Karlsruhe Institute of Technology

Functions of decision support systems (JRodos as an example): Overview and new features and products

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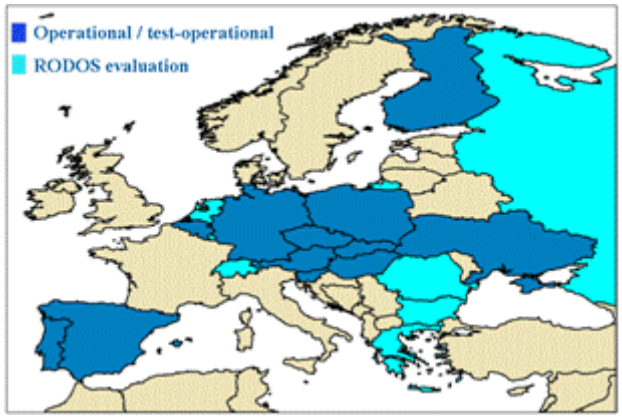
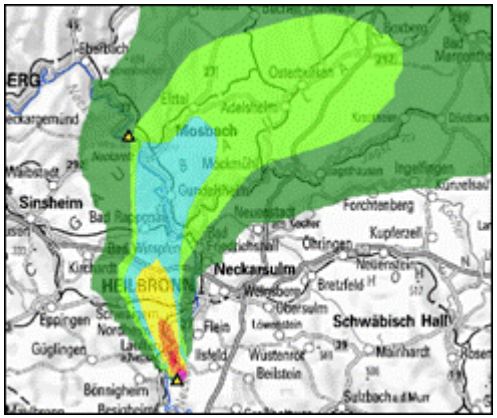
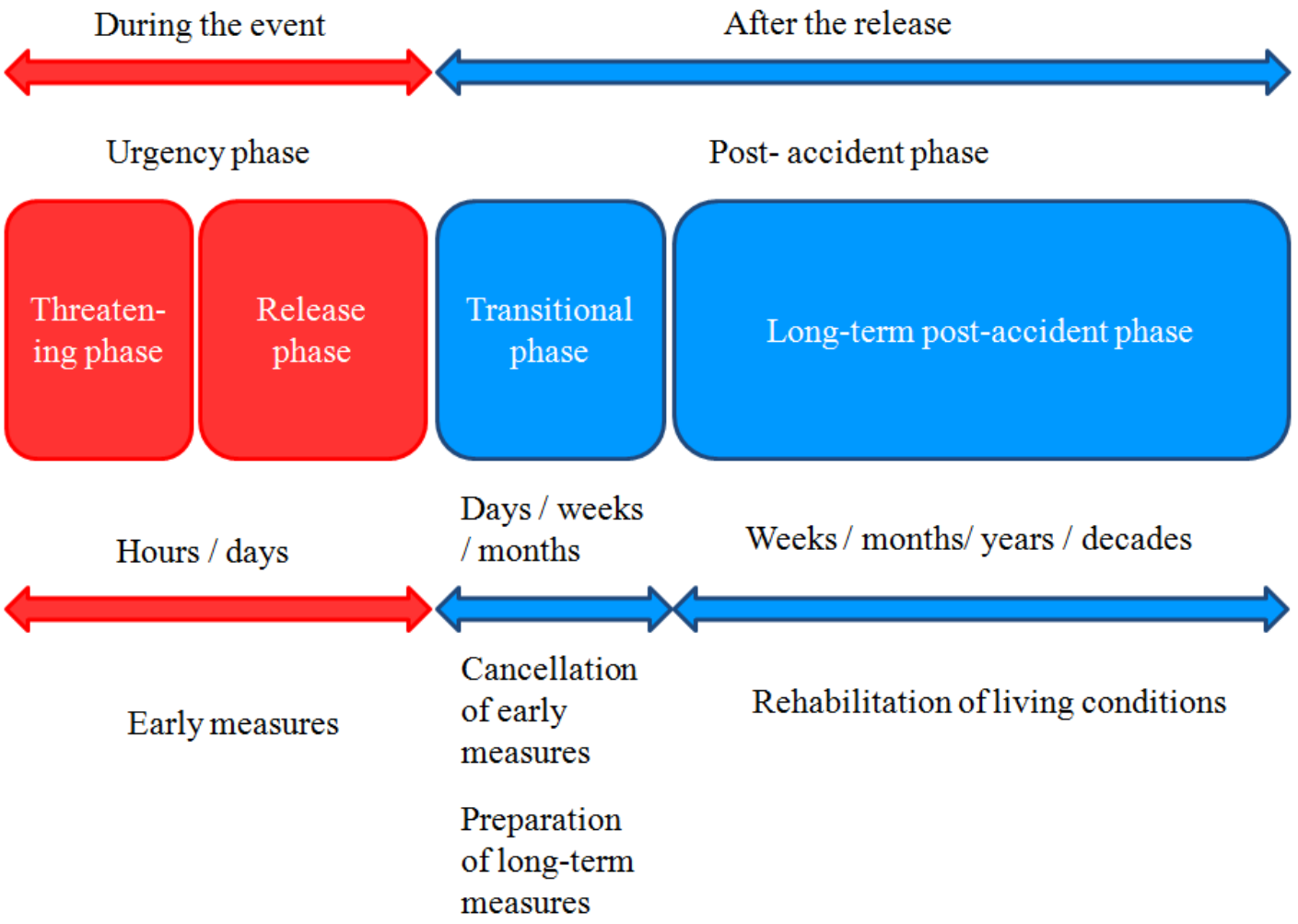




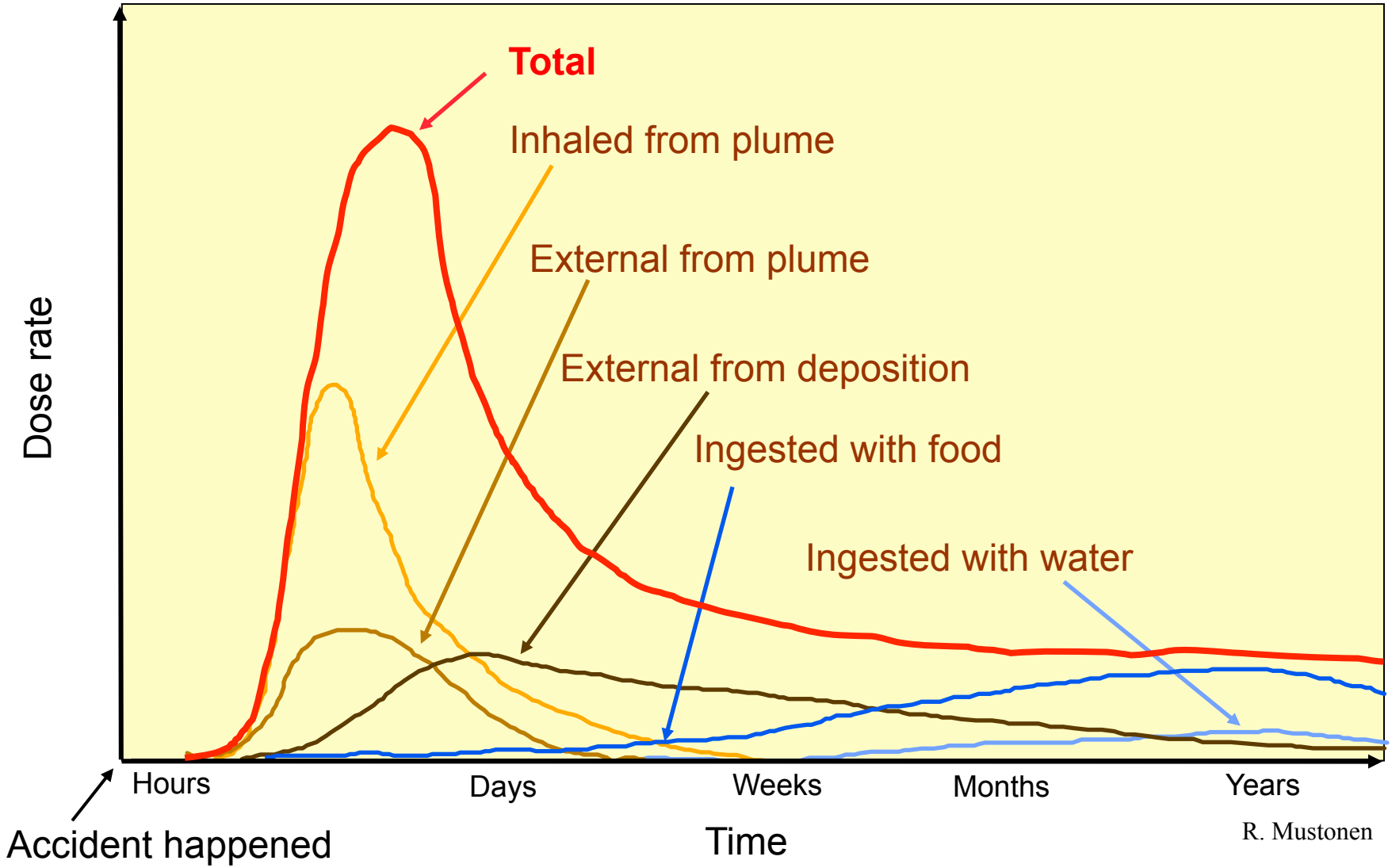
Outline

- What can a DSS deliver to the decision making team in case of a severe nuclear accident
- Main features of a DSS (RODOS as example)
- New features developed in NERIS-TP

Phases


During the event
After the release
Urgency phase
Post- accident phase
Threaten-ing phase
Release phase
Transitional phase
Long-term post-accident phase
Hours / days
Days / weeks / months
Weeks / months/ years / decades
Early measures
Cancellation of early measures
Preparation of long-term measures
Rehabilitation of living conditions

Exposure during and after a nuclear accident



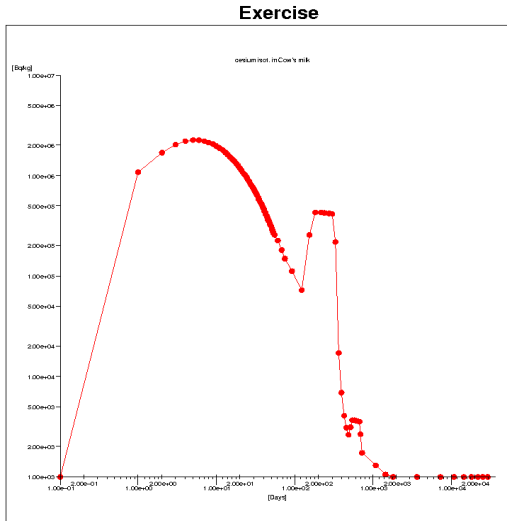
R. Mustonen

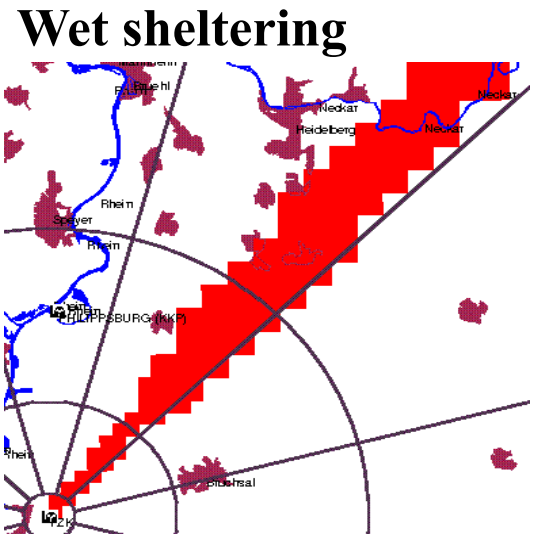
Information available in the threat phase

- 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**

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
- Proposes area to initiate early countermeasures, simulates early countermeasures to estimate the performance of individual or combined measures





Information available in the release phase

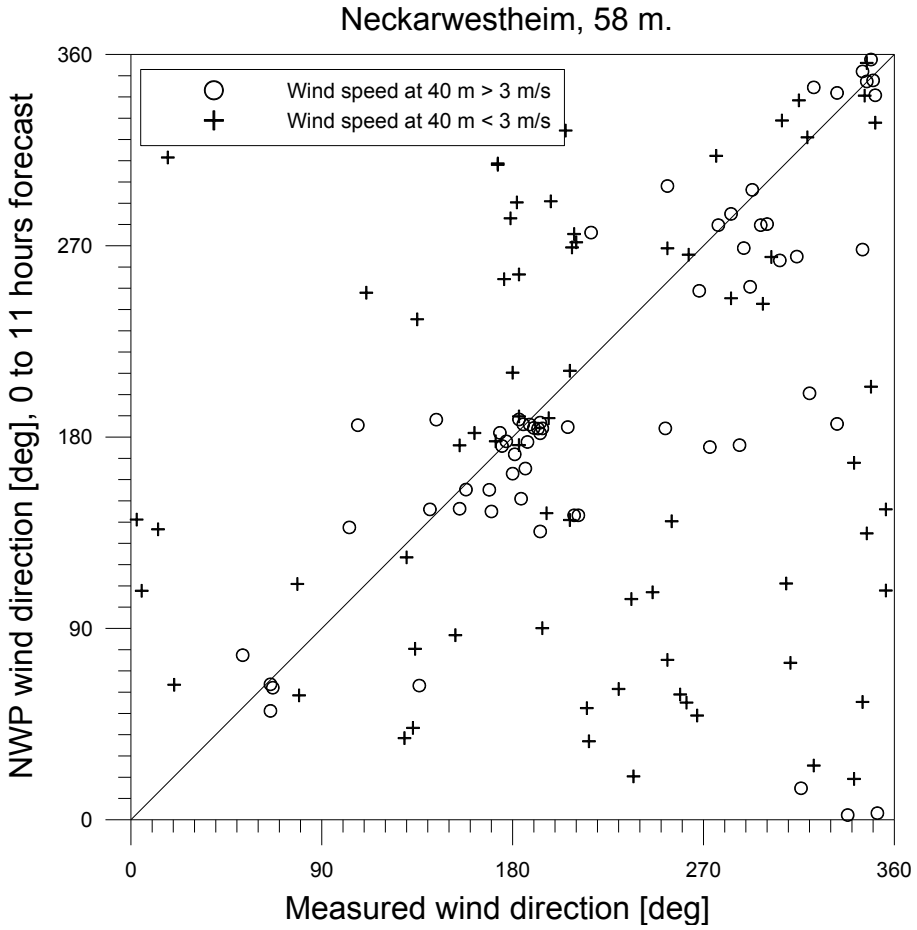
- Status of NPP and the potential evolution of the accident, including an estimation of the source term (monitored via stack (best), monitored by external instruments close to the building (some help) no monitors (very uncertain), not appropriate or defect monitors (disaster))
- Radiological monitoring
- On-site meteorological data and prognostic weather data
- 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**

Support provided by a DSS

- 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!
  - Measurements only represent situation at one time at one particular location
  - But required are quantities representative for a longer time period and area
- Data assimilation can combine both monitoring and modelling

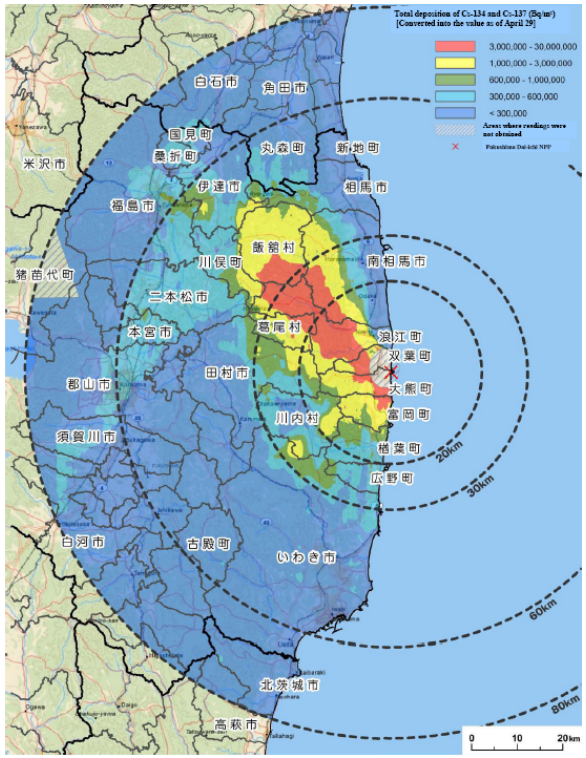
Comparison of on-site and prognostic weather data



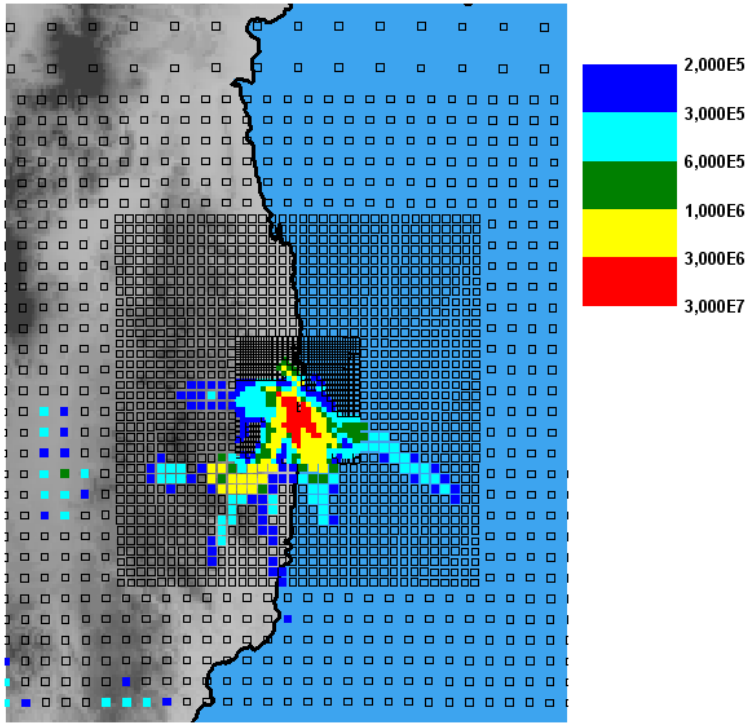
- Results for a NPP in hilly terrain in Germany
- Statistics of differences between numerical weather forecast and Neckarwestheim data for the first 11 hours of a 48 hour prognosis
- Limited set of data (less than 3 months)

Comparison of station data with NWP data

- Source term as before, but weather data only from station near Fukushima (RODOS with ATSTEP, from BfS)

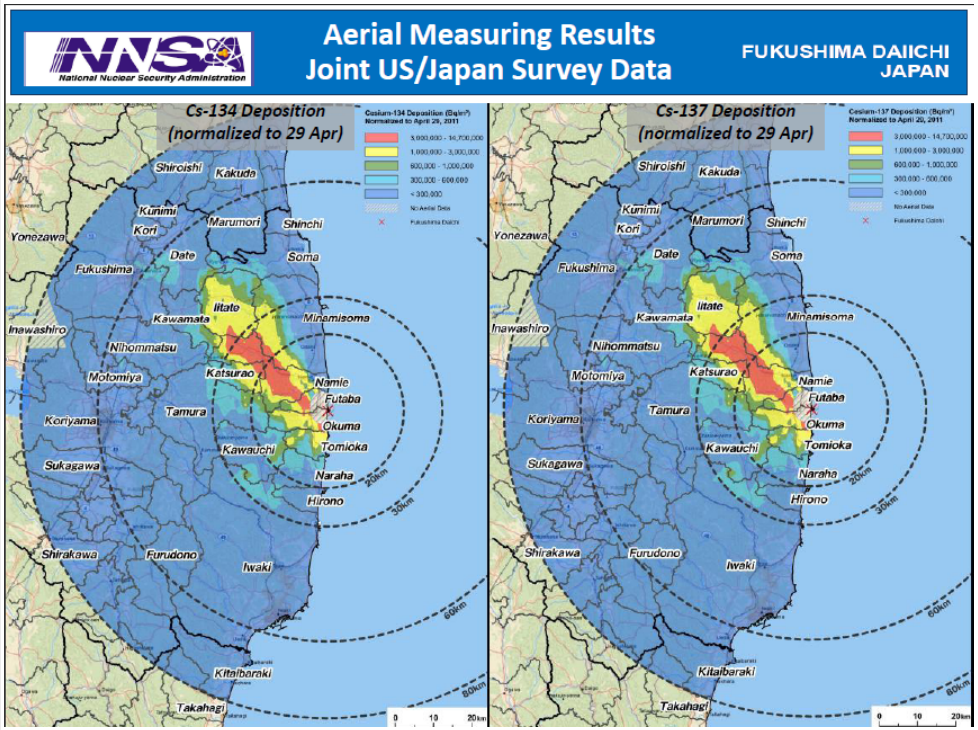


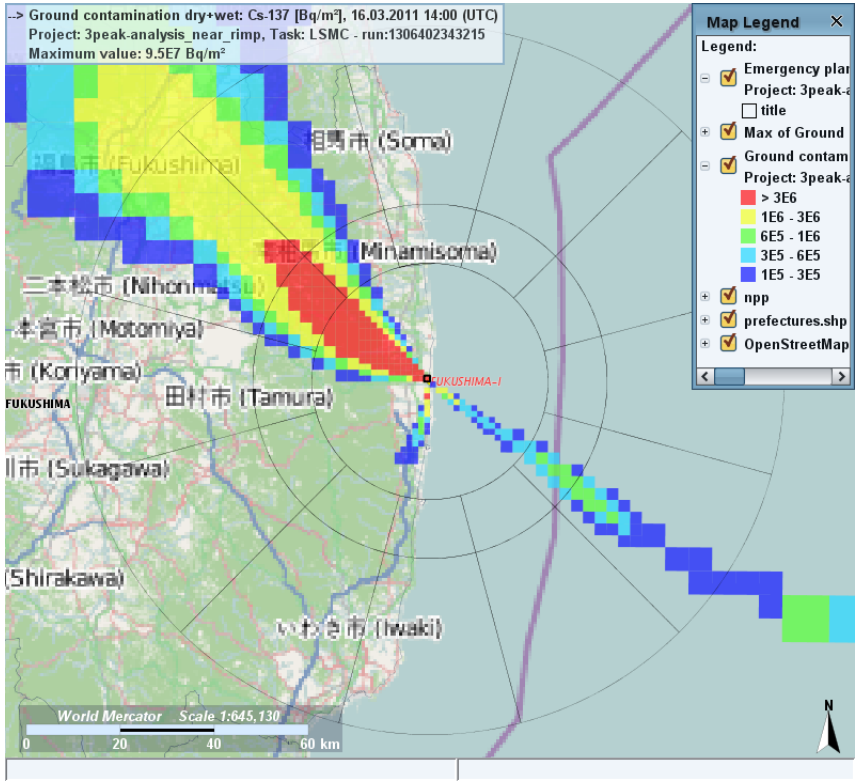
Monitoring total Cs



Calculations total Cs

Simulation with numerical weather





U.S. Department of Energy

http://energy.gov/news/10194.htm

Cs-137 only

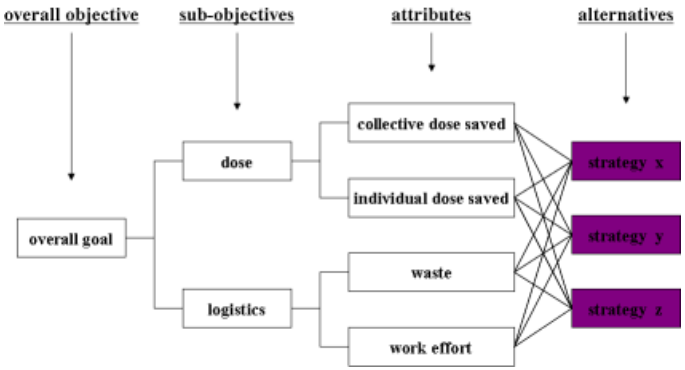
Numerical weather WRF

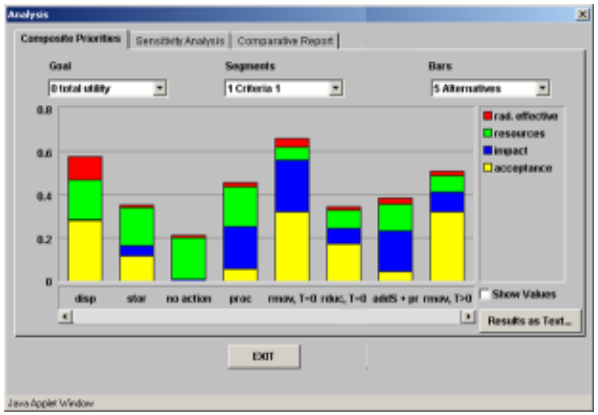
Information available in the post-release phase

- Status of the NPP (release has stopped)
- Radiological monitoring (radiological situation is stable)
  - Nuclide vector
  - Identify hot spots
  - Footprint of the cloud
  - Doses to the population/rescue teams
- Prognostic information is still needed
  - Time evolution of the activity concentrations, doses and potential areas to initiate late phase countermeasures (relocation, decontamination, food banning) wherever necessary

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. inhabited areas and food)
- Simulation of countermeasures
- Evaluation of countermeasures to point out the most effective ones





Use of a DSS in the preparedness phase

- Possible areas for application
  - Support the preparation of countermeasure strategies in the various phases of an emergency and the recovery
  - Check compliance with the new ICRP recommendations
  - Support exercises
  - Support the training of emergency staff
  - Recalculation of historic events
  - Support stakeholder engagement
    - Development of scenarios for the discussion
    - Use of MCDA tools to structure the problem

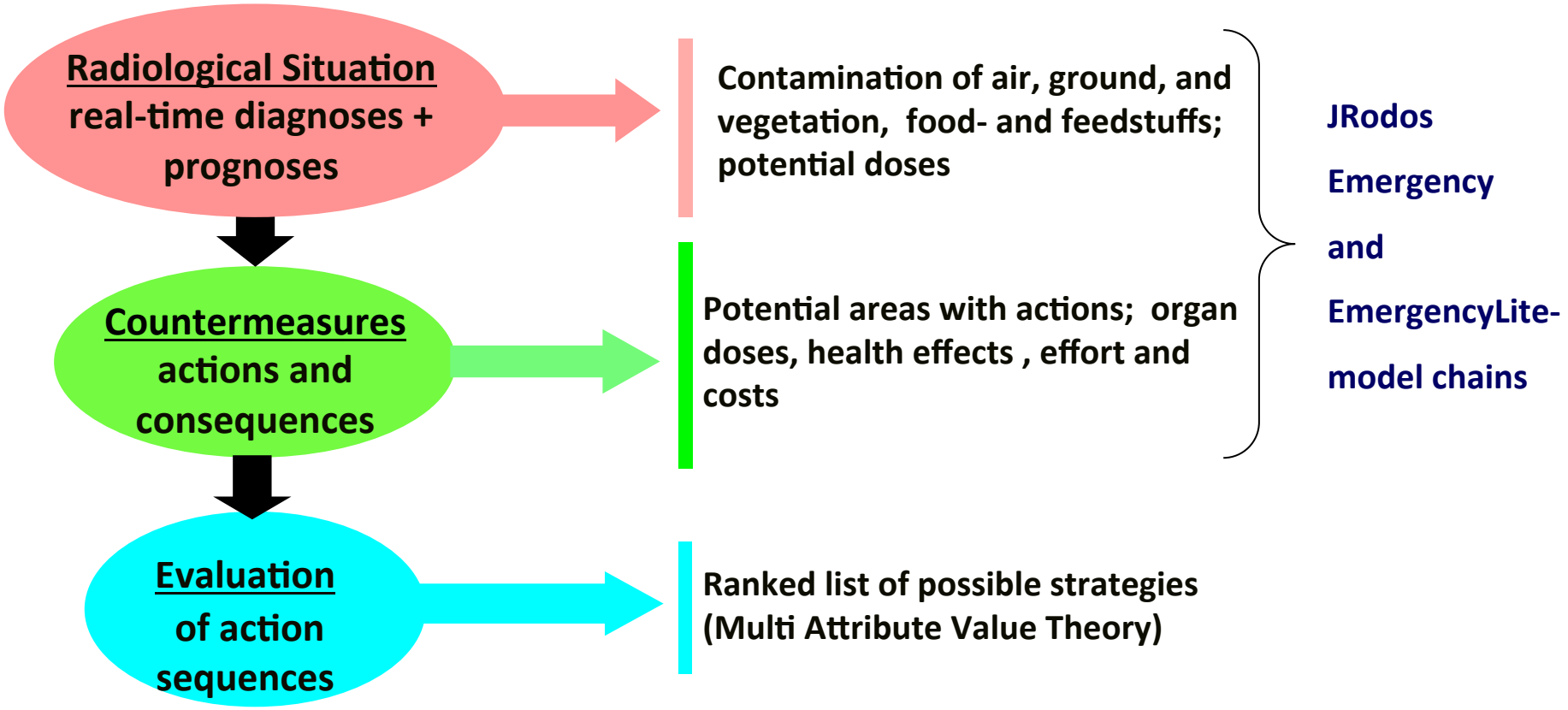
Key features of RODOS
Real-time On-line Decision Support system

- ***Multi-user operation in national/regional emergency centres for off-site nuclear emergency management***
- ***Provision of information for decision-making***
  - **on local / national / regional / European scales,**
  - **in the early and later phases of an accident,**
  - **for all relevant emergency actions and countermeasures.**
- ***Wide IT applicability - HP-UX and Linux (RODOS), Microsoft Windows, Linux and Mac OS (JRodos)***

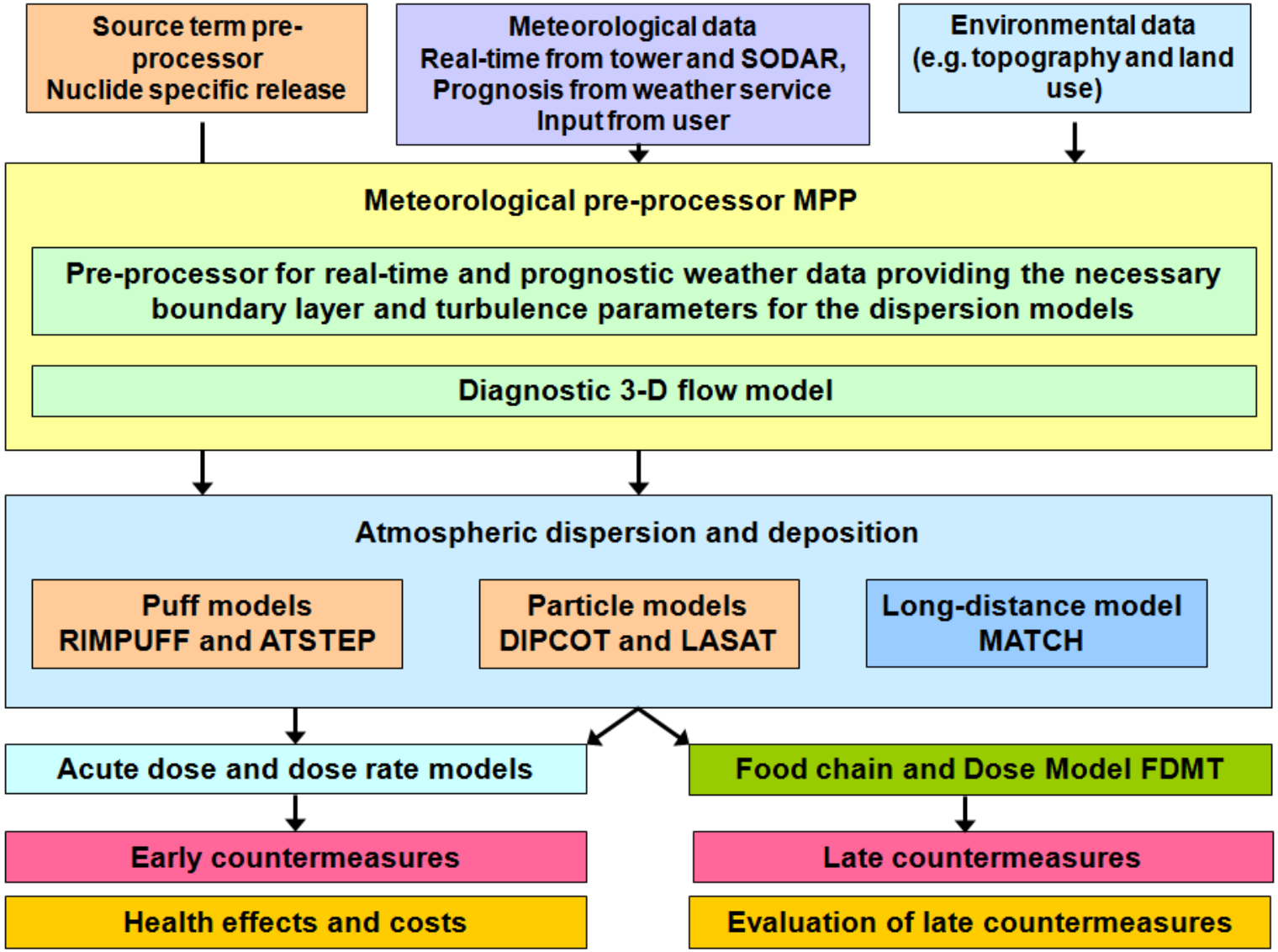
JRodos: Tasks, input data, output

Meteorology and Release (Measurements / Prognoses / User specified)

Geo-referenced data (orographical data, population, land use, ...); nuclide data, dose factors etc.; intervention criteria and levels; Scenarios for exercises

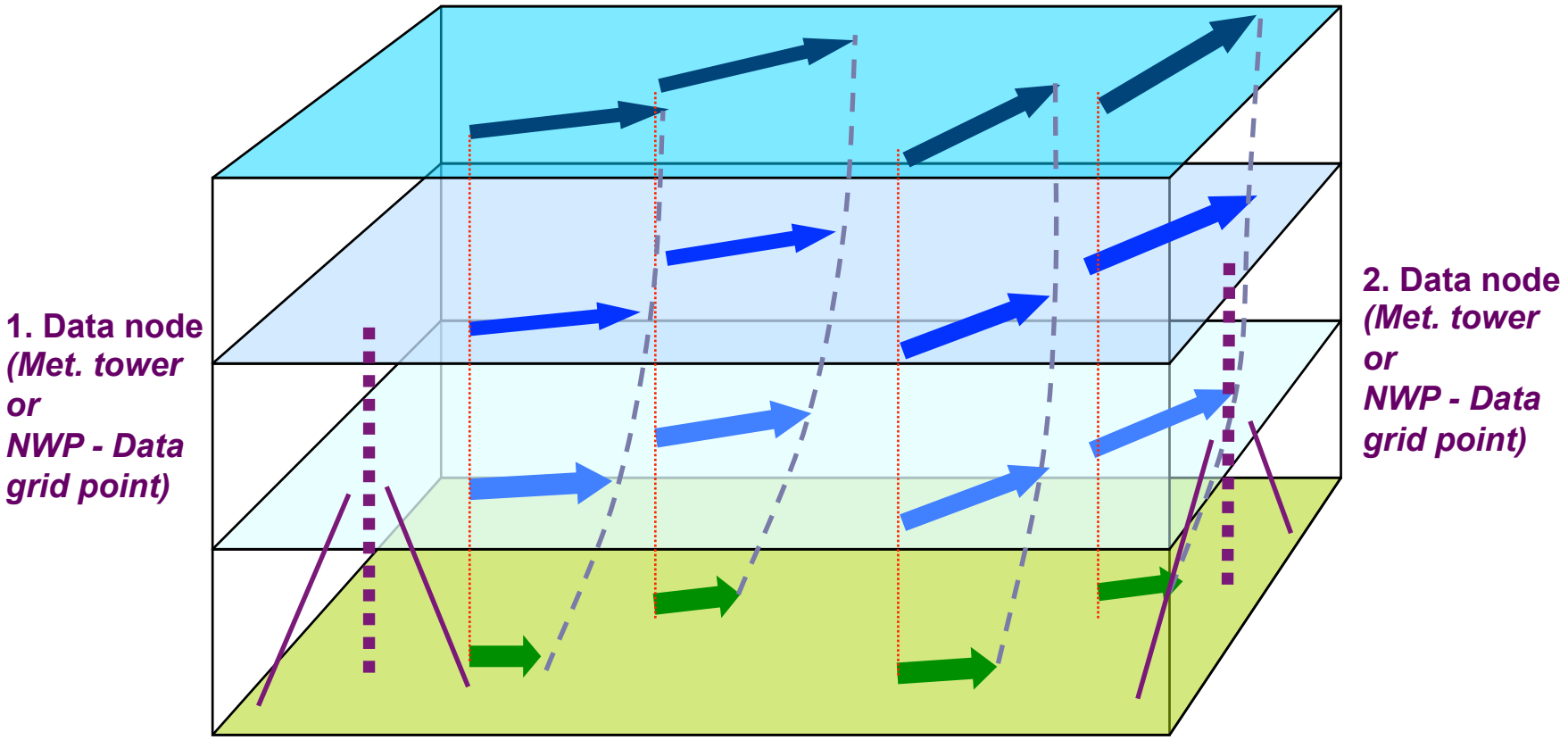


Task: Assessment of radiological situation – JRodos models



Near-range model chain: Meteorological Pre-Processor

- ***3-dimensional mass-consistent wind vector-field with vertical profile; PG-stability, mixing height, Monin-Obuchov Length, friction velocity, precipitation fields, atmospheric resistances (Demokritos, Athen)***

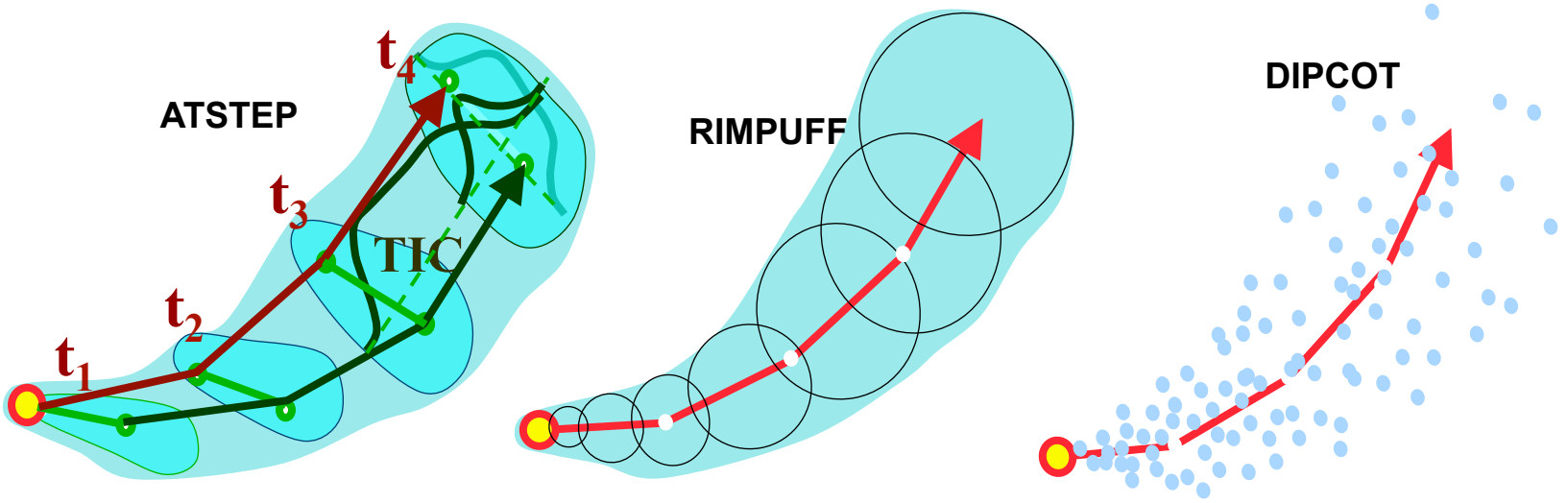


Near-range ADM models in JRodos

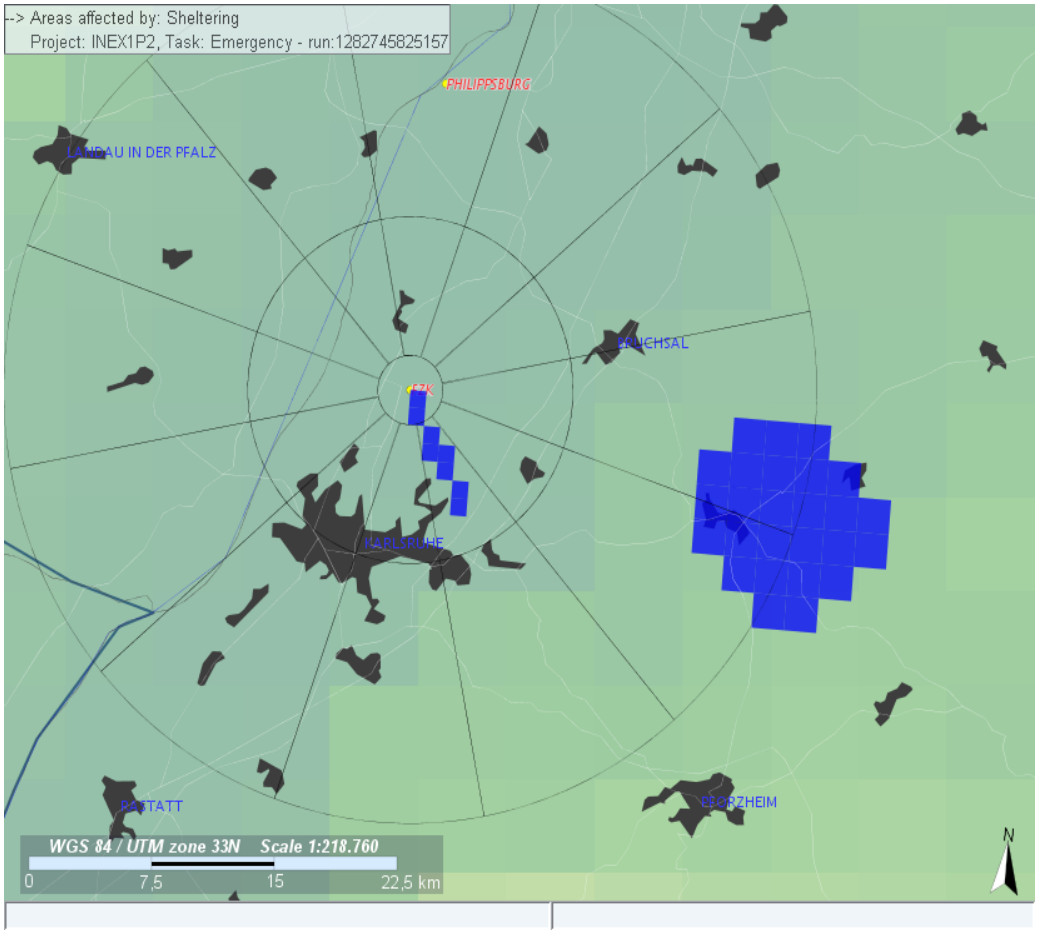
- ATSTEP: Gaussian Puff Model with elongated puffs; Karlsruhe-Jülich and Mol- diffusion parameters (KIT/IKET Karlruhe)
- RIMPUFF: Gaussian Puff Model; Carruthers diffusion parameters (DTU, Roskilde)

For complex windfields and terrain: Lagrangean Particle Models (LPM)

- DIPCOT: LPM; in JRodos operating as Gaussian kernel version (Demokritos, Athen)
- LASAT: LPM; served as basis for AUSTAL2000, the official reference model of the German TA Luft (in implementation, licence paid)

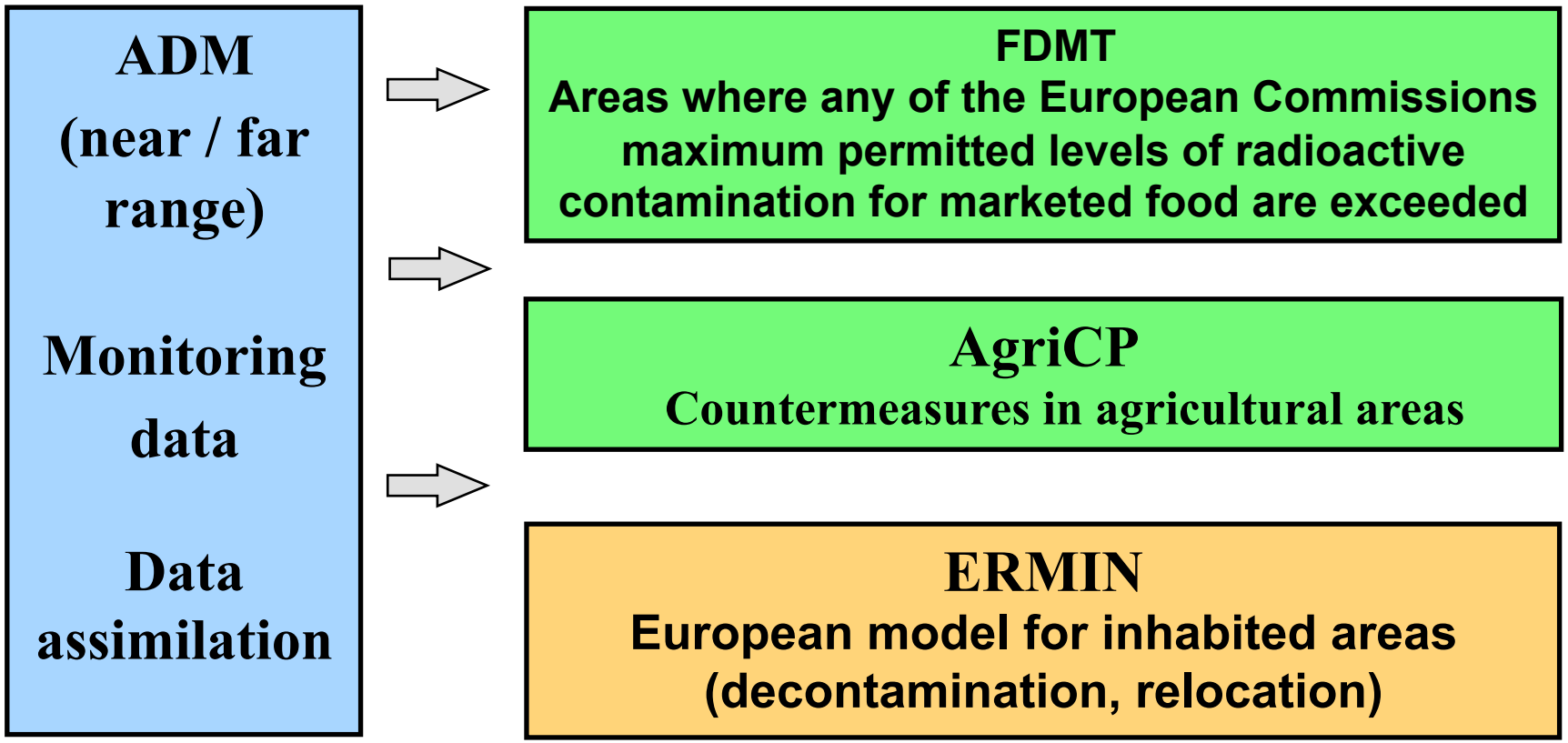


Early countermeasures simulation model EmerSim

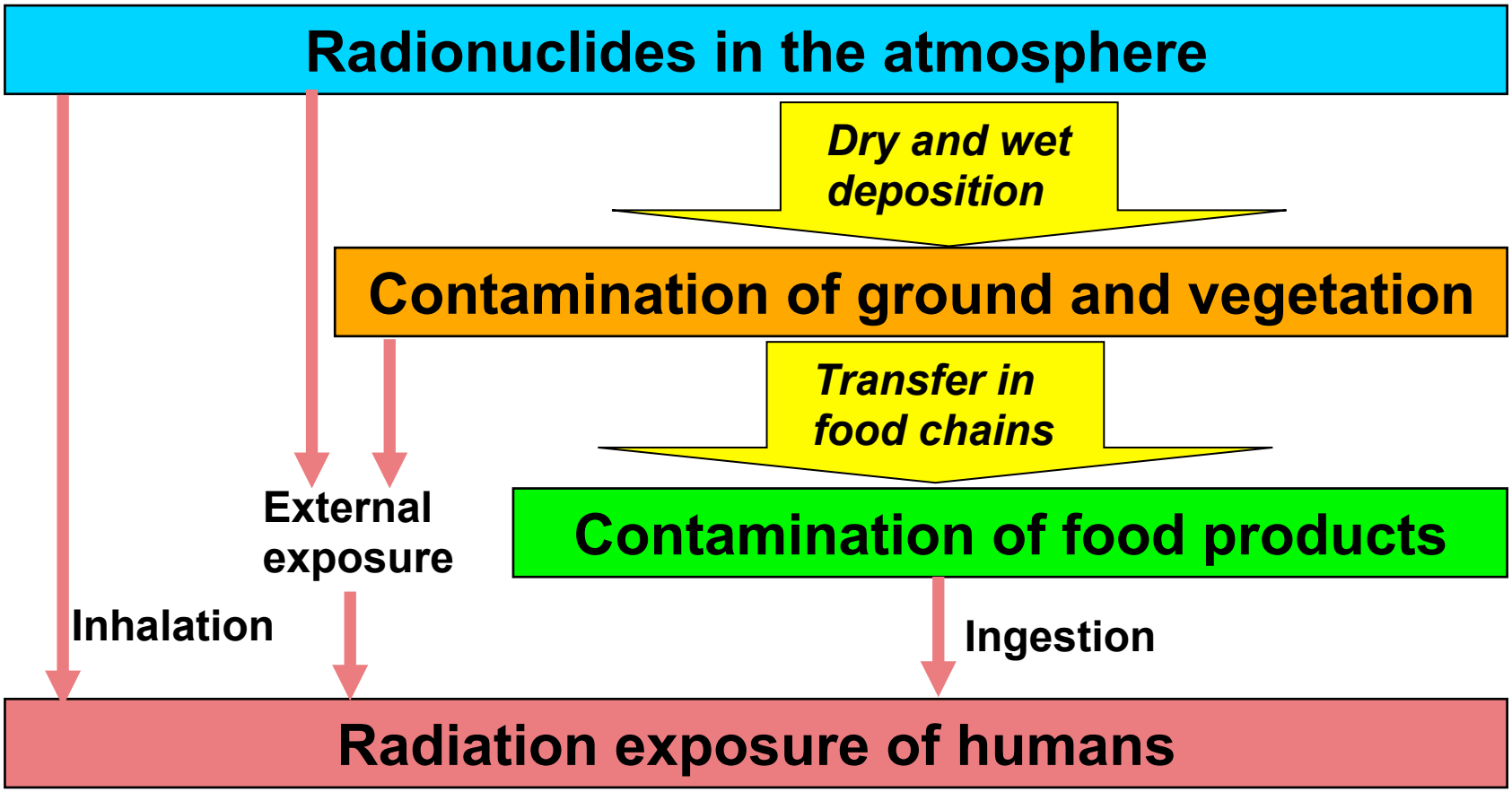


- Areas with
  - Evacuation
  - Sheltering
  - Iodine tablets
- Doses without/with early countermeasures
- Simple model for areas with deterministic health effects
- Simple model for economic consequences of early countermeasures

JRodos structure - Late phase models -



Food chain and dose model, terrestrial - FDMT



JRodos late phase models: Inhabited area model ERMIN

- ERMIN is a European model to investigate the effect of countermeasure option in inhabited areas that has been developed in the frame of the EURANOS project
- ERMIN is a dynamic model that calculates the deposition to individual surfaces and the behaviour of the radionuclides in the environment (not only uses a set of pre-calculated library data)
- Seven different environments are considered in ERMIN

JRodos late phase models: Agricultural Countermeasures Program (AgriCP)

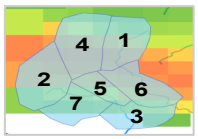
- AgriCP combines dynamic food chain calculations and countermeasure simulations in one model
- The calculation of countermeasures inside the food chain modelling allows to consider complex strategies in a physically more adequate way than using sets of pre-calculated library data
- AgriCP has been developed as part of the EURANOS Project and considers approaches from the European handbook on food production systems

Hydrological model chain HDM

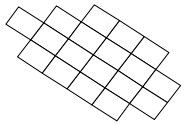
Watershed runoff/
pollution wash-off

2D - Model
Water and sediment
transport in rivers

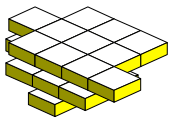
Compartment model
Radionuclide transport in
water and fish



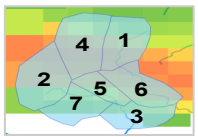
2D - Model
Radionuclide transport in in
shallow reservoirs, lakes,
coastal waters



3D - Model
Radionuclide transport in
complex water bodies



Aquatic food chains

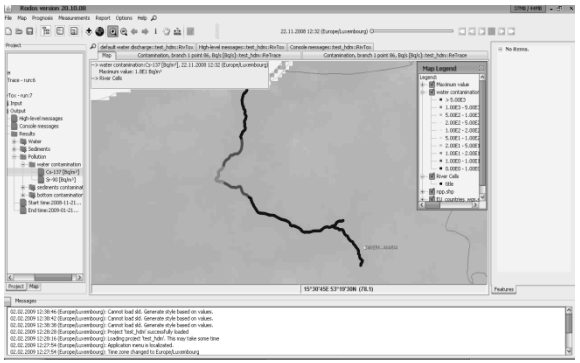


HDM

- RETRACE
- RIVTOX
- POSEIDON
- COASTOX
- THREETOX
- FDMA

JRODOS

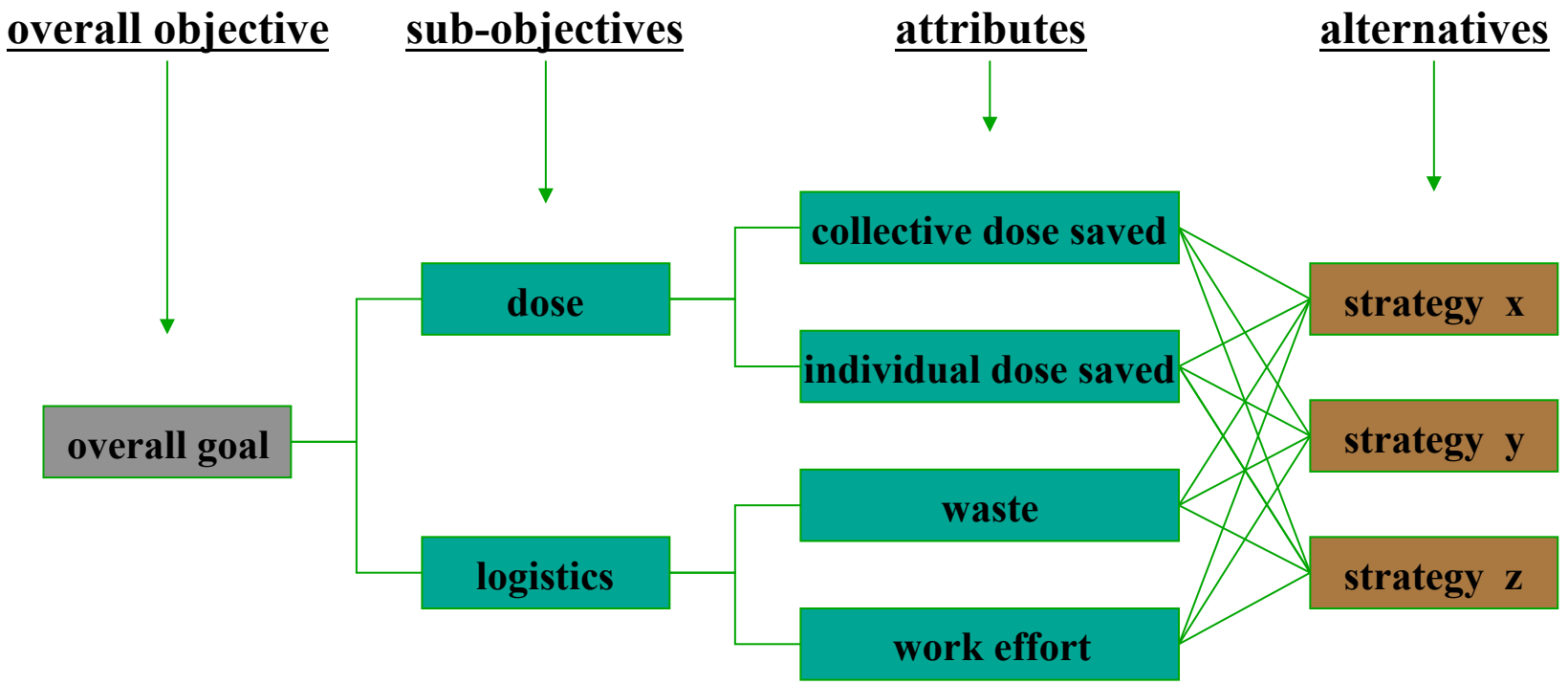
- ADM
- HDM
- Data Base



Evaluation of measures outside RODOS

Evaluation and ranking of optional countermeasure strategies

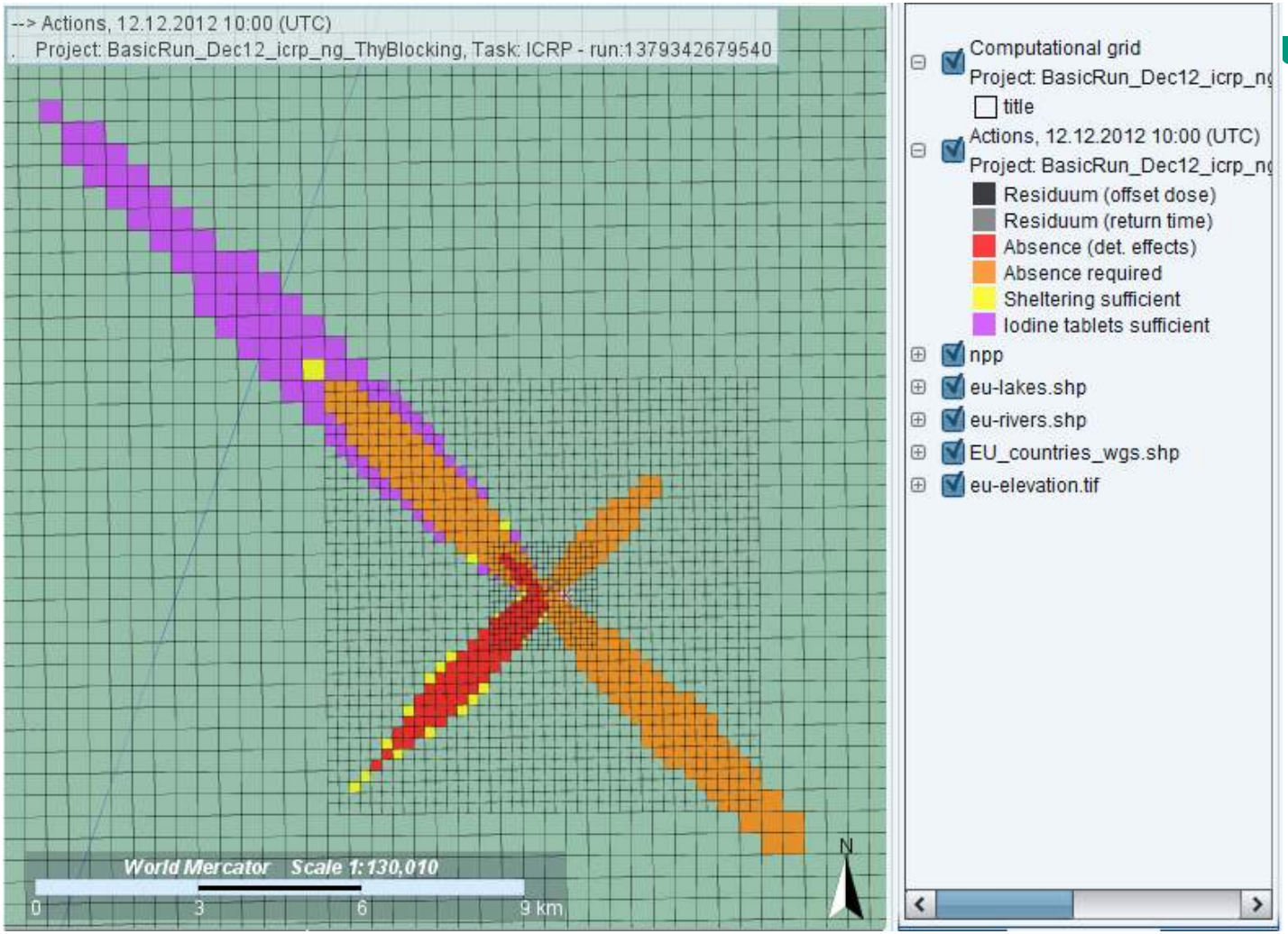
- Elucidation of problem structure by hierarchically modelling of decision criteria, and
- Balancing of benefits and disadvantages by accounting for constraints (feasibility, public acceptability...), preferences of decision makers, and socio-psychological and political aspects



Topics identified after EURANOS

- Expand the simulation models for the new “residual dose” approach of ICRP-103
  - So far existing models treat countermeasures individually
  - The new recommendations requested that all exposure pathways should be taken into account in the countermeasure simulations
  - Strategies of individual measures should be possible
- As result, the ICRP model has been developed
  - Screening for individual measures or combinations including food
  - One issue for this week is to identify how to further develop such a model for operational use in developing countermeasures strategies in a national regulatory framework

Sheltering-Evacuation-Relocation+Iodine/ ingestion Area of Interest



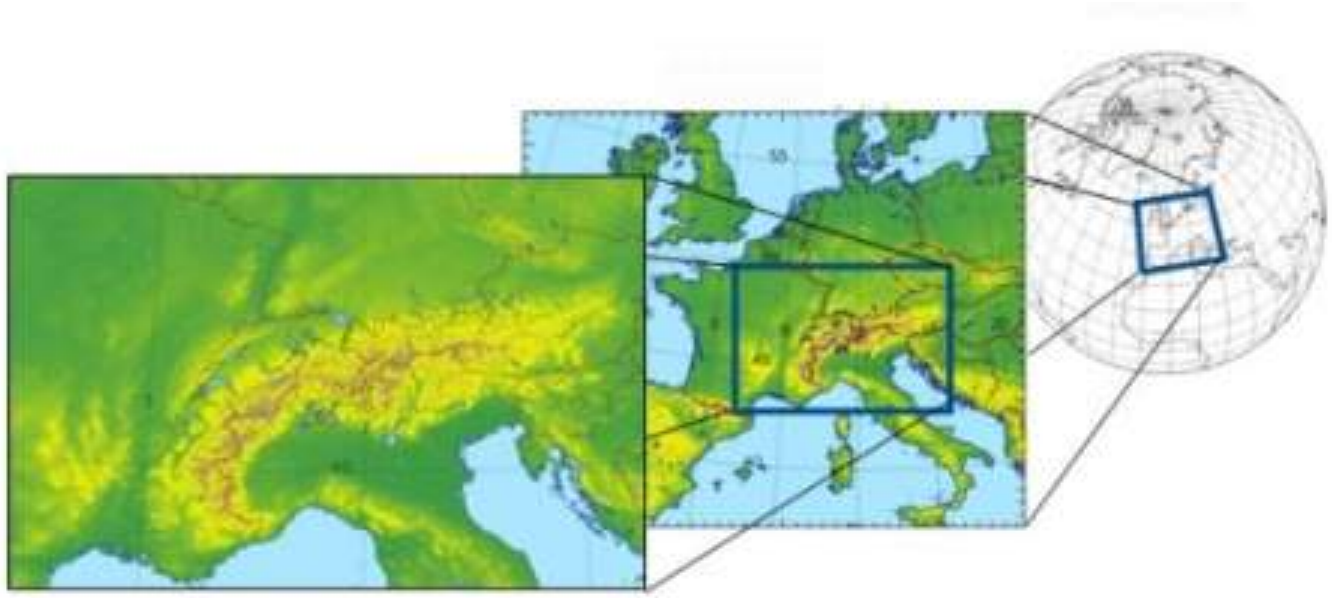
- Absence times from area associated with above action set

Topics identified after EURANOS

- Develop a support system that uses freely available meteorological data world wide and adapt this data to the near range applicability
  - Global NOMADS data are available - except the US is bankrupt like in 2013
  - Such a service could be also provided by a national weather service
  - World wide forecast data for several days are available
  - Re-analysis for detailed recalculation is also available
  - Important to scale the global data down to the area of interest – via WRF

Topics identified after EURANOS

- As result, the NOMADS – WRF chain has been established
  - First NOMADS data can be used for a fast evaluation
  - In a second step WRF calculations can be requested, but takes more time

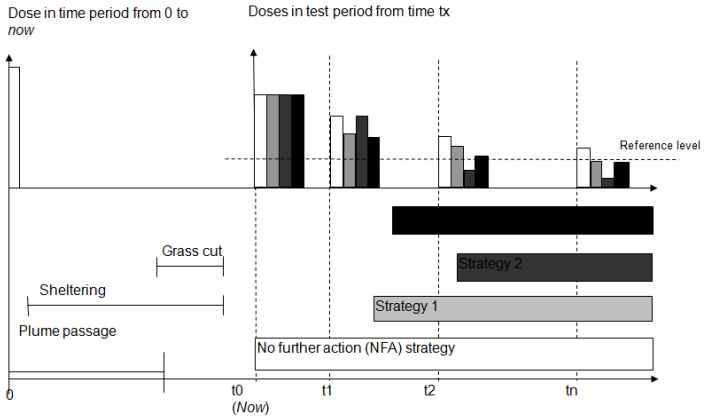


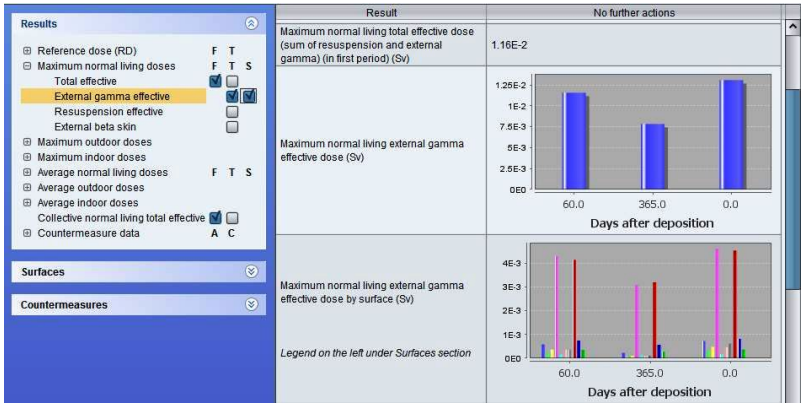
Topics identified after EURANOS

- Coupling of a DSS (RODOS and ARGOS) to an early notification system (possibly IAEA or ECURIE)
  - Objective was to use any source term data and information characterising the release as starting point for a calculations with the DSS in a semi-automatic way
- As result, the USIE interface was developed
  - The interface is still not complete as we as developer do not have full access to the documentation – at least we have not had it so far
  - We are ready to further work on the interface and will discuss this at the RUG meeting in February 2014 (IRIX interface)
  - We are also interested to establish the same for ECURIE – even after NERIS-TP, supported via the RUG or by KIT alone

Topics identified after EURANOS

- Improvement of ERMIN
  - Development of a wizard that facilitates the development of decontamination strategies
- As result, ERMIN-2 was developed
  - The wizard exists, which guides the user through the selection of measures based on the contributing surfaces
  - How to further develop the tool by integrating objectives such as costs or others in the strategy selection – beyond NERIS-TP





Topics identified after EURANOS

- Improvement of AGRICP
  - Development of a pre-processor to run the model based on monitoring data
  - Improve AGRICP in general
- As result, AGRICP was further developed
  - AGRICP has been tested and is operational
  - Documentation is now available
  - The pre-processor is available but still not operational – not connected to data base
  - Objective in this week is to demonstrate how to use the tool in the best possible way

Thank you very much for your attention

Questions?

http://www.rodos.fzk.de
http://www.eu-neris.net