

Implementation of uncertainty in the decision support system ARGOS

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Introduction - ARGOS



Accident
Reporting
Guidance and
Operational
Support

Analysis for
operational use

- Monitoring
- Measurements
- Modeling
 - Urban/Short-range/
Long-range
Dispersion calculation
 - External Dose
 - Food Dose



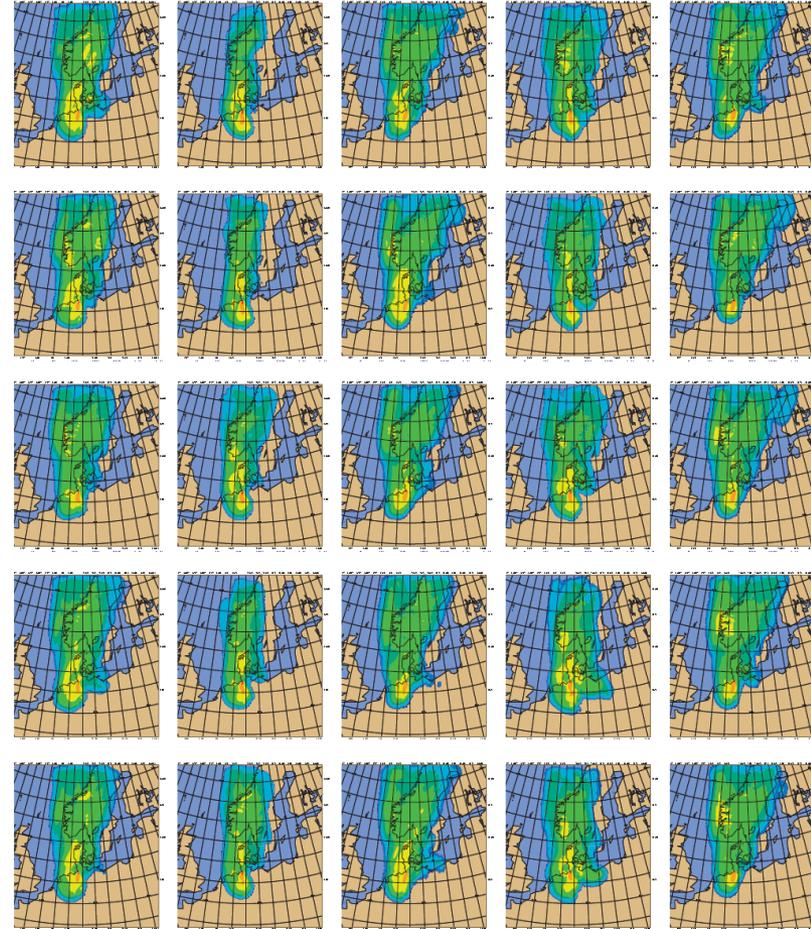
ARGOS collects data in order to provide

INFORMATION

Meteorological Ensemble



- 25 ensemble members from NWP model implies
- 25 ensemble calculations of the dispersion model DERMA
- DERMA delivers ADM and statistical results to ARGOS
 - Probability results
 - Percentile results



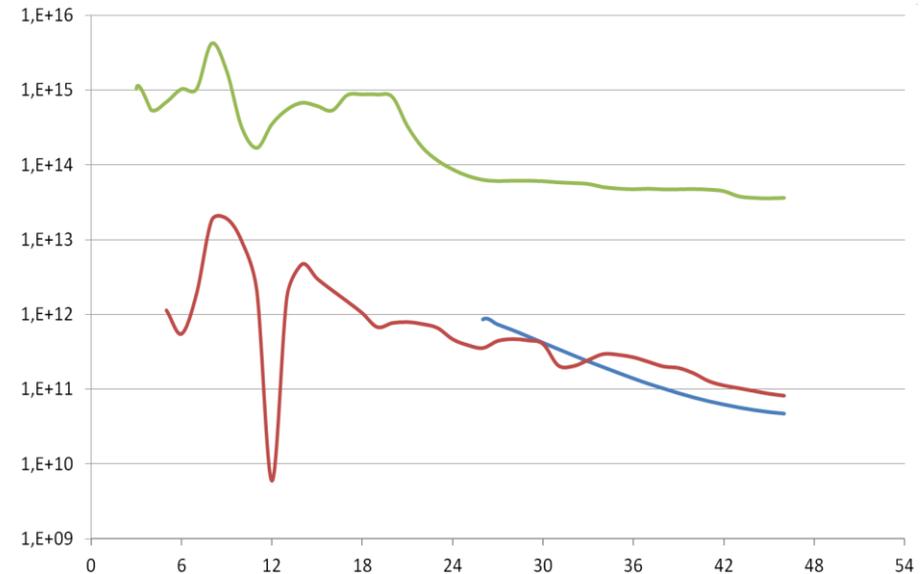
Source-term Ensemble



In the following, a serious accident leading to a core melt-down followed by melt-through is considered.

Source-term ensemble covers release scenarios ranging

- from a filtered release involving spraying after two hours and a filter factor of 1500 (blue),
- through a medium release involving spraying after 8 hours and a filter factor of 500 (red),
- to the most severe scenario without spraying leading to an unfiltered release (green).



Time-dependent release of Cs-137 for the three selected source terms named "Small", "Medium" and "Large" depicted by blue, red and green curves, respectively. The release rates are given in units of Bq/h, and the time in hours since SCRAM.

Requesting a run



- Request dialog for DERMA
 - Fields are dynamic based on various model's requirements
- New Source term type is introduced: Ensemble
- Interface between ARGOS and external model is updated to handle ensembles of source terms

The screenshot shows a software dialog box titled "Atmospheric Dispersion: Request Run". It contains several input fields and buttons:

- Service:** A dropdown menu set to "DERMA (Long range)".
- Run ID:** A text input field containing "AVESOME_Test_Run".
- Reactor Name:** A dropdown menu set to "RINGHALS-2".
- Source term type:** A dropdown menu set to "Ensemble".
- Model source term:** A dropdown menu set to "Nordic".
- Output Timestep [h]:** A dropdown menu set to "6".
- Start Time [UTC]:** A date and time input field set to "14-dec-2017 09:37".
- Buttons:** "Send Request" and "Cancel" buttons are located in the top right corner.
- Resolution:** A section with two radio buttons: "High (larger files)" (selected) and "Low".
- Coordinates:** A section with "Lon: 12*6*26" and "Lat: 57*15*29" input fields, and a "Coordinate System:" dropdown menu set to "WGS84".

ARGOS source terms



- Time dependent release rates of individual nuclides
- Additional properties
 - Iodine distribution
 - Release height
 - Heat flux
 - Release type – distribution of particle sizes

Absolute source term definition

FKA Large German filter bypass

Only allow nuclides in the release from this group:

Basic

Release Interval Characteristics and Iodine Composition: Altitude Range

#	Duration [mins]	Iodine Elem %	Iodine Orga %	Iodine Aero %	Heat Flux [kW]	Release type	Altitude [m]
1	36	0	0	100	0	Default	30
2	48	0	0	100	0	Default	30
3	63	0	0	100	0	Default	30
4	31	0	0	100	0	Default	30
5	59	0	0	100	0	Default	30
6	154	0	0	100	0	Default	30
7	193	0	0	100	0	Default	30
8	167	0	0	100	0	Default	30
9	167	0	0	100	0	Default	30
10	167	0	0	100	0	Default	30
11	167	0	0	100	0	Default	30
12	148	0	0	100	0	Default	30
13	185	0	0	100	0	Default	30
14	167	0	0	100	0	Default	30
15	167	0	0	100	0	Default	30
16	167	0	0	100	0	Default	30
17	167	0	0	100	0	Default	30
18	167	0	0	100	0	Default	30
19	167	0	0	100	0	Default	30
20	167	0	0	100	0	Default	30
21	167	0	0	100	0	Default	30
22	83	0	0	100	0	Default	30

Nuclide Distribution:

Nuclide	Intrv. 1 [Bq]	Intrv. 2 [Bq]	Intrv. 3 [Bq]	Intrv. 4 [Bq]	Intrv. 5 [Bq]	Intrv. 6 [Bq]	Intrv. 7 [Bq]
Ba-140	2.2200E+14	2.4600E+14	6.3900E+14	1.9100E+12	7.6700E+15	8.1400E+15	1.1300E+
Ce-144	9.8100E+08	1.2800E+09	5.4800E+09	8.4200E+09	3.6200E+14	5.0600E+14	2.4800E+
Cm-242	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.6800E+11	3.4600E+11	9.2000E+
Cm-244	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	6.6700E+09	1.3800E+10	3.6600E+
Cs-134	3.3200E+15	5.2200E+14	2.0000E+15	3.0200E+14	1.7200E+15	4.3700E+14	9.7400E+
Cs-137	2.8500E+15	4.4800E+14	1.7100E+15	2.5900E+14	1.4800E+15	3.7400E+14	8.3500E+
I-131	3.3900E+16	5.4900E+15	1.9200E+16	2.8100E+15	1.6400E+16	5.2400E+15	7.7600E+
I-132	4.4500E+16	7.1900E+15	2.5100E+16	3.6500E+15	2.1200E+16	6.7400E+15	9.9000E+
I-133	3.9100E+16	6.1800E+15	2.0900E+16	2.9500E+15	1.6800E+16	5.3200E+15	7.7100E+
I-134	3.4600E+14	4.2600E+13	8.6200E+13	4.6800E+12	8.6600E+08	2.7300E+08	3.9600E+
I-135	1.0700E+16	1.5400E+15	4.4800E+15	5.4000E+14	2.7400E+15	8.6500E+14	1.2500E+
Kr-87	6.6400E+14	7.7700E+13	1.1800E+14	2.9600E+12	1.3700E+11	5.1800E+10	1.0200E+
Kr-88	6.0300E+15	7.2200E+14	1.1700E+15	3.7000E+13	2.6400E+14	9.9800E+13	1.9600E+
La-140	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.4400E+13	2.9600E+13	7.8500E+
Mo-99	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	1.3600E+07	1.7700E+08	2.4500E+
Pu-238	1.0800E+06	1.4000E+06	6.0100E+06	9.2400E+06	3.9700E+11	5.5600E+11	2.7200E+
Pu-241	7.6600E+07	9.9900E+07	4.2800E+08	6.5700E+08	2.8200E+13	3.9500E+13	1.9400E+
Ru-103	8.2600E+09	1.7400E+10	5.4800E+10	1.1100E+08	1.6100E+09	6.6500E+08	5.5300E+
Ru-106	2.1000E+09	4.4100E+09	1.3900E+10	2.8200E+07	4.0900E+08	1.6900E+08	1.4100E+
Sr-90	7.7100E+12	8.5400E+12	2.2200E+13	6.6600E+10	2.6800E+14	2.8600E+14	3.9700E+
Te-132	3.7000E+16	6.8100E+15	1.6400E+16	2.3000E+15	2.0700E+16	2.3800E+15	7.4000E+
Xe-133	4.0800E+17	6.2900E+16	1.6500E+17	1.1200E+16	2.4400E+17	9.3500E+16	1.8800E+
Xe-135	1.1000E+17	1.6600E+16	4.2300E+16	2.8000E+15	6.0100E+16	2.2700E+16	4.4800E+
Zr-95	1.5300E+09	2.0000E+09	8.5500E+09	1.3100E+10	5.6400E+14	7.9000E+14	3.8600E+

Buttons: Add Interval, Delete Interval, Add Nuclide, Delete Nuclide, Add Daughters, Save As..., OK, Cancel

Ensemble of source terms



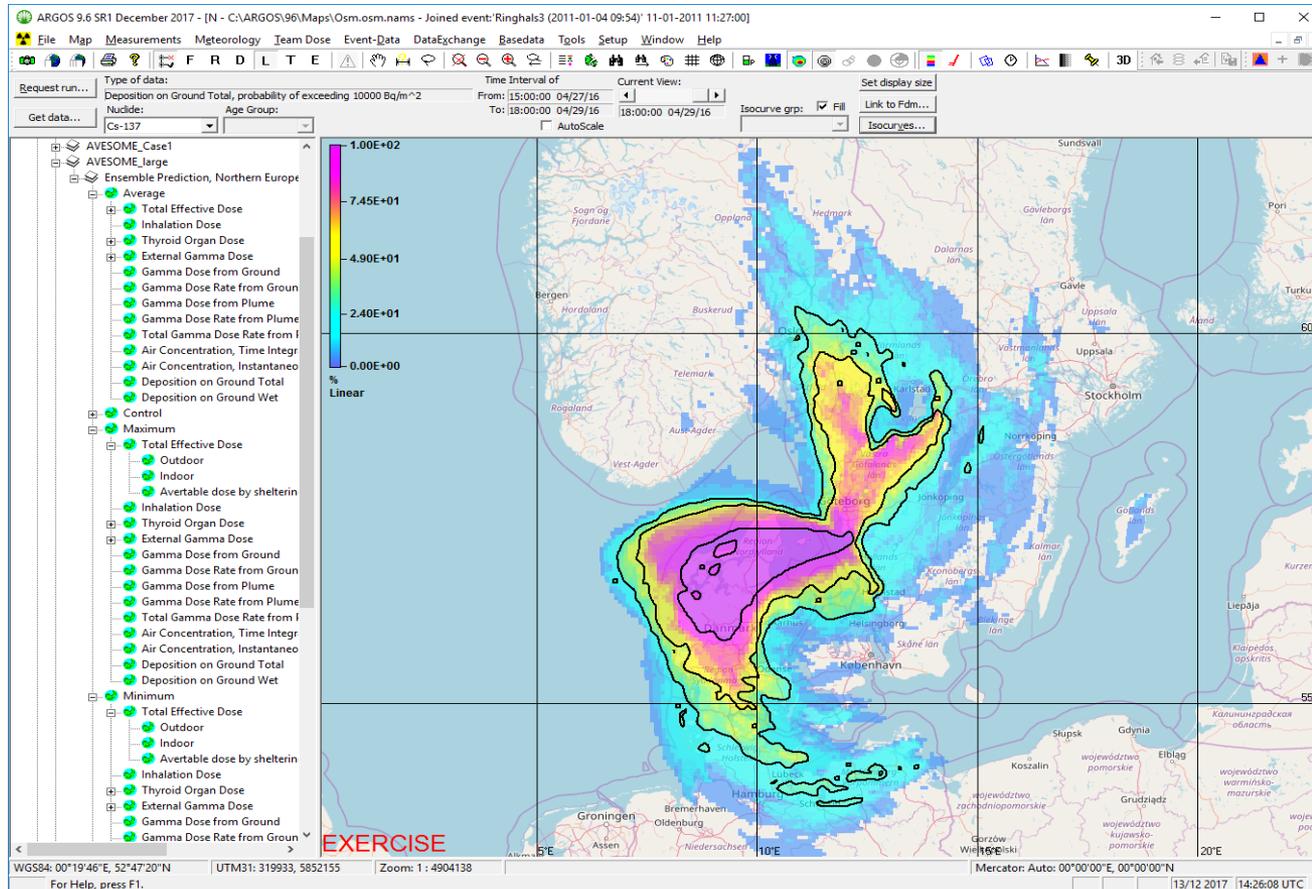
- A list of source terms – including a weight factor – probability
- Limited to Absolute Source terms

The screenshot shows a dialog box titled "Ensemble source term definition". It has a tab labeled "Ensemble sample" and a checkbox for "Basic" which is currently unchecked. Below this, there is a section labeled "Source terms:" containing a table with the following data:

Source term	Probability
FKA Default	70 %
FKA Worst	20 %
FKA last	10 %

At the bottom of the dialog, there are three buttons: "Add ST", "Delete ST", and "Save As...". On the right side, there are "OK" and "Cancel" buttons.

Probability plots



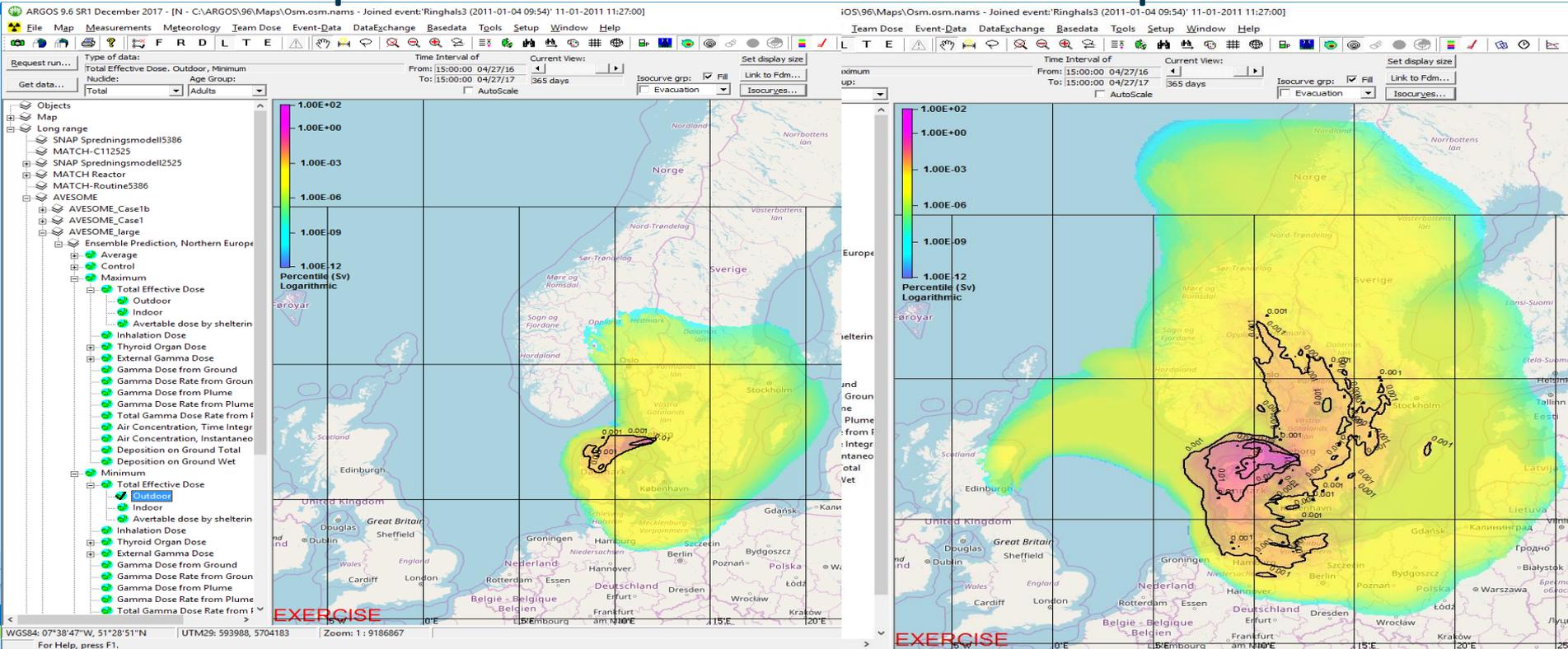
Probability of exceeding 10 kBq/m² deposition of Cs-137

Percentile plots



Minimum percentile

Maximum percentile

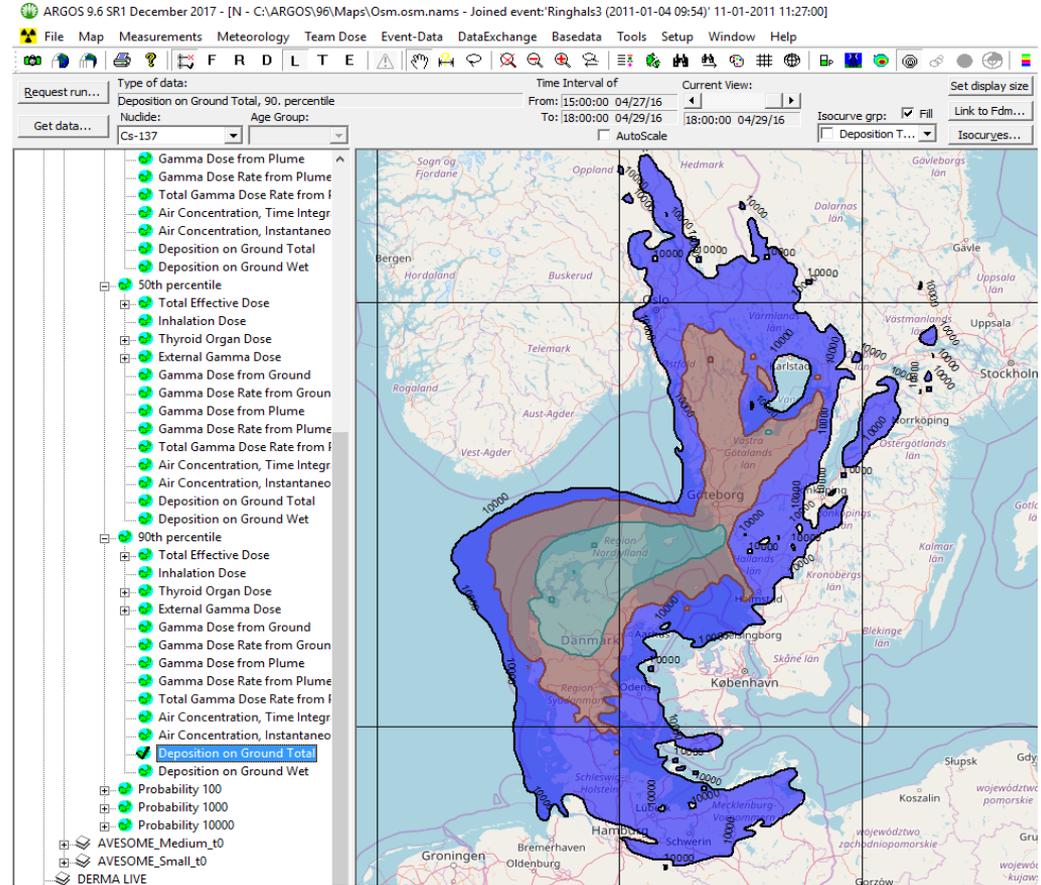


Isolines for 1, 10 and 50 mSv Total Effective Dose

Percentile plots - comparison



Comparison of
10th (green)
50th (brown)
90th (blue)



Three percentiles for 10 kBq/m² deposition of Cs-137

Limitations



Amount of data and computation is huge!

- Currently all NWP-data resides at HPC facility, and ADM and statistical analysis performed at HPC
- Communication between HPC and DSS limited to (selected) deterministic results and statistical results
- Method tested on short-range ADM (RIMPUFF)
Implementation will require ADM to run at HPC

Outlook – work in progress



- Introduction of source term uncertainty in DSS
 - Protocol for communication DSS - HPC in place
 - Handling of GUI
 - Importing ensembles of source terms
 - Easy "grouping" of predefined source terms into ensembles
 - The overall aim is to determine risk zones for emergency preparedness and management

Further the use of uncertainties in DSS requires:

- Education/training of emergency response staff
- Careful communication with decision makers