

State of the art in volcano monitoring infrastructure
(ground based and satellite/airborne remote sensing)
in Colombia

Case Study: Nevado del Ruiz volcano

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Servicio Geológico Colombiano

February 23th 2021

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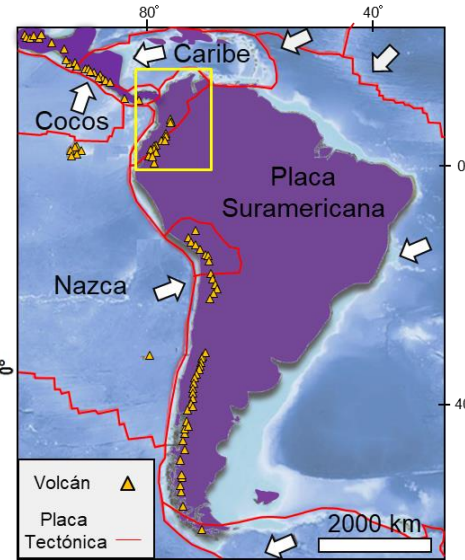
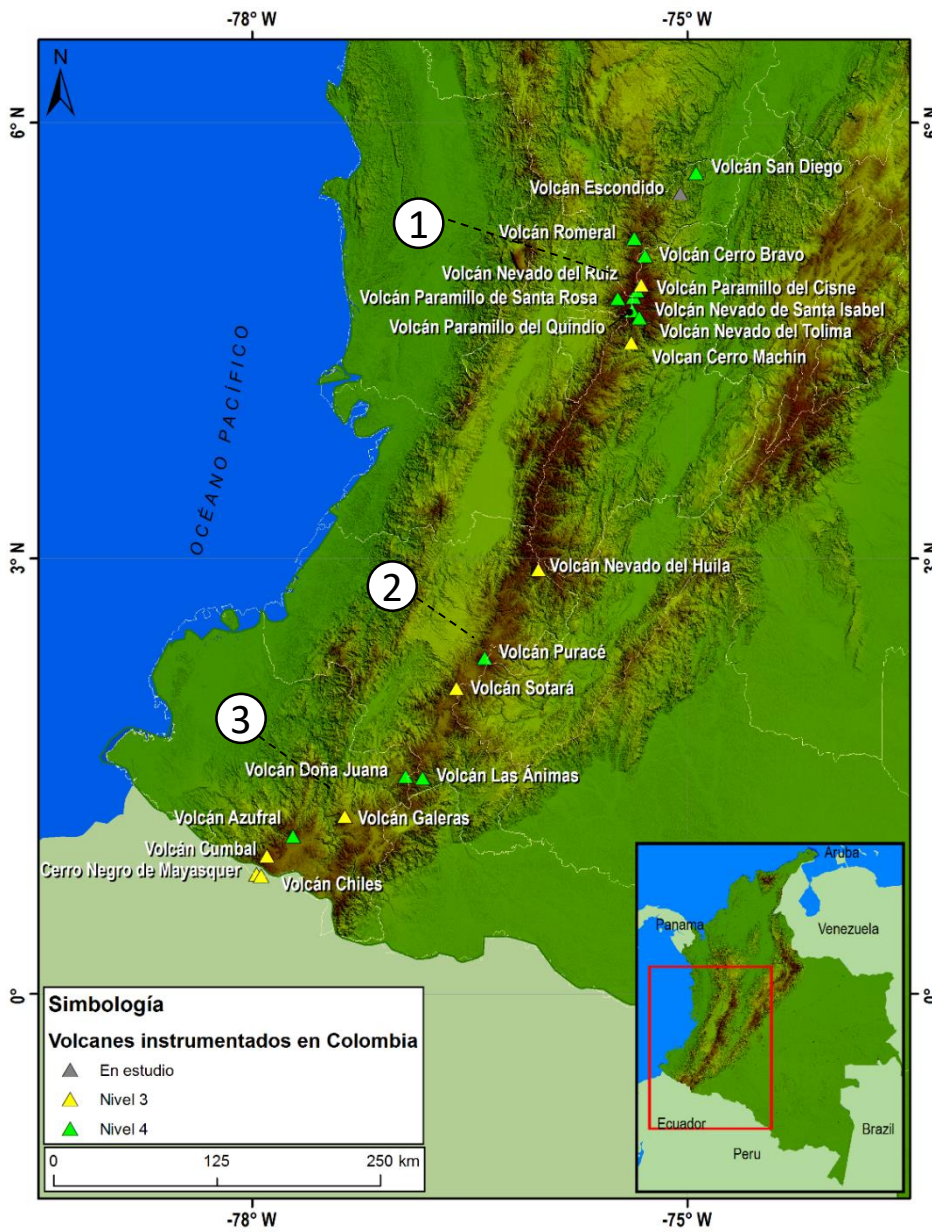


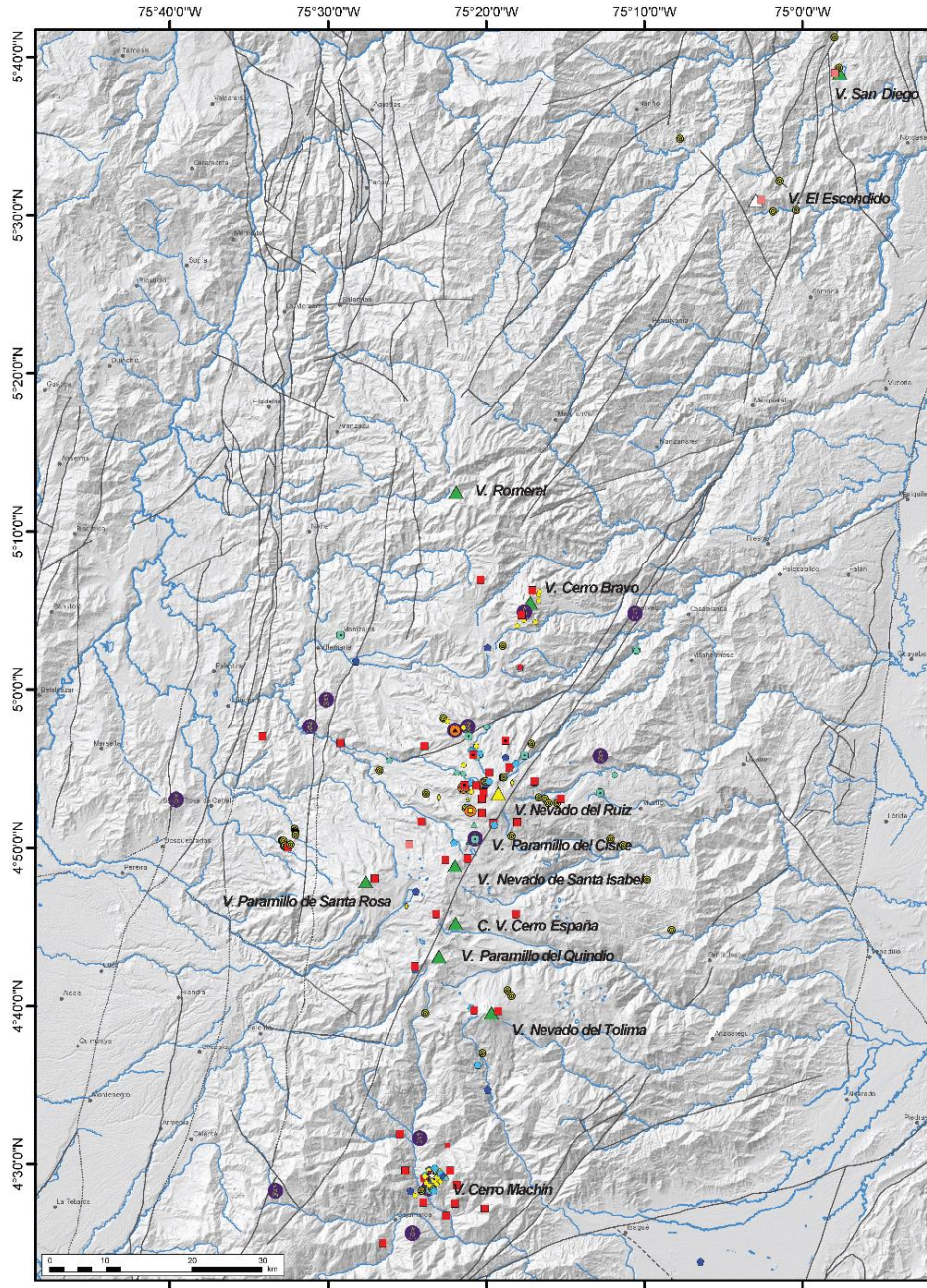


Active volcanoes monitored in Colombia

Observatories

- ① SGC-OVS Manizales
- ② SGC-OVS Popayán
- ③ SGC-OVS Pasto

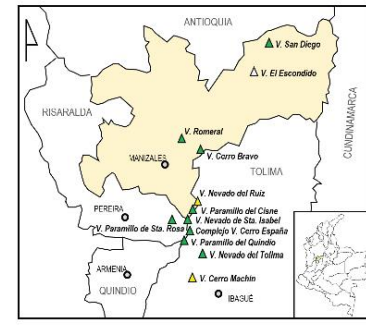




- RED DE VIGILANCIA VOLCÁNICA**
- Área de Geofísica:**
- Sensor banda ancha
 - Sensor banda ancha (estación portátil)
 - Sensor banda ancha e infrasonido
 - Monitor flujo de lodo
 - ▲ Magnetómetro
 - Autopotencial
 - Cámara IP
 - Termocupla
 - ☆ Estación meteorológica
- Área de Deformación:**
- GNSS
 - Inclímetro Electrónico
- Área de Geoquímica:**
- ScanDoas
 - Trampa de Radón
 - Trampa de CO2
 - Trampa Alcalina
 - Fuente Termal
 - Fumarolas
- Comunicaciones:**
- Repetidor

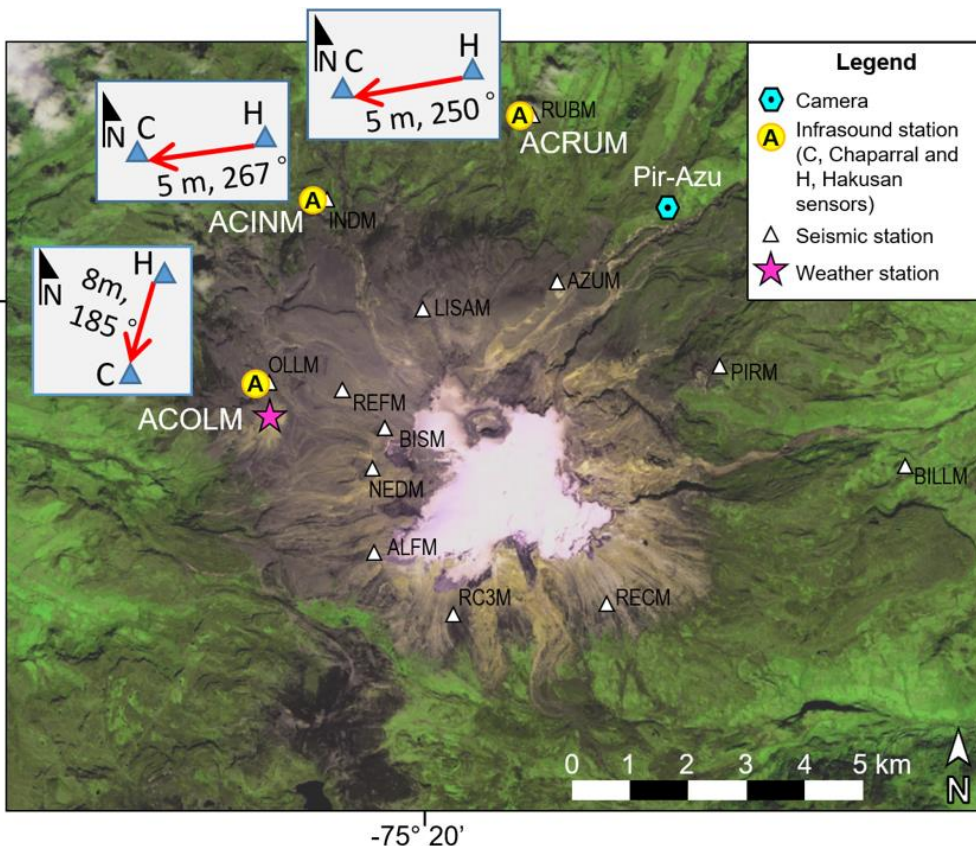
- CONVENCIONES CARTOGRÁFICAS**
- ▲ Volcán en Nivel de Actividad Verde
 - ▲ Volcán en Nivel de Actividad Amarillo
 - △ Volcán en estudio
- Falla
- Falla cubierta
- Falla inferida
- Lineamiento
- Drenaje principal
- Municipios
- MDE a partir de ALOS PALSAR (resolución 12 m)
- Valor
- High : 5317
- Low : 0

GROUND-BASE MONITORING

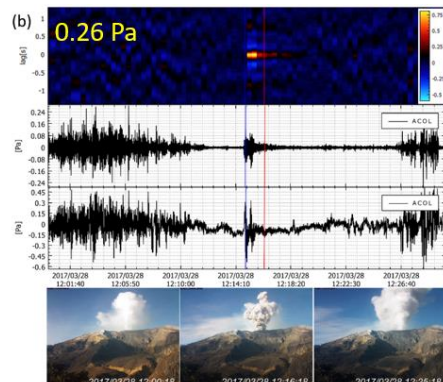
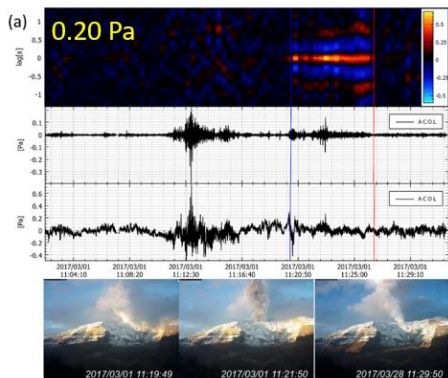




Infrasound sensors

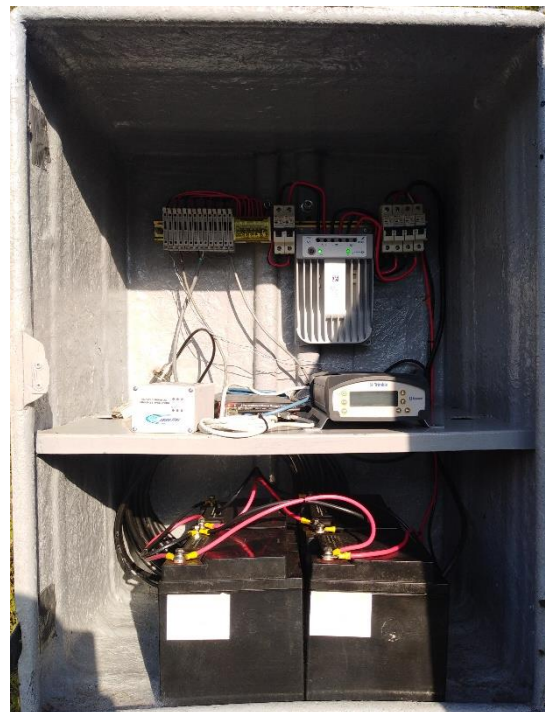


- Infrasound network operating since december 2016
- Distance from crater
 - ACOLM (OLLETA): 4.2 km
 - INDM (INDERENA): 5.3 km
 - ACRUM (RUBÍ): 6.0 km
- Sensors:
 - Chaparral 60Vx
 - Hakusan SI104
- Digitisation:
 - Guralp DM26 digitazer,
 - sampling to 100 Hz and miniseed format.



Castaño et al. (2020)

GNSS stations





NEVADO DE SANTA ISABEL



PARAMILLO DEL QUINDIO

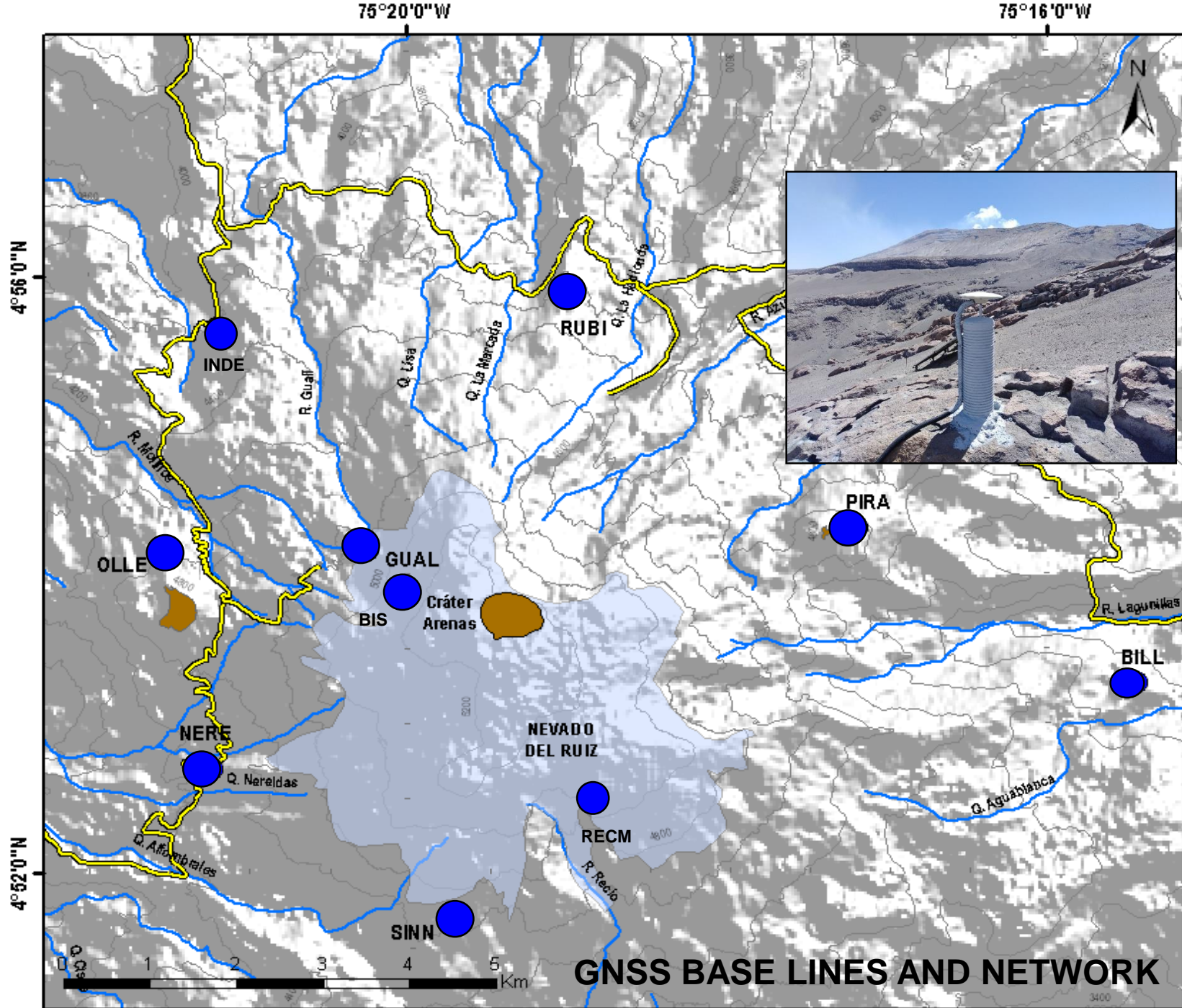


NEVADO DEL TOLIMA



NEVADO DEL RUIZ

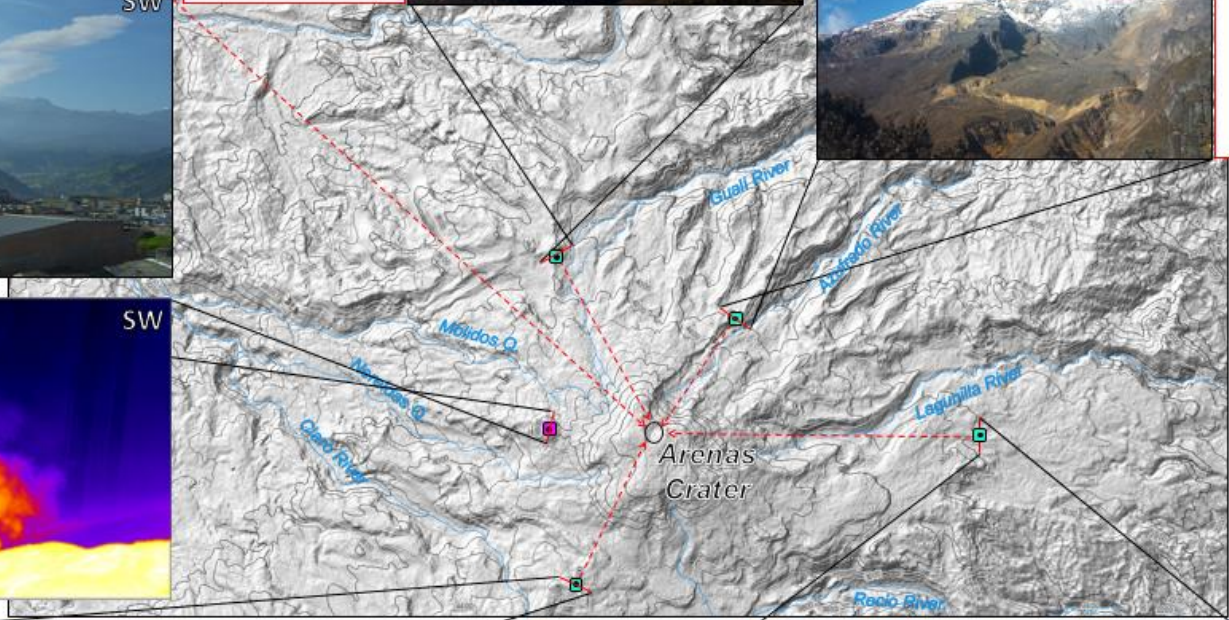
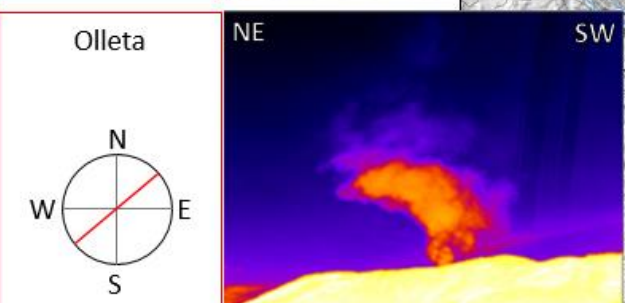
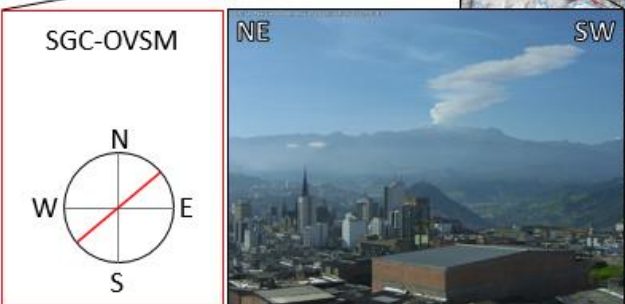
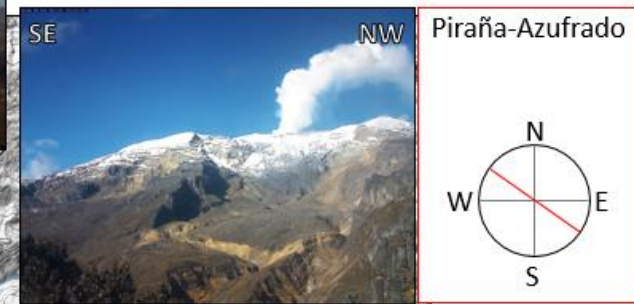
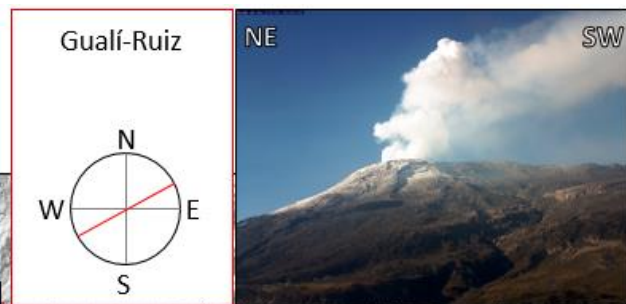






Crater view cameras

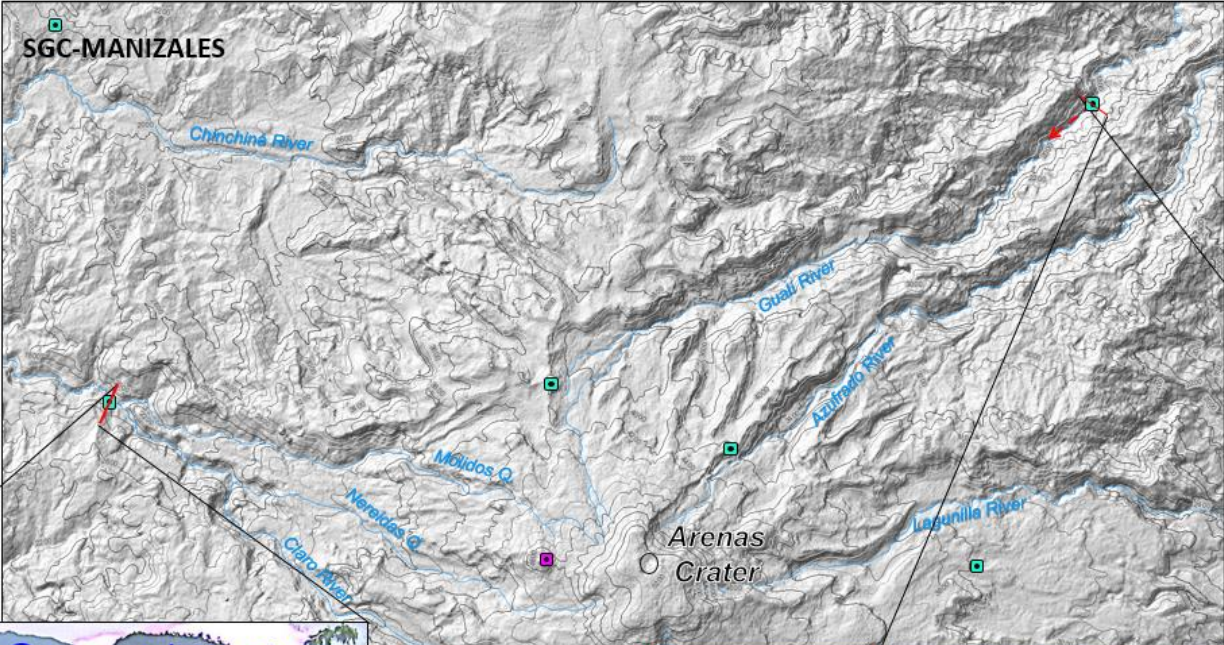
- IR camera
- VIS camera



River view cameras



- IR camera
- VIS camera

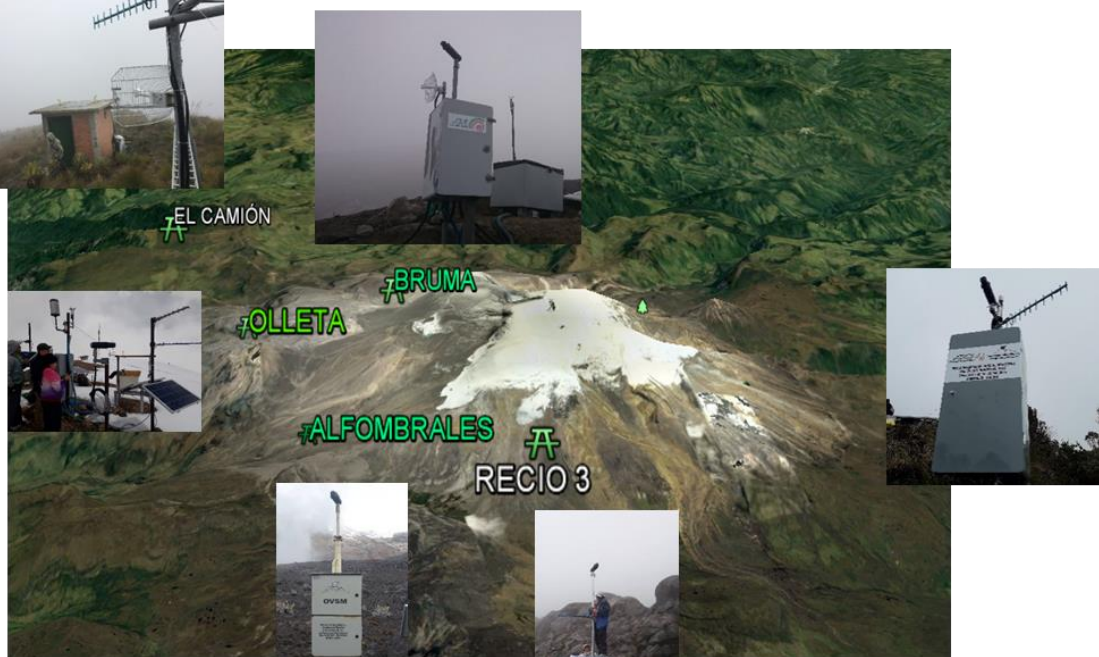
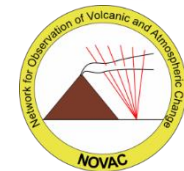


Balcones-Claro R.

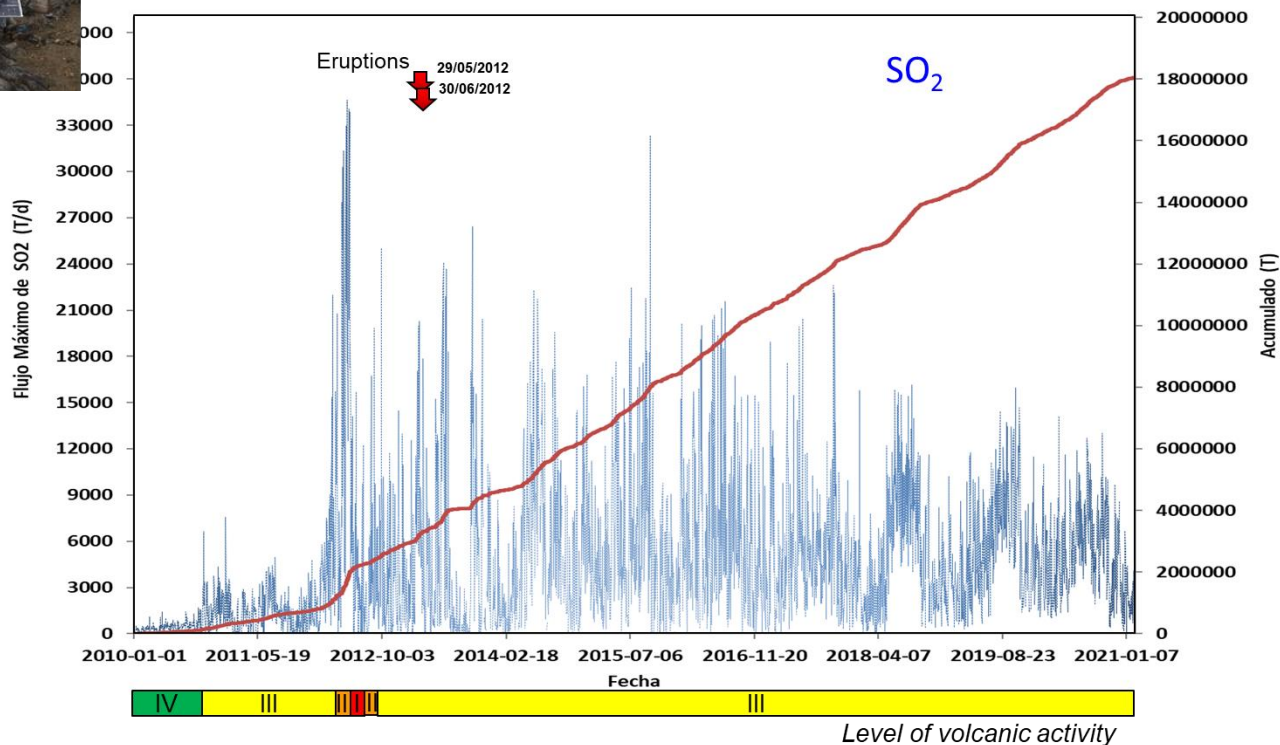


Gualí R.





ScanDOAS network

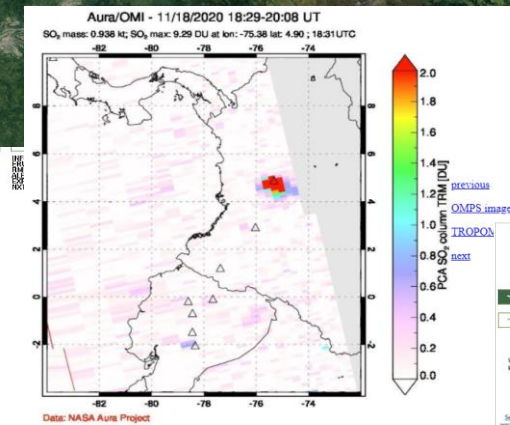
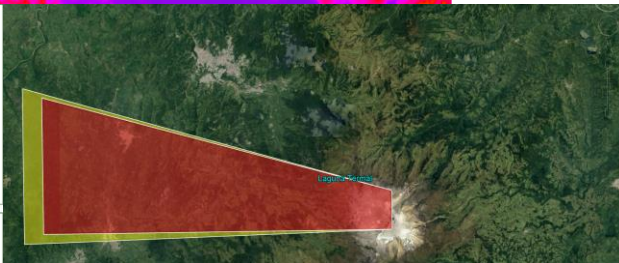
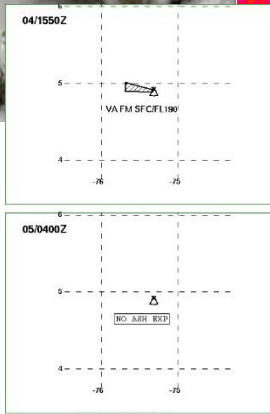
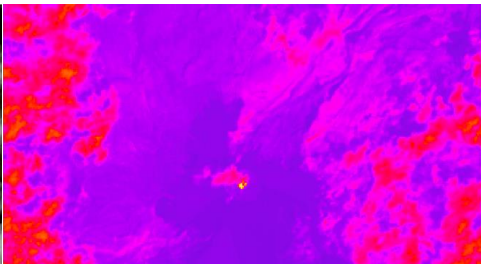
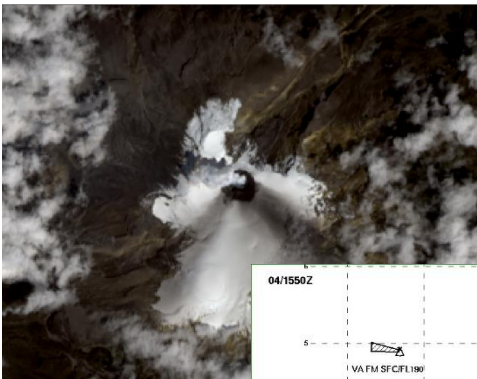


Thermal

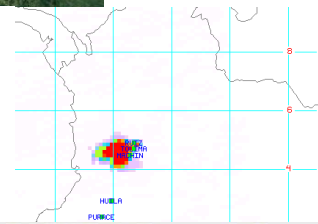


SPACE-BASED MONITORING

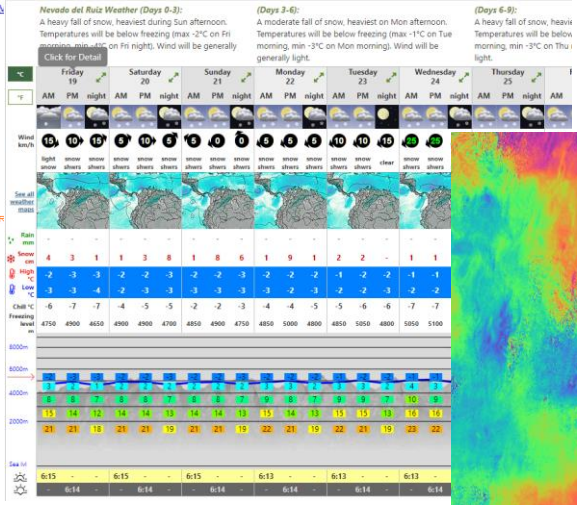
Ash



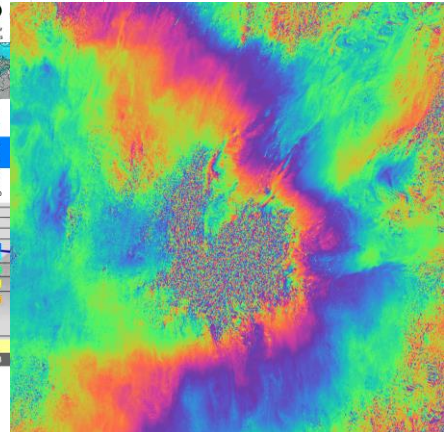
Gas



Meteorological

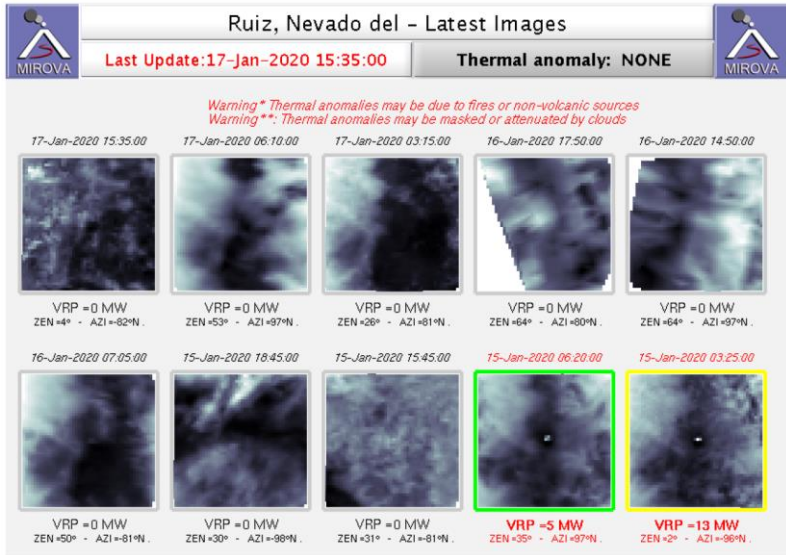


Deformation



SECTOR_TIME: 12/04/2019-1818UTC..._OR

Thermal anomalies



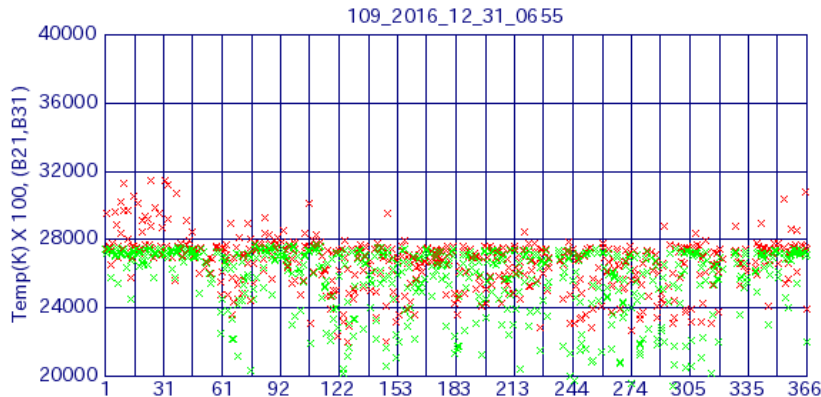
http://www.mirovaweb.it/?action=volcanoDetails&volcano_id=351020

REALVOLC
Central and South America

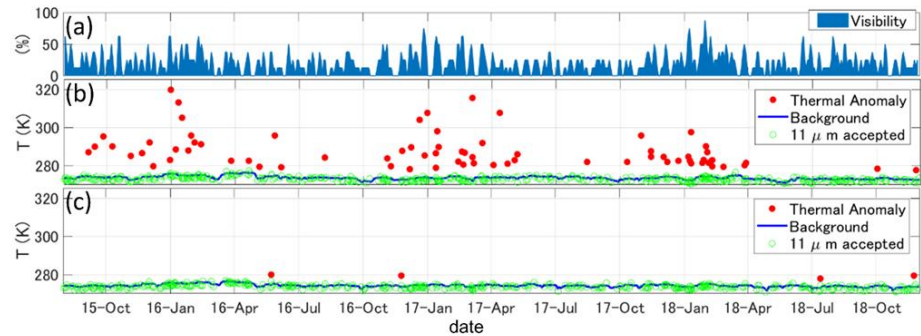
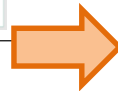
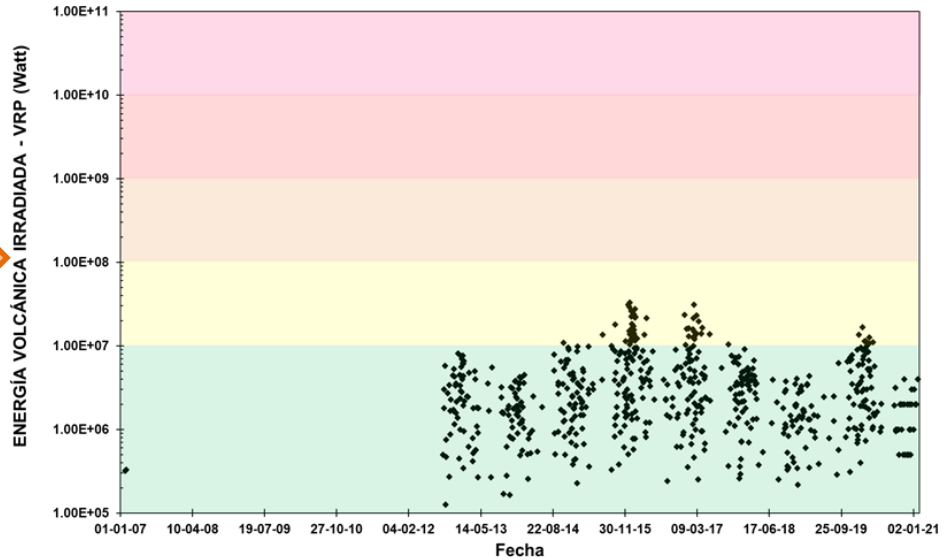
東京大学 THE UNIVERSITY OF TOKYO
Earthquake Research Institute,
The University of Tokyo

SATREPS
Science and Technology Research Partnership
for Sustainable Development Program

1008-Nevado del Ruiz (Colombia)



<http://vrsserv2.eri.u-tokyo.ac.jp/index.html>

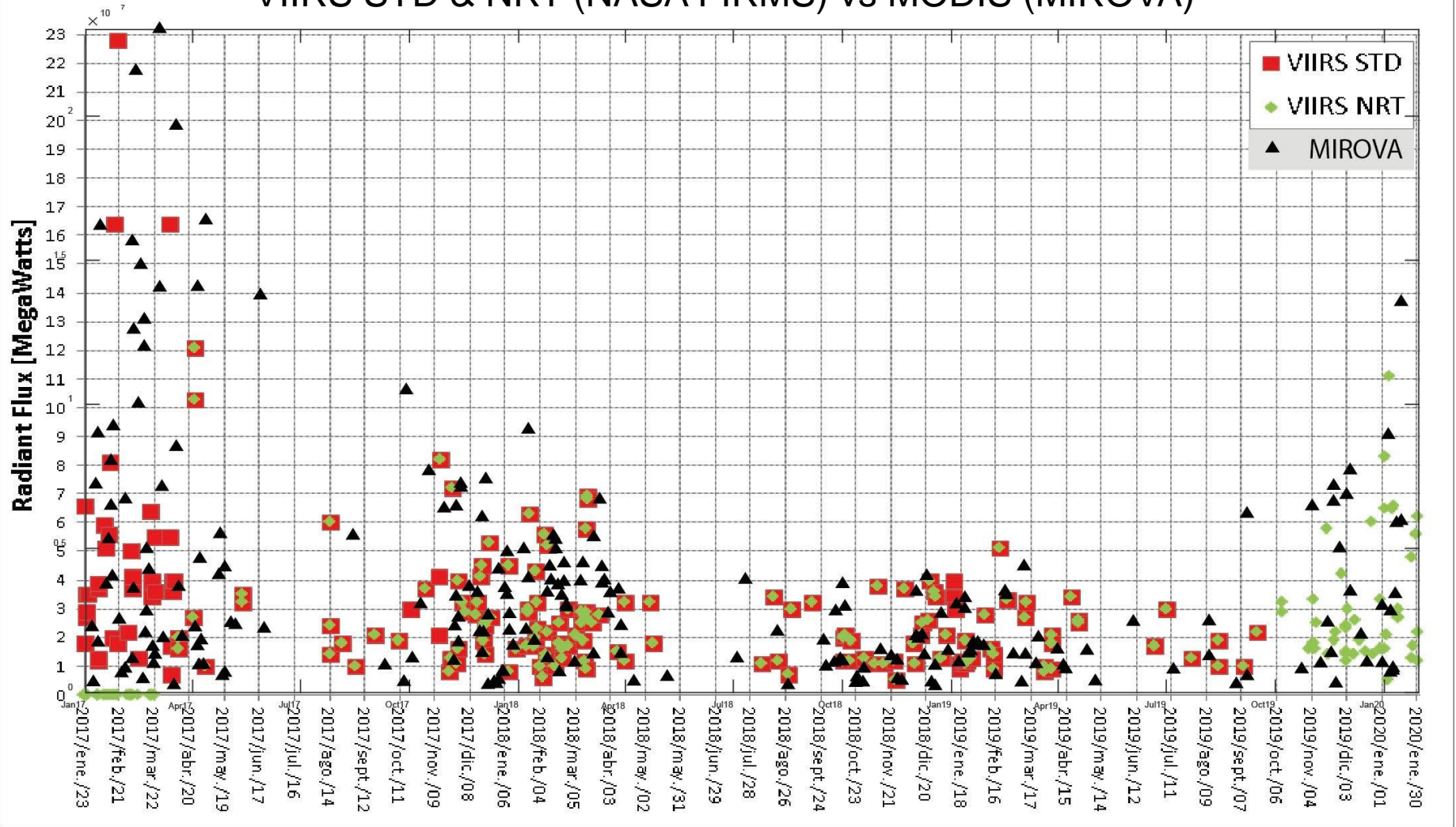


Castaño et al. (2020)

Correlation between two sources of radiant flux data

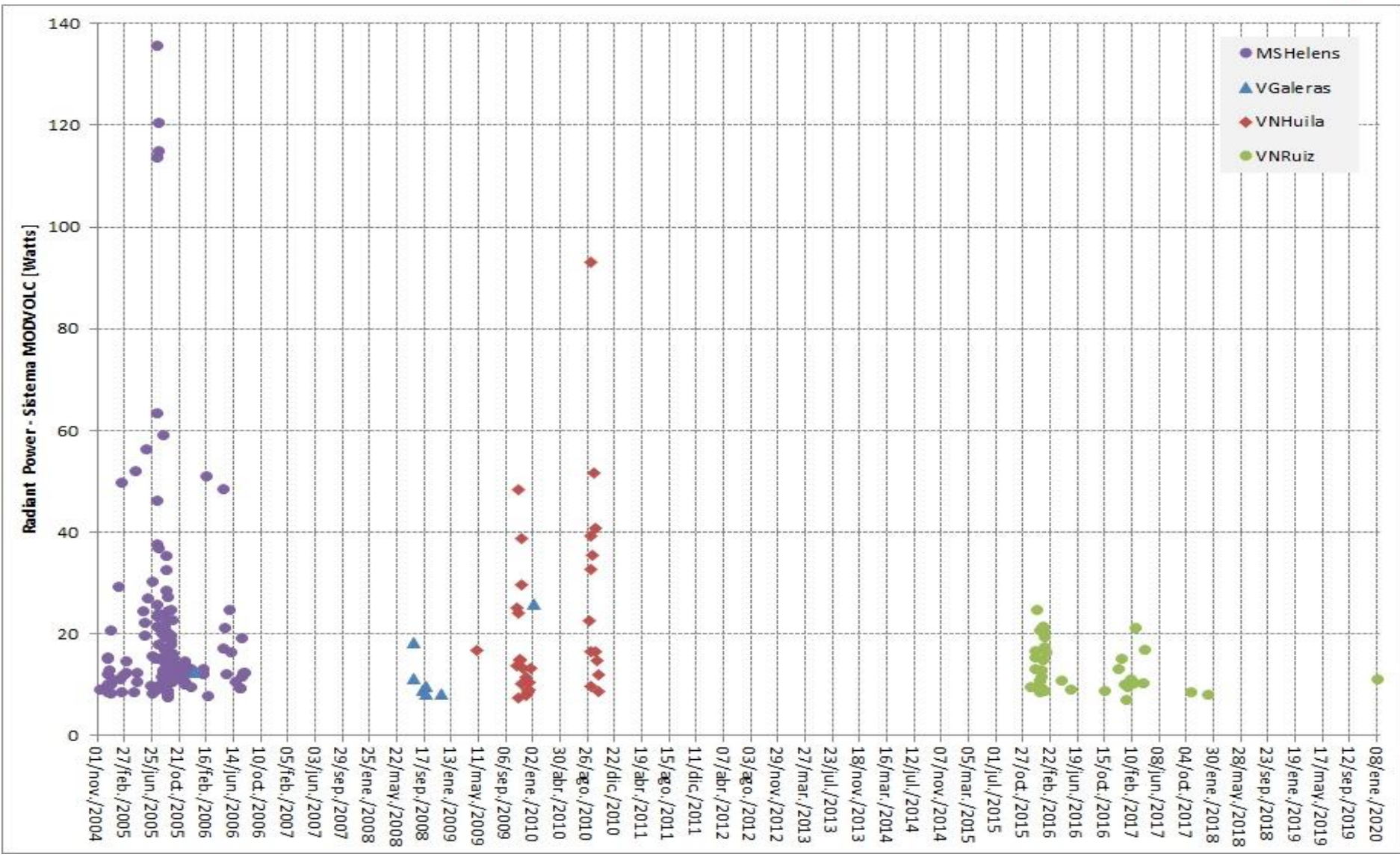


VIIRS STD & NRT (NASA FIRMS) vs MODIS (MIROVA)





Dome growing processes' comparison using MODVOLC data*



* <http://modis.higp.hawaii.edu/>

Gas monitoring

Earth Engine Apps Experimental

Visor TROPOMI Latinoamérica

Promedios por píxel para imágenes del sensor TROPOMI (acoplado al satélite Sentinel-5p de ESA), para diferentes productos (incluyendo SO2 volcánico). Inspirado en el "TROPOMI SO2 Explorer" de Pascal Hedelt, para fines didácticos y/o de monitoreo volcánico.

Periodo de tiempo con disponibilidad de datos:
NRTI: 2018-10-02 a 2021-02-14T22:22:25
OFFL: 2018-11-28 a 2021-02-12T20:44:11

Fecha Inicial [yyyy-mm-ddThh:mm:ss]
Fecha Final [yyyy-mm-ddThh:mm:ss]

Seleccione un Producto TROPOMI
NRTI SO2 VCD 15 km (Volcánico)

Aplicar filtros

Umbral para definir la escala cromática [DU en los casos que aplique]

Mínimo:
Máximo:
Radio del buffer para Series de Tiempo [km]:

Series de Tiempo
De clic en un punto del mapa para generar un histograma de series de tiempo
Punto de análisis Lon: -75.32 Lat: 4.89
Series de tiempo para el periodo de observación seleccionado:

Series de tiempo para el periodo de observación completo de TROPOMI: Haga clic sobre el histograma para mostrar la imagen procesada para la fecha seleccionada.



Visor TROPOMI Latinoamérica

Promedios por píxel para imágenes del sensor TROPOMI (acoplado al satélite Sentinel-5p de ESA) para diferentes productos (incluyendo SO2 volcánico). Inspirado en el "TROPOMI SO2 Explorer" de Pascal Hedelt, para fines didácticos y/o de monitoreo volcánico. Si Usted tiene una cuenta de Google Earth Engine, puede acceder al código fuente de esta aplicación a través del siguiente enlace:

<https://code.earthengine.google.com/d001522b0c991468f45eeb1b78ec5340> Mayor información: claverde@sgc.gov.co

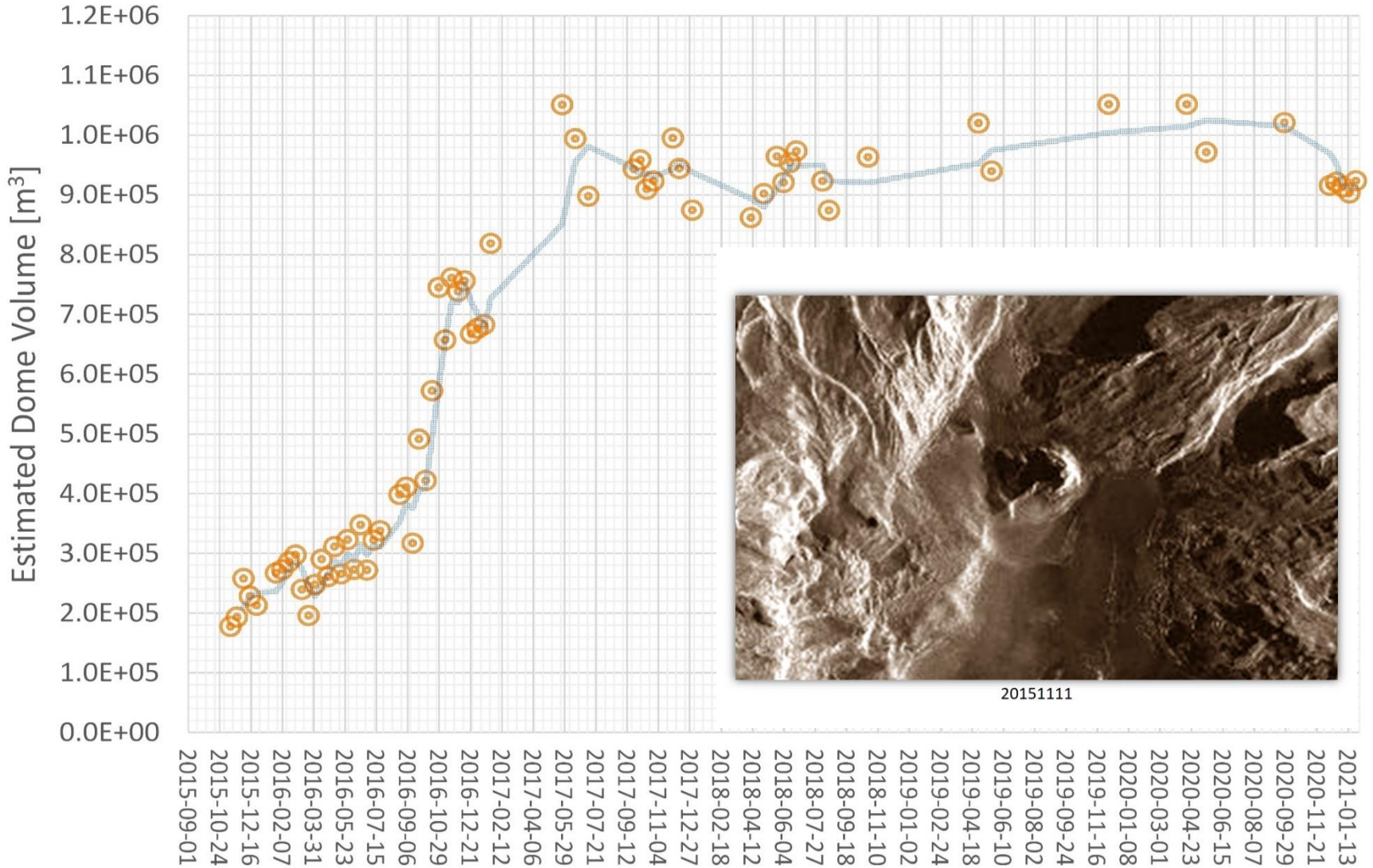
VIEW THE APP

<https://claverde.users.earthengine.app/>

Morphological evolution of VNR Lava dome



Estimated Dome Volume [m³]



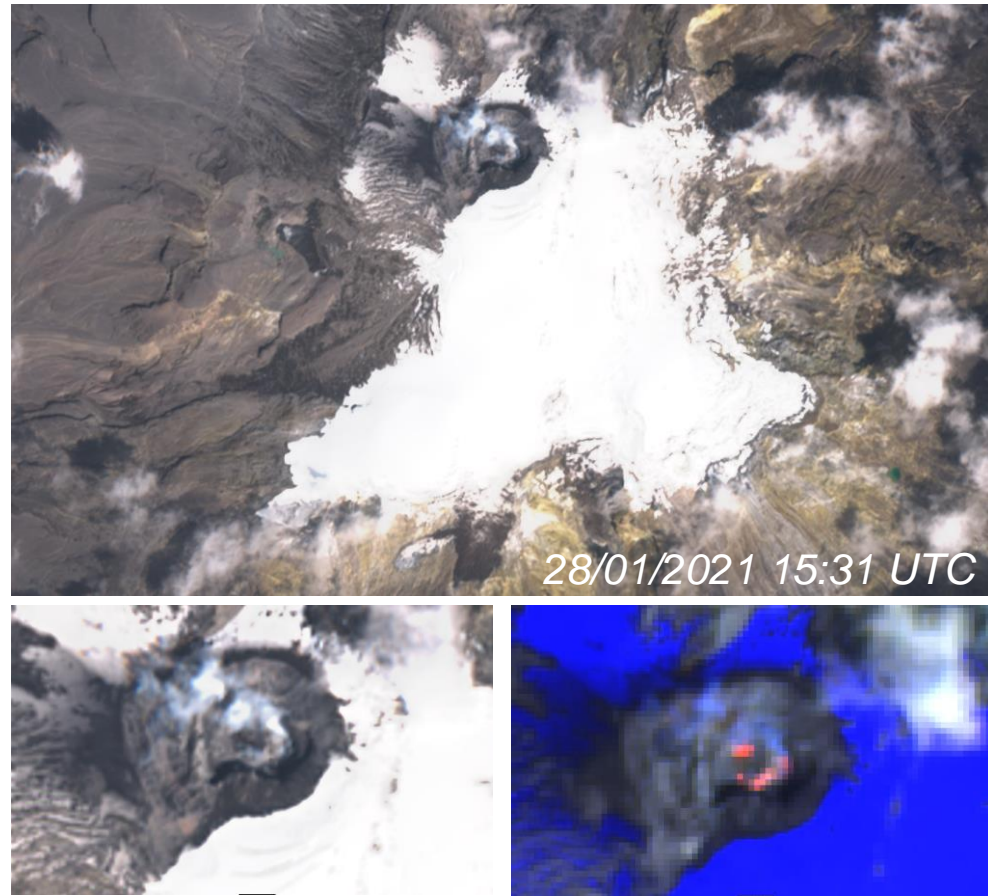
Morphological evolution of VNR Lava dome



Planet SkySat



Sentinel-2

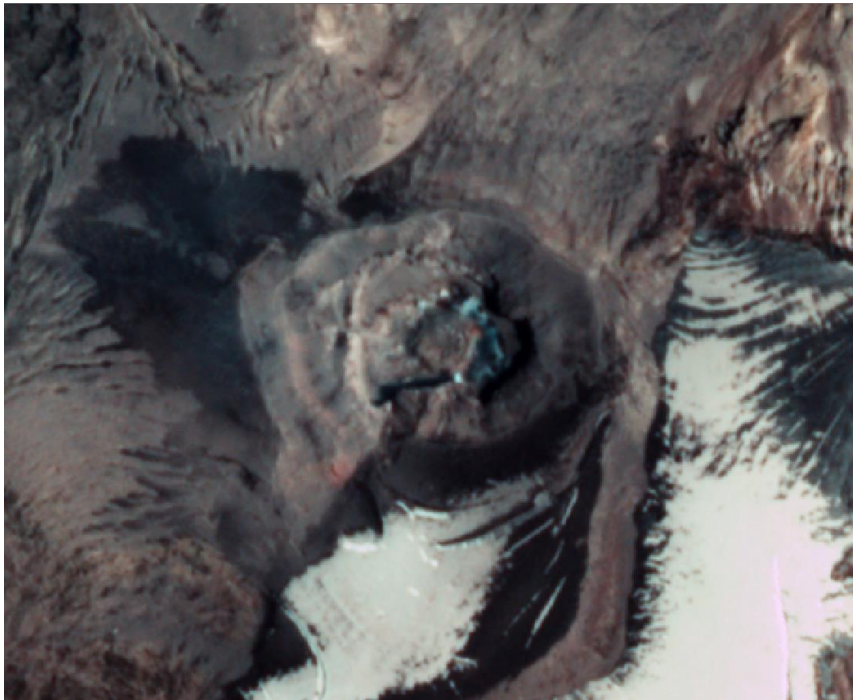


Surface Activity and Morphological Changes

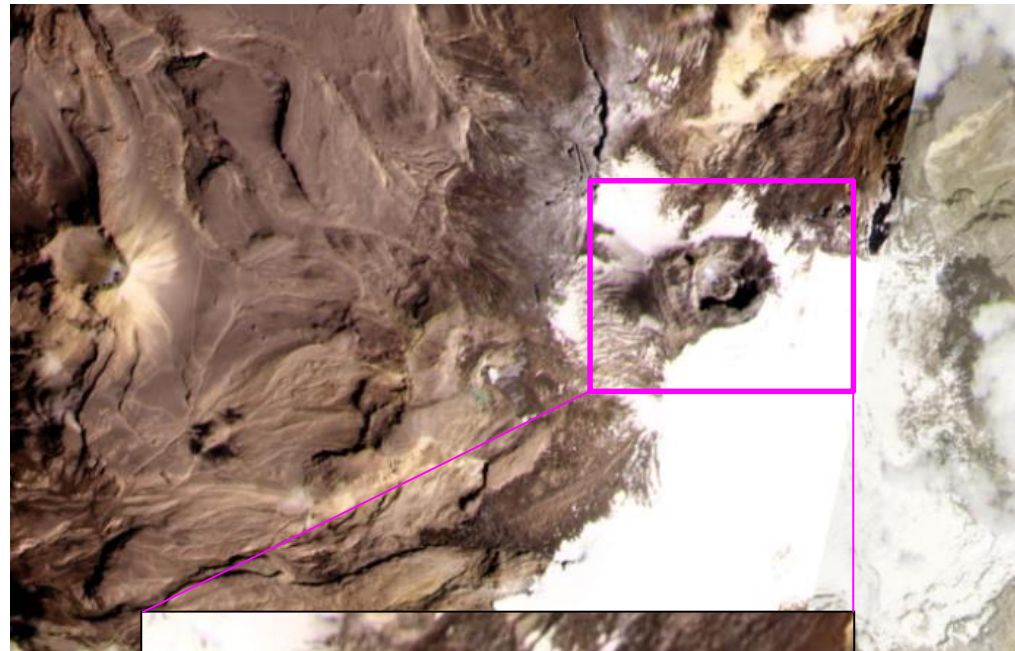


29/01/2021 14:46 UTC

Planet Scope

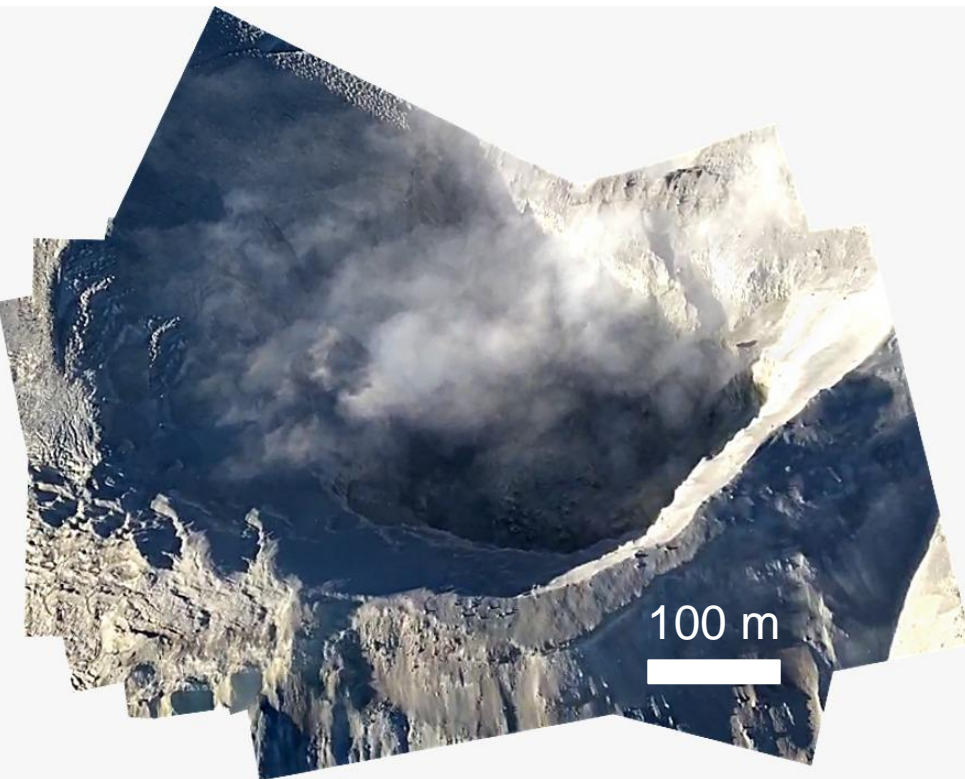


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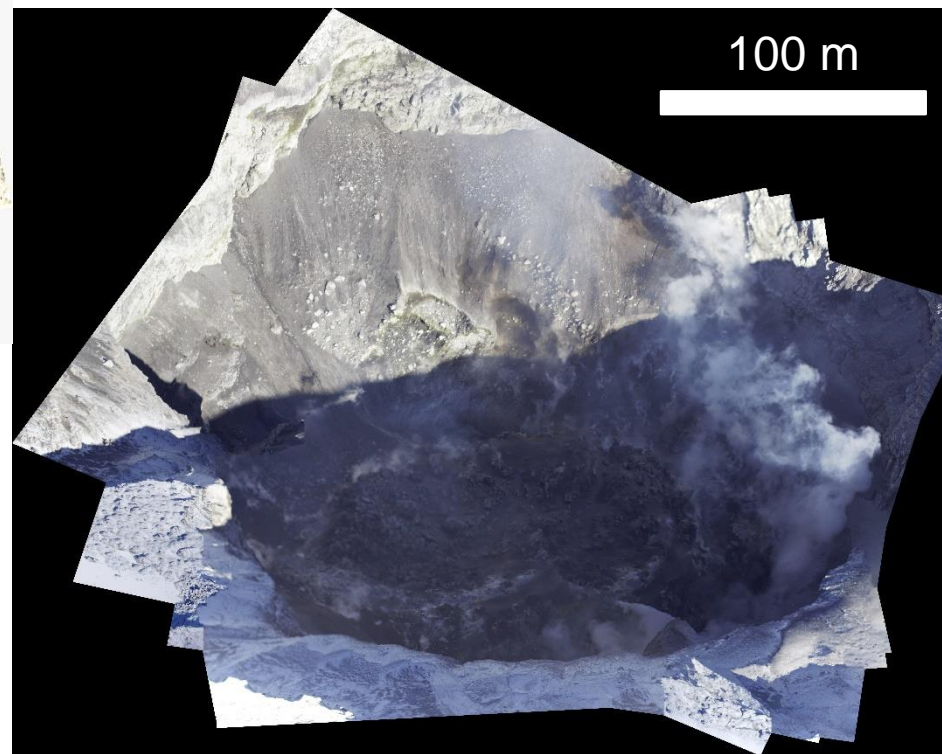




Airborn monitoring (Helicopter overflies)



January 10th of 2020



January 29th of 2021



Multiparameter time-series



Volcanoes About News

Ruiz, Nevado del

Colombia

Latitude Longitude Altitude ID
4.892 -75.319 5321 m 351020

Monitoring priority: **high**

Time series

Image grid

Image player

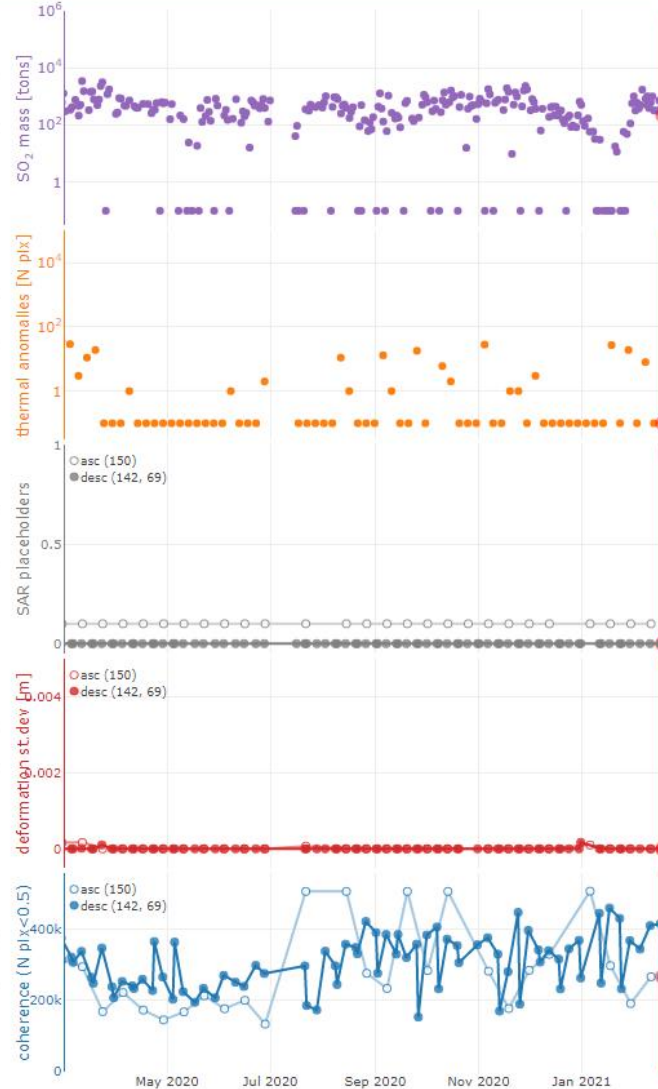
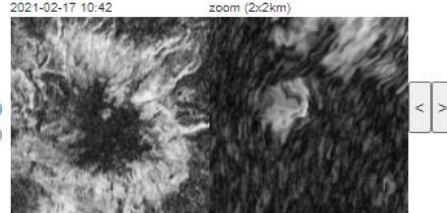
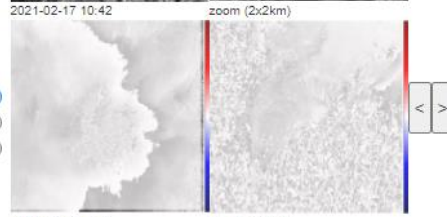
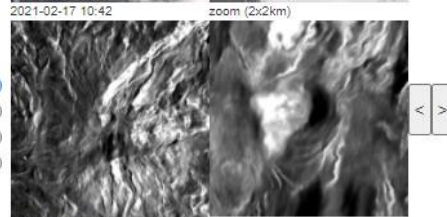
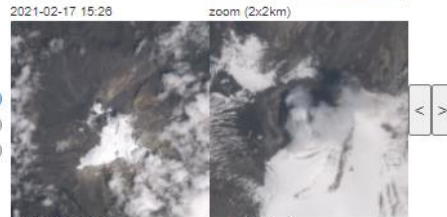
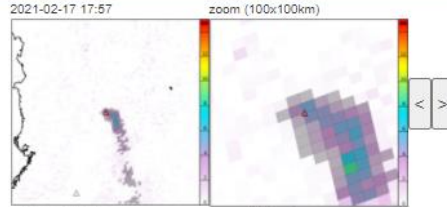
Image slider

Google Earth

Earthquakes

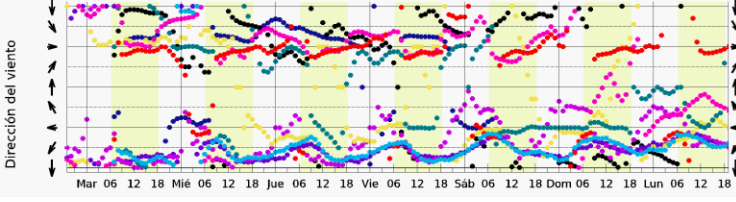
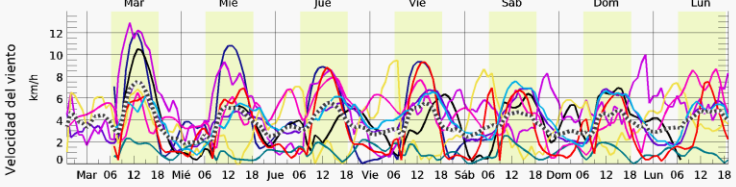
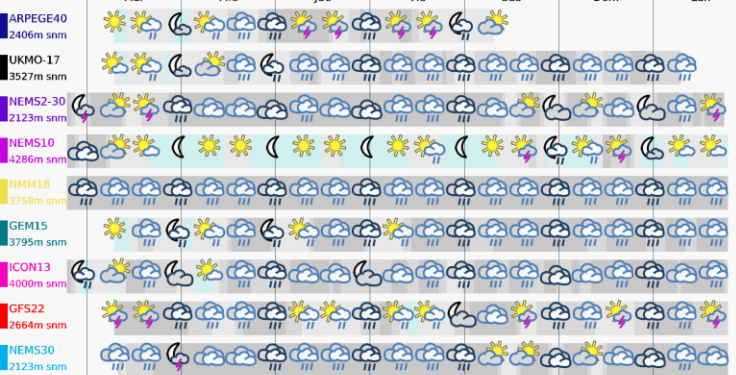
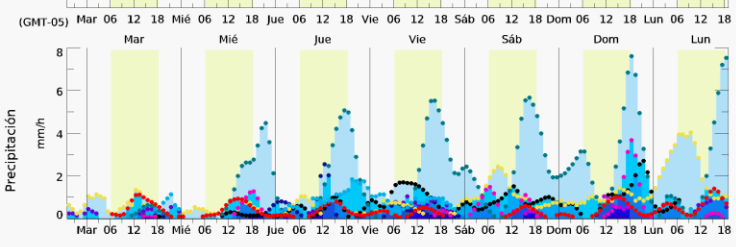
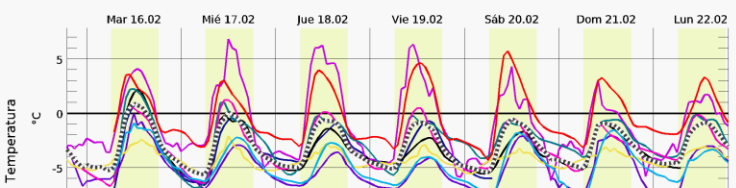
MIROVA

Off select page options



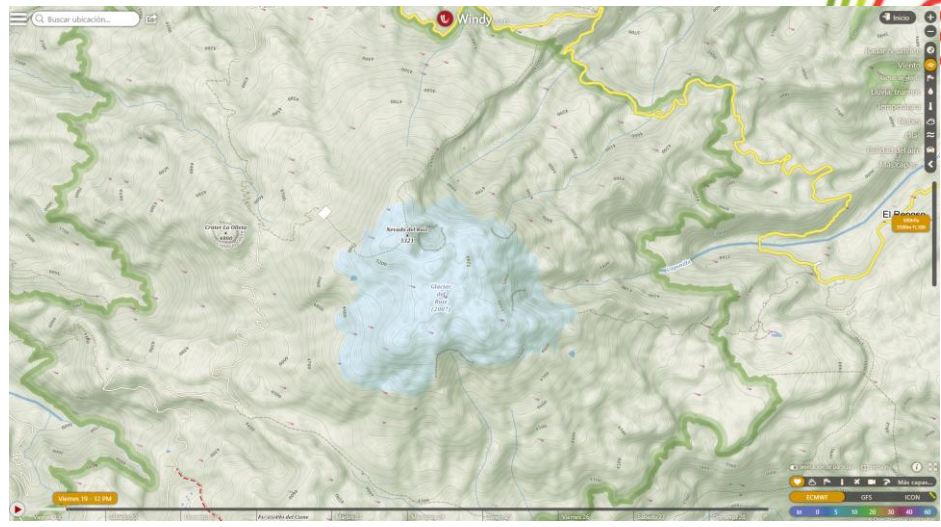
<http://www.mounts-project.com/home>

Nevado del Ruiz 4.89°N / 75.32°W (5300m snm)

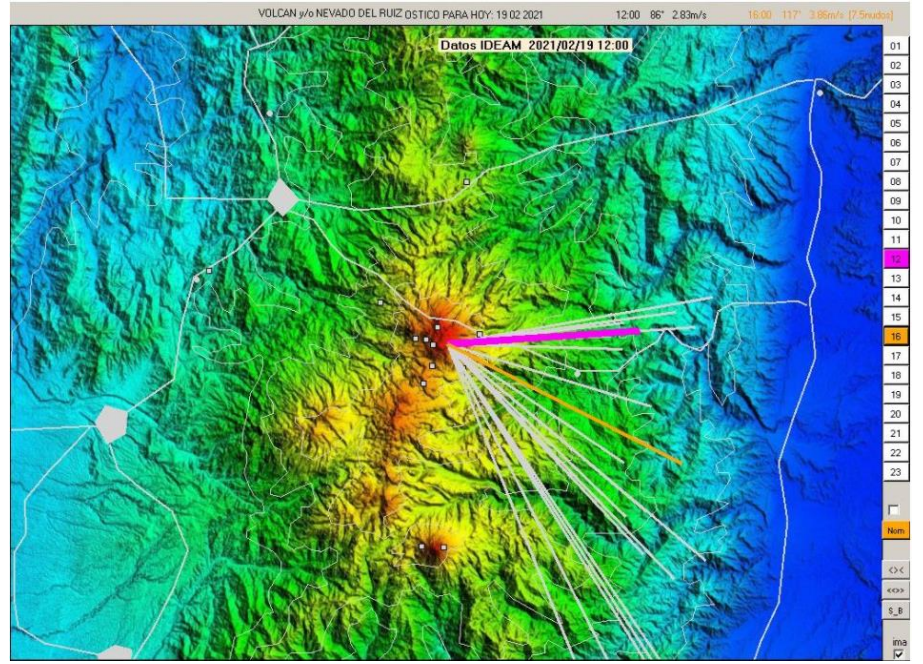


https://www.meteoblue.com/es/tiempo/pronostico/multimodel/nevado-del-ruiz_colombia_3670563

Meteorological data



<https://www.ventusky.com/>



WRF hourly forecast (IDEAM)



Current needs/lacks

- In general, to improve our institutional knowledge in processing and data analysis.
- Implementation of Drones / UAV's for geological field work and photogrammetric DEM generation.
- Professionals in the Observatories dedicated exclusively to this knowledge area.
 - Access to high resolution VIS+NIR imagery
- Apply to more and more Spatial Agencies' research data access proposal opportunities.

Future plans with satellite/airborne remote sensing data



Next step using remote sensing data: Increasing OWN PROCESSING capabilities, including “quantification” from images (temperature/radiative power, deformation and dome growth rates)

- * Installation of more thermal cameras around volcanoes
- Developing/Improving InSAR processing and analysis capabilities
- Developing photogrammetric/stereogrammetric processing capabilities (USGS-VDAP support), DEMs generation, topographic-morphological analysis
- Integrate semi-automatically or automatically these data from imagery quantifications to multiparameter database of volcanic monitoring

Global Volcano Monitoring Infrastructure (GVMID)



- SGC would be glad to follow contributing data to GVMID / WOVOdat.
- SGC in past years have contribute with information from Colombian volcanoes and Colombian observatories to WOVOdat database, but currently we need to update our information.
- We need to discuss internally a little more about the data sharing policy, but it is posible for us share with GVMID the spatial information from our monitoring networks database.



SERVICIO GEOLÓGICO COLOMBIANO
Observatorio Vulcanológico y Sismológico de Manizales

Gracias!!!

Visítenos: <https://www.sgc.gov.co/volcanes/index.html>
<https://www.facebook.com/sgcolombiano/>

Foto: Laura Victoria Carmona, 15 /12 / 2014