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Bayesian model selection and uncertainty modeling

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We present a new technique for model selection problem in atmospheric remote sensing. The technique, called AARJ, is based on Markov chain Monte Carlo sampling and it allows model selection, calculation of model posterior probabilities and model averaging in Bayesian way. We show how the AARJ algorithm can be implemented and used for model selection and averaging, and to directly incorporate the model uncertainty in case of nonlinear inverse problems. We demonstrate the technique by applying it to the statistical inversion problem of Envisat/GOMOS constituent profile retrieval and EOS-Aura/OMI aerosol retrieval problem. In both cases various aerosol models are simultaneously included in the retrieval problem. The technique allows us to study the probability of different aerosol models and also to include the uncertainty related to aerosol model selection into the nonlinear posterior distributions of other constituents retrieved simultaneously. The method itself is general and can be applied to several other model selection problems as well.