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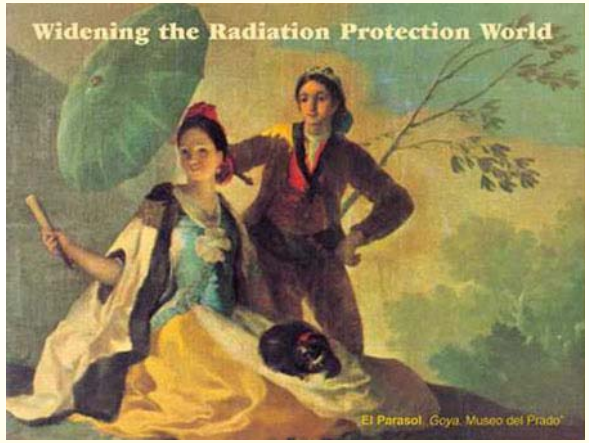


Refresher Course

SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ÉTUDE DE L'ÉNERGIE NUCLÉAIRE

Emergency and Post Accident Management

Neale Kelly and Carlos Rojas Palma

Scope

- Improvements and developments in the past decade
  - in particular in Europe
- Major challenges and action needed
  - main conclusions of a recent international symposium on Emergency Management

Major improvements and developments

- RODOS decision support system
- Source term estimation
- Assimilation of model predictions and measurements.
- Evaluation of countermeasures.
- Stakeholder involvement
- Management of contaminated environments
- Data and information exchange

Decision support systems (DSS)

- DSS support
  - policy development
  - emergency preparedness arrangements
  - actual emergency response
- Major improvements in past decade
  - advances in informatics and communications
- RODOS
  - comprehensive and broadly applicable
  - state of the art, developed with EC support
  - will contribute to more coherent response

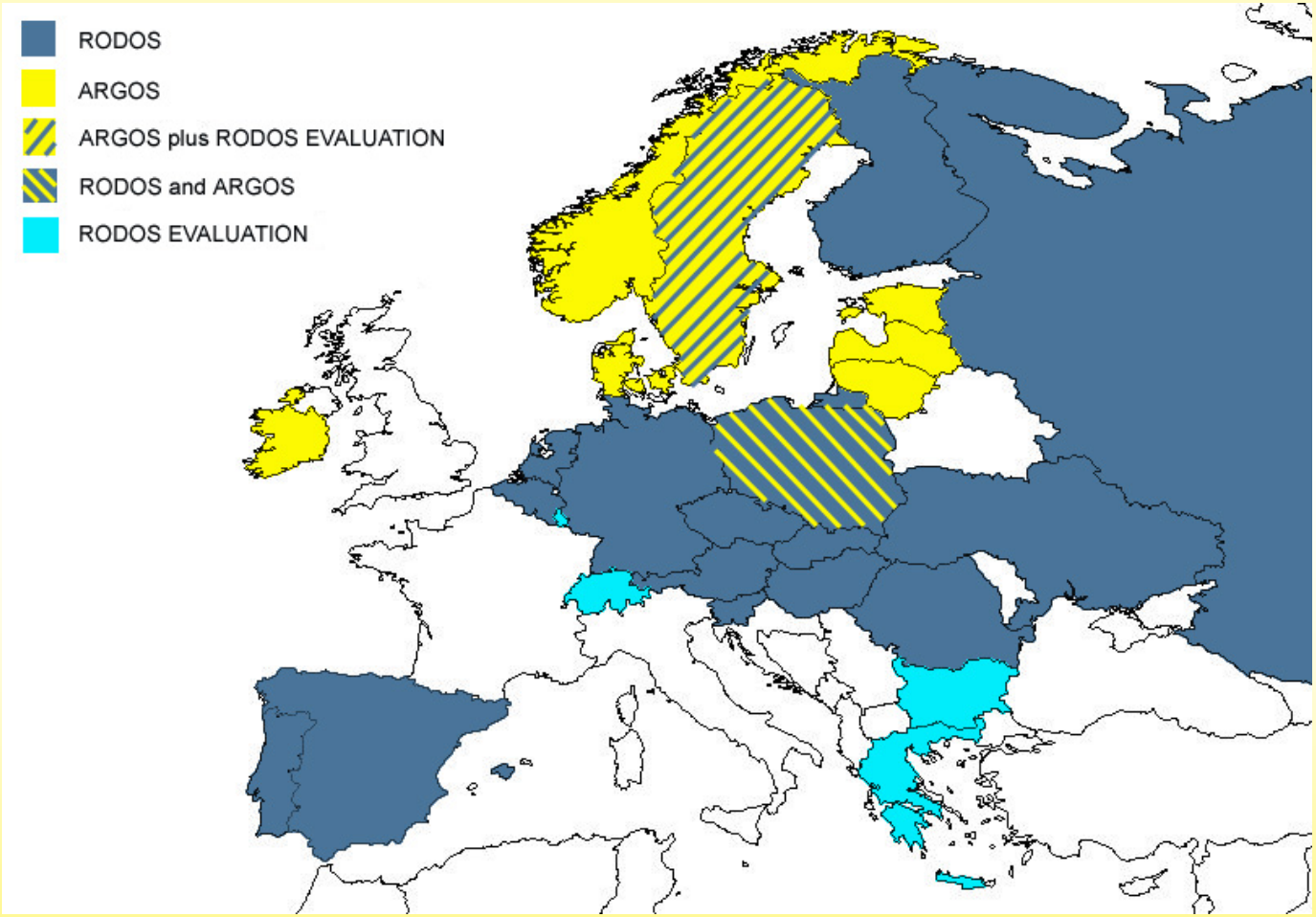
RODOS DSS

- Applicable anywhere subject to customisation
- Applicable to all stages of an accident
  - threat or pre-release phase
  - release and post release phases
  - long term management and restoration of contaminated areas
- Implementation in emergency centres
  - pre- or operational use in B, SF, D, H, NL, PL, P, SK, ES, UA
  - being installed in AT, CZ and SI
  - foreseen for installation in RO, RF and BU
  - under consideration in SE, LU and CH

ARGOS DSS

- Initially designed with limited functionality
  - collection/processing environmental monitoring data
- Functionality progressively being extended
  - by integration of RODOS products
- Implementation in emergency centres
  - pre- or operational use in DK, ES, LV, LT, NO, IE, CAN
  - under consideration in SE

RODOS & ARGOS in Europe



RODOS key features

Inputs

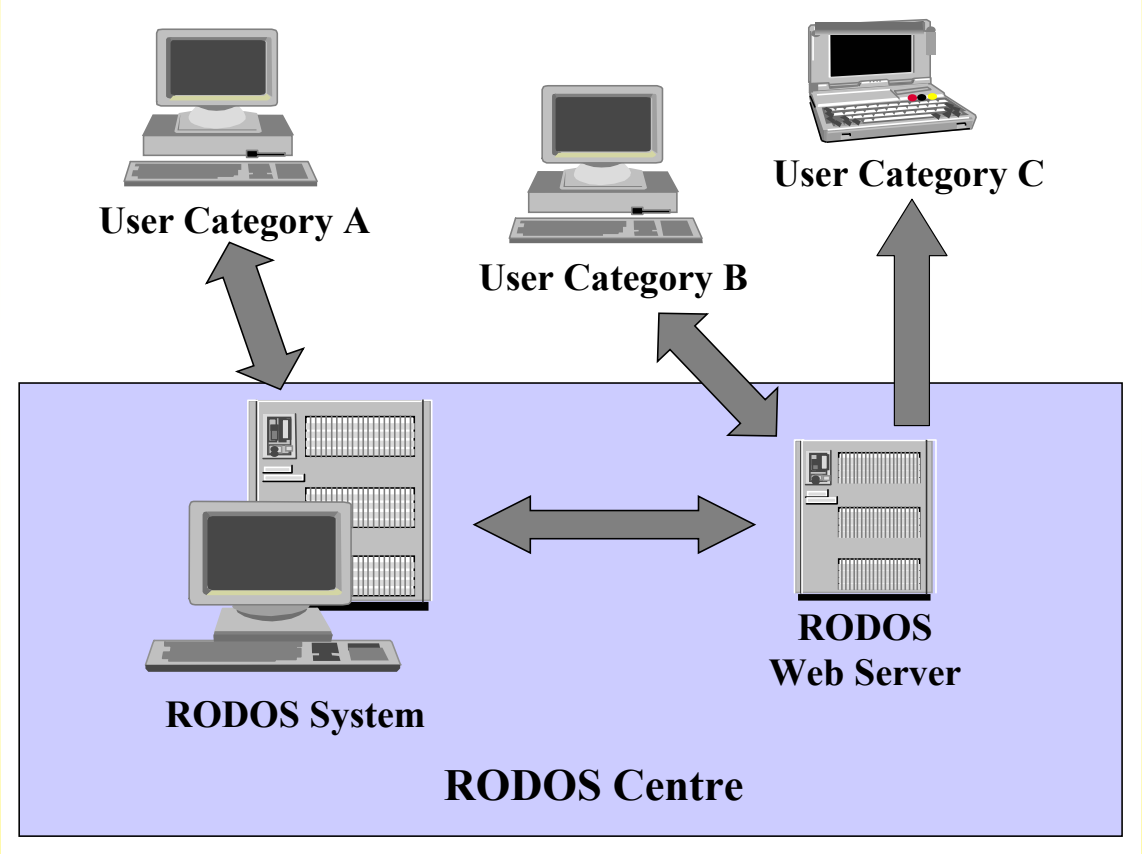
- release to the environment
  - directly from measurements
  - indirectly from plant status
- prevailing and forecast meteorological conditions
- prevailing and forecast conditions of water bodies and their catchments
- measurements in the environment

RODOS key features cont'd

OUTPUTS

- Dispersion of radioactive material in time and space
- Contamination of foodstuffs, buildings, water bodies, etc
- Exposures of the population and potential health effects
- Impact of countermeasures
  - economic and social costs
  - averted doses
- Effective communication with other users and systems
- Evaluation system to assist decision makers choose between alternative countermeasure strategies.

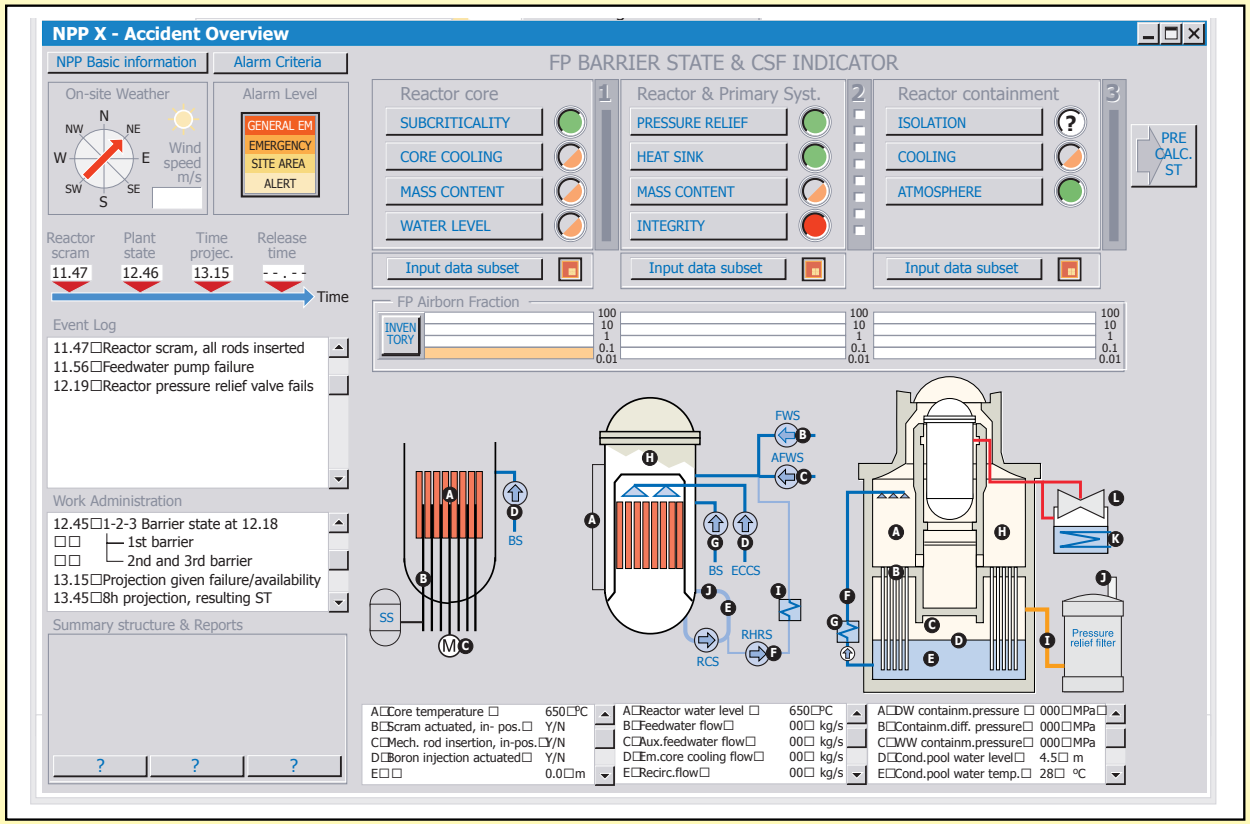
RODOS – user interaction



Source term estimation

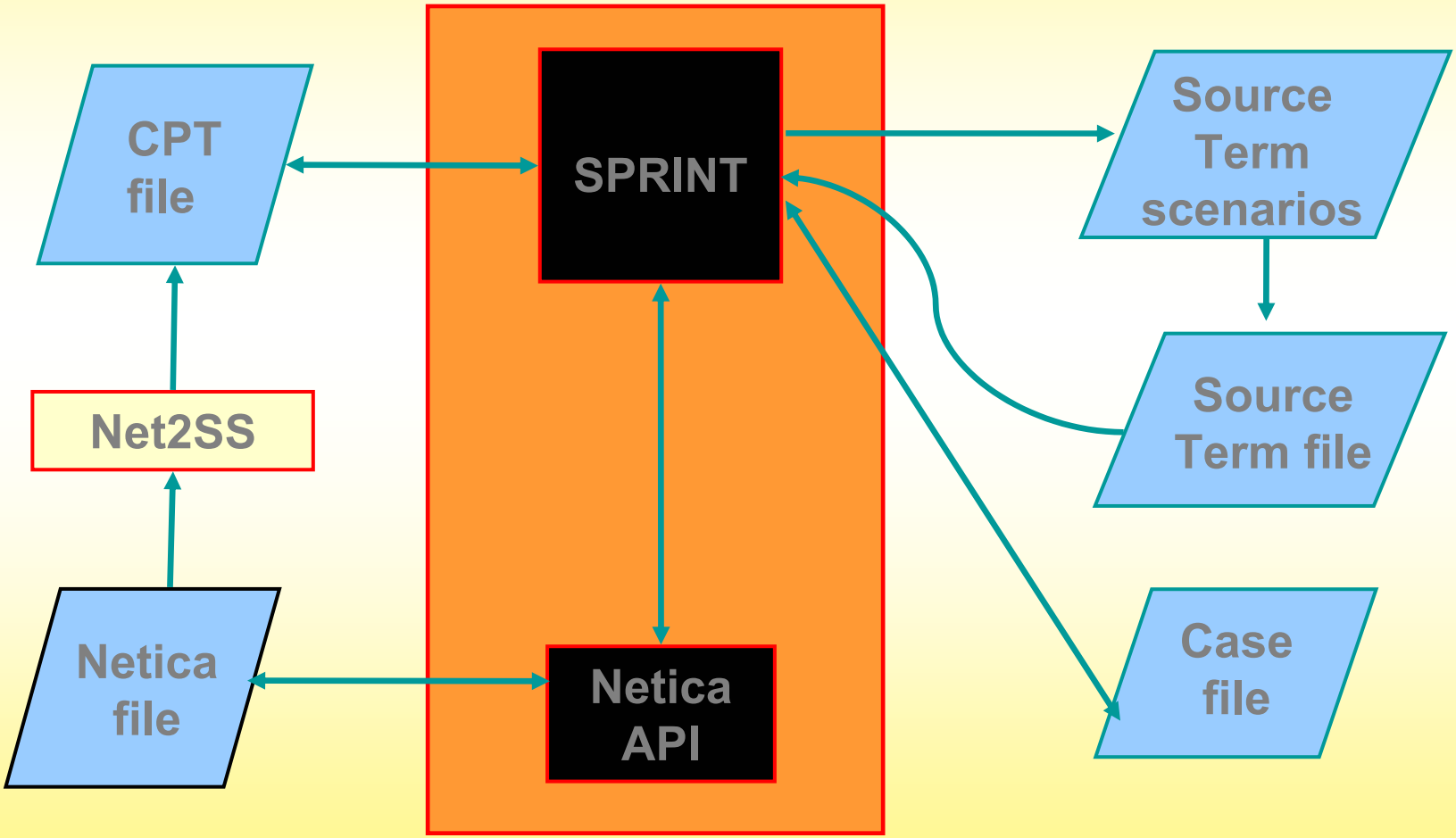
- Based on plant status and its prognosis
- Applicable pre- and post- release
- Major progress in past decade
  - Two modules that can be interfaced with RODOS or other DSS
    - ASTRID - deterministic approach
    - STERPS - probabilistic approach

The ASTRID user interface



STERPS: A probabilistic approach to source term estimation

SPRINT Software Architecture



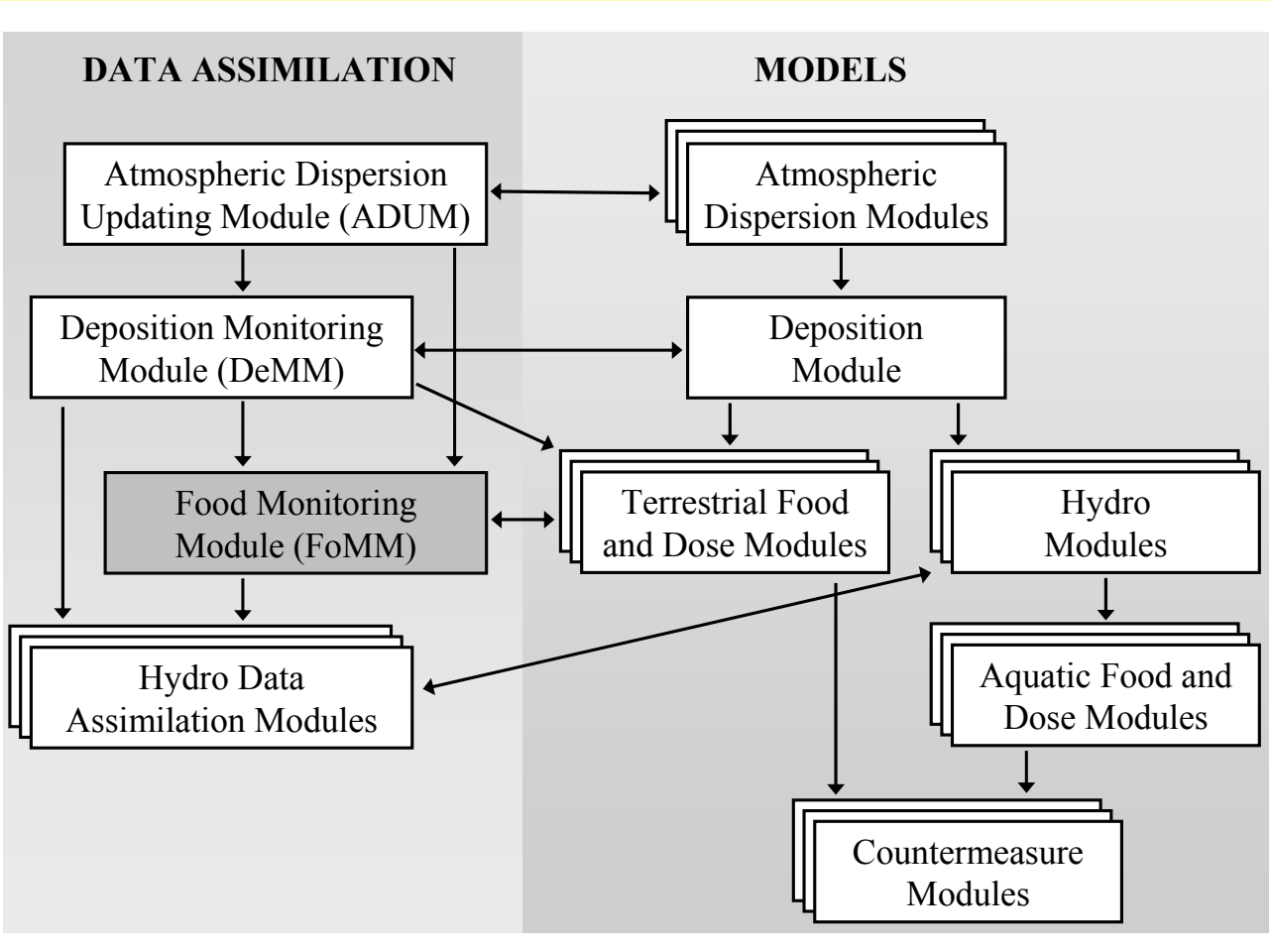
“Data” Assimilation (DA)

- DA - assimilation of measurements, predictions, expert judgement, etc, to better inform decisions
- Essential to:
  - resolve conflicts between predictions and measurements
  - improve quality of predictions where no/few measurements exist
- Critical feature of well conceived and functional DSS
  - **but not present in many DSS**

DA in RODOS

- Uses the Kalman filter technique
- Applied to atmospheric, food and hydrological transfers
- Accounts for uncertainties in predictions and measurements as well as expert judgement
- Operates in real time
- Uncertainties transferred between model chains

DAONEM cont'd

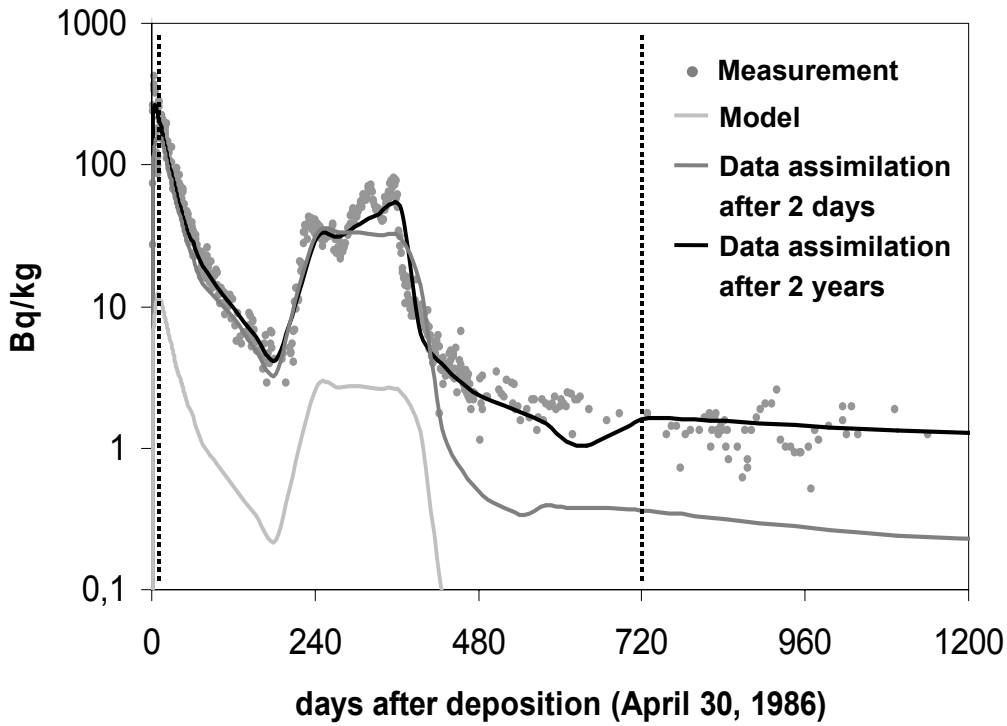


Data assimilation in the late phase

Two separate modules

- **Deposition**
  - progressively updates predictions of deposition (over time and space) based on available measurements of gamma dose rate and concentrations on plants
- **Food Chain**
  - progressively updates predictions of of concentrations in feed- and foodstuffs (over time and space) based on available measurements of these quantities

Data assimilation based on ^{137}Cs activity concentration in milk after the deposition from the Chernobyl accident

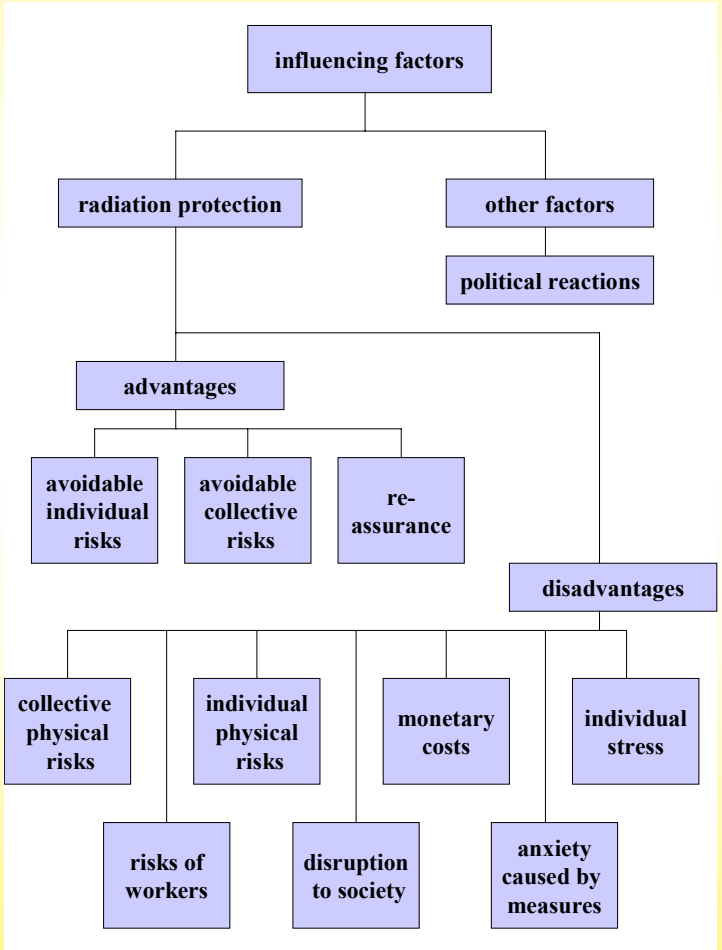


Evaluation of countermeasure strategies in RODOS

- Enable decision makers to make informed choices on countermeasures
  - important for development of policy and emergency arrangements and for actual response

- Achieved through use of the ESY sub-system
  - uses multi attribute techniques
  - ranks countermeasure options subject to decision makers' values and preferences
  - accommodates broad range of inputs, eg, doses, risks, costs, social and political impacts, anxiety, etc

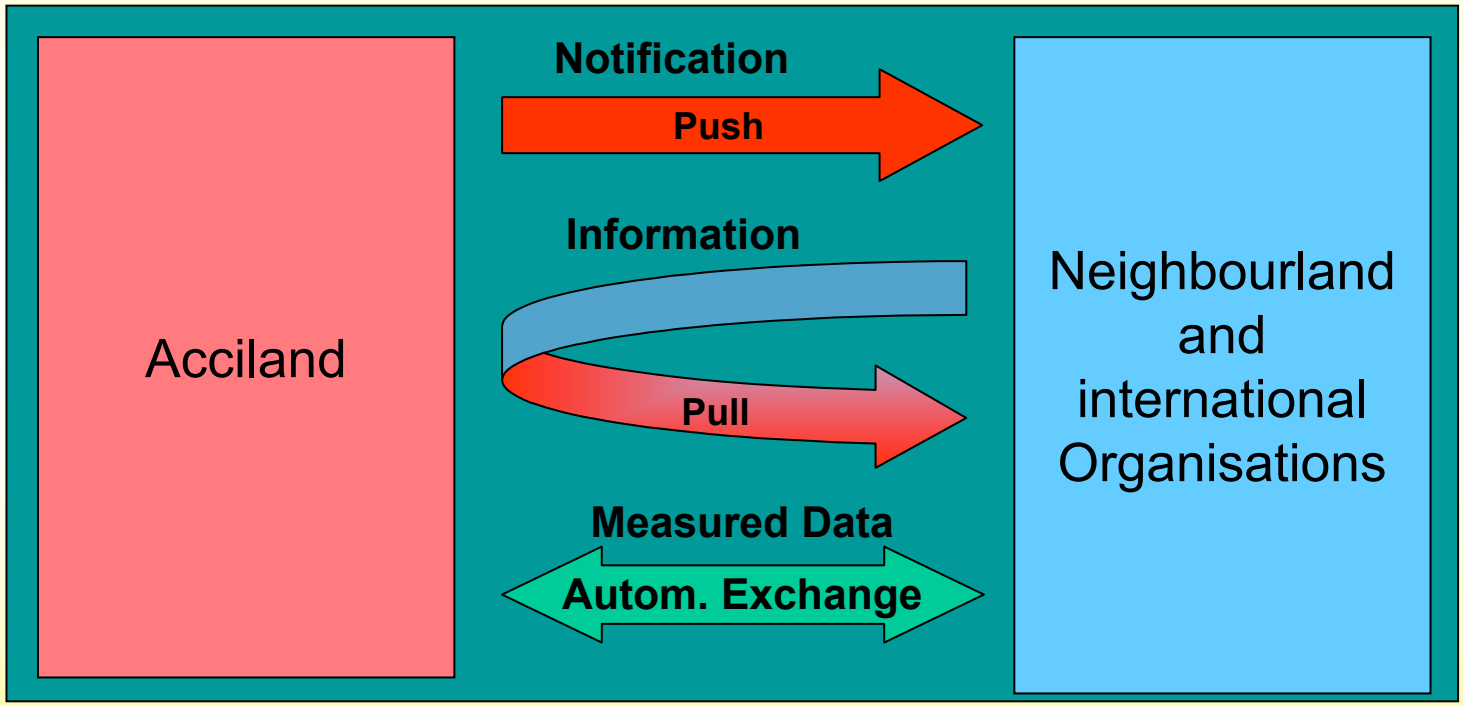
attributes that might be considered as relevant to decisions in the early phase of a nuclear emergency



Information exchange - MODEM project

- Develop a platform independent communication system between existing DSS
  - using state of the art internet technology
  - enable prompt and effective transfer of diverse information
- Complement existing operational systems
  - provide direct communications on a common basis between linked DSS in different countries.

MODEM concept



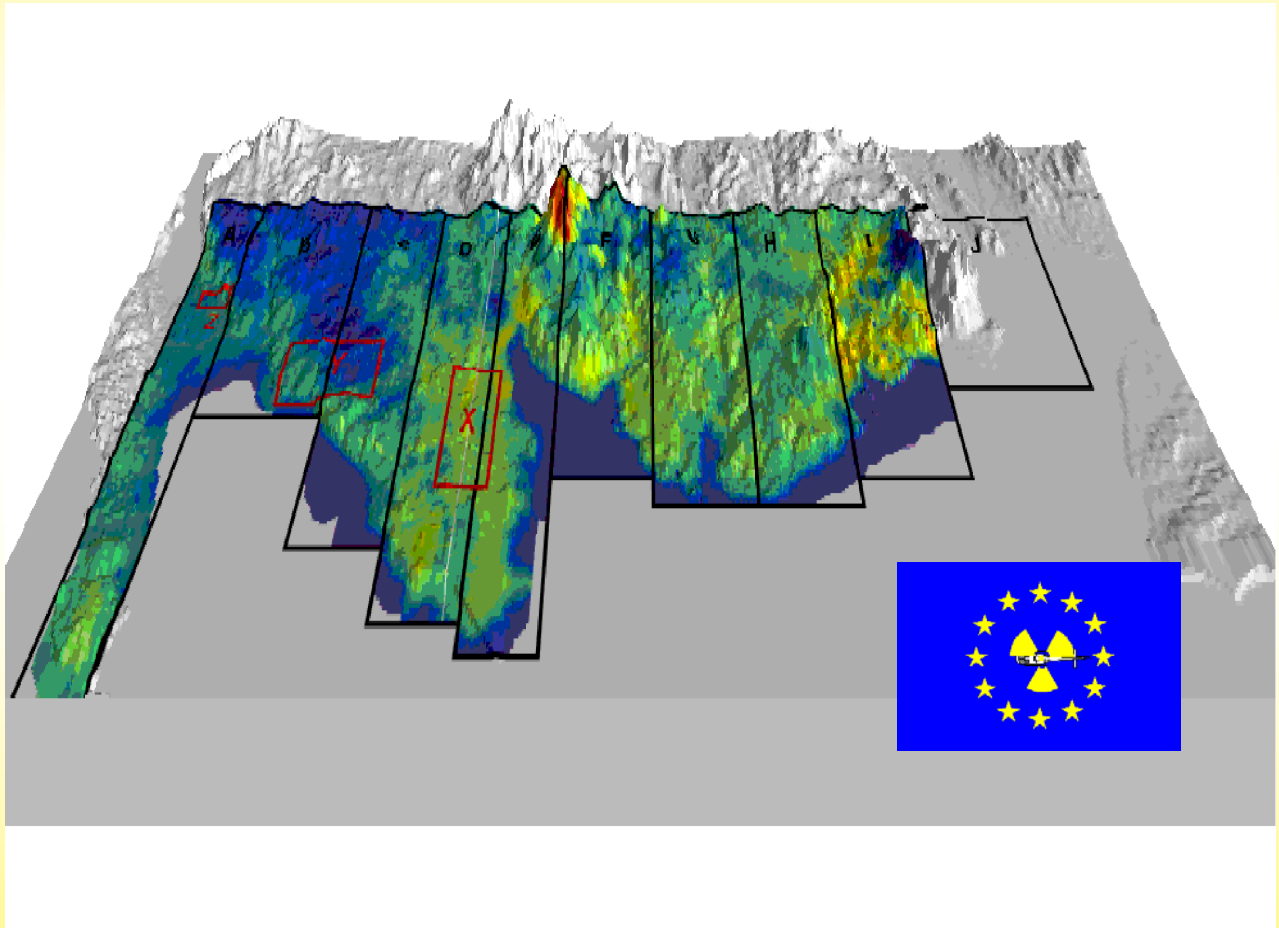
MODEM

- Combines messaging and web services to notify and populate contents on web servers
- Rapid and semi-automated to exchange data and information and to visualize other DSS results.
- Successfully connected RODOS (EU), ARGOS (DK) and RECASS (RF)
- Extend in the future to the US, CAN and JP

Airborne monitoring

- Rapid characterisation of deposition
  - critical for effective post accident management
  - public reassurance
- European capability, pre-Chernobyl, limited but major advances since
- Capability demonstrated in RESUME exercises
  - most recently with joint mapping of deposition in Southern Scotland in real time
- Opportunities to enhance capability through deeper integration

Dose rate map from Southern Scotland



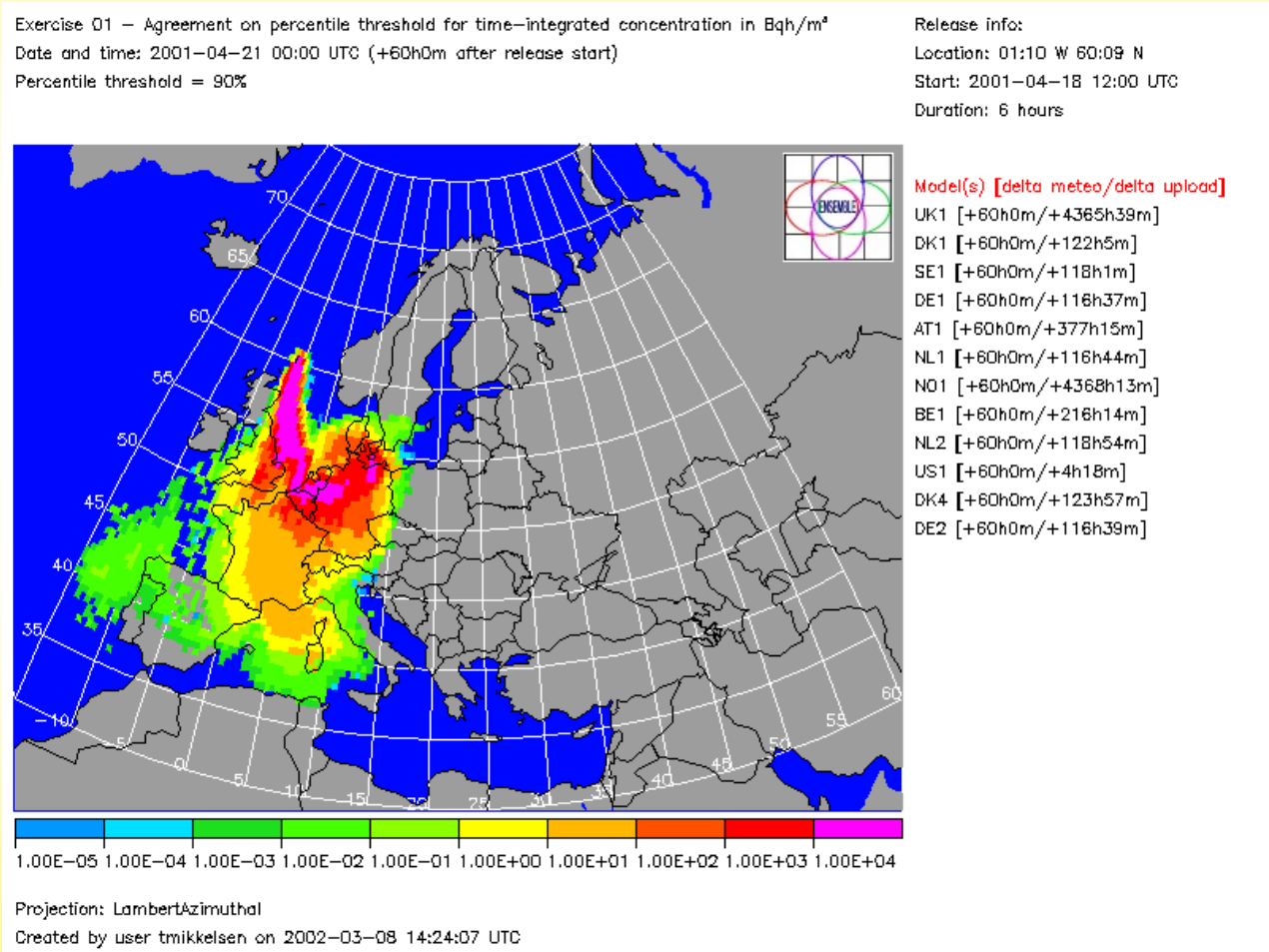
ENSEMBLE - harmonisation of long-range atmospheric dispersion forecasts

- Major differences in forecasts of national meteorological services
  - may cause differences in response
  - source of public concern and confusion

- ENSEMBLE aims to better inform the decision process
  - demonstrates the degree of coherence/divergence of forecasts

- ENSEMBLE is
  - a web based tool to compare forecasts in real time
  - exercised frequently involving > 20 forecasting organisations
  - being further developed

ENSEMBLE cont'd



Stakeholder involvement

- FARMING - Agriculture and food
  - stakeholder panels in several EU countries to establish more practicable, cost effective and broadly acceptable countermeasures

- EVATECH - Urban areas
  - facilitated workshops held in several EU countries with a broad range of stakeholders to establish more practicable, cost effective and acceptable countermeasures for contaminated urban areas

Long term management and rehabilitation of contaminated areas - ETHOS project

- Novel “bottom up” and more inclusive approach to improve conditions in contaminated areas
  - population taking greater responsibility for its actions
  - production of less contaminated food
  - social and economic improvements

- Responding to earlier failures caused by:
  - the development of a dependency culture
  - highly centralised approach

ETHOS cont'd

- Implemented initially in one settlement,Olmany
- Extended to several villages in Stolyn district
- Approach adopted as important element of Belarus policy for sustainable redevelopment of contaminated areas
- Approach now being rolled out to several regions in Belarus under the CORE project
  - with support from several European countries and international organisations

Over to Neale

Major Challenges

- Intervention levels
- Role of radiation protection
- Stakeholder involvement
- Preparedness and exercising for the late phase
- Rehabilitation and long term management
- Regional co-operation and mutual assistance
- Maintaining competence
- Malevolent uses
- Research and development

Intervention Levels

Issue

- Broad international agreement on principles
- Major differences in IL/DIL adopted nationally
- Will cause major problems, post accident

Action needed

- Identify reasons for differences
- Evaluate opportunities for greater harmonisation
- Inform the political process

Role of Radiation Protection

Issue

- Historically RP has taken a leading role
- Is emergency and post accident management:
  - a social problem with RP inputs or
  - an RP problem with social inputs
- More enlightened have recognised that it is the former but practice has been otherwise

Role of Radiation Protection (cont'd)

Action needed

- Revisit guidance on emergency and post accident management
- Incorporate a broader range interests (stakeholder involvement)
- Learn from projects such as FARMING, STRATEGY and EVATECH and practical experience post Chernobyl and elsewhere

Stakeholder Involvement

Issue

- Arrangements have had a long gestation and largely determined by “technologists”
- In general, little broader stakeholder involvement

Action needed

- Review extent to which views and needs of stakeholders are reflected in arrangements
- Initiate more inclusive and sustainable process where potentially important deficits identified

Preparedness and Exercising for Post Accident Management

Issue

- In general, rudimentary and much less frequent compared with emergency phase

Action needed

- Enhance detailed level of planning and preparedness
- Radically increase frequency and the nature of exercises
- Need to address:
  - management of contaminated agricultural land and inhabited areas and
  - interfaces between changing lead organisations

Rehabilitation and Long Term Management

Issue

- Undue focus on “narrow” radiological issues is misguided and has led to failure
- Not addressing broader issues (eg, social, cultural, ethical, political, environmental, etc) can only lead to failure
- Nature and importance of the problem not broadly recognised among the radiological and decision making communities

Rehabilitation and Long Term Management (cont'd)

Action needed

- Develop shared understanding of issues
- Develop framework that can assist authorities in establishing policy, with guidance on application
- Demonstrate efficacy of framework and its related guidance
- Disseminate the framework widely and promote its use
- Develop and maintain international competence

Regional Co-operation and Mutual Assistance

Issue

- Fewer resources in future
  - even maintaining status quo will be difficult
- Regional cooperation could lead to better resource allocation and more integrated response
  - but resistance due to some loss of autonomy
- Mutual assistance arrangements in place
  - but add-ons to, and rarely an integral part of, national arrangements

Regional Co-operation and Mutual Assistance (cont'd)

Action needed

- Evaluate merits of, and impediments to, regional approaches (particularly in Europe)
- Potential greatest for:
  - regional emergency centres, decision support systems
  - airborne gamma monitoring, mobile and personal monitoring
  - biological dosimetry, treatment of highly exposed individuals, etc
- Better integrate mutual assistance into national arrangements
- Important progress in Central Europe a stimulant for cooperation elsewhere
  - coordination around RODOS DSS and EURANOS project

Maintaining Competence

Issue

- Declining competence
  - due to maturity of the nuclear industry
  - ageing of the workforce
  - moratoria on new nuclear build in many countries
- Exacerbated (in Europe) due to large increase in resources post Chernobyl
- Situation worse for late phase
  - emergency arrangements are an integral part of plant operation/licensing

Maintaining Competence (cont'd)

Action needed

- Problem well recognised but less clear how it should be resolved. Possible actions include:
  - achieving critical mass through collaboration at regional or international levels
  - regional/international task forces on particular topics
    - eg, airborne gamma monitoring, waste management, monitoring special nuclides, etc
  - mapping competence
  - education and training
- Solutions will require political accords

Malevolent Uses of Radioactive Material

Issue

- Arrangements largely developed for fixed installations
  - additional demands when location of source unknown

Action needed

- Review adequacy of existing arrangements for response to malevolent uses
- Identify any major deficits and rectify
  - particular attention to be given to the diversity of sources and how they may be used

Research and Development

Issue

- Most research has a largely technical focus
  - but many of the challenges have a social or political as opposed to technical origin

Action needed

- Ensure that research agendas remain responsive to the most pressing needs
- Initiatives to increase participation of the social humanitarian, management and political sciences in problem definition and resolution