Long term variation of stratospheric NO₂ from ground based Zenith Sky DOAS observations at Kiruna, Sweden

MOTIVATION

• Distribution of NO₂ in the stratosphere plays a crucial role in the photochemistry of ozone.

- Destroying ozone through the NO_x catalytic destruction cycles
- -Mitigating ozone depletion (by converting active Chlorine, hydrogen, and bromine into their reservoir species)
- \Rightarrow Thus its abundance and temporal trends should be studied.
- In this study, we investigate the temporal characteristics of stratospheric NO_2 in a polar region using zenith-sky DOAS in Kiruna, Sweden (68.8°N, 20.4°E).
- For the determination of the NO₂ VCDs we apply the Langley-plot method on a daily basis.

ANALYSIS CONDITIONS

(a) Setup for the UV retrieval of NO₂ Vertical columns

Parameter	Information
Fitting window	356 – 392 nm
Cross-sections	
NO_2	Vandaele et al. (1998)
O_4	Greenblatt et al. (1990) Shift amount :0.3nm
O ₃	Bogumil et al. (2003),
Ring effect	
Polynomial order	5
Reference spectrum	<u>Daily basis</u>
AMF calcualtion	NDACCs NO ₂ AMF I
Determination of NO_2 amout in the reference spectrum (SCD _{ref})	Langley plot (Vaughar
SZA range for twilight determination of VCDs	87 – 91 °, 89 – 91 °

(b) NDACC Climatology NO₂ AMFs LUTs

Parameter	Information
NO ₂ Profile	17 – 12 Km : SAOZ balloon climatol
	Below 12 Km : NO_2 Conc. set to zero
	UARS HALOE v19 and SPOT-4 PO
	data
O ₃ and Temperature profile	US standard Atmosphere and TOMS
Radiative transfer model	UVSPEC/DISORT RTM (Mayer and
SZA	10, 30, 50, 70, 80, 82.5, 85, 86, 87, 8
Wavelength	350 to 550nm step 40nm
Surface albedo	0 and 1

(c) Langley plot method on a daily basis

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$$VCD(\theta) = \frac{DSCD(\theta) + SCD_{ref}}{AMF(\theta)}$$

The upper equation is used for the retrieval of VCDs. $VCD(\theta)$: The vertical column density at SZA(θ) **DSCD**(θ) : The differential slant column density at SZA θ SCD_{ref} : Actual amount of NO₂ in the reference spectrum AMF(θ): The airmass factor at SZA θ

SCD_{ref} is derived using the Langley plot method, which is a rearanged form of the equation above. Plotting the DSCD(θ) as a function of $AMF(\theta)$, the slope and ordinate of the curve refer to VCDs for NO_2 and SCD_{ref} , respectively.



Several studies deriving NO_2 column densities, used a single reference spectrum or some reference spectra were used for measurement period. (G. Vaughan et al., 2006, P. A. Cook et al., 2009) In this work, we attempt to use daily reference spectra to improve the trends for long-term measurement data.



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RESULTS

•Both: The NO₂ variation obtained between daily-based langely plot method and integrated the retrieved profile show good agreement. The difference between the daily based Langley plot method and total column densities from profile is mainly due to photochemical reacations.

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NO₂ trends. retrievals.

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•Analysis of longer period to determine the stratospheric BrO and

•Our future work involves profile inversion, comparison of SCIAMACHY limb with ground-based UV BrO and NO₂ profile