

Slide 1

**Information being available to decision makers in different phases of a nuclear emergency**

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**Layout of the presentation**

- Information available in the pre-release phase
- Information available in the release phase
- Information available in the later phases (rehabilitation not part of this presentation)
- Support of decisions to be taken?

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**Information available in the pre-release phase**

- Reception of the alert
- Status of the NPP and the potential evolution of the accident (uncertain, partly unknown and not fully understood), including a first estimation of a source term (source term might be uncertain: amount and timing)
- General information
  - On-site meteorological data and radiological data
  - On request prognostic meteorological data
  - Pre-planning
  - Availability of teams

Early phase countermeasures are most effective when implemented early before the release

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### Support provided by a DSS

- Collects all data in one place and provides information in a consistent way
- Performs dose assessments
- Provides results in terms of maps and time functions on activity concentrations, doses and dose rates in the area of interest
- Proposes area to initiate early countermeasures, simulates early countermeasures to estimate the performance of individual or combined measures

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### Issues in the pre-release phase

Problem	How to deal with it
<ul style="list-style-type: none"> <li>• Source term very uncertain</li> <li>• Results from dose assessments are uncertain due to the very uncertain source term and uncertainties in the weather forecast (besides limitation of the dispersion model and the conversion of activity to dose)</li> </ul>	<ul style="list-style-type: none"> <li>• In plant data used to estimate source term on best information available (ASTRID, STERPS)</li> <li>• Improve weather forecast and simulation models</li> </ul>

Decisions have to be taken with very uncertain input to initiate evacuation, sheltering or distribution of stable iodine

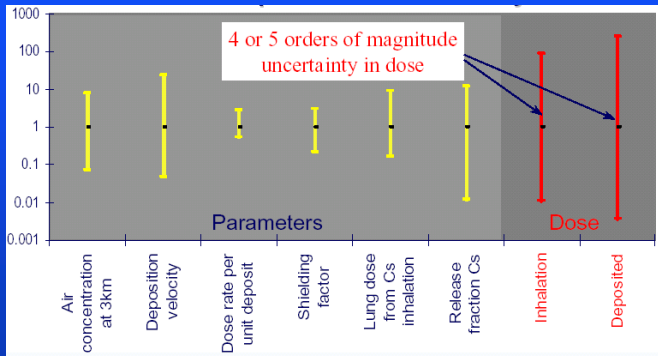
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### Uncertainties in model predictions



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## Model and reality

**Chernobyl contamination**




“hot spots“

**Typical result of model calculations**



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## Information available in the release phase

- Status of NPP and the potential evolution of the accident, including an estimation of the source term (monitored via stack (best), monitored by external instruments close to the building (some help) no monitors (very uncertain), not appropriate or defect monitors (disaster))
- On-site meteorological data and prognostic weather data
- Radiological monitoring
- Prognostic information is requested on
  - Activity concentrations, doses and potential areas to initiate early countermeasures in the vicinity (~100 km) of the accident location

Early phase and early late phase (e.g. food) countermeasures have to be considered

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## Monitoring systems

- Gamma dose rate monitoring networks
- Air monitoring stations
- Meteorological monitoring stations
- Airborne systems (partly with direct measurement of cloud)
- Survey teams
- Monitoring of environmental and food contamination
- Monitoring of individual doses

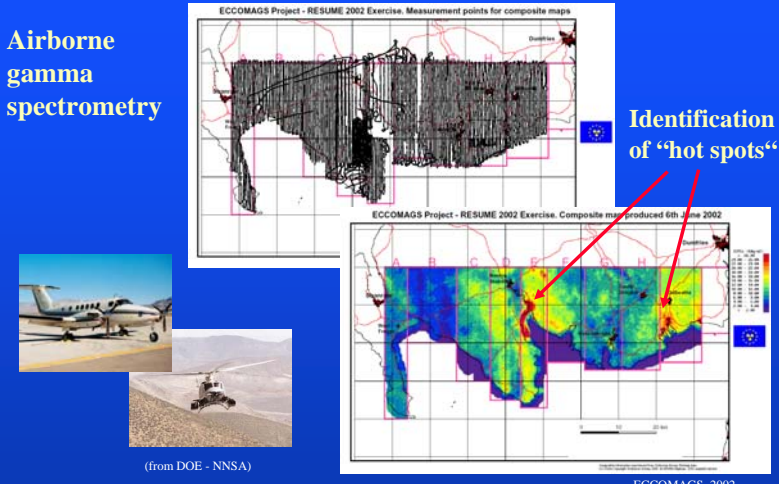
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**Airborne gamma spectrometry**



Identification of "hot spots"

ECCOMAGS Project - RESUME 2002 Exercise. Measurement points for composite maps

ECCOMAGS Project - RESUME 2002 Exercise. Composite map produced 6th June 2002

(from DOE - NNSA)

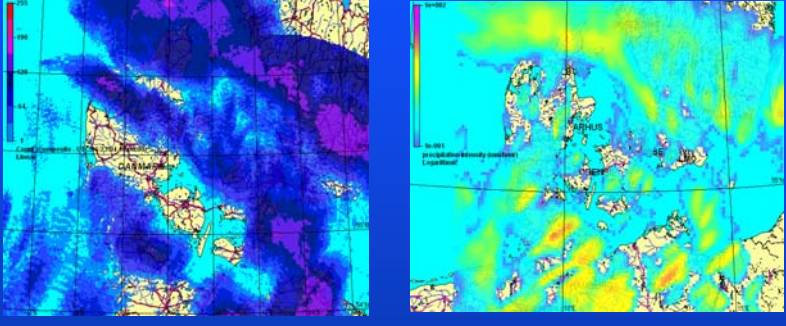
ECCOMAGS, 2002

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**Rain radar**



Measured

Simulated

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**Support provided by a DSS in collecting data**

Decision support system



meteorological forecasts;

site and plant data of European NPPs; source term data base; emission data; local meteorology

local monitoring data; airborne gamma spectrometric measurements

national monitoring data

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### Support provided by a DSS (2)

- As for the pre-release phase
  - Data collection, simulation of activity concentrations and countermeasures (early)
- Two different sets of information are available:
 

Measured and predicted data
- Important to bring both together!
- Why
  - Measurements only represent situation at one time at one particular location
  - But required are quantities representative for a longer time period and area
- How
- Data assimilation

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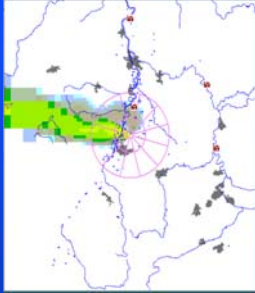


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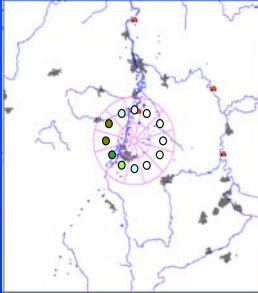
### Data assimilation

**Model prediction of deposited activity**




- covers whole area
- required quantity
- low accuracy

**Measurements of gamma dose rate**



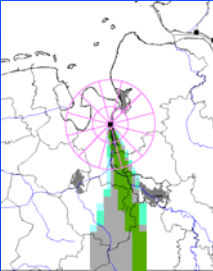
- reliable
- sparse
- no prediction of future

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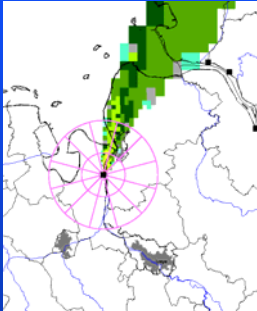
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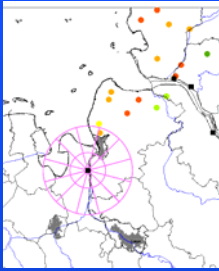


Predicted Cs-137 contamination

Data assimilation




“Corrected“ Cs-137 contamination



Gamma dose rate monitors (measurements)

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### Issues in the release phase

Problem	How to deal with it
<ul style="list-style-type: none"> <li>• Source term very uncertain</li>   <li>• Measurements and model predictions are available and may contradict each other</li> </ul>	<ul style="list-style-type: none"> <li>• In plant data used to estimate source term on best information available (ASTRID, STERPS)</li>   <li>• Data assimilation for the best estimation of the radiological situation and an improved estimate of its evolution</li> </ul>

Decisions have to be taken with uncertain input to initiate early measures, including early food interventions

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### Information available in the later phase

- Status of the NPP (release has stopped)
- Radiological monitoring (radiological situation is stable)
- Prognostic information is requested on
  - Time evolution of the activity concentrations, doses and potential areas to initiate late phase countermeasures (relocation, decontamination, food banning) wherever necessary

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### Monitoring in the later phase

- Locate the footprint of the cloud
- Identify “hot spots“
- Define areas where intervention levels are exceeded and measures (e.g. relocation) are still to be taken (deposition, gamma dose rate)
- In situ gamma-spectrometry to obtain the information on the nuclide vector
- Monitoring in rescue centres to assure that evacuated/relocated people are decontaminated
- Food samples to confirm food bans

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### Support provided by a DSS

- As for the other phase
  - Data collection, simulation of activity concentrations and countermeasures (early and late)
- Support monitoring (e.g. in inhabited areas)
- Data assimilation (e.g. food)
- Simulation of countermeasures


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### Optimisation of monitoring



Dispersion models (inc. rainfall data)  
and in situ stations can best indicate areas  
where monitoring resources should be concentrated

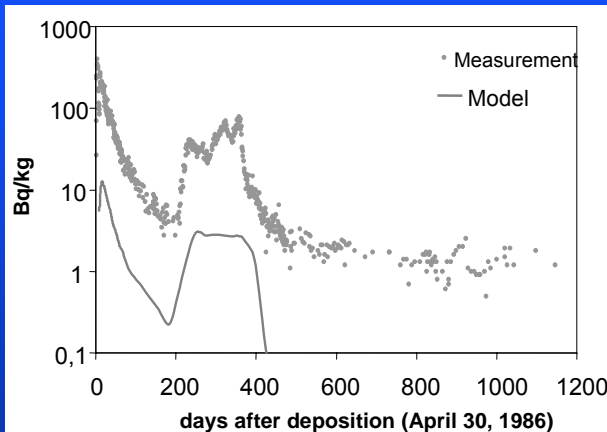
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### Food monitoring and assimilation



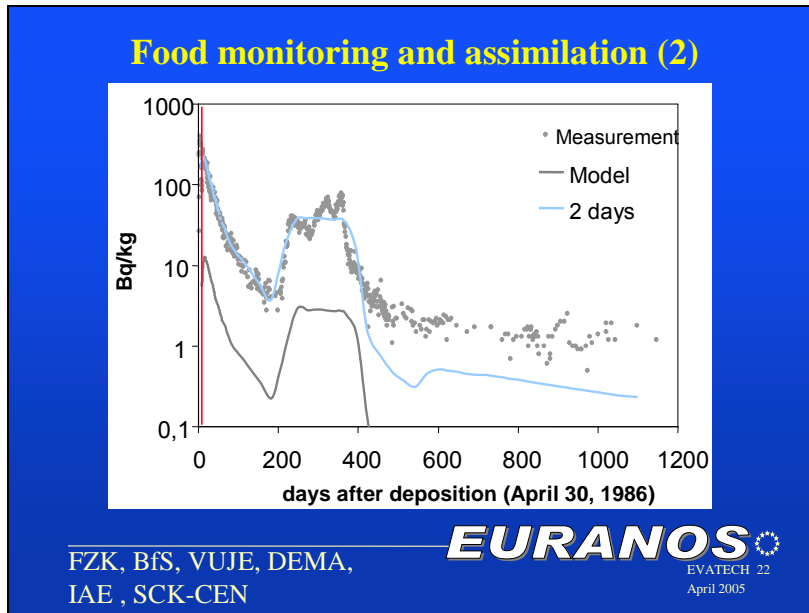
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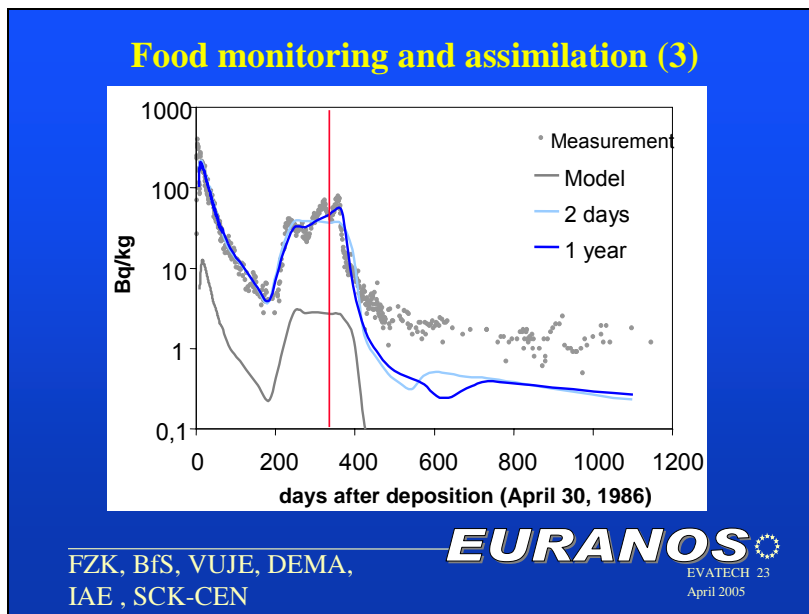
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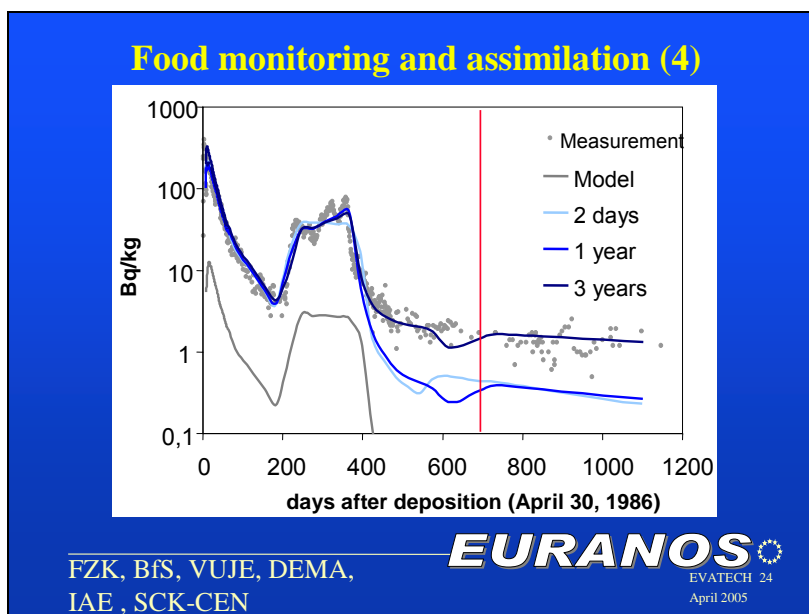
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## Countermeasures in the later phase

- **Food countermeasures**
  - >10 single measures and up to 30 sensible combinations
  - Information on effectiveness and dose saved but also on production lost, resources and doses to workers available
- **Decontamination options**
  - > 10 single options (combinations are under development)
  - Information on effectiveness and dose saved but also on resources and doses to workers available
- **Relocation**
  - Information on effectiveness and dose saved but also on resources and doses to workers available

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## Issues in the later phase

Problem	How to deal with it
<ul style="list-style-type: none"> <li>• Many possible countermeasures might be applicable to reduce the dose or consequences</li> <li>• Non quantifiable factors influence the decision</li> </ul>	<ul style="list-style-type: none"> <li>• Measurements and countermeasure simulations by DSS provide basis for a decision</li> <li>• Decisions analysing support tools provide means to deal with non quantifiable factors such as social or political aspects</li> </ul>

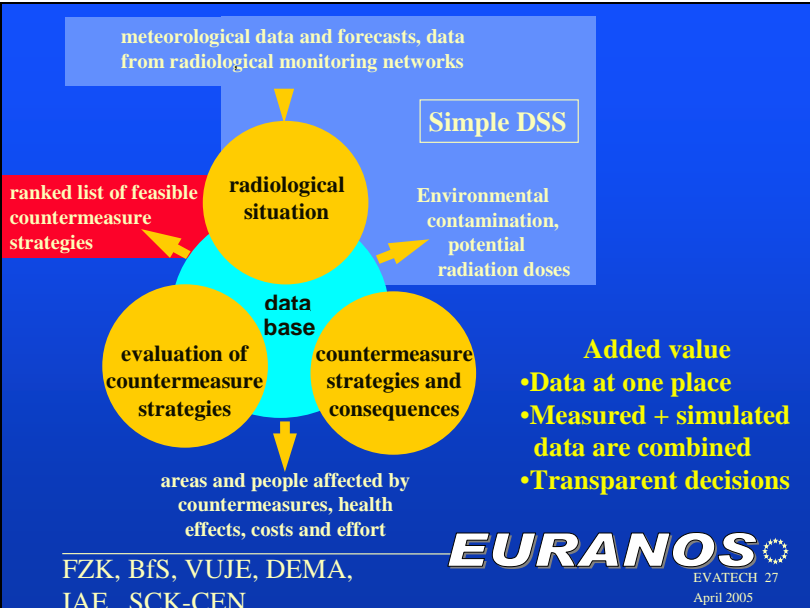
Decisions have to be taken with relative certain input but other „soft“ factors have to be taken into account

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## Evaluation of countermeasures in the later phase

- Radiological aspects (from DSS)
- Feasibility aspects (partly from DSS)
- Economical (partly from DSS)
- Social aspects
- Political aspects



Stakeholder involvement is necessary  
Special evaluation tools are important for decision making in the later phase (next sessions)

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