UNIVERSITY OF TARTU
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Variability and trends in daily minimum and maximum temperatures and in diurnal temperature range in Lithuania, Latvia and Estonia

Jaak Jaagus
Dept. of Geography, University of Tartu
Agrita Briede
Dept. of Geography, University of Latvia
Egidijus Rimkus
Dept. of Hydrology and Climatology, Vilnius University

Outline

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- Objective
- Data and methods
- Spatial and temporal variability
- Trends
- Conclusions

Introduction

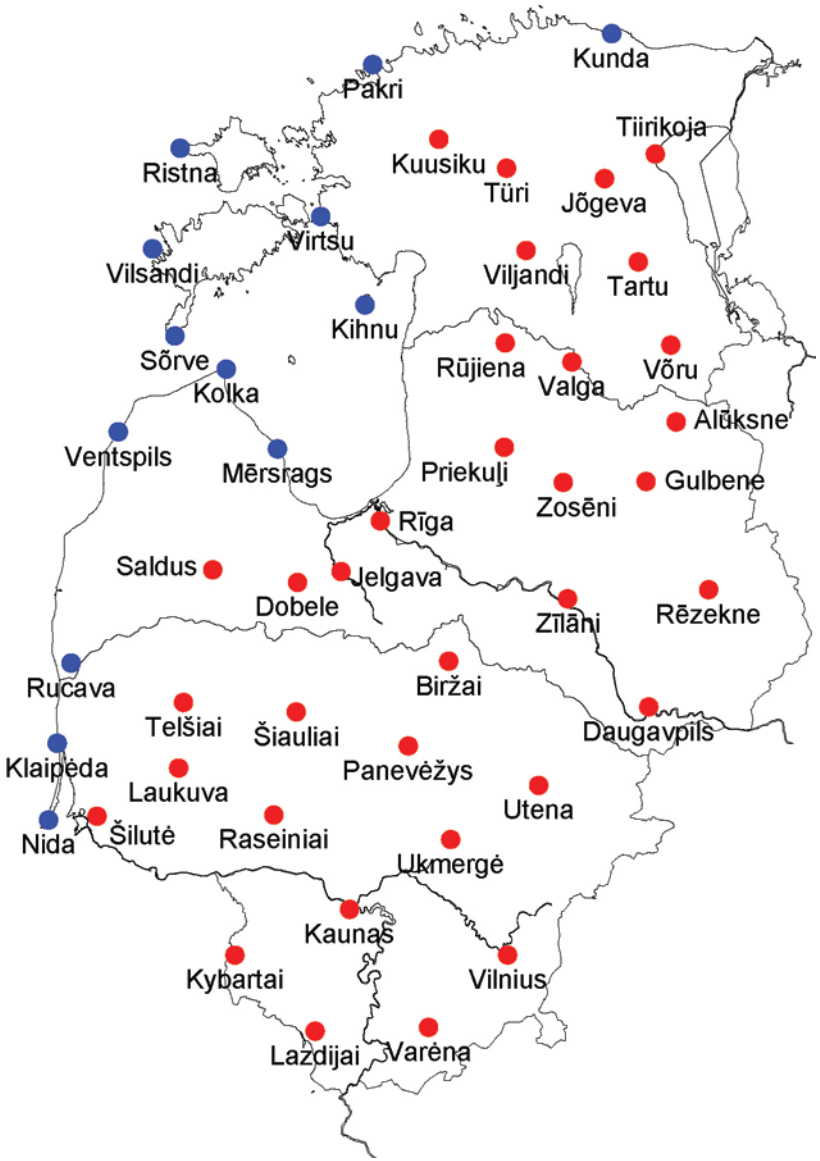
- Long-term warming by 0.07-0.10 K per decade (BACC)
- It was significantly higher during the second half of the 20th century, especially in winter and spring
- Globally, daily minimum temperature has increased faster than daily maximum temperature, thus daily temperature range (DTR) has decreased
- Similar results have been obtained from Fennoscandia, Poland and other regions of Europe
- Increase in DTR in April and May, and decrease in winter was detected in Latvia during 1913-2006

Objective

- analyse variability and trends in the time series of daily minimum and maximum temperature and DTR in the three Baltic countries during 1951-2010, emphasising on seasonal differences in trends

Data and methods

- Daily minimum and maximum temperatures and DTR at 47 stations in the Baltic countries (16 stations in Lithuania and Latvia, 15 in Estonia) in 1951-2006
- The stations were divided into two groups: continental and maritime
- Variables calculated – monthly mean and lowest minimum temperatures, monthly mean and highest maximum temperatures and DTRs
- Mann-Kendall test, Sen's method
- Local landscape variables were used for mapping using the methodology by Jaagus et al. 2010 and Remm et al. 2011


Kunda
Pakri
Tiirikoja
Kuusiku
Ristna
Türi
Jõgeva
Virtsu
Vilsandi
Viljandi
Tartu
Kihnu
Sõrve
Rūjiena
Võru
Valga
Kolka
Alūksne
Ventspils
Priekuļi
Mērsrags
Gulbene
Zosēni
Rīga
Saldus
Jelgava
Dobele
Zīlāni
Rēzekne
Rucava
Biržai
Telšiai
Šiauliai
Daugavpils
Klaipėda
Panevėžys
Laukuva
Utena
Šilutė
Nida
Raseiniai
Ukmergė
Kaunas
Kybartai
Vilnius
Lazdijai
Varėna

Maximum	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia – maritime	-0.7	-1.7	1.2	6.6	12.7	17.4	20.1	19.5	15.0	9.9	4.7	1.4	8.9
Estonia-continental	-3.0	-2.9	1.8	9.3	16.3	20.4	22.2	20.8	15.3	9.0	2.6	-1.1	9.3
Latvia-maritime	0.1	-0.4	2.8	8.4	14.2	18.4	20.7	20.4	16.1	10.8	5.2	1.8	9.9
Latvia-continental	-2.7	-2.3	2.4	10.1	16.9	20.5	22.3	21.2	15.7	9.5	3.0	-0.9	9.7
Lithuania-maritime	0.2	0.1	3.3	9.3	15.1	18.8	21.0	21.0	16.7	11.4	5.8	2.3	10.5
Lithuania continental	-1.9	-1.3	3.3	11.0	17.6	21.0	22.7	22.0	16.7	10.6	4.0	-0.1	10.5

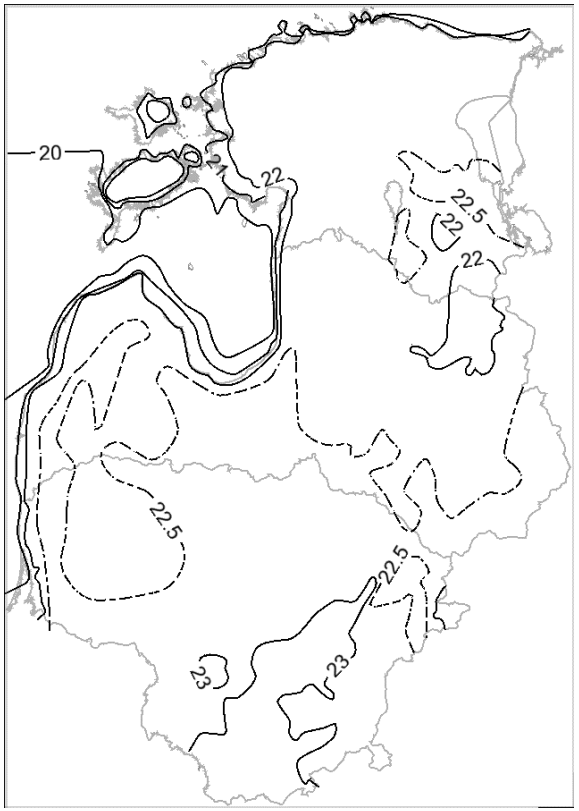
Minimum	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia – maritime	-5.2	-6.5	-4.2	0.7	5.7	10.7	13.8	13.6	9.8	5.5	0.9	-2.6	3.6
Estonia-continental	-8.8	-9.7	-6.3	-0.2	4.8	9.2	11.5	10.8	6.7	2.7	-2.0	-6.2	1.1
Latvia-maritime	-4.9	-5.8	-3.5	0.9	5.5	9.9	12.6	12.5	8.9	5.0	0.9	-2.7	3.3
Latvia-continental	-8.0	-8.4	-5.1	0.9	5.9	9.9	12.0	11.4	7.3	3.2	-1.4	-5.6	1.9
Lithuania-maritime	-4.6	-4.9	-2.3	2.5	7.3	11.6	14.5	14.5	10.8	6.5	1.7	-2.1	4.7
Lithuania continental	-7.0	-7.2	-4.0	1.7	6.5	10.2	12.3	11.7	7.8	3.8	-0.4	-4.7	2.6

Results

- Two main large-scale factors – latitude and the Baltic Sea
- Higher temperatures in Lithuania and lower in Estonia, difference 1-2 K
- The highest difference in spring in maritime stations and in winter in continental stations, the lowest difference in midsummer
- Exception in case of minimum temperature at the maritime stations in Latvia
- DTR is much lower in the coastal region

Monthly mean minimum and maximum temperatures for January

Monthly mean minimum and maximum temperatures for July



Monthly and annual mean DTR

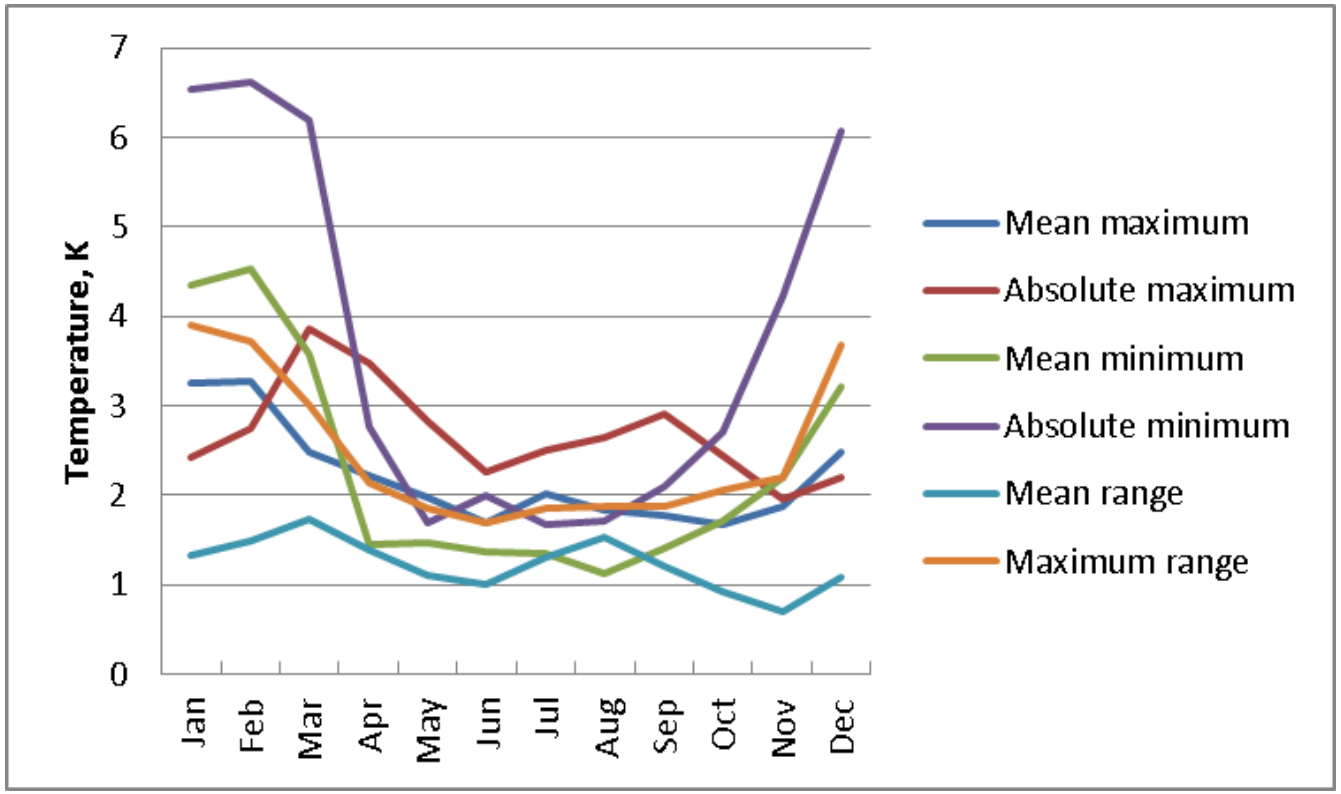
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia – maritime	4.4	4.7	5.3	5.9	7.0	6.6	6.2	5.9	5.3	4.3	3.8	4.0	5.3
Estonia-continental	5.8	6.6	8.2	9.4	11.5	11.2	10.7	10.1	8.7	6.3	4.5	5.1	8.2
Latvia-maritime	4.9	5.4	6.3	7.5	8.8	8.5	8.1	7.9	7.2	5.8	4.3	4.5	6.6
Latvia-continental	5.3	6.1	7.4	9.2	11.0	10.6	10.3	9.8	8.5	6.3	4.4	4.7	7.8
Lithuania-maritime	4.8	4.8	5.6	6.7	7.8	7.2	6.5	6.4	5.9	4.9	4.1	4.4	5.8
Lithuania continental	5.2	5.8	7.3	9.4	11.1	10.8	10.4	10.3	8.9	6.7	4.4	4.6	7.9

Monthly mean DTR in July and annual mean DTR

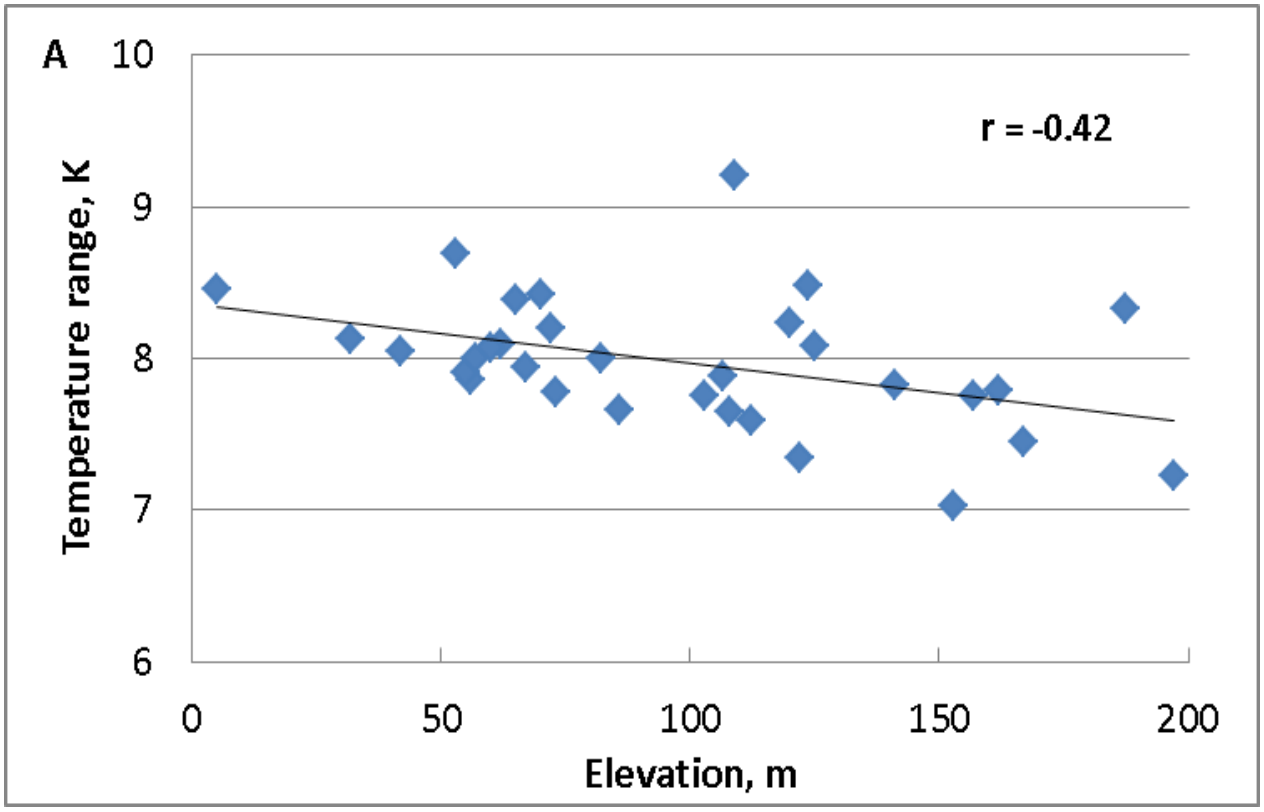
Extreme values

- The highest maximum – 36.8°C in Varėna, southern Lithuania on 13 July 1959
- The lowest minimum – -43.2°C in Daugavpils, eastern Latvia on 8 February 1956
- The highest DTR – 38.6 K in Jõgeva, eastern Estonia on 1 February 1956

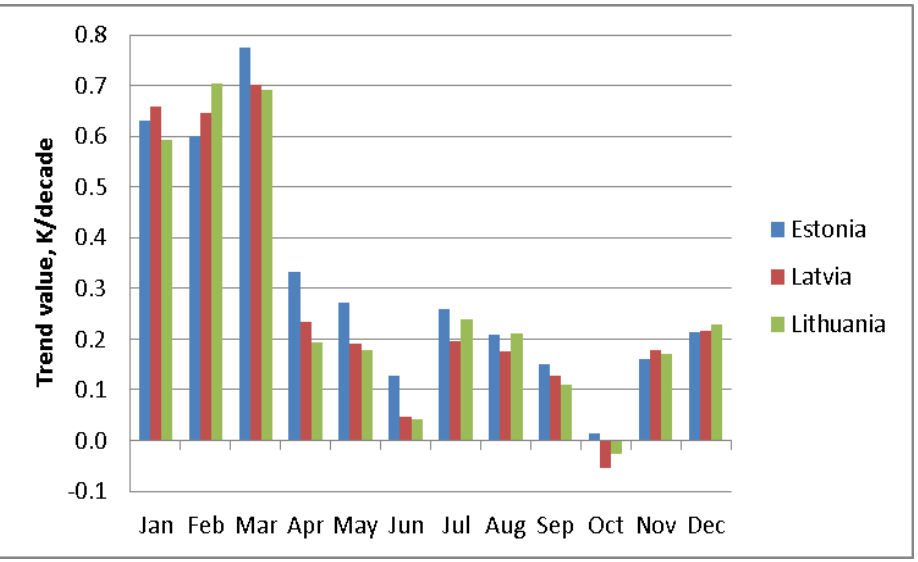
Standard deviations on monthly mean values

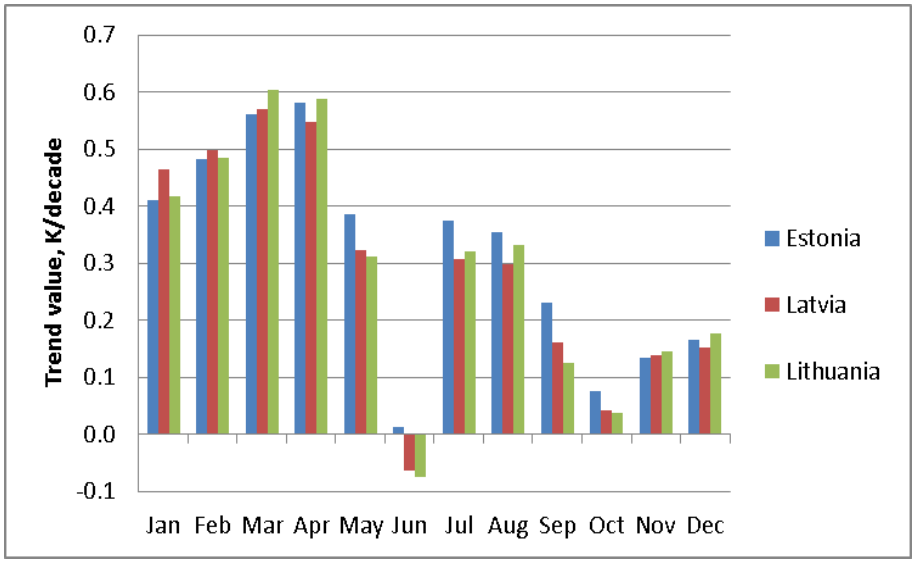


Relationship between the elevation of continental stations and annual mean DTR



Trend values (K/decade) for monthly mean minimum and maximum temperatures in 1951–2010 averaged for the countries

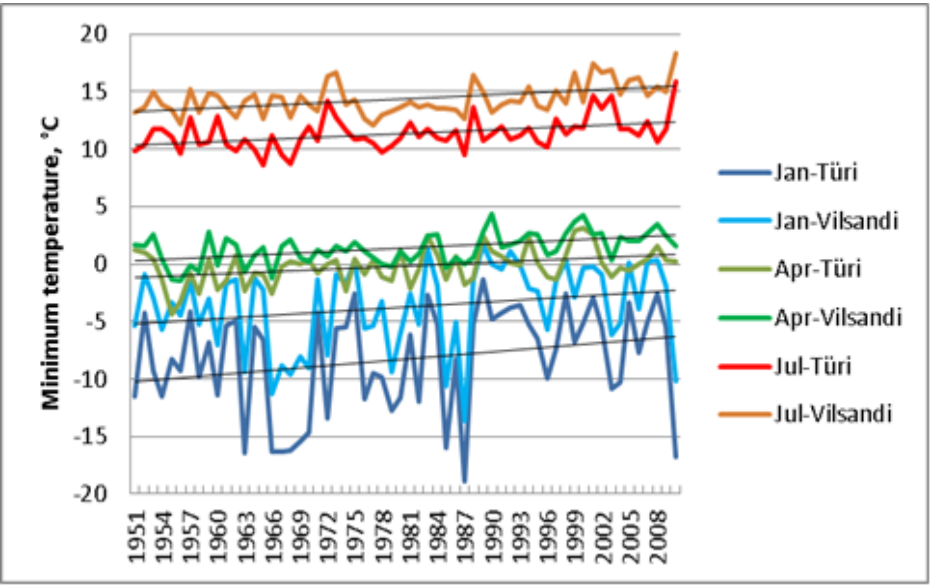


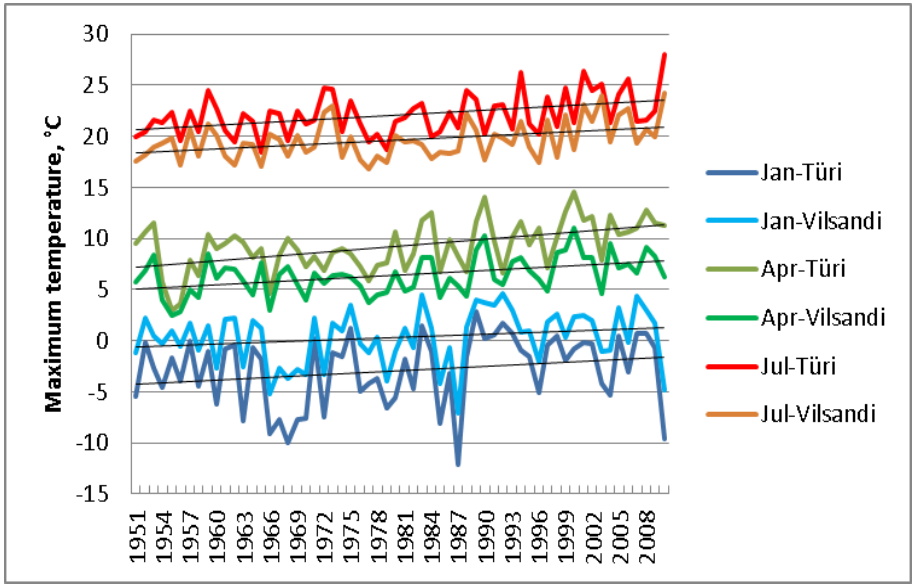


Maximum	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia–maritime	0.34	**0.43**	**0.55**	**0.52**	**0.39**	0.04	**0.35**	**0.35**	0.22	0.06	0.12	0.16	**0.32**
Estonia-continental	**0.45**	0.50	**0.60**	**0.59**	**0.40**	-0.03	**0.38**	**0.33**	0.23	0.09	0.14	0.17	**0.32**
Latvia-maritime	0.38	**0.50**	**0.50**	**0.47**	**0.37**	-0.03	**0.36**	**0.37**	0.14	0.01	0.12	0.14	**0.27**
Latvia-continental	0.45	0.44	**0.52**	**0.54**	**0.31**	-0.08	**0.27**	**0.26**	0.15	0.05	0.12	0.14	**0.28**
Lithuania-maritime	0.37	0.47	**0.53**	**0.48**	**0.32**	-0.02	**0.36**	**0.40**	0.18	0.04	0.12	0.14	**0.28**
Lithuania continental	0.42	0.48	**0.60**	**0.62**	**0.31**	-0.07	**0.32**	**0.37**	0.11	0.04	0.14	0.18	**0.25**

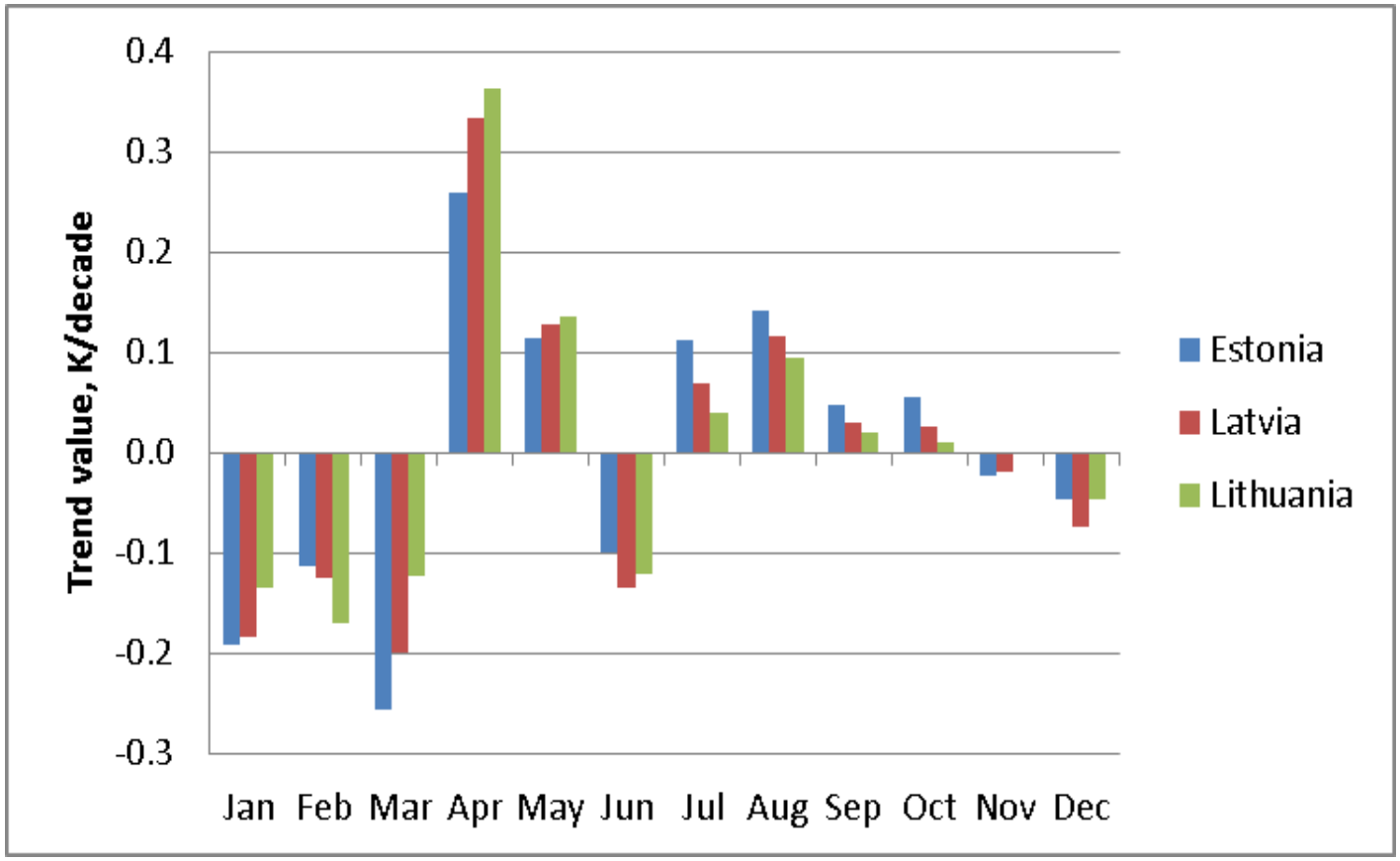
Minimum	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia – maritime	**0.51**	0.58	**0.73**	**0.34**	**0.32**	0.10	**0.22**	**0.18**	0.12	0.01	0.13	0.20	**0.30**
Estonia-continental	**0.74**	0.59	**0.80**	**0.33**	**0.24**	0.15	**0.28**	**0.22**	0.18	0.02	0.17	0.25	**0.35**
Latvia-maritime	**0.49**	**0.62**	**0.53**	**0.19**	**0.23**	0.09	**0.19**	**0.22**	0.15	-0.09	0.12	0.18	**0.25**
Latvia-continental	**0.68**	0.63	**0.68**	**0.23**	0.17	0.03	**0.19**	**0.15**	0.12	-0.03	0.18	0.24	**0.26**
Lithuania-maritime	**0.56**	**0.65**	**0.66**	**0.36**	**0.37**	**0.23**	**0.37**	**0.35**	0.17	-0.01	0.18	0.23	**0.37**
Lithuania continental	0.64	0.70	**0.69**	0.17	0.15	0.01	**0.23**	**0.19**	0.10	-0.02	0.18	0.23	**0.25**

Time series of monthly mean minimum and maximum temperatures in a continental (Türi) and maritime (Vilsandi) station in Estonia for January, April and July during 1951–2010 and their trends





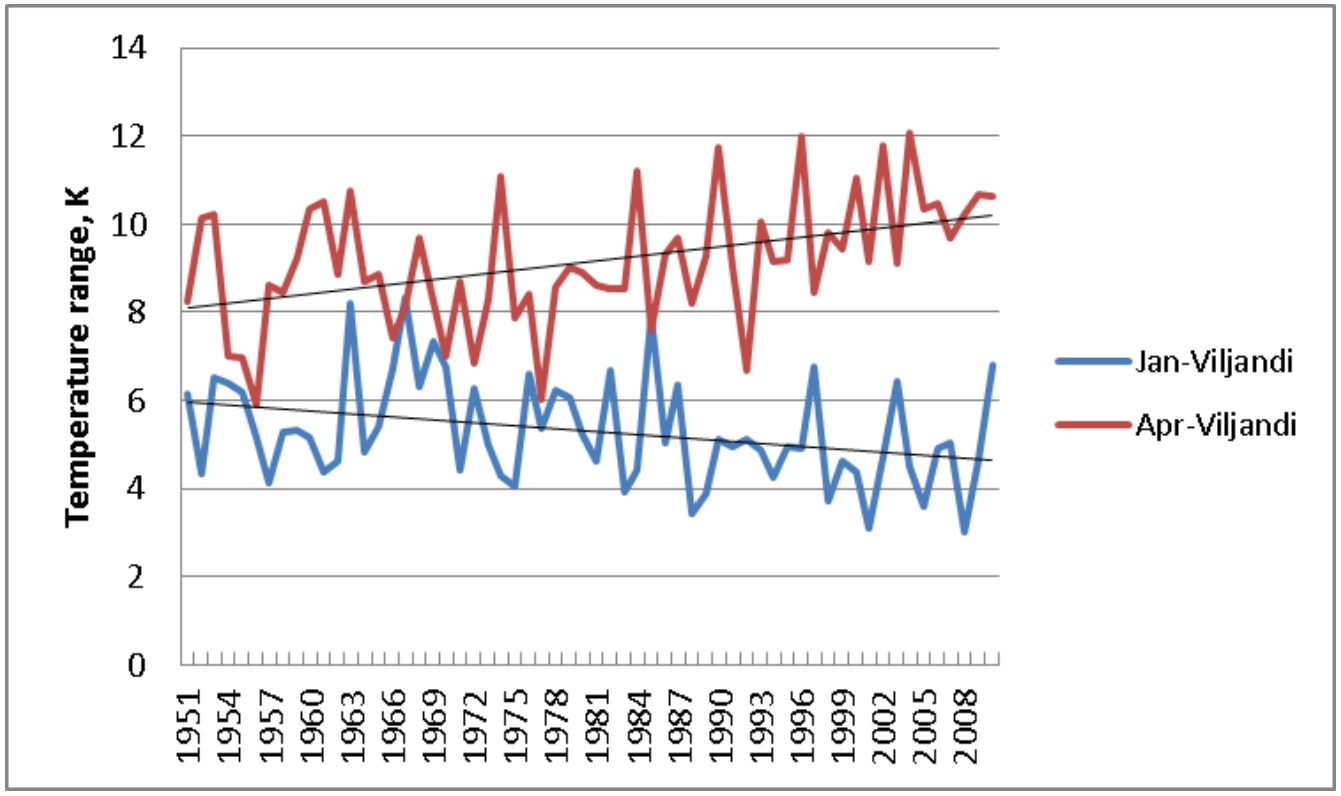
Trend values (K/decade) for monthly mean DTR in 1951–2010 averaged for the countries



Trend values of annual and monthly mean DTR (K/decade) spatially averaged by countries and by station groups during 1951–2010

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Estonia – maritime	-0.16	-0.11	-0.19	**0.17**	0.09	-0.03	**0.16**	**0.17**	0.08	0.07	-0.03	-0.01	0.02
Estonia-continental	**-0.24**	-0.12	-0.31	**0.33**	0.14	**-0.17**	0.08	0.12	0.01	0.04	-0.01	-0.08	-0.02
Latvia-maritime	-0.12	-0.09	-0.12	**0.30**	**0.16**	-0.07	0.13	0.16	0.02	0.05	0.01	0.01	0.04
Latvia-continental	**-0.18**	-0.11	-0.20	**0.33**	0.13	**-0.12**	0.07	0.09	0.02	0.02	-0.01	-0.08	0.00
Lithuania-maritime	-0.14	-0.21	-0.18	0.11	-0.07	**-0.23**	-0.02	0.02	-0.01	0.04	-0.04	-0.03	-0.06
Lithuania continental	-0.13	-0.18	-0.12	**0.42**	**0.16**	-0.12	0.06	0.10	0.03	0.01	0.00	-0.05	0.02

Time series of monthly mean DTR in Viljandi for January and April during 1951–2010 and their linear trend lines



Conclusions on trends

- Trends in maximum and minimum temperatures are similar to trends in mean temperature
- General warming was detected in March, April, July, August and annually
- Maximum temperature has increased also in May and at some stations in January and February
- Minimum temperature has significantly increased, first of all, in winter (Jan, Feb, Mar)
- DTR has weaker trends – positive in April and May, and with the less extent in Jul-Oct
- Negative trend in DTR revealed in Nov-Mar and June

Conclusions on trends

- The increase in DTR in April was much higher in the continental regions of the Baltic countries and lower in the coastal regions
- This change is stronger in the southern part of the study area (Lithuania) and weaker in its northern part (Estonia)
- The increase in DTR during the period from July to October was higher in Estonia
- The decrease in DTR in January and March was higher in Estonia, and in February it was higher in Lithuania
- The trend values in Latvia were mostly intermediates between the values obtained from Estonia and Lithuania