short name	name of the model / tool	exposure target	route of exposure	sources of exposure	product class / chemicals / substances	tier / complexity	strengths	limitations	evaluation status	source / reference / download	platform	availability	level of maintenance	owner / developer	language	model input	model structure	model output	tool	model	remarks on model / tool	version available	last update	edited by
ADL AMEM	ADL Polymer Migration Estimation Model (AMEM)	Different Targets	inhalation, dermal	articles			realistic migration rates (note very old - MS DOS)			http://www.epa.gov/oppt/exposure/pubs/amemdl.htm	free				englisch						estimation of the additive originally in the polymer sheet that			
AISE REACT	AISE REACT Consumer Tool	Consumer	inhalation, dermal, oral	Household Products				Based on industry H&P data. Some scenarios are known to be conservative	Europe		https://www.aise.eu/our-activities/product-safety-and-innovation/reach/consumer-safety-exposure-assessment.aspx	Excel spreadsheet	free			english	Quantitative values	linear equations	Quantitative values	yes	yes		1	2010	NvG
APEX	Air Pollutants Exposure Model	Humans	inhalation	outdoor, indoor, in-vehicle	air pollutants	Tier 3	Realistic and flexible. Enables modelling of vulnerable populations within the bulk population	Does not consider interactions between modelled pollutants; Modelling domain size roughly a large city's metropolitan area; default input files parameterized for the US	Johnson et al., 2018: https://doi.org/10.1080/23311843.2018.1453022	https://www.epa.gov/fera/human-exposure-modeling-air-pollutants-exposure-model	Windows-based executable	free	active	United States Environmental Protection Agency (EPA)	English	quantitative values, distributions		quantitative values, distributions	yes	yes	Some defaults based on US data, but model fully customizable to a non-US-based location. Used for setting air quality standards for air pollutants	5,2		NvG
BROWSE model	see sheet "Worker"	Worker, general population	inhalation, dermal, oral	Plant protection products, pesticides																				
Calendex	Calendex	General population	inhalation, dermal, oral	food, drinking water, environmental exposure	pesticides and other chemicals	Tier 3		US		Benchmarking with other models available.	https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/deem-fcidcalendex-software-installer		free		US-EPA/ Exponent	english							10		NvG
CARES	CARES	Consumer	inhalation, dermal, oral		pesticides, single/aggregate/cumulative	Tier 1, 2 and 3		US		Benchmarking with other models available.	https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/models-pesticide-risk-assessment		free		US-EPA	english						older Version of CARES NG			NvG

Name	Full name	User	Routes	Products/materials		Tier	Description		Benchmarking	URL	Software	Cost	Status	Developer	Language	Input	Method	Output			Notes	Version	Year	By
CARES NG	Creme Cumulative and Aggregate Risk Evaluation System Next Generation (CARES NG)	Consumer	oral		Pesticides					https://www.cremeglobal.com/products/cares-ng		Commercial software	active	Creme Global	english	quantitative values, distributions		quantitative vaues, distributions			based on CARES (free software)			NvG
CEM	Consumer Exposure Model	Consumer	inhalation, dermal, oral	products/materials in the indoor environment						https://www.epa.gov/tsca-screening-tools/cem-consumer-exposure-model-download-and-install-instructions	Microsoft Access and Visual Basic for Applications (VBA)	free		US-EPA	english							2,1		NvG
Chesar		Consumer	inhalation, dermal, oral							https://chesar.echa.europa.eu/		free		European Chemicals Agency (ECHA)					yes	no	based on Ecetoc TRA	3,6	2021	NvG
ConsExpo	ConsExpo / ConsExpo web	Consumer	inhalation, dermal, oral	Consumer products, e.g. paint, cleaning agents, personal care product; vapour and particulates		Tier 2	Data and scenarios can be saved. Fore specific scenarios, necessary parameters can be extracted from ConsExpo fact sheets, which have recently been updated by a consortium.	Comparatively many parameters. For some parameters, default values given	Benchmarking with other models available. Some modules tested against experimental data, e.g. the spray module (Delmaar & Bremmer, 2009, RIVM rapport 320104005) and the PC&P module used by PACEM (Dudzina et	https://www.rivm.nl/en/Topics/C/ConsExpo https://www.rivm.nl/en/Documents_and_publications/Scientific/Reports/2016/december/ConsExpo_Web_Consumer_exposure_models_Model_documentation	web-based	free	Active – several versions, continuous updates available from RIVM (NL) webpage	Dutch National Institute for Public Health and the Environment (RIVM)	english	Quantitative values	Differential equations based on physical-chemical laws	Quantitative values	yes	yes		4,1	2016	NvG
Creme Care & Cosmetics	Creme Care & Cosmetics	Consumer	inhalation, dermal, oral	Personal care and cosmetic products	cosmetic ingredients	Tier 2 & 3				https://www.cremeglobal.com/products/creme-care-cosmetics		Commerical software	active	Creme Global	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions			Page not found			NvG
Creme Food Safety	Creme Food Safety	Consumer	oral	Food	Food constituents and ingredients	Tier 3	Probabilistic model based on food consumption surveys. Regulator Acceptance. Scenario Analysis with detailed statistical analysis			https://www.cremeglobal.com/products/creme-food-safety		Commercial software	active	Creme Global	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions	yes	yes				NvG

Creme Nutrition	Creme Nutrition	Consumer	oral	Food	nutrients	Tier 3	Probabilistic model based on European food consumption data. Full distribution of intake broken down by foods or groups of foods.			https://www.cremeglobal.com/creme-nutrition/		Commercial software		Creme Global	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions	yes	yes				NvG
Creme RIFM	Creme RIFM	Consumer	inhalation, dermal, oral	personal care and cosmetic products	Fragrance compounds	Tier 2 & 3	Probabilistic, individual-based model, based on population use data			https://www.cremeglobal.com/products/creme-rifm		Commerical software on cloud-based platform.	active	Creme Global	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions	yes	yes				NvG
DEEM-FCID	Dietary Exposure Evaluation Model - Food Commodity Intake Database	General population	oral	Food	pesticides	Tier 1 and 2		US		https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/deem-fcidcalendex-software-installer		free			english							4,02		NvG
DIAMOND	DIAMOND	Consumer	oral	Food	pesticides, nutrients, contaminants, food additives and food ingredients	unknown		Australia and New Zealand		https://www.foodstandards.gov.au/science/exposure/Pages/fsanzdietaryexposure4439.aspx		restricted use	old model, under re-evaluation	Food Standards Australia New Zealand (FSANZ)	english									NvG
DustEx	DustEx tool	Consumer	inhalation, dermal, oral	Consumer products via the indoor environment (dust, air)	Semi-volatile organic compounds (SVOCs)	Tier 2				https://www.dustex.nl/	web-based	free	active	RIVM	english				yes	yes		1	2017	NvG
dynamiCROP	dynamiCROP: dynamic assessment model for human health impacts due to CRop uptake of Organic Pollutants	Consumer	ingestion	Food	organic contaminants	screening level, quantitative, dynamic analysis of chemical residues in food crops; includes Monte Carlo uncertainty analysis	accounts for dynamics of chemicals in plant-environment system until crop harvest; considers parameterizations for various food and feed crops		Crop residue estimates evaluated for different food crops against measured residue data	http://dynamicrop.org	Excel spreadsheet, coupled to Matlab and Python for ODE solvers	free	active	Technical University of Denmark (DTU)	english	Quantitative values	Differential equations based on physical-chemical laws, structured in matrices (e.g. for rate constants) and vectors (e.g. initial mass conditions)	quantitative values	yes	yes	Included as parameterized version for 6 crop archetypes in the UNEP-SETAC global scientific consensus model USEtox; version for LCA available	3,12	2021	
EASY-TRA	see sheet "Worker"	Consumer, worker, environment	inhalation, dermal, oral		several																			

Tool	Full name	Target	Routes	Products	Substances	Level/Tier	Strengths	Limitations	Validation	Link	Software	Cost	Activity	Developer	Language							Version	Year	
Ecetoc TRA	Ecetoc TRA	Consumer (also modules for workers and environment available)	inhalation, dermal, oral	consumer products		Tier 1, 1.5, 2	Widely accepted in European regulation, large variety of product applications covered	Gases and fibres out of scope, not directly applicable to molten solids used at elevated temperature. Inhalation exposure to liquid aerosols not covered. For spray processes using liquids, only vapour exposure estimated.	several validation studies, e.g. ETEAM + peer-review studies to explore the validity (reliability) of the exposure estimates	https://www.ecetoc.org/tools/targeted-risk-assessment-tra/	Excel spreadsheet	free		CEFIC, Ecetoc		Quantitative values	linear equations	Quantitative values				3,1	2014	NvG
E-FAST	E-FAST (Exposure and Fate Assessment Tool)	Consumer	inhalation, dermal, oral	Vapor and particulates			built-in examples. Considers essentially all major routes of exposure Model can incorporate different environments indoor (residence, office, school, or automobile) and outdoor Model can estimate parameters	Many parameters needed, but most can be estimated within the model or using EpiSuite.	consumer exposure portions of E-FAST have been peer reviewed by experts outside EPA	https://www.epa.gov/tsca-screening-tools/e-fast-exposure-and-fate-assessment-screening-tool-version-2014	Access	free		US-EPA - Office of Pollution Prevention and Toxics	english				yes	yes		2	2014	NvG
EPA ExpoBox	US EPA Exposure tool box	Different Targets, Overview platform	inhalation, dermal, oral		chemicals					https://www.epa.gov/expobox https://cfpub.epa.gov/ncea/risk/expobox/efhToolSearch.cfm			active	United States Environmental Protection Agency (EPA)	english						Continuously updated			
ESIG EGRET	ESIG EGRET Consumer Exposure Tool (GES/CSA tool)	Consumer	inhalation, dermal	Household Products, solvents		conservative			http://www.nature.com/jes/journal/v24/n1/full/jes2012128a.html	https://www.esig.org/reach-ges/consumers/		free		European Solvents Industry Group (ESIG)	english							2,1	2017	NvG
EUSES	European Union System Evaluation Substances	General population, environment	inhalation, oral, environmental compartments (water, wastewater)		chemicals	screening level	multi-compartment calculations, consideration of all uses of a substance within the assessment (regional / continental environmental concentrations)	Currently not applicable for anorganic substances, nanomaterials, substances that are ionisable under environmental conditions. Does not take into account sector-specific RRMs.		https://echa.europa.eu/de/support/dossier-submission-tools/download-euses		free		RIVM and European Commision	englisch							2.1.2		NvG

ExpoCast	ExpoCast: Exposure Science for Prioritization and Toxicity Testing	General population	inhalation, dermal, oral		Environmental pollutants		Tool that combines Near-field (SHEDS) and Far-field (RAIDAR) models		https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=211811		free	active	United States Environmental Protection Agency (EPA)										NvG
FACET	FACET	General population	oral	Aggregate and single product flavours, additives and food contact materials		Tier 3		based on EU registrations and legislation	https://ec.europa.eu/jrc/en/scientific-tool/flavourings-additives-and-food-contact-materials-exposure-tool		free		JRC	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions				3.0.2		NvG
FAIM	Food Enzyme Intake Model	General population	oral	Aggregate and single product		Tier 1	comprises process-specific calculators for food processing	based on EU registrations and legislation	https://zenodo.org/record/154725#.YGXgGGixXOQ	Excel spreadsheet	free		EFSA	english				yes	yes		1,1	2013	NvG
FHX model	FHX (Far-field Human eXposure) model	General population	inhalation, dermal, oral		organic chemicals	Screening			https://arnotresearch.com/fhx/		Free, registration needed	complete	ARC Arnot Research	englisch									NvG
ICECRM	The Indoor Chemical Exposure Classification/Ranking Model	General population	topical, inhalation, oral (non dietary exposure)	indoor multimedia			realistic concentrations		https://arnotresearch.com/ICECRM/	The ICECRM model is implemented (coded) in Visual Basic for Applications (VBA) and the Graphical User Interface is designed in Excel™.	free	active	ARC	english									NvG
INTERA	INTERA	Consumer	inhalation, dermal, oral	articles		realistic, including uncertainty analysis			http://www.intera-home.eu/		Free, registration needed		Consortium	english									NvG
iRISK	iRISK	Consumer	oral	Food	chemicals and pathogens	Tier 1 and 2			https://irisk.foodrisk.org/		free		Food and Drugs Agency (FDA)	english	quantitative values, distributions	Monte Carlo simulations, also 2D	quantitative values, distributions	yes			4,2		NvG
MCCEM	MCCEM	Consumer	inhalation	released from articles	environmetal /indoor air				http://www.epa.gov/opptintr/exposure/pubs/mccem.htm		free			english						calculated as single day doses, chronic average daily doses, or lifetime average daily doses			

						Tier	Description	Validated	Application	URL	Cost	Status	Developer	Language	Input	Model	Output			Version	Year	
MCRA tool	Monte Carlo Risk Assessment tool	General population	oral	Food		Tier 3	Probabilistic model based on European food consumption data. Full distribution of intake broken down by foods or groups of foods.			https://mcra.rivm.nl	Free, registration needed	active	RIVM/Rikilt	english	quantitative values, distributions	Monte Carlo simulations, also 2D	quantitative values, distributions	yes	yes		9	NvG
Merlin-Expo tool	**M**odelling **E**xposure to chemicals for **R**isk assessment: a comprehensive **L**ibrary of multimedia and PBPK models for **I**ntegration, u**N**certainty and sensitivity analysis	General population	inhalation, dermal, oral	Environmental sources	Environmental pollutants		Allows lifetime risk assessments (rather than just simple daily intakes) for different human populations including exposure through multiple pathways			https://merlin-expo.eu/	free	active	EU	english								NvG
MOEEBIUS	MOEEBIUS	Enegry optimization and air quality	inhalation	activities with chemicals	vapour, particles	Tier 1 to 2 (depends on parametrisation)		Validated (single compartment model)	Application	https://www.moeebius.eu/	free	active	AIHA's Exposure Assessment Strategies Committee (EASC)	English	quantitative values, distributions	Differential equations based on physical-chemical laws	Quantitative values	No	yes		2017	JK
NanoRiskCat / Nano-Database	see sheet "Worker"	Consumer, worker	Oral, dermal, inhalation		Nano specific		generic in nature and can be used on all kinds of nanomaterials and applications															
NanoRiskCat / Nano-Database	see sheet "Worker"	Consumer, worker	Oral, dermal, inhalation		Nano specific	generic in nature	can be used on all kinds of nano materials and applications															
PACEM	Probabilistic Aggregate Consumer Exposure Model	Consumer	inhalation, dermal, oral	Cosmetics and personal care products; household cleaning products		Tier 2 & 3	Probabilistic, individual-based model, based on population use data		R-Shiny	https://zenodo.org/deposit/1475191.	free R-Shiny beta version available, free web-version under development		Gosens et al. (2014), Delmaar et al. (2014), Dudzina et al. (2015), Karrer et al. (2019)	english	quantitative values, distributions	Monte Carlo simulations	quantitative values, distributions	no	yes	beta	2019	NvG

Name	Full Name	Population	Routes	Emissions/Releases	Chemicals	Level/Type	Applicability	Resolution/Scale	Model Description	Link	Software	Access	Status	Institution	Language	Input	Equations	Output			Recommendation	Version	Date	
Pangea	Pangea	General population	inhalation, oral	industrial releases, agricultural applications	organic chemicals	screening level, quantitative, geospatialized analysis	global applicability; can be adapted to any spatial region and resolution; only model for chemical pollution that provides a flexible spatial grid resolution with global coverage	maximum resolution is limited to scales for which 2nd order processes can be neglected	Spatial model output evaluated in case studies against measured environmental concentrations; Underlying processes based on USEtox, and with that evaluated via several in-depth model comparisons between 2002-2008	http://www.pangea-model.org	Matlab (math engine), ArcGIS (geospatialization engine), Python (processing engine)	only accessible by model owners	active	Technical University of Denmark (DTU)	english	Quantitative values	Differential equations based on physical-chemical laws, structured in matrices (e.g. for rate constants) and vectors (e.g. emission sources)	Quantitative values	yes	yes	Enviornmental and exposure processes entirely based on UNEP-SETAC global consensus model USEtox	2.0	10/19	
PiF Model	Product Intake Fraction (PiF) Model	Consumer	inhalation, dermal, oral	direct indoor/outdoor emissions, industrial releases	organic chemicals, chemicals in consumer products	quantitative; builds on dynamic solutions of direct consumer exposure	global applicability; parameterized for situations where specific household or other exposure settings are unknown; steady-state, but underlying product models are dynamic	Steady-state solution for overall mass balance	Framework based on several modules for products and indoor exposure that have all been evaluated against measurement data	http://doi.org/10.1016/j.envint.2016.06.010	Excel spreadsheet (underlying product models implemented in Excel or Matlab)	free	active (as implemented in USEtox 3.x)	Technical University of Denmark (DTU)	english	Quantitative values	Differential equations based on physical-chemical laws, structured in matrices (e.g. for rate constants) and vectors (e.g. sources)	Quantitative values	yes	yes	Recommended by UNEP-SETAC Life Cycle Initiative for use in LCA and comparative risk screening	1.0	10/17	
PRIMo	Pesticide Residue Intake Model	General population	oral		pesticides, single product only	Tier 1		EU		https://www.efsa.europa.eu/en/applications/pesticides/tools	Excel spreadsheet with Macros	free		EFSA	english	Quantitative values		Quantitative values	yes	yes		3,1	2018	NvG
RAIDAR	Risk Assessment IDentification And Ranking (RAIDAR) model	General population, environment	inhalation, oral		Organic chemicals	Prioritization and screening-level assessments	High-throughput exposure and risk estimation	Regional scale, evaluative enviroment	Arnot, J. A. et al. ES&T, 2006, 40, (7), 2316-2323; Arnot et al. EHP, 2012, 120, (11), 1565-1570.	https://arnotresearch.com/RAIDAR/	Excel/VBA	free, registration needed	active	ARC Arnot Research and Consulting Inc.	english				yes	yes		2,02	2014	NvG

Name	Description	Population	Route	Application	Substances	Concentration	Assessment	Applicability	Reference	Link	Platform	Access	Status	Developer	Language	Input	Output	...	...	...	Version	Notes	Contributor
RAIDAR-ICE	Risk Assessment IDentification and Ranking – Indoor and Consumer Exposure (RAIDAR-ICE) Model	General population	inhalation, topical/ dermal, oral	near field direct and indirect exposure	neutral organic chemicals	realistic concentrations Prioritization and screening-level assessments	High-throughput and screening-level exposure and risk estimation	Currently applicable for discrete neutral organic chemicals	Li, L.; Westgate, J. N.; Hughes, L.; Zhang, X.; Givehchi, B.; Toose, L.; Armitage, J. M.; Wania, F.; Egeghy, P.; Arnot, J. A. Environ. Sci. Technol. 2018, 52, (24), 14235-14244.	https://arnotresearch.com/RAIDAR-ICE/	online Excel/VBA	free, registration needed	active	ARC Arnot Research and Consulting Inc.	english			yes				RAIDAR-ICE is part of the US EPA's ExpoCast System for the Empirical Evaluation of Models (SEEMS) human exposure framework	NvG
RIFM 2-Box	RIFM 2-Box Indoor Air Dispersion Model	Consumer	inhalation	Cosmetics and personal care products		Tier 1 or 2				https://www.rifm.org/rifm-science-assessment-tools.php#gsc.tab=0		restricted use, RIFM database subscription needed										NvG
RIVM Emission tool	RIVM Emission tool	Consumer	inhalation	articles		realistic air concentrations				www.consexpo.com		free				english							NvG
SHEDS-HT	SHEDS-high throughput	General population	inhalation, dermal, oral			screening level				https://www.epa.gov/chemical-research/stochastic-human-exposure-and-dose-simulation-sheds-estimate-human-exposure	SAS 9.1 or higher	free, registration needed	active	United States Environmental Protection Agency (EPA)	english	quantitative values, distributions	quantitative values, distributions	yes	yes		beta		NvG
SHEDS-Multimedia	Stochastic Human Exposure and Dose Simulation (SHEDS) model	General population	inhalation, dermal, oral	Food, residential exposures		screening level, Tier 2 & 3				https://www.epa.gov/chemical-research/stochastic-human-exposure-and-dose-simulation-sheds-estimate-human-exposure	SAS 9.1 or higher	free, registration needed	active	United States Environmental Protection Agency (EPA)	english	quantitative values, distributions	quantitative values, distributions	yes	yes		v3		NvG
SprayExpo	see sheet "Worker"	Consumer		Biocides	Biocidal substances																		
SWIMODEL	SWIMODEL	General population	oral, dermal, inhalation, buccal/sublingual, nasal/orbital, aural	water indoor swimming pools and spas	biocides, pesticides					https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/swimmer-exposure-assessment-model-swimodel	excel spreadsheet	free			english								NvG

| USEtox | The UNEP-SETAC scientific consensus model for characterizing human and ecotoxicological impacts of chemical emissions in life cycle assessment | General population, consumers, specific population groups (e.g. children) | inhalation, dermal, oral | global applicability; parameterized for situations where emission locations are unknown, and parameterized (sub-)continental regions | organic chemicals and metal ions, industrial releases, agricultural emissions | screening level | steady-state and dynamic version available, far-field and near-field exposure modules | global parameterization model with limited applicability to local situations | Evaluated via several in-depth model comparisons between 2002 and 2008 | https://usetox.org | Excel spreadsheet and Matlab version (for internal use) | free | active | USEtox International Centre hosted at the Technical University of Denmark (DTU) | englisch | Reference model in life cycle impact assessment and environmental footprinting | Differential equations based on physical-chemical laws, structured in matrices (e.g. for rate constants) | impact characterization factors including fate, exposure, and effect factors | yes | yes | Endorsed by UNEP-SETAC Life Cycle Initiative for use in LCA and comparative risk screening; recommended by EU (ILCD) and US-EPA (TRACI) | v2.12, v3beta | 03/22 | |