

# Validation of T/q Retrievals from a Ground-Based FT-IR and Satellites (Aqua/AIRS and MetOp/IASI) against Radiosonde Observations at Anmyeon-do, Korea

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## Abstract

The National Institute of Meteorological Research has operated the Atmospheric Emitted Radiance Interferometer (AERI), which is the Fourier Transform InfraRed spectroradiometer (FT-IR), at Anmyeon-do, Korea since June 2010. To retrieve temperature and mixing ratio profiles from measured AERI spectra, AERIPROF, which was developed by the University of Wisconsin, was employed and optimized to characterize site features. Validation of the T/q retrievals from the AERI was carried out against 39 radiosonde observations under clear sky weather conditions during the period of 2010–2012. T/q retrievals from MetOp/IASI were also compared with those from the AERI. In addition, T/q retrievals from the Aqua/AIRS were validated against radiosonde and compared with both T/q profiles from the AERI and from the MetOp/IASI.

As a result of the validation, the atmospheric inversion structures, which are not described by the satellite observations, were found to be significantly well-captured by the AERI in the lower troposphere. In addition, AERI is likely able to provide temperature profiles that are closer to radiosonde observations compared with the satellite retrievals. From 1000 to 700 hPa, temporally and vertically-averaged RMSEs of T/q retrievals from the AERI were 1.395 and 1.776, whereas those from IASI (AIRS) were 2.096 and 1.488 (2.441 and 1.763), respectively. Temperature RMSE (1.314) of the AERI from 1000 to 200 hPa shows better scores than those from IASI (1.646) and AIRS (2.336). However, in the same vertical range, the over-estimated mixing ratio was retrieved from the AERI, and its RMSE was higher than both RMSEs from IASI and AIRS.

## INTRODUCTION

The Korea Meteorological Administration (KMA) and EUMETSAT have bilaterally collaborated since 2009. In this regard, the National Institute of Meteorological Research (NIMR) has contributed to ground validation of IASI products. The NIMR has operated the Atmospheric Emitted Radiance Interferometer (AERI; Figure 1), which is the Fourier Transform InfraRed spectroradiometer (FT-IR) at Anmyeon-do, Korea since June 2010. In particular, this study is to compare T/q retrievals from IASI with those from ground-based FT-IR and to validate them against radiosonde observations.

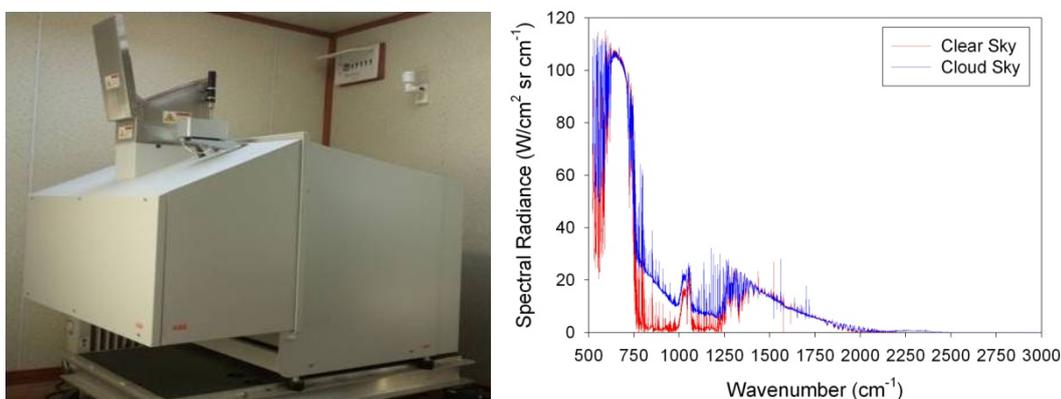


Figure 1 : Snap shot of AERI (left) and measured spectra (right). Red (Blue) line is FT-IR spectrum of clear (cloud) sky.

## Retrieval Algorithm

The T/q retrieval algorithm, AERIPROF V3, was developed by the Space Science and Engineering Center (SSEC) at the University of Wisconsin (Feltz et al., 2003). All of the AERI retrievals in this study were produced by the modified and optimized T/q retrieval algorithm in Korea on the basis of AERIPROF V3 (Kang et al., 2013). Major algorithm optimizations, for example, new statistical regression coefficients to make first guess profiles and bias correction of the measured spectrum, were carried out to make better descriptions of site characteristics. New statistical regression coefficients were computed by using 1,371 radiosonde profiles in Korea during 2009–2011. Kang et al. (2013) reveal that the new coefficients provide more realistic T/q profiles in the lower troposphere (1000–700 hPa) than the original coefficients, which were optimized at the Southern Great Plains (SGP) site in the United States (Feltz et al., 2007). Differences between measured spectra and simulated spectra, which are estimated by LBLRTM v12.1 on the basis of radiosonde profiles launched at Anmyeon-do, were used to correct the bias in measured spectra. In addition, to obtain site-specific initial guess profiles for the surface, weather parameters observed at the station were used, and for the pressure level, reanalysis data assimilated by the Korea Local Analysis and Prediction System (KLAPS) were used. Figure 2 shows the flowchart of the T/q retrieval algorithm.

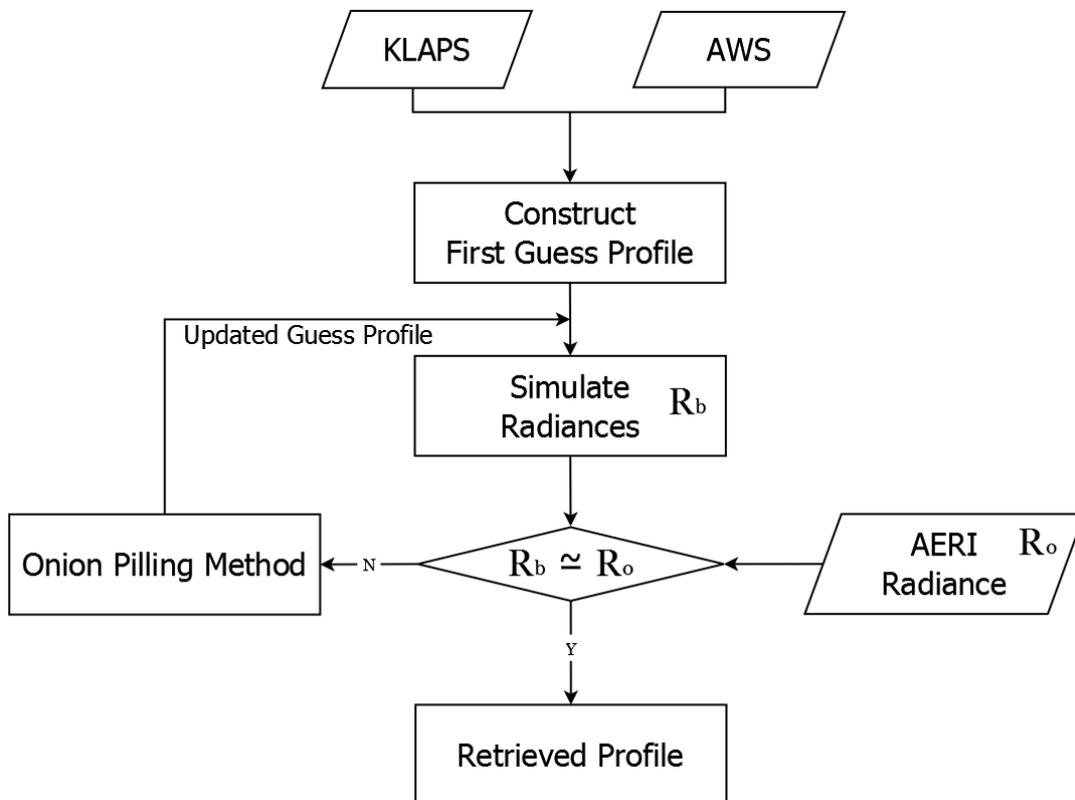


Figure 2 : Flowchart of T/q retrieval algorithm

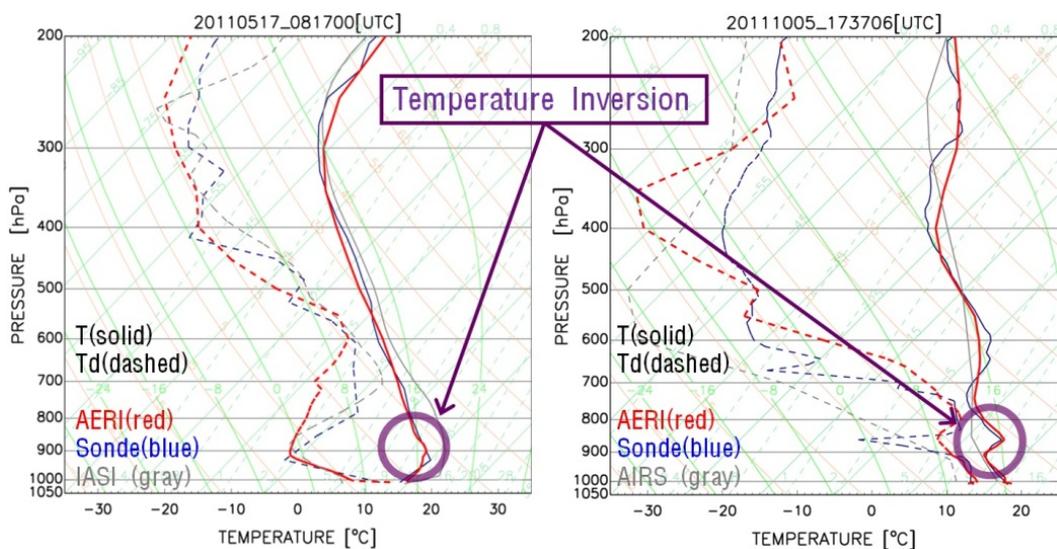
Table 1 : BIAS and RMSE of temperature and mixing ratio of AERI, IASI and AIRS between 200–1000 hPa.

	Temperature		Mixing Ratio	
	BIAS	RMSE	BIAS	RMSE
AERI	-0.720	1.314	-0.585	1.369
IASI	-0.175	1.646	-0.286	0.956
AIRS	-1.073	2.336	0.035	0.703

## Validation of AERI T/q retrievals

Under clear sky weather conditions, 39 radiosonde observations were performed at Anmyeon-do during the period of 2010–2012 to validate the T/q retrievals from the AERI and from satellites (Aqua/AIRS and MetOp/IASI). In the skew T-log P diagram (Figure 3), the atmospheric inversion structures were significantly well captured by the AERI in the lower troposphere. In addition, vertical distributions of AERI temperature retrievals are more similar to the radiosonde observations than those from the IASI and AIRS retrievals.

Although the maximum altitude of valid information that AERIPROF is able to provide is reported to be up to 3 km (about 700 hPa) (Feltz et al., 1998), the AERI temperature retrievals were found to have comparable profiles to radiosonde observations up to 200 hPa (Figure 3). Temporally and vertically averaged RMSEs for temperature retrievals from AERI from 1000 to 200 hPa were smaller than those of IASI and AIRS (Table 1.). In addition, better scores of the AERI temperature retrieval described in Table 1 were illustrated in the RMSE and bias profiles in Figure 4. However, in the same vertical range, the over-estimated mixing ratio was retrieved from the AERI compared with the IASI and AIRS.



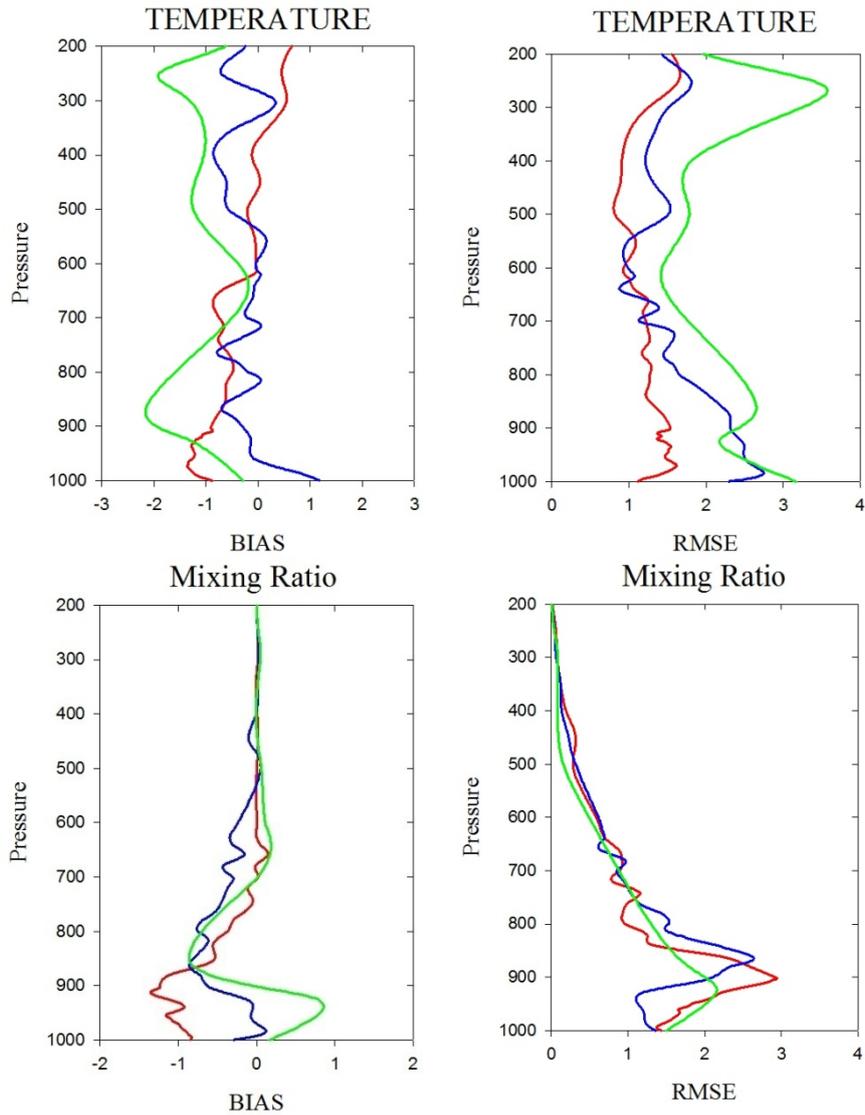
**Figure 3 :** T (solid)/q (dashed) profile of AERI (red), Sonde (blue), Satellite of AIRS and IASI (gray) at 08:17 UTC on 17 May 2011 (left) and at 17:37 UTC on 05 October 2011 (right).

## SUMMARY

The NIMR has contributed to ground validation of IASI products in the bilateral collaboration of the KMA and EUMETSAT. In this regard, IASI T/q retrievals were compared with those of ground-based FT-IR, which is called the AERI. Temperature and mixing ratio profiles were retrieved from the measured spectrum of the AERI using the AERIPROF algorithm optimized to Korea. Radiosonde observations were performed to validate the T/q retrievals from the AERI, IASI, and AIRS. The AERI is able to provide temperature profiles closer to radiosonde observations than the IASI and AIRS retrievals. Temporally and vertically averaged RMSEs for temperature retrievals from the AERI were smaller than RMSEs of the IASI and AIRS up to 200 hPa. Particularly, the AERI has the ability to capture significant atmospheric structure in the lower troposphere, which is not easily detected by the satellite retrievals.

## ACKNOWLEDGEMENT

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**Figure 4** : BIAS and RMSE of temperature and mixing ratio of AERI (red), IASI (blue) and AIRS (green) against radiosonde.

## REFERENCES

- Feltz, W. F., Smith, W. L., Knuteson, R. O., Revercomb, H. E., Woolf, H. M., and Howell, H. B., 1998, Meteorological applications of temperature and water vapor retrievals from the ground-based Atmospheric Emitted Radiance Interferometer (AERI), *J. Appl. Meteor.*, 37, 857-875.
- Feltz, W. F., Howell, H. B., Knuteson, R. O., Woolf, H. M., and Revercomb, H. E., 2003, Near-continuous profiling of temperature, moisture, and atmospheric stability using the Atmospheric Emitted Radiance Interferometer (AERI). *J. Appl. Meteor.*, 42, 584-597.
- Feltz, W. F., and Coauthors, 2007, Retrieving temperature and moisture profiles from AERI radiance observation: AERIPROF value-added product technical description. Revision 1, DOE ARM Tech. Rep. DOE/SC-ARM-TR-066.1, 31 pp.
- Kang Shin-Hoo, Goo Tae-Young, and Ou Mi-Lim, 2013, Improvement of AERI T/q Retrievals and Their Validation at Anmyeon-Do, South Korea, *J. Atmos. Oceanic Technol.*, 30, 1433-1446.
- Smith, W. L., Feltz, W. F., Knuteson, R. O., Revercomb, H. E., Woolf, H. M., and Howell, H. B., 1999, The Retrieval of Planetary Boundary Layer Structure Using Ground-Based Infrared Spectral Radiance Measurements, *J. Atmos. Oceanic Technol.*, 16, 323-333.