IASI Validation Studies using Airborne Field Campaign Data

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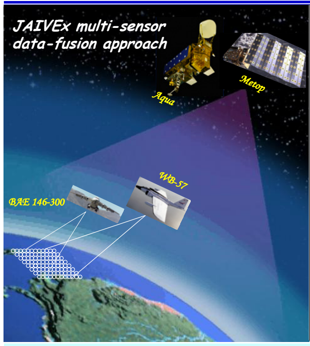
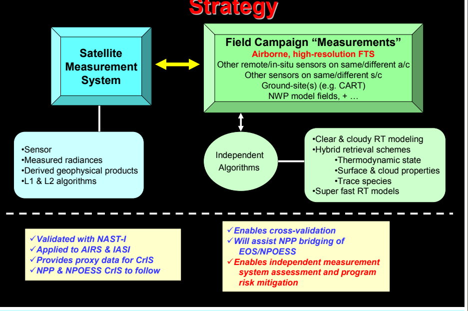
LaRC SD



Airborne-Field-Campaign-Centric Cal/Val Strategy



Abstract: Measurement system validation is critical for advanced satellite sensors to improve observations of the Earth's atmosphere, clouds, and surface for enabling enhancements in weather prediction, climate monitoring capability, and environmental change detection. Field campaigns including satellite under-flights with well-calibrated FTS sensors aboard high-altitude aircraft are an essential part of the validation task. This presentation focuses on IASI validation studies performed using data from the recently-completed Joint Airborne IASI Validation Experiment (JAIVEx) field campaign. Methodology developed and employed herein for IASI radiance validation will be discussed along with recent results.

Calibration validation approach *

- Spatial
  - Landmark navigation
    - compare observations to databases for known, time invariant distinct features (e.g., coastlines)
  - Comparison with coincident observations
    - spatial feature variability (coastlines, thermal gradients, clouds, hot lava, fires, etc.)
- Spectral
  - Comparison with simulations
    - obs vs LBL RTA calculations; vary simulated instrument spectral response to minimize residuals (e.g., effective metrology laser wavenumber for FTS or channel SRFs for grating)
  - Comparison with coincident observations
    - compare obs to same-scene view high-spectral resolution measurements (i.e., a/c- or s/c-based FTS)
- Radiometric
  - Comparison with other coincident observations and simulations
    - compare varying scene temp, uniform scenes with other (a/c & s/c) observations/calculations
      - High-spectral resolution & broadband measurements
      - RTA calculations (using, e.g., lidar, radiosondes, dropsondes, a/c in-situ, NWP)

* *Applied to each detector, i.e. FTS band, grating channel, etc.*

Joint Airborne IASI Validation Experiment (JAIVEx)

US-European collaboration focusing on validation of radiance and geophysical products from MetOp (IASI/AMSU) and Aqua (AIRS/AMSU) to provide data and experience for NPP & NPOESS (CrIS/ATMS) Cal/Val and program risk mitigation

Location/dates
–Ellington Field (EFD), Houston, TX, 14 Apr – 4 May, 2007

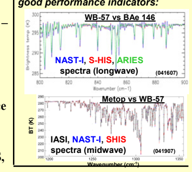
Aircraft
–NASA WB-57 (NAST-I, NAST-M, S-HIS)
–UK FAAM BAe146-301 (ARIES, MARSS, SWS; dropsondes; in-situ cloud phys. & trace species)

Satellites
–Metop (IASI, AMSU, MHS, AVHRR, HIRS, ASCAT)
–A-train (Aqua AIRS, AMSU, HSB, MODIS; Aura TES; CloudSat; and Calipso)

Ground-sites
–DOE ARM CART site (RAOBS, Raman Lidar, AERI, etc.) & GOM (scene uniformity—radiometric, spatial, & spectral)

Participants
–LaRC, UKMO, UW, MIT, MIT-LL, NASA, IPO, EUMETSAT, ECMWF, + …

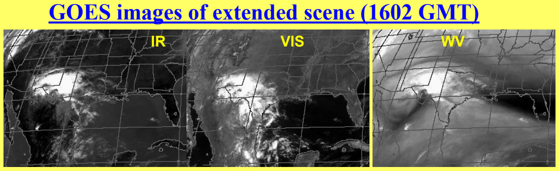
In-field product comparisons provide good performance indicators:



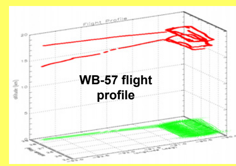
Case Study: 29 April 2007—JAIVEx

- **Flight mission objective**
  – Coordinated WB-57 and BAe-146 aircraft under-flight of Metop (1550 GMT) and Aqua (1919 GMT) satellites over northern Gulf of Mexico

GOES images of extended scene (1602 GMT)



- **Aircraft flight profiles**
  – WB-57 flew north-south-oriented oval racetrack pattern (@ ~ 17 km) in between satellite overpass events; BAe-146 characterized atmosphere and surface, from a range of altitudes below the WB-57

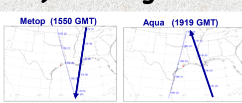


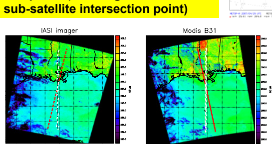
  – WB-57 arrived on-station 20 min prior to Metop, and remained until 10 seconds after Aqua (for a 3 hr & 50 min on-station duration). Conditions ranged from very clear on northern part of race track, to low, puffy cumulus sparsely populating southern extent of flight profile

Infrared Spectral Radiance Comparisons: JAIVEx aircraft underfly both Metop (1550 GMT) & Aqua (1919 GMT) within single flight mission (042907) enabling a/c sensors to obtain space/time coincident observations with both satellites

IASI vs AIRS:

Nadir and common x-sections are compared (+/- 5 deg latitude from sub-satellite intersection point)

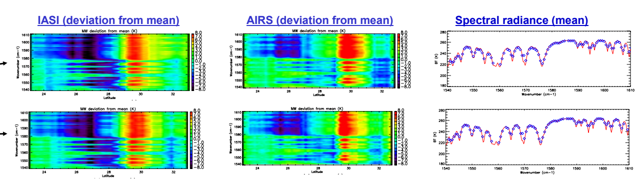




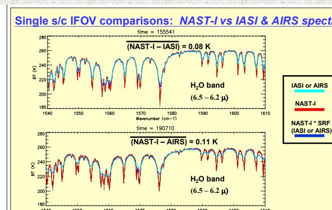
Nadir X-sections: coincidence = point in space

Common X-sections: coincidence = line in space

MW-band x-section comparisons



Single s/c IFOV comparisons: NAST-I vs IASI & AIRS spectra

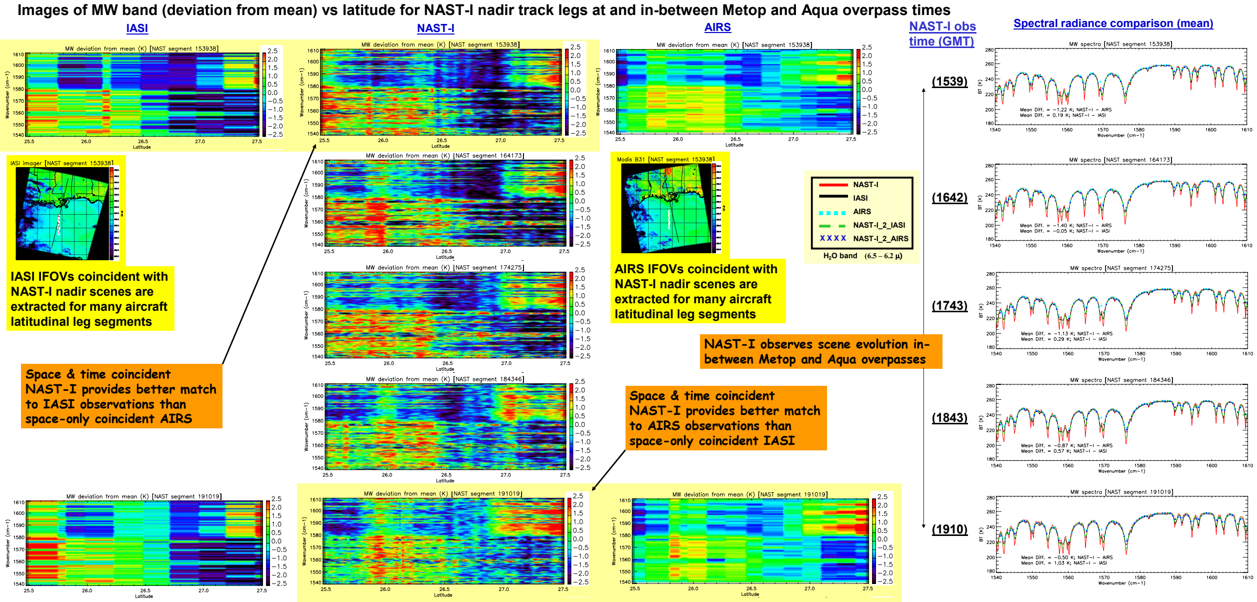


Comparisons show IASI & AIRS matching NAST-I to within ~ 0.1 K (band-averaged spectral radiances)

IASI vs NAST-I vs AIRS:

NAST-I X-sections: coincidence = line in space & time to enable best comparison

Images of MW band (deviation from mean) vs latitude for NAST-I nadir track legs at and in-between Metop and Aqua overpass times



IASI IFOVs coincident with NAST-I nadir scenes are extracted for many aircraft latitudinal leg segments

AIRS IFOVs coincident with NAST-I nadir scenes are extracted for many aircraft latitudinal leg segments

NAST-I observes scene evolution in-between Metop and Aqua overpasses

Space & time coincident NAST-I provides better match to IASI observations than space-only coincident AIRS

Space & time coincident NAST-I provides better match to AIRS observations than space-only coincident IASI

Summary and Conclusions

- Post-launch validation activities, including airborne field campaigns, are critical to verify quality of satellite measurement system (i.e., sensor, algorithms, and data products)
- High-altitude, airborne FTS systems enable assessing radiometric and spectral fidelity of spaceborne measurements
- The need for exact spatial/temporal coincidence increases with the degree of scene non-uniformity, and is uniquely satisfied by airborne sensors
- **JAIVEx was a great success!**
  – Campaign data are proving to be very useful for IASI and AIRS algorithm and product validation, and are serving to further refine methodologies for future advanced sounder validation activities (e.g., CrIS on NPP & NPOESS)
  – Demonstrates cross-validation capability and importance of field experiment campaigns

The 16th International TOVS Study Conference (ITSC-16), Angra dos Reis, Brazil, 7-13 May, 2008.