Environmental Forecasting

There are a number of natural and anthropogenic phenomena, causing the emission of passive or reactive compounds into the atmosphere. These phenomena have a serious negative impact on the environment and human health. Modeling the air dispersion of pollutants helps to estimate the negative effects of such emissions in order to make decisions in critical situations. Therefore, the development and operational implementation of these models is an important task for government organizations and scientific communities.

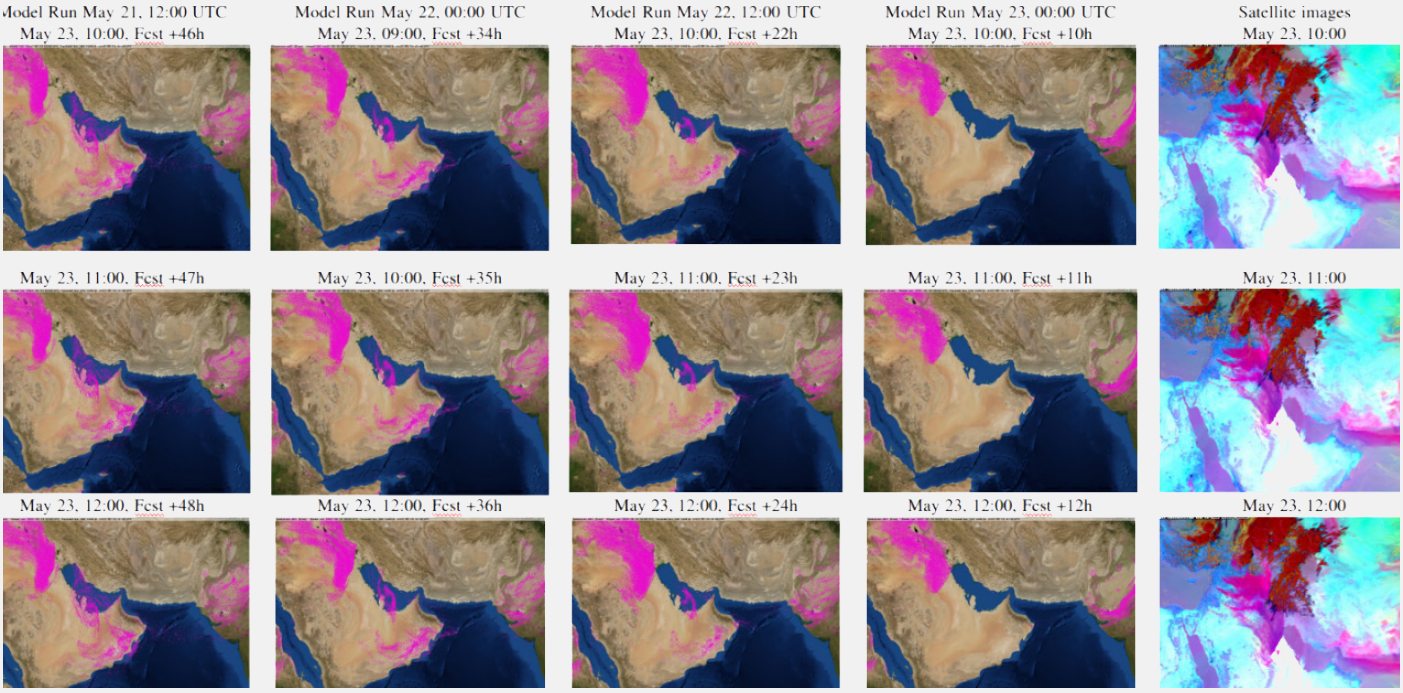
Dispersion models differ by calculations they use, but they all require data input, which may include:

- Meteorological conditions: wind speed and direction, atmospheric turbulence (characterized by the so-called "stability class"), air temperature, the height of the lower boundary of the inversion layer, cloudiness, and solar radiation;
- Release source parameters: location, height, type of source, pollutant release rate, release temperature, and intensity;
- Terrain elevations at the source location and at the receptor site(s), such as near homes, schools, businesses, and hospitals;
- Location, height, and width of any obstacles in the trajectory of the released pollution plume, surface roughness.

In MicroStep-MIS, the **IMS4 Model Suite system** is designed to predict the transport of pollutants in the atmosphere. The core of this system are two numerical models:

1. FLEXPART is used for forecasting the long-range transport of dust and radionuclides.
2. CALPUFF is used to predict air quality in near (< 50 km) and far (> 50 km) zones from the pollution source.

FLEXPART ("FLEXible PARTicle dispersion model") is a Lagrangian dispersion model suitable for modeling a wide range of atmospheric transport processes. In addition to transport and turbulent diffusion, it is capable to calculate dry and wet deposition, radioactive decay, and linear chemistry. The FLEXPART model can be used in direct or reverse modes, with specified emission source parameters or with initial

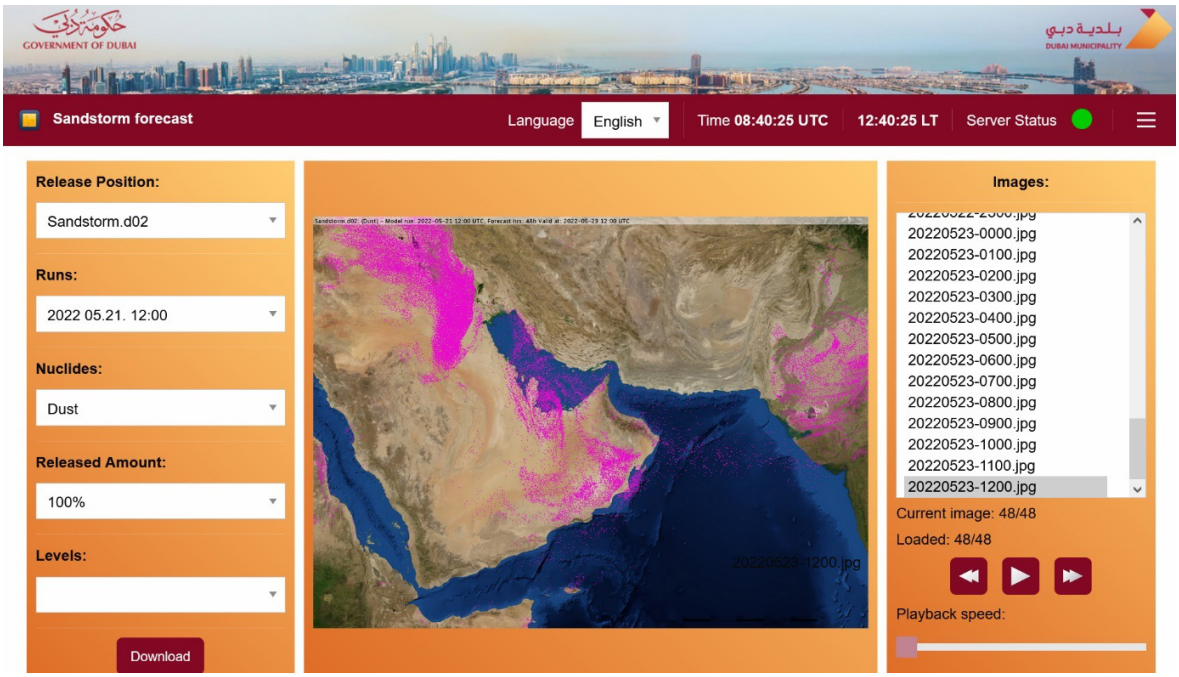


Comparison of severe dust storm forecast (developed by MicroStep-MIS) with satellite data

conditions obtained from an external (e.g. Barcelona Dust center) model. FLEXPART is applied at a wide range of spatial scales, from local to global. The model is open source, which allows making the necessary changes to the model.

For applications involving atmospheric dust transport, the amount of airborne dust can be calculated in the FLEXDUST preprocessing module based on the critical velocities for each land use or can be derived from an external model. The FLEXPART model is able to predict aerosol concentrations of various sizes: PM10, PM5, PM3.5, PM2.5, and PM1.0. It is also used in MicroStep-MIS to predict the transport of radionuclides: ^{134}Cs, ^{137}Cs, ^{131}I, ^{90}Sr, ^{133}Xe, and ^{85}Kr.

CALPUFF is a multilayer non-stationary club Gaussian dispersion model that takes into account the influence of meteorological conditions varying in time and space on the transport of various types of pollutants, such as CO, CO_2, NO_x, SO_2, CH_4, PM10, PM2.5, as well as their transformation, dry and wet deposition. An important advantage of the CALPUFF model is its flexibility, which implies the model usage for different regions of the Earth, including regions with complex

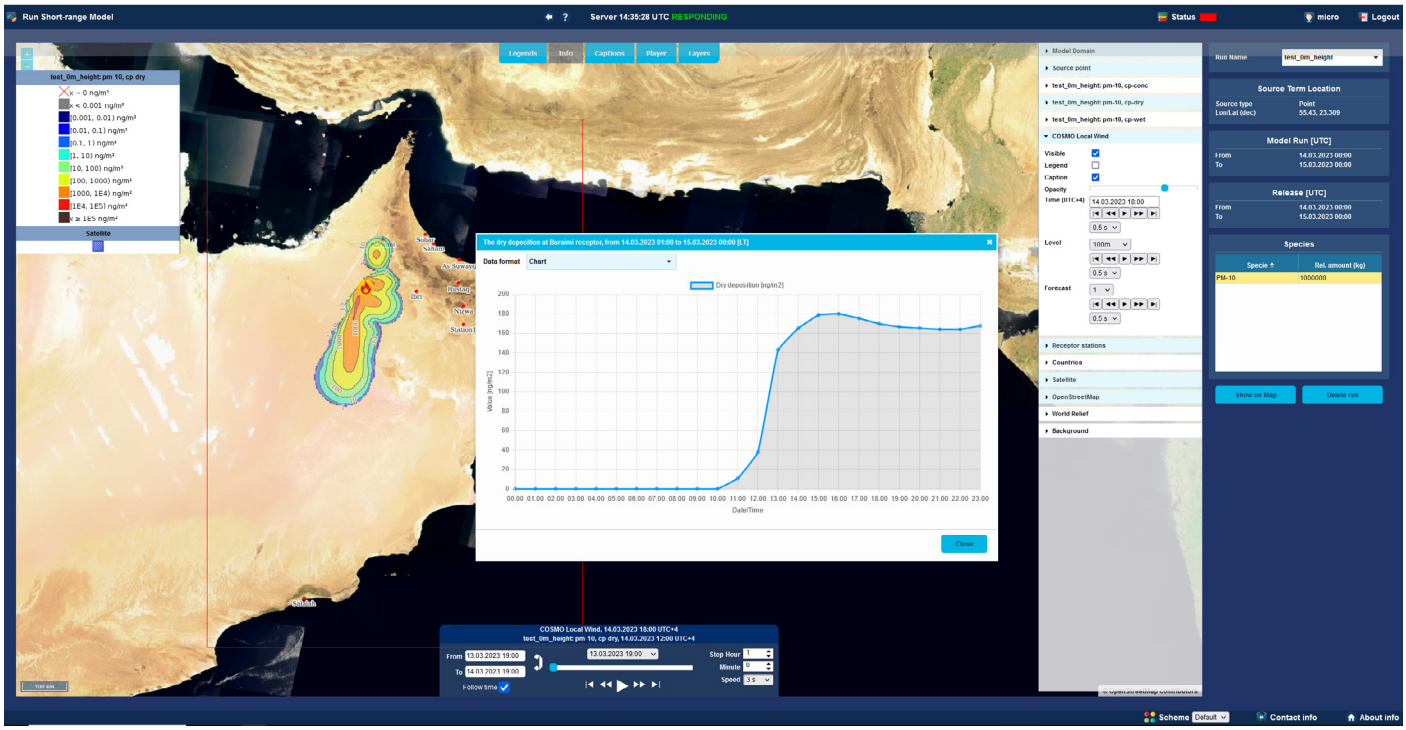


Regular forecast of dust storms (for Dubai Municipality)

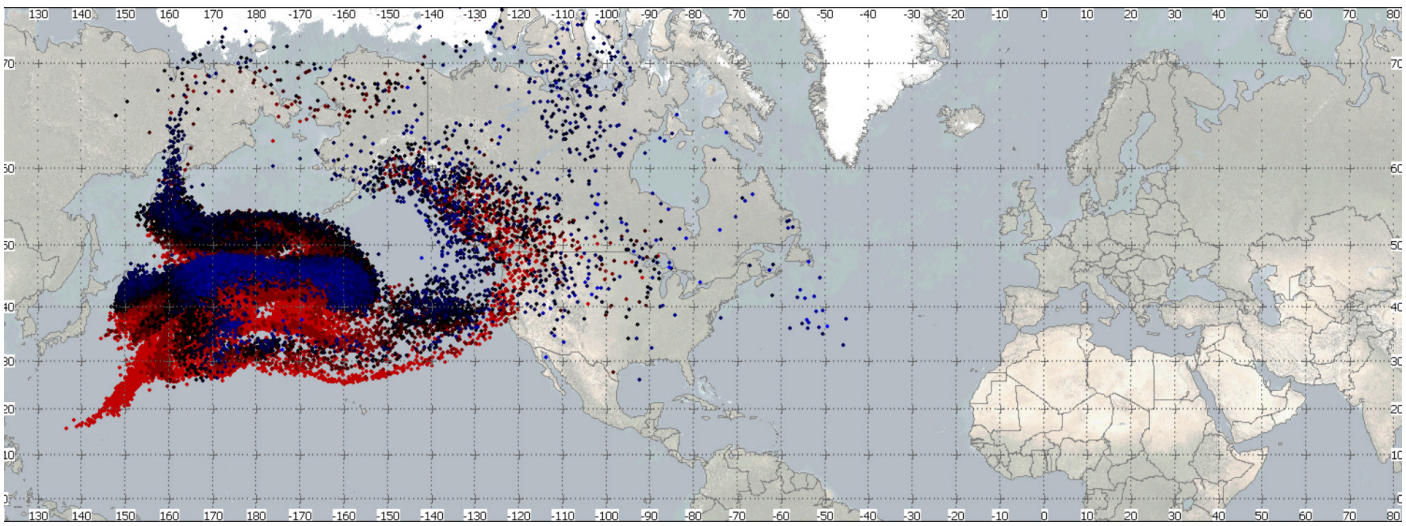
topography, on different spatio-temporal scales, and with different emission source parameters. The CALPUFF model is compatible with various types of meteorological products. The following can be used as meteorological forcing in CALPUFF:

- Atmospheric model forecast fields, such as WRF-ARW or COSMO;
- Observational data from a network of meteorological stations;
- Combined data from atmospheric model calculations and observations from a network of meteorological stations.

In addition to the FLEXPART and CALPUFF models themselves, the IMS4 Model Suite provides users with a wide range of options for setting personalized pollution parameters such as the coordinates and type of release source, release height, e.g. transfer of radionuclides after a severe accident beyond design basis (caused by events not included in accident strategy) at a nuclear power plant. The graphical interface greatly simplifies the work with the system for users. The Pollutant Transport Prediction Module also includes tools for visualizing simulation results in the form of 2D pollutant concentration plots, animations to track plume evolution over time and space, etc.



Planning of accident scenario in IMS4 Model Suite



Radioactive polution descrtibtion from Fukushima accident