The Development of AMSU FCDR's and TCDR's for Hydrological Applications

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Outline

- Brief Project Overview
- Approach
- Results/Accomplishments
- Validation Strategy/Results
- Algorithm/Product Maturity
- Issues/Risks & Work-Off Plans
- Schedule
- Transition Plan
- Societal Benefits
- Resources

Overview

- Goals
  - Develop AMSU-A/-B (MHS) FCDR's for "window" and "water vapor" channels
    - AMSU-A: 23.8, 31.4, 50.3, 52.8, 89.0 GHz
    - AMSU-B/MHS: 89, 150/157; 183+1, 183+3, 183+7/190.3 GHz
  - Develop TCDR's for hydrological products (rain, snow, *etc.*)
- Source Data
  - NOAA-15,16,17,18,19 & MetOp-A L1B data
- Deliverables
  - FCDR's from 2000 – 2010 for all satellites (perhaps to 1998 for N-15 AMSU-A)
  - TCDR's; same time periods
- ECVs addressed
  - Precipitation, TWP, Clouds (CLW, IWP), SWE, SIC
- Review Product Description matrix

The product description matrix has been updated

Approach (1/2)

- FCDR single satellite calibration
  - Window channels
    - Antenna pattern correction: Mo's method for AMSU-A; Atkinson's method for AMSU-B/MHS
    - Onboard RFI: NOAA-15 AMSU-B, Atkinson's method
    - Geolocation correction
      - Attitude angle error: difference between asc and des orbits
      - Geolocation: modified Ellickson *et al.*'s method
    - Scan bias correction
      - Ocean: vicarious cold calibration and CRTM simulation
      - Land: vicarious warm calibration and CRTM simulation
  - Water vapor channels
    - Antenna pattern correction: Atkinson's method
    - Onboard RFI: NOAA-15 and -17 AMSU-B, Atkinson's method
    - Geolocation correction
      - Attitude angle error: difference between asc and des orbits
      - Geolocation: modified Ellickson *et al.*'s method
    - Scan bias correction: CRTM simulation

Approach (2/2)

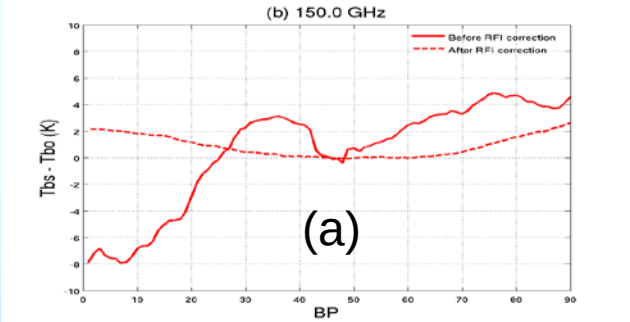
- FCDR inter-satellite calibration – multiple paths
  - Vicarious calibration
    - Diurnal cycle
  - Double difference
    - Satellite matching
  - Simultaneous Nadir Overpass (SNO)
    - Polar region
    - Global (overlapping in certain periods: N15 & N16; N17 & MetOp-A; N18 & N19)

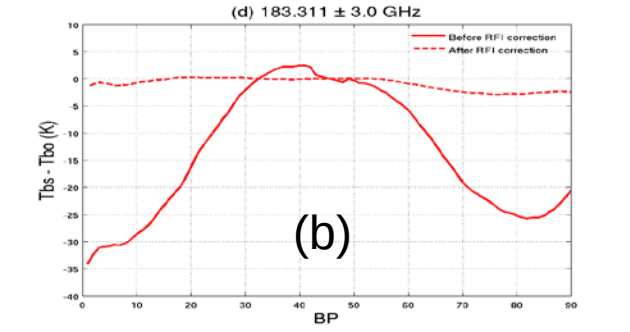
Results/Accomplishments (1/4)

- Collected all source data and majority of ancillary data.
- Obtained the AMSU L1B operational log and the MSPPS project log. Compiled a list of sensor/system/data changes based on the logs – important for metadata
- QC of the source data to eliminate short, redundant files
- Investigated several cloud clearing methods and finalized on using PATMOS-x cloud data

Results/Accomplishments (2/4)

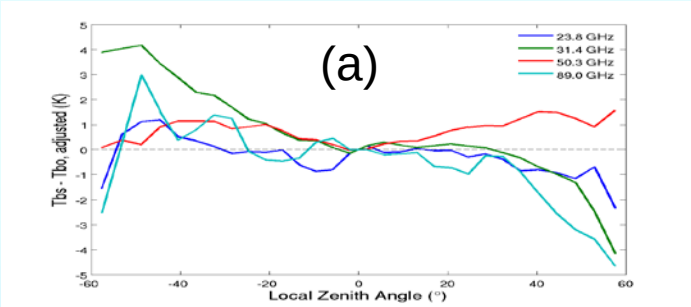
- Held community workshop, March 2-3, 2011, College Park, MD
  http://www.star.nesdis.noaa.gov/star/meeting_CDR2011.php
  - Received valuable feedbacks from the 40+ attendees
  - Engagement with experts with whom we are now working with: Jörg Ackermann (EUMETSAT), Wesley Berg (CSU), Steve Bilanow (NASA), Darren McKague (UMich), James Shuie (NASA) *etc.*
  - A meeting summary will soon be published in EOS.
- Onboard RFI
  - Material mismatch in NOAA-15 S-band antennas caused damage to certain parts and compromised the electrical path. The down link capacity was eventually recovered by switching to different antennas.
  - Figs (a) and (b) are (Tbs – Tbo) of NOAA-15 AMSU-B channel-2 and -4, respectively, before (solid line) and after (dashed line) RFI correction

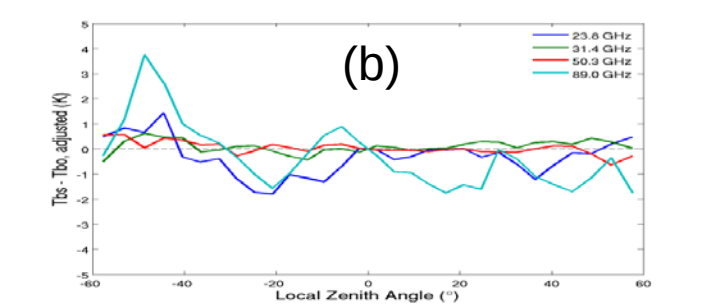




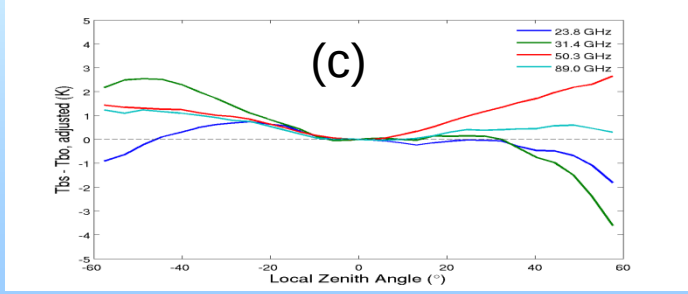
Results/Accomplishments (3/4)

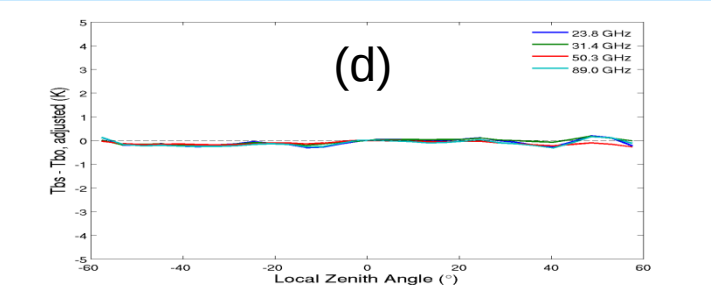
- Scan bias correction – window channels over ocean
  - NOAA-15 AMSU-A window channels
  - Clear sky, 30N-30S ocean
  - Figs (a) and (b): Year 2008 (simulation – observation) Tb across scan line using vicarious cold calibration, (a) before correction; (b) after correction using year 2004 data.





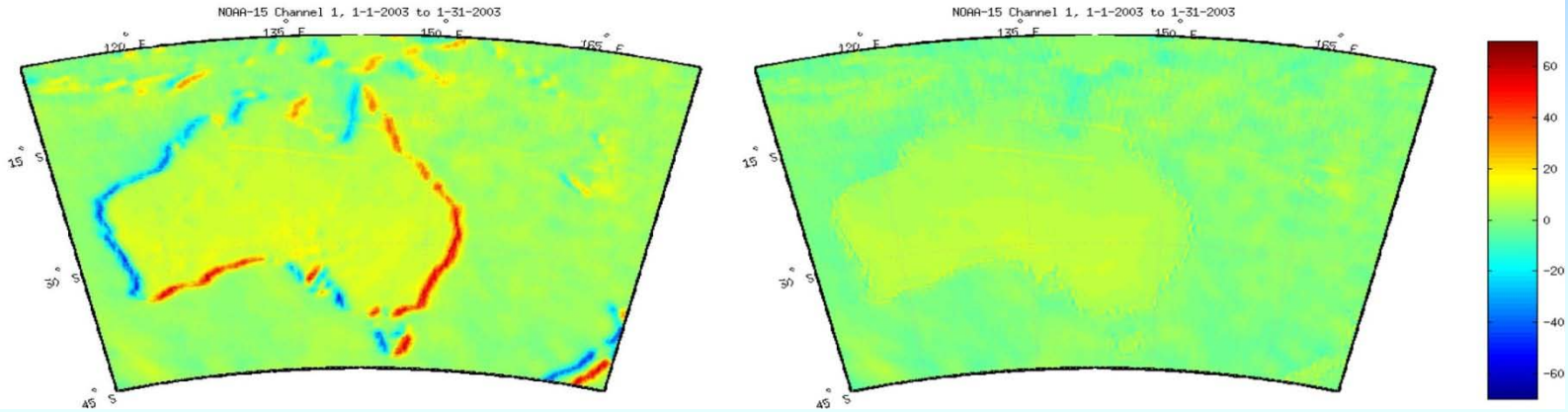
  - Figs (c) and (d) are similar to (a) and (b) but using Most Probable Value (MPV), (c) before correction; (d) after correction using year 2004 data.





Results/Accomplishments (4/4)

- Geolocation correction – finished 50% of data



Differences between NOAA-15 channel-1 ascending and descending brightness temperatures before (left) and after (right) geolocation correction

- Test Data
  - One-year N15 AMSU-A window channels
  - Geolocation and scan bias corrected
  - NetCDF4 with metadata
  - Available in mid-Sept 2011

Validation Strategy

- Look for consistency in various FCDR paths
- Inter-compare with Aqua AMSU-A when possible
- Evaluations of TCDR's
  - Look for "well known" signatures
  - Orbital drift impacts (vary with TCDR)
  - Independent data sets

Issues/Risks & Work- Off Plans

- Window channels are subject to impacts from both atmosphere and surface
  - Complexity over land imposes a challenge – adopt appropriate methods such as vicarious calibration
  - Intense diurnal cycle over land – apply diurnal cycle model
- Water vapor channels are used in the ERA-interim reanalysis data
  - Need to do satellite data impact analysis before using the reanalysis data in simulation or use other data source
- Satellite matching in inter-calibration
  - No POES satellite intersects with all other POES satellites – use appropriate inter-calibration methods such as vicarious calibration

Schedule

- By August 2012:
  - Complete major single satellite and inter-satellite calibrations and determine best path for TCDR's
  - Develop prototype FCDR's and TCDR's
    - Not all sensors or all years yet
    - Begin validation
    - Establish web-based interface/work with NCDC developed tools for product visualization
- By ~ Mar 2013:
  - Complete FCDR's and TCDR's (2000 – 2010)
    - Perhaps extend back to 1998 for N-15 AMSU-A
  - Deliver archive to NCDC
    - Follow CDR Program's requirements on data and metadata formats
- By project end:
  - Complete all software and external documentation

Transition Plan

- DOCUMENTATION
  - Climate Algorithm Theoretical Basis Document (C-ATBD)
    - Delivery date: May 2013
  - Data Flow Chart and Maturity Matrix
    - Delivery date: March 2013
- DATA SET(S)
  - What format are you using: NetCDF4
  - Quality of Metadata: Will follow CDR Program's metadata guide
  - Size of data set: 1.5 TB
- SOURCE CODE
  - Level of Documentation: Medium
  - Language: C and Fortran2008
  - README: Will be included
- CONCERNS (Risks)
  - None yet

Benefit to the Science Community

- Science user communities who will benefit.
  - Precipitation community: CMORPH, TRMM 3B42, PERSIANN, IPWG, GEWEX (GPCP), *etc.*
  - NWP reanalysis community (benefit from the new bias correction techniques)
  - Climate and water cycle communities: IPCC, GEWEX, WCRP, GCOS, *etc.*
  - Other universities and research institutes: researchers who work with AMSU data in general
- Practical examples where AMSU CDR will make a difference.
  - CMORPH: A MW/IR precipitation product by NOAA/NWS/Climate Prediction Center that uses MSPPS precipitation retrievals and will benefit from using the AMSU RR TCDR. (Joyce *et al*., 2004: CMORPH: A method that produces global precipitation estimates from passive microwave and infrared data at high spatial and temporal resolution. *J. Hydromet*., 5, 487-503)
  - TRMM 3B42: A MW/IR/Gauge precipitation product by NASA which uses MSPPS precipitation retrievals and will benefit from using the AMSU RR TCDR. (Huffman *et al*., 2007: The TRMM multi-satellite precipitation analysis: quasi-global, multi-year, combined-sensor precipitation estimates at fine scale. *J. Hydrometeor*., 8(1), 38-55)
  - NESDIS Blended TPW product: An AMSU/SSM/I blended TPW product by NOAA will benefit from using the AMSU TPW TCDR. (Kidder and Jones, 2007: A blended satellite total precipitable water product for operational forecasting. *J. Atmos. and Oceanic Tech*., 24, 74-81)

Benefit to Society

- Weather Forecasting and Analysis
  - A blended Total Precipitable Water (TPW) product that uses AMSU TPW is in the AWIPS system and is routinely used by the NWS weather forecasters, in particular, to monitor "atmospheric rivers" which contribute to flooding events in the United States
  - The blended TPW product is currently undergoing reformatting with will allow it to be in suitable for TV weather broadcasters
- Climate Analysis and Monitoring
  - The AMSU products are key contributors to global "blended" climate analyses (e.g., multiple satellite and ground measurements) due to their accuracy and global coverage, every 4 hours
- Decision and Policy Makers
  - These products can provide key information on regional climate changes which can influence decision/policy makers including
    - Water resource managers, agricultural assessments, energy providers

Resources

- Number of personnel employed for project
  - R. Ferraro & H. Meng (STAR) – 0.5 FTE in total (no cost to project)
  - CICS: W. Yang (Apr 2010); C. Devaraj (Nov 2010); I. Moradi (Jan 2011)
  - CICS "corporate" experience – Gruber, Adler, Arkin, Janowiak, … (no cost)
- Key equipment or observatories used
  - CICS computing environment ("Beast"; "S.O.B.") and other LINUX boxes
- Key collaborating projects or personnel
  - CDR/MSU (PI: C. Zou); CDR/SSMI (PI: C. Kummerow)
  - PMM/X-Cal (PI: T. Wilheit)
  - SDS/OLR (PI: H. Lee) (diurnal cycle)
  - JCSDA/CRTM (PI: Y. Han)
- NOAA points-of-contact or collaborators, as applicable
  - T. Mo (STAR) – AMSU instrument scientist
  - F. Weng (and colleagues - STAR) – GSICS
  - S. Boukabara (and colleagues – STAR & JCSDA) – MiRS; CRTM
  - D. Han (OSPO) – AMSU data preprocessing
  - H. Semunegus (NCDC) – Data formats and archive
- Target NOAA Data Center
  - NCDC
- How can the CDR Program Office help you?
  - Provide guidelines on data/metadata/code/documentation requirements