



Fig 1. True color reflectance from Terra/MODIS and Fire&Thermal anomalies from VIIRS/NOAA20 [22/08/2023].

RATIONAL BEHIND THIS WORK

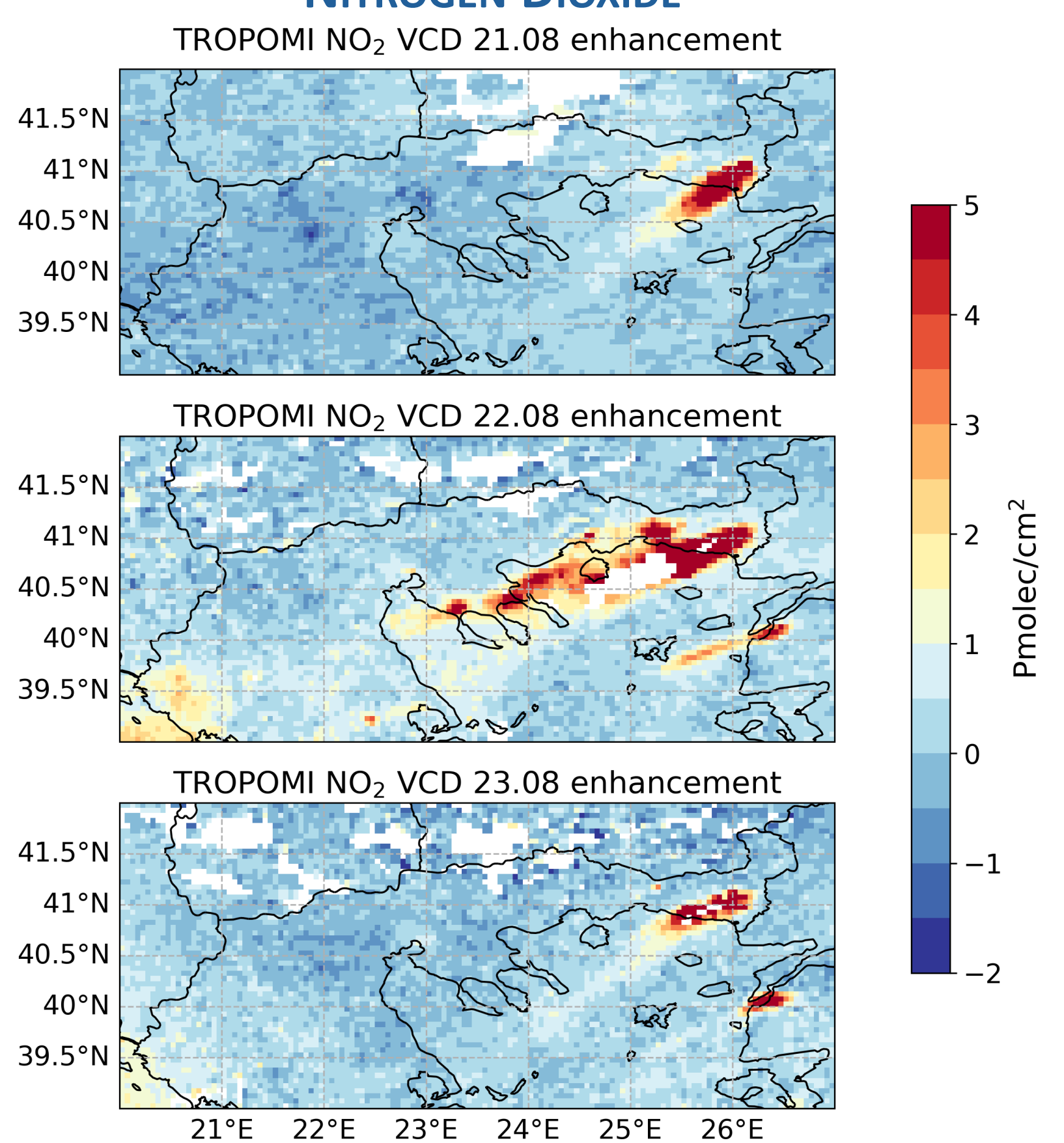
The aim of this work is to examine the effect of the Northern Greece forest fires in August 2023 on regional air quality levels. On August 21st, a massive forest fire started within the Dadia Forest National Park, a protected area, nearby the city of Alexandroupolis. During the nearly ten-day duration of the fire, approximately 80khectares burned, while the strong prevailing easterly winds transporting smoke particles and biomass burning gases over Northern Greece and the Mediterranean Sea, reaching the coasts of Italy and Tunisia. Using S5P/TROPOMI satellite observations, MAX-DOAS spectrophotometer observations and FTIR spectroscopy measurements in the city of Thessaloniki, the extend of the degradation of air quality has been quantified. Satellite observations show an enhancement of NO₂, HCHO and CO levels up to 82%, 54% and 26% over the fire location, respectively. Ground-based remote sensing resulted in similar findings with MAX-DOAS spectrophotometer observations reporting increased NO₂, HCHO and CO levels well beyond typical summertime levels over the metropolis of Thessaloniki.

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EFFECT ON AIR QUALITY LEVELS OVER THESSALONIKI, GREECE | MONITORING BY S5P/TROPOMI

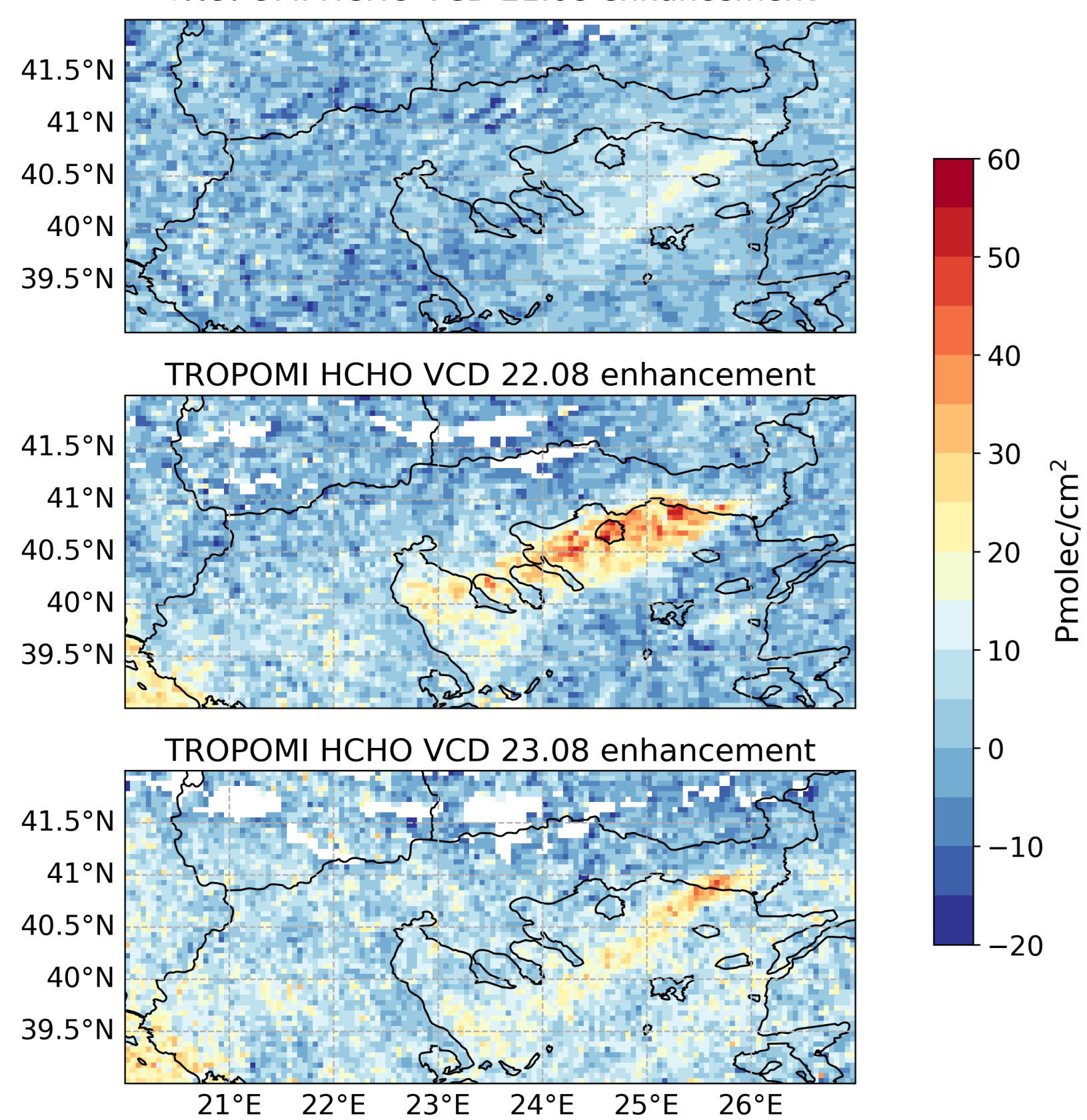
NITROGEN DIOXIDE



21 - 25 August	Relative NO ₂ enhancements [%]			
	Alexandroupoli		Thessaloniki	
	mean	upper 10 th %	mean	upper 10 th %
2018	37.66	81.81	48.75	100.63
2019	16.08	64.72	2.42	47.19
2020	29.72	92.04	6.52	52.95
2021	19.65	62.51	20.58	62.25
2022	56.90	174.96	23.33	90.40
2023	82.02	128.85	35.95	98.93

Fig 2. TROPOMI NO₂ tropospheric VCD enhancements shown as daily differences from the average August TROPOMI lifetime [2018-2023].
Table 1. Relative mean and upper 10th percentile NO₂ enhancements for the prominent fire period [21-25 August 2023].

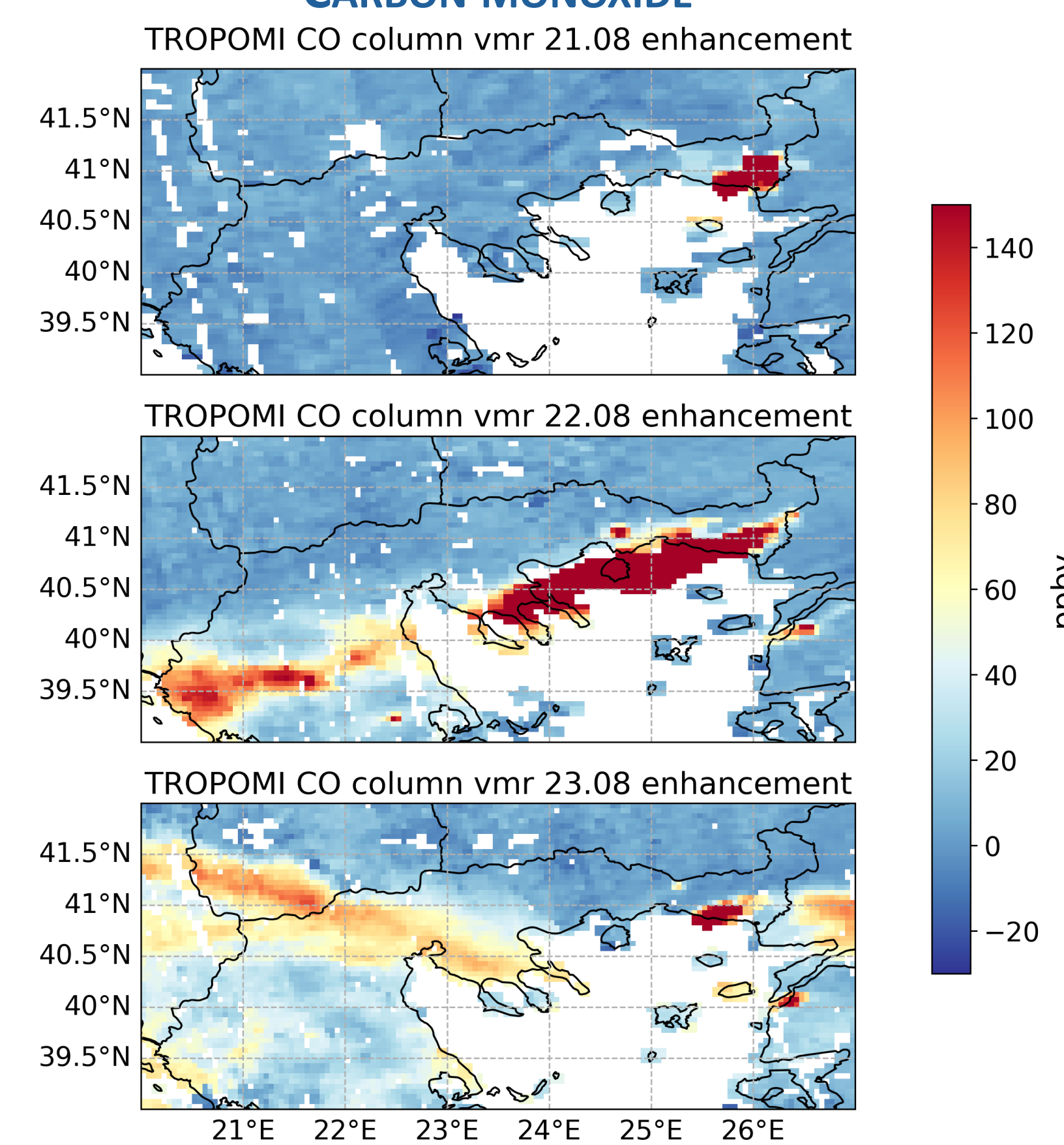
TROPOMI HCHO VCD 21.08 enhancement



21-25 August	Relative HCHO enhancements [%]			
	Alexandroupoli		Thessaloniki	
	mean	upper 10 th %	mean	upper 10 th %
2018	-11.16	54.23	22.2	104.27
2019	21.61	97.63	53.89	150.65
2020	16.19	99.11	46.87	145.02
2021	-9.92	63.7	45.47	133.66
2022	6.25	94.76	18.23	144.07
2023	54.43	165.65	114.1	225.11

Fig 3. TROPOMI HCHO tropospheric VCD enhancements shown as daily differences from the average August TROPOMI lifetime [2018-2023].
Table 2. Relative mean and upper 10th percentile HCHO enhancements for the prominent fire period [21-25 August 2023].

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21-25 August	Relative CO enhancements [%]			
	Alexandroupoli		Thessaloniki	
	mean	upper 10 th %	mean	upper 10 th %
2018	2.51	8.81	5.86	12.36
2019	0.21	7.05	2.1	8.14
2020	-9.66	-3.14	-6.95	0.17
2021	31.95	49.27	38.18	54.06
2022	-7.57	1.55	-6.6	4.79
2023	26.9	47.76	26.2	78.88

Fig 4. TROPOMI CO volume mixing ratio enhancements shown as daily differences from the average August TROPOMI lifetime [2018-2023].
Table 3. Relative mean and upper 10th percentile CO enhancements for the prominent fire period [21-25 August 2023].

EFFECT ON AIR QUALITY LEVELS OVER THESSALONIKI, GREECE | MONITORING BY GROUND-BASED REMOTE SENSING INSTRUMENTS

NITROGEN DIOXIDE

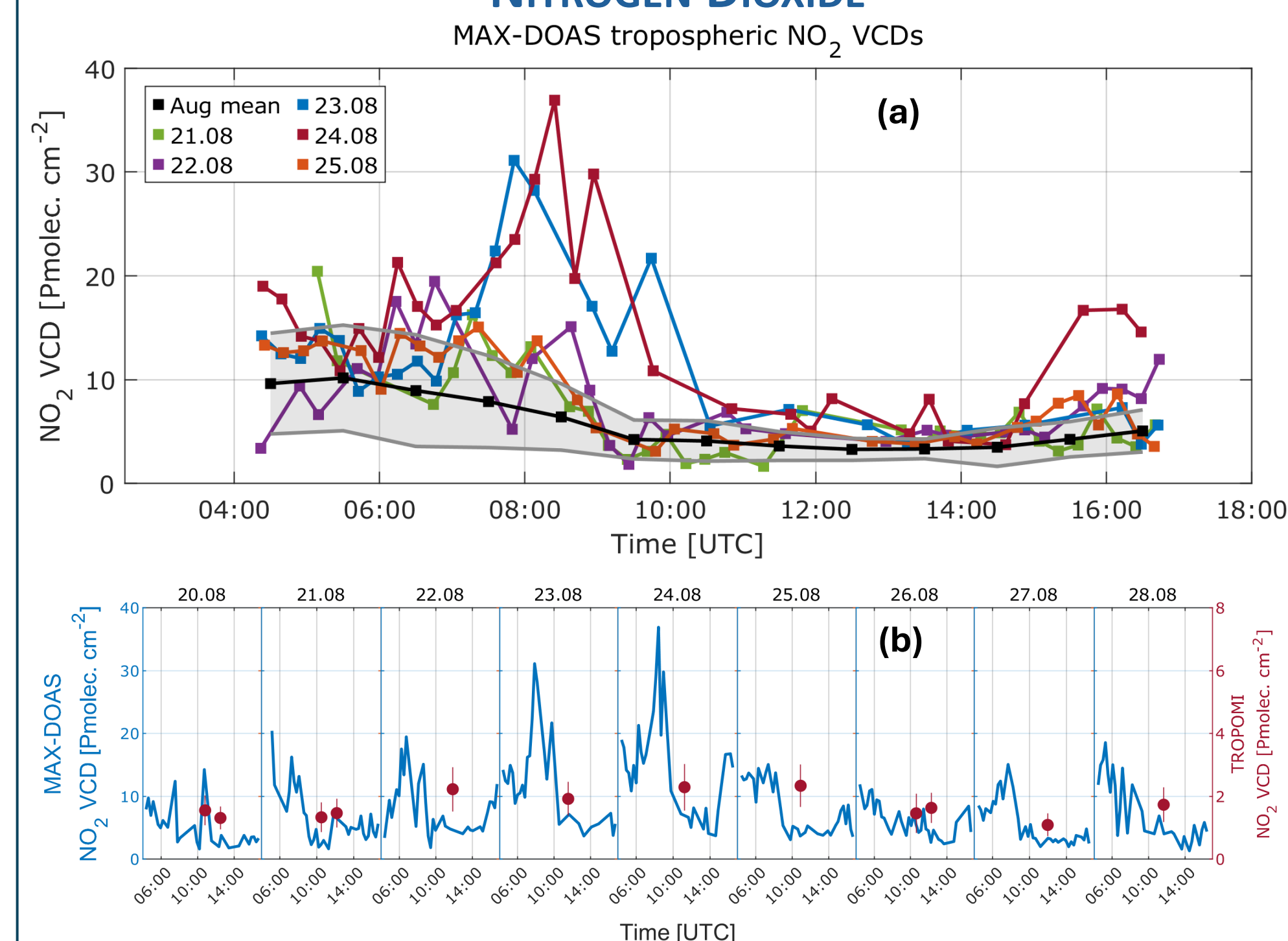


Fig 5. Tropospheric NO₂ VCD [Pmolec/cm²] over Thessaloniki. (a) Diurnal variability during the wildfire event and the typical August mean values measured by the MAX-DOAS system. (b) Time series of the days before, during and after the fire event observed by the MAX-DOAS system [blue] and the TROPOMI observations [red]. 23rd of August is the most affected day.

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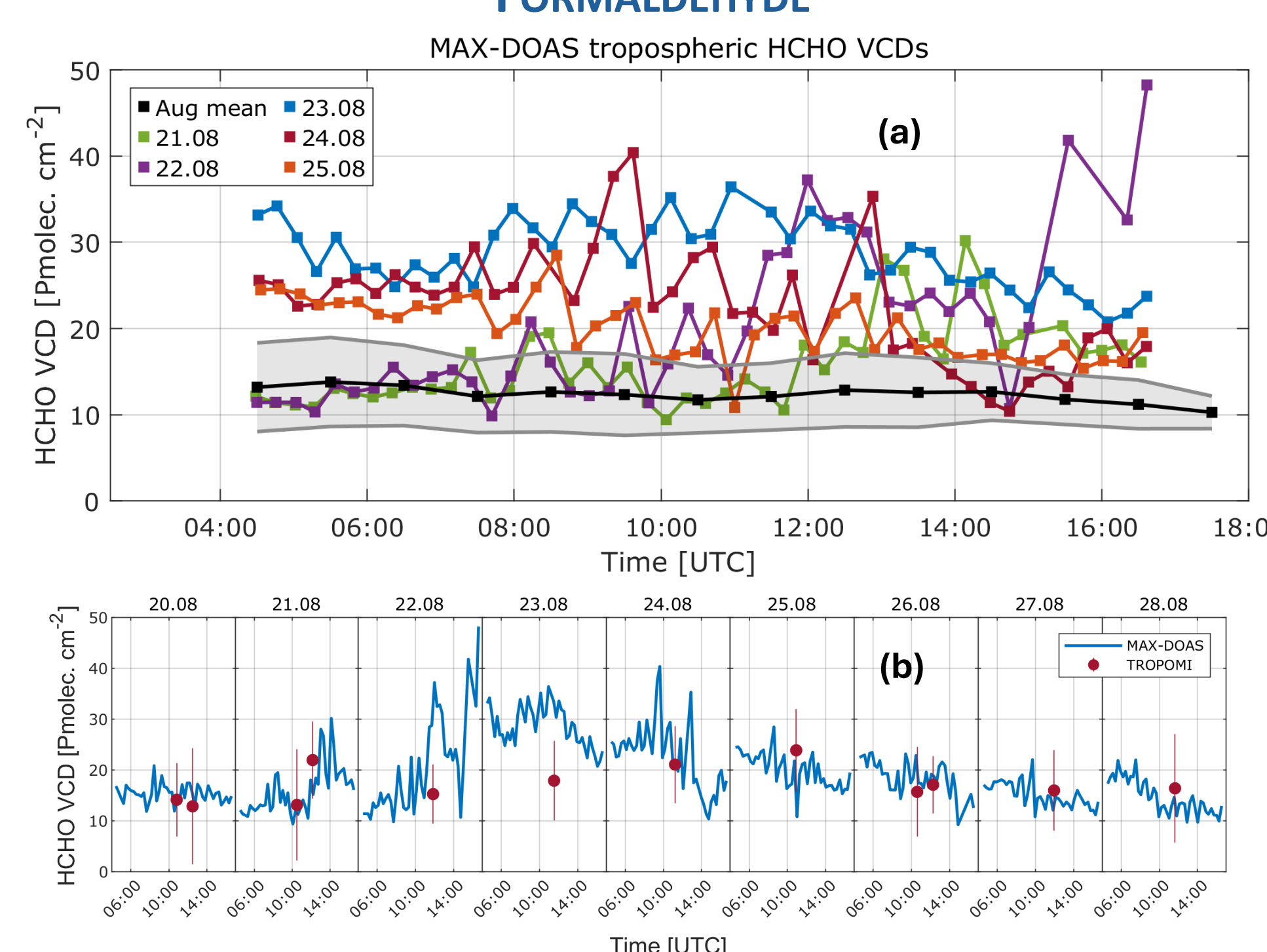


Fig 6. Tropospheric HCHO VCD [Pmolec/cm²] over Thessaloniki. (a) Diurnal variability during the wildfire event and the typical August mean values measured by the MAX-DOAS system. (b) Time series of the days before, during and after the fire event observed by the MAX-DOAS system [blue] and the TROPOMI observations [red]. 23rd of August is the most affected day.

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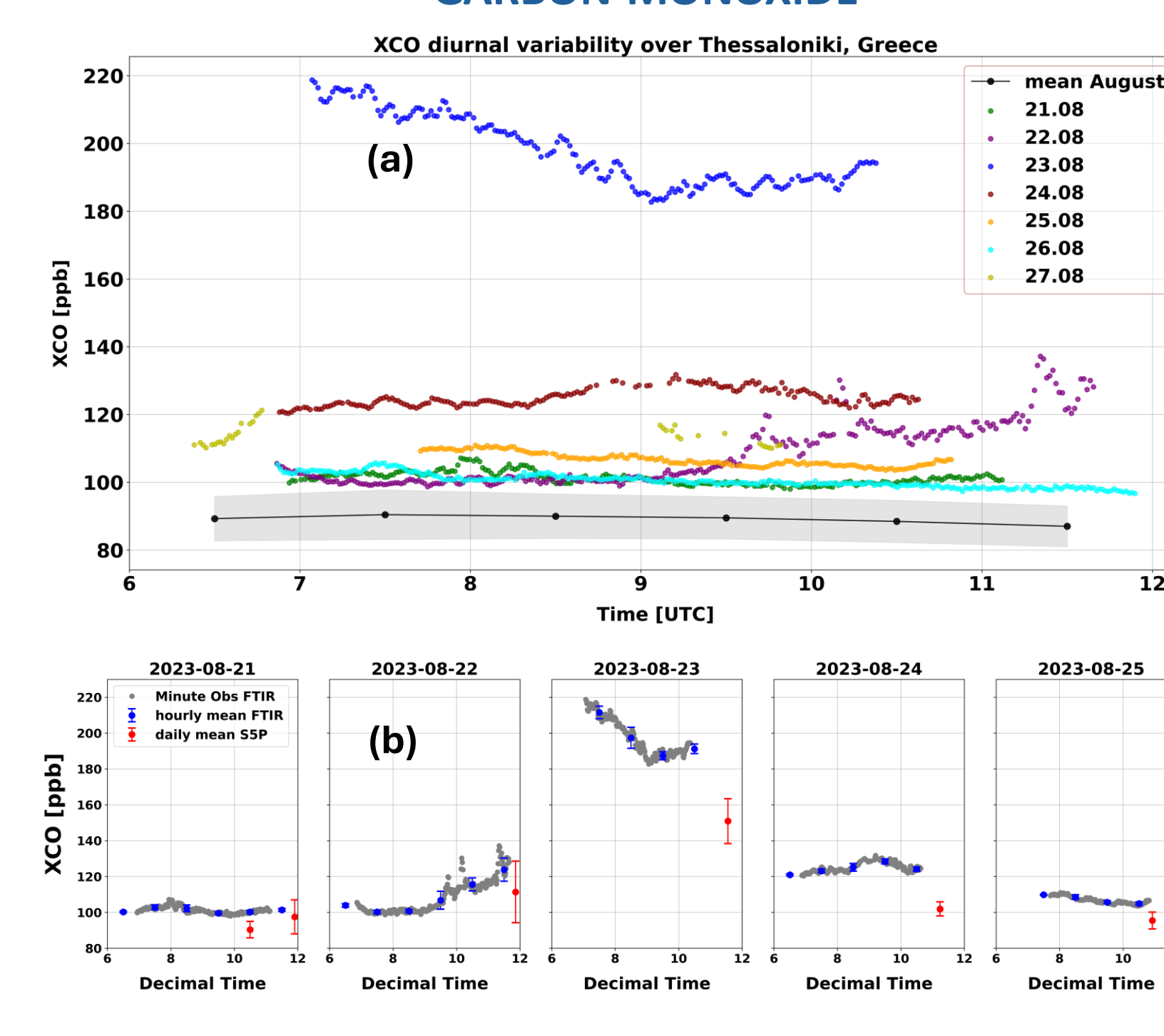


Fig 7. (a) Diurnal variability of CO [in ppbv] over Thessaloniki during the days of the fire event and the typical summertime average observed by the FTIR system. (b) CO diurnal variability during the main event fire days observed by FTIR [blue] and TROPOMI [red]. 23rd of August is the most affected day.

Key remarks

- For NO₂ and HCHO, MAX-DOAS and TROPOMI observations report loads up to 30 and 40 Pmolec/cm², respectively, exceeding summertime typical values [~10 Pmolec/cm²] over Thessaloniki.
- For CO, FTIR and TROPOMI observations over Thessaloniki report values of 200-250 ppbv, showing a 130-150% relative enhancement compared to summertime typical values [~90 ppbv].

Data Availability. The S5P/TROPOMI observations are currently publicly available from the Copernicus Data Space Ecosystem (<https://dataspace.copernicus.eu/>, last accessed on 20 February 2024). The Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, Greece MAX-DOAS data are available upon request from A. Bais (abais@auth.gr) or D. Karagkiozidis (dkaragki@auth.gr). The Laboratory of Atmospheric Physics, Aristotle University of Thessaloniki, Greece FTIR data are available upon request (mmermigk@physics.auth.gr).

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