QOS 2021

October 3 (Sunday) - 9 (Saturday), 2021

Online Meeting

QUADRENNIAL OZONE SYMPOSIUM

[C-158] Surface ozone concentration over Russian territory in 2020-2021

E.V.Stepanov[1], V.V.Andreev[2], M.Yu.Arshinov[3], B.D.Belan[3], S.B.Belan[3], Chelibanov[4], V.P. Chelibanov[4], D.K. Davydov[3], N.F. Elansky[5], G.A. Ivlev[3], A.V. Kozlov[3], S.N. Kotel'nikov[1], I.N. Kuznetsova[6], V.A. Lapchenko[7], E.A. Lezina[8], O.V. Postylyakov[5], D.E. Savkin[3], I.A. Senik[3], G.N. Tolmachev[3], A.V. Fofonov[3], I.V. K.A. Shukurov[5]

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Goals of the study

Comparative analysis of 2020 series of surface ozone variations over Russian territory

Comparison of different integral characteristics of ozone variations used for data analysis

Identification of specificity caused by the difference in the regime of production and degradation of surface ozone in the regions

Comparison of local daily production and background in the regions

Comparison of surface ozone concentrations observed in Russia with European levels

Comparative analysis of seasonal daily variations in 2020 and 2021

Surface ozone concentration over Russian territory in 2020-2021

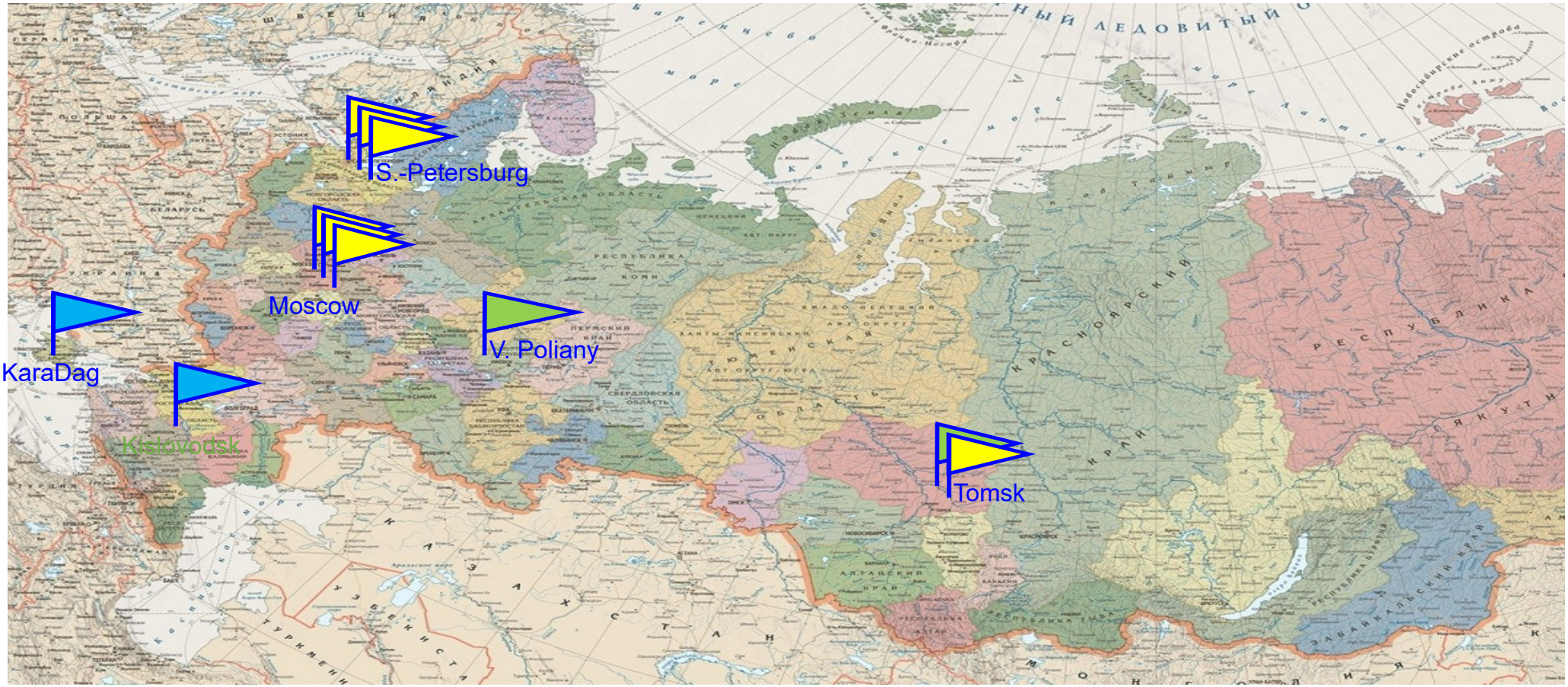
Stations where surface ozone concentration was measured

Station	Region	Type	Latitude	Longitude	Altitude above sea level, m	O_3 Monitor
OPTEC-PR	Leningrad region	Background	60°42′59″	30°03′24″	40	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
OPTEC-P	St. Petersburg	Urban	59°56′27″	30°15′14″	8	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
OPTEC-N	St. Petersburg	Urban	59°55′23″	30°23′17″	1	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
KaraDag SBEM	Crimean Peninsula	Background	44°55′	35°14′	180	APOA-370 optical gas analyzer (HORIBA, Japan)
RUDN	Moscow	Urban	55°42′37″	37°36′78″	149	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
ACAP “Maryino”	Moscow	Urban	55°39′14″	37°44′58″	135	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
ACAP “Gagarin Square”	Moscow	Urban	55°42′31″	37°34′57″	120	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
KHMSS	Northern Caucasus	High mountain	44°41′31″	43°39′40″	2096	Dasibi 1008-AH network ozone gas analyzer (Environmental corp., US)
Vyatskie Polyany	Kirov Region	Background	56°13′33″	51°03′56″	74	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
Fonovaya observatory	Tomsk Region	Background	56°25′07″	84°04′27″	80	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)
TOR	Tomsk Region	Suburban	56°28′41″	85°03′15″	133	3.02P-A hemiluminescent ozone analyzer (OPTEC, Russia)

Surface ozone concentration over Russian territory in 2020-2021

Location of the surface ozone monitoring stations involved in the study on the map

- megalopolis, urban
- background
- mountain, seaside



Stations of surface ozone monitoring and tools used

Atmospheric monitoring stations commercially produced by OPTEC, Russia

- Chemiluminescent ozone analyzer 3.02P-A
- Meteorological complexes based on weather station
-Monitors of surface concentration of NO, NO2, SO2, CO, PM10, PM2.5 and PM1.0

All measuring tools at the stations are certified and annually verified

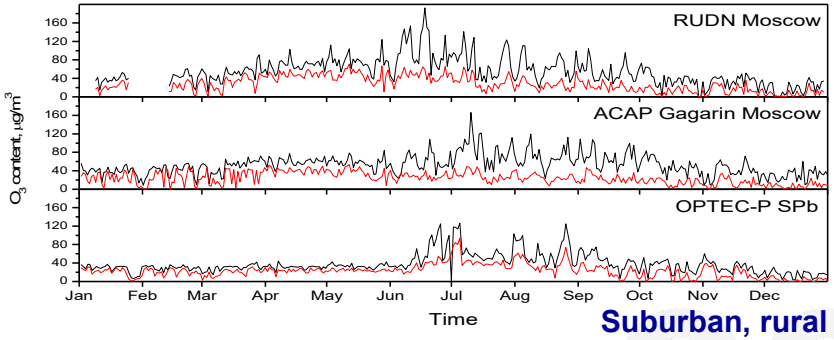
The OPTEC station of air quality monitoring in the RUDN University, Moscow

Surface ozone concentration over Russian territory in 2020-2021

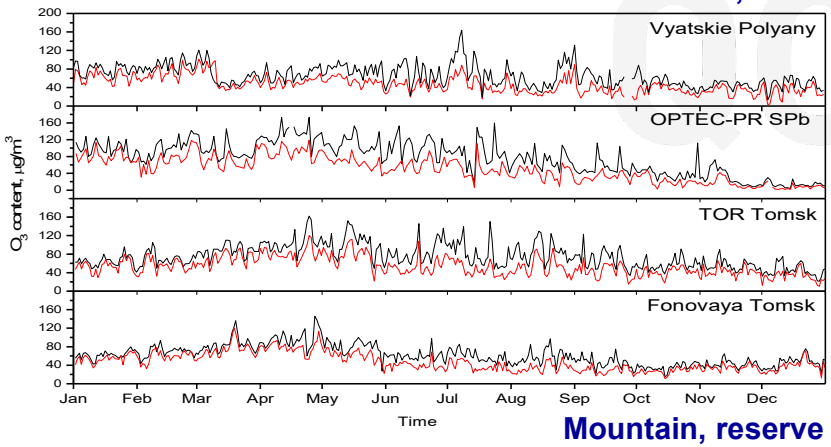
QUADRENNIAL OZONE SYMPOSIUM

Used data

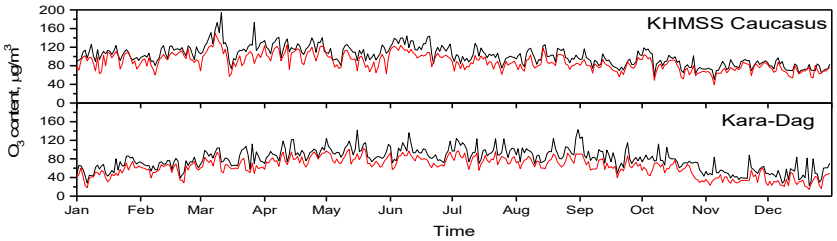
Megalopolis



Suburban, rural

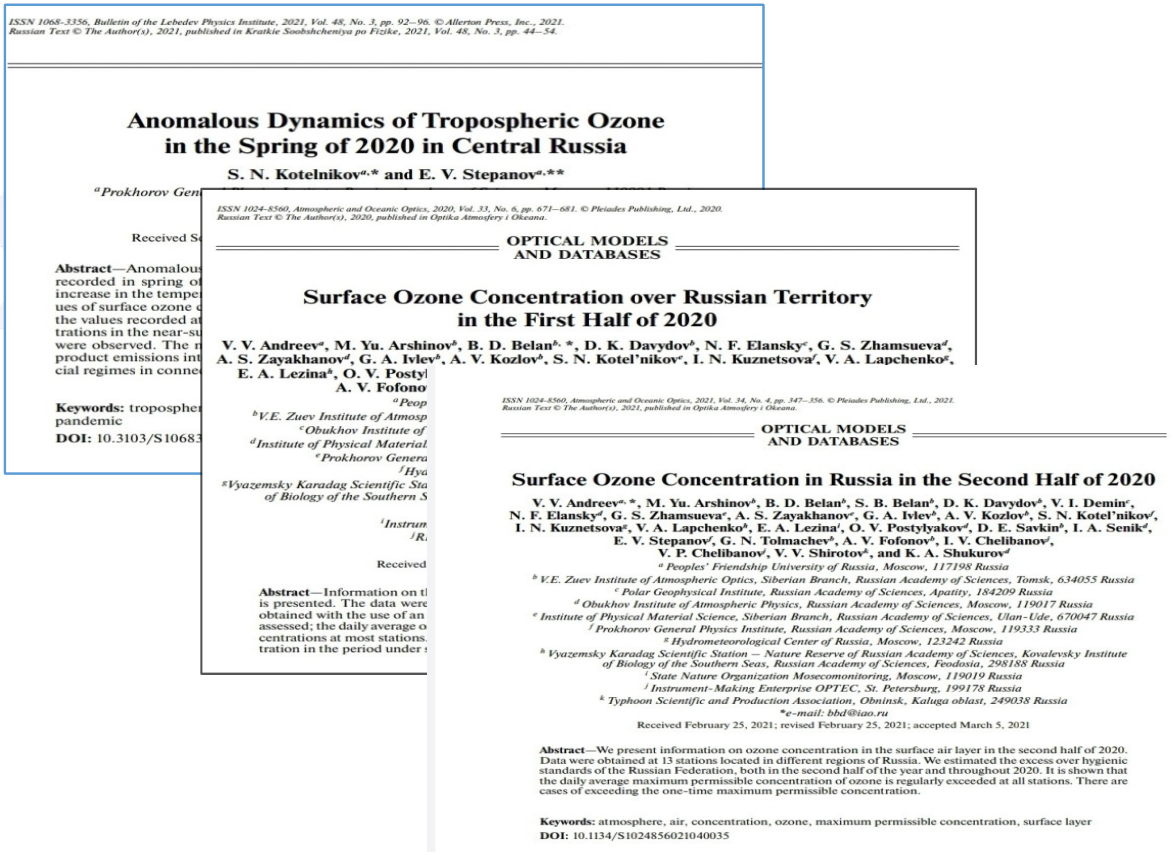


Mountain, reserve



9 surface ozone monitoring stations over Russian territory

2020 series of daily average (red curve) and 1-hour daily maximum (black curve) of surface ozone concentrations



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Anomalous Dynamics of Tropospheric Ozone in the Spring of 2020 in Central Russia

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OPTICAL MODELS AND DATABASES

Surface Ozone Concentration over Russian Territory in the First Half of 2020

V. V. Andreev[a], M. Yu. Arshinov[b], B. D. Belan[b, *], D. K. Davydov[b], N. F. Elansky[c], G. S. Zhamsueva[d], A. S. Zayakhanov[d], G. A. Ivlev[b], A. V. Kozlov[b], S. N. Kotel'nikov[e], I. N. Kuznetsova[f], V. A. Lapchenko[g], E. A. Lezina[h], O. V. Postyl
A. V. Fofono

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OPTICAL MODELS AND DATABASES

Surface Ozone Concentration in Russia in the Second Half of 2020

V. V. Andreev[a, *], M. Yu. Arshinov[b], B. D. Belan[b], S. B. Belan[b], D. K. Davydov[b], V. I. Demin[c], N. F. Elansky[d], G. S. Zhamsueva[e], A. S. Zayakhanov[e], G. A. Ivlev[b], A. V. Kozlov[b], S. N. Kotel'nikov[f], I. N. Kuznetsova[g], V. A. Lapchenko[h], E. A. Lezina[i], O. V. Postylyakov[e], D. E. Savkin[h], I. A. Senik[d], E. V. Stepanov[f], G. N. Tolmachev[b], A. V. Fofonov[b], I. V. Chelibanov[f], V. P. Chelibanov[f], V. V. Shirotov[k], and K. A. Shukurov[d]

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Abstract—We present information on ozone concentration in the surface air layer in the second half of 2020. Data were obtained at 13 stations located in different regions of Russia. We estimated the excess over hygienic standards of the Russian Federation, both in the second half of the year and throughout 2020. It is shown that the daily average maximum permissible concentration of ozone is regularly exceeded at all stations. There are cases of exceeding the one-time maximum permissible concentration.

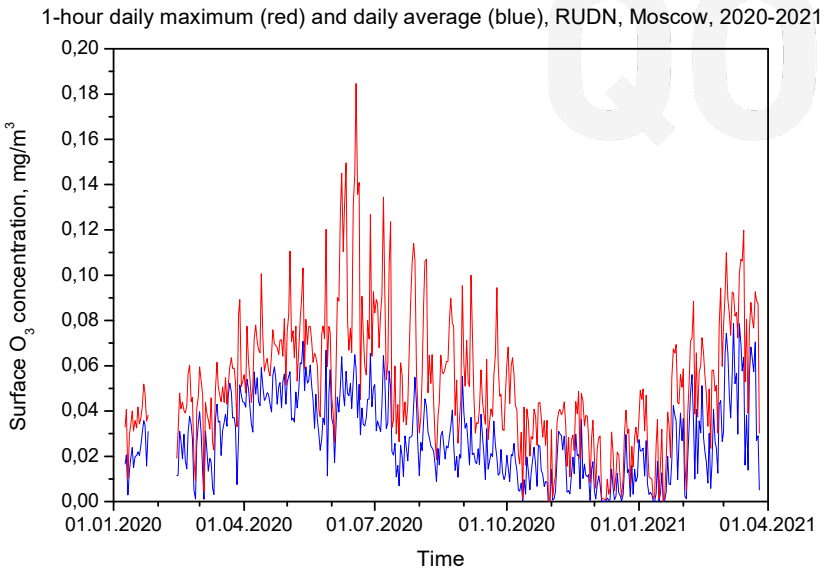
Keywords: atmosphere, air, concentration, ozone, maximum permissible concentration, surface layer

DOI: 10.1134/S1024856021040035

Surface ozone data available for the analysis

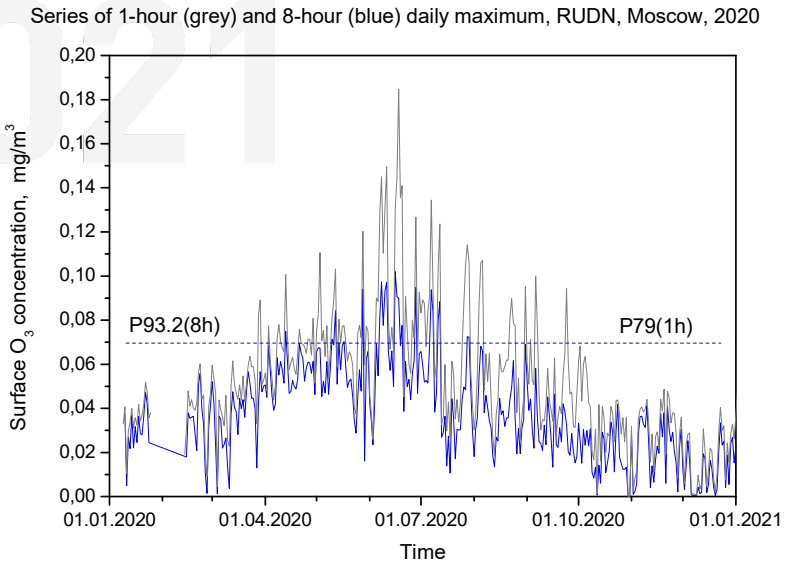
For every station:
Series of daily average
Series of 1-h daily maximum

For several stations:
2020Y and 2021Y series of 1-h data



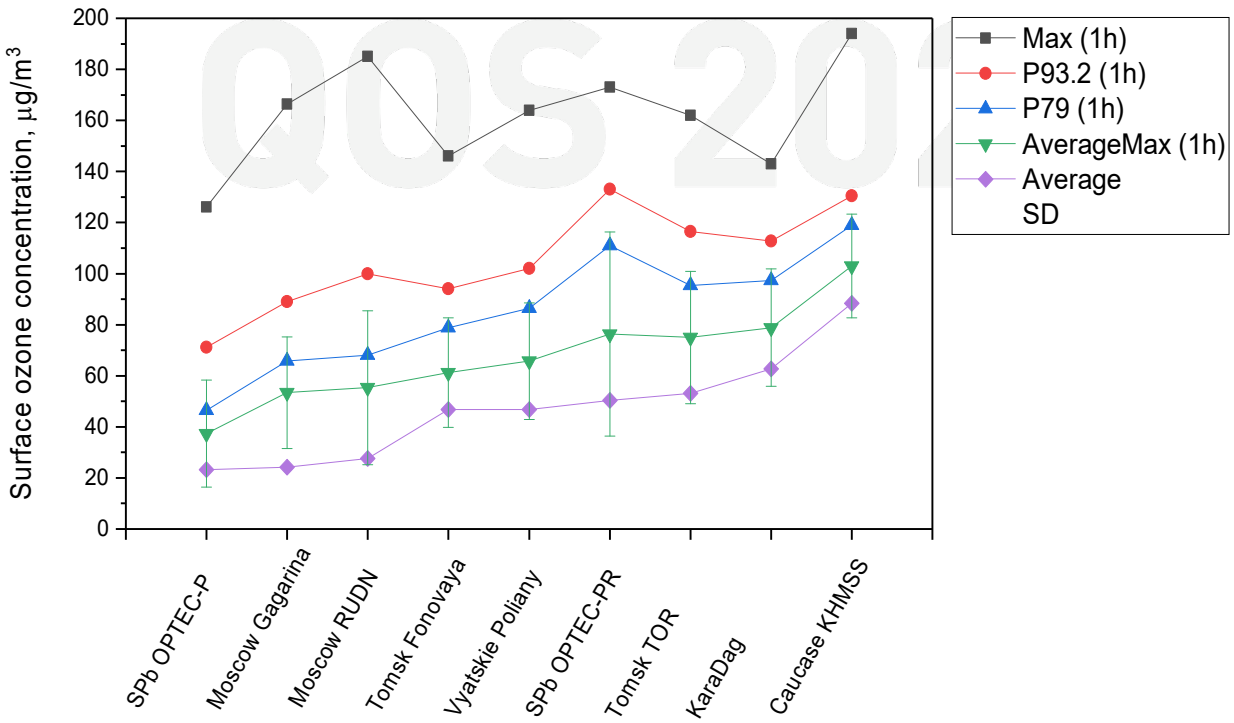
Comparison and analysis of 1-hour and 8-hour daily maximum series

The 8-hour daily maximum percentile P93.2 is close to the percentile P79 of 1-hour daily maximum



Comparison of some integral parameters of 2020 year series of surface ozone concentration for different RF stations

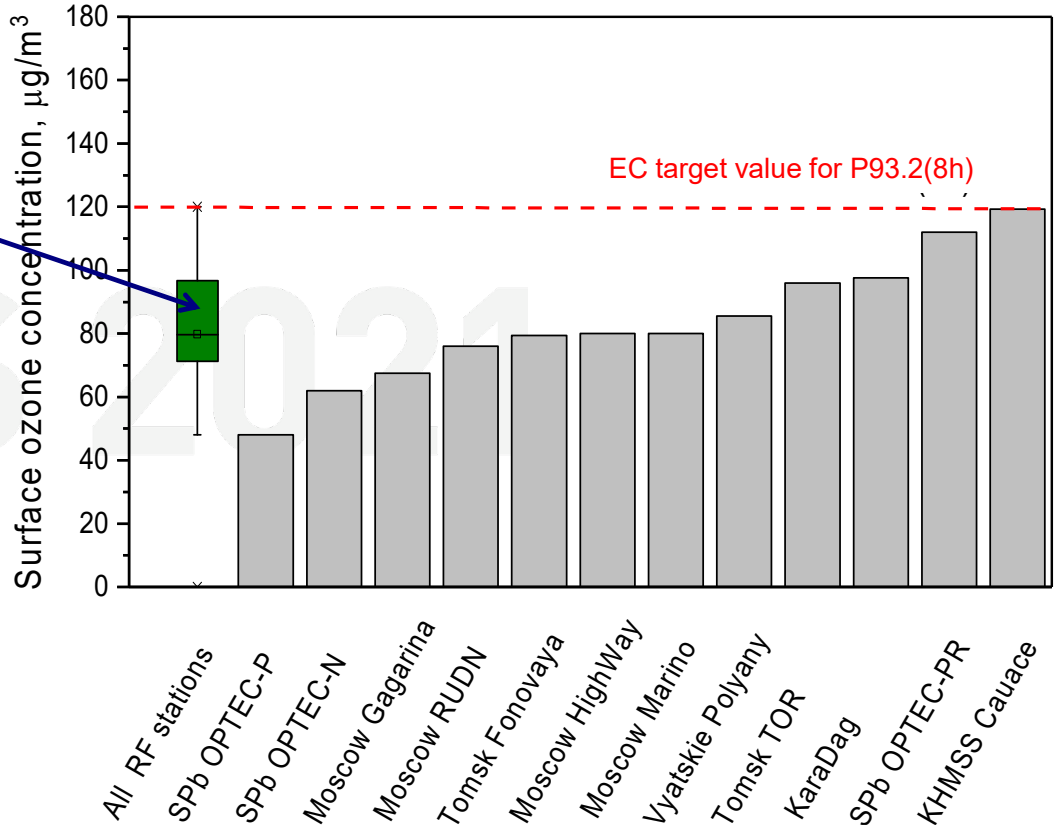
- Maximum of hourly average surface ozone concentration in 2020-year series
- Percentile P93.2 of daily maximum of hourly average in 2020 data series
- Percentile P79 of daily maximum of hourly average in 2020 data series (close to the EC P93.2 for 8-hour average)
- Average of 1-hour daily maximum over 2020 series
- Average of 1-hour data in 2020 series



Surface ozone concentration over Russian territory in 2020-2021

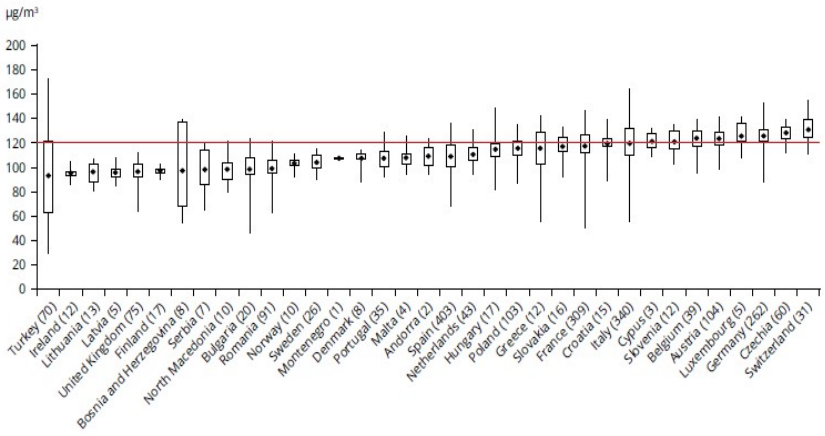
Percentile P80(1h) of hourly average daily maximum in 2020 data series for surface ozone stations in RF (P80(1h)~P93.2(8h))

The median, box and whiskers for all RF sites included in the study in 2020 year



P93.2(8h) for EC countries in 2018

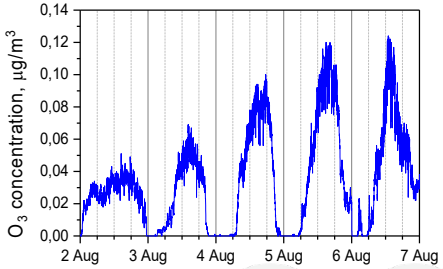
Figure 5.1 O_3 concentrations in relation to the target value in 2018 and number of stations considered for each country



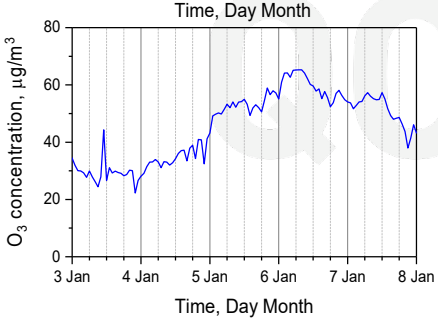
The overall situation with surface ozone in Russian Federation was better in 2020 year than in any European country in 2018 !

The dependence of averaged daily data on the regime of production and destruction of surface ozone

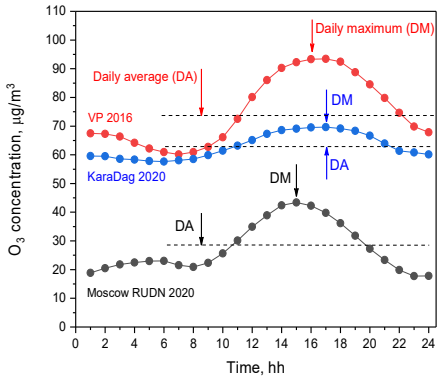
Real time variations of surface ozone content at different regime of ozone cycle



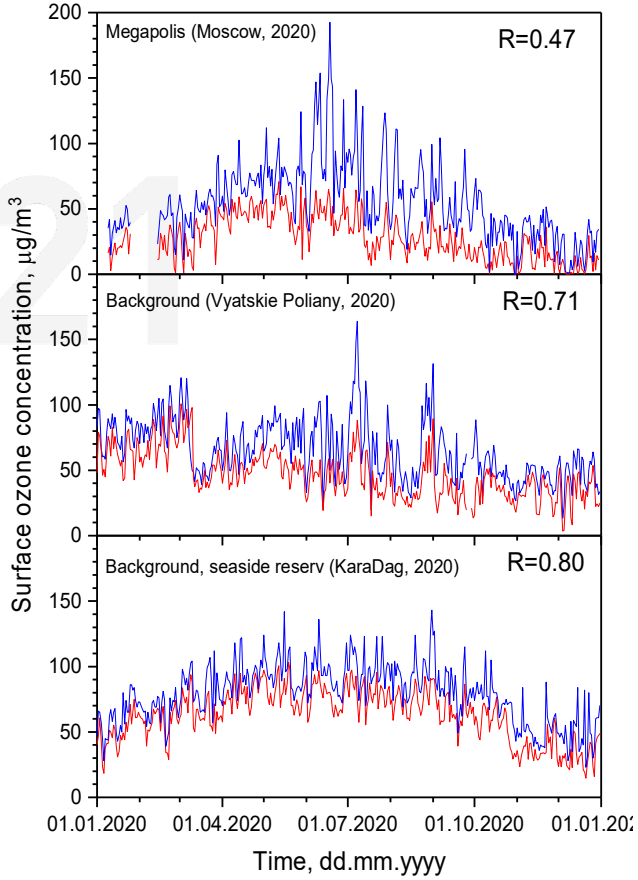
Regime "Megalopolis" Summer time



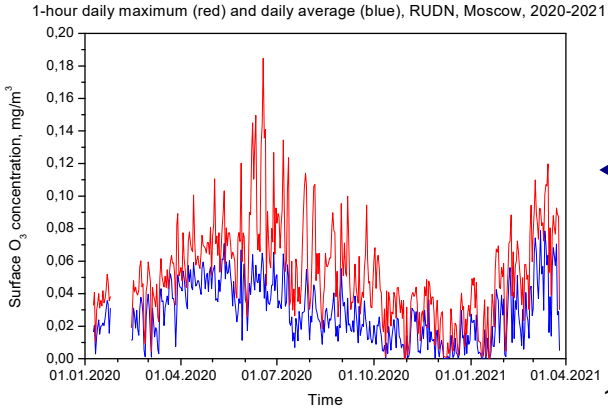
Regime "Background, reserve" Winter time



Surface ozone daily average (red) and daily 1-hour maximum (blue) for three different regime of ozone cycle



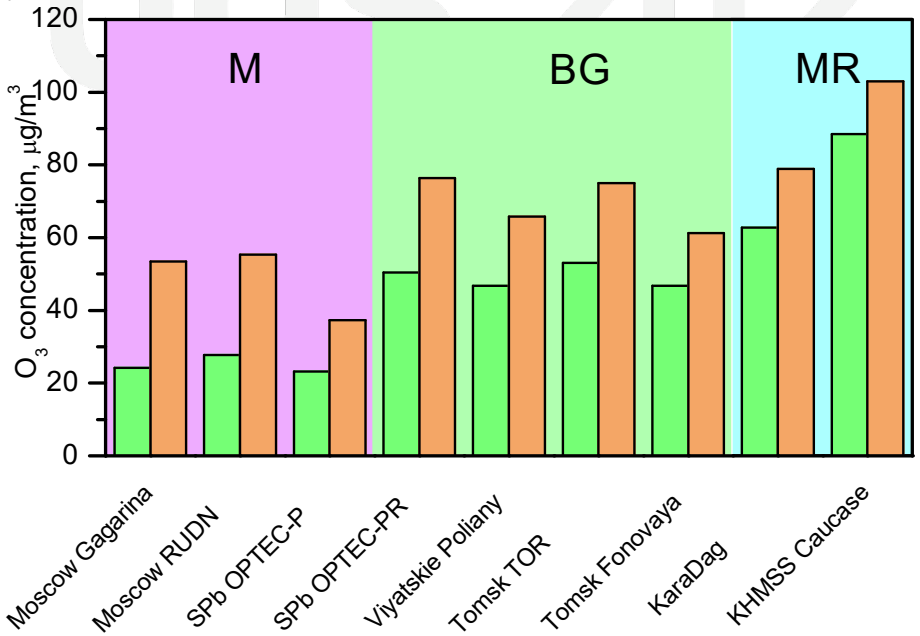
The ratio of 1-hour daily maximum (DM) to daily average (DA) averaged for the whole year reflects the specificity of surface ozone production and destruction at the site



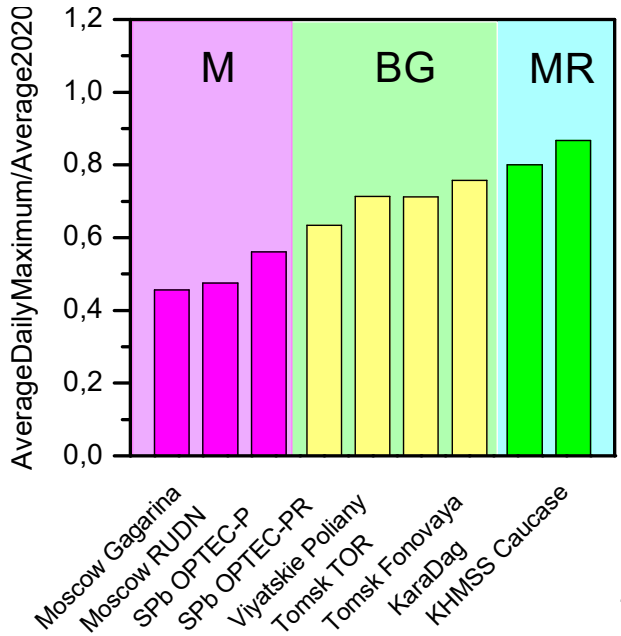
Variations of 1-hour daily maximum (DM) and daily average (DA) during the whole year

M – megalopolis
BR - background and rural
MR – mountain and reserve

1-hour daily maximum (red) and daily average (green) averaged over the whole year for different sites

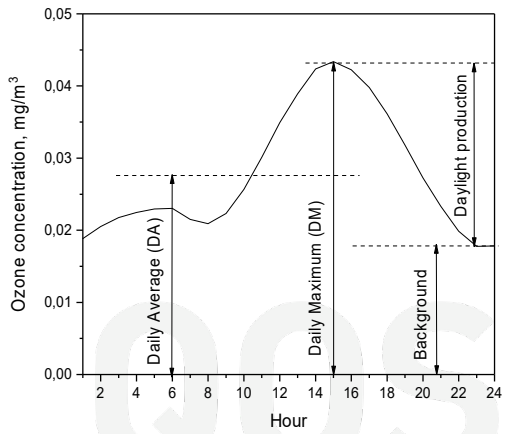


Ratio of DA to DM for different sites

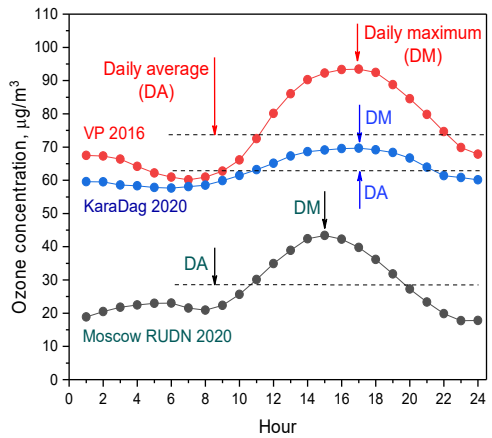


Calculation of Daily Production and Background from one year averaged Daily Average and Daily Maximum values (with an accuracy better than 10%)

Parameters of the ozone diurnal cycle

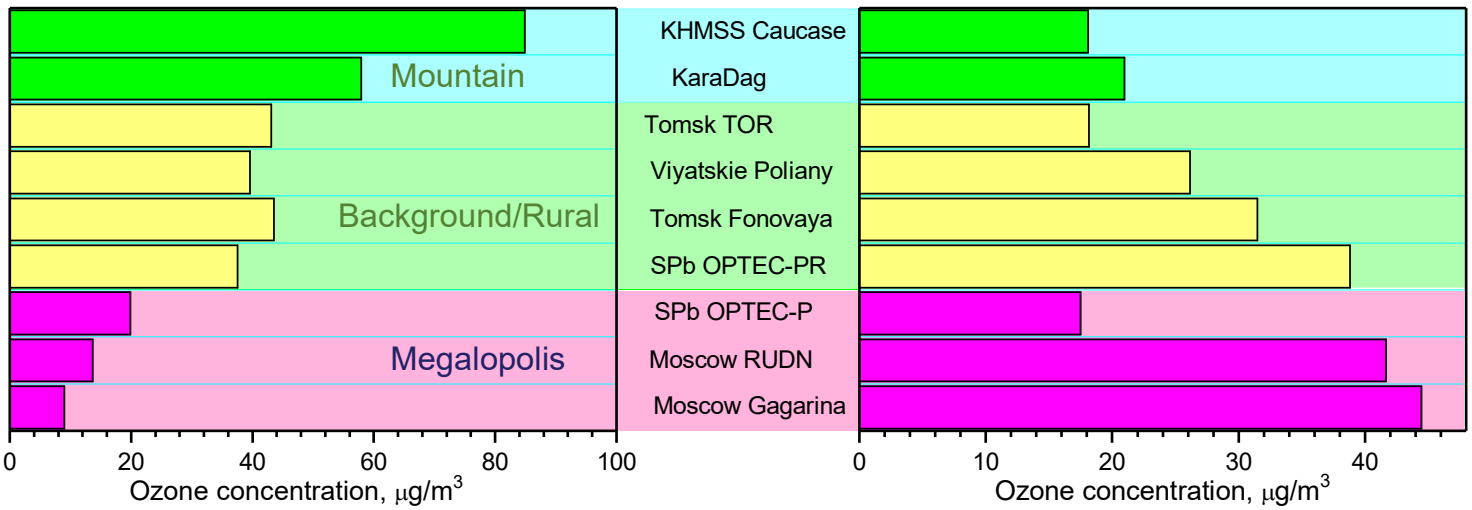


Parameters of one year averaged diurnal cycle for different ozone production regimes and sites



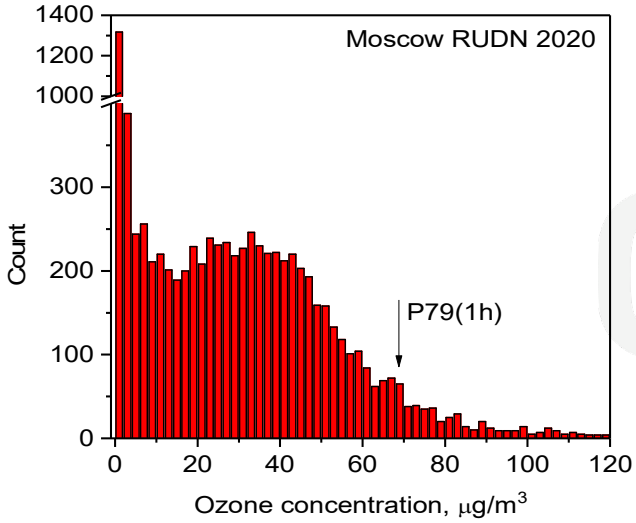
Surface ozone background for different regions

Daylight ozone production for different regions

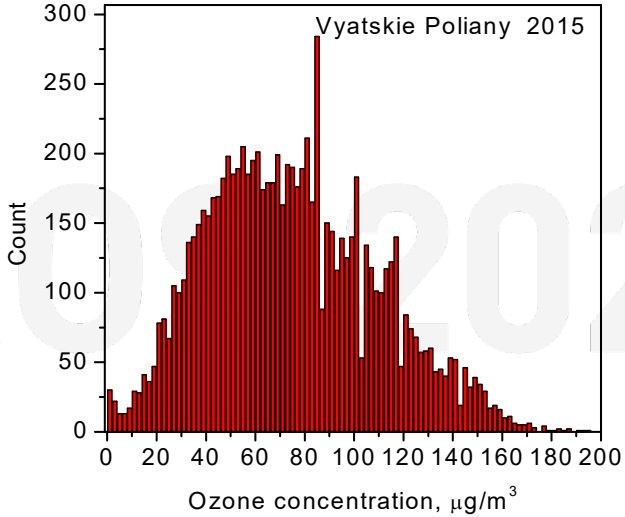


Statistical distribution of surface ozone concentration for regions with different ozone cycle regimes

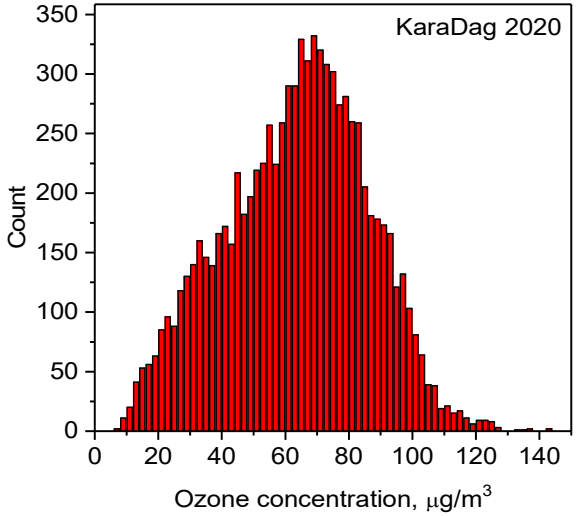
Megapolis



Rural and background



Seaside reserve



Seasonal evolution of surface ozone concentration at different RF site in 2020 and 2021 year

- **Significant growth in Moscow during summer 2021 due to strong heat waves and blocking anticyclone.**
- **Moderate difference between 2020 and 2021 at rural and background sites including S.Petersburg.**
- **Practically no difference between 2020 and 2021 and high background level for seaside reserve station in KaraDag.**
- **Moderate decrease in 2021 in Siberia region (Tomsk)**