NOAA Unique CrIS/ATMS Processing System (NUCAPS)

- NUCAPS Products Summary
  - Utilize CrIS and ATMS sounding data
  - Variational physical retrieval assures final EDRs are consistent to within uncertainty of measurements/fwd model
  - 7+7 EDRs: T, H_2O, O_3, CO, CO_2, CH_4, OLR, SO_2, HNO_3, N_2O, cloud top pressure and fraction, surface temperature and emissivity
- Team members
  - Mark Liu, Nick Nalli, Changyi Tan, Kexin Zhang, Flavio Iturbide-Sanchez (NOAA)
  - Chris Barnet, Antonia Gambacorta (STC)
  - Xu Liu, Susan Kizer (NASA)
- Users
  - Operational and research users
  - AWIPS-II, Direct Broadcast, NOAA/CPC

NOAA Sounding Enterprise Algorithm

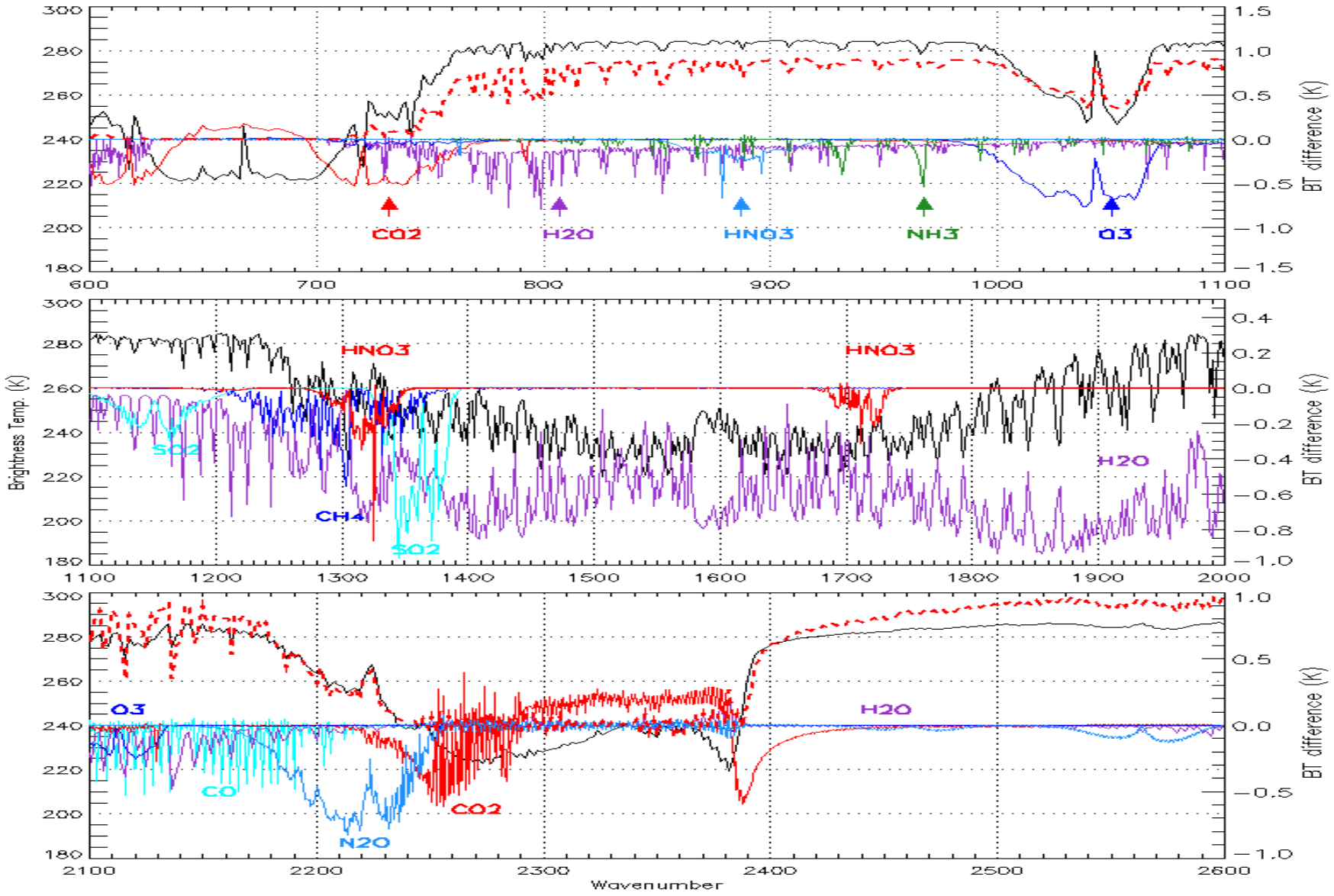
- Multi Satellites

  Suomi NPP, Metop-A and B, EOS Aqua, J1

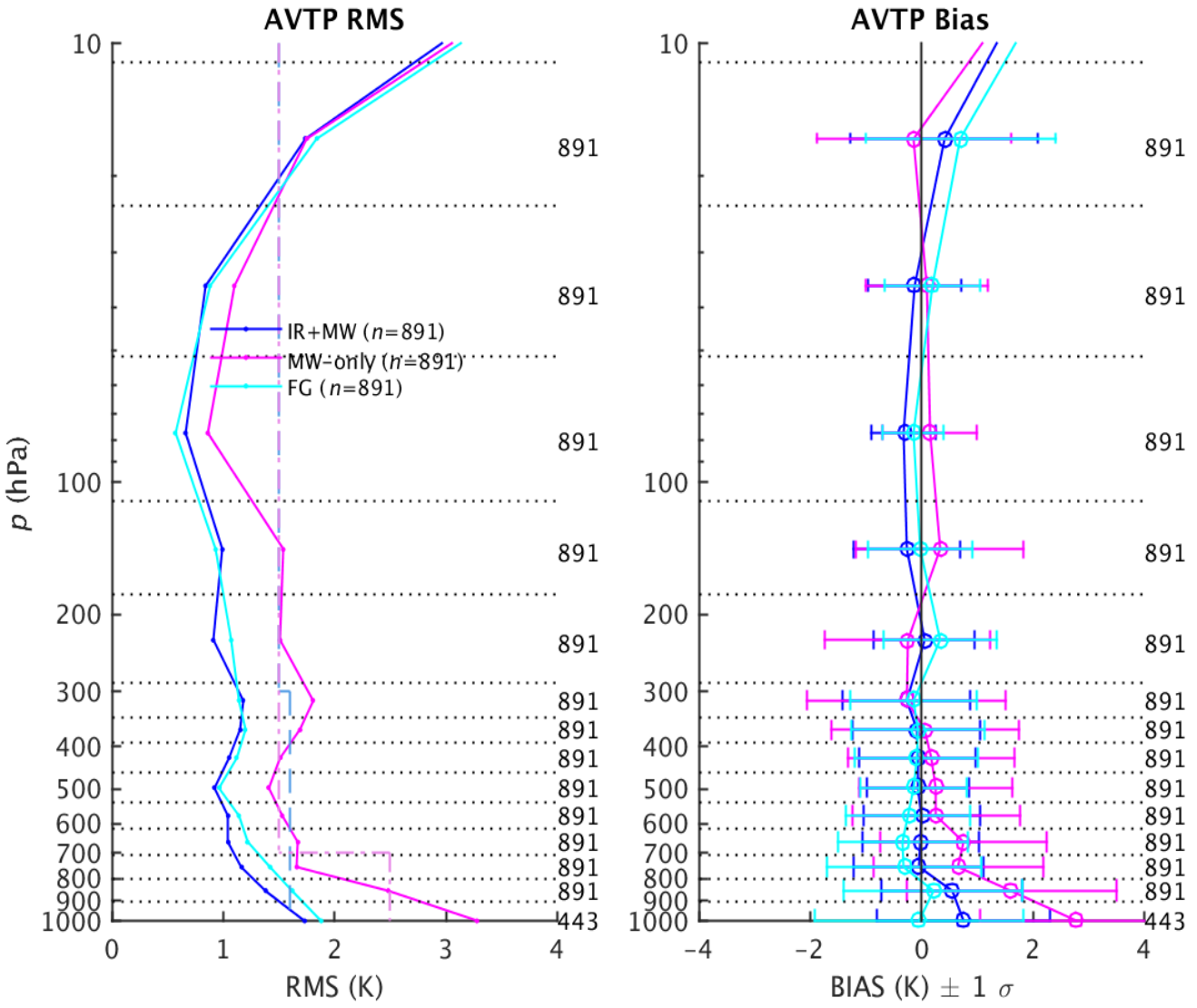
- Multi Sensors
  - Microwave sounders: ATMS, AMSU-A, MHS
  - Infrared sounders: CrIS, IASI, AIRS

- Multi EDRs
  - T, H_2O, O_3, CO, CO_2, CH_4, SO_2, NH_3, HNO_3, N_2O, cloud liquid, rain, snow, ice water contents, TPW, snow cover, ice cover, surface temperature, cloud top height and fraction, surface emissivity

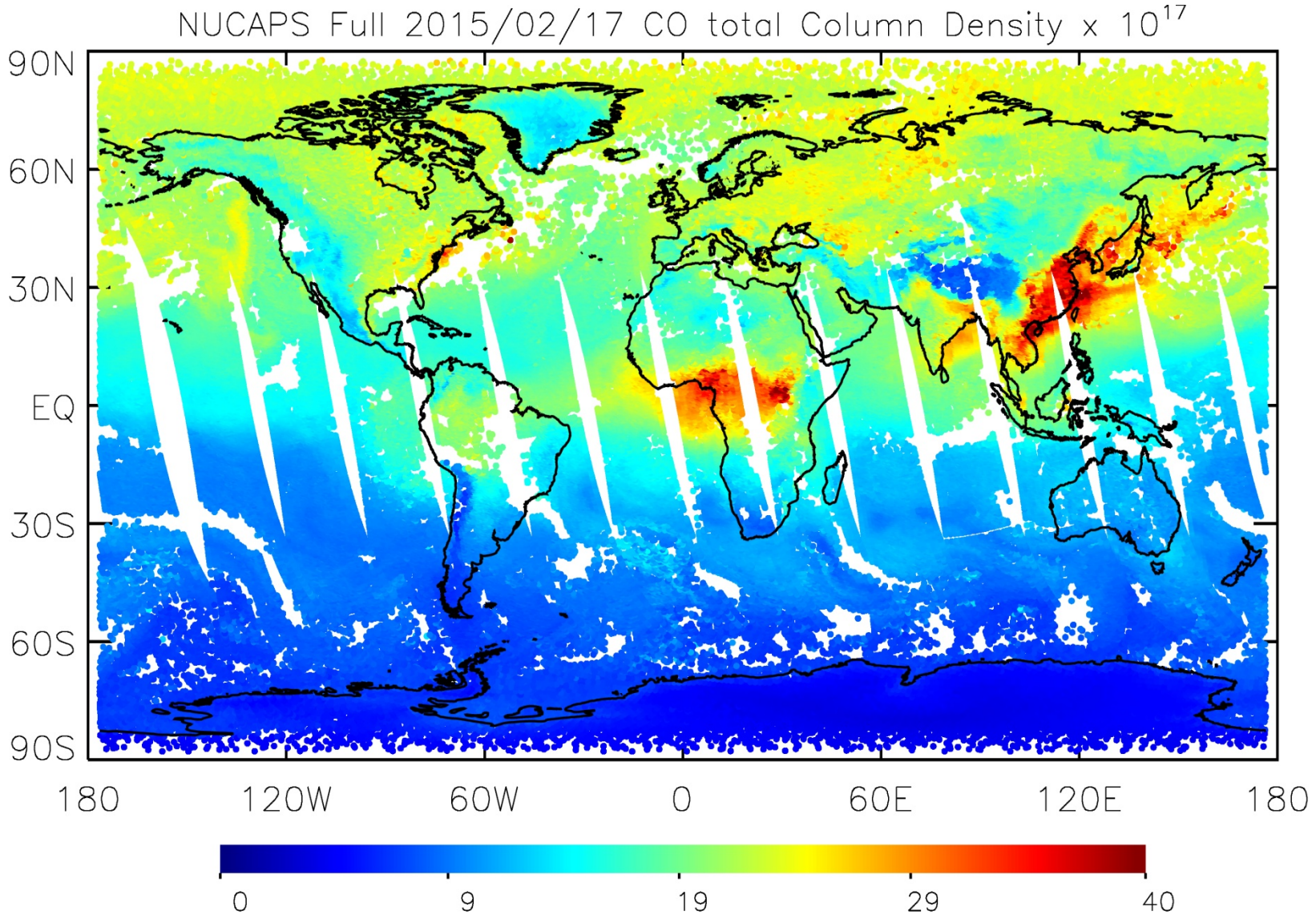
CrIS Information Content



NUCAPS Validated T against Radiosondes



First global look of CO from CrIS full-spectral data



NUCAPS: Lessons Learned

- Team work (STAR, STC, OSPO) is important and very productive. NUCAPS v1.5 delivered for CrIS and IASI
- Version Control is important

  Two disks were crushed, some codes and tools are lost.

  Without version control, historic record of codes, namelist and coefficient files are untraceable.
- Code standard is important

  Without code standard, it is difficult to debug and to add new functions. The results can be changed using different machines or different compilers. Even using the same machine and same compiler, the result may be different by using different options.

Path Forward

- Planned developments
  - NUCAPS for CrIS full-spectral data
  - CO, CO2, CH4 retrievals
  - NUCAPS Readiness for JPSS-1
  - Will consider upgrades from climate version of NUCAPS being developed at STC under NASA grant.

- Upcoming Deliveries/Reviews
  - New Channel selection
  - Update to the radiative transfer model (SARTA)
  - Updates to the coefficient files (regression, tuning, noise, and namelists)
  - Refine retrieval algorithm for trace gases
  - Deliver NUCAPS for CrIS full-spectral data in September 2016
  - Validation maturity review for Ozone, OLR

- Risks
  - New SARTA transmittance files
  - Validation data for CO, CO2, and CH4.

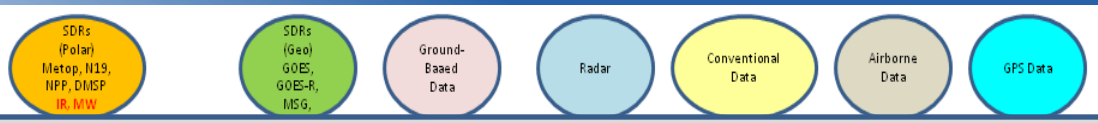
Consideration of Future Enterprise Products

- Data Usage
  - < 0.5% hyperspectral radiances are assimilated
  - Few EDRs are used in NWP models
  - Lack of error estimates for every variables in EDR
- Science improvements
  - Advanced forward model, e.g. including atmospheric polarization
  - Adopt data assimilation concepts to utilize POES and GOES EDRs
  - All-sky radiance assimilation
- Technical improvements
  - GSI framework
  - Uniform and high space and temporal resolution (hourly). Weaken priori info and incease weights for observations
- Coordinating with AWIPS, direct broadcasts, WPC/OPC to assess Data Fusion products

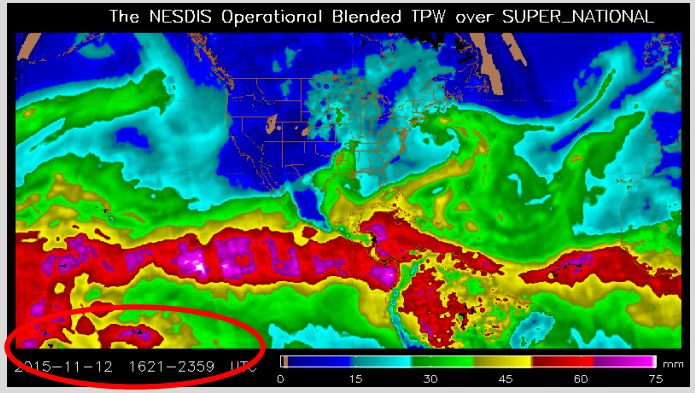
GSI Raadiance Usage, 00Z Feb. 05, 2015

Sat id	instrument	# read	# keep	# assim	assim %	qccpen
metop-a	hirs4	2681831	174534	44648	1.66	0.36107
aqua	airs	161147880	2262268	516918	0.32	0.27020
n15	amsua	986535	116417	77121	7.81	0.22713
n18	amsua	1542870	138083	90112	5.84	0.47785
metop-a	amsua	1098390	127025	84573	7.69	0.44063
aqua	amsua	8019000	98033	51945	0.64	0.30062
n18	mhs	2941560	47745	24607	0.83	0.20097
metop-a	mhs	2859350	47095	25090	0.87	0.22223
f17	ssmis	12405912	205200	50274	0.40	0.13871
f18	ssmis	13626864	220089	62903	0.46	0.13884
metop-a	iasi	171459904	6267376	972451	0.56	0.21984
n19	amsua	1517355	138984	86335	5.68	0.40858
n19	mhs	2950200	48145	9111	0.30	0.23508
m10	seviri	1579816	25582	6232	0.39	0.11214
metop-b	amsua	1138590	136389	101026	8.87	0.44614
metop-b	mhs	2879475	46970	23293	0.80	0.20356
metop-b	iasi	172077136	6287762	941410	0.54	0.20361
npp	atms	605880	232782	142948	23.59	0.18814
npp	cris	32319000	4797177	268615	0.83	0.58085E-01
g15	sndrd1	1125936	14670	6567	0.58	0.16916
g15	sndrd2	1140444	14616	6065	0.53	0.18839
g15	sndrd3	1161252	14508	6502	0.55	0.19450
g15	sndrd4	1138536	14436	6000	0.52	0.19363

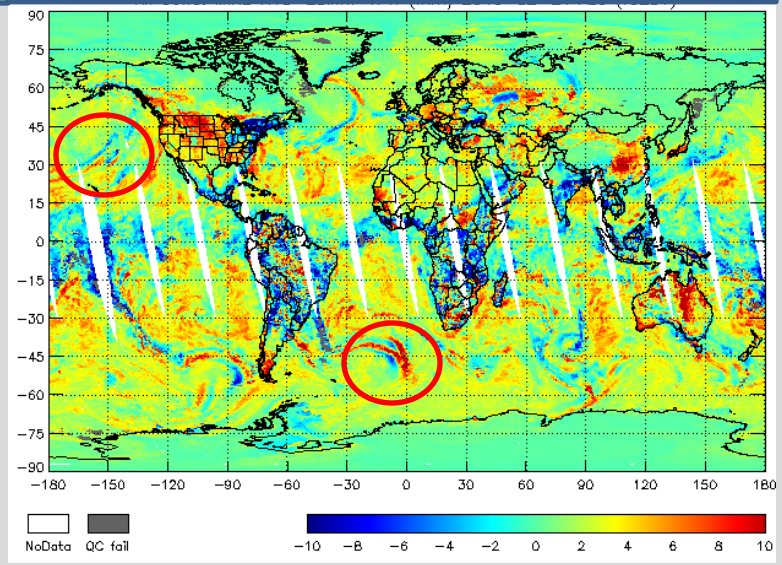
Data Fusion Concept



Current Blended TPW



Current O-A (TPW) Background-Weighted



Added value to current products

- Remove gaps in 2D fields
- Smooth transitions in time and space
- Precise data age

Added value to current DA

- Resolve displacements between observations and analysis fields

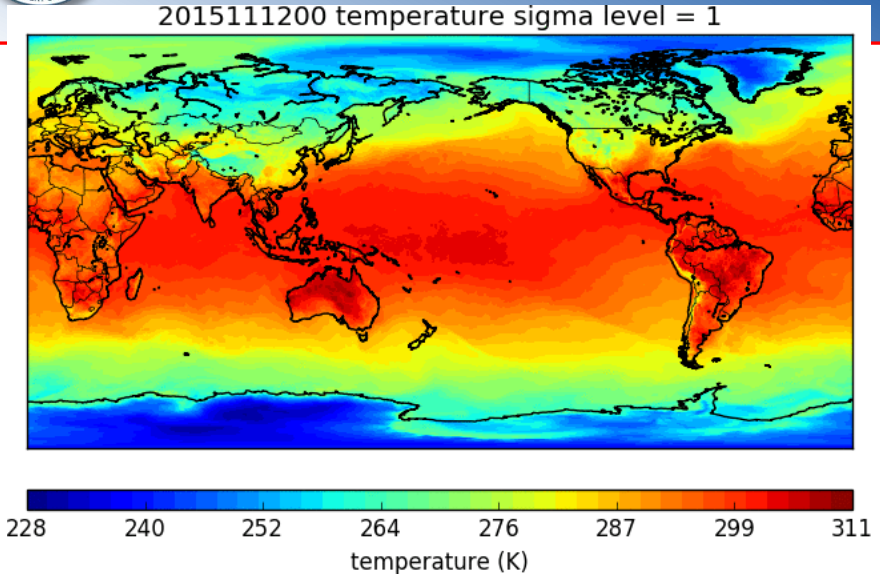
Overarching added value

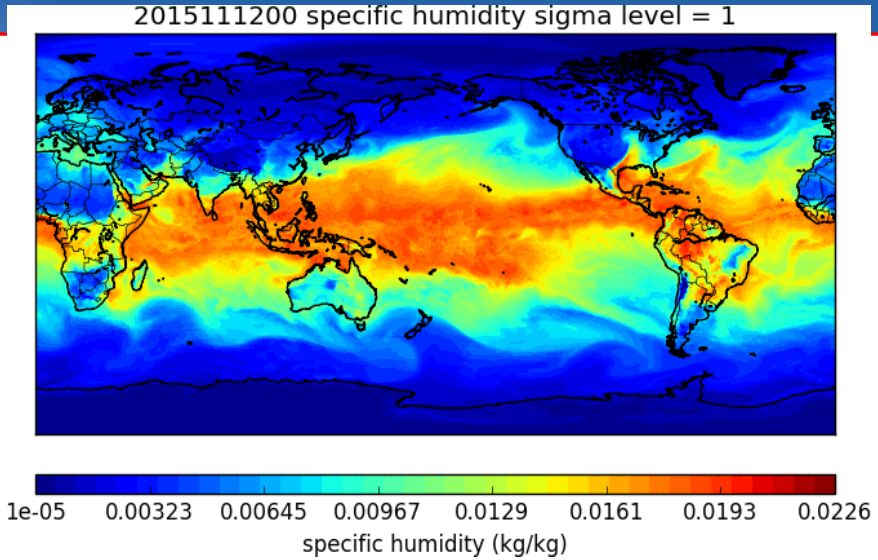
All analysis parameters are physically consistent with all observations

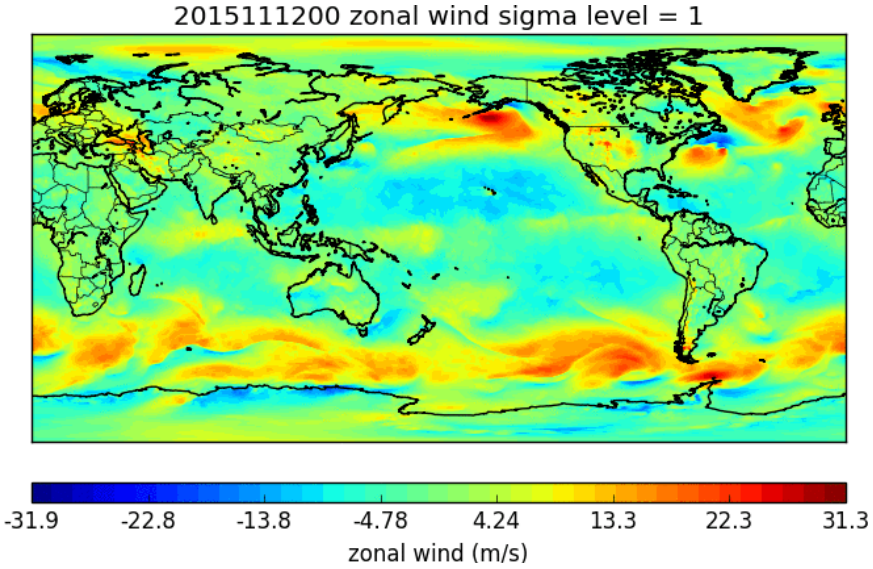
- Added value QC and geophysical products (beyond traditional retrieval products)
- Added value to traditional data assimilation analyses by adding more fields
- Consistent error characteristics across all output parameters
- Consistent dissemination/latency for all output parameters

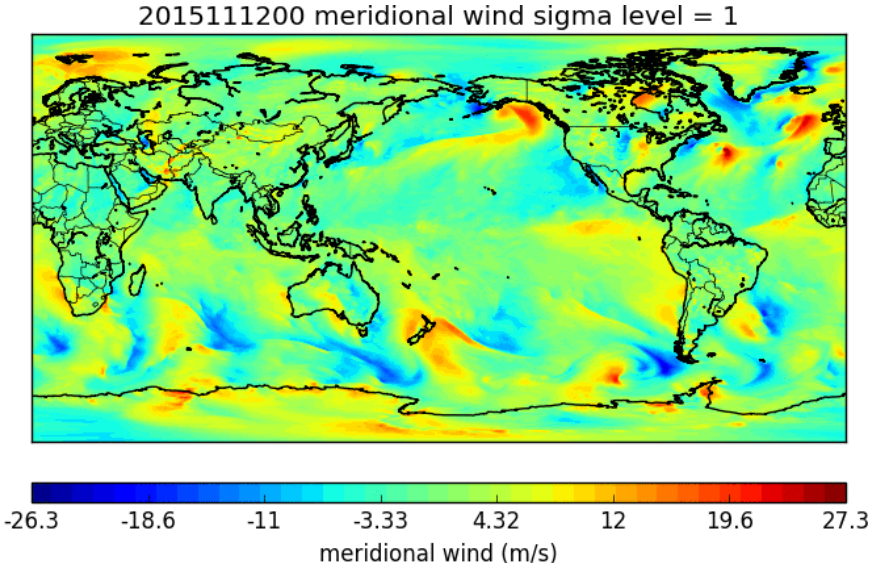
Courtesy: Boukabara et al

Data Fusion Phase 1 Global, hourly analysis fields









48 hour time series of q, t, u, and v hourly analyses at sigma level 1 (conversion to pressure surfaces pending)

Courtesy: Boukabara et al

Summary

- Outstanding Issues
  - Integrated NUCAPS for NPP, J1, and Metop-A and B, multi sensors (amsu-a, mhs, atms, iasi, and CrIS), multi EDRs

- EDRs assimilation system - Future Enterprise Products
  - Framework
  - Visualization and Performance Analysis
  - Science improvements
  - Technical improvements
  - Reprocessing sounding EDRs with advanced NUCAPS algorithms and reprocessed high quality CriS and ATMS SDRs