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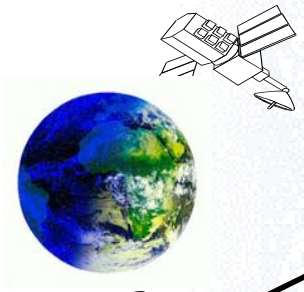
- **Developments in present production system**
  - **new features of the grid editor software: SmartTools**
  - **aviation applications and products**
  - **some verification results**
  - **oil spill movement model (customer application)**
  - **atmospheric dispersion model (customer application)**

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)



Climatological database

Visualisation and Editing by forecaster

Customers:

Observations:
- satellites
- weather radars
- surface observations
- soundings

Real time database:
- observations
- numerical forecasts
- final forecasts
- interpretations

Numerical weather forecast models (by supercomputers)

Old Vax Workstation

Post processing: creates customer products from the data edited by forecasters; texts, graphics, etc.

Old manual process

Forecasting process at FMI

Old VAX workstation

Old manual forecast process and production still exits: 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

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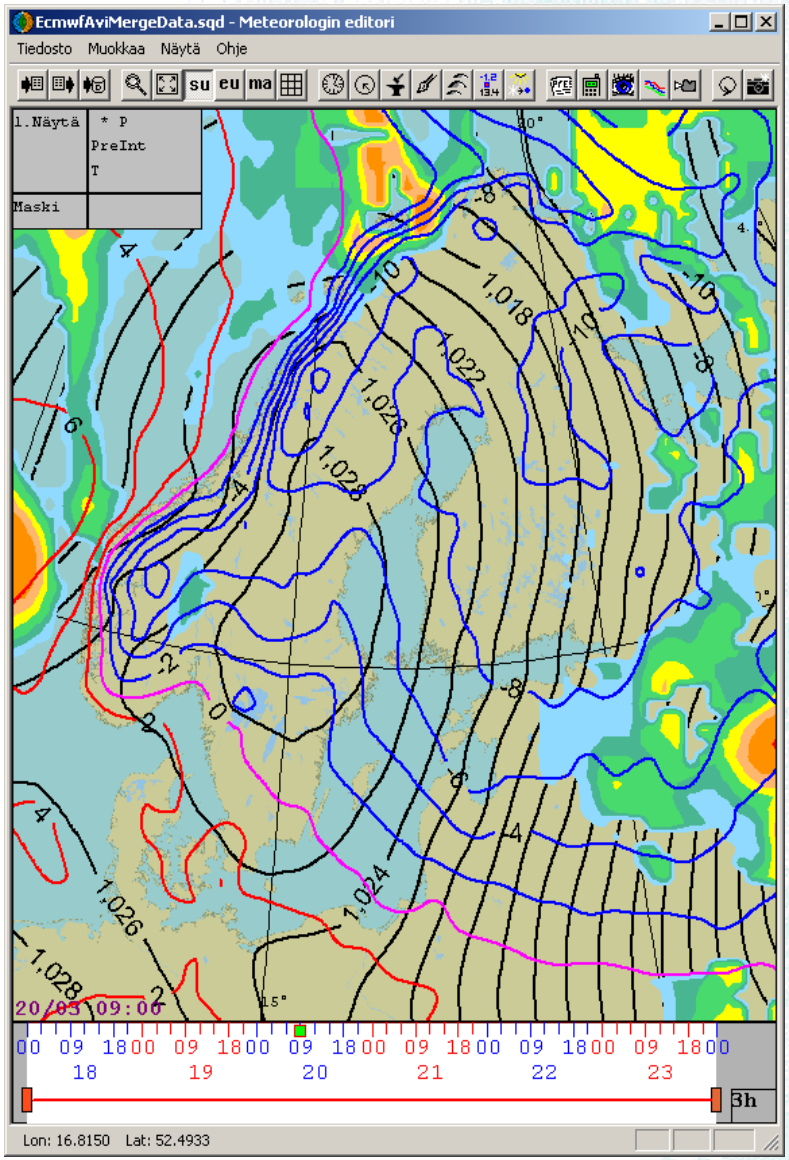
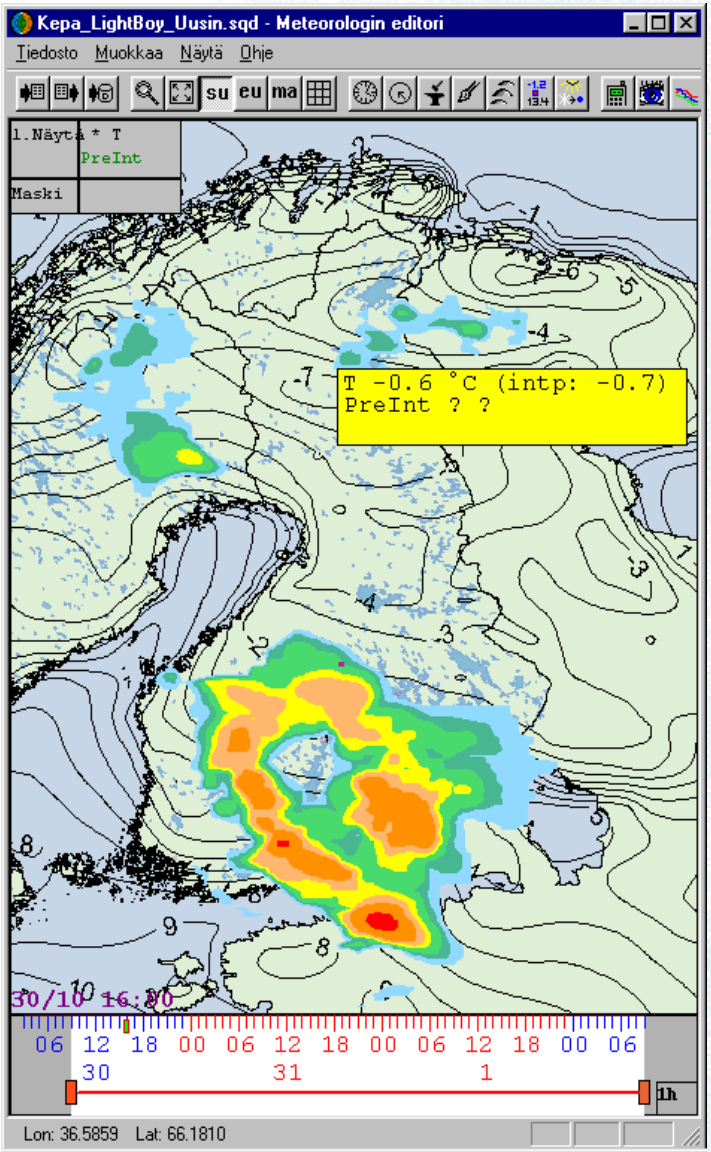


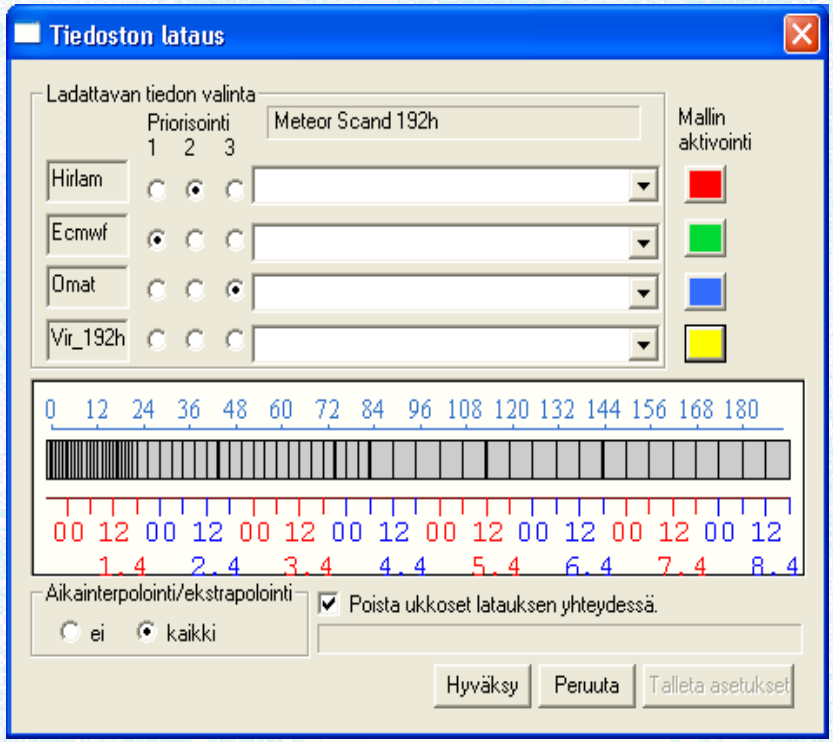
The Grid Editor

- 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

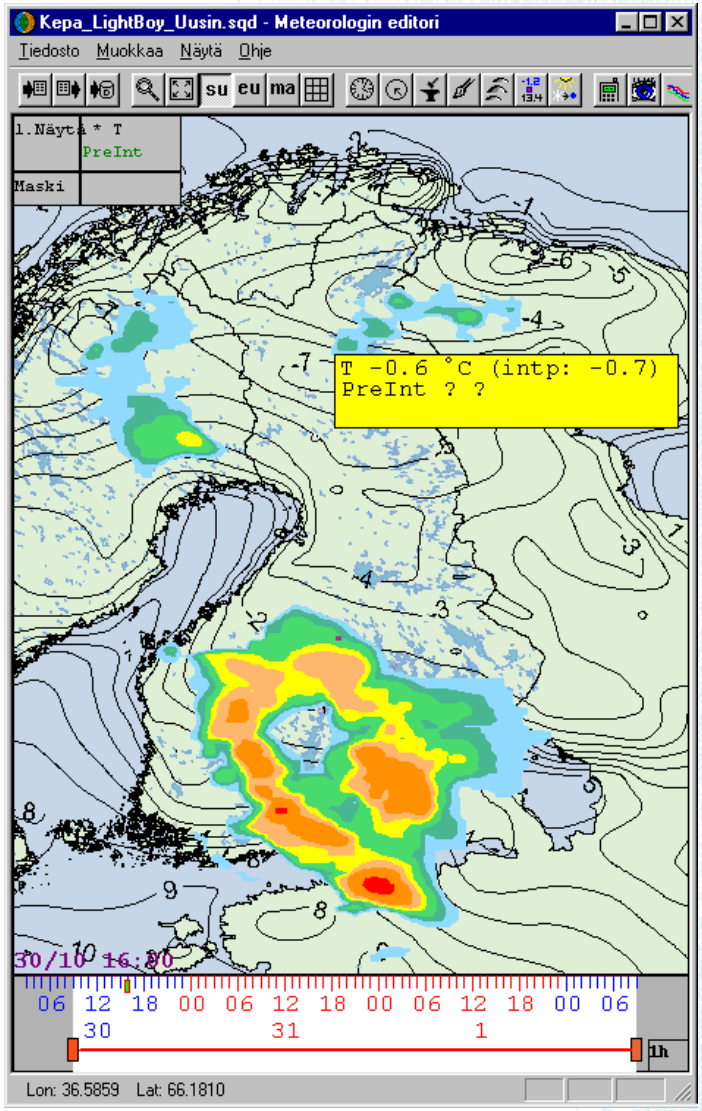
Chooce of the initial data/model

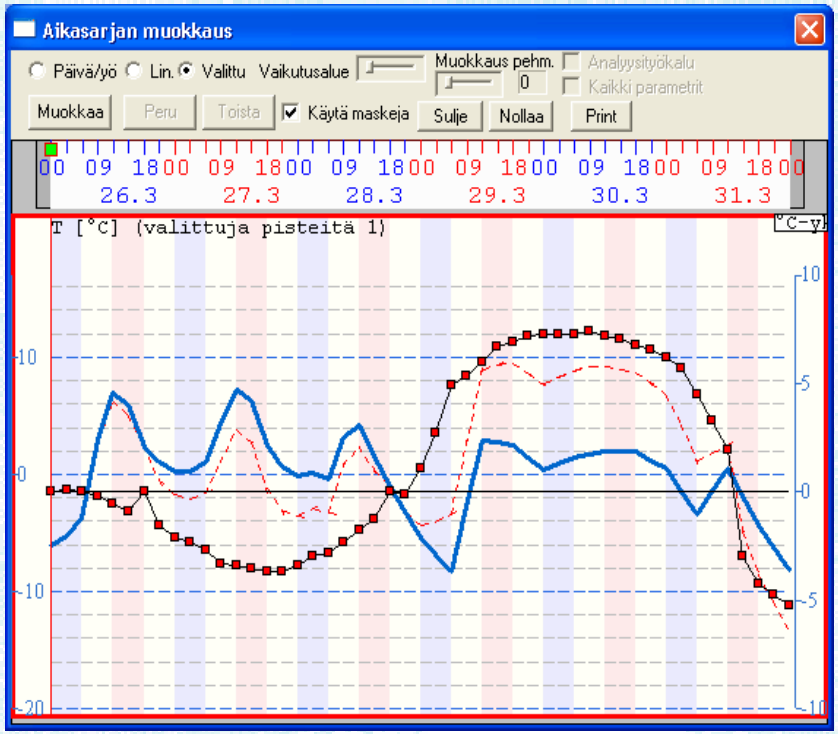




The Grid Editor

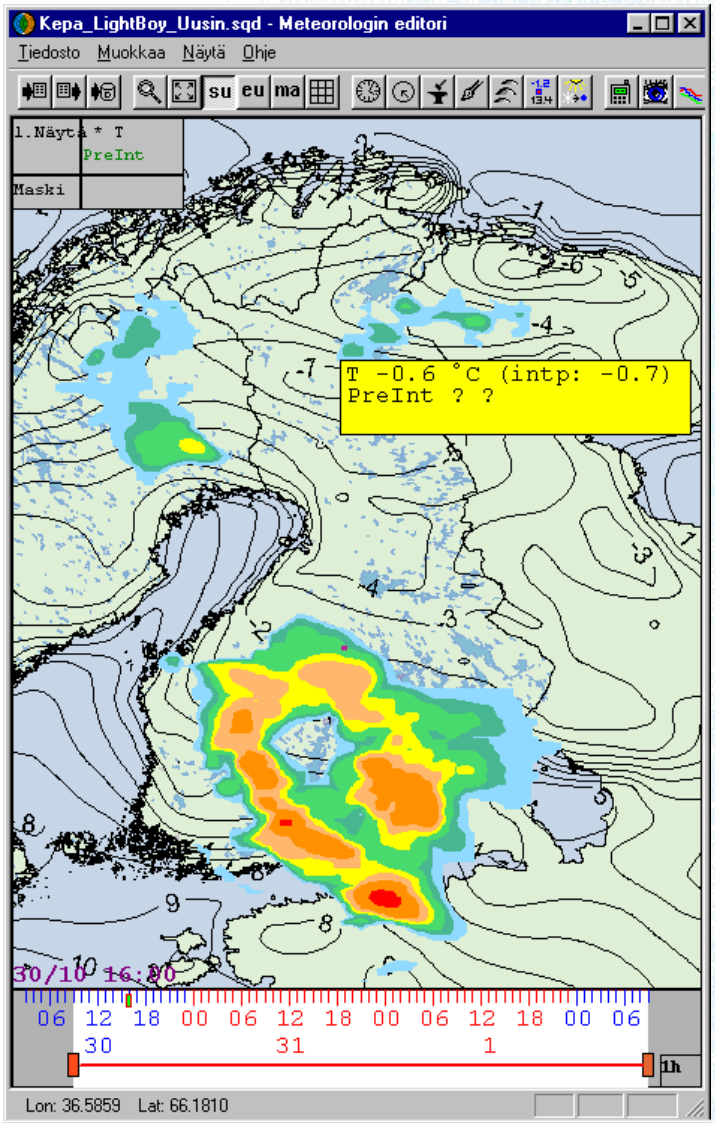
Time series editing tool

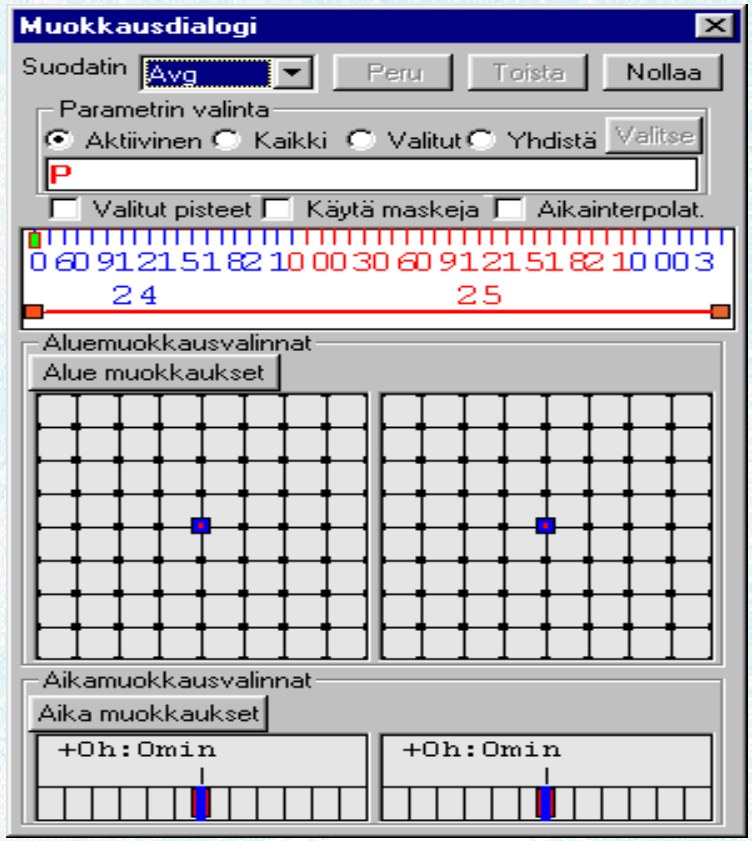




The Grid Editor

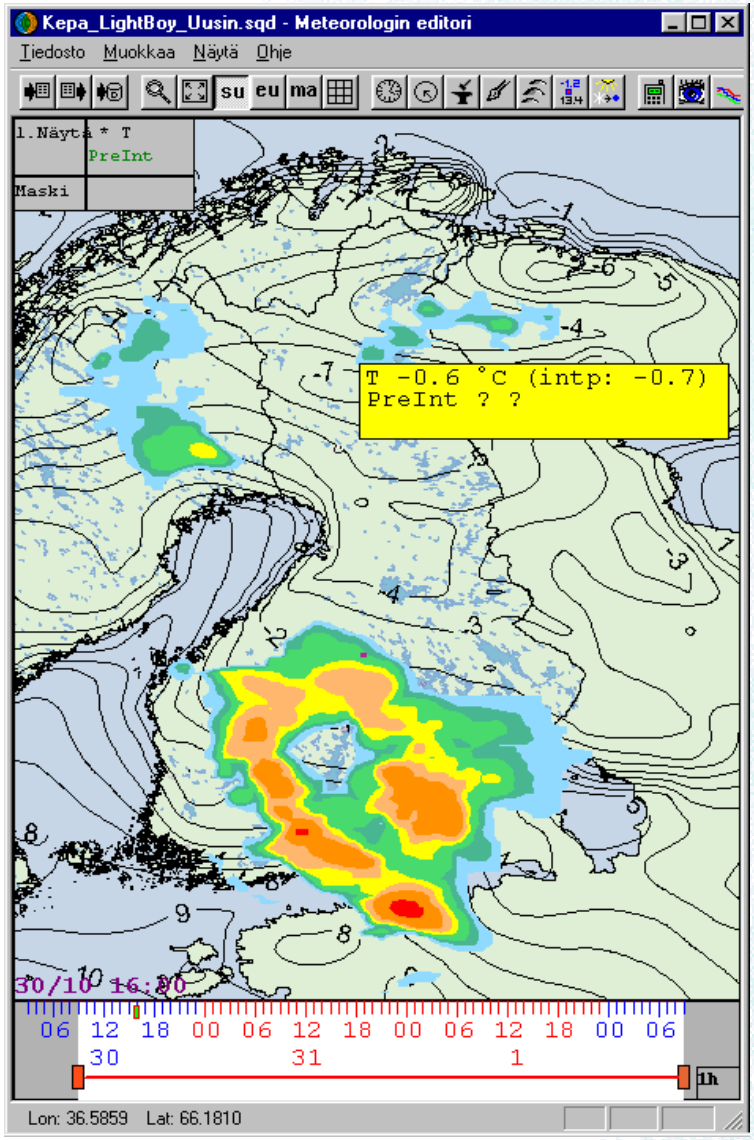
Grid editing windows

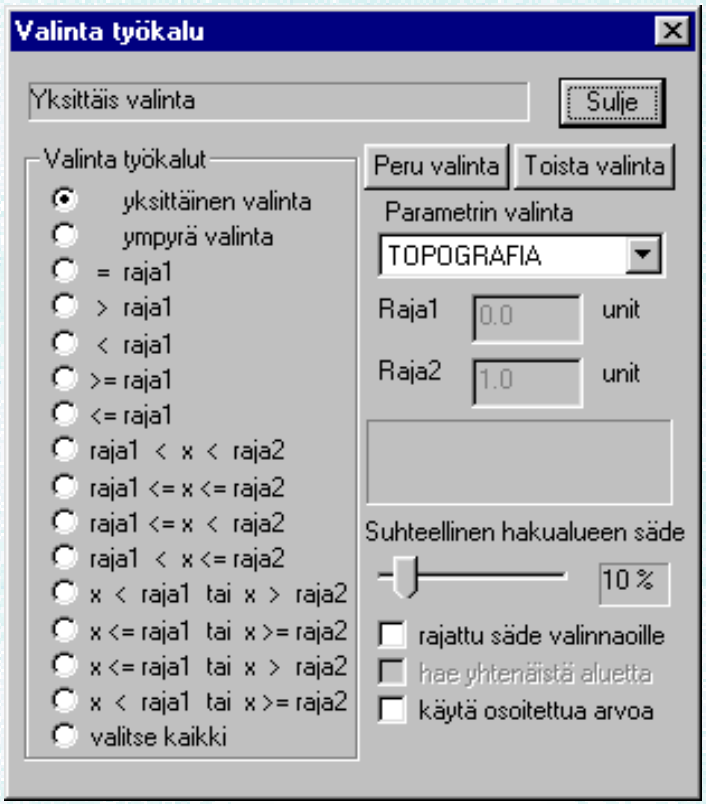




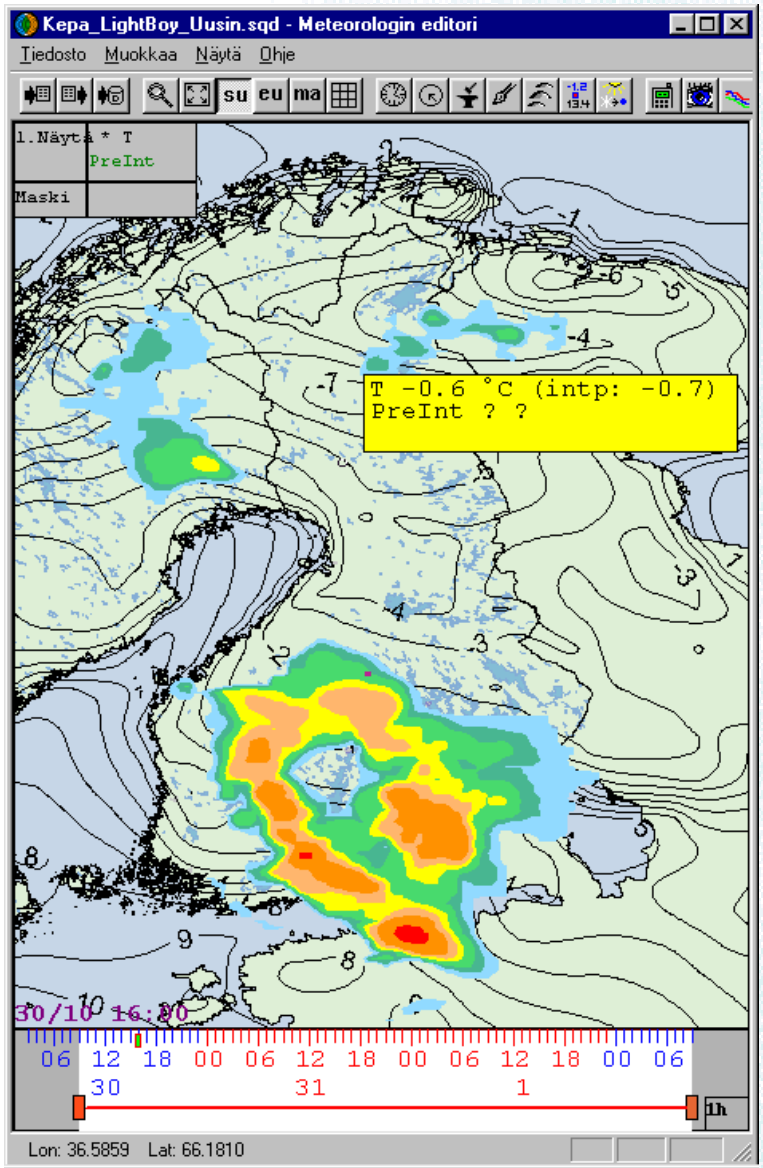
The Grid Editor

Mask editing windows





The Grid Editor



Paint brush tool

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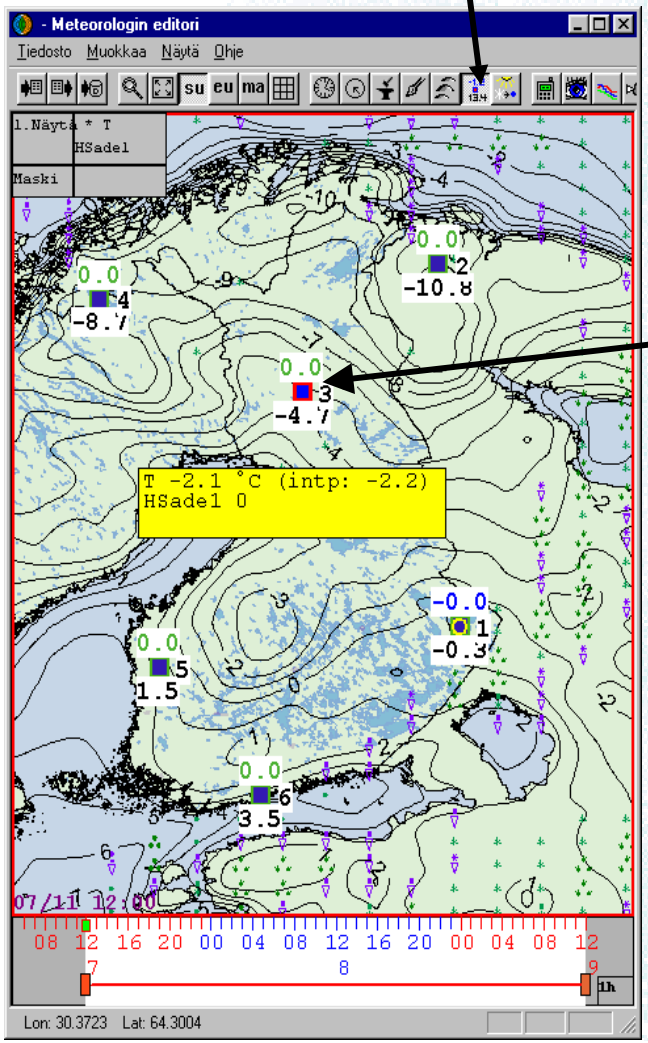
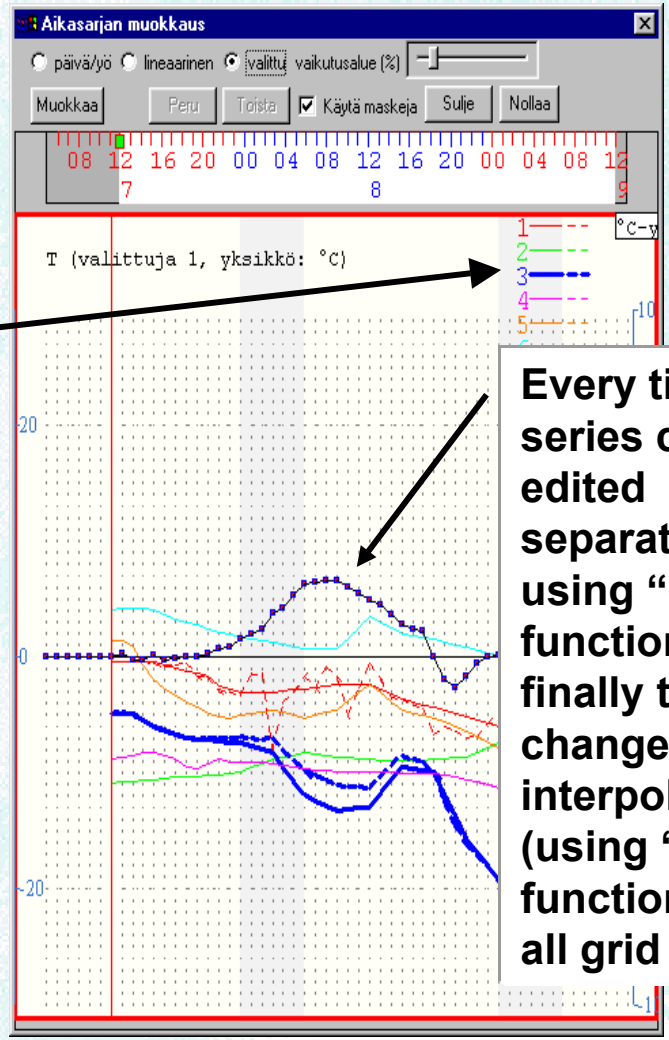
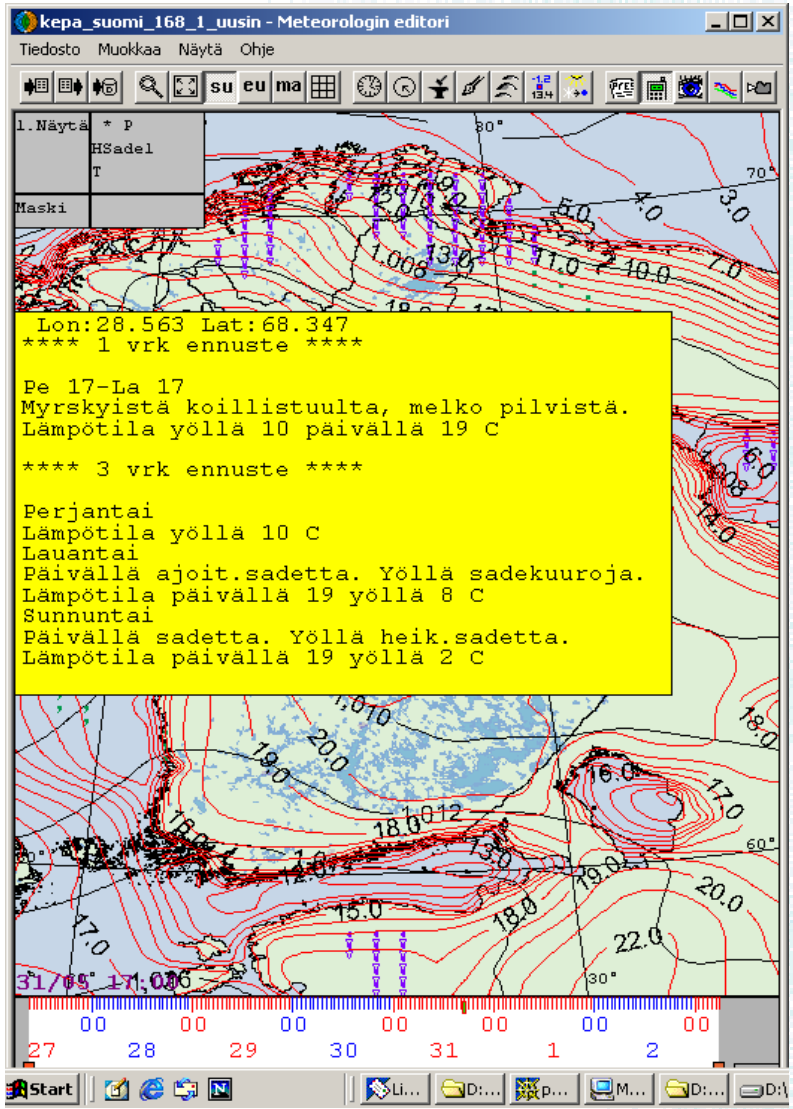
Control point editing





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



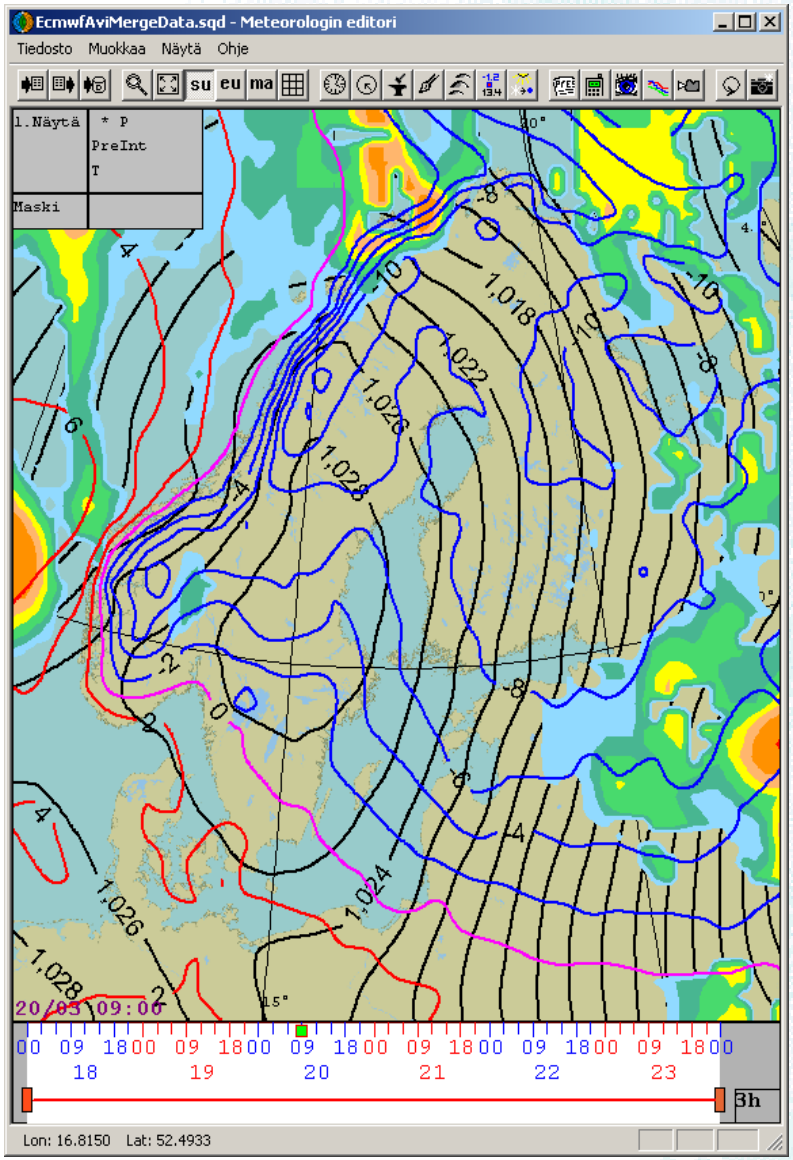
The Grid Editor

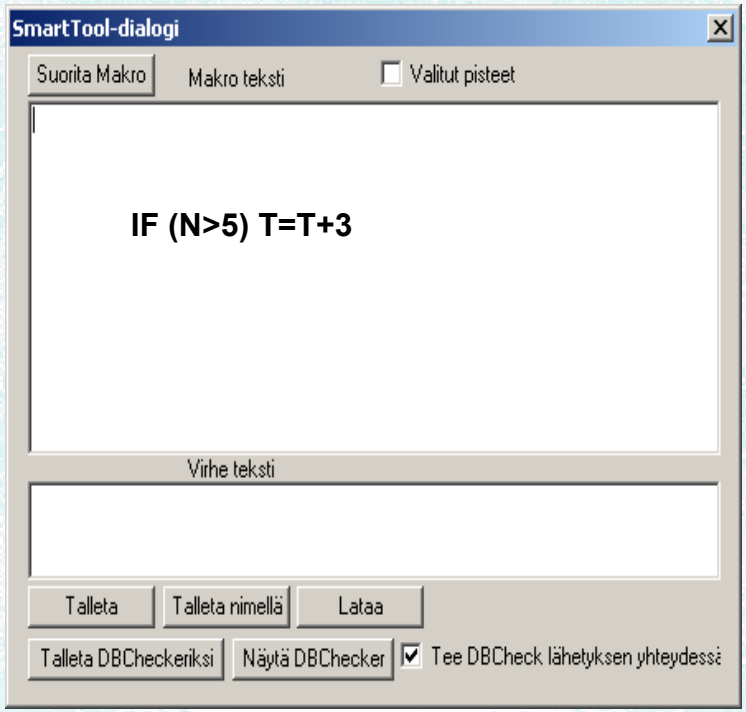
Text generation tool:

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

The Grid Editor

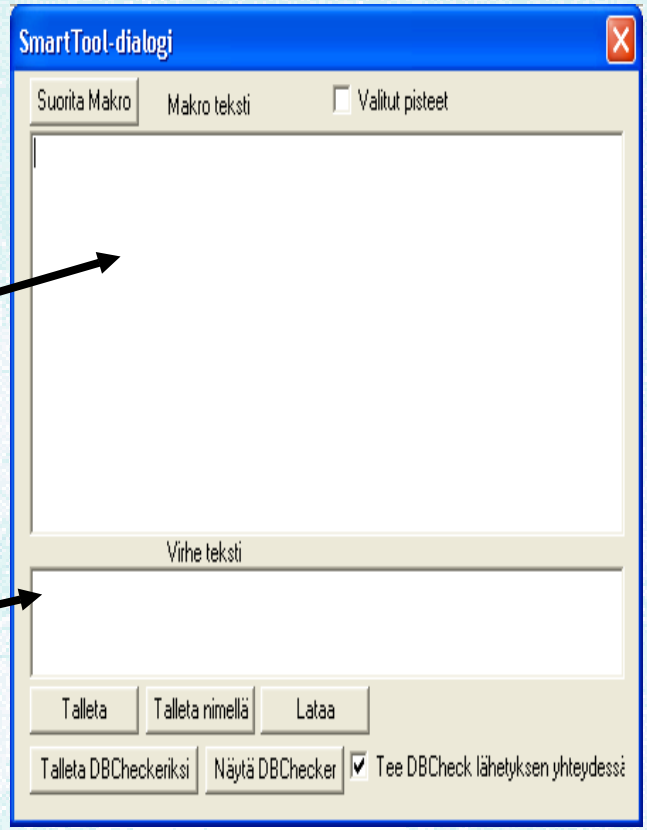
Smart Tools: ability to make scripts to perform more complicated and often repeated editing actions in a more easy manner





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
    betweenn 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 (CONTINOUS, 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	SHORTES 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 maximim 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 (douple ramp)

Grid Editor - SmartTools

```
// Säteilykorjaus  (Radiation correction)
// SN 2002.09.30
// pilvisyys korjataan => säteilyt korjataan
// ECMWF-lyhytaaltosäteily liian pieni selkeissä tilanteissa => 20% lisäys,
// Viitteet: Lauros Johanna, 2001, Tienpinnan talviset liukkausolosuhteet 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
```

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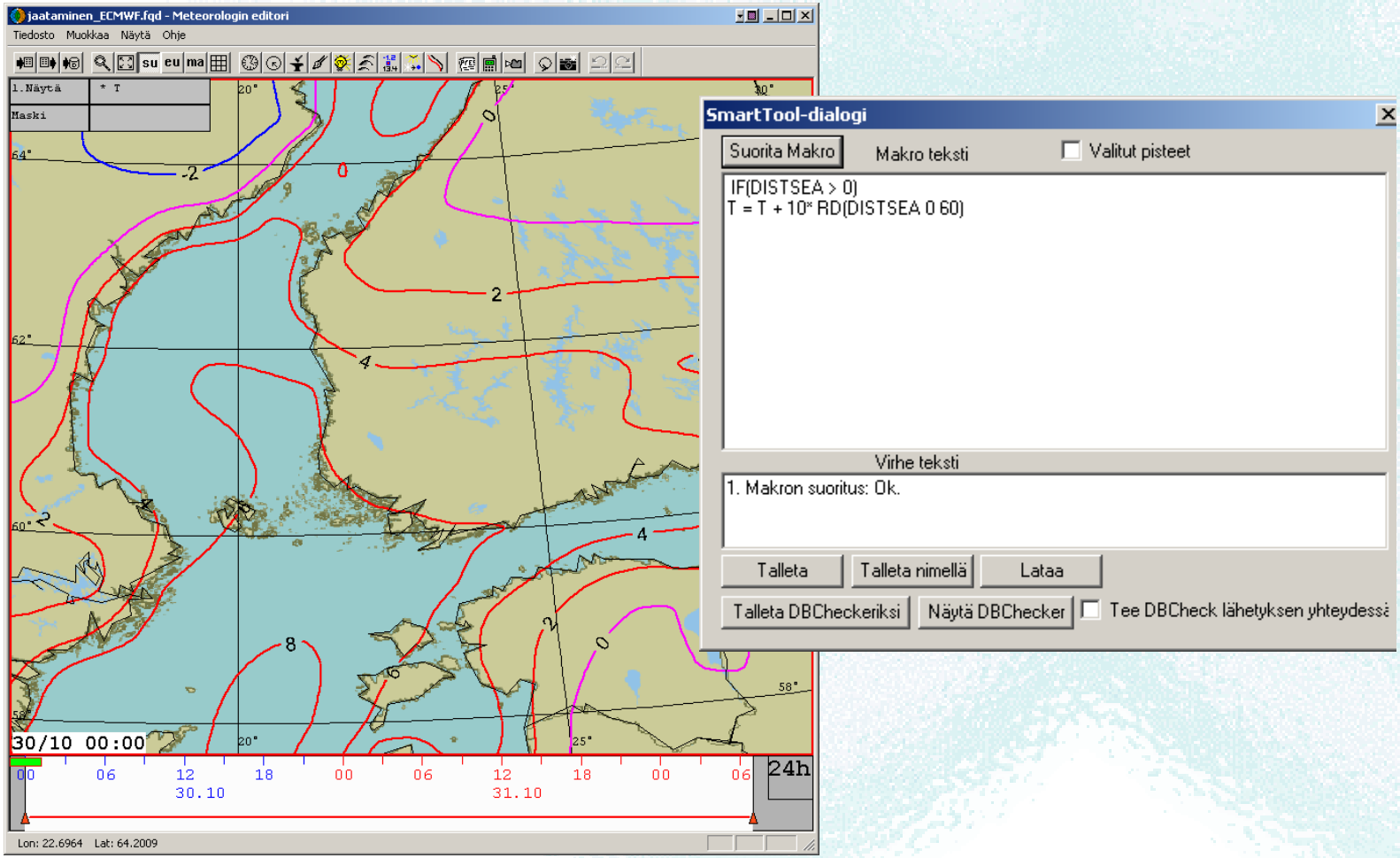
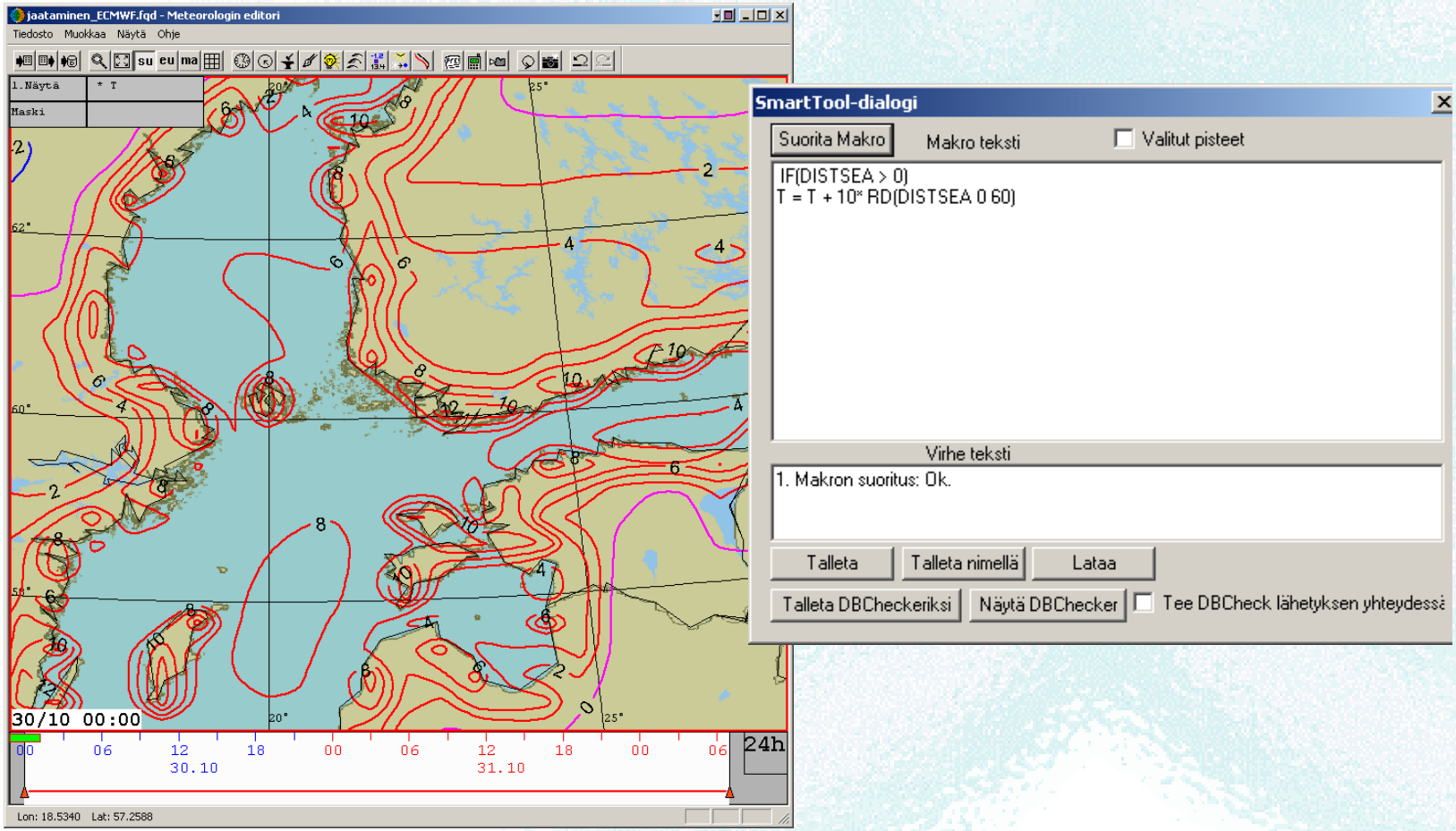
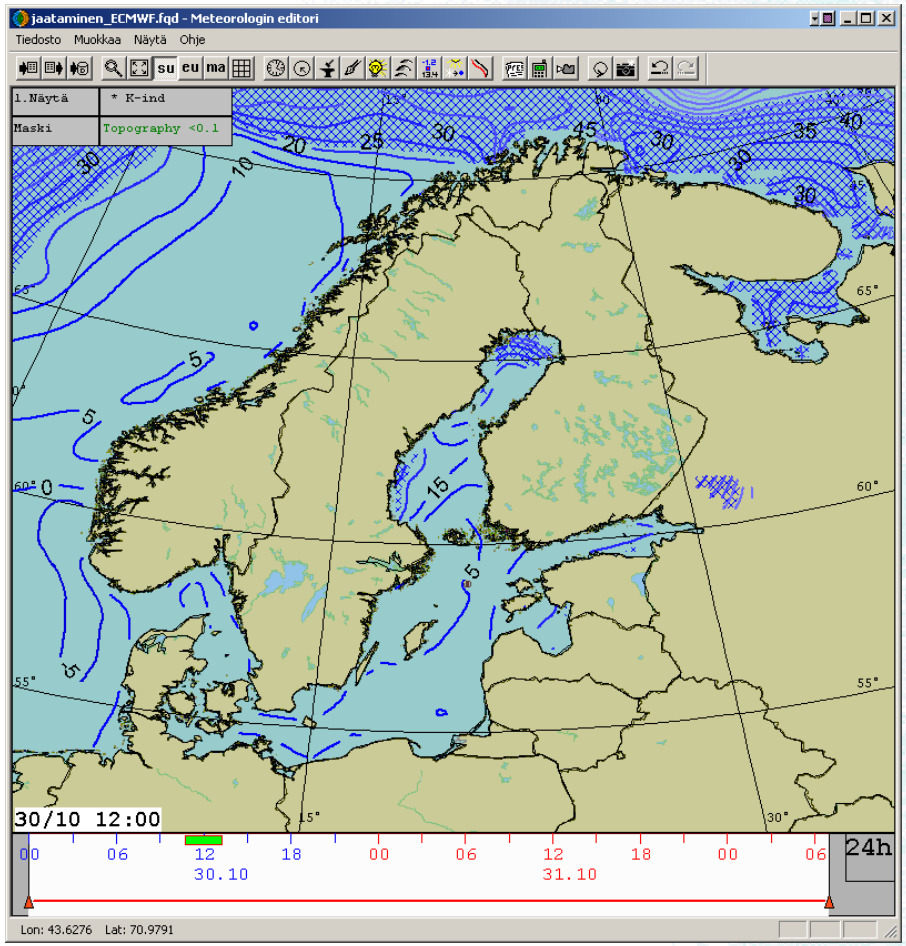
Grid Editor – SmartTools
Application: Small scale editing

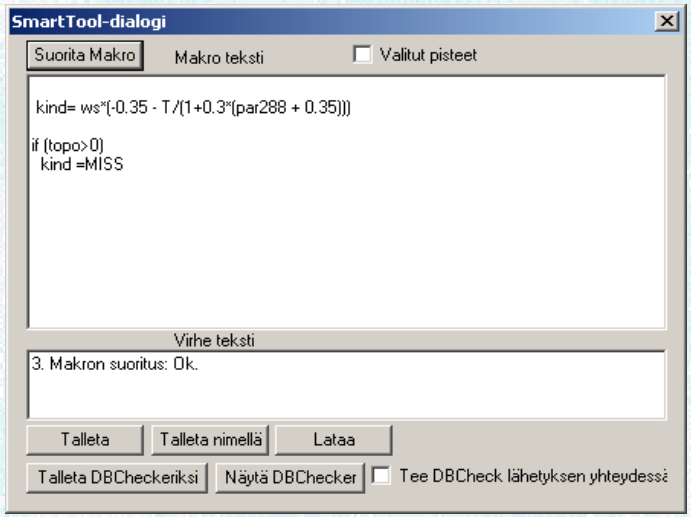


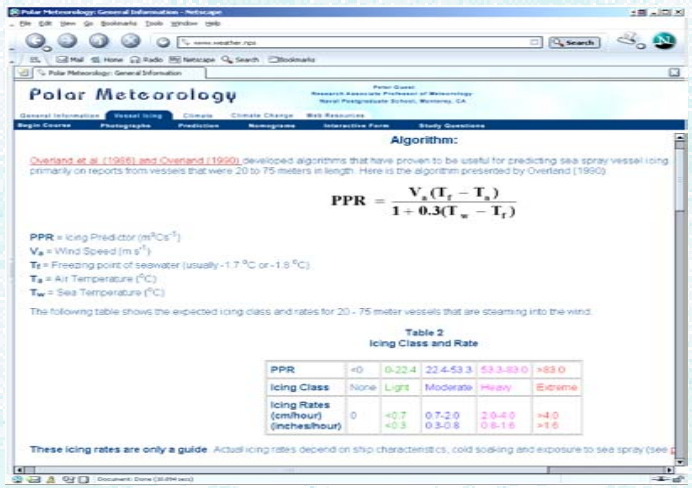
Grid Editor - SmartTools



Grid Editor – SmartTools
Application: Icing predictor for Oceans







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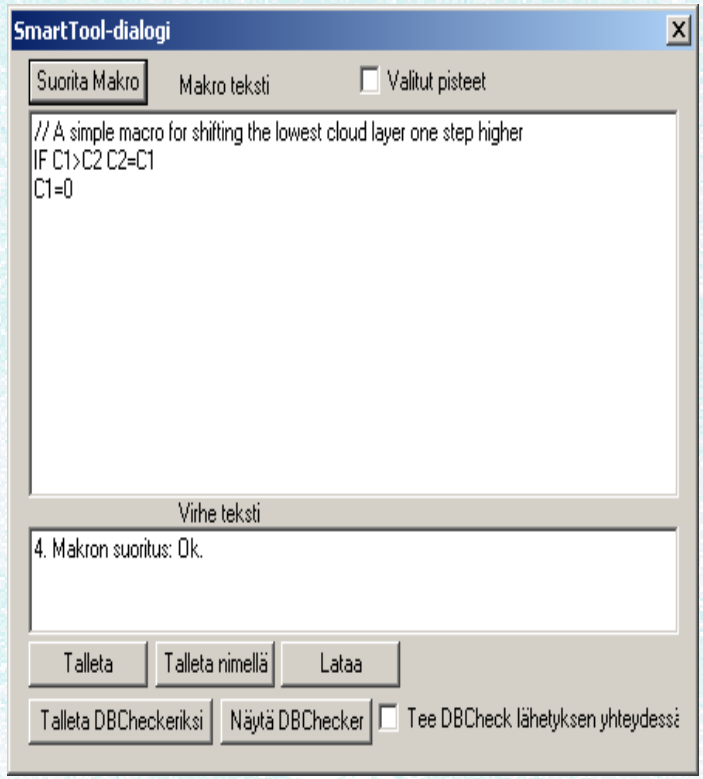
Editing of aviation parameters (near future)

Edited parameters:

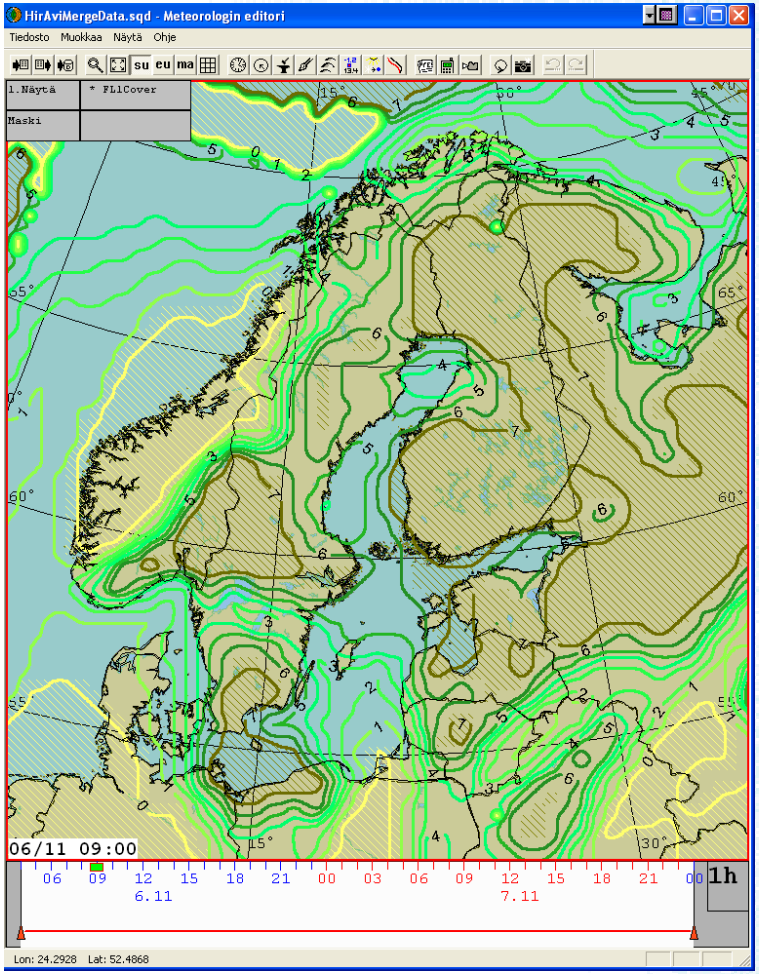
cloud amount in ICAO layers
intensity of fog (0,1,2)
intensity of precipitation (mm/h)
(edited already elsewhere)

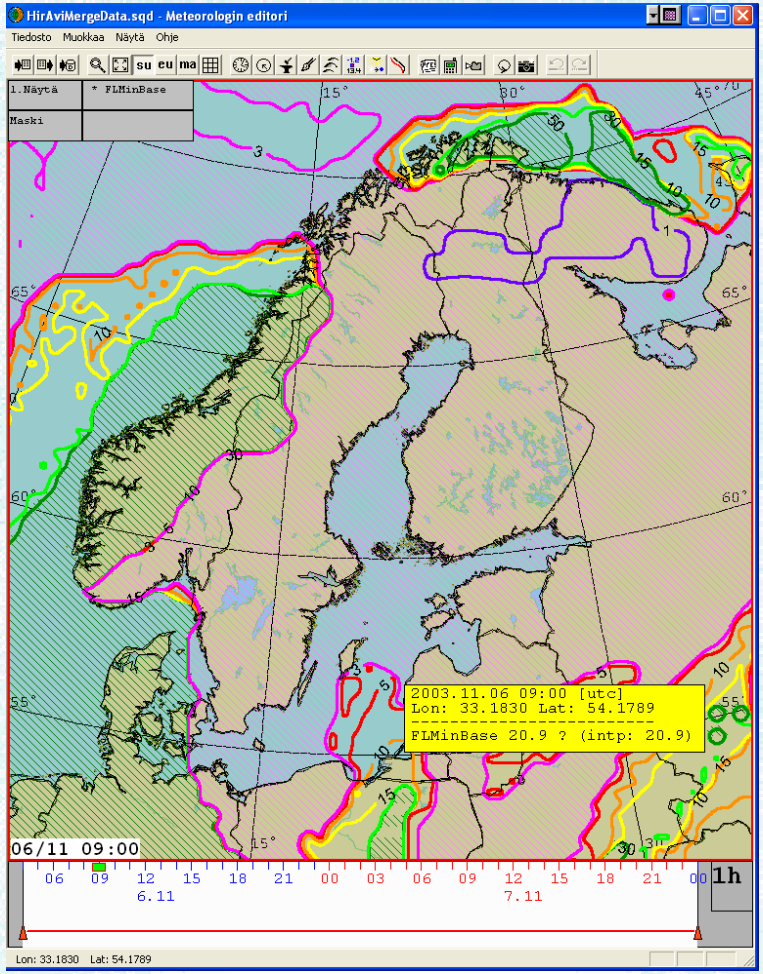
SmartTools scripts are mainly used

Visibility and ceiling height are derived from edited and interpreted parameters

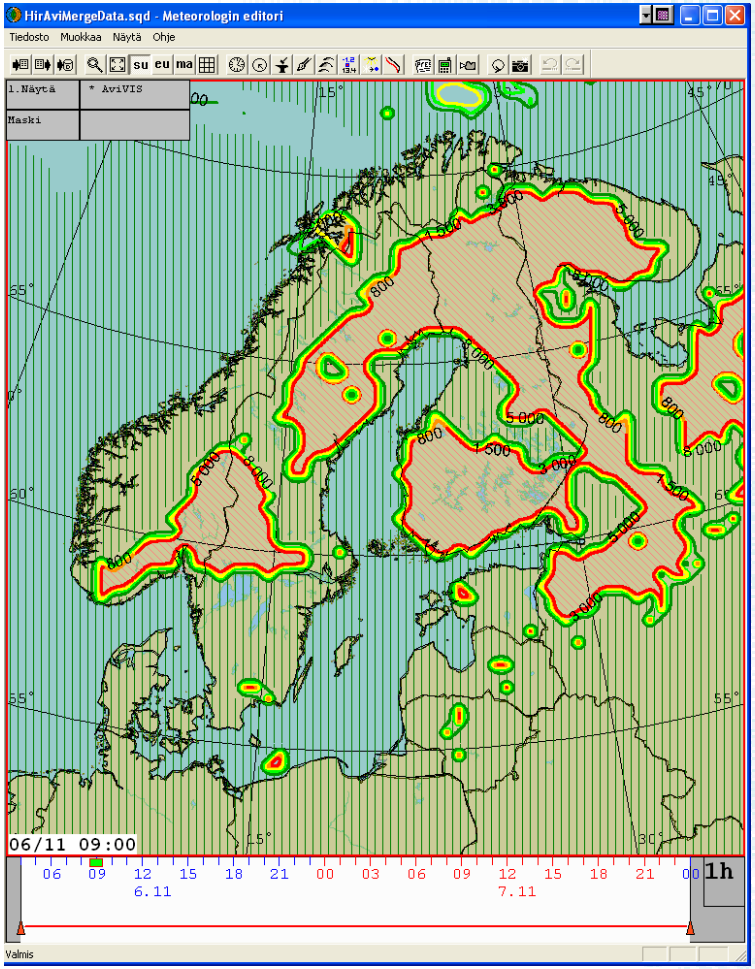


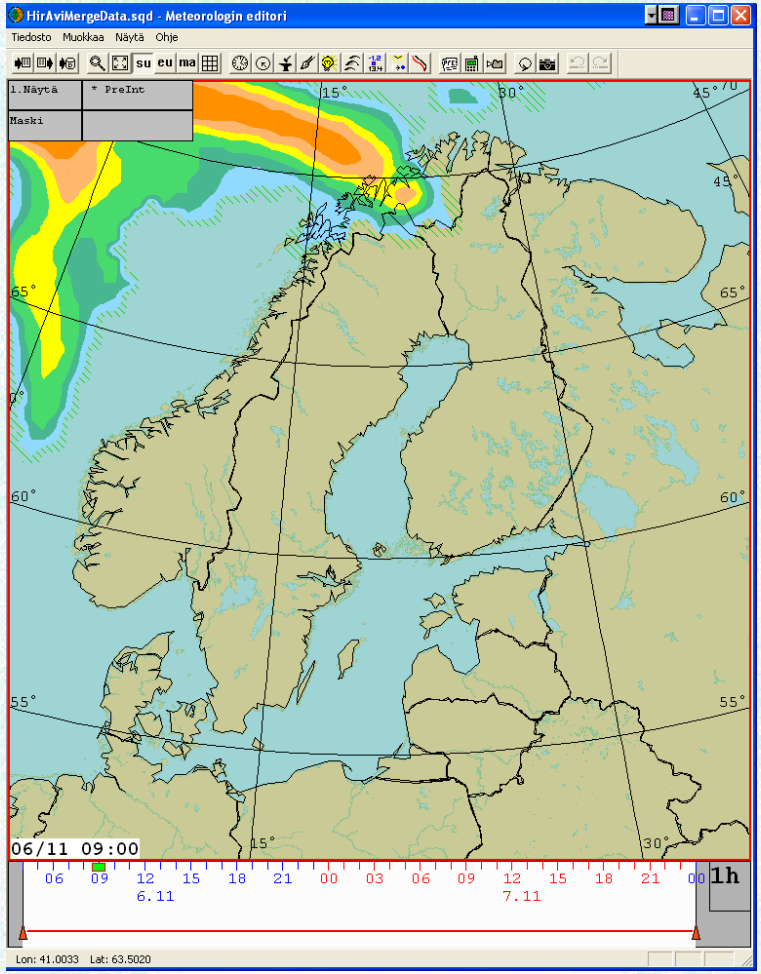
Editing of aviation parameters (cloud base)





Editing of aviation parameters (visibility/rr)





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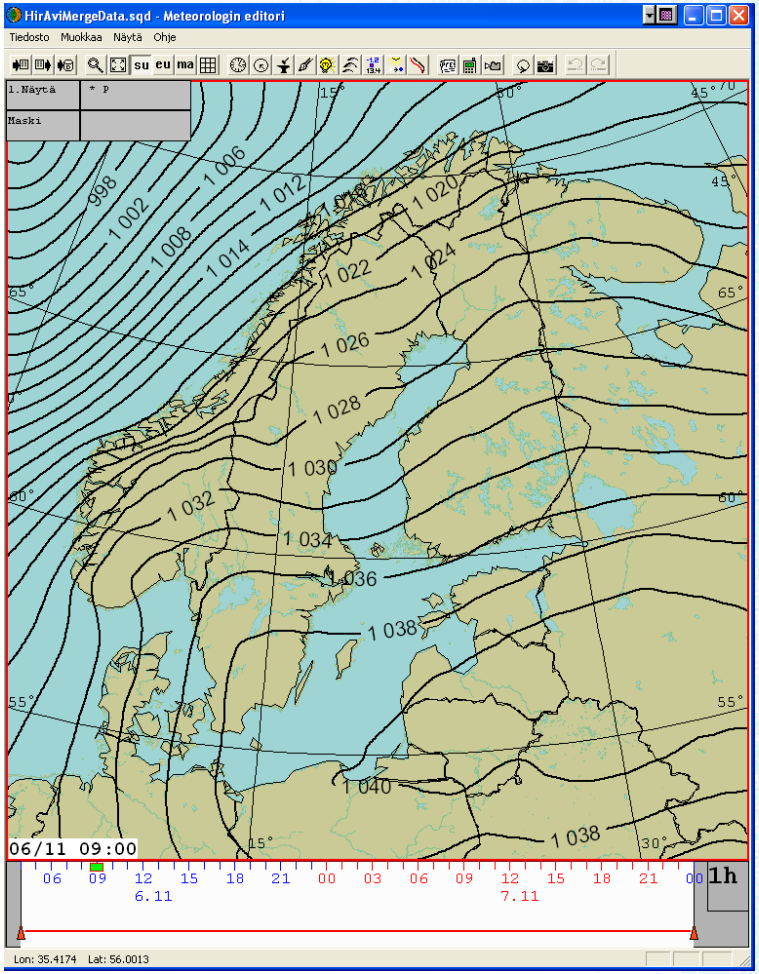
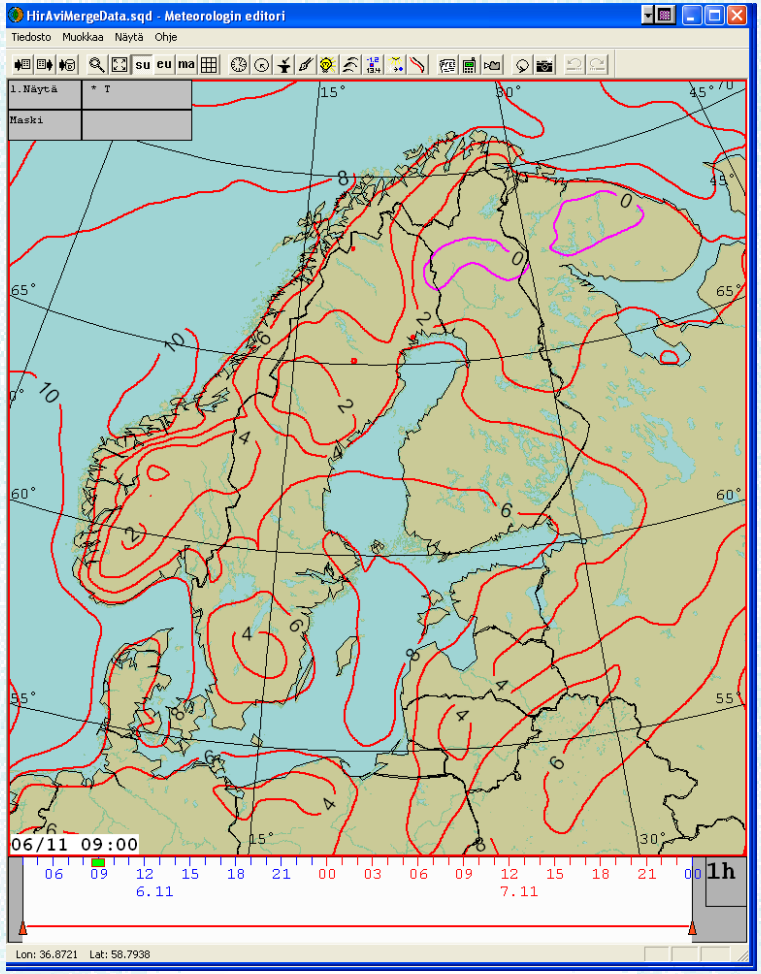
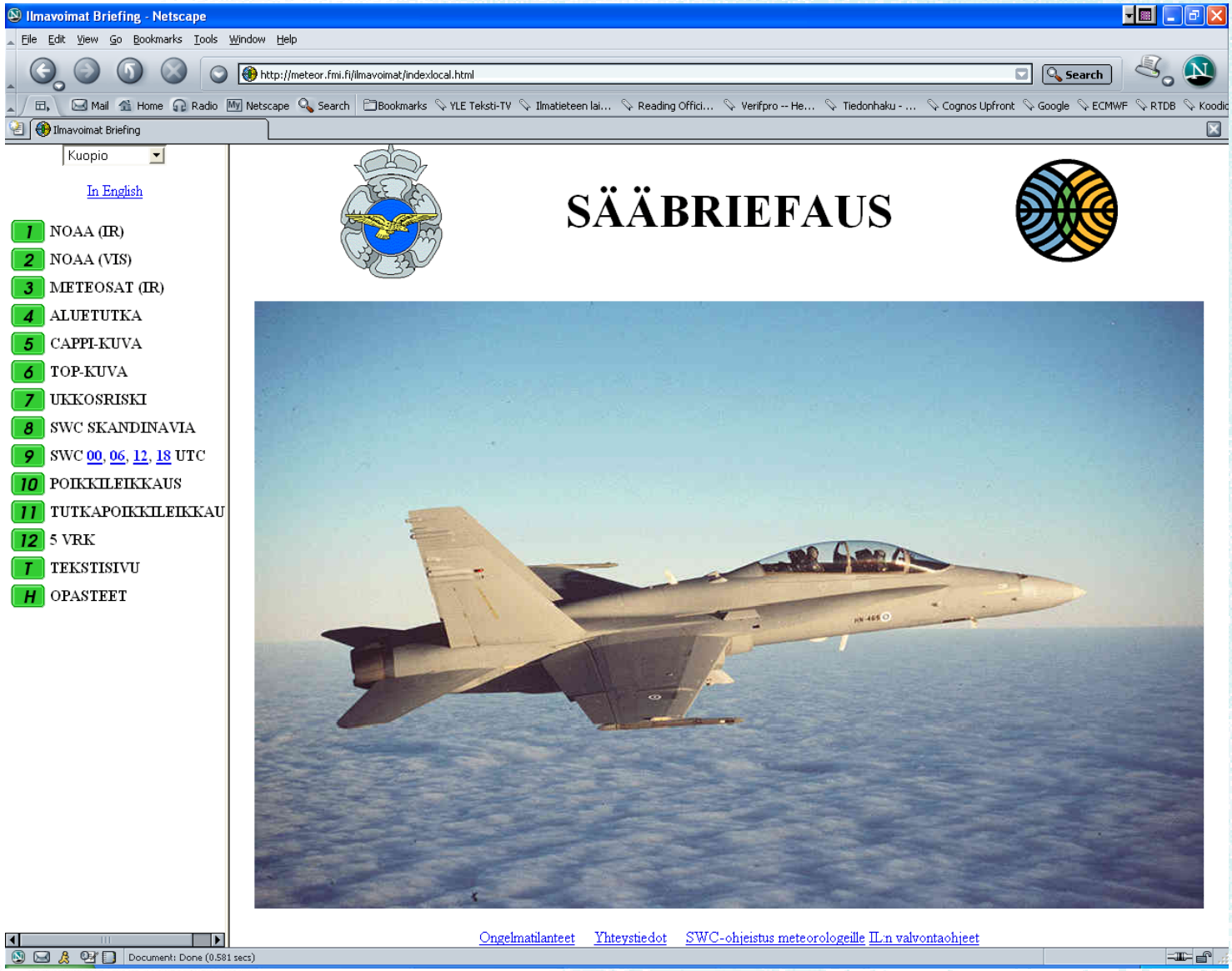
Editing of standart parameters (ps/T2m)







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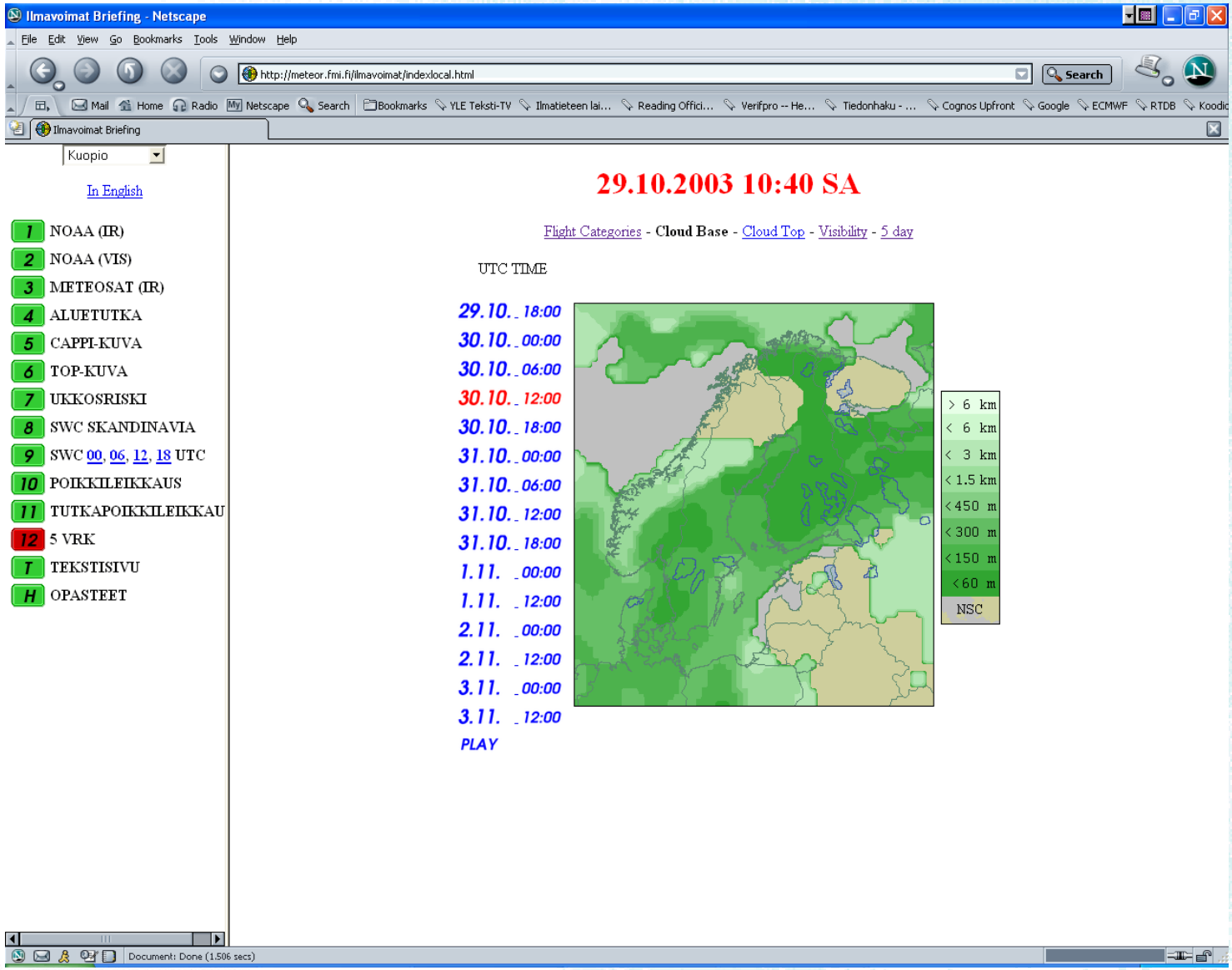
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5 CAPPI-KUVA
6 TOP-KUVA
7 UKKOSRISKI
8 SWC SKANDINAVIA
9 SWC 00, 06, 12, 18 UTC
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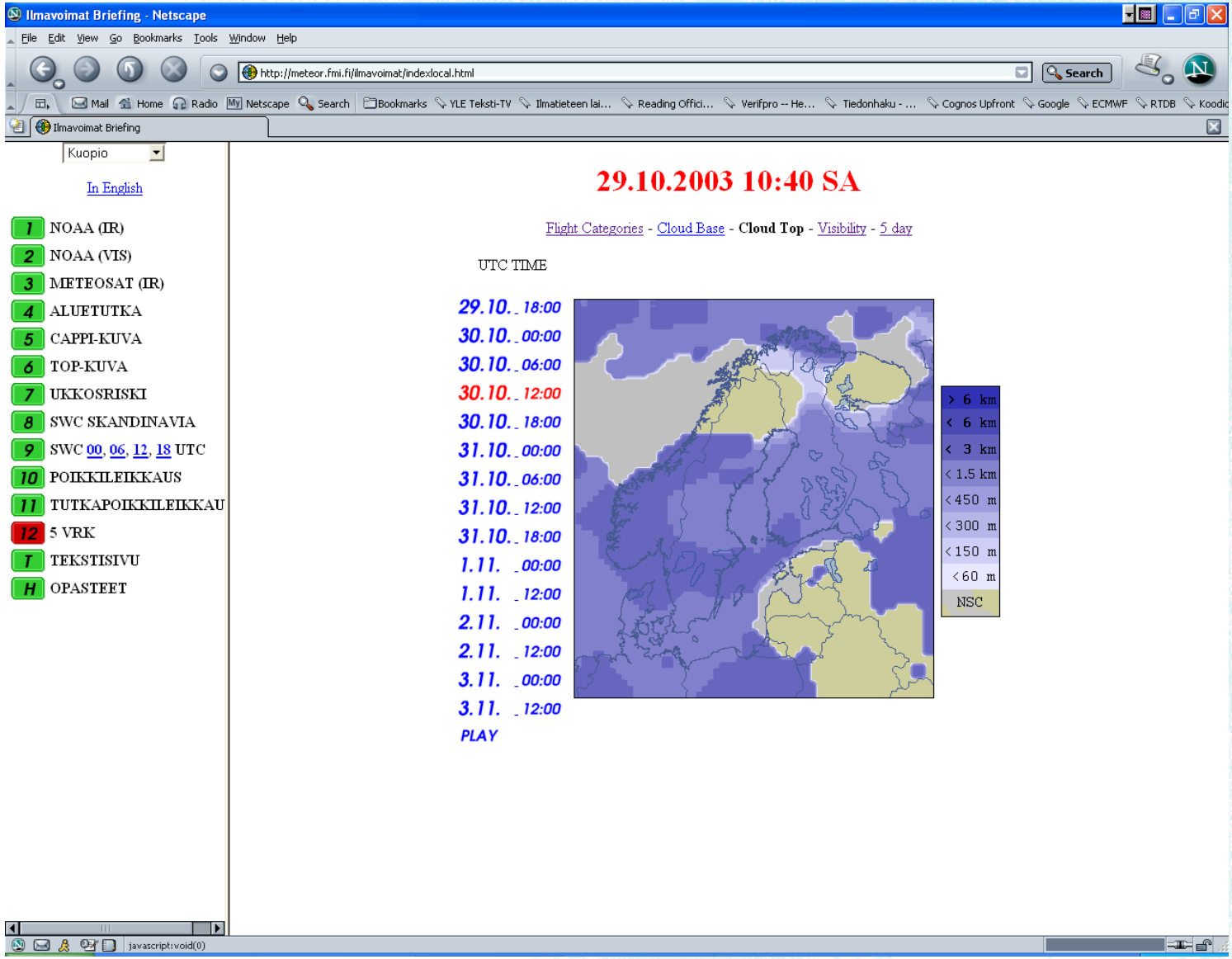

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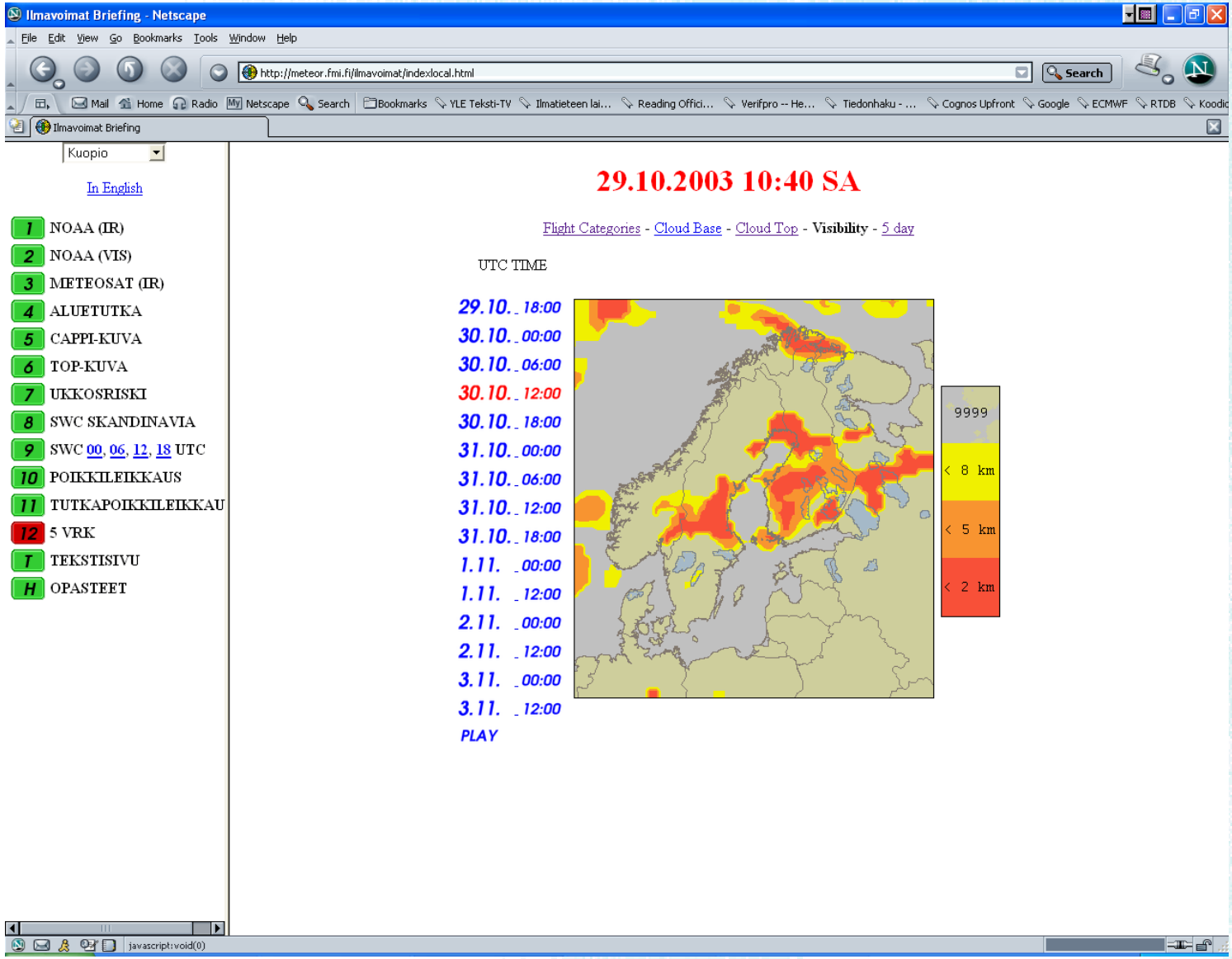
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3 METEOSAT (IR)
4 ALUETUTKA
5 CAPPI-KUVA
6 TOP-KUVA
7 UKKOSRISKI
8 SWC SKANDINAVIA
9 SWC 00, 06, 12, 18 UTC
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12 5 VRK
T TEKSTISIVU
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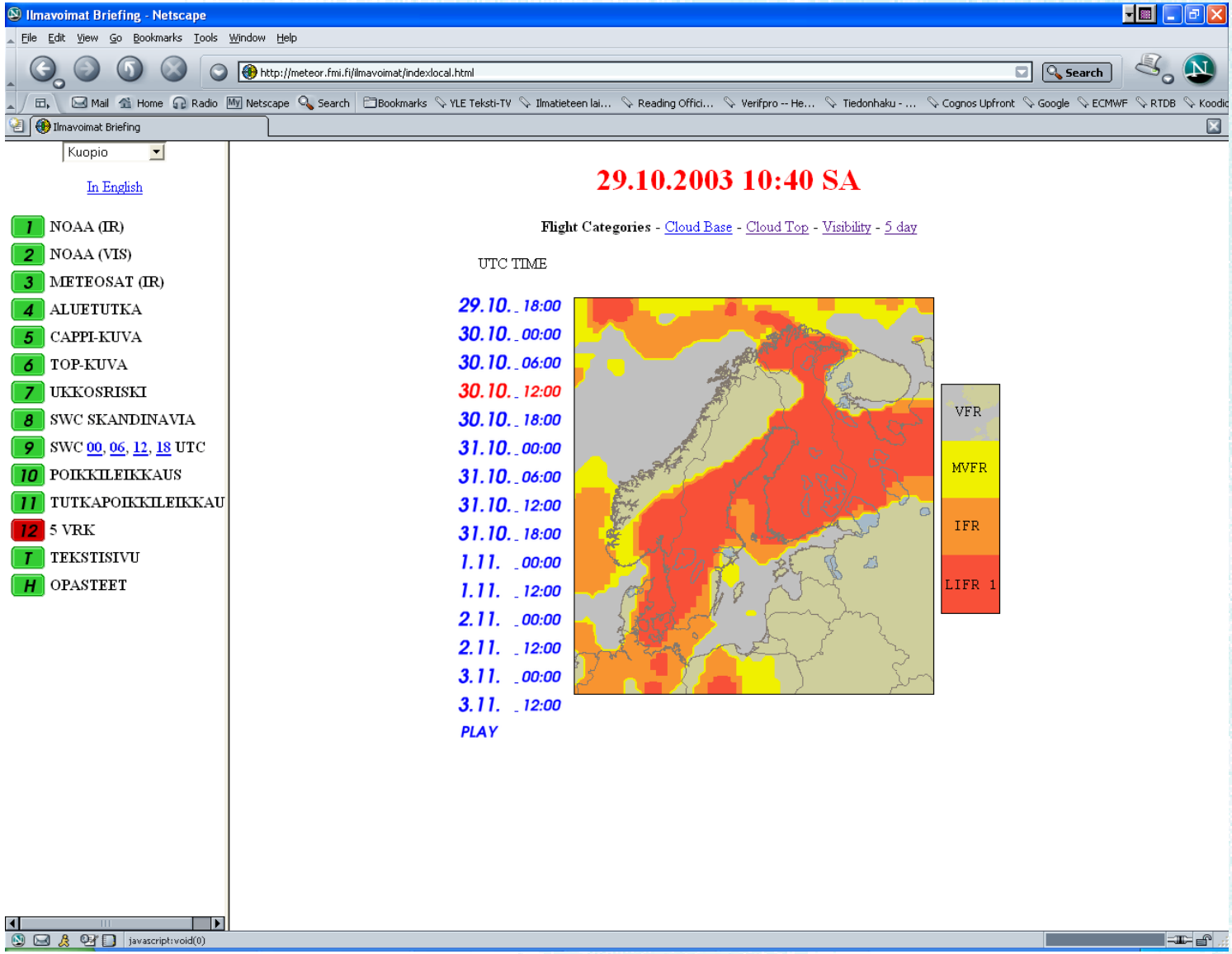
29.10.2003 10:40 SA
Flight Categories - Cloud Base - Cloud Top - Visibility - 5 day
UTC TIME
29.10. 18:00
30.10. 00:00
30.10. 06:00
30.10. 12:00
30.10. 18:00
31.10. 00:00
31.10. 06:00
31.10. 12:00
31.10. 18:00
1.11. 00:00
1.11. 12:00
2.11. 00:00
2.11. 12:00
3.11. 00:00
3.11. 12:00
PLAY
9999
< 8 km
< 5 km
< 2 km
javascript:void(0)



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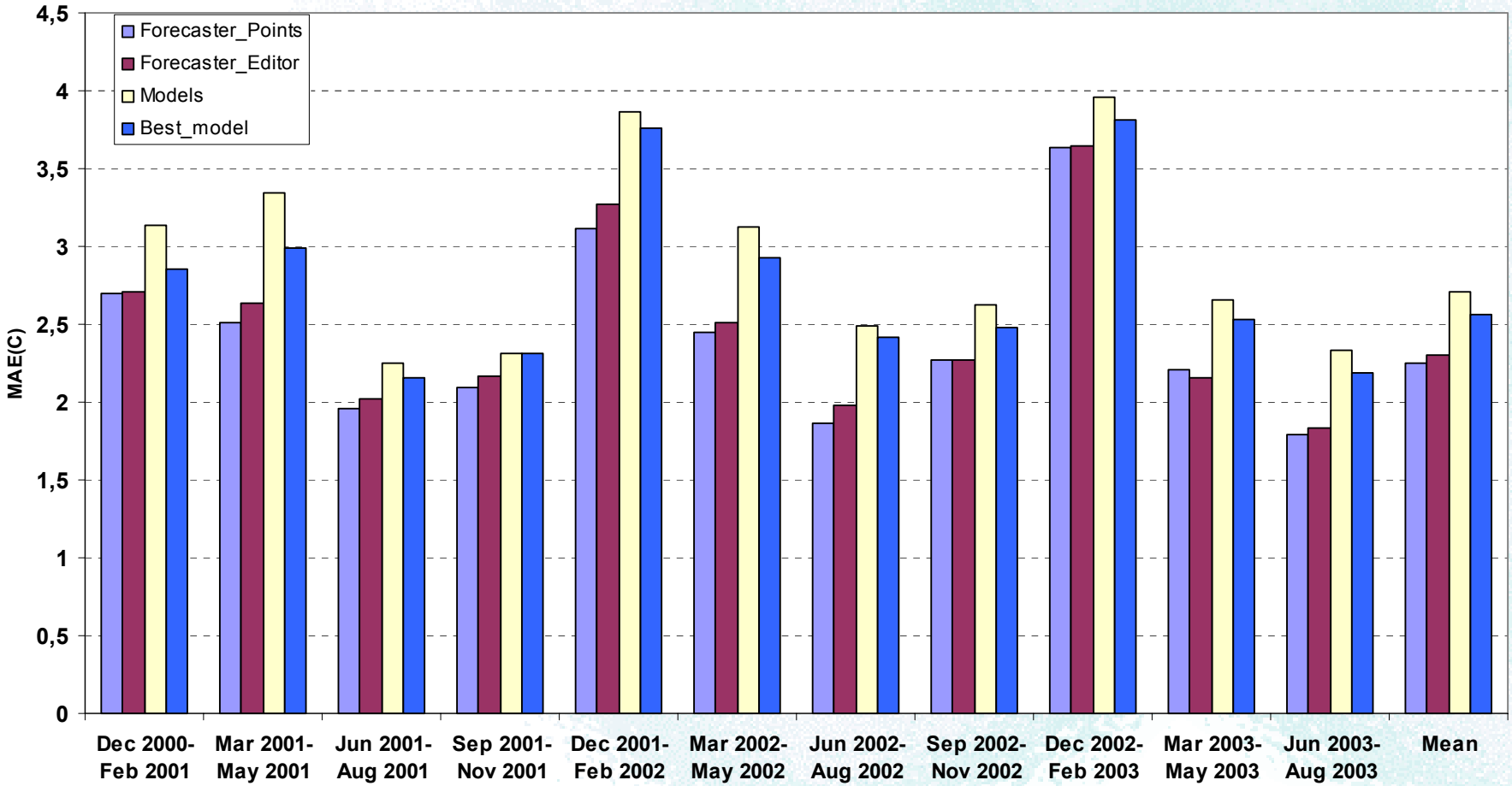
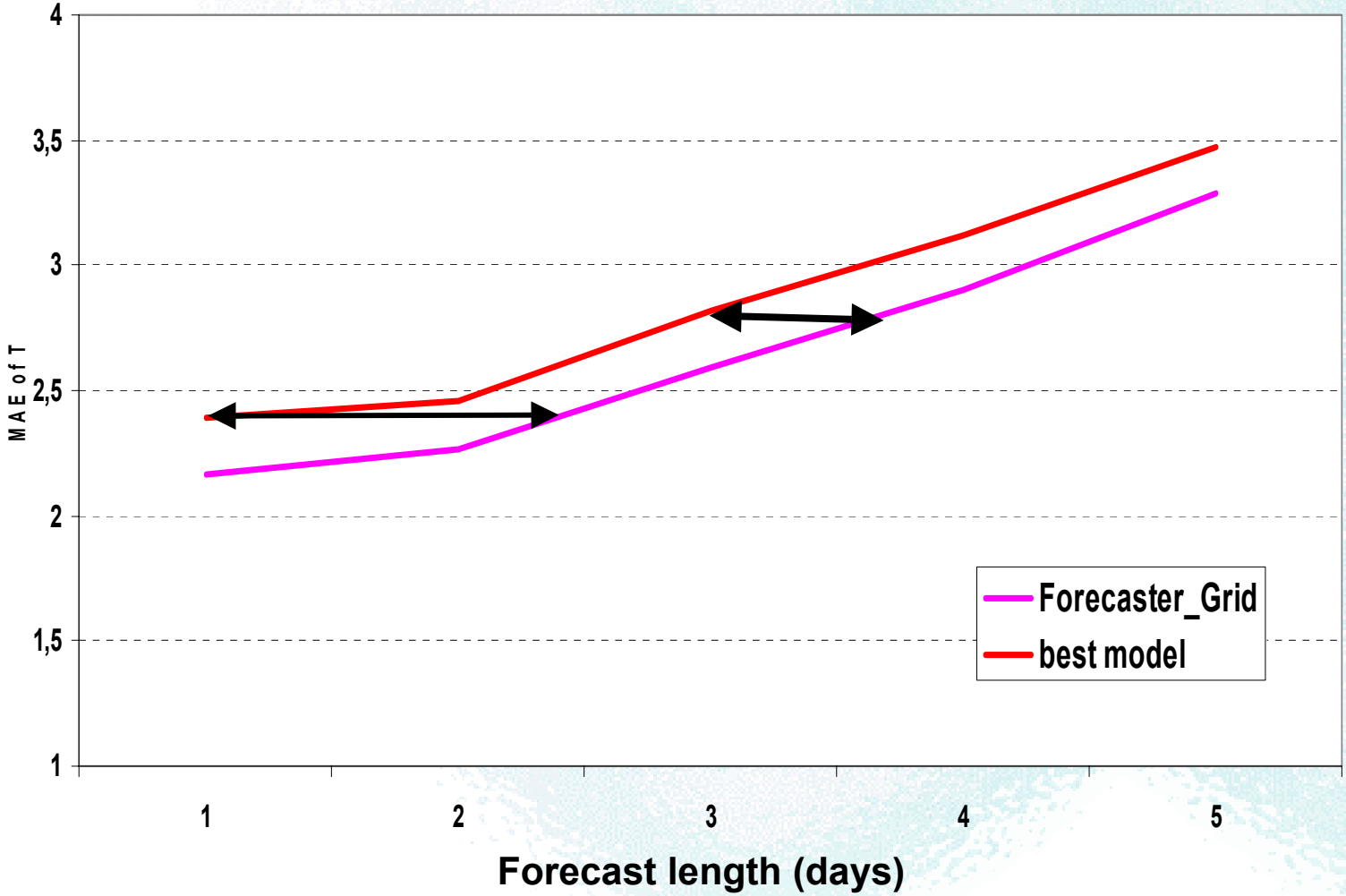
FINNISH METEOROLOGICAL INSTITUTE

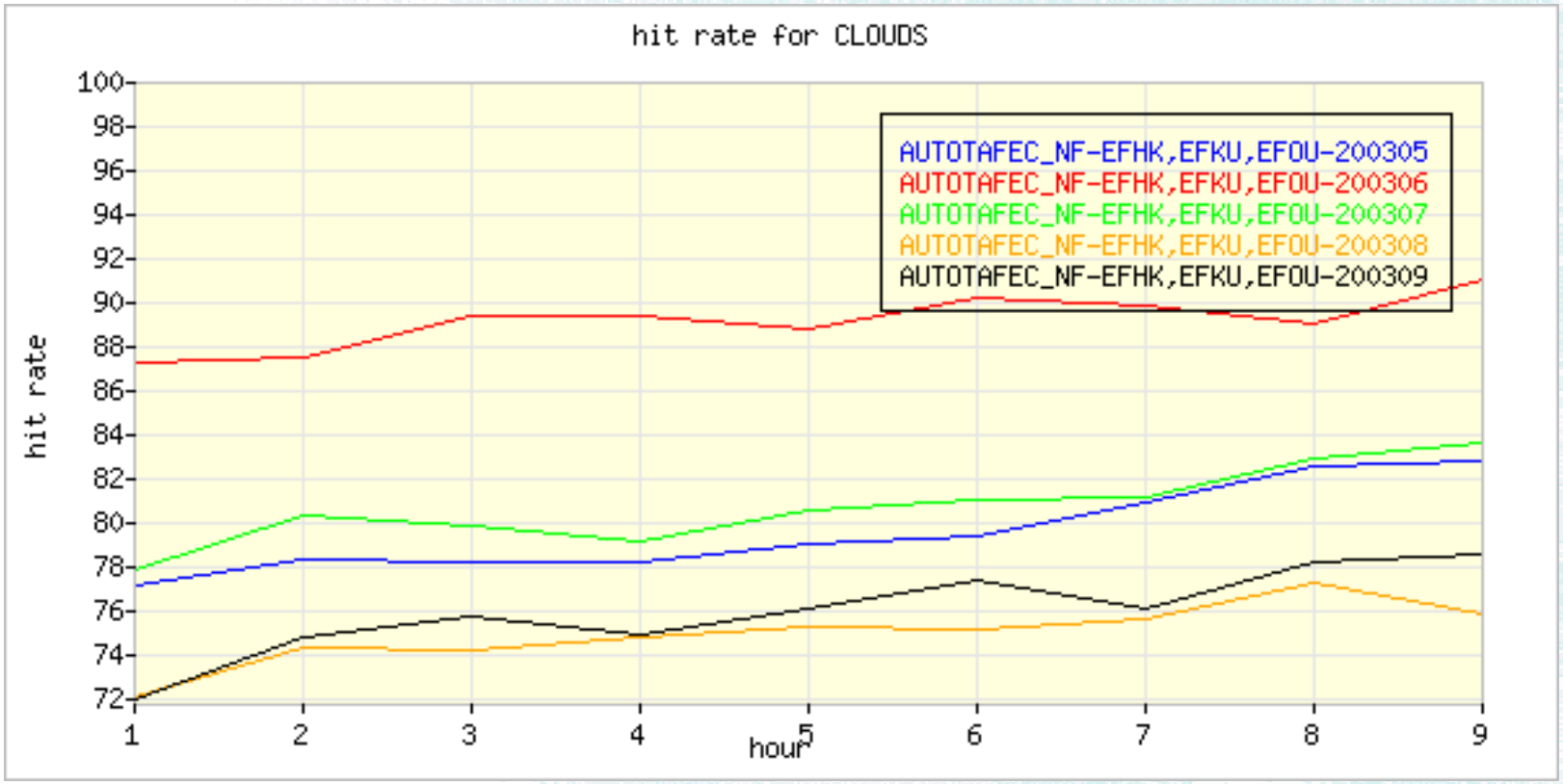
MAE of pooled temperature forecasts (3 stations, 11 seasons, 0.5-5 d)



MAE of temperature forecasts (3 stations, 2 years)



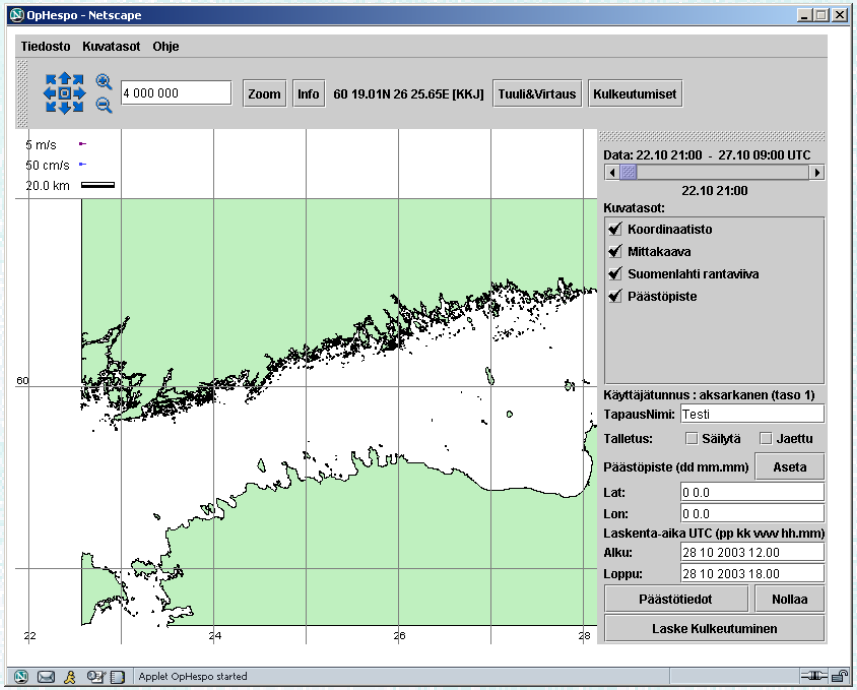
HIT RATE of Ceiling height forecast based on ECMWF data (raw data)



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 pricades etc. use system)
- User interface with Java
- Co-operation between FMI, Finnish Environment Institute and Finnish Institute of Marine Research



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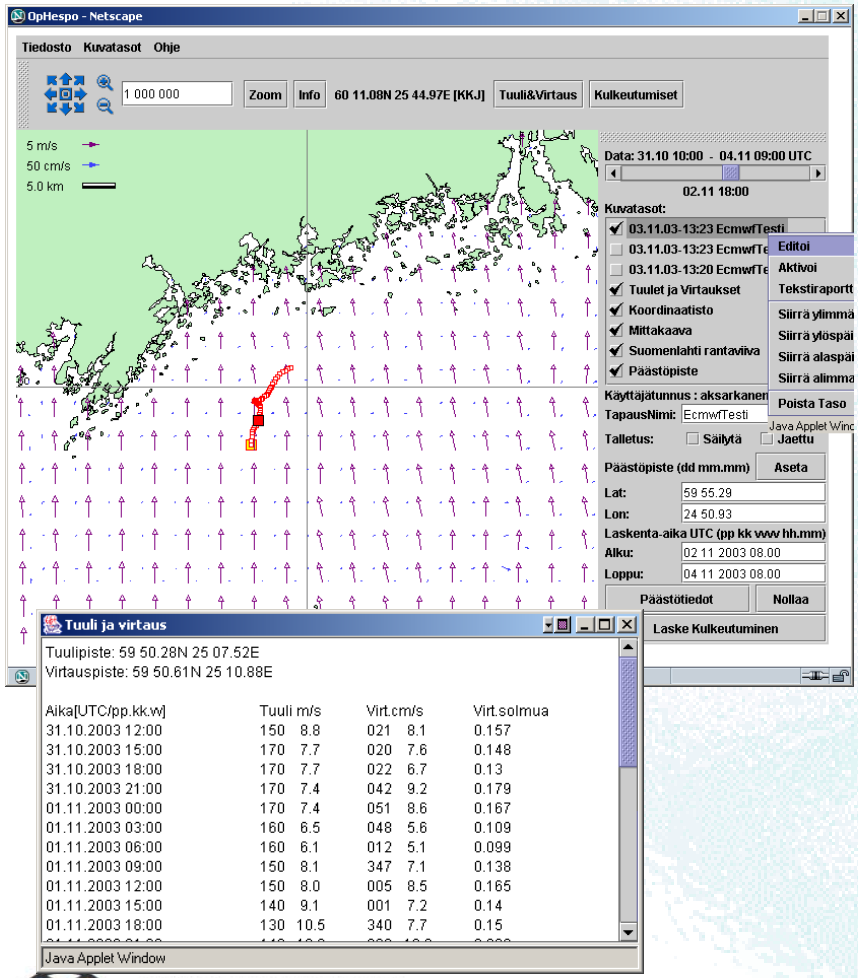
The model for oil spill movement in the Gulf of Finland



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

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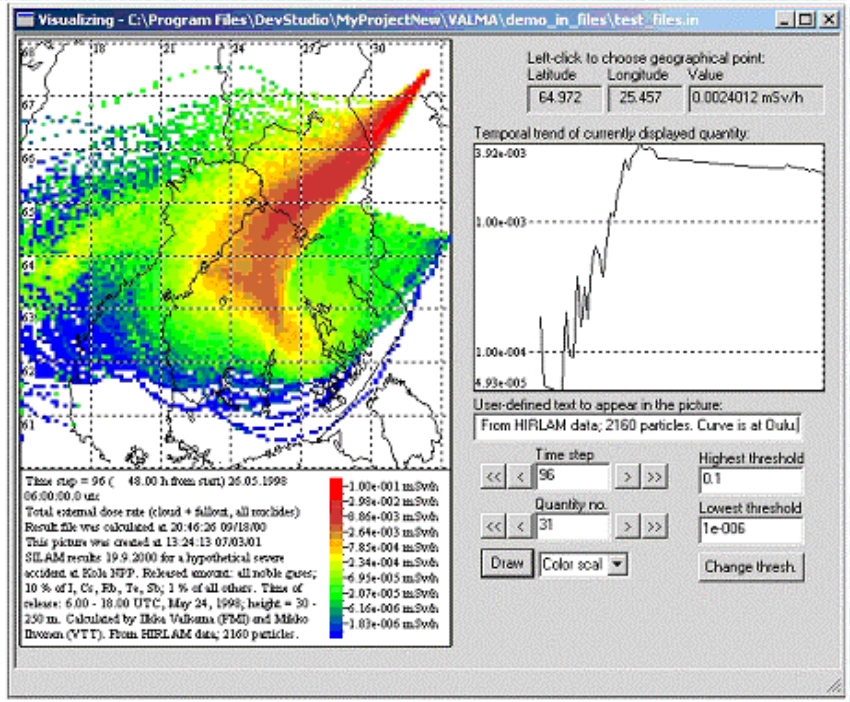
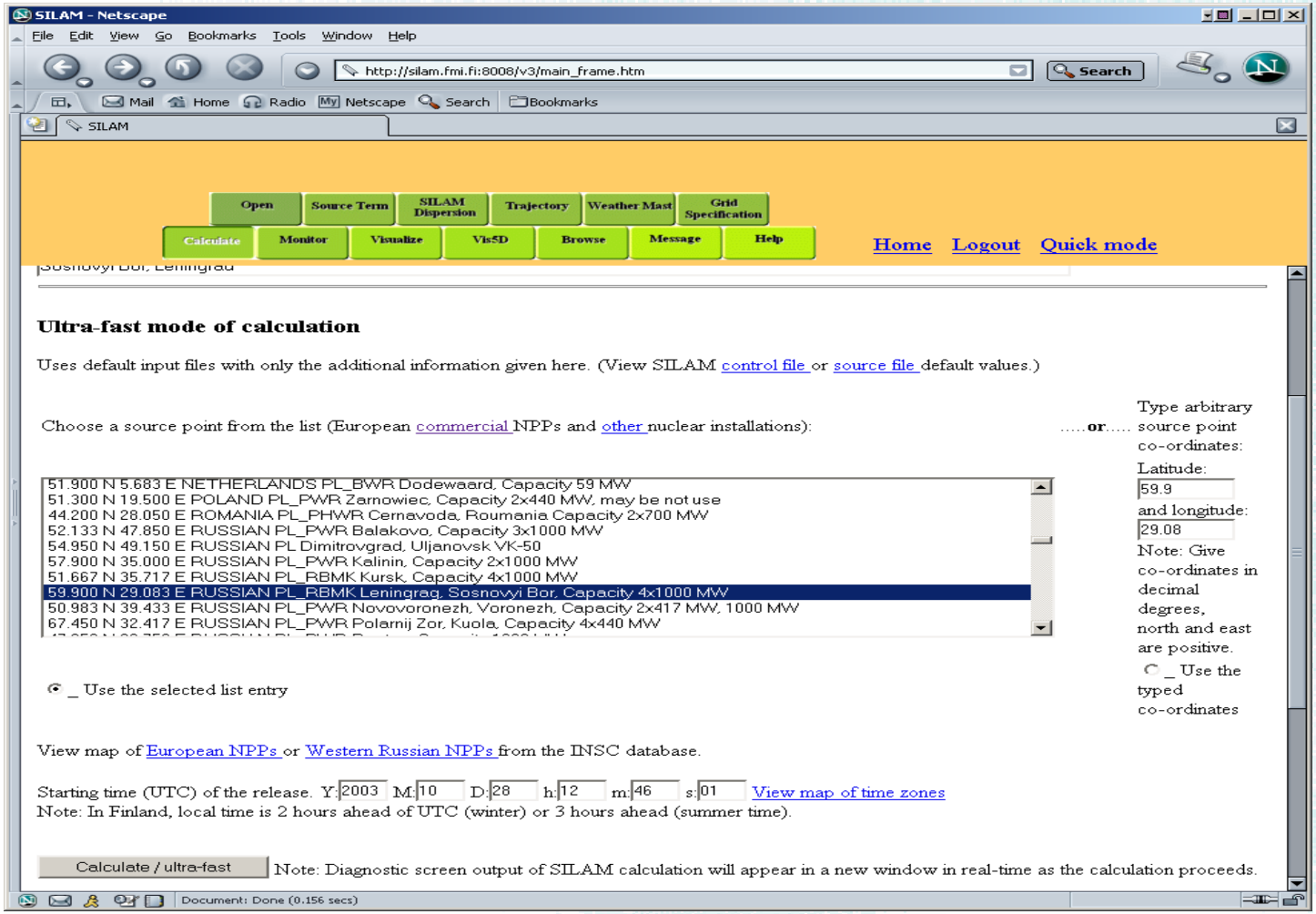
SILAM atmospheric dispersion and dose assessment model

- 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

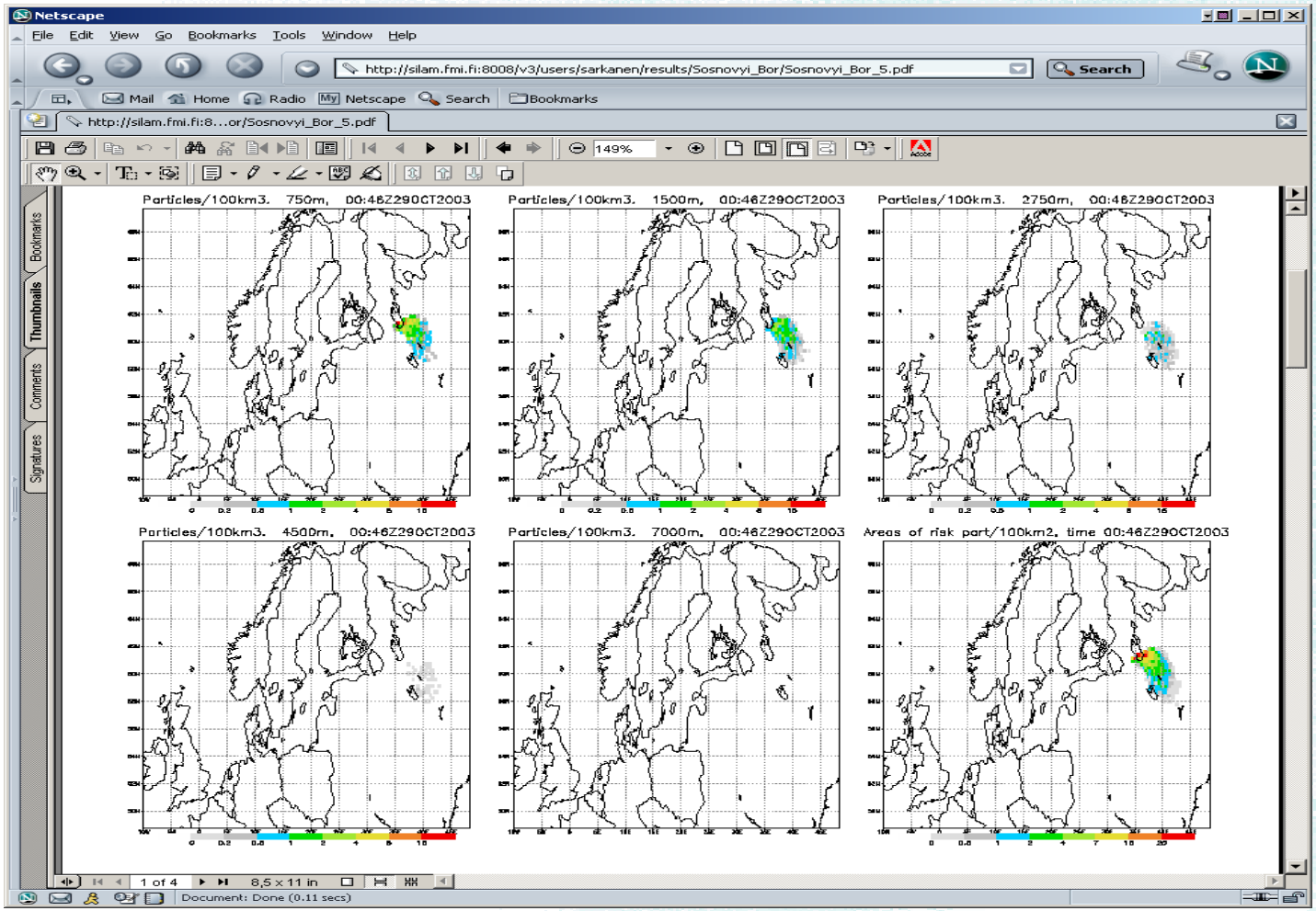


SILAM atmospheric dispersion and dose assessment model

SILAM atmospheric dispersion and dose assessment model



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