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Computer Models

…getting more out
than you put in!

What is a model?

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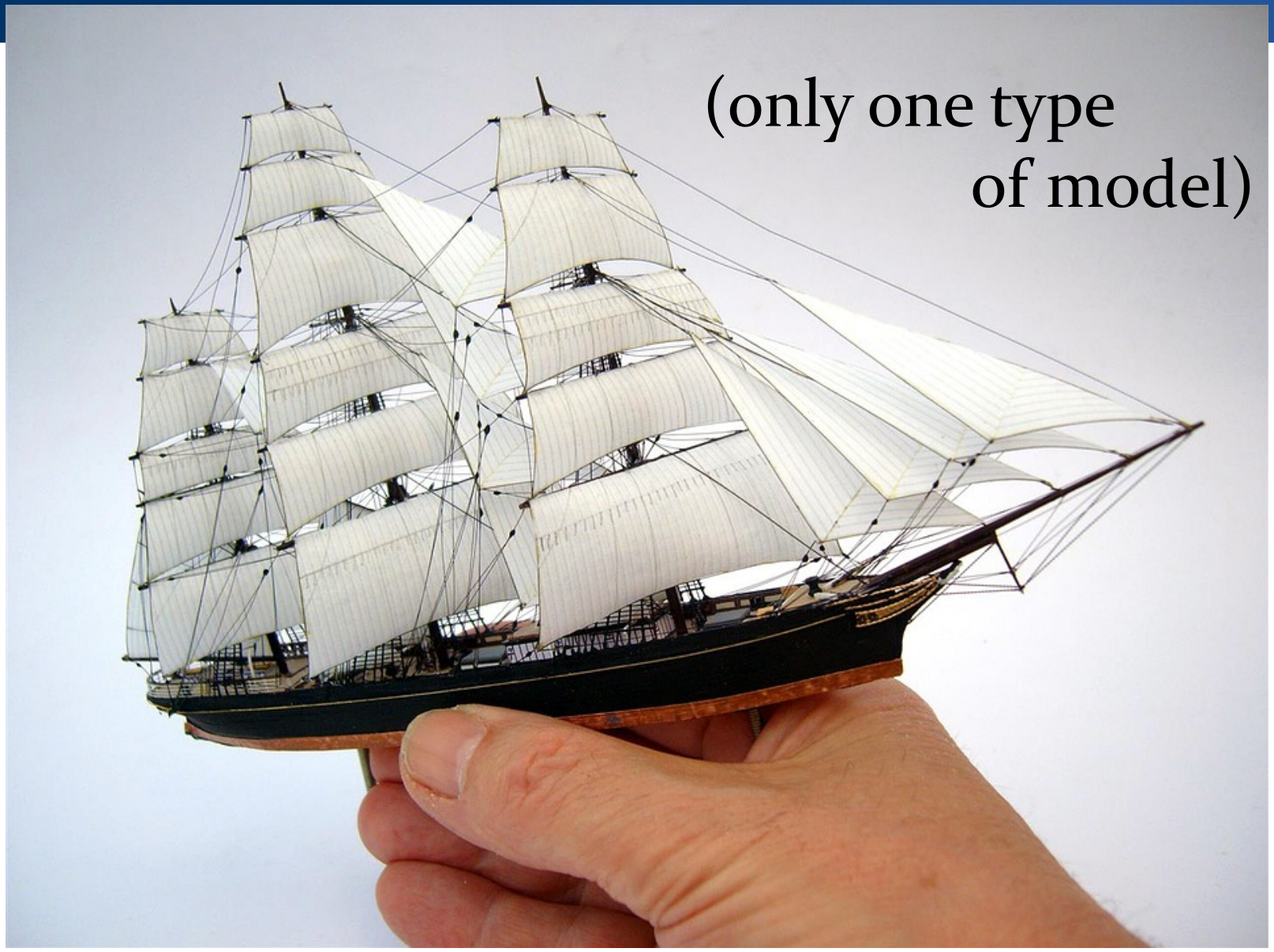

webinar trajectory…

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1) expansive view of models

2) computer models

3) approaches to get the most out of computer modeling

What is a model?

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A model is:

an anthropogenic system or object,
created to represent a subset of reality,
often (but not always) to scale,
and useful for…

…explanation, prediction, and control

simple example

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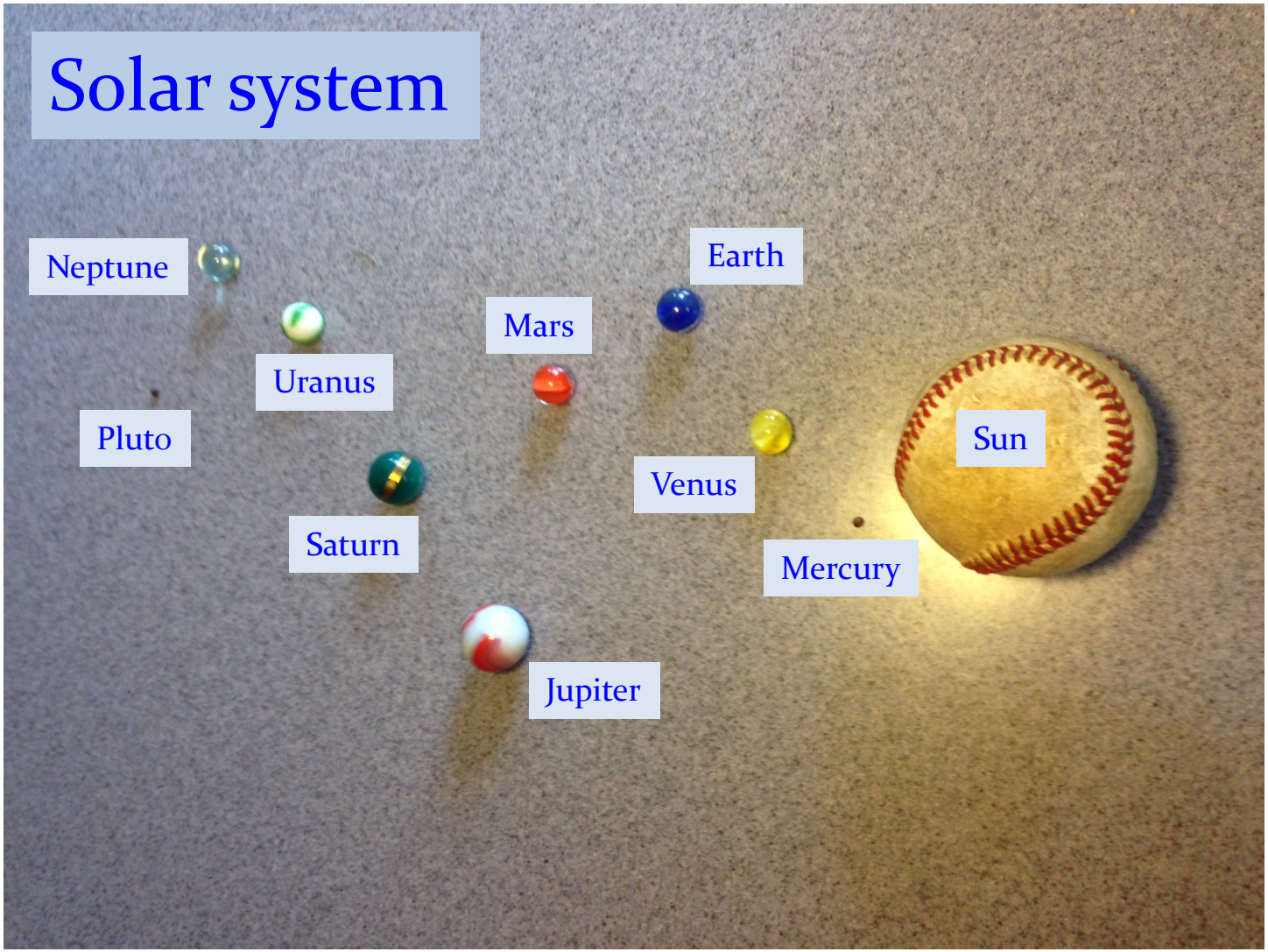

simple example

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physical vs. mathematical

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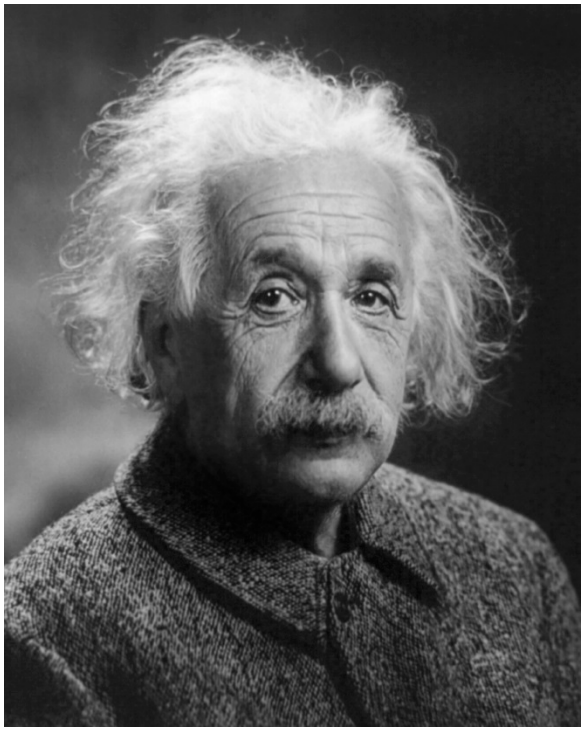
Most models are not physical.



"thought experiments"
are models too.

Is a map a model?

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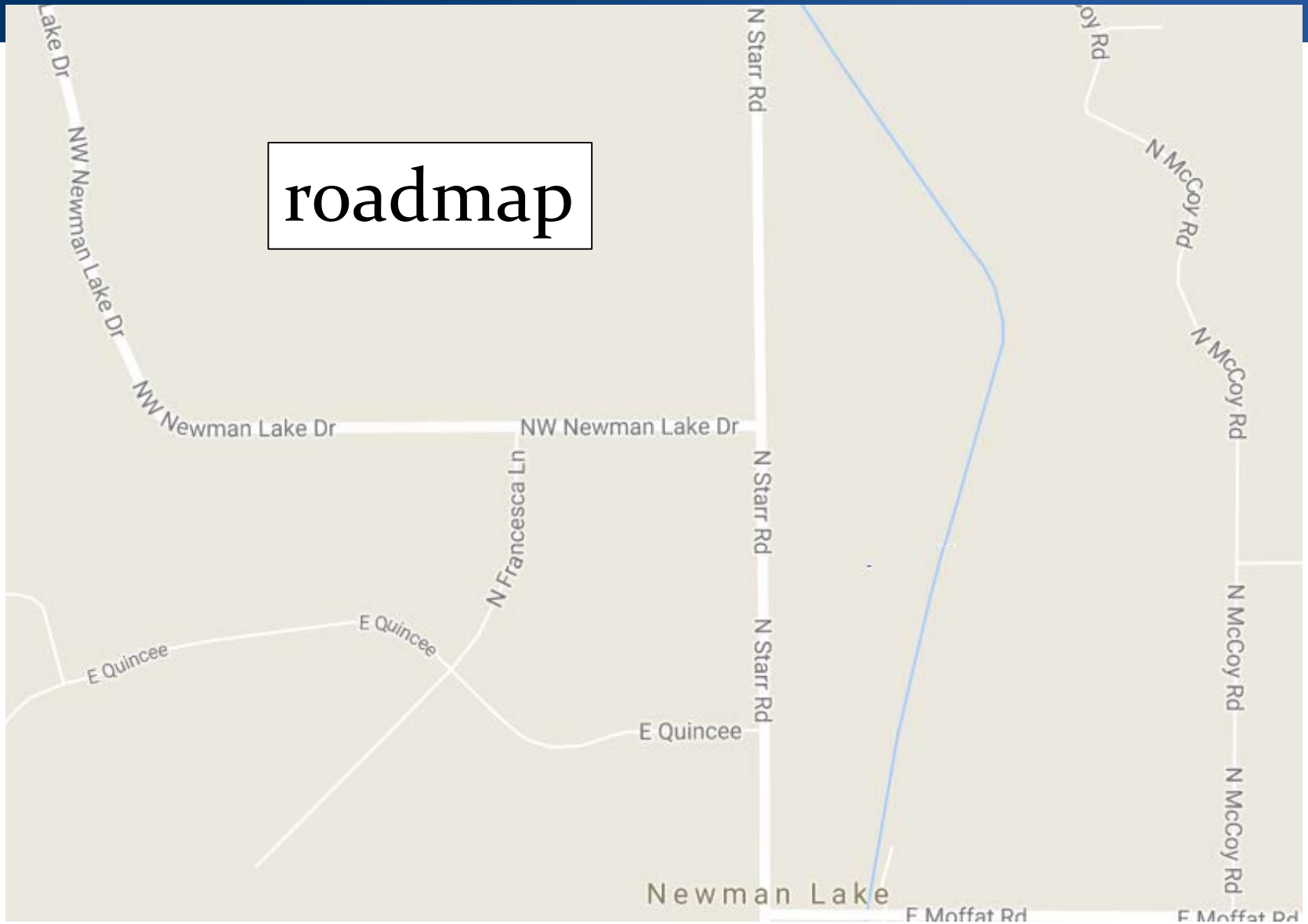

What about ideas?

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Everything we are thinking

is some type of model!

never “one to one”

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No model, map, or idea has a
one to one relationship with reality.

Some stuff is left out!

Which is ok, if…

…nothing important has been left out!

Model Dependent Realism

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We judge models the same way we judge ideas.

Do they “work”?

human nature

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Models
that do not
correspond
very well
with **reality**

are usually not
very reliable!

homework...

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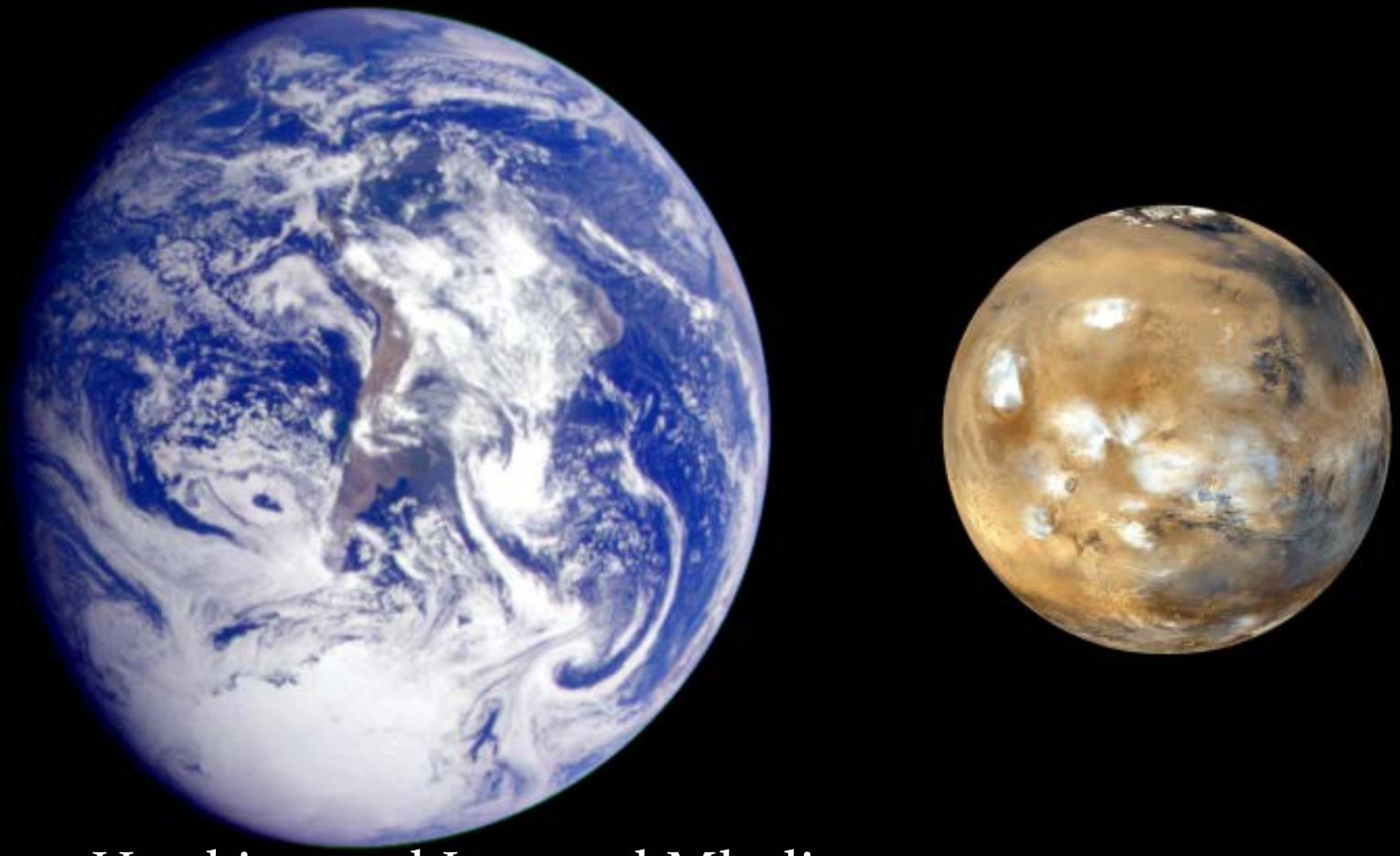
Google “Model Dependent Realism”



Stephen Hawking and Leonard Mlodinow,
“The Grand Design” 2010.

homework...

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from The Grand Design:

"We make models in science,
but we also make them in everyday life.

Model-dependent realism applies
not only to scientific models
but also to the conscious mental models we create

in order to interpret and understand the everyday world."

computer models

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Grace Hopper

(who coined the term "debugging")

computer models

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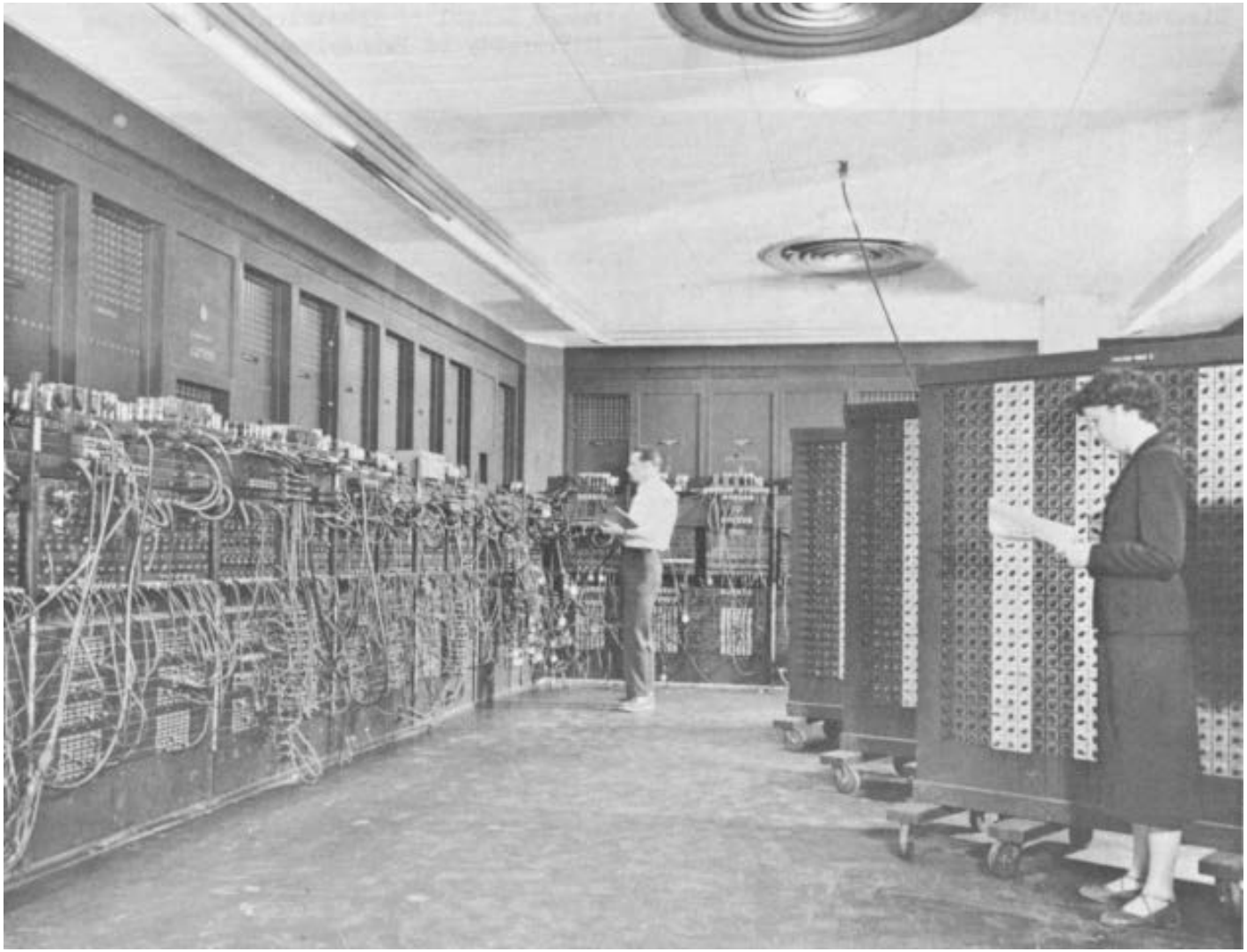
NOTE:
the
computer
is not
the model!

(just a tool)



computers vs. human nature

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computers vs. human nature

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"It may be 'garbage in, garbage out'…"

"…but *my* input is never garbage!"

computer models

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How do you know
what a computer model is good for?

Need to understand roles of:
developer
user
customer (beneficiary)

Also, if you are the user:
have a good "conceptual model"

computer models

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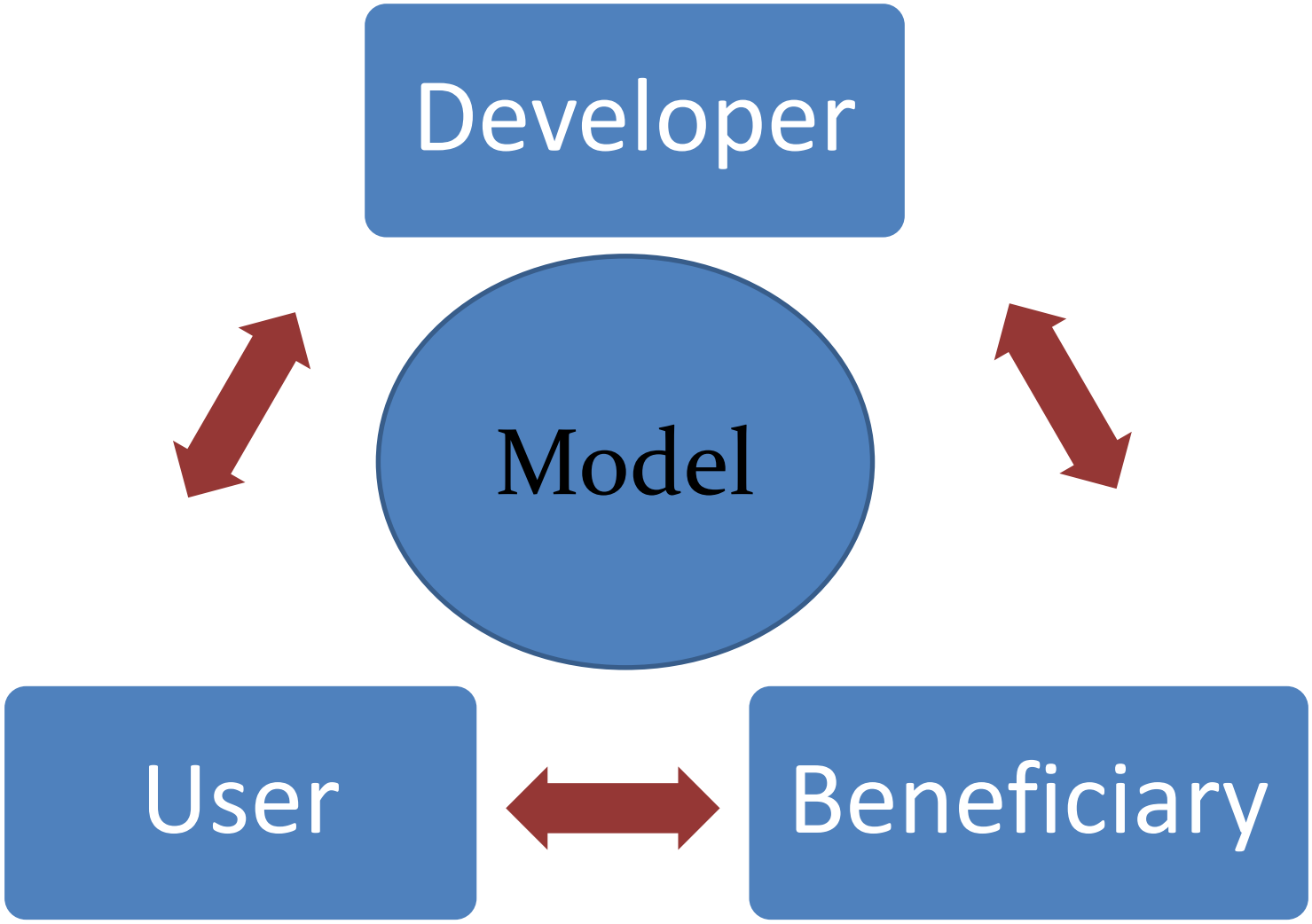

computer models

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Developer

creates it: cooperation between content experts & programmers

User

runs it: gathers input data, assembles model pieces, interprets output

Customer/Beneficiary

applies changes: to solve problems

computer models

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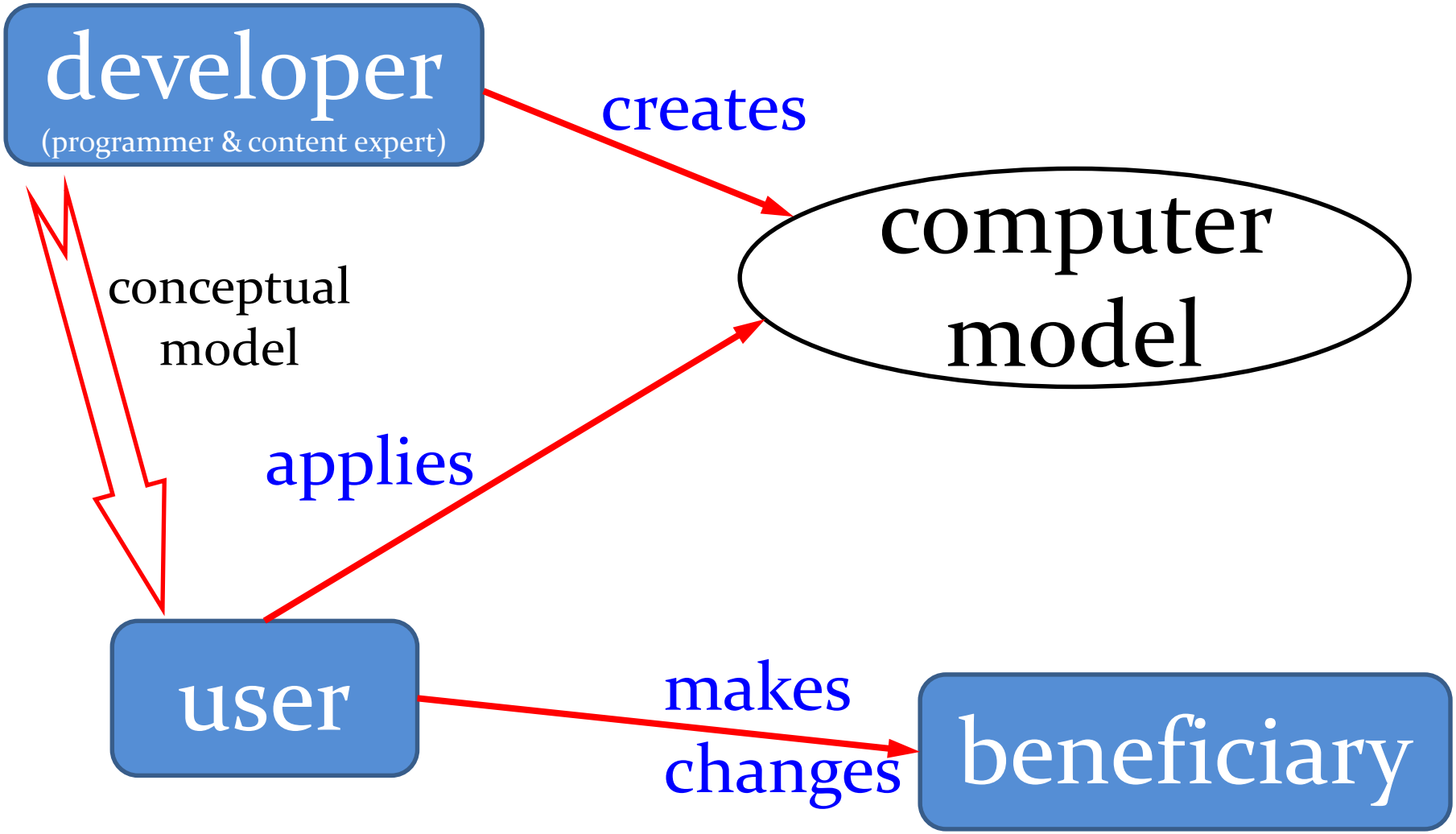

model developer

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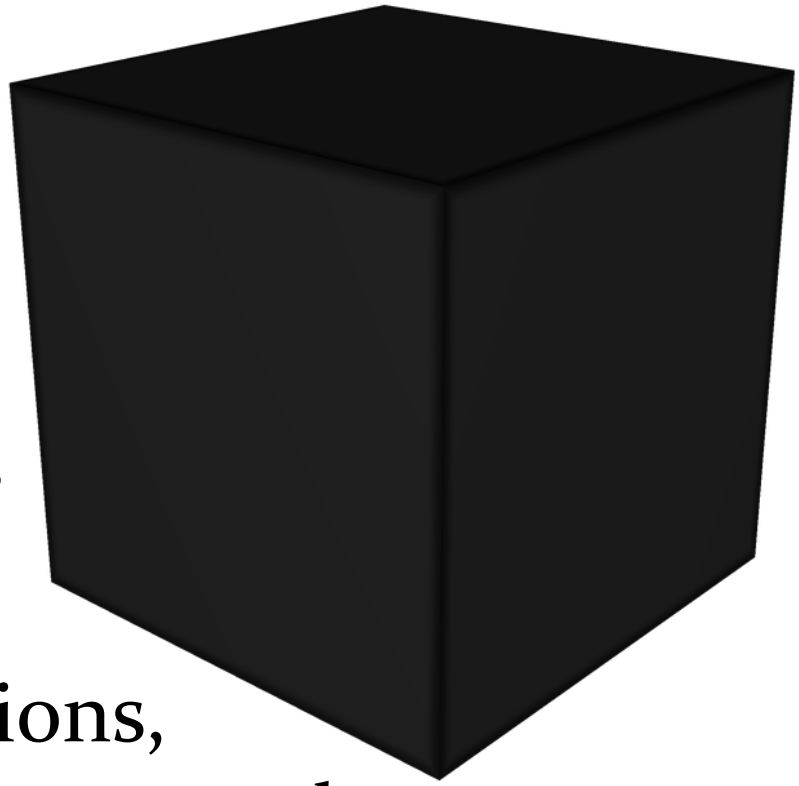
Model user and customers

developer / user relationship

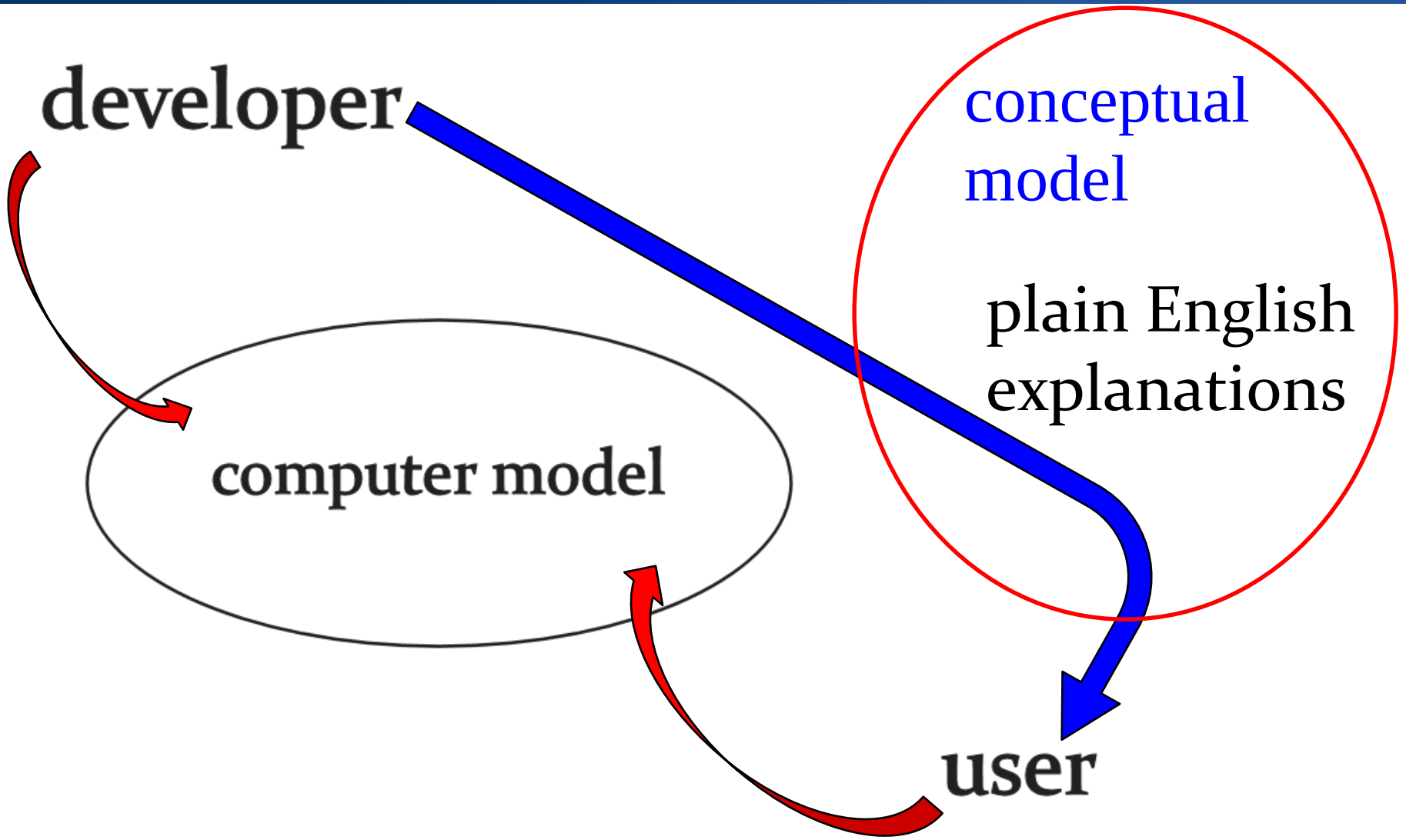
...every model is, to some extent, a black box.



The responsible developer provides the user with a valid "**conceptual model**"

through interface, instructions, or user manuals.

developer / user relationship



homework...

check out
"The Design of Everyday Things"

by Don Norman, 1988
(or Google him!)

developer / user relationship

The user can get mixed up if the developer:

1) provides no conceptual model

2) one that is incorrect or misleading

3) one that is unnecessarily complicated

developer / user relationship

The developer
should provide a good
conceptual model, but…

developer / user relationship

...the user does bear
some responsibility!

(RTFM)

model complexity

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Let's say, simple, medium, and complex…

model complexity

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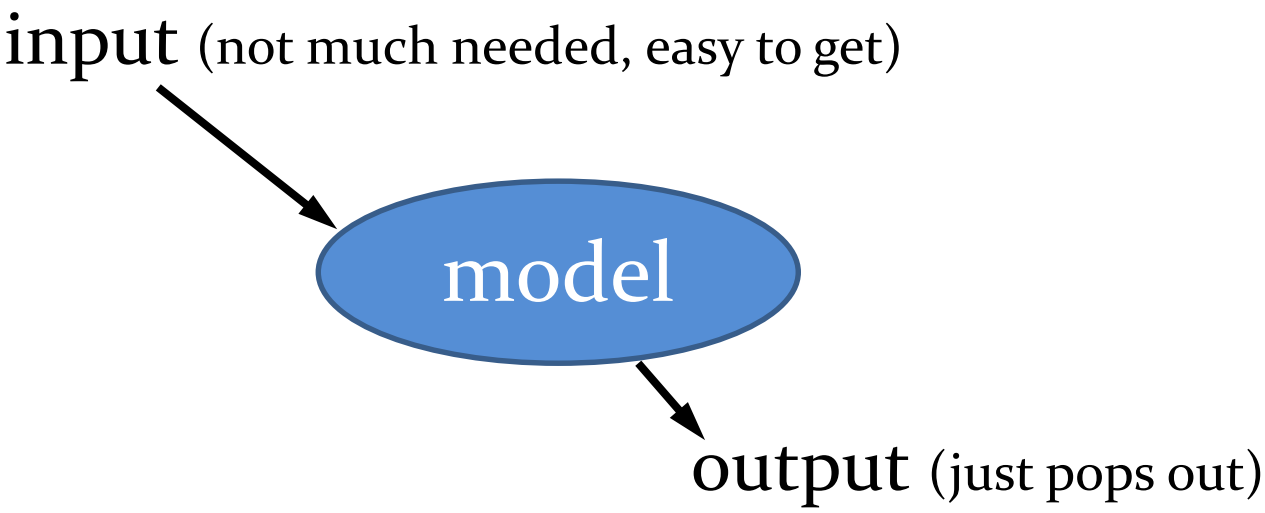
Let's say, simple, medium, and complex…



model complexity

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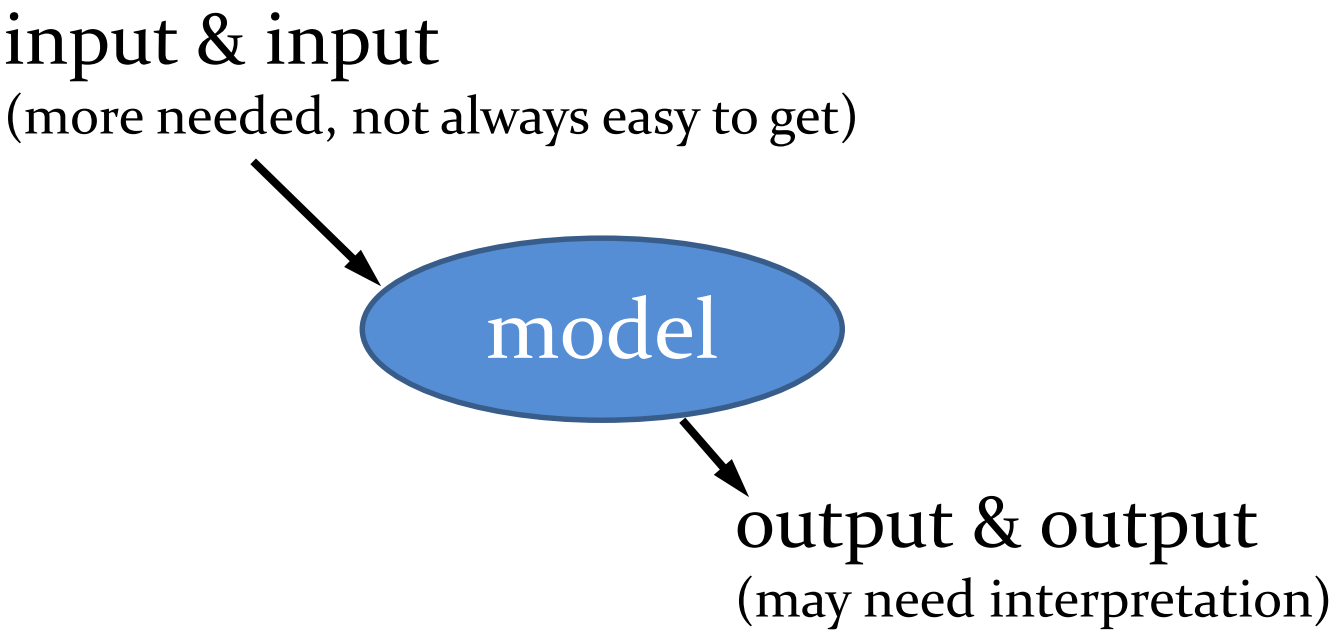
Let's say, simple, medium, and complex…



model complexity

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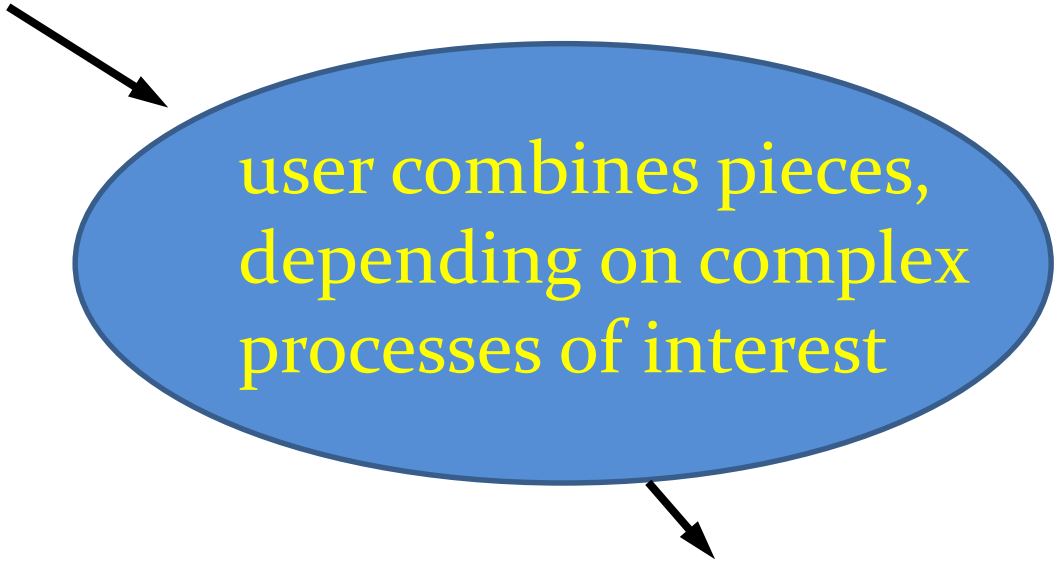
Let's say, simple, medium, and complex...

input (lots needed, often hard to get)

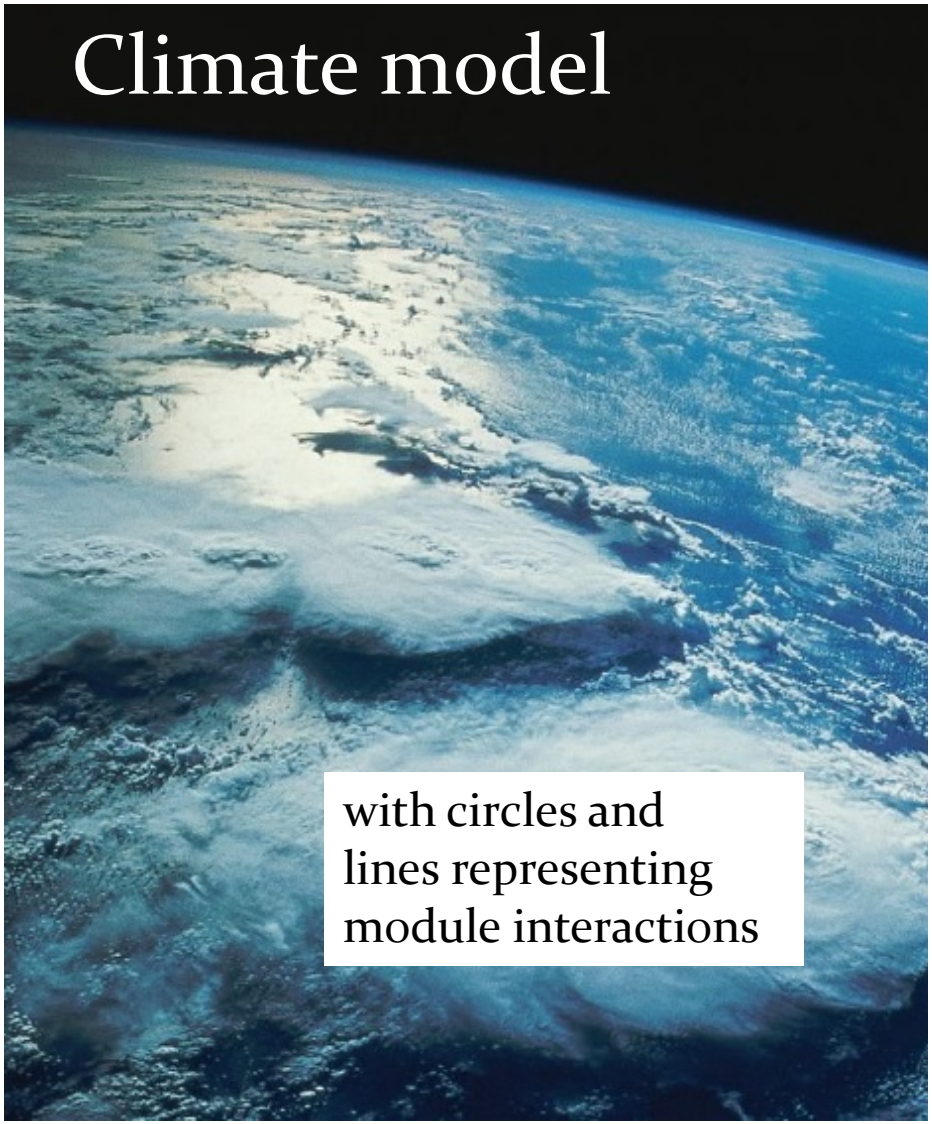


output

(model might "blow up", output may need much interpretation)

complex example

Climate model



with circles and lines representing module interactions

The software structure (subroutine) of CLM. Each circle represents an individual subroutine with the area of the circle showing the time spent on the subroutine with linear representation. Image credit: Wang, D. et al., "Environmental Modeling and Software" 55 (2014).

complex example

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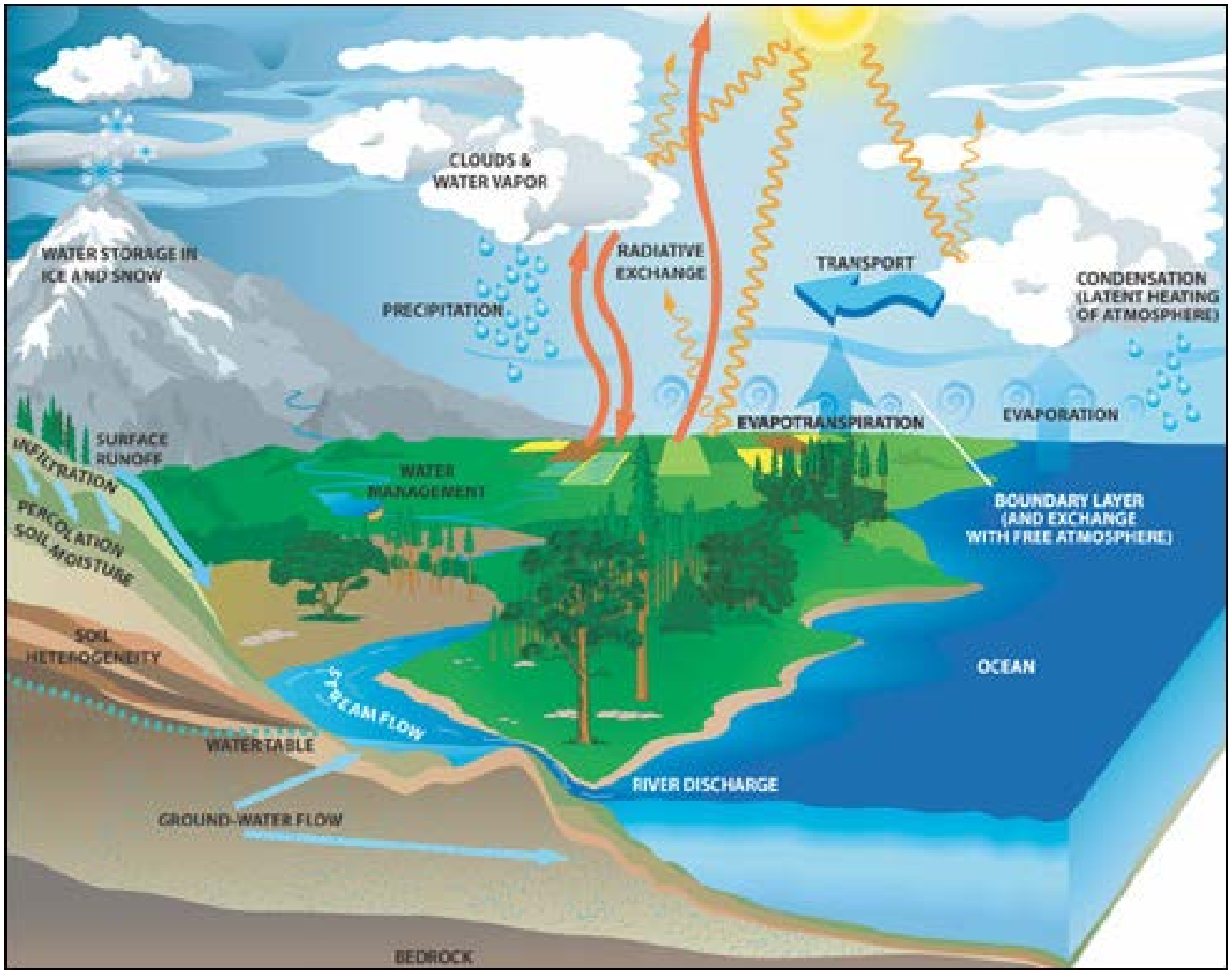
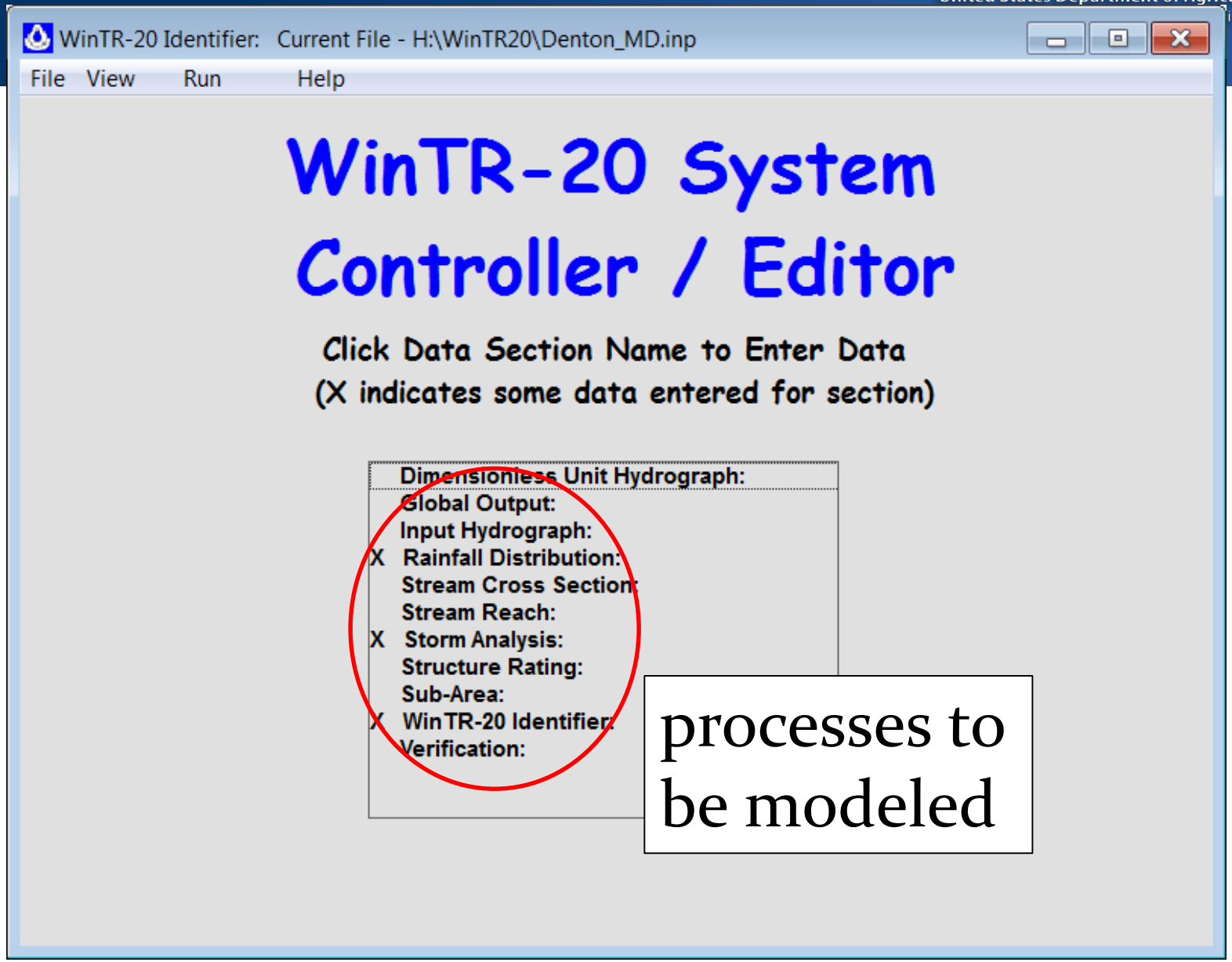
hydrology
(rainfall-runoff)



WinTR-20


WinTR-20 Identifier: Current File - H:\WinTR20\Denton_MD.inp
File View Run Help
WinTR-20 System Controller / Editor
Click Data Section Name to Enter Data
(X indicates some data entered for section)
Dimensionless Unit Hydrograph:
Global Output:
Input Hydrograph:
X Rainfall Distribution:
Stream Cross Section:
Stream Reach:
X Storm Analysis:
Structure Rating:
Sub-Area:
X WinTR-20 Identifier:
Verification:
processes to be modeled

HecHMS

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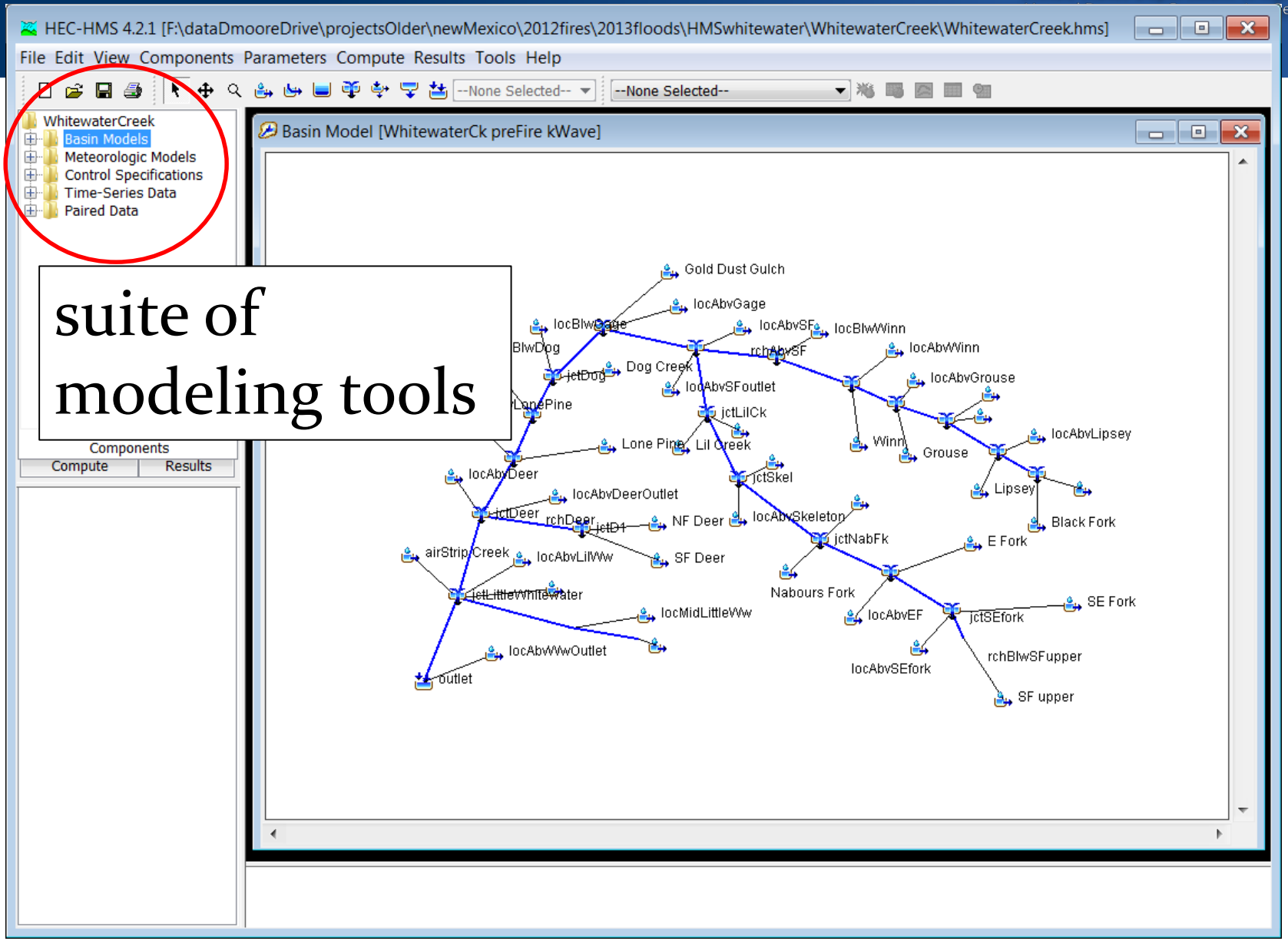
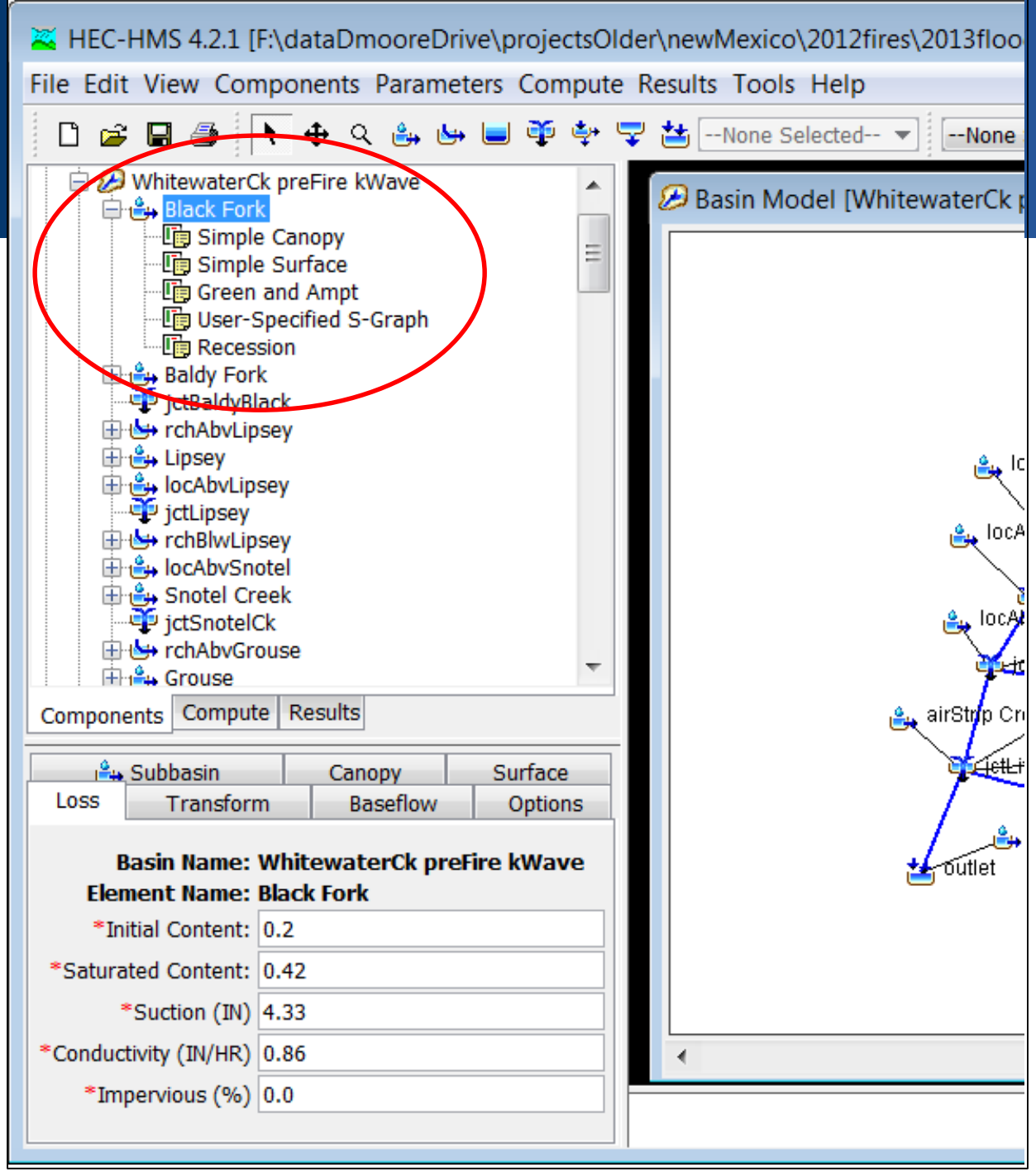


suite of modeling tools

HecHMS

The user decides the best way to model each process.



hydrologic model application

keys to success

The responsible model user will:

Learn how the model works by reading and understanding user manuals,

Get training, if needed,

Interact with other users and support teams,

Be *organized* and *document* model use.

hydrologic model troubleshooting

Second, build & test the model incrementally…

With a complicated model,
don't build the whole thing
before running a single test.

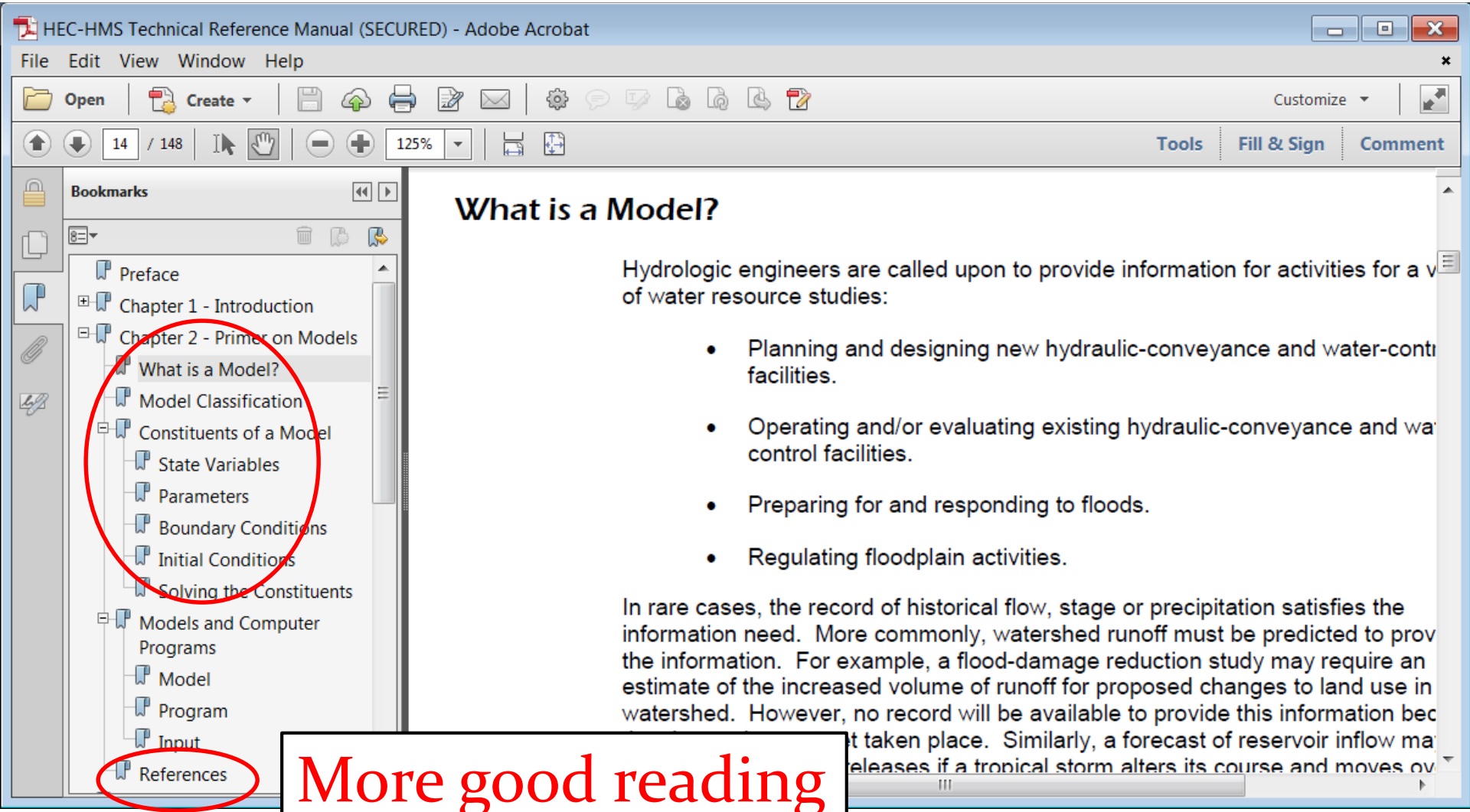
Make a simple version work, and
add complications one at a time,
testing as you go.

hydrologic model troubleshooting

Third, use Occam's Razor…

Look first for the simplest explanation
to a problem
before assuming
a more complicated explanation.

a good reference (HMS user manual)



More good reading

NRCS Models

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WQIag

Water Quality Index for Agricultural Runoff

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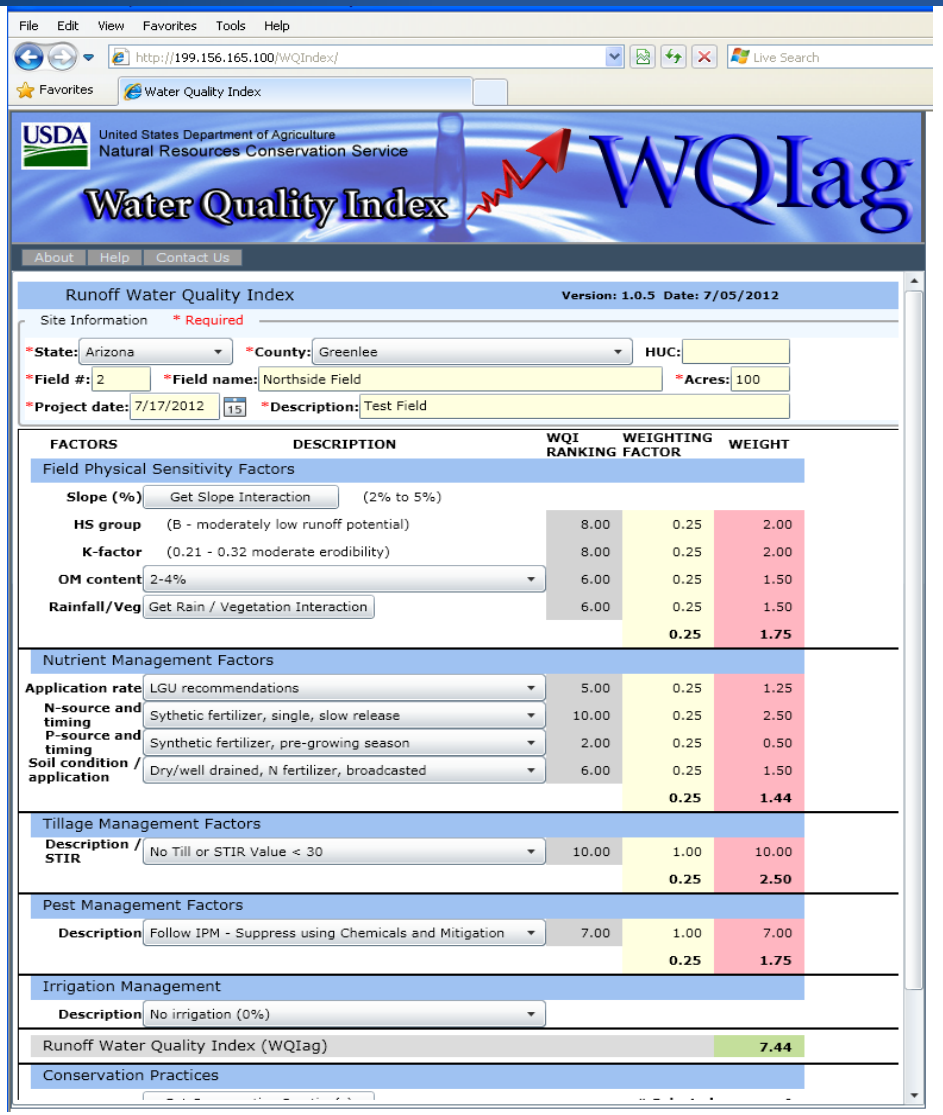
For assessing the impact of crop production systems and conservation practices on environmental benefits—primarily runoff water quality.

NRCS Field Staff and TSPs and other federal, state and local agencies

Understanding of field characteristics and agricultural operational management including conservation practices

The initial web-based system used and adopted by several agencies. The new spreadsheet version is under development



AWM
Animal Waste Management System

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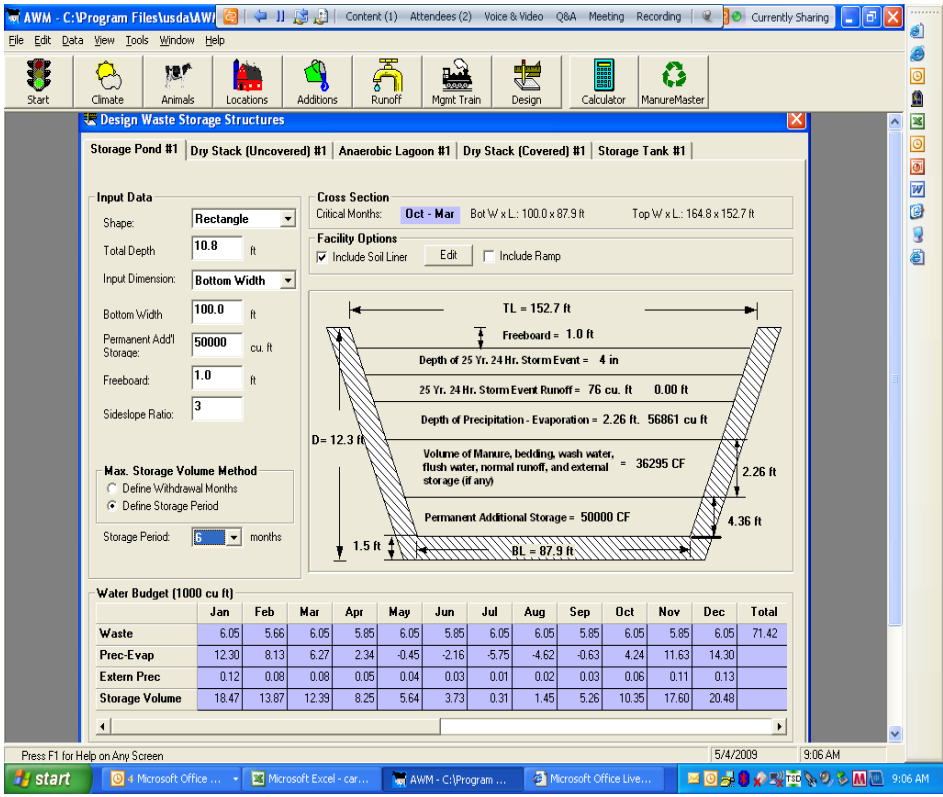
Planning/designing/evaluating waste storage structures for animal feeding operations

NRCS field engineers and TSPs

A good understanding of the operation including regulatory requirements of waste storage periods and application timings



MMP
Manure Management Planner

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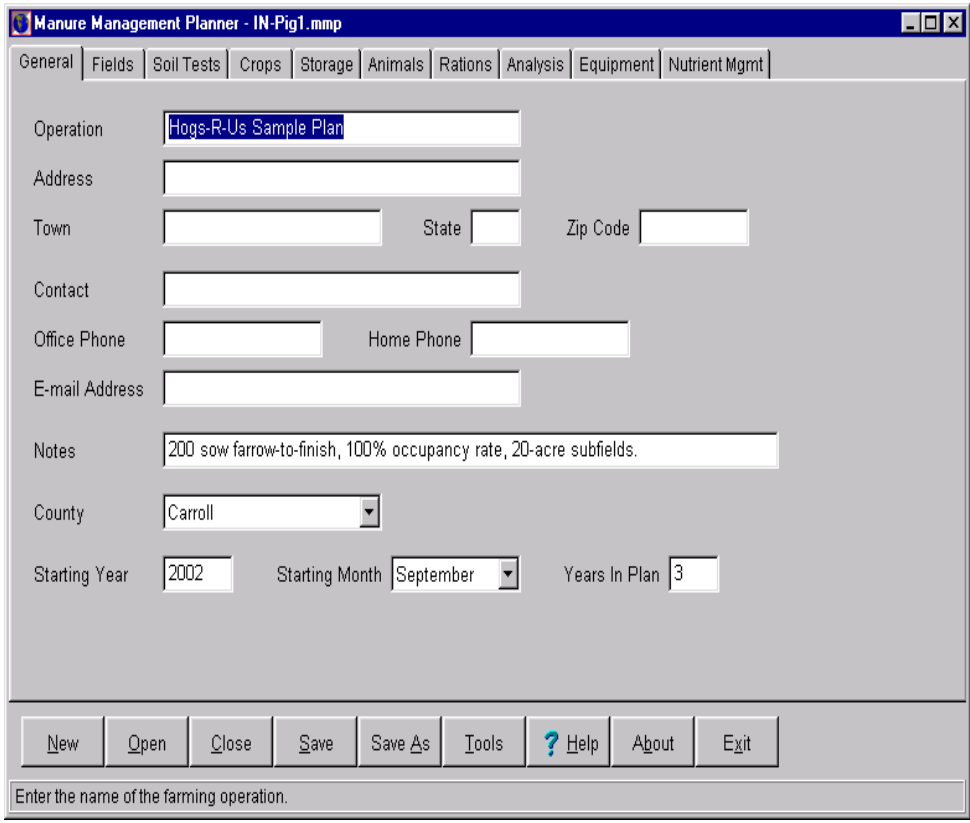
Creating manure management plans for crop production for animal feeding operations

NRCS field engineers and TSPs

A good understanding of field crops and their nutrient requirements /appropriate timing of applications



NTT
Nutrient Tracking Tool

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Estimating change (delta) in crop yield, nutrient (N&P) and sediment losses for current and alternative management/conservation practice(s) scenarios for resource planning and generating water quality credits

Primarily for TSPs and other entities involved in water quality credits for environmental markets

Basic GIS knowledge and understanding of input requirements and interpretation of the reports

NTT Conceptual Framework & Its Complexities

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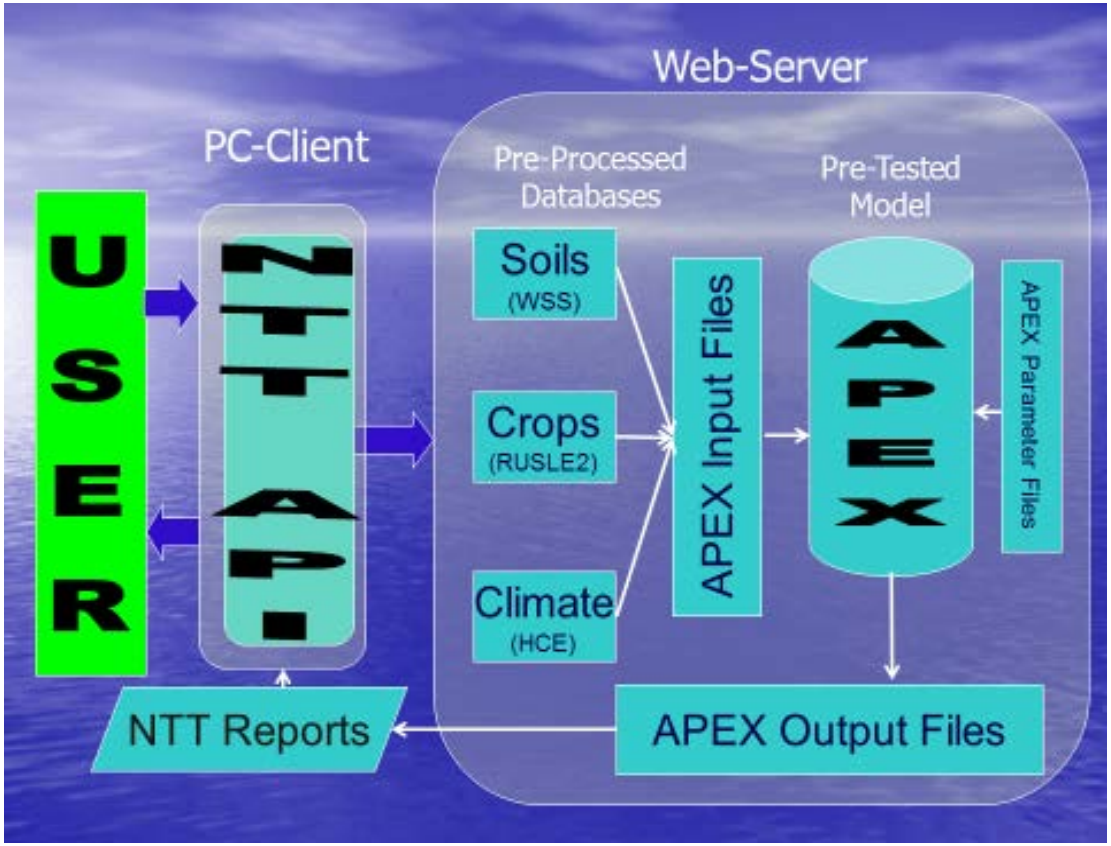

A complex framework with a linkage to a very sophisticated model (APEX)

Several possibilities for error intrusions:

- Collecting user-input data
- Translating user-supplied and other input data into APEX input files
- Properly and successfully running the APEX model with dynamic and static input files
- Analyzing APEX output files to prepare and present NTT reports

Making the Best of a Model

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Understanding its framework, strengths and limitations

Reliability and accuracy of the input data and their sources

Accurately transforming input data from their source into the format acceptable to the model

Stability and accuracy of the model judged through

i. Verification
ii. Sensitivity Analysis
iii. Calibration
iv. Validation

Analysis and interpretation of the model output results

Making the Best of a Model

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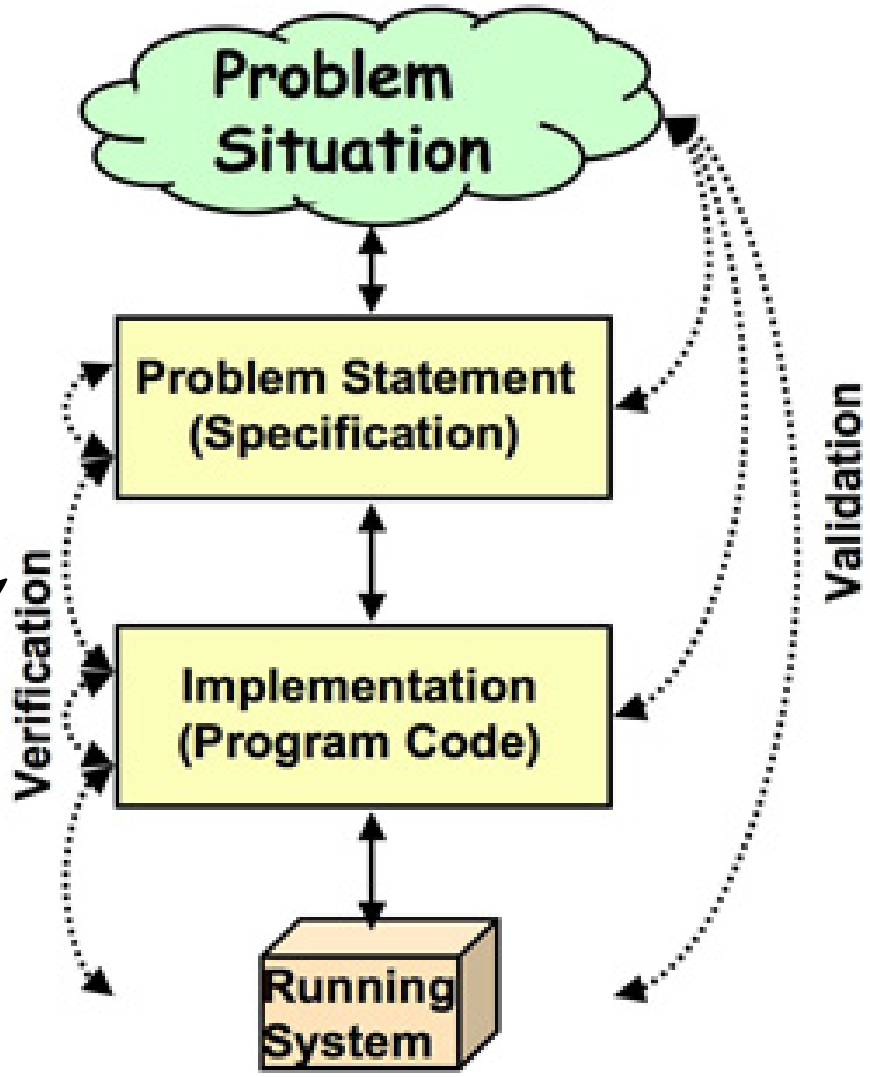
Verification

A process of demonstrating the formalism of the "Model" is correct



Developer responsibility

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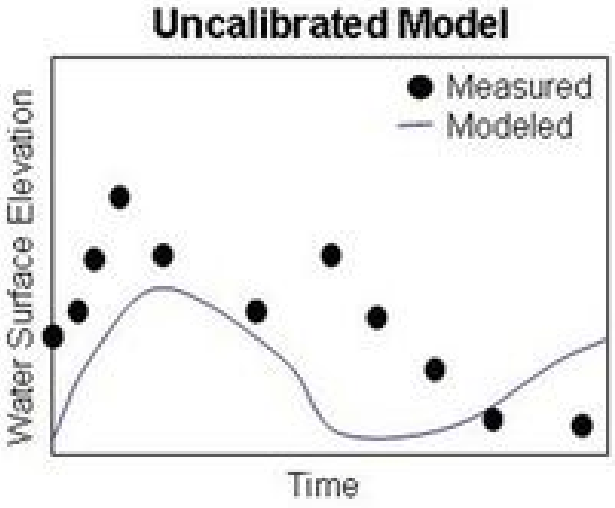
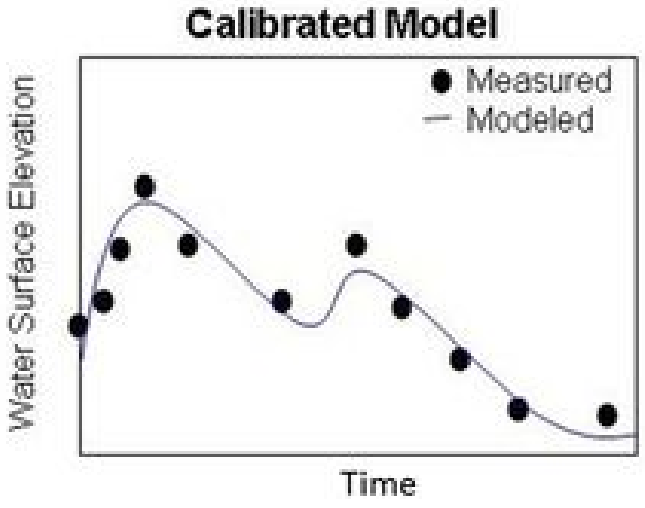
Calibration / Parameterization

A process of estimating and adjusting parameters and constants of the "Model" to improve the agreement between its output and the real life observations





Developer/User responsibility

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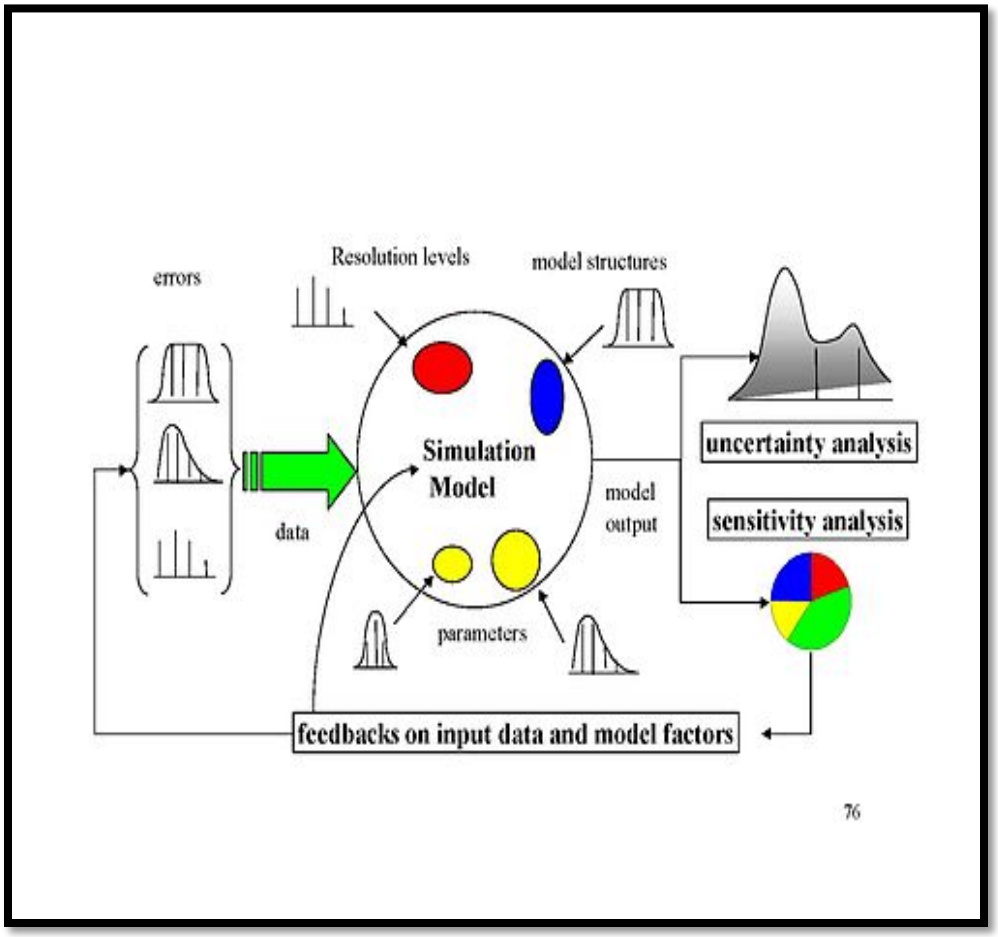

Sensitivity Analysis

A process of studying how the uncertainty in the "Model" output can be apportioned to different sources of uncertainty in its input data

User responsibility

Making the Best of a Model

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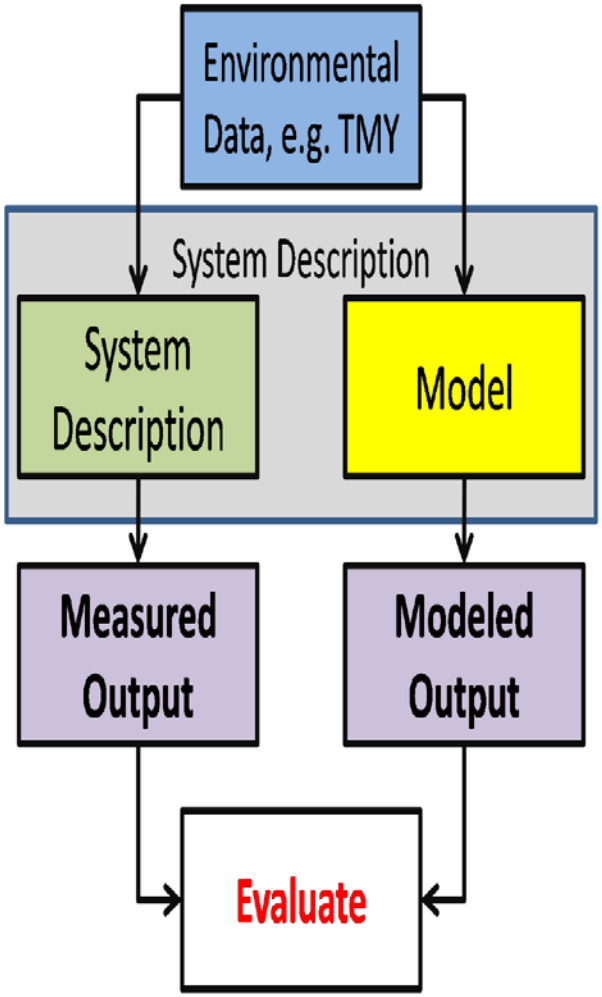
Validation

A process of demonstrating that the model possesses a satisfactory range of accuracy consistent with its intended application within its domain of applicability



An Example of Model Validation

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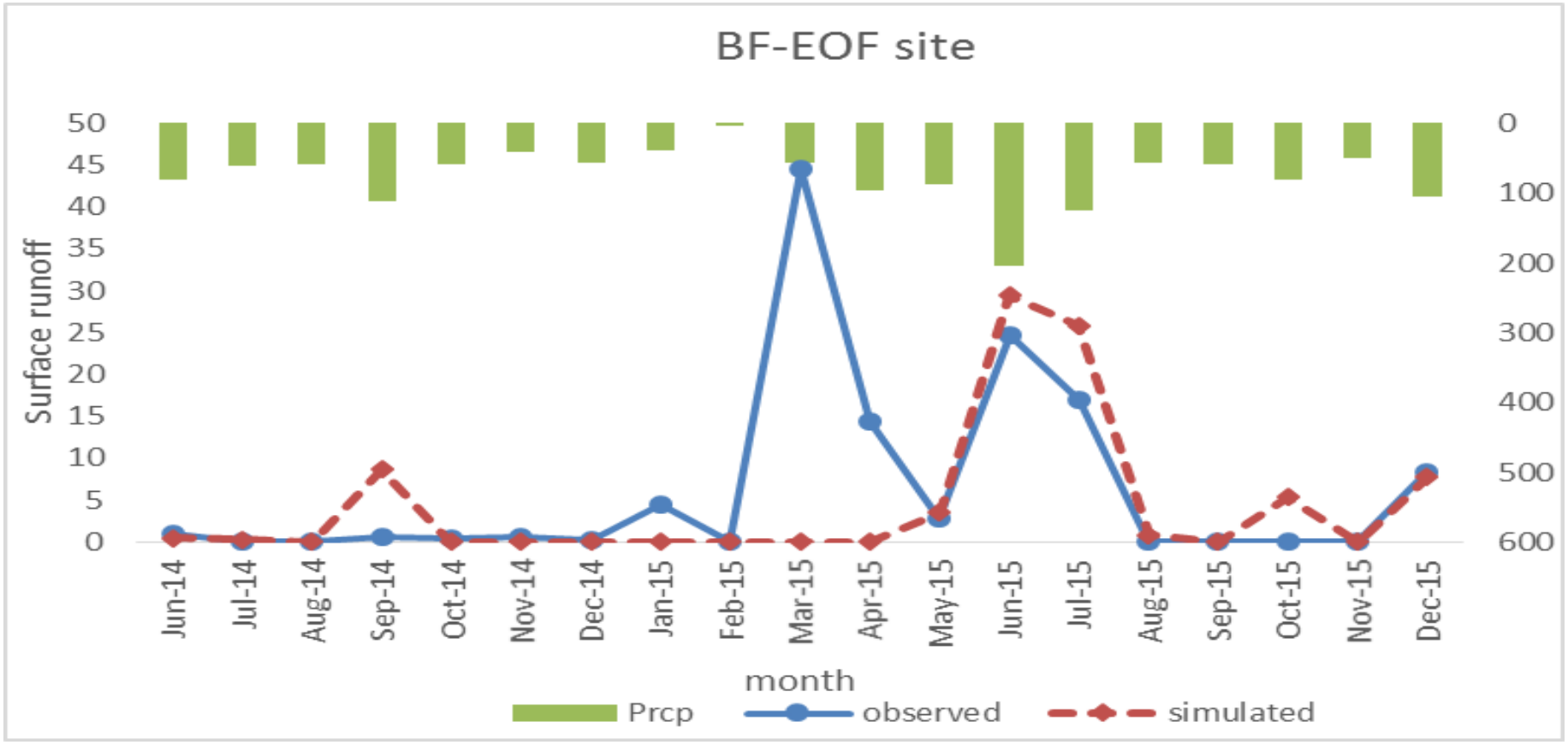

Improving Models Reliability

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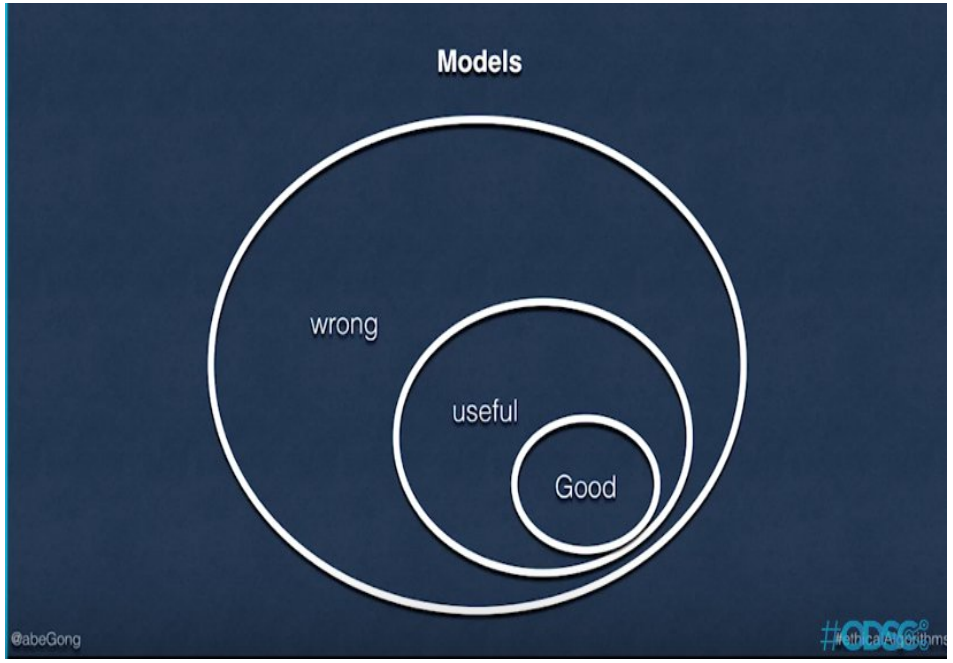
Making Models more **Useful…**

- **Thorough Verification**
- **Proper Calibration/ Parameterization**
- **In-depth Validation**
- **Being aware of the model sensitivity to different factors**



summary

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summary

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Of the three roles, the **model user** may be the most important…

Selecting good models for pertinent uses.

Appling skill: input, output, interpretation.

Being a good presenter to the customer.

summary

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How can you get more out of a computer model than you put in?

As a model user, put more into yourself!

Become a modeling connoisseur!

important final tip:

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Finally…

Try to keep the right perspective!

contact info

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