Chapter 121
flexRISK – Flexible Tools for Assessment of Nuclear Risk in Europe

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Abstract flexRISK studies the geographical distribution of the risk due to severe accidents in nuclear facilities, especially nuclear power plants (NPP) in Europe. Starting with source terms and accident frequencies, the large-scale dispersion of radionuclides in the atmosphere is simulated for about 1,000 meteorological situations. Together with the subsequent calculation of resulting radiation doses the consequences of severe accidents can be estimated. In this contribution, a description of the flexRISK project is provided.

Keywords FLEXPART • Nuclear risk assessment

121.1 Introduction

After a long break in the construction of new nuclear power plants in most countries, since a few years, licensing procedures for new plants have been started in several European countries, and also some developing countries increase their efforts to embark on a nuclear energy path. Also, many aging plants continue to

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D.G. Steyn and S. Trini Castelli (eds.), *Air Pollution Modeling and its Application XXI*, NATO Science for Peace and Security Series C: Environmental Security 4,
DOI 10.1007/978-94-007-1359-8_121,

operate, often with life-time extensions up to 60 years and power uprating. Severe accidents, continue to carry the potential for widespread contamination.

121.2 The flexRISK Project

Considering this context, flexRISK [3] (continuation of the RISKMAP project [5]) aims at studying the geographical distribution in Europe of the consequences of severe accidents in nuclear facilities providing a flexible set of tools, for the present situation as well as foreseeable developments, according to the state-of-the-art knowledge. To achieve this three main work areas have been defined:

121.3 Definition of Source Terms and Accident Frequencies

Source terms and accident frequencies for different reactors or reactor types are defined on the base of available technical literature. For each reactor unit, two representative release scenarios are selected. Where no detailed information is available, generic assumptions are made. For each, the timing of the release, effective release heights, and release fractions for nuclide groups such as noble gases, iodine-caesium, etc. are specified. Source terms and emission inventories are in a tabular form used for the following dispersion and dose calculations.

121.4 Atmospheric Dispersion Modelling

Atmospheric dispersion is simulated for a large number of representative meteorological situations within a 10 year period for the defined scenarios and all nuclear power plant sites in Europe. The latest version of the state-of-the-art transport and dispersion model FLEXPART [7] is applied to produce contamination patterns of the ground and near-surface concentrations of relevant radionuclides. Several preliminary decisions regarding both meteorological data and set-up of the dispersion model have been made:

1. *Meteorological input data*. ERA40 and ERA-Interim datasets from the European Centre for Medium-Range Weather Forecasts (ECMWF) were considered. ERA-Interim has higher horizontal and vertical resolution, better data assimilation and a more recent model system than ERA-40. As washout of radionuclides is very important in such a study, averaged total precipitation obtained from both data sets has been compared with gridded precipitation observations [4]. The total precipitation from the ERA-interim data deviates less from the measurements for an overlapping period of 10 years (from 1990 to 2002) which supports the decision of taking ERA-Interim to drive FLEXPART.

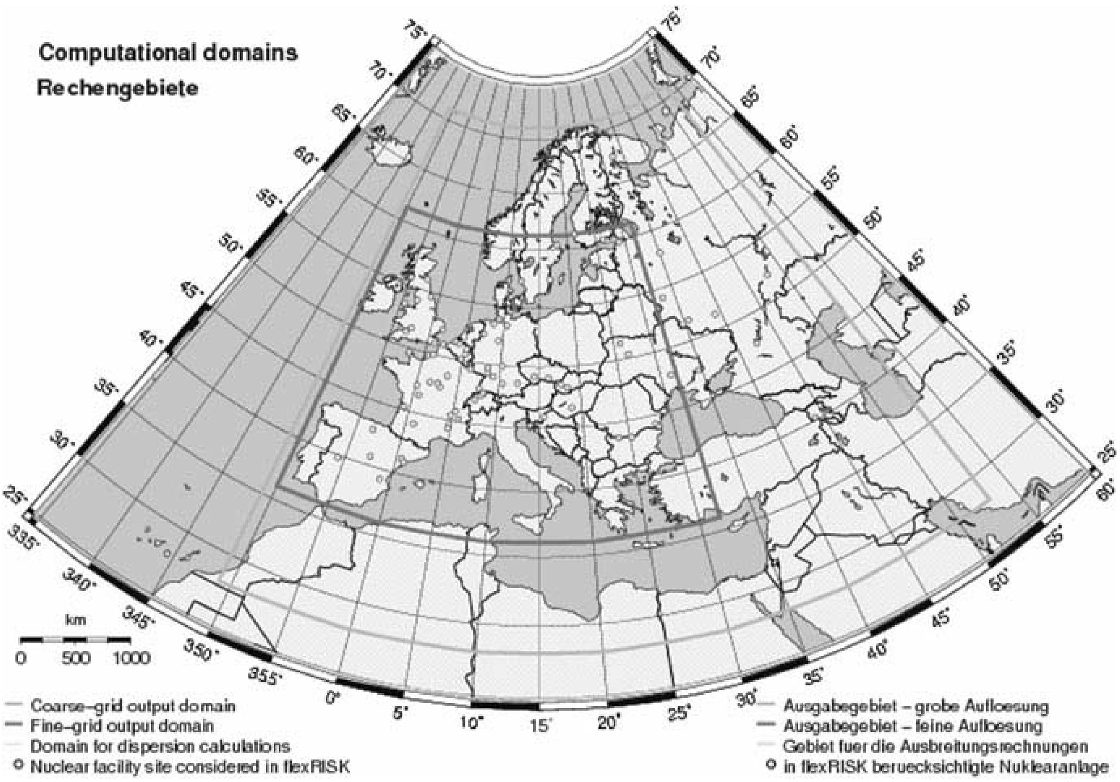

Fig. 121.1 Map with the three domains used in flexRISK. The computational domain (*yellow line*) for the dispersion calculations. The region for evaluation of the results in a 1 × 1° grid (*in orange*), and the smallest domain (*red line*)

2. *Computational domains*. Two domains will be used to collect gridded output (Fig. 121.1). An outer domain with a horizontal resolution of 1°×1° and an inner one covering most of central and western Europe, with a finer horizontal grid size. Both domains will have a common vertical resolution of two layers to allow a more accurate calculation of the dose due to cloudshine.
3. *Computational species*. Two different species of radionuclides will be transported, radionuclides attached to aerosol and noble gases.

Since the large number of FLEXPART runs is computationally expensive and it produces large output the FLEXPART code has been also modified.

121.5 Dose Calculations

Radiation doses will be derived from the dispersion calculations with a dose model, and will be compared with, inter alia, limits of the Austrian intervention regulations. As a first step to define the radionuclides that contribute most (up to 95%) to the dose and thus, to be considered, test runs with the COSYMA [2] code to assess radiological impact have been performed with release scenarios from US EPR final safety report AREVA 2009 [1] and radioactive inventories described in the Germany's radiation protection commission's "Guide for protection in radiological emergencies" [6]. The tests included the most probable early release scenario from AREVA 2009 (Release Category 304) under different stability classes, with and without precipitation, and an unlikely early release scenario but with the maximum activity released (Release Category 802). The output provided the percentage contributions of all major radionuclides to different organ and effective 7-day doses and, in one case, also the 1-year doses at a distance of 28 and 155 km from the release point. These tests have lead to a final set of 15 radionuclides (Ca-134 Ca-136 Ca-137 I-131 I-132 I-133 I-135 Ke-88 Rb-88 Ru-103 Ru-106 Sr-89 SR-91 Te-132 Xe-135) which will be considered.

Acknowledgments flexRISK is funded by the Austrian Climate and Energy Fund in the framework of "NEW ENERGIES 2020". The computational results presented have been achieved [in part] using the Vienna Scientific Cluster (VSC).

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