ASSISTT – Introduction to Enterprise Approach Transition to Operations

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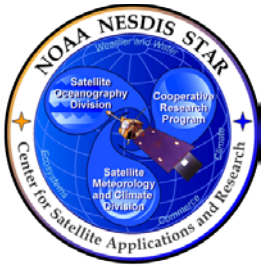
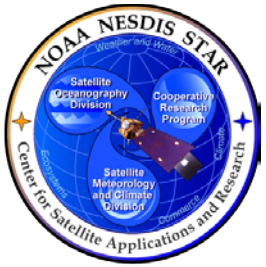
ASSISTT – Algorithm Scientific Software Integration and System Transition Team

Overview



- For the JPSS program, over the past few years we have been transitioning the IDPS EDR algorithms to new, advanced algorithms that have been termed Enterprise Algorithms
- These Enterprise Algorithms are transition to NDE for operational implementation
- The Enterprise Algorithms will not only be used to create S-NPP and J1 products but also products from other instrument suites from GOES, MetOP, and NOAA satellites

What is an Enterprise Algorithm?

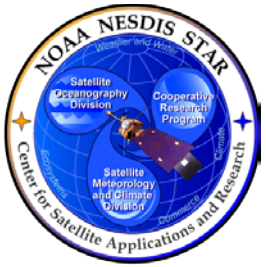


An enterprise algorithm is an endorsed algorithm that uses the same scientific methodology (ie., physical basis, including assumptions) and software base to create the same classification of product from differing input data (satellite, in-situ, or ancillary)

Benefits:

- Consistent products with similar characteristics and performance can be generated for different instruments. Users benefit from this.
- Fewer algorithms and systems to be maintained.

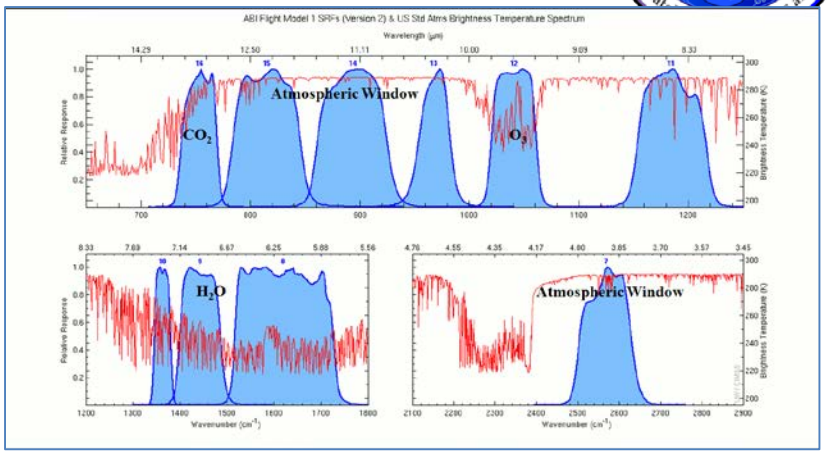
Endorsed Algorithm



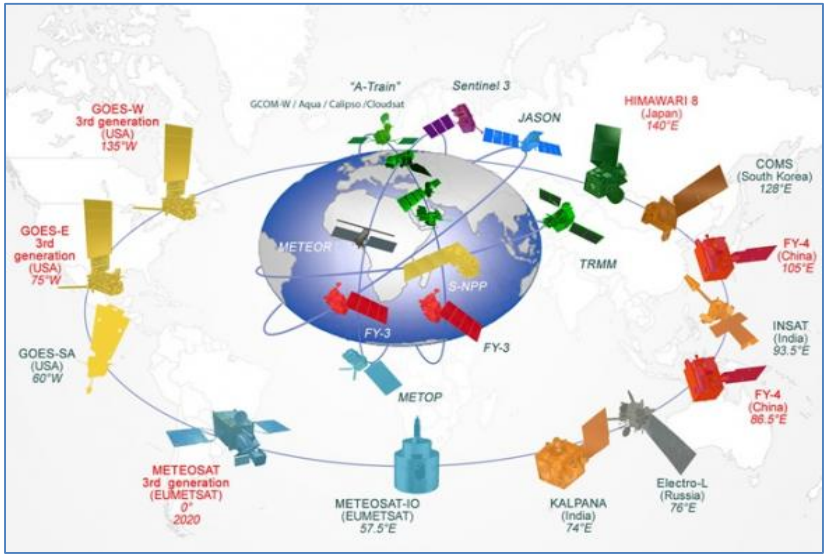
- Is well vetted and peer reviewed by independent reviewers
- Is well documented in an Algorithm Theoretical Basis Document (ATBD) and in the scientific literature
- Test and validation procedures are well established
- Performance is well demonstrated and characterized to the extent possible using available real or proxy data
- Algorithm meets the requirements

Synergies Among Instruments

- Instrument channels are carefully chosen (ie., central frequency, bandwidth) to measure/observe specific environmental (atmospheric or land) phenomenon (ie., aerosols, dust, smoke, vegetation, etc) being sought



- Coordination among satellite operators through the World Meteorological Organization (WMO) Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS) helps populate the Global Observing System (GOS) with similar instruments and channels.



Common Channels (1 of 2)

ABI Band	GOES-R Central Wavelength (microns)		Typical Use	GOES I-L Central Wavelength (microns)	GOES M-N Central Wavelength (microns)	GOES O-P Central Wavelength (microns)	AVHRR Central Wavelength (microns)	MODIS Central Wavelength (microns)	VIIRS Central Wavelength (microns)	SEVIRI Central Wavelength (microns)
1	0.47	Visible	Aerosol over land/Haze	-	-	-		0.469	0.488	0.45 – 1.05
2	0.64	Visible	Clouds/ Albedo	0.65	0.65	0.65	(1) .58-.68	0.645	0.64	0.64
3	0.865	Visi/NIR	Aerosol over water; Vegetation	-	-	-	(2) .725-1.0	0.858	0.865	0.81
4	1.378	NIR	Daytime Cirrus, Contrails	-	-	-		1.375	1.38	--
5	1.61	NIR	Snow, Phase	-	-	-	(3a) 1.58-1.64	1.64	1.61	1.64
6	2.25	NIR	Cloud / Aerosol Particle size	-	-	-		2.13	2.25	--
7	3.9	IR	Cloud/Fog Discrimination .; Fire	3.9	3.9	3.9	(3b) 3.55-3.93	3.96	3.75	3.92

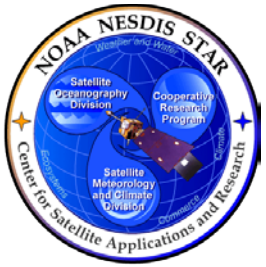
Note the synergy of bands across sensors.
This is not by accident.

Common Channels (2 of 2)

ABI Band	GOES-R Central Wavelength (microns)		Typical Use	GOES I-L Central Wavelength (microns)	GOES M-N Central Wavelength (microns)	GOES O-P Central Wavelength (microns)	AVHRR Central Wavelength (microns)	MODIS Central Wavelength (microns)	VIIRS Central Wavelength (microns)	SEVIRI Central Wavelength (microns)
8	6.19	IR	Hi-Lev Water vapor	-	-	-		--	--	6.25
9	6.95	IR	Mid Lev Water Vapor	6.75	6.55	6.55		6.72	--	--
10	7.34	IR	Low-Lev Water Vapor	-	-	-		7.33	--	7.36
11	8.5	IR	Total Water, cloud phase	-	-	-		8.55	8.55	8.7
12	9.61	IR	Ozone	-	-	-		9.73	--	9.66
13	10.35	IR	Surface; LL WV & Cloud	-	-	-		--	--	--
14	11.2	IR	IR Window	10.7	10.7	10.7	(4) 10.8	11.03	*10.76*/11.45	10.8
15	12.3	IR	Dirty Window	12			(5) 11.8			
16	13.3	IR	Cloud Top Temperature		13.35	13.35				

Note the synergy of bands across sensors.
This is not by accident.

Synergies Among Instruments



Benefits:

- Algorithms can be developed and applied fairly easily, with relatively minor updates, to different instruments
- Consistent products with similar characteristics and performance can be generated from different instruments
- **Who benefits the most?** **Our Users!**

Reduced Algorithm Development and Maintenance Costs

- Core algorithm software is reused across instruments
- Only one software base to maintain
  - Algorithm updates will be implemented across all instruments
- Same output file/format for products across instruments

Enterprise EDR Algorithm Progress

- **Enterprise Clouds, Cryosphere, and Aerosol** algorithms updated delivery: 04/14/17
- **ACSPO SST V2.41** delivery: 03/01/17
- **VIIRS Ocean Color MSL12** Operational Readiness Review (ORR) 11/9/2016
- **VIIRS Polar Winds update (using ECM instead of VCM)** delivery: 05/16/17
- **MiRS patch deliveries:**
  - Radiometric bias corrections based on ATMS full radiance SDR: 03/06/17
  - Metadata update (add orbit numbers, production_site and production_environment): 06/07/17
  - Update to fix the file creation time: 06/23/17
- **GCOM patch deliveries:**
  - GCOM Day-2 algorithms update: 02/17/17
  - Update to handle the compressed OISST ancillary data files: 04/18/17
  - Ocean code bug fix; pre-processing the L1B and L1R files separately to help reduce latency: 06/30/17
- **Active Fires** update deliveries:
  - Remove ADL dependence; update quality flags; new metadata for product monitoring: 05/11/17
  - Internal NetCDF file compression: 08/09/17

The Enterprise Processing System (EPS) products became operational in NESDIS on July 5, 2017. The products include **Ice** Concentration and Cover, Ice Surface Temperature, Ice Thickness/Age, Snow Cover, and Fractional Snow Cover; Aerosol Detection, Aerosol Optical Depth, Aerosol Particle Size, Volcanic Ash Mass Loading, Volcanic Ash Height; Cloud Mask, Cloud Top Phase, Cloud Type, Cloud Top Height, Cloud Top Temperature, Cloud Top Pressure, Cloud Optical Depth, Cloud Particle Size Distribution, Cloud Liquid Water, and Cloud Ice Water Path.

In addition to the science improvement gained by the development of the Enterprise (NOAA-unique) products, they also demonstrate NOAA's goal of enterprise solutions by employing same algorithms for POES and GOES satellite systems.

Current Status of Algorithms Yet to be Operational

- Land Surface Reflectance operational date: 09/29/2017
  - Final DAP already delivered to NDE
- Land Surface Albedo and Surface Temperature operational date: 12/20/2017
  - Final DAP to be delivered in October
- Vegetation Indices operational date: 11/30/2017
  - Final DAP to be delivered in September

Example: Enterprise Algorithms Used With Other Instruments

- **Derived Motion Winds** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS, GOES, AVHRR, SEVIRI, MODIS
- **Cloud Products** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS, GOES, AVHRR, SEVIRI, MODIS
- **Volcanic Ash** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS, AVHRR
- **Cryosphere Ice Products** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS
- **Aerosol Detection** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS
- **Aerosol Optical Depth** – GOES-R ABI, Himawari-8 AHI, S-NPP VIIRS
- **Land Surface Temperature** – GOES-R ABI, S-NPP VIIRS

J1 Enterprise Algorithm Schedule

- The full J1 EDR enterprise algorithm schedule is shown on the following slides

- The schedule includes the CDR, Software Review, ARR, ORR and operational date for each algorithm

Top-Level Schedule

J1 Polar ESPC Products		FY 17-2016			FY17-2017								
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Reformatting toolkit SDR BUFR	△	△							△ △			△	△
Reformatting toolkit EDR BUFR and GRIB2		△											
NUCAPS CrIS subsetter		△ △	△						△ △		△		
NUCAPS Level 2		△											
CrIS OLR		△											
Polar Winds		△											
MiRS		△											
GVF		△											
ACSPO		△											
Ocean Color		△											
Active Fires		△											
Mircrowave Tropical Cyclone		△											
Veg Health		△											

△ CDR △ Prelim DAP △ SCR △ ARR/AMR △ SRR △ Final DAP △ ORR △ OPS

Top-Level Schedule

J1 Polar ESPC Products		FY 17-2016			FY17-2017								
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
V8TOz/LFSO2		△											
V8Pro		△											
Surface Reflectance		△											
Vegetation Indices		△											

△CDR △Prelim DAP △SCR △ARR/AMR △SRR △Final DAP △ORR △OPS

Top-Level Schedule

J1 launch date

J1 Polar ESPC Products	FY 18- 2017			FY18-2018								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Reformatting toolkit SDR BUFR												
Reformatting toolkit EDR BUFR and GRIB2					△	△		△	△	△		
NUCAPS CrIS Subsetter	△											
NUCAPS Level 2												△
CrIS OLR											△	
Polar Winds									△	△		
MiRS					△		△					
GVF												△
ACSPO										△		△
Ocean Color												
Active Fires											△	△
Mircrowave Tropical Cyclone												
Veg Health									△		△	

△CDR △Prelim DAP △SCR △ARR/AMR △SRR △Final DAP △ORR △OPS

Top-Level Schedule

J1 launch date

J1 Polar ESPC Products	FY 18- 2017			FY18-2018								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
V8TOz/LFSO2					△	△△	△					
V8Pro					△	△△	△					
Surface Reflectance	△										△	
Vegetation Indices												△

△CDR △Prelim DAP △SCR △ARR/AMR △SRR △Final DAP △ORR △OPS

Top-Level Schedule

J1 Polar ESPC Products	FY 19- 2018			FY19-2019								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Reformatting toolkit SDR BUFR												
Reformatting toolkit EDR BUFR and GRIB2												
NUCAPS CrIS Subsetter												
NUCAPS Level 2		▲						▲	▲▲	▲		
CrIS OLR		▲						▲	▲▲	▲		
Polar Winds		▲	▲▲	▲								
MiRS	▲▲	▲	▲									
GVF	▲			▲		▲▲	▲					
ACSPO				▲	▲	▲	▲					
Ocean Color												▲
Active Fires				▲	▲▲	▲						
Mircrowave Tropical Cyclone					▲		▲					
Veg Health				▲								

▲ CDR ▲ Prelim DAP ▲ SCR ▲ ARR/AMR ▲ SRR ▲ Final DAP ▲ ORR ▲ OPS

Top-Level Schedule

J1 Polar ESPC Products	FY 19- 2018			FY19-2019								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
V8TOz/LFSO2												
V8Pro												
Surface Reflectance												
Vegetation Indices												

CDR Prelim DAP SCR ARR/AMR SRR Final DAP ORR OPS

Top-Level Schedule

J1 Polar ESPC Products	FY 20- 2019			FY20-2020								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
MIRS												
Ocean Color												
Microwave Sounder based Tropical Cyclone												
Veg Health												

J1 Polar ESPC Products	FY 21- 2020			FY21-2021								
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Ocean Color												

CDR Prelim DAP SCR ARR/AMR SRR Final DAP ORR OPS

Summary

- By the end of 2017, all EDR algorithms (beside Imagery) will be updated to Enterprise Algorithms
  - Implementation of the latest science
  - Consolidation of science across satellite systems
  - Minimization of software to maintain
- These same algorithms will be used for J1
- Note that a couple of algorithms like Fires and Surface Reflectance need more work to become completely enterprise

ADL/MX Build Status and Algorithm Integration

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STAR JPSS 2017 Annual Science Team Meeting,14-18 August 2017, College Park, Maryland

Outline

1. Overview
2. Background
3. BLK2 Builds
4. ASSISTT Configuration Management (CM)
5. Algorithm Building and Testing Steps
6. Integration and Change Request Package
7. Algorithms
8. Summary

Overview

- JPSS and S-NPP SDR algorithms and VIIRS Imagery algorithms are currently processed in IDPS
- Algorithm Development Library (ADL) is the Test System, mimics IDPS and released as MX Builds with version names MX1.0, MX2.0 etc.; Current Version is MX 3.0
- JPSS ASSISTT Uses MX Build Versions for Algorithm Integration, Testing, Change Request Package Creation and Submission

Background

- IDPS was used to Process All the Algorithms
- The Version was BLK1 and Released as MX Builds (MX7.2, MX8.5 etc.)
- Current Version is BLK2 and BLK2 Builds are Released as MX Builds from January 2017. Before MX Builds they were released as PSAT versions (PSAT 22, PSAT 26 etc.)
- BLK 2 ADL MX 1.0 - Released on 1/10/2017 in Raytheon CM
- BLK 2 ADL MX1.0 (with 2 patches) - Released on 4/11/2017 in Raytheon CM
- BLK 2 ADL MX 2.0 – Released on 5/30/2017 in Raytheon CM
- BLK 2 ADL MX 3.0 – Released on 6/2/2017 in Raytheon CM

BLK2 Builds

- In BLK2 the Inputs and Outputs are managed by Data Management System (DMS)
- After ADL executables are built, DMS should be created
- ADL Tools exist to manage inputs and outputs
  - RemoveFromDms.plx
  - ExportFromDms.plx
  - RetrieveFromDms.plx
  - InsertIntoDms.plx
  - ImportIntoDms.plx
  - extractSaveset
  - DataCollector.exe

ASSISTT Configuration Management (CM)

- ASSISTT Keeps All MX Builds in its own CM system (Git)
- ASSISTT has compiled all the Libraries needed to build ADL
- ASSISTT has developed Scripts to run ADL
- People with access to STAR Collaborative Environment can use ASSISTT Libraries to build ADL and test new algorithms.

Algorithm Building and Testing Steps

- **Step 1:** Get ADL Version from Raytheon CM system
- **Step 2:** Put these versions in STAR ASSISTT CM system
- **Step 3:** Find out the special days for specific testing
- **Step 4:** Organize all the needed input files for this date
- **Step 5:** Build the particular version of ADL
- Step 6: Run the Executables to generate Product Data

Note: Use the ADL Version that mimics the Version in Operations

Integration and Change Request Package

- Scientists develop code changes and Look-Up-Table changes to improve the algorithms
- ASSISTT tests these changes in ADL MX Build that is compatible to operational version of the algorithm
- Communicates with Science Team and DPE to confirm results and test package
- ASSISTT Submits the Algorithm Package

Algorithms

- OMPS SDR – NP and NM
  - *Weekly DARK Table Testing*
  - *Biweekly OSOL and WAVELENGTH tables for OMPS NP*
  - *JCT5 Table delivery*
  - *Others such as Bias Correction etc.*
- CrIS SDR
  - *PCT tables that needed xml file changes*
  - *Spike Correction*
  - Control generation frequency of CrIS-<FS>-SDR-ENGPKT-BACKUP-AUX
- ATMS SDR
  - *Updated PCT*
- VIIRS SDR
  - *Monthly DNB LUT Moon Update*
  - *J01 Prelaunch Table Update*
  - *Incorrect M6 Reflectance Values Update*
- VIIRS Imagery SDR

Summary

- Current MX Build is MX3.0
- ASSISTT uses MX3.0 for Testing and Submitting Change Request Package
- Creates README file and Testing Guideline Document
- Communicates with Science Team and DPES
- Attends Meetings (DRAT, TIM, Reviews and Science Team Meetings)
- Uses the MX Build that is Active in Operations

Questions?

EDR Transition to NDE and Associated Algorithm Testing

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The ASSISTT Role in Algorithm Transition to NDE – Process

- Implementation of QA and Standard Processes
  - Work with teams to conduct a standard set of project reviews
  - Standard set of operational documentation (ATBD, SMM, EUM)
  - Facilitating stakeholder interaction (e.g. NDE, OSPO, JPSS, NCEI, NWS, JCSDA, NASA, DOD, CSPP, etc.)
    - Supporting pIPT, ESPDS PGIPT, TIMs
    - Work with ESPC on availability of operationally supported ancillary data
    - Working with end users to identify specific contents required in product files
  - Requirements development/refinement
  - Risk tracking and mitigation

The ASSISTT Role in Algorithm Transition to NDE – Technical

- Technical Work
  - Code cleanup, refactoring, rewriting
  - Coding standards
  - Use of standard languages, tools, and libraries
  - Implementation of common data formats and metadata (CF & NDE)
  - Configuration management
  - Delivered Algorithm Package (DAP): packaging, verification, and delivery
  - Algorithm package testing

The ASSISTT Algorithm Package Testing – What We Do and Why

- Unit testing
  - Verify functionality new code
  - Regression testing for validating old capabilities.

- End-to-end testing in near real time over long periods using automated offline demonstration systems
  - Ensure code is robust
  - Acquire information on algorithm system requirements (run times, memory, disk usage)
  - Produce data to support science development and validation efforts
    - Provide data for LUTs
    - Provide data to validate the science
  - Provide product distribution to support to end users
    - User pre-operational readiness
    - User-supplied data/product validation
  - Provides a way to check or troubleshoot issues in the NDE I&T or OPS string
    - STAR doesn't have access to NDE and OSPO hardware, compilers, file systems
    - If we use the same input data stream, code, hardware, compilers we may be able to actually diagnose and fix problems
    - May reveal subtle issues with environmental differences, problems with production rule implementation differences or DAP update implementation

Algorithm Testing Examples – NUCAPS Offline Demonstration Processing

- NUCAPS Offline Demonstration Processing System
  - End-to-end processing system generating all products globally
    - Schedules and manages multiple runs, simultaneous jobs, ingests data, executes algorithms, handles processing dependencies, and distributes products.
    - Executes pre and post-processing of data. Runs the Reformatter Toolkit for BUFR generation.
    - Modular such that individual processing units can be extracted from the NUCAPS offline system, put into a DAP, and delivered to NDE. This works because the delivered modules have the interfaces as the NDE system.
    - Automated and running continuously 24/7 for the last 8 years.
    - Environment and compilers match that of NDE (OS and compilers).
  - Data
    - Initially generated simulated CrIS and ATMS from GFS using the SDP Toolkit and then produced output mimicking the CrIS and ATMS SDR and TDR HDF5 formats.
    - Currently pulls the CrIS SDR, ATMS TDR, and VIIRS JPSS Enterprise Clouds from SCDR.
    - Distributes through the STAR ftp server to (e.g. NCO, AWIPS, NCEI, CPC, NPROVS, GMAO, DOD).

Algorithm Testing Examples – NUCAPS Offline Demonstration Processing

- NUCAPS Offline Demonstration Processing System tasks:
  - Supported data flow of CrIS FSR BUFR to NCO/EMC for 1.5 years prior to operational implementation (NCO ingest and GFS implementation)
  - Generate Focus days for the science team in support of regression generation and validation
  - Supported troubleshooting differences between NDE I&T and OPS
  - Running continuously to provide EDRs to NPROVS for T & q validation
  - Running in different modes
    - Comparing different versions of the retrieval
    - Full spectral CrIS vs Nominal spectral CrIS
    - IR-only vs IR+MW
    - S-NPP vs J1
    - With or without VIIRS clouds
      - VIIRS clouds from JPSS Enterprise vs IDPS

Algorithm Testing Examples – GCOM Offline Demonstration Processing

- GCOM Offline Demonstration Processing System:
  - End-to-end processing system generating all products globally
    - Schedules and manages multiple runs, simultaneous jobs, ingests data, executes algorithms, handles processing dependencies, and distributes products.
    - Executes pre and post-processing of data. Runs the Reformatter Toolkit for BUFR generation.
    - Modular such that individual processing units can be extracted from the GCOM offline system, put into a DAP, and delivered to NDE. This works because the delivered modules have the interfaces as required by the NDE system.
    - Automated and running continuously 24/7 for the last 4 years.
    - Environment and compilers match that of NDE (OS and compilers).
  - Data
    - Initially used AMSR2 L1B and L1R from JAXA
    - Currently pulls the AMSR2 L1B and L1R from SCDR (from NDE via PDA).
    - Distributes through a dedicated ftp server to end users (NHC, NAVO, NWS, OSPO)

Algorithm Testing Examples – GCOM Offline Demonstration Processing

- GCOM Offline Demonstration Processing System Tasks:
  - Support early data availability for end users
  - Support reprocessing for science team validation
  - Supported troubleshooting differences between NDE I&T and OPS
  - Supported testing of JAXA code in the processing chain to evaluate
    - JAXA code version differences
    - Allocated latency
    - Timestamp bugs
  - Supported testing impacts of granule vs orbital dump processing
  - Supported reprocessing for GHRSST generation and validation

Algorithm Testing Examples – STAR ASSISTT Cluster Offline Demonstration Processing

- STAR ASSISTT Offline Demonstration Processing System:
  - End-to-end processing system generating products globally
    - Schedules and manages multiple runs, simultaneous jobs, ingests data, executes algorithms, handles processing dependencies, and distributes products.
    - Executes pre and post-processing of data. Runs the Reformatter Toolkit for BUFR generation.
    - Modular such that individual processing units can be extracted from the Cluster, put into a DAP, and delivered to NDE. This works because the delivered modules have the interfaces as the NDE system.
    - Automated and running continuously 24/7.
    - Environment and compilers match that of NDE (OS and compilers).
  - Data
    - Pulls JPSS data from SCDR (from GRAVITE via PDA).
    - Distributes through
      - STAR ftp server to end users (NWS, OSPO)
      - STAR ftp THREDDS server to access controlled data

Algorithm Testing Examples – STAR ASSISTT Cluster Offline Demonstration Processing

- STAR ASSISTT Cluster
  - Uses HTCondor for high-throughput distributed processing of jobs
  - 13 machines (Production)
    - 24 cores, 256 GB memory each
  - 4 machines (QA)
    - For testing of upgrades and other software packages before deploying to the rest of the cluster
  - 8 additional servers waiting to be setup
  - Currently Implementing
    - Docker
      - Combined with other tools for continuous integration
  - Currently Evaluating
    - Job schedulers (currently using CRON, looking at JobScheduler)
    - File systems (GlusterFS)

Algorithm Testing Examples – STAR ASSISTT Cluster Offline Demonstration Processing

- STAR ASSISTT Cluster Offline Demonstration Processing System Tasks:
  - Supports end-to-end NRT testing of JPSS Enterprise algorithm packages for limited coverages (see next slide)
  - Future support of early data availability for end users
    - VIIRS Enterprise LST to EMC
  - Run short-term (2.5 month) global processing to validate latest science team updates with CRTM 2.1.3 for next Enterprise DAP delivery (Sep 2017)

JPSS Enterprise Algorithms Running in NRT on the STAR Cluster

Algorithm	Current Coverage
Cloud Mask	CONUS
Cloud Phase	CONUS
Cloud Height	CONUS
Cloud DCOMP	CONUS
Cloud NCOMP	CONUS
Cloud Base	CONUS
Aerosol ADP	CONUS
Aerosol AOD	CONUS
Volcanic Ash	CONUS
Ice Concentration	CONUS and Polar
Ice Age	CONUS and Polar
Snow Cover	CONUS and Polar
Polar Winds	Polar
Land Surface Albedo	CONUS
Land Surface Temperature	CONUS
Coverage of JPSS NRT algorithms: CONUS (126 W, 66 W; 22N, 50 N) Polar regions (above of 50)	

Goal: to have global processing of the Enterprise Algorithms within the HTCondor cluster by the end of 2017

Summary

- ASSISTT facilitates the NDE EDR transition to ops process with near real time algorithm testing in offline demonstration systems as follows:
  - Supports software functional testing
  - Supports science development and validation
  - Supports troubleshooting in I&T and OPS
  - Supports user readiness