



## **Combining Apples and Oranges: Lessons from Weighting, Inversion, Sensitivity Analysis, and Uncertainty**

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Combining different data types can seem like combining apples and oranges. Yet combining different data types into inverse modeling and uncertainty quantification are important in all types of environmental systems. There are two main methods for combining different data types.

- Single objective optimization (SOO) with weighting.
- Multi-objective optimization (MOO) in which coefficients for data groups are defined and changed during model development.

SOO and MOO are related in that different coefficient values in MOO are equivalent to considering alternative weightings. MOO methods often take many model runs and tend to be much more computationally expensive than SOO, but for SOO the weighting needs to be defined. When alternative models are more important to consider than alternate weightings, SOO can be advantageous (Lu et al. 2012).

This presentation considers how to determine the weighting when using SOO. A saltwater intrusion example is used to examine two methods of weighting three data types. The two methods of determining weighting are based on contributions to the objective function, as suggested by Anderson et al. (2015) and error-based weighting, as suggested by Hill and Tiedeman (2007). The consequences of weighting on measures of uncertainty, the importance and interdependence of parameters, and the importance of observations are presented. This work is important to many types of environmental modeling, including climate models, because integrating many kinds of data is often important. The advent of rainfall-runoff models with fewer numerical deamons, such as TOPKAPI and SUMMA, make the convenient model analysis methods used in this work more useful for many hydrologic problems.