

IMS4 Model Suite

Complex Monitoring and Forecasting Suite

The IMS4 Model Suite provides a composition of modern models and simulation technologies for meteorology, hydrology, radiation and air quality. Models run both operatively and in research mode. IMS4 Model Suite is an integrated, easy-to-use, powerful system for modeling, processing, visualisation and model validation.



Radiation and pollutant crisis modeling



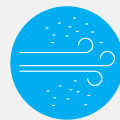
Road condition modeling



High resolution, short term weather forecasting and nowcasting



Visibility modeling



Sand storm modeling

IMS4 Model Suite is a complex system for supporting forecasters as well as crisis managers. Its application ranges from regular daily forecasting purposes to decision support in emergency.

Supported models:

- **Numerical Weather Prediction:** 3D regional weather prediction model capable of high resolution forecast (non-hydrostatic option)
- **Nowcasting** integrating radar, satellite and field data

- **Dispersion Models** for modeling of pollutant and radioactivity dispersion in several scales from high resolution local to continental
- **Road/Runway Condition Model** for short term forecasting of temperature and state of road/runway
- **Fog Prediction:** 1D nowcasting and short term prediction model
- **IMS4 Model Suite Center** seamlessly interfaces data sources (UDCS, EnviDB), checks data quality, schedules regular runs of model cascade, allows for manual runs,

provides model configuration interfaces and exports data to visualization tools

- **Tide Model:** tidal analysis and prediction
- **Wave Model** for operational ocean wave predictions
- **Dust/Sand Dispersion Model** for dust load and sandstorm modeling
- **Hydrological Modeling:** rainfall-runoff or 1-D/2-D hydraulic modeling, flash floods

Tools and services:

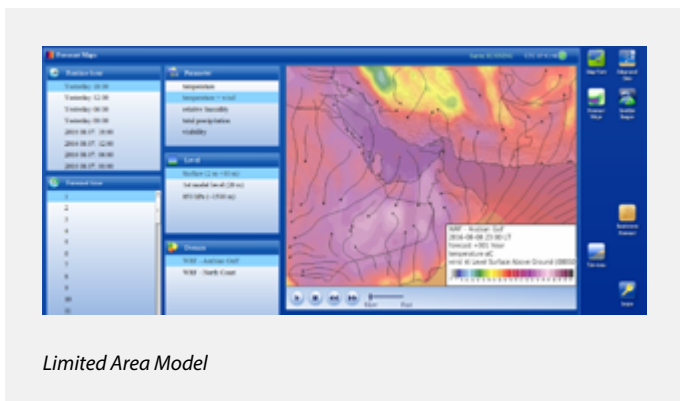
- **Visualisation, map services**
- **Doses calculation** for events encompassing radioactive materials
- **Model Validation Tools** for easy monitoring of simulation quality
- **High Performance Computing:** installation and support of servers centers for demanding meteorological simulations
- **Basic and Advanced Training, Support, System monitoring**
- **Data mining:** training neural networks, inducing decision trees, application to hydro-meteorological systems

The main users of the system are usually meteorologists, hydrologists or authorities responsible for the crisis management at local, regional or national levels. The optional subsystems include but are not limited to call center with digital recording systems, GIS, warning and notification systems.

The models and data bases comply with international standards in the respective areas, however they can be customized to meet the geographical, climatic, environmental as well as organizational specifics of the customer.

Numerical Weather Prediction Models

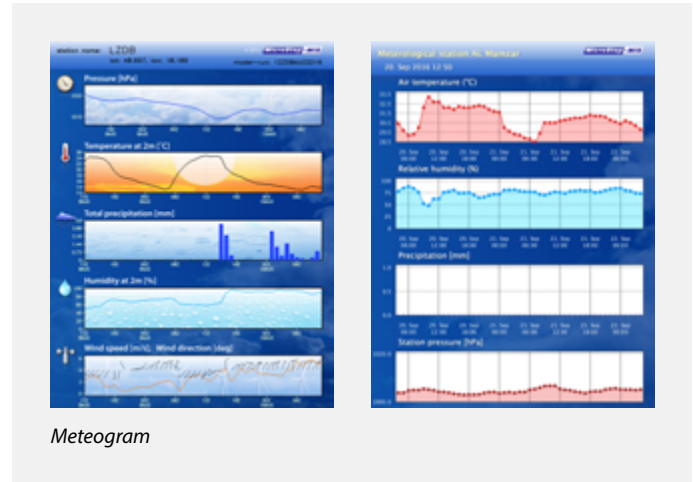
NWP Model provides forecast of different parameters (temperature, humidity, precipitation, etc.) on 3D grid, using the newest physical and numerical approach. Model is highly tunable to fulfill demands in different regions.



Limited Area Model

MicroStep-MIS skilled team of meteorologists is able to provide support in tuning the model as well as evaluation of the statistical achievement.

Visualization of model outputs can be set up to easy interpretation without deep knowledge of meteorology (easy map presentation, meteograms) or for more complex study in different meteorological formats (GRIB, netCDF).



Meteogram

Dispersion models

These modules incorporate the dispersion models for simulation of release and dispersion of pollutant (radioactive or non-radioactive) in atmosphere.

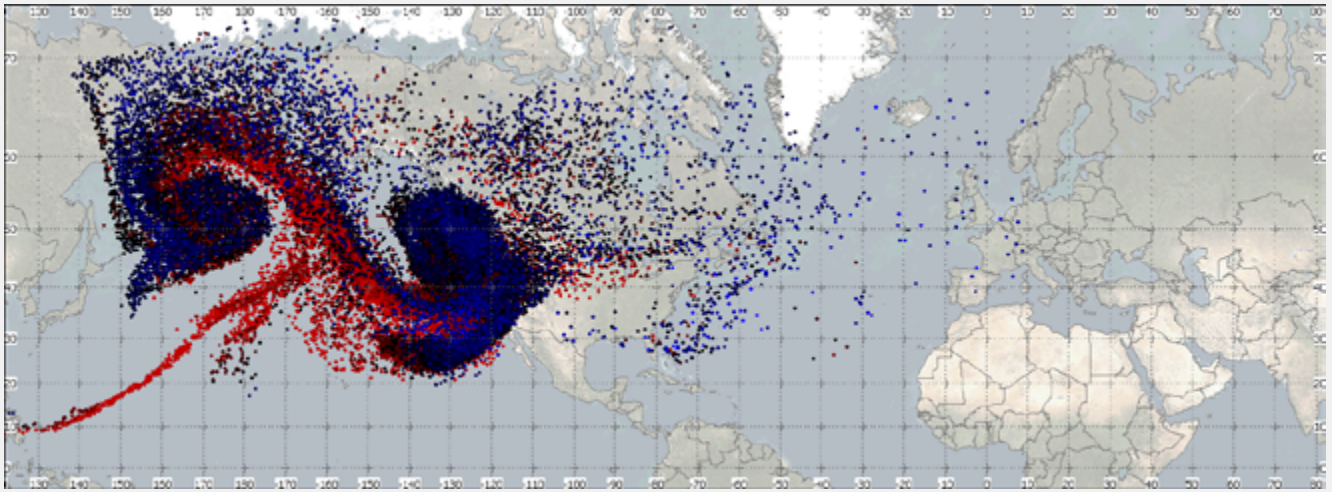
Performance

- Short or long range atmospheric transport and diffusion under changing weather conditions, wet and dry deposition
- Radioactive decay (if applicable)
- Continuous or Short-Term Release
- Planetary boundary layer concepts
- Simultaneous emission of multiple pollutant species
- Pre-defined source terms, accident and release scenarios
- GUI integrated decoding and visualization of meteorological data

High resolution dispersion modeling is suitable for simulation of pollutants behavior (radioactive or non-radioactive) near areas of possible dangerous leakages (factories, power stations, ship yards, oil rigs, etc.).

The Model Suite can be used for simulation of probable emergency scenarios:

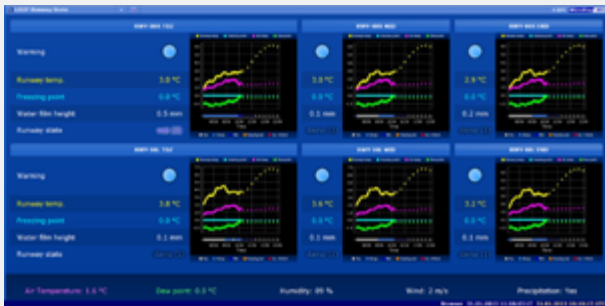
- before an accident (emergency planning)
- at the moment of the accident
- after the accident



Simulation of the Fukushima accident in 2011

Road/runway condition model

Road/Runway Condition Model is suitable for prediction of potential risk on roads or runways caused by winter conditions. Model provides nowcasting and/or short term forecasting of road/runway condition based on radiation and heat budgets. It is very powerful tool for supporting road maintenance during winter season.



Road/Runway Condition Model

Fog prediction approaches

3D meteorological model is executed for a limited region; its outputs are converted using empirical formula into visibility. This approach by itself cannot achieve results of satisfactory quality and common meteorological models can fail to handle inversion weather conditions, which commonly produce fog.

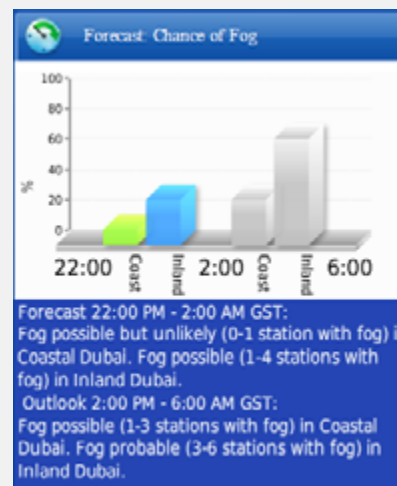
Therefore there are several experimental models in development worldwide, which further process the results of common meteorological model: 1D physical radiation fog modeling methods or statistical post-processing of model outputs and data mining (neural networks, decision trees, etc.).



Dubai without fog



Dubai with fog

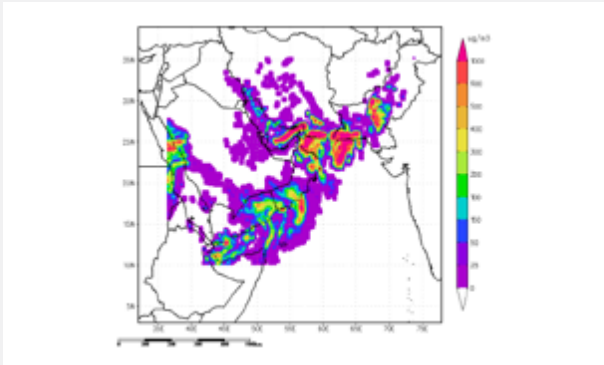


Fog Prediction Approaches

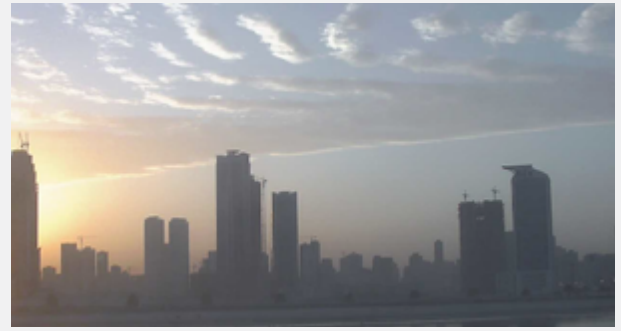
Sandstorm modeling

Sandstorm model is based on the state-of-the-art of the 3D numerical weather prediction and the model for sand uplift, dispersion and deposition.

It is verified against geostationary and polar orbiting satellites, lidar and aerodrome reports. Results of the IMS4 Model Suite Sandstorm prediction system are very promising and indicate that the system will help public prepare for sandstorm events.



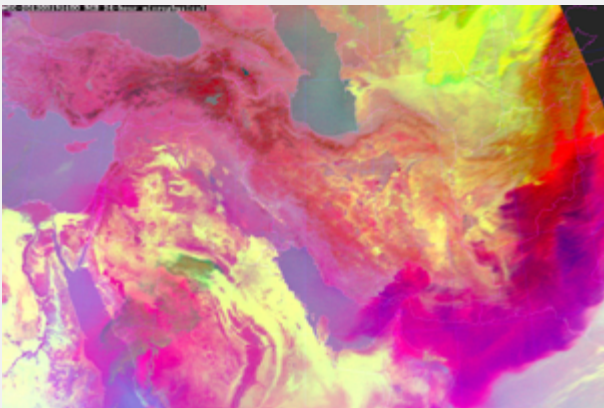
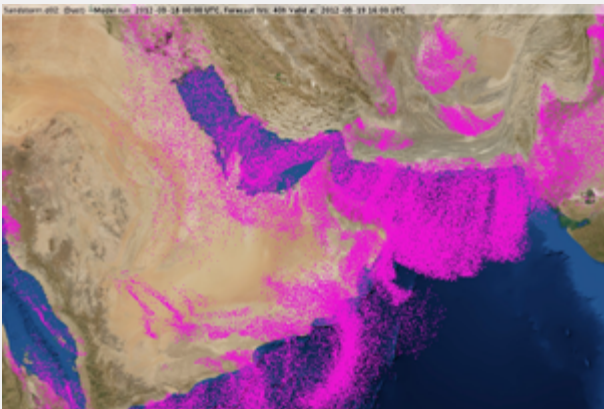
Concentration of dust particles during sandstorm



Dubai without sandstorm



Dubai with sandstorm



The sandstorm predicted by model (purple dots = modeled dust cloud) and the sandstorm on the satellite image (dust cloud appears pink/violet)



Photo of sandstorm

Hydrological modeling

The complex network of models is used for the water level and discharge forecast or 1-D/2-D hydrodynamic calculations. The variety of models is ranging from simple empirical formulas to rainfall-runoff or hydraulic models with deterministic or ensemble data sets. The advanced system for models configuration and management is a part of the IMS4 Model Suite. The data visualization and processing is also fully integrated into the hydrological portal. Following hydrological models have been integrated in order to enable the user to solve wide range of hydrological issues in one forecasting system:

- Models for rainfall-runoff modeling and forecasting (HBV, HYPE, HEC-HMS)
- 1-D/2-D hydraulic modeling and flood hazard mapping (HEC-RAS)

The models provide tools for the modeling of the hydraulic structures such as bridges, culverts, dams, weirs and spillways. The manipulation with these structures can be modeled.

Flash floods

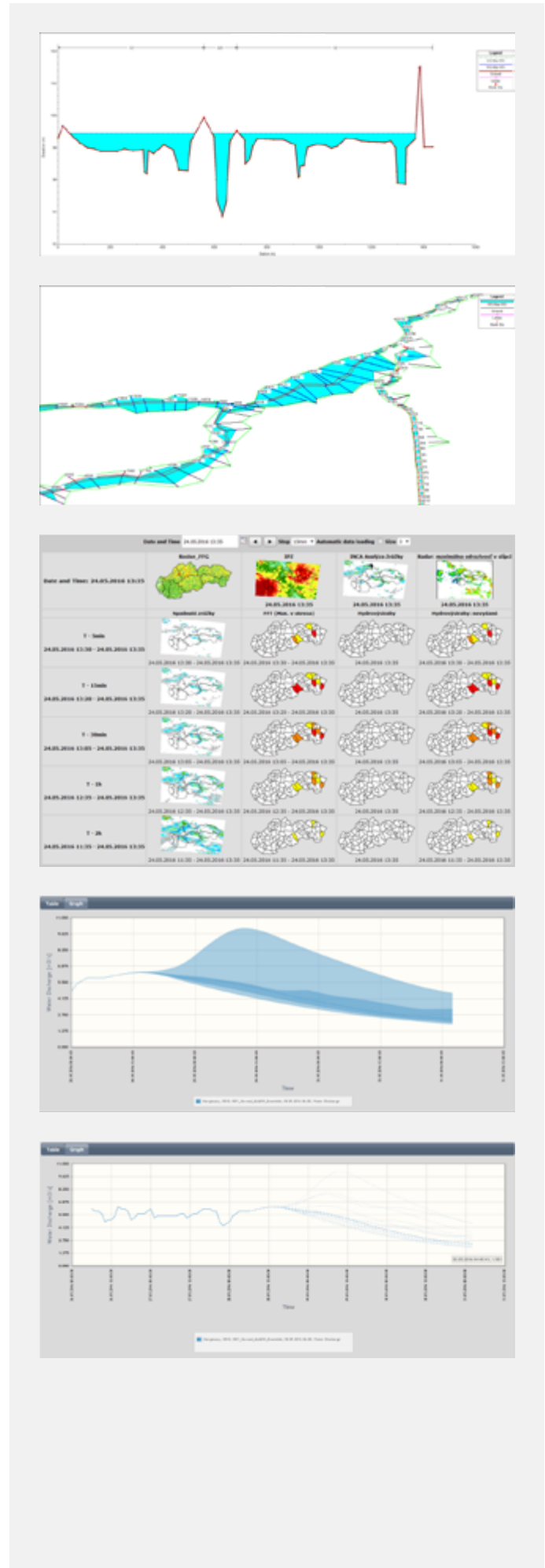
When integrated with the precipitation nowcasting system, IMS4 Model Suite Flash Flood module provides early warnings for the rapidly developing, spatially limited flash floods. The system based on concepts of flash flood guidance and flash flood threat uses the GIS data (terrain slope, land use, soil characteristics) and rainfall data (gauge/radar) and it performs the real-time comparison of observed or forecasted rainfall volume of a given duration at the grid points to a characteristic volume of rainfall for that grid that generates flooding at the particular locations.

Ensemble forecasting

In order to cope with the uncertainty in forecast models (imperfect initial conditions, amplified by the chaotic nature of the evolution equations of the dynamical system, errors introduced due to imperfections in the model formulation, etc.), the IMS4 Model Suite has the built-in support for the ensemble forecasting, including the possibility of the calculation of the ensemble statistics (forecast mean, median/percentiles, etc.).

SNOWSENSE

The snowsense system developed by VISTA company is improving the accuracy of hydrological forecasts in winter conditions. System is combining in field measuring of Snow Water Equivalent (SWE) and the Liquid Water Content (LWC) in snow at all requested locations by a novel GNSS based solution. To provide spatial and temporal continuous



information on the snow cover, the water Balance is calculated using meteorological inputs and the parameters of the land surface by a physically model (PROMET). The direct snow measurements from the SnowSense In-Situ stations and satellite derived spatial snow information are assimilated for exact and reliable results. Calculation of the run-off and aggregated products of hydro-power potential and forecast is optional.

Flood warning system

Flood mitigation requires knowledge of the meteorological and hydrological conditions in the past, at the present and forecast into the future. The complete flood warning system can be provided on a turnkey basis:

- Automatic weather and hydrological stations
- Remote sensing systems
- UDCS / EnviDB – the data acquisition and operational/long

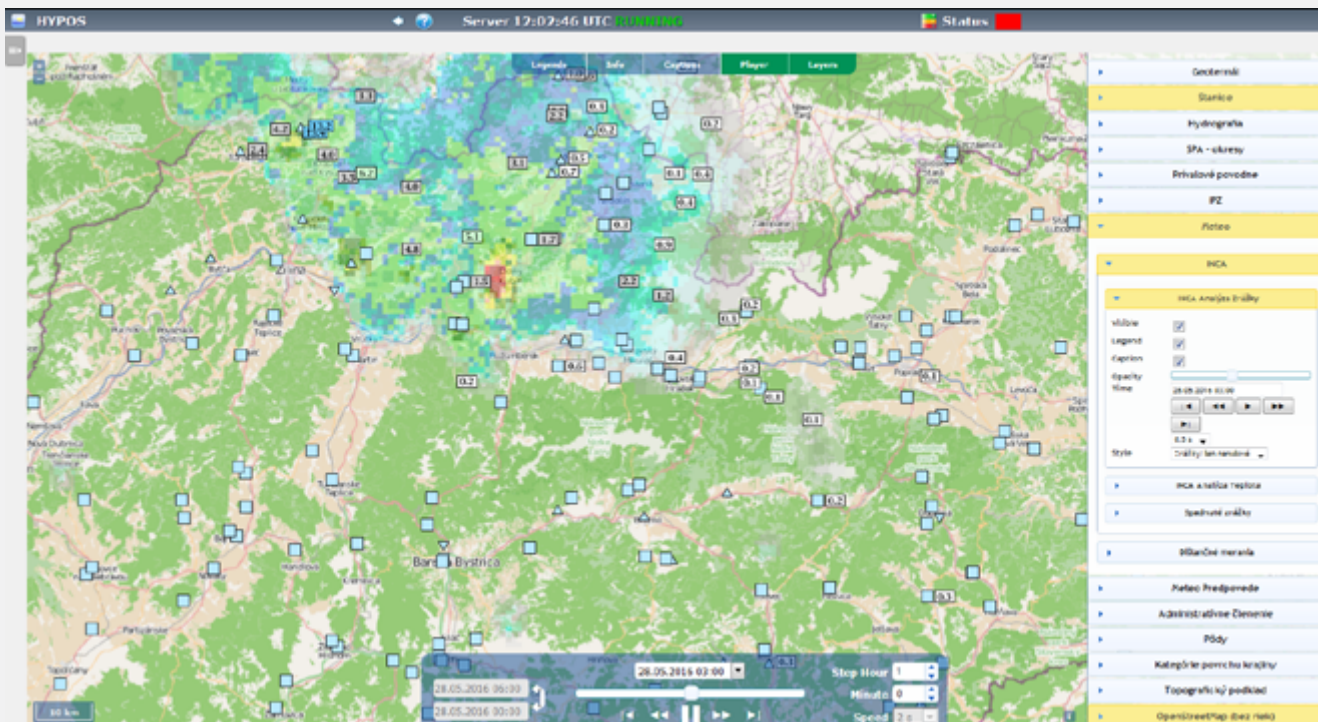
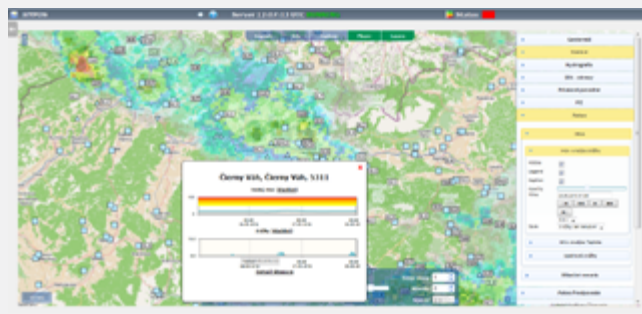
term database

- IMS4 Model Suite – NWP and hydrological models
- Map Server and/or IMS4 Weather Studio – hydrological situation visualization

Map server

Publication of the spatial data using open standards. Implementing the Web Map Service, the maps are created in the variety of formats.

- Connection to the traditional GIS architecture such as ESRI ArcGIS
- Topographic/geographic data
- Station data layer
- Forecast layer
- Meteo data layer – gridded data (models, radars, satellite images)
- “Movie” mode



Integration with IMS4 Weather Studio

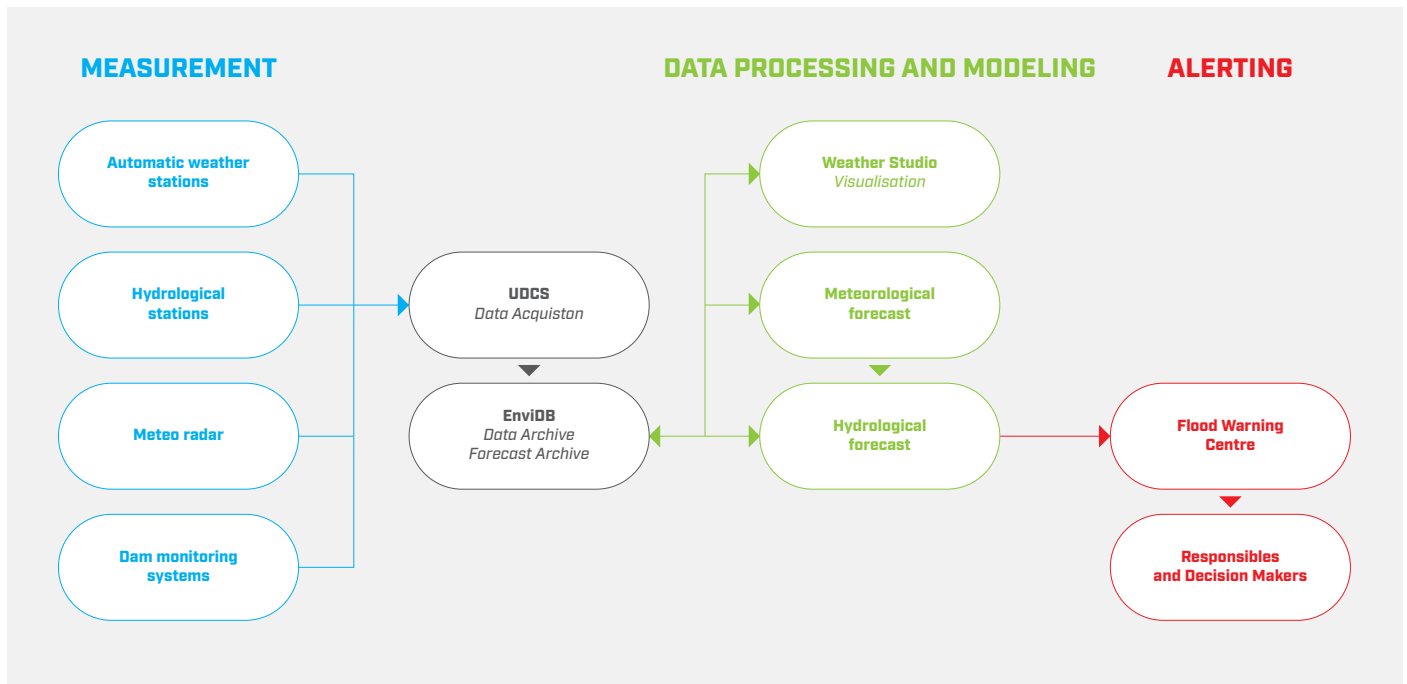
All the IMS4 Model Suite products can be visualized using IMS4 Weather Studio application.

Conformance to standards

IMS Model Suite is in compliance with numerous international/ industrial standards: WMO, ICAO, OGC, etc.:

- Open Geospatial Consortium:

- KML
- NetCDF
- OpenMI
- WaterML
- Web Map Service
- Web Feature Service
- World Meteorological Organization:
 - WMO No. 306 Manual on Codes



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