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Agenda Item: II /3

REGIONAL TEMPERATURE-HUMIDITY SOUNDINGS OF THE ATMOSPHERE FROM NOAA-16 ATOVS MEASUREMENTS

Summary and purpose of the WP

This document reports on the processing package that has been developed to retrieve atmospheric temperature and humidity profiles from the ATOVS/NOAA-16 measurements of local area coverage. The basic algorithms of ATOVS data inversion are described. The accuracy characteristics of ATOVS based temperature profile retrievals are presented and discussed.

Action proposed: no action required.

REGIONAL TEMPERATURE-HUMIDITY SOUNDINGS OF THE ATMOSPHERE FROM NOAA-16 ATOVS MEASUREMENTS

During 2000-2001 at the SRC Planeta, Moscow a software package has been developed and tested for NOAA-15, 16 ATOVS data processing. It's name is ISADP for "Integrated System for the ATOVS Data Processing". "Integrated" means that the satellite data are analyzed combined with NWP outputs moreover the relevant radiozonde observations (RAOBS) are also accounted for [Soloviev et al, 2001]. The ISADP consists of two basic modules: first module performs preprocessing of ATOVS data while the second module is designed for thematic processing. The prototype for the first module is AAPP [Klaes et al, 1999], while the second module has been developed using IAPP [Li et al, 2000]. Both mentioned modules were obtained officially from Eumetsat (AAPP, end of 1998) and CIMSS Wisconsin (IAPP, 1999) and than were updated to existing computing facilities (PC, Windows 98). Along with this the framework around the ISADP has been settled to provide all necessary interfaces for input files (such as NWP, RAOBs) as well as for output sounding products. The NWP fields (Bracknell's 12h forecast for the 2.5^0 x 2.5^0 grid) and RAOBs are regularly extracted from special database supported by Hydrometeorological Center in Moscow while the ATOVS-based sounding products (vertical profiles of atmospheric temperature T(p) and humidity q(p)) are placed at the isolated section of the same database.

The main steps of the ATOVS thematic processing are the following:

1. Forward model adjustment
2. Detection of clouds & precipitation zones
3. Derivation of the first guess
4. Retrieval of geophysical parameters
5. Quality control and editing of the retrievals (retrieval bias adjustment).

The procedures of model adjustment and cloud detection are quite similar to those from [Li et al, 2000]. Derivation of the first guess profiles $T^0(p)$, $q^0(p)$ is performed using technique of principal components analysis and linear statistical regression. This procedure is also quite similar to [Li et al, 2000]. Step 4 is carried out using iterative solution of original inverse problem, moreover unlike [Li et al, 2000] the modified procedure of smoothing parameter calculation is applied.

The new procedure has been developed for correction of biases in output retrievals. The biases are explained by the mathematical properties of inverse problem and can be generated by the model errors and the biases in the first guess used.

To reduce biases the following formulae is proposed for corrected retrievals:

$$T^{cor}(p_k) = a_k T^{sat}(p_k) + (1-a_k)T^{fc}(p).$$

Here $T^{sat}(p)$, $T^{fc}(p)$ are retrieved and forecasted temperature profiles; the weights a_k are derived through minimization the RMS differences between T^{cor} and collocated RAOBs. According to results of experiments with (NOAA-16) ATOVS data the values a_k are rather stable (for the matched sample of retrievals, forecasts and RAOB's during two week period) and change in the range 0.2-0.5 (for the levels between 850 and 100 hPa) and equal 1 for the levels above 100 hPa.

The algorithms and the software package ISADP were tested with ATOVS measurements; NOAA-16 ATOVS data of regional coverage (HRPT receiving station in Moscow) from the period March – June 2001 were used in a thorough comparison between ATOVS-based retrievals $T^{cor}(p)$ as well as forecasts $T^{fc}(p)$ and "true" profiles i.e. collocated RAOBs, or NWP

analysis.

Retrieval error statistics is shown at fig 1, 2. The plotted are RMS profiles, for corrected retrieval $T^{cor}(p)$ and forecasts $T^{fc}(p)$. The time period for compiled matched sample is 14 days of April-May 2001. The size of the sample is between 30 (for 10 hPa level) and 243 (for levels below 100 hPa). According to the analysis of this and other ensembles the mean RMS error of the $T^{cor}(p)$ (averaged for the atmospheric layer between 1000 and 10 hPa) is in the range 1.6-1.65^{0}C while the mean RMS error for T^{fc} equals 1.9^{0}C. As it was expected, the positive effect is more pronounced for the levels above 100 hPa. Fig. 3 demonstrate the field of differences $dT=T^{cor}(p) - T^{an}(p)$, p=500 hPa, over the limited area {10-55^0 East, 35-70^0 North}. It is seen that the discrepancy (positive or negative) between retrievals and "truth" is rather small for the majority of subregions within this area, excluding some isolated "spots".

As a result of described studies we can conclude that the developed software package ISADP works satisfactorily and can provide rather accurate temperature profile retrievals. Now the works on the accuracy assessment for the retrievals are continued, paying special attention to humidity retrievals.

References:

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3. Solovjev V.I., Uspensky A.B., Kucharsky A.V., 2001: Regional temperature/humidity soundings of the atmosphere from NOAA-16 measurements. Meteor. and Hydrol., In press.

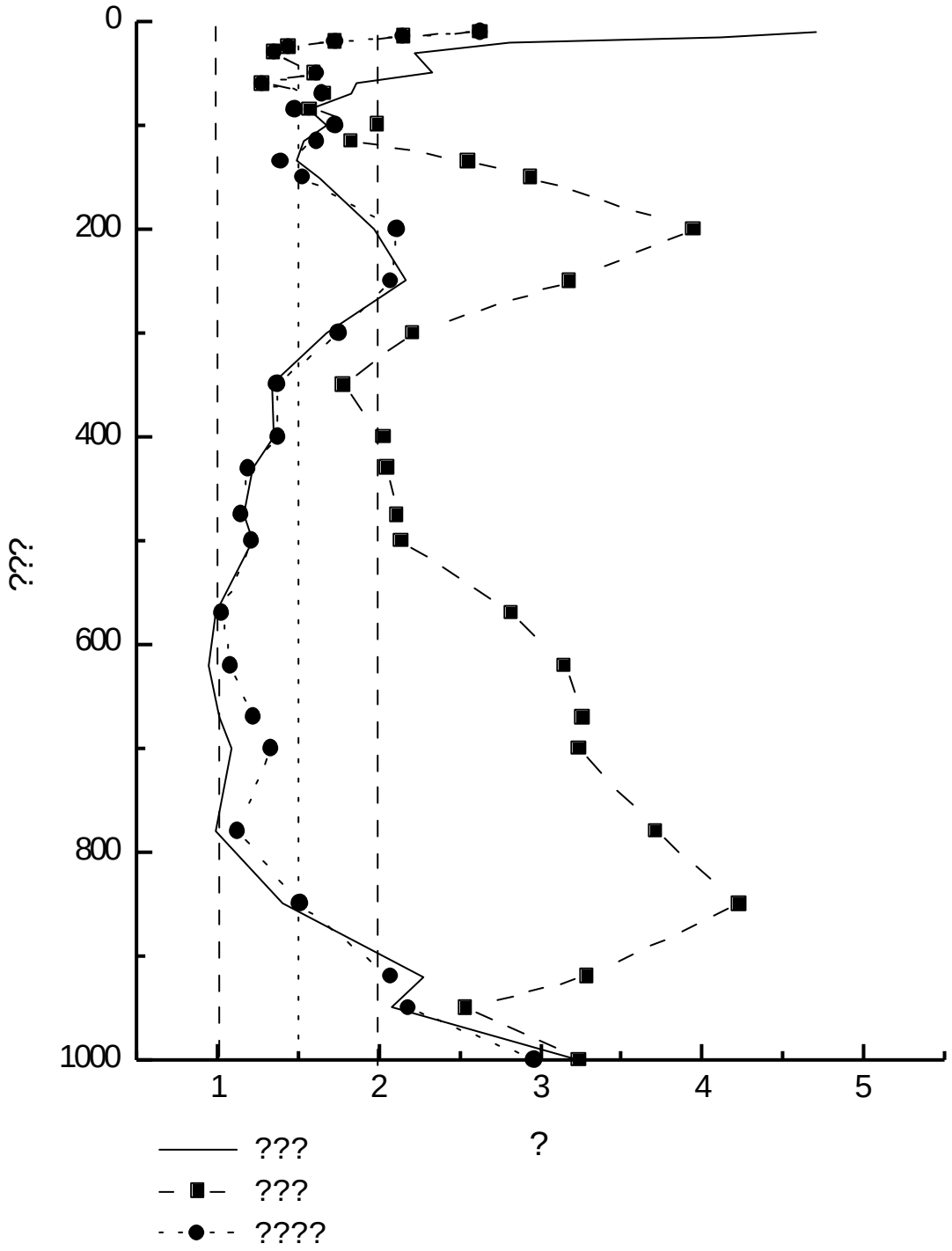

Fig. 1 Profile RMS errors for T^{fc} ( ), T°(■) and T^{cor} (•)

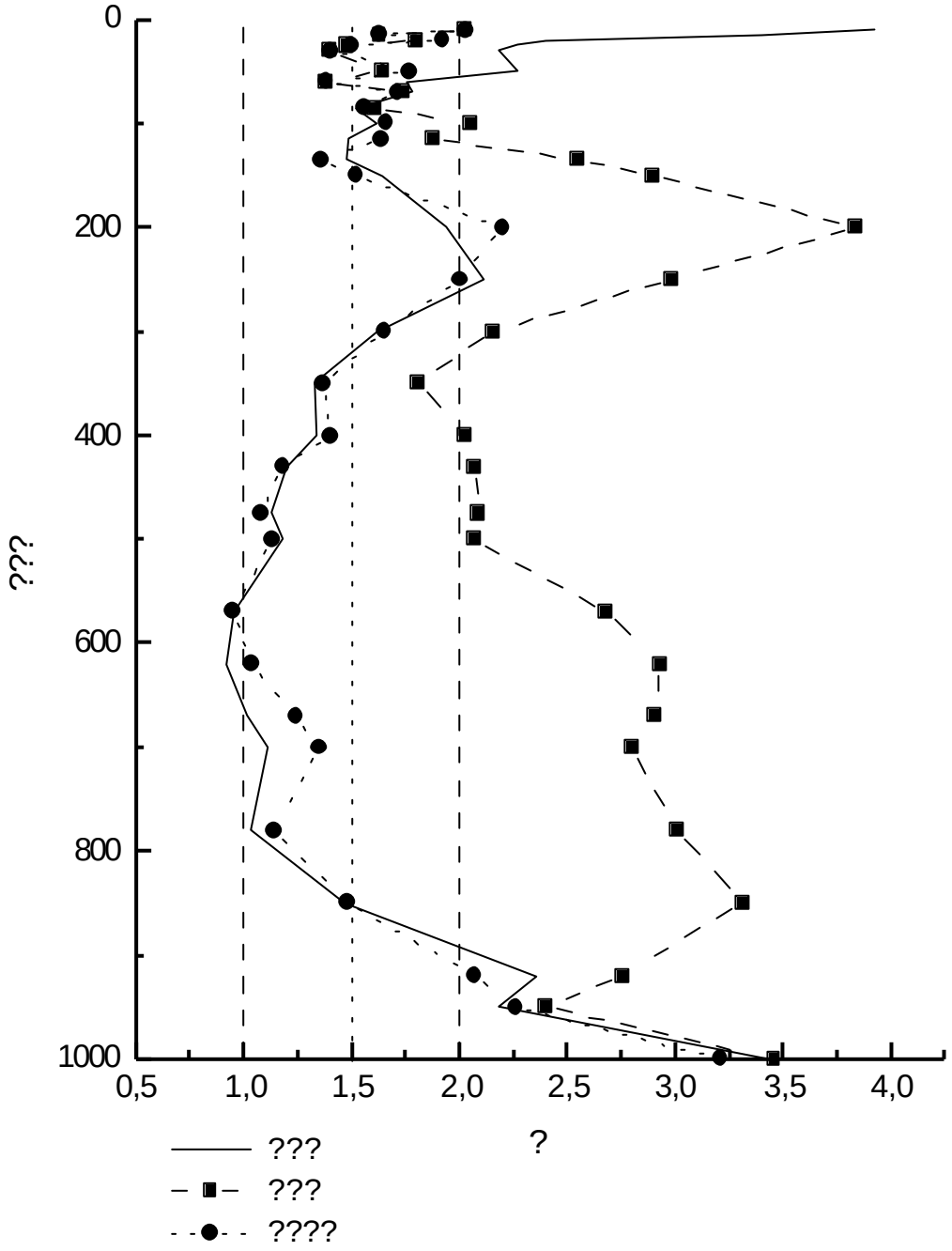

Fig.2 Profile RMS errors for T^{fc} (___), T°(■) and T^{cor} (•)
(clear atmosphere)

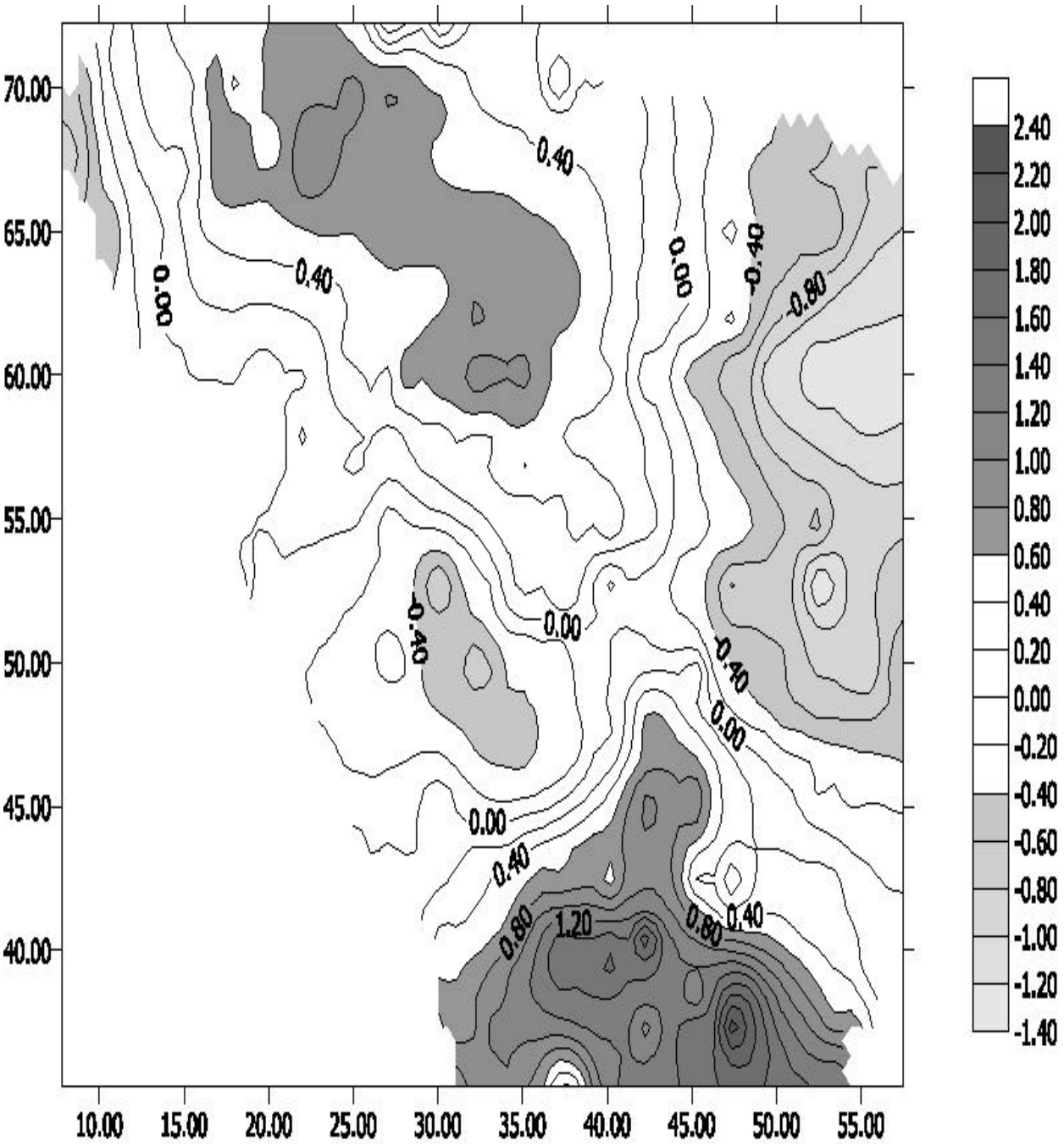

Fig.3 NWP analysis - T^{cor} ; P=500hPa,10-55º East, 75- 35º North