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LAPS

Analysis and forecasting system for Finland/Scandinavia

Finnish Meteorological Institute
Erik Gregow

19.01.10

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Presentation layout (~20 min):

- **Overview of LAPS status at FMI**

- **Developments:**

  LAPS precipitation accumulation (assimilation of radar and gauges)

  LAPS cloud analysis (use of NWCSAF-cloud product)

  Using LAPS for “hot-start” of FMI high resolution forecast model, HARMONIE

  High resolution topographical input for LAPS

- **LAPS end-user applications**

- **Future plans**

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The Local Analysis and Prediction System (LAPS) at FMI:

Assimilates a wide range of observational datasets

3D-analysis of atmosphere (surface and upper air) at every full hour

Vertical resolution: 44 pressure levels (higher res. at lower alt., 10 hPa ~80 meter)

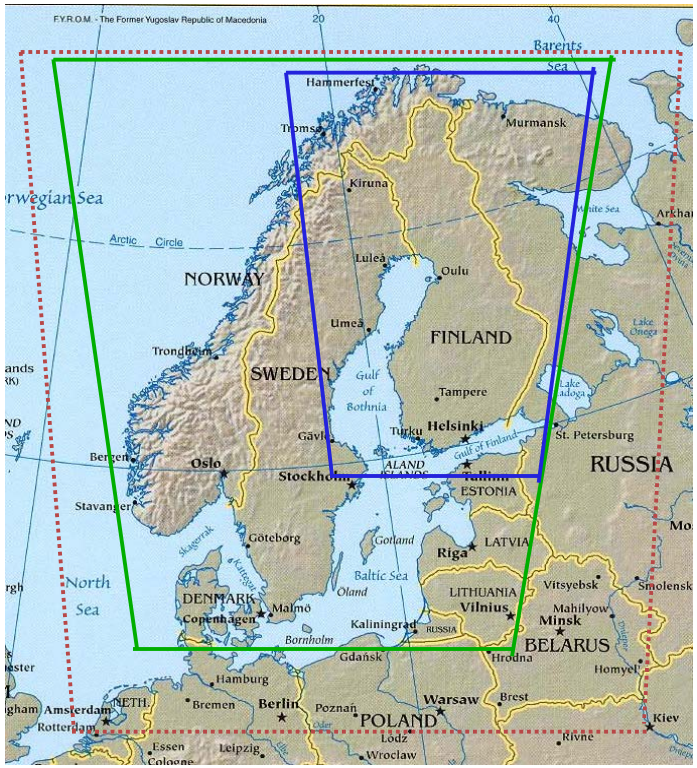
LAPS can be ingested into forecast models (WRF, HARMONIE etc.)

Operational domains at FMI:

Finland area:
Resolution 3 km, 270*400 gp
Runtime: ~12 min

Scandinavia area:
Resolution 3 km, 490*560 gp
Runtime: ~25 min

Scandinavia-SFC area:
Resolutioin 3km, 685*765 gp
Runtime: ~4 min



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FMI LAPS observational ingest:

Background fields

ECMWF

Satellite: MSG9

AMDAR/Airplanes

Helsinki Testbed

LAPS

3-D analysis

Radar: IRIS Doppler

Road-Weather stations

Soundings

Lidars

Synop & Metar

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LAPS visualization and verification at FMI:

SMARTMET, visualization & editor system – See SMARTMET

Webpages - http://testbed.fmi.fi/history_browser-laps-finland-public.php
http://testbed.fmi.fi/WORK_AREA/history_browser-laps-Scandinavia.php

Animation browser - http://weather.weatherproof.fi/animbrowser/

Verification Meteor (surface) - http://meteor.fmi.fi/verif/

Verification MONITOR (surface & 3-D) -
http://fminwp.fmi.fi/WebgraF/FMI-LAPS/?choice_ind=Temp_prof

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LAPS 1-hour accumulation Finland: Combining radar and gauges

Radar accumulation (based on reflectivity) is the high-resolution “first guess” field

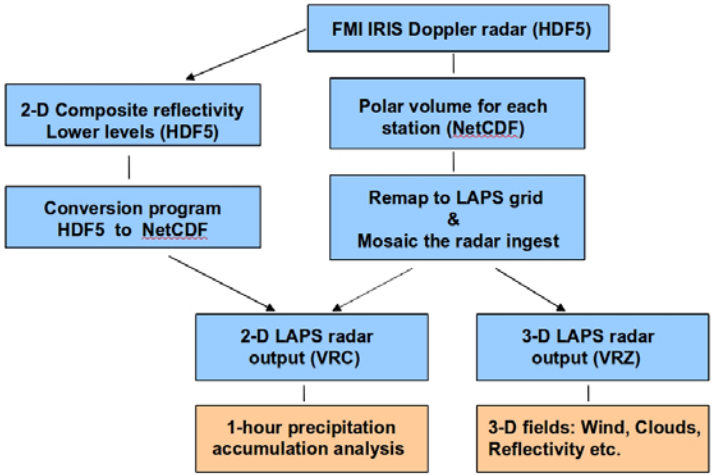
Gauge observations are used to correct the “first guess” field

Two methods are combined to perform the correction:

1) Regression method (linear correction)
   The correction will increase or/and decrease the “first guess” accumulation
   This is a “global” correction, affecting to whole domain

2) Barnes multivariate method (bias correction)
   A bias correction is performed and spreads to the nearby surroundings
   This is a “local” accumulation correction, affecting to small areas

Note:
Gauge observations is considered to be the truth here!



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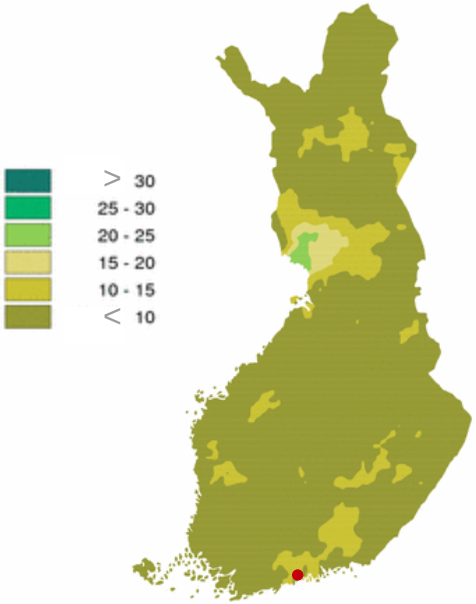
LAPS Accumulation verification:

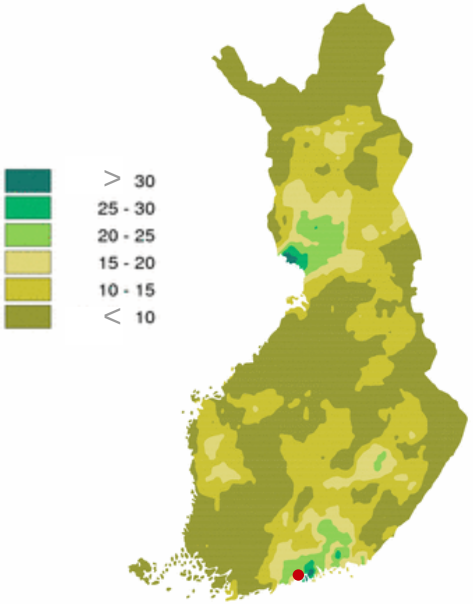
Case study for 27-28 September 2012 (24 h period)

Intensive rain-showers/lightning in southern Finland, frontal passage in northern Finland

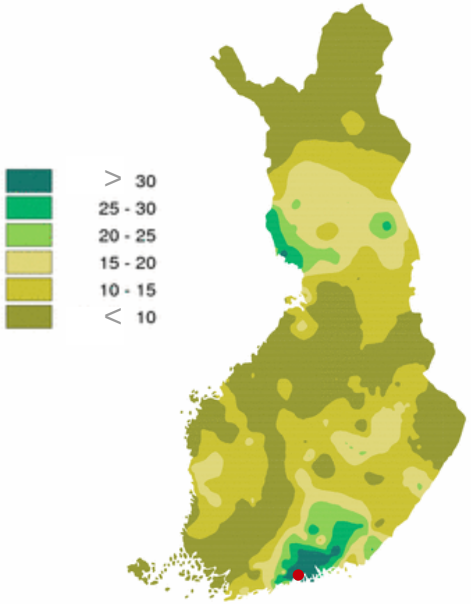
Radar (operative) accum.



New LAPS accum.



Gauges accum. (~500)



• Helsinki

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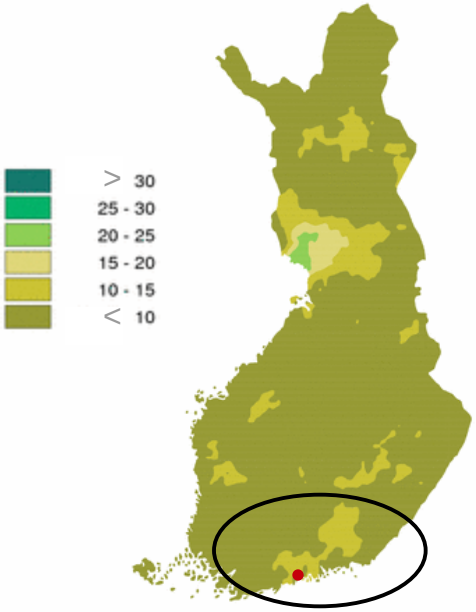

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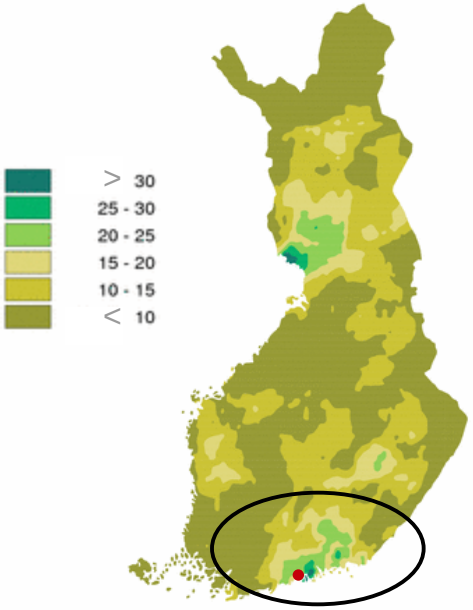
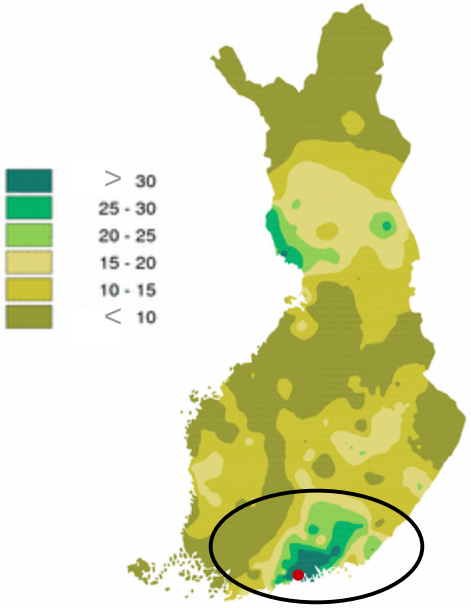


Gauges accum. (~500)



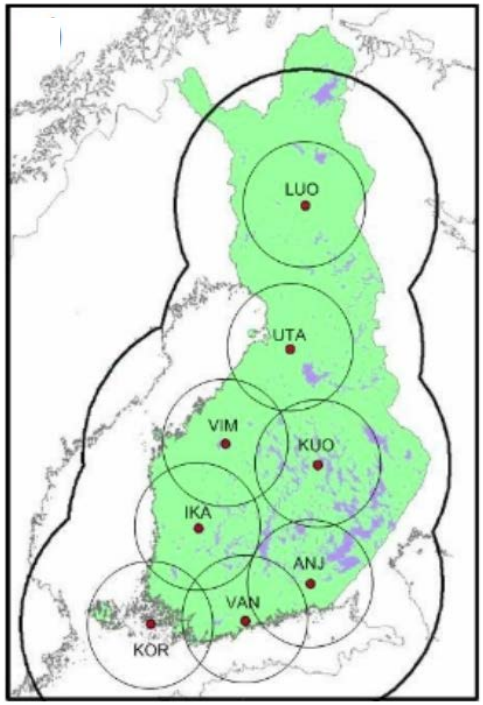
Longer verification of LAPS precipitation accumulation:

Period: April – October 2011

Four methods are compared/verified:

- Radar only (based on reflectivity)
- LAPS Regression
- LAPS Barnes
- LAPS Regression and Barnes combined (new method)

Studies based on “dependent” and “independent” gauge stations



- Dependent stations
- Independent stations

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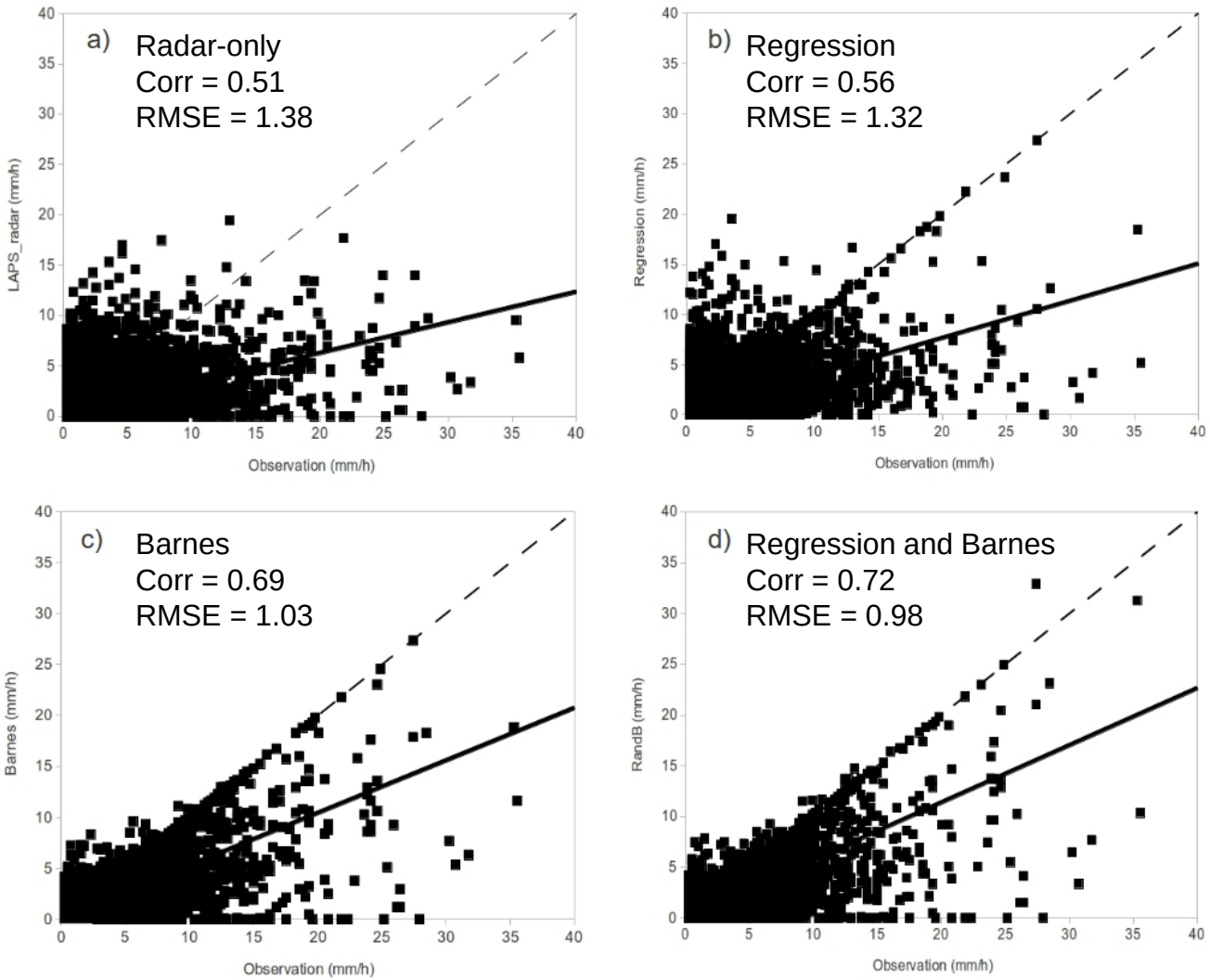
LAPS precipitation accumulation (dependent), period April – October 2011:



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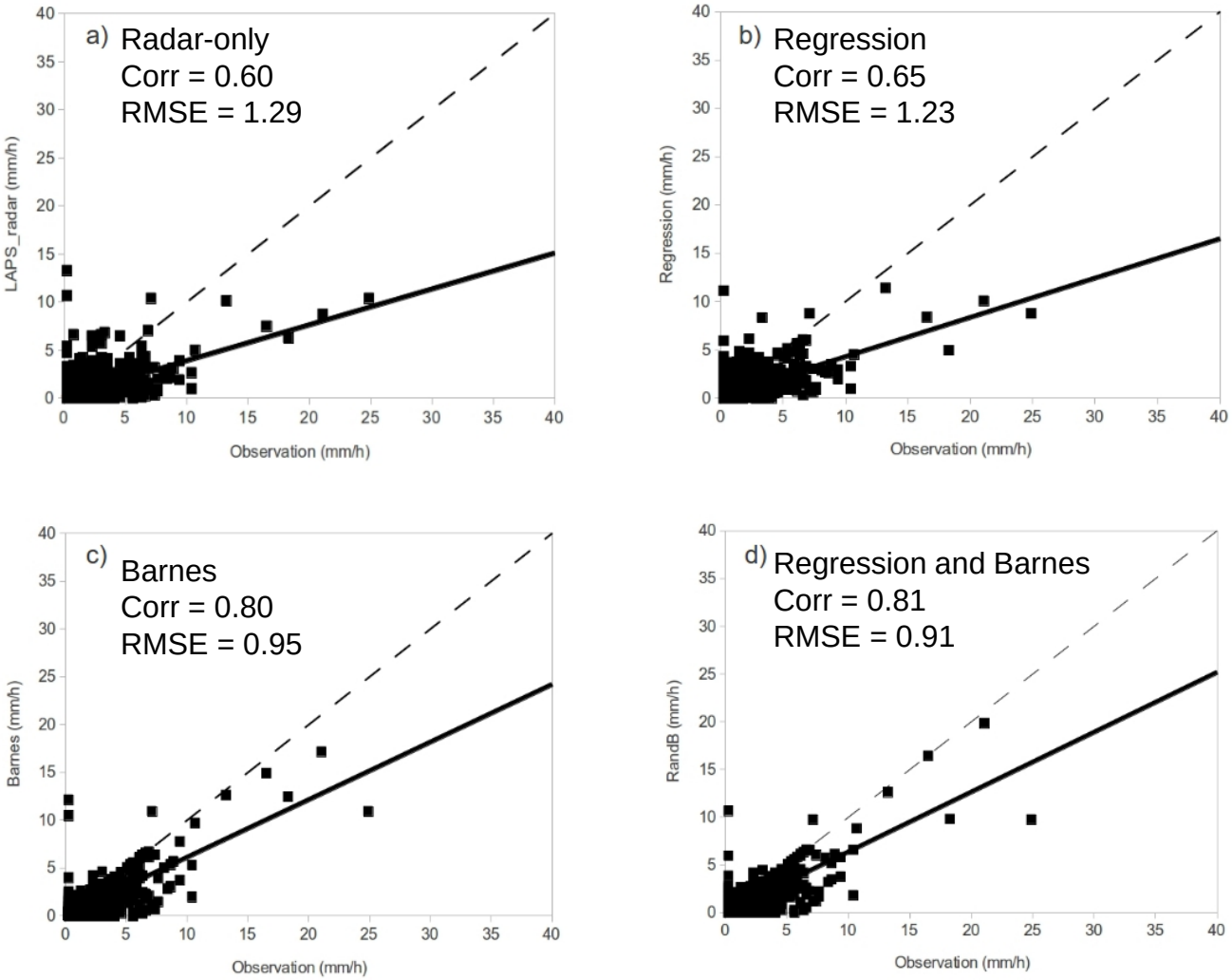
LAPS precipitation accumulation (independent), period April – October 2011:



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FMI LAPS cloud analysis (Night time clouds):

Original LAPS code use 2 temperature differences, from satellite channels and surface, to detect the clouds during night time:

laps/src/cloud/istat_cloud_39.f → IR3.9-IR11.2

and

laps/src/cloud/insertsat.f → IR11.2-Tsfc

Modifications to these detection schemes have been made at FMI, to improve the cloud analysis for our latitudes (presented during last workshop 2010)

Still there are lot of problems to detect all clouds (or in some cases too much clouds)

With larger domains (especially in latitude) there are difficulties to fine-tune these temperature differences, especially when low clouds and temperature-inversions occur

Now FMI is testing to ingest a 2-D cloud-mask from NWCSAF: http://www.nwcsaf.org/

NWCSAF use advanced methods to determine the cloud-mask:

- Use of 6-8 different satellite channels differences
- NWP parameters (SFC-temp., inversions etc.)
- Trying to solve the “twilight problem” as best possible
- Detection of snow/ice

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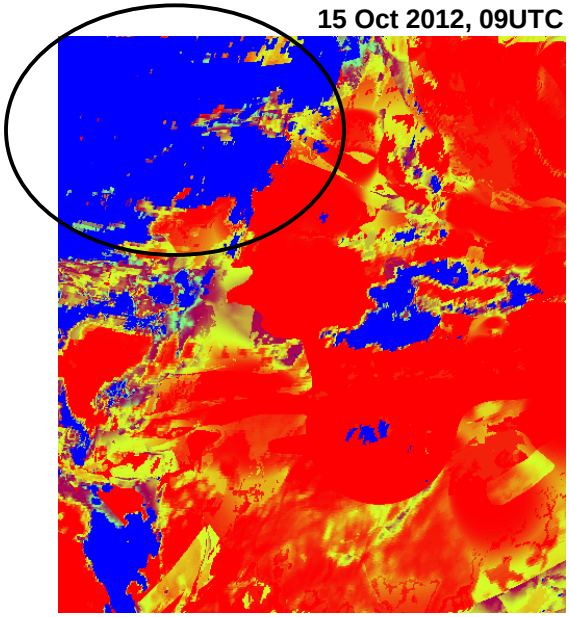
FMI LAPS cloud analysis:

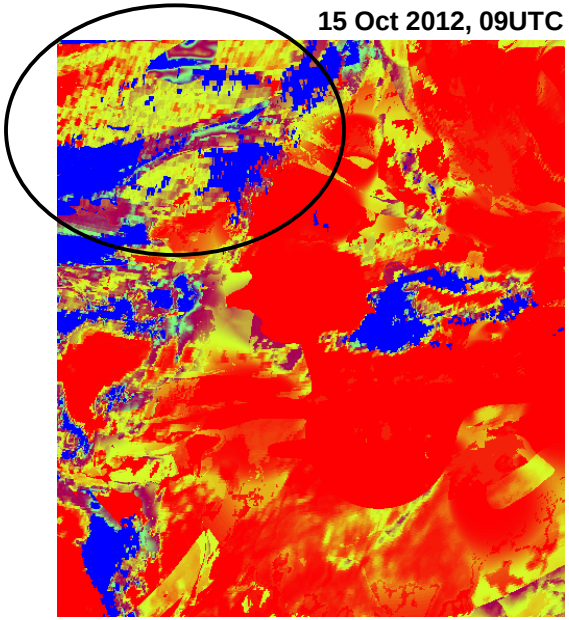
The new NWCSAF cloud-mask is ingested into LAPS analysis, as a new array, in file:

laps/src/cloud/laps_cloud_sub.f

after the “call get_istat_39()”



2-D cloud analysis
Normal



2-D cloud analysis
With NWCSAF

Potentially there are also other cloud variables to be used from NWCSAF products...

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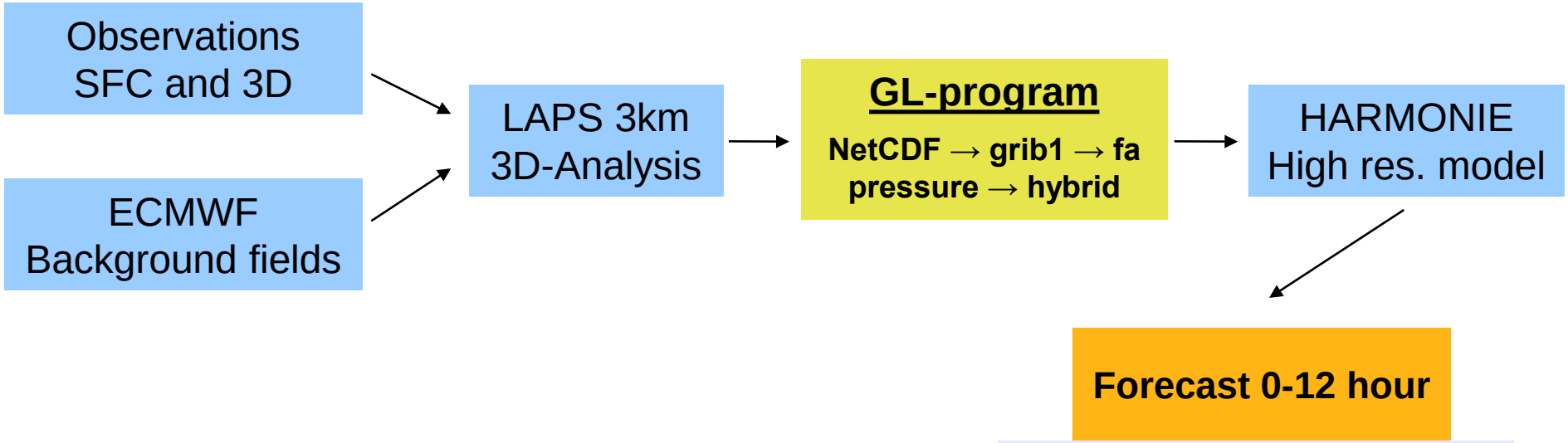
LAPS-HARMONIE: hot-start of high resolution forecast model:

On-going work to connect LAPS and HARMONIE

So far only upper-air fields are ingested



http://fminwp.fmi.fi/Harmonie-Laps/

Potential benefits:

Filling a gap for now-casting purposes, faster available forecasts

Through LAPS, satellite and radar information are brought into the forecast

Possibly, wind-, cloud- and precipitation fields could be better captured from the beginning of the forecast (especially in convective situations)

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New topographical input data for Scandinavia:

During summer 2012 FMI created a new high resolution topographical dataset

The domain covers lat. 49N-71N and lon. 3W-48E

Datasets combined to create a new topographical dataset:

- National Land Survey of Finland – Finland area, resolution: 25 m
- ASTER GDEM2 – Almost global coverage (deg. 83N – 83S), resolution: 75 m
- SRTM – Coverage deg. 60N - 54S, resolution: 100 m
- Viewfinder – Almost global coverage , resolution: 100 m
- CORINE – land/sea mask
- OpenStreetMap – land/sea mask

Tools to create new topographical dataset:

- GDAL and Phyton

Output format:

- GeoTIFF, Ehdr,.... there are many options for the output format!

Tested to use converter tool for LAPS ingest:

- TOPOGRABBER (http://laps.noaa.gov/topograbber/) ……. didn't get it to work .....!?

Does anyone have more information on this?

- LAPS ingest format?

- Conversion tool?

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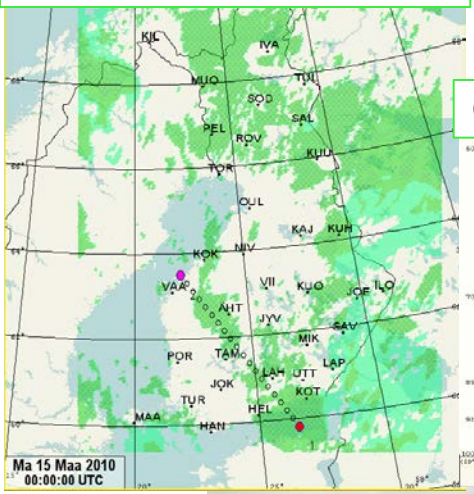
Example of FMI application areas for the LAPS analyzes:

Aviation:

3D-clouds (base/top), temp., visibility, icing intensity, winds, severe weather etc.

LAPS 2D - cloud

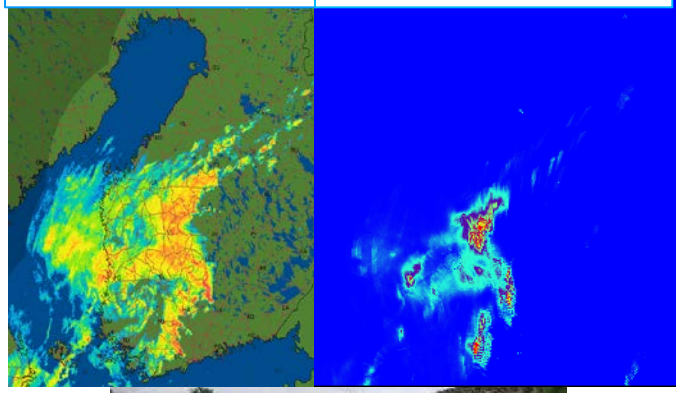


Cross-section: clouds + icing

Precipitation Accumulation:

Combining radar and observations (gauges) to estimate the rain accumulation. Important for heavy rain situations, flooding, public warnings, hydrological models etc.

Radar Refl. | **LAPS Accumulation**



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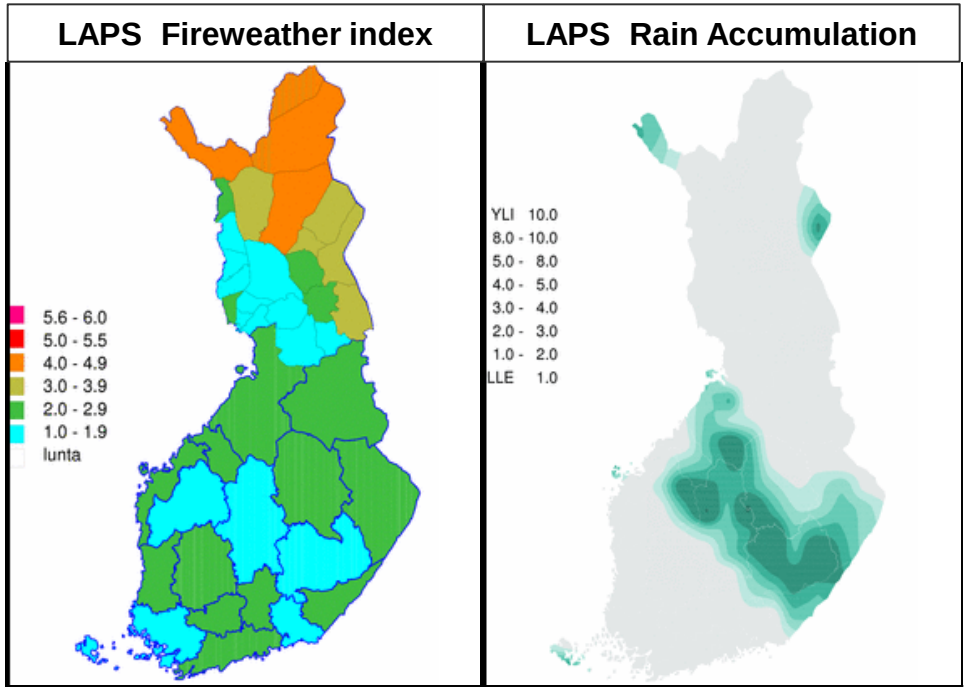
Example of FMI application areas for the LAPS analyzes:

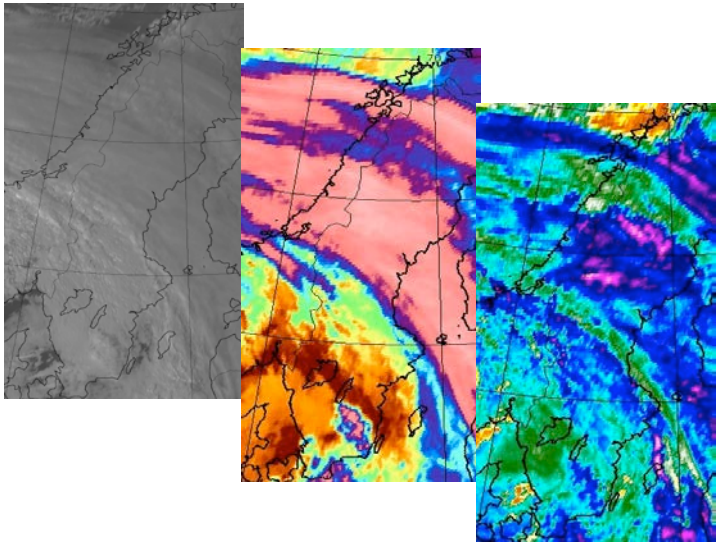
Fire-weather index:

Based on LAPS Precipitation Accumulation, public fire warnings.



Wind power plants (LOWICE):

Estimating power production, icing on wings, power losses due to icing.



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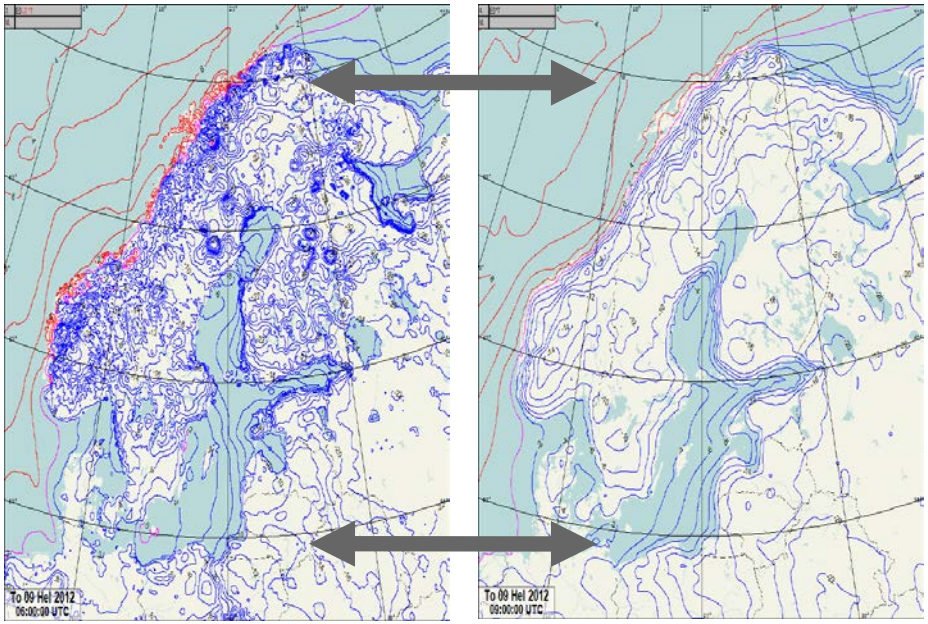
Example of FMI application areas for the LAPS analyzes:

FMI Commercial department (KAP):

KAP merge/ interpolate LAPS analysis with first forecast steps, giving a smooth transition between them.

Parameters (surface):
Temp., Rel. Hum. and Press.

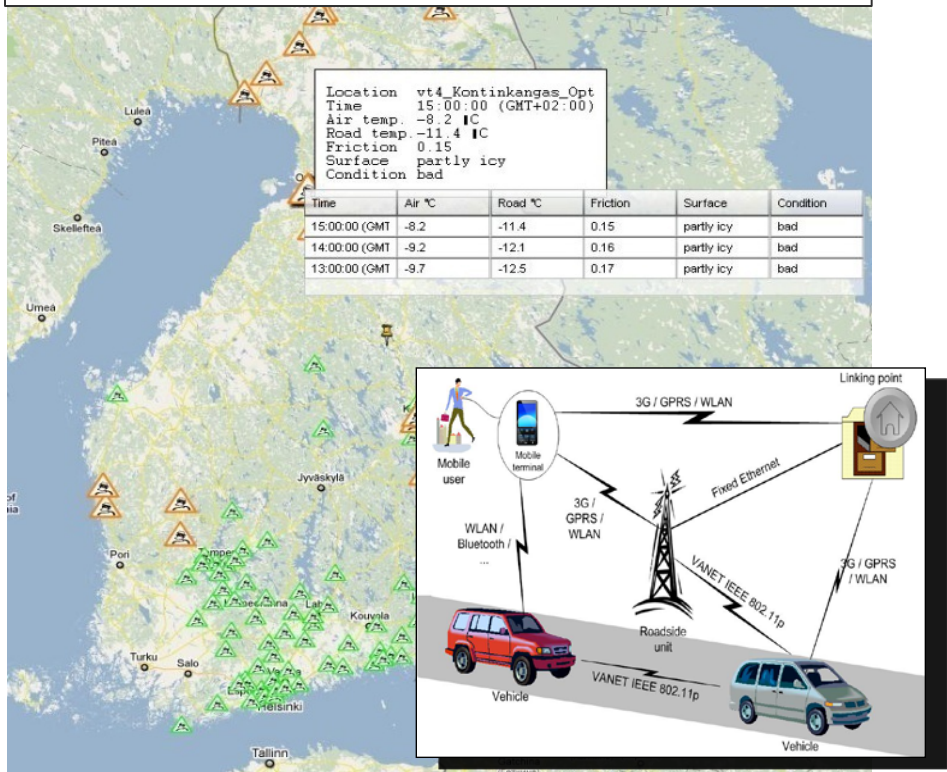


LAPS Model fc.

Road-Weather model:

LAPS analyzed variables are being used and tested to initialize the FMI road weather model.

Road weather model: Friction condition at stations



Time	Air °C	Road °C	Friction	Surface	Condition
15:00:00 (GMT	-8.2	-11.4	0.15	partly icy	bad
14:00:00 (GMT	-9.2	-12.1	0.16	partly icy	bad
13:00:00 (GMT	-9.7	-12.5	0.17	partly icy	bad

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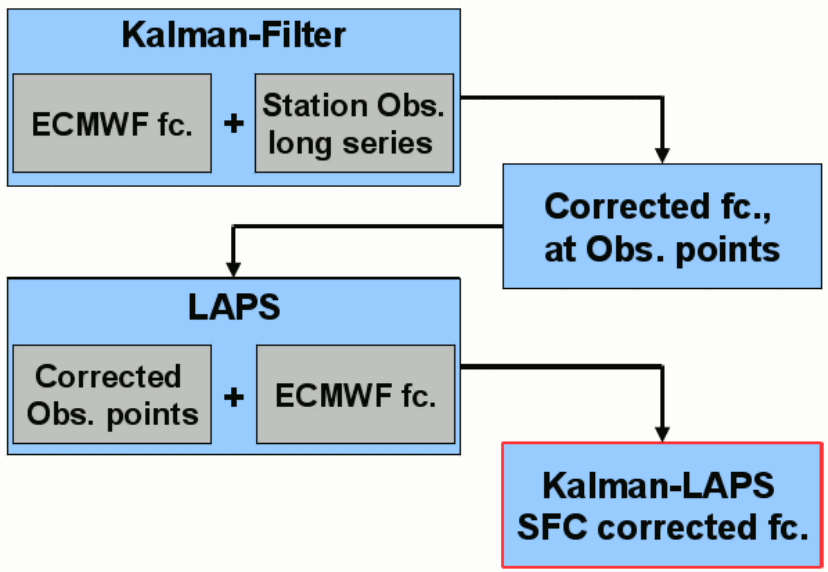
Example of FMI application areas for the LAPS analyzes:

LAPS - KALMAN forecasts:

Kalman corrected 5-days forecast, at observation points. Here LAPS is used to spread the corrected point-forecast to the surroundings.

Parameters (surface): Temperature



Air-Quality model:

LAPS analysis may serve as background field for dispersion Models (FMI ESCAPE model).

Aerosol/plume spread due to wind direction and stability.

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Future plans:

Continue work on:

- LAPS accumulation
- NWCSAF cloud ingest to LAPS
- LAPS-HARMONIE short term high-resolution forecast/now-casting

Starting to look at:

- Lightning data as ingest to LAPS (cooperate with Antti Pessi)
- Scatterometer data (winds from sea-waves)
- MTG-IRS hyper-spectral sounder as ingest to LAPS
- Low-level icing
- STMAS

Make my PhD-work on those topics

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