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Common Formats and Consistent Products from Sounders
Part 2: Science Issues

Eric Fetzer and Evan Manning

Jet Propulsion Laboratory, California Institute of Technology

NASA Sounder Science Team Meeting

Greenbelt, MD

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See Van Dang's talk this afternoon for a preliminary analysis

Comparison Between AIRS, NUCAPS and GSFC of CrIS and ECMWF Temperature and Water Vapor Profiles

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Some Questions

- **How do we interpret quality flags from non-identical instruments in different orbits?**
- **How do we convey vertical resolution from those different instruments?**
- **What about uncertainties?**
  - ***Aside from empirical estimates of relative differences.***
- **How do clouds affect the sampling of different IR instruments?**
- ***What about fundamentally different retrieval algorithms?***

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More Than Plans:
We are creating a data set

A Merged Temperature and Water Vapor Record from Modern Sounders

A proposal to the Satellite and Calibration Interconsistency Studies NASA Research Announcement (NNH15ZDA001N-SCIS)

Eric Fetzer, PI; Van Dang, Co-I; Sun Wong, Co-I; Evan Fishbein, Collaborator; Steven Friedman, Collaborator; Bjorn Lambrigtsen, Collaborator; Brian Kahn, Collaborator; Baijun Tian, Collaborator' Qing Yue, Collaborator

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Relevant instruments providing temperature and water vapor retrievals (from our proposal)

Infrared Instrument	AIRS	IASI	CrIS	IASI
Microwave Instruments	AMSU-A, HSB	AMSU-A, MHS	ATMS	AMSU-A, MHS
Agency	NASA	EUMETSAT	NOAA	EUMETSAT
Satellite	Aqua	MetOp-A	S-NPP	MetOp-B
Start Date	31 Aug 2002	19 Oct 2006	28 Oct 2011	17 Sep 2012
Equator crossing time	1:30 PM	9:30 PM	1:30 PM	9:30 PM
Orbit Period	98 minutes	101 minutes	101 min	101 minutes
Orbit altitude	700 km	817 km	817 km	817 km

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What we will do

- ***Objective 1:*** **Cross-validation. Provide estimates of the *mutual uncertainties* in retrieved temperature and water vapor for all the sensors in table.**
  - ***See Van's talk.***
- ***Objective 2:*** **Consistent behavior. Check that retrievals from all instruments have similar depictions of the atmosphere.**
- ***Objective 3: Data Merger.***
  - ***Create and deliver a merged Level 2 record of temperature and water vapor for high quality retrievals… in a common format with shared quality control and error estimates.***
  - ***Assemble a merged Level 2 record of microwave-only retrievals for the remaining 30% of scenes from a related S-NPP project lead by Collaborator B. Lambrigtsen.***
- ***Objective 4: Analysis Tools.*** **Create methodologies for assessment of retrieval algorithms being developed as part of our Sounder SIPS activities.**

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Ranking of Data Merger Challenges
Hard to Easy

1. **Providing consistent Level 2 (and 3) information content from different instrument suites on separate platforms.**
   - ***Not something our community has done in the past.***

2. **Organizing that information in a way that is useful to ALL users.**
   - ***Many lessons learned already, work is underway.***

3. **Implementing a common data format.**
   - ***Evan Manning is organizing this for hundreds of variables.***

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A Challenge: Inconsistent Coarse Pressure Coordinates

- **<u>AIRS Standard</u>: 1100, 1000, 925, 850, 700, 600, 500, 400, 300, 250, 200, 150, 100, 70, 50, 30, 20, 15, 10, 7, 5, 3, 2, 1.5, 1, 0.5, 0.2, 0.1**
- **<u>AIRS Support</u>: …904.866, 931.524, 958.591, 986.067, 1013.95, 1042.23, 1070.92, 1100.0**

- **CrIMSS**
  - ***<u>Temperature</u>: 0.5, 0.7, 0.9, 1, 3, 5, 7, 9, 10, 30, 50, 70, 90, 100, 125, 150, 175, 200, 225, 250, 275, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 870, 890, 900, 920, 940, 960, 980, 1000, 1020 hPa***
  - ***<u>Water Vapor</u>: 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 870, 890, 910, 930, 950, 970***

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Another Challenge: *Organizing Variables*

- **Over a decade of experience with levels vs. layers, mixing ratios vs. column densities, etc…**

- **The GES DISC (Goddard DAAC) will support subsetting services.**

⇒ **Organize data into "menu" items by science AND technical themes. Some suggestions:**

  - ***Moist thermodynamics:*** ***Temperature, water vapor and clouds.***
  - ***Composition:*** ***ozone, carbon monoxide.***
  - ***Surface properties:*** ***SST, LST, emissivity.***
  - ***Diagnostic variables:*** ***First guess, intermediate output, etc.***
  - ***Custom orders:*** ***User chooses.***
  - ***Etc…***

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AIRS
Atmospheric Infrared Sounder

AIRS Version 6.0
Released Files Description

January 2014
Version 1.0.1

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This is a prototype for grouping L2 data by science user themes. Similar CrIMSS docs.

A1-7. L2 Standard Atmospheric/ Surface Product Interface Specification

	integer		pressure (i.e. lowest altitude)for which Quality = 0 or 1. A value of 29 indicates that no part of the profile passes the test. (1 ... 29)
Surface Property Retrievals			
TSurfStd	32-bit floating-point	None	Surface skin temperature in Kelvins
TSurfStd_QC	16-bit unsigned integer	None	Quality flag for TSurfStd.; 0: Highest Quality; 1: Good Quality; 2: Do Not Use
TSurfStdErr	32-bit floating-point	None	Error estimate for TSurfStd
numHingeSurf	16-bit integer	None	Number of IR hinge points for surface emissivity and reflectivity
freqEmis	32-bit floating-point	HingeSurf (= 100)	Frequencies for surface emissivity and reflectivity in cm-1 (in order of increasing frequency. Only first numHingeSurf elements are valid)
emisIRStd	32-bit floating-point	HingeSurf (= 100)	Spectral IR Surface Emissivities (in order of increasing frequency. Only first numHingeSurf elements are valid)
emisIRStd_QC	16-bit unsigned integer	HingeSurf (= 100)	Quality Control for emisIRStd.; 0: Highest Quality; 1: Good Quality; 2: Do Not Use
emisIRStdErr	32-bit floating-point	HingeSurf (= 100)	Error estimate for emisIRStd
Air Temperature Retrievals			
TAirStd	32-bit floating-point	StdPressureLev (= 28)	Atmospheric Temperature at StdPressLev in Kelvins.
TAirStd_QC	16-bit unsigned integer	StdPressureLev (= 28)	Quality Control for TAirStd.; 0: Highest Quality; 1: Good Quality; 2: Do Not Use
TAirStdErr	32-bit floating-point	StdPressureLev (= 28)	Error estimate for TAirStd
TSurfAir	32-bit floating-point	None	Surface air temperature in Kelvins
TSurfAir_QC	16-bit unsigned integer	None	Quality Control for TSurfAir.; 0: Highest Quality; 1: Good Quality;

FROM STEVE FRIEDMAN'S 2015 SOUNDER SCIENCE TEAM MEETING TALK

Introducing:

The SounderCDF data model

**an extensible data model
for sounder data products**

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Use CF naming convention whenever possible

- **See http://cfconventions.org**

NetCDF Climate and Forecast (CF) Metadata Conventions

Version 1.7.2 DRAFT, 28 March, 2014

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PROPOSED Common Variable Names
See Evan Manning's talk for details

AIRS Name	CrIMSS Name	Proposed Name
latAIRS	Latitude	lat
lonAIRS	Longitude	lon
solzen	SolarZenithAngle	sol_zen
solazi	SolarAzimuthAngle	sol_azi
PSurfStd	SurfacePressure	surf_pres
PSurfStd_QC	?	surf_pres_qc
…		
PBest	?	Eliminated or aux/pbest
PGood	?	Eliminated or aux/pgood
…		
TSurfStd	N/A?	surf_temp
TSurfStd_QC	N/A?	surf_temp_qc
…		
TAirSup	Temperature	air_temp
TAirSup_QC	?	air_temp_qc
…		
TSurfAir	Not defined?	air_temp_surf
…		
num_Temp_Func	?	aux/xxx
…		
Temp_ave_kern	?	?
…		
H2OCDSup	H2O	col_den/h2o_vap_lay_mol_col
RelHum	N/A	rel_hum_lev

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Plans and Concerns

- **Short Term Plan for AIRS and CrIMSS**
  - ***Use 100 pressures.***
  - ***Use common names following CF convention.***
  - ***Group types (Moist thermodynamics, Composition,…).***
  - ***Place in SounderCDF format.***

- **High Priority / Unresolved Issues:**
  - ***A coarse coarse resolution pressure coordinate.***
  - ***Consistent information; averaging kernels.***
  - ***Quality flags.***

- **Addressing physical consistency between products in our SCIS project**
  - ***Common formatting will simplify this.***