Assessment of Reanalysis Datasets Using AIRS and IASI Hyperspectral Radiances

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Several reanalysis projects have been carried out in recent years, which produce data over decadal periods using modern weather forecast analysis systems with metrological observations as inputs. These datasets provide us with the best available four-dimensional, homogeneous datasets for studying the climate and weather systems and for possible validation of climate models. In order to have confidence in the use of reanalysis data for the above-mentioned studies, it is important to see how they compare with a common dataset with high data quality and to understand any discrepancies among them.

Carried on the NASA's Earth Observing System *Aqua* spacecraft and launched in May 2002, the Atmospheric Infrared Sounder (AIRS) is the first high spectral resolution infrared sounder that measures the thermal infrared spectrum with 2378 spectral channels covering the 3.75–4.59 μm (2181–2665 cm^{-1}), 6.20–8.22 μm (1217–1614 cm^{-1}), and 8.8–15.4 μm (650–1136 cm^{-1}) spectral regions with a nominal spectral resolution of $\nu/\Delta\nu$ = 1200. The Infrared Atmospheric Sounding Interferometer (IASI) is the first operational interferometer in space measuring the 3.5-16.4 μm (610-2825 cm^{-1}) spectrum in 8461 spectral channels with a spectral resolution of 0.5 cm^{-1} and a spectral sampling interval of 0.25 cm^{-1}, successfully launched on *Metop-A* in October 2006. Since spectral resolved infrared radiances provide sensitivity to nearly all forcing, response and feedback terms, such as changes in CO2, CH4, carbon monoxide (CO), O3, N2O, water vapor (H2O), aerosols, temperature, clouds, and surface characteristics, they have been proved useful for assessing the accuracy of climate and weather model [e.g., Huang et al. 2007; Goldberg et al. 2009]. In this study, we use the AIRS and IASI hyperspectral radiances to evaluate the data quality of reanalysis datasets, including NASA*'s* Modern Era Retrospective-analysis for Research and Applications (MERRA), European Centre for Medium-Range Weather Forecast's ERA-Interim Reanalysis, Japanese 25-year

Reanalysis (JRA-25), and NOAA NCEP's Climate Forecast System Reanalysis and Reforecast (CFSRR).

In the first part, an inter-comparison of AIRS and IASI spectral radiances is performed. The purpose here is to demonstrate the stability and accuracy of AIRS and IASI and to give the confidence that AIRS and IASI can be used as Climate Data Records (CDRs) to assess the accuracy of reanalysis datasets. Two different methods, including 1) a direct comparison at a orbital crossing point of satellites occurring at high latitudes – the so-called simultaneous nadir overpass (SNO) observations and 2) double-differences between a pair of sensor radiance biases relative to a common transfer target (GOES imagers are chosen here), are used to comprehensively evaluate the data quality of AIRS and IASI at different climate regimes [Wang et al. 2009].

Secondly, we briefly discuss the method on how to use the raw AIRS and IASI data to generate the spectrally resolved infrared radiances (SRIR) [Goldberg et al. 2009]. The main aim here is to generate the girded, limb-adjusted, and clear sky brightness temperature datasets that are easily used for reanalysis evaluations.

The third part – the assessment of reanalysis datasets - forms the core of this study. We use the reanalysis fields including temperature, water vapor, ozone profiles as inputs to radiative transfer models, and then simulate the AIRS and IASI radiances based on different analysis datasets. The simulated radiances are compared to the SRIR datasets, and the differences of each reanalysis relative to the SRIR data are evaluated at different time scales. Particularly, we focus on the spectral signature region of stratosphere temperature and upper troposphere water vapor. The discrepancies among these reanalysis datasets will be discussed and analyzed.

References:

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Biography:

Likun Wang received the B.S. degree in atmospheric sciences and the M.S. degree in meteorology from Peking University, Beijing, China, in 1996 and 1999, respectively, and the Ph.D. degree in atmospheric sciences from the University of Alaska, Fairbanks, in 2004. He was a Postdoctoral Research Associate with the University of Maryland, College Park, from 2004 to 2005. He is currently a Research Scientist with Dell Perot Systems Government Services, Inc., Fairfax, VA, in support of satellite sensor calibration for the National Environmental Satellite Data and Information Service, National Oceanic Atmospheric Administration. His principal areas of interest include lidar/radar remote sensing and satellite sensor calibration.

Mitchell D. Goldberg is the Chief of the Satellite Meteorology and Climatology Division, National Environmental Satellite, Data, and Information Service (NESDIS) Center for Satellite Applications and Research, National Oceanic and Atmospheric Administration (NOAA), Camp Springs, MD, and the Program Manager for the GOES-R Algorithm Working Group. He has extensive experience in the development and improvement of algorithms for deriving atmospheric temperature and moisture profiles from satellite observations. In 1990, he was with the NESDIS Office of Research and Applications. He is a member of the competitively awarded NASA Atmospheric Infrared Sounder science team and the European Organization for the Exploitation of Meteorological Satellites Infrared Atmospheric Sounding Interferometer Science Working Group. He contributes to both teams by developing and validating scientific algorithms for deriving geophysical parameters from space-based hyperspectral infrared observations and also oversees the development of processing systems for data distribution. He also serves on the Integrated Program Office National Polarorbiting Operational Environmental Satellite System (NPOESS) Sounding Operational Algorithm Team, which is an advisory board for the hyperspectral NPOESS Cross-track InfraRed Sounder. He is also a member of the NOAA Climate Board and the World Meteorological Organization Atmospheric Observations Panel for Climate. In 2002, he was promoted to Chief of the Climate Research and Applications Division, which was reorganized into the Satellite Meteorology and Climatology Division. The division, consisting of nearly 40 federal employees and supported by more than 60 contractors and visiting scientists, applies remote sensing science to monitoring and describing the Earth/atmosphere system, develops and demonstrates new applications of satellite data and product processing systems, provides calibration of satellite instruments, validates satellite products, conducts training, and transfers technology to operations.