Climate of Latvia

Climatic conditions in the territory of Latvia are affected by **north-west location of the Eurasia continent**, which provides **continental climate**

In turn, the air mass transfer by the atmospheric circulation from the Atlantic Ocean provides maritime climate

Frequent weather variability is associated with active cyclonic activities over the territory of Latvia

According to the climate classification, the territory of Latvia is located in wet climatic zone with warm summers and snow precipitation in winters


Sita, Balvu novads (Flickr: Māris Pehlaks)


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SUNSHINE DURATION AND SOLAR RADIATION

Alūksnes ezers (Flickr: Māris Pehlaks)

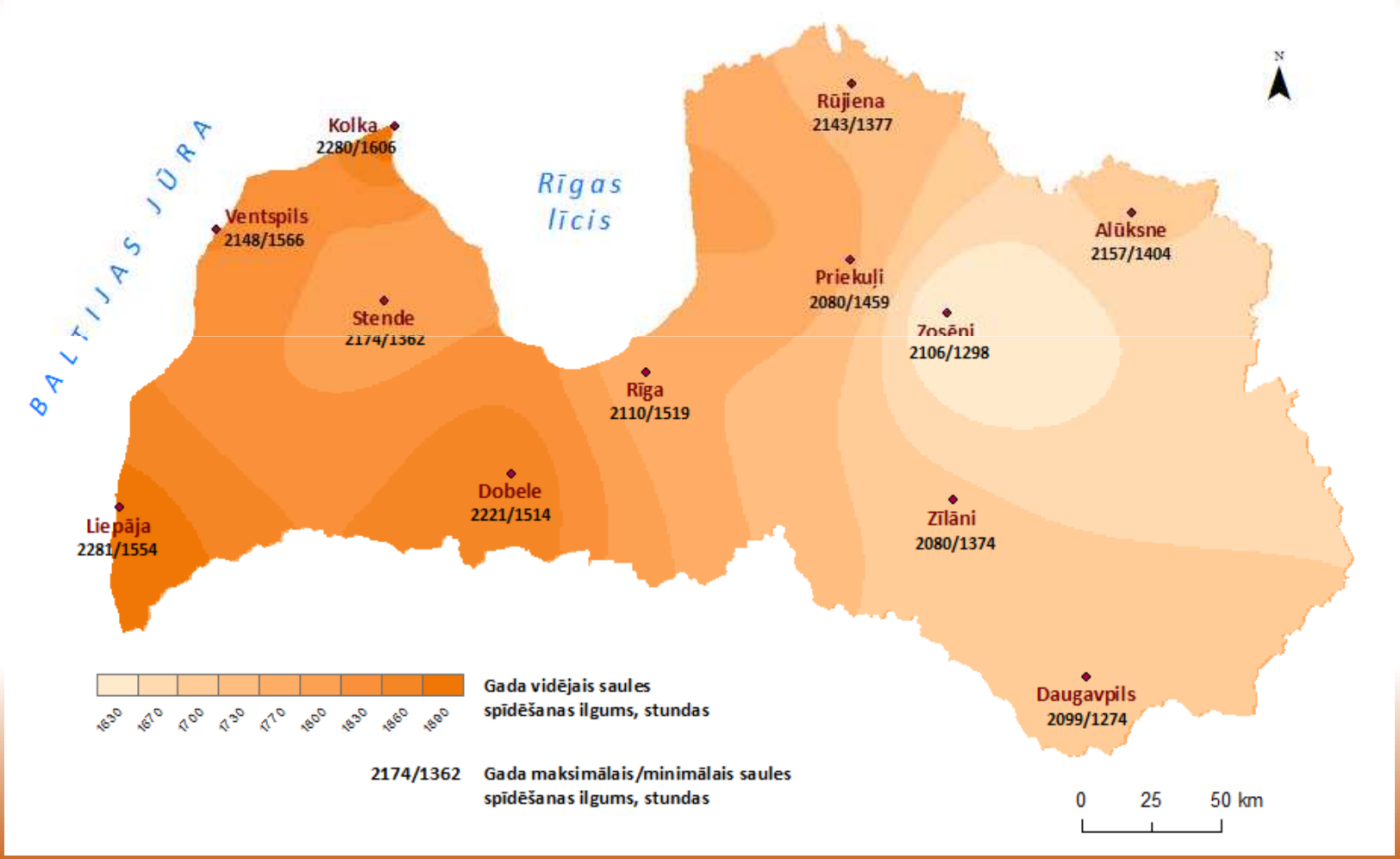
In the territory of Latvia, the day length and the sunshine duration during the year is variable

The longest day is June 22 (day length 17-18 hours), and the shortest day is December 22 (day length 6-7 hours)

Overall, on average the sun shines 1,790 hours per year – varying over the territory of Latvia from 1,600 to 1,970 hours per year

The longest sunshine duration is observed on the Baltic Sea coast (Kolka, Ventspils, Liepaja) where it is from 1,840 to 1,940 hours per year

Average duration of sunshine (hours) in Latvia (1950-2010)

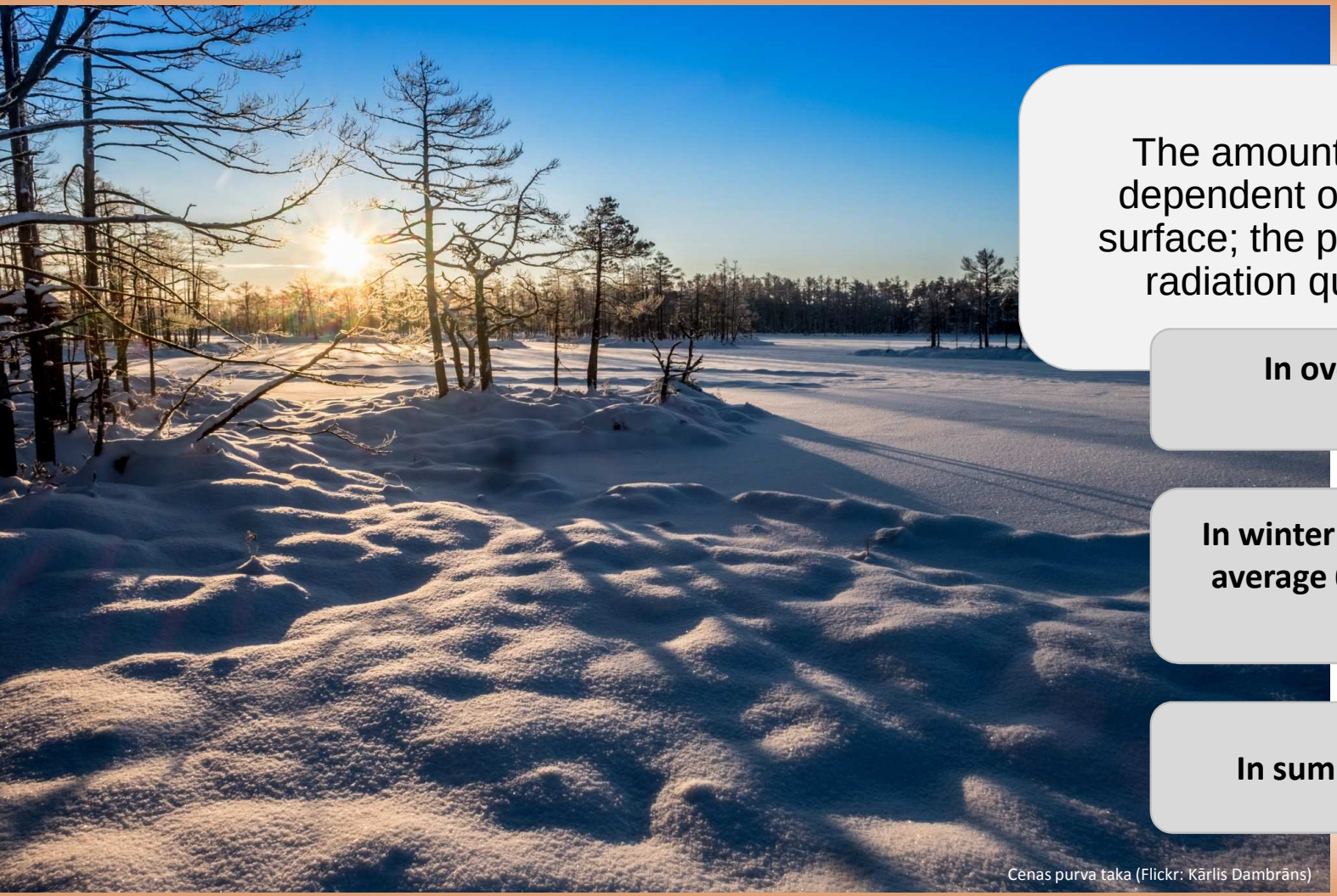


Absorbing the solar radiation, the Earth surface at the same time loses it by long-wave radiation, and this process is called **the effective emissivity**

The radiation balance is the difference between received energy by the Earth's surface and lost solar energy

In November, December and January the radiation balance is negative, but in other months – positive

Rīga (Flickr: Niks Freimanis)



Cenas purva taka (Flickr: Kārlis Dambrāns)

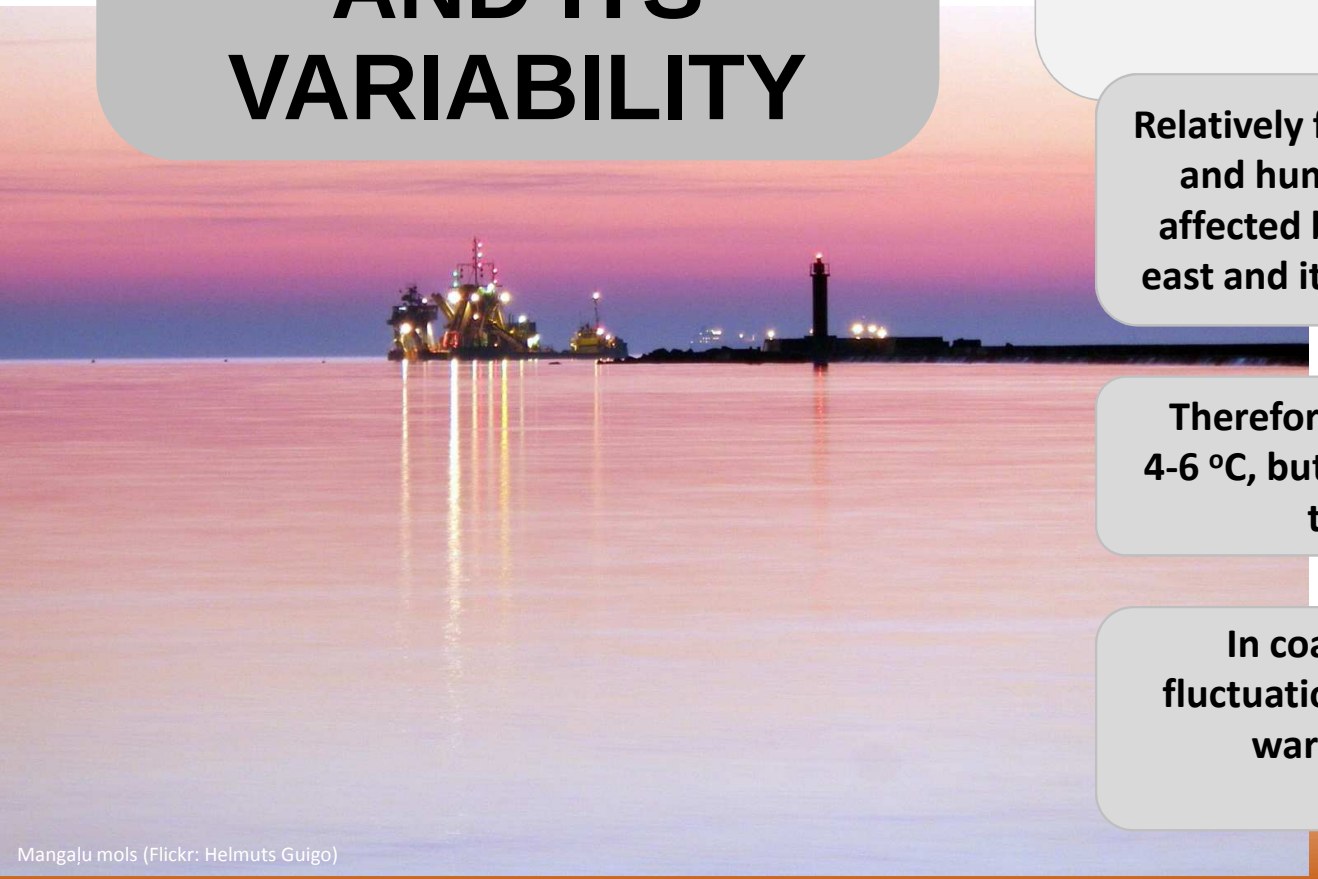
The amount of reflected radiation is dependent on specifics of the Earth's surface; the percentage of the reflected radiation quantity is called **albedo**

In overall, the average annual albedo is 27 %

In winter albedo values are higher (on average 65-70 %), partly due to large snow reflectance

In summer albedo is around 22 %

AIR TEMPERATURE AND ITS VARIABILITY



Mangaļu mols (Flickr: Helmuts Guigo)

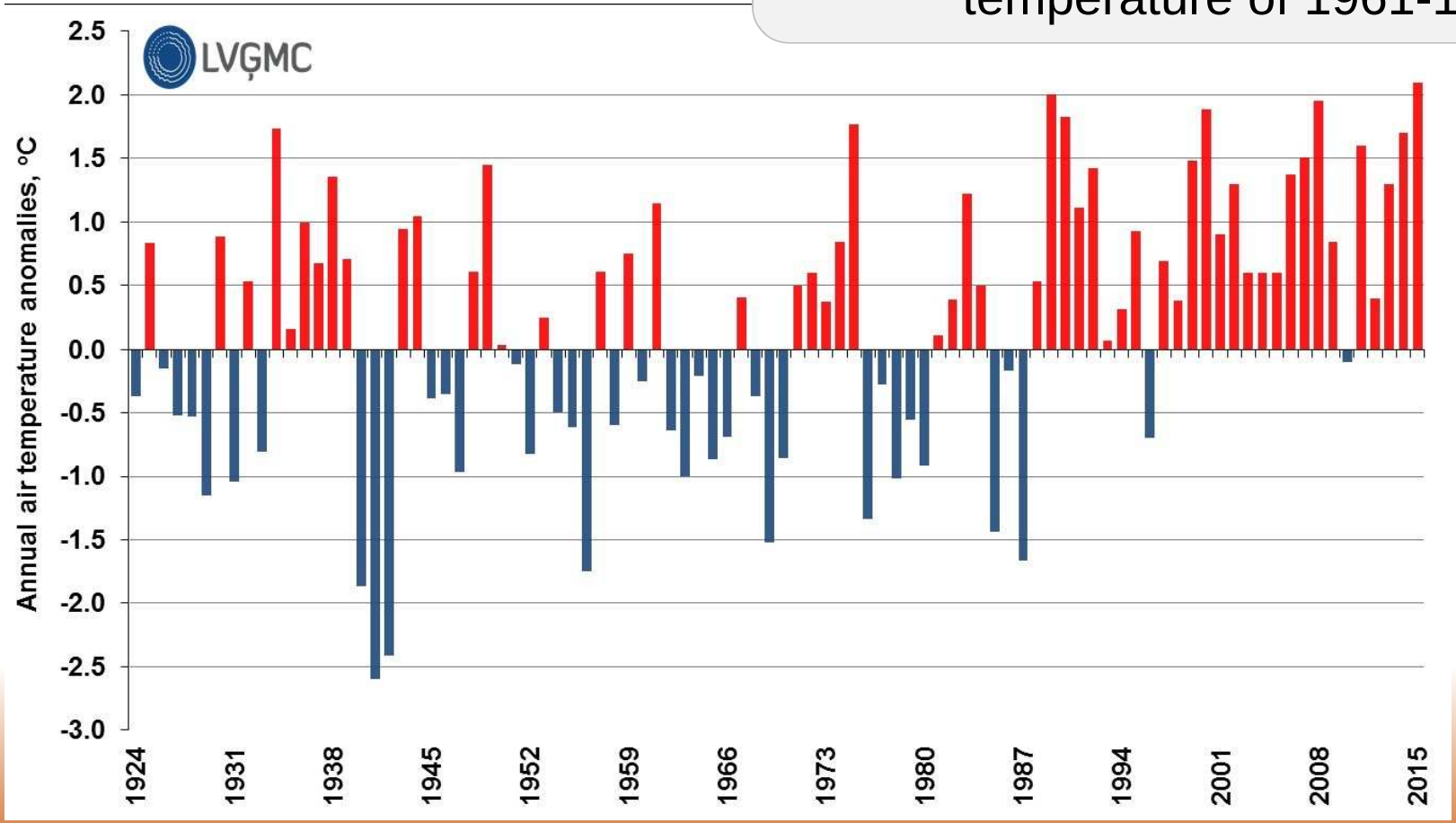
Regime and distribution of air temperature over the territory of Latvia is determined by **the quantity of received solar radiation, atmospheric circulation characteristics, as well as by the Baltic Sea, the Gulf of Riga and land relief**

Relatively flat relief is the cause for movement of warm and humid maritime air mass flows of the Atlantic affected by the planetary flows moving from west to east and its penetration far on the European continent

Therefore, in Latvia average annual temperature by 4-6 ^{o}C, but in winter even by 9 ^{o}C, exceeds the average temperature of the current latitude

In coastal areas there are lesser temperature fluctuations – winters and autumns on the coast are warmer than deeper into the shore, while springs and summers are cooler

Anomalies of annual air temperature in Latvia in comparison with mean temperature of 1961-1990



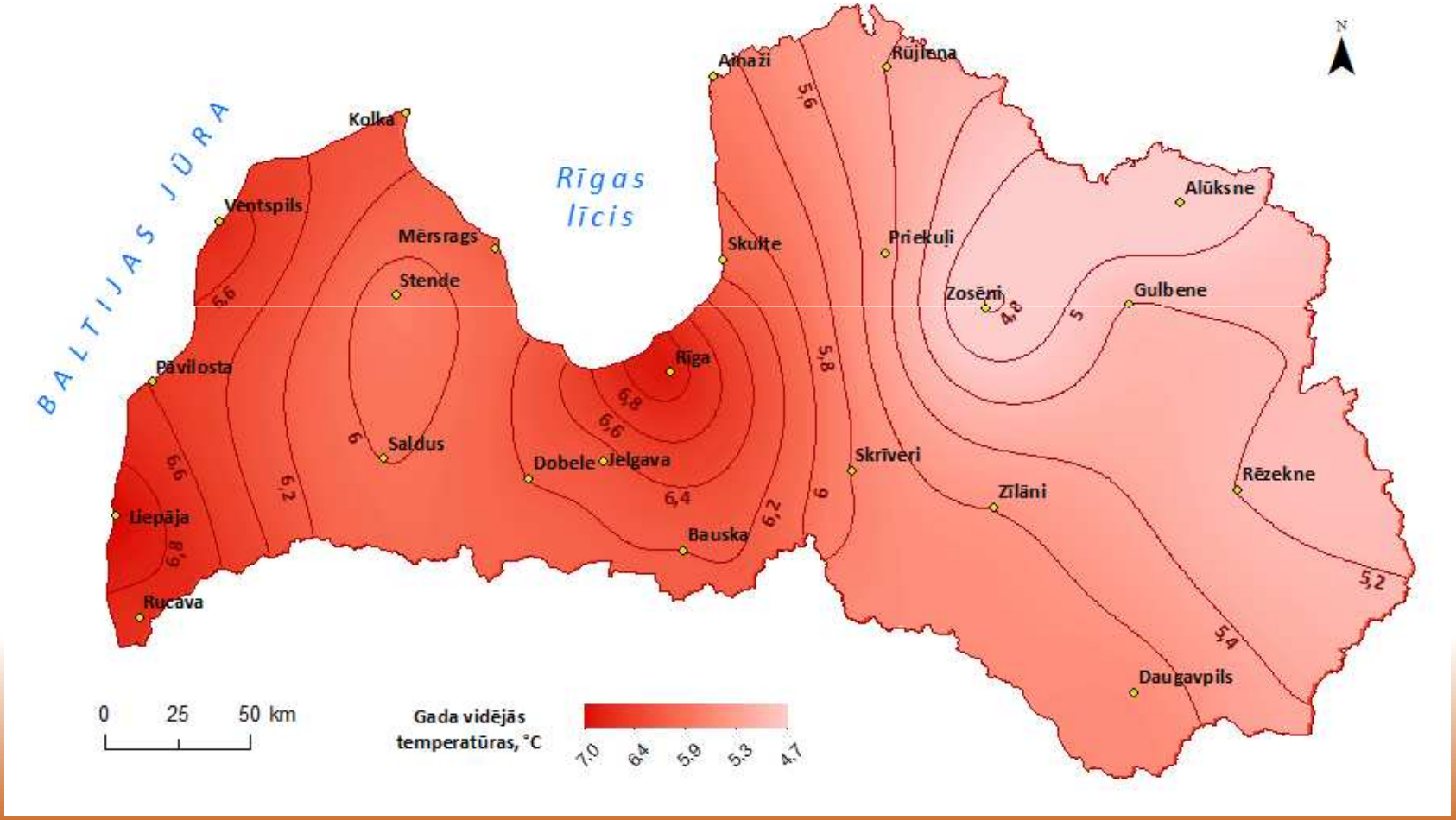
Marienburga, Alūksnes novads (Flickr: Māris Pehlaks)

Based on the long-term observations (1950-2010), average annual temperature in Latvia has been 6.0 ºC, but calculation for the last 30 years (1981-2010) reveals that it is increased to 6.4 ºC

The highest annual average air temperature is detected on the coast of the Baltic Sea, the lowest – in Vidzeme and Latgale highlands area

In overall, average annual temperature (1951-2010) in the territory of Latvia fluctuates from 4.8 ºC (in Zoseni, Aluksne) to 7.0 ºC (in Liepaja)

Average annual air temperature in Latvia (1950-2010)



Vasara Latvijā (Flickr: Reinis Pauliņš)

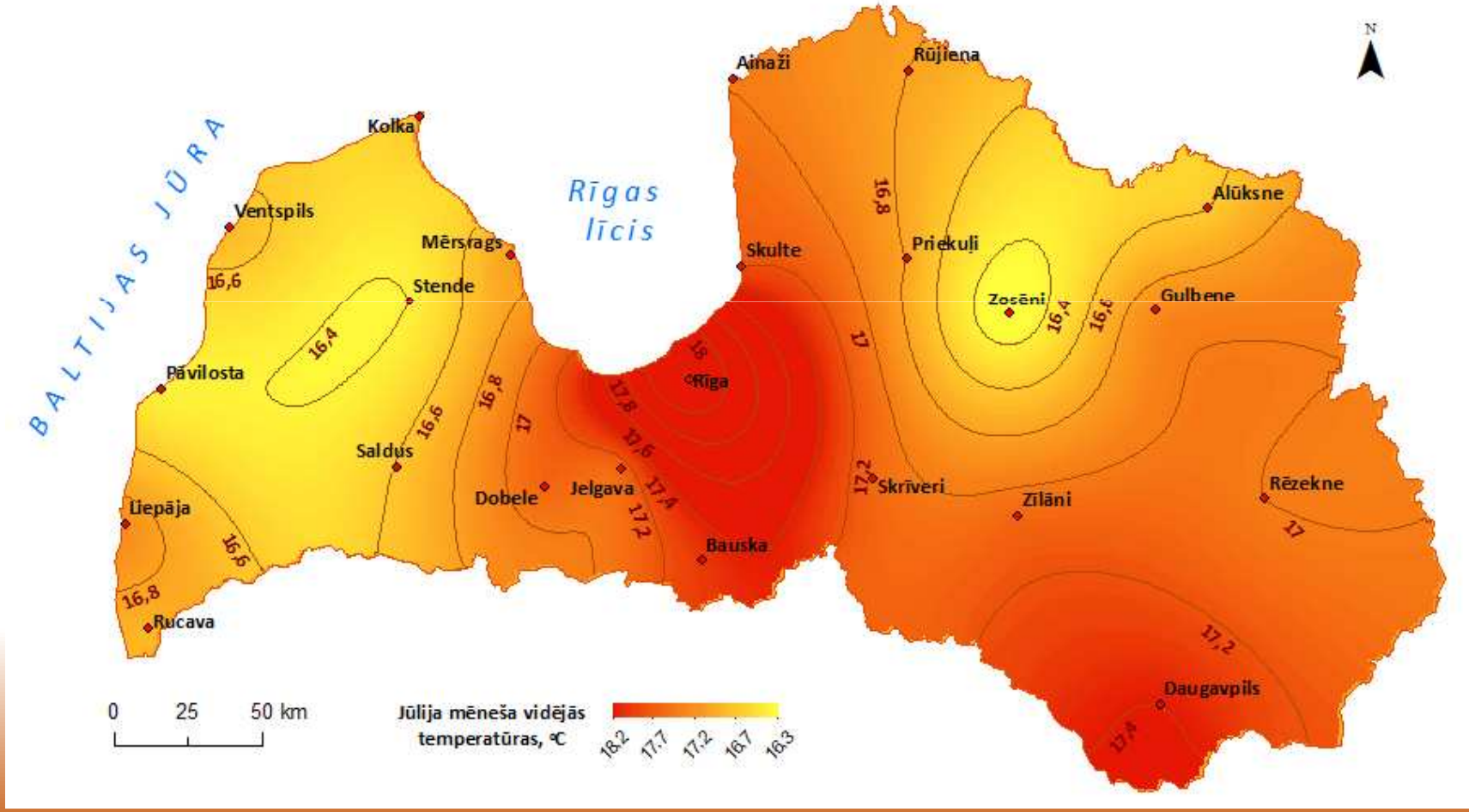
The warmest month of the year in Latvia is **July**

Average air temperature in July in Latvia is 16.9 °C (1950-2010)

Calculation of average temperature in July for the last 30 years (1981-2010) reveals the increase up to 17.4 °C

Average air temperature in July varies from +18.2 °C (in Riga) to +16.3 °C (in Zoseni) and +16.4 °C (in Pavilosta, Stende)

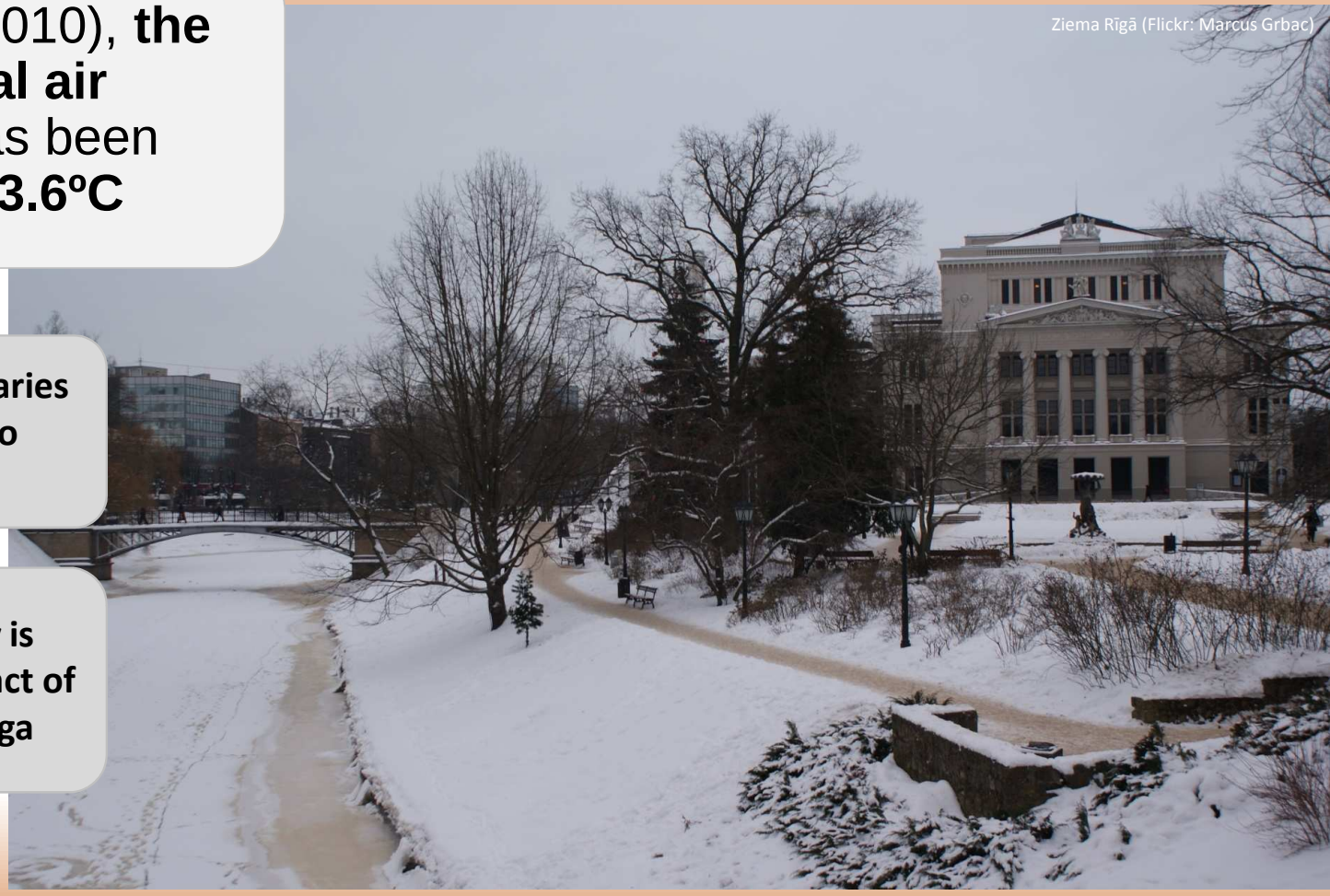
Average air temperature in July in Latvia (1950-2010)



In the last decades (1981-2010), **the lowest average annual air temperature** in Latvia has been observed in **February -3.6ºC**

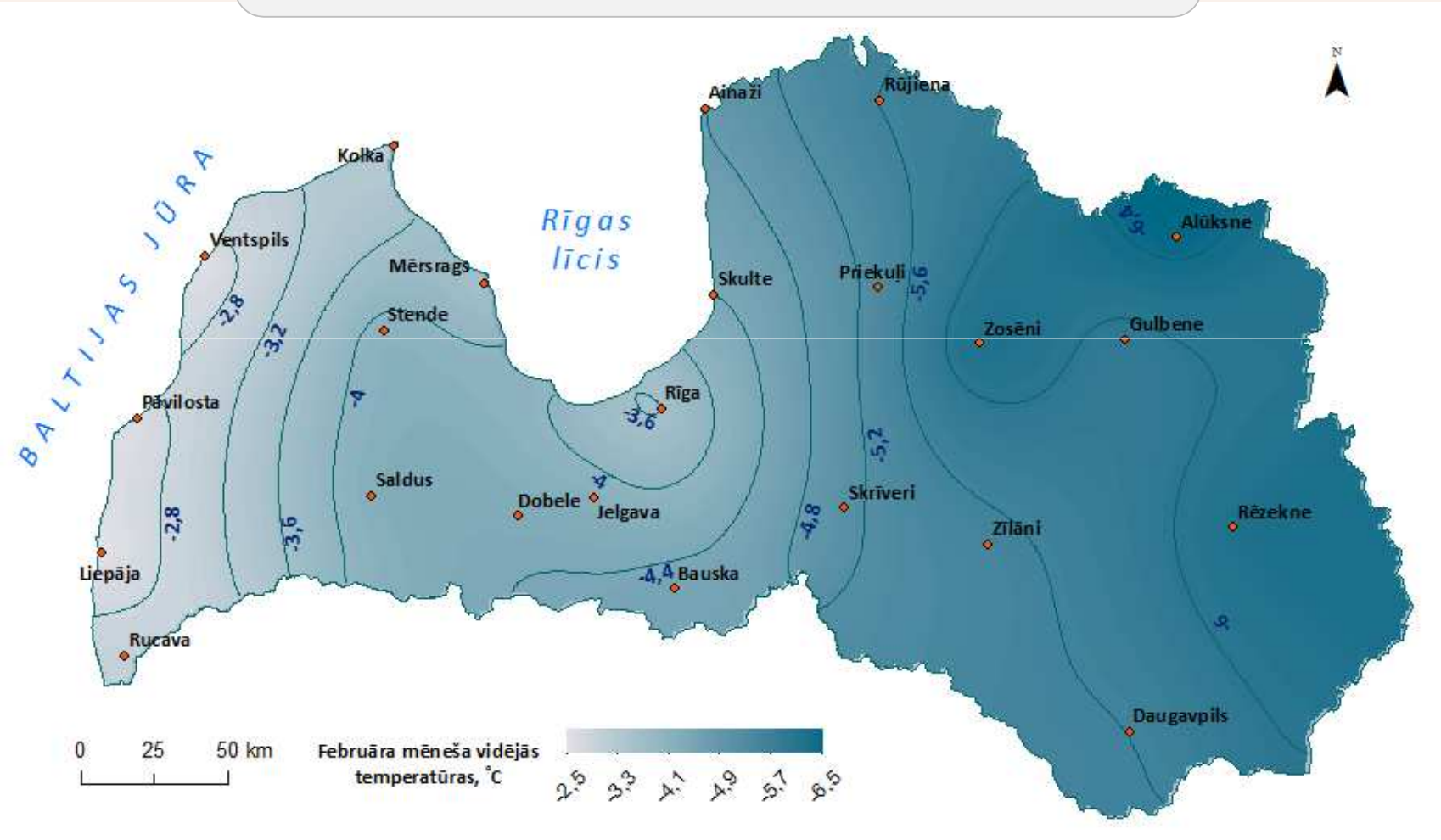
Air temperature in February varies from -2.5 ºC (in Ventspils) to -6.5 ºC (in Aluksne)

Air temperature in February is obviously affected by the impact of the Baltic Sea and Gulf of Riga



Ziema Rīgā (Flickr: Marcus Grbac)

Average air temperature in February in Latvia (1950-2010)

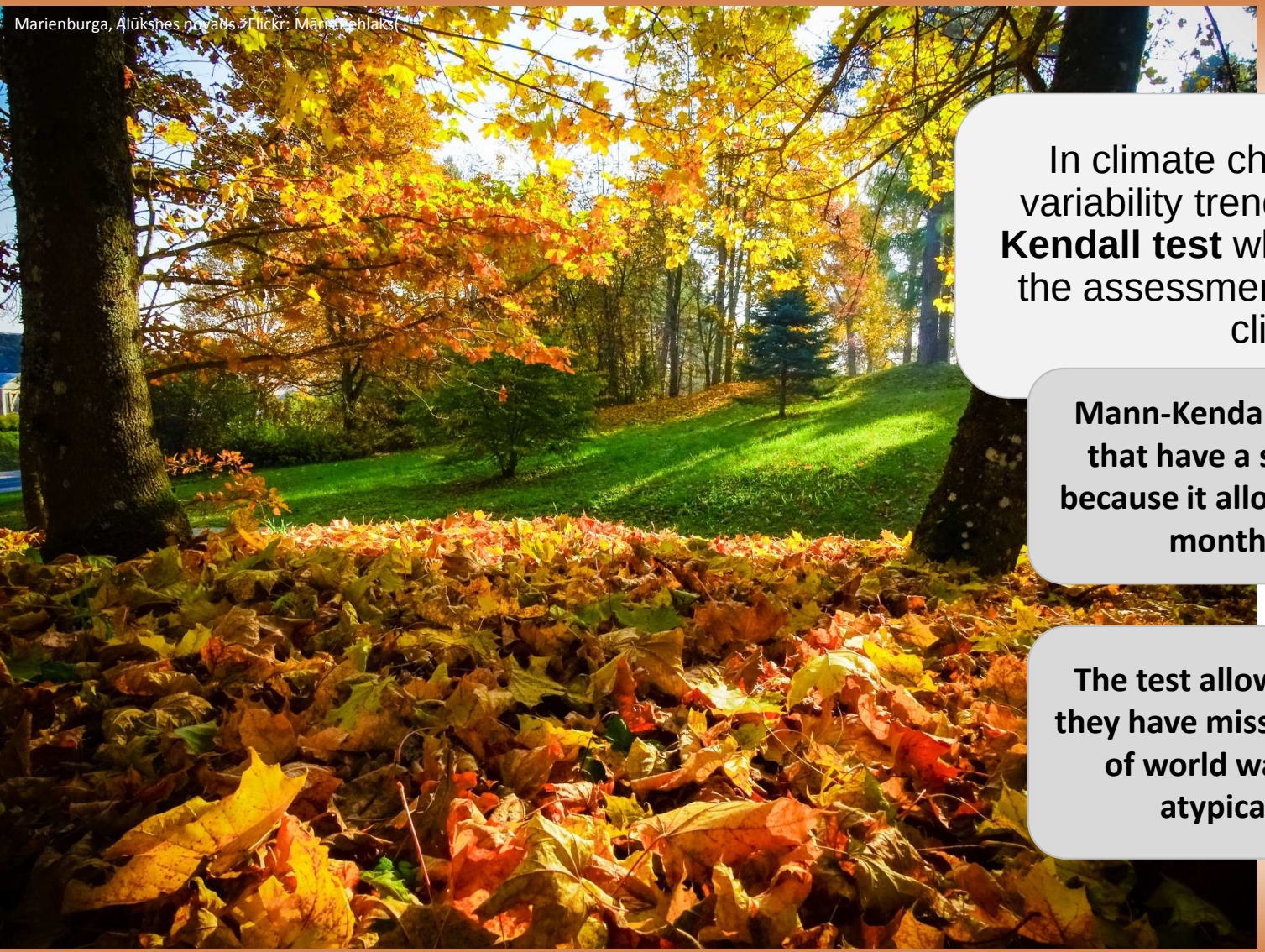


Absolute temperature minimum -43.2 ºC in Latvia was observed on February 8 of 1956, in Daugavpils

Absolute temperature maximum +37.8 ºC in Latvia was observed on August 8 of 2014, in Ventspils

Thus, amplitude of extreme air temperature in Latvia is calculated 81.0 ºC

Slīteres nacionālais parks, Kolka (Flickr: Julian-G. Albert)


Marienburga, Alūksnes novads - Flickr: Mariens Lehlaks

In climate change research evaluation of variability trends is determined using **Mann-Kendall test** which is designed specifically for the assessment of changed in tendencies of climatic parameters

Mann-Kendall test can be used for data rows that have a seasonal or seriated variability, because it allows calculation of values for each month or data series separately

The test allows analysis of data series even if they have missing values (such as a time period of world wars), as well as the data series atypical (very high or low) values

Air temperature is the indicators of climate change, which is most often used to describe the process of global warming

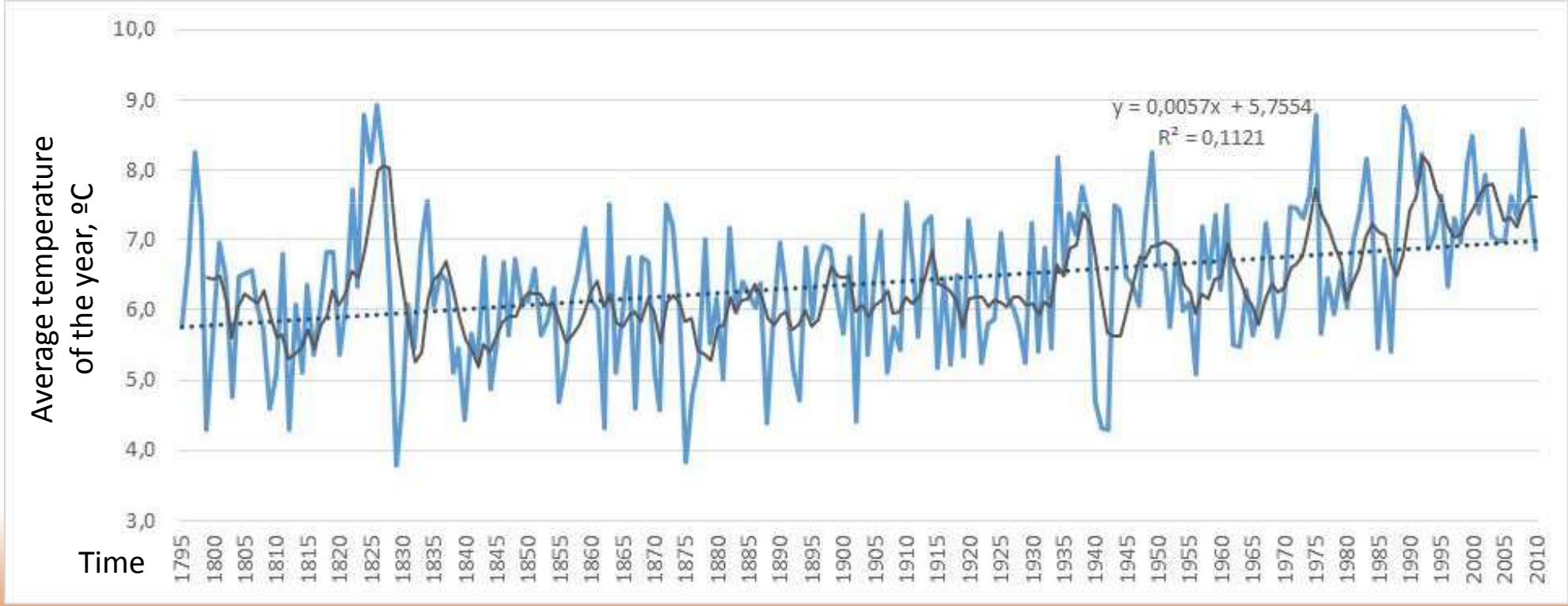
Variability of air temperature easily understandably reveals that in recent decades air temperature is increasing

Variability of air temperature can be characterized by the distinction between the terms «climate» and «weather»

Climate is characterized by long-term average values, but weather is characterized by conditions that occur in a shorter amount of time in a certain place

Salna (Flickr: Dainis Matisons)

Average annual changes of air temperature in long-term (1795-2010) regression line after the data derived at the Riga-LU observation station



Long-term temperature variability is expressed **as fluctuations of annual average temperature** – data reveal that the temperature variations since the middle of 20th century has **a strong upward trend**

Increase of annual average temperature in Riga during the period from 1795 to 2010 is 1.3 ^{o}C , but the highest it is during the spring months (May, April, March) and early winter (December)

Air temperature in Riga is characterized by a considerable variability in the amplitude – the minimum monthly average temperature (-17.1 ^{o}C) was observed in January of 1803, but the maximum (+22.8 ^{o}C) in July of 1914

Summer seasons of 2002, 2010 and 2011 have been the warmest in the history of meteorological observations in Latvia

PRECIPITATION AND VARIATIONS OF ITS QUANTITY

Lietus (Flickr: Edijs Pālens)

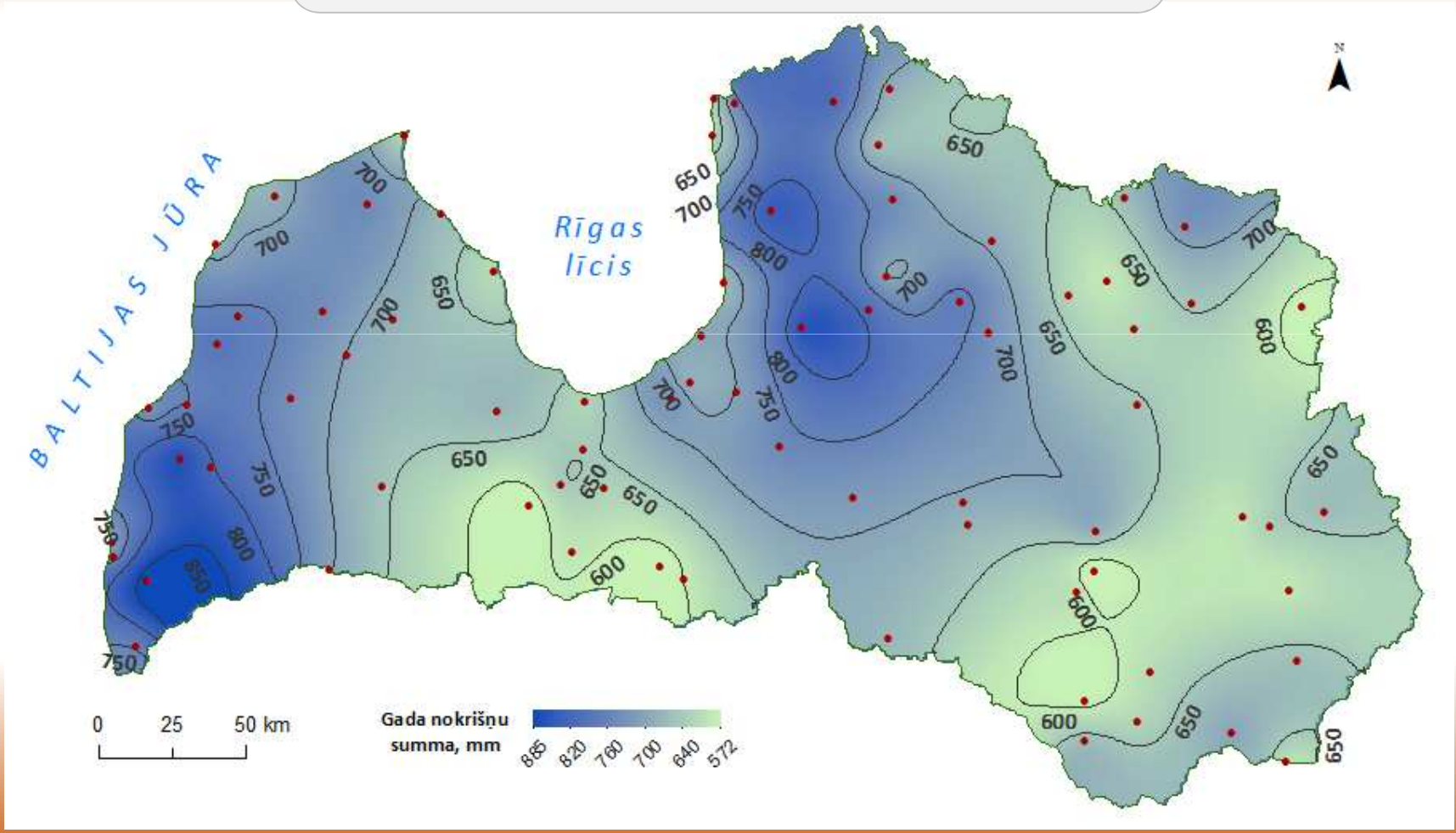
Amount of precipitation in Latvia is determined by a **large-scale atmospheric circulation** (West planetary flow) that affects the transfer of wet air masses from the Atlantic Ocean across the Baltic Sea, mainly due to the cyclonic activity

Western planetary flow in mid-latitude occurs in the troposphere and stratosphere

Thus, in the territory of Latvia the amount of precipitation is large enough – on average 685 mm

Although the highlands of Latvia are not too high, they are affecting distribution of temperature and precipitation at local scale

Average annual precipitation in Latvia (1950-2010)



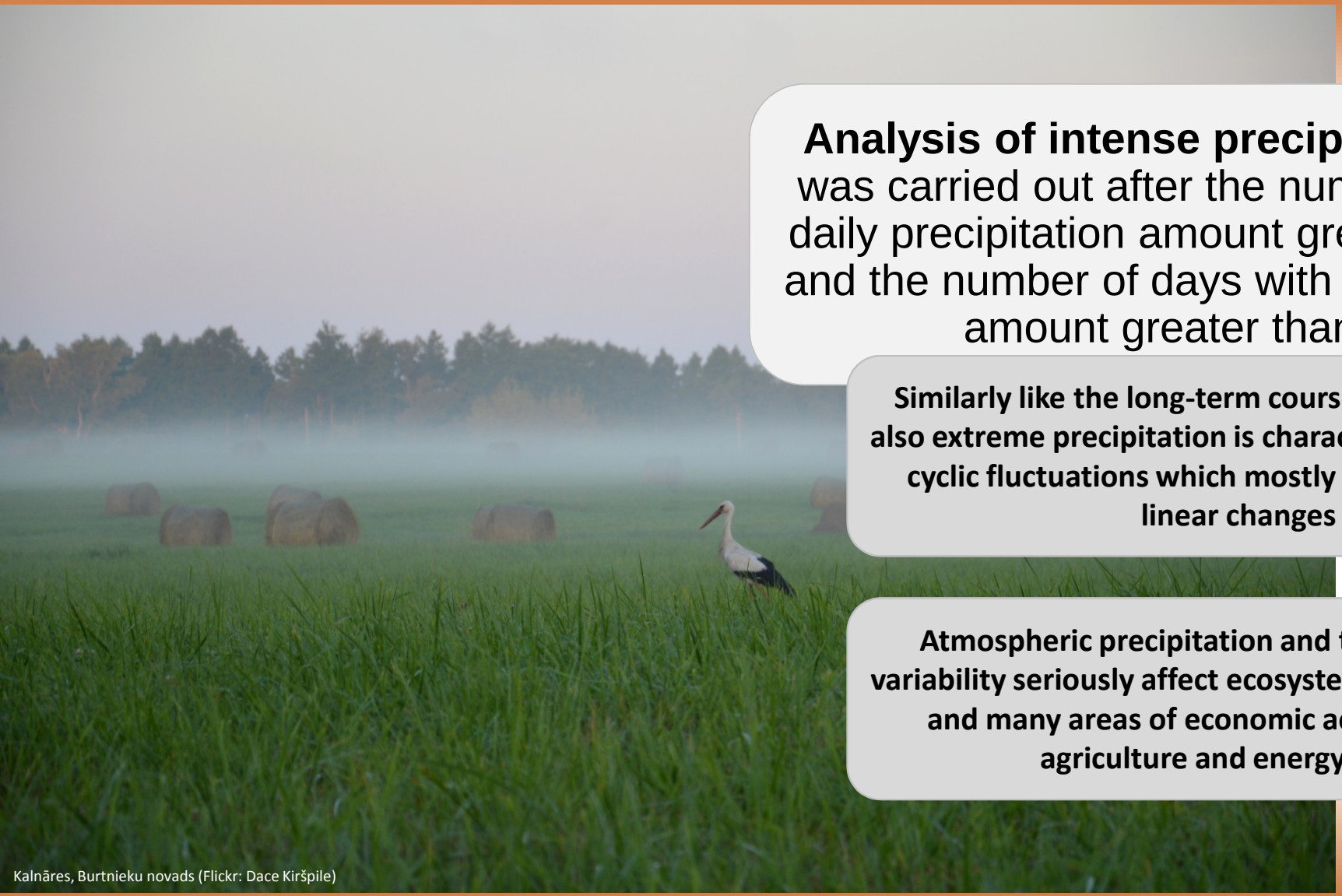
In the distribution of annual average precipitation several common regularities are dominating:

The largest average annual precipitation (760-870 mm) is a characteristic of west slopes of the Vidzeme highland, Rietumkursa highland and Latgale highland

The lowest amount of precipitation (580 mm) is observed in the Zemgale plain and in the depression zones located in leeward slopes of highlands

The largest monthly precipitation (>80 mm per month) is observed during summer, but during cold seasons the amount of precipitation is considerably lower (about 20 mm per month)

Lietus (Flickr: Alexander Okunew)



Kalnāres, Burtnieku novads (Flickr: Dace Kiršpile)

Analysis of intense precipitation changes was carried out after the number of days with daily precipitation amount greater than 10 mm and the number of days with daily precipitation amount greater than 20 mm

Similarly like the long-term course of precipitation, also extreme precipitation is characterized by inherent cyclic fluctuations which mostly are explicated as linear changes

Atmospheric precipitation and the nature of its variability seriously affect ecosystems, human habitat, and many areas of economic activities such as agriculture and energy sector

EXTREME WEATHER EVENTS

Vētra Tūjā (Flickr: Helmuts Guigo)

Extreme weather conditions or events are weather conditions that are marginal in a historical perspective, particularly atypical, severe or unusual weather conditions

Extreme weather conditions due to their relatively small-scale impact most often are defined locally, as they are characterized as specific and different for the certain area

Extreme weather events by type can be divided as sudden (intense rainfalls, storms) or long term (heat waves, droughts)

Each extreme weather event is unique to scale, time, location and in terms of human social context

Extreme weather conditions affect the sectors which are closely linked to the climate, such as water security, agriculture, forestry, human health, tourism etc.

Plūdi Rīgā 2010.g. 18.jūlijā (Flickr: David Holt)

Pavasara pali un plūdi Ogrē 2013.gada aprīlī (Flickr: Latvijas Armija, Gatis Dieziņš)

Changes of contemporary climate **induce increase of extreme weather events**, their frequency and intensity nowadays and in future

Even if the changes in the average climatic parameters are not observed, tendencies of extreme weather events may occur

Extreme weather conditions is not the meteorological situation that occurs only in modern times

Extreme weather events in the history of Latvia are compiled the study «Unusual weather in Latvia (900-1860)» performed by professor Guntis Eberhards

Summary of historical data reveals that in Riga the most extreme was **the year 1709**:

«Flooding has already begun in the previous autumn. In November, such an extremely strong storm destroyed many houses in Riga, partly also the Dome Cathedral, which lost their roof. Water during the storm flooded the shores and islands of the River Daugava shores, washing away houses, livestock and people. Ships were smashed and thrown ashore...

After the storm a hard frost followed that continued for almost all winter. In the River Daugava ice was 1.5 meters thick – at some places it was frozen to the bottom. 22 ships were icebound...

During that winter almost all orchards in Latvia were destroyed by frost. At the beginning of spring thaw (atkusnis), the stream of the Daugava brought ice downstream where the ice masses caused huge ice jam...

Ice massed and flood waters broke the gates of the city, flowed into the city, flooding the streets, buildings and basements. In the Dome Cathedral water chopped up to the altar. Turned upside down in a jumble there were floating benches, coffins and corpses»

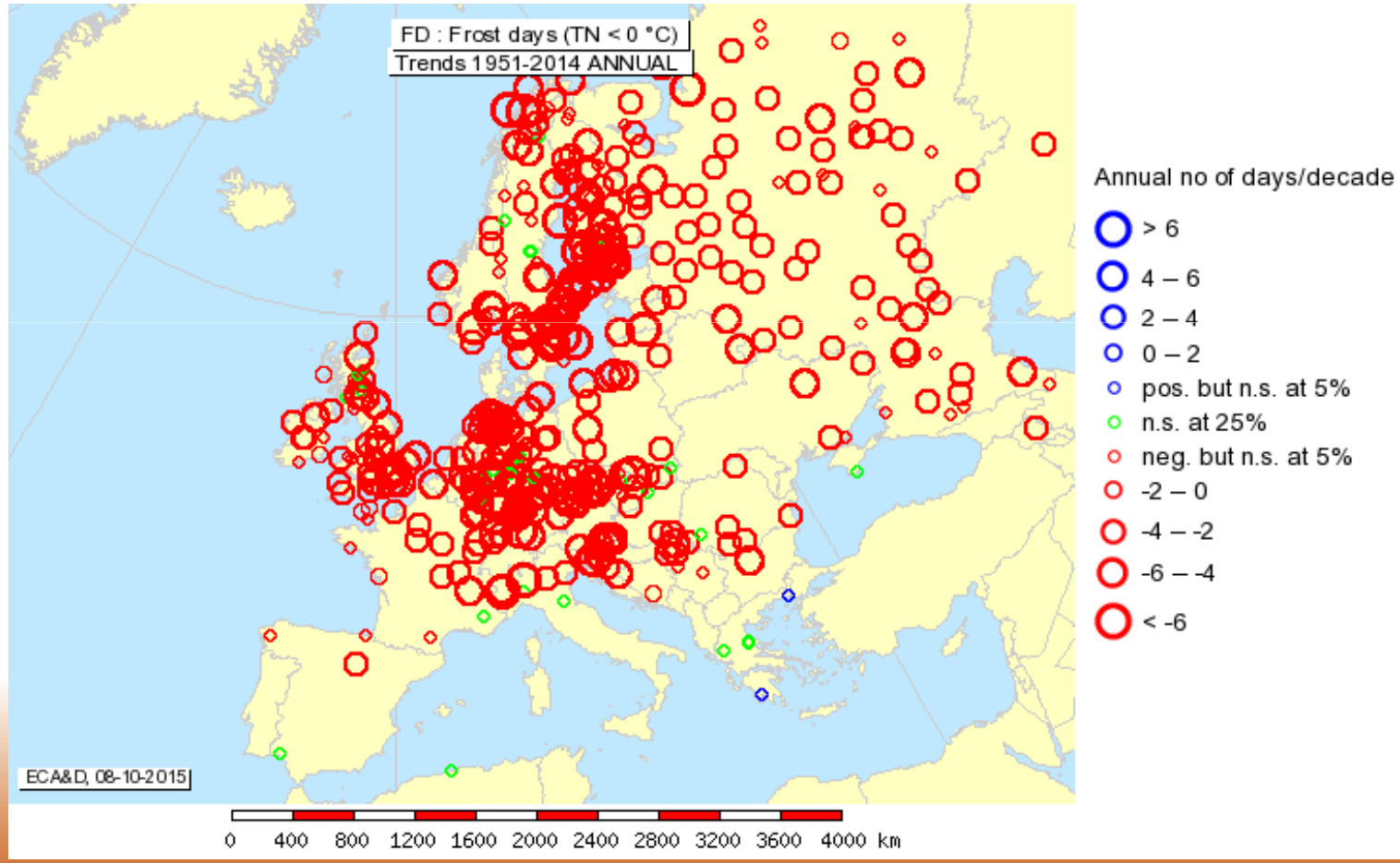
Jūrmala (Flickr: Pablo Andres Rivero)

Today's research shows that in long-term period of time, there are observed significant changes of extreme climatic events in Latvia:

Extremely hot days and nights are more and more frequent as well as the number of days with strong precipitation

By contrast, extremely cold days are observed rarely

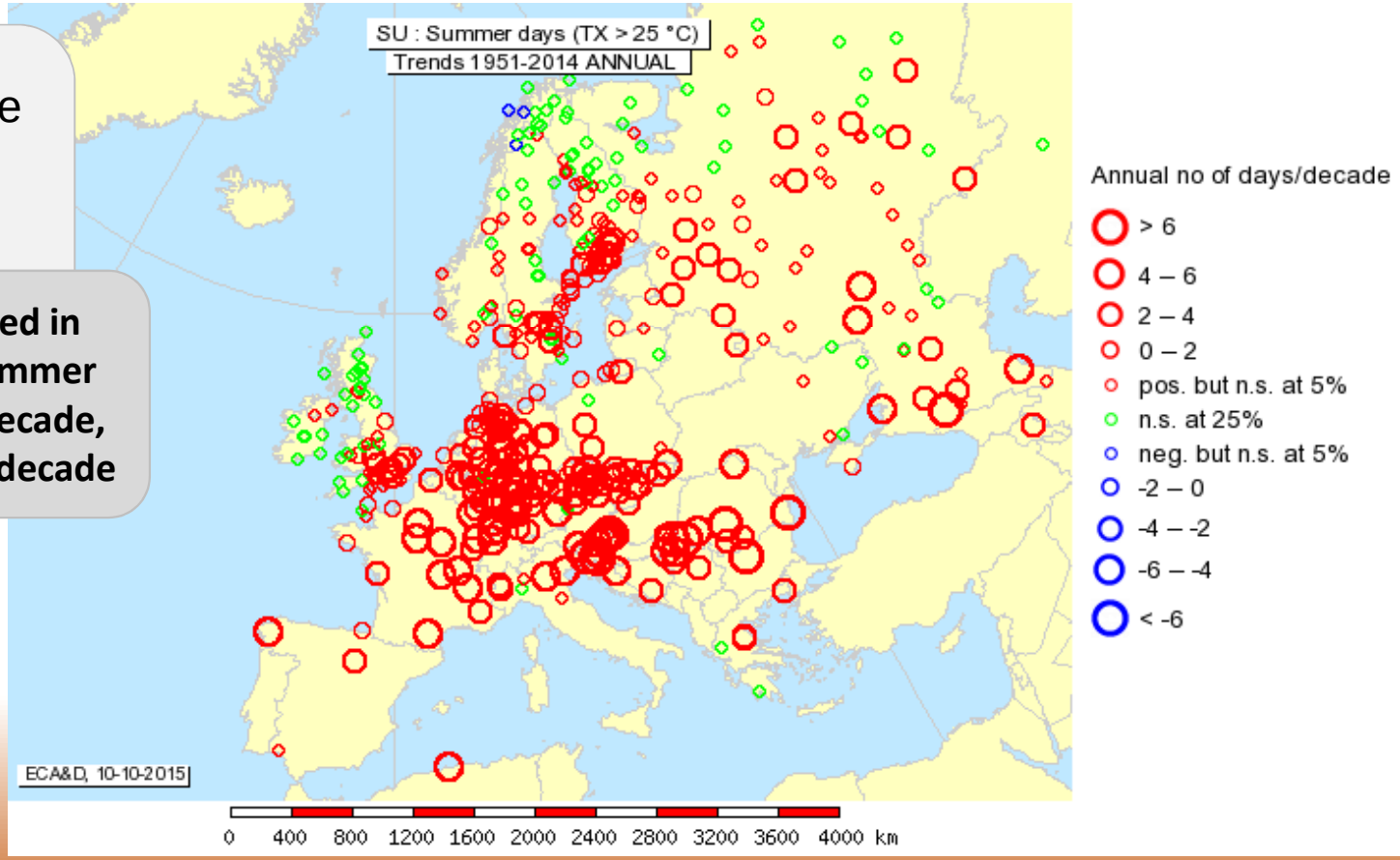
Changes of days of frost in Europe (1951-2014)



Change of summer days in Europe (1951-2014)

In the greatest part of Europe the number of summer days has increased **by an average of 4 days per decade**

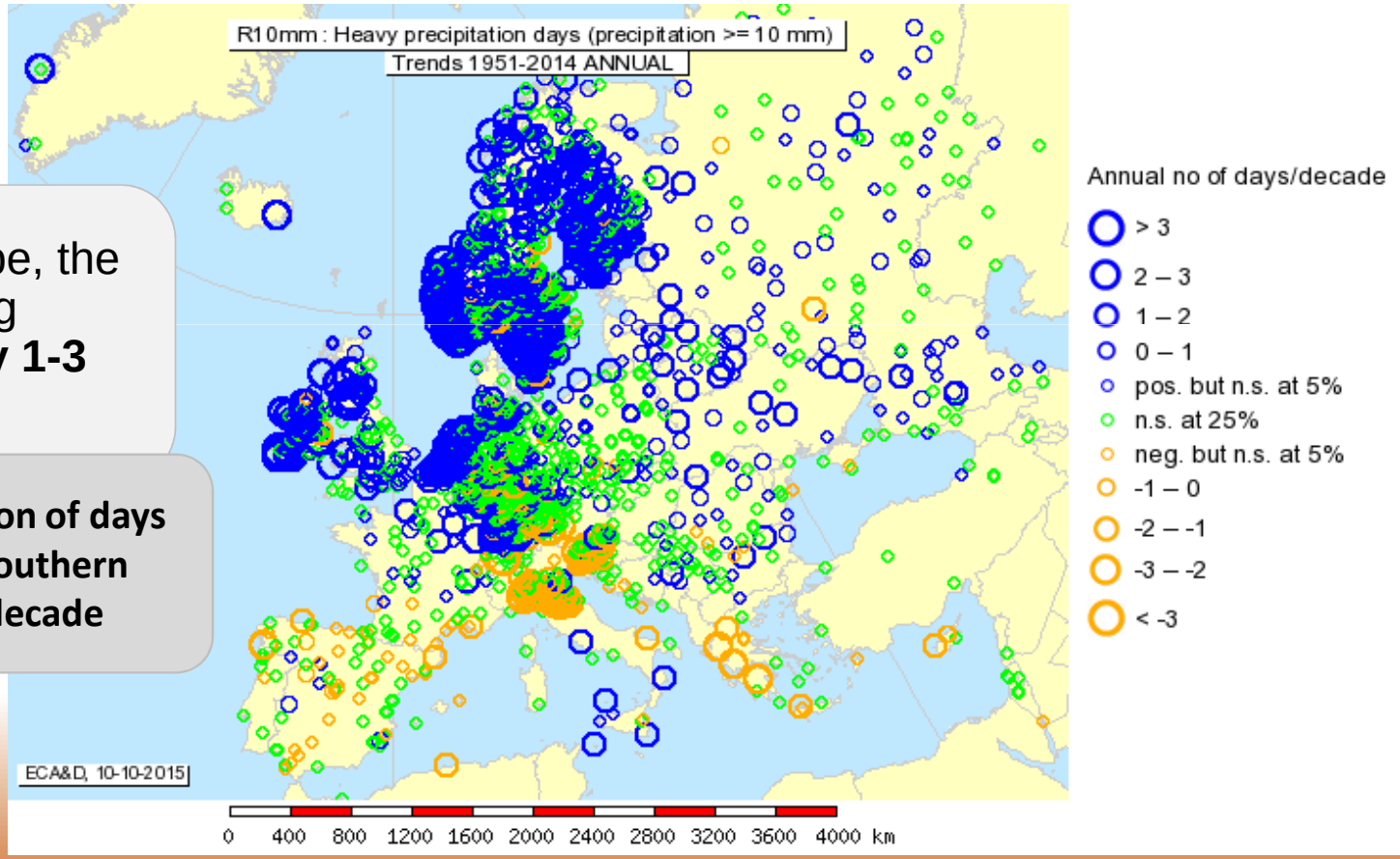
A larger increase in summer day is observed in southern regions, where the number of summer days has increased by about 4-6 days per decade, but in central areas - by about 2-4 days per decade

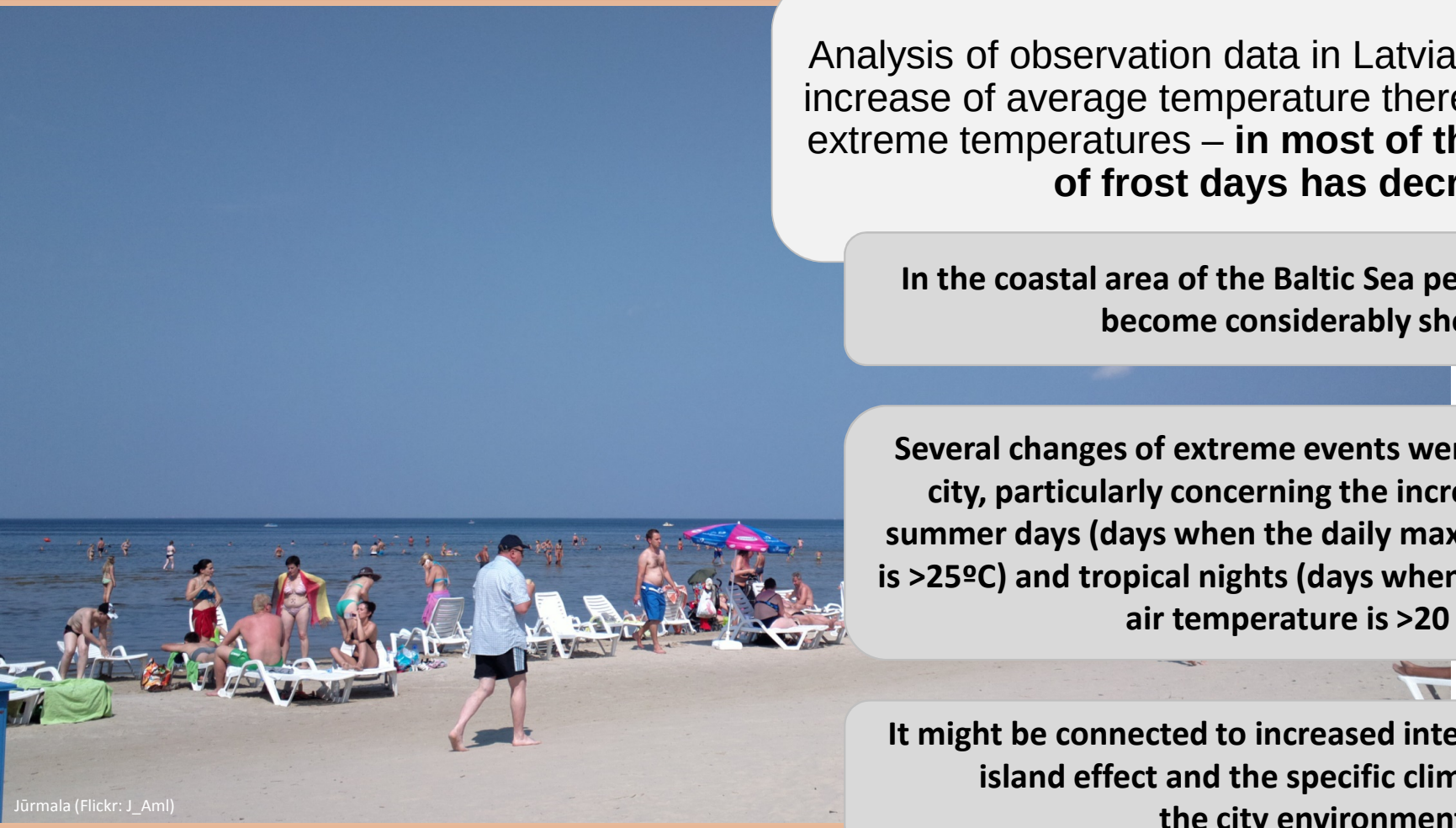


Annual number of days with strong precipitation in Europe (1951-2014)

it is typically, that in north Europe, the number of days with strong precipitation has increased **by 1-3 days per decade**

By contrast, the most substantial reduction of days of strong precipitation is observed in southern Europe – by 1 to 3 or more days per decade





Jūrmala (Flickr: J_Aml)

Analysis of observation data in Latvia reveals that with the increase of average temperature there are also changes in extreme temperatures – **in most of the area the number of frost days has decreased**

In the coastal area of the Baltic Sea periods of frost have become considerably shorter

Several changes of extreme events were observed in Riga city, particularly concerning the increased number of summer days (days when the daily maximum temperature is >25ºC) and tropical nights (days when the daily minimum air temperature is >20 ºC)

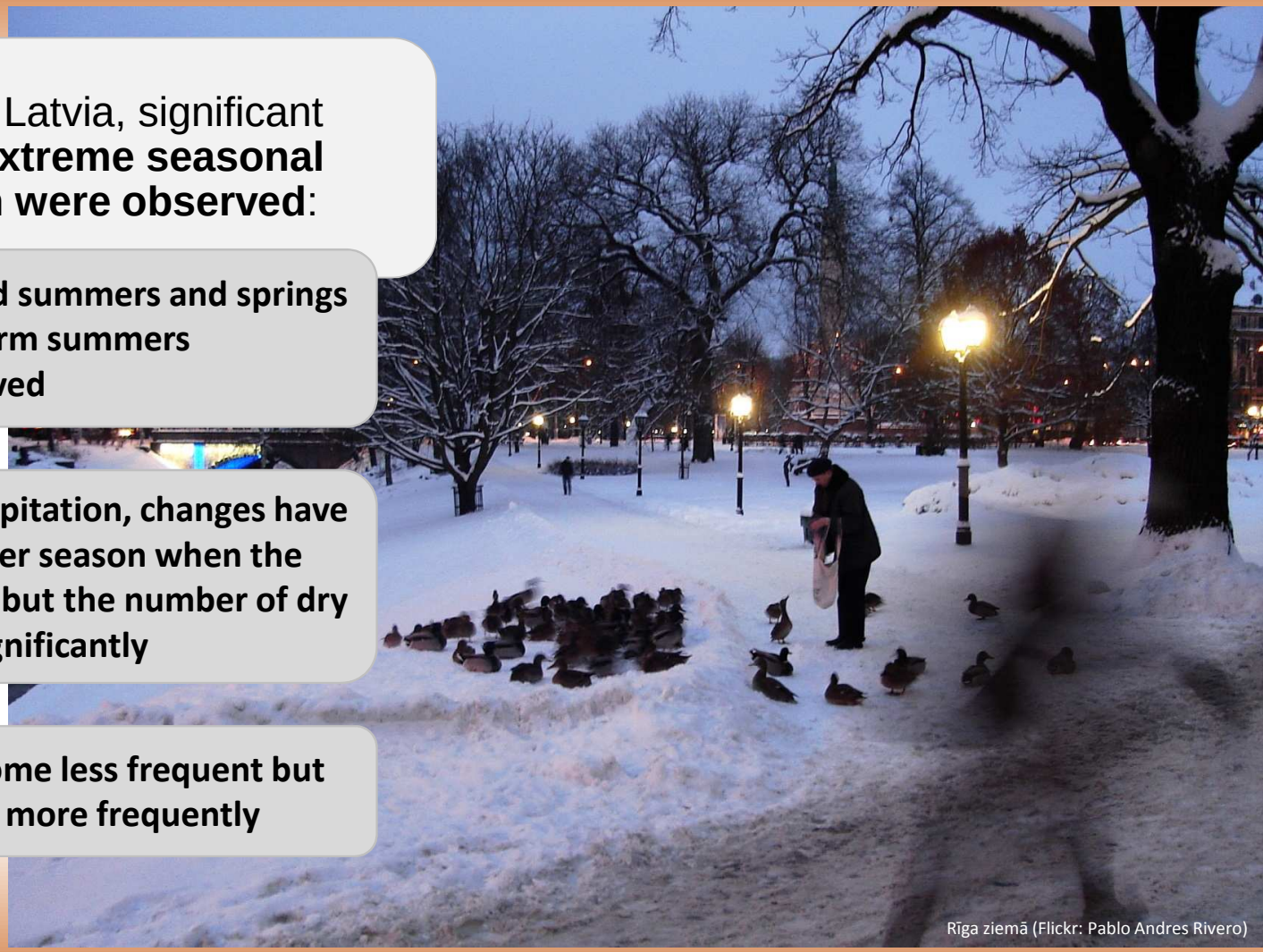
It might be connected to increased intensity of urban heat island effect and the specific climatic effect of the city environment

During the period 1923-2012, in Latvia, significant **changes of temperature and extreme seasonal variability due to precipitation were observed**:

A significant reduction of extremely cold summers and springs and increase of extremely warm summers and springs is observed

Taking into account the amount of precipitation, changes have had a significant impact only on winter season when the number of wet seasons have increased, but the number of dry seasons have decreased significantly

Thus, extremely dry winters have become less frequent but extremely wet winters are occure more frequently



Rīga ziemā (Flickr: Pablo Andres Rivero)

Long-term trends of extreme seasons (Mann-Kendall test values) in Latvia during 1923-2012

	Summer	Autumn	Winter	Spring
	Minimum air temperature			
Cold seasons	**-2.06**	0.01	-1.59	**-2.3**
Warm seasons	**2.21**	-0.26	0.97	**2.69**
	Maximum air temperature			
Cold seasons	-1.82	-0.6	-1.48	**-3.1**
Warm seasons	**2.49**	0.77	1.05	1.86
	Precipitation			
Cold seasons	1.31	0.18	**4.03**	-0.17
Warm seasons	-0.14	-1.5	**-3.08**	-1.66

Examples of recent extreme weather events in Latvia:

Vētra Rīgā 2010.g. 18.jūlijā (Flickr: David Holt)

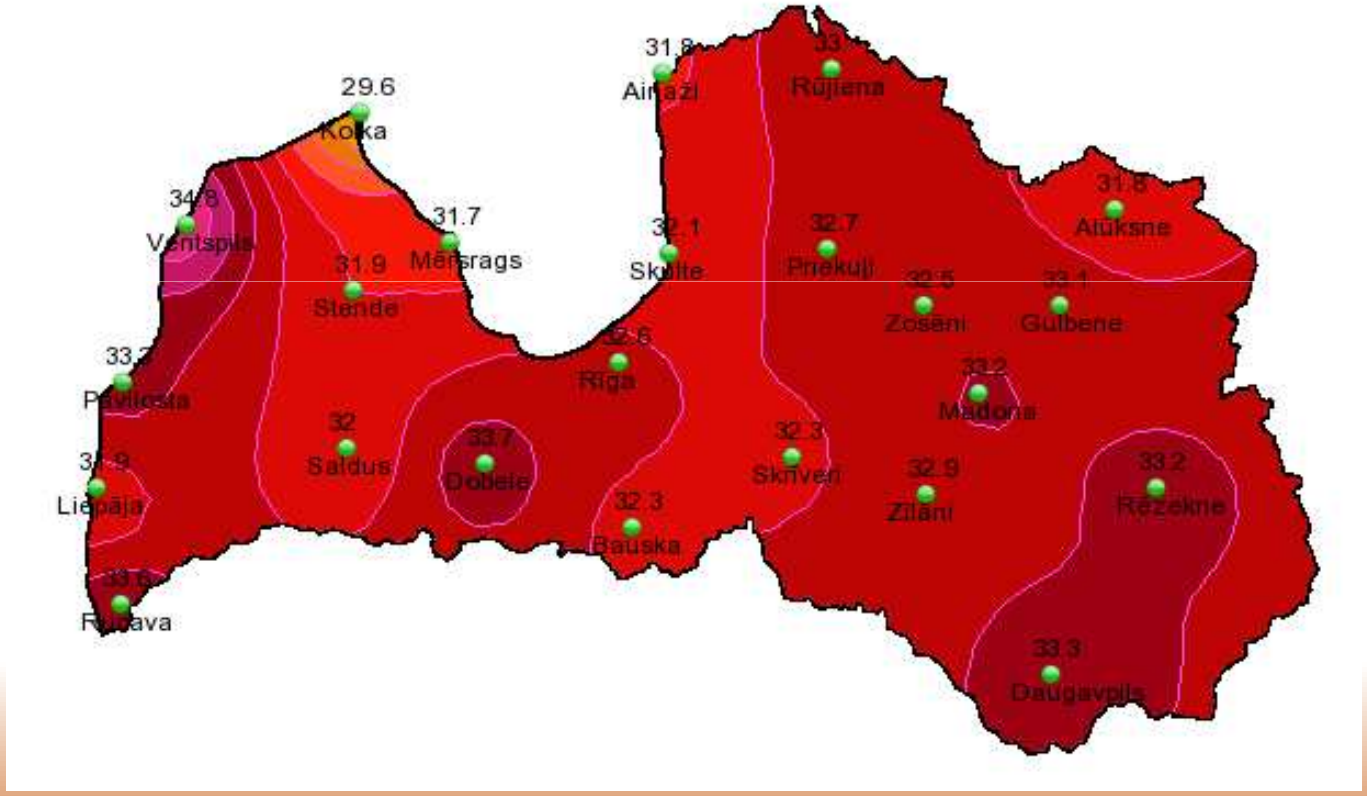
In January 8-9 of 2005 – very strong storm – in Ventspils maximum wind speed at blasts reached 40 m/s. In the port of Riga water level rised up to 213 cm above the «0» point mark

As a result of water level rise large areas in Riga, agglomeration of Riga and Jurmala were flooded

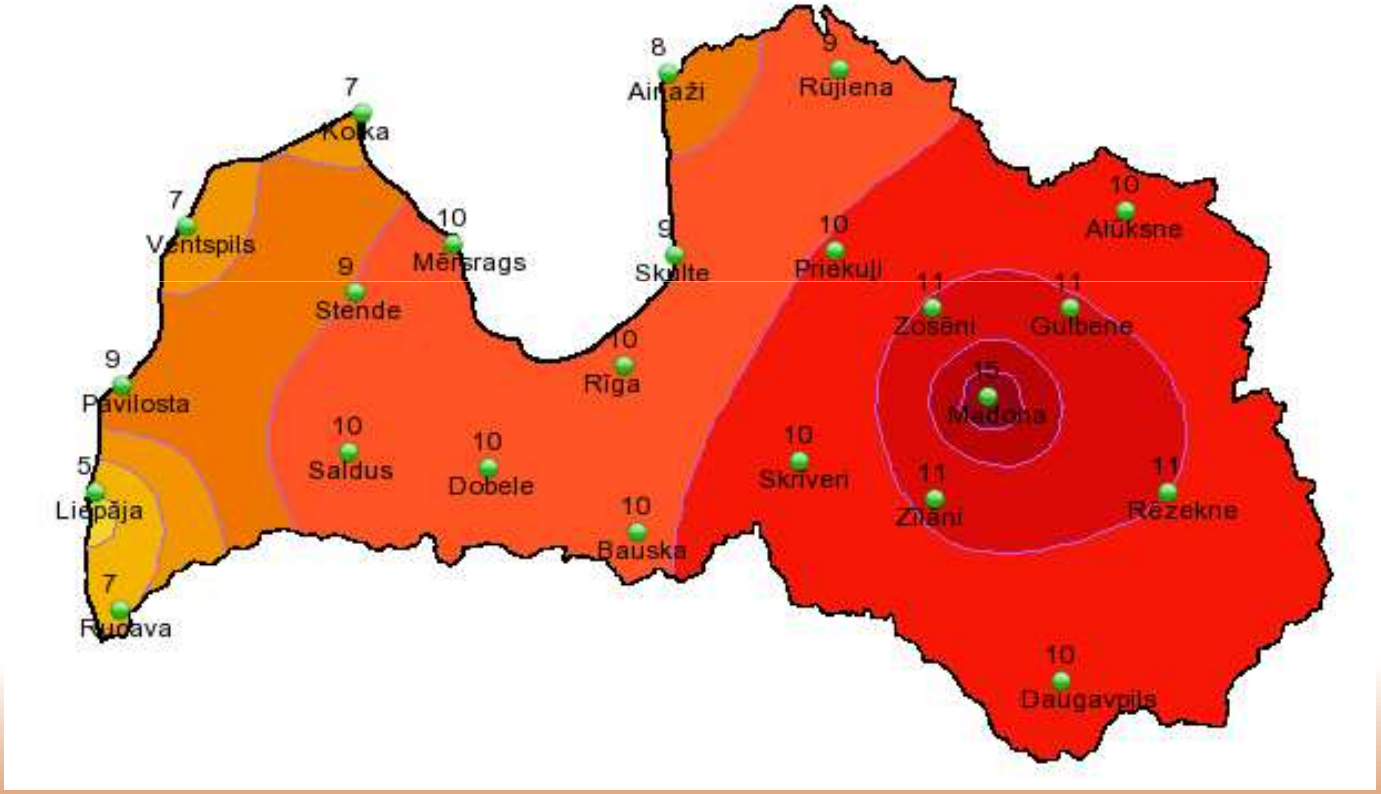
Due to the strong wind in many areas the electricity supply and communications were interrupted, trees were tear up and uprooted, roofs were pulled off and huge material losses for land assets, agriculture, forestry were caused

In September, 2005 – opposite hydrometeorological situation: high water temperature and low water level affected quality of water and ecological disaster occurred such as massive fish hypoxia in the River Lielupe

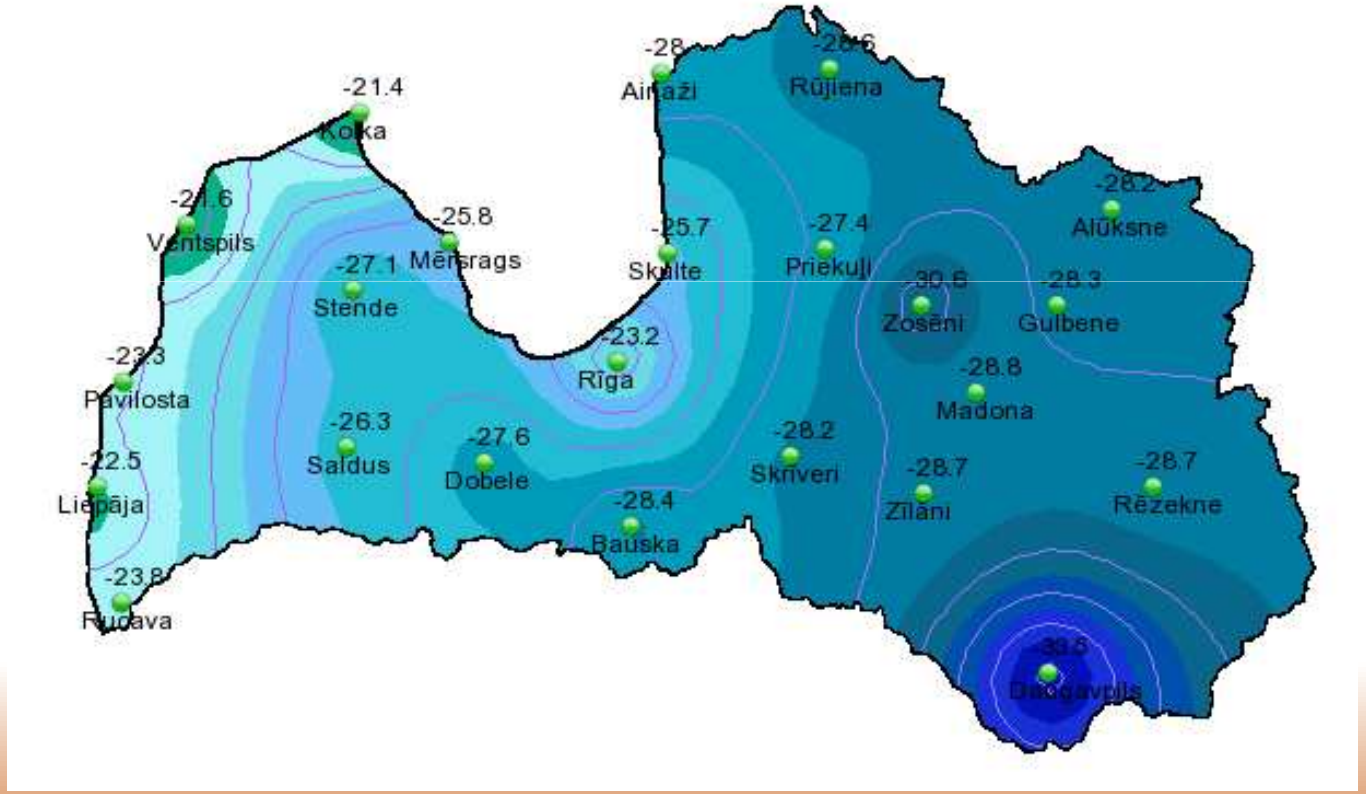
Maximum air temperature in summer, 2010, in Latvia



Number of days with the following days with temperature above +25 ºC in summer, 2010, in Latvia



Minimum air temperature in winter, 2010, in Latvia



Vātra Rīgā 2010.g. 18.jūlijā (Flickr: David Holt)

Examples of recent extreme weather events in Latvia:

Extremely deep snow and floods in spring, 2013 – in March in highland areas of eastern Latvia the thickness of snow was up to 2.5 times above the average, some days reaching 50-60 cm, but in the first decade of April average snow depth was 40 cm or about 10 times above the normal level

The highest water level rise was observed in the River Ogre near the town Ogre. Estimates suggested that reached maximum water level – 24.5 m (4 meters above the long-term average) – might repeat with probability 0.5%, i.e., once every 200 years

Very heavy thunder showers in Sigulda, on July 29, 2014 – after a prolonged heat wave very strong thunder rain hit Latvia – rainfall in Sigulda during six hours reached level of 123 mm

NATURE OF SNOW COVER ITS VARIABILITY

Ķemeri, 2014.gada ziemā (Flickr: Chris)

Seasonal snow cover may contain a great amount of water melting of which can significantly affect both, surface and groundwater hydrology

Water content of snow cover to great extent affect waterpower resources as well as is an important characteristic parameter of flood risk prediction

Consequently, snow cover is not only essential concerning climate change, but also from the economic point of view

Depth of snow cover and duration of it are important factors for development of many crop species, particularly, in agriculture

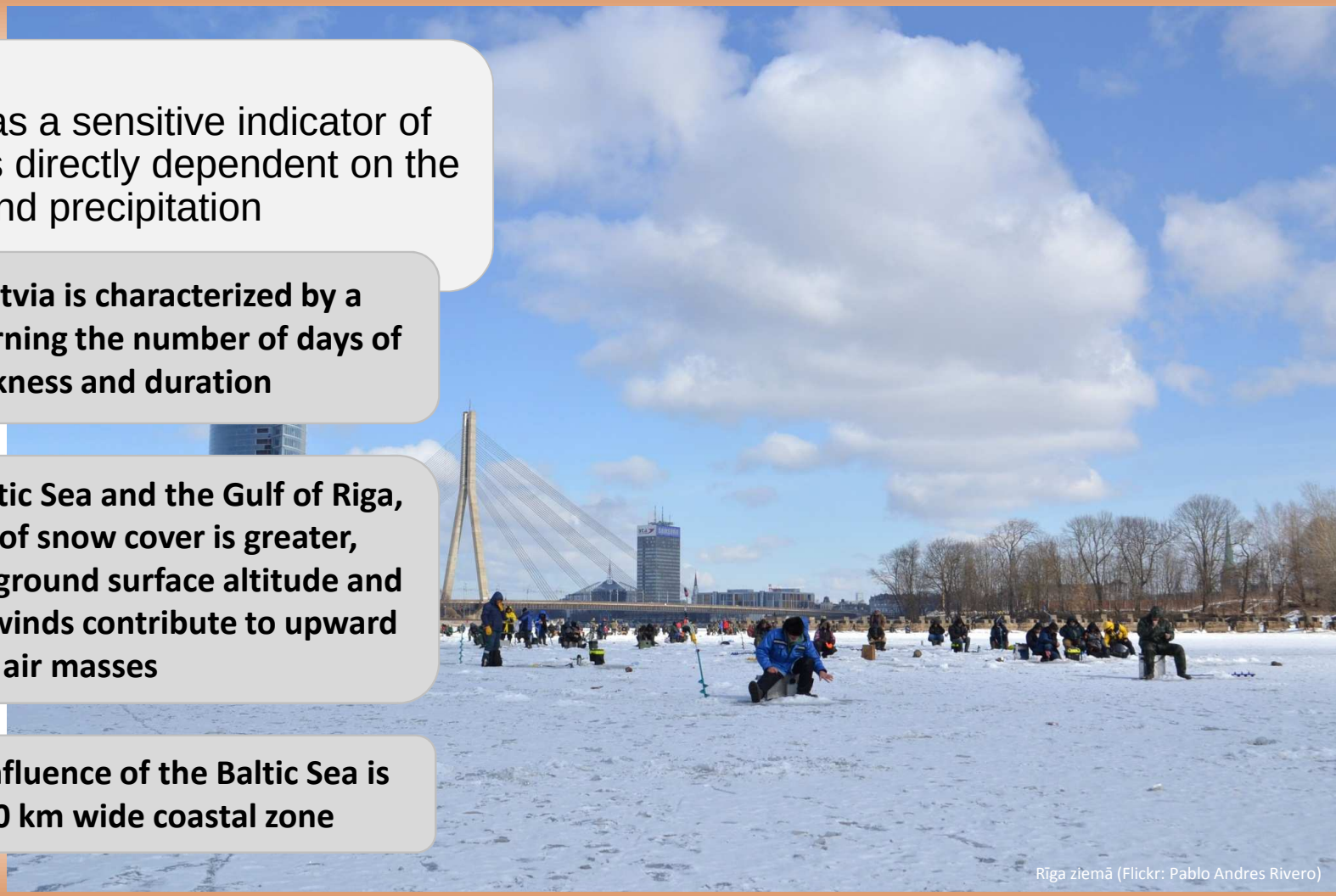
Presence and duration of snow cover is also important for recreation and sports development during cold seasons, road upkeep etc.

Snow cover is considered as a sensitive indicator of climate change, because it is directly dependent on the air temperature and precipitation

In general, snow cover in Latvia is characterized by a relatively high diversity concerning the number of days of its formation, its thickness and duration

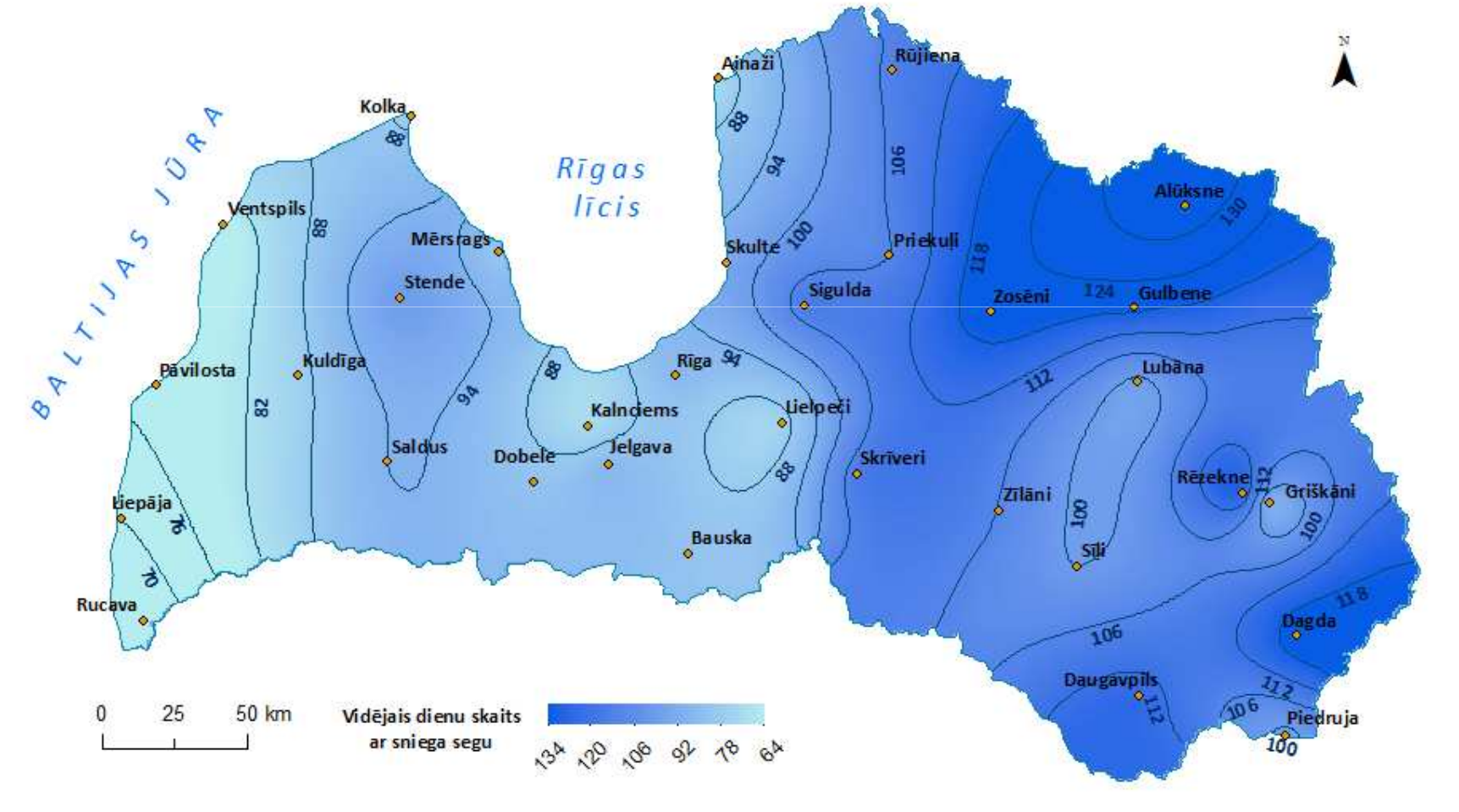
The further away from the Baltic Sea and the Gulf of Riga, the thickness and duration of snow cover is greater, especially, in areas where the ground surface altitude and position as for the prevailing winds contribute to upward movement of air masses

It has been proved that the influence of the Baltic Sea is tangible within the 30-100 km wide coastal zone



Rīga ziemā (Flickr: Pablo Andres Rivero)

Average number of days with snow cover in Latvia (1950-2010)



Līvi, Amatas novads, Pasaules snovborda diena 2009 (Flickr: Ernests)

Geographic location affects not only the duration of snow cover, but also the thickness snow cover (both, seasonal average and the maximum of decade)

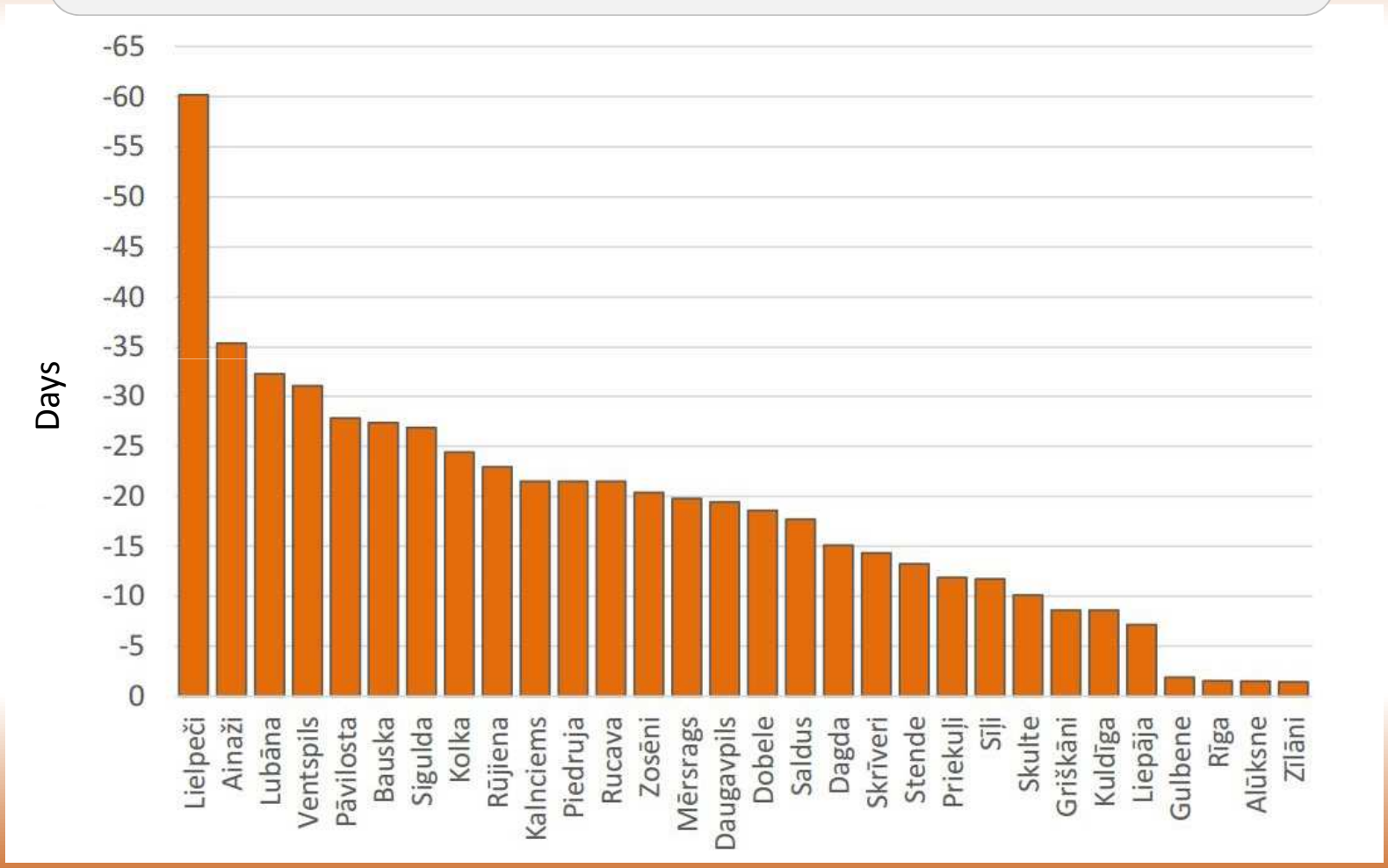
Geographical location is considered as one of the most important indicators characterizing the snow cover

The data of meteorological observations in Latvia revealed that snow cover reaches a maximum thickness on the 3rd decade of February

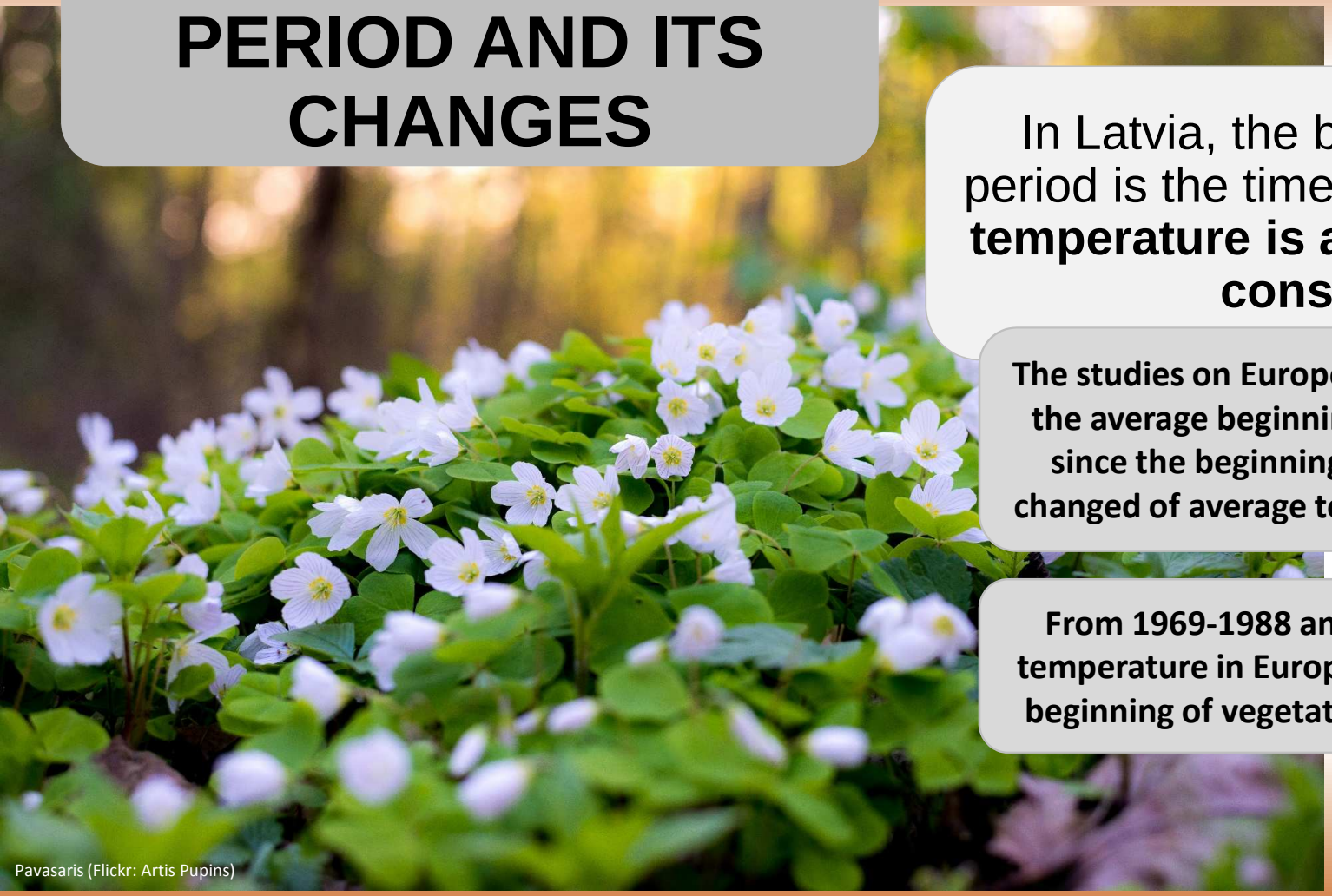
Also the accumulation period of snow cover peaks to maximum in February

Snowfall period usually is relatively gradually and steady, while snowmelt period after the peak of maximum is characterized as rapid

Decrease of the number of days with snow cover (1966-2009) observed at meteorological stations of Latvia



VEGETATION PERIOD AND ITS CHANGES



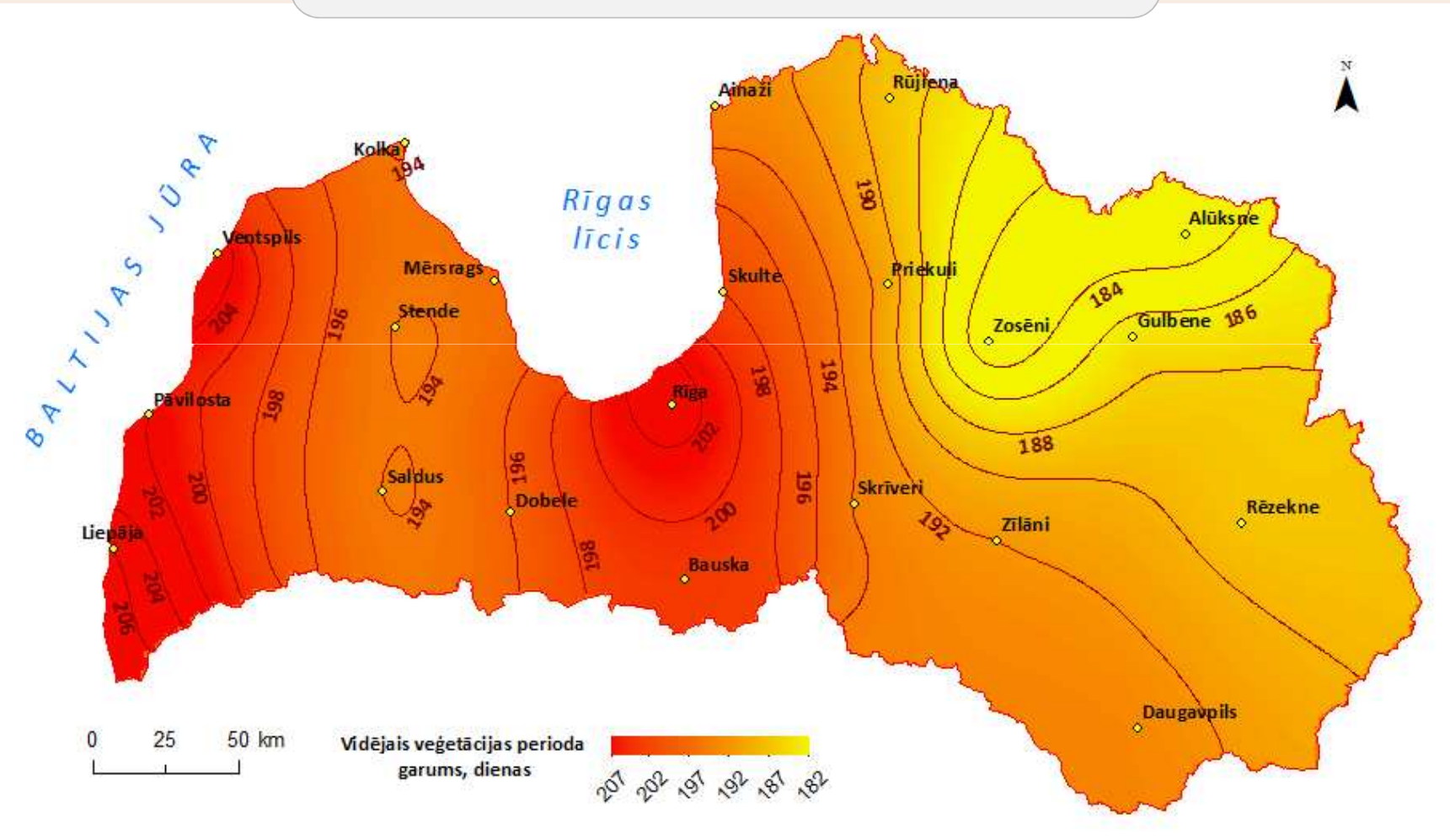
Pavasaris (Flickr: Artis Pupins)

In Latvia, the beginning of vegetation period is the time when **the average daily temperature is above 5 ºC for at least 5 consequent days**

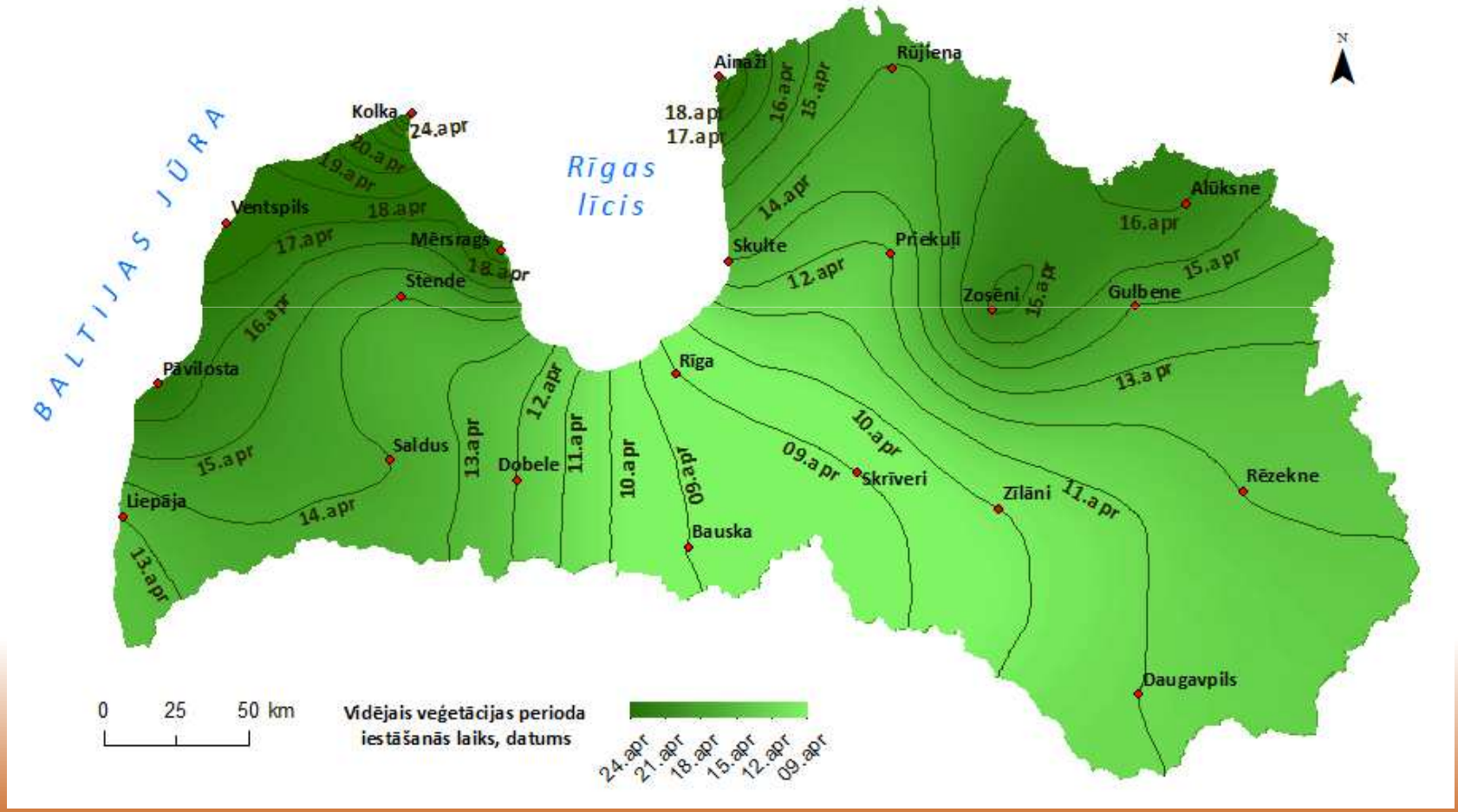
The studies on European scale indicated that changes in the average beginning of vegetation period in Europe since the beginning of 1989 complies well with the changed of average temperature from February to April

From 1969-1988 and 1989-1998, the average spring temperature in Europe increased by 0.8 ºC, the average beginning of vegetation period occurred 8 days earlier

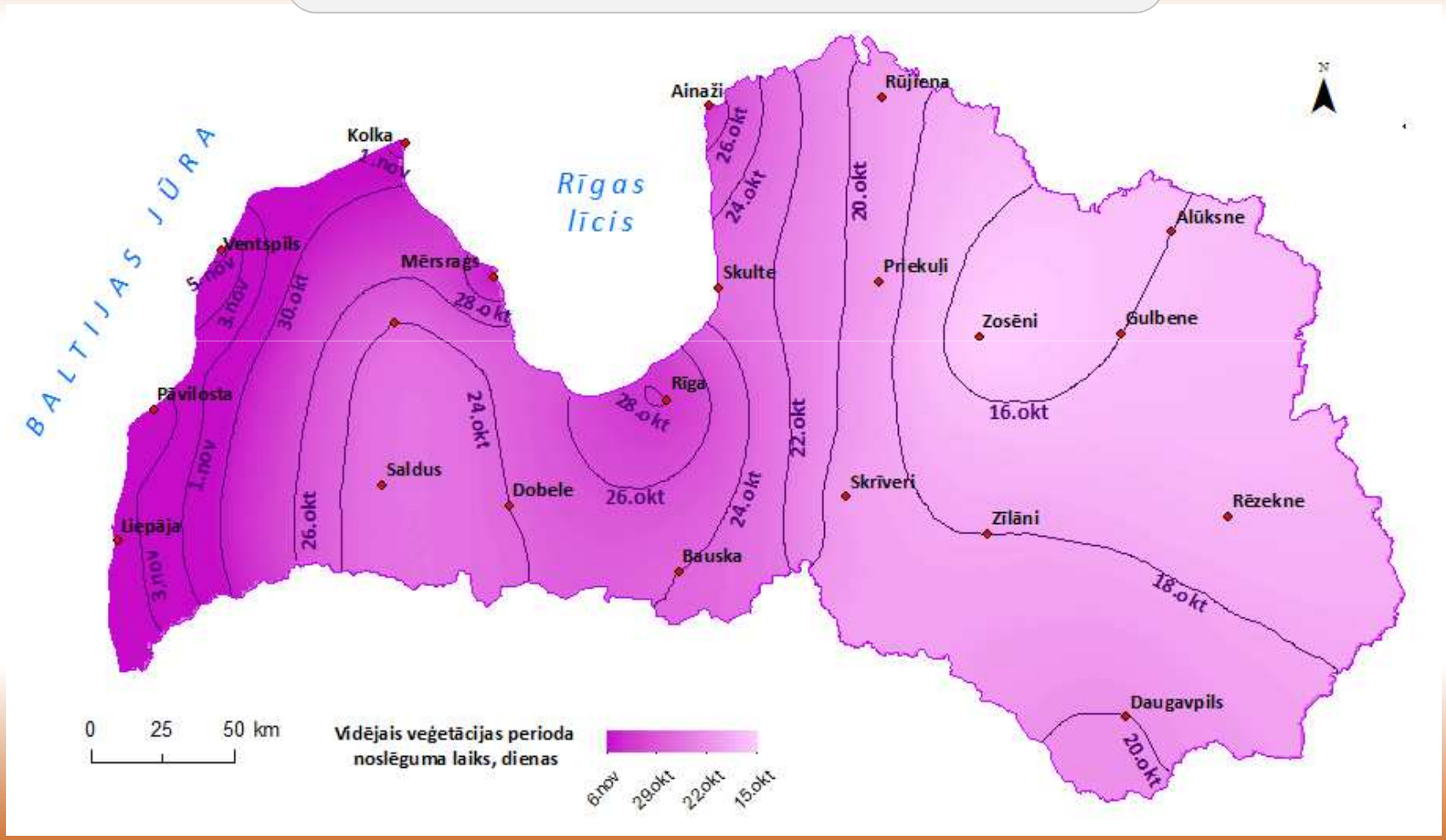
Duration of vegetation period in Latvia (1971-2010)



Beginning of vegetation period in Latvia (1971-2010)



The end of vegetation period in Latvia (1971-2010)



WIND AND LONG-TERM CHANGES OF ITS CHARACTERISTIC PARAMETERS

Rīga (Flickr: Kārlis Dambrāns)

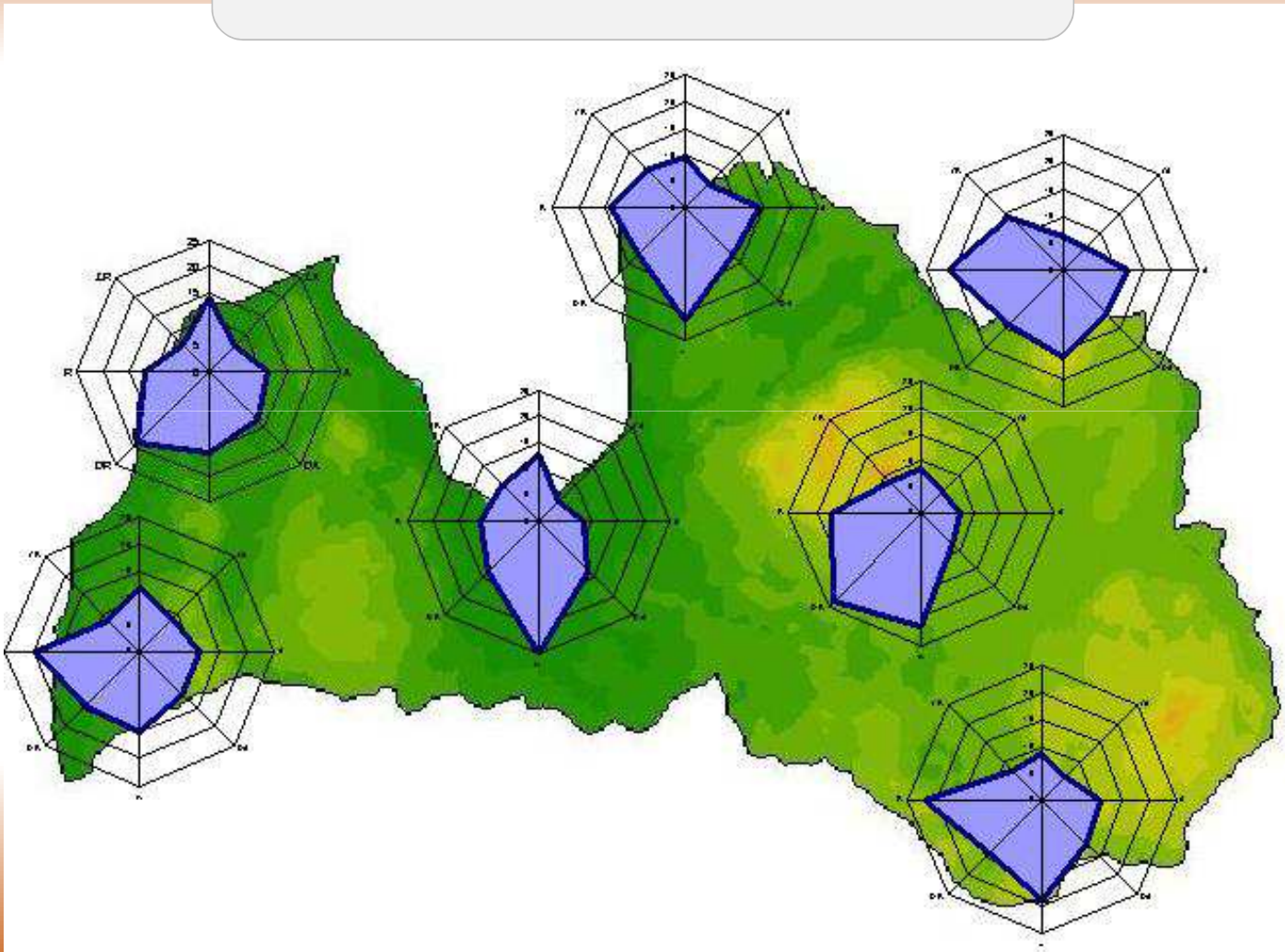
Regional atmospheric pressure and wind direction differences in Latvia are not as impressive as the wind speed distribution

Yearly changes of atmospheric pressure are dependent on the prevailing isobaric systems during different seasons, and are varying due to the warming or cooling of active surface by the balance of radiation

Across the territory of Latvia, yearly variations of atmospheric pressure reveal the maximum in February, May and October, but the minimum in April, July and December

In the continental part the main maximum is reached in February, but near the Baltic Sea and the Gulf of Riga – in May

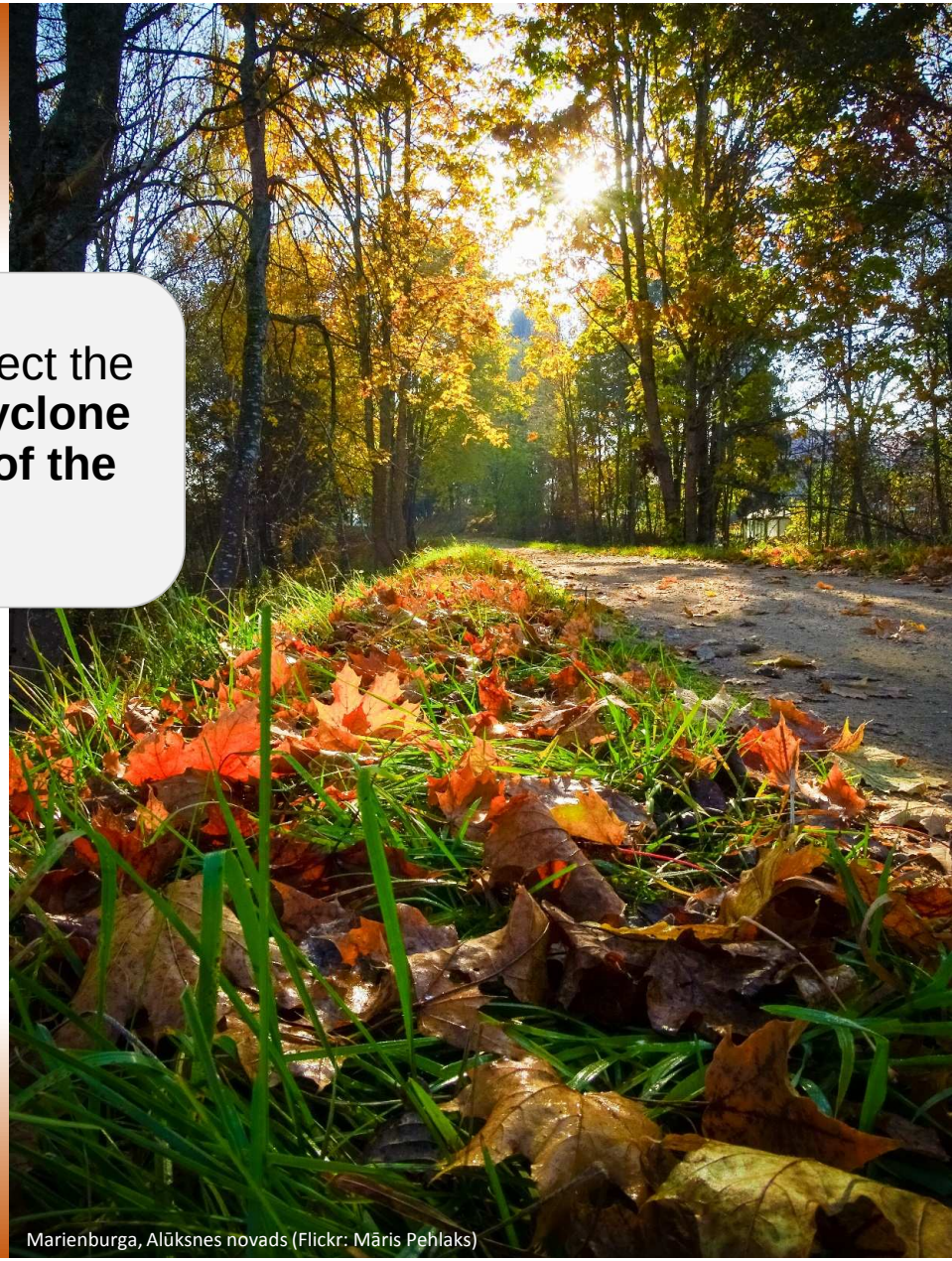
Yearly average prevailing wind directions in Latvia



During cold seasons, the main isobaric formations that affect the climatic conditions in Latvia are: **a wide stationary anticyclone over Asia (Asian maximum)** and **a low-pressure area of the north of Atlantic Ocean (Iceland minimum)**

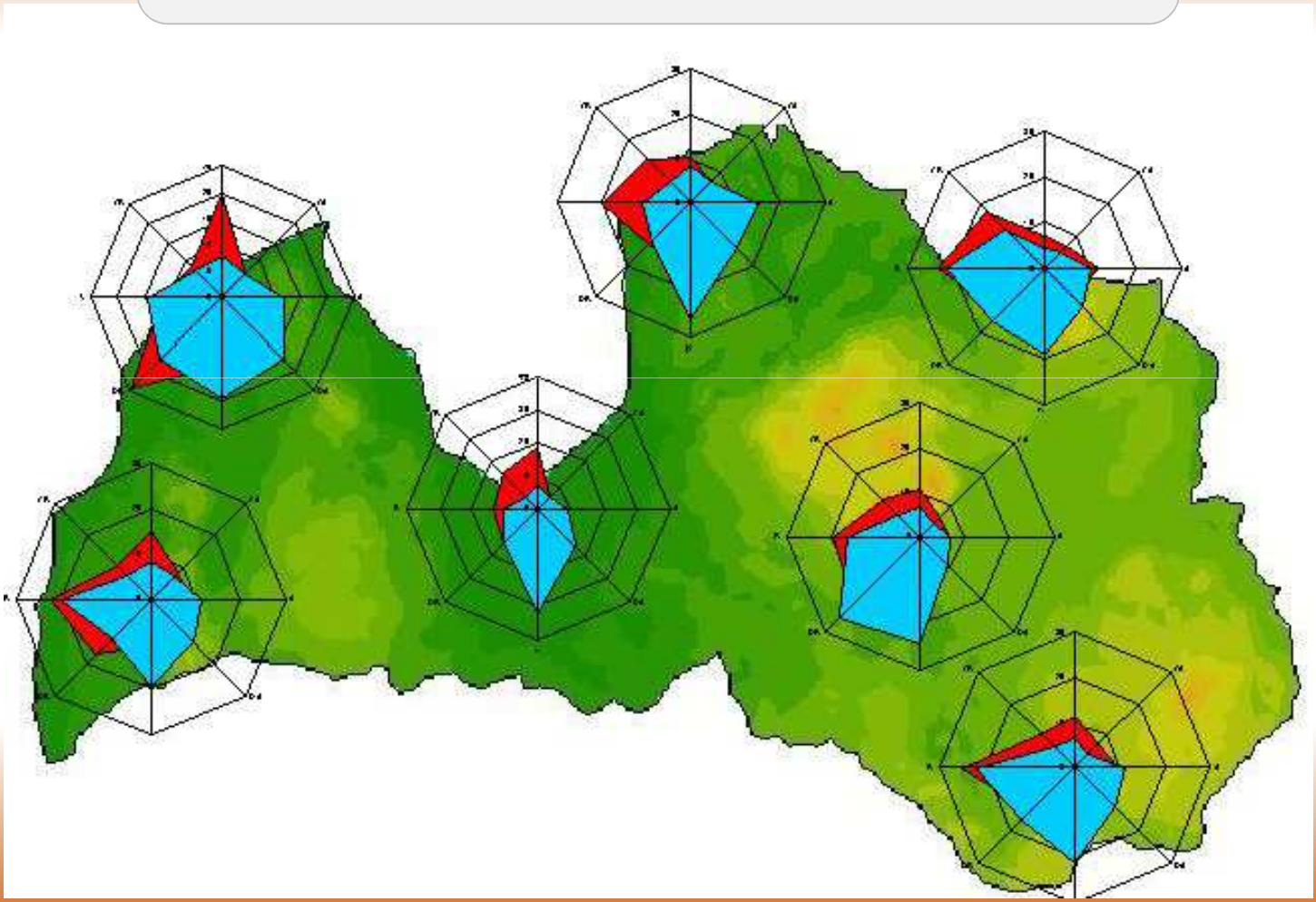
The prevailing wind directions during the cold seasons are the southern and south-western winds that are blowing with a moderate or strong strength

During the summer seasons, due to the isobaric formations decrease of wind speed is observed, as well as increase of the western and northern winds

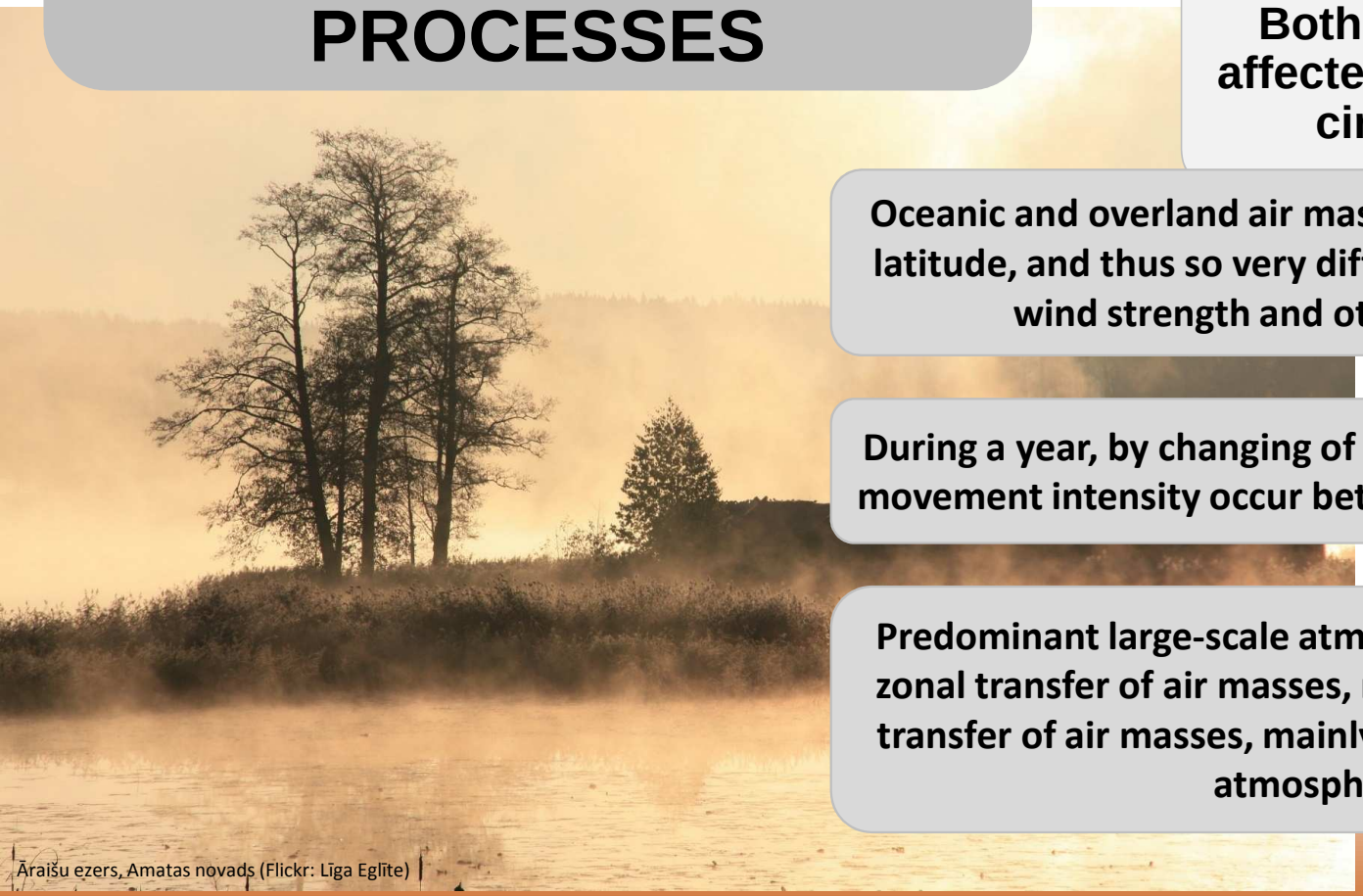


Marienburga, Alūksnes novads (Flickr: Māris Pehlaks)

Prevailing wind directions in Latvia in summer (red) and in winter (blue)



VARIABILITY OF ATMOSPHERIC CIRCULATION PROCESSES



Āraišu ezers, Amatas novads (Flickr: Līga Eglīte)

Both, the climate and the weather, are affected by the processes of atmospheric circulation and air mass transfer

Oceanic and overland air masses of various origin, formed at different latitude, and thus so very different in heat content, moisture content, wind strength and other properties enters into Latvia

During a year, by changing of solar radiation influx, changes in air mass movement intensity occur between the different geographical latitudes

Predominant large-scale atmospheric air mass circulation processes – zonal transfer of air masses, mainly from west and east or meridional transfer of air masses, mainly from north, which are described by the atmospheric circulation index

Impact of climate change on the river hydrology in Latvia


Ļoti stipras lietusgāzes Sigulldā 2014.g. 29.jūlijā

It is important to analyze the indicators of climate change at different spatial and temporal scale

Studies on climate change in conditions of Latvia can provide important information because environmental observations in many cases have been performed for a long time, but the regular observations (monitoring) of the main climate indicators across the territory of Latvian are carried out since 20-ties of the 20th century

Moreover, some parameters such as the beginning of ice-drift in the River Daugava have been observed already since 1536, but descriptions of unusual environmental events can be found in the oldest chronicles concerning Latvia territory

Both, water regime and the effects of extreme environmental events, can have a significant impact on the population, economy, agricultural production and hydropower

Meža ugunsgrēks

Gaujas pali 2013.g. aprīlī (Flickr: Līga Eglīte)

Possible climate changes in Latvia during the 21st century

Gauja 2013.g. Aprīlī (Flickr: Irita Kirsbluma)

The climate in all periods of time has been variable and one of the reasons for that is a cyclic character of climate parameters

However, it should be emphasized that the amplitude of variability of climate change indicators has been different

How will change the climate in Latvia in the near and distant future? – With a degree of uncertainty, the answer can be given by the future climate models

Variability of meteorological parameters and potential impact of global warming of particular importance are linked to the fact that these changes can seriously affect many important areas of human life

Global warming may affect agriculture, forestry, fishing industry, recreation and tourism, energy, particularly, hydro-power, food industry, medical care and many other areas

Increase of the probability of natural disasters associated with climate variability can affect everyone

Therefore, it is important to continue to explore the nature of climate change and to develop solutions to mitigate the adverse effects of these changes

Vētra Rīgā 2010.g. 18.jūlijā (Flickr: David Holt)

Thank you for attention!