

# **Contribution of Russian terrestrial ecosystems to global soil respiration flux**

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**ENVIROMIS-2010, 5-11 July 2010, Tomsk, Russia**



# **INTRODUCTION**

**The global CO<sub>2</sub> flux from soils is an important regulator of climate change as well as determinant of net ecosystem C balance (Baggs, 2006).**

**The territory of Russia occupies more than 1/9 of the land surface. The role of Russian soils in the global carbon cycle is very considerable;**

**Therefore, more accurate estimates of the carbon fluxes from the terrestrial ecosystems of Russia should be obtained.**

# Previous estimates of total and microbial respiration for Russian territory:

- **Total respiration flux:**
  - 3.12 Pg C yr<sup>-1</sup>** - *only for growing period (Kudeyarov et al., 1995);*
  - 4.50 Pg C yr<sup>-1</sup>** - *for whole year (Kudeyarov, Kurganova, 1998);*
- **Microbial respiration flux:**
  - 2.60-3.05 Pg C yr<sup>-1</sup>** (*Kudeyarov, 2000; Nilsson et al., 2000*).



# **This study was aimed to:**

- (1) gather and analyze the database on soil respiration in Russia;**
- (2) develop a model for the assessment of the annual CO<sub>2</sub> fluxes from soils on the basis of summer CO<sub>2</sub> fluxes observations;**
- (3) calculate the total respiration flux from Russian soils for the whole territory of Russia with the use of geo-information technologies.**

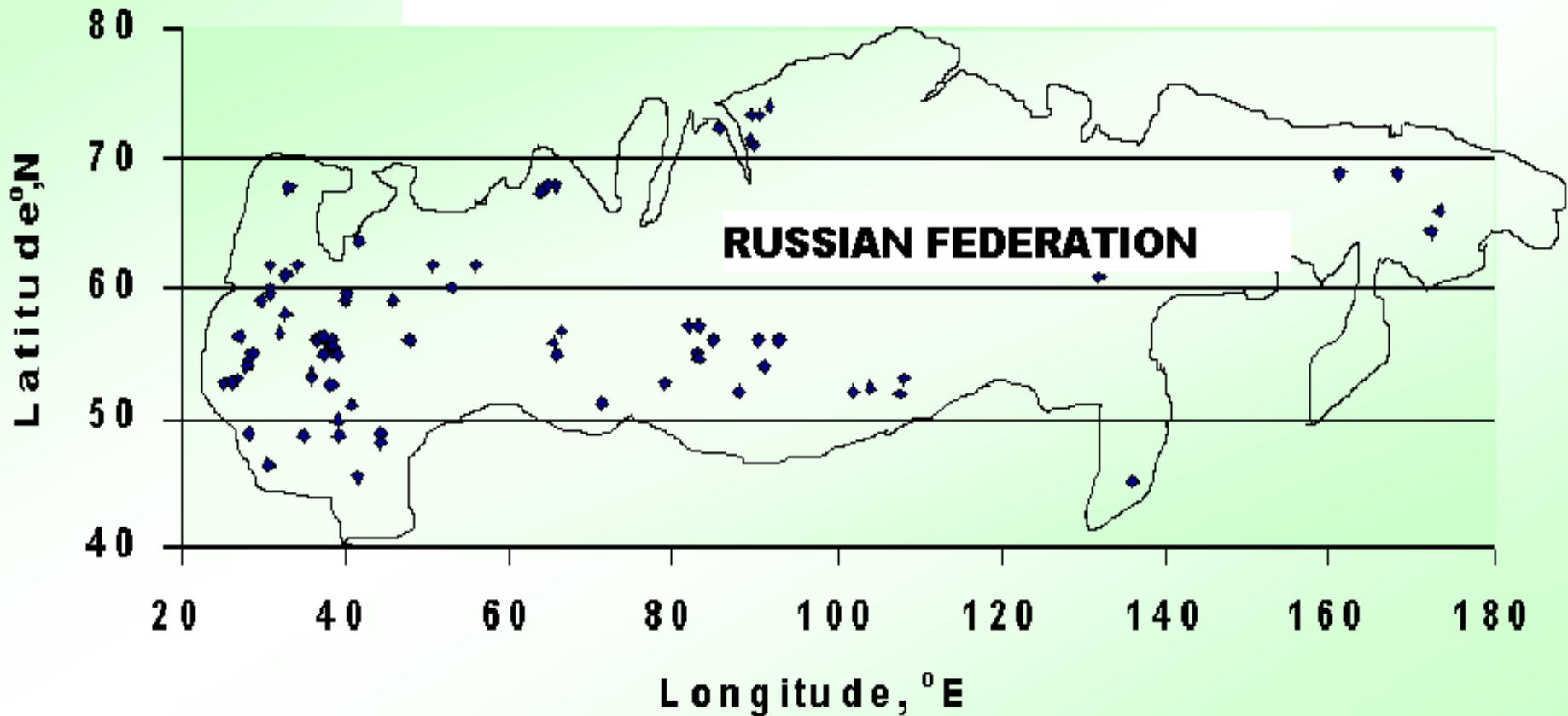


A background image of a dense forest with green foliage and tree trunks, split into two horizontal panels. The top panel shows a close-up of green leaves, while the bottom panel shows a wider view of the forest floor with tree trunks and branches.

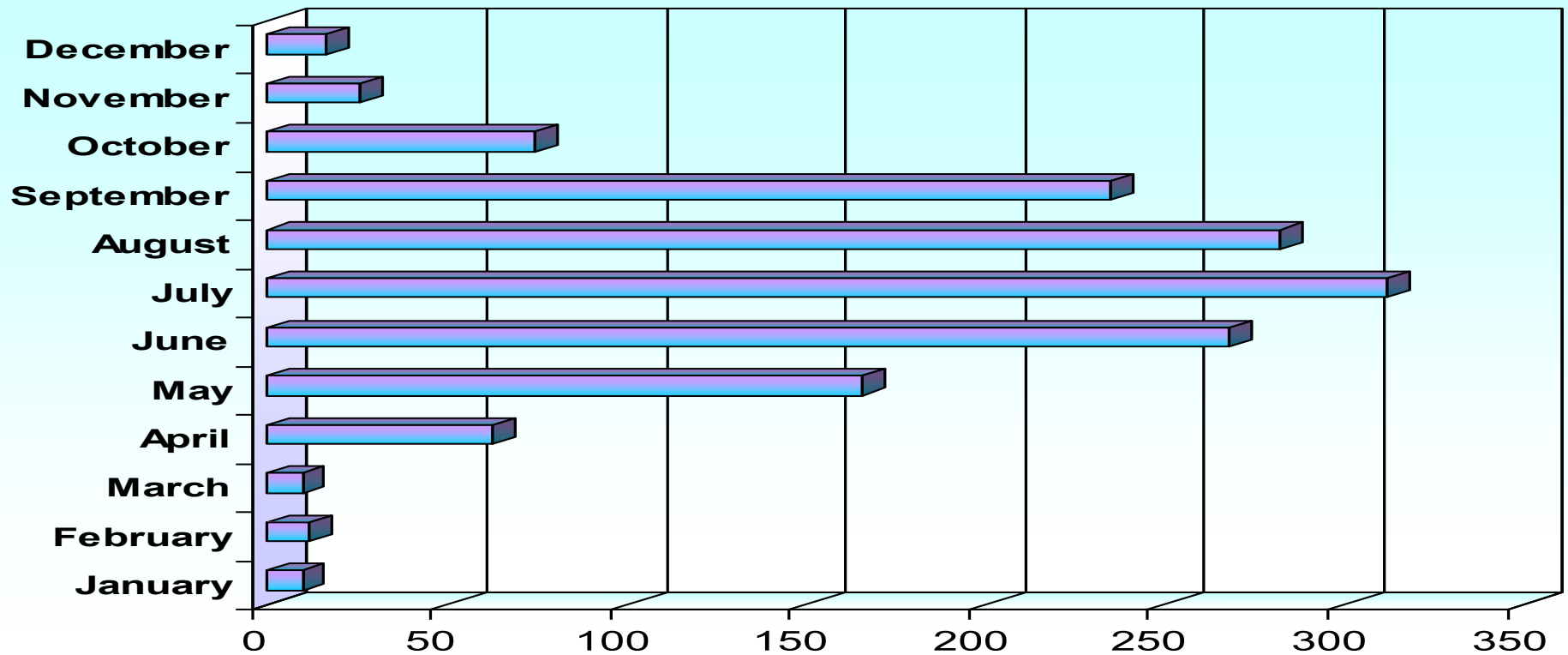
# **Analysis of soil respiration database**

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# Location of sites on soil respiration (SR) measurements

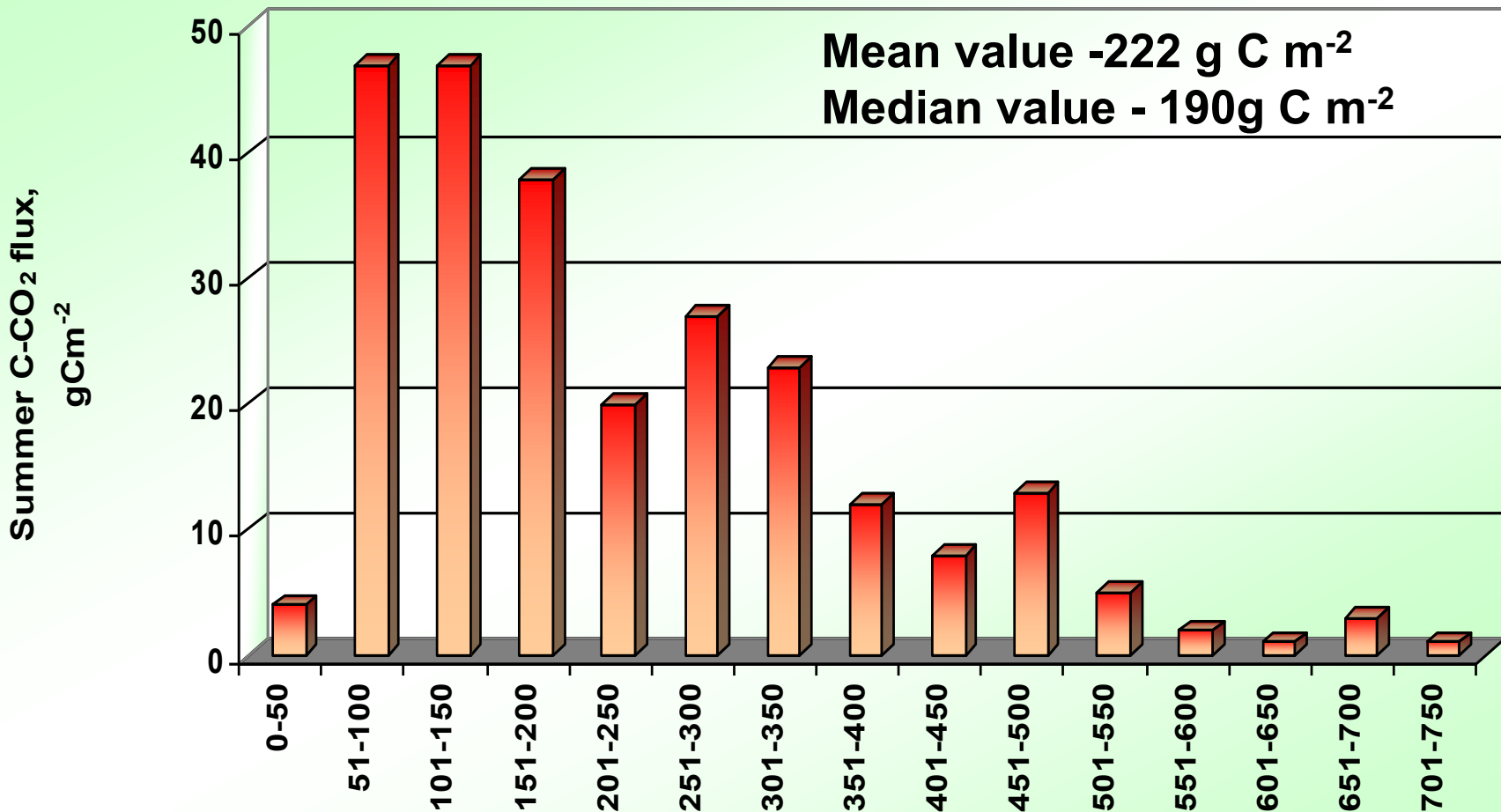


# Histogram of SR measurements according to different months



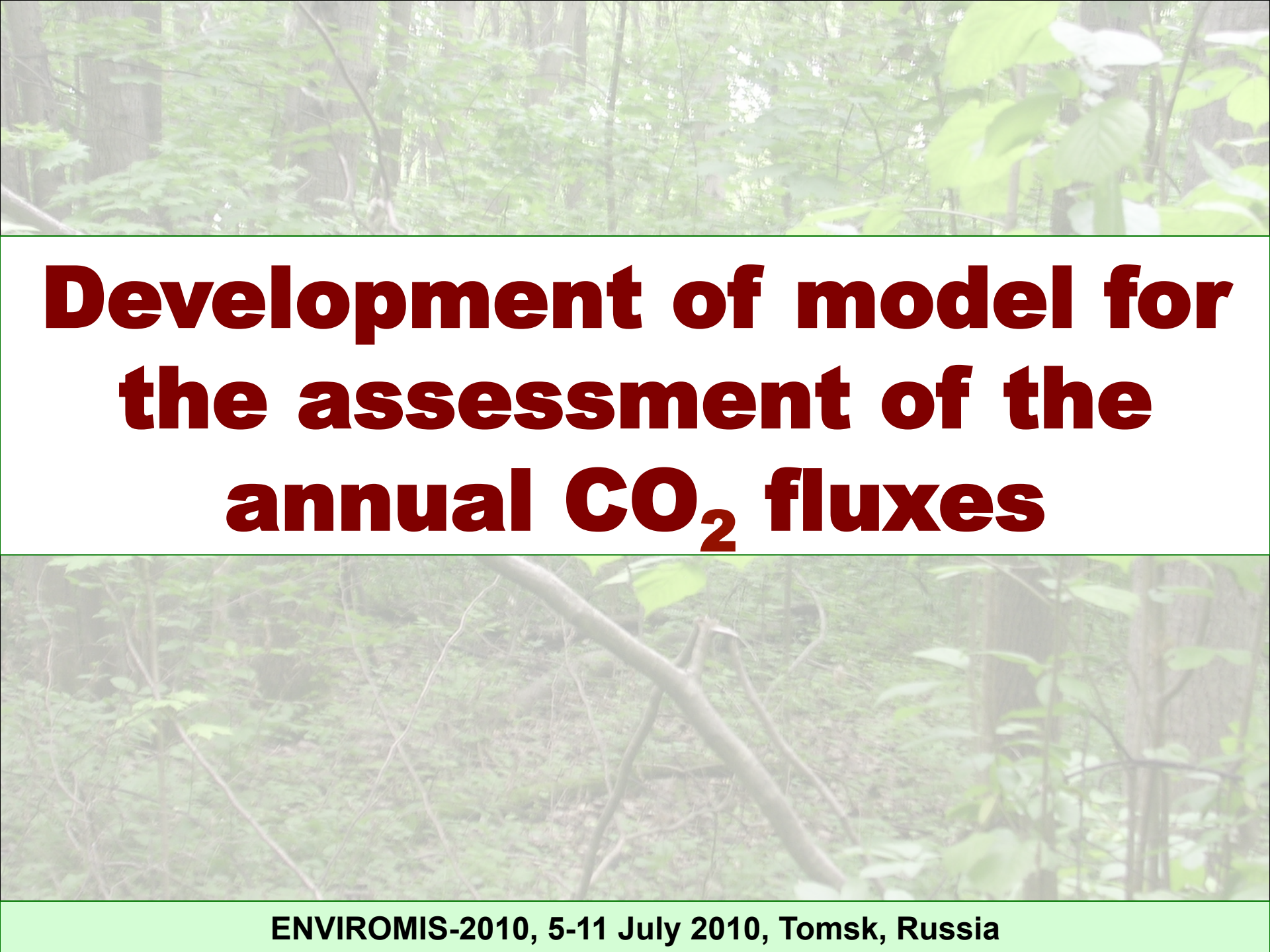
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# Histogram of summer CO<sub>2</sub> fluxes from soils in Russian terrestrial ecosystems



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A background image of a dense forest with green foliage and tree trunks, split horizontally into two sections. The top section shows a close-up of green leaves, while the bottom section shows a wider view of the forest with more tree trunks and branches.

# **Development of model for the assessment of the annual CO<sub>2</sub> fluxes**

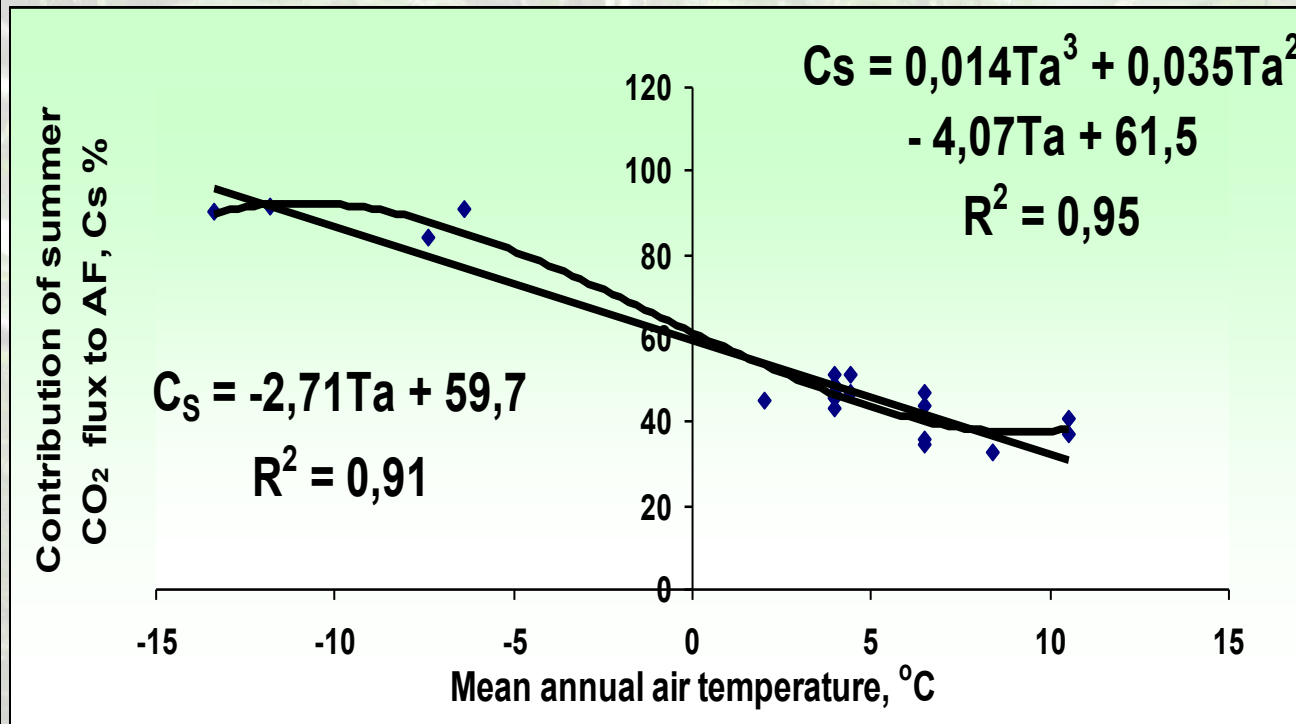
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# Mean annual air temperature and share of summer CO<sub>2</sub> flux (C<sub>S</sub>) to the annual CO<sub>2</sub> flux

N	Soil	Vegetation	Mean annual, air T, °C	C <sub>S</sub> , %	Reference
1	Podbur tundra	Moss-lichen	-13,4	90,2	Zamolodchikov, Karelin, 2001
2	Podbur tundra	Moss-lichen	-11,8	91,3	Zamolodchikov, Karelin, 2001
3	Podbur tundra	Moss-lichen	-7,4	84,2	Zamolodchikov, Karelin, 2001
4	Podbur tundra	Moss-lichen	-6,4	91,0	Zamolodchikov, Karelin, 2001
5	Sandy soil	Spruce forest	2	45,0	Havas&Maenpaa, 1972
6	Sod-podzolic	Forest mixed	4,0	45,6	Lopes de Gerenyu et al., 2001
7	Sod podzolic	Grassland	4,0	45,6	Lopes de Gerenyu et al., 2001
8	Grey forest soil	Forest Mixed	4,0	48,8	Lopes de Gerenyu et al., 2001
9	Grey forest soil	Grassland	4,0	43,1	Lopes de Gerenyu et al., 2001
10	Grey forest soil	Arable	4,0	51,6	Lopes de Gerenyu et al., 2001
11	Podzol (iron)	Pine (scots) forest	4,4	47,3	Pajary, 1995
12	Podzol (iron)	Pine (scots) forest	4,4	51,4	Pajary, 1995
13	Loamy sandy	Beech-spruce forest	6,5	35,9	Dorr&Munich.,1987
14	Peat-bog	Low bog	6,5	44,0	Adam, Star, 1997
15	Brownerde	Spruce Forest	6,5	46,9	Adam, Star, 1997
16	Kolluvisol	Grassland	6,5	34,8	Adam, Star, 1997
17	Soil	Crops	8,4	32,9	Monteith et al., 1964
18	Soil	Sweet Chestnut	10,5	37,4	Anderson, 1973
19	Soil	Beech	10,5	40,9	Anderson, 1973



# Models for calculation of total annual CO<sub>2</sub> flux (AF):



**C<sub>s</sub>** - contribution of summer CO<sub>2</sub> flux (F<sub>s</sub>) to AF, %;

**T<sub>a</sub>**- mean annual air temperature, °C;

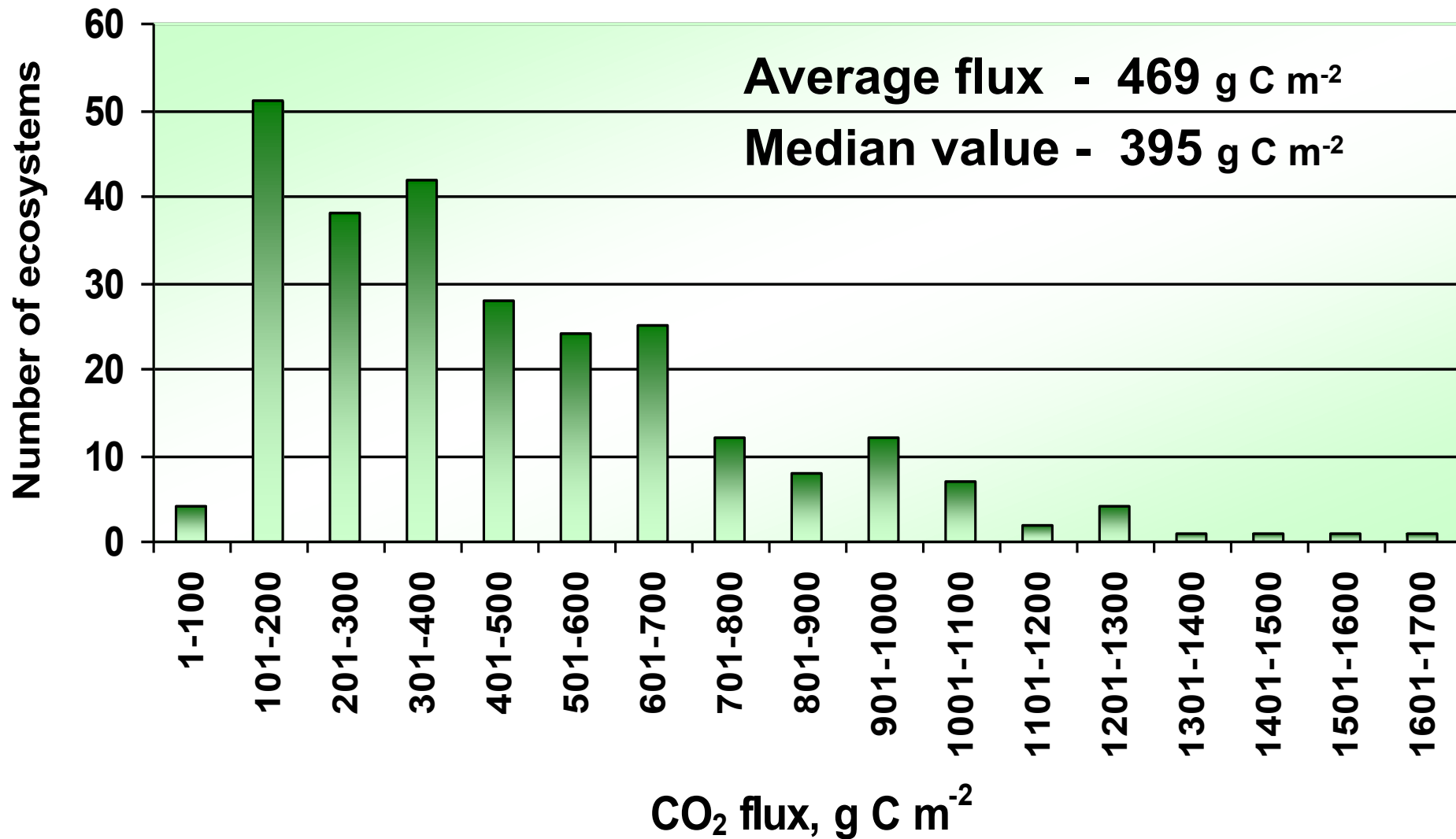
## We know (from data base):

- summer CO<sub>2</sub> flux **F<sub>s</sub>**;
- mean annual air temperature, **T<sub>a</sub>**;

## We can calculate:

- C<sub>s</sub>** (according to model),  
**AF = F<sub>s</sub> \* 100 / C<sub>s</sub>**

# Histogram of annual CO<sub>2</sub> fluxes from soils in Russian forest zone



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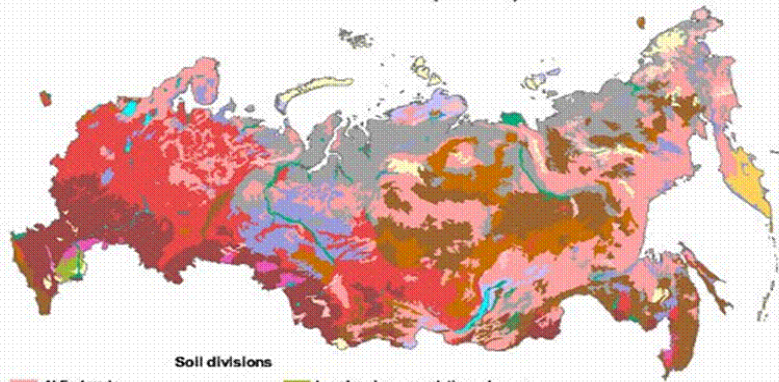
**Estimate of total  
respiration flux from  
Russian soils**



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# Soil division and soil respiration maps

Soil divisions (Russia)

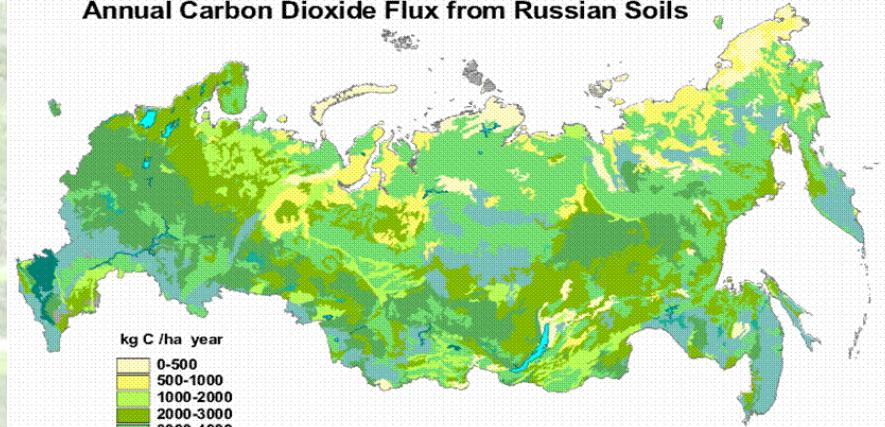


- Soil divisions
- Al-Fe-humic
  - Alcaline clay-differentiated
  - Alluvial
  - Cryozems
  - Gleyszems
  - Halomorphic
  - Humic-accumulative
  - Lithozems
  - Low-humic accumulative-calcareous
  - Metamorphic
  - Peat
  - Shallow weakly developed
  - Sod organic-accumulative
  - Texture-differentiated
  - Volcanic
  - Nonsoil formation (sands, rock outcrops, glaciers)

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Annual Carbon Dioxide Flux from Russian Soils

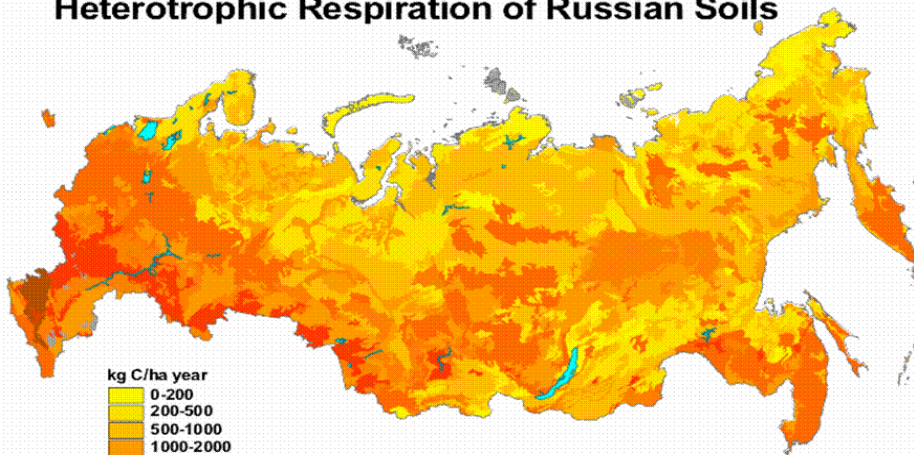


- kg C /ha year
- 0-500
  - 500-1000
  - 1000-2000
  - 2000-3000
  - 3000-4000
  - 4000-6000
  - 6000-8000
  - 8000-10000
  - >10000
  - Nonsoil objects
  - Water

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Heterotrophic Respiration of Russian Soils

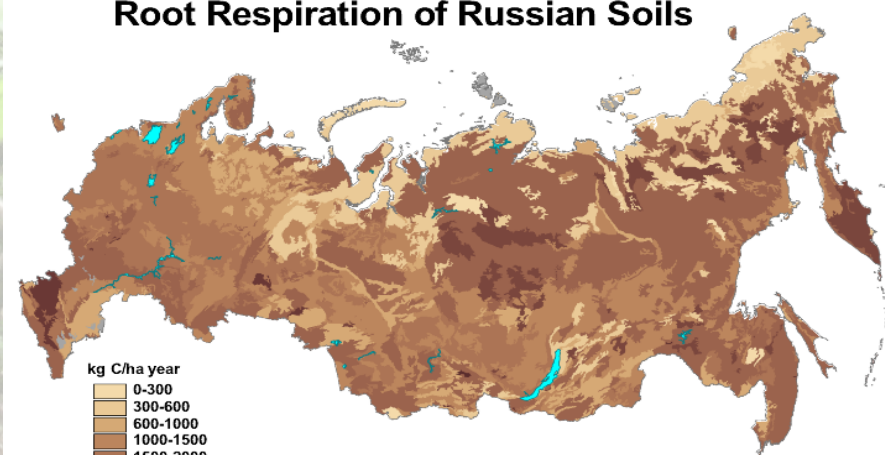


- kg C/ha year
- 0-200
  - 200-500
  - 500-1000
  - 1000-2000
  - 2000-3000
  - 3000-4000
  - 4000-6000
  - 6000-8000
  - >8000
  - Nonsoil objects
  - Water

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Root Respiration of Russian Soils



- kg C/ha year
- 0-300
  - 300-600
  - 600-1000
  - 1000-1500
  - 1500-2000
  - 2000-3000
  - 3000-4000
  - 4000-5000
  - >5000
  - Nonsoil objects
  - Water

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# Contribution of Russian terrestrial ecosystems to global C-fluxes

Parameter	World	Russia	
		abs.units	%
Area, million km <sup>2</sup>	<b>148.65</b>	<b>17.08</b>	<b>11.5</b>
<b>NPP, Gt C/yr</b>	<b>60</b>	<b>4.41</b>	<b>7.4</b>
<b>TSR, Gt C/yr</b>	<b>64-72</b>	<b>5.67</b>	<b>7.9-9.3</b>
Industrial CO <sub>2</sub> emission, Gt C/yr	<b>7.7</b>	<b>0.41</b>	<b>2.5</b>
Soil organic C pool (0-100cm), Gt C	<b>1500</b>	<b>296</b>	<b>20</b>
<b>C-balance, Gt C/yr</b>	<b>2.7</b>	<b>0.91</b>	<b>33.7</b>

# Conclusions:

▮ The presented estimation of total CO<sub>2</sub> flux from Russian terrestrial ecosystems (5.67 Gt/yr) could be approximately addressed to the 1990s – the initial period of Kyoto Protocol.

▮ Uncertainties of this estimation depend upon amount and quality of available experimental data, accuracy and resolution of the soil map at scale 1:5 million, spatial aggregation techniques and regression models used.

▮ To update this estimate, it needs to increase the numbers and the geographical representatives of long-term measurements, and to use up-to-date areas of croplands, grasslands and forests on Russian territory.





**Thank you for attention!**

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