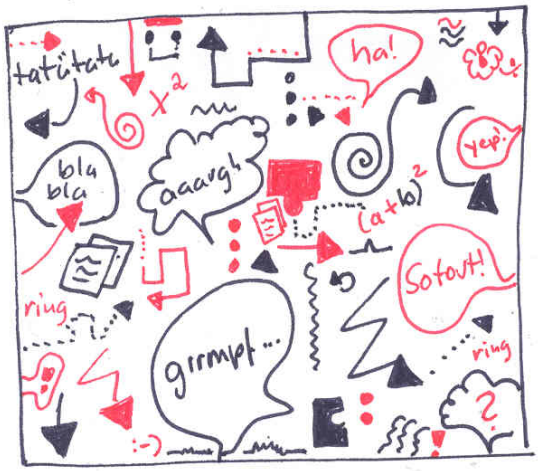
TRACE documents for good modelling practice

Volker Grimm

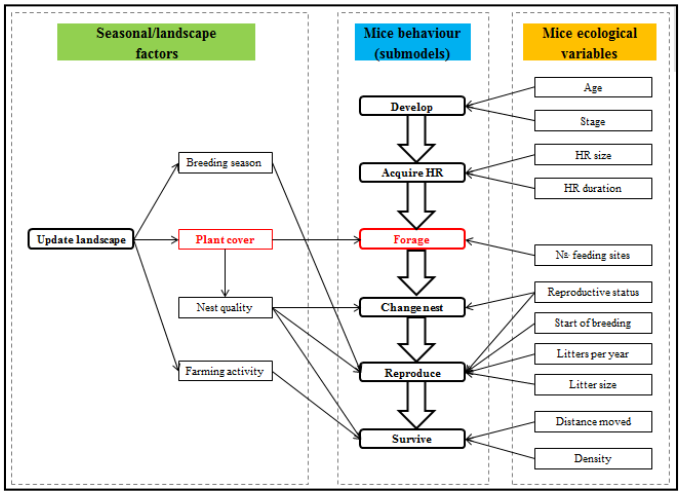
ZEE QUESTION: IS THE MODEL GOOD ENOUGH?

Model 1

Model 2



http://rotundschwarz-kd.blogspot.de/2010_05_01_archive.html



GOOD MODELLING PRACTICE

Do the right thing:

- Communicate the model
- Justify underlying simplifying assumptions
- Document sources of biological information
- Document tests and understanding
- Provide evidence that model is realistic enough
- Communicate sensitivity and uncertainty
- Make predictions that are relevant for risk assesment

Review by Schmolke et al. (2010)

- Elements of Good Modelling Practice **are all there** and well-known, in principle, and not too controversial
- Very good attempts to provide guidance already exist (EPA; also in hydrological modelling)

THE REAL PROBLEM IS

- **NOT** so much defining (guidance for) Good Modelling Practice

BUT getting this practice – into practice

BASIC IDEA OF TRACE

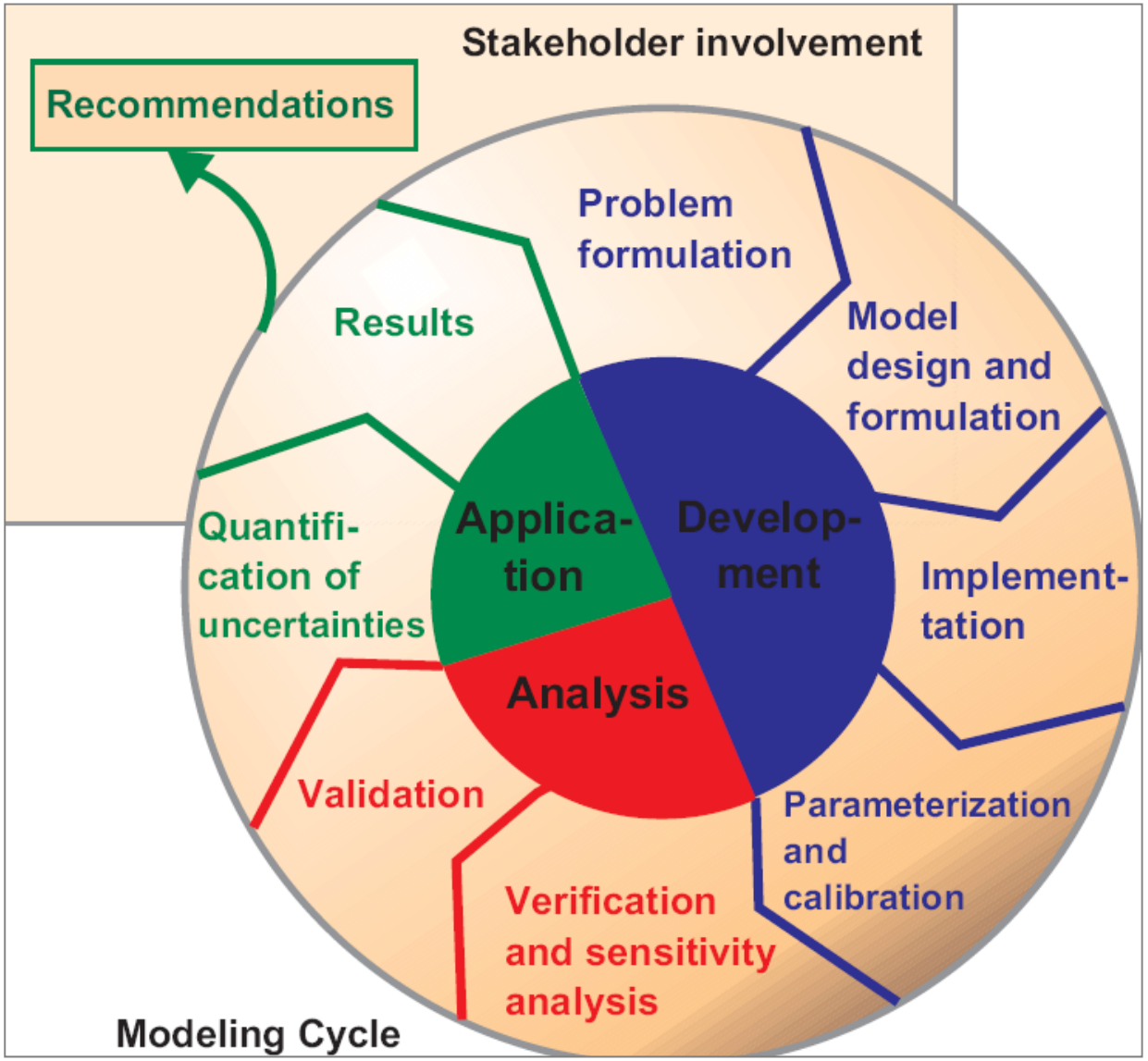
Instead of:

Do the right thing!

Document the right thing!

Establish a **standard** for documenting models, their development, and their analysis

BASIS OF STANDARD: THE MODELLING CYCLE



Box 1. TRACE (transparent and comprehensive ecological modeling) documentation structure

I. Model development

Problem formulation: *Context* in which the model will be used, and the type of audience addressed; *specification of the question(s)* that should be answered with the model; statement of the *domain of applicability* of the model, including the extent of acceptable extrapolations; assessment of the *availability of knowledge and data*; specification of necessary *model outputs.*

Design and formulation: Description of the *conceptual model*; description and justification of the *modeling approach* used and of the *complexity*; *entities and processes represented* in the model; most important, the applied *assumptions* about the system.

Model description: Detailed *description of the actual model* and how it has been *implemented* (programs, software platforms, scripts).

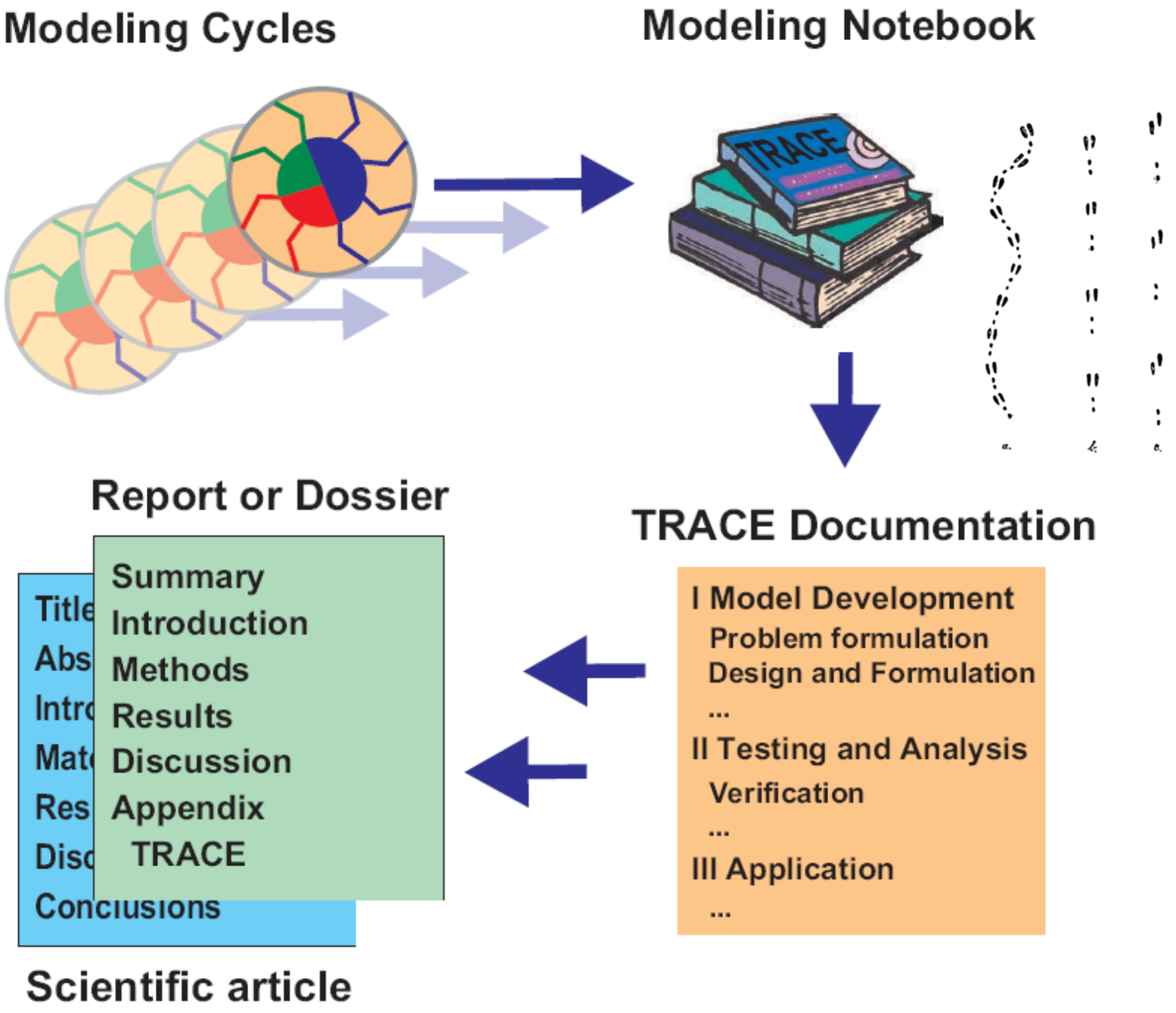
Parameterization: *List of all parameter values* used in the model, the *data sources*, and how the parameter values were obtained or calculated; *uncertainties* associated with each parameter.

Calibration: Documentation of the *data sets used* for calibration; *which parameters* were calibrated; what *optimization method* was used.

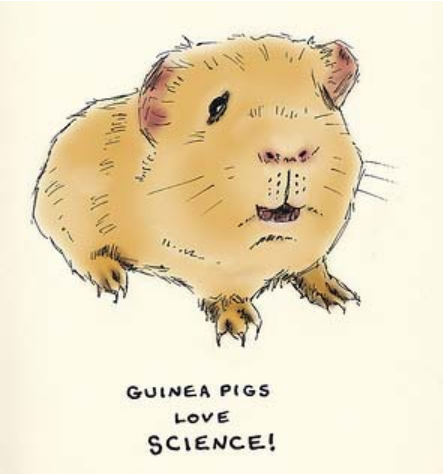
II. Model testing and analysis

Verification: Assessment of whether the model is working according to its specifications; documentation of what tests have been conducted.

Sensitivity analysis: Exploration of the model behavior for *varying parameters*; documentation of which *parameter combinations* have


Modeling Cycles
Modeling Notebook
TRACE
Report or Dossier
TRACE Documentation
Summary
Introduction
Methods
Results
Discussion
Appendix
TRACE
Conclusions
I Model Development
Problem formulation
Design and Formulation
...
II Testing and Analysis
Verification
...
III Application
...
Scientific article

OK – LET US TEST THIS IDEA



- Special Issue in "Ecological Modelling": about 10 TRACE documents produced
- TRACE II article (under construction) based on lessons learned in CREAM and elsewhere

http://laikaspoetnik.files.wordpress.com/2010/05/30-5-2010-1-18-46-guinea-pigs-love-science.png

TRACE: FREQUENTLY ASKED QUESTIONS

- Unclear what exactly should be included in TRACE documents
- Level of detail and style of presentation very diverse
- Relation between ODD, TRACE, Modelling Notebook unclear
- Overlap of ODD and TRACE
- Overlap of TRACE categories (parameterization, calibration, sensitivity analysis)
- TRACE only for new models?
- Who is going to read 100 pages or more?
- TRACE is technical, for modellers only (Wang and Luttik 2012)

UPDATE PAPER (under construction)

Towards better modelling and decision support: documenting model development, testing, and analysis using TRACE

Running head: TRACE

Volker Grimm*[1,2], Andreas Focks, Béatrice Frank, Faten Gabsi,
Alice S. A. Johnston[3], Katarzyna Kulakowska, Chun Liu, Benjamin T. Martin,
Mattia Meli, Viktoriia Radchuk, Amelie Schmolke, Pernille Thorbek,
Steven F. Railsback

TRACE: FREQUENTLY ASKED QUESTIONS

- Unclear what exactly should be included in TRACE documents
- Level of detail and style of presentation very diverse
- Relation between ODD, TRACE, Modelling Notebook unclear
- Overlap of ODD and TRACE
- Overlap of TRACE categories (parameterization, calibration, sensitivity analysis)
- TRACE only for new models?
- Who is going to read 100 pages or more?
- TRACE is technical, for modellers only (Wang and Luttik 2012)

- Information that significantly adds to the credibility of your model
- More specific guidance and templates are needed
- Oh, come on!

- Ja ja. Easy to fix.
- Will be fixed.

- Of course not, Chris!
- Supplement. Hierachical structure/reading
- Misunderstanding. Biological background IS part of TRACE!

STILL SOMETHING FUNDAMENTALLY WRONG

TRACE provides

- **a standardized structure and terminology for documentation**
- **a checklist for modellers and decision makers**

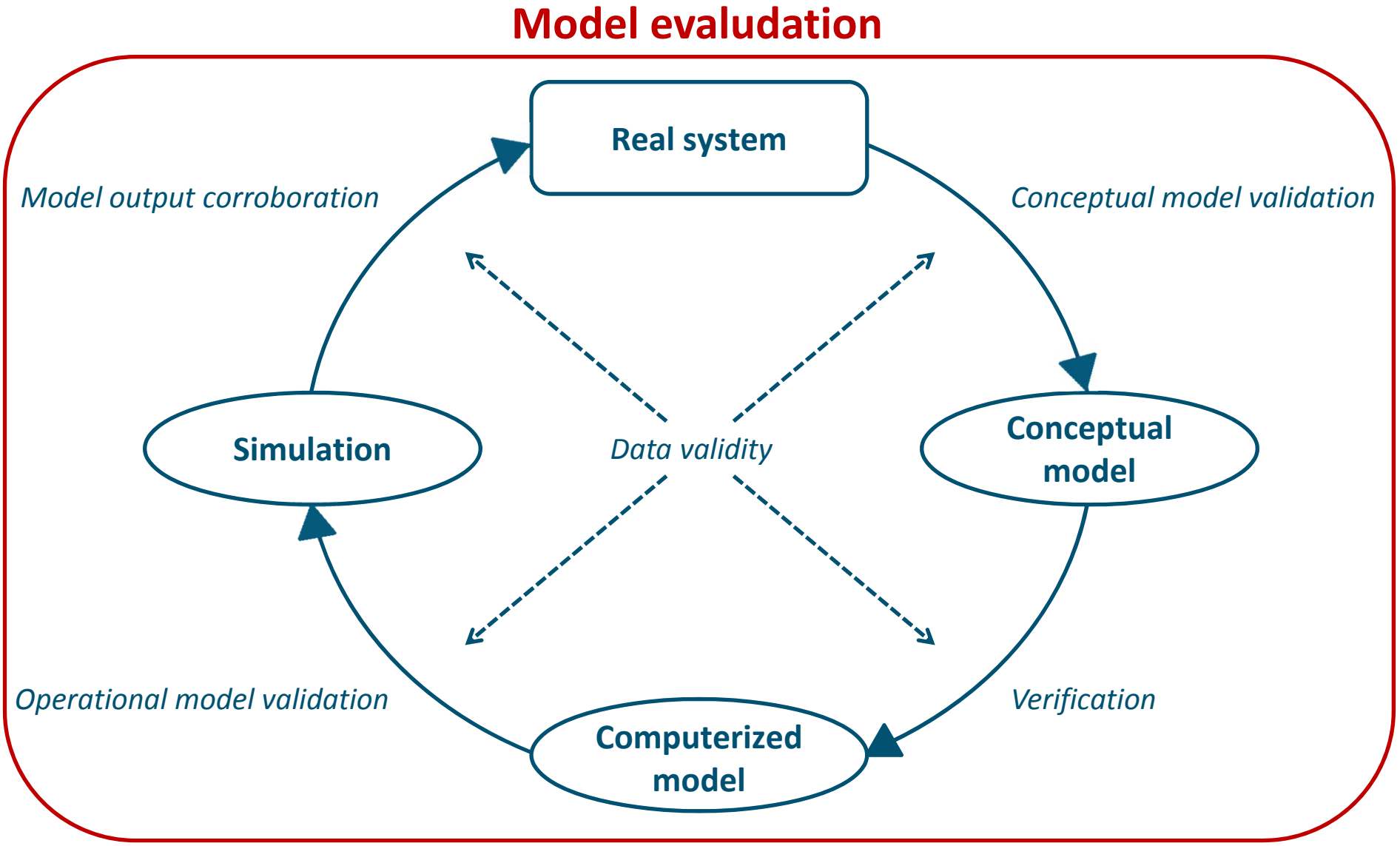
So far, so good, but:

HOW BORING IS THAT, documentation?

TRACE needs to be much clearer linked to a purpose or process!

- **This would make writing and reading TRACE documents much easier and more useful**

TRACE AND EVALUDATION: CLOSELY RELATED



LINKING TRACE AND EVALUDATION

EVALUDATION:

'The entire **process** of establishing model quality and credibility throughout all stages of model development and application' (Augusiak et al., in prep.)

TRACE:

- A standard format for organizing and documenting the five elements of model evaludation
- A means to and end: documenting to what degree and how good modelling practice was followed

But: There is still Valery's question

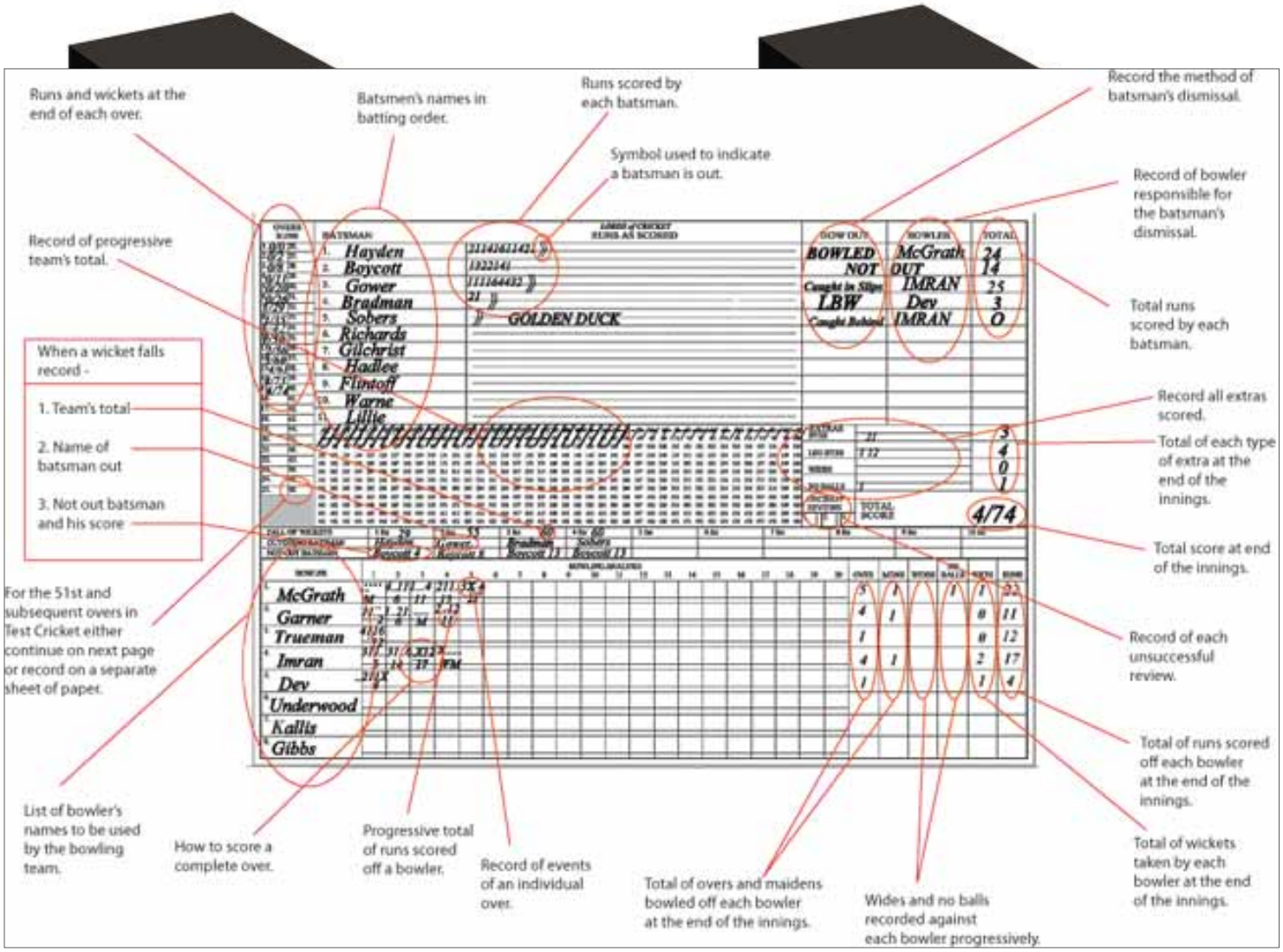
VALERY'S QUESTION

"But .. when IS a model good enough to base a decision on it?"

TRACE and Evaludation do not answer this question, but:

- For each step of model evaludation/the TRACE document, we can **assemble criteria and approaches**, from **simple and not too powerful** to **complex but convincing**
- "Good enough" should then be **related to the purpose** of the model (e.g., screeing, scenario assessment, quantitative predictions)

IS THE MODEL GOOD ENOUGH: FILL IN THE SCORE SHEET



EXAMPLE

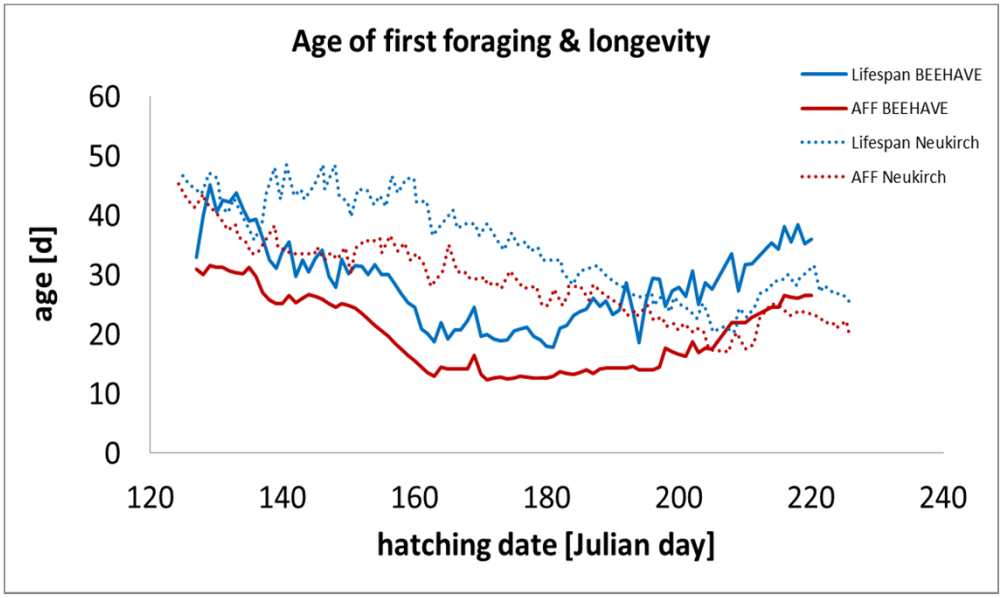
Table 1. Comparison of experimental data and model results for average age of onset of foraging (AAOF) and lifespan.

Colony	Flightspan (days)	Deathrate, m (days^{-1})	AAOF		Lifespan	
			Observed	Model	Observed	Model
1 (Large)	7.5	0.133	18.6	19.4	22.8	26.9
2 (Large)	6.5	0.154	18.4	17.7	22.3	24.2
3 (Small)	6.7	0.149	23.8	17.6	26.6	24.3
4 (Small)	8.8	0.114	22.2	20.4	26.4	29.2

Experimental data is from Rueppell et al [33] and model results were obtained by running the model for 40 days (approximately the observational period used by Rueppell et al). At the start of each model run $H = 9000$ for large colonies and 4500 for small colonies and $F = 0$. The parameters were $L = 2000$, $w = 27000$, $\alpha = 0.25$ and $\sigma = 0.75$.

doi:10.1371/journal.pone.0018491.t001

Khoury et al. 2011. PLoS ONE 6(4): e18491.



BEEHAVE, Becher et al., in prep.

How much does this information add to the credibility of the models?

SUMMARY

- How can decision makers assess and use models?
- Idea of TRACE still good, but
- Update needed
- Link TRACE and Evaludation
- On the basis of this, define assessment criteria ("score sheet")