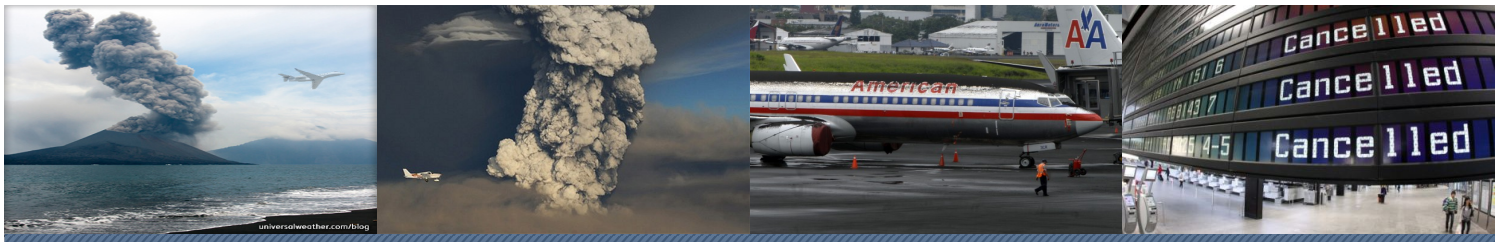


2017 VASAG Update: Volcanic Cloud Remote Sensing

Michael J. Pavolonis
NOAA/NESDIS/STAR

Topics

1. Latest developments
2. Discernible ash and strength of evidence checklist
3. Satellite inter-comparison

Topics

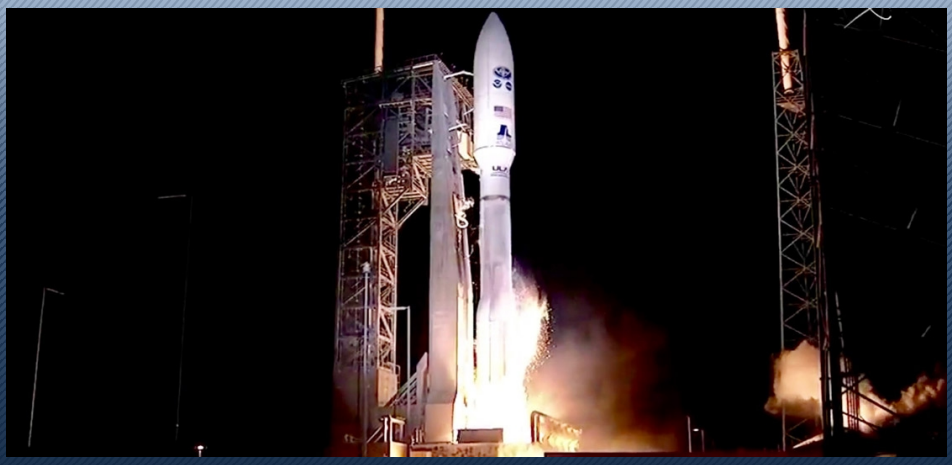
1. Latest developments

2. Discernible ash and strength of evidence checklist

3. Satellite inter-comparison

UPDATE ON OPERATIONAL SATELLITE CAPABILITIES

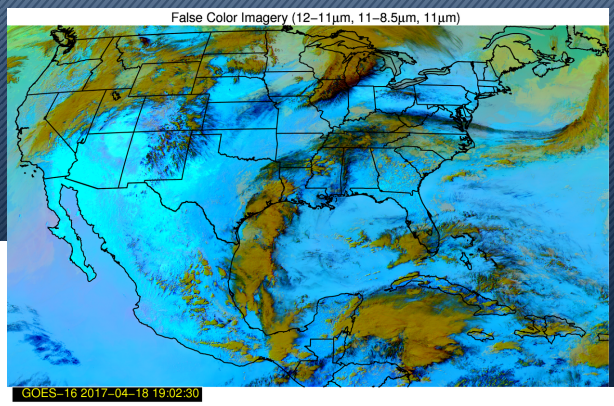
GOES-R



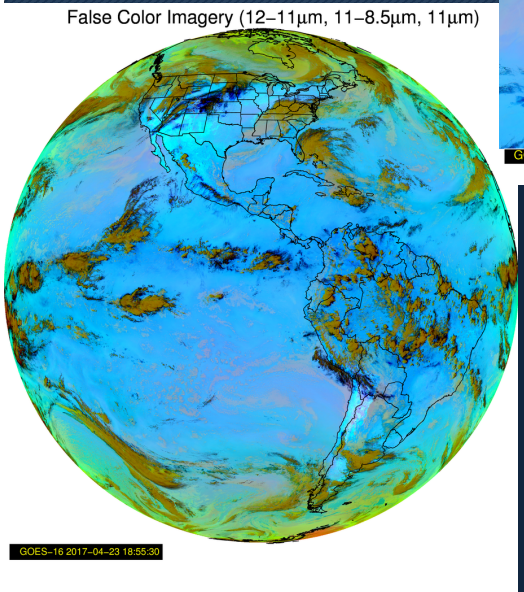
- GOES-R was successfully launched on November 19, 2016.
- GOES-16 L1b data are currently provisional and not yet operational https://www.ncdc.noaa.gov/sites/default/files/attachments/README_ABI-L1b-CMI_Provisional_Maturity.pdf
- GOES-16 will become GOES-East in November 2017 (no data will be collected during 2 week transit to eastern position)
- Although not yet operational, the Washington VAAC is using GOES-16 data
- GOES-S is currently scheduled to be launched in the Spring of 2018

GOES-R Scan Strategies

Refresh: 5 minutes

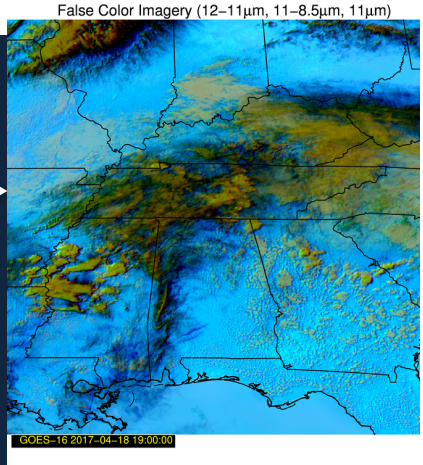


Refresh: 15 minutes



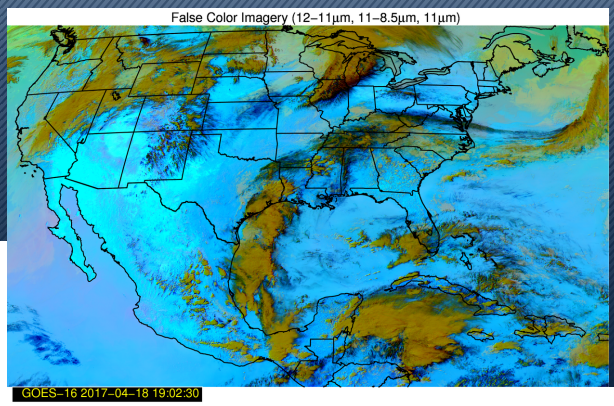
Refresh: 1 minute (2 domains)

Volcano focused 1 minute collections are possible →

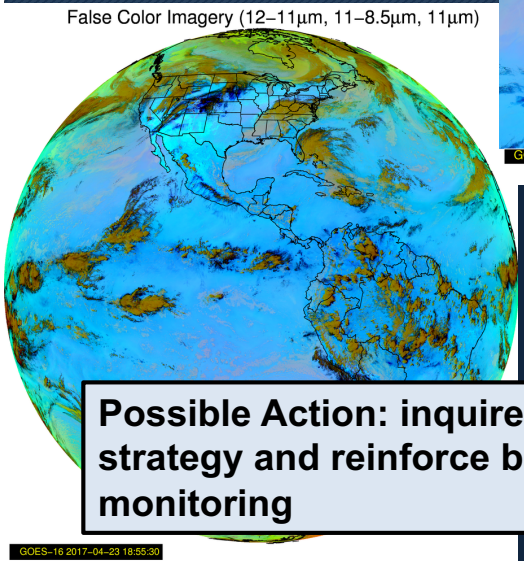


GOES-R Scan Strategies

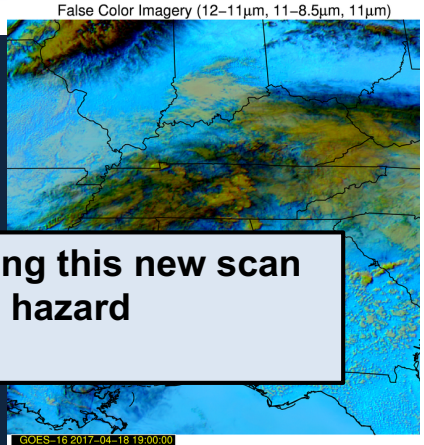
Refresh: 5 minutes



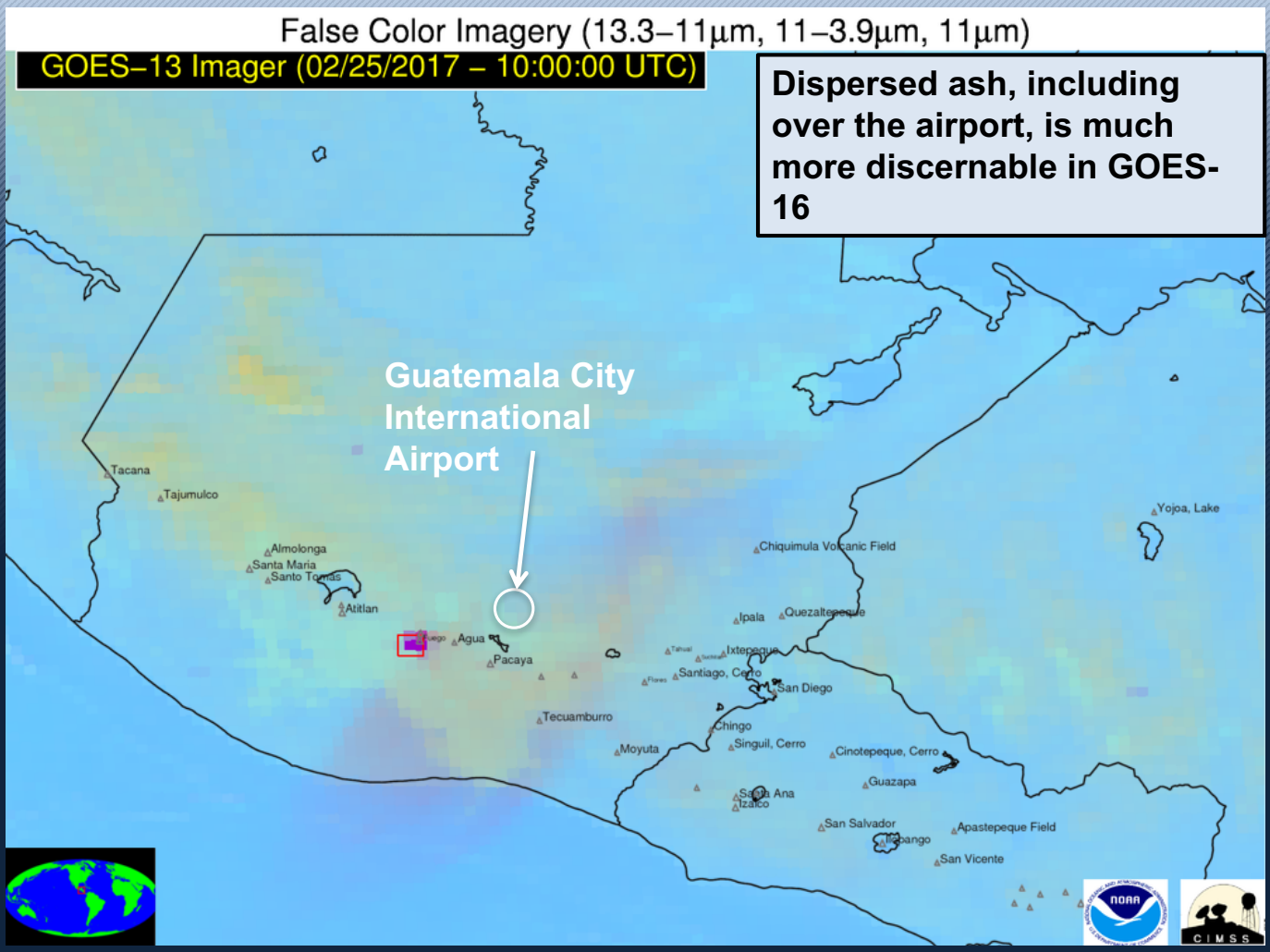
Refresh: 10 minutes



Refresh: 1 minute (2 domains)



Possible Action: inquire about the status of implementing this new scan strategy and reinforce benefits for operational volcanic hazard monitoring



GOES-16 data are currently experimental

Michael Peterson (U. Maryland)

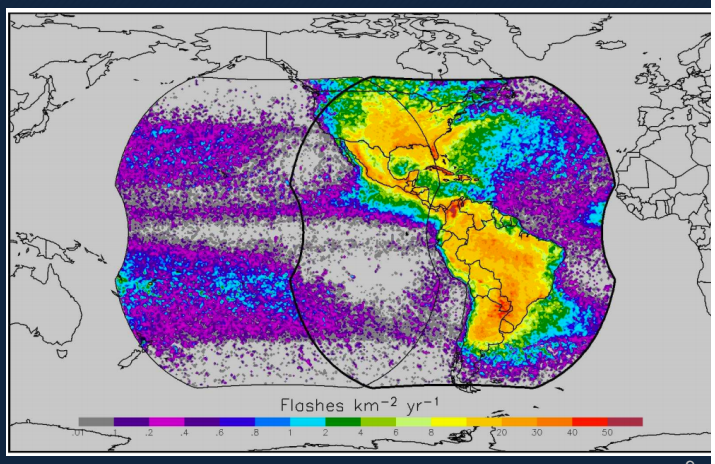
GOES-R Geostationary Lightning Mapper (GLM)

Measures total lightning at 8-10 km spatial resolution every 20 sec

Strengths: can aid (early) eruption detection and characterization and complements ground based lightning detection and characterization (GLM is being integrated into VOLCAT products)

Limitations: domain excludes higher latitudes (e.g. Alaska) and data are still preliminary

Meteosat Third Generation will include a lightning mapper



New Operational Satellites

Himawari-8/9 (JMA, GEO): In orbit

GOES-16 (NOAA, GEO): In orbit

FY4 (CMA, GEO): In orbit

JPSS-1 (NOAA, LEO): Fall 2017

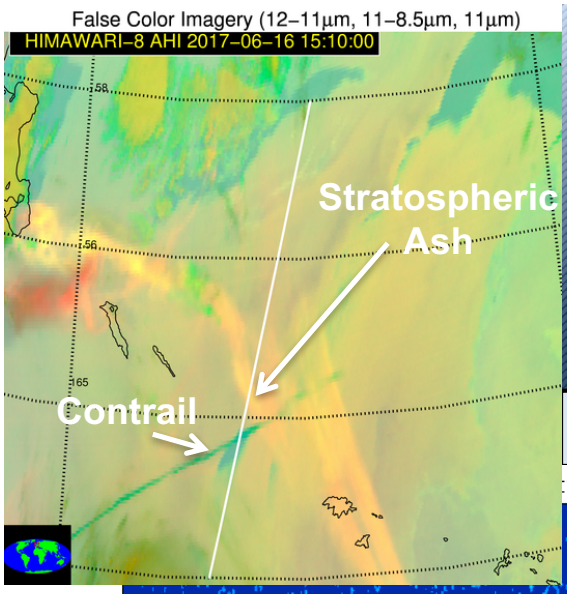
GOES-S (NOAA, GEO): Spring 2018

GEO-KOMPSAT-2A (KMA, GEO): Spring 2018

MTG (EUMETSAT/ESA, GEO): 2021

MetOp Second Generation (EUMETSAT/ESA): 2021

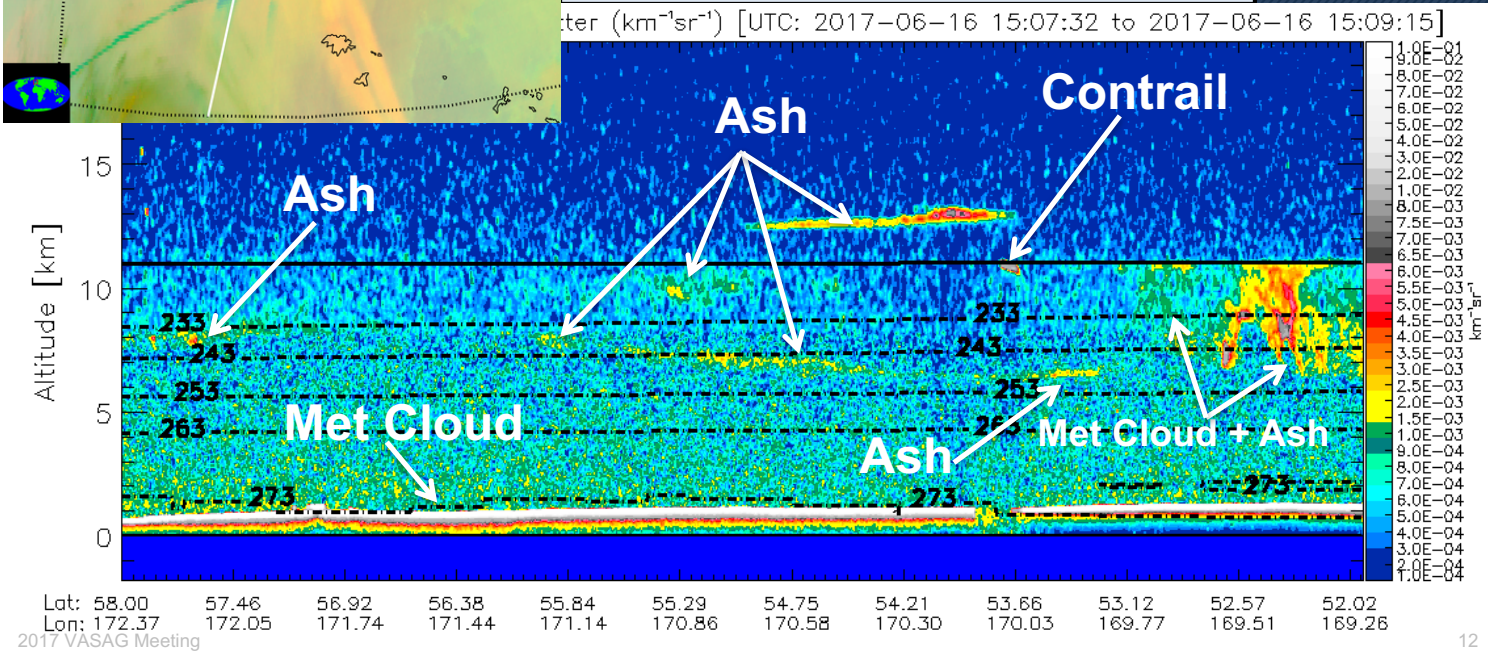
RESEARCH MISSIONS: SPACEBORNE LIDAR



NASA Mission: CALIPSO

CALIOP is near the end of life. Despite the relatively high latency, CALIOP has been a valuable resource, particularly for large, long-lived, volcanic clouds

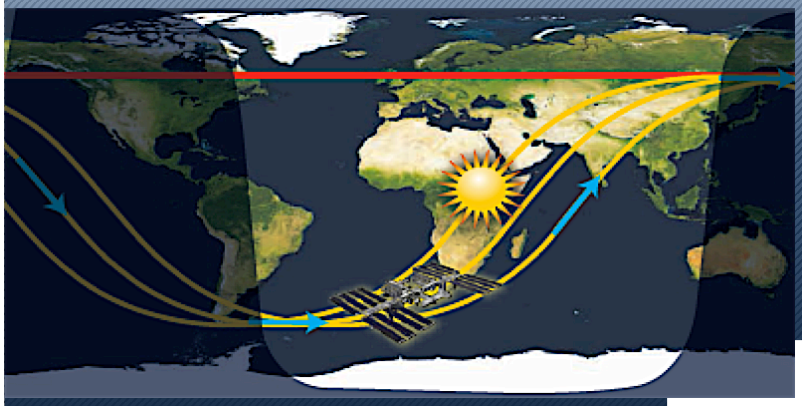
June 16, 2017 (~15:10 UTC)



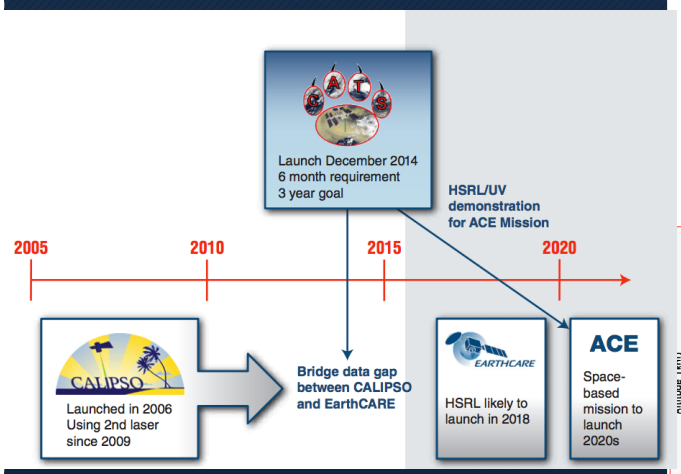
ESA/JAXA Mission: EarthCARE

Current launch schedule: August 2019

NASA Mission: CATS

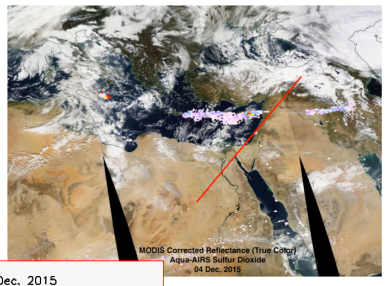


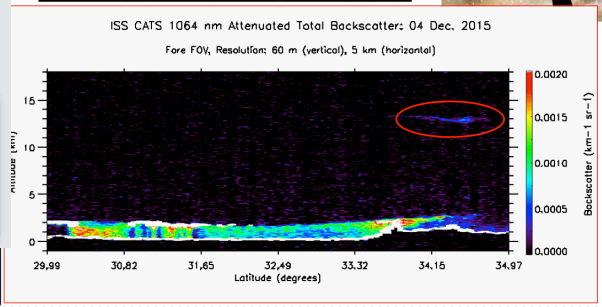
CATS is a very capable lidar onboard the International Space Station (ISS). It is intended to bridge the gap between CALIPSO and EarthCARE. ISS operations impact data collection.



Mt. Etna Plume

10 Dec 2015 |





Mt. Etna (Sicily) erupted on 03 Dec. 2015 (top left). The plume was observed by CATS on 04 Dec. at 15:44 UTC at altitude of 13 km (bottom left) over the Middle East (ISS track in red on top right). A group at NASA GSFC is working on using CATS data for future forecasting of volcanic plumes.

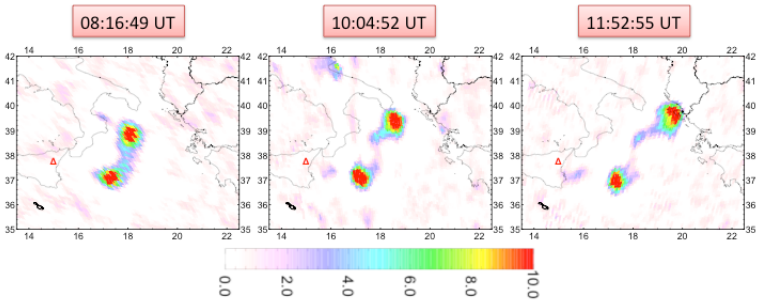
NEW SATELLITE MISSIONS RELEVANT TO SO_2

NOAA/NASA Mission: DSCOVR

EPIC on DSCOVR has SO_2 sensitive UV channels (similar to TOMS)

Operational monitoring of volcanic SO_2 using EPIC is not yet possible (SO_2 algorithms for EPIC are still being developed and image latency is ~hours)

Etna Eruption:
SO_2 Quantification on12/03/2015

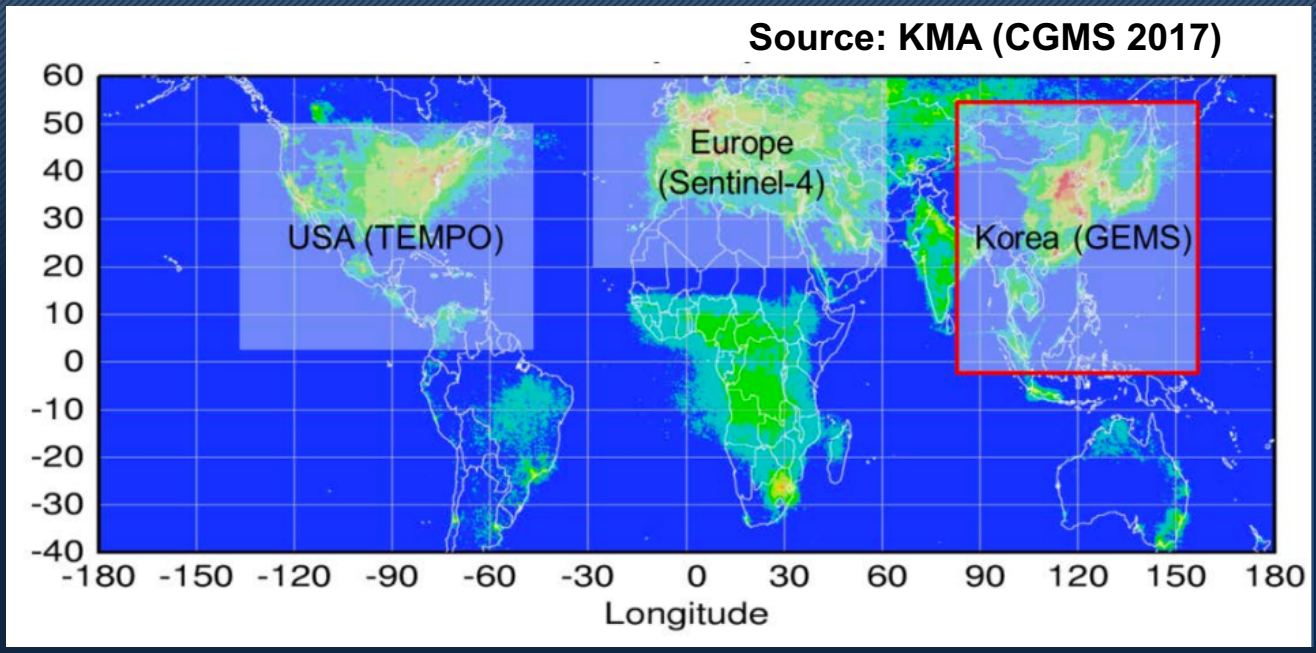


Kai Yang (UM)

Planned Geostationary UV Missions

TEMPO – NASA (2018)
Sentinel-4 – ESA/EUMETSAT (> 2020)
GEMS – KMA (2019)

Source: KMA (CGMS 2017)



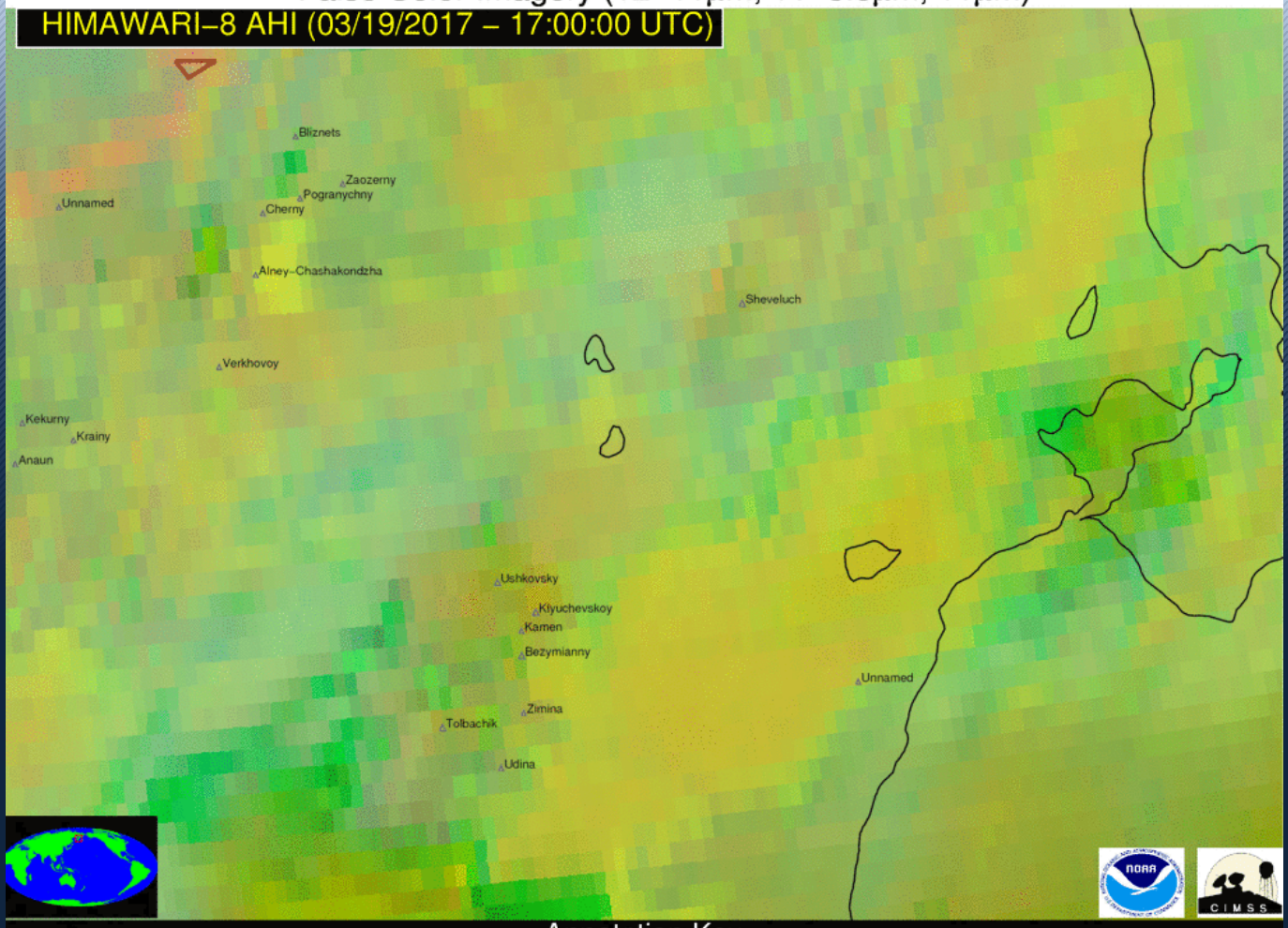
- **Will allow for multiple SO_2 measurements over the same area each day**
- **Limited Southern Hemisphere coverage**

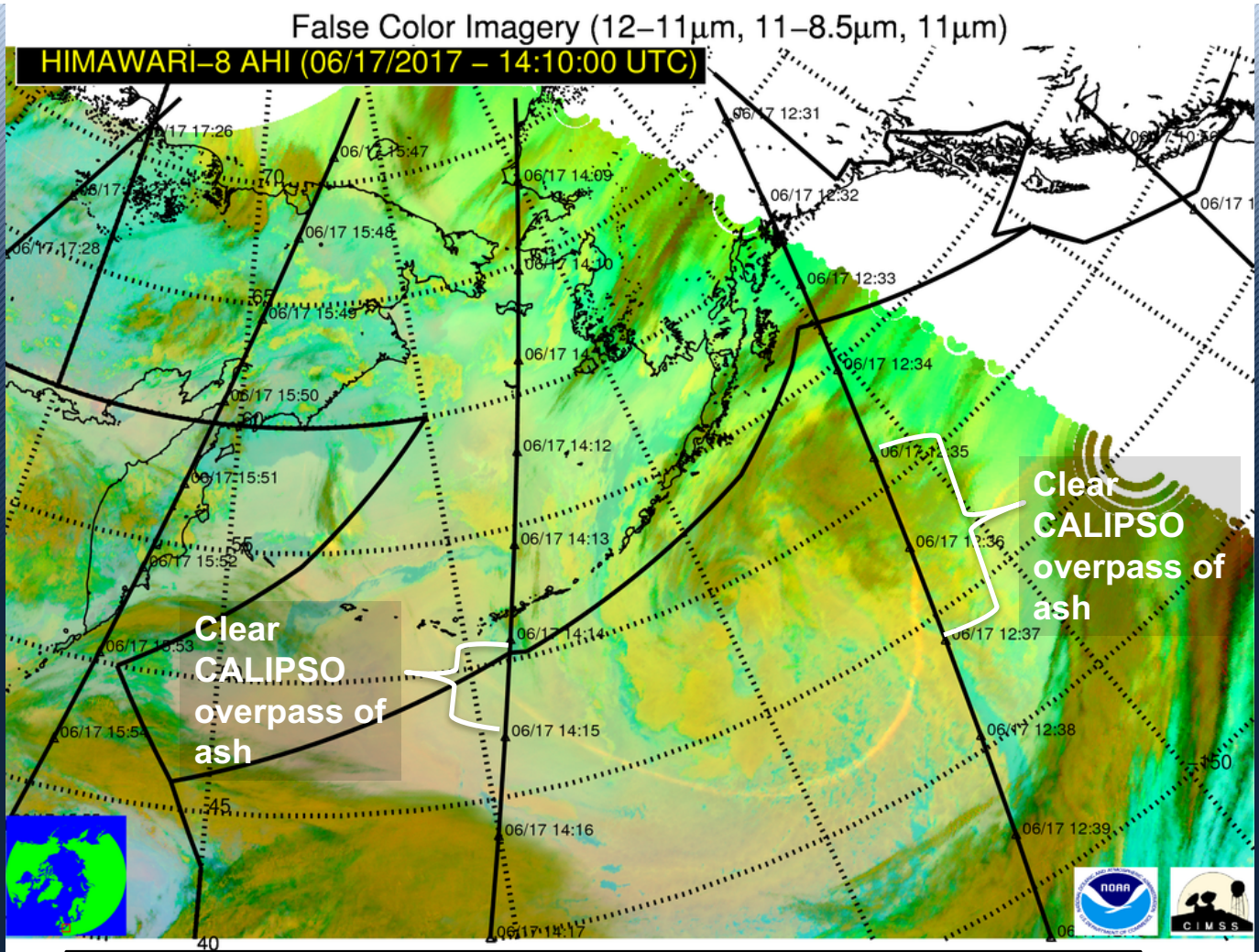
PRIMARY IMPACTS AND CHALLENGES

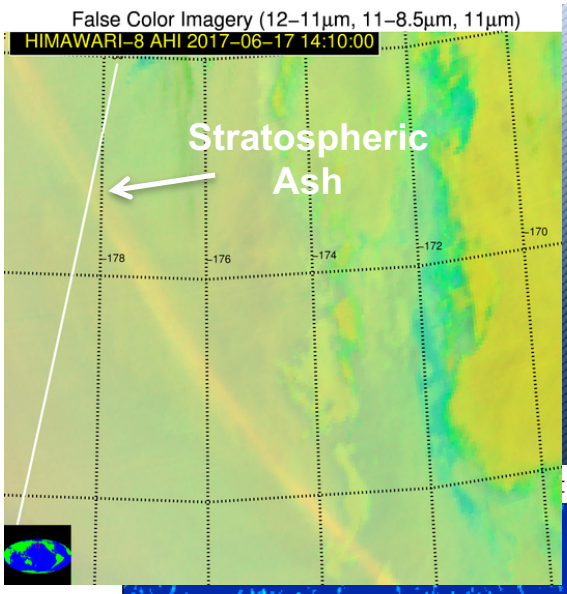
Impacts of Next Generation Satellites on Operations

- Earlier detection of eruptions
- Increased frequency of detection of smaller, short-lived, ash emissions
- Impacts on ash cloud tracking range from incremental to profound, depending on the properties of the volcanic cloud and background
- Improved sensitivity to ash cloud properties (composition, height, and loading)
- Better SO_2 detection and characterization

False Color Imagery (12–11µm, 11–8.5µm, 11µm)




False Color Imagery (12–11µm, 11–8.5µm, 11µm)
HIMAWARI–8 AHI (06/17/2017 – 14:10:00 UTC)
Clear CALIPSO overpass of ash
Clear CALIPSO overpass of ash
Lines with date/time label = CALIPSO overpasses

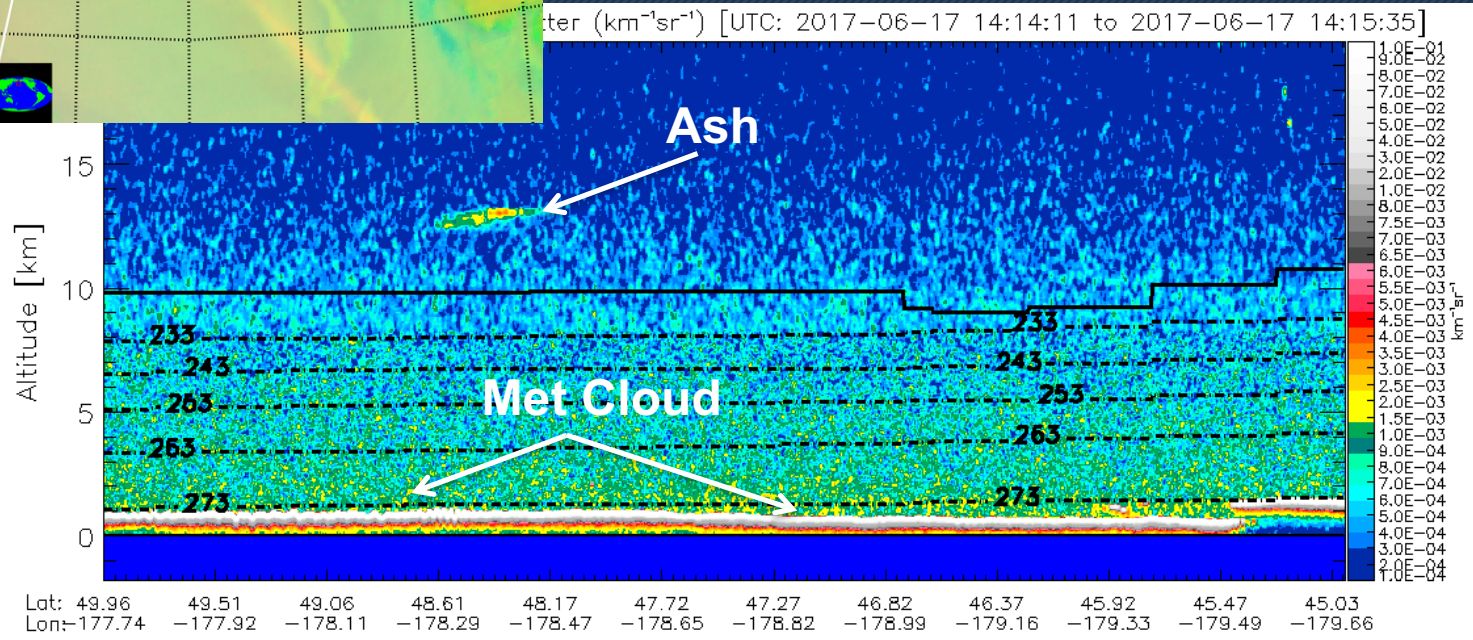


June 17, 2017 (~14:10 UTC)

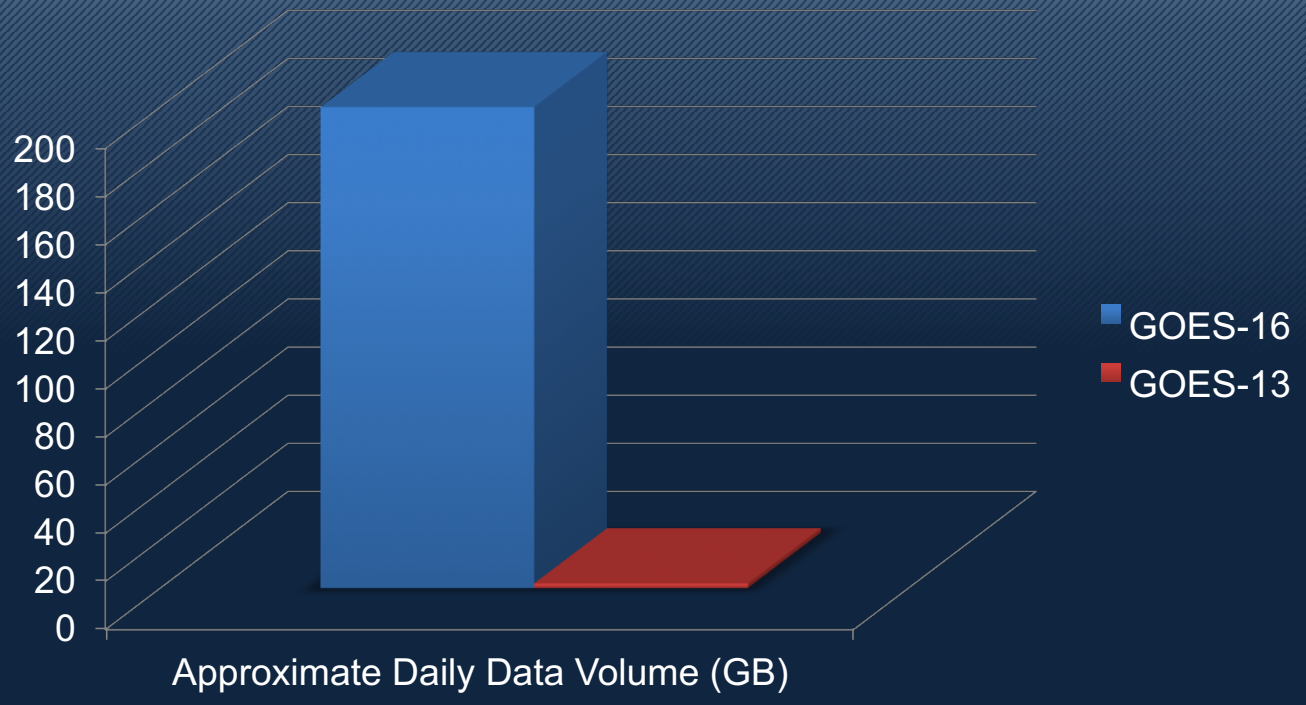
Changing definition of discernible ash:

New generation of geostationary satellites often allows for longer tracking of thin ash clouds, especially at larger viewing angles.

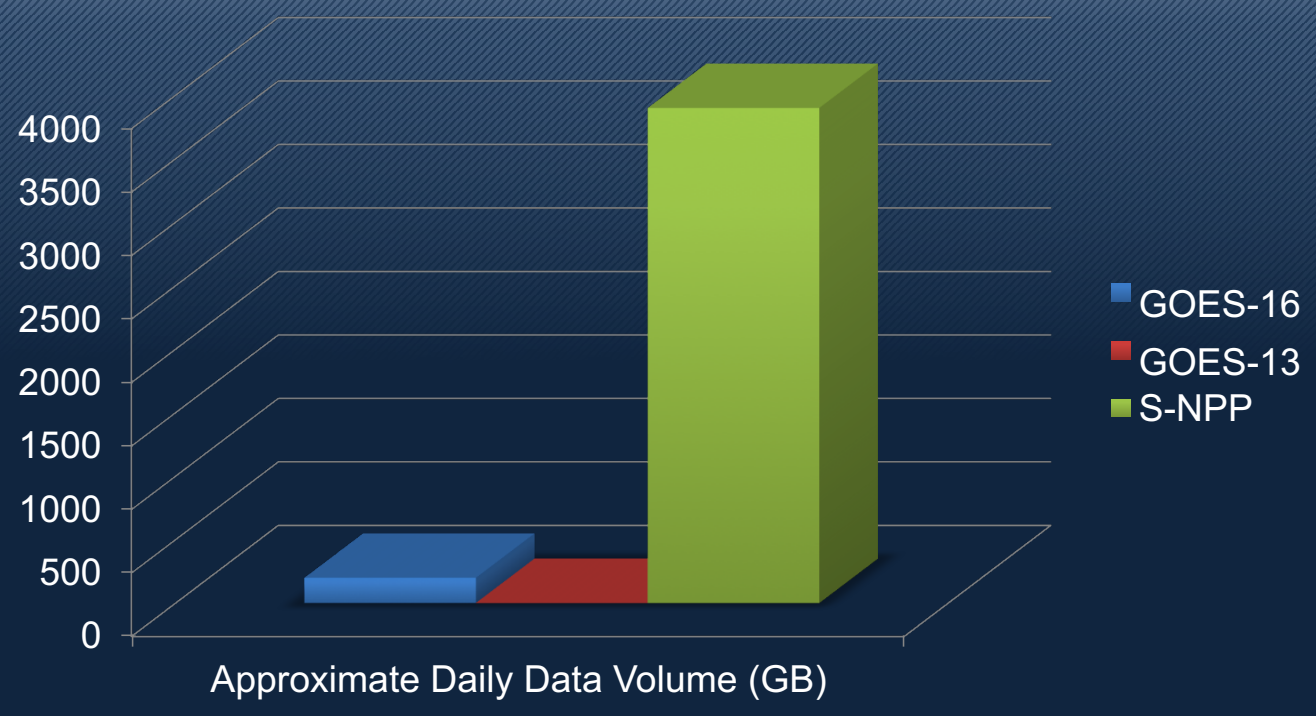
Paradigm shift?



“Big Data”


200
180
160
140
120
100
80
60
40
20
0
Approximate Daily Data Volume (GB)
GOES-16
GOES-13

“Big Data”


4000
3500
3000
2500
2000
1500
1000
500
0
Approximate Daily Data Volume (GB)
GOES-16
GOES-13
S-NPP

Data to Information

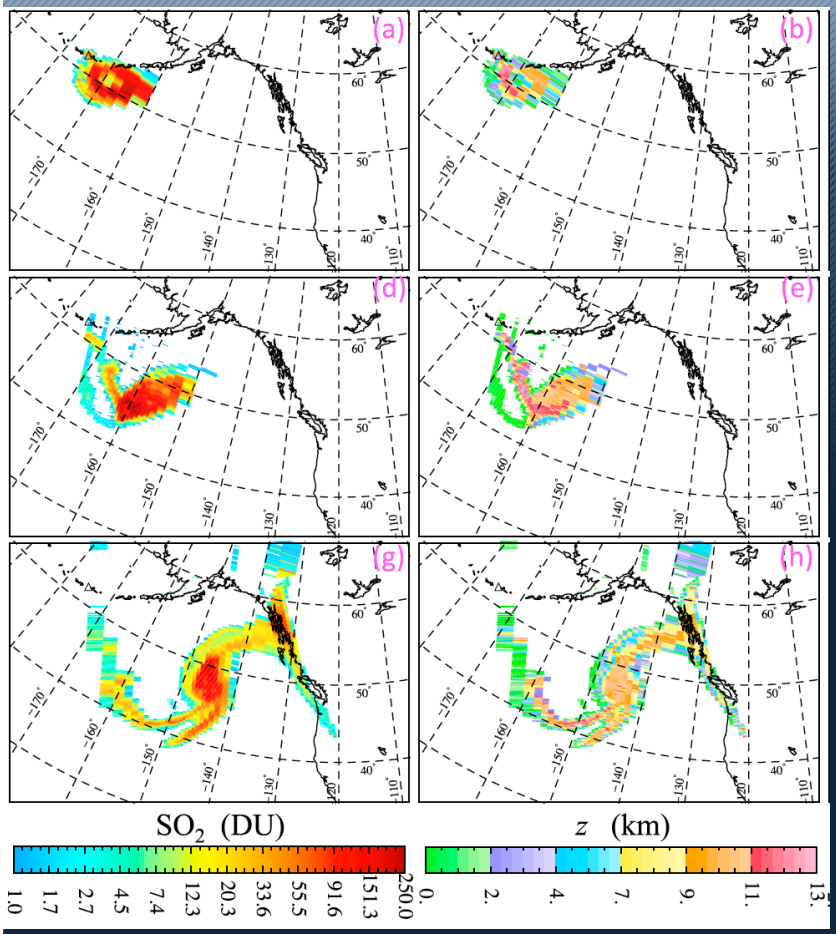
Research related to fully automated data fusion is key

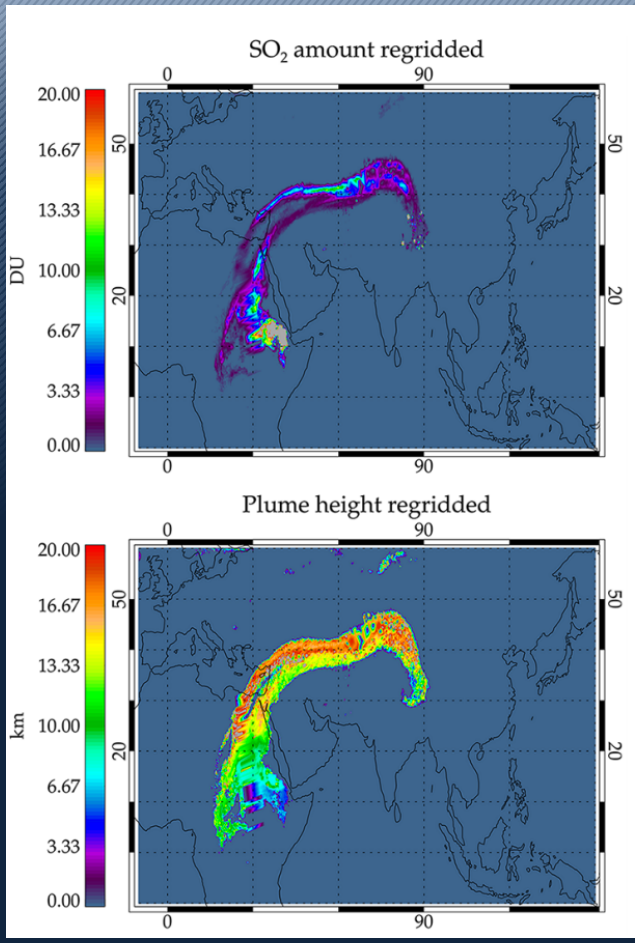
- **Eruption alerts**
- **Eruption source parameters**
- **Volcanic cloud properties (composition, height, loading, size distribution)**

The volume of volcano relevant satellite measurements is incredibly large (many TB's per day) and growing. There are also many relevant non-satellite data sources. Volcanic cloud monitoring is best served using an integrated approach. Sole reliance on manual integration will result in under-utilization of relevant measurements in operations.

RECENT RESEARCH HIGHLIGHTS

SO_2 Height

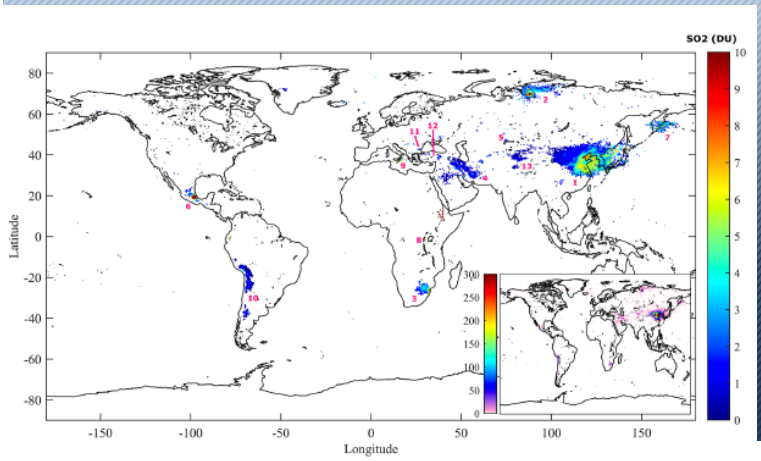




Yang et al., 2010

Carboni et al., 2016

Other SO_2

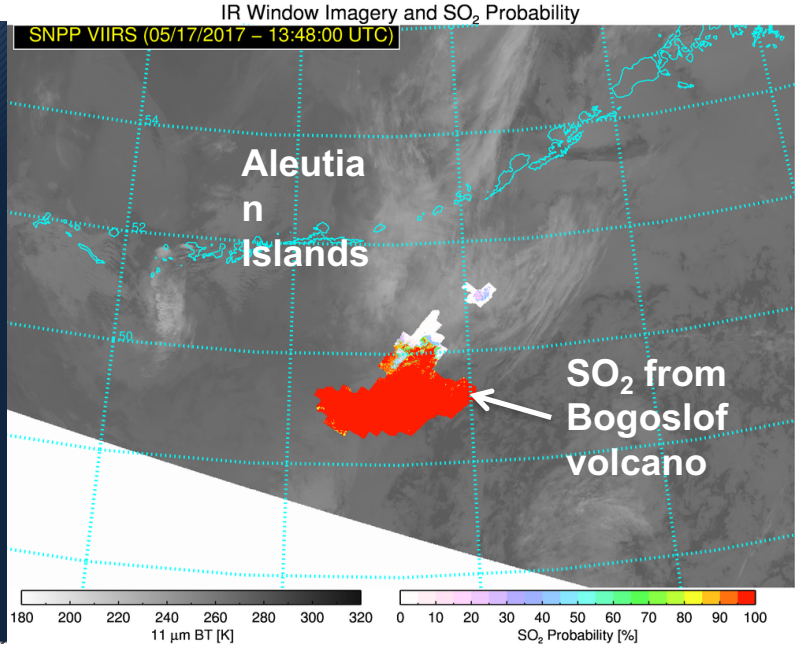


Bauduin et al., 2016

Low level SO_2 from hyperspectral infrared (IASI)

NOAA VOLCAT: Multi-sensor SO_2 products for automated tracking and characterization as a function of time; being developed in support of operational requirements

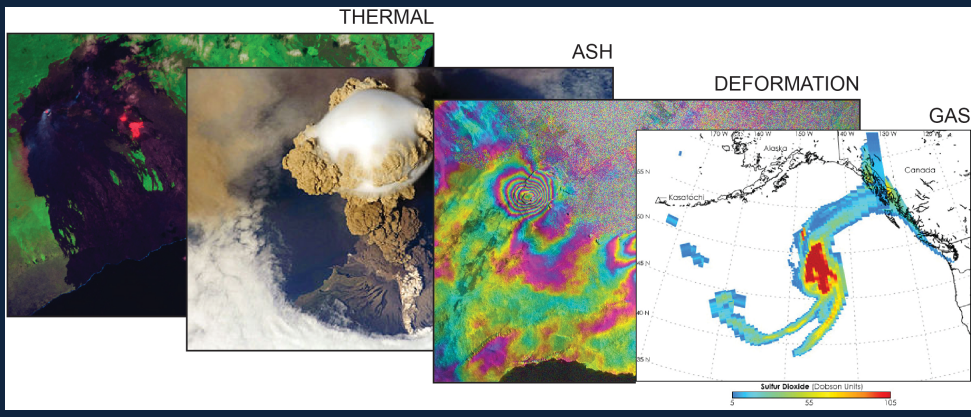
IR Window Imagery and SO_2 Probability



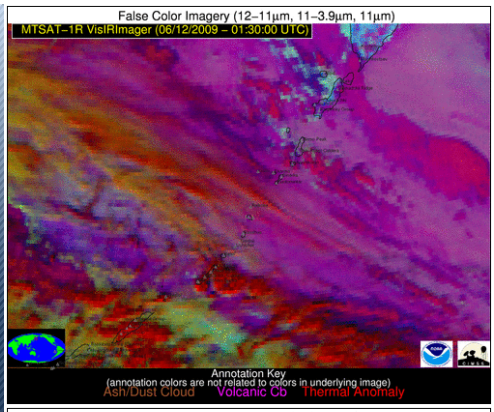
USGS Powell Center Project

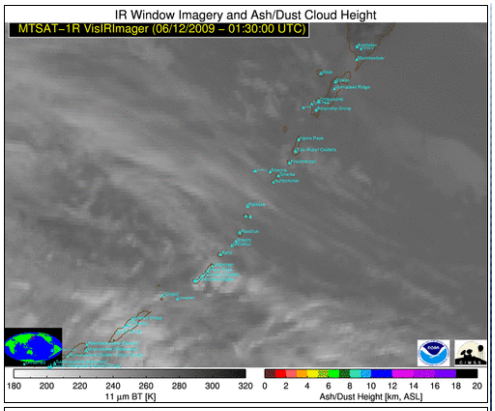
Matt Pritchard (Cornell) - PI
Mike Poland (USGS) – PI
Ben Andrews (Smithsonian)
Juliet Briggs (U. Bristol)
Simon Carn (Mich. Tech)
Julie Griswold (USGS)
Brenda Jones (USGS)
Sue Louglin (British Geological Survey)
Taryn Lopez (UAF)
Paul Lindgren (JPL)
Franz Meyer (UAF)
Mike Pavolonis (NOAA)
Ivan Petiteville (ESA)
Kevin Reath (Cornell)
Dave Schneider (USGS)
Greg Vaughan (USGS)
Christell Wauthier (Penn St.)
Rick Wessels (USGS)
Rob Wright (U. Hawaii)

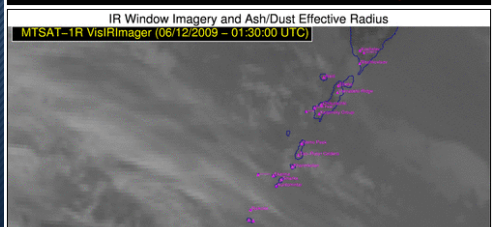
USGS
science for a changing world

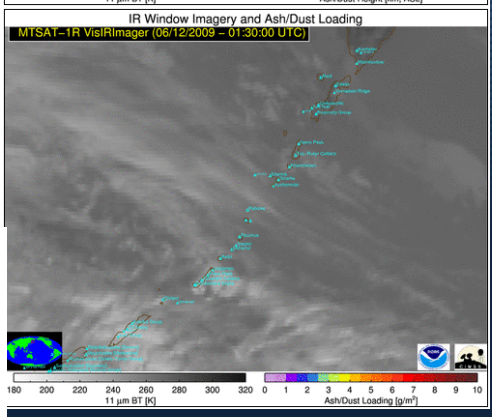


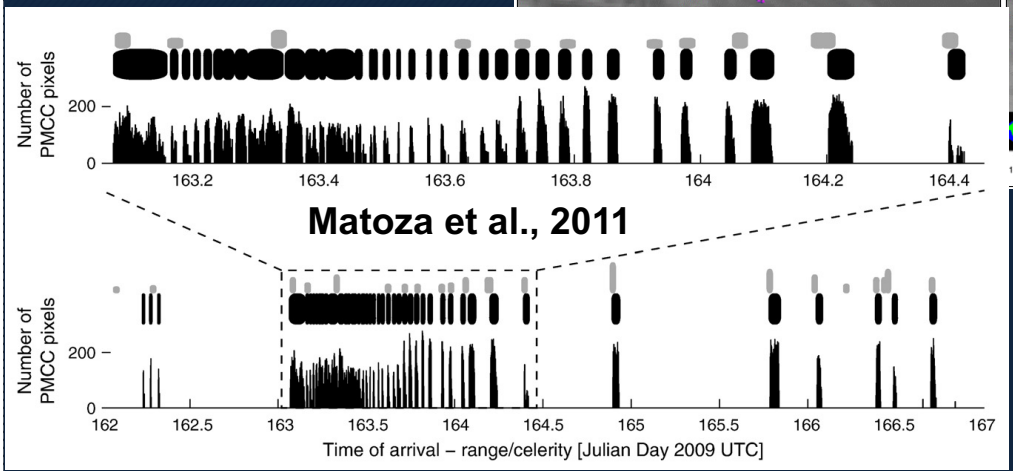
Fusion with non-satellite measurements



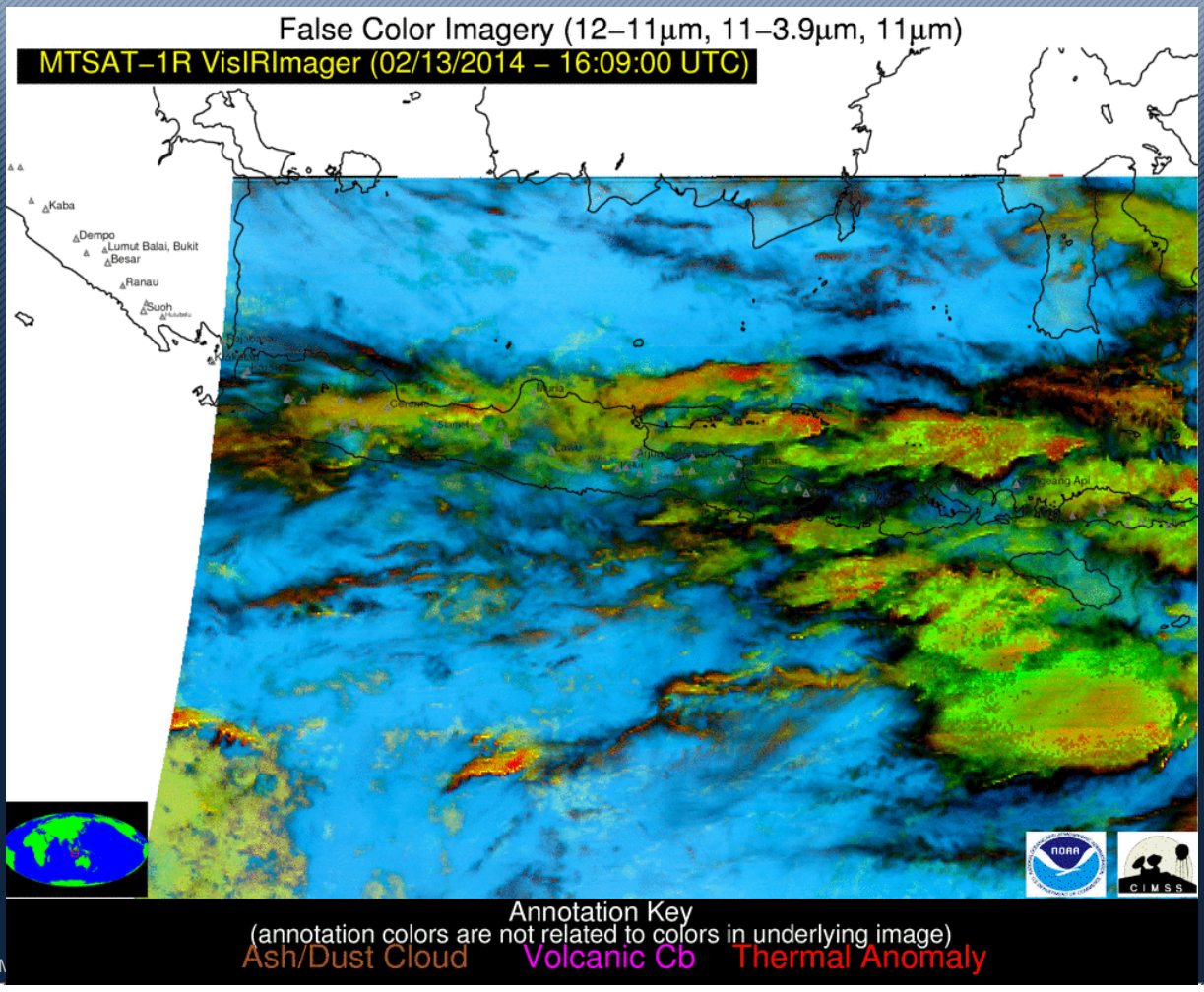




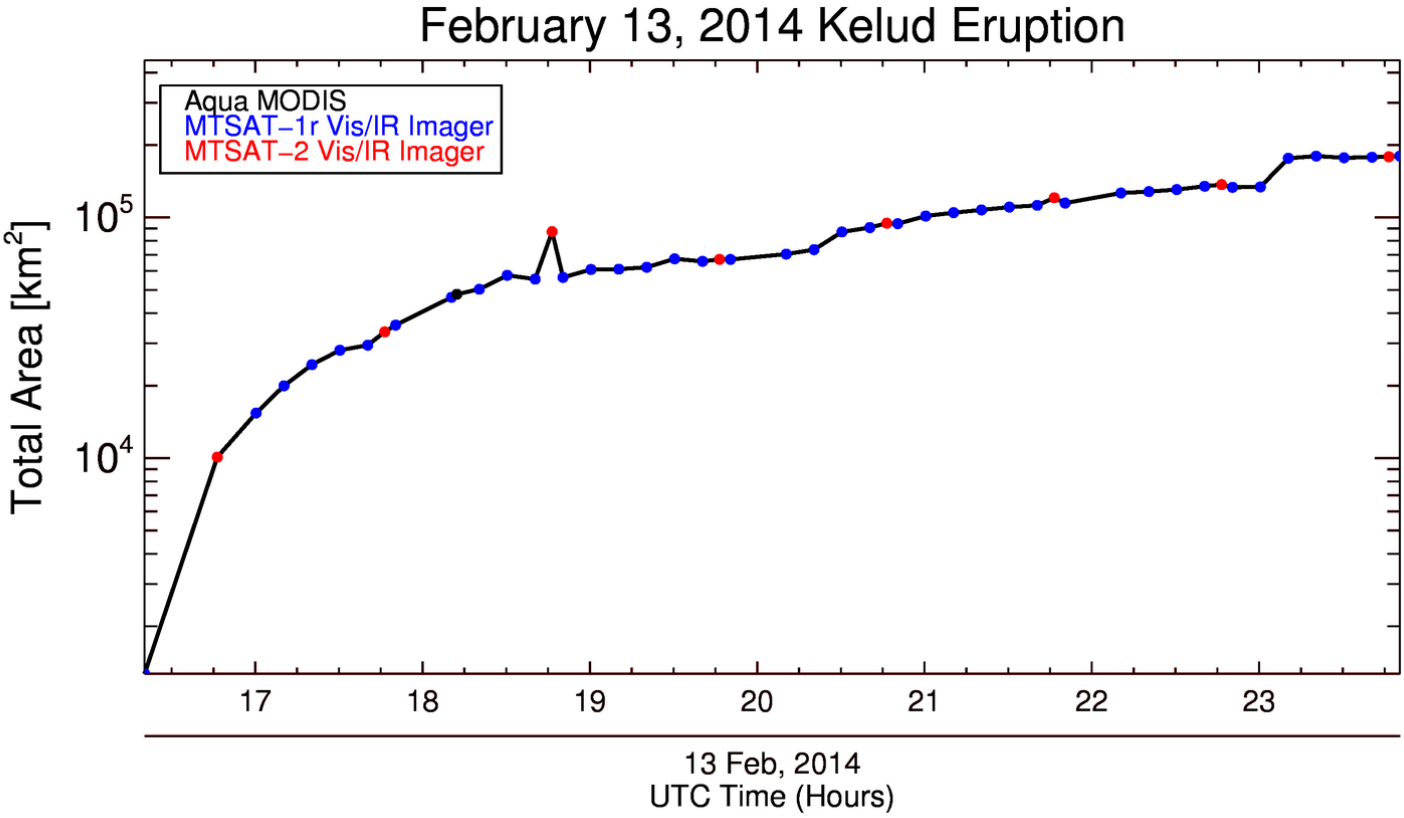




Temporal: Multi-sensor Cloud Tracking



Automated Time Series Generation



The time evolution of cloud can be used to derive mass eruption rate – a critical parameter required by dispersion models (e.g. Pouget et al., 2013)

The VOLcanic Cloud Analysis Toolkit (VOLCAT)

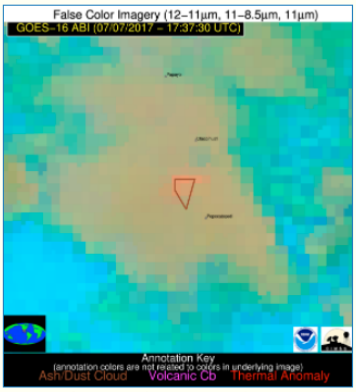
Automated early detection of volcanic eruptions using cloud objects (Pavolonis et al., 2015a; Pavolonis et al., 2015b)

Volcanic Cloud Alert Report

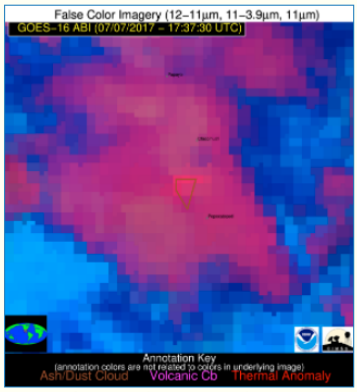
Date:	2017-07-07
Time:	17:37:30
Production Date and Time:	2017-07-07 17:44:35 UTC
Primary Instrument:	GOES-16 ABI

More details ▼

Possible Volcanic Ash Cloud



False Color Image (12-11, 11-8.5, 11) [zoomed-in]



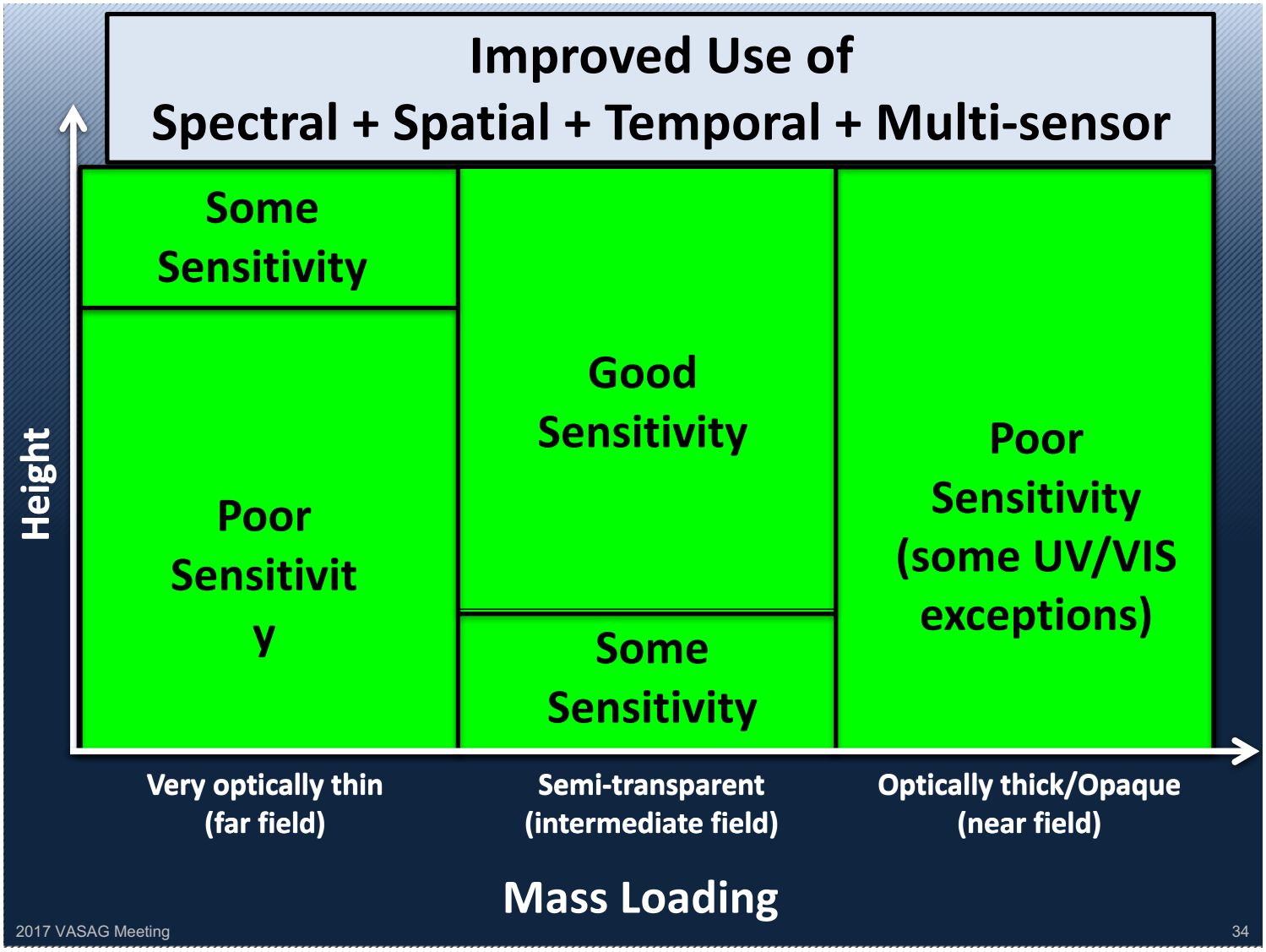
False Color Image (12-11, 11-3.9, 11) [zoomed-in]

```
FVXX21 KNES 071809
VA ADVISORY
DTG: 20170707/1809Z

VAAC: WASHINGTON

VOLCANO: POPOCATEPETL 341090
PSN: N1901 W09837

AREA: MEXICO

SUMMIT ELEV: 17802 FT (5426 M)

ADVISORY NR: 2017/056

INFO SOURCE: NOAA CIMSS ALERT/CENAPRED

ERUPTION DETAILS: NEW VA EM AT 07/1719Z

RMK: WE HAVE RECEIVED INFORMATION SUGGESTING A
POSSIBLE VA EMISSION. WE WILL GATHER FURTHER
INFORMATION AND ISSUE A FULL ADVISORY AS SOON AS
POSSIBLE.

NXT ADVISORY: AS SOON AS POSSIBLE
```

Basic Information

Volcanic Region(s)	Mexico and Central America
Country/Countries	Mexico
Volcanic Subregion(s)	Mexico
VAAC Region(s) of Nearby Volcanoes	Washington
Identification Method	Puff
Mean Object Date/Time	2017-07-07 17:37:30UTC
Radiative Center (Lat, Lon):	19.100°, -98.680°
Nearby Volcanoes (meeting alert criteria):	Popocatepetl (2.80 km)
Maximum Height [AMSL]	9.20 km ; 30184 ft
90th Percentile Height [AMSL]	9.10 km ; 29856 ft
Mean Tropopause Height [AMSL]	16.50 km ; 54134 ft

Show More ▲ View all event imagery »


Improved Use of
Spectral + Spatial + Temporal + Multi-sensor
Some Sensitivity
Poor Sensitivit y
Good Sensitivity
Some Sensitivity
Poor Sensitivity (some UV/VIS exceptions)
Height
Very optically thin (far field)
Semi-transparent (intermediate field)
Optically thick/Opaque (near field)
Mass Loading

Topics

1. Latest developments

2. Discernible ash and strength of evidence checklist

3. Satellite inter-comparison

Strength of Evidence Checklist (Darwin VAAC)

Evidence Quality	Volcano: Dukono	
Remote Sensing Evidence		
Weak	Anomalously rapid cloud development above a known volcano	☐
Weak	Convective development, that is asynchronous with the regional convective cycle, above a known volcano	☐
Moderate	Stationary, persistent (>1 hr) overshooting cloud top embedded within meteorological cloud above a known volcano	☐
Moderate	Hot spot at a known volcano	☐
Moderate	Anomalous lightning activity above a known volcano	☐
Weak	Low altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Moderate	High altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Strong	Grey or brown discolored clouds in true color imagery emmanating from a known volcano	☑
Strong	Cloud with a significant reverse absorption signal emmanating from a known volcano	☐
Strong	Anomalous linear or wedge shaped cloud emmanating from a known volcano	☑
Strong	Convective cloud like development in a stable air-mass above a known volcano	☐
Airborne Evidence		
Weak	Pilot report of a sulfurous smell from a location downwind of a known volcano	☐
Weak	Pilot report of visible ash from a location downwind of a known volcano	☐
Moderate	Pilot report of a volcanic eruption from a known volcano	☐
Strong	Pilot report of identified volcanic ash airframe impacts	☐
Ground Based Evidence		
Strong	Web-cam image of a buoyant non-white volcanic plume emanating from a known volcano	☐
Strong	State Volcano Observatory report of an ash generating eruption	☐
Weak	ASHTAM/NOTAM/SIGMET indicating an eruption at a known volcano	☐
Weak	Unofficial media report of an eruption from a known volcano	☐
Moderate	Official media report of an eruption from a known volcano	☐
Weak	Geophysical report indicating volcanic activity at a known volcano	☐
Moderate	Ground lidar observation of a significant aerosol cloud emanating from a known volcano	☐
Moderate	Ground radar observation of a plume emanating from a known volcano	☐
Conceptual Evidence		
Weak	Volcano is currently on ACC Orange	☑
Moderate	Volcano is currently on ACC Red	☐
Strong	SVO advice that an eruption from the volcano is immanent	☐
Strength of Evidence	Sufficient	
Sufficient	The balance of evidence suggests that an ash producing eruption has occurred	
Insufficient	Insufficient evidence to suggest that an ash producing eruption has occurred	
Submit (takes 20 seconds)		

Satellite Observations

Pilot Reporting

Ground Based Observations

Volcanological Status

Evidence Quality	Volcano Dukono	
	Remote Sensing Evidence	
Weak	Anomalously rapid cloud development above a known volcano	☐
Weak	Convective development, that is asynchronous with the regional convective cycle, above a known volcano	☐
Moderate	Stationary, persistent (>1 hr) overshooting cloud top embedded within meteorological cloud above a known volcano	☐
Moderate	Hot spot at a known volcano	☐
Moderate	Anomalous lightning activity above a known volcano	☐
Weak	Low altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Moderate	High altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Strong	Grey or brown discolored clouds in true color imagery emmanating from a known volcano	☑
Strong	Cloud with a significant reverse absorption signal emmanating from a known volcano	☐
Strong	Anomalous linear or wedge shaped cloud emmanating from a known volcano	☑
Strong	Convective cloud like development in a stable air-mass above a known volcano	☐

What constitutes anomalous rapid development?

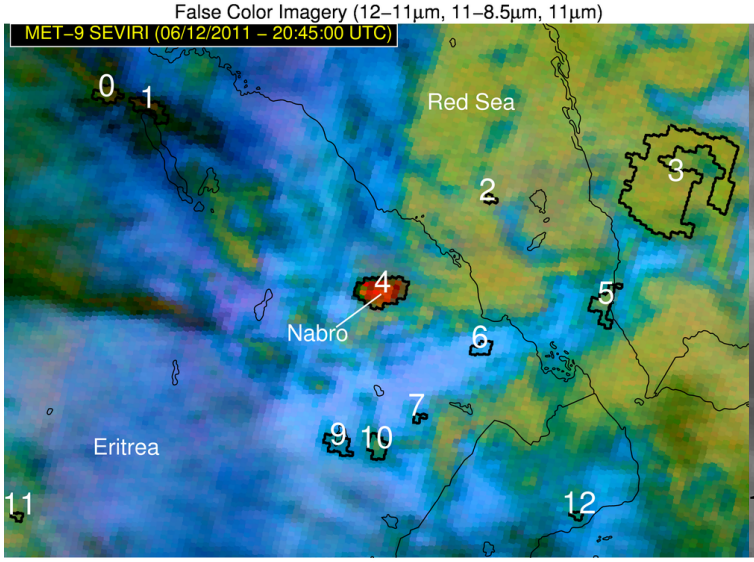
When is cloud development a truly robust indicator of an eruption?

No mention of cloud microphysics

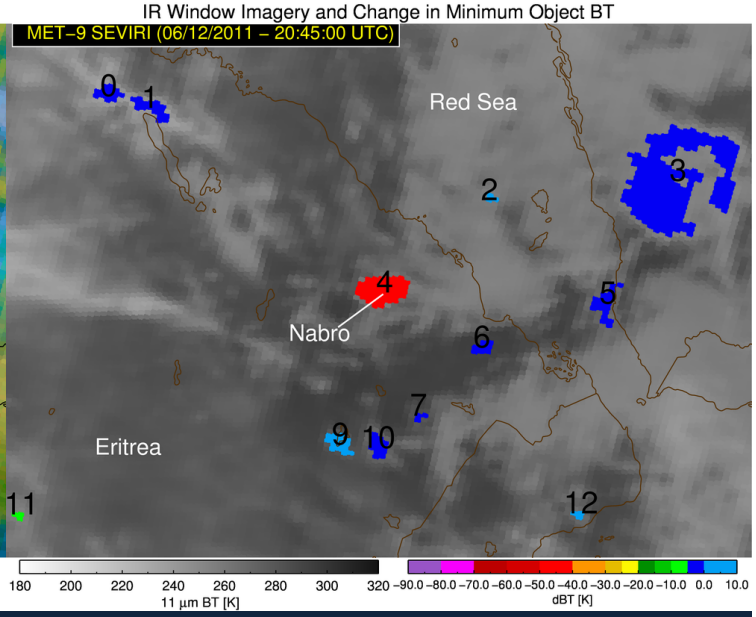
Temporal – Cloud Vertical Growth

In lieu of multi-spectral information, can the image-to-image change in cloud properties be used to identify explosive volcanic eruptions?

False Color Imagery (12–11μm, 11–8.5μm, 11μm)



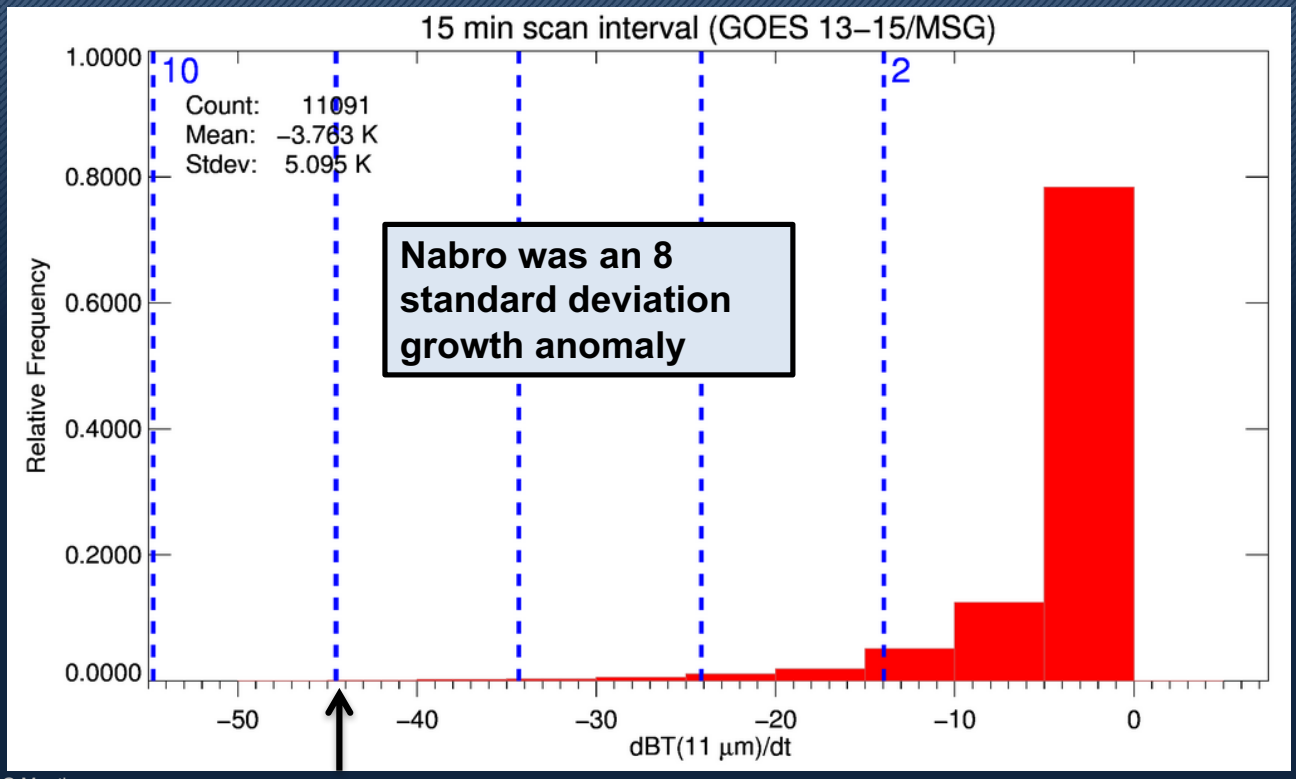
IR Window Imagery and Change in Minimum Object BT



Pavolonis et al. (2017, in prep)

How anomalous is vertical growth of Nabro cloud given the pixel area, time interval between the images, and background cloudiness?

Pavolonis et al. (2017, in prep)



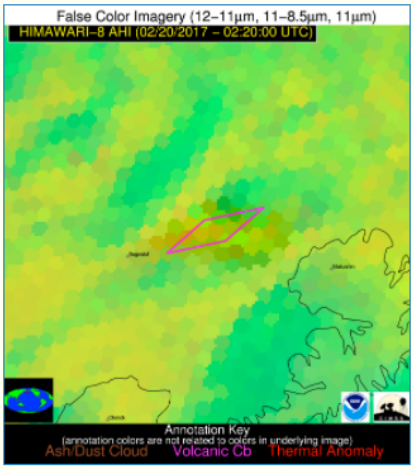
Example NRT alert based on cloud vertical growth anomaly

Volcanic Cloud Alert Report

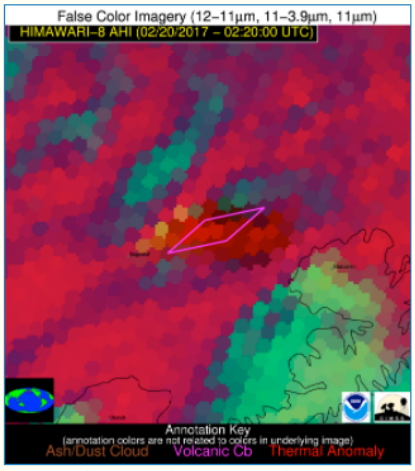
Date:	2017-02-20
Time:	02:20:00
Production Date and Time:	2017-02-20 02:43:32 UTC
Primary Instrument:	Himawari-8 AHI

More details ▼

Possible Volcanic Cb



False Color Image (12-11, 11-8.5, 11) [zoomed-in]



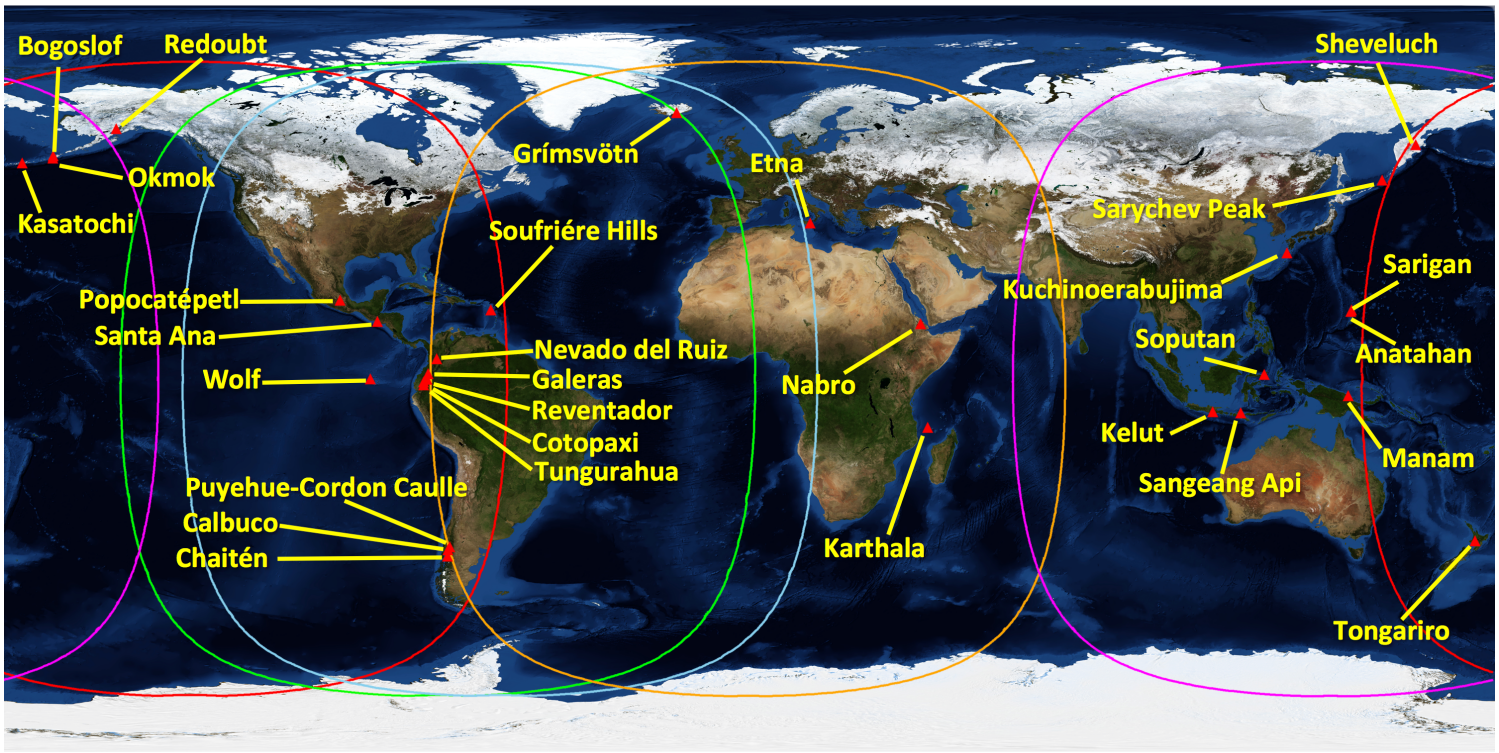
False Color Image (12-11, 11-3.9, 11) [zoomed-in]

Basic Information

Volcanic Region(s)	Alaska
Country/Countries	United States
Volcanic Subregion(s)	Aleutian Islands
VAAC Region(s) of Nearby Volcanoes	Anchorage
Identification Method	Basic Growth
Mean Object Date/Time	2017-02-20 02:20:33UTC
Radiative Center (Lat, Lon):	53.900°, -167.940°
Nearby Volcanoes (meeting alert criteria):	Bogoslof (4.60 km)
Trend in IR Brightness Temperature	-25.50 °C
Vertical Growth Rate Time Interval	10 minutes
Vertical Growth Rate Anomaly	14.40 number of stddev above mean
Maximum Height [AMSL]	9.60 km ; 31496 ft
90th Percentile Height [AMSL]	9.60 km ; 31496 ft
Mean Tropopause Height [AMSL]	8.70 km ; 28543 ft

Show More ▲ View all event imagery »

VOLCAT automatically detected 14 explosive events at Bogoslof since December 21, 2016



Geostationary Satellite Coverage

GOES-West GOES-East GOES-Central MSG MTSAT/Himawari

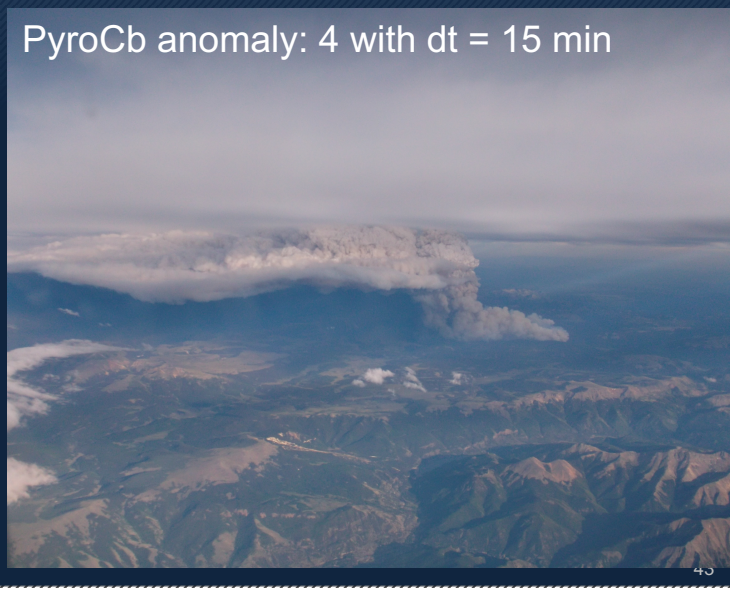
Number of cloud objects processed per day: ~3 million
Number of growing cloud objects processed per day: 1 million
Average number of false alerts per day: 3-4

Volcano/Event	Date (UTC)	Image Start Time (UTC)	Satellite	DT (min)	Anomaly
Kelut	2014-02-13	16:19	MTSAT-1R	10	40.2
Chaiten	2008-05-06	12:28	GOES-10	13	30.3
Sangeang Api	2014-05-30	08:32	MTSAT-2	60	25.8
Bogoslof	2017-01-04	06:30	Himawari-8	10	24.4
Bogosof	2016-12-26	23:30	Himawari-8	10	22.1
Calbuco	2015-04-22	21:38	GOES-13	33	21.5
Grimsvotn	2011-05-21	19:19	Meteosat-8	5	21.3
Tungurahua	2013-07-14	11:45	GOES-13	32	21.3
Soufriere Hills	2010-02-11	17:15	GOES-13	30	19.5
Sarychev Peak	2009-06-13	21:30	MTSAT-1R	33	18.7
Sarychev Peak	2009-06-14	18:57	MTSAT-1R	27	18.3
Wolf	2015-05-25	07:15	GOES-13	30	17.0
Okmok	2008-07-12	20:00	GOES-11	15	16.7
Calbuco	2015-04-23	04:08	GOES-13	30	16.0

Volcano/Event	Date (UTC)	Image Start Time (UTC)	Satellite	DT (min)	Anomaly
Grimsvotn	2011-05-21	19:19	Meteosat-8	5	21.3
Grimsvotn	2011-05-21	19:15	Meteosat-9	15	12.7
Kelut	2014-02-13	16:19	MTSAT-1R	10	40.2
Kelut	2014-02-13	16:32	MTSAT-2	60	7.3

EF5 storm anomaly: 14 with dt = 9 min

PyroCb anomaly: 4 with dt = 15 min



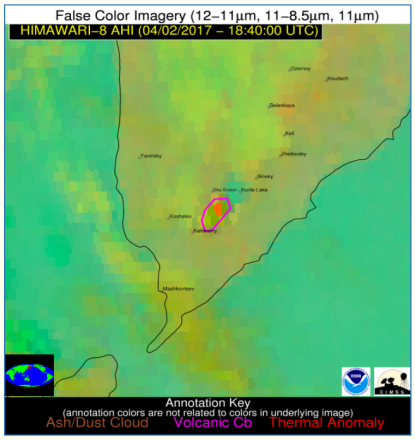
Example NRT alert based on cloud vertical growth anomaly

Volcanic Cloud Alert Report

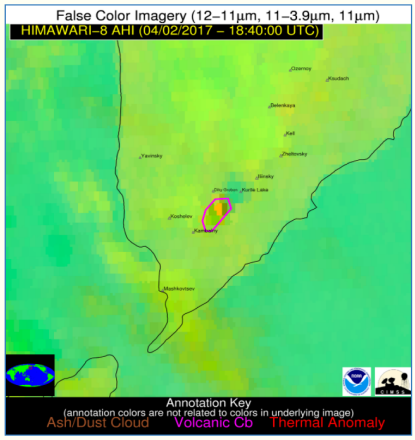
Date:	2017-04-02
Time:	18:40:00
Production Date and Time:	2017-04-02 19:02:23 UTC
Primary Instrument:	Himawari-8 AHI

More details ▼

Possible Volcanic Cb



False Color Image (12-11, 11-8.5, 11) [zoomed-in]



False Color Image (12-11, 11-3.9, 11) [zoomed-in]

Basic Information

Volcanic Region(s)	Kamchatka and Mainland Asia
Country/Countries	Russia
Volcanic Subregion(s)	Kamchatka Peninsula
VAAC Region(s) of Nearby Volcanoes	Tokyo
Identification Method	Basic Growth
Mean Object Date/Time	2017-04-02 18:40:33UTC
Radiative Center (Lat, Lon):	51.310°, 156.960°
Nearby Volcanoes (meeting alert criteria):	Kambalny (2.20 km)
Trend in IR Brightness Temperature	-19.80 °C
Vertical Growth Rate Time Interval	10 minutes
Vertical Growth Rate Anomaly	6.20 number of stddev above mean
Maximum Height [AMSL]	8.40 km ; 27559 ft
90th Percentile Height [AMSL]	2.50 km ; 8202 ft
Mean Tropopause Height [AMSL]	8.70 km ; 28543 ft

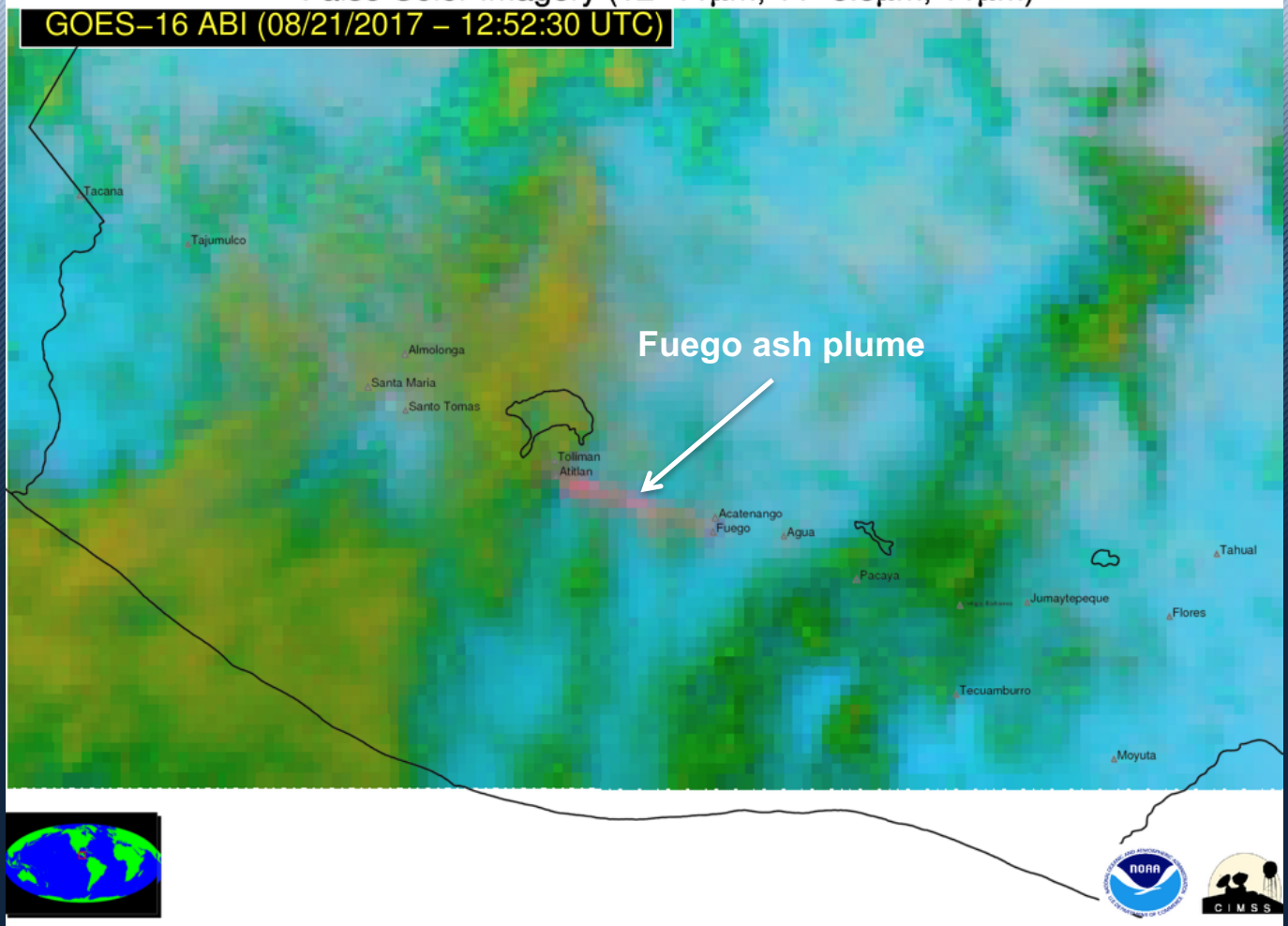
Show More ▲ View all event imagery »

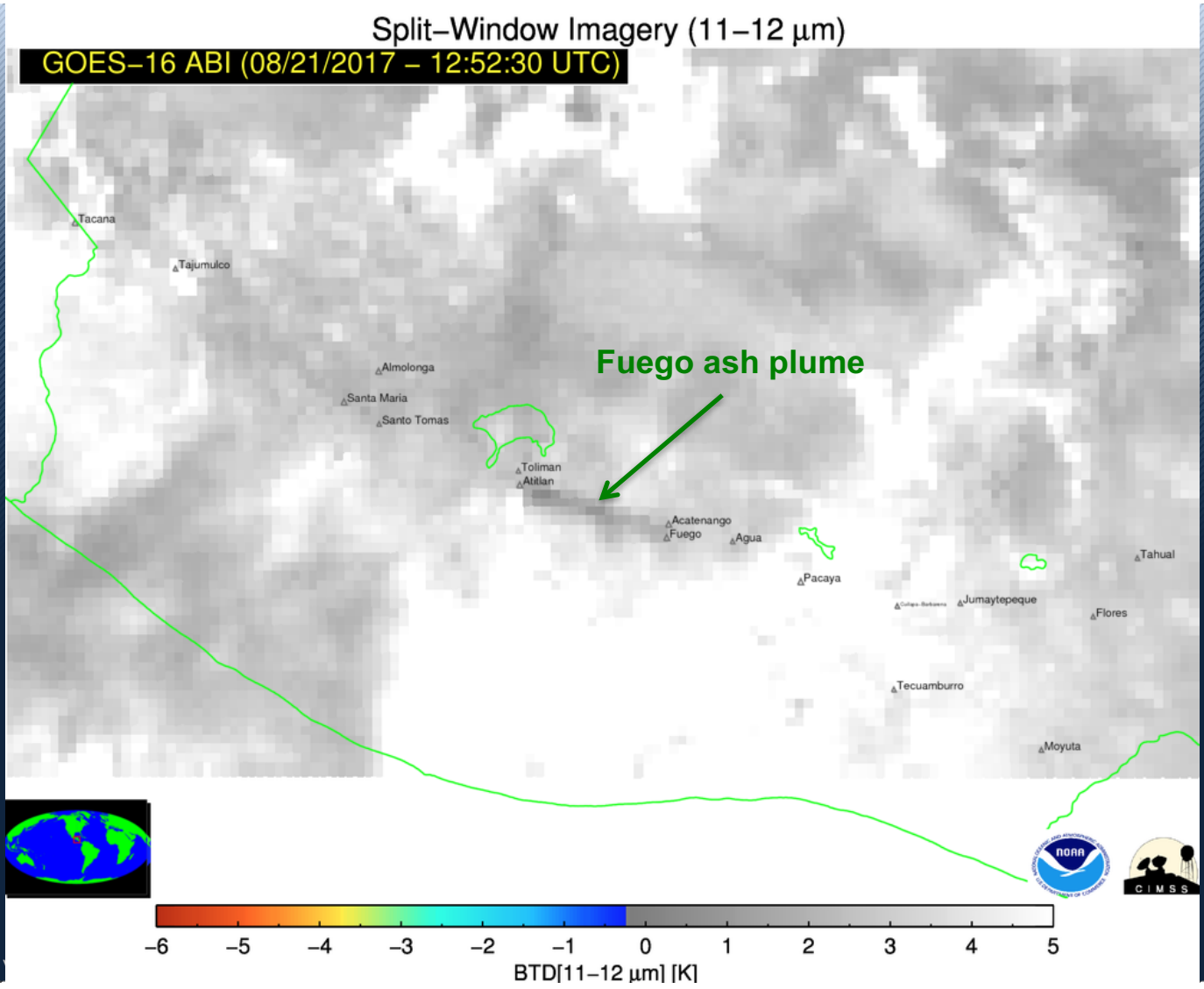
Kambalny

Evidence Quality	Volcano Dukono	
	Remote Sensing Evidence	
Weak	Anomalously rapid cloud development above a known volcano	☐
Weak	Convective development, that is asynchronous with the regional convective cycle, above a known volcano	☐
Moderate	Stationary, persistent (>1 hr) overshooting cloud top embedded within meteorological cloud above a known volcano	☐
Moderate	Hot spot at a known volcano	☐
Moderate	Anomalous lightning activity above a known volcano	☐
Weak	Low altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Moderate	High altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Strong	Grey or brown discolored clouds in true color imagery emmanating from a known volcano	☑
Strong	Cloud with a significant reverse absorption signal emmanating from a known volcano	☐
Strong	Anomalous linear or wedge shaped cloud emmanating from a known volcano	☑
Strong	Convective cloud like development in a stable air-mass above a known volcano	☐

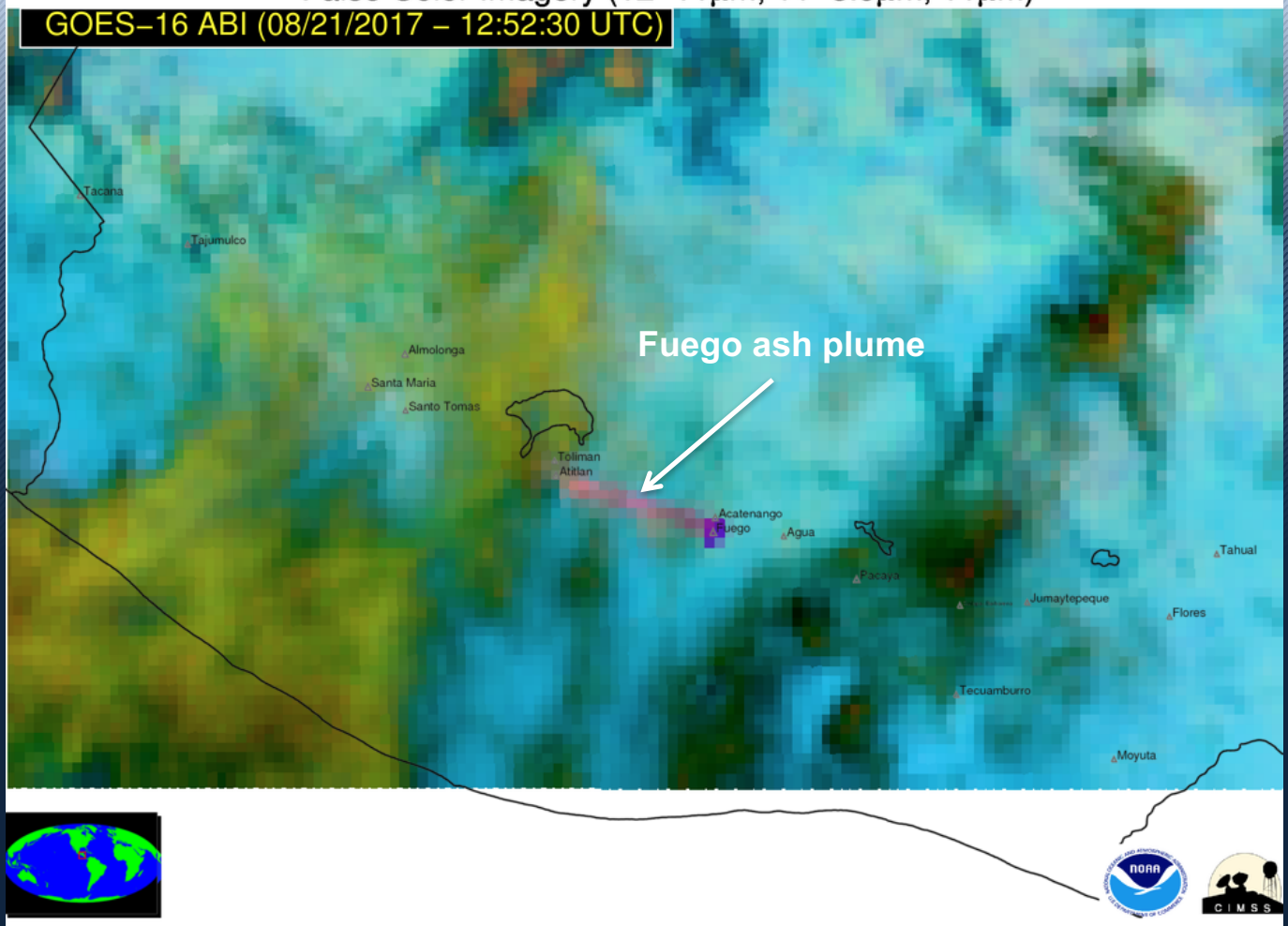
Strength of reverse absorption signal is relative. Reverse absorption should be examined within the context of other differential absorption signals to maximize value of spectral information.

False Color Imagery (12–11µm, 11–8.5µm, 11µm)

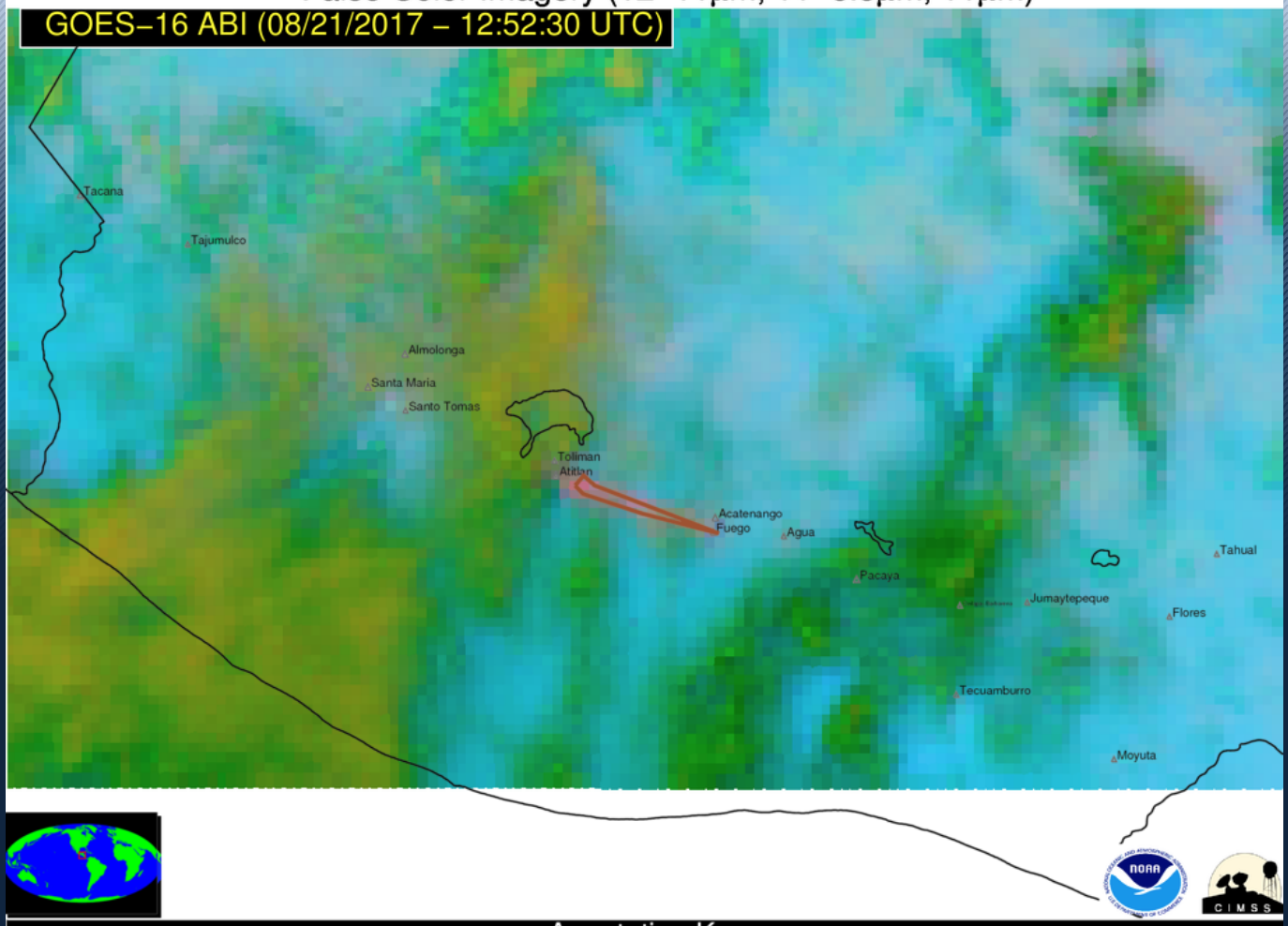



Split–Window Imagery (11–12 µm)
GOES–16 ABI (08/21/2017 – 12:52:30 UTC)
Tacana
Tajumulco
Almolonga
Santa Maria
Santo Tomas
Toliman
Atitlan
Fuego ash plume
Acatenango
Fuego
Agua
Pacaya
Tahual
Jumaytepeque
Flores
Tecuamburro
Moyuta
NOAA
CIMSS
–6 –5 –4 –3 –2 –1 0 1 2 3 4 5
BTD[11–12 µm] [K]

False Color Imagery (12–11µm, 11–3.9µm, 11µm)

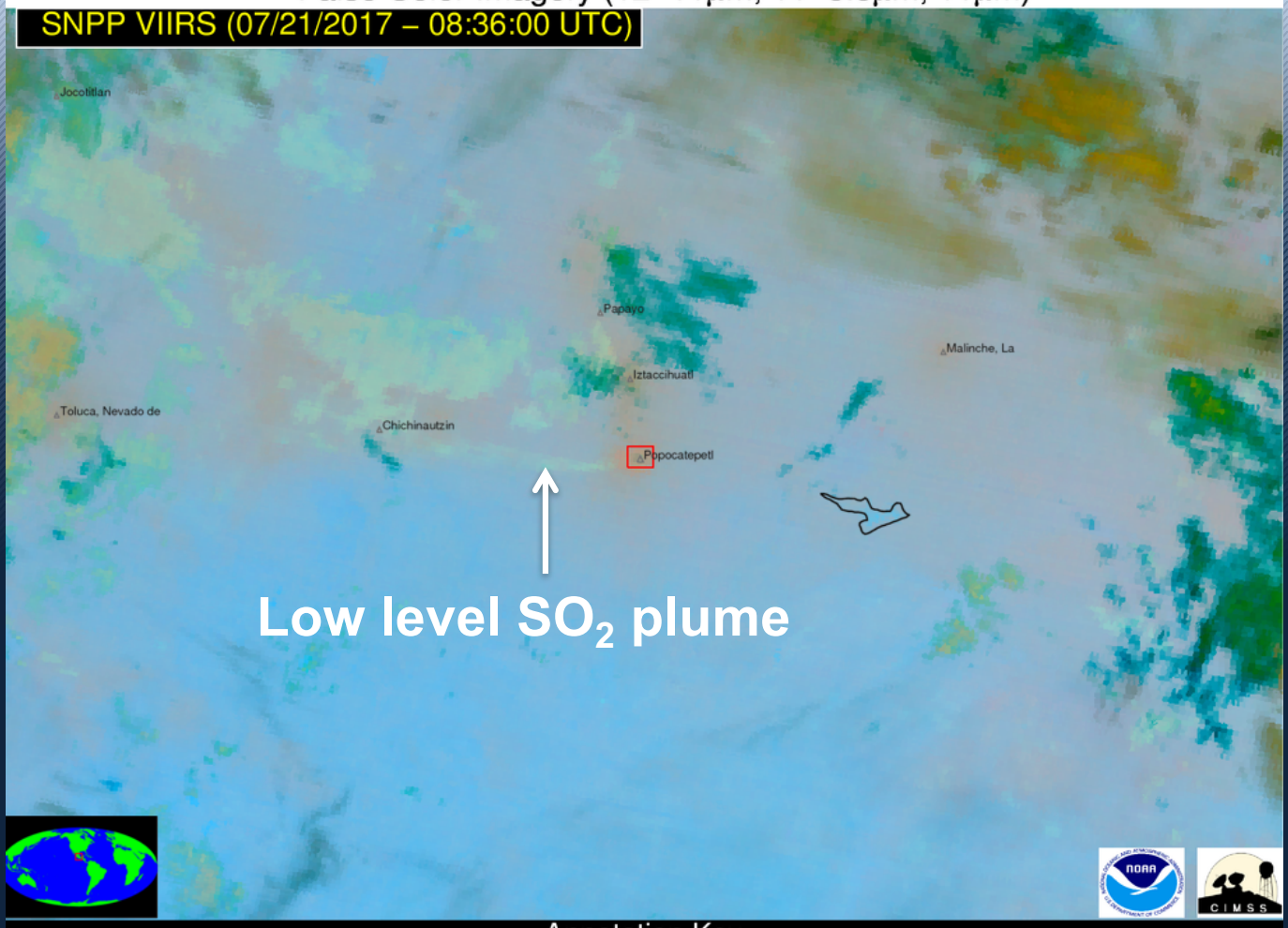


False Color Imagery (12–11μm, 11–8.5μm, 11μm)

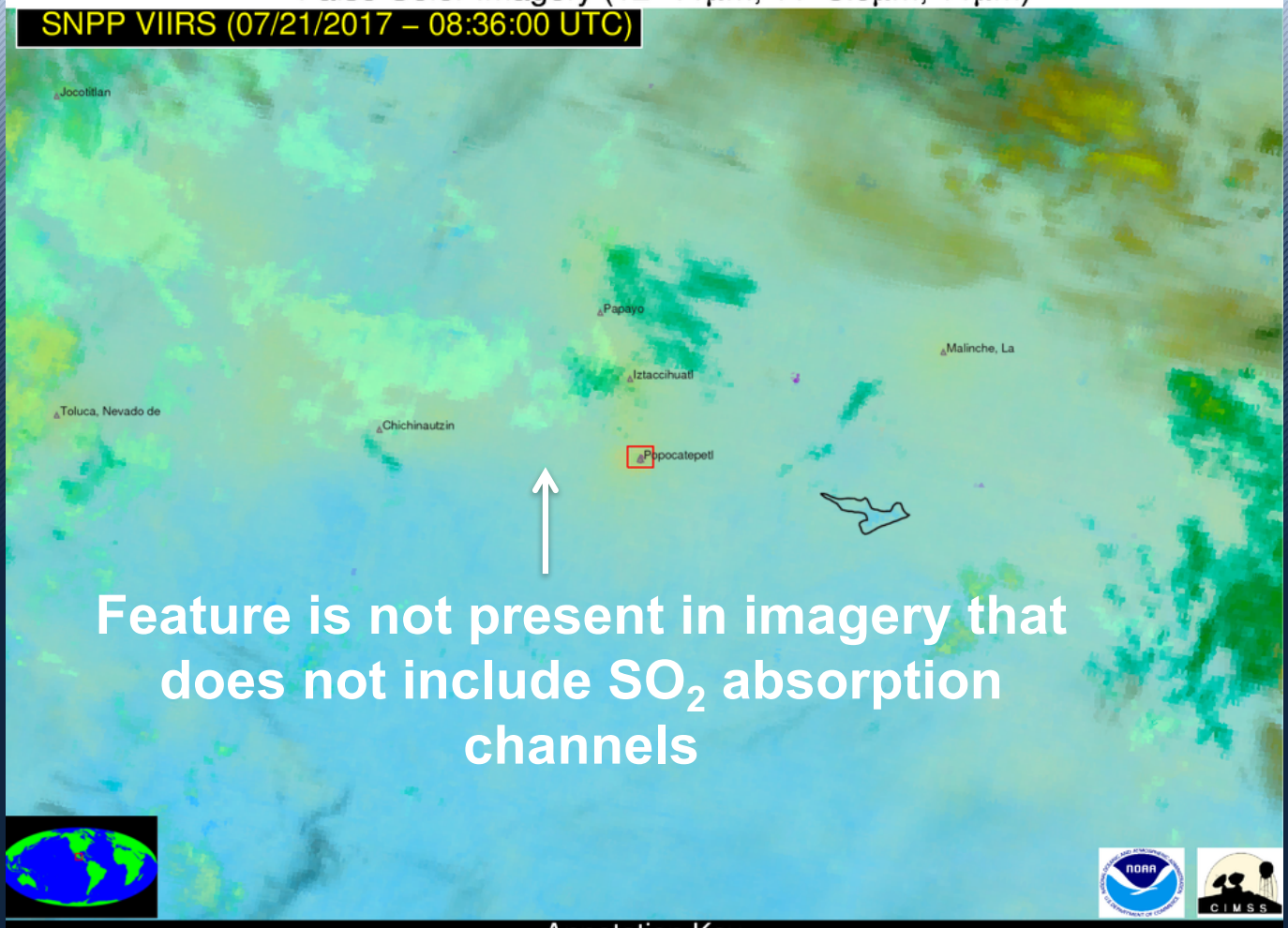


Annotation Key
(annotation colors are not related to colors in underlying image)
Ash/Dust Cloud Volcanic Cb Thermal Anomaly

False Color Imagery (12–11µm, 11–8.5µm, 11µm)



False Color Imagery (12–11µm, 11–3.9µm, 11µm)

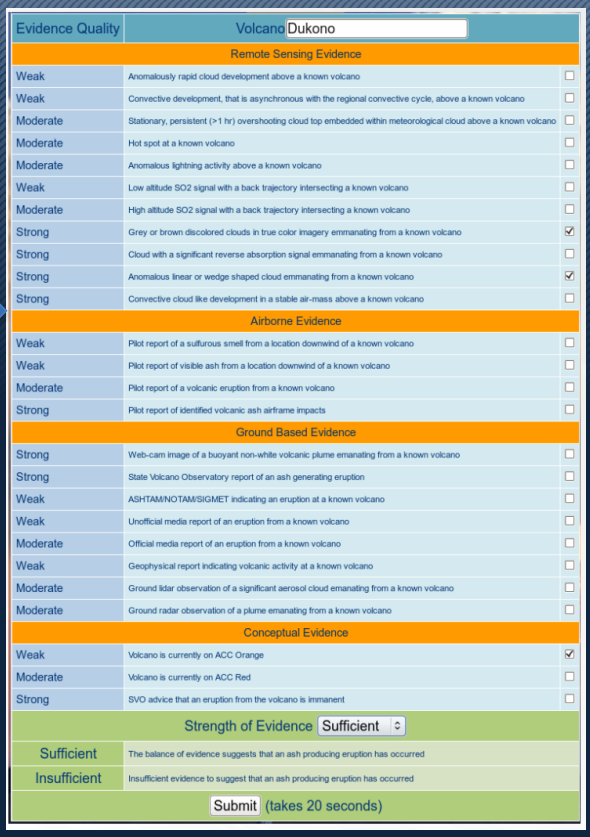


Role of Alerting in Workflow?

1. Cloud of interest from routine manual monitoring

1. Alert from satellite or other source

Relationship to KPI's?



Evidence Quality	Volcano: Dukono	
	Remote Sensing Evidence	
Weak	Anomalously rapid cloud development above a known volcano	☐
Weak	Convective development, that is asynchronous with the regional convective cycle, above a known volcano	☐
Moderate	Stationary, persistent (>1 hr) overshooting cloud top embedded within meteorological cloud above a known volcano	☐
Moderate	Hot spot at a known volcano	☐
Moderate	Anomalous lightning activity above a known volcano	☐
Weak	Low altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Moderate	High altitude SO2 signal with a back trajectory intersecting a known volcano	☐
Strong	Grey or brown discolored clouds in true color imagery emmanating from a known volcano	☑
Strong	Cloud with a significant reverse absorption signal emmanating from a known volcano	☐
Strong	Anomalous linear or wedge shaped cloud emmanating from a known volcano	☑
Strong	Convective cloud like development in a stable air-mass above a known volcano	☐
	Airborne Evidence	
Weak	Pilot report of a sulfurous smell from a location downwind of a known volcano	☐
Weak	Pilot report of visible ash from a location downwind of a known volcano	☐
Moderate	Pilot report of a volcanic eruption from a known volcano	☐
Strong	Pilot report of identified volcanic ash airframe impacts	☐
	Ground Based Evidence	
Strong	Web-cam image of a buoyant non-white volcanic plume emanating from a known volcano	☐
Strong	State Volcano Observatory report of an ash generating eruption	☐
Weak	ASHTAM/NOTAM/SIGMET indicating an eruption at a known volcano	☐
Weak	Unofficial media report of an eruption from a known volcano	☐
Moderate	Official media report of an eruption from a known volcano	☐
Weak	Geophysical report indicating volcanic activity at a known volcano	☐
Moderate	Ground lidar observation of a significant aerosol cloud emanating from a known volcano	☐
Moderate	Ground radar observation of a plume emanating from a known volcano	☐
	Conceptual Evidence	
Weak	Volcano is currently on ACC Orange	☑
Moderate	Volcano is currently on ACC Red	☐
Strong	SVO advice that an eruption from the volcano is immanent	☐
	Strength of Evidence: Sufficient	
Sufficient	The balance of evidence suggests that an ash producing eruption has occurred	
Insufficient	Insufficient evidence to suggest that an ash producing eruption has occurred	
	Submit (takes 20 seconds)	

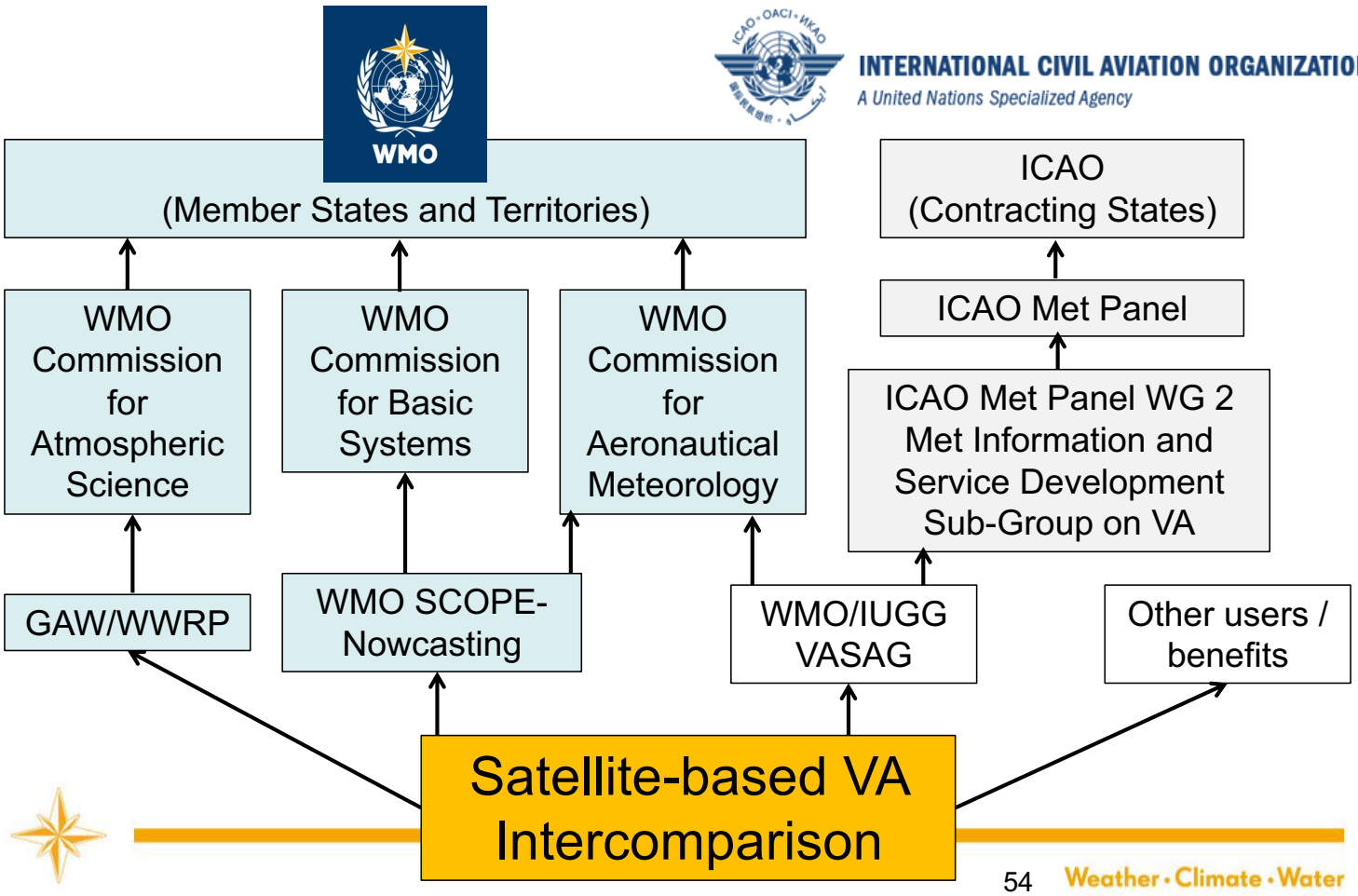
Topics

1. Latest developments

2. Discernible ash and strength of evidence checklist

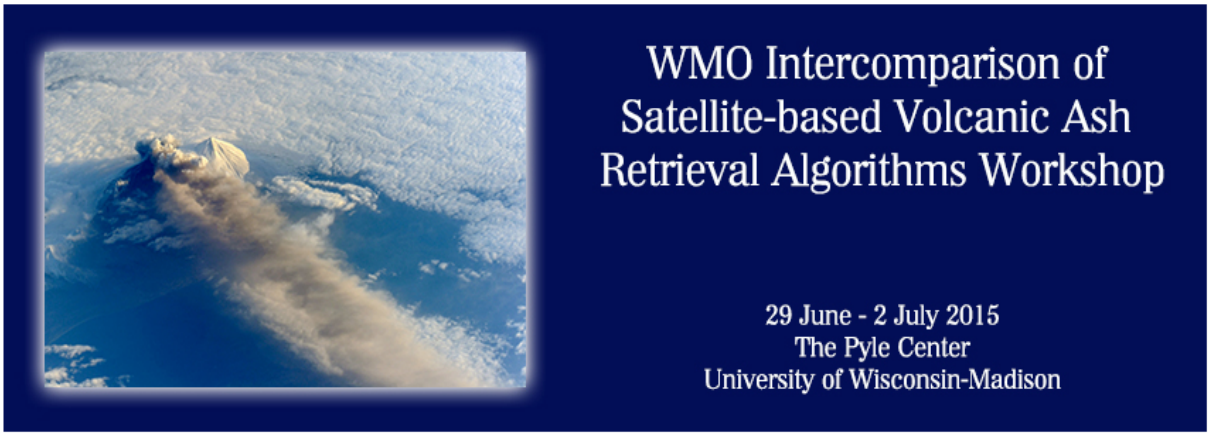
3. Satellite inter-comparison

VA Intercomparison: Need for Guidance



http://cimss.ssec.wisc.edu/meetings/vol_ash15/

Apple (122) Yahoo! eBay Amazon News (1,802)



Volcanic ash from Pavlof Volcano as photographed by astronauts aboard the International Space Station on May 18, 2013 (credit: NASA)

Venue | Program | Hotel | Register | Madison

Description of Meeting

In support of aeronautical meteorological services, WMO is sponsoring the Intercomparison of Satellite-based Volcanic Ash Retrieval Algorithms Workshop, which presents an excellent opportunity to improve the consistency of quantitative volcanic ash products from satellites. This meeting will be hosted by NOAA and Space Science and Engineering Center (SSEC) at the University of Wisconsin in Madison WI, USA, on 29 June through 2 July 2015. The volcanic ash intercomparison activity is embedded in the WMO-sponsored SCOPE-Nowcasting initiative (Sustained Coordinated Processing of Environmental Satellite Data for Nowcasting), which aims at improved rapid access to satellite data by member states, and at improved confidence in satellite products for nowcasting. The meeting in Madison is supported by the WMO Space Programme, the Aeronautical Meteorological Programme, and the Atmospheric Research and

http://www.wmo.int/pages/prog/sat/documents/SCOPE-NWC-PP2_VAIntercompWSReport2015.pdf

Algorithm Contributions (Total: 27 (22))

Organization	Algorithm(s)
NOAA	SEVIRI_NOAA MODIS_NOAA
Oxford University	IASI_OXFORD TERRA_MODIS_ORAC AQUA_MODIS_ORAC
Université Libre de Bruxelles	IASI_ULB
CMA	SEVIRI_CMA
EUMETSAT	METOP-A_PMAP METOP-B_PMAP SEVIRI_EUMOP
Australian BOM	MTSAT2_BOM MODIS_BOM
DLR Germany	SEVIRI_VADUGS
SNM Argentina	MODIS_CENZARG
INGV Italy	MODIS_LUT MODIS_VPR
SRC Planeta, Russia	METOP_PLANETA
University of Bristol	BRISTOL_IASI
UK MetOffice	SEVIRI_MO AVHRR_MO

Organization	Algorithm(s)
JMA	MTSAT2_JMA MTSATIR_JMA
STFC RAL, UK	SEVIRI_ORAC_RAL TERRA_MODIS_RAL AQUA_MODIS_RAL
FMI	AATSR_FMI
NASA	MISR

"Validation" Sources

- FAAM UK Airborne lidar
- CALIPSO CALIOP
- Ground-based Lidar
- Expert assessment

Inter-comparison: Primary Conclusions

- The accuracy of satellite-based volcanic ash products is a strong function of the retrieval methodology, satellite sensor capability, and scene complexity.

- Additional analyses are required to better understand differences and provide a consensus outlook on end-to-end capabilities for operational applications

Proposed Actions - ~12 month effort

- Reaffirm commitment from algorithm contributors (contributors will have a chance to update their data sets)
- Expand ash detection validation through comparison with expert analyses
- *Gain detailed insight into differences in retrieved ash cloud properties:* Compare all retrieval inputs (satellite measurements and ancillary data) for a select number of common pixels, co-located with validation data, with different background conditions (water background, land background, meteorological cloud background, etc.). For the same common pixels, analyze all retrieval outputs.
- Inter-compare volcanic ash products derived from the first of the next generation geostationary satellites (Himawari-8 AHI) for a single event from start to finish
- Hold a workshop to document results, formulate best practices, and assess ability to meet demands of aviation community for more quantitative volcanic ash advisories

Near Real-time Products

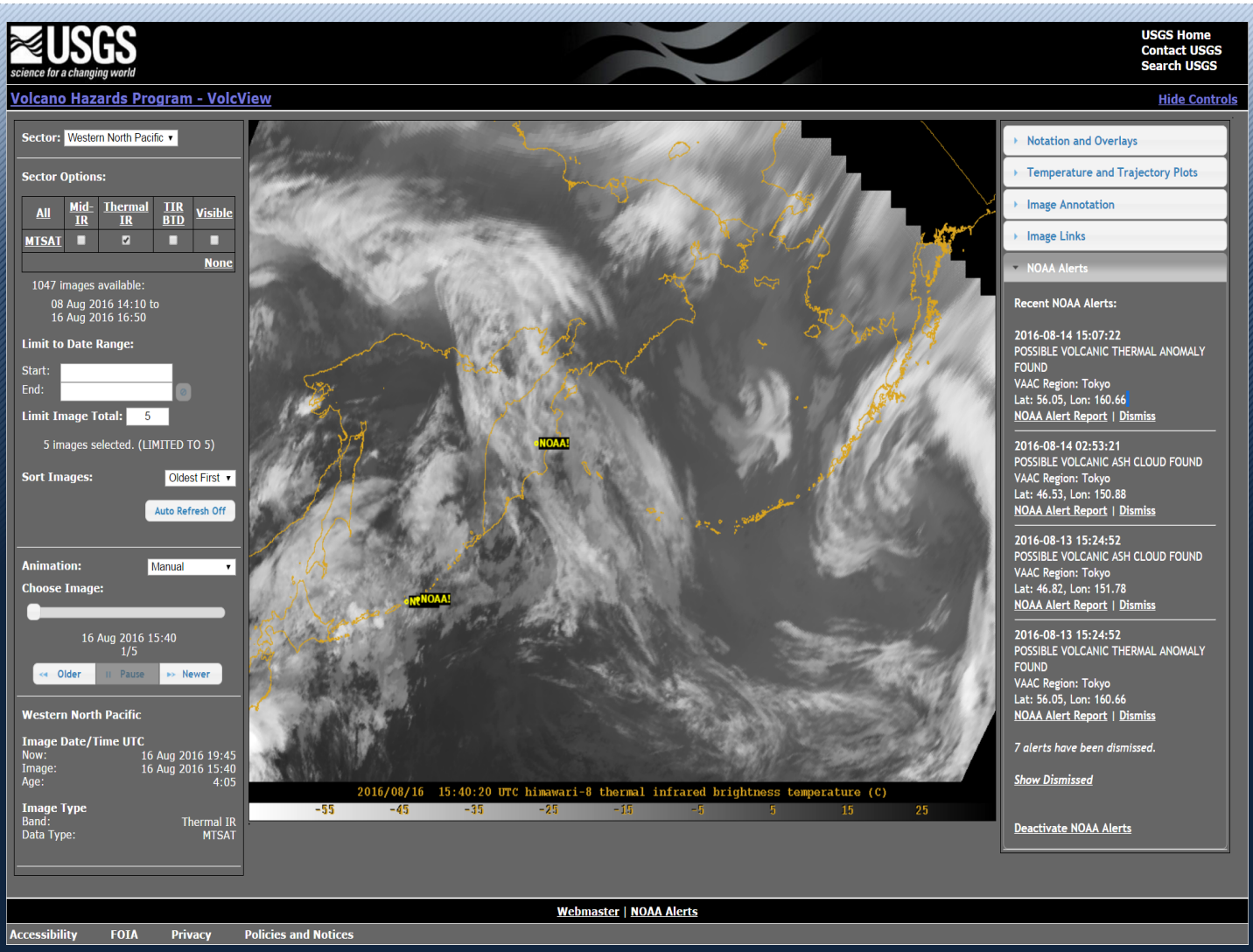
EUMETSAT: GOME-2 absorbing index, multi-sensor aerosol optical properties (PMAp), SEVIRI ash flag
https://www.eumetsat.int/website/home/Data/Products/Atmosphere/index.html

ESA and Partners: Support to Aviation Control Service (SACS) SO_2 and ash alerts using IASI, AIRS, GOME-2, and OMI (low earth orbit hyperspectral sensors)
http://sacs.aeronomie.be/

JMA: Comparison of NOAA VOLCAT volcanic ash products (2014 version) and JMA/EUMETSAT method using AHI
http://www.data.jma.go.jp/mscweb/en/va_testbed/

NOAA: VOLcanic Cloud Analysis Toolkit (VOLCAT) – global eruption alerts and ash characterization products from many GEO and LEO sensors
http://volcano.ssec.wisc.edu/

USGS: VolcView – Imagery and tools for detecting and characterizing volcanic cloudss in the North Pacific and other regions
https://volcview.wr.usgs.gov/


USGS
science for a changing world
USGS Home
Contact USGS
Search USGS
Volcano Hazards Program - VolcView
Hide Controls
Sector: Western North Pacific
Sector Options:
All
Mid-IR
Thermal IR
TIR BTD
Visible
MTSAT
None
1047 images available:
08 Aug 2016 14:10 to
16 Aug 2016 16:50
Limit to Date Range:
Start:
End:
Limit Image Total: 5
5 images selected. (LIMITED TO 5)
Sort Images: Oldest First
Auto Refresh Off
Animation: Manual
Choose Image:
16 Aug 2016 15:40
1/5
Older
Pause
Newer
Western North Pacific
Image Date/Time UTC
Now: 16 Aug 2016 19:45
Image: 16 Aug 2016 15:40
Age: 4:05
Image Type
Band: Thermal IR
Data Type: MTSAT
NOAA!
NOAA!
2016/08/16 15:40:20 UTC himawari-8 thermal infrared brightness temperature (C)
-55 -45 -35 -25 -15 -5 5 15 25
Notation and Overlays
Temperature and Trajectory Plots
Image Annotation
Image Links
NOAA Alerts
Recent NOAA Alerts:
2016-08-14 15:07:22
POSSIBLE VOLCANIC THERMAL ANOMALY FOUND
VAAC Region: Tokyo
Lat: 56.05, Lon: 160.66
NOAA Alert Report | Dismiss
2016-08-14 02:53:21
POSSIBLE VOLCANIC ASH CLOUD FOUND
VAAC Region: Tokyo
Lat: 46.53, Lon: 150.88
NOAA Alert Report | Dismiss
2016-08-13 15:24:52
POSSIBLE VOLCANIC ASH CLOUD FOUND
VAAC Region: Tokyo
Lat: 46.82, Lon: 151.78
NOAA Alert Report | Dismiss
2016-08-13 15:24:52
POSSIBLE VOLCANIC THERMAL ANOMALY FOUND
VAAC Region: Tokyo
Lat: 56.05, Lon: 160.66
NOAA Alert Report | Dismiss
7 alerts have been dismissed.
Show Dismissed
Deactivate NOAA Alerts
Webmaster | NOAA Alerts
Accessibility FOIA Privacy Policies and Notices