POLARCAT - PARTNERS

DLR & CNRS

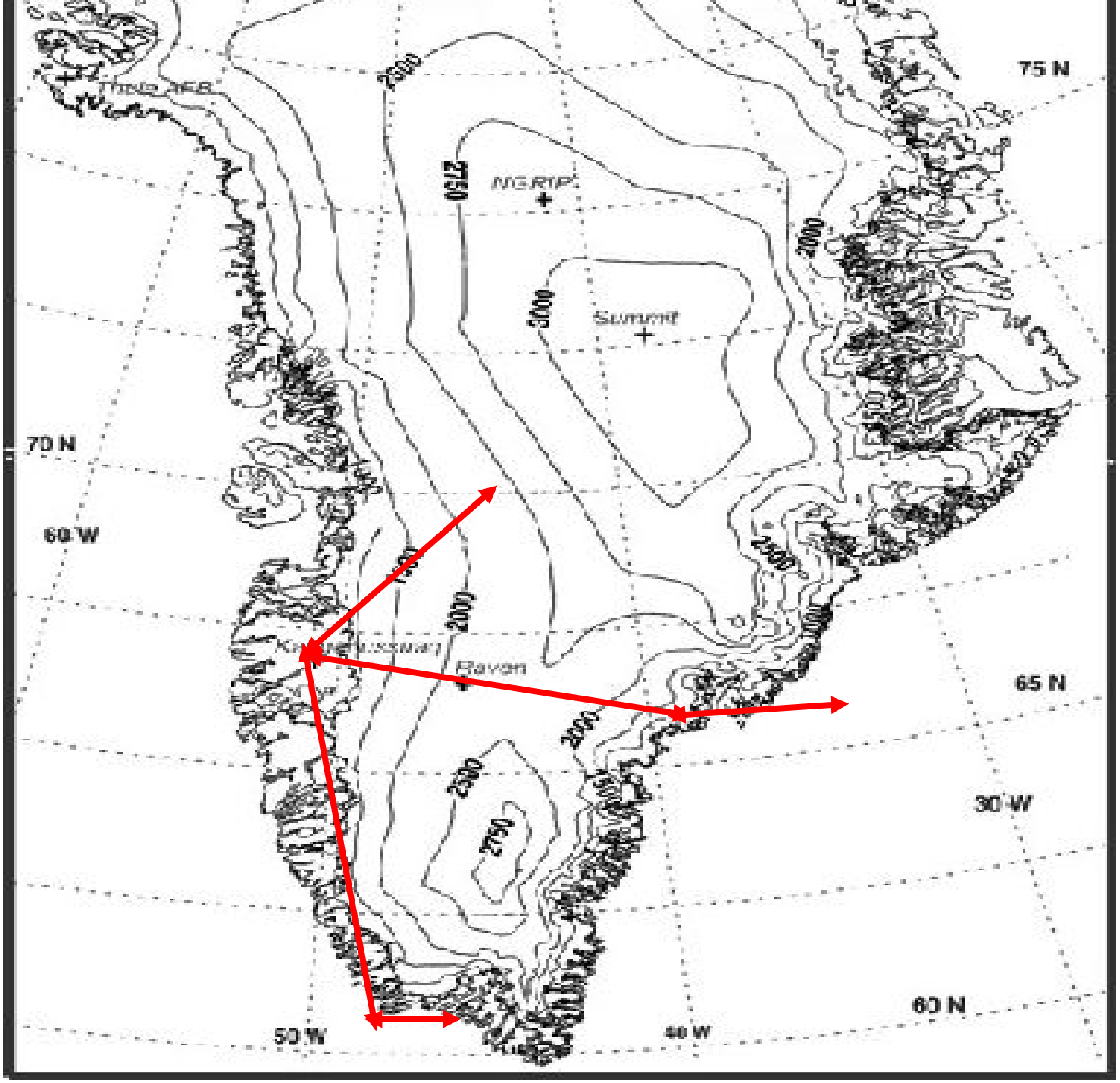
GRACE

Greenland Aerosols and Chemistry Experiment

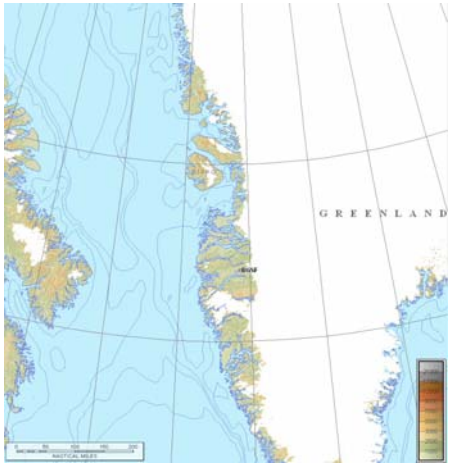
Kangerlussuaq
June, 30th to July 14, 2008

YAK

Siberia, Russia
1 – 20 July, 2008


75 N
70 N
65 N
60 N
60 W
50 W
40 W
30 W
2000
2500
2750
3000
NGRIP
Summit
Raven

POLARCAT



- Period: June 30th to 14 July, 2008
- Base camp: Kangerlussuaq (BGSF), Greenland
- Aircraft: ATR42, Rég. F-HMTO
- Operator: SAFIRE, Service des Avions Français Instrumentés pour la Recherche en Environnement (French government organization)
- ~12 flights, ~36 hours

POLARCAT-GRACE Aircraft

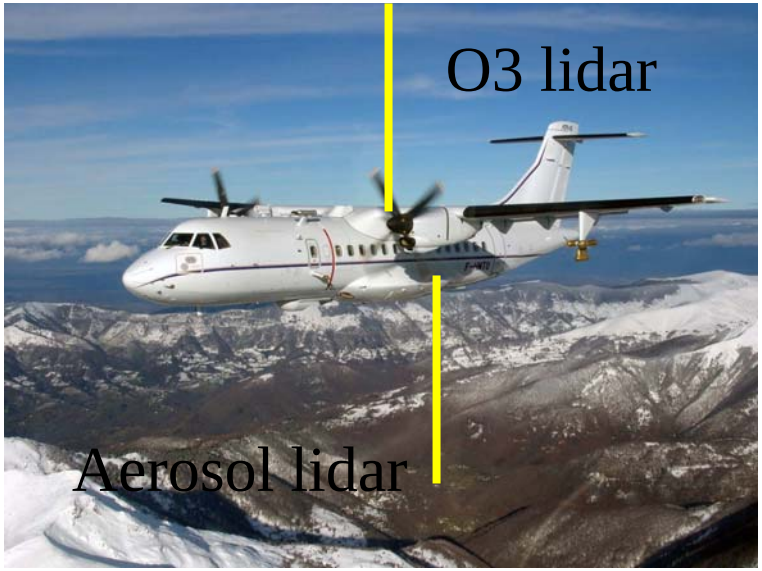
FALCON

DLR Research Aircraft FALCON (Call sign: D-CMET)

Full chemical package:

O3, CO, CO2, NO, NO2, NOy, j(NO2)
PAN, PPN, NPAN
BrO, OClO
Aerosols CPC, PCASP

ATR



LNG aerosol lidar (down)
ALTO ozone lidar (up)
Aerosol sampling *plus*
PSAP, neph, SMPS, impacters
PMS PCASP *(0.2-10μm)*
PMS FSSP, 2D-C + images *(3-800μm)*
AMS (MPI Mainz)
O3, CO

Instrument	Parameter	Contact person
Lidar ALTO DIAL UV Upward looking	Profile O3 Aerosol backscatter 316 nm	SA (C. Laqui)
Lidar LNG Aerosol backscatter 355, 532, 1064 including High Spectral Resolution Measurement downward looking	Profile aerosol backscatter and extinction	DT+SA (F. Blouzon)
2 racks aerosol using CNRM inlet probe + 1 rack for inlet control (SAFIRE)	Aerosol Size distribution, concentration nephelometer 3 wavelen., Filters	LAMP (A. Schwartzenboeck)
Aerosol Masse Spectrometer (AMS) mounted also on the CNRM inlet probe	Composition aerosol	MP de Mayence (Borrmann, Schneider)
PCASP on pod carrying crown located on the fuselage	Aerosol Size distrib	SAFIRE
Lab. Aerologie MOZAIC sensor	O3+CO in-situ	SAFIRE
Microphysics on pod carrying crown located on the fuselage	FSSP 300, 2DC probe	SAFIRE+LAMP (JF Gayet)
Radiation	UV[AG1], visible, IR	SAFIRE
Standard met. parameters	Meteo, position	SAFIRE

DLR Research Aircraft FALCON (Call sign: D-CMET)

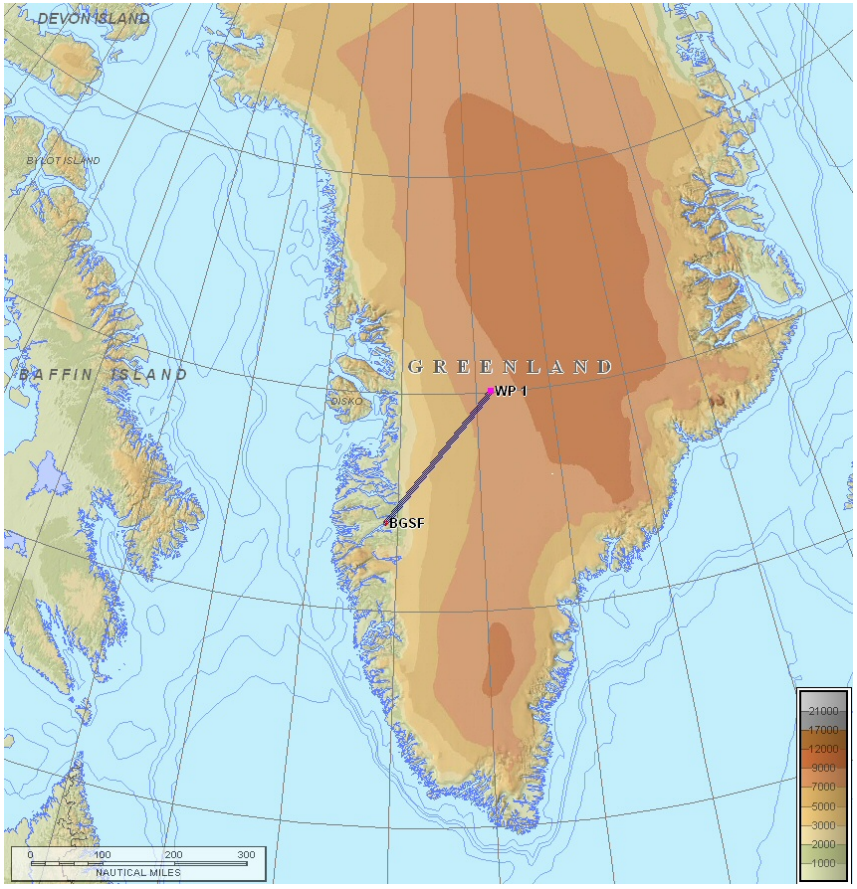
Falcon Measurements

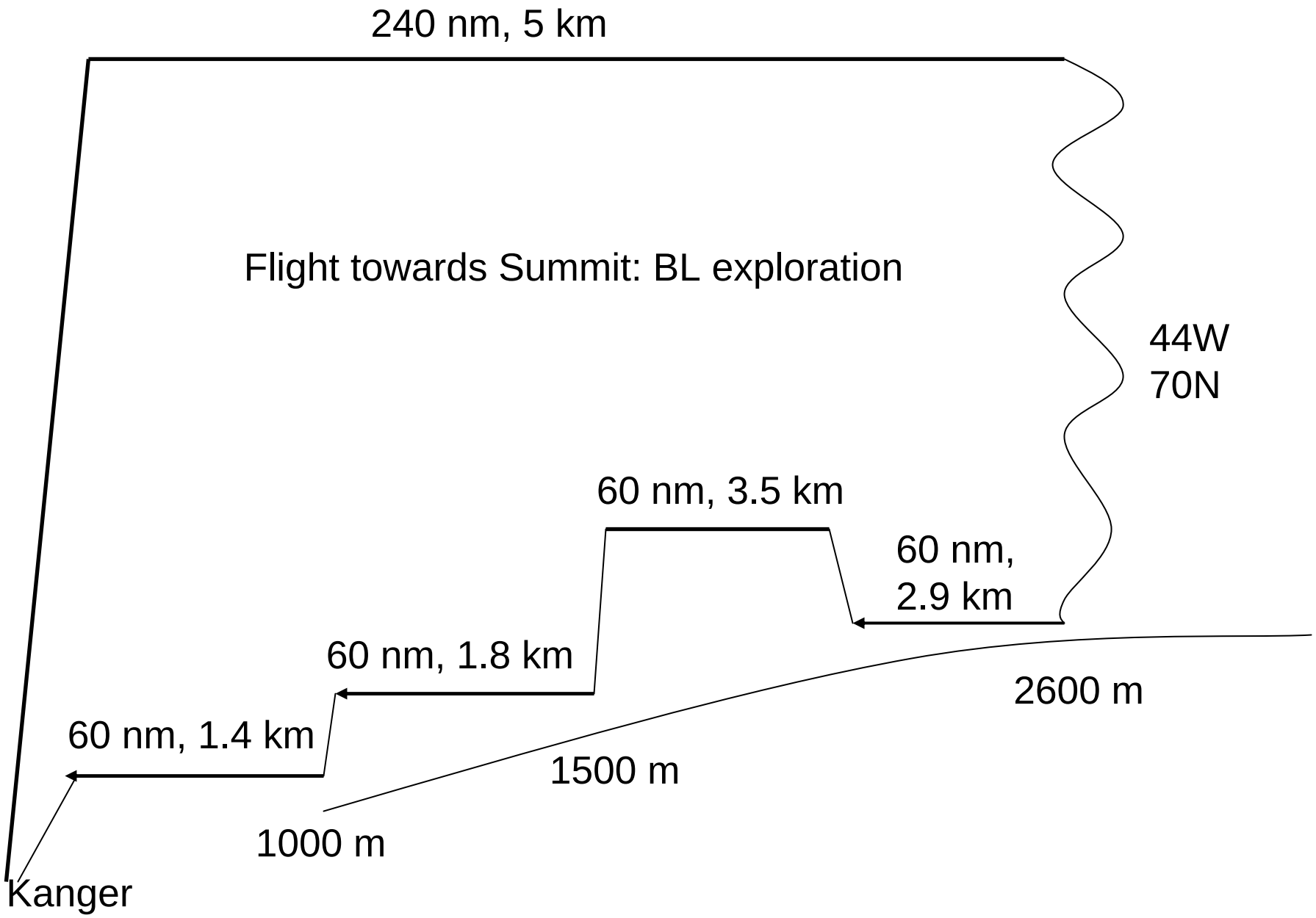
The measurements to be performed from the Falcon during POLARCAT-GRACE are as follows:

Species / parameter	Technique	PI / Group
O3	UV absorption	Schlager, DLR
CO	VUV fluorescence	-"-
CO2	IR absorption	-"-
NO	CL	-"-
NO2	CL	Sitnikov, CAO
NOy	Reduction converter + CL	Schlager, DLR
J(NO2)	Filter radiometer	-"-
PAN, PPN, MPAN	CIMS	-"-
PFC (C6F12, C9F18)	samples + GC, CIMS	-"-
H2O (total)	Lyman-alpha hygrometer	Schiller, FZJ
BrO, OClO	DOAS	Pfeilsticker, Uni HD
Nucleation and Aitken mode aerosol concentration	4-channel CPC system	Minikin, DLR
Accumulation and coarse mode aerosol concentration	PCASP-100X, FSSP-300	-"-
Semi- and non-volatile aerosol fraction	2-channel CPC system with thermodenuder	-"-
Meteorological parameter P, T, wind, relative humidity	Standard probes	Mallaun, DLR
Aircraft position	INS, GPS	-"-

POLARCAT

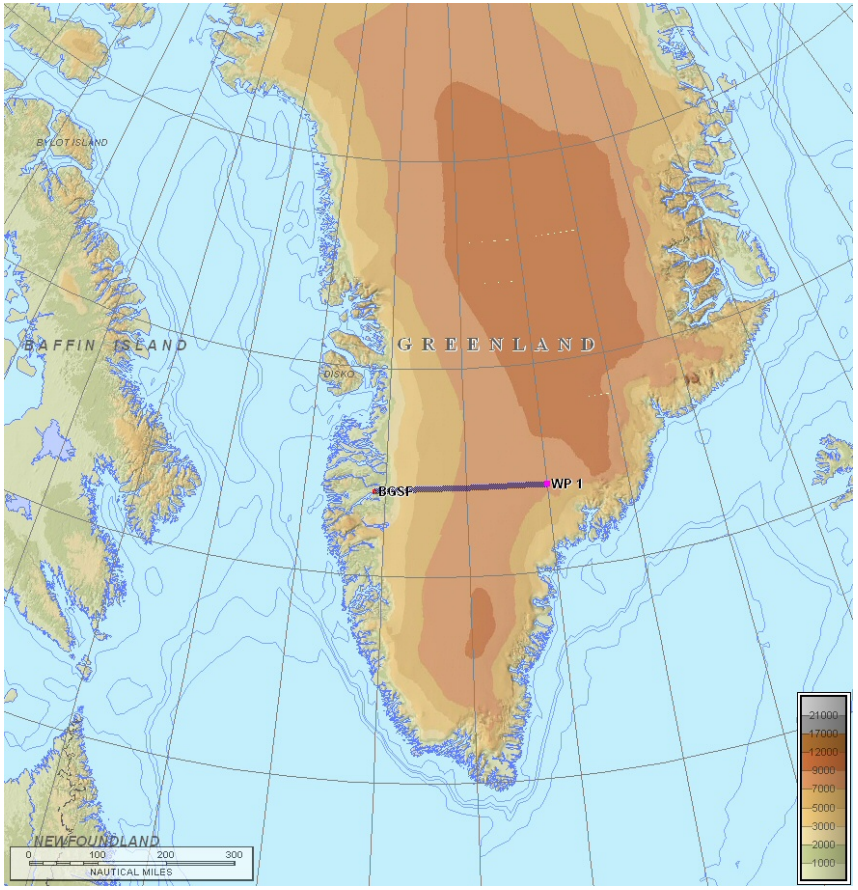
- Flight **Type 1:**
- Towards N70° W044°,038°T 240 Nm from BGSF, 13 000ft AMSL
- Return at 3000ft AGL (12 000ft to 3500ft AMSL)
- 3 hours
- VMC conditions / IFR X flight




240 nm, 5 km
Flight towards Summit: BL exploration
44W
70N
60 nm, 3.5 km
60 nm,
2.9 km
60 nm, 1.8 km
2600 m
60 nm, 1.4 km
1500 m
1000 m
Kanger

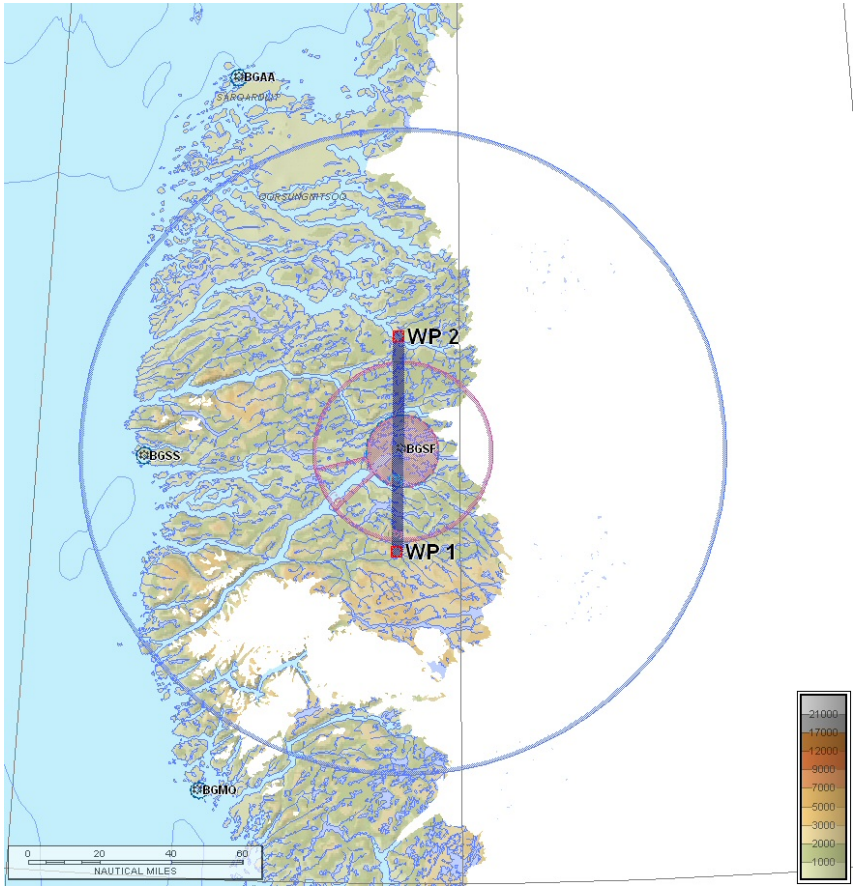
POLARCAT

- Flight **Type 2**: 1 flight
- Towards N67°W040°28’, 090°T 240 Nm from BGSF, 13 000ft AMSL
- Return at 3000ft AGL (12 000ft to 3500ft AMSL)
- 3 hours
- VMC conditions / IFR X flight



POLARCAT

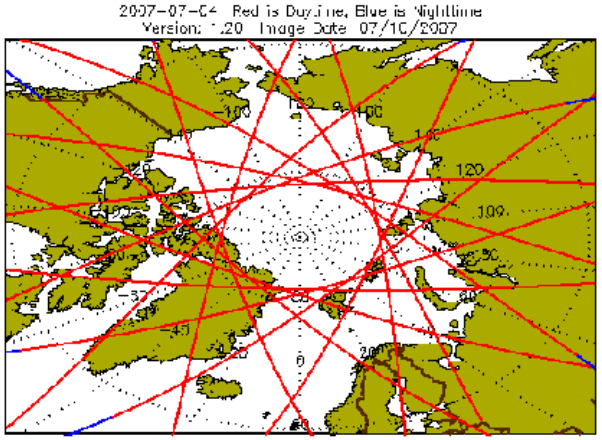
- Flight **Type 3**: 3-4 flights
- 60 NM North/South path centered over BGSF
- 3 altitudes for each flight: 3500ft, 7000ft, 10 000 ft
- 3 hours
- VMC conditions / IFR X flight

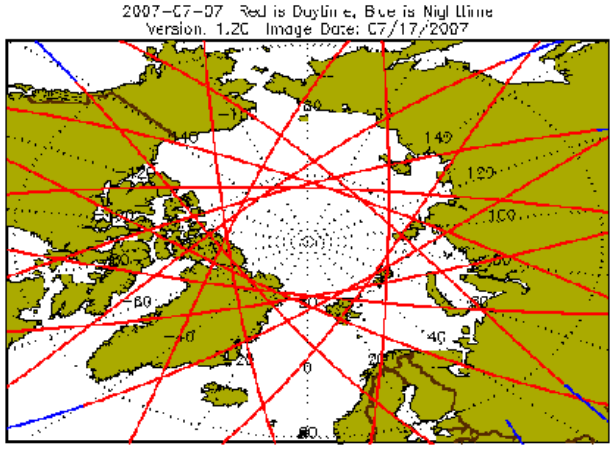


POLARCAT

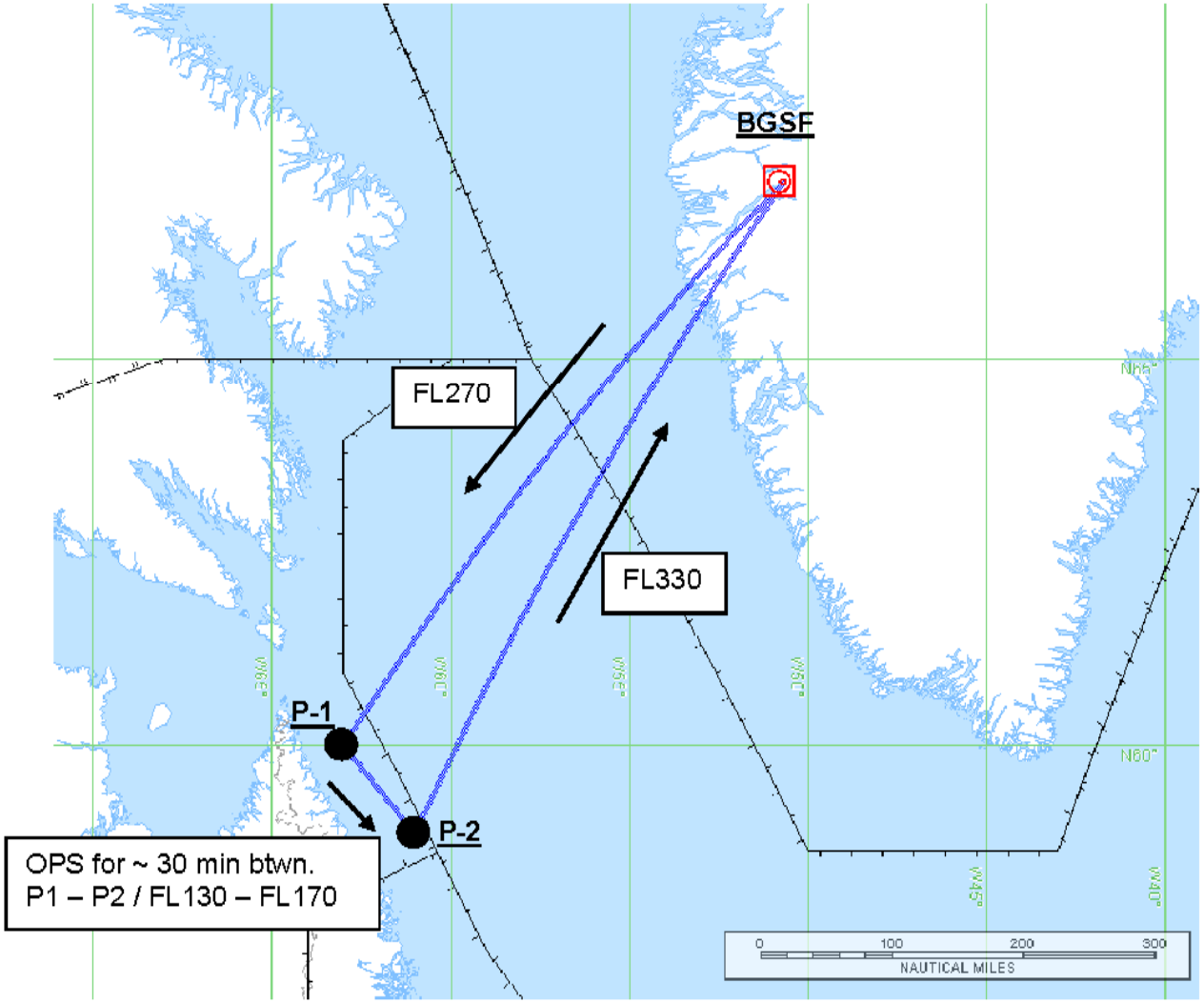
- Flight **Type 4**: 2x2 flights
- Below satellites tracks (IASI and CALIPSO)
- Better over the sea
- 3 hrs
- VMC (better) / IFR X flight
- H24
- After TKOF sonding to 17 000ft (spin climb)
- Following satellite track 1 hr at 17000 ft AMSL
- Track back at 3500 ft AGL

examples





POLARCAT-GRACE 2008 **D-CMET** **Flightpattern S1a**



Pattern Name: S1a

Type of a/c: FA20

Call-Sign: D-CMET

EET: 3:45

Altitudes: FL270
FL130 – FL170
FL330

Planned Routing:

BGSF
P-1 N6000 W06300
P-2 N5845 W06100
BGSF

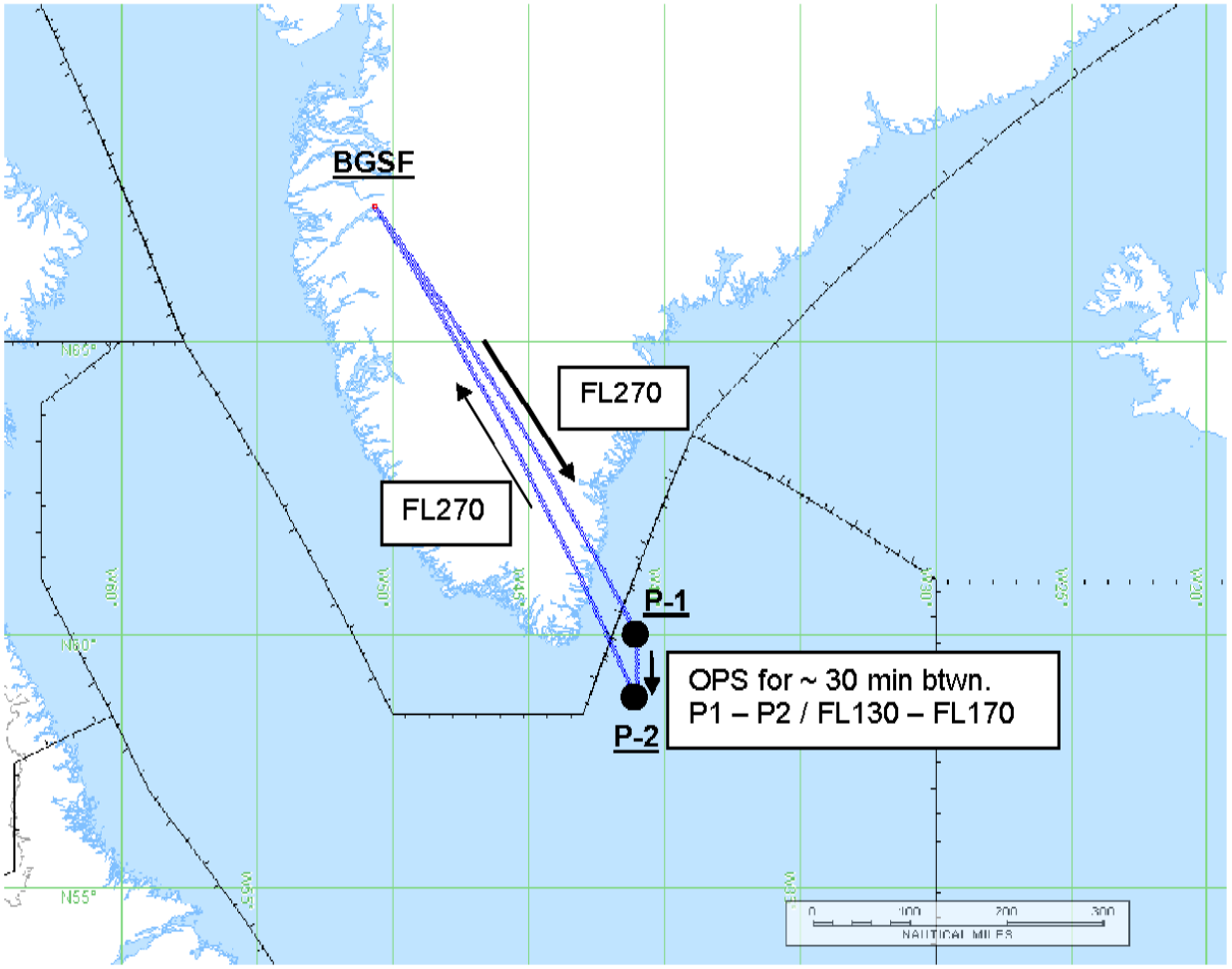
Penetrated Airspace:

Sondreström, Reykjavik, Gander, Montreal

Remark:

Location of P-1 an P-2 may change depending on weathe situation

POLARCAT-GRACE 2008 **D-CMET** **Flightpattern S1b**



Pattern Name: S1b

Type of a/c: FA20

Call-Sign: D-CMET

EET: 3:45

Altitudes: FL270
FL130 – FL170
FL330

Planned Routing:

BGSF
P-1 N6000 W04100
P-2 N5845 W04100
BGSF

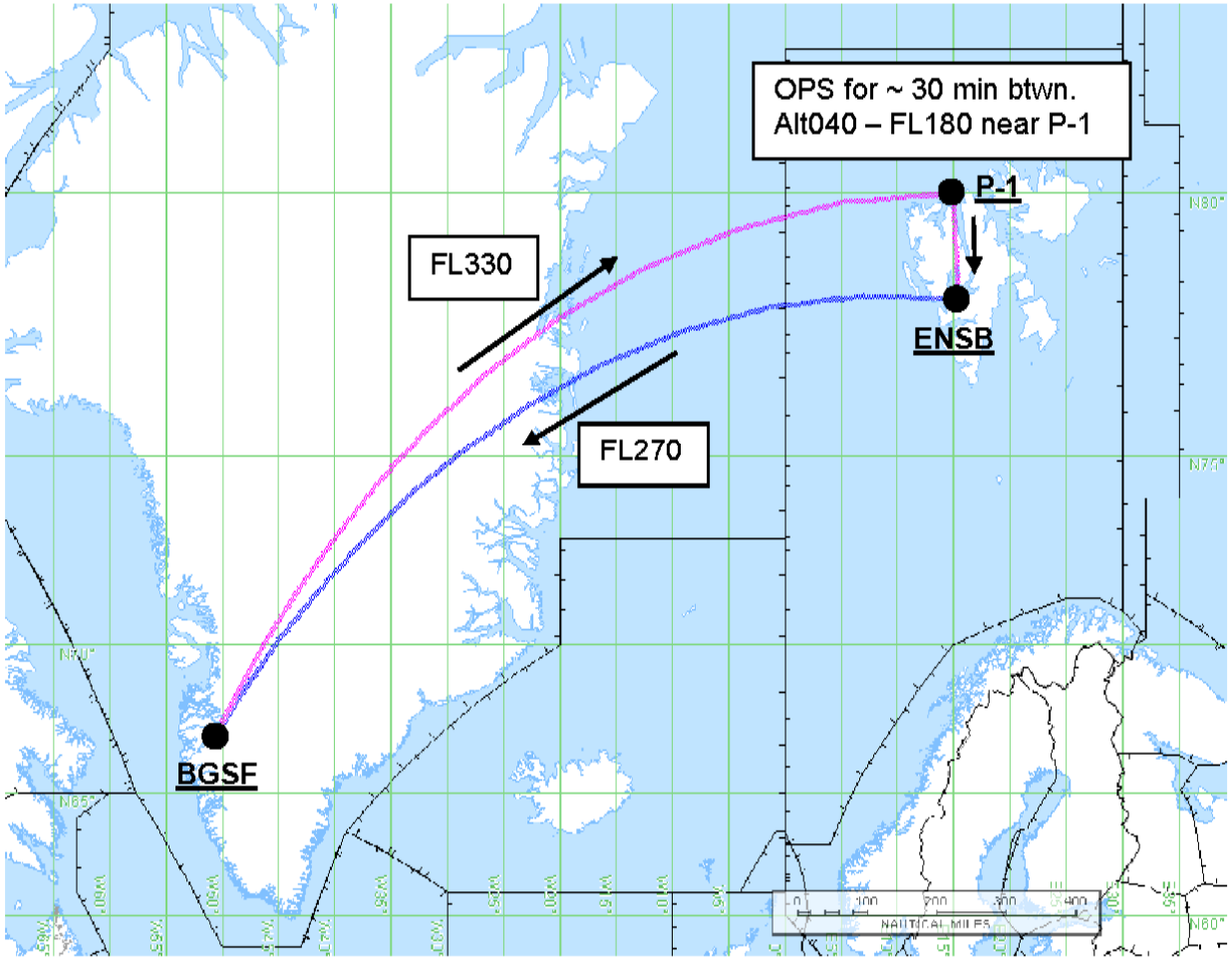
Penetrated Airspace:

Sondreström, Reykjavik, Gander

Remark:

Location of P-1 an P-2 may change depending on weather situation

POLARCAT- GRACE 2008 **D-CMET** **Flightpattern**



Pattern Name: S2 (2 Flights)

Type of a/c: FA20

Call-Sign: D-CMET

EET: 4:00 + 3:45

Altitudes: FL330
ALT040 – FL180

FL270

Planned Routing:

BGSF
P-1 N8000 E01500
ENSB (Refueling)

ENSB
BGSF

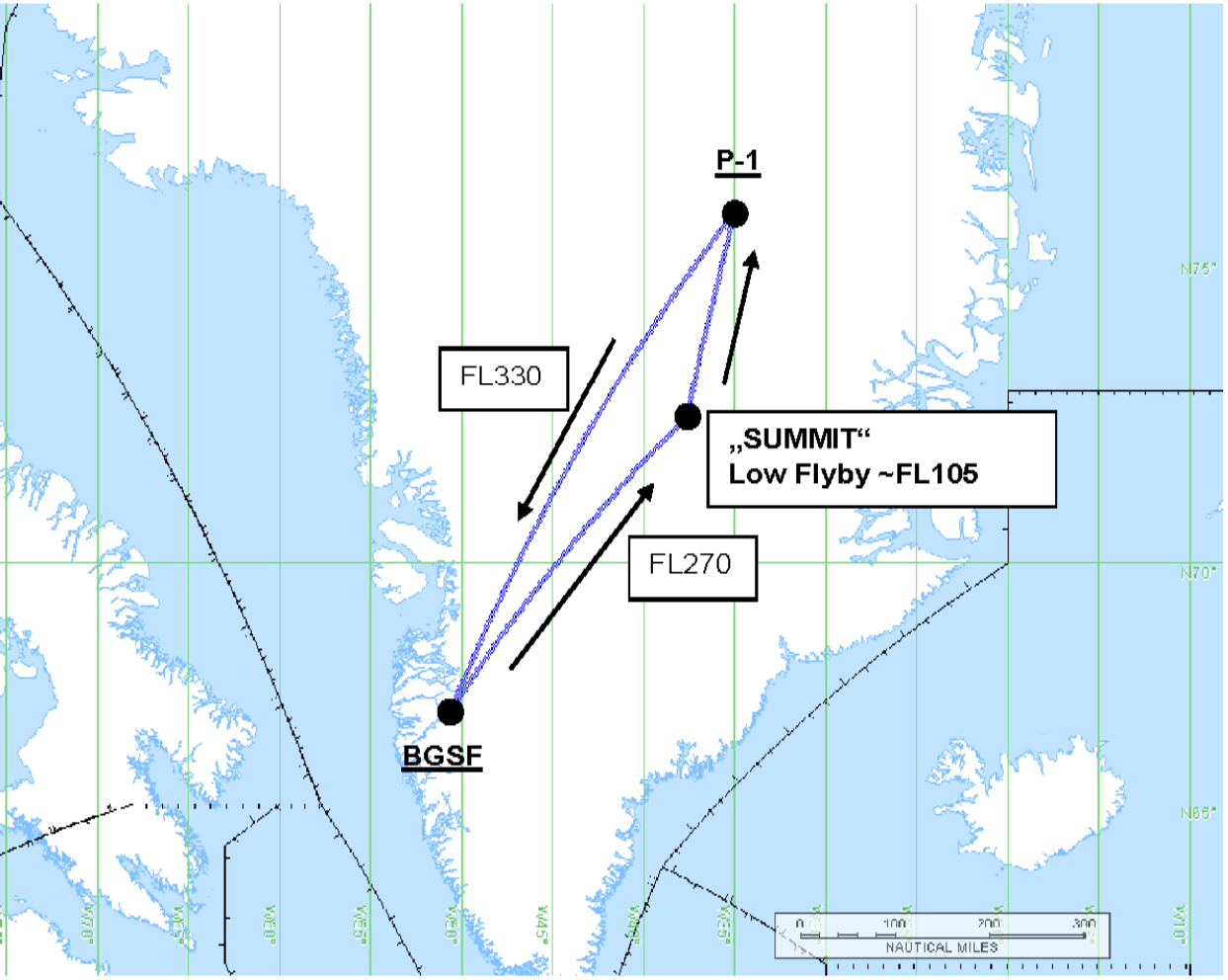
Penetrated Airspace:

Sondreström, Reykjavik, Bodø

Remark:

Location of P-1 may slightly change depending on weather situation

POLARCAT- GRACE 2008 **D-CMET** **Flightpattern**



Pattern Name: S3

Type of a/c: FA20

Call-Sign: D-CMET

EET: 3:45

Altitudes: FL270
~ FL105
FL330

Planned Routing:

BGSF
SUMMIT (N7234 W03738)
P-1 N7540 W03500
BGSF

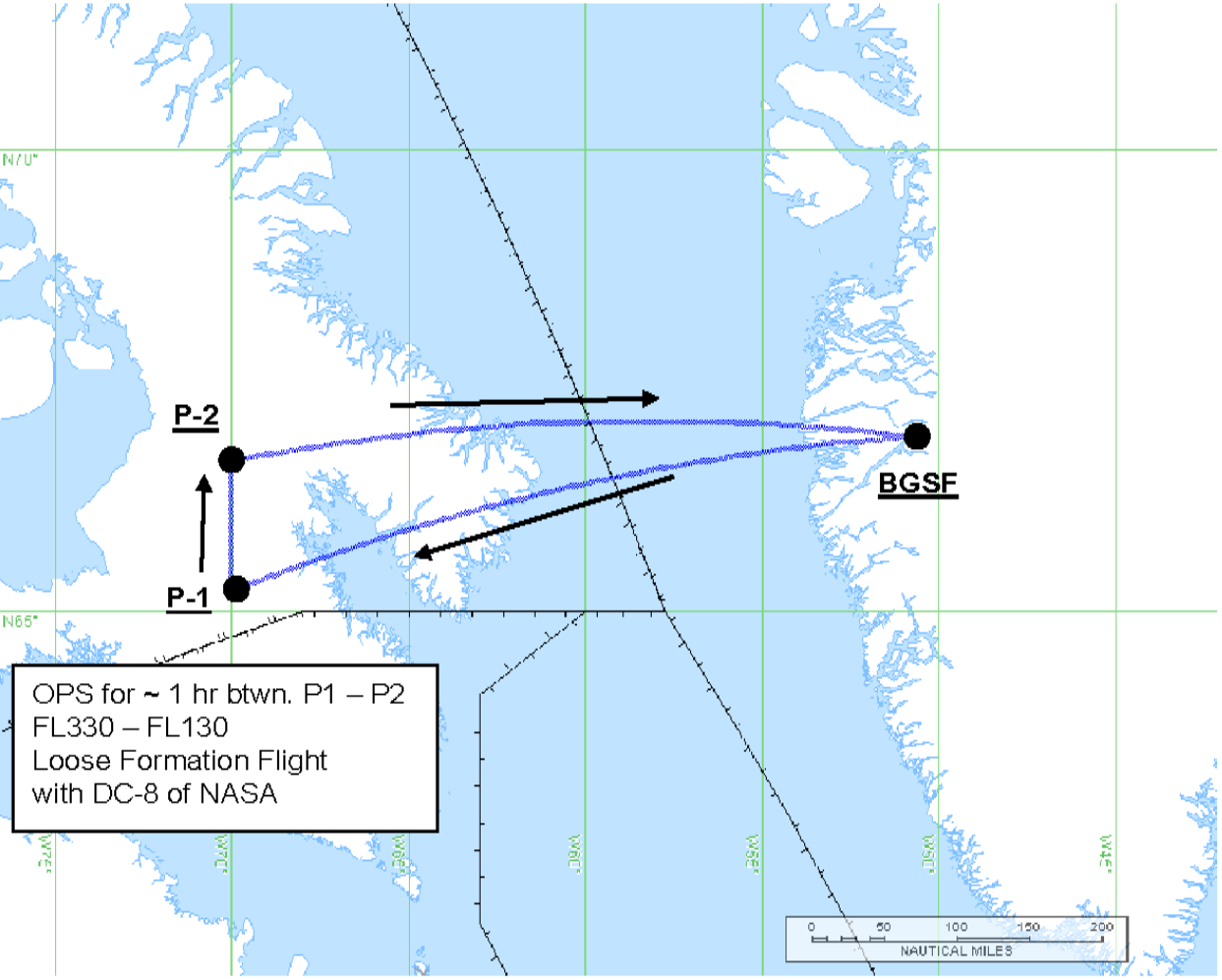
Penetrated Airspace:

Sondreström, Reykjavik

Remark:

Location of P-1 may slightly change depending on weather situation

POLARCAT- GRACE _ 2008 **D-CMET** **Flightpattern S4**



Pattern Name: S4

Type of a/c: FA20

Call-Sign: D-CMET

EET: 3:45

Altitudes: FL330
FL330 – FL130
FL330

Planned Routing:

BGSF
P-1 N6515 W07000
P-2 N6645 W07000
BGSF

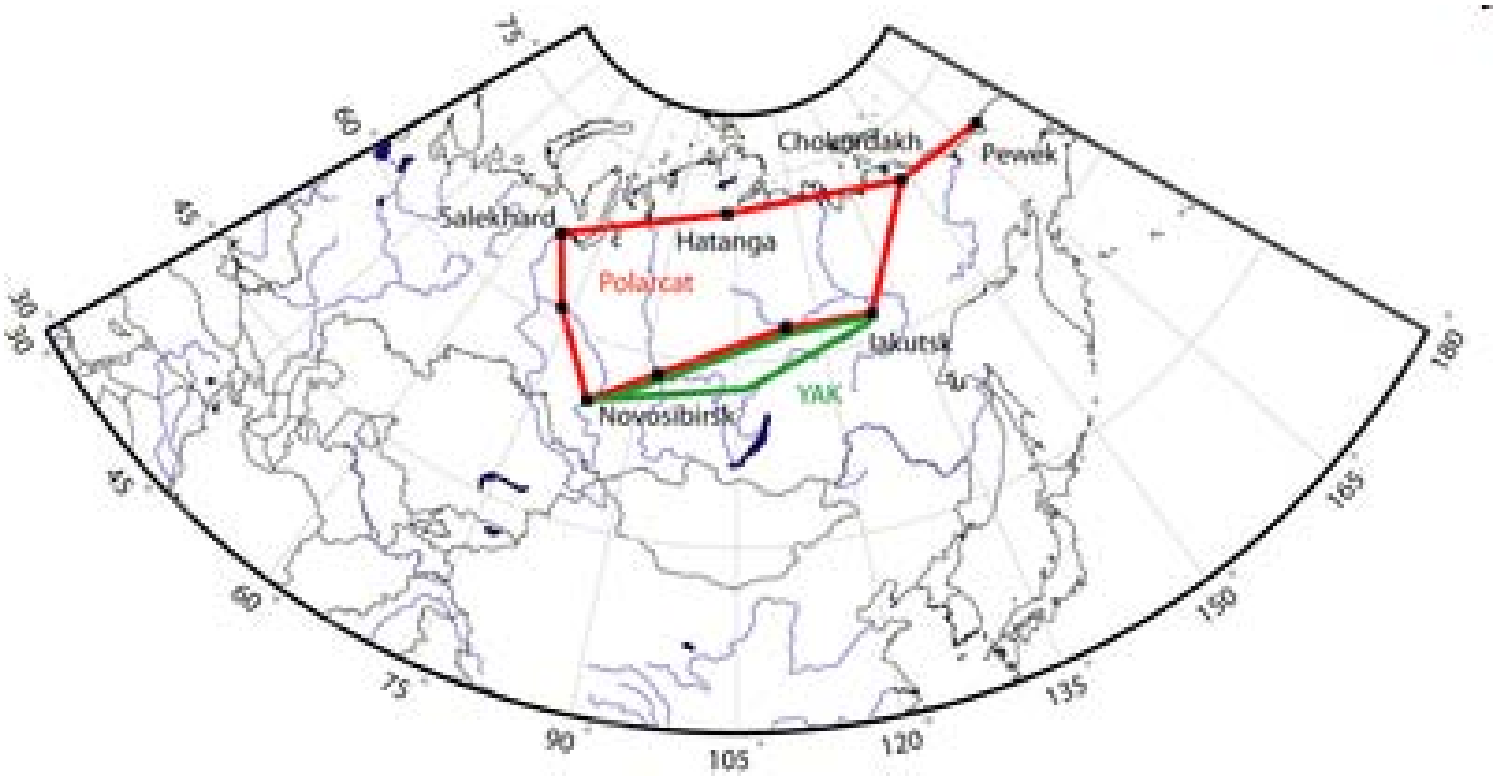
Penetrated Airspace:

Sondreström, Reykjavik, Edmonton

Remark:

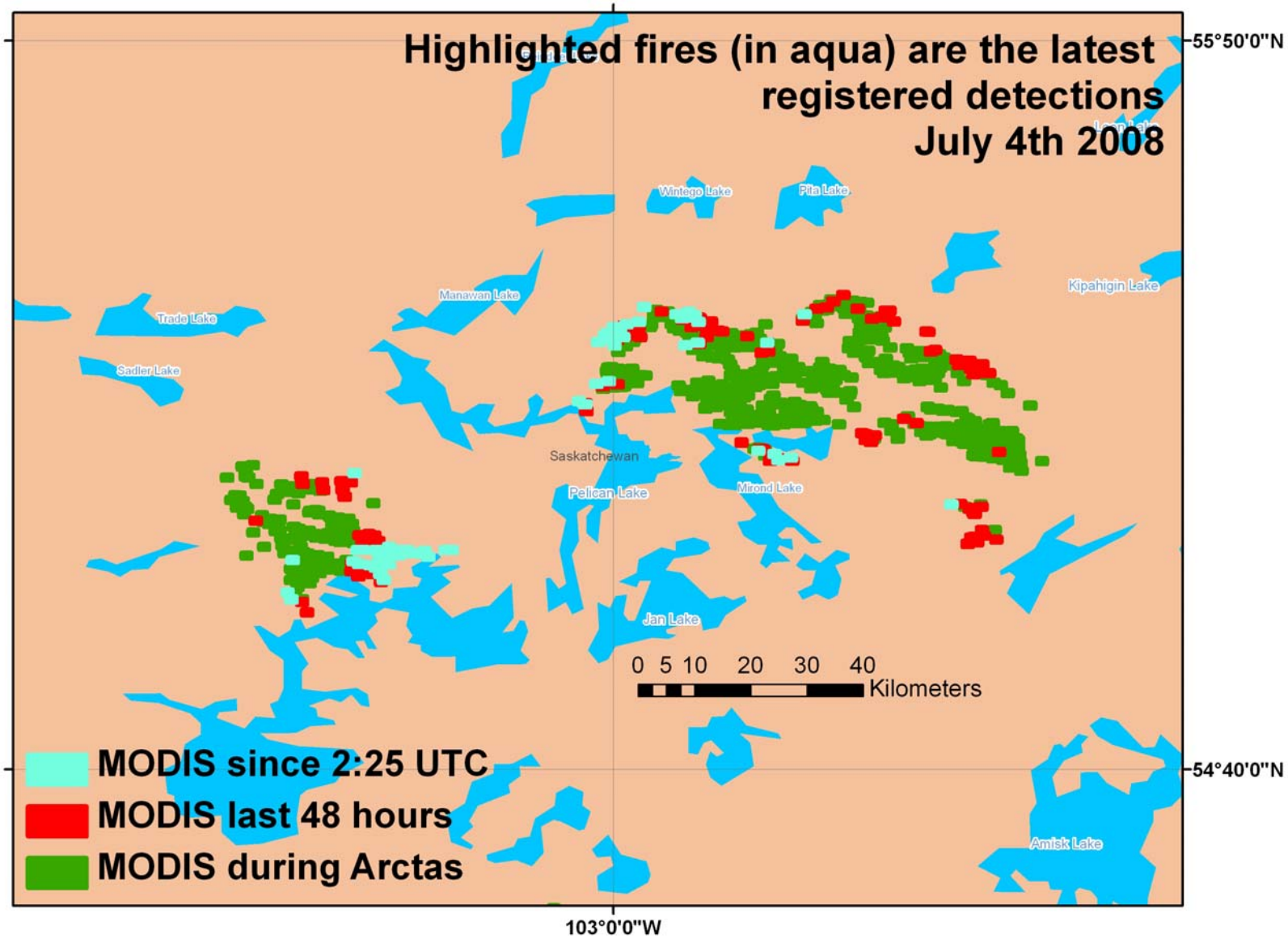
Location of P-1 an P-2 may change depending on weather situation and arrangements with DC-8

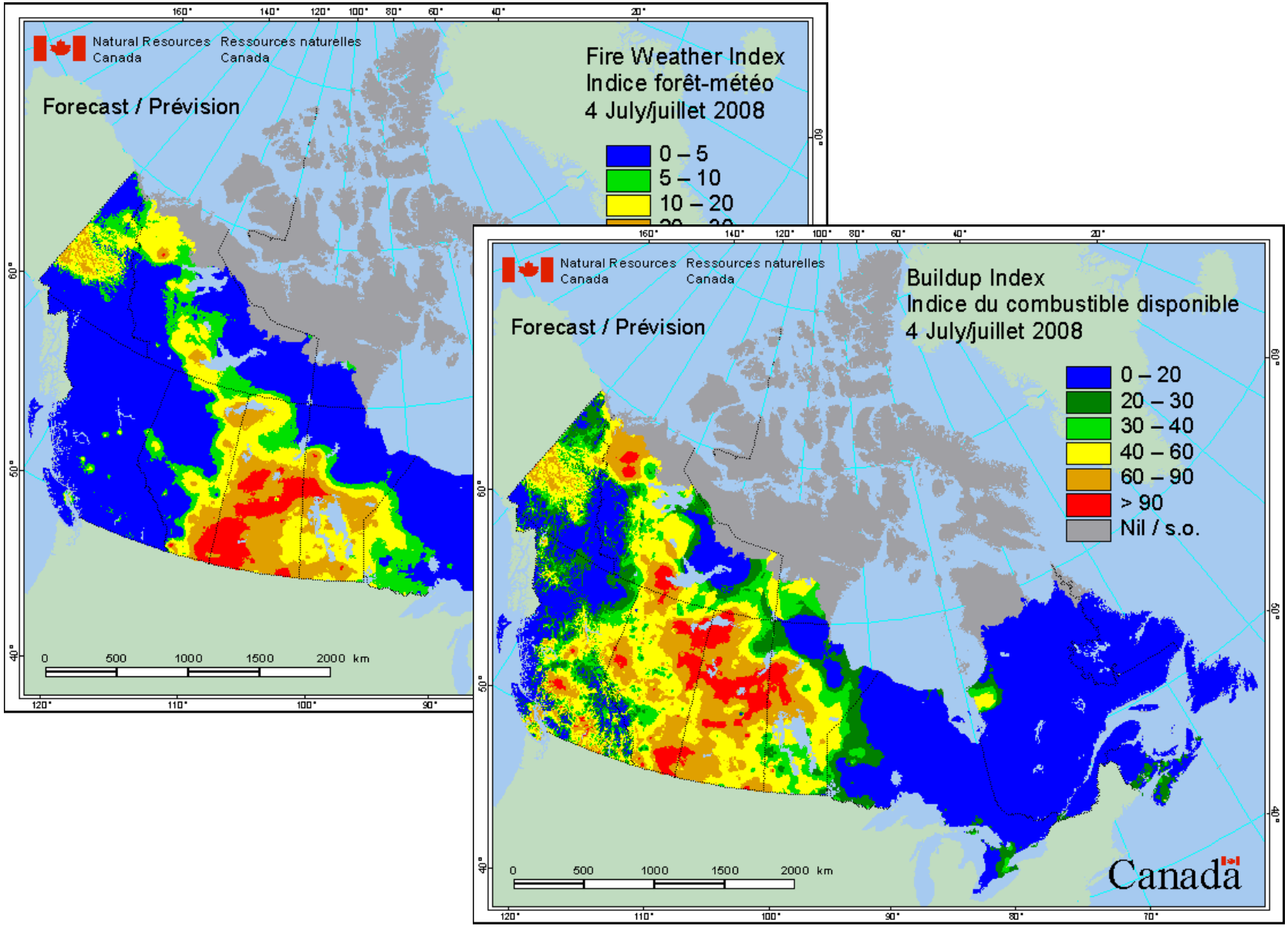
YAK
Siberia, 1-20 July

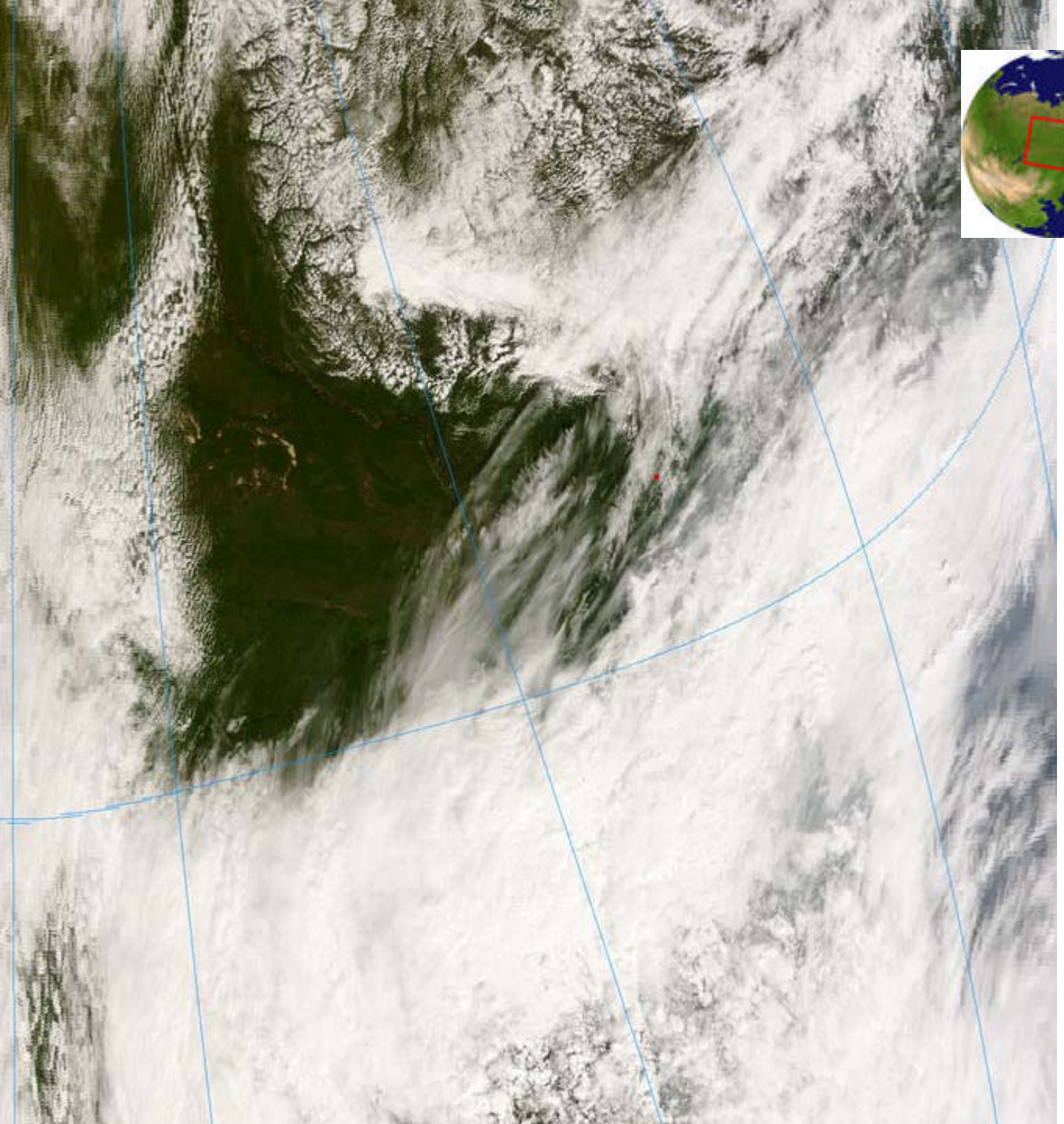


Fire Activity/Potential
July 4/08

- Scattered rain yesterday – most fires still very active (>60 fires)
- Convective activity today expected to enhance vertical development of fires – particularly in PN area
- Communication with SK fire managers excellent
- Decreasing fire potential tomorrow – will take time to build back up


Highlighted fires (in aqua) are the latest registered detections
July 4th 2008
55°50'0"N
54°40'0"N
103°0'0"W
Wintego Lake
Pita Lake
Kipahigin Lake
Manawan Lake
Trade Lake
Sadler Lake
Saskatchewan
Pelican Lake
Mirond Lake
Jan Lake
Amisk Lake
0 5 10 20 30 40
Kilometers
MODIS since 2:25 UTC
MODIS last 48 hours
MODIS during Arctas

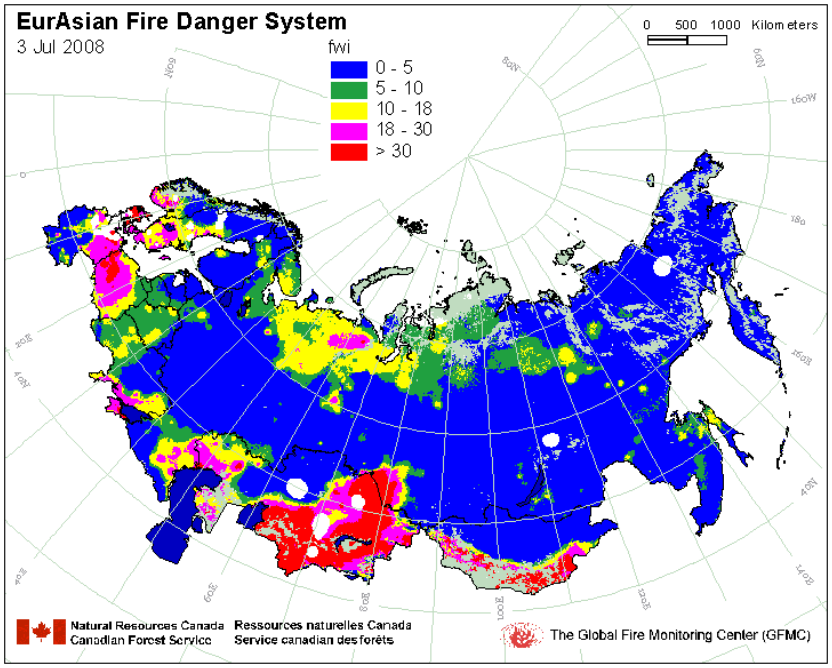

Natural Resources Canada
Ressources naturelles Canada
Forecast / Prévision
Fire Weather Index
Indice forêt-météo
4 July/juillet 2008
0 – 5
5 – 10
10 – 20
0 500 1000 1500 2000 km
Natural Resources Canada
Ressources naturelles Canada
Forecast / Prévision
Buildup Index
Indice du combustible disponible
4 July/juillet 2008
0 – 20
20 – 30
30 – 40
40 – 60
60 – 90
> 90
Nil / s.o.
0 500 1000 1500 2000 km
Canada

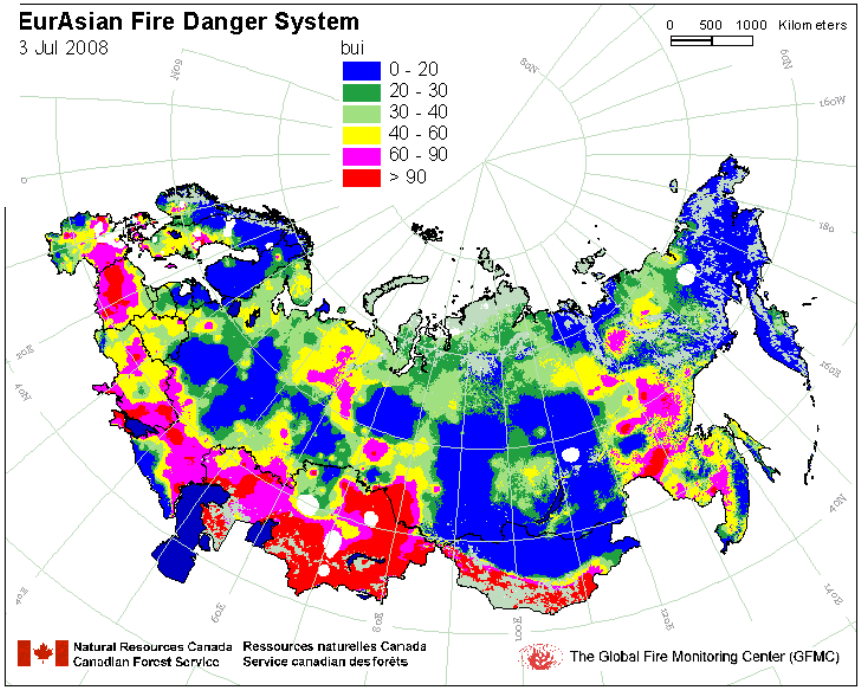


Siberia
Far East

MODIS Terra

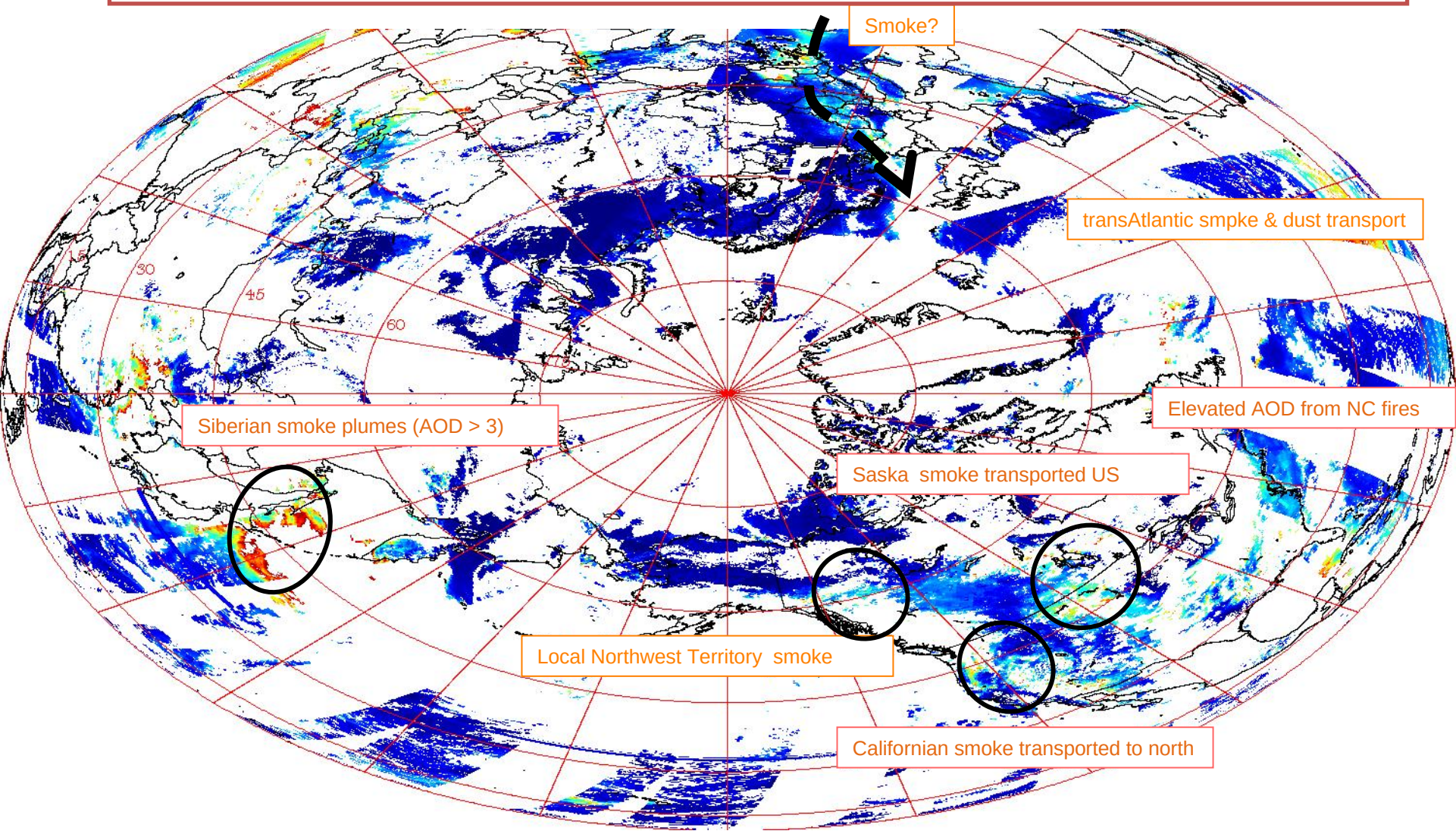
July 04 2008
02:45 UTC


EurAsian Fire Danger System
3 Jul 2008
fwi
0 - 5
5 - 10
10 - 18
18 - 30
> 30
0 500 1000 Kilometers
Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
The Global Fire Monitoring Center (GFMC)


EurAsian Fire Danger System
3 Jul 2008
bui
0 - 20
20 - 30
30 - 40
40 - 60
60 - 90
> 90
0 500 1000 Kilometers
Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
The Global Fire Monitoring Center (GFMC)

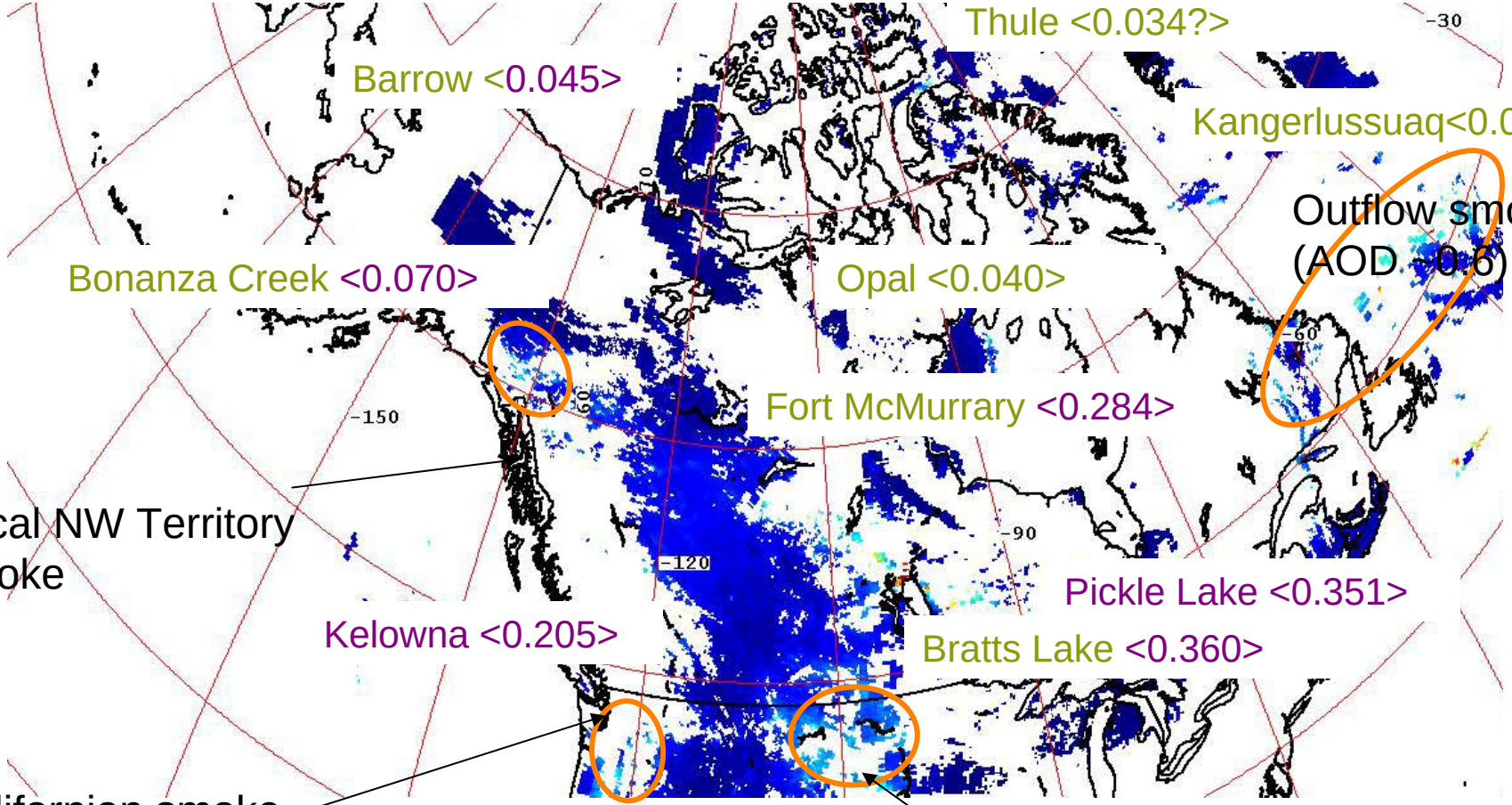
MODIS AOD Hot Spots in Northern Hemisphere (0° - 90° N)

Slide 1: New features - Northwest Territory local smoke and smoke from Greece (see the thick arrow)

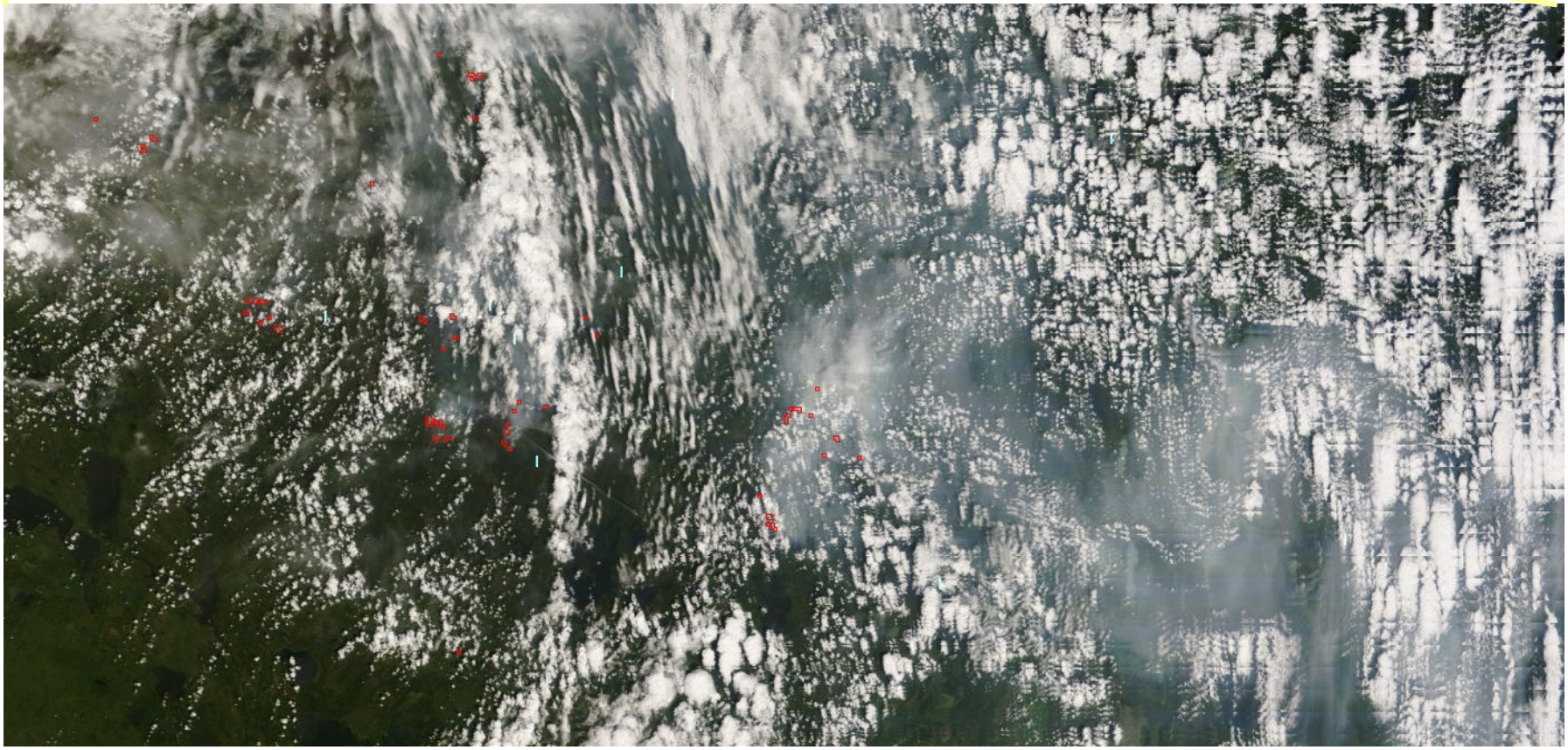


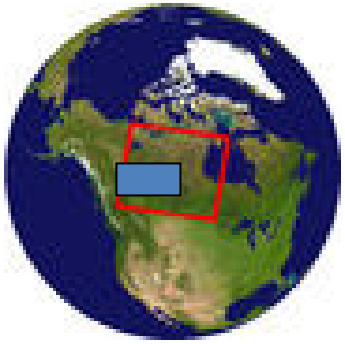
MODIS AOD Hot Spots in Northern America July 3

Slide 2: Northwest Territory local smoke, Californian smoke, Saska smoke, as well as smoke outflow over northern Atlantic Ocean

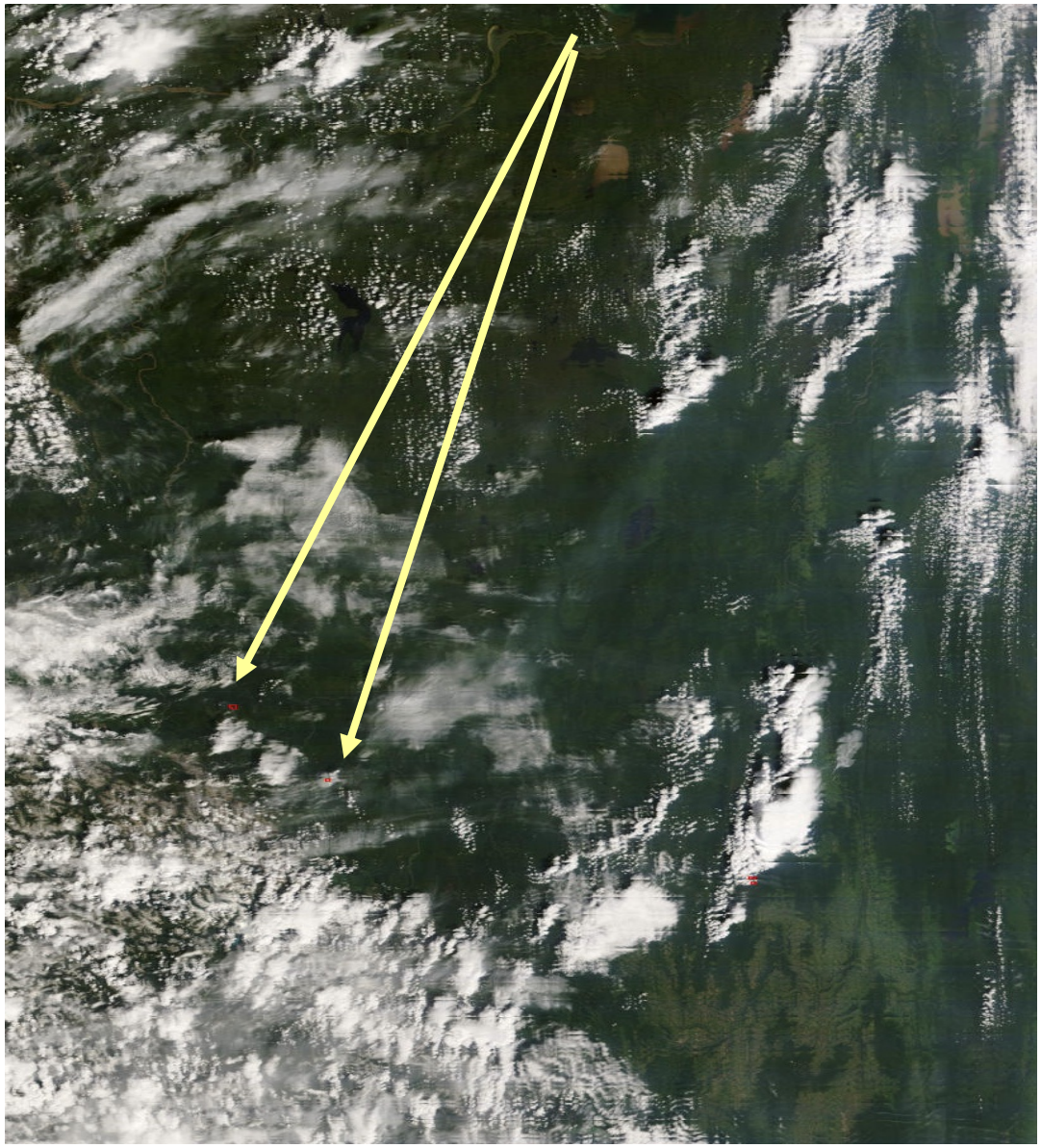


Smoke plumes in Manitoba to be sampled today by DC-8

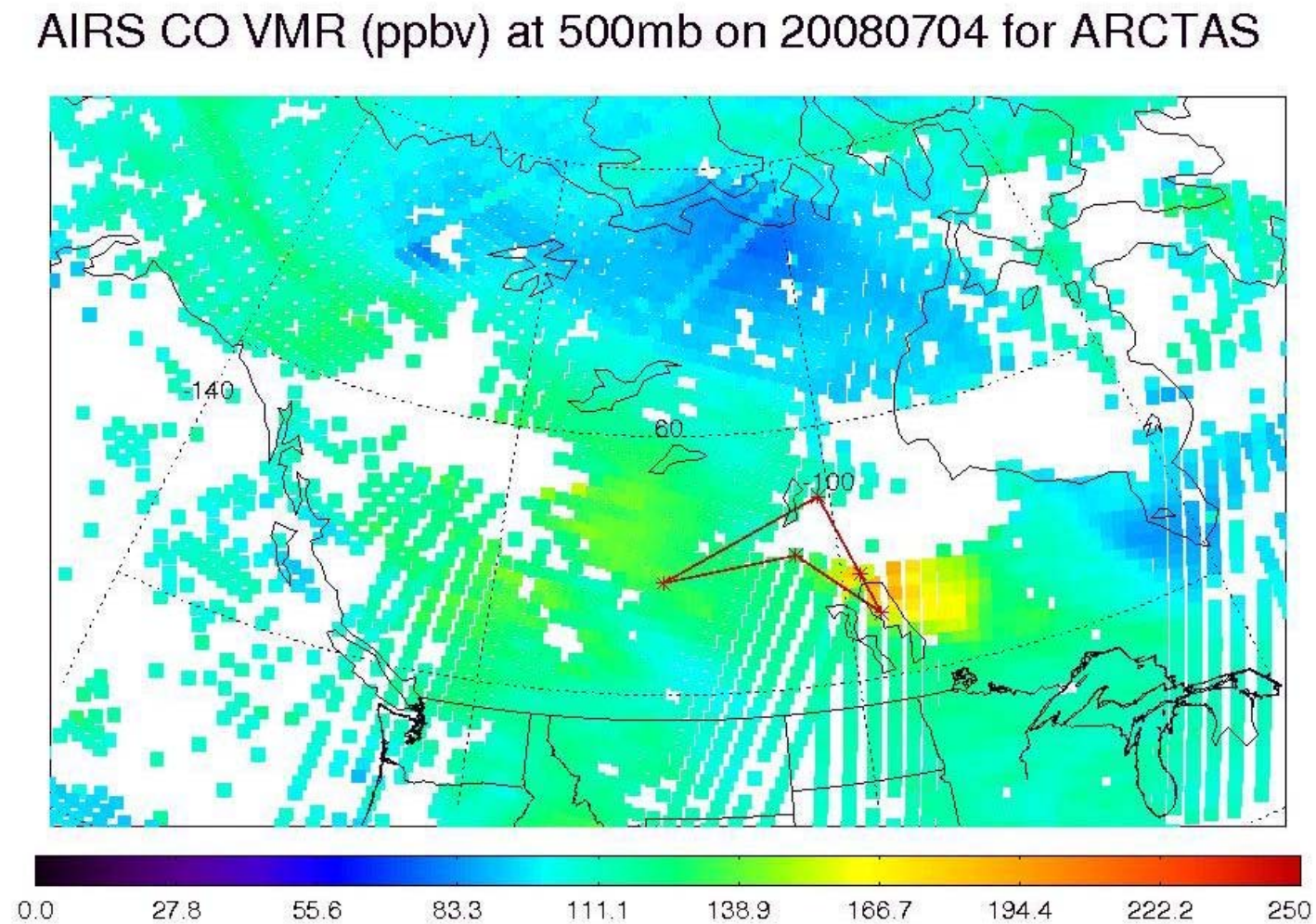




Local smoke in NW Territory

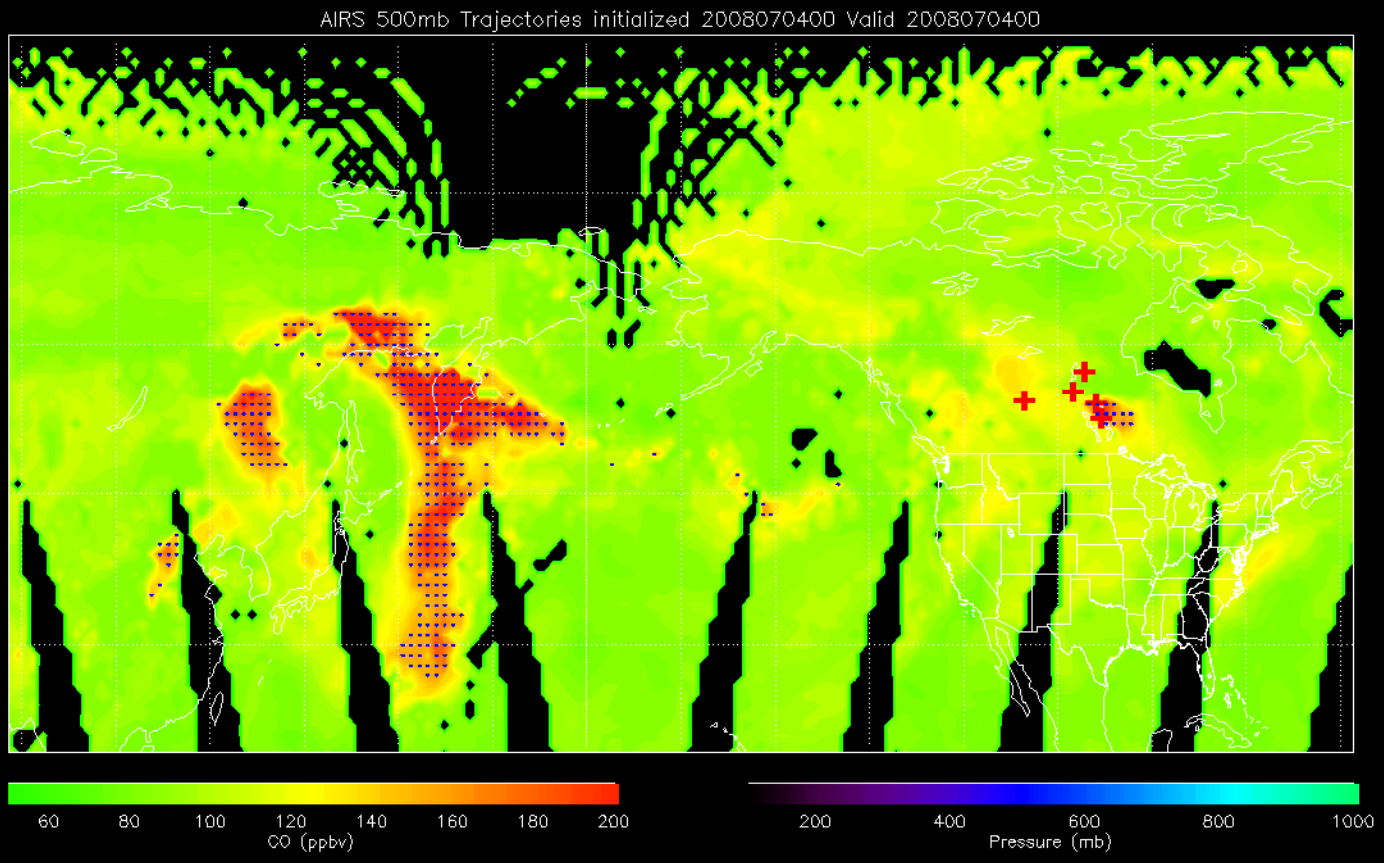


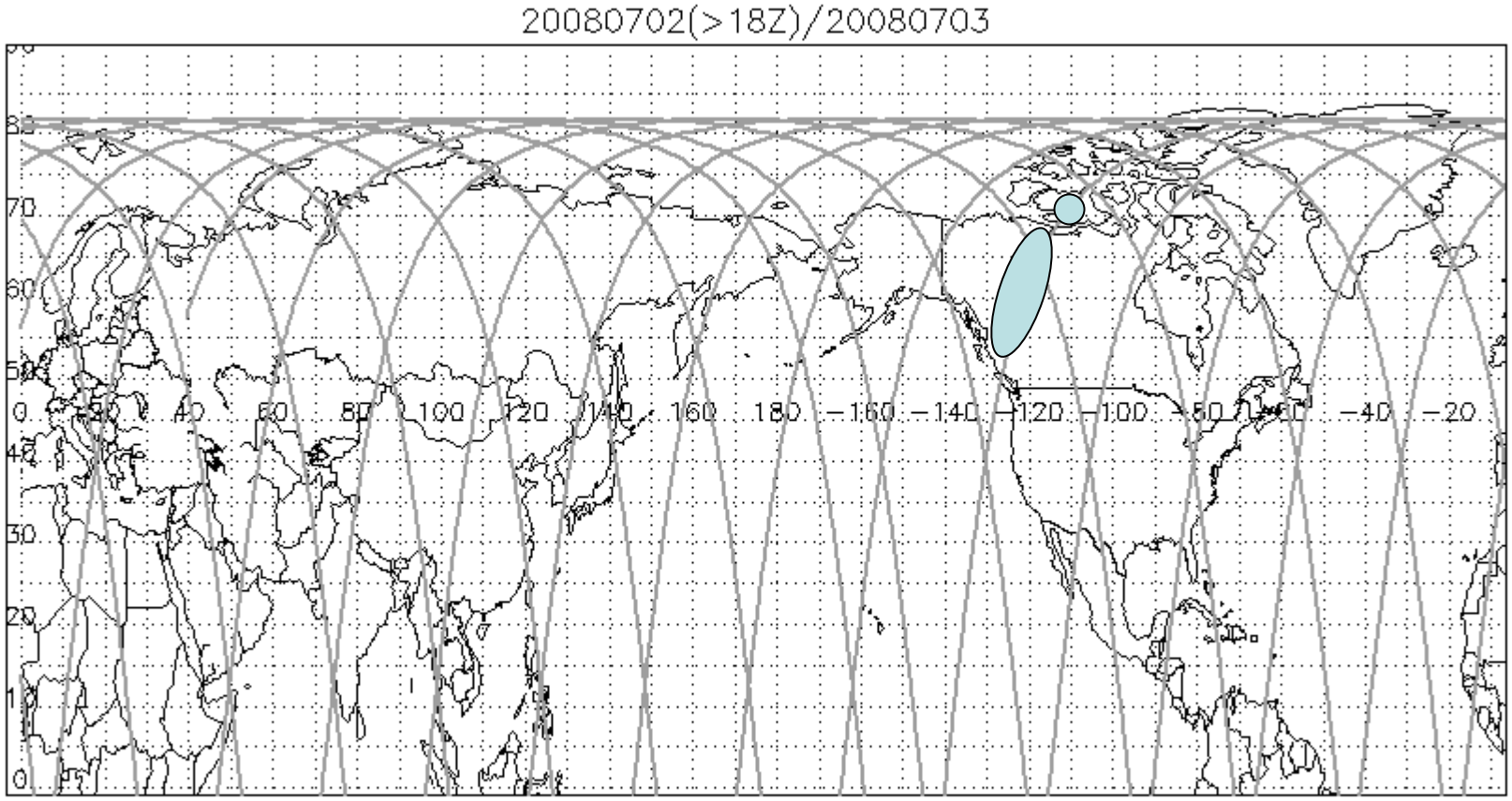
AIRS Support for ARCTAS



ACKNOWLEDGEMENT: AIRS NRT products by NASA DAAC

Manitoba fire emission strong.
Could not identify fire emissions from NW Territory yet.


AIRS 500mb Trajectories initialized 2008070400 Valid 2008070400
60
80
100
120
140
160
180
200
CO (ppbv)
200
400
600
800
1000
Pressure (mb)

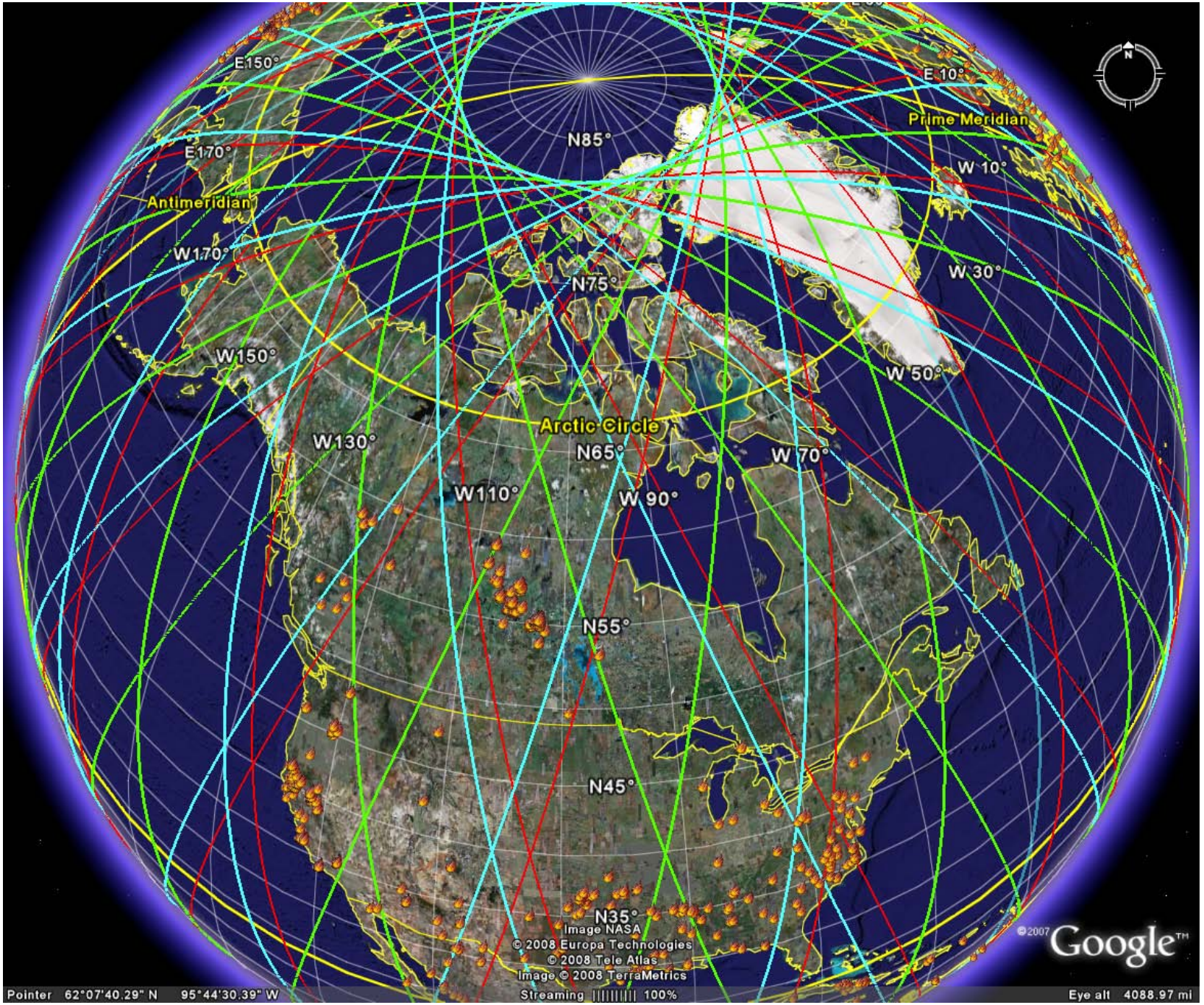


Cloud

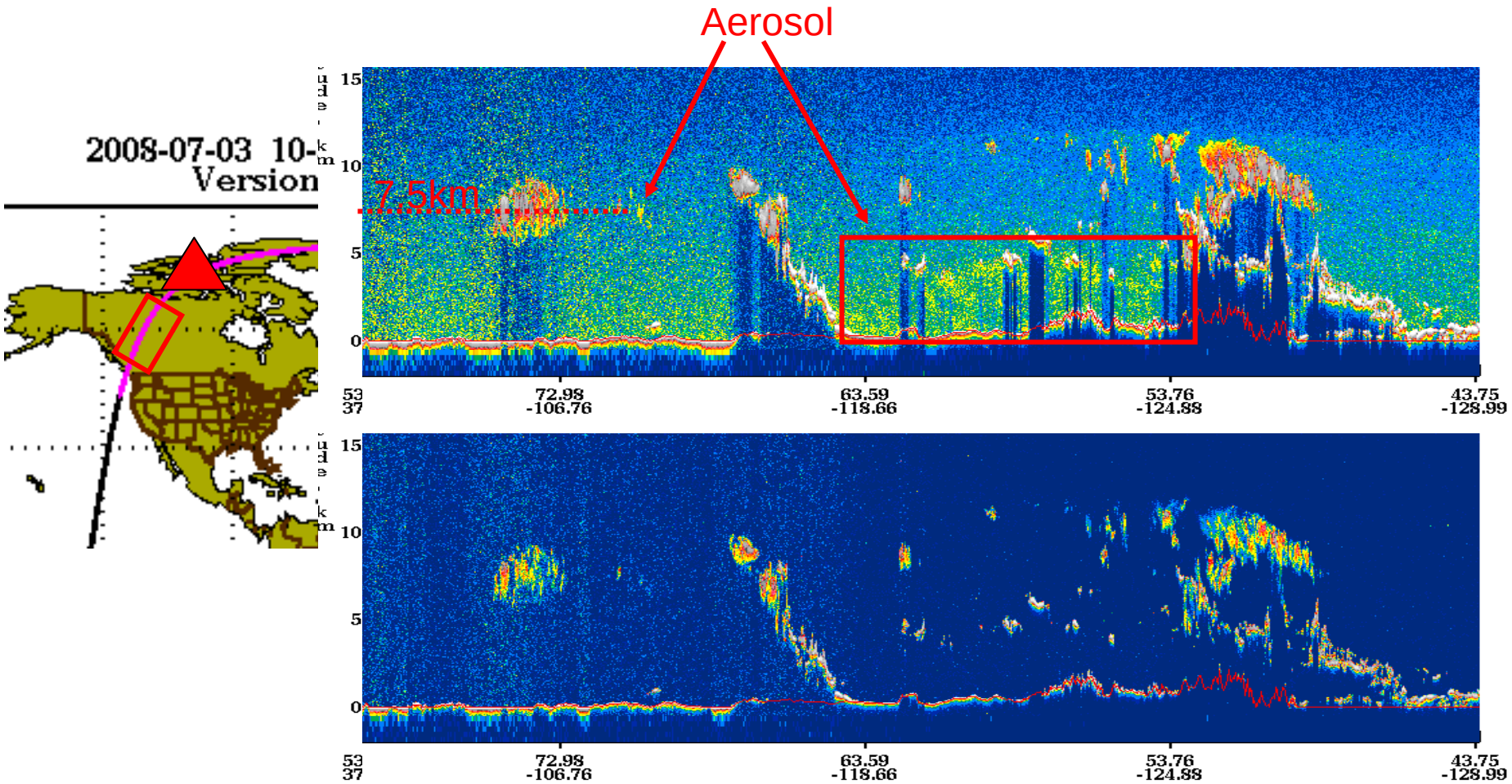
Aerosol Layer- low aerosol loading

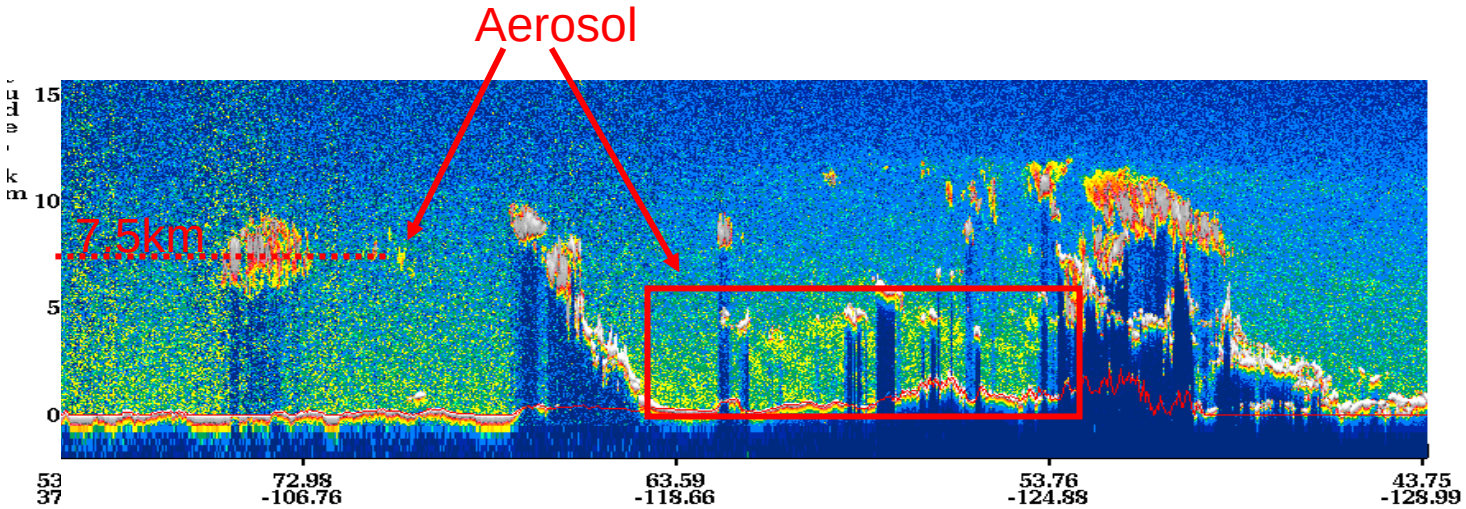
Aerosol Layer- medium aerosol loading

Aerosol Layer- high aerosol loading

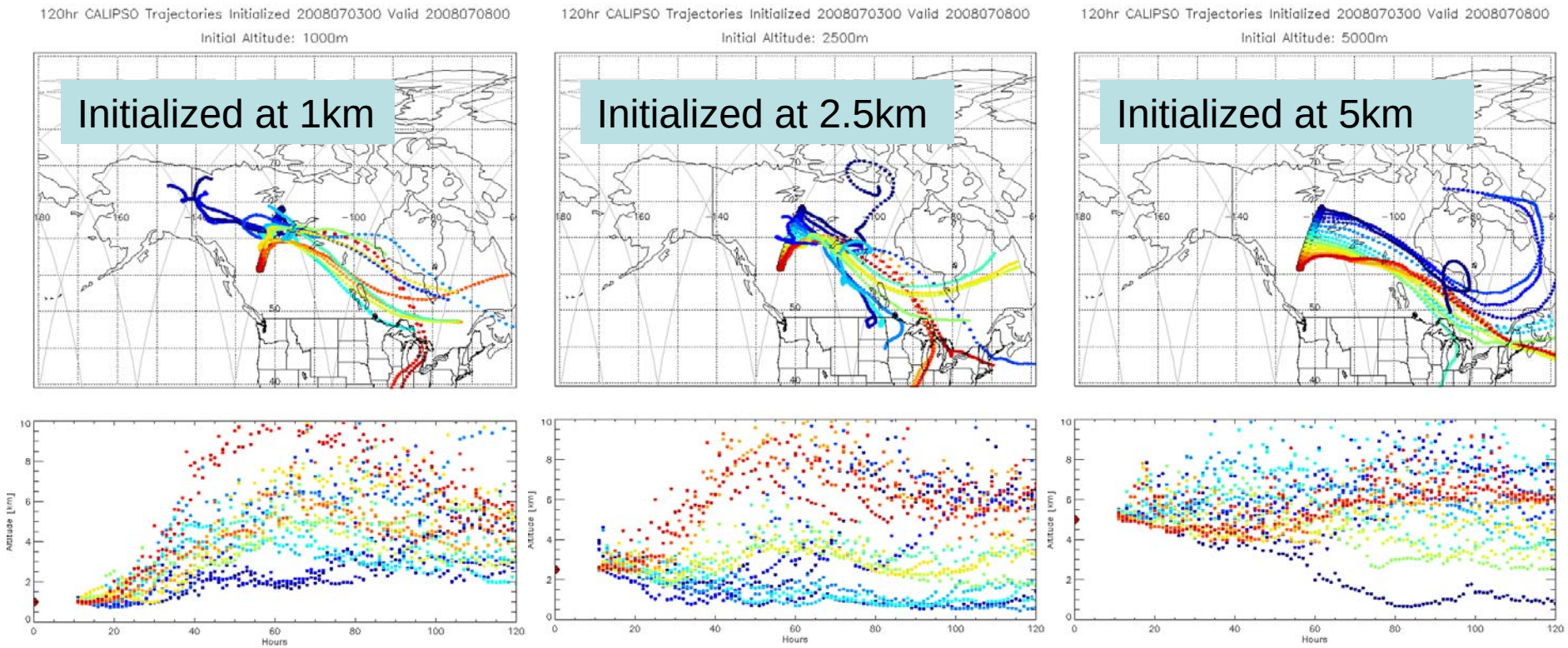

E150°
E 10°
Prime Meridian
N85°
E170°
W 10°
Antimeridian
W170°
W 30°
N75°
W150°
W 50°
Arctic Circle
W130°
N65°
W 70°
W110°
W 90°
N55°
N45°
N35°
Image NASA
© 2008 Europa Technologies
© 2008 Tele Atlas
Image © 2008 TerraMetrics
©2007 Google™
Pointer 62°07'40.29" N 95°44'30.39" W
Streaming 100%
Eye alt 4088.97 mi

CALIPSO Obs 7/3: W Canada





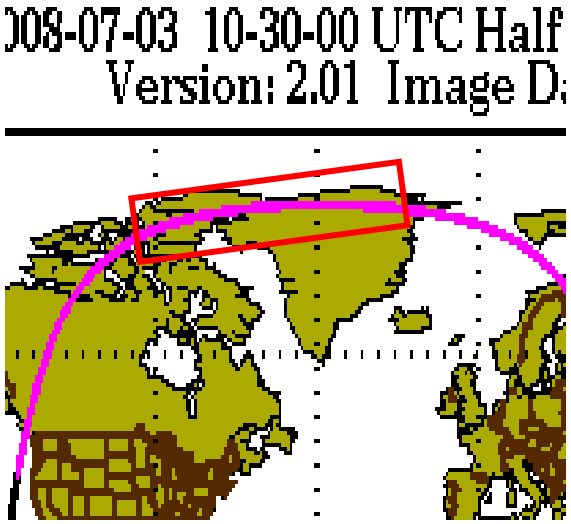
5-day forward trajectories

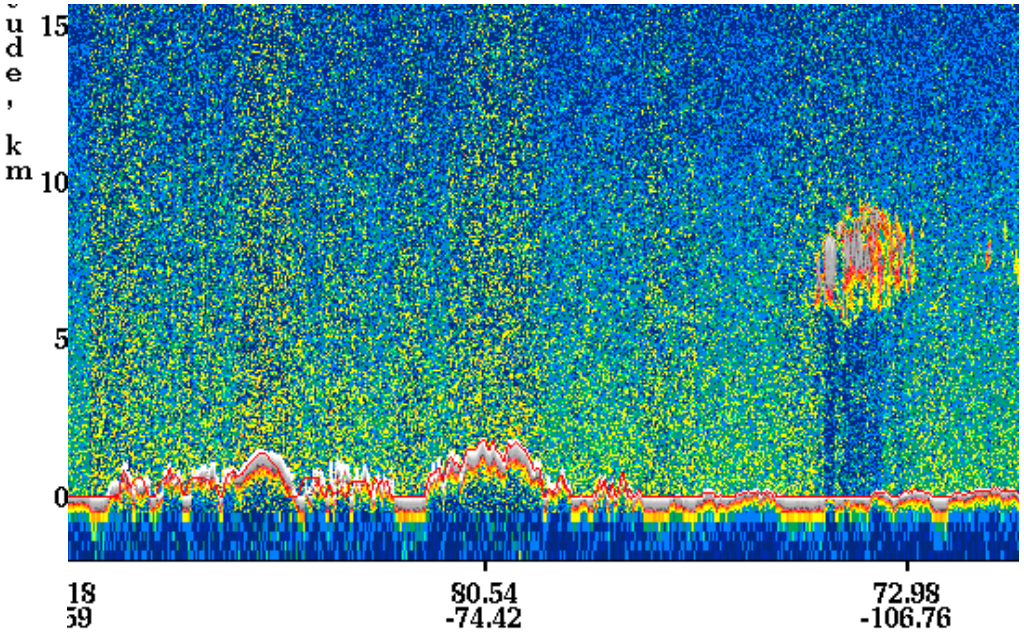


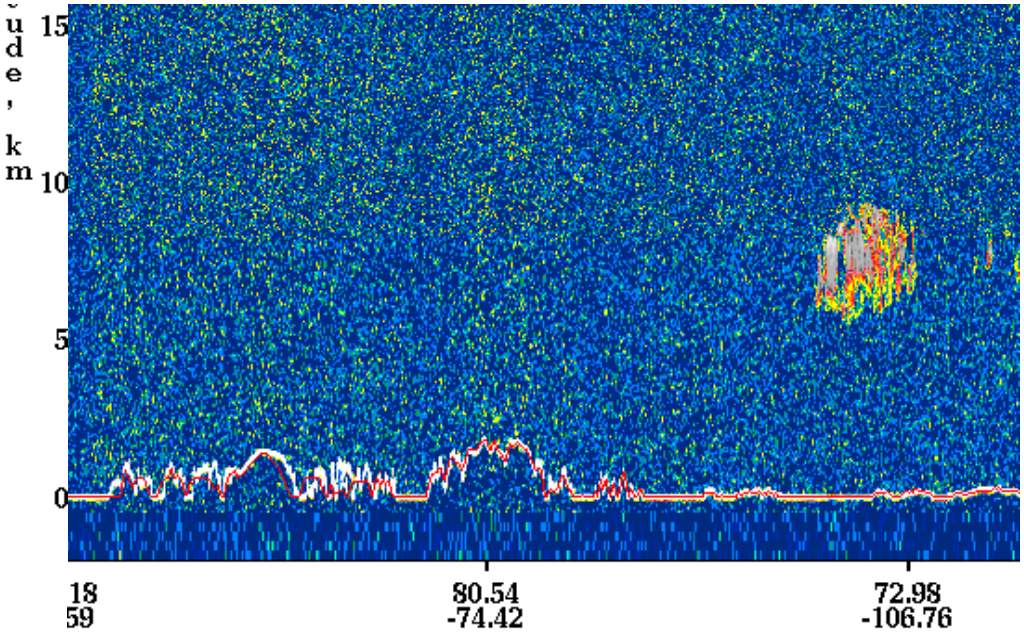
5-day forward trajectories provided by Brad Pierce (NOAA/NESDIS)

CALIPSO Obs 7/3:

Greenland

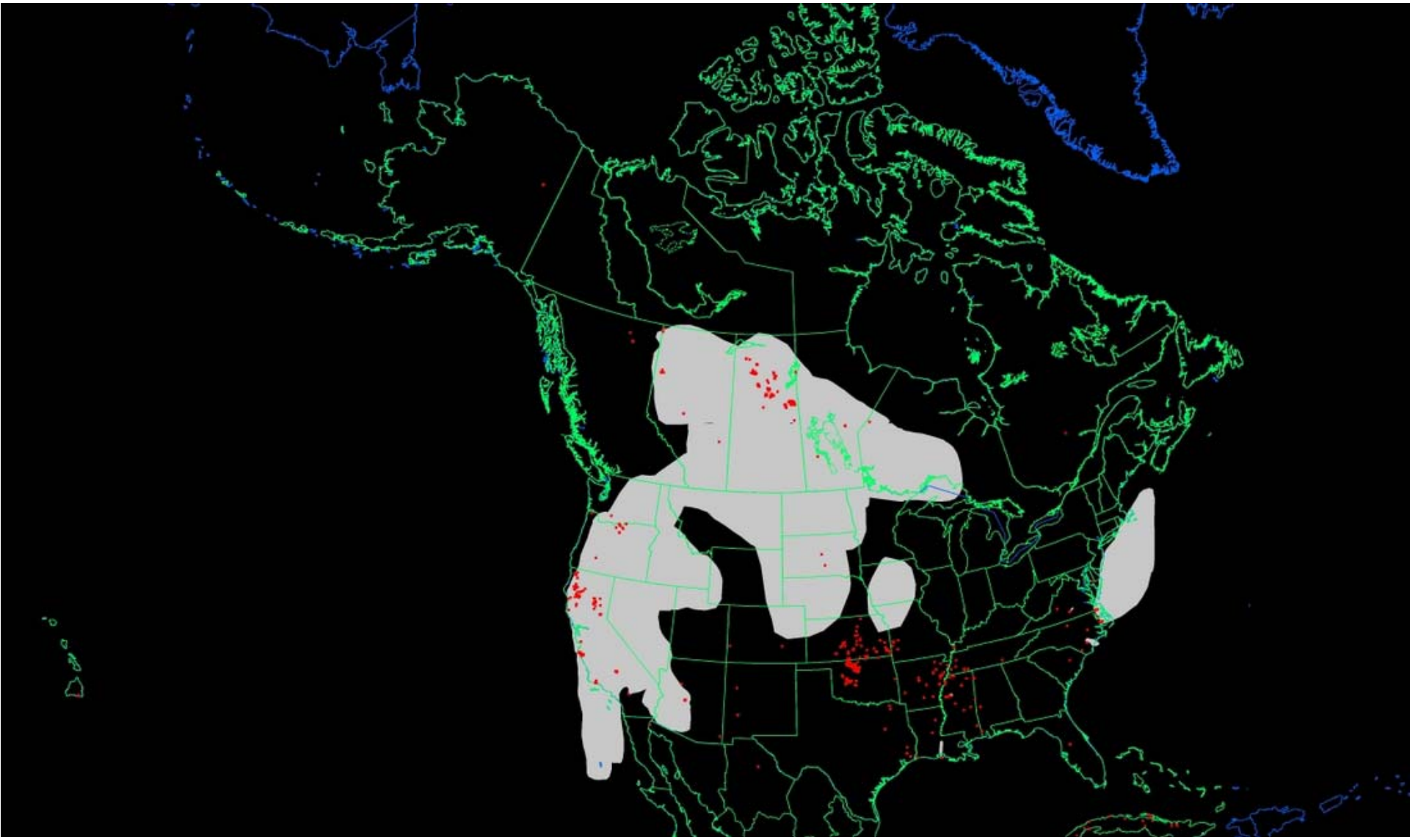






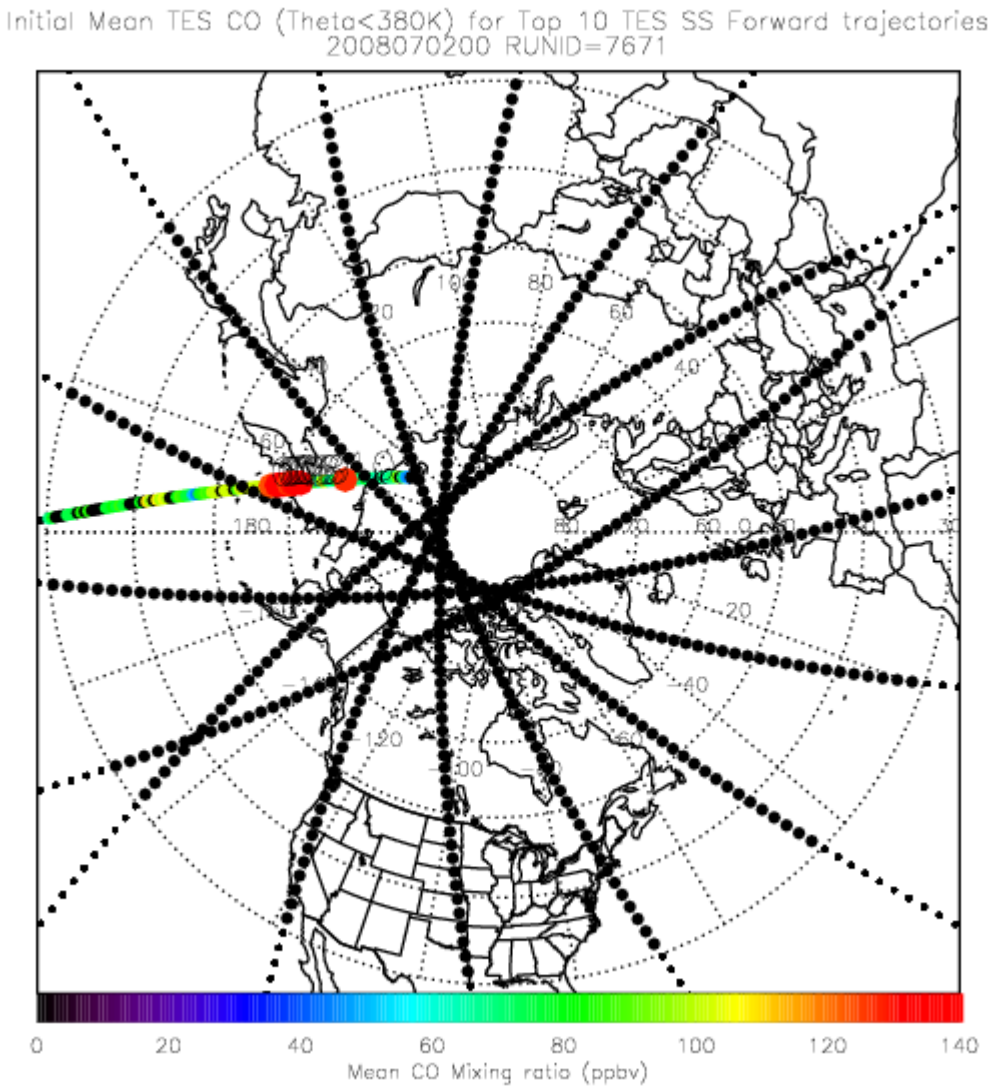
NOAA Hazard Mapping System Fire and Smoke Product

http://www.ssd.noaa.gov/PS/FIRE/hms.html



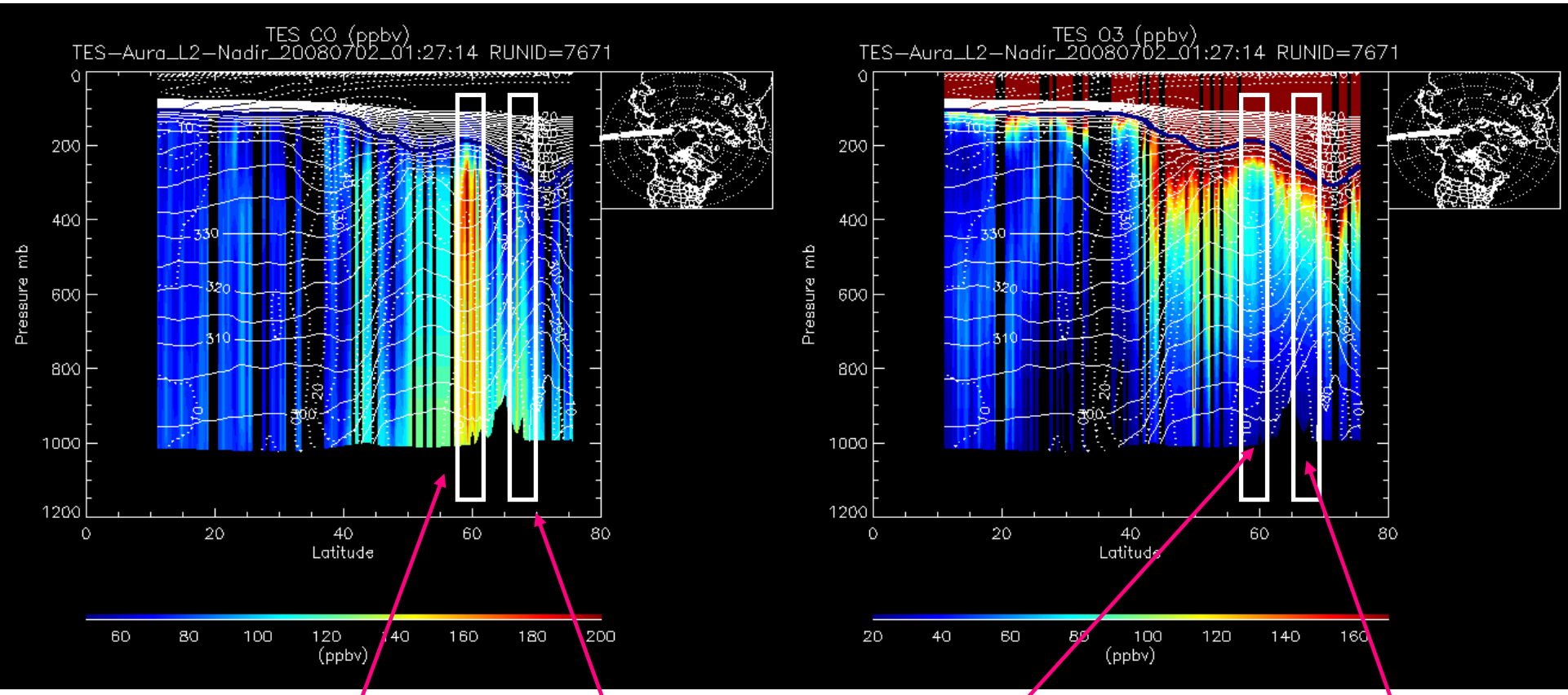
Analysis for day 7/3/2008 last updated at 7/4/2008 09:50:02 GMT

TES Step&Stare Obs 07/02 (Run ID 7671): Mean CO below 380K



TES CO (left) and O3 (right) curtains from SS orbit 7671 (07/02)

White boxes show regions of selected profiles



CO in excess of 200 ppbv

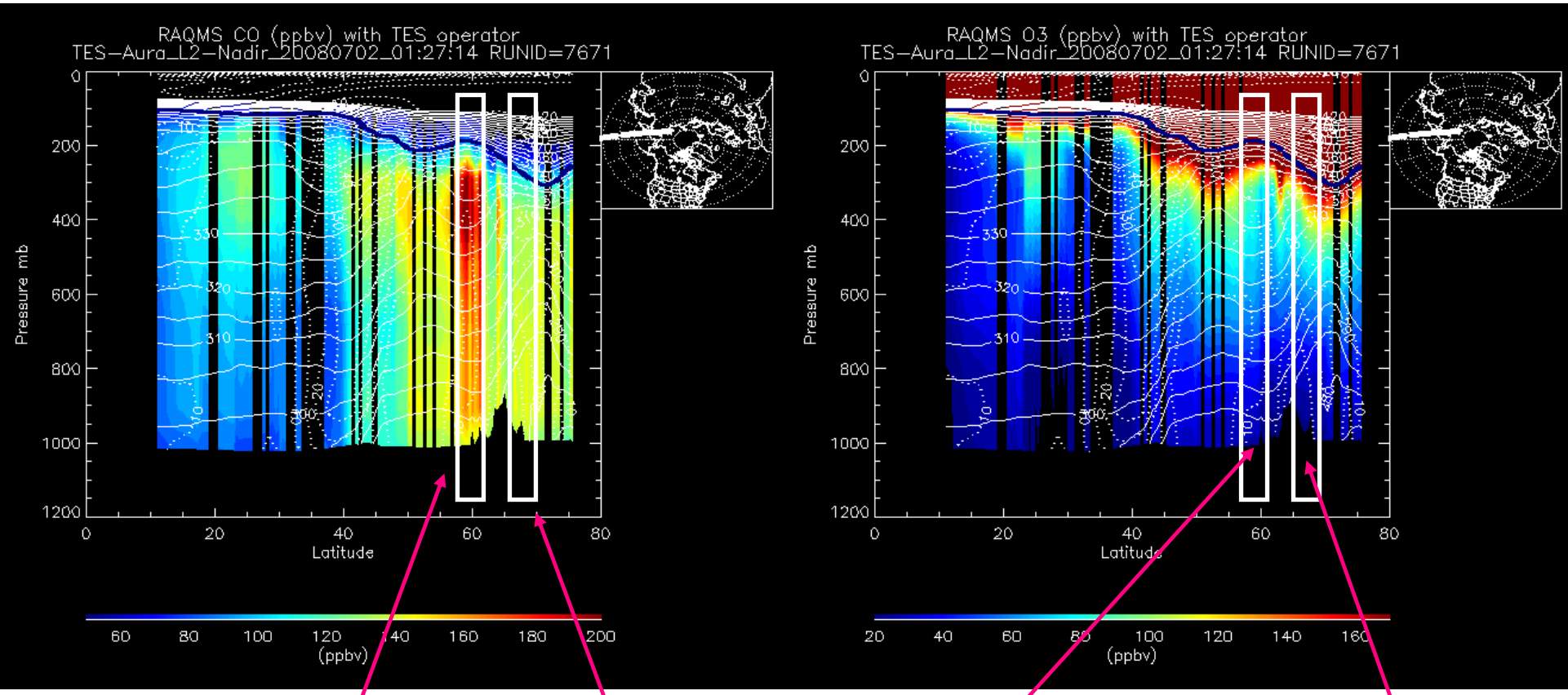
Co-located O3 enhancement

Single profile shows CO in excess of 150 ppbv

Co-located O3 enhancement in mid troposphere

$RAQMS_{TES_sens}$ CO (left) and O3 (right) curtains, SS orbit 7671

White boxes show regions of selected profiles



Largest model CO near surface and in upper trop; some enhancement througout free trop

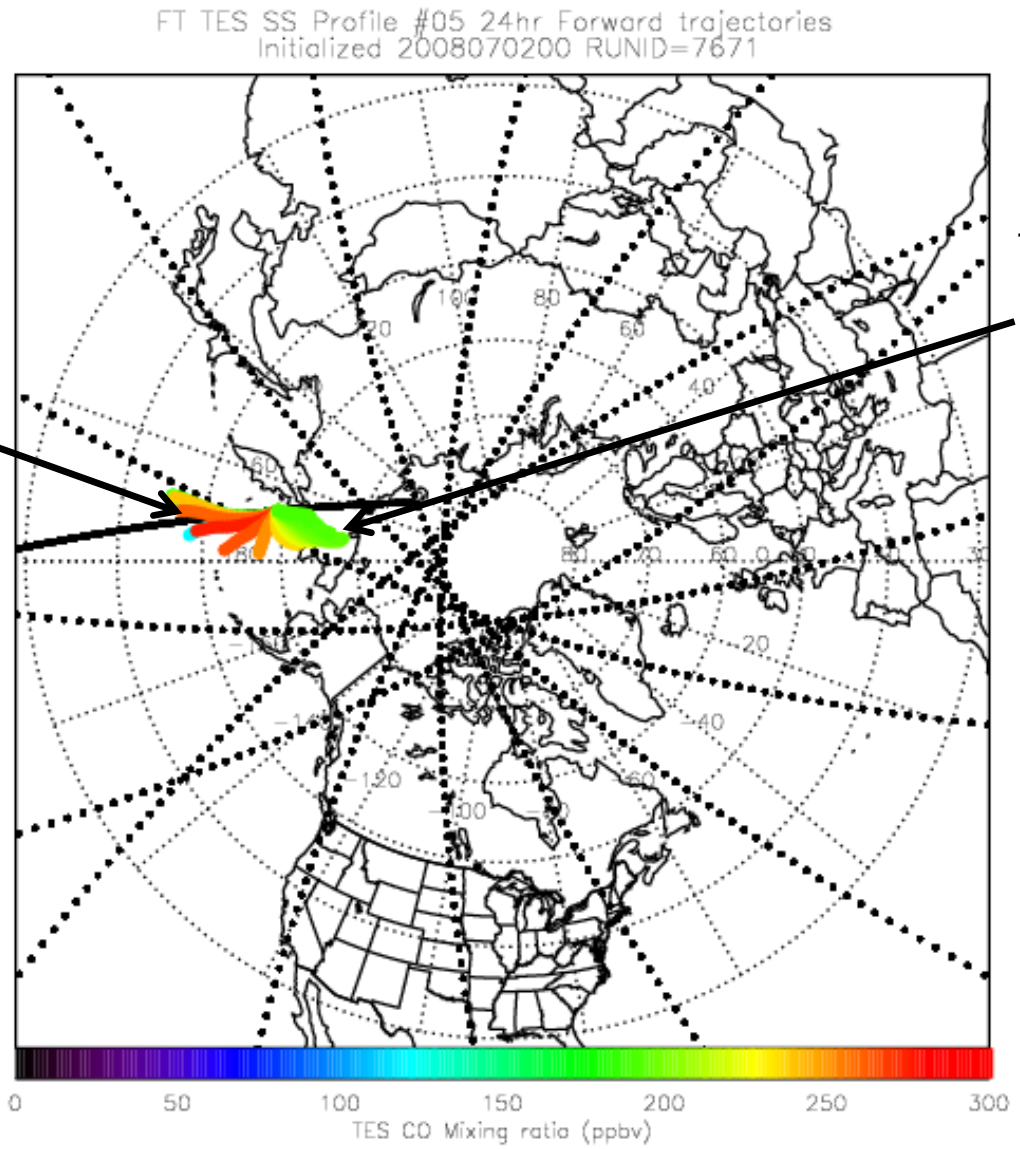
CO approx. 150 ppbv

Very little O3 enhancement in model

No O3 enhancement

PLAN A - TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/03

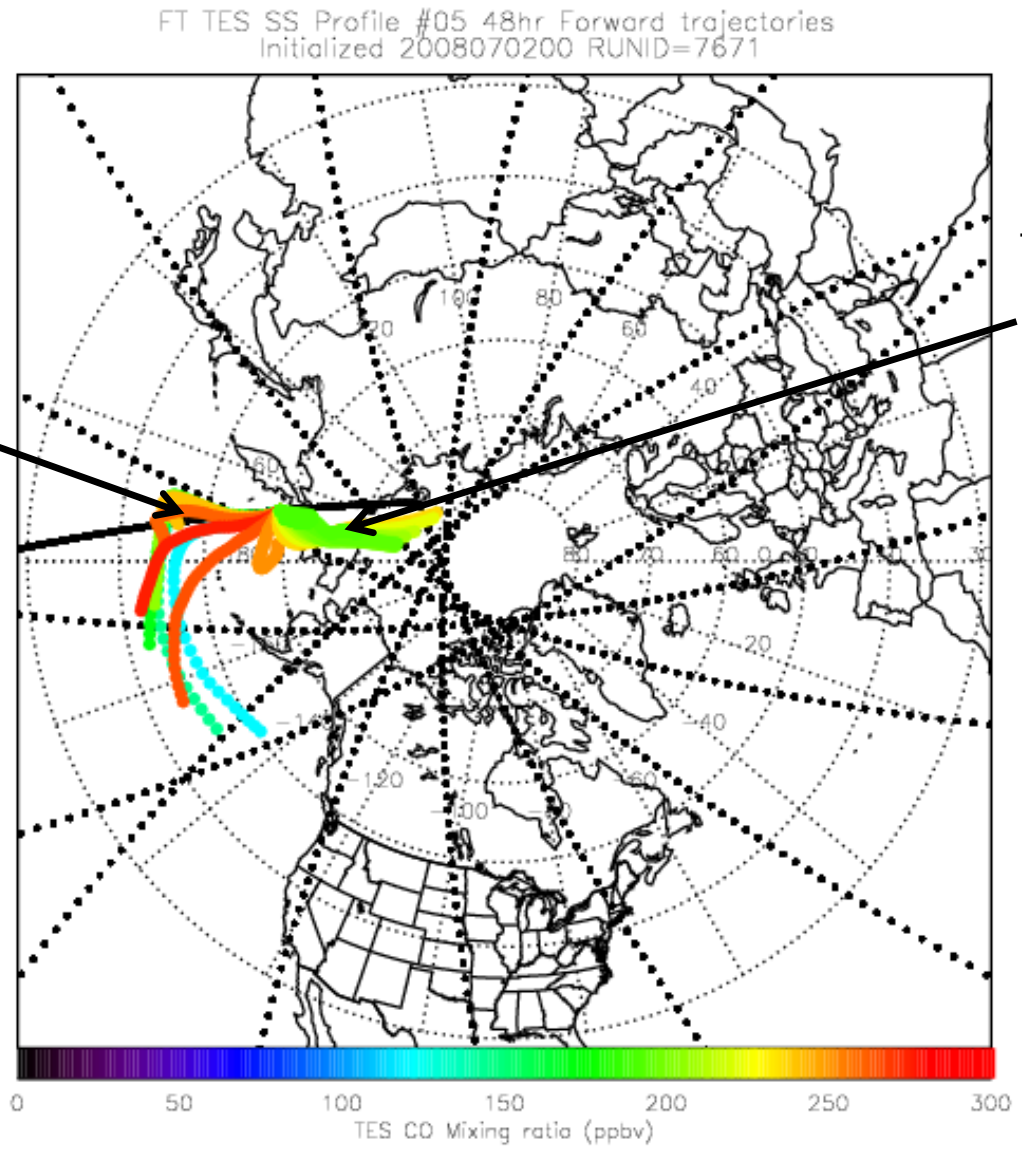
Mid to upper tropospheric air initially moves southwards



Whilst the lower tropospheric air moves northward

TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/04
(Late afternoon 07/03 mountain time)

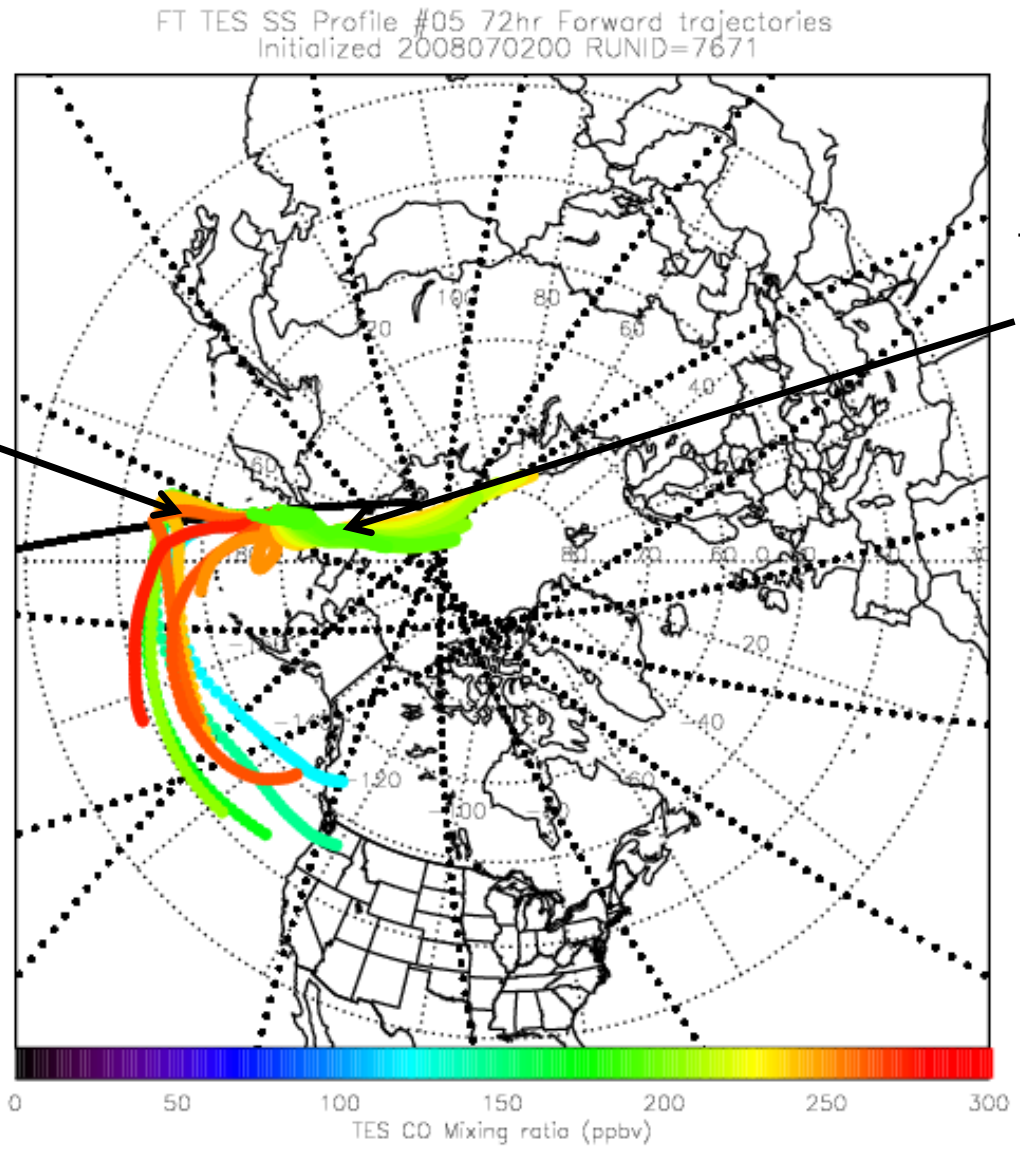
Mid to upper tropospheric air ini moves southwards



Whilst the lower tropospheric air moves northward

TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/05
(Late afternoon 07/04 mountain time)

Mid to upper tropospheric air initially moves southwards

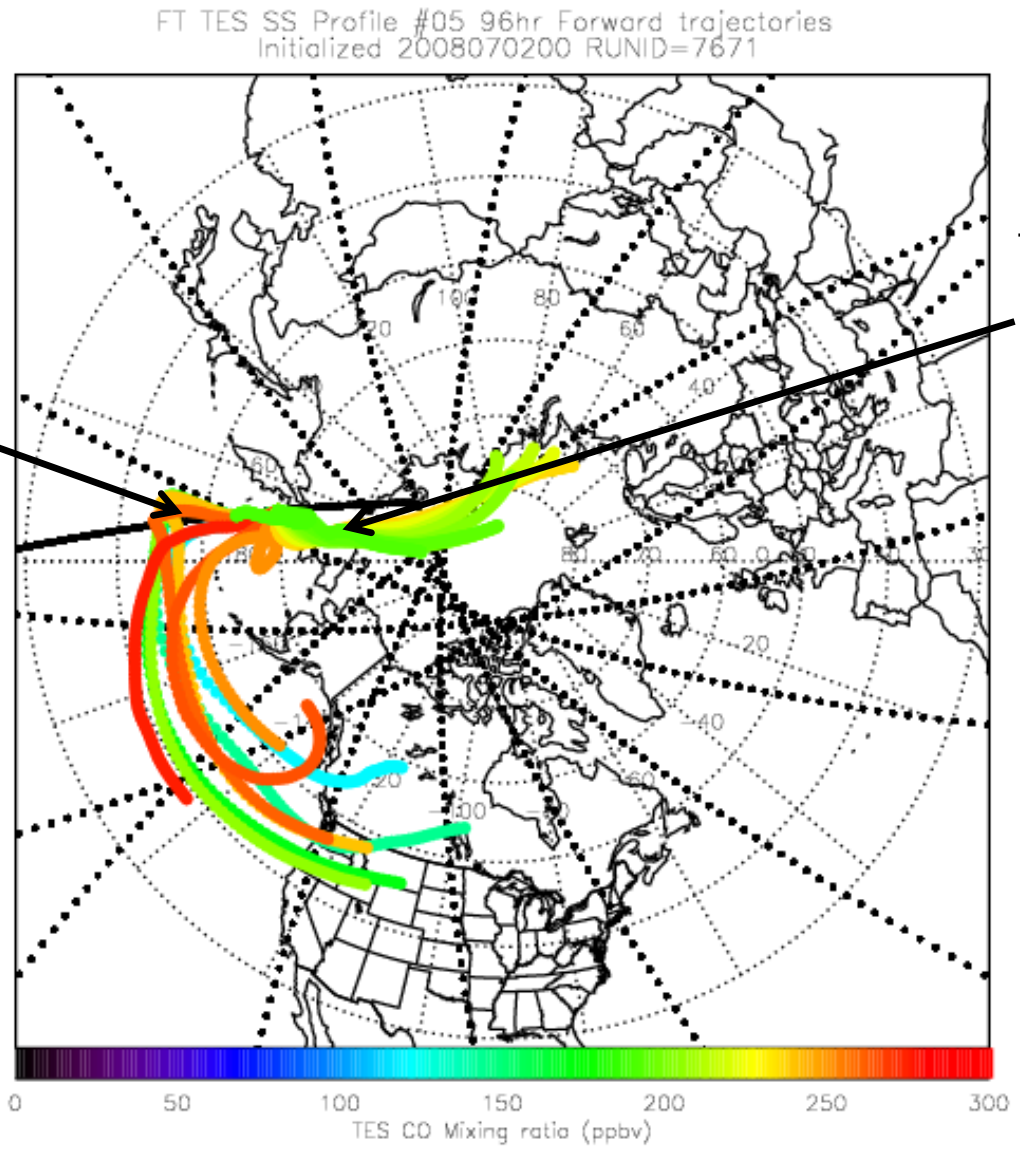


Whilst the lower tropospheric air moves northward

TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/06
(Late afternoon 07/05 mountain time)

Mid to upper tropospheric air initially moves southwards

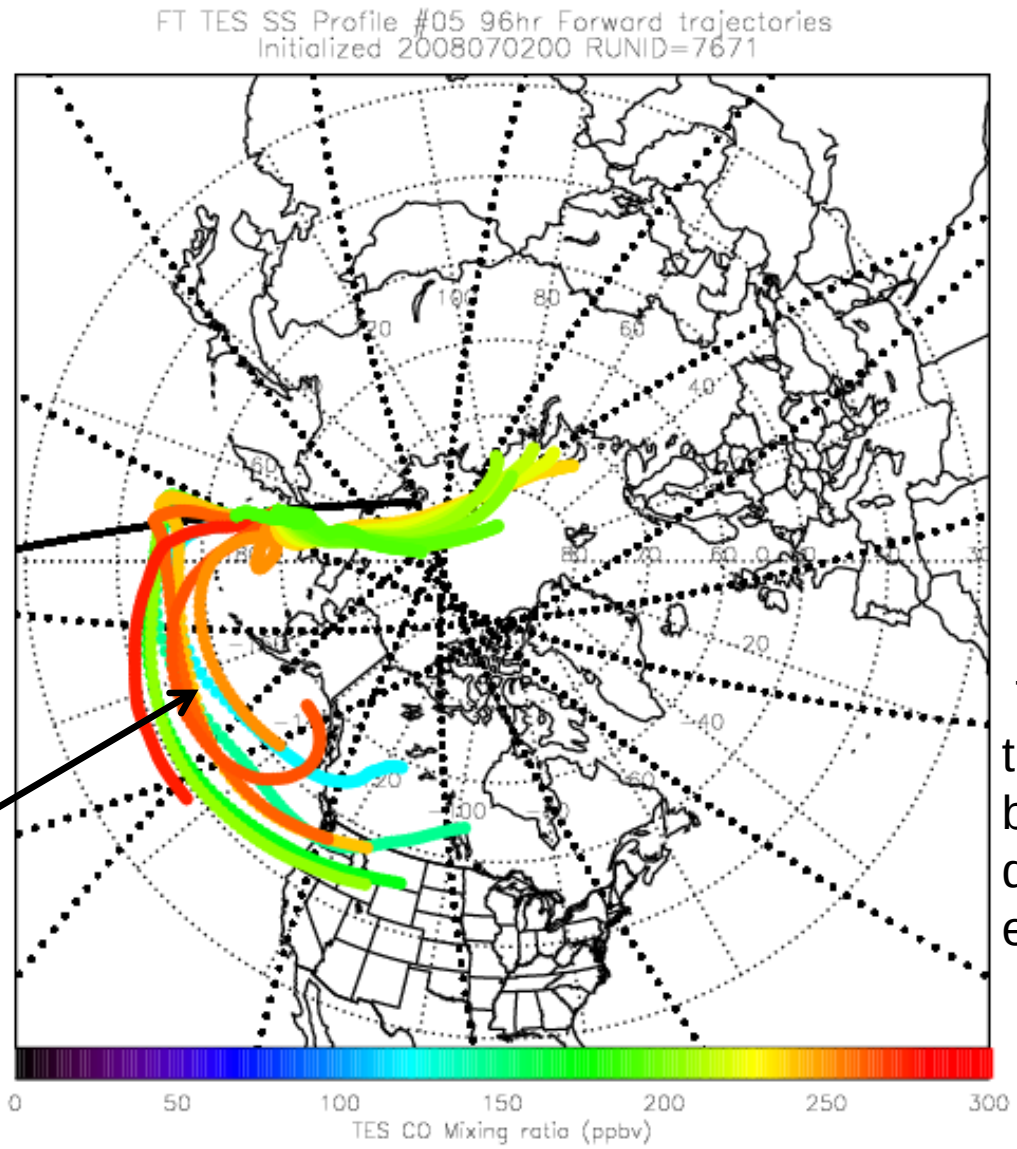
Whilst the lower tropospheric air moves northward



TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/06
(Late afternoon 07/05 mountain time)

These trajectories represent the likely location of the Siberian plume at the flight time tomorrow according to RAQMS.

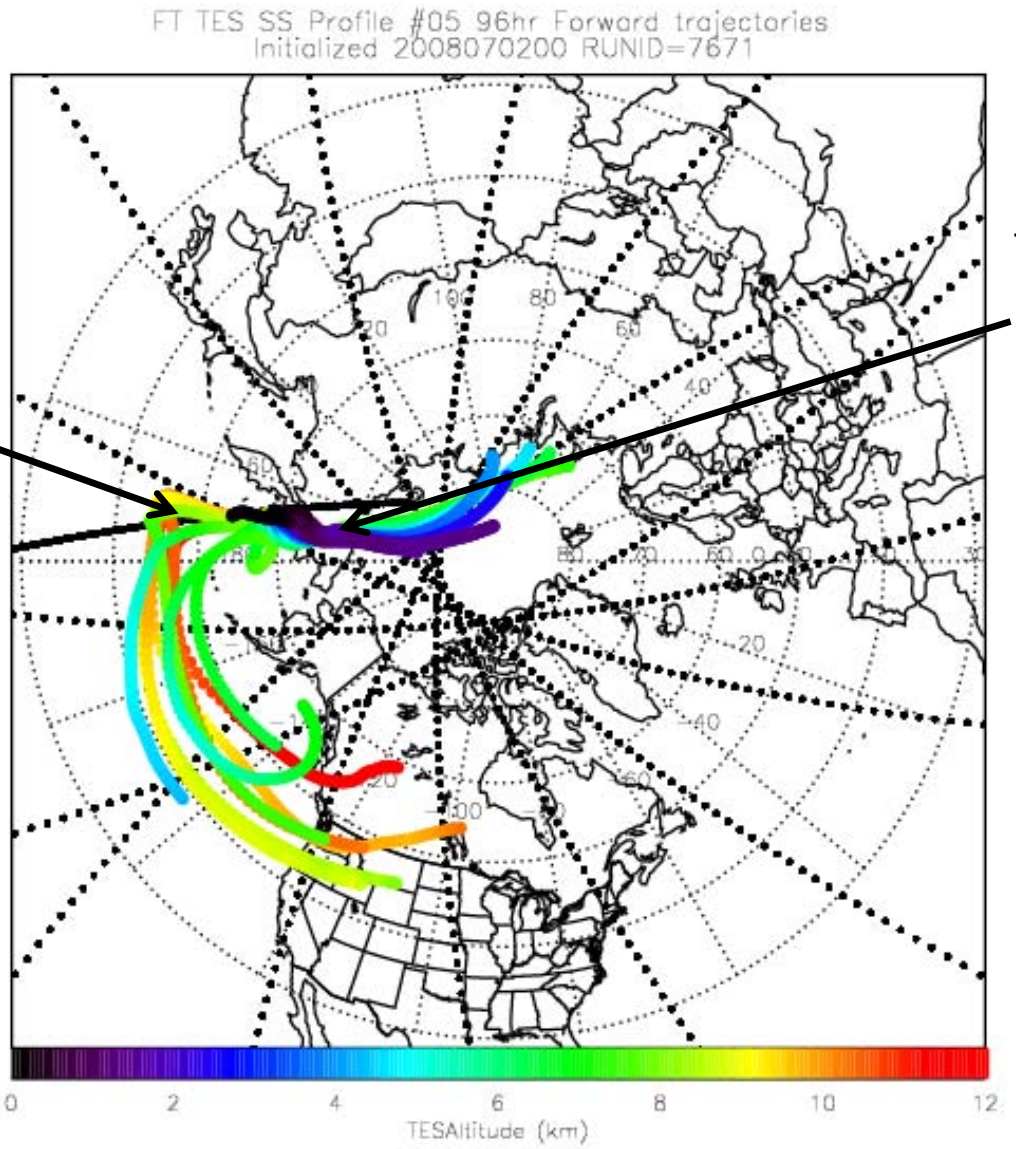
This flow pattern is broadly represented across several trajectories.



The other trajectories show broader spatial distribution of the elevated CO

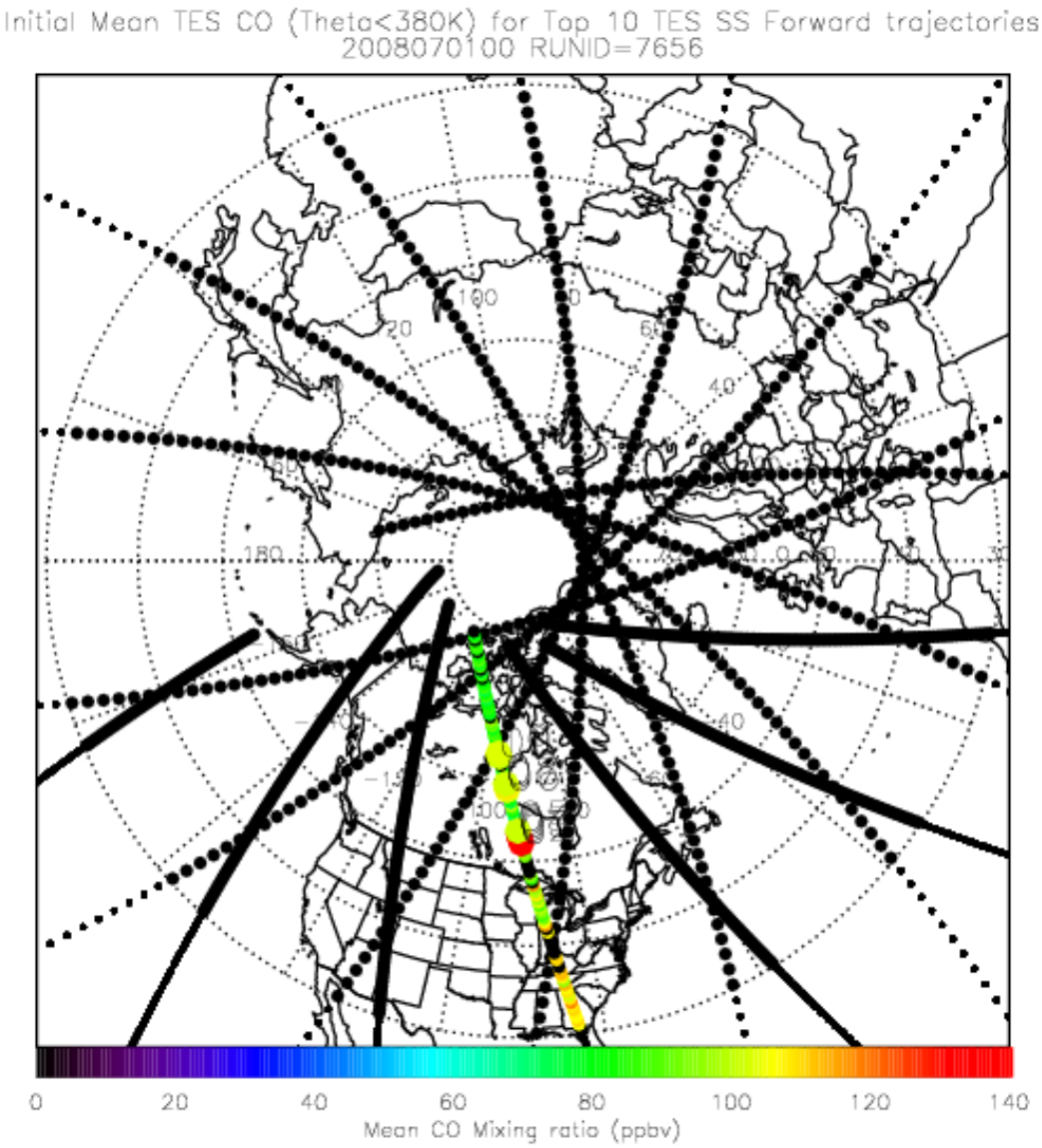
TES SS Forward Trajectories “Profile 5”, RunID 7671 Valid 00Z 07/06
(Late afternoon 07/05 mountain time)

Mid to upper tropospheric air initially moves southwards

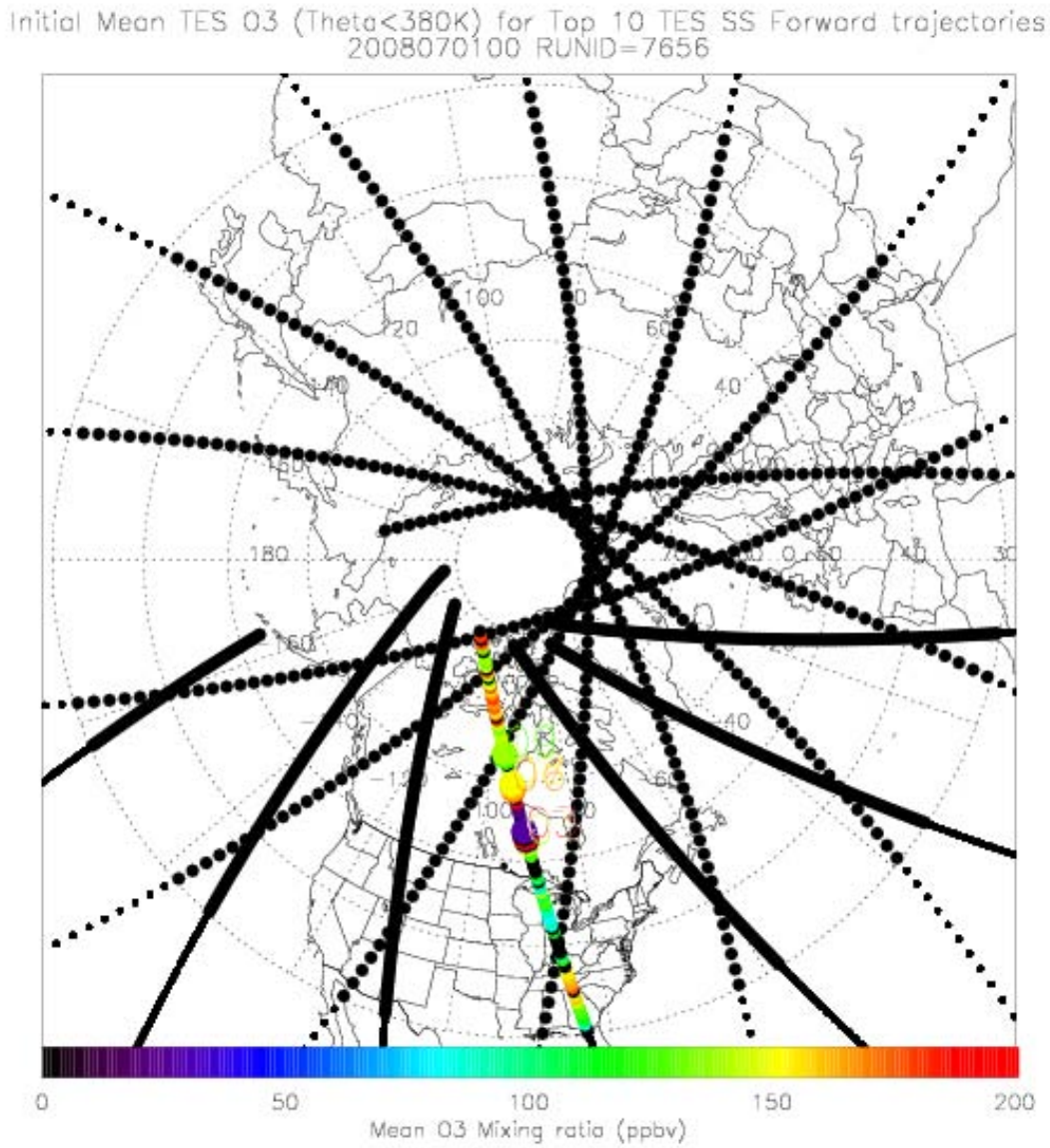


Whilst the lower tropospheric air moves northward

TES Step&Stare Obs 07/01 (Run ID 7656): Mean CO below 380K

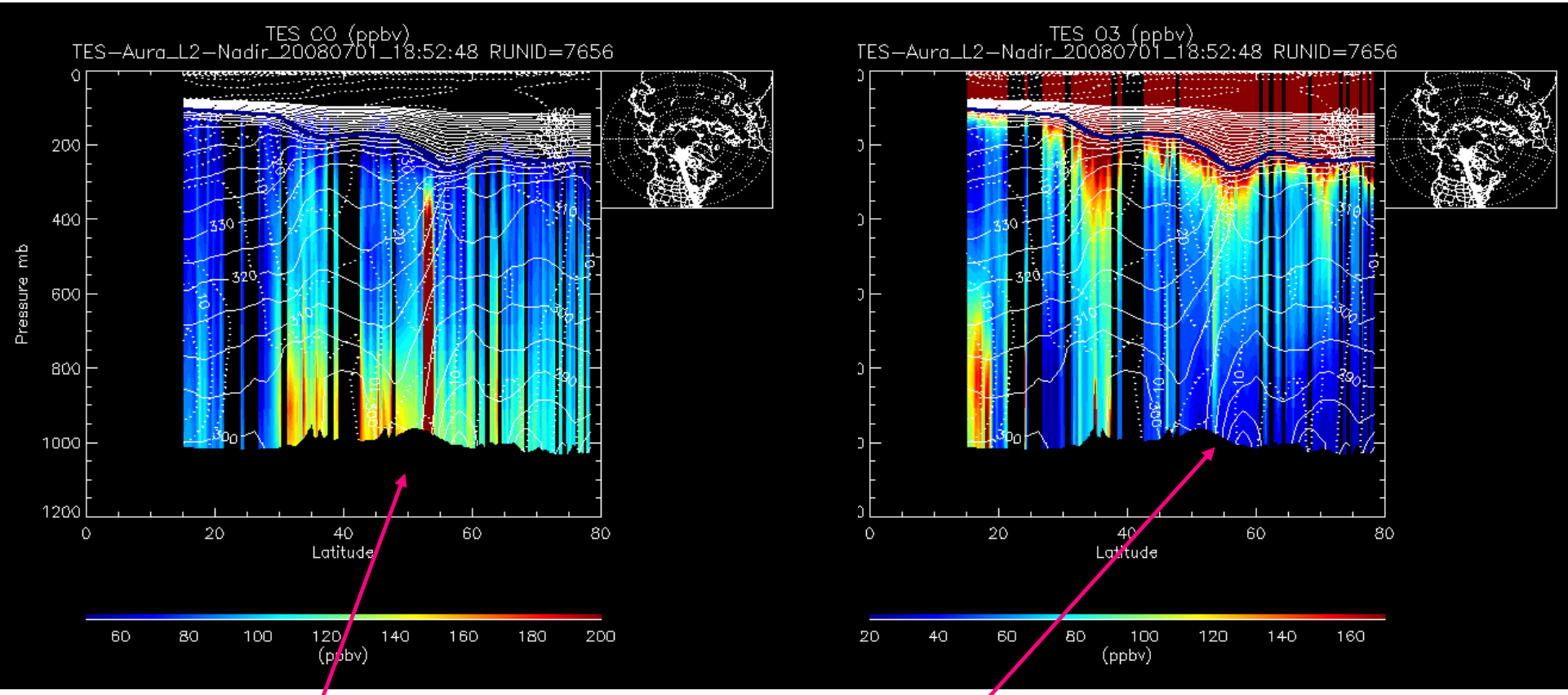


TES Step&Stare Obs 07/01 (Run ID 7656): Mean O_3 below 380K



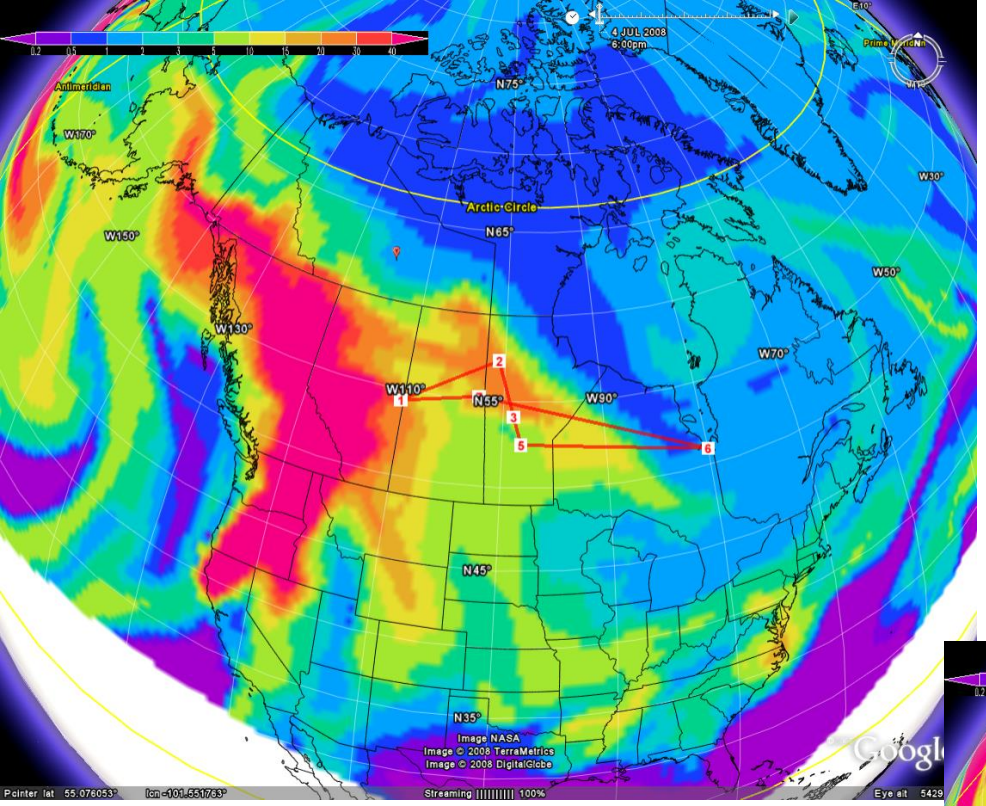
TES CO (left) and O3 (right) curtains from SS orbit 7656 (07/01)

White boxes show regions of selected profiles



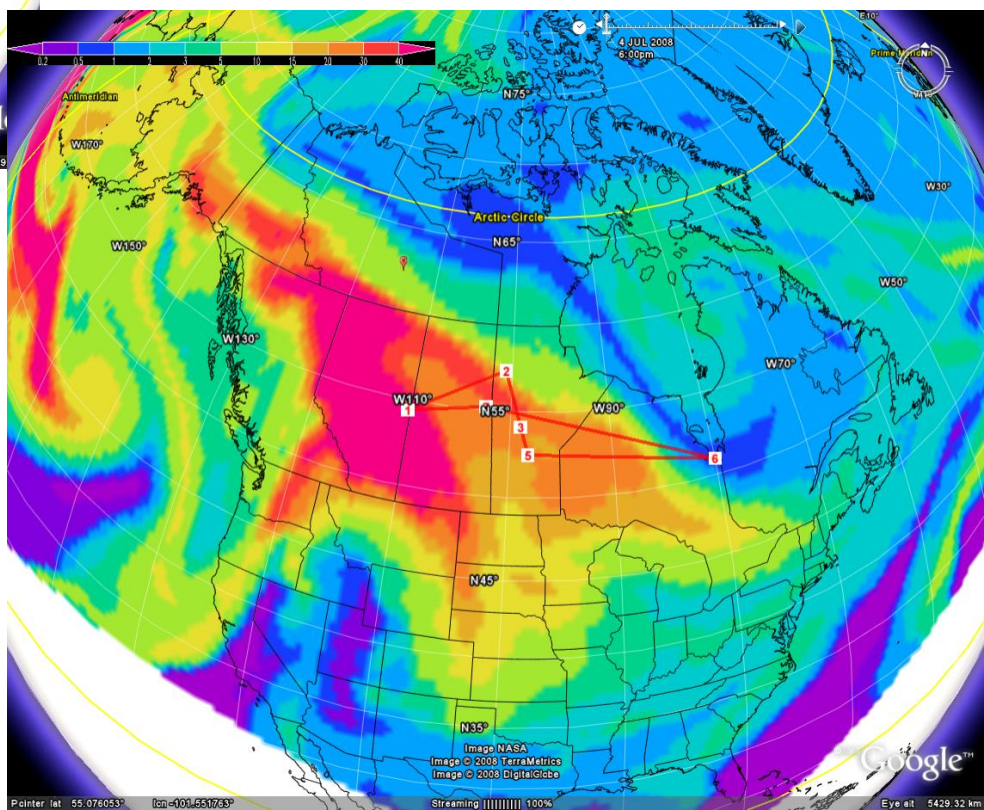
CO actually in excess of 600 ppbv

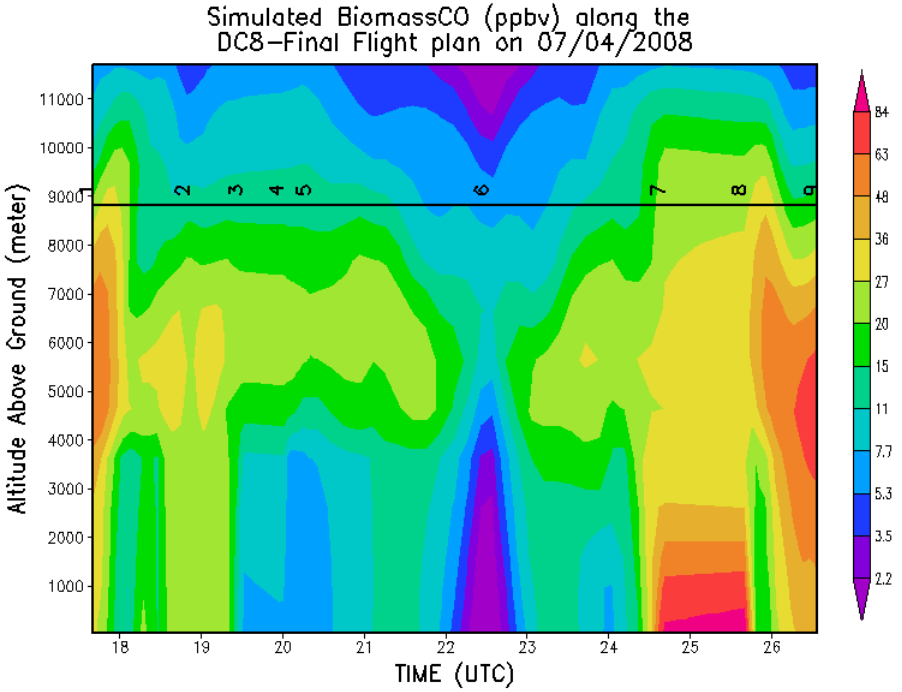
Co-located O_3 enhancement

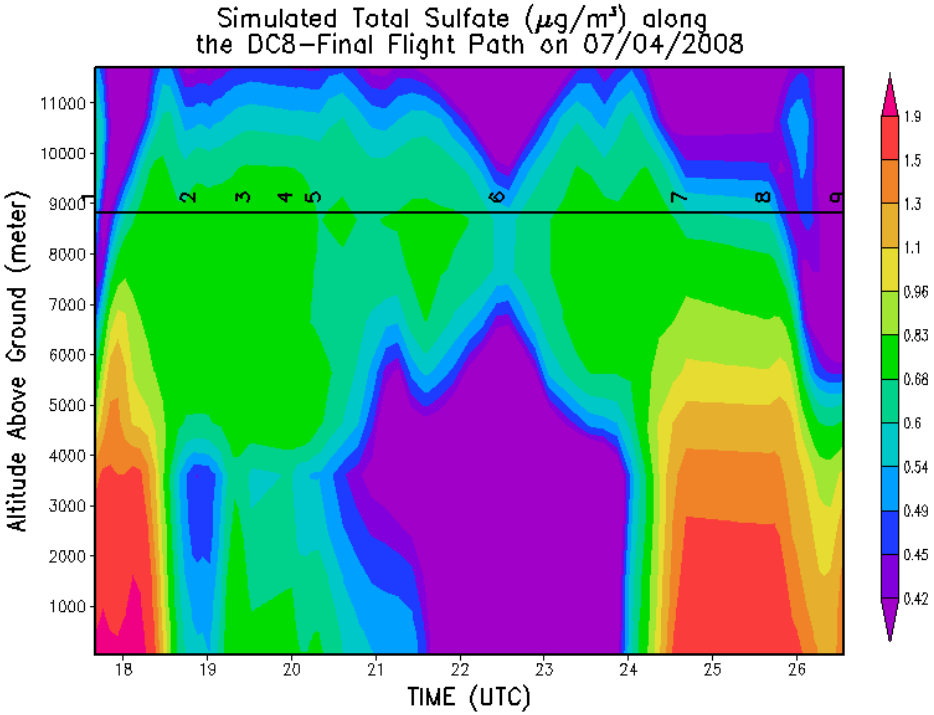


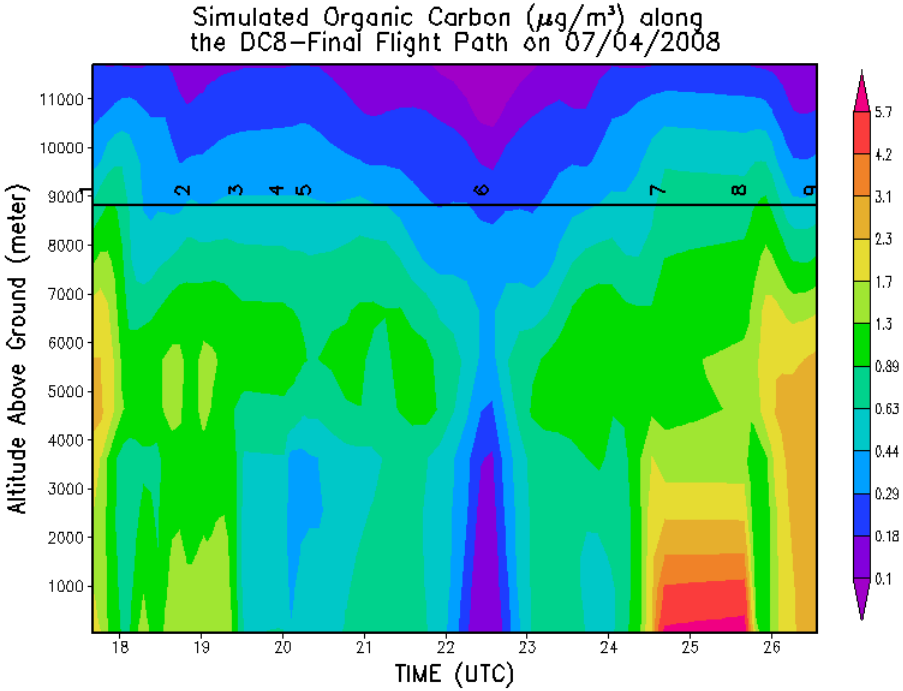
Biomass CO, 18Z, 1.5km

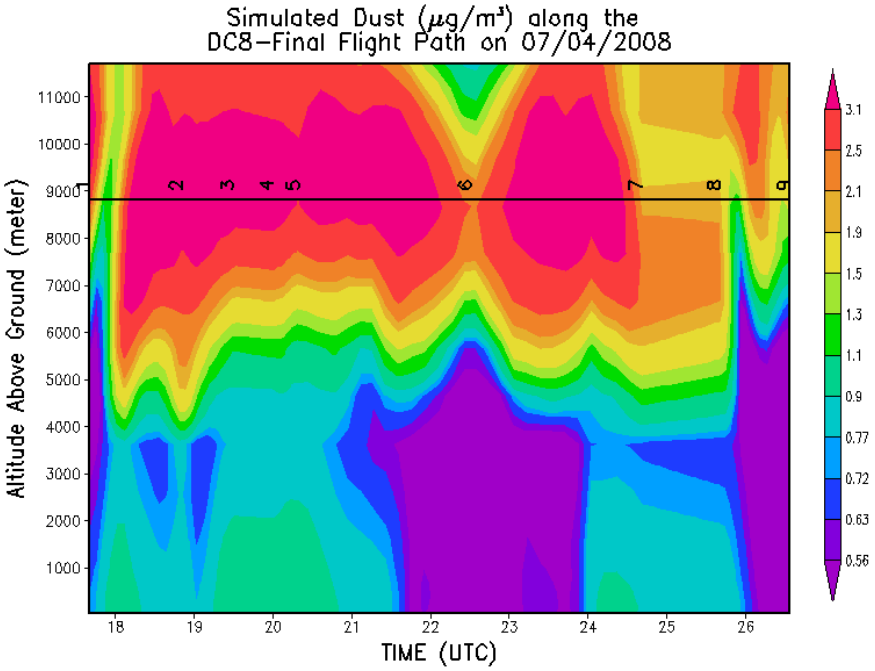
Biomass CO, 18Z, 5.5km



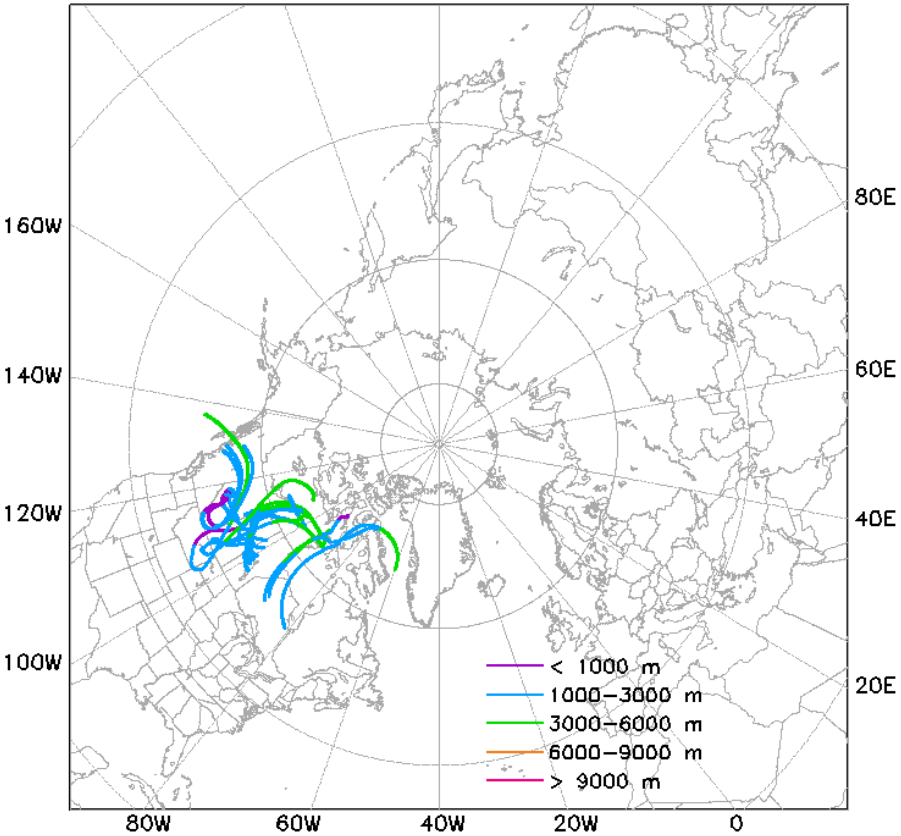

Simulated BiomassCO (ppbv) along the
DC8-Final Flight plan on 07/04/2008
Altitude Above Ground (meter)
TIME (UTC)
84
63
48
36
27
20
15
11
7.7
5.3
3.5
2.2


Simulated Total Sulfate (μg/m³) along
the DC8-Final Flight Path on 07/04/2008
Altitude Above Ground (meter)
TIME (UTC)
1.9
1.5
1.3
1.1
0.96
0.83
0.68
0.6
0.54
0.49
0.45
0.42

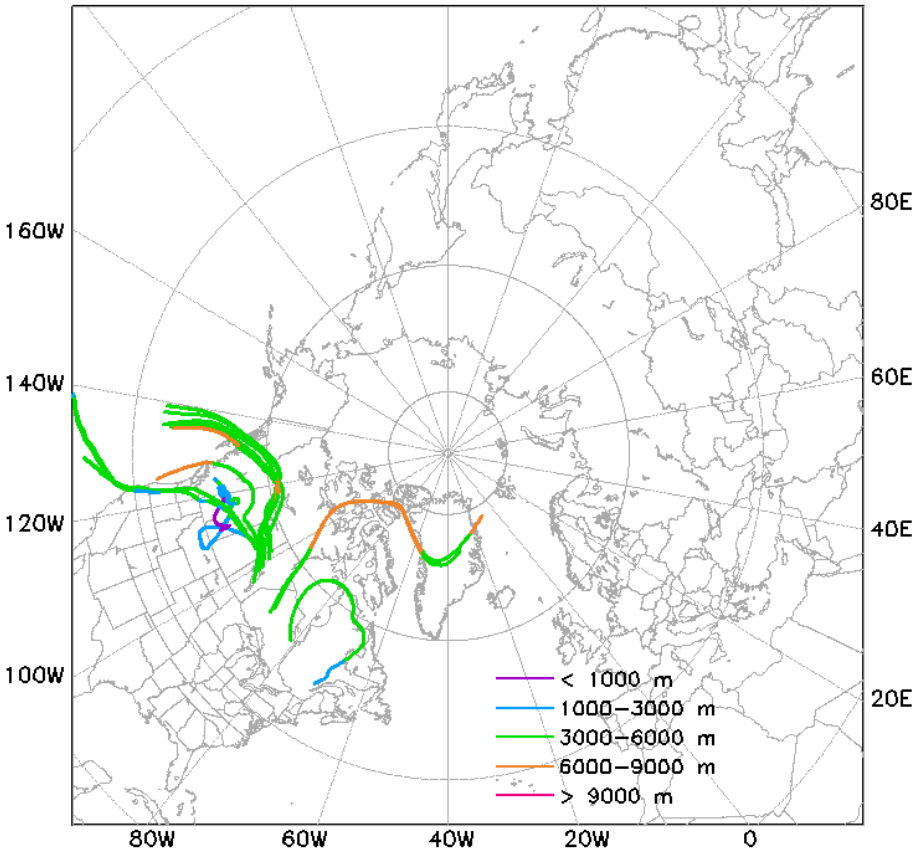

Simulated Organic Carbon (μg/m³) along
the DC8-Final Flight Path on 07/04/2008
Altitude Above Ground (meter)
TIME (UTC)
5.7
4.2
3.1
2.3
1.7
1.3
0.89
0.63
0.44
0.29
0.18
0.1


Simulated Dust (μg/m³) along the
DC8-Final Flight Path on 07/04/2008
Altitude Above Ground (meter)
TIME (UTC)
3.1
2.5
2.1
1.9
1.5
1.3
1.1
0.9
0.77
0.72
0.63
0.56

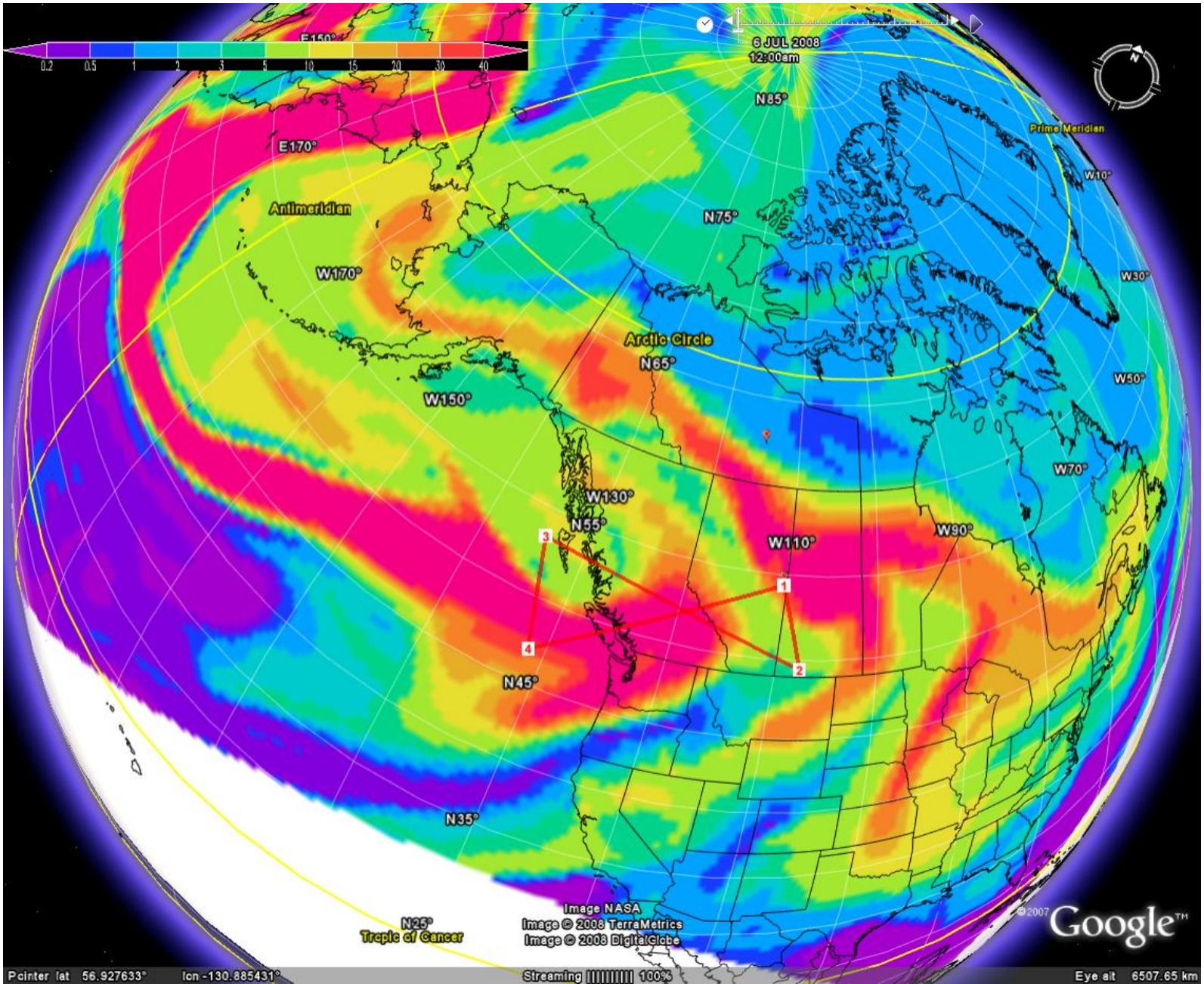
ARCTAS backtraj DC8-Final 07/04/2008 at 2 km

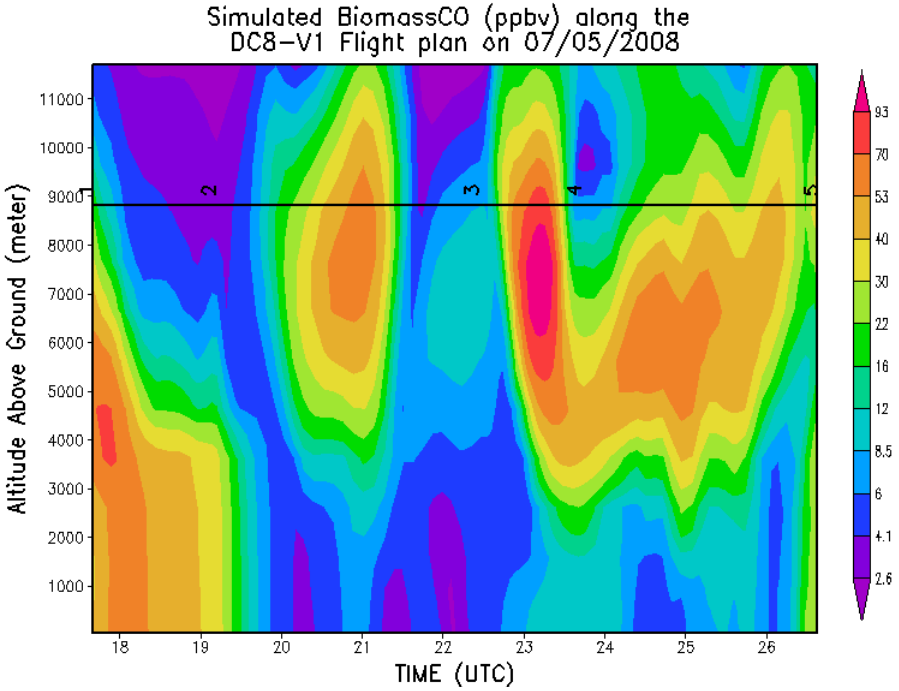


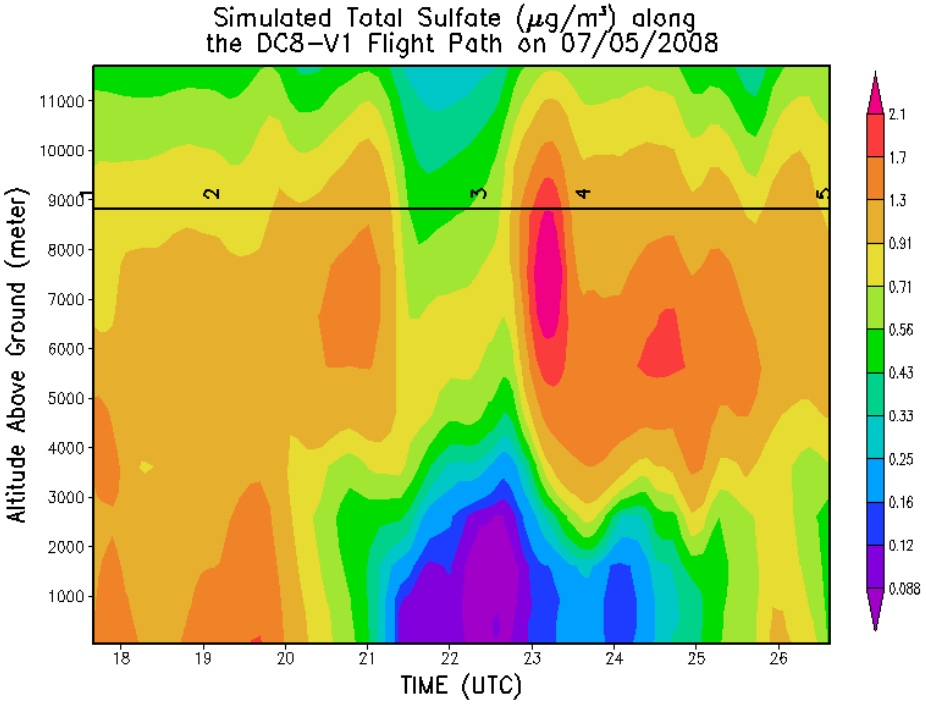
ARCTAS backtraj DC8-Final 07/04/2008 at 5 km

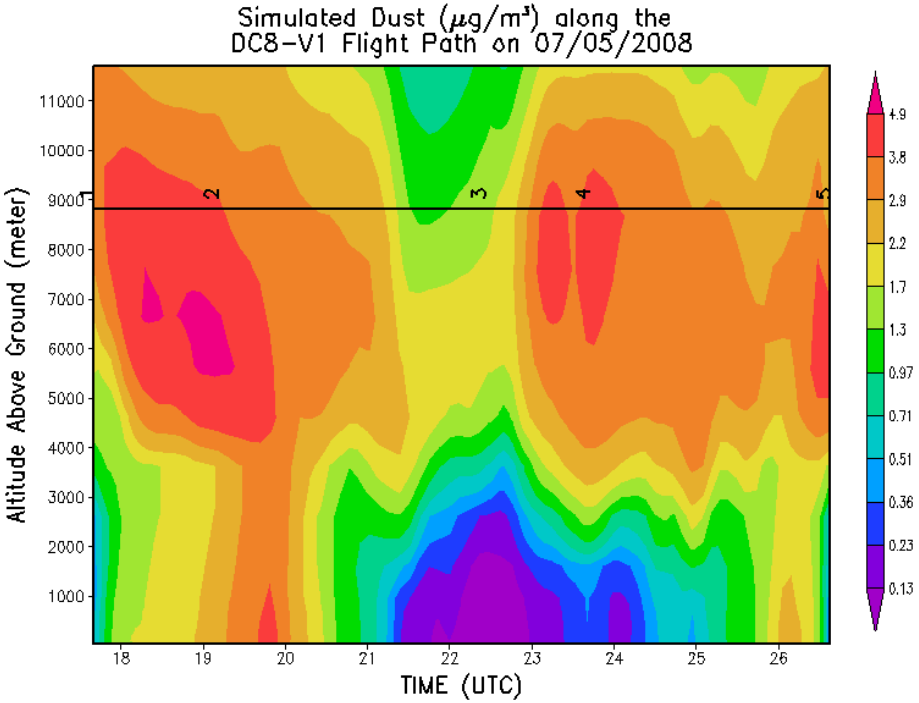


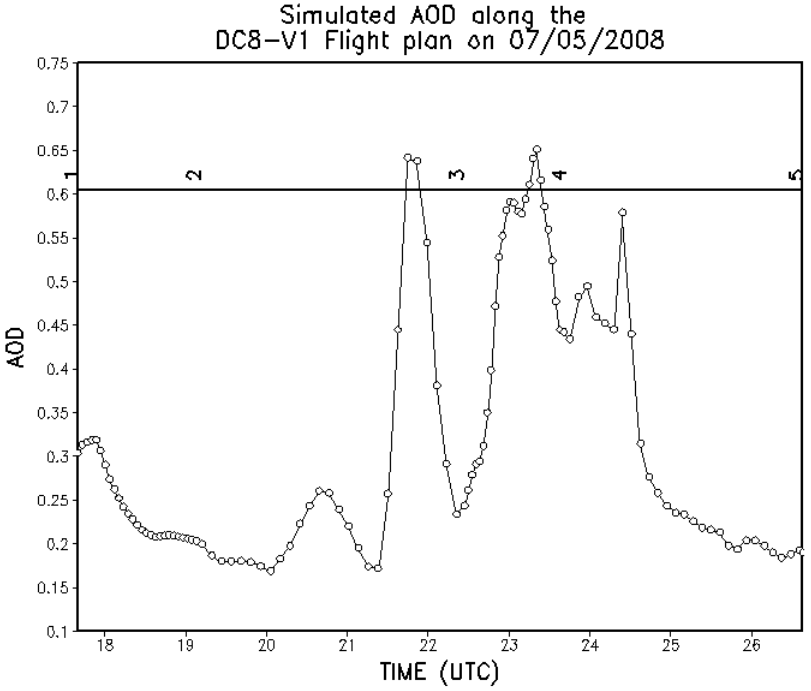
DC8-V1, Biomass CO, 5.5 km 0Z,Jul6



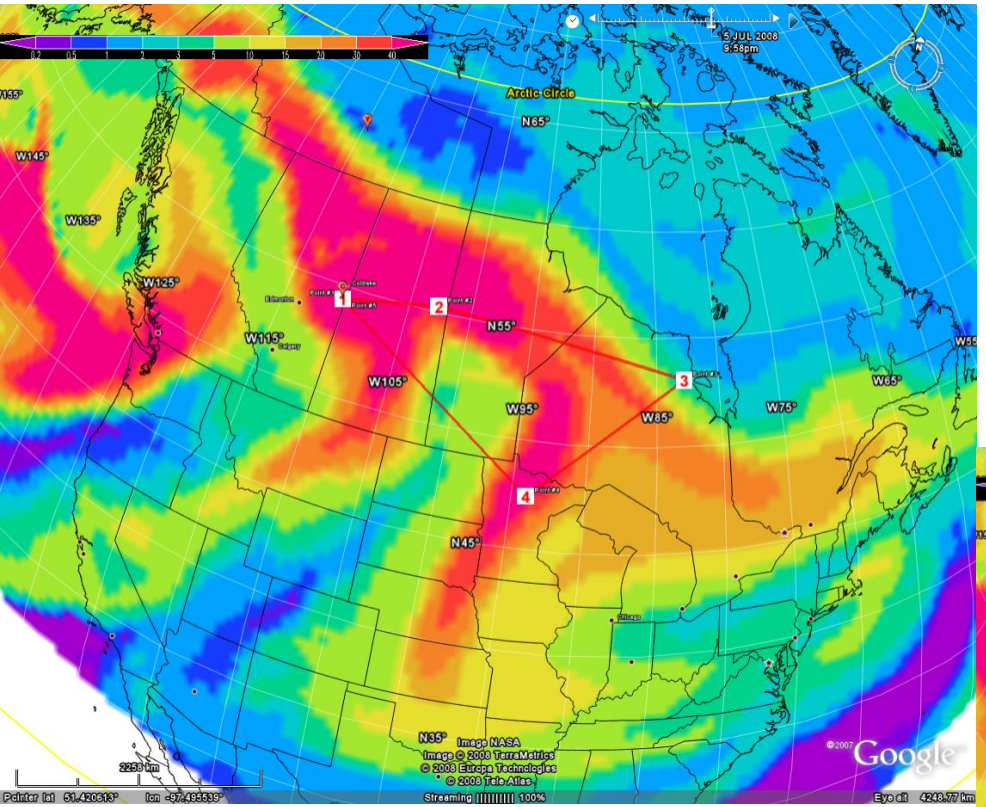

Simulated BiomassCO (ppbv) along the
DC8-V1 Flight plan on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
1
2
3
4
5
93
70
53
40
30
22
16
12
8.5
6
4.1
2.6


Simulated Total Sulfate (μg/m³) along
the DC8-V1 Flight Path on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
1
2
3
4
5
2.1
1.7
1.3
0.91
0.71
0.56
0.43
0.33
0.25
0.16
0.12
0.088


Simulated Dust (μg/m³) along the
DC8-V1 Flight Path on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
1
2
3
4
5
4.9
3.8
2.9
2.2
1.7
1.3
0.97
0.71
0.51
0.36
0.23
0.13

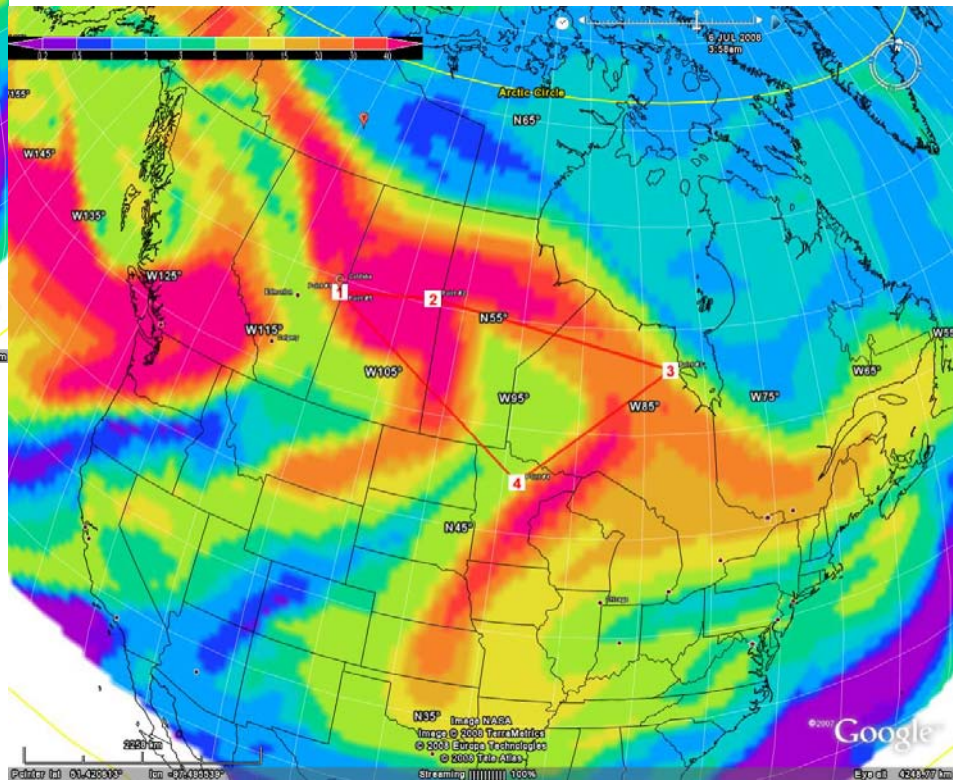

Simulated AOD along the
DC8-V1 Flight plan on 07/05/2008
AOD
TIME (UTC)
1
2
3
4
5

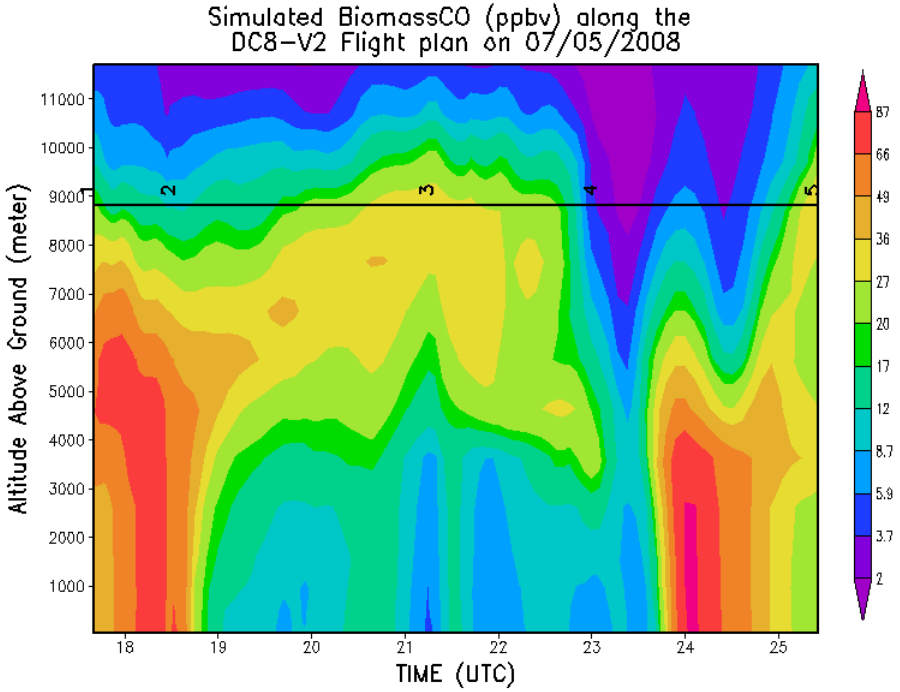
DC8v2-July5, 5.5km

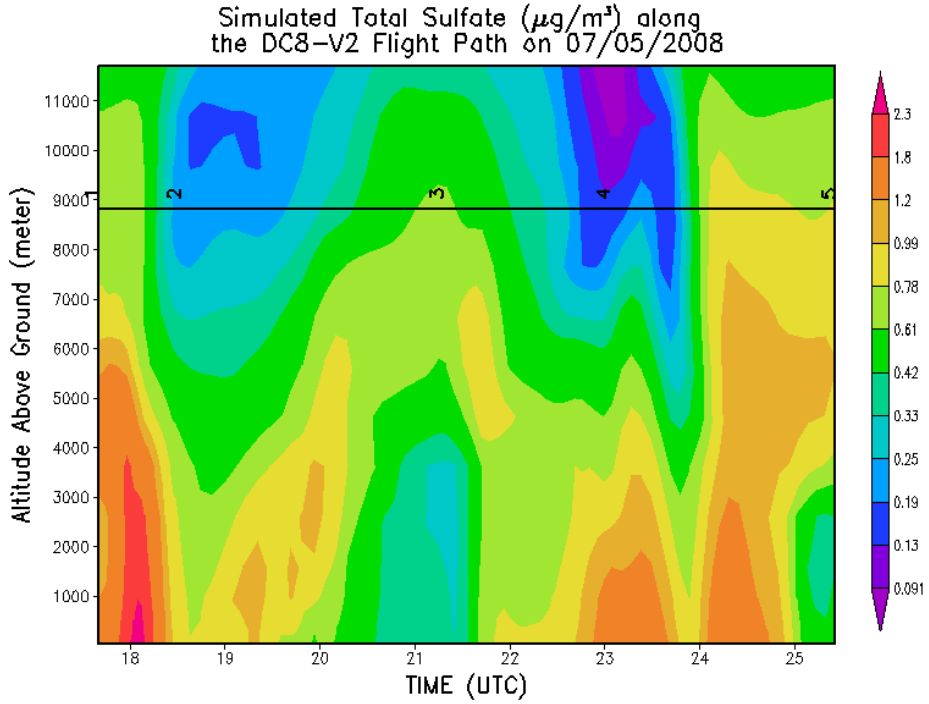


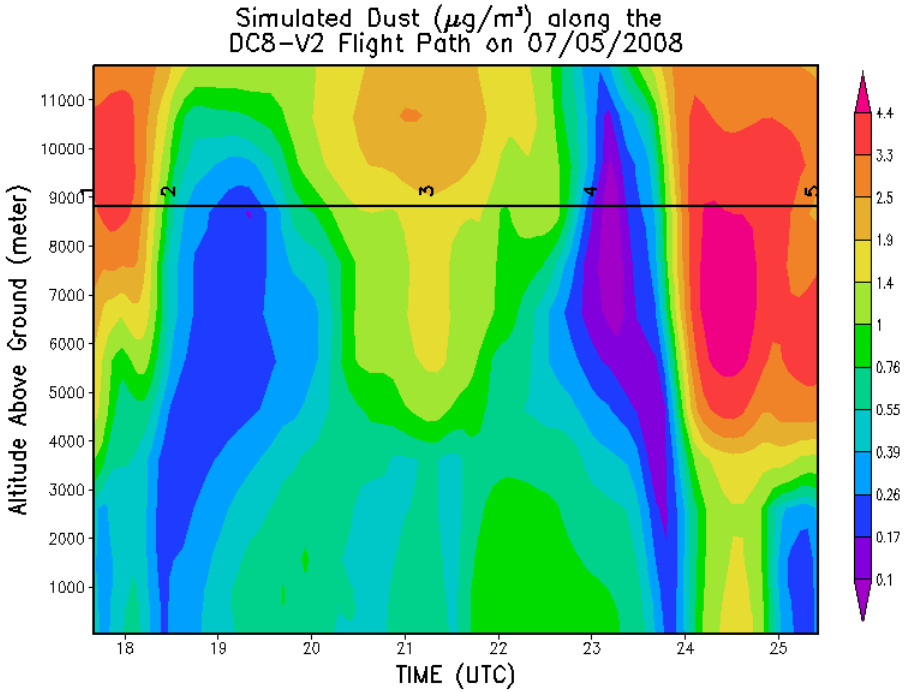
18Z,July5

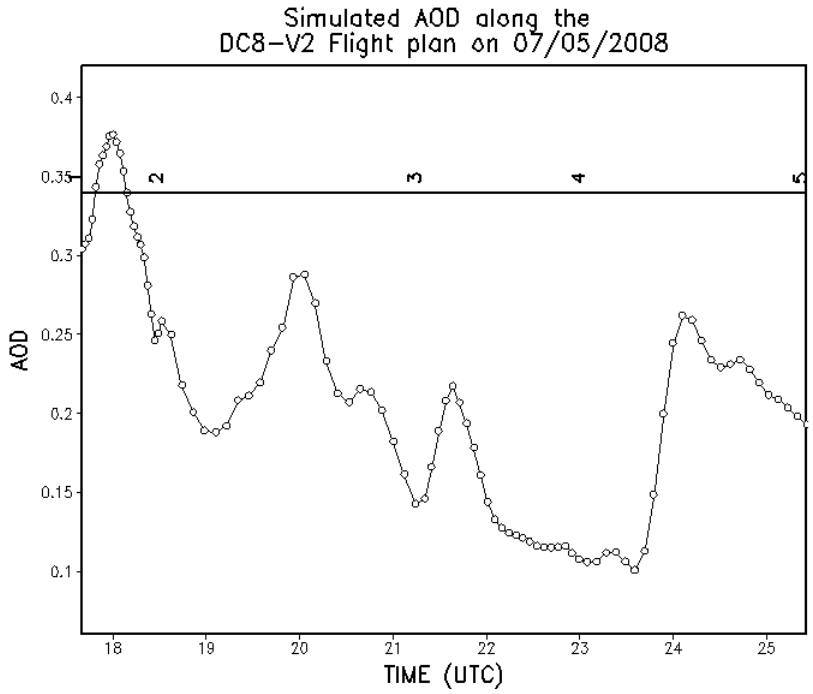
0Z,july6

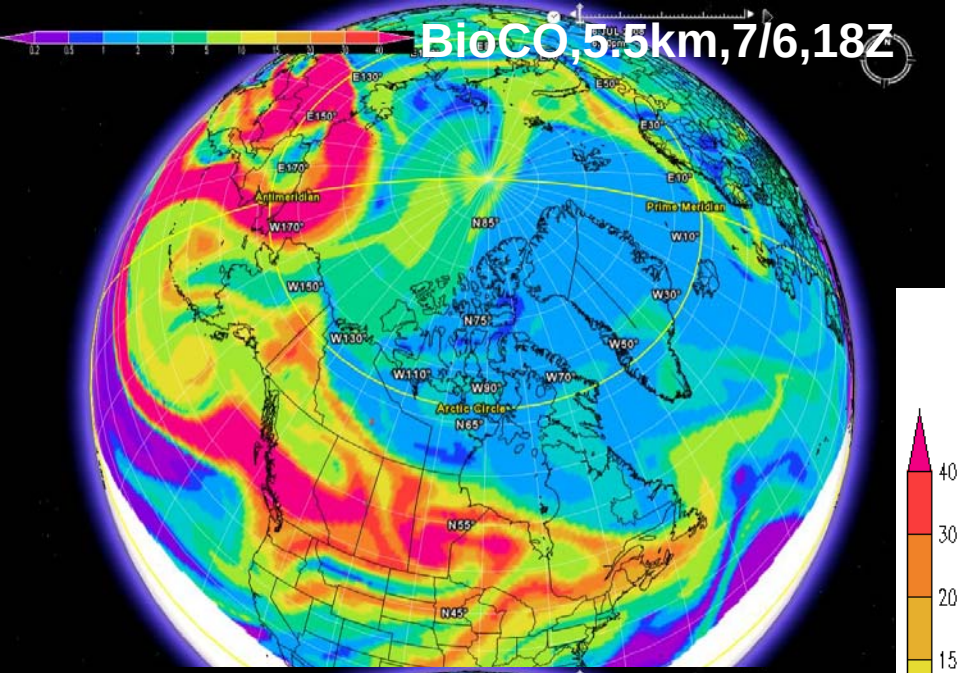


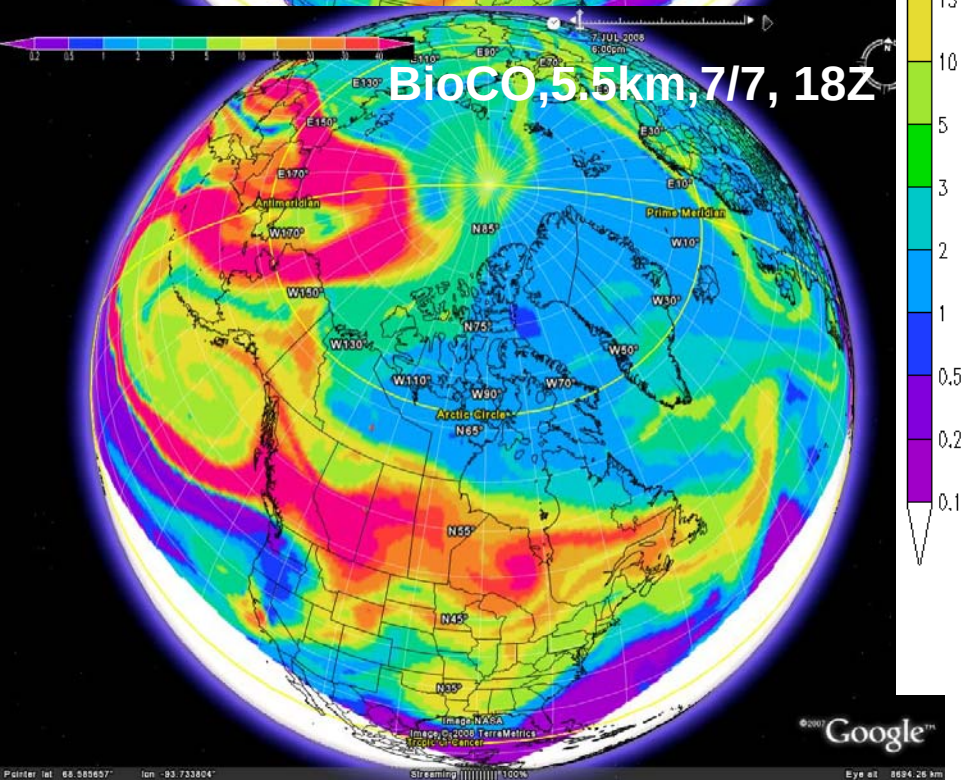

Simulated BiomassCO (ppbv) along the
DC8-V2 Flight plan on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
87
66
49
36
27
20
17
12
8.7
5.9
3.7
2

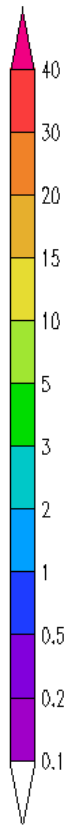

Simulated Total Sulfate (μg/m³) along
the DC8-V2 Flight Path on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
2.3
1.8
1.2
0.99
0.78
0.61
0.42
0.33
0.25
0.19
0.13
0.091

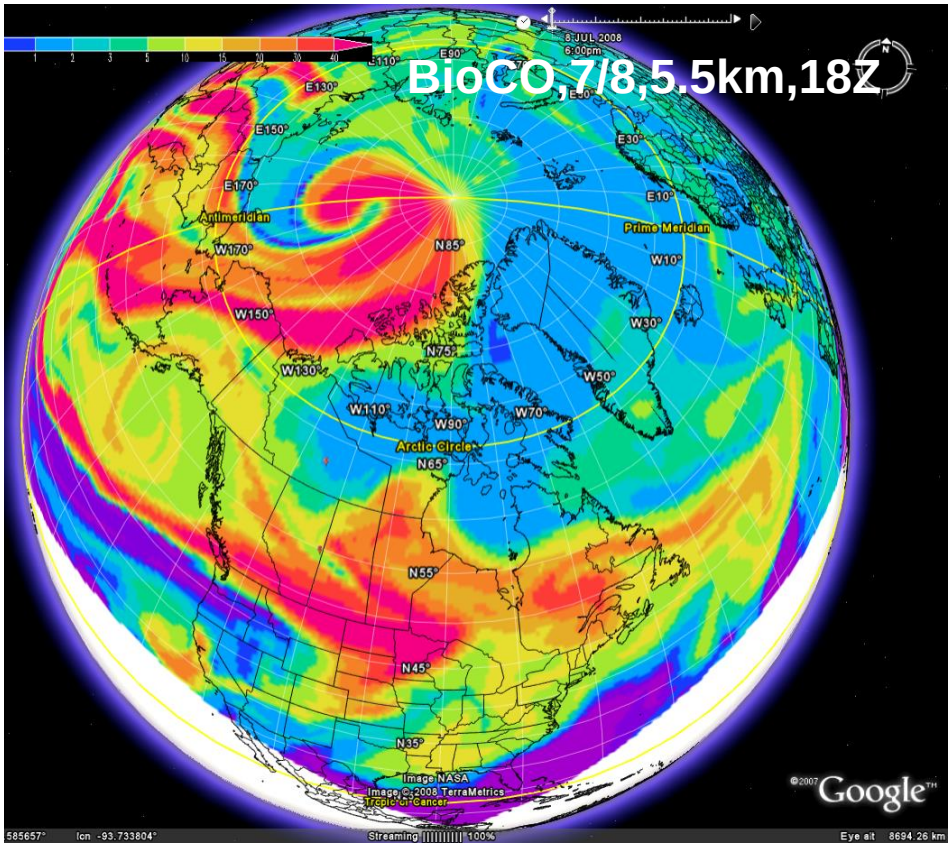

Simulated Dust (μg/m³) along the
DC8-V2 Flight Path on 07/05/2008
Altitude Above Ground (meter)
TIME (UTC)
4.4
3.3
2.5
1.9
1.4
1
0.76
0.55
0.39
0.26
0.17
0.1

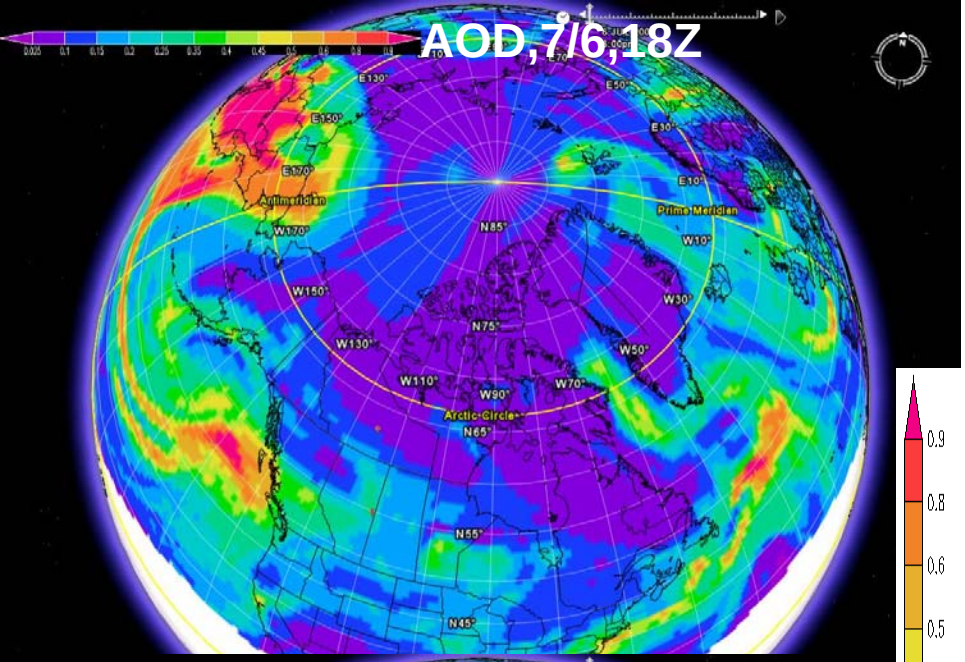

Simulated AOD along the
DC8-V2 Flight plan on 07/05/2008
AOD
TIME (UTC)

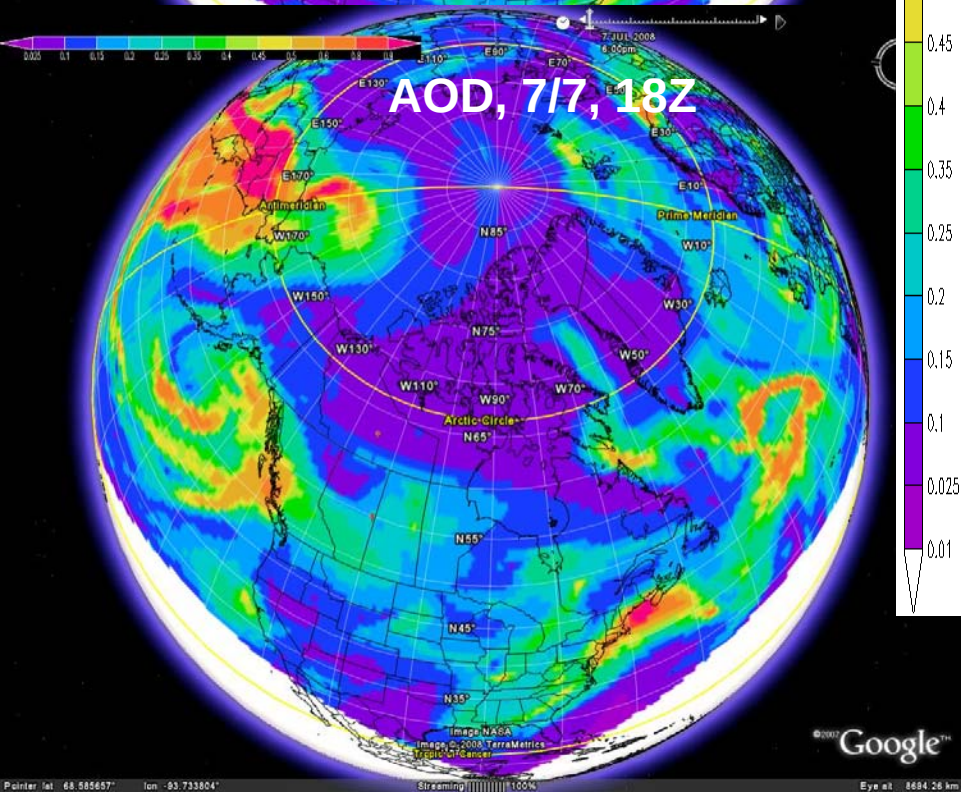

BioCO,5.5km,7/6,18Z
Antimeridian
Prime Meridian
Arctic Circle
Image NASA
Image © 2008 TerraMetrics
Tropic of Cancer
©2007 Google™

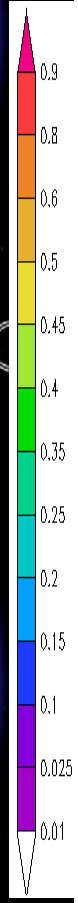

BioCO,5.5km,7/7, 18Z
Antimeridian
Prime Meridian
Arctic Circle
Image NASA
Image © 2008 TerraMetrics
Tropic of Cancer
©2007 Google™

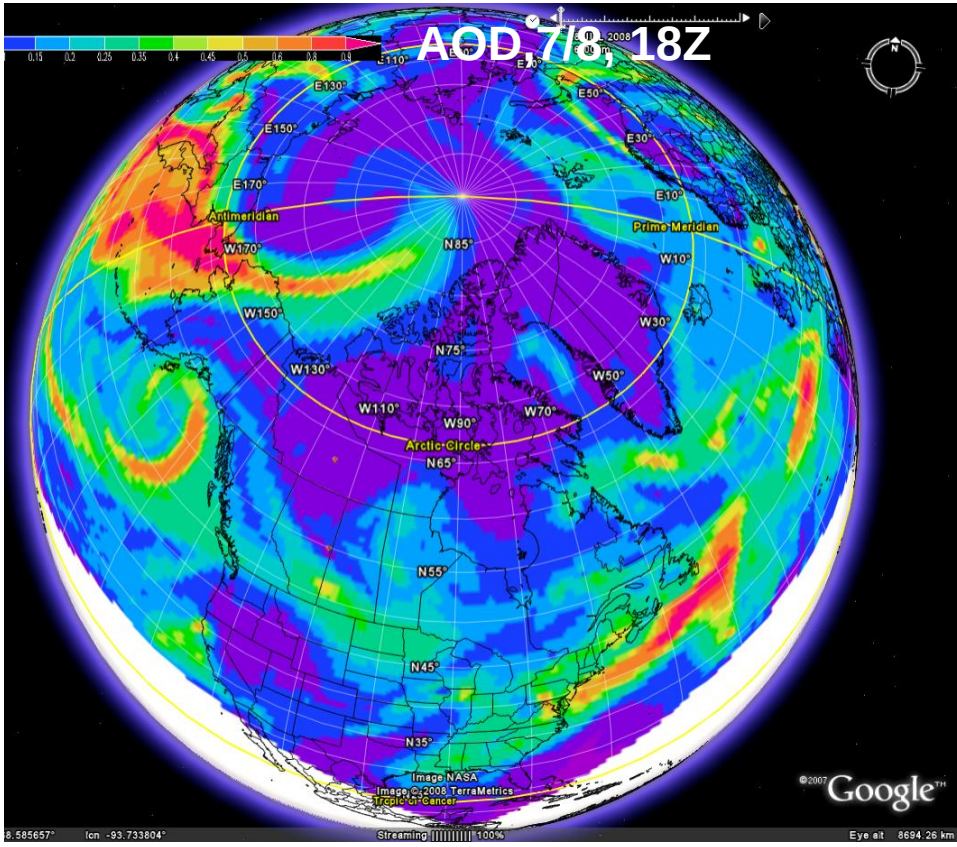

40
30
20
15
10
5
3
2
1
0.5
0.2
0.1

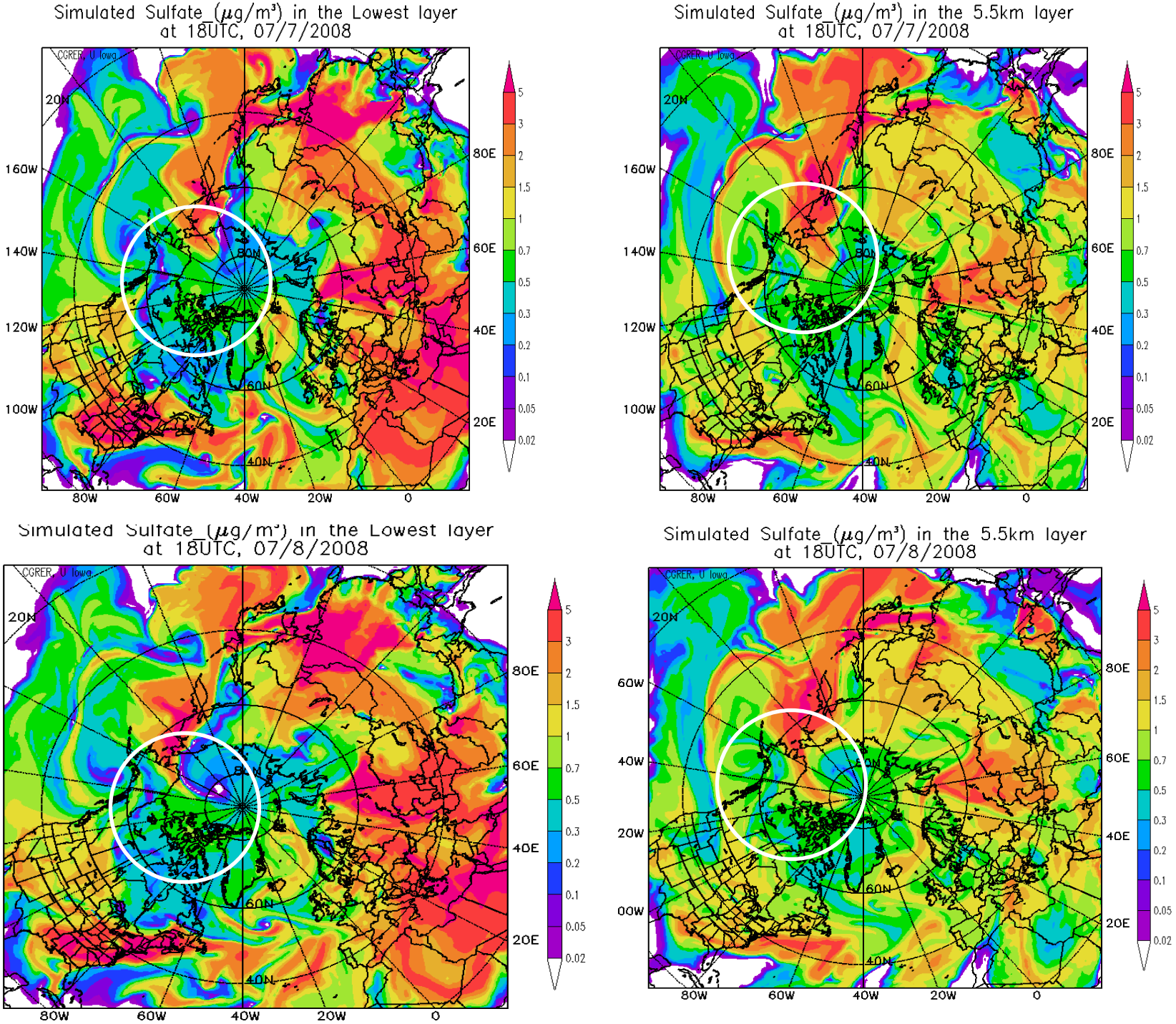

BioCO,7/8,5.5km,18Z
Antimeridian
Prime Meridian
Arctic Circle
Image NASA
Image © 2008 TerraMetrics
Tropic of Cancer
©2007 Google™


AOD,7/6,18Z
Antimeridian
Prime Meridian
Arctic Circle


AOD, 7/7, 18Z
Antimeridian
Prime Meridian
Arctic Circle
Image NASA
Image © 2008 TerraMetrics
Tropic of Cancer
©2007 Google


0.9
0.8
0.6
0.5
0.45
0.4
0.35
0.25
0.2
0.15
0.1
0.025
0.01

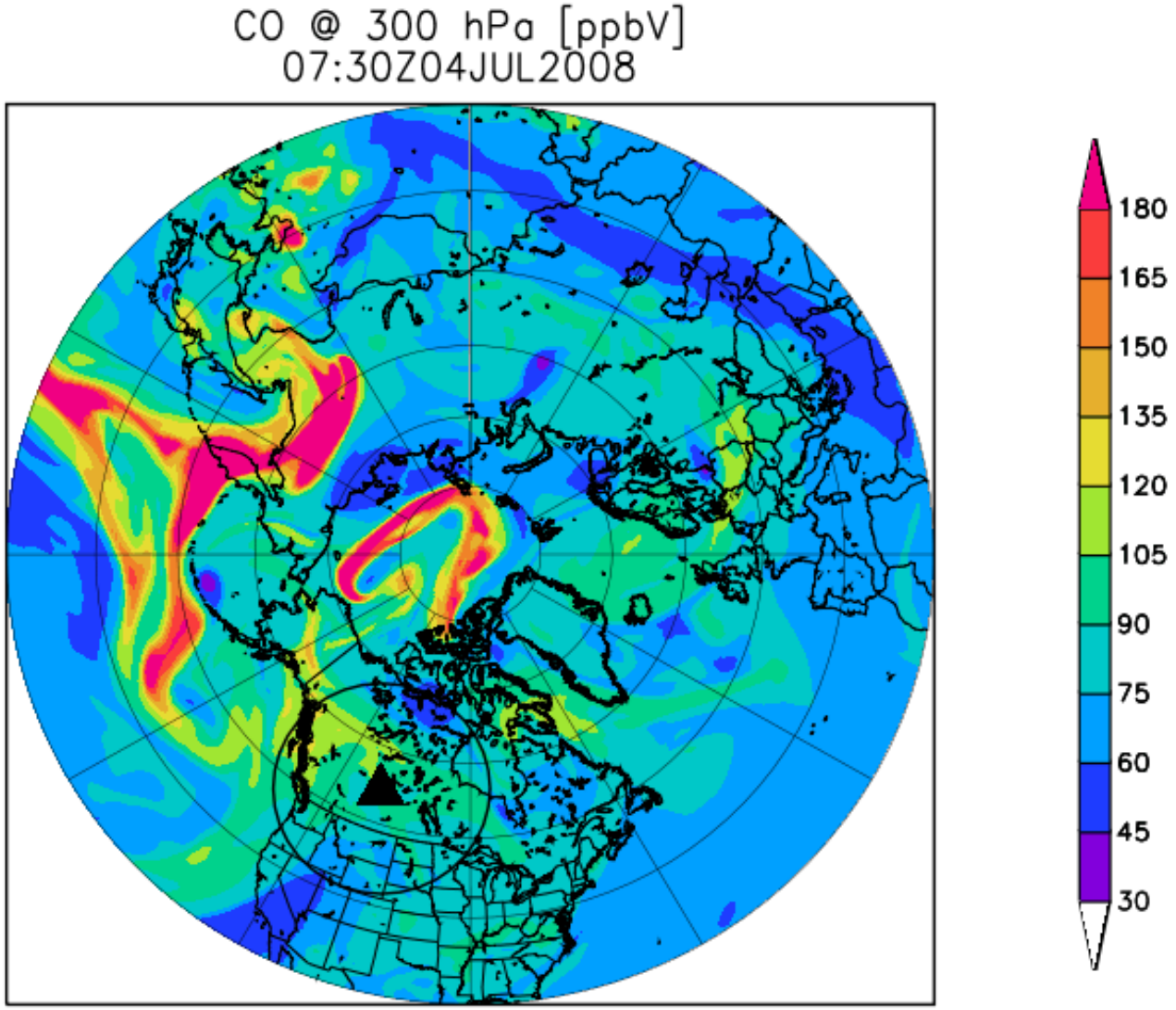

AOD,7/8, 18Z
Antimeridian
Prime Meridian
Arctic Circle
Image NASA
Image © 2008 TerraMetrics
Tropic of Cancer
©2007 Google


Simulated Sulfate (μg/m³) in the Lowest layer
at 18UTC, 07/7/2008
Simulated Sulfate (μg/m³) in the 5.5km layer
at 18UTC, 07/7/2008
Simulated Sulfate (μg/m³) in the Lowest layer
at 18UTC, 07/8/2008
Simulated Sulfate (μg/m³) in the 5.5km layer
at 18UTC, 07/8/2008
CGRER, U Iowa
20N
40N
60N
80N
160W
140W
120W
100W
80W
60W
40W
20W
0
80E
60E
40E
20E
5
3
2
1.5
1
0.7
0.5
0.3
0.2
0.1
0.05
0.02

300 mb

5-Day Total CO Animation

- Old Siberian continues to circulate in Arctic.
- New Siberian Fire & Asian Anthro. plume arrives in Arctic.
- Another Asian Anthro. & Siberian Fire plume crosses Pacific Oc. & should be over Cold Lake July 5th-8th.



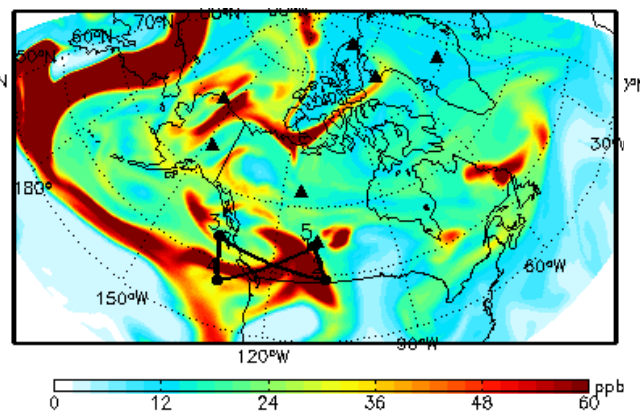
July 5: Choosing a DC8 Flight Plan

Plan A

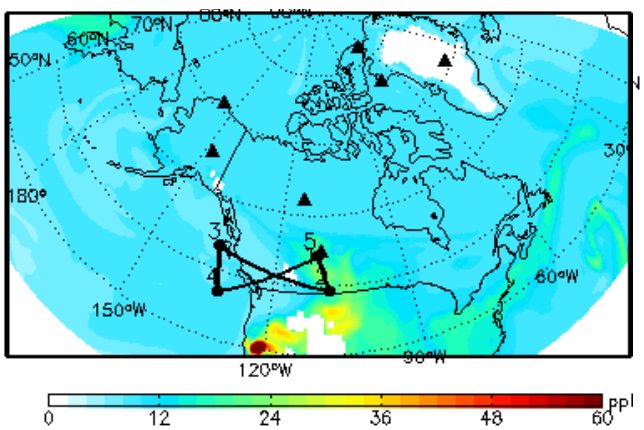
Plan B

July 5 DC8 Flight Plan A

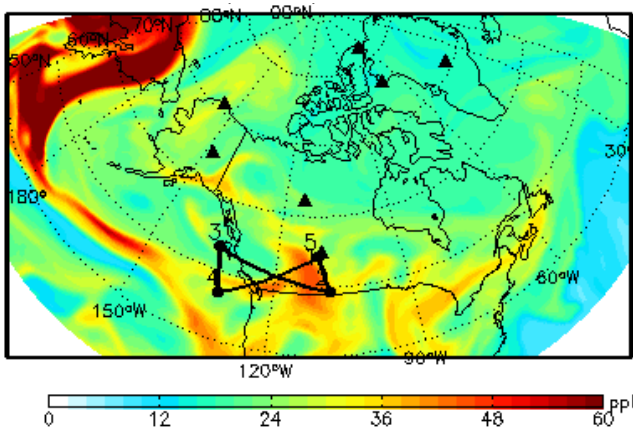
Boreal BB CO: 350 hPa



California B.B. CO: 800 hPa



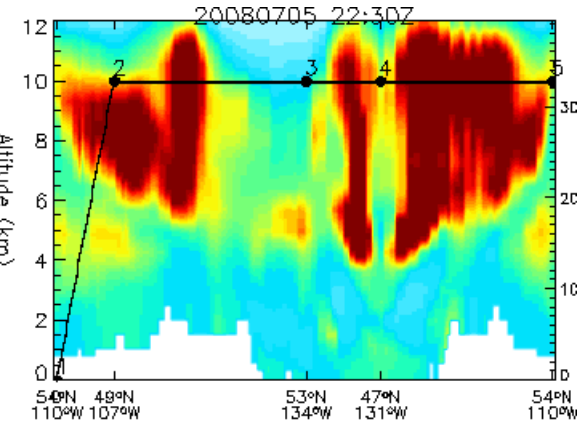
Asian Anthro. CO: 350 hPa



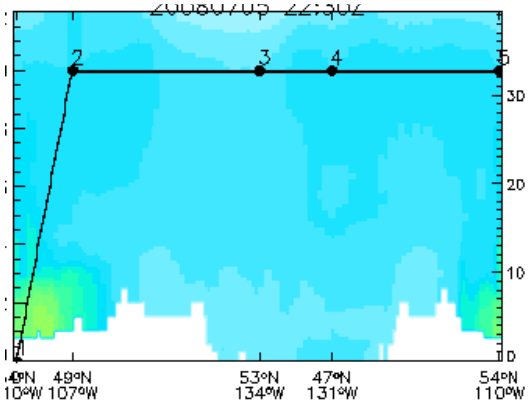
Much more Siberian B.B. than Asian Anthro., though it does supply a significant background.

Californian pollution no big deal.

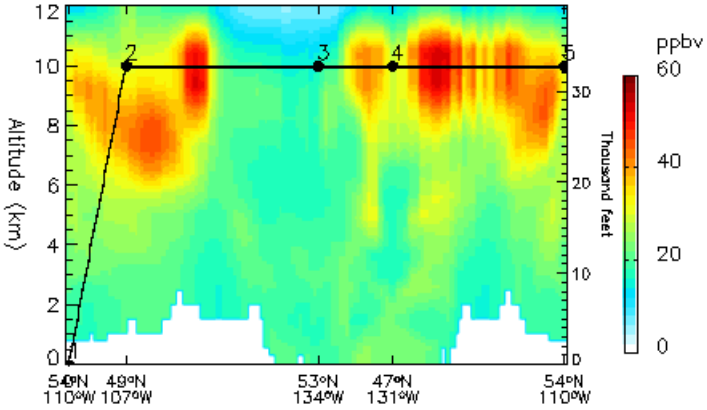
Boreal BB CO: Curtain



California B.B. CO: Curtain

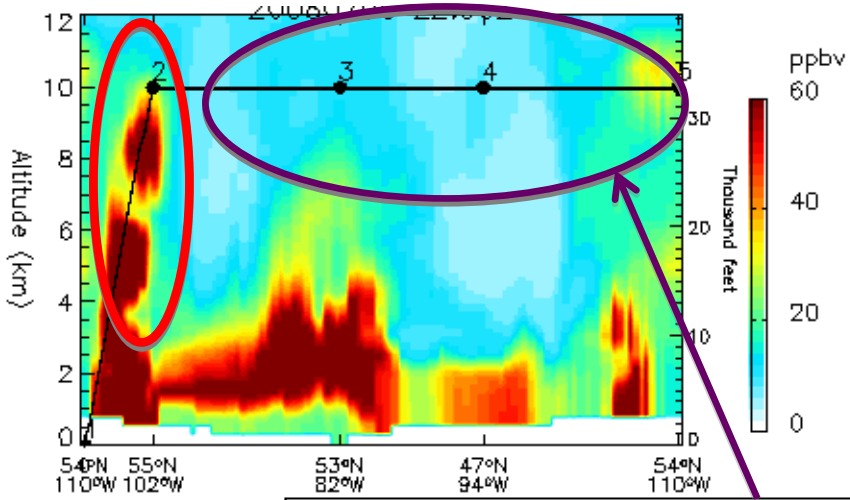


Asian Anthro. CO: Curtain



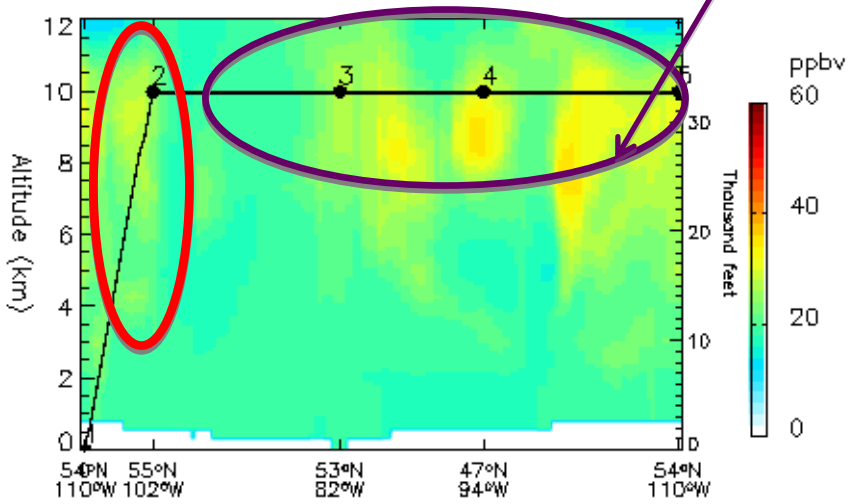
July 5 DC8 Flight Plan B:

Boreal BB CO: Curtain



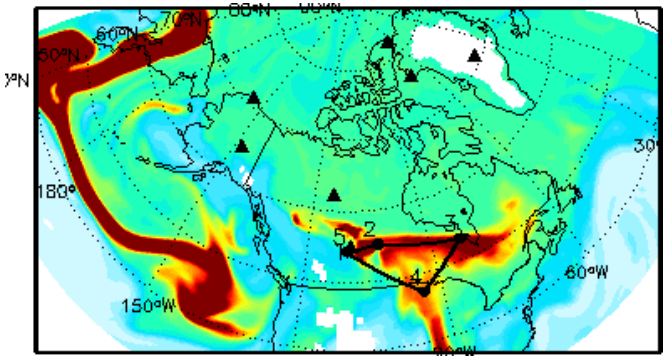
Different Signatures in upper troposphere:
Boreal BB signals are probably local

Asian Anthro. CO: Curtain

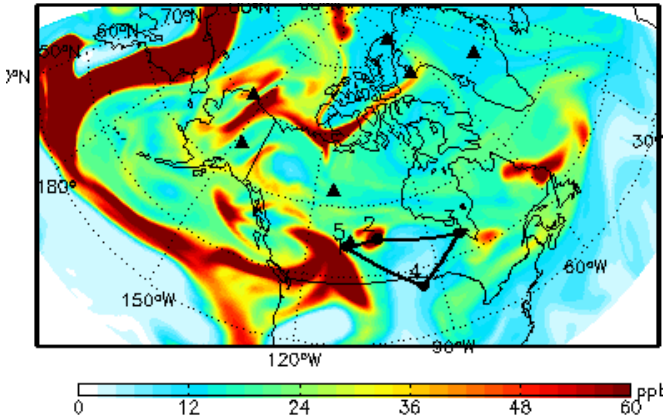


Significant lofting
of local BB plumes

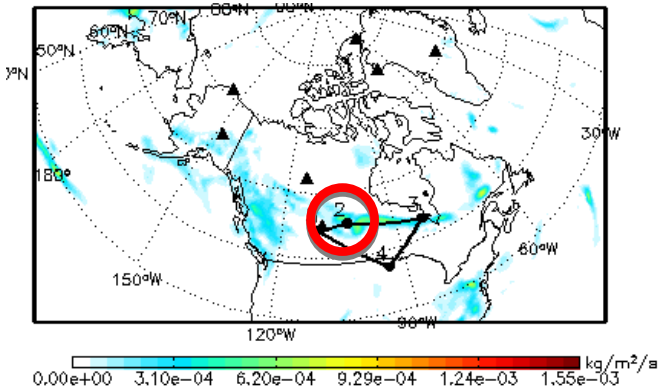
Boreal BB CO: 800 hPa (2 km)



Boreal BB CO: 350 hPa (8.1 km)

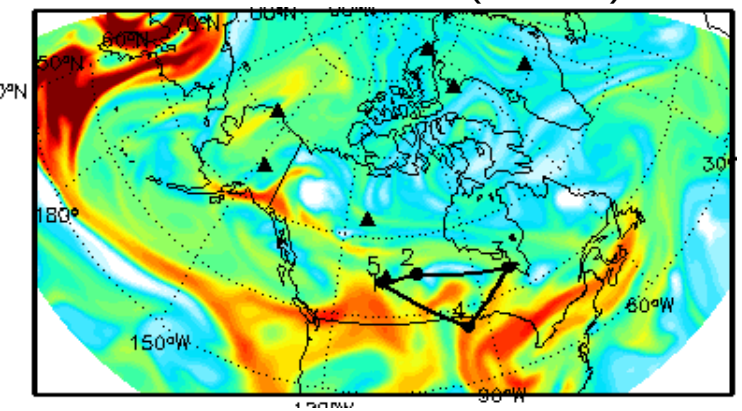


Precip: Note hotspot



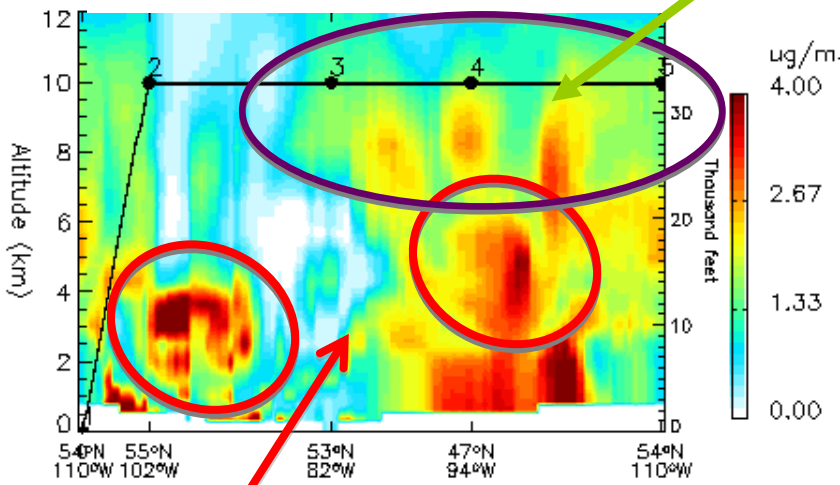
July 5 DC8 Flight Plan B: Aerosols

Sulfate: 350 hPa (8.1 km)

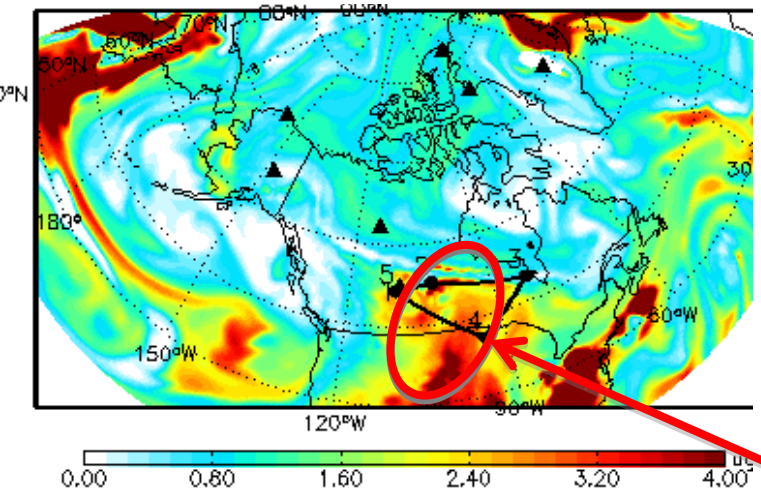


Sulfate: Curtain

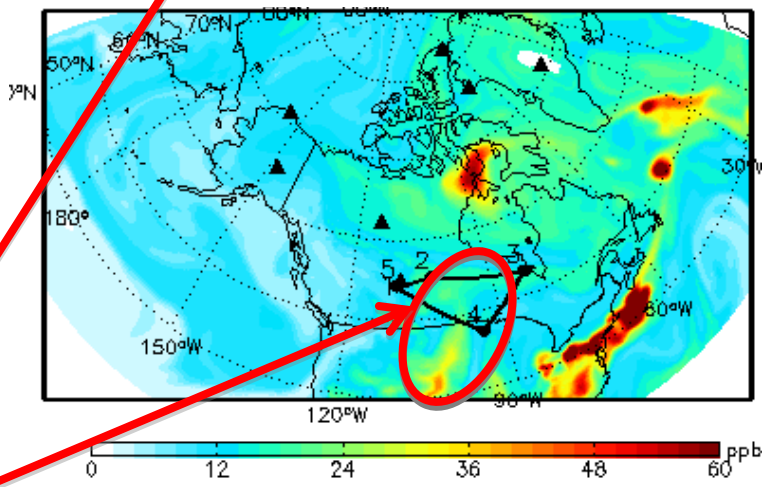
Asian



Sulfate: 700 hPa (3 km)

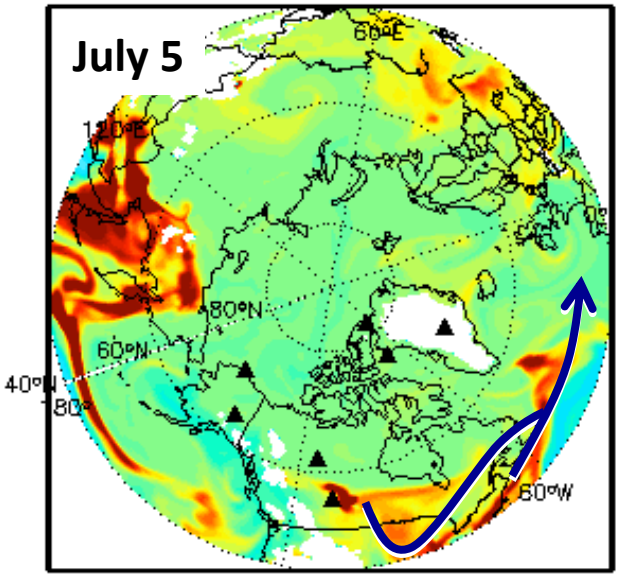


N. Amer. Anthro CO: 700 hPa (3 km)

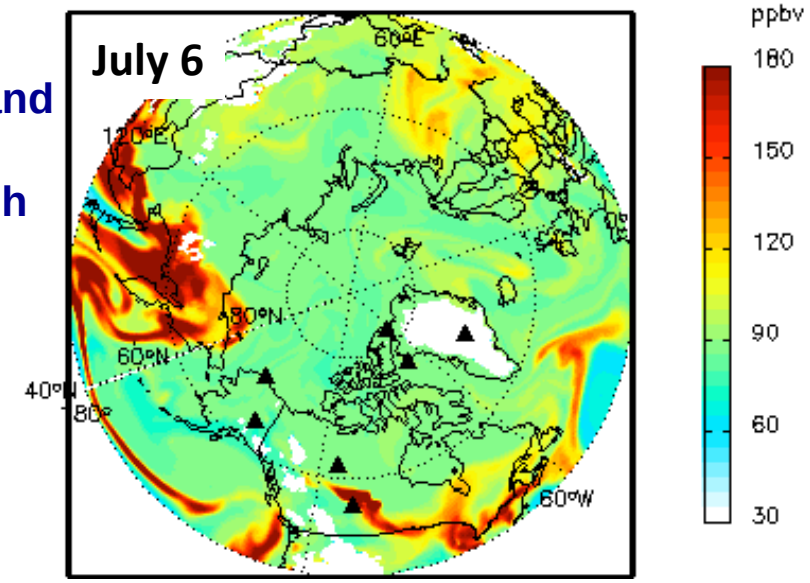


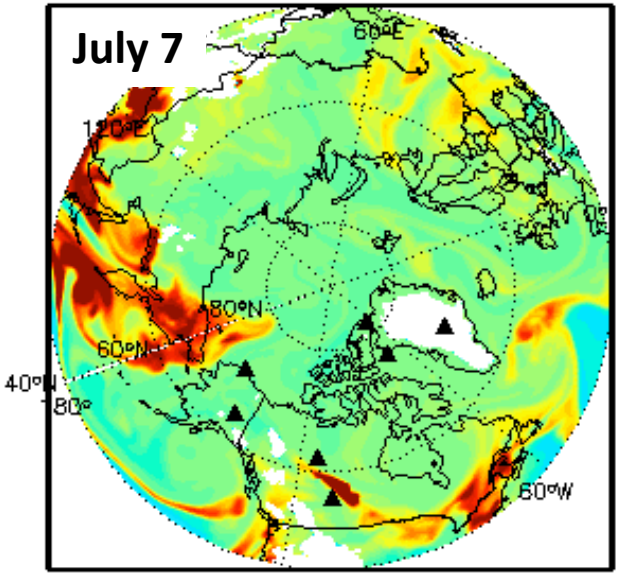
Sulfate from North American Anthropogenic

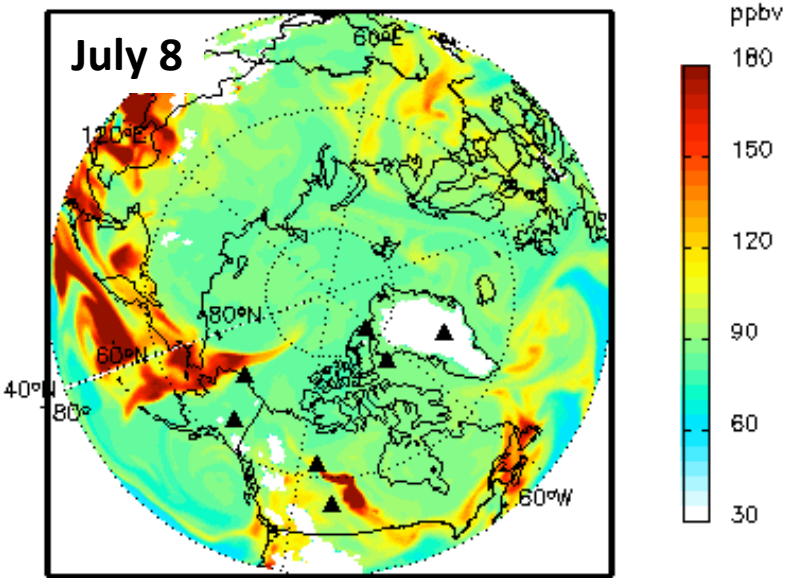
GEOS5 Outlook for next four days – Total CO @ 850 hPa



Bulk of N. Am. outflow (pollution and fires) is across Atlantic, not through Davis Strait



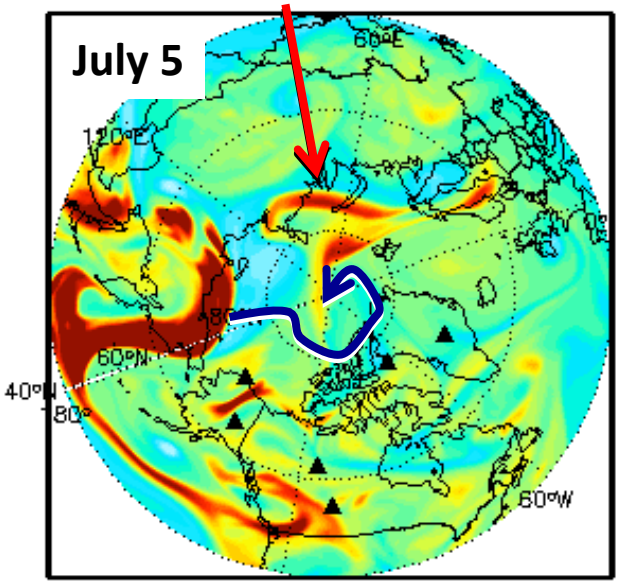




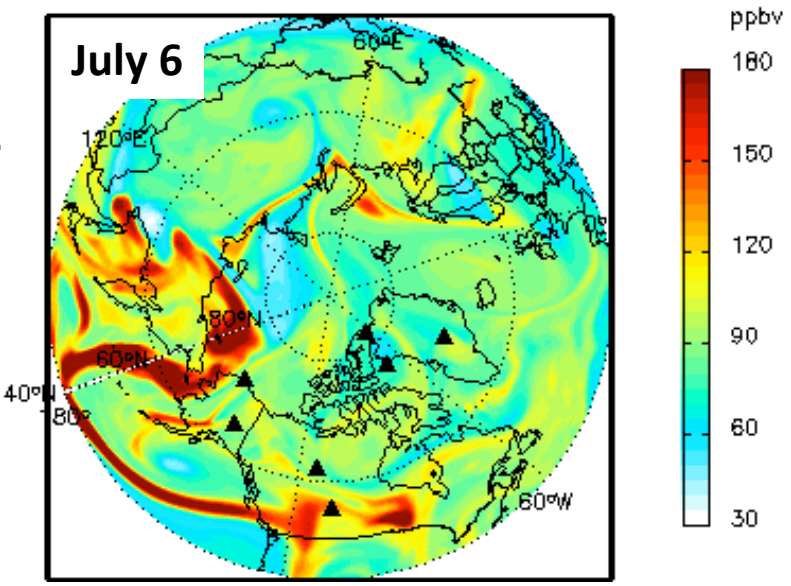
Initialized 20080704 – 06Z

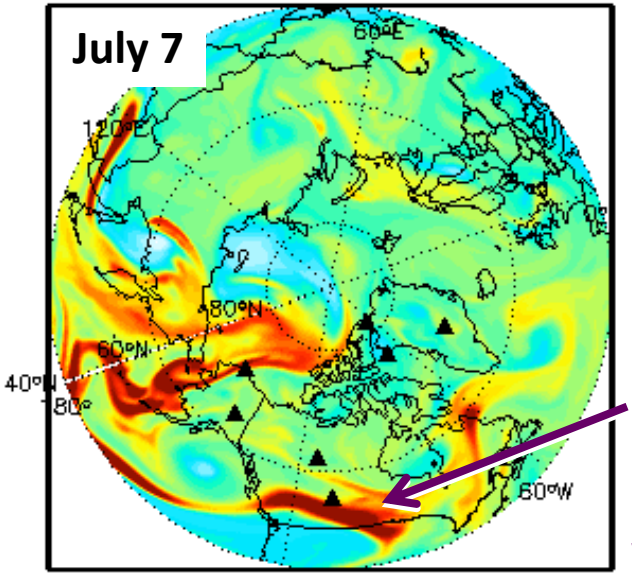
GEOS5 Outlook for next four days – Total CO @ 300 hPa

Remnants of older Siberian plume.



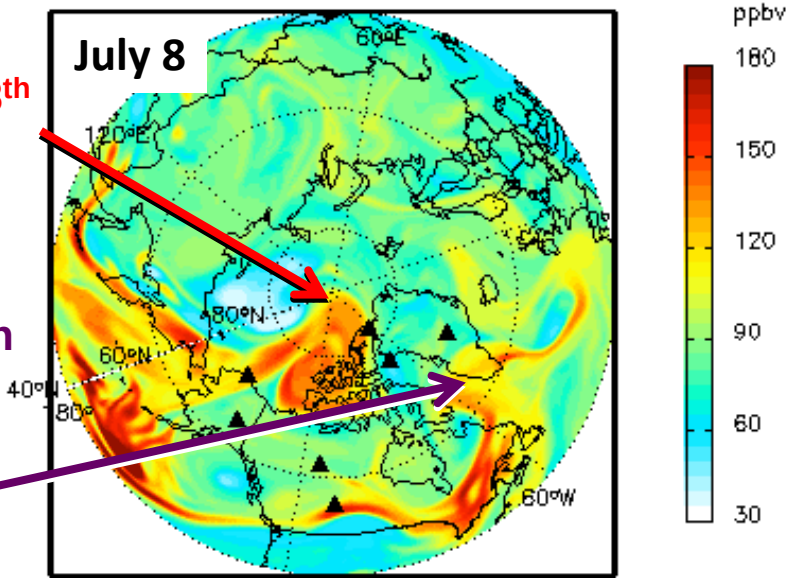
Sib. plumes mixed with Asian pollution are transported over the pole at many levels.





Directly over Thule on July 8th from 4-10 km!

Large Siberian/Asian plume over Cold Lake on July 7th. Heads north over Summit, Greenland.

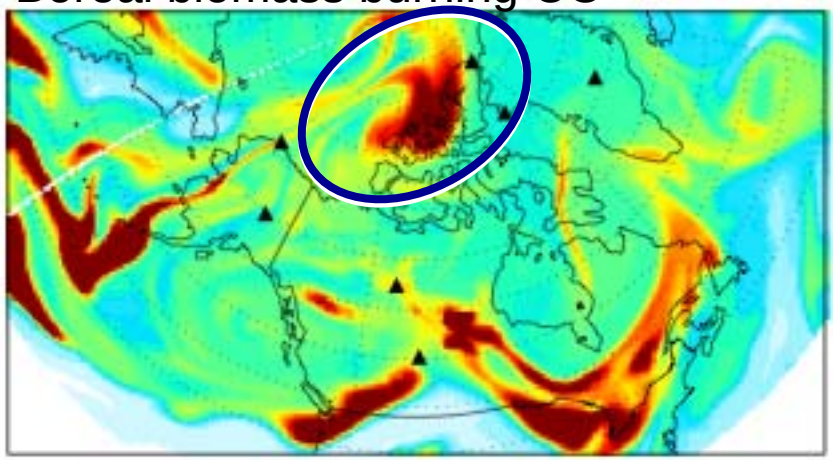


Initialized 20080704 – 06Z

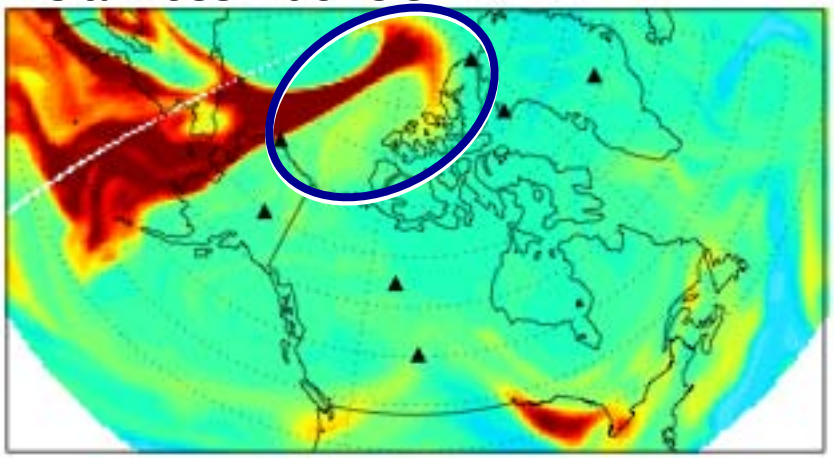
Plume over pole on 7/8 is no longer “pure” Siberian fire emissions

500 hPa

Boreal biomass burning CO

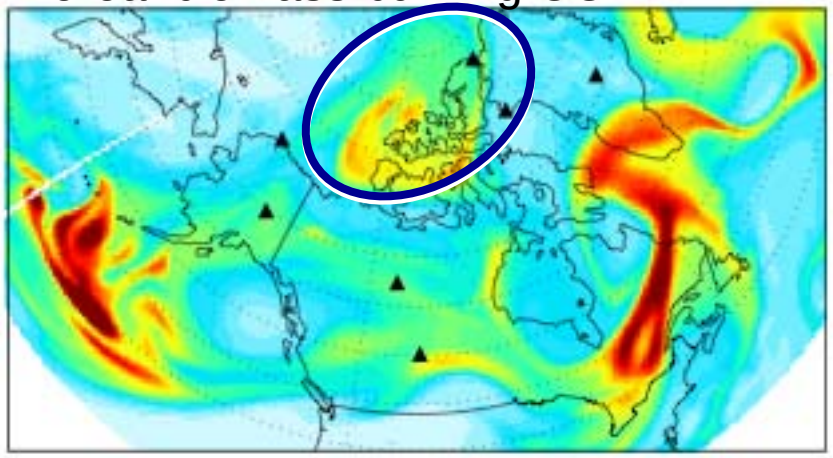


Asian fossil fuel CO

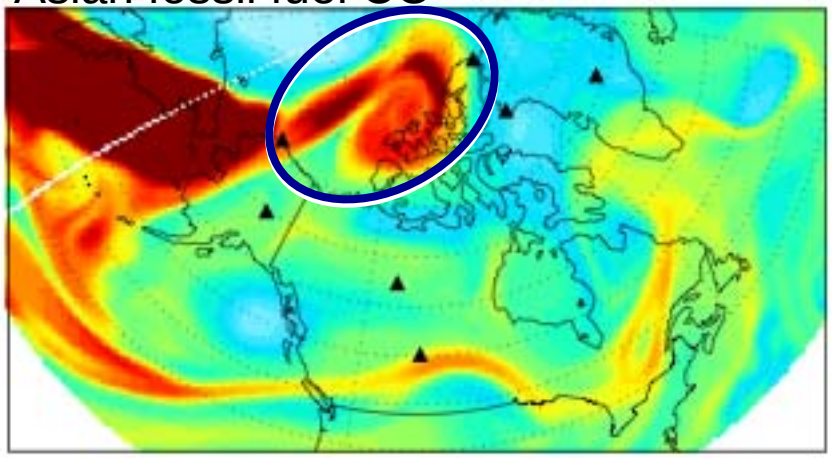


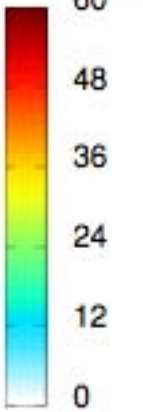
250 hPa

Boreal biomass burning CO



Asian fossil fuel CO

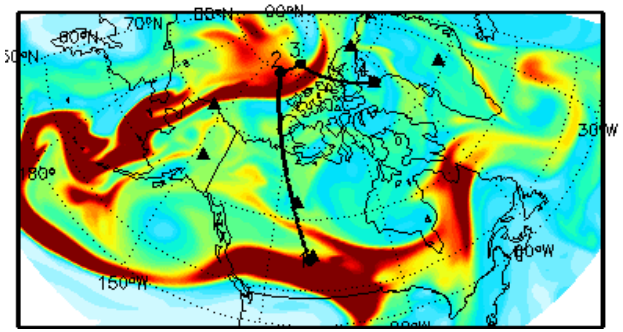




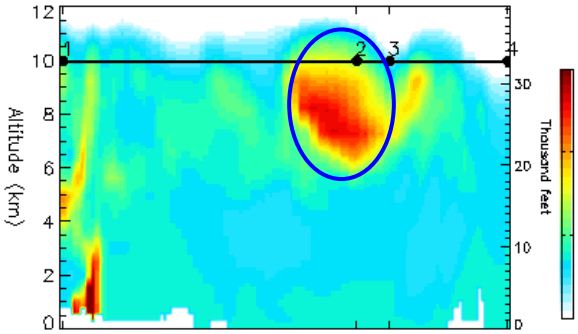
Initialized 20080704 – 06Z

July 7 -- Potential flight track to catch Siberian+Asian plume in Arctic

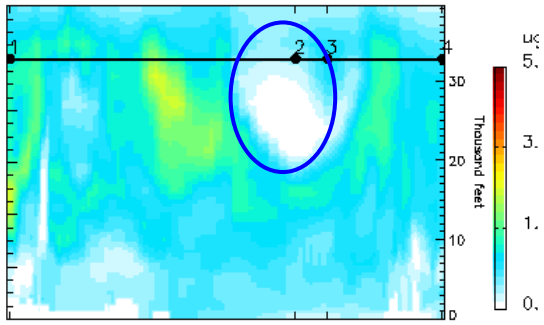
Total CO – 300mb



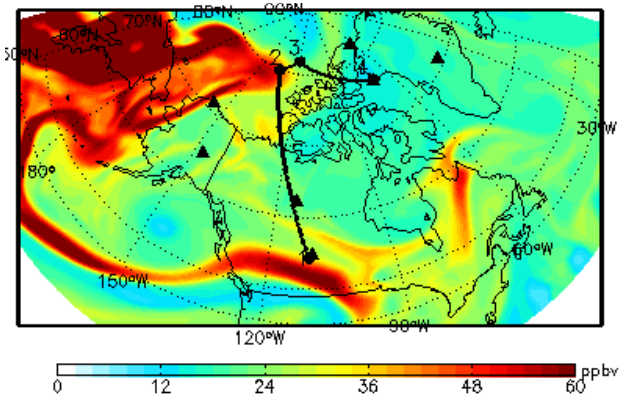
Total CO



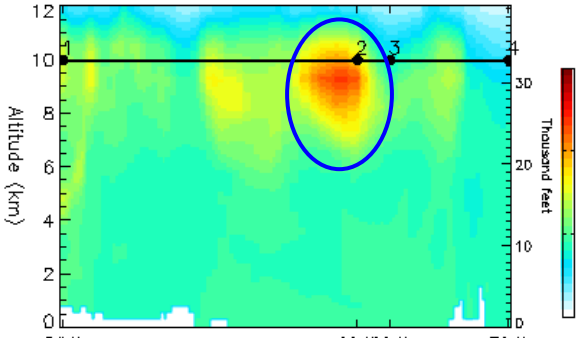
Sulfate



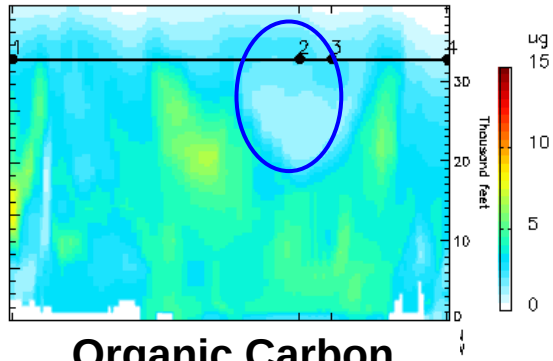
Asian Anthro. CO – 300mb

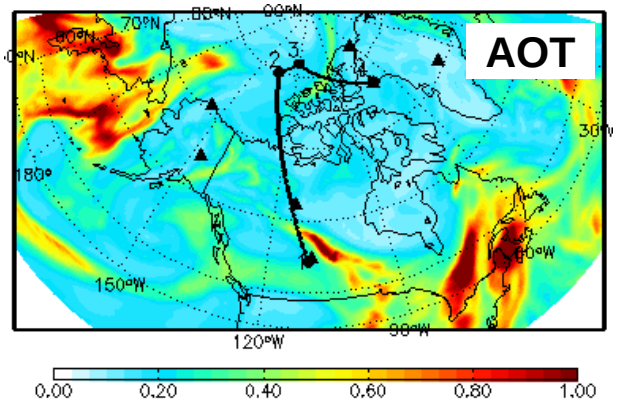


Asian Anthro. CO

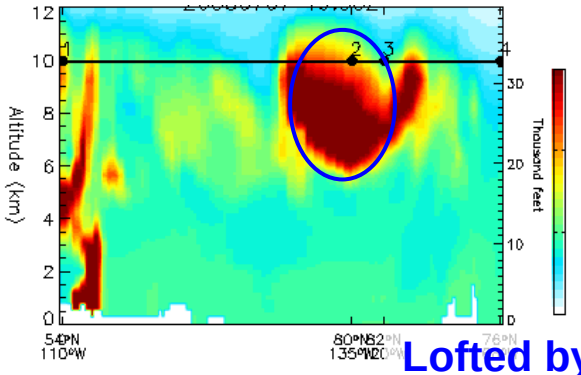


Dust

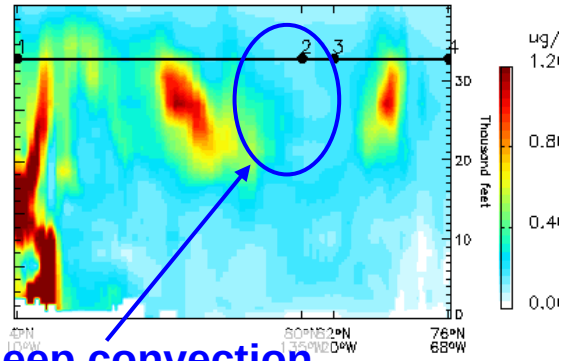




Boreal Biomass Burning CO



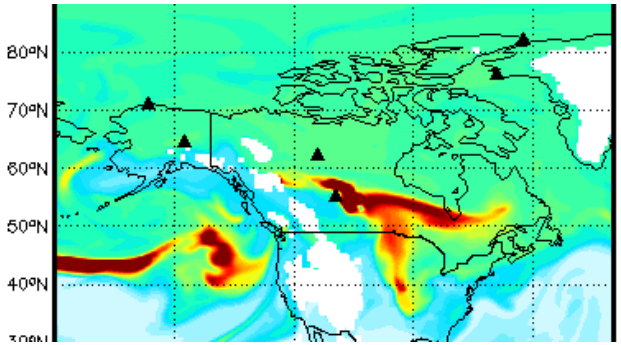
Organic Carbon



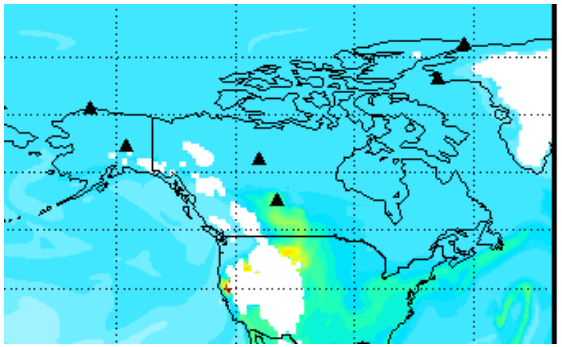
Lofted by deep convection => washout

July 5th (22:30Z) : 3-levels

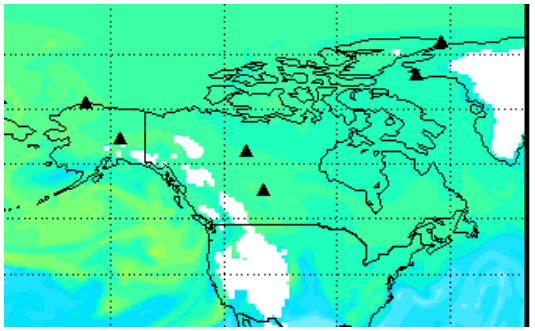
BOREAL : 850 mb



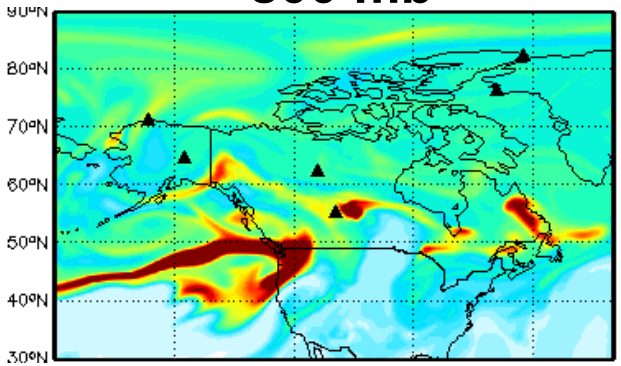
NON-BOREAL : 850 mb



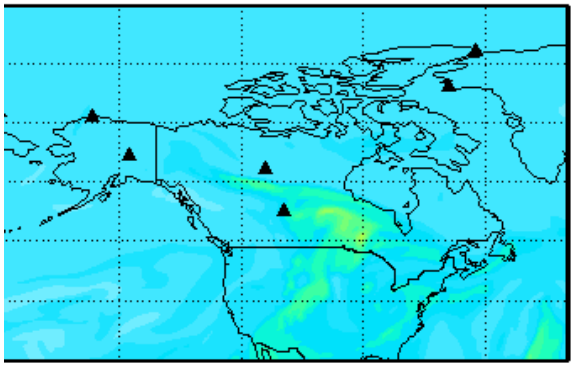
Asian FF/BF : 850 mb



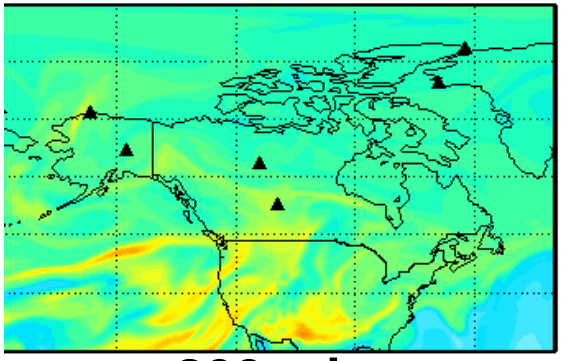
500 mb



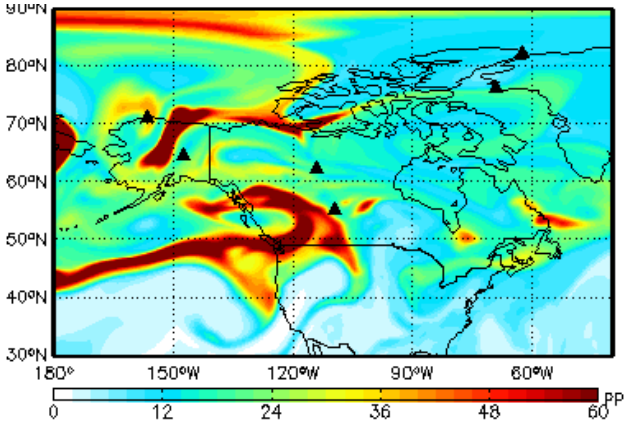
500 mb



500 mb



300 mb



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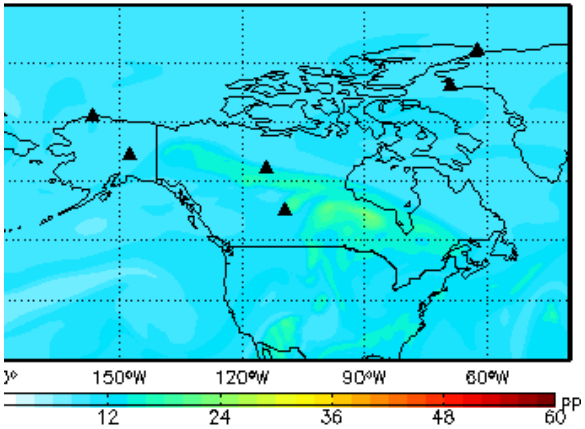

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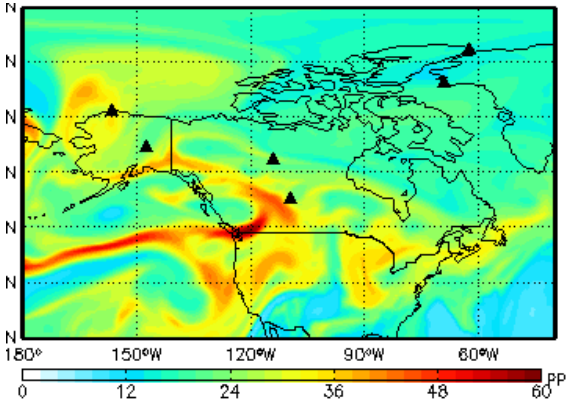
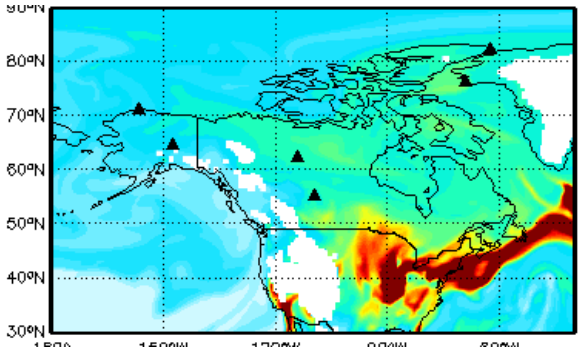
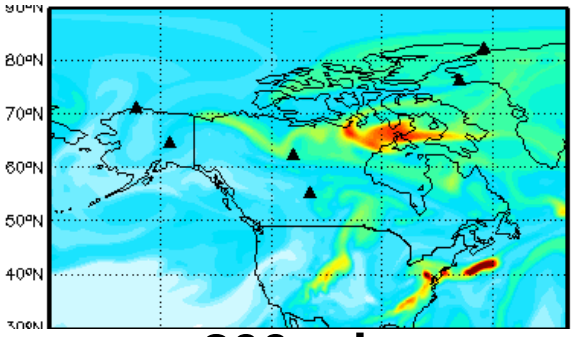


July 5th (22:30Z) : 3-levels

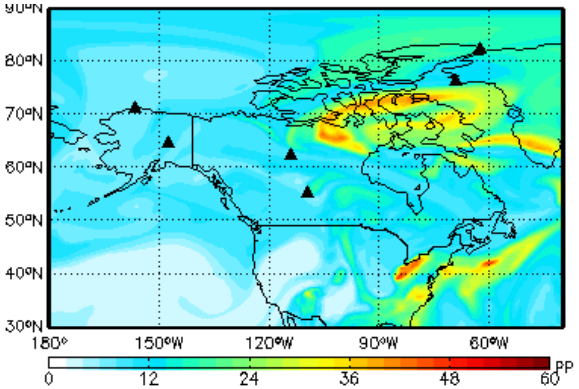
N. American : 850 mb



500 mb

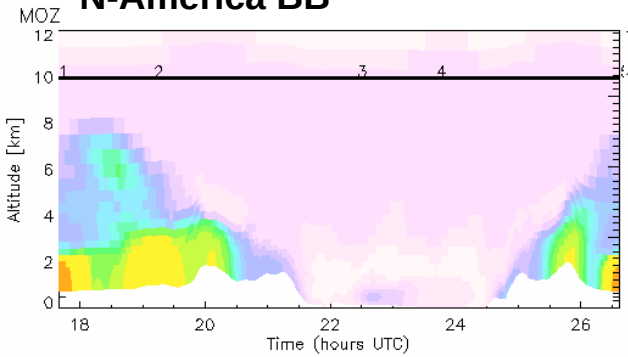


300 mb

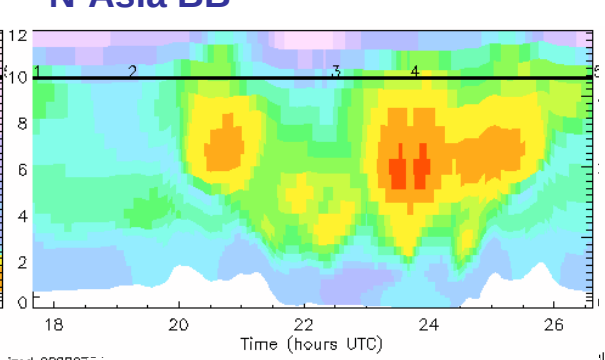


Flight 5 July - V1 MOZART

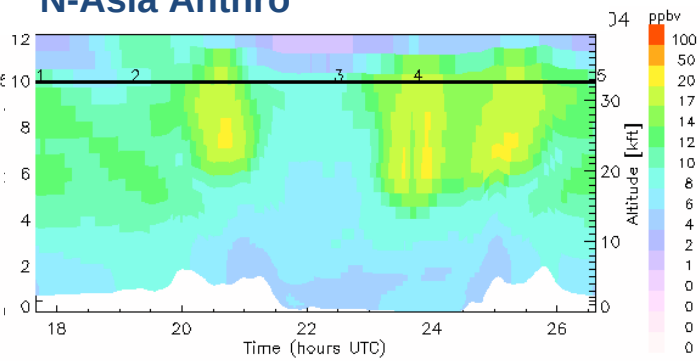
N-America BB

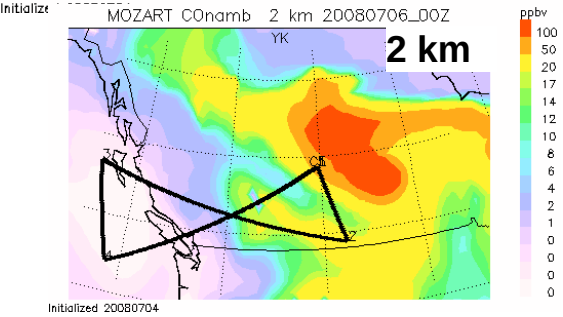


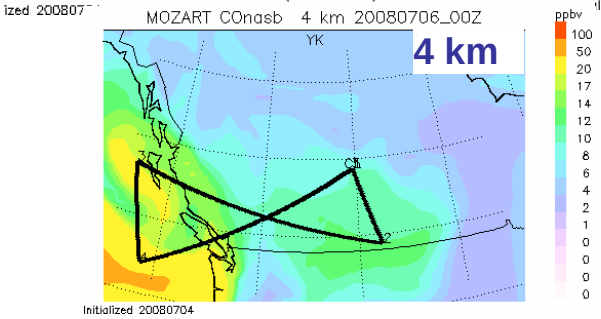
N-Asia BB

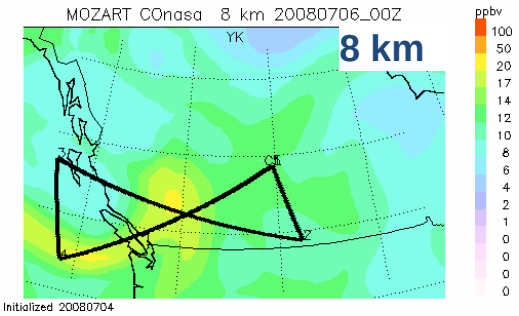


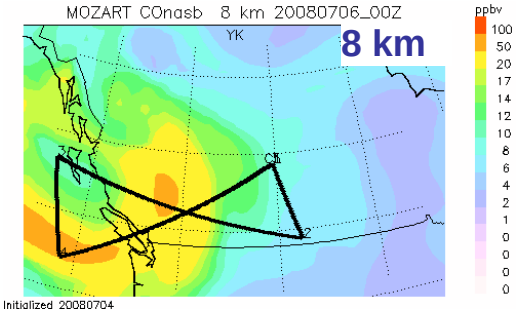
N-Asia Anthro





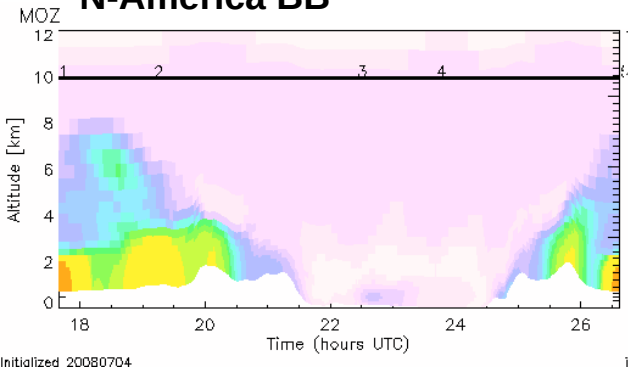




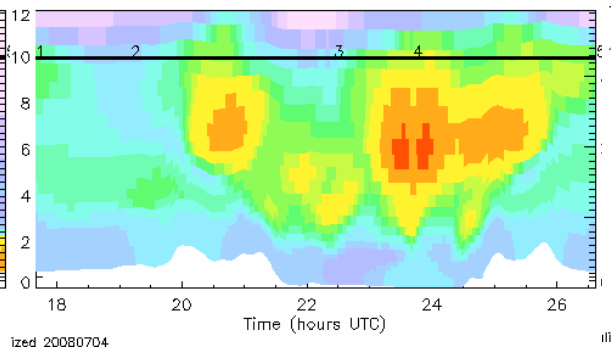


Flight 5 July - V1 MOZART

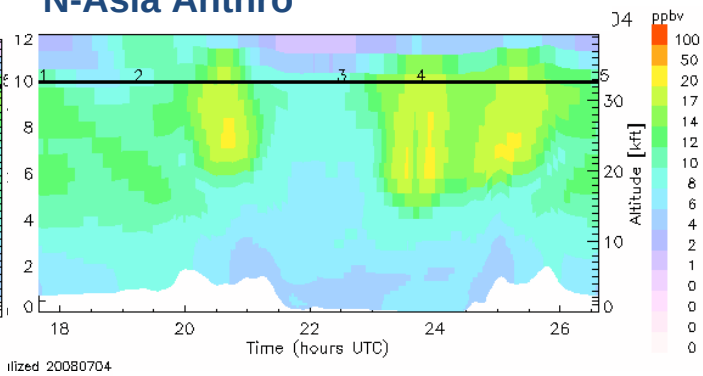
N-America BB

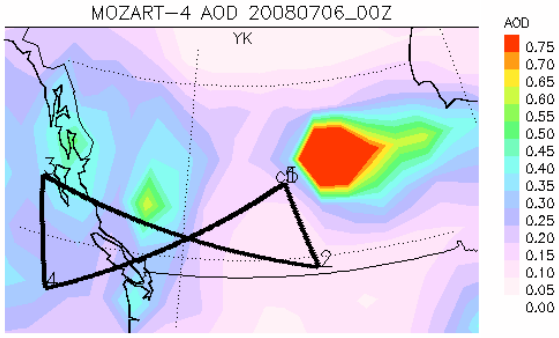


N-Asia BB

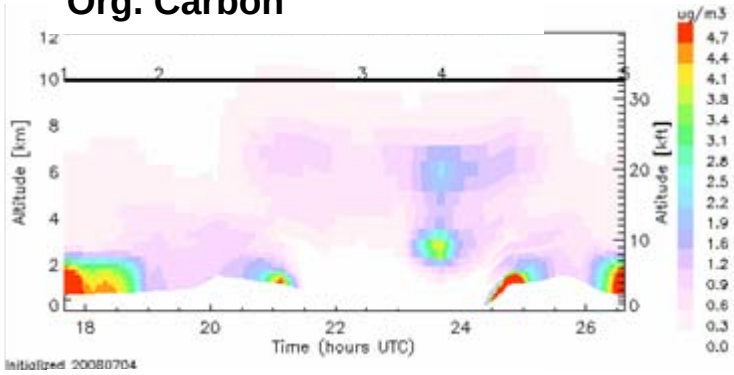


N-Asia Anthro





Org. Carbon



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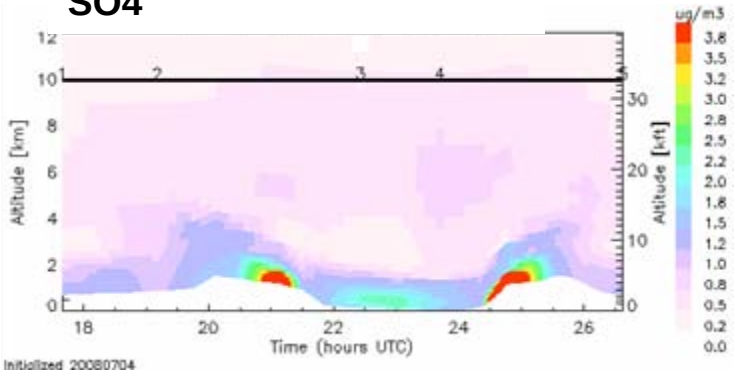
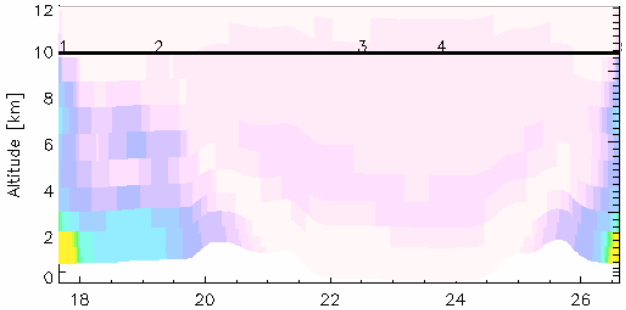


Flight 5 July - V1 CAM-Chem

N-America BB



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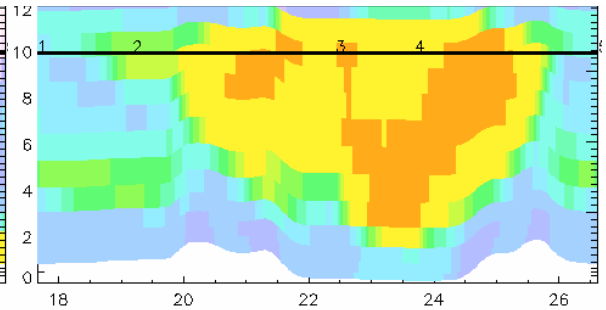

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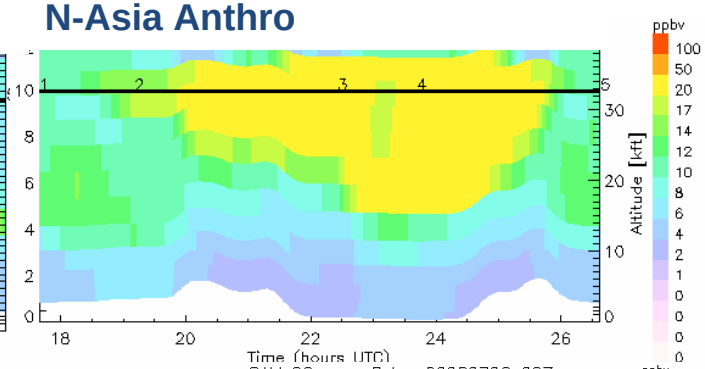

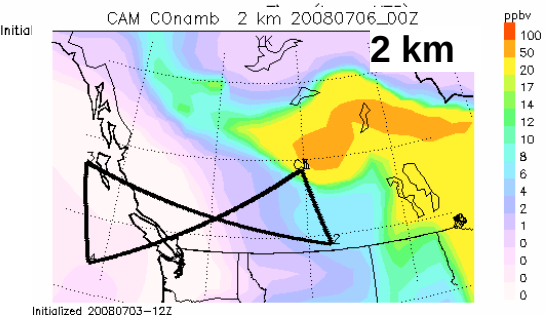

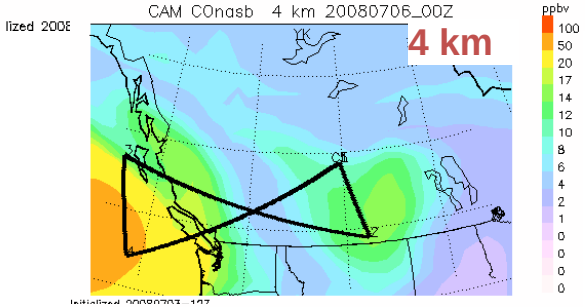

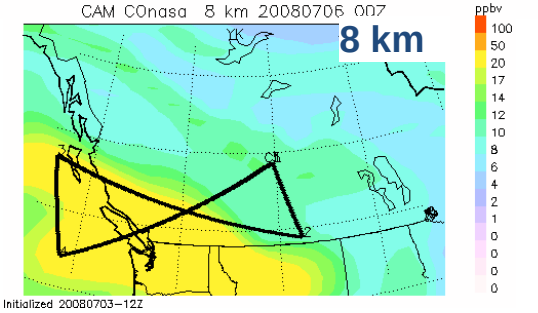

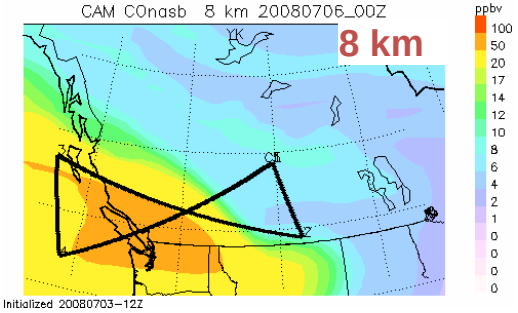

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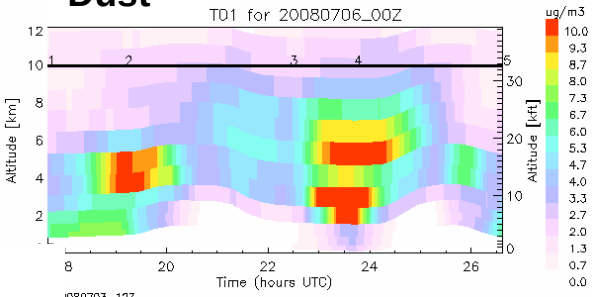

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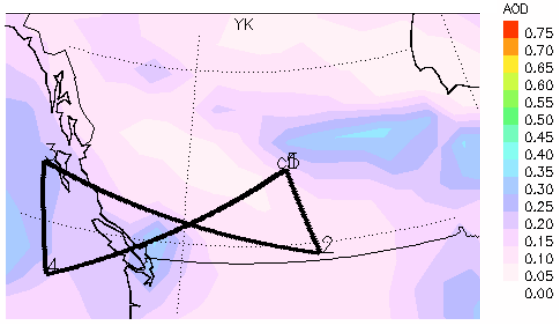
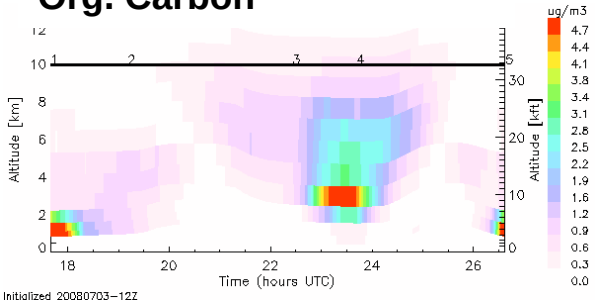


Org. Carbon



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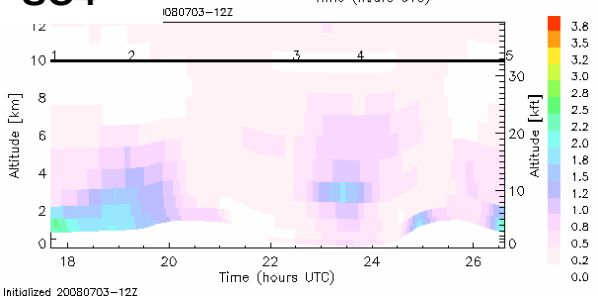
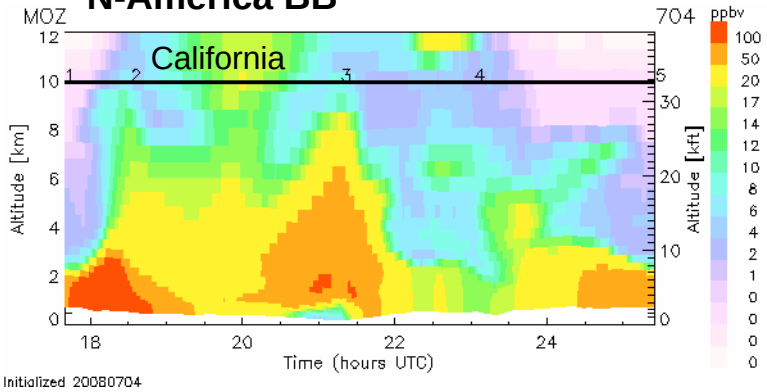
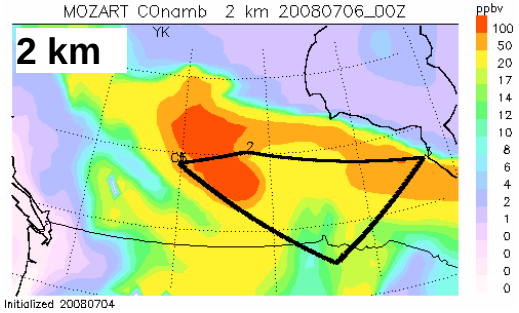
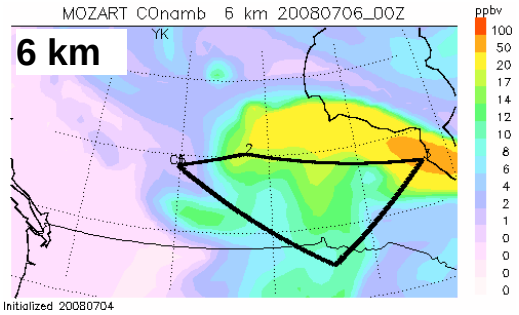


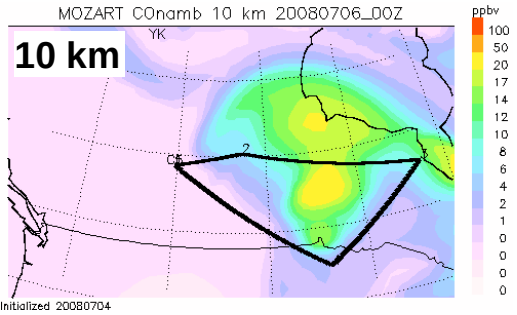
Flight 5 July - V2 MOZART

N-America BB









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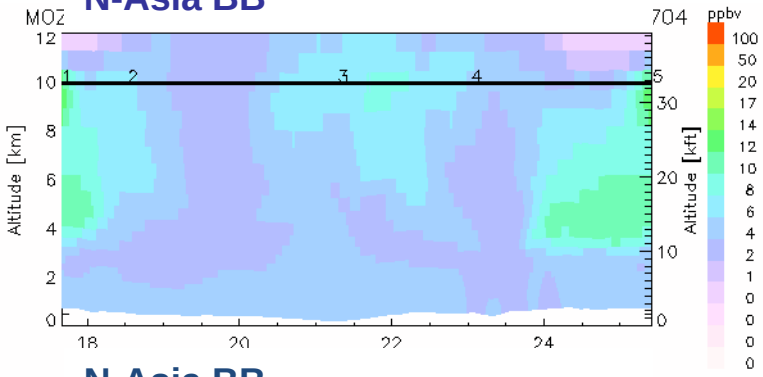

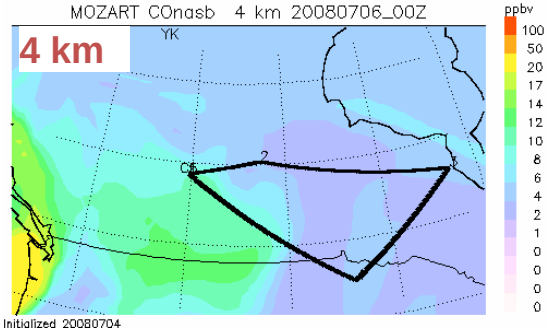

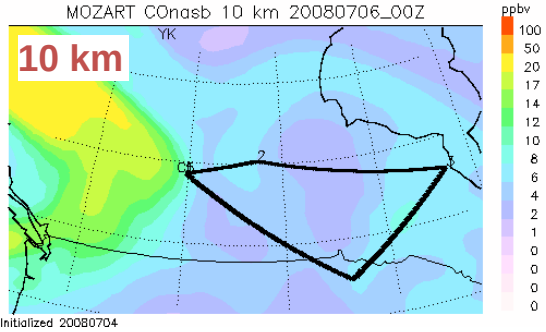

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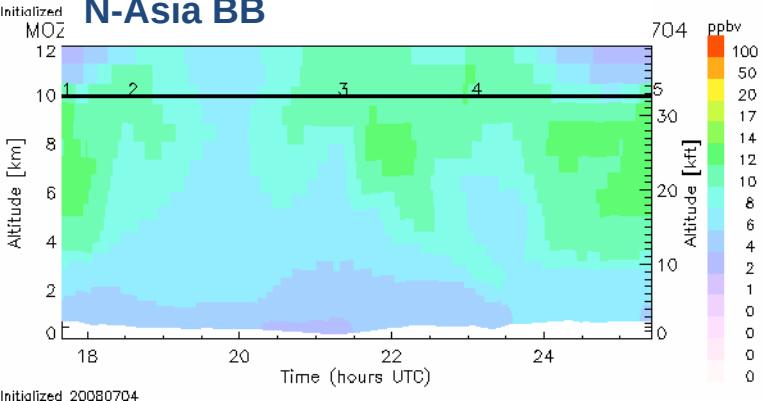
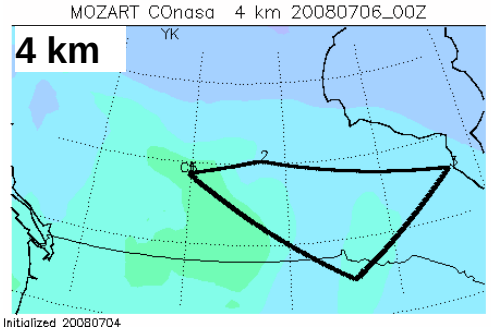
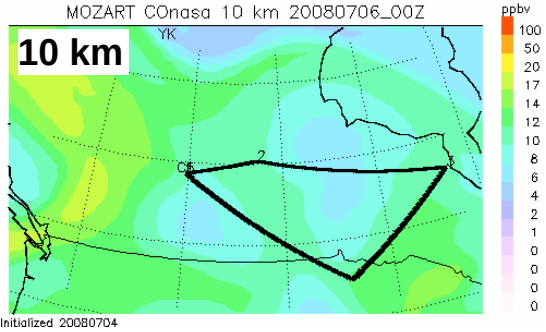
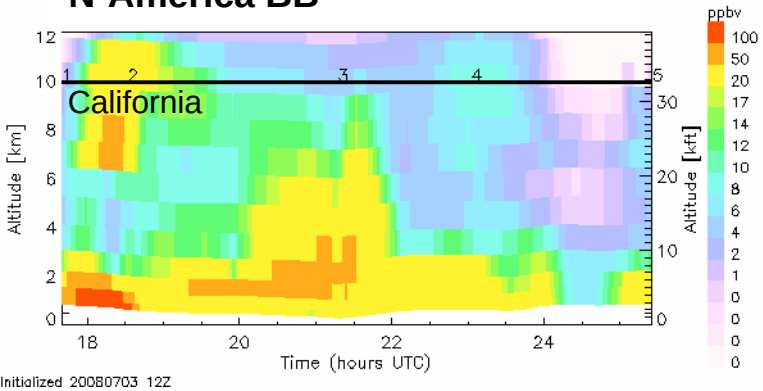


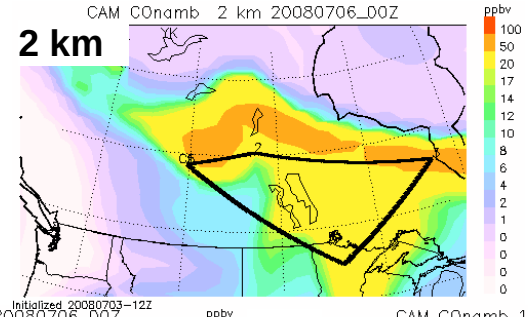


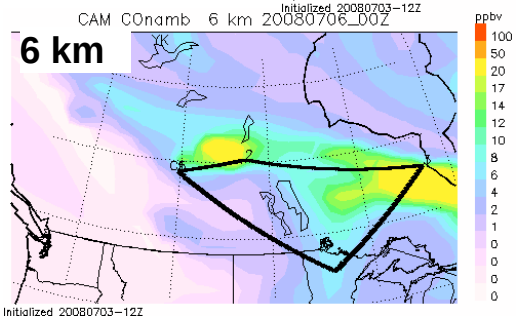


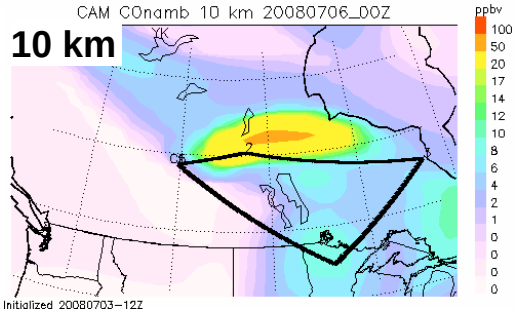
Flight 5 July - V2 CAM-Chem

N-America BB









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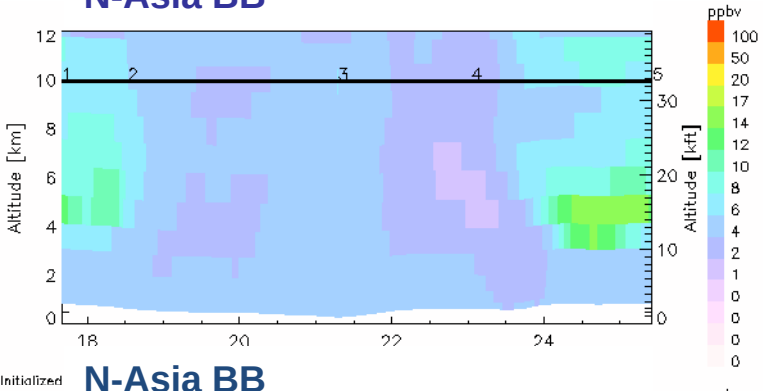

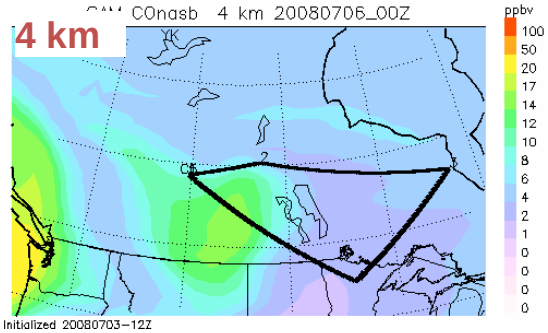

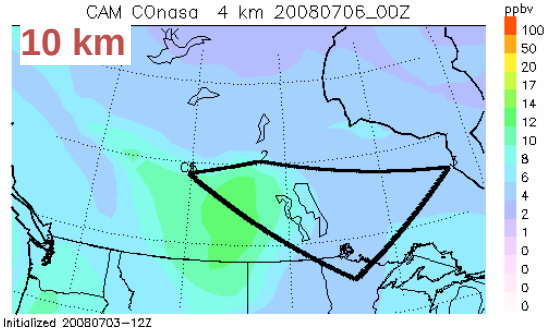

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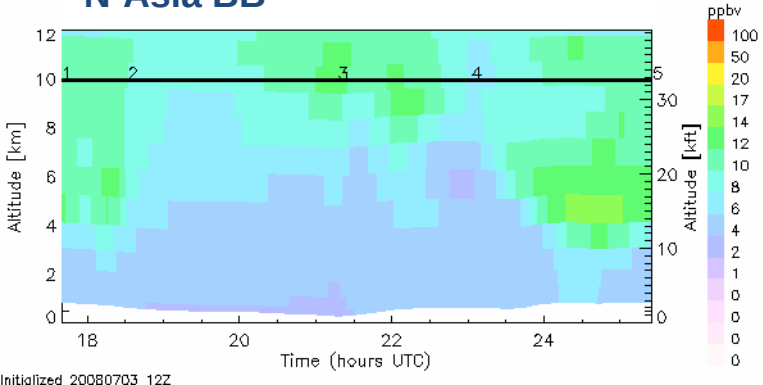
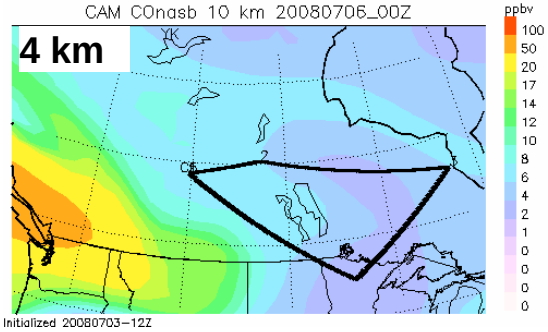
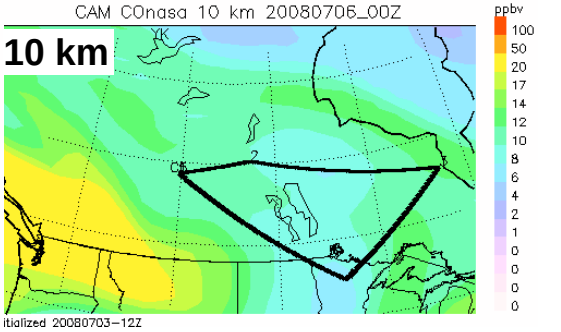


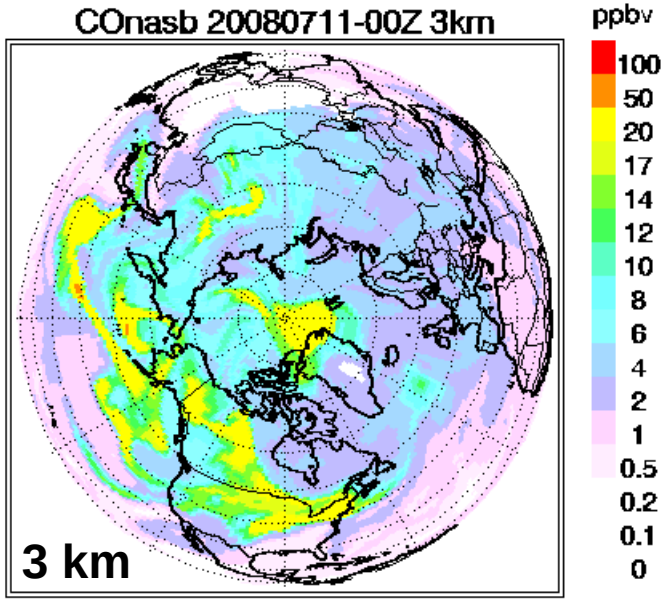




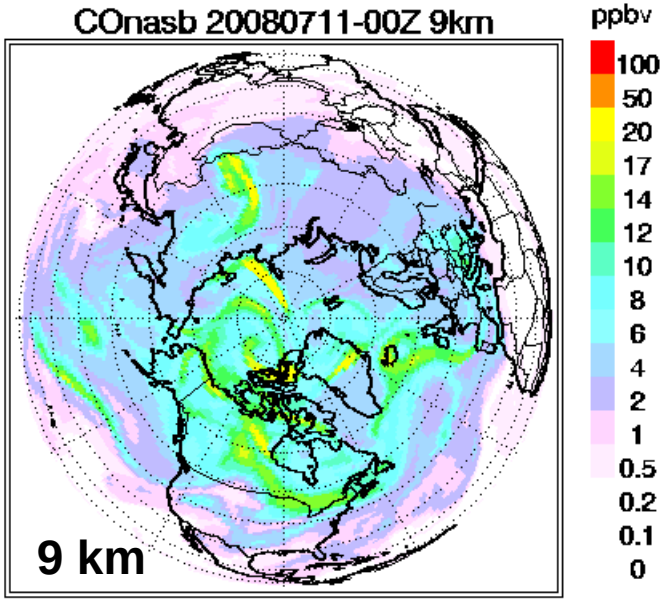
NCAR/CAM-Chem for Jul 4-10 Siberian Plumes

July 10

Fires

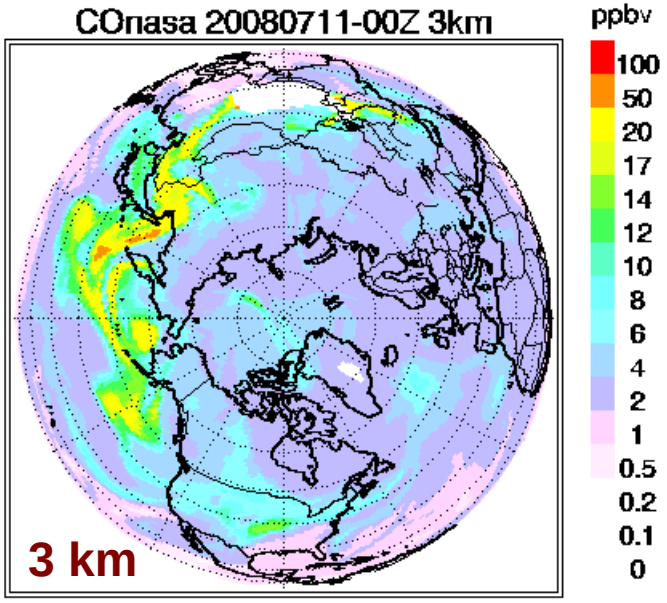


CAM Forecast from 20080703



CAM Forecast from 20080703

Anthro



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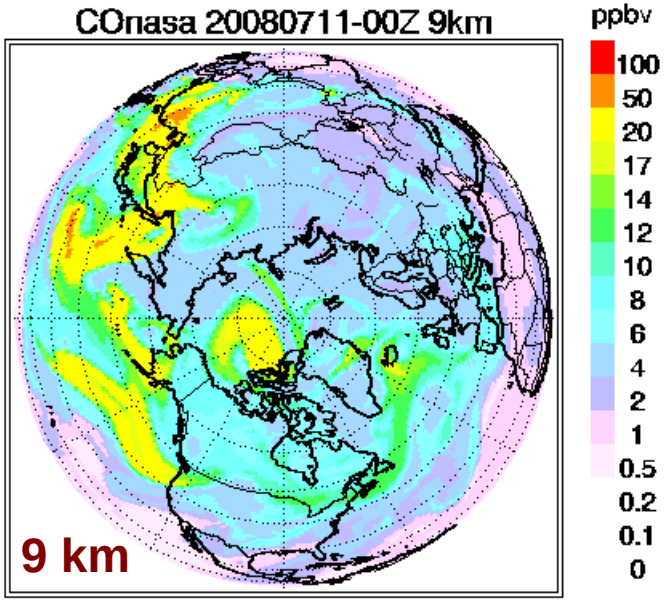
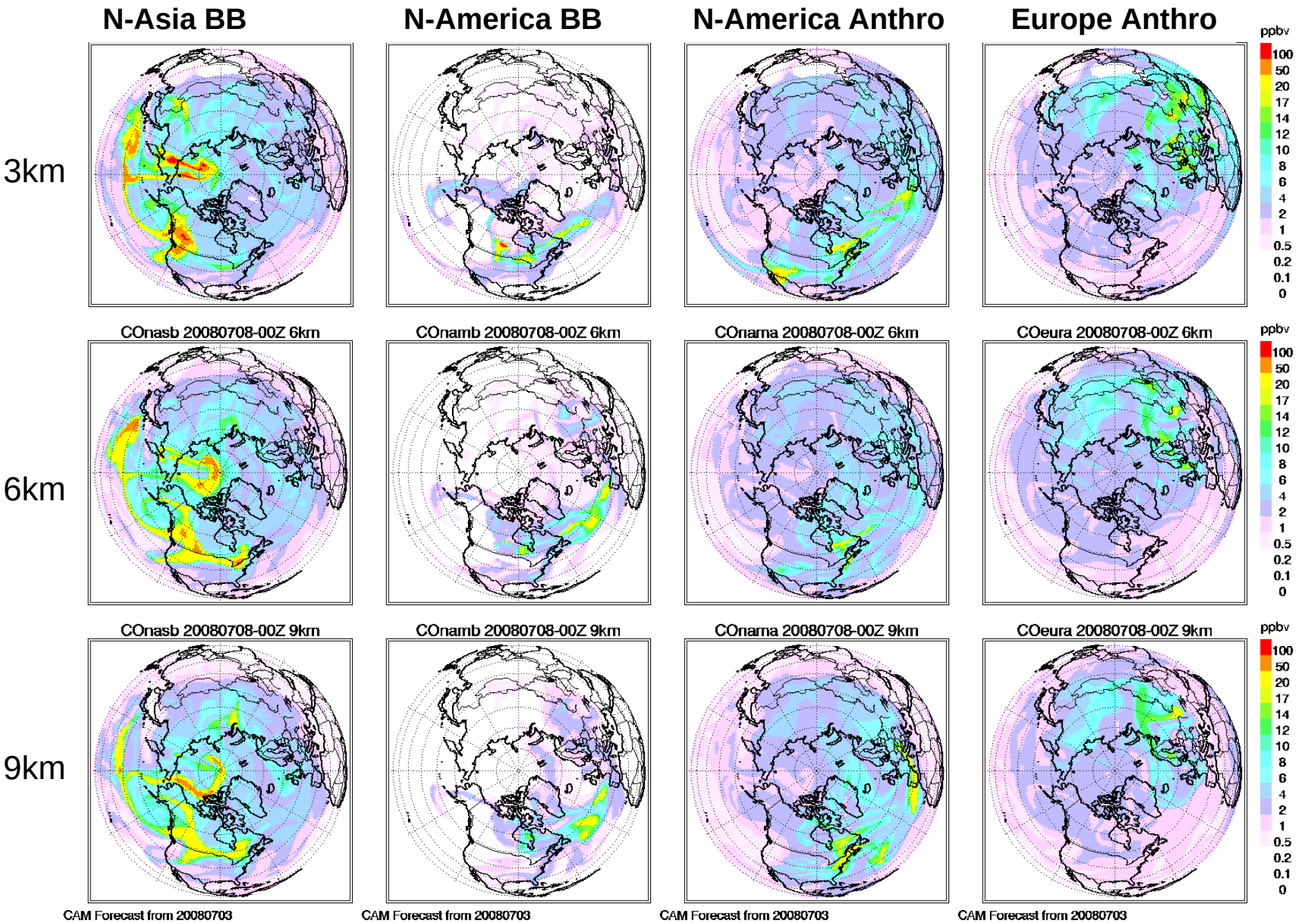


CAM Forecast from 20080703

CAM-Chem for July 7 - CO Tracers



FLEXPART Forecasts: POLARCAT – ARCTAS
Cold Lake, Alberta, 1 – 12 July 2008

Burkhart, John F.

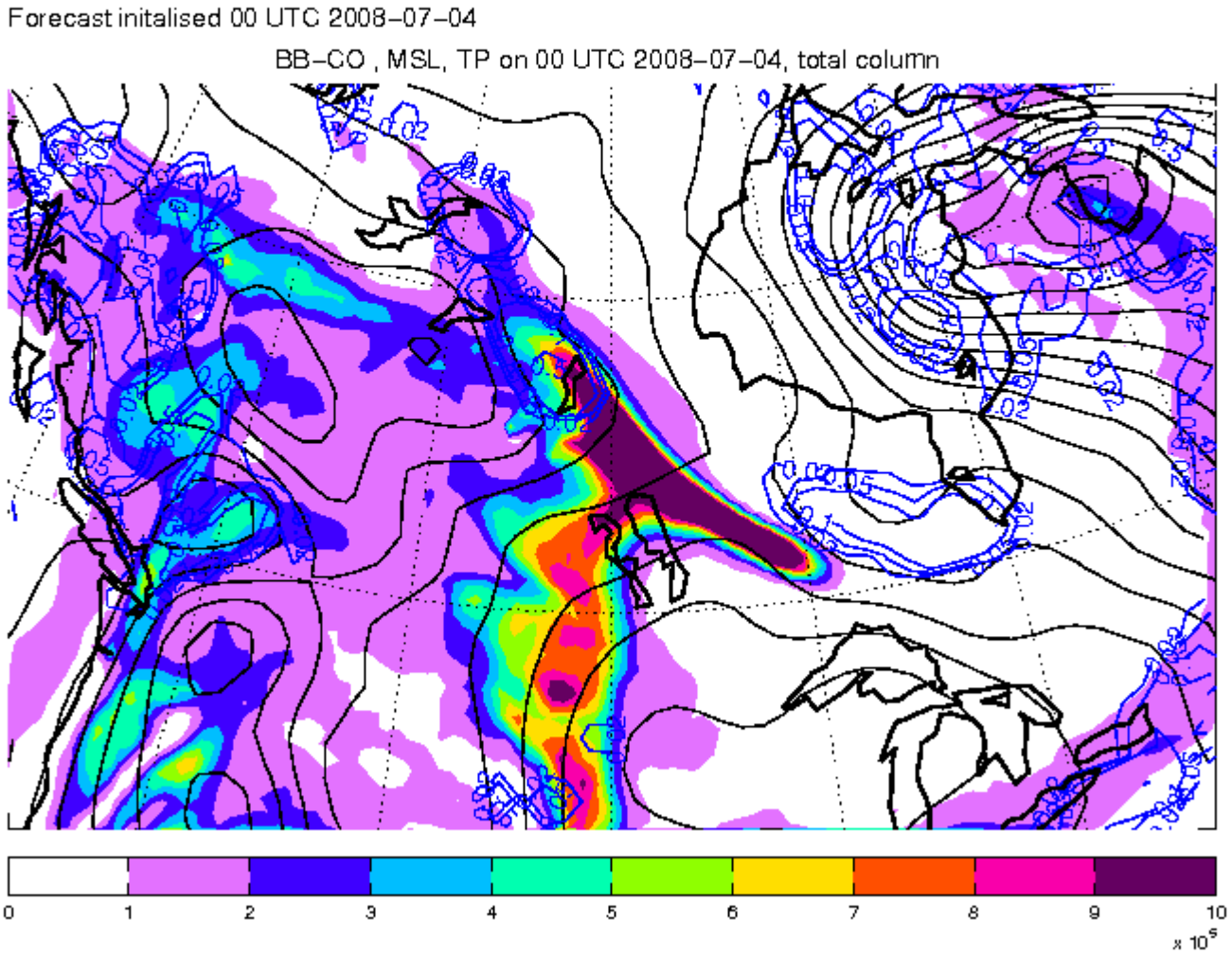
Stohl, A; Sodemann, H; Eckhardt, S; Tørseth, K
Department of Atmospheric and Climate Research, Norwegian Institute for Air Research (NILU), Norway

Prepared:

4 July 2008

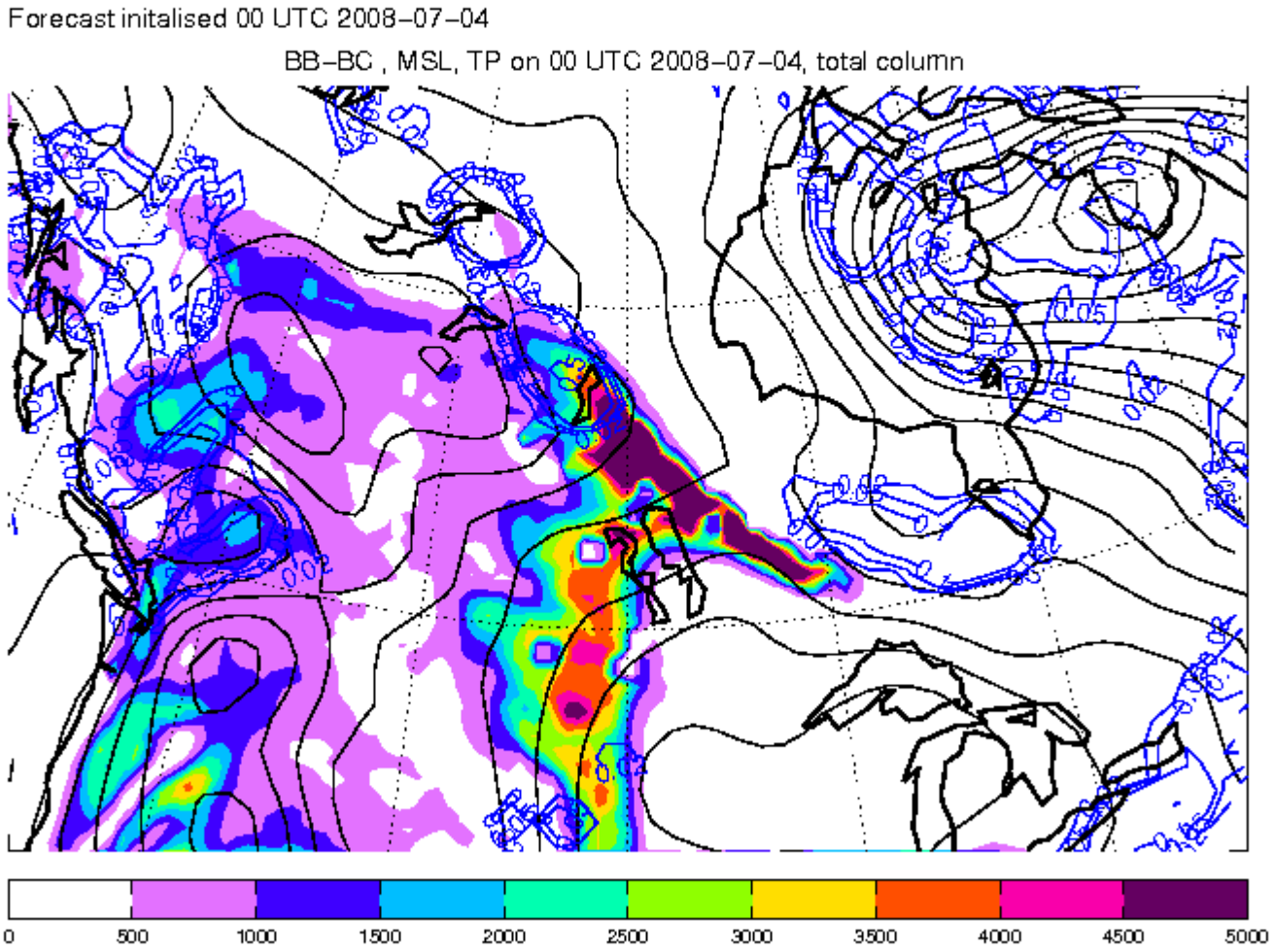
FLEXPART Forecasts – 4 July 2008

Flight

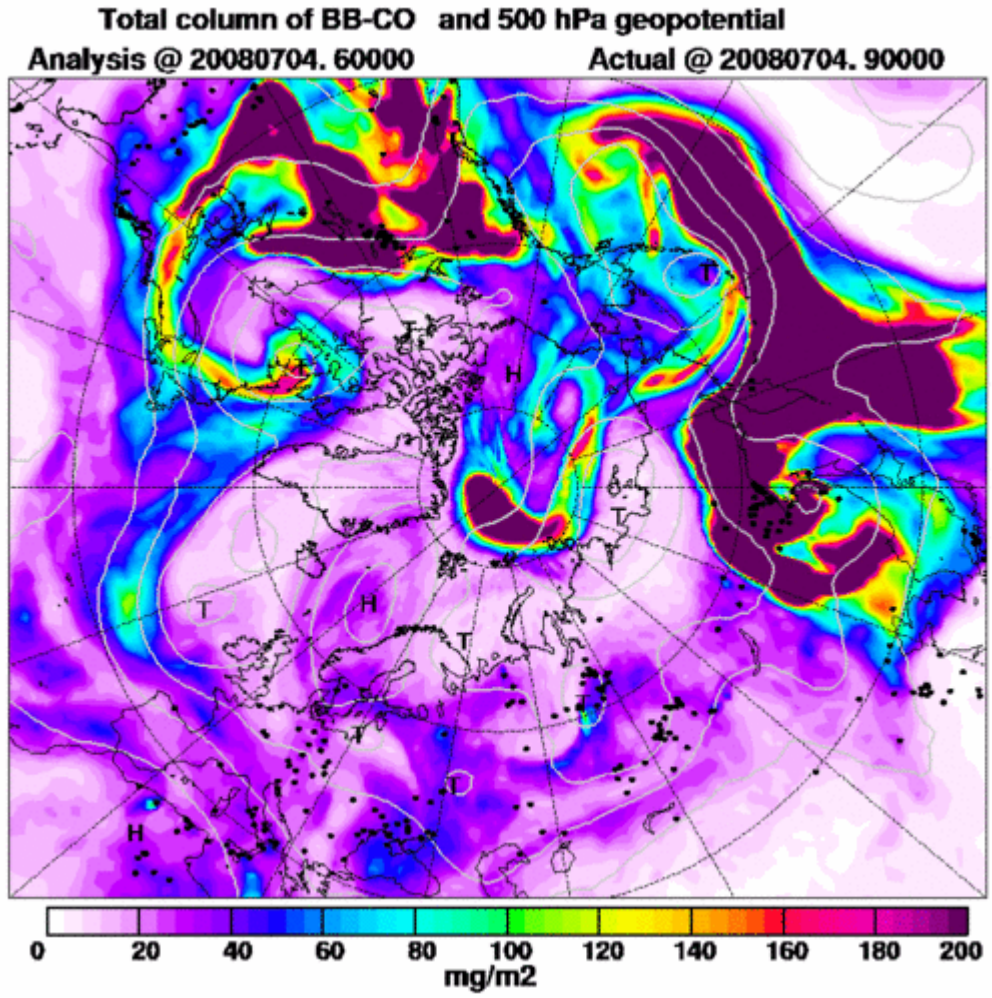


FLEXPART Forecasts – 4 July 2008

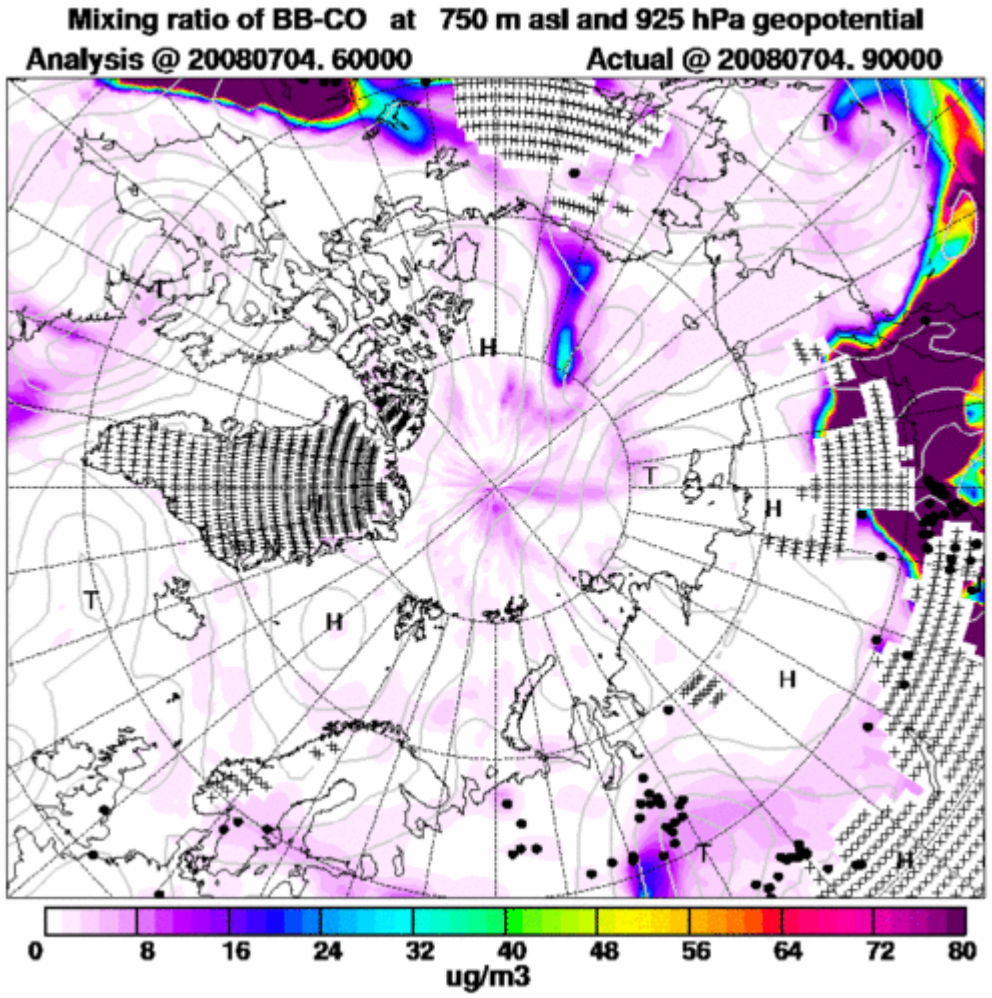
Flight



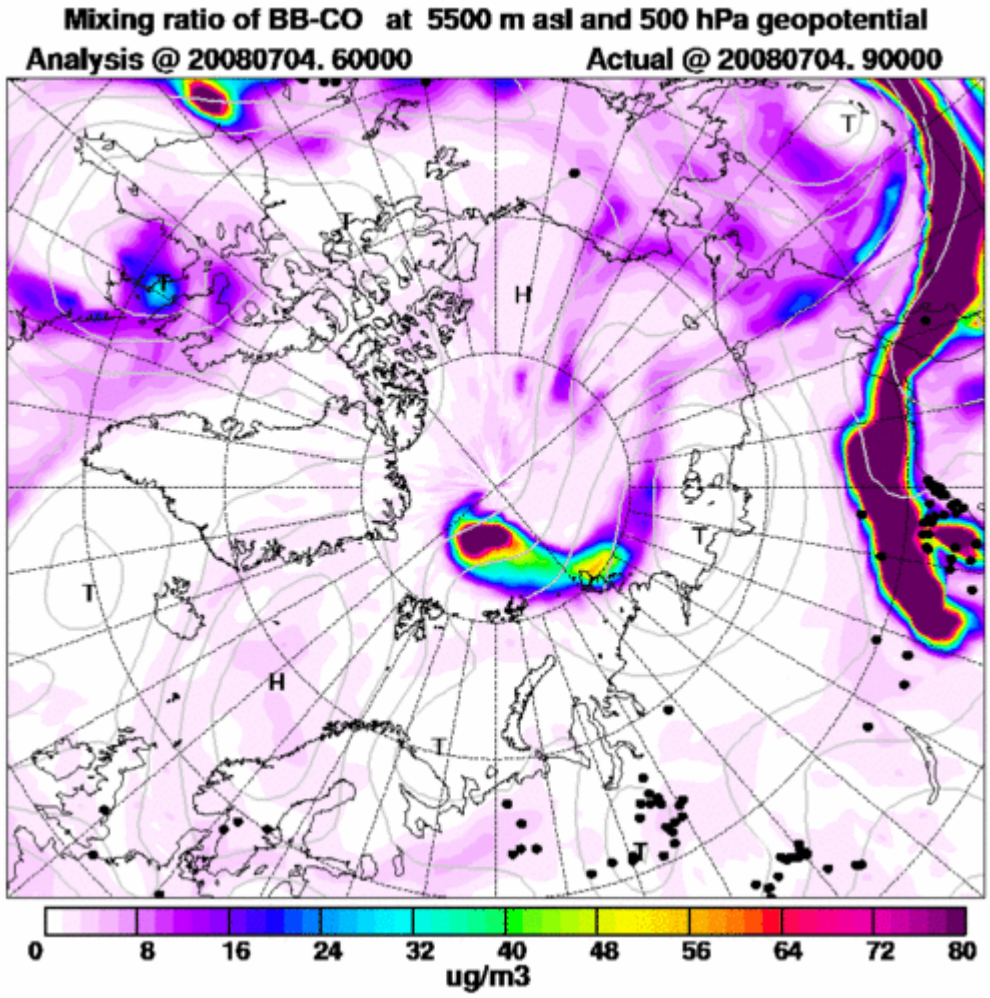
FLEXPART Forecasts – 4 July 2008



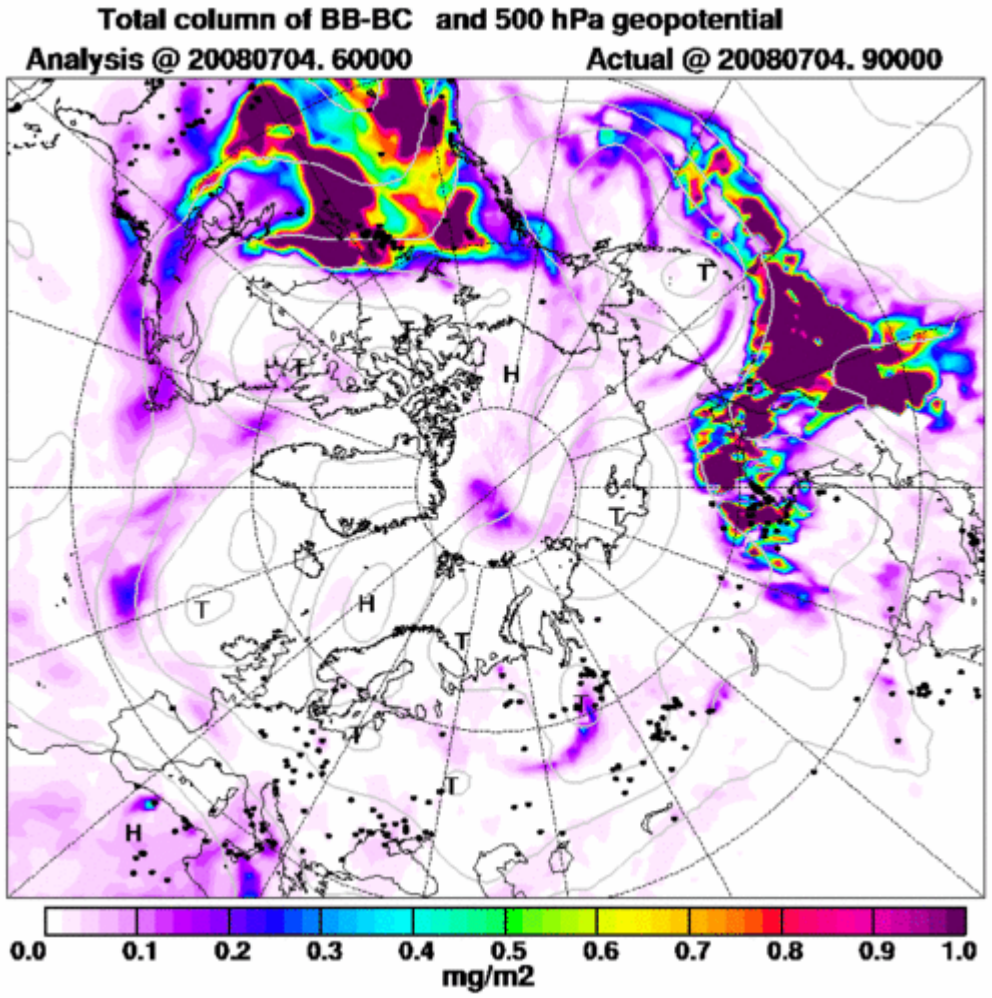
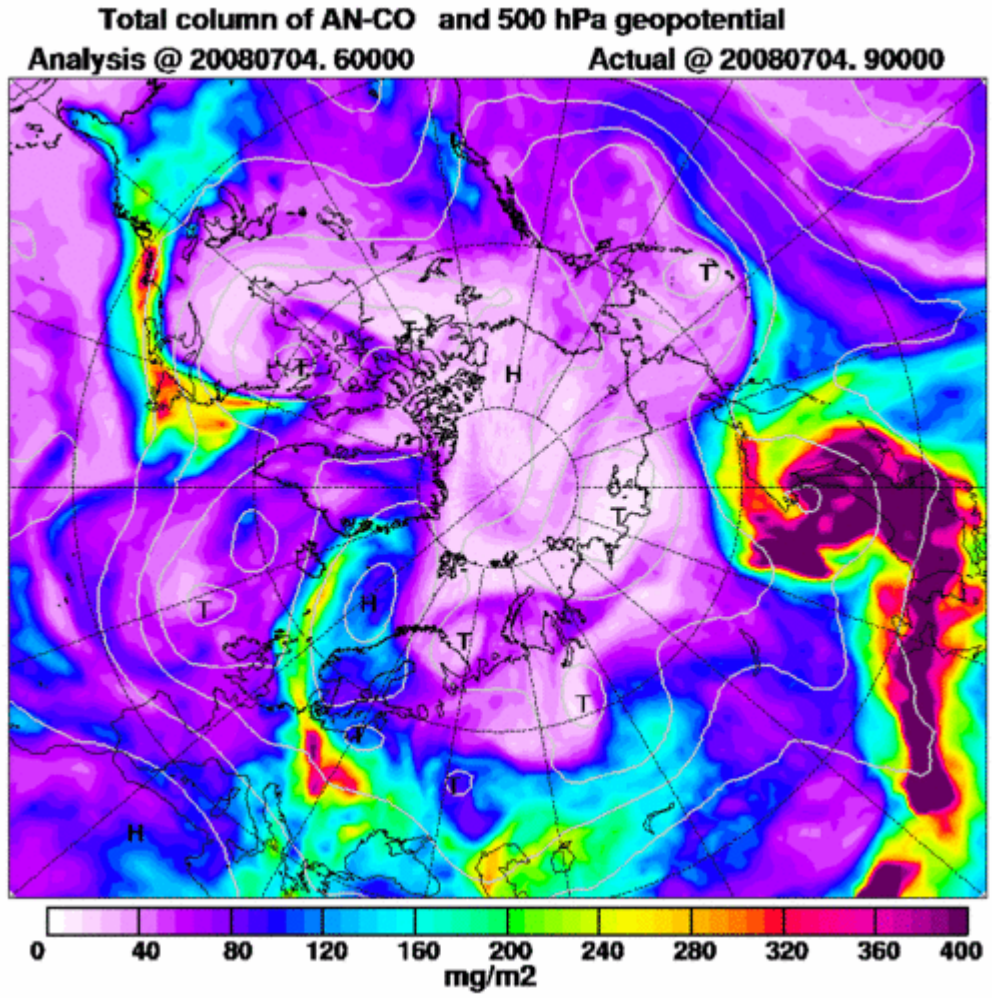
FLEXPART Forecasts – 4 July 2008



FLEXPART Forecasts – 4 July 2008



FLEXPART Forecasts – 4 July 2008



FLEXPART Forecasts – 4 July 2008