Atmospheric moisture and ozone sounding products from high resolution IR radiance spectra

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The new-generation IR-sounders IASI, CrIS on board future weather satellites MetOp,NPOESS will provide high resolving power spectral radiance measurements that can reveal valuable information on radiatively active atmospheric constituents (water vapor, ozone).The paper summarizes the performance characteristics of statistical regression approach to the inversion of IASI-like measurements and retrieval of atmospheric water vapor (q) and ozone concentration (Q) profiles. Because of highly increased satellite data volume, large number of sought variables, and data intrinsic properties several refinements and modifications of standard regression technique have been developed and examined, involving the selection of the most informative channels as well as the physically valid choice of relevant predictor/predictand variables. The proposed algorithm of optimal channels subset selection consequently analyses sensitivity of various channels to sought parameters, the altitude dependence of weighting function maximums, as well as level of the main interfering factors contribution to the measured radiance in each initially selected IASI channel.Its execution has resulted in the specification of 123 IASI channels centered within 1206-1650 cm-1 band (dedicated for q-profile retrieval) and 58 channels centered within 1000-1070 cm-1 band (Q-profile retrieval) universal for all atmospheric conditions.The specification of relevant predictor/ predictand variables helped to overcome (at least, partially) the non-linearity of original inversion problem and to account for the effect of interfering factors. To reduce the impact of surface temperature Ts and T-profiles variations (as key interfering factors) on the measured radiances the developed regression scheme assumes a priori knowledge for these factors at the level of 0.5K and 1.5 K/km, respectively. Basing on these assumptions, the vectors of predictors have been specified with variables formally coinciding for both retrieval schemes. In turn the vectors of predictands contain the values of log of water vapor (or ozone) mixing ratios at the number of atmosphere levels together with the column integrated contents. Proposed algorithms have been evaluated in the series of retrieval experiments with synthetic IASI data extracted from specially prepared global dataset. The original dataset incorporates about 20000 state vectors extracted from well- recognized data ensemble NOAA 88/89 and ECMWF 60-level sampled database as well as respective "pieces"of synthetic spectra generated with specially developed fast radiative transfer model. Beforehand about 10000 implementations of the clear-sky atmospheric models and spectra have been identified. The application of developed algorithms is shown to enable reasonable accuracy levels for q-, Q- profile retrievals close to those specified in IASI mission objectives.As for q-profile retrievals, the r.m.s. errors (in terms of mixing ratio) do not exceed the magnitude of 25% up to the level of 10 km and are about or even less than 10-20% within 1-7km altitude range;moreover the achieved retrieval accuracy for water vapor column is about 8-9%.As for Q-profiling, the achieved retrieval accuracy within 20-50 km altitude range is about 10-15 % while the r.m.s. errors do not exceed 10% for ozone column derivation .