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On use of hydrologic and geologic data for model development and simulation of integrated groundwater-surface water systems

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Using 64 alternative models developed for the groundwater system of Maggia Valley in Southern Switzerland, we carry out two analyses. (1) With five representative conceptual models that vary in complexity, we perform a detailed statistical analysis using linear and non linear measures to evaluate the importance of observations to calibration and predictions. (2) We rank all 64 alternative models based on the AICc, BIC, KIC information criteria using the new code for multi-model ranking and inference (MMRI, Poeter et al., 2005). Using model averaging, we estimate optimal parameter values and evaluate predictions. In the first analysis, the linear measures are dimensionless and composite scaled sensitivities, DFBETA's, Cook's D, OPR, information criteria (AICc, BIC, GCV) and the nonlinear measures are derived from cross validation results. The cross validation results are used to assess the performance of linear measures. As a first result, we show that the model discrimination results produced using information criteria are very similar to results from cross validation, and require less than one percent of the computational effort. In the second analysis, the multi-model ranking and inference analysis clearly shows the effect of three types of enhancements 1) new bedrock representation, 2) the use of recharge values assigned all over the domain, and 3) use of the StreamFlow routing package for MODFLOW-2000 instead of the River package. The analysis indicates that the model improvements depend on all three being used simultaneously. Individually, the most important improvement for the groundwater model is the introduction of a recharge value: 21 out of the 25 "best" models represent recharge either as a constant value or a distributed value evaluated by means of a rainfall-runoff model. The other models have zero recharge: the approximation of zero recharge was originally thought to be

valid because of a lengthy dry period preceding the measurement of heads. Although significant improvements from the baseline model are achieved, the results show that none of our groundwater models is able to correctly represent both heads and flows in the Northern and Southern part of the valley due to the lack of observations constraining the model, mostly in the Southern part. This indicates once more the importance of adequate monitoring network to provide the essential knowledge of the aquifer system for a successful and reliable modelling.