



Land-Cover and Land-Use Change Program



The utilization of Pandora observation modes for validation of tropospheric NO_2 vertical column derived from TROPOMI satellite.

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Contents

1

Introduction

2

Methods

3

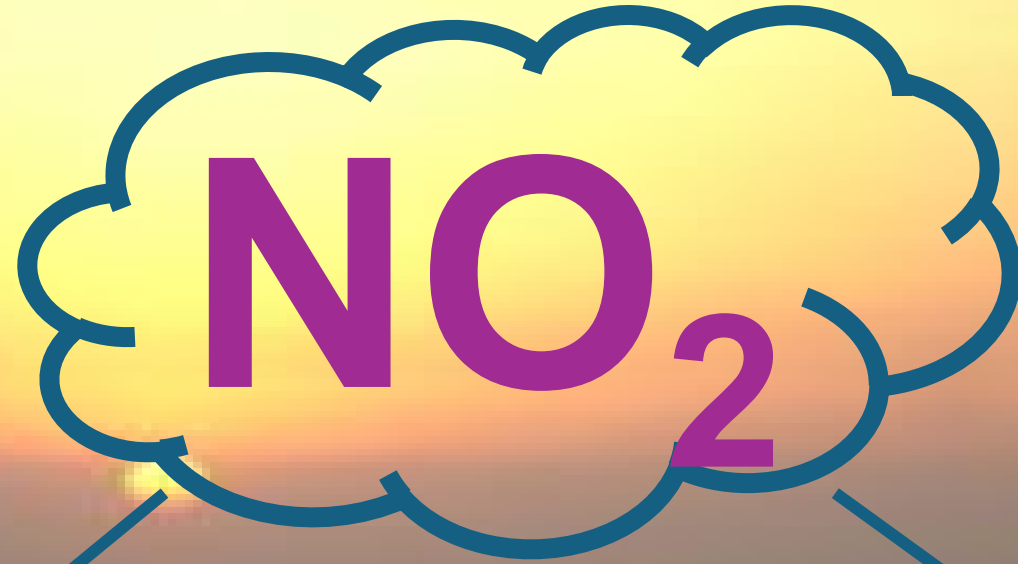
Results

- Inter-comparison of two Pandora stations
- Pandora and TROPOMI NO₂ TropVCD
- Aerosol effect
- Pandora NO₂ surface concentrations

4

Next steps

1. Introduction



ozon
e

aeros
ol



sentinel-2

sentinel-3

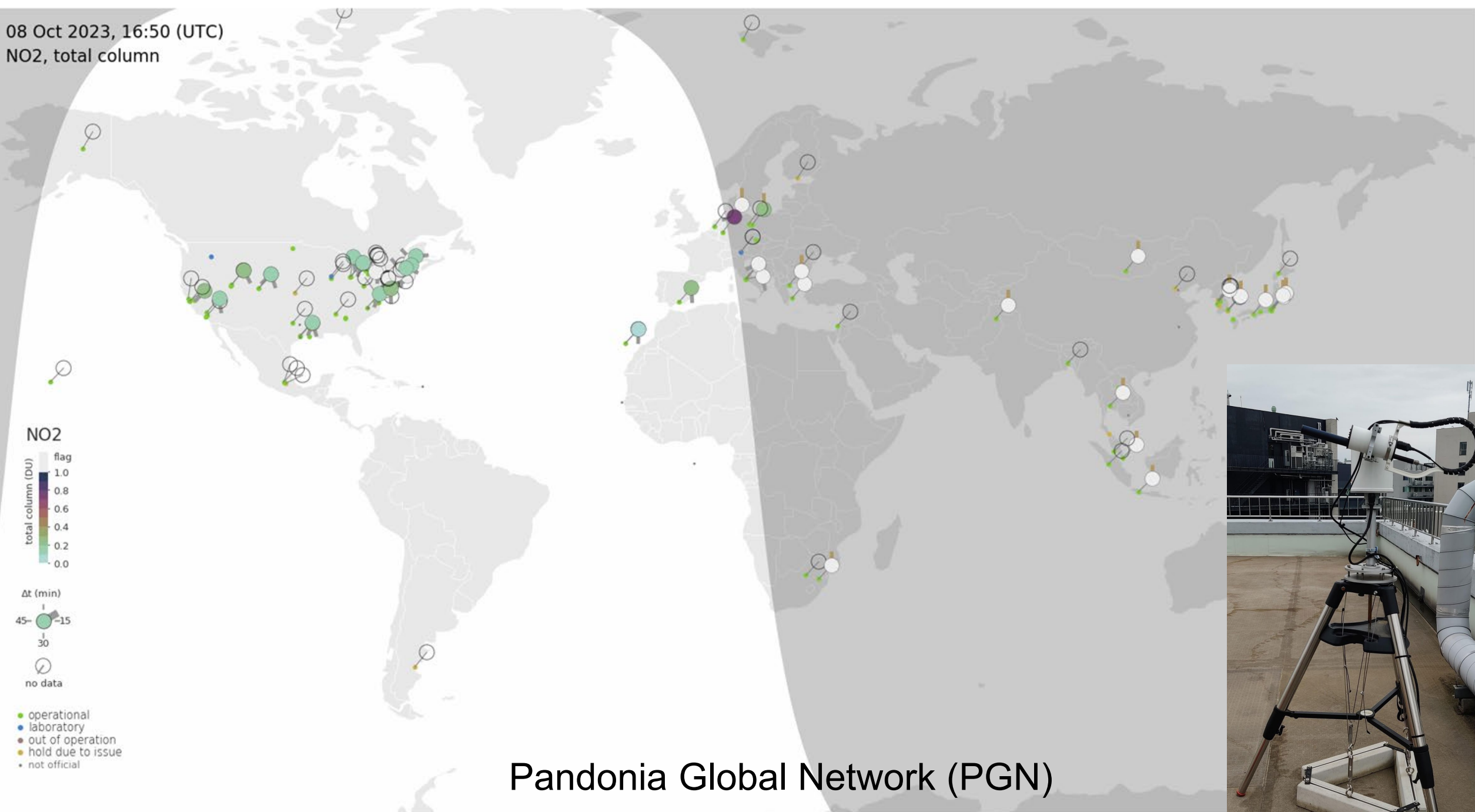
sentinel-1

high spatial resolution and daily global coverage

sentinel-5p

sentinel-5

08 Oct 2023, 16:50 (UTC)
NO₂, total column

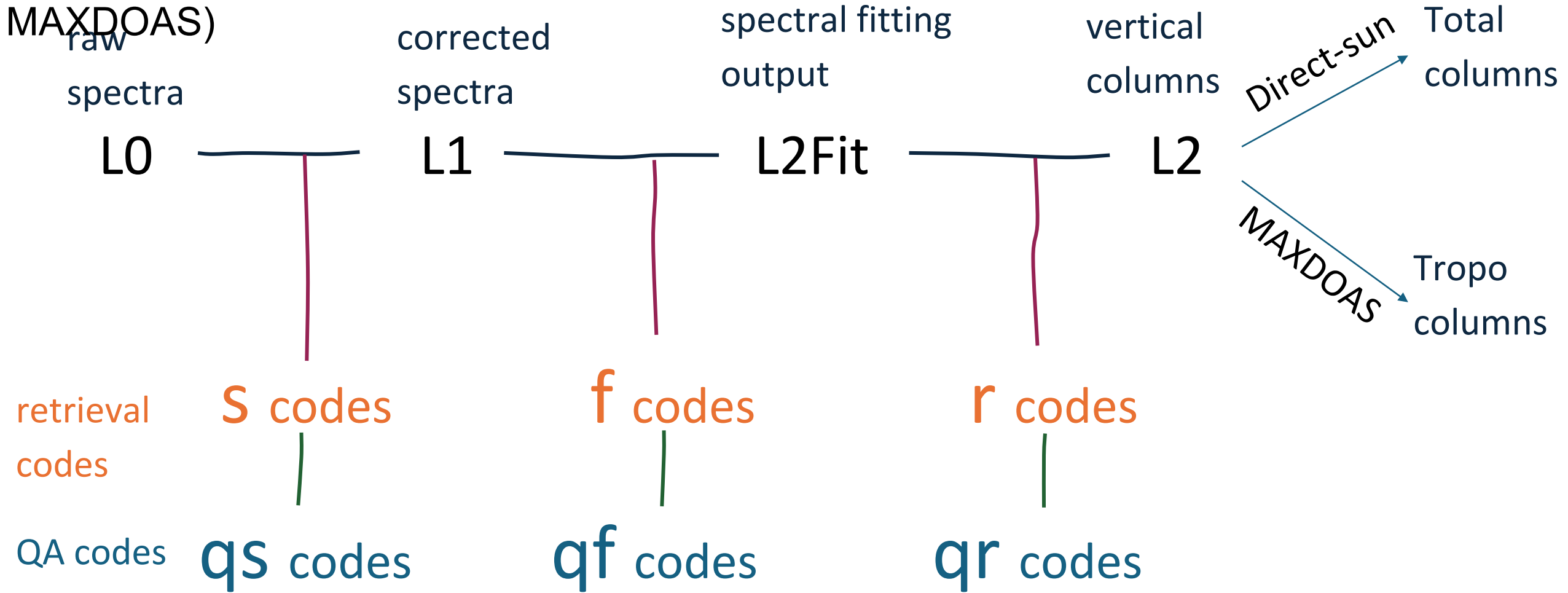


Pandonia Global Network (PGN)



1. Introduction

(Direct-sun,
MAXDOAS)



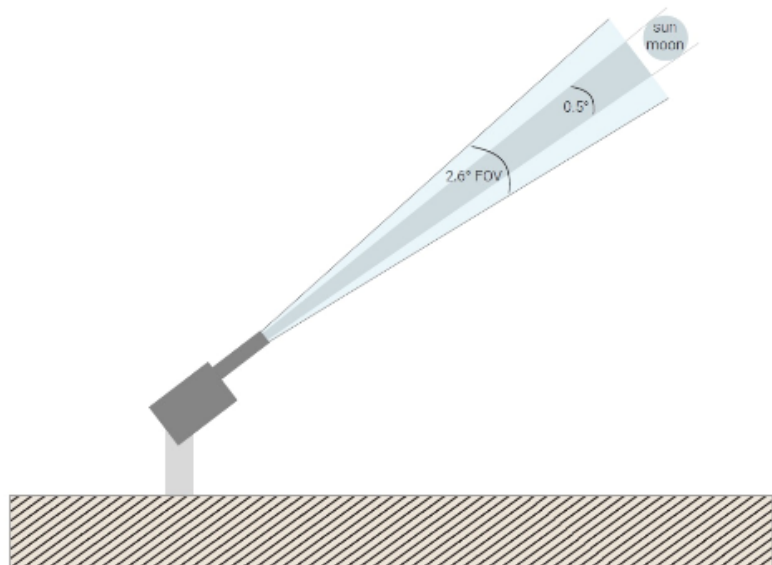


Figure 3: Direct sun observations

Direct
sunlight

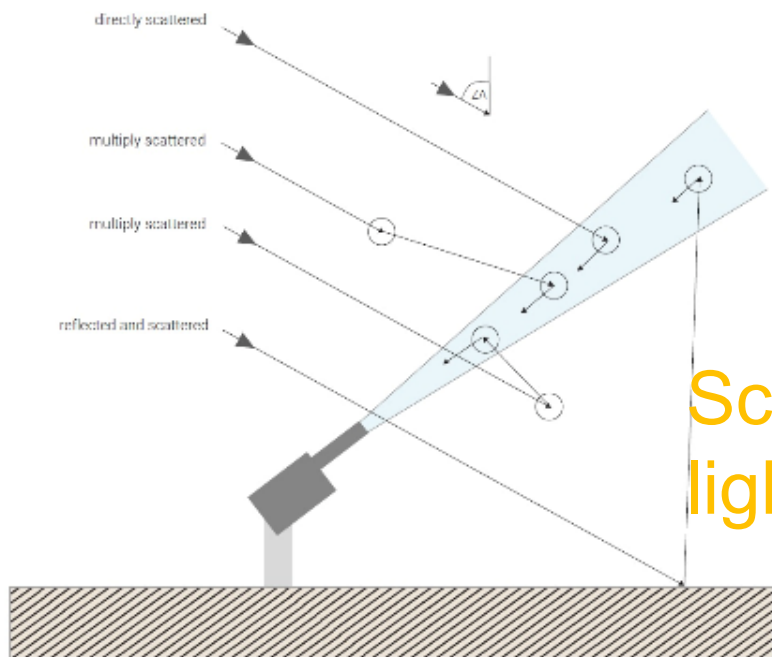


Figure 5: MAXDOAS observations

Scattered
light

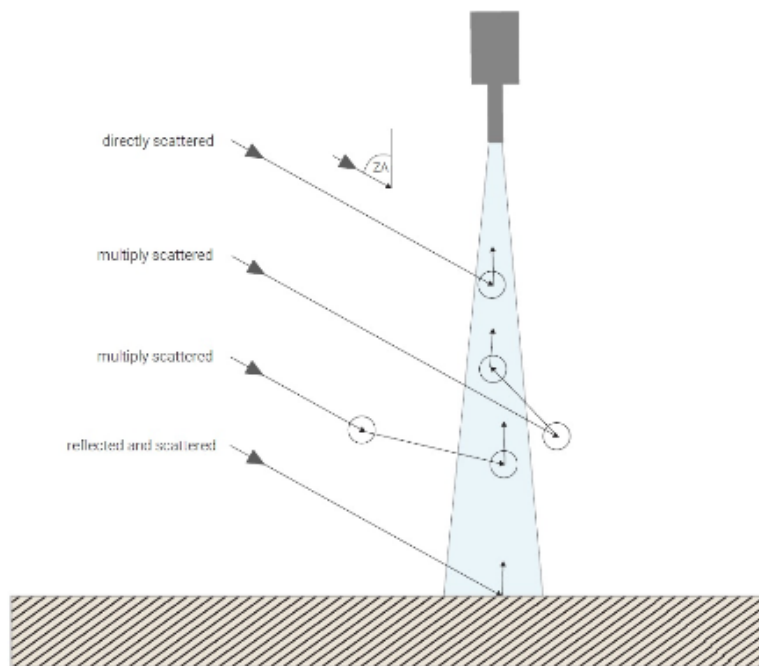


Figure 6: Nadir observations

(Source: PGN DataProducts Readme v1-8-5)

- comparison of Pandora MAXDOAS mode and Direct-sun mode for validation of TROPOMI tropospheric vertical column.

2. Methods

Pandora stations in Japan

No.	Station	Instruments number	Data start time
1	Yokosuka	146	2018/11/23
2	Tsukuba_NIES	176	2021/08/05
3	Tsukuba	193	2021/04/12
4	Tokyo	194	2021/12/22

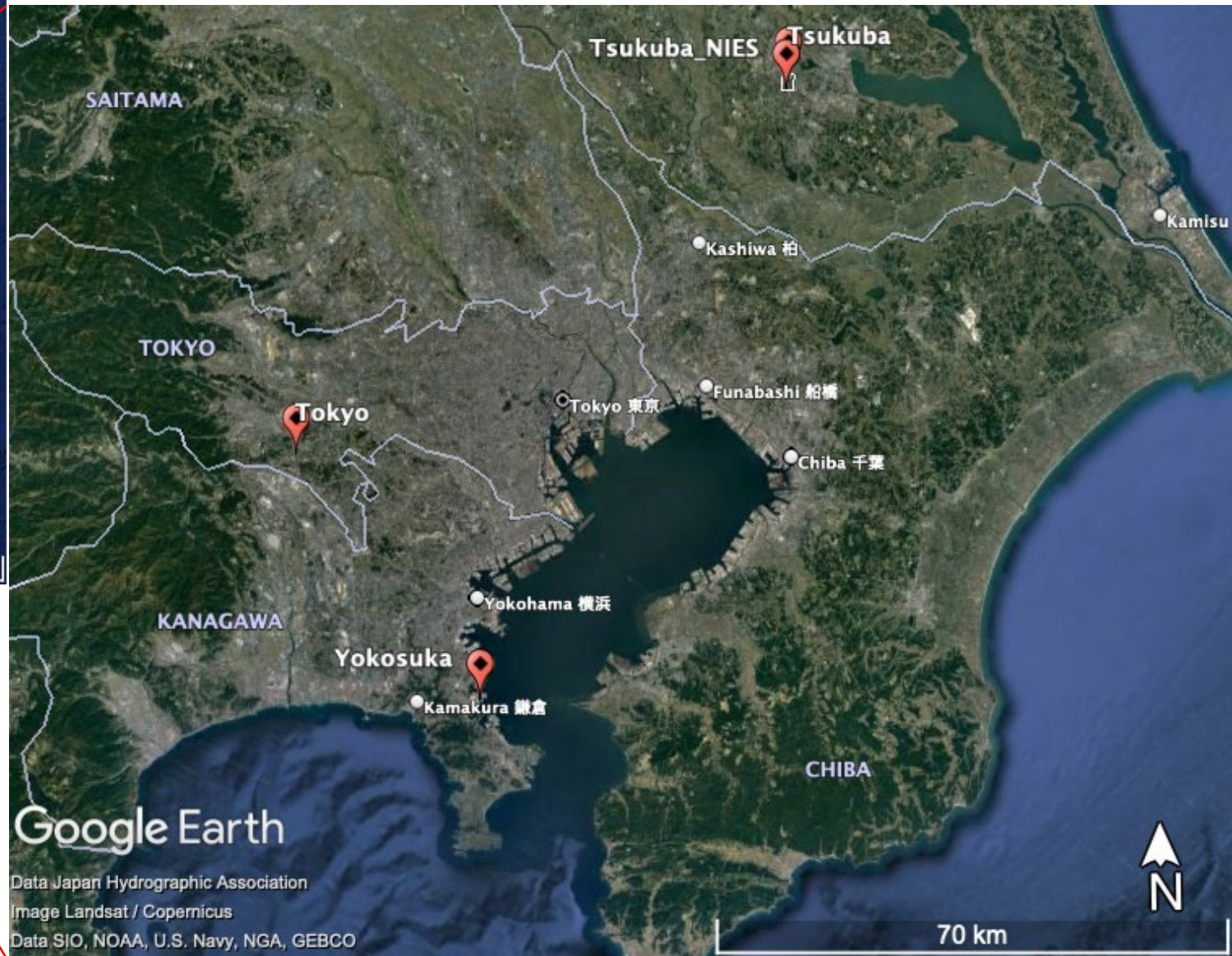
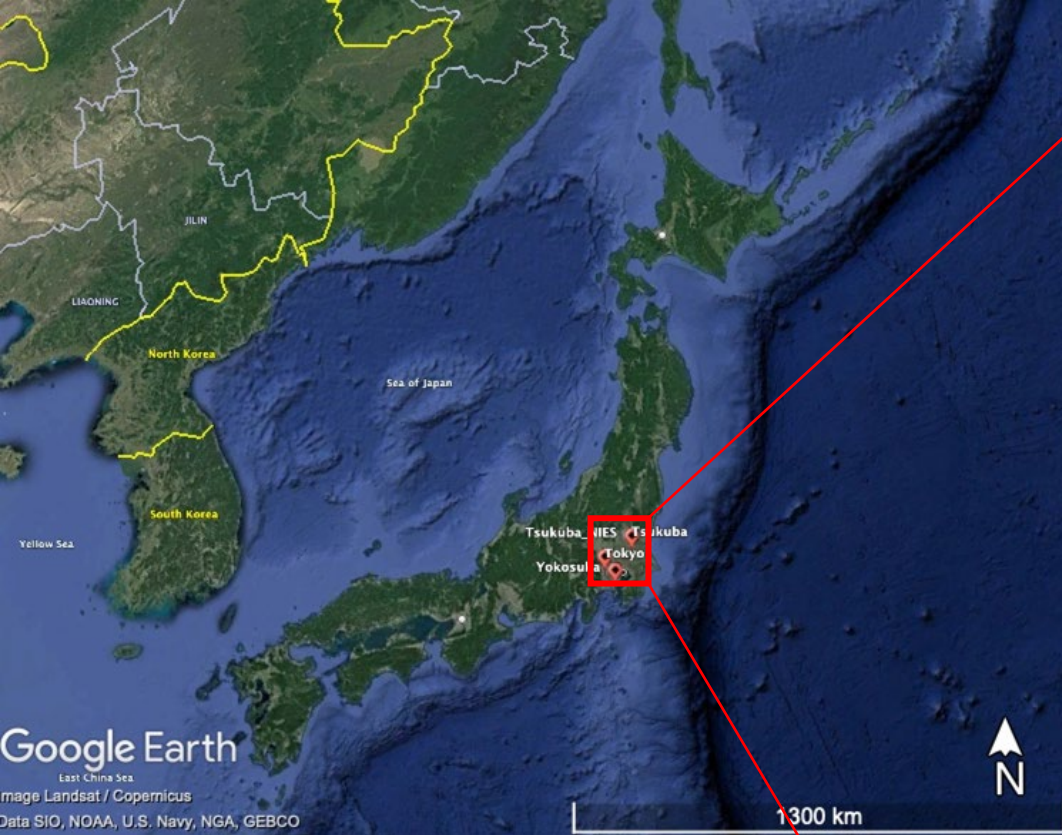


Fig. Map of Pandora stations in Japan

TROPOMI and Pandora dataset

NO₂ Tropospheric vertical column

Data filtering

TROPOMI

(L2 data, Processor version:
02.04.00 and 02.05.00 (2023-03-12
to now)):

- $qa_value > 0.75$
- $Cloud_fraction < 30\%$

Pandora (*MAXDOAS mode*)

- $Value > uncertainty$
- Quality Flag (high and medium)
- Remove spikes
- $SZA < 75^\circ$
- Averaged value within $\pm 30min$
TROPOMI overpass time

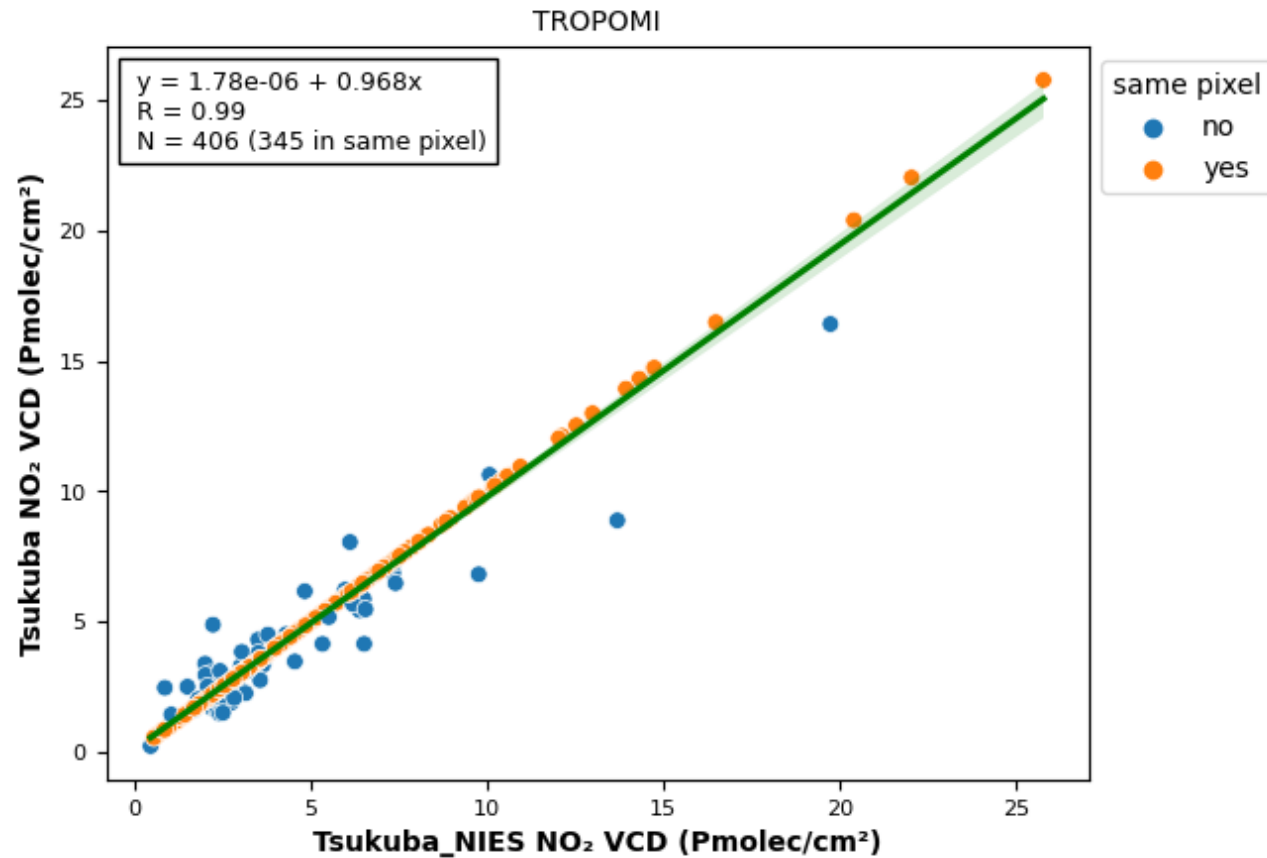
✓ *Pandora (Direct-sun mode)*

Direct-sun NO₂ tropVCD = total column – stratospheric column

3. Results

Tsukuba and Tsukuba_NIES

station TROPOMI data



➤ The two stations are usually in the same TROPOMI pixel

Pandora data

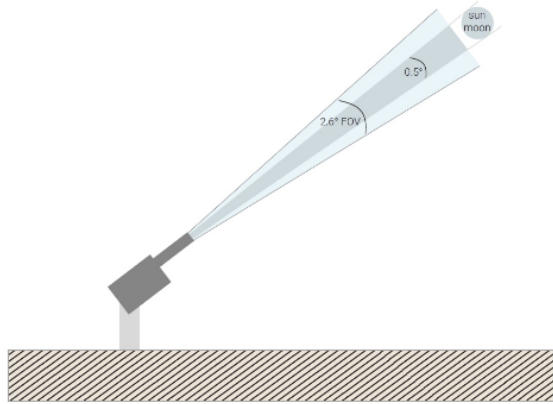


Figure 3: Direct sun observations

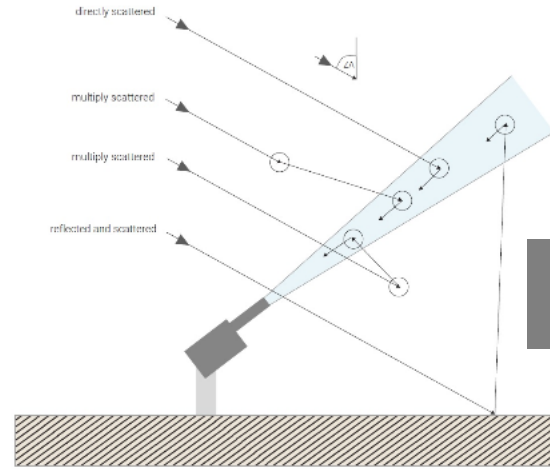
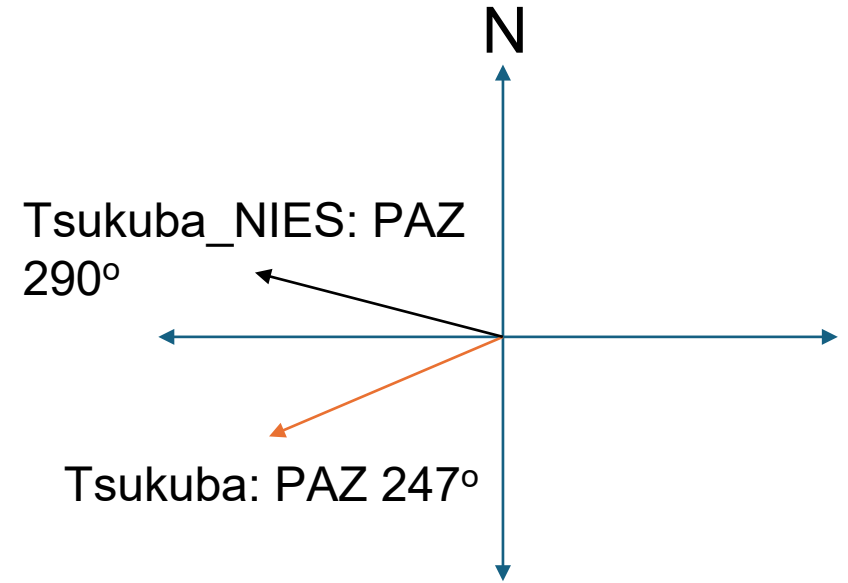
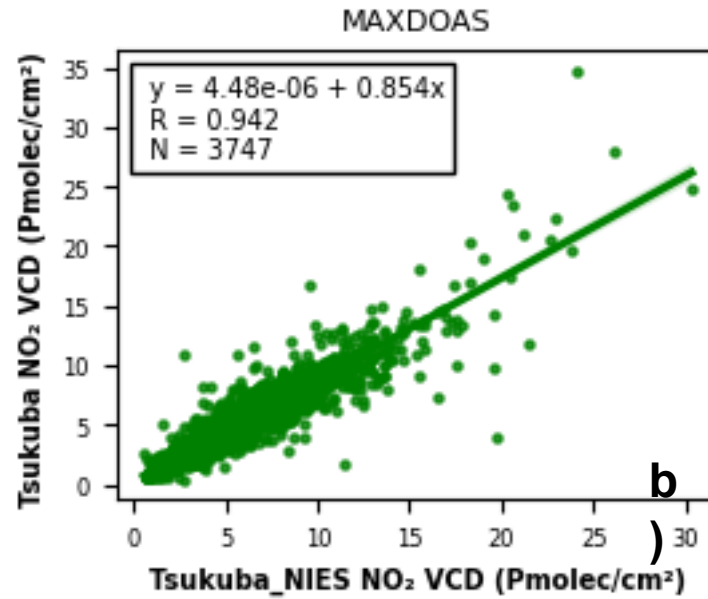
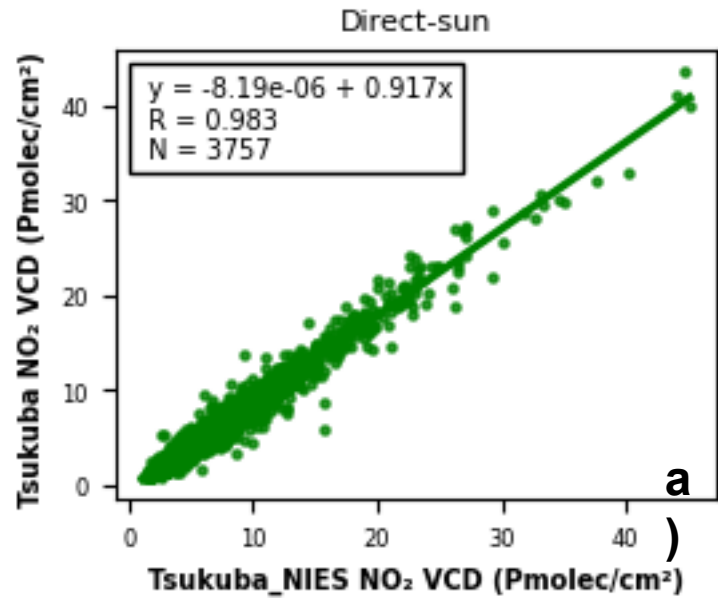


Figure 5: MAXDOAS observations

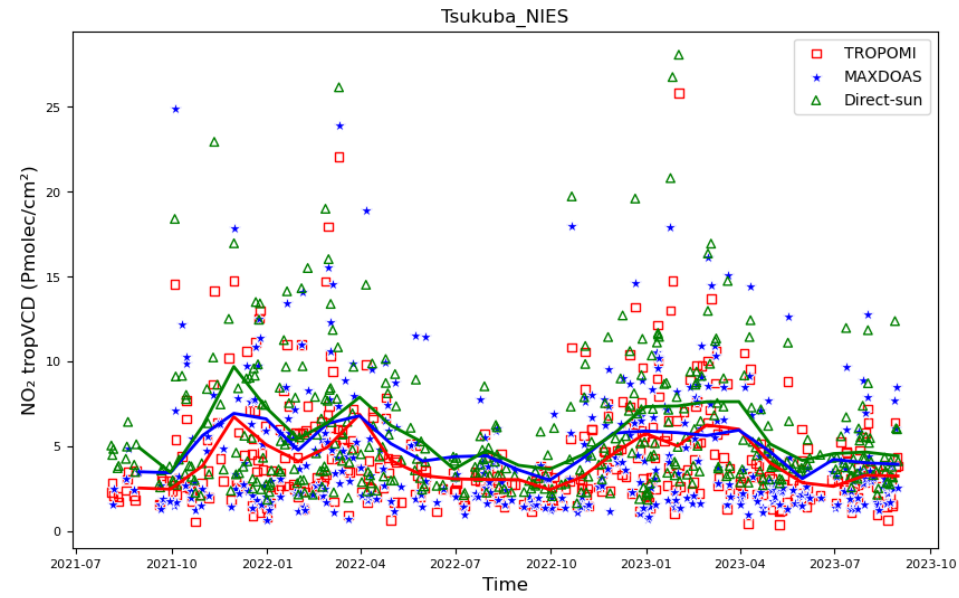
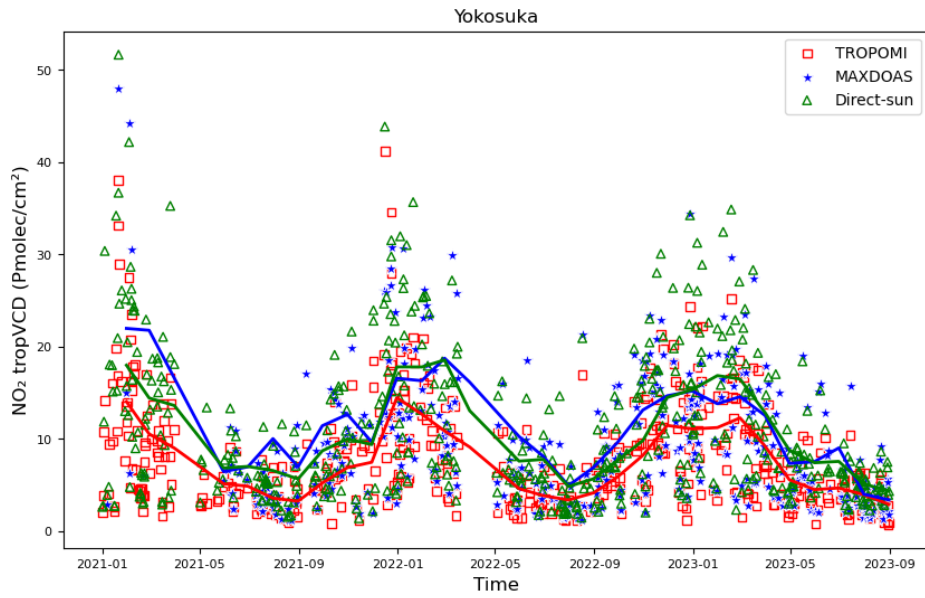
➤ Different air mass



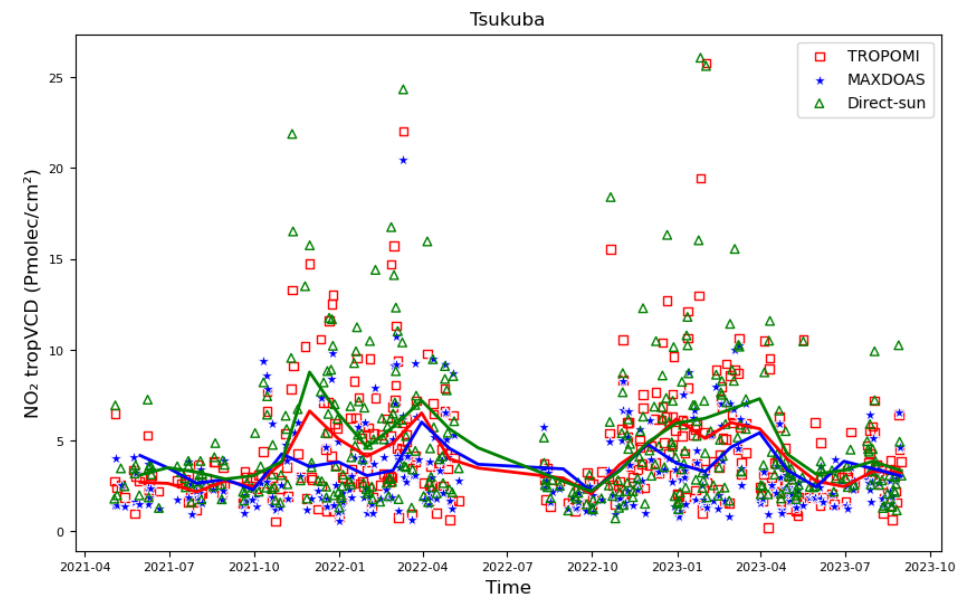
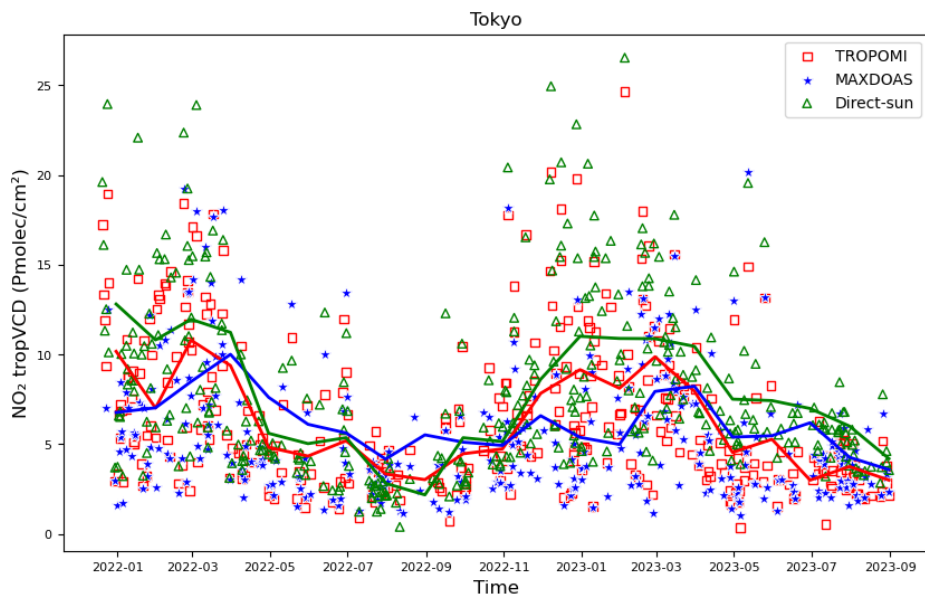
Pointing azimuth angle (PAZ)

➤ The important of viewing direction.

Time series of of NO₂ tropVCD

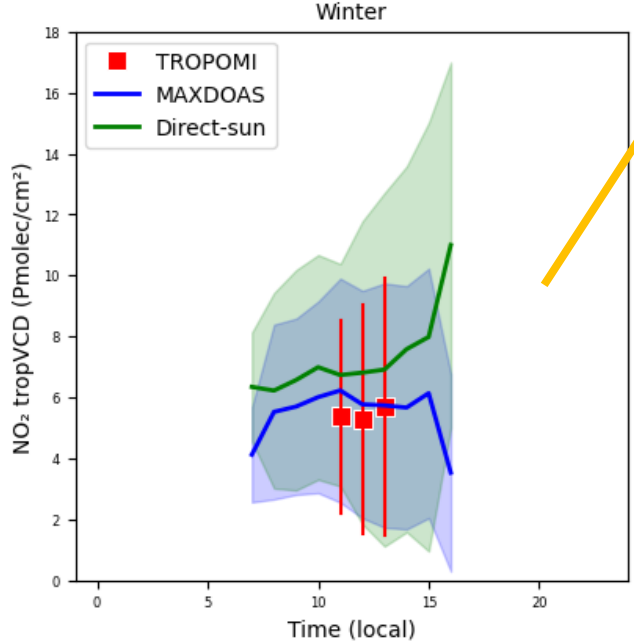
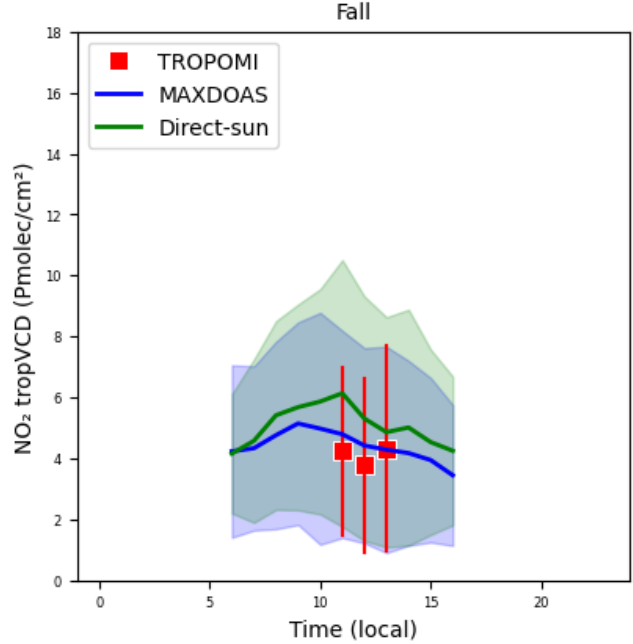
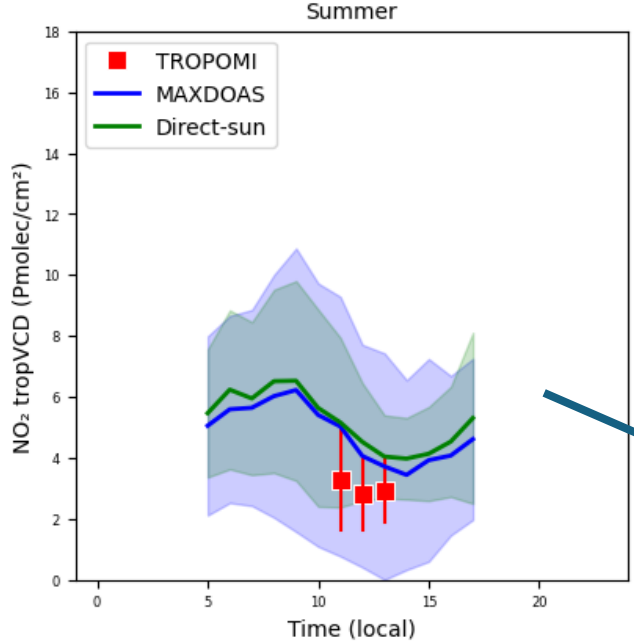
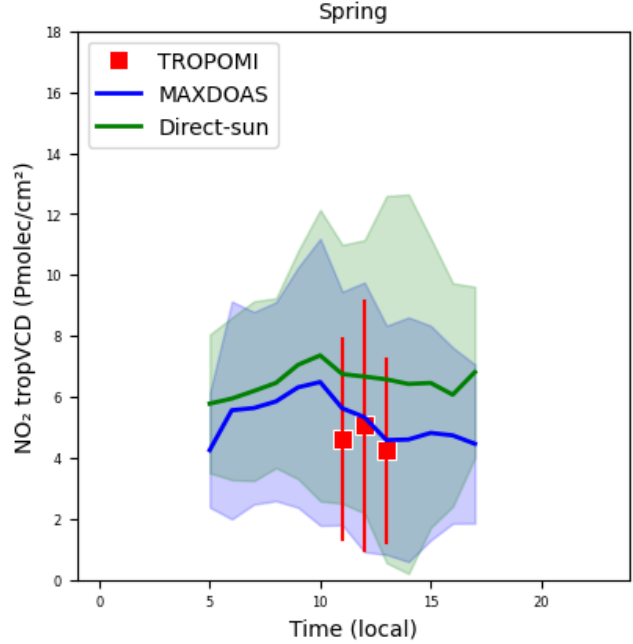


higher in
Winter



lower in
Summer

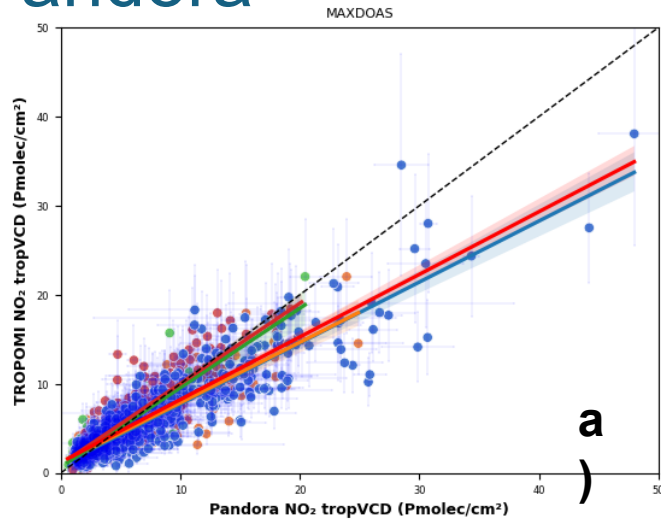
Diurnal variation of TROPOMI, Pandora NO₂ tropVCD at Tsukuba_NIES



Pandora Direct-sun and MAXDOAS observation have a good agreement in Summer and more difference in Winter

TROPOMI hourly means close to MAXDOAS observation

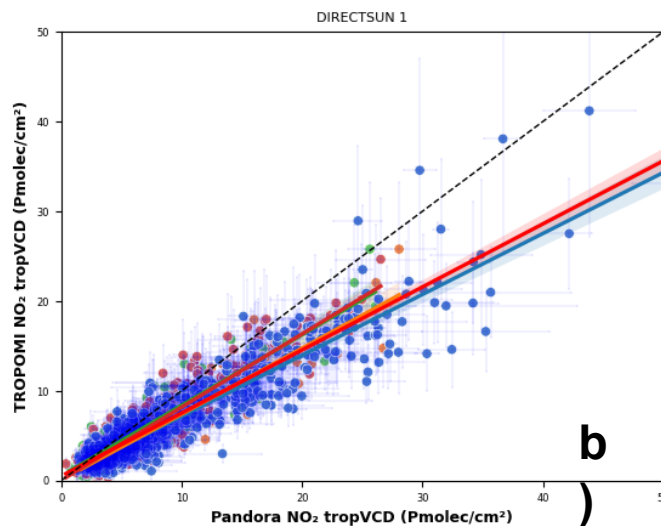
Agreement of NO₂ tropVCD between TROPOMI and Pandora



site

- 146 $y = 0.887 + 0.685x$, $R = 0.9$, $N = 427$
- 176 $y = 1.092 + 0.679x$, $R = 0.88$, $N = 403$
- 193 $y = 0.665 + 0.891x$, $R = 0.88$, $N = 299$
- 194 $y = 0.987 + 0.903x$, $R = 0.89$, $N = 319$

All stations: $y = 1.208 + 0.703x$, $R = 0.89$, $N = 1448$



site

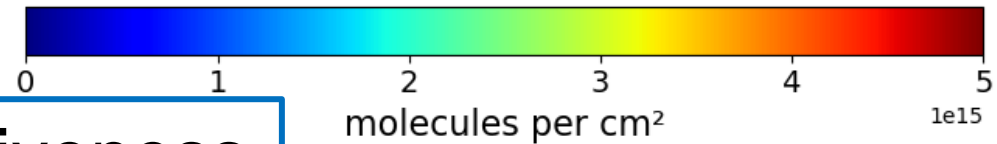
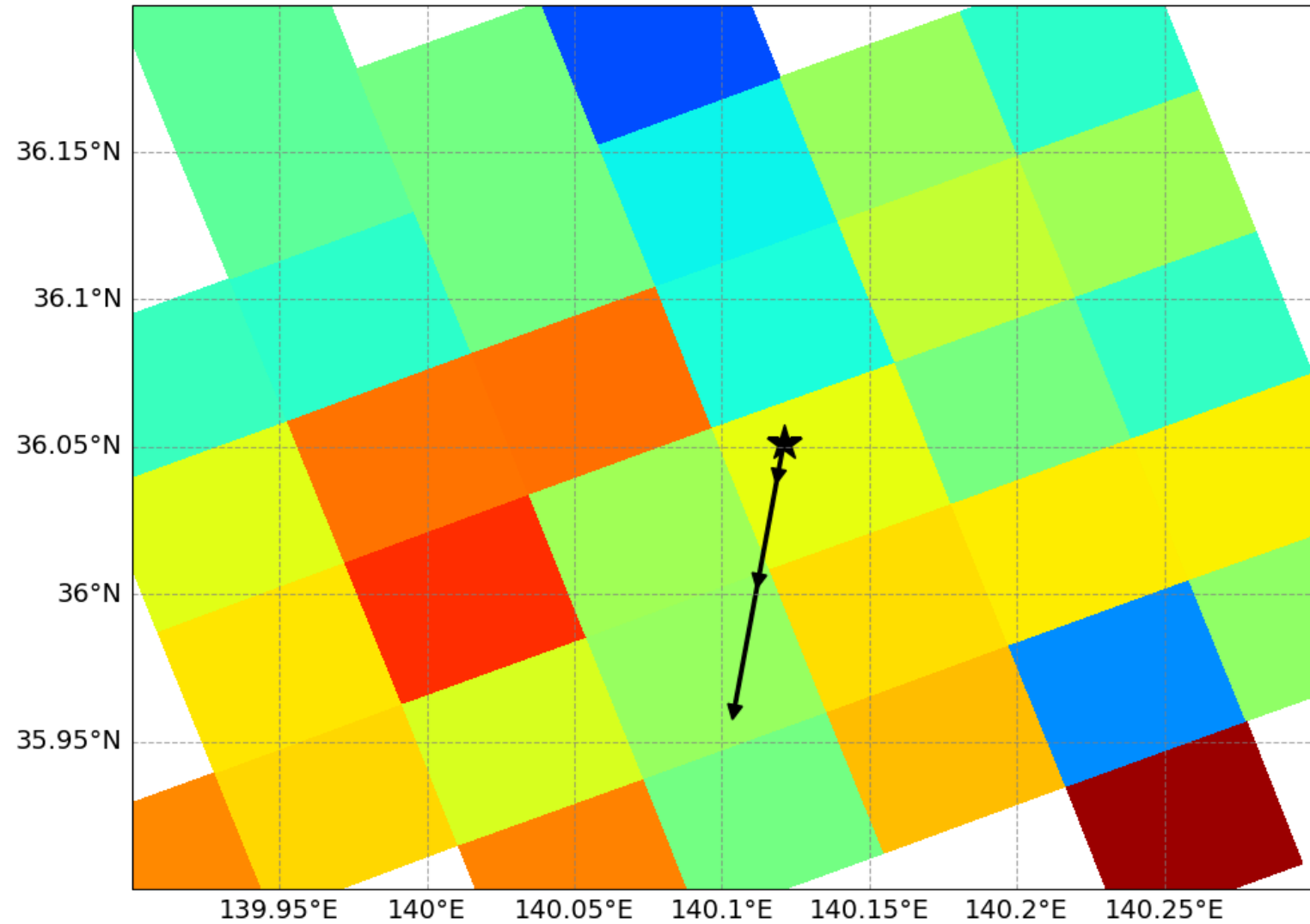
- 146 $y = 0.369 + 0.679x$, $R = 0.93$, $N = 519$
- 176 $y = 0.044 + 0.735x$, $R = 0.92$, $N = 408$
- 193 $y = 0.519 + 0.786x$, $R = 0.92$, $N = 372$
- 194 $y = 0.027 + 0.815x$, $R = 0.92$, $N = 354$

All station: $y = 0.504 + 0.702x$, $R = 0.93$, $N = 1653$

Direct-sun mode

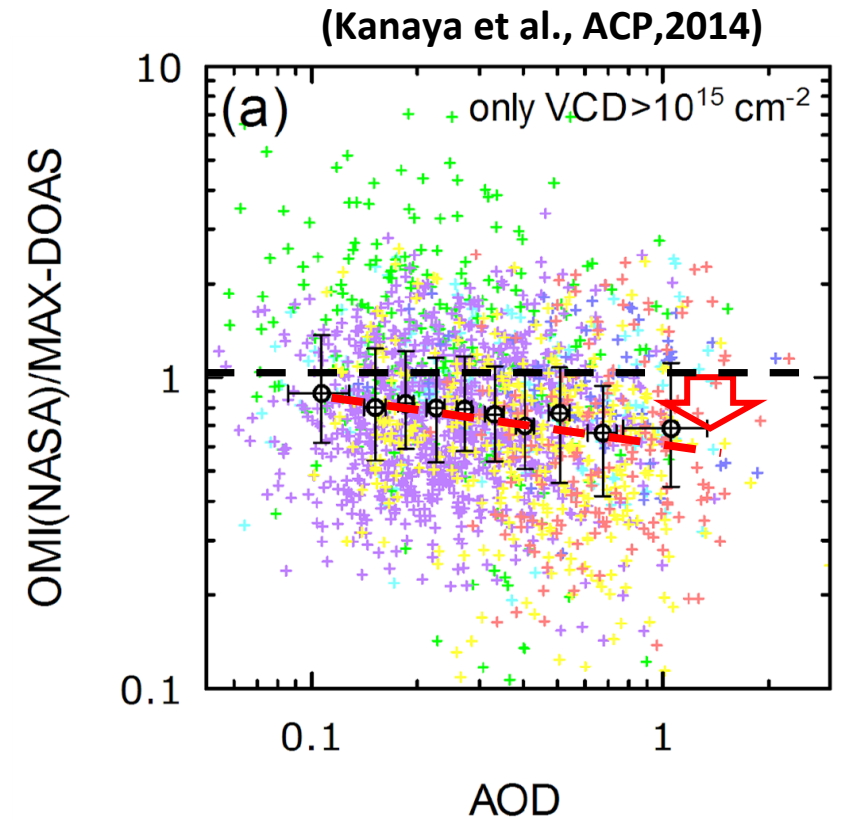
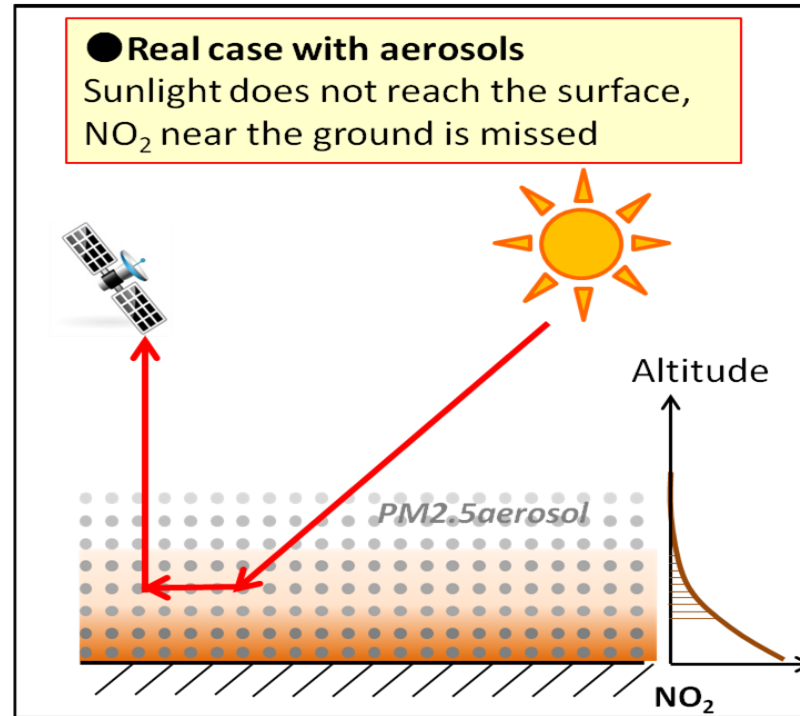
- Increase the statistics
- Increase R

Tropospheric vertical column of nitrogen dioxide 2023-01-05



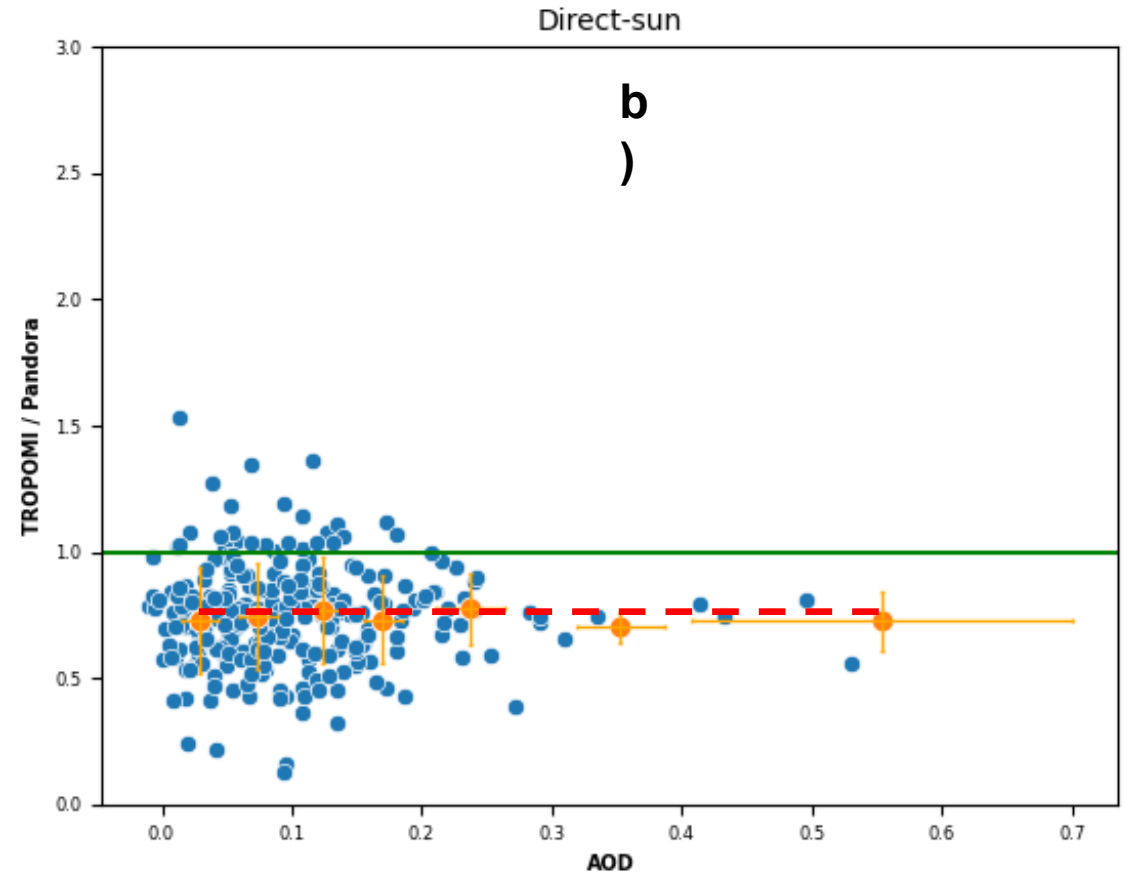
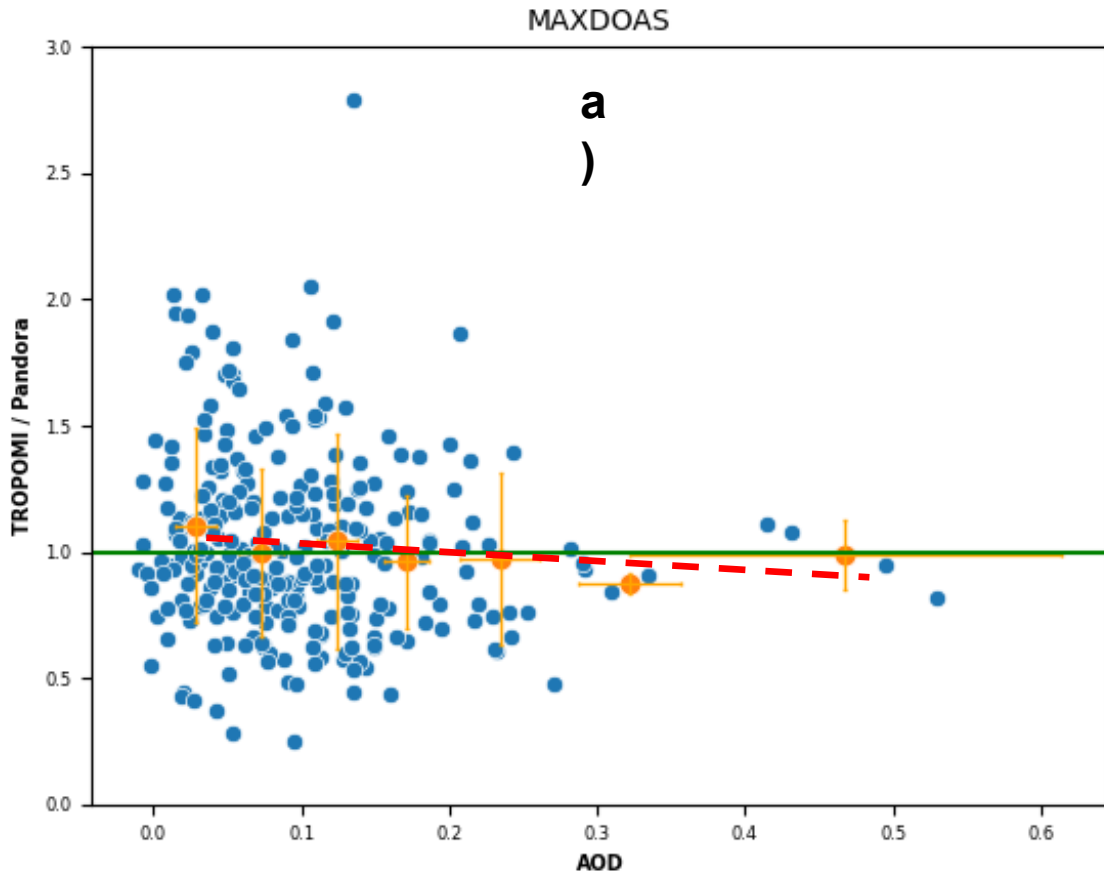
Correct horizontal representativeness

Aerosol



- Lower NO₂ tropospheric vertical column (Kanaya et al., ACP, 2014)

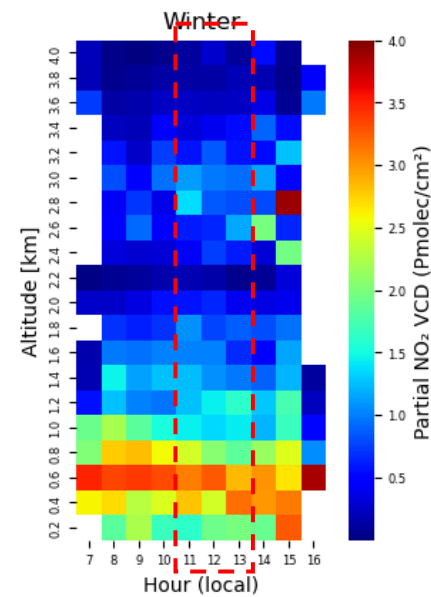
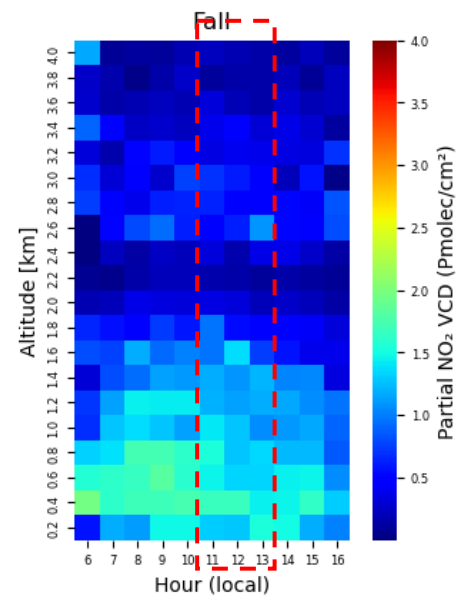
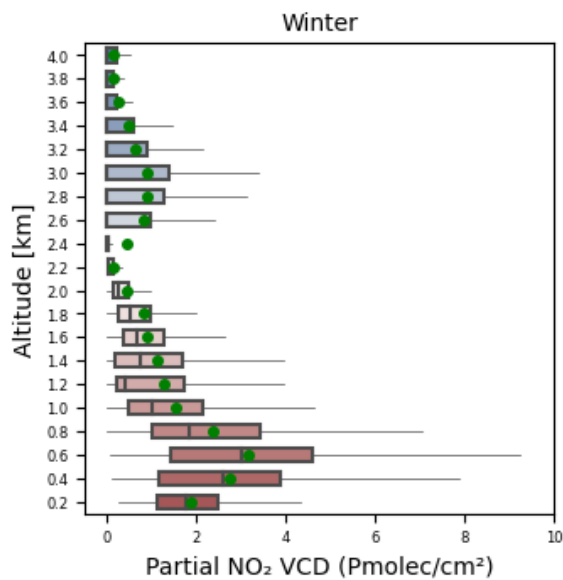
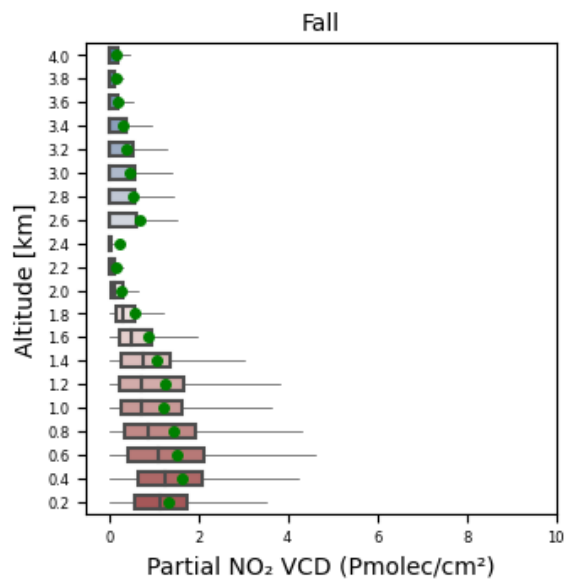
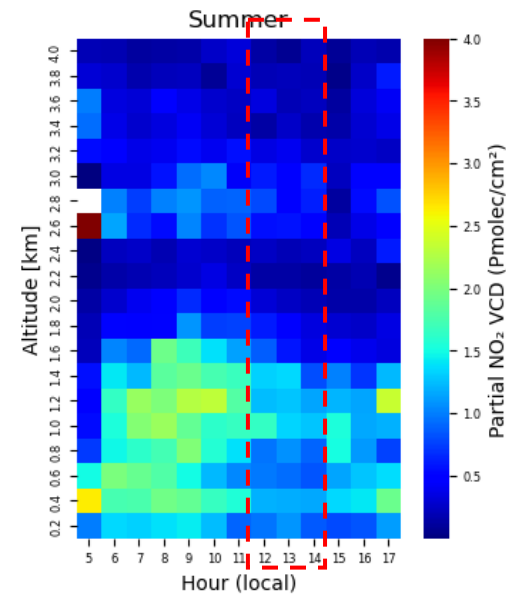
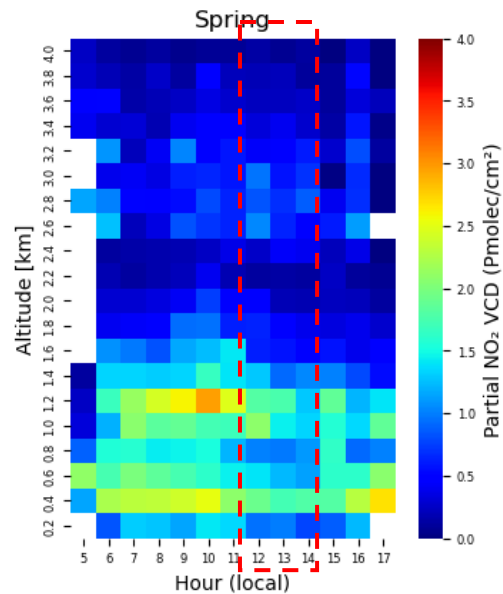
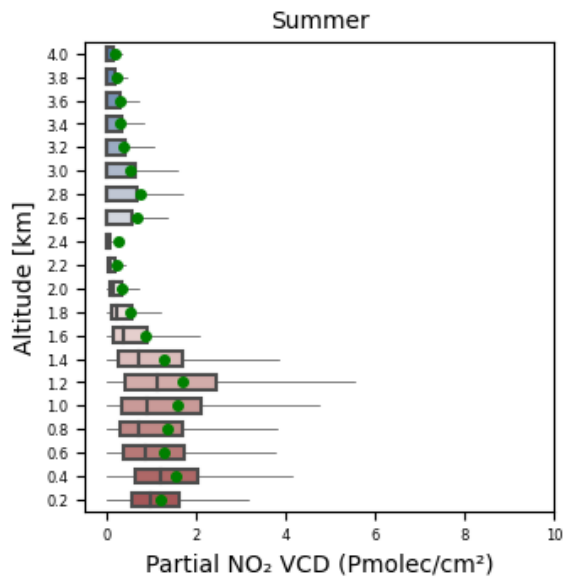
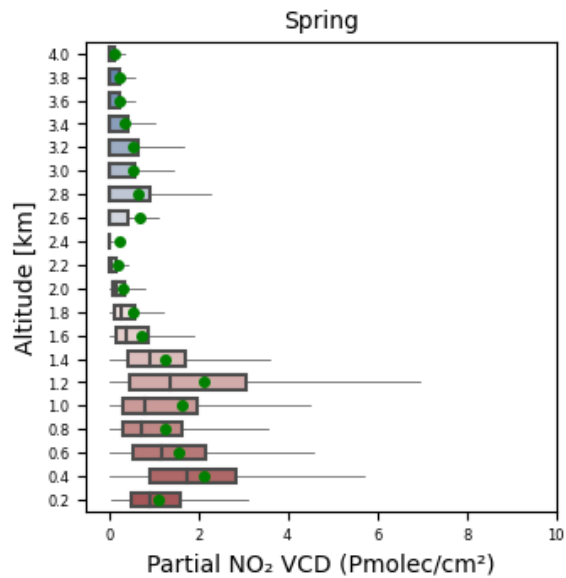
TROPOMI/Pandora ratios for NO₂ tropVCD as a function of AOD at 532 nm (at Tsukuba_NIES)



The ratio varied around the unity, and have a decline when higher AOD

The ratio remains lower than 1

NO₂ vertical profile (Tsukuba_NIES)



In Winter: more NO₂ at the surface → *inhomogeneous spatial distribution of NO*

Future works

- Correct horizontal representativeness
- Focus on the NO₂ partial columns, and its effect to the correlation between Pandora and TROPOMI as well as between Pandora surface concentration and in-situ measurement.

Thank you for your
attention!