

Methane in the atmosphere over Russia: TROICA experiments

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*Main goals of **TRanscontinental Observations Into the Chemistry of the Atmosphere (TROICA)** project*

- 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

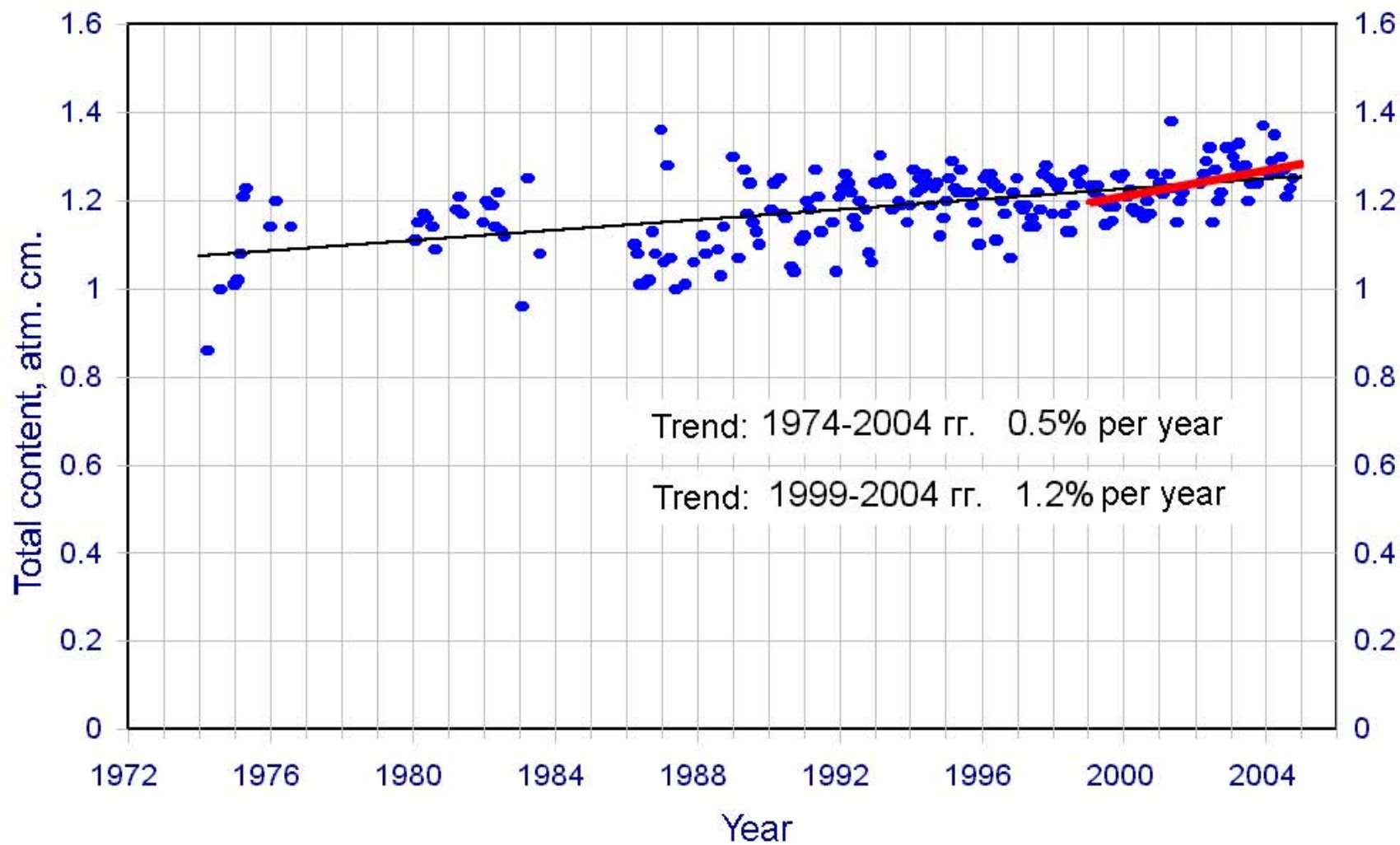
Transcontinental Observations Into the Chemistry Of the Atmosphere Using Mobile Observatory

<u>Experiment</u>	<u>Work period</u>	<u>Route</u>
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

The scheme of railway routes



CH₄ monthly mean data, Zvenigorod



*TR*ansportable *O*bservatory for *I*nvestigations and *C*ontrol of the *A*tmosphere (*TROICA*)





Carriage #1: Observatory



***Instruments for gas
measurements***



Carriage #2: Chemical laboratory



Measurements (TROICA-8)



Surface gases: O₃, NO, NO₂, CO, CO₂, SO₂, CH₄, THC

Surface aerosols: size distribution (2 nm-10 μm), scattering coefficient, mass concentrations; black carbon

Remote sensing: CO (total content) ,

- O₃ (total content and vertical profiles (optical: 0-45 and microwave: 20-65 km)),
- NO₂ (total content , vertical profiles (0-45 km), slant abundance at 9 angles from each sides)

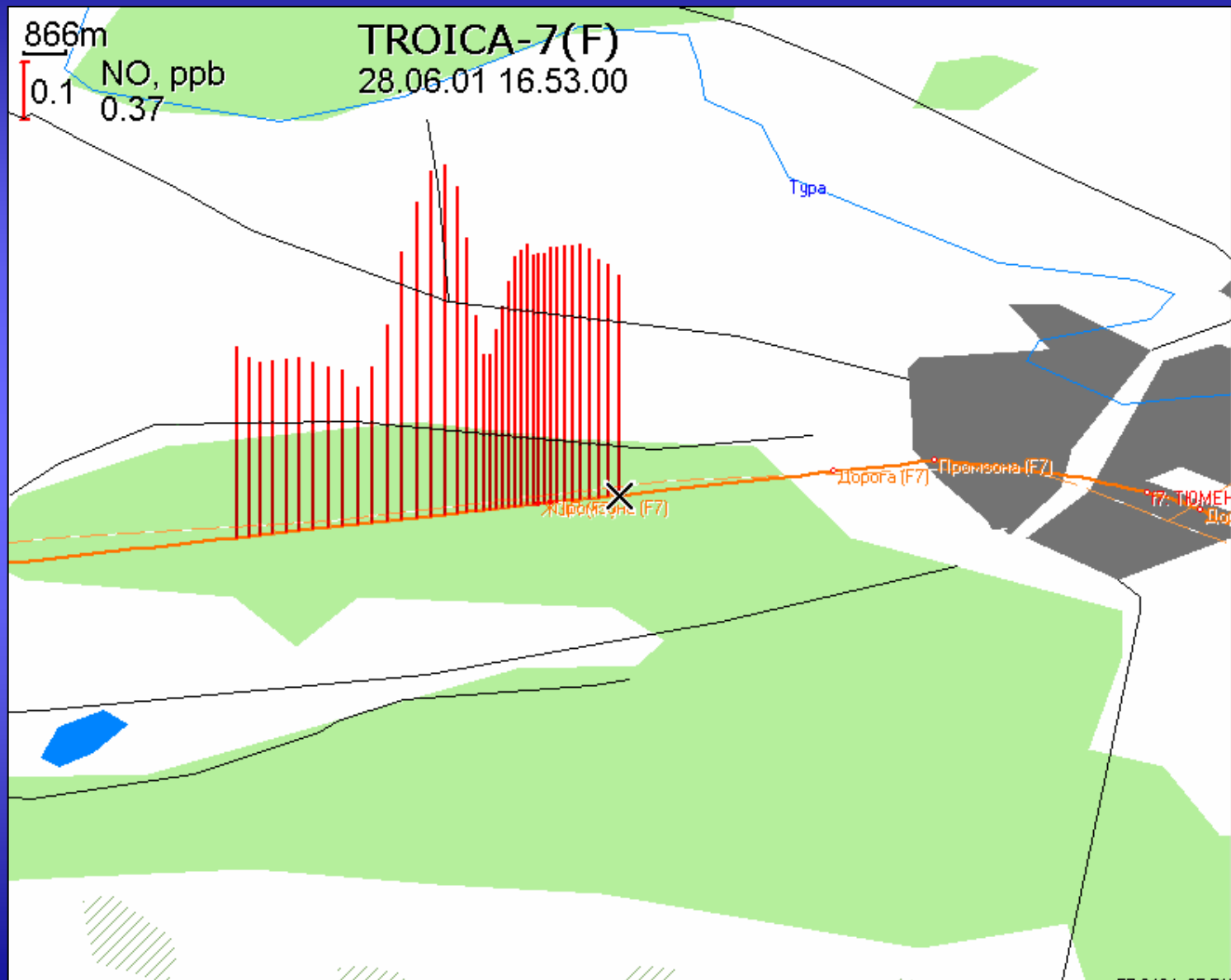
Solar radiation: integral, UV-A, UV-B, photodissociation rate J(NO₂)

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

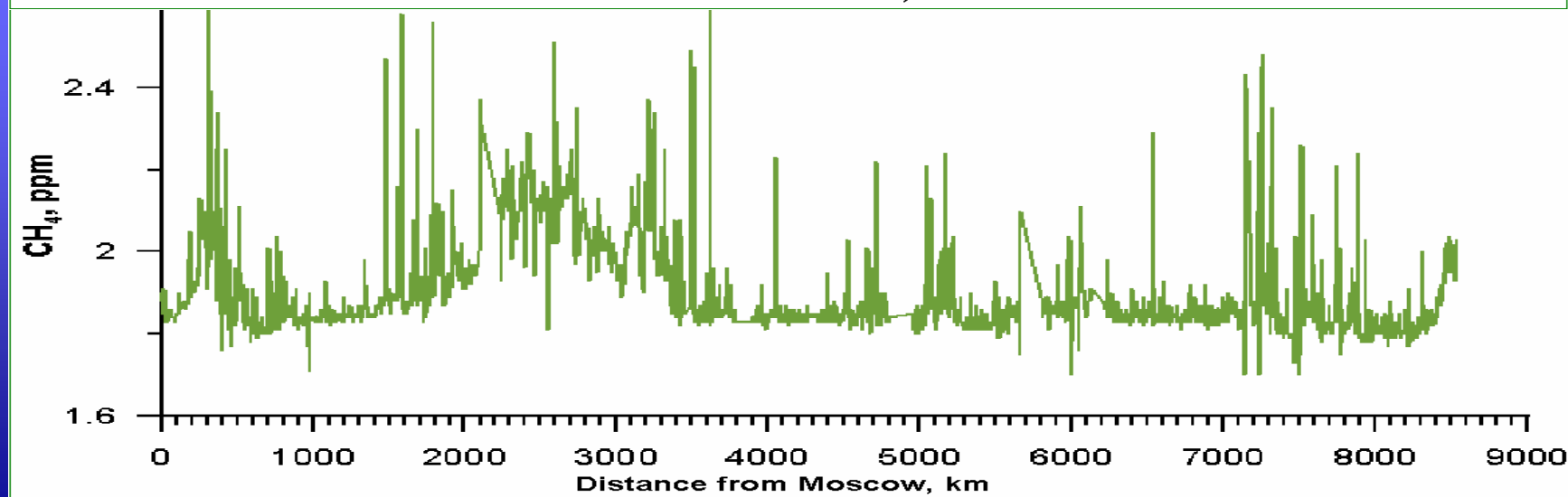
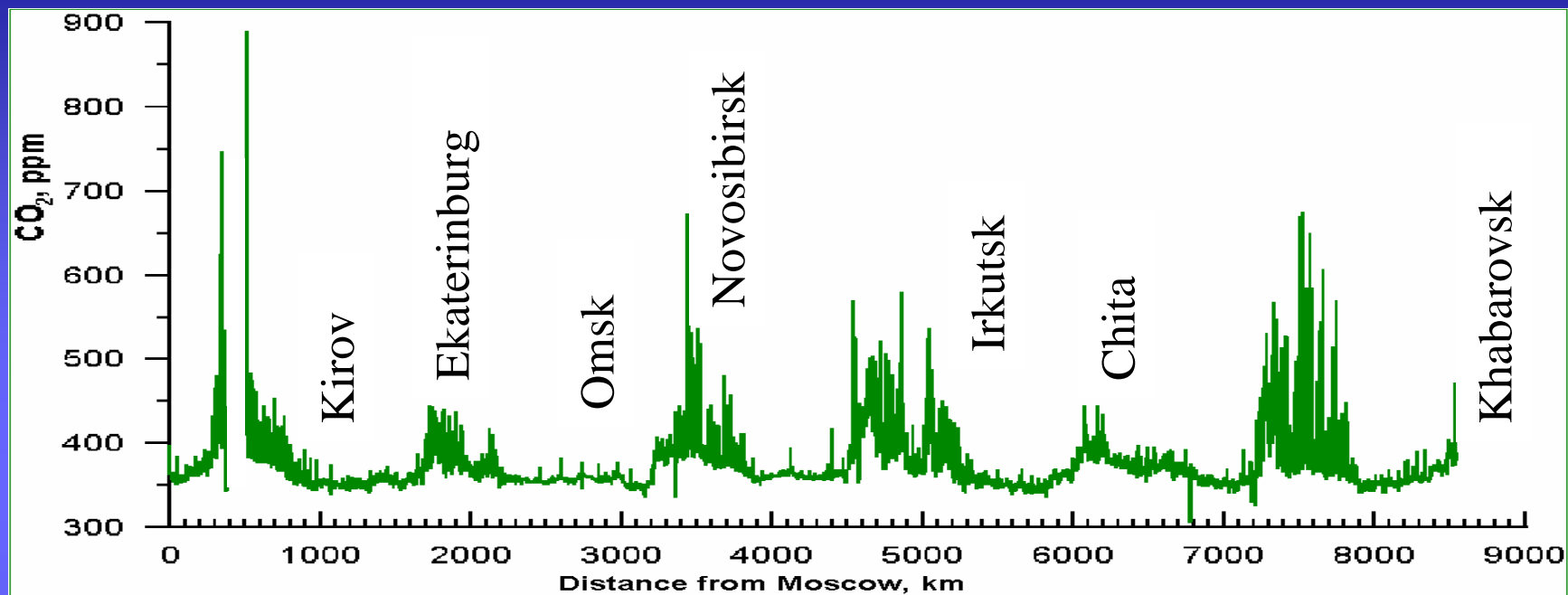
Sampling: green-house gases and VOC; chemical, elements and morphological composition of aerosol, isotope composition of CO, CO₂, CH₄ (¹³C, ¹⁴C, ¹⁸O, D),

Others: navigation parameters (GPS), ²²²Rn, radionuclides, TV pictures of surrounding (both sides), TV pictures of cloudiness, samples of water, soil, vegetation

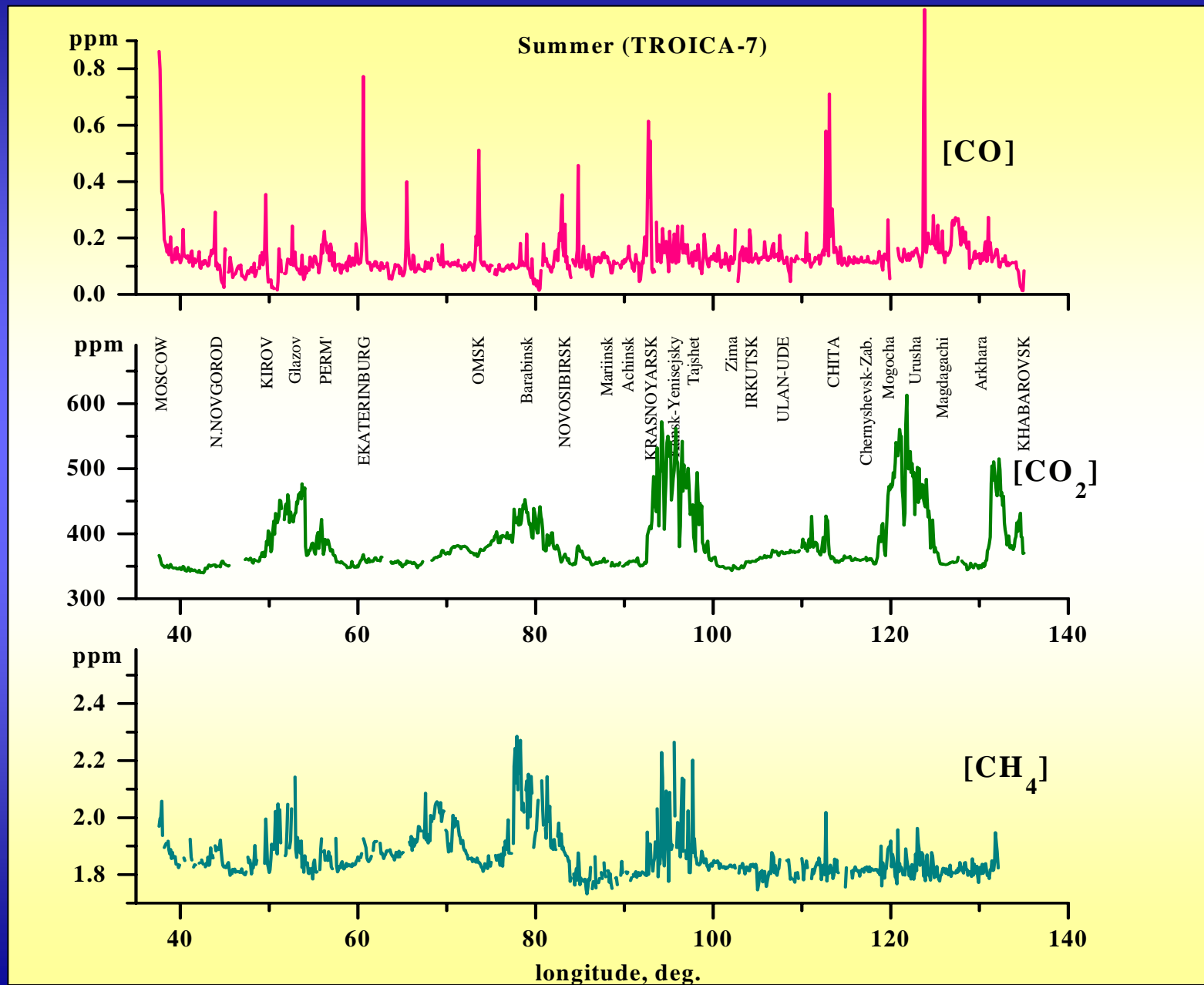
Изменение NO в окрестностях Тюмени в экспедиции TROICA-7



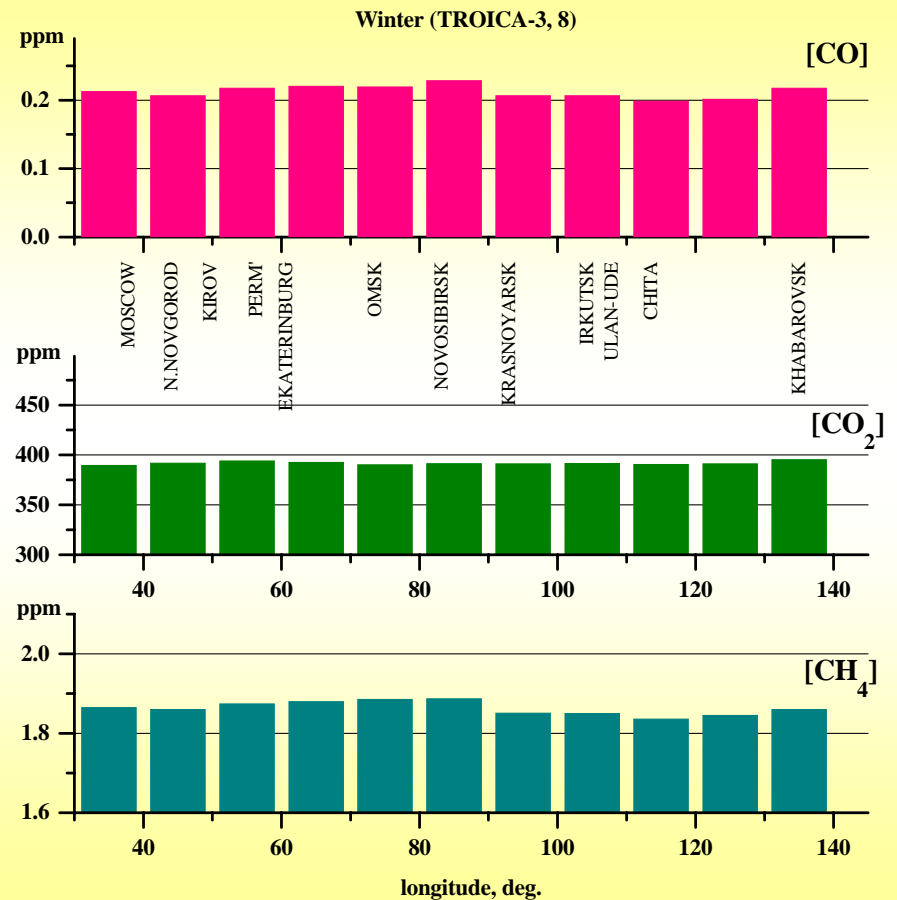
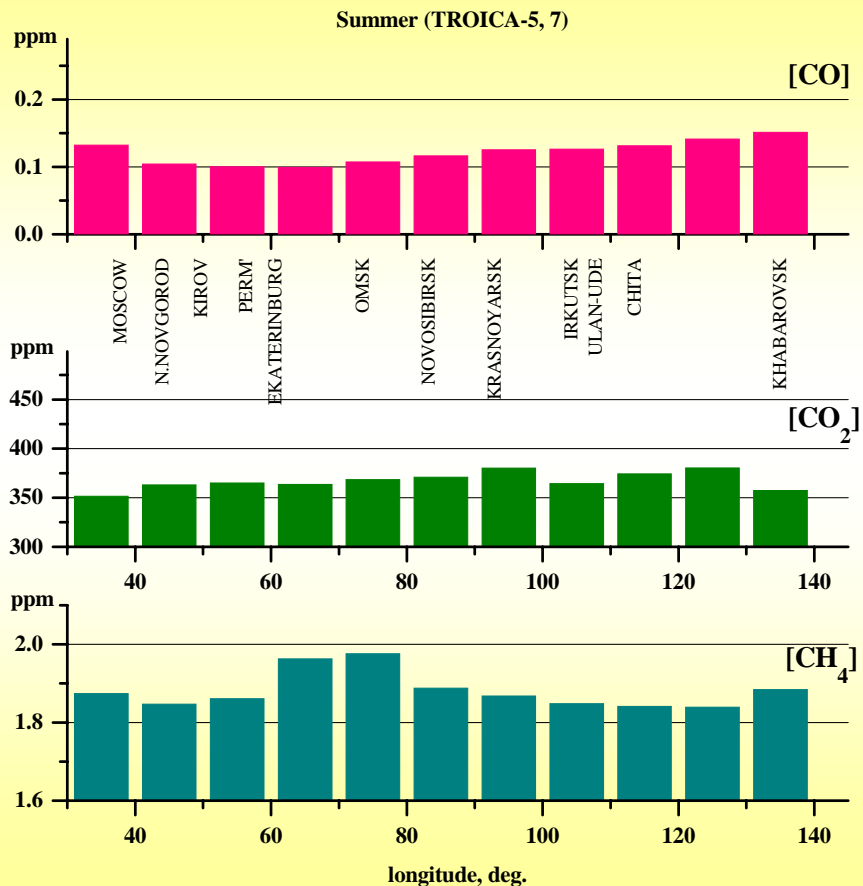
Surface CO_2 and CH_4 concentrations in TROICA-5 June 25–July 2, 1999 (movement to East, 10 km averaged)



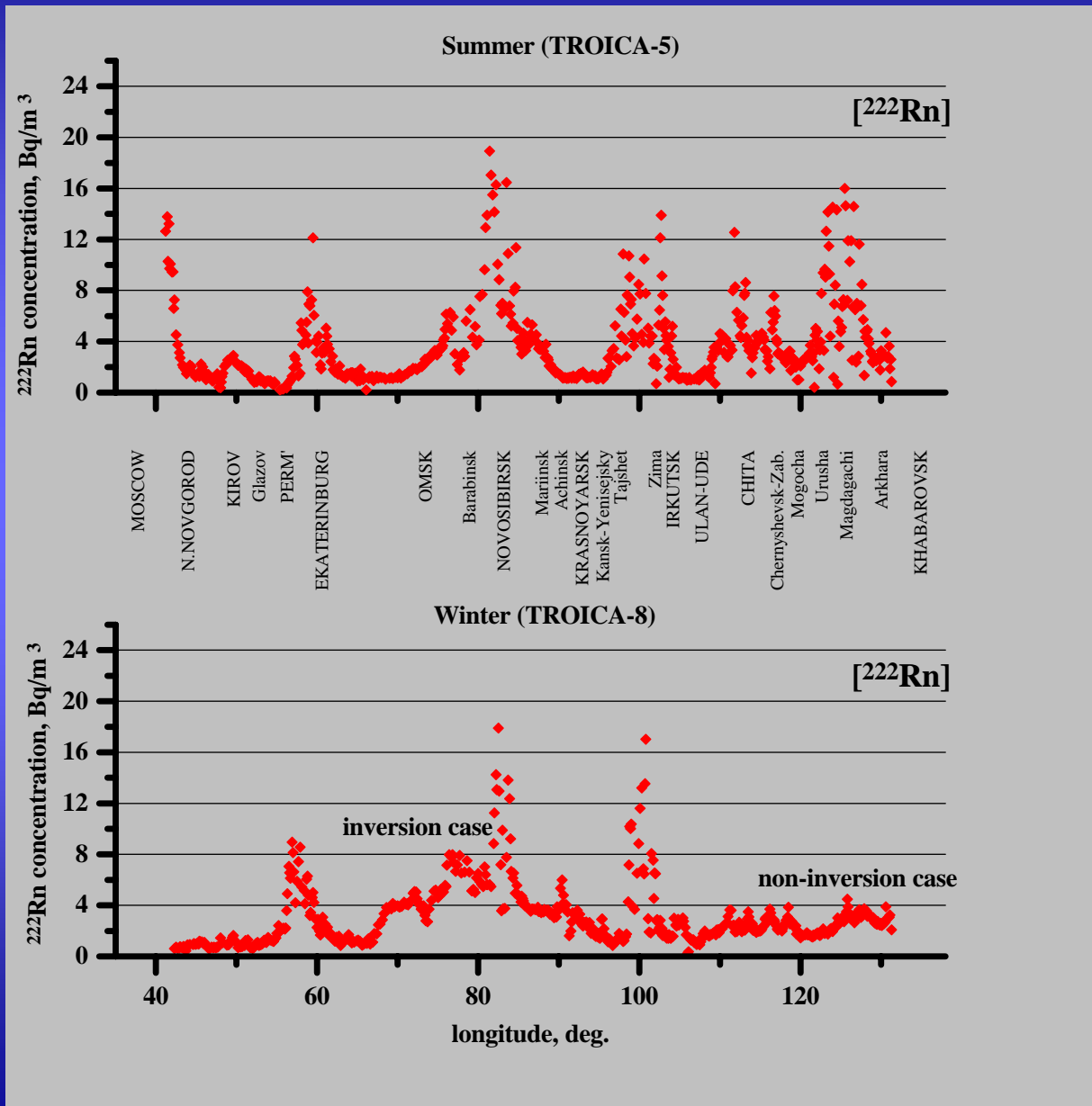
**Initial observation data obtained during summer expedition TROICA-7.
(averaging 0.1 deg. longitude)**



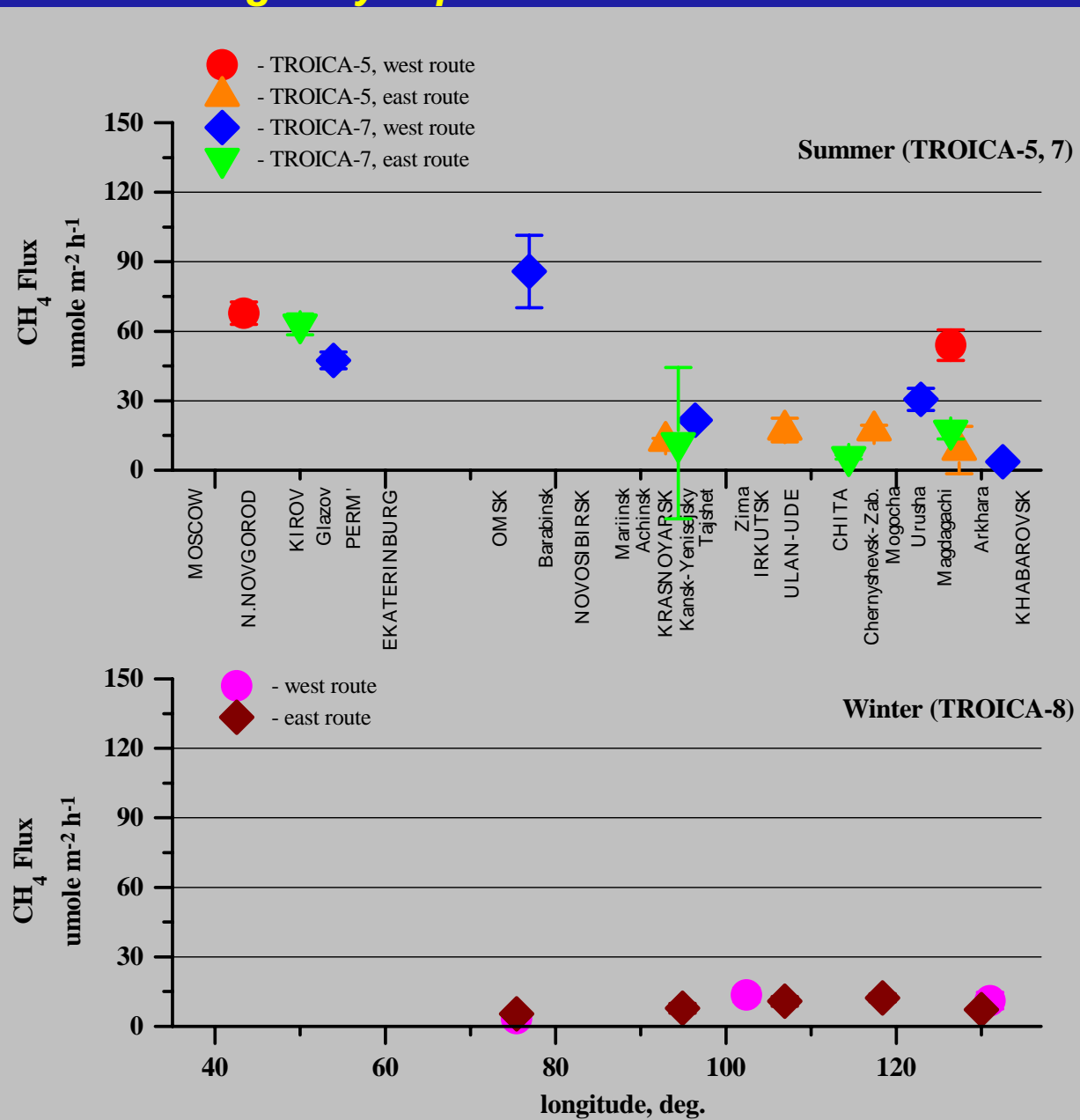
Spatial distribution of CO, CO₂ and CH₄ concentrations between Moscow and Khabarovsk



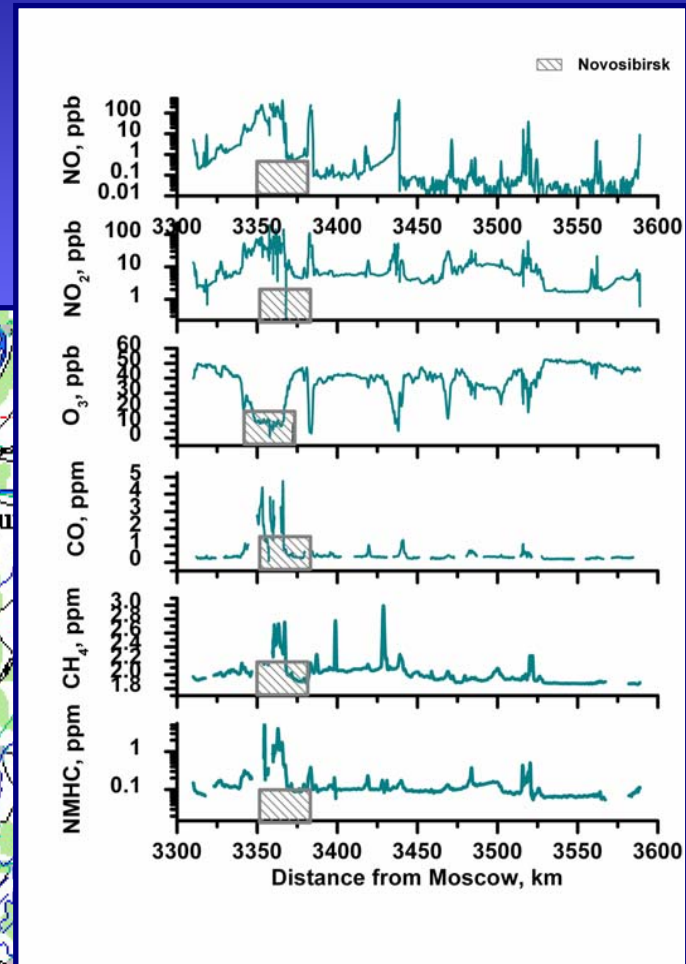
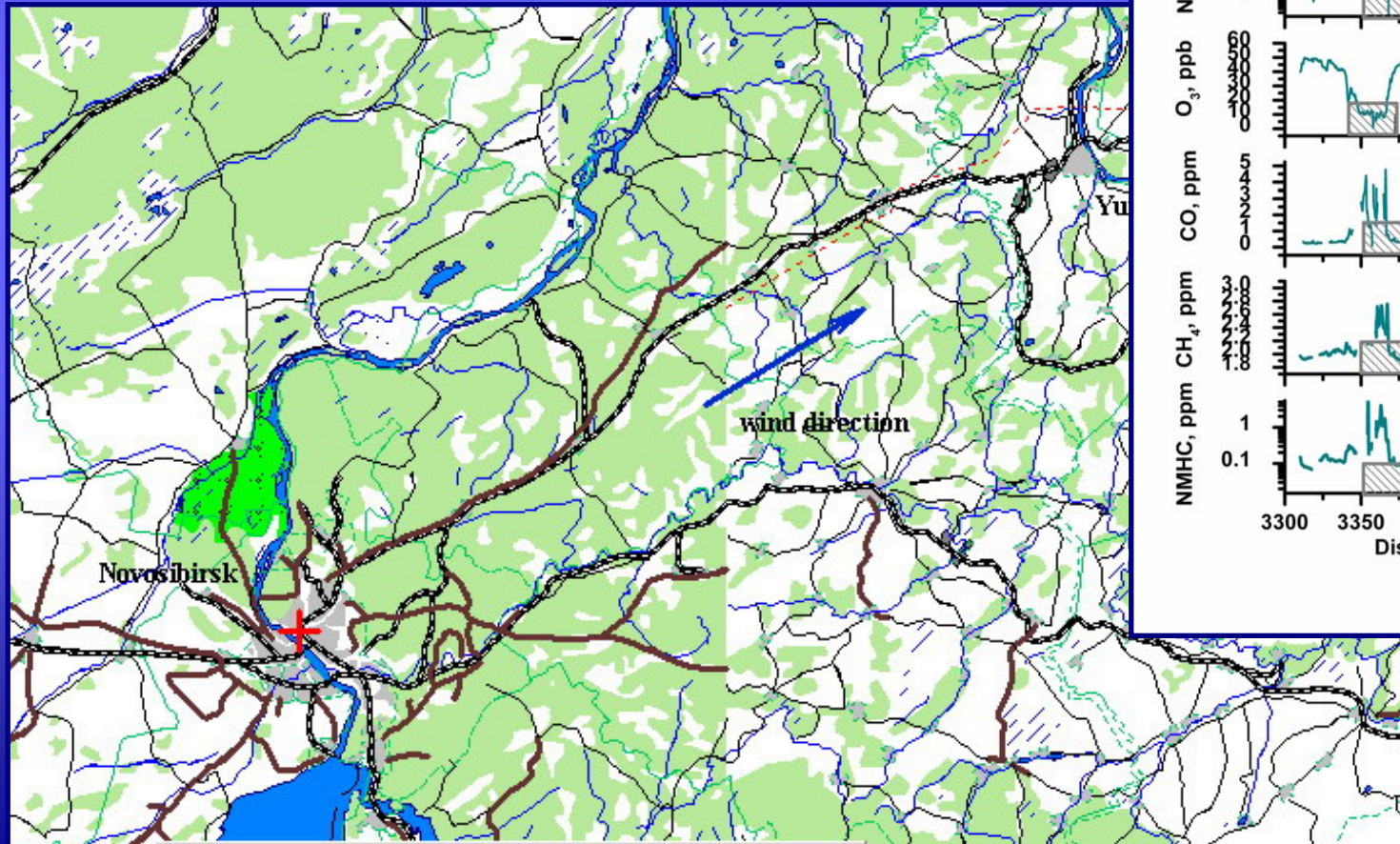
Initial ^{222}Rn concentration data obtained during TROICA-5 and 8 expeditions (averaging 1 deg. longitude)



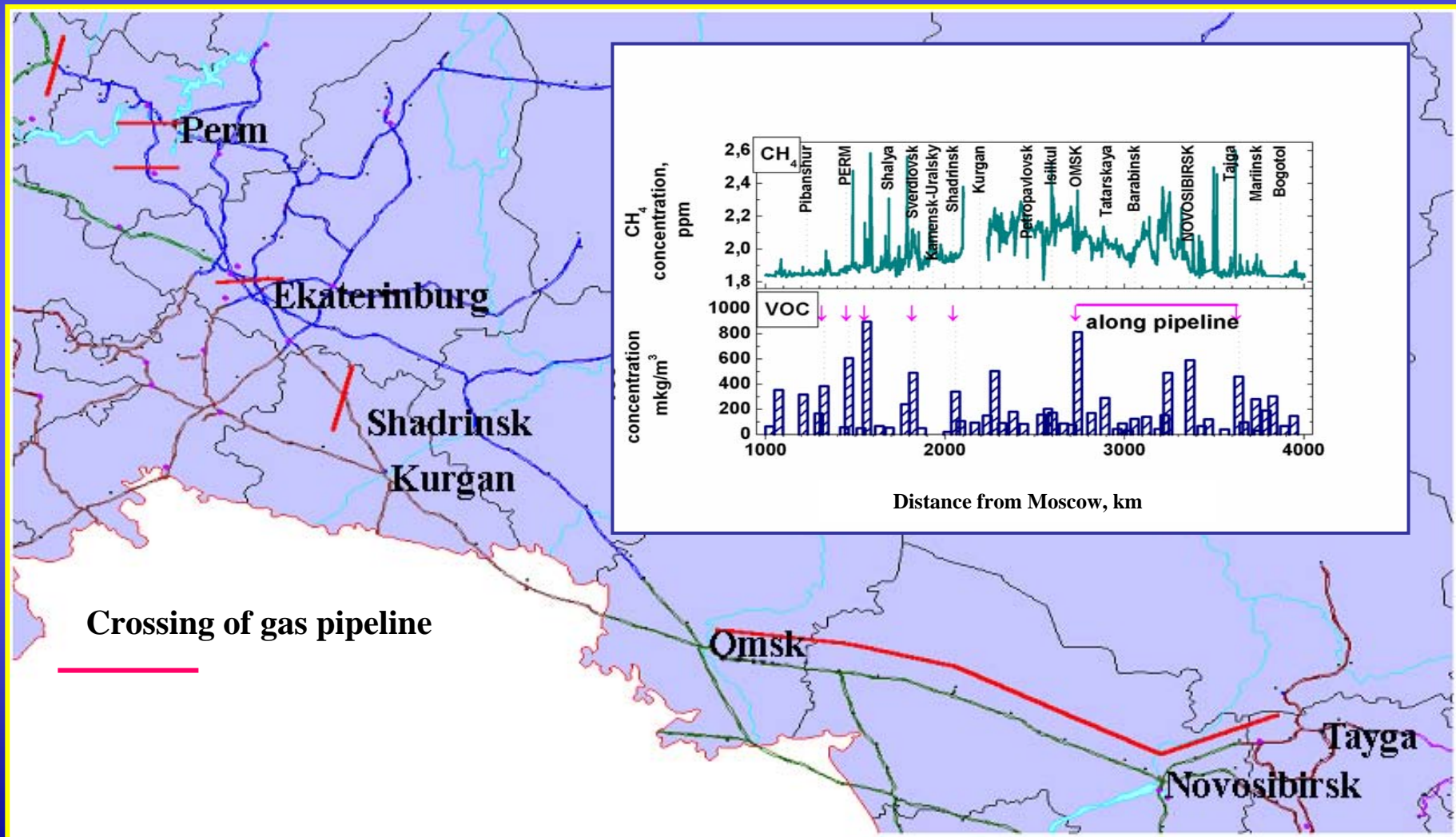
Estimated CH₄ soil fluxes after 222Rn and CH₄ concentration measurements at Transsiberian highway expeditions



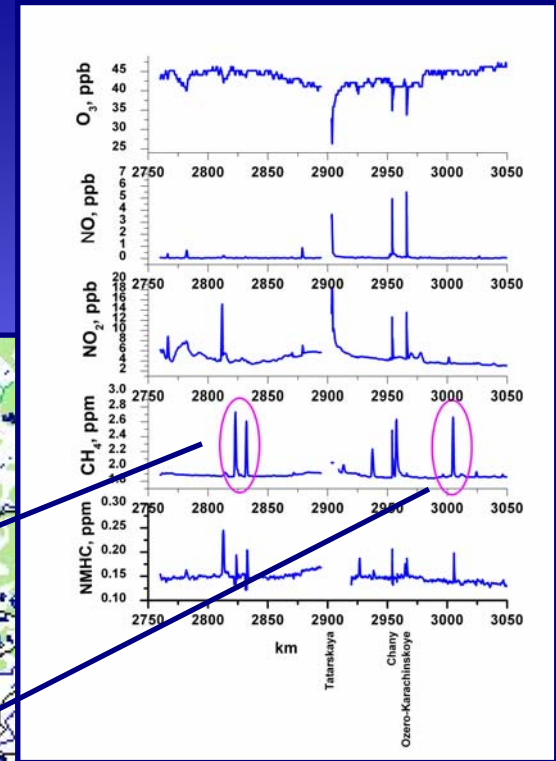
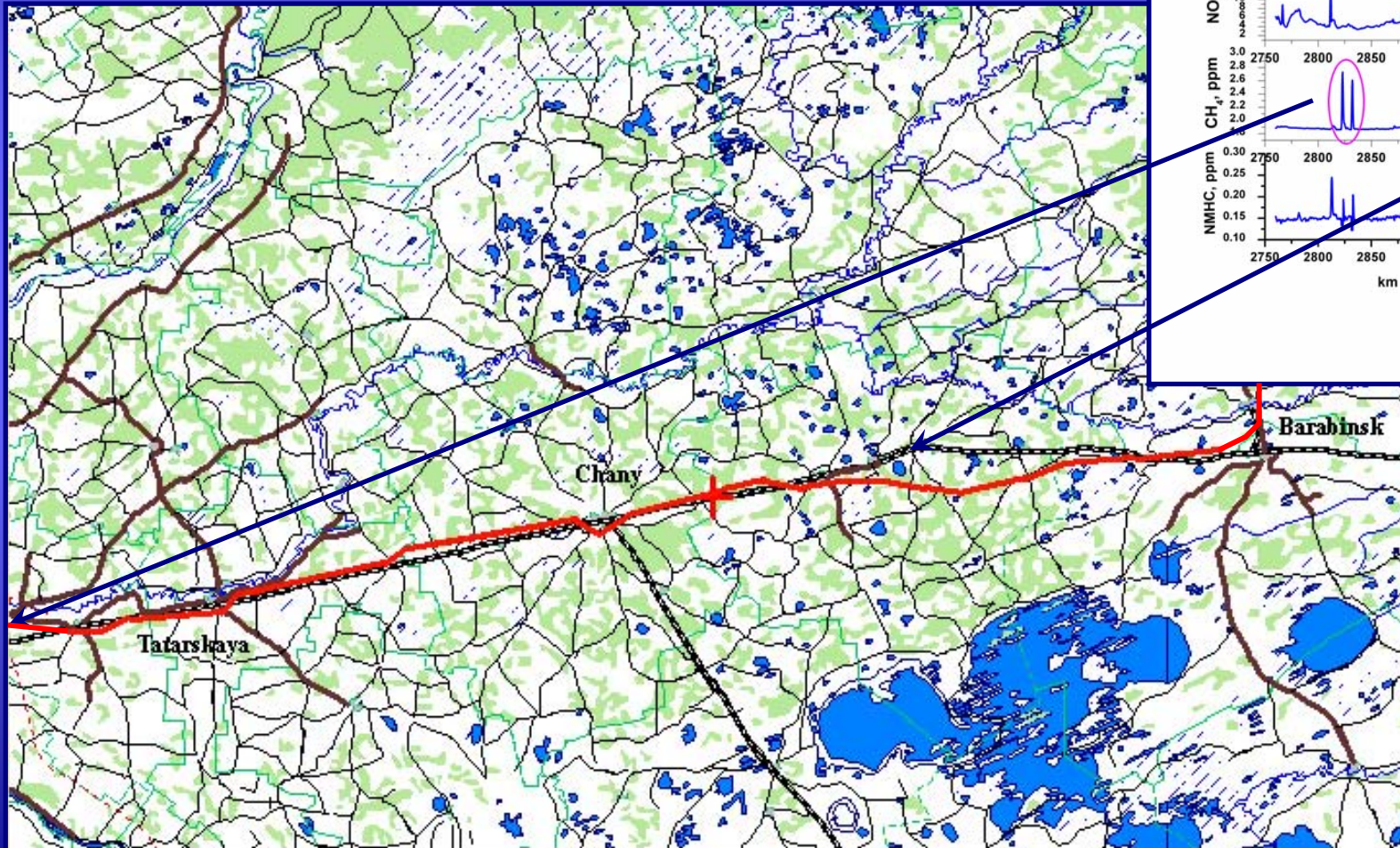
CH₄ and other gases plum from Novosibirsk (30.03.2004)



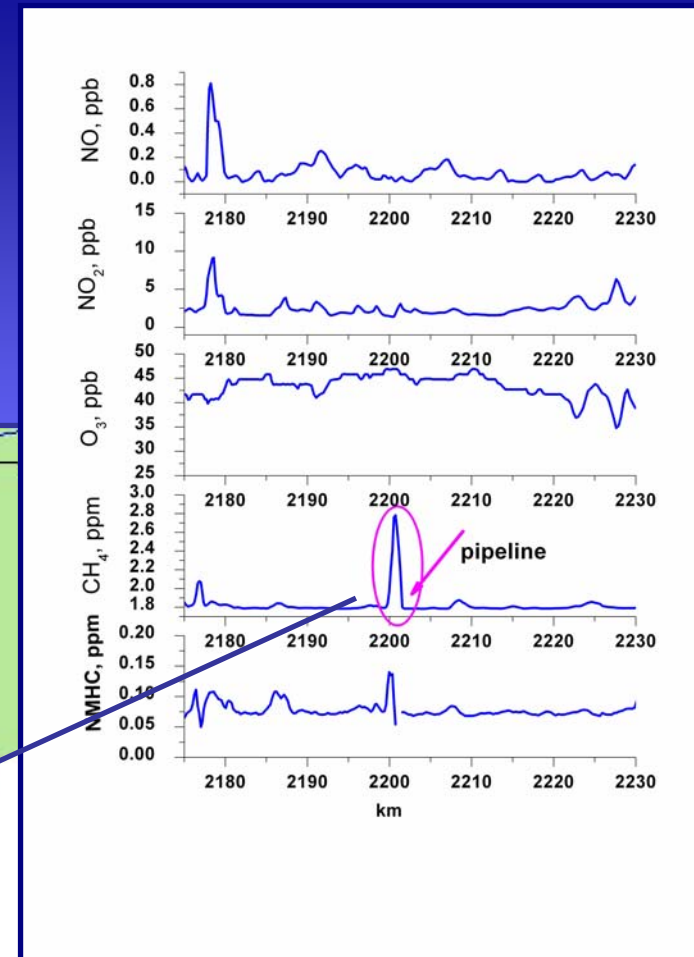
Increase of of methane and VOC concentration at crossing the main gas pipelines



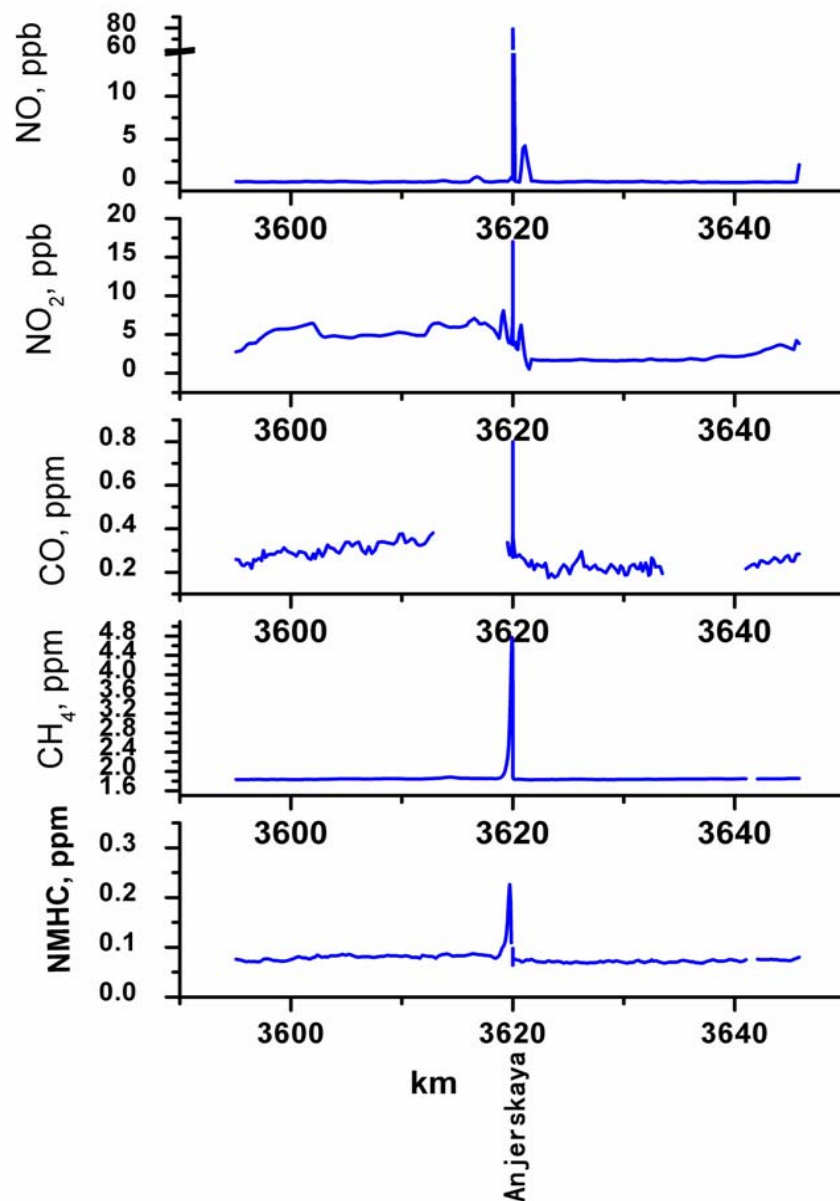
Peaks of CH₄ concentration near the gas pipeline Omsk-Novosibirsk (21.03.2004)



Changes of gases concentrations in the place of crossing main pipelines (Tumen region 30.03.2004)

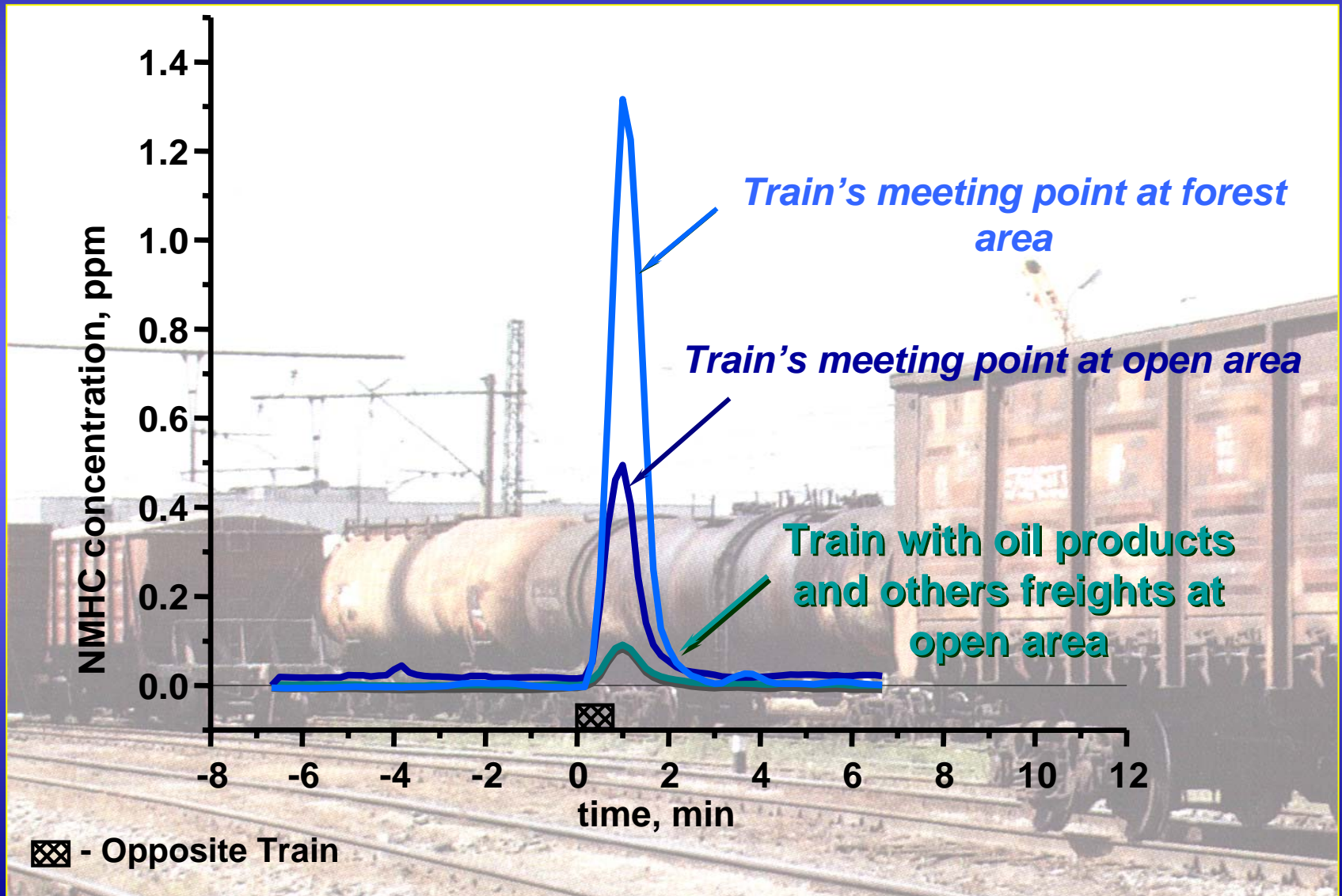


Changes of gas concentrations near Anjerskaya town (active coal mines 29.03.2004)

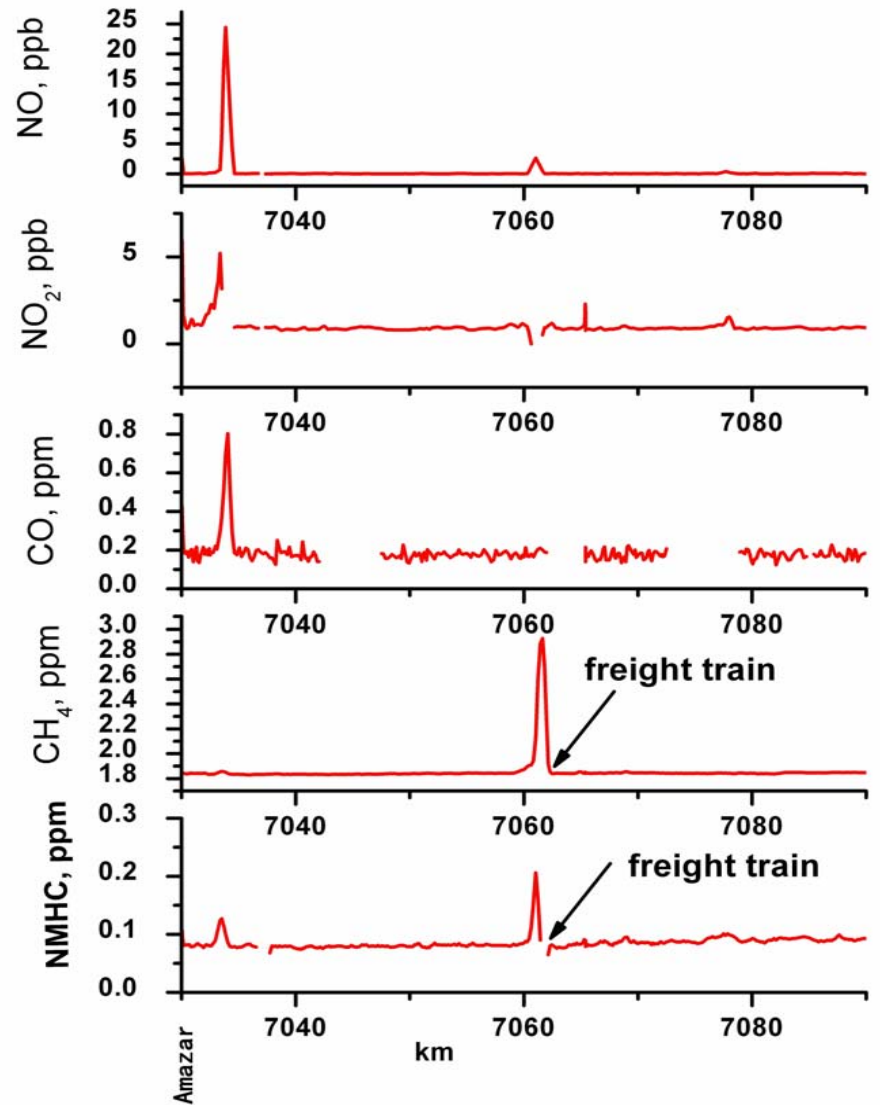


Change of gas concentration at Anjerskaya station in TROICA-8, motion to west

Increasing of NMHC concentrations after opposite train with oil products

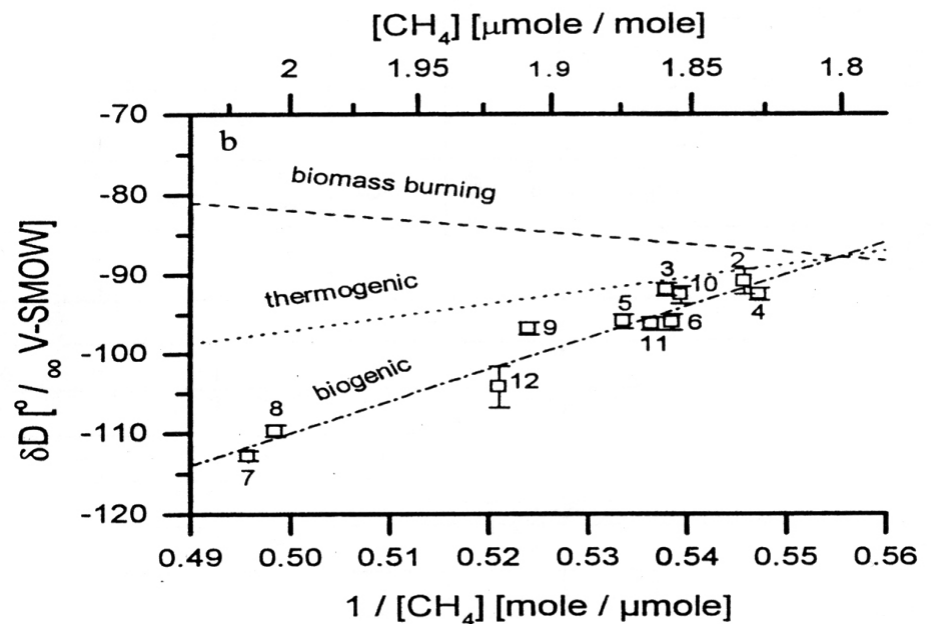
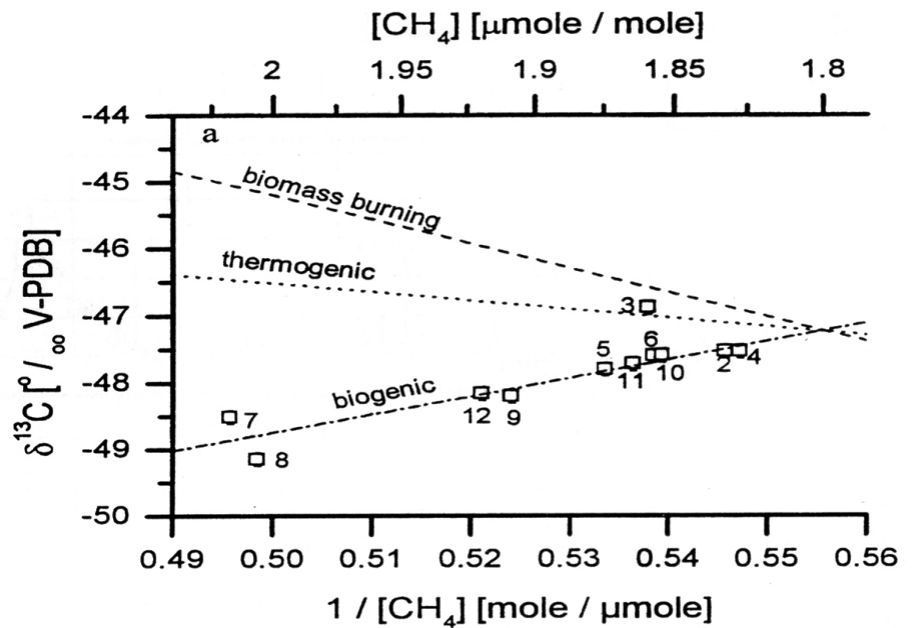


**Example of methane
and other gases
concentrations
variations at the
moment of opposite
freight train passing
(27.03.2004)**

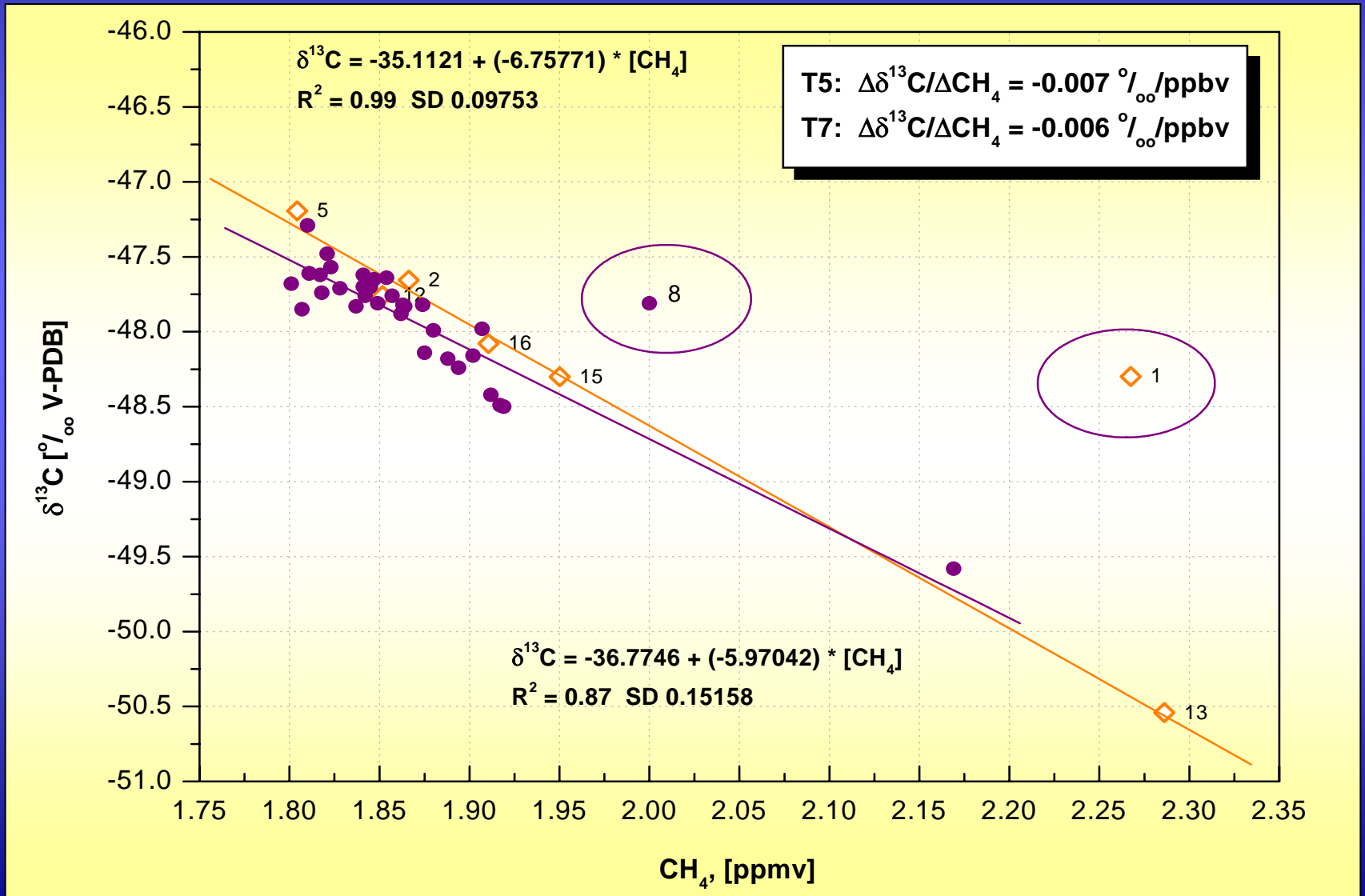


Increase of metan concentration at the passing freight train

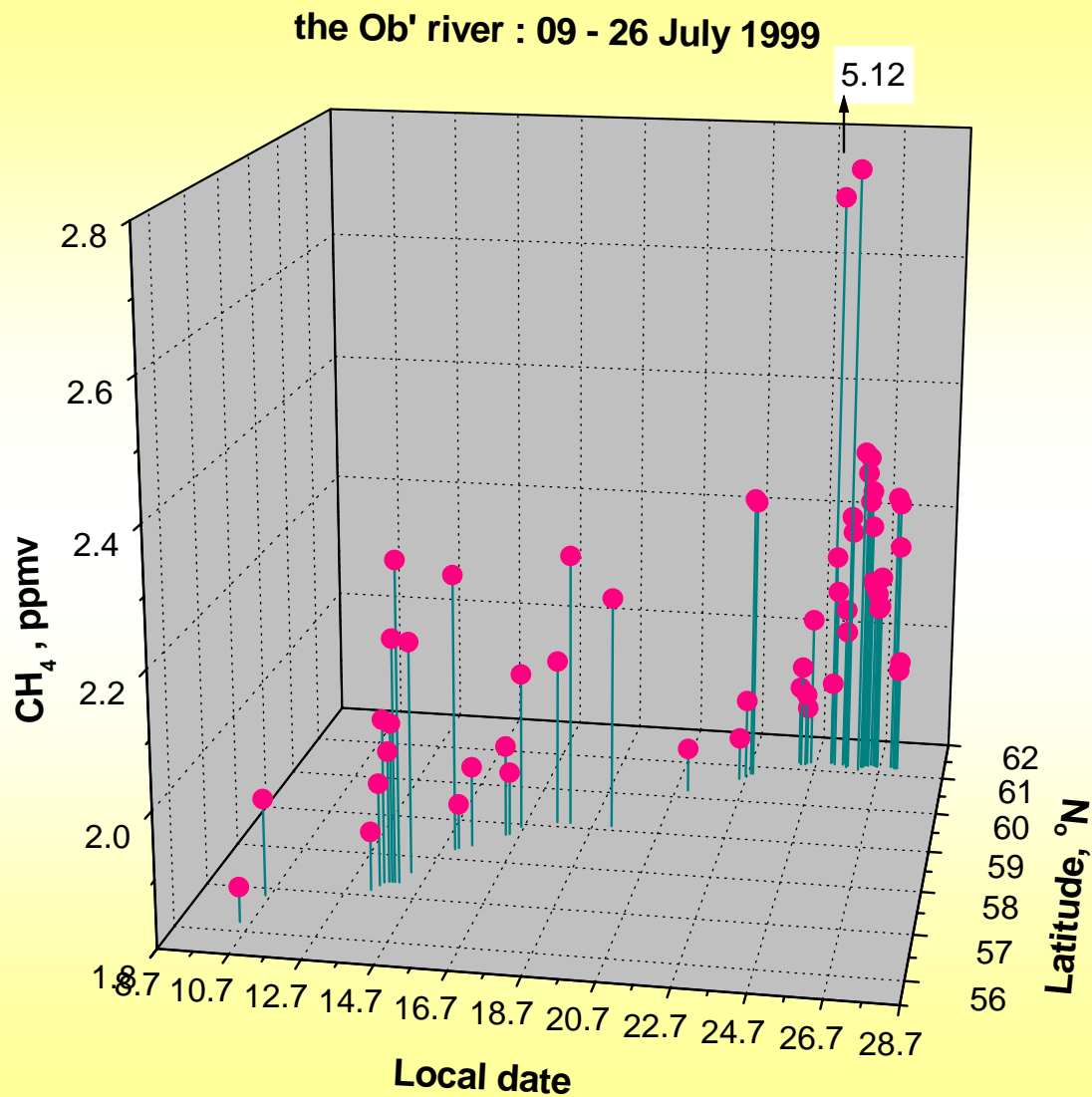
Stable isotopes ^{13}C and D content versus inverse CH_4 concentrations in air samples taken at the route Khabarovsk-Moscow (TROICA-2)



$\delta^{13}\text{C}$ versus the CH_4 concentration for measurements during TROICA 5 from the train and boat (open diamonds) and TROICA 7 (solid circles).



Plot of the CH₄ concentrations against the local time and latitude observed along the Ob river in West Siberia, July 1999 (solid circles mark discrete air sample analyses from the aluminium canisters).



(a) $\delta^{13}\text{C}$ versus inverse CH_4 mixing ratio for TROIICA 5; (b) δD versus inverse CH_4 mixing ratio for TROIICA 5, error bars in (a) and (b) overlap symbols and are not shown; (c) $\delta^{13}\text{C}$ versus inverse CH_4 mixing ratio for TROIICA 7.

