International scientific co-operation in atmospheric researches

Oksana Tarasova
Moscow State University, Moscow, Russia &
Max-Planck Institute for Chemistry, Mainz, Germany

Involvement of Russian (MSU) groups in the international projects

- Since 1996 – TROICA project (***TRanscontinental Observations Into the Chemistry of the Atmosphere)***
- 1999-2002 EUROTRAC TOR-2 (Tropospheric Ozone Research – 2 subproject)
- 2002-2004 INTAS "Spatial and temporal variations of tropospheric ozone and precursors over Russia"
- 2004-2008 ACCENT project (Atmospheric Composition Change – the European Network of Excellence), ***T&TP subproject*** **(Transport and Transformation of Pollutants)**
- 2005 - 2008 SCOPE (Scientific Co-operation with Eastern Europe) research project "Variability and long-term trends of tropospheric ozone: Comparison and interpretation of measurements of Caucasian and Central European mountain sites using a Lagrangian approach"

Other ongoing activities

•GEOMON

•Cooperation projects in the framework of FP7

TROICA project

Coordinator: Elanksy N. F. *Obukhov Institute of Atmospheric Physics of RAS, Russia*

www.troica.ru

Project participants:

- **A.M. Obukhov Institute of Atmospheric Physics RAS (Russia)**
- **Max Planck Institute of Chemistry (Germany)**
- **Russian Research Institute of Railway Transport (Russia)**
- **L.Y. Karpov Institute of Physical Chemistry (Russia)**
- **Finish Meteorological Institute (Finland)**
- **Helsinki University (Finland)**
- **Climate Monitoring and Diagnostics Laboratory NOAA (USA)**

What is TROICA?

An international project addressed to study the troposphere composition across Russia- *TRanscontinental Observations Into the Chemistry of the Atmosphere (TROICA) project*

The main goals:

- **Observations of atmospheric chemical composition over continent**
- **Estimation of natural and anthropogenic emissions of atmospheric constituents**
- **Investigations of air quality in different cities and industrial regions**
- **Detection of extreme ecological situations**
- **Validation of models and satellite products**

Advantages of the train platforms

-Measurements are performed in the boundary layer

-Huge spatial coverage with reasonable expenses

Disadvantage

- Results present a complex mixture of the spatial and temporal variability

Measurements

Trace gases (continuous): O_3, NO, NO_2, CO, CO_2, SO_2, CH4, NMHC, NH_3, ^{222}Rn

Aerosols: size distribution (2 nm-10 mkm), scattering coefficient, mass concentrations; black carbon

Remote sensing: CO (total content) ,
O_3 (total content and vertical profiles,
NO_2 (total content , vertical profiles (0-45 km), slant abundance at 9 angles from each side)

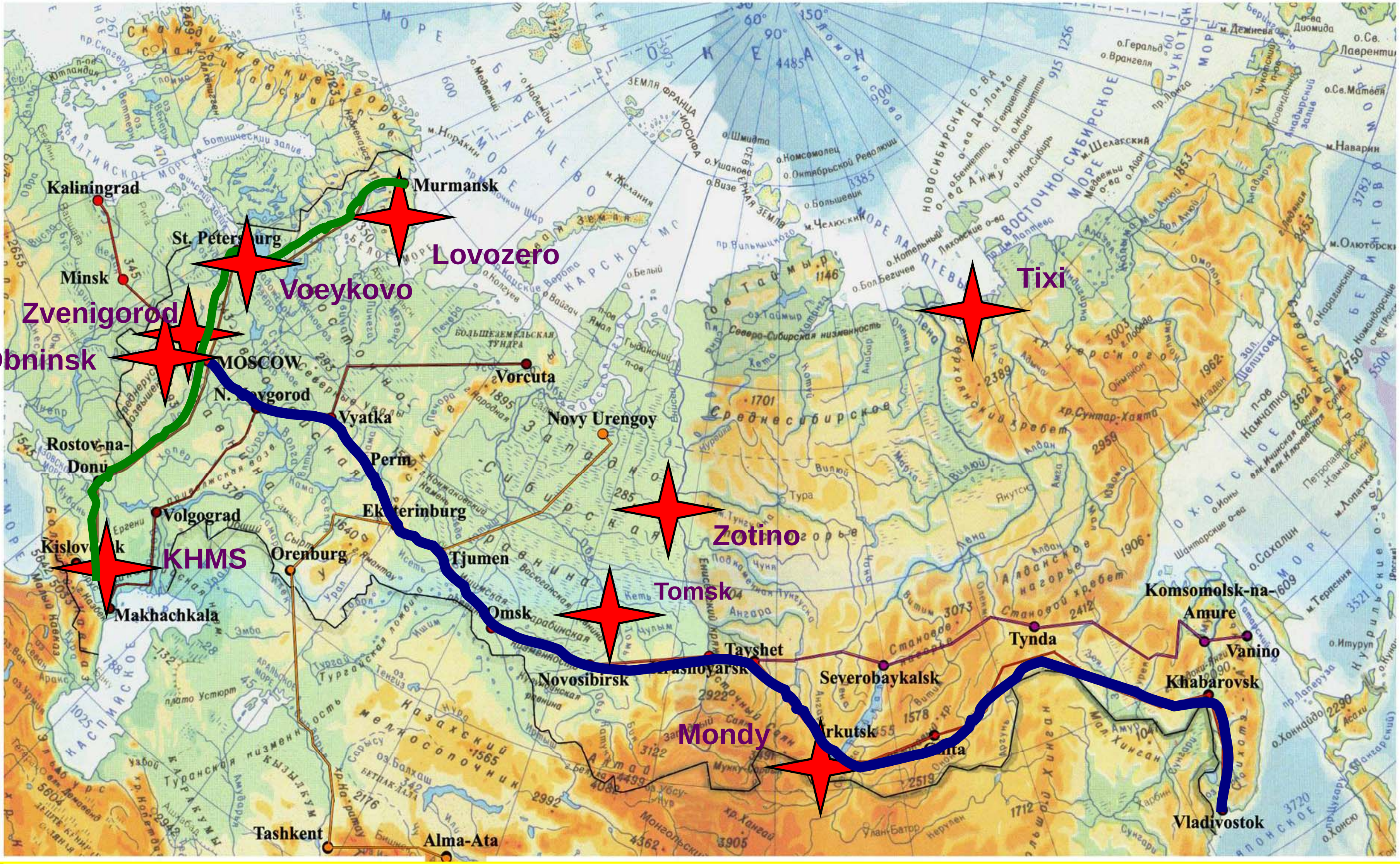
Solar radiation: integral, UV-A, UV-B, J(NO_2)

Meteorology: pressure, temperature, humidity, wind (speed and direction), temperature profile (0-600 m)

Sampling: green-house gases and VOC; chemical, elements and morphological composition of aerosol, isotope composition of CO,CO2,CH4(^{13}C,^{14}C,^{18}O, D),

Others: navigation parameters (GPS), radionuclide, TV pictures of surrounding (both sides), TV pictures of cloudiness, samples of water, soil, vegetation

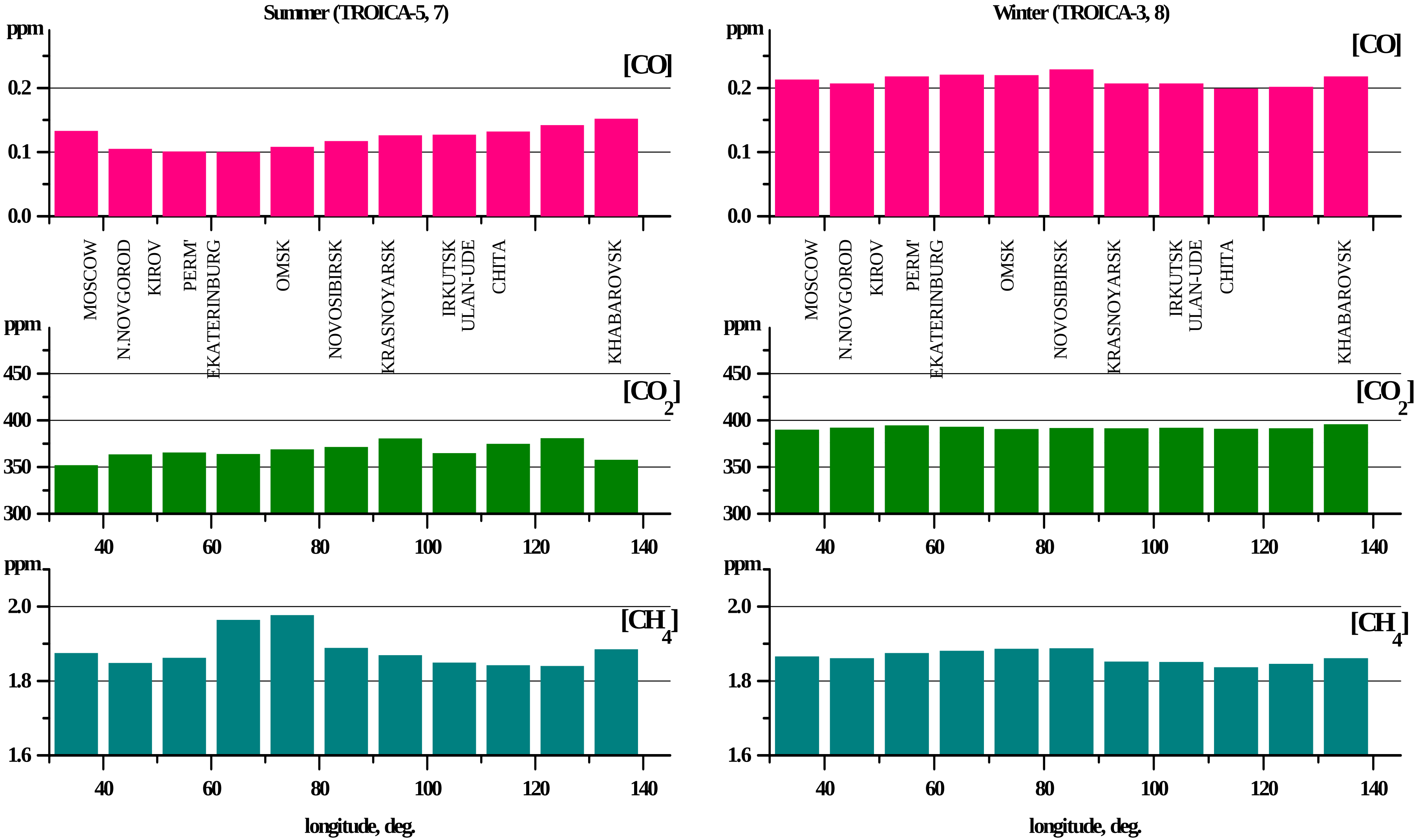
Role of the project in the national system of the environmental monitoring



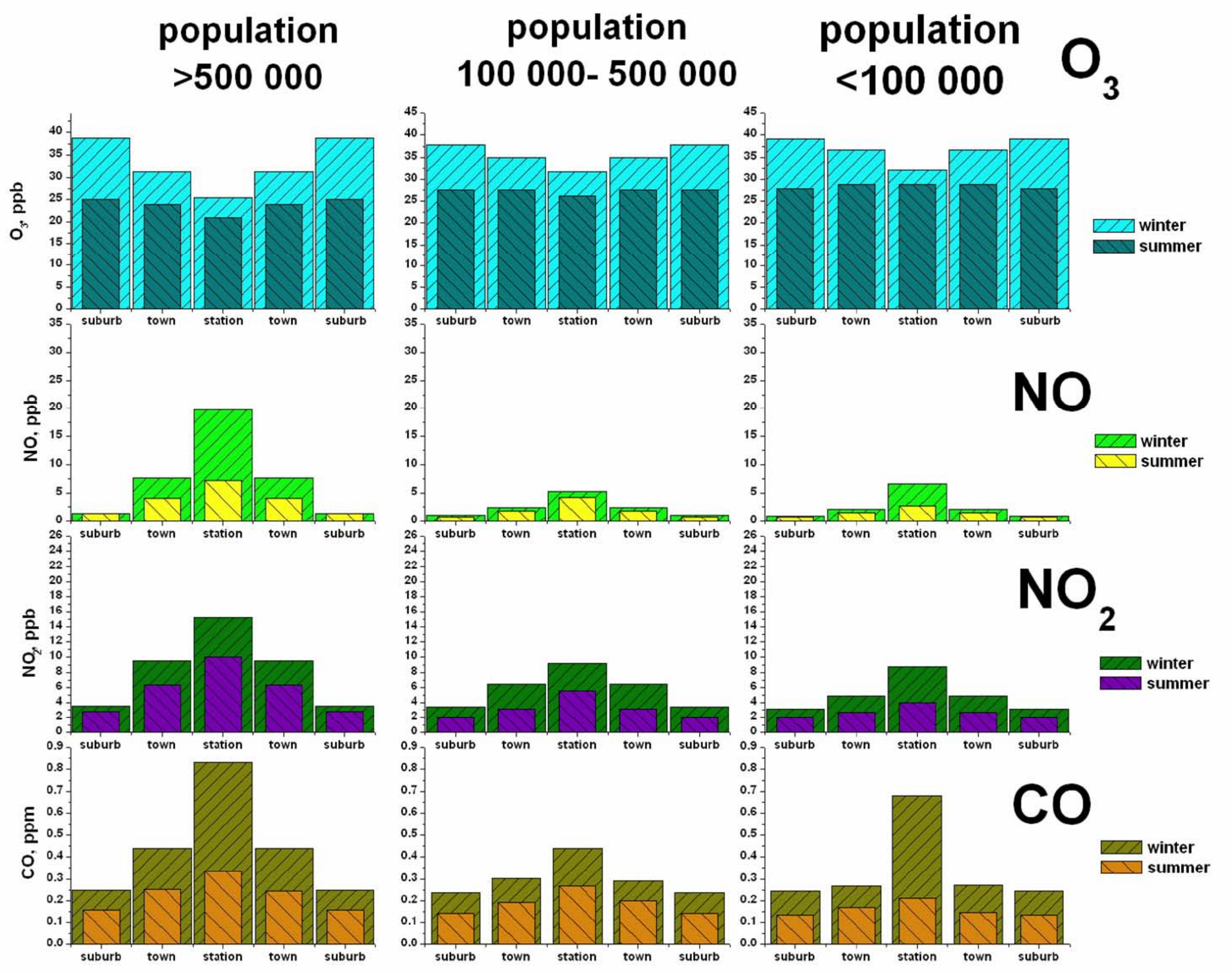
TROICA missions

Experiment	Work period	Route
TROICA-1	1995 Nov 17 – Dec 2	N.Novgorod-Khabarovsk-Moscow
TROICA-2	1996 Jul 26 – Aug 13	N.Novgorod-Vladivostok-Moscow
TROICA-3	1997 Apr 1 – Apr 14	N.Novgorod-Khabarovsk-Moscow
TROICA-4	1998 Feb 17 – Mar 7	N.Novgorod-Khabarovsk-N.Novgorod
TROICA-5	1999 Jun 26 – Jul 13	N.Novgorod-Khabarovsk-Moscow
TROICA-6	2000 Apr 6 – Jun 25	Moscow-Murmansk-Kislovodsk-Murmansk-Moscow
TROICA-7	2001 Jun 27 – Jul 10	Moscow-Khabarovsk-Moscow
TROICA-8	2004 Mar 19 – Apr 1	Moscow-Khabarovsk-Moscow
TROICA-9	2005 Oct 4 – Oct 18	Moscow-Vladivostok-Moscow
TROICA-10	2006 Oct 4 – Oct 7	Moscow megacity
TROICA-11	2007 Jul 22 – Aug 5	Moscow-Vladivostok-Moscow

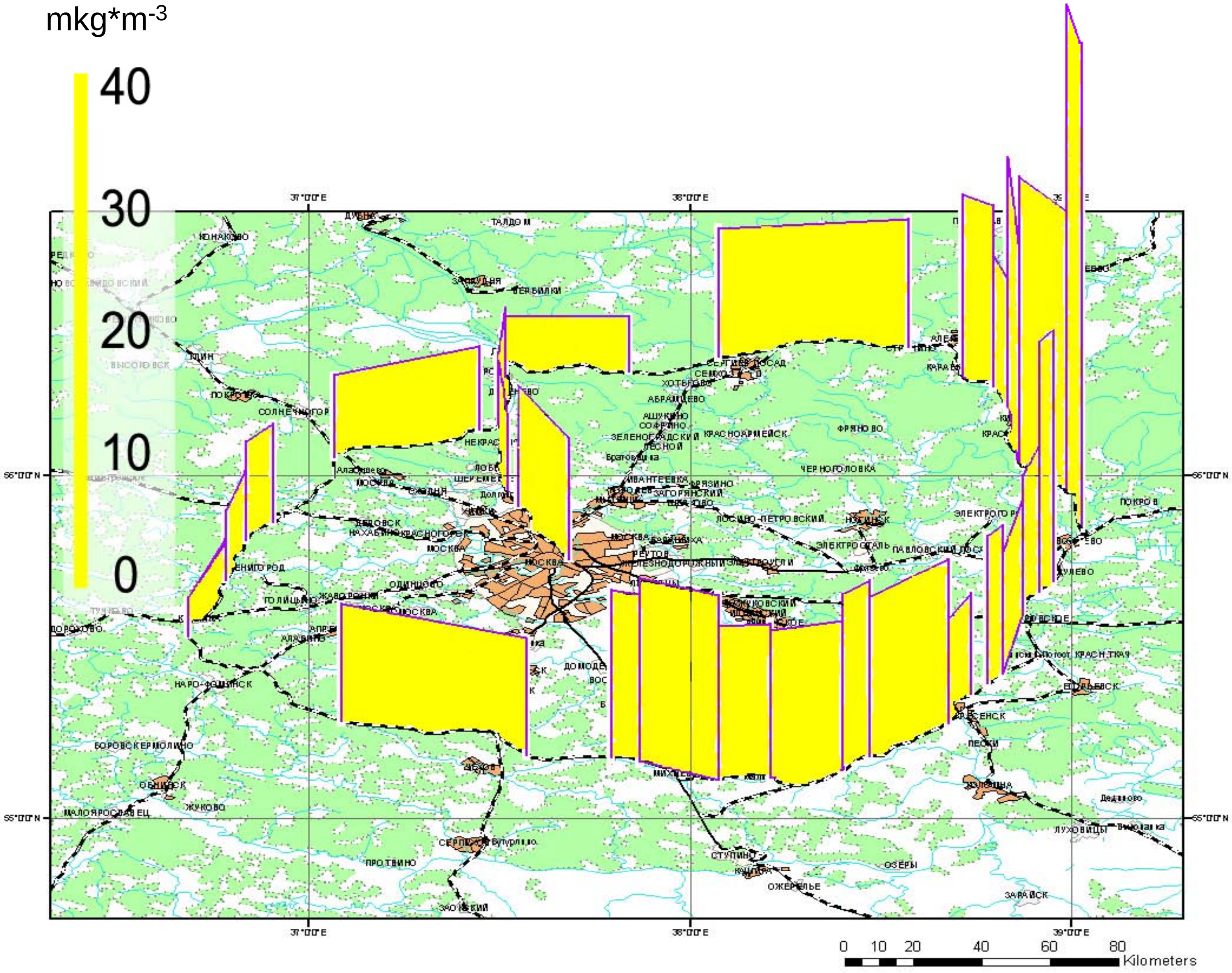
Spatial distribution of CO, CO_2 and CH_4 concentrations between Moscow and Khabarovsk (10 deg. longitude averaging)



Average pollutants' concentration in cities and their suburbs



Total concentration of aromatic hydrocarbons in Moscow region - TROICA-10



Summary

- **The mobile carriage-laboratory is the effective tool for investigation of spatial variations of atmospheric constituents over the continent, their sources and sinks, long-range transport and chemical transformation. It can be a part of GAW/WMO network responsible for observations over vast territories in Eurasia**

- **The mobile laboratory could be used as international laboratory and operate on the territory of European and Asian countries uniting professionals in different fields of research and giving training and ecological education for students and young scientists.**

EUROTRAC Tropospheric Ozone Research (phase 2)

Aims of the TOR-2 subproject is to

Quantify crucial processes in the atmosphere in order to improve the scientific background for the development of effect-based control strategies for photochemical oxidants over Europe.

More specifically the project will focus on the following aims:

•evaluate the long term trends in ozone, oxidants and precursors in relation to the changes in emissions over Europe occurring after 1980 for various parts of Europe;

•estimate the effect of ozone exchange between the atmospheric boundary layer and the free troposphere over Europe during various meteorological conditions;

•isolate and quantify the chemical and physical mechanisms of the spring ozone maximum in terms of the differing spatial and temporal scales in the troposphere.

•improve the understanding of ozone climatology in Eastern Europe.

EUROTRAC Tropospheric Ozone Research (phase 2)

Main conclusions on trends:

- Observations in polluted areas show a substantial decrease in NMVOC and CO (-35/-50%), and NOx(-20/-40%) levels over the last 10-15 years.
- For traffic there is an excellent agreement with emission trends.
- Ozone peak values have been decreasing significantly over the last 10 years, while background ozone and low ozone values in polluted areas have increased.
- There is strong evidence, that the lower percentiles in the ozone values in polluted areas have increased, in particular during winter.

EUROTRAC Tropospheric Ozone Research (phase 2)

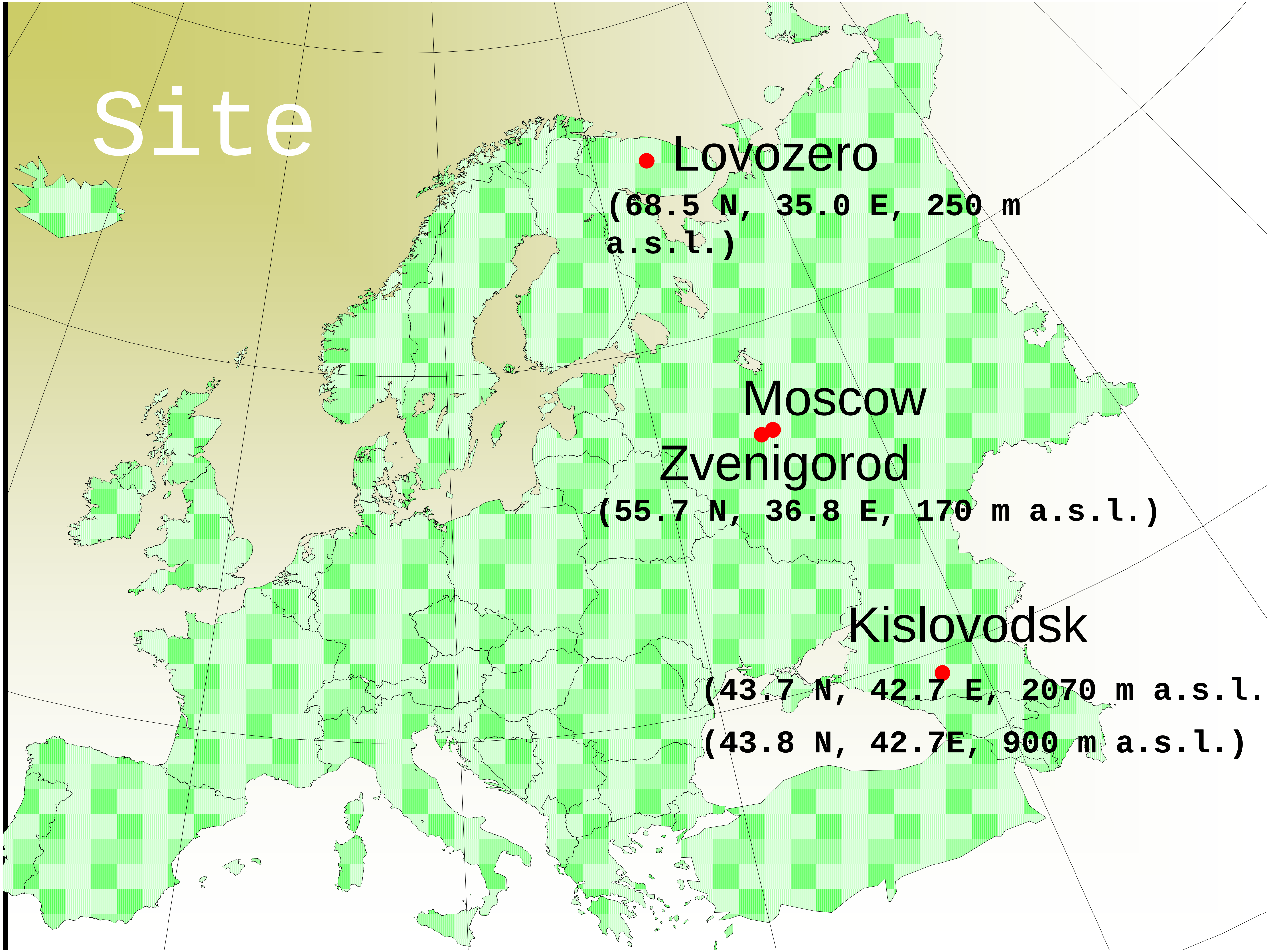
Main conclusions on vertical exchange:

In summary, case studies (observations and modelling) have documented the **variety of processes contributing to vertical uplifting** of boundary layer air into the free troposphere. In particular, **warm conveyor belts** have been shown to be an efficient mechanism for uplifting pollutants into the upper free troposphere and in particular from the North American boundary layer into the European free troposphere. Mountain regions like the Alps **have an additional effect** but primary and secondary pollutants are only raised to the middle troposphere. Also (deep) **convection** may be an important uplifting mechanism but has not been specifically addressed in this subproject.

INTAS "Spatial and temporal variations of tropospheric ozone and precursors over Russia"

- Comparison of the surface ozone regime at several stations of the European Russia
- Modeling of the surface ozone distribution over European Russia

Site



Lovozero
(68.5 N, 35.0 E, 250 m a.s.l.)
Moscow
Zvenigorod
(55.7 N, 36.8 E, 170 m a.s.l.)
Kislovodsk
(43.7 N, 42.7 E, 2070 m a.s.l.
(43.8 N, 42.7E, 900 m a.s.l.)

LOTOS model description

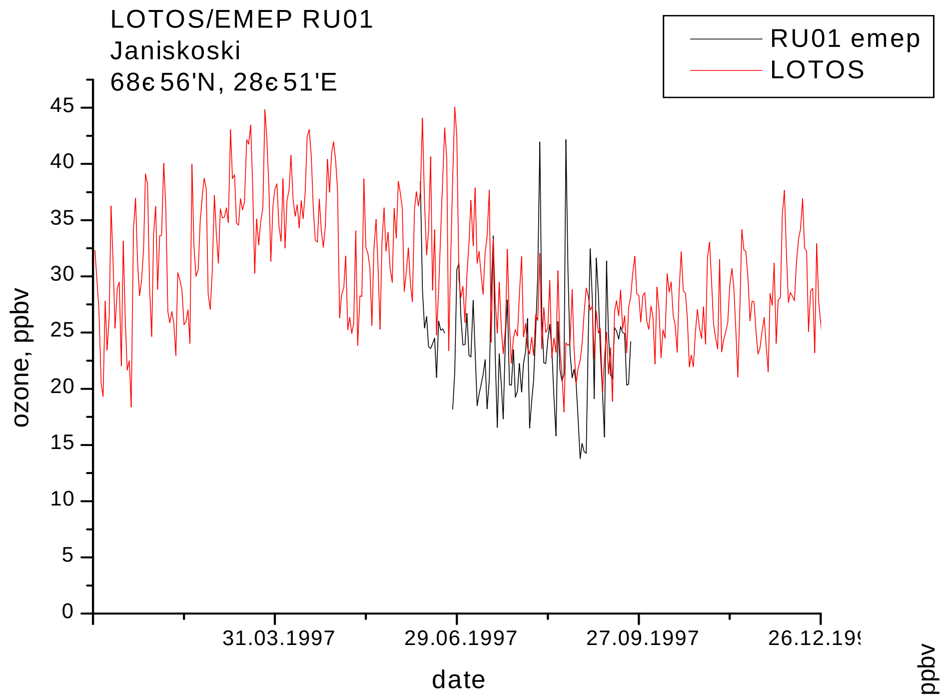
- LOTOS is a three-dimensional Eulerian grid model for Europe provided by TNO (The Netherlands).
- The domain is (10W, 60E); (35N,70N)
- The resolution is at 0.50 longitude x 0.25 latitude, approximately 30x30 km.
- The standard output includes 28 gaseous and aerosol components.
- In the vertical there are three dynamic layers, plus a diagnostic “surface” layer.
- The model extends in vertical direction about 2-3 km above the surface.
- The main prognostic equation in the model is the continuity equation that describes the change in time of a component as a result of the following processes:
  - Transport (advection in 3 dimensions, horizontal and vertical diffusion, entrainment)
  - Chemistry (CBM-IV mechanism)
  - Dry and wet deposition (DEPAC model)
  - Emissions (TNO emissions database)

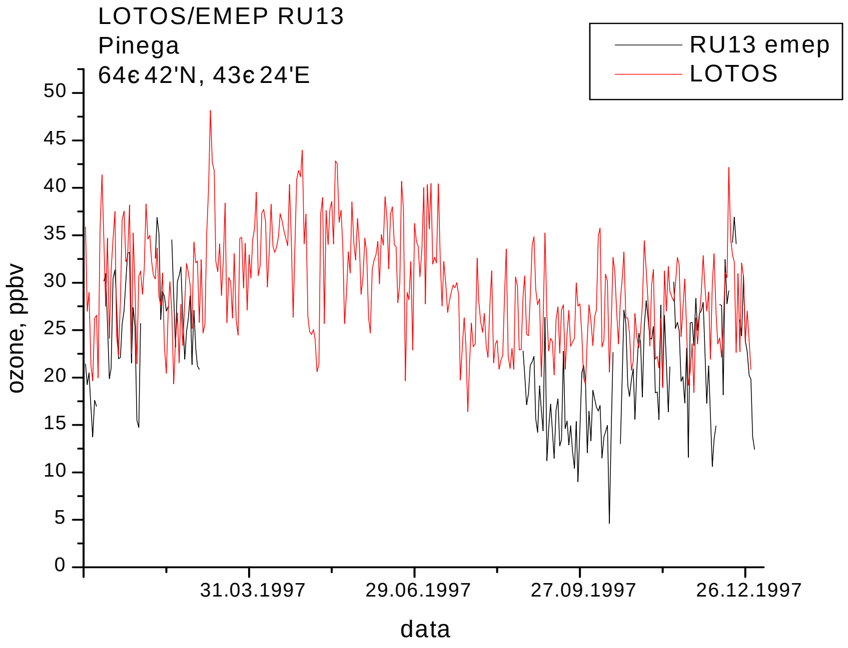
Model validation

- **RUN1** (TROTREP) provides spatial distribution of 17 parameters (including mean and max O_3, NOx) with daily resolution for the domain 10W-60E, 35N-70N**.** Output parameters are presented for the surface layer only.
- **RUN2** was performed for the limited domain 20E-60E, 35N-70N and has 1 hour resolution of output parameters.
- **In both validation runs DEPAC module for deposition velocity calculation was <u>OFF</u> (deposition velocity is fixed).**

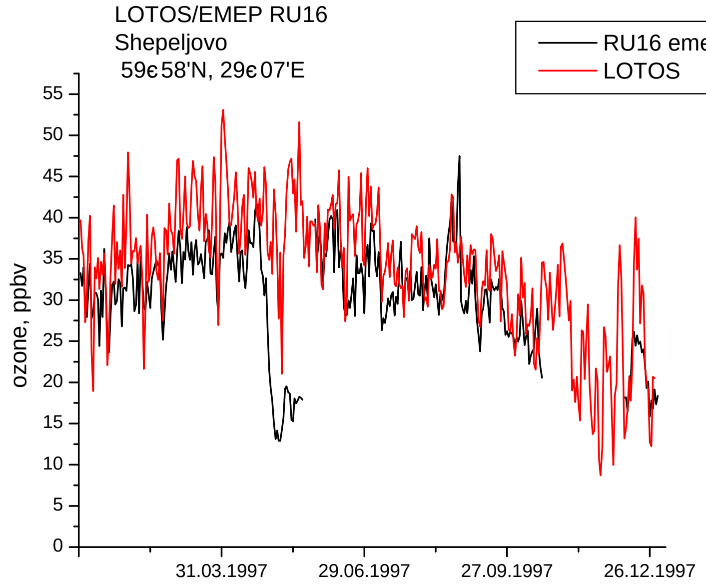
- **COMPARISONS:**
- **LOTOS (run2)/EMEP sites**
- **LOTOS (run2)/TROICA-3 expedition**
- **LOTOS (run2)/Kislovodsk High Mountain Station**

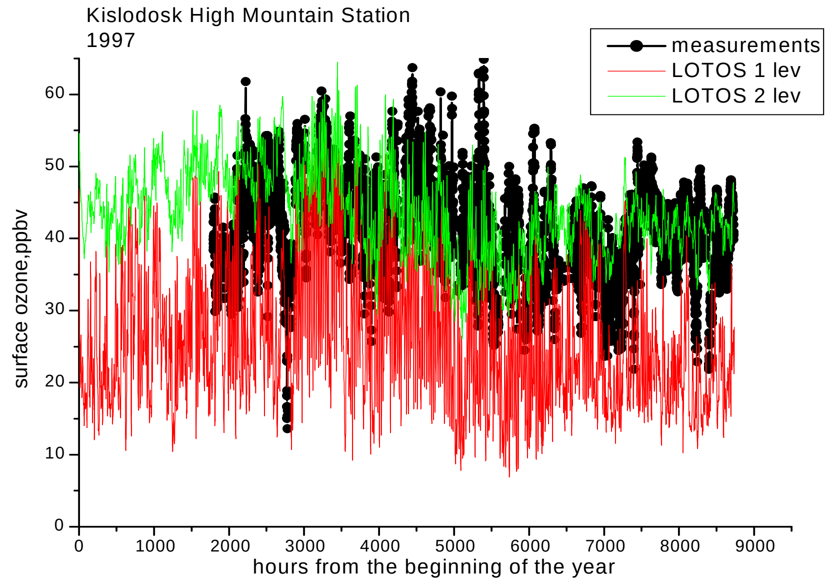
Model validation

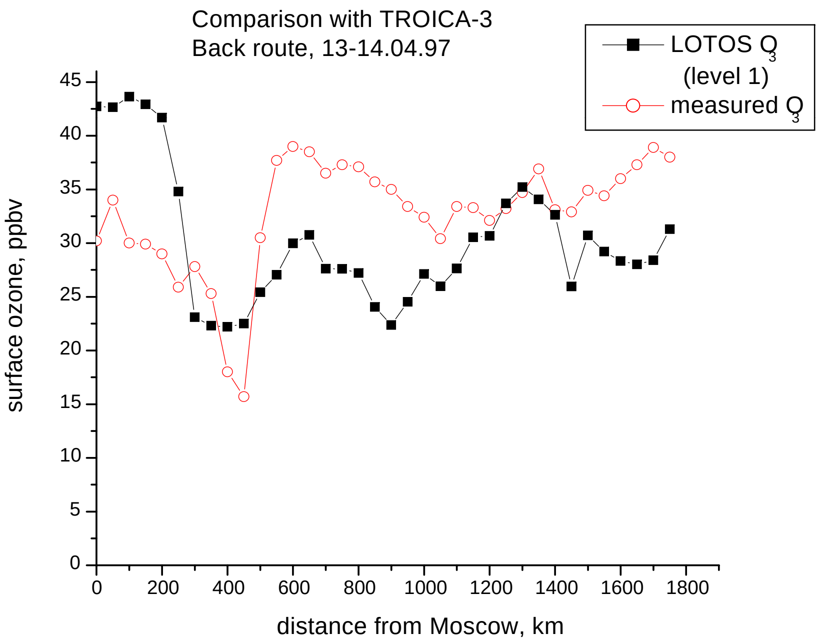


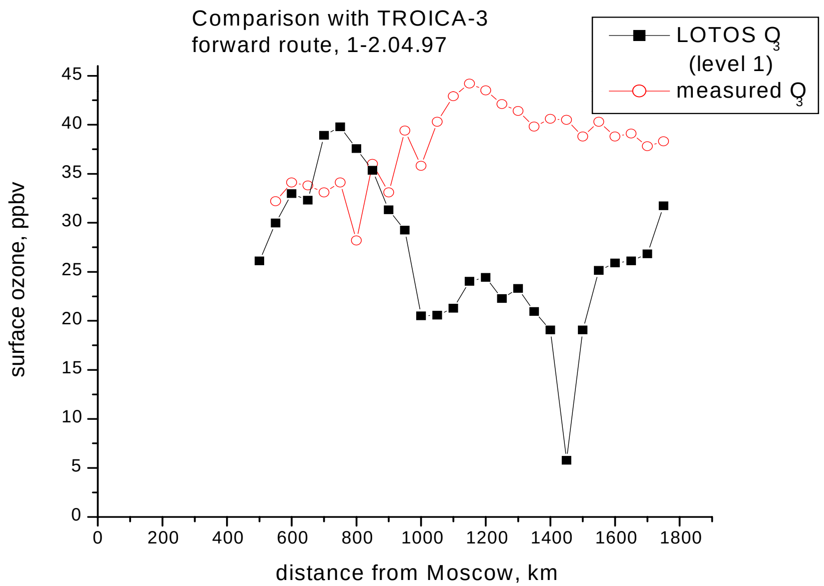


Model validation





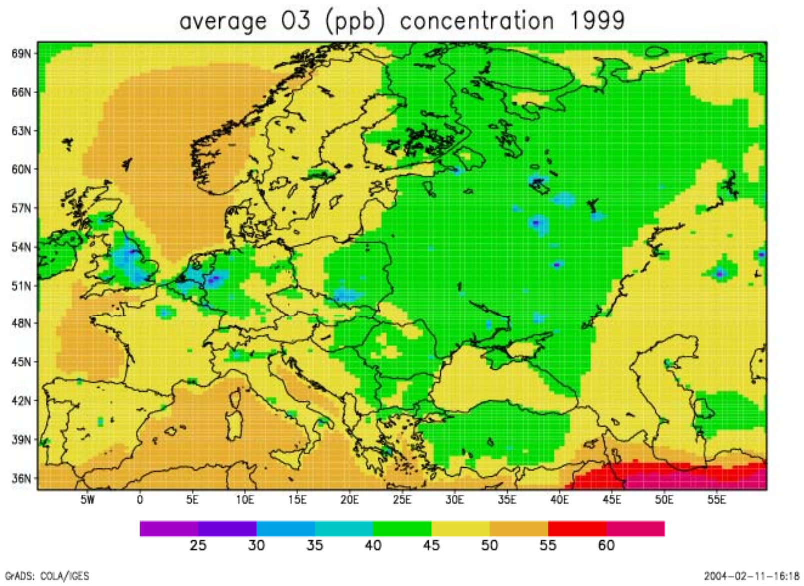


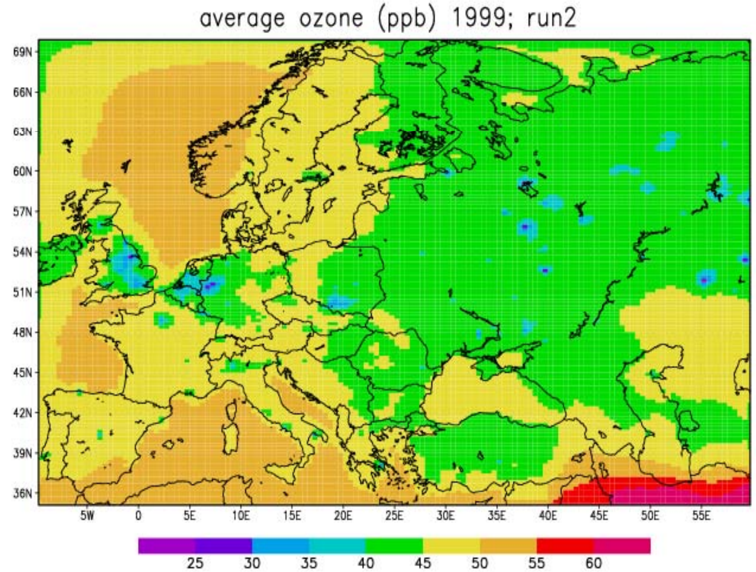


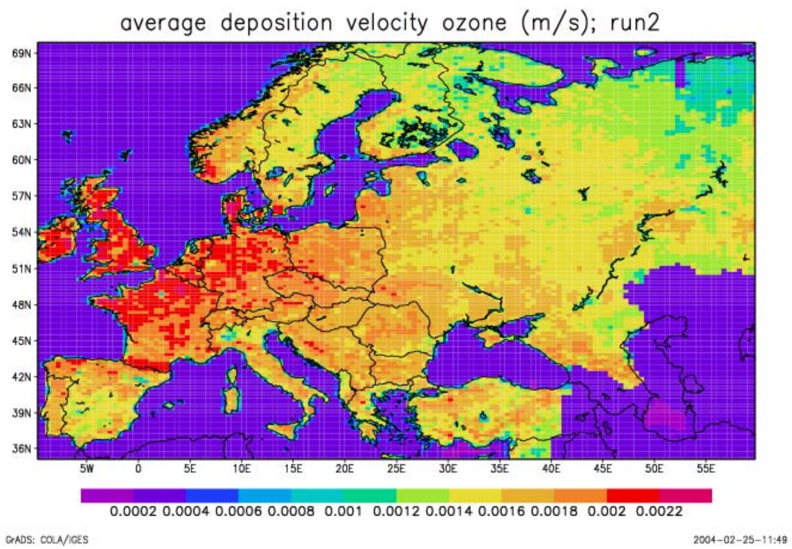
Scenarios description

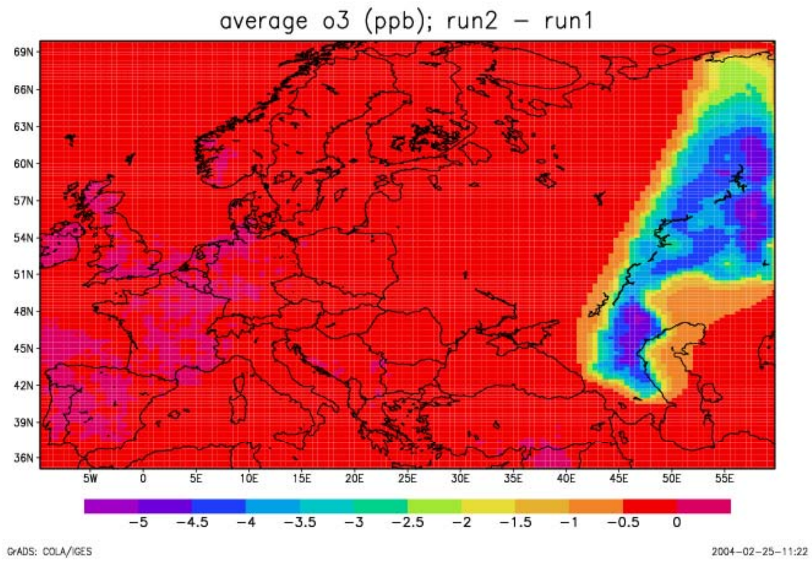
- **The basic year is 1999. Several runs are performed.**
- **RUN 1: TNO emissions for 1999, meteorology of 1999, DEPAC model ON to describe dry deposition velocity of ozone, PELINDA land use data base**
- **RUN 2: the same as RUN 1 but with corrected land use data base (IIASA)**
- **RUN 3: the same as RUN 2, double anthropogenic emissions all over domain**
- **RUN 4: the same as RUN 2, double anthropogenic emission over European Russia**

Comparison of RUN 1 and RUN 2

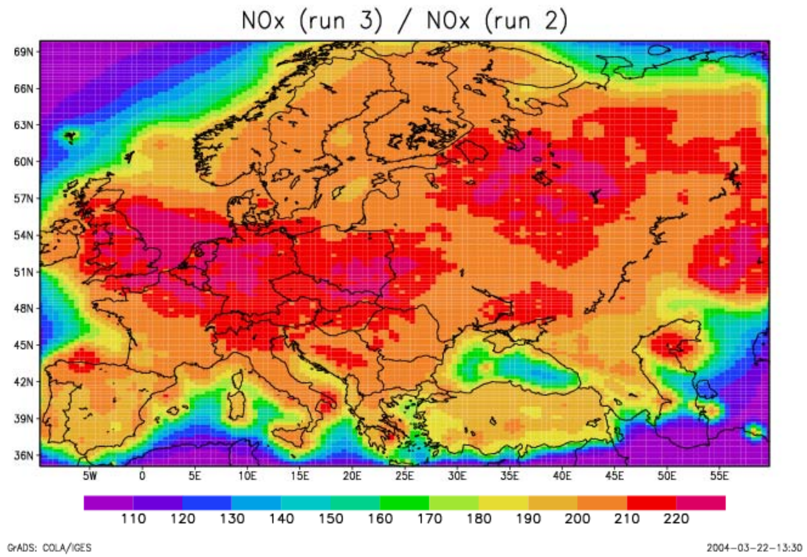


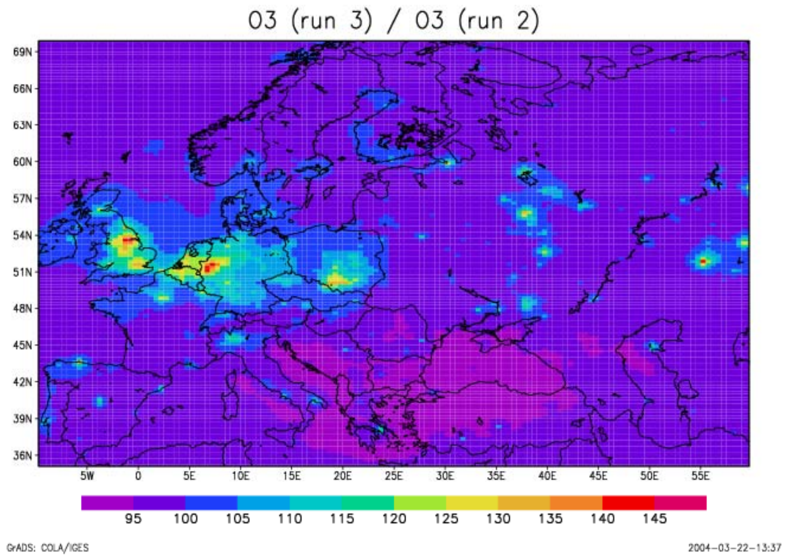


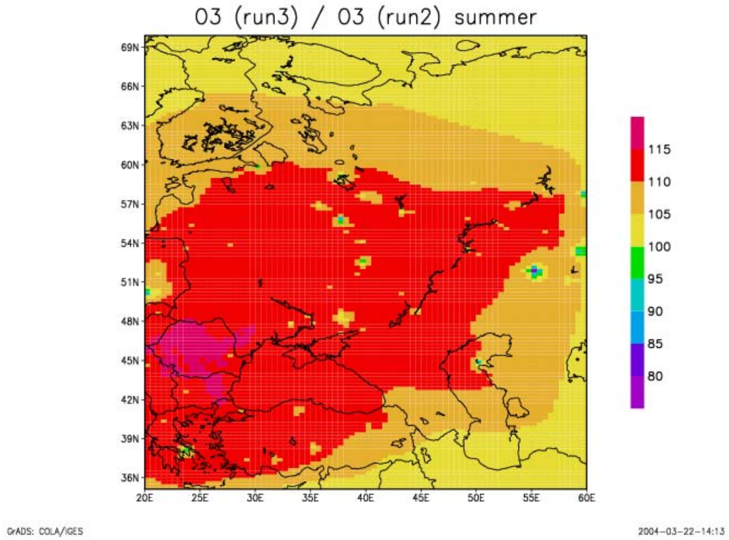


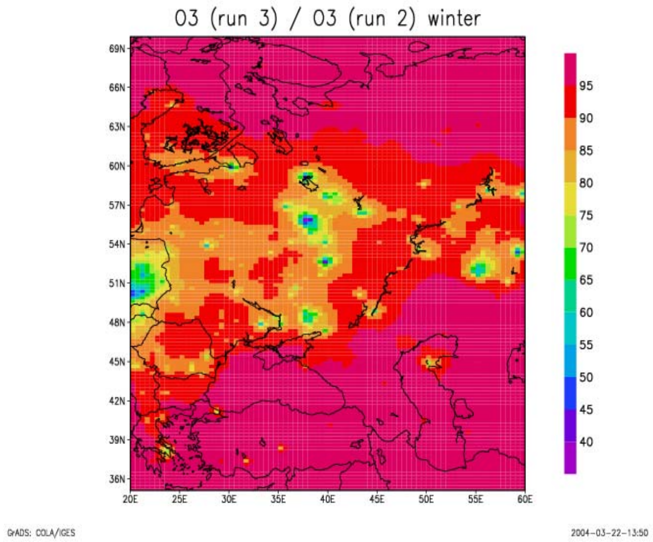


Comparison of RUN 3 and RUN 2

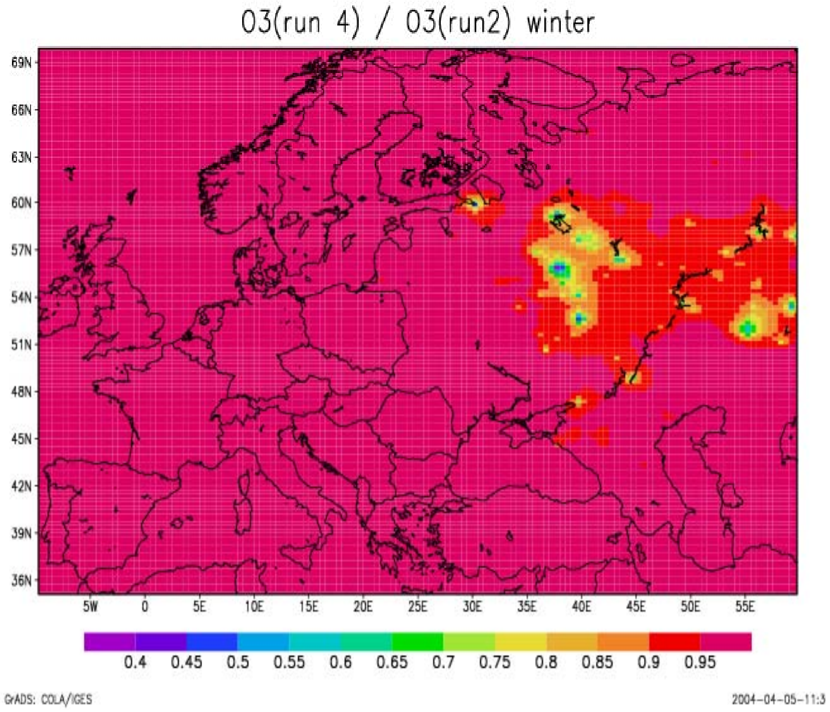


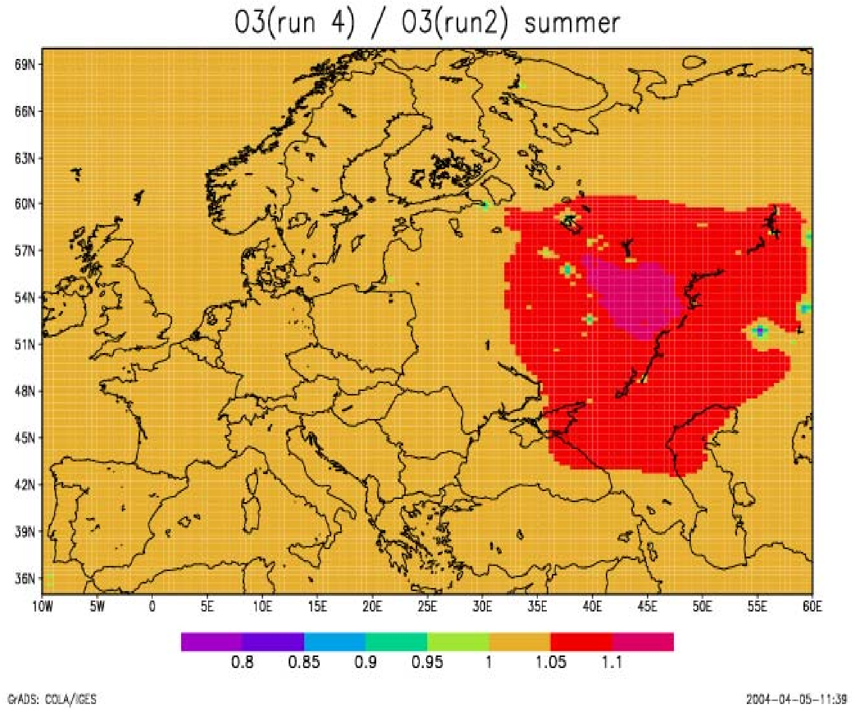






Comparison of RUN 4 and RUN 2





Conclusions

- The model was validated on the basis of Russian ozone-measuring network data and data of TROICA expeditions and showed a reasonable agreement for 1997 model year.
- The estimates of emissions impact were carried out on the basis of real emission values for 1999.
- Application of **DEPAC model provides rather low deposition** velocity and hence too high mean ozone concentration over Europe.
- Doubling of anthropogenic emissions by all the Europe has the highest response in the emissions regions and distributed not uniformly over domain with substantial winter decrease (up to -**60%**) and summer concentration increase (up to **15%**).
- Similar response is observed over European Russia if doubling only Russian emissions.

http://www.accent-network.org

Project Objective

The overall goals of ACCENT are to promote a common European strategy for research on atmospheric composition sustainability, to develop and maintain durable means of communication and collaboration within the European scientific community, to facilitate this research and to optimise the interactions with policy-makers and the general public.

- In so doing, ACCENT will establish Europe as an international leader in atmospheric composition research, able to steer research agendas through its involvement in major international programmes. ACCENT will also reinforce European environmental policy-making and will support Member States and the European Union in international negotiations and agreements
- ACCENT aims to become the authoritative voice in Europe on issues dealing with atmospheric composition sustainability and its societal implications. Such authority will be based on the integration of competencies and activities of the Partners and of the wider European scientific community in the field, and on the interaction with the international scientific community.

Scientific subprojects

- Aerosols
- Biosphere Atmosphere Exchange of Pollutants (BIAFLUX)
- Joint Field Campaigns
- IA3 Modelling
- Atmospheric Sustainability
- Transport and Transformation (T&TP) of pollutants

Expert Workshop

- **Air Quality in Eastern Europe (A Review of Measurement and Modelling Practices and Needs)**
- **An ACCENT/JRC Expert Workshop**
- held at Birini Castle, Latvia
- Monday 19th and Tuesday 20th June 2006

- **The aim of the workshop was to review the present scientific problems in tropospheric chemistry specifically related to the conditions in Eastern Europe, and to make recommendations for the necessary research to solve them.**

The workshop was divided into two working groups:

- 1. Measurements and air pollution dynamics in Eastern Europe
- 2. Regional and local modelling and Emission Inventories for Eastern Europe

Global Earth Observation and Monitoring of the atmosphere

GEOmon is a European project contributing to GEOSS. Its mission is to build an integrated pan-European atmospheric observing system of greenhouse gases, reactive gases, aerosols, and stratospheric ozone. Ground-based and air-borne data are sustained and analyzed, complementary with satellite observations, in order to quantify and understand the ongoing changes of the atmospheric composition.

First workshop was in 2007

http://www.geomon.eu/index.html

GEOMON Management

GEOMON is an Integrated project within the 6th FRAMEWORK PROGRAMME of the European Union with a duration of four years. It is coordinated by_the Commissariat à l'Energie Atomique CEA, France and includes 38 participating institutes. GEOMON is organized in six activities plus management, as listed below.

Activities and respective leaders

Act 0: Project Management, GEOMON coordination team
Act 1: Greenhouse gases & CO2 CH4 & Global Warming, E. G. Nisbet, RHUL, UK
Act 2: Reactive Gases, Pollutants& Climate, B. Buchmann, Empa, CH
Act 3: Atmospheric Aerosols & Climate, G. de Leeuw, UHEL, Finland
Act 4: Stratospheric Ozone & Climate, M. De Mazière, BIRA-IASB, B
Act 5: Integration & Supporting Modelling Studies, M. Schulz, LSCE, F
Act 6: System Architecture & Outreach, S. Godin-Beekmann, SA, F; K. Torseth, NILU, NO

Seventh Research Framework Programme (FP7)

2007 - 2013

- Environment (including Climate Change) Calls: **FP7-ENV-2009-1**

- FP7-ENV-2009-1
- **Identifier:** FP7-ENV-2009-1
- **Publication Date:** 03 September 2008
- **Budget:** € 193 500 000
- **Deadline:** 08 January 2009 at 17:00:00 (Brussels local time)
- **OJ Reference:** OJ C226 of 03 September 2008
- **Specific Programme(s):** Cooperation
- **Theme:** Environment (including Climate Change)

http://cordis.europa.eu/fp7/dc/index.cfm