Atmospheric Temperature and Moisture Profiles from Recently Launched INSAT-3DS Sounder

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Abstract

The present work demonstrates the development of the 1-dimensional Variational (1DVAR) based retrieval algorithm for the atmospheric profiles of temperature (T) and moisture (Q) from INSAT-3DS Sounder observations. The algorithm is assessed on both the simulated and the actual observations of INSAT-3DS Sounder for a limited period. A preliminary evaluation shows that the developed algorithm performs well on both simulated and actual observations and appropriately adjusts the first guess profiles to estimate the optimum atmospheric T/Q profiles.

Introduction

The knowledge of vertical distribution of atmospheric T/Q is a key to understand its thermodynamic state. This information is also essential to predict the accurate weather forecasts. Moreover, these profiles along with cloud liquid water, etc. determine the vertical transport of heat, moisture and momentum between the surface, boundary layer and free troposphere. T/Q vertical profiles can be efficiently retrieved from the observations from a multispectral Infrared (IR) sounder aboard the satellites such as INSAT-3DS. The present study demonstrates the development of a new retrieval algorithm for the atmospheric T and Q profiles from INSAT-3DS Sounder observations using 1-Dimensional Variational (1DVAR) or Optimal Estimation (OE) Method.

Data

- INSAT-3DS Sounder L1B observations.
- GFS forecast for first-guess (FG) profiles of T/Q and GFS analysis as a reference.

1DVAR Method

- An a priori distribution of the retrieval parameters (T and Q profiles) is used to constrain a non-linear iterative optimal-estimation scheme which uses the method of Rodgers (1976) to minimize the cost function $J(x)$ to find the optimal solution x:

$$J(x) = (x - x_0)^T B^{-1}(x - x_0) + \big(y - y(x)\big)^T R^{-1}\big(y - y(x)\big)$$

where, x_0 is the prior atmospheric state having error covariance B, y is the observations with error covariance R, and $y(x)$ is the observations simulated through forward model using atmospheric state x.

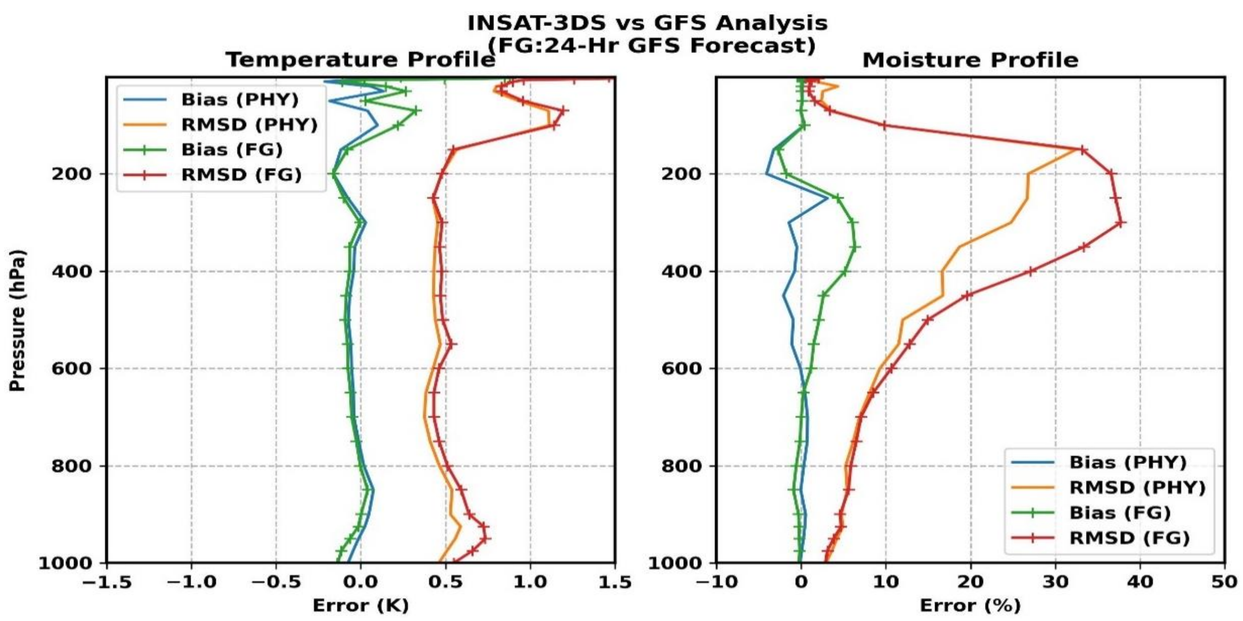
- The iterative solution for the minimization of the cost function $J(x)$ was provided by Rodgers (1976):

$$x_{n+1} = x_0 + BH_n^T(H_nBH_n^T + R)^{-1}[y - y(x_n) - H_n(x_0 - x_n)]$$

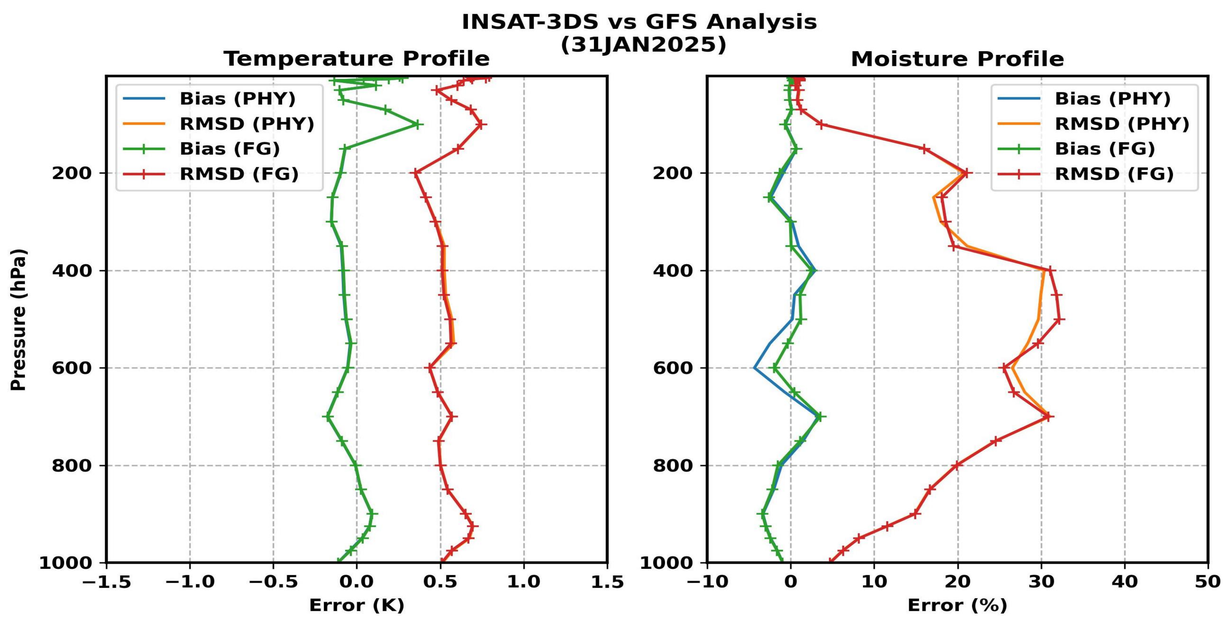
where, x_n is the n^{th} estimate of atmospheric state. H_n is known as Jacobian matrix.

Results

Assessment on Simulated Observations



Assessment on Actual Observations



Conclusions

- A preliminary assessment shows that the developed algorithm successfully modifies the first-guess profiles using INSAT-3DS observations to get the optimum profiles.
- The error in the retrieved profiles of Q indicates an improvement for both simulated and actual observations of INSAT-3DS Sounder.
- No change is observed in T profile error as compared to FG profiles when applied on actual observations of INSAT-3DS Sounder.

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Reference

- Rodgers, C. D., “Retrieval of atmospheric temperature and composition from remote measurement of thermal radiation,” Rev. Geophys. Space Phys., 14, 609-624, 1976.

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