AIRS Methane Data for Siberia: Present and Future.

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Acknowledgerments to AIRS Science team members, also to Mikhail Arshinov (Tomsk Institute of Atmospheric Optics), Mikhail Glagolev (Moscow University), and Vyacheslav Zakharov (Ural State University)

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Outline

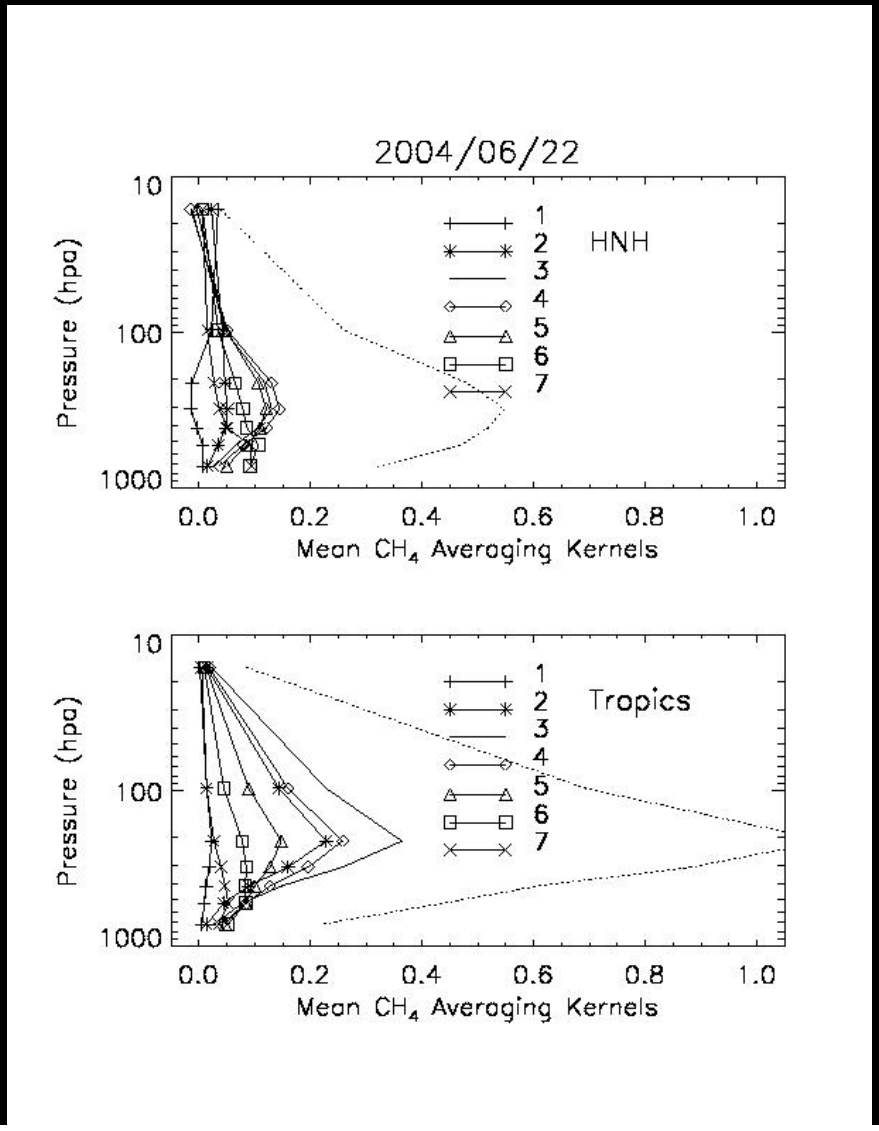
- Standard AIRS CH4 v.5 level 3 product for N. Eurasia and N. America
- Comparison with SCIAMACHY
- Topography effect in winter- spring
- Seasonal changes of CH4 content

Future possibilities:

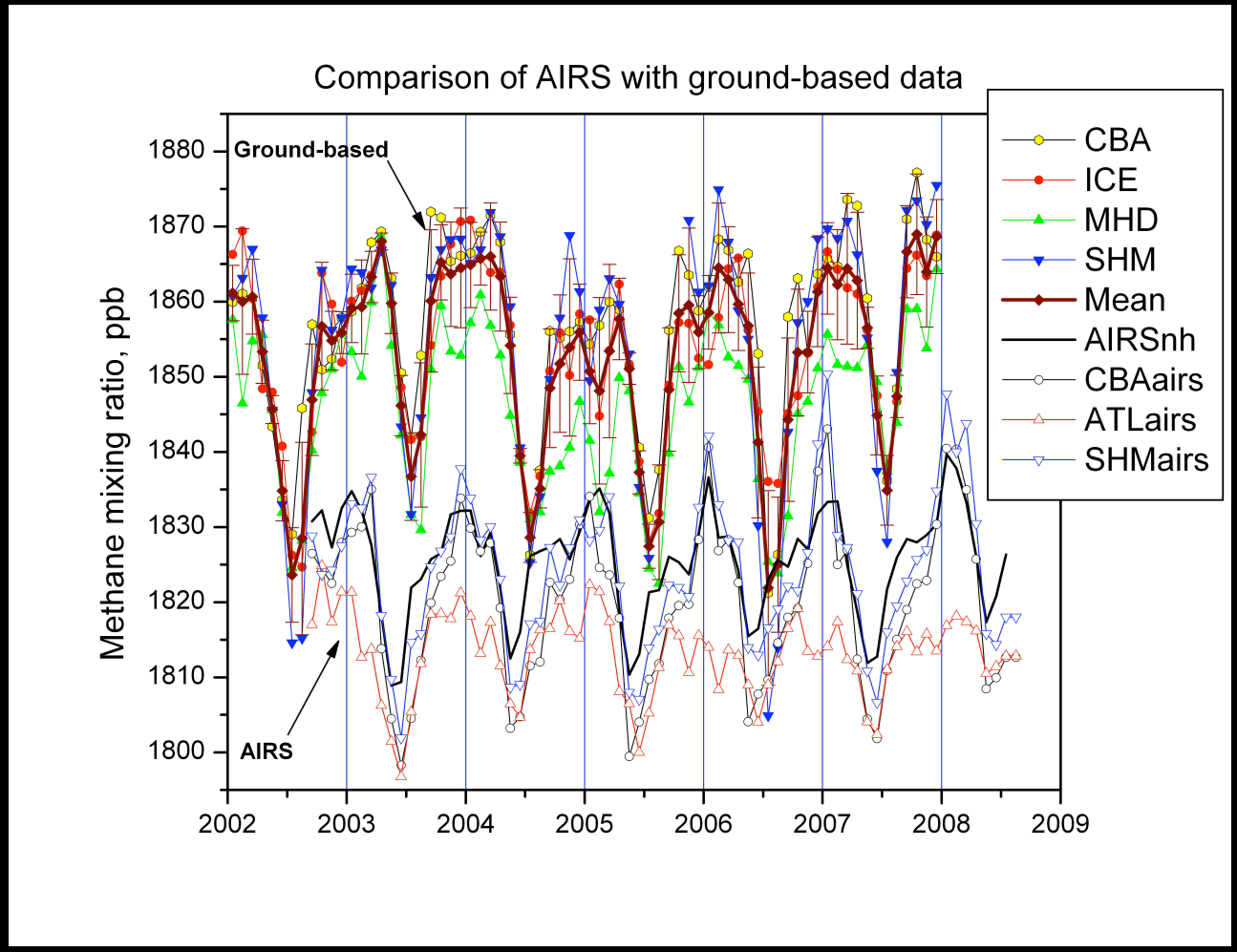
- Using local Russian data from the bottom for interpretation of AIRS CH4 and CO2
- Total columns from FTIR in Siberia

AIRS CH4 Averaging Kernels

(by X. Xiong et al., J. Geophys. Res. –B, 2008)



CH4 seasonality near the surface and in the free troposphere over Atlantic and Pacific



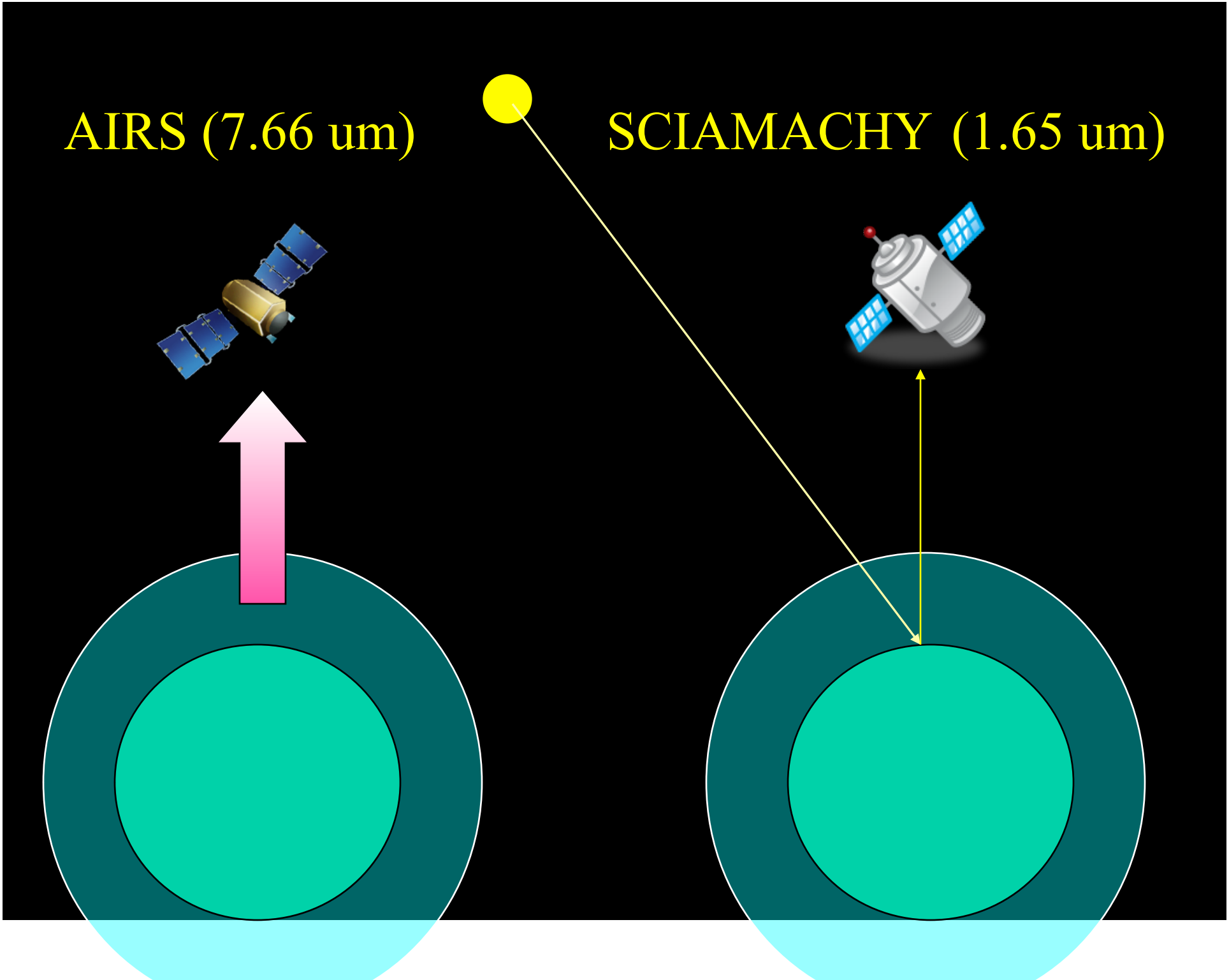
CBA – Alaska

ICE – Iceland

SHM – Pacific

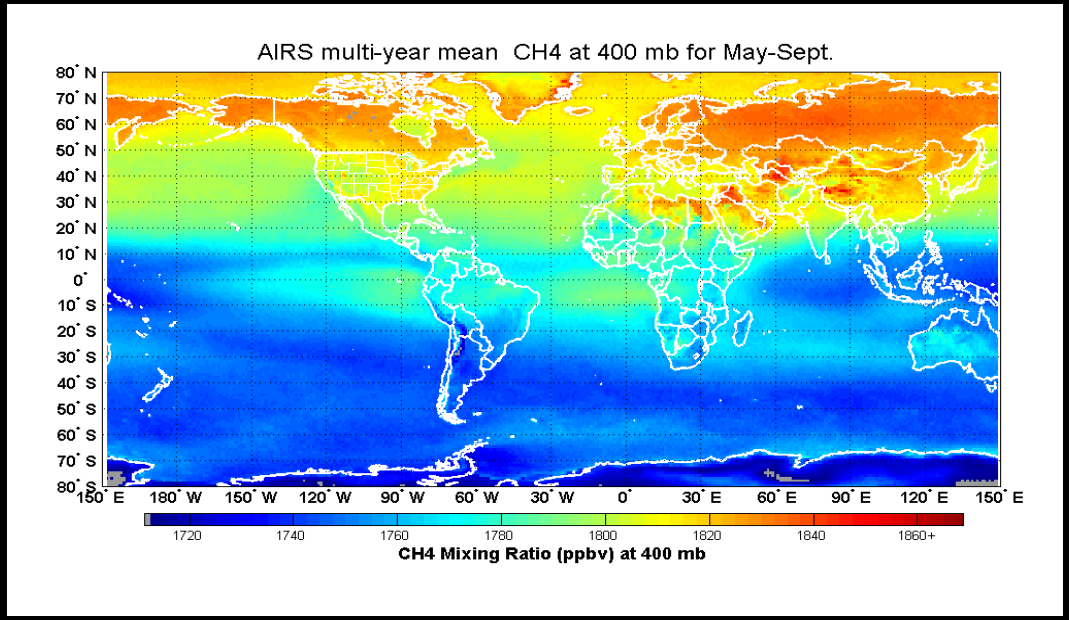
MHD – Ireland

A bias ~ 30 ppb


AIRS (7.66 um)
SCIAMACHY (1.65 um)

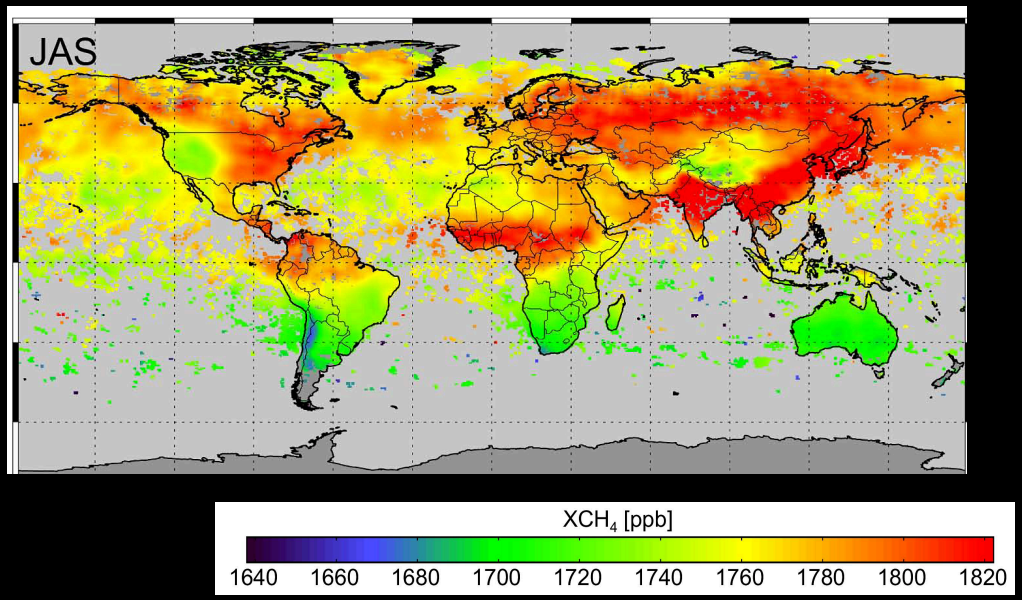
Mixing ratios in the troposphere

AIRS (FT)
(May - September)
[L3 downloaded]



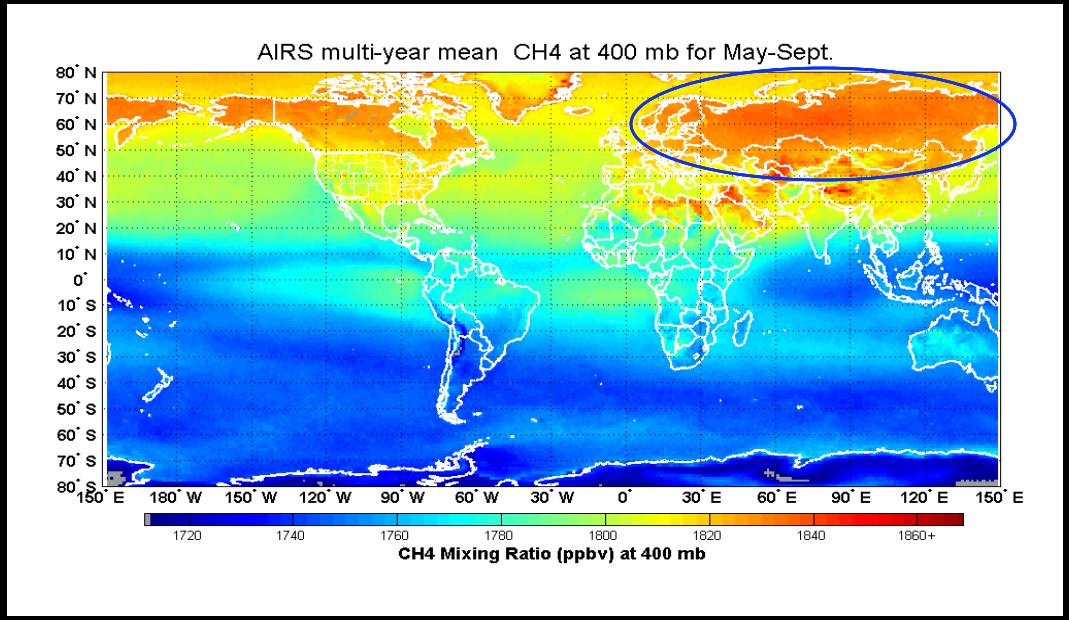
NH bias ~ 40 ppb or 2%
(AIRS values are
higher, not lower,
as could be expected)

SCIAMACHY (FT+BL)
(July - September)
[Schneising et al., ACPD, 2008]

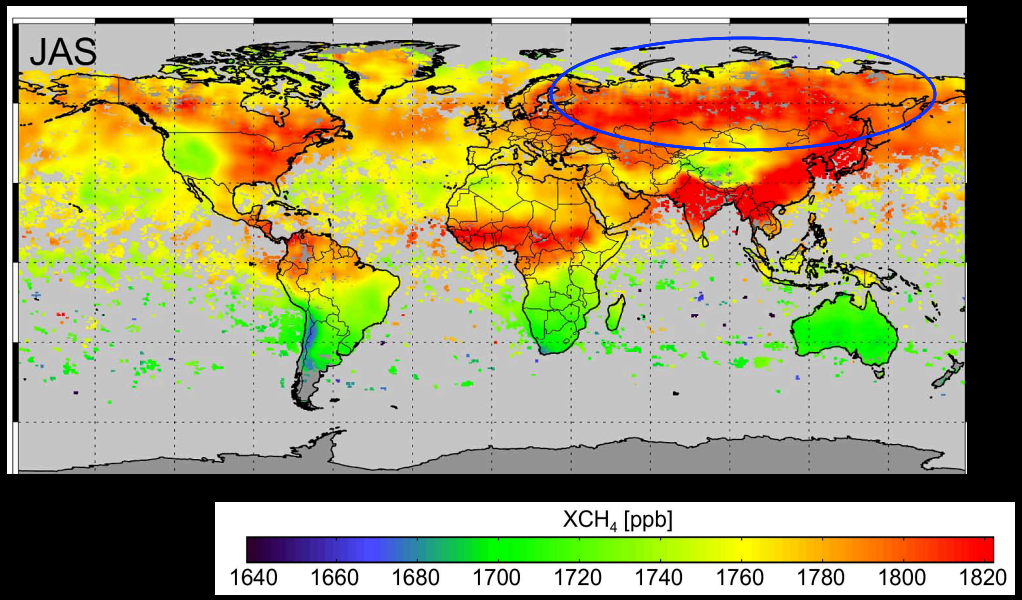


AIRS (FT)

(May - September)
[downloaded]

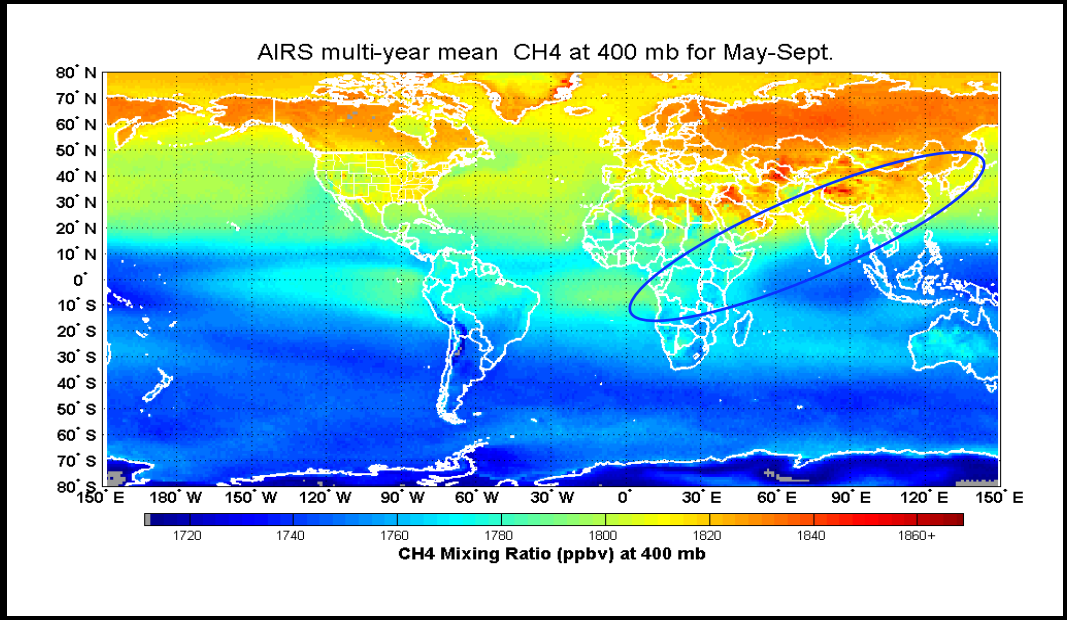


North Eurasia



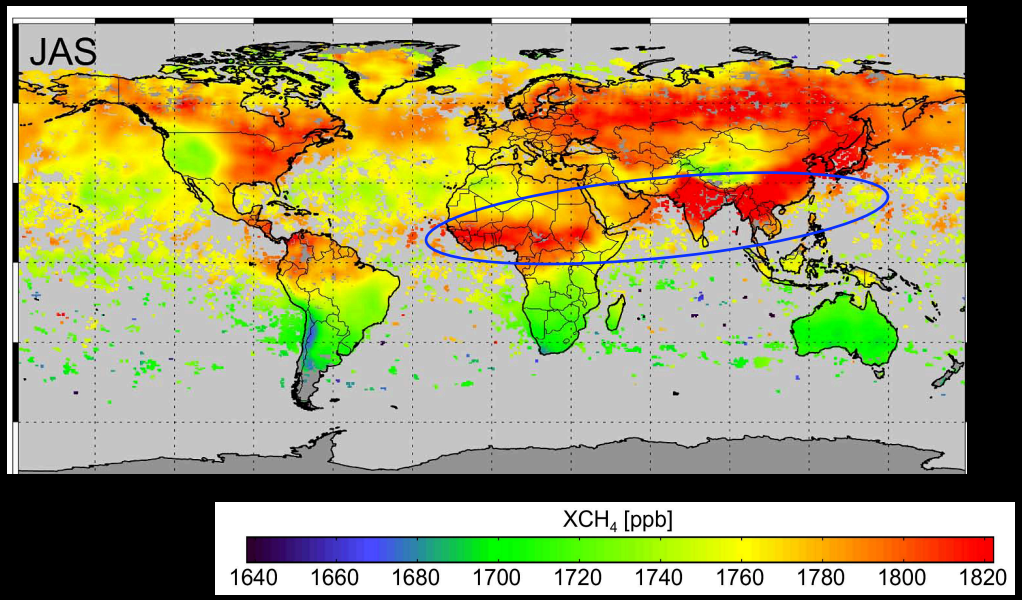
SCIAMACHY (FT+BL)
(July - September)
[Schneising et al., ACPD, 2008]

AIRS (FT)
(May - September)
[downloaded]



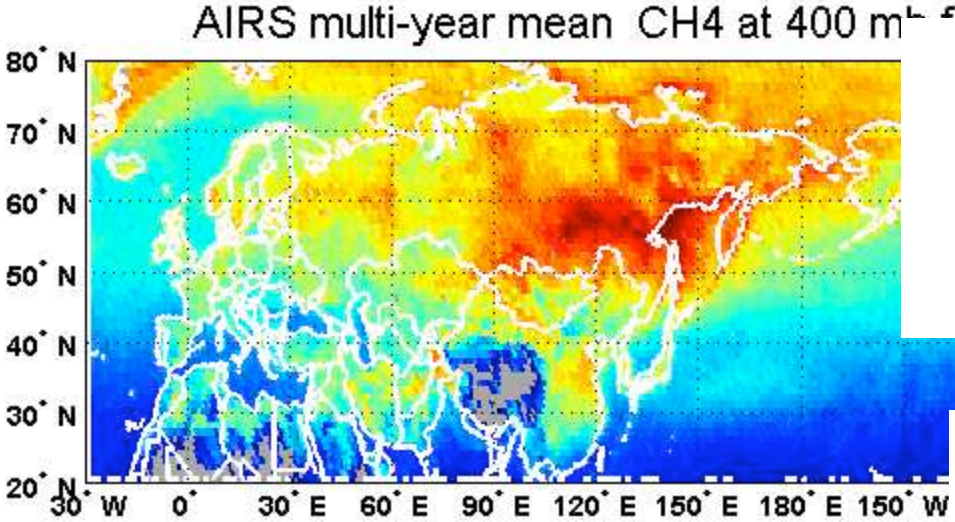
Africa, India, China

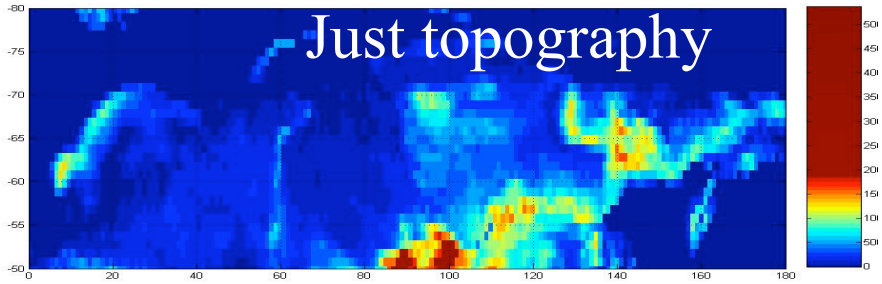
SCIAMACHY (FT+BL)
(July - September)
[Schneising et al., ACPD, 2008]

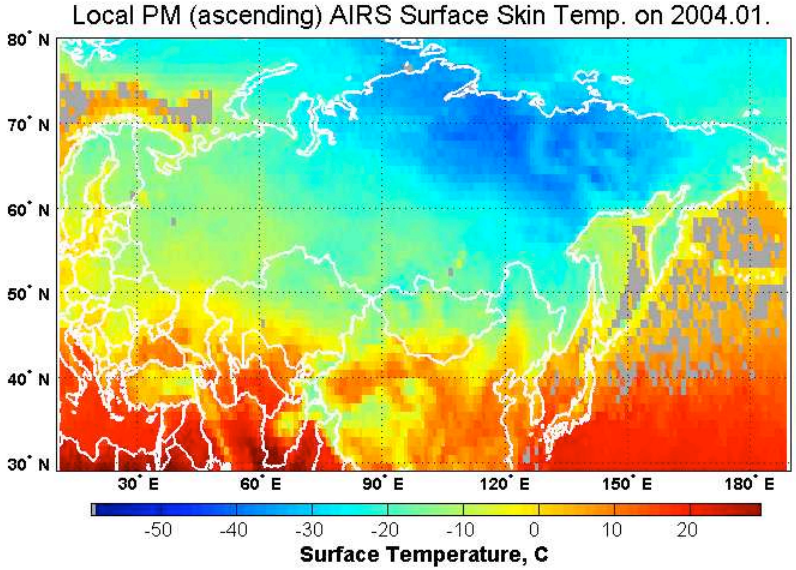


AIRS winter time errors connected with topography

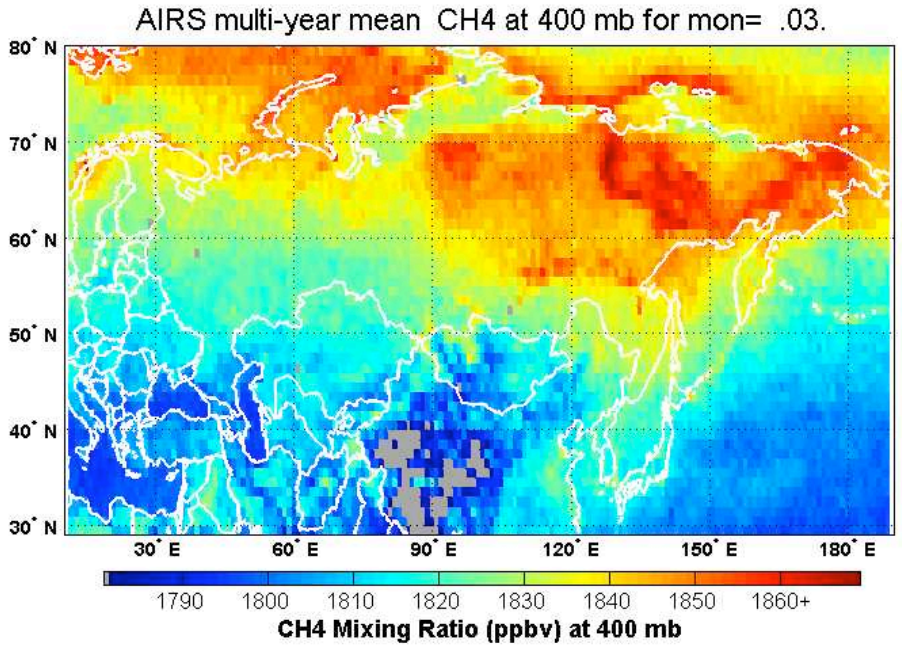
AIRS in winter time (January): topography effect

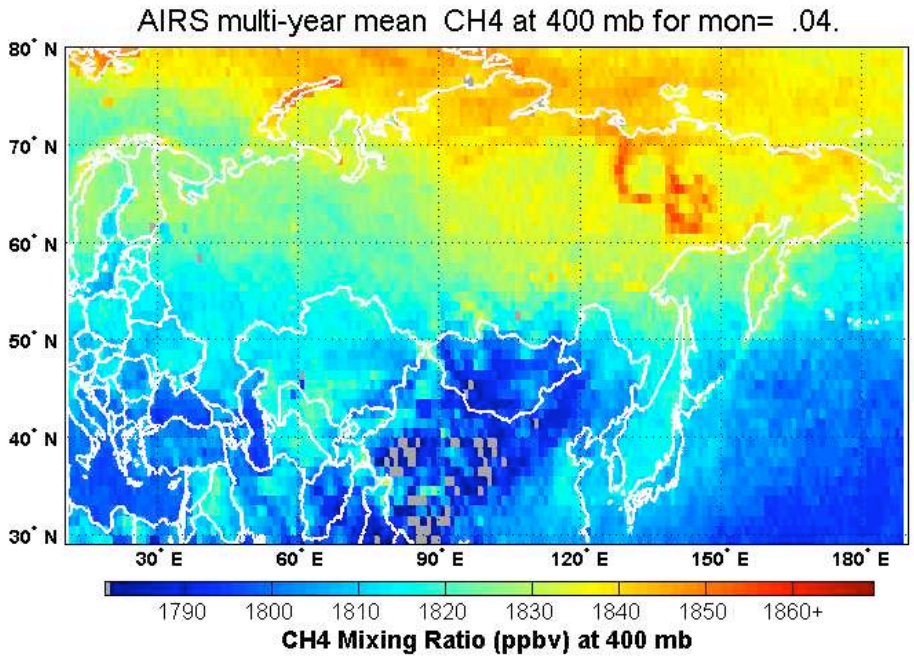


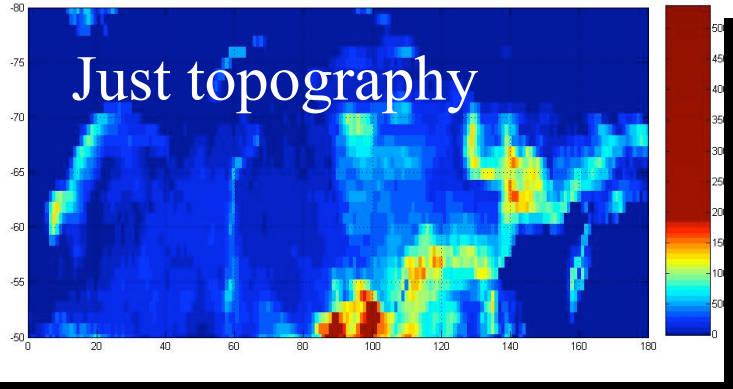




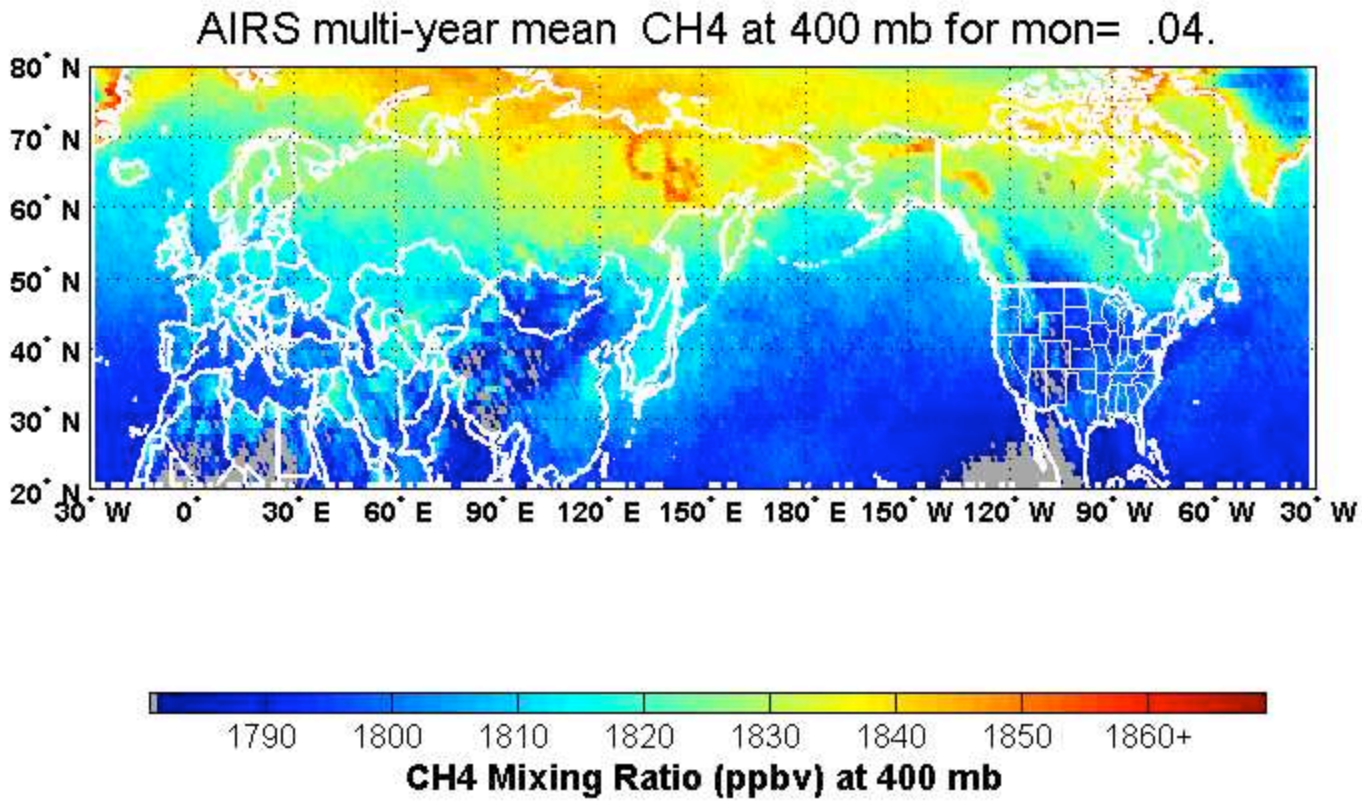
AIRS in spring time (March and April)

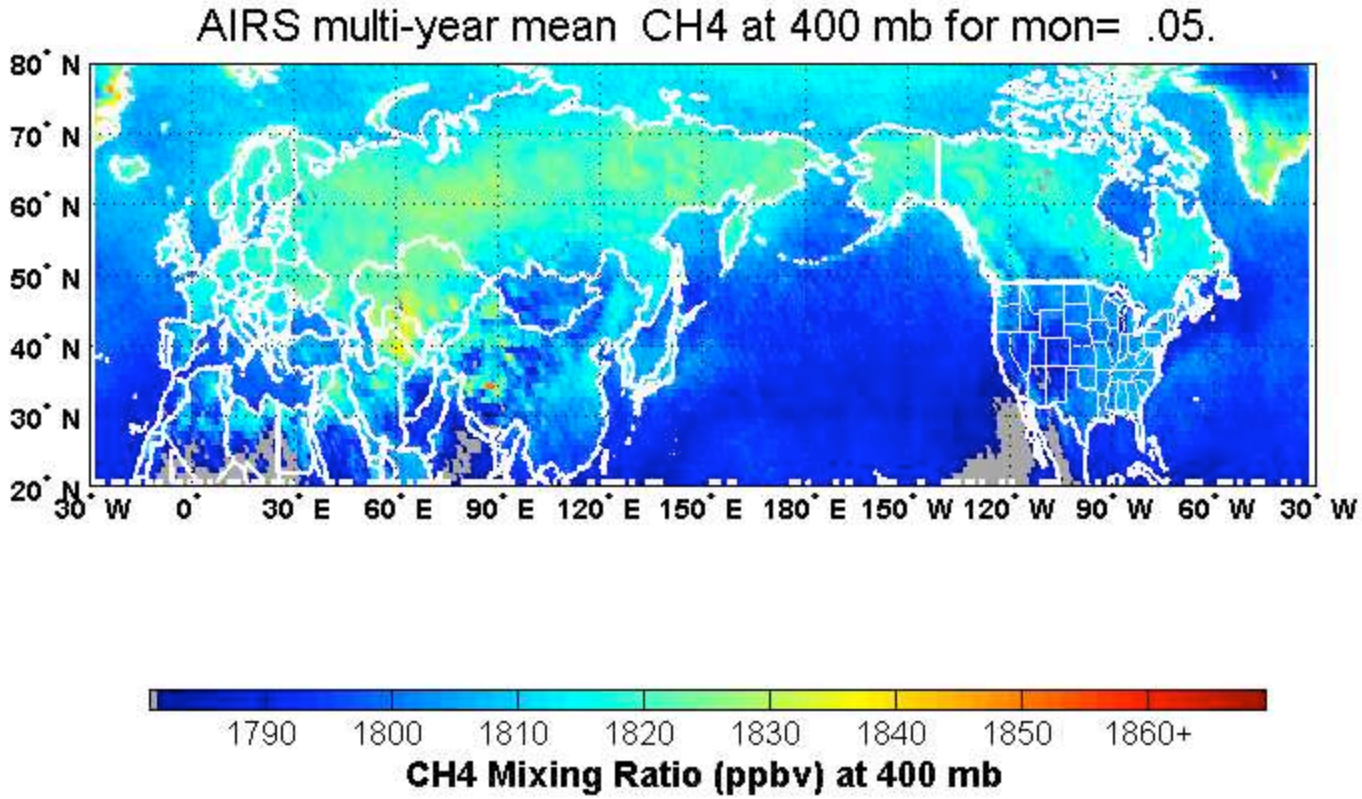


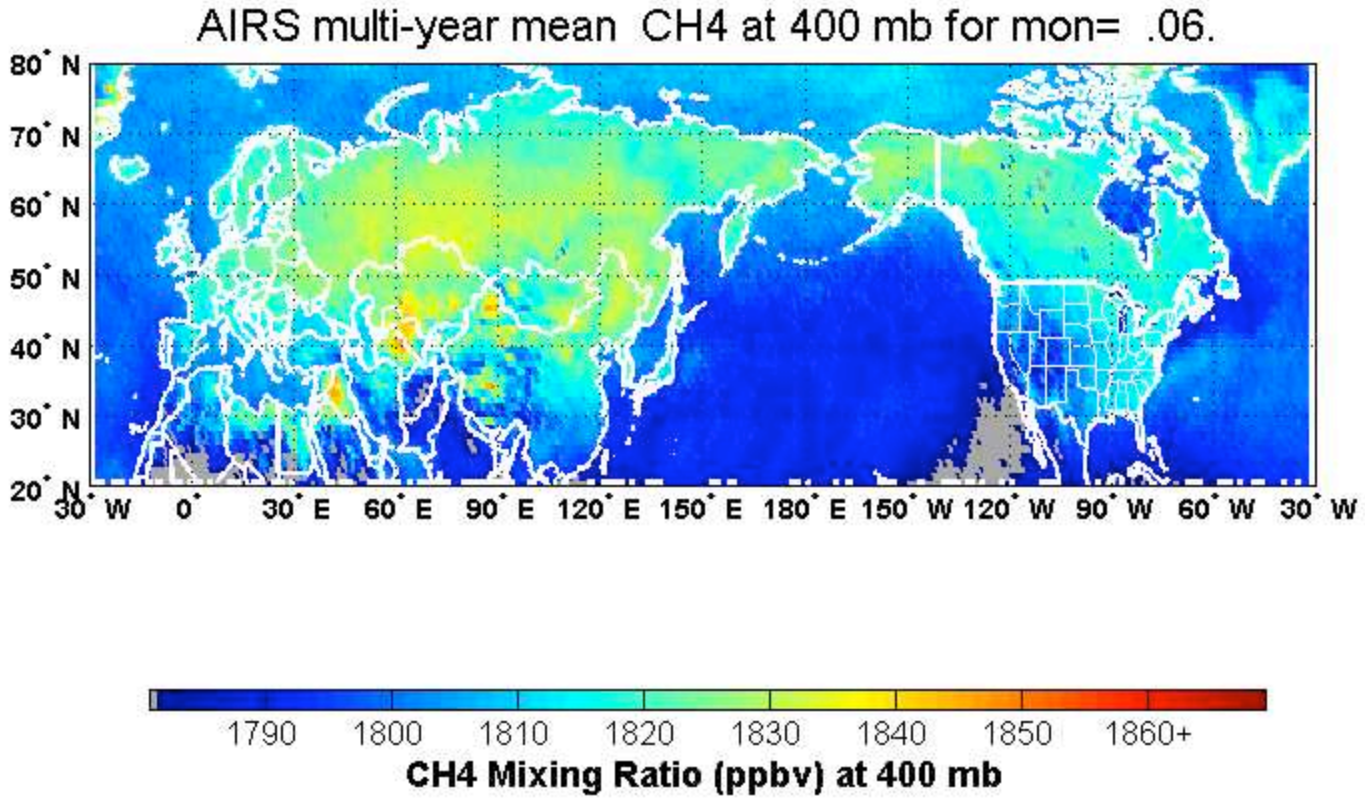


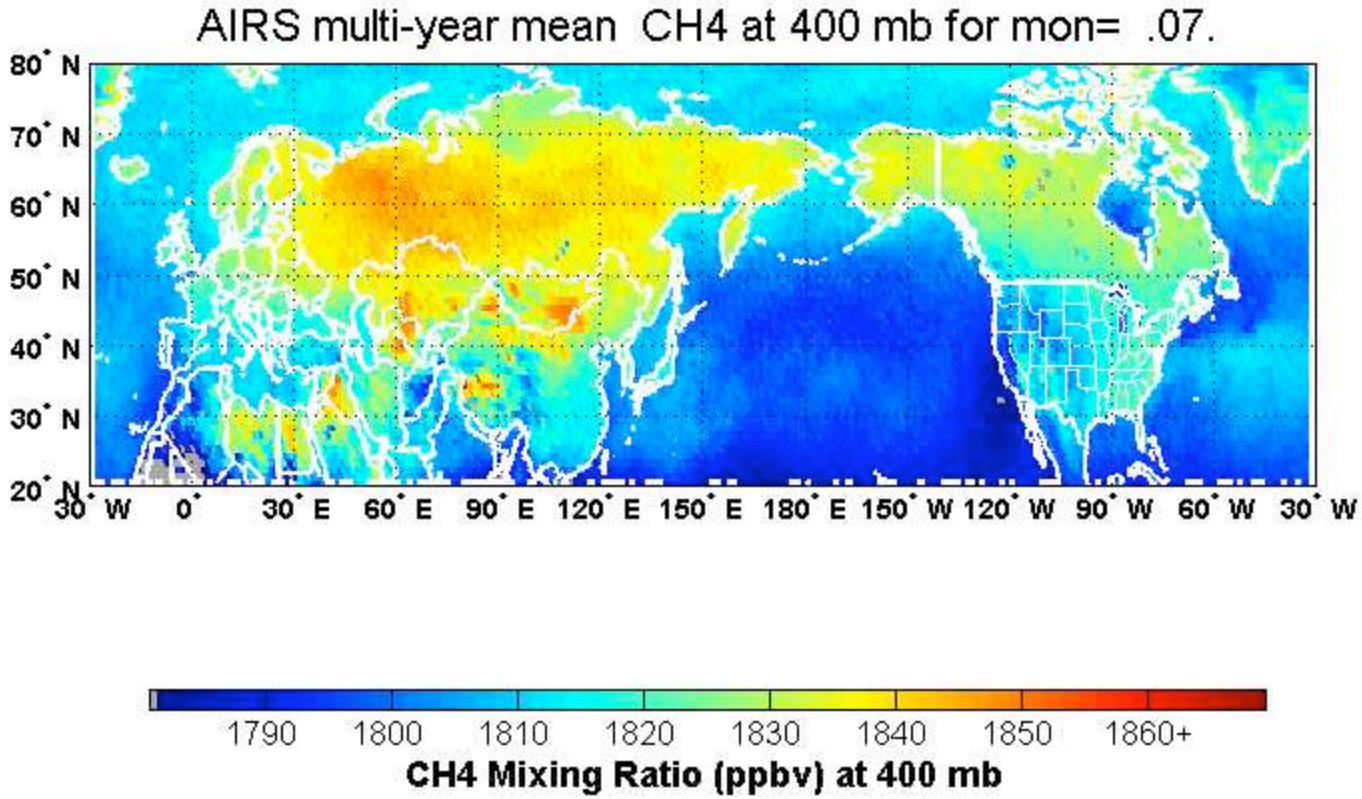


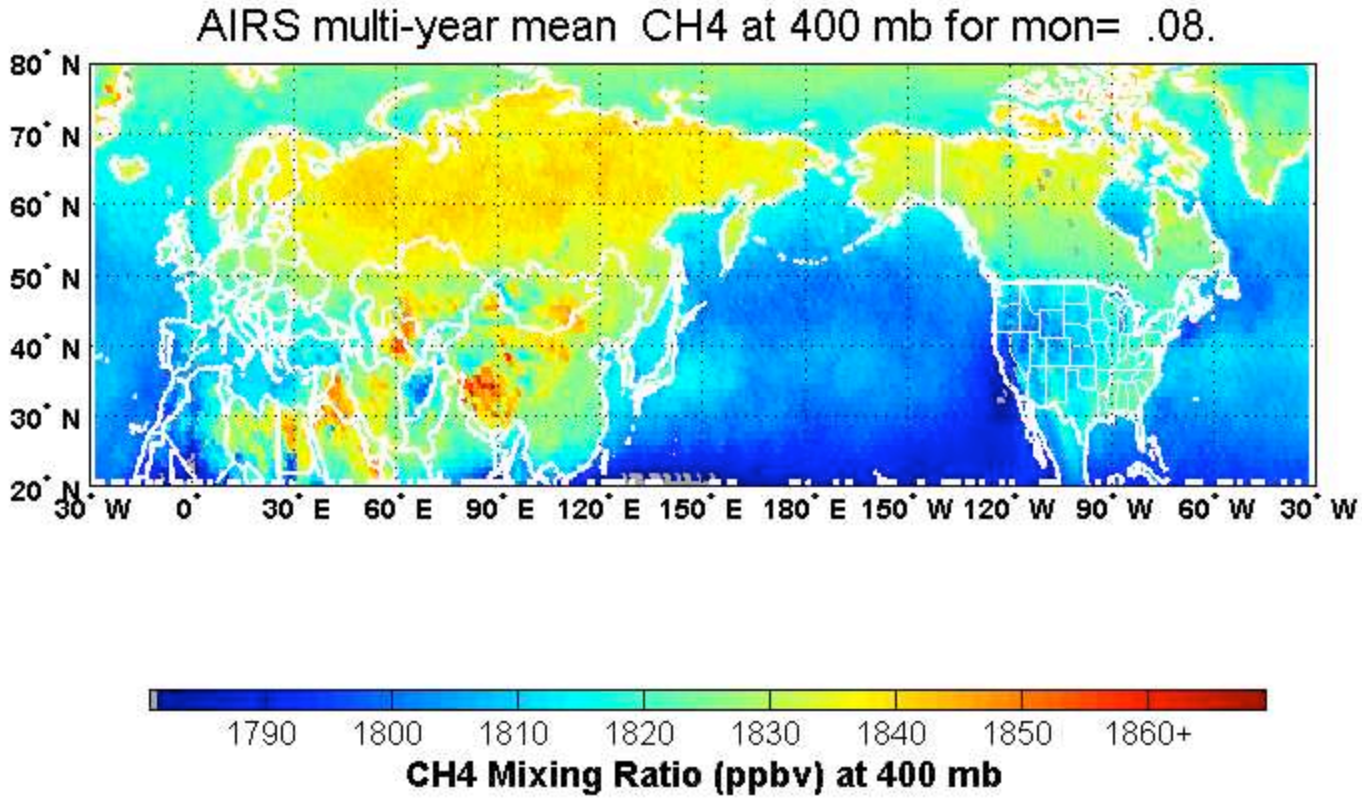
Monthly
AIRS, 2003-2007 averaging

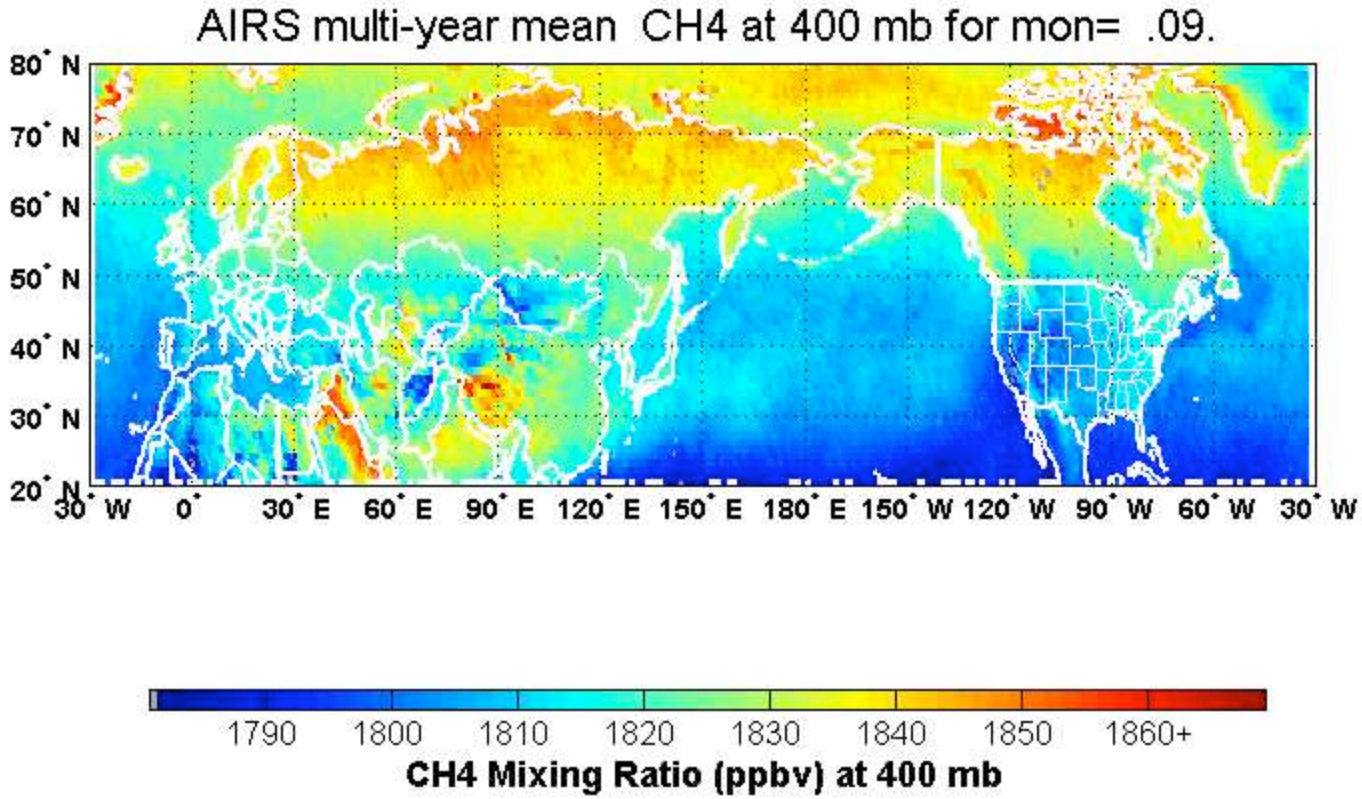

AIRS multi-year mean CH4 at 400 mb for mon= .04.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

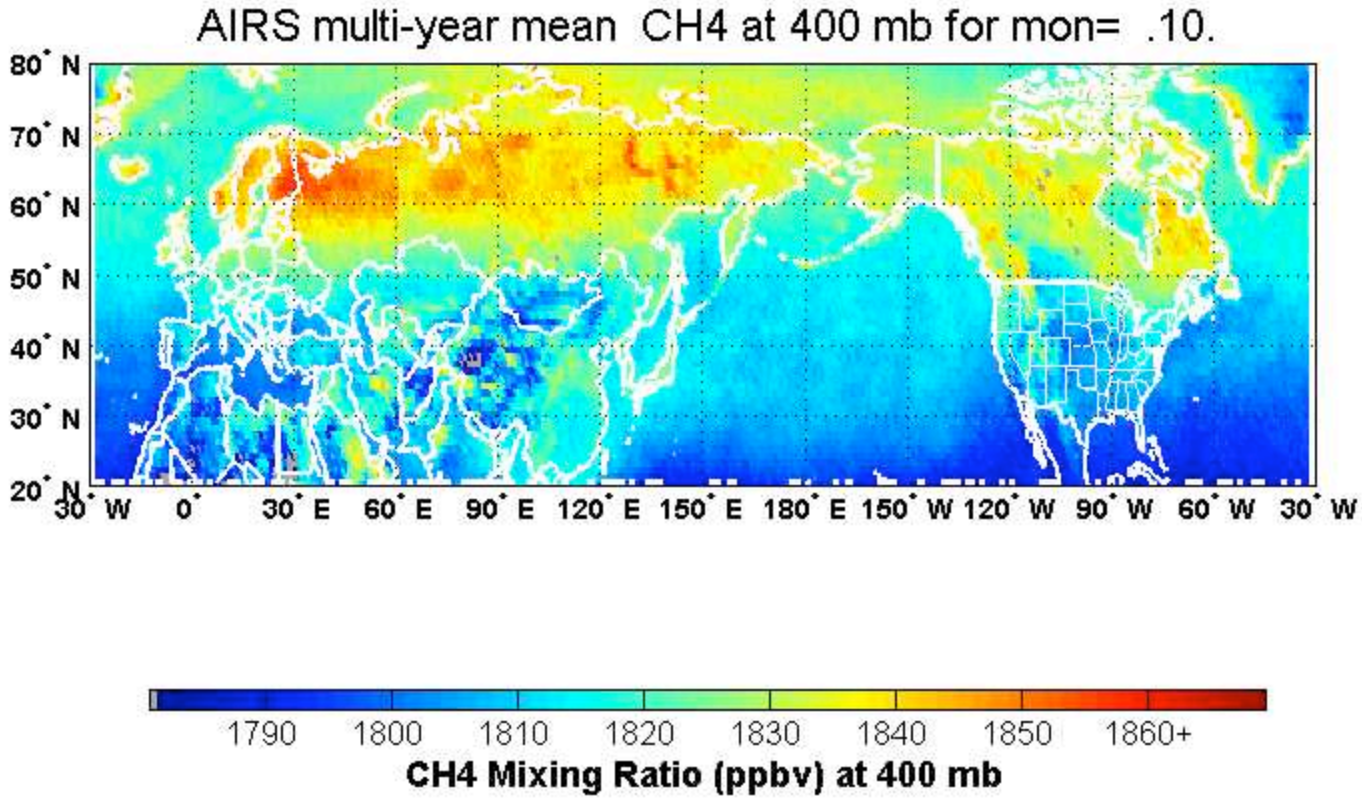

AIRS multi-year mean CH4 at 400 mb for mon= .05.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


AIRS multi-year mean CH4 at 400 mb for mon= .06.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

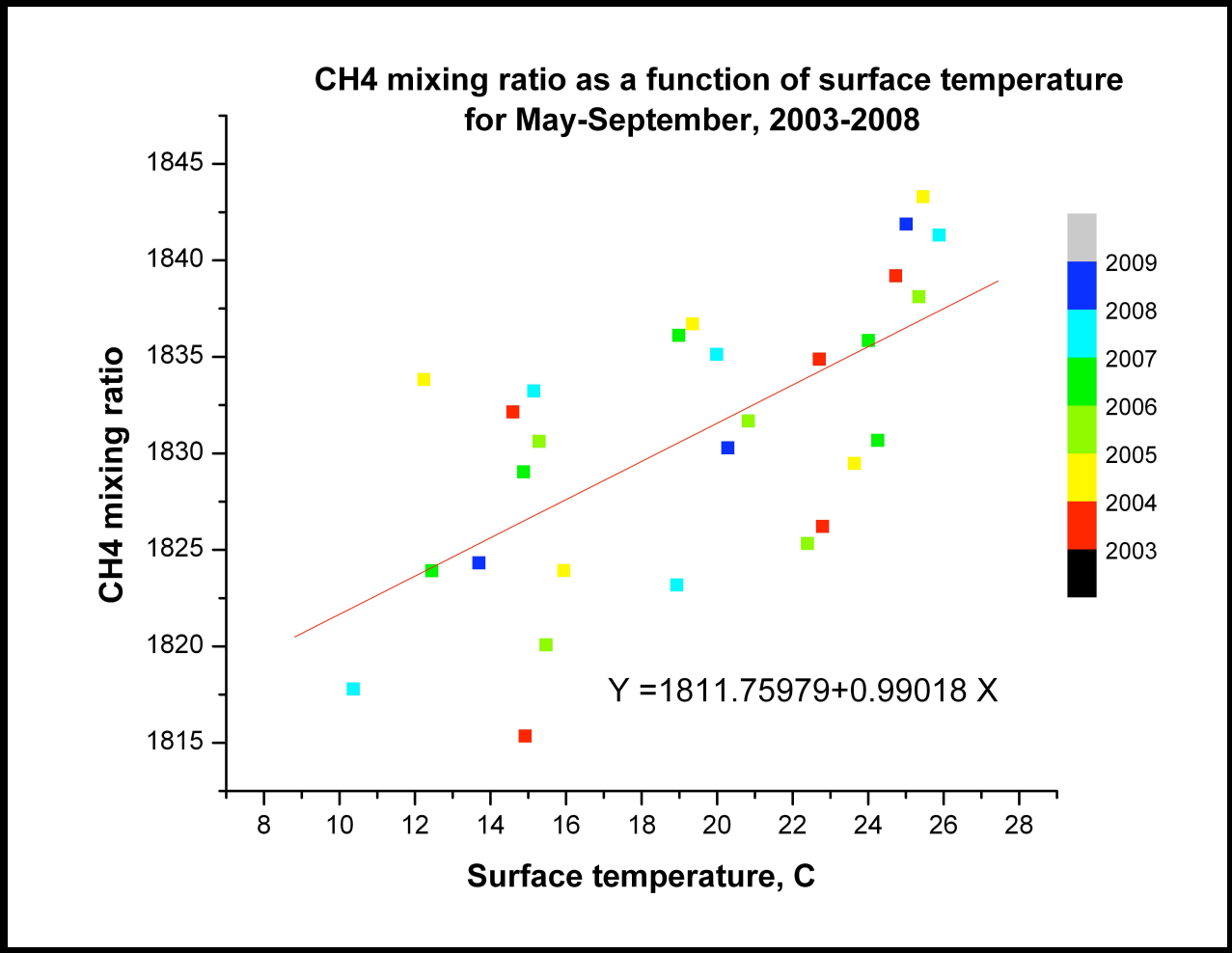

AIRS multi-year mean CH4 at 400 mb for mon= .07.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


AIRS multi-year mean CH4 at 400 mb for mon= .08.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


AIRS multi-year mean CH4 at 400 mb for mon= .09.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


AIRS multi-year mean CH4 at 400 mb for mon= .10.
80° N
70° N
60° N
50° N
40° N
30° N
20° N
30° W
0°
30° E
60° E
90° E
120° E
150° E
180° E
150° W
120° W
90° W
60° W
30° W
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

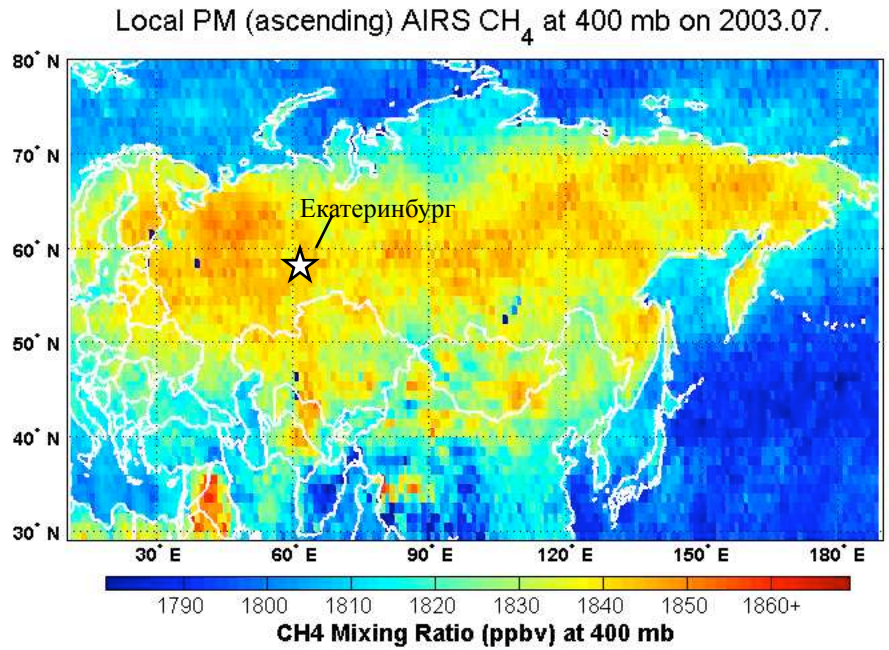
May - September methane in **West Siberia**: correlation with surface skin temperature

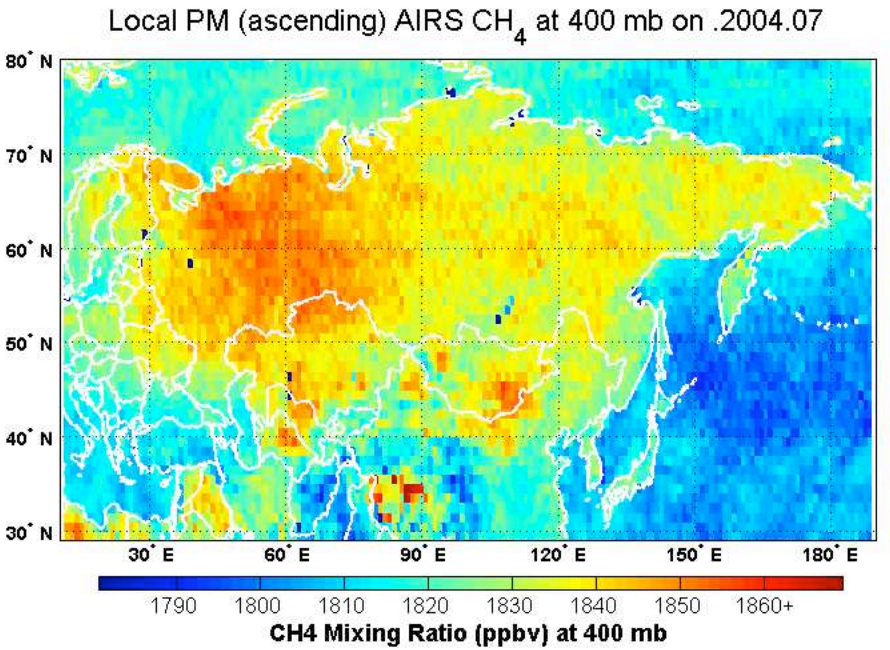


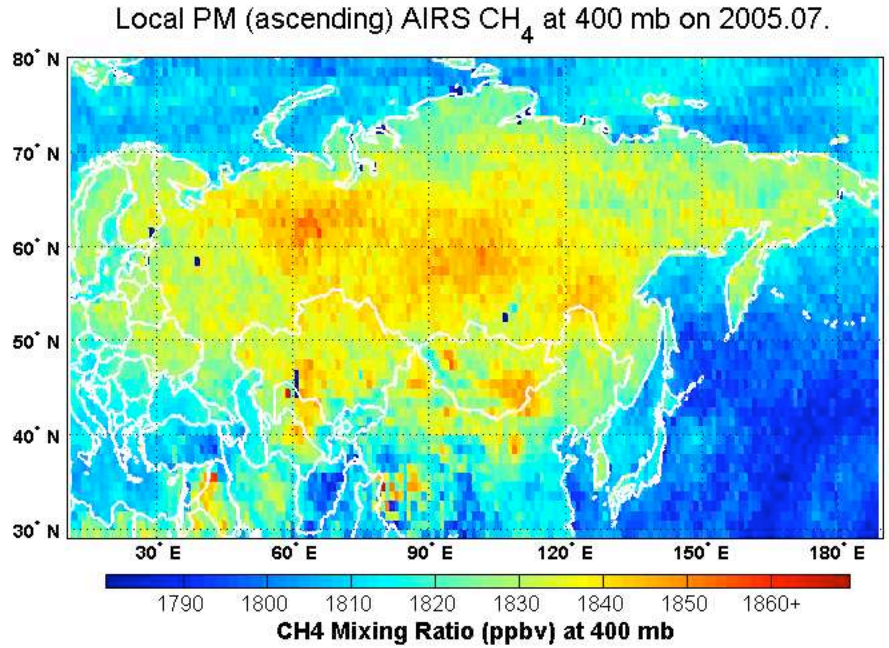
Interannual variations

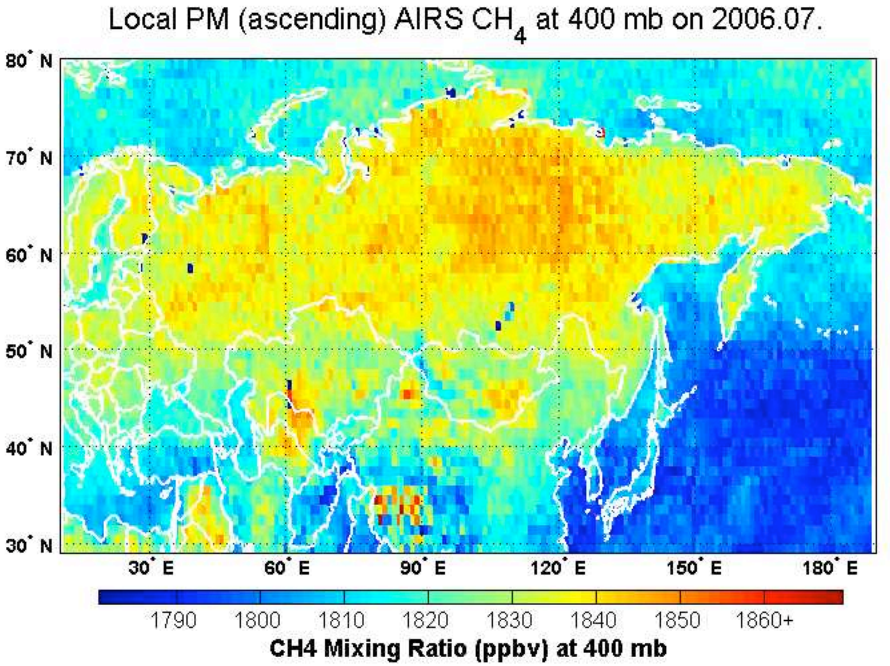
CH4 in July between 2003 and 2008:

Soil Bacteria (??)

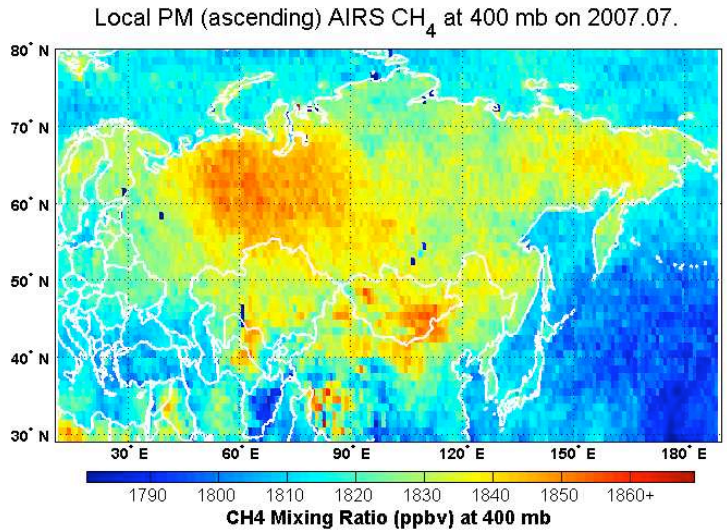

Local PM (ascending) AIRS CH4 at 400 mb on 2003.07.
Екатеринбург
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

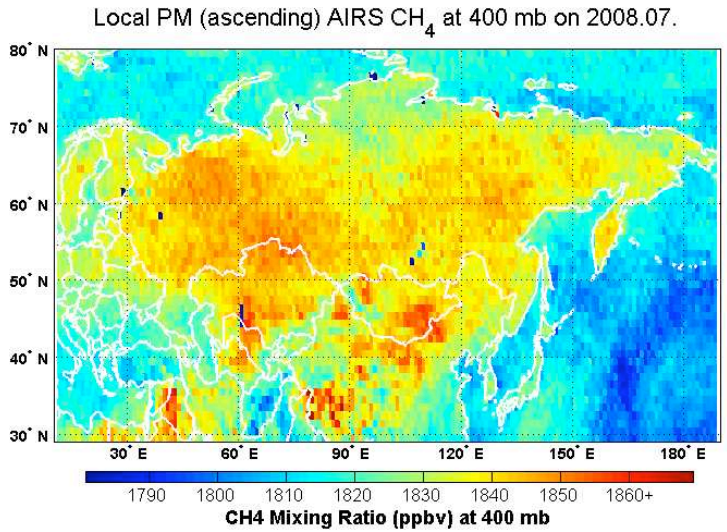

Local PM (ascending) AIRS CH4 at 400 mb on .2004.07
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


Local PM (ascending) AIRS CH4 at 400 mb on 2005.07.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

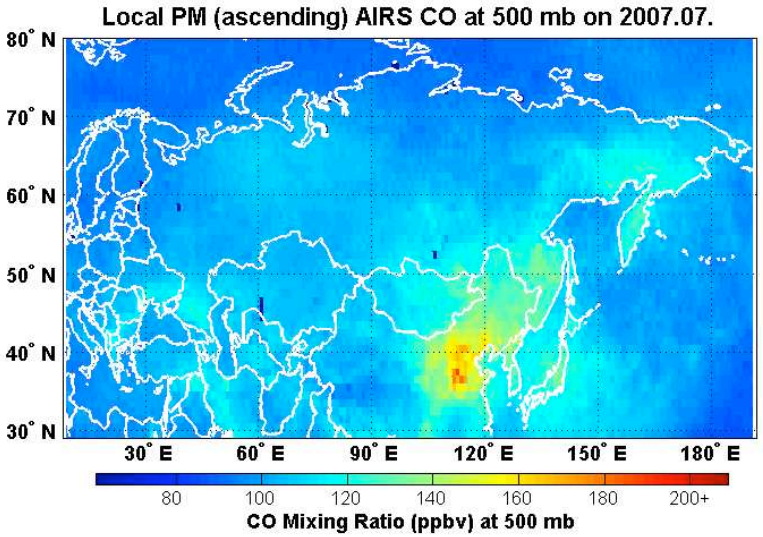

Local PM (ascending) AIRS CH4 at 400 mb on 2006.07.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

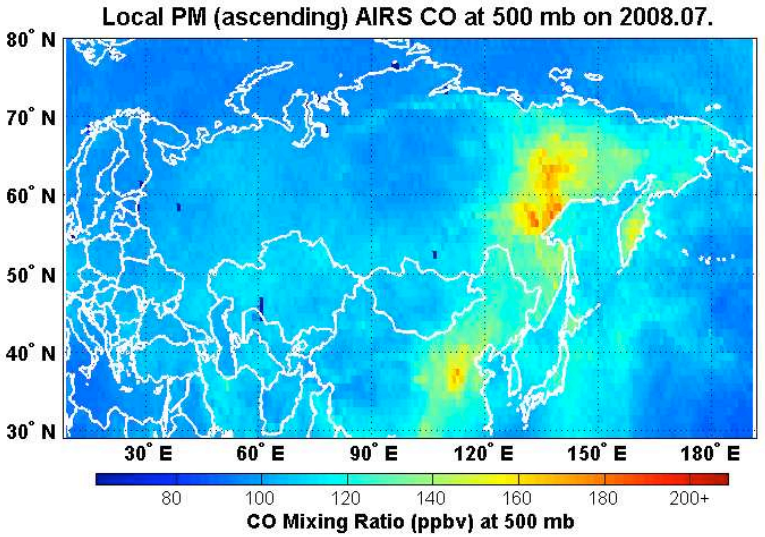
July methane in 2007 and 2008





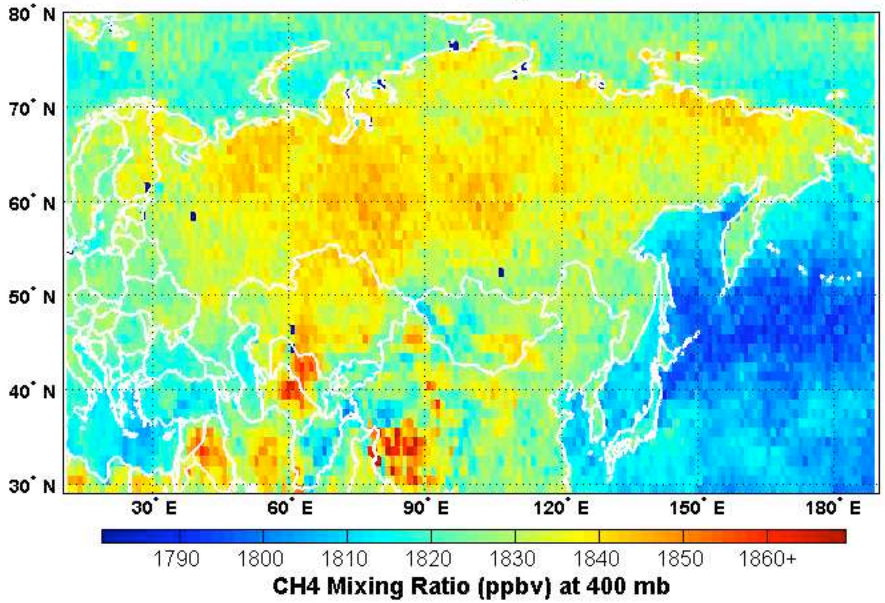
July CO in 2007 (no fires) and 2008 (fires) for comparison



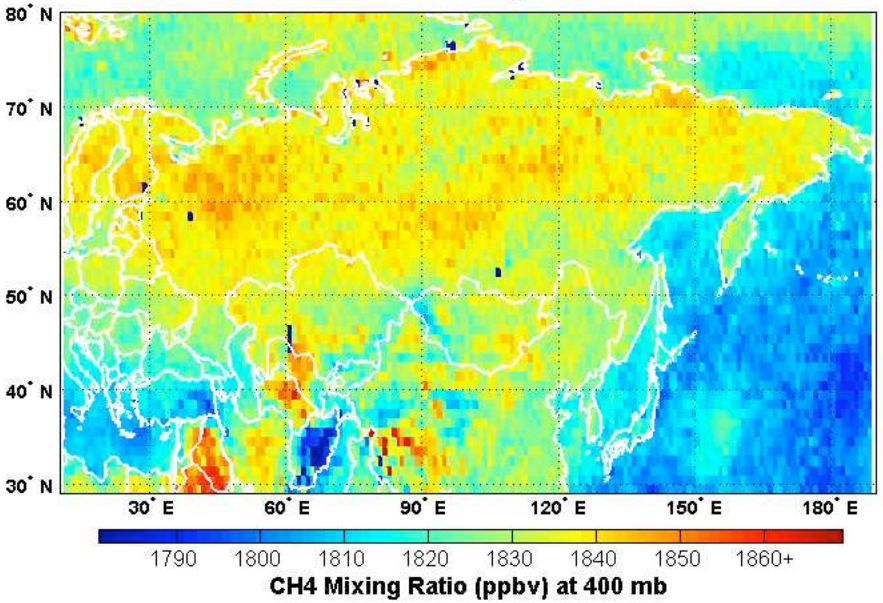


CH4 in August between 2003 and 2008

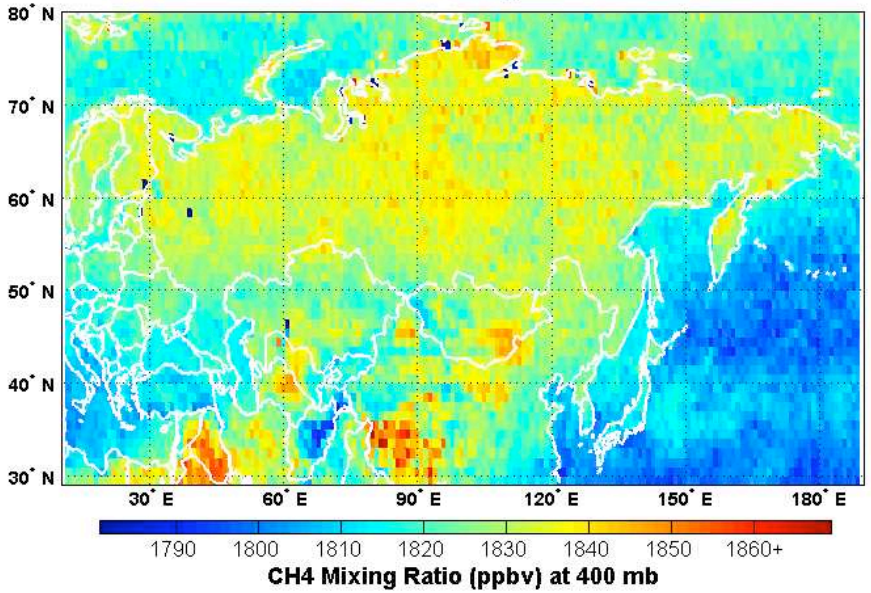
Local PM (ascending) AIRS CH_4 at 400 mb on 2003.08.



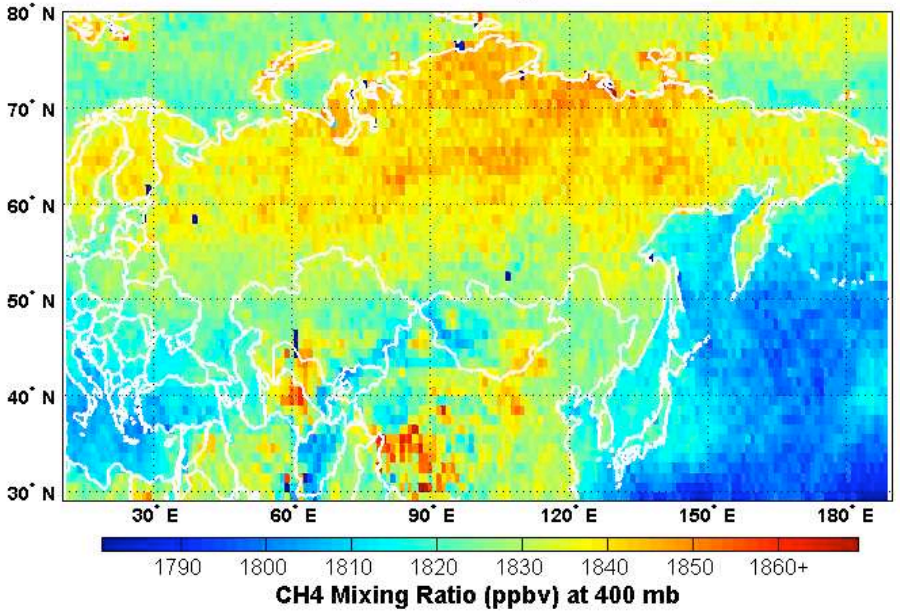
Local PM (ascending) AIRS CH_4 at 400 mb on .2004.08

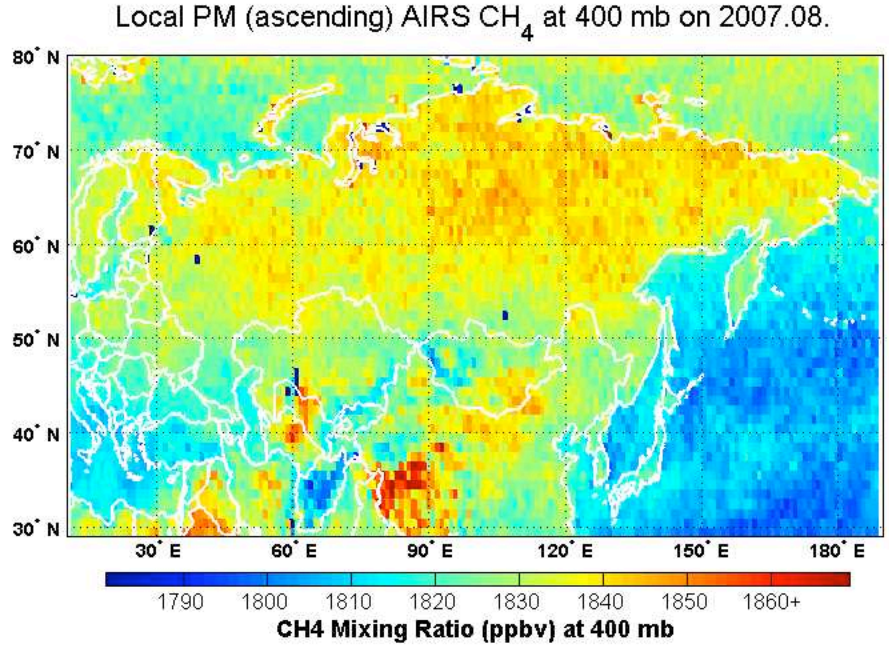


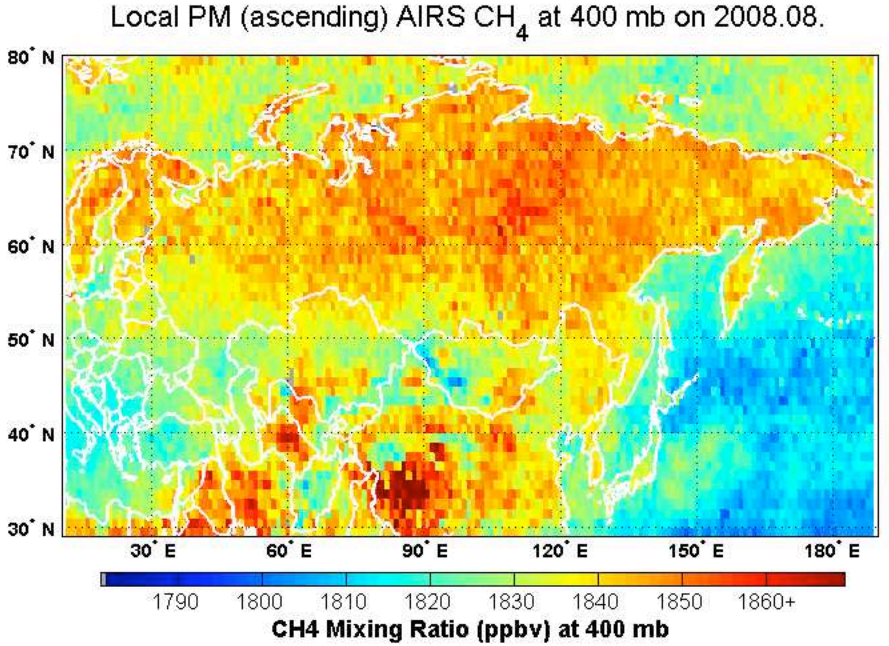
Local PM (ascending) AIRS CH_4 at 400 mb on 2005.08.



Local PM (ascending) AIRS CH_4 at 400 mb on 2006.08.



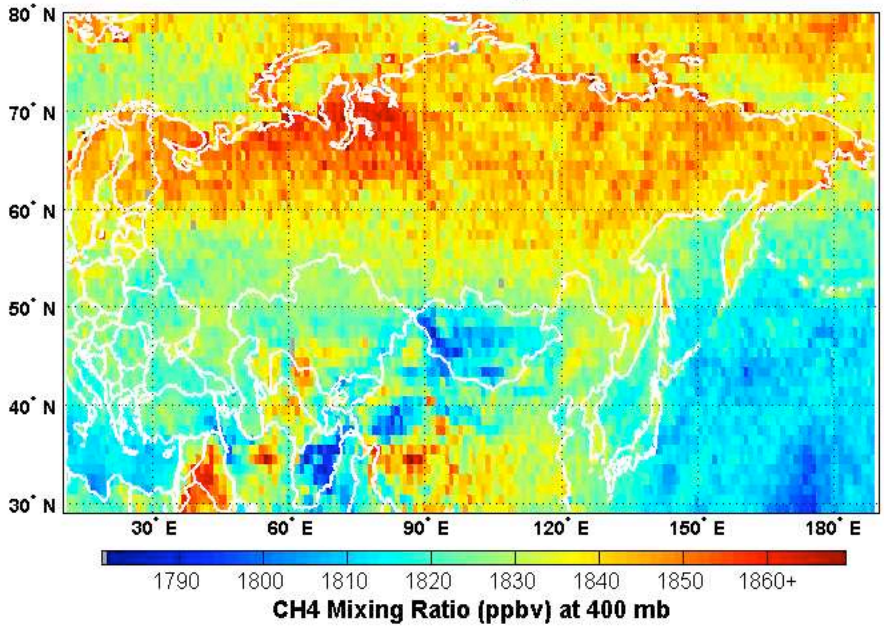

Local PM (ascending) AIRS CH4 at 400 mb on 2007.08.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


Local PM (ascending) AIRS CH4 at 400 mb on 2008.08.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb

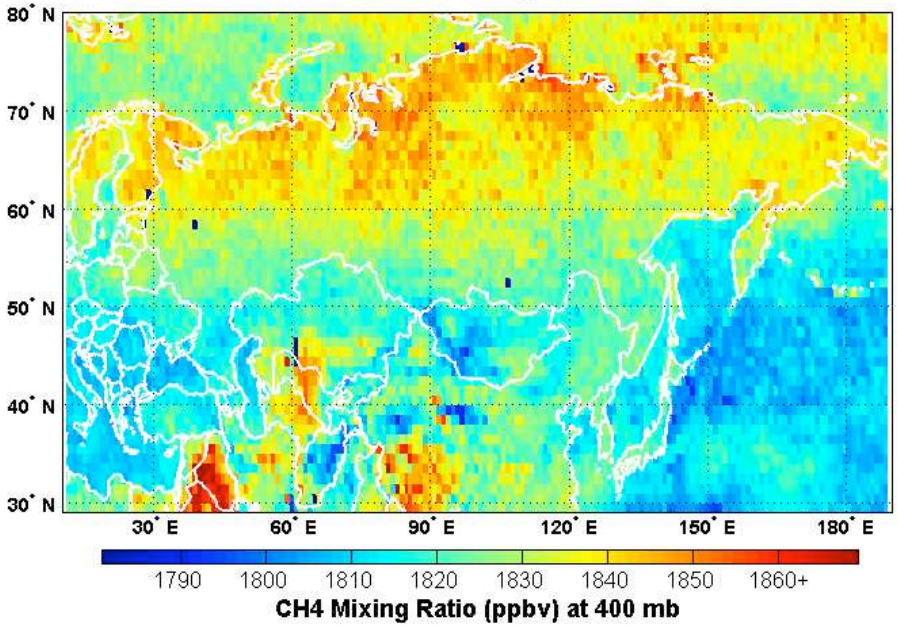
CH4 in September between 2002 and 2008:

Tundra sources or marine sources (??)

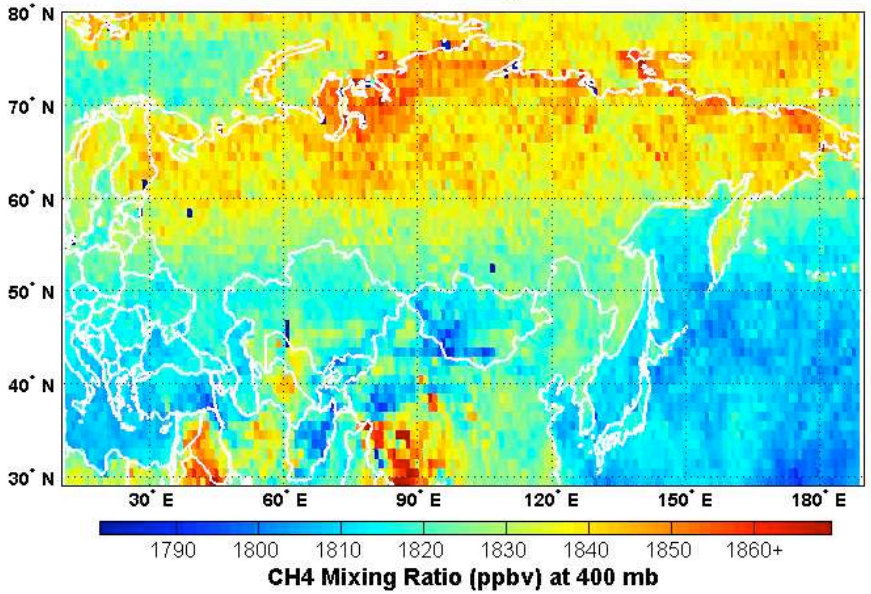
Local PM (ascending) AIRS CH_4 at 400 mb on 2002.09.



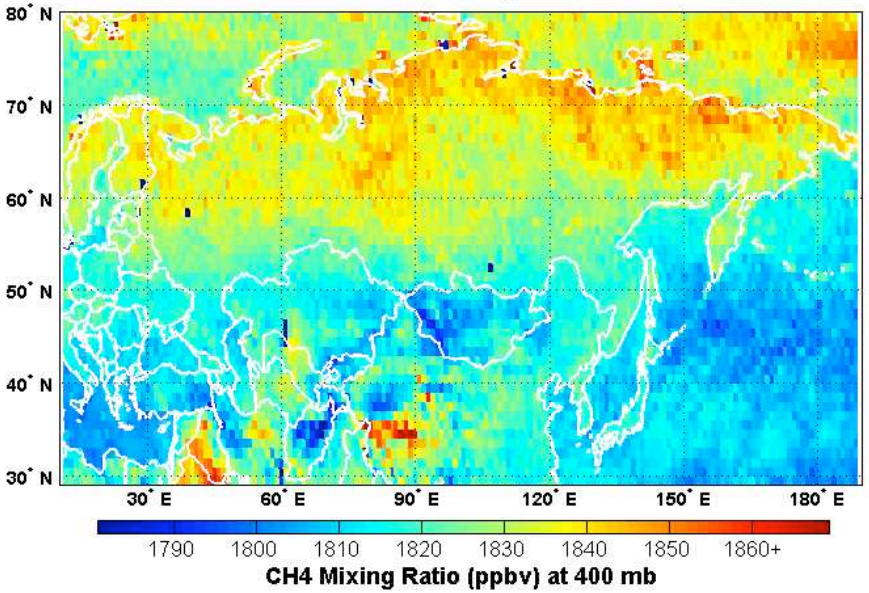
Local PM (ascending) AIRS CH_4 at 400 mb on 2003.09.

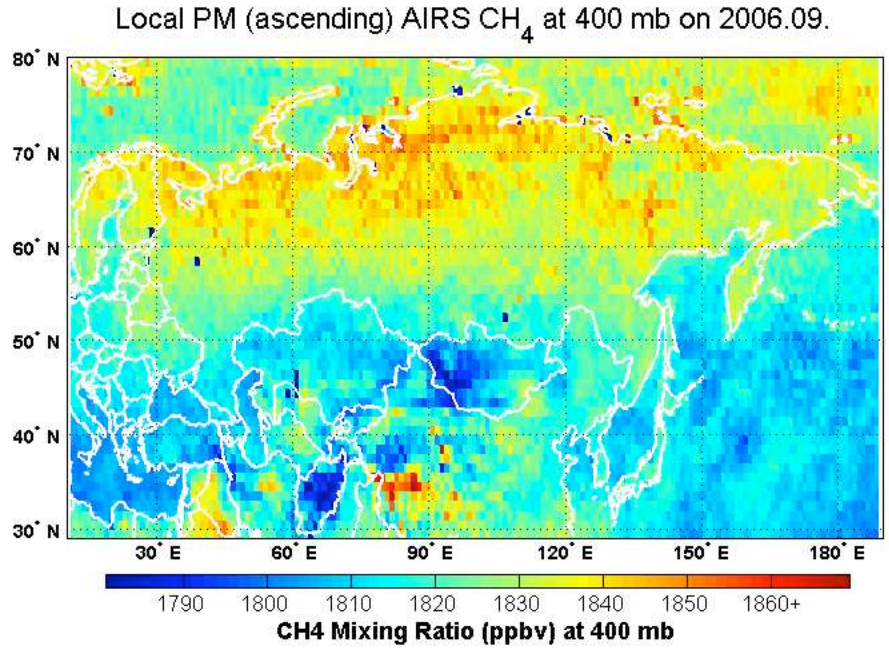


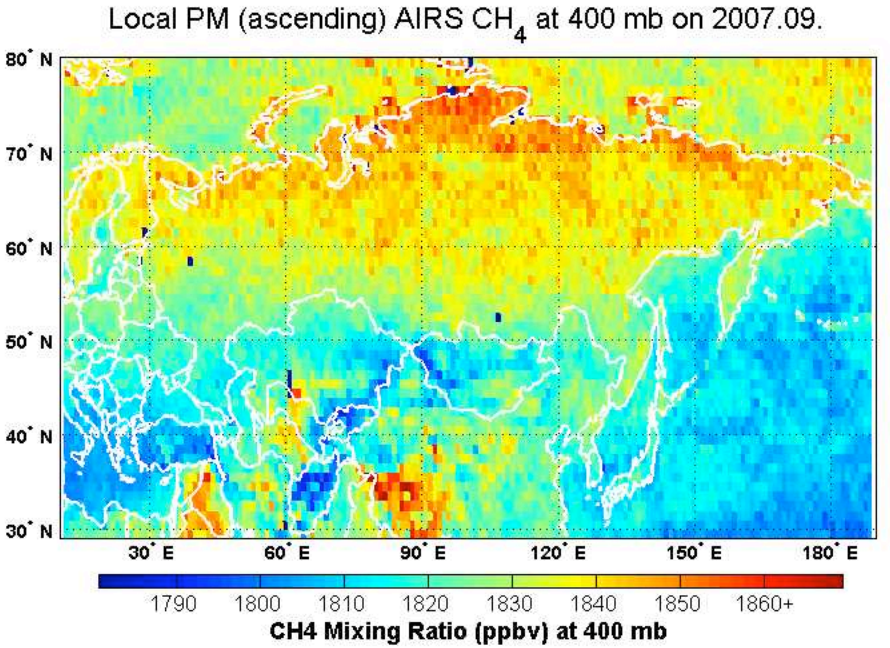
Local PM (ascending) AIRS CH_4 at 400 mb on .2004.09

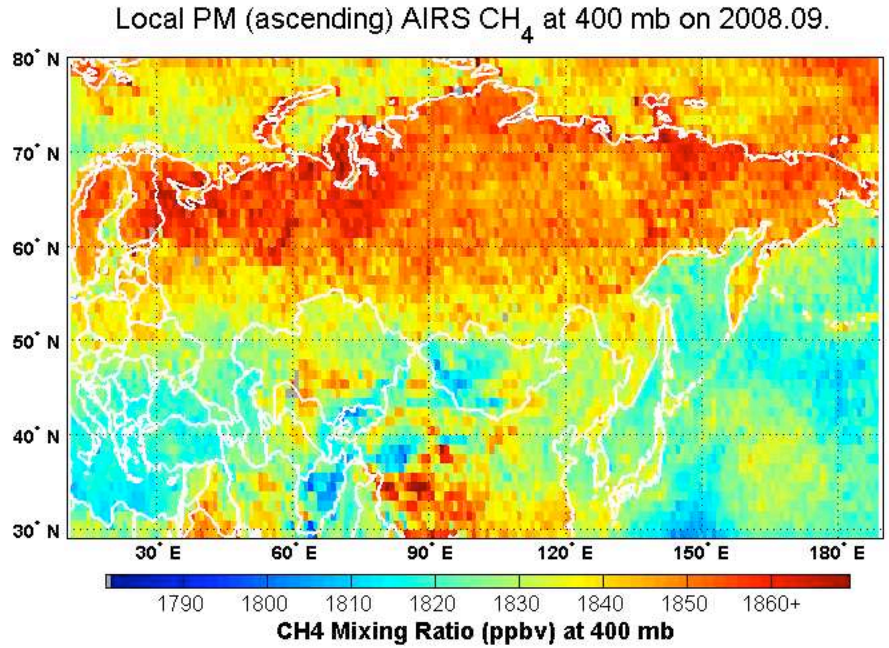


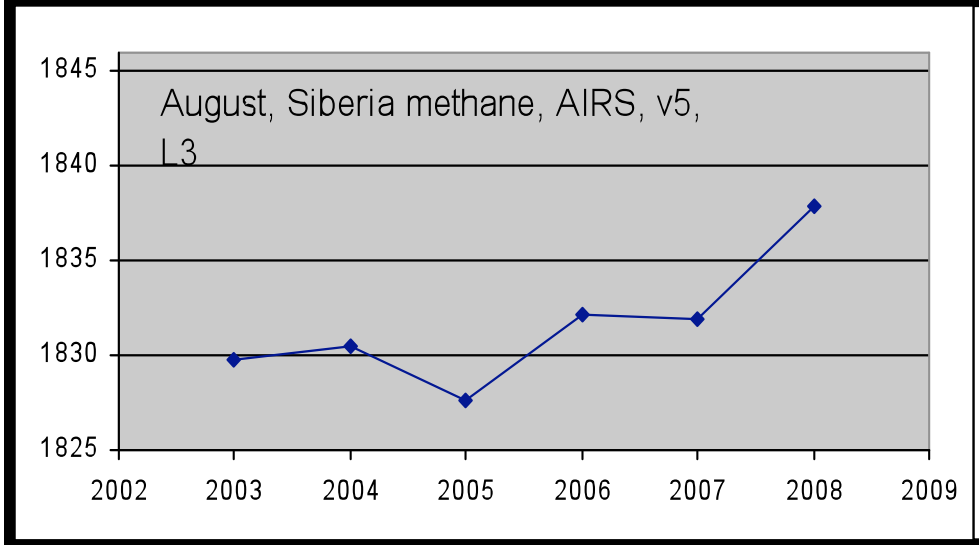
Local PM (ascending) AIRS CH_4 at 400 mb on 2005.09.

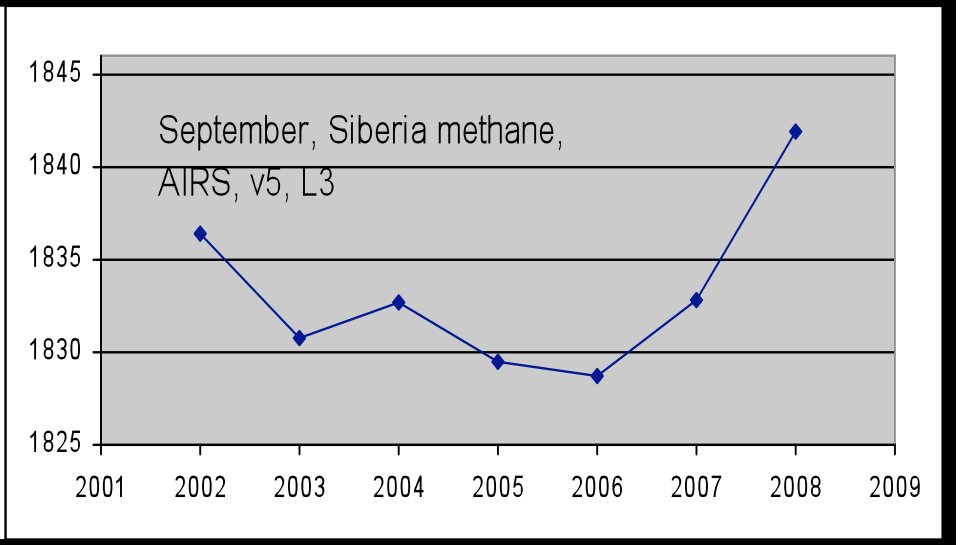


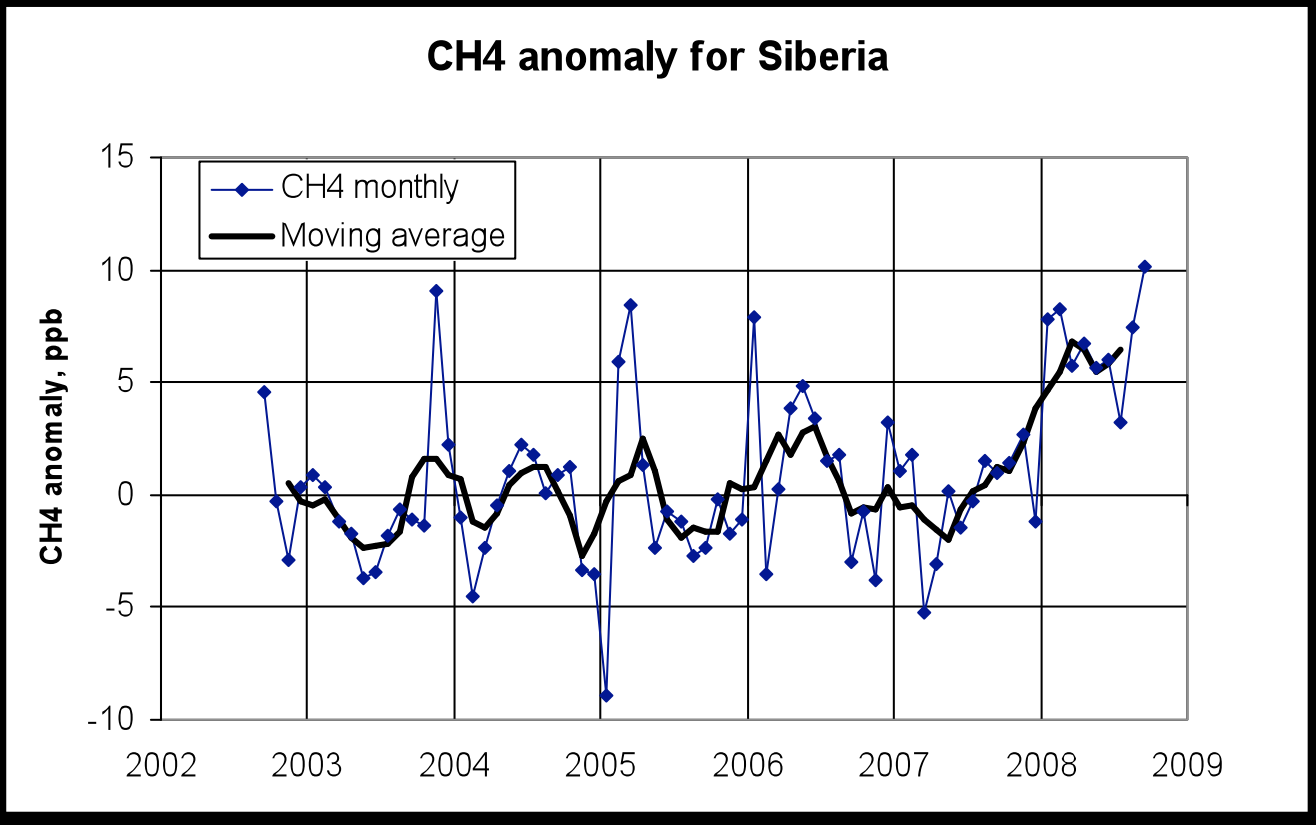

Local PM (ascending) AIRS CH4 at 400 mb on 2006.09.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


Local PM (ascending) AIRS CH4 at 400 mb on 2007.09.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


Local PM (ascending) AIRS CH4 at 400 mb on 2008.09.
80° N
70° N
60° N
50° N
40° N
30° N
30° E
60° E
90° E
120° E
150° E
180° E
1790
1800
1810
1820
1830
1840
1850
1860+
CH4 Mixing Ratio (ppbv) at 400 mb


August, Siberia methane, AIRS, v5, L3
1845
1840
1835
1830
1825
2002
2003
2004
2005
2006
2007
2008
2009


September, Siberia methane, AIRS, v5, L3
1845
1840
1835
1830
1825
2001
2002
2003
2004
2005
2006
2007
2008
2009


CH4 anomaly for Siberia
CH4 monthly
Moving average
CH4 anomaly, ppb
15
10
5
0
-5
-10
2002
2003
2004
2005
2006
2007
2008
2009

Could we trust to satellite data?

***In-situ* measurements in Western Siberia are available!**

Spatio-temporal distribution of GHG in the surface atmospheric layer over Western Siberia

M.Yu. Arshinov[1], B.D. Belan[1], D.K. Davydov[1],

O.A. Krasnov[1], A.V. Fofonov[1]

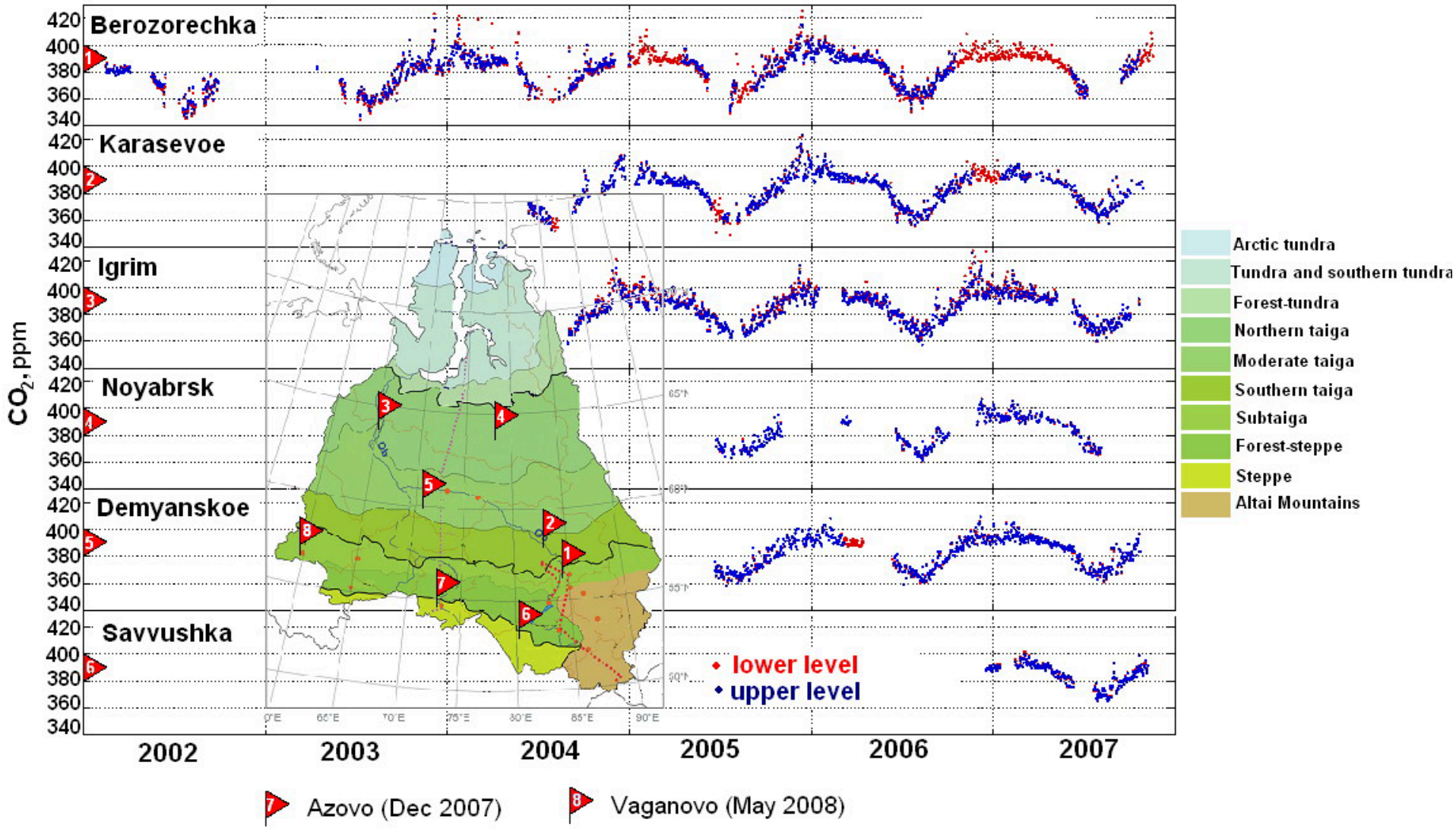
G.Inoue[2], T.Machida[2], Sh. Maksutov[2], K. Shimoyama[2]

[1] *Institute of Atmospheric Optics SB RAS,Russia*

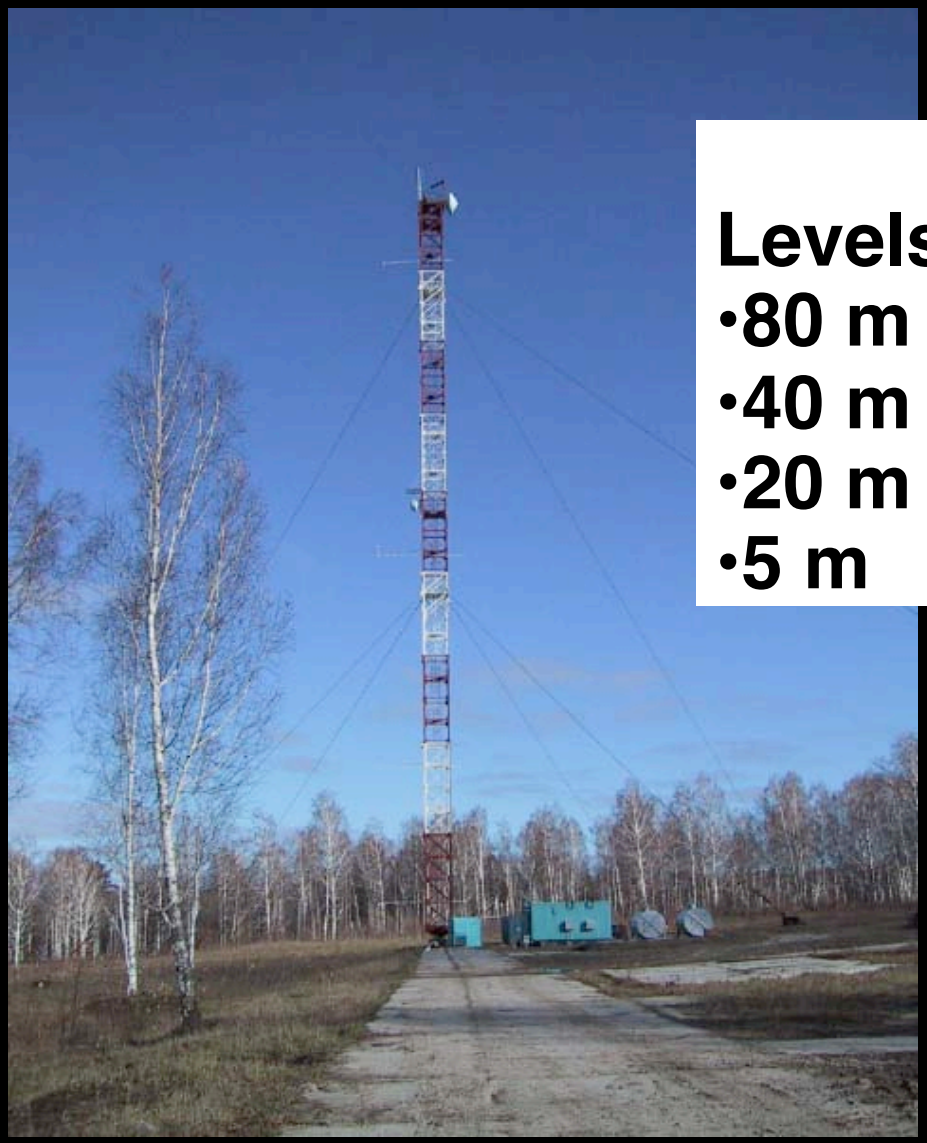
[2] *National Institute for Environmental Studies, Japan*

International Conference in Kislovodsk, Russia, 7 October 2008

GHG Monitoring Network in W. Siberia



Berezorechka Tower (pioneer system)



Levels:
- **80 m**
- **40 m**
- **20 m**
- **5 m**

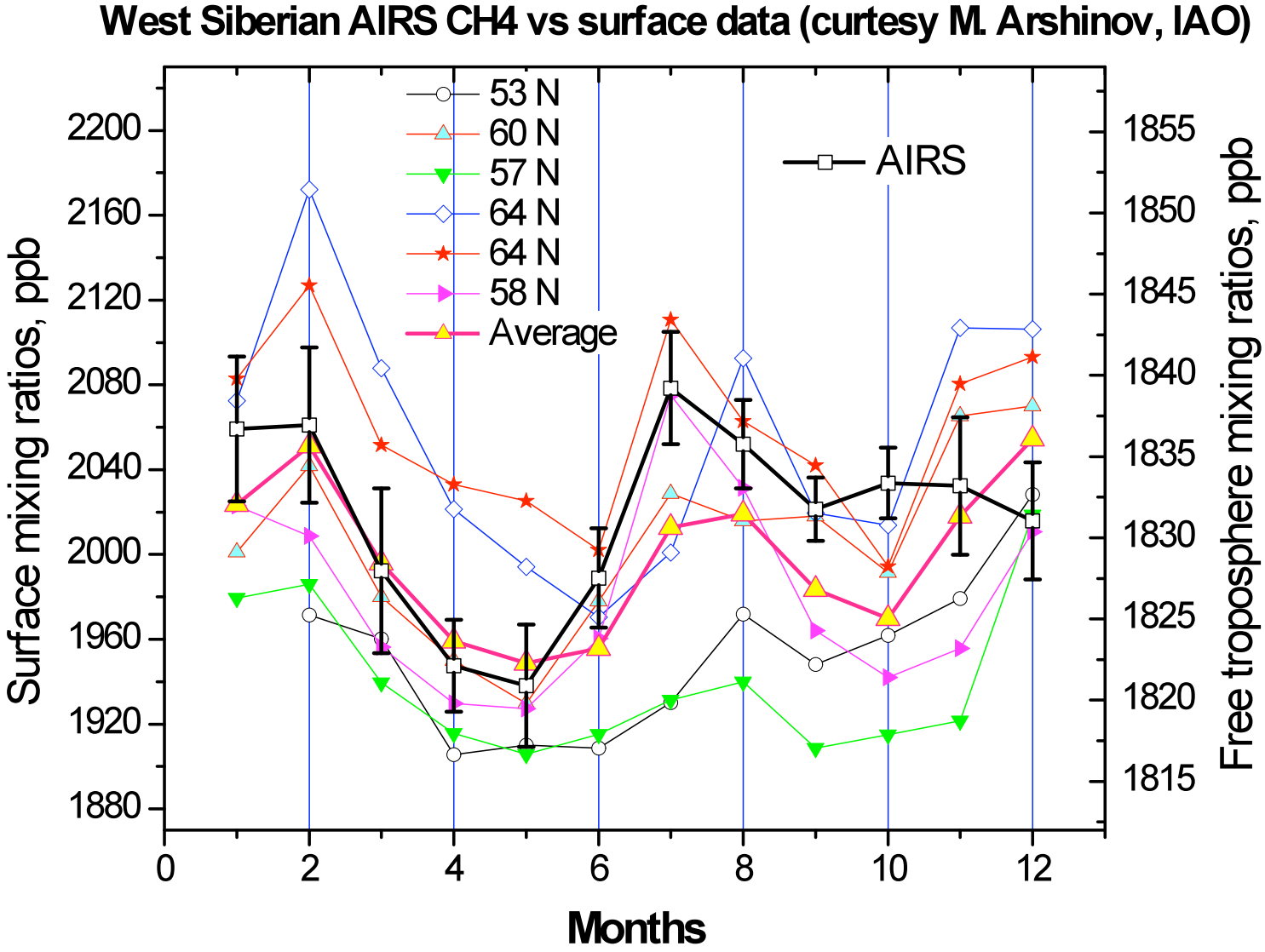
Measured parameters:

CO_2 concentration,

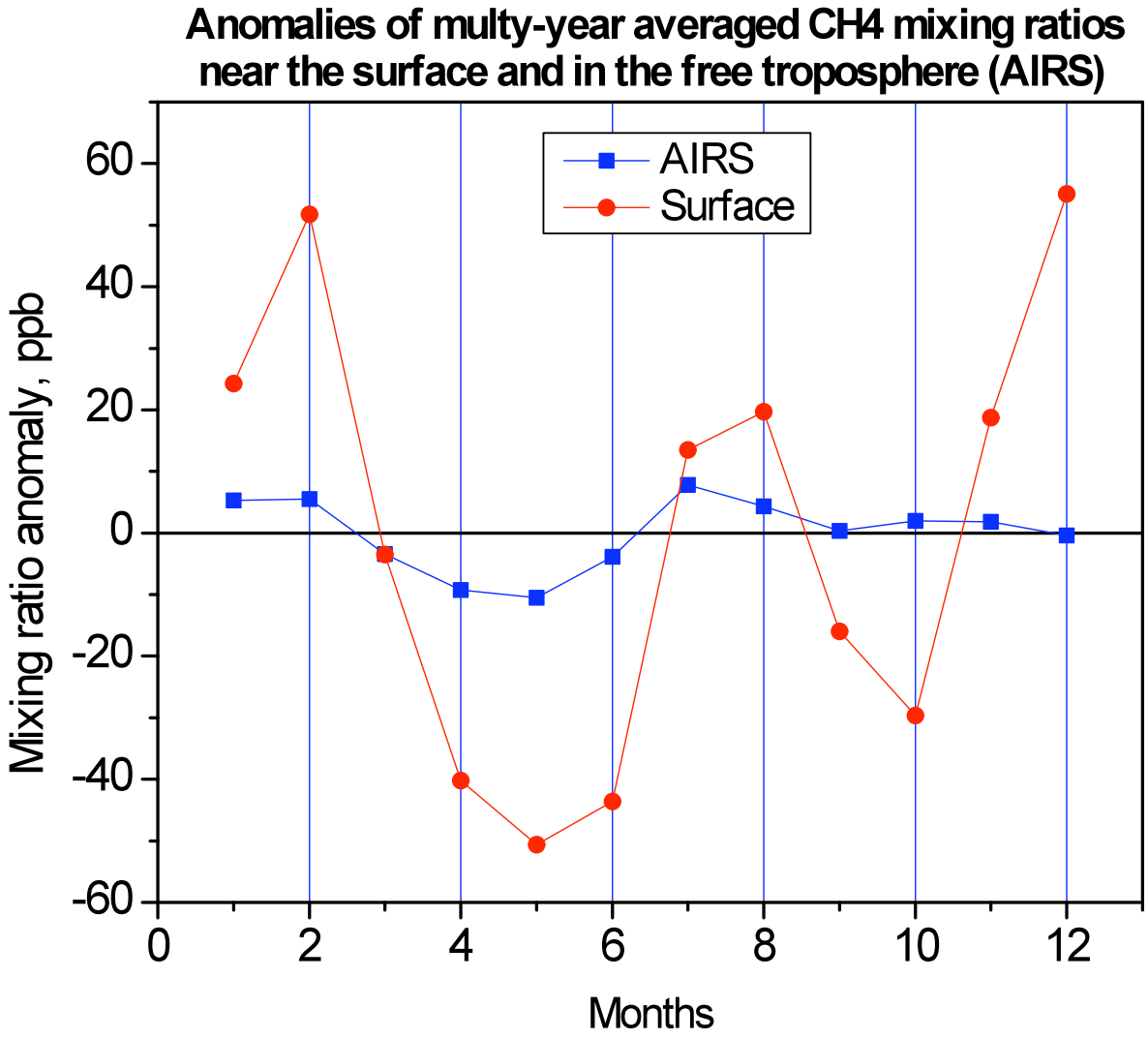
CH_4 concentration,

t and RH, wind velocity, solar radiation, precipitation, ambient pressure

Comparison of AIRS (right scale) with surface data at 6 sites (left scale) 2003 - 2007



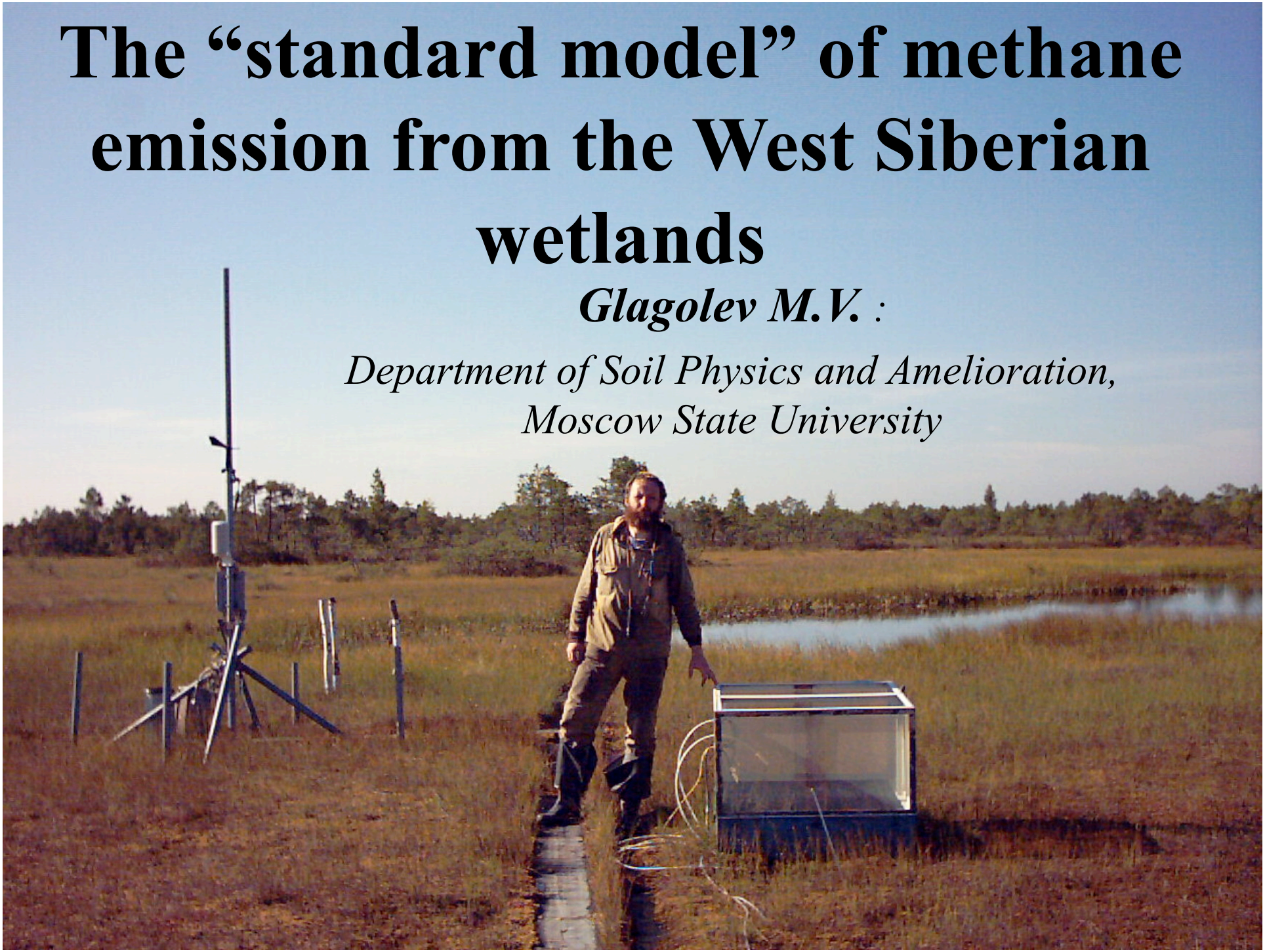
Comparison of anomalies in the same scale



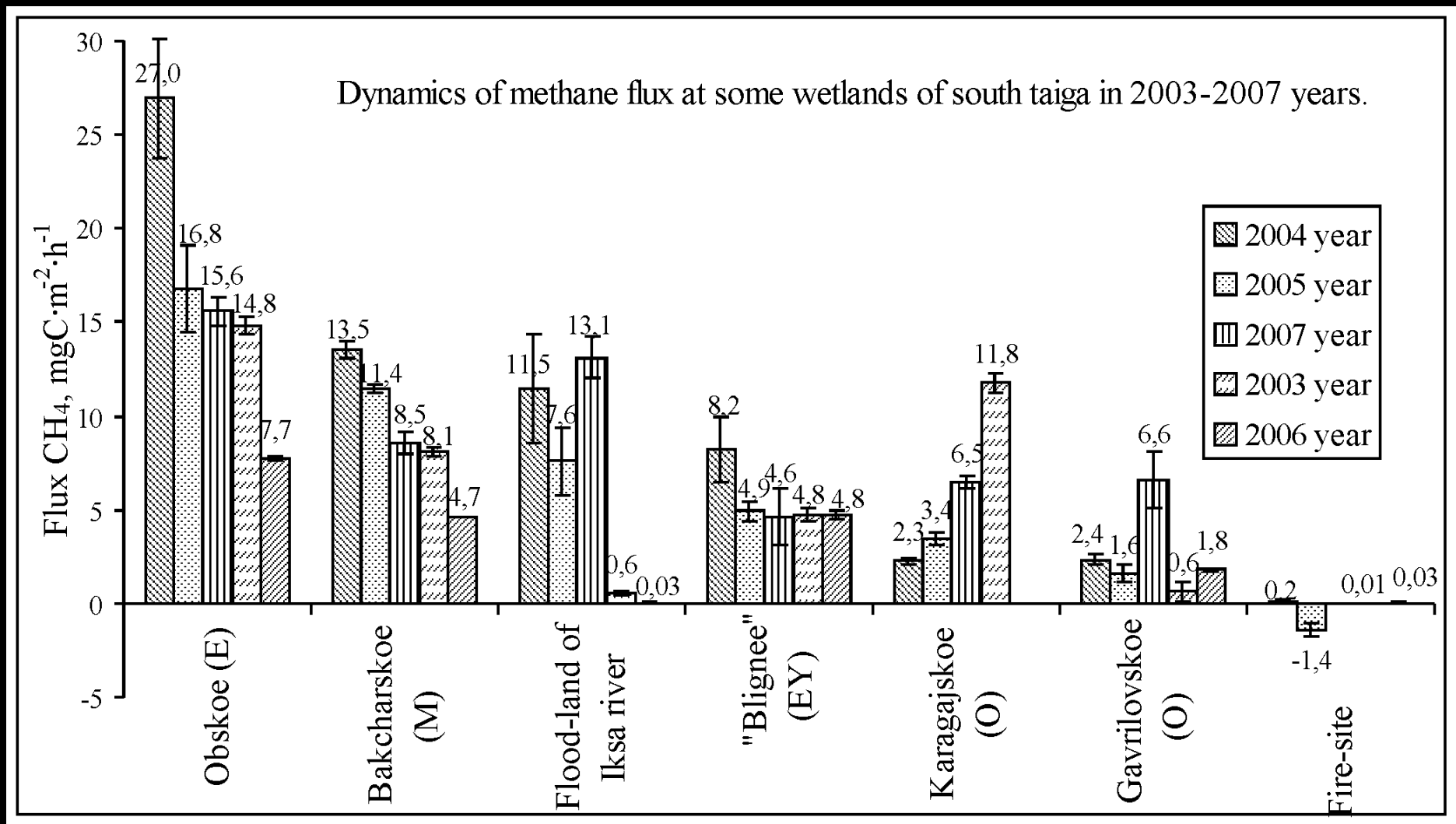
The “standard model” of methane emission from the West Siberian wetlands

Glagolev M.V. *:*

Department of Soil Physics and Amelioration,
Moscow State University

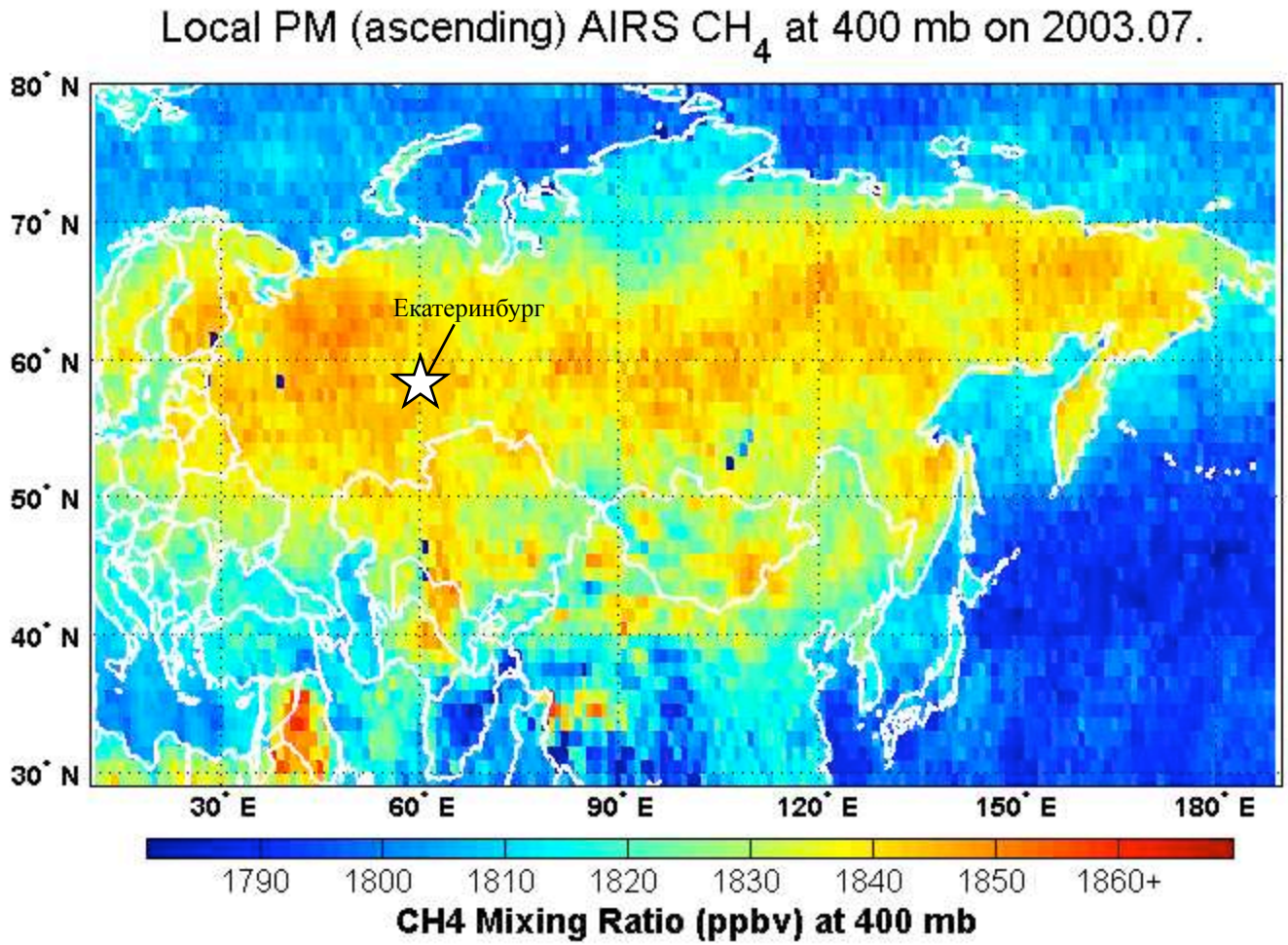


Principal methane flux measuring sites at territory of Russia


Dynamics of methane flux at some wetlands of south taiga in 2003-2007 years.
Flux CH_4, $mgC \cdot m^{-2} \cdot h^{-1}$
30
25
20
15
10
5
0
-5
2004 year
2005 year
2007 year
2003 year
2006 year
27,0
16,8
15,6
14,8
7,7
13,5
11,4
8,5
8,1
4,7
11,5
7,6
13,1
0,6
0,03
8,2
4,9
4,6
4,8
4,8
2,3
3,4
6,5
11,8
2,4
1,6
6,6
0,6
1,8
0,2
-1,4
0,01
0,03
Obskoe (E)
Bakcharskoe (M)
Flood-land of Iksa river
"Blignee" (EY)
Karagajskoe (O)
Gavrilovskoe (O)
Fire-site

Sun-viewing FTS for validation

Location of a new Bruker 125HS FTS (0.003 cm-1 resolution, 3800-20,000 cm-1 spectral coverage)



Dr. Zakharov (PI) and Dr. Yurganov near the existing building of a solar telescope

Dr. Zakharov is inspecting the status of preparatory construction

A pit for a massive concrete pedestal for the interferometer
(it will be separated from the main building)

So!

- SCIAMACHY and AIRS supply reasonable CH4 data, but they need to be validated and compared to independent surface data.
- Methane retrieval algorithm needs to be improved. In particular topographic influence should be investigated and fixed. Sensitivity to lower free troposphere and PBL might be increased. A subset for northern high latitudes looks promising.

- **According to AIRS, bacterial emission from wetlands maximizes in July, the warmest month of the year. It appears as an important CH4 source on a global scale.**
- **A maximum of CH4 over tundra (e.g., at Victoria and Banks islands in Canada) occurs in September: WHY?**
- **Secondary CH4 maximum over Finland and Karelia is observed in October: WHY?**
- **Ground truth data from Russia are useful for both CH4 and CO2!**

An increase of methane in August-September 2008 is noteworthy

These questions will be a matter of study for the future

Thank you!