GOES-R Algorithm Working Group (AWG)

Jaime Daniels, AWG Deputy Program Manager
Mitchell D. Goldberg, AWG Program Manager
Walter Wolf, Algorithm Integration Manager
Xingpin Liu, Quality Assurance/EVM Manager
Wayne MacKenzie, AWG Support
AWG Application Team Leads and Members

NOAA/NESDIS Center for Satellite Applications and Research

OUTLINE

- The Algorithm Working Group (AWG): An Introduction
- AWG Current Efforts in GOES-R Level-2 Product Development and Validation
- Level-2 Product Calibration/Validation Planning
- Summary

The GOES-R AWG: An Introduction

- *Mission*
- *Relationship and synergies with other GOES-R Programs*
- *Makeup*
- *Roles and responsibilities*

Algorithm Working Group

PURPOSE: To select, develop, test, validate, and demonstrate Level-2+ product algorithms that will meet GOES-R requirements and provide them to the GOES-R Ground Segment. Provide sustained life cycle validation and Level-2 product enhancements.

- Leverages nearly 100 scientists from NOAA, NASA, NOAA's Cooperative Institutes (CIMSS, CIRA, CICS), and Universities
- Applies first-hand knowledge of algorithms developed for POES, GOES, DMSP, AIRS, MODIS, and MetOP.
- Leverages other programs & experiences (GOES, POES, MODIS, AIRS, IASI, NPOESS and other prototype instruments and international systems)
- Seeks to facilitate algorithm consistency across satellite platforms -- prerequisite for Global Earth Observation System of Systems (GEOSS)

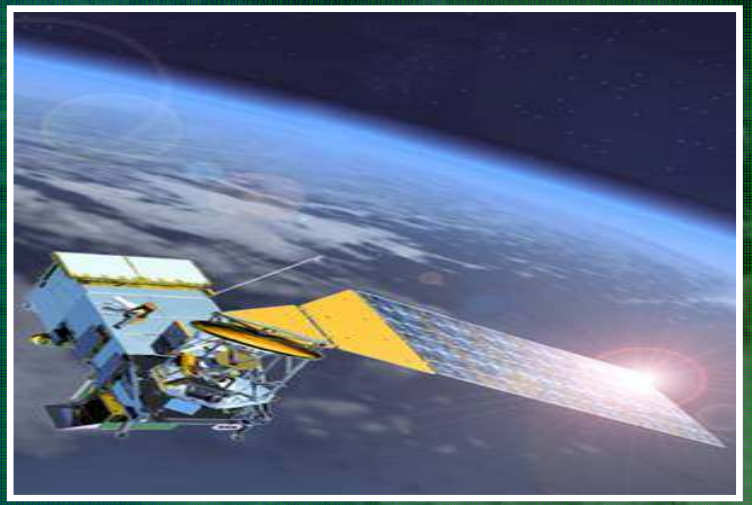
AWG Capabilities and Experience

End-to-End Capabilities

- Instrument Trade Studies
- Proxy Dataset Development
- Algorithm Development
- Product Demonstration Systems
- Development of Cal/Val Tools
- Integrated Cal/Val Enterprise System
- Application Development
- User Readiness
- Sustained Product Validation
- Algorithm and application improvements

Experience in Algorithm Delivery and Implementation

- Developed, tested, delivered, and implemented operational product generation systems
  - POES
  - GOES
  - DMSP (NOAA applications)
  - AIRS, MODIS
  - METOP (IASI, GOME, ASCAT)
  - NPOESS (NDE Project)



AWG brings capabilities that are applicable through the lifetime of the GOES-R Program

GOES-R Algorithm/Product Readiness

Underpinning Research & Development (new applications & Day 2 Products)	Pre & Post Launch Sensor Calibration and Validation	Operational Algorithm Readiness Development and Transition to Operations	Sustained Post Launch Validation and Reactive Science Maintenance	Proving Grounds and User Readiness
Risk Reduction	GOES-R Calibration Team ***(AWG is a team member)***	***Algorithm Working Group***	***Algorithm Working Group***	Proving Ground & Risk Reduction

Key components of a successful satellite program

Established GOES-R programs/activities and working groups that directly support these components

AWG Teams

GOES-R Products are Mapped to AWG Product Application Teams

AWG Product Application Teams	Team Lead
Imagery	Tim Schmit
Soundings	Tim Schmit
Winds	Jaime Daniels
Clouds	Andrew Heidinger
Aviation	Ken Pryor, Wayne Feltz
Hydrology	Robert Kuligowski
Land	Bob Yu
Cryosphere	Jeff Key
Radiation Budget	Istvan Lazslo
Lightning	Bill Koshak
SST	Alexander Ignatov
Ocean Dynamics	Eileen Maturi
Aerosols/Air Quality/Atmos. Chemistry	Shobha Kondragunta

AWG Specialty Teams	Team Lead
Proxy Data	Fuzhong Weng
Cal/Val (Sensor)	Changyong Cao
Algorithm Integration	Walter Wolf

AWG Algorithm Development Scope

Develop algorithms for the following L2 products…

Advanced Baseline Imager (ABI)

GLM

BASELINE Products

- **Clouds and Moisture Imagery (KPP)**
- Clear Sky Mask
- Cloud Top Pressure and Height
- Cloud Top Phase
- Cloud Top Temperature
- Cloud Particle Size Distribution
- Cloud Optical Path
- Temperature and Moisture Profiles
- Total Precipitable Water
- Stability Parameters (Lifted Index)
- Aerosol Detection
- Aerosols Optical Depth
- Derived Motion Winds
- Hurricane Intensity
- Fire/Hot Spot Characterization
- Land and Sea Surface Temperature
- Volcanic Ash
- Rainfall Rate
- Snow Cover
- Downward Solar Insolation: Surface
- Reflected Solar Insolation: TOA

- Lightning Detection

OPTION-2 Products

- Cloud Layer/Heights
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Type
- Convective Initiation
- Turbulence
- Low Cloud and Fog
- Enhanced “V”/Overshooting Top
- Aircraft Icing Threat
- SO_2 Detections (Volcanoes)
- Visibility
- Upward Longwave Radiation (TOA)
- Downward Longwave Radiation (SFC)
- Upward Longwave Radiation (SFC)
- Total Ozone
- Aerosol Particle Size
- Surface Emissivity
- Surface Albedo
- Vegetation Index
- Vegetation Fraction
- Flood Standing Water
- Rainfall probability and potential
- Snow Depth
- Ice Cover
- Sea & Lake Ice Concentration, Age, Extent, Motion
- Ocean Currents, Currents: Offshore

AWG Teams

- Product Application Teams
- Proxy Data Team
- Algorithm Integration Team
- Cal/Val (sensor) Team

AWG Roles & Responsibilities

- Develop all Level-2 product algorithms → ***Product Application Team Role***
- Acquire/develop proxy data for algorithm development & testing → ***Product Application and Proxy Team Roles***
- Perform Level-2 product Cal/Val → ***Product Application Team Role***
- Ensure GOES-R L1b integrity → ***Cal/Val (sensor) Team Role***
- Lead cross sub-team activities → ***Algorithm Integration Team Role***

AWG Algorithm Integration Team

Roles & Responsibilities…

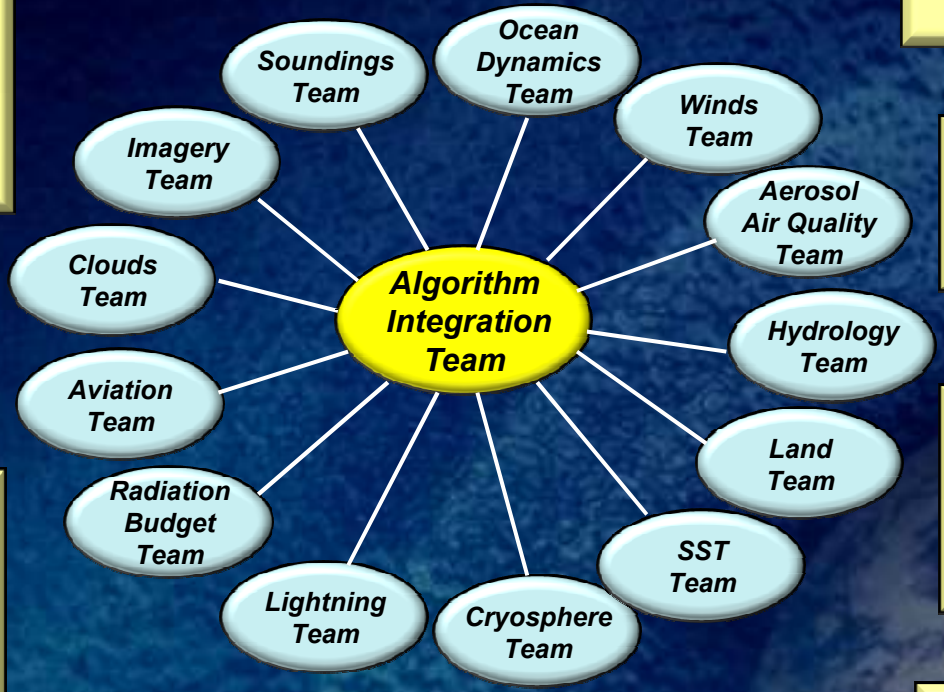
Manage Processes

- Initial Requirements Analysis
- Algorithm Design Review
- Critical Design Review
- Test Readiness Review
- Code Unit Test Review
- Algorithm Readiness Review
- Software CM

Execute & Follow

Enforce Standards

- *Algorithm Theoretical Basis Document*
- *Metadata (FGDC guidelines)*
- *Interface Control*
- *System Description*
- *Users Manual*
- *Fortran Programming*
- *C/C++ Programming*
- *Test Plan*
- *Algorithm Implementation Instructions*
- *Latency Reports*



Coordinate Algorithm Development & Integration Activities

Develop and Maintain Algorithm Framework and Testbed

Integrates algorithm software from the product application teams

AWG Focal Point for interactions between AWG, GOES-R Ground Segment, and Harris/AER

AWG Current Efforts in GOES-R ABI Level-2 Algorithm Development and Validation

- *Algorithm Development and Validation Strategies*
- *Proxy and Validation Data Sources*
- *Status of AWG Deliverables*
- *Product Examples*

Algorithm Development Strategy

A wide variety of instrument proxy datasets have been assembled and are being used…

"Real" ABI PROXY Data Sources

Current GOES

Meteosat/ SEVIRI

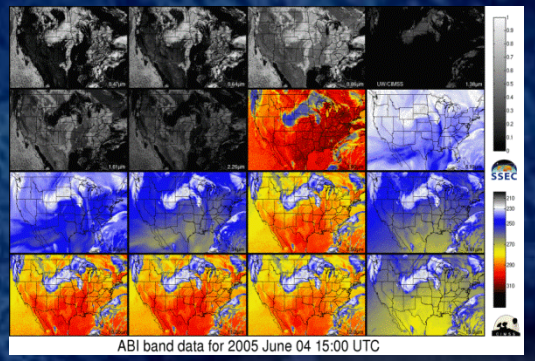
AVHRR

MODIS

TRMM/LIS

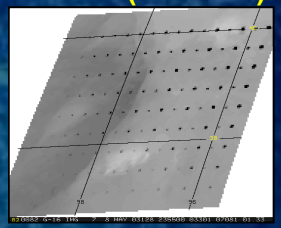
"Simulated" ABI Proxy Data Sources

(FD, CONUS, Meso)

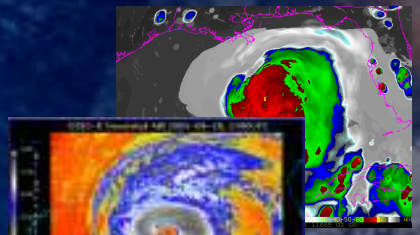


Case Studies

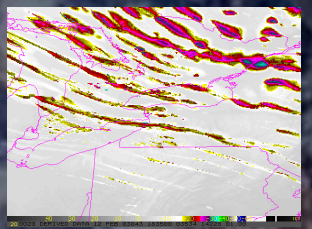
3.9um (for fires)



10.35um (Hurricane Lili)



10.35um (Lake Effect Snow)



11.2 um (HurricaneKatrina)

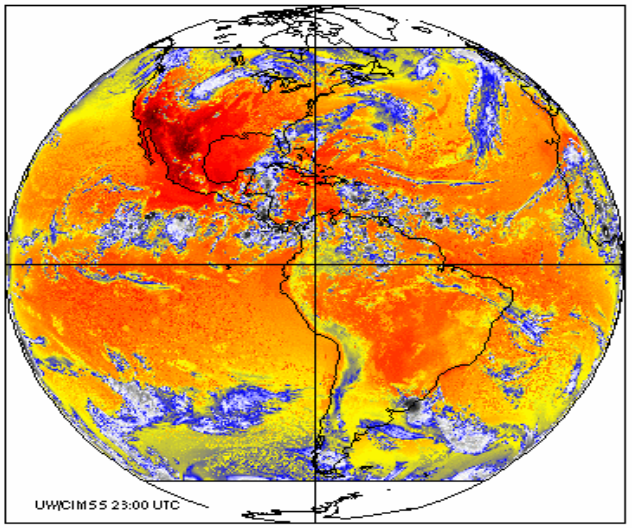
AWG Proxy and Product Application Teams have assembled a wide variety of instrument proxy and simulated datasets to use for algorithm development, testing, and validation activities

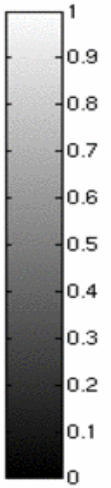
GOES-R ABI Proxy Datasets

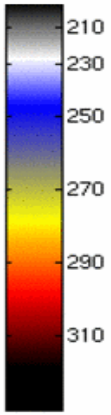
From the AWG Proxy Team at CIMSS…

15 minutes of ABI

ABI band 14 (11.2 μm) BT (K) 2005-06-04



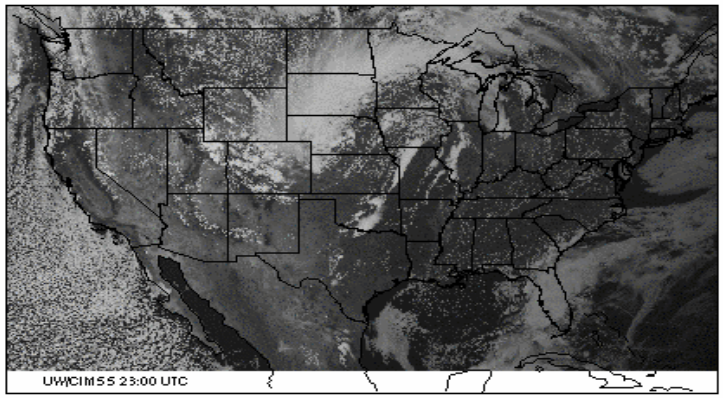




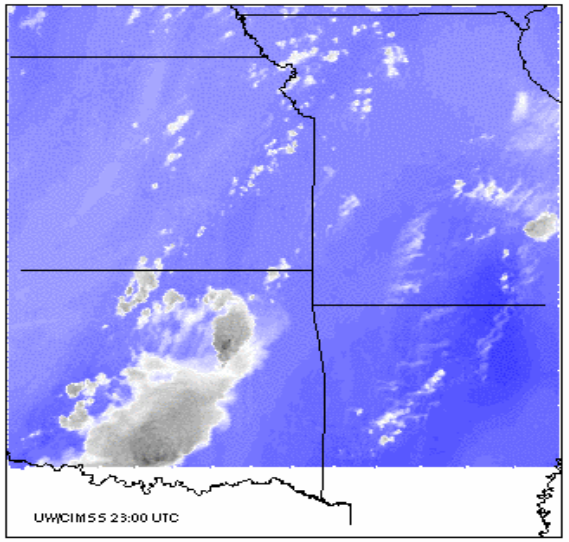
SSEC CIMSS

June 4, 2005 23:00 UTC

ABI band 2 (0.64 μm) reflectance 2005-06-04



ABI band 8 (6.19 μm) BT (K) 2005-06-04



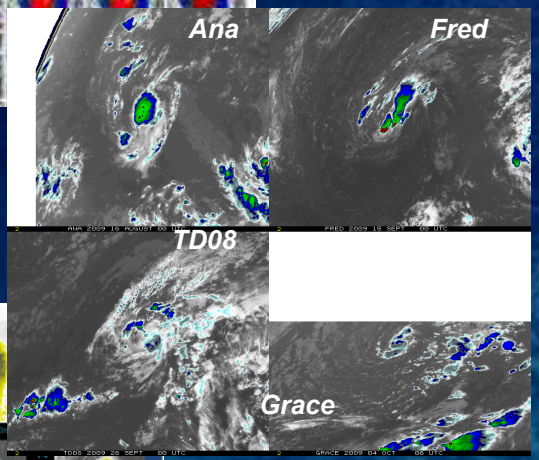
These high fidelity simulated datasets are important for algorithm development and validation activities

GOES-R ABI Proxy Datasets

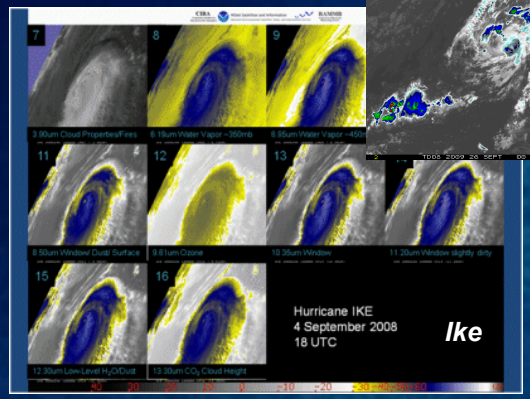
From the AWG Proxy Team at CIRA…

Tropical Storm Proxy Datasets

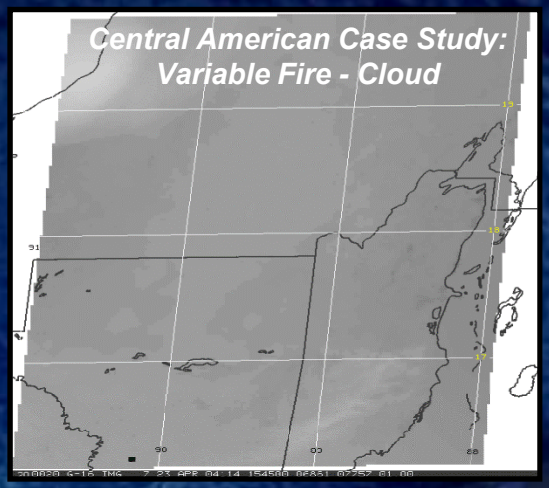
AVHRR, MODIS, GOES-12 data collection for 11 tropical storms over the period 2002-2006

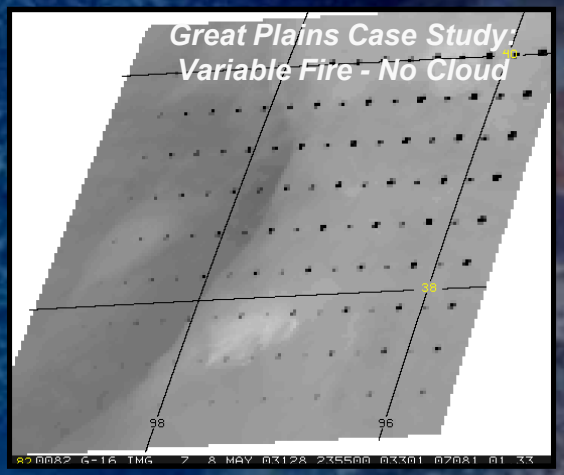


Synthetic ABI imagery for a number of tropical cyclone cases



Fire/Hot Spot Datasets





Simulated ABI 3.9 µm band with prescribed fires/hot spots inserted

Simulation Scenarios:

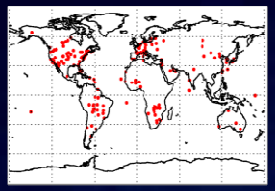
- **constant fire/no cloud**
- **constant fire/with cloud**
- **variable fire/no cloud**

These specialized ABI proxy datasets are important for algorithm development and validation activities

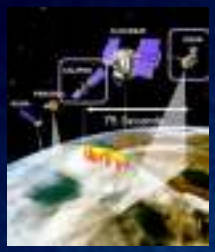
Algorithm Validation Strategy

A wide variety of reference ("Ground Truth") datasets have been assembled and are being used…

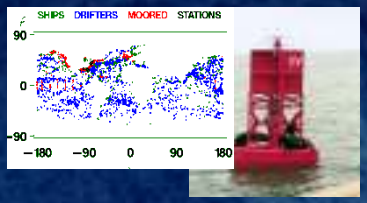
Aeronet Stations
Aerosol Optical Depth



CALIPSO, CLOUDSAT
Clouds, Icing



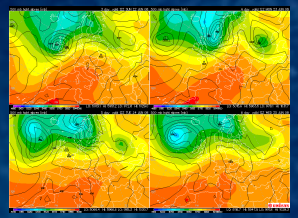
Bouys, Ships
SST



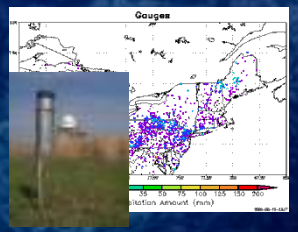
SURFRAD, ARM
LST, Radiation

Radiosondes
Winds, Temperature, Moisture, Stability

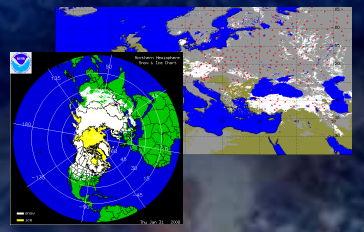
NWP Analyses
Winds, Temperature, Moisture



Rain Guages
Precipitation

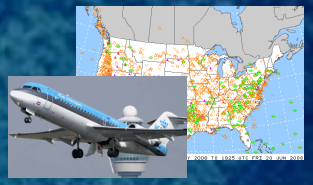


Sfc Snow Reports, NESDIS IMS
Snow

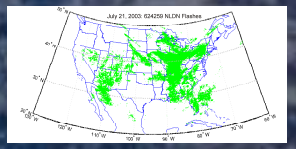


Ground-based Ozone
Ozone

Pilot Reports
Icing, Turbulence



National Lightning Detection Network (NLDN)
Lightning



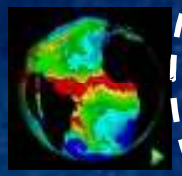
AWG Product Application Teams and the Proxy Data Team have assembled a wide variety of "Ground Truth" datasets to use for Level-2 product validation activities

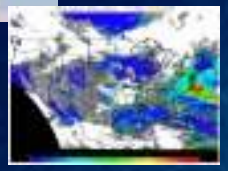
Algorithm Development and Validation Strategies

An iterative process…









Seasonal conditions represented

Wide variety of atmospheric and surface conditions are represented

Algorithm Iterations

Level 2 Product Generation

Validate with Ground Truth

MORE IS BETTER!

As algorithms mature…

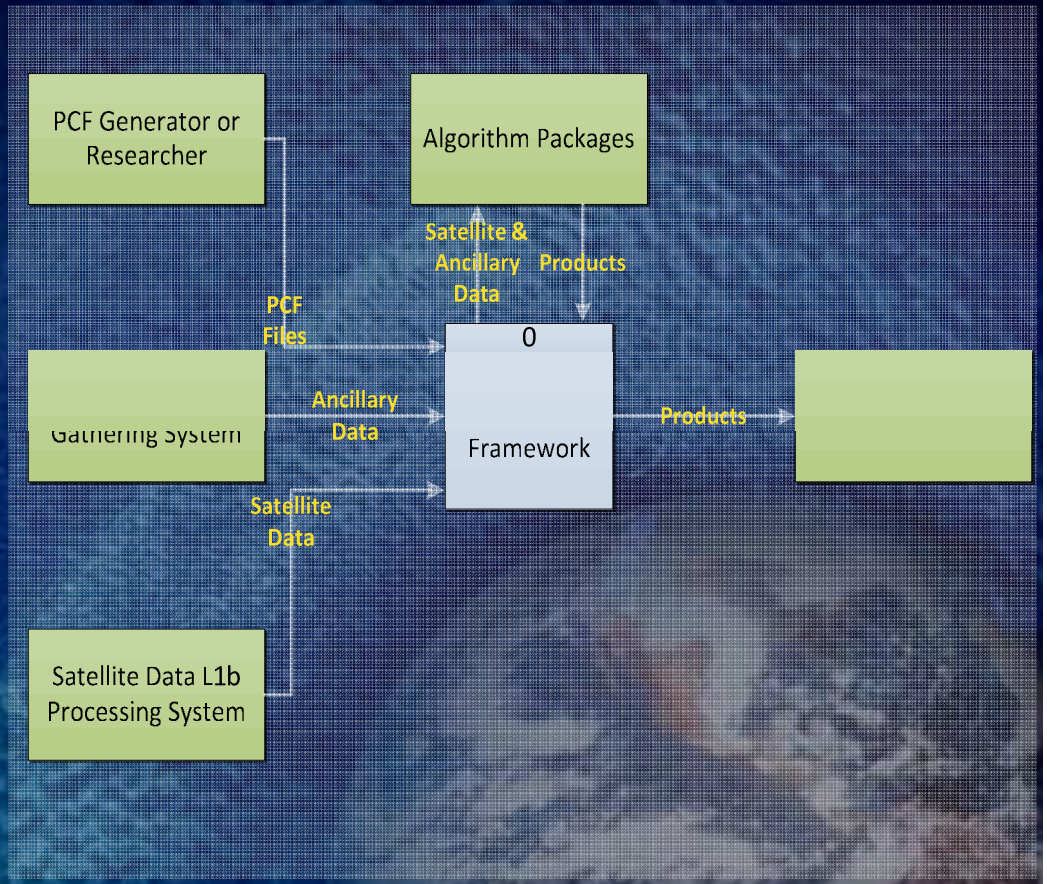
- ✓ Better estimates of product performance
- ✓ Increased confidence that on-orbit product performance will meet specs
- ✓ Increased confidence that user needs are met

AWG is responsible for Level-2 product accuracy and precision specifications, and has therefore, worked to establish robust pre-launch validation strategies for each product

AWG Algorithm Framework

Developed by the AWG Algorithm Integration Team…

- Test bed for AWG algorithm development and performance testing
  - Enables testing of code, algorithm integration, compilers, use of common ancillary data and forward models
  - Enables algorithm chaining (ie., product algorithm precedences)
- Used for verification of Level-2 algorithm performance (accuracy & precision specifications) and output
  - For long-term, common proxy datasets
    - SEVIRI and MODIS
    - 10 and 16 week proxy datasets covering all seasons
    - Special datasets

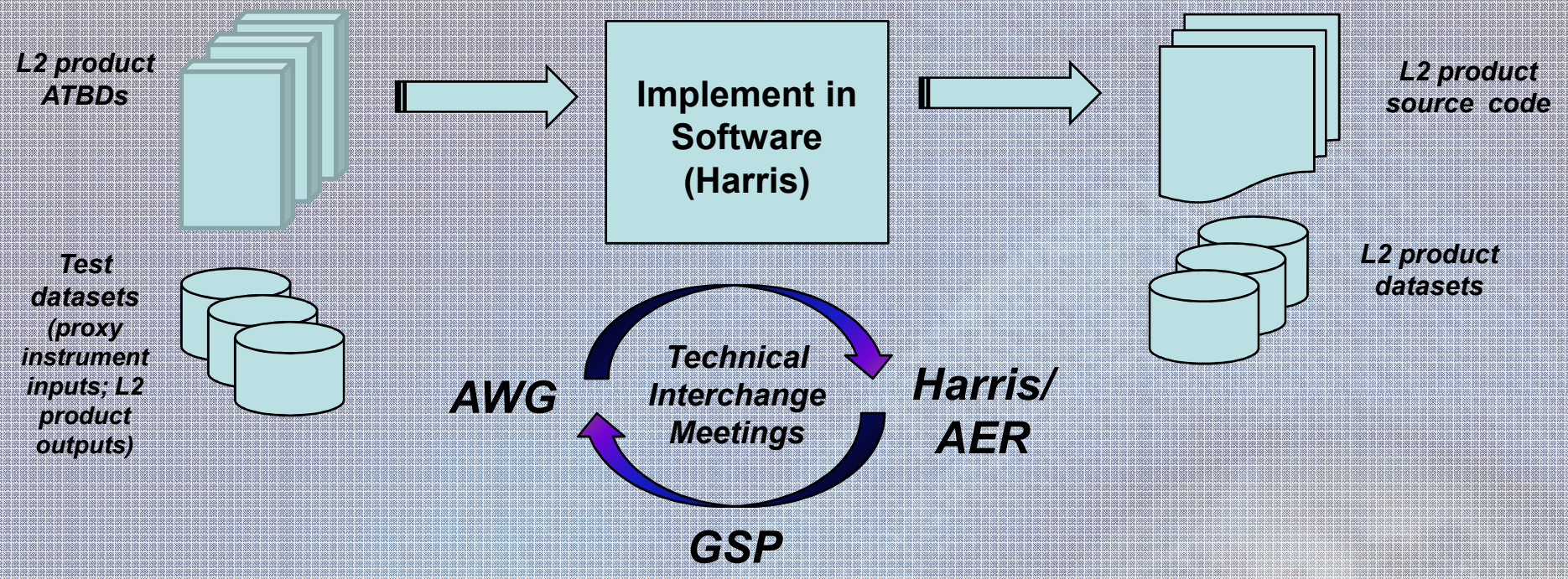


Status of AWG Deliverables to the GOES-R Ground Segment

- **Algorithm Packages (APs)**
  - Algorithm Theoretical Basis Documents (ATBD)
  - Instrument proxy datasets
  - Product output datasets (for reproducibilty)
  - Algorithm Interfaces and Ancillary Data Description (AIADD) document

- **Schedule of Deliveries to the GOES-R Program**
  - ✓ September 2008: As-Is ATBDs (Baseline & Option 2)
  - ✓ September 2009: 80% APs for Baseline Products
  - ✓ November 2010: 100% APs for Baseline Products
    80% APs for Option 2 Products
  - September 2011: 100% APs for Option 2 Products

From ATBDs to Level-2 Product Software



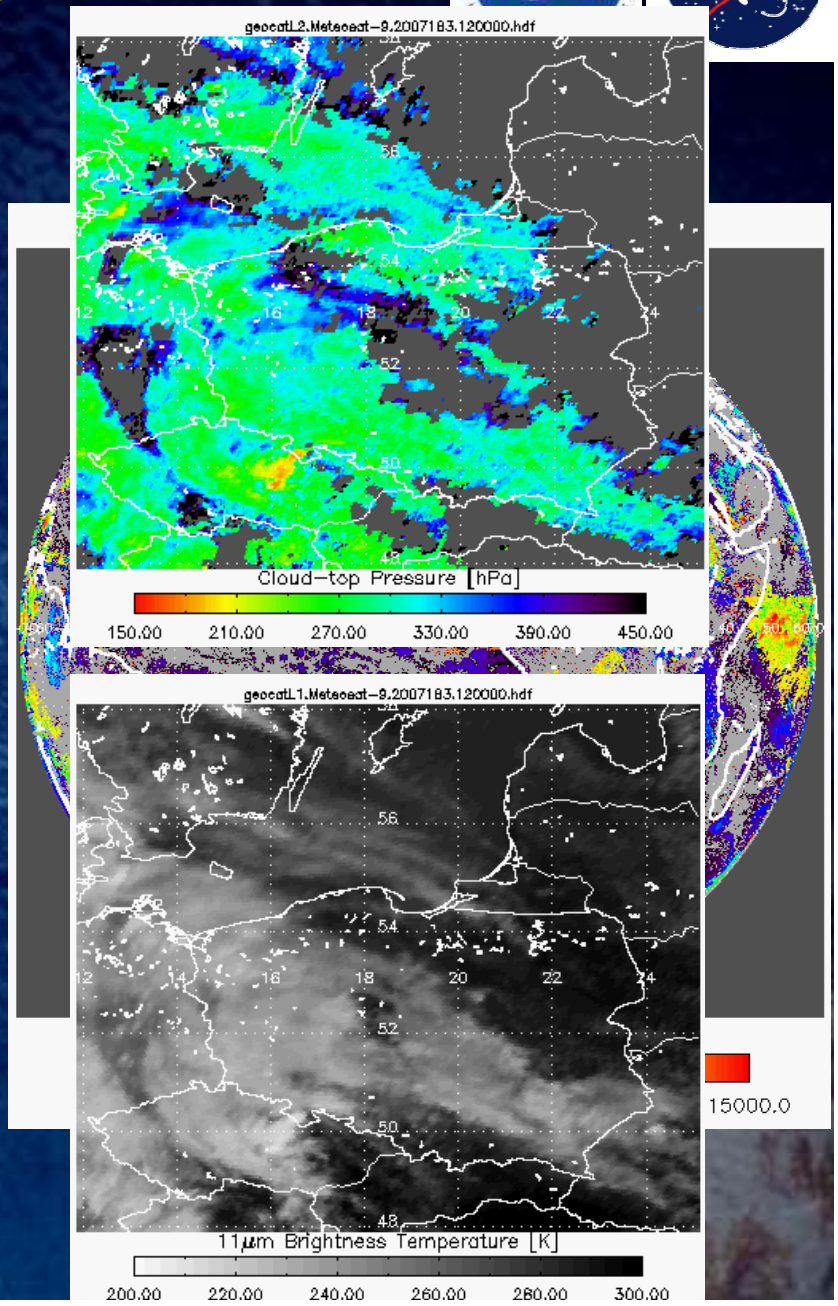
- **AWG is currently working closely with Harris/AER and the GOES-R Ground Segment Project (GSP) and Harris/AER in support of Harris' implementation of GOES-R Level-2 product algorithms**
  - Process is critical for proper implementation of the L2 product algorithms
  - Process is key for Harris to meet the reproducibility requirement (GSFPS-2758)

GOES-R Level-2 Product Examples

Cloud Height

- **Algorithm Highlights**
  - Algorithm uses the 11, 12 and 13.3μm channels to estimate cloud temperature, cloud emissivity and a cloud microphysics.
  - Algorithm uses an optimal estimation approach that provides error estimates.
  - Cloud pressure and height are computed from NWP profiles.
  - For multi-layer clouds, lower cloud height estimates obtained from surrounding pixels.
  - Cloud heights in the presence of low level inversions are handled using similar logic that is employed in the MODIS algorithms.

- **Operational Applications**
  - Aviation Terminal Aerodrome Forecasts (TAFs)
  - Supplements Automated Surface Observing System (ASOS) with upper-level cloud information
  - Cloud initialization
  - Assimilation into NWP models



Temperature & Moisture Soundings, Precipitable Water, Atmospheric Stability Products

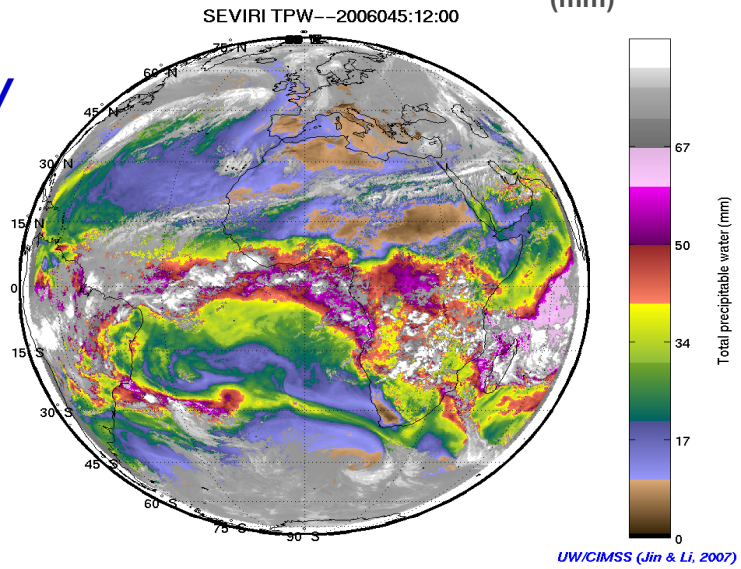
- **Algorithm Highlights**
  - 1D-variational physical retrieval algorithm that has heritage with MODIS and current operational GOES sounder physical retrieval algorithms
  - Regression-based initial guess T/Q profiles
  - Utilizes NWP forecast T/Q profiles
  - Utilizes the 6.15, 7.0, 7.4, 8.5, 9.7, 10.35, 11.2, 12.3, and 13.3 μm bands)
  - Exploits recent improvements in fast clear-sky radiative transfer models and ancillary data (surface emissivity)

- **Operational Applications**

  Nowcasting
  - Gulf of Mexico return flow
  - Southwest US monsoon
  - QPF (heavy rain, flash flooding)
  - Convective potential and morphology
  - Fog potential
  - Situational awareness in pre-convective environments for potential watch/warning scenarios

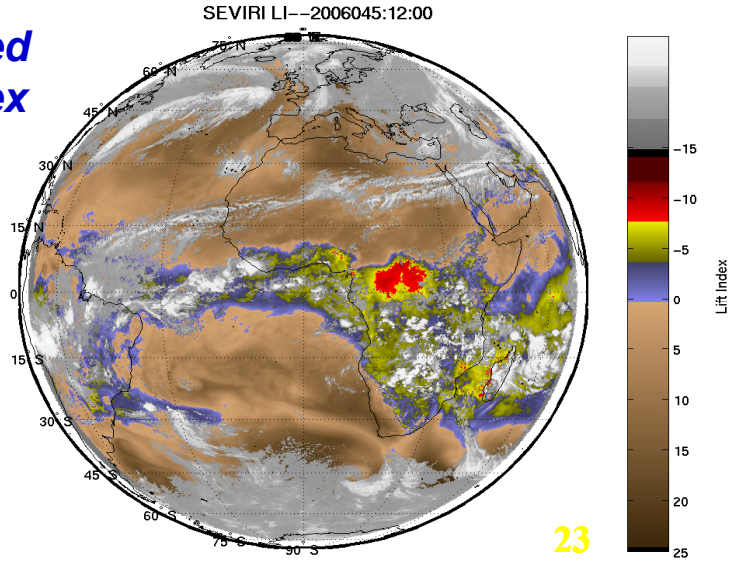
  NWP
  - Assimilation into regional and mesoscale NWP models (TPW)

TPW



UW/CIMSS (Jin & Li, 2007)

Lifted Index



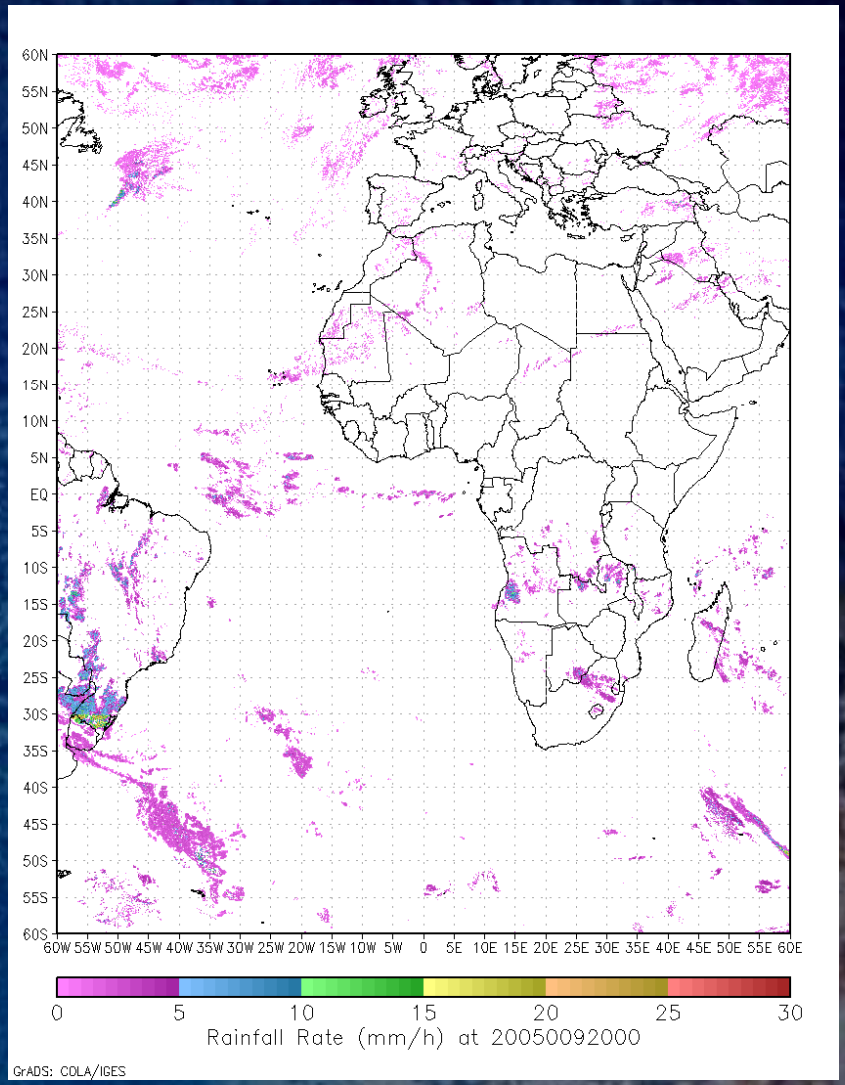
UW/CIMSS (Jin & Li, 2007)

Rainfall Rate/QPE

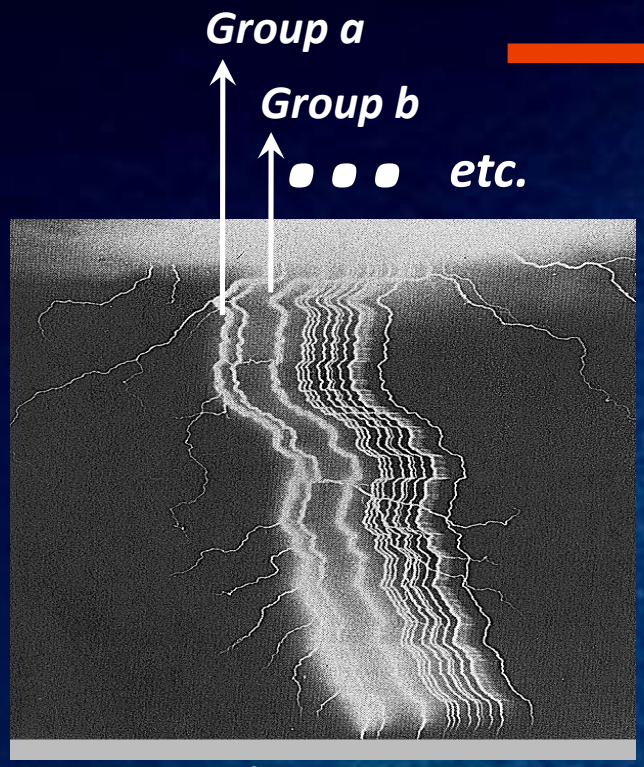
- **Algorithm Highlights**
  - Self-Calibrating Multivariate Precipitation (SCaMPR) retrieval algorithm
  - VIS/IR-based algorithm that is dynamically calibrated against satellite-based microwave (MW) derived rain rates (SSM/I, AMSU, AMSR-E and TRMM)
  - Calibration is continuously updated to reflect time changes in MW-IR relationship
  - Dynamic channel selection
  - Leverages ABI's higher spatial and temporal resolution data

- **Operational Applications**
  - Flash flood forecasting
  - Nowcasting
  - Assimilation into hydrologic models

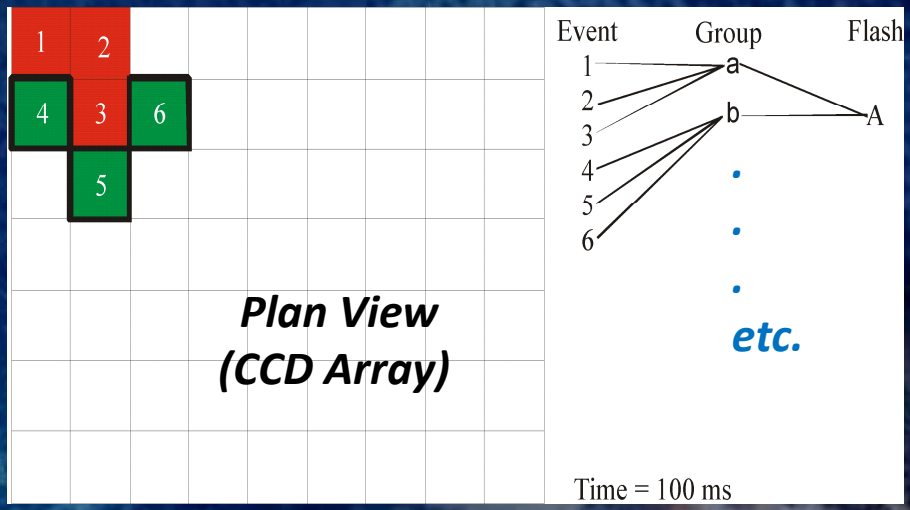
Rainfall rate derived from Meteosat-8 SEVIRI
2000 UTC on 09 January 2005



GLM Lightning Product



Groups Help Track Strokes & other components of the flash.

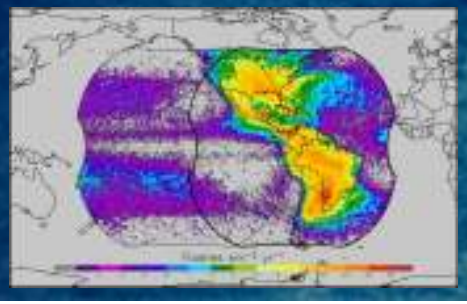


Event: *The occurrence of a single pixel exceeding the background threshold during a single frame*

Group: *Two or more adjacent <u>events</u> in the same time frame*

Flash: **A set of <u>groups</u> sequentially separated in time by no more than 330 ms and in space by no more than 16.5 km**

GLM FOV
(1372 x 1300)

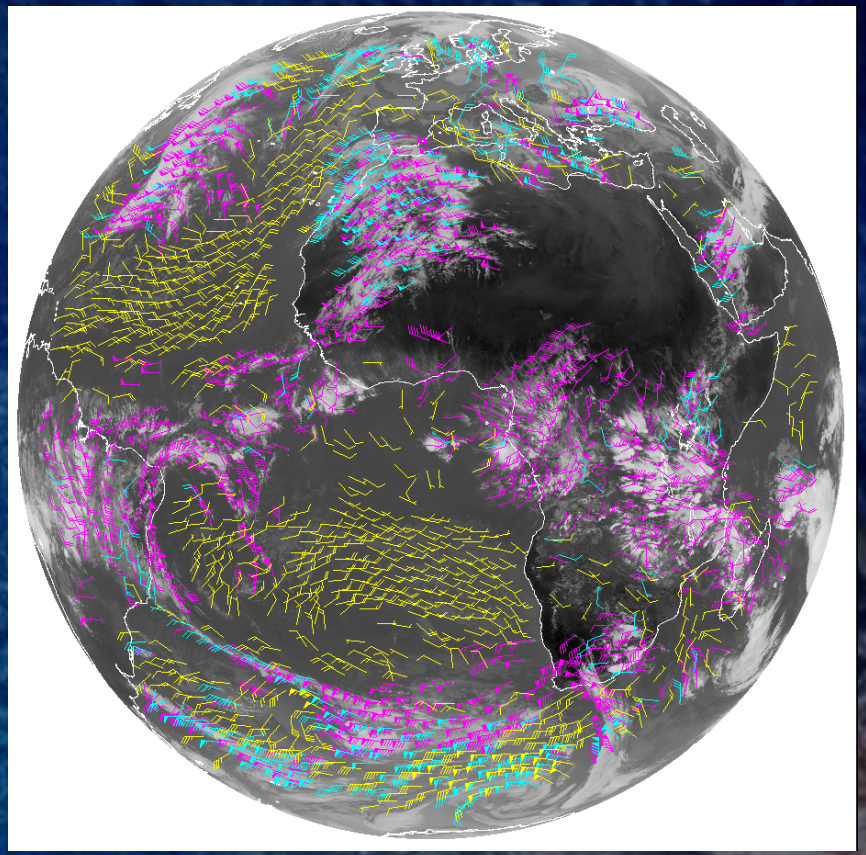


Derived Motion Winds

- **Algorithm Highlights**
  - Heritage in targeting, tracking, and QC algorithms lie with current NESDIS operational winds algorithms
  - New nested tracking algorithm introduced that makes use of a two-dimensional clustering algorithm to capture the dominant motion in each target scene
  - Utilizes clear sky mask product
  - Wind height assignment will rely on utilization of pixel level cloud heights generated upstream via algorithms delivered by AWG cloud application team
  - Leverages ABI's higher spatial and temporal resolution data

- **Operational Applications**
  - Weather Forecasting
  - Assimilation into mesoscale and global NWP models
  - Aviation (flight routing)

Cloud-drift Winds derived from a Full Disk Meteosat-8 SEVERI 10.8 μm image triplet centered at 1200 UTC 01 February 2007

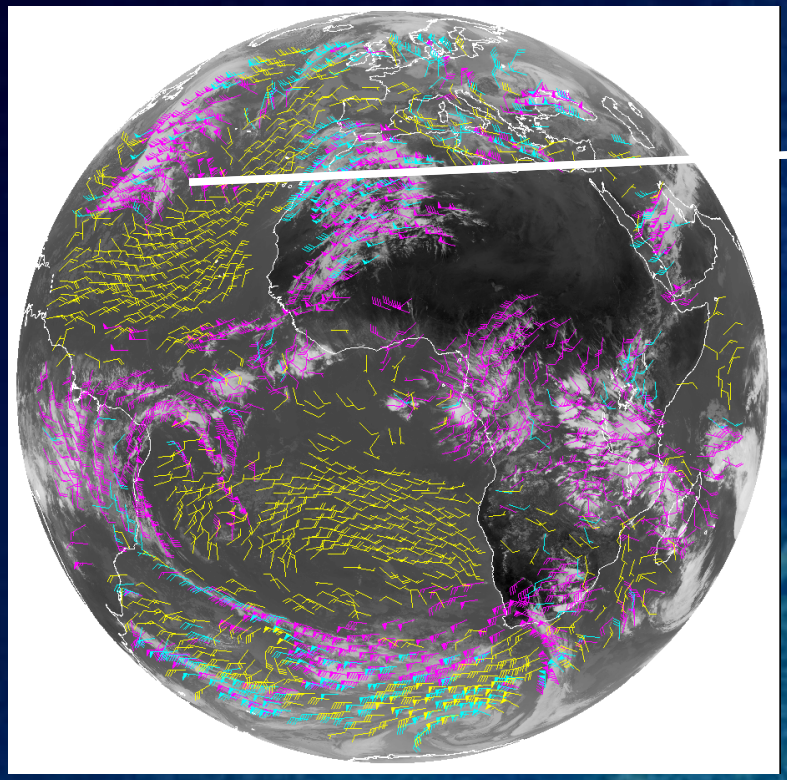


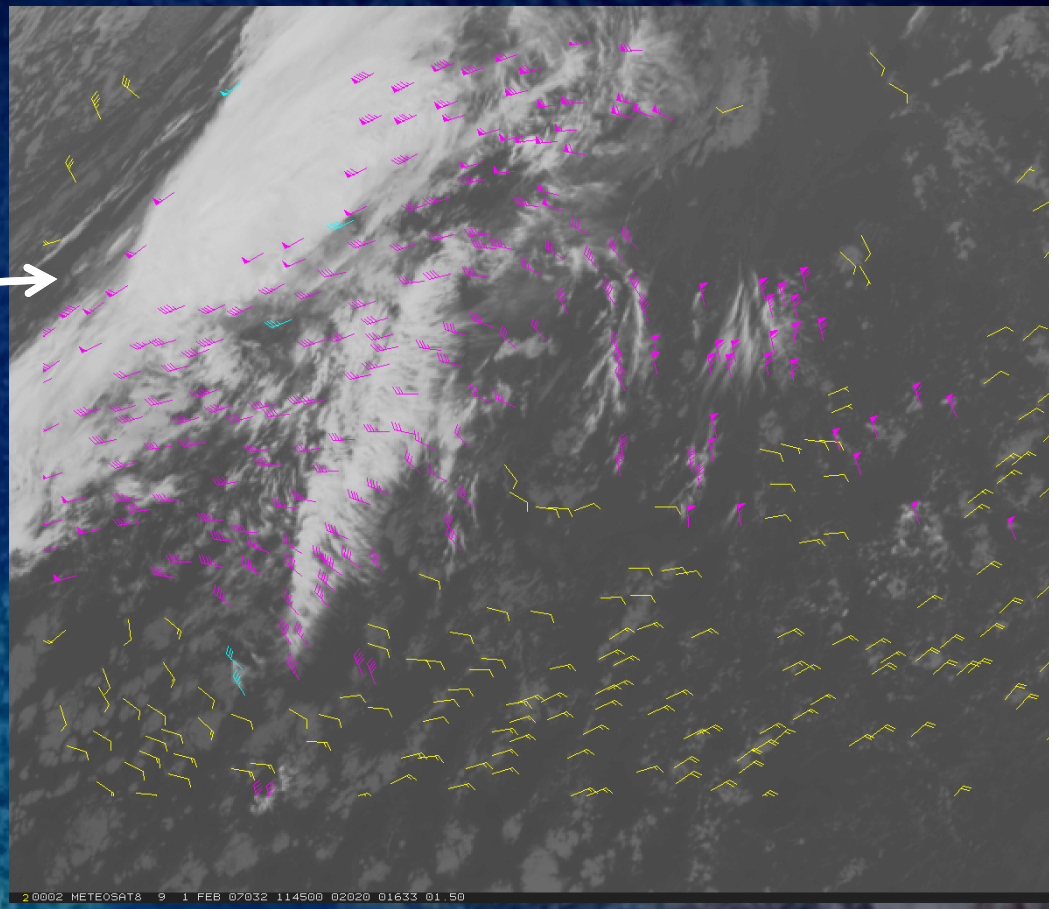
High Level 100-399 mb Mid-Level 400-699 mb Low-Level >700 mb

Derived Motion Winds

Long-wave IR Cloud-drift Winds

Cloud-drift Winds derived from a Full Disk Meteosat-8 SEVERI 10.8 μm image triplet centered at 1200 UTC 01 February 2007





High-Level 100-400 mb

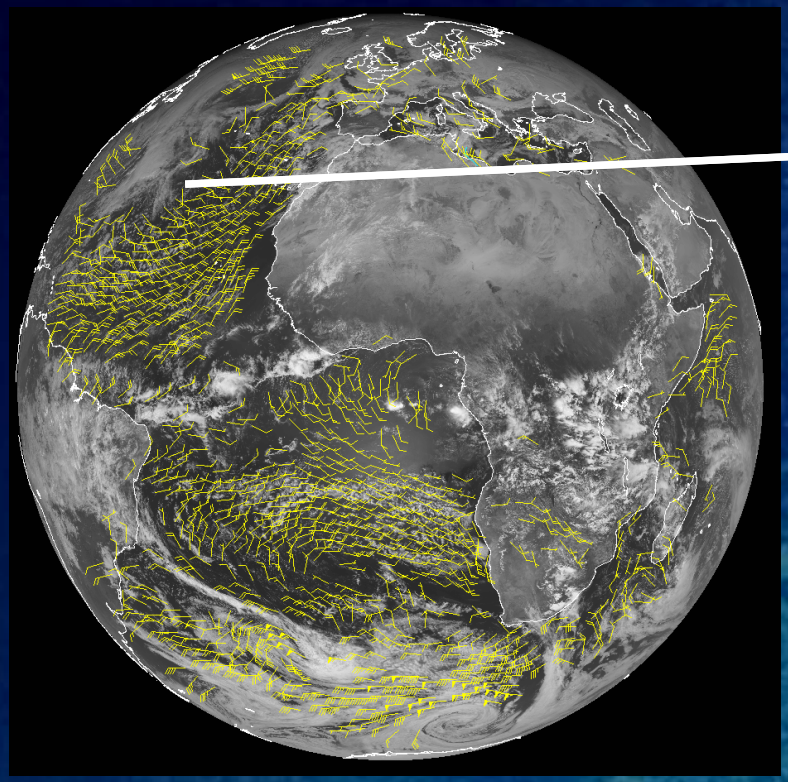
Mid-Level 400-700 mb

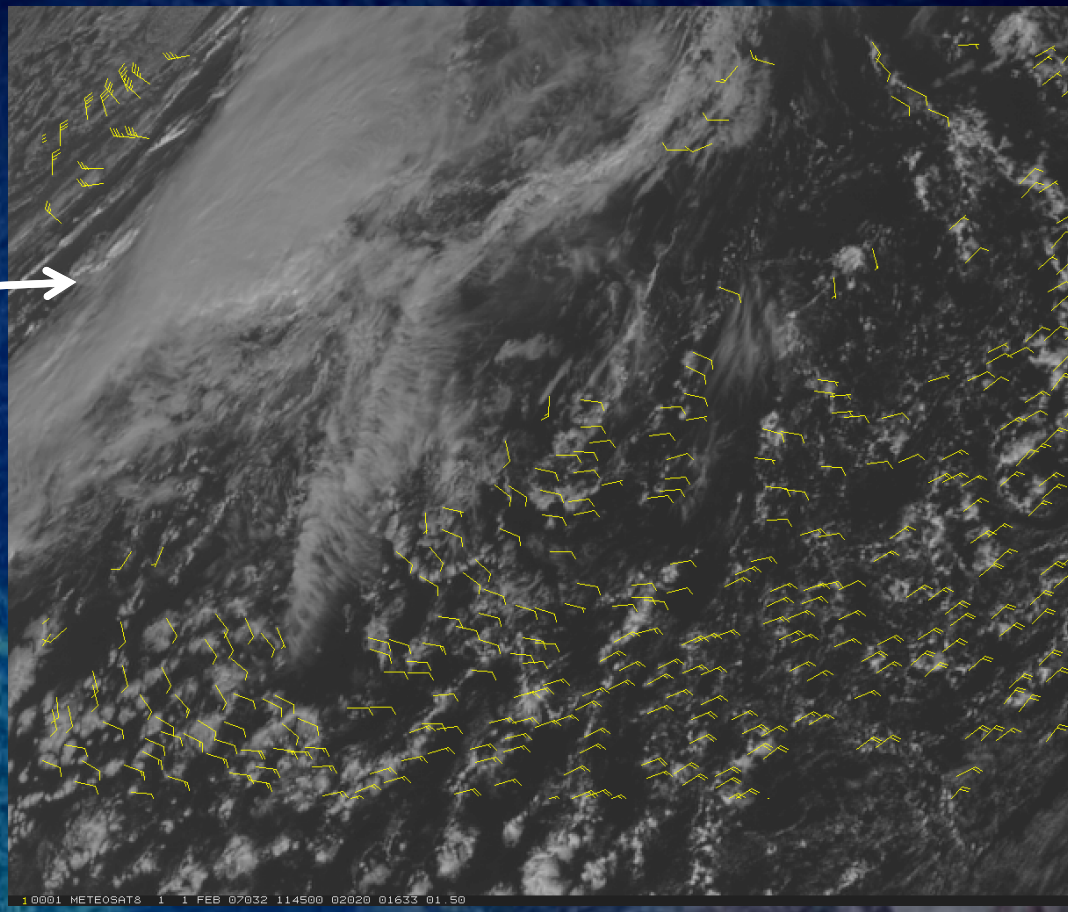
Low-Level >700 mb

Derived Motion Winds

Visible Cloud-drift Winds

Cloud-drift Winds derived from a Full Disk Meteosat-8 SEVERI 0.60 um image triplet centered at 1200 UTC 01 February 2007



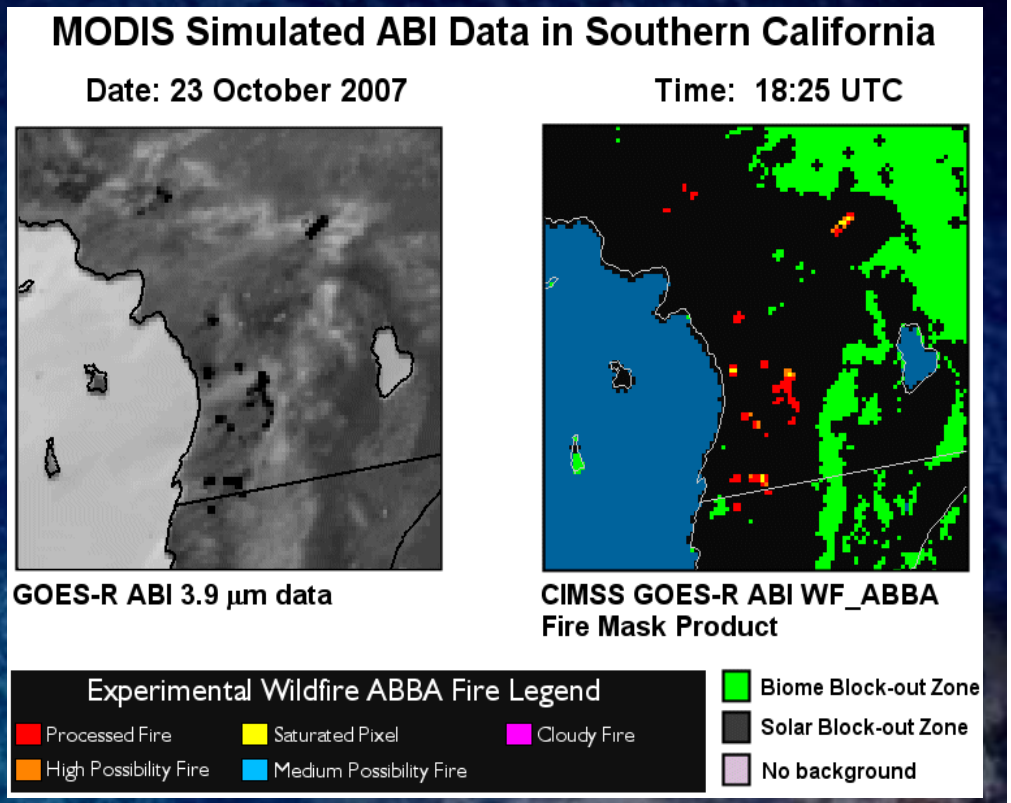


Low-Level >700 mb

Fire/Hot Spot Characterization

- **Algorithm Highlights**
  - Heritage lies with the GOES operational Wildfire Automated Biomass Burning Algorithm (WF_ABBA)
  - Dynamic, multi-spectral, thresholding contextual algorithm
  - Utilizes the 0.64, 3.9, 11.2 and 12.3 μm channels
  - Leverages ABI's higher spatial and temporal resolution data

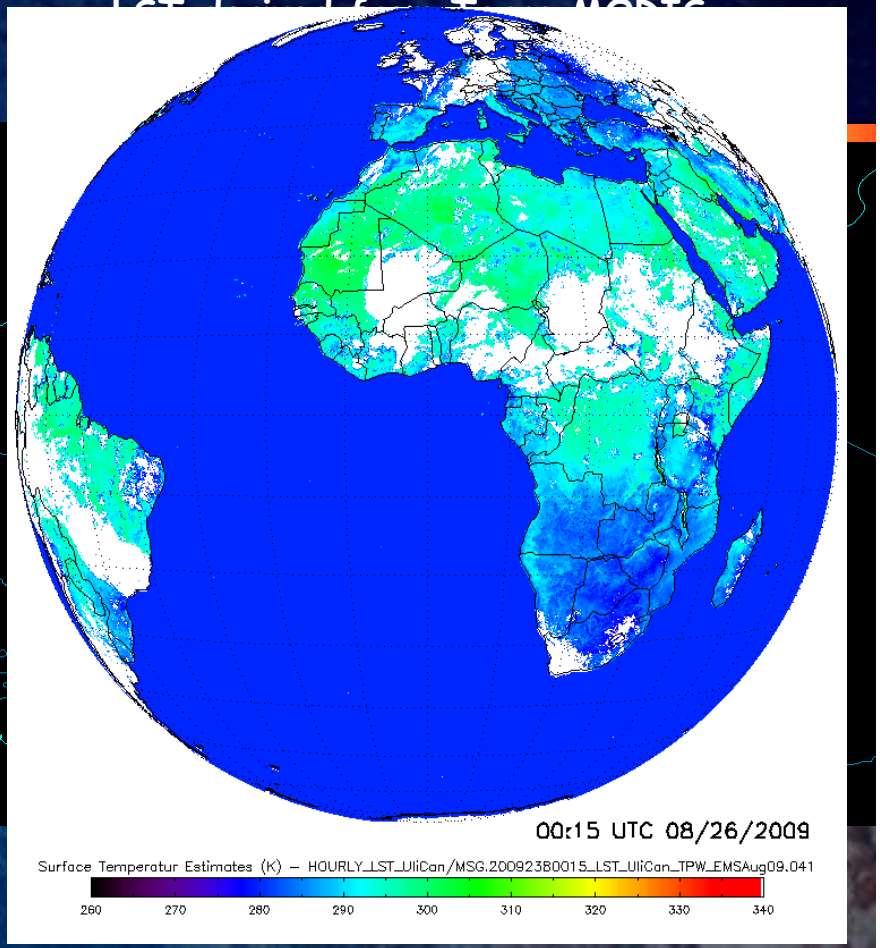
- **Operational Applications**
  - Fire weather forecasting
  - Air quality forecasting



Land Surface Temperature

- **Algorithm Highlights**
  - Utilizes ABI clear sky mask product
  - Regression-based algorithm that uses the 11.2 and 12.3 μm channels
  - Split-window algorithm has significant heritage (geo & leo)
  - Leverages ABI's higher spatial resolution data

- **Operational Applications**
  - Fog forecasting
  - Frost/freezing temperature forecasting
  - Assimilation into land surface models
  - Assimilation into mesoscale and climate NWP models
  - Climate prediction

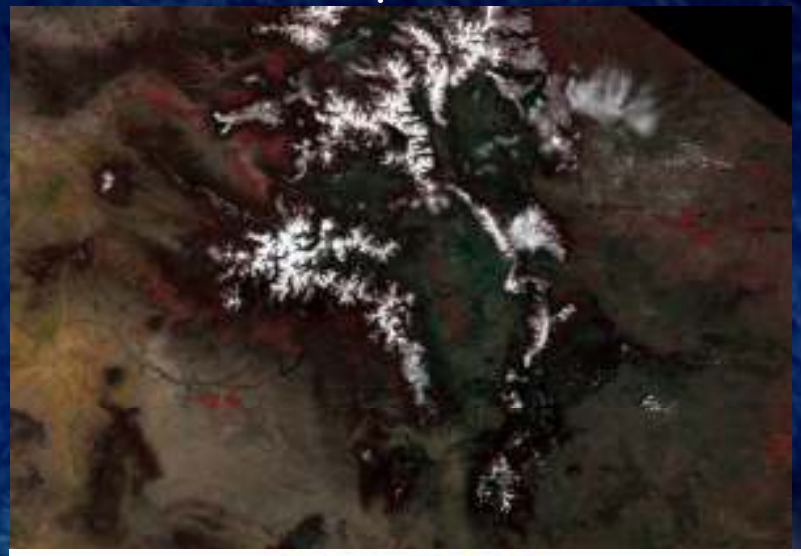


Snow Cover

- **Algorithm Highlights**
  - Retrieves sub-pixel fractional snow cover and grain size estimates via computationally efficient spectral mixture modeling
  - Heritage derived from
    - MEMSCAG (Multiple Endmember Snow Covered Area and Grain size) algorithm for imaging spectrometers (AVIRIS, Hyperion, HYDICE, ARTEMIS)
    - MODIS-based fractional snow cover and grain size (MODSCAG) algorithm
  - Leverages ABI's higher temporal resolution data and spectral coverage (VIS/near IR bands :0.47, 0.64, 0.86, 1.6, and 2.25 um)

- **Operational Applications**
  - Assimilation into NOAA/NOHRC snow model
  - Hydrologic forecasts and warnings, including river and flood forecasts
  - Stream-flow forecasting/modeling
  - Snowpack monitoring, analysis
  - Water management
  - Climate studies

MODIS Color Composite (Colorado Rockies)
30 April 2007

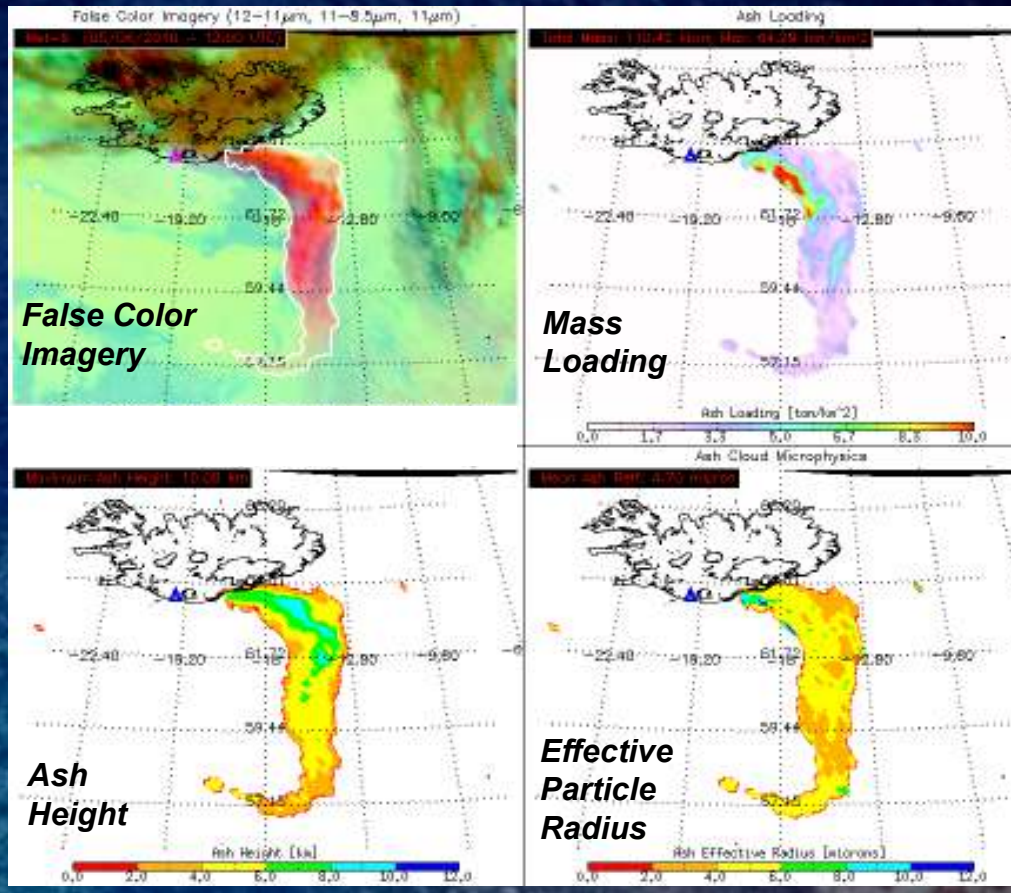


Retrieved Fractional Snow Cover

Volcanic Ash

Iceland's Eyjafjallajökull Volcano

- **Algorithm Highlights**
  - Detects volcanic ash and estimates its height and mass loading
  - Leverages the new ABI 8.5 μm band, The 8.5 μm, 11.2 μm, and 12.3,11.2 μm channel pairs are used to detect volcanic ash
  - An optimal estimation approach is used to estimate ash cloud temperature, emissivity and microphysical index.
  - Ash cloud height determined from NWP profiles.
  - Mass loading estimated from computed optical depth and effective particle size
  - Leverages ABI's new 8.5 μm channel, along with 11.2 μm and 12.3 μm for sensitivity to cloud microphysics (including composition)
- **Operational Applications**
  - Aviation safety
  - Health safety
  - Climate studies

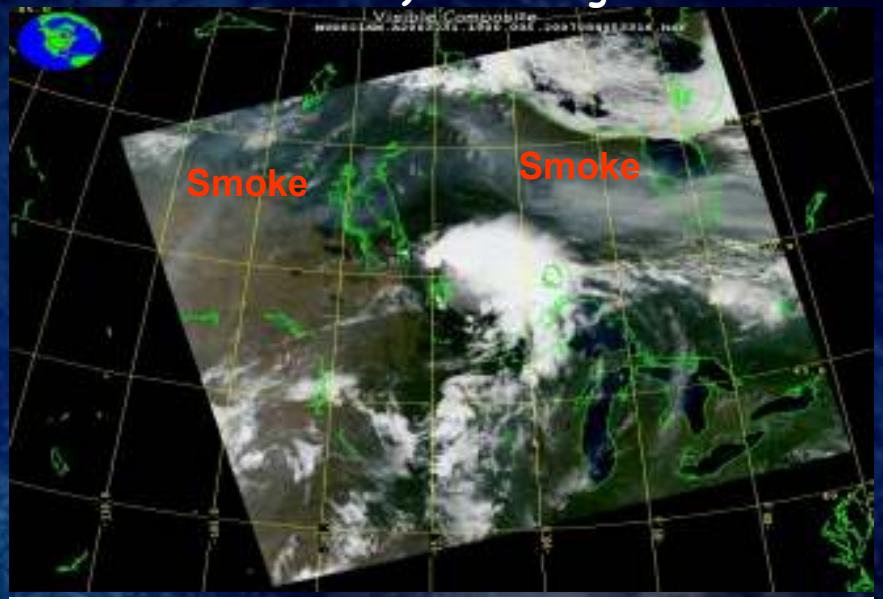


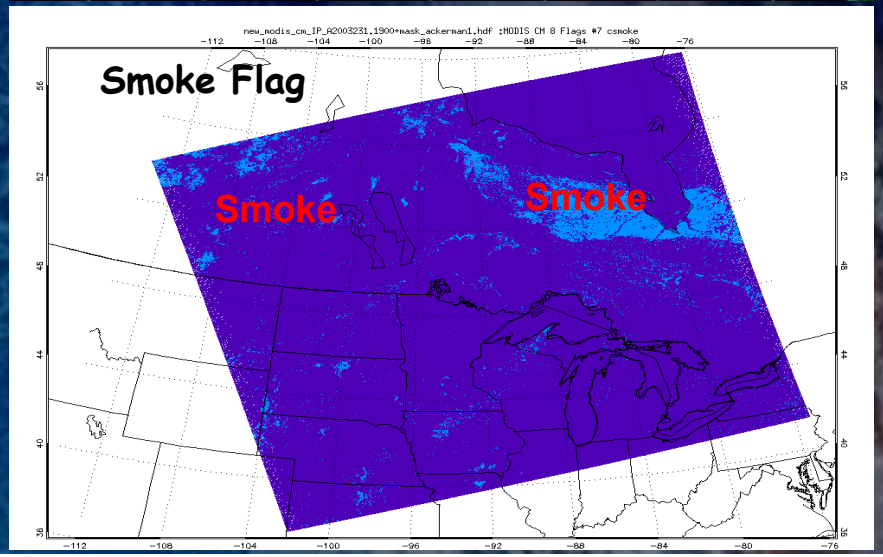
Aerosol Detection

(Smoke & Dust Detection)

- **Algorithm Highlights**
  - Spectral threshold algorithm that uses spectral (wavelength dependent) characteristics of surface, aerosols, and clouds to identify aerosols
  - Heritage derived from AVHRR and MODIS-based aerosol detection algorithms
  - Synergy with VIIRS aerosol retrieval algorithm
  - Leverages ABI's higher spectral (VIS/near IR portion) coverage data
- **Operational Applications**
  - Air quality forecasting
  - Air quality assessment and management
  - Climate studies

MODIS Color Composite (British Columbia, Canada Fire Event) 19 August 2003





Level-2 Product Calibration/Validation

- *Guiding Principles*
- *Importance of Validation*
- *Objectives*
- *Strategies*
- *Cal/Val Phases/Timelines*
- *AWG Role in Cal/Val*

Putting the pieces together for a successful GOES-R Cal/Val Program…

Calibration/Validation

Guiding Principles…

1) Sensor Performance and Characterization are the cornerstone of all data products.
2) Experience and resources from Past and Current Operational and Science Missions should be fully exploited and incorporated in the GOES-R Cal/Val Program.
3) Customer and User Satisfaction is achieved through participation in the Cal/Val process.
4) User community Proficiency with Operational Algorithms and products are essential to efficient Cal/Val, user community buy-in, and user readiness.
5) Space-borne assets, Global models, Surface Networks and Data Assimilation provide a cost effective comprehensive first view of sensor and algorithms performances.
6) Targeted Campaigns and Special Studies should be planned and executed as needed.
7) Plan for Level-2 Product algorithm tuning and corrective actions during the post-launch period.

(From Heather Kilcoyne, SPIE 2009 presentation on NPP Cal/Val)

What is Validation?

Validation:

The process of determining that the deliverable item satisfies its intended use in its intended environment.

- *GOES-R Program Acronym and Glossary*

The process of assessing, by independent means, the quality of the data products derived from the system outputs. [For example, assessing a derived L2 product against similar Reference/"Ground Truth" observations obtained from some other observing system (ground-based, satellite, NWP.]

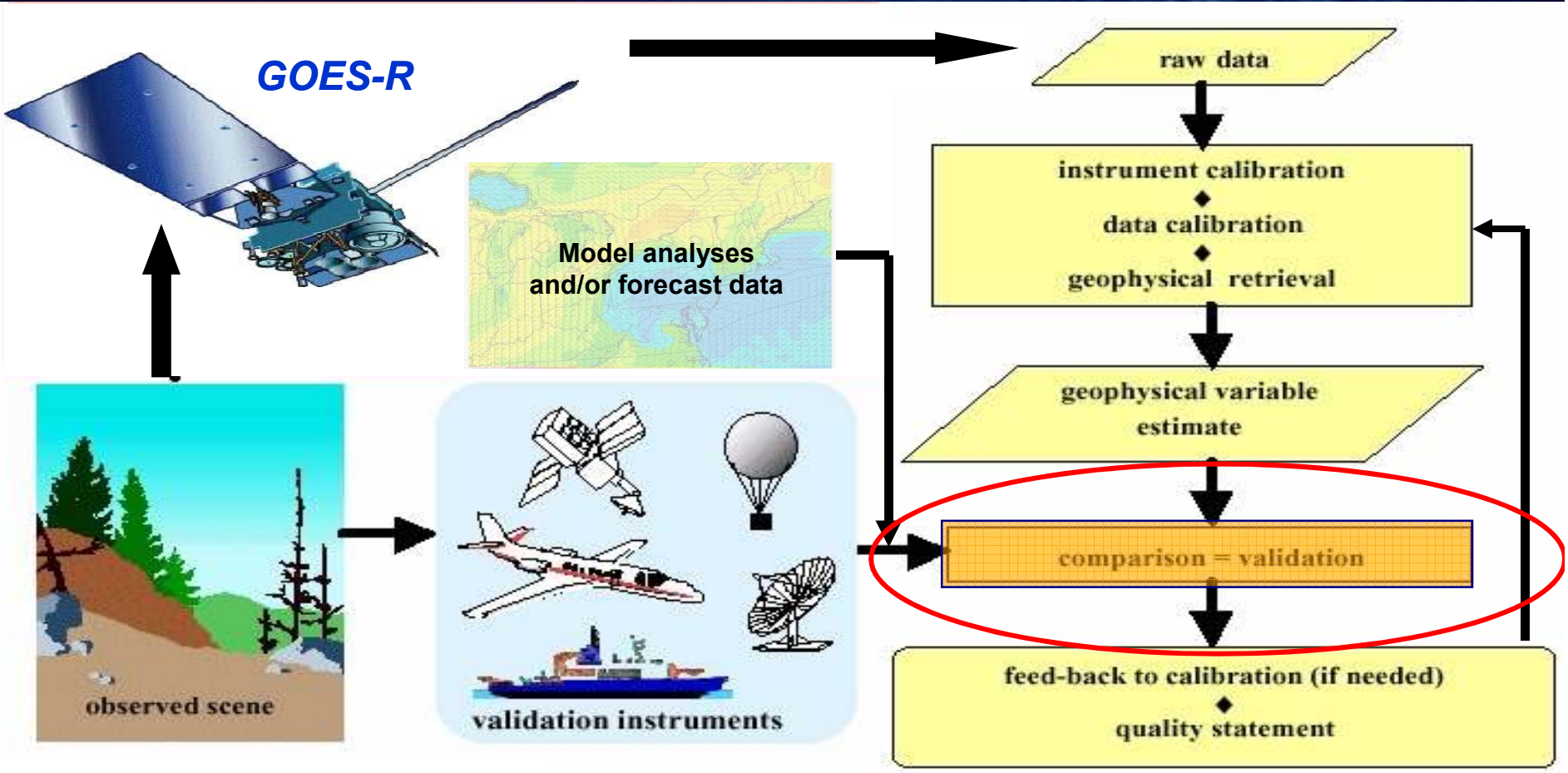
- Committee on Earth Observation Satellites

Sections 3.3.3.1- 8; 3.3.4.1-7; 3.3.5.1-3 of the GOES-R Mission Requirements Document (MRD) provide requirements for L2 product geographic coverage, vertical resolution, measurement range, accuracy, precision, refresh rate, latency, and qualifiers.

Section 4.1 of the MRD provides requirements for the validation of all GOES-R derived products pre-launch, post-launch, and throughout the mission.

What is Validation?

Validation is the process of assessing by independent means the quality of the data products derived from the system outputs



Product Calibration/Validation
Objectives…

- ***Characterize performance of*** GOES-R Level-2 products and ***demonstrate*** that they meet their respective specification requirements as described in the GOES-R Requirement Documents
  - Level-1 Requirements Document (L1RD)
  - Mission Requirements Document (MRD)
  - Functional & Performance Specification (F&PS) document

- Provide the GOES-R user community with operationally viable, validated, and useful data products for their applications and missions

- Provide investigations into any product issues that impact a customer's ability to fulfill their missions and provide effective solutions

Product Calibration/Validation

Strategies…

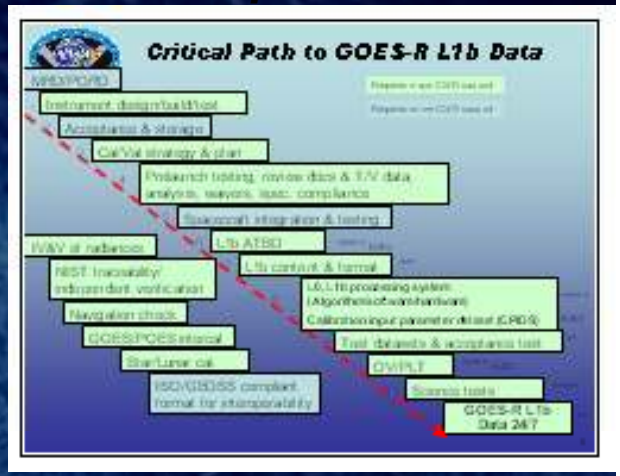
- Build the necessary infrastructure and leverage existing infrastructures
  - Hardware/Network
    - Compute & data storage facilities
  - Data
    - Instrument datasets **(proxy data followed by real data)**
    - "Ground truth"/Reference datasets
  - Level-2 product algorithms
  - Level-2 product processing capability
  - Cal/Val tools for Collocation, Data Analysis, and Visualization
- Build the necessary collaborations
  - Research community
  - User community
  - Operational data providers

Strategies that enable the execution of all GOES-R Level-2 product validation activities from pre-launch through the post-launch phases of the GOES-R Program

The Four Phases of Cal/Val

- Pre-Launch
- Early check-out and Post-Launch Tests (PLT)
- On-orbit verification (OV) & Intensive Cal/Val (ICV)
- Long-Term Monitoring (LTM)

Critical path identified



Important to view Cal/Val in the context of an end-to-end system and through the entire life cycle of the system

Calibration/Validation Activities

With a focus on L2 Product Validation…

Launch

Pre-Launch		Post-Launch	
Pre-launch Cal/Val	*Early Orbit Check-out*	*Intensive Cal/Val*	*Long Term Monitoring & Operations*
Sensor characterization - Radiometric calibration - Geolocation/navigation	**Post-Launch Tests (PLT) and engineering tests (compliance)**	**Established sensor stability**	**QC/QA processes in place**
Proxy data generation	**Calibration Processing;** **Analysis of L1b products**	**Sensor characterization** - Radiometric calibration - Geolocation/navigation	**Continuous assessment & monitoring, trend analysis of product quality**
Algorithm assessment and verification	**Quick look analysis of L2 products; comparisons to NWP model/analyses**	**Finalize L2 algorithm tuning and testing; Establish L2 product stability**	**Algorithm improvements**
Determination of validation strategies, including identification and acquisition of "ground-truth"/reference datasets	**Work to establish sensor stability;** **Work to establish L1b and L2 product stability;** **L1b and L2 algorithm testing and tuning**	**L1b/L2 product validation processes in place;** **L1b and L2 product validations**	**Full and continuous data release to the user community**
Cal/Val tool development	**Establish routine validation processes**	**Increasing data release to the user community**	**Cal/Val tool improvements**
Development of L1b & L2 Cal/Val Plans	**Data released to users, but data is understood to be non-operational**	**Cal/Val tool improvements**	**Data Archival**
	Data Archival	**Data Archival**	

Today's Timeline (Current GOES): ~6 months

GOES-R Timeline: Not unrealistic to assume that more than 6 months will be needed

STAR/AWG Calibration/Validation Scope
(Pre-Launch)

- STAR/AWG is participating on the GOES-R Cal/Val Team
  - Focus is on performance of GOES-R instruments
  - Ensure GOES-R L1b integrity
  - Provide technical support to the GOES-R Flight and Ground Projects
- Validation and Quantification of product performance
  - Specifically addressing the L2 product specifications (ie., *accuracy, precision*) since these have been allocated to the AWG
  - *Using proxy data* and comparing resultant products to other correlative data sources (in situ, NWP, satellite-based product, etc…)
- Development of product cal/val tools needed for
  - Routine product monitoring
  - "Deep-dive" assessments and analysis of products
- Continued Level-2 product demonstrations and validation studies
  - Establish routine generation of L2 products from ABI proxy data
  - Continue product validation
  - Outlier studies (identify stressing cases, algorithm improvements)

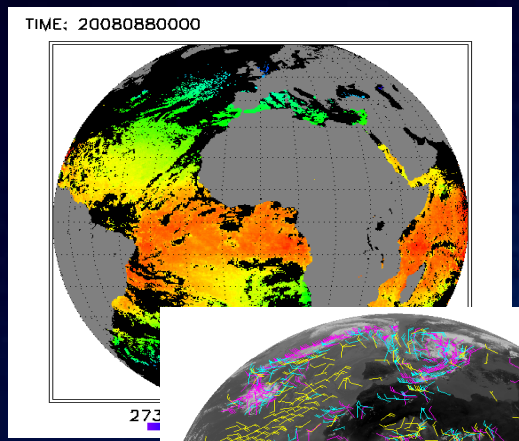
Routine Cal/Val Tools

- Targeted for the routine and automated monitoring of operational Level-2 products
- Enable the visualization of products and/or reference (‘truth”) data
- Perform the routine daily collocation of Level-2 products with their associated reference (“truth”) observations and the creation of comprehensive collocation databases
- Enable the generation and visualization of comparison statistics
- Rely on/built upon a variety of existing libraries that that enable data analysis and visualization capabilities
  - Man-computer Interactive Data Access System (McIDAS)
  - Interactive Data Language (IDL)
  - Java
  - Other

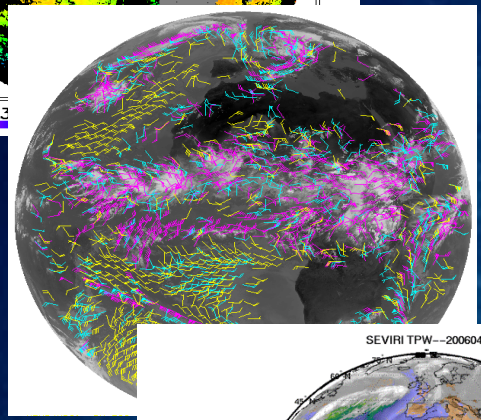
Routine Cal/Val Tools

Some Example Output…

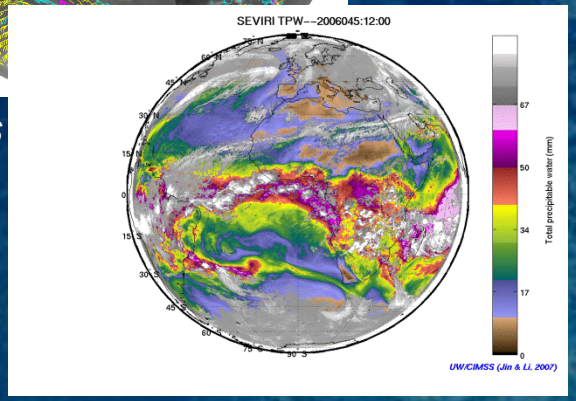
Product Displays



SST



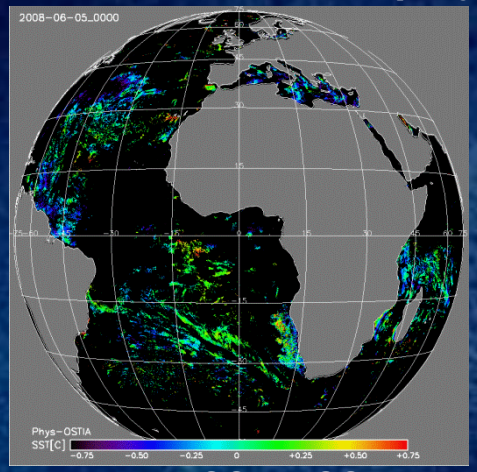
Winds



TPW

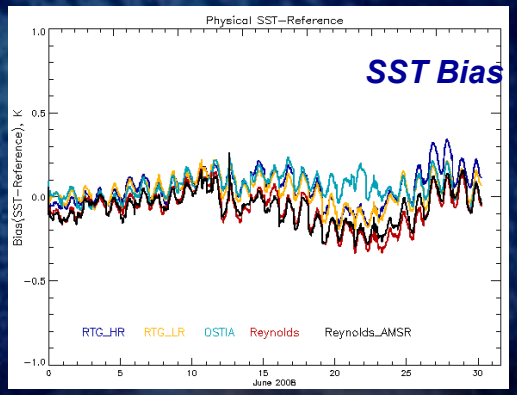
Retrieved Product – Reference/"Truth" Data

Horizontal Displays

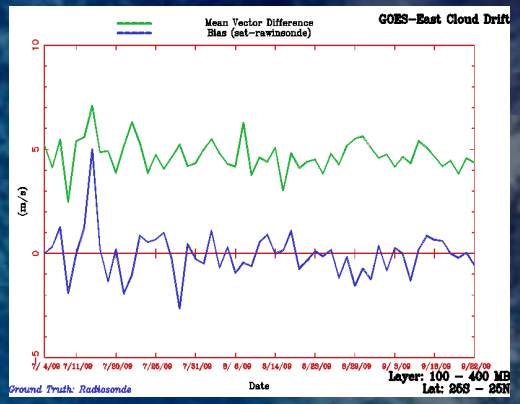


Retrieved SST – SST Analysis (UK Met Office)

Time Series of Comparison Statistics



Retrieved SST – 5 different reference SST datasets

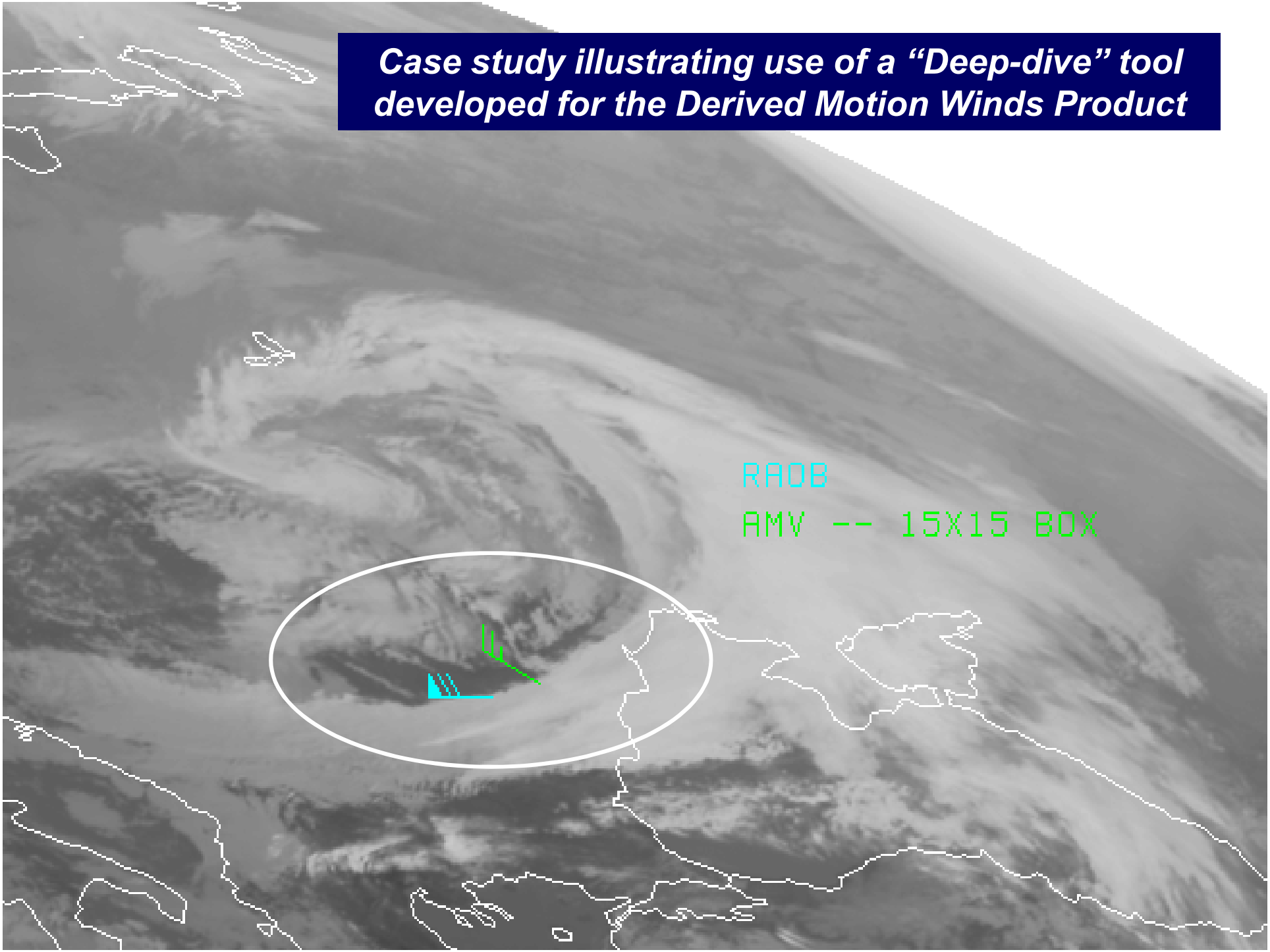


Time series of mean vector difference and speed bias metrics between high level (100-400 hPa) GOES-12 infrared cloud-drift IR winds and radisosondes

"Deep-Dive" Cal/Val Tools

- Set of customized tools targeted for "deep-dive" assessment of Level-2 products in the research and development environment
- Provide algorithm developers with the means to assess the performance of an algorithm, including any and all ancillary and intermediate data needed by the algorithm to generate the product
- Product reprocessing capability
  - In whole or individual retrievals
- Enhanced visualization capabilities that enable more detailed scientific analyses
- Rely on/built upon a variety of existing libraries that enable data analysis and visualization
  - Man-computer Interactive Data Access System (McIDAS)
  - Interactive Data Language (IDL)
  - MATLAB
  - Java
  - Other

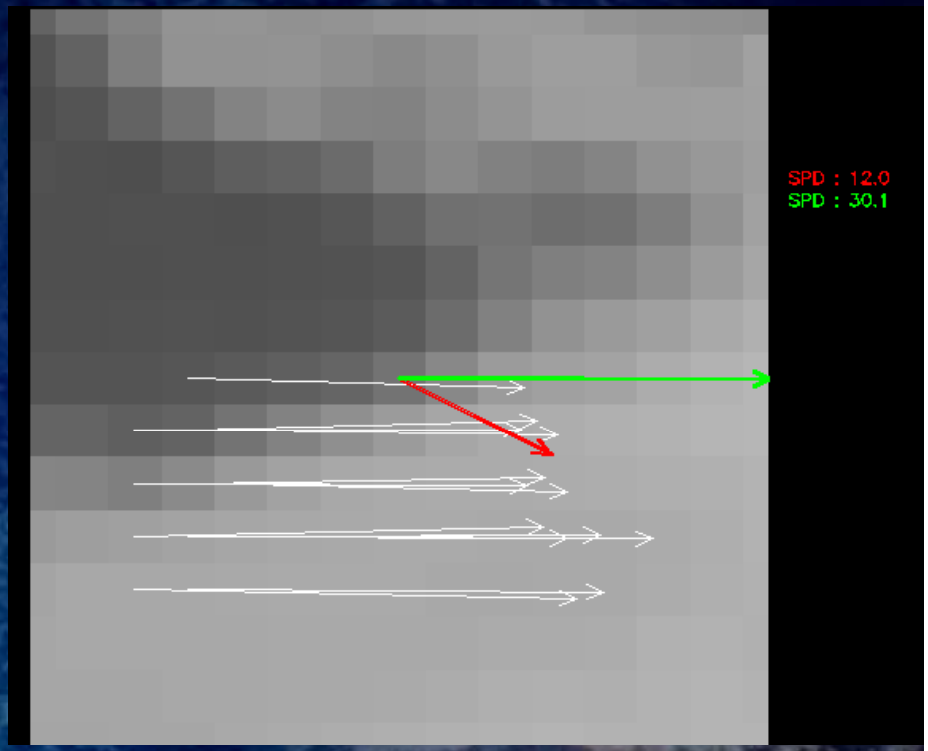
Case study illustrating use of a "Deep-dive" tool developed for the Derived Motion Winds Product



Example of a "Deep-Dive" Tool for the Derived Motion Winds Product

- Stand-alone tool that enables
  - The generation of a single derived motion wind vector for a single target scene
  - The display of the retrieved, guess, or ground truth wind vector over the target scene in question

- Here we were testing the nested tracking algorithm for case shown in previous slide and comparing the wind vector derived from it to the wind derived from the control algorithm



Retrieved wind from control algorithm (Speed: 12m/s)

Retrieved wind from the nested tracking algorithm where wind is derived from the sample of local wind vectors (in white) (Speed: 30.1m/s)

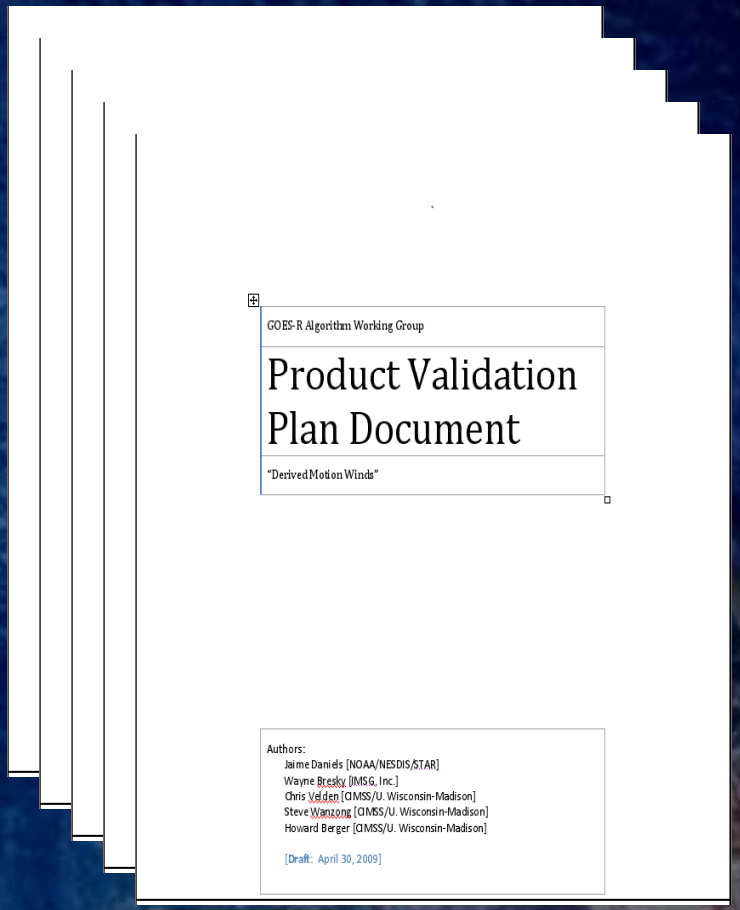
GOES-R L2 Product Cal/Val Plan

In Progress…

- AWG Product teams have prepared validation plans for *each* GOES-R Baseline Level-2 product they are responsible for

- Individual plans describe how each product will be validated during the pre-launch and post-launch phases of the GOES-R program
  - *Discuss validation strategies*
  - *Identify pre-launch and post-launch validation activities*
  - *Identify proxy data*
  - *Identify correlative data sources*
  - *Discuss validation tools to be developed*

- These individual Level-2 product validation plans are being folded into a Master GOES-R Product Cal/Val Plan
  - *Identify roles & responsibilities*
  - *Coordinated field campaigns*
  - *Schedule of activities*
  - *Community review and acceptance*



Summary and Planned Activities

- **AWG algorithm development activities are progressing well**
  - Baseline (100%) and Option-2 (80%) Level-2 product algorithm packages have been delivered to the GOES-R Program
  - Teams are working to refine the Option-2 Level-2 product algorithms and deliver 100% mature algorithms to the GOES-R Program (Sept 30, 2011)
  - Extensive collection of proxy and validation datasets established
  - Algorithm processing framework is in place

- **AWG is actively supporting the baseline Level-2 product algorithm implementation activity being done by the Harris Team**

- **AWG Next Steps**
  - Product application teams have identified and began development of Cal/Val tools (routine & deep-dive)
  - Increased validation efforts
  - Outlier studies and analysis
  - Support GOES-R Proving Ground Demonstrations (User Readiness and Training)