IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Requirements for the validation of exposure models

Dr. Dorothea Koppisch
IFA, Germany

Theoretical Background and Application of Occupational Exposure Models

Workshop, 20th October 2020

Different aspects for the validation / evaluation of models

- **Internal (conceptual) evaluation**:
  - Check if the model concept and the theory behind it is sound
  - Uncertainty analysis
- **Operational analysis**:
  - Check if the tool in which the model is imbedded is **user-friendly**
  - Check if the **between-user variability** is not too high
- **External validation**:
  - Comparing of model predictions with measured data,
  - Check if the output is accurate and precise

After: Tischer et al. (2017) Ann Work Exp Health; 61: 911–920

Internal (conceptual) evaluation

In order to check if the concept and theory behind a model is sound the following questions (and more) have to be answered:

- Is information on the model background, the used principles and all methods used to derive the model equations well documented and publicly available?
- Is the applicability domain well described by the model developers?
- Are the model assumptions plausible and consistent with established knowledge and theories?
- How uncertain are the model assumptions and determinants?

Operational analysis

- Methods for investigating the **user-friendliness**
  - Telephone interviews / asking users to fill in questionnaires
  - Usability testing: creating a scenario, the users then have to perform a list of tasks while observers watch and take notes
  - Usability inspection: a set of methods where an evaluator inspects a user interface judging its compliance with recognized usability principles

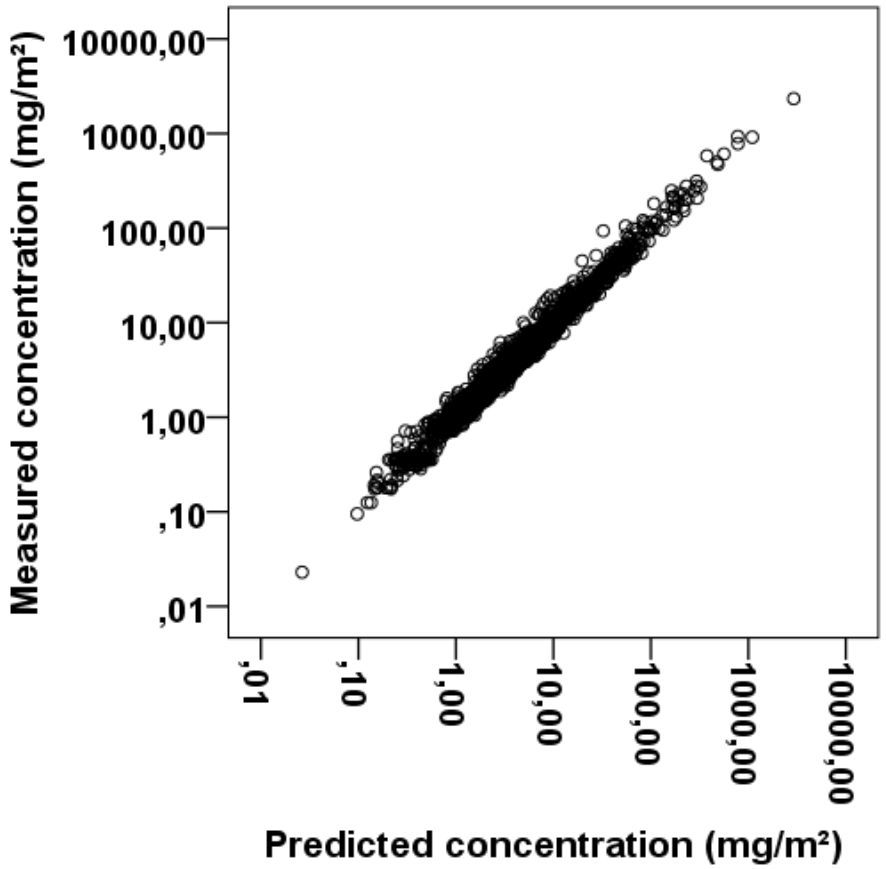
- Methods for investigating the **between-user variability / reliability**
  - Asking a group of users to estimate independently different exposure scenarios giving them the same description of work places and then comparing the individual results
  - Can be influenced by the user interface in which the model is implemented (“a tool is more than a model”)

External validation

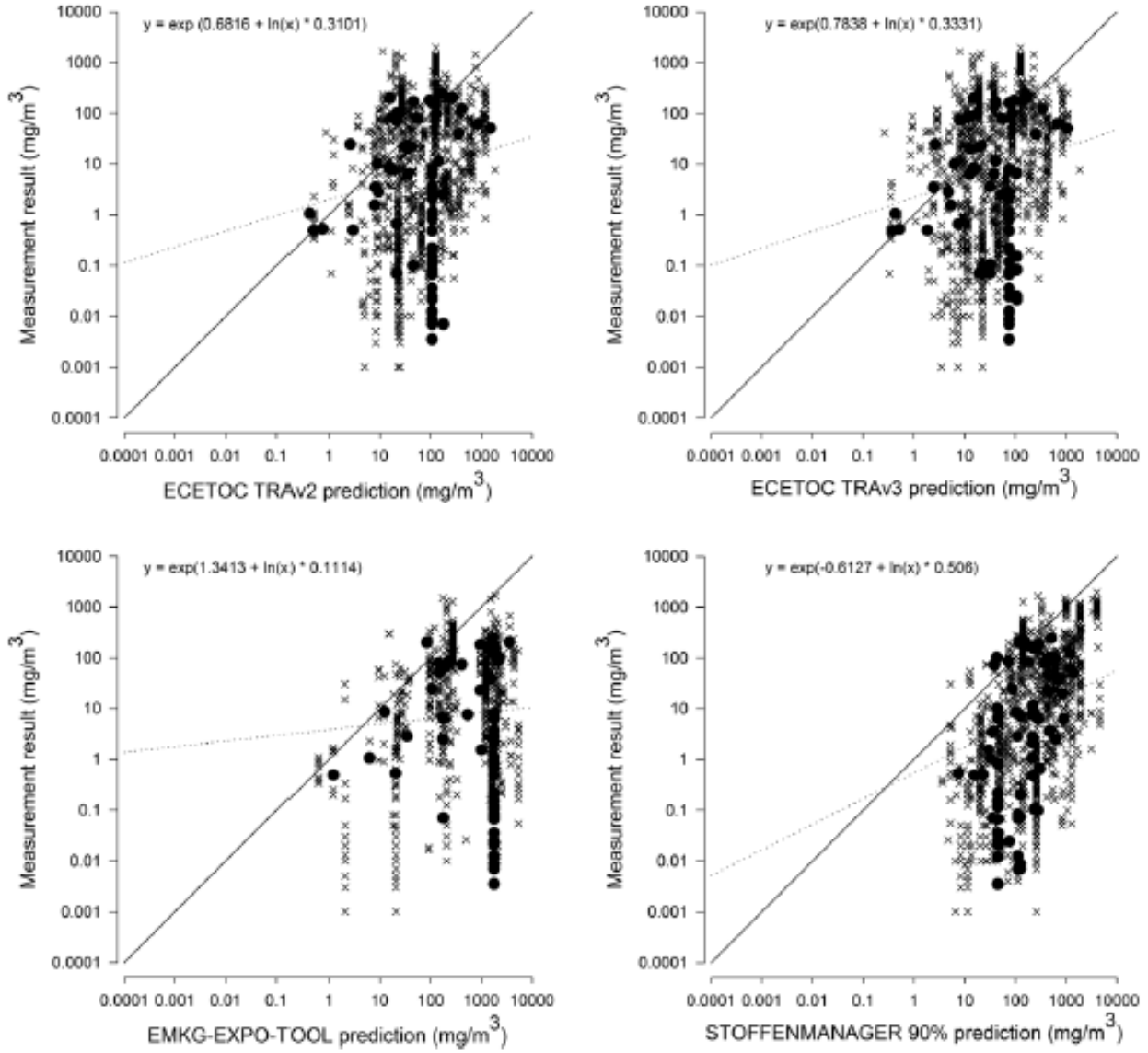
Comparing model predictions with measured data, to check if the output is accurate and precise

- Statistical parameters:
  - Correlation coefficients
  - Bias and precision
  - Ratios of the AM (or GM) of measurements over the AM (or GM) of the tool estimates
  - Percentage of measurements that exceed the respective tool estimate as a measure for the conservatisms of the model respectively the percentile that is estimated
- Pitfalls:
  - All factors needed for the calculation of the tool estimate must be documented for the measurement values
  - **Influence of variability of exposure height**

Is the output accurate and precise? Theory:



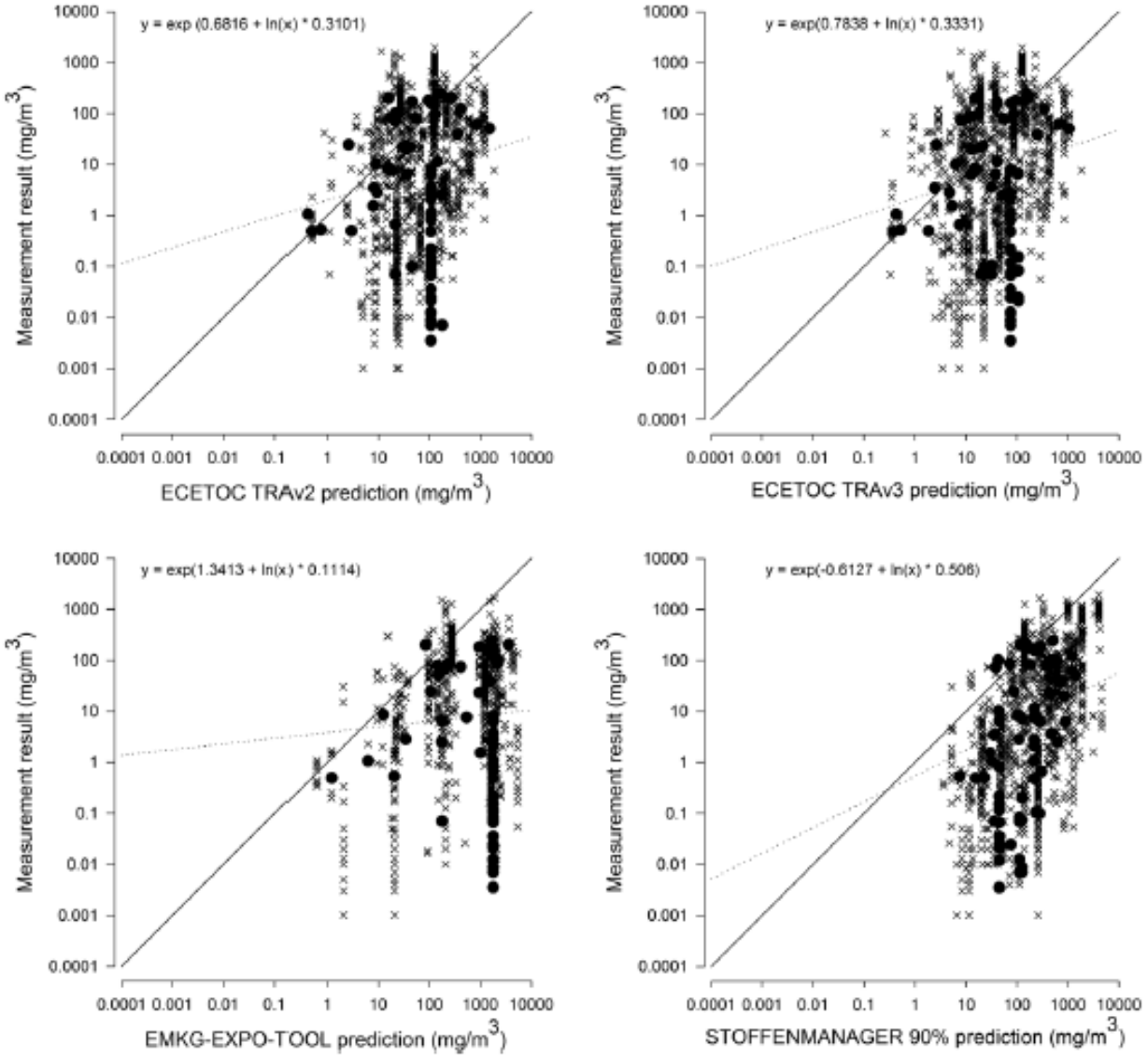
Is the output accurate and precise? Reality:



- High variability of exposure height at real working places leads to “clouds” in external validation
- This does not mean, that the model is bad, but that models in occupational hygiene have to take into account variability

Source: E-TEAM: External validation for volatile liquids
Van Tongeren et al. (2017)
Ann Work Exp Health; 61: 921-938

External validation: Incorporating variability



Percent of measurements that exceed the respective tool estimate:

- ECETOC TRAv2: 26
- ECETOC TRAv3: 32
- EMKG-EXPO-Tool: 5
- STM, 90. percentile: 12

Source:
Van Tongeren et al. (2017)
Ann Work Exp Health; 61:
921-938

External validation: Incorporating variability

Interval of percentiles of the Stoffenmanager estimate	Expected percentage of measurements	Measurements within the intervals of estimated percentiles handling of powders and granules	
		number	%
0-50	50	161	41
>50 – 60	10	43	11
>60 - 70	10	51	13
>70 - 75	5	22	6
>75 - 80	5	20	5
>80 - 90	10	46	12
>90 - 95	5	26	7
>95 - 100	5	21	5
CHI^2		13.90	p>0.05

Number and percentage of measurements that fall into the respective interval of the Stoffenmanager estimate. Data for inhalable dust during the handling of powders and granules.

Source:
Koppisch et al. (in preparation): Variability in exposure level and model validation – interval testing

IFA
Institut für Arbeitsschutz der
Deutschen Gesetzlichen Unfallversicherung

Thank you for your attention.

dorothea.koppisch@dguv.de

Institute for Occupational Safety and Health
of the German Social Accident Insurance