SmartMet

FMI Weather Information and Forecast Production System

SmartMet – Software Tool for Visualizing and Editing Meteorological Data

1 SmartMet is forecaster’s most important working tool

The purpose of the visualizing and editing software is to provide a tool that can be used to include the forecaster’s knowledge and expertise to the numerical weather forecast model so that this expertise is available for all weather information users.

With SmartMet forecaster can modify the numerical weather model output taking into account all the available observations and the meteorologist’s own expertise. SmartMet includes numerous features and options to facilitate forecaster’s daily work and to ensure that the weather forecasts and products - which are generated from the edited data - have the best quality.

What makes SmartMet unique is that it isn't just a great viewing tool for all meteorological data but it gives the user the possibility to change the model data (i.e. improve data) and to bring out the improved data from parameter to parameter and/or layer to layer as grid formatted information. From these improved grid-files, which the forecaster has edited, it’s possible to create tailor-made weather forecasts for unlimited amount of users in the most economical and efficient way.
2 SmartMet’s features

SmartMet includes the following features.

- Time series editing
- Data modifying with brush tool
- Time-shifting and Smoothing
- Control point editing
- Combination of data from different sources
- SmartTools (a scripting feature)
- MacroParam (create your own parameters and fields)
- Harmonization
- Trajectories
- Sounding editing and visualization
- Vertical cross sections
- Observation and forecast table view
- Create isolines from the observation data
- Forecasters can work simultaneously with same data package

2.1 Data types used in SmartMet

SmartMet is able to use all grid formatted data for example air quality data and numeric weather prediction models (all available levels) e.g. ECMWF-, HIRLAM- and GFS-data. The SmartMet programme gives you the possibility to select which weather prediction model and what time step you are using as a base information on your editing data.

SmartMet can visualize different kinds of observations:

- Satellite data from e.g. EUMETSAT, NOAA and MTSAT satellites
- Observation data such as SYNOP, METAR and SHIP buoys messages and other data from observation systems including automatic weather stations, road weather stations, and precipitation stations
- Data from weather radars
- Data from lightning detection network
- Data from radio soundings, wind profilers and airplane take off and landing profiles
SmartMet reads all required data each time the system is opened and automatically updates all data information when for example new observations or models becomes available on the server.

Due to the reason that SmartMet can use all common meteorological data formats it is easy to install anywhere in the world.

**SmartMet locations**
2.2 Visualization

In different weather situations different weather parameters are in the main role. The software tool enables the user to freely and simultaneously select data from various sources to the same map image and to change the order and the drawing properties of each individual parameter.

Parameter drawing properties:
You can select how single parameters are visualized (isolines, numbers, color contours, symbols, wind vectors and streamlines) and interactively influence to the parameters color scales.
Grid size: You can select a grid of any desired size to the map display. It is possible to set options that range from a 1x1 grid to a 5x10 grid (5 rows and 10 columns).

Time step: SmartMet gives the user an easy way to select the time step between 5 minutes to 48 hours. It is also possible to choose whatever time step you want. The model data will be automatically interpolated to the selected time interval.

Multiple Map views: In SmartMet there are three separate map views that may use independent data which makes comparing different models or following observations same time with model data very easy.
**Vertical cross sections:** It is possible to create vertical cross sections of various parameters between any two optional grid points on the map. The maximum count of visible cross-section views at the same time is five and parameter count in each view is unlimited. At the map display you will see cross-section circles, end points and intermediate points, which are used in cross-section calculations. It is also possible to make a vertical time series to any chosen point.

**Observation tables:** You can simultaneously view observations on the map and on a table so that the selected observation in the table appears highlighted on the map and vice versa.
The table view shows the observations currently visible on the map area in a table. This means that if you have chosen the map area of the whole world the table view lists the synoptical observations of the whole world. However, only one country may be also selected to be viewed. The viewed observation time may be changed and on the table you can sort the table by any parameter column. (e.g. listing the whole world temperature observations from warm to cold).

**Trajectories:** SmartMet gives a user the possibility to create various kinds of trajectories. You can choose the grid point from the map and the height of the air parcel and SmartMet calculates the trajectory of the air from the chosen point and height at the chosen time. All this is done in 3D. SmartMet also gives a scattering of results by chosen probability.

**Soundings:** SmartMet can display both model and observation soundings and you may also overlay two or more soundings to compare them. Also soundings from other sources can be shown if those are available (e.g. wind profiler data and airplane take off and landing profiles) and it is easy to choose skew-T or Emagram display. When the sounding display is on the locations of the sounding observations will appear on the map at sounding times. Model soundings can be chosen at any point and time you want.
SmartMet also calculates automatically most common instability indexes from the data. Soundings may also be edited in space and time and after editing the sounding all stability indexes will be re-calculated.

MacroParameters: By using SmartMet you can visualize self-derived meteorological fields such as accumulated precipitation totals (3h, 6h 12h). With Macroparameters user can calculate new weather parameters from the existing ones and then see them on the map view. Simple example, you can calculate the temperature difference between two models (Formula: RESULT =T_GFS-T_EC calculates surface temperature difference between GFS and ECMWF -models).
Observation comparison:
SmartMe gives a user possibility to revise and follow the forecast against observations and it is easy to see the differences between the observations and the model output.

Animations:
With SmartMet it’s also possible to do animations (e.g. animate pressure field movements). In the animation dialog you can adjust the animation speed, give the starting and ending time and the time step.

View macros:
SmartMet’s workspace settings may be saved as so-called view macros to make working fast and easy. A view macro stores the following information: positions and sizes of all open data viewing windows, the parameters that are presented in them, the drawing properties of the parameters etc. This way user’s own settings may also be shared between other users.
2.3 SmartMet Beta – Image and Video File Production

SmartMet Beta Production tool: SmartMet enables production of image file sequences and video files directly from the map view of the workstation for fast publishing of different kind of weather data animations. Forecaster may select freely the animated data and area as well as animation length and time step. The animations brings additional content into several platforms; Image and video animations may be used in www-pages, mobile applications or in TV and it gives forecaster a good tool for animating for example movement of a severe weather phenomena in social media. Forecaster may freely select when the production is launched and the production may be also automatized. See examples of videos here:

https://www.youtube.com/watch?v=m9dWBuD_mnA
https://www.youtube.com/watch?v=rplQq2Qf0cw

2.4 Editing

The SmartMet Workstation includes versatile possibilities and advanced tools for editing the NWP-data for automated weather forecast production.

Model selection: When SmartMet is opened it gives you a possibility to select which weather prediction model and what time step you are using as a base information on your editing dataset. Forecaster may also blend different models.
Control point modifier: Data can be viewed and edited in the time series view. The time series view shows the time series of a selected point (for example some city) in the map view. It is easy to modify time series, e.g. if you modify single point’s parameters the tool will spread the changes smoothly in time and space to surrounding grid points.

Brush Tool: With brush tool forecaster may simply paint an area of a certain value of a parameter or decrease or increase a value of a parameter.
**Analysis tool:** You may also use analysis tool for example to equalize the difference of the observed and forecasted temperature in a given time window.

**SmartTools:** You can create mathematical/meteorological equations and conditional expressions, familiar from programming languages that can be used for modifying the forecast. This means that the calculations are performed for all the times and locations that you want to use. For example if the wind blows from certain direction it affects the coastal temperatures and you may create an equation to change all coastal temperatures. With SmartTool you may also mix parameters from different models.

**Harmonization tool:** You can also create linked chains that can be used to bring the interdependent parameters in a meteorological balance (e.g. change in precipitation type will affect visibility and change in the temperature affects the dew point temperature).

**Mask:** Masks can restrict modifications done with different tools. You may for example set up a mask for limited area (meteorological or geographical). For example set up a mask for all land areas if you want changes to apply only to land areas.

**Undo/redo:** With the help of the Undo/redo function you can discard unwanted changes made to the data and redo them.
2.5 Several forecasters can work at the same time

With SmartMet several forecasters can work together using the same data set and the editing tool. One of the forecasters has to be “the main forecaster” others are “helpers”. This way a group of forecasters can simultaneously edit same data (for example one edits temperatures, other precipitation, third winds etc.). The main forecaster decides when and how helpers’ data is called in.
SmartMet Weather Forecast Production System – SmartMet Server

SmartMet Server is an on-demand data hub for meteorological, climate & environmental data. It has been in operational use at FMI since 2008 serving over 650 requests per second in peaks. It provides high capacity and availability services for M2M interfaces and user interfaces. INSPIRE harmonized formats were added in 2013 and are currently used for distribution of the open data of Finnish Meteorological Institute and for FMI INSPIRE Services. SmartMet Server sits in the core of the modern day weather service: It has all the necessary building blocks for any modern weather service for disseminating data and forecast products in all essential formats for public or private users.

SmartMet Server provides Open Geospatial Consortium (OGC) compliant services including Web Map Service (WMS), Web Feature Service (WFS) and Web Coverage Service (WCS) as well as Web Processing Service (WPS) style of service. There are also several other interfaces e.g. json and xml to facilitate creation of the mobile and web services.
SmartMet Server can be used as a data delivery service for open or private data. Data can be divided on demand during the delivery, so users can retrieve data only for needed domain, time and parameters.

SmartMet Server has built-in text generating capability. It creates forecast texts from gridded data for any given area and time period and it has specialized texts for general and marine forecasts. Texts can also be customized based on local configurations and may be created for any area such as cities or provinces. Area may be also defined simultaneously with the data acquisition, which means that the end-user can select the area freely from the user interface and see the text forecast for that specific area. Forecasts may be either regional or point-forecasts.
SmartMet Server also enables fully automatized production of graphical and textual products for newspapers. The Products can be customized graphically and they are ready for printing for the customers.

4 Why SmartMet

Finnish Meteorological Institute has developed the system and successfully operated it more than ten years and sold the SmartMet also to other Institutes. Because FMI’s forecasters use SmartMet in every day work it is monitored 24/7 and it can be updated and improved according to forecasters needs.

SmartMet gives you cost-effective and efficient way to create to a large number of customers an unlimited number of tailor-made high quality weather products with limited number of staff.

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