



# Real Time Volcanic Cloud products and predictions for Aviation Alerts



## Stage 1 Team:

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Keith Evans (UMBC)

## Stage 2 collaborators/partners

Davida Streets ( NOAA – NESDIS - SAB)

Barbara Stunder , Roland Draxler (NOAA -ARL)

Mike Pavolonis (NOAA – NESDIS)

Dave Schneider, Marianne Guffanti (USGS)

Tom Heinrichs ( UAF - GINA )

Seppo Hassinen, Johanna Tamminen (FMI)

Robert Hoffman (Metron Aviation)

Colin Seftor, Mike Linda (NASA OPEATE- SSAI)

Kelvin W. Brentzel (NASA - DRL )

NASA Disasters Project Managers: Francis Lindsay and John Murray



# NASA A-Train

Aura (2004-)

**OMI** -  $\text{SO}_2$ ,  $\text{NO}_2$ , BrO

**TES** -  $\text{SO}_2$

**MLS** - strat.  $\text{SO}_2$ , HCl

CloudSat (2006-)

**CPR (radar)** –  
precipitation,  
hydrometeors

Aqua (2002-)

**MODIS** -  $\text{SO}_2$ , ash, sulfate

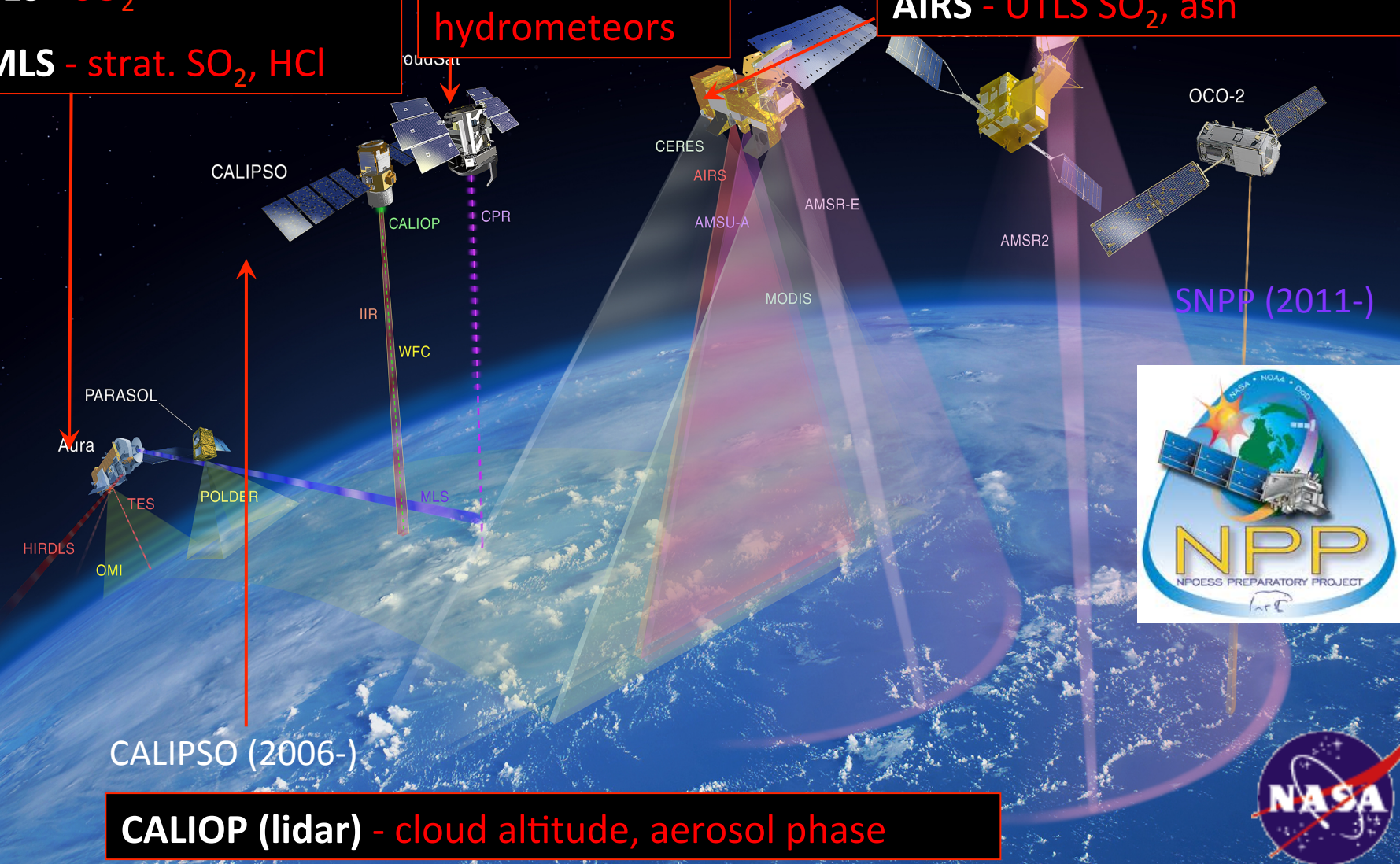
**AIRS** - UTLS  $\text{SO}_2$ , ash

OCO-2

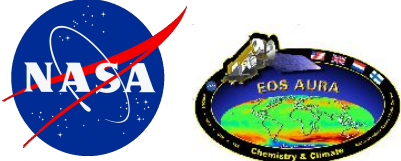
SNPP (2011-)

CALIPSO (2006-)

**CALIOP (lidar)** - cloud altitude, aerosol phase



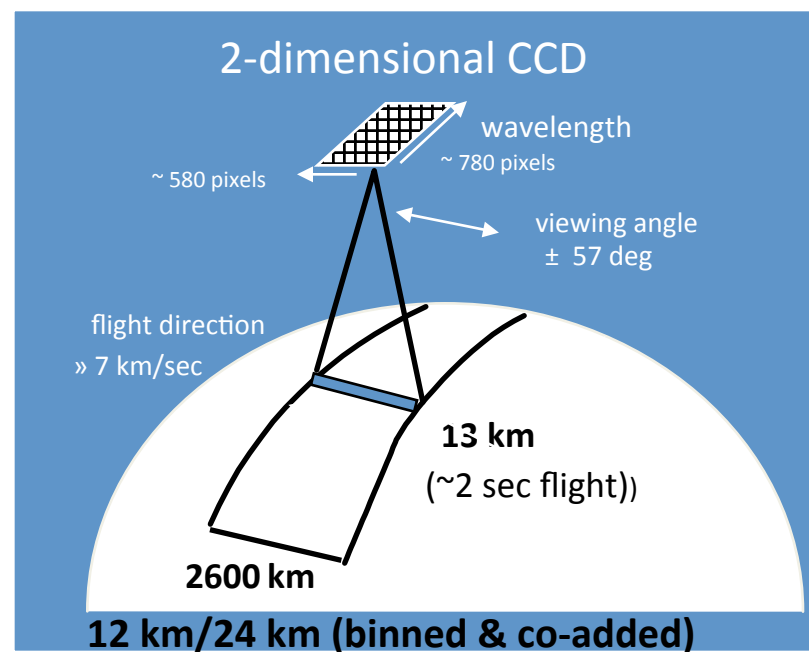
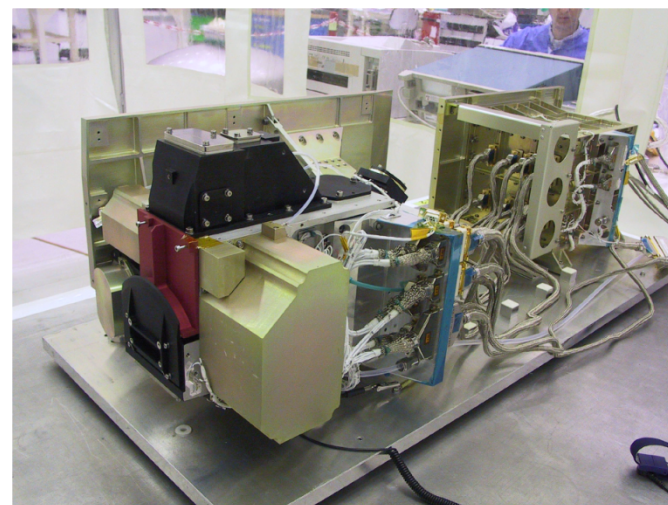




# Aura / Ozone Monitoring Instrument (OMI) continues 30+ year $O_3$ and $SO_2$ records



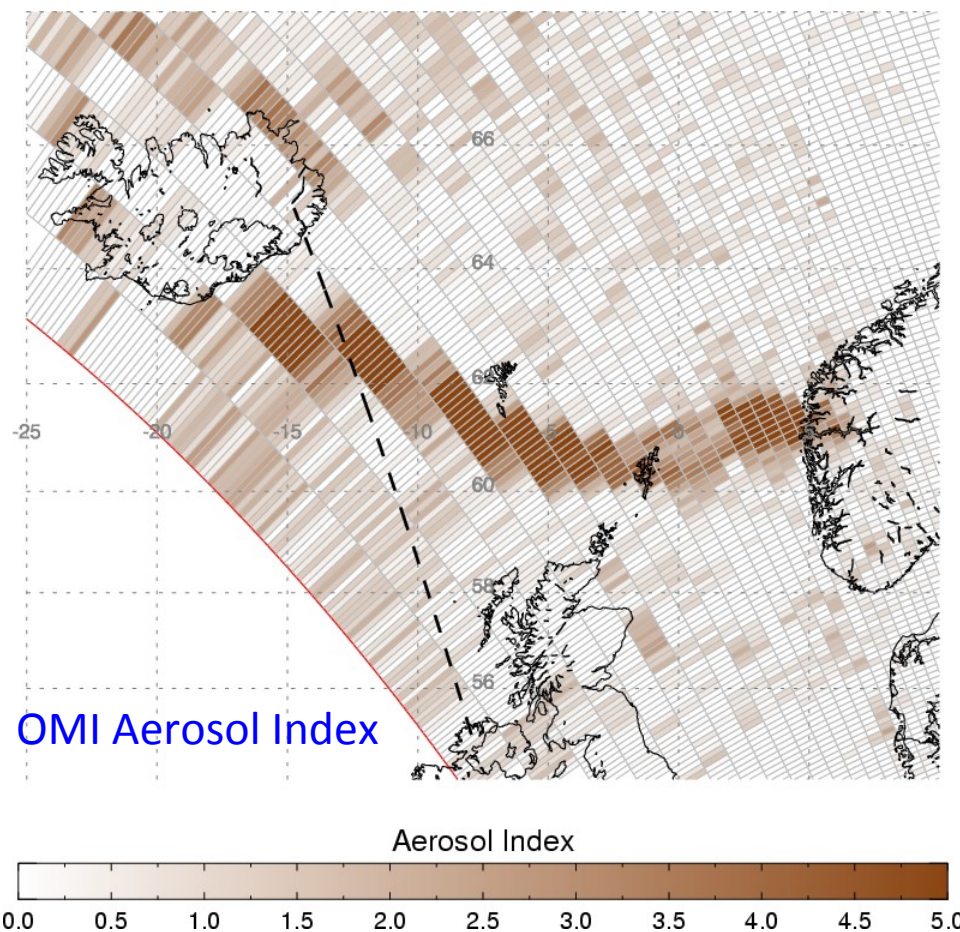
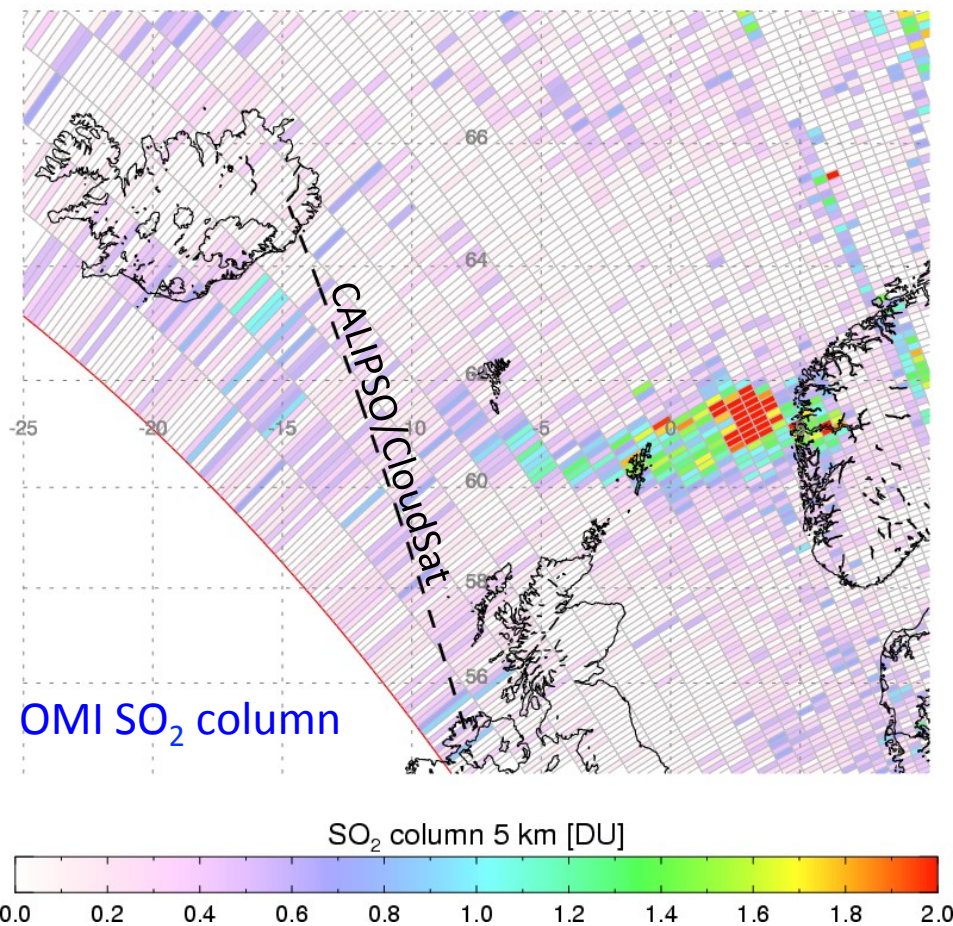
- Launched on NASA EOS Aura platform in 2004,
- Joint Dutch-Finnish Instrument with Dutch/Finish/ U.S. Science Team
  - PI: P. Levelt, KNMI
  - Hyperspectral wide FOV Radiometer
    - 270-500 nm
    - 13x24 km nadir footprint (highest UV resolution from space !)
    - Swath width 2600 km ( contiguous coverage )
  - Radicals: Column  $O_3$ ,  $NO_2$ , BrO, OCIO
  - $O_3$  profile ~ 5-10 km vert resolution
  - Tracers: Column  **$SO_2$** , HCHO
  - Aerosols ( **Volcanic Ash**, smoke, dust)
  - Cloud top press., cloud coverage
  - Surface UVB
  - Tropospheric ozone





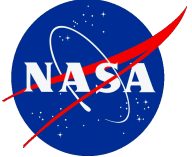


# Aura/OMI volcanic SO<sub>2</sub> and UV Aerosol Index maps of Eyjafjallajökull eruption plume on April 15, 2010




- Near real-time (NRT) OMI SO<sub>2</sub> and AI data produced within 3 hours of satellite overpass and displayed at NOAA operational site: <http://satepsanone.nesdis.noaa.gov/pub/OMI/OMISO2/index.html>
- NASA LANCE web site: <https://earthdata.nasa.gov/labs/worldview/>





# Near Real-time Volcanic Cloud Products from NASA LANCE project:



National Aeronautics and Space Administration  
Goddard Space Flight Center

Flight Projects | Sciences and Exploration

Atmospheric Chemistry and Dynamics Laboratory (Code 614)

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### Volcanic Hazards Project

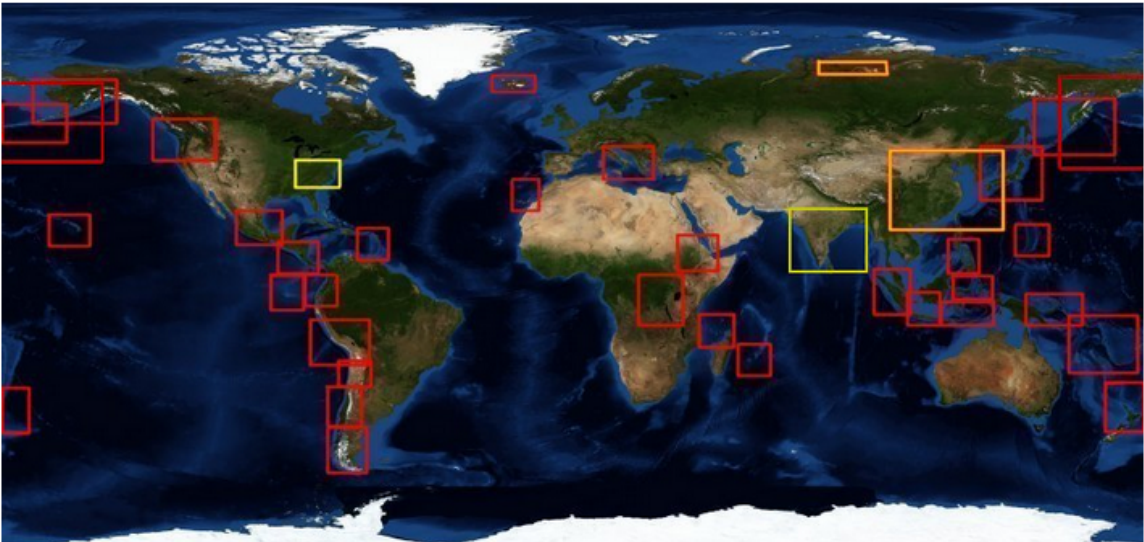
Latest SO<sub>2</sub> eruption alerts [NOAA-NESDIS](#) [SACS\\_BIRA](#) [IASI-ULB](#).  
SO<sub>2</sub> Near Real-Time Images: [NASA\(DR\)](#) [FMI\(DR\)](#) [NASA\(NRT\)](#) [NOAA\(NRT\)](#) [AIRS\(NRT\)](#) [SACS\(NRT\)](#).

### MEaSUREs project:

[TOMS images \(1979-2005\)](#) | [AIRS images \(2003-present\)](#) | [OMI images \(2004-present\)](#) | [OMPS images \(May 2012-present\)](#)

### Latest Daily (OMI/OMPS) Images of SO<sub>2</sub> (click on a highlighted rectangle)

Red = daily volcanic regions, orange = daily pollution regions, yellow = long-term pollution images



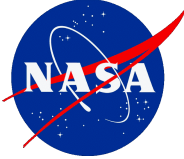




# NRT Terra MODIS True color map of the ash cloud from Sangeang Api eruption







# NASA A-train: NRT Aqua MODIS True Color map

<https://earthdata.nasa.gov/labs/worldview/>

Global Sulfur Dioxide Mon... x EOSDIS Worldview (Alpha) x +

https://earthdata.nasa.gov/labs/worldview/ Google

NASA WORLDVIEW alpha

Active + - <

Base Layers

Corrected Reflectance (True Color) Aqua / MODIS

Overlays

National Boundaries SEDAC / National Boundaries

2014-05-31

2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

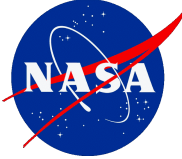
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

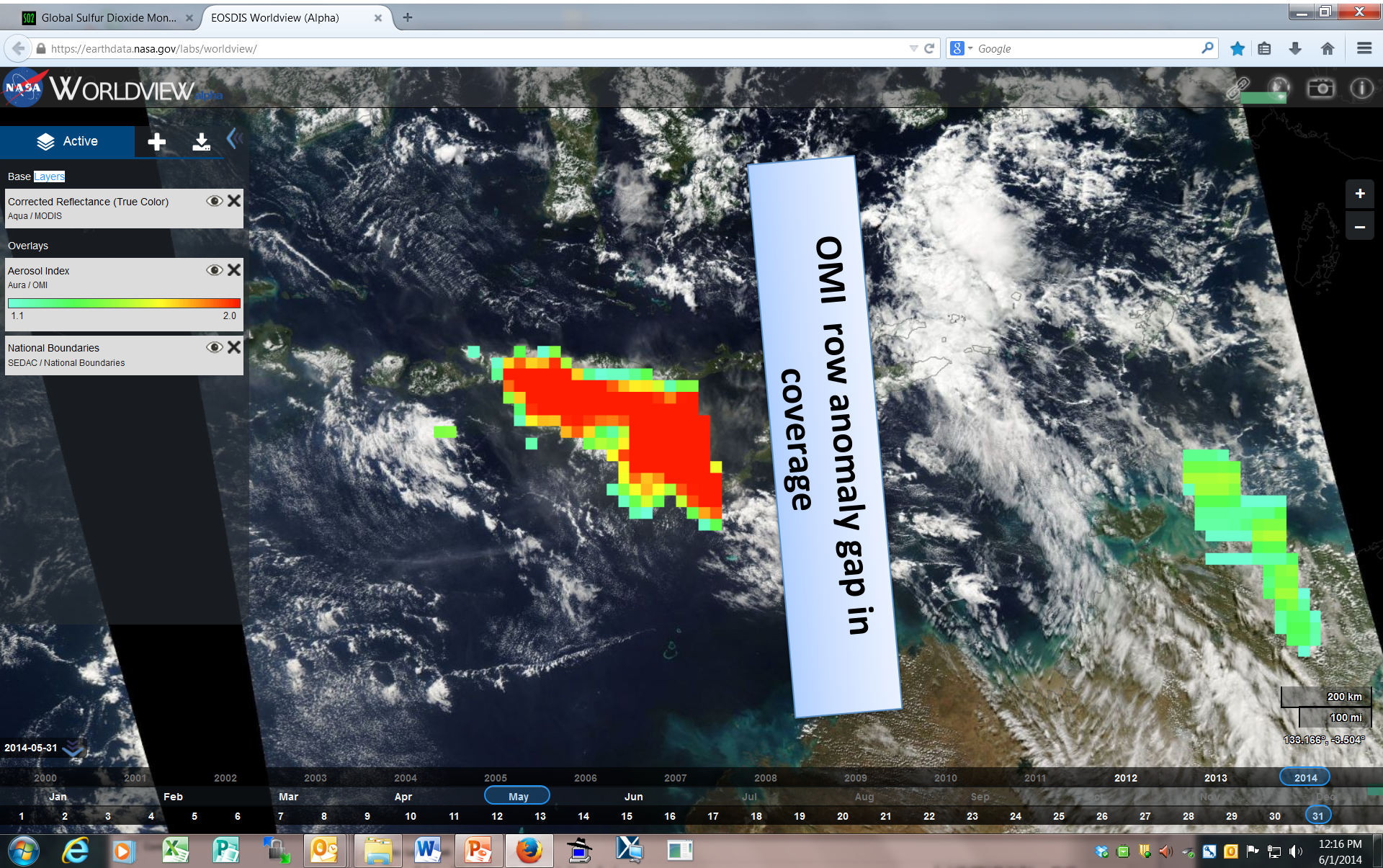
200 km 100 mi 113.664° -8.691°

12:15 PM 6/1/2014

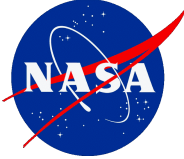




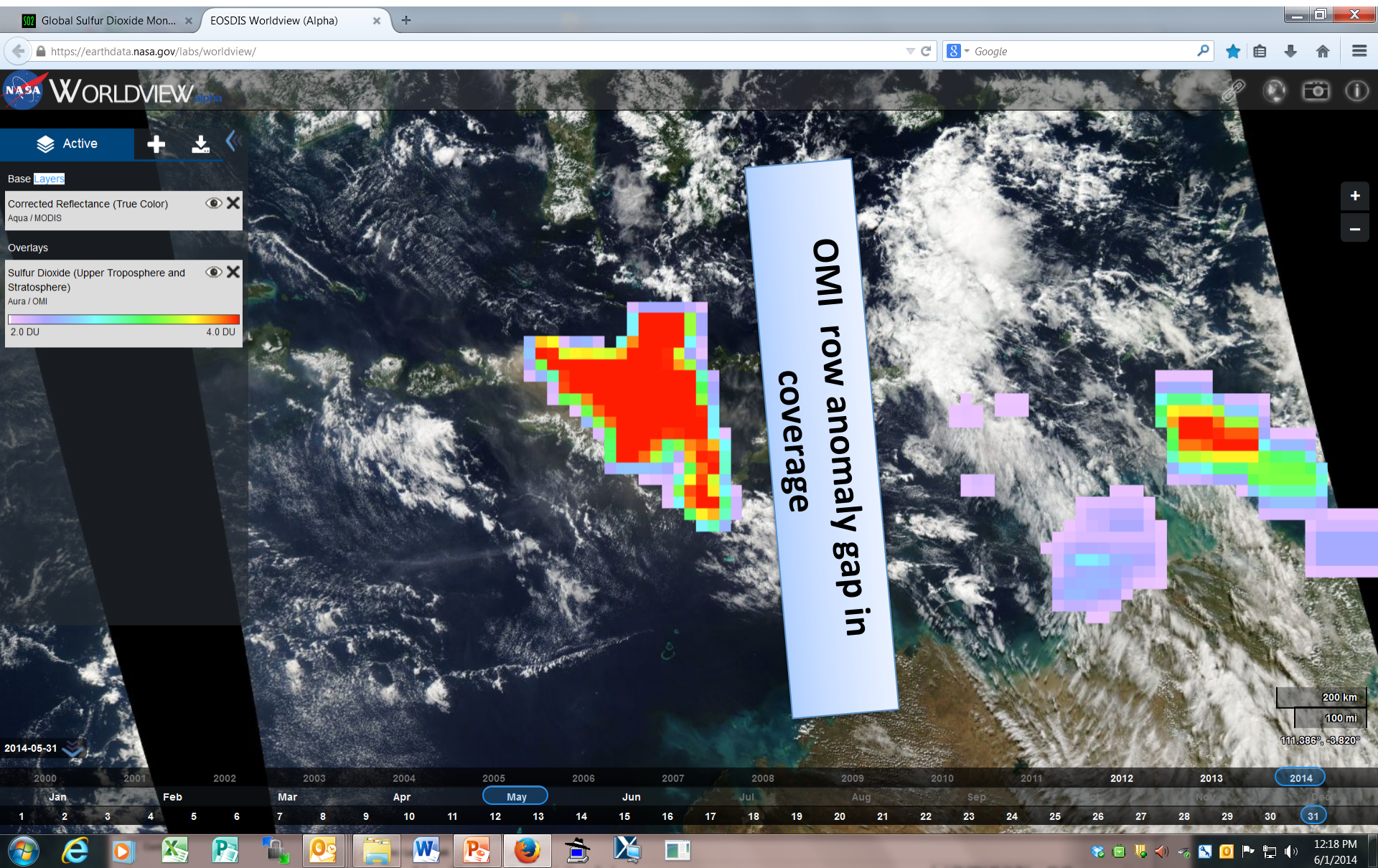
# Aqua MODIS True Color + OMI UV Aerosol Index (Ash)







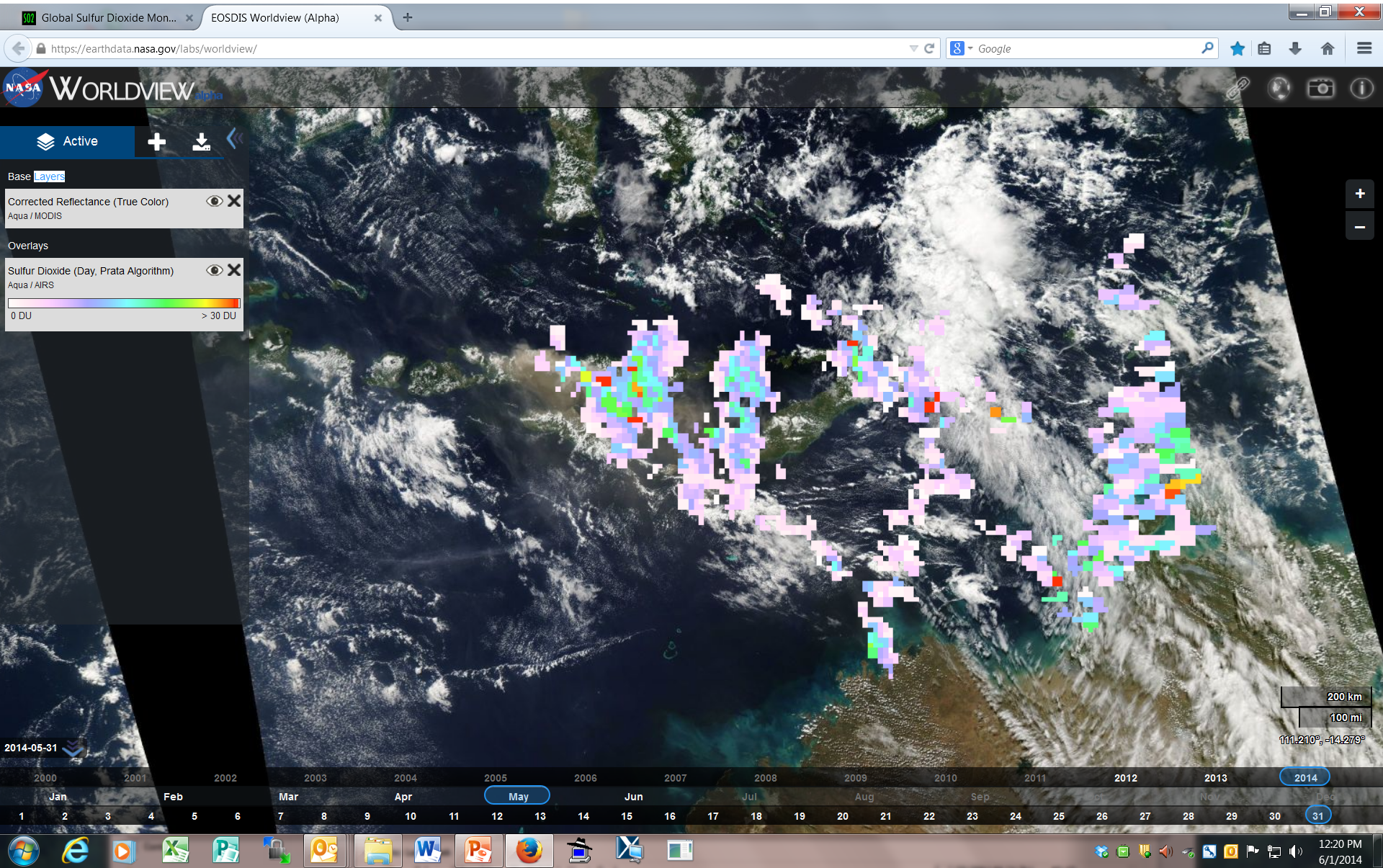
# Aqua MODIS True Color + OMI SO<sub>2</sub> (volcanic)



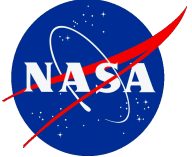





# Aqua MODIS True Color + AIRS SO<sub>2</sub> (Fred Prata algorithm)







# Near Real-time AIRS Volcanic SO<sub>2</sub> from GSFC DISC web site:



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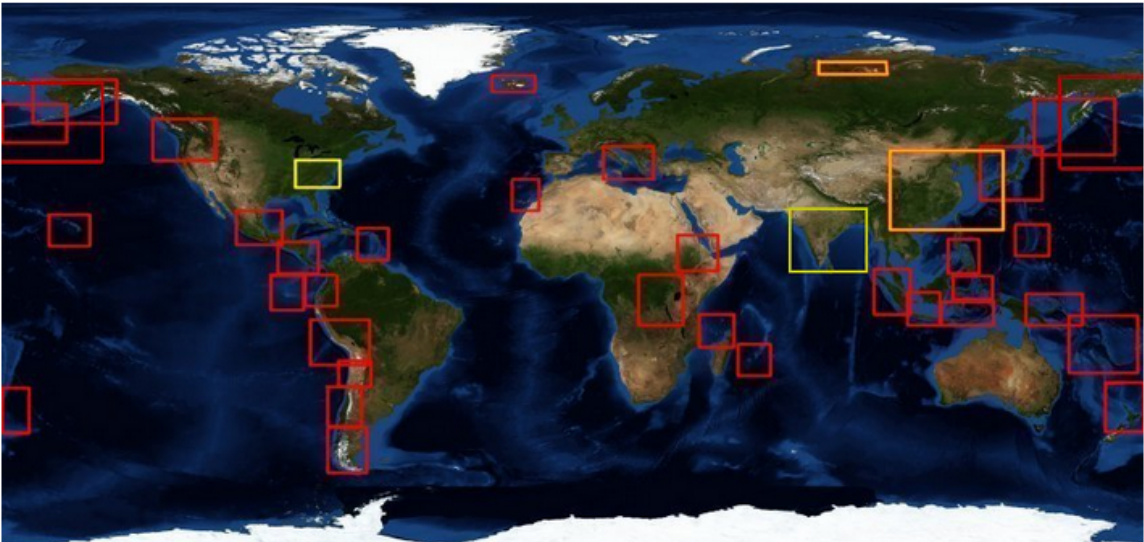
Global Sulfur Dioxide Monitoring Home Page

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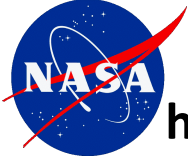
**Volcanic Hazards Project**  
[Latest SO<sub>2</sub> eruption alerts](#) [NOAA-NESDIS](#). [SACS\\_BIRA](#). [IASI-ULB](#).  
[SO<sub>2</sub> Near Real-Time Images](#): [NASA\(DR\)](#). [FMI\(DR\)](#). [NASA\(NRT\)](#). [NOAA\(NRT\)](#). [AIRS\(NRT\)](#). [SACS\(NRT\)](#).

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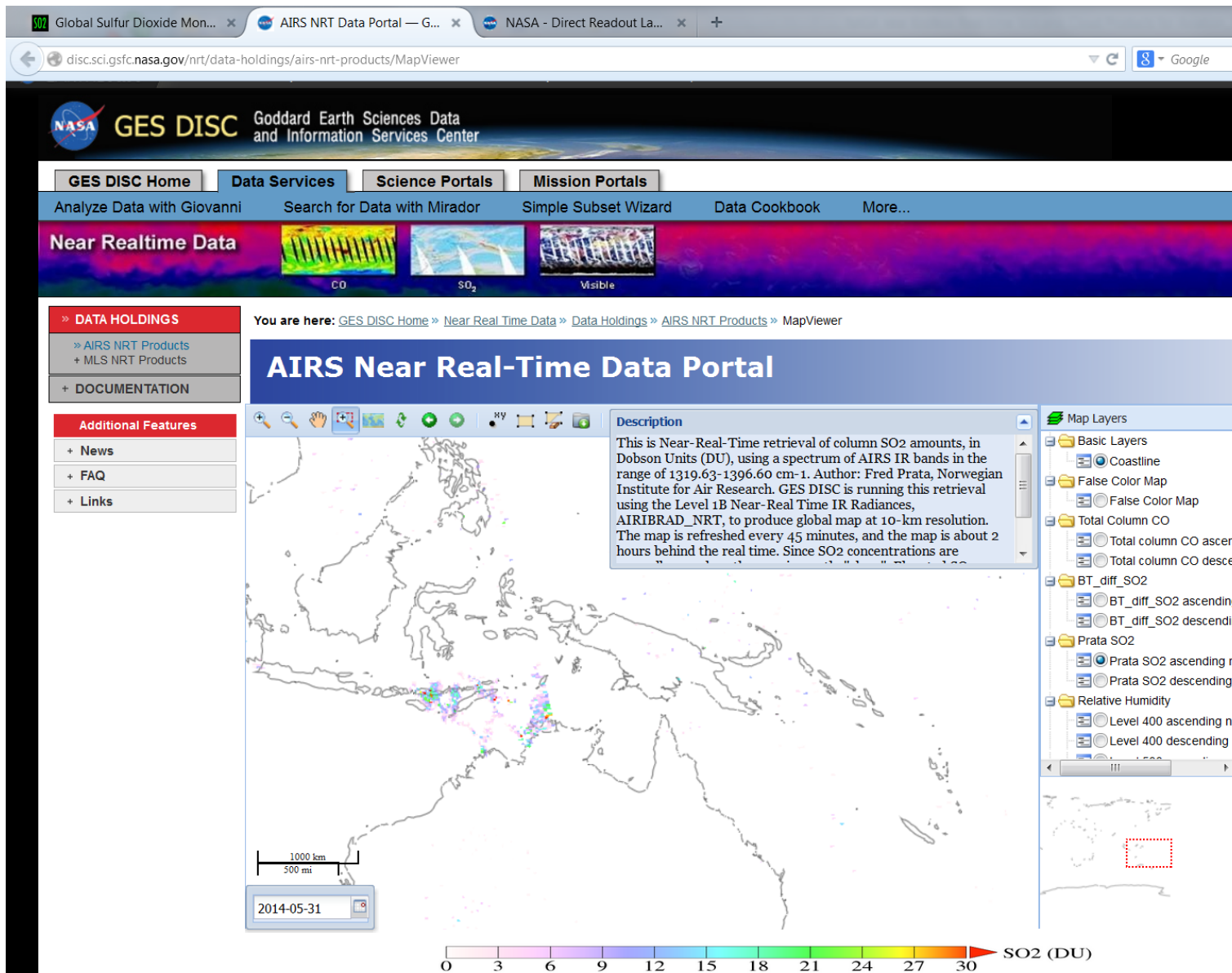
**Latest Daily (OMI/OMPS) Images of SO<sub>2</sub> (click on a highlighted rectangle)**  
**Red** = daily volcanic regions, **orange** = daily pollution regions, **yellow** = long-term pollution images



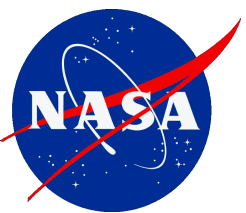




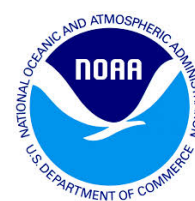
# GSFC DISC provides NRT volcanic SO<sub>2</sub> (Prata alg) mapping service: <http://disc.sci.gsfc.nasa.gov/nrt/data-holdings/airs-nrt-products/MapViewer>



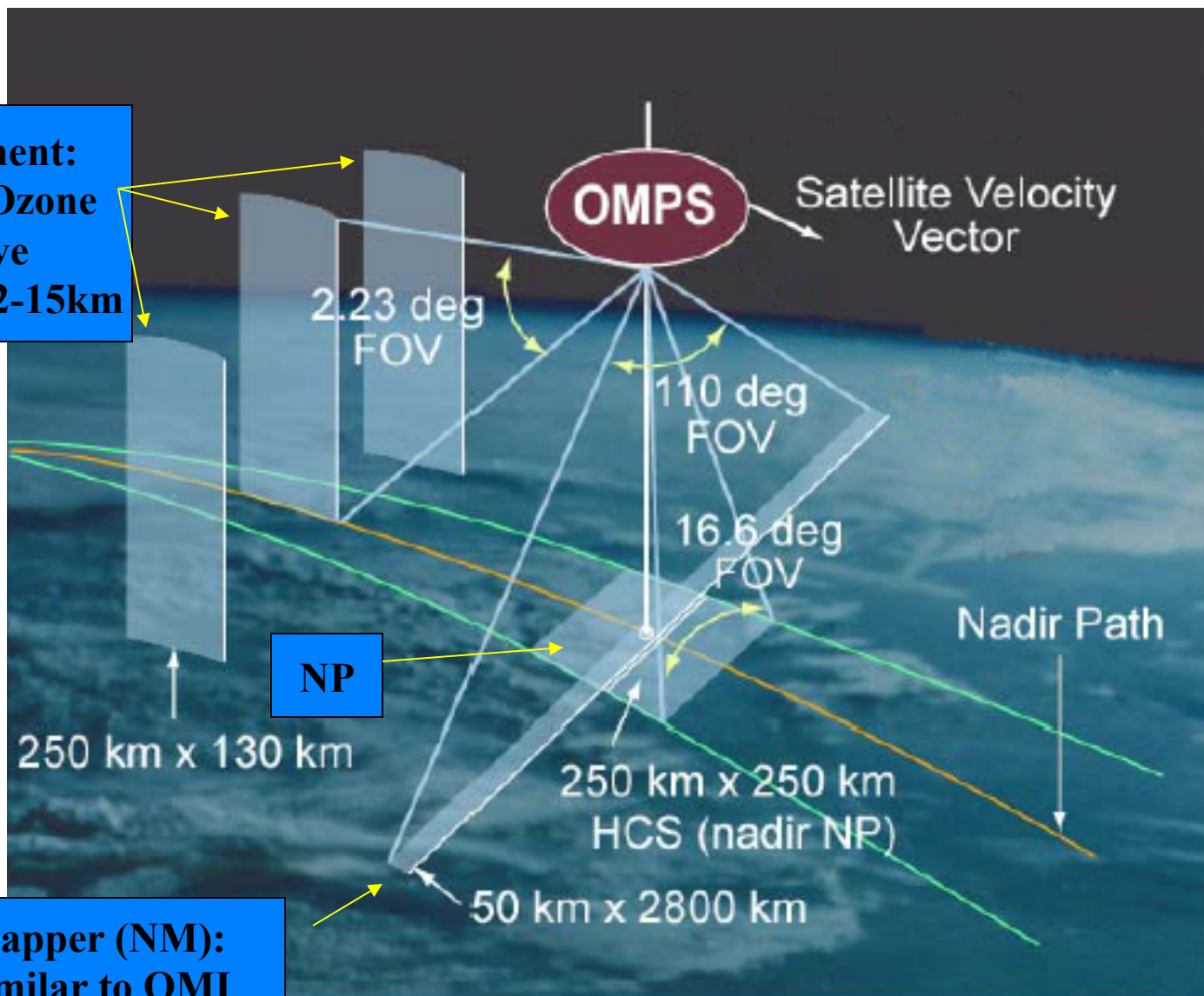




# Suomi-NPP/OMPS UV Sensors

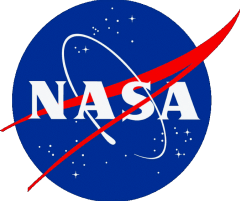


**Limb instrument:**  
**Aerosol and Ozone**  
**profiles above**  
**tropopause 12-15km**

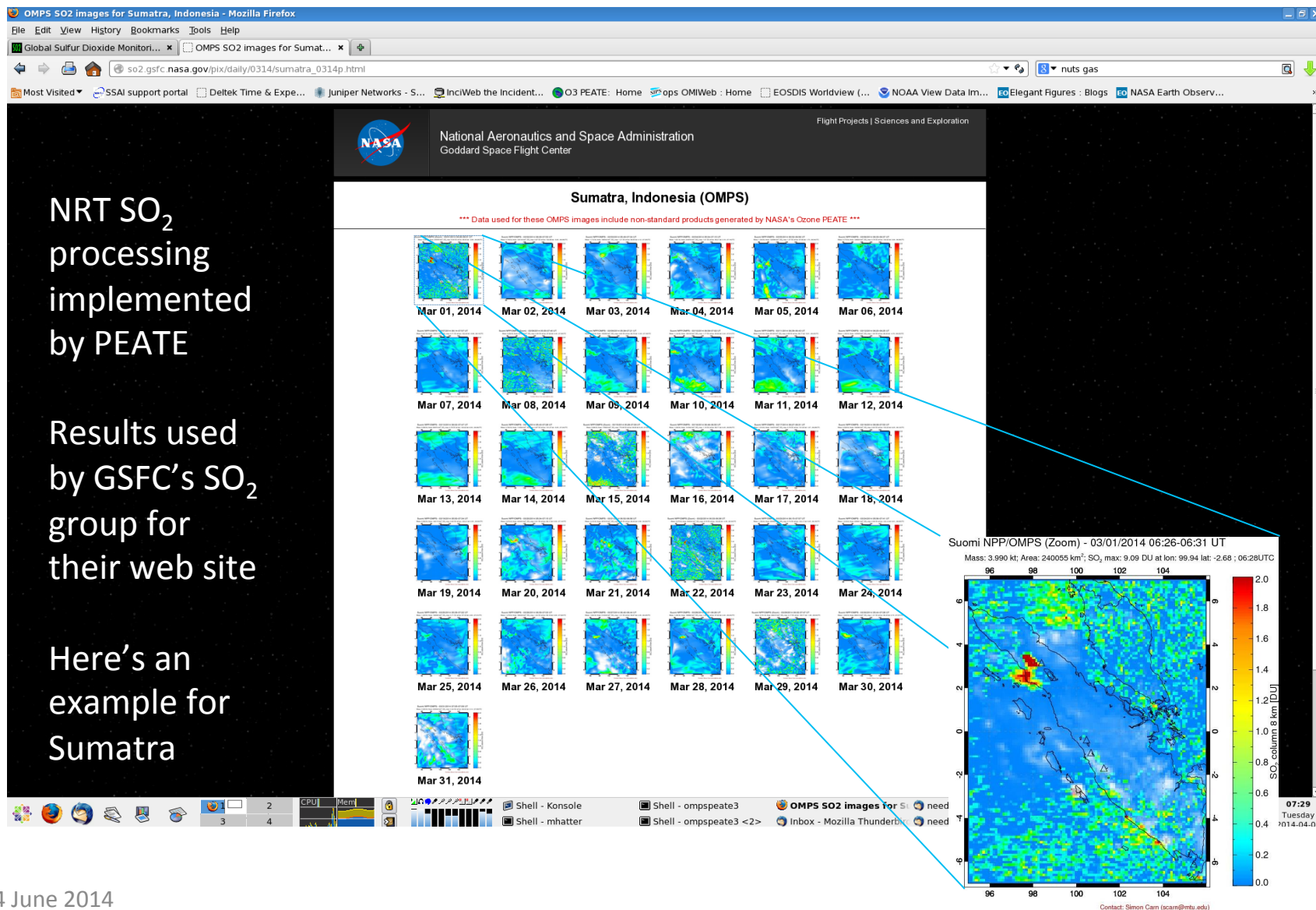


**Nadir Mapper (NM):**  
**swath similar to OMI**





# NRT SO<sub>2</sub> Processing at NASA Ozone PEATE

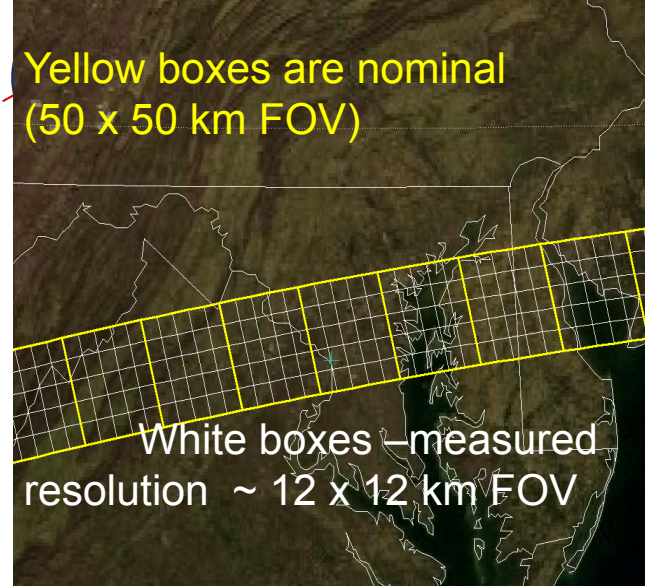


4 June 2014



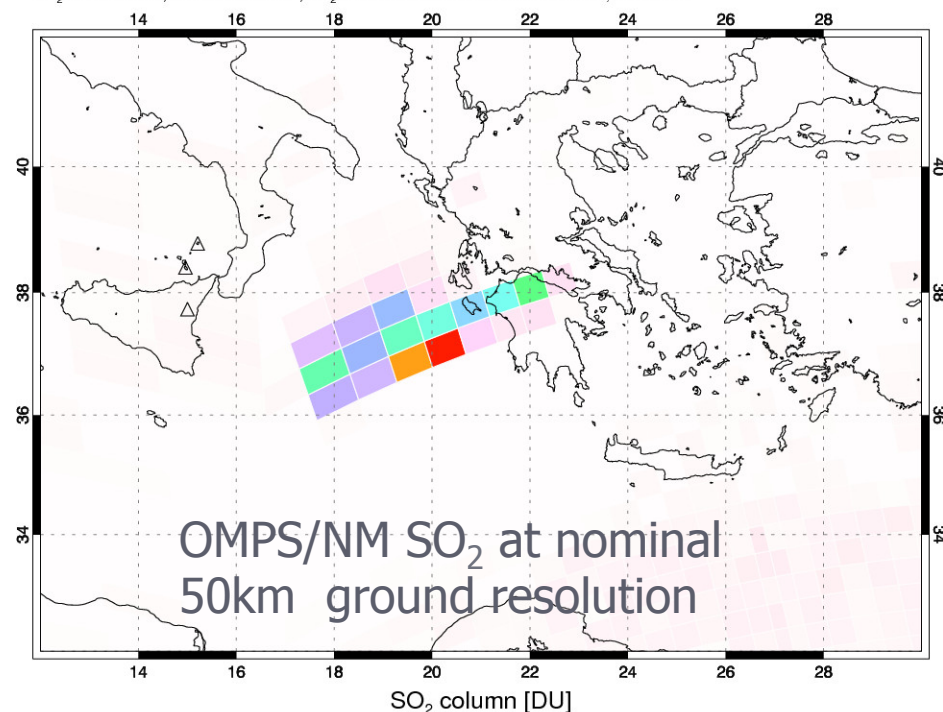
# OMPS NM operational SO<sub>2</sub> data

- Co-adding NM pixels on board results in low ground resolution ~50km (left map). Allowing higher data rate improves resolution to 12km by 12 km: better than current Aura OMI (OMI SO<sub>2</sub> map from Etna eruption on right)



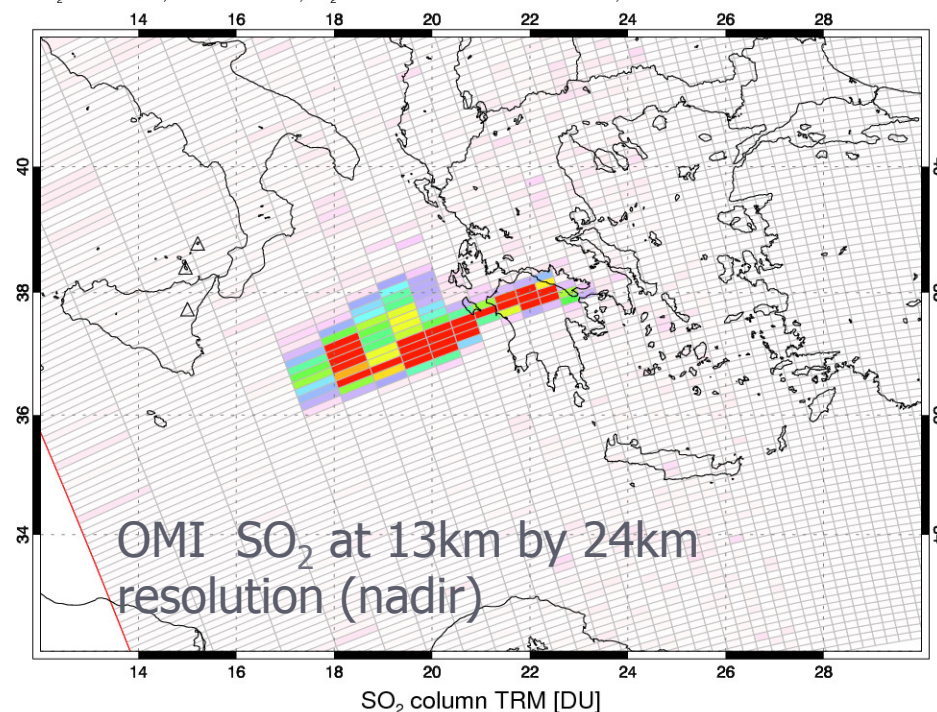
Suomi NPP/OMPS - 04/24/2012 11:12-12:57 UT

SO<sub>2</sub> mass: 5.80 kt; Area: 850843 km<sup>2</sup>; SO<sub>2</sub> max: 4.99 DU at lon: 20.28 lat: 37.11 ; 11:14UTC

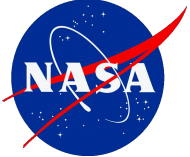


Aura/OMI - 04/24/2012 11:27-11:30 UT - Orbit 41360

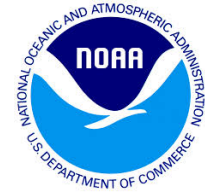
SO<sub>2</sub> mass: 8.63 kt; Area: 387355 km<sup>2</sup>; SO<sub>2</sub> max: 19.32 DU at lon: 20.23 lat: 37.20 ; 11:28UTC







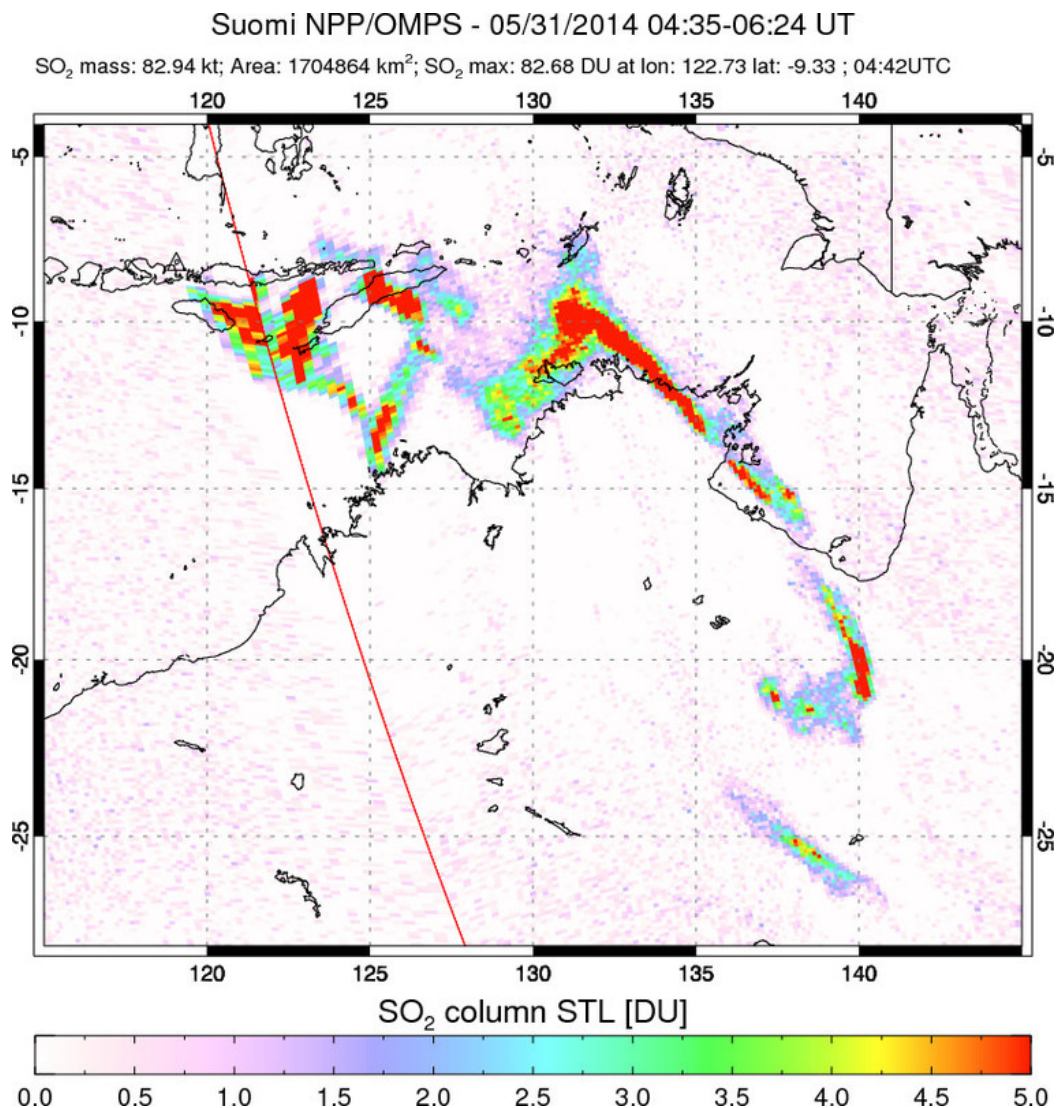
# Off-line SNPP OMPS SO<sub>2</sub> map of Sangeang Api volcanic cloud on May 31 2014



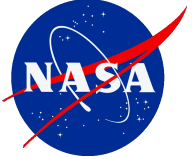
OMPS currently operates in spatial 'zoom' mode on Saturdays, with 10x10 km pixels as opposed to the usual 50x50 km. The measured SO<sub>2</sub> amount is similar to AIRS and OMI (~0.1 Tg)

SO<sub>2</sub> Map courtesy  
Simon Carn, MTU

OMPS SO<sub>2</sub> data are  
produced at NASA OPEATE  
PI Dr. Kai Yang





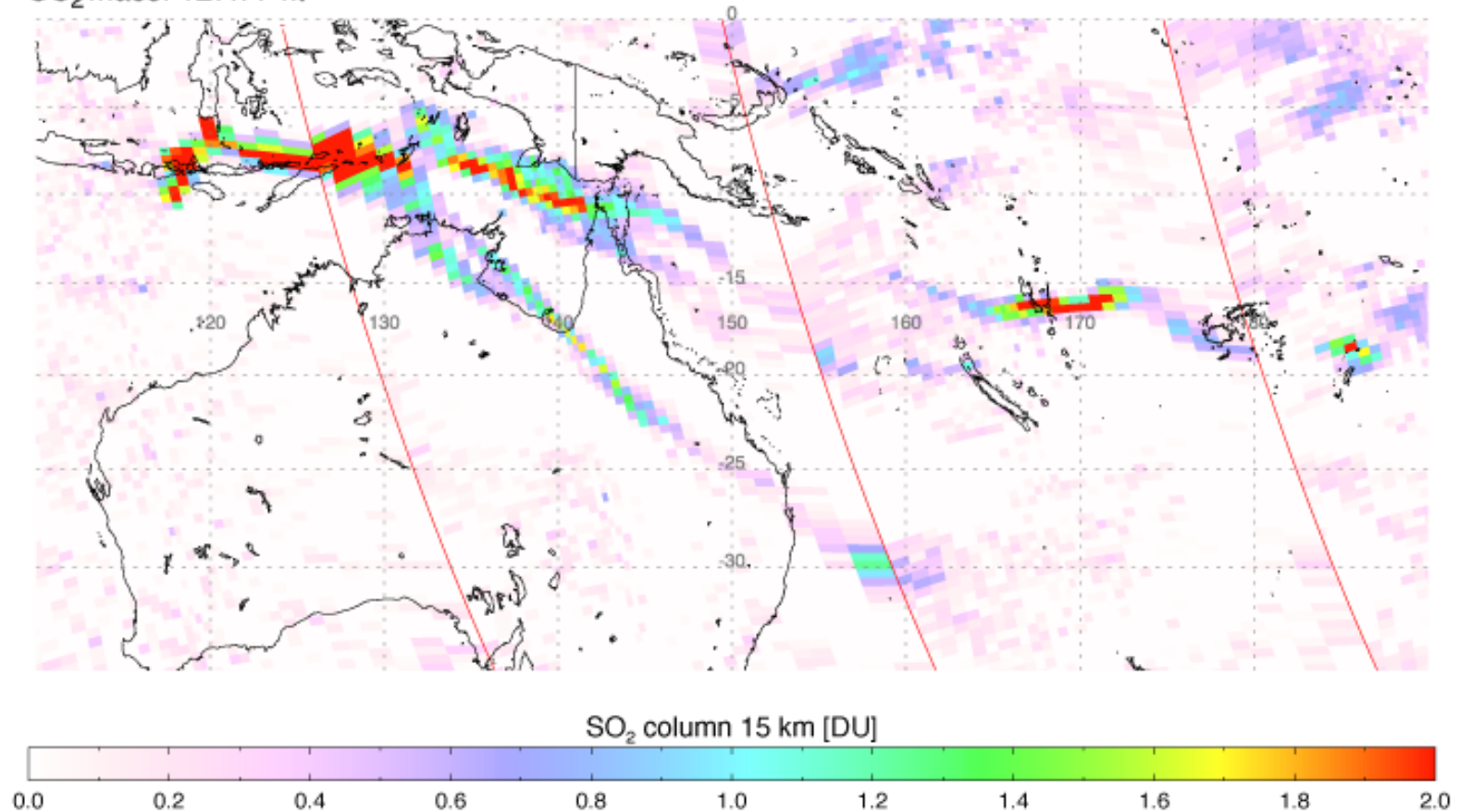


# Off- line SNPP OMPS SO<sub>2</sub> map of Sangeang Api volcanic cloud on June 1 2014



NPP/OMPS - 06/01/2014 (00:52-06:06 UT) - Orbit 13431 - 13434

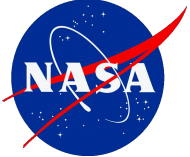
SO<sub>2</sub> mass: 127.77 kt



SO<sub>2</sub> Map courtesy  
Simon Carn, MTU


OMPS SO<sub>2</sub> data are produced at  
NASA OPEATE, PI Dr. Kai Yang





# Near Real-time OMI Volcanic Cloud Products from NOAA operational web site





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### Volcanic Hazards Project

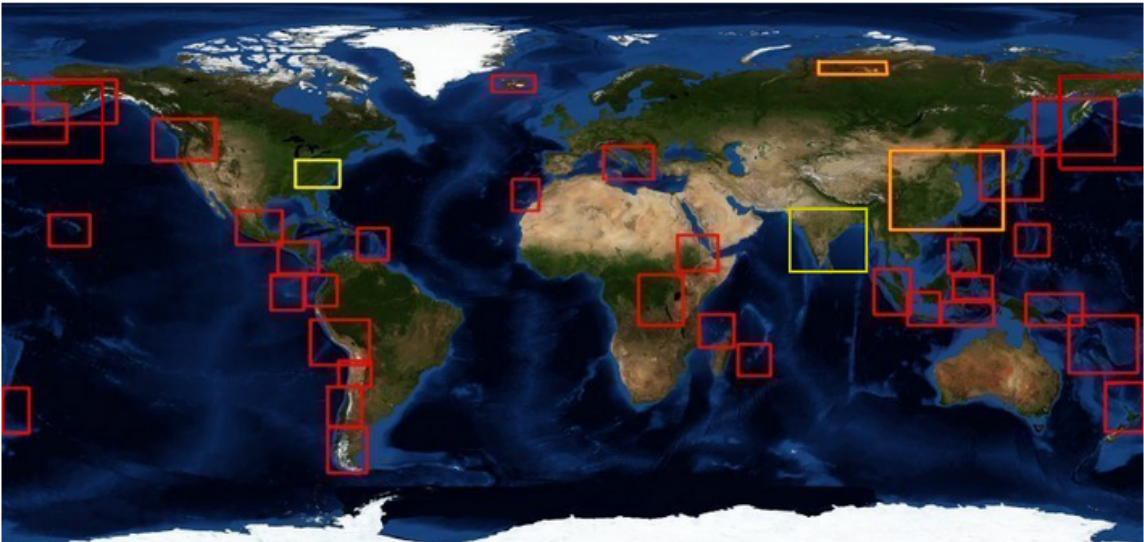
Latest SO<sub>2</sub> eruption alerts [NOAA-NESDIS](#). [SACS\\_BIRL](#). [IASI-ULB](#).  
SO<sub>2</sub> Near Real-Time Images: [NASA\(DR\)](#). [FMI\(DR\)](#). [NASA\(NRT\)](#). [NOAA\(NRT\)](#). [AIRS\(NRT\)](#). [SACS\(NRT\)](#).

### MEaSUREs project:

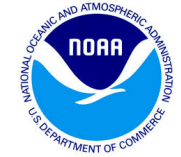
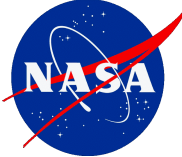
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### Latest Daily (OMI/OMPS) Images of SO<sub>2</sub> (click on a highlighted rectangle)

Red = daily volcanic regions, orange = daily pollution regions, yellow = long-term pollution images





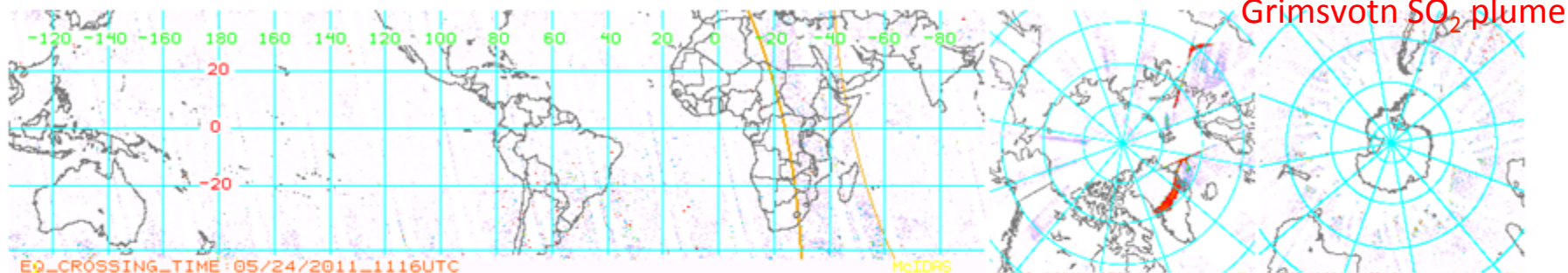


# NASA currently provides operational NRT volcanic SO<sub>2</sub> and AI data stream to NOAA

<http://satepsanone.nesdis.noaa.gov/pub/OMI/OMISO2/index.html>

## Latest OMI SO<sub>2</sub> Column 5Km - 24-Hour Composite Images

[Important Information for OMI Data Users](#)



Current OMI SO <sub>2</sub> Composites	<a href="#">Tropics</a>	<a href="#">Northern Hemisphere</a>	<a href="#">Southern Hemisphere</a>
Current & Previous Digital Images GeoTiff, NetCDF, McIDAS, GIF	<a href="#">Tropics</a>	<a href="#">Northern Hemisphere</a>	<a href="#">Southern Hemisphere</a>

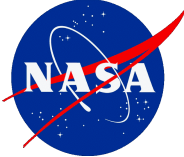
## Latest OMI\_SO<sub>2</sub> Column 5Km by Volcano

<a href="#">Alaska, USA</a>	<a href="#">Aleutian Islands, Alaska, USA</a>	<a href="#">Anatahan, Mariana Islands</a>	<a href="#">Cascade</a>
<a href="#">Central America</a>	<a href="#">Comoro Islands</a>	<a href="#">Eastern China</a>	<a href="#">Ecuador</a>
<a href="#">Etna, Sicily, Italy</a>	<a href="#">Galapagos Islands, Ecuador</a>	<a href="#">Hawaii, USA</a>	<a href="#">Iceland</a>
<a href="#">Japan</a>	<a href="#">Java, Indonesia</a>	<a href="#">Kamchatka, Russia</a>	<a href="#">Mexico</a>
<a href="#">Montserrat, West Indies</a>	<a href="#">New Zealand</a>	<a href="#">North Western Europe</a>	<a href="#">Northern Atlantic</a>
<a href="#">Northern Chile</a>	<a href="#">Nyiragongo, DR Congo</a>	<a href="#">Peru</a>	<a href="#">Philippines</a>
<a href="#">Papua New Guinea</a>	<a href="#">Red Sea</a>	<a href="#">Reunion Island</a>	<a href="#">Southern Chile</a>
<a href="#">Sulawesi Sangehe, Indonesia</a>	<a href="#">Sumatra, Indonesia</a>	<a href="#">Tanzania</a>	<a href="#">Vanuatu, South Pacific</a>

**DISCLAIM:** This page is experimental and for testing purpose only

For AIRS SO<sub>2</sub> products check the [AIRS SO<sub>2</sub> Alert Site](#)

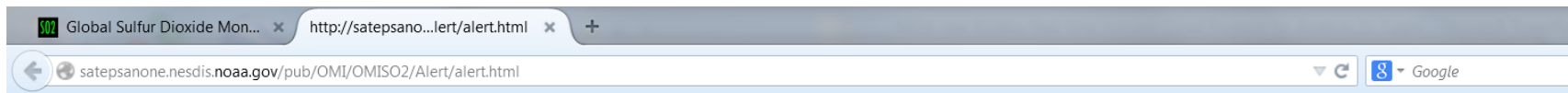
For science quality products check with [NASA GES DISC](#) and with the [UMBC OMI Sulfur Dioxide Group](#)



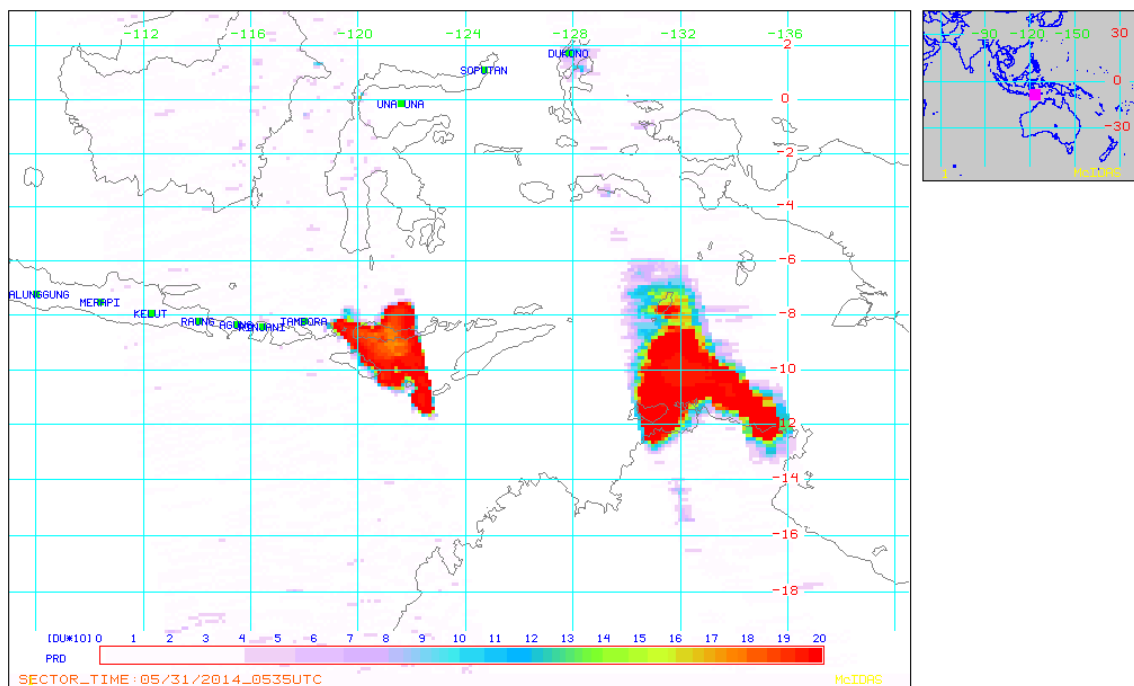
# Automatic NOAA e-mail alerts based on OMI SO<sub>2</sub> data



<http://satepsanone.nesdis.noaa.gov/pub/OMI/OMISO2/Alert/alert.html>



## AUTOMATED OMI SO<sub>2</sub> ALERT SYSTEM HIGH SO<sub>2</sub> CONCENTRATION AREAS



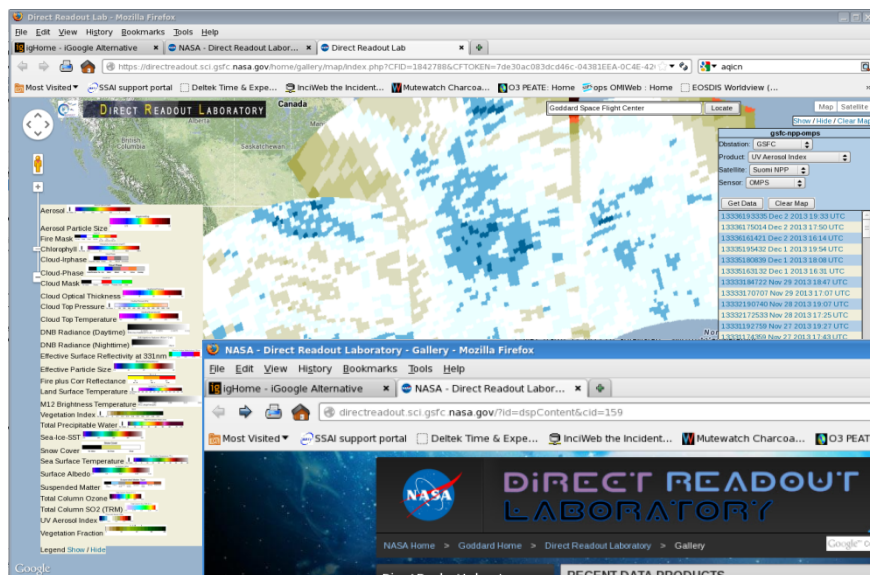
Date 20140531 (yyyymmdd)

[BACK TO OMISO2 MAIN PAGE](#)

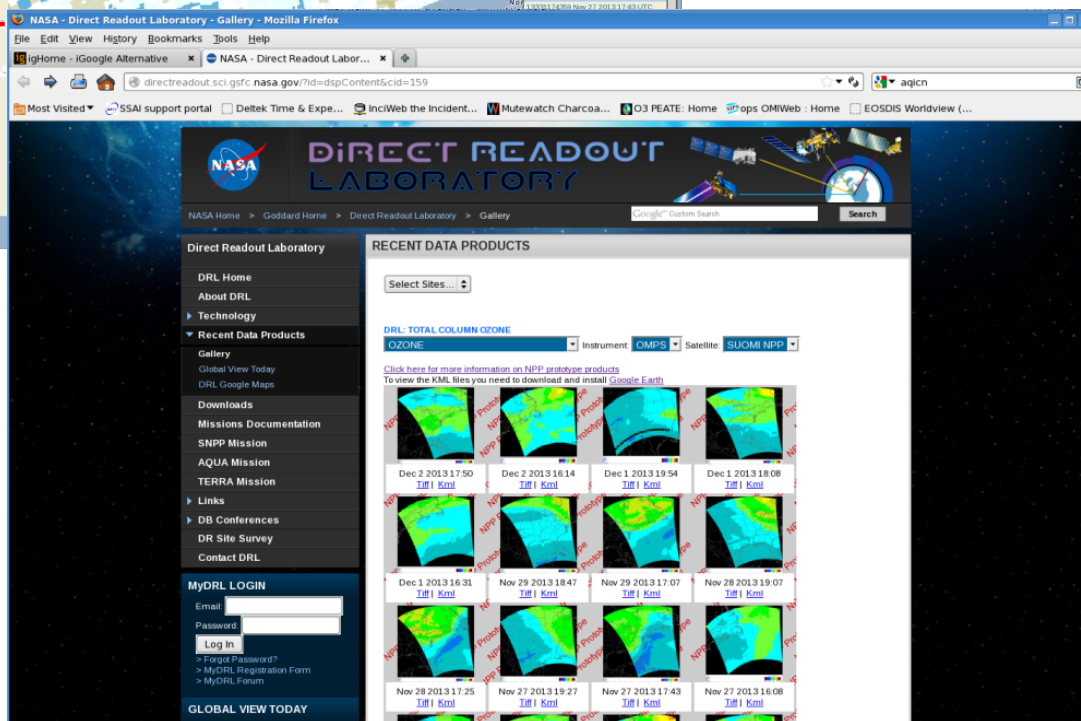




# SNPP OMPS Ozone, AI and SO<sub>2</sub> now part of GSFC's Direct Broadcast Package



Science Team / PEATE worked with GSFC's Direct Readout Lab to develop real-time processing capability (using NASA algorithms) for OMPS direct broadcast data



Ozone, Aerosol Index, Reflectivity, and SO<sub>2</sub> available

# NASA Direct Readout data processing at FMI and UAF/GINA

Direct Broadcast from Aura and S-NPP satellites



Receiving station in  
Sodankylä (FMI)



OMI and OMPS  
DR processing in  
Sodankylä



Receiving station at  
GINA/UAF in  
Fairbanks Alaska

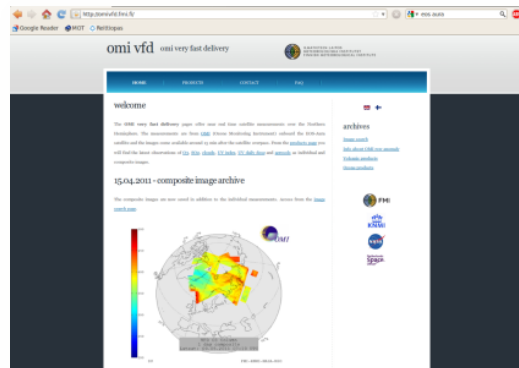


OMPS DR  
Processing at  
UAF/GINA

NASA/GSFC Direct Readout  
Laboratory and NPP ozone  
PEATE create software  
package for local processing  
of NPP DR data

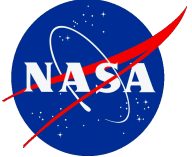
WWW and FTP services.  
Available within 20 min  
after data reception.

WWW and FTP services to Alaska  
Volcano Observatory. Available  
within 20 min after data reception.




<http://omivfd.fmi.fi>





# Real-time Volcanic Cloud Products from NASA DRL





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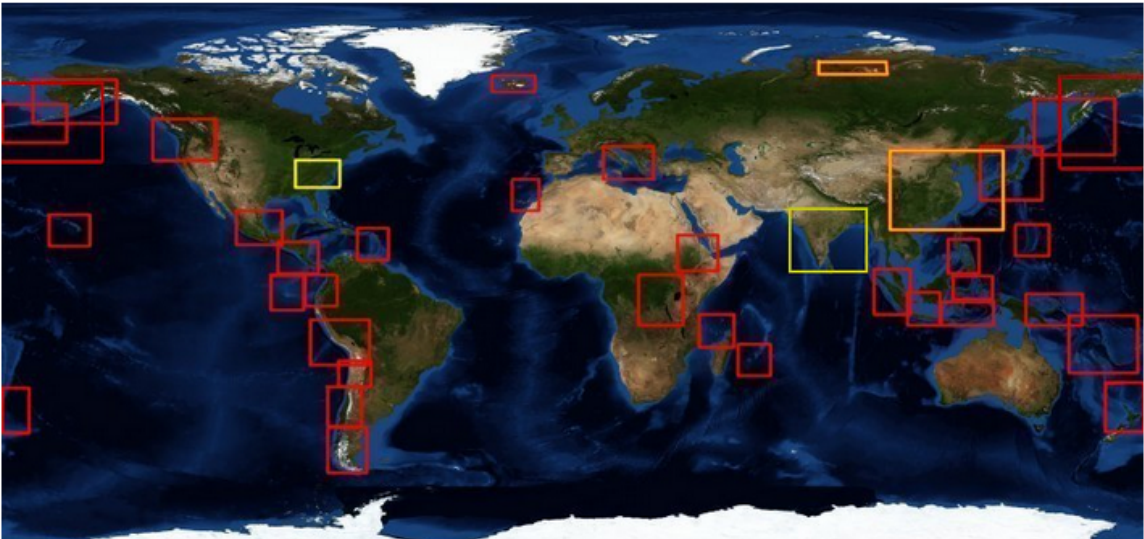
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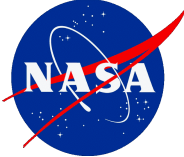
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**NASA SGFC Direct Readout Laboratory (DRL) in cooperation with Ozone PEATE has developed software package for local processing of OMPS DR data. The package is under testing at FMI and GINA.**

<https://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=159>

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NASA Home > Goddard Home > Direct Readout Laboratory > Gallery

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  - Global View Today
  - DRL Google Maps
- Downloads
- Missions Documentation
  - SNPP Mission
  - AQUA Mission
  - TERRA Mission
- Links
- DB Conferences
- DR Site Survey
- Contact DRL

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**GLOBAL VIEW TODAY**

**RECENT DATA PRODUCTS**

Select Sites... ▼

GINA: TOTAL COLUMN SO2 (TRM)

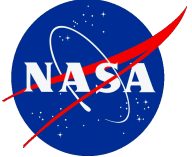
SUOMI NPP Instrument: OMPS Product: SO2

To view the KML files you need to download and install [Google Earth](#)

Jun 4 2014 14:02	Jun 4 2014 12:22	Jun 4 2014 10:41	Jun 4 2014 00:19
<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>
<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>
<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>
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<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>	<a href="#">Tiff</a>   <a href="#">Kml</a>

**Mt. Pavlof  
eruption  
June 3**






# Real-time Volcanic Cloud Products from FMI VFD



FINNISH METEOROLOGICAL  
INSTITUTE



National Aeronautics and Space Administration  
Goddard Space Flight Center

Flight Projects | Sciences and Exploration

Atmospheric Chemistry and Dynamics Laboratory (Code 614)

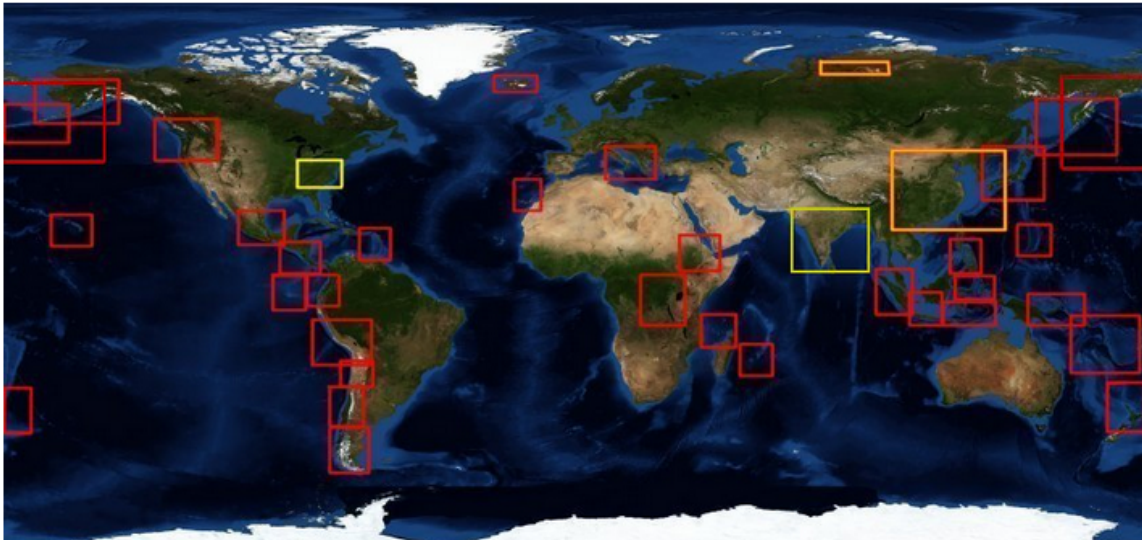
Global Sulfur Dioxide Monitoring Home Page

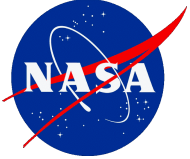
[Home](#) | [News](#) | [Past SO<sub>2</sub> images](#) | [Documentation](#) | [Publications](#) | [Personnel](#) | [Links](#)

**Volcanic Hazards Project**  
Latest SO<sub>2</sub> eruption alerts: [NOAA-NESDIS](#), [SACS\\_BIRA](#), [IASI-ULB](#).  
SO<sub>2</sub> Near Real-Time Images: [NASA\(DR\)](#), [FMI\(DR\)](#), [NASA\(NRT\)](#), [NOAA\(NRT\)](#), [AIRS\(NRT\)](#), [SACS\(NRT\)](#).

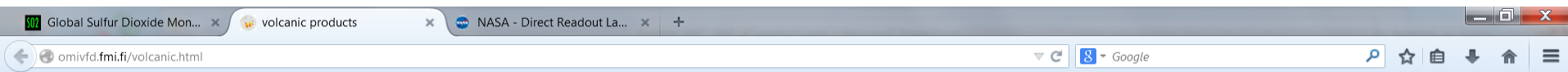
**MEaSUREs project:**  
[TOMS images \(1979-2005\)](#) | [AIRS images \(2003-present\)](#) | [OMI images \(2004-present\)](#) | [OMPS images \(May 2012-present\)](#)

**Latest Daily (OMI/OMPS) Images of SO<sub>2</sub> (click on a highlighted rectangle)**  
**Red** = daily volcanic regions, **orange** = daily pollution regions, **yellow** = long-term pollution images





# FMI has developed Very Fast Delivery Service (VDF) using DR OMI data



omi vfd omi very fast delivery



HOME

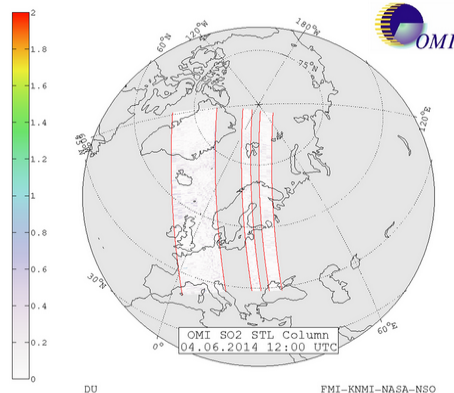
PRODUCTS

CONTACT

FAQ

## volcanic products

These products can be used to monitor volcanic eruptions.



SO2 AI CF

[SO21](#) [AI1](#) [CF1](#)

[SO22](#) [AI2](#) [CF2](#)

[SO23](#) [AI3](#) [CF3](#)

[SO24](#) [AI4](#) [CF4](#)

[SO25](#) [AI5](#) [CF5](#)

[SO26](#) [AI6](#) [CF6](#)

AI = Aerosol Index

CF = Cloud Fraction



## archives

[Image search](#)

[Info about OMI row anomaly](#)

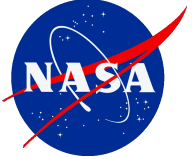
[Volcanic products](#)

[Ozone products](#)

[OMI VFD highlights](#)







# FMI is extending Very Fast Delivery Service (VDF) to include DR SNPP OMPS data



Highlights

omivfd.fmi.fi/jj2j3f0/volcanic.html

Google

SAMPO

Satellite Measurements from Polar Orbit

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### Volcanic products (from OMPS)

2  
1.8  
1.6  
1.4  
1.2  
1  
0.8  
0.6  
0.4  
0.2  
0



OMPS SO2 STL Column  
03.06.2014 10:43 UTC  
DU FMI-NASA

SO<sub>2</sub> AI CF

SO<sub>21</sub> AI<sub>1</sub> CF<sub>1</sub>

SO<sub>22</sub> AI<sub>2</sub> CF<sub>2</sub>

SO<sub>23</sub> AI<sub>3</sub> CF<sub>3</sub>

SO<sub>24</sub> AI<sub>4</sub> CF<sub>4</sub>

SO<sub>25</sub> AI<sub>5</sub> CF<sub>5</sub>

SO<sub>26</sub> AI<sub>6</sub> CF<sub>6</sub>

SO<sub>27</sub> AI<sub>7</sub> CF<sub>7</sub>

SO<sub>28</sub> AI<sub>8</sub> CF<sub>8</sub>

SO<sub>29</sub> AI<sub>9</sub> CF<sub>9</sub>

SO<sub>210</sub> AI<sub>10</sub> CF<sub>10</sub>

AI = Aerosol Index

CF = Cloud Fraction


[Image search](#)


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[Highlights](#)

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