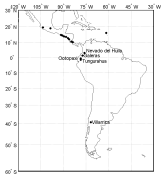
VOLCANIC SO2 FLUX DERIVED FROM SATELLITE AND FROM NOVAC GROUND-BASED SYSTEMS

G. Pinardi[1]*, M. Van Roozendael[1], C. Fayt[1], J. van Geffen[1], R. Campion[2], B. Galle[3], S. Carn[4], P. Valks[5], M. Rix[5]
(1) BIRA-IASB, Belgium, (2) ULB, Belgium, (3) Chalmers, Sweden, (4) MTU, USA, (5) DLR, Germany

aeronomie.be

Context

NOVAC: Network for Observation of Volcanic and Atmospheric Change project for the set up of measurement of volcanic SO_2 emissions by UV absorption spectroscopy (more than 21 volcanoes); B. Galle et al., JGR 2010



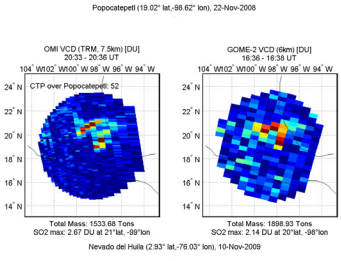
Monitoring of volcanic SO_2 from satellite:

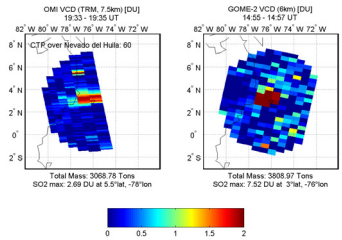
	GOME-2: Global Ozone Monitoring Experiment	**OMI:** Ozone Monitoring Instrument	**ASTER:** Advanced Spaceborne Thermal Emission and Reflection Radiometer
Platform and launch date:	Onboard MetOp-A, launched in 2006.	Onboard AURA, launched in 2004.	flying on Terra, launched in 1999.
Overpass Time:	~9h30 UT	~12h-13h30 UT	9h59 GMT
Pixel resolution:	**80x40km²** (at nadir – swath of 1920 km)	**13x24km²** (at nadir – swath of 2600 km, CTP from 1 to 60)	**90x90m²** (whole image 60x60km²)
Data Origin:	Operational product from DLR (EUMETSAT). SO2 columns given for SO2 content at: 2 km **6 km** 15 km	OMSO2 operational product from NASA. SO2 columns given for SO2 content at: 0.9 km (PBL, pollution) 2.5 km (TRL) **7.5 km (TRM)** 17 km (STL)	Data obtained from Robin Campion (ULB), personal communication.

> explore and inter-compare different satellite SO_2 data-sets (OMI and GOME-2)
> use NOVAC ground-based data to validate satellites estimates of gas flux emissions
> case study over Etna involving OMI and ASTER: impact of spatial inhomogeneities of the SO_2 within an OMI pixel; importance of external information (as the height of the volcanic plume) to reduce the error on the SO_2 estimation.

OMI and GOME-2 data

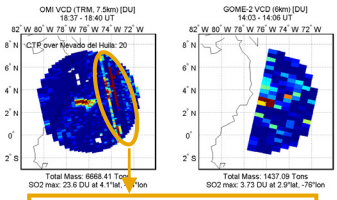
A) Extraction of SO2 data from OMI and GOME-2 around every NOVAC station and visualisation of daily maps





B) Comparison of the 2 datasets and calculation of total SO2 masses:

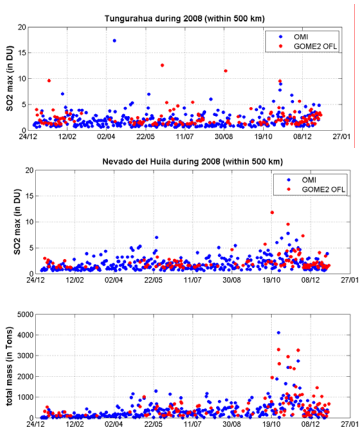
$$Mass = (VCD_{fi} - mean(VCD_{notfi})) \cdot AirPix_{fi} \cdot \frac{M_{SO2}}{N_A}$$



Row anomalies affecting L1B and L2 data for different CTP (http://www.temis.nl/docs/omi_warning.html) à problem: evolution during time

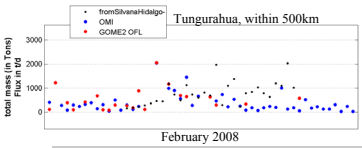
M_{SO2}= 64 g/mol, N_A= 6.022e23 mol/molec, *fi*: pixels above the threshold values of 0.6 DU for OMI and 1.15 DU for GOME-2

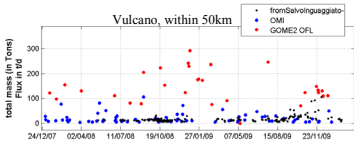
Good comparisons of OMI and GOME-2 over most stations, but degradation over time (insufficient correction of row anomalies).

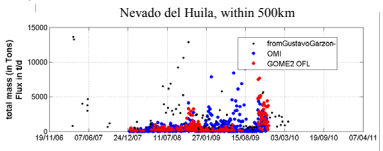


Comparisons with NOVAC

Comparison of satellite's masses and NOVAC ground-based fluxes (few stations)



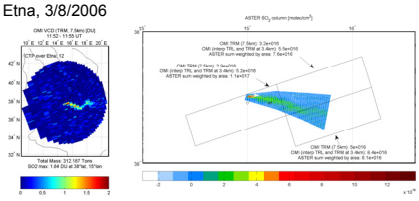




Preliminary comparisons shows good agreement in Tungurahua for OMI, GOME-2 and NOVAC data, some very good agreements in conditions of very low SO2 emission over Vulcano Island for OMI, but differences with GOME-2 (larger pixels effected by Etna?). Over Nevado del Huila the mobileDOAS fluxes are often much larger than the mass seen by the satellites.

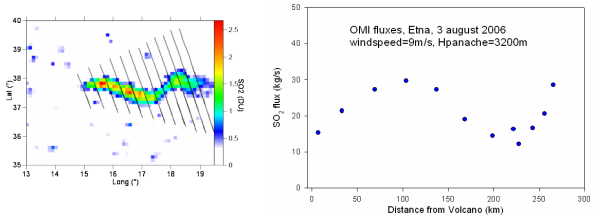
OMI and ASTER comparison

Etna, 3/8/2006



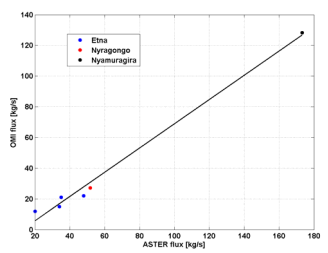
Several orders of magnitude difference for raw comparison of max SO2 (4.8e16 vs 1.4e19 molec/cm²); good agreement when resampling on OMI pixel size and adapting OMI column to ASTER plume height. Considering transport (sum on the 3 pixels): 1.91e+17 molec/cm² for OMI and 2.66e+17 molec/cm² for ASTER .

Application of the flux calculation routine of ASTER to OMI: (needs external wind information)



OMI mean flux value of 22 kg/s, compared to ASTER value of 48 kg/s 2 hours before.

Application to several other days over Etna and to Nyriagongo (18/1/2010) and to Nyamuragira (19/6/2007)



Good correlation, with OMI fluxes generally smaller than those retrieved by ASTER. Slope of 0.79 and intercept of -10kg/s for the linear regression line.

Conclusions and future work

- OMI and GOME-2 SO2 columns around the NOVAC stations have been extracted and compared. Total SO2 masses have been calculated and compared to fluxes derived by ground-based NOVAC instruments at 3 stations. More NOVAC data are needed to conclude on the validity of the exercise.
- Flux estimation from OMI has been developed (possibility to extend to GOME-2) and comparisons with ASTER show a good correlation but an underestimation of OMI compared to ASTER. Smoothing of the SO2 column within an OMI has also been showed for a test study over Etna.

Acknowledgements: The NOVAC project is funded by The European Union, FP6, Global Change and Ecosystems, Natural Disasters program.