The EURDEP system during the Fukushima accident: data analysis and information exchange and the radiological consequences for Europe

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Ispra - Italy

http://itu.jrc.ec.europa.eu/

http://www.jrc.ec.europa.eu/

Content

European Commission

I. EC International information and data exchange systems

- ECURIE, emergency response, information policy
- EURDEP: dose rate, air monitors

II. synopsis of observations in Europe

- radionuclide concentrations in air
- radionuclide ratios
- estimation methods
- fallout, foodstuff
- doses

Part I:

EC international information and data exchange systems

Council Decision 87/600

- **The ECURIE system is the practical implementation of the Council Decision 87/600. It is the early notification system for radiological accidents of the EC.**

  When a Member State decides to take counter-measures, it shall forthwith notify the Commission and the affected MS's
- **This Council Decision was taken to assure a better preparedness and response to transboundary events as caused by the Chernobyl accident**
- **The Council Decision is binding for EU Member States and foresees that each country nominates a Contact Point (CP, 24/7 available) and Competent Authority (CA). Other countries can subscribe on a voluntary basis.**
- **The Commission shall immediately forward notifications to all the national competent authorities (CA)**
- **Any MS will inform the Commission of the levels of radioactivity that it measures**

ECURIE <> IAEA

- **The worldwide counterpart of ECURIE is the early notification system of the IAEA (EMERCON/ENATOM).**
- **Intense collaborations have resulted in the definition of a common data-format (International Radiological Information eXchange : IRIX) and an identical set of information to exchange during an event.**
- **The EC has signed the IAEA early notification convention.**
- **WebECURIE and USIE (IAEA) will both be compatible to the IRIX standards.**

- ***Being able to use the same data-format for the EC and the IAEA reduces need for duplication, therefore the EU MSs are strongly facilitated in notifying the two organizations during an accident.***

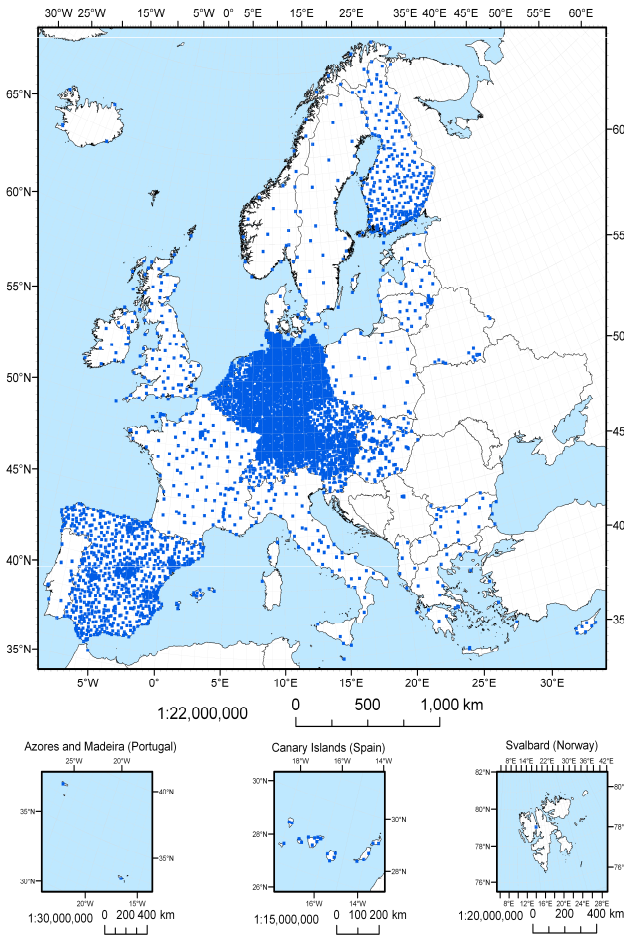
European radiological monitoring networks

(status 2008)

European Commission

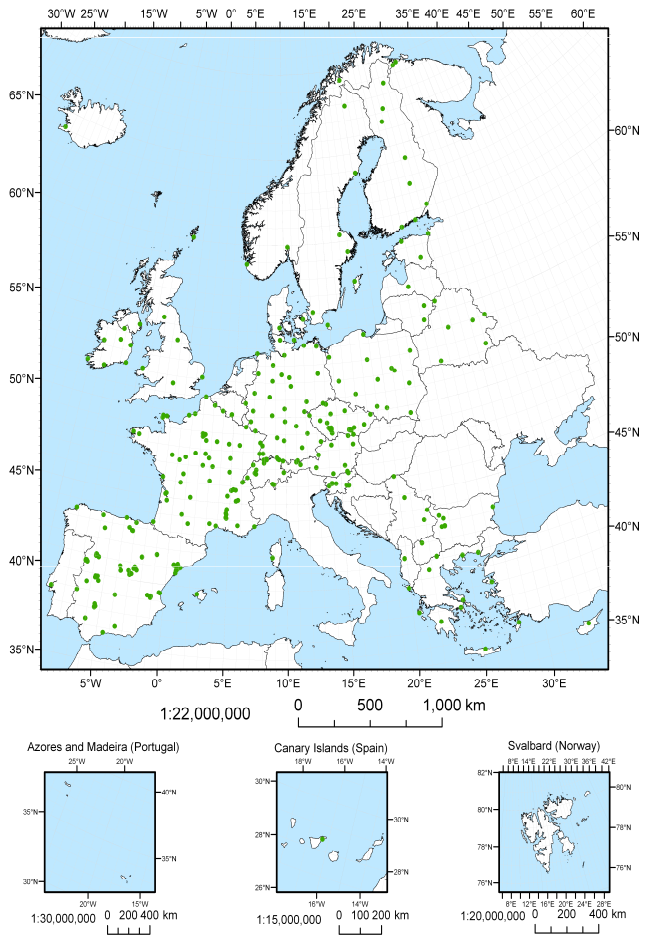
Ambient dose-rate

on-line stations: ±4500

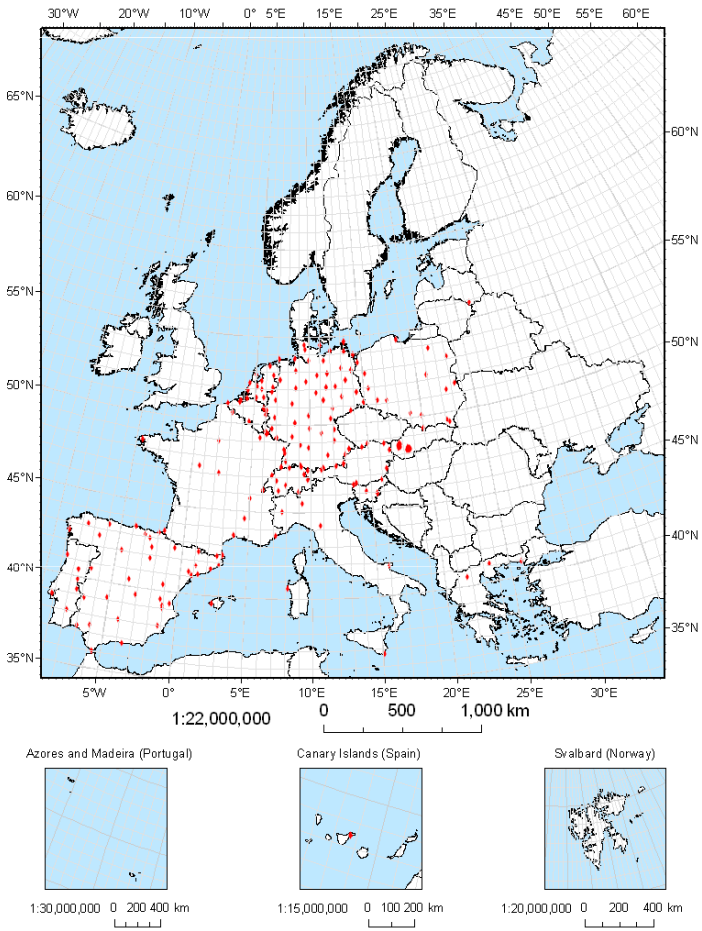


Air concentration

on-line stations: 236



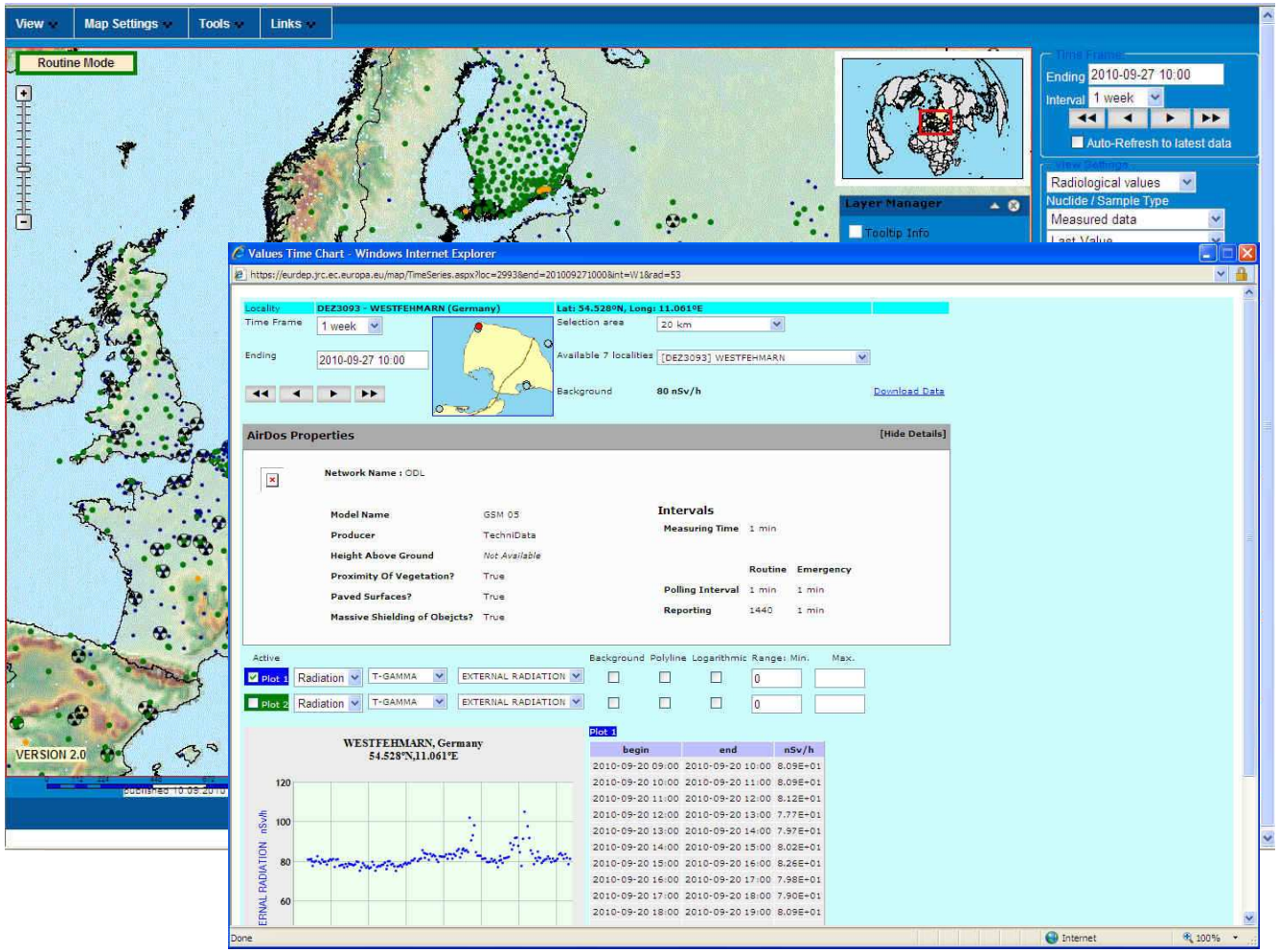
off-line stations: 383



EURDEP - On-line data base - WWW

European Commission

- Internationally recognized standard format for radiological data;
- Network (35 European countries with 4500 stations participating);
- daily and hourly transmissions, mostly γ-dose rates;
- Raw data available at 3 mirror-sites (Ispra, Italy – Freiburg, Germany – Luxembourg)
- Web-site to view and download data.



http://eurdep.jrc.ec.europa.eu

Data availability

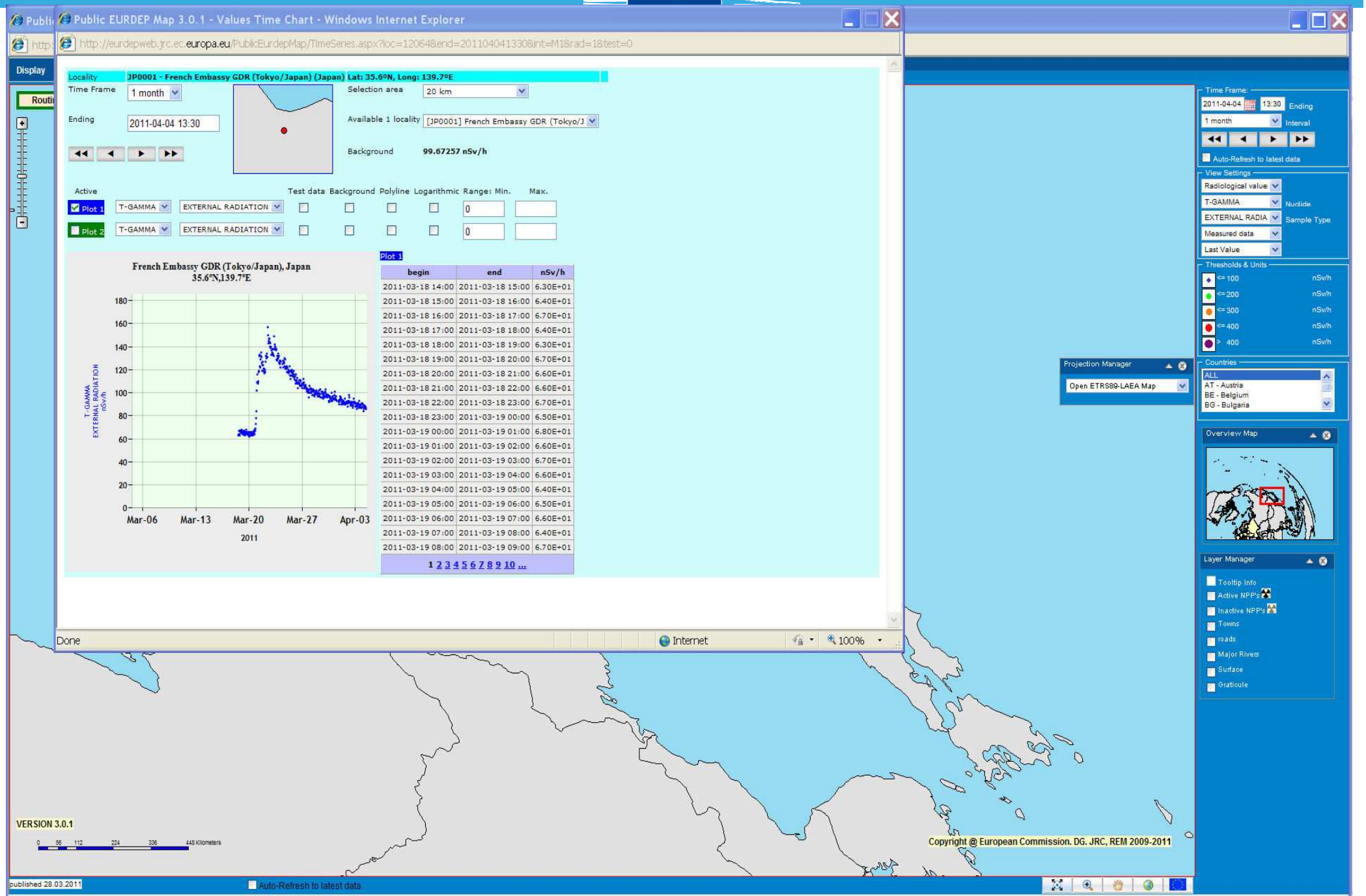
- To all data-providers
- National and international governmental Organizations related to emergency response
- Some exceptions for research
  - Authorization by EC and/or IAEA
  - Authorization by national Contact Point
  - Reference to data-providers
- Public web-site
  - Country imposed delay
  - No download of data
  - No meteo-data

IRMIS / EURDEP relation

- **EURDEP technology available to IAEA**
  - **Web-site with configuration file to run as EURDEP private, EURDEP public, IRMIS private, IRMIS public**
  - **Further development by EC / JRC**
  - **IAEA is part of decision making structure to define future requirements**
  - **All data collected under EURDEP is available at IRMIS, all data collected under IRMIS is available at EURDEP**

Part II:

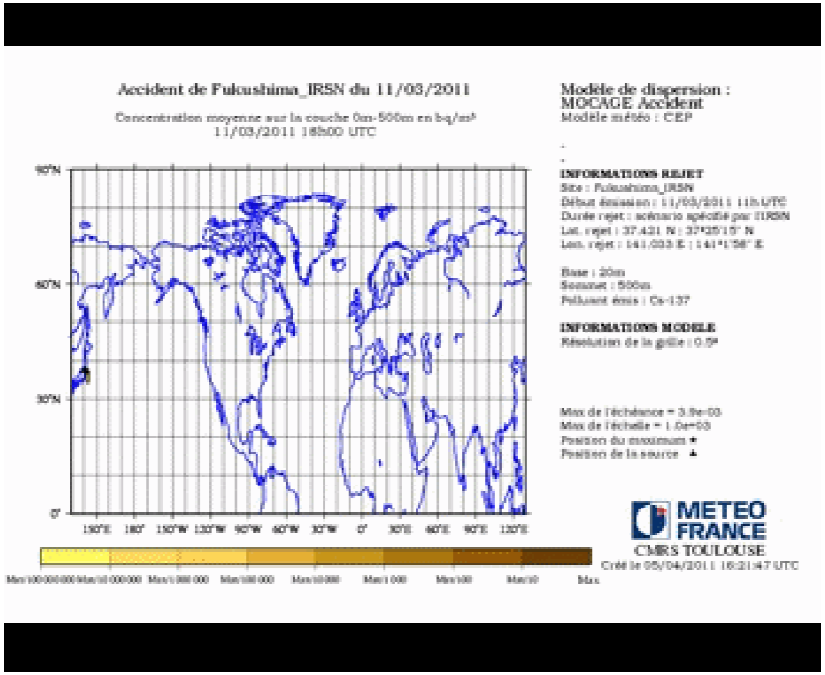
Observations in Europe after the accident in Fukushima Daiichi NPP


Public EURDEP Map 3.0.1 - Values Time Chart - Windows Internet Explorer
http://eurdepweb.jrc.ec.europa.eu/PublicEurdepMap/TimeSeries.aspx?loc=120648end=201104041330&int=M1&rad=1&test=0
Locality JP0001 - French Embassy GDR (Tokyo/Japan) (Japan) Lat: 35.6ºN, Long: 139.7ºE
Time Frame 1 month
Ending 2011-04-04 13:30
Selection area 20 km
Available 1 locality [JP0001] French Embassy GDR (Tokyo/J
Background 99.67257 nSv/h
Active Test data Background Polyline Logarithmic Range: Min. Max.
Plot 1 T-GAMMA EXTERNAL RADIATION
Plot 2 T-GAMMA EXTERNAL RADIATION
French Embassy GDR (Tokyo/Japan), Japan
35.6°N,139.7°E
T-GAMMA EXTERNAL RADIATION nSv/h
Mar-06 Mar-13 Mar-20 Mar-27 Apr-03
2011
Plot 1
begin end nSv/h
2011-03-18 14:00 2011-03-18 15:00 6.30E+01
2011-03-18 15:00 2011-03-18 16:00 6.40E+01
2011-03-18 16:00 2011-03-18 17:00 6.70E+01
2011-03-18 17:00 2011-03-18 18:00 6.40E+01
2011-03-18 18:00 2011-03-18 19:00 6.30E+01
2011-03-18 19:00 2011-03-18 20:00 6.70E+01
2011-03-18 20:00 2011-03-18 21:00 6.60E+01
2011-03-18 21:00 2011-03-18 22:00 6.60E+01
2011-03-18 22:00 2011-03-18 23:00 6.70E+01
2011-03-18 23:00 2011-03-19 00:00 6.50E+01
2011-03-19 00:00 2011-03-19 01:00 6.80E+01
2011-03-19 01:00 2011-03-19 02:00 6.60E+01
2011-03-19 02:00 2011-03-19 03:00 6.70E+01
2011-03-19 03:00 2011-03-19 04:00 6.60E+01
2011-03-19 04:00 2011-03-19 05:00 6.40E+01
2011-03-19 05:00 2011-03-19 06:00 6.50E+01
2011-03-19 06:00 2011-03-19 07:00 6.60E+01
2011-03-19 07:00 2011-03-19 08:00 6.40E+01
2011-03-19 08:00 2011-03-19 09:00 6.70E+01
1 2 3 4 5 6 7 8 9 10 ...
Done
Internet
100%
Time Frame
2011-04-04 13:30 Ending
1 month Interval
Auto-Refresh to latest data
View Settings
Radiological value
T-GAMMA Nuclide
EXTERNAL RADIA Sample Type
Measured data
Last Value
Thresholds & Units
<= 100 nSv/h
<= 200 nSv/h
<= 300 nSv/h
<= 400 nSv/h
> 400 nSv/h
Countries
ALL
AT - Austria
BE - Belgium
BG - Bulgaria
Projection Manager
Open ETRS89-LAEA Map
Overview Map
Layer Manager
Tooltip Info
Active NPP's
Inactive NPP's
Towns
roads
Major Rivers
Surface
Graticule
VERSION 3.0.1
0 56 112 224 336 448 Kilometers
Copyright @ European Commission. DG. JRC, REM 2009-2011
published 28.03.2011
Auto-Refresh to latest data

Arrival of contaminated air in Europe

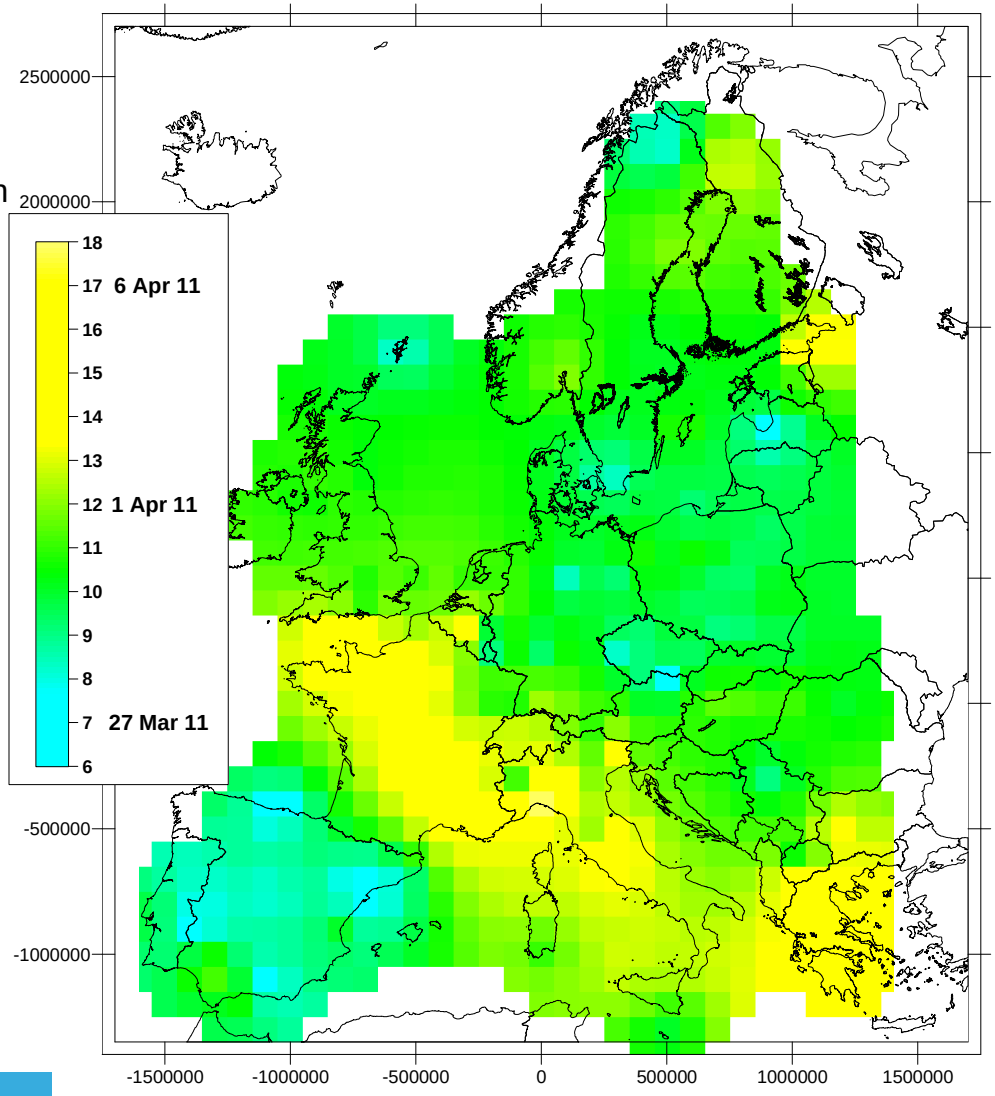
European Commission

- Earthquake:
  11 Mar 2011, 14:46;
  Tsunami ca. 15:27
- Explosions, venting
- First notice in Europe:
  CTBTO Reykjavik (Iceland), 20/21 Mar 11
- Maxima in Europe:
  27 Mar – 6 April 11

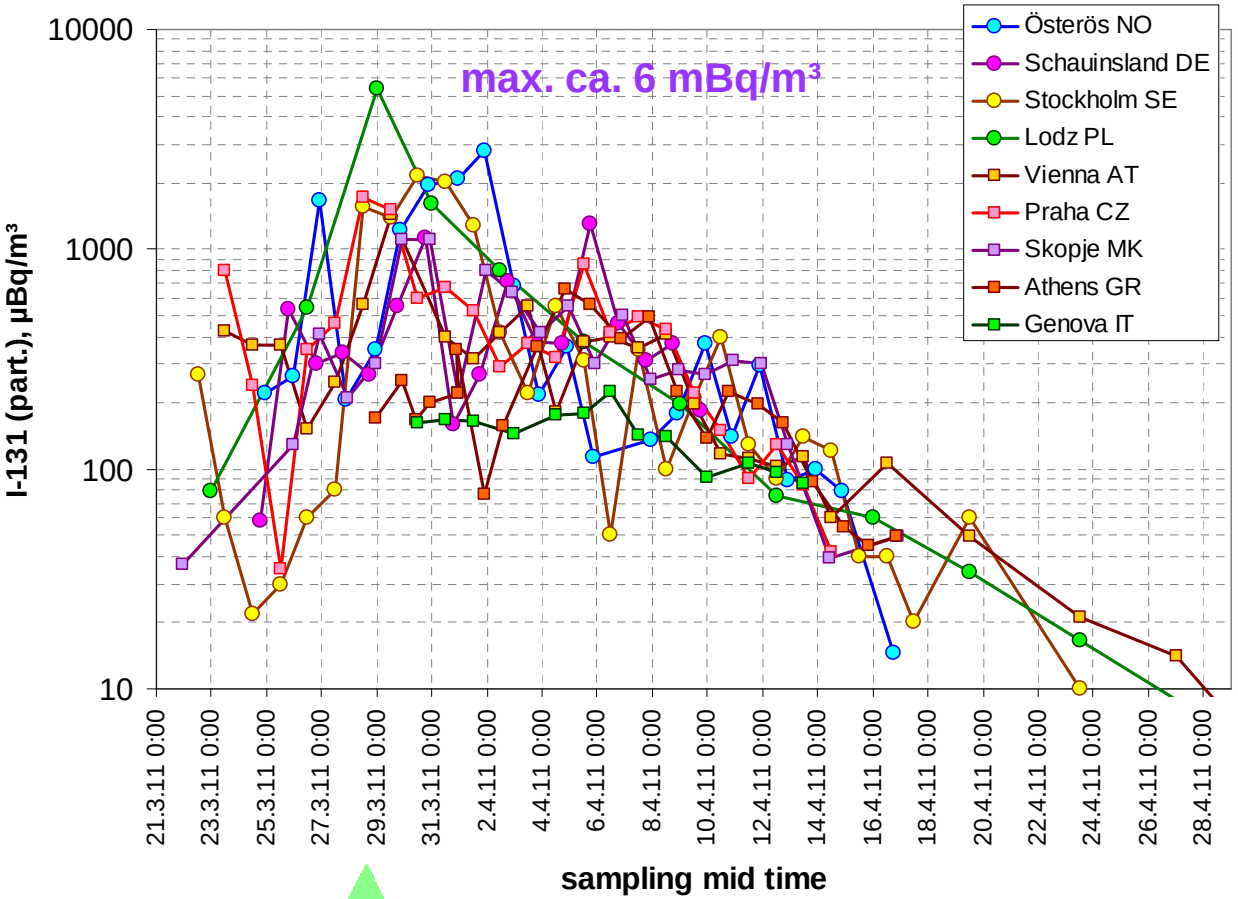


source: IRSN

Approximate passage date of the maximum concentration of ^{131}I (part.). Scale: days after 20 March 2011. Axis units: m.

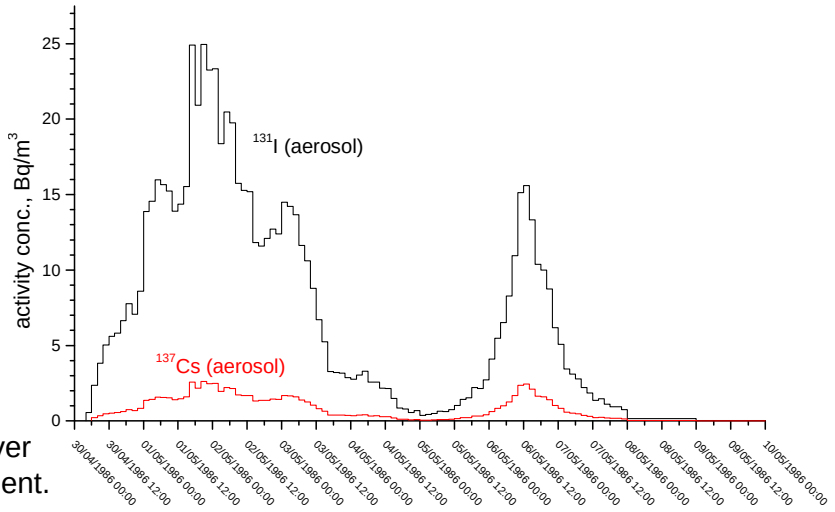


Time series



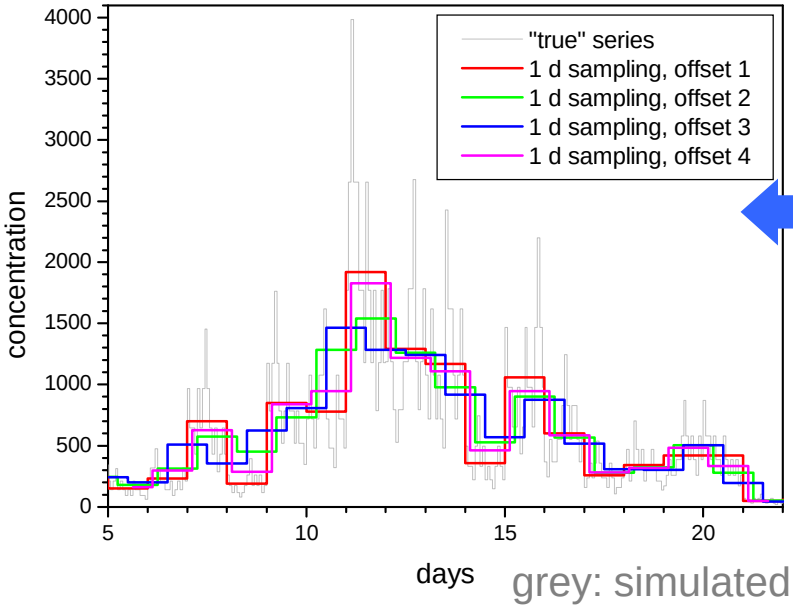
- Data from 227 stations available;
- Different quality;
- 150 could be used for spatial evaluations;
- Stat.-based adaptation and harmonization necessary in many cases

Fukushima, Central Europe: >3 orders of magnitude lower than Chernobyl!



^{131}I and ^{137}Cs concentrations in air over Ispra (Italy) after the Chernobyl accident. Source: REM database.

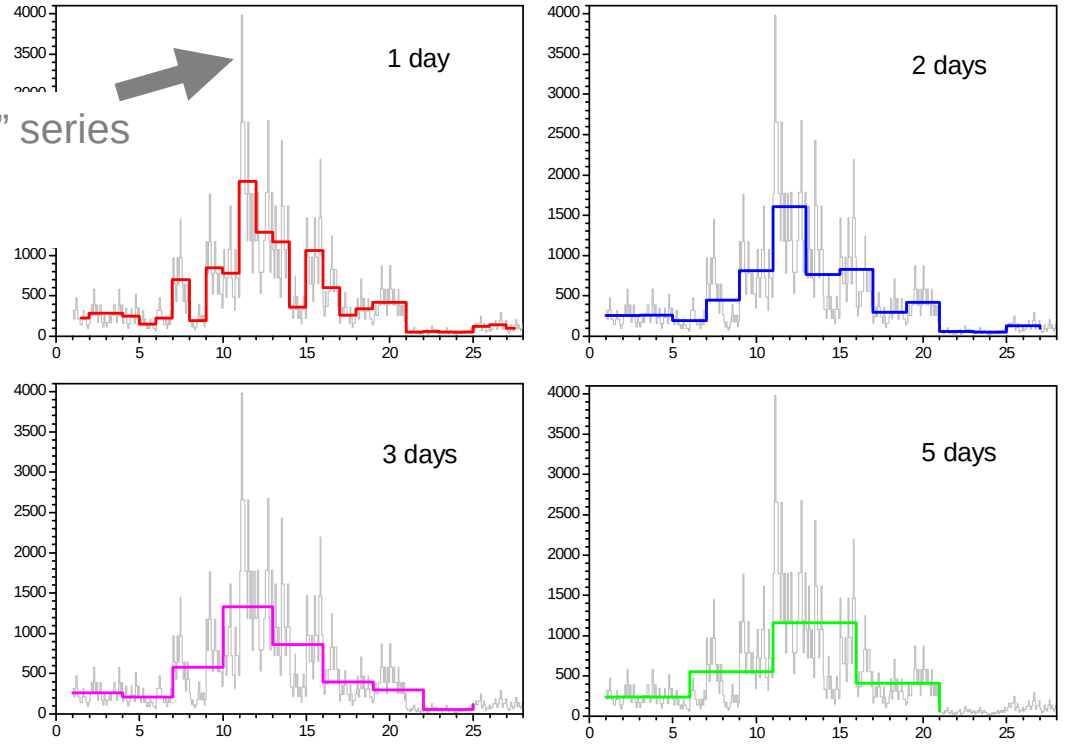
Problems of data harmonization



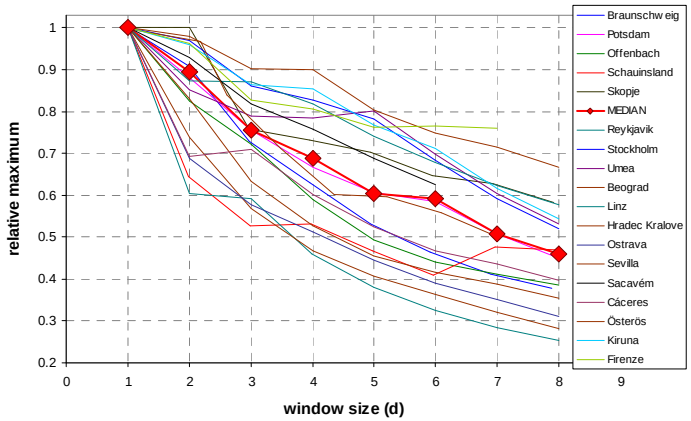
grey: simulated "true" series (principle: multiplicative cascade)

Establish a consistent input data set.
Among problems:

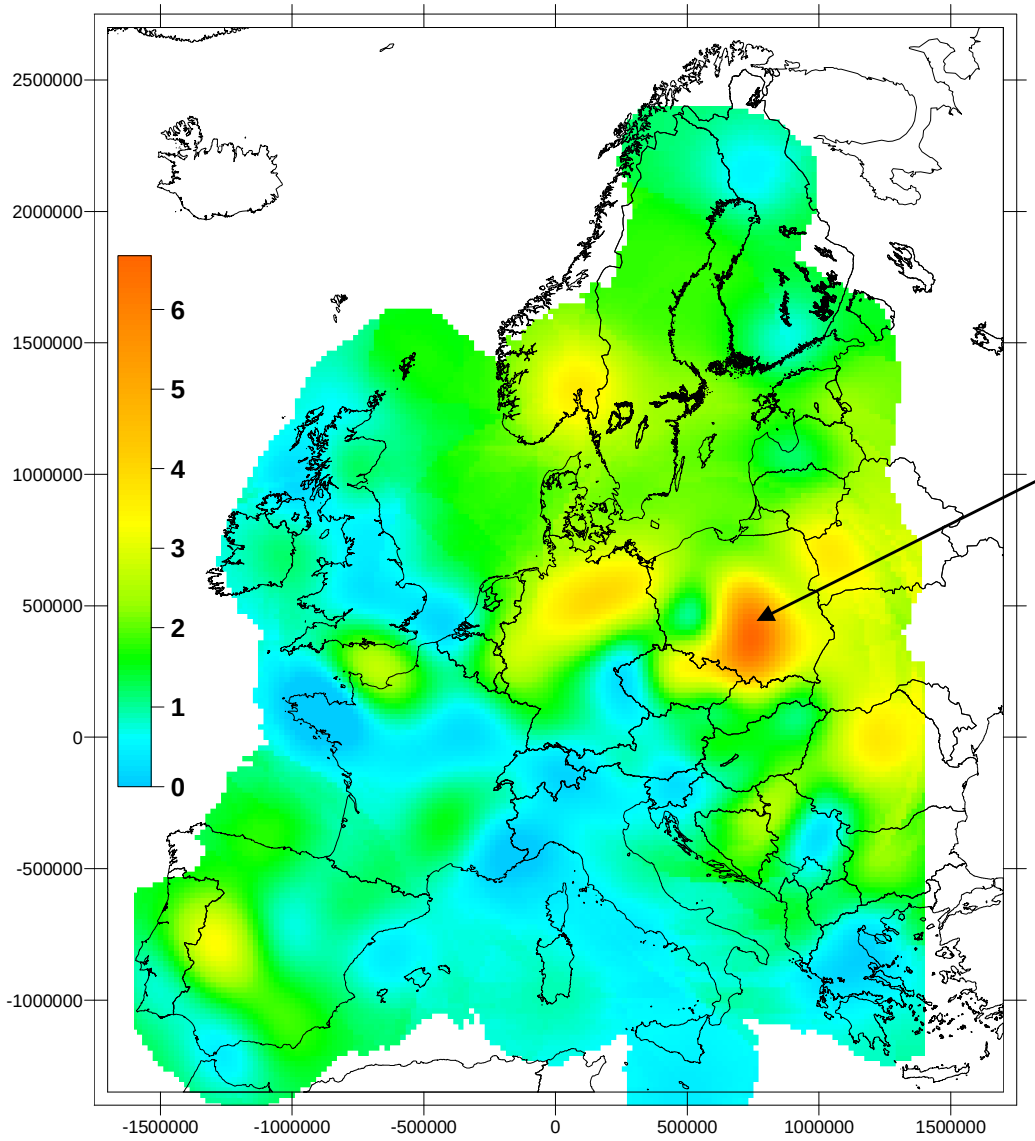
- **Stations have different offsets of sampling period;**
- **Stations have different durations of sampling periods.**



scaling of maximum with size of observation window



^{131}I concentrations in aerosols



observed maximum within domain (corrected for sampling offset and duration):

6.4 mBq/m³ (±11%), Łodz, PL, 29.3.11

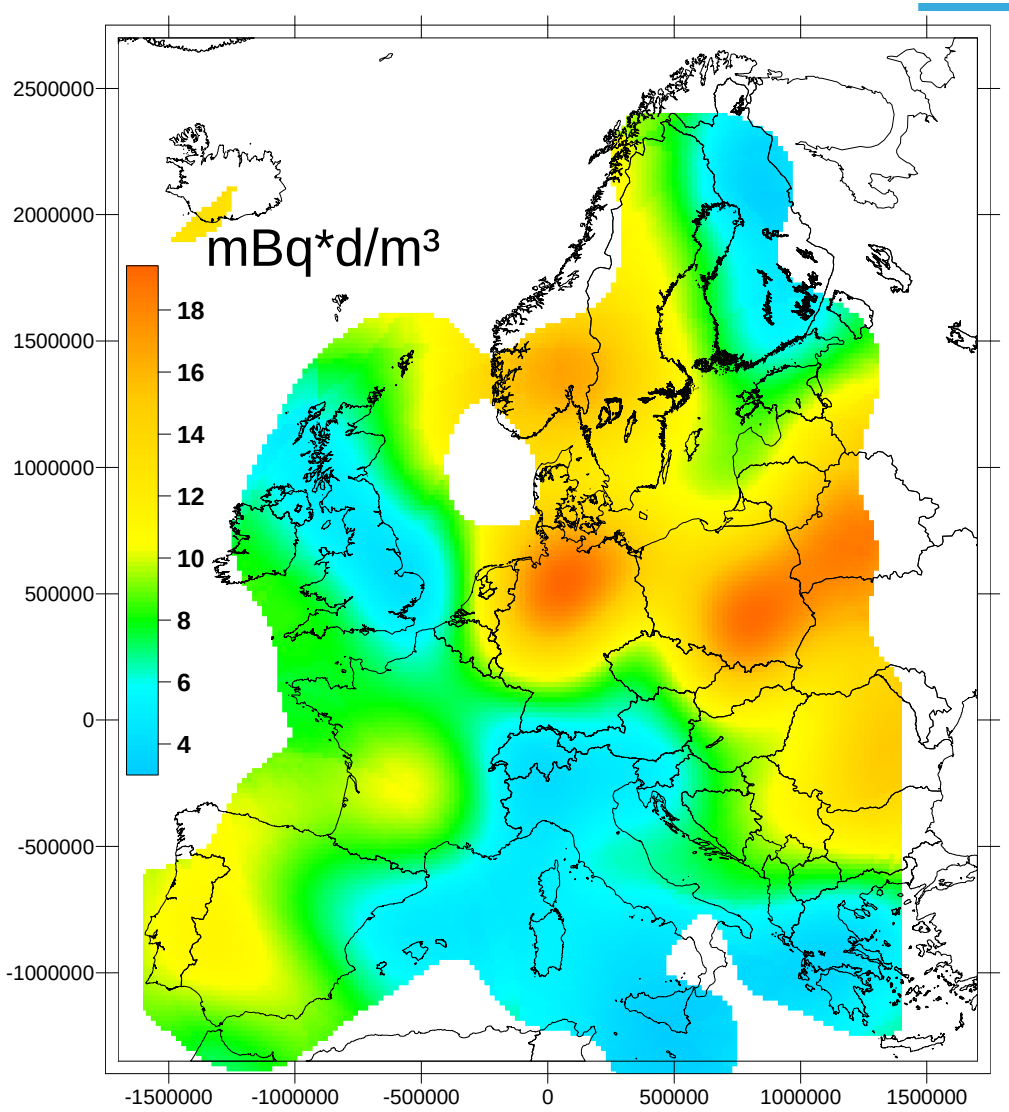
source of most maps and graphs:

- P. Bossew, G. Kirchner, M. De Cort, G. de Vries, A. Nishev, Luca de Felice: Radioactivity from Fukushima-Dai-ichi in air over Europe, part 1: Spatio-temporal analysis. publ. on-line, JER
- G. Kirchner, P. Bossew, M. De Cort: Radioactivity from Fukushima Dai-ichi in air over Europe, part 2: What can it tell us about the accident? publ. on-line, JER.

Estimated distribution of maximum ^{131}I (particulate) concentration over Europe. Scale unit: mBq/m³. Axis units: m.

^{131}I concentrations in aerosols

European Commission

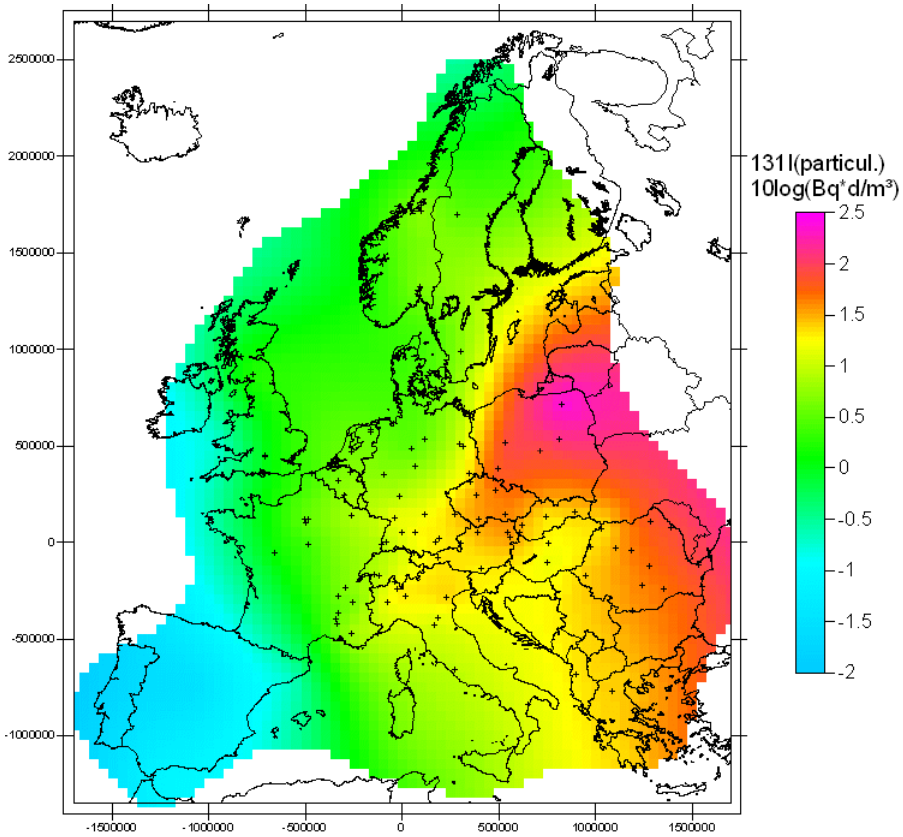


Estimated distribution of time-cumulated ^{131}I (particulate) concentration over Europe. Scale unit: mBq*d/m³. Axis units: m.

plot: $E[Z(U(x))|\{z_i\}]$

spatial mean in domain:
9.1 mBq*d/m³

observed max. (corr. for cut-off)
23.3 mBq*d/m³ (±4%), Utena, LT



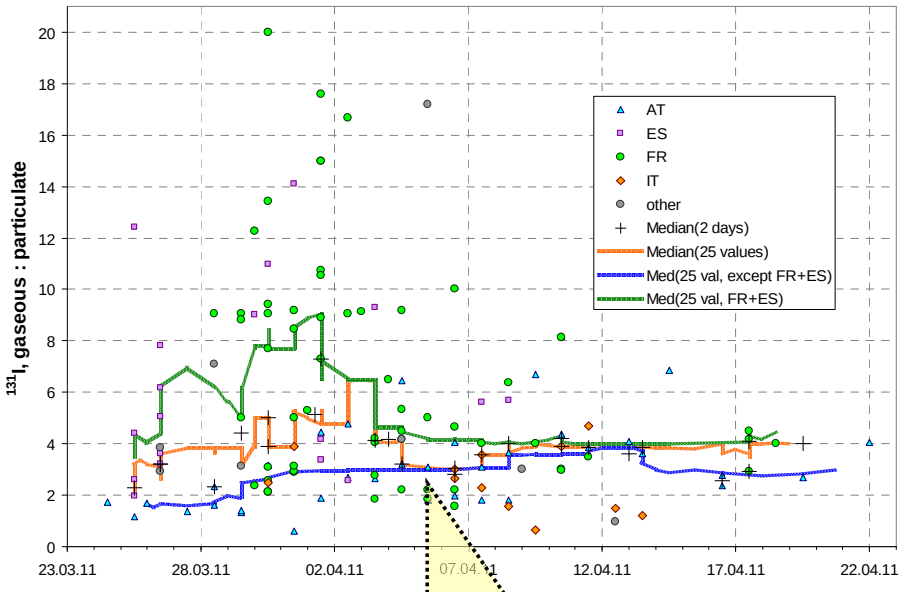
Chernobyl (1986); mean (Austria): 30 Bq*d/m³

radionuclide ratios 1

European Commission

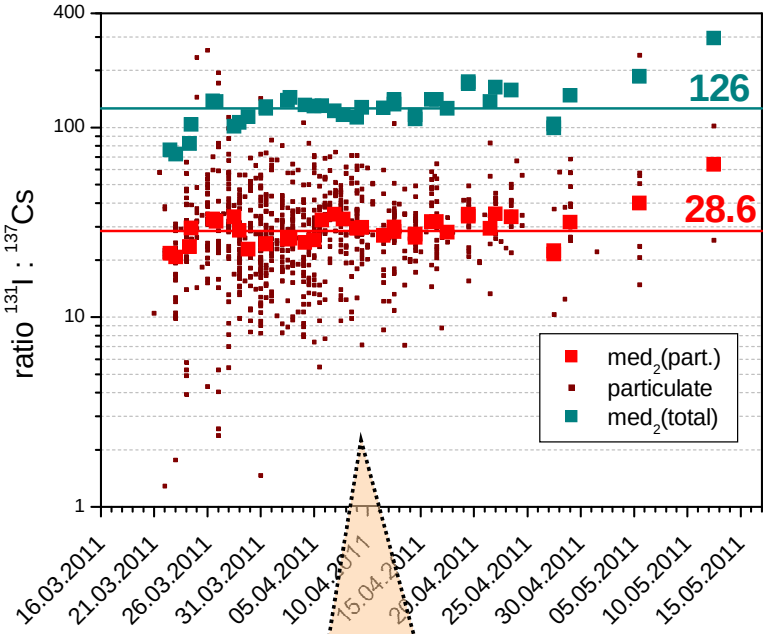
derived from observations over Europe

^{131}I, gaseous : particulate



- ratio regionally and temporally variable (meteo influence?)
- Median over Europe ± constant

^{131}I : ^{137}Cs

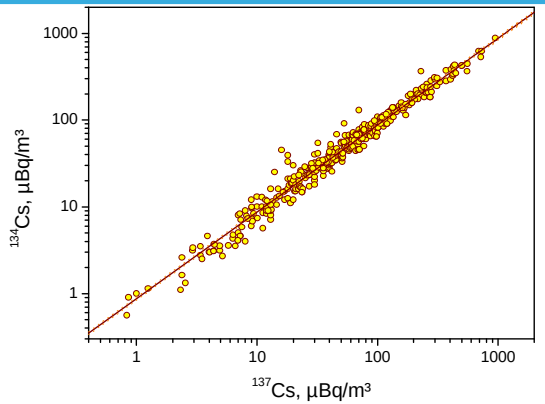


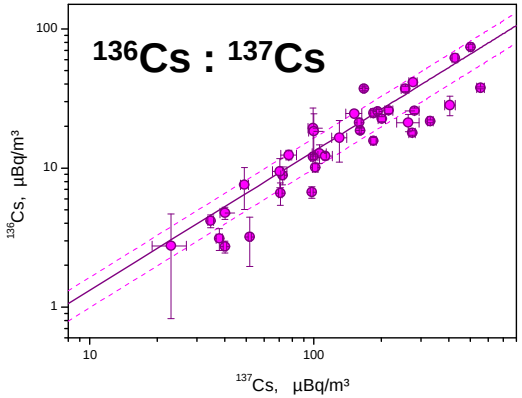
ratio over Europe ± temporally constant

radionuclide ratios 2

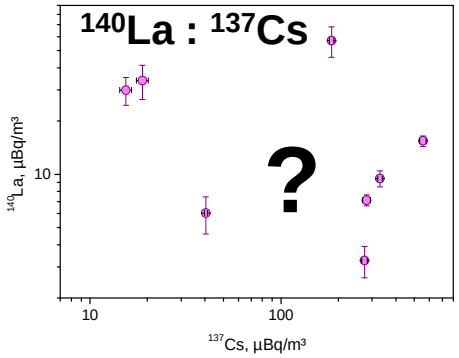
European Commission

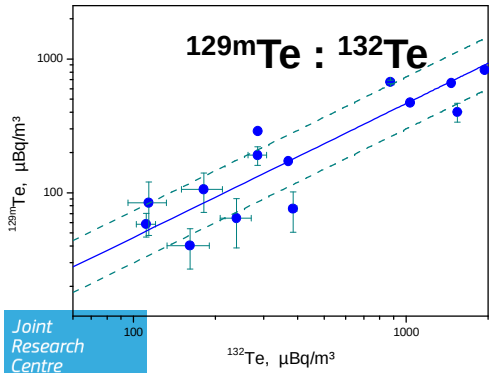
ref: 20.3.2011	# samples	median	5%	95%	p level
^{131}I (gas): ^{131}I (part.)	136	**3.71**	3.19	4.36	<0.001*
^{131}I (part): ^{137}Cs	862	**28.6**	27.3	29.8	<0.001*
^{134}Cs : ^{137}Cs	393	**0.874**	0.840	0.907	<0.001*
^{136}Cs : ^{137}Cs	38	**0.132**	0.099	0.164	<0.001*
^{132}Te : ^{137}Cs	121	**2.45**	2.21	2.75	<0.001*
^{129m}Te : ^{132}Te	14	**0.46**	0.30	0.73	0.002*
^{95}Nb : ^{137}Cs	10	**0.9**	0.5	2.3	0.37
^{140}La : ^{137}Cs	8	**0.2**	0.04	0.4	0.91

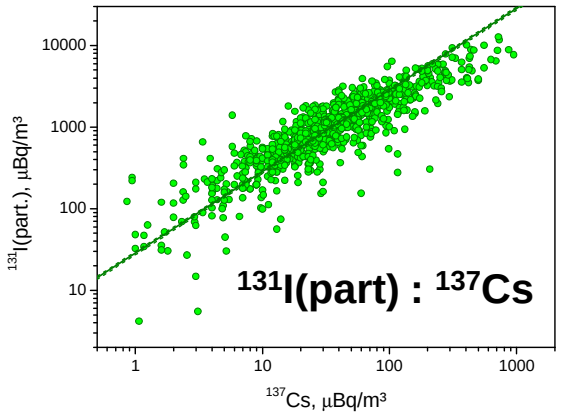




Sr, Pu: not observed in European air filters, to our knowledge;
except one Pu result reported from Lithuania (Lujaniene et al., JER 2012):
$^{239+240}$Pu ≈ 26 nBq/m³, $^{239+240}$Pu/^{137}Cs ≈ 2*10^{-4}.

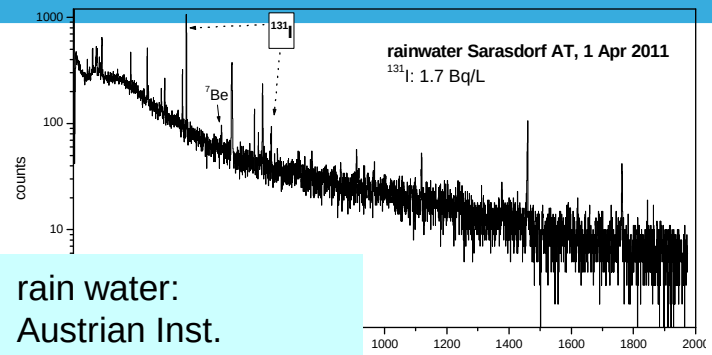




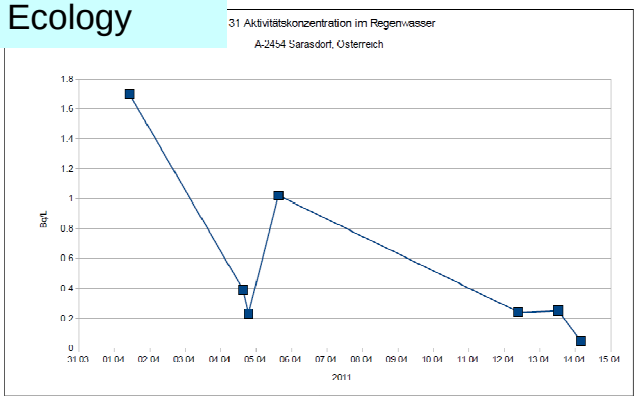


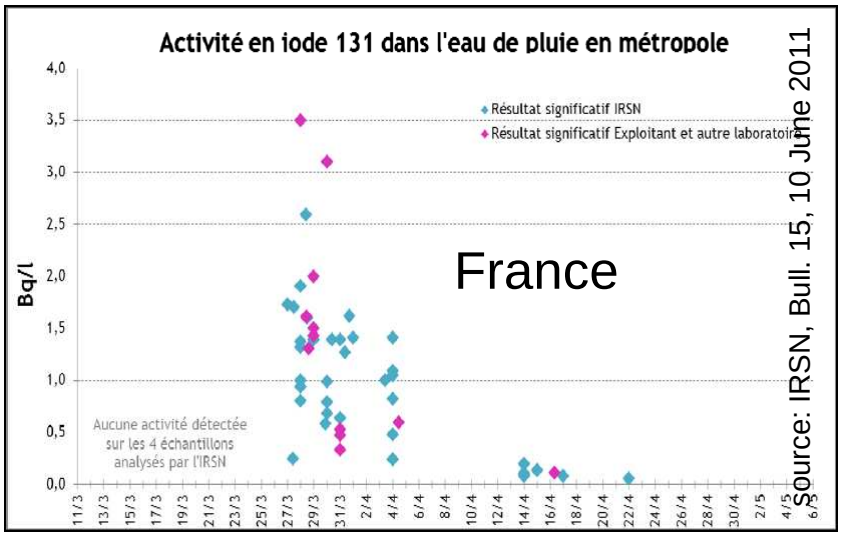
Joint Research Centre

Environment: rain, fallout, ...



rain water:
Austrian Inst.
Applied Ecology



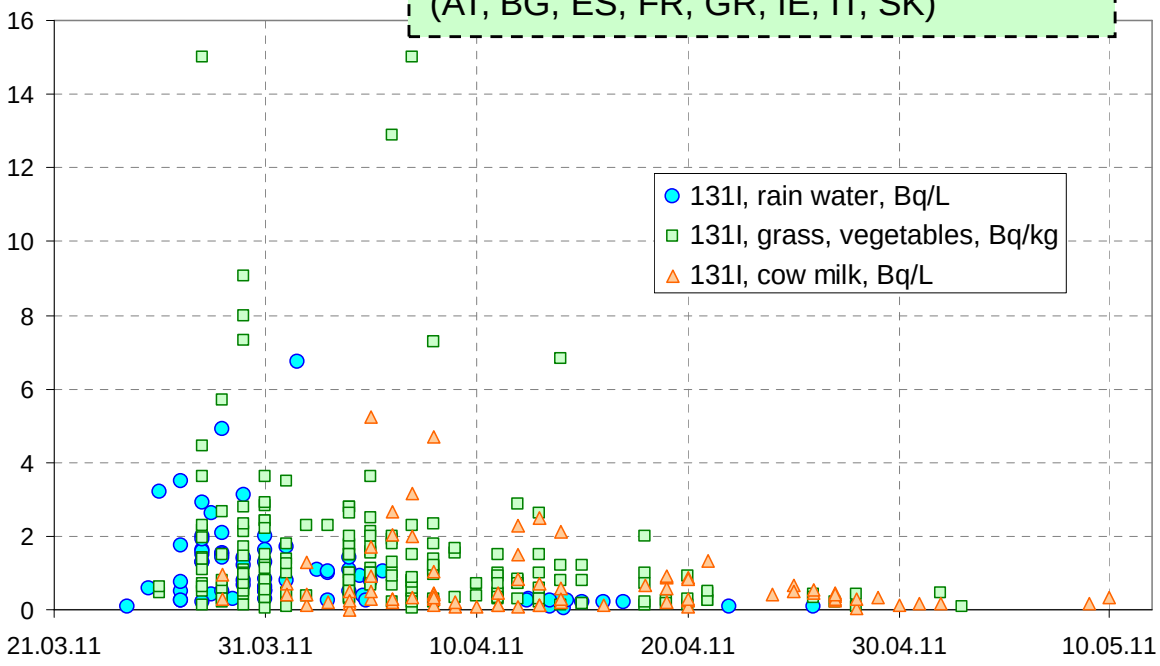


European Commission

deposition, Austria:

	^{137}Cs, kBq/m²
global	**up to 10**
Chernobyl	**up to 200**
Fukushima	**up to 0.001**

compilation of European data
(AT, BG, ES, FR, GR, IE, IT, SK)

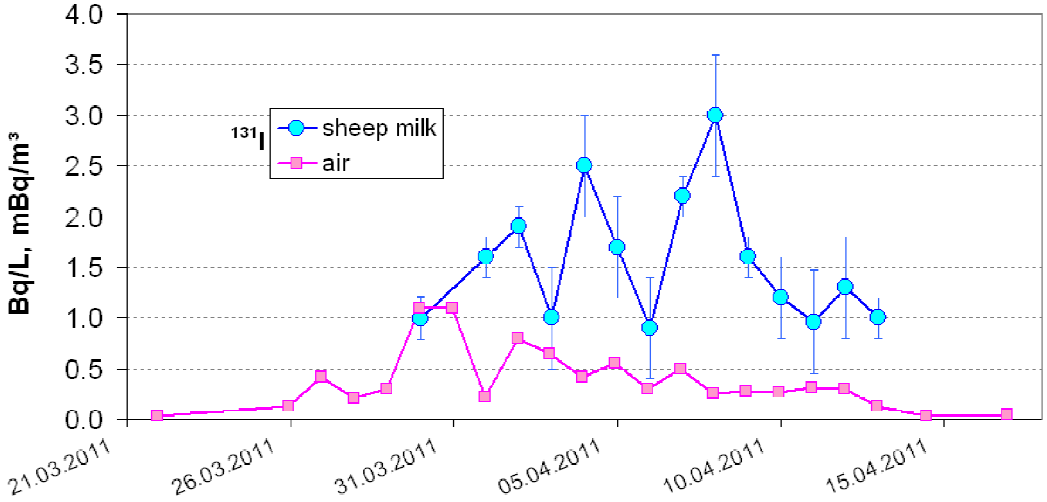


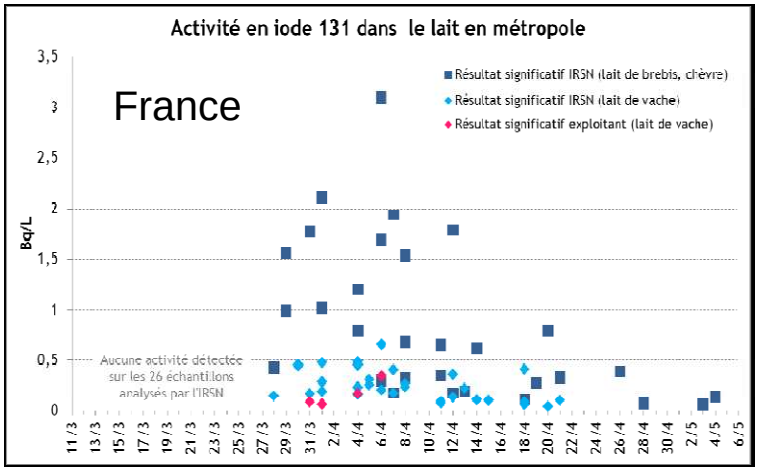
....grass, milk, veggies

European Commission

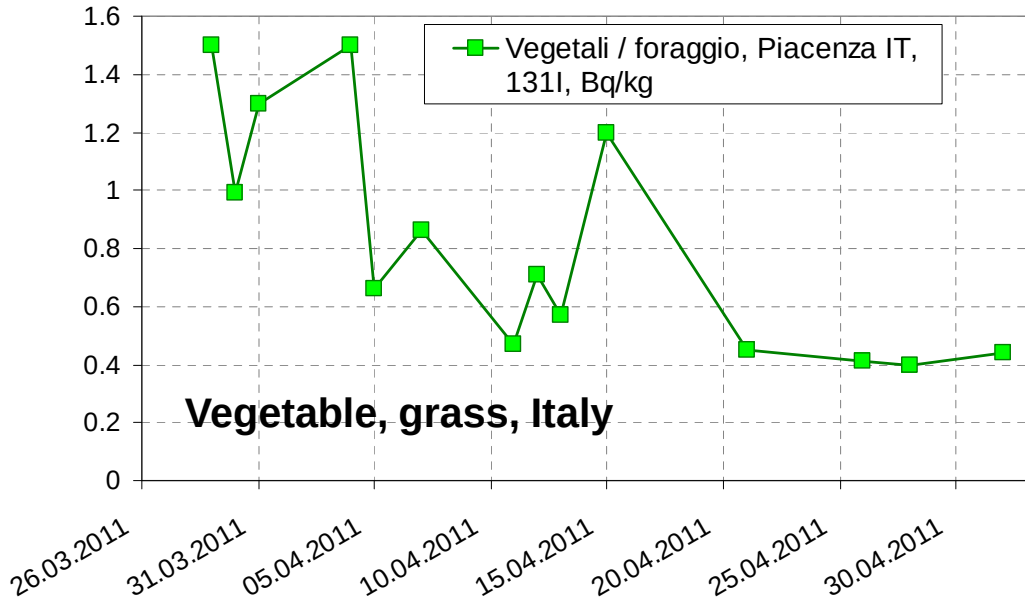
^{131}I, Sheep milk, Macedonia

data: Zdenka Stojanowska, Skopje

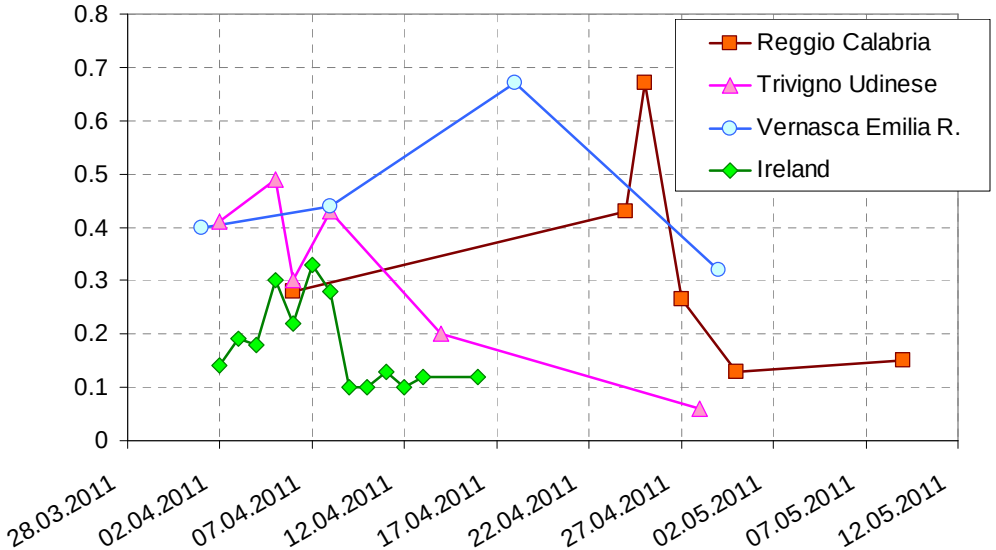




source: IRSN, Bull. 15, 10 June 2011



^{131}I, cow milk, Bq/L; Italy, Ireland



data: ISPRA / ARPA, RPII

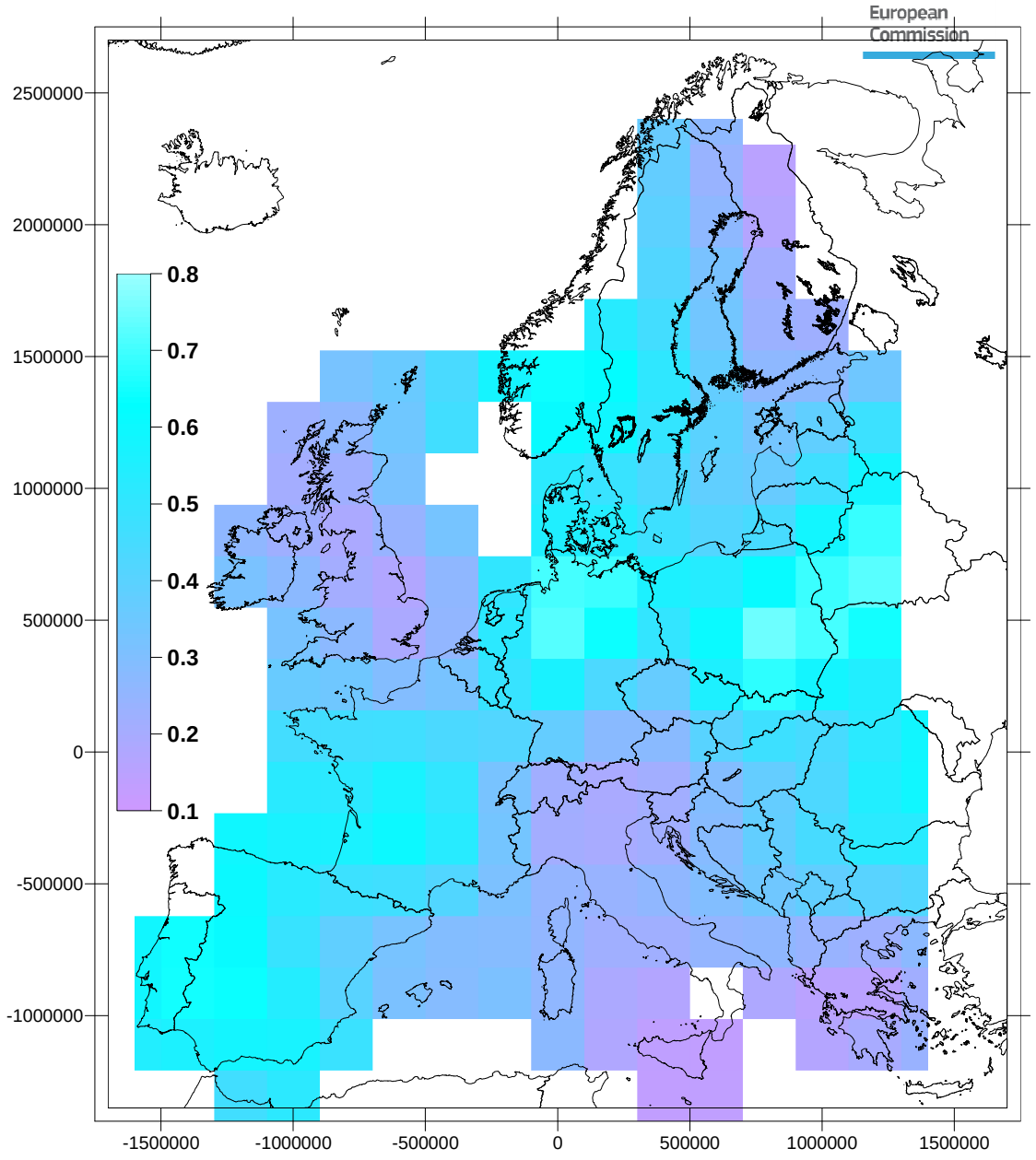
Environmental media: summary

European Commission

		Japan except Fukushima pref.	Fukushima prefecture	Europe
fallout	^{137}Cs, Bq/m²	-10² kBq/m²	up to >10 MBq/m²	~ 1 Bq/m²
rainwater	^{131}I, Bq/L ^{134}Cs, Bq/L			- 7 - 0.8
tap water	^{131}I, Bq/L	- 400	- 1000	0
cow milk	^{131}I, Bq/L	- 1700	- 5300	- 6 most < 1
sheep milk	^{131}I, Bq/L			- 10 most < 3
grass, veggies	^{131}I, Bq/kg (fresh m.)	-54000! (Ibaraki) - 5000	- 22000	- 15 most < 3
seafood	^{131}I, Bq/kg ^{134}Cs, Bq/kg	- 4000 - 220	- 12000 - 15000	0

from Hamada & Ogino, JER 2012

doses 1: inhalation



- Assumptions for spatio-temporal dynamic of ^{131}I(part:gas) ratio;
- Committed ^{131}I thyroid dose probably **below 1µSv;** mean ≈ 0.4 (10 y child)
- Comm. eff. dose,
  ^{131}I: 24 nSv (child),
  11 nSv (adult)
  $^{134+7}$Cs: < 1nSv

(Chernobyl: mean over Austria, thyroid: ca. 900 µSv)

doses of 10 y children due to inhalation of ^{131}I. Scale unit: µSv. Axis units: m. Spatial variability of estimated committed thyroid

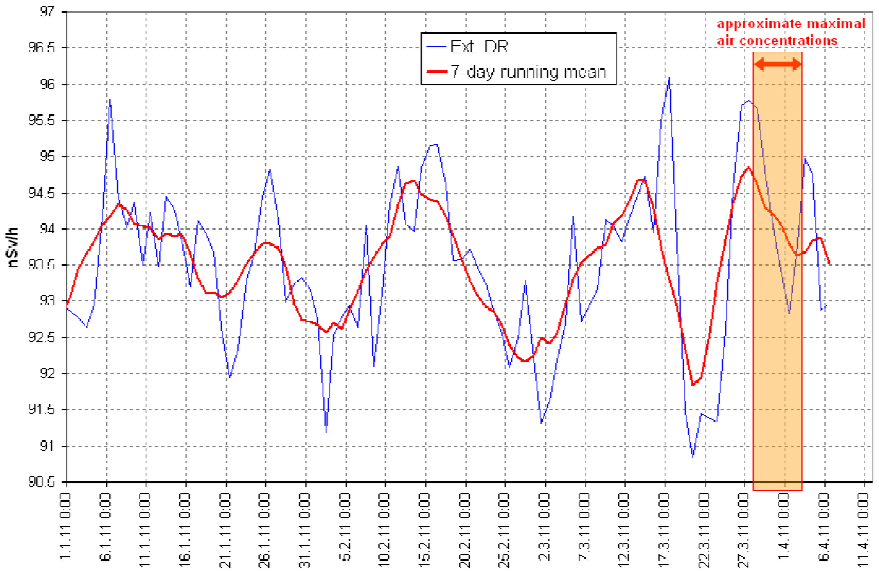
dose 2: external gamma:

European Commission

immersion:

External dose rate monitoring systems

- LLD typically ~ 10 nSv/h
- immersion by Fukushima cloud,
  Europe: ~ pSv/h; 10 days ⇒ ~1.5 nSv



External dose rate, daily means over all European stations (ca. 4000) and weekly running average….
no detectable effect!

Chernobyl, Central Europe:
up to ~ 3 µSv/h

ground radiation:

Deposition, ^{137}Cs: 1 Bq/m²; max= 2 ?
50 y dose, incl. inhal. due to resuspension, no shielding, 100% outdoor; factors: IAEA Tecdoc 1162

nuclide	Bq/m²	nSv/(Bq/m²)	**nSv**	**%**
^{134}Cs	0.9	5.1	4.6	3.0
^{136}Cs	0.13	2.3	0.30	0.2
^{137}Cs	1	130	**130**	**84.7**
^{131}I	30	0.27	8.1	5.3
^{132}Te	2.5	0.69	1.7	1.1
^{129m}Te	1.2	0.22	0.26	0.2
^{140}Ba	0.2	2.5	0.5	0.3
^{140}La	0.2	0.32	0.064	0.0
^{95}Nb	0.9	2.1	1.9	1.2
^{95}Zr	0.9	6.8	6.1	4.0
total			**154**	100

probably very conservative!

Chernobyl, Central Europe:
^{137}Cs up to ~200 kBq/m²

Doses 3: ingestion

10 y child	assumed contamination high / max	days (2)	consumption (rough)	activity (Bq)	dose conversion factor (3)	comm. eff. dose, µSv
cow milk	^{131}I: 2 / 6 Bq/L $^{134+7}$Cs: 0.05 / 0.2	30	0.3 L/d	18 / 54 0.57 / 1.8	52 nSv/Bq 12 nSv/Bq (1)	0.94 / 2.8 0.007 / 0.02
veggies	^{131}I: 3 / 15 Bq/kg $^{134+7}$Cs: 0.4 / 3	30	0.1 kg/d	9 / 45 1.2 / 9	52 nSv/Bq 12 nSv/Bq (1)	0.47 / 2.3 0.014 / 0.11
total						**1.4 / 5.2**

adult	assumed contamination	days	consumption	activity	dose conversion factor	comm. eff. dose, µSv
cow milk	^{131}I: 2 / 6 Bq/L $^{134+7}$Cs: 0.05 / 0.2	30	0.4 L/d	24 / 72 0.72 / 2.4	22 nSv/Bq 16 nSv/Bq (1)	0.53 / 1.6 .012 /.038
veggies	^{131}I: 3 / 15 Bq/kg $^{134+7}$Cs: 0.4 / 3	30	0.2 kg/d	18 / 90 2.4 / 18	22 nSv/Bq 16 nSv/Bq (1)	0.40 / 2.0 .038 / 0.30
total						**1.0 / 3.9**

(1) ^{134}Cs:^{137}Cs = 1:1
(2) duration, assumed
(3) from EU-Basic Safety Standards

conservative! In parts of Europe still winter
⇒ no cows outside, no fresh vegetables!

Doses 4, sum

European Commission

doses: comm. eff., µSv; mean, high / max

orders of magnitude only!

	adult	**10 y child**
inhalation	0.011 / 0.022	0.024 / 0.048
γ immersion	0.002	0.002
ground gamma	0.15 / 0.3	0.15 / 0.3
ingestion	1.0 / 3.9	1.4 / 5.2
total	**mean, high < 1.3 max < 4.3**	**mean, high < 1.7 max < 5.6**

- **in Europe trivial doses! …. very different from Japan!**
- probably conservative!; 'max' most probably exaggerated!
- ground gamma: mainly from ^{137}Cs, others mainly from ^{131}I.
- only ^{131}I and $^{134+7}$Cs considered; other radionuclides: minor contribution

European Commission

Grazie per l'attenzione!

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