# Integrated Processing including CSPP

Mitch Goldberg

# Topics

- **Why integrated processing?**
- **Desirable attributes of integrated processing**
- **Road to integrated processing.**
  - **JPSS Risk Reduction project – ABI algorithms for VIIRS**
- **Community Satellite Processing Package (CSPP) as a step in the right direction**

# Why Integrated Processing?

- Large increases in satellite data
  - POES to JPSS
  - GOES to GOES-R
  - Continuation of METOP
  - NASA Decadal Missions
  - International satellites
    - China, Europe (ESA), Japan, India, Korea, Russia, ……
- Great opportunities for data integration

# Emerging landscapes

- Satellite programs overseas are growing.
  - Use of NOAA and non-NOAA satellites for operations
  - JPSS, GOES-R, METOP, NASA decadal missions, International geostationary satellites, China's FY3 series, GCOM-W (AMSR2), GCOM-C (SGLI), ESA Sentinel 3, JASON series ……
- Products and services benefit from a global observations with high temporal refresh.
- Multisensor and blended products
- Societal benefit applications for end-users and decision makers.
- Decreasing budgets, increasing demand
- Interoperability to gain efficiencies and cost reductions
  - common hardware to process multiple satellite data streams
  - same software to generate products from different sensors

# Emerging Solutions

- Consistency in procedures
  - Gathering requirements
  - Algorithms
  - Processing
  - Instrument cal/val
  - Product validation
  - Data Formats and Metadata
  - User Readiness
- Multisensor algorithm/application teams
- Integrated processing software systems

# Problem: Consistency and Standards

## Traditionally

- Each satellite program pursues its own algorithm development program, and separate ground system
- Each program develops mission unique pre-launch and post-launch instrument calibration validation approach
- Each program has its own user engagement and training. (of varied quality)
- Each program has its own formulation, software development, documentation, schedule practices

**Result:** Increased and redundant costs,
Sub-optimal performance,
More complex transitions to operations
Difficulty in blending products due to different algorithms and processing
Widely varying user preparation/readiness

# Instead of:

- Stovepipe processing systems
- Stovepipe algorithm development and validation
- Stovepipe user readiness

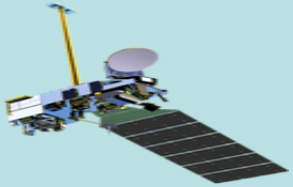
## The emerging solution is:

- Integrated processing systems
- Integrated algorithm development and validation
- Integrated user readiness

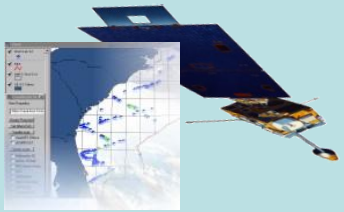
# New and Old Algorithm Product Capabilities

| POES | GOES | Aqua | METEOSAT | MTSAT | DMSP |
|---|---|---|---|---|---|
| POES Algorithm Processing | GOES Algorithm Processing | Aqua Algorithm Processing | Meteosat Algorithm Processing | Algorithm Processing | DMSP Algorithm Processing |
| POES products | products | products | METEOSAT products | MTSAT products | DMSP products |

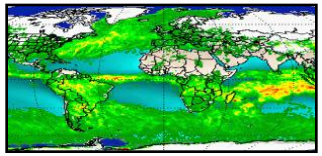
Old era: Software and algorithms tailored to specific satellite data streams



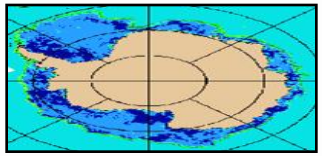
*Satellites and Measurements from GEOSS*

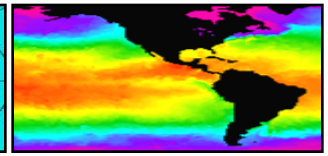


*Integrated Algorithm and Product Processing System*



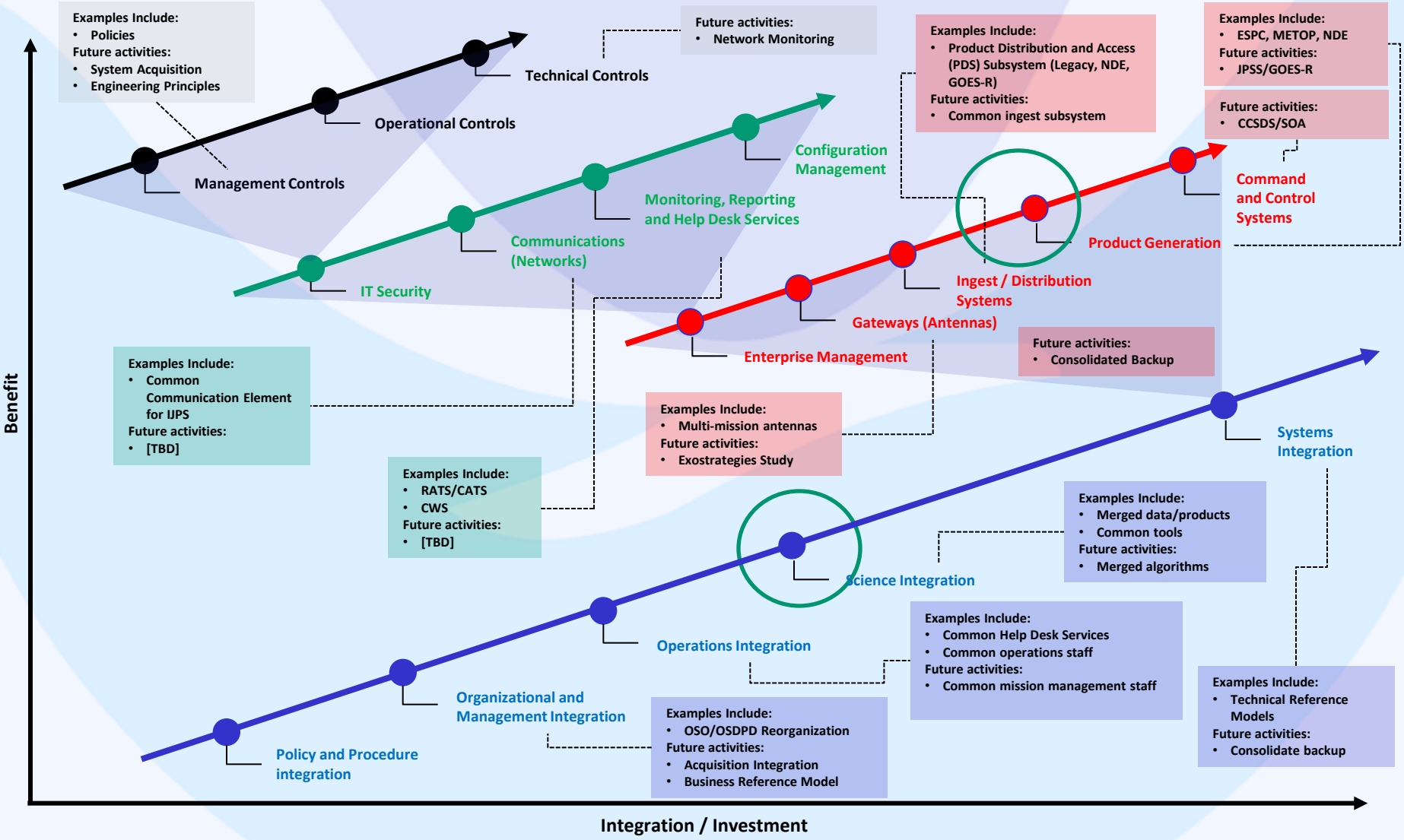
***Integrated observations & products***





New era: Software and algorithms work for variety of satellite and in-situ data streams

# NOAA Enterprise Architecture Towards Integrated Algorithm and Production Generation



# NOAA needs a pathway towards integrated processing

- **Algorithm consistency - same algorithms process similar data streams from different sensors; reusable software being employed across platforms**

- **Integrate Sensors**: Simplify the complexity of building products using multiple instruments on one platform

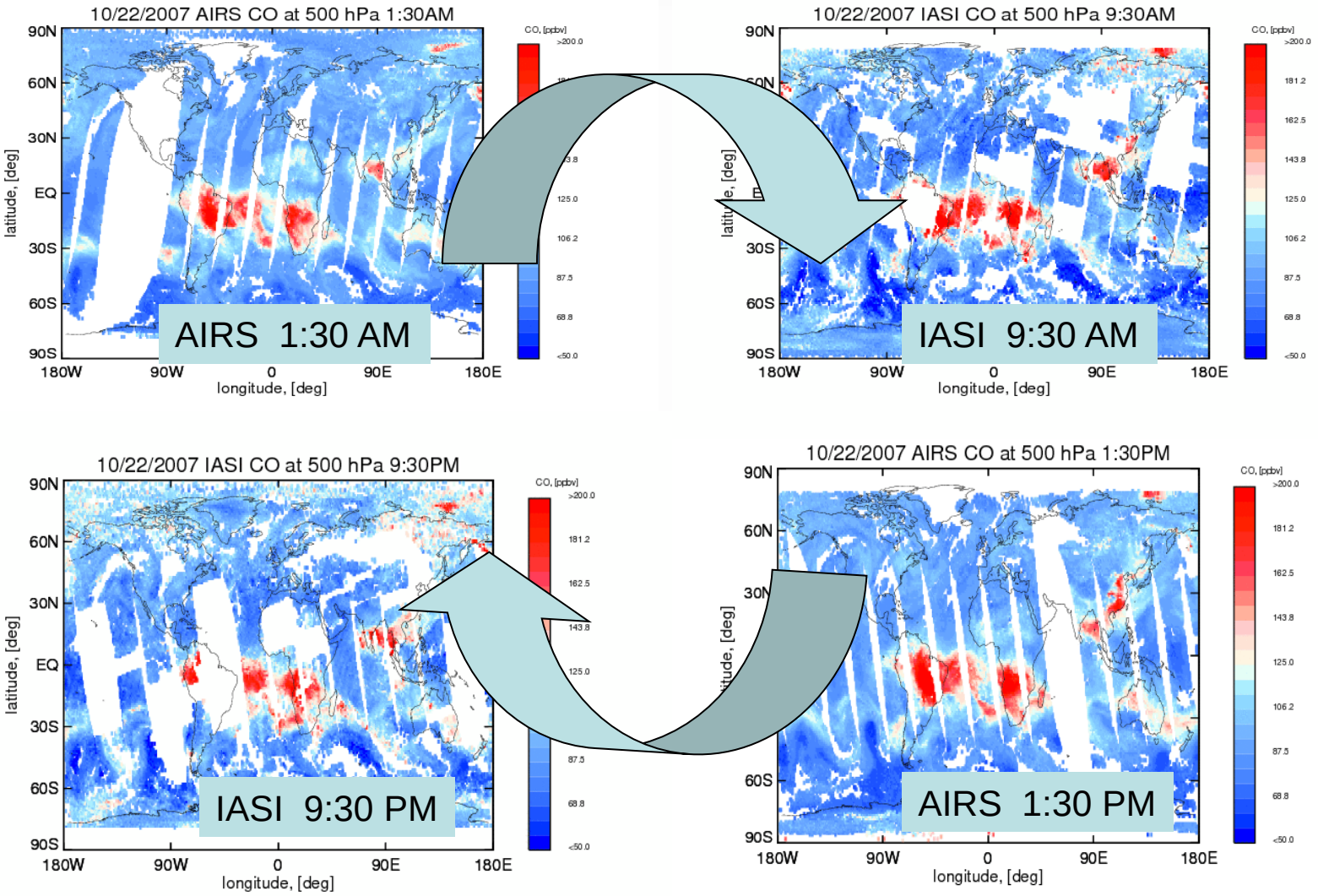
- **Integrate Calibration**: Evaluate and calibrate data between multiple satellites & sensors in different orbits

- **Integrate Satellites**: Utilize cross-calibrated, collocated data sets to build enhanced products

# Benefits from Integration

- Coordinated and more detail requirements analysis
- Multipurpose solutions to improve efficiency, costs and maintenance
- Consistency of scientific algorithms
- Consistency of sensor and product validation
- Consistent and repeatable processes/standards for development.
- Enables the generation of blended products
- Faster research to operations
- Consistency in user readiness and training

# Multisensor algorithms allow time continuity of IASI & AIRS Carbon Monoxide products



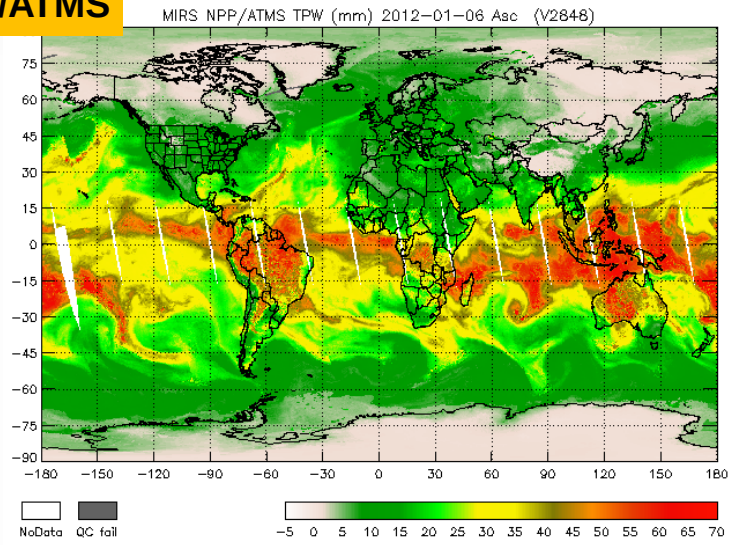
# Microwave Integrated Retrieval System (MIRS)

| SDR/EDR | POES METOP AMSU-A/B; MHS | DMSP SSMIS | JPSS ATMS |
|---|---|---|---|
| Radiances | ✓ | ✓ | ✓ |
| Temp. profile | ✓ | ✓ | ✓ |
| Moist. profile | ✓ | ✓ | ✓ |
| Total precipitable water* | ✓ | ✓ | ✓ |
| Hydr. profile | ✓ | ✓ | ✓ |
| Precip rate* | ✓ | ✓ | ✓ |
| Snow cover* | ✓ | ✓ | ✓ |
| Snow water equivalent* | ✓ | ✓ | ✓ |
| Sea ice * | ✓ | ✓ | ✓ |
| Cloud water* | ✓ | ✓ | ✓ |
| Ice water* | ✓ | ✓ | ✓ |
| Land temp* | ✓ | ✓ | ✓ |
| Land emis* | ✓ | ✓ | ✓ |
| Soil moisture | | | ✓ |

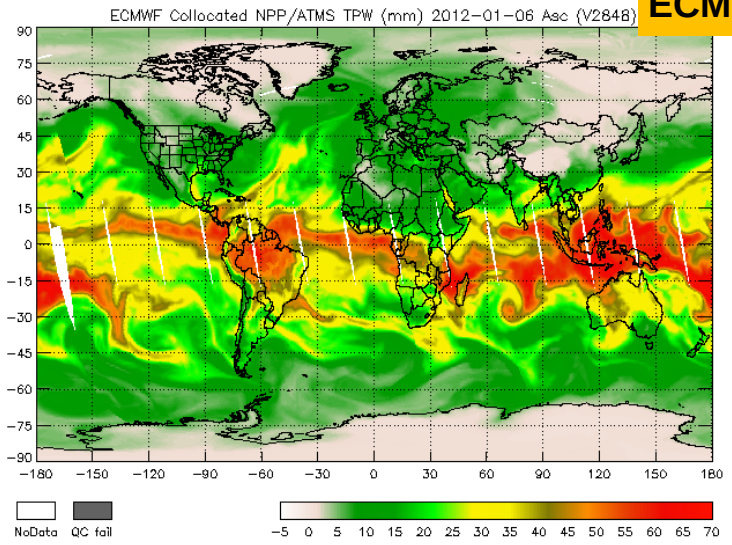
- MIRS Capabilities
  - Generates integrated "microwave-only" products from SSMIS, AMSU-A/B, AMSU/MHS, and ATMS
  - Significant Results:
    - Substantial cost savings (compared to stand alone product systems for each sensor type and product)
    - Improved science productivity (reduced software for basic physics)
    - Improved lifecycle software maintenance
    - Faster research to Ops

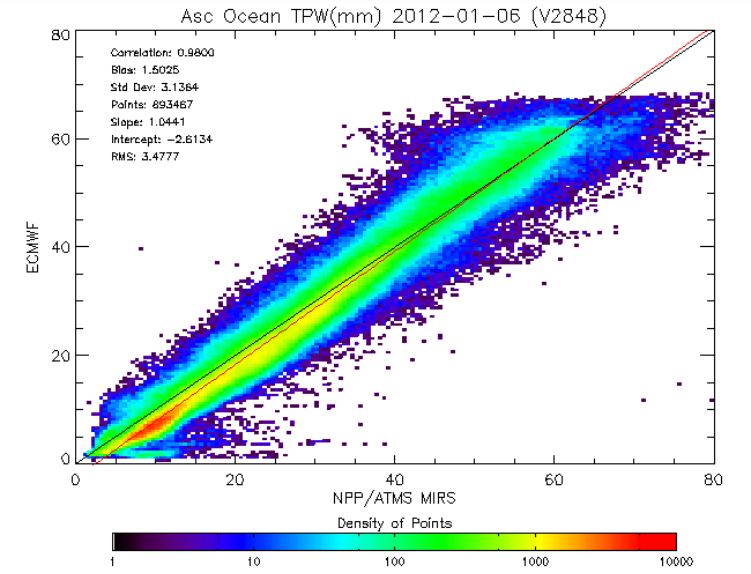
# NPP/ATMS Real Data
## *TPW*

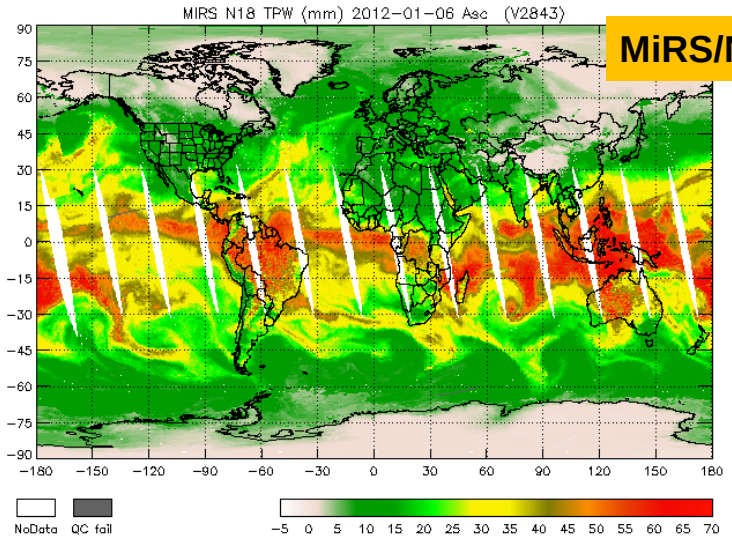
**MiRS/ATMS**




**ECMWF**

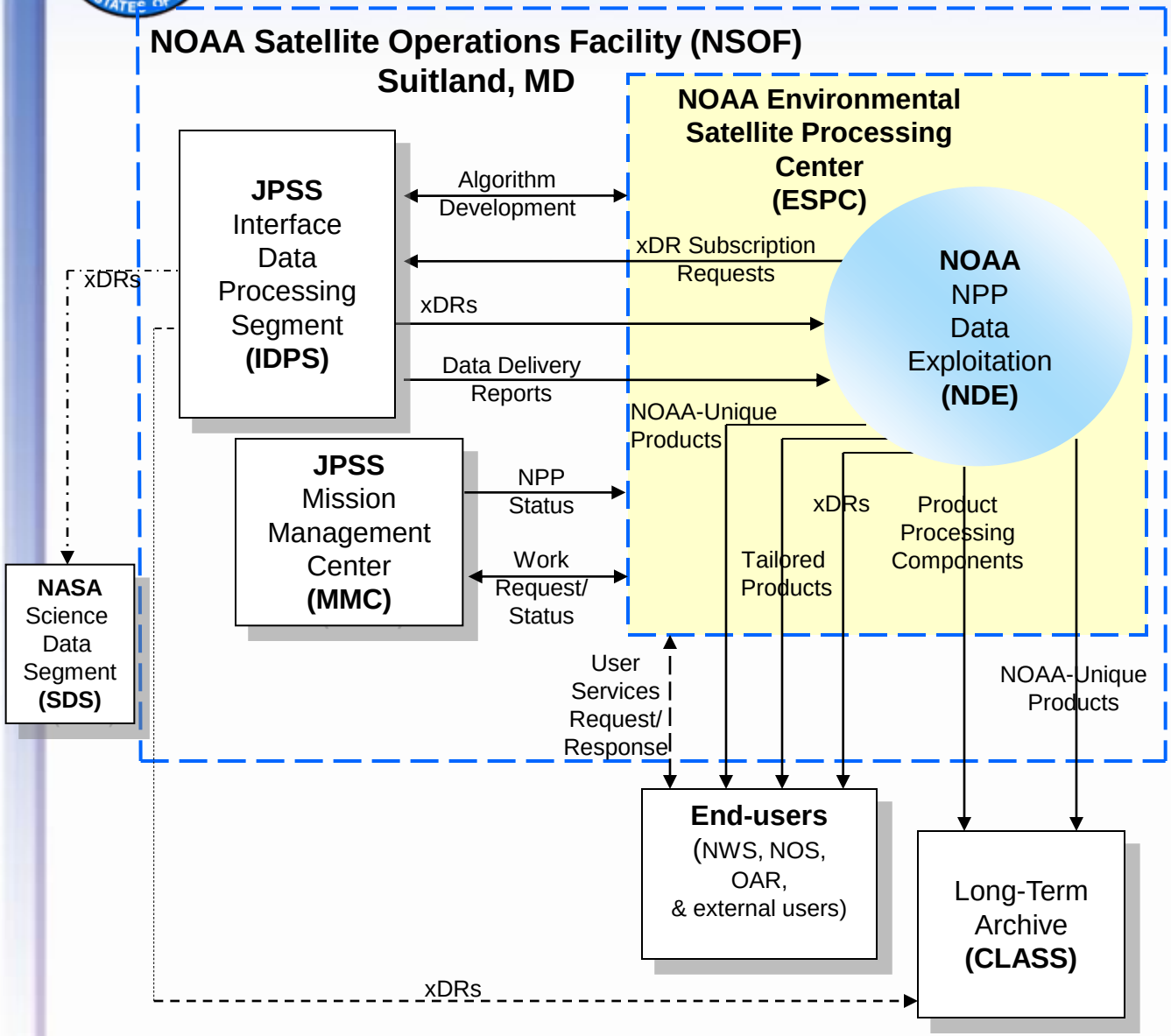



**MiRS/N18**

# Functional Scope: The NESDIS Central




## Office of Satellite & Product Operations (OSPO) will provide common services:

- Data Center Operations
- Telecommunications
- User Services (Help Desk)
- Config. Management
- Security Controls
- Distribution

## Center for Satellite Applications and Research (STAR) and partners provides:

- Validation of sensor and environmental data records
- Algorithm development and improvements
- Supports both JPSS IDPS and NDE

# JPSS RISK REDUCTION PROJECT

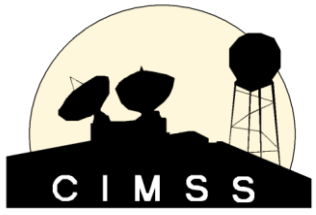
- **Title: Uniform Multi-Sensor Algorithms for Consistent Products**

- **ABI Algorithms used by VIIRS within NDE**
  - **All ABI Cloud, Aerosol, Cryosphere and Volcanic Ash Algorithms**
  - **Operational from NDE in 2014**
- **Benefits**
  - **Allows for improved integration of products from LEO and GEO**
  - **Demonstration of NOAA's goal of enterprise solutions by employing same algorithms for "POES" and "GOES"**
  - **Supports NWS OS&T implementation strategy of multi-sensor algorithms and products**
  - **Software is being developed to allow processing of the related GOES-R option 2 orphans.**

# Community Satellite Processing Package (CSPP) for NPP/JPSS

Liam Gumley, Allen Huang, Scott Mindock, Graeme Martin, Ray Garcia, Geoff Cureton, Kathy Strabala, Elisabeth Weisz, Nadia Smith, Bill Smith

ITSC-18, Toulouse France, 23 March 2012

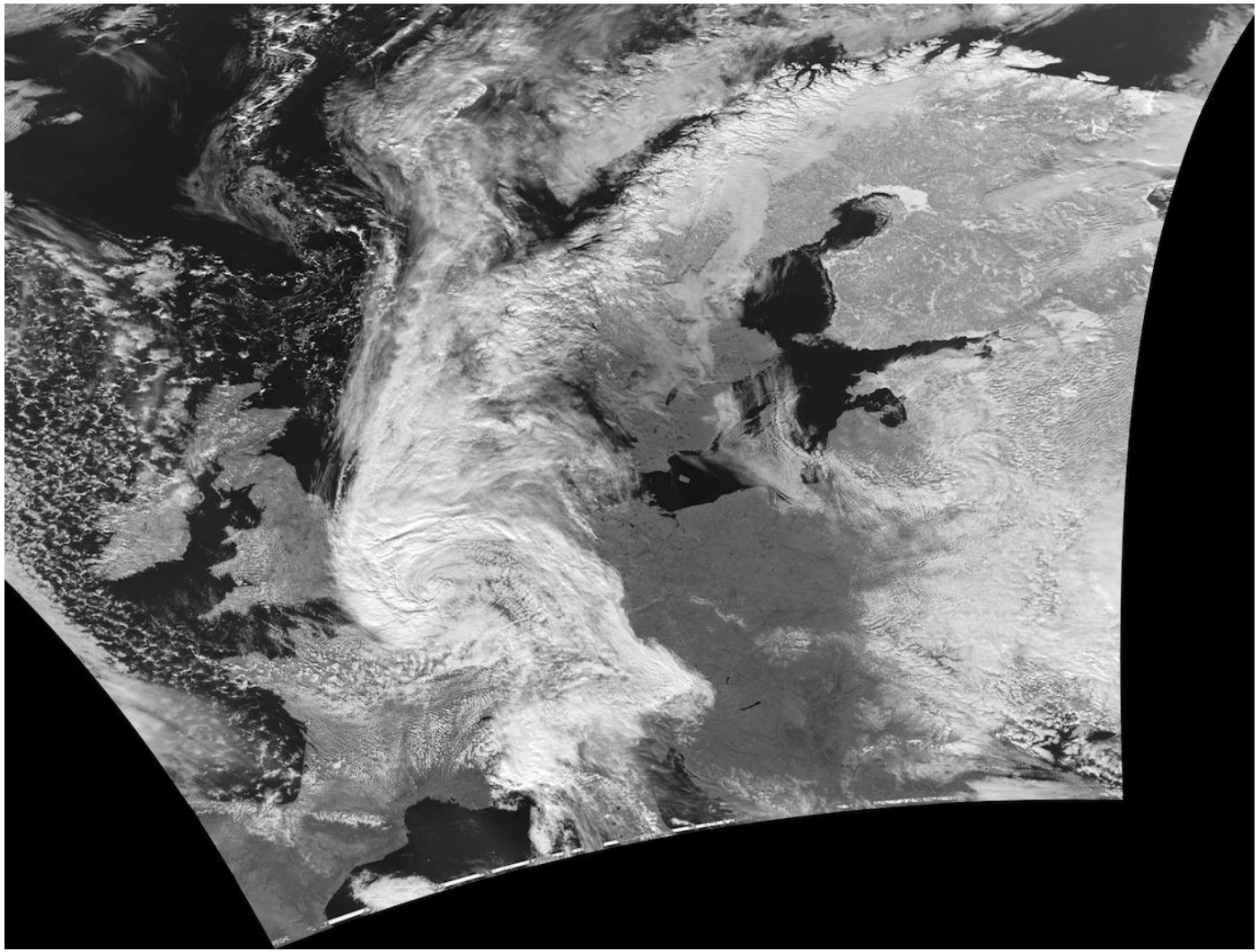





# What is CSPP?

- CSPP (Community Satellite Processing Package) is the new software system for processing direct broadcast data from Suomi NPP.
- Funded by NOAA JPSS Program Science
- Developed and supported by CIMSS/SSEC, UW-Madison.
- For Suomi NPP, we use the Algorithm Development Library (ADL) version of the Suomi NPP operational processing software.
- CSPP will do more than just NPP…

# Suomi NPP acquired and processed by Finnish Meteorological Institute, 2012/03/05



VIIRS M7, Courtesy of Timo Ryyppö, FMI Sodankylä

# Community Satellite Processing Package

- CSPP will include support for Suomi NPP and JPSS, POES, Metop, and FY-3.
- For Suomi NPP, supported sensors will include VIIRS, CrIS, ATMS (SDRs and a subset of EDRs)
- For POES and Metop, supported sensors will include AVHRR and IASI (Level 2 products only; Level 1 processing provided by AAPP).
- For FY-3, supported sensors will include VIIR and MERSI (Level 2 products only; Level 1 processing provided by NSMC).
- 64-bit Intel Linux is the host platform for all CSPP software.

# CSPP for Suomi NPP

- SSEC is preparing algorithms for
  - VIIRS, CrIS, and ATMS RDR to SDR processing,
  - VIIRS Cloud Mask, Active Fires, Cloud Properties, and Aerosol Properties EDRs,
  - CrIS single FOV temperature and moisture retrievals.
- Primary distribution format is compiled code (ready to run).
- Source code will be available if desired (in ADL).
- Supported host platform is Red Hat Enterprise Linux 5 (64-bit), minimum of 16 GB of RAM is required.
- Nigel Atkinson recommends dual Intel hex-core 3.06 GHz CPUs and 64 GB RAM (10 min. VIIRS pass processed in 10 min).

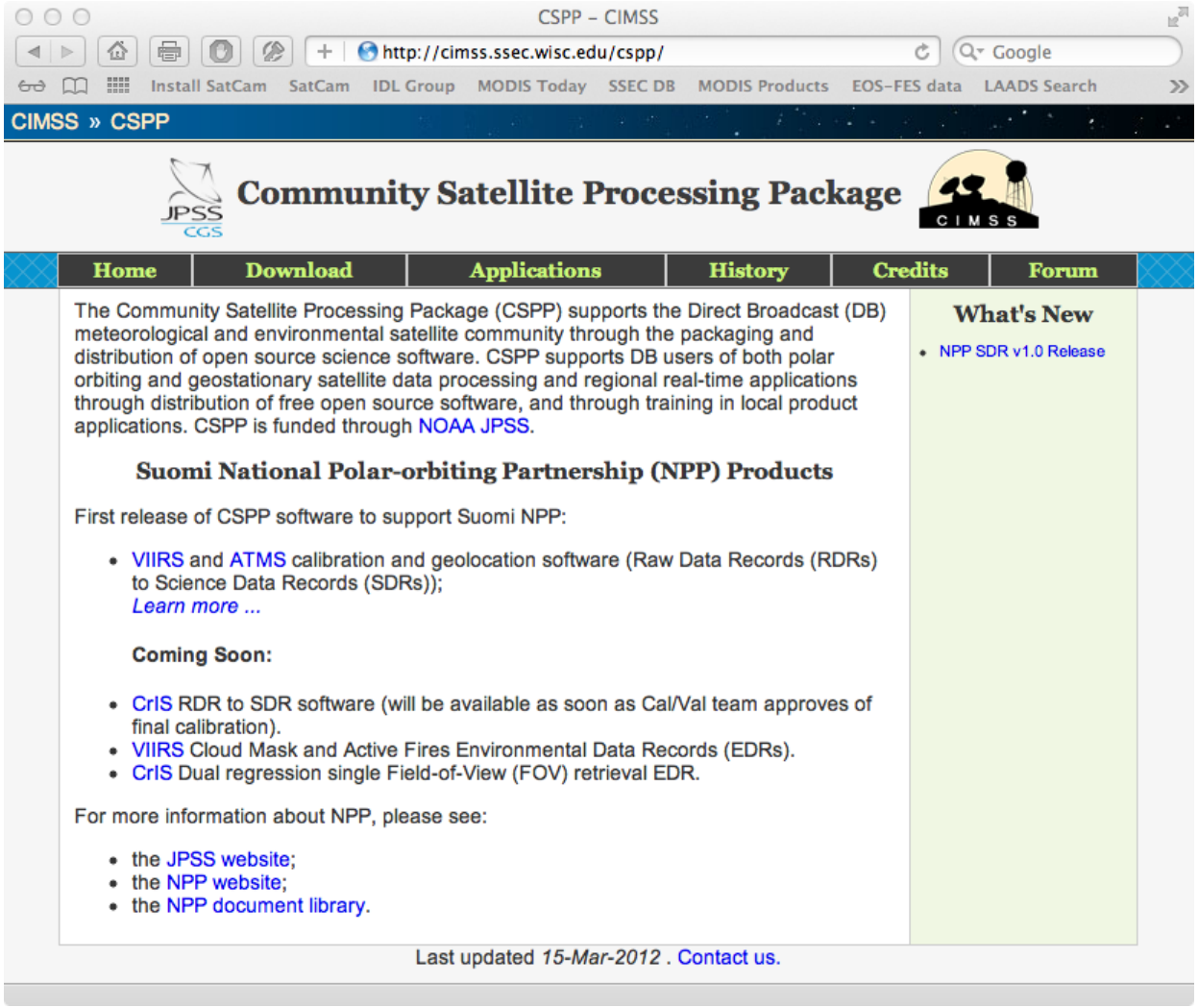
# CSPP for POES and Metop

- SSEC is planning to release the CLAVR-X AVHRR Level 2 software package for POES and Metop (from Andy Heidinger, NOAA) using Level 1 data from AAPP.
- Cloud Mask, Cloud Top Properties, Cloud Optical Thickness, NDVI, SST.
- Output format is HDF4.
- Mapped image products will also be available.
- CIMSS/SSEC (Weisz/Smith) have developed a dual-regression single FOV retrieval algorithm for IASI and CrIS (temperature and moisture profiles, cloud properties), which will be released as part of CSPP.

# CSPP for FY-3

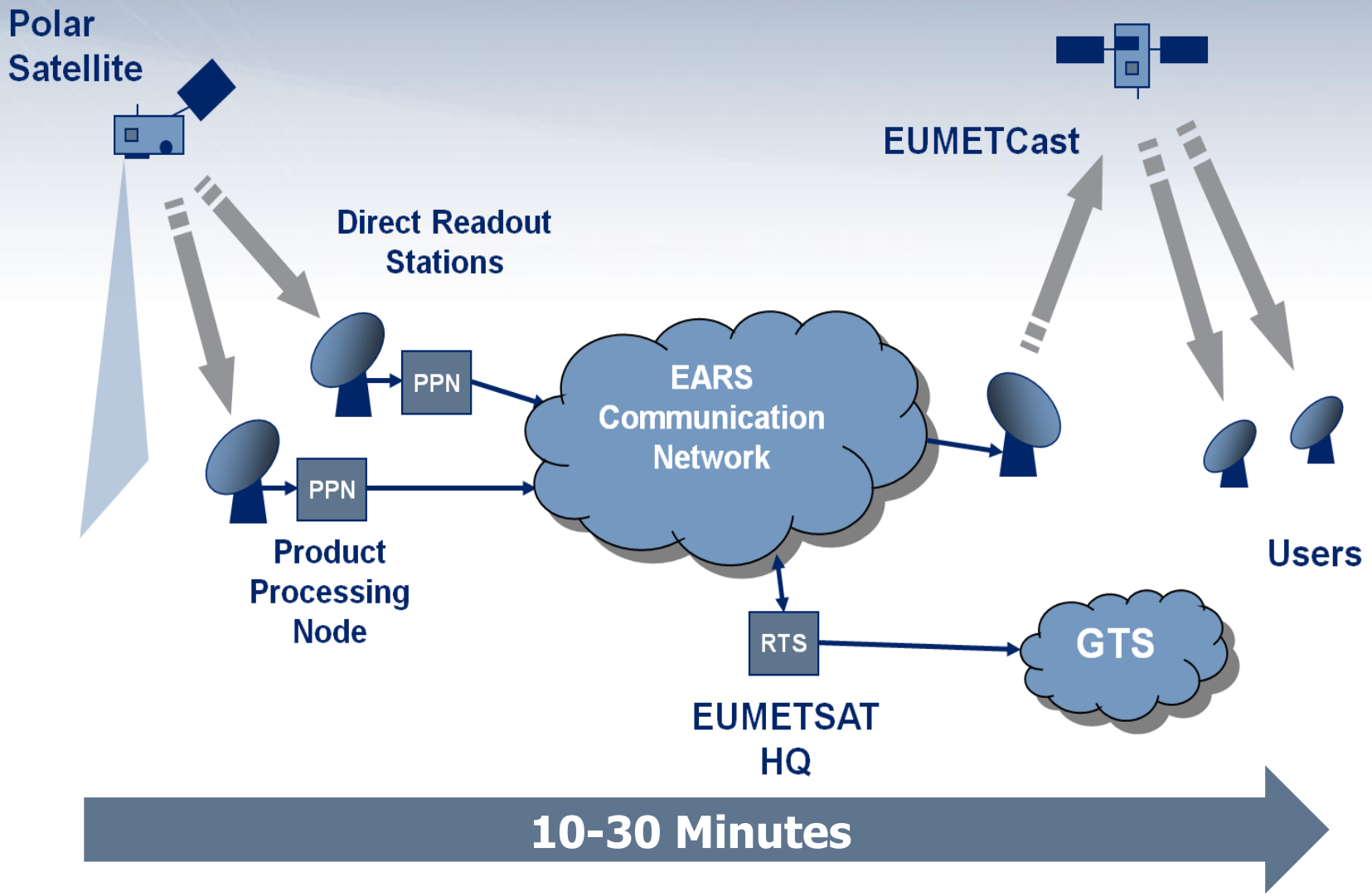
- SSEC is planning to adapt the CLAVR-X AVHRR Level 2 software package for FY-3 VIRR.
- Level 1 processing is already provided by NSMC http://www.nsmc.cma.gov.cn/newsite/NSMC_EN/Home/Index.html
- Cloud Mask, Cloud Top Properties, Cloud Optical Thickness, NDVI, SST for VIRR.
- SSEC will work with NSMC to release the MERSI Image Processing System (MIPS) to the DB community. MIPS provides true and false color images from MERSI in JPEG, GeoTIFF, and KML formats.

# CSPP Website




http://cimss.ssec.wisc.edu/cspp/

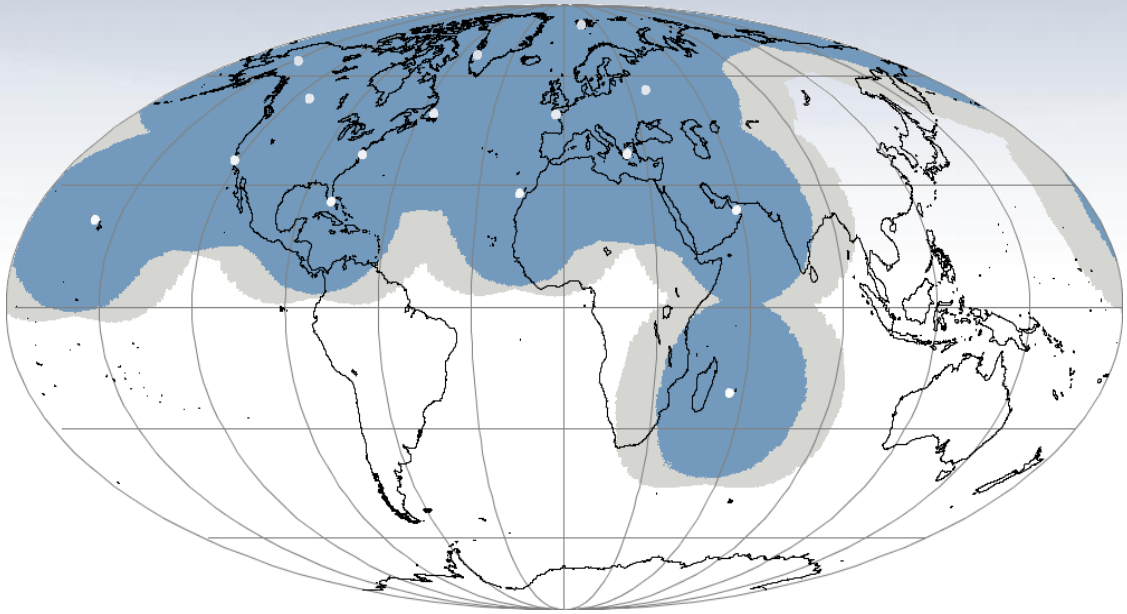
# CSPP is being used by the EUMETSAT ATOVS Retransmission Service (EARS) for SUOMI NPP




EUMETSAT

# EARS – Current Status

| Services | |
|---|---|
| EARS-ATOVS | L1 |
| EARS-ASCAT | L2 Winds |
| EARS-AVHRR | L0 |
| EARS-IASI | L1C |
| EARS-NWC | L2 Clouds |



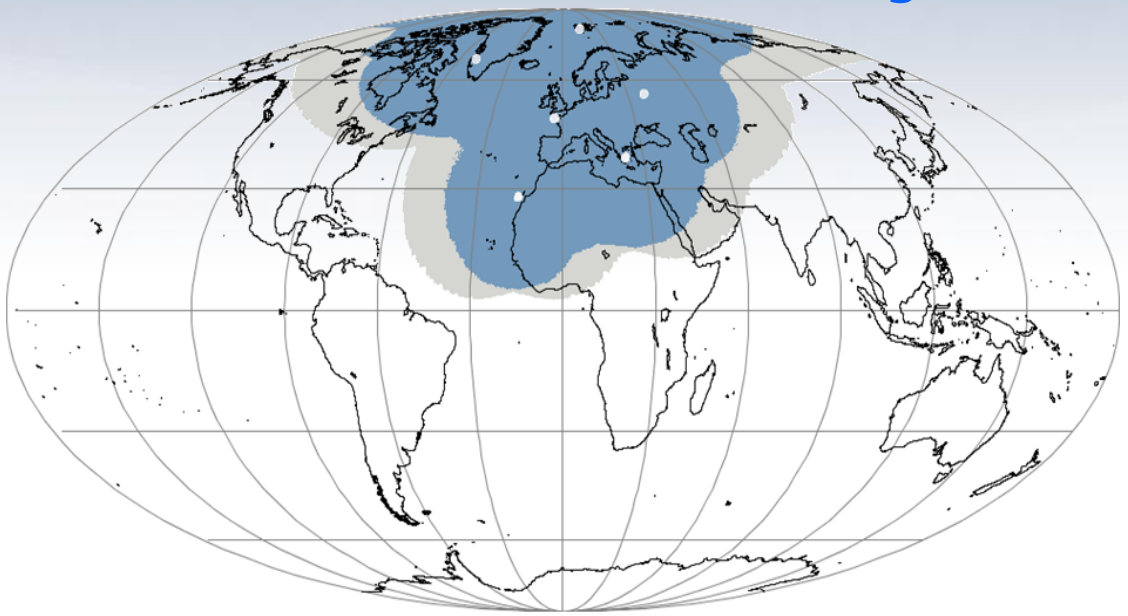
**Satellites:** NOAA POES
Metop

EUMETSAT

# EARS – New Regional Suomi NPP Services

| Services | |
|---|---|
| EARS-ATOVS | L1 |
| EARS-ASCAT | L2 Winds |
| EARS-AVHRR | L0 |
| EARS-IASI | L1C |
| EARS-NWC | L2 Clouds |
| EARS-ATMS | SDR (L1) |
| EARS-CrIS | SDR (L1) |
| EARS-VIIRS | SDR (L1) |

## Initial Suomi NPP Coverage



**Satellites:** NOAA POES
Metop
Suomi NPP

EUMETSAT

# Summary

- Moving towards integrated processing (enterprise solutions) does not occur overnight
- JPSS is funding two activities:
  - ABI  cloud, aerosol, volcanic ash, and cryosphere algorithms applied to VIIRS in an operational environment (NDE).
  - CSPP  -  provide direct broadcast users with products from NPP/JPSS, MeTOP and FY3