TREXMO+

ADVANCED SELF-LEARNING MODEL FOR OCCUPATIONAL EXPOSURE ASSESSMENT

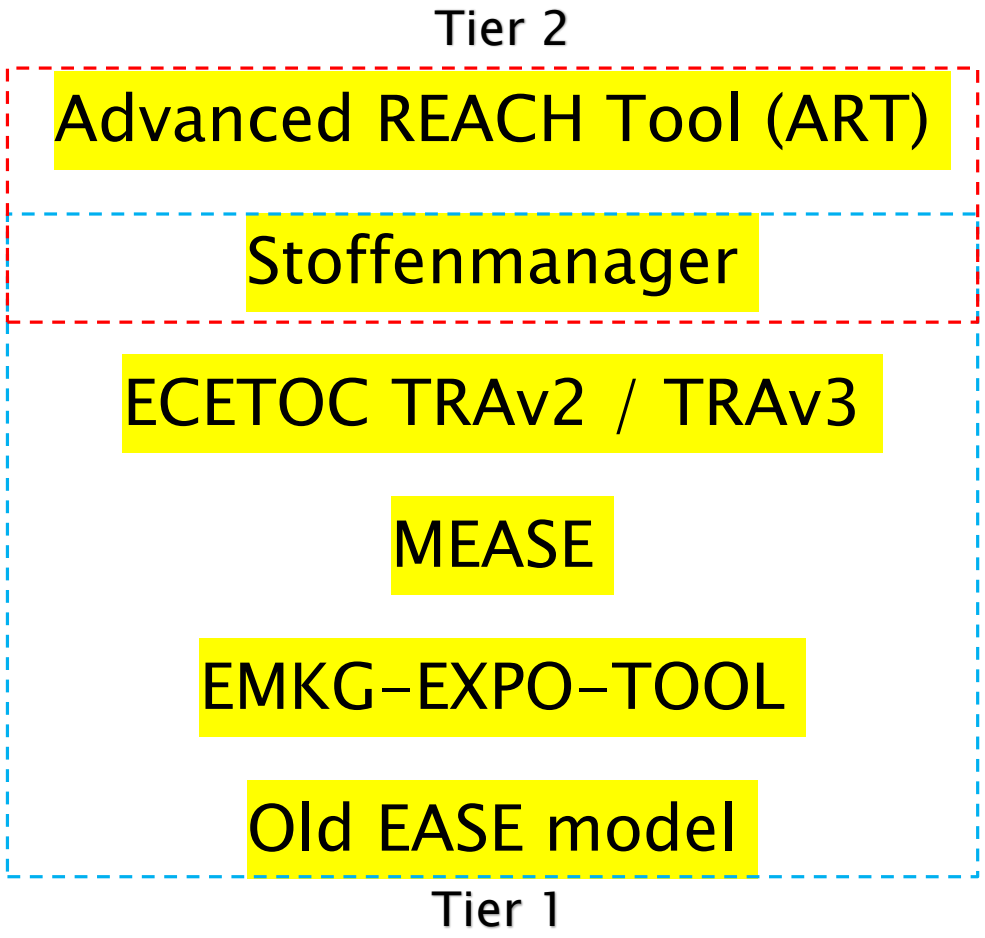
05/07/2019

Dr. Nenad Savic
nenad.savic@unisante.ch

ISES Europe

Workgroup:
Exposure Models

REACH MODELS



Tier 1

Several models developed

Simple conservative tools

Screening tools

Tier 2

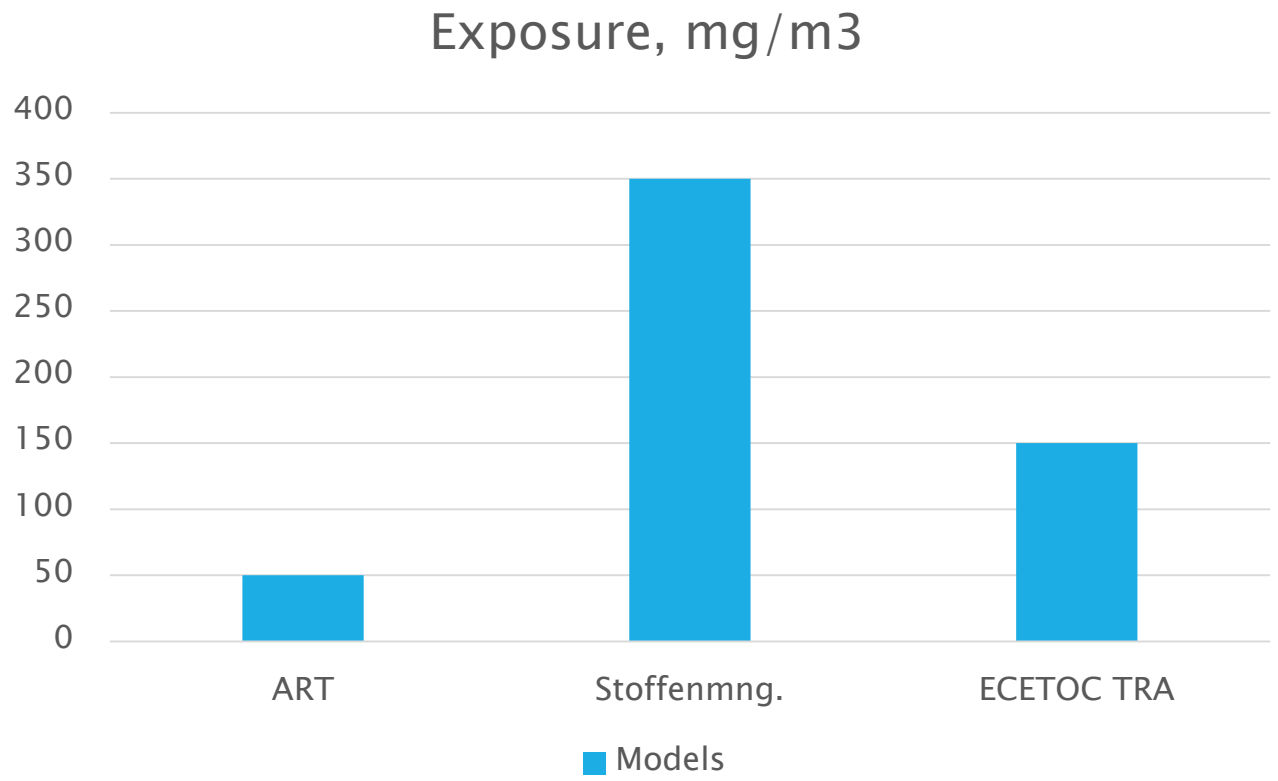
ART / Stoffenmanager (Tier 1.5)

Require more exposure information

More precise predictions

Exposure distribution

REACH MODELS



TREXMO

Translation of Exposure Models

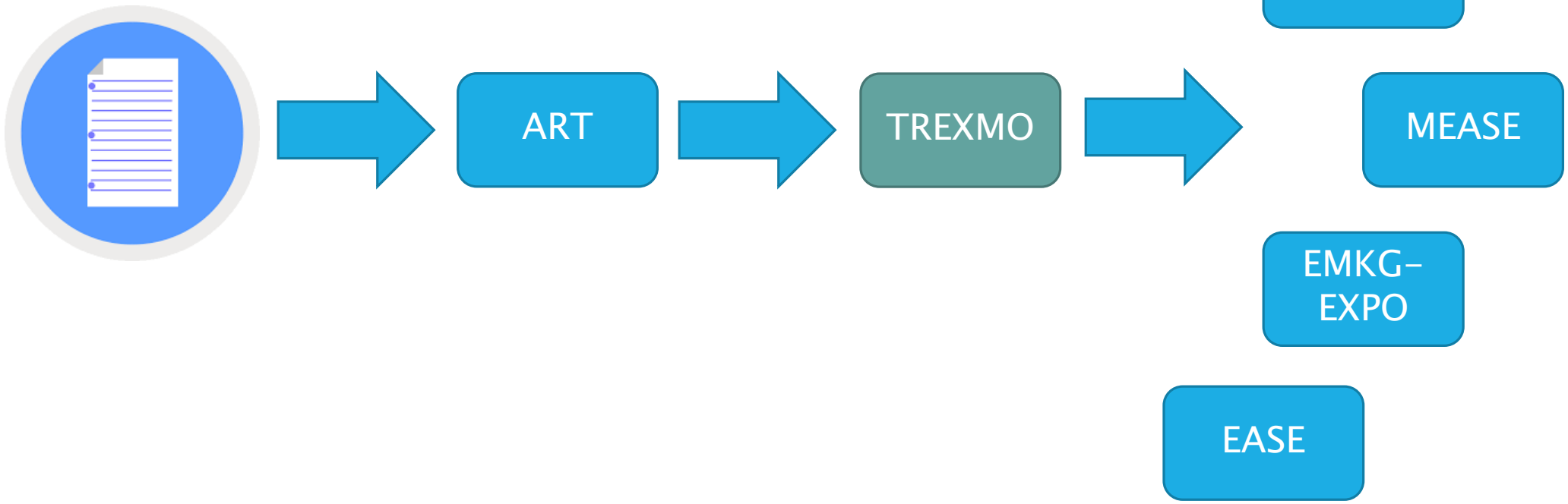
Input parameters of one model translated into another

Simultaneous use of several models

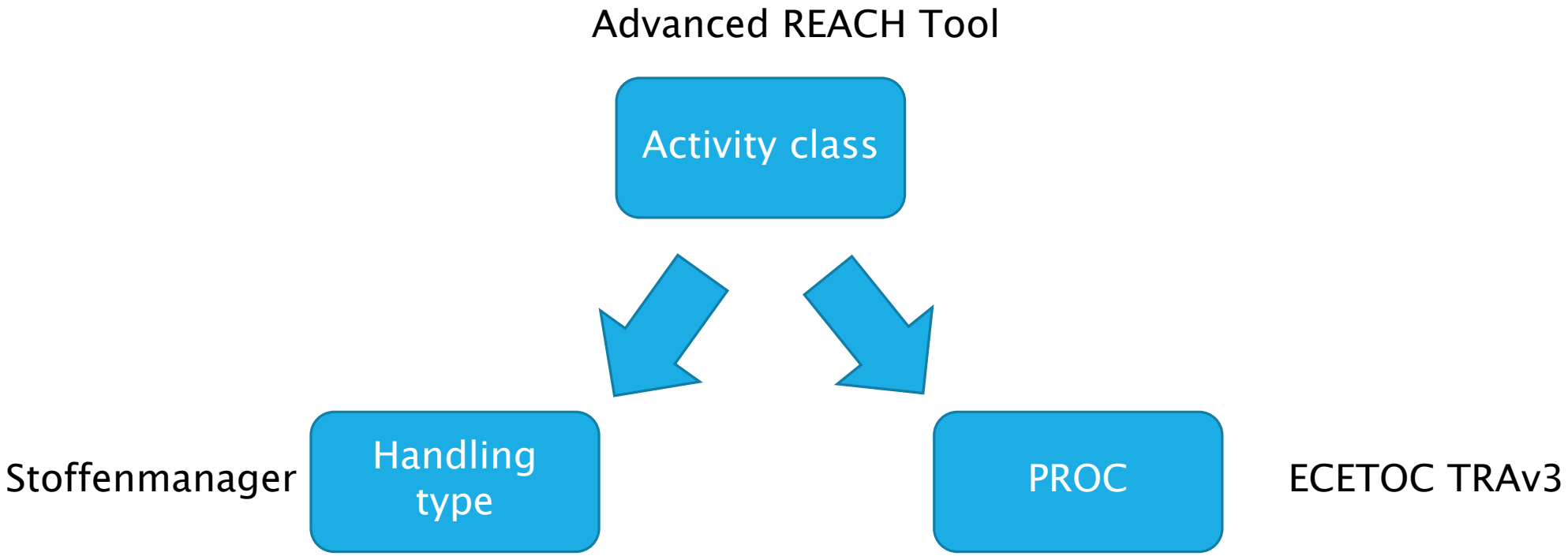
One calculation step: different predictions

TREXMO

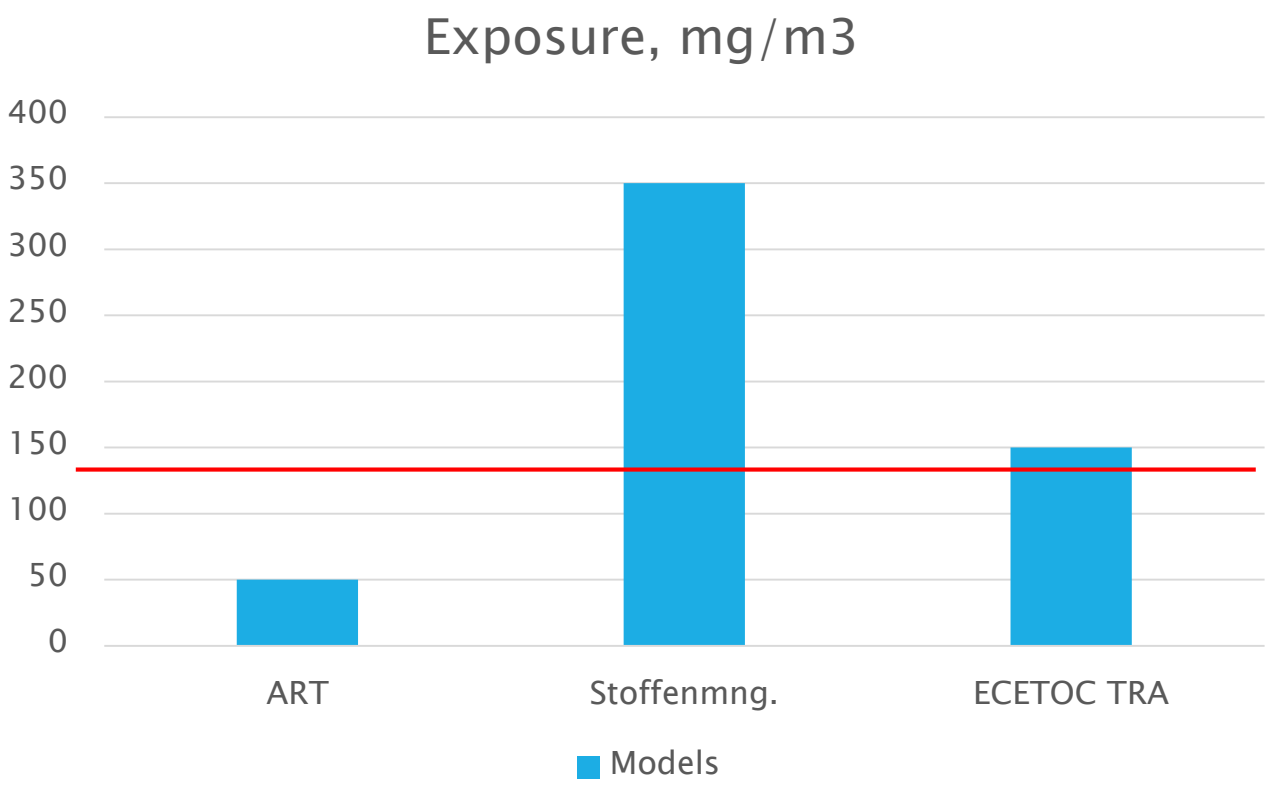
Data interpretation *coding* *translation*



TRANSLATIONS



INTER-MODEL VARIABILITY



MODEL X > DNEL

MODEL Y < DNEL

TREXMO+

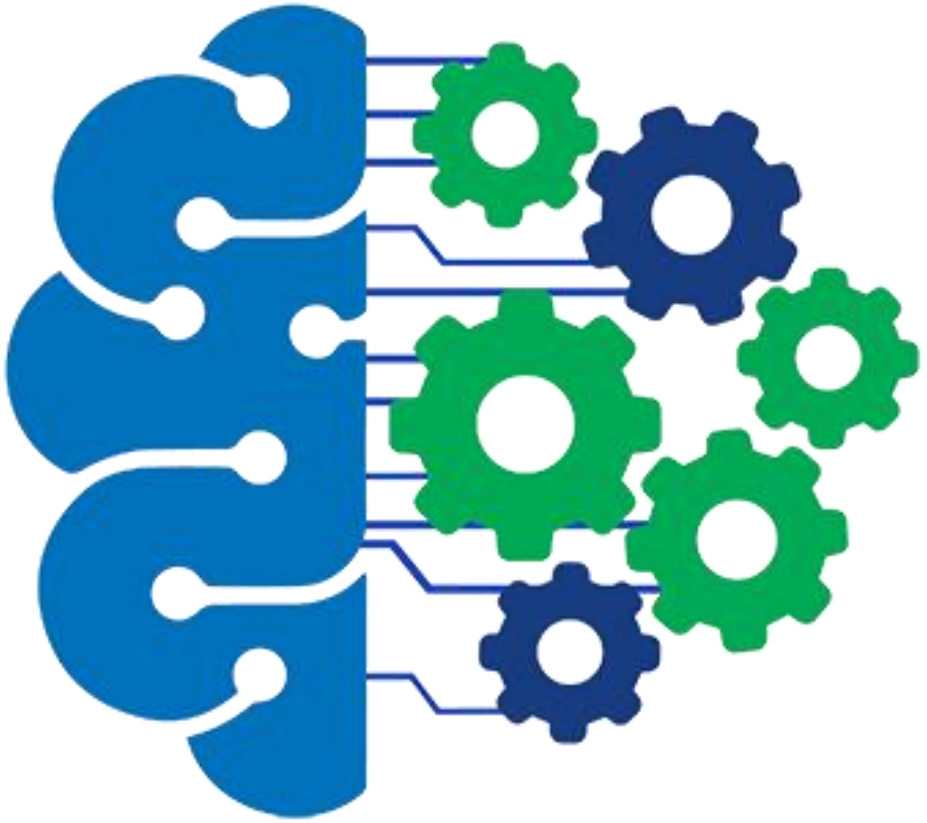
Next generation model

Existing models independent predictors of exposure

TREXMO+ learns about weaknesses and strengths

Based on the fact that different models are good in different situations

When more data available the algorithm performs automatic self-refinement



MACHINE
LEARNING

ALGORITHM

Exposure models have different performance for different exposure conditions!

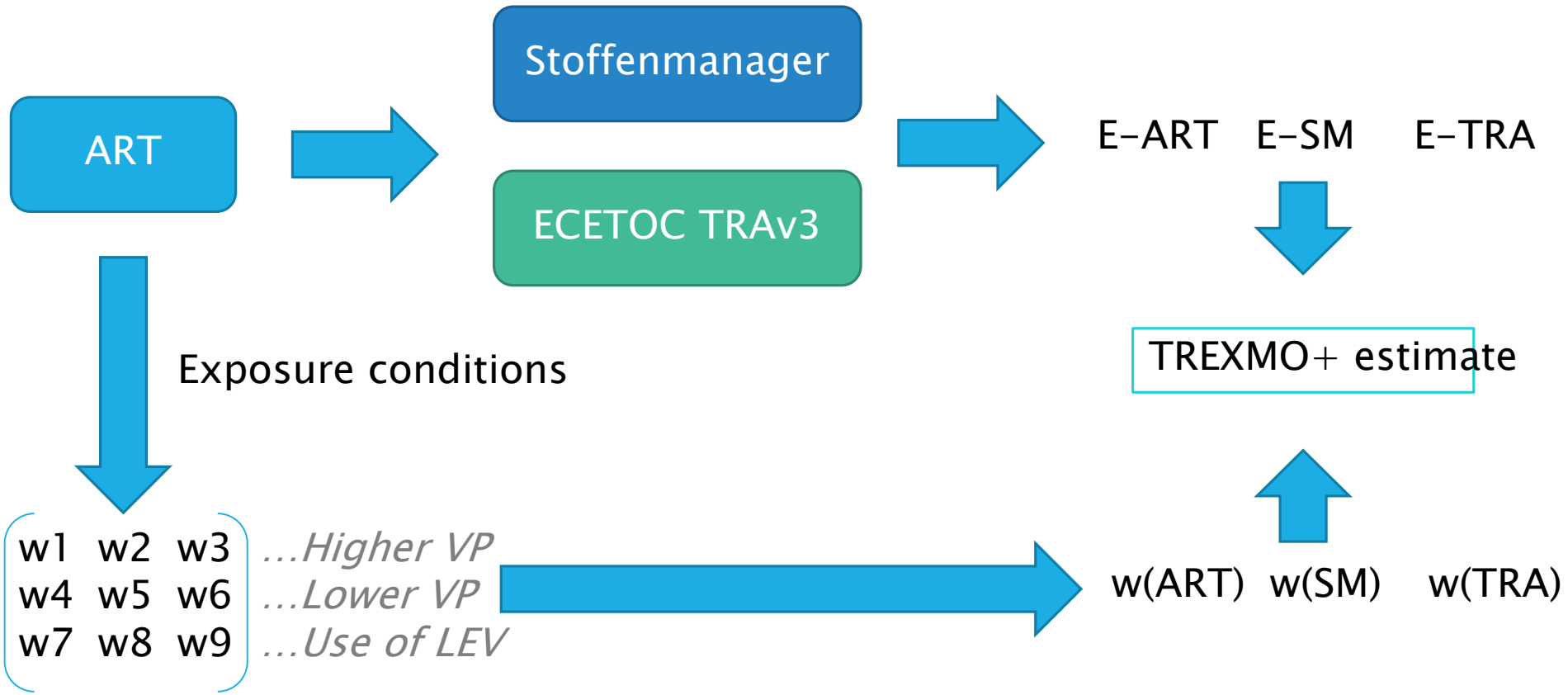
Usually one model is closer to the actual (real) exposure concentration!

$$TrPlus = w_{ART}E_{ART} + w_{SM}E_{SM} + w_{TRA}E_{TRA}$$

w – "weights" – *regression coefficients*

E – *Exposure predictions (mg/m3)*

WORKFLOW


ART
Stoffenmanager
ECETOC TRAv3
E-ART E-SM E-TRA
TREXMO+ estimate
Exposure conditions
w1 w2 w3 …Higher VP
w4 w5 w6 …Lower VP
w7 w8 w9 …Use of LEV
w(ART) w(SM) w(TRA)

ALGORITHM STRUCTURE

1. Classification layer

Requires an external exposure dataset. Uses conditional regression trees to classify the exposure situations into smaller subsets that address similar conditions.

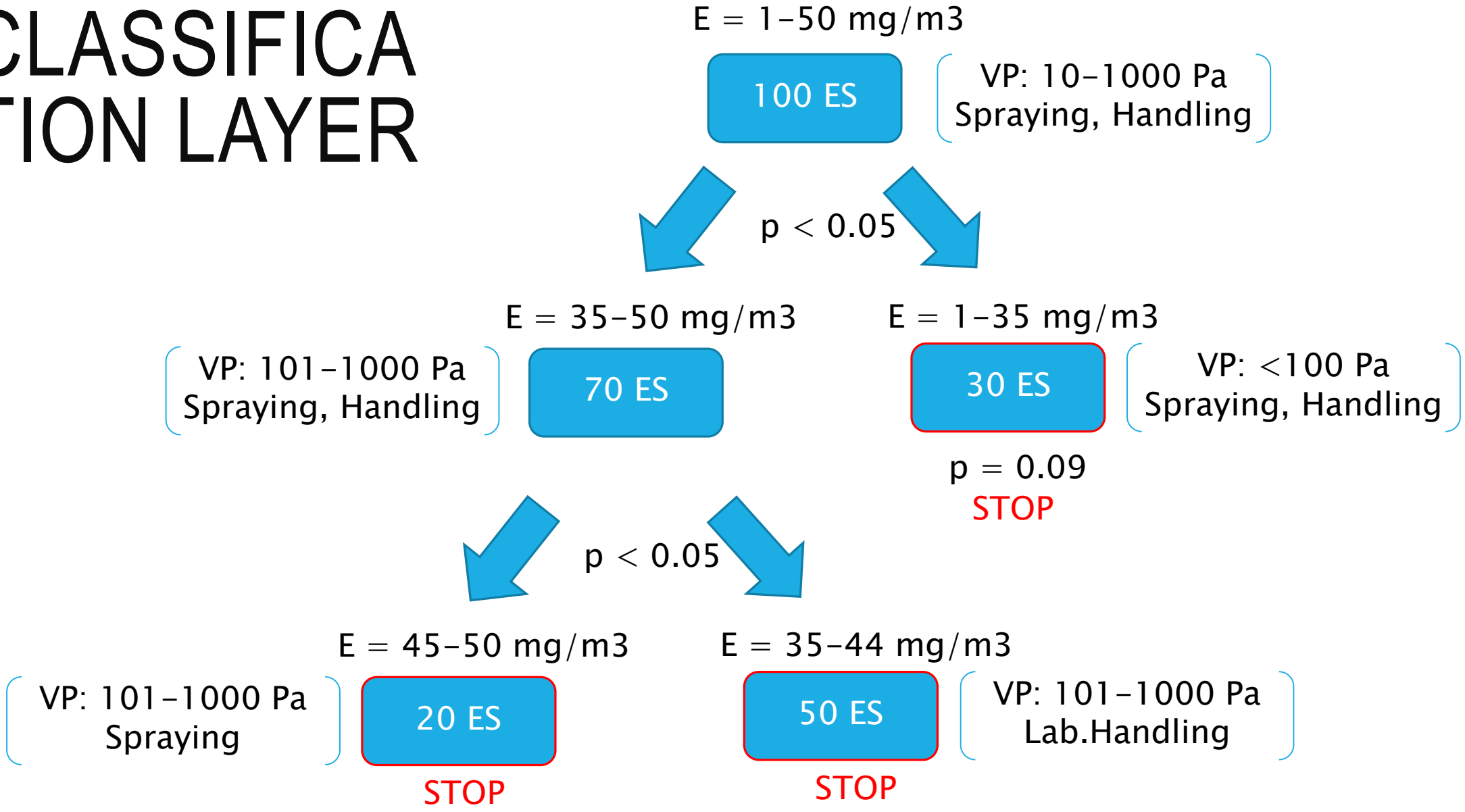
2. Learning layer

For each subset from the first layer, TREXMO+ applies multiple regression analysis to evaluate the regression coefficients for ART, SM and TRAv3

3. Calculation layer

Based on the provided set of exposure conditions, TREXMO+ searches the corresponding triplet of weights for the three models in the matrix established in the layer 2.

CLASSIFICATION LAYER



LEARNING LAYER

E = 45-50 mg/m3

20 ES

VP: 101-1000 Pa
Spraying

E = 1-35 mg/m3

30 ES

VP: 101-1000 Pa
Lab.Handling

E = 35-44 mg/m3

50 ES

VP: <100 Pa
Spraying, Handling

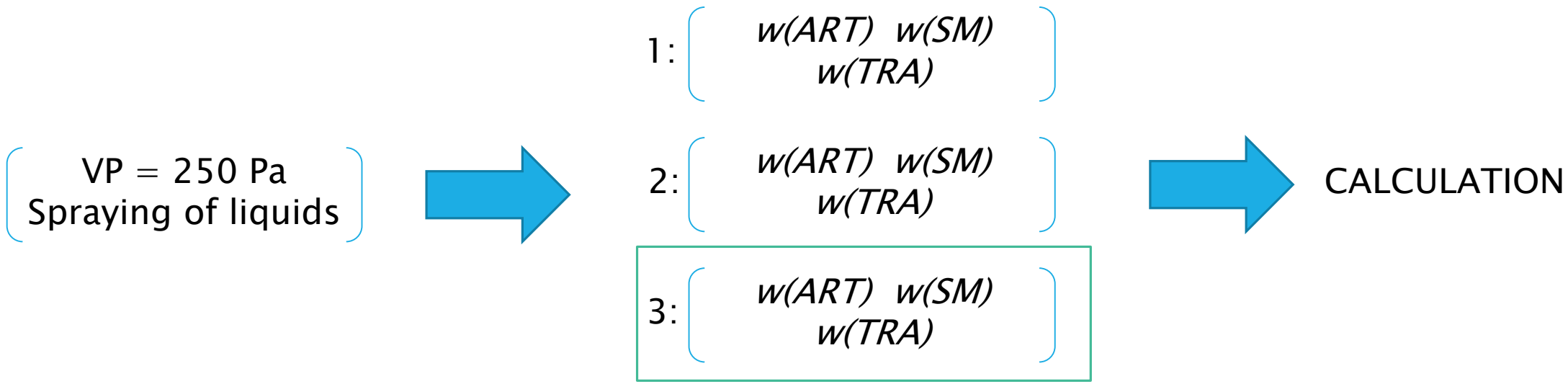
Regression analysis

1: *w(ART) w(SM) w(TRA)*

2: *w(ART) w(SM) w(TRA)*

3: *w(ART) w(SM) w(TRA)*

CALCULATION LAYER



$$TrPlus = w_{ART}E_{ART} + w_{SM}E_{SM} + w_{TRA}E_{TRA}$$

EXPOSURE DATA

> 1300 exposure measurements

US and Swiss exposure data (NIOSH, SUVA)

The data was not used previously for the development of any of the existing models

SUVA
> 700
measurements

NIOSH
> 500
measurements

VAPOURS
POWDERS
ABRASIVES
MISTS < 20 measurements
METALS (n.a.)
FUMES (n.a.)

RESULTS

Bias

$$bias = \frac{1}{n}\sum_{i=1}^{n} \log \hat{y}_i - \log y_i \qquad relative\ bias = \left(e^{bias} - 1\right) \times 100\%$$

Accuracy

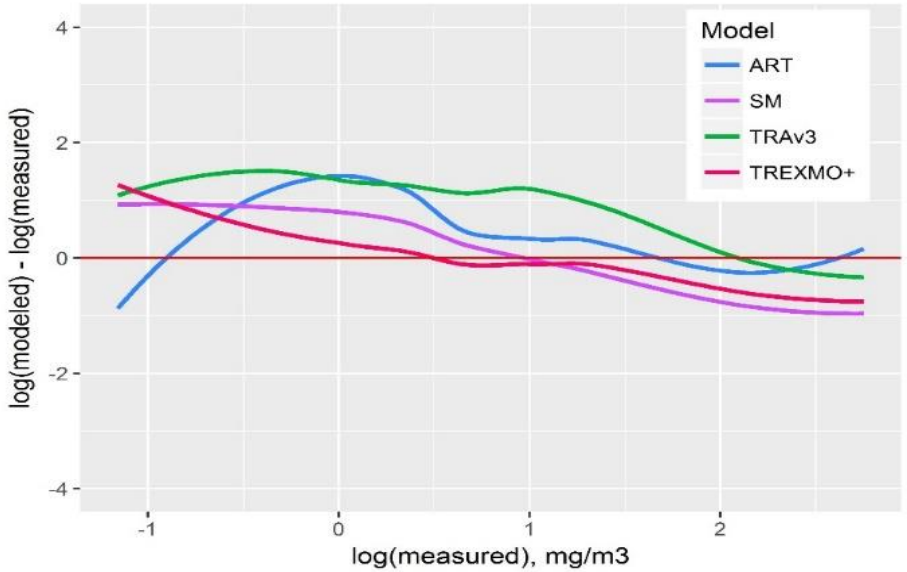
$$accuracy = \frac{1}{n}\sum_{i=1}^{n} |\log \hat{y}_i - \log GM_i|$$

Model	Relative Bias (%)				Accuracy		
	Liquids	Powders	Solids		Liquids	Powders	Solids
ART	86	1004	-57		1.00	0.85	0.61
SM	9	325	-34		0.66	0.63	0.53
TRAv3	410	818	171		1.16	1.04	0.45
TREXMO+	-33	-24	-22		0.48	0.45	0.31

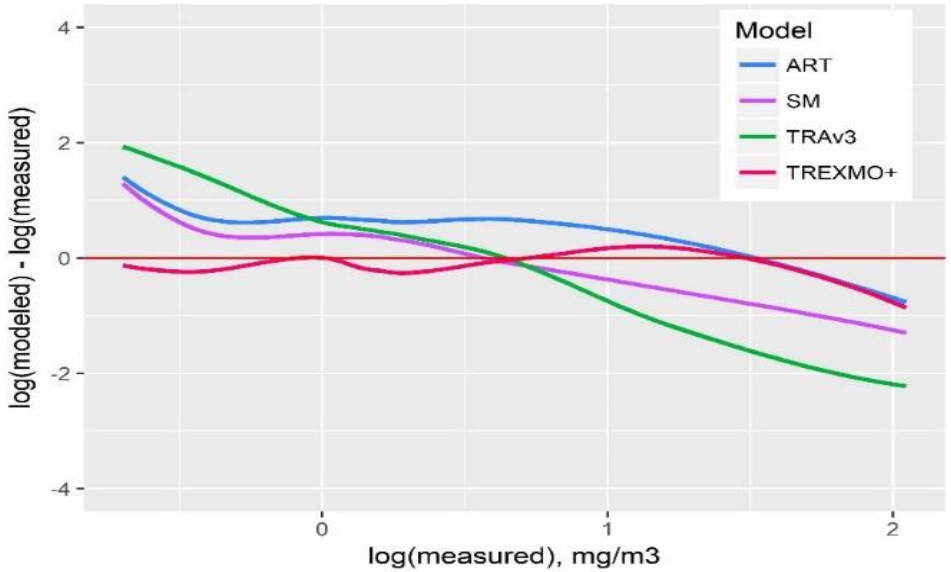
RESULTS

Predicted vs measured exposures
Locally-weighted smoothed residuals

$$r_i = \log \hat{y}_i - \log y_i$$

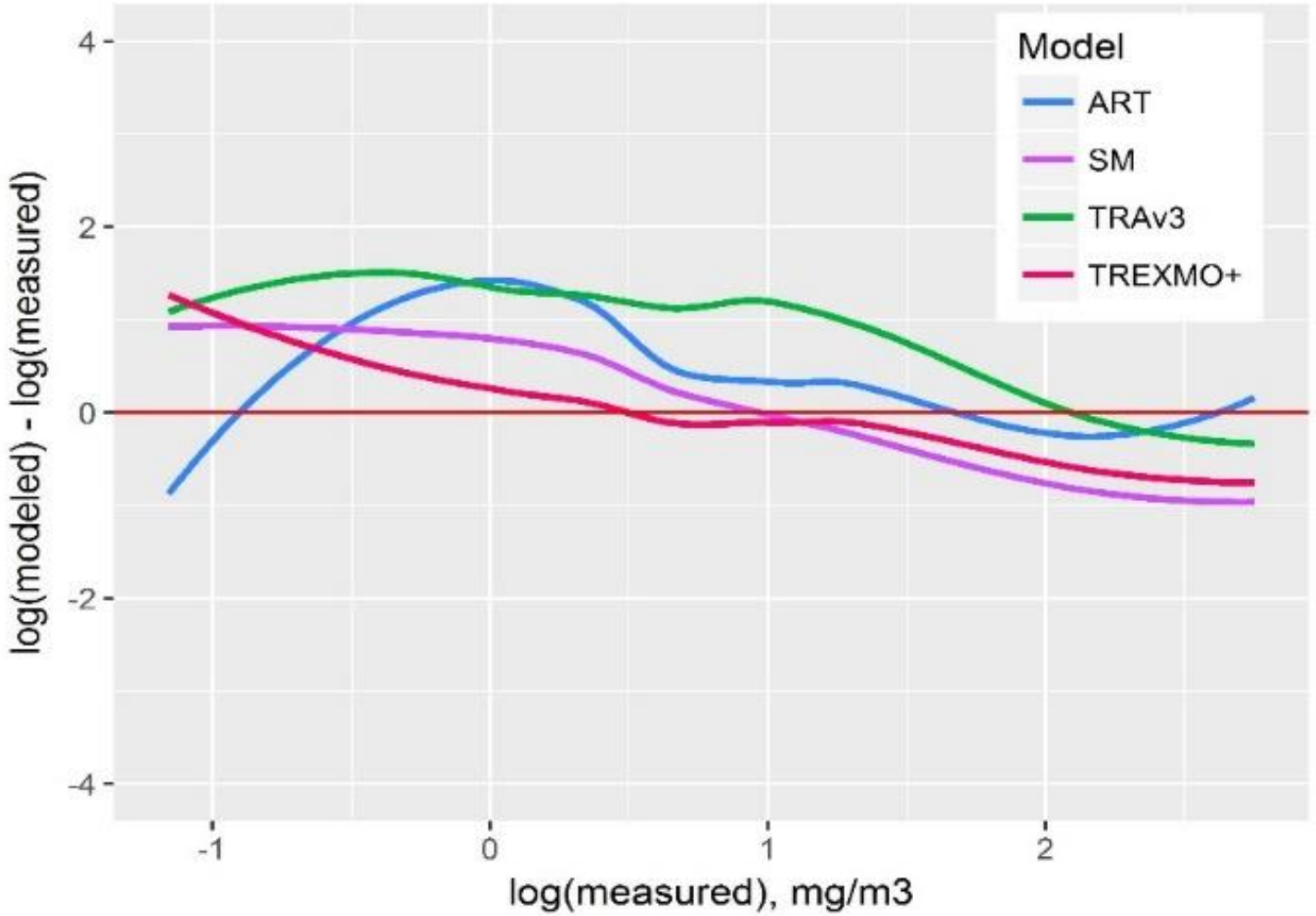


Liquid products

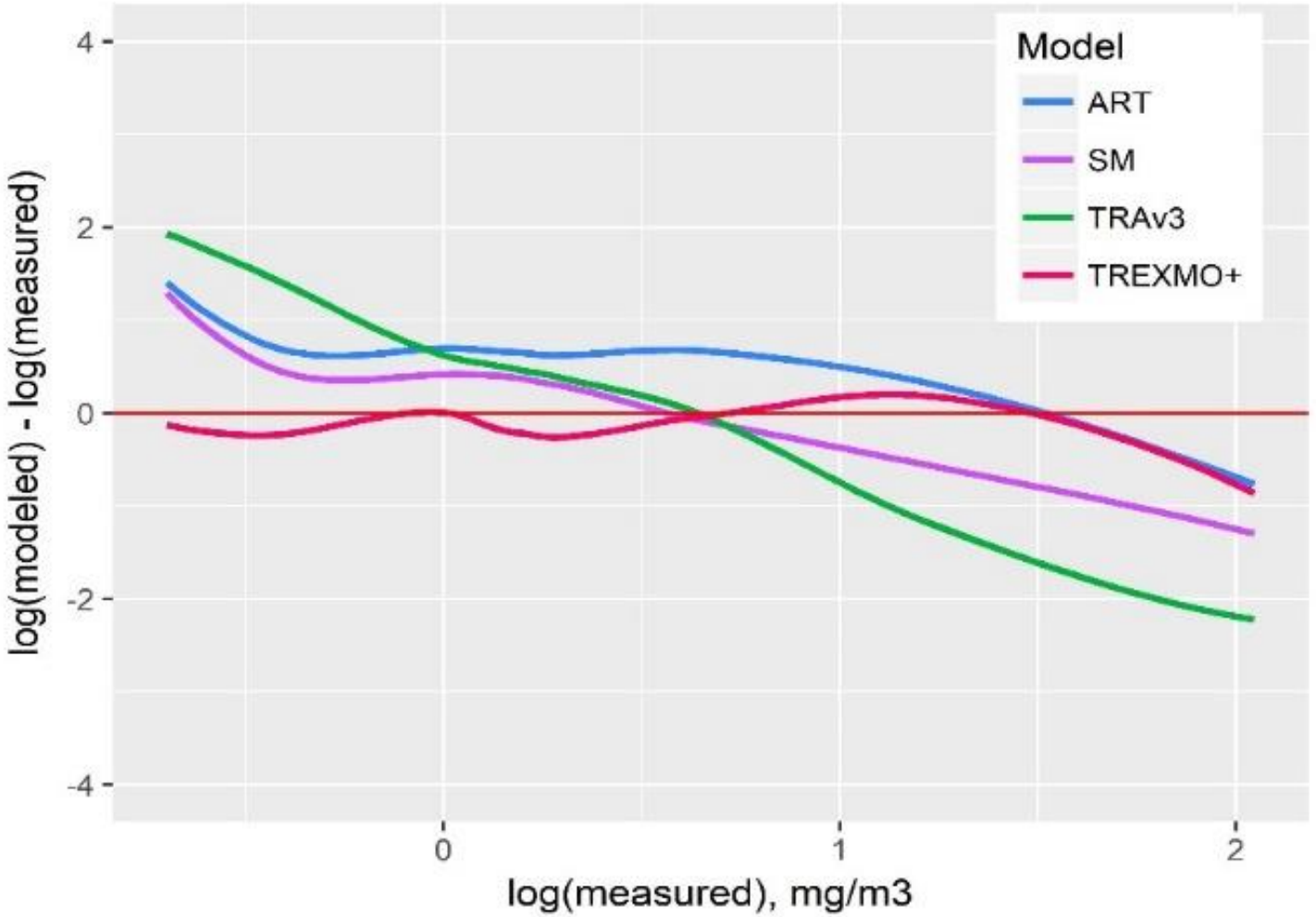


Dusty products (powders)

LIQUIDS


Model
ART
SM
TRAv3
TREXMO+
log(modeled) - log(measured)
4
2
0
-2
-4
-1
0
1
2
log(measured), mg/m3

POWDERS


Model
ART
SM
TRAv3
TREXMO+
log(modeled) - log(measured)
4
2
0
-2
-4
0
1
2
log(measured), mg/m3

THANK YOU FOR YOUR ATTENTION

unisanté

Centre universitaire de médecine générale et santé publique · Lausanne

Dr. Nenad Savic
nenad.savic@unisante.ch