"Data Archive for NOy from Observations and Construction and Testing of Airborne Instrument for Simultaneous Measurement of NO, NO2, NOy and O3"

Final Report
(funding period:1/1/94-12/31/95)

Author: Mary Anne Carroll

University of Michigan
Space Research Building
2455 Hayward Street
Ann Arbor, Michigan 48109-2143

December 1995

Prepared for

NASA/Headquarters
Grant NAG2-879

Final Report for the AEAP/SASS NO_x, NO_y Data Archive I oject

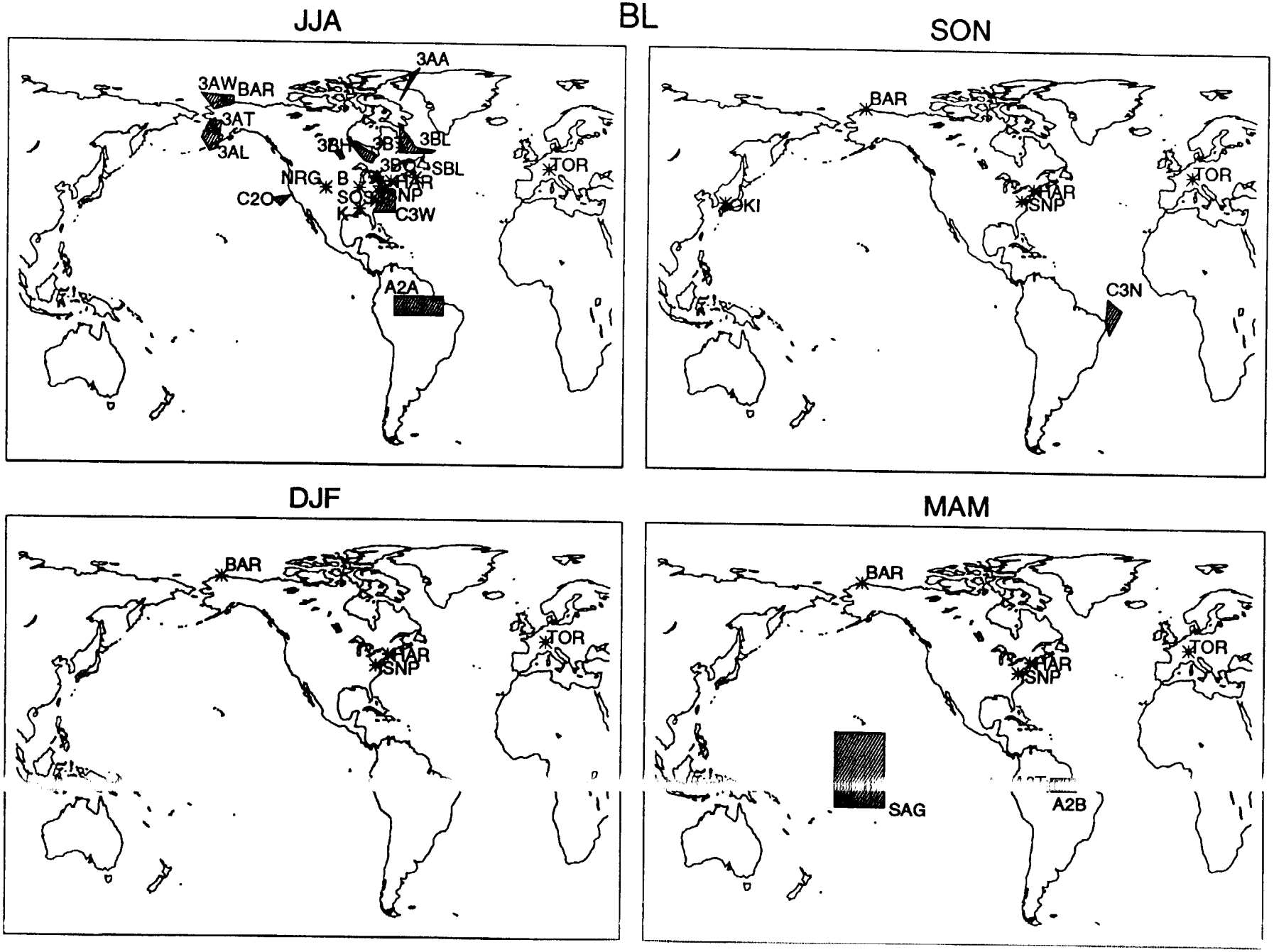
Mary Anne Carroll and Louisa Emmons
Department of Atmospheric, Oceanic and Space Scienc
University of Michigan
Ann Arbor, MI 48109-2143
December 21, 1995

The compilation and archiving of NO_x and NO_y measurements began in nid-March, 1994 when Dr. Louisa Emmons arrived at the University of Michigan. Details were given in th Year 1 report (and incorporated into the SASS Program Report) of the rese rchers contacted the format of the data files decided upon, archive policy and the data se s archived. Sinc the submission of the first report, data summaries have been obtained for the TROPOZ II STRATOZ III, OCTA and TOR/Schauinsland campaigns, and the full dat sets will becom a part of this archive in the near future.

Climatologies of NO_x and NO_y have been developed from these and p viously archive data sets, including the available GTE campaigns (ABLE-2A,B, -3A,B, CI E-2, -3, TRACE A, PEM WEST-A) and AASE 1 and 2. The data have been grouped by s son and altitud (boundary layer and 3 km ranges in the free troposphere). Maps showing median values o midday NO, NO_x and NO_y have been produced for each season for the b ndary layer and 3 km ranges of the free troposphere. The statistics of the data (median, m an and standard deviation, central 67% and 90%) have also been determined, and are shown in representativ figures included here. Figure 1 shows the statistics for the Boundary Laye (which include ground sites and aircraft measurements below 0.5 km) for midday NO, NO$_z$ and NO_y, with a map showing the location of the data. Similarly, Figure 2 shows the dis ibutions for the 3–6 km layer. Similar analyses have been made for any ozone and CO dat that is available in these data sets.

Since the Year 1 summary report of this project two talks on the archiv have been given. The climatologies that have been compiled from the newly archived data, long with other archived data sets, were presented at the AEAP Annual Meeting in Vir nia Beach, VA, April 23-28, 1995. The abstract for this meeting is attached. We were also i vited to present these results at the Combined IGAC Meeting: GIM/GEIA/GLOCHEM, in Fairfax, VA, Dec 6-8, 1995. A copy of the viewgraphs shown there are also attached. The *Eos* news article that was written, announcing the availability of the archive, is expected to be published by the end of Dec. 1995. The final version is included here.

In completion of this project we are preparing a manuscript for publicat on in the special issue on AERONOX in *Atmospheric Environment* presenting these clim tologies of NO, NO_x and NO_y. Comparison will be made to results from several chemic tracer models, including GFDL (H. Levy), Lawrence Livermore (C. Atherton), NCAR (G. Brasseur and D. Hauglustaine), KFA Jülich (F. Rohrer) and KNMI (P. van Velthoven and H. Viel Wauben).


BL
JJA
3AA
3AW
BAR
3AT
3AL
3BH
3BL
3BC
SBL
NRG
B
C2O
SNP
C3W
A2A
TOR
SON
BAR
TOR
OKI
SNP
C3N
DJF
BAR
TOR
SNP
MAM
BAR
TOR
SNP
SAG
A2B

Midday NO BL
SON
MAM
JJA
DJF
NO (pptv)
Midday NO (pptv)
10000
1000
100
10
1
BAR
HAR
SNP
TOR
OKI
C3N
A2T
SAG
3AT
3BT
C2O
C3W
3AL
3AW
3AA
3BO
3BH
3BL
59
301
555
271
140
31
328
386
234
36
2994
240
854
77
243
404
35
103
131
252
47
177
94
71
6
16
47
18

NOx BL
SON
MAM
DJF
JJA
NOx (pptv)
10000
1000
100
10
HAR
TOR
C3N
1671
1189
38
1776
1119
1265
309
1343
183
3602
475
824
0
1105
1080
30
192
80
40
2
13
124
45

NOy BL
SON
MAM
JJA
DJF
NOy (pptv)
10000
1000
100
BAR
HAR
SNP
TOR
OKI
C3N
429
2105
2248
1126
290
251
205
1850
1569
976
627
1729
1640
252
4195
438
1067
1037
1019
90
244
144
107
7
16
124
45
SBL
3BH
3BO
3AA
3AW
3AL
C3W
C2O
TOR
SCO
3BT
3AT
SBL
SOS
SNP
HAR
BAR
1142
1432
1132

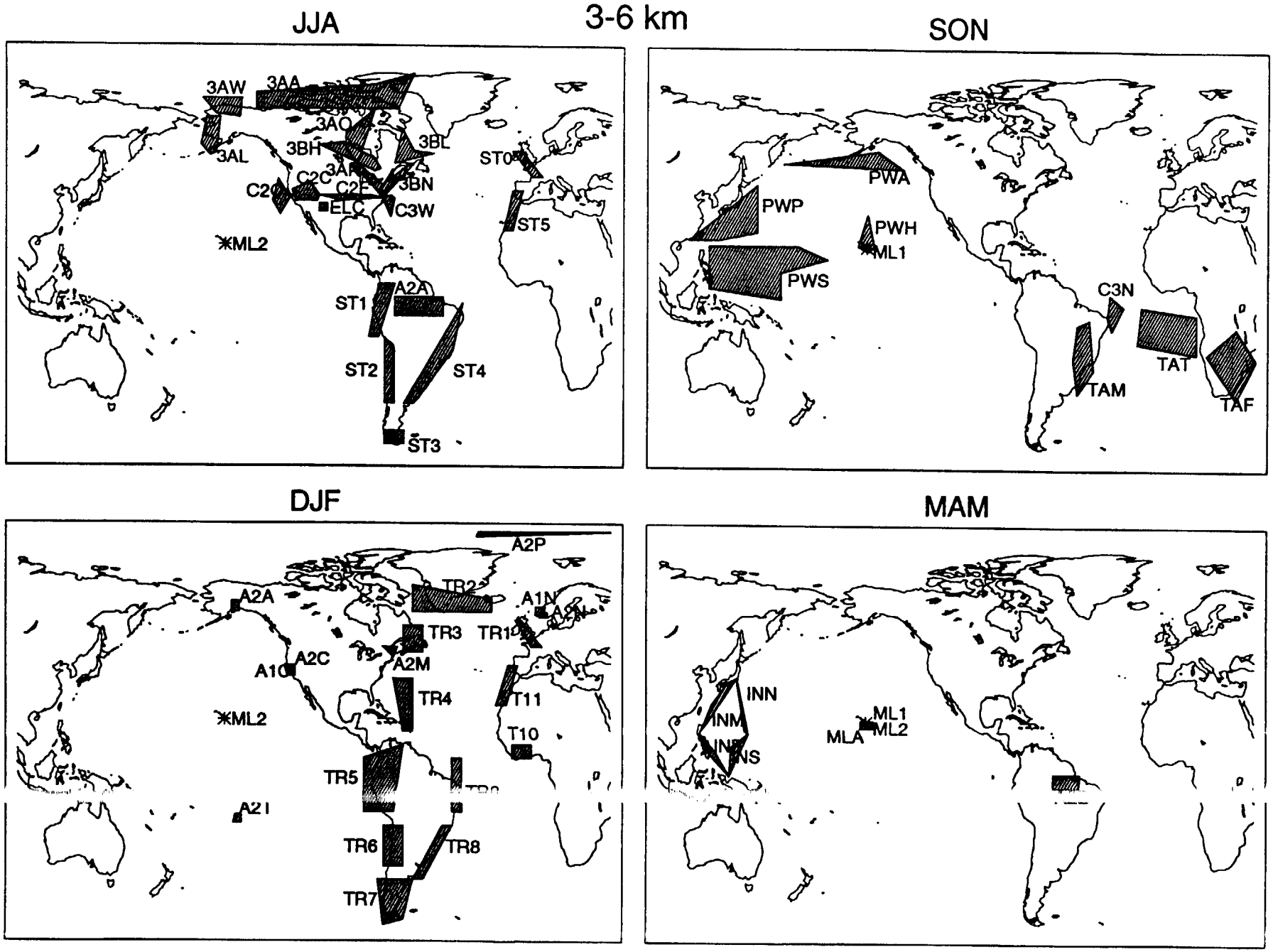
Legend for Boundary Layer data.

	Summer
BAR	Barrow, AK, Apr 10-May 30, 1990
HAR	Harvard Forest, MA, Mar 1-May 31, 1990-1993
SNP	Shenandoah NP, VA, Mar 1-May 31, 1989
SOS	SOS/SONIA, Aug 7-17, 1991
SBL	NARE-Sable Island, Aug-Sep, 1993
3AT	ABLE 3A - Bethel, AK, Jul 10-Aug 12, 1988
3BT	ABLE 3B - Schefferville, Quebec, Jun 27-Aug 16, 1990
TOR	TOR-Schauinsland, Germany, Jun-Aug, 1989-1993
NRG	Niwot Ridge, CO, 1984
BND	Bondville, IL, 1988
Egb	Egbert, Ontario, 1988
SCO	Scotia, PA, 1986
KNT	Kinterbush, AL, 1990
C2O	CITE-2, Ocean flights
C3W	CITE-3, Wallops flights, Aug 22-Sep 1, 1989
3AL	ABLE 3A, Bethel flights
3AW	ABLE 3A, Barrow flights
3AA	ABLE 3A, Arctic flights
3BO	ABLE 3B, Wallops-Ontario flights
3BH	ABLE 3B, Hudson Bay flights
3BL	ABLE 3B, Labrador flights
A2A	ABLE-2A, Jul 11-Aug 13, 1985

	Fall
BAR	Barrow, AK, Apr 10-May 30, 1990
HAR	Harvard Forest, MA, Mar 1-May 31, 1990-1993
SNP	Shenandoah NP, VA, Mar 1-May 31, 1989
TOR	TOR-Schauinsland, Germany, Mar-May, 1989-1993
OKI	PEMWEST-A, Oki Island, Sep 10-Oct 24, 1991
C3N	CITE-3, Natal, Sep. 12-28, 1989,

	Winter
BAR	Barrow, AK, Apr 10-May 30, 1990
HAR	Harvard Forest, MA, Mar 1-May 31, 1990-1993, NW flow
SNP	Shenandoah NP, VA, Mar 1-May 31, 1989
TOR	TOR-Schauinsland, Germany, Mar-May, 1989-1993

	Spring
BAR	Barrow, AK, Apr 10-May 30, 1990
HAR	Harvard Forest, MA, Mar 1-May 31, 1990-1993
SNP	Shenandoah NP, VA, Mar 1-May 31, 1989
TOR	TOR-Schauinsland, Germany, Mar-May, 1989-1993
A2T	ABLE 2B Tower, Apr 22-May 7, 1987
SAG	SAGA 3, Feb 14-Mar 10, 1990
A2B	ABLE-2B, Apr 1-May 13, 1987


3-6 km
JJA
3AW
3AA
3AO
3AL
3BH
3AR
3BL
3BN
C2C
C2E
C2C
ELC
C3W
ST0
ST5
ML2
A2A
ST1
ST2
ST4
ST3
SON
PWA
PWP
PWH
ML1
PWS
C3N
TAT
TAM
TAF
DJF
A2P
TR2
A2A
A1N
TR3
TR1
A2C
A1C
A2M
TR4
T11
ML2
T10
TR5
A21
TR6
TR8
TR7
MAM
INN
INM
INS
ML1
ML2
MLA

Midday NO 3-6 km
SON
MAM
JJA
DJF
NO (pptv)
1000
100
10
1
ML2
TAM
TAF
TAT
PWP
PWS
C3N
ML1
INS
INN
A2B
INM
INB
A1N
A2T
A2A
A2N
TR1
TR2
TR3
TR4
TR5
TR6
TR7
TR8
TR9
T10
T11
T1
T2
T3
T4
T5
T6
T7
T8
T9
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
C32
C33
C34
C35
C36
C37
C38
C39
C40
C41
C42
C43
C44
C45
C46
C47
C48
C49
C50
C51
C52
C53
C54
C55
C56
C57
C58
C59
C60
C61
C62
C63
C64
C65
C66
C67
C68
C69
C70
C71
C72
C73
C74
C75
C76
C77
C78
C79
C80
C81
C82
C83
C84
C85
C86
C87
C88
C89
C90
C91
C92
C93
C94
C95
C96
C97
C98
C99
C100
C101
C102
C103
C104
C105
C106
C107
C108
C109
C110
C111
C112
C113
C114
C115
C116
C117
C118
C119
C120
C121
C122
C123
C124
C125
C126
C127
C128
C129
C130
C131
C132
C133
C134
C135
C136
C137
C138
C139
C140
C141
C142
C143
C144
C145
C146
C147
C148
C149
C150
C151
C152
C153
C154
C155
C156
C157
C158
C159
C160
C161
C162
C163
C164
C165
C166
C167
C168
C169
C170
C171
C172
C173
C174
C175
C176
C177
C178
C179
C180
C181
C182
C183
C184
C185
C186
C187
C188
C189
C190
C191
C192
C193
C194
C195
C196
C197
C198
C199
C200
C201
C202
C203
C204
C205
C206
C207
C208
C209
C210
C211
C212
C213
C214
C215
C216
C217
C218
C219
C220
C221
C222
C223
C224
C225
C226
C227
C228
C229
C230
C231
C232
C233
C234
C235
C236
C237
C238
C239
C240
C241
C242
C243
C244
C245
C246
C247
C248
C249
C250
C251
C252
C253
C254
C255
C256
C257
C258
C259
C260
C261
C262
C263
C264
C265
C266
C267
C268
C269
C270
C271
C272
C273
C274
C275
C276
C277
C278
C279
C280
C281
C282
C283
C284
C285
C286
C287
C288
C289
C290
C291
C292
C293
C294
C295
C296
C297
C298
C299
C300
C301
C302
C303
C304
C305
C306
C307
C308
C309
C310
C311
C312
C313
C314
C315
C316
C317
C318
C319
C320
C321
C322
C323
C324
C325
C326
C327
C328
C329
C330
C331
C332
C333
C334
C335
C336
C337
C338
C339
C340
C341
C342
C343
C344
C345
C346
C347
C348
C349
C350
C351
C352
C353
C354
C355
C356
C357
C358
C359
C360
C361
C362
C363
C364
C365
C366
C367
C368
C369
C370
C371
C372
C373
C374
C375
C376
C377
C378
C379
C380
C381
C382
C383
C384
C385
C386
C387
C388
C389
C390
C391
C392
C393
C394
C395
C396
C397
C398
C399
C400
C401
C402
C403
C404
C405
C406
C407
C408
C409
C410
C411
C412
C413
C414
C415
C416
C417
C418
C419
C420
C421
C422
C423
C424
C425
C426
C427
C428
C429
C430
C431
C432
C433
C434
C435
C436
C437
C438
C439
C440
C441
C442
C443
C444
C445
C446
C447
C448
C449
C450
C451
C452
C453
C454
C455
C456
C457
C458
C459
C460
C461
C462
C463
C464
C465
C466
C467
C468
C469
C470
C471
C472
C473
C474
C475
C476
C477
C478
C479
C480
C481
C482
C483
C484
C485
C486
C487
C488
C489
C490
C491
C492
C493
C494
C495
C496
C497
C498
C499
C500
C501
C502
C503
C504
C505
C506
C507
C508
C509
C510
C511
C512
C513
C514
C515
C516
C517
C518
C519
C520
C521
C522
C523
C524
C525
C526
C527
C528
C529
C530
C531
C532
C533
C534
C535
C536
C537
C538
C539
C540
C541
C542
C543
C544
C545
C546
C547
C548
C549
C550
C551
C552
C553
C554
C555
C556
C557
C558
C559
C560
C561
C562
C563
C564
C565
C566
C567
C568
C569
C570
C571
C572
C573
C574
C575
C576
C577
C578
C579
C580
C581
C582
C583
C584
C585
C586
C587
C588
C589
C590
C591
C592
C593
C594
C595
C596
C597
C598
C599
C600
C601
C602
C603
C604
C605
C606
C607
C608
C609
C610
C611
C612
C613
C614
C615
C616
C617
C618
C619
C620
C621
C622
C623
C624
C625
C626
C627
C628
C629
C630
C631
C632
C633
C634
C635
C636
C637
C638
C639
C640
C641
C642
C643
C644
C645
C646
C647
C648
C649
C650
C651
C652
C653
C654
C655
C656
C657
C658
C659
C660
C661
C662
C663
C664
C665
C666
C667
C668
C669
C670
C671
C672
C673
C674
C675
C676
C677
C678
C679
C680
C681
C682
C683
C684
C685
C686
C687
C688
C689
C690
C691
C692
C693
C694
C695
C696
C697
C698
C699
C700
C701
C702
C703
C704
C705
C706
C707
C708
C709
C710
C711
C712
C713
C714
C715
C716
C717
C718
C719
C720
C721
C722
C723
C724
C725
C726
C727
C728
C729
C730
C731
C732
C733
C734
C735
C736
C737
C738
C739
C740
C741
C742
C743
C744
C745
C746
C747
C748
C749
C750
C751
C752
C753
C754
C755
C756
C757
C758
C759
C760
C761
C762
C763
C764
C765
C766
C767
C768
C769
C770
C771
C772
C773
C774
C775
C776
C777
C778
C779
C780
C781
C782
C783
C784
C785
C786
C787
C788
C789
C790
C791
C792
C793
C794
C795
C796
C797
C798
C799
C800
C801
C802
C803
C804
C805
C806
C807
C808
C809
C810
C811
C812
C813
C814
C815
C816
C817
C818
C819
C820
C821
C822
C823
C824
C825
C826
C827
C828
C829
C830
C831
C832
C833
C834
C835
C836
C837
C838
C839
C840
C841
C842
C843
C844
C845
C846
C847
C848
C849
C850
C851
C852
C853
C854
C855
C856
C857
C858
C859
C860
C861
C862
C863
C864
C865
C866
C867
C868
C869
C870
C871
C872
C873
C874
C875
C876
C877
C878
C879
C880
C881
C882
C883
C884
C885
C886
C887
C888
C889
C890
C891
C892
C893
C894
C895
C896
C897
C898
C899
C900
C901
C902
C903
C904
C905
C906
C907
C908
C909
C910
C911
C912
C913
C914
C915
C916
C917
C918
C919
C920
C921
C922
C923
C924
C925
C926
C927
C928
C929
C930
C931
C932
C933
C934
C935
C936
C937
C938
C939
C940
C941
C942
C943
C944
C945
C946
C947
C948
C949
C950
C951
C952
C953
C954
C955
C956
C957
C958
C959
C960
C961
C962
C963
C964
C965
C966
C967
C968
C969
C970
C971
C972
C973
C974
C975
C976
C977
C978
C979
C980
C981
C982
C983
C984
C985
C986
C987
C988
C989
C990
C991
C992
C993
C994
C995
C996
C997
C998
C999
C1000

NOx 3-6 km
SON
MAM
JJA
DJF
NOx (pptv)
1000
100
10
69
64
68
161
58
62
76
8034
C3N
PWH
PWS
PWP
TAT
TAF
TAM
ML2
101136
124136
ML2
ML1
3476
76
216
269
232
350
248
84
48
14
82
139
59
5077
124136
ELC
C3W
C2O
C2C
C2F
3BL
3BH
3BN
3AN
3AO
3AA
3AL
3AW
ML2
ML1
13
6
33
6
13
7
156
17
11767
A2P
A2N
A2M
A2A
A2C
A2T
A1N
A1C
ML2

NOy 3-6 km
SON
MAM
JJA
DJF
NOy (pptv)
10000
1000
100
C3N
PWH
PWS
PWP
TAT
TAF
TAM
MLA
MLZ
MLI
ELC
C3W
C2O
C2C
C2F
3BL
3BH
3BN
3AN
3AO
3AA
3AL
3AW
MLZ
MLA
MLI
MLC
A1N
A2T
A2C
A2A
A2W
A2N
A2A
TR1
TR2
TR3
TR4
TR5
TR6
TR7
TR8
TR9
T10
T11
107
156
50
166
60
62
77
5002
30000
7062
10430
22
95
54
41
61
53
58
32
19
20
21
14
27
58
30
33
8
195
16
8092
105
88
429
419
186
352
261
84
111
47
160
243
211
4324

Legend for 3–6 km data.

	Summer
ML2	MLOPEX 2, Jul 15-Aug 15, 1992
3AW	ABLE 3A, Barrow flights, Jul 10-Jul 24, 1988
3AL	ABLE 3A, Bethel flights, Jul 24-Aug 11, 1988
3AA	ABLE 3A, Canadian Arctic flights, Jul 7-Aug 17, 1988
3AO	ABLE 3A, Ontario flights, Jul 7-Aug 17, 1988
3AN	ABLE 3A, Northeast US flights, Jul 7-Aug 17, 1988
3BN	ABLE 3B, New England flights, Jul 6-Aug 15, 1990
3BH	ABLE 3B, Hudson Bay flights, Jul 6-Jul 30, 1990
3BL	ABLE 3B, Labrador flights, Jul 30-Aug 14, 1990
C2F	CITE-2, Ferry flights: VA-CO (NOx by Carroll)
C2C	CITE-2, CA flights
C2O	CITE-2, Ocean flights
C3W	CITE-3, Wallops flights, Aug 22-Sep 1, 1989
ELC	ELCHEM, Jul 27-Aug 22, 1989
A2A	ABLE-2A, Jul 11-Aug 13, 1985
ST0	STRATOZ 3, Europe 40-60N
ST1	STRATOZ 3, S.America 15N-15S
ST2	STRATOZ 3, W. S.America 15S-40S
ST3	STRATOZ 3, S.America ¡40S
ST4	STRATOZ 3, E. S.America 40S-Eq
ST5	STRATOZ 3, E.Atlantic 20-40N
	Fall
ML1	MLOPEX-2, Sep 15-Oct 23, 1991
TAM	TRACE-A, E. South America, Sep 24-Oct 3, 1992
TAF	TRACE-A, S.Africa, Oct 3-Oct 11, 1992
TAT	TRACE-A, Trop. S.Atlantic, Oct 11-Oct 24, 1992
PWA	PEMWEST-A, Alaska, Sep 16-17, 1991 (GIT)
PWP	PEMWEST-A, W. Pacific, Sep 17-Oct 6, 1991
PWS	PEMWEST-A, SW Pacific, Oct 6-18, 1991
PWH	PEMWEST-A, Hawaii, Oct 20-21, 1991
C3N	CITE-3, Natal, Sep 12-28, 1989

	Winter
ML2	MLOPEX-2, Jan 15-Feb 15, 1992
A1C	AASE 1, Western US
A1N	AASE 1, Norway
A2T	AASE 2, Tahiti
A2C	AASE 2, West. US
A2A	AASE 2, Alaska
A2M	AASE 2, Maine
A2N	AASE 2, Norway
A2P	AASE 2, Arctic
TR1	TROPOZ 2, Europe 40-60N, Jan 9-Feb 1, 1991
TR2	TROPOZ 2, Greenland 60-70N
TR3	TROPOZ 2, E.Canada 40-60N
TR4	TROPOZ 2, W.Atlantic 15-40N
TR5	TROPOZ 2, S.America 15N-15S
TR6	TROPOZ 2, W. S.America 15S-40S
TR7	TROPOZ 2, S.America ¡40S
TR8	TROPOZ 2, E. S.America 40S-15S
TR9	TROPOZ 2, NE S.America 15S-5N
T10	TROPOZ 2, W. Africa 0-20N
T11	TROPOZ 2, E. Atlantic 20-40N
	Spring
ML1	MLOPEX 1, May 1-June 4, 1988
ML2	MLOPEX-2, Apr 15-May 15, 1992
MLA	MLOPEX-2, Apr 22-May 11, 1992)
INN	INSTAC-1, Narita-Saipan, Mar 7, 1989
INS	INSTAC-1, Saipan-Biak, Mar 8, 1989
INB	INSTAC-1, Biak-Manila, Mar 9, 1989
INM	INSTAC-1, Manila-Narita, Mar 5-10, 1989
A2B	ABLE-2B, Apr 1-May 13, 1987

Access NO_x and NO_y Measurements Onli e

Submitted to *Eos*, December 20, 1995

An archive of previously published, but not publicly archived, *in situ* measurements of NO, NO_2 and NO_y (total reactive nitrogen) in the atmosph re is now accessible by anonymous ftp at the University of Michigan. Measurem nts from the non-urban surface, boundary layer, free troposphere and lower strato here, for all seasons over the past ten years have been included in the archive. A y coincident measurements, of other species or parameters such as temperature or wi ds, have also been included. These datasets and the climatologies compiled from the will be used in conjunction with model results to assess our level of understanding o tropospheric photochemistry.

A summary of the archived data sets is given in Table 1. To acces the archive, ftp to `sassarch.sprl.umich.edu` and access the directory `/pub/ARC IVE`. Please retrieve the text files in this directory for protocol and file format info nation. Additional information may be obtained by contacting Louisa Emmons v . Internet at `lkemmons@umich.edu`.

The data are presently in a standard ascii file format and reside on a UNIX workstation. The archive will eventually be accessible from the Langley Distri uted Active Archive Center (DAAC). The data protocol is similar to those of other rchives; the data in this archive is not considered proprietary since it has been publ hed. Those using the data, however, are encouraged to contact the principle investi tors for the data prior to use to verify suitability and it is recommended that user extend the

option of co-authorship to the principle investigators for any publicati ıs or presentations that use their data.

The archived data, along with data from some of the Global Tropos heric Experiment (GTE) campaigns, the Airborne Arctic Stratospheric Experiment (AASE 1 & 2), the Stratospheric Ozone (STRATOZ 3), Tropospheric Ozone (TRO OZ 2), and Oxidizing Capacity of the Tropospheric Atmosphere (OCTA) campaig s, were used to construct climatologies of NO, NO_x and NO_y. They were sorted b season and 3 km altitude regions, and the statistics for each campaign were calcu ıted. Figure 1 shows the median values of midday NO for the boundary layer to 3 km, 3-6 km, 6-9 km, and 9-12 km. The stars indicate measurements from ground ites and the shading shows where airborne measurements were taken. The stars on awaii in the 3-6 km map represent measurements at Mauna Loa Observatory (elev ion 3.4 km) during "downslope" flow, when free tropospheric air was sampled. The -12 km data represent tropospheric data that was filtered using coincident O_3 and N_2O or H_2O data.

Information on how to access the GTE archive at NASA Langle is available from James Hoell (gte+archive@larc.nasa.gov) or the Langley DAAC WWW page (http://eosdis.larc.nasa.gov/).

Acknowledgements. We thank those who submitted their data to th archive: R. Honrath, B. Doddridge, R. Dickerson, J. W. Munger, B. Ridley, Y. Kon lo, L. Kleinman, and R. Leaitch. We also thank B. Ridley and J. Walega for providi g the NCAR archives of the MLOPEX campaigns. The ABLE-3A and 3B data were o tained from

the NASA Langley Research Center EOSDIS Distributed Active Archive Center, and other GTE datasets not yet in the DAAC were made available by J. Hoell and D. Owen. This archiving project was funded by NASA's Subsonic Assessment program, an element of the Atmospheric Effects of Aviation Project.

Mary Anne Carroll and Louisa Emmons, Department of Atmospheric Oceanic and Space Science, University of Michigan, Ann Arbor, MI 48109-2143.

Captions

Fig. 1. Median values of midday NO mixing ratios in 3-km altitude ranges. The upper left map includes surface measurements in the boundary layer (indicated by asterisks) as well as airborne measurements between 0.5 and 3 km (shading). For clarity, surface measurements are shown for summer only. The type of shading indicates the 3 months during which the measurements were made.

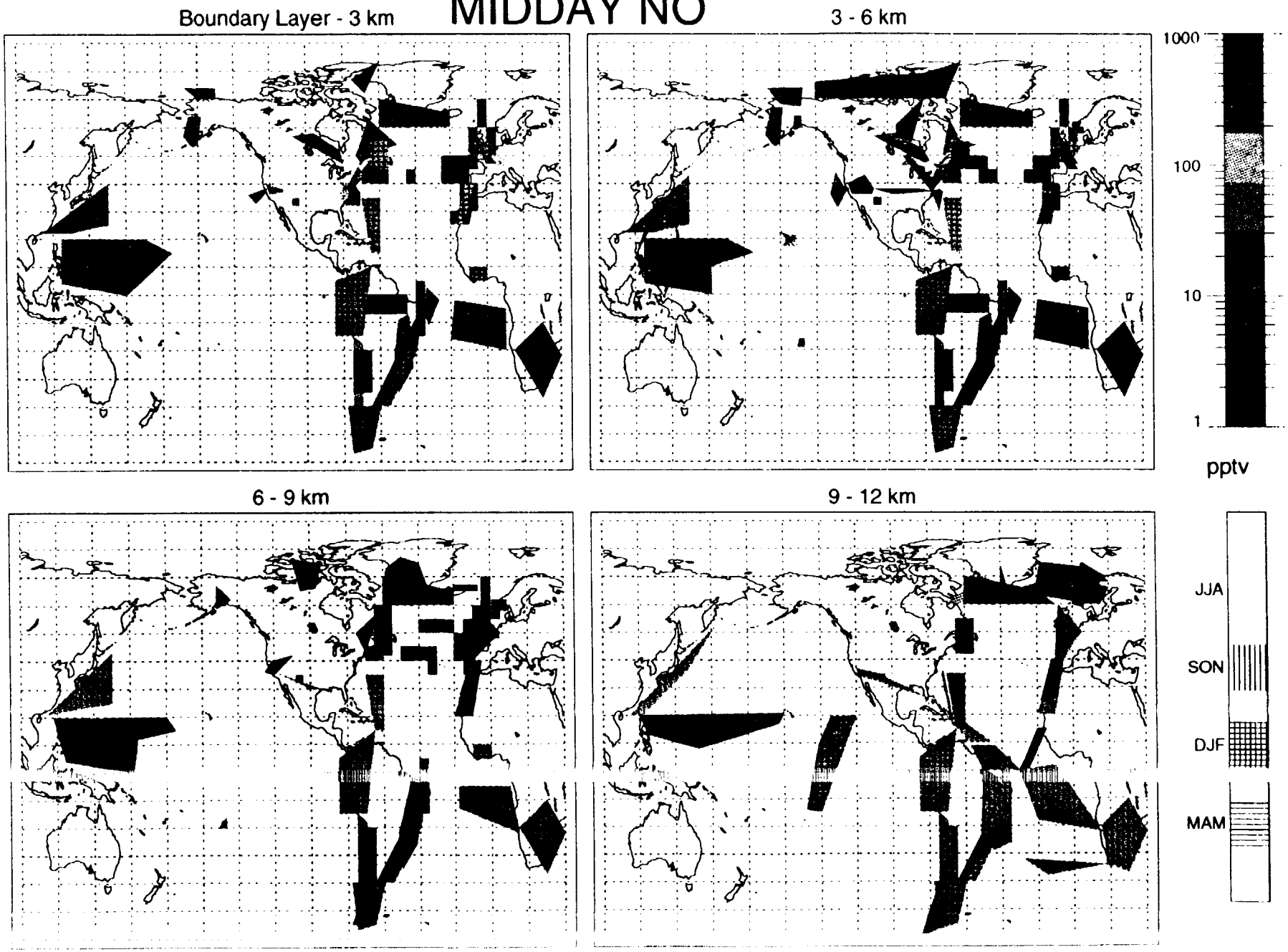
Table 1. Archived data sets, with the location, type (airborne or ground-based) and dates measurements were taken, along with the species sampled.

Table 1: Archived data sets, with the location, type (airborne or grou ıd-based) and dates of measurements, along with the species sampled. Explanation o acronyms are given in the notes, with the name and institution of the Principal Invest gator(s).

Campaign (Location)	Type	Date	Species	Notes
MLOPEX-1 (HI)	gnd	May 1–June 4, 1988	all data	1
MLOPEX-2 (HI)	gnd	Sep 15–Oct 23, 1991 Jan 15–Feb 15, 1992 Apr 15–May 15, 1992 Jul 15–Aug 15, 1992	all data	1
MLOPEX-2 (HI)	air	Apr 22–May 11, 1992	NO_y,O_3	1
ELCHEM (NM)	air	Jul 27–Aug 22, 1989	NO,NO_2,NO ,O_3	2
Barrow, AK	gnd	Mar–Nov, 1990	NO, NO_3	3
Shenandoah NP, VA	gnd	Oct 1988–Oct 1989	NO,NO_y,O_3 CO	4
Harvard Forest, MA	gnd	1990–1993	NO,NO_2,NO_y,(3,CO	5
SOS/SONIA (NC)	gnd	Aug 7-17, 1991	NO,NO_2,NO_y,(3,CO	6
INSTAC-1 (W. Pacific)	air	March 5-10, 1989	NO,O_3	7
NARE (Nova Scotia)	air	Aug 9–Sep 7, 1993	NO_y,O_3	8
NAPS (BC, Ontario)	gnd	1980–1992	NO,NO_2,C	9
North Bay (Ontario)	air	Jul–Aug, 1988, Mar–Apr, 1990	NO_2,O_3	10

1: Mauna Loa Observatory Photochemistry Experiment, Project scientist: B.A. Ridley, E.L. Atlas, National Center for Atmospheric Research.
2: B.A. Ridley, J.E. Dye, National Center for Atmospheric Research.
3: R. Honrath, D. Jaffe, University of Alaska.
4: B. Doddridge, R. Dickerson, University of Maryland.
5: J.W. Munger, Harvard University.
6: Southern Oxidants Study, SONIA site: Candor, NC, B. Doddridge, R. Dickerson, University of Maryland.
7: International Stratospheric Air Chemistry campaign, Y. Kondo, Nagoya University.
8: North Atlantic Regional Experiment, L. Kleinman, Brookhaven National Lab.
9: National Air Pollution Surveillance, J. Shelton, Environment Canada.
10: R. Leaitch, Atmospheric Environment Service.

MIDDAY NO


Boundary Layer - 3 km
3 - 6 km
6 - 9 km
9 - 12 km
1000
100
10
1
pptv
JJA
SON
DJF
MAM

Abstract for the AEAP Annual Meeting
Virginia Beach, VA, April 23-28, 1995

Climatologies from the SASS NO_x, NO_y data archiv :

Louisa K. Emmons and Mary Anne Carroll
University of Michigan, Dept of AOSS, Ann Arbor, MI 481( )

An archive has been compiled of previously published, but no publicly archived, *in situ* measurements of NO, NO_2 and NO_y. The emp nasis has been on obtaining non-urban surface measurements, as well as data i n the free troposphere and lower stratosphere. Any coincident measurement: of other species or parameters such as temperature or winds, have also been included.

From these data, along with data from the GTE and AASE c mpaigns, climatologies of NO_x and NO_y have been constructed by season an altitude. For ground sites, the statistics of the data (median, mean, central 67% and central 90%) have been found for each season. For aircraft measure ents, the data have been grouped in small geographical regions and 3 km alt ude bins for each campaign, and the statistics found for each range. False c lor maps of the median NO_x and NO_y values have been made for each seas n of data from the boundary layer, 0–3 km, 3–6, 6–9 and the troposphere ab ve 9 km. Accompanying plots show the full statistics for each ground site r aircraft measurement region.

The ratio NO_x/NO_y can be used to characterize the history of th sampled air masses with respect to photochemistry and transport. NO_x/NO_y has been computed for coincident measurements within each data set. False c lor maps of the median ratios, along with plots of the full statistics, will be resented. An ozone climatology has also been developed with data from the c ntributed data sets. As well, linear regressions for the correlation of O_3 with CO have been computed and are examined with respect to ambient O_3 variab ity. Continuing studies include computation of net ozone production and t e rate of ozone production per NO_x oxidized.

Climatologies of NO_x, NO_y and O_3

Louisa K. Emmons
and
Mary Anne Carroll

Dept of Atmospheric, Oceanic & Space Sciences
University of Michigan

IGAC Meeting, Fairfax VA
Dec 6-8, 1995

Funded by the
NASA Subsonic Assessment program

The SASS NOx & NOy Archive

- In situ measurements of NO, NO_2, NO_y and any coincident data

- Non-urban ground sites, free troposphere and lower stratosphere

- Data stored in ascii files with common format: NASA Ames Data Exchange Format by Hipskind and Gaines (AASE)

- Accessible by anonymous ftp: sassarch.sprl.umich.edu, /pub/ARCHIVE (lkemmons@umich.edu)

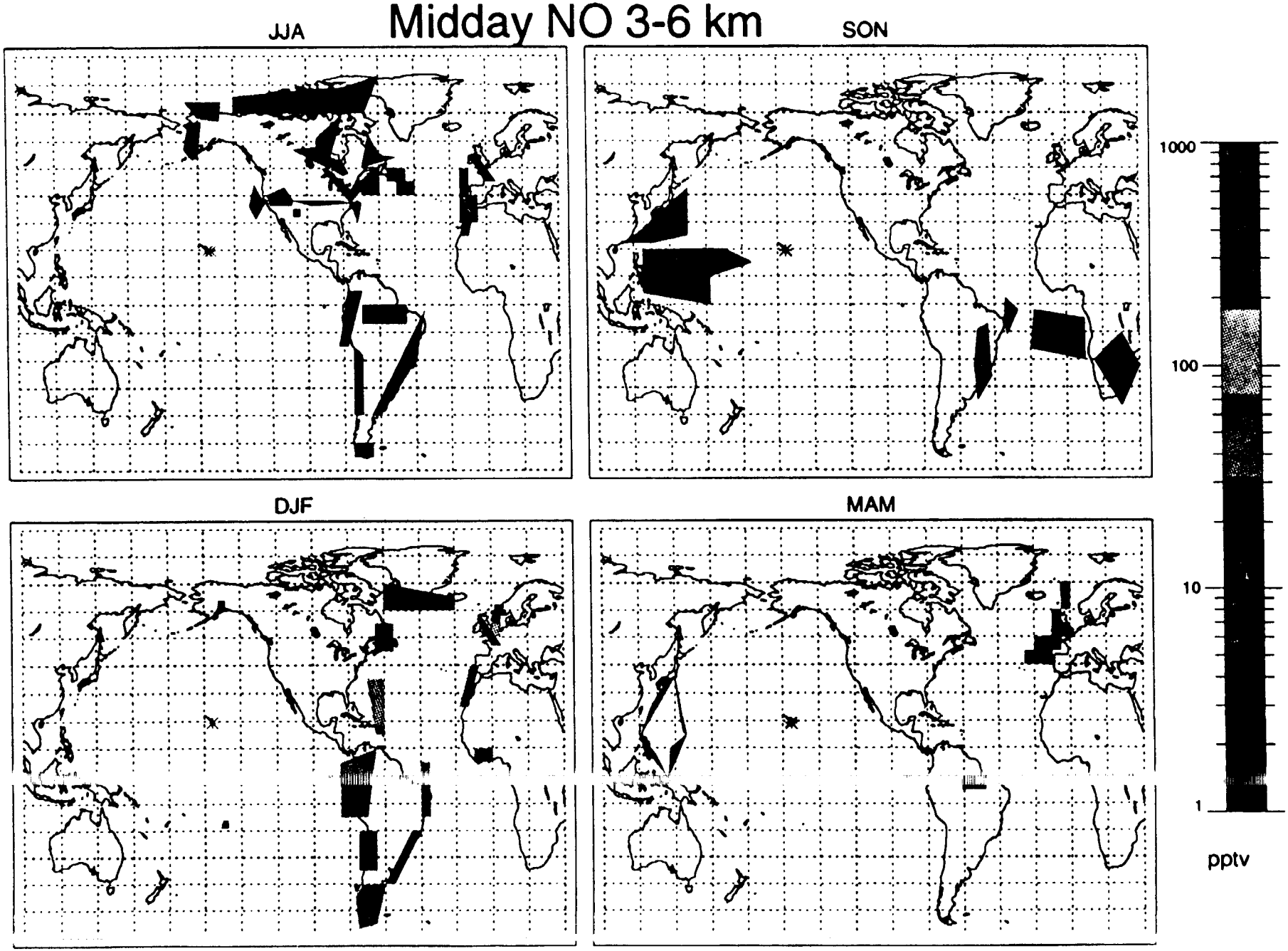
- Other data available:
  - GTE: Langley Distributed Active Archive Center (DAAC) http://eosdis.larc.nasa.gov/
  - AASE, MLOPEX: CD-ROMs

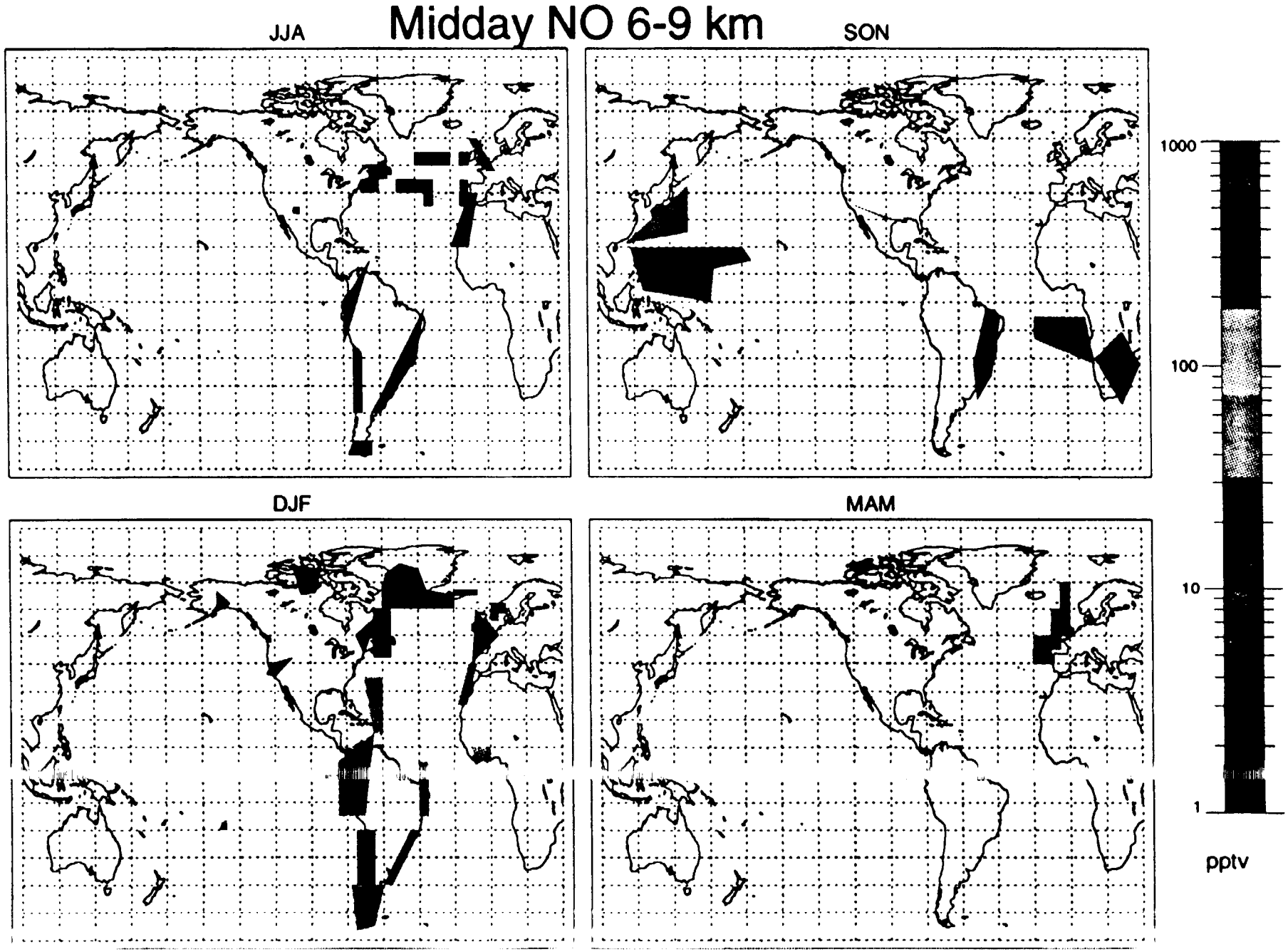
Archived Datasets

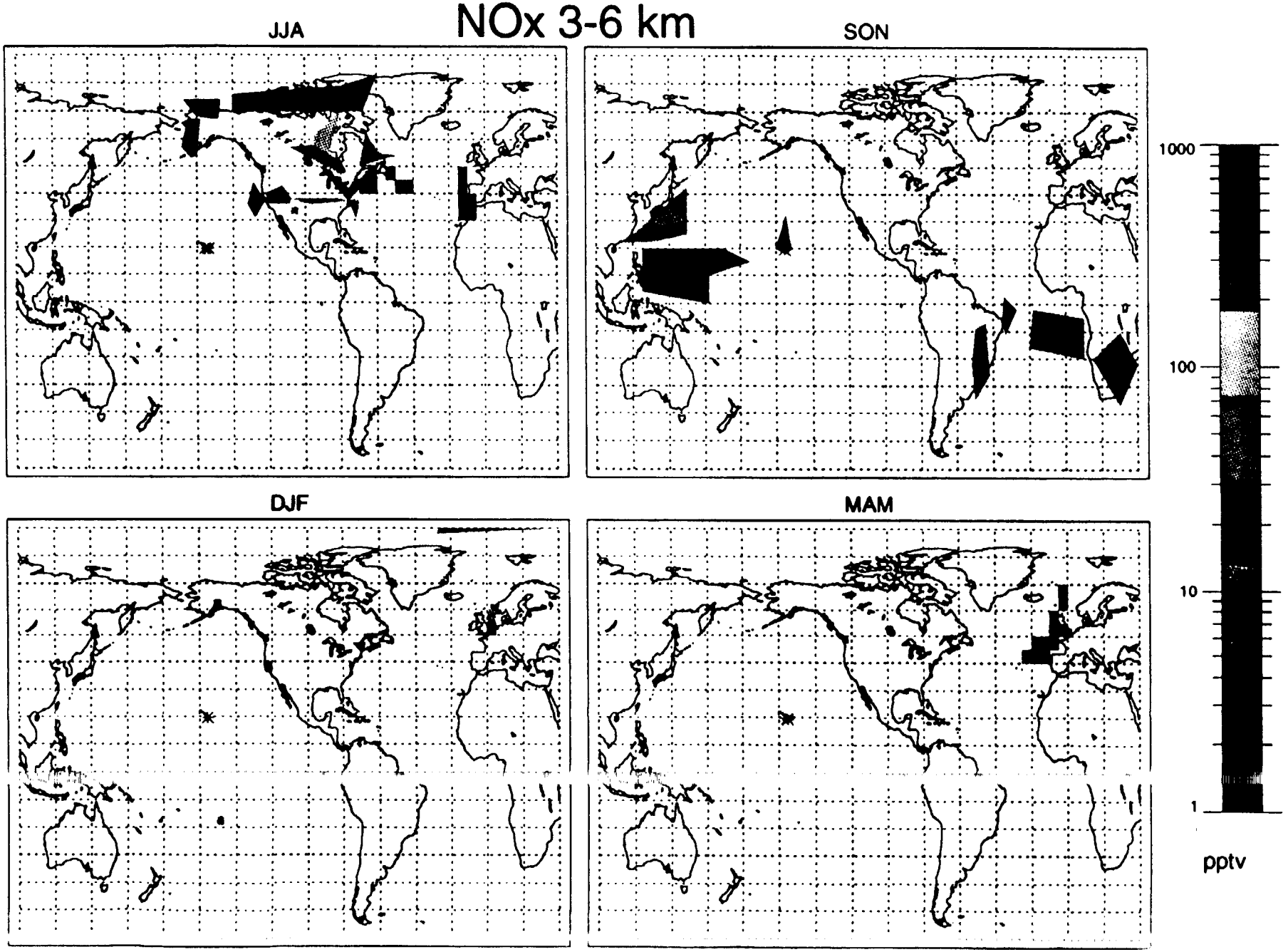
Campaign	Type	Date	Species
MLOPEX-1	gnd	May–Jun 1988	NO,NO_2,NOy,O_3 et al.
MLOPEX-2	gnd	Sep–Oct 1991	NO,NO_2,NOy,O_3 et al.
		Jan–Feb 1992	
		Apr–May 1992	
		Jul–Aug 1992	
MLOPEX-2	air	Apr–May 1992	NOy,O_3 et al.
ELCHEM	air	Aug–Sep 1991	NO,NO_2,NOy,O_3
Barrow, AK	gnd	Mar–Nov 1990	NO, NOy
Shenandoah	gnd	Oct 1988–Oct 1989	NO,NOy,O$_3$,CO
Harvard Forest	gnd	1990–1993	NO,NO_2,NOy,O_3,CO
SOS/SONIA	gnd	Aug 1991	NO,NO_2,NOy,O_3,CO
INSTAC-1	air	March 1989	NO,O_3
NAPS	gnd	1980–1992	NO,NO_2^*,O
North Bay	air	Jul–Aug 1988,	NO_2^*,O_3
		Mar–Apr 1990	

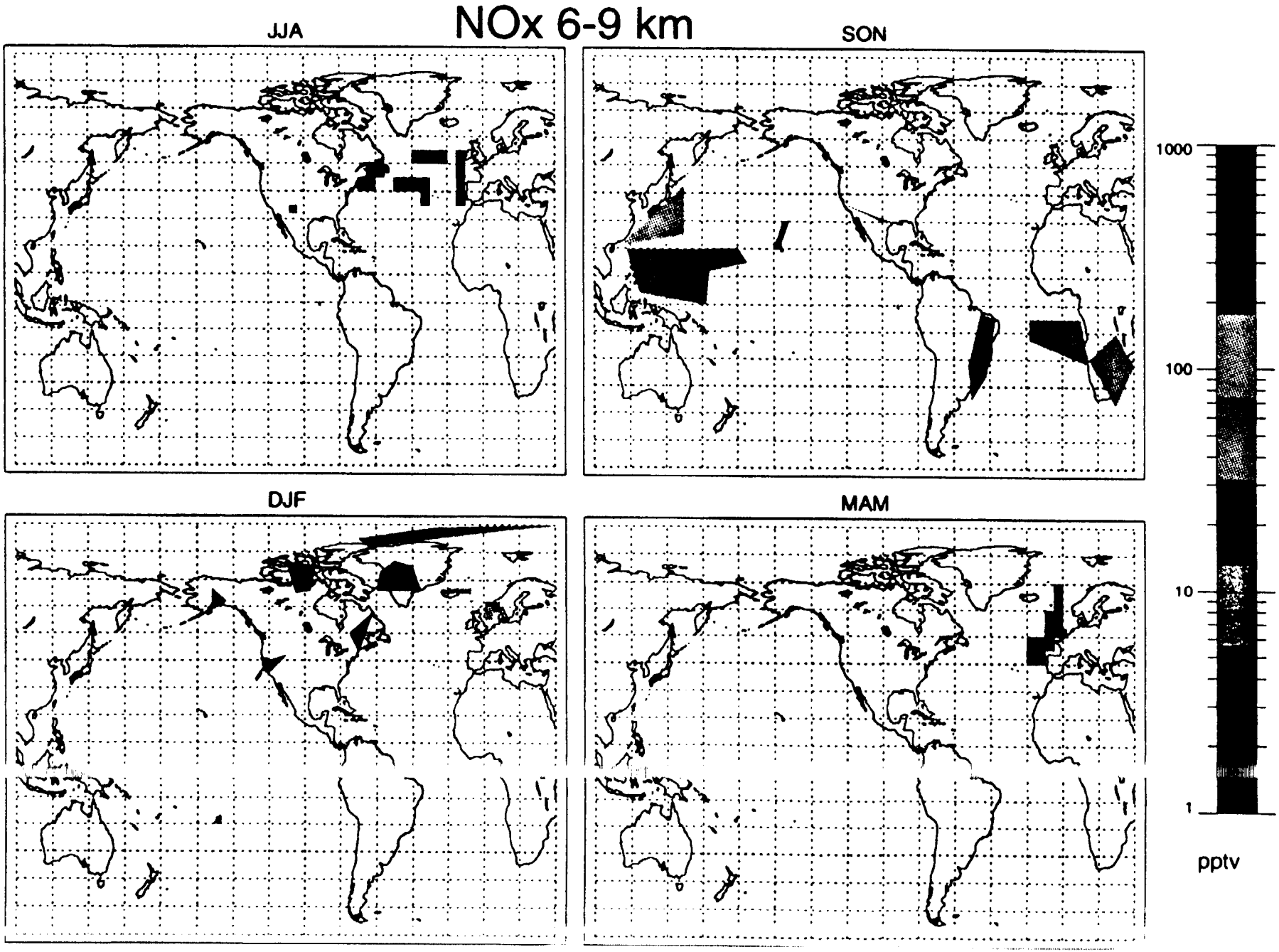
Additional Data used in Climatologies

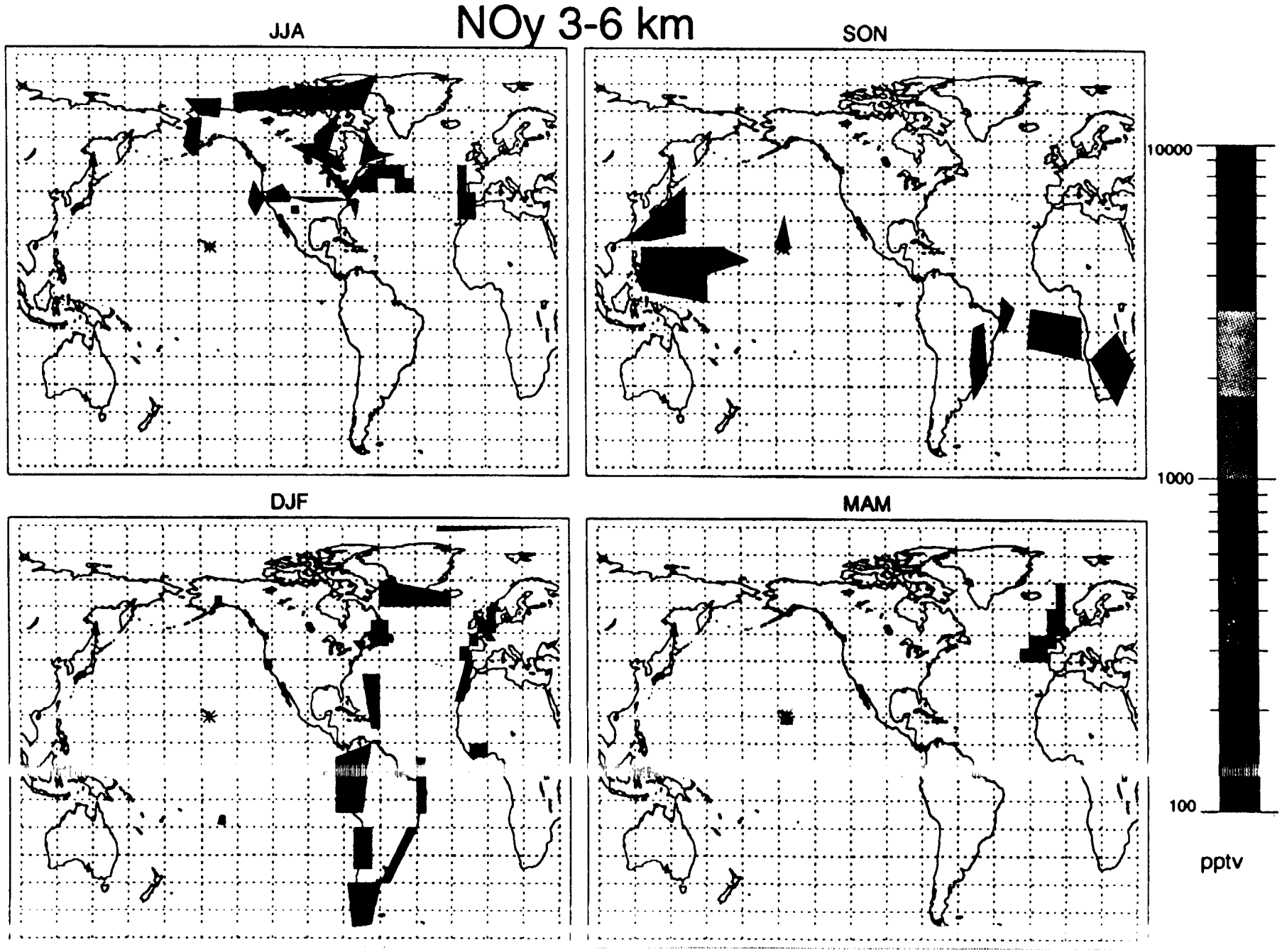
Campaign/Site	Type	Date	Species	
ABLE-2A	air	Jul–Aug 1985	NO, O_3	
ABLE-2B	gnd	Apr–May 1987	NO, NOy, O_3	
ABLE-2B	air	Apr–May 1987	NO, O_3	
CITE-2	air	Aug 1986	NO, NOx, NOy, O_3	
CITE-3	air	Aug–Sep 1989	NO, NOx, NOy, O_3	
ABLE-3A	gnd	Jul–Aug 1988	NO, NOx, NOy, O_3	
ABLE-3A	air	Jul–Aug 1988	NO, NOx, NOy, O_3	
ABLE-3B	gnd	Jul–Aug 1990	NO, NOx, NOy, O_3	
ABLE-3B	air	Jul–Aug 1990	NO, NOx, NOy, O_3	
TRACE-A	air	Sep–Oct 1992	NO, NOx, NOy, O_3	
PEM WEST-A	air	Sep–Oct 1991	NO, NOx, NOy, O_3	
AASE 1	air	Jan–Feb 1989	NO, NOx, NOy, O_3	
AASE 2	air	Jan–Mar 1992	NO, NOx, NOy, O_3	
NARE/Sable I.	gnd	Aug–Sep 1993	NO, NOx, NOy	
OCTA	air	Spr,Sum 1993 Win,Spr 1994	NO, NOx	NOy
STRATOZ III	air	Jun 1984	NO	
TROPOZ II	air	Jan 1991	NO, NOy	
TOR/Schauinsland	gnd	1989-1994	NO, NOx, NOy	
Pt Arena, CA	gnd	Summer	NOx	
Niwot Ridge, CO	gnd	Summer	NOx	
Scotia, PA	gnd	Summer	NOx	
Bondville, IL	gnd	Summer	NOx	
Egbert, Ont.	gnd	Summer	NOx	
ROSE (AL)	gnd	Summer	NOx	

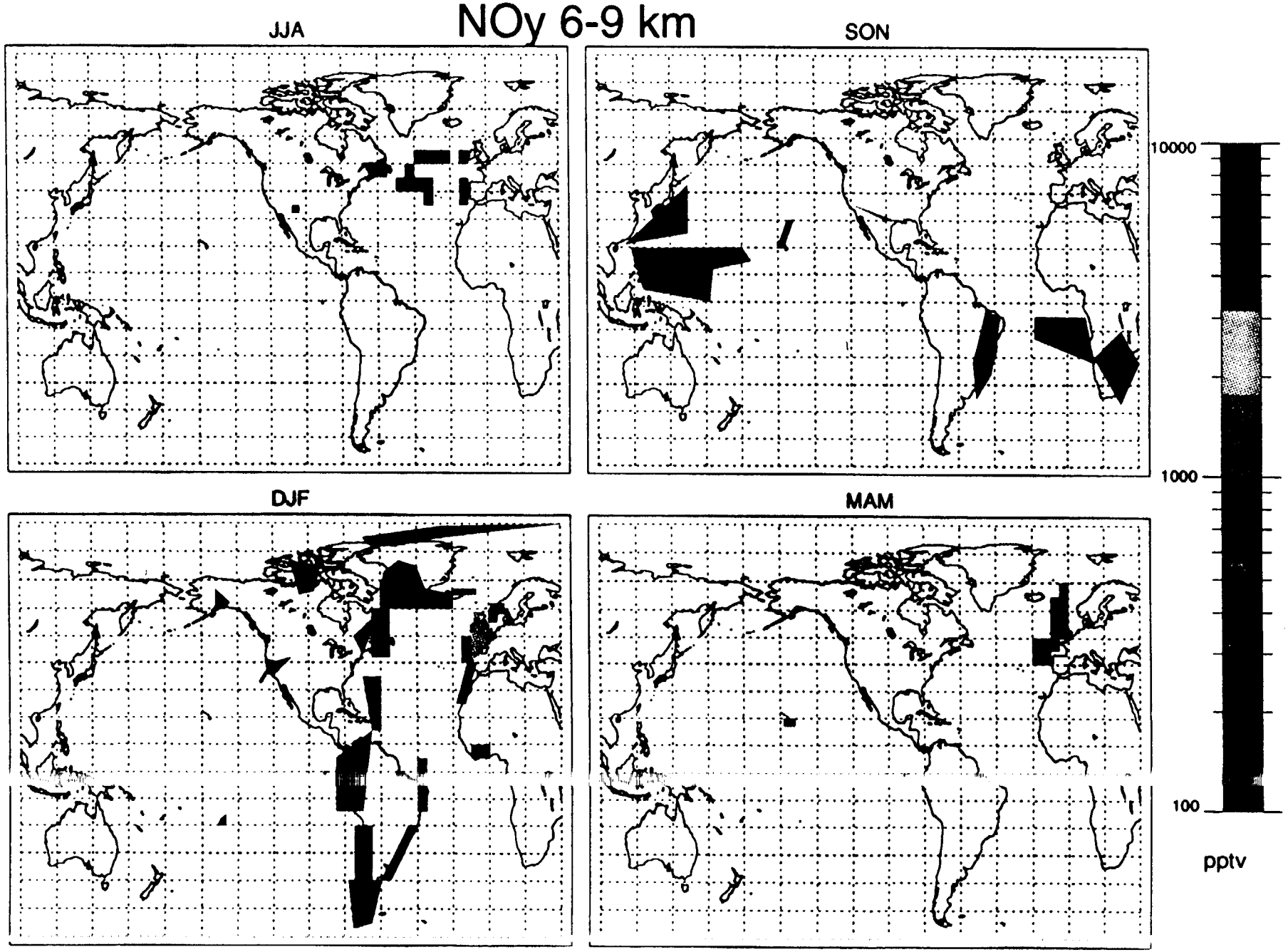

Midday NO 3-6 km
JJA
SON
DJF
MAM
1000
100
10
1
pptv


Midday NO 6-9 km
JJA
SON
DJF
MAM
1000
100
10
1
pptv

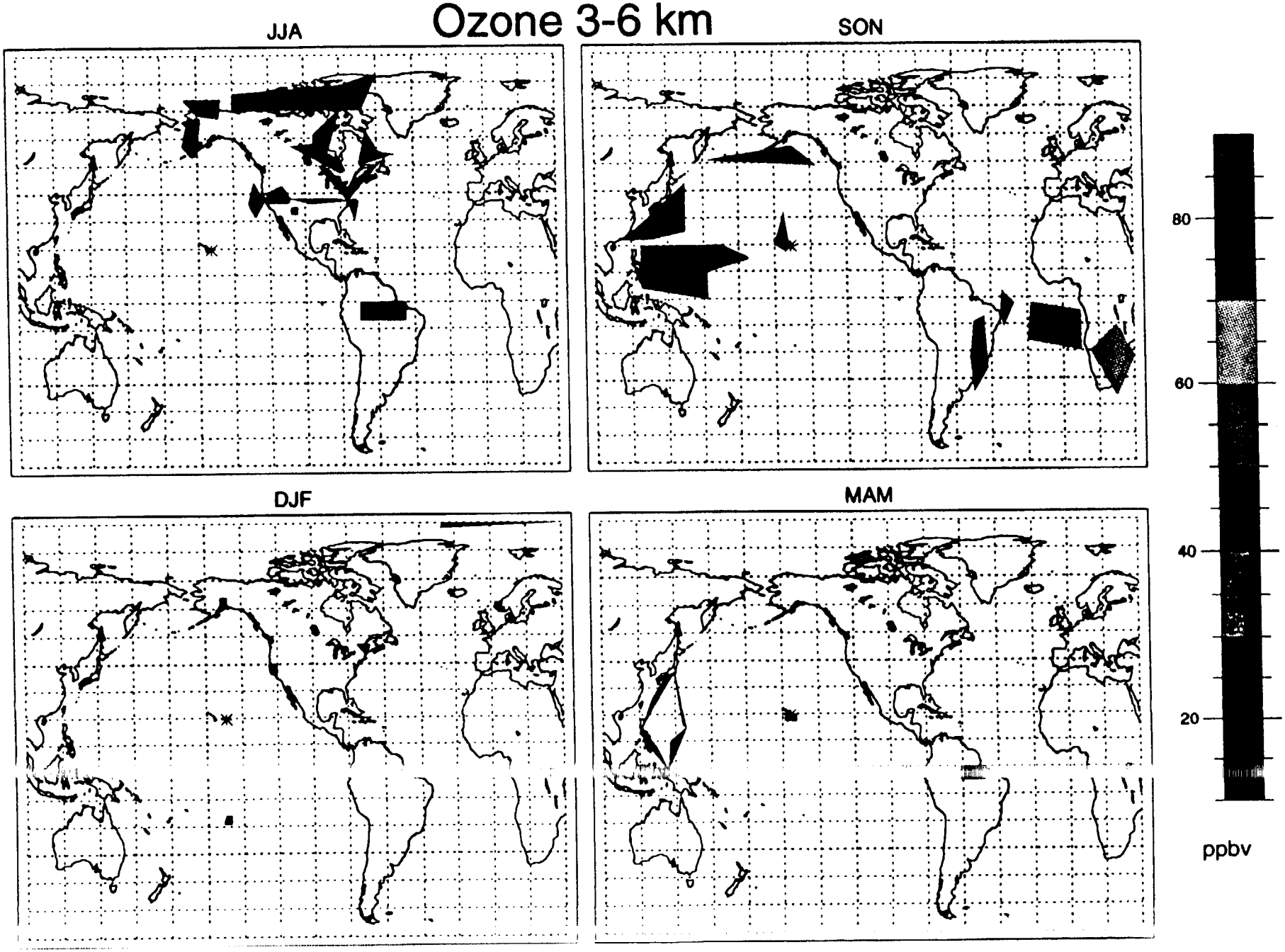

NOx 3-6 km
JJA
SON
DJF
MAM
1000
100
10
1
pptv

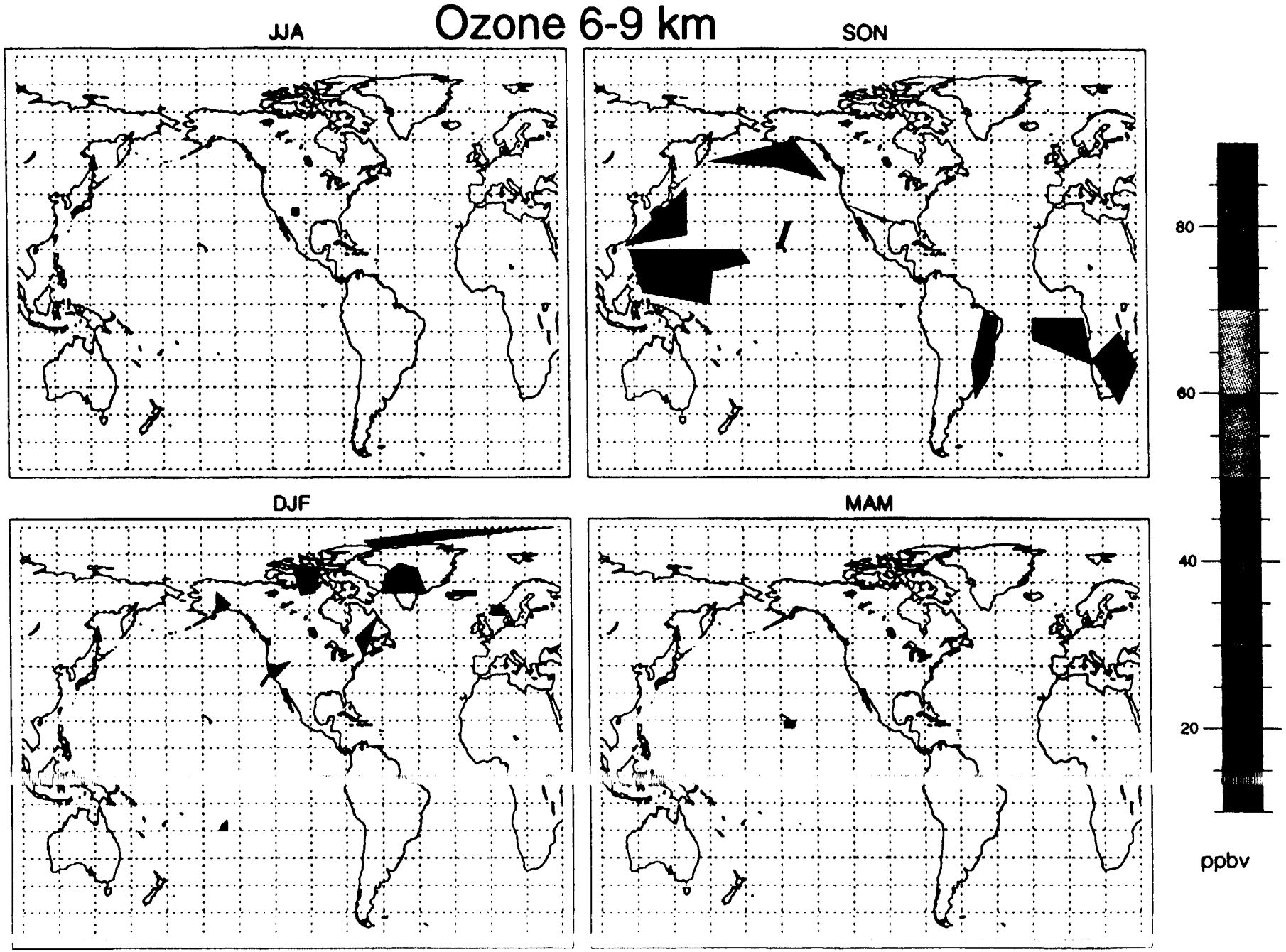

NOx 6-9 km
JJA
SON
DJF
MAM
1000
100
10
1
pptv


NOy 3-6 km
JJA
SON
DJF
MAM
10000
1000
100
pptv

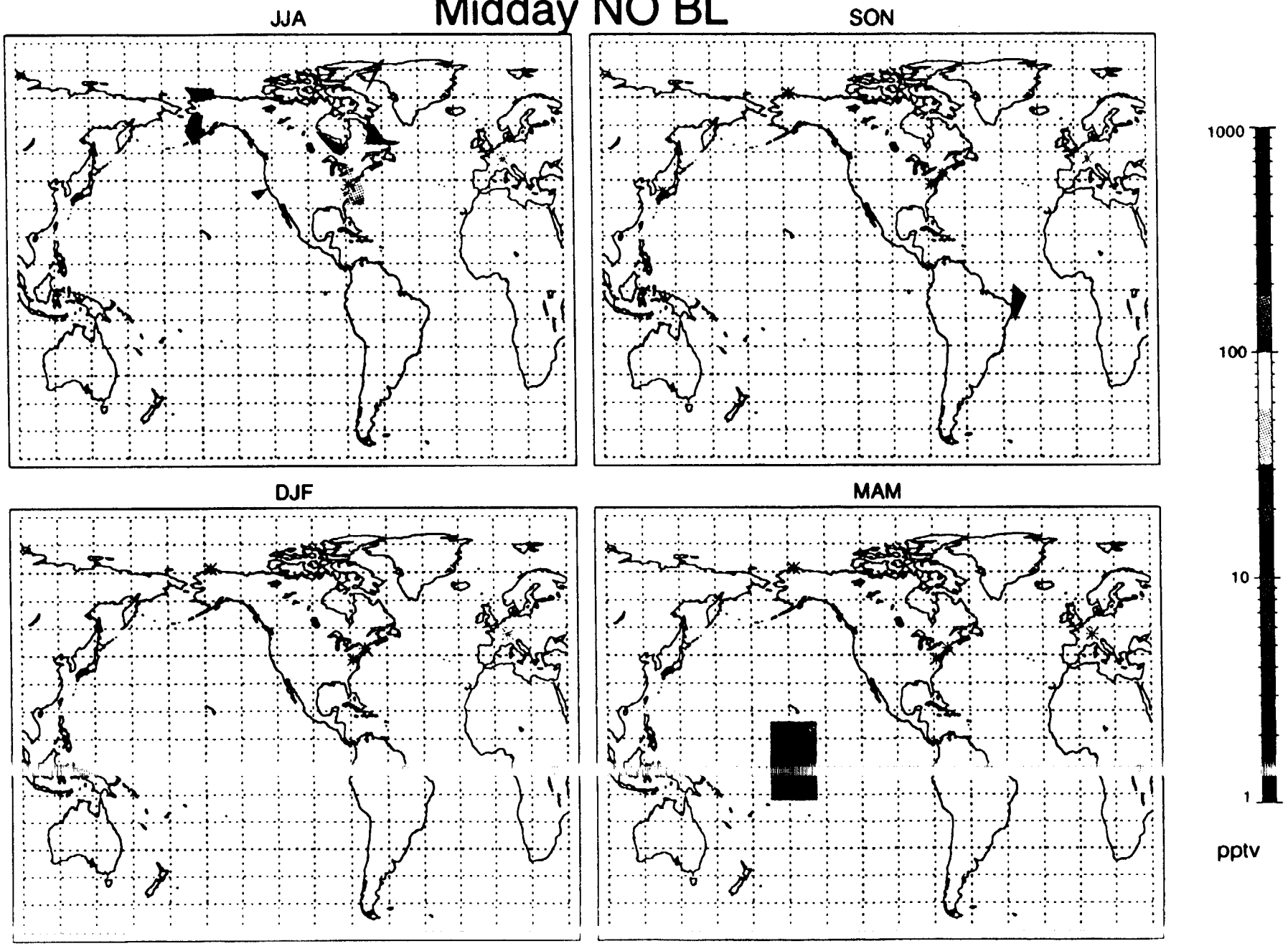

NOy 6-9 km
JJA
SON
DJF
MAM
10000
1000
100
pptv

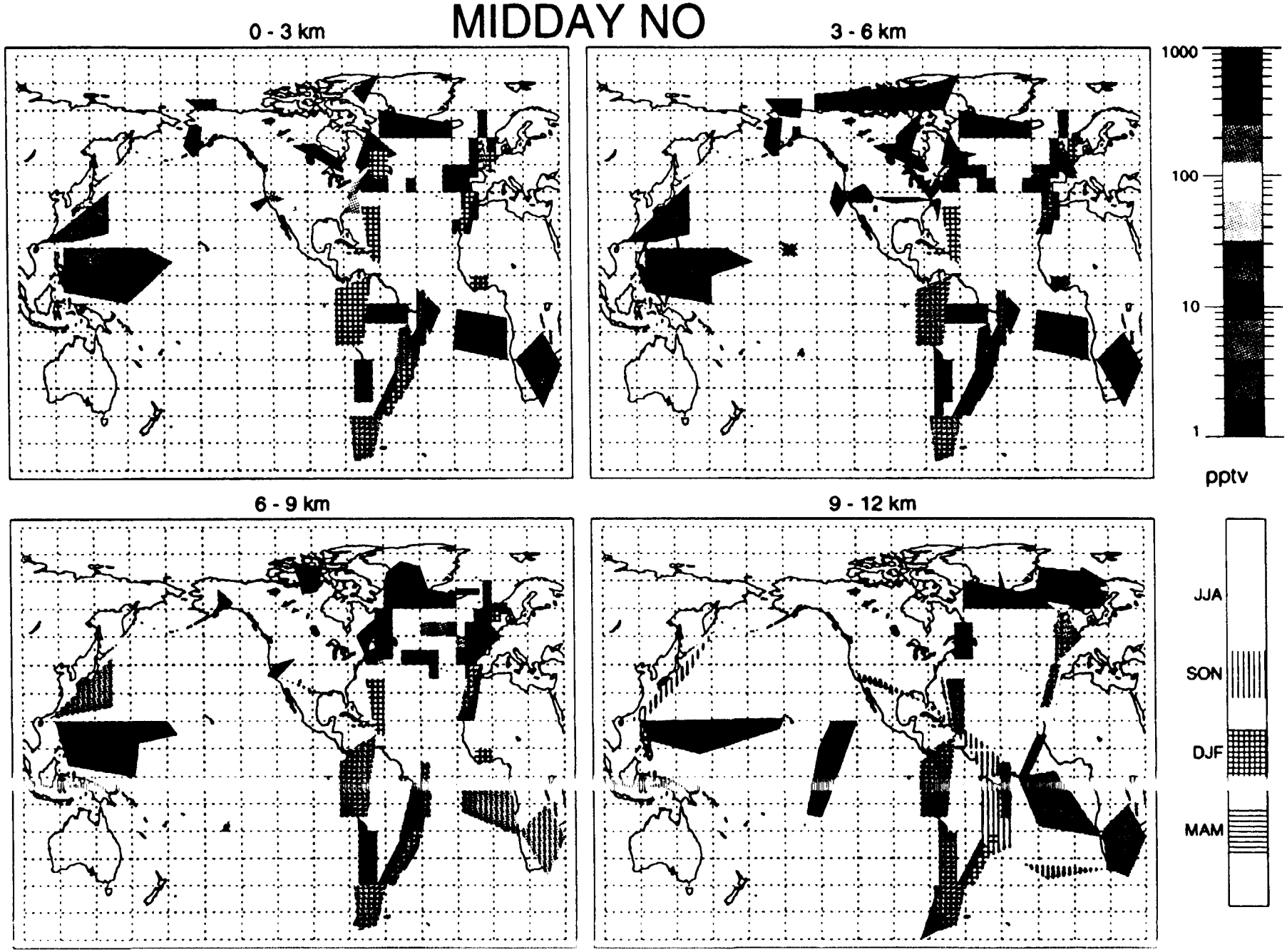
Ozone 3-6 km




Ozone 6-9 km
JJA
SON
DJF
MAM
80
60
40
20
ppbv

Midday NO BL




MIDDAY NO
0 - 3 km
3 - 6 km
6 - 9 km
9 - 12 km
1000
100
10
1
pptv
JJA
SON
DJF
MAM

Future Work

- Photochemical studies
  - Climatology of net ozone production: $P_{net}(O_3)$
  - Examine O_3 vs (NO_y–NO_x): Does this represent O_3 produced per NO_x oxidized?
  - Comparison of calculated and measured NO_2

- Comparisons to global Chemical Transport Models
  (GFDL, LLNL, NCAR, KFA Jülich)

- Collaboration with NCAR
  - Model comparisons
  - Extend climatologies to the lower stratosphere (ER-2 data)
  - Continue to add new datasets to the arch.