run-up algorithm. The code requires as input detailed information on seismic source mechanisms, gridded bathymetric data information for the open sea propagation, and a set of gridded Digital Elevation Models (DEM) containing bathymetry and topography for use during the inundation phase. Accurate bathymetry and topography data for Rhodes were purchased/collected from various sources, GIS-processed and coupled in the nested bathymetry/topography grids shown in Figure 1.

Hundreds of simulations were performed based on both a deterministic and a probabilistic approach and various types of tsunami inundation (inland penetration) maps were produced (see Figure 2). The deterministic maps have been produced from simulations based on worst-case scenarios with the aim of assessing the impact of unusually large (hypothetical) seismic events. The probabilistic maps were the outcome of simulations based on multiple near-field tsunami scenarios and took into account the uncertainty associated mainly with the location of the seismic source. The comparison of the various deterministic and probabilistic scenarios led to the conclusion that the city of Rhodes is most heavily affected by the probabilistic scenario of a 1000-year event. All conclusions and results were utilized for the needs of the vulnerability and risk analysis.

For the purposes of the latter task specific basic data were identified, collected and analysed in order to obtain estimates of vulnerability and risk. To this end, elements such as land cover/use, buildings and coastal structures and infrastructure (roads, ports, piers) were identified, as well as tourist populations with high seasonal variation. All these relevant data were combined with the results of simulations and used to produce flooding risk maps and their representation within a GIS. The estimation of tsunami risk was based on the inundation maps as well as on the computed values of the flow depth in the coastal areas. Tsunami risk zones were defined and presented in GIS layers and maps, see Figure 3. Based on this analysis, the FORTH-IACM team developed and proposed detailed recommendations.

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Comprehensive Modelling and Simulation System for Decision Support in the Field of Radiation Protection

by Petr Pecha and Radek Hofman

Potential failures in man–made processes can result in the accidental release of harmful substances into the environment. Risk evaluation and a decision-making process that is focused on protecting the population has the highest priority. Historically, accidents in nuclear facilities have revealed a lack of sufficiently advanced decision support software tools. Great attention has been paid to this topic since the Chernobyl disaster. The software system HARP (HAzardous Radioactivity Propagation) is designed for the fast assessment of the radiological consequences of such a release of radionuclides into the environment.

The HARP system is the application part of a grant project supported by the Grant Agency of the Czech Republic (period 2007–2009), which was solved in the Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic. The new version of the product is a complex software tool for modelling the radiological consequences of radionuclide releases due to the normal and emergency operation of a nuclear facility. Aerial transport of discharged radionuclides is studied up to a 100km radius from the pollution source. Dispersion, deposition and successive radioactivity migration towards the human body is simultaneously modelled. As the system contains a database of demographical data on the area of interest, it can evaluate the major radiological quantities and the radiological burden on the population due to different pathways of irradiation in both the early and the late phases of a radiation accident.

The core of the system is an atmospheric dispersion model. Generally, the modular architecture of the system enables an arbitrary dispersion model to be inserted. The default is the segmented Gaussian plume model. Although simple, the Gaussian model is consistent with the random nature of atmospheric turbulence and is an approximate solution of the Fickian diffusion equation. Proven semi-empirical formulas are available for the approximation of important effects like the interaction of the plume with proximal buildings, momentum and buoyant plume rise during release, power-law formula for estimation of wind speed changes with height, depletion of the plume activity due to the removal processes of dry and wet depositions, radioactive decay and creation of daughter products, dependency on physical-chemical forms of admixtures and land-use characteristics, plume lofting above the inversion layer, and so forth.

A special emphasis is laid on the proper treatment of types of input parameter fluctuations, in the sense of differentiation between variability and uncertainty. Some model uncertainties arising from the conceptual limitations can be roughly estimated on the basis of an

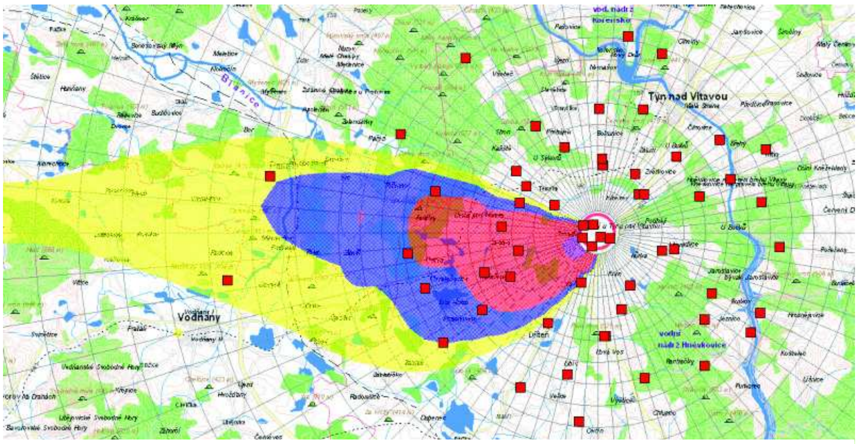

Figure 1: Prediction of terrain contamination based on meteorological forecast due to a continuous release of mixture of radionuclides just after the three hours since the release start. Red squares denote locations of fictitious measuring stations providing measurements for assimilation with the model predictions.

ensemble-based approach with alternative parameterization of physical effects taking place in the atmospheric dispersion. The system offers an extensive interactive graphical user interface for presenting a wide range of outputs important for decision makers. Thus, the system also comprises a simulation and training tool enabling responsible staff to improve their knowledge and perception of the problem details. The HARP code has proved useful in the fields of evaluation of environmental impact assessment (EIA) and probability safety assessment (PSA) studies, where the influence of operation of a nuclear facility on the surrounding environment is appraised.

Advanced data assimilation methods based on Bayesian filtering developed within the grant project are incorporated into the assimilation subsystem. This means that the system offers a framework for the embodiment of relevant information from different sources, such as measurements and expert judgements, in a statistically optimal way. Provided that the system is connected to a monitoring network, it can be run in the online regime, where the subjectively chosen parameters regarding the release scenario (magnitude of release etc) are iteratively re-estimated upon measurements. This assimilation methodology can be also used as a tool to test the different topologies of a monitoring network and select the best one with regard to its functionality and to economical and other constraints.

The HARP system is tuned and tested in cooperation with National Radiation Protection Institute of the Czech Republic in Prague, where the product is connected to a database server providing up-to-date short-term meteorological forecasts on a three-dimensional grid. Exploitation of detailed meteorological data further improves the reliability of the embedded dispersion model.

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Massively Parallel Simulations of Star-Forming Gas Clouds

by Stephen O'Sullivan and Turlough Downes

Many of the stars in our universe form inside vast clouds of magnetized gas known as plasma. The complexity of these clouds is such that astrophysicists wishing to run simulations could comfortably use hundreds of thousands of processors on the most powerful supercomputers. In the past, a serious obstacle to capitalizing on such computational power has been that the methods available for solving the necessary equations were poorly suited to implementation on massively parallel supercomputers.

Background: The Physics of Multifluid Gases

Usually, to study how a plasma behaves when a magnetic field is present, astrophysicists assume a single fluid with the field firmly anchored into it: if the plasma moves then so does the field, and vice versa. This picture makes some intuitive sense since charged particles try to travel along magnetic field lines – this is the principle used in older cathode-ray tube TV sets to direct the electrons onto the phosphor inside the screen.

The single-fluid picture, however, is only approximate. Most real plasmas consist of different families of particles, each of a different size and charge. These families will behave differently when interacting with the same magnetic field and with the rest of the gas. Indeed, many particles in astrophysical plasmas have no charge and so feel no direct effect of the magnetic field at all!

So, in many environments the physics is far richer than the simple single-fluid approximation: electrons, ions, neutral particles and even electrically charged dust grains can move differently. The plasma can no longer be said to act as a single coherent fluid with a tied-in magnetic field. As a consequence, the field may spread and twist in complex ways in response to the differing flows of the different families of particles. Under these circumstances, it becomes necessary to adopt a true multifluid picture of the system.