Automatic procedures for submitting essential climate variables (ECVs) recorded at Italian Atmospheric Observatories to WMO/GAW data centers – Supplementary Material

Luca Naitza[1], Davide Putero[1], Angela Marinoni[1], Francescopiero Calzolari[1], Fabrizio Roccato[1], Maurizio Busetto[1], Damiano Sferlazzo[2], Eleonora Aruffo[3], Piero Di Carlo[3], Mariantonia Bencardino[4], Francesco D'Amore[4], Francesca Sprovieri[4], Nicola Pirrone[4], Federico Dallo[5], Jacopo Gabrieli[5], Massimiliano Vardè[5,6], Carlo Barbante[5], Paolo Bonasoni[1], and Paolo Cristofanelli[1,*]

[1] *CNR–ISAC, National Research Council – Institute of Atmospheric Sciences and Climate, Bologna, Italy*
[2]*ENEA, SSPT-PROTER-OAC, Lampedusa, Italy*
[3]*Chieti University, Chieti, Italy*
[4]*CNR–IIA, National Research Council – Institute of Atmospheric Pollution, Rende, Italy*
[5]*CNR–IDPA, National Research Council – Institute of Dynamics for Environmental Processes, Mestre-Venezia, Italy*
[6]*Dept. of Chemical and Pharmaceutical Sciences, Ferrara University, Ferrara, Italy*

1. Automatic processing of ECVs: data products

In this Supplementary Material, we provide a graphical overview of the data products which are routinely produced by the automatic processing chain. The data products are updated on a daily basis, by using specific routines based on R codes. To this aim, some specific functions of the "OpenAir" package (Carslaw and Ropkins, 2012) are also used.

The data products are arranged as a function of different time windows: daily, monthly, seasonal and yearly. In total, 9 data products are operationally produced for each ECV. Data products are ".png" files identified by the following name code:

SSS_PPP_yyyy_mm_PERIOD_TYPE_YYYYMMDD.png

where SSS is the station code, PPP is the ECV code (see Table 3 of the main manuscript), yyyy_mm identifies the time validity of the product (for data products related to a full calendar year the code yyyy_01 is conventionally adopted), PERIOD is the period of time spanned by the data products (i.e., "DAILY", "MONTHLY", "SEASONAL", "SEMESTER", "ANNUAL"), "TYPE" denotes the class of data product (i.e., "GRAPH", "TIMEVARIATION", "CALENDAR", see Table 6 of the main manuscript), and "YYYYMMDD" is the file production date.

As explanatory case, we provide several examples for the NO processing chain. For a full explanation of the single products, please refer to the main paper.

1.1 Daily data product (SSS_ECV_yyyy_mm_DAILY_GRAPH_YYYYMMDD.png)

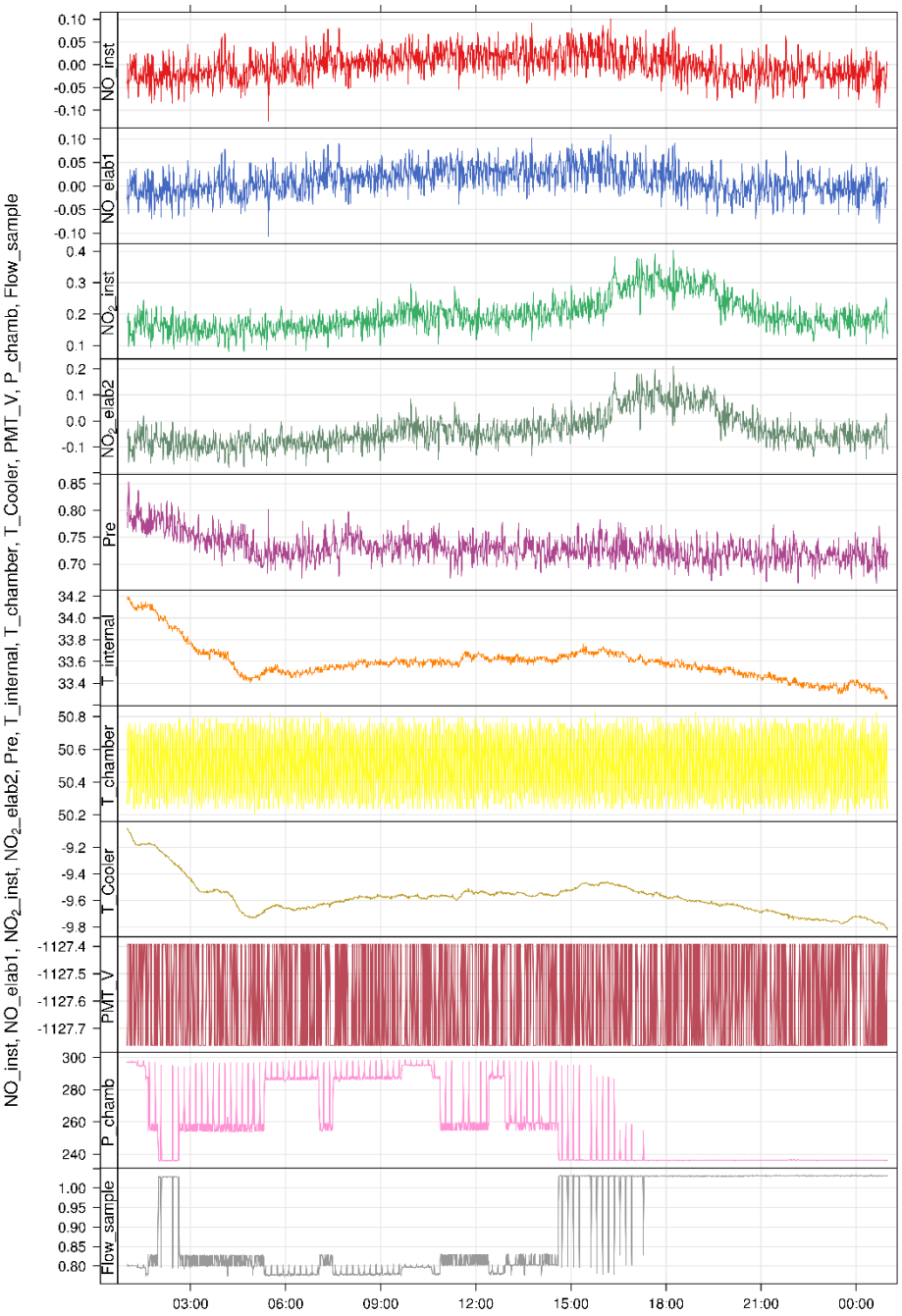


Figure S1. Daily data product for CMN Thermo-42i-TL instrument, which reports: raw NO and NO_2 reading ("NO", "NO_2" expressed as nmol/mol), corrected and calibrated NO ("NO_elab1" expressed as nmol/mol) and NO_2 ("NO_2_elab2" expressed as nmol/mol), pre-concentration NO value ("Pre" expressed as nmol/mol), internal temperature, ("T_internal", expressed as °C), detection chamber temperature ("T_chamber", expressed as °C), cooler temperature ("T_cooler", expressed as °C), PMT voltage ("PMT_V"), chamber pressure ("P_chamber", expressed as mmHg), sample flow ("Flow_sample", expressed as l/min).

1.2 Monthly data product 1 (SSS_ECV_yyyy_mm_MONTHLY_GRAPH_YYYYMMDD.png)

Figure S2. Monthly data product n. 1 for CMN Thermo-42i-TL instrument (referring to January 2018): NO Level-2 data ("NO-L02") and its average (red line), minimum ("Min") and maximum ("Max") monthly values. Also reported are the time series of Level-1 numflag values, the selected internal diagnostic parameters (pre-concentration value–"Pre", sample flow–"Flow_sample", chamber pressure–"P_chamber", cooler temperature–"T_cooler", and PMT voltage–"PMT_V"), along with basic statistic for Level-2 data (bottom).

1.3 Monthly data product 2 (SSS_ECV_yyyy_mm_MONTHLY_TIMEVARIATION_YYYYMMDD.png)

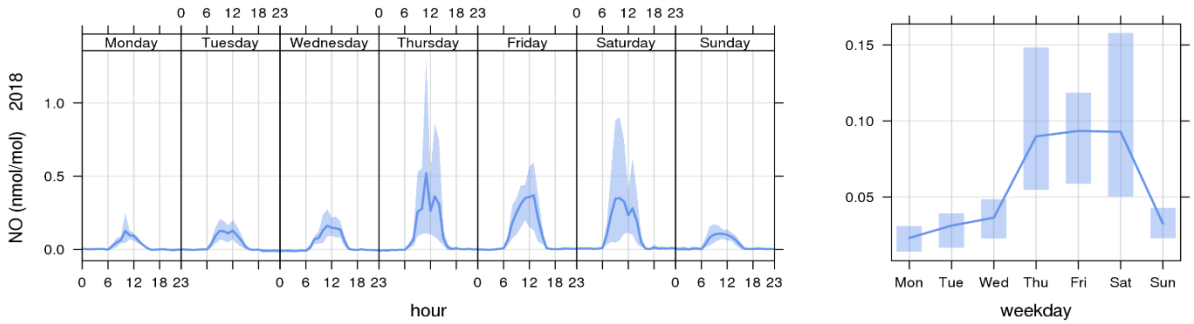


Figure S3. Monthly data product n. 2 for NO at CMN (referring to January 2018): average diurnal variability as a function of the days of the week (left) and average weekly cycle (right). Shaded areas (left plot) and vertical bars (right plot) denote the 95% confidence intervals of the averages.

1.4 Monthly data product 3 (SSS_ECV_yyyy_mm_SEMESTERn_GRAPH_YYYYMMDD.png, n =1,2)

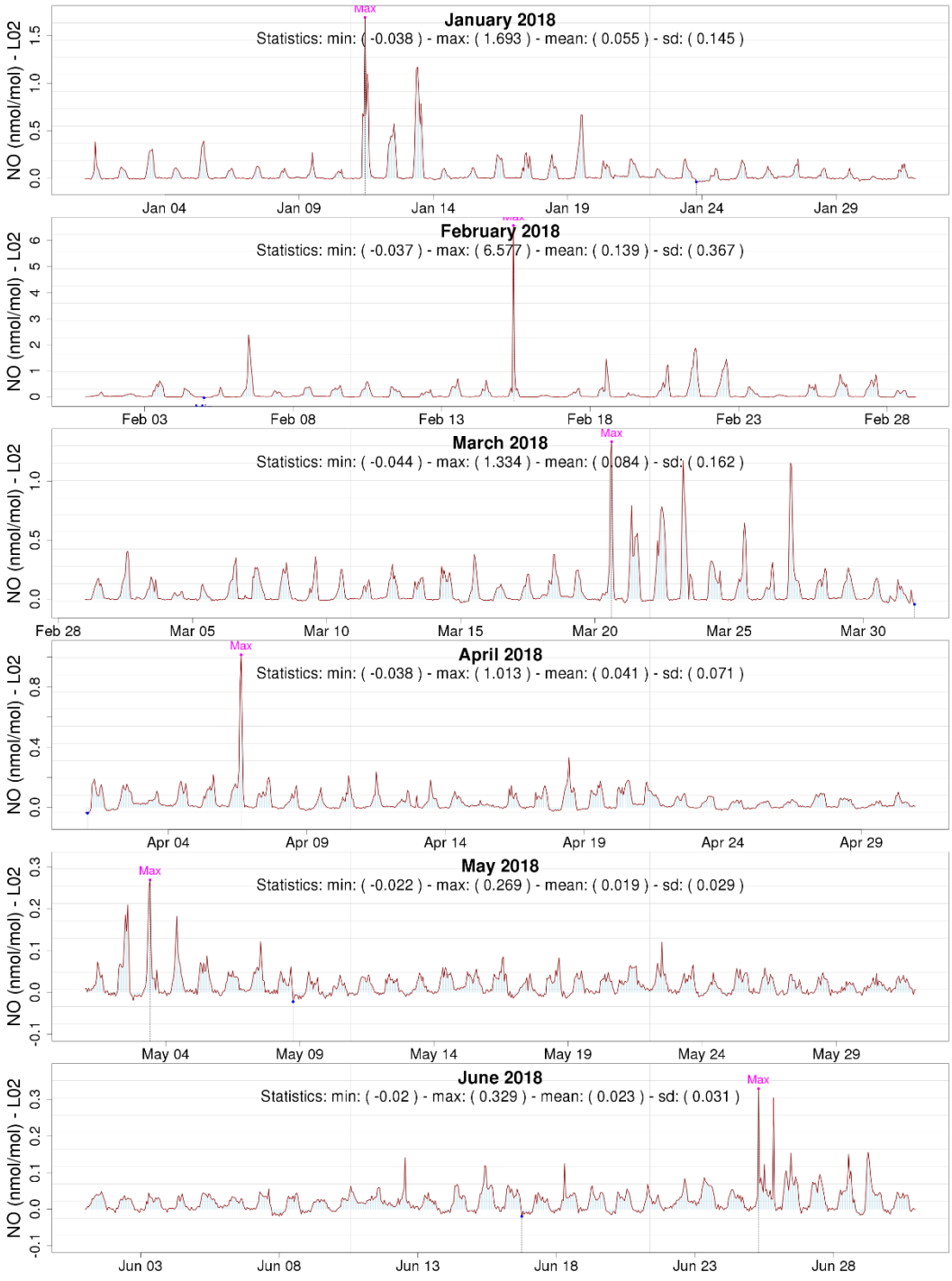


Figure S4. Monthly data product n. 3 for NO at CMN (year 2018): for each month, the Level-2 NO is reported together with the minimum ("Min") and maximum ("Max") values.

1.5 Quarterly data product (SSS_ECV_yyyy_mm_SEASONAL_GRAPH_YYYYMMDD.png)

Figure S5. Quarterly data product for NO at CMN (year 2018): the Level-2 NO time series together with its minimum ("Min") and maximum ("Max") values, the population histogram (left) and the power density function (right) are reported for each quarterly period (JFM, AMJ).

1.6 Yearly data product 1 (SSS_ECV_yyyy_mm_ANNUAL_GRAPH_YYYYMMDD.png)

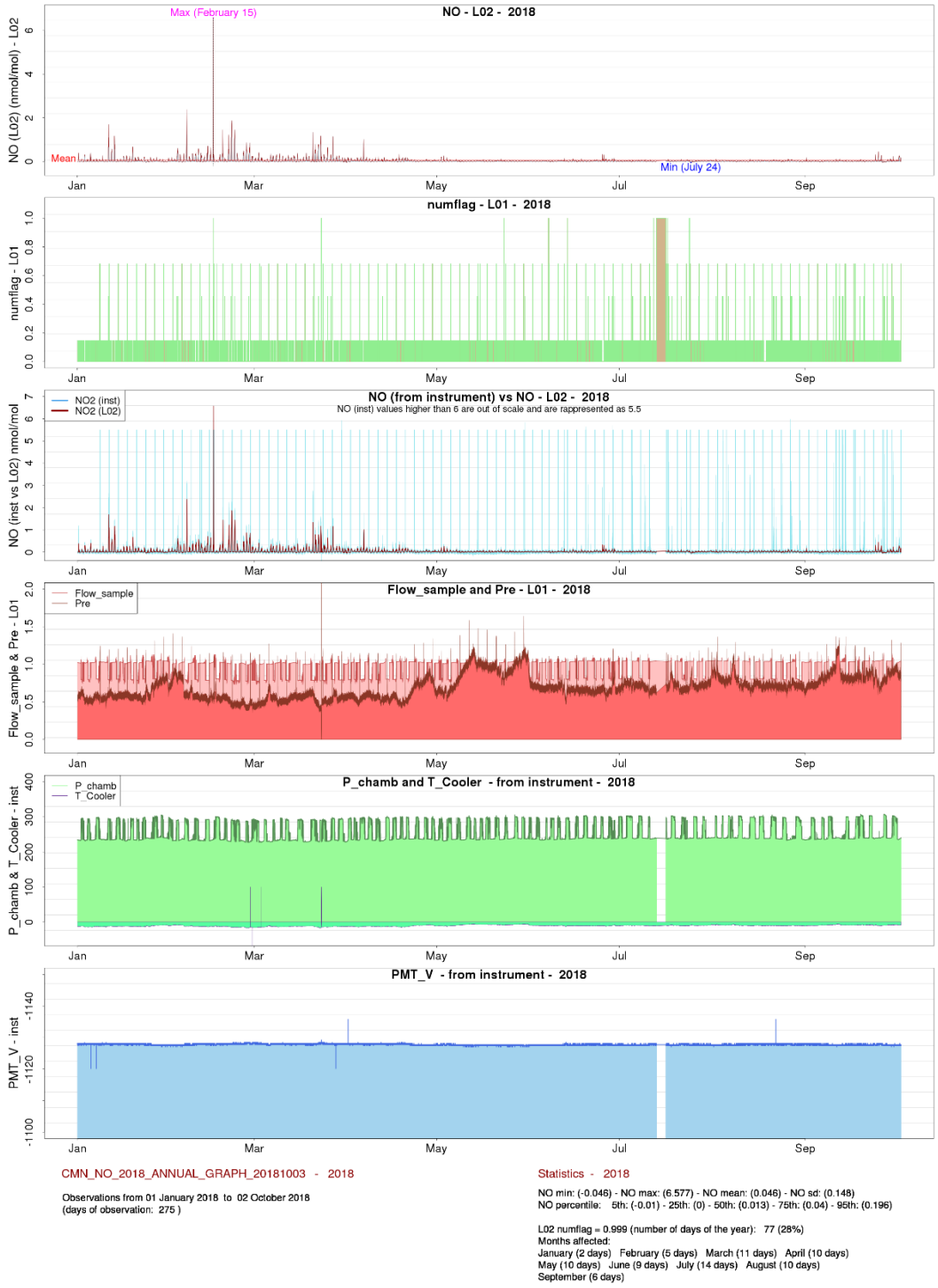
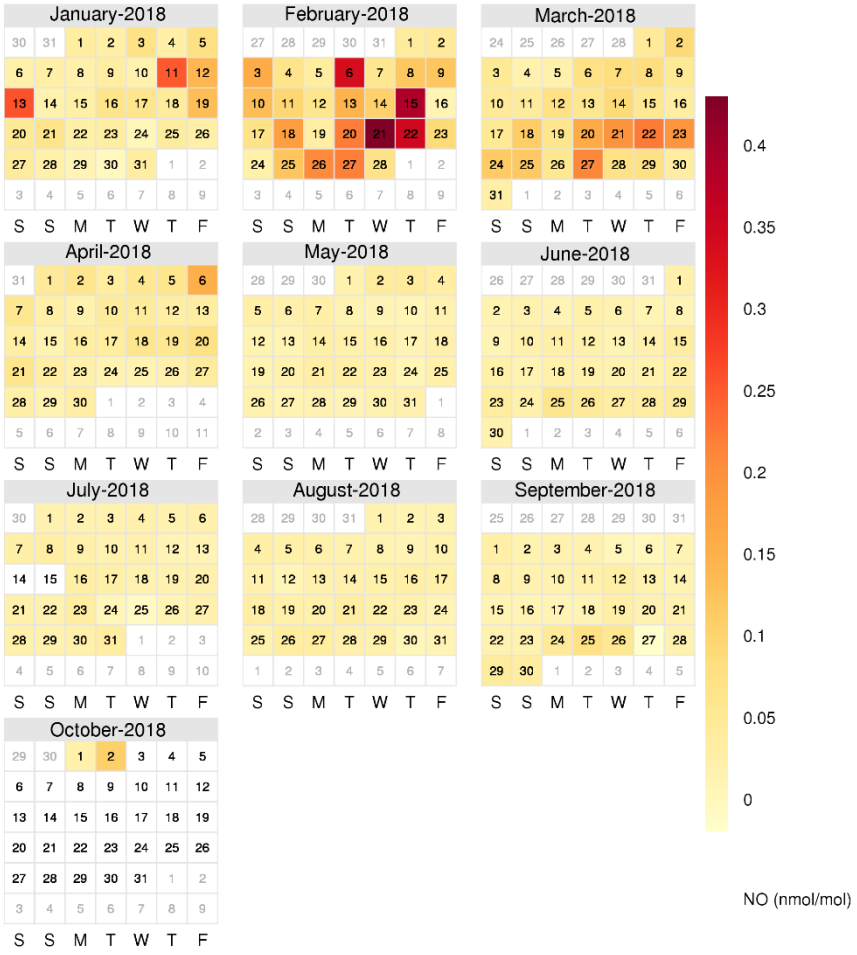


Figure S6. Yearly data product n. 1 for NO at CMN (year 2018): time series of Level-2 NO (minimum–"Min" and maximum–"Max" values are also reported), numflag for Level-1, comparison between Level-2 and raw "instrumental" data, and internal diagnostic parameters (pre-concentration value–"Pre", sample flow–"Flow_sample", chamber pressure–"P_chamber", cooler temperature–"T_cooler", and PMT voltage–"PMT_V"). A table with basic statistical values for Level-2 NO is embedded in the bottom plate.

74 1.7 Yearly data product 2 (SSS_ECV_yyyy_mm_ANNUAL_CALENDAR_YYYYMMDD.png)



75

76 **Figure S7.** Yearly data product n. 2 for NO at CMN (year 2018): average daily values of Level-2 NO.

77

1.8 Yearly data products 3 (SSS_ECV_yyyy_mm_ANNUAL_TIMEVARIATION_YYYYMMDD.png)

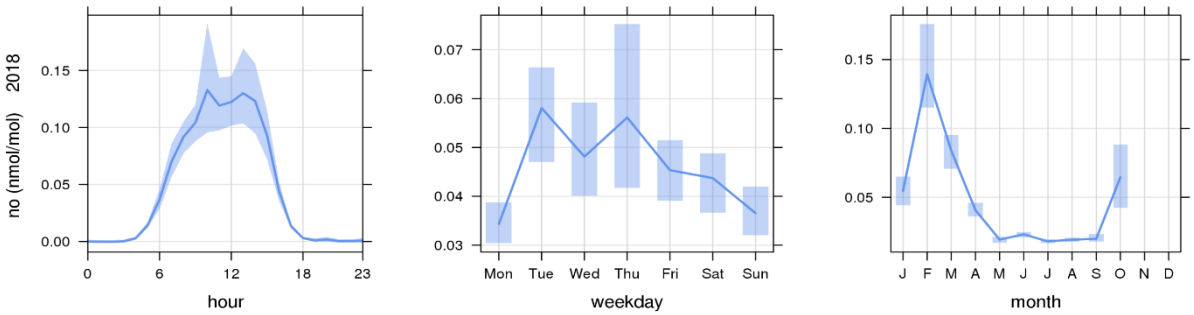


Figure S8. Yearly data product n. 3 for NO at CMN (year 2018): average diurnal variability (left), average weekly cycle (center), and mean monthly values (right). Shaded areas (left plot) and vertical bars (center and right plots) denote the 95% confidence intervals of the averages.