



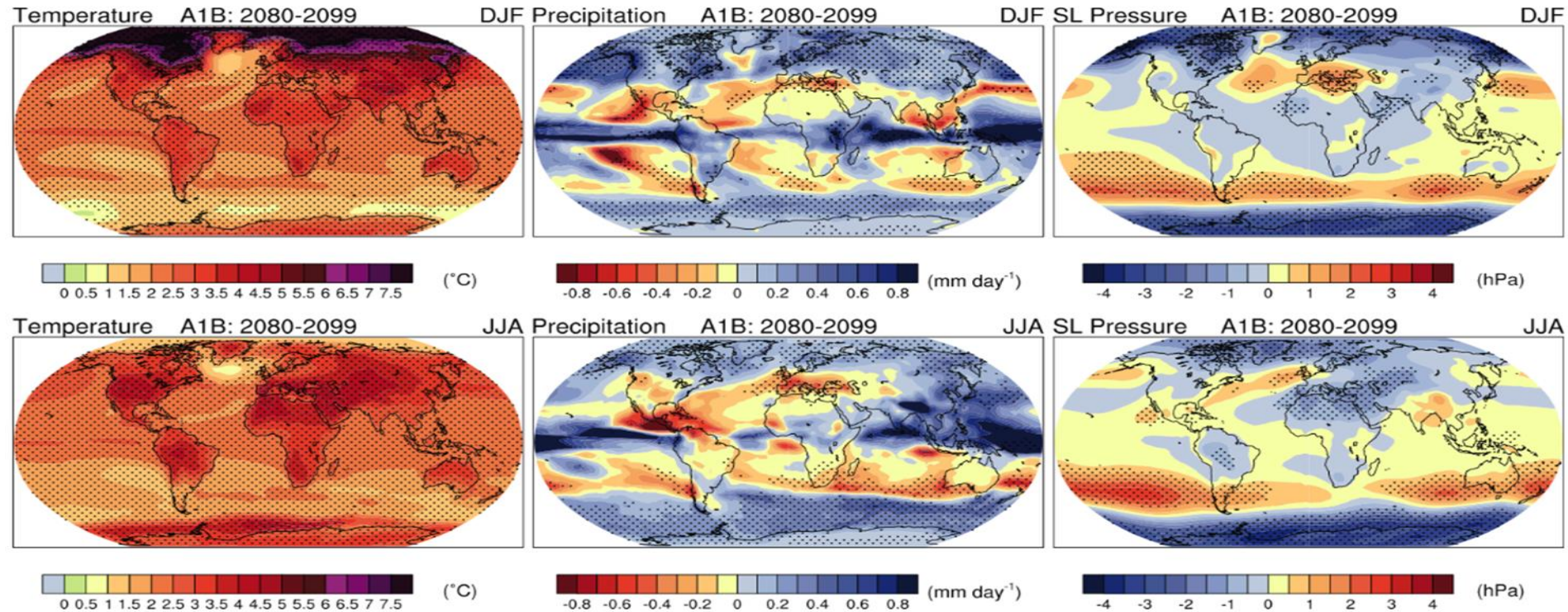
STUDY OF PERMAFROST-DOMINATED ECOSYSTEMS OF NORTH-EASTERN EURASIA UNDER THE CONDITIONS OF GLOBAL WARMING AND INCREASING ANTHROPOGENIC PRESS IN THE LATE XX - EARLY XXI CENTURIES

Trofim Chr. MAXIMOV, Dr.Sci., Prof.

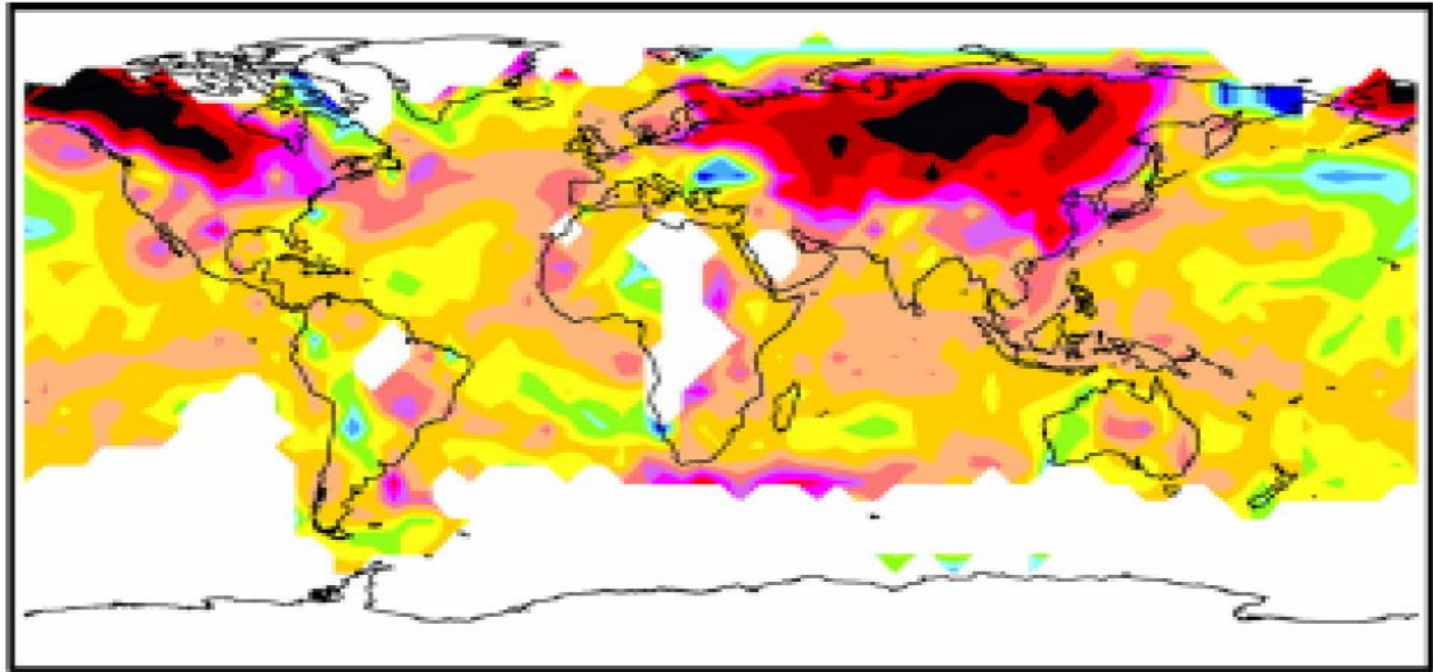
* Federal Research Center “Yakutian Scientific Center SB RAS”,
Institute for Biological Problems of Cryolithozone, SB RAS

** Russian Society of Plant Physiologists

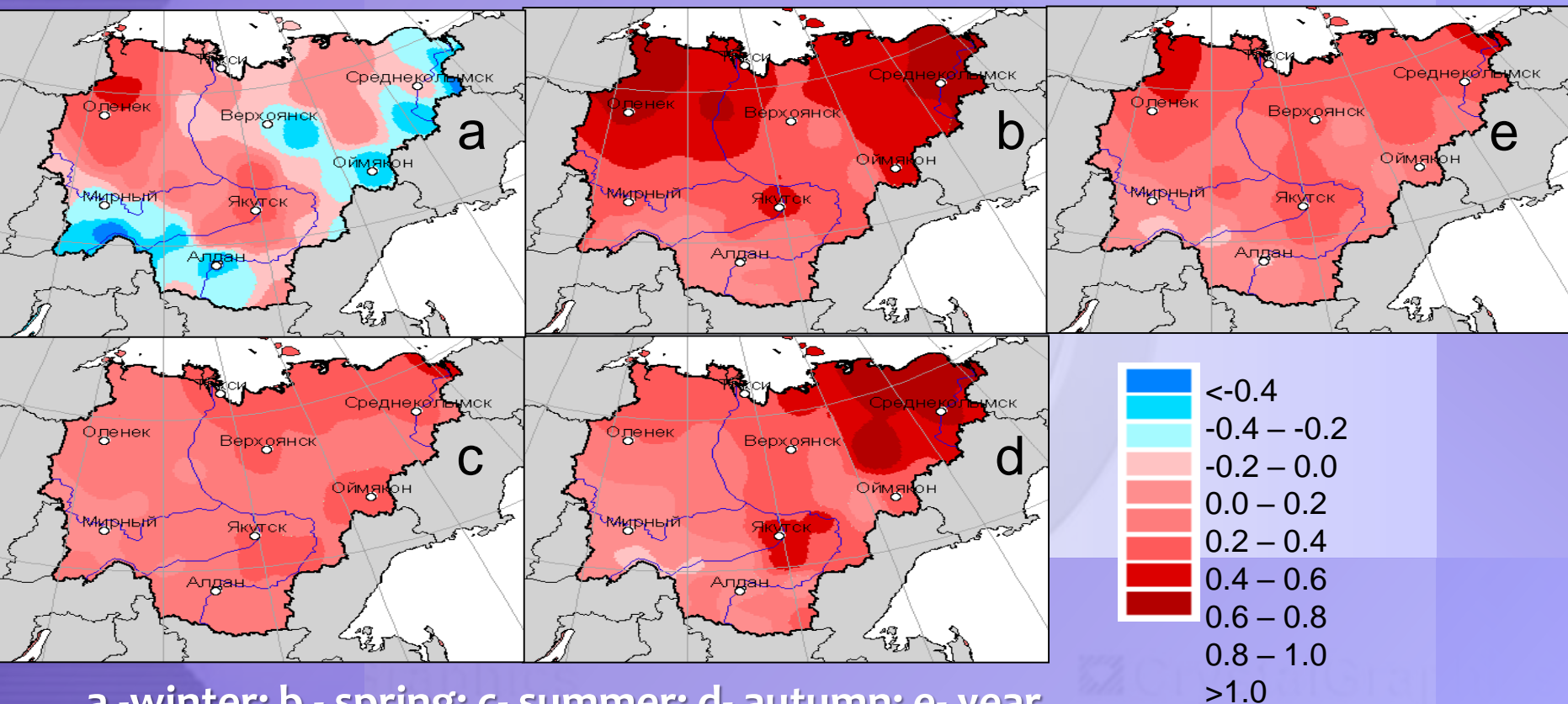
Strong global warming is expected in Arctic regiond (IPCC report, 2010)



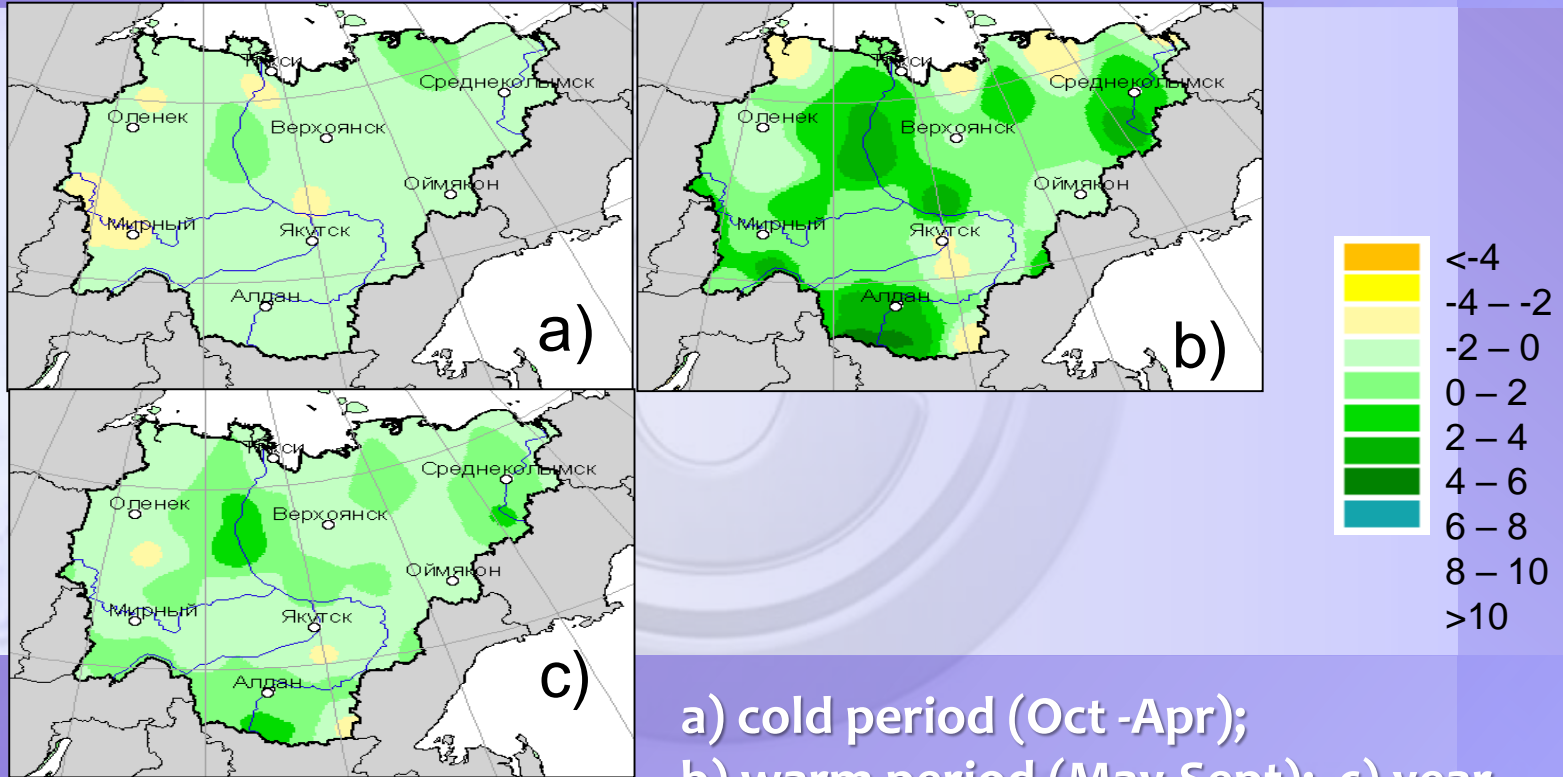
Changing of winter temperature, 1965-2014



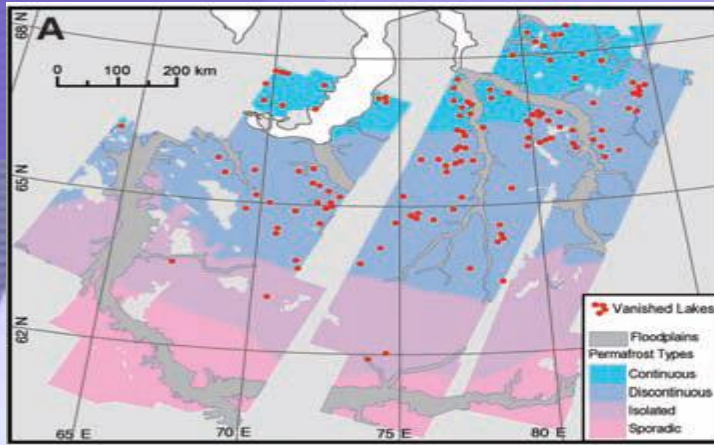
Air temperature trends ($^{\circ}\text{C}$ for 10 year), 1978-2015 гг.



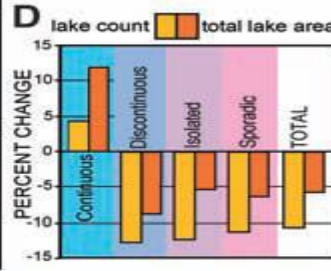
Precipitation trend, 1978-2015



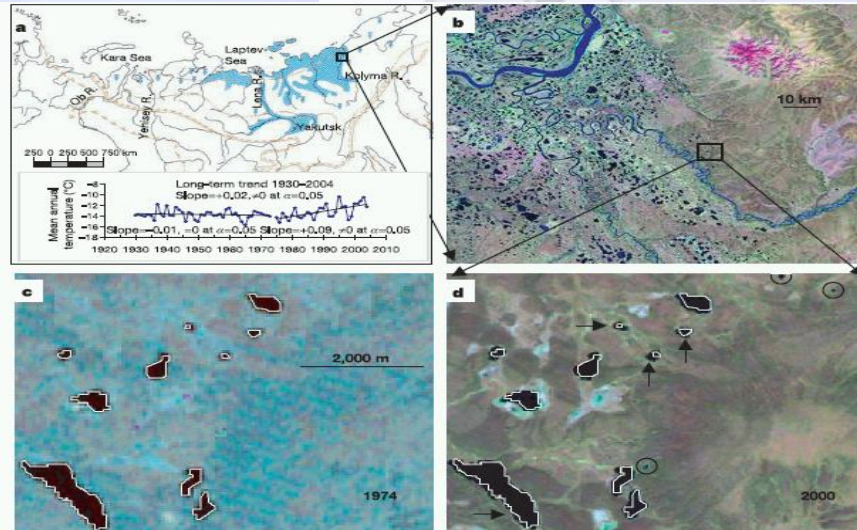
a) cold period (Oct -Apr);
b) warm period (May-Sept); c) year



12 %



by Smith et al. (2005; Science)



14.7%

by Walter et al. (2006; Nature)

Discoloration of boreal larch forest near Yakutsk. June 2008



Soil erosion and landslides at Yakutia



Increasing of thermocarst process near town



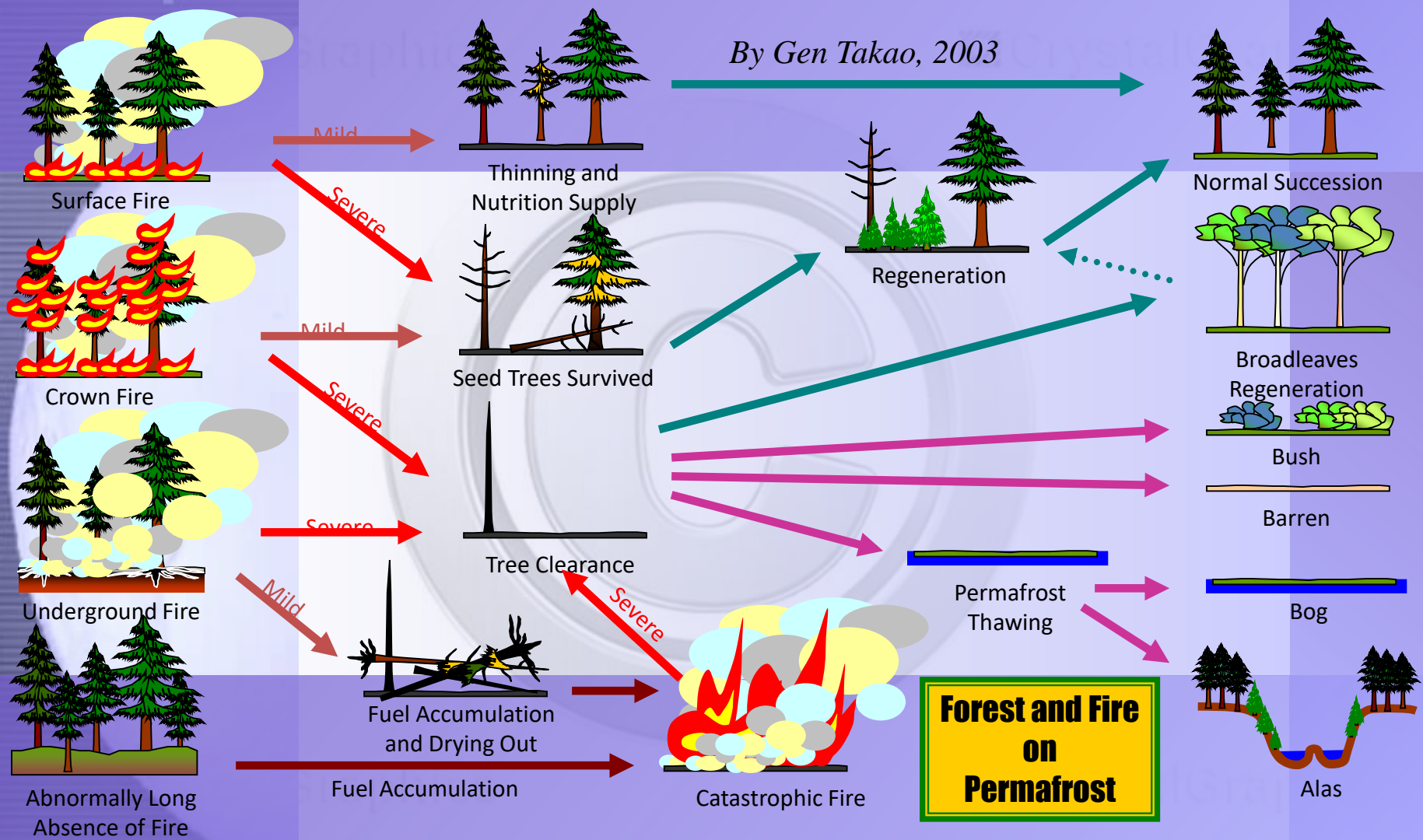
Number of described plant and animal species in Yakutia

Group of organisms	Year			
	1935	1965	1995	2000
Fungi			241	>500
Plants:				
- vascular	1190	1560	1839	1916 (76%*)
- cryptogams	577	1830	3609	3609 (62%)
including:				
- mosses	181	236	444	517 (55%)
- lichens	42	300	550	705 (67%)
- algae	354	1300	2615	2836 (65%)
Animals:				
- insects	600	1100	4000	4300(40%)
- fishes (species and forms)	36	53	53	53(97%)
- amphibians	2	2	4	5(99%)
- reptiles	2	2	2	2(99%)
- birds	138	250	280	291(92%)
- mammals	37	60	63	75(98%)

*in parentheses - supposed % of examination

Solomonov, 2004

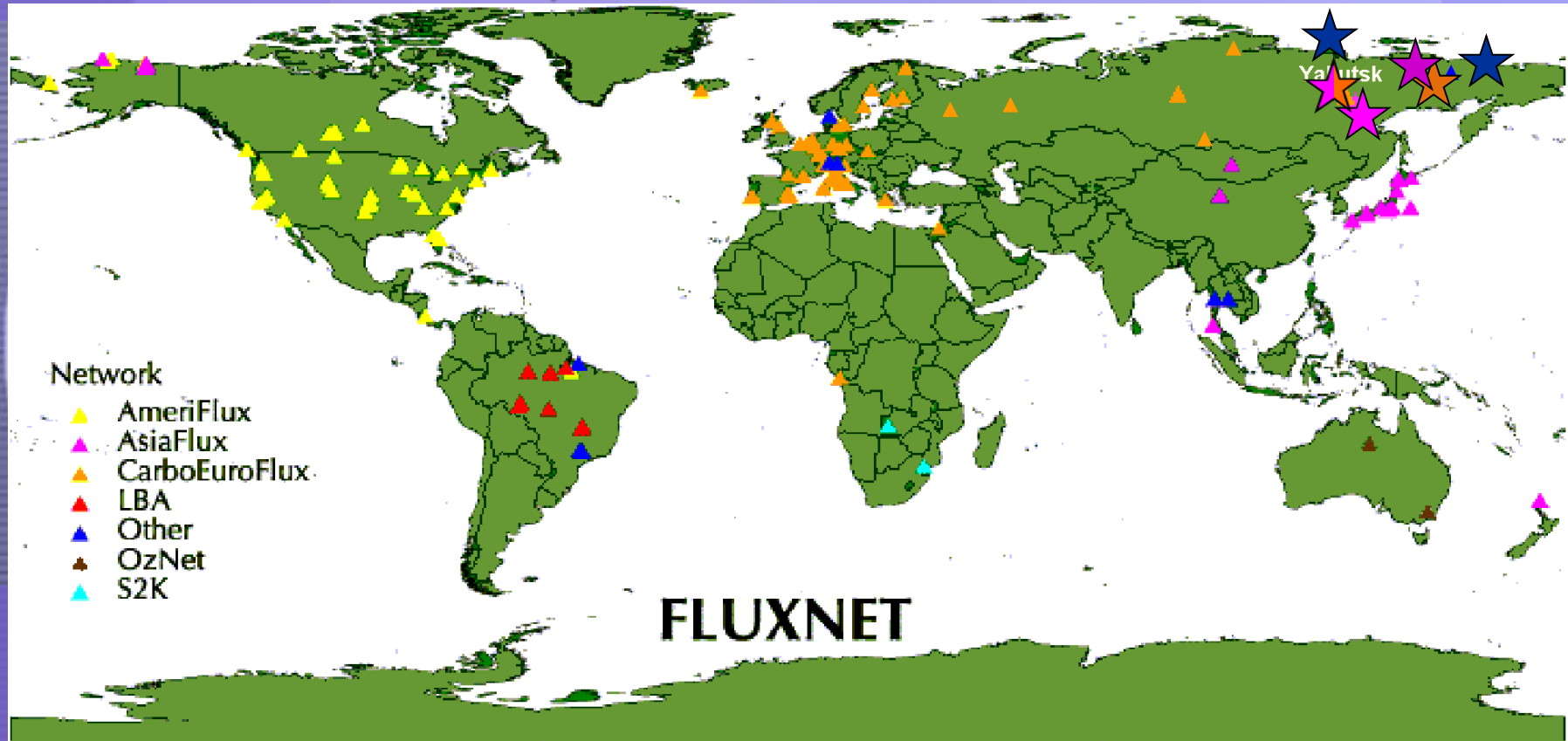
By Gen Takao, 2003



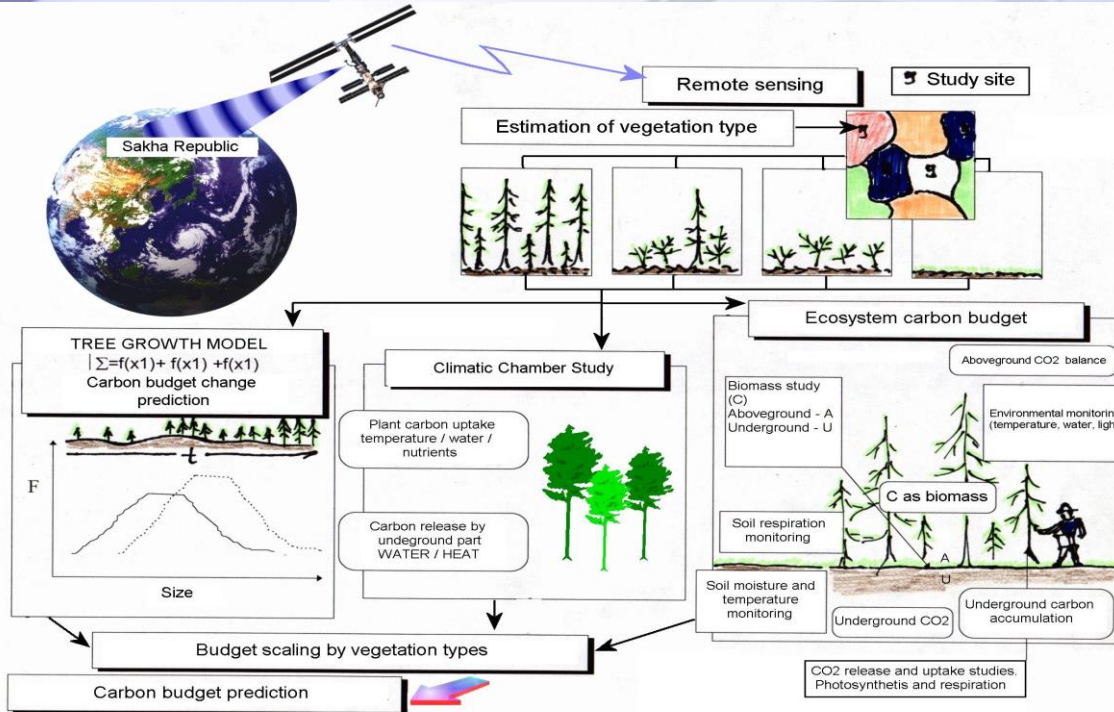
Direct Fire Emissions of 1998

- **Total burnt area** 9.8 million ha
- **Including forest land** 6.6 million ha
- **Consumed organic matter** 154 Tg C
- **Emissions to the atmosphere**
 - 459 Tg CO₂
 - 1.4 Tg CH₄
 - 8.5 Tg of particles
 - 45 Tg CO
 - 1.0 Tg NMHC
 - 1.6 Tg NO₂

Global, continental and regional observational networks of heat, water and carbon dioxide fluxes



The main purpose of research is to carry out interdisciplinary scientific research to address fundamental issues that reveal a complete real picture of the status of the environment, the nature of the interaction of all its parts (atmosphere, biosphere, hydrosphere, cryolithosphere), their impact on biodiversity, parameterization of ecosystems and forecasting and mitigation of possible directions and the consequences of global changes in the environment, as well as for solving the tasks of short-term monitoring of various aspects of human life



4M methodology is using for research on climate change at local, regional and global scales

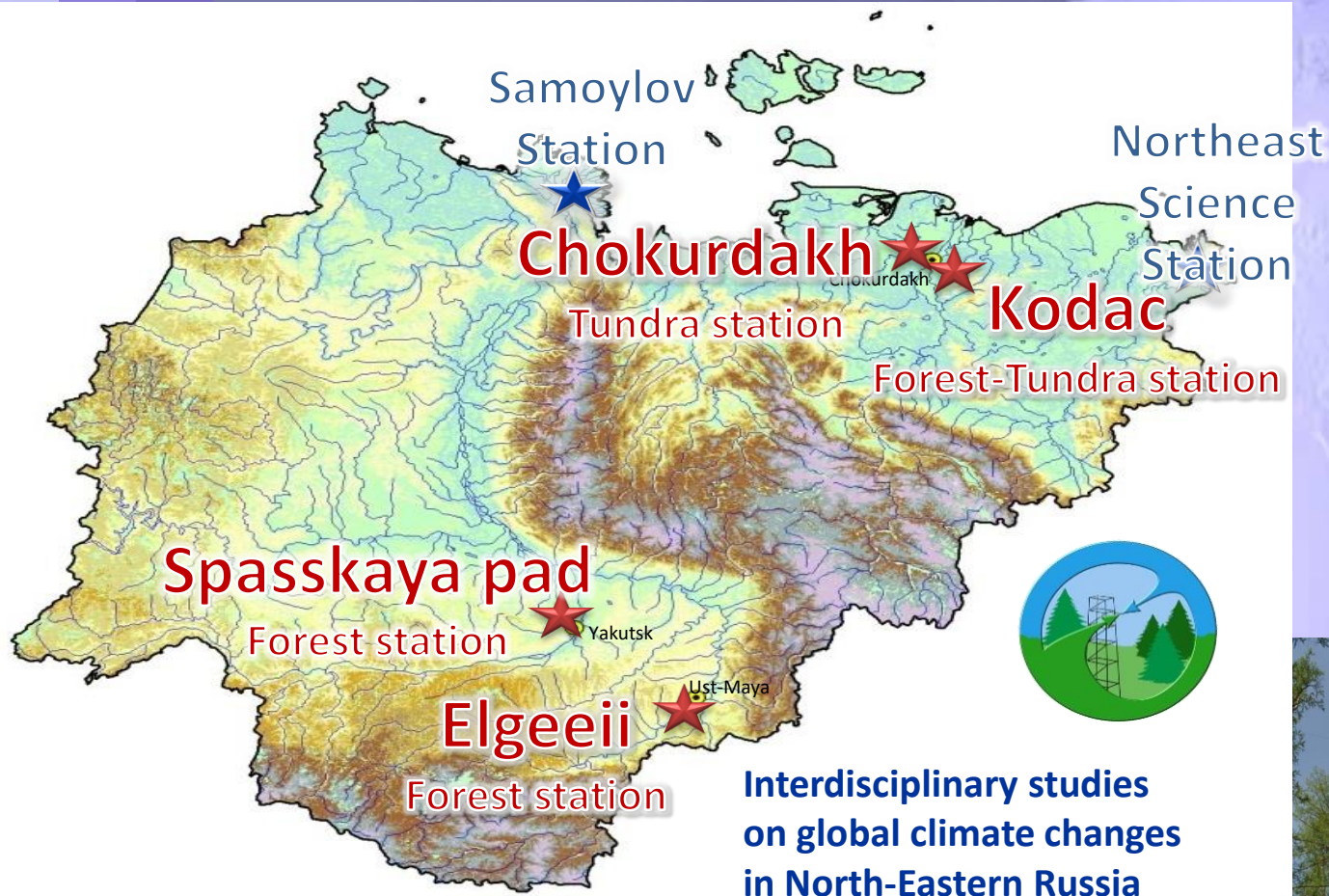
1M – Monitoring ;
2M - Manipulation;
3M – Modeling;
4M – Management

Monitoring of climate change at SakhaFluxNet research stations

- Space (Aqua, NASA & JAXA),
- Aerovisual (IL-18, AN-2, drones and aerostat),
- Land surface (high-rise towers and masts),
- Permafrost



SakhaFluxNet instrumentations

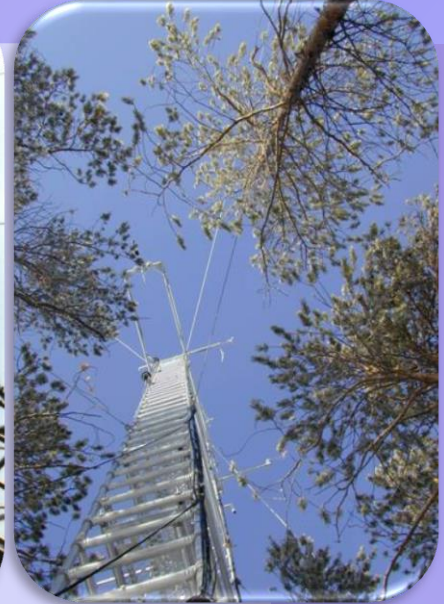


**Interdisciplinary studies
on global climate changes
in North-Eastern Russia**

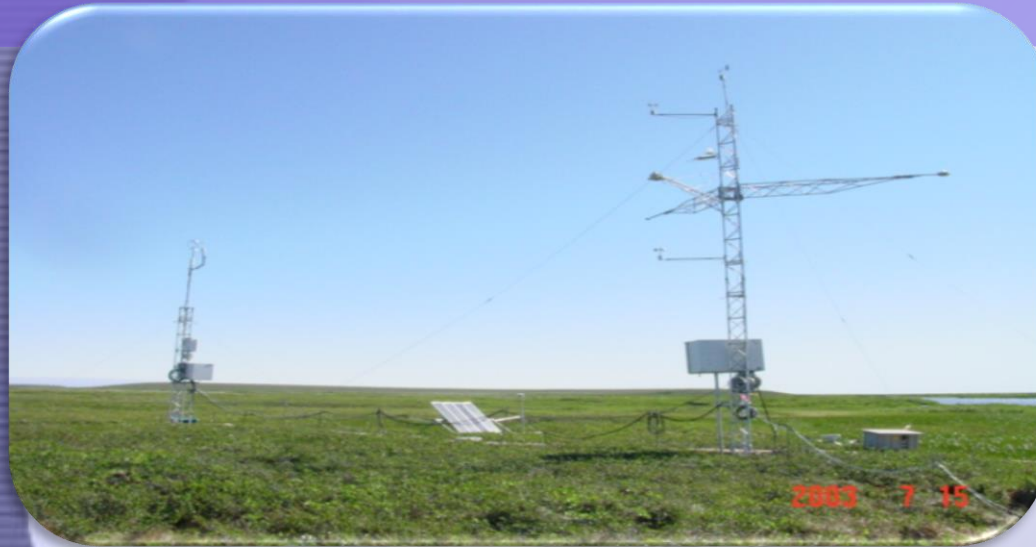
SAKHAFLUXNET



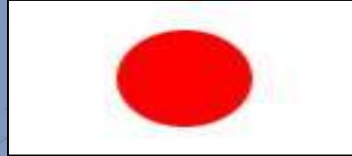
❖ Forest station Spasskaya Pad, Central Yakutia, 62°N



❖ Tundra station Chokurdakh, North-Eastern Yakutia, 70°N

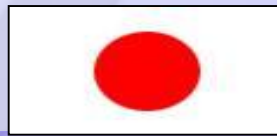


❖ Forest station Elgeei, South-Eastern Yakutia, 60°N



Since 2009

❖ Forest-tundra station Kodac, North-Eastern Yakutia, 70°N



Since 2011



The Lena river catchment experiment

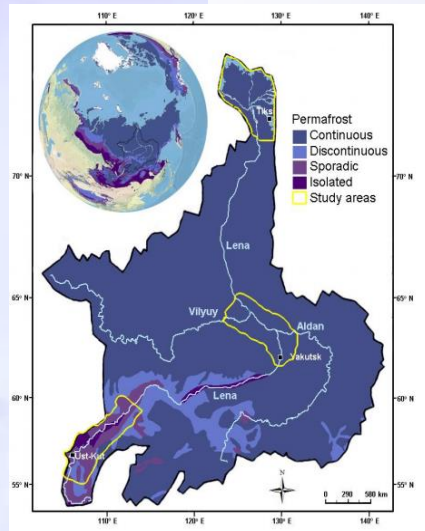
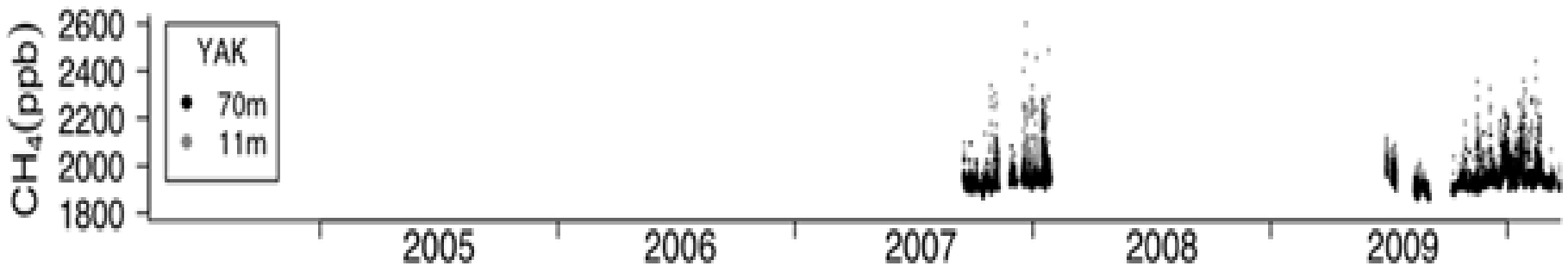
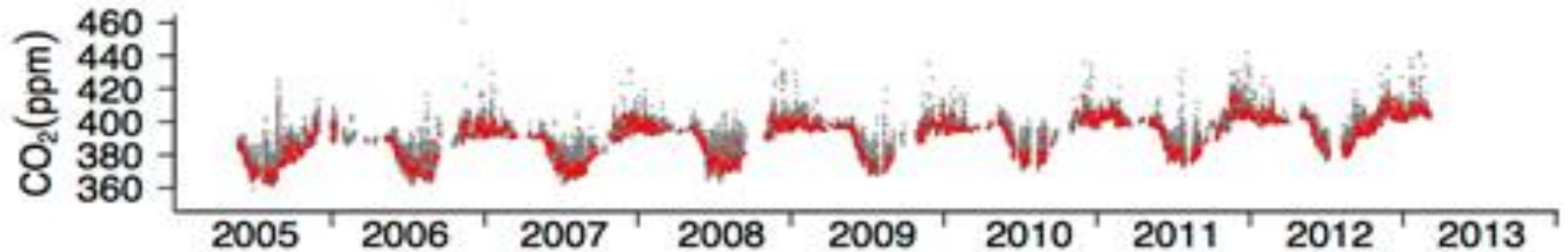


Table 1. Facts about the Lena River ⁴

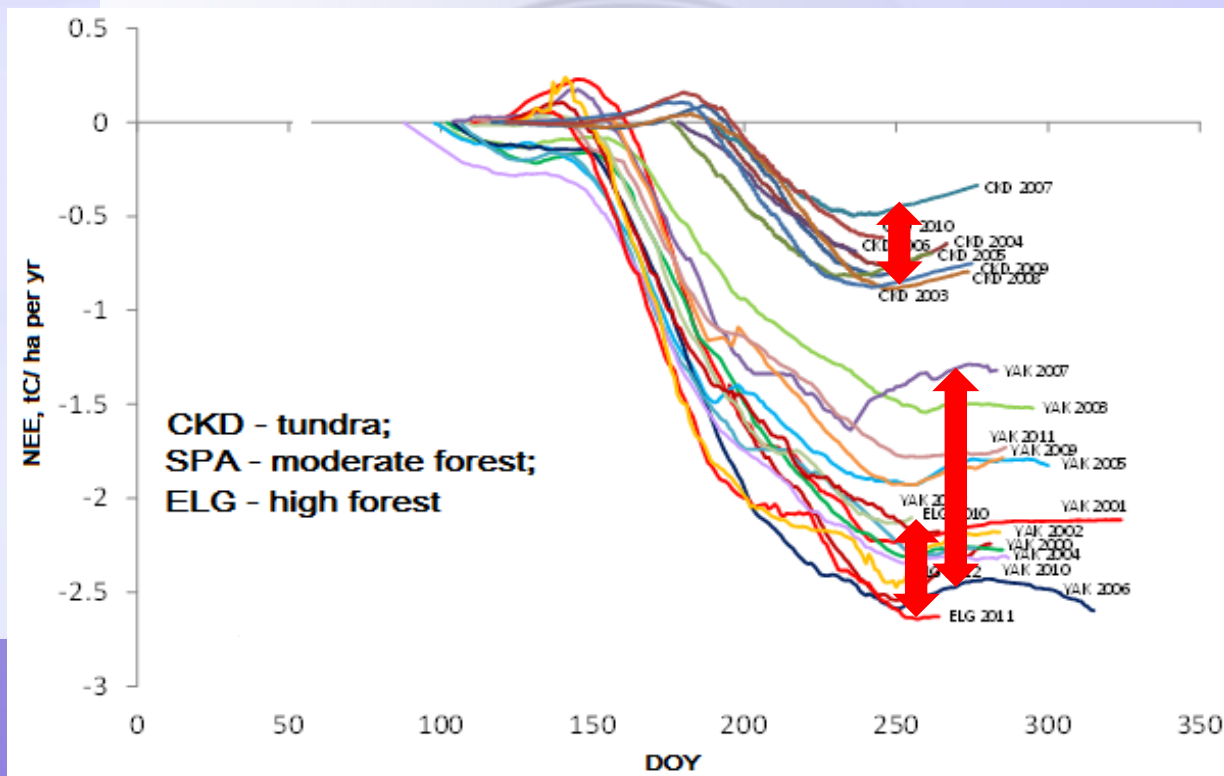
Length	~ 4400 km
Discharge area	~ 2,5 million km ²
Discharge volumes	~ 525 km ³ /year
Suspended load	> 20 million ton/year
Major tributaries	Aldan, Vilyui, Vitim, Olekma

[CO₂] and [CH₄] in atmosphere over Yakutsk

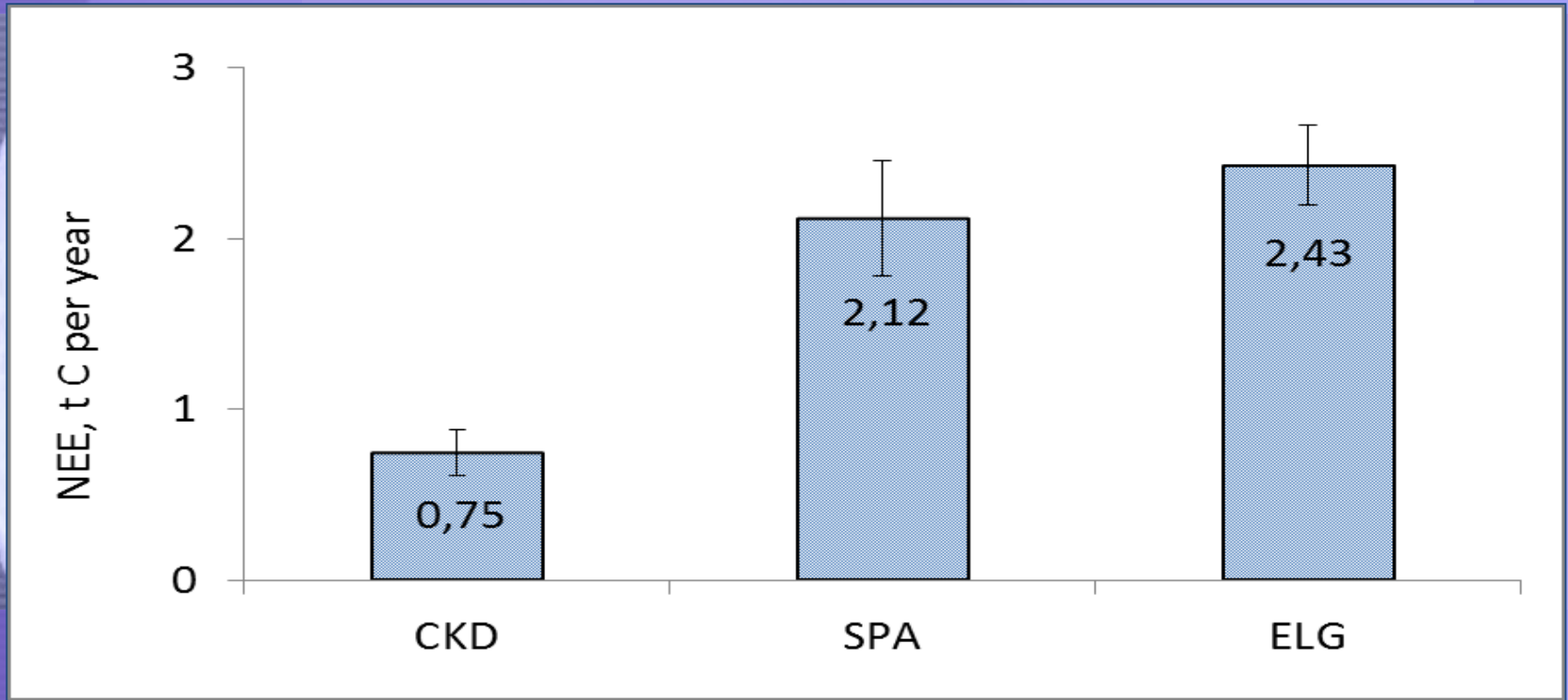


Machida, 2014 submitted

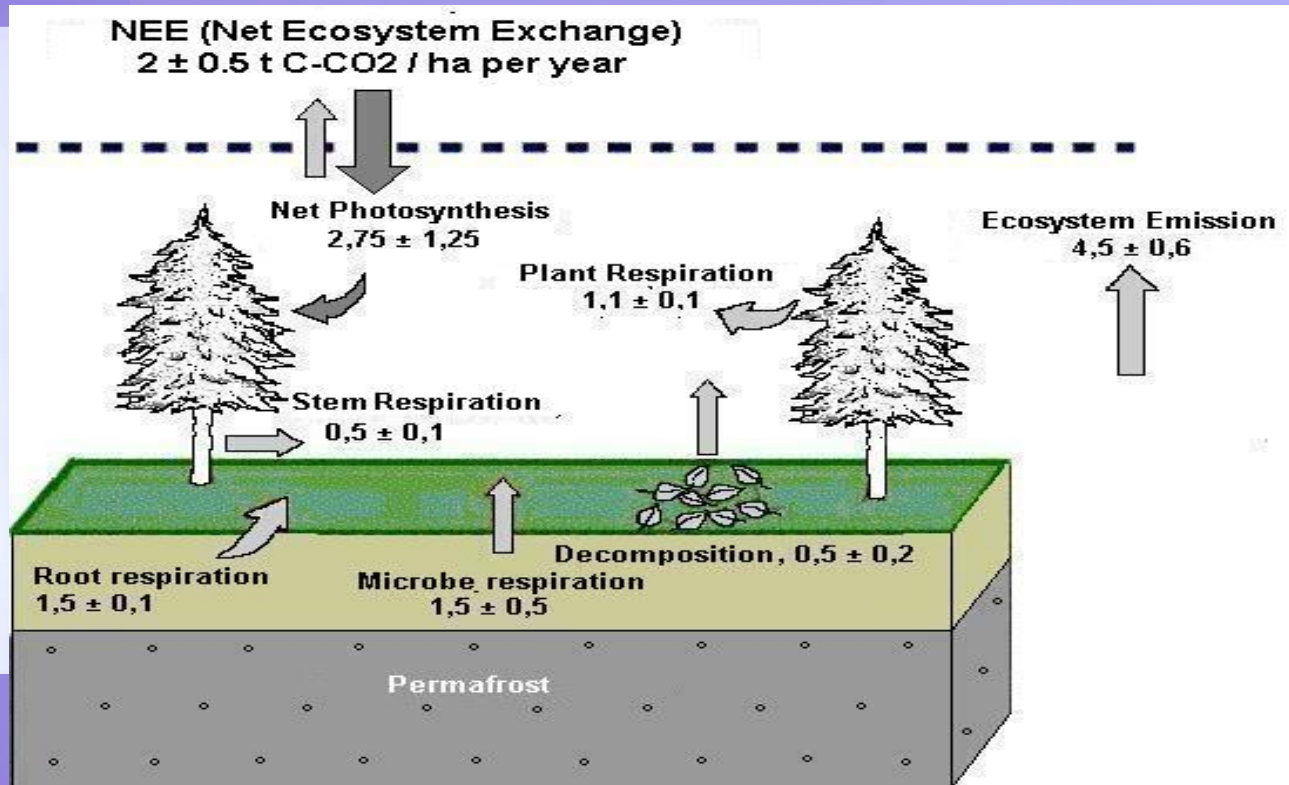
Cumulative carbon of representative permafrost ecosystems in eastern Siberia



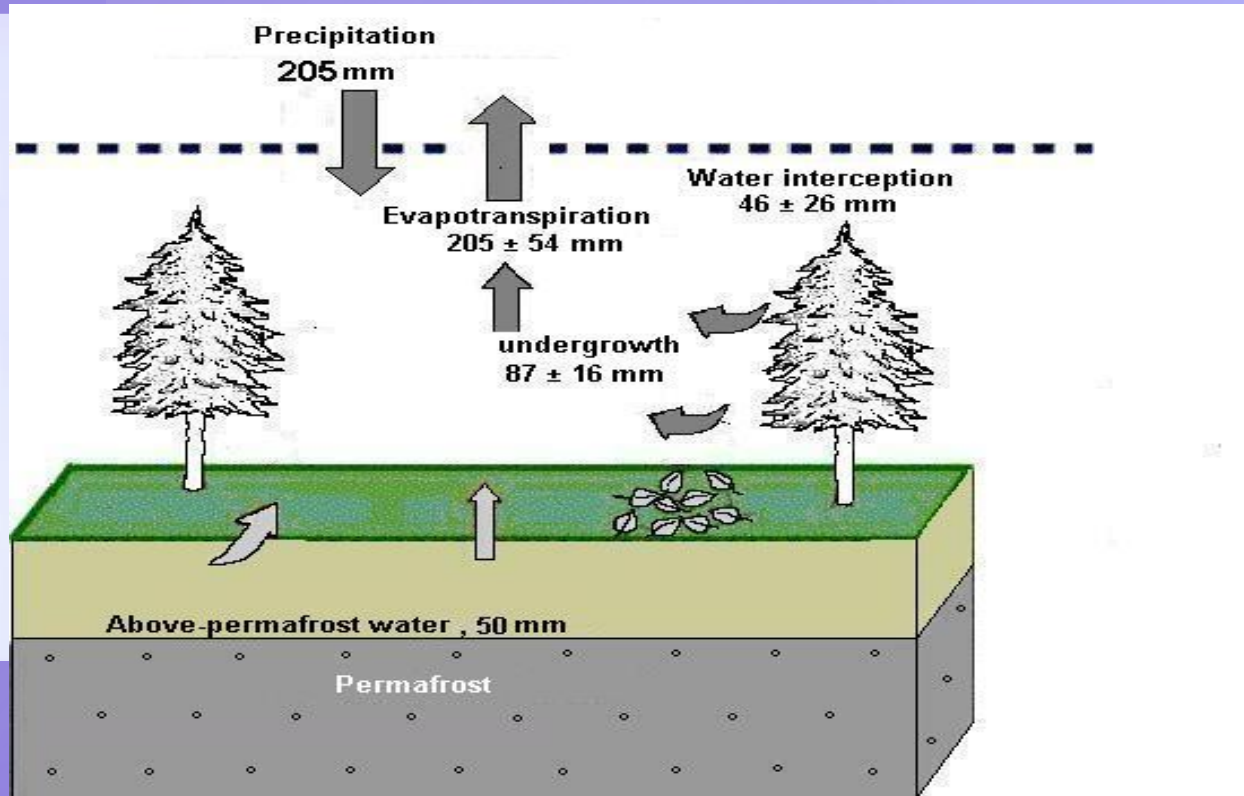
Seasonal carbon uptake by northern ecosystems



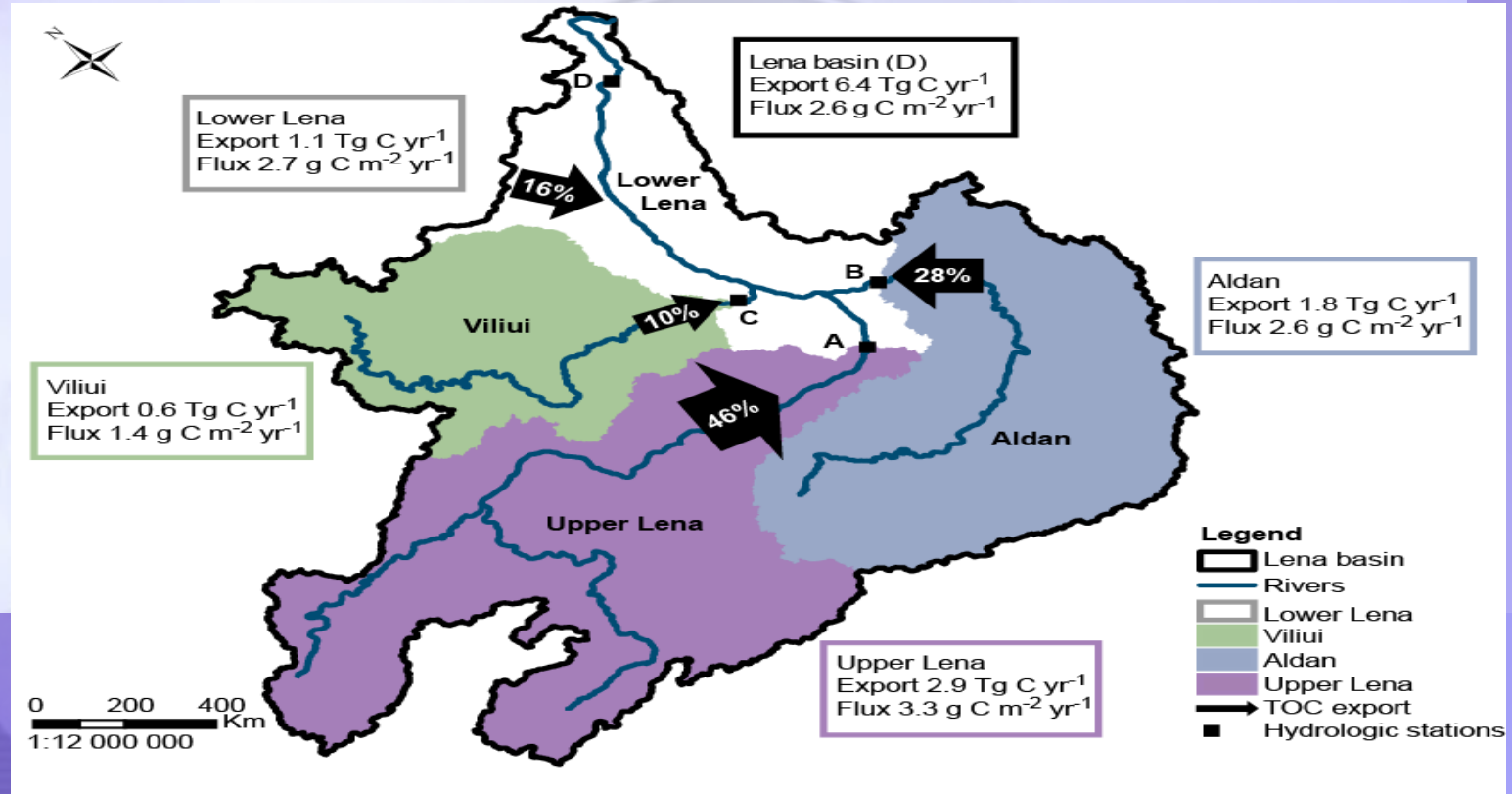
Annual carbon budget of permafrost forest ecosystems, t C/ha per year



Annual water budget of permafrost forest ecosystems, mm per year

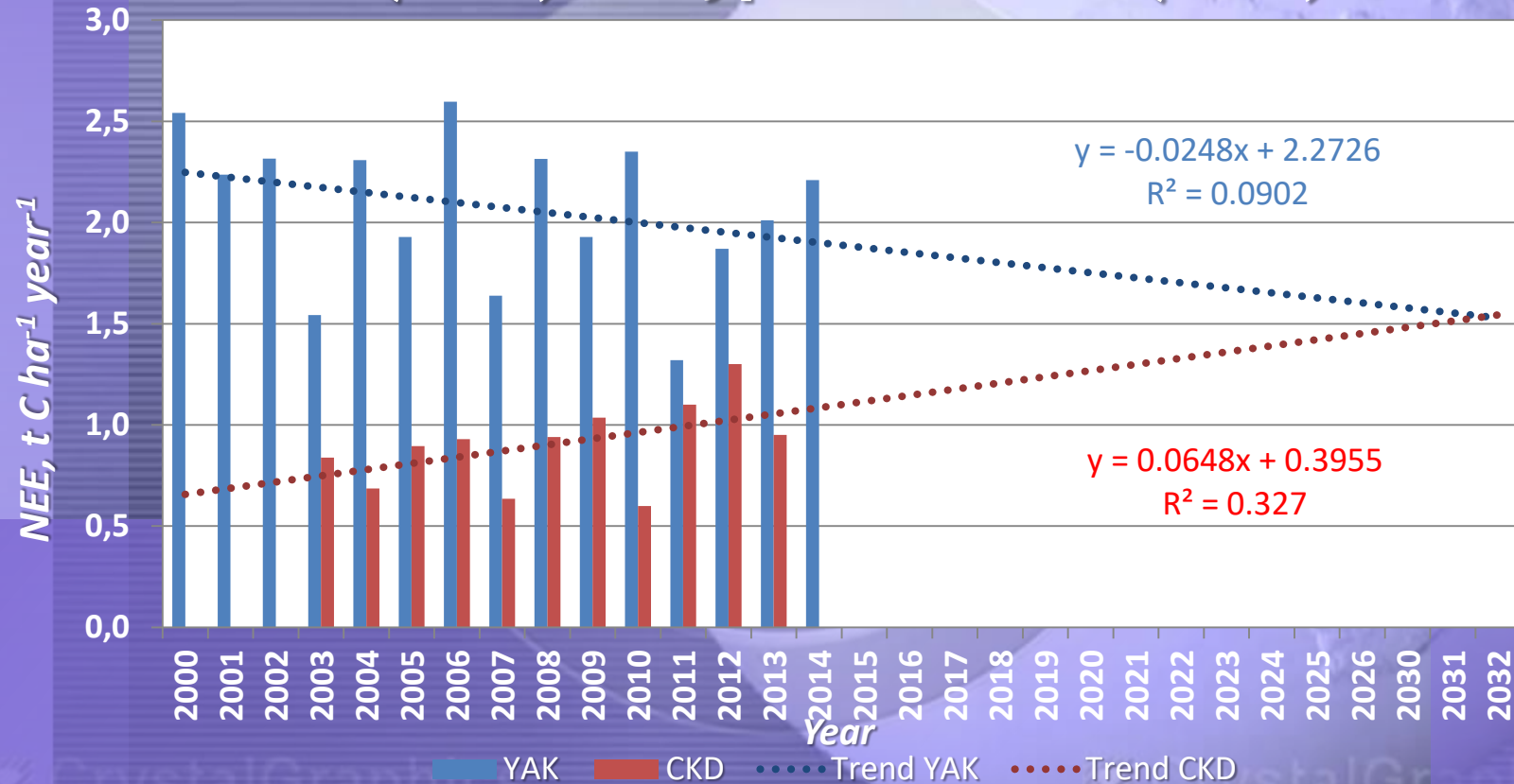


Annual export and TOC flux from Lena river to Arctic ocean

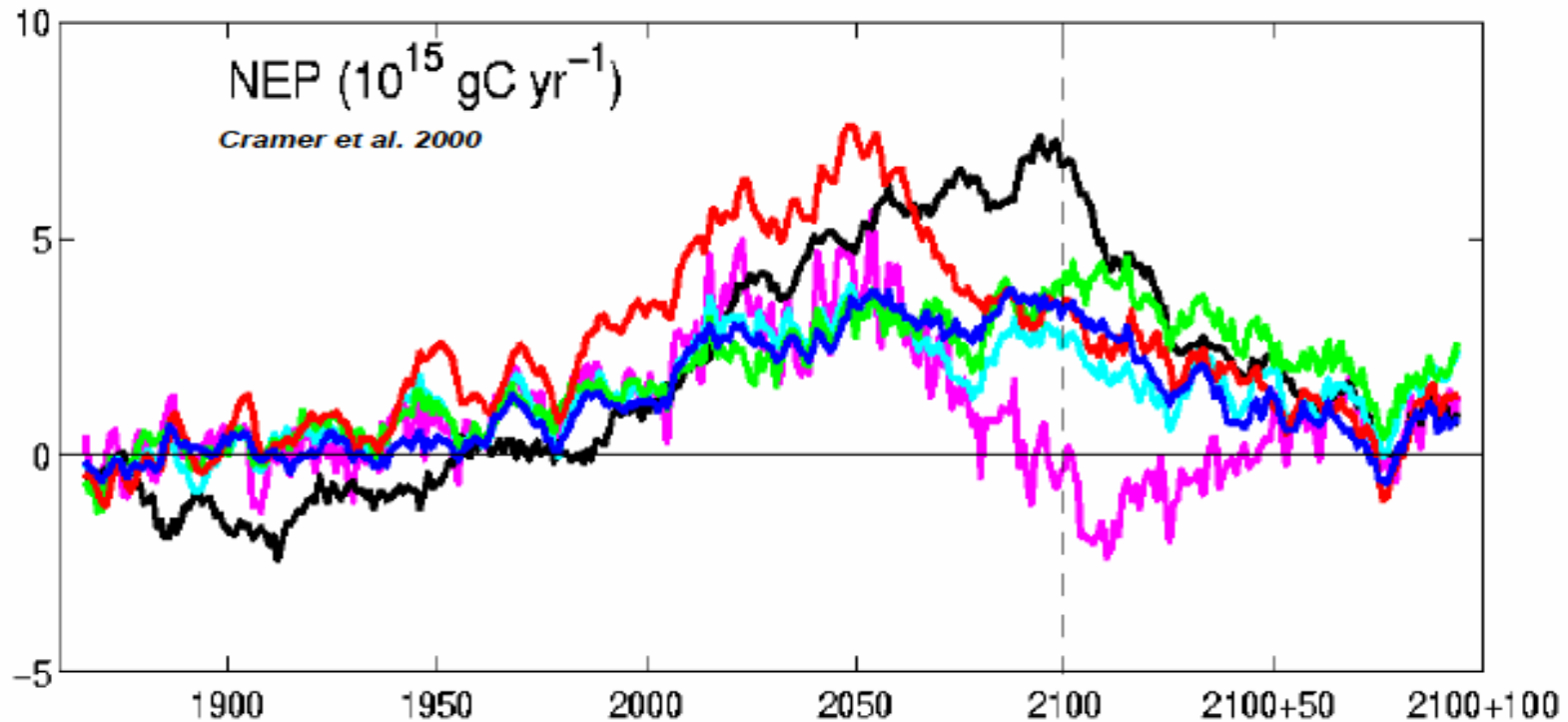


Cumulative fluxes

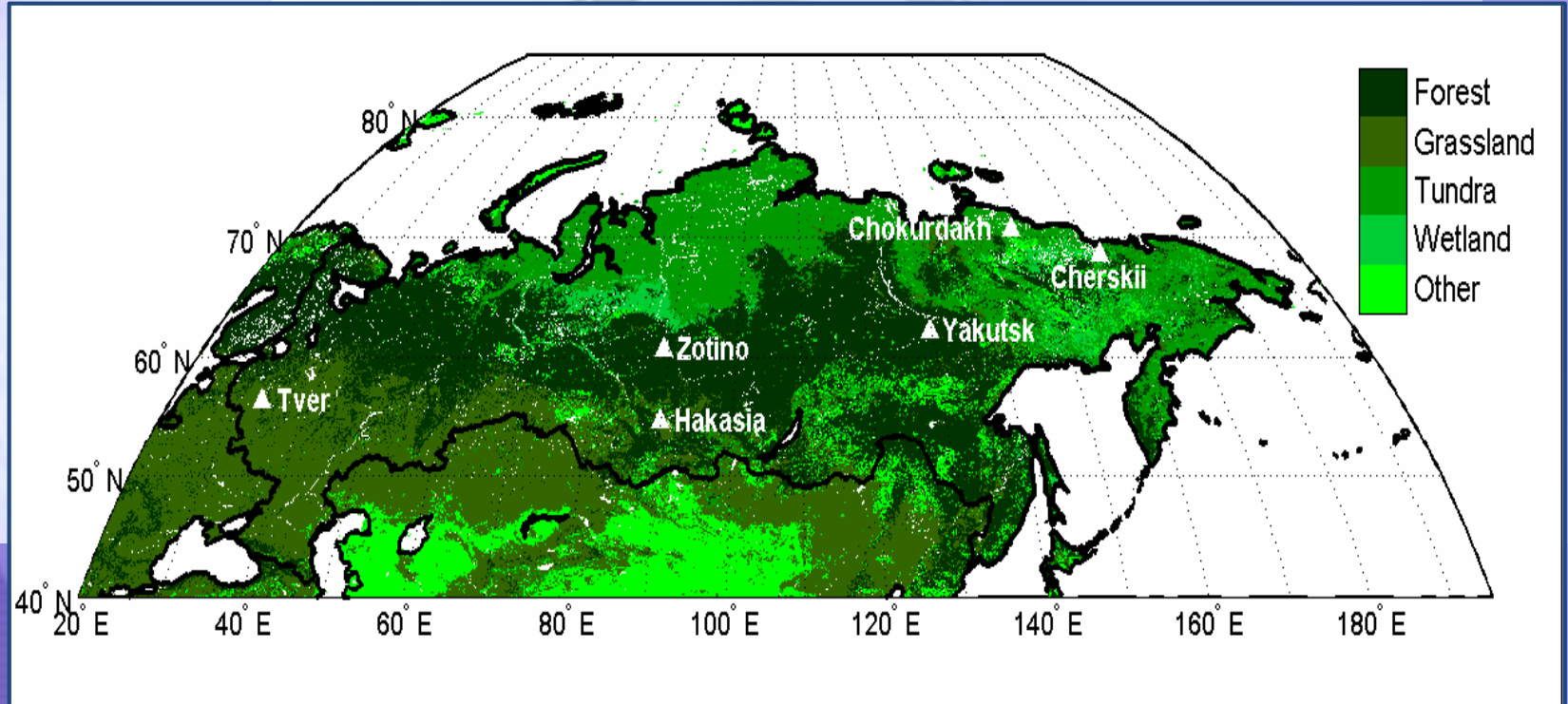
Larch forest (YAK) vs Typical tundra (CKD)



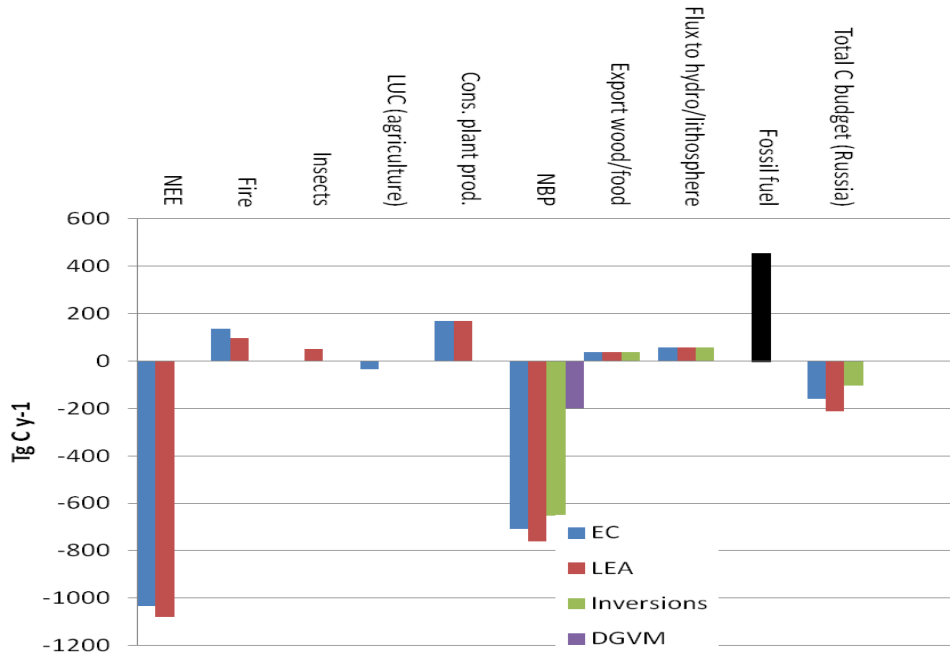
Net Ecosystem Production in various prediction models. Cramer et al., 2000



Land cover map of the Russian Federation and measurement sites



Carbon budget of Russia



	Carbon fluxes (Tg C-CO ₂ /y)			
	EC	LEA	Invers.	DGVM
NEE	-1033	-1079.2		
<i>Fire</i>	137	97.2		
<i>Insects</i>	50.8	50.8		
<i>LUC (agriculture)</i>	-34			
<i>Cons. plant prod.</i>	170.4	170.4		
NBP=NEE-D	-708.8	-760.8	-653	-199
Wood net export	20	20	20	
Food net export	18	18	18	
hydro/lithosphere	56	56	56	
NBP=NEE-D-F	-614.8	-666.8	-559	
Fossil fuel*	454	454	454	
NEE-D-F-Fossil Fuel	-160.8	-212.8	-105	

*UNFCCC, Shvidenko et al. 2011

CH₄ emissions not included but estimates are uncertain:

19.5 Tg C-CH₄ /y (EDGAR)- all sources

27.6 Tg C-CH₄ (Petrescu et al. 2010)-only boreal arctic wetlands



Thank you for your attention!