Numerical Weather Prediction at the Deutscher Wetterdienst

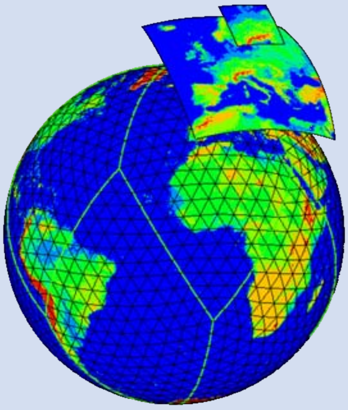
Global Model
GME

Operational hydrostatic global model

Icosahedral-hexagonal grid

Mesh size ~ 30 km, 655362 grid points/layer
60 layers, top layer at 5 hPa

Prognostic variables:
$u, v, T, p_s, q_v, q_c, q_i, q_r, q_s, O_3$



Structure of GME grid and model domains of COSMO-EU and COSMO-DE.

Regional Models
COSMO-EU

Operational non-hydrostatic, fully compressible limited area model

Rotated latitude-longitude grid

Mesh size ~ 7 km, 665 x 657 grid points/layer
40 layers, top layer at 22 km above mean sea level

Prognostic variables:
$u, v, w, T, p', q_v, q_c, q_i, q_r, q_s$, TKE

COSMO-DE

Model for very short-range NWP with rapid update cycle

Data assimilation including radar data (via LHN)
Runge-Kutta 3rd order (2 time level) time-splitting scheme
5th order upwind horizontal advection
6-class cloud microphysics scheme
No parameterization of deep convection

Mesh size ~ 2.8 km, 421 x 461 grid points/layer
50 layers, top layer at 22 km above mean sea level

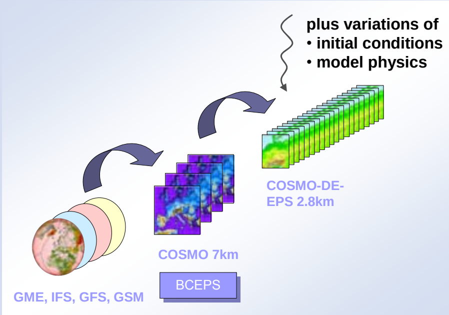
Prognostic variables:
$u, v, w, T', p', q_v, q_c, q_i, q_r, q_s, q_g$, TKE

Convective-scale Ensemble
COSMO-DE-EPS

Pre-operational ensemble prediction system based on model COSMO-DE

20 ensemble members

- lateral boundaries by different global models
- COSMO-DE initial conditions modified by different global models
- several configurations of COSMO-DE model physics



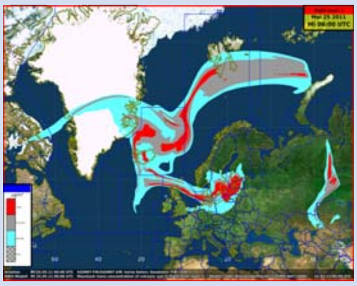
Ensemble chain of COSMO-DE-EPS

COSMO-ART
(Eruption of volcano Grimsvötn in Iceland)

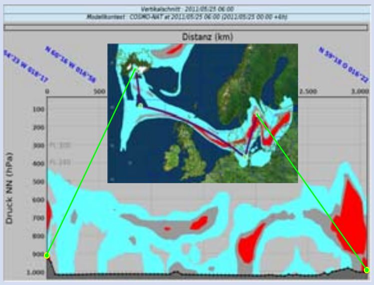
Fully coupled environmental modeling at DWD is based on the COSMO-ART (Aerosols, Reactive Trace gases) system which has been developed at the Karlsruhe Institute of Technology (KIT).

Accompanying the eruption of the Icelandic volcano Grimsvötn, simulations of the dispersion of the volcanic ash plume over Europe were performed at DWD. The emission of volcanic ash was parameterized for six different monodisperse ash particle classes with diameters in the range from 1 to 30 µm. The source height and strength was continuously adjusted to the observed situation.

The simulations take into account advective and parameterized convective transport, turbulent diffusion, sedimentation, deposition at the ground and washout due to precipitation.



Maximum mass concentration of volcanic ash in the layer between the surface and flight level 200 (approx. 6100 m above ground).

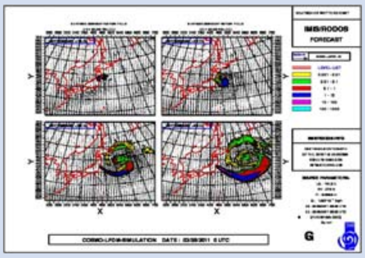


Vertical cross section of the mass concentration of volcanic ash along an arbitrary flight track within the plume.

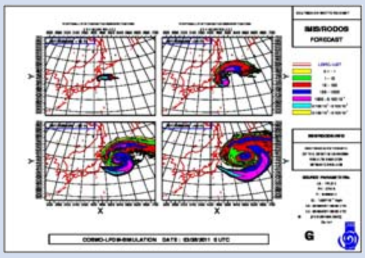
LPDM - Lagrangian Particle Dispersion Model
(Accident at Fukushima nuclear power plant)

As a part of the German radioactive emergency systems IMIS/RODOS a Lagrangian Particle Dispersion Model (LPDM) calculates trajectories of a multitude of particles emitted from a point source using the grid-scale winds and turbulence parameters of the NWP-model and a time scale based Markov-chain formulation for the dispersion process. Dry deposition parameterisation follows a deposition velocity concept and wet deposition is evaluated using isotope-specific scavenging coefficients. Also included is radioactive decay, a vertical mixing scheme for deep convection processes and optionally particle-size depending sedimentation coefficients.

During the release phase of the Fukushima accident (March/April 2011) DWD provided dispersion forecasts for the public mainly based on GME data. Additionally, a COSMO model (with a 7-km grid spacing) was run in an experimental mode for the relevant region covering Japan and its surroundings.



Simulated COSMO-LPDM nuclide concentrations near the surface (0 – 500 m) for different forecast ranges based on the COSMO forecast from 25 March 2011 00 UTC .



Simulated COSMO-LPDM nuclide concentrations in the free atmosphere (vertically integrated from the surface to the model top).