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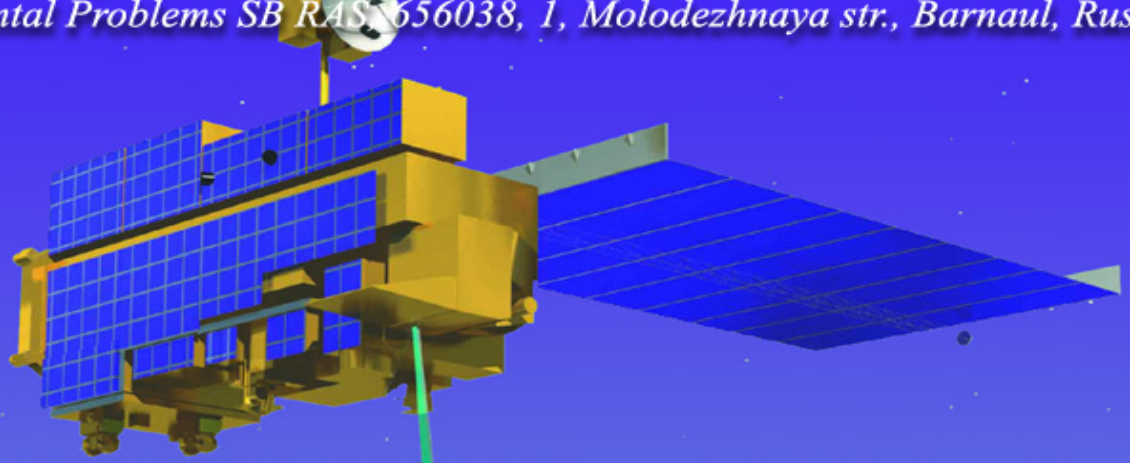

The monitoring of the areas of technogenic pollution of the land surface for the large industrial centers in the South of West Siberia with MODIS and land observations

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Goals:

- Determination of the pollution areas within the vicinities of the large industrial centers of the South of West Siberia (Novosibirsk, Tomsk, Kemerovo, Barnaul, Zarinsk) using the MODIS/(Terra + Aqua) data.

- Analysis of the AOT distribution in these areas.

- Analysis of the land-based measurements.

Outline

1. *Remote sensing center at Altai State University*
2. *MODIS specifications*
3. *MODIS atmosphere processing*
4. *Snow mapping*
5. *Snow / ice temperature*
6. *Polluted snow*
7. *AOT*
8. *Albedo*
9. *Snow pollution in the Altai region*
10. *Conclusion*

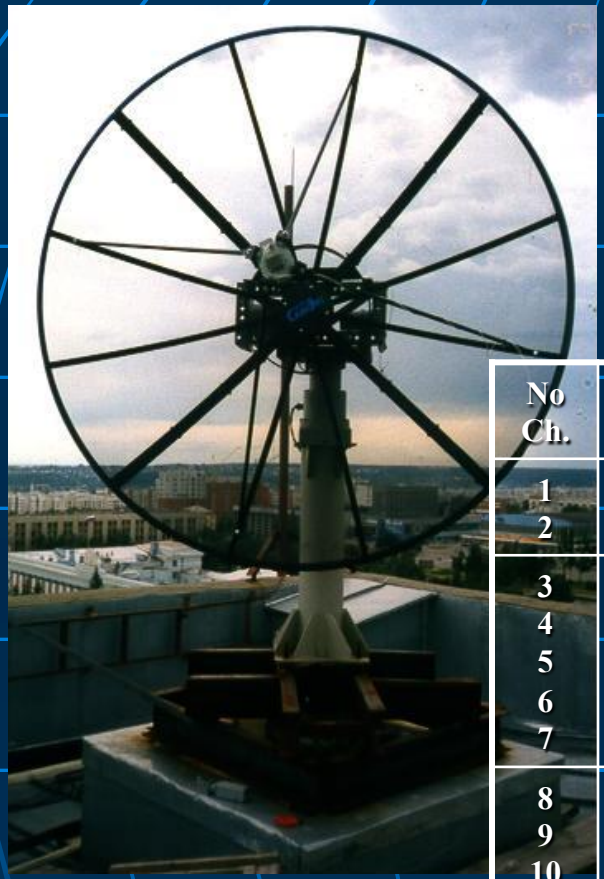
Remote sensing center at Altai State University

EOScan receiving station

is located in Barnaul

(53°21′ N, 83°47′ E).

MODIS specifications



MODIS bands and their uses:
A – atmospheric research;
LS – land surface research;
O – oceanografy;
Oz – ozone measurement;
FF –forest fires.

No Ch.	Wavelength (nm)	Resolution (m; nadir)	Primary use	No Ch.	Wavelength (nm)	Resolution (m; nadir)	Primary use
1	620 – 670	250	A, LS	20	3660 – 3840	1000	O, LS
2	841 – 876	250	A, LS	21	3929 – 3989	1000	FF
3	459 – 479	500	LS	22	3929 – 3989	1000	A, LS
4	545 – 565	500	LS	23	4020 – 4080	1000	A, LS
5	1230 – 1250	500	LS	24	4433 – 4498	1000	A
6	1628 – 1652	500	A, LS	25	4482 – 4549	1000	A
7	2105 – 2155	500	O, A	27	6535 – 6895	1000	A
8	405 – 420	1000	O	28	7175 – 7475	1000	A
9	438 – 448	1000	O	29	8400 – 8700	1000	LS
10	483 – 493	1000	O	30	9580 – 9880	1000	Oz
11	526 – 536	1000	O	31	10780 – 11280	1000	A, LS
12	546 – 556	1000	O	32	11770 – 12270	1000	A, LS
13	662 – 672	1000	O	33	13185 – 13485	1000	A, LS
14	673 – 683	1000	O	34	13485 – 13785	1000	A
15	743 – 753	1000	O	35	13785 – 14085	1000	A
16	862 – 877	1000	O	36	14085 – 14385	1000	A
17	890 – 920	1000	A				
18	931 – 941	1000	A				
19	915 – 965	1000	A				
26	1360 – 1390	1000	A				

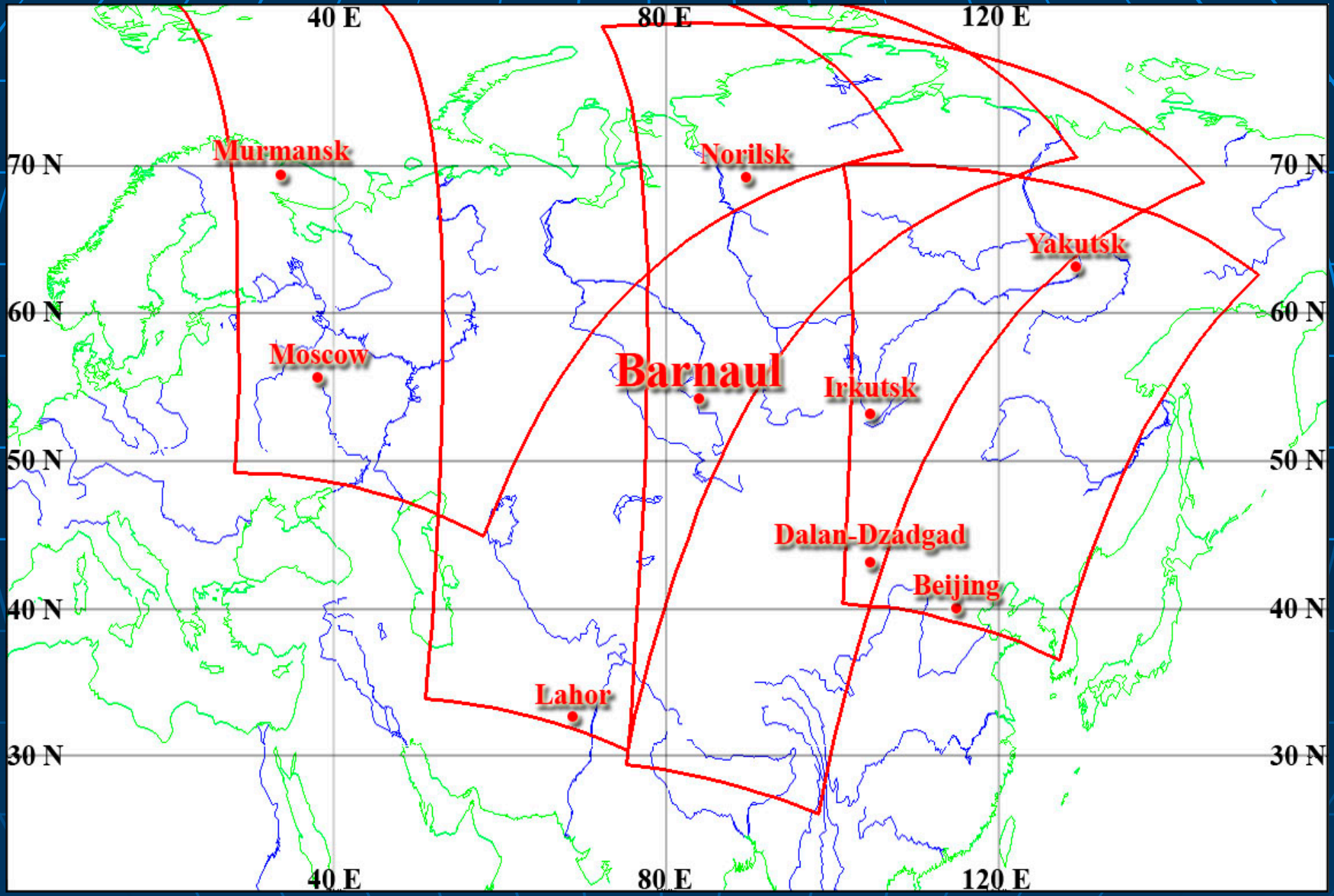
Instruments and information products used at Altai State University RSC

- *Receiving stations*
  - **EOScan**

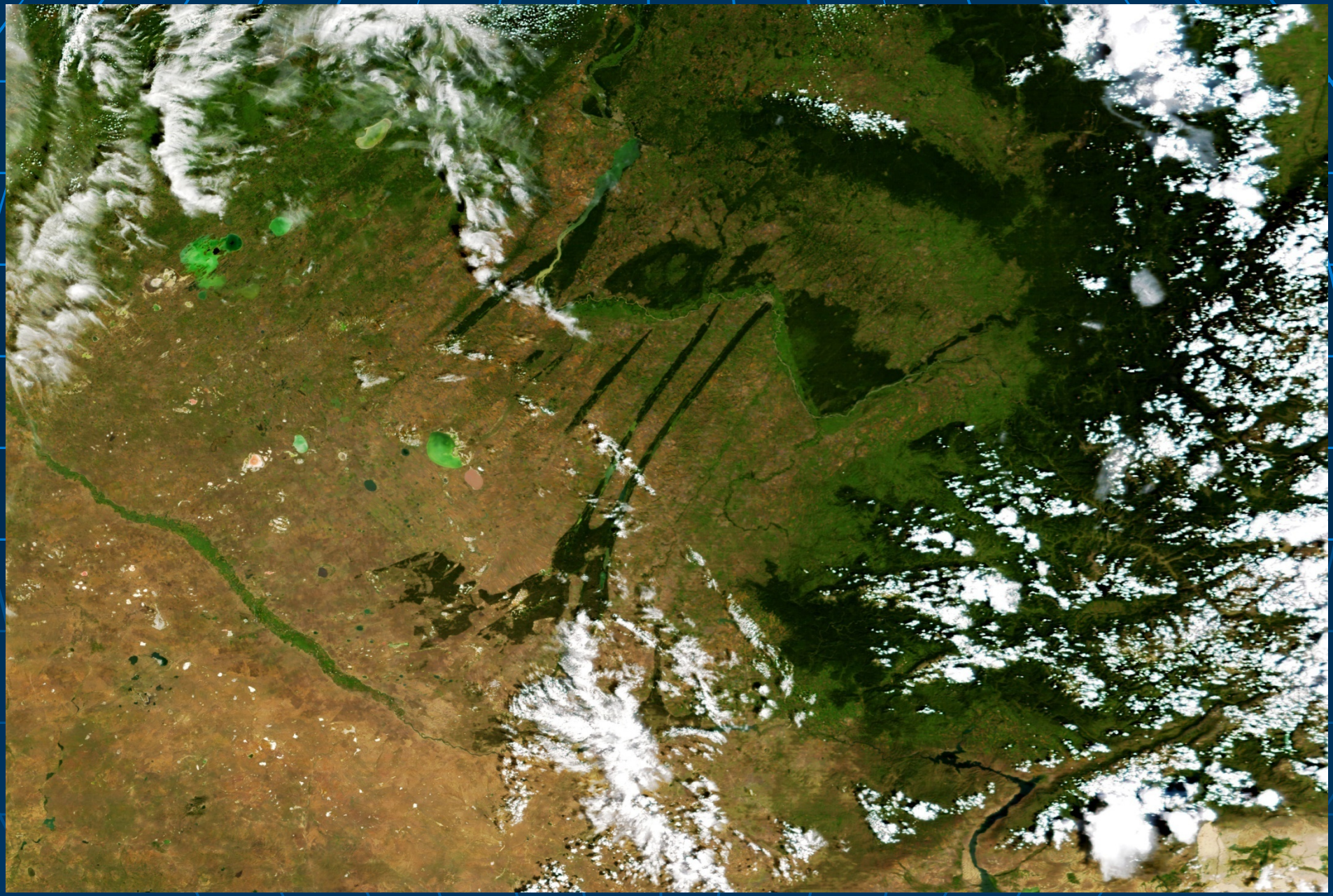
- *Radiometers*
  - **MODIS/Terra**
  - **MODIS/Aqua**
  - **AMSR-E/Aqua**
  - **AIRS/Aqua**
  - **AMSU-A/Aqua**

- *REANALYSIS, ERA-40, GDAS*

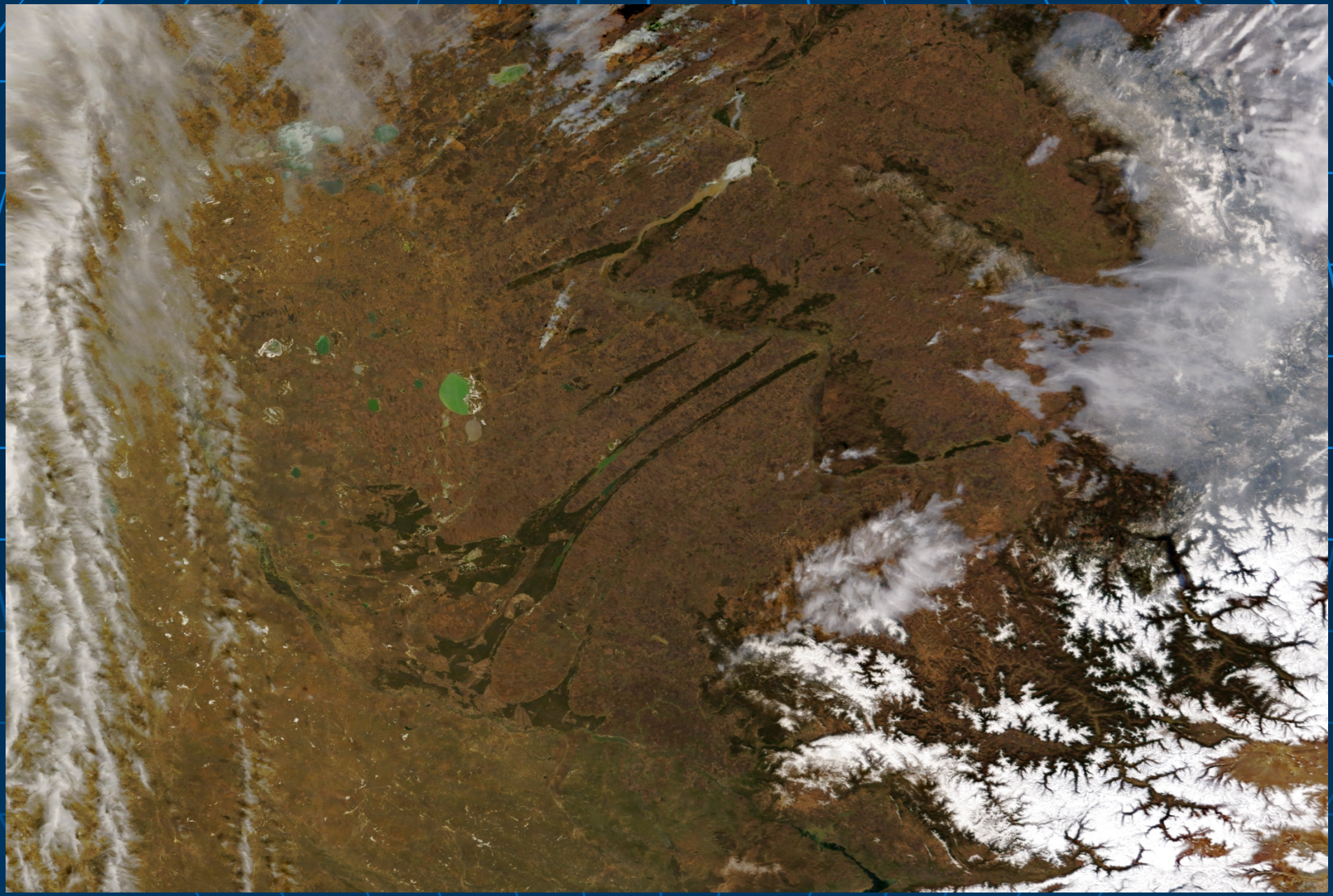
Example of coverage by MODIS/Terra using the station located in Barnaul



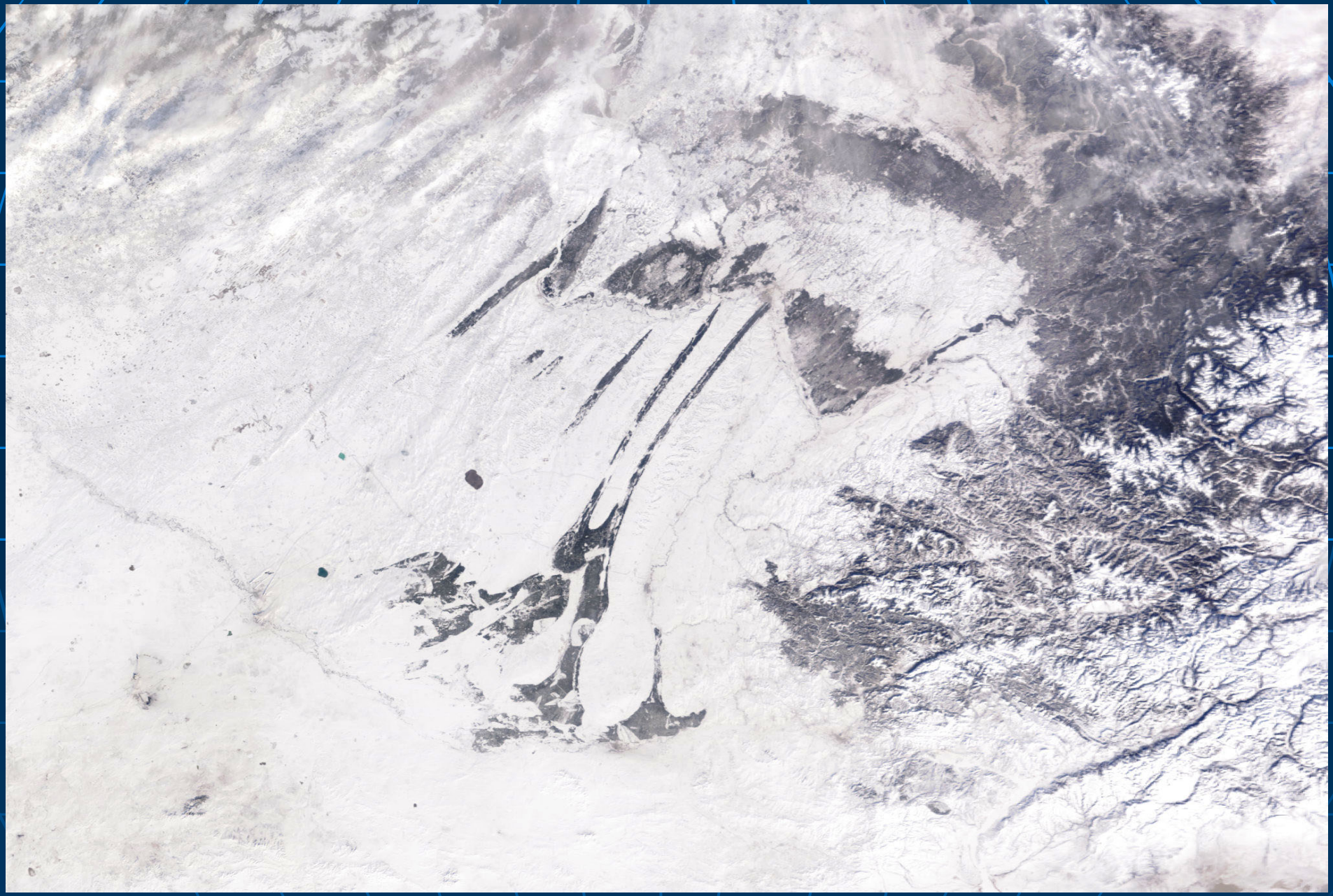
Altai region

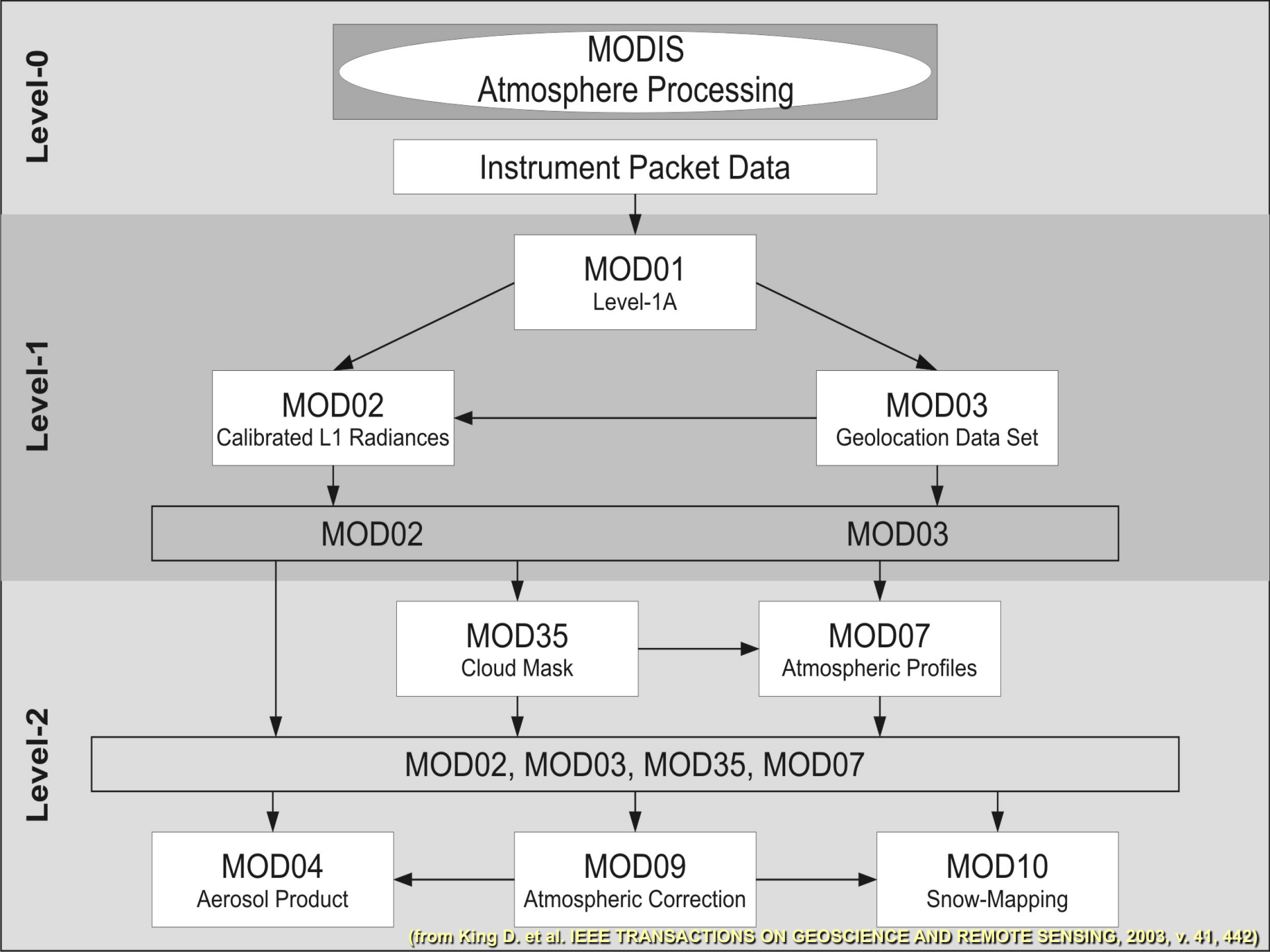


Altai region, AOT, May 12, 2006



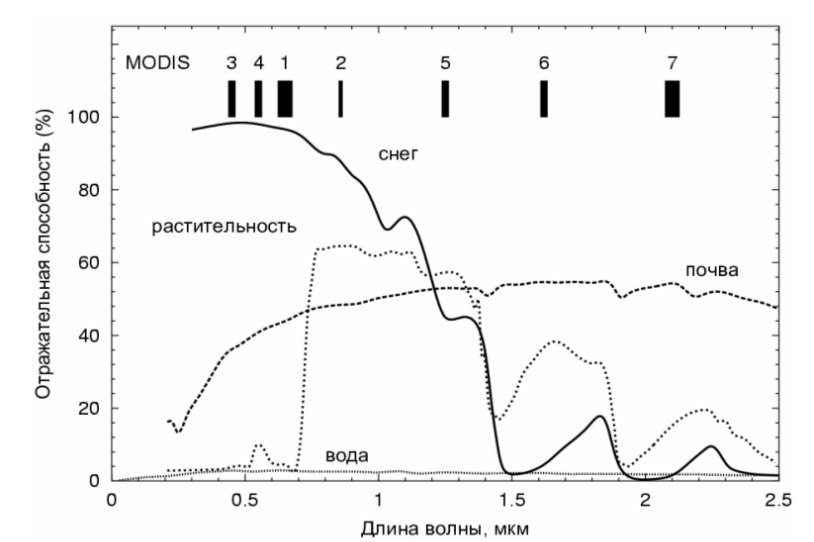
Altai region





(from King D. et al. IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING, 2003, v. 41, 442)

Snow mapping



Reflectance of snow, water, soil and vegetation (according to Klein A. G. et al., 1998) and location of the MODIS channels (1 – 7)

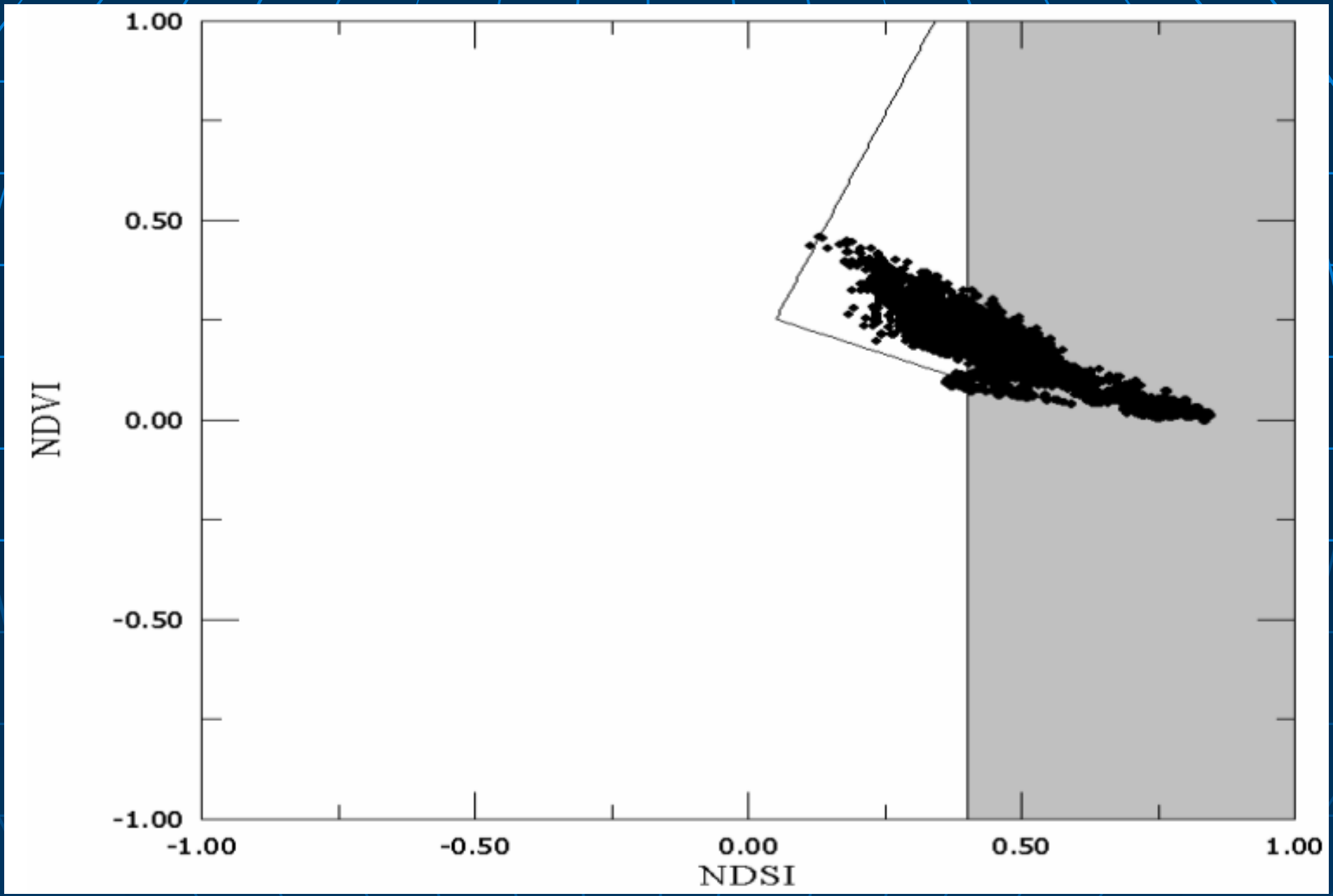
Criteria applied in snow mapping using MODIS data

Number	Criterion
1	NDSI = (R4 – R6) / (R4 + R6) ≥ 0,4
2	R2 > 0,11
3	0,05 ≤ NDSI <0,4 and NDVI = (R2 – R1) / (R2+R1) Є D
4	R4 ≥ 0,1

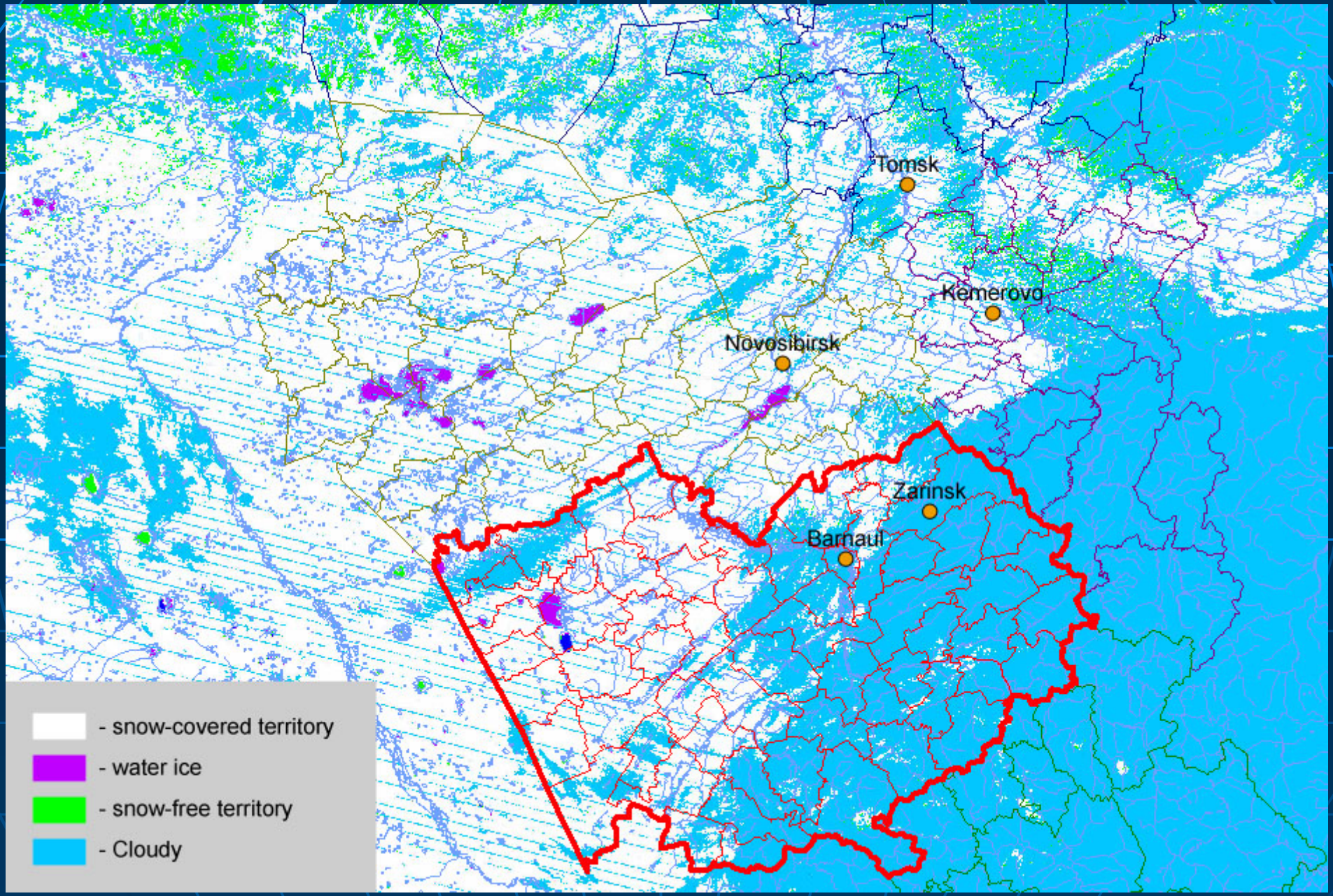
- Hall D. K. et al. // Remote Sens. Environ., 1995, v. 54, pp. 127-140.
- Hall D. K. et al. // Remote Sens. Environ., 1998, v. 66, pp. 129-137.
- Klein A. G. et al. //Hydrol. Process., 1998, v. 12, pp. 1723-1744.
- Hall D. K. et al. Algorithm theoretical basis document (ATBD) for the MODIS snow and sea ice-mapping algorithms. NASA EOS-MODIS Doc., 2001, 55 p.

NDSI versus NDVI plot for snow-covered siberian forests.

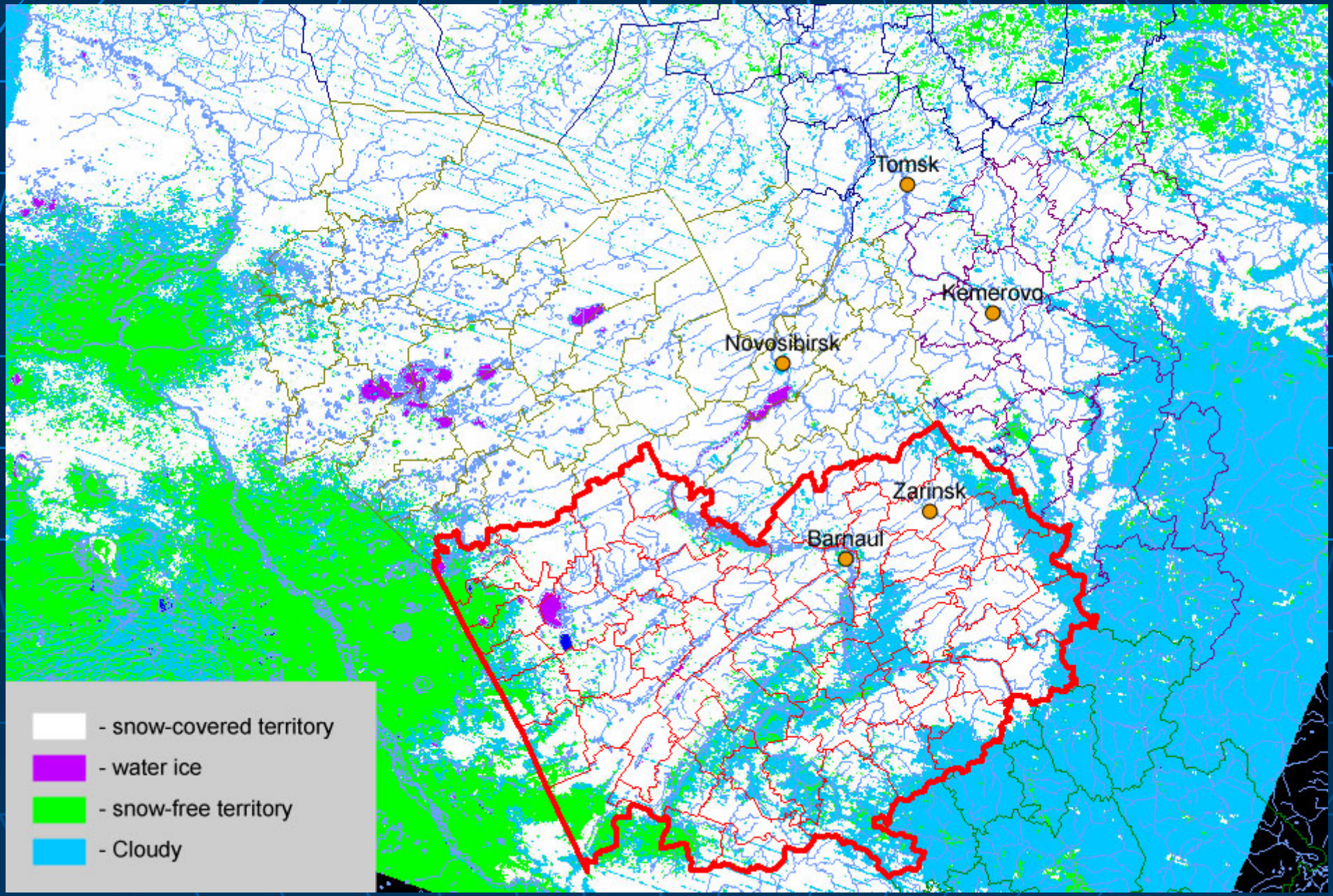
• - our data, — - Klein A. G. et al., 1998



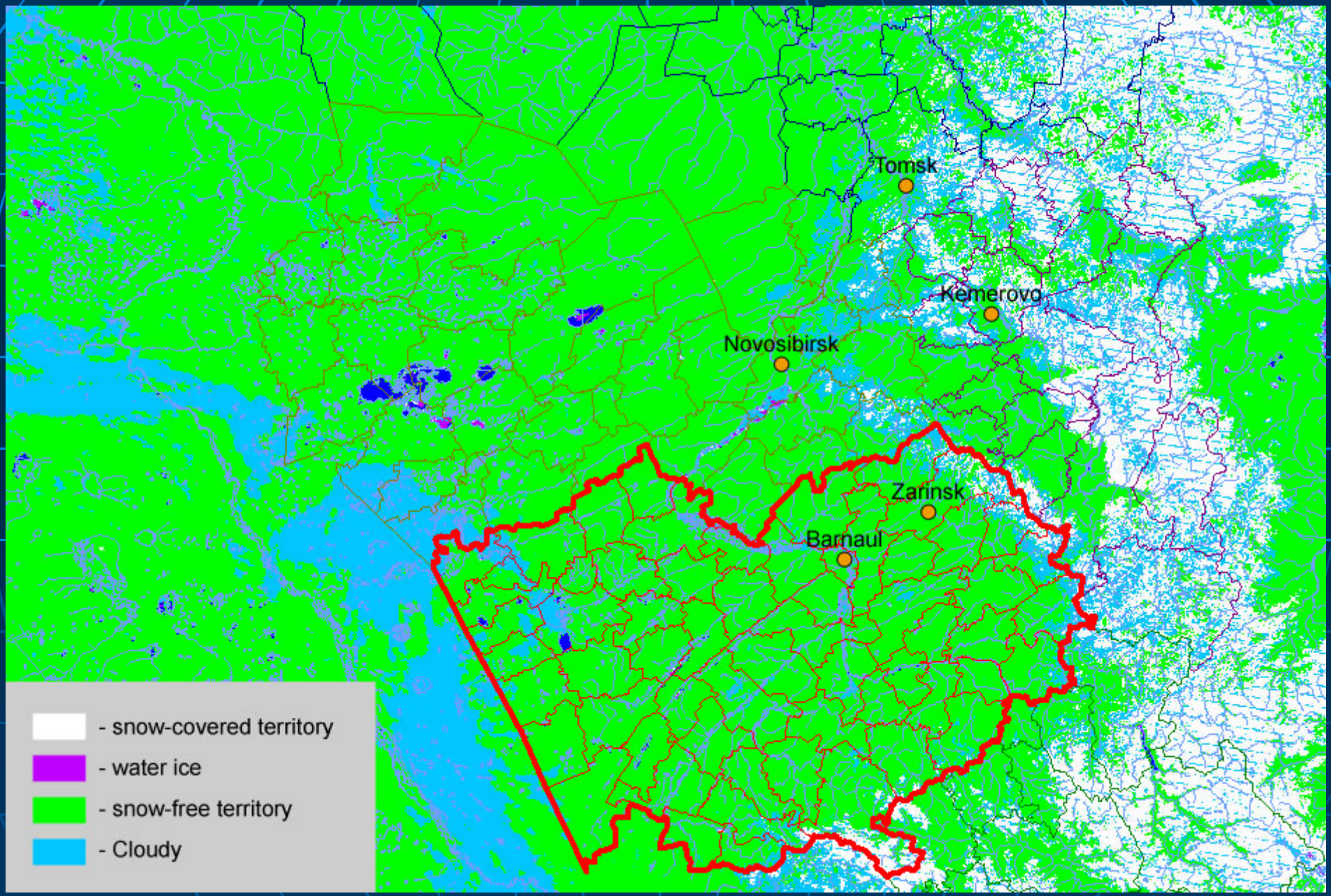
Snow mapping. MODIS data. March 22, 2010



Snow mapping. MODIS data. April 10, 2010



Snow mapping. MODIS data. April 27, 2010



Snow/ice temperature

$$T_S = a + b \cdot BT_{31} + c \cdot [BT_{31} - BT_{32}] + d \cdot [BT_{31} - BT_{32}] \cdot [\sec\theta_V - 1]$$

BT31 (K) – brightness temperature; channel 31 (‹λ› = 11.0 μm)

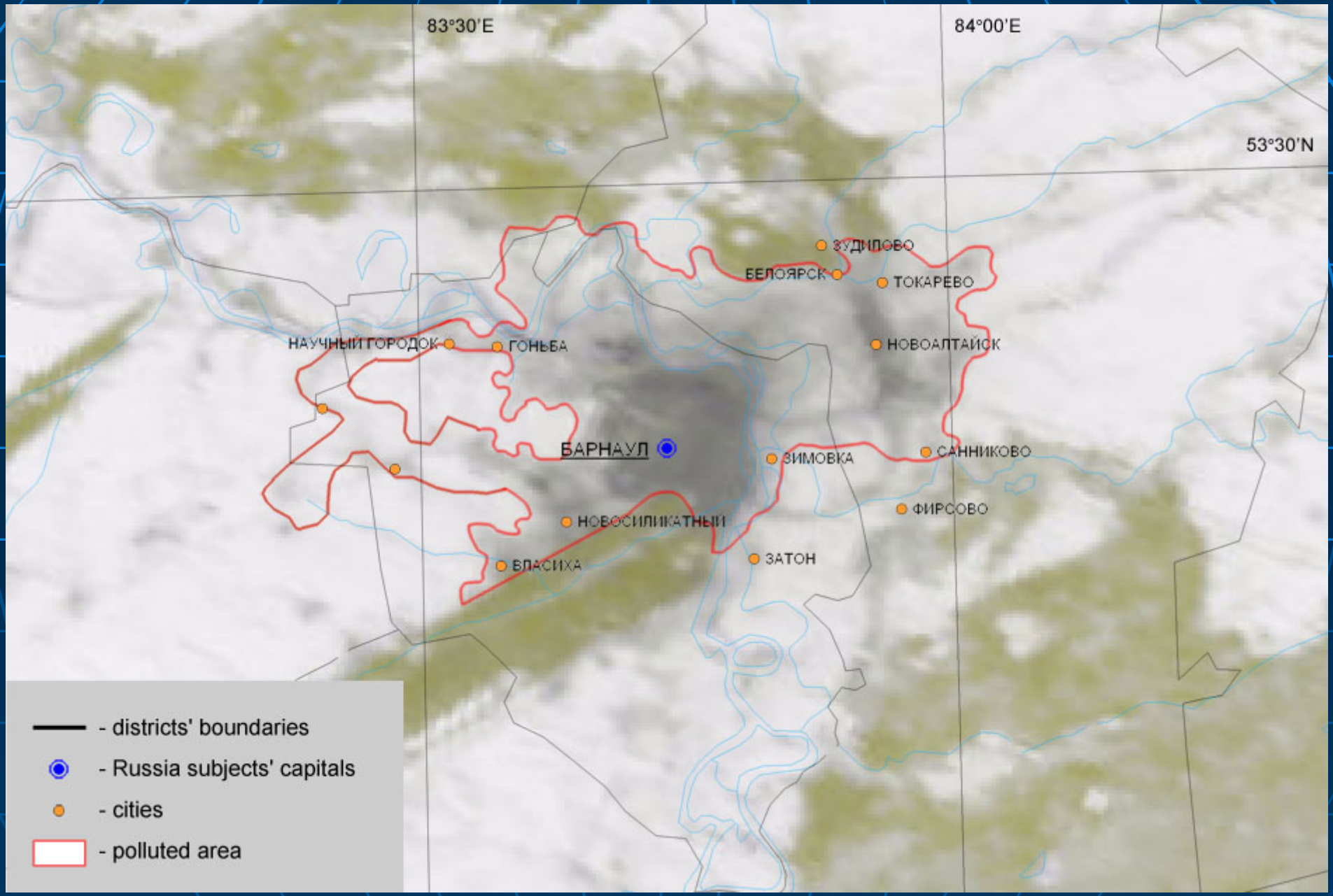
BT32 (K) – brightness temperature; channel 32 (‹λ› = 12.0 μm)

θ_V – zenith angle

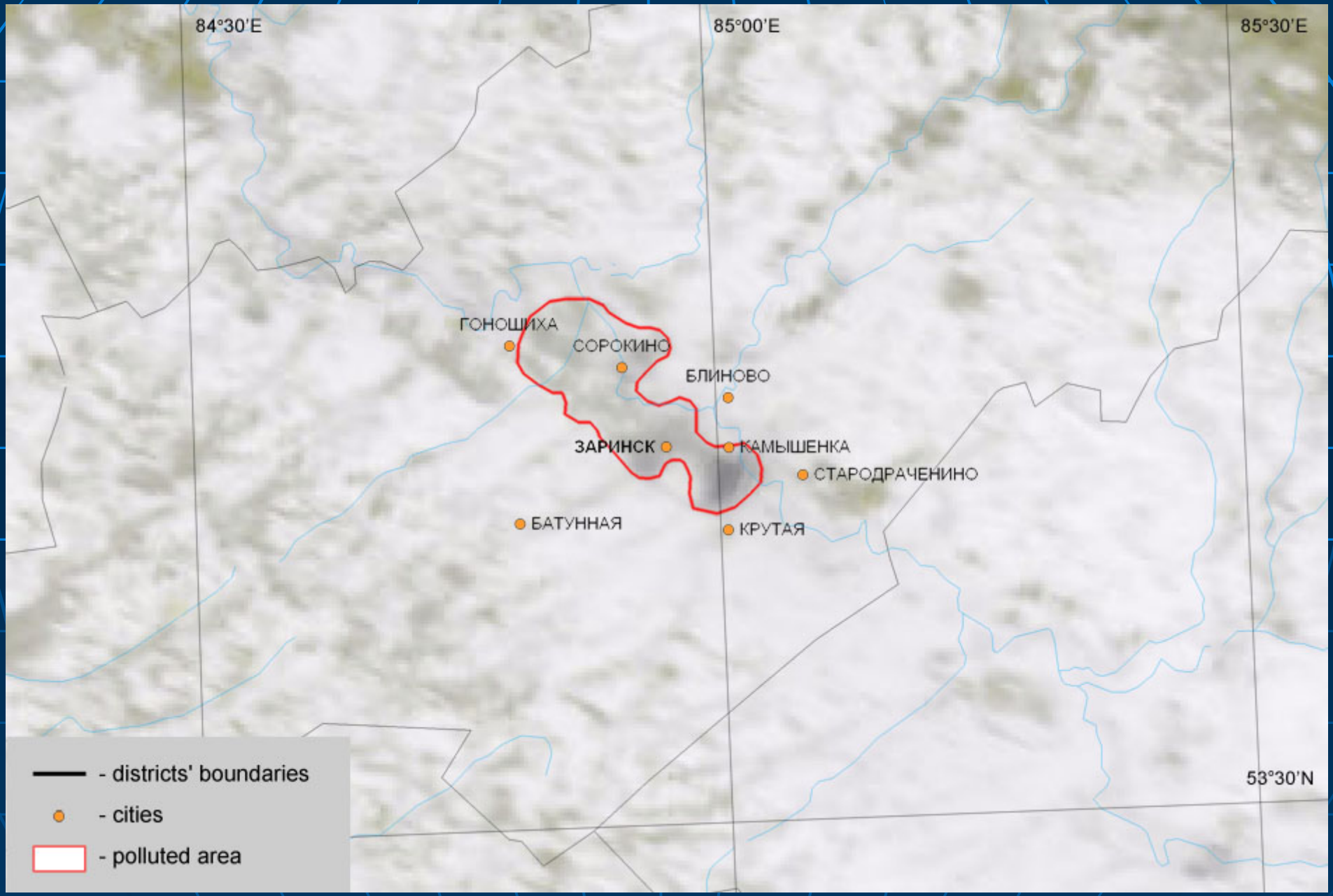
a, b, c, d – empirical coefficients (from PGE07)

Brightness temperature in channel 31 (BT31)	a	b	c	d
BT31< 240 K	–1.5711228087	1.0054774067	1.8532794923	–0.7905176303
BT31∈[240÷260] K	–2.3726968515	1.0086040702	1.6948238801	0.2052523236
BT31>260 K	–4.29530463	1.0150179031	1.9495254583	0.1971325790

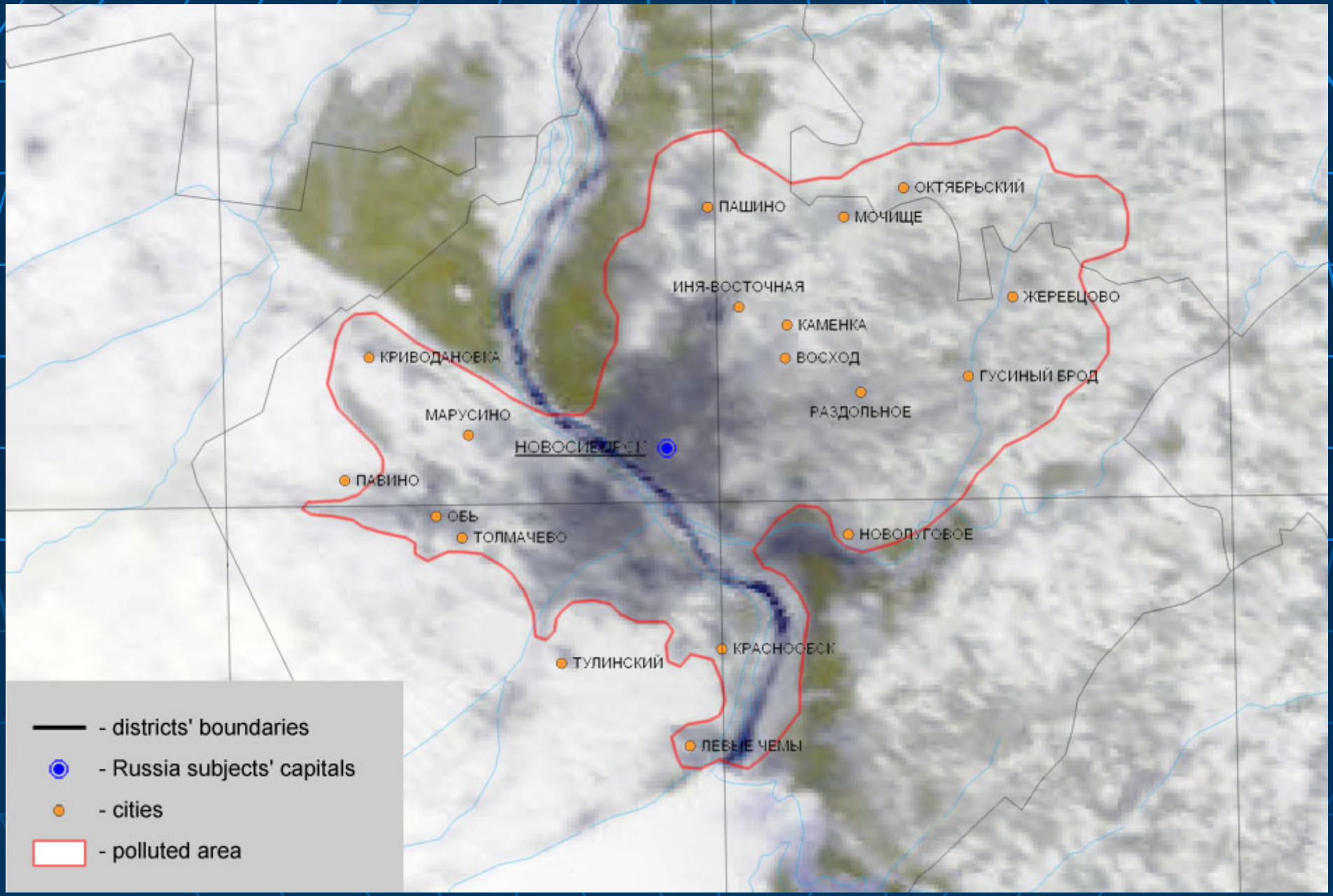
Polluted snow around Barnaul. MODIS data. March 29, 2009



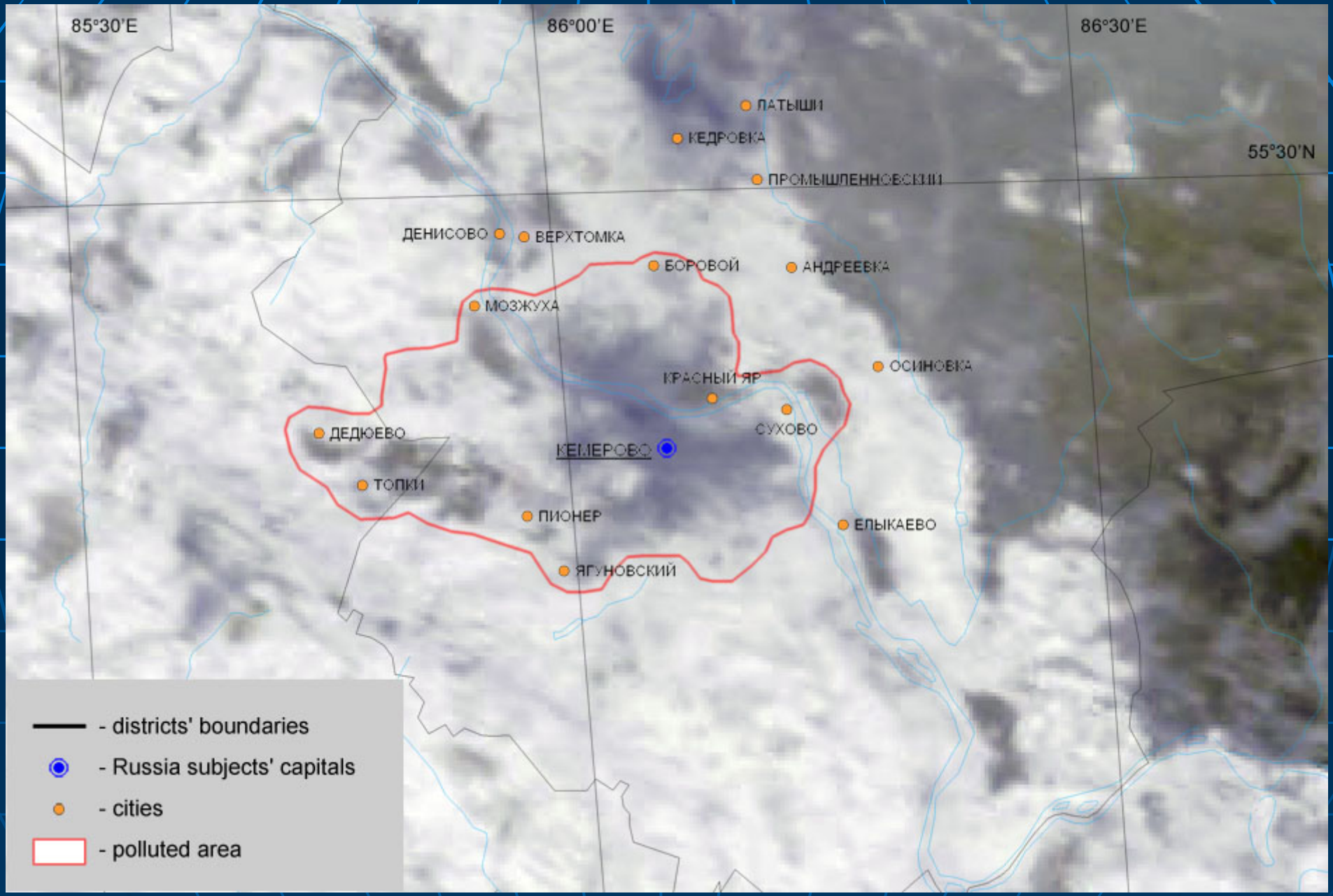
Polluted snow around Zarinsk. MODIS data. March 29, 2009



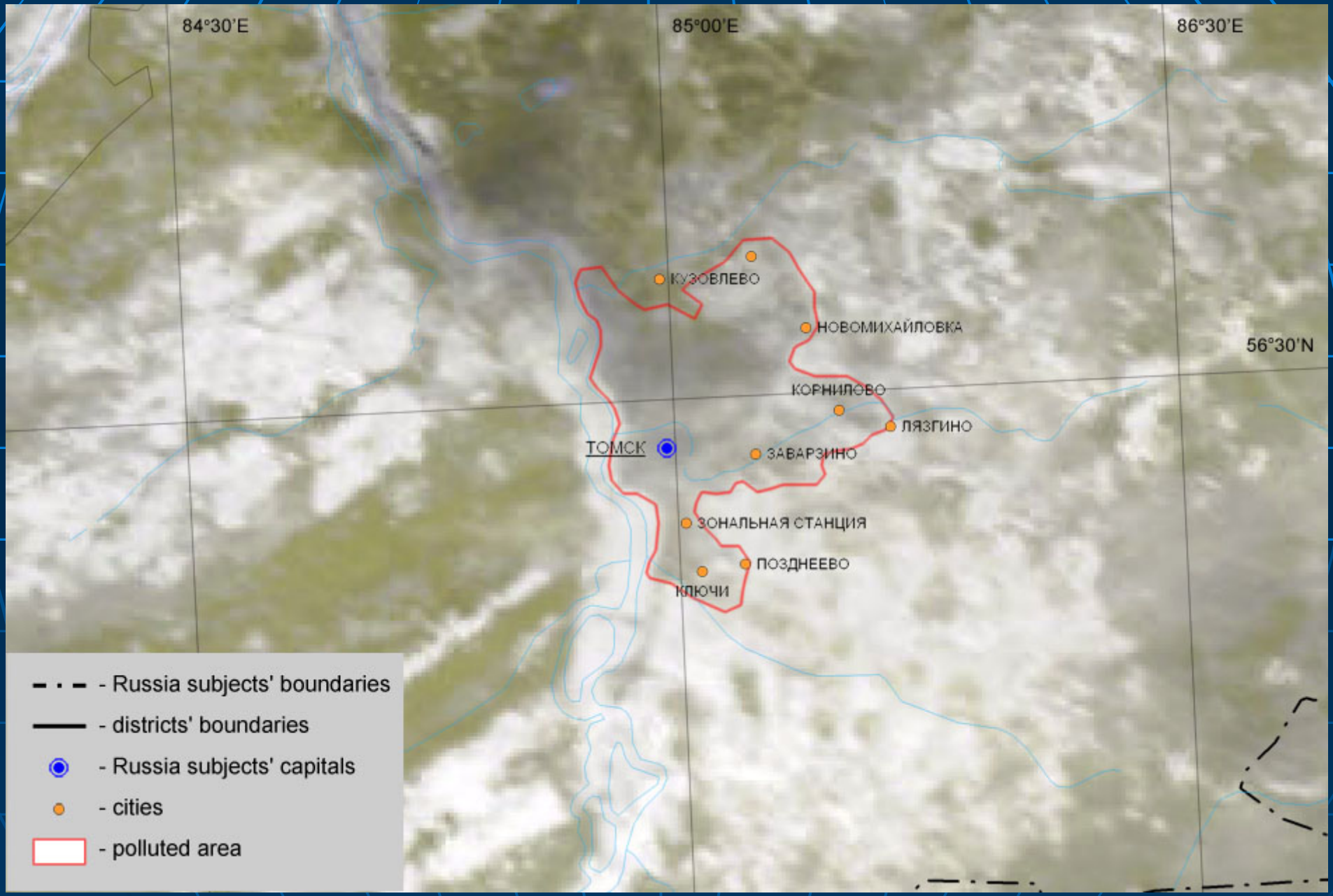
Polluted snow around Novosibirsk. MODIS data. March 29, 2009



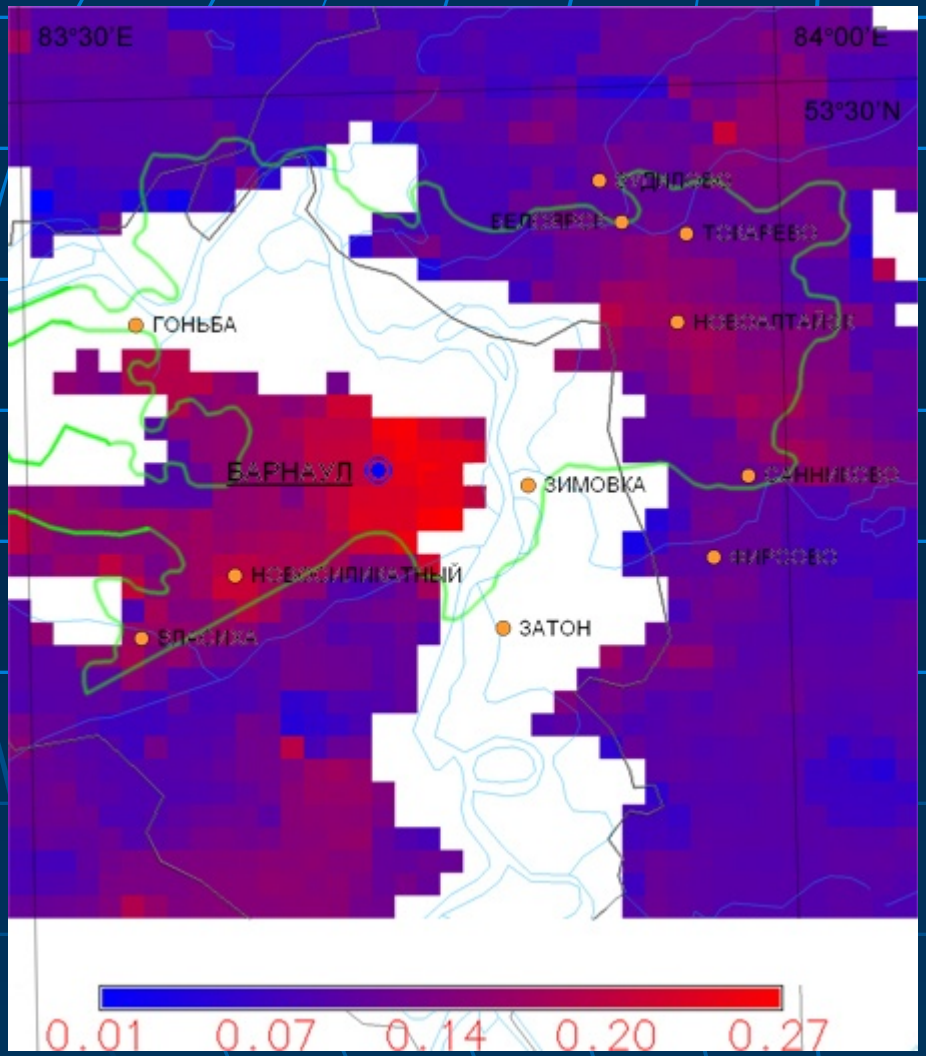
Polluted snow around Kemerovo. MODIS data. March 29, 2009

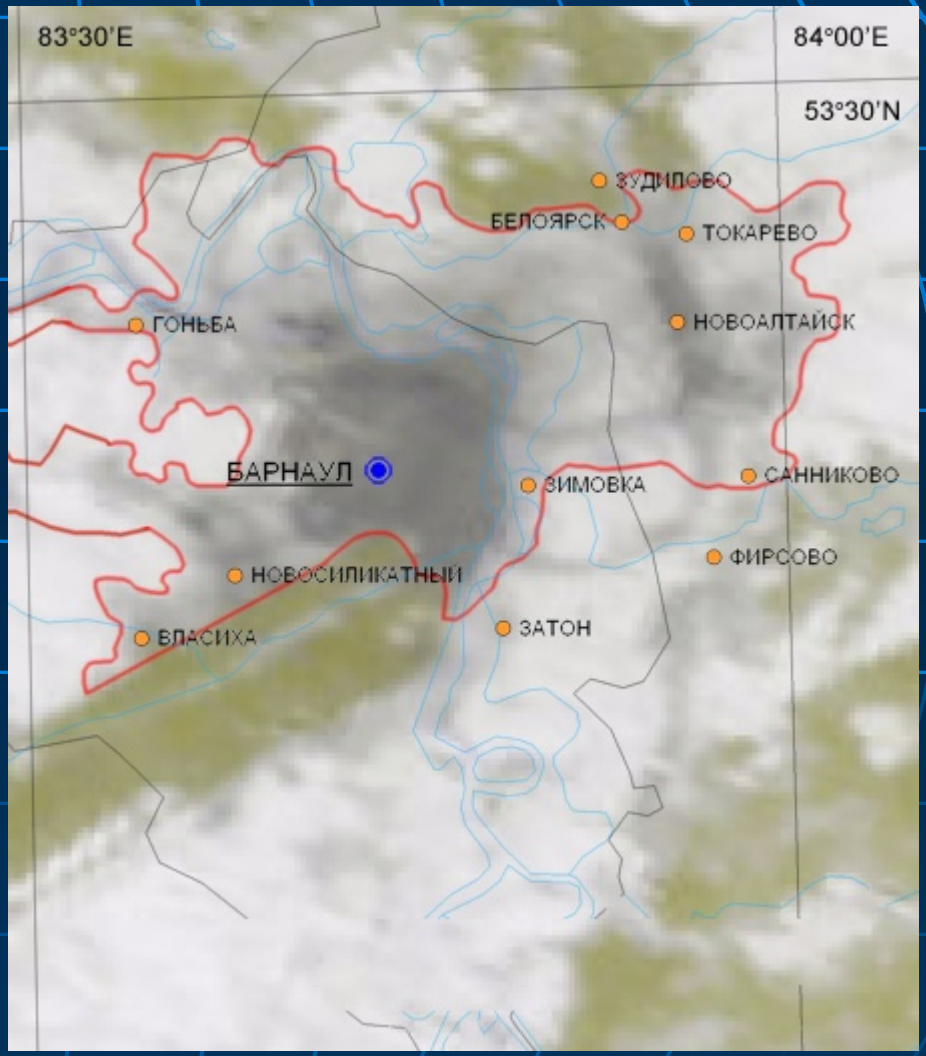


Polluted snow around Tomsk. MODIS data. March 29, 2009

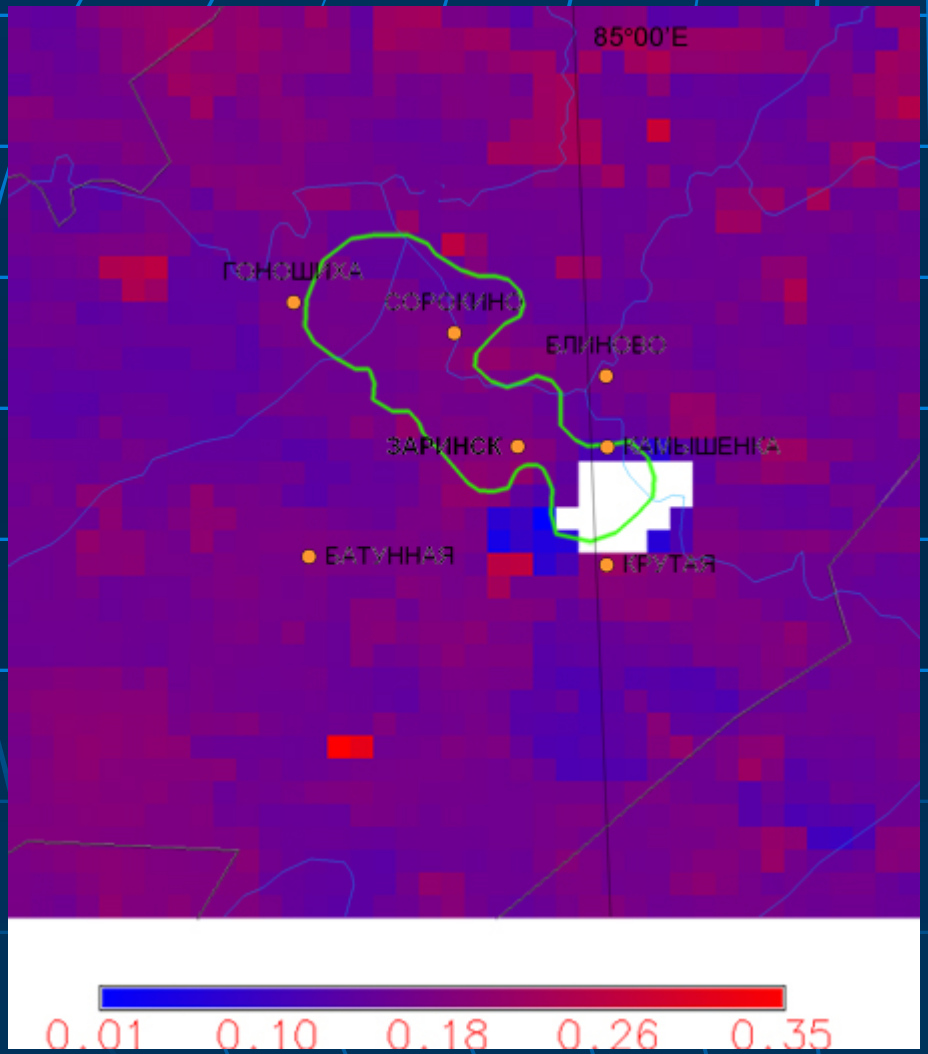


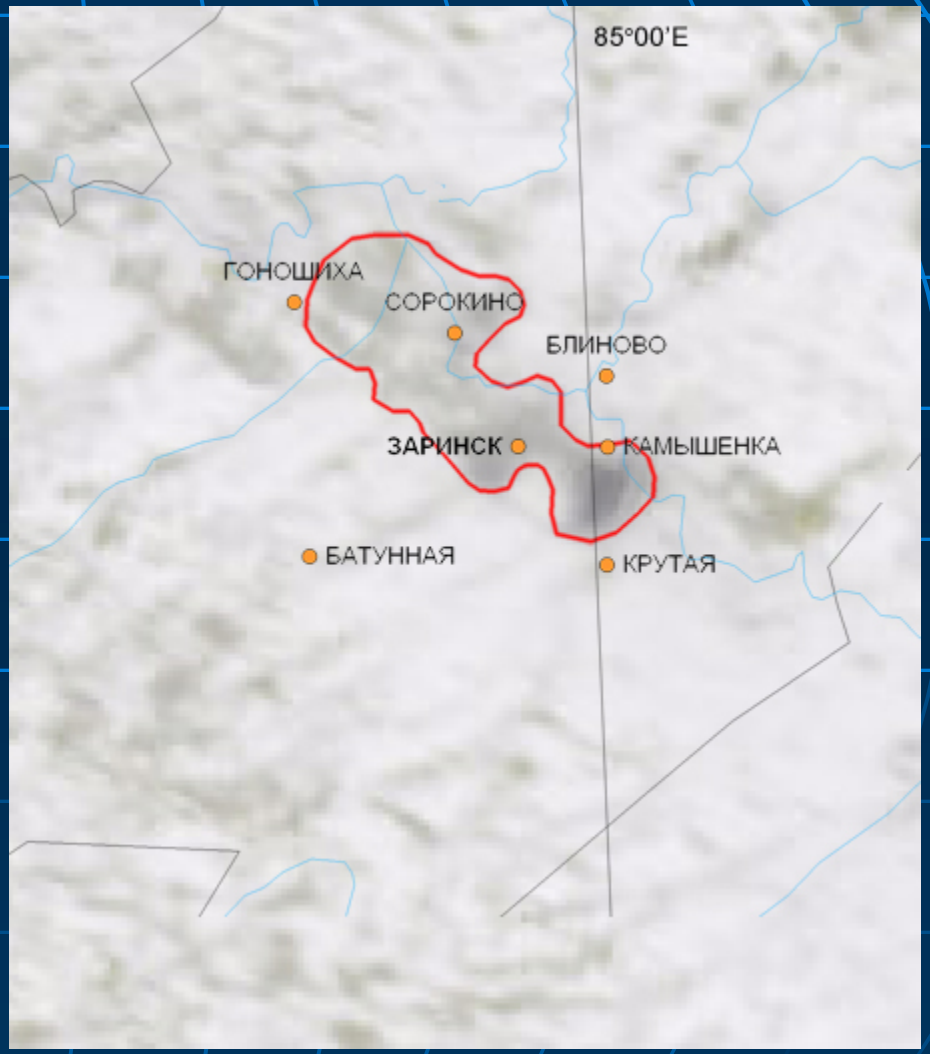
AOT around Barnaul. MODIS data. April, 2009



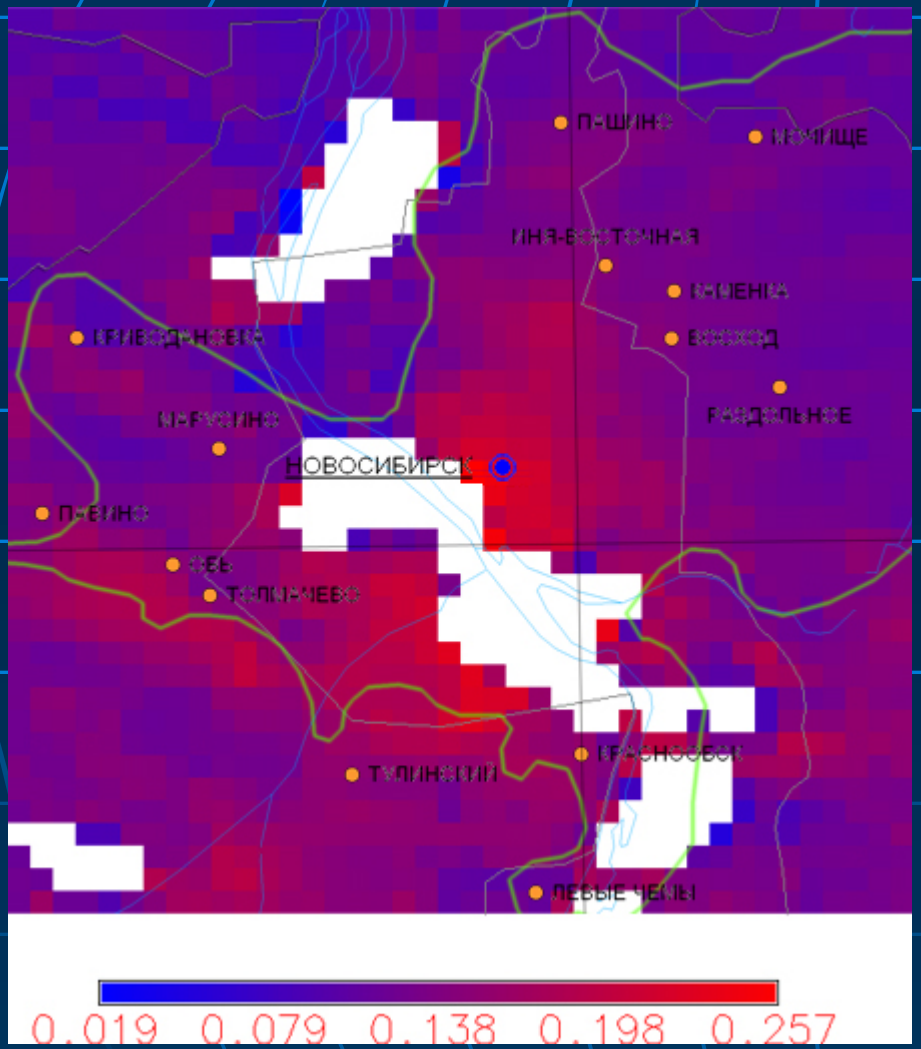


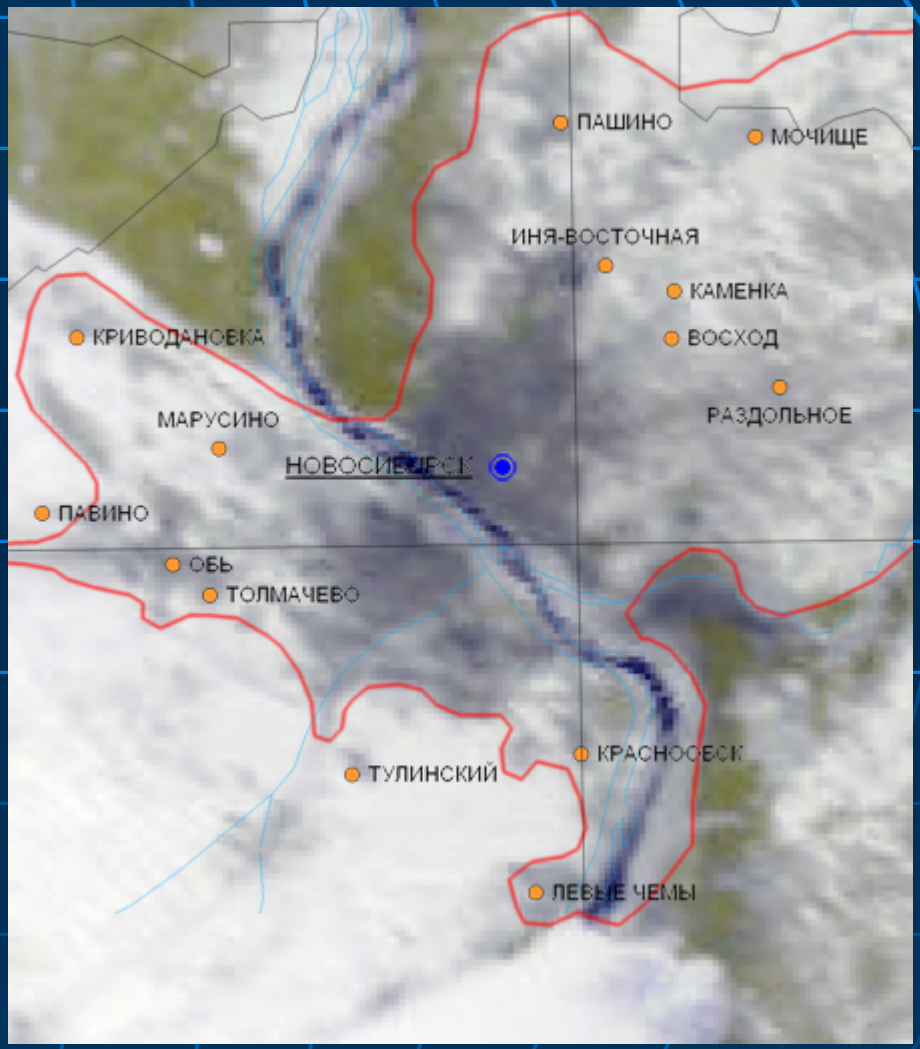
AOT around Zarinsk. MODIS data. June, 2009



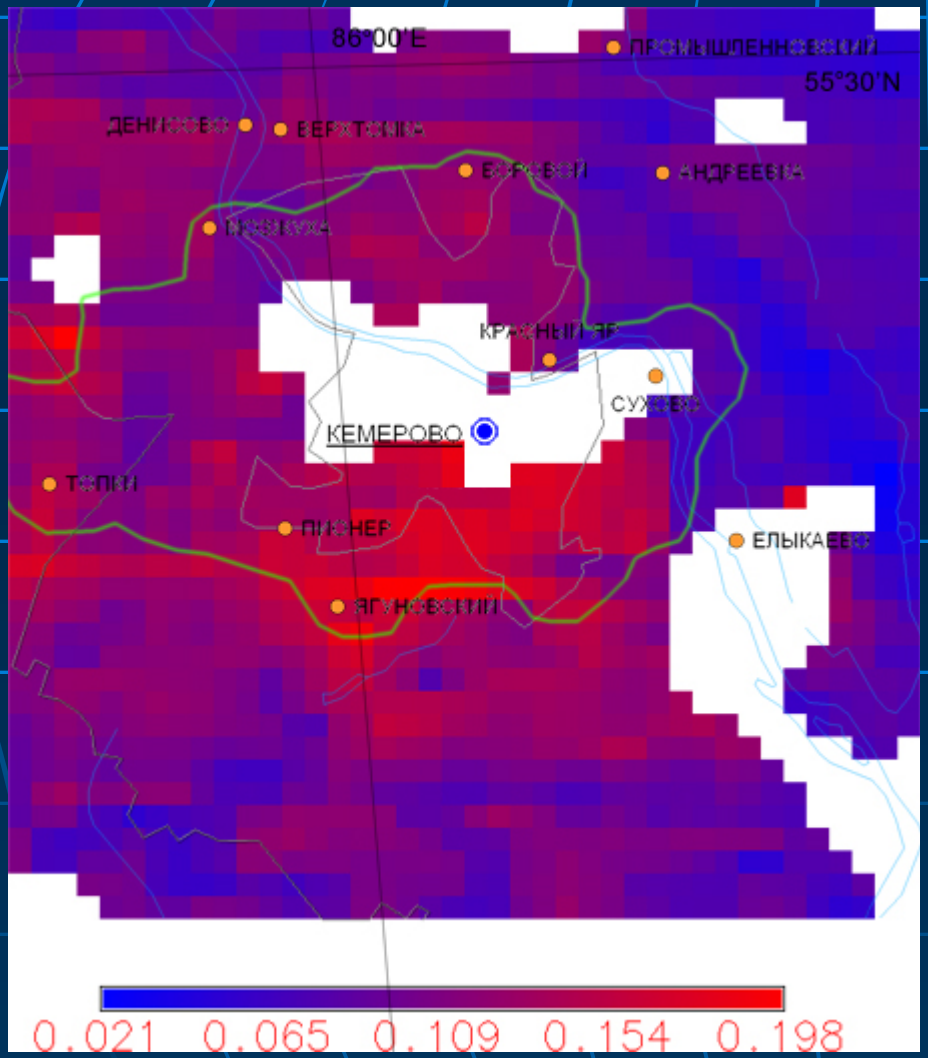


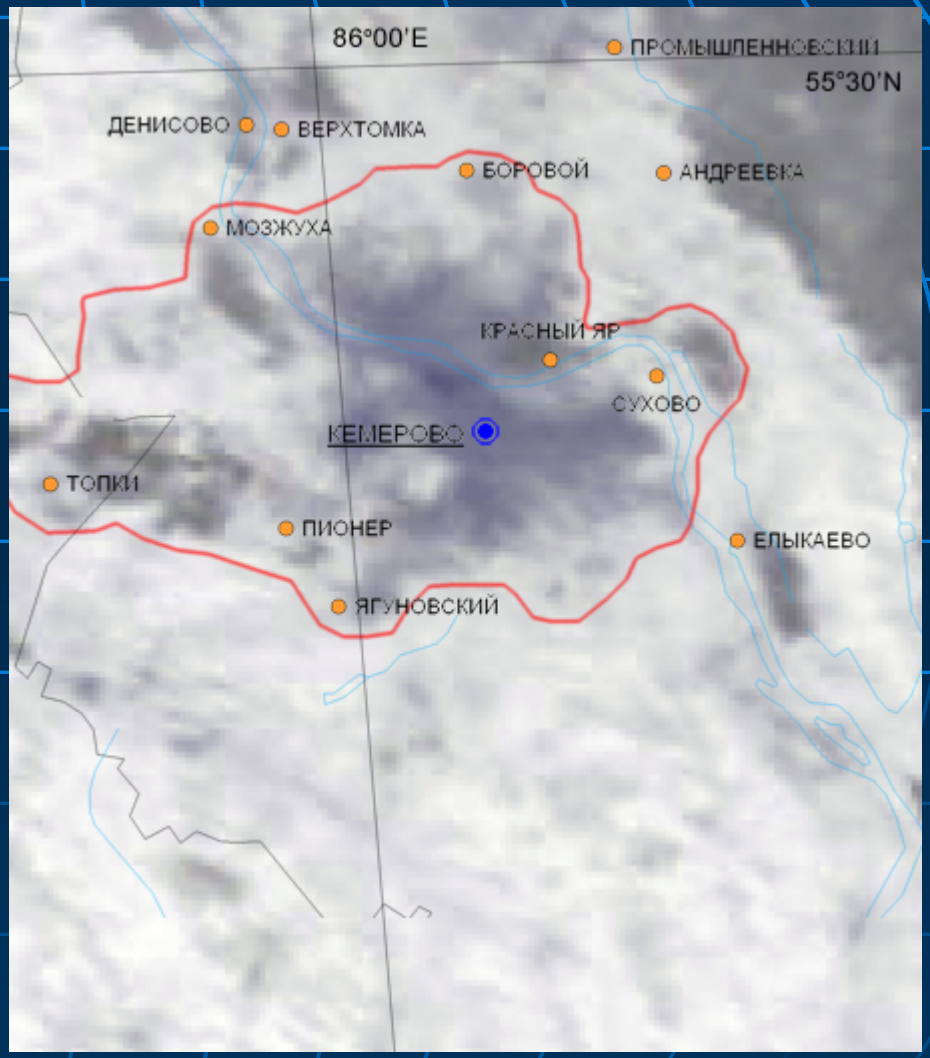
AOT around Novosibirsk. MODIS data. April, 2009



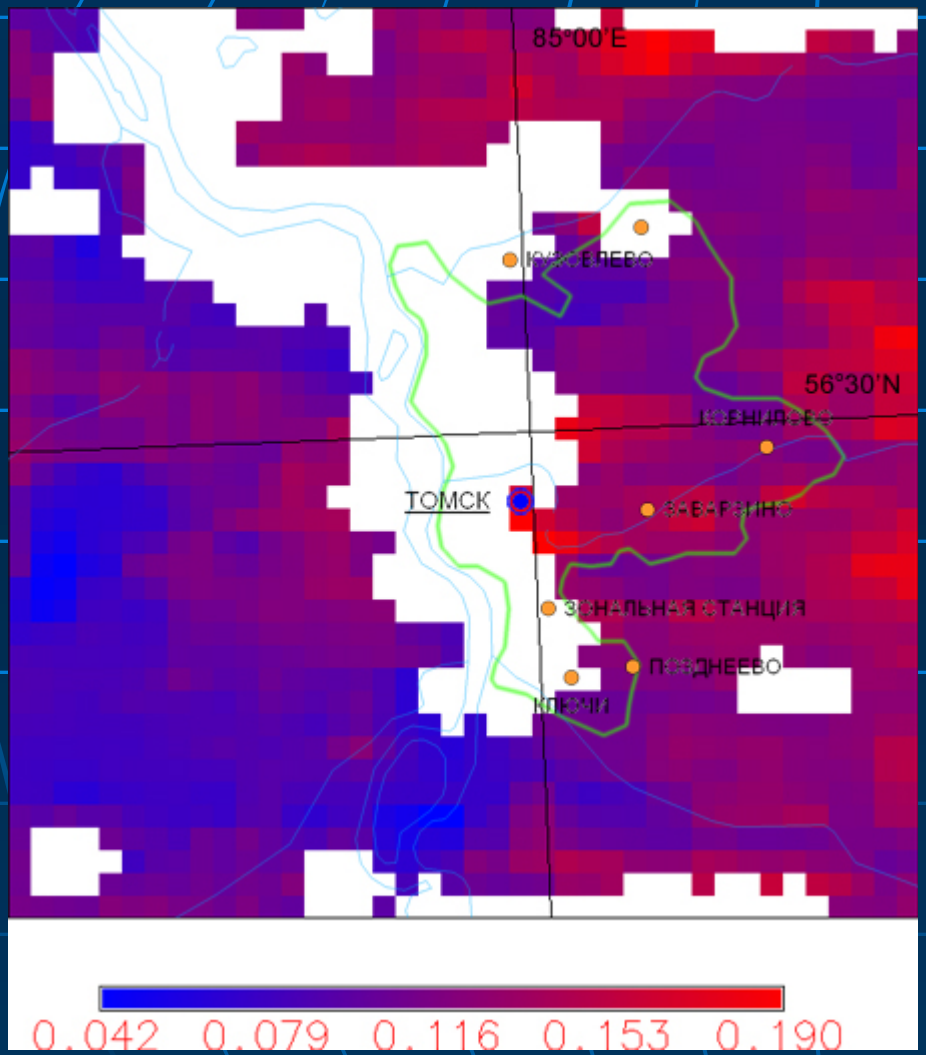


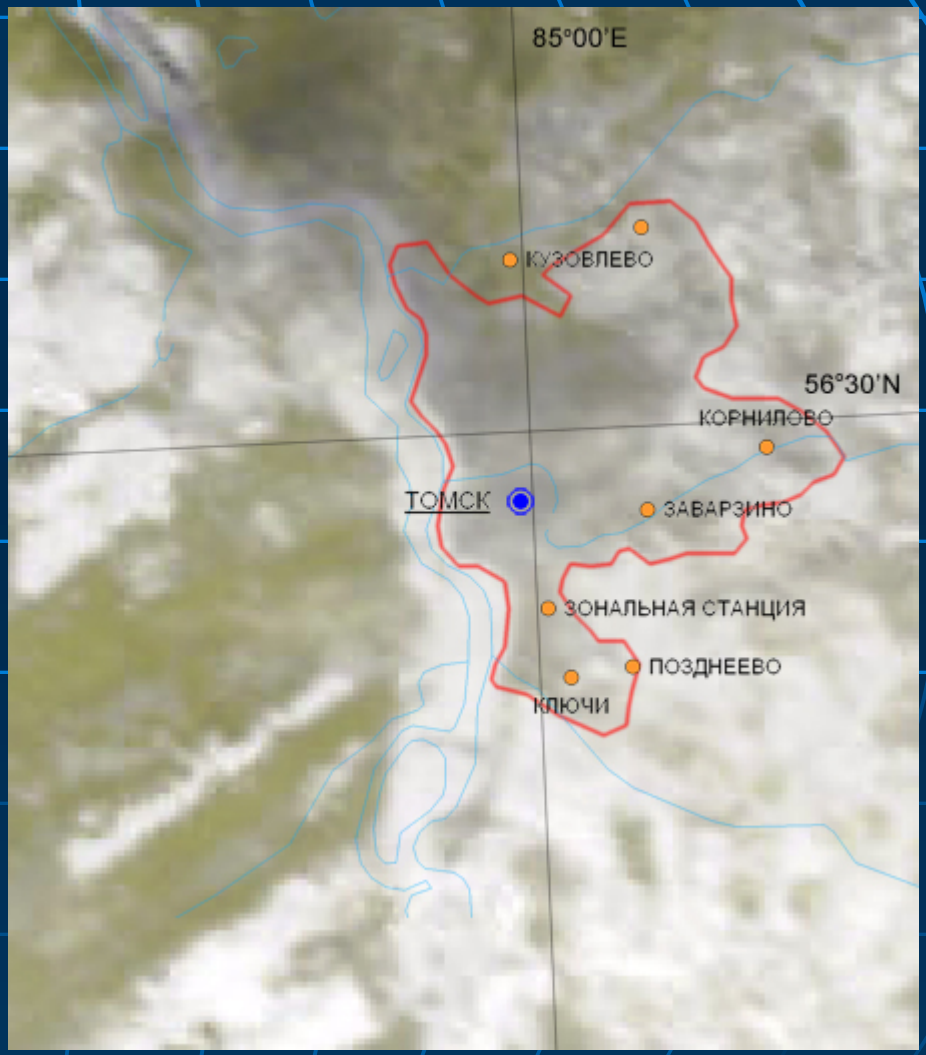
AOT around Kemerovo. MODIS data. May, 2009



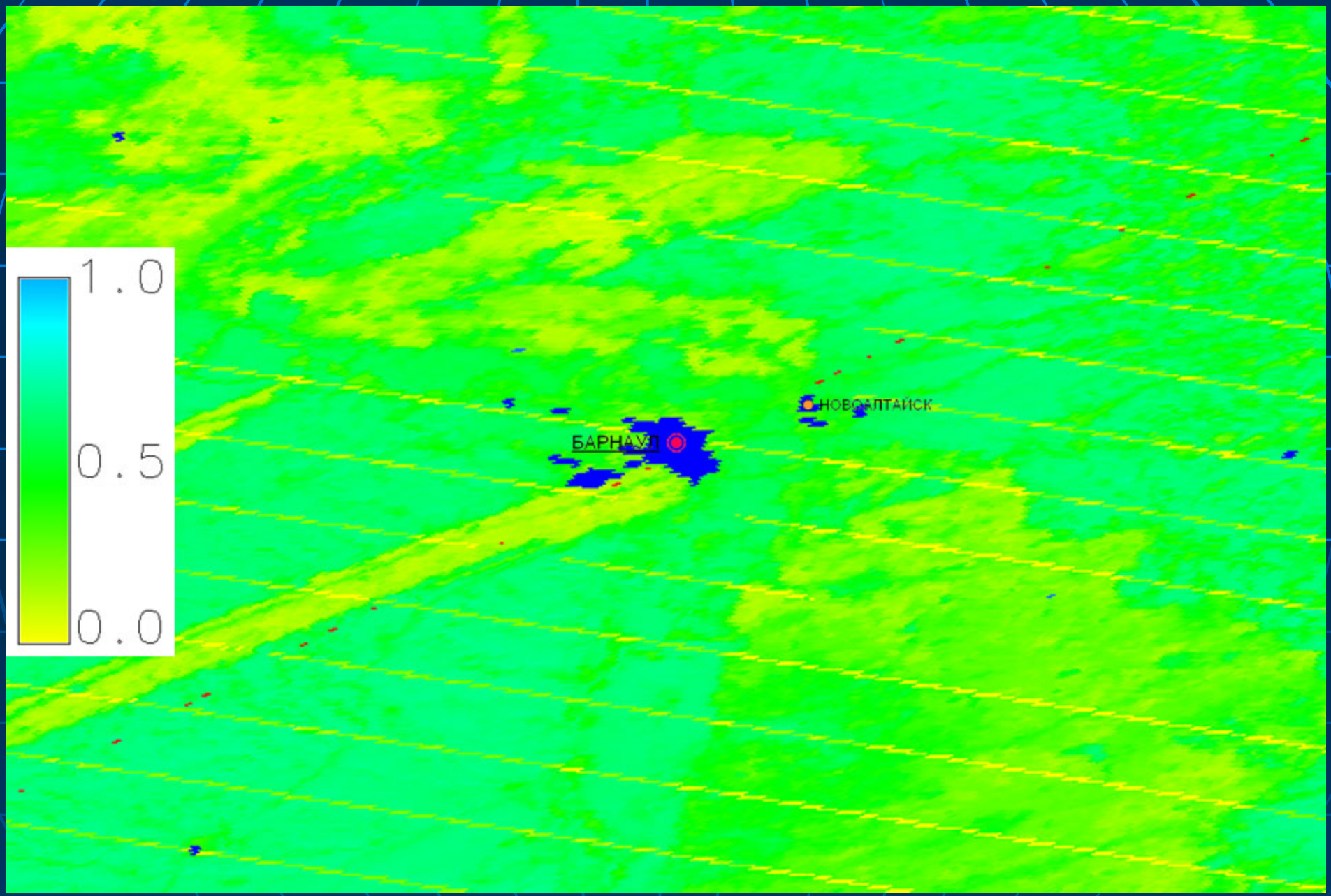


AOT around Tomsk. MODIS data. April, 2009





Albedo. MODIS data. March, 2009



REMOVED LABORATORY IWEP SB RAS

TAKING SNOW

Elements concentration in unsoluble part of snow species in Altay region (2006 year, 28.02 -15.03.06)

mg/kg

Number of species	1	2	3	4	5	6	7	8
Elements								
Cl	117	145	80	140	120	270	110	457
K	825	620	175	685	185	517	980	1570
Ca	2530	2950	1740	3110	1470	2115	2870	3675
Ti	145	170	150	550	110	870	120	220
Cr	74	10	55	370	277	670	95	395
Mn	215	88	80	535	340	1450	890	1070
Fe	1120	1370	1370	1780	2565	11565	10105	4585
Co	10	10	5	15	5	25	10	175
Ni	18	40	85	15	145	220	110	10
Cu	55	50	83	155	65	355	215	840
Zn	145	105	280	115	370	1380	380	750
Ga	10	5	0	5	0	15	0	10
Ge	0	5	0	5	0	5	0	10
As	10	15	5	22	25	15	20	10
Se	0	0	10	15	15	22	25	20
Br	25	10	10	17	85	45	55	85
Rb	5	3	10	5	0	0	0	25
Sr	15	32	15	10	0	140	85	110
Y	0	0	5	0	5	5	0	0
Zr	5	45	10	15	50	65	35	60

ANALYSIS DATA of SNOW SPECIES DEALS WITH the SOLID UNSOLUBLE SUBSTANCES around the RIVERS in ALTAY REGION (selected part)

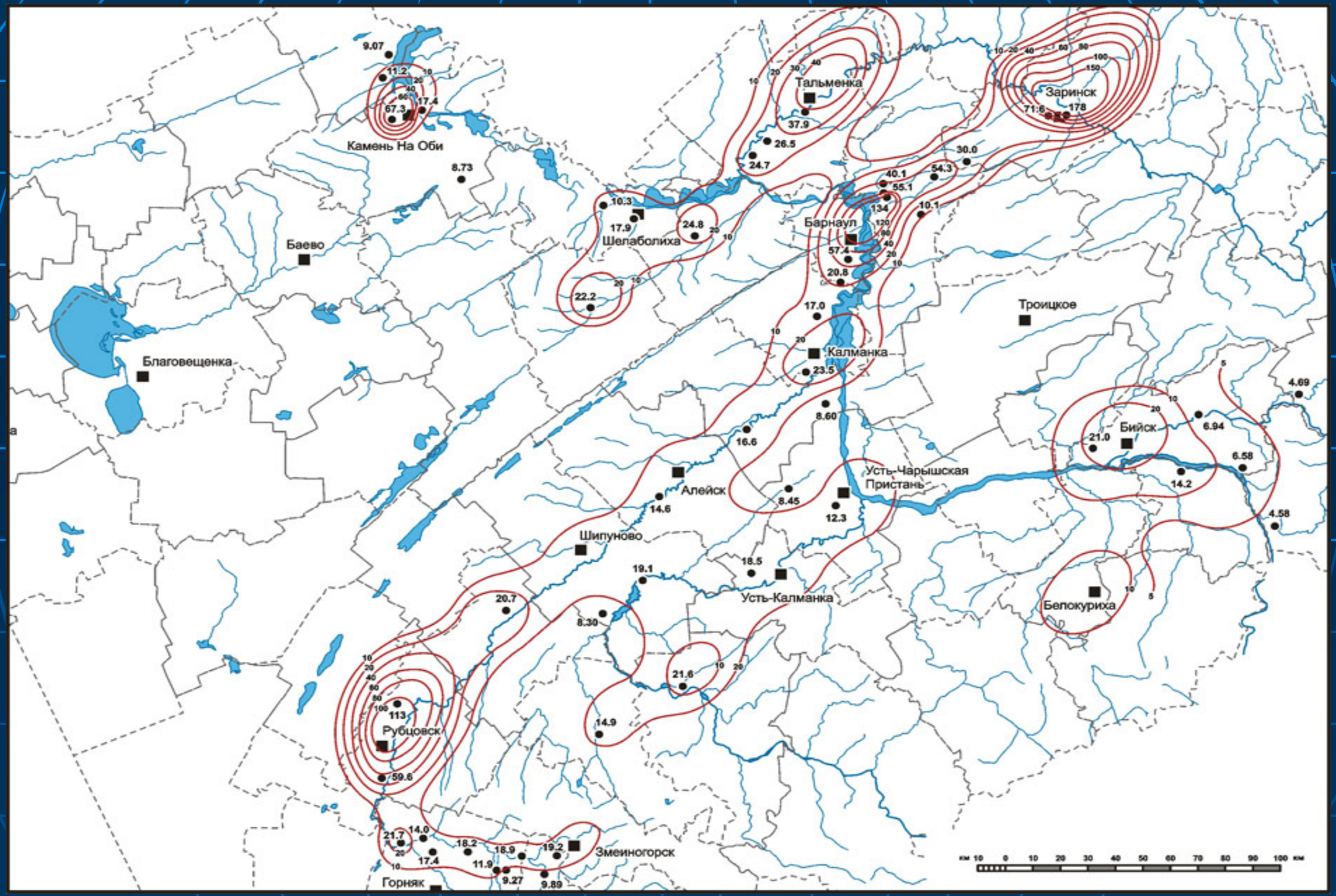
№	Место отбора и дата	Координаты	Толщина снежного покрова, м	Объем пробы, л	Вес нерастворимого остатка, г	Отношение г/л	Отношение $г/м^2$	Запас воды в снеге, мм
1	2	3	4	5	6	7	8	9
1.	Пойма реки Лосиха, 5 км в сторону с. Жилино 23.02.06	53 º 23 I А. с. ш. В. 84 º 10 i С. в. д. Д.	0,40 0,35 0,55	4,1 3,5 5,3	0,31 0,35 0,40	0,08 0,10 0,08	7,8 8,8 10,0	80 70 110
2.	Пойма реки Чемровка, 1 км на юг от пос. Нов. Чемровка 23.02.06	52 º 31 I А. В. 85 º 02 i С. Д.	0,45 0,50 0,50	4,3 4,8 5,1	0,27 0,38 0,32	0,06 0,08 0,06	6,8 9,5 8,0	85 100 100
3.	Пойма реки Катунь за пос. Верх Катунское 23.02.06	52 º 25 I А. В. 85 º 30 i С. Д.	0,40 0,45 0,50	4,1 4,3 4,8	0,51 0,63 0,55	0,12 0,15 0,12	12,8 15,8 13,8	80 85 93
4.	Пойма реки Катунь за пос. Сростки 23.02.06	52 º 25 I А. В. 85 º 50 i С. Д.	0,50 0,45 0,45	5,0 4,4 4,5	0,26 0,30 0,32	0,05 0,07 0,07	6,5 7,5 8,0	100 89 90
5.	Пойма реки Иша перед пос. Усть Иша 24.02.06	52 º 12 I А. В. 85 º 59 i С. Д.	0,40 0,45 0,45	3,8 4,4 4,4	0,18 0,22 0,25	0,05 0,05 0,06	4,5 5,5 6,3	80 88 90

AVERAGED GEOMETRIC CONCENTRATIONS of ELEMENTS in ALTAY REGION, KEMEROV REGION and EARTH CLARKS (mg/kg)

ELEMENT	Cl	K	Ca	Ti	Mn	Fe	Cu	Zn	Br	Pb
ALTAY REGION	110	563	1 027	244	223	3 050	119	135	110	74
K E M E R O V O REGION	510	6 011	12 990	634	9 360	69 349	598	1 147	751	321
EARTH CLARKS	450	24 000	33 900	6 200	900	50 800	100	50	1,6	16

This data are used for the estimation of anthropogenic pollution of the fresh water region of Upper Ob river by different elements. The weight of pollution elements in Altay region: Cl – 86,9; K – 444,8; Ca – 811,3; Ti – 192,8; Mn – 176,2; Fe – 2409,5; Cu – 94,0; Zn – 106,7; Br – 86,9; Pb – 58,5 (10^3 kg).

MAP of SNOW POLLUTION in ALTAY REGION



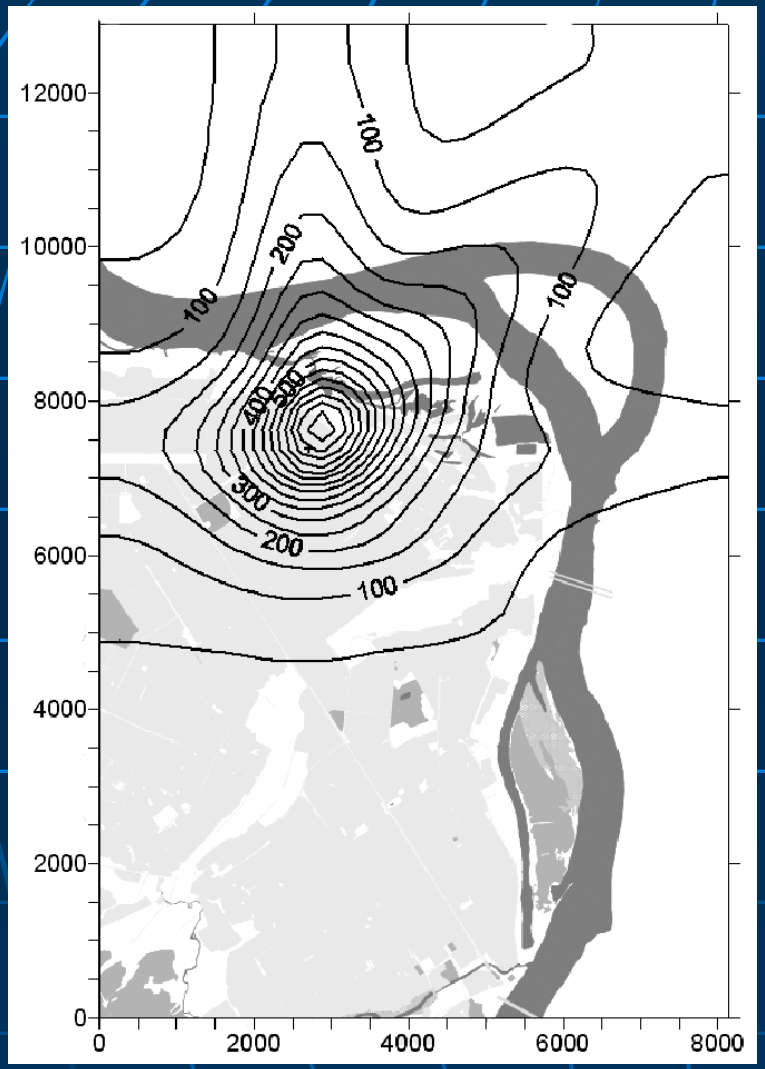
Calculated and measured masses of cox emitted per the unit of area at the different distances from heat power station -2 in Barnaul city

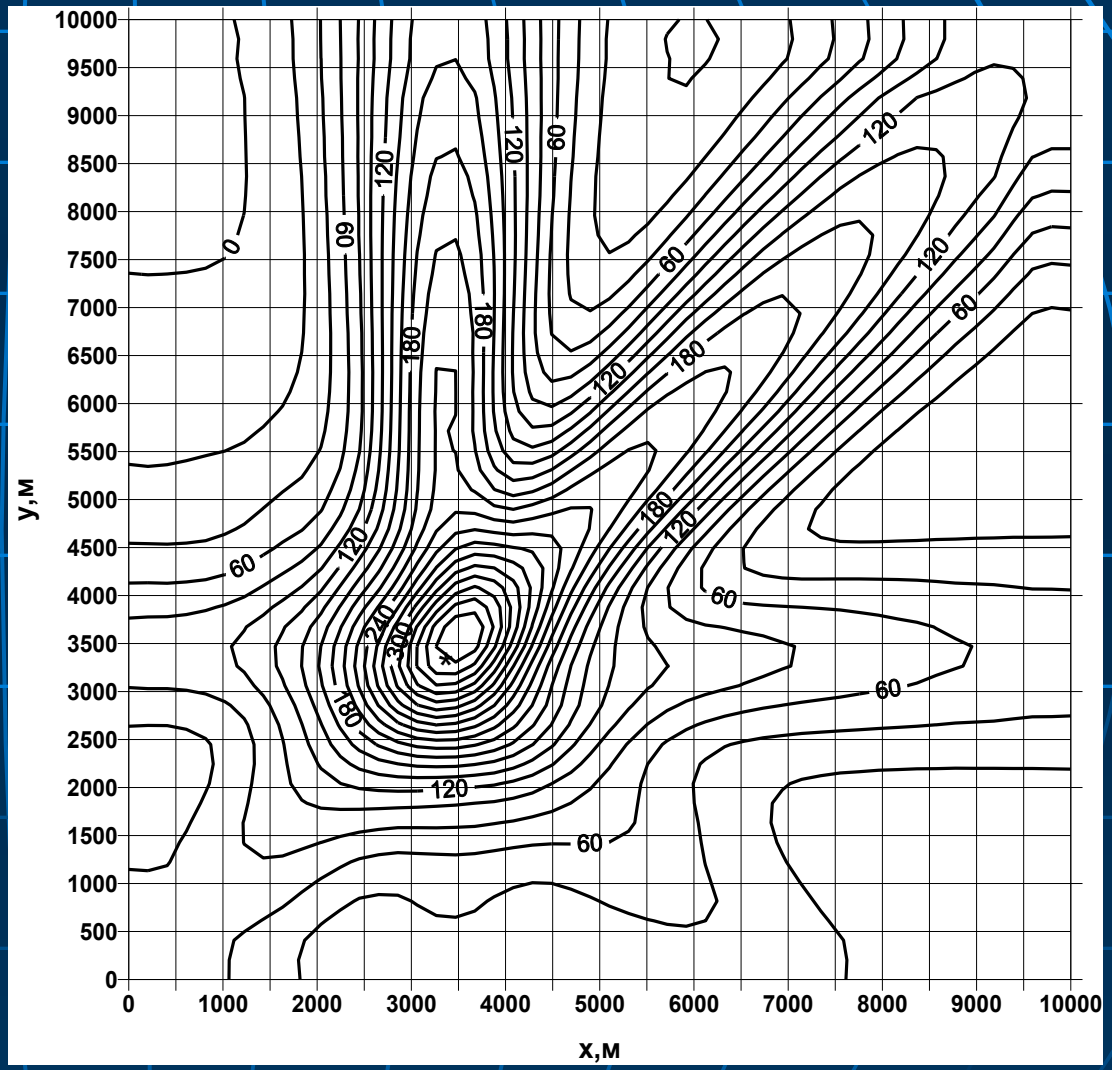
№ точки отбора пробы	Расстояние от источника (км)	Измеренная масса аэрозоля на ед. площади (г/м^2)	Расчетная масса аэрозоля на ед. площади (г/м^2)	Относительная погрешность %
1	1(ЗСЗ)	500	500	0
2	1(ССЗ)	653	550	23,4
3	2(ССЗ)	255	250	1,9
4	3(ССЗ)	123	125	1,6

Calculated and measured masses of cox emitted per the unit of area at the different distances from heat power station in Kuchuk plant

№ точки отбора пробы	Расстояние от источника (км)	Измеренная масса аэрозоля на ед. площади (г/м^2)	Расчетная масса аэрозоля на ед. площади (г/м^2)	Относительная погрешность %
1	0,8(ССЗ)	425	360	15,3
2	1,5(ССЗ)	193	240	24,4
3	3(ССЗ)	78	100	28,2

THE SCHEME of CALCULATED DISTRIBUTION of COX (heat power station-2 in Barnaul city)

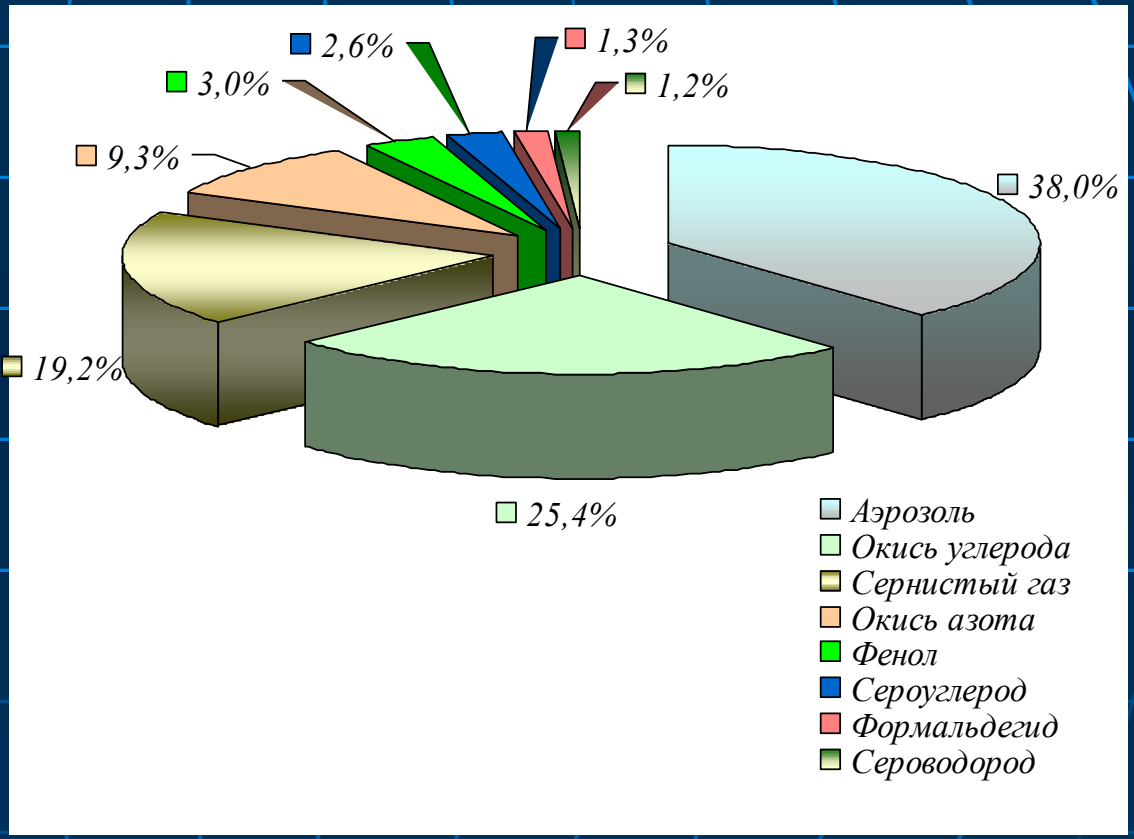




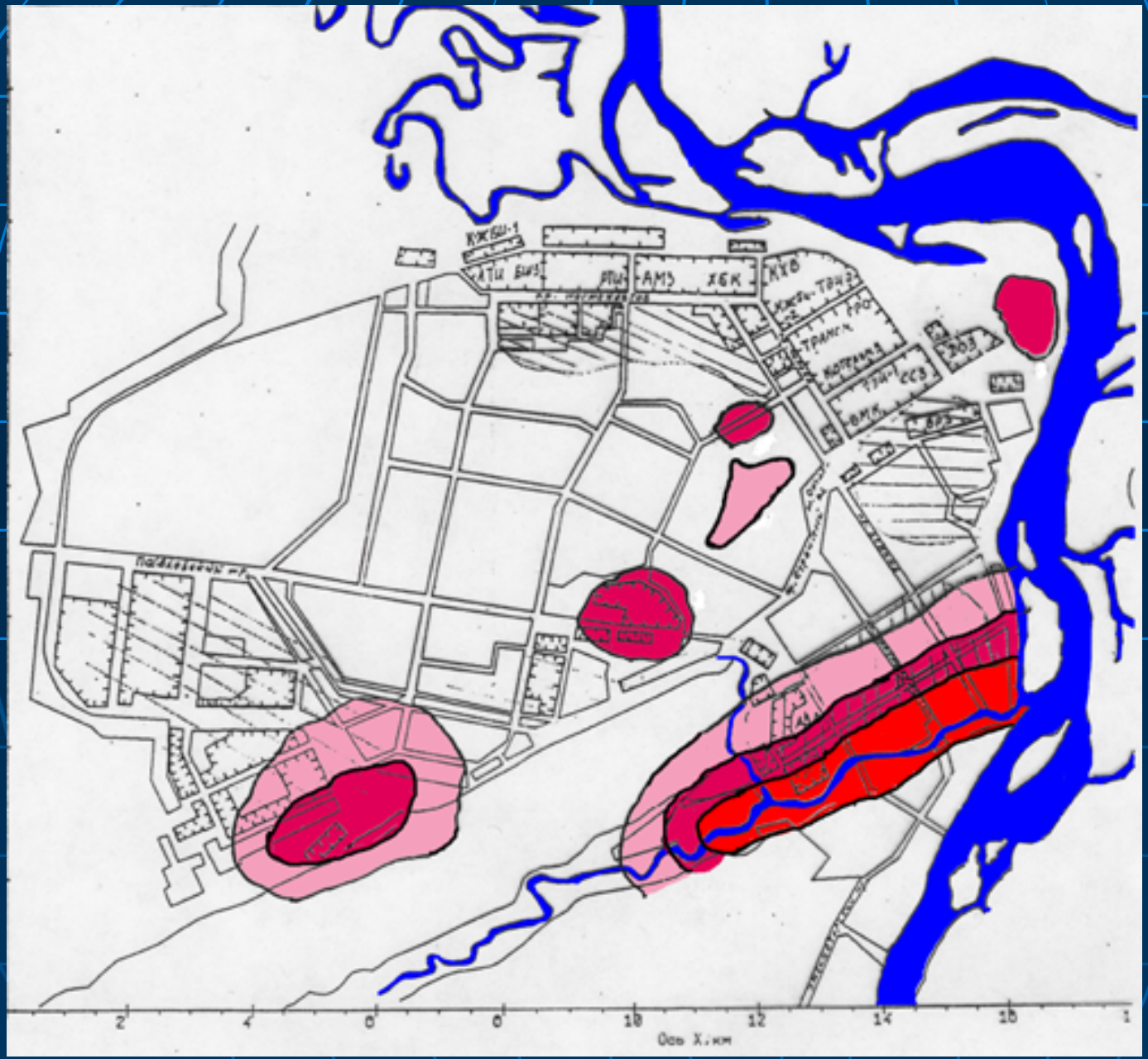
THE SCHEME of CALCULATED DISTRIBUTION of COX (Kuchuk plant Heat power station)

THE MAIN POLLUTIONS EMITTED INTO ATMOSPHERIC AIR of BARNAUL CITY

pollution	Volume percent
aerosol	38,0%
CO	25,4%
SO2	19,2%
NO2	9,3%
Phenol	3,0%
CS4	2,6%
C2H2	1,3%
CH2	1,2%



Domains with the different relative concentrations of the earth aerosol hase In Barnaul city under AMC



CONCLUSION

The presented measured results show the possibility of the technogenic pollutions monitoring of snow surfaces in the big industrial centres of West Siberia using MODIS and observation data

THANK YOU FOR ATTENTION!