Snow forecasts for airports

PNOWWA -Probabilistic Nowcasting of Winter Weather for Airports

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Snow affects many activities

Runway Maintenance

Pilots

Passengers

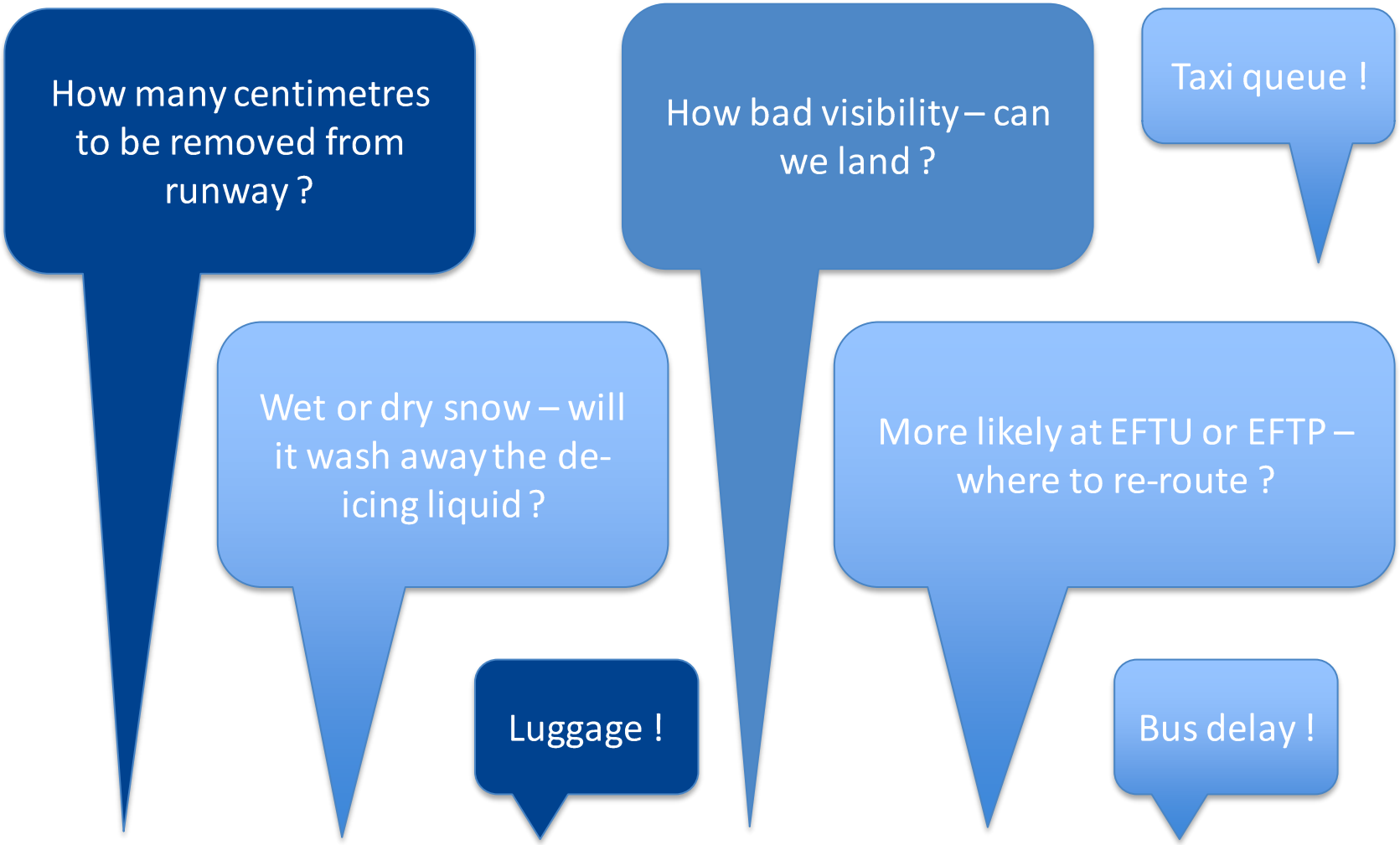
De-icing crews

Air Traffic management

Ground operations

Landside

Snow is not only snow



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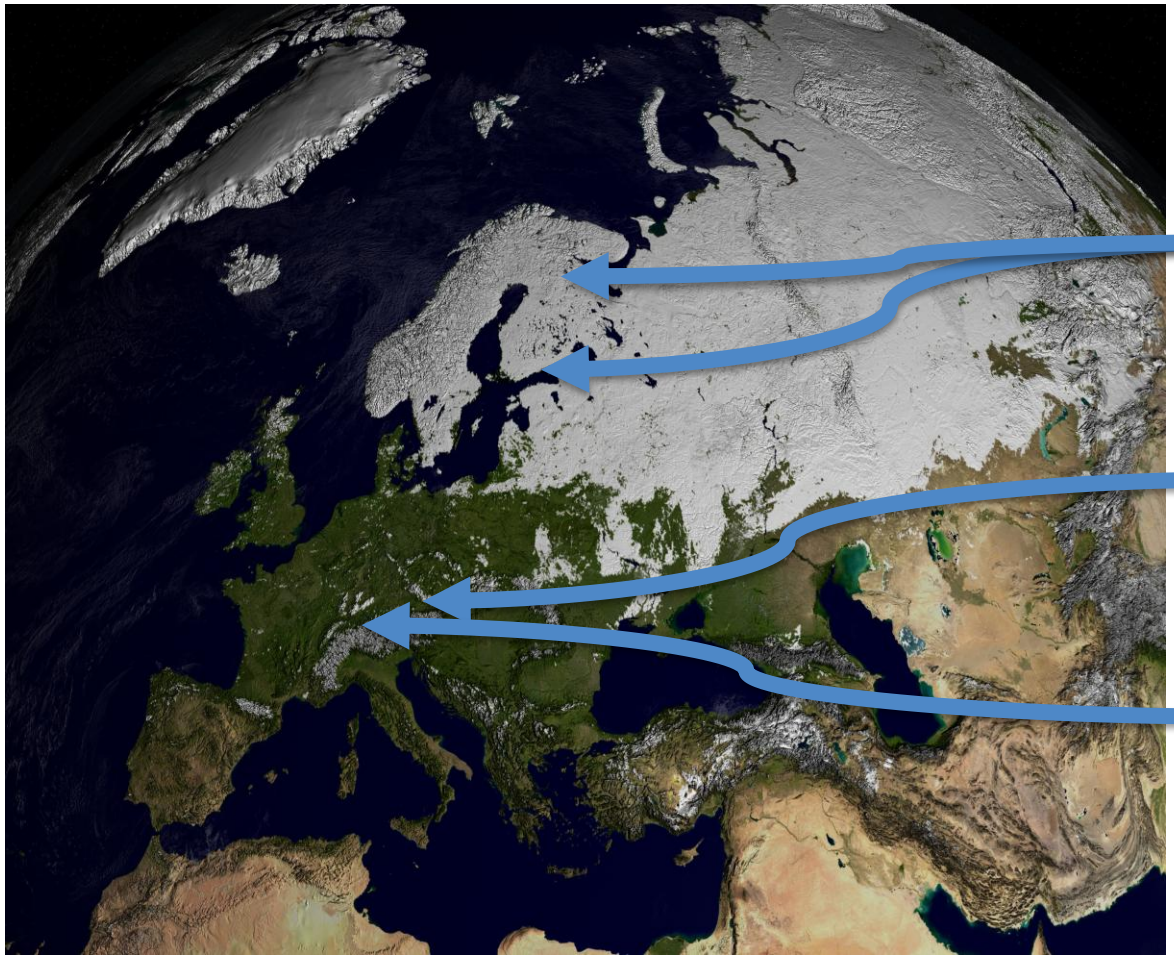
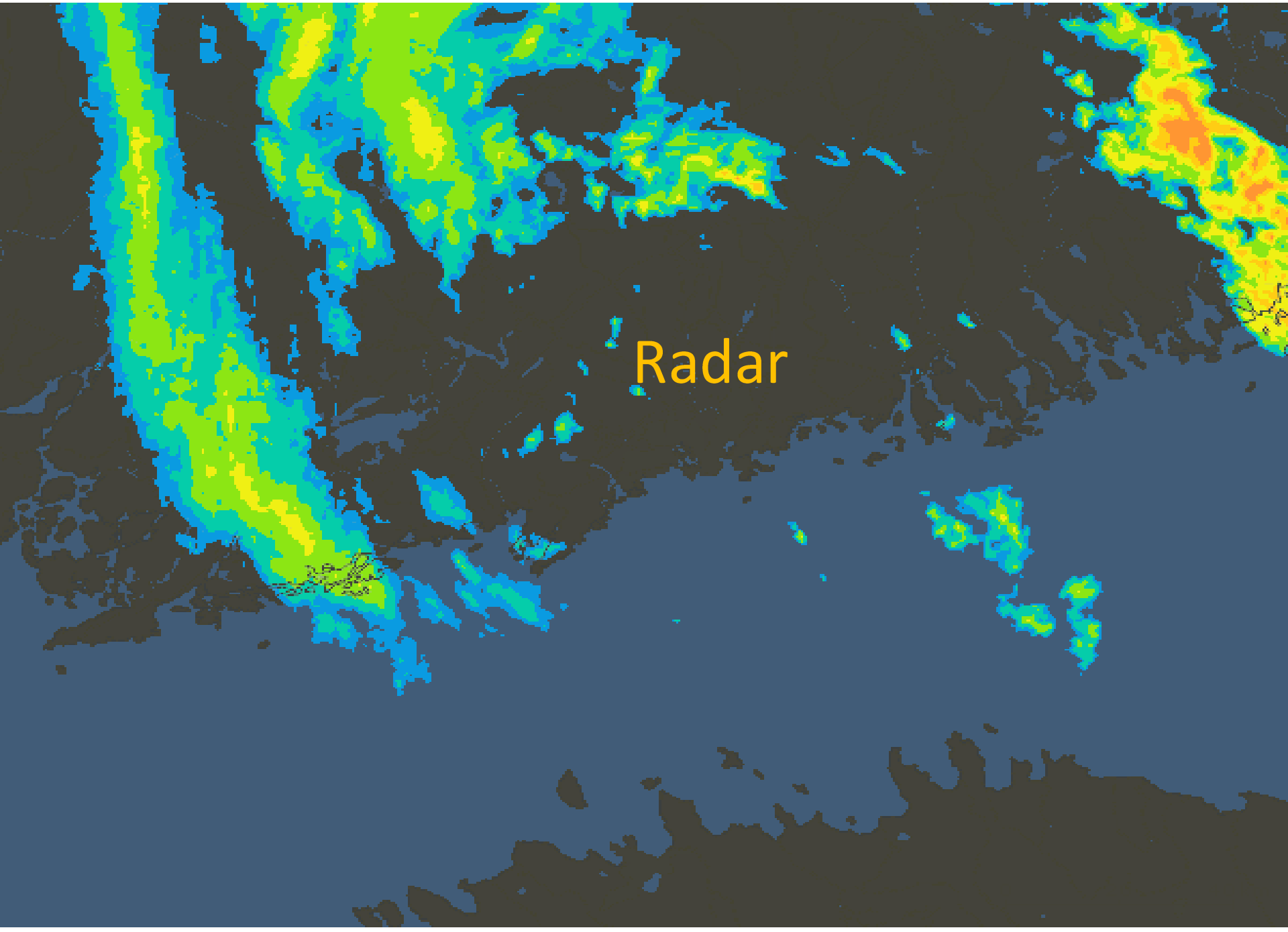


Finnish Meteorological Institute

Austrocontrol

Deutsches Zentrum für Luft- und Raumfahrt (DLR)

PNOWWA
Project Goals


Radar


Winter weather
FINNAIR
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Winter weather influences at airports

Weather effects can be **mitigated** if

- Forecasts are good
- Information reaches users

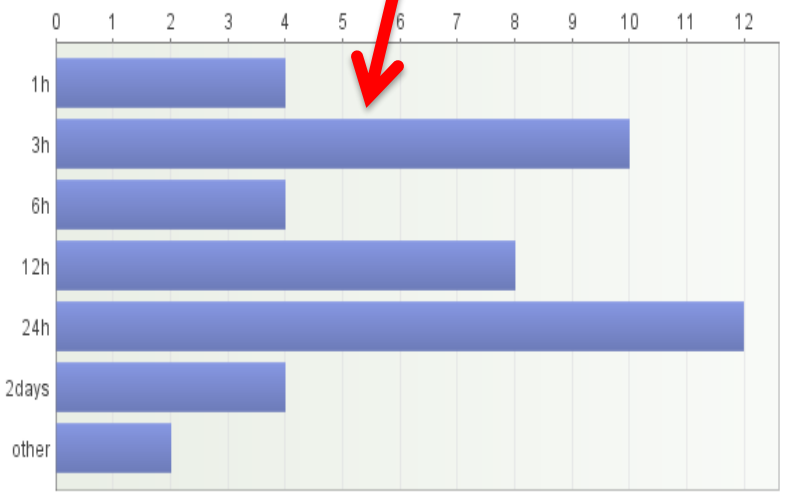
Better forecasts help
better timing of airport activities
needed to reduce the effects of adverse weather.

If used by all stakeholders at airport, the MET nowcasting can

- support improvement in airport throughput
- enable improving efficiency and punctuality of air traffic

Airport users opinions for probabilistic winter weather forecasts – potential benefits

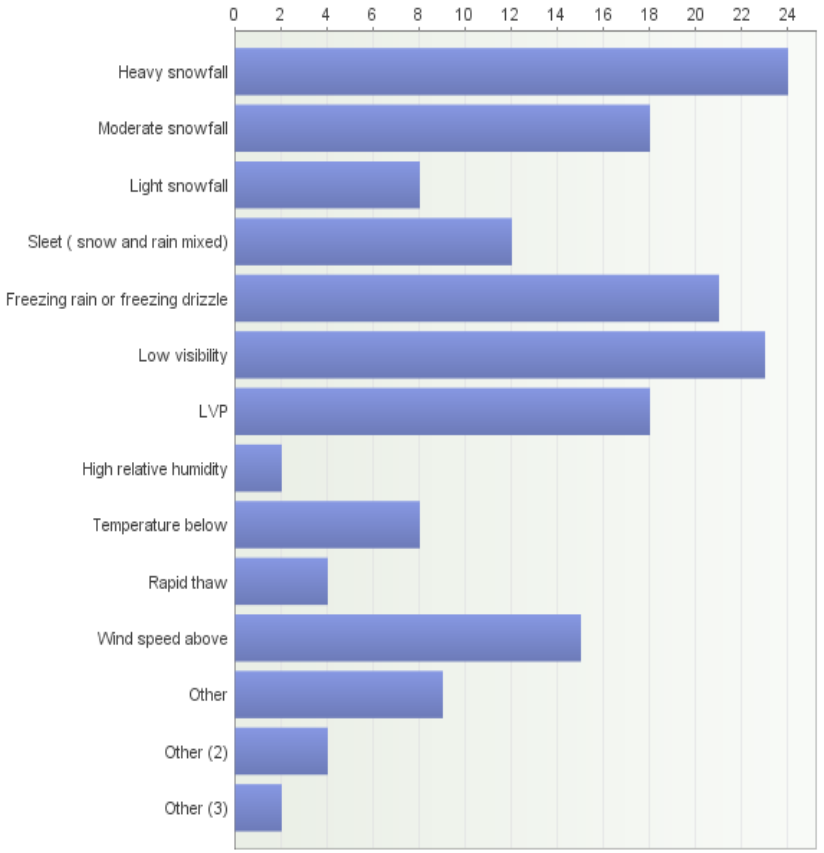
- Helps to make objective decisions
- When cost-loss ratios are known it can be used in decision support
- Positive attitude to probabilistic forecasts
- Need for lead time 3 and 12-24 hours products



Useful lead time for warning of critical weather for all responsens (PNOWWA survey)

Airport users opinions– highest negative impact affecting on airport operations

1. Heavy snowfall
2. (low visibility)
3. Freezing rain and drizzle
4. Moderate snowfall
5. Wind speed above
6. Sleet

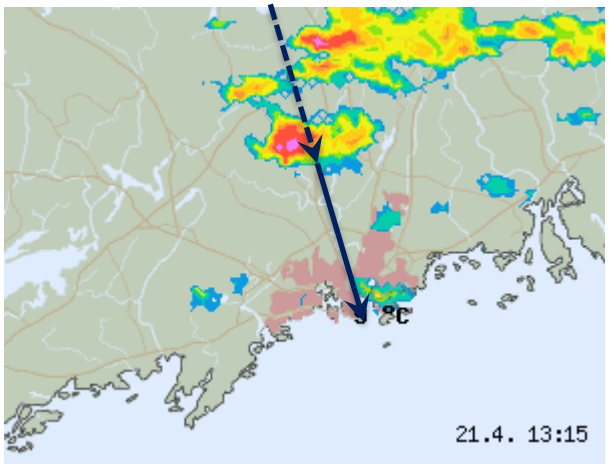


the type of winter weather affecting negatively to airport operation (PNOWWA survey)

Nowcasting with extrapolation of radar images in PNOWWA

Comparing three approaches:

- Old (Andersson)
- Operational (RAVAKE)
- New (STEPS)



Common principle:

Time= distance/speed

Example:

storm 75 km away,

moving 50 km/h

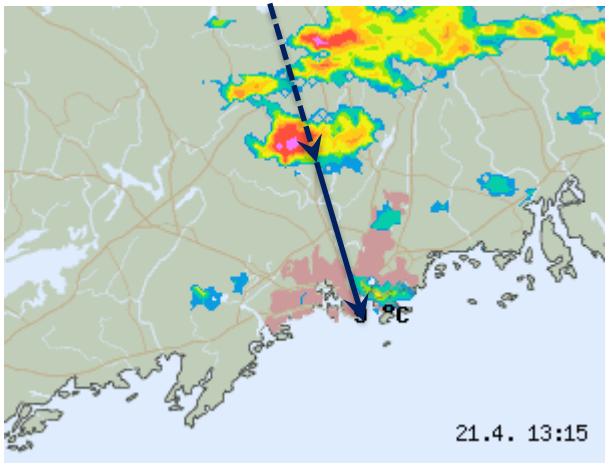
arrives in 90 minutes

15	30	45	60	75	90	105	120	135	150	165

…..dry…….. snow…maybe

Task split in two

- Calculate the motion vectors and their uncertainty
- Move the radar image with the vectors, assess uncertainty



In PNOWWA we have tried three methods for both.

- Simple one from 1990s (Andersson & Ivarsson 1991)
- Operational one from Finnish Met Institute (Hohti et al 2000)
- New ones in research (Proesmans et al, Pulkkinen et al.)

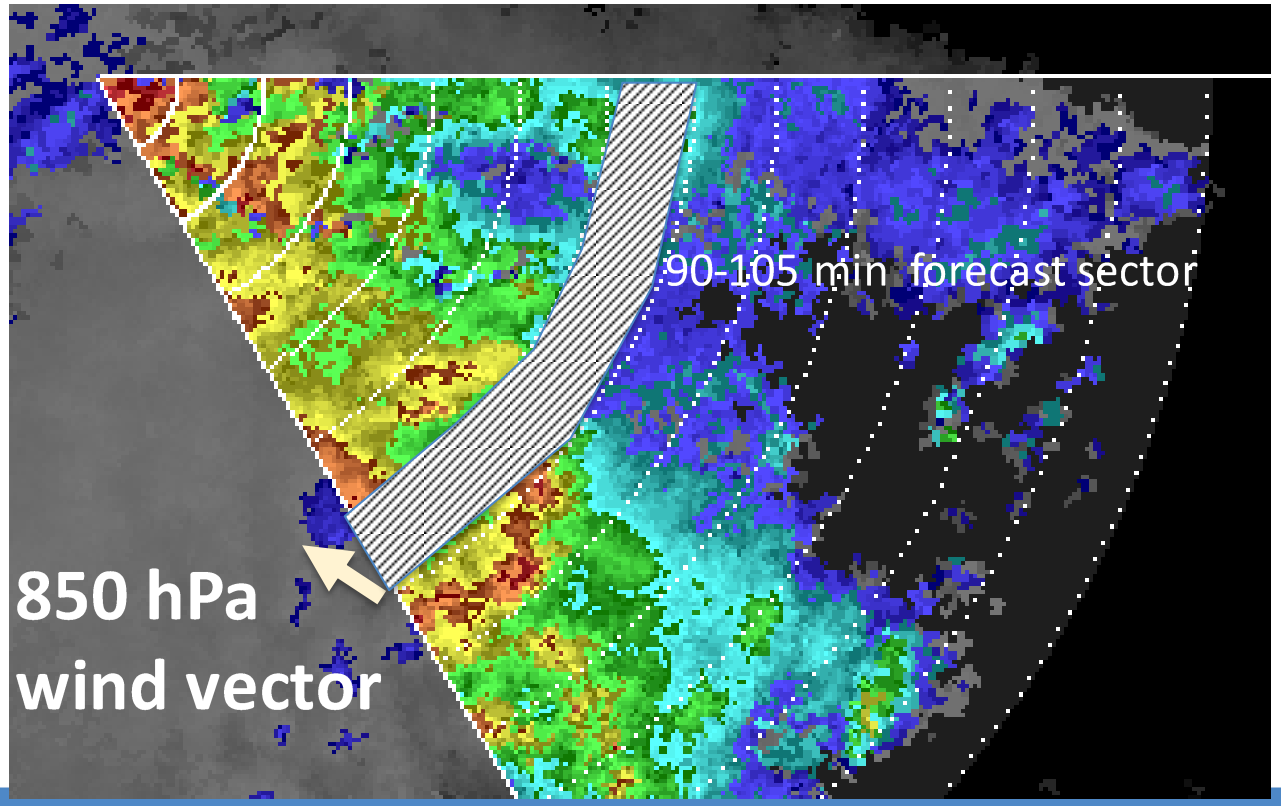
- References:

- Andersson T, Ivarsson K (1991) A model for probability nowcasts of accumulated precipitation using radar. J Appl Meteorol 30:135–141 DOI: http://dx.doi.org/10.1175/1520-0450(1991)030<0135:AMFPNO>2.0.CO;2
- Hohti H., J. Koistinen, P. Nurmi, E. Saltikoff, K. Holmlund , (2000) Precipitation Nowcasting Using Radar-Derived Atmospheric Motion Vectors. Proceedings of ERAD – the First European Radar Conference. Bologna, Italy.
- Proesmans, M. L. Van Gool, E. Pauwels, and A. Oosterlinck (1994): Determination of optical flow and its discontinuities using non-linear diffusion, in *3rd European Conference on Computer Vision*, ECCV'94, 1994, Vol. 2, pp. 295–304.
- Pulkkinen S., J. Koistinen, A-M Harri (2016): Consistency-Driven Optical Flow Technique for Nowcasting and Temporal Interpolation ERAD the 9th European Radar Conference

Benchmark:
Andersson & Ivarsson 1991

Motion vector = 850 hPa wind vector of numerical weather prediction model

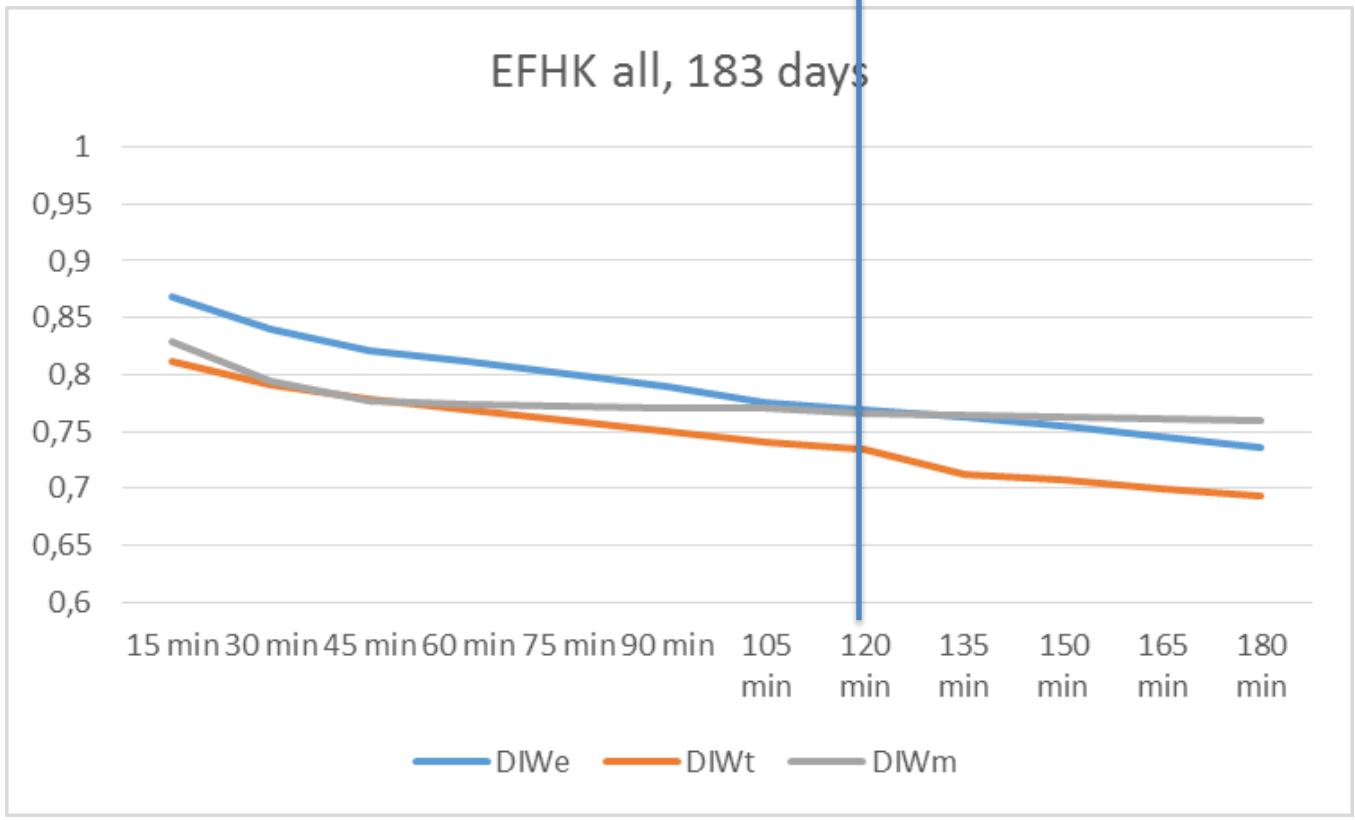
Uncertainty of movement direction = area of sector
Uncertainty growing with time, related to precip field texture



Helsinki-Vantaa, 15 minutes steps: radar better than model up to 2h

Hitrate, winters 2015-2016.

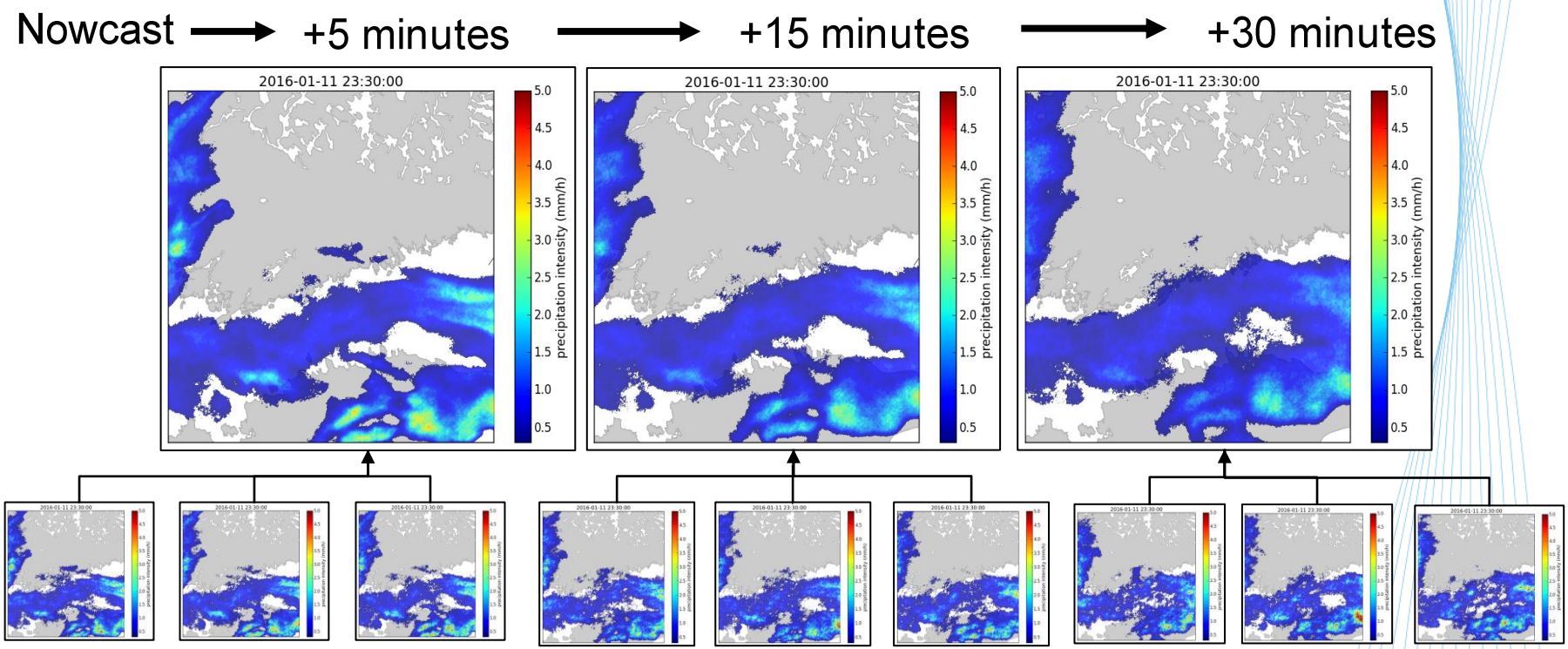
Colours: Radar-based extrapolation TAF NWP Model



New nowcasting method based on Stochastic Ensembles: STEPS

- Motion field from consecutive radar images
- Uncertainty of motion
  assessed from a set of trajectories
- Uncertainty due to **growth and decay**
  modeled by a stochastic random field

STEPS: Forecast Ensembles and Probabilities



- 51 ensemble members are obtained by perturbing precipitation intensities and motion field.
- The ensemble mean represents the “most probable” precipitation intensity.
- The mean field becomes smoother when the forecast time increases: badly predictable scales are filtered out.
- The ensembles also yield probability distributions of precipitation intensities.

Forecasts in our demos look like this

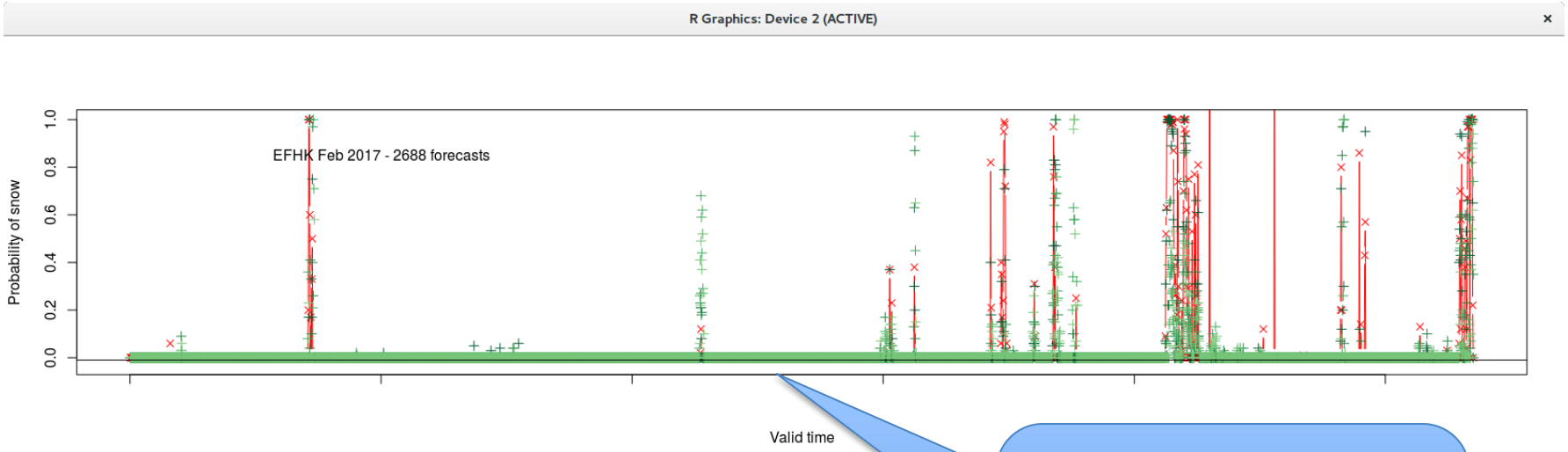
RUNWAY MAINTENANCE (UPDATED 2017-02-22 15:30:00 UTC)													
accumulation% dry snow, mm/15min	0-15 min	15-30 min	30-45 min	45-60 min	60-75 min	75-90 min	90-105 min	105-120 min	120-135 min	135-150 min	150-165 min	165-180 min	180-195 min
over 10 mm	0	0	0	0	0	0	0	0	0	0	0	0	0
5-10 mm	0	0	0	0	0	0	0	0	0	0	0	0	0
1-5 mm	100	100	100	40	0	10	30	30	30	40	40	30	40
less than 1 mm	0	0	0	60	100	90	80	70	70	60	60	70	60

Time steps of 15 minutes

Probabilities to exceed a threshold agreed with the end user.

In plain english: It snows for 45-60 min now, but after that, there will be at least a 30 minute break !

The simple method was used in first demos, and it performed quite well !



EFHK Feb 2017 (2688 forecasts)
Red: Observations (15 minutes)
Green shades: 30-120 min forecasts

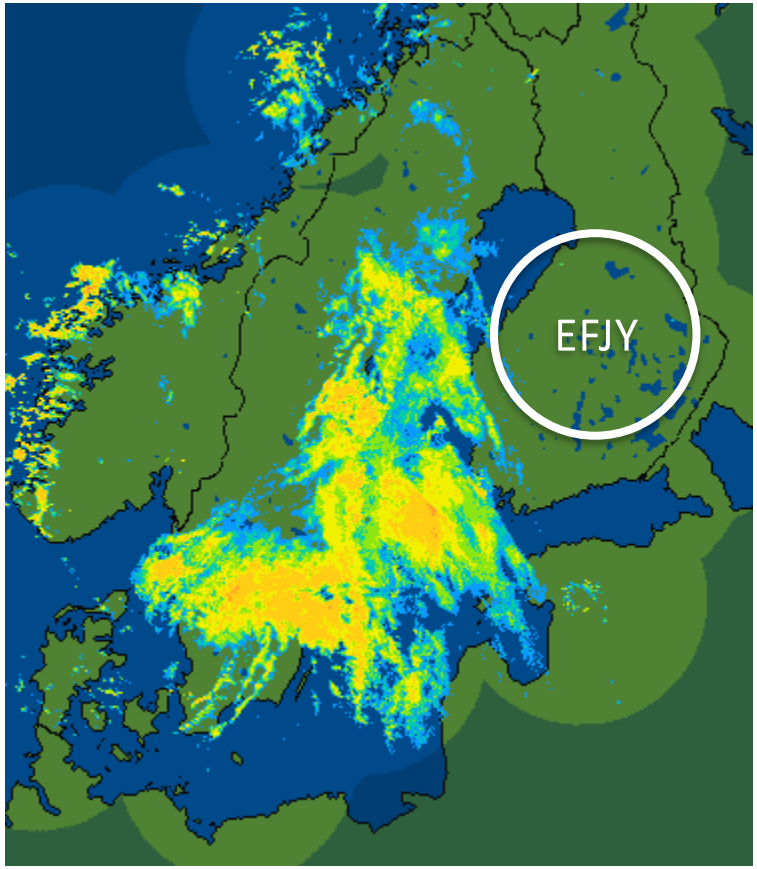
"It is not snowing now. And it will not snow for a while."

”Radar is an excellent tool to say it is not raining”

Based on this image we can say that the precipitation does not start in EFJY in 2 hours.

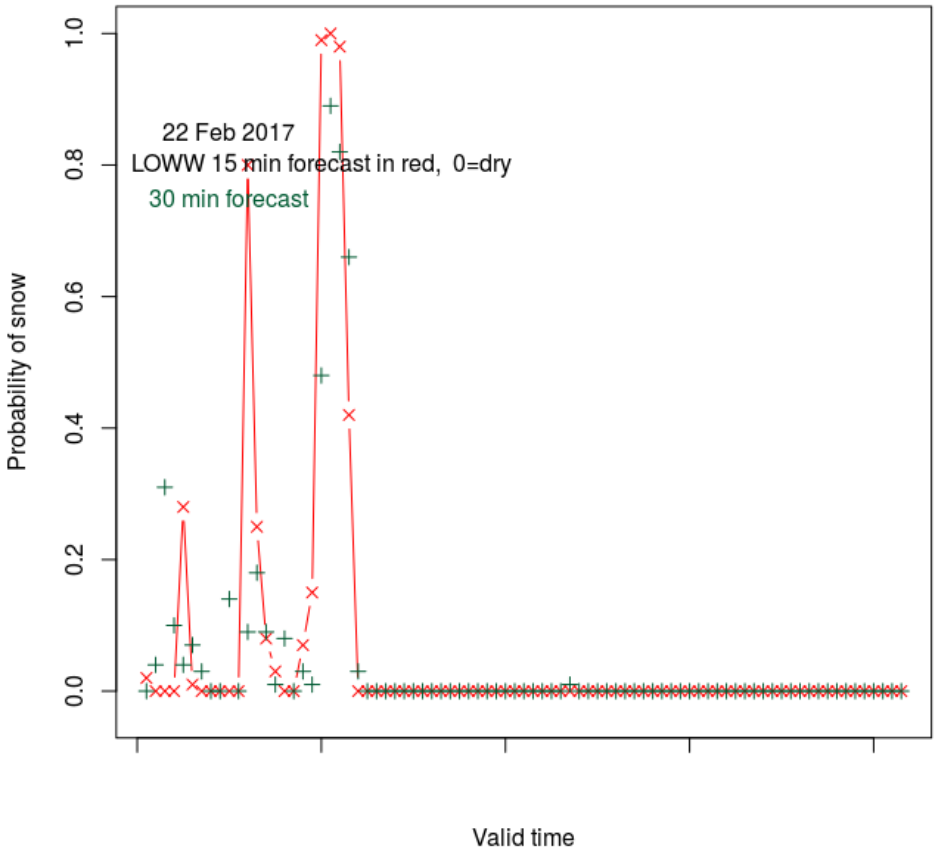
It is obvious for a meteorologist*.

But it is valuable information for the snowplough driver.



*In Finland, in wintertime

30 min forecasts are usually brilliant

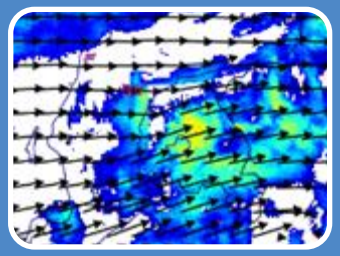


The ”probabilistic observation” is the frequency of radar pixels over a threshold indicating snowfall at the airport. It can be seen as indicator of how large fraction of the first 15-minutes period it is snowing.

Snow at airport

Different users need different parameters

- Visibility reduced by snowfall
- Snow depth, snow type, …



Radar is a useful tool for nowcasting

- Timing in steps of 15 minutes
- Lead times up to 2-3 hours

It is also important to forecast that it will not snow

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Thank you very much for your attention!

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