THE AIRS/AMSU/HSB SUITE

AIRS/AMSU/HSB launched on EOS Aqua May 4, 2002
AIRS is a multi-detector array grating spectrometer
2378 channels between 650 cm\(^{-1}\) and 2760 cm\(^{-1}\)
Channel spacing \(\approx \frac{\nu}{2400}\) (0.25 cm\(^{-1}\) - 1.1 cm\(^{-1}\))
Resolving power \(\frac{\nu}{\Delta \nu} \approx 1200\) (0.5 cm\(^{-1}\) - 2.2 cm\(^{-1}\))
Footprint 13 km at nadir
3 x 3 array within AMSU A footprint - collocated with HSB
One sounding produced per AMSU A footprint
HSB failed on February 5, 2003
OBJECTIVES OF AIRS/AMSU/HSB

Provide data to improve operational weather forecasting

Required global accuracy in up to 80% cloud cover:

1 K RMS error in 1 km layer mean tropospheric temperature

20% RMS error in tropospheric 1 km layer precipitable water

Provide long-term global coverage of surface and atmospheric parameters

Monitor climate variability and trends

Study processes affecting climate change
AIRS/AMSU PRODUCTS

Primary

Atmospheric profiles
- Temperature - surface air to 0.1 mb
- Water vapor - surface air to 100 mb
- Ozone - eight layers, surface to 1 mb

Surface Parameters
- Skin temperature
- IR spectral emissivity
- MW spectral emissivity
- Clear column radiances $\hat{R}_i$ - used to produce the solutions

Cloud parameters - one product every AIRS FOV
- Cloud top pressure - 2 cloud levels
- 2 effective cloud fractions $\alpha \varepsilon$ (fraction times 11 μm emissivity)
- OLR, clear sky OLR

Research
- CO and CH$_4$ profile, CO$_2$ total burden
OVERVIEW OF AIRS TEAM RETRIEVAL METHODOLOGY

Start with initial guess that agrees with microwave radiances
Derive IR clear column radiances, $\hat{R}_i^0$, valid for 3x3 array of AIRS FOV’s

$\hat{R}_i$ is estimate of radiance channel i would see if no clouds were present
Obtain AIRS regression guess consistent with $\hat{R}_i^0$ (1504 channels)
Derive $\hat{R}_i^1$ consistent with regression state - $\hat{R}_i^1$ is more accurate than $\hat{R}_i^0$
Derive all surface and atmospheric parameters using $\hat{R}_i$ (415 channels)
Derive cloud parameters consistent with solution and observed $R_i$
Apply Quality Control

Reject solution if retrieved cloud fraction > 80% or other tests fail
Redetermine cloud parameters using initial guess and $R_i$ if retrieval is rejected
Simulated Noise–free AIRS Spectrum, indicating Retrieval Channels

Brightness Temperature (K)

Temperature (red), CO₂ (dark blue), Water (light blue)

Surface (black), O₅ (green), CH₄ (orange), CO (purple)

Selected Daytime Cloudy case, January 25, 2003
AIRS DATA SETS

JPL Version 3.0.8
Used operationally by Goddard DAAC to produce AIRS Level 2 Products since August 2003.

JPL Version 3.1.9
Improved version used by JPL and Mitch Goldberg (NOAA)

GSFC Version 3.1.8
Slightly different from JPL version 3.1.9
Used to analyze AIRS focus day September 6, 2002 and all of January 2003
January 2003 data used in forecast impact test
Monthly mean values were compared to ECMWF
AIRS EXPERIMENTS WITH FVSSI

Global data assimilation system used:
fvSSI: fvGCM - Resolution: 1x1.25 SSI (NCEP) analysis-T62

Period of assimilation:
1 January - 31 January, 2003

Experiments:

**Control:** All Conventional Data + ATOVS Radiance (NOAA-14, 15, 16) + CTW + SSM/I TPW+ SSM/I Wind Speed + QuikScat + SBUV Ozone

**Control + AIRS Retrieved Temperature Profiles** (Clear $\alpha \epsilon < 0.02$ /Ocean / -40 - + 40 deg)

**Control + AIRS Retrieved Temperature Profiles** (Clear $\alpha \epsilon < 0.02$ /Ocean/Global)

**Control + AIRS Retrieved Temperature Profiles** (Clear +Partly Cloudy $\alpha \epsilon < 0.4$ /Ocean/Global)

Forecasts:
13 forecasts run every two days beginning on 6 January, 2003
Global Extratropical Cyclone Forecast Error
From 11 Five-day FVSSI Forecasts

CON = Control
CLR1 = Control+clear AIRS (40S–40N)
CLR2 = Control+clear AIRS (global)
PC = Control+partly cloudy AIRS (global)
Impact of AIRS on 72hr Forecast of Sea Level Pressure

Control Forecast

AIRS Forecast

NCEP Analysis

January 31, 2003 00Z
SUMMARY

Global AIRS temperature profiles, in up to 80% cloud cover, approach required accuracy

Results degrade only slowly with increasing cloud cover

Assimilation experiments using AIRS temperature retrievals over ocean show:
  • 8 hour improvement in 5-day Southern Hemisphere extratropics forecast skill
  • Global improvement in 5-day forecast of cyclone position and intensity
  • Addition of retrievals in partially cloudy conditions further improves forecasts