

International Data Sets for Use in Testing Environmental Transport Models

Assembled by

SENES Oak Ridge, Inc.
Center for Risk Analysis
102 Donner Drive
Oak Ridge, TN 37830
senesor@senes.com
<http://www.senes.com>

This collection includes a number of environmental data sets that have become available through environmental monitoring and dose reconstruction activities at various sites throughout the world. The purpose of the collection is to assure the long-term availability of high-quality data sets for use in development and testing of environmental transport models, especially those used in dose reconstruction activities. The present collection includes data sets previously used in model validation exercises; several additional data sets from the former Soviet Union that have not been previously used in test exercises will be made available at a later date.

Data sets in this collection include contaminant concentrations resulting from major accidental releases such as Chernobyl and from historical short- and long-term releases such as those from the U.S. and Soviet nuclear facilities. Several data sets based on Chernobyl fallout have been the focus of recent international model-testing studies (Table 1), including BIOMOVs (Biospheric Model Validation Study, sponsored by the Swedish Radiation Protection Agency from 1986-1990), BIOMOVs II (sponsored by organizations in Sweden, Canada, and Spain from 1990-1996), VAMP (Validation of Environmental Model Predictions, sponsored by the International Atomic Energy Agency from 1988-1994), and BIOMASS (Biosphere Modelling and Assessment Methods, organized by the International Atomic Energy Agency in 1996). These international studies have provided an opportunity for large-scale, blind testing of assessment models against field data, as well as for intercomparison of results and modeling approaches among investigators from many countries.

A summary of the international data sets available for model testing purposes is provided in Table 2. The summary includes the name of the scenario (data set), a description including the radionuclides and types of data available, and references to published reports and papers describing the data sets or the corresponding model testing exercises carried out with the data sets. Links from the table to the individual data sets will be established as the data sets become available. Each data set includes a summary of the model-testing situation, complete input information, and tables of endpoint data to which model predictions may be compared. Documentation of all measurements and references to published information are included as appropriate.

Table 1. Summary of major international model-testing studies.

Study, duration, and sponsoring organizations	References
<p>BIOMOVS (Biospheric Model Validation Study), 1986-1990</p> <p>Swedish Radiation Protection Institute S-171 16 Stockholm, Sweden</p>	1
<p>BIOMOVS II (Biospheric Model Validation Study, Phase II), 1990-1996</p> <p>Canadian Nuclear Safety Commission (formerly The Atomic Energy Control Board of Canada) P.O. Box 1046, Station B Ottawa, Ontario, K1P 5S9 Canada</p> <p>Atomic Energy of Canada Limited Chalk River Laboratories Chalk River, Ontario, K0J 1J0 Canada</p> <p>Centro de Investigaciones Energéticas Medioambientales y Tecnológicas Avenida Complutense 22 28040 Madrid, Spain</p> <p>Empresa Nacional de Residuos Radiactivos, S.A. Emilio Vargas, 7 28043 Madrid, Spain</p> <p>Swedish Radiation Protection Institute S-171 16 Stockholm, Sweden</p>	2, 3, 4
<p>VAMP (Validation of Environmental Model Predictions), 1988-1994</p> <p>International Atomic Energy Agency Wagramer Strasse 5 P.O. Box 100 A-1400 Vienna, Austria</p>	5
<p>BIOMASS (Biosphere Modelling and Assessment Methods), 1996-2000</p> <p>International Atomic Energy Agency Wagramer Strasse 5 P.O. Box 100 A-1400 Vienna, Austria</p>	6

Table 2. Summary of international data sets available for testing of environmental transport and dose assessment models.

Scenario Name	Description	References
<p>Scenario A1</p> <p>(Aquatic systems in the U.S. and Canada; model testing exercise from the BIOMOVS program)</p>	<p>Mercury in aquatic environments.</p> <p><u>Starting points:</u> Mercury concentrations in water, sediment, invertebrate biota, and fish; descriptions of the environments; mean water quality parameters.</p> <p><u>Endpoints:</u> Mercury concentrations in edible tissues of fish, at specified locations and times.</p>	1, 7
<p>Scenario A4</p> <p>(Deposition and short-term food-chain transport of ^{131}I and ^{137}Cs; model testing exercise from the BIOMOVS program)</p>	<p>Multiple-site scenario using Chernobyl fallout data.</p> <p><u>Starting points:</u> Concentrations of radionuclides in air at 13 locations (Europe, Asia, North America); daily total rainfall during passage of the contaminant plume; background meteorological conditions and agricultural practices.</p> <p><u>Midpoint:</u> Wet, dry, and total deposition of ^{131}I and ^{137}Cs.</p> <p><u>Endpoints:</u> Time-integrated concentrations of ^{131}I and ^{137}Cs in forage and milk; time-integrated concentrations of ^{137}Cs in beef and barley; time-dependent concentrations of radionuclides in forage, milk, and beef.</p>	1, 8, 9, 10
<p>Scenario A5</p> <p>(Lake ecosystems; model testing exercise from the BIOMOVS program)</p>	<p>Chernobyl fallout data for 2 Scandinavian lakes (^{137}Cs); experimental data for a U.S. lake (^{133}Cs).</p> <p><u>Starting points:</u> Amount of ^{137}Cs deposited or ^{133}Cs released; background information on lake conditions.</p> <p><u>Midpoints:</u> Time-dependent concentrations of ^{137}Cs or ^{133}Cs in lake water; time-dependent and time-integrated concentrations of ^{137}Cs or ^{133}Cs in specified sediment layers.</p> <p><u>Endpoint:</u> Time-dependent and time-integrated concentrations of ^{137}Cs or ^{133}Cs in edible tissues of fish species.</p>	1, 11

Table 2 (continued)

Scenario Name	Description	References
Scenario CB (Central Bohemia, Czech Republic; model testing exercise from the VAMP program)	<p>Multiple-pathways scenario based on Chernobyl fallout data.</p> <p><u>Starting point:</u> Concentrations of ^{137}Cs in air and soil in 1986.</p> <p><u>Midpoint:</u> Time-dependent quantities of ^{137}Cs in various types of food and fodder (1986-1989).</p> <p><u>Endpoints:</u> Time-dependent concentrations of ^{137}Cs in the whole body for adult humans (1986-1989); estimates of doses to adult humans from external and internal radiation exposure (1986-1989). (Data for some endpoints are available for 1986-1991.)</p>	12, 13
Scenario S (Southern Finland; model testing exercise from the VAMP program)	<p>Multiple-pathways scenario based on Chernobyl fallout data.</p> <p><u>Starting point:</u> Concentrations of ^{137}Cs in air and soil in 1986.</p> <p><u>Midpoint:</u> Time-dependent quantities of ^{137}Cs in various types of food and fodder (1986-1990).</p> <p><u>Endpoints:</u> Time-dependent concentrations of ^{137}Cs in the whole body for humans (men, women, and children; 1986-1990); estimates of doses to humans from external and internal radiation exposure (1986-1990).</p>	12, 14, 15

Table 2 (continued)

Scenario Name	Description	References
Scenario W (Wash-off scenario; model testing exercise from the BIOMOVs II program)	<p>Wash-off of ^{137}Cs and ^{90}Sr from two experimental plots near the Chernobyl Nuclear Power Plant from heavy rain or from snow melt)</p> <p><u>Starting points:</u> Characteristics of the initial aerial deposition of the radionuclides; data on topography, soil type and characteristics, and time-varying precipitation.</p> <p><u>Midpoint:</u> Vertical distribution of concentrations of exchangeable and nonexchangeable forms of ^{137}Cs and ^{90}Sr in the soil of the experimental plots.</p> <p><u>Endpoints:</u> Concentrations of ^{137}Cs and ^{90}Sr in runoff water from the experimental plots; total amounts of ^{137}Cs and ^{90}Sr removed by runoff from the experimental plots.</p>	2, 16, 17, 18, 19
Scenario CP (Cooling Pond scenario; model testing exercise from the BIOMOVs II program)	<p>Assessment of the consequences of the radioactive contamination of aquatic media and biota.</p> <p><u>Starting points:</u> Characteristics of the cooling pond ecosystem (hydrological, hydrochemical, and hydrobiological conditions); estimated amounts of ^{137}Cs in the Chernobyl cooling pond in 1986; estimated amounts of other radionuclides in the Chernobyl cooling pond, sediment, and biota.</p> <p><u>Endpoints:</u> Concentrations of ^{137}Cs in the cooling pond water, the sediment layers, and fish (total, nonpredators vs. predators, and by age class; 1986-1995); concentrations of other radionuclides in the cooling pond water, the sediment layers, and fish (1986-2000); estimates of dose and risk to humans from hypothetical consumption of contaminated fish from the cooling pond (1986-1988).</p>	2, 17, 20, 21, 22

Table 2 (continued)

Scenario Name	Description	References
Scenario R (Resuspension scenario; model testing exercise from the BIOMOVs II program)	<p>Atmospheric resuspension of radionuclides from contaminated soils.</p> <p>Exposure situations: Locations within the highly contaminated 30-km zone (resuspension dominated by local processes); urban area outside the 30-km zone (local processes include extensive vehicular traffic); rural location outside the 30-km zone (upwind sources of contamination are important).</p> <p><u>Starting points:</u> Characteristics of the ^{137}Cs ground contamination around specific sites at various distances from the Chernobyl NPP site; climatological data for the sites; characteristics of the terrain and topography; locations of sampling sites.</p> <p><u>Endpoints:</u> Calculation of average air concentrations due to resuspension of ^{137}Cs initially released from the Chernobyl reactor, for the specified locations; calculation of specified resuspension factors and rates. (Some data are also available for ^{90}Sr and $^{239+240}\text{Pu}$.)</p>	2, 17, 23, 24, 25
Hanford Scenario (Hanford, Washington; model testing exercise from the BIOMASS program)	<p>Historic release of ^{131}I from the Hanford facility in 1963.</p> <p><u>Starting points:</u> Available measurements of ^{131}I in air, vegetation, and milk; background information for the site.</p> <p><u>Endpoints:</u> Time-dependent and time-integrated concentrations of ^{131}I in air, vegetation, and milk at specified locations; total deposition at specified locations; contour maps of air concentrations and deposition; thyroid burden of two specified children; external and internal doses to humans at specified locations.</p>	26

Table 2 (continued)

Scenario Name	Description	References
Iput River Scenario (Iput River catchment basin, southern Russia; model testing exercise from the BIOMASS program)	Multiple-pathways scenario based on Chernobyl fallout data. <u>Starting points:</u> Concentrations of ^{137}Cs in air, soil, and water in 1986. <u>Midpoint:</u> Time-dependent quantities of ^{137}Cs in various types of food and fodder (1986-1991). <u>Endpoints:</u> Time-dependent concentrations of ^{137}Cs in the whole body for adult humans (men and women; 1986-1991); estimates of doses to adult humans from external and internal radiation exposure (1986-1991). (Data for additional years will be added.)	27

References

- (1) BIOMOVS (Biospheric Model Validation Study). 1993. Final Report. Swedish Radiation Protection Institute, Stockholm, BIOMOVS Technical Report 15.
- (2) BIOMOVS II. 1996. An Overview of the BIOMOVS II Study and its Findings. Stockholm: Swedish Radiation Protection Institute, BIOMOVS II Technical Report No. 17.
- (3) Davis, P.A. 1999. Editorial. *Journal of Environmental Radioactivity* **42**:115-116.
- (4) Davis, P.A., Avadhanula, M.R., Cancio, D., Carboneras, P., Coughtrey, P., Johansson, G., Little, R.H., Smith, G.M., Watkins, B.M. 1999. BIOMOVS II: An international test of the performance of environmental transfer models. *Journal of Environmental Radioactivity* **42**:117-130.
- (5) IAEA and CEC (International Atomic Energy Agency and Commission of the European Communities). 1993. Validation of Environmental Model Predictions (VAMP). A programme for testing and improving biospheric models using data from the Chernobyl fallout. International Atomic Energy Agency, Vienna, STI/PUB/932.
- (6) BIOMASS (The IAEA Programme on Biosphere Modelling and Assessment Methods). 1996. Themes for a New Co-ordinated Research Programme on Environmental Model Testing and Improvement. Theme 1: Radioactive Waste Disposal, Theme 2: Environmental Releases, and Theme 3: Biosphere Processes. International Atomic Energy Agency, Vienna, BIOMASS/G/WD01.
- (7) BIOMOVS (Biospheric Model Validation Study). 1990. Mercury in Aquatic Ecosystems (B.G. Blaylock, ed.). Swedish Radiation Protection Institute, Stockholm, BIOMOVS Technical Report 7, Scenario A1.
- (8) BIOMOVS (Biospheric Model Validation Study). 1991. Multiple Model Testing using Chernobyl Fallout Data of I-131 in Forage and Milk and Cs-137 in Forage, Milk, Beef and Grain (H. Köhler, S.-R. Peterson, and F.O. Hoffman, eds.). Swedish Radiation Protection Institute, Stockholm, BIOMOVS Technical Report 13, Vol. I-II, Scenario A4.
- (9) Hoffman, F.O. 1990. Conclusions of BIOMOVS Phase I. In: BIOMOVS - On the Validity of Environmental Transfer Models. Oct. 8-10, 1990. Stockholm: National Institute of Radiation Protection, pp. 405-411.
- (10) Peterson, S.-R., Hoffman, F.O., and Köhler, H. 1996. The BIOMOVS A4 Scenario: Testing models of the air-pasture-cow milk pathway using Chernobyl fallout data. *Health Physics* **71**:149-159.

- (11) BIOMOVS (Biospheric Model Validation Study). 1990. Dynamics Within Lake Ecosystems (E.B. Sundblad, ed.). Swedish Radiation Protection Institute, Stockholm, BIOMOVS Technical Report 12, Scenario A5.
- (12) Hoffman, F.O., Thiessen, K.M. 1995. Use of Chernobyl data to test predictions and uncertainty estimates from exposure assessment models. In: *Environmental Impact of Radioactive Releases*. Proceedings of an international symposium, Vienna, Austria, 8-12 May 1995. IAEA-SM-339/20. International Atomic Energy Agency, Vienna, pp. 325-336.
- (13) IAEA (International Atomic Energy Agency). 1995. Validation of models using Chernobyl fallout data from the Central Bohemia region of the Czech Republic–Scenario CB. First Report of the VAMP Multiple Pathways Assessment Working Group. International Atomic Energy Agency, Vienna, IAEA-TECDOC-795.
- (14) IAEA (International Atomic Energy Agency). 1996. Validation of models using Chernobyl fallout data from southern Finland–Scenario S. Second Report of the VAMP Multiple Pathways Assessment Working Group. International Atomic Energy Agency, Vienna, IAEA-TECDOC-904.
- (15) Thiessen, K.M., Hoffman, F.O., Rantavaara, A., Hossain, S. 1997. Environmental models undergo international test: The science and art of exposure assessment modeling were tested using real-world data from the Chernobyl accident. *Environmental Science & Technology* **31**(8):358A-363A.
- (16) BIOMOVS II. 1996. Wash-off of Sr-90 and Cs-137 from Two Experimental Plots: Model Testing Using Chernobyl Data. Stockholm: Swedish Radiation Protection Institute, BIOMOVS II Technical Report No. 9.
- (17) Hoffman, F.O., Thiessen, K.M., and Watkins, B. 1996. Opportunities for the testing of environmental transport models using data obtained following the Chernobyl accident. *Health Physics* **70**:5-7.
- (18) Konoplev, A.V., Bulgakov, A.A., Popov, V.E., Popov, O.F., Scherbak, A.V., Shveikin, Yu.V., and Hoffman, F.O. 1996. Model testing using Chernobyl data: I. Wash-off of ⁹⁰Sr and ¹³⁷Cs from two experimental plots established in the vicinity of the Chernobyl reactor. *Health Physics* **70**:8-12.
- (19) Konoplev, A.V., Bulgakov, A.A., Hoffman, F.O., Kanyár, B., Lyashenko, G., Nair, S.K., Popov, A., Raskob, W., Thiessen, K.M., Watkins, B., Zheleznyak, M. 1999. Validation of models of radionuclide wash-off from contaminated watersheds using Chernobyl data. *Journal of Environmental Radioactivity* **42**:131-141.

- (20) BIOMOVS II. 1996. Assessment of the Consequences of the Radioactive Contamination of Aquatic Media and Biota: Model Testing Using Chernobyl Data. Stockholm: Swedish Radiation Protection Institute, BIOMOVS II Technical Report No. 10.
- (21) Kryshev, I.I., Sazykina, T.G., Ryabov, I.N., Chumak, V.K., and Zarubin, O.L. 1996. Model testing using Chernobyl data: II. Assessment of the consequences of the radioactive contamination of the Chernobyl Nuclear Power Plant cooling pond. *Health Physics* **70**:13-17.
- (22) Kryshev, I.I., Sazykina, T.G., Hoffman, F.O., Thiessen, K.M., Blaylock, B.G., Feng, Y., Galeriu, D., Heling, R., Kryshev, A.I., Kononovich, A.L., Watkins, B. 1999. Assessment of the consequences of the radioactive contamination of aquatic media and biota for the Chernobyl NPP cooling pond: Model testing using Chernobyl data. *Journal of Environmental Radioactivity* **42**:143-156.
- (23) BIOMOVS II. 1996. Atmospheric Resuspension of Radionuclides: Model Testing Using Chernobyl Data. Stockholm: Swedish Radiation Protection Institute, BIOMOVS II Technical Report No. 11.
- (24) Garger, E.K., Hoffman, F.O., and Miller, C.W. 1996. Model testing using Chernobyl data: III. Atmospheric resuspension of radionuclides in Ukrainian regions impacted by Chernobyl fallout. *Health Physics* **70**:18-24.
- (25) Garger, E.K., Hoffman, F.O., Thiessen, K.M., Galeriu, D., Kryshev, A.I., Lev, T., Miller, C.W., Nair, S.K., Talerko, N., Watkins, B. 1999. Test of existing mathematical models for atmospheric resuspension of radionuclides. *Journal of Environmental Radioactivity* **42**:157-175.
- (26) BIOMASS (The IAEA Programme on Biosphere Modelling and Assessment Methods). 1999. Model Testing Using Data on Iodine-131 Released from Hanford. BIOMASS Theme 2, Environmental Releases, Dose Reconstruction Working Group. International Atomic Energy Agency, Vienna, BIOMASS/T2DR/WD01.
- (27) BIOMASS (The IAEA Programme on Biosphere Modelling and Assessment Methods). 2000. Model Testing Using Chernobyl Fallout Data from the Iput River Catchment Area, Bryansk Region, Russia: Scenario "Iput." BIOMASS Theme 2, Environmental Releases, Dose Reconstruction Working Group. International Atomic Energy Agency, Vienna, BIOMASS/T2DR/WD02.