INFRARED SPECTRAL RADIANCE INTERCOMPARISONS WITH SATELLITE AND AIRCRAFT SENSORS

Allen M. Larar[a], Daniel K. Zhou[a], Xu Liu[a], and William L. Smith[b]*

[a]NASA Langley Research Center, Hampton, VA, USA
[b]University of Wisconsin-Madison, Madison, WI, USA
*Allen.M.Larar@nasa.gov

1. INTRODUCTION

Measurement system validation is critical for advanced satellite sounders to reach their full potential of improving observations of the Earth's atmosphere, clouds, and surface for enabling enhancements in weather prediction, climate monitoring capability, and environmental change detection. Experimental field campaigns, focusing on satellite under-flights with well-calibrated FTS sensors aboard high-altitude aircraft, are an essential part of the validation task. Airborne FTS systems can enable an independent, SI-traceable measurement system validation by directly measuring the same level-1 parameters spatially and temporally coincident with the satellite sensor of interest. Continuation of aircraft under-flights for multiple satellites during multiple field campaigns enables long-term monitoring of system performance and inter-satellite cross-validation. The NASA / NPOESS Airborne Sounder Testbed - Interferometer (NAST-I) [1] has been a significant contributor in this area by providing coincident high spectral/spatial resolution observations of infrared spectral radiances along with independently-retrieved geophysical products for comparison with like products from satellite sensors being validated. This presentation gives an overview of benefits achieved using airborne sensors such as NAST-I utilizing examples from recent field campaigns. The methodology implemented is not only beneficial to new sensors such as the Cross-track Infrared Sounder (CrIS) [2] flying aboard the Suomi NPP and future JPSS satellites but also of significant benefit to sensors of longer flight heritage such as the Atmospheric InfraRed Sounder (AIRS) [3] and the Infrared Atmospheric Sounding Interferometer (IASI) [4-6] on the AQUA and METOP-A platforms, respectively, to ensure data quality continuity important for climate and other applications. Infrared spectral radiance inter-comparisons are discussed with a particular focus on usage of NAST-I data for enabling inter-platform cross-validation.

Data from campaign under-flights with airborne FTS systems, such as the NAST-I, have proven to be very useful in earlier AIRS and IASI validation studies [7,8]. NAST-I team analysis is further benefited from implementing an independent set of algorithms associated with, e.g., fast radiative transfer modeling and geophysical product retrievals to enable an independent, concurrent validation of derived level-2 products [9]. Field campaign data from coincident measurement assets (i.e., ground, balloon, aircraft, and satellite) are then available for not only the implementation and improvement of validation methodologies but, also, to implement, validate, and improve radiative transfer and retrieval algorithms. The Suomi NPP (SNPP) airborne field campaign was conducted during the 6 – 31 May, 2013 timeframe based out of Palmdale, CA, and focused on under-flights of the SNPP satellite with the NASA ER-2 aircraft in order to perform cal/val of the satellite instruments and their corresponding data products. Aircraft flight profiles were designed to under-fly multiple satellites within a single sortie, when feasible, to address satellite sensor validation and cross-validation; specifically, in addition to under-flying SNPP, flight profiles were defined to also obtain data coincident with the NASA A-train (i.e. AQUA), MetOP-A, and MetOP-B satellites to enable inter-comparisons with instruments aboard those platforms (e.g. AIRS, IASI, and CrIS). An effort was made to maximize space / time coincidence of aircraft data with that from the satellite sensors, radiosondes and ground truth data sites, while observing desired meteorological and surface target scenes. This presentation gives an overview of the SNPP campaign and summarizes results to date for infrared spectral radiance inter-comparisons involving NAST-I.

2. ANALYSIS APPROACH

Spectral radiance inter-comparison is a fundamental first-step prior to assessing derived geophysical parameter quality. Space and time collocation is critical for this task when the scenes being inter-compared contain significant non-uniformity. Airborne assets are uniquely able to provide such collocation and enable the best overall direct radiance inter-comparisons. As discussed by Larar et al. [7], infrared spectral radiance inter-comparison using data from 29 April 2007 of JAIVEx show NAST-I to compare quite favorably with IASI and AIRS spectra. JAIVEx aircraft under-flew both Metop (1550 GMT) and Aqua (1919 GMT) within a single flight mission to enable aircraft sensors to obtain space and time coincident observations with both satellites on this case study day. Comparisons show IASI and AIRS matching NAST-I to within ~ 0.1 K (band-averaged spectral radiances). These comparisons are for single spacecraft sensor IFOVs with NAST-I observations coincident in space and time to both. Since NAST-I is of higher spectral resolution than the spacecraft sensors, quantitative comparisons are made after degrading these data to enable same-spectral resolution comparisons. Such inter-comparisons yield the closest levels of direct radiance comparisons and verification to these levels is hard to achieve using other approaches. NAST-I can also serve as a calibration reference to compare other measurements indirectly, exploiting the fact that its accuracy stability is less uncertain than absolute accuracy itself; employing this approach for a JAIVEx flight has demonstrated longwave band differences between IASI and AIRS on the order of less than 0.05 K [10]. Additional comparisons using this type of methodology will be discussed herein with a specific focus on the most recently conducted SNPP cal/val field campaign.

3. SUMMARY

This presentation stresses the importance of post-launch validation activities, including field campaigns employing airborne FTS systems, to verify the quality of satellite measurement systems (i.e., sensors, algorithms, and data products). Airborne FTS systems such as the NAST-I play a vital role in assessing radiometric and spectral fidelity of spaceborne sensor observations since they provide the best means of comparison with spatially- and temporally-coincident direct measurements, along with independently-retrieved geophysical products for comparison with like products from satellites. Continuation of aircraft under-flights for multiple satellites during multiple field campaigns enables long-term monitoring of system performance and inter-satellite cross-validation. Methodology herein has been developed and implemented for AIRS and IASI validation and most recently applied to data obtained from under-flying the Cross-track Infrared Sounder (CrIS) instrument launched aboard the SNPP satellite (28 October 2011).

Acknowledgment

The authors wish to acknowledge NASA SMD, NASA Langley Research Center, NOAA JPSS (formerly the NPOESS Integrated Program Office, IPO) and the various team members and their respective institutions for their continued, enabling support of the NAST program and studies such as those conducted herein.

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Biography: Dr. Allen Larar is a Senior Research Scientist at NASA Langley Research Center. He has had extensive involvement in most aspects associated with the development and implementation of advanced, passive remote sensors of the Earth's atmosphere, and is currently involved in several programs employing Michelson and Fabry-Perot interferometer systems.