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ClimEd Training 3 (Online)

"Digital tools and datasets for climate change education"

Presentation of Group A 6. Homework Assignments

«Dynamics of the meteorological regime and climate of the Antarctic Peninsula»

Group A 6: **Halyna Borovska, Larysa Nedostrelova, Oleg Prokofiev, Antonina Savchenko**.

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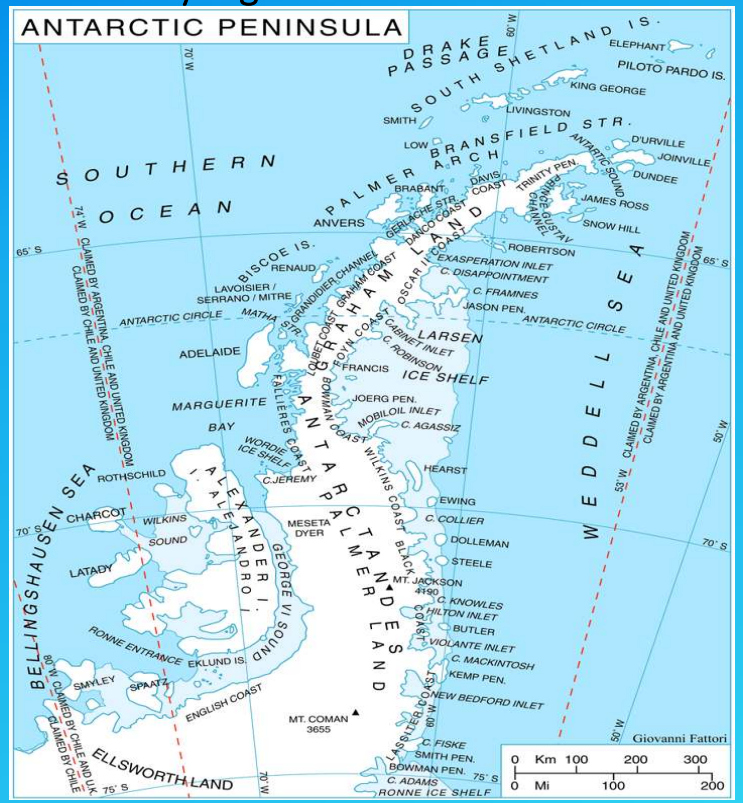
Study region



Research topic: «Dynamics of the meteorological regime and climate of the Antarctic Peninsula»

The Urgency of the topic is determined by the need for constant monitoring of the meteorological regime and climate of Antarctica and its dynamics in the light of modern climate change.

The purpose of the work is a comprehensive statistical study of spatio-temporal changes in the meteorological regime and climate of the Antarctic Peninsula.

It is planned to use the average monthly values of meteorological values (surface air temperature, wind direction and speed, atmospheric pressure at sea level, etc.) as the **research material**.

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The main objectives of scientific research:

- to determine the characteristic features of the meteorological regime and climate of the Antarctic Peninsula;
- to establish features of long-term changes of investigated meteorological sizes;
- to determine the trends in the dynamics of the meteorological regime of the Antarctic Peninsula.

The object of research is the meteorological regime of the Antarctic Peninsula.

The subject of research - the average monthly values of meteorological values.

Our research results are consistent with the following UN SDGs:

Database:

- https://climexp.knmi.nl/plot_atlas_form.py?id=
- https://worldview.earthdata.nasa.gov
- https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels-monthly-means?tab=form
- https://era5.lobelia.earth/en
- https://legacy.bas.ac.uk/met/READER/data.html

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Expected results:

- analysis of the trend of long-term changes in the studied meteorological values;
- analysis of statistical characteristics of the studied meteorological values;
- analysis of significant periods of oscillations in the series of studied meteorological values;
- analysis of trend components of the studied meteorological values;
- analysis of anomalies of the studied meteorological values for ten-year periods;
- analysis of the dynamics of the meteorological regime of the studied region.

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№	Station name	Latitude	Longitude	Altitude
1	Jubany	62,2 S	58,6 W	4m
2	King_Sejong	62,2 S	58,7 W	11m
3	Bellingshausen	62,2 S	58,9 W	16m
4	Marsh	62,2 S	58,9 W	10m
5	Great_Wall	62,2 S	59,0 W	10m
6	Arturo_Prat	62,5 S	59,7 W	5m
7	O_Higgins	63,3 S	57,9 W	10m
8	Esperanza	63,4 S	57,0 W	13m
9	Marambio	64,2 S	56,7 W	198m
10	Faraday\Vernadsky	65,4 S	64,4 W	11m
11	Rothera	67,5 S	68,1 W	32m
12	San_Martin	68,1 S	67,1 W	4m

The research period is 1986-2015.

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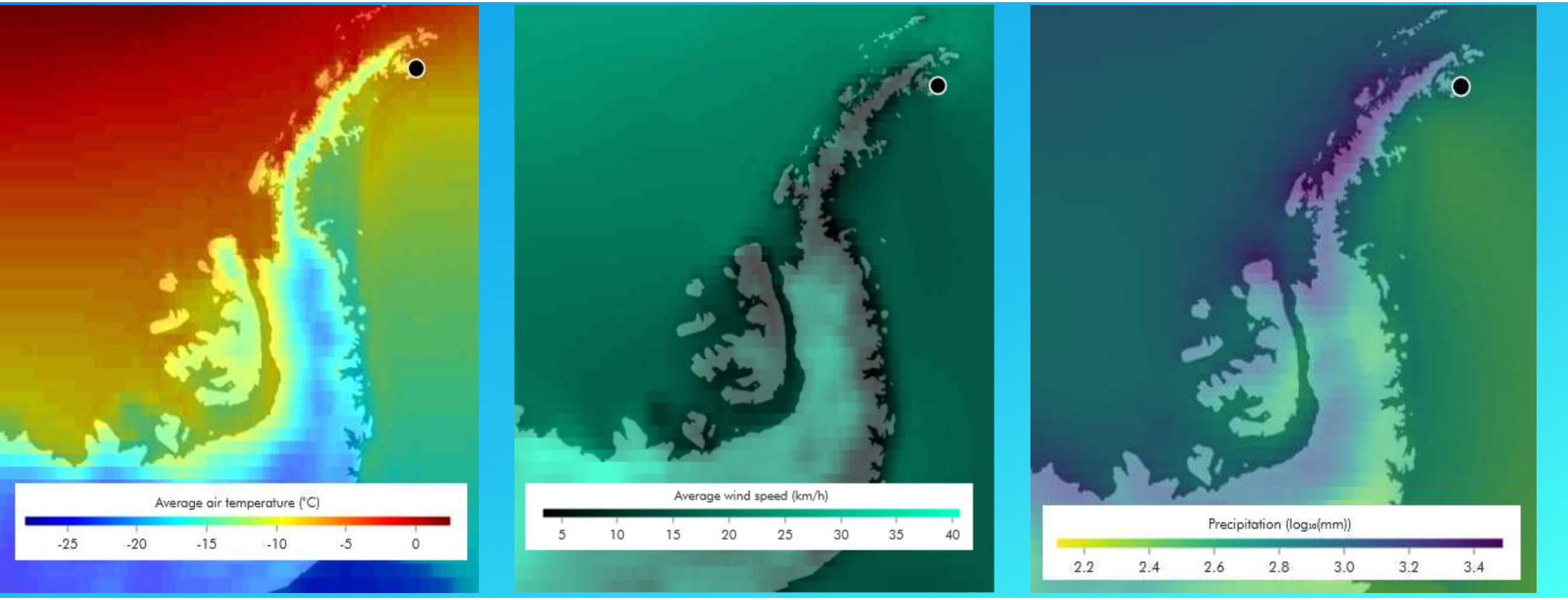

https://era5.lobelia.earth

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https://era5.lobelia.earth

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Dynamics of the thermal regime of the Antarctic Peninsula

Average values of surface air temperature

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Marambio	-0,8	-1,4	-5,2	-11,4	-13,0	-15,6	-15,1	-13,3	-10,9	-8,2	-3,7	-1,0	-8,3
Esperanza	1,1	0,4	-1,3	-6,0	-8,1	-10,7	-10,7	-9,2	-6,9	-4,5	-1,5	0,6	-4,7
O Higgins	0,6	0,3	0,7	-3,1	-4,4	-6,9	-7,7	-7,3	-5,8	-3,9	-1,9	-0,1	-3,3
Jubany	1,9	1,8	0,6	-2,0	-2,6	-4,6	-5,9	-5,5	-3,9	-2,2	-0,3	0,9	-1,8
King Sejong	1,6	1,6	0,6	-1,6	-2,9	-5,0	-5,3	-5,3	-3,7	-2,1	-0,4	0,8	-1,8
Bellingshausen	1,4	1,4	0,3	-1,7	-3,5	-5,4	-6,3	-5,9	-4,4	-2,8	-1,0	0,4	-2,3
Marsh	1,1	1,1	0,2	-1,6	-3,0	-4,7	-5,9	-5,6	-4,3	-2,8	-1,1	0,1	-2,2
Great Wall	1,3	1,2	0,4	-1,8	-2,6	-4,6	-6,6	-5,8	-4,5	-2,7	-1,0	0,3	-2,2
Arturo Prat	1,5	1,5	0,5	-1,8	-2,4	-4,4	-6,1	-5,7	-4,6	-2,6	-1,0	0,4	-2,1
Faraday\Vernadsky	0,8	0,6	-0,4	-2,0	-3,6	-5,5	-7,1	-7,9	-7,3	-5,0	-2,0	-0,2	-3,3
San Martin	1,4	0,8	-1,4	-3,4	-4,9	-9,3	-11,7	-12,7	-9,4	-6,4	-2,4	0,5	-4,9
Rothera	0,9	0,4	-1,5	-3,2	-5,1	-8,5	-10,3	-10,5	-8,6	-5,9	-2,6	0,1	-4,6

https://era5.lobelia.earth
https://legacy.bas.ac.uk/met/READER/data.html
https://cds.climate.copernicus.eu

Statistical characteristics of surface air temperature

№	Station name	Latitude	Longitude	Altitude	$x_{cep.}$	x_{min}	x_{max}	Mo	Sx^2	Sx	As	E
1	Jubany	62,2S	58,6 W	4m	-1,9	-3,1	-0,4	-1,8	0,24	0,49	0,13	0,62
2	King_Sejong	62,2S	58,7 W	11m	-2,9	-4,6	-1,0	-4,0	1,19	1,09	0,14	-1,57
3	Bellingshausen	62,2S	58,9 W	16m	-2,4	-4,0	-0,7	-1,8	0,57	0,75	-0,16	-1,01
4	Marsh	62,2S	58,9 W	10m	-8,5	-10,9	-6,2	-9,3	1,51	1,23	-0,61	-0,99
5	Great_Wall	62,2S	59,0 W	10m	-2,2	-3,4	-0,7	-3,1	0,57	0,75	0,04	-1,31
6	Arturo_Prat	62,5S	59,7 W	5m	-2,3	-4,2	-0,5	-2,2	0,71	0,84	-0,08	-0,87
7	O_Higgins	63,3S	57,9 W	10m	-3,8	-5,4	-2,3	-4,2	0,57	0,76	0,12	-1,09
8	Esperanza	63,4S	57,0 W	13m	-5,3	-7,7	-3,0	-5,3	1,39	1,18	0,14	-0,97
9	Marambio	64,2S	56,7 W	198m	-8,5	-10,9	-6,2	-9,3	1,51	1,23	-0,05	-0,99
10	Faraday\Vernadsky	65,4S	64,4 W	11m	-3,8	-8,1	-1,2	-2,5	2,74	1,66	-0,69	-0,28
11	Rothera	67,5S	68,1 W	32m	-4,4	-8,6	-1,8	-3,9	2,04	1,43	-0,77	0,35
12	San_Martin	68,1S	67,1 W	4m	-4,7	-6,8	-2,6	-4,2	1,12	1,06	0,02	-1,11

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Periods of fluctuations (year) of surface air temperature

Station	Periods of oscillation												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Jubany	5,3	3,4	2,5	2,0	2,0	2,0	3,4	1,8	1,8	2,5	2,2	4,2	3,4
King_Sejong	3,9	3,2	2,1	3,9	3,9	2,0	3,9	3,9	2,1	2,5	6,7	2,4	3,9
Bellingshausen	2,4	2,0	8,7	3,3	1,9	1,9	8,7	2,3	6,5	2,9	2,1	2,4	6,8
Marsh	2,0	4,6	8,3	3,5	2,0	8,3	7,9	8,3	2,6	2,0	2,0	2,4	8,3
Great_Wall	2,9	2,2	11,5	2,2	2,0	2,9	2,9	1,8	2,9	2,0	2,2	4,2	2,5
Arturo_Prat	3,4	2,0	7,9	5,1	2,1	2,7	2,0	4,6	5,6	3,2	1,9	2,7	2,1
O_Higgins	2,5	3,0	5,2	3,3	6,1	5,2	4,0	4,5	3,3	2,5	6,1	4,5	5,2
Esperanza	7,8	2,0	2,7	3,4	6,0	1,9	1,9	2,0	2,0	2,1	6,7	2,4	2,0
Marambio	2,0	2,0	4,9	6,2	3,8	7,9	3,8	2,3	3,4	2,1	7,9	3,8	3,4
Faraday	11,7	11,7	11,7	5,1	5,8	5,8	9,5	2,0	4,				
Rothera	2,0	4,4	2,6	3,8	2,0	2,6	5,4	2,0	3,				
San_Martin	2,0	4,4	2,3	2,0	2,3	3,5	2,4	2,0	3,				

Trend analysis

https://legacy.bas.ac.uk/met/READER/data.html
https://cds.climate.copernicus.eu
MATLAB
Grid Analysis and Display System (GrADS)

The value of the trend component of surface air temperature (ºC)

Station	trend value												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
Jubany	-0,1	-0,3	0,2	0,7	3,0	1,0	0,5	0,3	0,5	1,6	0,2	-0,2	0,3
King_Sejong	-0,8	-0,8	-0,3	-0,6	1,5	-0,6	-1,3	-0,6	***-1,2***	0,5	-0,4	-0,8	-0,4
Bellingshausen	0,4	0,3	0,4	0,2	2,5	1,6	2,0	2,3	1,1	0,2	0,1	-0,2	0,9
Marsh	-0,2	-0,5	-0,1	-0,2	1,8	0,5	1,8	3,1	-0,1	-0,5	-0,5	***-1,2***	0,5
Great_Wall	-0,3	-0,4	-0,3	0,2	2,2	0,8	0,4	-0,2	0,1	1,0	0,3	0,1	0,3
Arturo_Prat	1,4	1,5	1,6	1,3	**4,0**	2,8	1,0	3,0	-0,5	0,0	0,3	0,4	1,3
O_Higgins	0,4	1,1	1,0	0,6	**3,8**	2,7	1,0	2,5	0,5	0,0	0,3	-0,3	1,1
Esperanza	2,0	3,0	2,4	1,5	**3,9**	1,1	0,5	2,8	1,0	0,8	1,3	1,1	1,8
Marambio	2,0	2,5	2,0	1,0	2,1	0,0	-1,0	1,5	2,5	-0,4	1,3	0,9	1,2
Faraday\Vernadsky	1,7	1,7	1,7	1,8	2,6	**4,5**	**8,2**	**7,0**	**3,8**	2,0	1,2	1,9	3,5
Rothera	0,3	0,8	1,2	1,5	**4,0**	2,5	**4,0**	**4,0**	3,0	3,0	1,3	0,0	2,3
San_Martin	1,4	2,0	1,7	1,6	**4,5**	2,0	2,0	3,2	**3,9**	2,8	0,1	0,7	1,8

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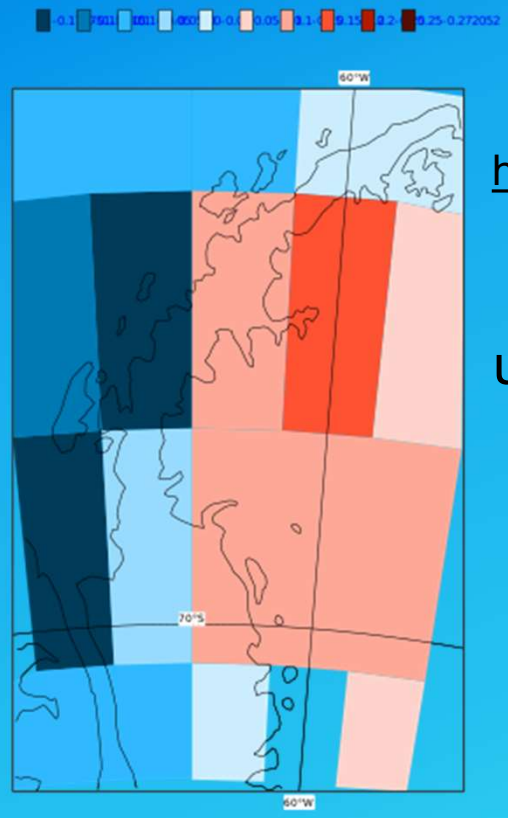
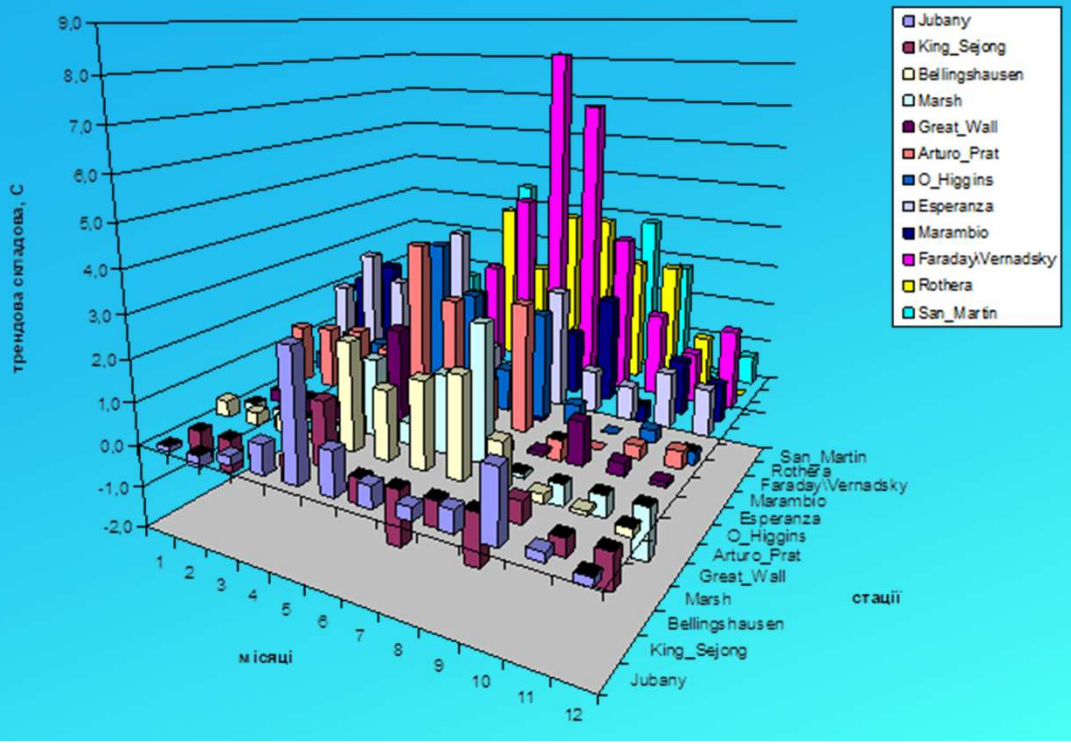


The resource https://cds.climate.copernicus.eu/, a Microsoft Office software package, was used to visualize the data



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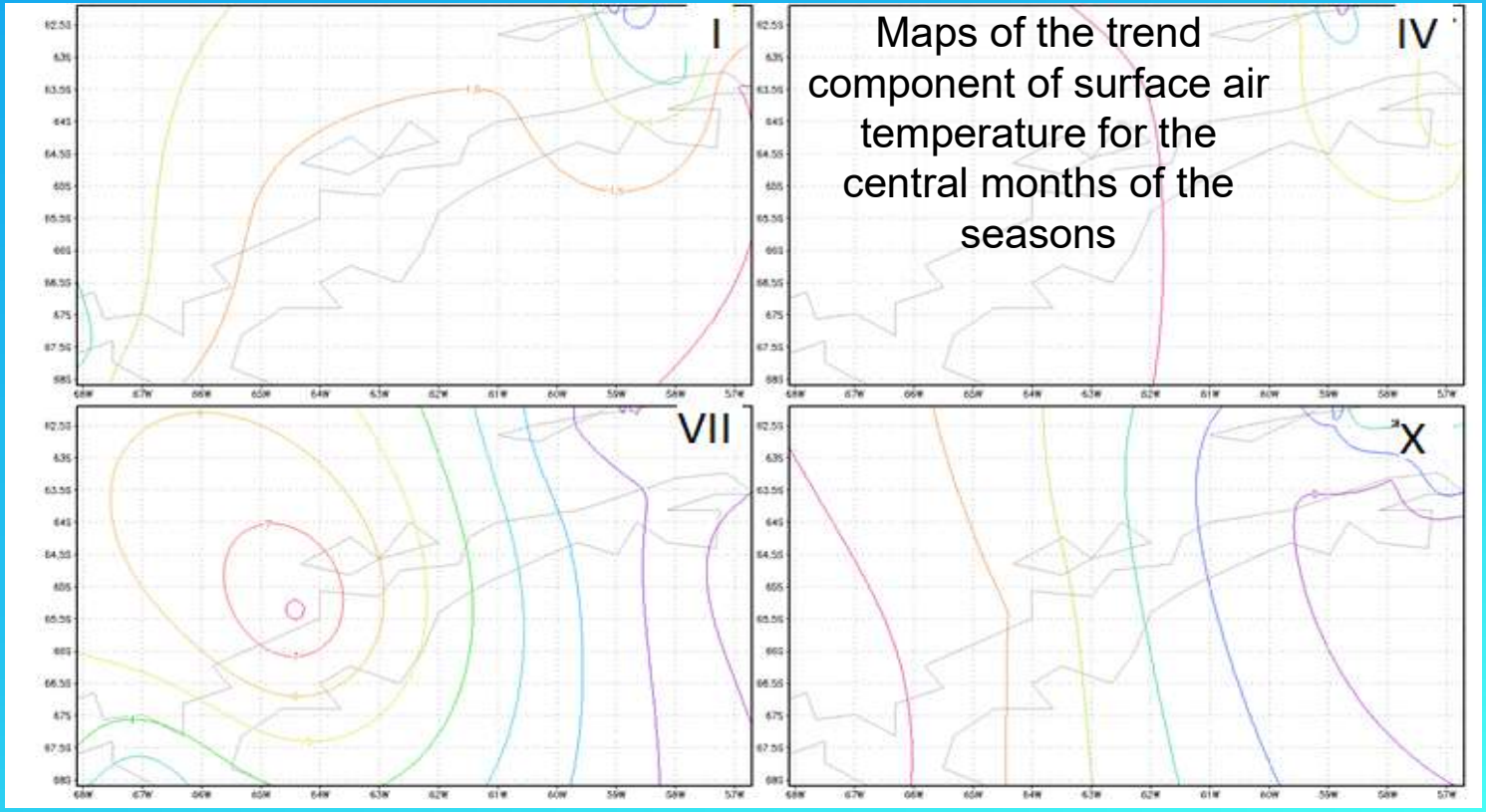
…and the Grid Analysis and Display System (GrADS)



Maps of the trend component of surface air temperature for the central months of the seasons

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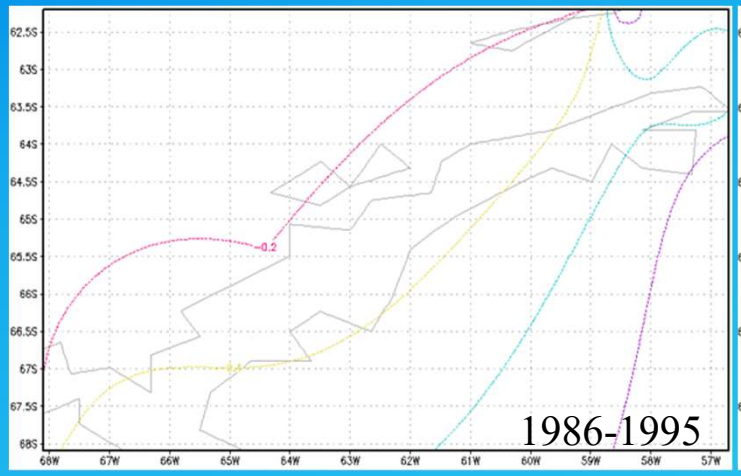
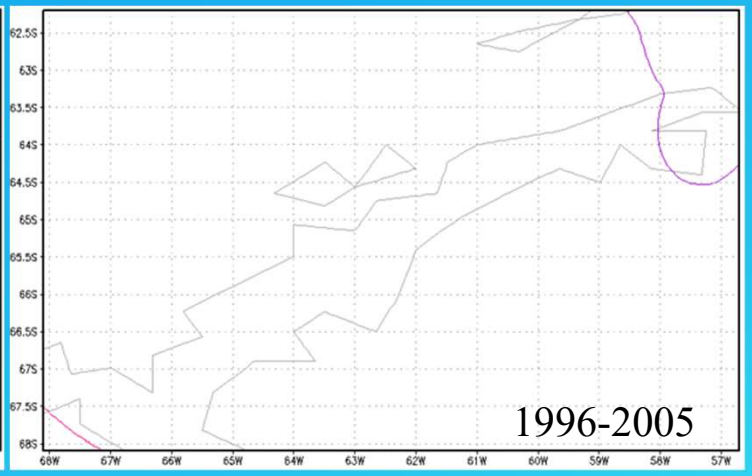
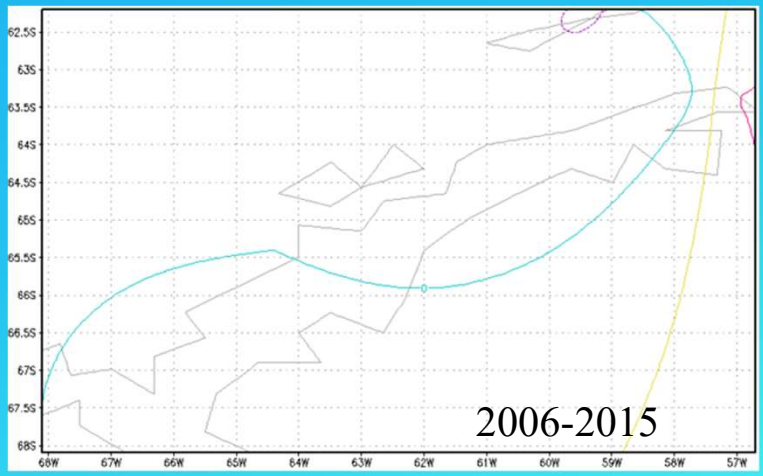
ANALYSIS OF AIR TEMPERATURE ANOMALIES







Spatio-temporal distribution of surface air temperature anomalies (January)

Analysis and Display System (GrADS)

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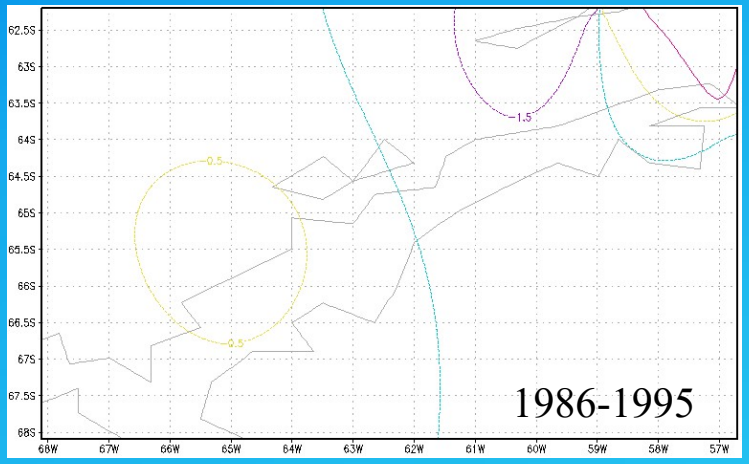
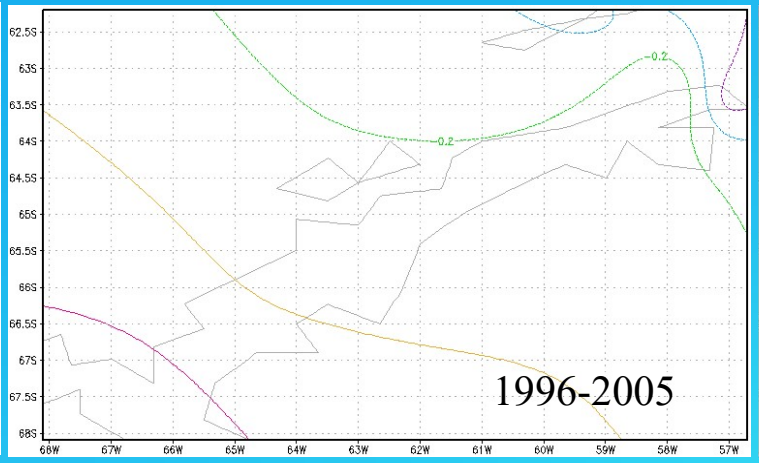
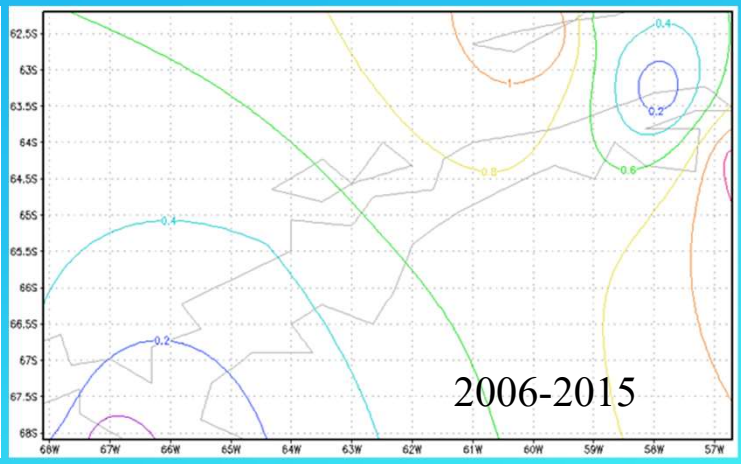
ANALYSIS OF AIR TEMPERATURE ANOMALIES







Spatio-temporal distribution of surface air temperature anomalies (April)

Analysis and Display System (GrADS)

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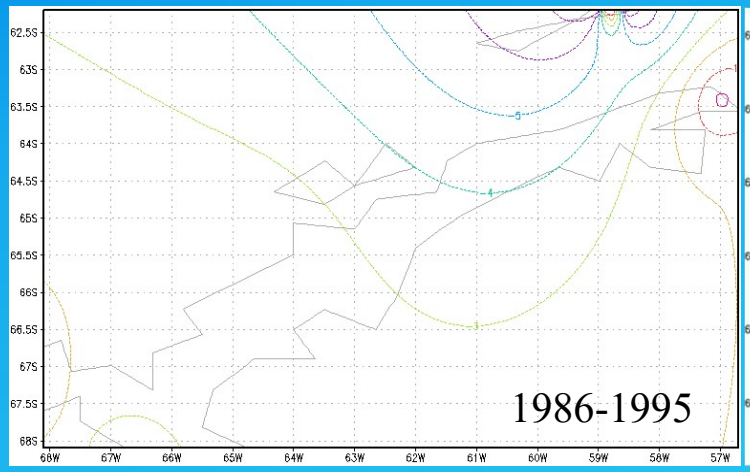
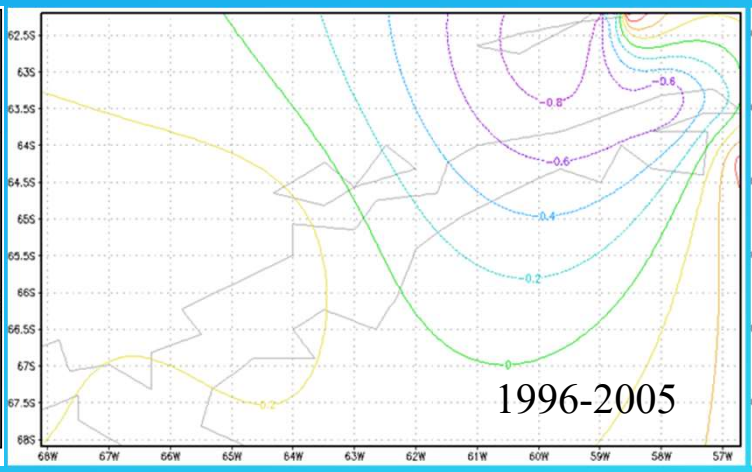
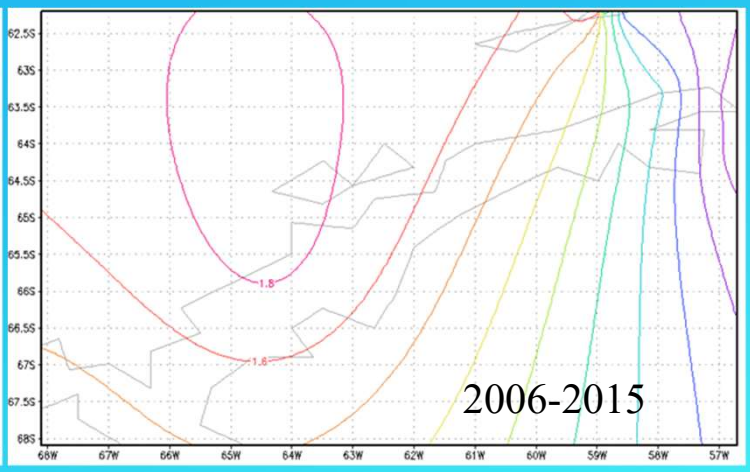
ANALYSIS OF AIR TEMPERATURE ANOMALIES







Spatio-temporal distribution of surface air temperature anomalies (July)

Analysis and Display System (GrADS)

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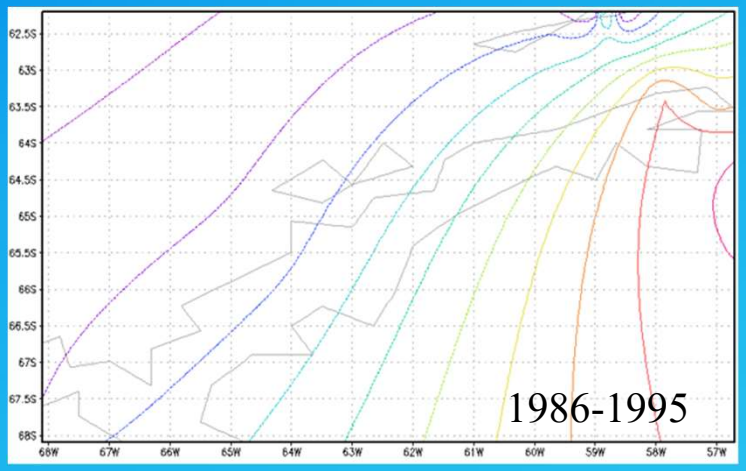
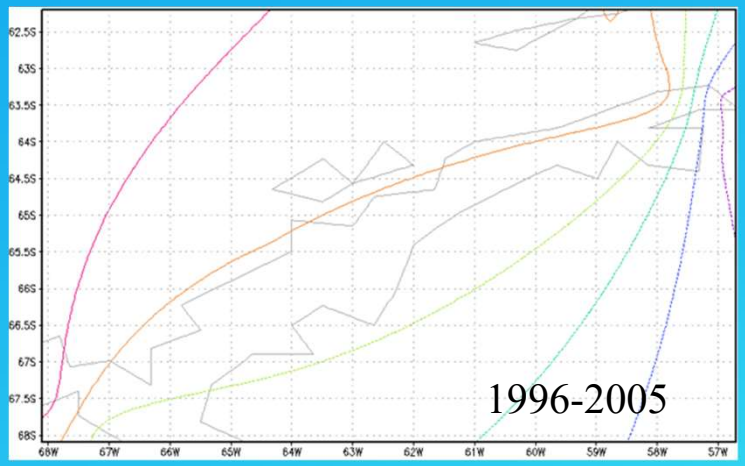
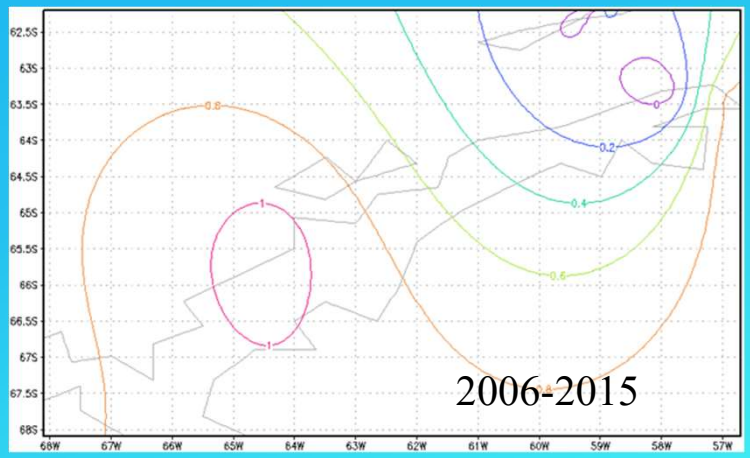
ANALYSIS OF AIR TEMPERATURE ANOMALIES







Spatio-temporal distribution of surface air temperature anomalies (October)

Analysis and Display System (GrADS)

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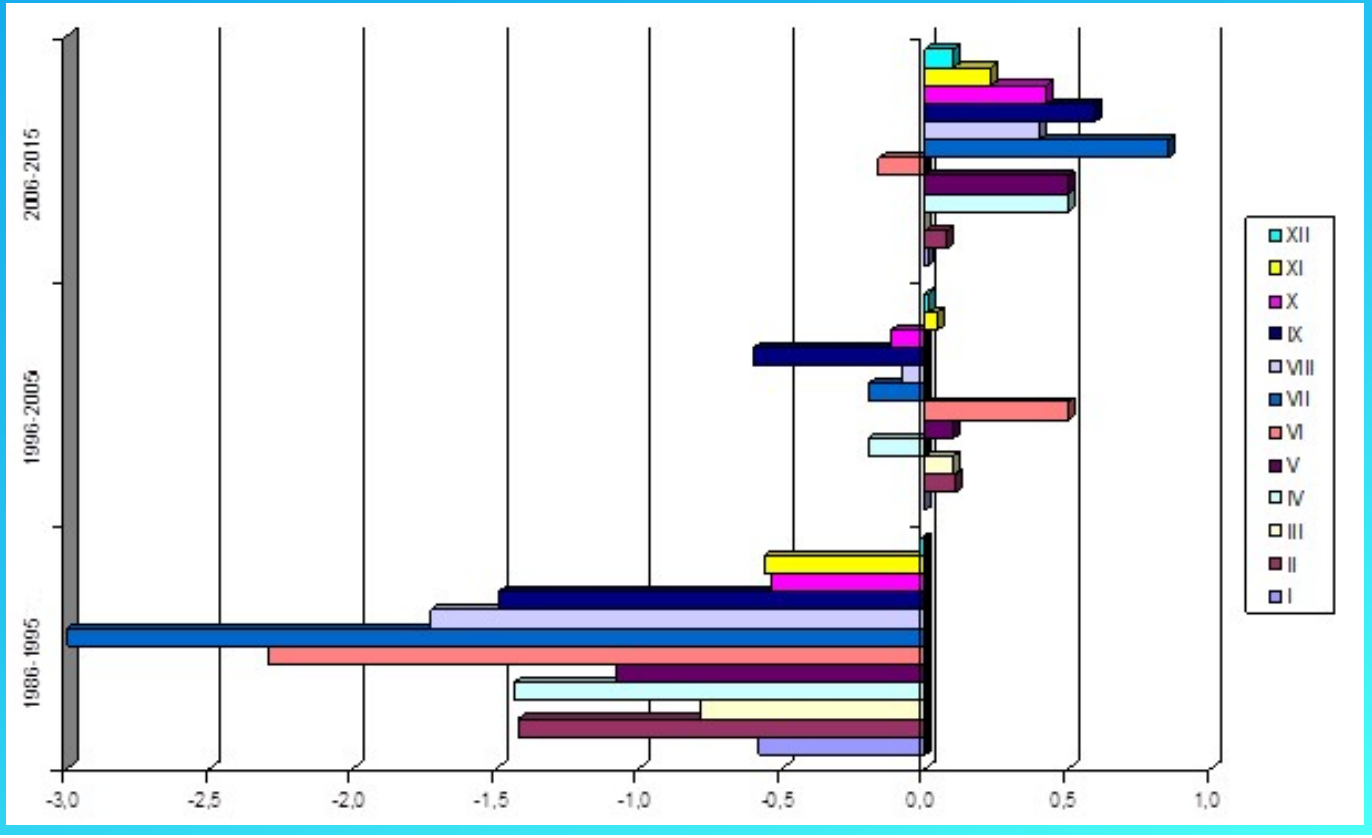
Sums of anomalies of the surface temperature of the Antarctic Peninsula for decades by months



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Generalizations:

The study area recorded an increase in surface air temperature during the study period during most months of the year. The biggest positive trends are observed during the Antarctic winter. The maximum was recorded at Faraday \ Vernadsky and San_Martin stations (8.2 and 4.5 ºC, respectively). Negative values of the trend are recorded mainly in the summer (December-January).

Analysis of air temperature anomalies showed that in the last decade (2006-2015) there has been an increase in surface air temperature in the Antarctic Peninsula in all months of the year. The largest temperature anomalies are recorded in winter.

Analysis of the spatio-temporal distribution of anomalies of surface air temperature in the Antarctic Peninsula suggests that currently there is an increase in surface temperature throughout the study area relative to the thirty-year average for most months of the year. The magnitude of warming in some cases reaches 7-8 ºC.

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Increase in surface air temperature in comparison with the studied period (model data CMIP5)

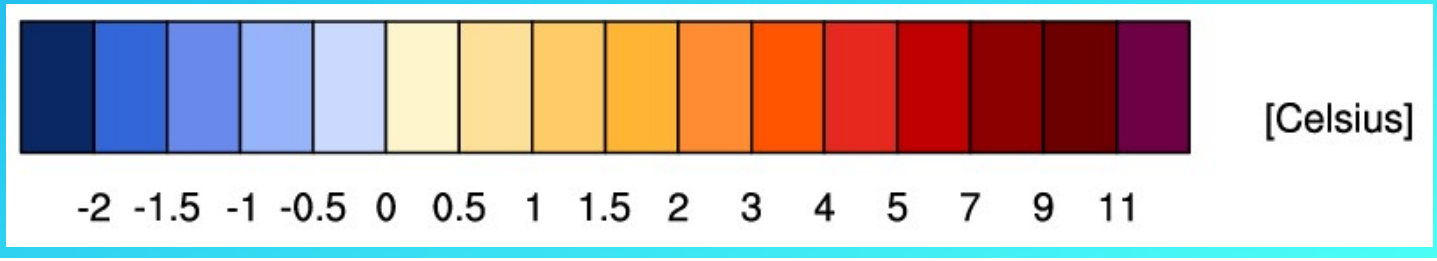
2026-2055

2056-2085

2085-2100

scenario RCP 2,6

https://climexp.knmi.nl



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Increase in surface air temperature in comparison with the studied period (model data CMIP5)

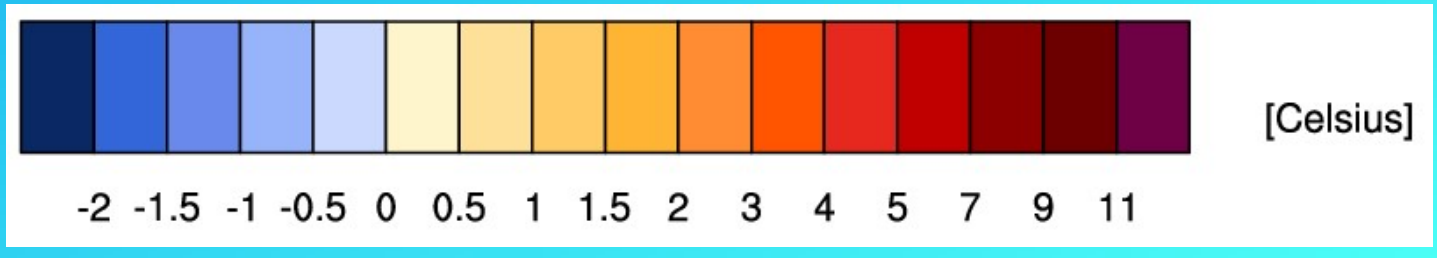
2026-2055

2056-2085

2085-2100

scenario RCP 4,5

https://climexp.knmi.nl



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Increase in surface air temperature in comparison with the studied period (model data CMIP5)

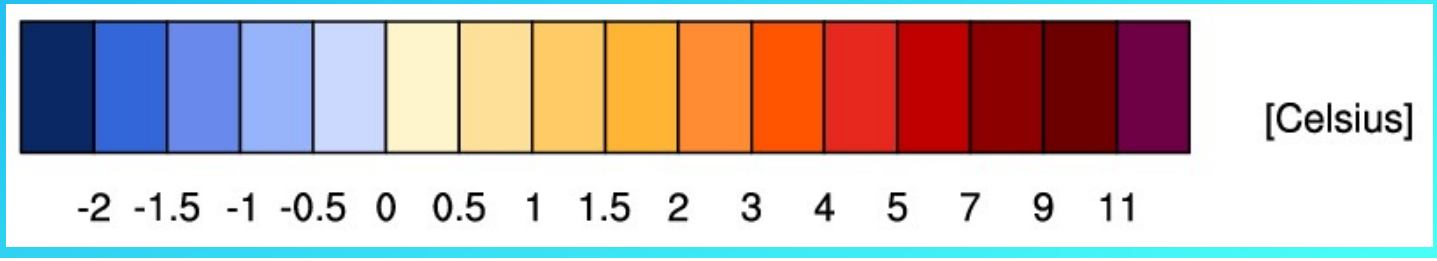
2026-2055

2056-2085

2085-2100

scenario RCP 8,5

https://climexp.knmi.nl



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Conclusions:

Analysis of the meteorological regime of the Antarctic Peninsula shows that there are certain changes in the region, namely the strengthening of the role of cyclones in northwestern trajectories (East Pacific and South American branches of cyclones) in the summer, and their weakening in winter.

Over the last thirty years, there has been a steady trend of increasing surface air temperature and wind speed with decreasing atmospheric pressure during most months of the year, which may indicate a violation of the meteorological regime of the Antarctic Peninsula, which will only intensify over time.

Similar calculations were performed for all studied meteorological values, namely:

- **air temperature,**
- **wind direction and speed,**
- **atmospheric pressure at sea level.**

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Thank you!