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Progress Report

ATMOSPHERIC INFRARED SOUNDER

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Submitted to Team Leader
Moustafa T. Chahine
Jet Propulsion Laboratory
Pasadena, CA 91109

Submitted by

Team Members
Philip W. Rosenkranz
David H. Staelin

Research Laboratory of Electronics
Massachusetts Institute of Technology
Cambridge, MA 02139

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Microwave First-Guess Algorithm

The algorithm was modified for 100 levels; this mainly involved replacing one of the ancillary data files. However, it eventually was determined (by S.Y. Lee) that the simulations had not correctly calculated radiative transfer in the thin layer next to the surface. The forward algorithms were modified to fix this problem. New simulations use realistic surface emissivity. Therefore, the surface brightness-temperature routine was modified to use seawater emissivity when the surface is entirely covered by water.

Equations for determining the optimum weighting of nine HSB or AIRS fields-of-view to simulate an AMSU-A field-of-view, given the antenna beam shape, were derived.

New transmittance coefficients for AMSU-A and AMSU-B (or HSB) were delivered to JPL. These coefficients are based on an improved model for the water-vapor continuum. Although not being used in the current simulations, they are recommended for use with satellite data, which should become available in 1998.

Anomaly-Coding Compression Algorithm

Three activities were pursued: 1) evaluation of AIRS test data from Lockheed Martin (LM), 2) evaluation of the computational burden of the Anomaly-Coding (AC) algorithm, and 3) continued improvement of the AC algorithm. The LM test data revealed the presence of "blinkers" on some channels, as expected, and the presence of 1/f noise, which also is more significant on certain channels. These effects are being incorporated into the tests used to refine the AC algorithm.

The computational burden was evaluated for each step of the algorithm in its present form. Most operations are part of large matrix multiplications, which can generally be performed efficiently in parallel-processor accelerators attached to standard CPU's. The word-size requirements for such accelerators were also estimated, and word lengths of over 6 or 7 bytes seem indicated for at least some steps. A few million floating-point operations per AIRS spot also seems to be a plausible requirement, absent all housekeeping operations, but much more work remains before the final answer will be known.

The algorithm has been improved in two ways. First, a calibration component now pre-processes the data before it is coded and, second, noise-adjusted principal components have been used in the spatial domain to help code the slow drifting of the instrument. Preliminary tests based on the LM data suggest that raw compression ratios of ~25 might become 10-15 once the 1/f drifting has been accommodated by the AC algorithm.

Preparation for Aircraft Flights Supporting AMSU

Under sponsorship of the National Polar Orbiting Environmental Sensor System (NPOESS) Integrated Program Office, the NPOESS Advanced Sounder Testbed (NAST) is being developed by the MIT Lincoln Laboratory and others for flight aboard the NASA ER-2 high-altitude aircraft. NAST has both an advanced infrared sounder (NAST-I) and an advanced 54-GHz and 118-GHz imaging spectrometer (NAST-M) with spectral resolution and coverage comparable (or superior) to both AIRS and AMSU, particularly when flown in combination with other sensors such as the NASA GSFC MIR, which incorporates a 183-GHz spectrometer and several window channels below

90 GHz. The first science flights are expected to occur in the spring (TEFLUN) and late summer (CAMEX) of 1998.

The activities reported here are for the purpose of tuning and validating retrieval algorithms to be used later by AIRS/AMSU on EOS. The most critical objective of the early ER-2 NAST flights with respect to AIRS/AMSU is the testing and validation of the initial precipitation detection and microwave cloud clearing algorithms.

During this reporting period prior 118-GHz spectral images obtained by the MIT Microwave Temperature Sounder (MTS) on the ER-2 were analyzed in a preliminary way to develop an improved microwave-only cloud flag that is relatively insensitive to surface emissivity and other non-cloud environmental variations. By deriving a first principal component of the radiance vector in the absence of clouds and removing it from the radiance data, a second first principal component for all data, including clouds and precipitation, has yielded a good first approximation to a cloud flag for 118-GHz spectral data. This technique will be improved and then extended to the NAST data to be obtained from its early missions.

In addition, enough progress was made here in developing the RF, calibration, and data system to be used by NAST-M in supporting the AIRS/AMSU flight experiments that the very tight deadline posed by the 1998 flight schedule can probably be met. The unique results to be provided by these flights are expected to be critical in developing the required high performance microwave-dependent algorithms prior to launch of AIRS/AMSU.

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15. Supplementary Notes

16. Abstract

This report summarizes the activities of AIRS Team Members P.W. Rosenkranz and D.H. Staelin during the second half of 1997.

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