

# **Conceptual Issues in Model Assessment: What Can We Learn From Past Mistakes?**

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In recent years, there has been growing recognition that complex models of natural systems cannot be validated, and that the term validation is misleading from both scientific and regulatory standpoints. From a regulatory standpoint, problems arise because of differences in the way the term validation is interpreted by expert and lay communities. From a scientific standpoint, problems arise when we assume that model validation provides confirmation of the underlying scientific conceptualization.

Most efforts at model validation concentrate on comparing model output with the natural world. While such comparisons can be useful, they do not provide adequate basis for confidence in the accuracy of the model. There have been many cases in the history of science of models that made accurate, quantitative predictions, but were later shown to be conceptually flawed. This paper examines three examples. In each case, the conceptual flaws were not apparent to their designers and users, yet appear obvious in retrospect. Furthermore, because the flaws were conceptual, quantitative assessment of model accuracy would not have revealed the underlying problems. Hindsight suggests that conceptually flawed models may still be useful for the immediate predictive problems for which they were designed, but they are not reliable for understanding processes and structures. A well-confirmed model may thus be acceptable for a design or problem-solving purpose, as long as that purpose does not require comprehension of underlying causes.