# The impact of Russian coal-burning power plants in Siberia on atmospheric environment and their possible role in the long range transport of sulfur

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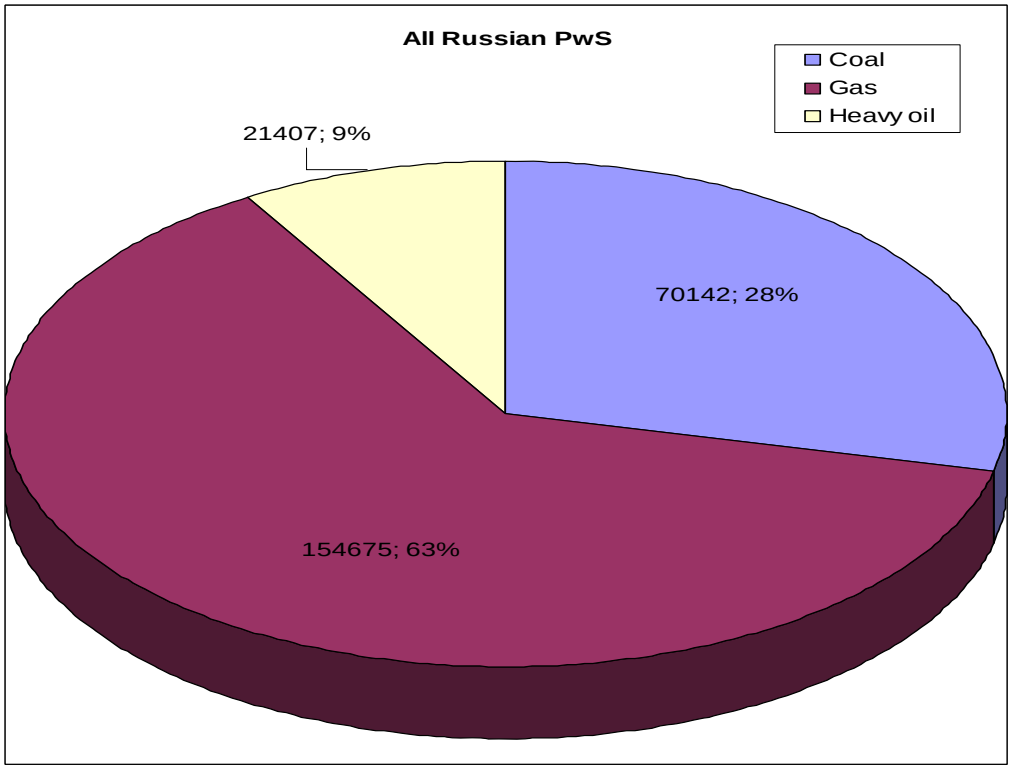
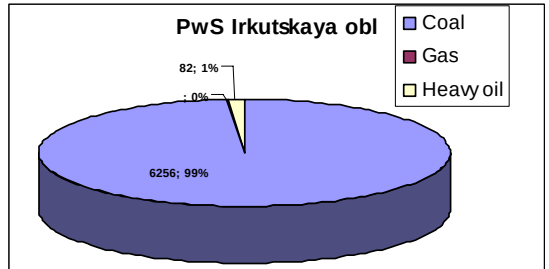
# Related information on expert profile

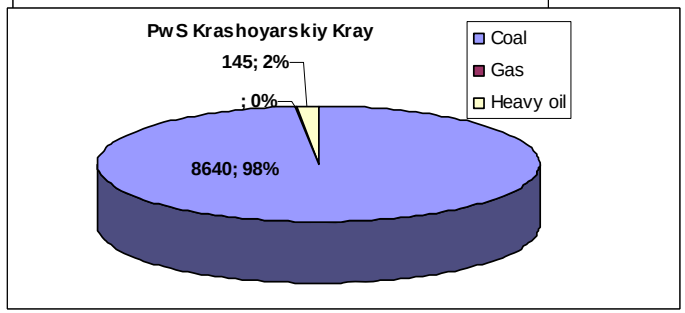
- Member of UN ECE/EMEP Task Forces (on Measurements and Modeling, on Hemispheric Transport of Atmospheric Pollution), of EANET TF
- Member of Research team on emission evaluation of sulfur and nitrogen oxides and on atmospheric S and N balances over the former SU (EU INTAS project, INTAS-RFBR projects) [1996-2000]
- Principal Investigator on evaluation of atmospheric heavy metal fluxes including estimation of anthropogenic emissions over FSU [1999-2002]
- Expert for reviewing of EMEP-CORINAIR Emission Guidebook with national experience [1993-1998]
- Expert in atmospheric pollution monitoring & assessment

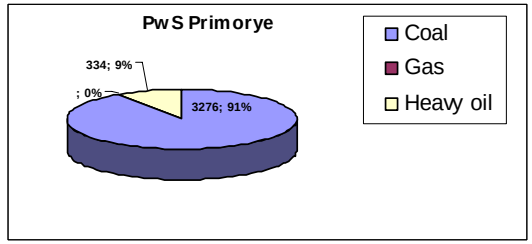
# Coal using in Russian power production

- Fuel consumption (thous. Tonn of equivalent) for 2000 in Asian regions of Russia



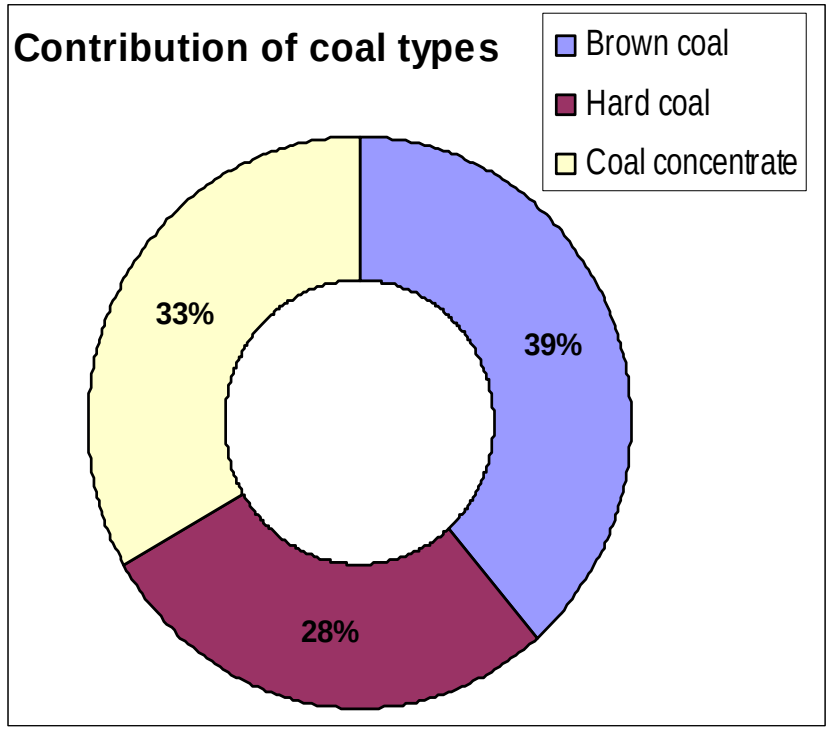



# Coal using in Russian power production

- The contribution of fuel burning power production – 65,6%. (Statistics of Russian Federation, 2002)
- Content of sulfur in coals 0.3-3.5% (more used is 0.6-0.9%)
- Content of lead and cadmium – around 25 and 0.5 ug/ton
- For large point sources (power plants, in particular) over the FSU the heights of mean-weighted emission was evaluated higher than 100 m

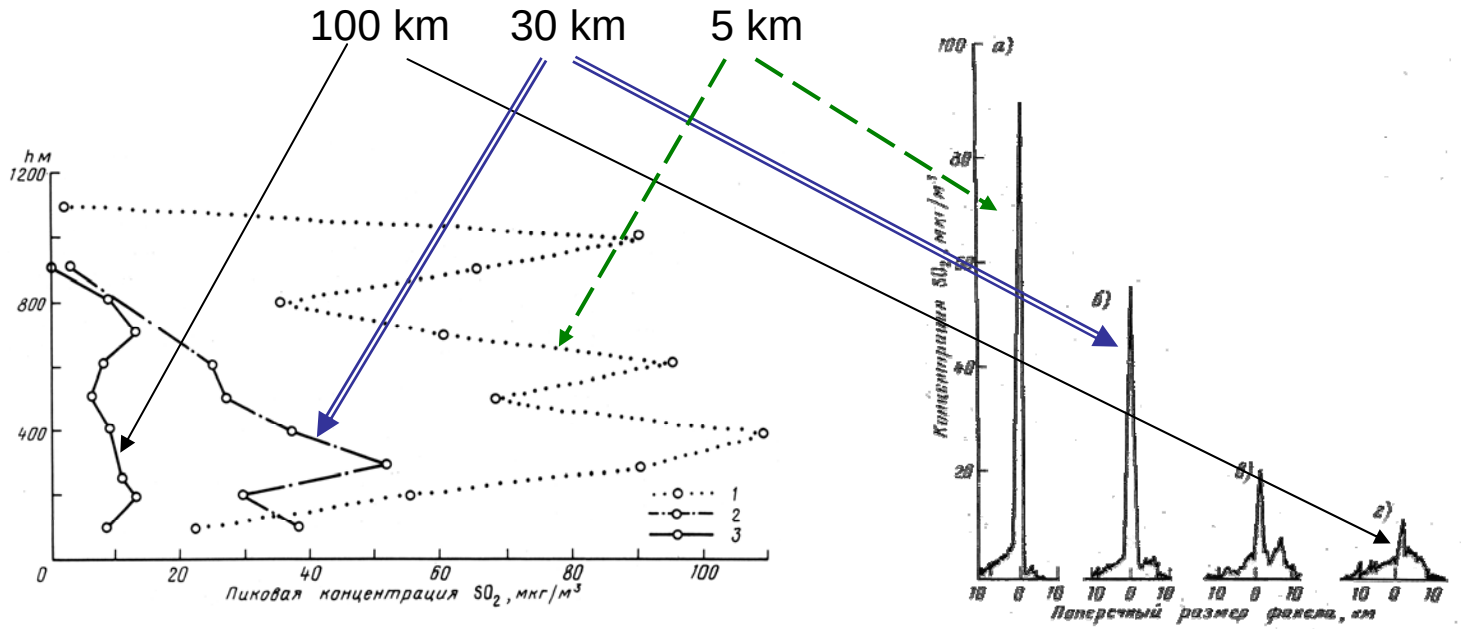


# Experimental researches for emission transport from large power station

- Evaluated during the design of huge project with several high capacity power station within brown coal mining basin in Siberia
- Based on operated power station of 1400 MW under brown coal using
- Aircraft measurements of plume downwind more than 100 km
- Main compounds: sulfur dioxide and sulfate

# Experimental researches for emission transport from large power station (2)

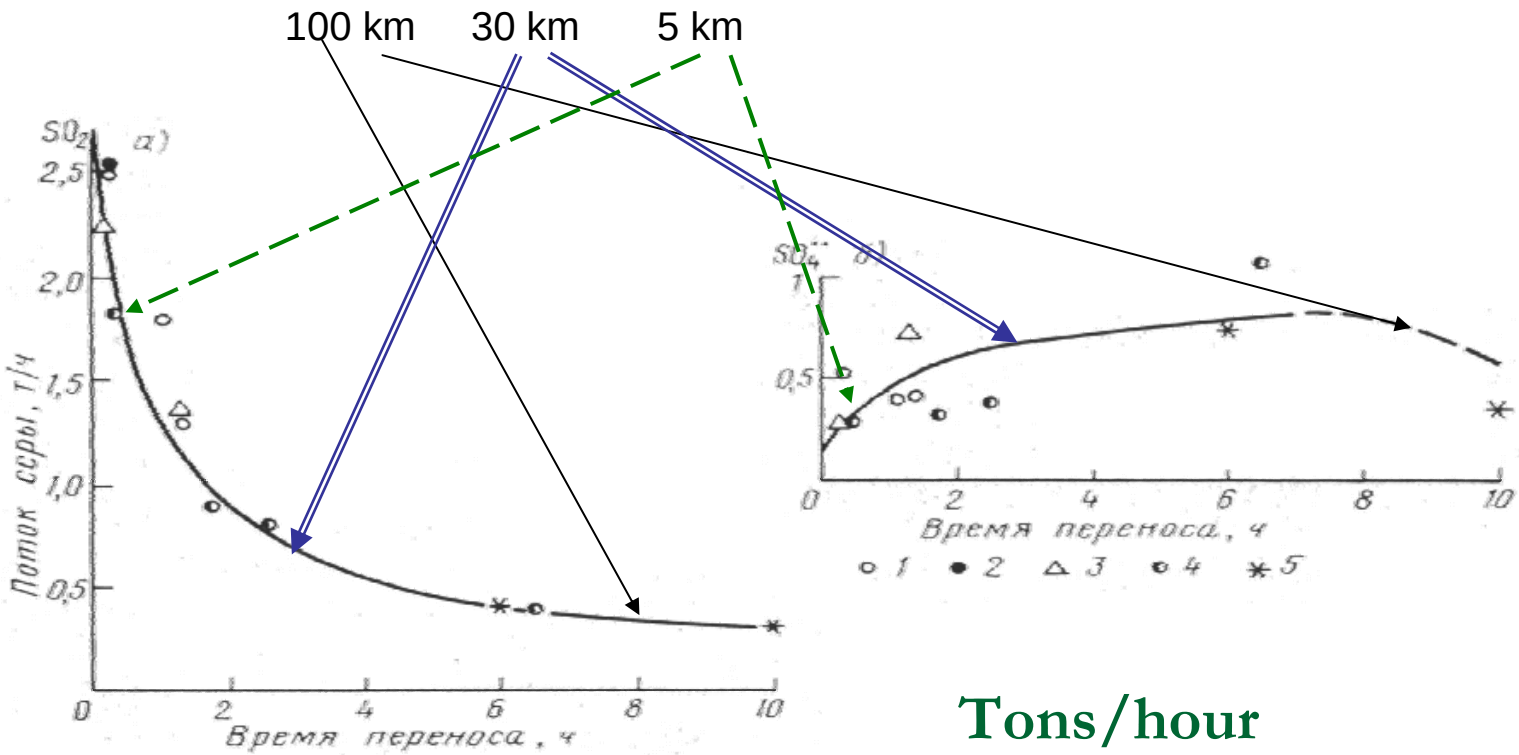
- Decreasing of $SO_2$ content in plume:
  vertical profile cross profile




ug/m$^3$

# Experimental researches for emission transport from large power station (2)

- Decreasing of $SO_2$ flux with plume parcel age and increasing of sulfate fluxes




**Tons/hour**

# Understanding of acid deposition problems in Russia

- Regional scale of atmospheric transport
- Result of natural physical-chemical transformation of anthropogenic emission
- Caused by emissions on both national territory and other countries of surround
- Proved environmental effects on natural and regulated ecosystems
- Monitoring, control and mitigation are needed

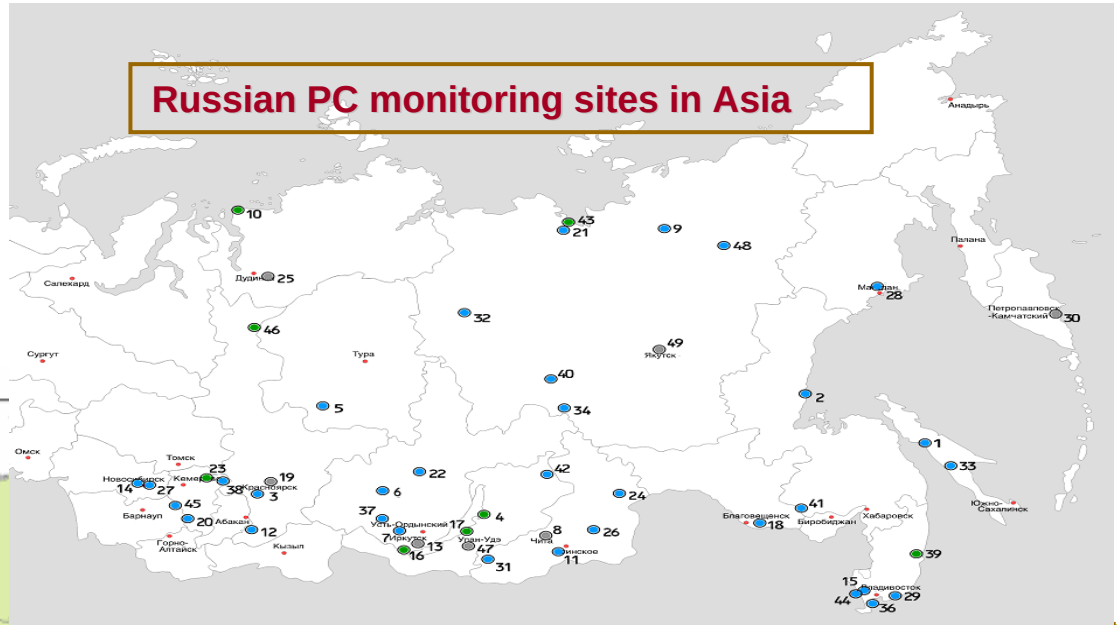
# Data provision: Monitoring Networks

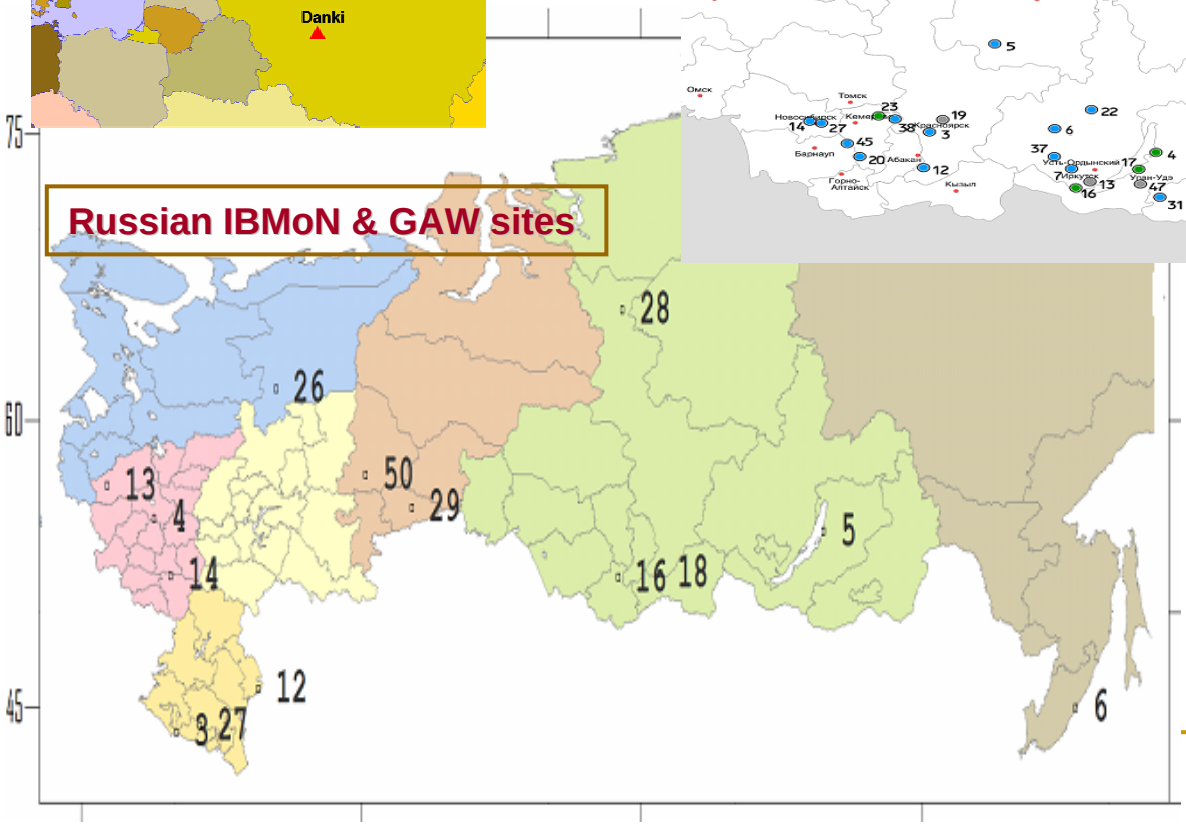
**Under the supervision of Roshydromet**
**With support on methodologies, data collection and evaluation by research institutes**

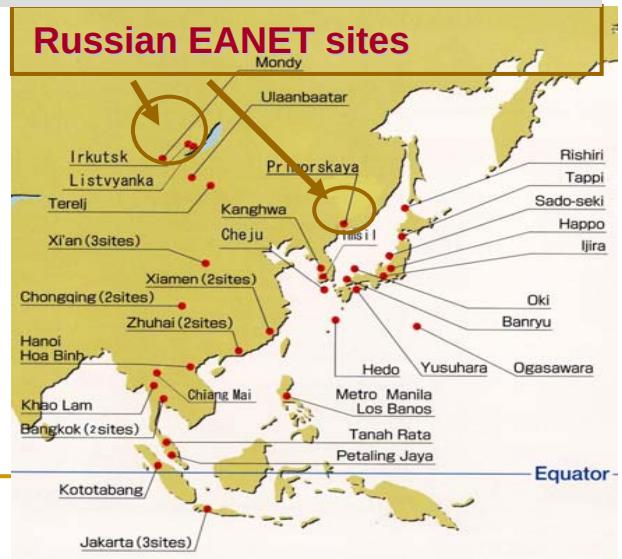
**Established networks related acid deposition monitoring:**

- **EMEP (north-western European part, since 1980s)**
- **national precipitation chemistry (PC) network (whole Russia and former SU, since 1960s)**
- **WMO-GAW (national-wide, since 1980s)**
- **IBMoN (national-wide, since 1980s)**
- **CLRTAP ICP-IM (Integrated monitoring of air pollution effects on ecosystems) (European part, since 1990s)**
- **EANET (South-eastern Siberia and Far East, since 1998)**

# Relevant Monitoring Networks in Russia

# Data provision: Monitoring Parameters

Under the coordination of Roshydromet
With support on methodologies, data collection and evaluation by research institutes

Measurements of air concentrations:

- sulfur dioxide, sulfate (EMEP, IBMoN, EANET)
- nitrogen oxides, nitrate, ammonium (EMEP, EANET)

Measurements of major ions concentrations in precipitation:

- national precipitation chemistry (PC) network (monthly)
- WMO-GAW (weekly or monthly)
- IBMoN (monthly)
- CLRTAP ICP-IM (monthly)
- EANET (daily or events)

# Data provision: Emission Inventories

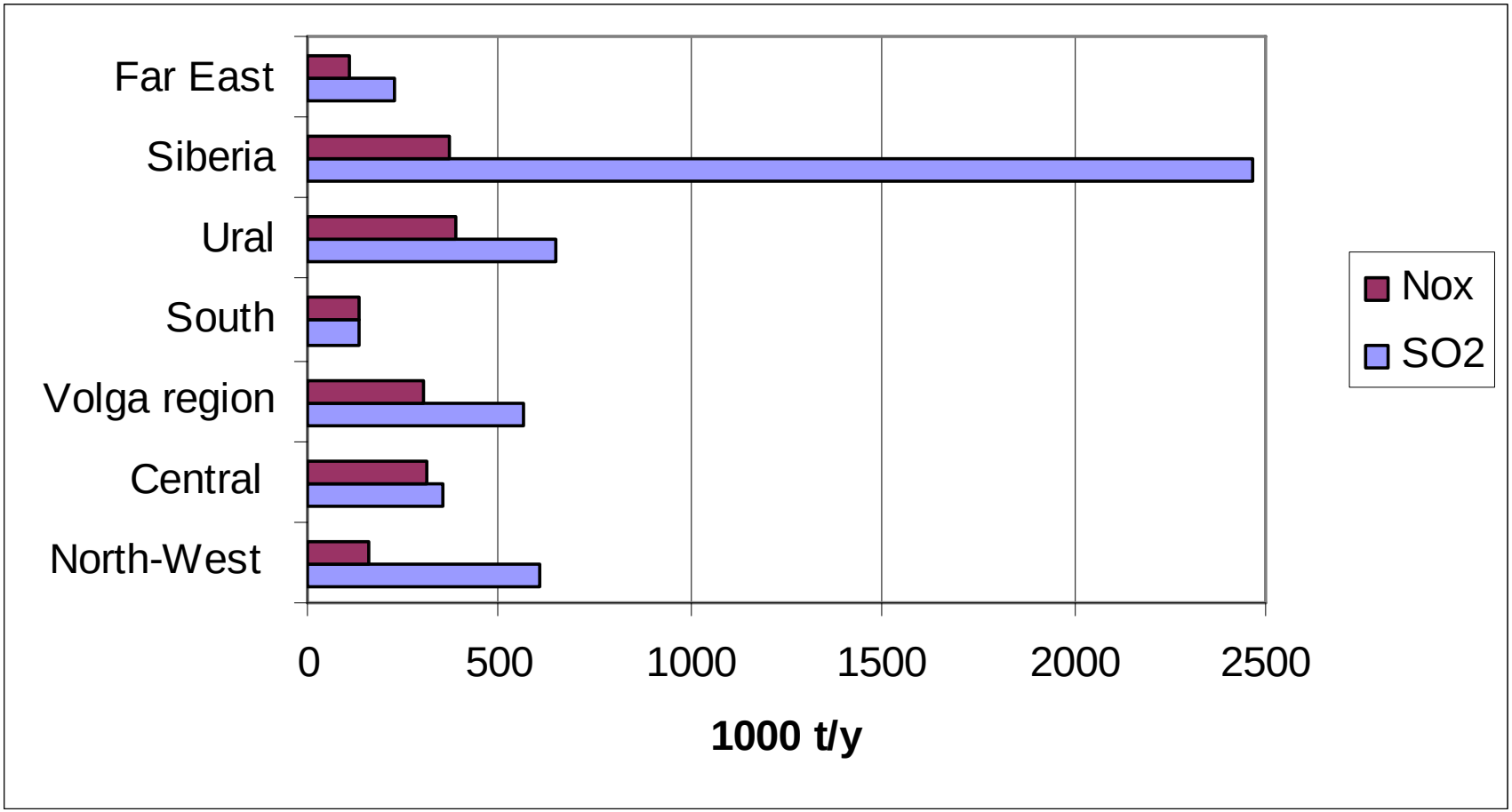
**Under the supervision of Rostechnadzor**
**With support on data collection and evaluation by research institutes**

**Established "bottom-up" system to collect related emission data from the level of enterprises:**

- **for national reports (data aggregation for industrial activities and big territorial units)**
- **for EMEP (data aggregation for source types, and grid-cell domain of European part)**

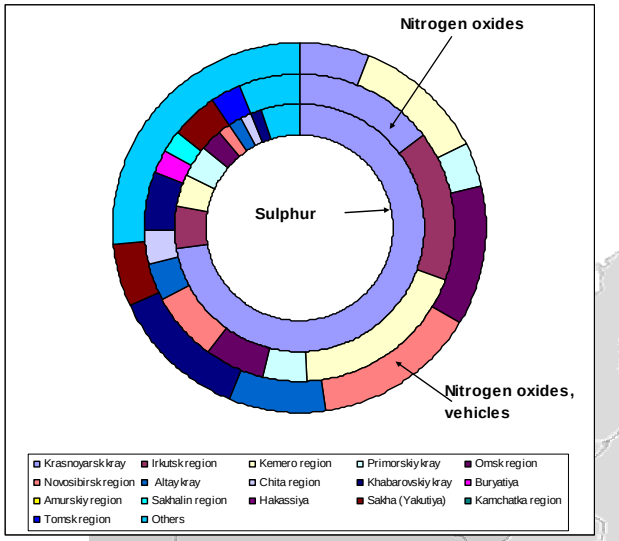
**Expert evaluations based on "top-down" approach from the level of territorial units or industrial activities**

# Aggregated data on industrial emissions of sulphur and nitrogen oxides for the regions of Russia.



# Data provision: Emission Inventories

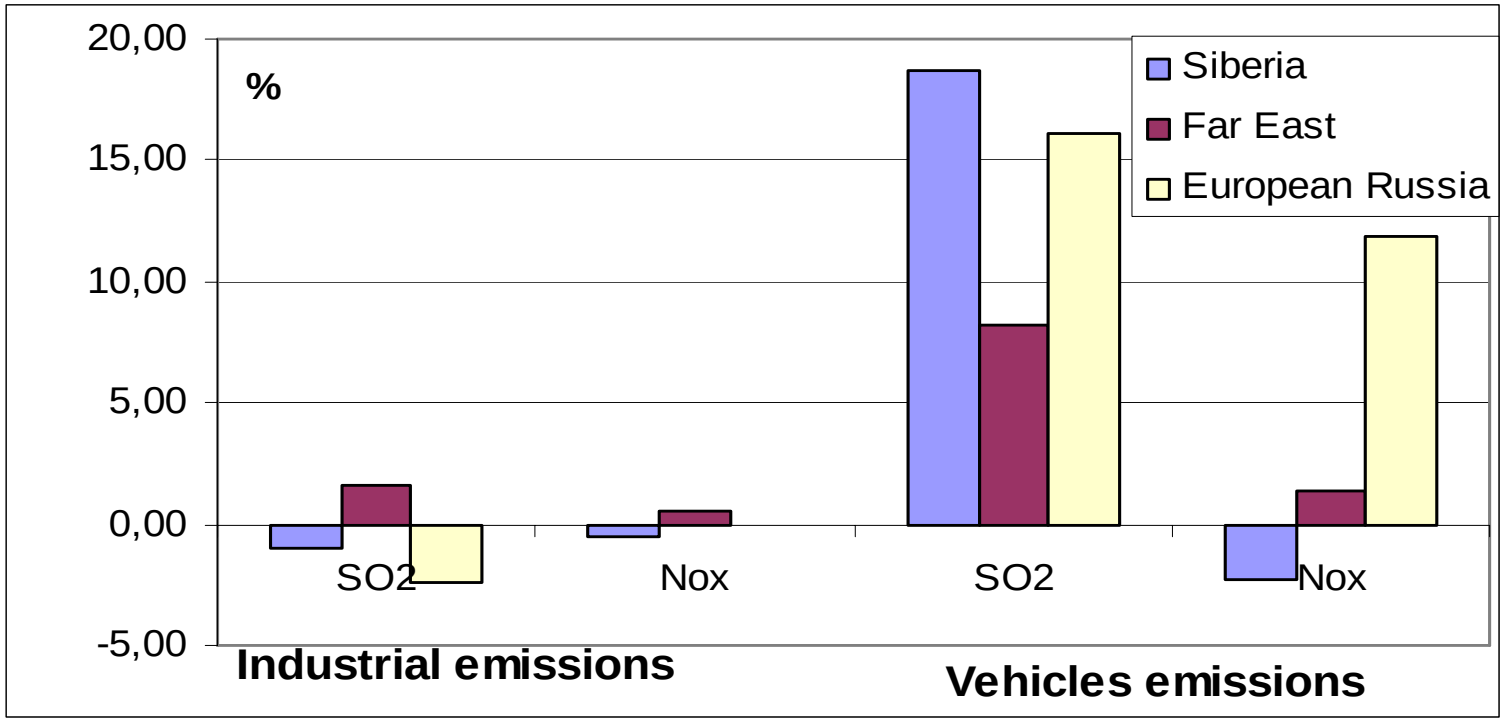
## Industrial emissions of $SO_2$ and $NO_x$ in provinces of Siberian and Far East federal regions



# Assessment: Emissions

Evaluation of emission data: mostly trend analysis

Changes of SO2 and NOx emissions for 5 years period



# Tendency of total emissions changes at Russian regions during the 5 years period (for 1998-2002).


1 – Far East; 2 – Siberia; 3 – Ural;
4 – South European; 5 – Volga region; 6 - Central European;
7 – North-Western European

# Assessment: Common evaluation of Emissions and Monitoring Results

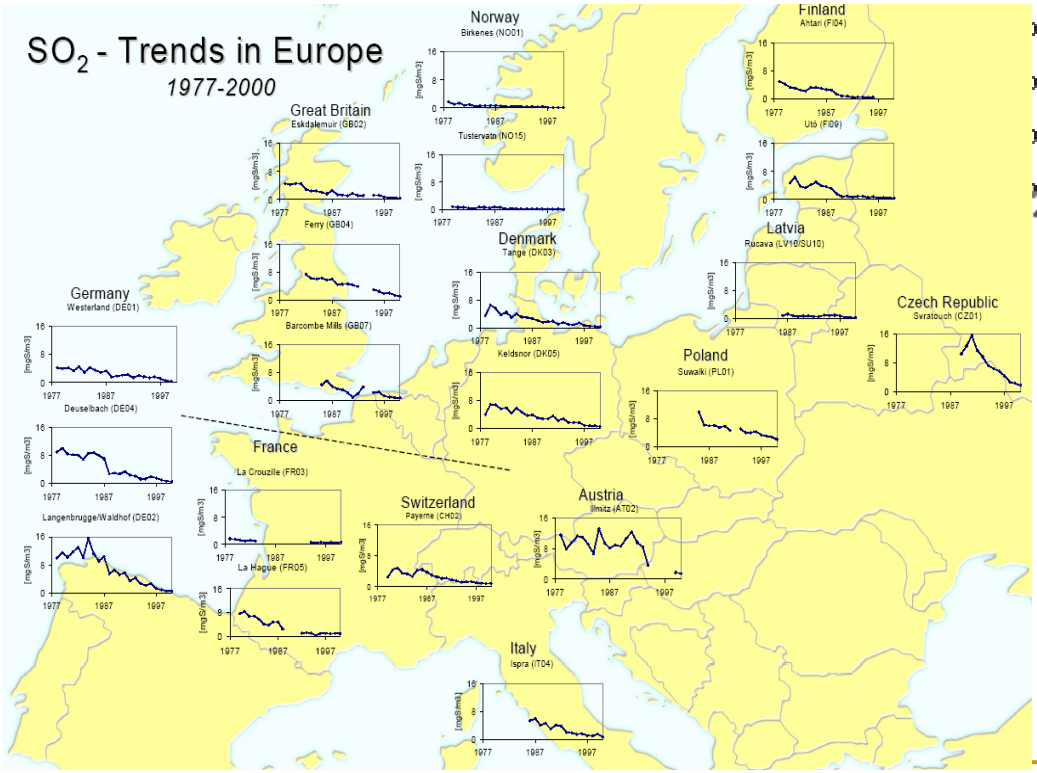
Most evident and developed way – to use modelling:

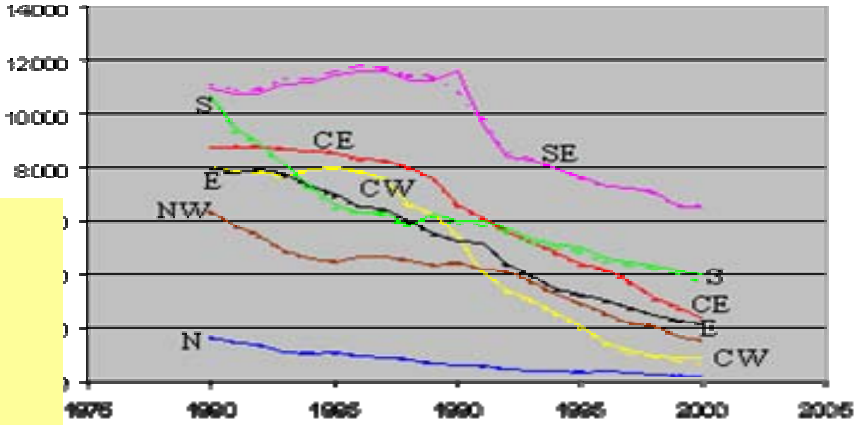
- Validation of models and results with monitoring data;
- Source-receptor relationships;
- Emission scenarios evaluation

More empirical – review of data in parallel

- Trend analysis for regions

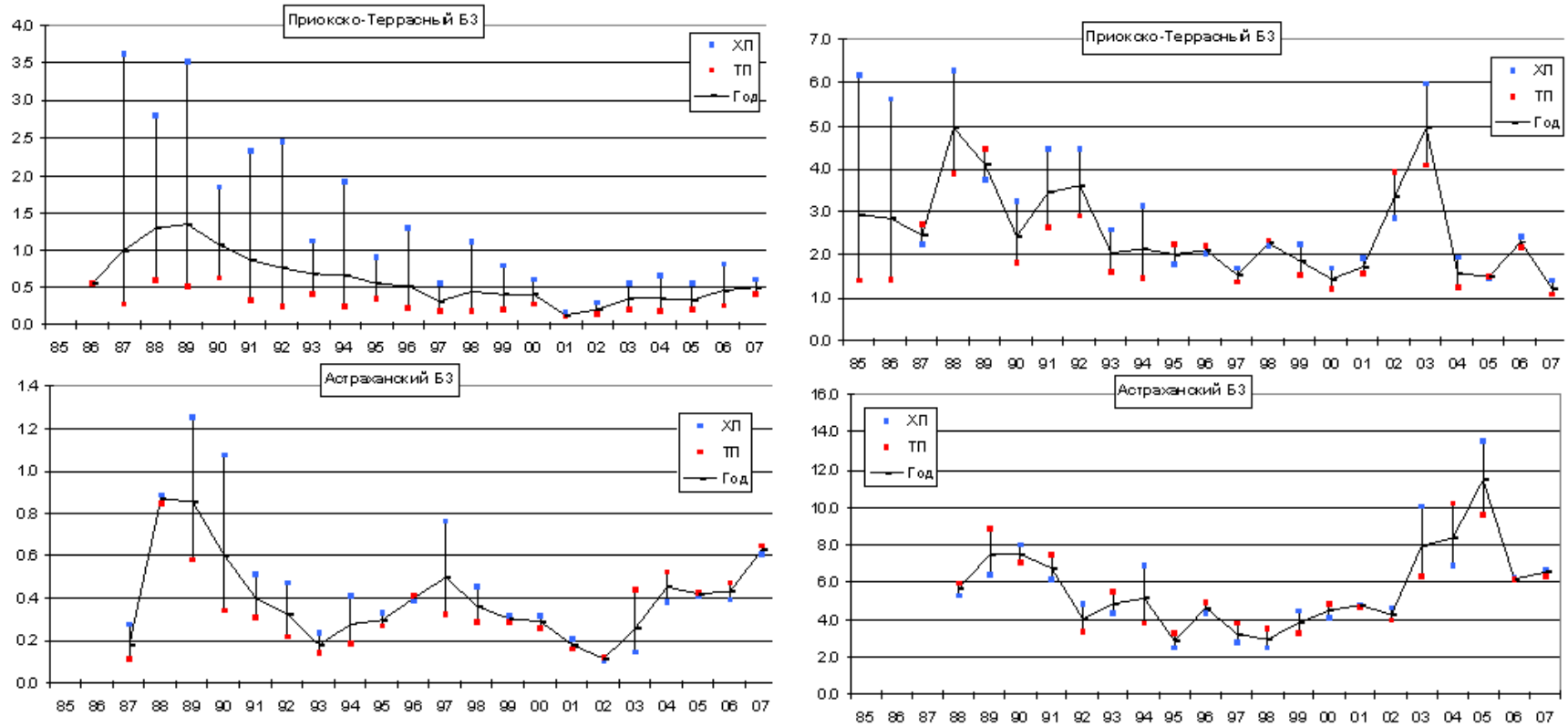
# Decreasing of Sulphur emissions in Europe (1980-2000) and related trends of $SO_2$ at European EMEP sites



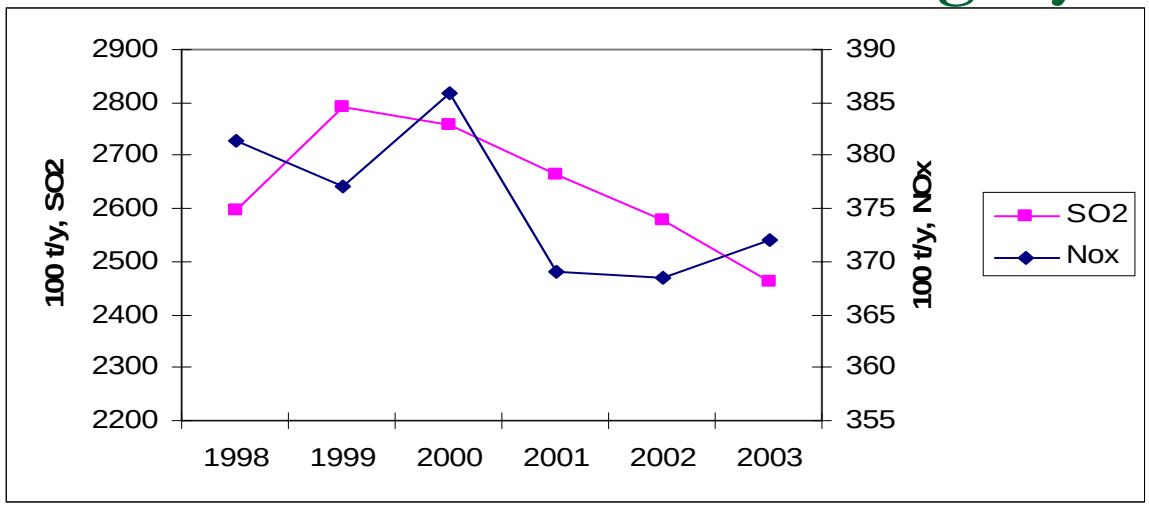

| Countries | $SO_2$ |
|---|---|
| **E** = Estonia, Latvia, Lithuania and Russia (European part)* | -73% |
| **SE** = Albania, Armenia, Belarus, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Georgia, Kazakhstan, Republic of Moldova, Romania, Slovenia, The FYROM Macedonia, Turkey, Ukraine and Yugoslavia | -40% |
| **TOTAL EUROPE** (excluding ships ) | **-67%** |

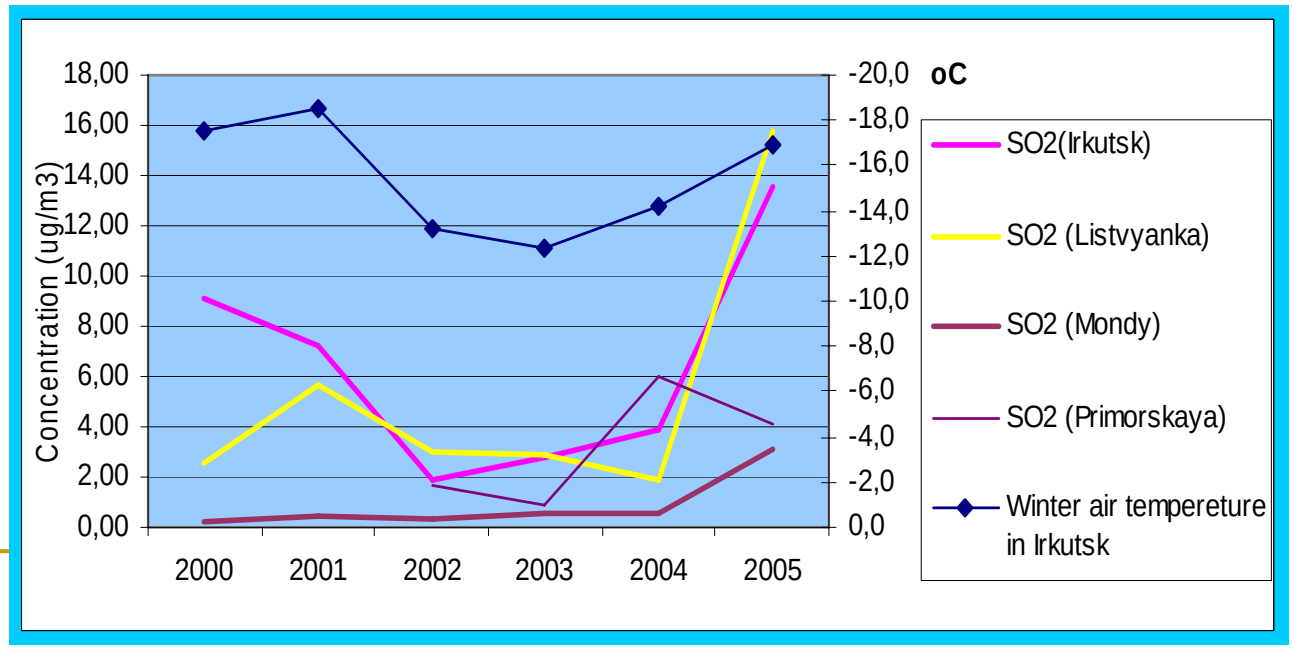
# Trends of airborne sulfur oxides at Russian IBMoN stations for the period 1986-2007.



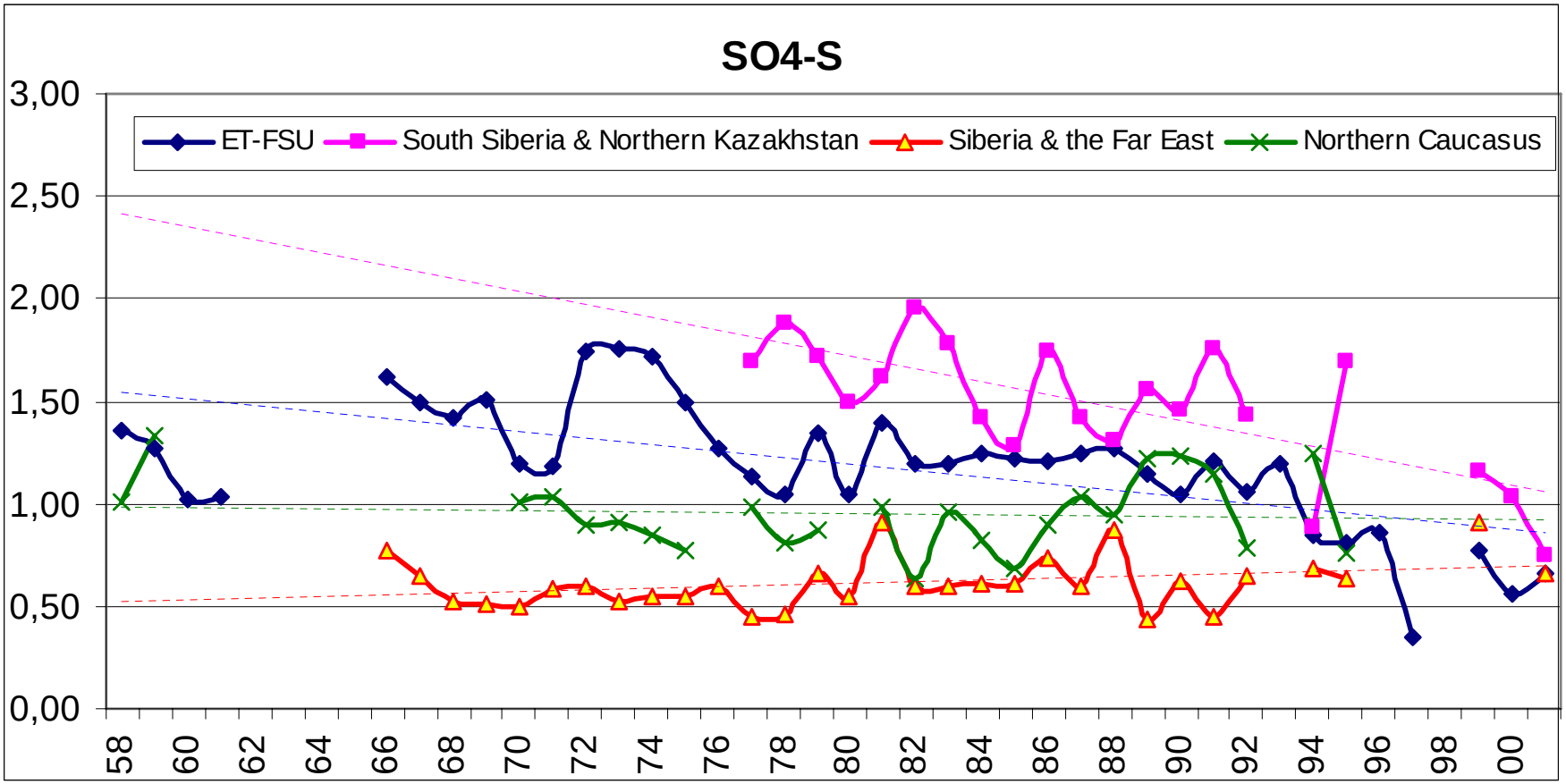

SO2 (left) and sulfate (right):
1 – Central European, 2 –South European

# Time trends of emissions and $SO_2$ concentrations in Siberian Russia during 5 years periods.



# Trends of sulphur concentrations (mg/l) in precipitations over Russian regions



# Mitigation: Emission Control and Environmental Protection Measures

Introduction and implementation of emission control:

- Industrial emission sources;
- Fuel combustion

Environmental Protection:

- Purification and cleaning of fuel;
- Introduction of less harmful fuel and row materials;
- Regulation of emission quotas; etc

# International regional environmental programs

Russia participates in a number of regional environmental programs such as EANET, EMEP and AMAP. A considerable part of efforts on air quality management is undertaken in Russia according to the international agreements

***Convention on Long-Range Transboundary Air Pollution in Europe***

- Emissions reduction and data submission,
- Monitoring activity,
- Transboundary issues (country to country)

***AMAP program***

- No strict obligations on countries,
- Monitoring and emissions databases,
- Assessment activity

***FCCC, Kyoto protocol***

- Control of green-house gases emissions

# Useful outcomes from implementation of International regional environmental programs

- The long range transport from large point sources (power stations) could be traced by field experiments and combination of meteorological analysis and monitoring data evaluation
- The long range effects (including transboundary one) on air quality and related impact by pollutant deposition could be evaluated on the base of modeling
- The quality of emission is essential to provide the reliable estimation (note: the contribution to model errors caused by emission uncertainties were estimated as about 50%)
- The long term high performance monitoring is extremely important for model validation, improvement and confirmation