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Introduction to meteorological research at FMI

Priit Tisler

27 August, 2007

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Organization

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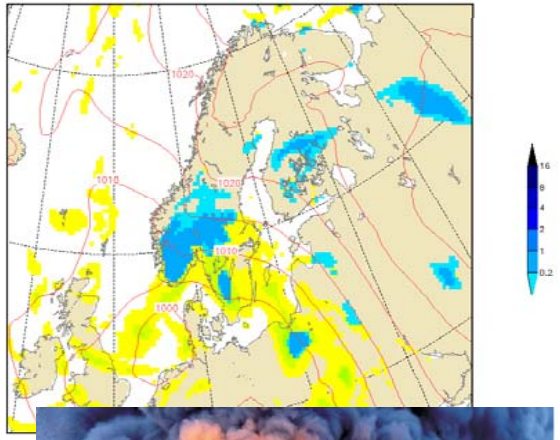
Highlights of MET-research:



- **NWP research and development**

  Maintaining cutting-edge NWP know-how, and ensuring delivery of numerical products for short range numerical forecasting and other applications in the range of 0-54 hours.

- **Research and development of meteorological applications**

  Performing research, developing and testing tools in applied meteorology, with a focus on high-impact and severe weather features, socio-economical customer's needs and the renewable energy sector.

- **Expert-services in the field of air-quality**

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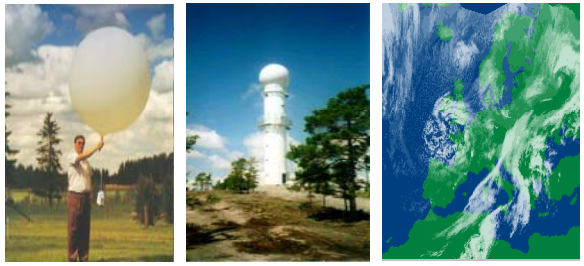
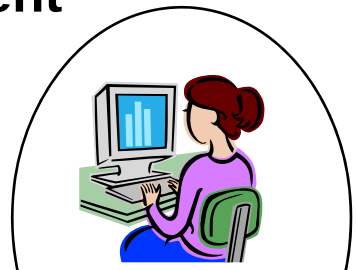
Weather forecasting
Value-chain from observations to information content



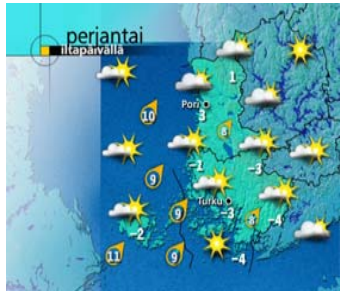
Observations

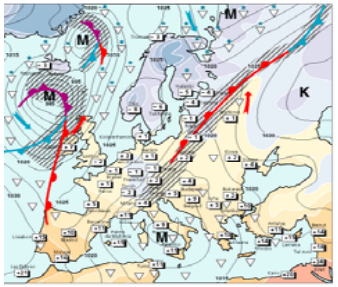
Forecast

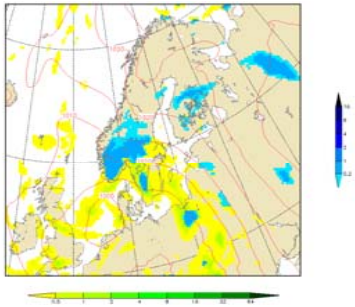


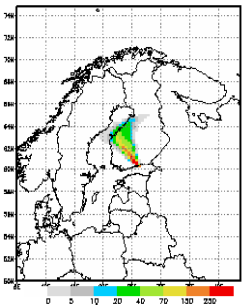
Manual or automatic

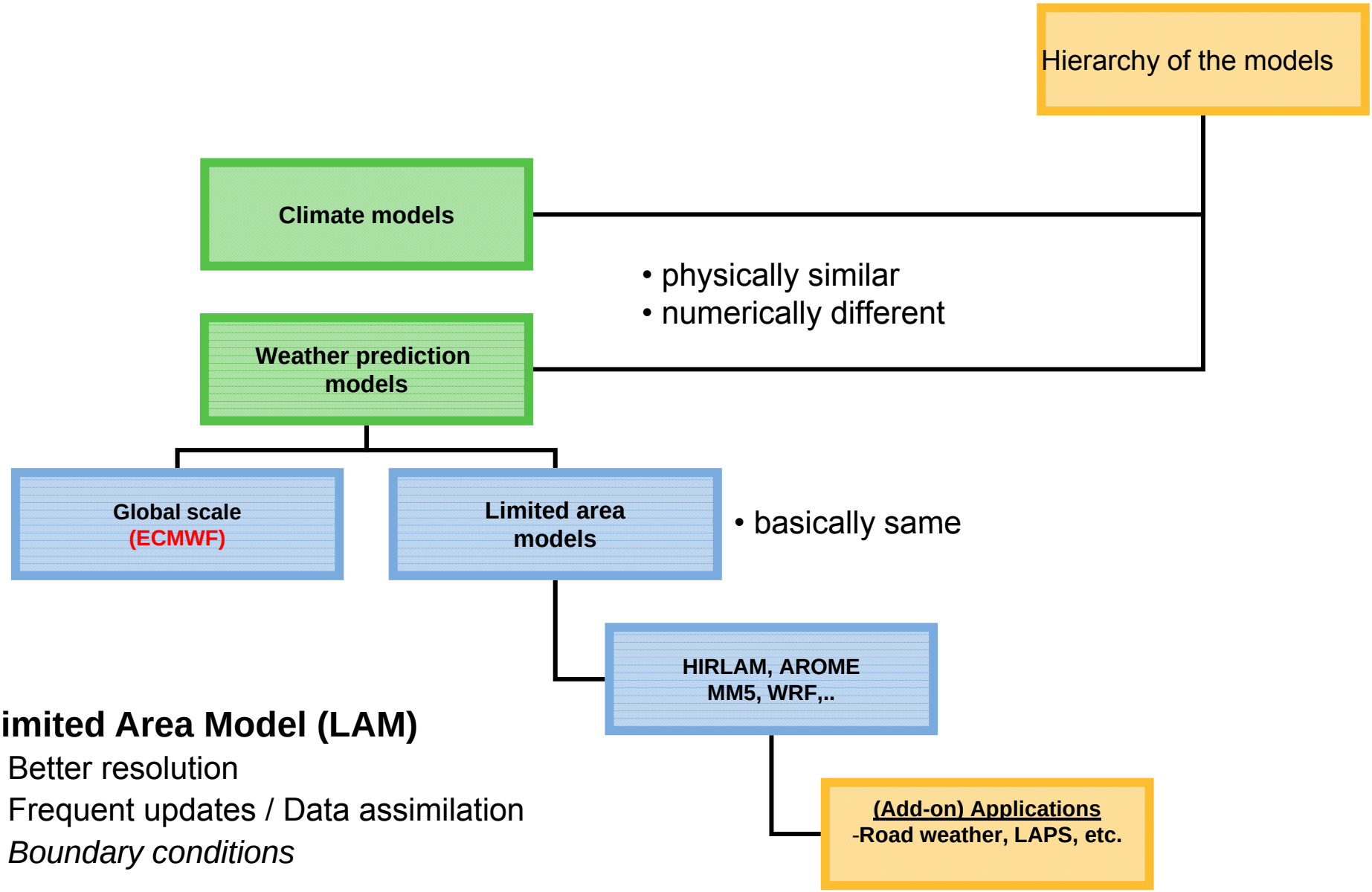
Automatic production







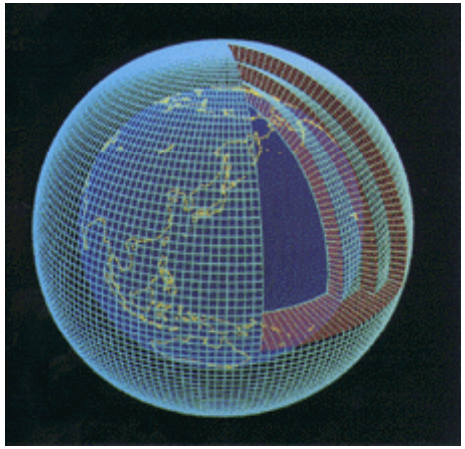




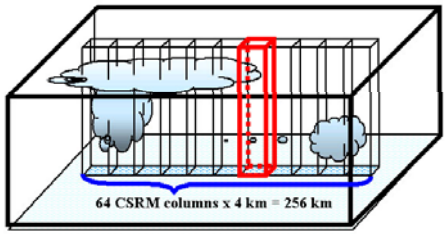
Limited Area Model (LAM)

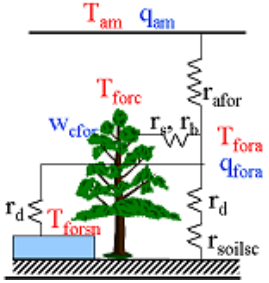
- Better resolution
- Frequent updates / Data assimilation
- *Boundary conditions*

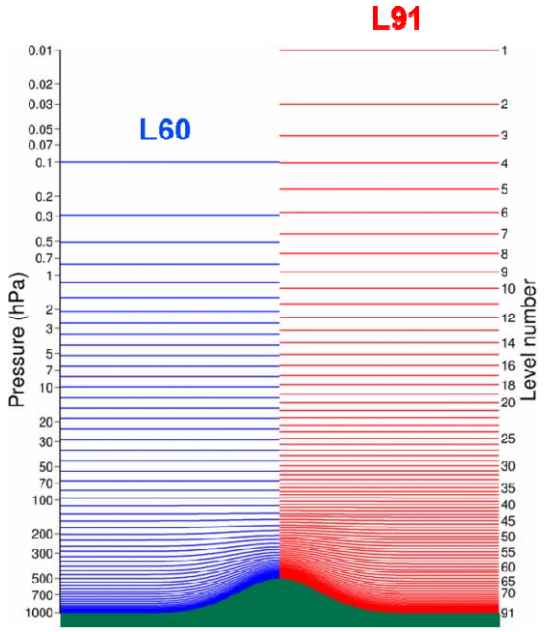
Numerical modeling



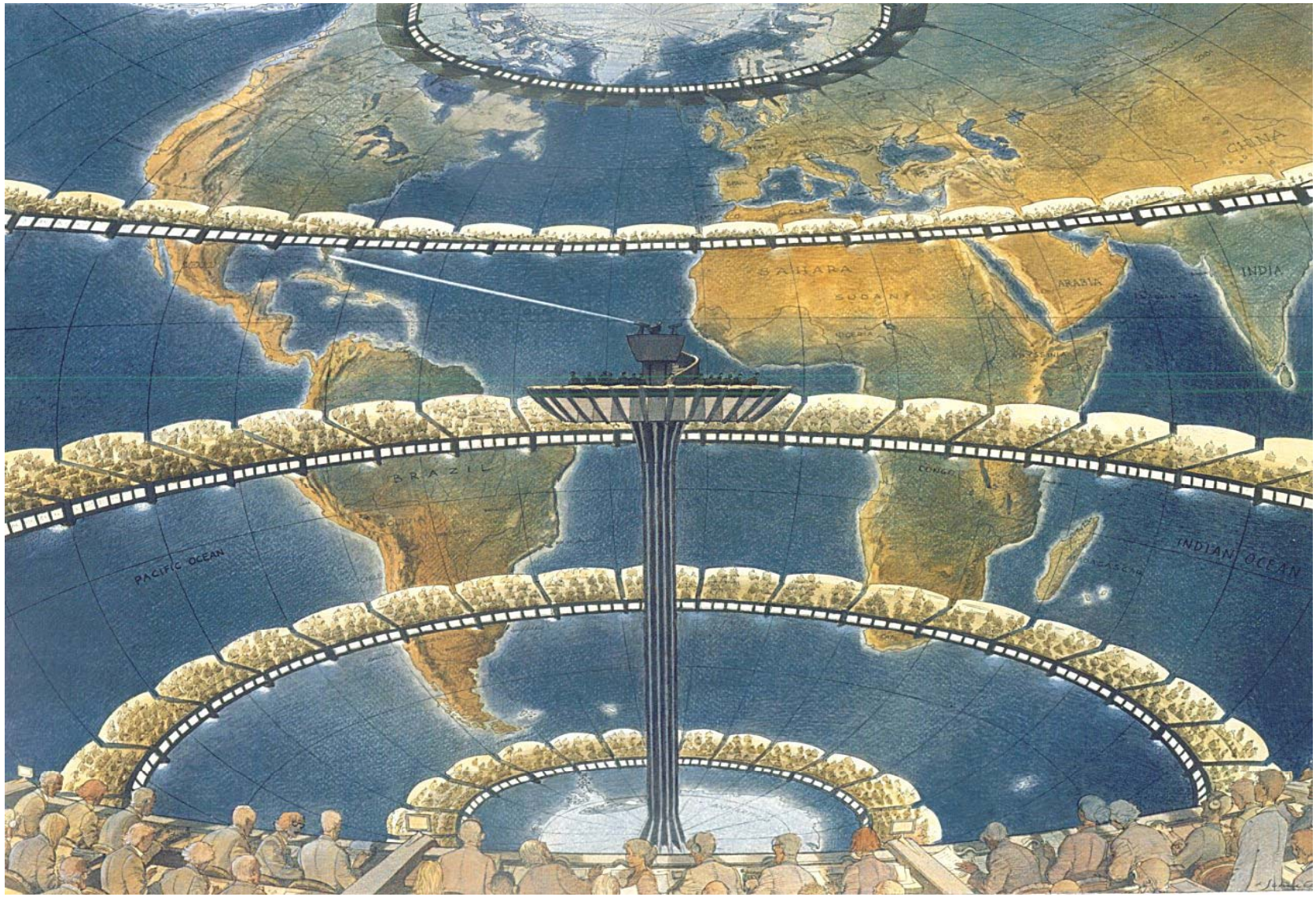
- **Atmospheric volume ➔ discrete points**
  - distance between points = resolution
- **Basic atmospheric equations**
  - contininuity, temperature, moisture, momentum
- **Limited resolution (~10-20 km)**
  - parametrisation
    - clouds, convection, turbulence
    - land surface - atmosphere interaction







Richardson's Forecast Factory



Computer system

- **Silicon Graphics Altix-3700 BX2**
  - Intel Itanium 2 -processors, 1.5 GHz, with 4MB internal cache
  - Total of 304 processors, 304 GT shared memory
    - 2 parts : 256 + 48 (jumbo + sambo)
    - HIRLAM : 42 processors in sambo
  - Novell Suse Linux
  - Intel compilers (C, Fortran)
  - LSF load management system

- **Silicon Graphics Altix-350**
  - 16 processors, 64 GT shared memory
  - Red Hat Enterprise Linux

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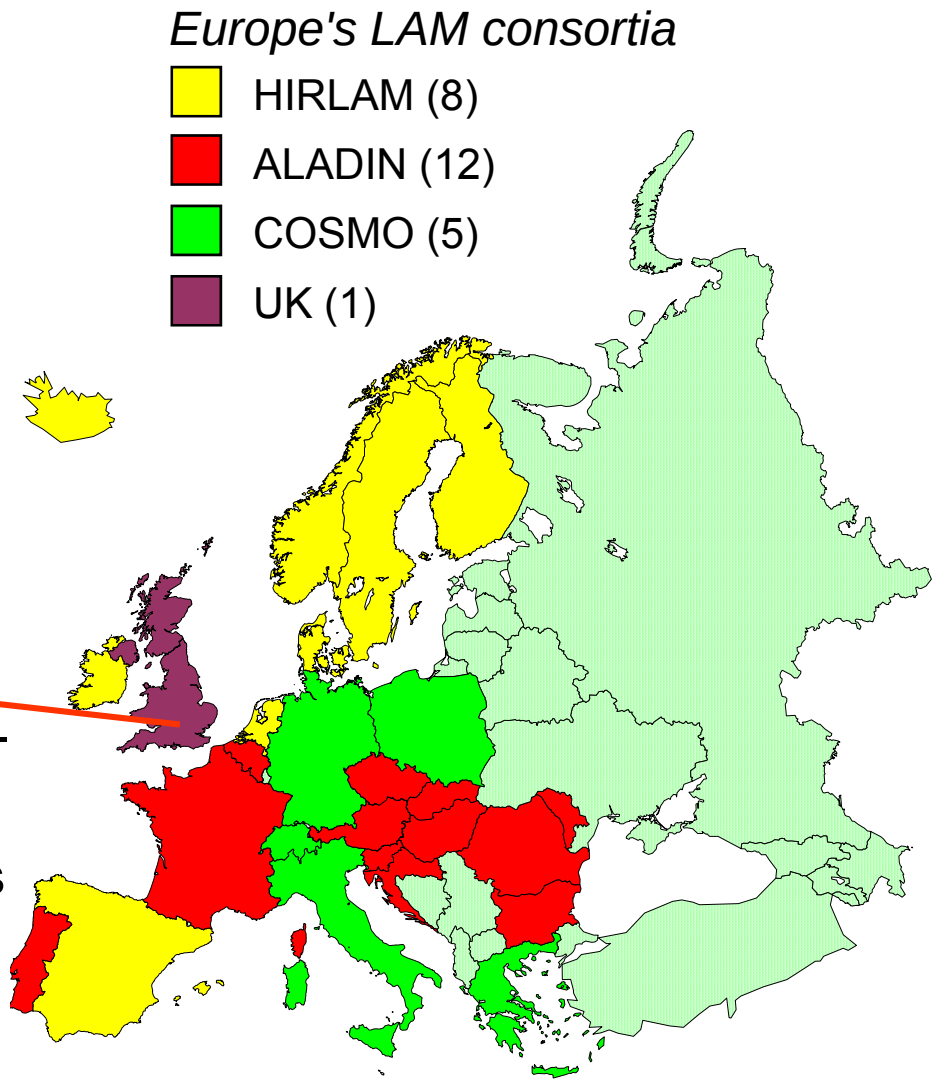
HIRLAM

- **High Resolution Limited Area Model**
- **8 countries (22 man-year)**
  - development + operative use
  - FMI : reference runs (RCR)
- **ECMWF**
  - European Centre for Medium-Range Weather Forecasts
  - global forecast => boundaries for member LAMs
- **Hirlam ver 1.0 y.1990**
  - 2007 : Hirlam 6 ➡ Hirlam A



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HIRLAM

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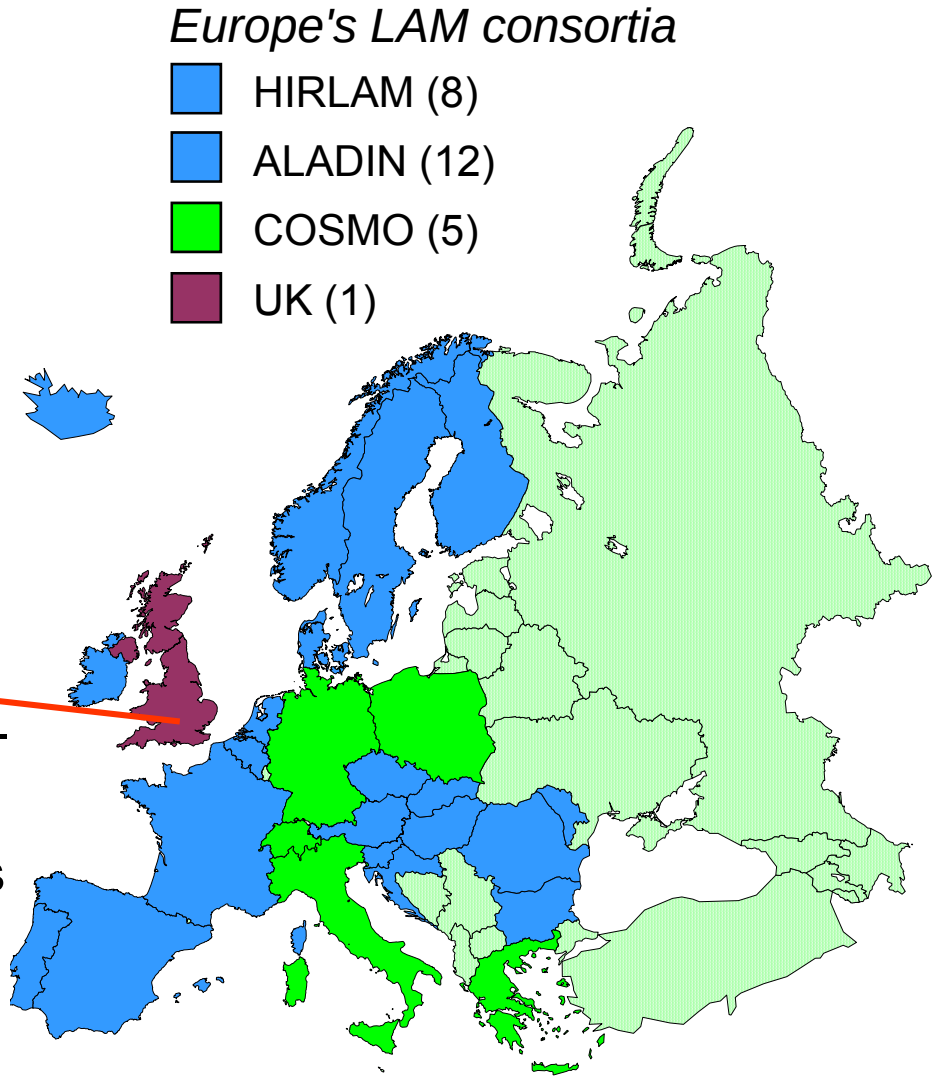
- **Hirlam ver 1.0 y.1990**
  - 2007 : Hirlam 6 ➡ **Hirlam A : Hirlam + Aladin (meso model)**
  - **Program Leader 2006 - > : Jeannette Onvlee / KNMI (Holland)**



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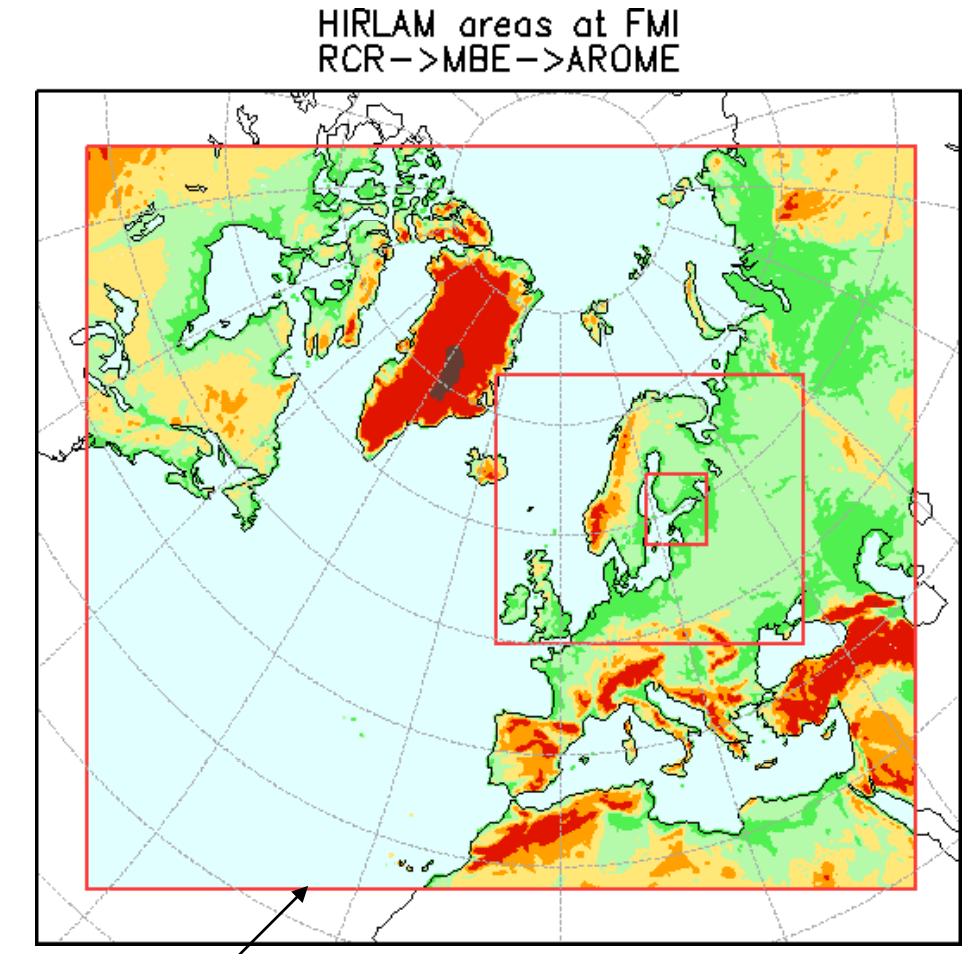
Numerical Weather Prediction at FMI

- **RCR: Hirlam Regular Cycle with the Reference system**
  - dh = 0.15° ~ 17 km
  - 60 vertical levels (1000 – 10 hPa)
  - dt = 6 min
- **MBE: Hirlam Meso BEta**
  - dh = 0.08° ~ 9 km
  - 40 vertical levels (1000 – 10 hPa)
  - dt = 3 min
- **AROME: Meso-gamma model**
  - dh = 2.5 km
  - 40 vertical levels
  - dt = 1 min



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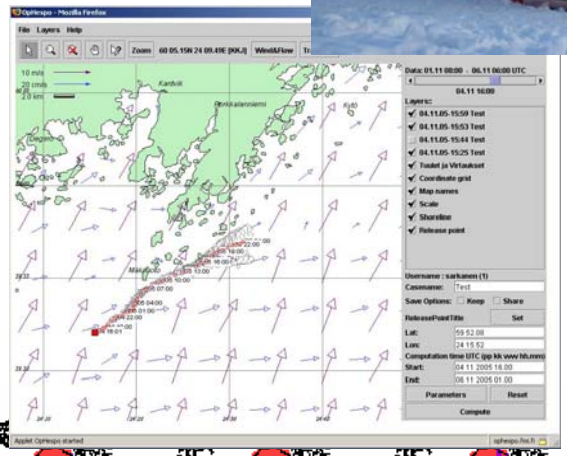
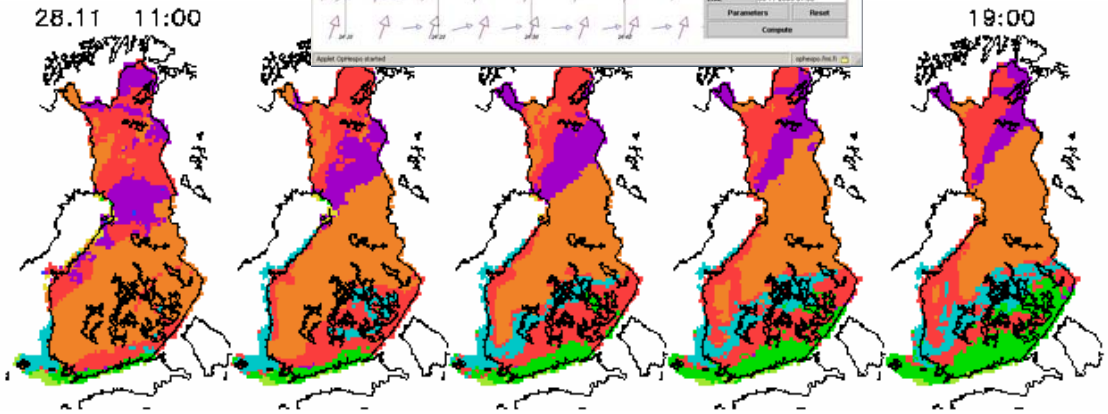
MET applications

- **Based on primary or secondary products from the FMI-NWP and ECMWF, to develop and test products and services for FMI's value-chain and for various Finnish core authorities and sectors of economies as well as foreign customers.**



- **High-impact weather and severe weather**
- **Road weather**
- **Forest fires**
- **Flooding**
- **Drifting-applications**
- **ECMWF-applications**
- **Verification methods**
- **Educational services**
- **Renewable energy**
- **…**



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Road Weather Services

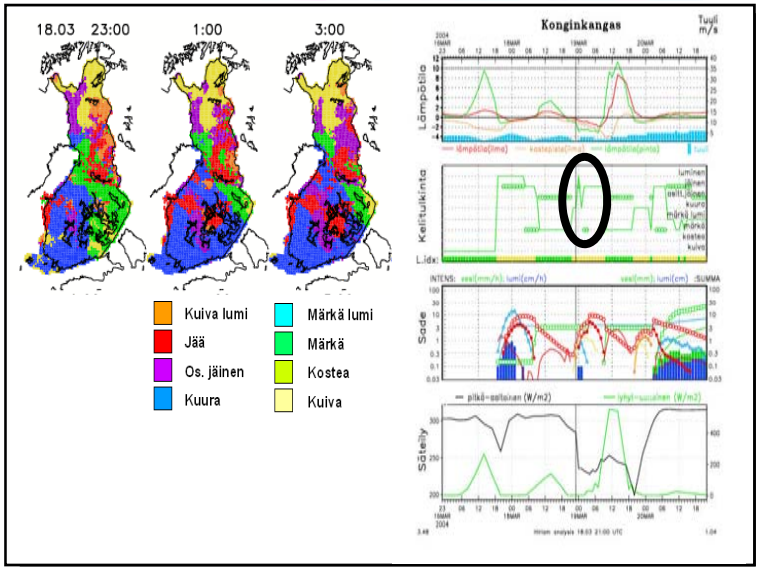
Road Weather Center

Together with Finnish Road Enterprise

Road Weather Services

- **Extranet**
- **Internet**
- **Telephone**
- **Consultancy**

- **Enhanced snow storage manipulation**
- **Advance warning of snow accumulation for maintenance scheduling**
- **Snow removal (ploughing) included in the model**
- **Specially in wintertime**



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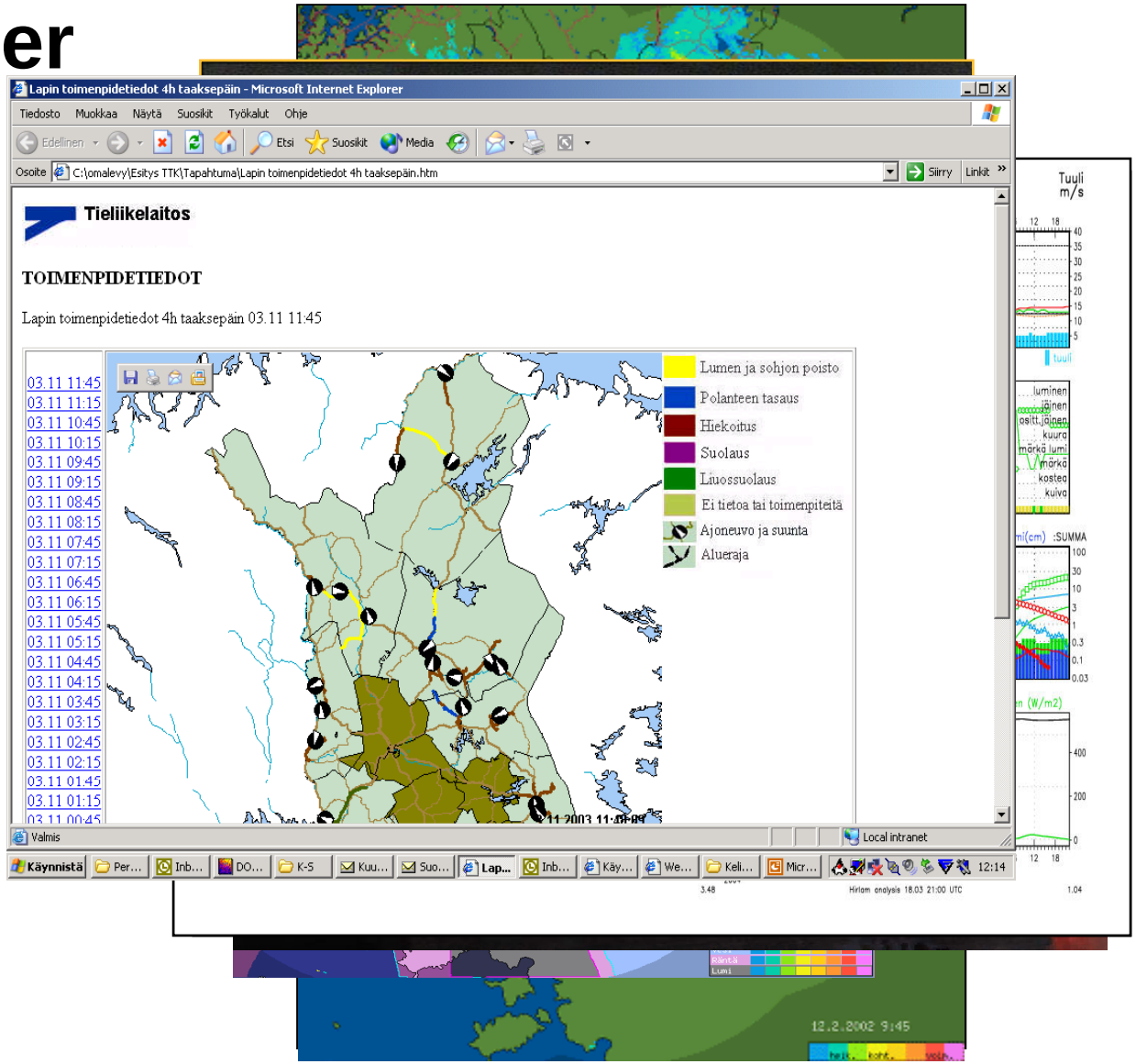
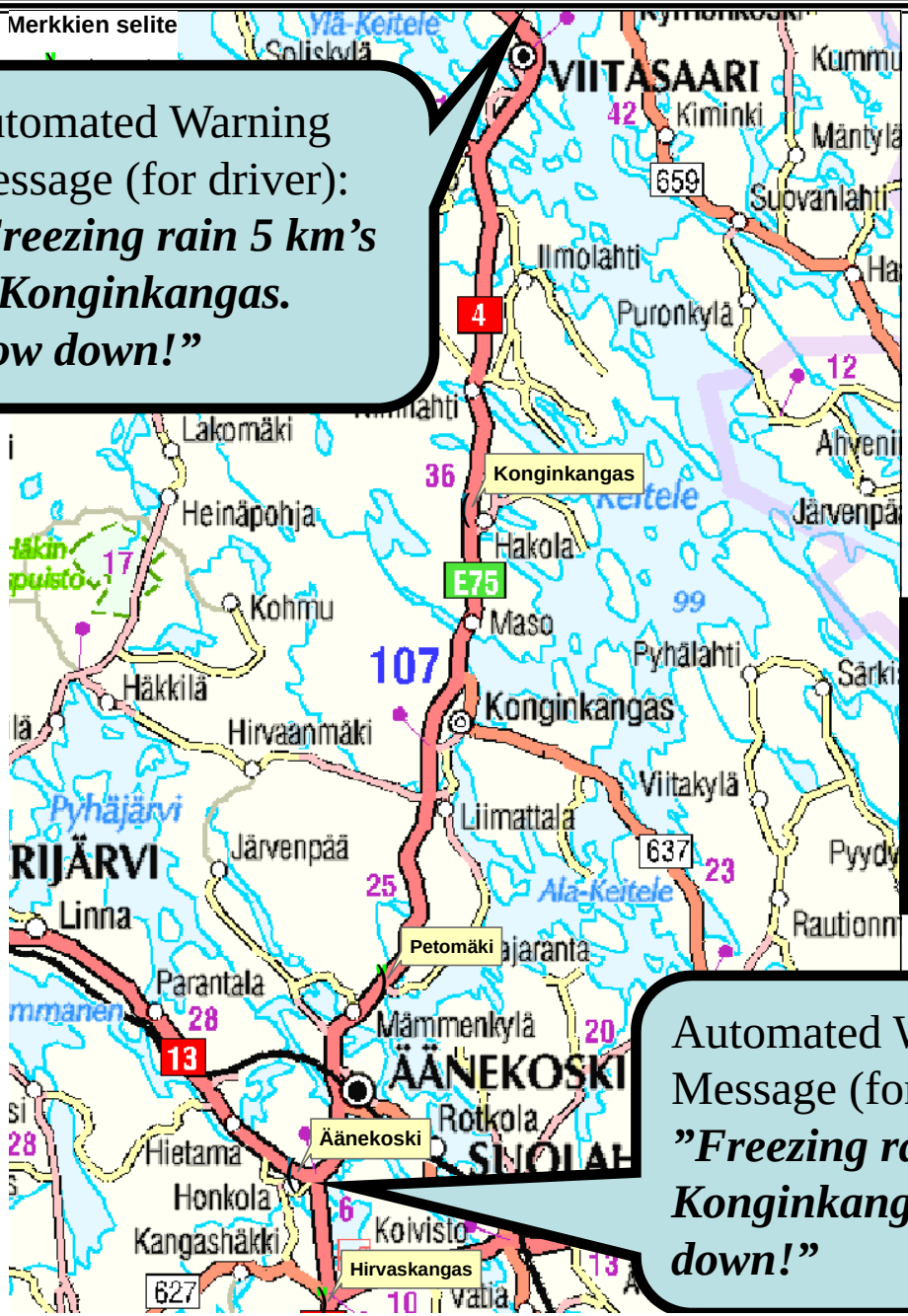
Road Weather

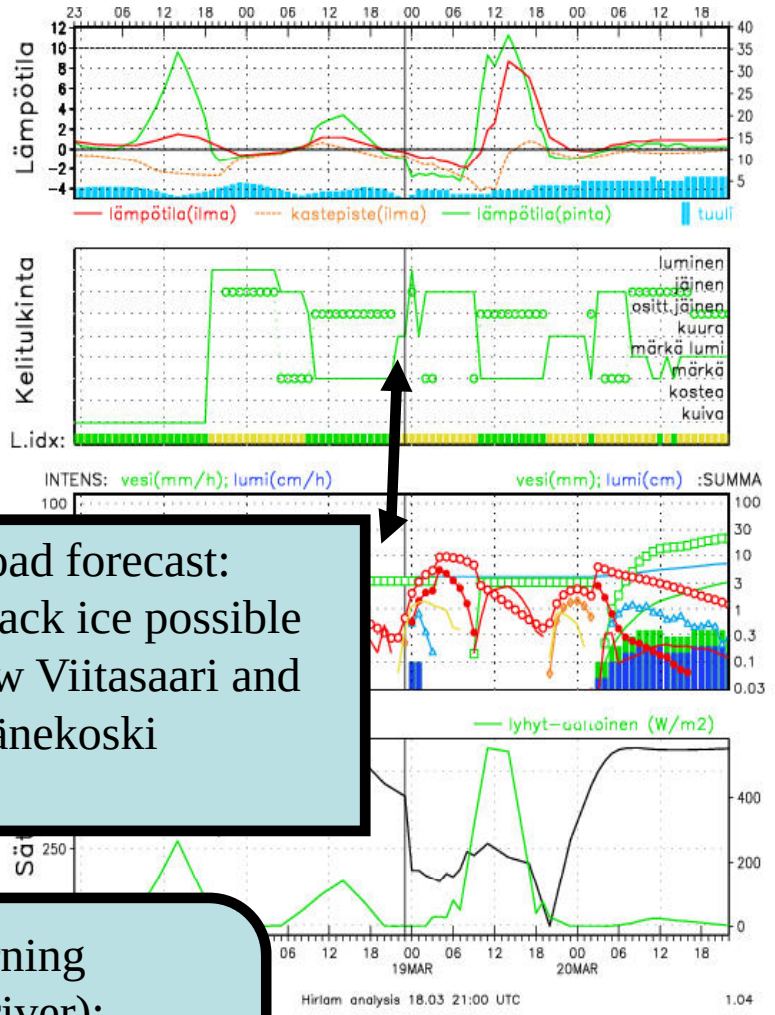


Real-time warnings for road conditions



Automated Warning Message (for driver): ***"Freezing rain 5 km's at Konginkangas. Slow down!"***

Road forecast: Äänekoski - Viitasaari



Road forecast: Black ice possible btw Viitasaari and Äänekoski

Automated Warning Message (for driver): ***"Freezing rain 5 km's at Konginkangas. Slow down!"***

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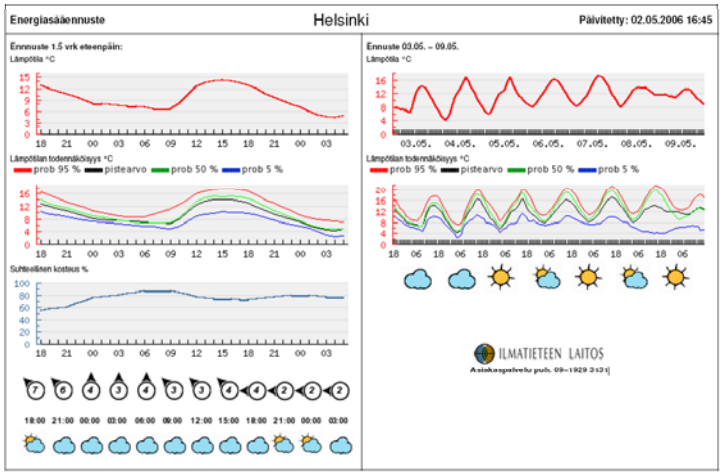
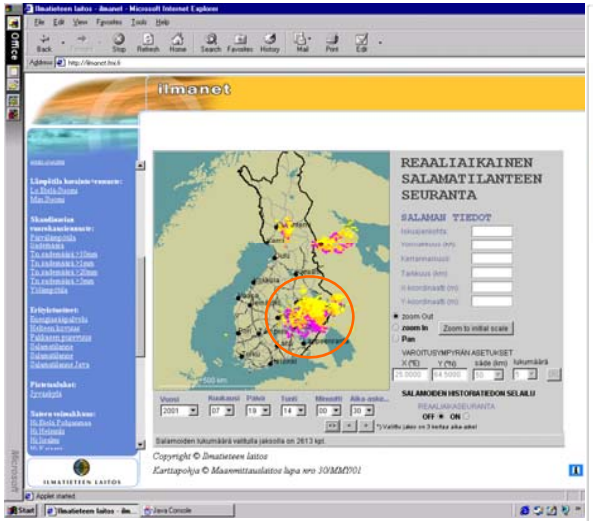
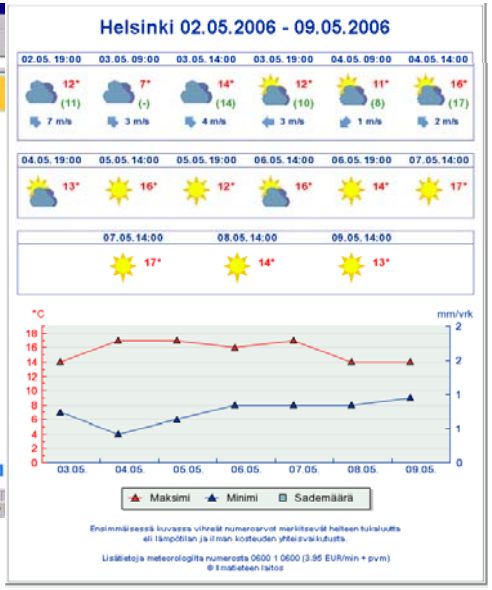
Energy and Industry

- **Weather forecast**
  - **Directly into customers own systems**
  - **Extranet**
- **Lightning services**
  - **Energy, teleoperators**
- **Supply Forecasting for wholesalers & Industry**
  - **weather is important variable**







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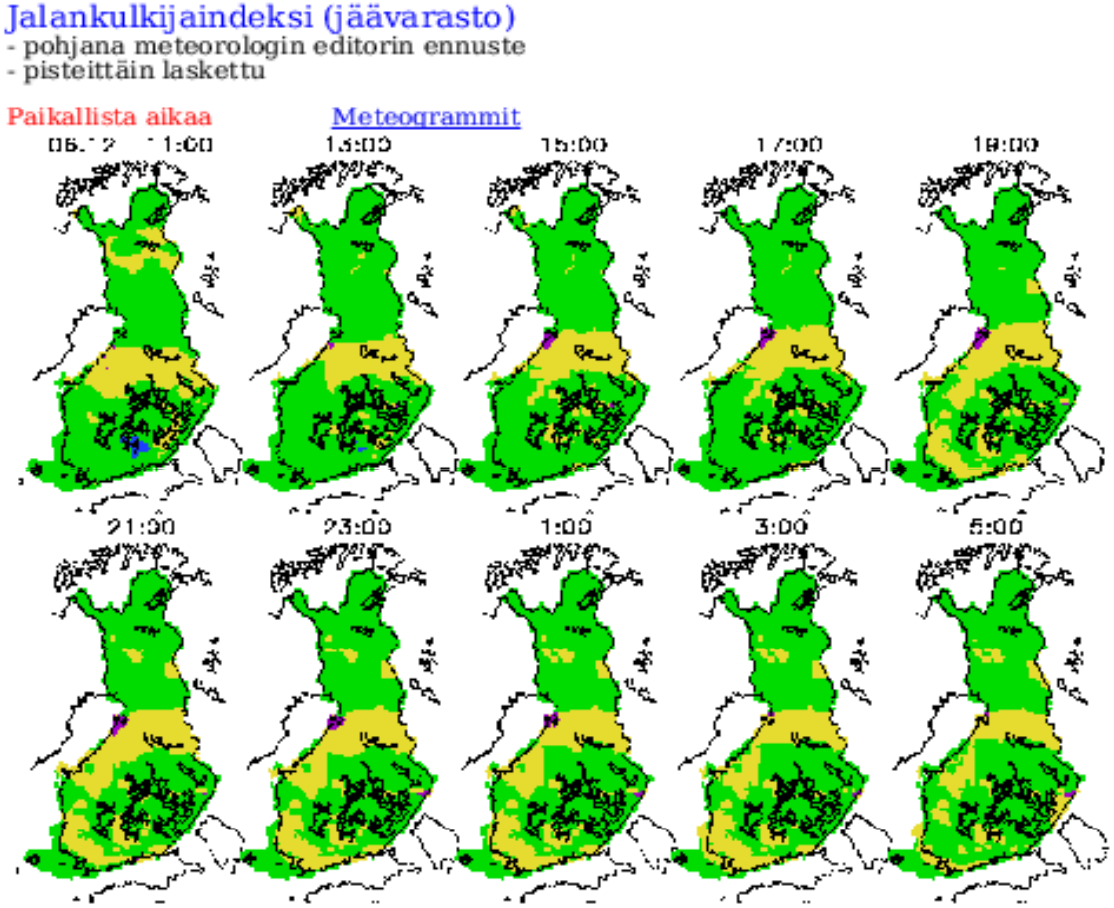
Pedestrian traffic

Jalankulkijaindeksi

http://dev.hirlam.fmi.fi/kelimalli/jalankulku/traffic/lframe/Tra



- Normaali
- Liukas
- Tamppautuminen
- Erittäin liukas 1 (vettä jäällä)
- Erittäin liukas 2 (kuivaa lunta jäällä)

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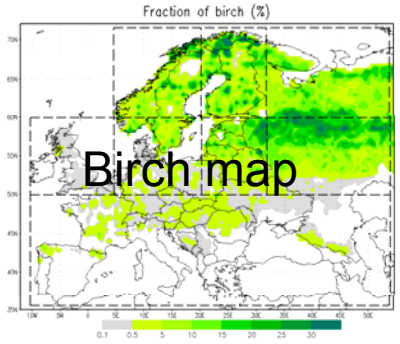
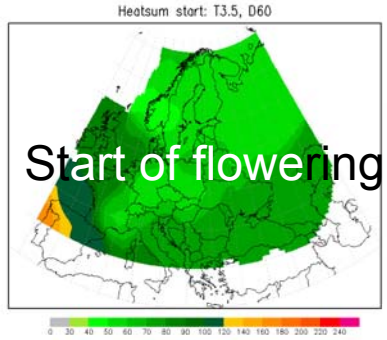
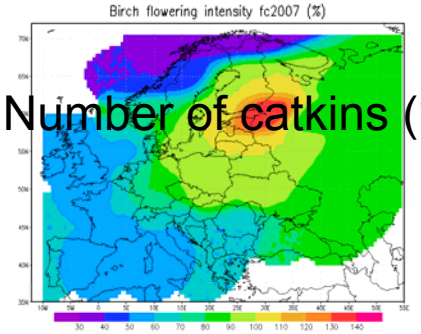
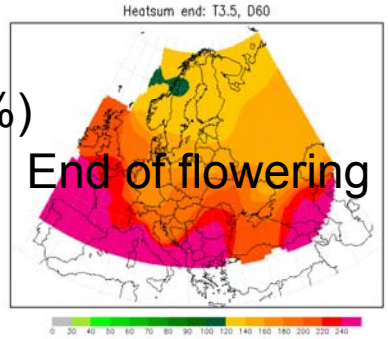
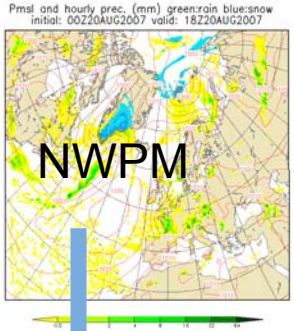
Birch pollen long-range transport forecasts





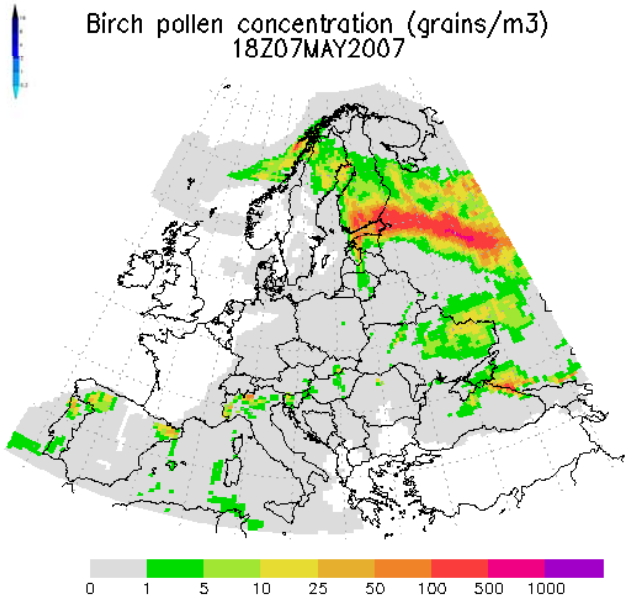


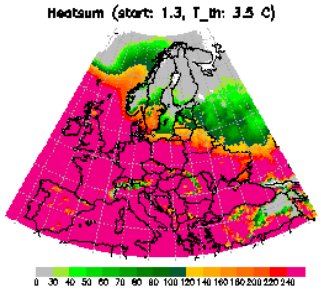


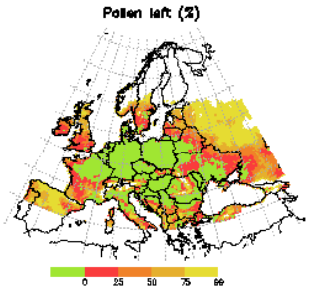


Dispersion model
SILAM

Release
Transport
Sinks







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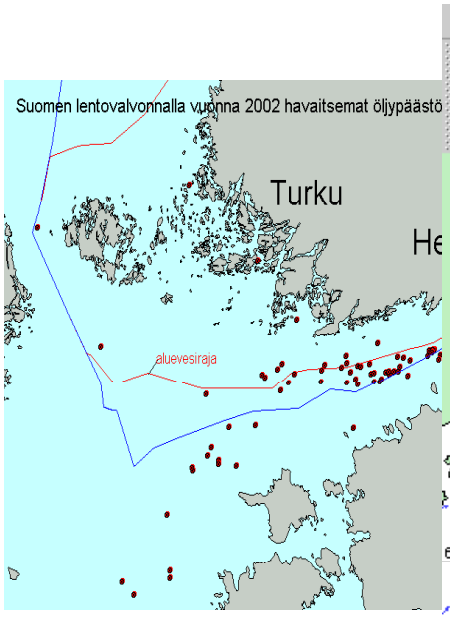
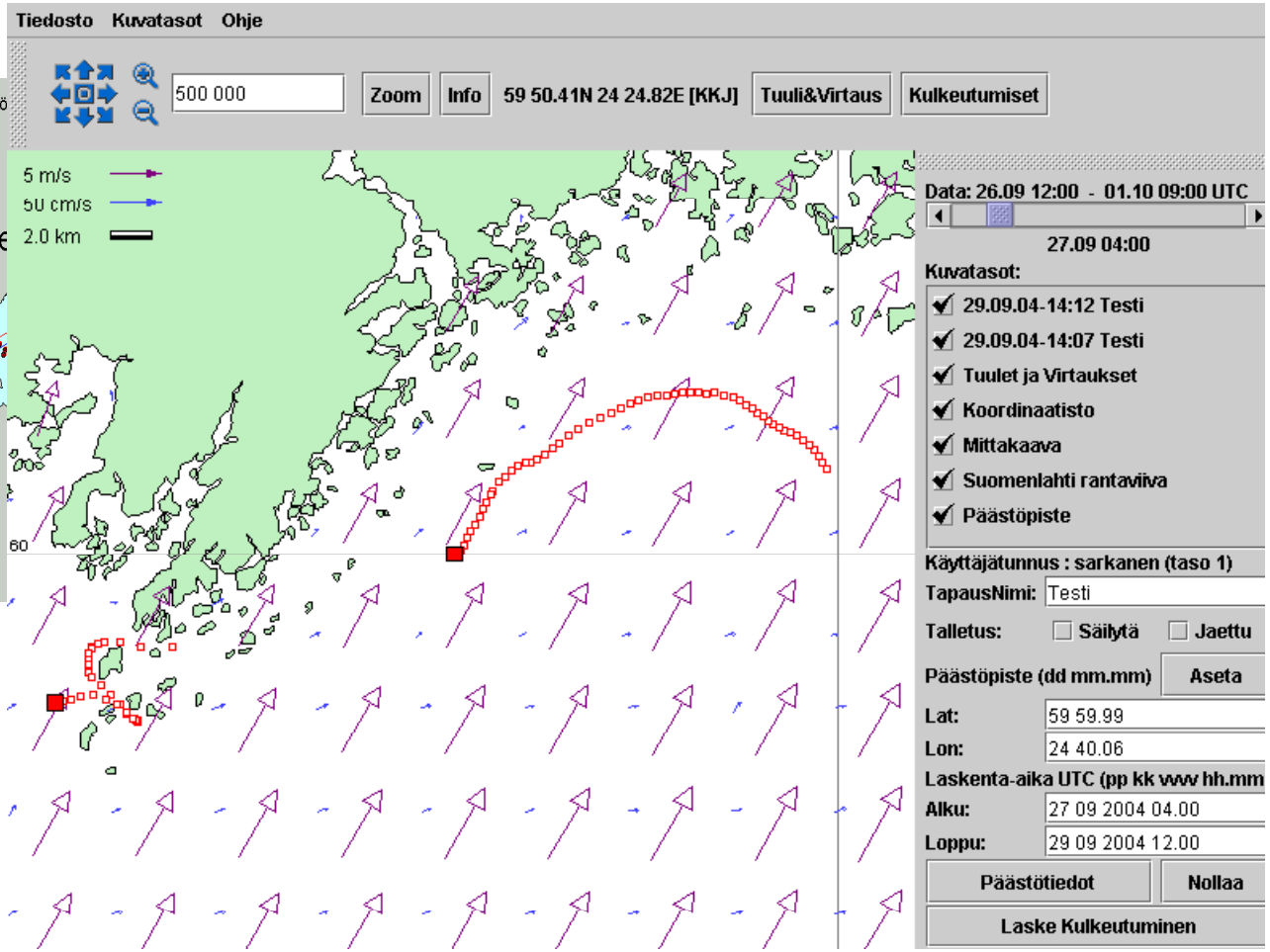
Drift model





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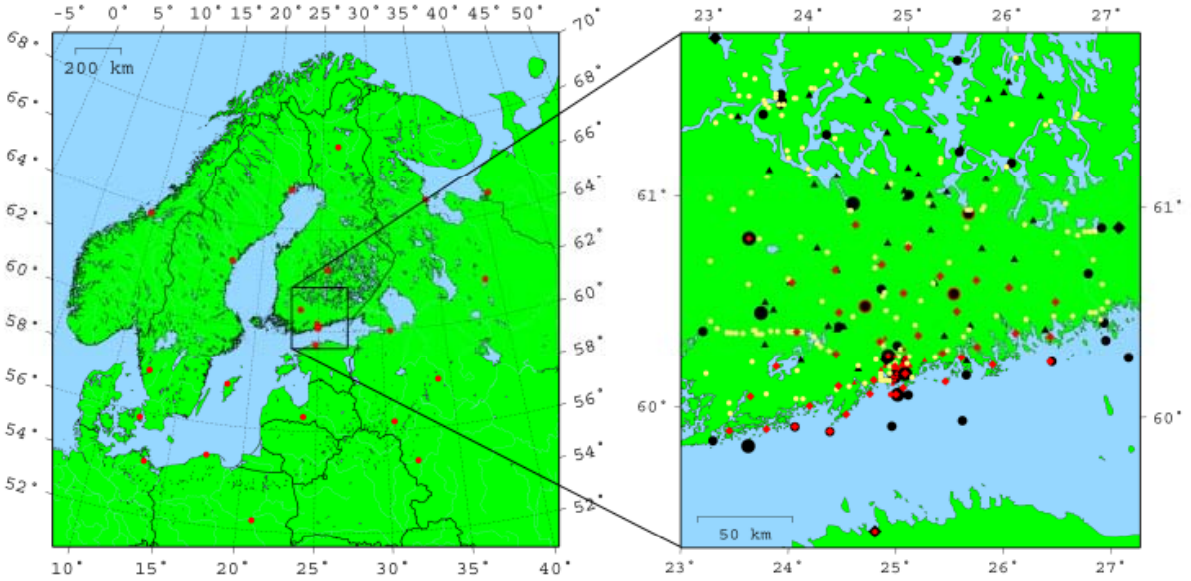
Helsinki Testbed (http://testbed.fmi.fi)

- Mesoscale weather research
- Forecast and dispersion models development and verification
- Information systems and technology integration
- End-user product development and demonstration
- Data distribution for public and research community



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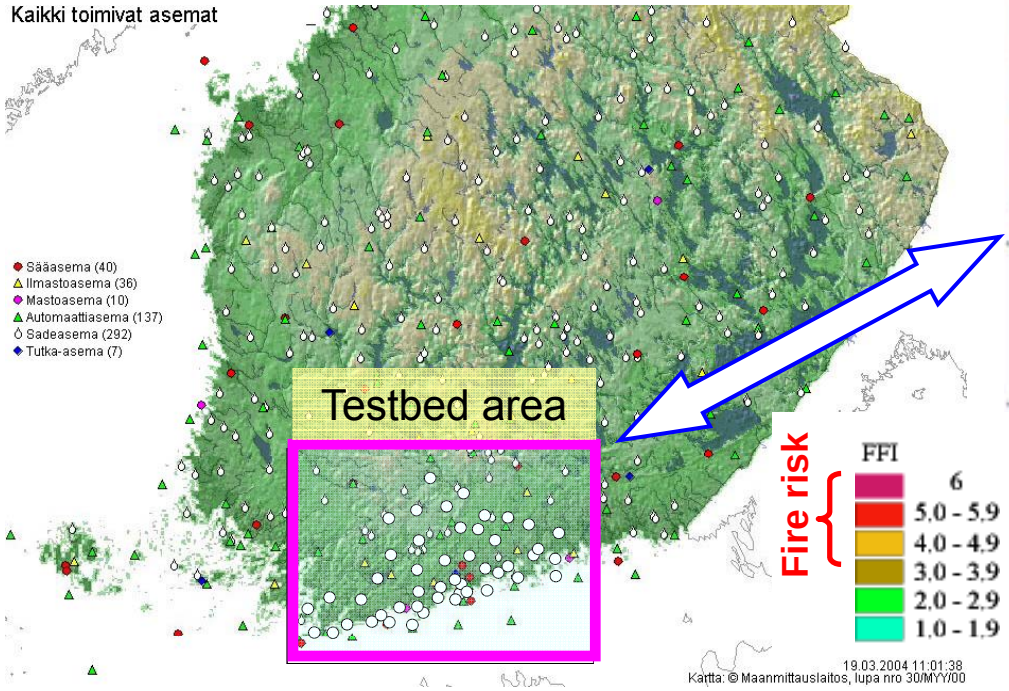
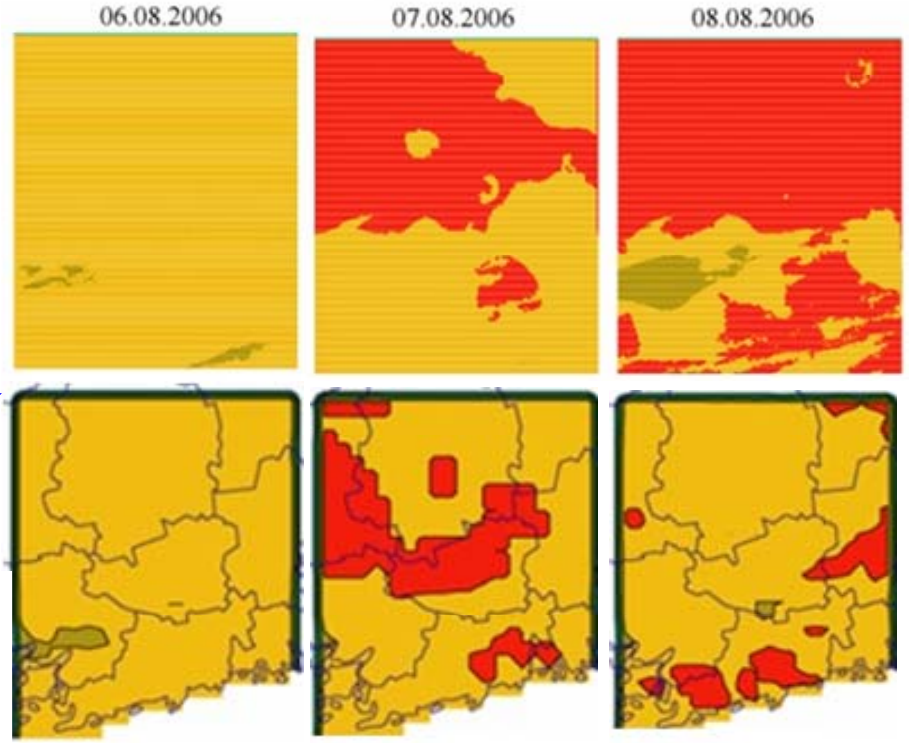
Helsinki Testbed

- ✓ Mesoscale meteorology research project
- ✓ Intense meteorological measurements
- ⇨ Meteo-hydro forecasting-verification studies
- ⇨ Road wx modelling applications
- ⇨ Forest fire index R&D
- ⇨ Wind energy R&D
- ⇨ etc.



Spatial variation of the Forest Fire Index (FFI)

1*1 km² (upper row)



10*10 km² (lower row)

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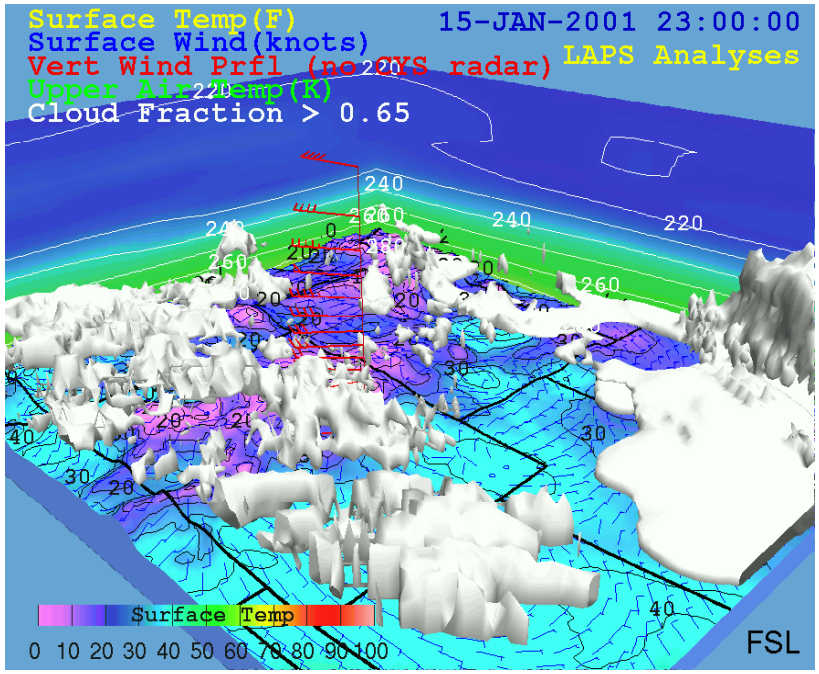
Local Analysis and Prediction System (LAPS)

- Since 1988
- NOAA Global Systems Division (ent. Forecast Systems Laboratory)
- Developed for Nowcasting
- Produces 3-D analyses for limited area



FORECAST SYSTEMS LABORATORY
BOULDER, COLORADO

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

MET Verification: R&D&T Activities

Recommendations for the verification and intercomparison of QPFs from operational NWP models

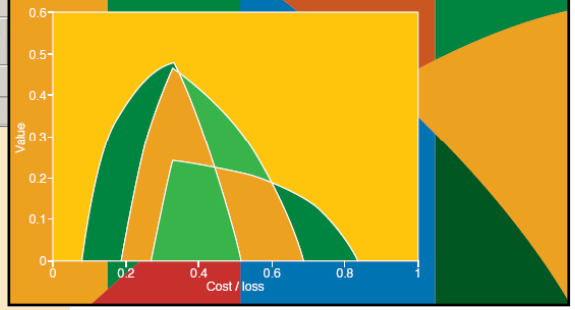
WWRP/WGNE Joint Working Group on Verification

December 2004

3rd International Verification Methods Workshop

January 29 – February 2, 2007

To be held at ECMWF, Reading, UK



www.eumetcal.org/…/verification

MSG Modules - Netscape Browser

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User Unknown

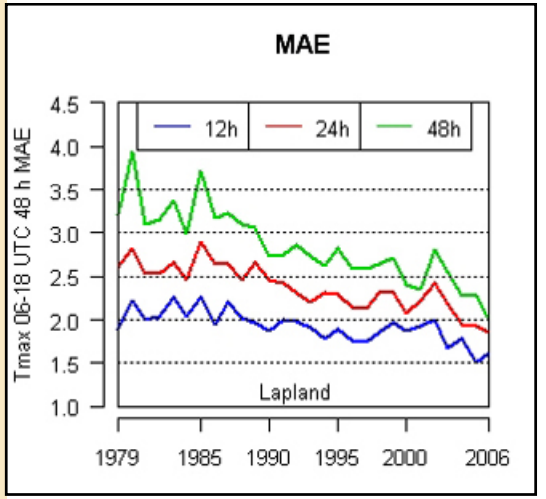
Forecast Verification

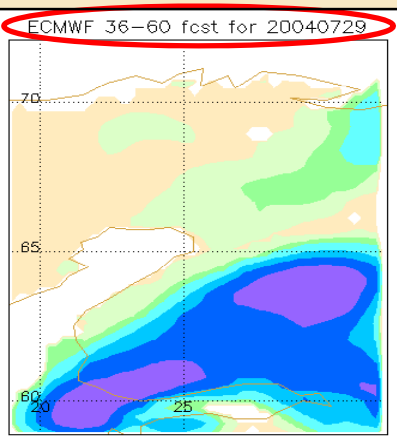
Welcome to the modules on forecast verification. The modules are designed both for users of verification results, who wish to understand what the results really mean, and those who wish to dabble in verification methodology themselves.

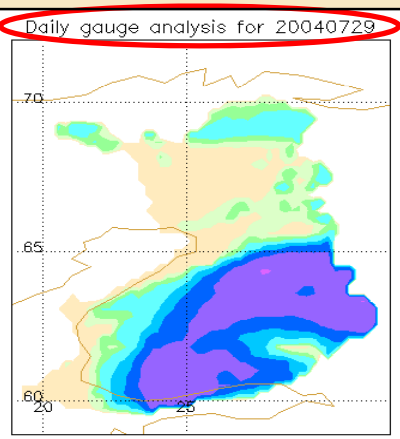
There are 4 modules in this course. The introductory module covers general issues about reasons for verifying, and the different types of forecast and observation data used in verification. The other modules are organized by type of forecast. If you are new to the subject of verification, then it is highly recommended that you complete the introductory module, which will help put the other modules into better perspective. If, on the other hand, you already know what a "deterministic forecast of a continuous variable", or a "probability forecast of a categorical variable" is, then feel free to skip the generalities of the introduction and go directly to the modules on the various forecast types.

Module Index

- Introduction
- Verification of continuous variables
- Verification of probability forecasts
- Verification of categorical forecasts







"Flooding" Example CRA

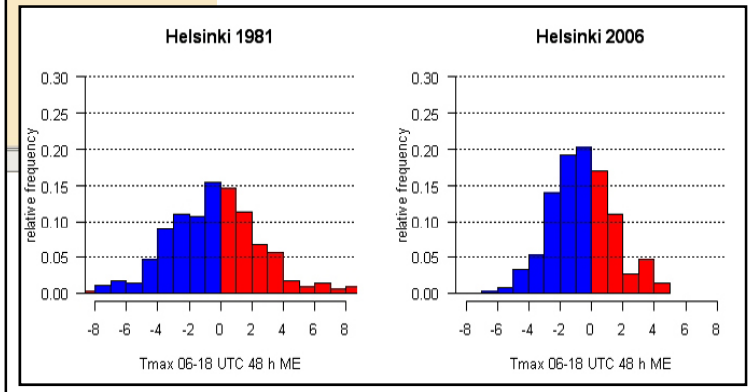
No data
<0.3 mm
0.3–1 mm
1–2 mm
2–5 mm
5–10 mm
10–20 mm
20–50 mm
50–100 mm
100–150 mm
150–200 mm

Forecast \ Observed	≥10	<10
≥10	134	39
<10	35	245

Validation statistics for 20040729 n=453 Verif. grid=0.400°

	Analysed	Forecast
# gridpoints raining	169	173
Average rainrate (mm/d)	27.44	22.89
Rain volume (km³)	3.79	3.24
Maximum rain (mm/d)	48.25	49.64
Max 0.255° rain (mm/d)	53.80	

Mean abs error = 6.02 mm/d
RMS error = 10.00 mm/d
Correlation coeff = 0.662
Bias score = 1.024
Probability of detection = 0.793
False alarm ratio = 0.225
Hanssen & Kuipers score = 0.656
Equitable threat score= 0.484



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METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Trends & challenges

- Customers need highly tailored products
- Society, industry, and commercial sector need meteorological/atmospheric information in real-time, and in high resolution
- The role of remote sensing is increasing
- Coupled applications
- Development of ensemble forecasting : probabilistic forecasts
- Monthly and seasonal scale forecasting
- Now-casting
- Emphasis on severe weather prediction
- Expert services in Finland and internationally