The 2003 CTBTO-WMO Experiment: An example how exchange of standardized source receptor relationship data facilitates joint source region estimation

Presented at 9th International Conference on Harmonization within Atmospheric Dispersion Modelling for Regulatory Purposes, Garmisch-Partenkirchen, Germany, 1 - 4 June, 2004

Andreas Becker and Gerhard Wotawa, Atmospheric Sciences Officers, and Lars-Erik De Geer, Unit Head, IDC/RS/Radionuclide Development

Preparatory Commission for the Comprehensive
Nuclear-Test-Ban Treaty Organization
Provisional Technical Secretariat
Vienna International Centre
P.O. Box 1200
A-1400 Vienna
AUSTRIA
andreas.becker@ctbto.org

Outline

1. Introduction

- CTBT Radionuclide Network
- Radionuclide Sample Categorization
- Role of Atmospheric Transport Modelling in the CTBT context

2. PTS Dispersion Modelling Capabilities

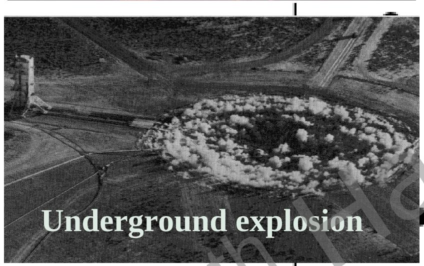
- Source receptor sensitivity field concept
- PTS Layered Atmospheric Transport Modelling (ATM) concept
- Current ATM processing

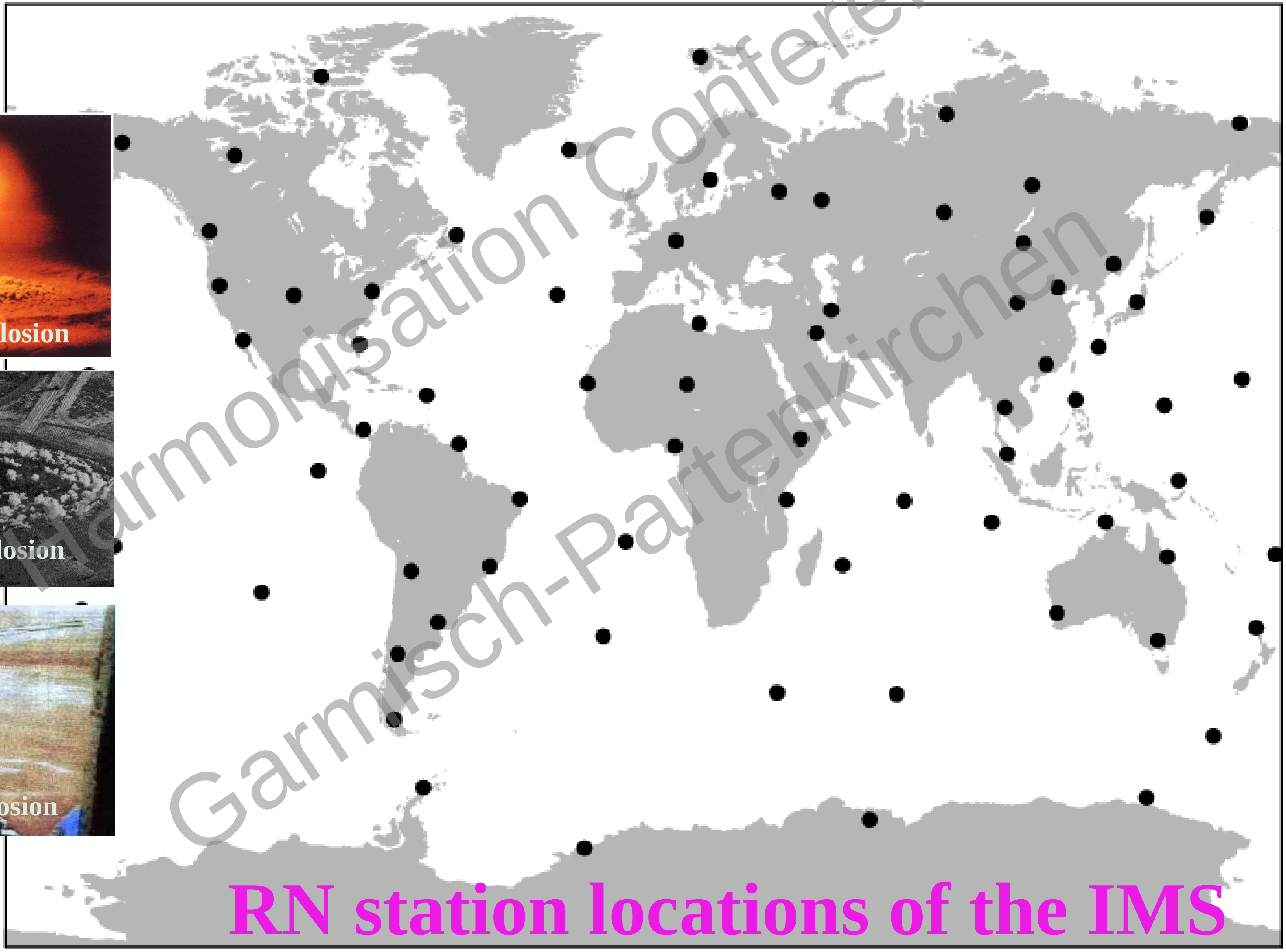
3. Model inter-comparison and SRS fields uncertainty

- Methodology applied for SRS field inter-comparison
- Introduction to the SRS field specific cross-comparison (CC) matrix
- Aggregation of all 23 SRS fields CC matrices into the experiments score table
- Some remarks on the possibilities to quantify SRS fields uncertainty

Summary, Conclusions and Acknowledgements

The CTBT Bans All Nuclear Explosions





CATEGORIZATION OF RADIONUCLIDE SPECTRA

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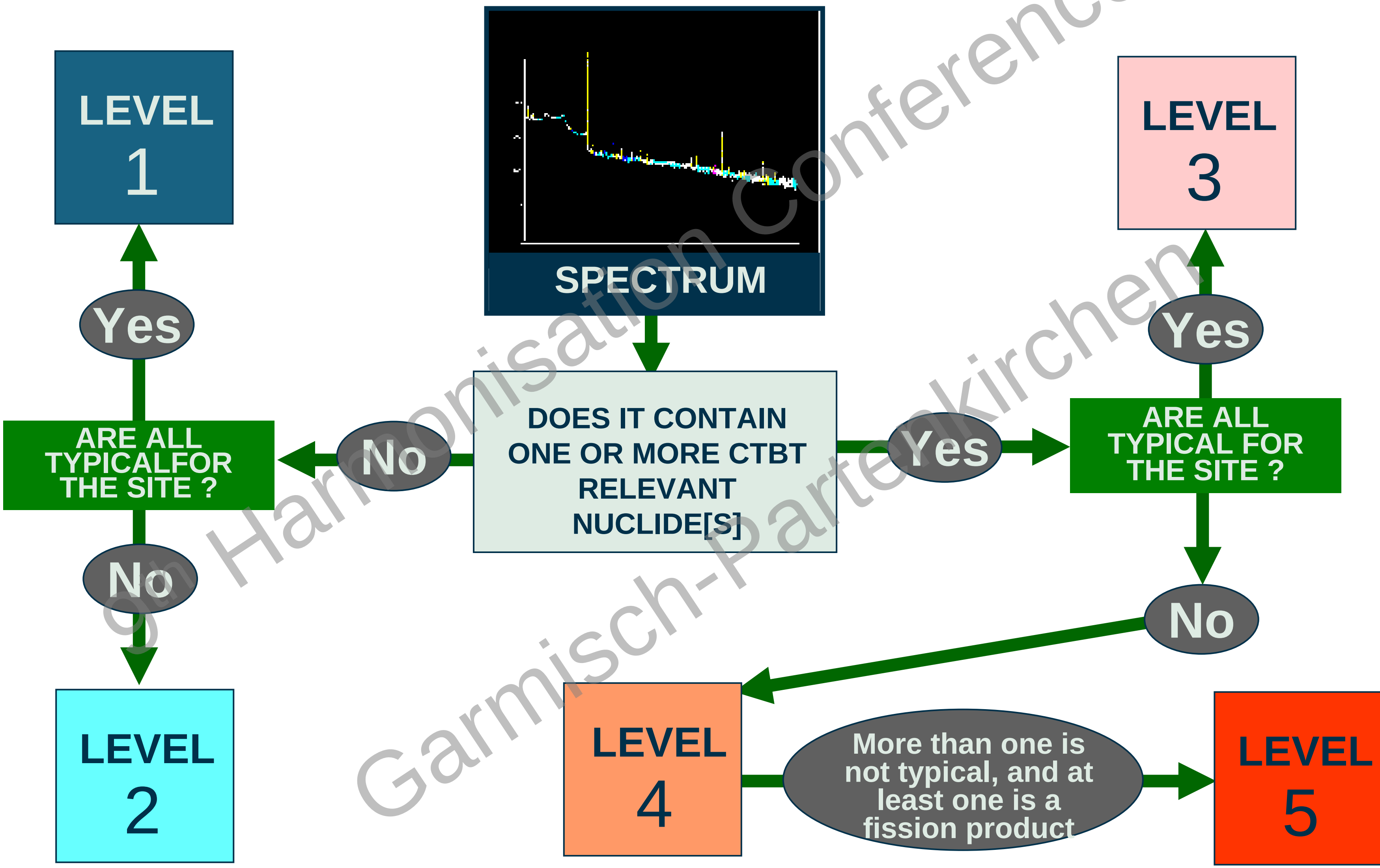

Level 4 & 5 events at operational stations in 2003

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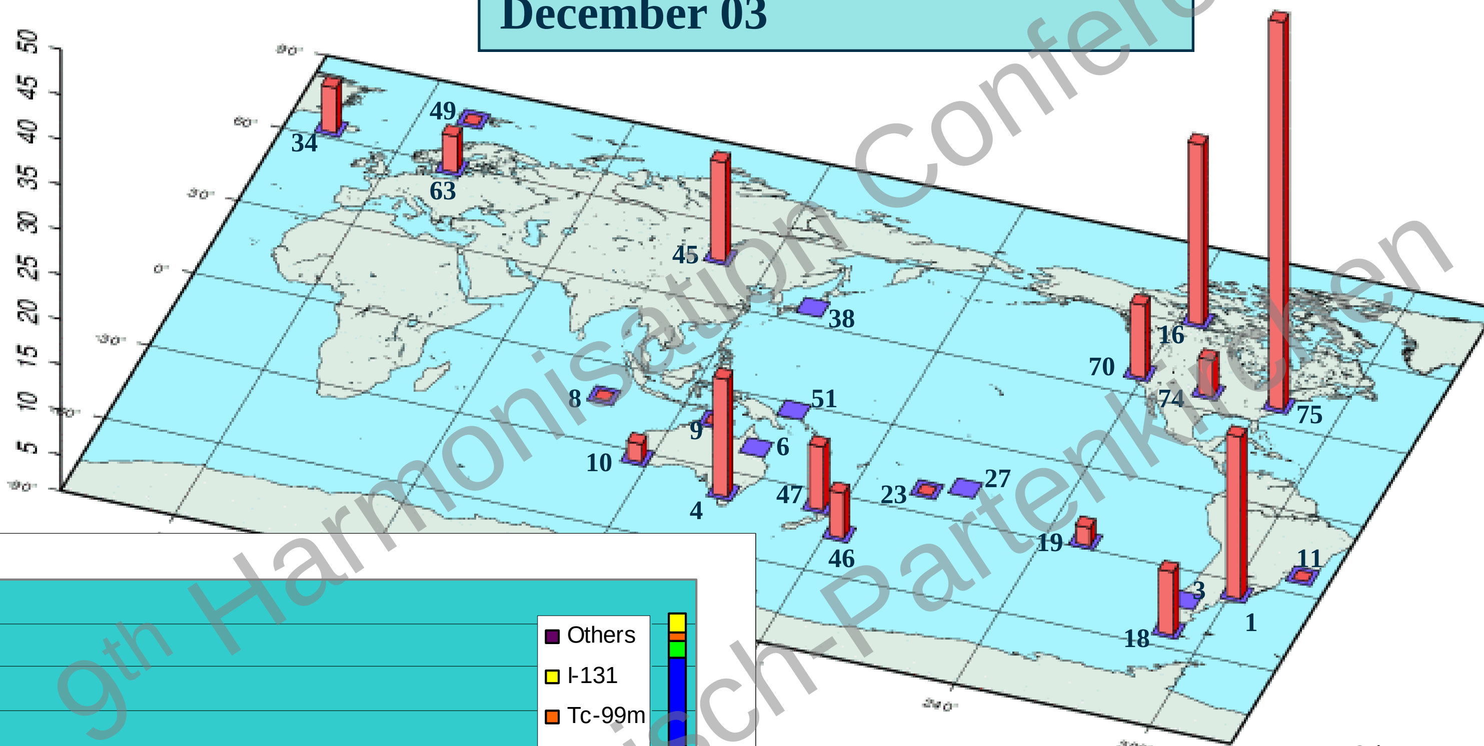
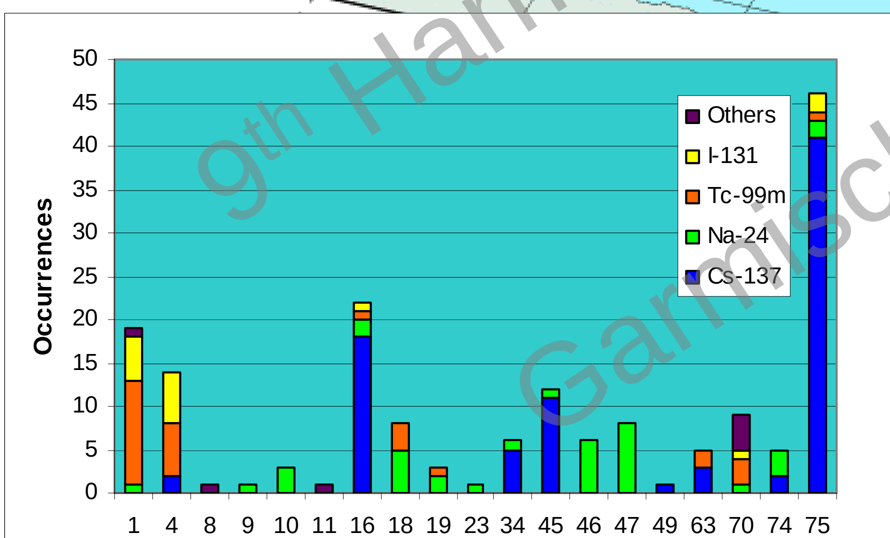
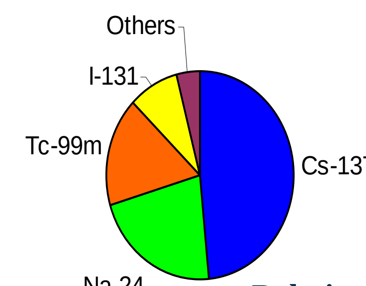
24 Stations in Operations at 31 December 03







Relative nuclide detections

Role of ATM in CTBT Verification

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Why is ATM particularly important for the Radionuclide Technology?

- In the waveform technologies (SHI) it is a straight forward process to geo-locate the source of events with fairly limited uncertainties by generalised triangulation.
- In contrast radionuclide (RN) signals are inherently more difficult to associate with a limited region due to the ever moving medium that carries the signals - the earth's atmosphere
- ***Atmospheric Transport Modelling (ATM) provides the only means of geo-temporal event location for the radionuclide technology. ATM results are a prerequisite for the interpretation of RN data as well as for fusion with SHI events.***

⇒

PTS performs Source Attribution Modelling for a Global Station Network in 24h/7d Mode

Source receptor relationship concept

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Introduce the RN sample specific 3-dimensional (2 spatial, 1 temporal) source receptor sensitivity (SRS) field as the dilution factor field [m^{-3}] which translates any **single grid point** release at position *i,j* and time *n* [Bq] into the measured activity concentration [Bqm^{-3}]:

$$c = M_{ijn} \cdot S_{ijn} \quad [1]$$

In case of *m* different samples at different stations and time intervals, equation [1] expands into a set of linear equations:

$$c_m = M_{m\,ijn} \cdot S_{ijn}$$

- M_m is the SRS field pertaining to sample *m* computed with backward (adjoint) runs of an Atmospheric Transport Model
- The ***sample specific*** ***Field-of-Regard*** (FOR_m) is directly derived from its M_m
- For the ***Possible Source Region*** (PSR) product an inversion problem is solved by putting together the relevant SRS fields yielding the source-receptor matrix ***specific for the (point) source-hypothesis*** tested.

Strengths and Prerequisites of the SRS field concept

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Strengths:

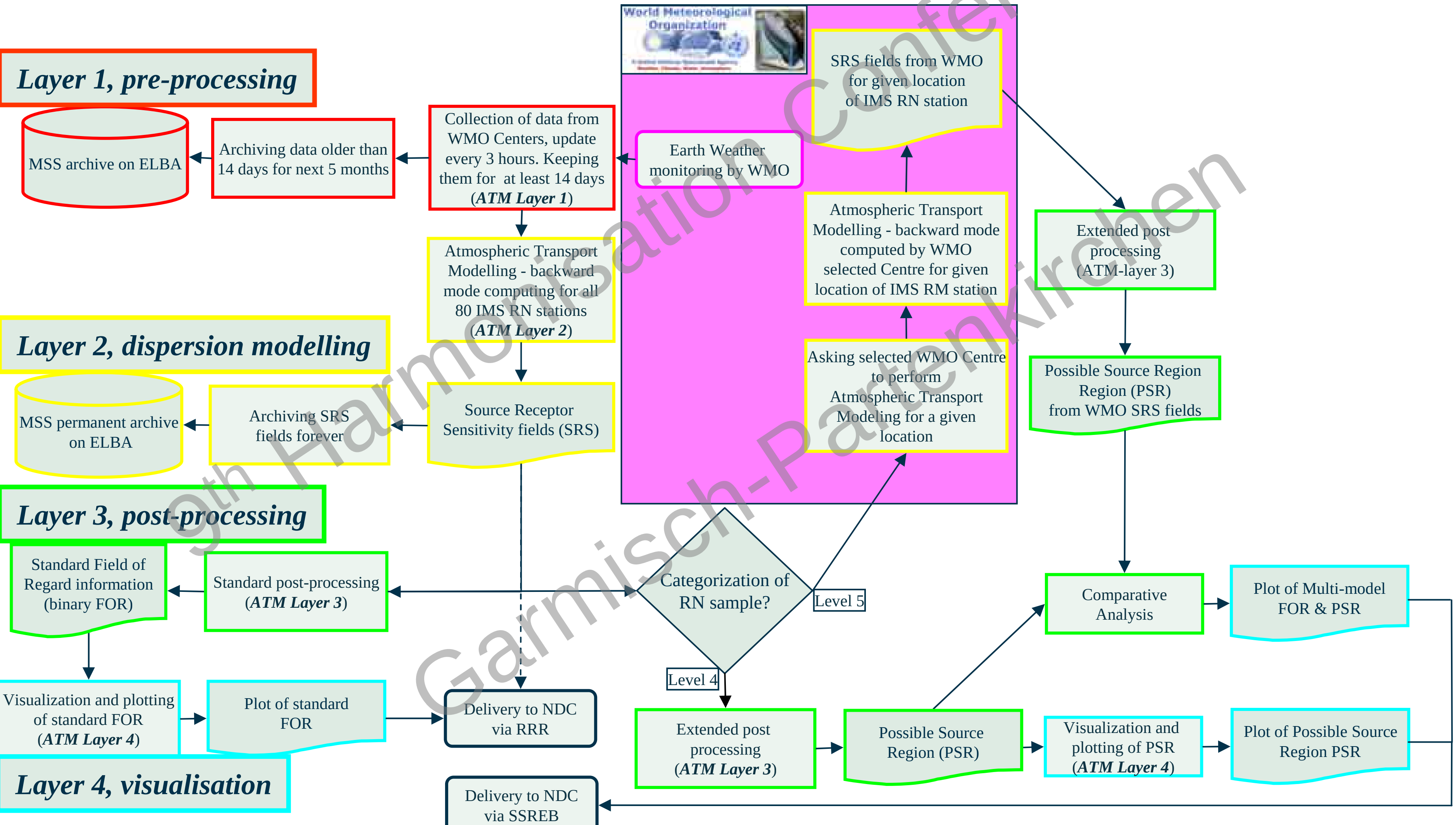
+ The concept enables a clear distinction between the computational demanding adjoint modelling and the rather fast inversion step, which is done in pure post-processing mode.
+ The SRS fields constitute a very efficient repository of the atmospheric transport information.
+ The range of the concepts applications is scale independent with the following prerequisites to be met.

Prerequisites

- With regard to the substance backtracked the receptor (detector) utilized should be highly sensitive and background concentrations should be low, in particular for applications in the global scale.
- For a fast inversion a pre-defined source geometry has to be assumed.
- The adjoint modelling is fully diagnostic. Therefore the resolution of the wind-fields (input) and the SRS fields (output) should be similar.
- The quality (uncertainty) of the wind-fields utilized has to be high (low) to warrant a high (low) quality of (uncertainty) of the SRS fields.

The first two prerequisites are given for CTBT verification problems. The third one can be controlled. The last one (uncertainty), however, has to be further explored.

Flow chart of the PTS 4-layered ATM system



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Benefits of a Layered Concept for Regulatory Purposes

- Clear defined Interfaces between the layers serve as ports for ATM products
- The core product and interface is constituted by the sample specific source-receptor relations stored in **source receptor sensitivity (SRS) fields**
- A network specific data base of SRS fields combined with the measurements raised in the network provides all information required to perform source attribution tailored to the customers needs in a pure post-processing step, that means within seconds, without the burden of additional ATM modelling
- Outside contributions can be easily implemented if they meet the requirements defined by the layers interfaces, in particular the easy to follow SRS field standard -> 2003 CTBTO-WMO experiment on source region estimation
- ***The SRS fields are calculated well in advance before they are actually needed. Hence they serve a high level of preparedness with regard to source attribution based on the RN sample borne in the PTS-IMS network***

At the CTBTO-WMO technical workshop in Vienna in 2002 the PTS proposed a two-step response system

Step 1 (ATM Layers 1 & 2): Joint ATM Modelling

Joint calculation and exchange of standardised source-receptor information between PTS and WMO centres

Step 2 (ATM Layer 3 & 4): Post-processing by the PTS

Post-processing of the standardised source-receptor by the PTS and dissemination of useful products to the CTBTO States Signatories.

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Participants (besides PTS)

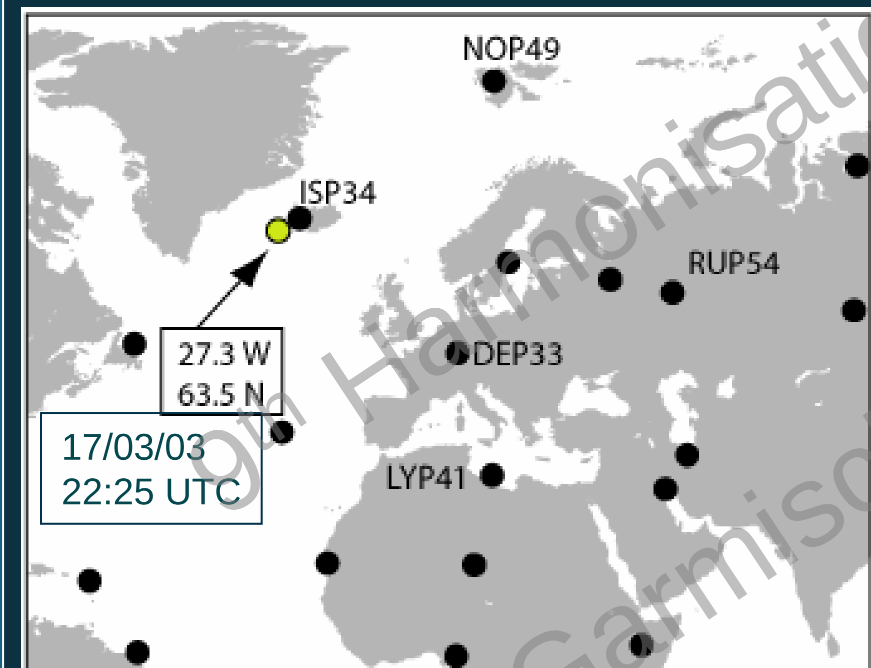
WMO Emergency Response Activities Group

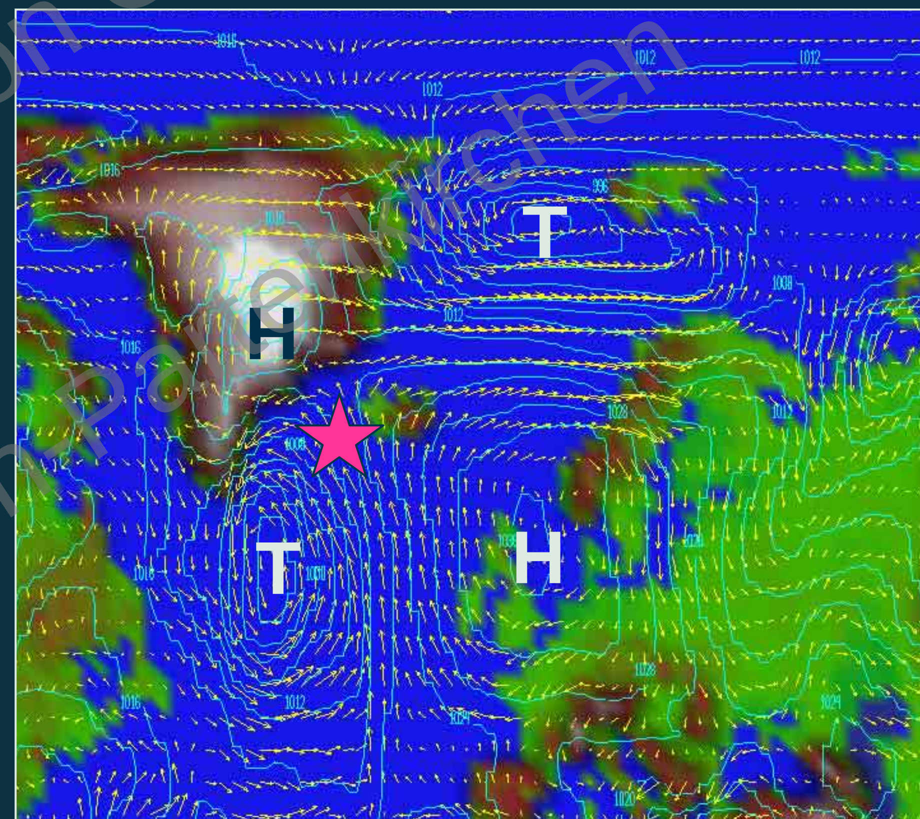
RSMCs
- Peking
- Melbourne
- Montreal
- Tokyo
- Toulouse
- Obninsk
- Washington

NDCs Austria, France and USA

WMO: World Meteorological Organization
RSMC: Regional Specialised Meteorological Centre (here for Dispersion Modelling)
NDC: National Data Centre to the CTBTO Preparatory Commission

The source region location was demanding for this case due to the meteorological starting and boundary conditions (quadruple pressure field at the release location)





Response System Step 1: Scenario Creation

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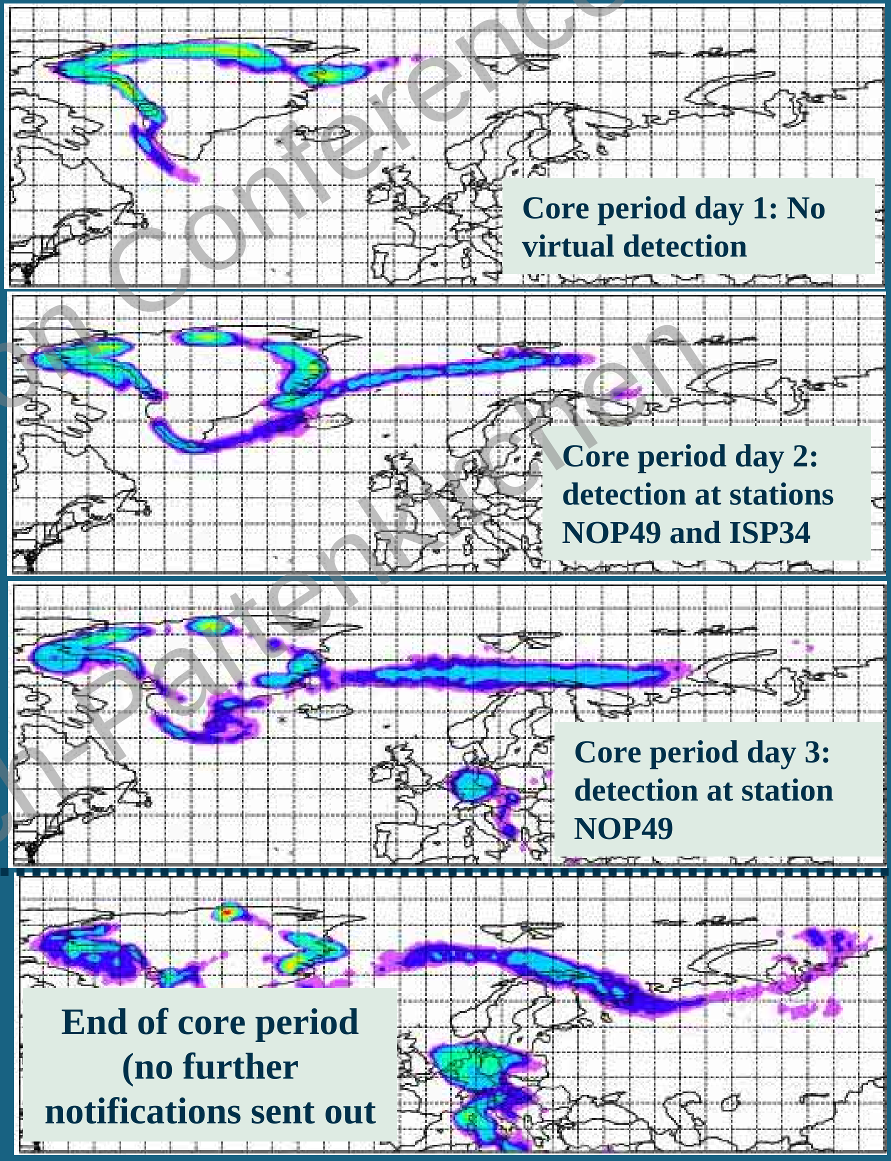
Virtual Event occurred south-west of Island

The radioactive debris from the virtual nuclear test was transported first to the north.

After the end of the core period (3 notification days), increased activity would have reached Central Europe

Plume dispersion shows a typical complex pattern which is also vertically structured

link to 3-D visualisation



Response System Step 1: Notifications

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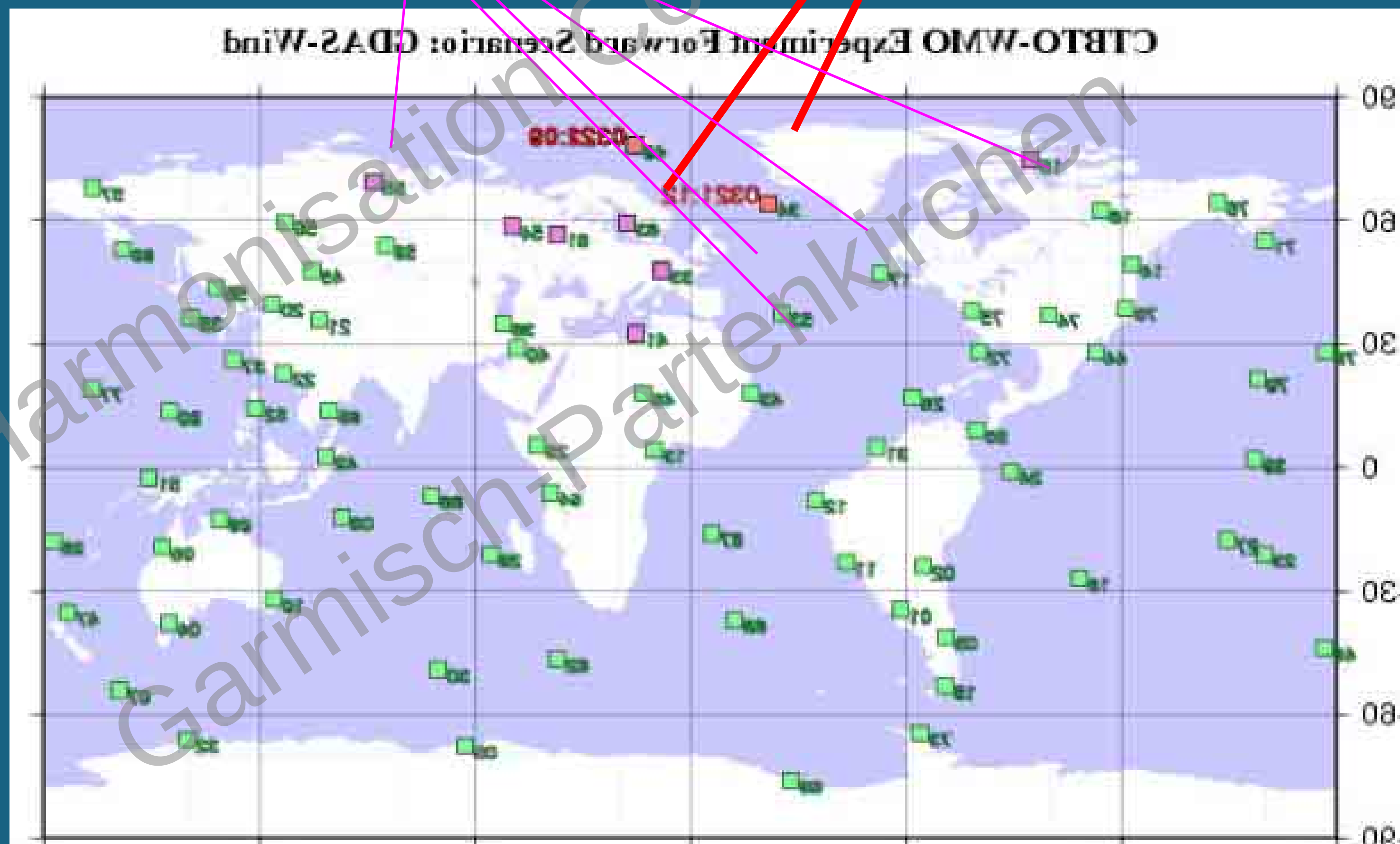
ATM computations were also requested for a number of neighbouring sites

2 Stations recorded virtual detection during the 3 experiment days: ISP34, NOP49

The IDC requested WMO centres support at 3 consecutive days

The requests covered 23 samples at 9 stations



Response System Step 1: Response Times

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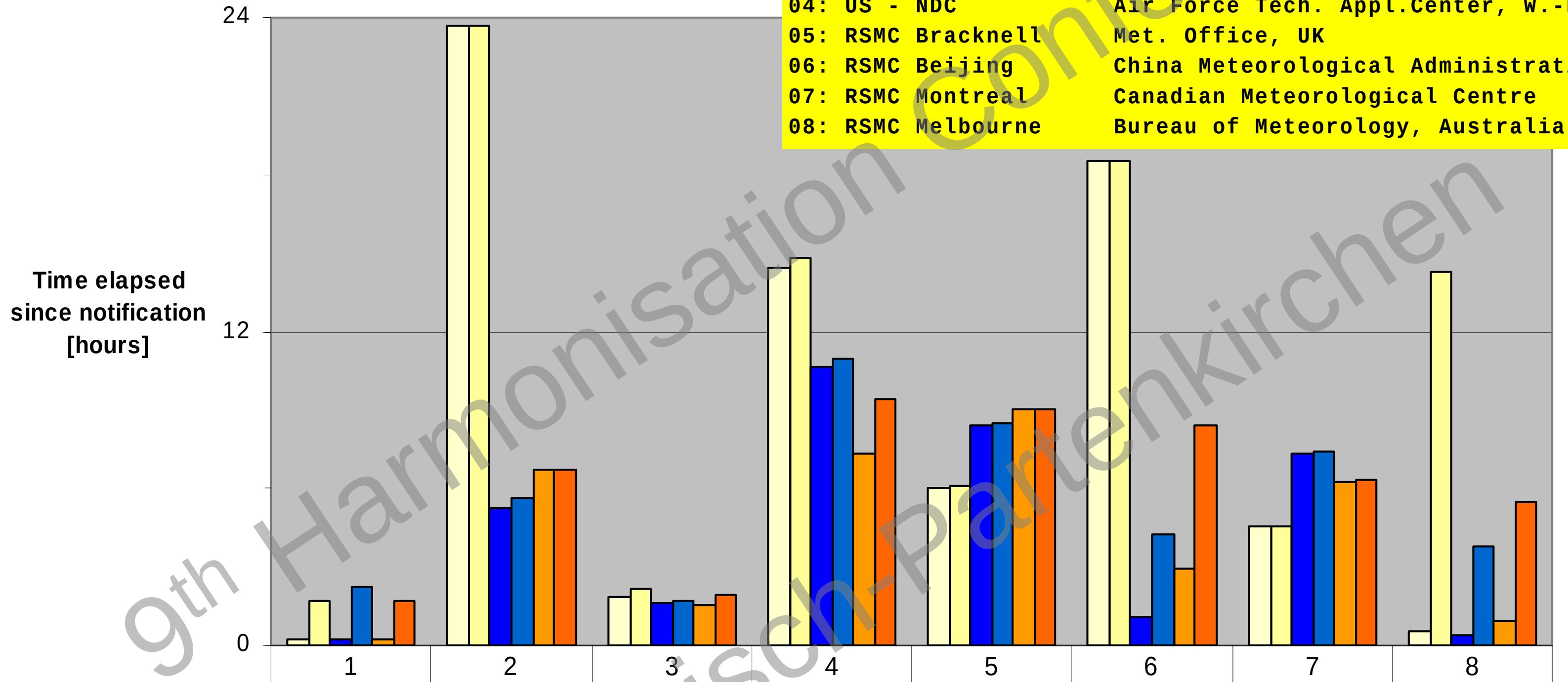
No.	Particpant	Organisation	WMO-Code
01:	RSMC Washington	NOAA Air Resources Lab	*NARL*
02:	RSMC Obninsk	FEERC of Roshydromet	*RUOB*
03:	RSMC Tokyo	Japan Meteorological Society	RJTD
04:	US - NDC	Air Force Tech. Appl.Center, W.-DC	*USNC*
05:	RSMC Bracknell	Met. Office, UK	EGRR
06:	RSMC Beijing	China Meteorological Administration	BABJ
07:	RSMC Montreal	Canadian Meteorological Centre	CWAO
08:	RSMC Melbourne	Bureau of Meteorology, Australia	AMMC

CTBTO-WMO 2003 Experiment: Response Times



	1	2	3	4	5	6	7	8
Day 1: First Station	0:12	23:40	1:53	14:28	6:02	18:31	4:31	0:31
Day 1: All Stations	1:41	23:41	2:09	14:50	6:04	18:31	4:33	14:18
Day 2: First Station	0:14	5:15	1:36	10:40	8:26	1:07	7:22	0:25
Day 2: All Stations	2:12	5:40	1:41	10:59	8:28	4:15	7:25	3:49
Day 3: First Station	0:12	6:41	1:34	7:18	9:01	2:58	6:15	0:54
Day 3: All Stations	1:41	6:44	1:58	9:26	9:03	8:24	6:20	5:31

No. of Participant and it's response Times [hh:mm]

Response System Step 2: IDC Report

A few hours after the final participant's results arrived, the IDC issued a first online report.

In the final set-up, such a highly automated report could

⇒ Provide without prejudice a fast, quick overview on the ATM-related results for the decision makers

⇒ Provide links to detailed results as soon as they come in, including uncertainty estimates and comparisons between the WMO centres, for experts in the field

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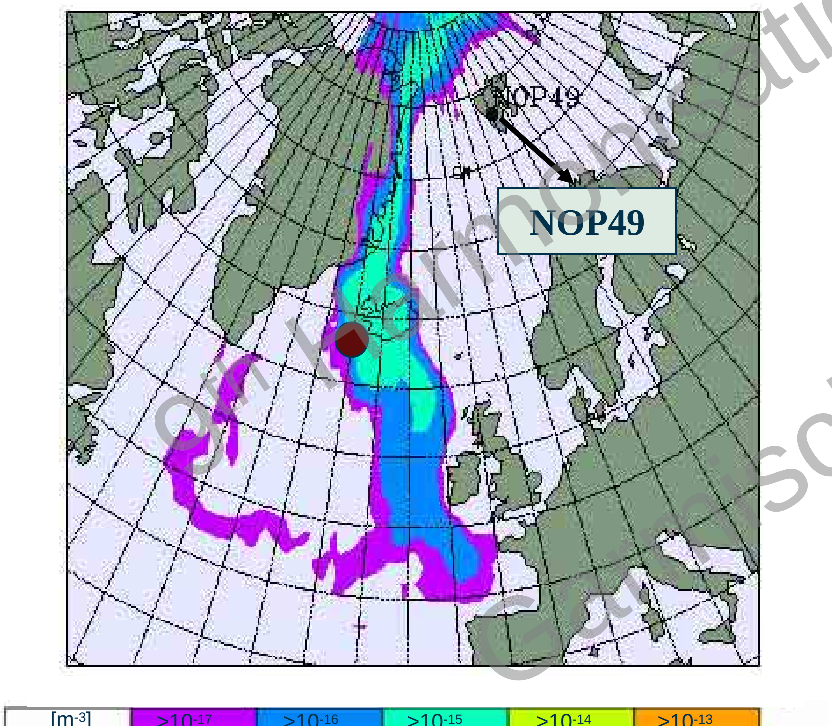
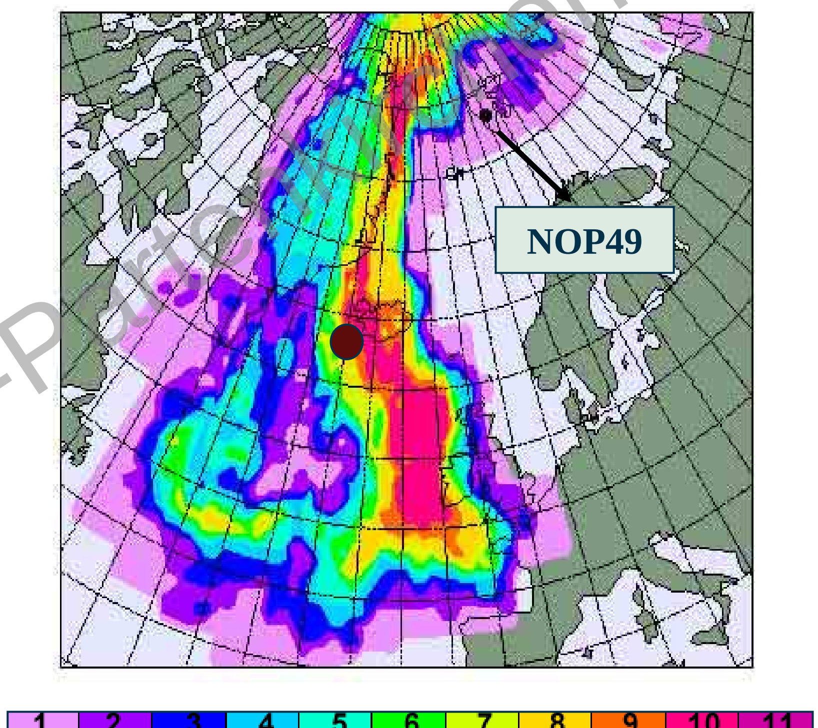
PTS FORs and multiple-model FORs

Field of Regard for the major detection during the experiment:

PTS differential FOR for NOP49, CS 20030322 09 UTC, CS-108 hours (time when event occurred)



Multiple model FOR for NOP49 CS 20030322 09 UTC, CS-108 hours (time when event occurred)



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Method of SRS field inter-comparison

- Standard SRS fields shared during the experiment serve the opportunity to perform a statistical inter-comparison
- Methodology has been derived from the exemplary papers of Mosca et al. (1998) and Draxler et al. (2001, Internal NOAA Report on DATEM project). For full reference see Doc. 8(3)
- The Methodology was used to provide cross-comparison matrices first of all specific for each SRS fields shared among the 11 experiments participants
- In doing so we pair-wise compared the "reference" SRS fields of values (O_i) of one participant with the predictor values (P_i) of all other participants **across all times stored**
- Without knowing the true reference SRS field, each participant played once the provider of the "observation" values (O_i) and was compared to the others
- Each comparison constitutes one row in the cross comparison matrix

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Applied Statistics

a) The fractional Bias (FB) (Table 1, bottom table):

$$FB = 2\overline{B}/(\overline{P}+\overline{O}) \text{ with } \overline{B} = \frac{1}{N}\sum_i (P_i - O_i)$$

b) The Scatter by the squared Pearson Cross-Correlation Coefficient R^2 (Table 1, third table):

$$R = \frac{\sum_i (O_i - \overline{O})(P_i - \overline{P})}{\sqrt{\sum (O_i - \overline{O})^2}\sqrt{\sum (P_i - \overline{P})^2}}$$

c) The spatial coverage by the so called Figure of Merit in Space (FMS), also known as Overlap Region (Table 1, second table):

$$FMS = 100\frac{A(p>0) \cap A(o>0)}{A(p>0) \cup A(o>0)}$$

d) Based on these three individual measures, the final Rank (RNK) value is computed as follows (Table 1, top table):

$$RNK = R^2 + (1 - |FB/2|) + FMS/100)$$

Example: RN068.20030201; "Dry Run"
NARL = Observation; CTBT = Predictor

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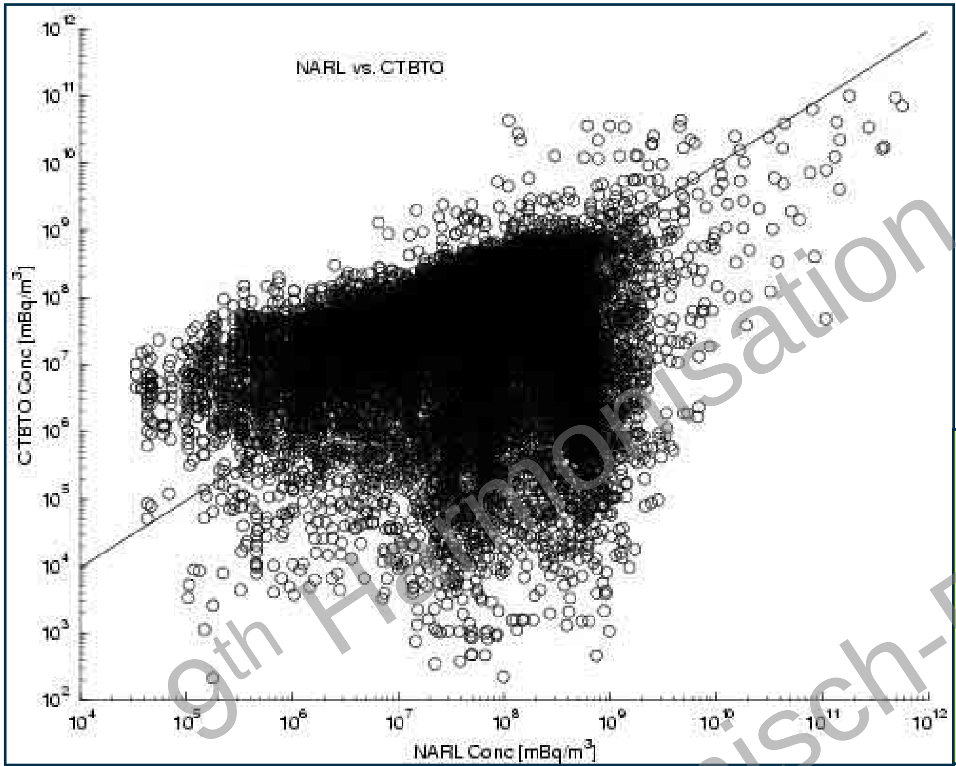
b) Scatter Diagram, Factor Of EXcedance (FOEX) and Pearson Correlation Coefficient, R^2



$$FOEX = [\frac{M}{N} - 0.5] \bullet 100$$

N: Number of Pairs plotted (=26472)

M: Number of Pairs where $c_O > c_P$

i.e. the number of dots above the y = x line

n[c(P,O)] > 0 = 26472; n = 3136368
FOEX= 4.27; FA2 = 53.94; FA5 = 63.53

FB = -0.51
R^2 = 0.19 (-0.04 below mean)
FMS = 57.09 (+12.57, above mean)
RNK = 1.51 (+0.11, above mean)

Raw Data

time[h]	FOEX=	fa2=	fa5=	SampleID	mean=	nall=	nsum=	fbias=	fms=	nmse=	R^2=	Rank=
144	-23.00	80.09	88.25	RN068.2003020100.AMMC.txt.Z	0.0012	19427	3136368	-0.67447	38.68	127204.45	0.00110	1.0507
144	-19.53	74.45	80.06	RN068.2003020100.ATNC.txt.Z	0.0019	21280	3136368	-0.20258	49.50	56192.43	0.33575	1.7294
144	-15.41	65.85	66.49	RN068.2003020100.BABJ.txt.Z	0.0084	25980	3136368	1.11189	8.81	87882.62	0.00000	0.5322
144	**4.27**	**53.94**	**63.53**	**RN068.2003020100.CTBT.txt.Z**	**0.0014**	**26472**	**3136368**	**-0.51388**	**57.09**	**86565.84**	**0.19152**	**1.5055**
144	-11.21	67.95	74.83	RN068.2003020100.CWAO.txt.Z	0.0010	23293	3136368	-0.78770	59.08	121705.74	0.29020	1.4872
144	-24.14	79.42	85.28	RN068.2003020100.EGRR.txt.Z	0.0018	20872	3136368	-0.26748	48.05	59224.13	0.28365	1.6304
144	-12.80	71.86	78.39	RN068.2003020100.FRNC.txt.Z	0.0008	22359	3136368	-0.97049	62.43	153792.39	0.34263	1.4817
144	**0.00**	**100.00**	**100.00**	**RN068.2003020100.NARL.txt.Z**	**0.0024**	**19134**	**3136368**	**0.00000**	**100.00**	**0.00**	**1.00000**	**3.0000**
144	14.49	42.44	50.82	RN068.2003020100.RJTD.txt.Z	0.0023	32096	3136368	-0.03236	54.22	71476.16	0.06367	1.5896
144	-3.46	56.48	59.93	RN068.2003020100.RUOB.txt.Z	0.0010	28989	3136368	-0.84627	50.85	153424.42	0.00063	1.0860
144	-28.05	89.16	95.64	RN068.2003020100.USNC.txt.Z	0.0015	19469	3136368	-0.47641	52.54	76368.42	0.40178	1.6890

Cross-Comparison Matrix for SRS field

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RN061.20030320: RNK and FMS

RNK	1	2	3	4	5	6	7	8	9	10	11	Row-AV
1	3	1.82	1.24	1.32	1.77	1.71	1.89	1.73	1.15	1.12	1.74	
2	1.82	3	1.44	1.68	2.33	1.87	1.91	1.66	1.30	1.37	1.83	
3	1.24	1.44	3	1.27	1.59	1.45	1.44	1.48	1.38	1.00	1.53	
4	1.32	1.68	1.27	3	1.62	1.50	1.58	1.28	1.29	1.14	1.64	
5	1.77	2.33	1.59	1.62	3	1.90	2.07	1.84	1.36	1.31	1.94	
6	1.71	1.87	1.45	1.50	1.90	3	1.69	1.92	1.40	0.90	2.12	
7	1.89	1.90	1.43	1.58	2.07	1.69	3	1.93	1.23	1.26	1.89	
8	1.73	1.66	1.48	1.28	1.84	1.92	1.93	3	1.35	0.84	2.15	
9	1.15	1.30	1.38	1.29	1.36	1.40	1.23	1.35	3	0.91	1.38	
10	1.12	1.37	1.00	1.14	1.31	0.90	1.27	0.84	0.91	3	0.95	
11	1.74	1.83	1.53	1.64	1.94	2.12	1.90	2.15	1.38	0.95	3	
Col.-AV	1.68	1.84	1.53	1.57	1.89	1.77	1.81	1.74	1.43	1.26	1.83	1.67
σ	0.52	0.48	0.52	0.51	0.47	0.53	0.49	0.56	0.54	0.61	0.52	0.52

FMS	1	2	3	4	5	6	7	8	9	10	11	
1	100	24.10	24.28	28.67	22.50	29.47	36.97	42.45	26.48	13.99	39.59	
2	24.10	100	45.18	48.80	63.69	38.79	39.90	22.48	45.07	47.39	39.07	
3	24.28	45.18	100	38.54	47.05	33.95	43.67	31.31	42.18	38.64	39.04	
4	28.67	48.80	38.54	100	52.38	54.22	47.50	30.79	37.59	30.91	51.07	
5	22.50	63.69	47.05	52.38	100	42.85	44.28	26.45	47.18	47.86	40.80	
6	29.47	38.79	33.95	54.22	42.85	100	40.16	32.04	33.77	23.28	47.52	
7	36.97	39.90	43.67	47.50	44.28	40.16	100	52.00	45.46	28.69	57.39	
8	42.45	22.48	31.31	30.79	26.45	32.04	52.00	100	33.98	16.21	49.57	
9	26.48	45.07	42.18	37.59	47.18	33.77	45.46	33.98	100	38.34	37.36	
10	13.99	47.39	38.64	30.91	47.86	23.28	28.69	16.21	38.34	100	23.97	
11	39.59	39.07	39.04	51.07	40.80	47.52	57.39	49.57	37.36	23.97	100	
Col.-AV	35.32	46.77	43.99	47.32	48.64	43.28	48.73	39.75	44.31	37.21	47.76	43.92

RN061.20030320: R^2 and FB

R^2	1	2	3	4	5	6	7	8	9	10	11	Row-AV
1	1	0.63	0.09	0.13	0.56	0.54	0.62	0.43	0.06	0.32	0.43	
2	0.63	1	0.13	0.25	0.73	0.65	0.56	0.61	0.07	0.18	0.57	
3	0.09	0.13	1	0.07	0.23	0.14	0.19	0.19	0.04	0.03	0.16	
4	0.13	0.25	0.07	1	0.18	0.18	0.10	0.19	0.19	0.08	0.31	
5	0.56	0.73	0.23	0.18	1	0.61	0.72	0.71	0.07	0.16	0.62	
6	0.54	0.65	0.14	0.18	0.61	1	0.51	0.61	0.11	0.11	0.69	
7	0.62	0.56	0.19	0.10	0.72	0.51	1	0.62	0.05	0.22	0.50	
8	0.43	0.61	0.19	0.19	0.71	0.61	0.62	1	0.06	0.12	0.69	
9	0.06	0.07	0.04	0.19	0.07	0.11	0.05	0.06	1	0.01	0.10	
10	0.32	0.18	0.03	0.08	0.16	0.11	0.22	0.12	0.01	1	0.12	
11	0.43	0.57	0.16	0.31	0.62	0.69	0.50	0.69	0.10	0.12	1	
Col.-AV	0.44	0.49	0.21	0.24	0.51	0.47	0.46	0.48	0.16	0.21	0.47	0.38

F-Bias	1	2	3	4	5	6	7	8	9	10	11	
1	0	-0.10	0.19	-0.20	-0.02	0.26	-0.20	0.24	0.35	-0.67	0.16	
2	0.10	0	0.28	-0.10	0.07	0.35	-0.10	0.34	0.44	-0.58	0.26	
3	-0.19	-0.28	0	-0.38	-0.21	0.07	-0.38	0.06	0.17	-0.83	-0.02	
4	0.20	0.10	0.38	0	0.18	0.45	0.00	0.44	0.54	-0.49	0.36	
5	0.02	-0.07	0.21	-0.18	0	0.28	-0.17	0.27	0.37	-0.65	0.19	
6	-0.26	-0.35	-0.07	-0.45	-0.28	0	-0.44	-0.01	0.09	-0.89	-0.09	
7	0.20	0.10	0.39	0.00	0.17	0.45	0	0.44	0.54	-0.49	0.36	
8	-0.24	-0.34	-0.06	-0.44	-0.27	0.01	-0.43	0	0.11	-0.88	-0.08	
9	-0.35	-0.44	-0.17	-0.54	-0.37	-0.09	-0.54	-0.11	0	-0.96	-0.19	
10	0.67	0.58	0.83	0.49	0.65	0.89	0.48	0.88	0.96	0	0.81	
11	-0.16	-0.26	0.02	-0.36	-0.19	0.09	-0.36	0.08	0.19	-0.81	0	
Col.-AV	0.00	-0.09	0.18	-0.20	-0.02	0.25	-0.19	0.24	0.34	-0.66	0.16	0.00

Evaluation of Cross-Comparison Matrix

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- The column averages (*Col.-AV*) of each measure (*RNK*, *FMS*, R^2, *FB*) represent each participants results compared to those of the other ones
- For the *RNK* value also the columns (participants) standard deviation (σ) is given
- The ***ROW-AV*** of these *Col.-AV*s yields the overall average and standard deviation. This number represents the ***ensemble mean specific for the SRS field*** shared
- If this mean is high for the *RNK* value the situation (the SRS field) was "friendly". If it is low it was "nasty" for all participants
- The participants deviations (anomalies) from this mean are rather to be interpreted than the sometimes quite low absolute values
- Therefore we have aggregated the *Col.-AV*s and their *ROW-AV* into a score table to facilitate a survey across all 23 SRS fields submitted by each participant during the experiment

Evaluation of the aggregated Score Table

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- In each row the Cross-Comparison Matrix Score for each SRS field is listed again
- To see your overall score just read the Score Table the same way as you have read the cross-comparison matrix:

most congruent

least congruent

RNK-Col.-AV-List	1	2	3	4	5	6	7	8	9	10	11	ROW-AV	STDEV
NOP49_2003032009	1.24	1.49	1.27	1.44	1.30		0.93	1.37	1.02	1.19	1.52	1.28	0.19
ISP34_2003032012	1.61	1.82	1.24	1.68	1.72		1.38	1.77	1.37	1.25	1.73	1.56	0.22
RN015_2003032000	1.26	1.17	0.86	1.23	1.12	1.17	0.29	1.03	0.90	0.90	1.21	1.01	0.28
DEP33_2003032006	1.63	1.83	1.52	1.50	1.72		1.72	1.79	1.36	1.44	1.78	1.63	0.16
RN055_2003032000	1.37	1.52	1.12	1.54	1.37	1.53	1.57	1.58	1.08	1.04	1.58	1.39	0.21
RN061_2003032000	1.68	1.84	1.53	1.57	1.89	1.77	1.81	1.74	1.43	1.26	1.83	1.67	0.20
SEP63_2003032009	1.50	1.60	1.51	1.56	1.79		1.29	1.65	1.28	1.45	1.77	1.54	0.17
NOP49_2003032109	1.37	1.44	1.00	1.42	1.32		1.12	1.31	1.19	1.31	1.47	1.29	0.15
ISP34_2003032112	1.68	1.76	1.30	1.69	1.83		1.42	1.69	0.96	1.34	1.78	1.55	0.28
RN015_2003032100	1.23	1.30	0.79	1.23	1.13	1.28	0.30	0.97	0.86	0.90	1.19	1.02	0.30
DEP33_2003032106	1.47	1.79	1.48	1.44	1.76		1.54	1.79	1.27	1.35	1.76	1.57	0.20
RN055_2003032100	1.62	1.79	1.29	1.65	1.68	1.68	1.71	1.79	1.27	1.08	1.83	1.58	0.25
RN061_2003032100	1.49	1.76	1.50	1.61	1.81	1.65	1.66	1.66	0.78	1.34	1.79	1.55	0.29
SEP63_2003032109	1.52	1.67	1.17	1.56	1.67		1.26	1.58	1.26	1.12	1.67	1.45	0.22
NOP49_2003032209	1.29	1.35	0.99	1.46	1.43		1.21	1.36	1.19	0.91	1.45	1.26	0.19
ISP34_2003032212	1.64	1.71	1.38	1.71	1.73		1.37	1.70	1.28	1.41	1.74	1.57	0.18
RN015_2003032200	1.26	1.44	0.82	1.39	1.26	1.37	0.31	1.09	1.04	0.97	1.41	1.12	0.34
DEP33_2003032206	1.36	1.51	1.33	1.34	1.45		1.19	1.53	1.14	1.14	1.49	1.35	0.15
RN055_2003032200	1.41	1.36	1.18	1.56	1.56	1.58	1.46	1.56	0.94	1.01	1.65	1.39	0.24
RN061_2003032200	1.43	1.24	1.09	1.49	1.57	1.44	1.37	1.55	0.87	1.20	1.49	1.34	0.22
SEP63_2003032209	1.60	1.64	1.45	1.68	1.81		1.41	1.66	1.17	1.31	1.81	1.56	0.21
RN041_2003032200	1.41	1.37	1.30	1.41	1.64	1.43	1.43	1.67	0.98	1.28	1.62	1.41	0.20
RN054_2003032200	1.59	1.72	1.36	1.63	1.65	1.52	1.64	1.60	0.92	1.26	1.68	1.50	0.24
Column-Average	*1.46*	*1.57*	*1.24*	*1.51*	*1.57*	*1.49*	*1.28*	*1.54*	*1.11*	*1.19*	*1.62*	***1.42***	***0.18***
Percentage of Max.	***48.8***	***52.4***	***41.3***	***50.4***	***52.5***	***49.8***	***42.6***	***51.4***	***37.0***	***39.8***	***54.0***	***47.3***	*5.93*
σ	*5.0*	*6.9*	*7.6*	*4.6*	*7.7*	*5.9*	*14.7*	*8.1*	*6.3*	*5.8*	*6.2*	*7.2*	
Perc. without No. 6	***50.2***	***54.9***	***43.4***	***52.0***	***54.8***		***44.4***	***53.6***	***40.5***	***42.7***	***56.0***	***49.2***	*5.89*
	1	2	3	4	5	6	7	8	9	10	11		

Quantification of Uncertainty

- PTS is aware of the limitations of its model inter-comparison due to the lack of a true reference SRS field based on observations
- PTS does not expect availability of SRS fields validated by observations in the mid-term future
- Therefore other ways have to be explored to estimate parts of the total uncertainty and to fulfil a tracking of errors through the dispersion modelling system yielding information to improve it
- A promising effort in this direction is Ensemble ATM

Ensemble ATM

- Can be realised in forward and backward (adjoint) mode by repeating the same dispersion ATM while perturbing the initial conditions (changing number of particles, perturbing release location, time and rate). See also submission of RSMC Washington (Doc. 5.1) for the Thursday morning session on Ensemble ATM for IAEA purposes
- Another possibilities are to introduce perturbation terms into the Markovian chains (Seibert, 2002) or to change the wind-field representation (Stohl et al. 1995)
- Standard procedures are not established yet. PTS is therefore very interested to follow discussions in the scientific community and within CBS/ERA-CG with regard to WMO-IAEA co-operation
- For the time being PTS proposes to restrict the uncertainty analysis to the model inter-comparison while keeping in mind its limited interpretation range

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Summary and Conclusions

- In the past three years PTS has built capacity in the field of ATM in designing, coding and installing its four layered ATM system capable to provide suitable output in the field of global source attribution in a 24/7 operational manner
- Based on the SRS field concept the system is open to communicate with similar dispersion ATM systems of RSMCs and other WMO NMHSs which has been proved in the spring 2003 experiment
- PTS has introduced an easy accessible scheme of model inter-comparison providing additional information on the uncertainty of the SRS fields data shared
- PTS is ready for a next experiment late this year
- The experiment will reflect the lessons learned so far and head towards further automation of the procedures involved including simple statistics
- In the mid-term future a highly automated CTBTO-WMO response system requiring very little human resources is aspired

Acknowledgement

- The achievements reached so far and the way forward to the CTBTO-WMO response system are strongly related to the contributions of all participants to the past experiments and their preparatory workshops
- The work presented in the past three papers [Docs 8(1-3)] relied on the available robust structure of the CBS/ERA CG which is highly appreciated

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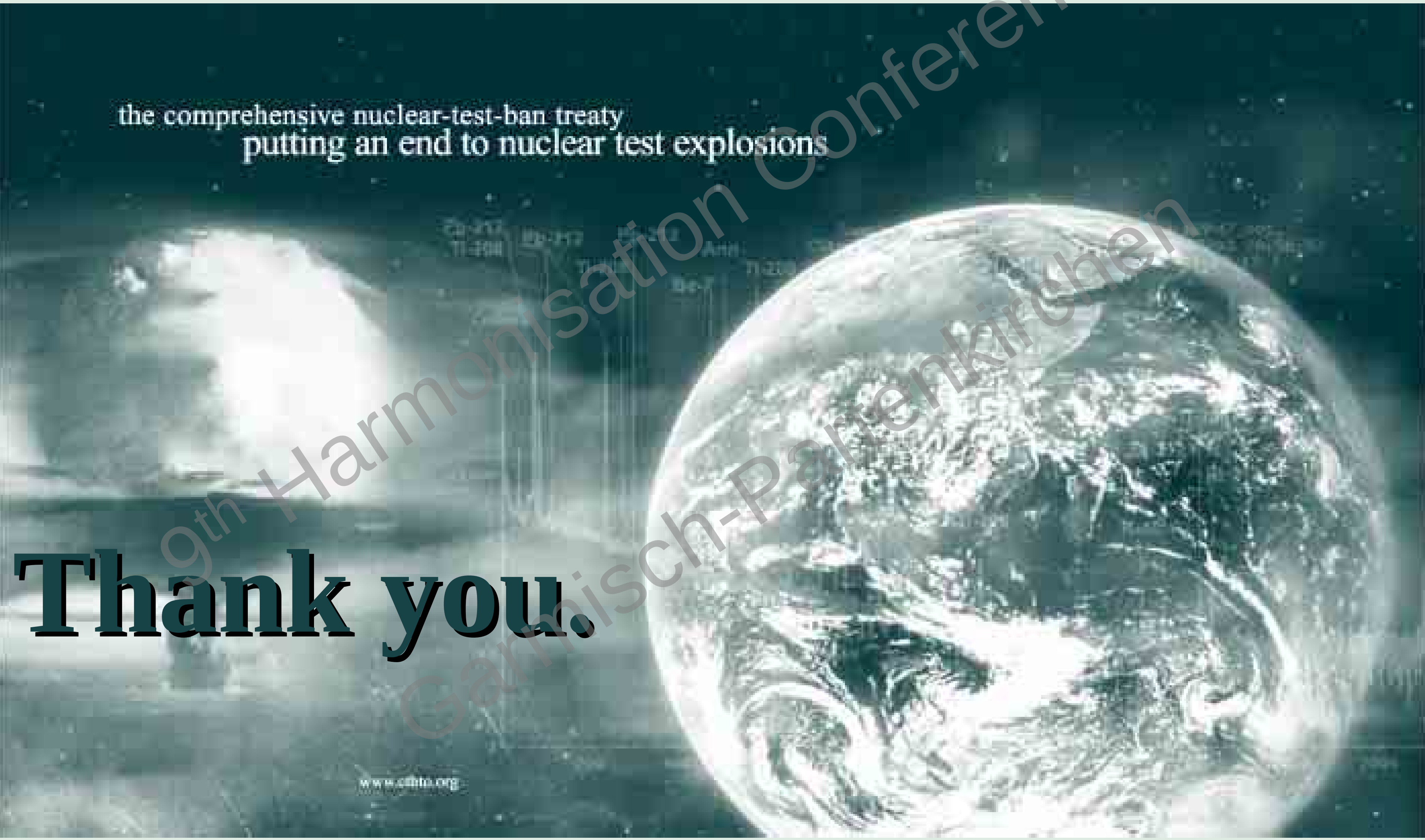

Thank you.