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Overview of existing issues with regard to technical factors, PPE and work wear, and their impact on exposure

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Introduction

Focus of presentation is to present overview of work carried out on PPE and technical controls at TNO in past recent years (within aims of project)

Not exhaustive and does not cover important work carried out by others

Focus on exposure modelling

Why?

PPE and technical controls important way to reduce exposure to PPPs or other chemicals

If used properly and under correct circumstances

PPE and work wear

PPE and work wear - Background and aim

- BROWSE: Bystanders, Residents, Operators and Workers Exposure models, EU 7th framework project
  - One of the key factors that influences (actual) exposure is use of personal protective equipment (PPE) and work wear by operators and workers.
  - Since use of PPE and work wear is considered as an important risk management measure (RMM), this issue was considered in more detail in order to come up with a practical approach on how to deal with this in the BROWSE exposure models.

- Outcome → PPE and work wear efficacy values

Review papers

- Starting point: Gerritsen-Ebben MG, Brouwer DH, van Hemmen JJ. Personal protective equipment for registration purposes of pesticides. Commun. Agric. Appl. Biol. Sci. 2007; 72 (2): 87-93
  (or TNO report V7333 + Addendum by Joop van Hemmen)

PPE / clothing	Operators	Workers
Single layer of uncoated clothing or coveralls	90%	80%
Gloves	90% liquids 95% solids	Only considered in very specific circumstances

Review papers - Search terms and databases

Search terms		Databases
pestic* OR bioci* OR microbicid* or antibact* or disinfectant*		MEDLINE(R) 1990-to date
personal adj protect*	efficie*	CAB Abstracts 1972- to date
protect* adj equip*	comfort*	AGRICOLA 1970- to date
protect* adj cloth*	performance*	AGRIS 1974- to date
protect* adj respirat*	default*	Biosis Previews(R) 1926- to date
respirator*	effect*	ToxFile 1965- to date
breathing adj apparatus	occup*	Enviroline(R) 1975-May 2008
PPE*	expo*	Environmental Sciences 1966- to date
RPE*	glove*	Pollution Abstracts 1966-to date
	clothi*	SciSearch(R) Cited Ref Sci 1990- to date
	respi*	SciSearch(R) Cited Ref Sci 1974-Dec 1989

Review papers - Results literature search

- Result search: 550 titles with abstracts period 2006-2012 → Evaluated for relevance based on abstract → 83 relevant papers identified

Study type	N
Survey on PPE use	52
Field study (exposure)	16
Biomonitoring	8
Laboratory penetration tests	4
Intervention study	3
Other (review, descriptive)	7

Review papers - Exposure reduction

Reference	Type PPE	Exposure reduction
Coble, 2011	Chemically resistant gloves	60%
Espanhol, 2012	Coverall with water repellent	>82%
Glass, SMT project	Coveralls (cottons and Tyveks)	58 - 100%
Machera, 2009	Coveralls (with and without water repellent)	96.7 - 99.6%
Mathers, 2006	Coveralls	40 - 100%
Moreira, 1999	Cotton coverall	99.5%
Protano, 2009	Full face mask, Tyvek coverall, boots, gloves Cotton garments	>97% 84 - 93%

Review papers - Exposure reduction

Reference	Type PPE	Exposure reduction
Shaw, 2008	Coverall with and without repellent finish	82 - 94%
Tacio, 2008	Agro light set and Azeredo set	96.2 - 96.7%
Tacio, 2010	Agro light set and Kit Tratorizado	92.8 - 94.2%
Tsariakis, 2010	Coverall with and without nano water repellent	97.3 - >99%
Tsariakis, 2011	Coverall with and without nano water repellent	97.5 - >99%
Vitali, 2009	Cotton clothing Tyvek	89.8% 97.6%

Review papers - conclusions

- Most papers on use surveys
- Limited amount papers with exposure reduction values
- Although lot of papers from outside EU, the use surveys show that the use of PPE and work wear by farmers can't be taken for granted
- Intervention studies aimed at training and awareness show that use of PPE can be improved and increased

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Surveys on use PPE

- Info from surveys carried out in framework EFSA and BROWSE

- EFSA:
- UK: Arable Crops, soft fruit
- Belgium: Greenhouse ornamentals, outdoor vegetables
- Spain: Greenhouse fruiting vegetables
- Greece: Greenhouse fruiting vegetables, arable (cotton/maize)
- Poland: Arable (wheat), orchard (apple)
- Italy: Vineyards (wine grapes)

- unique dataset, 428 farms, 581 operators, 749 sprayers, 481 workers, 17,058 rows of PPP operator data, 10,237 rows of worker data

Surveys on use PPE

- BROWSE:

- With regard to operators, 3 scenarios were included in the survey:
- Arable: In total 50 observations in UK, of which 19 questionnaire during interview, and 31 web survey
- Orchards: In total 52 observations, 27 in Greece and 25 in Italy, all questionnaire during interview
- Greenhouses: In total 41 observations, 25 in Greece and 16 in Italy , all questionnaire during interview

- Indication due to limited nr of operators and countries included and large variation in results

Surveys on use PPE

- Main results of surveys:

- Lot of variation in types of PPE and work wear used
- Use of PPE and work wear relatively low at least for some scenarios

- *Glass R, Garthwaite D, Pote A, et al. Collection and assessment of data relevant for non-dietary cumulative exposure to pesticides and proposal for conceptual approaches for non-dietary cumulative exposure assessment. External scientific report CFT/EFSA/PPR/2010/04. Supporting publications 2012:EN-346.*

Data analysis available exposure data - Migration

- BROWSE database (operator and worker, PPE terminology adapted → difficult with limited information)
- Southern Greenhouse database (ECPA)
- BfR Database: whole body garment analysis only

- Migration is actual exposure as a proportion of potential exposure

- Comparable sampling methods

- Analysis per body part and whole body garment

Data analysis - Dermal sampling methods

Body - Sampling method	# *
Surrogate technique – pads/patches	1120 (1120 / -)
Surrogate technique – whole body	2226 (1078 / 1148)
Missing	178 (- / 178)

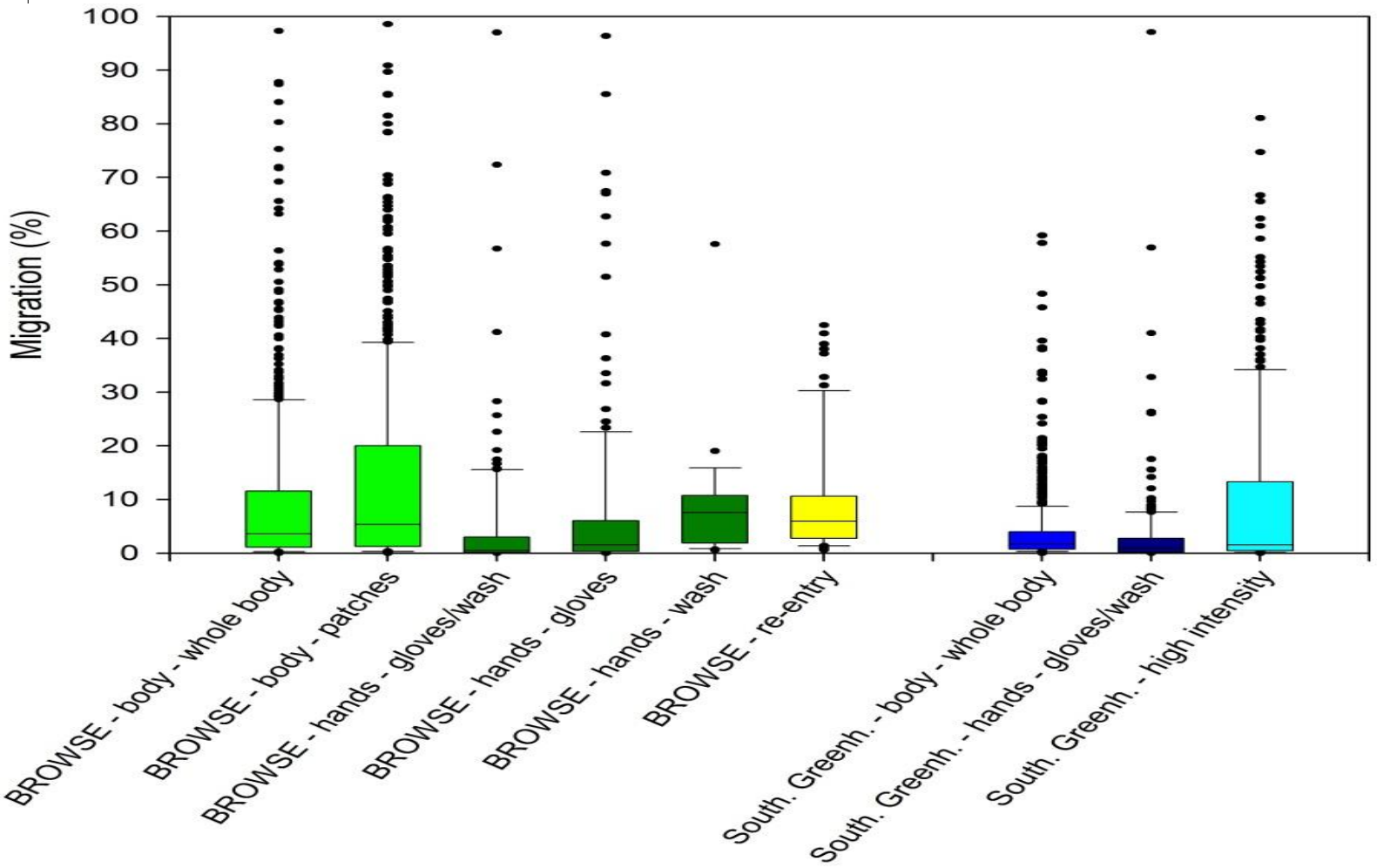
Hands - Sampling method	# *
Removal techniques – washing	29 (29 / -)
Surrogate technique – gloves	162 (162 / -)
Surrogate technique – gloves / Removal techniques – washing	383 (126 / 257)

* #= Number of individual body parts for which data is available
(BROWSE database / Southern Greenhouse model)

Data analysis - Statistics

- Migration will depend on factors difficult to take into account in all cases, for example:
  - Magnitude of PDE (loading of PPE)
  - Distribution of loading over the PPE
  - Age/use history/laundering of the PPE
  - Physical-chemical properties of the pesticide/chemical/tracer
  - Type of contact between PPE and contaminated surface
  - Duration of exposure (study)
  - Environmental conditions
  - Task performed

Migration – individual body parts, database and measurement method



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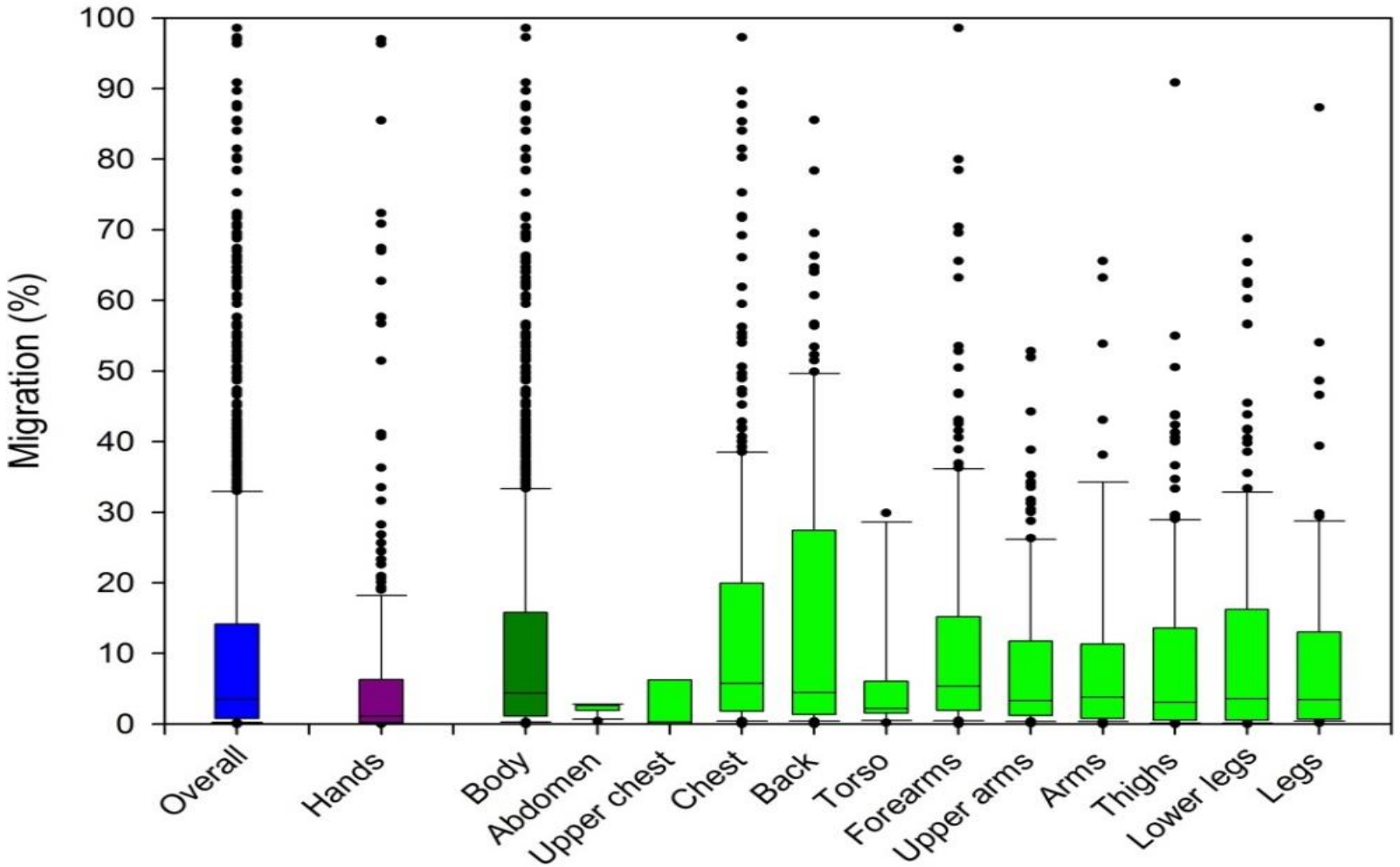
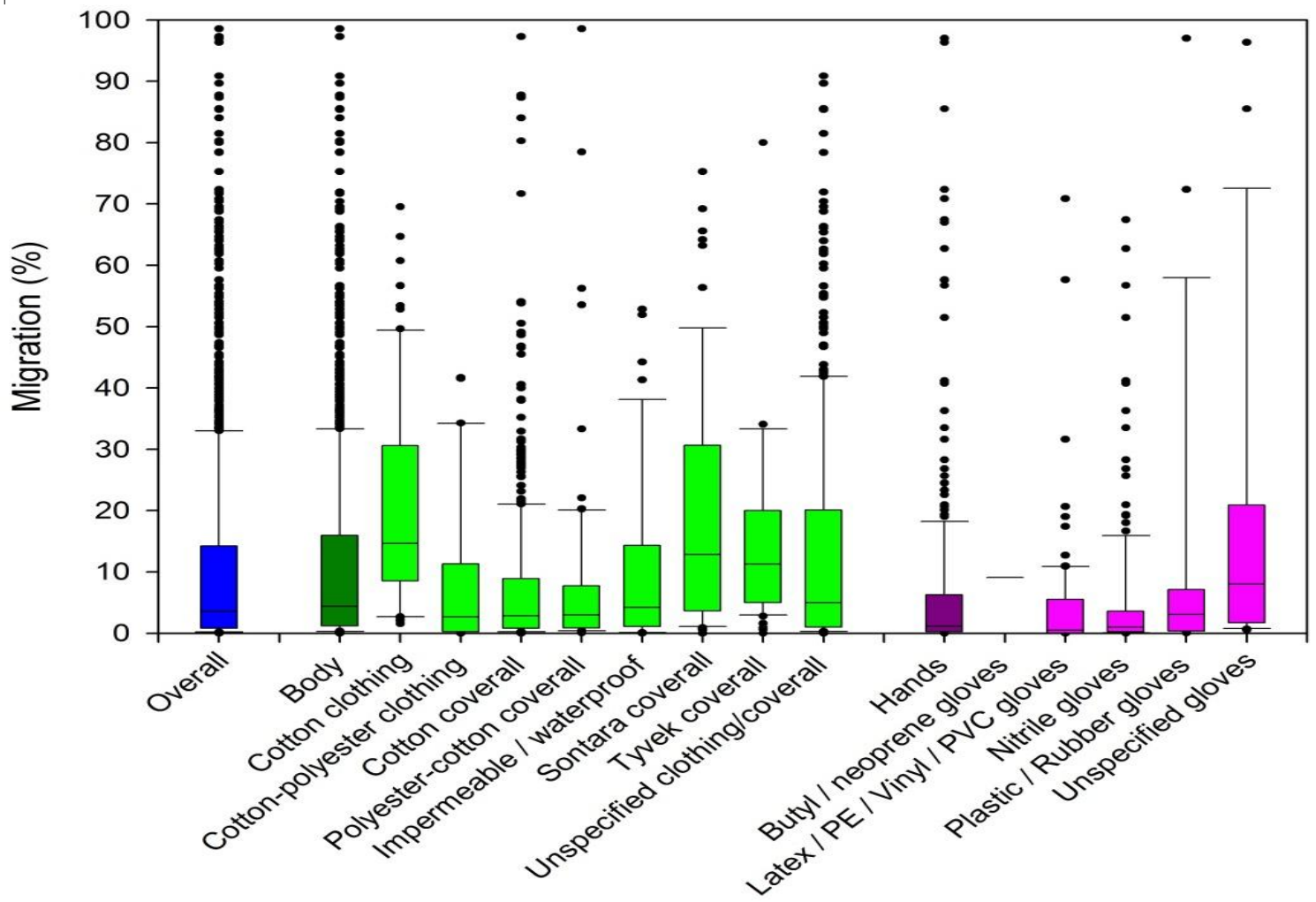
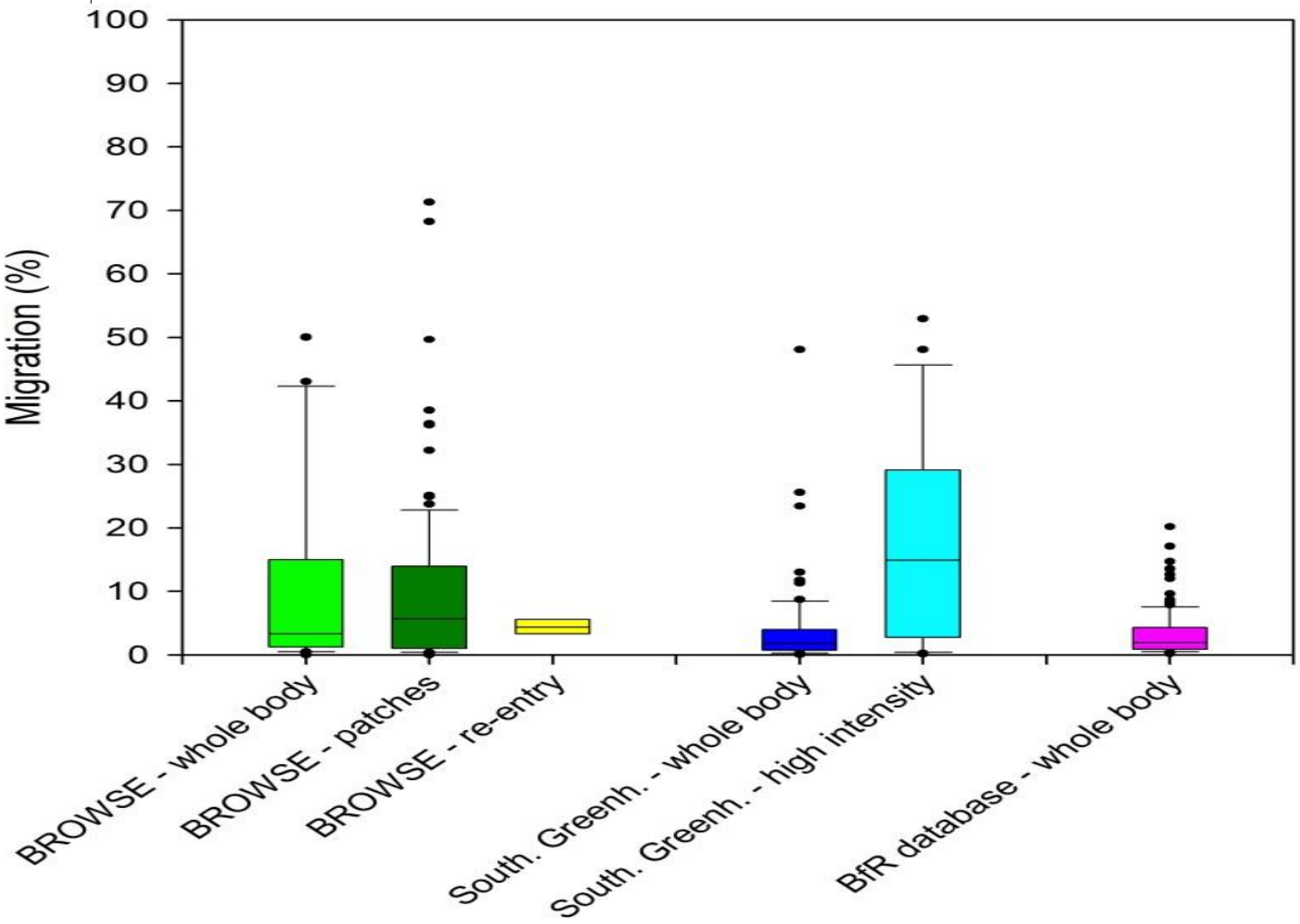
Databases combined - Per body part



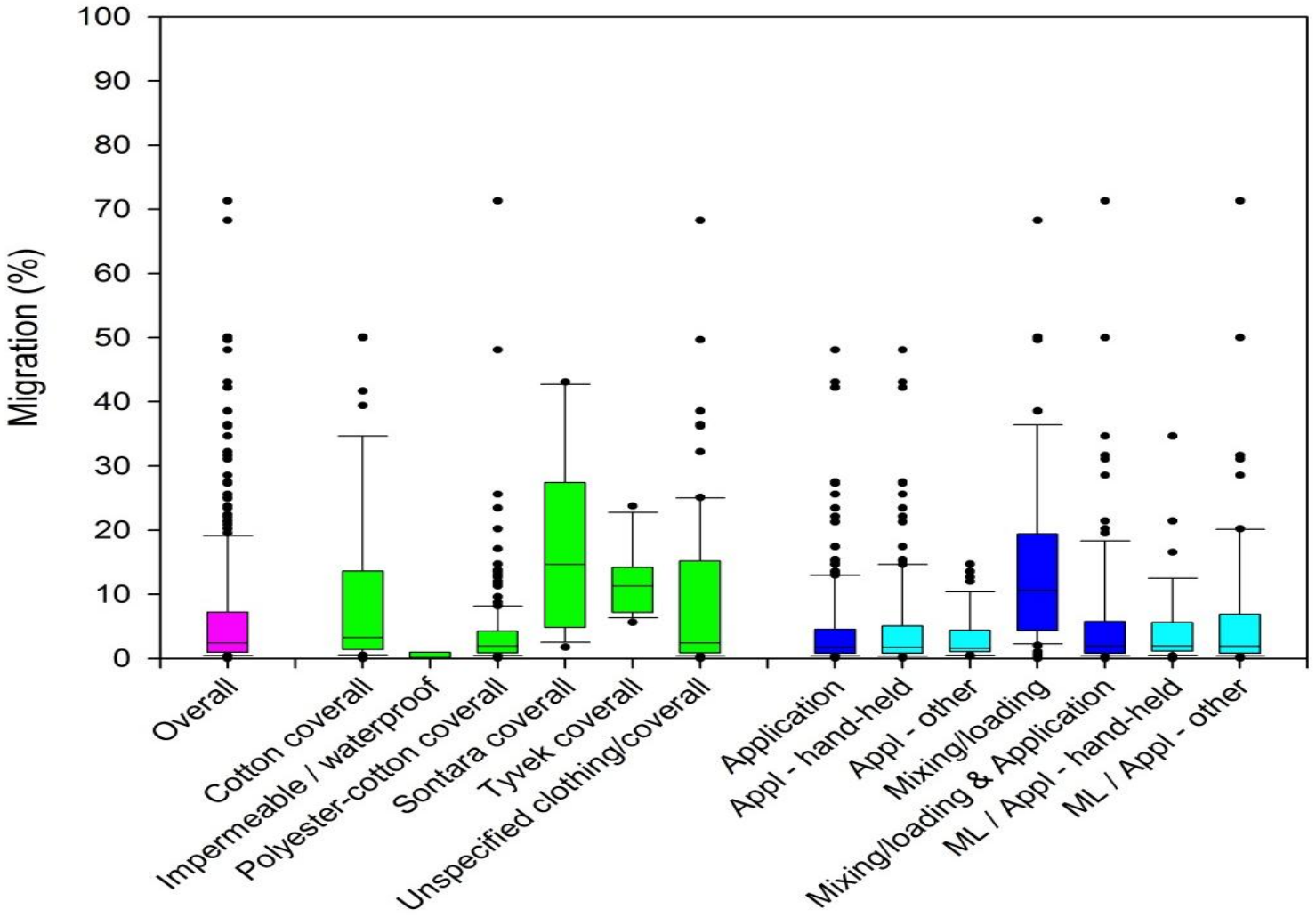
Databases combined - Per PPE type / work wear



Whole body garment - per database



Databases combined - Whole body garment - Per PPE type / work wear and per task performed



Proposal default efficacy values - Body

Proposed factors	N	AM	SD	GM	GSD	Min	P50	P75	P90	Max
BODY										
Unspecified work clothing	403	6.92	11.09	2.61	4.40	0.01	2.40	7.20	18.55	71.31
Cotton coverall	85	9.96	15.11	3.17	5.37	0.01	3.05	9.60	34.66	50.07
Polyester-cotton coverall	212	3.86	6.86	1.92	3.26	0.05	1.97	4.25	8.14	71.31
BODY - Indicative factors										
Re-entry (cotton clothing/coverall)	6	4.48	1.33	4.32	1.35	2.84	4.36	5.27	6.57	6.57
High intensity crop contact (polyester-cotton coverall)	28	17.99	16.42	7.71	5.68	0.16	14.92	29.08	45.40	52.92
Uncertified rain suit								0.2 *		
Certified coverall (Type 3/4)								0.1 *		

* Based on extrapolation

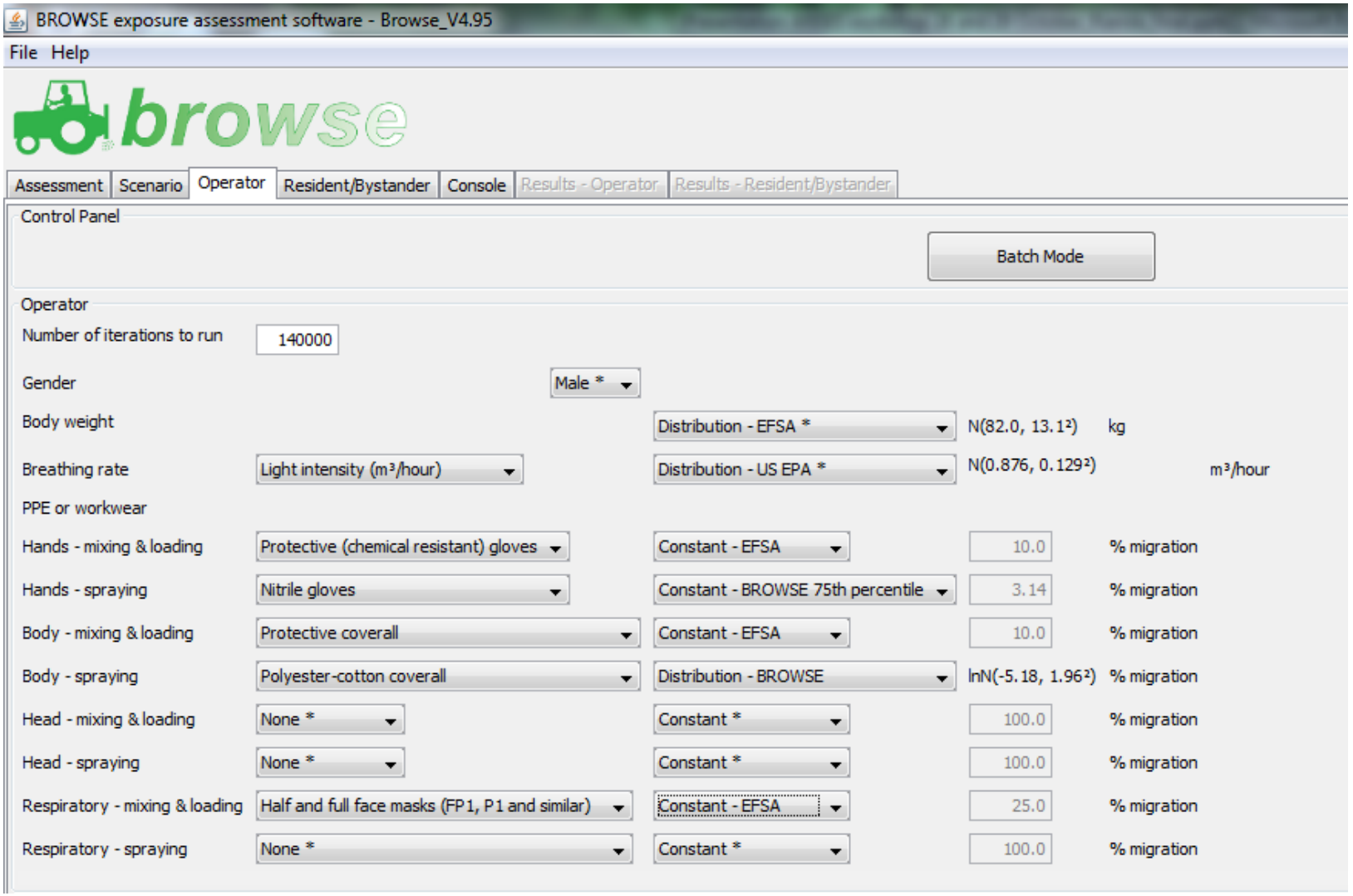
Proposal default efficacy values - Hands

Proposed factors	N	AM	SD	GM	GSD	Min	P50	P75	P90	Max
HANDS										
Unspecified gloves	508	5.47	13.08	0.82	9.94	0.00	1.00	3.95	14.48	97.07
- ML liquids	94	1.21	2.89	0.18	9.74	0.00	0.16	0.85	3.11	19.17
- ML solids	80	4.36	8.83	0.93	8.66	0.00	1.38	4.52	8.93	56.93
Latex / PE / Vinyl / PVC gloves	91	4.50	10.58	0.59	10.08	0.00	0.51	5.51	10.81	70.85
- ML liquids	31	0.50	1.04	0.09	6.61	0.00	0.08	0.18	1.80	4.05
Nitrile gloves	368	4.36	10.39	0.72	9.57	0.00	0.96	3.14	10.18	97.07
- ML liquids	51	1.44	3.58	0.19	11.47	0.00	0.28	0.85	2.75	19.17
- ML solids	75	4.30	9.10	0.84	8.87	0.00	1.27	4.15	9.09	56.93

PPE and work wear - Conclusions

- No real (significant) new information from papers reviewed to update defaults.
  - Actual use of PPE is still relatively low
- Statistical analysis in line with defaults in former report, but more distinction for types of PPE and work wear seems possible
- Default setting in BROWSE operator models possible

Screenshot BROWSE software _ PPE/work wear



Technical controls

Technical controls - Background and aim

- Since technical controls can also reduce exposures and thus can be considered as an important risk management measure (RMM), we considered these and investigated how to implement these in the BROWSE exposure models.
- Limited resource allocated to this task, investigating some specific controls

- Outcome → uptake of technical controls in the operator exposure models

Cabin efficiencies

- 15 recent papers available for review
- Cabin efficiencies were evaluated using the following types of information:
  - studies testing the ratio of the concentrations measured inside and outside of the cabin,
  - inhalation and dermal exposure measured with and without cabins, and
  - default values derived in other models.
- Important to note: Cabin efficiencies are context- and scenario-specific (depend on e.g. physical state, particle/droplet size, type of filters, concentration levels of the airborne contaminant)

Cabin efficiencies

- Results show that cabin efficiencies are highly variable ranging from 31 - >99 %

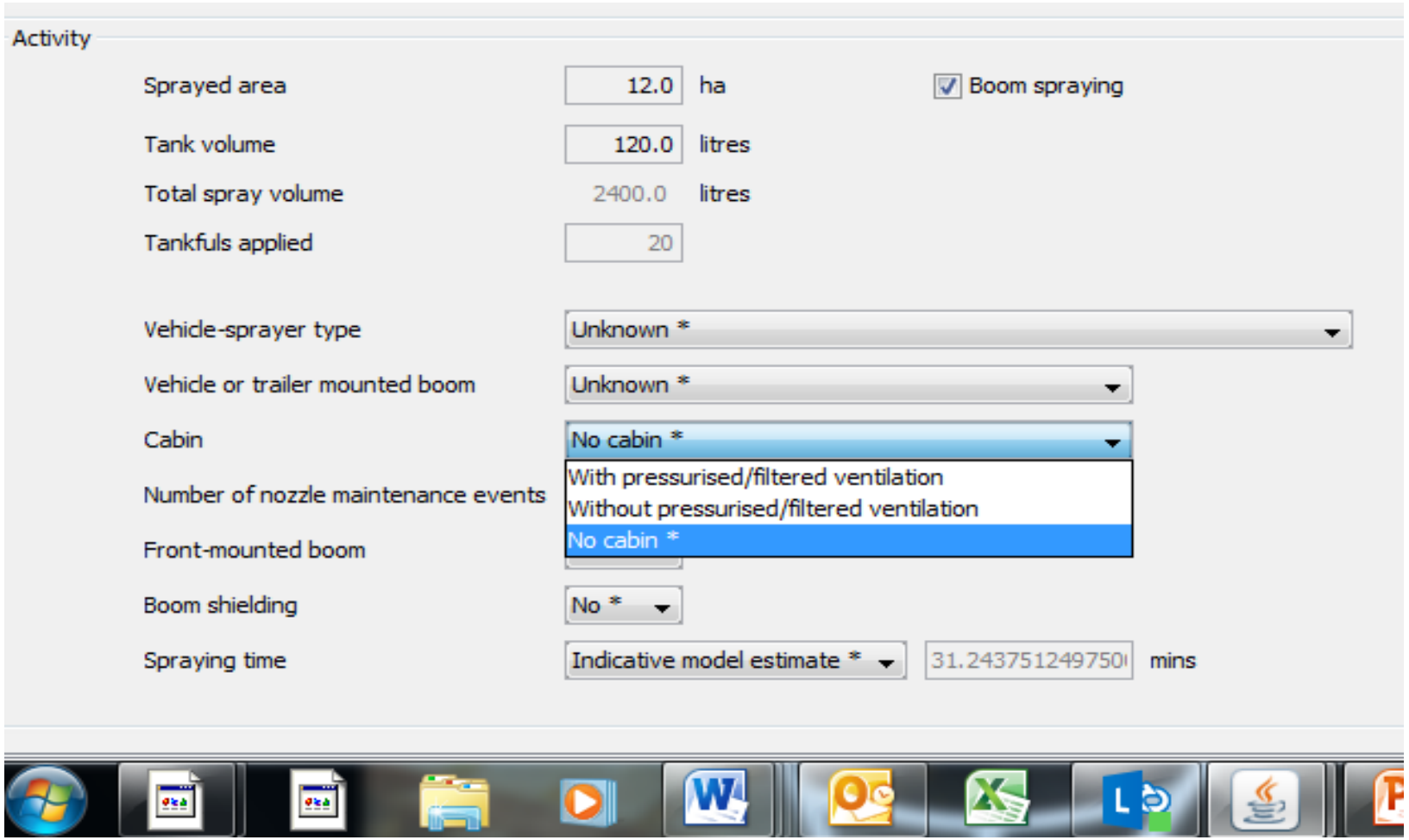
- For model development the following was considered important:
  - Open or closed cabins
  - Opening the cabin door (when exiting / entering)
  - Open or closed windows
  - Type of ventilation (e.g. positive pressure)
  - Filtering of air

Cabin efficiencies

- In the models 3 categories implemented:
  - No cabin (factor 1)
  - Cabin without positive pressure and filtered ventilation (factor 0.4)
  - Cabin with positive pressure and filtered ventilation (factor 0.1)

- Since cabin effectiveness is highly variable, probability distributions (lower and upper values) are included in the models

Screenshot BROWSE software - Cabin

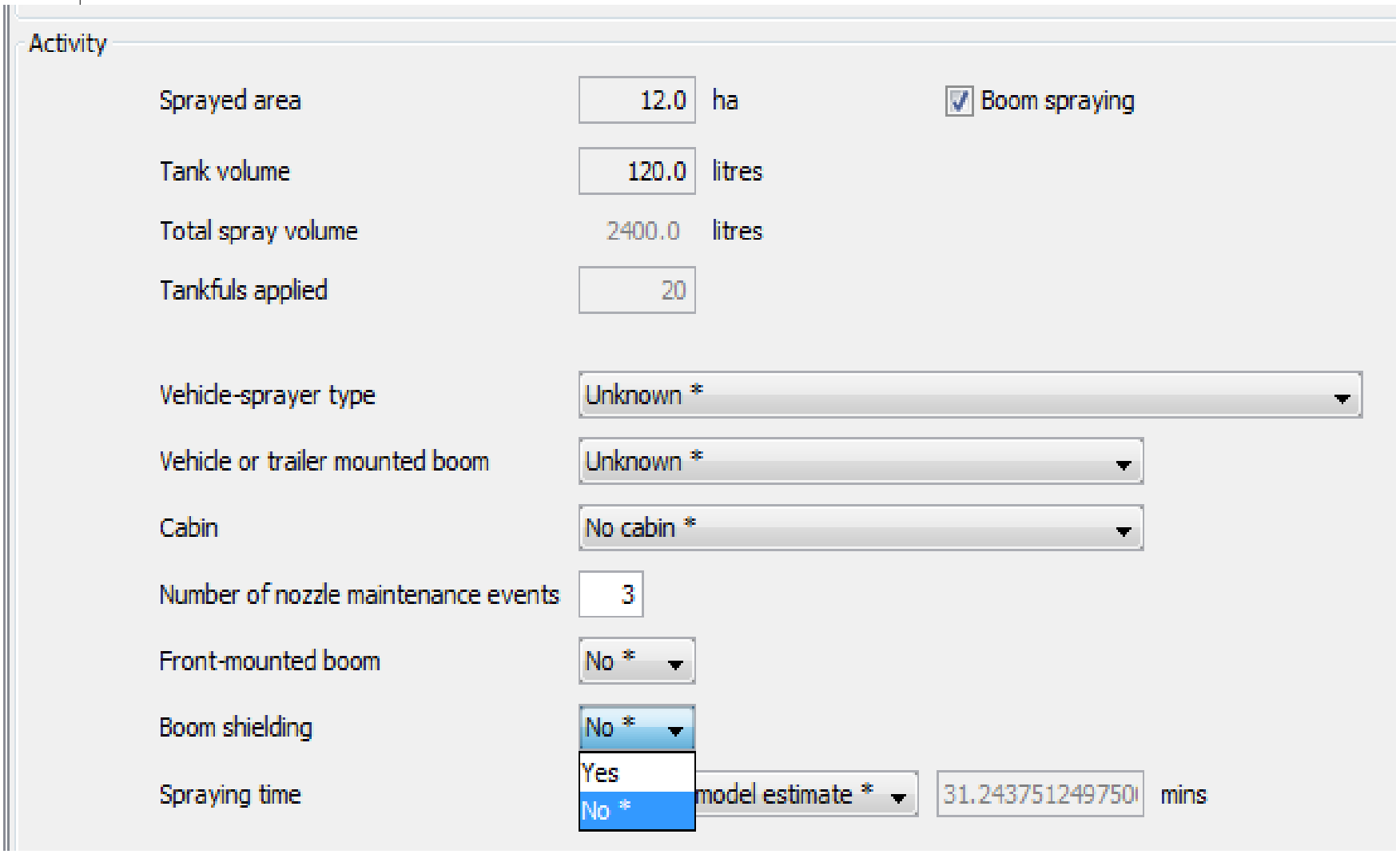


Boom shielding

- Only 6 relevant papers available
- Effect depends on factors such as nozzle type and angle, droplet size, shield type and angle → a lot off varying conditions

- For model development the following was considered important:
  - Since we may get access to more contextually-rich data (indicating the presence of boom shields) in the future, it was decided to include this parameter in the model
  - Default is set at ‘no shielding’ due to limited use
  - In the absence of detailed information a fixed factor is proposed in the lower range of spray drift reductions, namely 30% (factor 0.7)

Screenshot BROWSE software - Boomshielding

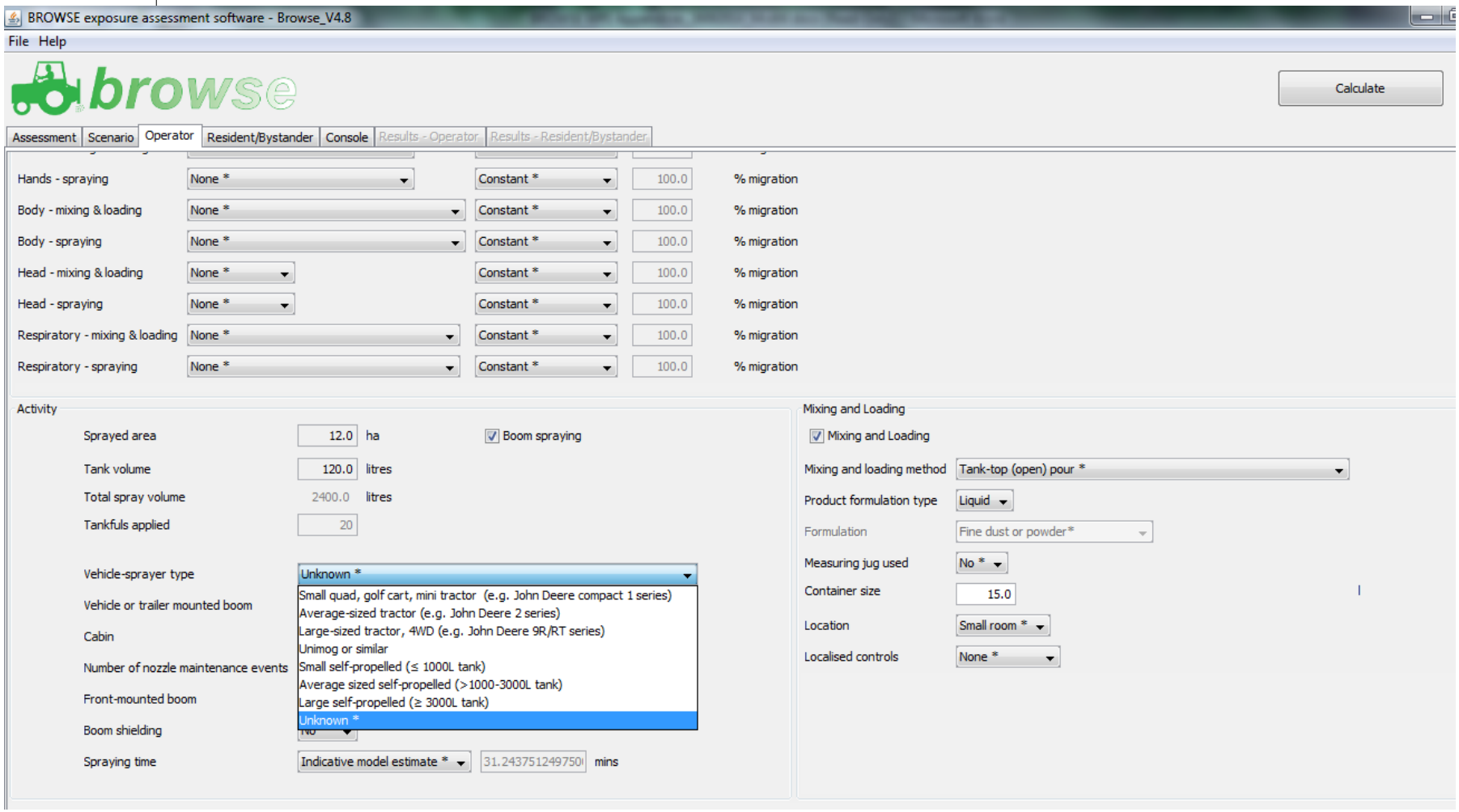


Other controls or options that can reduce exposure

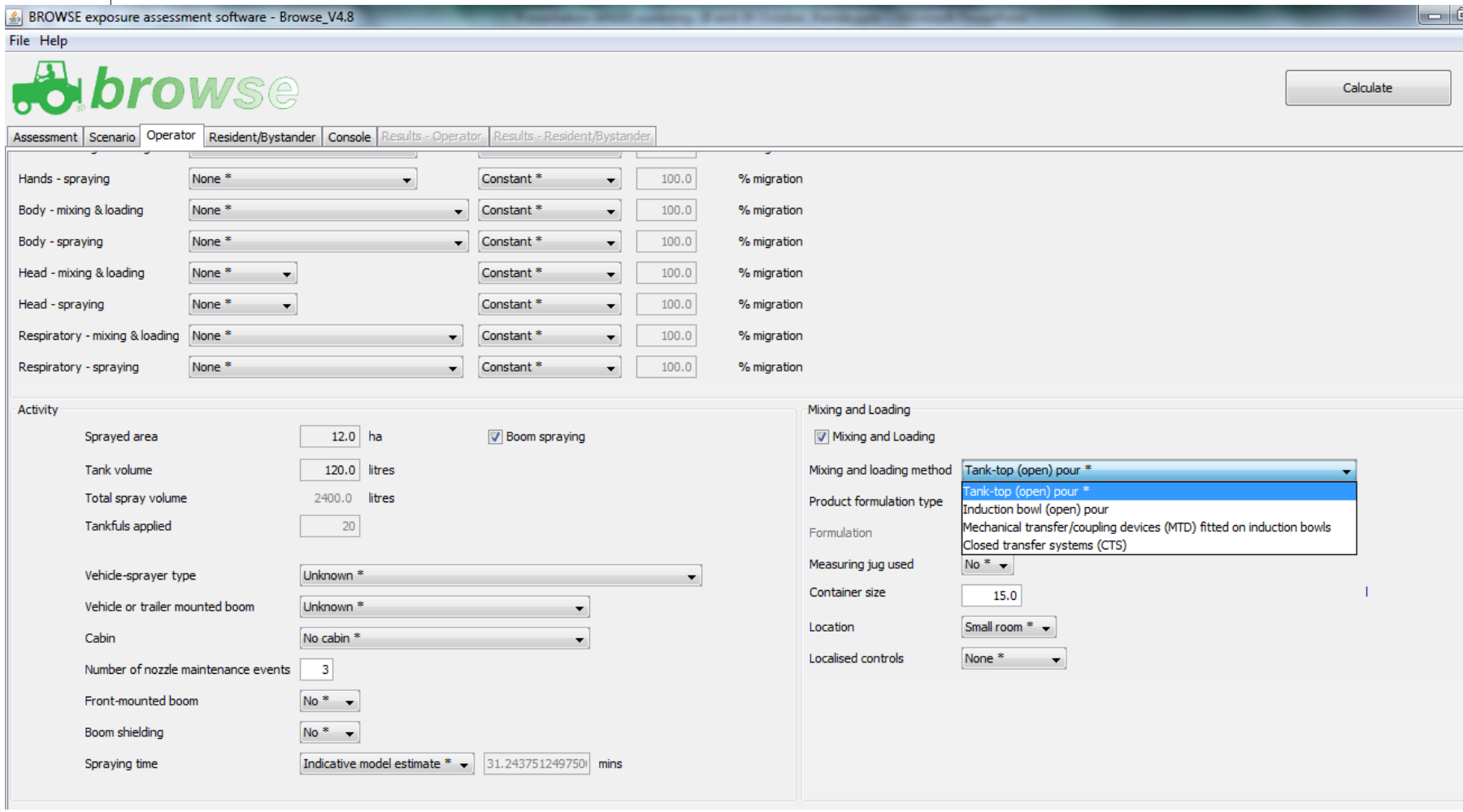
- Since the BROWSE models offer a lot of options and parameters to detail the exposure assessment you can vary these options to see the "best option" with regard to exposure

- Parameters that can vary:
  - Vehicle set up
  - Mixing and loading method
  - Package size
  - Dilution factor
  - Etc.

Screenshot BROWSE software - Other controls

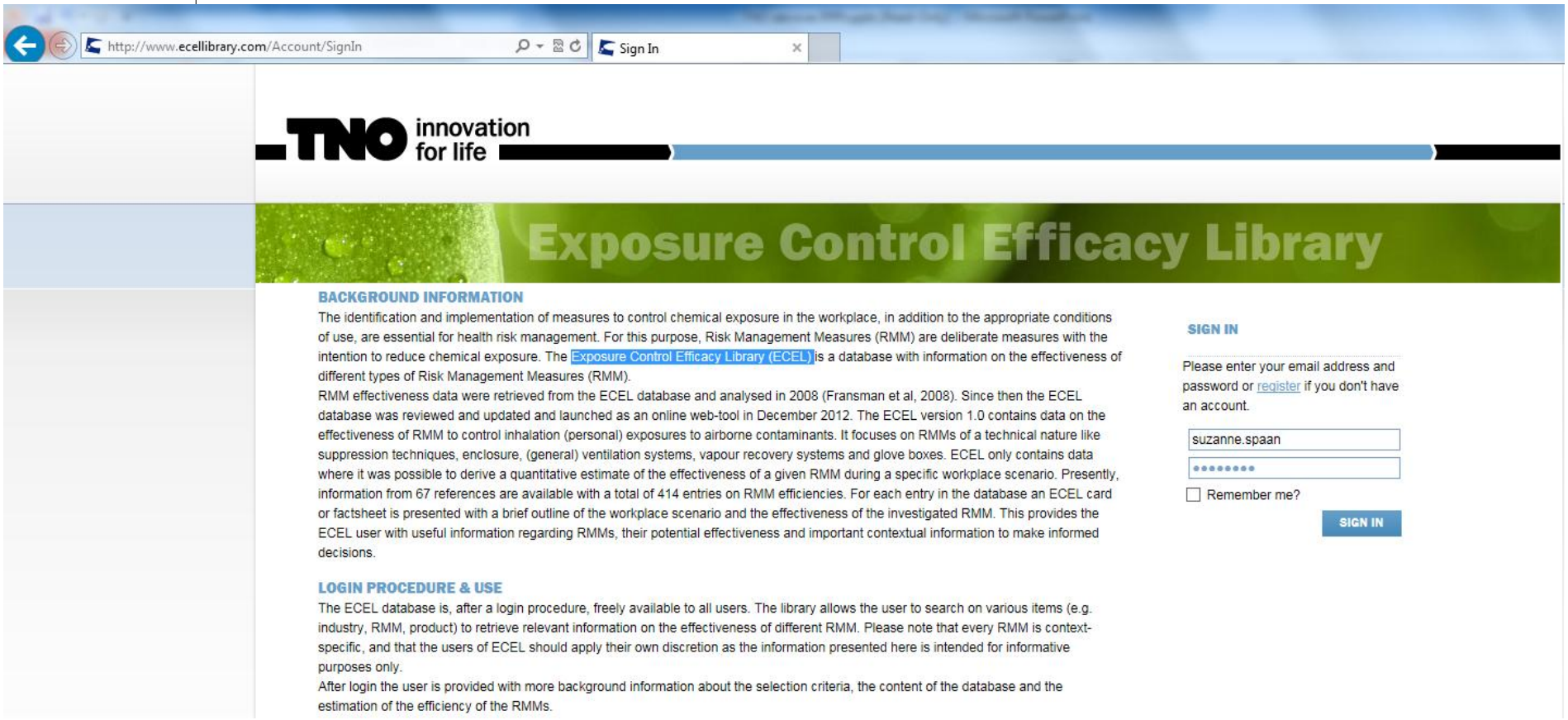


Screenshot BROWSE software - Other controls



Available info on other RMM

- ECEL: Exposure Control Efficacy Library (www.ecellibrary.com)



Thank you for your attention, any questions?