GEMS workshop
11 November 2022,
Seoul, S. Korea

Preliminary validation results of GEMS total O_3 product under the PEGASOS project

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Outline

- Total Ozone datasets
- Validation results
  - Against ground-based measurements
  - Satellite-to-satellite validation against TROPOMI/S5P
- Data issues to be discussed
- Conclusions

PEGASOS project

Product Evaluation of GEMS L2 via Assessment with S5P and Other Sensors (PEGASOS)

Duration: 24 months

Scope: to compare and validate several GEMS operational Level-2 products with co-located operational L-2 products from TROPOMI/S5P, as well as with independent ground-based data

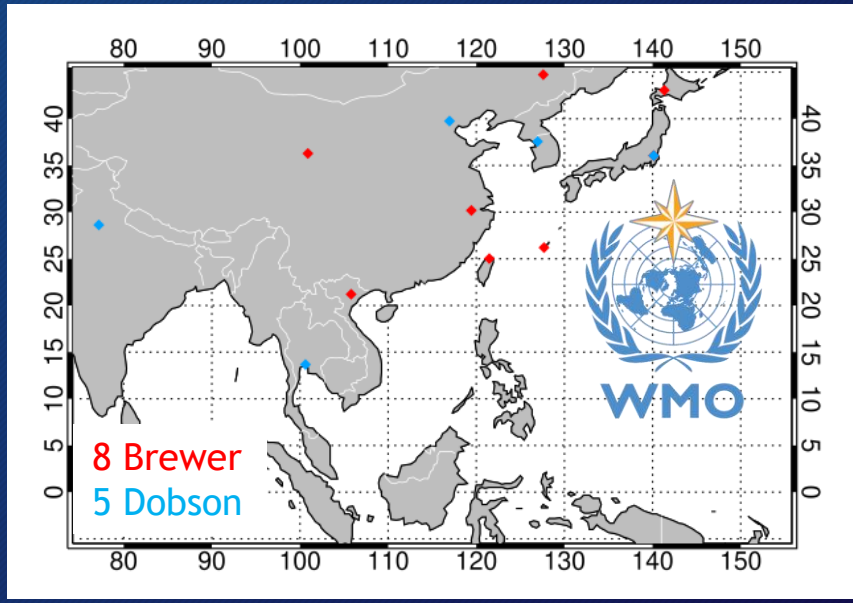
Total Ozone datasets

GEMS total ozone:

- O3T product, v1.0, all scans/day, all areas (FC, HK, HE, FW), "_DPRO_ORI" files
- Time range: 1 Dec. 2020 – 31 Aug. 2022
- No filters applied (issues with the FinalAlgorithmFlags to be discussed)

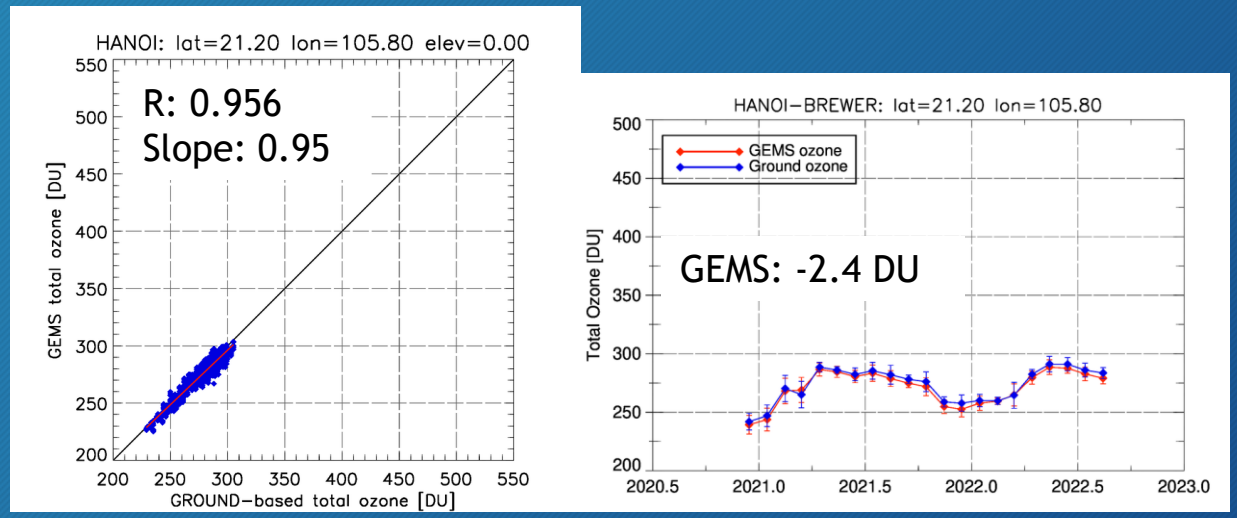
Reference measurements:

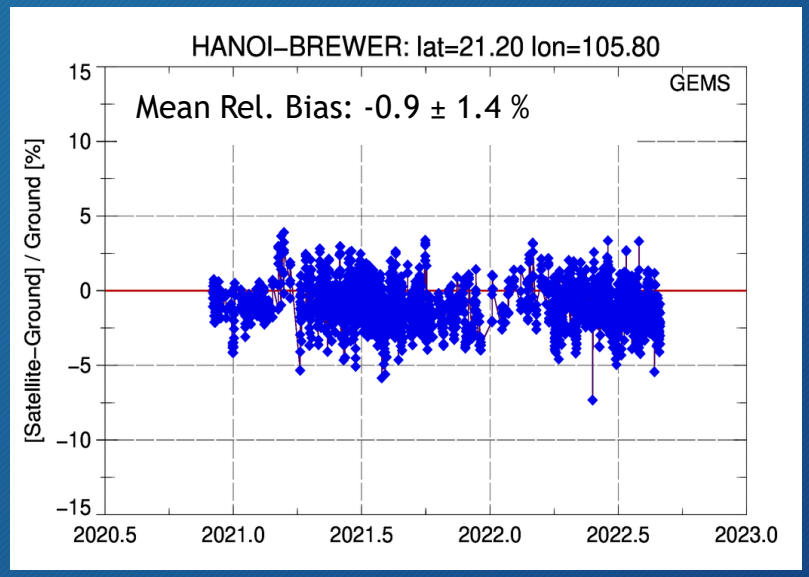
- Dobson and Brewer spatiotemporally co-located observations of total ozone (Quality controlled ground-based observations from WOUDC). Only Direct Sun measurements.
- Pandonia Global Network (PGN), co-located observations of total ozone, latest processing (v1.8)
- TROPOMI/S5P total ozone column operational product



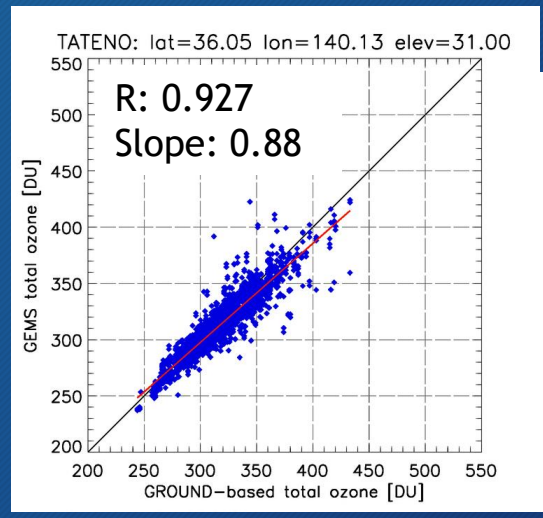
Total Ozone Validation results – per station

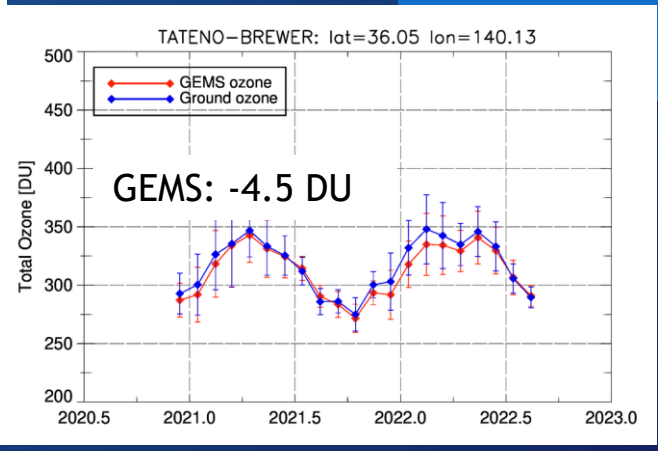
Hanoi, Vietnam (Brewer)

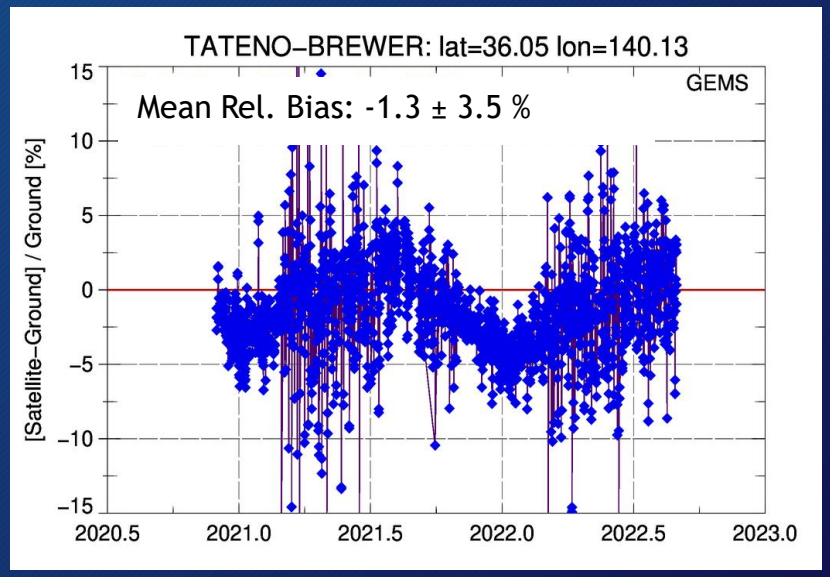




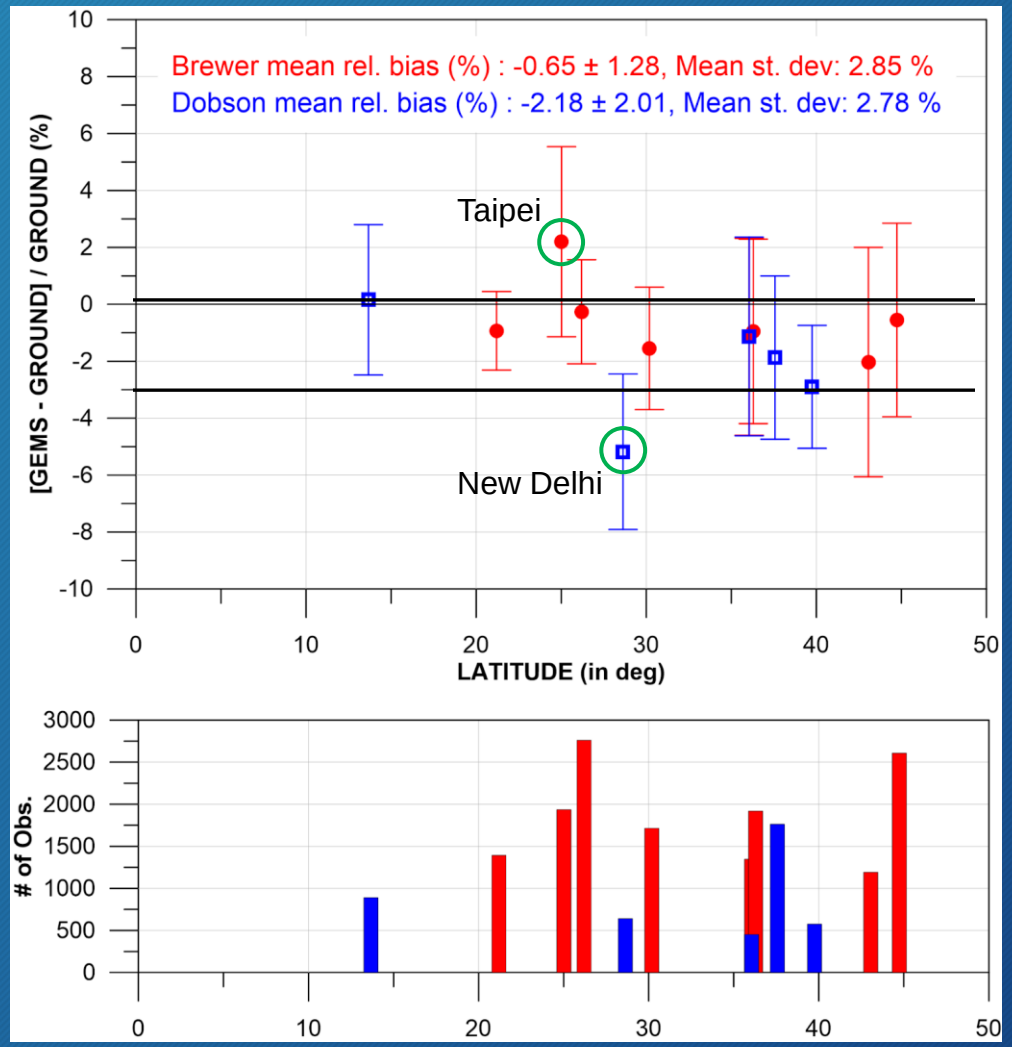
TATENO (Tsukuba), Japan (Brewer)



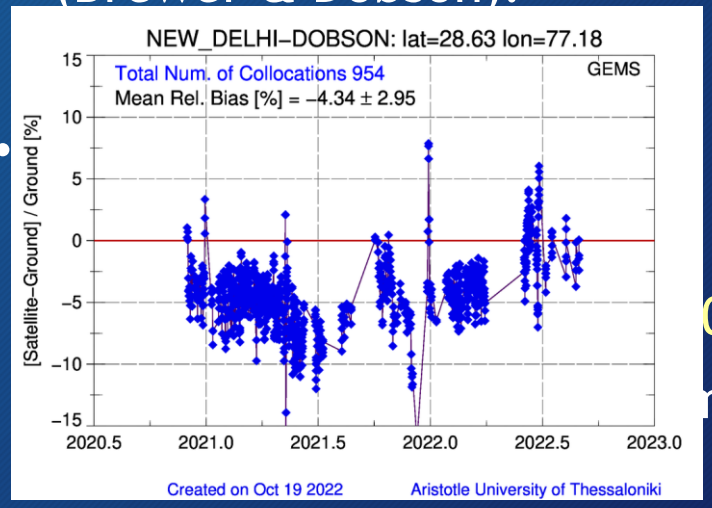


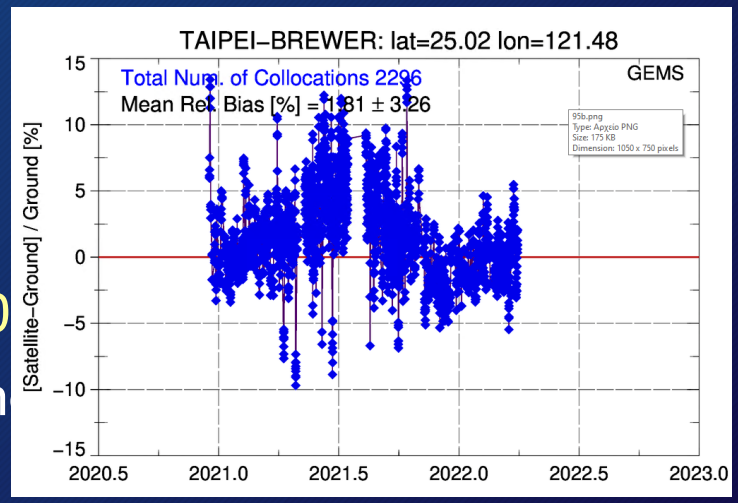


Total Ozone Validation results – mean bias per station



- Individual stations (except for 2): Mean rel. biases within 0 and -3%; Mean St. Dev. 1.5 to 4%
- Overall mean relative bias (Brewer & Dobson): **-1.2 ± 0.8 %**

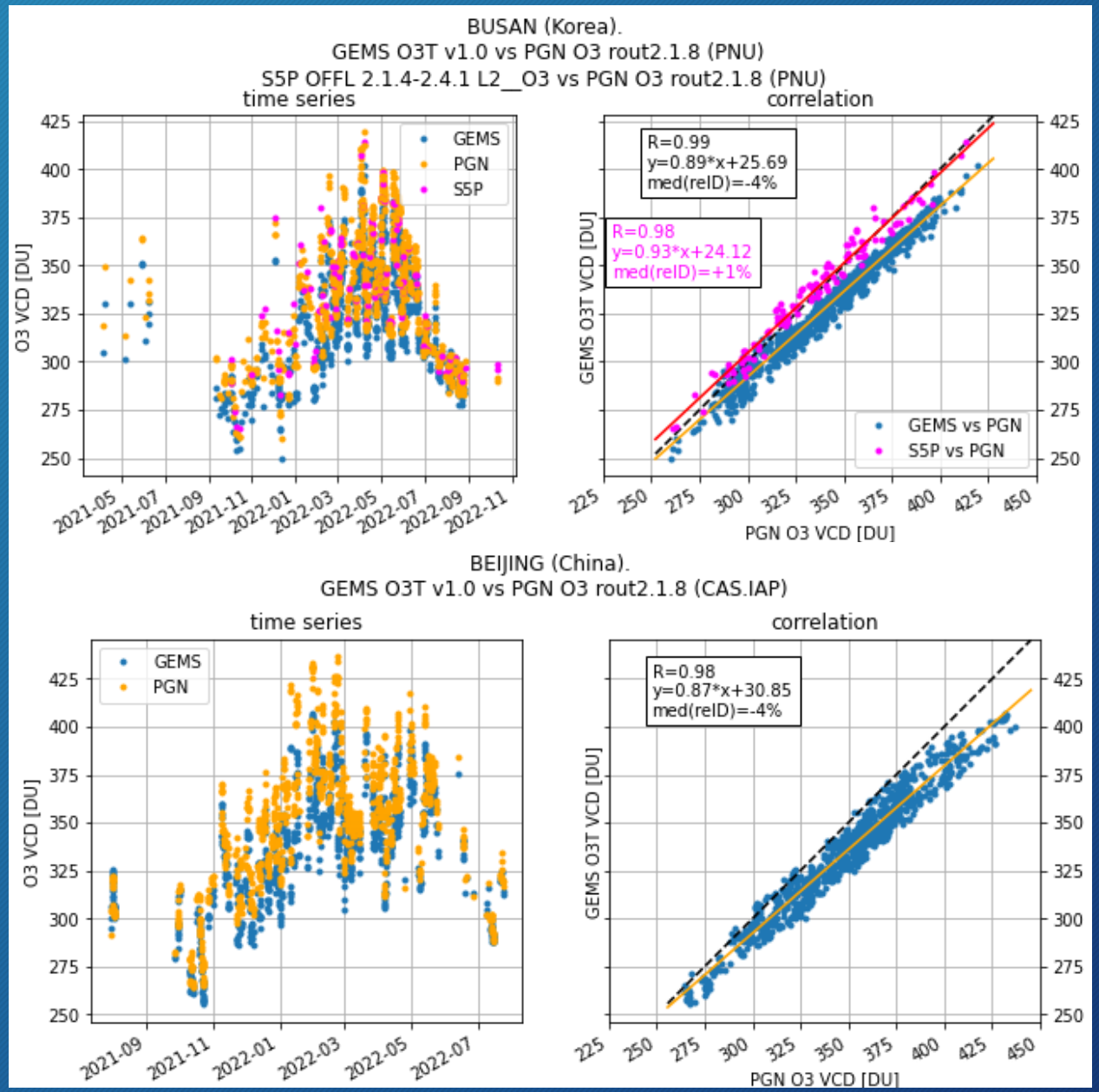


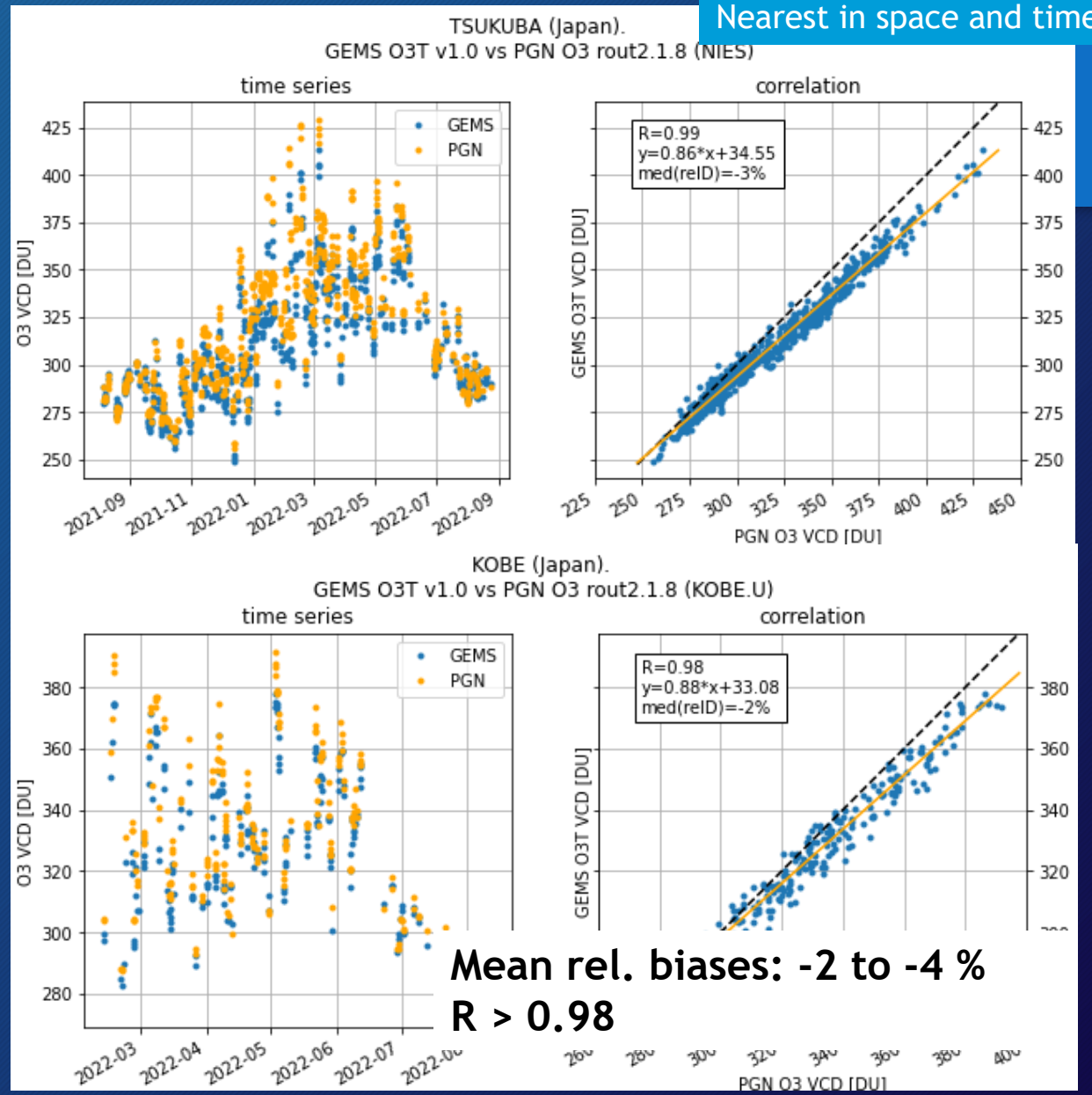


GEMS O3T vs Pandora (PGN)

Courtesy of St. Compernolle & T. Verhoelst, BIRA

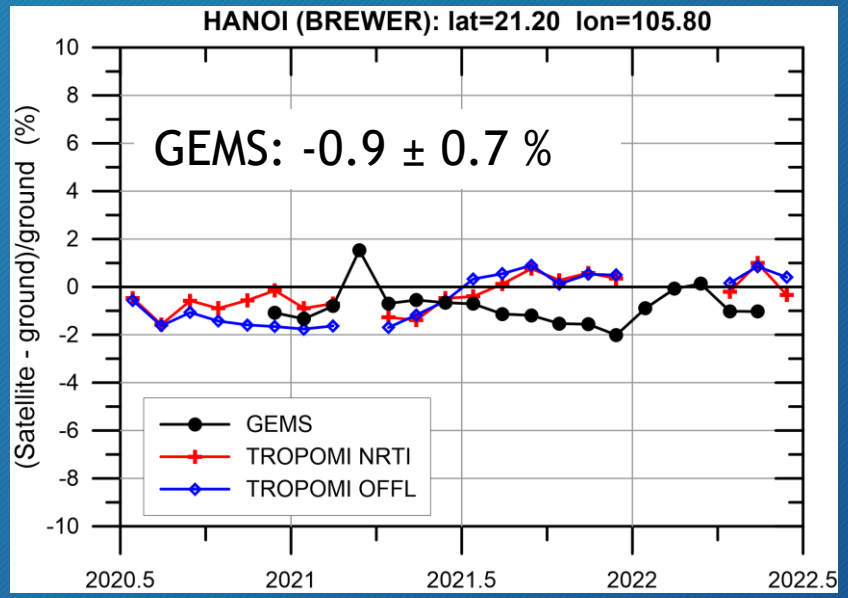
Collocation: ±0.5 h, 5 km.
Nearest in space and time

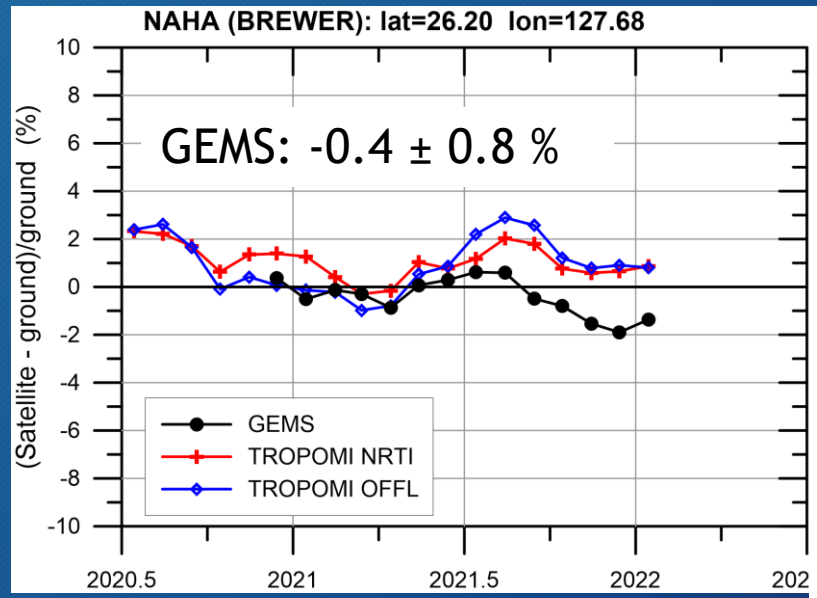


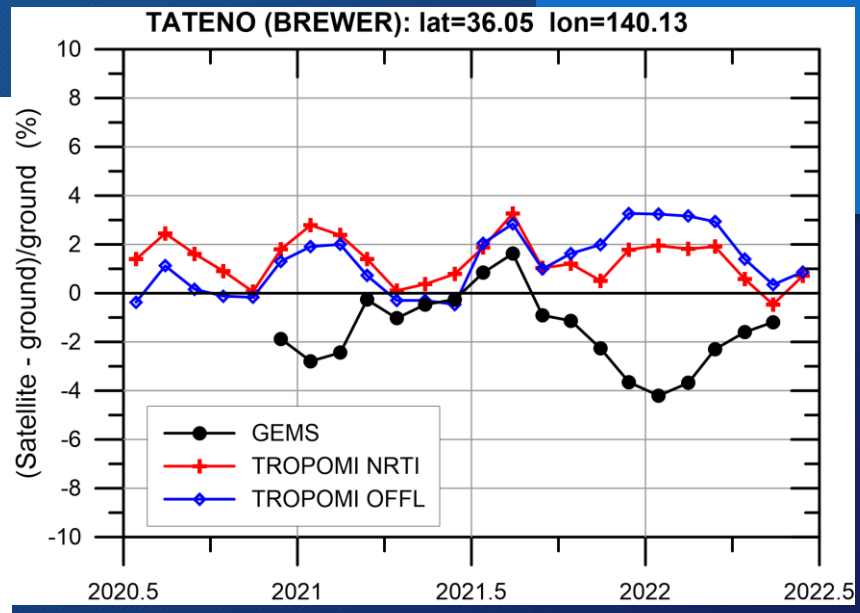


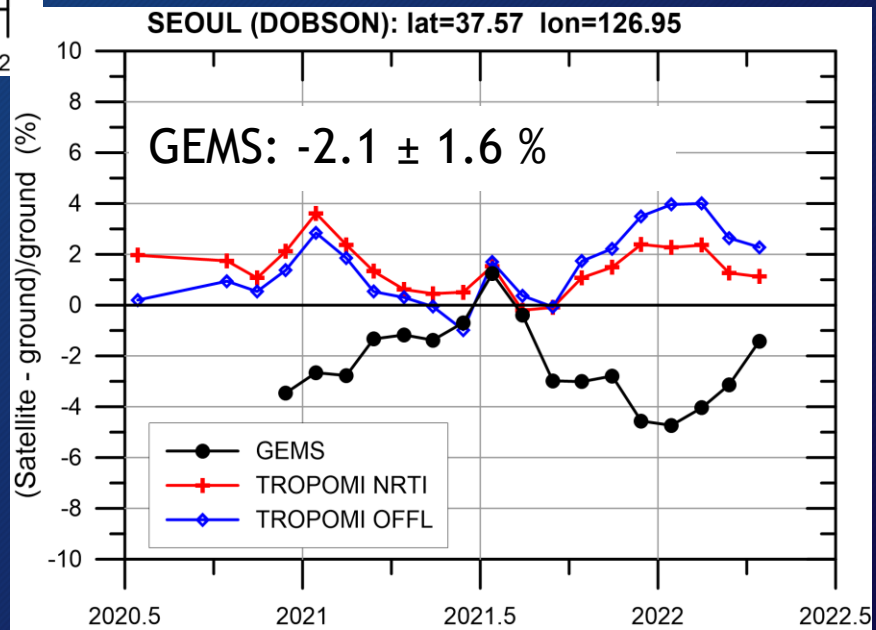
Mean rel. biases: -2 to -4 %
R > 0.98

Total Ozone Validation results – consistency check



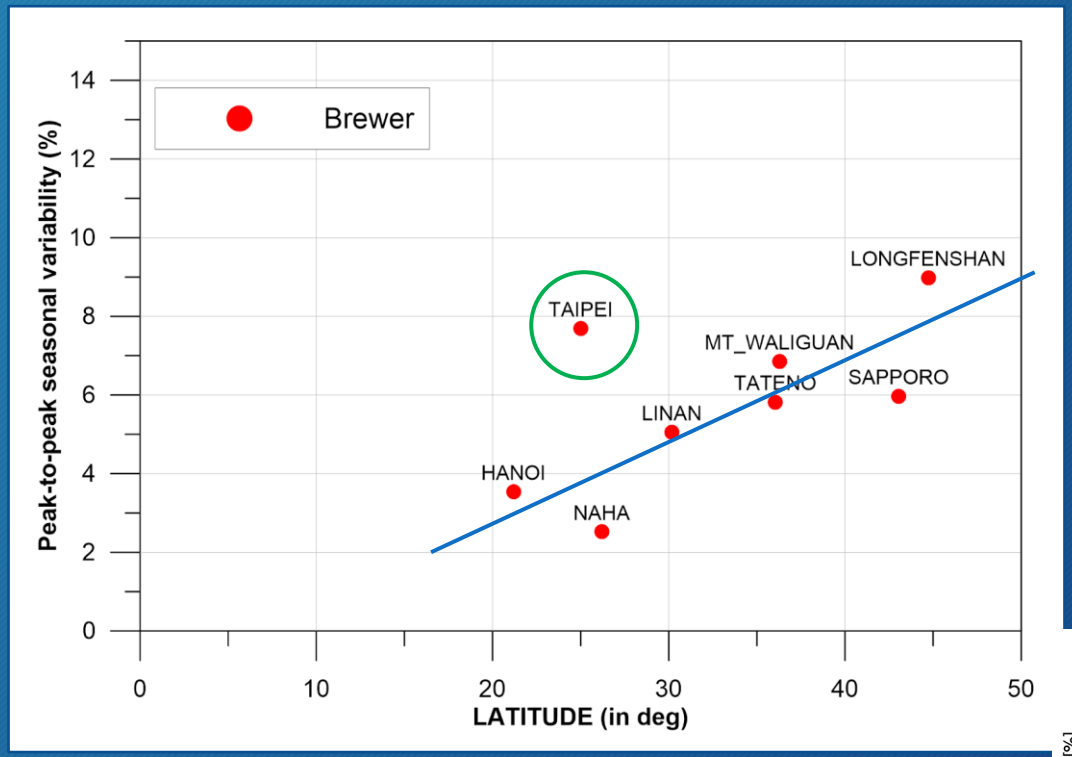






Total Ozone Validation results – seasonality per station

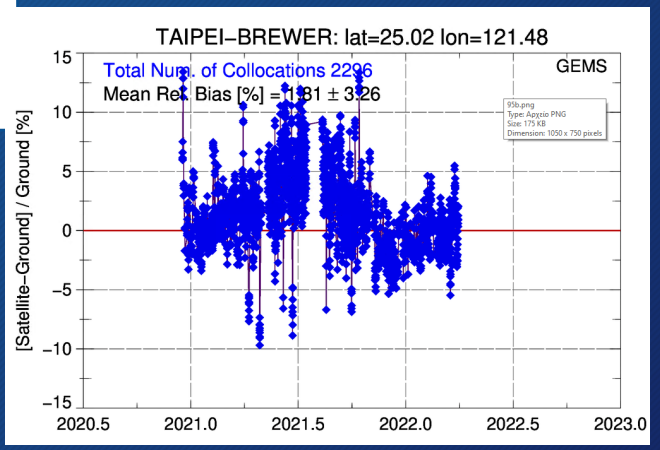
Seasonal variability (peak-to-peak) per station – Brewer only



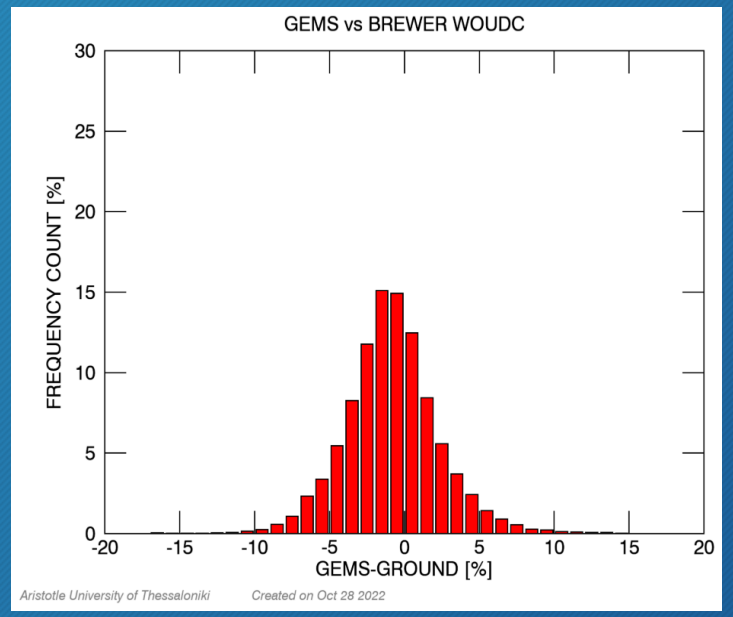
Seasonal variability:

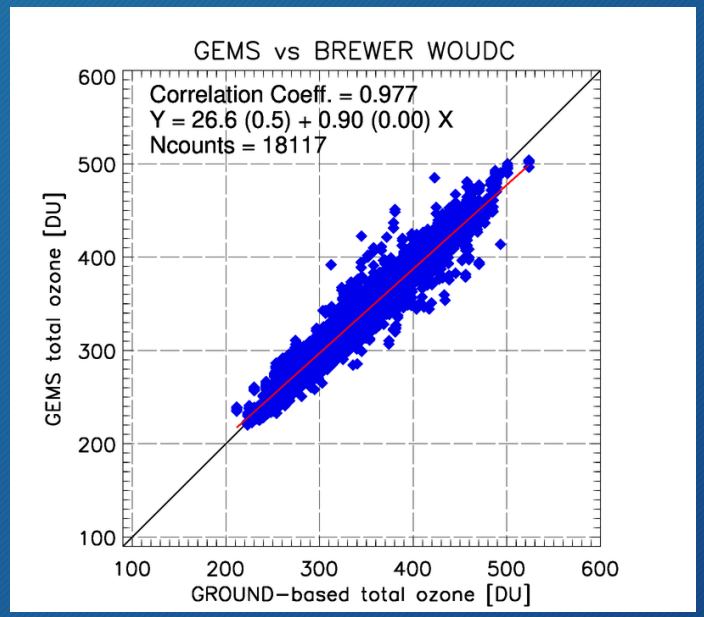
- 2-4% for stations in the latitude belt 20-30° (exception: Taipei, Taiwan → 7.7%)
- up to 9% at 45°

Strong indication of an increase in the seasonal variability of the comparisons with respect to the station's latitude.



Total Ozone Validation results - GEMS domain (Brewer & Dobson)

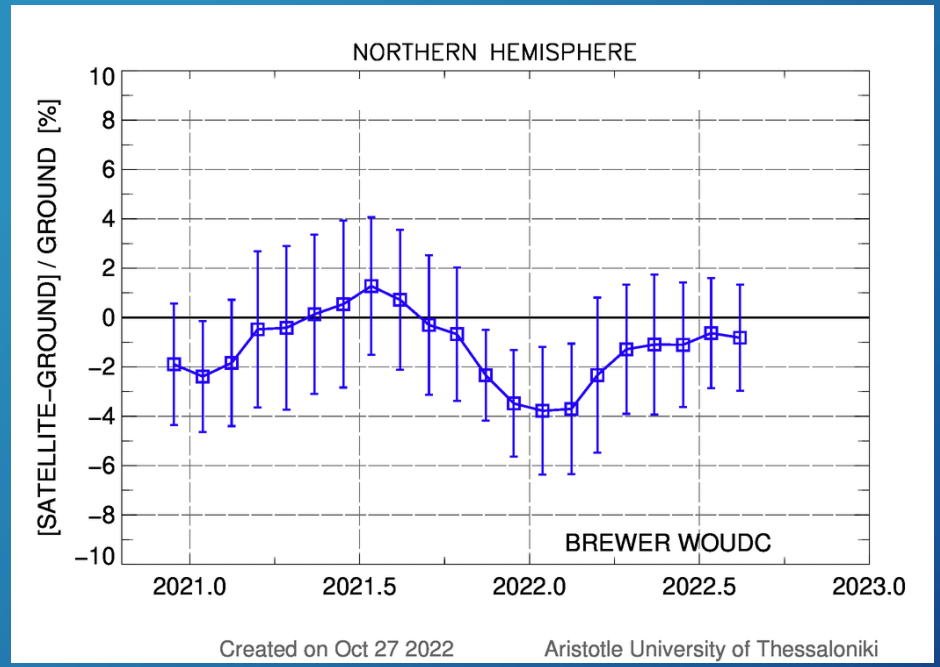




Overall statistics from individual co-locations per instrument:

	Brewer	Dobson
Mean Rel. Bias	-0.8 %	-2.0 %
Mean St. Deviation	3.2 %	3.2 %
Pearson cor. Coef.	0.977	0.970
Slope	0.90	0.91

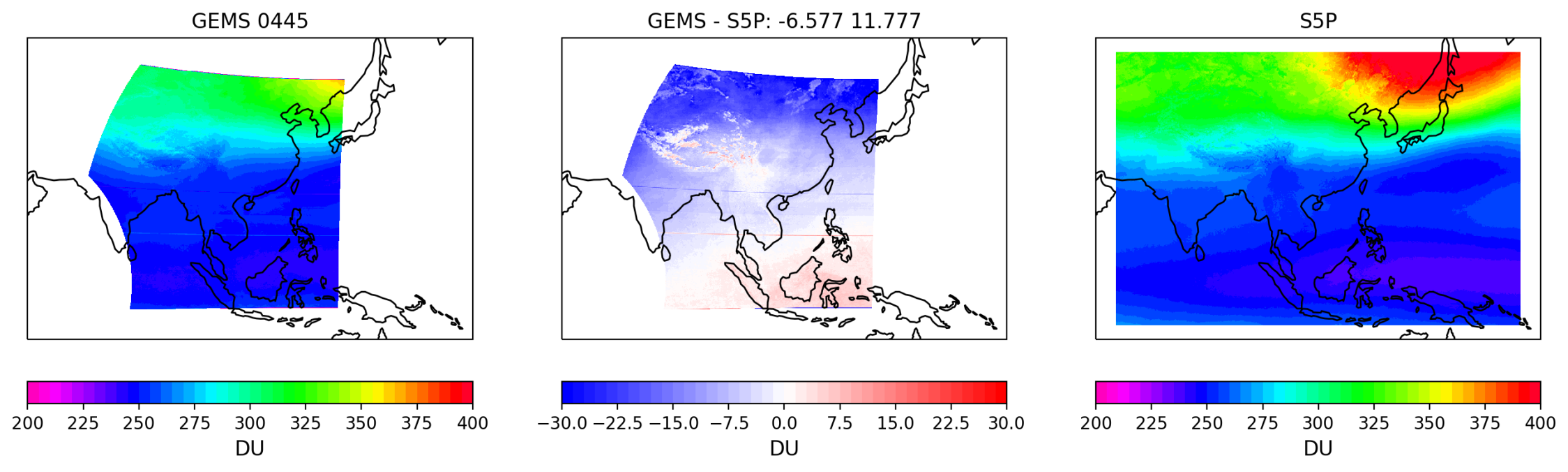
-1.2 % for both



- Very good agreement, within ± 1%, during spring, summer and fall months (March - October)
- GEMS is underestimating total ozone during winter months by -2 to -4% (to be further investigated)

Comparison between GEMS and S5P, December 2021

Courtesy of K.-P. Heue, DLR



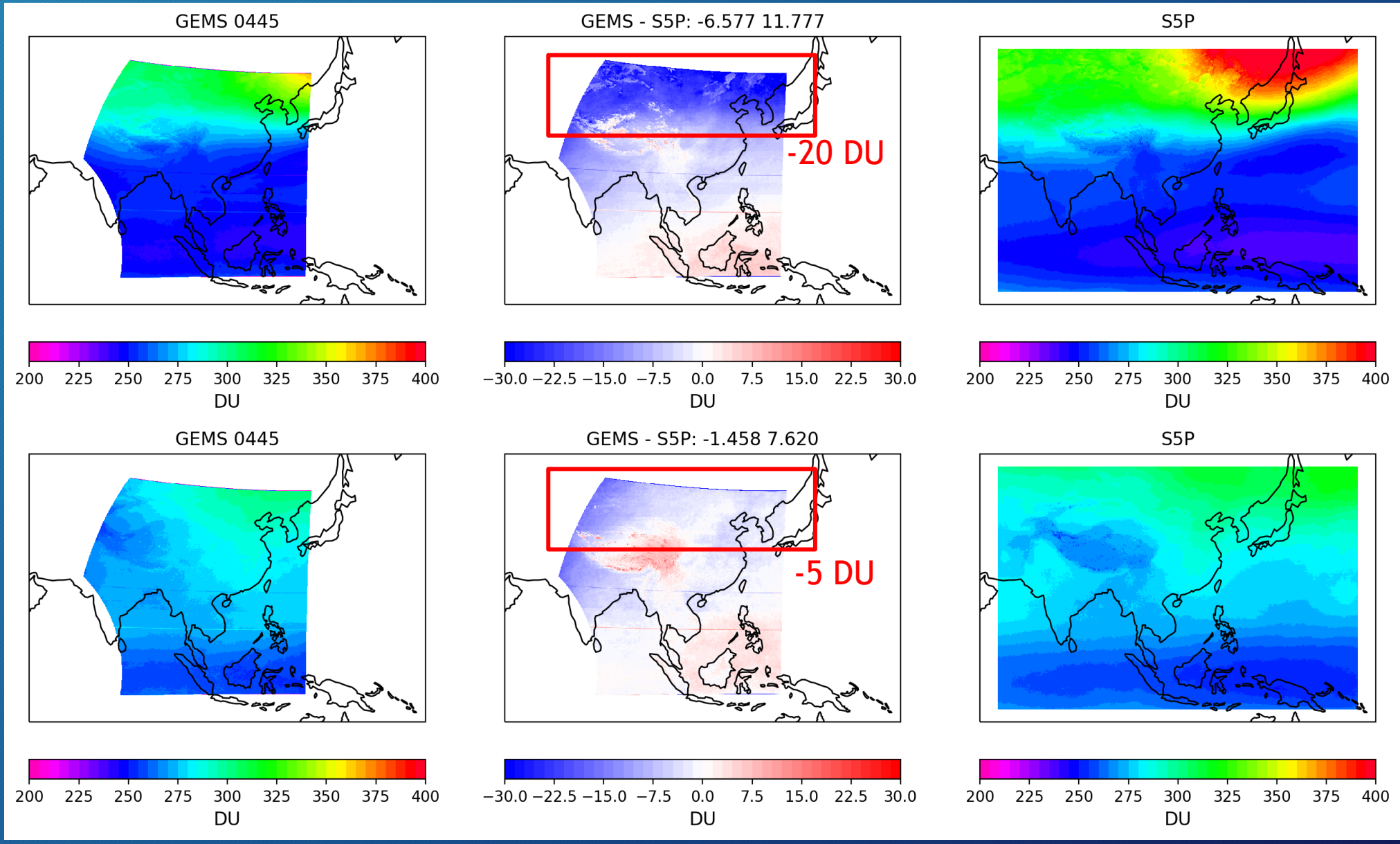
- Only data 04:45 scan
- Data gridded to 0.1 °
- No QA, No cloud filter
- Removed outliers outside 100-700 DU
- Rejected GEMS data with VZA >70° (north-west)

- Good agreement (±5 DU) in the center and the South
- Negative bias in the North
- Mean bias: - 6.6 DU or ~ -2.5%

- Data gridded to 0.1 °
- No QA filter
- No cloud filter

Comparison between GEMS and S5P

Courtesy of K.-P. Heue, DLR



December 2021

September 2021

Conclusions

Validation of ~ 2 years of GEMS total ozone data:

- Overall mean relative bias w.r.t. ground-based stations: -1.2 ± 0.8 % [4 PGN stations: -2 to -4 %]
- Mean standard deviation of the differences: 3.2 %
- Pearson correlation coefficient > 0.88 (within GEMS requirement)

Temporally:

- Very good agreement (within ± 1%) of GEMS and reference total ozone measurements (ground-based & TROPOMI/S5P) during spring, summer and autumn months
- During winter months and for higher latitudes (above 30°N) GEMS underestimates total ozone by up to 4-6%.

Future work:

- Investigation of the high latitude, winter underestimation
- Application of the correct filters to the GEMS dataset

Waiting for the new dataset (v2.0)

GEMS Total Ozone Validation

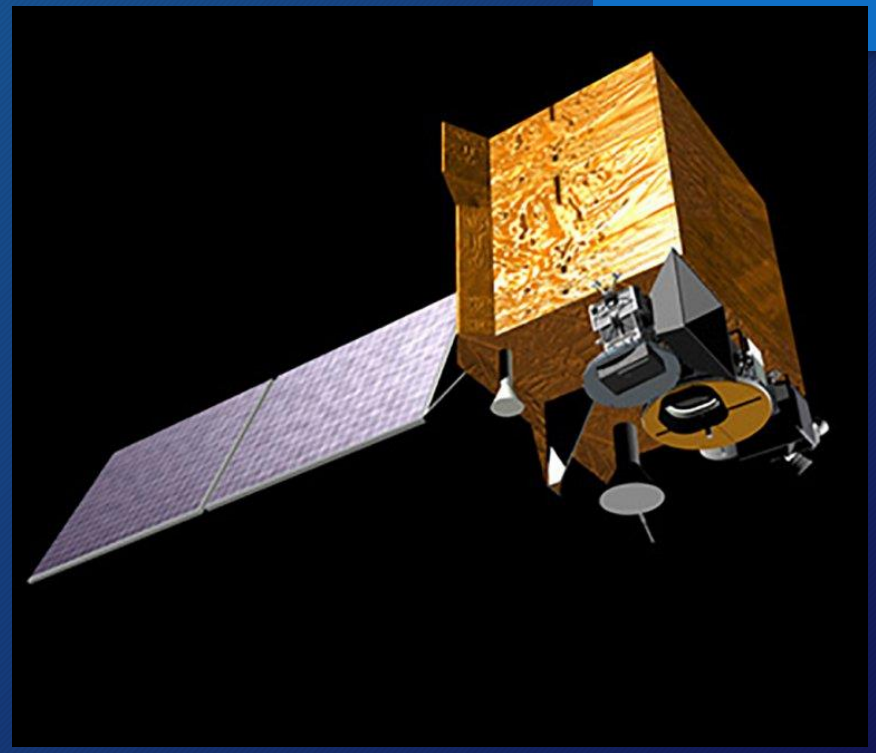
Documentation

- Two available documents: ATBD and “GEMS Level2 I/O Data Description”
- Some parameters were differently described in each document:
  e.g. FinalAlgorithmFlags
  - Files: bits (e.g. 0, 3, 145…)
  - ATBD: integers ranging 0-5 (0=good, 5=bad)
  - Level-2 I/O descriprion: bits (0-11), 0=“Any issues on output”

  also GroundPixelQualityFlags

- “Effective cloud fraction” parameter:
  - ATBD: no information
  - GEMS Level2 I/O Data Description: not included in the GEMS O3T output file fields
- “Cloud Pressure”: top, bottom or middle?
- “Estimated Error”: files → “unitless”, GEMS Level2 I/O Data Description → “DU”

Thank you for your attention!



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