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CLIMATE PROJECTIONS OVER THE ANTARCTIC PENINSULA REGION TO THE END OF THE 21st CENTURY. PART I: COLD TEMPERATURE INDICES

ABSTRACT. **Objective**. This paper deals with an estimation of the climate change at the Antarctic Peninsula region. During last decades, the most significant warming is observed in Polar regions, particularly in the Antarctic Peninsula region, where the Ukrainian Antarctic Akademik Vernadsky station is located. Therefore, the providing of the complex estimation of climate change trend is an important task for the region. These changes are taking place nowadays and will happen in the future. So, the main objective of the study is to estimate changes of climate characteristics in the Antarctic Peninsula region in the 21st century, based on calculation of the relevant climate indices. The projections of the temperature and precipitation characteristics in the Antarctic Peninsula region and Akademik Vernadsky station area for RCP4.5 and RCP8.5 scenarios are the objects of the research. **Methods** of the research are numerical simulation and statistical analysis of the regional climate model data for the Antarctic Peninsula region from the International Project Polar-CORDEX. Spatial distribution of this data is 0.44° and three periods are under consideration: historical climatic period (1986—2005) and two future periods 2041—2060 and 2081—2100. The R-code language and the modified computing code developed by Climate4R Hub project in Jupiter Notebook environment were used for climate data analysis in this research. Six parameters were chosen to estimate climate change in the Antarctic Peninsula region: number of frost days with minimal air temperature (T) less 0 °C, number of ice days with maximal T less 0 °C, annual total precipitation, mean precipitation rate, maximum yearly duration of periods without precipitation, maximum yearly duration of periods with precipitation more than 1 mm per day. **Results** as an analysis of the cold temperature indices are presented in the Part I of the paper, while an analysis of the wet/dry indices will be presented in the Part II of the paper. **Conclusions**. Over the Antarctic Peninsula region, both scenarios project an average decrease in the cold season period. This process will be more pronounced for the RCP 8.5 scenario, when even to the middle of the century the period with negative temperatures is rapidly decreasing over the Larsen Ice Sheet area, which may cause its total or partial collapse. Over Akademik Vernadsky station area, the climate indices changes will almost triple as high as the averaged values over the Antarctic Peninsula for the two scenarios, indicating a greater vulnerability to the climate change in the area.

Keywords: Antarctic Peninsula, Akademik Vernadsky station, climate change, regional climate model, Polar-CORDEX, RCP scenario.

INTRODUCTION

The Polar Regions are important components of the global climate system and have a significant impact on the ocean-land-atmosphere interaction. Increasing temperature at high latitudes causes melting glaciers, pack ice and changes in the cryosphere boundary conditions, which in turn affects other components of the climate system (IPCC, 2013). In recent decades, the most significant warming in the climate system is observed in the Polar Regions, in particular at the Antarctic Peninsula area, where Akademik

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Vernadsky stationis located (Convey and Smith et al. 2005; Krakovska et al., 2010; Tymofeyev, 2013; Krakovska et al., 2017). According to climate model projections from the 5th Assessment Report of the Working Group I of the Intergovernmental Panel on Climate Change (IPCC, 2013), mean surface air temperatures will also increase fastest in the high latitudes. In this regard, it is necessary to provide a comprehensive assessment of the climate change trend that is currently occurring and is expected in the future. Particularly, it is crucial for developing a strategy of future logistic and scientific operations in the region.

In overall, the reveal of the climate change dynamics in the Polar Regions according to different anthropogenic emission scenarios is vital for the early adaptation of humanity to the possible effects of climate change. The Antarctic Peninsula region is particularly vulnerable due to the large ice shelf existence, where considerable destruction and melting processes have been observed in recent decades. These rapid warming processes can cause a significant rise of sea level as like (IPCC, 2013).

Nowadays, a numerical modeling is the most effective tool for study the dynamics of the past and the future climate, as it allows quantifying a possible change in climate characteristics. Unfortunately, the use of numerical modeling in Antarctic region is limited due to the insufficient density of the observation network. Therefore, the estimation of model climate characteristics is based on numerical methods of interpolation and forecasting (IPCC, 2013; Covey et al., 2003; Giorgi et al., 2015). This causes differences, in some cases significant, between model estimation and observational data. Among the most significant discrepancies are the following: the temperature biases are usually slightly higher over the oceans than over the continents; there are also some inaccuracies in the relief models; there is a deviation of the precipitation model values from the reanalysis data, especially during cyclonic weather and intense cyclone activity (Krakovska et al., 2017; IPCC, 2013).

The calculation of physical processes within the model must always maintain a balance between the quality of the result and the required computational/economic costs. A more accurate representation of any process requires more of these costs, but at the end, the result of the simulation may not be significantly different from the simplified calculations. Moreover, the errors that exist in models at all spatio-temporal scales are related to constraints in the represented physical processes (Covey et al., 2003; Giorgi et al., 2015; Taylor et al., 2011). However, despite some shortcomings, regional and global climate models are currently the only opportunity to project the future climate change (Krakovska et al., 2017; IPCC, 2013; Krakovska et al., 2010). First Global Circulation Models (GCMs) and Regional Climate Models (RCMs) have already predicted that the mean surface air temperature will rise the fastest in the high latitudes. Recent observation data has confirmed these first projections, which also allows using these models for future periods with sufficient confidence.

Therefore, the purpose of the study is to analyze changes in the regional climate characteristics of the Antarctic Peninsula on the basis of calculations of a set of indicators under the scenarios RCP4.5 and RCP8.5. The subject of the study is current and predicted changes in air temperature and wet/dry indices in the Antarctic Peninsula region and at the Akademik Vernadsky station location.

The following tasks have been considered:

1. Calculation of climate indices for three RCMs and three scenarios (historical, RCP4.5, RCP8.5) and for three climatic periods: the historical baseline (1986–2005), the middle (2041–2060), and the end of the century (2081–2100).

2. For every index-period-scenario, calculate an ensemble average, multiyear mean for the Antarctic Peninsula region and for the Akademik Vernadsky station area.

3. Visualization and assessment of possible change in climate indices in the Antarctic Peninsula region at the middle and at the end of the 21st century.

DATA AND METHODS

An ensemble of regional climate models and the software tool Climat 4R to process the RCM outputs are used in the study. Climate change in the Antarctic Peninsula region has been estimated on the basis of some climate indices recommended by the World

Climate Research Program WCRP (Karl et al., 1999; Peterson et al., 2001).

The results of the study will be presented in two parts: Part I presents the results on the cold temperature indices, while some wet/dry indices will be presented in the Part II of this research.

The ensemble of regional climate models

Climate indices were calculated based on the model data from the Polar-CORDEX project (Coordinated Regional Climate Downscaling Experiment for the Polar Regions), which is a part of the International CORDEX initiative (Giorgi et al., 2015; Koenigk et al., 2015). Boundary and initial conditions for CORDEX were derived from the CMIP5 GCMs (Taylor et al., 2011). Three scenarios for Polar-CORDEX are considered:

1. Historical. Retrospective of 1950–2005 (Granier et al., 2011);
2. RCP 4.5 for the period 2006–2100 (Thomson et al., 2011);
3. RCP 8.5 for the period 2006–2100 (Riahi et al., 2011).

The study uses outputs from three regional Polar-CORDEX models, i.e. the ensemble included two versions of the regional model RACMO21P and the regional model HIRHAM5. These RCMs were chosen as only available for Antarctica region at the date. The regional climate model spatial resolution was 0.44°, as agreed for all CORDEX domains (Giorgi et al., 2015; Koenigk et al., 2015). For the first version of RACMO21P (van Meijgaard et al., 2008) and for the HIRHAM5, the EC-EARTH global climate model calculation data (http://www.ec-earth.org) were used as initial and boundary conditions. In the second version of RACMO21P the GCM HadGEM2 was used (Collins et al., 2008). The RCM RACMO21P is developed by the Royal Meteorological Institute of the Netherlands (KNMI) and the Utrecht Institute for Marine and Atmospheric Research. The developer of the HIRHAM5 is the Danish Meteorological Institute (DMI) (Christensen et al., 2007).

The project climate4R

The use of the climate data set usually requires the processing: multiple access to databases, interpolation to the common grid, harmonization in space and time, and post-processing with the visualization of the results. It is a time-consuming task that in many cases is performed with various tools, which is inevitably accompanied by a large number of an errors in the absence of the necessary tools for a reproduction and visualization. Climate4R is a package of software developed on the basis of the R-programming language for climate research, where the most general tasks can be accomplished using the libraries, which are ready for this purpose. A detailed description of the climate4R is provided in Iturbide et al. (2019). Climate4R enables access, post-processing and visualization of local and remote (OPeNDAP) data sources, providing complete information on data origin using METACLIP (Semantic METAdata for CLImate Products) (Bedia et al., 2019).

Climate indices

Temperature and precipitation are the main characteristics of regional climate and usually mainly discussed in climate change research (IPCC, 2013). Here we want to find and emphasize some peculiarities of projected Antarctic Peninsula regional climate change. Therefore, we decided to use defined climate indices but not mean temperature and precipitation change. To evaluate the climate dynamics of different regions of the world, WCRP/CLIVAR recommended 27 indices that provide a comprehensive description of climatic conditions and allow the comparison of different regions by a unified method (Karl et al., 1999; Peterson et al., 2001). Some of the recommended indices are more suitable for the Polar Regions.Therefore, six climate indices were selected for this study, which best characterize the temperature and precipitation change in the Polar Regions, particularly for air temperature near the water freezing point.

Cold indices:

1. **FD (Frost days)**. Number of days per year when TN (daily minimum temperature) <0 °C.
2. **ID (Ice days)**. Number of days per year when TX (daily maximum temperature) <0 °C.

Precipitation (wet/dry) indices:

3. **PRCPTOT (Precipitation total).** Total precipitation in the wet days: RR_{ij} is the daily rainfall per day *i* during

period j (every particular year). If I is the number of days i for the period j, then

$$PRCPTOT_j = \sum_{i=1}^{I} RR_{ij}.$$

4. **CWD (Consecutive wet days)**. Maximum duration of precipitation period, maximum number of consecutive days with RR ≥ 1 mm. If RR_{ij} is the daily rainfall per day i in period j, the highest number of consecutive days is calculated where $RR_{ij} \geq 1$mm.

5. **SDII (Simple daily intensity index).** Simple rainfall intensity index. Let RR_{wj} be the daily rainfall on wet days w ($RR \geq 1$mm) in period j. If W is the number of days with precipitation in j, then:

$$SDII_j = \frac{\Sigma_{w=1}^{W} RR_{wj}}{W}.$$

6. **CDD (Consecutive dry days)**. Maximum duration of the dry season per year, maximum number of days in a row with RR < 1mm. If RR_{ij} is the daily rainfall per day i in period j, the highest number of days in a row is calculated where $RR_{ij} < 1$mm.

Methodology of climate indices change analysis

Projections of the annual index values were used to identify trends in the climate characteristics. For each index based on the RCM ensemble some characteristics were calculated in grid nodes (multiyear mean and change relative to the base period), while others were aggregated over the entire Peninsula region or extracted for Akademik Vernadsky station. Thus, the change at the grid node was calculated as the difference:

$$\Delta_i = X_i - \bar{Y}_{historical},$$

where X_i – is the RCM ensemble mean annual index value, i – is a year, $i \in [2041–2060, 2081–2100]$, $\bar{Y}_{historical}$ – the multiyear average index value for the base period [1986–2005].

The calculation of the characteristics for Akademik Vernadsky station area was performed by interpolation of the climate4R set data to the location 65.25°S, 64.26°W.

RESULTS

This section presents the results of two climate indices calculations (ice and frost days) obtained with the climate4R software package (Iturbide et al., 2019). The multiyear mean and changes were calculated in future projections relatively the base period and averaged spatially and in time as pointed above.

Frost days, FD

FD multiyear mean

The average number of frost days from the RCM ensemble varies within the 355 ± 1 day in the baseline period. Under the scenario RCP4.5 the FD value decreases to 353 ± 1 days until the middle, and 352 ± ± 1 days until the end of the century. Under the RCP8.5 scenario, the FD value is significantly reduced in comparison to the RCP4.5 scenario. To the mid-century, FD will decrease in average to 352 ± 2 days, and by the end of the century to 346 ± 4 days in average. This means that in accordance with the model projections to the end of the century, the number of days with frost will decrease by three days under the scenario RCP4.5 in average, and by 9 days under the scenario RCP8.5. The obtained results are presented in Fig. 1, where the index changes according to the RCP4.5 scenario are shown on the left, and according to the RCP8.5 scenario on the right. The solid shaded area in Fig. 1 represents the range and the solid line represents the mean values for the RCM ensemble.

FD changes over the Antarctic Peninsula and Akademik Vernadsky station

The changes in the number of frost days for the RCP4.5 and RCP8.5 scenarios to the middle and to the end of the 21st century are presented in Fig. 2. Much lower variability of the characteristics over the entire Peninsula in comparison to the index trend for Akademik Vernadsky station is seen clearly.

Under the RCP4.5 scenario, the multiyear mean of the average index for the Peninsula is uniform with little interannual variability over several days. The multiyear mean change averaged by century is close to –2 days. To the end of the century it reaches –6 ± ± 1 day. For Akademik Vernadsky station, the decrease

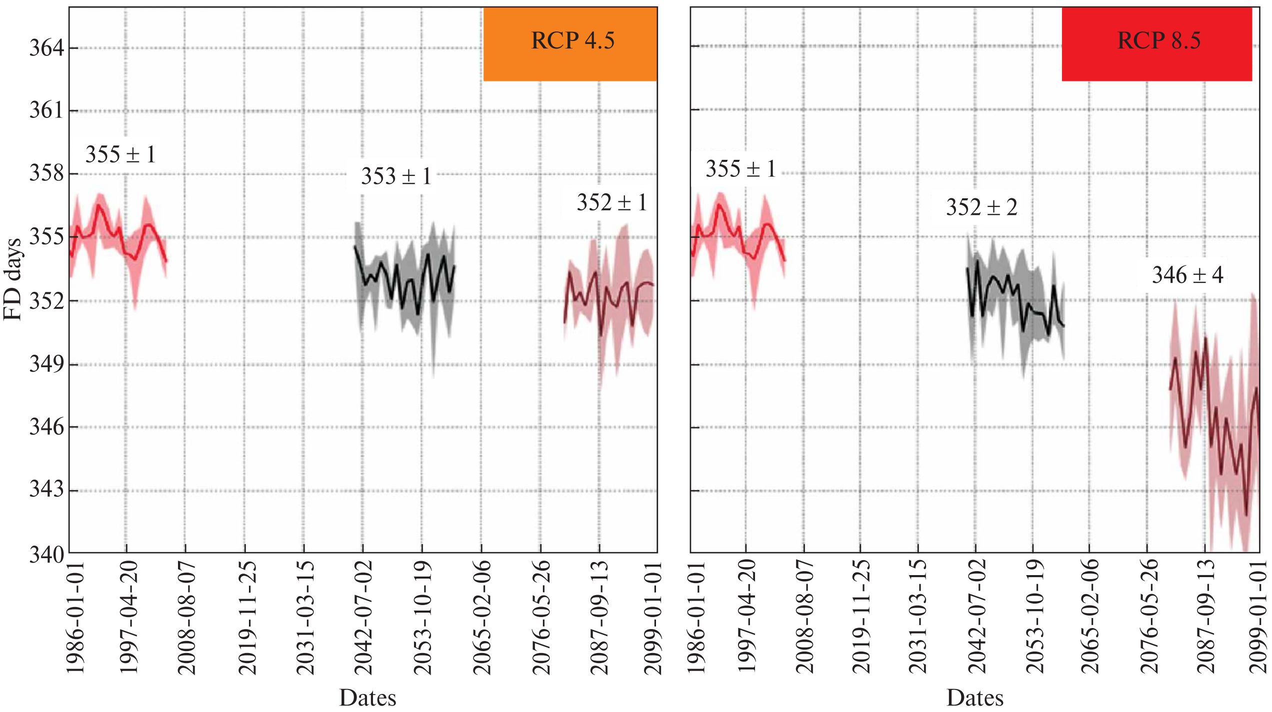


Fig. 1. Number of frost days (FD) for Historical, RCP4.5 and RCP8.5 scenarios for the 21st century

is much larger than for the Peninsula. It is in average– 30 ± 10 days and varies within –6 ÷ –44 days in the middle of the century. The range of values of individual models is +10 ÷ –70 days in individual years. But all three models show a significant decrease to 2050, when FD season may shrink by more than a month. At the end of the century, the FD changes are from –55 to –25 days for the station, when there is a relatively small decrease to –40 days by 2100.

According to the RCP8.5 scenario, FD decrease is observed for the entire Peninsula, which varies within –1 ÷ –5 days in the middle of the century. The decrease reaches to –11 days for the Antarctic Peninsula area by the end of the century.

For the Akademik Vernadsky station under the scenario of RCP8.5 for the middle of the century a significant reduction in FD is projected. During this period, deviations are observed in the range –25 ÷ –45 days with amplitude of ± 20 days approximately every five years. By 2060, the FD season will be reduced by almost 50 days. By the end of the century, the decrease is projected to continue, and under this scenario it will be equal to about –100 days at the end of the 21st century. More detailed information on fluctuations in the multiyear mean FD change trend is presented in Fig. 2.

Spatial distribution of the average FD change

The average FD value in the historical scenario is 355 days on the vast majority of the Antarctic Peninsula area (Fig. 3, *c*). In the northeastern (Larsen glacier) and southwestern (Alexander I Island, George VI glacier) parts of the Peninsula it decreases to 330 days. In general, the least frost days (up to 315) were found at the northern tip of the Peninsula and in its eastern slope, dominated by shelf glaciers with small elevations.

The results on FD show that the ensemble and the 20-year mean changes are almost the same in the vast majority of the Peninsula by RCP4.5 scenario over the century and in average is – 4 days. A slight positive change is projected in the southern part of the

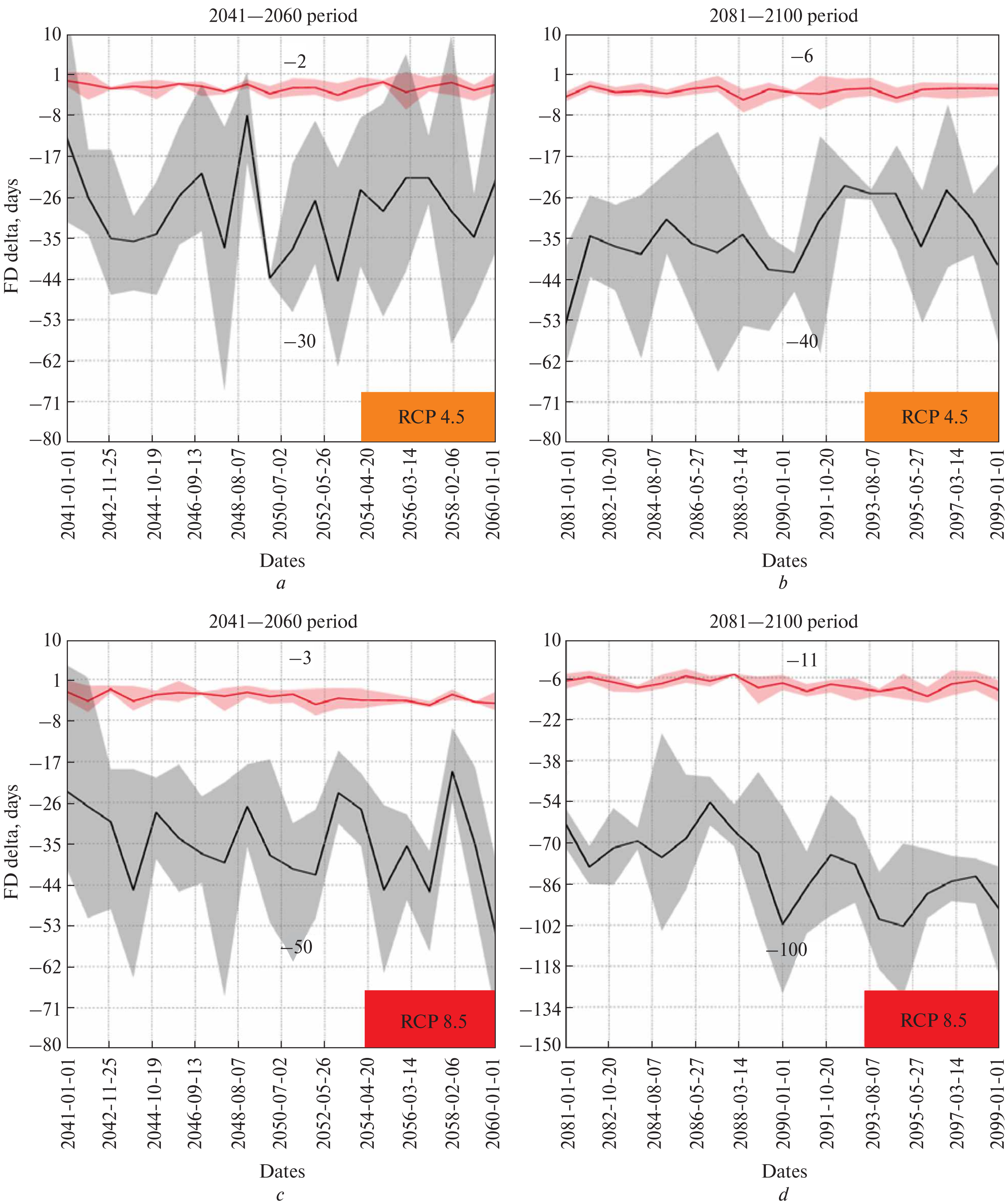


Fig. 2. Time series of FD change for Antarctic Peninsula (pink) and the Akademik Vernadsky station (black)

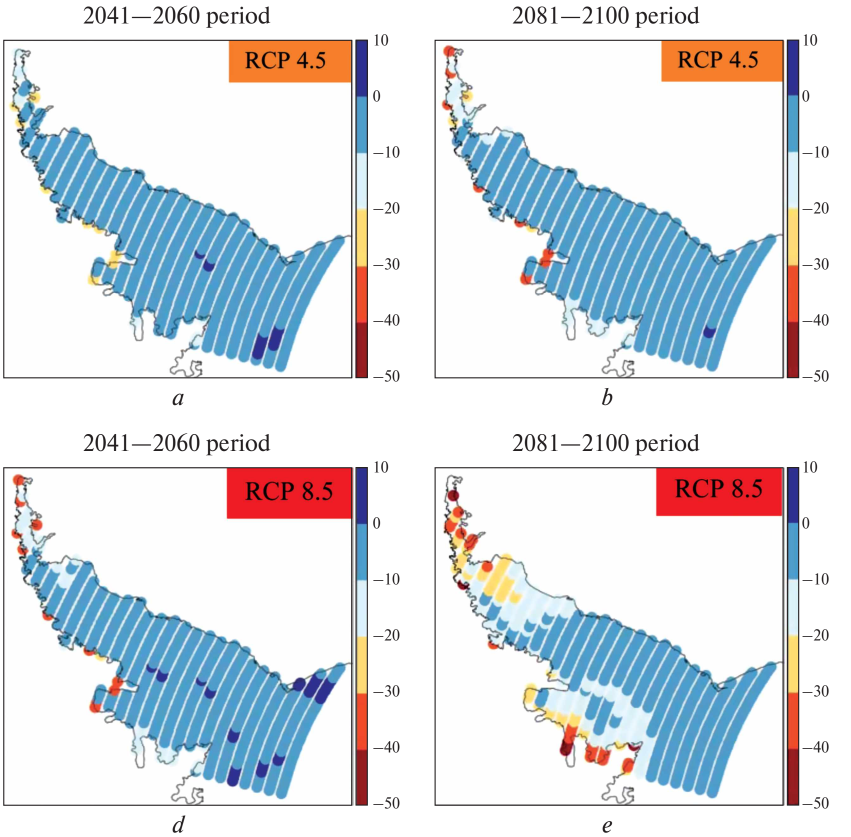


Fig. 3. Spatial distribution of FD for historical scenario (*c*) and mean change of FD for pointed climatic periods for scenarios RCP4.5 (*a*, *b*) and RCP8.5 (*d*, *e*)

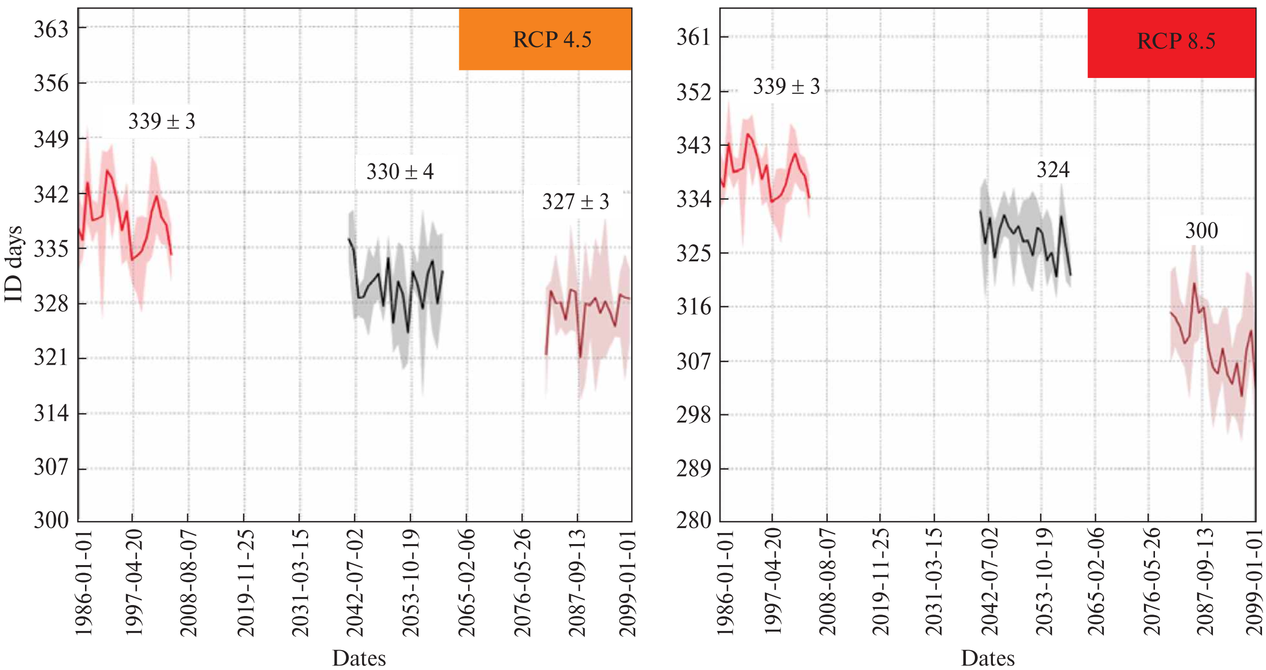


Fig. 4. Number of ice days (ID) for Historical, RCP4.5 and RCP8.5 scenarios in the 21st century

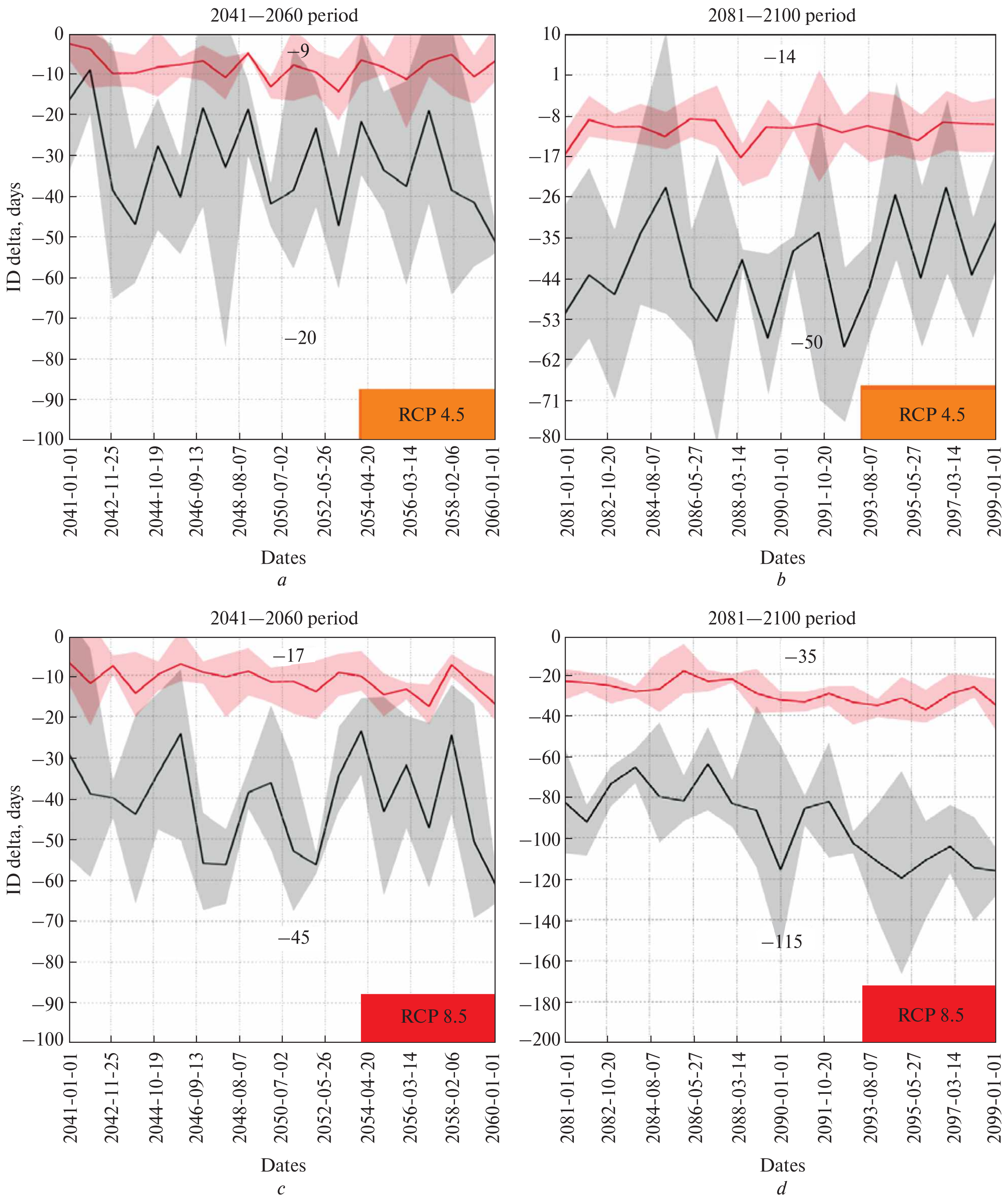


Fig. 5. Time series of the ID change over Antarctic Peninsula (pink) and over the Akademik Vernadsky station (black)

Peninsula in the region around Mount Coman (3655 m). This anomaly almost disappears at the end of the century. A significant negative change and its growth at the end of the century is expected on the western coast of the Peninsula and in coastal zones, in particular in the Akademik Vernadsky station region, where FD will decrease by 30 days in the middle and by 35 days before the end of the century (Fig. 3, *a, b*).

According the RCP8.5 scenario, the calculated index changes are significantly different from RCP4.5 scenario (Fig. 3, *d, e*). In average, the FD will decrease by 10 days in the middle of the century in the Peninsula region. At the end of the century, the values decrease revealed some heterogeneity within the Peninsula: in the northeastern and southern parts of the region, FD decreases by 10—20 days, but in some coastal areas – over –40 days. As for Akademik Vernadsky station, the number of frost days may decrease by an average of 35 days to the middle and by 80 days to the end of the century.

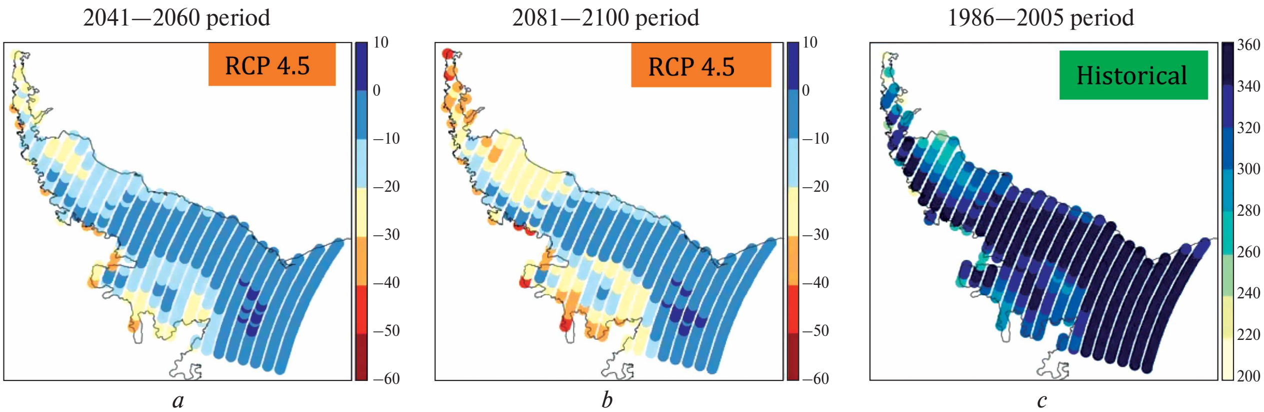
Ice days (ID)

ID Multiyear mean

In the historical period, the average ID value is 339 ± 3 days, with an annual variability from 334 to 345 days. The insignificant reducing ID trend is observed along all base period (Fig. 4).

The tendency of ID changes during the 21st century is similar to the FD change trend. Thus, under the scenario RCP4.5 in the middle of the century, the decrease in the number of ID compared to the baseline period up to 330 ± 4 days is observed. Over the last twenty years, the ensemble averaged ID value is 327 ± 3 days. In general, the slight trend towards ID decreasing is observed by the RCP4.5 scenario (Fig. 4).

The ID number rapid decrease is expected under the RCP8.5 scenario. In 2041–2060 period, the ID value will be reduced in average from 330 to 324 days. Over the last twenty years at the 21st century, the ID has decreased in average from 315 to almost 300 days (Fig. 4).



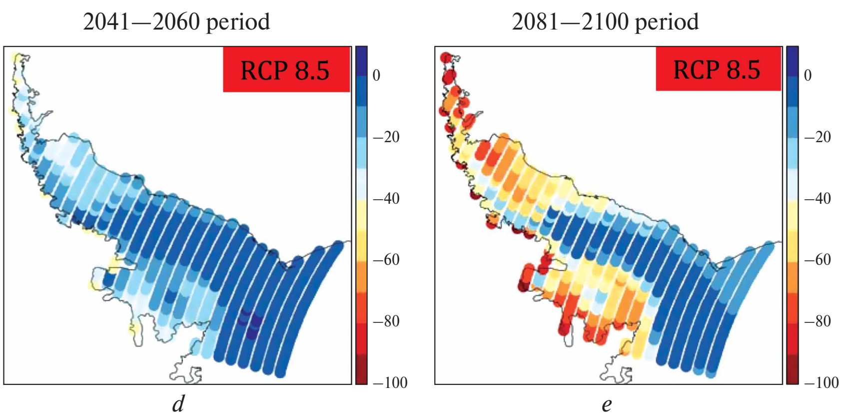


Fig. 6. Spatial distribution of the ID values for historical scenario (*c*) and mean ID change for the climate periods according to the RCP4.5 (*a, b*) and RCP8.5 (*d, e*) scenarios

ID changes over the Antarctic Peninsula region and Akademik Vernadsky station area

The ID multiyear mean change is more pronounced in the both scenarios for the Antarctic Peninsula region than for the FD. The extremes of the averaged ID change fluctuations are observed over the Peninsula and over Akademik Vernadsky station, although the values at the station are much higher than the average at the Peninsula for both scenarios (Fig. 5).

Under the RCP4.5 scenario, the change over the Peninsula is equal in average to –9 days in the middle and –14 days at the end of the century for the 20 year averages. The variability of the multiyear mean changes ranged from –5 to –15 days in the middle of the century and from –10 to –17 days at the end of the century. The significant ID decrease is observed over the Akademik Vernadsky station area in the 2041—2060 period.This decrease ranges from in average of –20 days at the beginning to –50 days at the end of the specified period. At the end of the century, both the multiyear mean ID change amplitude oscillation and its average value are falling up to–26 ÷ –60 days with the mean of –35 days decrease (Fig. 5).

According to the RCP8.5 scenario, the significant ID decrease is projected over both the Antarctic Peninsula and Akademik Vernadsky station. In the middle of the century, the multiyear mean ID change will decrease from –10 to –17 days with slight inter annual variability of 3–4 days over the Antarctic Peninsula. At the end of the century, this value will reach down to –35 days. According to the RCP8.5 scenario, the rate of the ID reduction is approximately equal to two days per year and exceeds significantly those calculated according the RCP4.5 scenario. Over the Akademik Vernadsky station, the IDnumber decrease is not linear. There are significant interannual oscillations with amplitudes up to 20 days and a higher frequency in the middle of the century, which become somewhat smoothed at the end of the century. In general, we can reveal a tendency for a significant decrease in the number of ID, when average values will be –45 days less at the middle and –115 days less at the end of the century (Fig. 5).

Spatial distribution of the average FD change

Over the historical period, the average ID values spatial distribution is shown in Fig. 6. This distribution is the mean of the RCM ensemble over the Peninsula area. The number of ID was approximately 340 days in the historical period over the central part of the Peninsula. In the northern (Larsen glacier, Graham Land) and southwestern (Alexander I Island, George VI glacier) parts of the Peninsula the number of ID is smaller with values of 260 days in average, indicating warmer (marine) climate than in the mountainous part of the Peninsula.

For the future, trends in the ID number decrease are much greater than the FD reduction. According to the RCP4.5 scenario, a significant negative change is expected for almost the entire Peninsula region in the middle of the century (Fig. 6, *a*), when it is only within 10 days in the central mountainous part of the Peninsula. Over the Larsen glacier, Alexander I Island and the southern coastal areas, this negative change is equal to –30 and –40 days in some grid nodes. At the end of the century, in these areas, the decreasing tendency will intensify (Fig. 6, *b*).

According to the RCP8.5 scenario, a significant ID decrease is expected with approximately 100 days less in some areas at the end of the century (Fig. 6, *e*). Over the mountainous area, the minimum ID changes about –10 days are observed in the middle of the century (Fig. 6, *d*), which will decrease at the end of the century (Fig. 6, *e*). Over the Larsen Glacier, Graham Land and the region around Alexander I Island, the mid-century average change will be of –30 days, reaching to –70 days at the end of the century.

Note, that in the considered projections, a slight increase in the number of ice days was found in the Mount Coman area according to the RCP4.5 scenario, and in the middle of the century according to the RCP8.5 scenario.

DISCUSSION AND CONCLUSION

In the Part I of the paper, the analysis of the two climatic indices is presented based on the projections of an ensemble of three RCMs calculated for two scenarios (RCP4.5 and RCP8.5) in the middle and at the end of the 21st century. These indices (ice and frost days) characterize the temperature regime around the water freezing point near the surface in the atmosphere and particularly relevant for the sustainability of cryosphere.

Over the Antarctic Peninsula region, an average decrease in the cold season period is projected by both scenarios. This process will be more pronounced for the RCP8.5 scenario.

According to the RCP4.5 scenario, both the FD and the ID indices have a slight change in values at the end of the century compared to the middle of the century, whereas according to the RCP8.5 scenario, the deviation for these parameters is almost twice as high at the end as in the middle of the century.

Aggregated over the Antarctic Peninsula RCM results reveal the decline of the number of ID days in average on 13 days according to the RCP4.5 scenario and on 37 days according to the RCP8.5 scenario at the end of the century.

The number of ice days (ID) tends to the faster decrease than the number of frost days (FD). This may indicate that the cold period of the year will be reduced in the study region, which is in line with the findings of IPCC and many other current studies. Both scenarios have projected the ID decrease over the entire Antarctic Peninsula, which indicates an increase of positive temperatures in the region. In particular, according to the RCP8.5 scenario, the period with negative temperatures is rapidly decreasing over the Larsen Ice Sheet area in the middle of the century, which may cause its total or partial collapse.

Over the Akademik Vernadsky station area, the climate indices changes are projected almost triple as high as the averaged values for the Antarctic Peninsula for both scenarios, indicating a greater vulnerability to the climate change in the area.

According to the results of the study, number of days with positive temperature will increase over the eastern part of the Antarctic Peninsula (Larsen Glacier, eastern slope of the mountains) and the islands of the Bellingshausen Sea (Brabant, Anvers, Renaud, Adelaide), and comparatively less changes have been found over Graham Land and Palmer Land. The significant changes in temperature regime towards extension of warm period are predicted according to both scenarios at the end of the century over the Akademik Vernadsky station area. Therefore, the tendency of the temperature change regime is revealed dependent on altitude above sea level with decrease of the warming tendency with altitude. A joint analysis of climate change modeling and the ice thickness information in each region will allow studying possible changes in the cryosphere and determining the area, which is more susceptible to warming. It is clear that the different contribution to the distribution of regional signs of climate change will be driven by changes in the atmosphere and ocean circulation in the region, but this issue needs further investigation.

Full summary of the results on the projected changes in cold temperature and wet/dry indices, together with the discussion of further possible directions of the study will be presented in the Part II of the article.

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КЛІМАТИЧНІ ПРОЕКЦІЇ В РАЙОНІ АНТАРКТИЧНОГО ПІВОСТРОВА ДО КІНЦЯ XXI СТОЛІТТЯ. ЧАСТИНА І: ІНДЕКСИ ХОЛОДУ

РЕФЕРАТ. **Актуальність.** Стаття присвячена оцінці змін, що відбуваються в районі Антарктичного півострова. Впродовж останніх десятиліть найсуттєвіше потепління в кліматичній системі спостерігається в полярних регіонах, зокрема в районі Антарктичного півострова, де розташована Українська антарктична станція «Академік Вернадський». У зв'язку з цим необхідно забезпечити кращу комплексну оцінку тенденцій кліматичних змін, які вже зафіксовані та прогнозуються в майбутньому. Відповідно, **мета** дослідження — оцінити зміни кліматичних характеристик в регіоні Антарктичного півострова в XXI столітті, на основі обчислення відповідних кліматичних показників. Об'єкт дослідження: проекції характеристик температури повітря та режиму зволоження в районі Антарктичного півострову та Української антарктичної станції «Академік Вернадський» за сценаріями RCP4.5 та RCP8.5 (Representative Concentration Pathway, RCP, Траєкторії репрезентативних концентрацій). **Методами** дослідження є чисельне моделювання та статистичний аналіз даних регіональних кліматичних моделей для регіону Антарктичного півострова від міжнародного проекту Polar-CORDEX (Coordinated Regional Downscaling Experiment for the Polar Regions, Скоординований експеримент з масштабування регіонального клімату для полярних регіонів). Просторовий розподіл цих даних становить 0,44° за історичний період (1986—2005) та два періоди майбутнього 2041—2060 та 2081—2100. У дослідженні було застосовано програмування мовою R для обробки кліматичних рядів даних та модифіковано розроблений проектом Climate4R Hub («Клімат для R») код в JupiterNotebook (Юпітер ноутбук). Для оцінки кліматичних змін, що відбуваються в районі Антарктичного півострова, були обрані наступні параметри: кількість днів з мінімальною температурою повітря (Т) менше 0 °С, кількість днів з максимальною Т менше 0 °С, загальна річна кількість опадів, середня інтенсивність опадів, максимальна річна тривалість періоду без опадів, максимальна річна тривалість періоду з опадами більше 1 мм на добу. В першій частині статті представлені **результати** аналізу температурних індексів. Результати аналізу режиму зволоження будуть представлені в другій частині статті. **Висновки.** Для регіону Антарктичного півострова обидва сценарії в середньому передбачають зменшення холодного періоду. Цей процес буде більш вираженим для сценарію RCP 8.5, для якого навіть до середини століття період з температурою менше 0 °С швидко зменшуватиметься в межах Льодовика Ларсена, що може спричинити його повне або часткове руйнування. В районі антарктичної станції «Академік Вернадський» зміни кліматичних індексів майже втричі вищі, ніж середні значення для Антарктичного півострова за обома сценаріями, що свідчить про більшу вразливість цього району до зміни клімату.

Ключові слова: Антарктичний півострів, Українська антарктична станція «Академік Вернадський», зміна клімату, регіональна кліматична модель, Polar-CORDEX, сценарій RCP.