

The impact of climate change on the expansion of *Ixodes persulcatus* habitat and the incidence of tick-borne encephalitis in the north of European Russia

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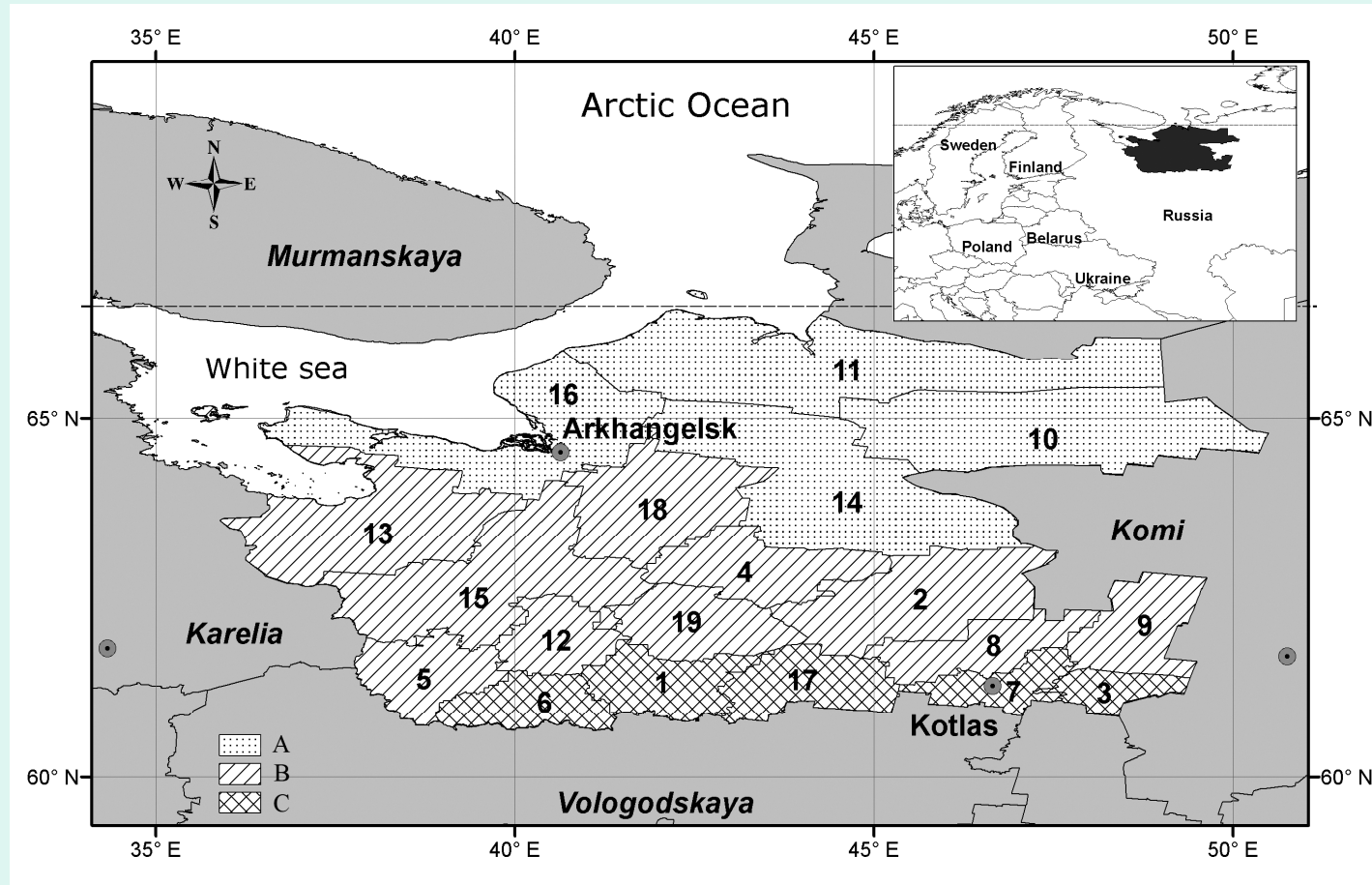
The study objective

The objective of this study was to find out if the climate change has real impact on the northward expansion of Ixodid ticks and the increase in TBE incidence in Arkhangelsk Oblast (AO) of Russia .

Arkhangelsk oblast location

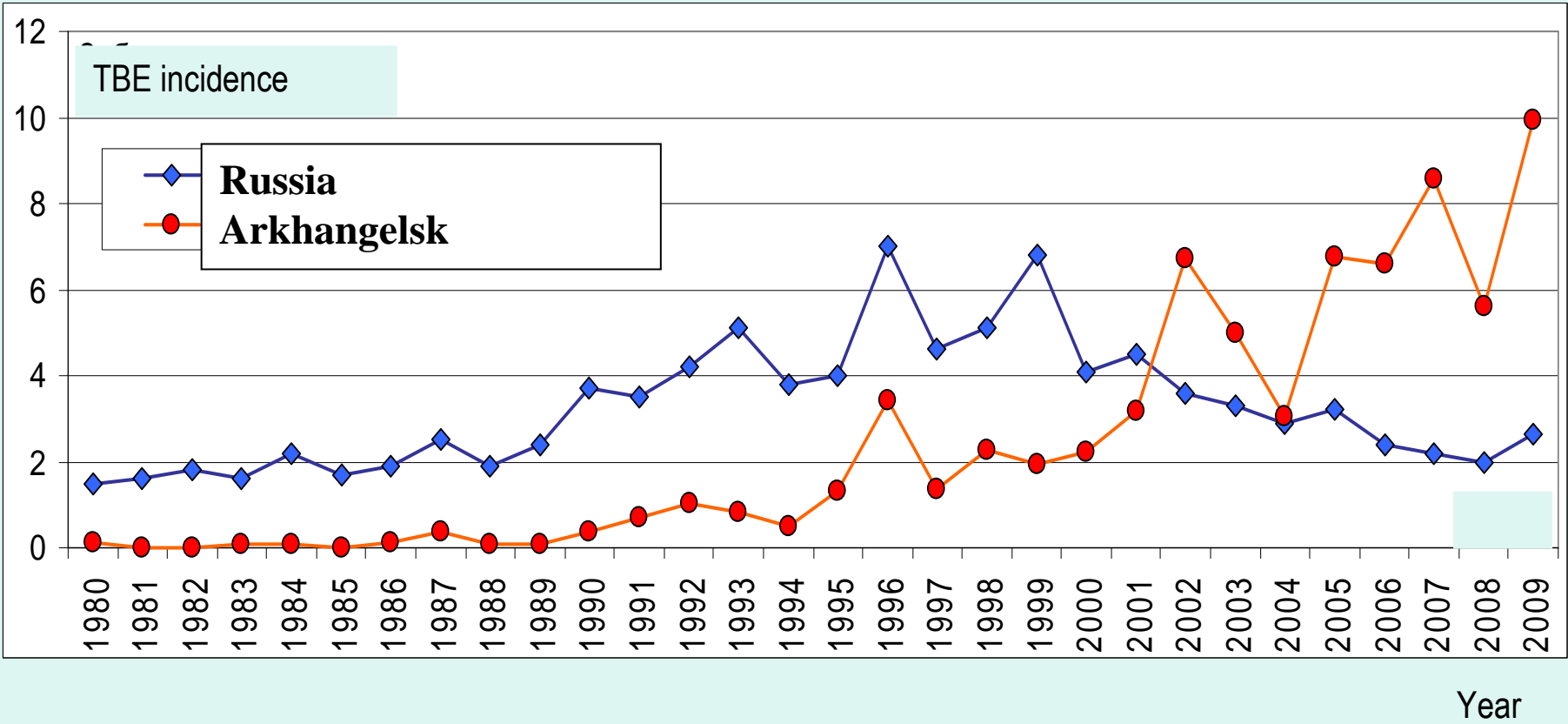


Arkchangel'sk oblast. Administrative division.



Arkhangelsk Oblast. A-northern group of districts, B-central group of districts, C- southern group of districts.

Incidence of Tick-Borne Encephalitis in the Russian Federation and Arkhangelsk Oblast

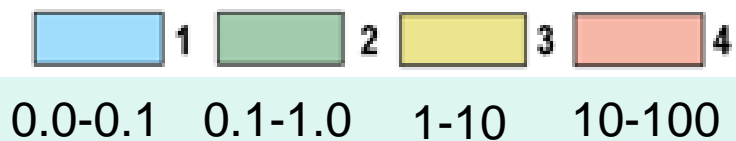
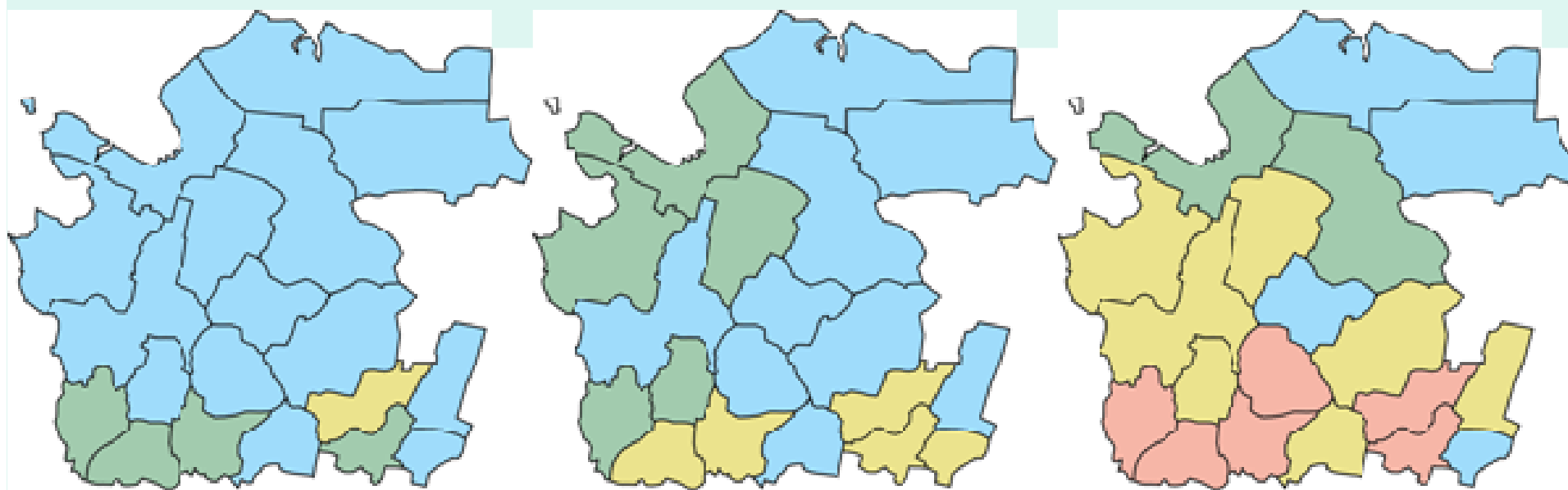


Incidence of Tick-Borne Encephalitis in Arkhangelsk Oblast for last three decades

1980 -1989

1990-1999

2000-2009

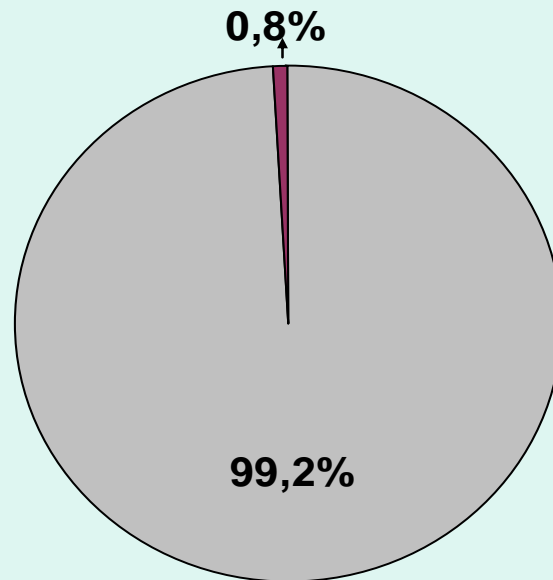


Tick-borne encephalitis incidence per 100 000

Transmissible and alimentary TBE infestation (%) in Arkhangelsk Oblast

Period	Transmission	Alimentary
1980-1990	100	0
1991-2000	94.8	5.2
2001-2009	98.7	1.3

Arkhangelsk Oblast
The percentage of *Ixodus persulcatus* Schulze
among all *Ixodus* ticks



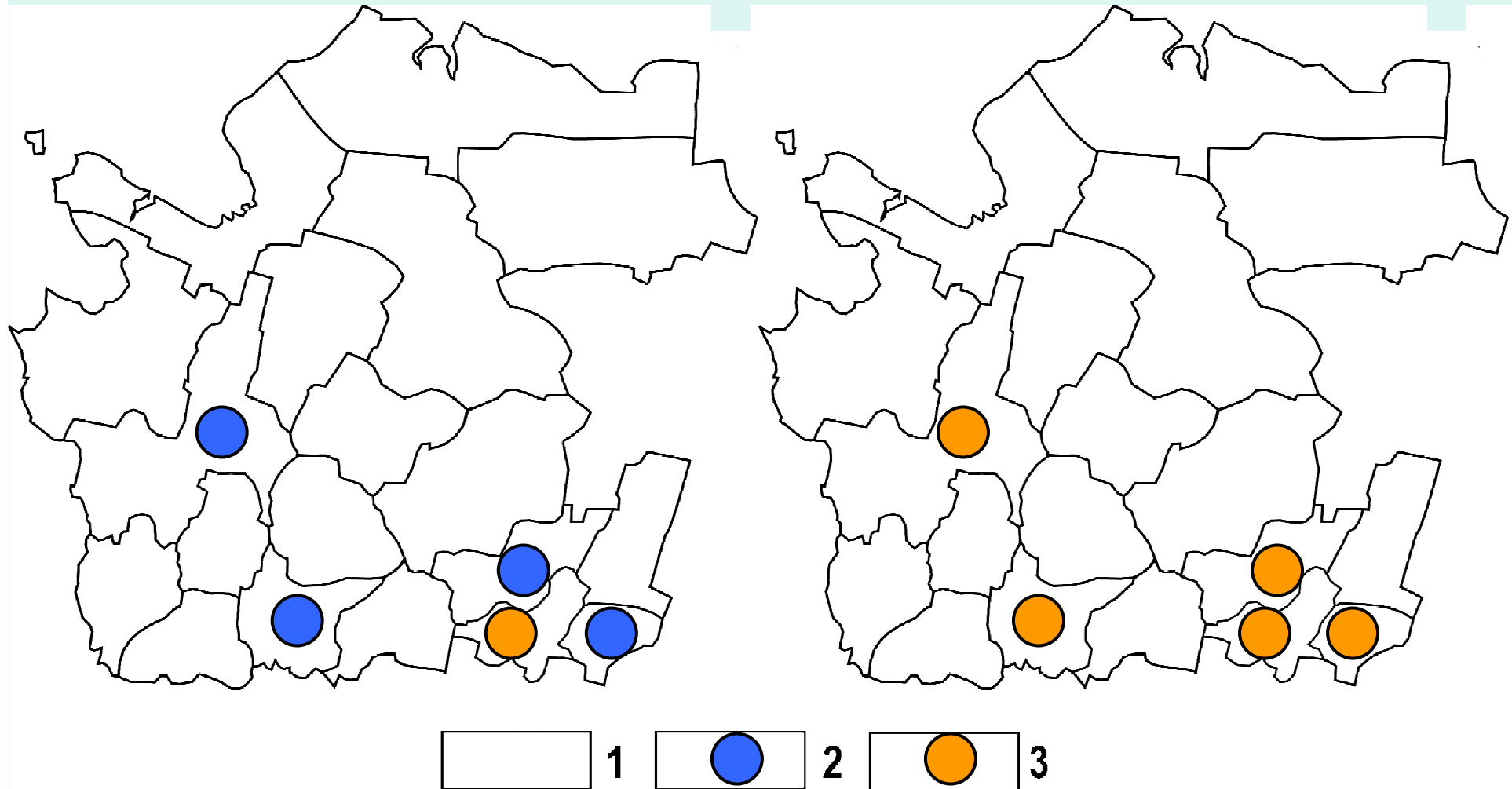
Ixodes persulcatus – 99.2%
Ixodes ricinus – 0.8%



Unfed adult *Ixodes persulcatus* collected from the surface plantation in Arkhangelsk Oblast

1992-1995

2006-2009



***Ixodes persulcatus*:**

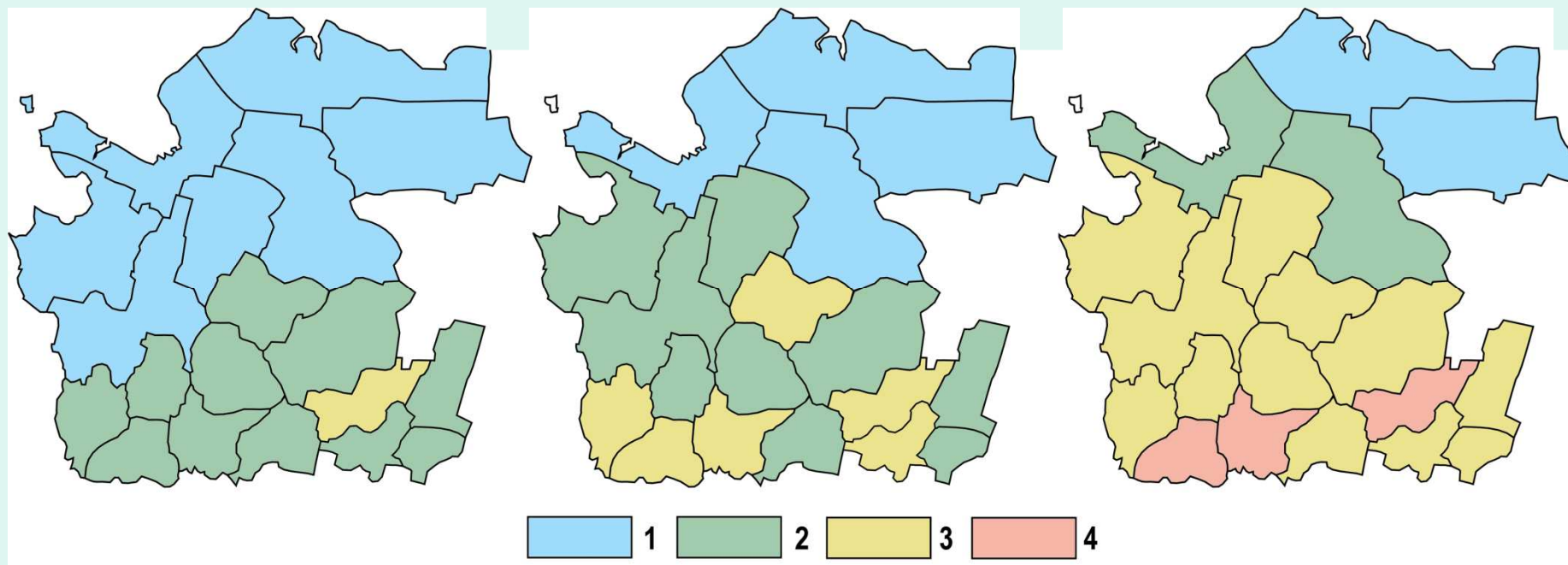
1 – unexplored, 2 – not detected, 3 – detected

Number of tick-bitten humans in Arkhangelsk Oblast for three decades

1980 -1989

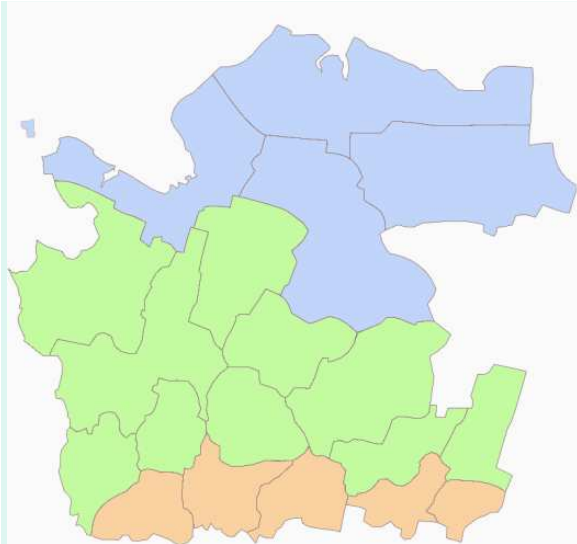
1990-1999

2000-2009

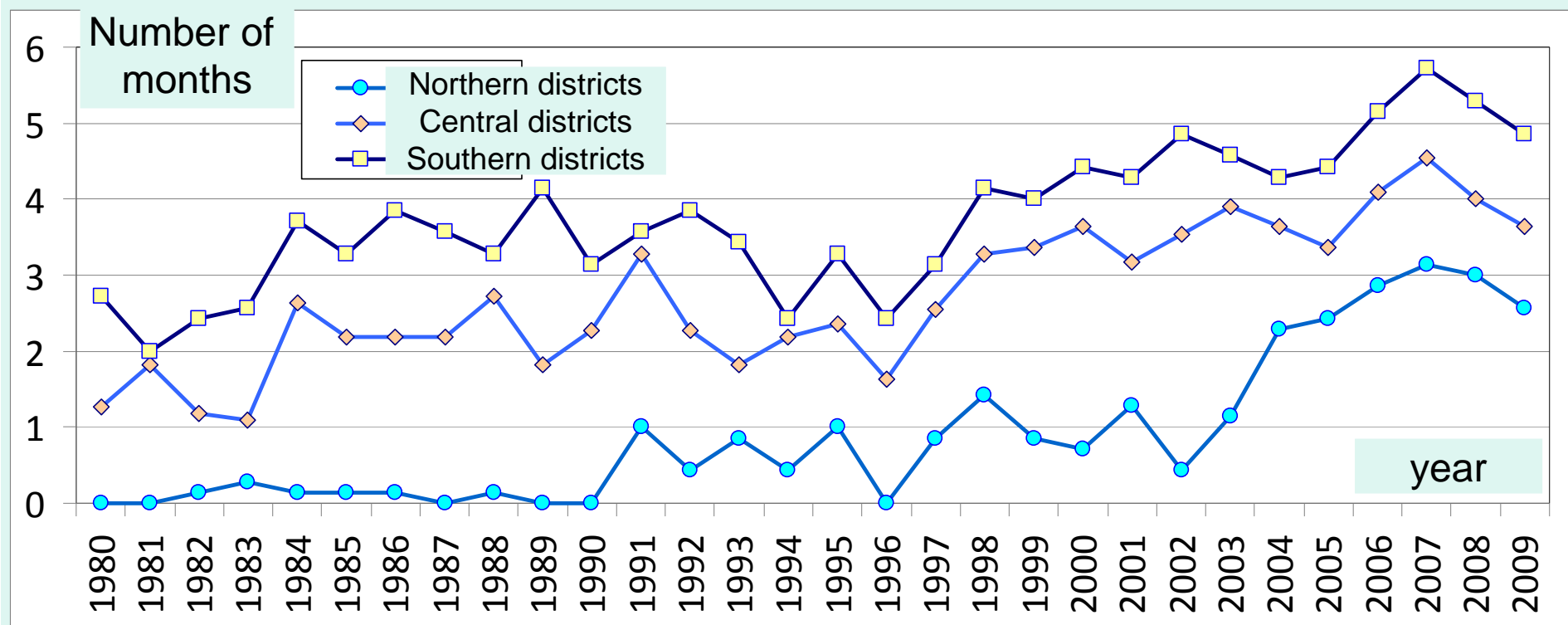


0-10 10-100 100-1000 >1000

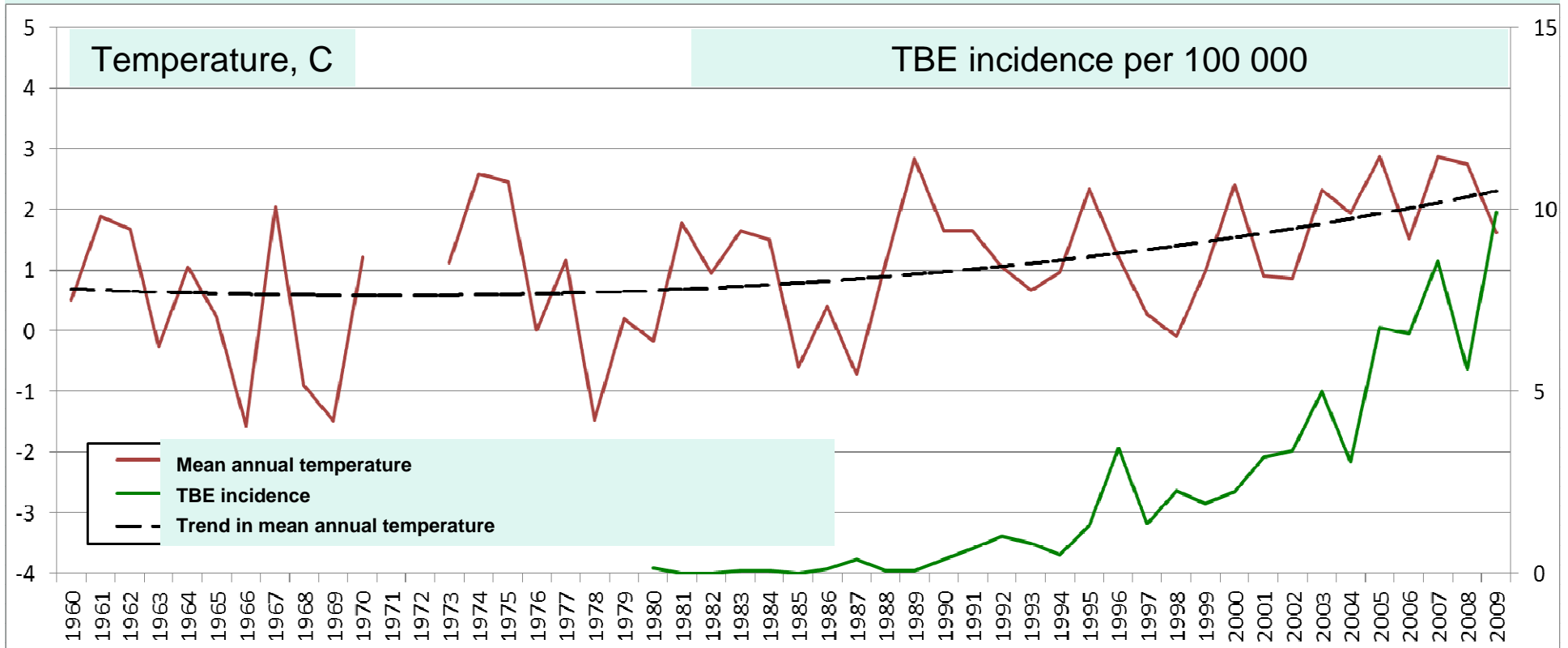
Number of tick-bitten humans per 100 000

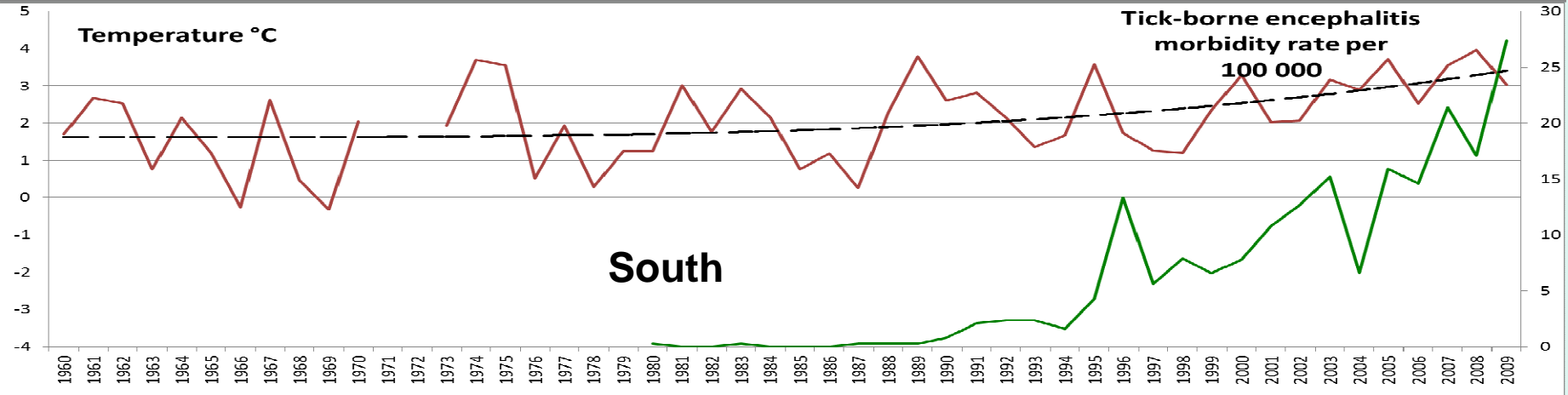
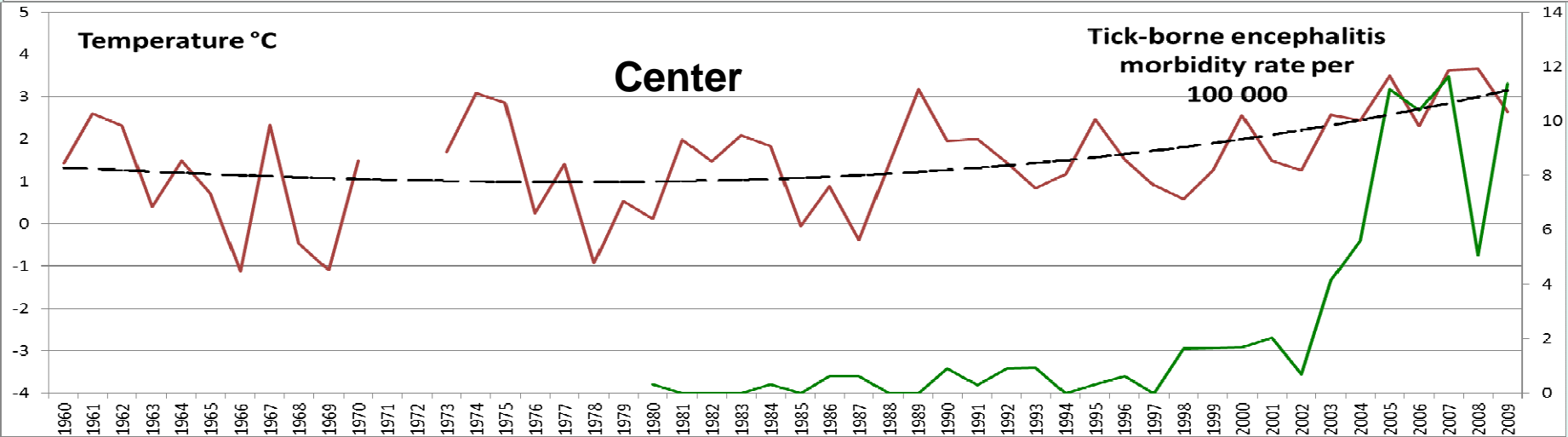
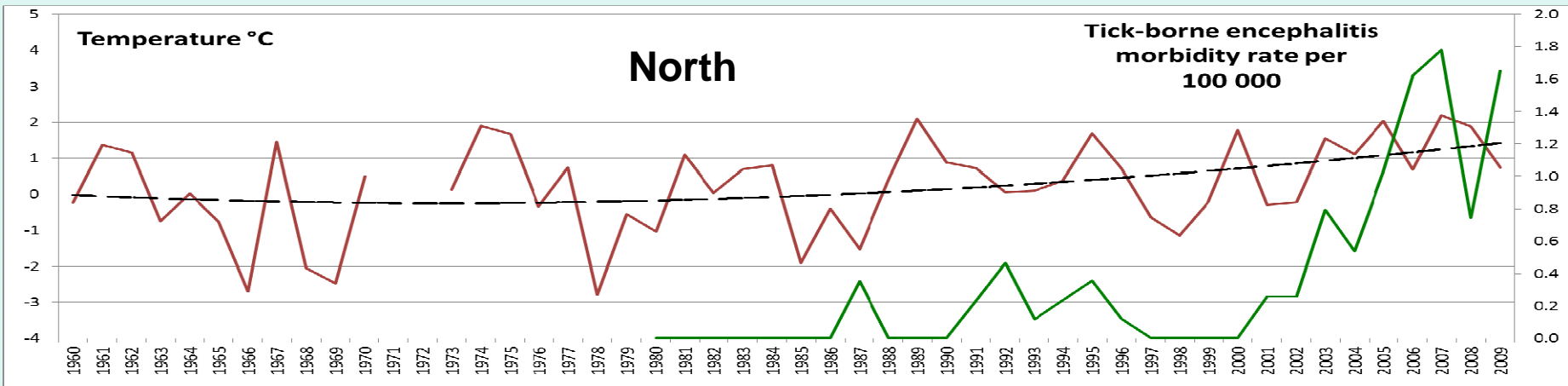


Period (months) of tick-bites registration in Arkhangelsk Oblast



Arkhangelsk Oblast. Changes in mean annual temperatures and TBE incidence





Sum of effective temperatures

$$S = \sum_{n=1}^{365} ET_n$$

Here:

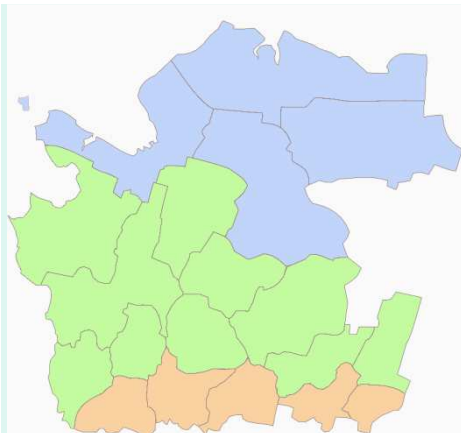
S - sum of annual effective temperatures for t_{min} ;

$ET_n = (t_n - t_{min})$ effective temperature in day “n”,

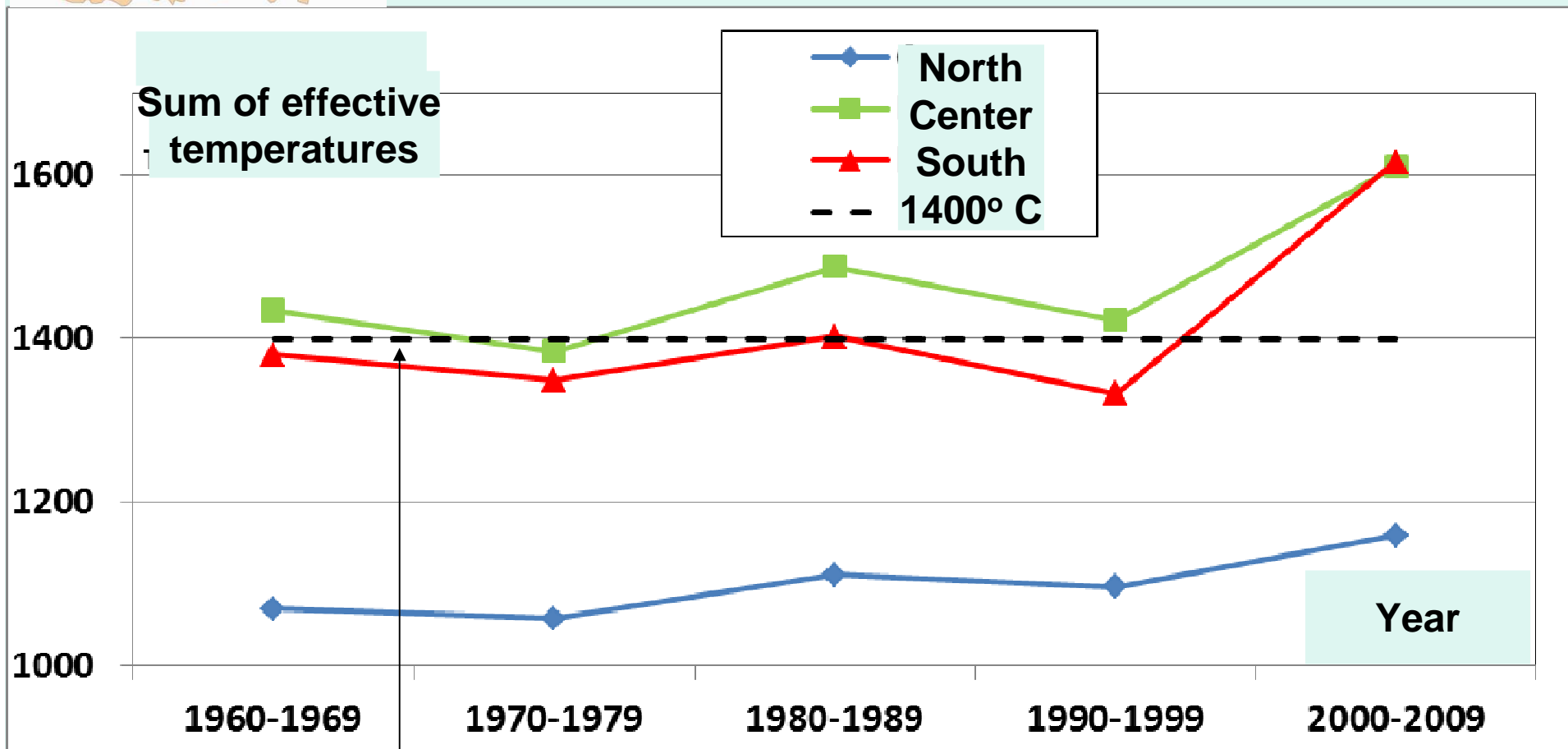
t_{min} – minimal temperature limit, °C (10°C for *Ixodes persulcatus*);

t_n – mean temperature in day “n”, °C; only $t_n > t_{min}$ are taken into account;

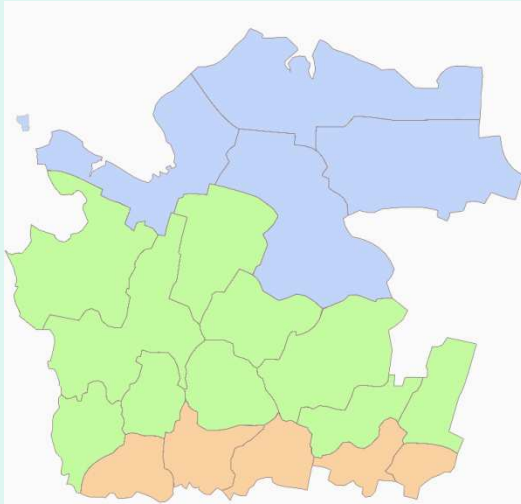
n – day number.



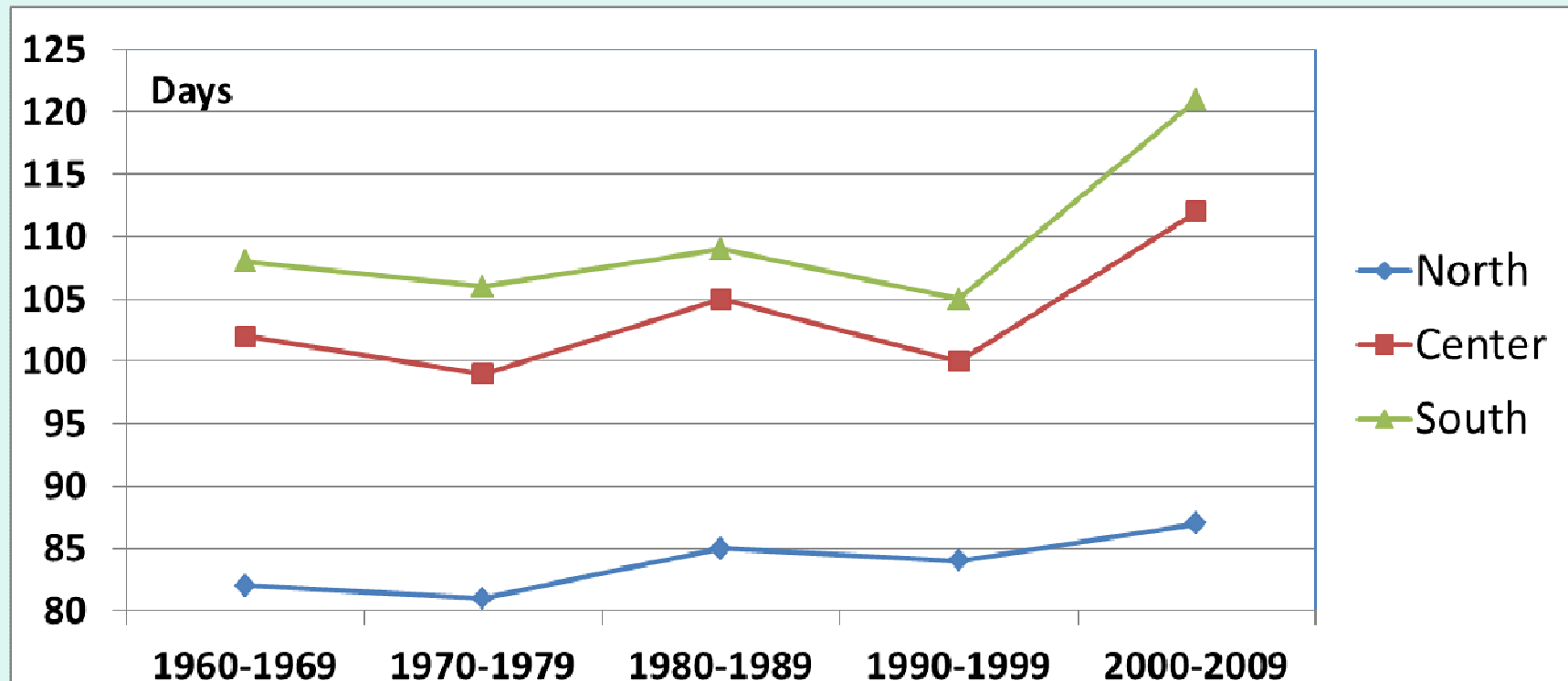
Sum of effective temperatures above 10°C in northern, central and southern zones of Arkhangelsk Oblast in 1960-2009



Dash line indicates the critical level 1400°C



Time period with effective temperatures above 10°C in northern, central and southern zones of Arkhangelsk Oblast in 1960-2009



Correlation analysis of the mean annual AO air temperatures and TBE incidence in AO during 1990-2009.

Territory	Correlation index	Confidence interval	P-value
AO	0.50	0.36-0.64	0.0248
Northern districts	0.50	0.36-0.64	0.0248
Central districts	0.71	0.62-0.81	0.0005
Southern districts	0.45	0.30-0.60	0.0465

Conclusions

1. In the north of European Russia, in Arkhangelsk Oblast within the period under study (1980-2009) there was obvious northward expansion of *I. persulcatus*.
2. Considerable increase in local mean annual temperatures and the sum of effective temperatures that provide adequate life conditions is an important factor of *I. persulcatus* expansion to new territory in the central districts of Arkhangelsk Oblast.
3. Very significant increase in TBE incidence in Arkhangelsk Oblast is connected considerably with the expansion of *I. persulcatus* area. The territory with reported TBE cases is now much larger. Climate changes are an important factor of the incidence growth.
4. Some other factors, for example, social factors cannot be ruled out. Their role in TBE incidence is to be estimated in future.

Acknowledgements

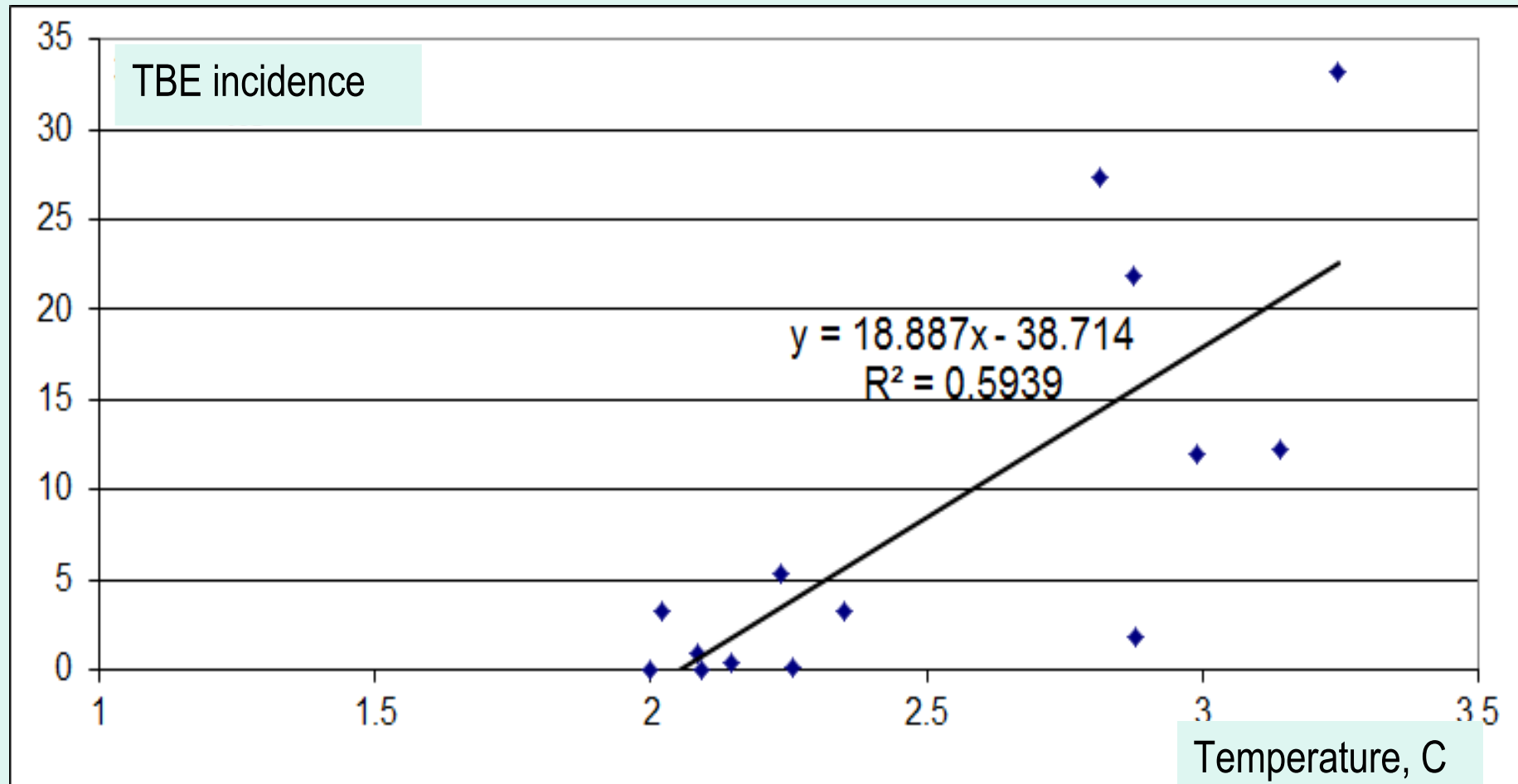
- This study was carried out within the WHO/BMU project on protecting health from climate change in Europe, coordinated by Dr. Menne and Dr. Nurse, WHO Regional Office for Europe.
- We are grateful for the financial support received from Germany.
- We also thank Drs. M.E.Eremeeva and G.A.Dasch from CDC (USA) and Dr.B.A.Revich from Institute of Economic forecasting, RAN (Russia) for useful comments

Thank you for
your attention

RESERVE

Air temperature and TBE incidence

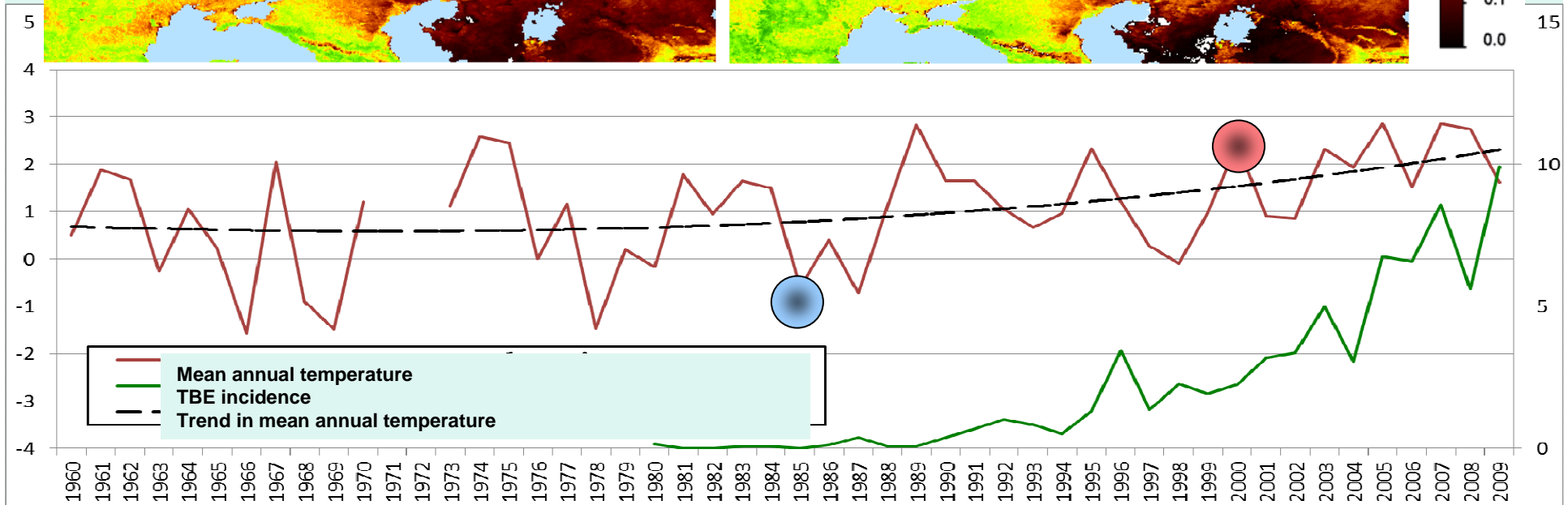
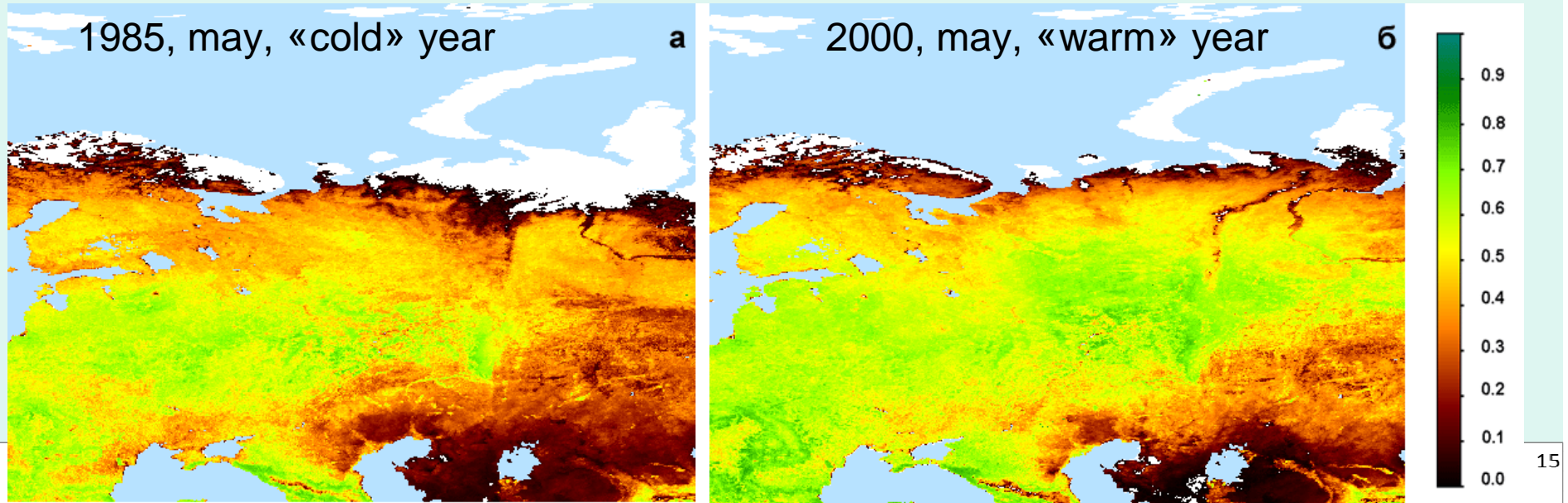
Regression analysis

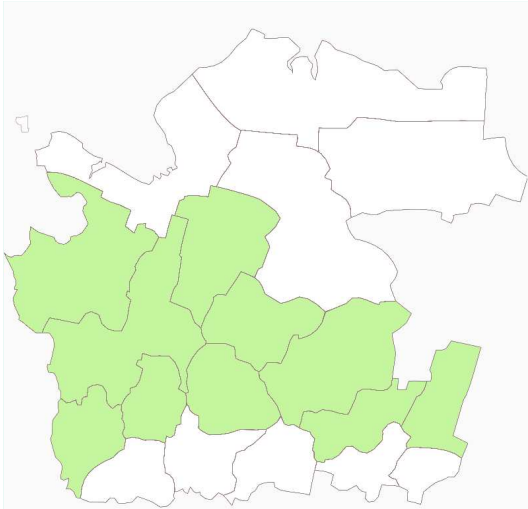


R=0.77 (0,74-0,80) p=99.9%

Satellite data

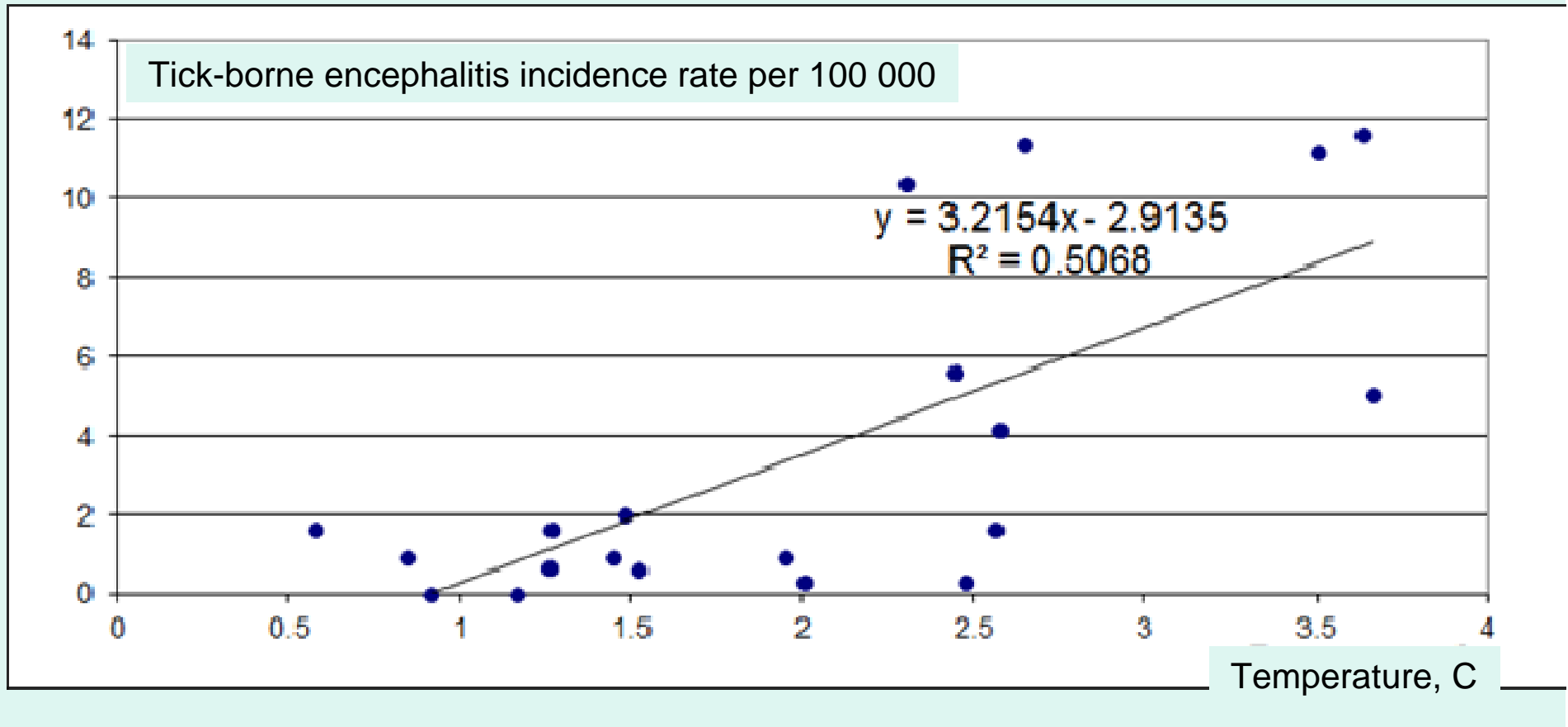
Normalized difference vegetation index (NDVI)





Change in mean annual temperatures and TBE incidence in the central zone of Arkhangelsk Oblast

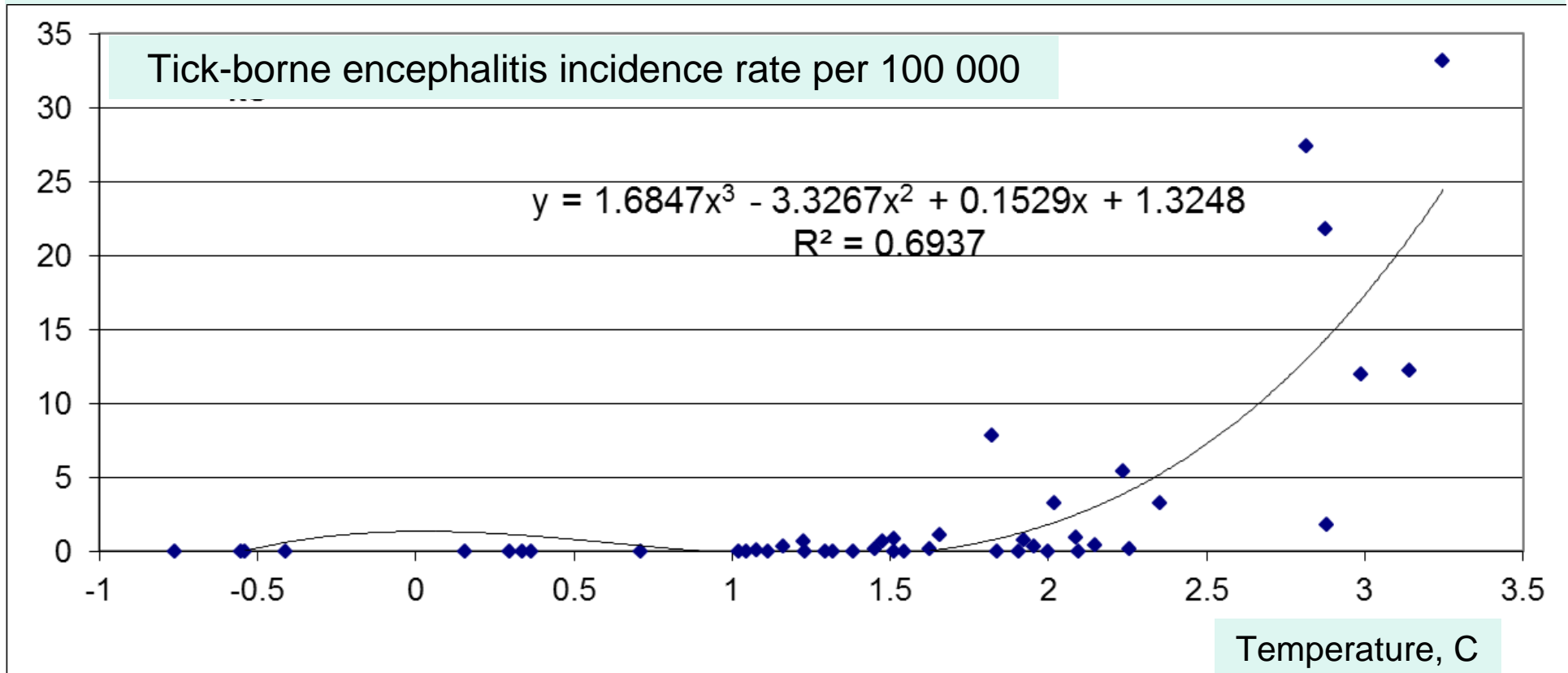
Linear correlation



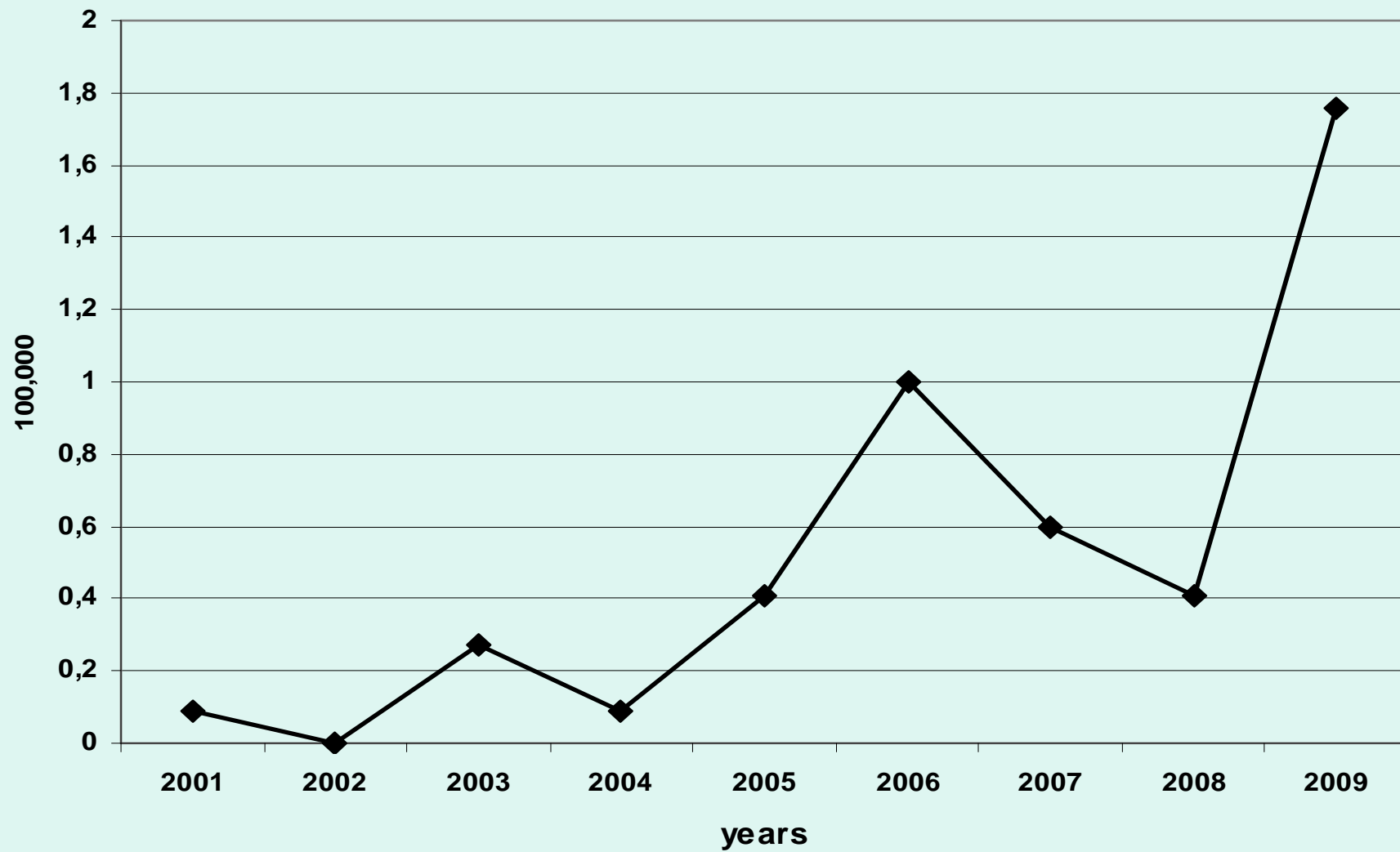
Change of annual average temperature and
incidence of Tick-Borne Encephalitis
in all zones of Arkhangel'sk Oblast

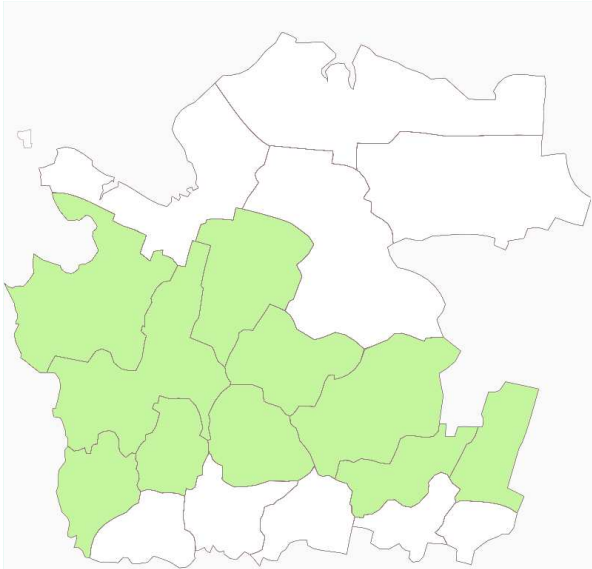
R=0.83

Non-linear correlation

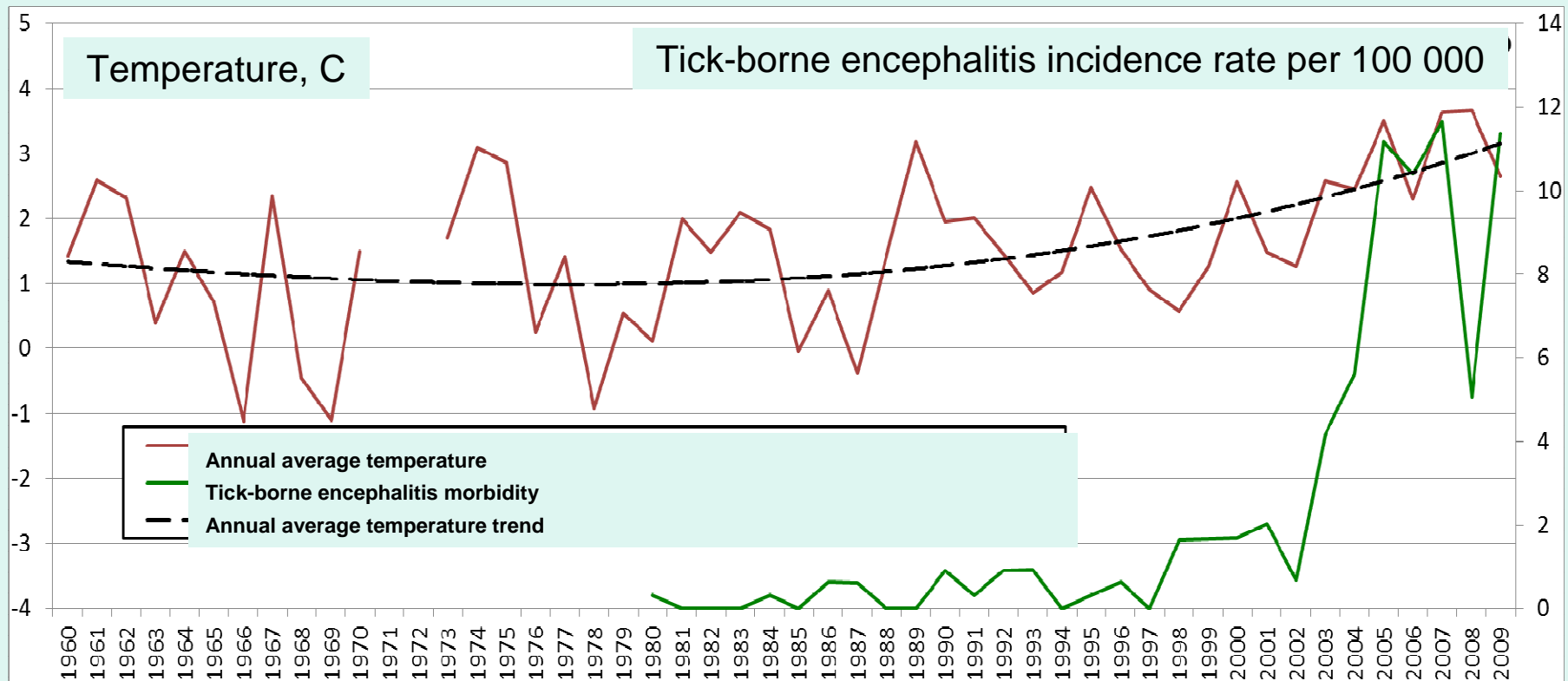


Incidence of Tick-Borne Encephalitis in Komi Republic of the Russian Federation





Arkhangelsk Oblast. Change in mean average temperature and TBE incidence in central districts



Arkhangelsk Oblast TBE virus infestation in ticks collected from surface plantation

Period	1996	1997	1998	1999- 2001	2002	2003	2004- 2005	2006	2007	2008- 2009
Number of studied ticks	134	n/a	222	n/a	78	n/a	32	52	47	116
Infestation rate, %	4.5	n/a	2.3	n/a	3.9	n/a	0	1.9	2.1	0

Arkhangelsk Oblast. Changes in mean annual precipitations and number of tick victims

