twenty years before the Comprehensive Nuclear-Test-Ban Treaty (CTBT) opened for signature, scientists from around the world played a key role in defining the Treaty's verification regime.

The Group of Scientific Experts (GSE) was established at the Conference on Disarmament in Geneva, a multilateral negotiation forum, and started to design and test a seismological global system for the verification of a comprehensive nuclear test ban in 1976. The GSE's system was also used as a model for all of the CTBT's monitoring technologies.

The CTBT, whose verification regime is the most complex and extensive ever created for a multilateral disarmament and non-proliferation treaty, uses advanced science and technology in a large number of disciplines. As well as developing the technical aspects of the Treaty, scientists have played an equally crucial role in implementing it either as members of the working group on verification issues of the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) or as CTBTO staff members.

Establishing and maintaining the CTBT's verification regime

One of the CTBTO's overriding goals is to establish and maintain a credible verification regime as prescribed by the Treaty. When the Treaty enters into force, the CTBTO must be able to:

- Maintain a viable and professional organization. This in turn requires that the CTBTO can recruit and retain highly professional staff members.
- Provide Member States with data products that meet high international standards.
- Operate and maintain the International Monitoring System (IMS) and perform the Treaty's International Data Centre (IDC) data analysis in a cost – effective way whilst meeting high quality standards.
- Further increase the readiness to conduct on-site inspections (OSI), including the development of OSI inspection technologies.

CTBTO must stay attuned to scientific and technological developments

To provide confidence and credibility, the CTBTO must be able to match the performance and quality of any national authority. The CTBTO must thus stay attuned to scientific and technological (S&T) developments and be able to incorporate such developments as appropriate.

Close cooperation with the scientific community is thus of strategic importance to the CTBTO, and the International Scientific Studies (ISS) project is a concerted effort to promote such cooperation. The project, which was launched in March 2008, has a long- and a short-term goal.

Long-term goal: Strategic partnership between CTBTO and the scientific community

The long-term goal of the ISS project is to develop a strategic partnership with the scientific community. The CTBTO has a number of scientists among its staff but it is not an organization tasked to carry out research; it has benefited and will continue to gain from S&T developments carried out at universities, research organizations and industries.

As well as keeping abreast of these developments, the CTBTO also needs to integrate knowledge from several disciplines into its operational and data analysis procedures and assess the implication of such new developments to its core functions. Based on such assessments, the CTBTO might decide to develop, test and implement new procedures or system components with industries on a commercial basis as well as with universities and research organizations.

SCIENTIFIC EXPERTS AND REPRESENTATIVES PARTICIPATING IN THE FIFTH SESSION OF THE AD HOC GROUP OF SCIENTIFIC EXPERTS, HELD IN GENEVA, FEBRUARY TO MARCH 1978.

A close relationship with the scientific community will also facilitate the recruitment of staff members with relevant scientific backgrounds.

Short-term goal: Evaluating the CTBT's verification regime

The project's short-term goal is to evaluate the capability and readiness of the CTBT's verification regime, both the IMS and the OSI regime, and to address the implications of the most significant S&T developments since the Treaty opened for signature in 1996. The assessments are conducted by scientists and scientific institutions worldwide; the CTBTO merely provides a coordinating and secretariat role.

We have witnessed not only gradual development in all areas but also some dramatic ones. Noble gas monitoring stations have now been developed and deployed in many places around the globe and the first

ever results from such measurements on a global scale are becoming available. These measurements may dramatically enhance the deterrence capability of the CTBT's verification regime.

In the field of infrasound, the first ever global network has started to provide data that form the basis for the re-emergence of a science that declined in popularity when atmospheric nuclear testing ended in 1980 until interest was revived with the establishment of the IMS's infrasound stations. Infrasound monitoring might also provide a unique insight into the properties of the atmosphere with applications beyond CTBT monitoring.

ISS project builds on efforts by scientists around the world

The ISS project is a new experience for the CTBTO as most of the activities take place independently and outside the organization. The project also benefits from the broad participation of the scientific community. In many ways the ISS project's method of work resembles that of the Intergovernmental Panel on Climate Change (IPCC), as it builds on and integrates efforts by a large network of scientists around the world.

Project activities include meetings and workshops with scientists in different fields, and active participation in scientific conferences. Joint studies are also conducted with scientific institutions on how to apply modern analysis methods to improve the efficiency of data analysis and the quality of related products.

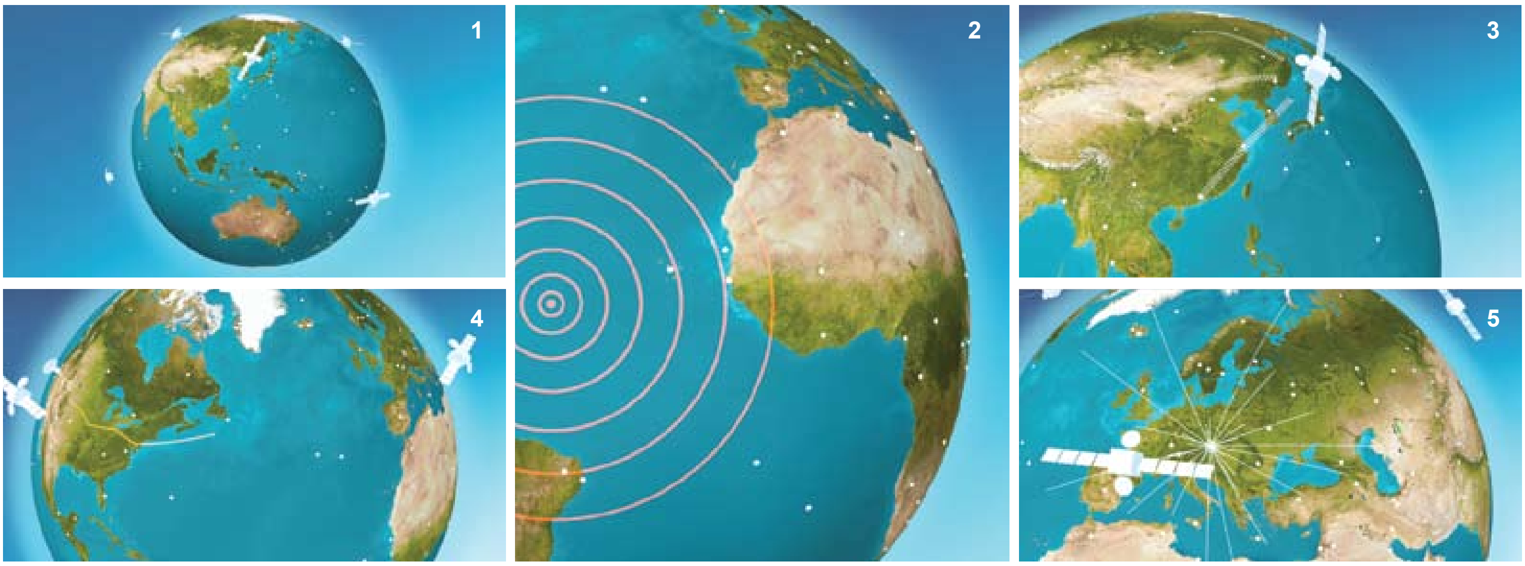
ISS09 Conference

The next main event will be the ISS09 Conference at the Hofburg Imperial Palace in Vienna, Austria from 10 to 12 June 2009. The topics to be covered by the Conference are outlined on page 3 and more detailed information is available at the dedicated area for the ISS project at www.ctbto.org.

The Conference will present the findings of the most comprehensive assessment of the CTBT's verification regime ever conducted and will discuss how science has evolved since the Treaty was negotiated. Involvement by the scientific community is of utmost importance to determine the system's capabilities and how it can be further improved within the framework of the Treaty. ■

Biographical note

Dr. Ola Dahlman has been engaged in arms control negotiations for over 30 years and spent his entire professional career at the Swedish Defense Research Institute in Stockholm, Sweden. He chaired the Group of Scientific Experts before and during the CTBT negotiations from 1982 to 1996. He subsequently headed the CTBTO's Working Group on verification issues from 1996 to 2006. Dr. Dahlman is currently leading the International Scientific Studies project. ■



THE GLOBAL ALARM SYSTEM
1 THE VERIFICATION REGIME STANDS READY
2 AN EXPLOSION TRIGGERS SHOCKWAVES THAT ARE DETECTED BY SEVERAL STATIONS...
3 ...WHICH IMMEDIATELY TRANSMIT THE SIGNALS THROUGH SATELLITES...
4 ...AND SECURE DATA CONNECTIONS ON THE GROUND TO THE IDC IN VIENNA.
5 FROM THE IDC, RAW DATA AND THEIR ANALYSES ARE DISTRIBUTED TO THE CTBT MEMBER STATES.

Verification science and potential civil applications

The importance of Atmospheric Transport Modelling: Over ten years of cooperation between the World Meteorological Organization and the CTBTO

by Peter Chen, Gerhard Wotawa and Andreas Becker

PART 2: THE NEW CTBTO-WMO RESPONSE SYSTEM AND OTHER RECENT HIGHLIGHTS

Part 1 of this article appeared in Issue 11 of Spectrum in September 2008. It outlined advances in Atmospheric Transport Modelling (ATM) since Chernobyl and areas of cooperation between the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and the World Meteorological Organization (WMO) including ATM, especially since their cooperation agreement was formalized in 2003.

When a joint response system between the CTBTO and the WMO entered into provisional operation on 1 September 2008, it represented a major step forward in detecting nuclear explosions.

The system uses ATM to backtrack the three-dimensional travel paths of radionuclides from where they were detected by one of the 80 radionuclide stations belonging to the CTBTO's International Monitoring System (IMS), to the area where they may have originated. As of March 2009, 55 of these stations had already been certified as meeting the CTBTO's strict standards and were transmitting data to the International Data Centre (IDC) in Vienna on a continuous basis. Another 17 radionuclide stations were either installed or under construction.

The response system: what happens if an anomalous radionuclide is detected

The IMS's radionuclide stations around the world send data to the IDC, where they are processed and analyzed. Whenever a radionuclide measurement from one of the stations is categorized by the IDC as indicative of a possible violation of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which bans all nuclear weapon testing anywhere on Earth, the following sequence of events takes place:

- The IDC sends notifications requesting support to nine WMO Regional Specialized Meteorological Centres/National Meteorological Centres around the globe.
- The requests inform the Centres of the measurement period and location of the IMS station that has detected the suspicious radionuclide and the five closest radionuclide stations. While the computations from the station that detected the event are the most relevant, backtracking by the neighbouring stations can help to further constrain the possible source region of a radionuclide.
- The WMO Centres submit their high-quality global ATM computations for all requested stations to the IDC within the next 24 hours.
- In case several radionuclide stations detect suspicious radionuclides, IDC staff would use the ATM results calculated in-house together with the results delivered by the WMO Centres to assist Member States to identify the possible source of the event.

Between September 2008 and March 2009, five requests for support were sent out to WMO Centres. None of the suspicious radionuclides examined were part of a multiple station detection scenario or indicated a possible nuclear test.

Why we need the response system

The reason why this corroborative response system is needed is simple. The reliability of one model calculation alone is limited. A number of calculations originating from the world's leading meteorological centres, however, significantly improve the reliability and certainty of the results through a diversity of computational methods that account for uncertainties in the atmospheric modelling. This method increases the confidence of the CTBTO's Member States in the IDC's related data analyses. The complementary information from the WMO specialized meteorological centres thus adds considerable credibility and reliability to the whole system and greatly enhances the CTBTO's ability to determine the location of a possible nuclear explosion.

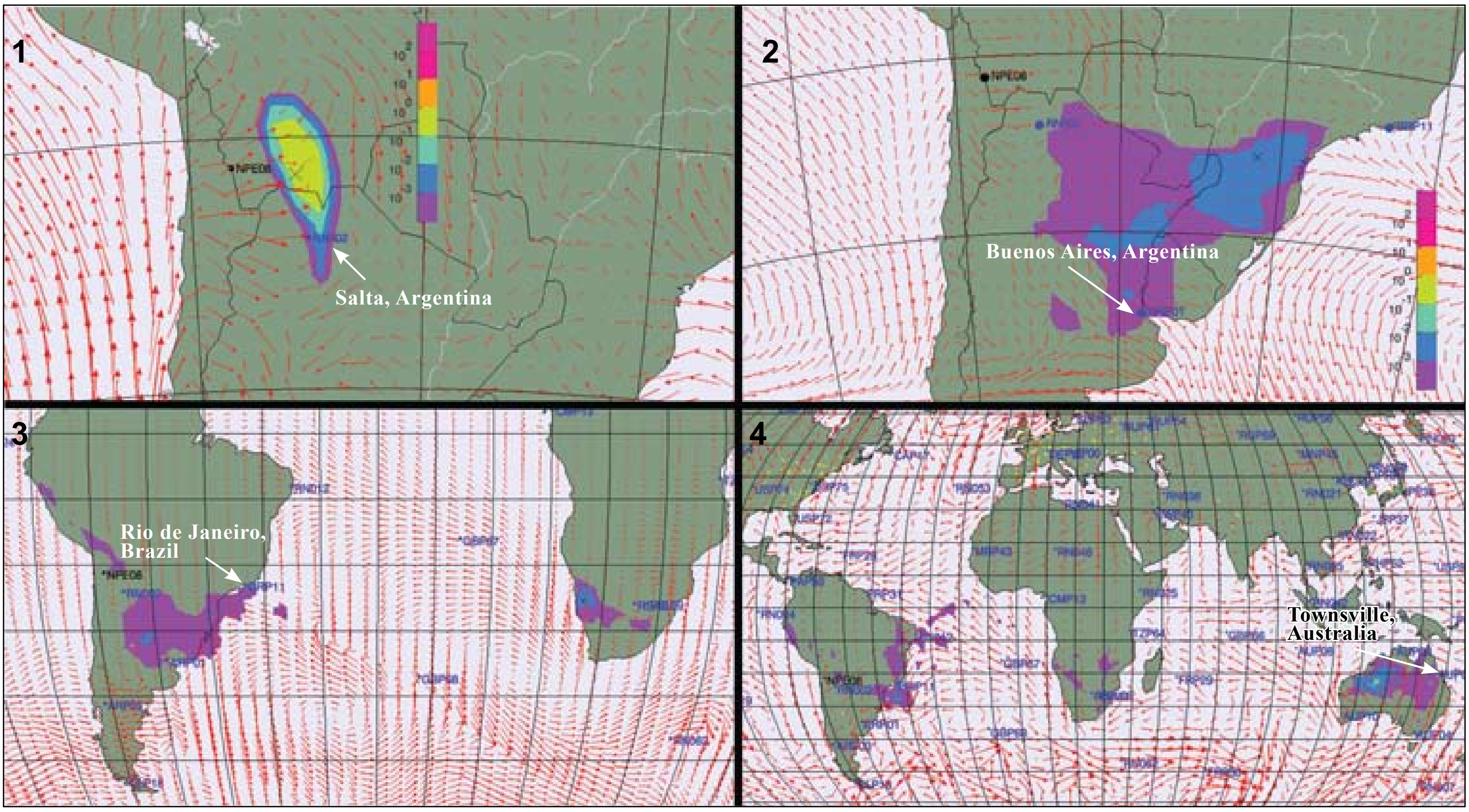
Data fusion: helping to find a needle in a haystack

The overall objective of possible source region analysis is to look for co-location with seismic explosion signals. This helps to establish whether the suspicious radionuclide measured by the radionuclide station could possibly have originated from a seismic event recorded at the same place and time. This analysis is called data fusion.

The IDC uses a software tool called WEB-GRAPE (web connected graphics engine) to identify the possible emission points of a radionuclide event and to perform the data fusion analysis mentioned above. The results are then communicated to the Member States to assist them in their assessment of the event.

Regular experiments ensure that the system is reliable

In order to ensure that this joint response system is well-maintained and fully functional, regular exercises are necessary. Joint global



THE FOUR STAGES OF A SIMULATED FORWARD NUCLEAR PLUME OVER A 17 DAY PERIOD FOLLOWING THE ASSUMED SURFACE RELEASE OF 10^{15} BECQUEREL OF THE RADIOACTIVE ISOTOPE, BARIUM-140. IT WAS DETECTED BY FOUR RADIONUCLIDE (RN) STATIONS: FIRST BY RN02 IN SALTA, ARGENTINA, THEN RN01 IN BUENOS AIRES, ARGENTINA, FOLLOWED BY RN11 IN RIO DE JANEIRO, BRAZIL, AND FINALLY RN06 AT TOWNSVILLE, AUSTRALIA. THE WIND THAT TRANSPORTED THIS PLUME IS DISPLAYED AS RED ARROWS. THIS TOOK PLACE DURING THE NDC PREPAREDNESS EXERCISE 2008.

exercises between the CTBTO and the WMO are therefore conducted once a year.

The goals of the exercise are threefold:

1. To test the timeliness and quality of the response of the WMO Centres.
2. To assess the reliability of the CTBTO's atmospheric transport computations.
3. To validate IDC data fusion capabilities under the assumption that a complete radionuclide network is already in existence.

In order to investigate IDC data fusion capabilities, the design of the exercise scenario has to be linked with a pre-selected seismic event. Such an event (the epicentre of an earthquake) is selected from the IDC's Standard Event List, a list which includes the location of seismic events. For the purposes of the exercise, it is then assumed that the selected event was a nuclear explosion, which released 10^{15} Becquerel[1] of a hypothetical, inert and long-lived radionuclide into the atmosphere. The assumption corresponds to the amount of the noble gas xenon-133[2], expected to be released during the first hours after the detonation of a one kiloton underground nuclear explosion that was not fully contained.

On that assumption, the CTBTO uses its ATM tools to predict a radionuclide measurement scenario that would suggest a Treaty violation, thus triggering the response system. This exercise is conducted along identical timelines to those applicable in the case of a real nuclear event so as to make the exercise as realistic as possible.

CTBTO-WMO exercises based on a hypothetical measurement scenario triggered by a selected seismic event were conducted in 2007 and 2008. In 2007, the event was selected by the CTBTO. In the subsequent exercise, the event was selected by the German National Data Centre (NDC) as part of the NDC Preparedness Exercise 2008[3].

ATM is an advanced computer-based technology for the calculation of the travel path of a given radionuclide, using meteorological data. This calculation can be performed in one of two ways:

- As **backtracking ATM**, which tries to identify the area from which a radionuclide may have been released calculated from the location where it was observed; or as
- **Forward ATM**, which predicts where radionuclides may travel from their known point of release.

[1] Becquerel is the amount of radioactive material in which one atom transforms every second.
[2] Xenon is a chemical element in gaseous form, which is called a noble gas since it is inert and rarely reacts with other chemicals. Several of its radioactive isotopes, of which one of the isotopes is xenon-133, can only be produced by a nuclear reaction and are therefore measured to detect clandestine underground nuclear explosions.
[3] The aim of this exercise was to enhance the ability of NDCs to detect and identify nuclear explosions.

Important lessons learned

A number of lessons were learned from both exercises. The CTBTO-WMO response system proved that it was able to perform at full efficiency in 2008, with all participants responding in a timely and accurate manner. In both exercises, the interactive data fusion method described above was able to narrow down the number of relevant seismic events that could have caused the radionuclide event from several hundred to two, illustrating the system's effectiveness.

With the CTBTO-WMO response system up and running and procedures for radionuclide source location and data fusion undergoing testing, an important element of the Treaty's verification regime when it enters into force is now in place. This system is unique and will add considerable value to the radionuclide monitoring efforts of the CTBTO.

Other synergies: scientific-technical cooperation

The WMO Secretariat continues to play an important role in ongoing ATM activities, including the International Scientific Studies (ISS) project, acting as an ATM topic coordinator *(see page 24 for more information about the project).*

The CTBTO and the WMO are open to extending their collaboration in line with the provisions of the 2003 cooperation agreement between the two organizations. This includes any field where IMS data may be useful for scientific research and development, such as emergency response or disaster mitigation. All of these potential civil and scientific applications of the CTBT's verification technologies serve as a means for enhancing capacity building, especially in developing countries. Further opportunities may also arise in the future for Member States, especially countries that host IMS facilities, for example, to participate more directly in climate change efforts if use can be made of the CTBT's verification data and/or communication infrastructure.

REGIONAL SPECIALIZED METEOROLOGICAL CENTRES (RSMCS) AND THE NATIONAL METEOROLOGICAL CENTRE (NMC) THAT ARE PART OF THE CTBTO-WMO RESPONSE SYSTEM

Climate change presents an unprecedented challenge for humanity and requires coordinated action by the international community. The WMO was designated by the United Nations Secretary-General to act as convener, together with United Nations Educational, Scientific and Cultural Organization (UNESCO), for the proposal of joint activities in the cross cutting area of climate knowledge: science, assessment, monitoring and early warning as part of the UN initiative "Acting on Climate Change: The UN System delivering as One."

In the past, the CTBTO has taken maximum advantage of the WMO's global data and operational numerical model infrastructure in the area of emergency response. The CTBTO could also derive additional benefits from exploring other existing infrastructures maintained by WMO and cooperating organizations. In turn, WMO could benefit from the collaboration by further considering the use of data and information that are by-products of the CTBT's verification efforts, which could feed and validate weather, climate and air quality models. ■

Biographical note

Peter Chen is Chief of the Data Processing and Forecasting Systems Division at WMO. He joined WMO in 2004 and is currently in charge of coordinating operational weather forecasting for National Meteorological Services of WMO, including numerical weather prediction, and ATM for environmental emergency response.

Dr. Gerhard Wotawa is a specialist in the modelling of atmospheric chemistry and transport. He joined the CTBTO in October 2000 and currently works as an Atmospheric Sciences Officer at the IDC.

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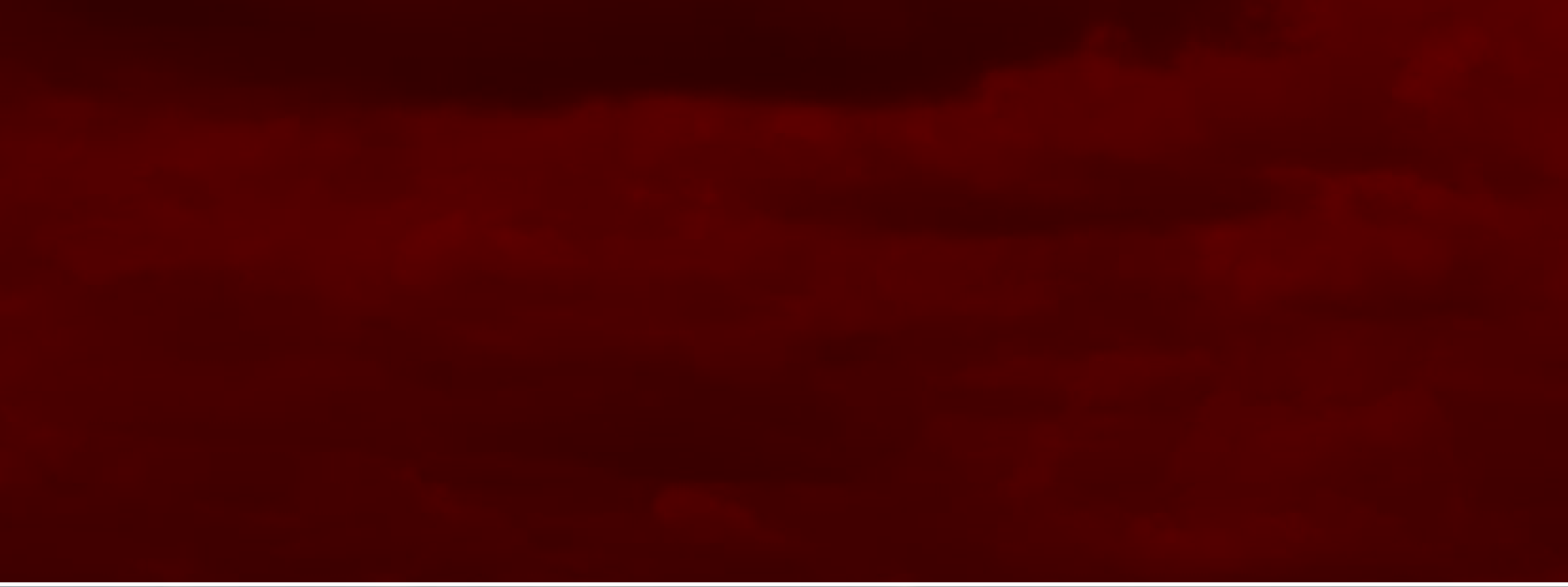

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