Supplementary information

Identification of missing anthropogenic emission sources in Russia: implication for modeling Arctic haze

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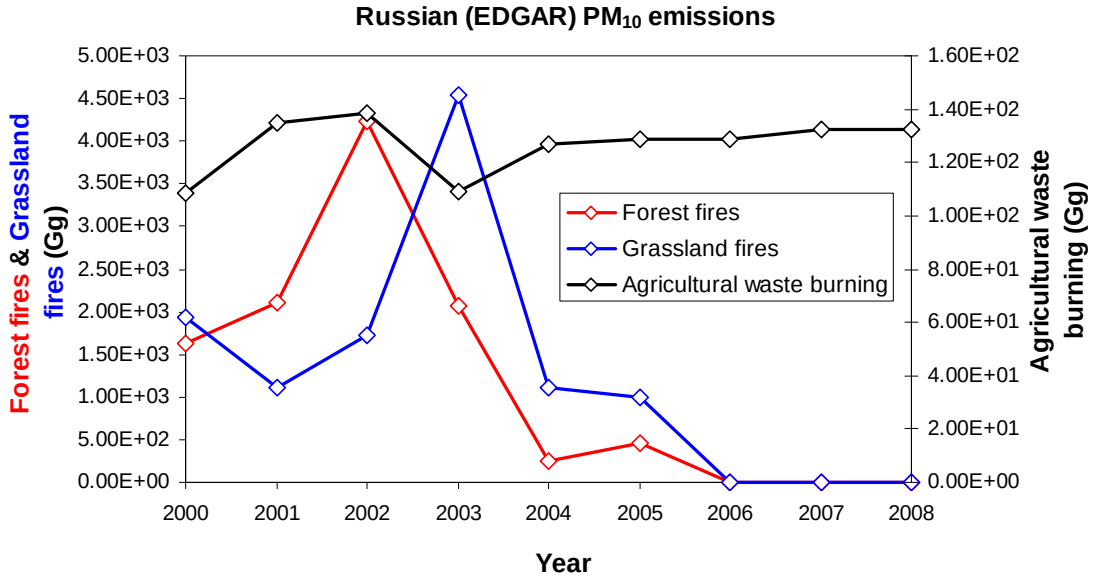

Fig. S1. Annual PM_{10} emissions (2000 – 2008) of Russia in three sectors that are relevant to biomass burning, i.e. agricultural waste burning, forest fires, and grassland fires.

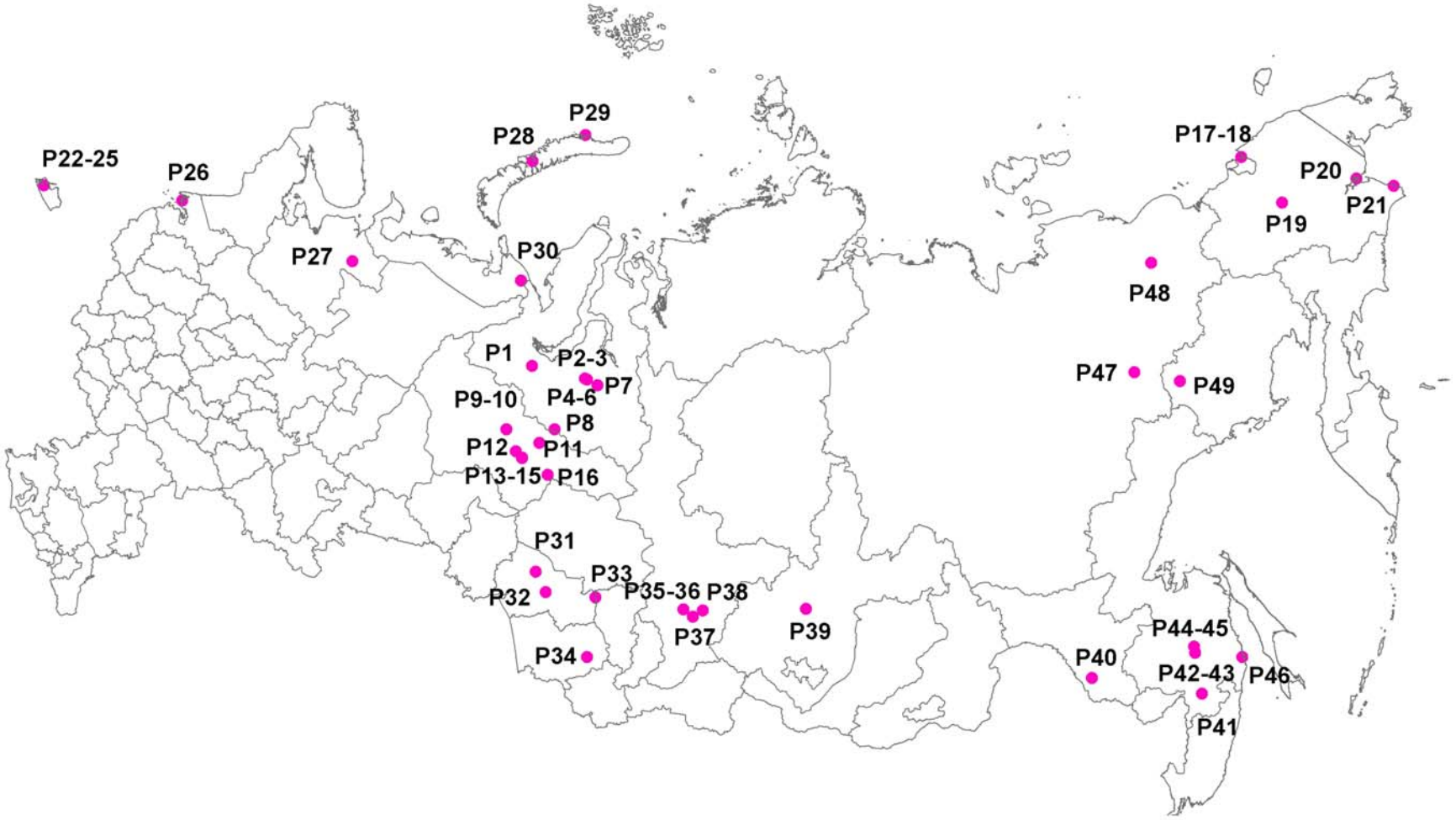

Fig. S2. Locations of missing power plants in the EDGAR emission inventory as compared to CARMA. Corresponding information of each power plant is listed in Table S1.

Description of Potential source contribution function

The PSCF is a technique for source region identification that requires both ambient air chemistry data and backward air mass trajectory. PSCF analysis yields a two-dimensional map that shows a synthetic probability field describing the source strength of a geographical area (i.e., a grid cell), which is called as the "Potential Source Contribution". The total numbers ($n_{i,j}$) of trajectory endpoints (i.e. coordinates of the back trajectory for each hour before arriving at the receptor site) falling within grid cell [i,j] during the study period are counted. Also, the number of those in the same grid cell with pollutant level higher than a set threshold was calculated as $m_{i,j}$. Then, the ratio between $n_{i,j}$ and $m_{i,j}$ is the PSCF value for this grid cell: $PSCF_{i,j} = m_{i,j}/n_{i,j}$. To minimize the biased PSCF caused by the low $n_{i,j}$ values, $PSCF_{ij}$ was weighted with w_{ij} by setting at 0.1 for $n_{i,j} < 9$, and 1.0 for $n_{i,j} \geq 10$. Note that PSCF didn't incorporate any emission input and couldn't resolve detailed small-scale features while it was an indication of the likelihood that a given region contributed to the receptor site.

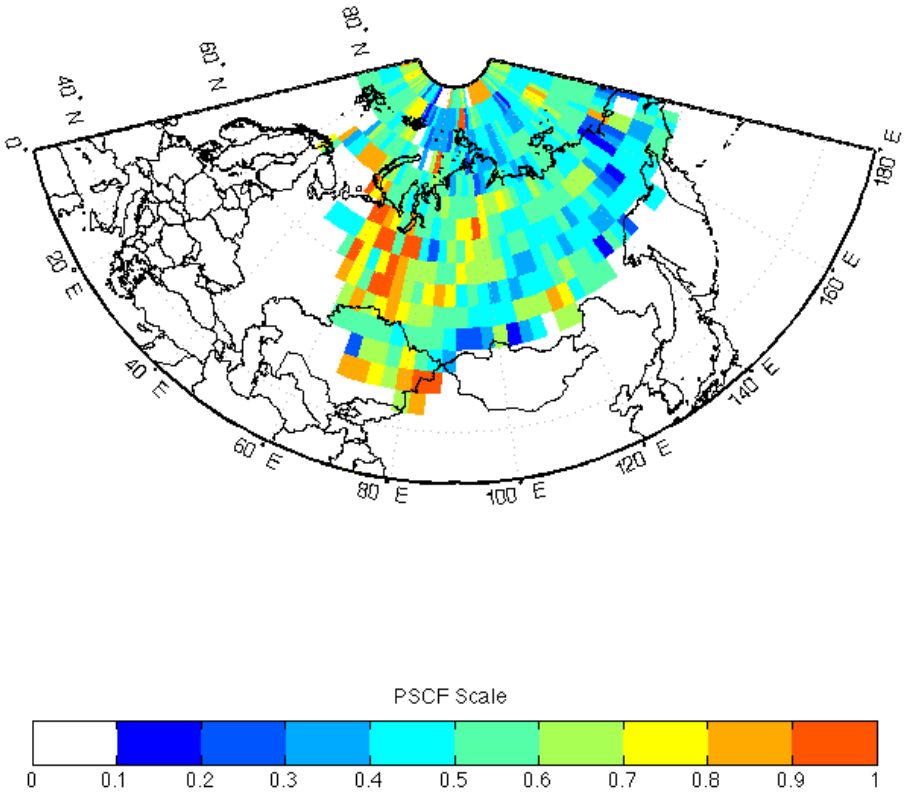

Fig. S3. Potential source contribution function (PSCF) probability map for black carbon measurement at Tiski (71.6° N, 128.9° E) during the autumn in 2010.

Table S1. Name, energy capacity, and locations of missing power plants as indicated in Figure S3.

Index	Power Plant Name	Energy_2007(MWh)	State	Latitude	Longitude
P1	Urengoy	167860	Yamal-Nenets	65.63	70.26
P2	NOVY URENGOI	35870	Yamal-Nenets	66.08	76.63
P3	NOVY URENGOI-2	148740	Yamal-Nenets	66.08	76.63
P4	TARASOVSKOYE FIELD	546830	Yamal-Nenets	66.07	76.93
P5	SEVERO-GUBKINSKY	94616	Yamal-Nenets	66.07	76.93
P6	HASIREYSK FIELD	237540	Yamal-Nenets	66.07	76.93
P7	URENGOYSK	167860	Yamal-Nenets	65.97	78.37
P8	NOYABRSK	831010	Yamal-Nenets	63.20	75.45
P9	WEST SALYMN FIELD	300500	Khanty-mansiy	62.23	70.64
P10	SEVERO-LABATYUGANSKOYE	159700	Khanty-mansiy	62.23	70.64
P11	VATYEGANSKOYE FIELD	756860	Khanty-Mansiy	62.27	74.48
P12	LYANTOR CITY HOSPITAL	58	Khanty-Mansiy	61.42	72.52
P13	SURGUT-2	15600000	Khanty-Mansiy	61.24	73.40
P14	SURGUT MUNICIPAL HOSPITAL	350	Khanty-Mansiy	61.25	73.42
P15	SURGUT ADMIN HQ	109	Khanty-Mansiy	61.25	73.42
P16	NIZHNEVARTOVSK	6707400	Khanty-Mansiy	60.93	76.55
P17	CHAUNSK	152617	Chukotka	69.70	170.31
P18	PEVEK DES	1755	Chukotka	69.70	170.31
P19	KUPOL MINE	88558	Chukotka	66.78	169.55
P20	ANADYR	360102	Chukotka	64.75	177.48
P21	BERINGOVSKIY	4416	Chukotka	63.05	179.32
P22	KALININGRAD MILL	997594	Kaliningrad	54.71	20.50
P23	KALININGRAD-02 CHPP	1314420	Kaliningrad	54.71	20.50
P24	KALININGRAD-05	166380	Kaliningrad	54.71	20.50
P25	KALININGRAD GT PLANT	22388	Kaliningrad	54.71	20.50
P26	SEVERO-ZAPADNAYA	2560327	Saint Petersburg	60.37	28.60
P27	LESHUKONSKAYA DES	2196	Arkhangel'sk	64.90	45.77
P28	NOVAYA ZEMLYA	18285	Arkhangelskaya	74.00	56.00
P29	VELSKAYA	212830	Arkhangelskaya	76.23	60.99
P30	VARANDEY TERMINAL	336380	Arkhangelskaya	69.05	64.00
P31	SURGUT-1	14827000	Novosibirskaya	56.06	78.72
P32	VERKH-TARSKOYE FIELD	55114	Novosibirskaya	55.22	80.14
P33	YURGINSKAYA	262340	Kemerovskaya	55.69	84.64
P34	BIYSK-1	3778294	Biysk	52.57	85.25
P35	KRASNOYARSK-1	1948200	Krasnoyarskiy Kray	56.01	92.79
P36	KRASNOYARSK-2	1194700	Krasnoyarskiy Kray	56.01	92.79
P37	SHAPINSKOE GAS PLANT	96652	Krasnoyarskiy Kray	55.72	93.76
P38	KRASNOYARSK-2 SDPP	3519000	Krasnoyarskiy Kray	56.11	94.59
P39	IRKUTSK-16	106755	Irkutsk	56.57	104.12
P40	LUKIANOVKA	3067	Amurskaya	50.83	128.20
P41	MUKHEN	24148	Khabarovsk Krai	48.10	136.10
P42	KHABAROVSK-1	1035700	Khabarovsk Krai	50.23	136.90
P43	AMUR-1	1029500	Khabarovsk Krai	50.23	136.90
P44	KOMSOMOLSK-2	1321400	Khabarovsk Krai	50.55	137.02
P45	KOMSOMOLSK-3	1359900	Khabarovsk Krai	50.55	137.02
P46	MAYSKIY	390060	Khabarovsk Krai	49.00	140.21
P47	INDIGIRSKA	14291	Sakha	64.57	143.20
P48	ALEKO-KYUEL	95	Sakha	68.70	151.90
P49	ARKAGALA	1190100	Magadanskaya	63.05	147.19