Inverse modelling of European N_2O emissions: Assimilating observations from different networks

Supplementary Material

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Figure Captions

Figure S-1: The 3 two-way nested domains used for all the zoomed simulations presented in this work. Locations of all stations used in the control inversion are also shown. Open circles represent flask measurements, and filled circles are continuous measurements.

Figure S-2: Monthly values for the atmospheric sink rates: Upper panel: reaction with $O(^1D)$, middle panel: photolysis. Values for January, April, July and October are shown to illustrate the seasonal variation. Bottom panel: N_2O mole fractions from the ECHAM model.

Figure S-3: Example of annual evolution of N_2O mole fractions at 8 of the available global stations: Alert, Ny-Ålesund, Barrow, Niwot Ridge, Mauna Loa, Ascension Island, Crozet Island, and South Pole. One year of data, from 1 January to 31 December 2006, is presented. As in Fig. 2, blue lines represent a priori simulations and red lines are a posteriori simulations for the reference inversion S1. Shaded areas represent estimated uncertainties of the model simulations. Measurements are shown as black dots. Latitude, longitude, and height (meters above sea level) are also reported for each station.

Figure S-4: A priori (top panel) and a posteriori (mid panel) annual emissions over the 6°x4° global domain for 2006 for the reference inversion S1. Bottom panel represents the difference between the two fields (a posteriori – a priori).

Figure S-5: A posteriori annual emissions for sensitivity inversion S2 (top left panel) and S3 (top right panel). In the bottom panels their differences to the reference inversion S1 are shown.

Figure S-6: A posteriori emission distribution for S4 (top panel) and difference to reference inversion S1 (mid panel of Fig. 3).

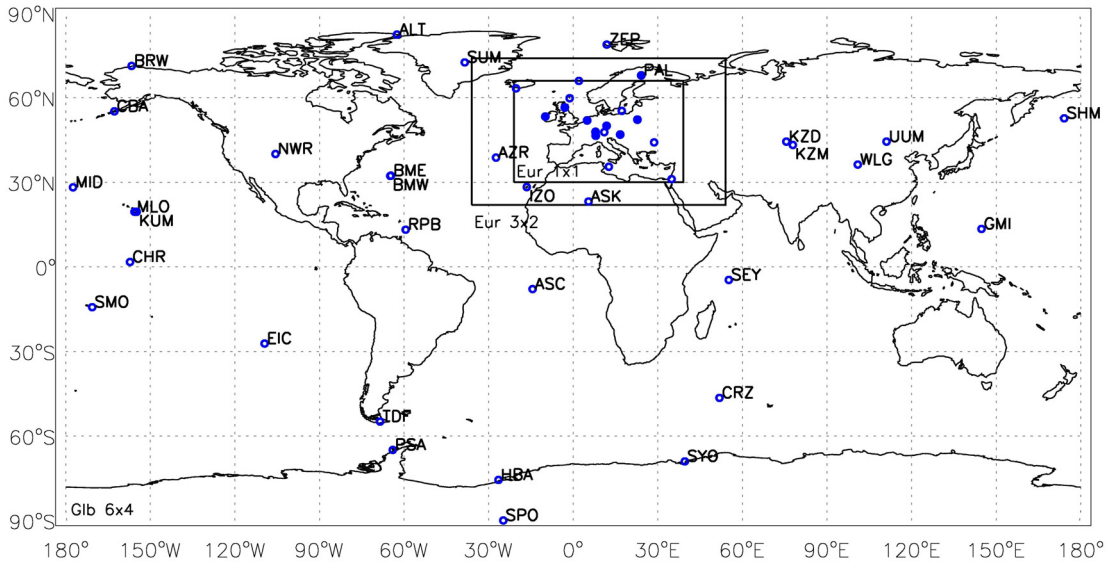
90°N
60°N
30°N
0°
30°S
60°S
90°S
180°
150°W
120°W
90°W
60°W
30°W
0°
30°E
60°E
90°E
120°E
150°E
180°
ALT
ZEP
SUM
PAL
BRW
CBA
NWR
BME
BMW
AZR
Eur 1x1
IZO
ASK
Eur 3x2
MID
MLO
KUM
RPB
CHR
SMO
EIC
ASC
SEY
CRZ
IDF
PSA
HBA
SYO
SPO
Glb 6x4
KZD
KZM
UUM
WLG
SHM
GMI

Figure S-1

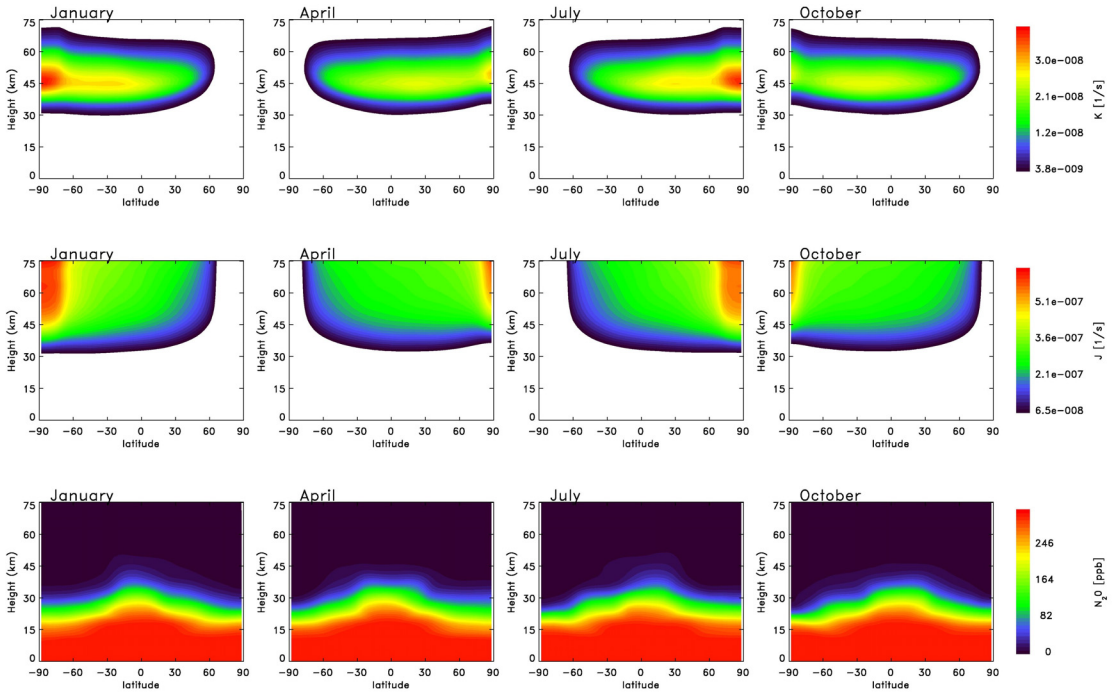
January
April
July
October
Height (km)
latitude
K [1/s]
3.0e−008
2.1e−008
1.2e−008
3.8e−009
J [1/s]
5.1e−007
3.6e−007
2.1e−007
6.5e−008
N2O [ppb]
246
164
82
0

Figure S-2

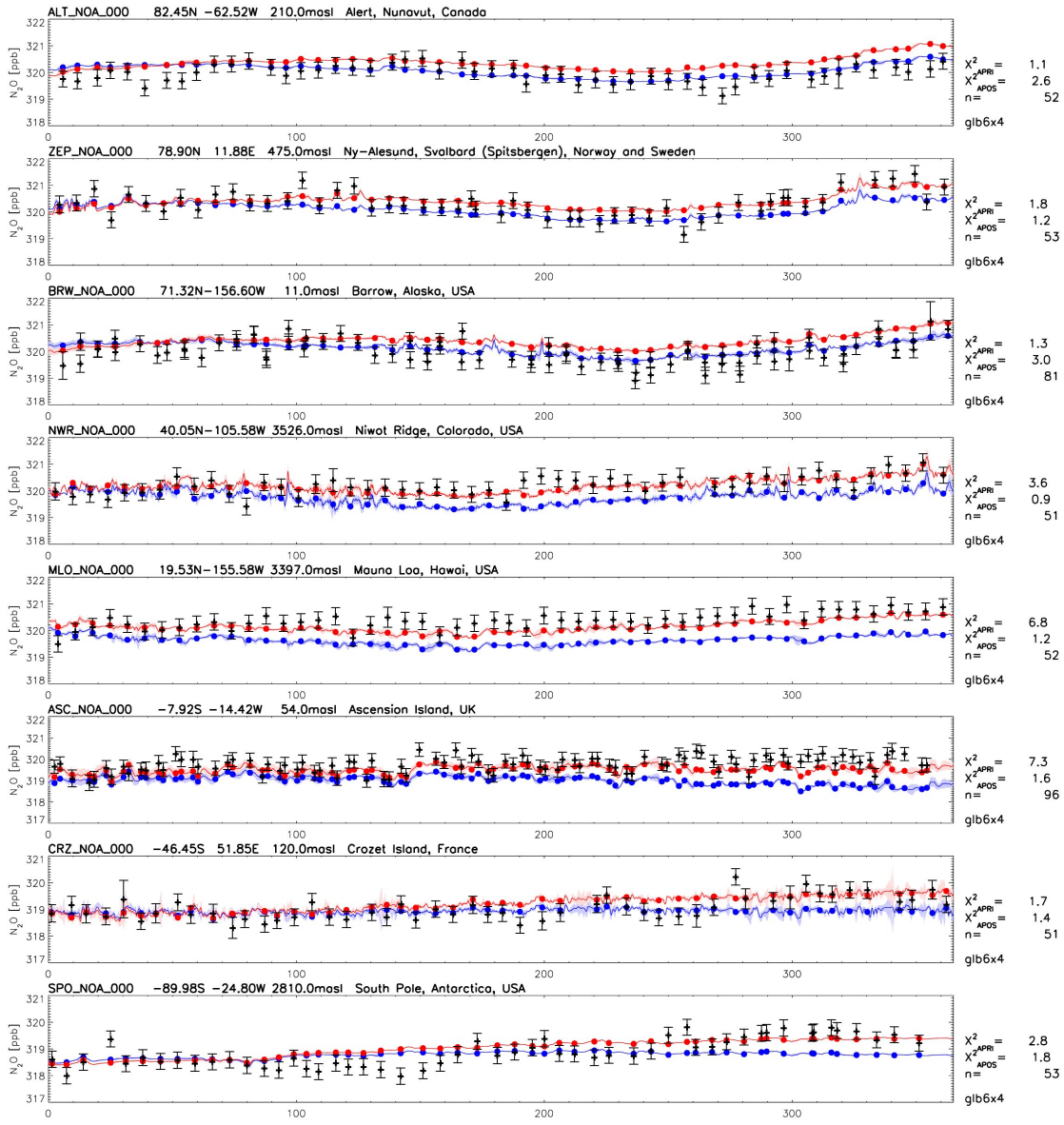
ALT_NOA_000 82.45N −62.52W 210.0masl Alert, Nunavut, Canada
ZEP_NOA_000 78.90N 11.88E 475.0masl Ny−Alesund, Svalbard (Spitsbergen), Norway and Sweden
BRW_NOA_000 71.32N−156.60W 11.0masl Barrow, Alaska, USA
NWR_NOA_000 40.05N−105.58W 3526.0masl Niwot Ridge, Colorado, USA
MLO_NOA_000 19.53N−155.58W 3397.0masl Mauna Loa, Hawai, USA
ASC_NOA_000 −7.92S −14.42W 54.0masl Ascension Island, UK
CRZ_NOA_000 −46.45S 51.85E 120.0masl Crozet Island, France
SPO_NOA_000 −89.98S −24.80W 2810.0masl South Pole, Antarctica, USA
N2O [ppb]
glb6x4

Figure S-3

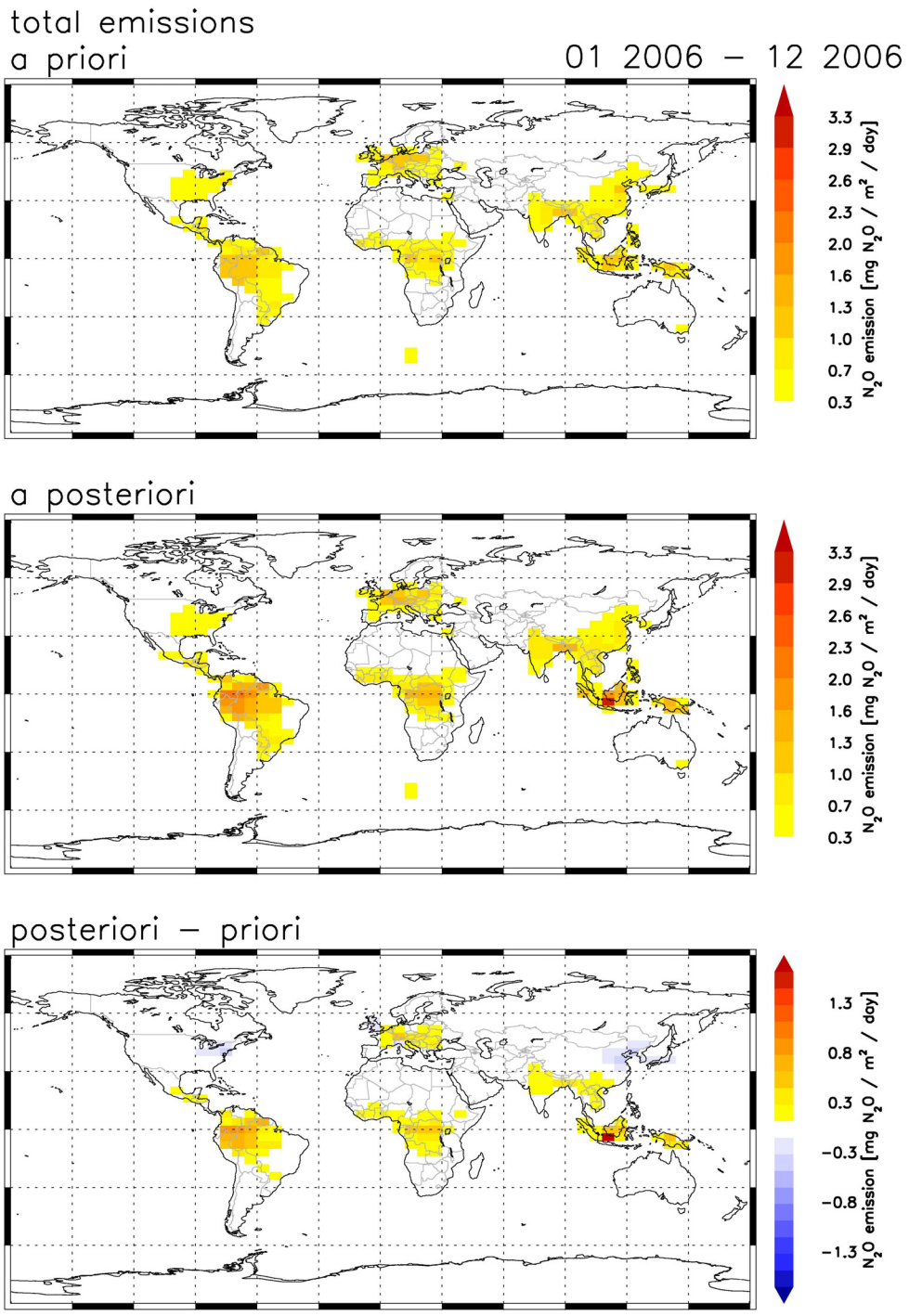
total emissions
a priori
01 2006 – 12 2006
3.3
2.9
2.6
2.3
2.0
1.6
1.3
1.0
0.7
0.3
N2O emission [mg N2O / m2 / day]
a posteriori
3.3
2.9
2.6
2.3
2.0
1.6
1.3
1.0
0.7
0.3
N2O emission [mg N2O / m2 / day]
posteriori – priori
1.3
0.8
0.3
−0.3
−0.8
−1.3
N2O emission [mg N2O / m2 / day]

Figure S-4

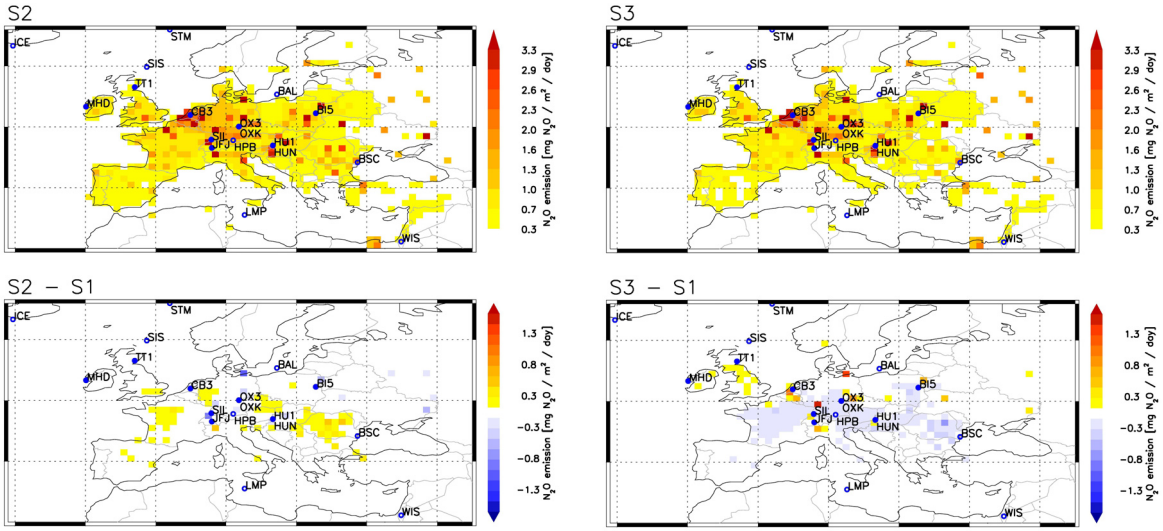
S2
S3
S2 – S1
S3 – S1
ICE
STM
SIS
TT1
MHD
CB3
BAL
Bi5
OX3
OXK
IPG
HPB
HU1
HUN
BSC
MP
WIS
N2O emission [mg N2O / m2 / day]

Figure S-5

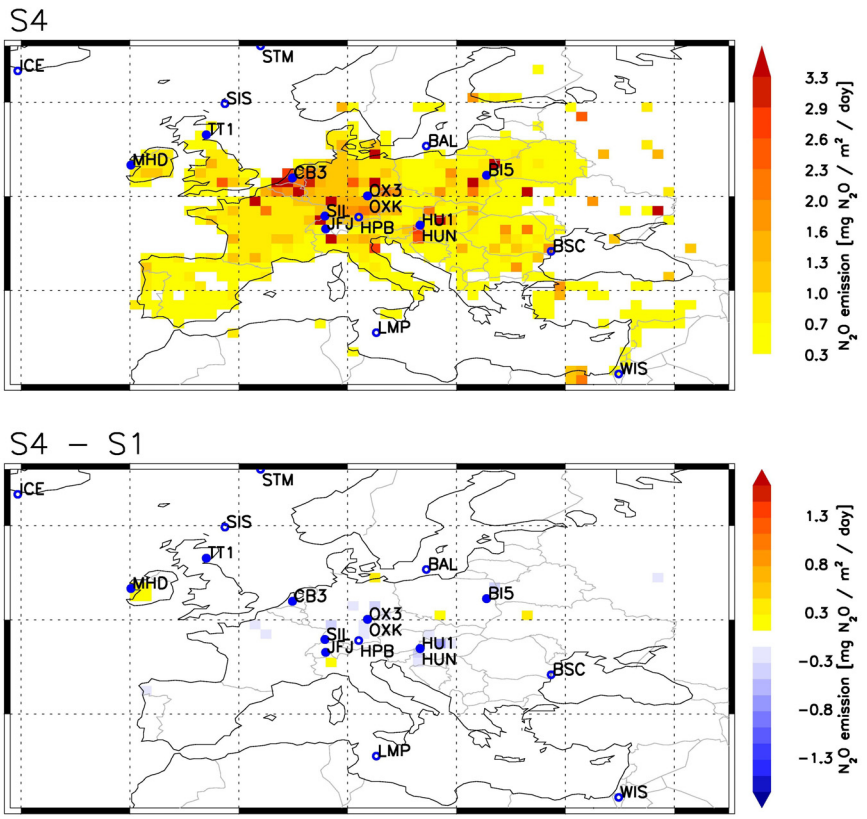
S4
ICE
STM
SIS
TT1
MHD
BAL
CB3
BI5
OX3
OXK
SIL
JFJ
HPB
HU1
HUN
BSC
LMP
WIS
3.3
2.9
2.6
2.3
2.0
1.6
1.3
1.0
0.7
0.3
N2O emission [mg N2O / m2 / day]
S4 – S1
ICE
STM
SIS
TT1
MHD
BAL
CB3
BI5
OX3
OXK
SIL
JFJ
HPB
HU1
HUN
BSC
LMP
WIS
1.3
0.8
0.3
−0.3
−0.8
−1.3
N2O emission [mg N2O / m2 / day]

Figure S-6