ABB Remote Sensing

Atmospheric Emitted Radiance Interferometer AERI™ system overview

The ABB Atmospheric Emitted Radiance Interferometer AERI™ provides thermodynamic profiling, trace gas detection, atmospheric cloud aerosol study, air quality monitoring, and more.

AERI high level overview

ABB offers a high precision scientific tool in the form of a ruggedized operational product, adding to the array of instruments used to gather meteorological data.

The AERI™ is an automated sounding spectroradiometer system used to characterize the properties of the atmospheric at the planetary boundary layer and lower tropospheric levels. It measures absolute downwelling atmospheric emitted infrared radiance with high accuracy. These measurements, when processed by its dedicated algorithms, can be used to estimate vertical boundary layer thermodynamic profiles in the lower atmosphere (up to about 3 km) with optimal vertical resolution of 100 m. This remote sensing tool can work year-round during both day and night (except during precipitation), continuously providing temperature and humidity profiles every 8 minutes.

The AERI multi-functional instrument is ideally suited to observe meteorologically important mesoscale phenomena, such as boundary layer evolution, cold/warm frontal passages, dry lines, and thunderstorm outflow frontiers. It is also especially useful to scientists wanting to monitor air quality (pollution), detect trace gas (GHG), study atmospheric clouds, aerosols (particularly dust), and more.

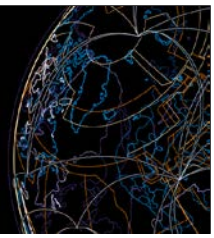
Applications

- Atmospheric research
- Weather forecasting
- Environmental climate studies
- Thermodynamic research
- Spectroscopic science
- Land and ocean surface characterization, etc.

Benefits

- Fully integrated and automated
- Robust, reliable, and simple to operate
- Can operate day and night (24/7), all year long
- Long-term stability
- No consumables or human interaction are needed
- Rapid sampling mode can provide radiometrically calibrated spectra every 20 seconds
- Can complement or even replace expensive radiosondes
- Passive remote sensing technology (stealth and eye-safe)
- Validation and calibration of satellite measurements
- Complementary synergy with other kinds of instruments (e.g. lidar, radars, microwave sounders)

Atmospheric Emitted Radiance Interferometer AERI™ system overview



General system elements

- ABB's MR Series Michelson interferometer with non-hydroscopic beamsplitter and optics.
- Automated system for providing sequential views of the sky (zenith) and two full-aperture temperature-controlled calibration reference sources (blackbodies).
- Environmental monitoring system, for collecting of blackbody temperatures and other housekeeping data.
- PC Computer and Data Handling System. The interface control allows sequencing all AERI operations, including scenes switching, ingesting of interferometer and Environmental Monitoring System data, calibration, and data transfer. Data handling includes acquisition, processing, display, and networking.

Radiometric performance specifications

Standard range AERI

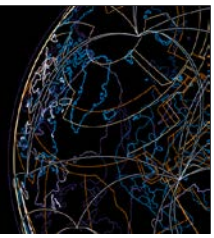
Spectral coverage	550 – 3000 cm^{-1} (3 – 18 µm)
NESR	≤ 0.2 mW/(m^2 sr cm^{-1}) for 670 – 1400 cm^{-1} ≤ 0.015 mW/(m^2 sr cm^{-1}) for 2000 – 2600 cm^{-1}, except 2300 – 2400 cm^{-1}, where CO_2 in the instrument reduces responsivity

Extended range AERI

Spectral coverage	400 – 3000 cm^{-1} (3 – 25 µm)
NESR*	≤ 0.8 mW/(m^2 sr cm^{-1}) for 425 – 455 cm^{-1} ≤ 0.4 mW/(m^2 sr cm^{-1}) for 455 – 1400 cm^{-1}, except at 667 cm^{-1}, where CO_2 in the instrument reduces responsivity < 0.015 mW/(m^2 sr cm^{-1}) for 2000 – 2600 cm^{-1}, except 2300 – 2400 cm^{-1}, where CO_2 in the instrument reduces responsivity
Spectral resolution	1.0 cm^{-1} apodized (0.8 cm^{-1} unapodized) Maximum optical path difference OPD ±1 cm
Wavelength calibration	Channel wavenumber knowledge: better than 0.01 cm^{-1}
Radiometric calibration	Absolute accuracy: < 1 % of ambient blackbody radiance Reproducibility: < 0.2 % of ambient blackbody radiance
Detector	MCT/InSb detector mounted in one stirling cryogenic cooler MTTF > 20000 hours
Instrument FOV	< 45 mrad (full angle)

* The NESR measurement is RMS for 2 min blackbody view in a purged state of the instrument with dry air (dew point –40°C) during a 24 h period prior to characterization.

Atmospheric Emitted Radiance Interferometer AERI™ system overview



Subsystem specifications

Blackbody characterization	Temperature knowledge	±0.1°C (of absolute temperature)
	Emissivity knowledge	< ±0.1 %
	Temperature stability	< 0.05°C over viewing period (≈120 s)
Nonlinearity knowledge	< 0.1 %	
Polarization knowledge	< 0.1 %	
Temporal sampling	Repeat cycle ≈ 8 min	

Automatic control system features

The standard AERI measurement cycle includes a sky measurement followed by measurements of the two internal blackbodies generating one accurately calibrated spectra every 8 minutes.

In the optional Rapid Sampling acquisition mode, the measurement rate can be increased to 125 calibrated sky spectra per hour, with reference blackbody measurements occurring every 5 minutes.

- Scheduled sequencing
  - Automatic scene switching between sky and blackbody views
  - Interferometer and housekeeping data acquisition and transfer
- 24 h continuous operations with data output at 8 min intervals
- Real time display with flags for out-of-limit conditions, including:
  - Spectra from sky and blackbody views
  - Housekeeping data (interferometer, ambient, electronics, and blackbodies temperatures)
  - Blackbody spectral variance
  - Scene mirror position
  - Environmental Monitoring System measurement stability (determined from dedicated channels reading fixed precision resistors)

Operating environment

The AERI system is composed of two main sections: the input and calibration module and the interferometer and electronics module. The first section is not stabilized in temperature and it is free running at exterior conditions. It is covered by an enclosure that protect against precipitation (rain or snow). The spectroradiometer module section features heating and cooling power to stabilize the internal surrounding air at about 20°C. These two constituents are rated to operate at the following environment temperatures:

Input and calibration enclosure: –70° to +40°C

Detector and control system: –30° to +40°C

Note: In the presence of precipitation, the system automatically goes to self-protection mode that temporarily stops acquisition, returning to normal acquisition mode once the precipitation has stopped.

Atmospheric Emitted Radiance Interferometer AERI™ system overview

Physical characteristics

Dimensions: 1.3 m (L) × 0.8 m (W) × 1.0 m (H) (H = 1.2 m with input port hatch opened)

Weight: 200 kg

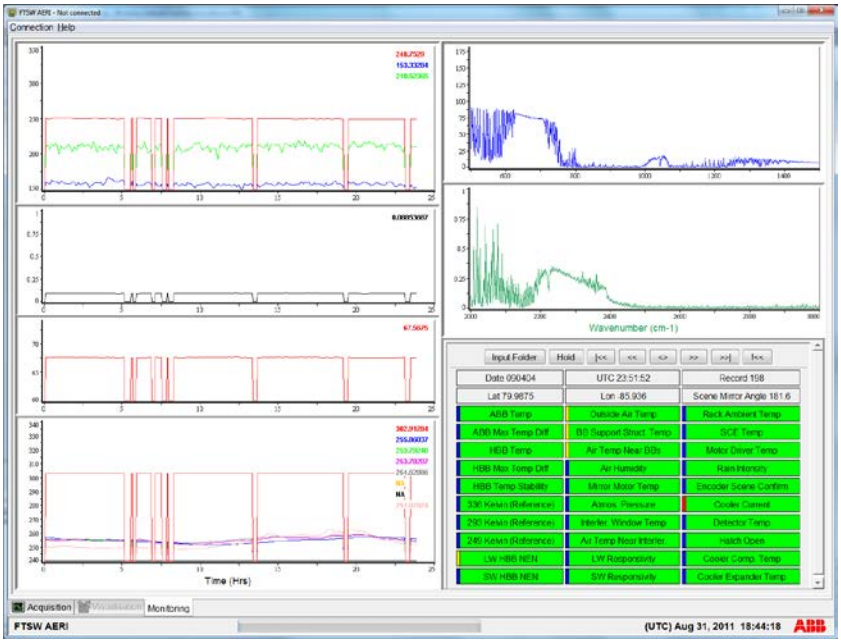
Data products

The AERI data products are divided into primary and secondary products. The primary products required for scientific use include evaluation of data quality. The secondary products provide important auxiliary information for real-time monitoring of operations as well as historical data for subsequent quality control.

- Primary (every viewing cycle; 8 min):
  - Calibrated spectra
  - Standard deviation for blackbody and sky views
  - Calibration coefficient and blackbody temperatures
- Secondary (every cycle):
  - Ambient air temperature, pressure, and humidity
  - Instrument housekeeping data

User interface

The AERI software user interface can access multiple systems via the internet to provide quick access to the latest acquired atmospheric radiance spectra, as well as to the health status of the instruments. The health status is color coded on the display interface to easily trace a system or module needing attention.

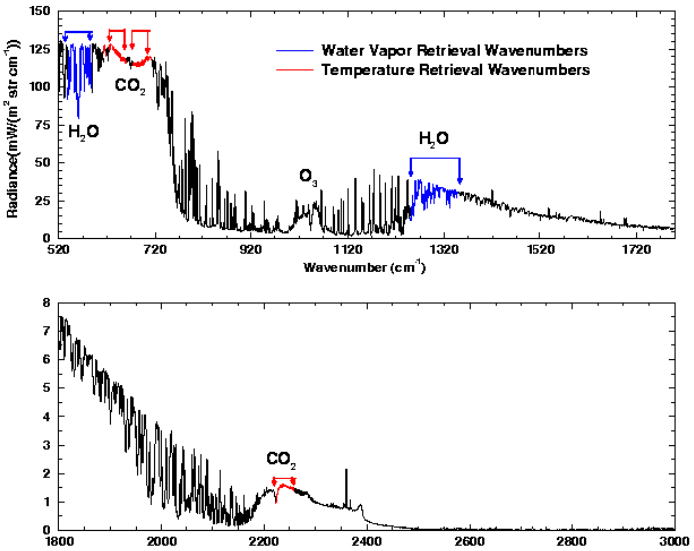


Atmospheric Emitted Radiance Interferometer AERI™ system overview

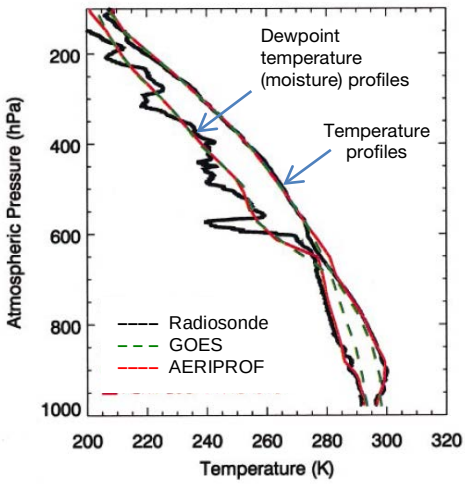
AERI retrieval algorithms

The thermal emitted radiance from atmospheric measurements is primarily dependent on temperature and water vapor concentration, allowing profiles of the planetary boundary layer to be derived from the acquired calibrated spectra. The calculation is performed by sophisticated retrieval algorithms of the AERIPROF software.

AERI radiance spectra from Channels 1 and 2
(computed from measured interferograms)



Retrieved atmospheric temperature
and water vapor profiles



Comparison of radiosondes with the nearest GOES retrievals and the final AERIPROF physical retrievals.

Atmospheric sounding performances

The sounding performance of the AERI was tested in a tempered climate zone. The following parameters are based on the AERI sounding performance test results:

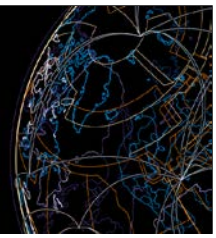
Vertical resolution	100 m at surface; gradually increase to 250 m at 3 km altitude
Limit of monitoring altitude	3 km or cloud ceiling
Time resolution	Vertical profile every 8 min
Humidity accuracy	5% in absolute water vapor compared to well calibrated radiosondes
Temperature accuracy	1 K

References

Feltz, *et al.*, 2003: “Near-Continuous Profiling of Temperature, Moisture, and Atmospheric Stability Using the AERI”, *J. Appl. Meteor.*, **42**, pp. 584–597.

Knuteson *et al.*, 2004: “AERI. Part I: Instrument Design & Part II: Instrument Performance”, *J. of Atmos. Oceanic Technol.*, **21**, p. 1763–1789.

Atmospheric Emitted Radiance Interferometer AERI™ system overview



About ABB

ABB Analytical Measurement continues to set the standards for FT-IR Spectroradiometry used in military, meteorological, and environmental applications. Building on 40 years of experience in Fourier spectrometers and optical instrumentation, ABB engineering department has the expertise and capabilities to efficiently serve customers interested in remote sensing aerospace applications. Its dedicated team of engineers offers the best solutions with reliable airborne and spaceborne instruments, infrared calibration systems, hyperspectral imagers, and software for ground segments and simulation.

To get more information, install QR code reader on your mobile device, scan the code and see more.

Contact us

ABB Analytical Measurement,
Remote Sensing department

Richard L. Lachance Ph.D.,
Business Development Specialist

585 Charest Boulevard East, suite 300
Quebec, (Quebec) G1K 9H4, Canada
(418) 877-2944 x242

Richard.L.Lachance@ca.abb.com
www.abb.com/analytical