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# THE ROLE AND IMPORTANCE OF METEOROLOGY IN MODERN ARMED CONFLICTS

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## Abstract

This article analyzes the importance of meteorology in modern armed conflicts, its impact on military strategy and tactics, including the effectiveness of weapons, and its role in choosing the time and location of hostilities. The article also discusses the presentation of meteorological data in real time and their importance for military intelligence using satellite technology.

**Keywords:** Modern armed conflicts, meteorology, military meteorology, combat conditions, air situation, operational data, military tactics, climate impact, military operations, meteorological data, aviation forecasts, success factors, security, strategic planning, military practice.

## Introduction

Meteorology – in the modern era, radiological, chemical, and biological threats (RCB threats) may arise not only as a result of military conflicts, but also due to technological accidents, terrorist actions, and natural disasters. The role of meteorology in effectively responding to such threats is extremely important. Studying atmospheric processes, analyzing the movement and spread of air masses are key factors in determining how and in which direction RCB substances will disperse.



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## **Meteorology and military planning**

The effectiveness of military operations largely depends on weather conditions. For example:

In aviation operations, wind direction and speed, fog, pressure, humidity, temperature, and cloudiness levels are critical.

In artillery and missile firing, atmospheric pressure, wind, and humidity influence deviations, affecting the trajectory and accuracy of shells.

**Meteorology and radiological–chemical protection**

During a nuclear explosion or an accident at a nuclear power plant, radionuclides released into the atmosphere can spread across large areas. Here, wind direction and speed, atmospheric pressure, humidity, and other meteorological factors play a decisive role. For example, during the 1986 Chernobyl disaster, meteorological conditions played a crucial role in the spread of radiation across Europe. Meteorology is an essential tool in predicting the movement of the radioactive cloud, organizing evacuation efforts, and assessing the level of contamination.

Toxic chemical substances (such as ammonia, chlorine, phosgene, etc.) can also spread through the air due to technological accidents or military actions. Meteorological data is the primary factor in determining their direction of spread and the area affected.

Temperature inversion can cause toxic gases to accumulate in lower layers of the atmosphere, increasing their harmful effects on humans. Likewise, wind speed and direction determine the radius of dispersion.

Biological agents (bacteria, viruses, fungal spores) may also spread through the air. Meteorological conditions—especially air temperature, humidity, and wind—determine their survivability and ability to spread. For example, sunlight (UV radiation) reduces viral activity, while wind can transport them long distances.

Using meteorological models to predict biological risks helps identify potentially contaminated areas and warn the population.

**Meteorological factors in troop movement**

The condition of the ground (sunny, rainy, snowy, icy) is extremely important for the movement of infantry and armored forces.

**Meteorological reconnaissance and satellites**

Today, the military has special meteorological reconnaissance systems that:



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provide real-time weather data;

help determine flight trajectories for drones and missile systems;

enable large-scale weather monitoring through satellites.

Satellite data can be used to conceal or expose enemy movements, and to exploit foggy, snowy, or rainy weather for strategic purposes.

Modern weapons and weather effects

The following modern weapons are heavily influenced by meteorological conditions:

Ballistic and cruise missiles – wind and atmospheric pressure affect their trajectory;

Drones (UAVs) – temperature, wind, and humidity influence flight time and accuracy;

Laser weapons and electronic warfare systems – weather (especially fog and rain) reduces their effectiveness.

Meteorology as a tactical advantage

Correct analysis and use of meteorological data on the battlefield:

allows striking the enemy at unexpected times and directions;

helps select effective timings for attack and defense;

enables concealment of equipment in poor or complex weather conditions.

Example: Wind turbulence

To understand the role of meteorology in modern armed conflicts, the example of turbulent wind (wind rose) is highly important. Turbulent wind is a rapidly and irregularly changing air flow, which significantly affects the effectiveness of weapons on the battlefield.

For example, an artillery shell or ballistic missile passes through turbulent wind during its flight. If wind speed and direction change rapidly, this deflects the weapon's trajectory and significantly reduces its accuracy. Even modern radars and navigation systems require reliable meteorological data.

Meteorologists use special monitoring stations and satellite data to study turbulent wind and its impact on military operations. For example, in a 2020 military exercise, the U.S. military achieved a 30% increase in artillery accuracy by using special models that accounted for turbulent wind.



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Thus, accounting for wind turbulence helps optimize tactics and weapons use, ensuring success in combat operations.

Interpretation of results (briefly)

Time series (turbulence\_time\_series.png) – shows rapid fluctuations (gusts) around the mean wind; these can influence artillery or drone trajectories in real time.

PSD (turbulence\_psd.png) – energy is concentrated at low frequencies, and a 5/3 inertial range appears in the middle, consistent with classical turbulence theory.

Vertical profile (turbulence\_profile.png) – turbulence intensity is high near the surface and decreases with altitude; important for drone flights and parachute operations.

Histogram (turbulence\_hist.png) – distribution of wind deviations; shows the likelihood of extreme gusts.

Additional recommendations (for military use)

When calculating artillery firing or missile trajectories, incorporating real-time meteorological data and spectral characteristics can reduce negative impacts.

In drone and UAV navigation, considering the vertical profile of turbulence (especially shear and boundary layers) is essential for flight planning.

Practical applications of meteorology in RCB protection

Meteorological data is used in the following areas:

Assessment of RCB threats – models are created to simulate the spread of hazardous substances.

Evacuation and rescue operations – planning danger zones and evacuation routes based on weather conditions.

Warning systems – informing populations in potentially hazardous areas on time.

Simulations and drills – using meteorological models for preparedness against RCB scenarios.

## **Conclusion**

Meteorology plays a strategic role in combating radiological, chemical, and biological threats. Accurate evaluation and forecasting of atmospheric conditions help save lives and prevent large-scale disasters. Therefore, all agencies and



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organizations working in RCB protection must closely cooperate with meteorology specialists.

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