# Autonomous Long-Path DOAS Measurements of Tropospheric Trace Gases at Neumayer Station III, Antarctica: First Results

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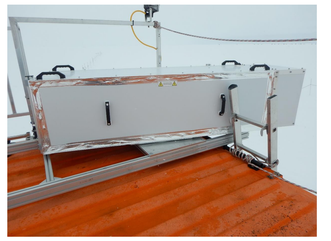


## Introduction

Reactive Halogen Species (like IO, BrO, ClO, etc.) have an important impact on atmospheric chemistry in Polar Regions:

- Change of the oxidative capacity of the atmosphere →influence on a number of chemical reaction cycles (e.g. sulpur cycle, $NO_x$ chemistry,…)
- Destruction of tropospheric ozone (in particular during springtime)
- Oxidation of gaseous elemental mercury (uptake into the biosphere)

The understanding of the underlying processes varies greatly between bromine, iodine and chlorine compounds. This is both because of technically challenging observation of these highly reactive trace gases with typical concentrations of a few *ppt* and because of the remoteness of the Polar Regions.

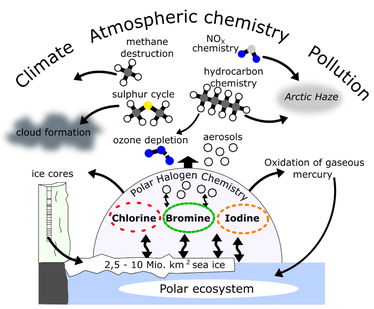



Fig 1: Impact of halogen chemistry on the Polar regions[1,5]

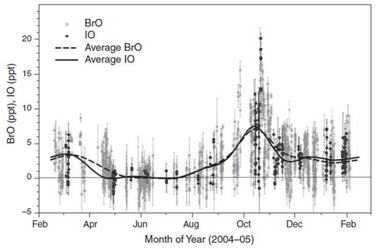



Fig 2: BrO and IO concentrations at Halley by Saiz-Lopez et al.[4]

Most measurements of RHS in Polar regions use scattered sunlight:

→ Instruments relatively simple and robust (autonomous operation)
→ However: limited availability of scattered light during Polar night and below the *Huggins* and *Hartley* bands in the UV (ClO absorption)

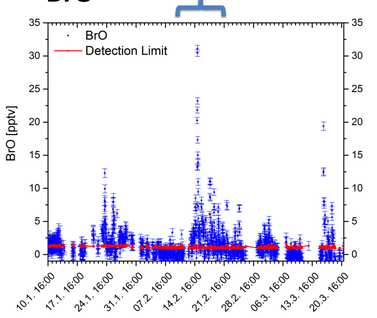
Active instruments such as Long Path DOAS have an own light source that allows measurements independent from sunlight. Because of the technical complexity of these instruments there are only a few measurements in Polar areas (e.g. by *Zielcke*[7] at Scott Base/Antarctica) and only one annual time series of BrO and IO concentrations by *Saiz-Lopez et al.*[4] at Halley/Antarctica.

The new instrument presented here considerably reduces the complexity of LP-DOAS measurements and is planned to operate largely autonomously for one year in Antarctica.

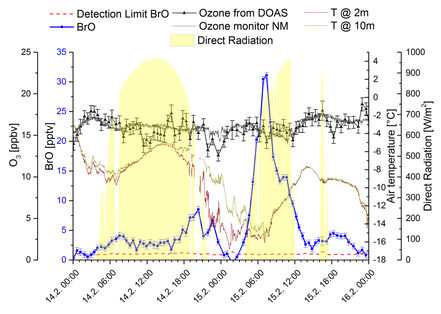
## Preliminary Results

- Regular BrO activation starting mid-January; unexpectedly high BrO concentrations of more than 30 ppt → might be explained by stable inversion layer above the surface and sea ice activity close by
- Detection of high ClO concentrations in march on days with low temperatures < -20° C; detection limit and evaluation require further investigation
- **IO**: detailed analysis pending; first : 1-2 ppt, never >3 ppt; DLs: 1,4 ppt (3,1 km) / 0,5 ppt (5,9 km)

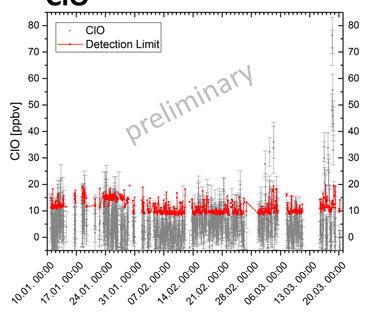
### BrO



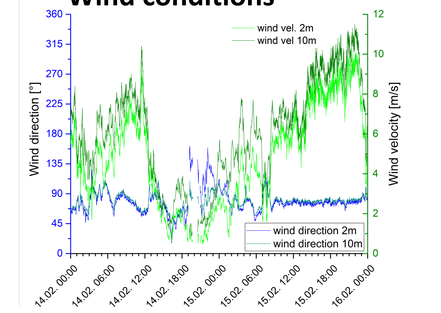

### BrO detail [2,3,6]




### ClO



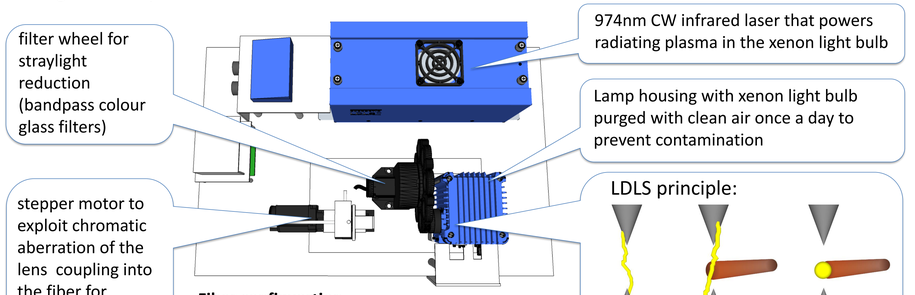

### Wind conditions [3]



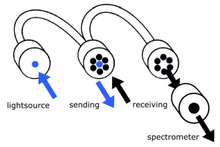

## Long Path DOAS instrument components

### Laser driven xenon light source (LDLS)

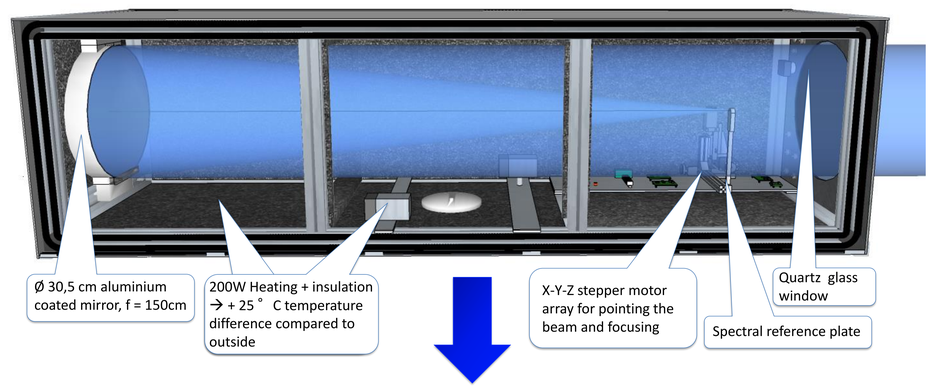
→ High intensity broad band emission from 180 to 800nm



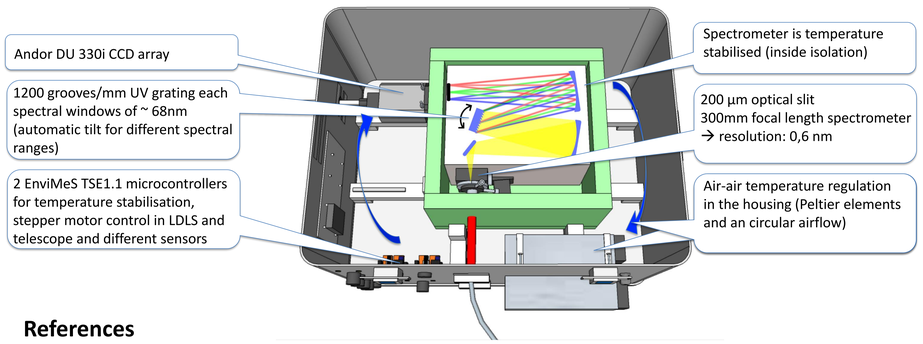

**Fiber configuartion**




### Telescope

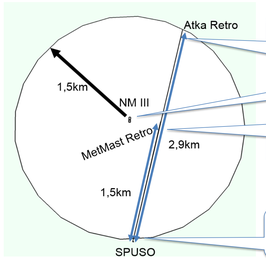



### Two-stage temperature stabilised spectrometer




## Setup at Neumayer Station III


Fig 3: Location of Neumayer III[8]




2,95 km Retro → 5,9 km light path

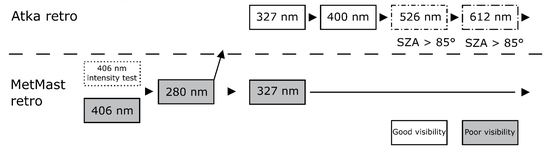
Neumayer III - Station

1,55 km Retro → 3,1 km light path

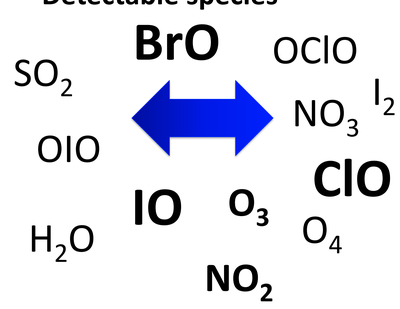
Instrument on trace gas observatory

### Measurement strategy

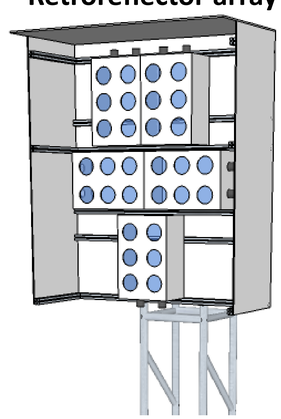
- 5 spectral windows with 68nm width




### Detectable species




### Retroreflector array



## Conclusions

- The new long path DOAS instrument was successfully put into operation at the Neumayer III station in Antarctica during the research season 2015/16
- It is in stable operation since mid January 2016 and delivers So far the operation has been reported to be uncomplicated and low maintenance
- The temporal resolution with the current analysis is 15-30min for BrO and IO and 60min for ClO.
- First halogen activation could be detected for BrO and potentially ClO in summer/early autumn
- High quality data from the metrology and chemistry observatories at Neumayer III will allow an in depth study and modelling of the detected processes.

### References

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