CGMS

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DEVELOPMENT OF A CLIMATE DATA SET FROM HYPERSPECTRAL IR INSTRUMENTS

In response to CGMS Recommendation 33.04

NOAA Response to CGMS XXXIII Recommendation 33.04

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1 INTRODUCTION

Recommendation 33.04 CGMS Members are encouraged to define and commence the development of a climate data set from hyperspectral IR instruments (AIRS, IASI, CrIS) that is substantially reduced in terms of data volume, in order to make climate processing of long time series tractable. It might be appropriate to defer this matter to the ITWG.

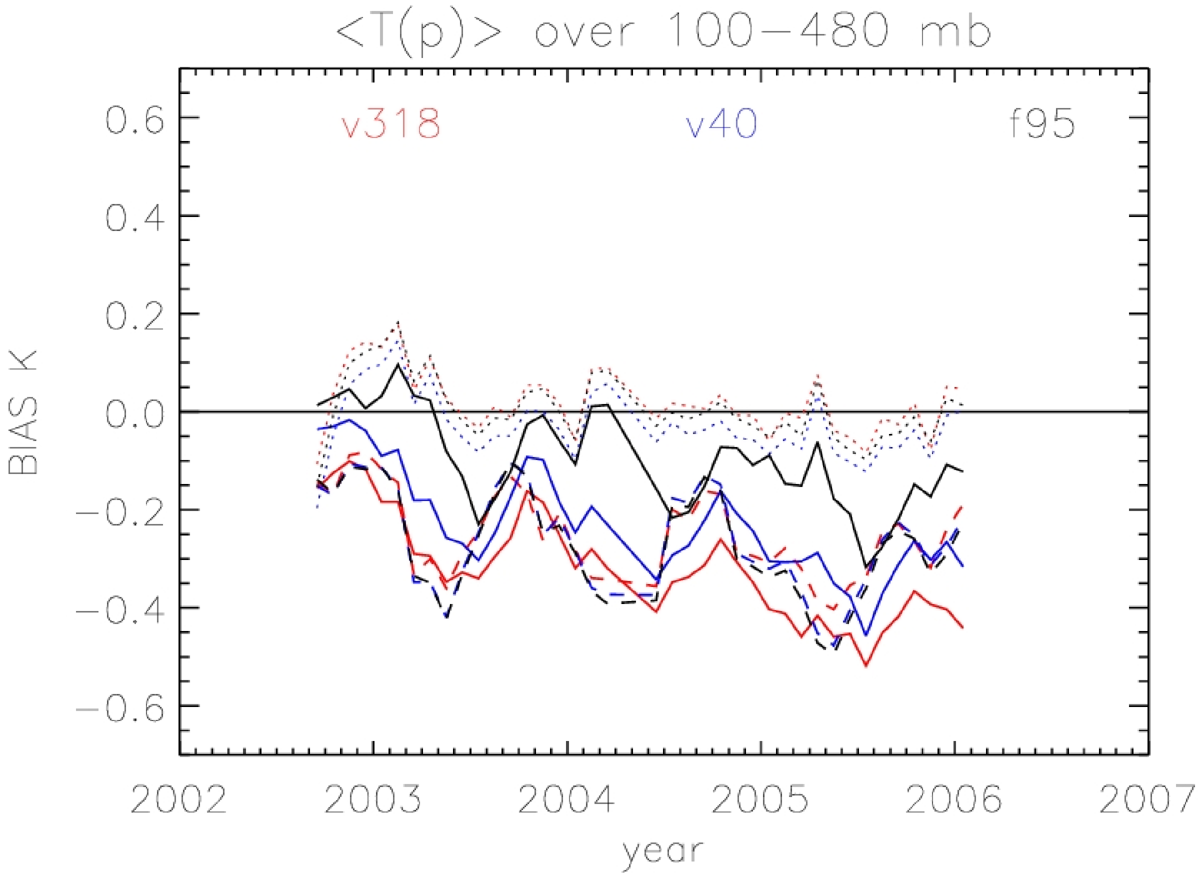
2 Development of a Climate Data Set from Hyperspectral IR Instruments

Constructing a climate data set for hyperspectral sounders requires the ability to reprocess the dataset frequently and easily to incorporate understanding of instrument characteristics and algorithm characteristics. At NOAA/NESDIS we have developed a number of subset files that should be of interest to the climate community. We plan on extending these datasets to IASI and CrIS. The datasets we have found most useful are:

1) Co-location of AIRS,IASI, and CrIS radiances to operational sondes. A full set of infrared radiances (a “golfball” of IR FOV’s associated with an AMSU FOV) are saved for any sonde launched within +/- 5 hours, +/- 100 km of AIRS overpasses. Also, ECMWF and GFS model products are saved for these scenes. Tighter co-location (e.g., +/- 1 hour) can be performed later.
2) Fetch closest “golfball” to points on a uniform 3x3 degree grid for ascending and descending passes (i.e., 2 files). ECMWF and AVN products are also saved for these scenes.

The sonde co-location file can be utilized to test for biases in the retrieval products that arise from either instrumental or algorithm effects. The ability to re-process this dataset is essential to evaluate mature algorithms. We have used this dataset to intercompare biases as a function of retrieval type (e.g., AMSU-only AIRS statistical regression, and AIRS/AMSU physical) and algorithm versions (e.g.,). Seasonal patterns and trends induced by algorithm deficiencies (e.g., cloud clearing errors, microwave side-lobe errors, etc.) can be analysed. This analysis forms the basis for uncertainties in climate products. In order to evaluate the impact of algorithm refinements (e.g., comparing v3.18, v4, v5, etc.) one must maintain the ability to re-process using earlier versions of algorithms. The sonde database has about 50,000 sondes per year per instrument. The AIRS/AMSU radiances, RAOB, and forecast products total about 5 GB per year/instrument over the 4 years that AIRS has been operational.

In Fig. 1 we show an example of the retrieval minus sonde biases between 100 and 500 mb for version 3.18 (red, circa 2003), version 4.0.9 (blue, circa late 2004), and version 5.0 (black, proposed for 2007) systems of the AIRS science team retrieval. The dotted lines are the AMSU-only retrieval, the dashed lines are the statistical regression retrieval (based on AIRS cloud cleared radiances), and the solid lines are the physical retrieval. The reduction of biases between these systems is due to incorporation of better instrument characterization, improvements in radiative transfer, and the incorporation of a simple CO2 climatology for the middle troposphere into the physical retrieval.



The gridded products can be used to test new algorithms and to look for interannual, seasonal and regional patterns in data products. The database files are manageable (about 750 GB per year per instrument) and we can re-process 1 year of AIRS data in about a day on a modest LINUX system. For example, with AIRS we are adding trace gas products, such as carbon monoxide, methane, carbon dioxide, nitric acid, nitrous oxide, and sulfur dioxide. These are difficult products that benefit from re-analysis of instrument characteristics, improvements in radiative transfer, and algorithm refinements. The trace gas products also improve the core products in the sense that improved knowledge of carbon dioxide and ozone can elimate biases in temperature. Knowledge of methane and nitric acid can elimate certain biases in moisture, etc.

In Fig. 2 we show the AIRS ozone (left panels) and carbon monoxide (right panels) products for October 2004 (top) and July 2004) bottom. The correlation of ozone production in the troposphere (300-800 mb layer average) from carbon monoxide (400-500 mb layer average) produced in biomass burning appears to be evident. The gridded subset product allows quick analysis of products to look for seasonal and regional signals that can then be studied in more detail with the full resolution AIRS product.