The Capability of Atmospheric Profile Retrieval from Satellite High Resolution Infrared Sounder Radiances

Li Jun (李 俊)①

Cooperative Institute for Meteorological Satellite Studies, Space Science and Engineering Center, University of Wisconsin–Madison, Madison, WI 53706, U.S.A.

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ABSTRACT

A non–linear Newtonian iteration retrieval method has been successfully applied to TIROS–N Operational Vertical Sounder (TOVS) data process and simulated Atmospheric Infrared Sounder (AIRS) data inversion. Usually, the Newtonian iteration procedure starts with a first guess or initial state of atmospheric temperature and water vapor profiles, in this paper, a climate mean profile and a regression retrieval from radiances were used as the first guess in AIRS data inversion, the Root Mean Square Error (RMSE) of both temperature and water vapor mixing ratio retrievals shows that high vertical resolution and accurate atmospheric temperature and water vapor profiles are achieved using either a poor (a climate mean profile) or good (a regression retrieval) first guess. This illustrates the capability of high resolution IR sounder radiances in atmospheric temperature and moisture profiles retrieval, which is important when there is no prior information or sample data set of atmospheric temperature and moisture available.

Key words: Retrieval, Newtonian Iteration

I. INTRODUCTION

The current used TOVS has 19 HIRS channels (Smith et al., 1979), and is playing an important role in Numerical Weather Prediction (NWP) (Eyer et al., 1993), the accuracy of temperature and water vapor retrievals from TOVS radiances is limited due to its low vertical resolution. Recently the high resolution infrared sounders such as AIRS, Interferometric Measurements of Greenhouse gases (IMG) etc. are developed for flying on future satellite or polar orbiting platform. Each kind of these instruments has thousands of channels for single Field of View (FOV). Also, a practical efficient Newtonian iteration method has been developed for temperature and water vapor profiles retrieval from IR sounder radiances (Li et al., 1994).

Usually, the Newtonian iteration procedure starts with a first guess or initial state of temperature and water vapor profiles, where the first guess can be obtained from a climate mean, a regression equation, and/or numerical forecast products. In this test, a climate mean profile and a regression retrieval were used as the first guess respectively in AIRS simulated data inversion. Results show that the accuracy of both temperature and water vapor mixing ratio retrievals using a poor guess is very close to that using a good guess, which

①Visiting Scientist from the Institute of Atmospheric Physics, Chinese Academy of Sciences, Beijing, CHINA

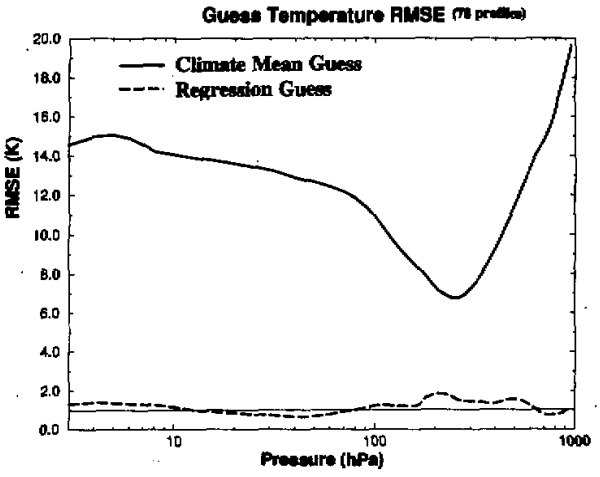

Fig. 1. The temperature first guess RMSE profiles.

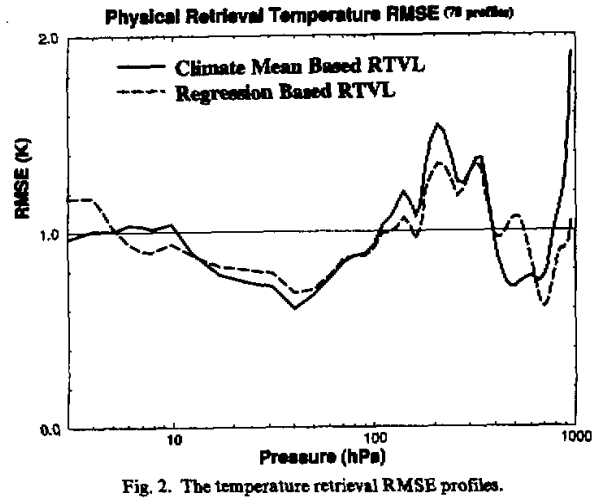

Fig. 2. The temperature retrieval RMSE profiles.

means the solution of temperature and moisture from AIRS is less dependent on the first guess selection. This indicates the capability of advanced sounder radiances in atmospheric parameters retrieval, and is important when there is no prior information of atmospheric state available.

II. RETRIEVAL EXPERIMENT

The Newtonian iteration retrieval procedure (Li et al., 1994) was applied to AIRS simulated F4D data set (78 atmospheric profiles) in this study. Maximum 8 iterations were applied in the iterative solution procedure. This procedure will result in an exact solution of the retrieval problem (i.e. an exact fit to the radiance). Also, it is prudent to use a set of less correlated channels which not only retains the majority of measurement information but also

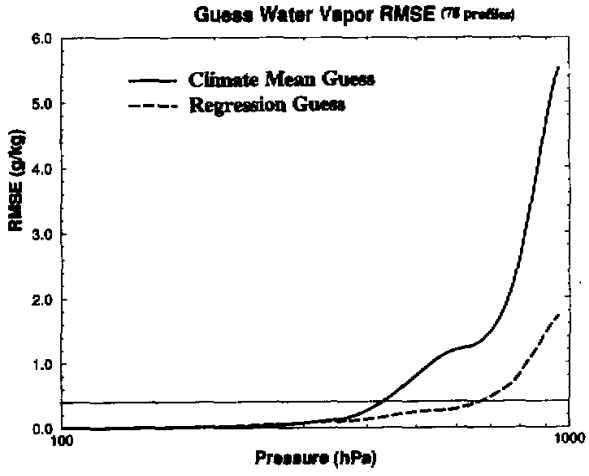

Fig. 3. The water vapor mixing ratio first guess RMSE profiles.

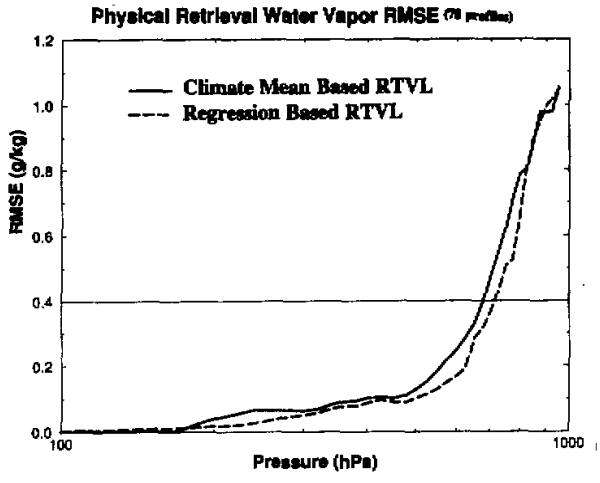

Fig. 4. The water vapor mixing ratio retrieval RMSE profiles.

yields the most accurate atmospheric profile retrievals, in this test, a set of statistically optimal 1150 channels (Li and Huang, 1994) was used in retrieval procedure. Figs. 1 and 2 are the temperature first guess and retrieval RMSE profiles. Figs. 3 and 4 are the water vapor mixing ratio first guess and retrieval RMSE profiles. It is obvious that the accuracy of both temperature and water vapor retrievals using a poor first guess is very close to that using a good first guess, this means the solution of temperature and water vapor from high resolution IR sounder radiances is less dependent on the first guess selection. Therefore, the Newtonian iteration procedure can just start with a climate mean of atmospheric temperature and moisture profiles in high resolution IR sounder radiances inversion, which is important when there

is no prior information of atmospheric state available.

III. CONCLUSION

With current low resolution IR sounder radiances only low vertical resolution atmospheric structure can be determined. It is necessary to start with a good guess condition (e.g. a regression retrieval) in the iteration solution procedure in order to obtain the reasonable accuracy of atmospheric temperature and water vapor retrievals. While the AIRS simulated data inversion shows the high vertical resolution and accurate atmospheric temperature and moisture profiles can be achieved from high resolution IR sounder radiances. The solution is less dependent on the guess condition selection which illustrates the capability of future advanced sounder radiances in deducing the high vertical resolution and accurate atmospheric parameters such as temperature and water vapor mixing ratio profiles.

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