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Consistent Level 2 and 3 Products from AIRS, CrIMSS, and Maybe IASI

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Sounder Discipline Telecon
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“A foolish consistency is the hobgoblin of little minds”

-- Ralph Waldo Emerson, *Self Reliance*

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Advantages

- **Similar 'information' from all hyperspectral infrared instruments.**
- **Sun-synchronous orbits**
- **Common local time (A-Train and Suomi-NPP).**
- **LOTS of familiarity with individual instruments.**

Challenges

- **Different orbital geometries: orbit periods, equator crossing times, etc.**
- **Different spectral information.**
- **A large number of (potentially) relevant parameters from each retrieval.**
- **Different retrieval algorithms for different instruments?**

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TODAY' MAIN MESSAGE
Challenges (as I see them)

1. **Consistently providing information content from different instrument suites on separate platforms.**

2. **Organizing that information in a way that is useful to ALL users.**

3. **A common data format.**

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Challenge 1:
More Questions on Information Content

- **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?**
- **How might clouds affect their sampling?**
- **What about retrievals from wildly different algorithms?**

SORRY, NO DEFINITIVE ANSWERS FROM ME TODAY

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An Open Question

Can we provide consistent products from separate retrieval algorithms?

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Challenge 2: Organizing *Variables*

- **We have very good ideas of how our communities use our data.**

- **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:*** ***Intermediate algorithm step output, etc.***
  - ***Custom orders:*** ***Users choose.***
  - ***Etc…***

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Challenge 3: Consistent formats

1. **Similar instruments should have similar interfaces.**

2. **Consistency will simplify the grand challenge: a merged product of similar quantities from different sounders.**

3. **OUR USERS WILL THANK US FOR MAKING THEIR LIVES EASIER.**

TAKEN FROM STEVE FRIEDMAN'S SOUNDER SCIENCE TEAM MEETING TALK

Introducing:

The SounderCDF data model

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

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SounderCDF Data Model

- **Sounder SIPS developed a "SounderCDF" data model**
  - Originally designed for Sounder SIPS data products
  - Is extensible to AIRS and other sounders
- **SounderCDF is formatted according to netCDF-4/HDF5**
  - netCDF:
    - was derived from NASA Common Data Format
    - is maintained as part of the "the Unidata" program at the University Corporation for Atmospheric Research (UCAR)
    - is a standard data format of the Open Geospatial Consortium
  - SounderCDF is also:
    - Compliant with Climate and Forecast (CF) conventions (≥ V1.6)
    - Supportive of the NASA ISO 19115 Metadata model
  - SounderCDF can take advantage of the large number of applications and tools developed for netCDF data

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SounderCDF Data Model

- **Both the Sounder SIPS and the AIRS Project will utilize the SounderCDF data model to produce standard products**
  - AIRS Version 7 products will adhere to the SounderCDF specification
  - The AIRS Project understands that this change will disturb the continuum, but…
    - After adjustment, we expect all will benefit from the change
    - On the plus side, SounderCDF will make it easier for users to read all Sounder products from both the AIRS Project and the Sounder SIPS
  - SounderCDF will facilitate:
    - Cross instrument product comparisons
    - Development of a multi-instrument product baseline

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Characteristics of AIRS V7 and SNPP Sounder Data Products Using SounderCDF

- **Scientists and developers will be able to read (and write) SounderCDF utilizing open source tools/utilities:**
  - ncgen, ncdump …
  - Matlab and IDL …
  - Geophysical and cartographic display tools
- **A library of SounderCDF readers/writers will not be developed**
  - Data users should be able to quickly develop their own readers/writers utilizing our SounderCDF data definitions and publicly available netCDF tools

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SounderCDF Standardization

- **SounderCDF standardization for all AIRS and Sounder SIPS data products including:**
  - Level 1B (L1B)
  - Level 2 (L2)
  - Level 3 (L3)
  - Calibration Subsets (Calsub)
  - Simultaneous Nadir Observations (SNO)
  - Eventually Match-ups and other files will be evaluated
  - Note:
    Geolocation information will be incorporated in each product file

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More SounderCDF Product Characteristics

- **Granularity: for both AIRS and Sounder SIPS**
- **L1, L2 will be constructed with 6-minute granules**
  - Start-time for SNPP will be 0 GMT
  - Start-time for AIRS is TBD, but probably will be consistent with current AIRS start times (~5.5 minutes after 0 GMT)
- **L3 products will be produced in accordance with practice:**
  - Daily
  - Multi-day
  - Monthly
- **Calsub products will be produced daily**
- **SNO products will be produced daily and aggregated monthly**

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Characteristics of AIRS V7 and SNPP Sounder Data Products Using SounderCDF

- **Level 2 Products to be parceled into multiple files**
  - Core retrieval products: temperature, water vapor, surface props
  - Minor gases
  - Cloud properties
  - Cloud-cleared radiances
- **Level 2 Verticality**
  - Verticality will be reported at granularity of each specific retrieval
  - No production of *AIRS-style* "standard products" at lower vertical resolution
- **Details are still being developed**
- **MW-Only and MW/IR will be in single product file if produced by one PGE**
  - Different product files if produced by multiple PGEs
  - netCDF construction will support aggregation if desired

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Agreed: Use CF naming conventions whenever possible

- **See http://cfconventions.org**
- **NOTE: Developed for climate model output, not satellite data.**
- **<u>Why?</u> This what much of the *modeling* community uses.**
- **<u>Why not?</u> Driven by modeling needs, not remote sensing needs.**

NetCDF Climate and Forecast (CF) Metadata Conventions

Version 1.7.2 DRAFT, 28 March, 2014

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Examples

From http://cfconventions.org/Data/cf-standard-names/27/build/cf-standard-name-table.html

View by Category

Atmospheric Chemistry	Atmosphere Dynamics	Carbon Cycle	Cloud	Hydrology
Ocean Dynamics	Radiation	Sea Ice	Surface	

Standard Name	Canonical Units	AMIP	GRIB
age of sea ice	year		
age of stratospheric air	s		
age of surface snow	day		
air density	kg m-3		
air potential temperature	K	theta	13
air pressure	Pa	plev	1
air pressure anomaly	Pa		26
air pressure at cloud base	Pa		
air pressure at cloud top	Pa		
air pressure at convective cloud base	Pa		
air pressure at convective cloud top	Pa		
air pressure at freezing level	Pa		
air pressure at sea level	Pa	psl	2 E151
air temperature	K	ta	11 E130
air temperature anomaly	K		25
air temperature at cloud top	K		
air temperature lapse rate	K m-1		19
air temperature threshold	K		
altimeter range	m		
altimeter range correction due to dry troposphere	m		
altimeter range correction due to ionosphere	m		
altimeter range correction due to wet troposphere	m		
altitude	m		8
altitude at top of dry convection	m		
ambient aerosol particle diameter	m		
amplitude of global average sea level change	m		

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Caveats on SounderCDF and CF Names.

- **Version 7 AIRS Level 2 and Level 3 variables names will be different.**
  - ***Users will grumble…***
- **V7 is changing from HDF-EOS to NetCDF4**
  - ***But, reading will be easier.***
- **CF was designed for models, not satellite data sets.**
  - ***Variable names can get awkward.***

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Some thoughts

- **Grouping variables is the (relatively) easy part.**

- **Reconciling quantities *empirically* is straightforward**
  => *Merged products.*

- **How do we deal with different information content, as from separate algorithms?**
  - ***QA and averaging kernels / information content may represent different things to different instruments.***

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Conclusions

- **The biggest scientific challenge will be providing (and demonstrating) consistent products between instrument.**
  - ***We can demonstrate consistency between products from different instrument, but what about vertical resolution, errors, quality flags, etc.***

- **Subsetting and reformatting will benefit from improved technology (NetCDF and ordering by subset).**
  - ***Still need to carefully choose and implement variable names and appropriate grouping of quantities.***