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Hydrology and Earth System Sciences Discussions

Interactive comment on "HESS Opinions "Climate, hydrology, energy, water: recognizing uncertainty and seeking sustainability"" *by* D. Koutsoyiannis et al.

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We thank Guido d'Urso for his thoughtful comment. We certainly agree that "since the 19th century, technology has made available unprecedented observation and measurement capabilities". The progress is indeed unprecedented and inconceivable in terms of the 19th century science. That said, caution is needed not to abandon the traditional ground measurement practices, which provide the basis for calibration and validation of the more sophisticated modern measurement technologies and are indispensable for processes that cannot be remotely sensed.

We also agree that "models should be able to reproduce and explain what we get from

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the observation". However, we do not interpret models as "measurement simulators". Rather, models are abstract representations of natural phenomena and measurements provide the empirical evidence for the phenomena. Models make several hypotheses that aim to approximate the processes involved in these phenomena, whether measured or not. The measurements provide then the empirical evidence to test the hypotheses, to estimate the model parameters and to validate the models. Models that have not been validated against evidence from data, either in local conditions or at least in areas with some similarity of conditions, are useless. Hypothesis testing, parameter estimation and model validation are all statistical tasks. Use of data from modern sophisticated measurement technologies (radars, satellites, microwave links, etc.) necessarily demands higher sophistication of the statistical framework because such technologies do not measure directly the required variable but an indicator thereof. Inverse (Bayesian) inference is then the general statistical framework for the assimilation of data of different sources and the study of their interplay with models.

We do not agree with the implied antithesis of "probability" vs. "physical principles", the characterization of the latter as "deterministic" and the classification of "deterministic physical principles" as the basis of "comprehension of the observation technique". The offered analogy of turbulence and eddy-covariance, which is an excellent one, shows just the opposite, i.e. that physical principles can be probabilistic and that these can offer comprehension. The eddy-covariance technique, as its name suggests, is a stochastic technique, which uses several assumptions of the stochastic properties of the small-scale fluctuations of atmospheric variables (e.g. air density, wind speed, etc.). And this could not be otherwise, because the appropriate theoretical framework to comprehend and model turbulence is provided by stochastics.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 2927, 2008.