

# Wind Farms and Climate Change in Eurasia and America

Semen Ilyich Gordeev, Victoria Nikolaevna Voloshina

School of Natural Sciences, Far Eastern Federal University, Vladivostok, Russian Federation

**Email address:**

seeman40@mail.ru (S. I. Gordeev), vviktorya2010@mail.ru (V. N. Voloshina)

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**Abstract:** The study of the natural phenomenon - global warming in the northern hemisphere of the planet was carried out on the basis of the definition of American climatologist Wallace Brooker, which implies an increase in the average temperature of the lower layers of the atmosphere and seas associated with the industrialization of the economy. That is, these are climatic changes that have arisen under the influence of anthropogenic factors. GISMETEO RF weather data and weather maps of Eurasia and North America were also used. The main and determining factor is the massive use of wind power on the paths of cyclones. The interaction of wind farms installed on the Atlantic coast of Europe and Atlantic cyclones is simulated. The results are presented as a synoptic map for Europe.

**Keywords:** Climate, Vortex Structures, Energy Transfer

## 1. Introduction

When studying the causes and consequences of global climate warming, the observational data for the current 21st century were considered. Particularly intensive changes have occurred over the past five years. Unprecedented natural phenomena began to occur more often and on a larger scale.

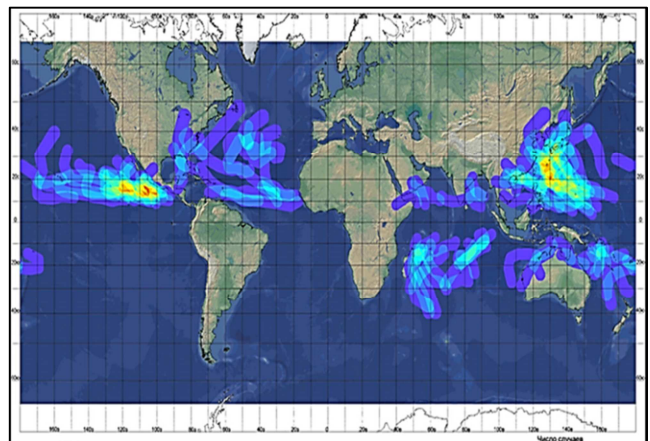
In just a two week from February 21 to March 4, 2018, events occurred that are difficult to explain by the presence of the greenhouse effect of carbon dioxide.

**CHRONOLOGY OF CLIMATE EVENTS:**

- On February 21, the air temperature in New York reached +26 degrees Celsius, which is 20-25 degrees above normal!
- On February 24, climatologist Zack Labe from the University of California, Irvine spoke about an abnormal thaw in the Greenland Sea, as a result of which the average Arctic temperature in February 2018 was +6 degrees Celsius. This is above the norm by 20 degrees !!!
- February 27 in Rome for 6 hours it was snowing. The level of snow cover reached 10 cm, which is quite a lot for Rome. In the city of Naples, for the first time since 1956, snow fell.
- February 28, the state of California was snowing
- On March 1, 2018, snowfall swept most of Europe,

including even the Mediterranean islands of Corsica, Capri, Spain.

- On March 4, in Moscow, there was so much snow as on March 4 it did not fall in 123 years.



**Figure 1.** Global tropical cyclone recurrence map for 2018. According to the Federal State Budgetary Institution Scientific Research Center Planet.

When studying the global warming problem in its modern manifestation, we settled on the definition of the American climatologist Wallace Brooker, which implies an increase in the average temperature of the lower layers of the atmosphere and seas associated with the industrialization of

the economy [3]. That is, these are climate changes that have arisen under the influence of anthropogenic factors. The generally accepted hypothesis of global climate change by anthropogenic factor implies global by-product of carbon dioxide.

However, the greenhouse effect does not work in the winter in Eurasia and America, that is, in the northern hemisphere. In our opinion, it is advisable to consider the influence of wind power plants on weather conditions, especially in areas of their mass use, as an anthropogenic factor.

## 2. Wind Farms

Wind farm - several wind generators assembled in one or several places. Large wind farms can consist of 100 or more wind generators. Wind farms are used in countries with suitable wind speeds, low terrain and lacking natural resources. The world leader in the use of wind power plants is Germany, in which ~ 9000 MW of power was built in a short period of time. The unit capacity of wind power plants increased to 3 MW.

In Germany, Denmark and England and other coastal states of Europe, intensive construction of wind power plants continues.

Wind speed increases with height. Therefore, wind farms are built on tops of hills or elevations, and generators are installed on towers 60-100 meters high. In September of 2019, the largest offshore power station was the Horns Rev 2 wind farm in the North Sea off the coast of Denmark.

The project is implemented by the Danish company DONG Energy. The wind farm consists of the 91st Siemens turbine with a capacity of 2.3 MW each. The height of the wind turbine is 114.5 m above sea level.



**Figure 2.** An offshore power plant - Horns Rev 2 wind farm in the North Sea off the coast of Denmark.

Today, Vattenfall's assets include wind farms with a total capacity of 536 MW on land and 686 MW in coastal waters, which produce 3-4 TW-hours per year for the UK, Sweden, Denmark, Germany, Poland, the Netherlands and Belgium. There are more than 26,000 operating wind turbines in Europe. Their total capacity is approaching 100 gigawatts.

Wind farms are being created at:

East coast of the USA. In the state of Texas, the city of Roscoe built the largest wind farm in the world, commissioned in October 2009. It consists of 627 turbines with a total capacity of about 780 megawatts. At the end of last year, it was announced the construction of a new world champion, whose capacity should be 845 megawatts, writes Prian.ru.

Wind farms are installed on:

The southeast coast of China. Where a gigantic wind farm has been installed since 2009 on the Yellow Sea coast. In 2010, the first stage was completed, as a result of which the capacity of the complex amounted to about 5.16 gigawatts. A subsequent increase in power of up to 40 gigawatts was assumed.

The construction of wind farms on the coast of China in the Yellow Sea has already touched the Far East coast of Russia - the Primorsky Territory. There have been no typhoons here since 2009 - there is no heat. Summer is shorter, rainier and more contrast - during the day the heat is about 30, and at night only 10 at best 15 degrees.

## 3. Cyclones Are Vortex Structures

Like all vortex structures in the northern hemisphere, they rotate counterclockwise. In the work of G. Helmholtz "On the Integral of Hydrodynamic Equations Corresponding to the Vortex Motion", the formulation of the vortex conservation theorem was first given. According to this theorem, when forces arise that satisfy the law of conservation of energy, it is impossible to create or exclude an existing vortex [8].

In his studies of the motion of two parallel vortices in an ideally incompressible fluid, Helmholtz revealed that a plane that divides the distance between a pair of vortices with equal stresses (equal in sign) can be taken as a wall if it is perpendicular to the specified distance [2].

The vortex should move parallel to this wall, and the effect of this wall is reduced to the effect that describes the shape of the vortex, if the wall is visualized as a mirror. Wind farms therefore create a "mirror" cyclone. Both cyclones rotate counterclockwise. Their interaction occurs along the line of location of wind power plants, or rather, a curve. This curve can be considered as a new trajectory along which the cyclone should move when the power of the mirror cyclone of wind power stations becomes comparable with the capacity of the cyclone.

Weather disasters in Europe are associated with a "fence" of wind farms installed on sea and land on the west coast of Europe. This "fence" constantly takes over hundreds of gigawatts of energy from wind flows every second and causes a change in the trajectories of wind flows that led to cataclysms in Europe's climate [2].

Such a selection of kinetic energy from Atlantic cyclones off the western coast of Europe leads to a sharp decrease in the distribution range of cyclones and precipitation in the near zone to the line of wind power stations. This is



facilitated by the vortex formation behind wind power plants, which leads to mixing of the upper cold layers with the lower warm ones [4].

Precipitation falls above the seas. A dehydrated and energy-losing cyclone is lost over Europe. In addition, heat removal decreases at the largest current in the Atlantic - the Gulf Stream and, accordingly, the removal of more heated warm waters into the Arctic Ocean increases. As a result, the ice cover of the Arctic Ocean has significantly decreased in recent years.

In the European part of Russia, the delay of Atlantic cyclones leads in the summer to drought from Mediterranean and Central Asian cyclones, and in winter to heavy snowfalls and ice rains from detained and lost Atlantic cyclones [6].

In developing the models, we used synoptic maps of the GISMETEO of the Russian Federation, mainly shown in Figures 3 and 4.

The GISMETEO diagram shows the trajectories of tropical cyclones 04/18/2019.

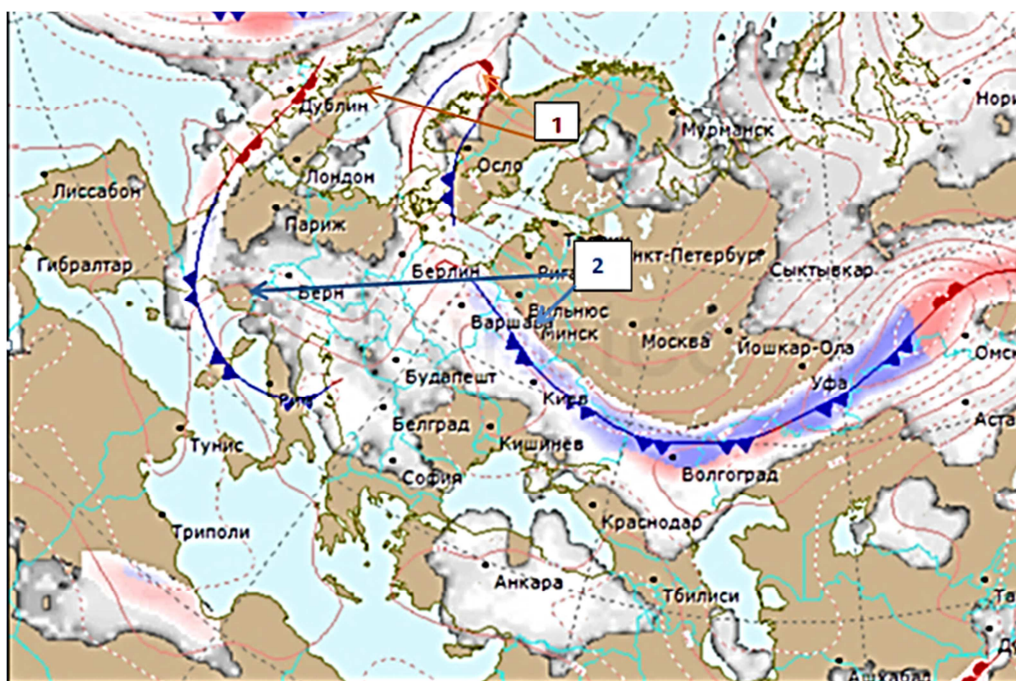


Figure 3. Synoptic maps with frontal analysis.

1. Warm Front - Generates overheated Gulf Stream. Greenland ice melt. Heat in Norway.
2. Cold Front - Abnormal cold in Europe (March 15, 2018).

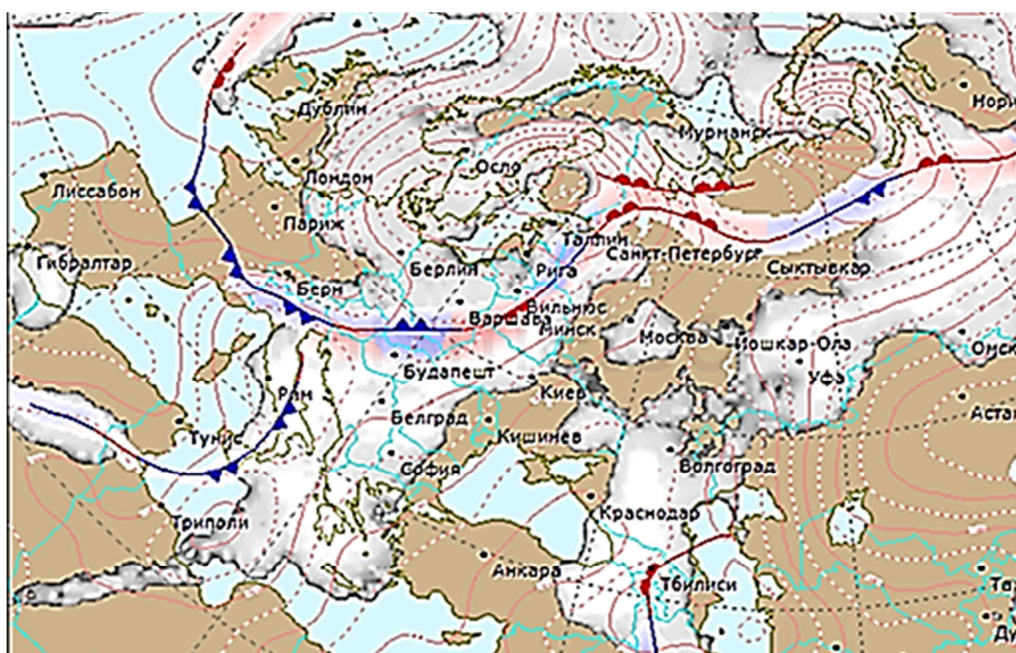


Figure 4. Synoptic maps with frontal analysis "planet".





Figure 5. Model of interaction between wind farms and Gulf Stream in Europe.

1. Gulf Stream.
2. Wind power line.
3. Warm or cold fronts in the Baltic depending on the time of year.
4. Cold front in Italy.
5. Warm or cold fronts depending on the time of year.

The map shows the trajectories of wind flows, the zones of their origin along which it is possible to predict the climate of Europe, taking into account the widespread use of wind power plants.

The developed model for changing global changes in

weather conditions in Eurasia and America is confirmed by the actual changes shown on synoptic maps in Figures 6 and 7 for 2012 and for the present - November 29, 2019. That is, the trend of changes in weather changes due to the massive use of wind power plants turns into a permanent factor.



Figure 6. Synoptic map of Europe from 24.08.2012 00h UTC Hydrometeorological Center of Russia.

1. Gulf Stream.
2. Wind power line.
3. Cold front in Italy.
4. Warm fronts.

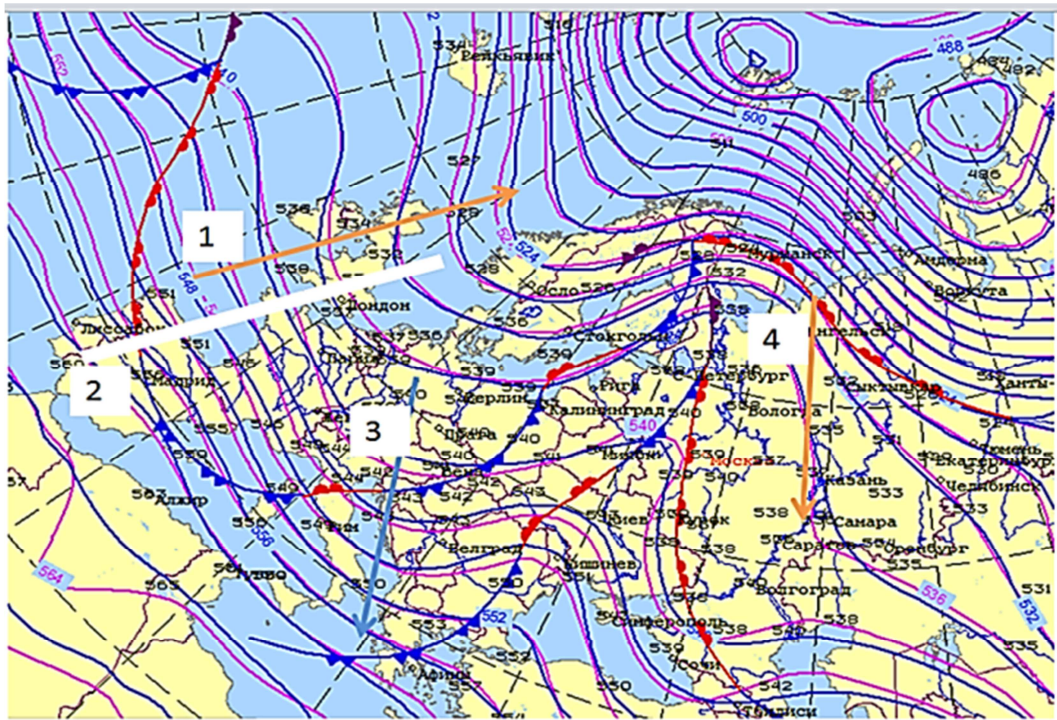


Figure 7. Synoptic map of Europe from 11.29.2019 00h UTC Hydrometeorological Center of Russia.

1. Gulf Stream.
2. Wind power line.
3. Cold front in Italy.
4. Warm fronts.

The construction of wind farms on the coast of China in the Yellow Sea has already touched Primorye, where since 2009 there have been no typhoons - there is no heat. Summer

is shorter, rainier and more contrast - during the day the heat is under forty, and at night only 10 at best 15 degrees.

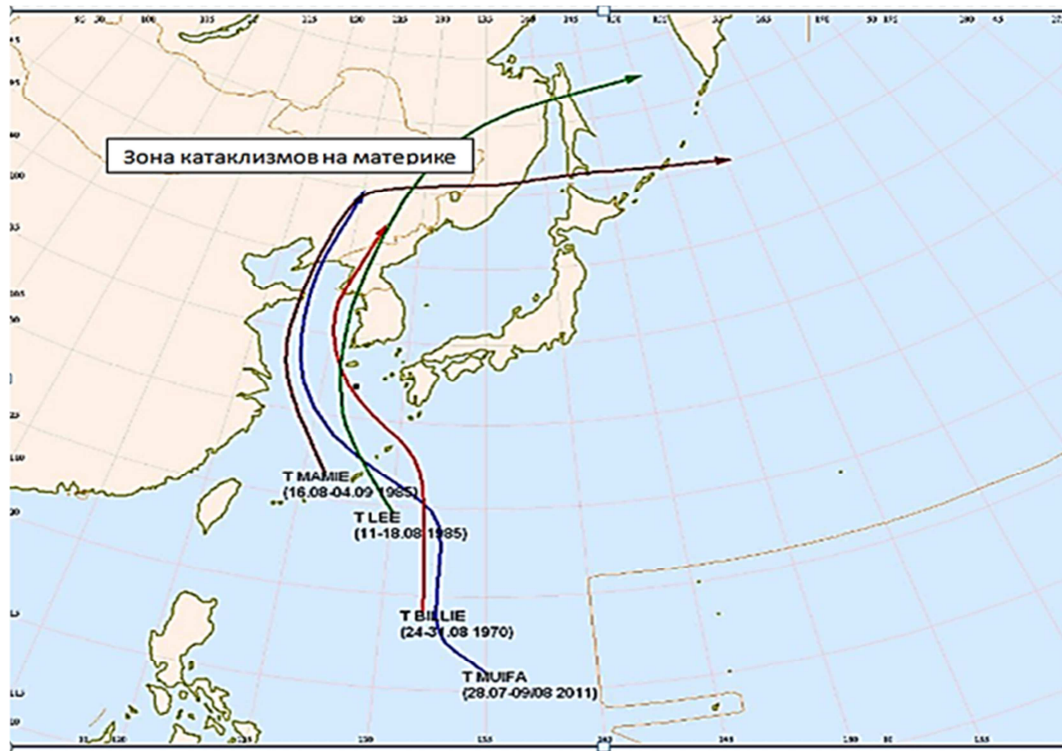


Figure 8. Synoptic maps with frontal analysis.



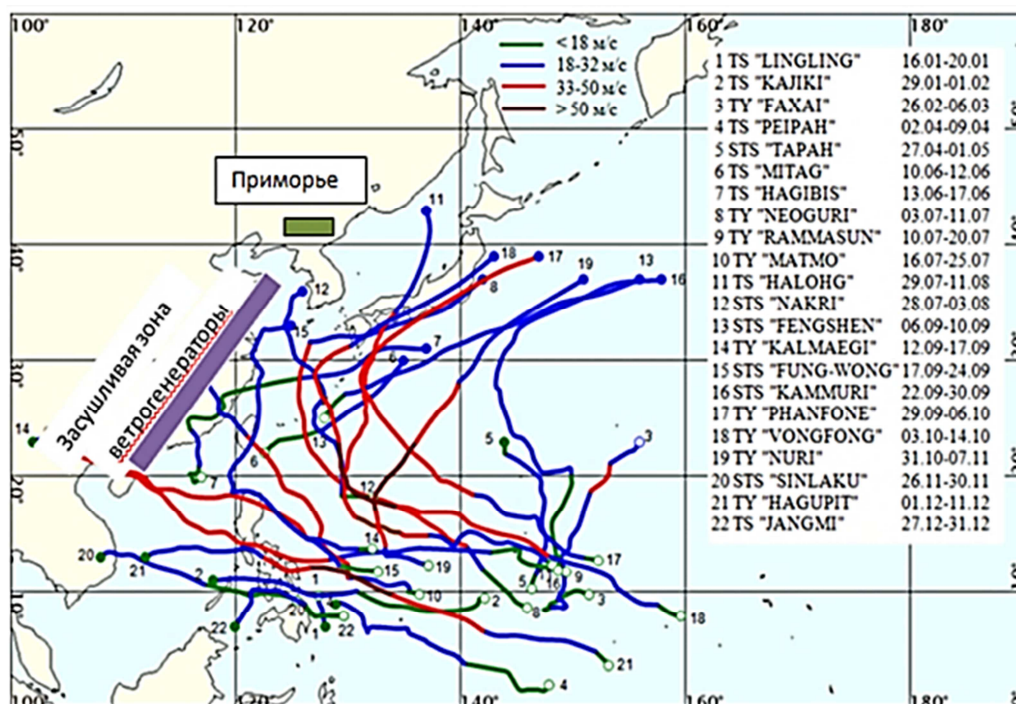


Figure 9. Synoptic maps with frontal analysis.

2002 tropical cyclone trajectories Climate - a zone of weather disasters on the mainland (Northeast China, the Russian Far East, Japan).

The monsoon climate, which created the uniqueness of the climate of Primorye, thanks to wind farms on the coast of China, is rapidly returning.

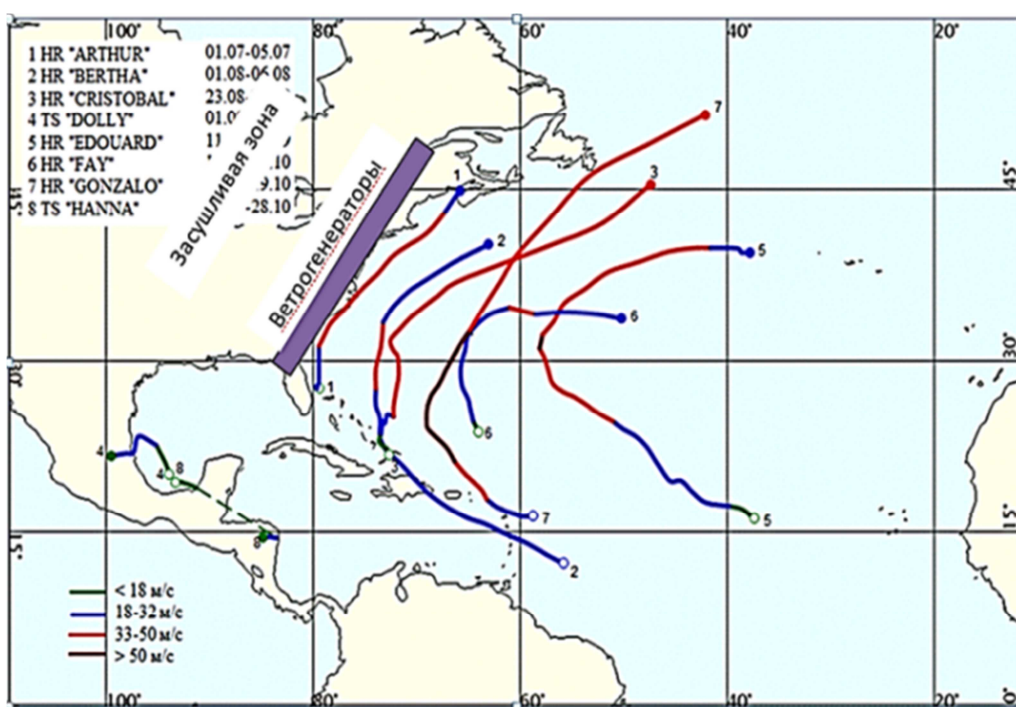


Figure 10. Trajectories of tropical cyclones in 2014.-East coast of the United States.

Climate characteristic - on the coast, a rainy zone, on land arid zone.

Changes in the trajectories of tropical cyclones due to energy withdrawal by wind farms lead to climate changes not only in coastal zones, but also on the continents - SA, Europe and Asia.

## 4. Conclusion

The use of wind power plants on a modern scale can be considered as an anthropogenic factor, which leads to

contrasting changes in weather conditions in many parts of Eurasia and America. The trajectories of cyclones in the northern hemisphere since the 21st century have changed from the northeast to the east and remain almost constant. These are cyclones in places of mass location of wind power plants on the southeastern coasts of the USA and China, Atlantic Europe. In the coastal areas of these regions, during the passage of cyclones, heavy rains and winds, which usually cause catastrophic consequences. Outside the coastal zone, due to the minimal amount of precipitation falling mainly in winter, arid zones are formed.

A further increase in the capacity of wind power stations will not fundamentally change the weather conditions in the considered regions of Eurasia and America. But by creating and increasing the capacity of wind farms in other regions, especially in the northern Indian Ocean, similar climate problems can be created.

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