INFORMATION APPROACH TO THE OPTIMAL SELECTION OF SPECTRAL CHANNELS: STELLAR OCCULTATION MEASUREMENTS

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Measurements of the atmosphere with instruments having a large number of spectral channels provide a large amount of information about the atmospheric composition, but it is not evident how to use it efficiently. The problem of optimal selection of measurements subset has two goals: 1) to reduce the dimension of problems in order to speed up the data processing; 2) to detect the most informative measurements (in spectroscopy - spectral channels) with the aim of optimization of instrument design.
We examine here methods for the selection of measurement subsets based on the information theory. These methods are applied to an overdetermined inverse problem typical for high resolution spectrometry. Two optimization problems of the channel selection, both taking the information content of the measurements as a criterion, are discussed. The concept of information content of each individual measurement is introduced and the basic theoretical relations are derived. The subset selection procedures that give an approximate solution of the optimization problems are proposed and their efficiencies are compared by means of Monte-Carlo generation of the forward model in a low-dimensional case.
As a real application, the selection of the most informative spectral channels for GOMOS measurements is considered. We show that both sequential selecting and deselecting procedures give similar subsets of most informative channels for ozone, NO2, NO3, air and aerosol retrieval. These channels cover most of UV-visible wavelength range. It is shown that about 40 % of channels at each altitude are non-informative, the retrieval can be performed with the selected channels only without any significant reduction of performance.