

# Recent development of visualisation at Finnish Meteorological Institute (FMI)

Juha Kilpinen and Annakaisa Sarkanen  
Finnish Meteorological Institute (FMI)  
<http://www.fmi.fi/>



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FINNISH METEOROLOGICAL INSTITUTE

# Recent development of visualisation at Finnish Meteorological Institute (FMI)

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- **Developments in present production system**
  - new features of the grid editor software: SmartTools
  - aviation applications and products
  - some verification results
  - oil spill movement model (customer application)
  - atmospheric dispersion model (customer application)

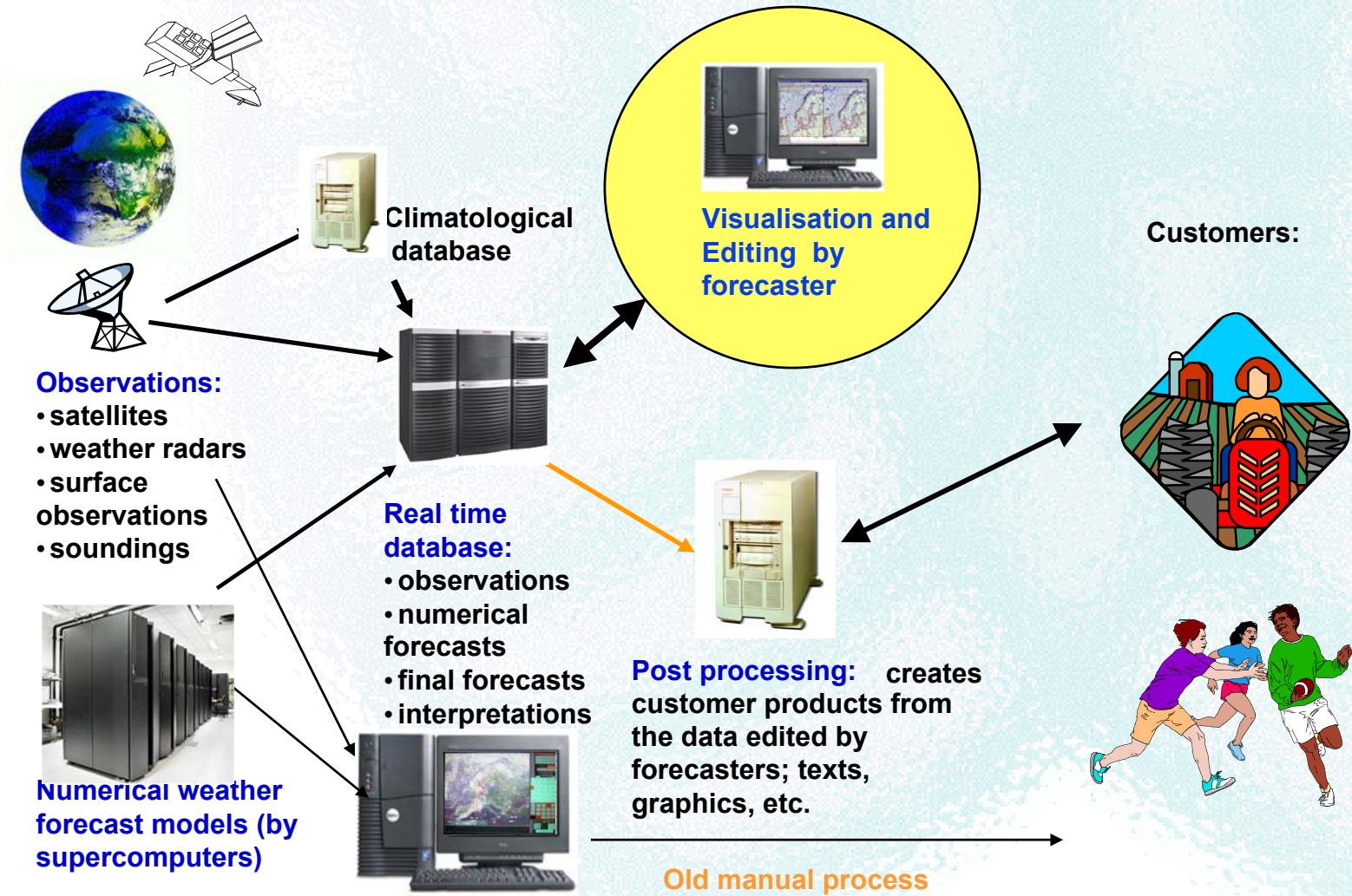


# Background of recent developments at FMI

- **To apply latest technology the forecasting and production process has to be changed (re-engineering, typically the most difficult part)**
- **The migration to new automated production process began at mid 1990's, the work is still continuing;**
- **The core of the new system is the real time database (grid data, observations etc)**
- **The forecasters duty is to keep the quality of data in database in best possible level: the grid editor is used to interact with the data**
- **Most commercial products for customers are made automatically from this data (the number of products is thousands); still the old manual process also in use**



# Forecasting process at FMI (technical aspect)



# Forecasting process at FMI



**Old VAX workstation**

**Old manual forecast process and production still exists:  
Hand drawing of maps, human  
Made text bulletins etc.....**



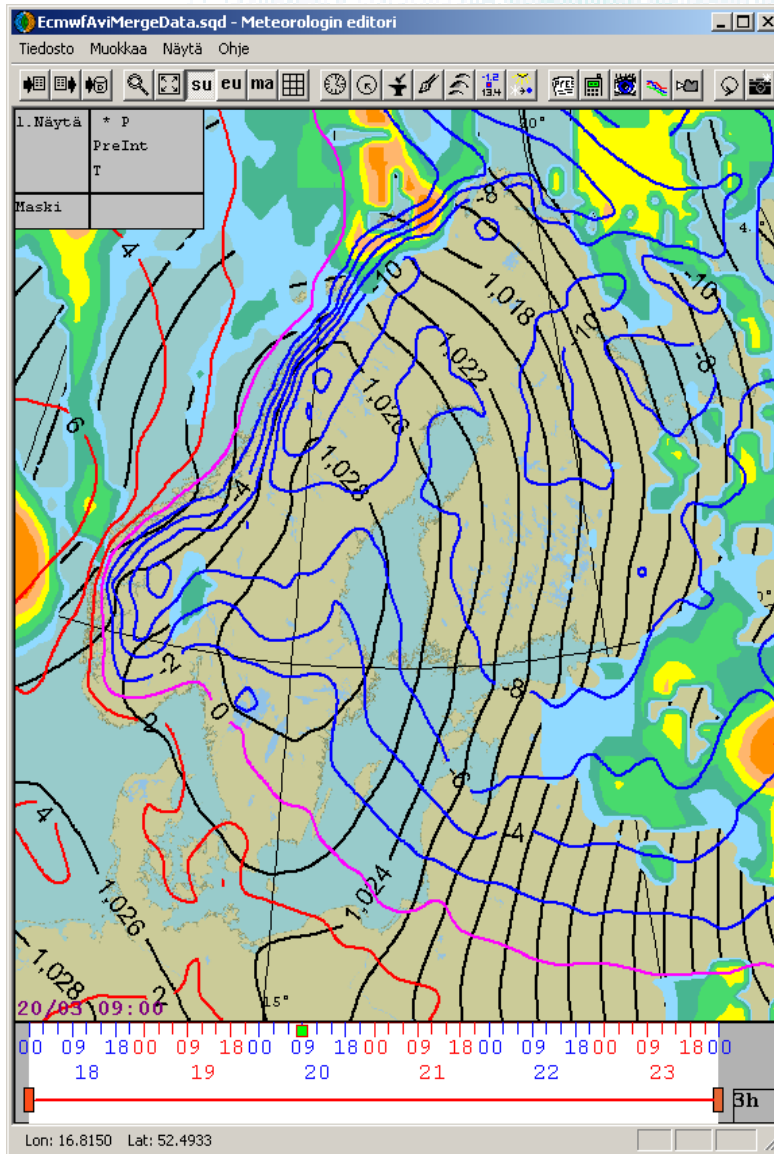
**TAF editor system  
with partly manual  
process**



**New Grid editor system with automated production process**

**The new forecast process expanding:  
integration of TAF-production to edited  
grid data; integration of road condition  
model and forest fire risk model**





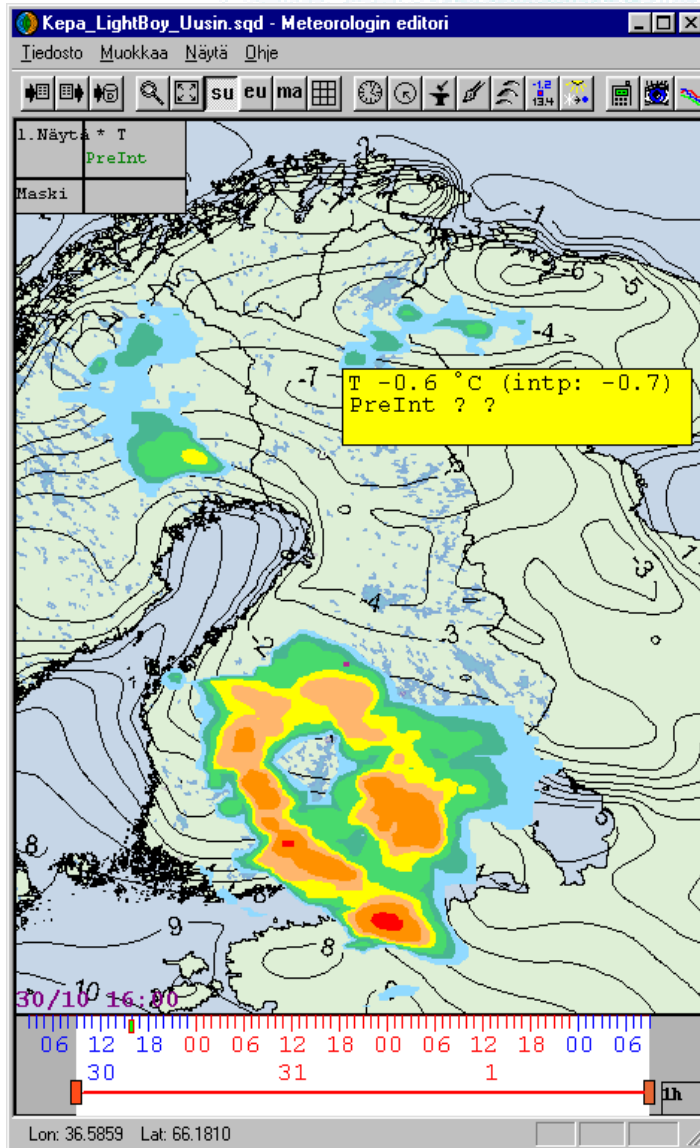
# The Grid Editor

- Time series editing using masks
- Paint brush
- Time-shifting and Smoothing
- Control point editing
- Combination of data from different sources
- Integrated visualisation and product generation
- SmartTools



# The Grid Editor

## Choice of the initial data/model



**Tiedoston lataus**

Ladattavan tiedon valinta

Priorisointi: Meteor Scand 192h

Mallin aktivointi

Hirlam  1  2  3 [dropdown]

Ecmwf  1  2  3 [dropdown]

Omat  1  2  3 [dropdown]

Vir\_192h  1  2  3 [dropdown]

0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180

00 12 00 12 00 12 00 12 00 12 00 12 00 12 00 12

1.4 2.4 3.4 4.4 5.4 6.4 7.4 8.4

Aikainterpolointi/ekstrapolointi  Poista ukkoset latauksen yhteydessä

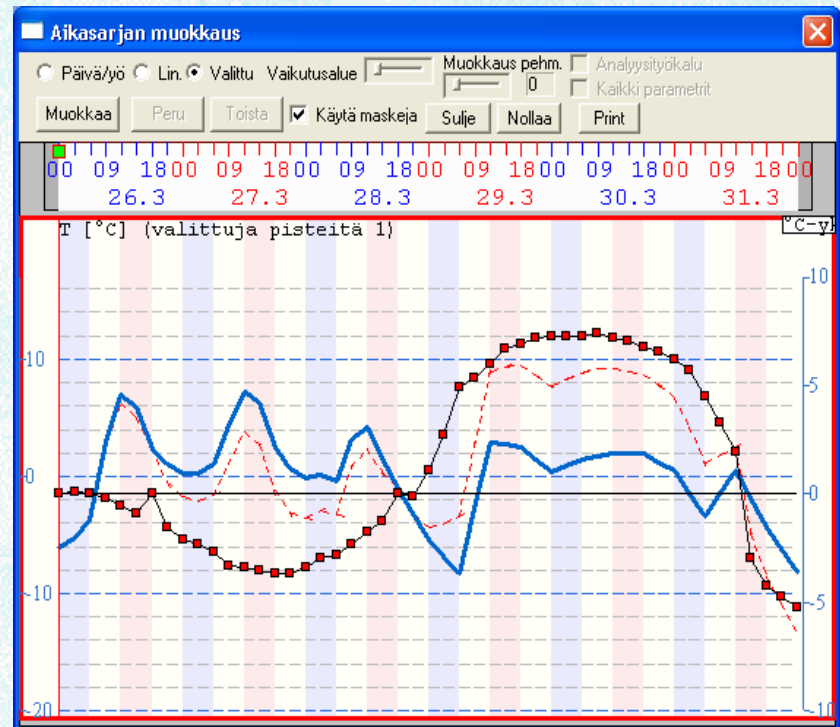
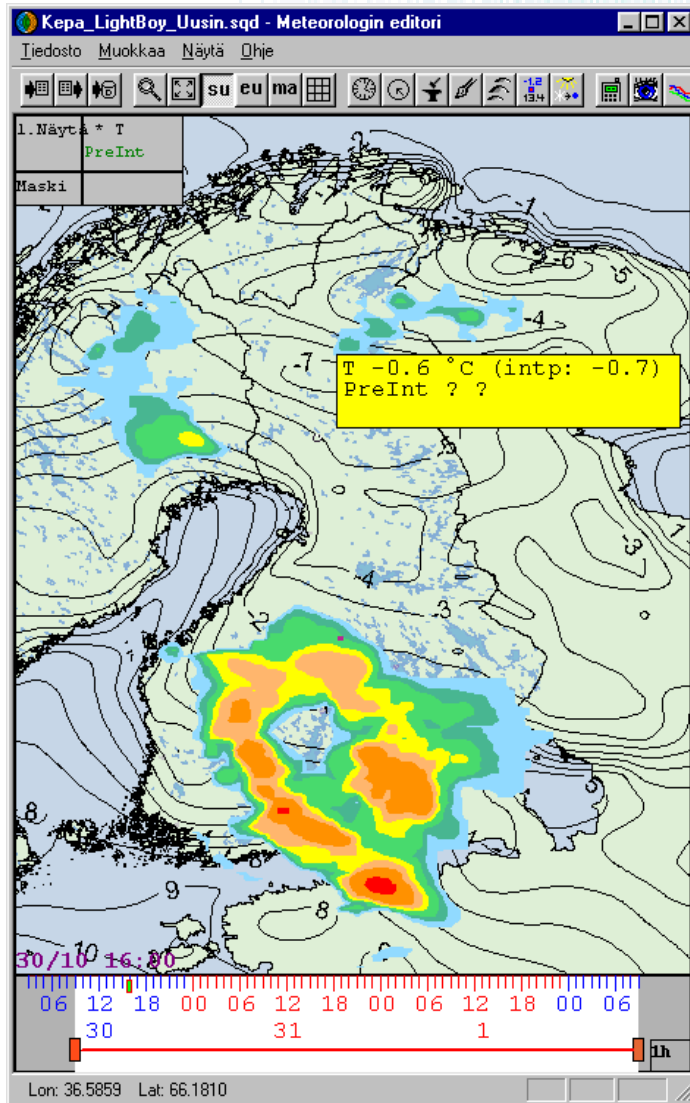
ei  kaikki

Hyväksy Peruuta Talleta asetukset



# The Grid Editor

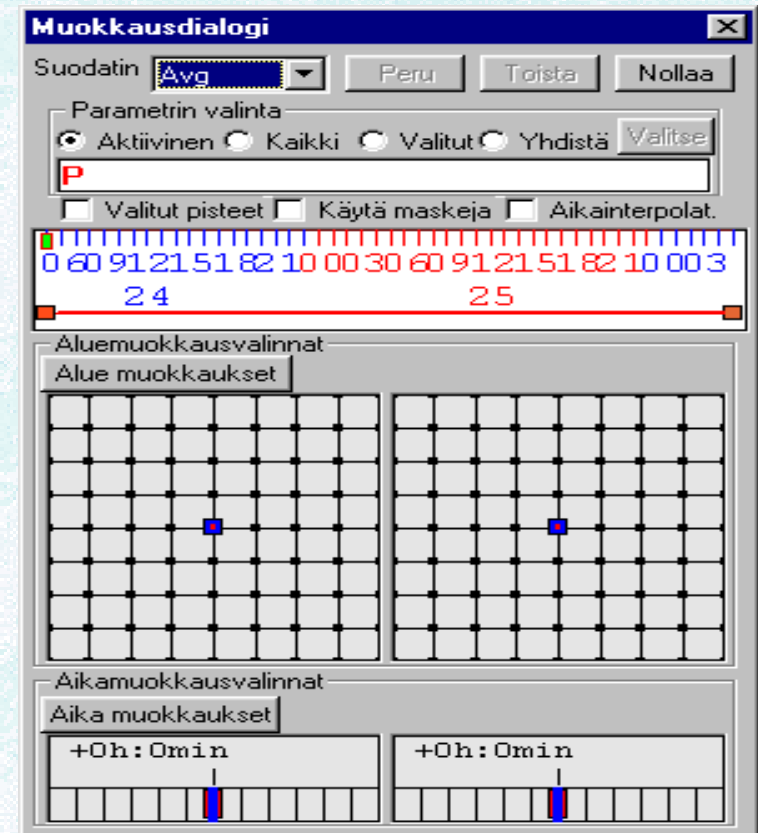
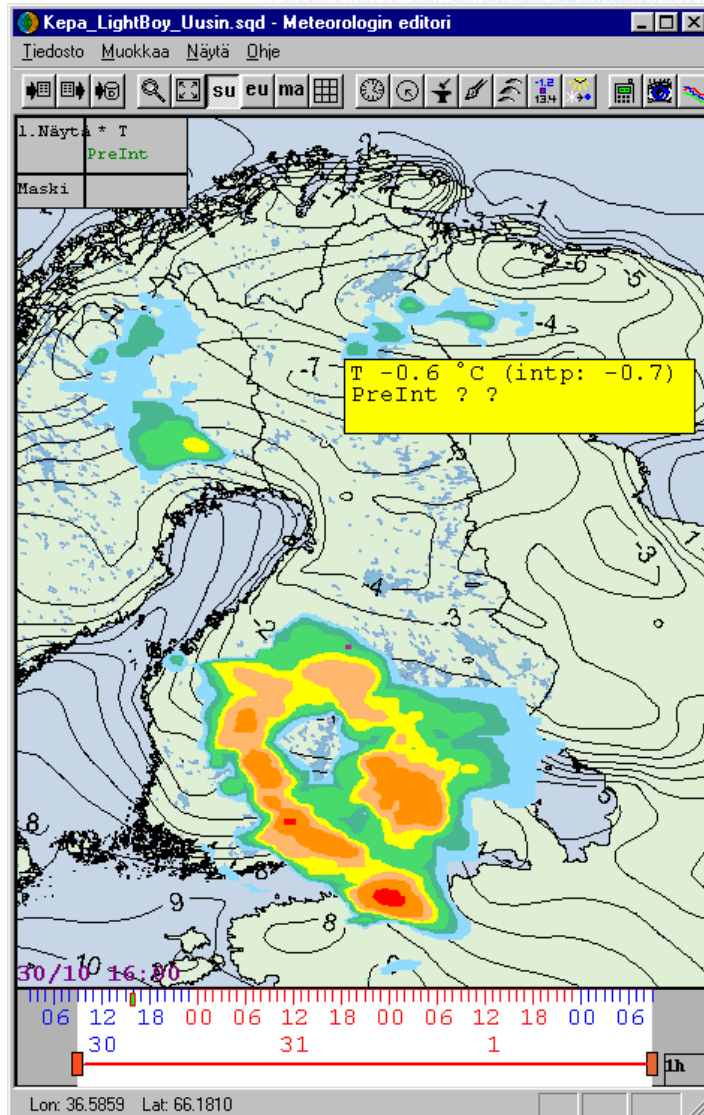
## Time series editing tool

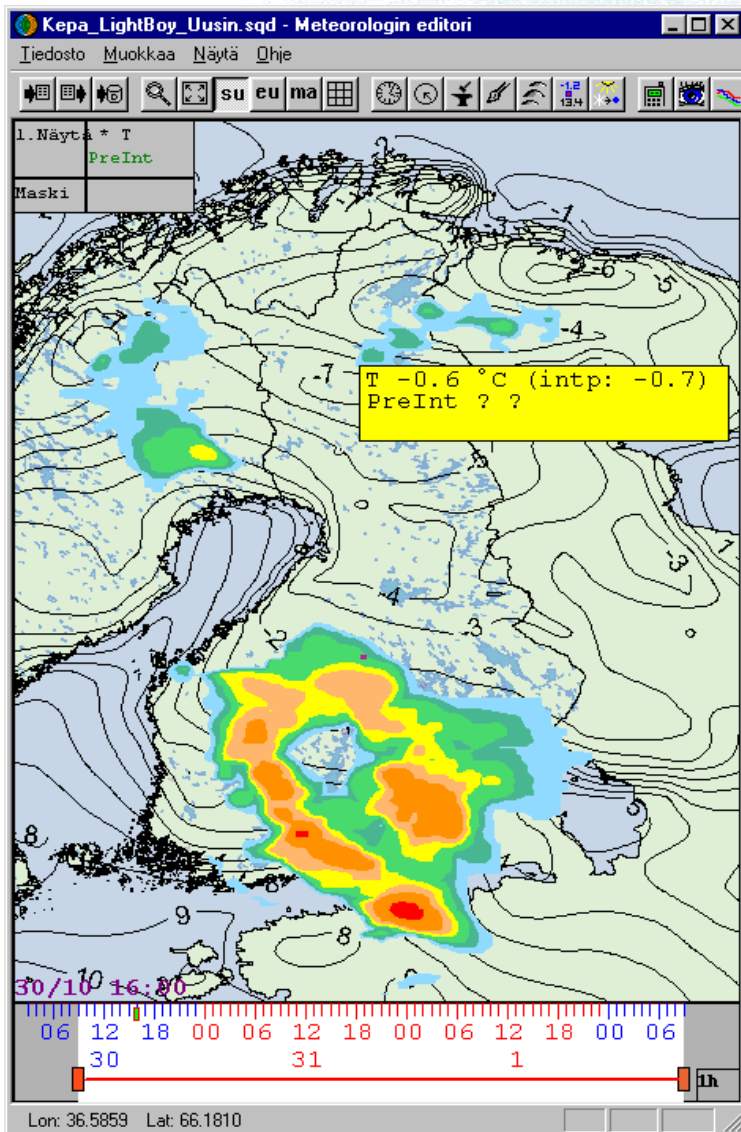




# The Grid Editor

## Grid editing windows

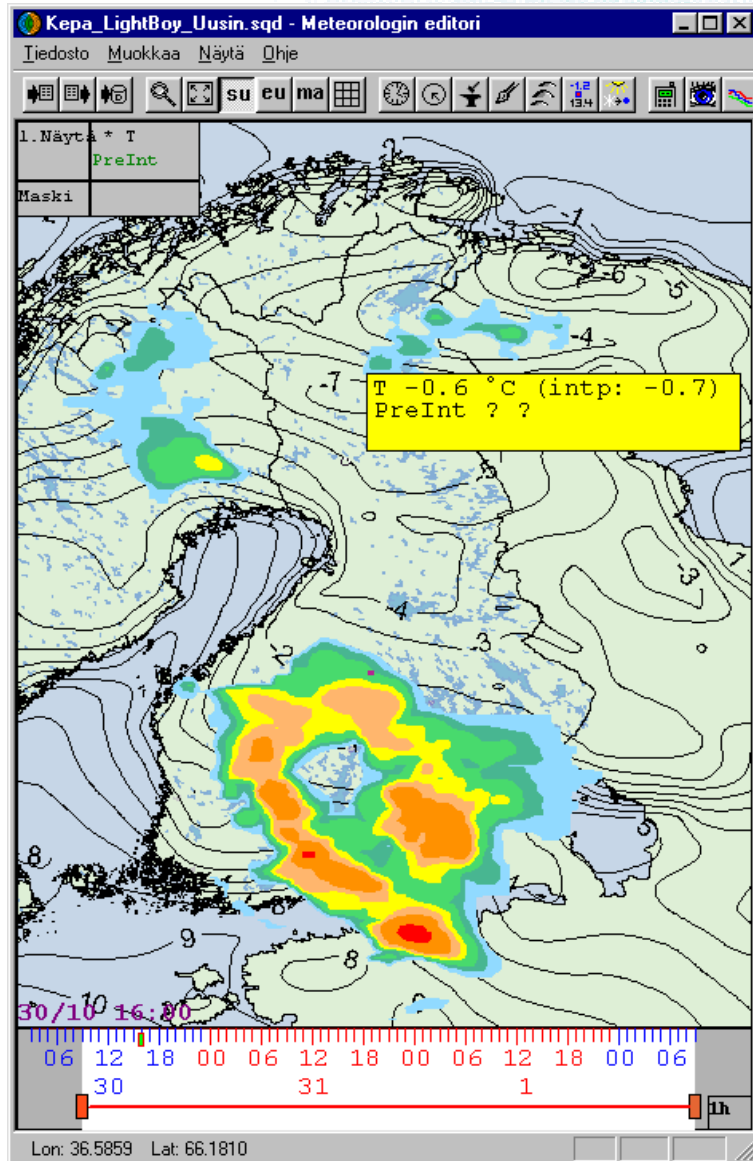




# The Grid Editor

## Mask editing windows



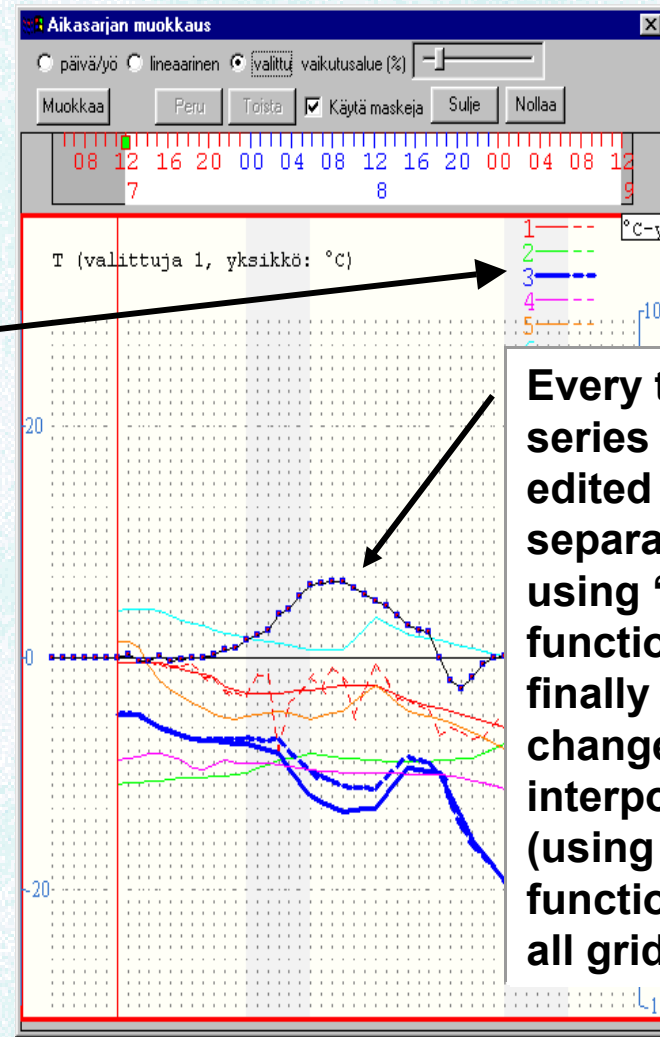
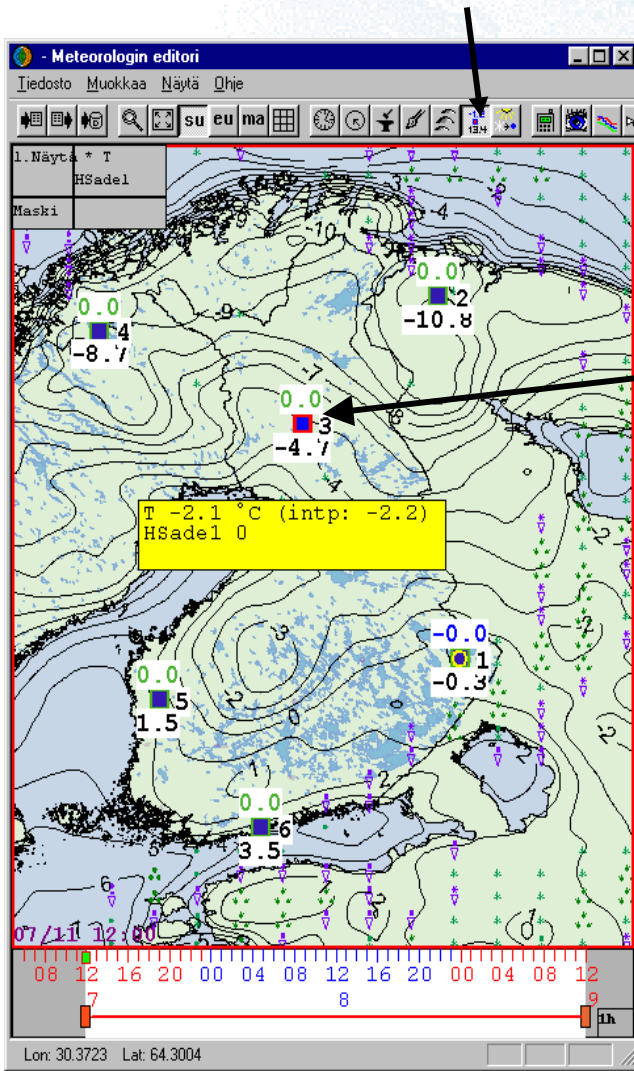


# The Grid Editor

Paint brush tool

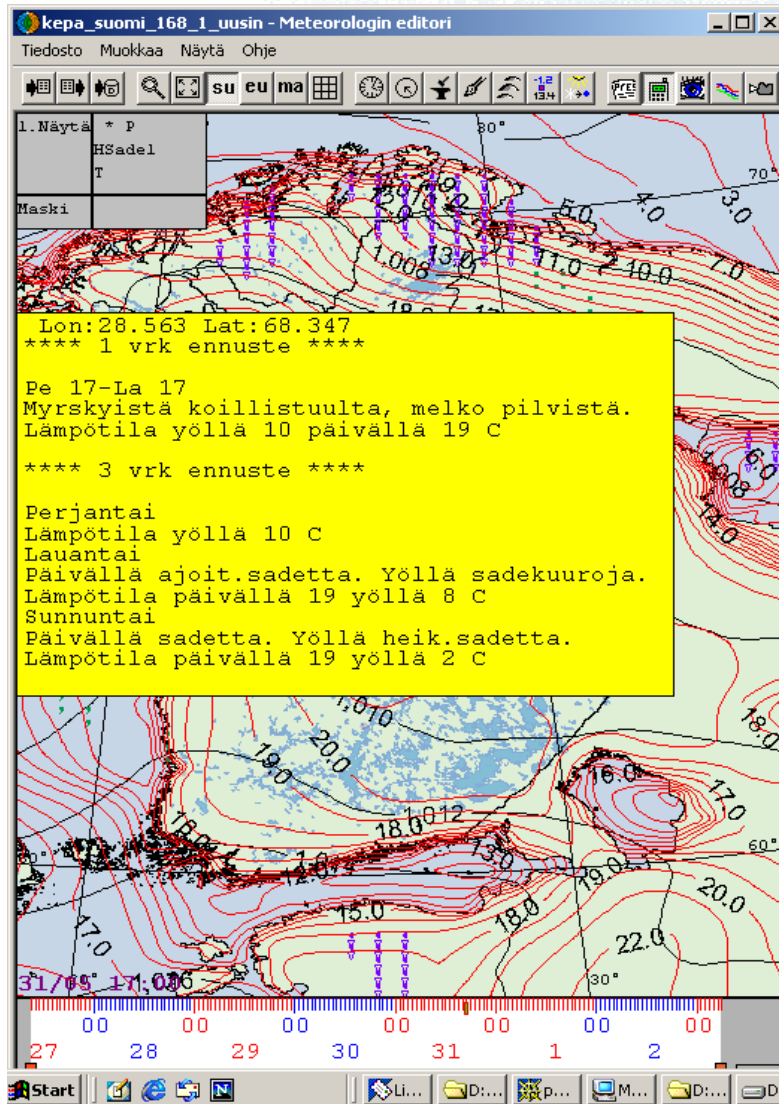


# Control point editing



Every time series can be edited separately using “delta functions” and finally the changes are interpolated (using “delta functions”) to all grid points



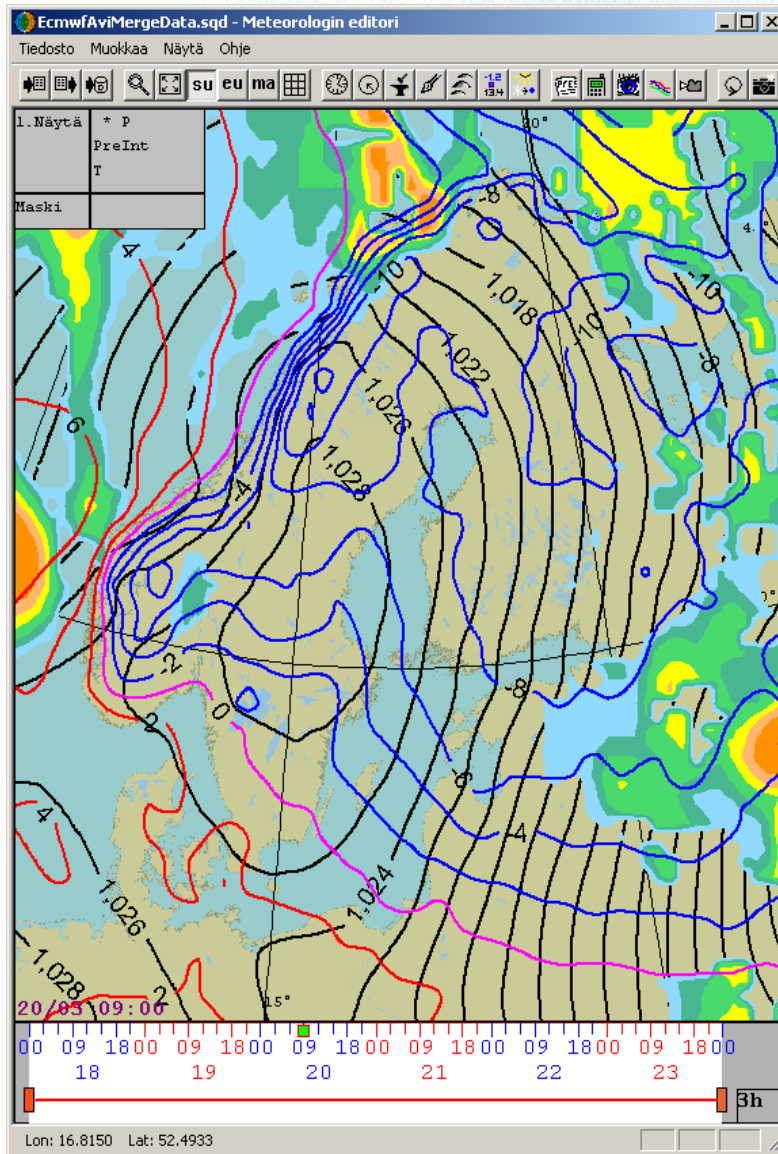


# The Grid Editor

## Text generation tool:

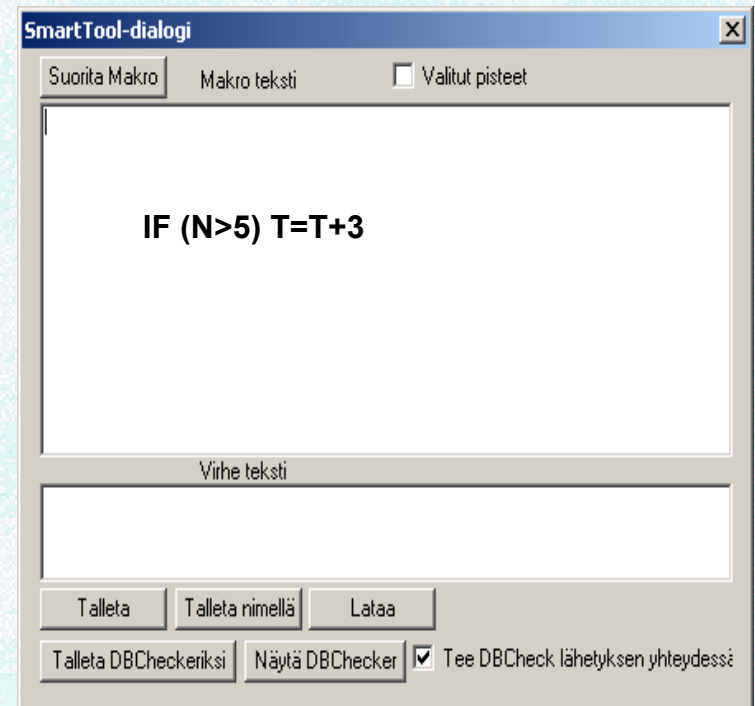
generates automated text forecasts for 1 and 3 days for the location indicated by cursor and time window





# The Grid Editor

**Smart Tools:** ability to make scripts to perform more complicated and often repeated editing actions in a more easy manner

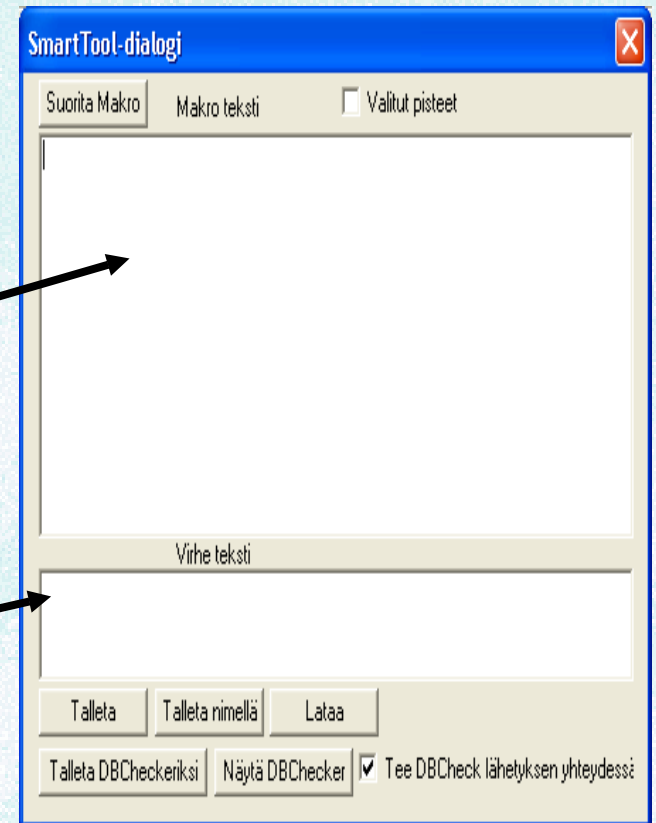


# Grid Editor - SmartTools

- Own scripting language:

- Editing window

- An error log window



# Grid Editor - SmartTools

- **Operators;**  
 $T = T + P * 0.123 - RH/100 * WS + (T - DP) ^ 2$
- **Blocks:**  
{  
   $T = T + 1$   
   $P = P + 1$   
   $RH = RH + 1$   
}
- **Conditionals:**  
IF( $T - DP > 2$ )  
   $T = T + 1$   
   $P = P + 1$  // both are executed if condition fulfills.





# Grid Editor - SmartTools

- **More complicated conditionals:**

**IF(T – DP > 4)**

**T = T + 1**

**P = P + 1**

**ELSEIF(T – DP > 2) // means actually that (T-DP) is  
between 2 and 4.**

**T = T + 2**

**P = P + 2**

**ELSE // in all other cases, if T – DP <= 2, then ELSE is  
executed**

**T = T + 3**

**P = P + 3**



# Grid Editor - SmartTools

- **T** TEMPERATURE
- **P** SURFACE PRESSURE
- **RH** RELATIVE HUMIDITY
- **KIND** K-INDEX
- **DP** DEW POINT
- **LRAD** LONG WAVE RADIATION
- **SRAD** SHORT WAVE RADIATION
- **WD** WIND DIRECTION
- **WS** WIND SPEED
- **N** TOTAL CLOUD COVER
- **CL** AMOUNT OF LOW CLOUDS
- **CM** AMOUNT OF MEDIUM CLOUDS
- **CH** AMOUNT OF HIGH CLOUDS
- **RR** INTENSITY OF PRECIPITATION
- **PREF** PRECIPITATION TYPE (RAIN, SLEET, SNOW)
- **PRET** PRECIPITATION TYPE (CONTINUOUS, SHOWER,..)
- **THUND** PROPABILITY OF THUNDER
- **FOG** INTENSITY OF FOG
- **HSADE** PRECIPITATION SYMBOL (NOT EDITABLE; SYNOP)
- **HESSAA** WEATHER SYMBOL (NOT EDITABLE)



# Grid Editor - SmartTools

- **FL1BASE** Flight Level 1 cloud Base
- **FL1TOP** Flight Level 1 cloud Top
- **FL1COVER** Flight Level 1 cloud COVER
- **FL1CLOUDTYPE** Flight Level 1 cloud TYPE
- **FL2BASE** Flight Level 2 cloud Base
- **FL2TOP** Flight Level 2 cloud Top
- **FL2COVER** Flight Level 2 cloud COVER
- **FL2CLOUDTYPE** Flight Level 2 cloud TYPE
- **FL3BASE** Flight Level 3 cloud Base
- **FL3TOP** Flight Level 3 cloud Top
- **FL3COVER** Flight Level 3 cloud COVER
- **FL3CLOUDTYPE** Flight Level 3 cloud TYPE
- .....
- **FL8BASE** Flight Level 8 cloud Base
- **FL8TOP** Flight Level 8 cloud Top
- **FL8COVER** Flight Level 8 cloud COVER
- **FL8CLOUDTYPE** Flight Level 8 cloud TYPE
- **FLCBBASE** Flight Level CB BASE
- **FLCBCOVER** Flight Level CB COVER
- **FLMINBASE** Flight Level cloud minimum BASE
- **FLMAXBASE** Flight Level cloud maximum BASE
- **AVIVIS** Aviation Visibility
- **VERVIS** Vertical Visibility



# Grid Editor - SmartTools

## STATIC AND NON STATIC FUNCTIONS

- **TOPO** TOPOGRAPHY (static)
- **SLOPE** SLOPE OF SURFACE
- **SLOPEDIR** DIRECTION OF DEEPIST SLOPE
- **DISTSEA** SHORTEST DISTANCE TO SEA
- **DIRSEA** DIRECTION TO SEA
- **DISTLAND** SHORTEST DISTANCE TO LAND
- **DIRLAND** DIRECTION TO LAND
- **LANDSEAMASK** LAND SEA MASK
- **RELTOPO** RELATIVE TOPOGRAPHY
- **LAT** *LATITUDE (non static)*
- **LON** *LONGITUDE (non static)*
- **EANGLE** *ELEVATION ANGLE (non static)*



# Grid Editor - SmartTools

## Integrating functions

- **AVG** calculates the arithmetic average
- **MIN** seeks the minimum value
- **MAX** seeks the maximum value
- **SUM** calculates the sum
- **WAVG** calculates the weighted average (?)

## Mathematical functions

- **SIN, COS, LN, SQRT, LOG, ATAN, EXP, ....**

## Ramp functions

- **RU (ramp up)**
- **RD (ramp down)**
- **DD (double ramp)**



# Grid Editor - SmartTools

```
// Säteilikorjaus (Radiation correction)
// SN 2002.09.30
// pilvisuus korjataan => säteilyt korjataan
// ECMWF-lyhytaaltosäteily liian pieni selkeissä tilanteissa => 20% lisäys,
// Viitteet: Lauros Johanna, 2001, Tienpinnan talviset liukkaussolosuhteet ja niiden mallintaminen,
// pro gradu, Helsingin yliopiston meteorologian laitos
// Katso myös gradun kirjallisuusviitteet: Niemelä Sami, Räisänen Petri, Savijärvi Hannu
// SRAD = (1 - 0.67 * (N/100) ^ 3.32) / (1 - 0.67 * (N_ORIG/100) ^ 3.32) * SRAD_ORIG
// LRAD = (1 + 0.22 * (N/100) ^ 2.75) / (1 + 0.22 * (N_ORIG/100) ^ 2.75) * LRAD_ORIG
// SRAD_SELKEA = 1000 * (1 - EXP(-0.06 * EANGLE)) * SIN(EANGLE) + 5 + 96 * (1 - EXP(-0.05 * EANGLE))
// missä EANGLE >= 0
IF (SRAD == SRAD_EC AND (N_ORIG <= 30 OR N <= 30))
{
  SRAD = 1.2 * (1 - 0.67 * (N/100) ^ 3.32) / (1 - 0.67 * (N_ORIG/100) ^ 3.32) * SRAD_ORIG
  LRAD = (1 + 0.22 * (N/100) ^ 2.75) / (1 + 0.22 * (N_ORIG/100) ^ 2.75) * LRAD_ORIG
}
ELSE
{
  SRAD = (1 - 0.67 * (N/100) ^ 3.32) / (1 - 0.67 * (N_ORIG/100) ^ 3.32) * SRAD_ORIG
  LRAD = (1 + 0.22 * (N/100) ^ 2.75) / (1 + 0.22 * (N_ORIG/100) ^ 2.75) * LRAD_ORIG
}
// IF ( SRAD > SRAD_SELKEA)
// SRAD = SRAD_SELKEA
// missä EANGLE >= 0
IF ( ( SRAD ) - ( 1000 * (1 - EXP(-0.06 * EANGLE)) * SIN(EANGLE) + 5 + 96 * (1 - EXP(-0.05 * EANGLE)) ) > 0 AND EANGLE >= 0 )
  SRAD = 1000 * (1 - EXP(-0.06 * EANGLE)) * SIN(EANGLE) + 5 + 96 * (1 - EXP(-0.05 * EANGLE))
ELSEIF ( ( SRAD ) - ( 1000 * (1 - EXP(-0.06 * EANGLE)) * SIN(EANGLE) + 5 + 96 * (1 - EXP(-0.05 * EANGLE)) ) > 0 AND EANGLE < 0 )
  SRAD = 1000 * (1 - EXP(-0.06 * 0)) * SIN(0) + 5 + 96 * (1 - EXP(-0.05 * 0))
IF ( SRAD < 0 )
  SRAD = 0
```



# Grid Editor – SmartTools

## Application: Small scale editing

The screenshot displays the Meteorologin editori application window titled "jaataminen\_ECMWF.fgd - Meteorologin editori". The main window shows a map of the Baltic Sea region with isotherms (contours of temperature) and a time axis at the bottom ranging from 00:00 on 30/10 to 06:00 on 31/10. A "SmartTool-dialogi" window is open over the map, containing the following text:

Suorita Makro    Makro teksti     Valitut pisteet

```
IF(DISTSEA > 0)
T = T + 10* RD(DISTSEA 0 60)
```

Virhe teksti

1. Makron suoritus: Ok.

Talleta    Talleta nimellä    Lataa

Talleta DBCheckeriksi    Näytä DBChecker     Tee DBCheck lähetysten yhteydessä



# Grid Editor - SmartTools

The screenshot displays the Meteorologin editori software interface. The main window shows a contour map of the Baltic Sea region with red contour lines and a grid. The map includes latitude and longitude markings (e.g., 62°, 60°, 54°, 20°, 25°). A time axis at the bottom indicates a 24-hour period from 00 to 06 on 30/10 and 00 to 06 on 31.10. The status bar shows coordinates: Lon: 18.5340, Lat: 57.2588.

The SmartTool-dialogi window is open, showing a macro script:

```
Suorita Makro      Makro teksti       Valitut pisteet
```

```
IF(DISTSEA > 0)  
T = T + 10* RD(DISTSEA 0 60)
```

Virhe teksti

1. Makron suoritus: Ok.

Talleta Talleta nimellä Lataa

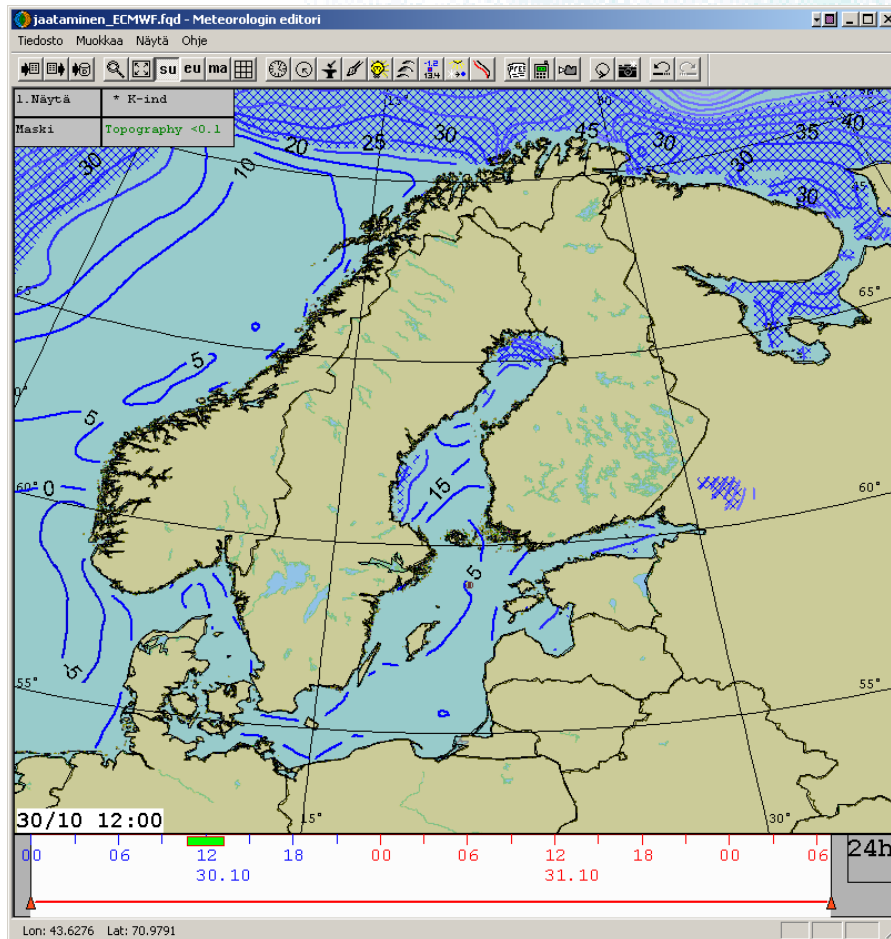
Talleta DBCheckeriksi Näytä DBChecker  Tee DBCheck lähetyksen yhteydessä





# Grid Editor – SmartTools

## Application: Icing predictor for Oceans



**SmartTool-dialogi**

Suorita Makro    Makro teksti     Valitut pisteet

```
kind= ws*(0.35 - T/(1+0.3*(par288 + 0.35)))
if (topo>0)
  kind=MISS
```

Virhe teksti

3. Makron suoritus: Ok.

Talleta    Talleta nimellä    Lataa

Talleta DBCheckeriksi    Näytä DBChecker     Tee DBCheck lähetysten yhteydessä

**Polar Meteorology**

Algorithm:

Overland et al. (1996) and Overland (1990) developed algorithms that have proven to be useful for predicting sea spray vessel icing primarily on reports from vessels that were 20 to 75 meters in length. Here is the algorithm presented by Overland (1990):

$$PPR = \frac{V_w(T_s - T_a)}{1 - 0.3(T_w - T_r)}$$

PPR = Icing Predictor (m<sup>3</sup>h<sup>-1</sup>)  
 V<sub>w</sub> = Wind Speed (m s<sup>-1</sup>)  
 T<sub>s</sub> = Freezing point of seawater (usually -1.7 °C or -1.6 °C)  
 T<sub>a</sub> = Air Temperature (°C)  
 T<sub>w</sub> = Sea Temperature (°C)

The following table shows the expected icing class and rates for 20 - 75 meter vessels that are steaming into the wind:

Table 2  
Icing Class and Rate

PPR	<0	0-22.4	22.4-53.3	53.3-93.0	>93.0
Icing Class	None	Light	Moderate	Heavy	Extreme
Icing Rates (cm/hour)	0	<0.7	0.7-2.0	2.0-4.0	>4.0
Icing Rates (inches/hour)	0	<0.3	0.3-0.8	0.8-1.6	>1.6

These icing rates are only a guide. Actual icing rates depend on ship characteristics, cold soaking and exposure to sea spray (see ...)



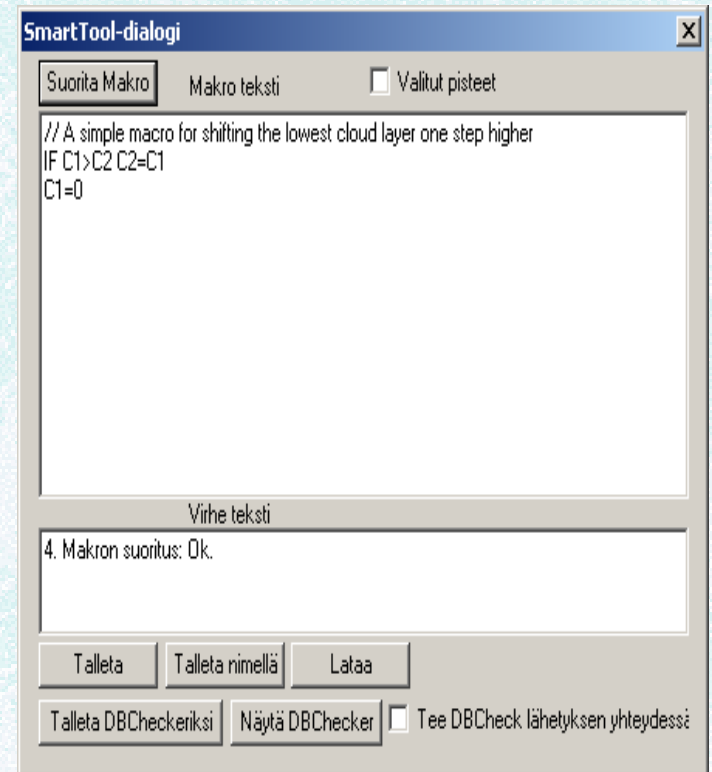
# Editing of aviation parameters (near future)

## Edited parameters:

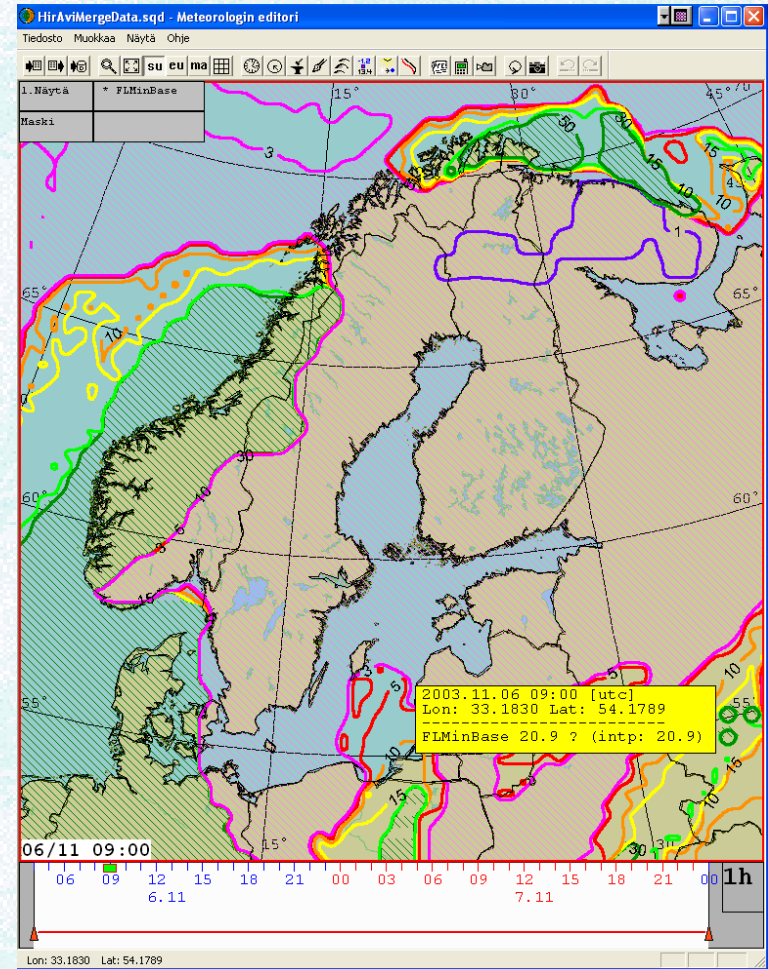
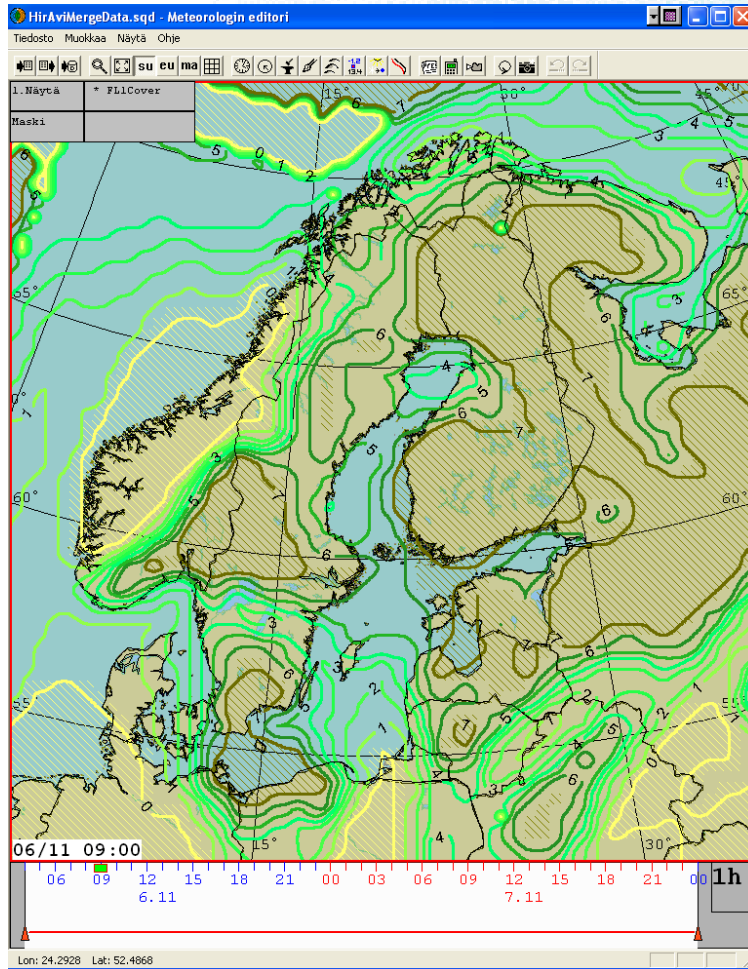
**cloud amount in ICAO layers**  
**intensity of fog (0,1,2)**  
**intensity of precipitation (mm/h)**  
**(edited already elsewhere)**

**SmartTools scripts are mainly used**

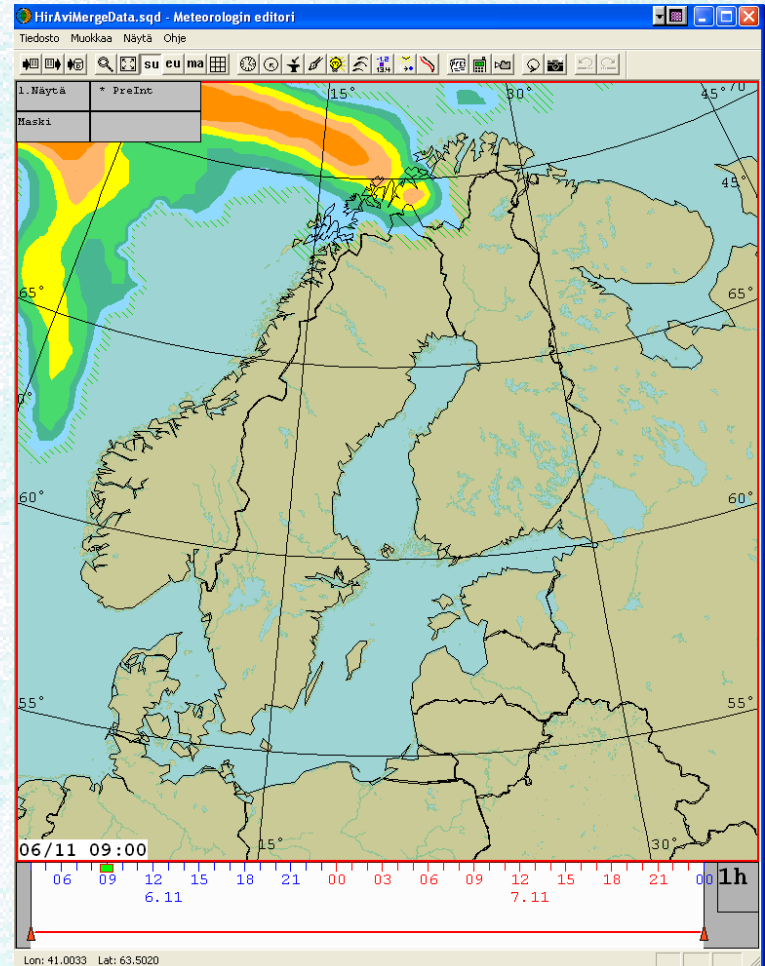
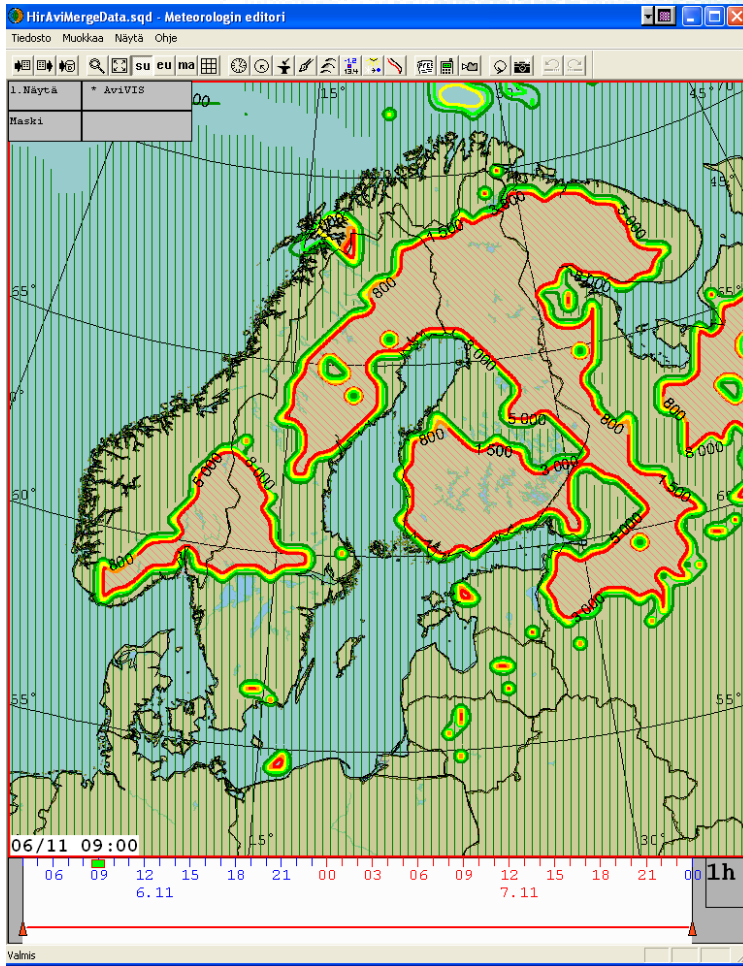
**Visibility and ceiling height are derived from edited and interpreted parameters**



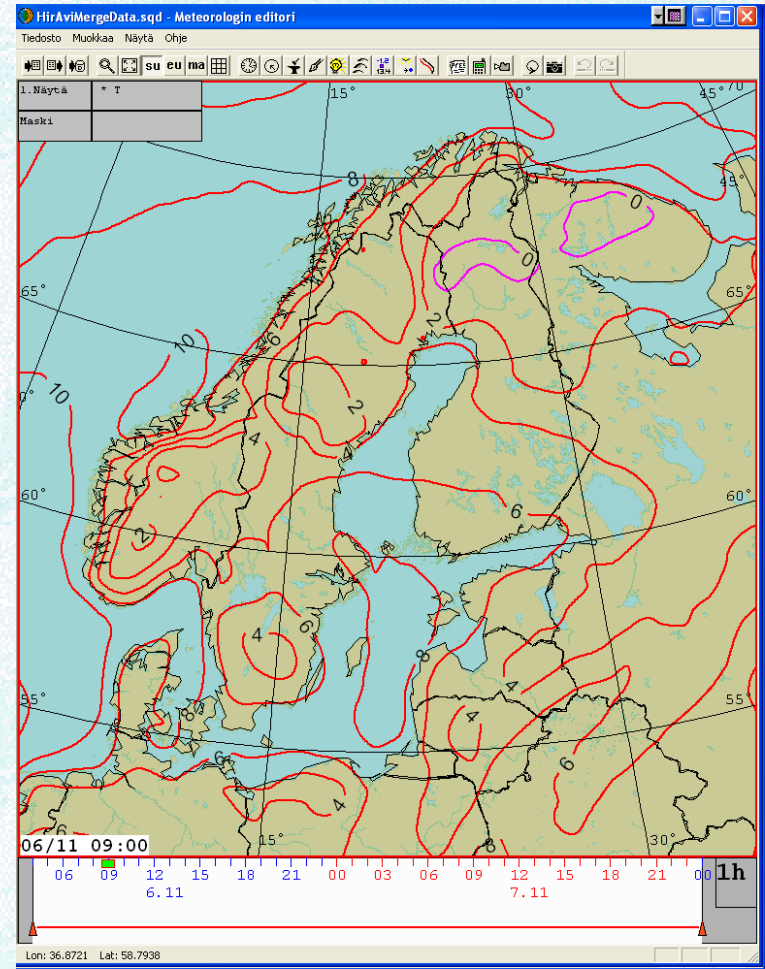
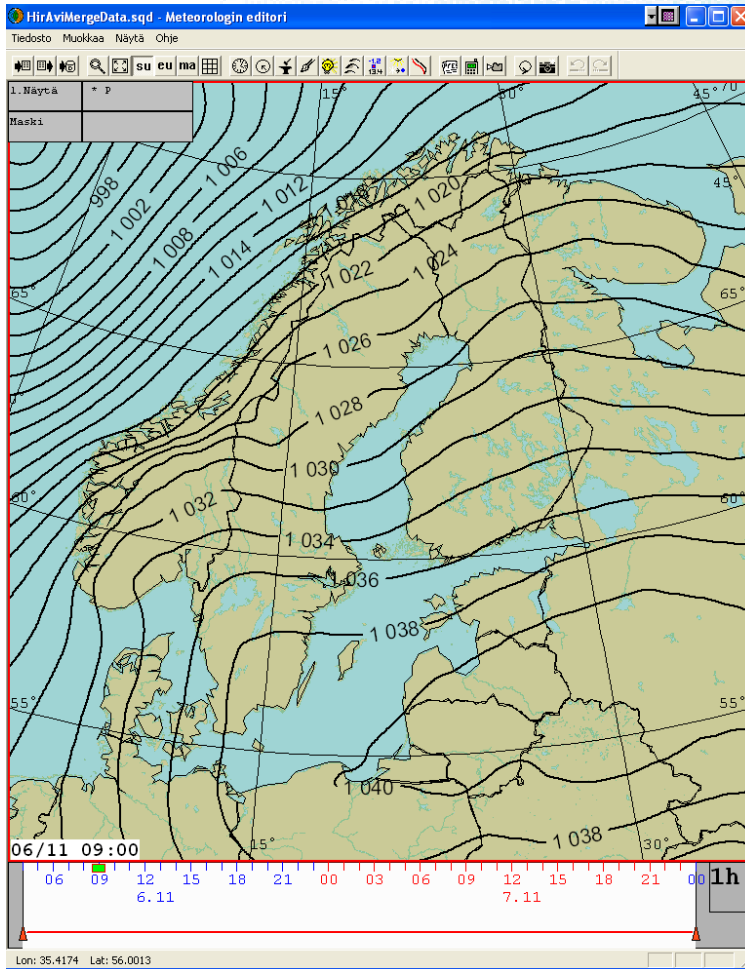
# Editing of aviation parameters (cloud base)



# Editing of aviation parameters (visibility/rr)



# Editing of standart parameters (ps/T2m)



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**29.10.2003 10:40 SA**

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UTC TIME

- 29.10. 18:00
- 30.10. 00:00
- 30.10. 06:00
- 30.10. 12:00
- 30.10. 18:00
- 31.10. 00:00
- 31.10. 06:00
- 31.10. 12:00
- 31.10. 18:00
- 1.11. 00:00
- 1.11. 12:00
- 2.11. 00:00
- 2.11. 12:00
- 3.11. 00:00
- 3.11. 12:00

PLAY

> 6 km  
 < 6 km  
 < 3 km  
 < 1.5 km  
 < 450 m  
 < 300 m  
 < 150 m  
 < 60 m  
 NSC

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UTC TIME

29.10.	18:00
30.10.	00:00
30.10.	06:00
30.10.	12:00
30.10.	18:00
31.10.	00:00
31.10.	06:00
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31.10.	18:00
1.11.	00:00
1.11.	12:00
2.11.	00:00
2.11.	12:00
3.11.	00:00
3.11.	12:00

PLAY





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[Flight Categories](#) - [Cloud Base](#) - [Cloud Top](#) - [Visibility](#) - [5 day](#)

UTC TIME

- 29.10. \_18:00
- 30.10. \_00:00
- 30.10. \_06:00
- 30.10. \_12:00**
- 30.10. \_18:00
- 31.10. \_00:00
- 31.10. \_06:00
- 31.10. \_12:00
- 31.10. \_18:00
- 1.11. \_00:00
- 1.11. \_12:00
- 2.11. \_00:00
- 2.11. \_12:00
- 3.11. \_00:00
- 3.11. \_12:00
- PLAY

9999

< 8 km

< 5 km

< 2 km



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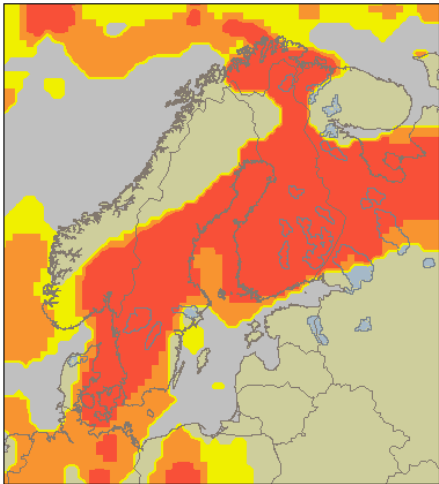
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- 6 TOP-KUVA
- 7 UKKOSRISKI
- 8 SWC SKANDINAVIA
- 9 SWC [00](#), [06](#), [12](#), [18](#) UTC
- 10 POIKKILEIKKAUS
- 11 TUTKAPOIKKILEIKKAUS
- 12 5 VRK
- T TEKSTISIVU
- H OPASTEET

**29.10.2003 10:40 SA**

Flight Categories - [Cloud Base](#) - [Cloud Top](#) - [Visibility](#) - [5 day](#)

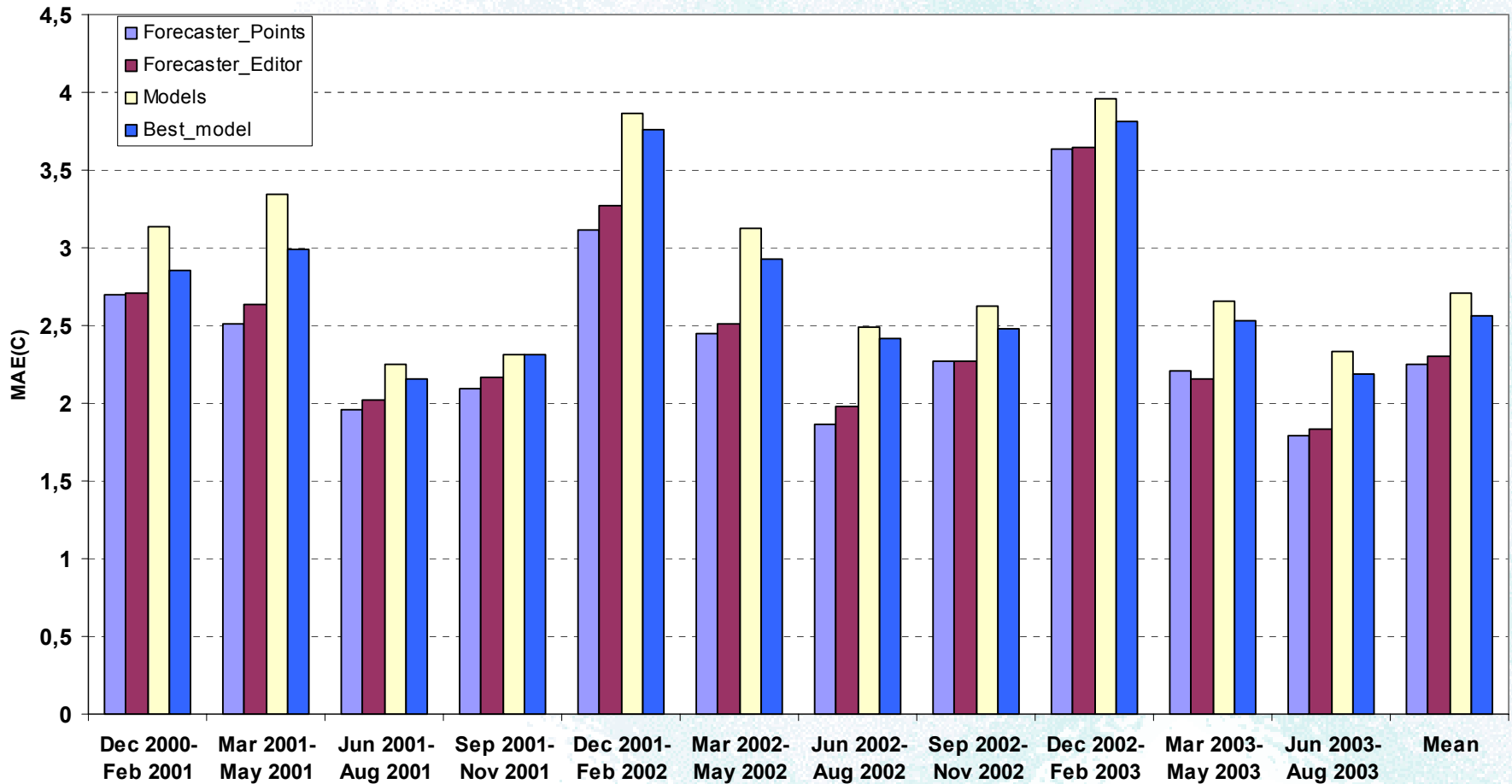
UTC TIME

29.10. 18:00	
30.10. 00:00	
30.10. 06:00	
30.10. 12:00	
30.10. 18:00	
31.10. 00:00	
31.10. 06:00	
31.10. 12:00	
31.10. 18:00	
1.11. 00:00	
1.11. 12:00	
2.11. 00:00	
2.11. 12:00	
3.11. 00:00	
3.11. 12:00	

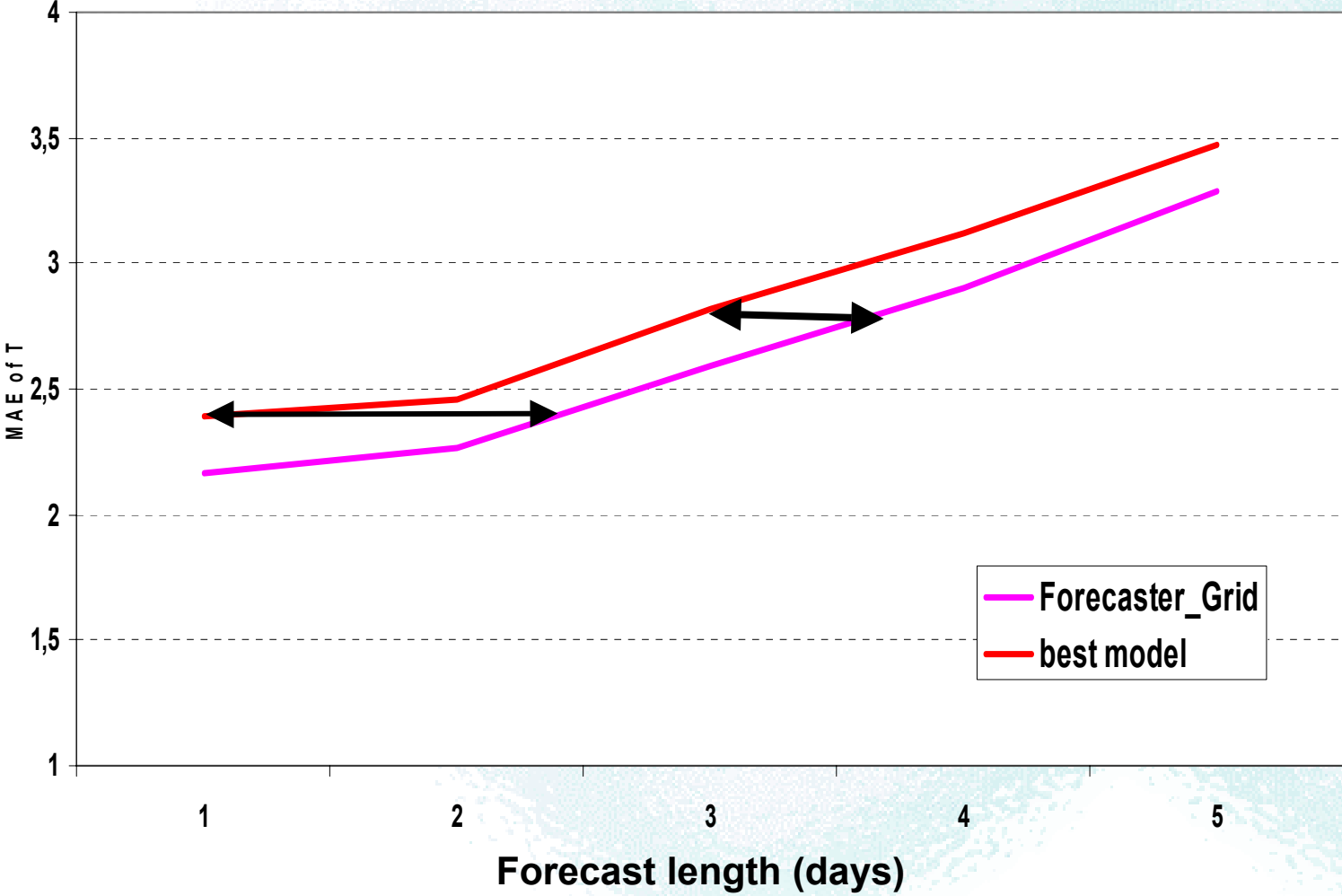
PLAY



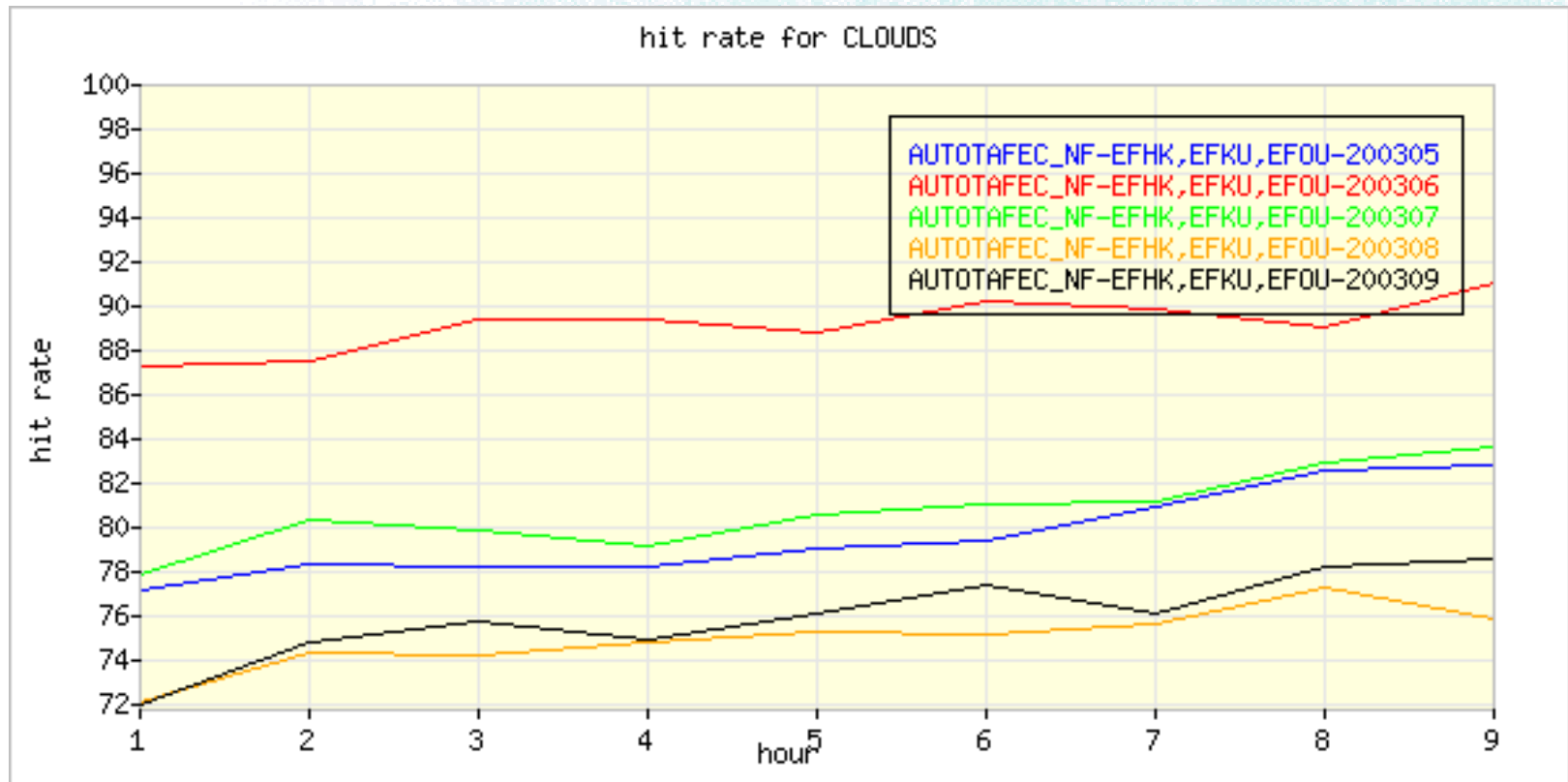
# MAE of pooled temperature forecasts (3 stations, 11 seasons, 0.5-5 d)



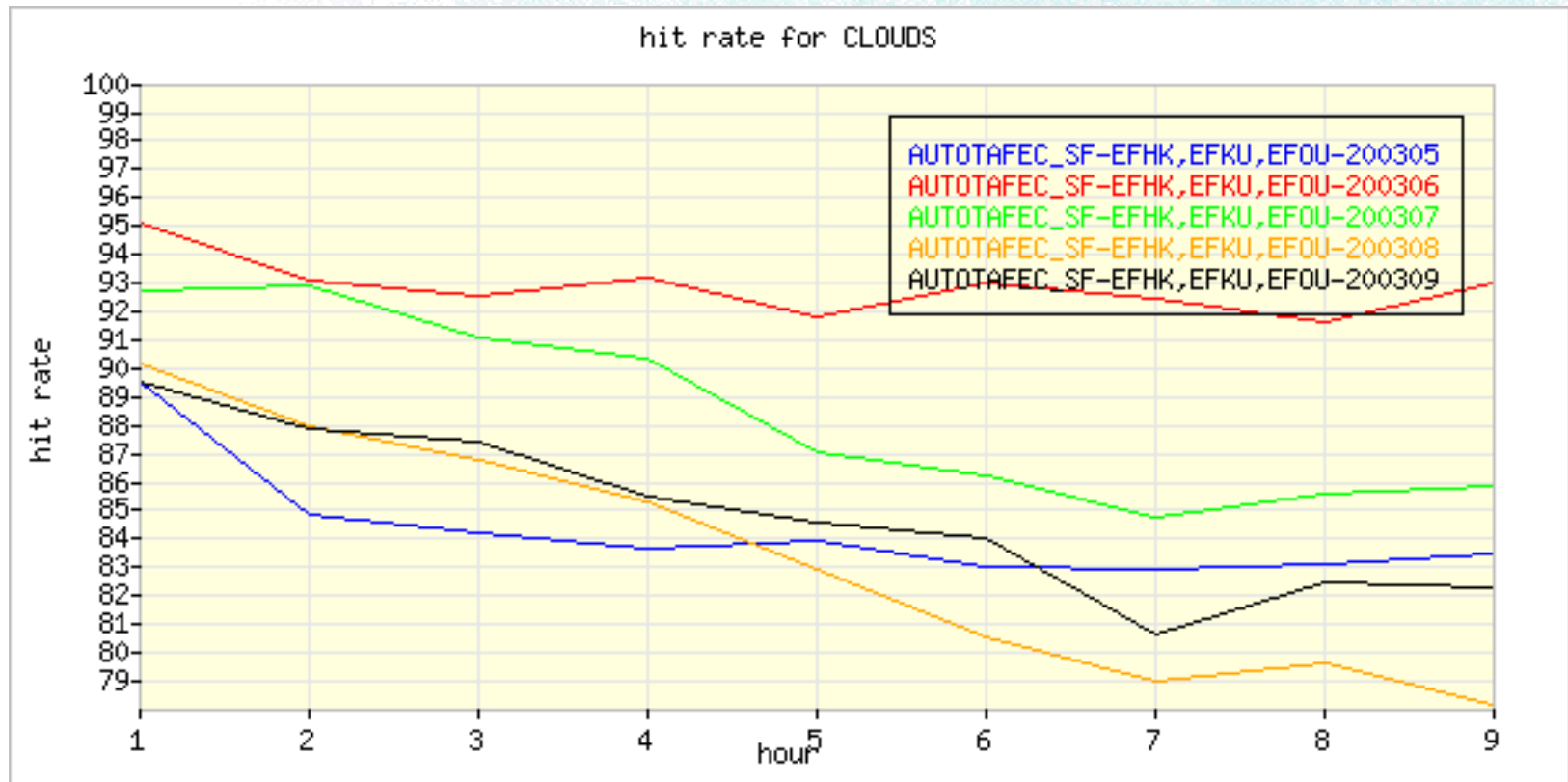
# MAE of temperature forecasts (3 stations, 2 years)



# HIT RATE of Ceiling height forecast based on ECMWF data (raw data)

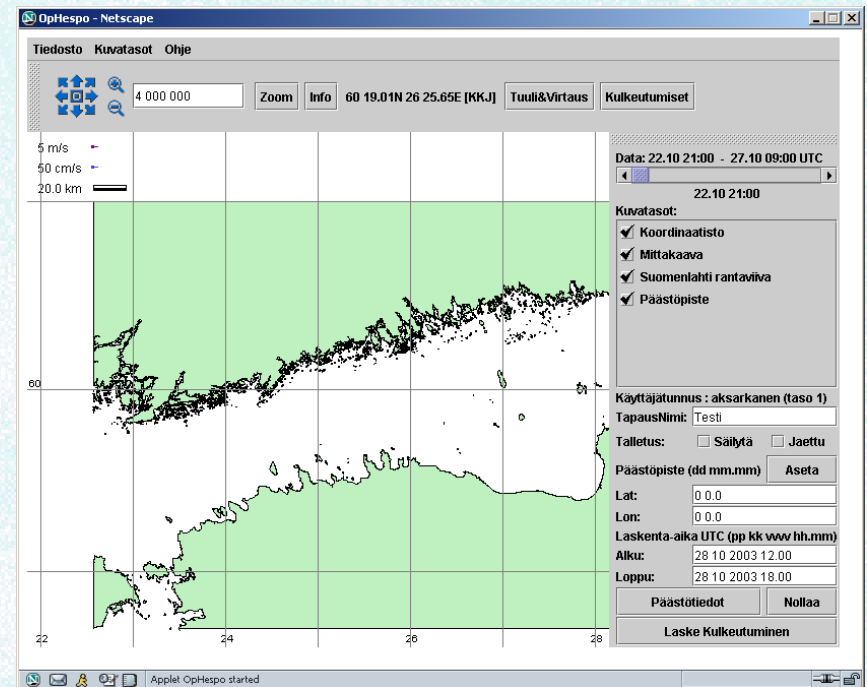


# HIT RATE of Ceiling height forecast based on ECMWF data (smart fit with METARs)

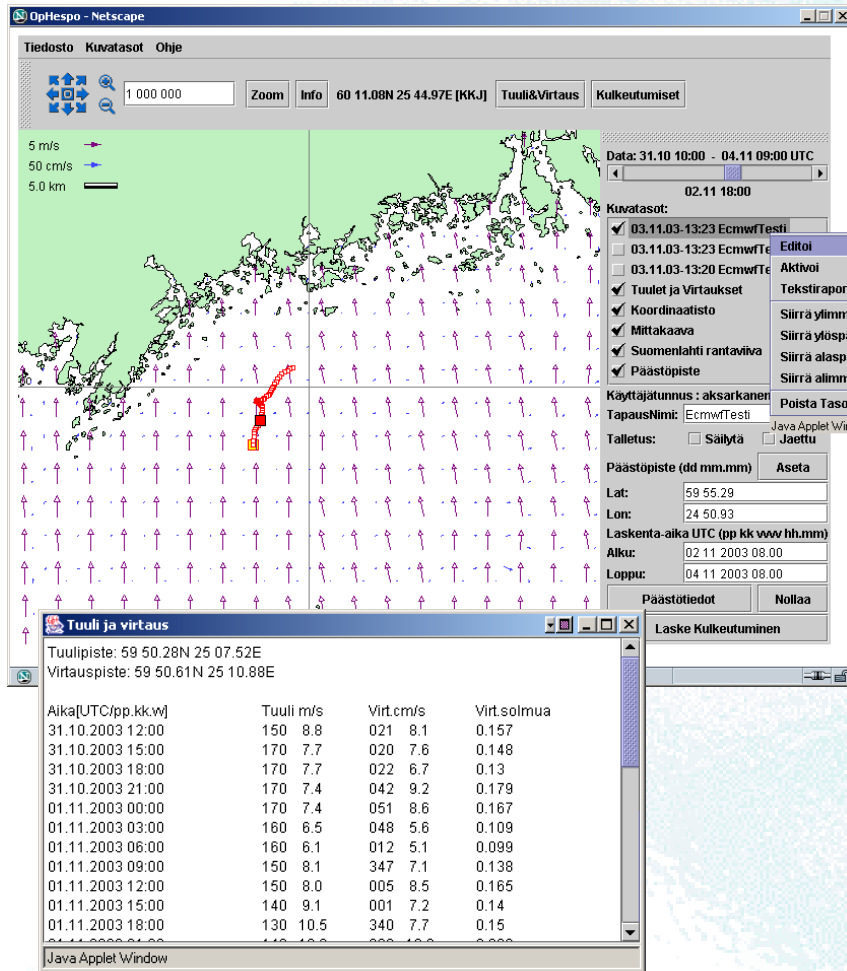


# The model for oil spill movement in the Gulf of Finland

- 3D hydrodynamic model
- Wind and current forecasts (ECMWF/HIRLAM data)
- Spill information, start/end time, location etc.
- Duty forecasters and oil combating authorities on duty are main users (also Coast Guard, fire brigades etc. use system)
- User interface with Java
- Co-operation between FMI, Finnish Environment Institute and Finnish Institute of Marine Research



# The model for oil spill movement in the Gulf of Finland



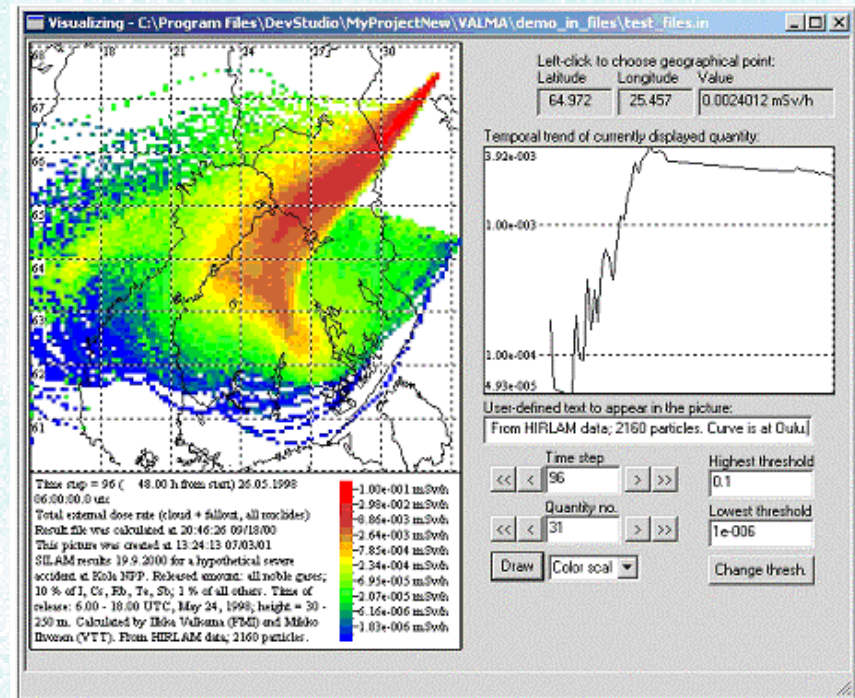
- Wind field (vectors)
- Surface current field (vectors)
- Drift trajectories (output)
- time series of wind and current forecasts (output)
- Additional information: SST and ice cover



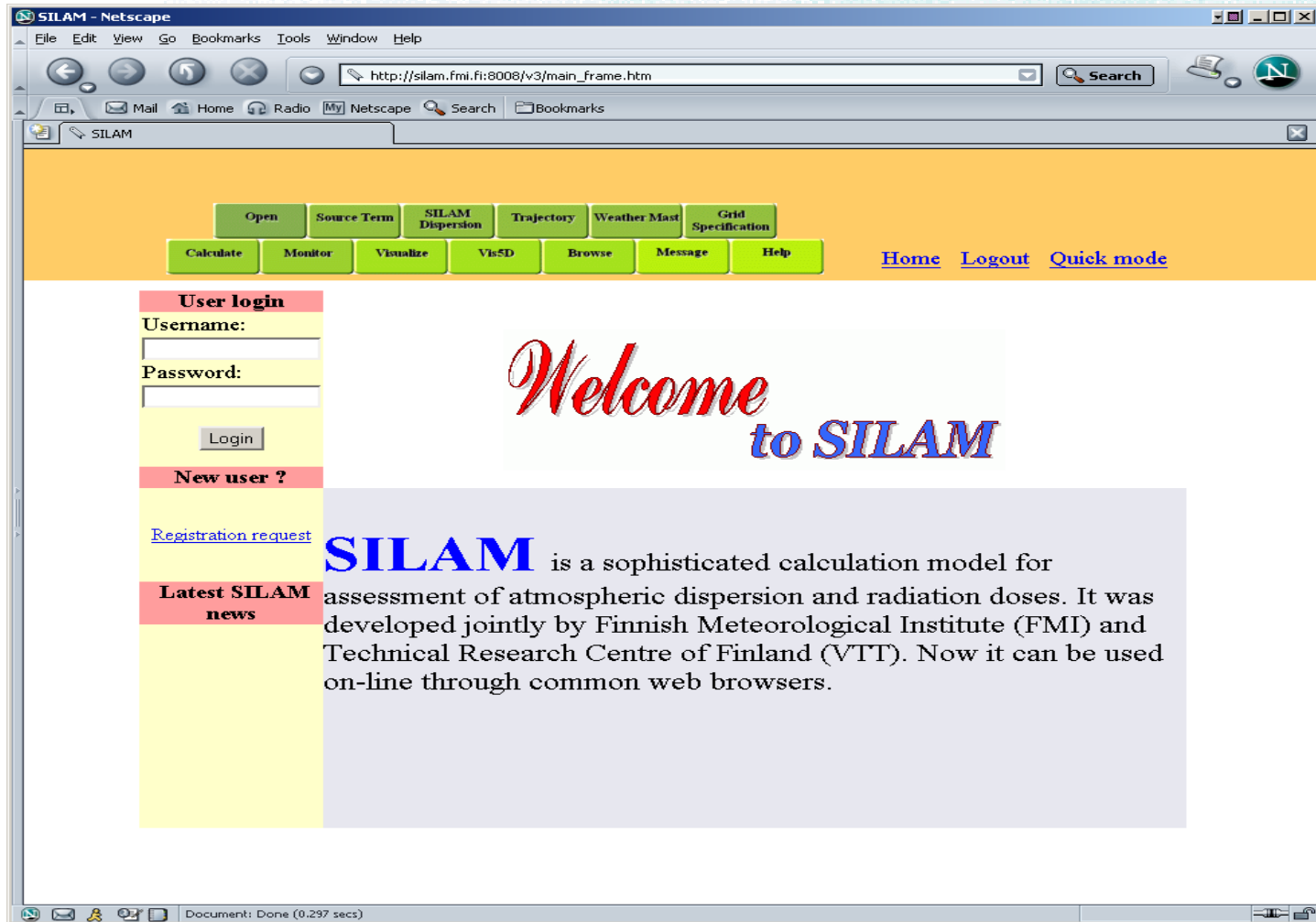


# SILAM atmospheric dispersion and dose assessment model

- Trajectory model (based on ECMWF/HIRLAM data)
- Partical distributions and risk area calculations
- Duty forecasters and Radiation safety authorities on duty are main users
- User interface on web (PHP)
- Co-operation between FMI, Radiation and Nuclear Safety Authority of Finland and Technical Research Centre of Finland



# SILAM atmospheric dispersion and dose assessment model



# SILAM atmospheric dispersion and dose assessment model

**Ultra-fast mode of calculation**

Uses default input files with only the additional information given here. (View SILAM [control file](#) or [source file](#) default values.)

Choose a source point from the list (European [commercial](#) NPPs and [other](#) nuclear installations):

- 51.900 N 5.683 E NETHERLANDS PL\_BWR Dodewaard, Capacity 59 MW
- 51.300 N 19.500 E POLAND PL\_PWR Zarnowiec, Capacity 2x440 MW, may be not use
- 44.200 N 28.050 E ROMANIA PL\_PWR Cernavoda, Roumania Capacity 2x700 MW
- 52.133 N 47.850 E RUSSIAN PL\_PWR Balakovo, Capacity 3x1000 MW
- 54.950 N 49.150 E RUSSIAN PL Dimitrovgrad, Uljanovsk VK-50
- 57.900 N 35.000 E RUSSIAN PL\_PWR Kalinin, Capacity 2x1000 MW
- 51.667 N 35.717 E RUSSIAN PL\_RBMK Kursk, Capacity 4x1000 MW
- 59.900 N 29.083 E RUSSIAN PL\_RBMK Leningrad, Sosnovyi Bor, Capacity 4x1000 MW**
- 50.983 N 39.433 E RUSSIAN PL\_PWR Novovoronezh, Voronezh, Capacity 2x417 MW, 1000 MW
- 67.450 N 32.417 E RUSSIAN PL\_PWR Polarnij Zor, Kuola, Capacity 4x440 MW

.....or..... Type arbitrary source point co-ordinates:  
 Latitude:   
 and longitude:   
 Note: Give co-ordinates in decimal degrees, north and east are positive.  
 Use the typed co-ordinates

Use the selected list entry

View map of [European NPPs](#) or [Western Russian NPPs](#) from the INSC database.

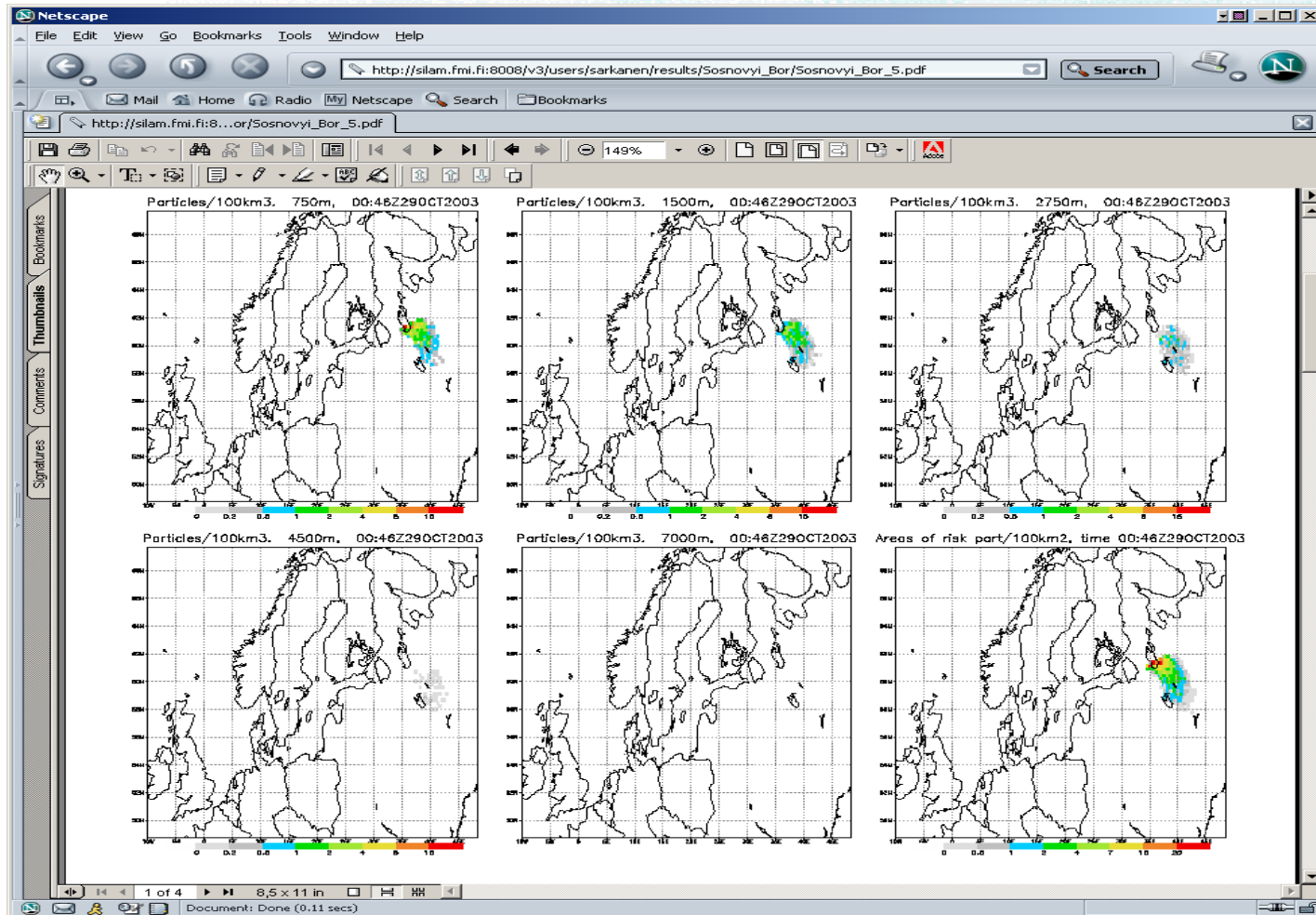
Starting time (UTC) of the release. Y: M: D: h: m: s: [View map of time zones](#)

Note: In Finland, local time is 2 hours ahead of UTC (winter) or 3 hours ahead (summer time).

Note: Diagnostic screen output of SILAM calculation will appear in a new window in real-time as the calculation proceeds.



# SILAM atmospheric dispersion and dose assessment model



# Conclusions

- **Changing the old forecasting process has been more complicated than expected**
- **The problems have been less scientific or technical than psychological**
- **Due to the highly automated forecasting process FMI still has commercial services**
- **There is still much to do on the non-commercial side of weather service**
  
- **In the next generation production system (on planning) the present and past experiences are to be taking into account**



# Thank you



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FINNISH METEOROLOGICAL INSTITUTE