

THEME 1: Radioactive Release Assessment

Working Group 3

The Chernobyl I-131 release: model validation and assessment of the countermeasure effectiveness working group

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EMRAS Iodine Working Group

Background

IWG continues some of the more traditional work of the previous international programmes that have been aimed at increasing confidence in methods and models for the assessment of radiation exposure related to the environmental releases.

the IAEA's Validation of Model Predictions (VAMP)

the IAEA's BIOMOV5

the BIOMOV5 II* (Biospheric Model Validation Study)

the IAEA's BIOMASS (Biosphere Modelling and Assessment)

terminated in 2001

* supported by organisations from Canada, Spain and Sweden.

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Background (cont.)

- activity of the IWG**
- environmental modelling exercises on radioiodine**
- **to test and compare models' predictions with real environmental data**
 - **to intercompare modelling approaches and model predictions among several assessors**

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major areas of emphasis:

- improvement of models predictions accuracy by identification the most important sources of bias and uncertainty
- implementation of new modelling procedures supported by current state of knowledge about processes and phenomena

main targets of IWG

- check models performance in dose reconstruction in case when ^{137}Cs (^{129}I) tracer is used for estimation of ^{131}I deposition
- check models applicability to countermeasure response

uncertainty ?, limitation ?, requested input data ?

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ADDITIONAL ASPECT OF IWG ACTIVITY

numerous reports have confirmed an increasing number of cases of thyroid cancer, particularly in the most heavily contaminated regions of Ukraine and Belarus, but also in Russia

the confident reconstruction of the average and personal thyroid dose in affected areas is required:

- **to confirm the special medical aid to the population and measures of social protection**
- **to provide information for the public and the authorities and ensure epidemiological investigations.**

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Background (cont.)

- **uncertainty ?, limitation?**
case-control studies of thyroid cancer

the quantitative relationship between radiation dose to the thyroid from Chernobyl and the risk of thyroid cancer.

the uncertainty combined with individual estimates of radiation dose constitutes a crucial point in establishing this relationship, since, any release of radioiodine into environment creates wide range of uncertainty for internal dose assessments.

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Background (cont.)

major sources of the uncertainty:

- **small number and poor quality of thyroid measurements performed after Chernobyl accident**
- **difficulties in evaluation and validation of the dynamic of the ¹³¹I intakes function into a human body based on sparse (single point) individual thyroid measurements and lack of milk samples in early periods of accident.**
- **large variety in inhabitants behaviour and agricultural practices (the time when cows had been put on a fresh pasture) have considerable impact on doses variability.**

Background (cont.)

Necessity of performing environmental modelling exercises ?

Selected conclusions of HANFORD SCENARIO (BIOMASS):

Predicted thyroid doses to the two children with high milk consumption ranged from 0.006 to 2 mSv

Compensatory effects (a high prediction in one model compartment being offset by a low prediction in another compartment)

Major sources of uncertainty in this exercise include:

- **atmospheric transport (which could contribute as much as a factor of 20-50),**
- **representativeness of available measurements,**
- **iodine speciation, treatment or neglect of terrain effects,**
- **actual consumption and metabolic rates**

EMRAS Iodine Working Group Summary

MILESTONES

1st Combined Meetings at the Agency Headquarters in Vienna

1–5 September, 2003

● **1st IWG Meeting**

● **2nd IWG Meeting**

(held at the CIEMAT, Madrid, Spain, 31 May to 2 June 2004)

2nd Combined Meetings at the Agency Headquarters in Vienna

8–11 November, 2004

● **3rd IWG Meeting**

● **4th IWG Meeting**

**(held at the Headquarters of the National Atomic Energy Agency PAA,
WARSAW, POLAND, 29-31 August 2005)**


3rd Combined Meetings at the Agency Headquarters in Vienna

21 - 25 November, 2005

● **5th IWG Meeting**

EMRAS Iodine Working Group Summary

MILESTONES

- before 1st EMRAS meeting (1-5 September 2003)
 Questionnaire
to identify participants of potential working group
to identify suitable data sets and models for testing
9 modellers 10 scenarios proposals
- 1st EMRAS meeting (1-5 September 2003)
developing appropriate scenarios for model validation and
collecting measurement data sets,
quality checking of input and measurement data
- end of January 2004

the Scenario Plavsk was evaluated and distributed among the participants together with prediction formularies (in Excel file)

The Scenario is also available on the EMRAS WEBSITE:

<http://www-ns.iaea.org/projects/emras/emras-iodine-131-wg.htm>

EMRAS Iodine Working Group Summary

MILESTONES

SCENARIO P (*draft*)

Validation of environmental models

using data from Chernobyl fallout in the Plovsk
agricultural area

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Institute of Radiation Hygiene
Mira St.8, 197101 St. Petersburg, Russia
E-mail: irvaz@iz10087.spb.edu

EMRAS Iodine Working Group Summary

MILESTONES

- from February to May 2004

blind test exercise

(when measurements results remained unknown to participants) and sent results before

- 2nd Meeting of the IAEA's EMRAS IWG
(held at the CIEMAT, Madrid, Spain, 31 May to 2 June 2004)

9 participants sent results, together with questionnaire summarized assumptions and used parameters.

Irina Zvonova provided the observed data for the Plavsk region.

analysing predictions versus observed data

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MILESTONES

- **2nd Meeting of the IAEA’s EMRAS IWG
(held at the CIEMAT, Madrid, Spain, 31 May to 2 June 2004)**

The group agreed that the first model validation and intercomparison exercise will be carried in 2004 using the Plavsk Scenario. Calculations for the Warsaw scenario will be delayed until after the completion of the Group’s work on the Plavsk Scenario.

- **2nd Combined Meetings of the IAEA (EMRAS)
8–11 November 2004**
 - ❑ **evaluation and discussion of results of second run predictions**
 - ❑ **preparation of draft Final Report**
 - ❑ **introduction to the Warsaw scenario**

EMRAS Iodine Working Group Summary

MILESTONES

- June – November 2004

TESTING AND VALIDATION OF DOSIMETRY
MODELS USING DATA FROM CHERNOBYL ¹³¹I
FALLOUT IN THE PLAVSK AGRICULTURAL AREA

Intermediate report of ¹³¹I Working Group
on the model validation
and assessment of the countermeasure effectiveness
of the Environmental Modelling for Radiation
Safety Programme (EMRAS)

The Report is also available on the EMRAS WEBSITE:

<http://www-ns.iaea.org/projects/emras/emras-iodine-131-wg.htm>

3rd Combined Meetings of the IAEA Programme on Environmental Modelling for Radiation Safety (EMRAS)

21–25 November 2005

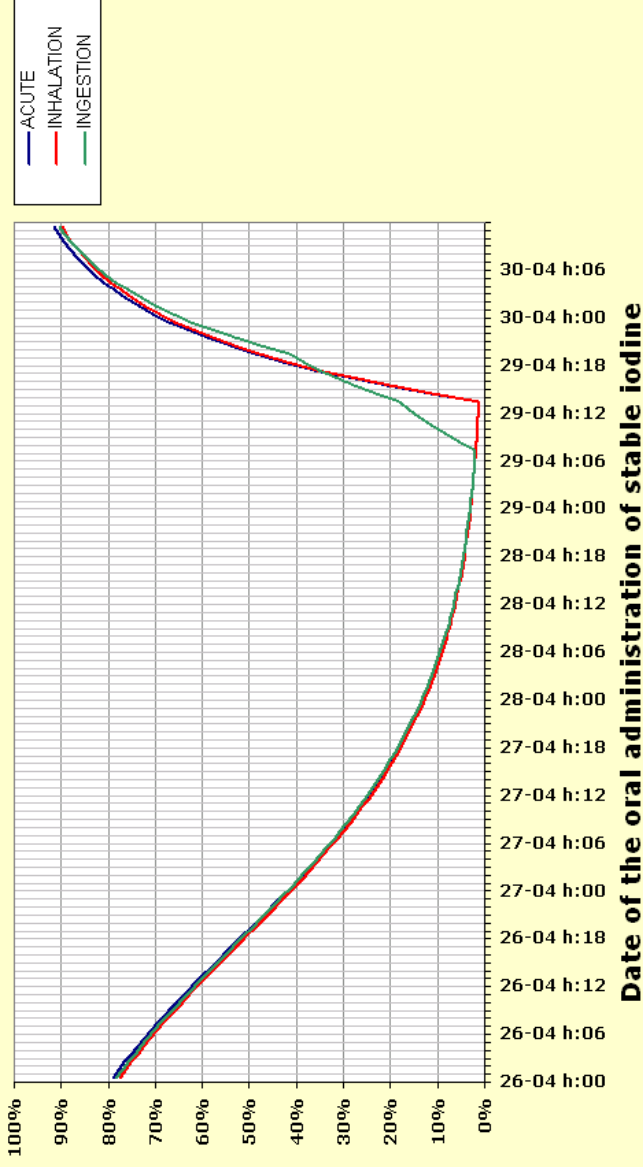
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MILESTONES

● June – November 2004

WORKSHEET "THYROID v2.2" (extended!)
SUPPORTED IODINE WORKING GROUP OF EMRAS PROGRAM

Reduction of the Integrated I-131 Thyroid Content
from the oral administration of 60 mg of stable iodine
as a function of time before and after an intake of radioiodine on 29-04 h:12



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MILESTONES

- end of June 2005
 - 1 distribution of the first draft of Warsaw Scenario
- IWG meeting 29 –31 August 2005, Warsaw
 - 1 discussion on Warsaw Scenario, additional required data
 - 1 presentation of new PRAGUE SCENARIO
- September - October - November 2005
 - 1 distribution of revised version of SCENARIO W (draft v2.2) including the comments from participants
 - 1 preliminary run of predictions **blind test exercise**
- 3rd Combined EMRAS meeting :
IAEA 21–25 November 2005 -
 - 1 disclosing observed data, evaluation of predictions, IWG Report

EMRAS Iodine Working Group Summary

MILESTONES PLANNED

end of January 2006

- ❏ Final Report on PLAVSK exercise
- ❏ second run of predictions for Warsaw Scenario ??
to be discussed
- IWG meeting end of May 2006 Prague ????
- ❏ Evaluation of predictions for Warsaw Scenario, Final Report
- ❏ preparation of PRAGUE Scenario
- 4th Combined EMRAS meeting :
IAEA Autom 2006 - disclosing observed data for Prague
Scenario, evaluation of predictions, IWG Report

3rd Combined Meetings of the IAEA Programme on
Environmental Modelling for Radiation Safety (EMRAS)

21–25 November 2005

MODELS (participants)

Model	Participant Name	Country	Organization
1 LIETDOS	Ms T. Nedveckaitė (BIOMASS) (PLAVSK) MAZOVIA	Lithuania	Institute of Physics
2 OSCAAR	Mr T HOMMA (BIOMASS) (PLAVSK) MAZOVIA??	Japan	Japan Atomic Energy Research Institute
3 UniVes	Mr B.Kanyár (BIOMASS) (PLAVSK) MAZOVIA	Hungary	University of Veszprém Department of Radiochemistry
4 CLRP	Mr P. Krajewski (BIOMASS) (PLAVSK) MAZOVIA	Poland	Central Laboratory for Radiological Protection
5 ASTRAL	Ms C. Duffa (New) (PLAVSK) MAZOVIA ??	France	Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
6 Ecosys-87	Mr M. Ammann (New) (PLAVSK) MAZOVIA	Finland	Radiation & Nuclear Safety Authority (STUK)
7 Plavsk Dose Calculator	Mr S. Simon (New) (PLAVSK) MAZOVIA??	USA	National Cancer Institute
8 SPADE V.4.6	Mr D. Webbe-Wood (New) (PLAVSK) MAZOVIA??	UK	Food Standard Agency
9 CLIMRAD	O. Vlasov (New) (PLAVSK) MAZOVIA	Russian Federation	Medical Radiological Research Center
10 MODEL	Irina Zvonova (New) MAZOVIA	Russian Federation	Institute of Radiation Hygiene

PUBLISHED SCENARIOS

PLAVSK Scenario (Chernobyl)

*Primery prepared by SENES, (description, electronically available input data) customised for
IWG by Irina Zwonowa, Paweł Krajewski*

- **model validation problem!**
- **reconstruction of ^{131}I deposition using ^{137}Cs as a tracer**
- **scenario advantages!**
- **numerous measurements of ^{131}I thyroid contents**
- **adequate data set of $^{131}\text{I}/^{137}\text{Cs}$ ratio in soil (28 May 1986)**
- **a new subject to be validated!**
- **^{131}I thyroid burden for new born and $<3\text{m}$:**
- **process - transfer factor from mother breast to milk**

PUBLISHED SCENARIOS

¹³¹I PLAVSK Scenario (Chernobyl)

end points considered for model validation:

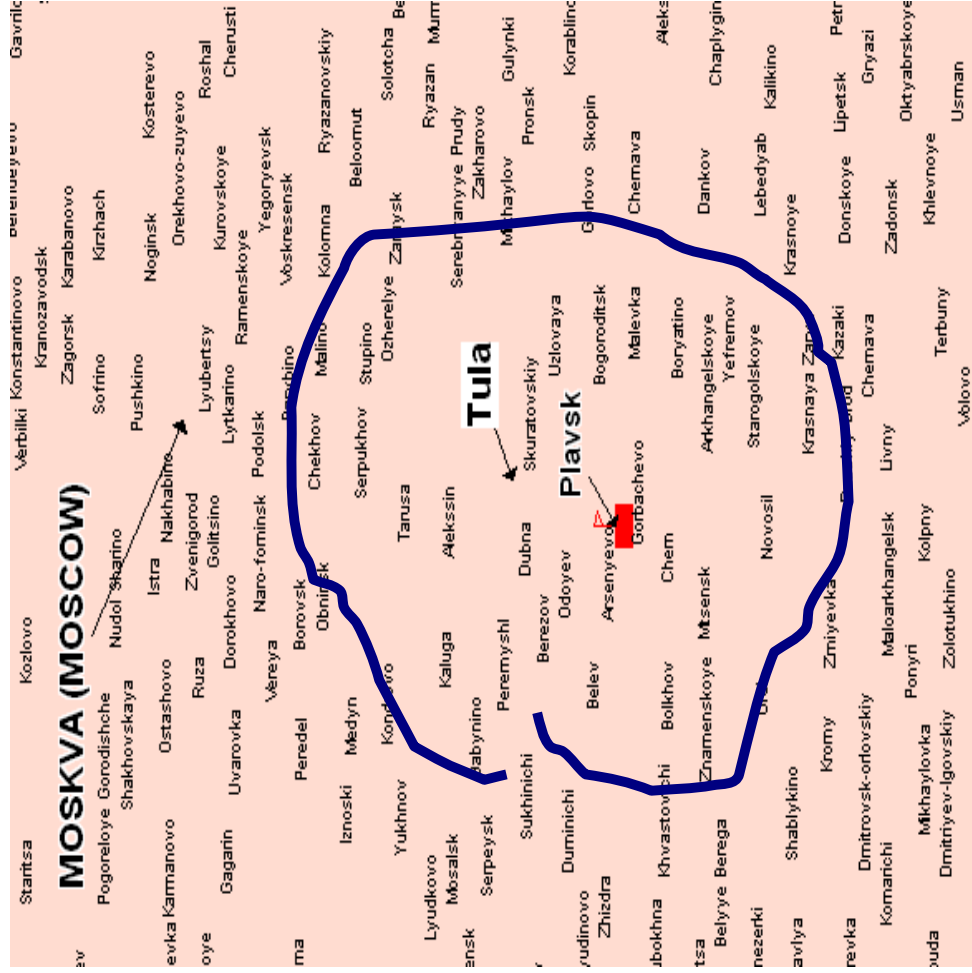
- **¹³¹I deposition (soil concentration)**
- **a time dependent ¹³¹I concentration in milk**
in the period 27 April –30 May 1986 for 18 milk farm and Town Plavsk
situated at different ¹³¹I deposition density
- **¹³¹I thyroid burden for different age groups:**
for urban population (Plavsk town): new born, 1-2, 3-7, 8-12, 13-17, adult
for specified rural locations: new born, 1-2, 3-7, 8-12, 13-17, adult

end points considered for model intercomparison:

committed doses to thyroid from ingestion
reconstruction of ¹³¹I air concentration from deposition
inhalation dose contribution to the total dose

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131 I PLAVSK Scenario (Chernobyl)

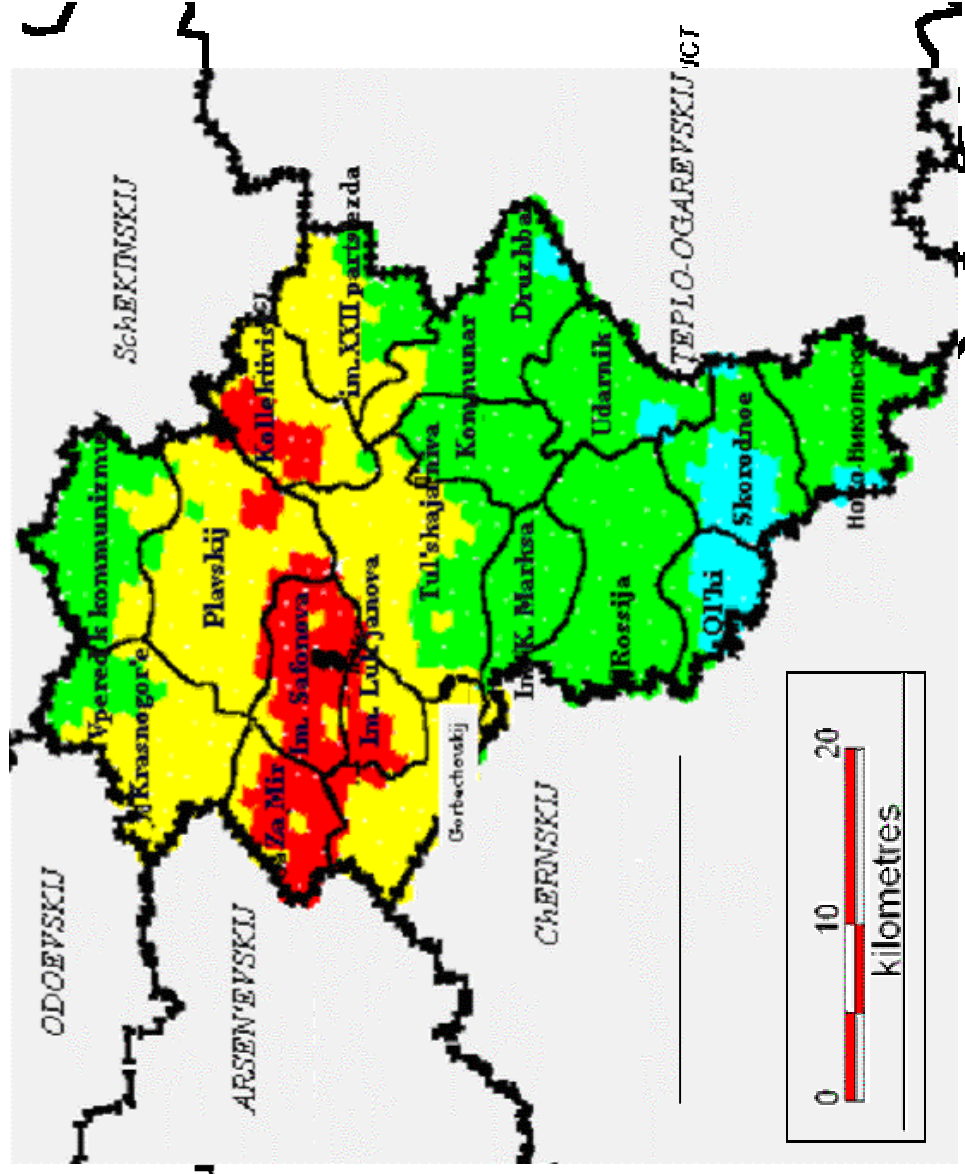


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21–25 November 2005

40 km width; 60 km high

- 1 Krasnogor'e
- 2 Za Mir
- 3 Im. Safonova
- 4 Plavskij
- 5 Vpered k kommunizmu
- 6 Im. Luk'janova
- 7 Gorbachevskij
- 8 Tul'skaja niva
- 9 Im. K. Marksa
- 10 Rossija
- 11 Kollektivist
- 12 Kommunar
- 13 Druzha
- 14 im.XXII parts'ezda
- 15 Udarnik
- 16 Ol'hi
- 17 Skorodnoe
- 18 Novo Nikol'skij



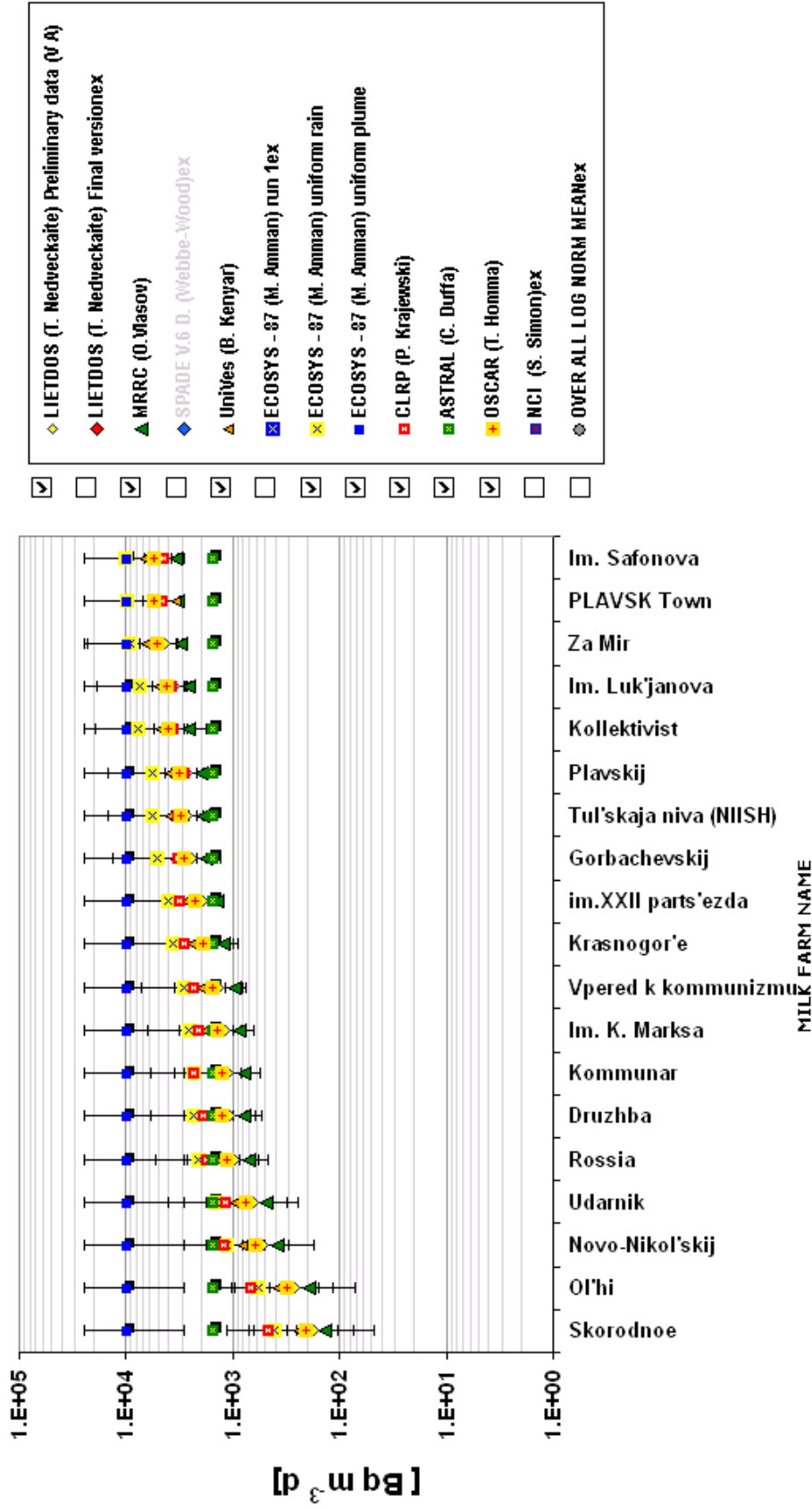
■ >37 kBq/m² ; ■ 37–185 kBq/m²; ■ 185–370 kBq/m²; ■ 370–555 kBq/m²; ■ 555 kBq/m²

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131I
 SORT ACCORDING DEPOSITION
 SORT ACCORDING SETTELMENT

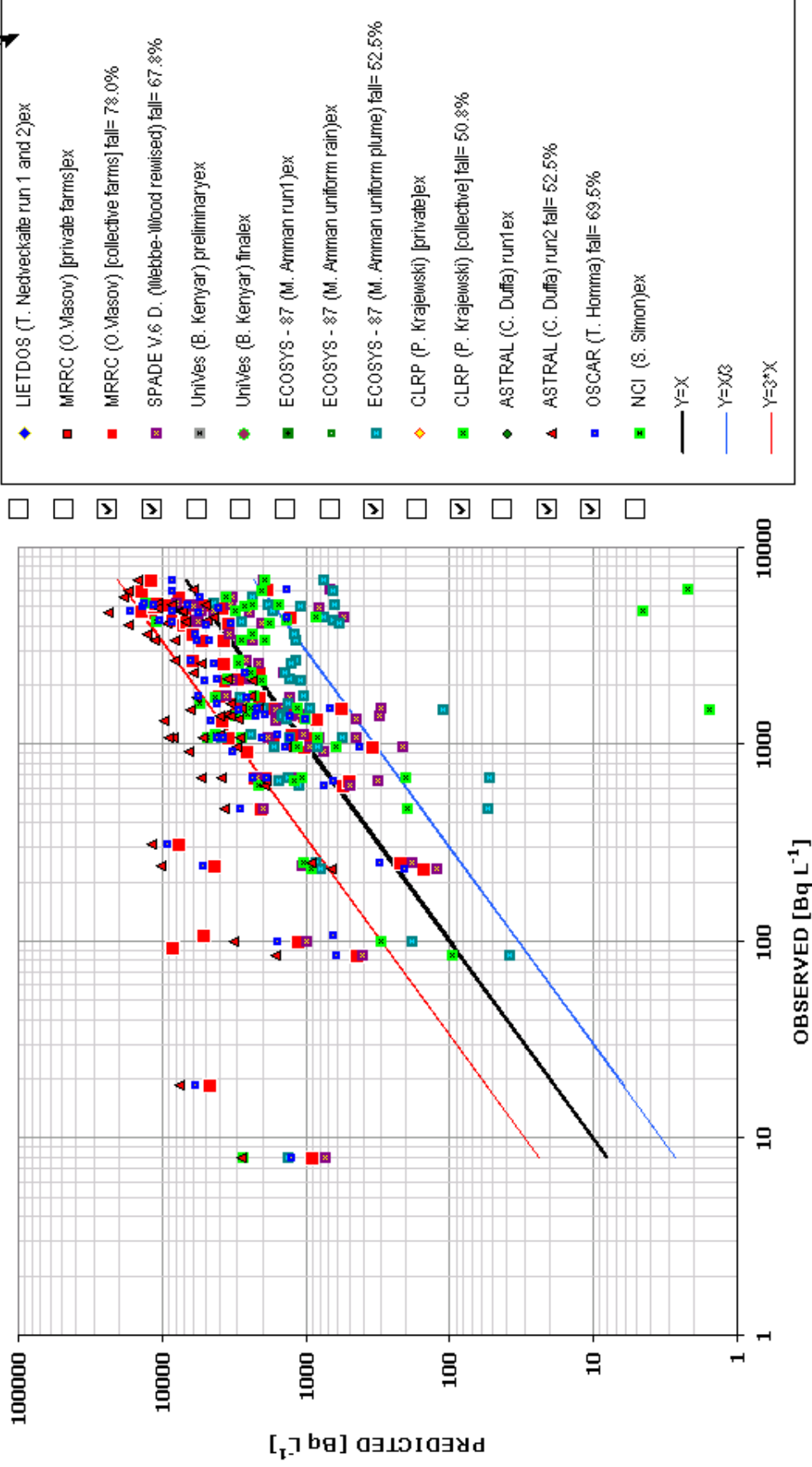
131I INTEGRATED AIR CONCENTRATION IN PLAVSK DISTRICT FOR PERIOD 29-April 1 May 1986



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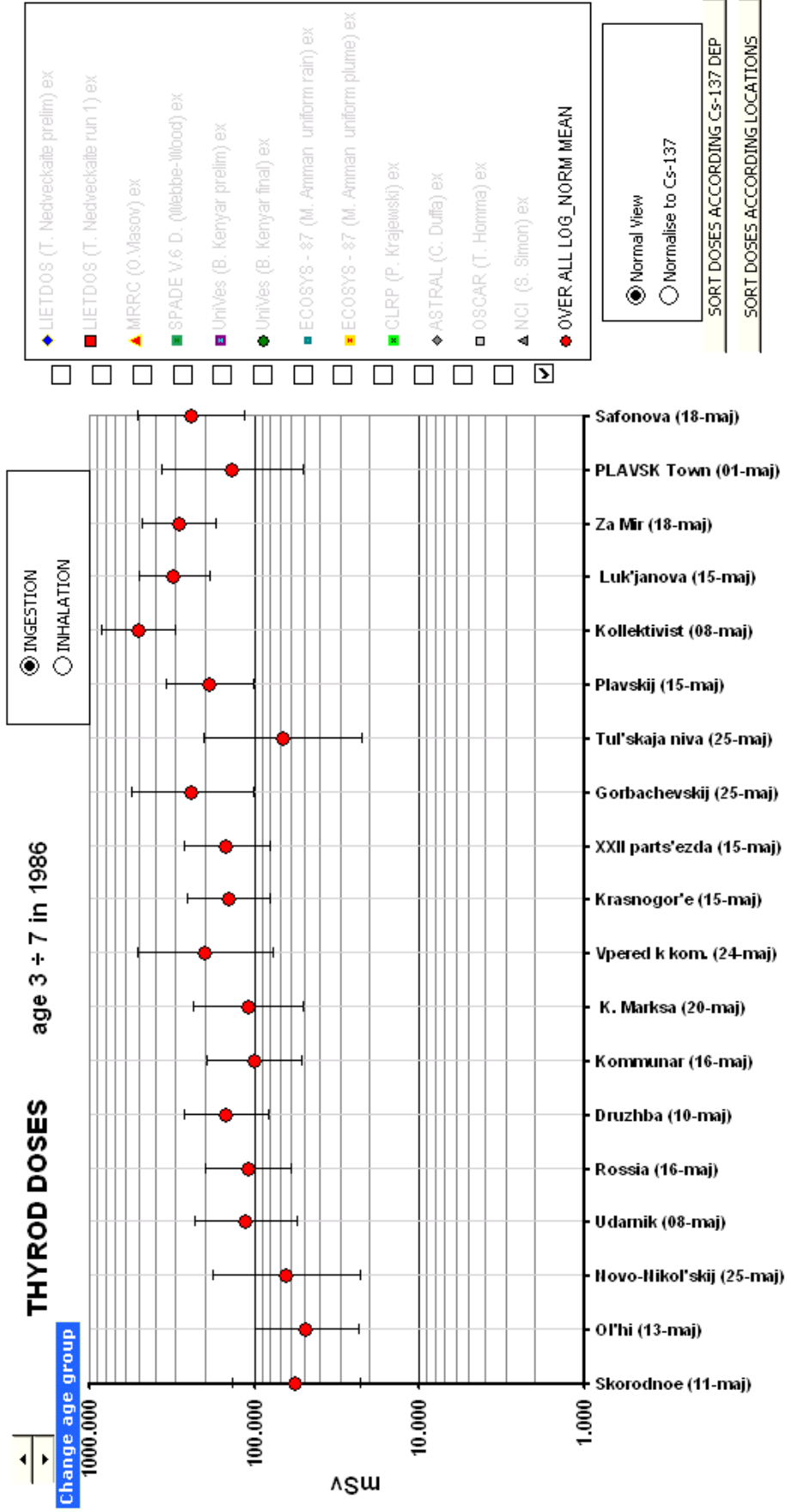
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I-131 CONCENTRATION IN MILK (PREDICTED versus OBSERVED)



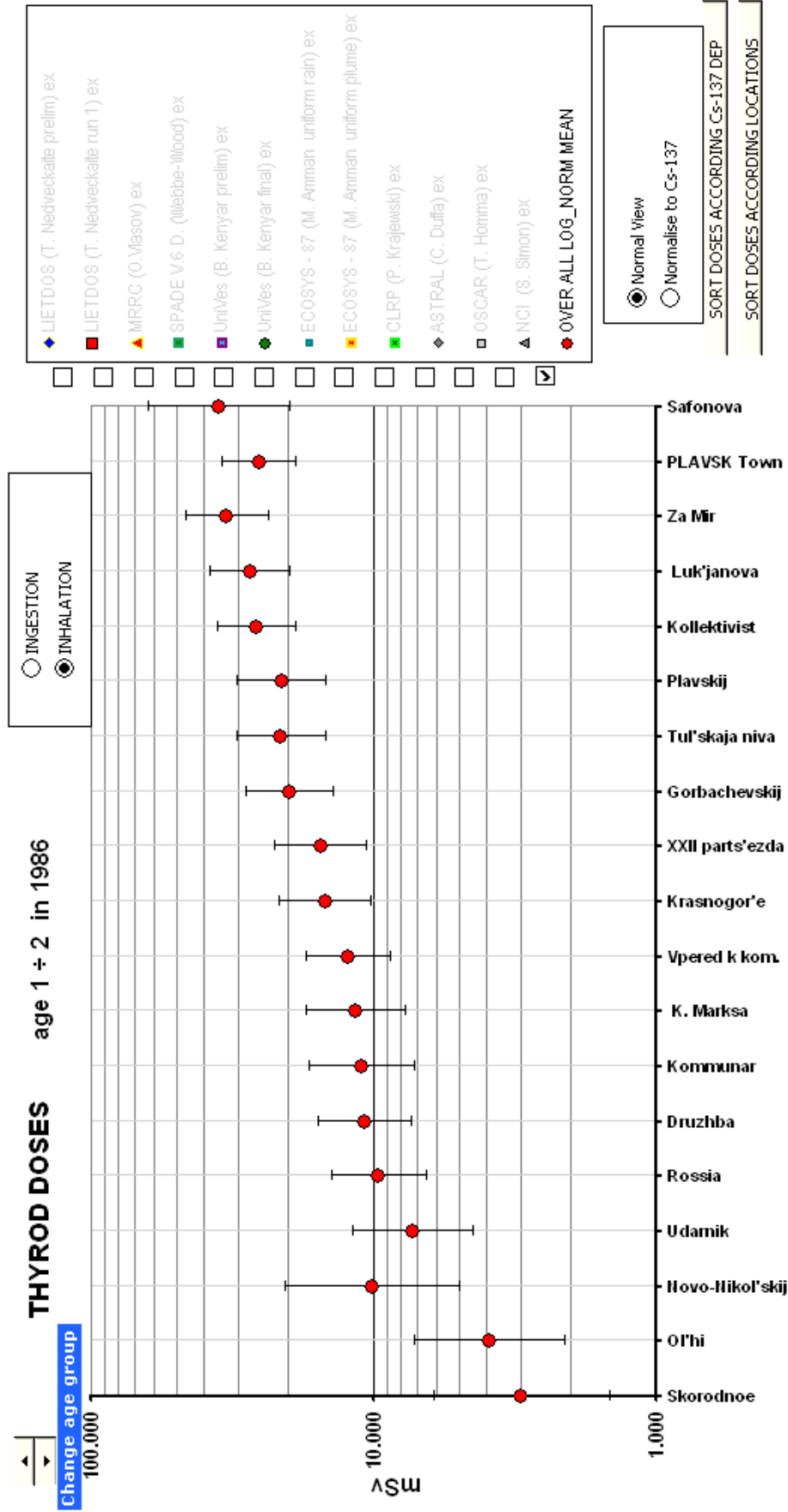
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General Conclusions from Plavsk Scenario

constant isotopic ratio $^{131}\text{I}/^{137}\text{Cs}$ provided by Scenario Plavsk gives an approximation of ^{131}I contamination of food-chain, however inhomogeneous ^{137}Cs deposition and relatively short time of rain during the cloud passage (6 hours) indicates that the radioactive fallout can be classified as mixed (dry&wet) and in this case a regional approach should be applied to determine more complex relationship between ^{131}I deposition and ^{137}Cs deposition.

model of grass interception in a case of mixed (dry&wet) radioiodine fallout need to be carefully considered.

General Conclusions from Playask Scenario (cont)

The time when cows have been put on a pasture seems to be the most important factor of miss predictions of ^{131}I concentration in milk and consequently ingestion doses.

In general, although IWG was dealing with areas of assessment modelling for which the capabilities are not yet well established; there is remarkably improvement in models performance comparing with previous radioiodine scenarios. Predictions of the various models were with in a factor of three of the observations, discrepancies between the estimates of average doses to thyroid produced by most participant not exceeded a factor of ten.

PUBLISHED SCENARIOS

131 I WARSAW SCENARIO (Chernobyl)

(description, electronically available input data, and templates for predictions)

crucial points for model validation!

- effectiveness of thyroid blocking!
- inhomogeneous ¹³¹I deposition

end points considered for model testing:

- ¹³¹I concentration in milk
- ¹³¹I thyroid burden for different age groups for two specified location

effectiveness countermeasures

- administration of stable iodine solution (interviews DB),
- limitation of fresh milk consumption (uncertain data),
- restriction of cows pasturing (uncertain data)

EMRAS Iodine Working Group Summary

IAEA/EMRAS, The Chernobyl I-131 release

MODEL VALIDATION AND ASSESSMENT OF THE COUNTERMEASURE EFFECTIVENESS WORKING GROUP

SCENARIO W

(*draft v2.2*)

revised version including the comments from participants

**VALIDATION OF ENVIRONMENTAL MODELS
USING DATA FROM CHERNOBYL AIR POLLUTION IN THE MAZOVIA AREA**

Pawel Krajewski

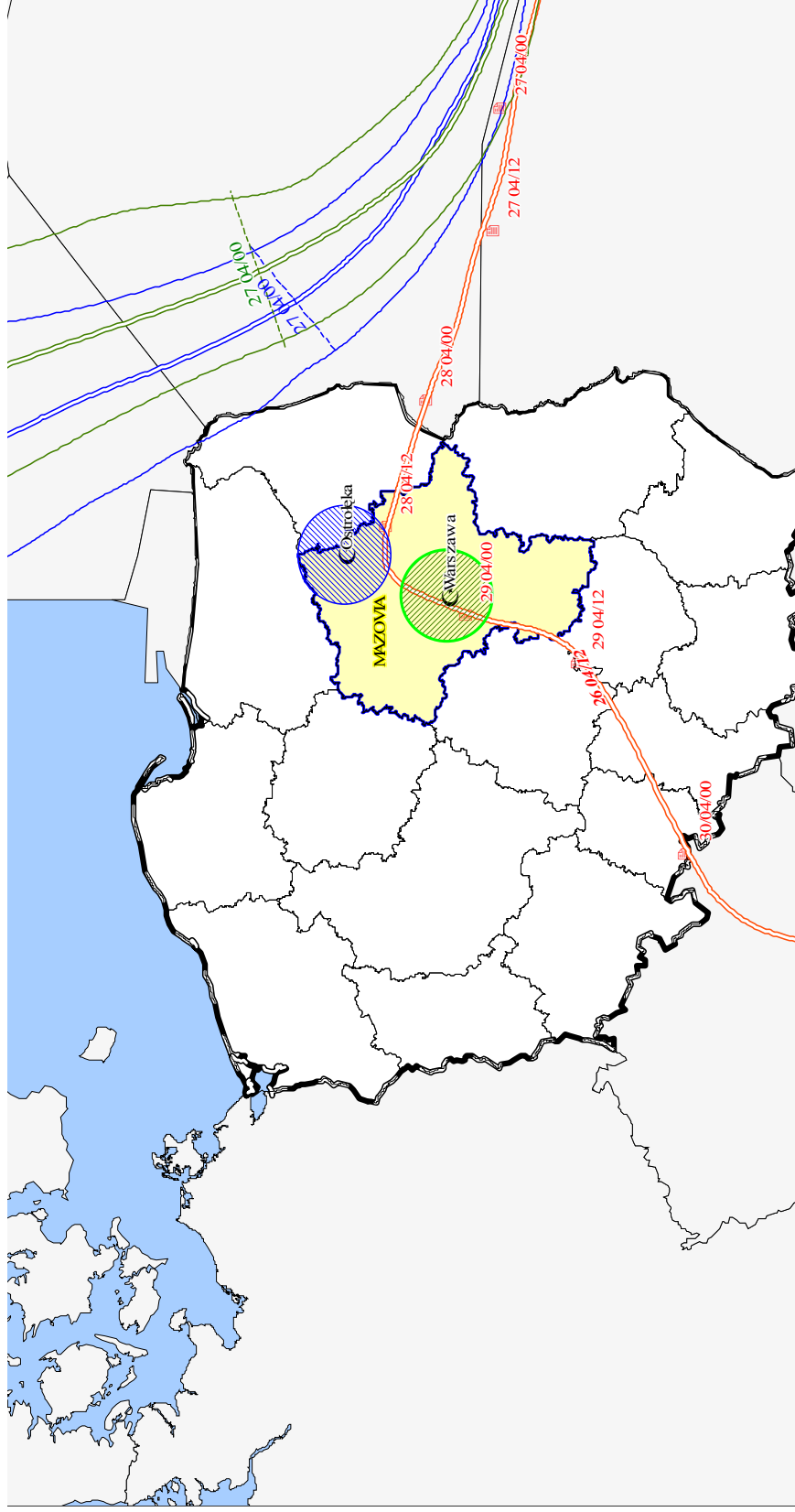
Central Laboratory for Radiological Protection

Konwalia St.7, 93 Warsaw, Poland

E-mail: krajewski@clor.waw.pl

SCENARIO MAZOWIA

DATA FROM CHERNOBYL AIR POLLUTION IN THE MAZOWIA AREA

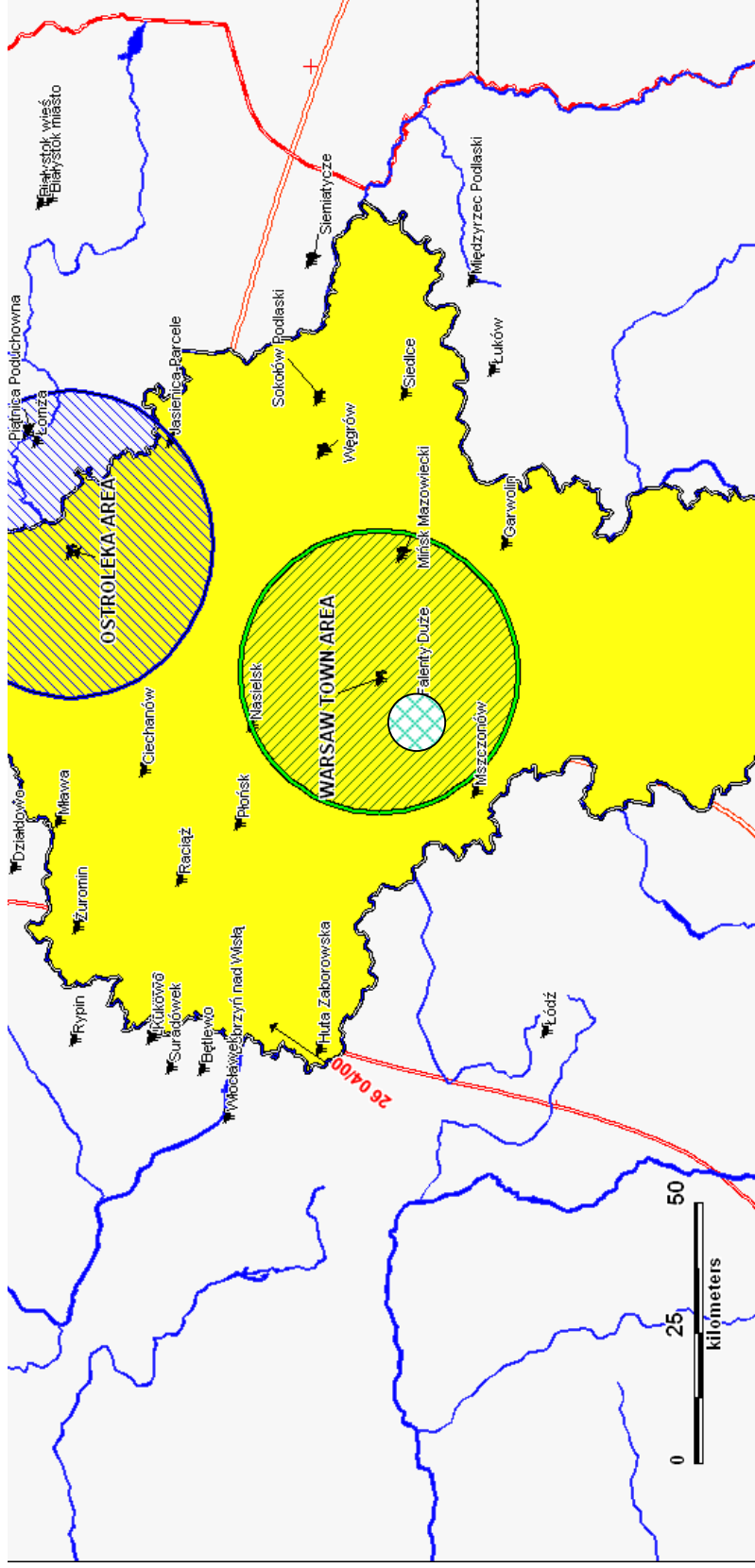


Air mass movements originating from Chernobyl on 26 April 12 GMT. Plumes red, blue, and green correspond to: surface winds, 925 mb – 800 m altitude, 850 mb – 1500 m altitude respectively.

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SCENARIO MAZOWIA

DATA FROM CHERNOBYL AIR POLLUTION IN THE MAZOVIA AREA



Localization of Warsaw town area and Ostrołęka area in the Mazovia province.
Milk sampling places during 28 April – 31 May 1986

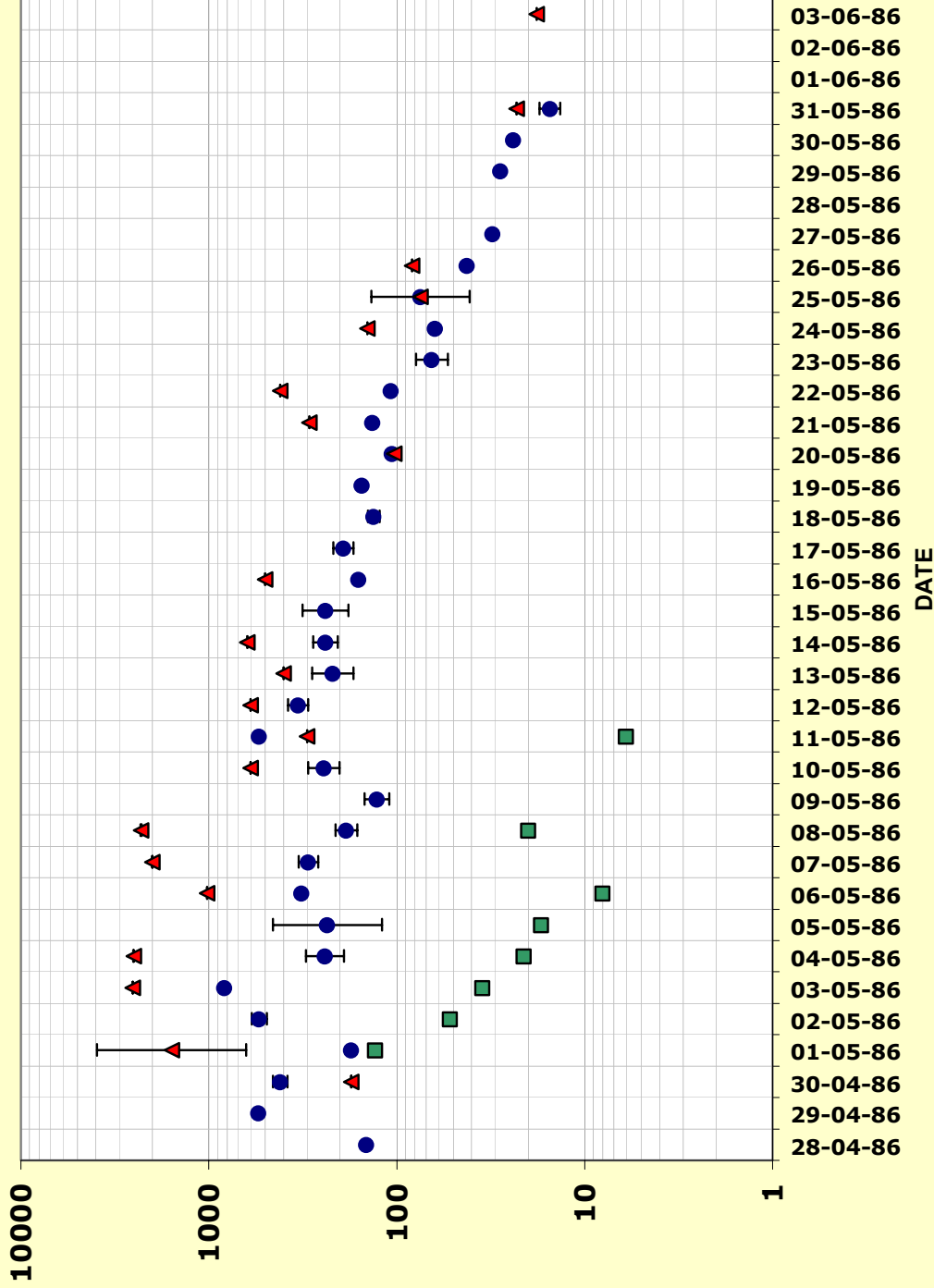
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I-131 [Bq/L]

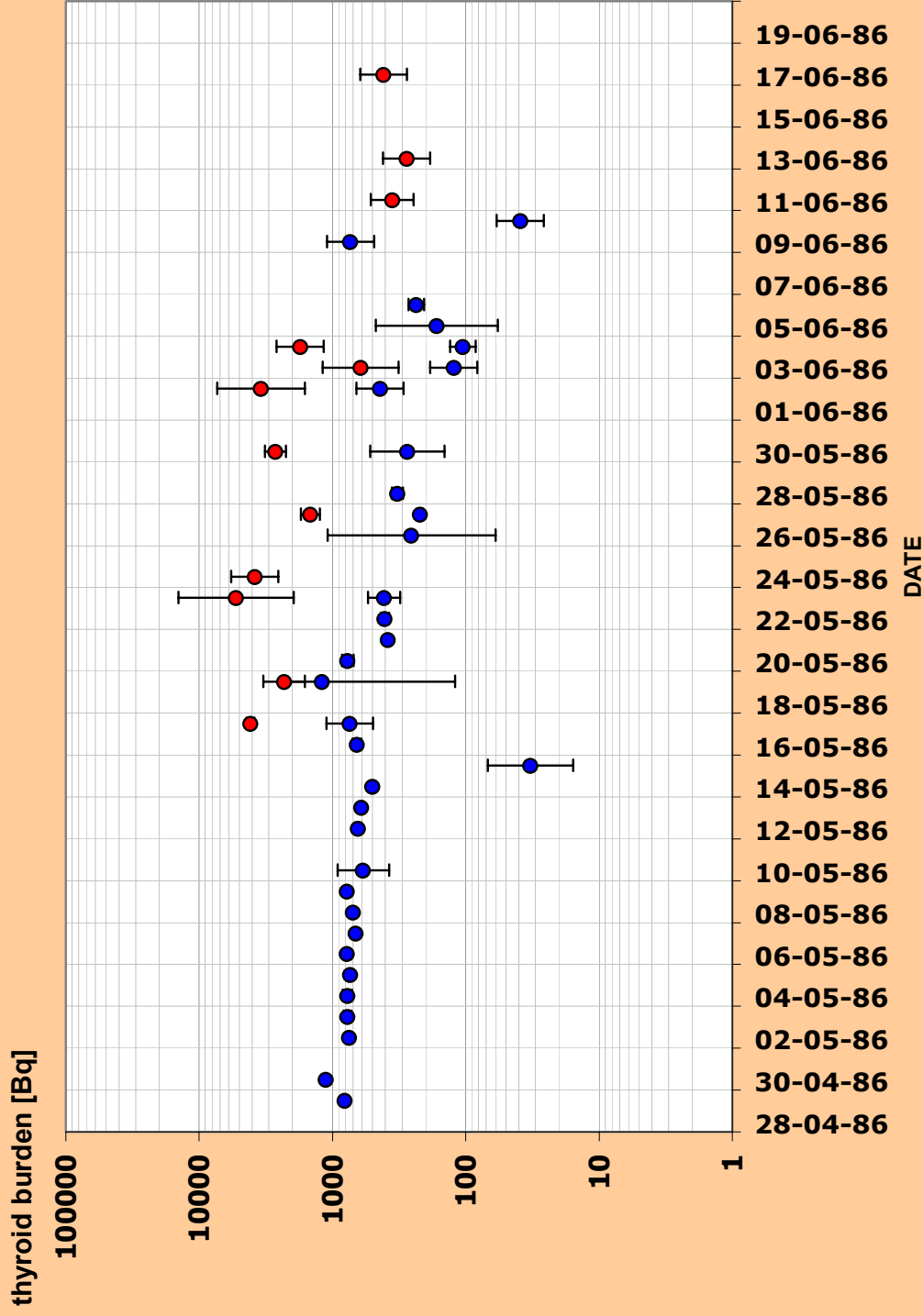
I-131 milk concentration in MAZOVIA DISTRICT

- WARSAW MILK
- Falenty milk
- ▲ Ostroleka area milk



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I-131 Thyroid burden for inhabitants of MAZOWIA district



SCENARIO UNDER PREPARATION

Irena Malátová, National Radiation Protection Institute, Czech Republic

(¹³⁷Cs in VAMP's Central Bohemia Scenario)

Chernobyl Prague

**Air, Precipitation, Vegetation, Animal feed, Water, Milk,
Human Thyroid**