INTERANNUAL VARIABILITY IN CLIMATE PRODUCTS FROM THE ATMOSPHERIC INFRARED SOUNDER

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1. INTRODUCTION

The Atmospheric Infrared Sounder (AIRS) is a hyperspectral infrared instrument on the EOS Aqua Spacecraft, launched on May 4, 2002. AIRS has 2378 infrared channels ranging from 3.7 μm to 15.4 μm and a 13.5 km footprint. AIRS, in conjunction with the Advanced Microwave Sounding Unit (AMSU), produces temperature profiles with 1K/km accuracy, water vapor profiles (20%/2km), infrared cloud height and fraction, and trace gas amounts for CO_2, CO, SO_2, O_3 and CH_4 in the mid to upper troposphere.[1] AIRS wide swath, ±49.5°, enables daily global daily coverage for over 95% of the Earth's surface. AIRS data are used for weather forecasting [2], validating climate model distribution [3] and processes [4], and observing long-range transport of greenhouse gases [5].

Early in the mission, the AIRS instrument demonstrated its value to the weather forecasting community by providing better than 6 hours of improvement on the 5 day forecast. Now with over seven years of consistent and stable data from AIRS, scientists are able to examine processes governing weather and climate and look at seasonal and interannual trends with high statistical confidence. The entire 7 year data set from AIRS are collected in this work for radiance subsets and global gridded data products for several key geophysical atmospheric variables. From this data set it is possible to identify interesting natural and anthropogenic events in Earth's atmosphere including hurricanes, biomass burning (CO plumes), inter-continental transport of carbon dioxide, ozone hole formation and several others.

2. METHODOLOGY

We start with the AIRS Level 1B product and compare its accuracy and stability to expected levels of climate change. The high accuracy demonstrated pre-flight and in-orbit meets the needs to serve as a benchmark for decadal scale variability [6]. Validation using buoy networks has shown radiances are stable to levels comparable to the estimated global ocean warming (better than 10 mK/yr) [7].

We then examine the AIRS Data as produced by the AIRS science team algorithms. Temperature and water vapor profiles and trace gas amounts are retrieved using a Singular Value Decomposition (SVD) algorithm in Version 5 and have demonstrated extremely high accuracy and yield [8]. Geophysical data products are generated at the GSFC GES/DISC [9] and stored in the AIRS Level 2 standard product. Most Level 2 products are produced on at 45 x 45 km resolution at nadir and are "cloud cleared", with valid retrievals up to 80% cloud cover [10]. This results in high yield that enable global daily animations of geophysical variables, some in 3 dimensions, showing long-range transport and dynamics. The AIRS processing system also generates Level 3 gridded products from the Level 2 data. Products are gridded into 1^{o} bins and available on 1-day, 8-day and monthly formats. In this effort, AIRS L3 data are combined to create zonal and weighted global averages for the mission duration. Methods for the binning and averaging involve standard statistical techniques and are presented. The zonal time series shed light on the high magnitude of the seasonal variability (a) and the small magnitude and high uncertainty of observed trends (b), and the difficulty with determining trends over short time spans.

3. RESULTS

The long-term multi-product data set allows examination of interesting natural and anthropogenic events including temperature, water vapor and cloud observations of tropical cyclones, hurricanes and deep convection. Interannual variability in these products reveals local anomalies including an increase in average surface temperatures in parts of the arctic polar ocean region in 2007 (c). AIRS global animations highlight transport of carbon monoxide from annual biomass burning in the Amazon (d), injection of water vapor and trace gases including methane into the upper troposphere, and ozone hole formation and daily circumpolar transport. Gridded monthly long-term data sets of CO2 show the variability of carbon dioxide in the mid troposphere formerly thought to be uniform (e).

4. CONCLUSIONS

Long-term gridded data sets from AIRS allow observation of seasonal and interannual variability and provide an observational climatology of critical parameters affecting climate including temperature, water vapor, ozone and greenhouse gases. We see a wide variety of natural and anthropogenic impacts to the distribution and transport indicating the atmosphere is extremely dynamic and complex in structure. With the AIRS expected to last until 2017, the record provided by these data sets for validating atmospheric models and improving model prediction become of increasing value to the scientific community.

5. REFERENCES

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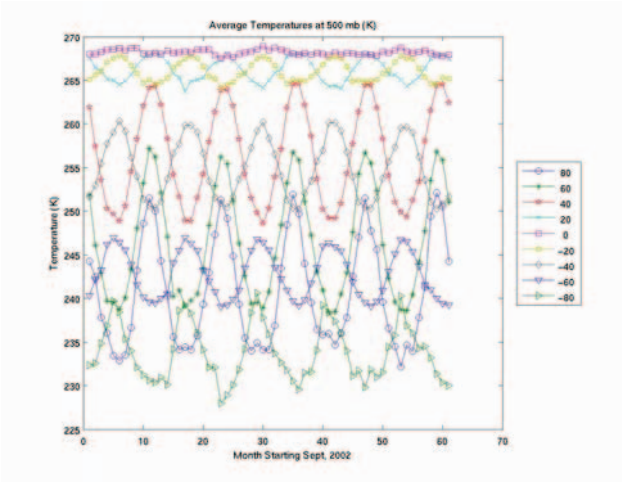
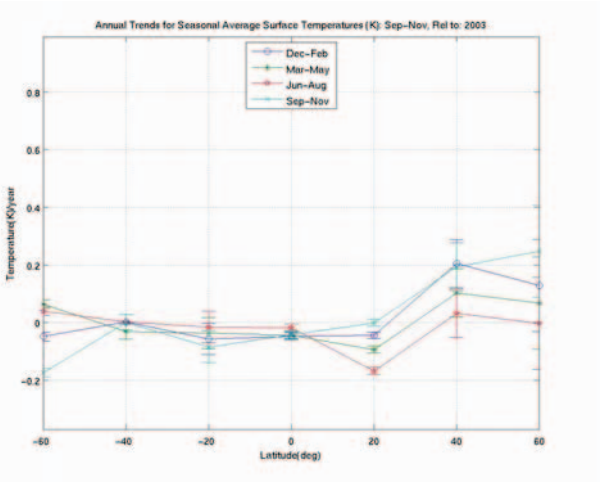


A)



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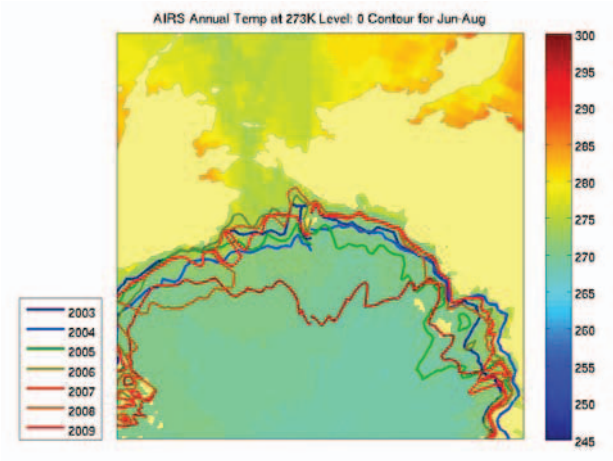

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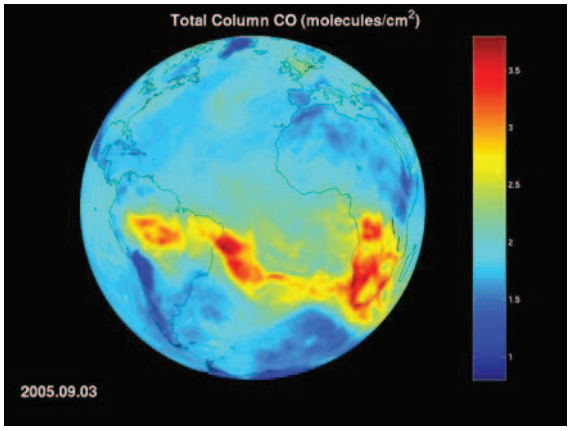

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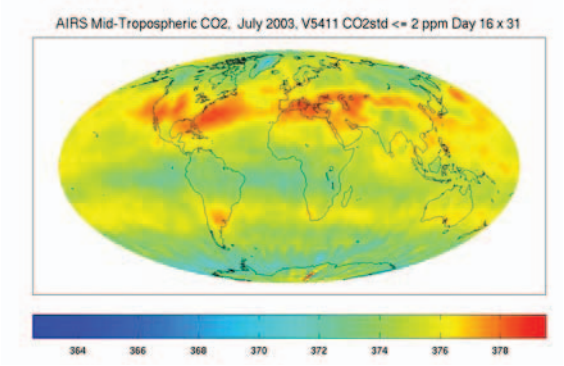

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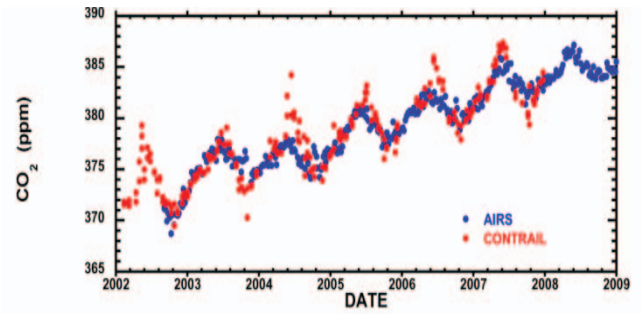

F)

A) Average Air Temperature obtained by AIRS at 500 mb for 9 zones over 7 years. B) Temperatures trends by season and zone are small and highly uncertain. C) Isotherms of surface temperature in arctic polar region show reduction in sea-ice in 2007. D) Carbon Monoxide total column amount on September 9, 2003. Animation of CO, CH4, O3, and other gases reveal long term transport. E) Global Distribution of Mid-Tropospheric Carbon Dioxide identify variability due to anthropogenic sources in the Northern Hemisphere. F) AIRS carbon dioxide is validated using aircraft observations; highlight seasonal and interannual variability.