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The Default Uncertainty is Always ZERO

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I have noticed that we tend to accept a phenomenally common and undeniably unfortunate practice where a failure to assess uncertainty means that the uncertainty reported (acknowledged, accepted) is identically ZERO. In other words if we do nothing at all, no work, no judgment, the work (modeling, simulation, experiment, test) is allowed to provide an uncertainty that is ZERO. This encourages scientists and engineers to continue to do nothing because this wildly optimistic assessment is a seeming benefit. If somebody does work to estimate the uncertainty the degree of uncertainty always gets larger as a result. This practice is desperately harmful to the practice and progress in science and incredibly common. Of course this is not the reality, the uncertainty is actually some value, but the lack of assessed uncertainty is allowed to be accepted as ZERO. The problem is the failure of other scientists and engineers to demand an assessment instead of simply accepting the lack of due diligence or outright curiosity and common sense. The reality is that the situation where the lack of knowledge is so dramatic, the estimated uncertainty should actually be much larger to account for this lack of knowledge. The only way to create a virtuous cycle is the acknowledgement that little information should mean large uncertainties, and part of the reward for good work is greater certainty (and lower uncertainty). One way to deal with all of

this uncertainty is to introduce a taxonomy of uncertainty where we can start to organize our lack of knowledge. For modeling and simulation exercises Im suggesting that three big bins for uncertainty be used: numerical, epistemic modeling, and modeling discrepancy. Each of these categories has additional subcategories that may be used to organize the work toward a better and more complete technical assessment. In the definition for each category we get the idea of the texture in each, and an explicit view of intrinsic incompleteness. Numerical: Discretization (time, space, distribution), nonlinear approximation, linear convergence, mesh, geometry, parallel computation, roundoff, . . . Epistemic Modeling: black box parametric, Bayesian, white box testing, evidence theory, polynomial chaos, boundary conditions, initial conditions, statistical,. . . Modeling discrepancy: Data uncertainty, model form, mean uncertainty, systematic bias, boundary conditions, initial conditions, measurement, statistical, . . . This whole topic is predicated on the observation

that we willingly enter into a system where effort increases the uncertainty. The direct opposite should be the objective where more effort results in smaller uncertainty. We also need to embrace a state where we recognize that the universe has an irreducible core of uncertainty. Admitting that perfect knowledge and prediction is impossible will allow us to focus more acutely on what we can predict. This is really a situation where we are willfully ignorant and over-confident about your knowledge. One might tag some of the general issue with reproducibility and replicatability of science to the same phenomena. Any effort that reports to provide a perfect set of data perfectly predicting reality should be rejected as being utterly ridiculous. One of the next things to bring to the table is the application of expert knowledge and judgment to fill in where stronger technical work is missing. Today expert judgment is implicitly present in the lack of assessment. If instead, the uncertainty is based on some sort expert judgment or previous experience, the evidence can be provided in this form.