Influence of ambient conditions on NOVAC BrO measurements

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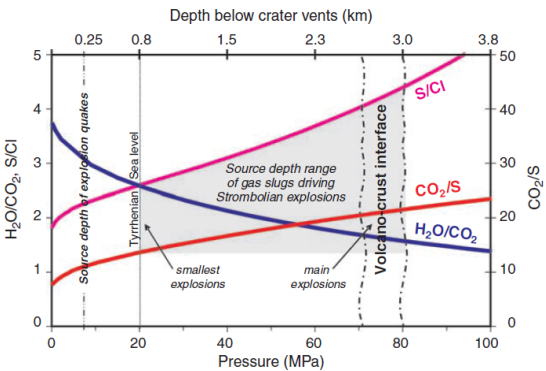
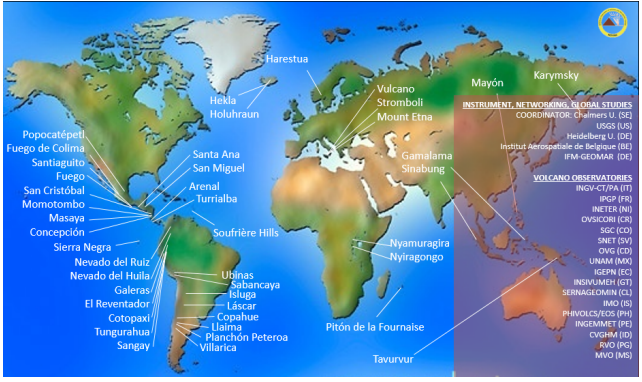
Motivation for BrO measurements

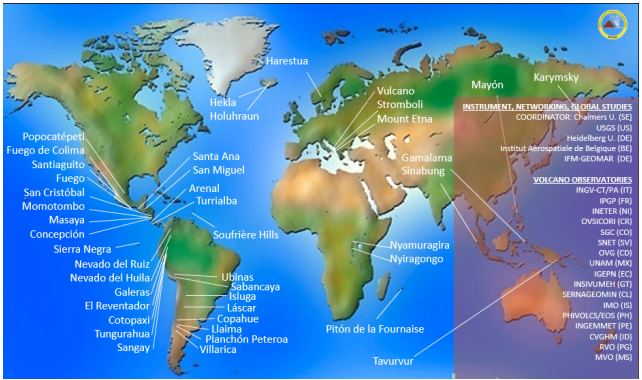
- The ratio of BrO and SO_2 changes with degassing source depth
  $\rightarrow$ The ratio of BrO and SO_2 is a proxy for the volcanic activity
- Change in BrO/SO_2 prior to eruption observed at Etna and Nevado del Ruiz
- Within NOVAC we are able to measure BrO and So2



Network for observation of volcanic and atmospheric change (NOVAC)



Network for observation of volcanic and atmospheric change (NOVAC)



- Primary use of data SO_2 flux monitoring
- Lübcke et al (2014) also retrieved BrO
- BrO close to detection limit
- Here we investigate techniques to improve the BrO evaluation from NOVAC data

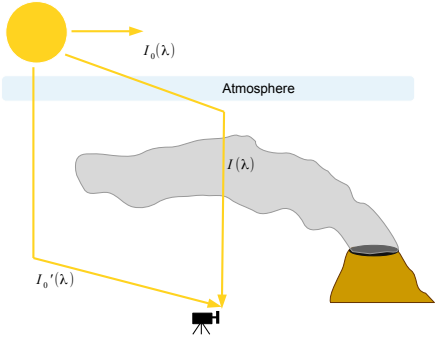
Differential optical absorption spectroscopy (DOAS)

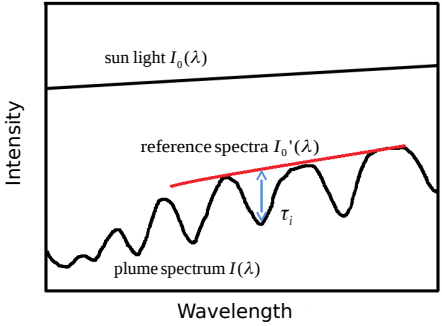
Lambert-Beer Law

$$I(\lambda) = I_0'(\lambda) \cdot exp\left(\sum_i \sigma_i \cdot c_i \cdot L\right)$$

Optical density

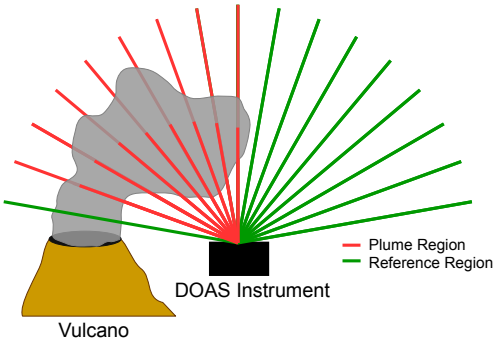
$$\tau_i = ln\left(\frac{I_0'(\lambda)}{I(\lambda)}\right) = S \cdot \sigma_i$$

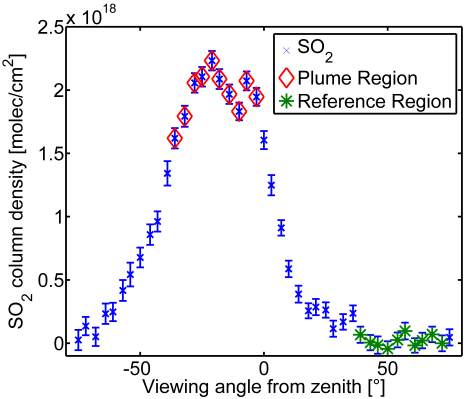




Multi Axis DOAS at NOVAC

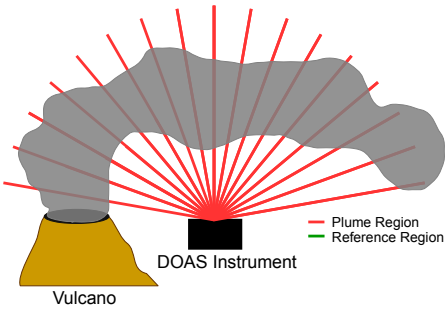
- Scan under difference viewing angles
- Retrieve Plume location from SO2 Fit

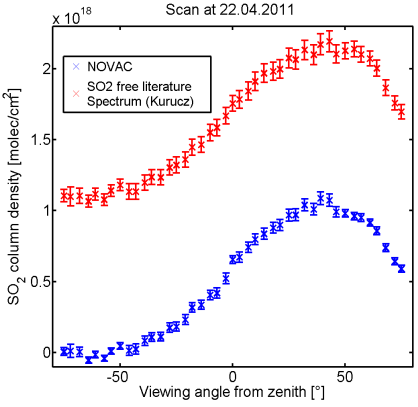




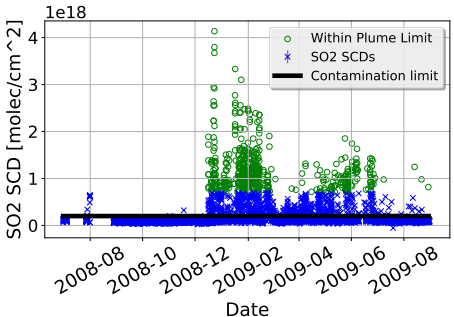
Contamination Problem

- If the whole scan is covered in the plume
  -the reference is contaminated





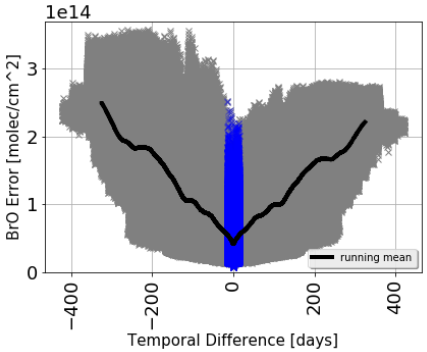
Checking for contamination



- Data are contaminated if the SO_2 amount in the reference is above $2 \cdot 10^{17}$

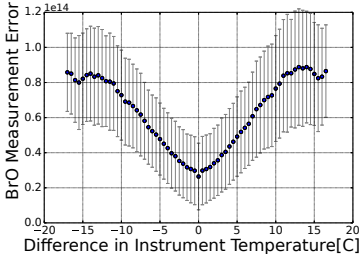
- Only accept SO_2 SCDs above the plume limit of $7 \cdot 10^{17} \frac{molec}{cm^2}$
- Possible contaminations can be checked by a theoretical solar atlas spectrum to evaluate the SO_2 amount in the reference.
- BrO can not evaluated by performing the retrieval with a solar atlas spectrum due to the small BrO amount in the plume

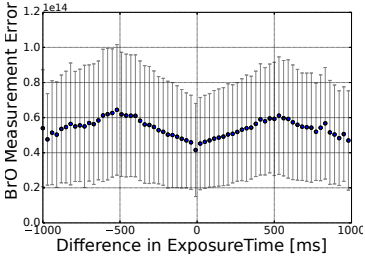
Temporal difference between the reference and the plume

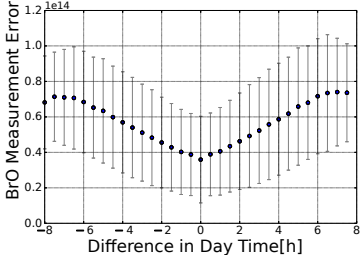


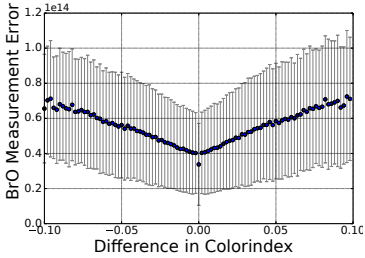
- Increase of BrO error with temporal difference
- The sign of the temporal difference irrelevant
- Restrict temporal difference to two weeks

Influence of ambient conditions on BrO measurement error



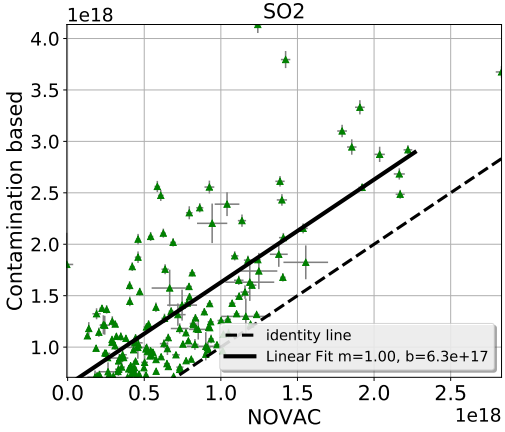




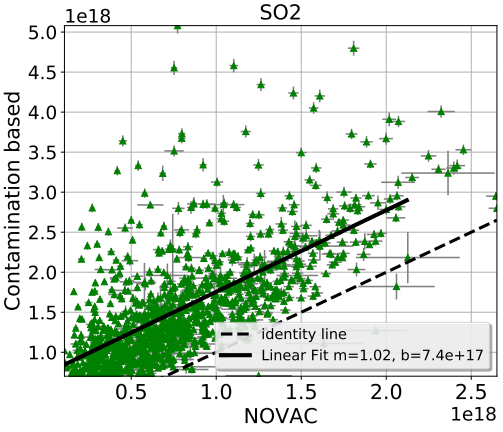


- Temperature
- Colorindex
- Exposure Time
- Elevation Angle
- Daytime

Comparison of the different evaluations - SO_2

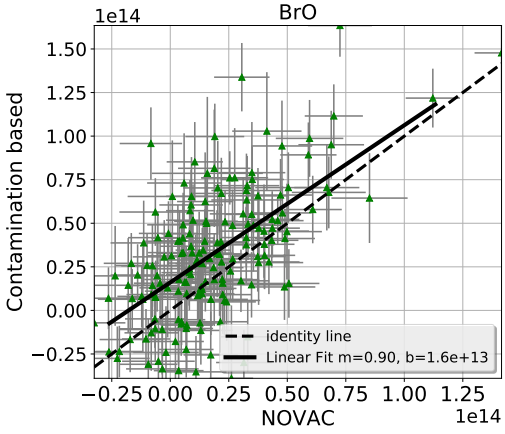


Data of Tungurahua



Data of Nevado Del Riz

Comparison of the different evaluations - BrO



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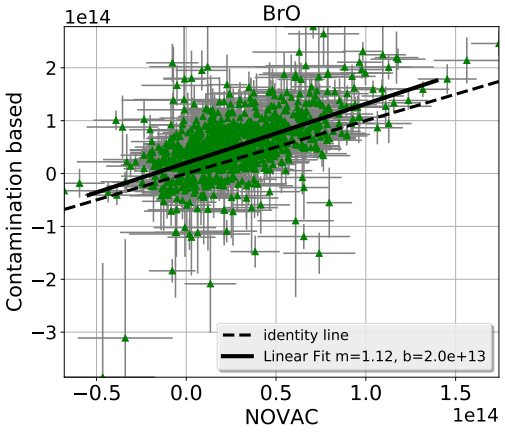
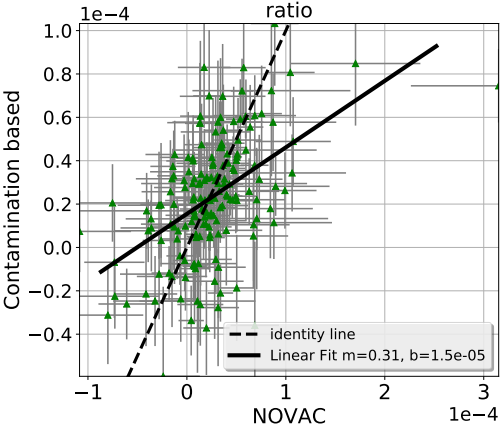


Data of Nevado Del Riz

Comparison of the different evaluations - BrO/SO_2



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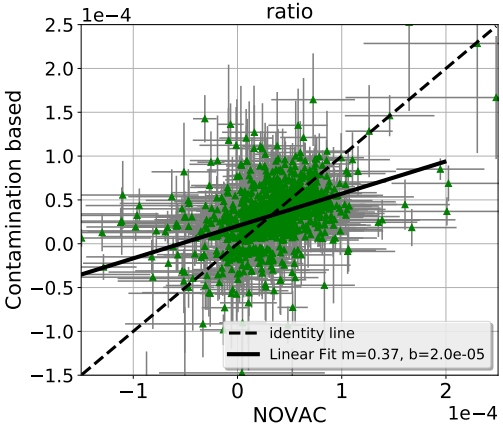
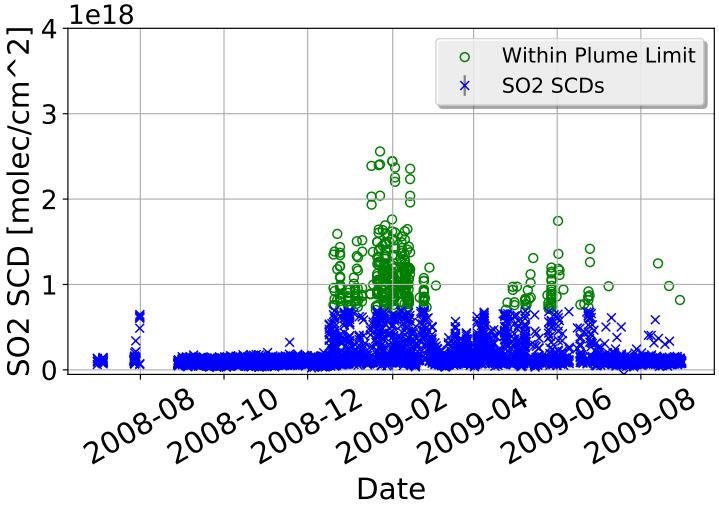


Data of Nevado Del Riz

Comparison with NOVAC evaluation



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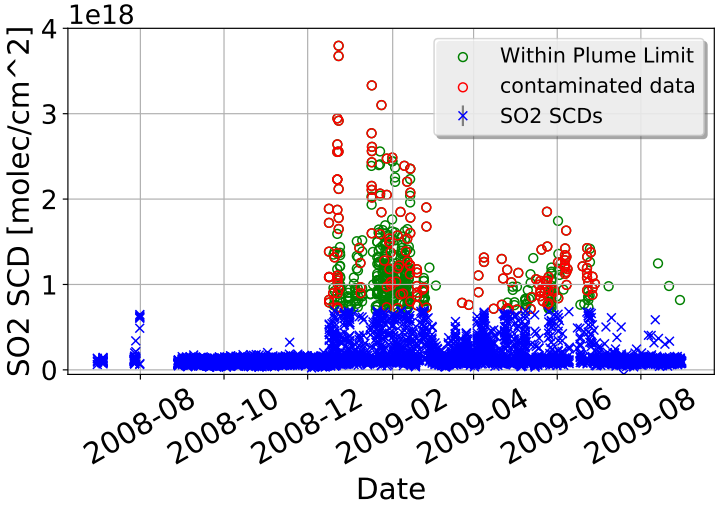

Conclusion and Outlook

Conclusion

- Contaminated reference spectra lead to significant underestimation of SO_2
- Optimized Evaluation: Keep environmental conditions of measurement and reference spectra similar
- More valid Data with optimized reference evaluation

Outlook

1. Examination of "Plume Contamination"
2. Chemical analysis of BrO lifetimes
3. Examine contamination of the plume by further measurements

Thanks for your attention