Satellite-Based Detection of Fog and Very Low Stratus

A High-Latitude Case Study Centred on the Helsinki Testbed Experiment

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Outline


Motivation

4 killed in 250-vehicle pileup in Italy

Fog is blamed in high speed chain reaction crash

PADUA, Italy (CNN)

A high-speed chain reaction crash Thursday involving 250 vehicles on a fog-bound highway in northeastern Italy left at least ... and injured ... immediat...

Scores of crumpled and burnt cars, trucks and buses were piled behind one another on both sides of the four-lane road linking Padua and Bologna. Some vehicles plunged down a grass bank into a ditch. Some of the victims were reported to have burned to death. Emergency crews rushed ... sifting through ... for possible...

Police said fog had reduced visibility to less than 60 yards (200 meters) when the chain reaction crash began about 9a.m. The first collision occurred on the southbound side ... the road but there were fa... both directions. Son... traffic as the ... at the pil...

With both lanes blocked, emergency vehicles had trou... ble reaching victims. The fo... was so thick, helicopters co... not land to remove the injur...

A truck carrying uranium w... in the midst of the wre... determine if its c...

Web posted Saturday, June 19, 2004

Heavy fog leads to fatal boat crash

Signs of alcohol found in boat that sped head-on into pier; Autopsy planned

By RICHARD HARROL...
Staff writer

A 20-year-old Saugatuc...

Fog led to a 200-car pileup on the Long Beach (Calif.) freeway that left several...

A passenger, Thomas Su... of Holland sustained mir... and was treated and rele... Holland Community Hos...

BBC NEWS WORLD EDITION

Last Updated: Thursday, 10 July, 2003, 11:52 GMT 12:52 UK

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Crash pilot 'confused by fog'

A motor racing millionaire may have become confused just before the plane he was piloting crashed in thick fog killing all five people on board, a report has said.

Guernsey racing promoter Brian Kreisky was taking family and friends on a festive break to Majorca when the light aircraft crashed on 23 December, 2000.

The Beech 200 plane had just taken off from Blackbushe airport near Camberley, in Surrey, when the left propeller lost ... power, a report from the Air ...idents Investigation Branch (AAIB) said.

Mr Kresiky was flying family and friends to Majorca for Christmas

WORLD

Fog blamed in Uzbek plane crash

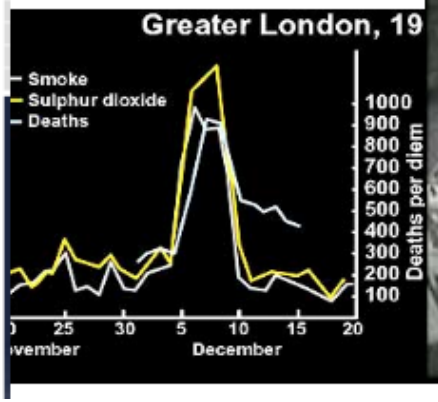
Wednesday, January 14, 2004 Posted: 10:06 PM EST (0306 GMT)

TASHKENT, Uzbekistan (AP) --An airliner was making its second attempt to land in heavy fog when it crashed just short of the runway, killing all 37 people on board, including the top U.N. official in this Central Asian country.

Four foreigners were among the passengers on the Uzbekistan Airways flight that crashed Tuesday evening, Prosecutor General Rashid Kadyrov said.

They were Richard Conroy, a

Uzbek officials inspect the crash site at Tashkent airport.



Aims

Fog detection system should offer

- High spatial resolution (fog margins)
- High temporal resolution (nowcasting)
- Long time series (climatology)

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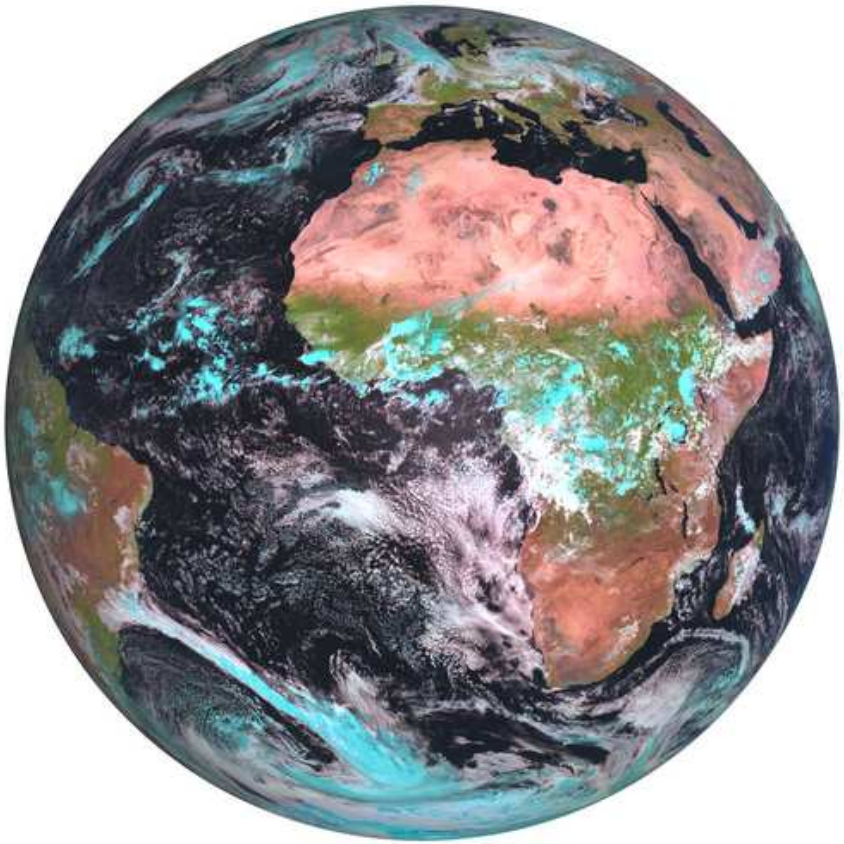
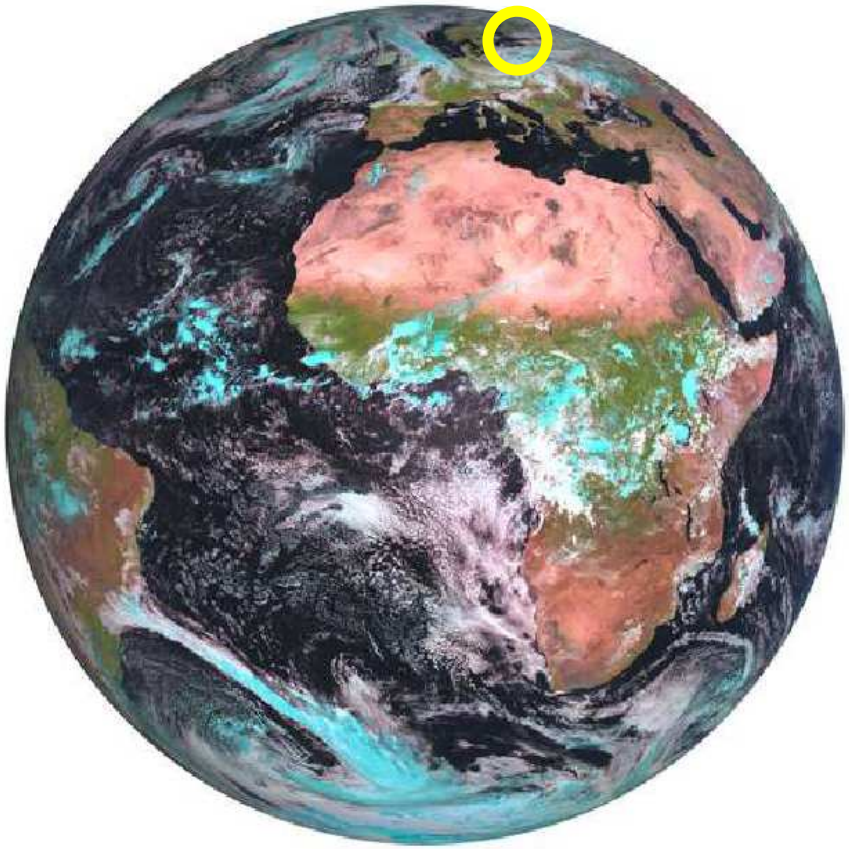
Only geostationary satellite data suited!

Satellite system: Meteosat 8 SEVIRI



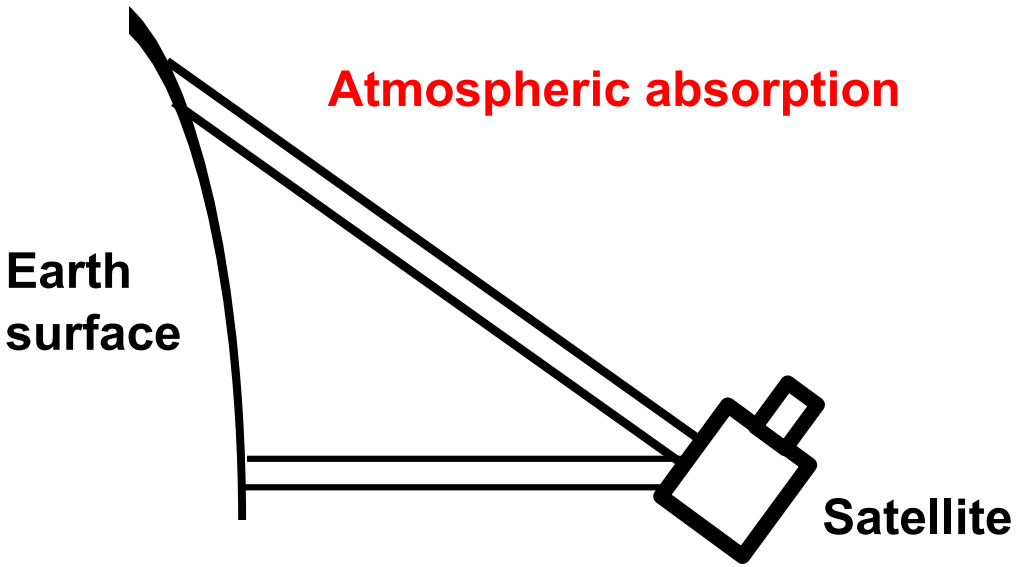
- 3 km spatial resolution
- 15 min repeat rate
- 11 spectral channels
- Operational since 2004

High Latitudes: Finland



- Latitude southern Finland: $\approx 61°$
- Satellite zenith angle: $\approx 70°$
- Reduced spatial resolution
- Low solar elevation
- Enhanced atmospheric effect

High Latitudes: Difficulties



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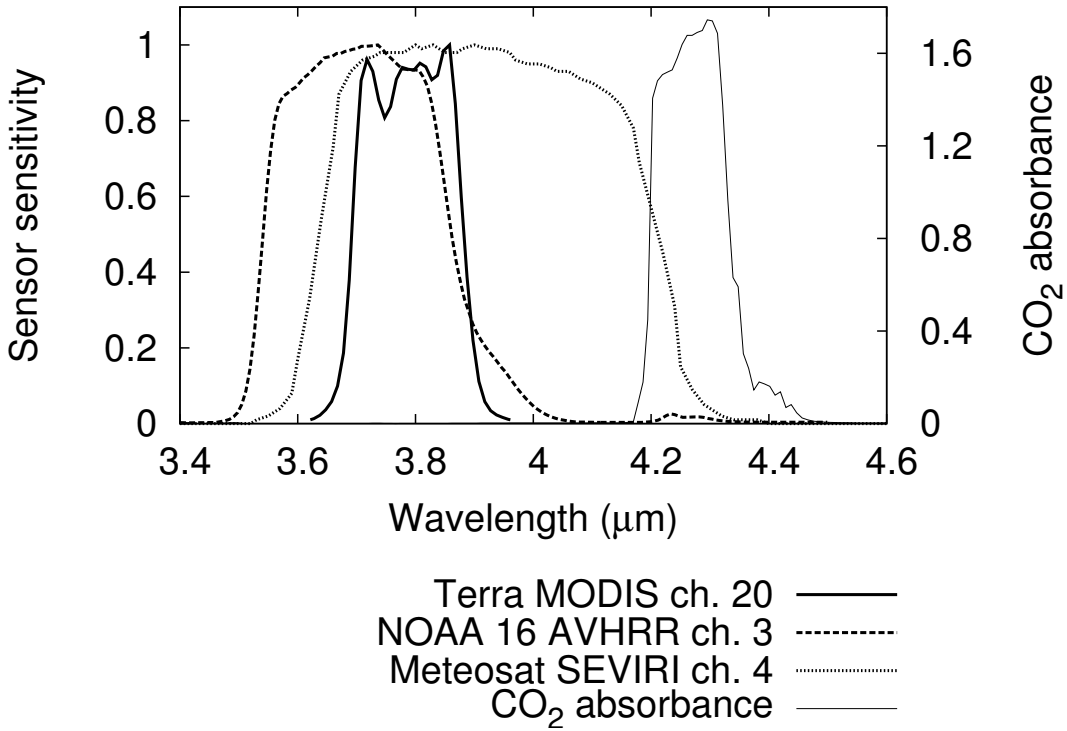

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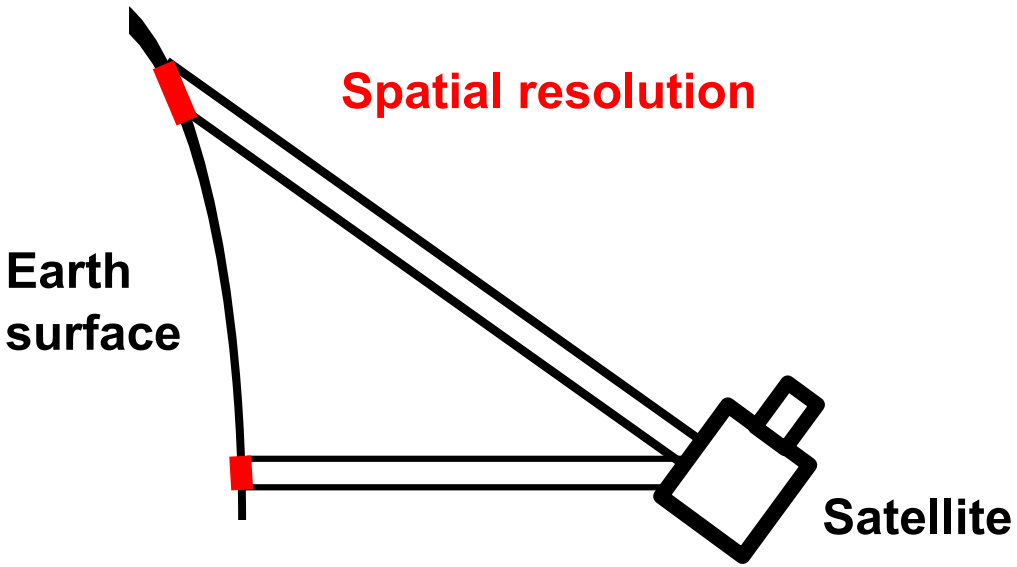


Research Question

Problem

Is the detection of fog and very low stratus possible

- *from a geostationary platform*
- *at high latitudes?*

To be investigated with detailed measurements.

Helsinki Testbed

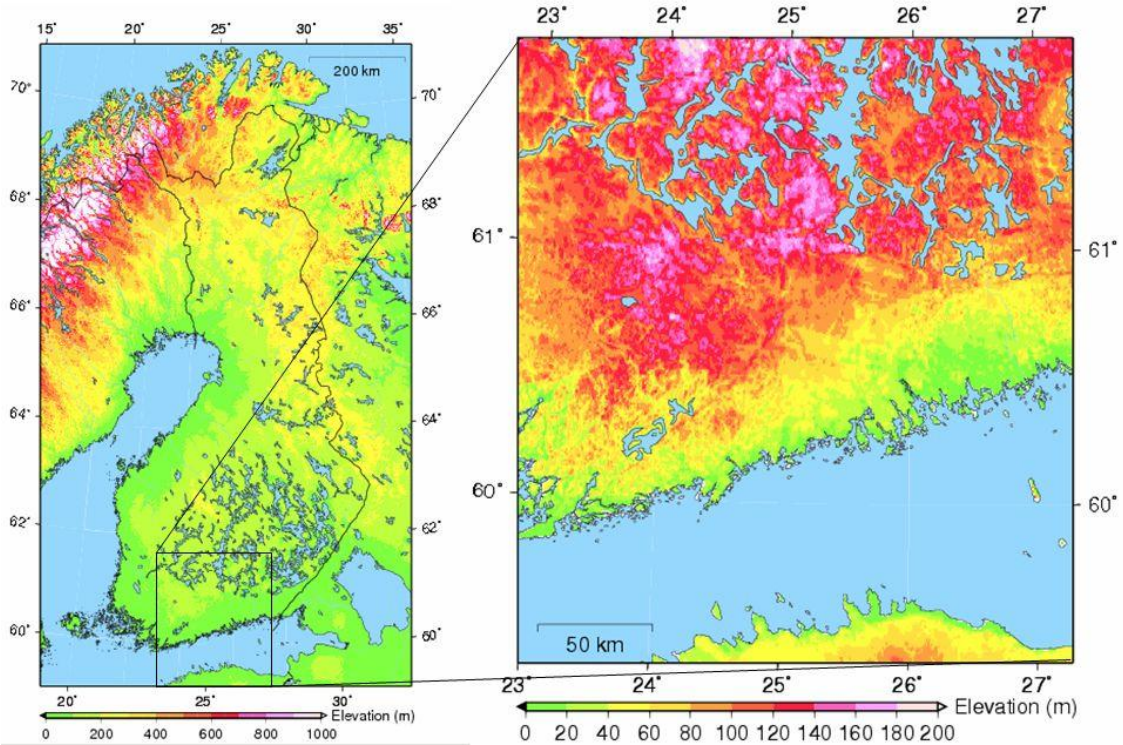
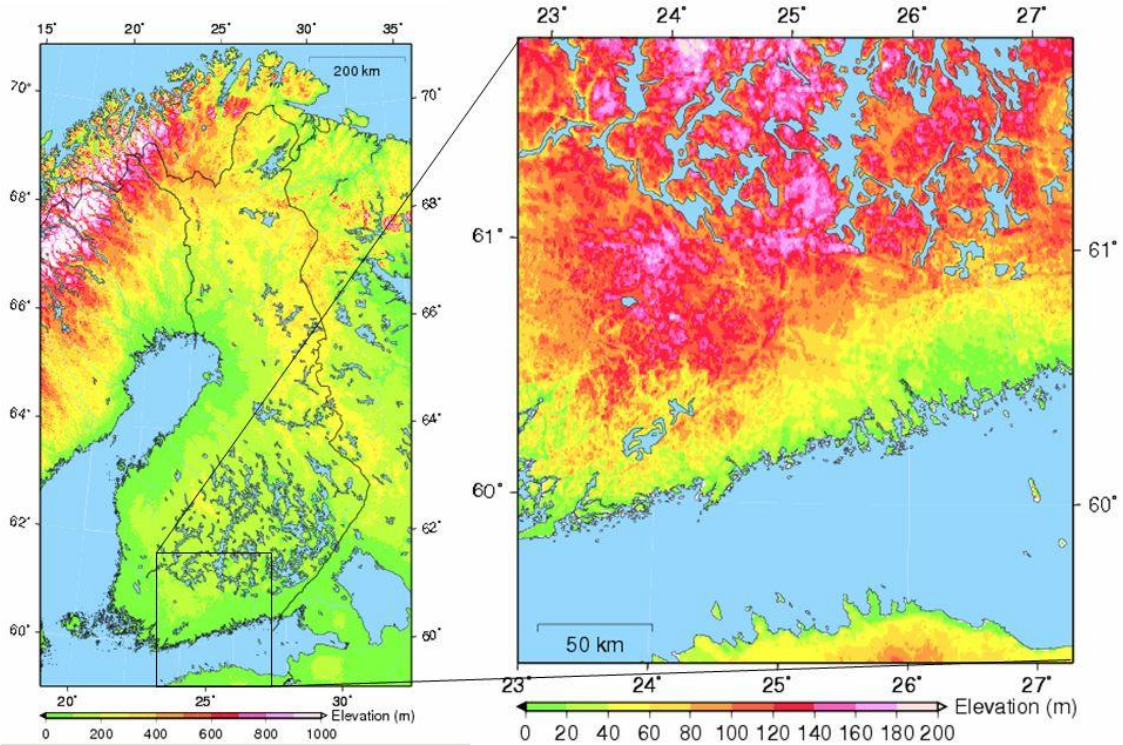


Figure: J. Poutiainen, 2006

Helsinki Testbed



- 2005–2007
- Mesoscale weather research
- System integration
- Model development
- Data and info on www.fmi.fi/testbed

Figure: J. Poutiainen, 2006

Measurements

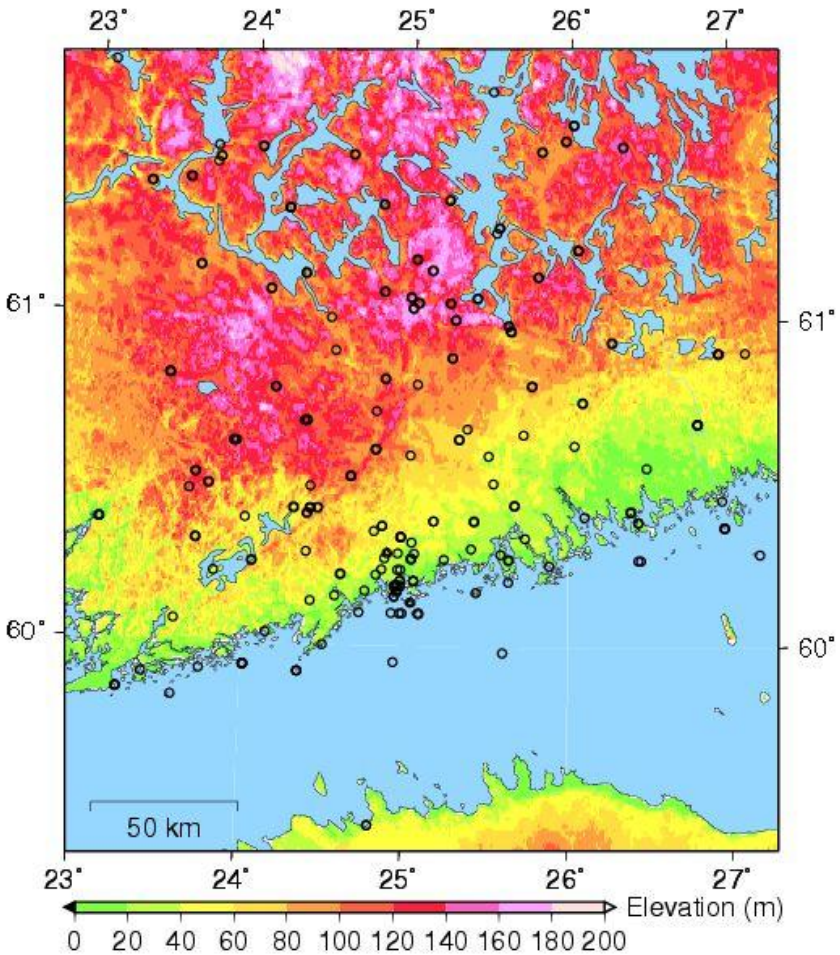


Figure: J. Poutiainen, 2006

Targeted measurements for

- Nowcasting applications
- Precipitation type
- Sea breeze
- Convection
- *Stable boundary layer*

SOFOS

SOFOS – *S*atellite-Based *O*perational *F*og *O*bservation *S*cheme

Fog as a

- *cloud*
- in the *water phase*
- *low* above ground
- with a *stratiform* surface
- impairing visibility *at the ground*.

SOFOS

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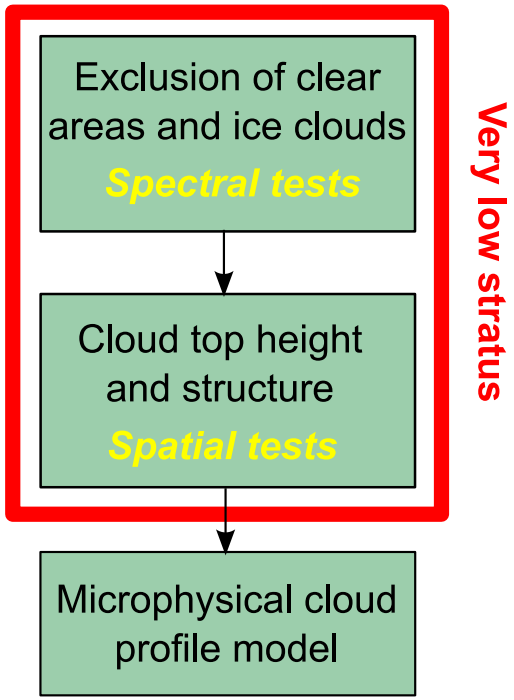

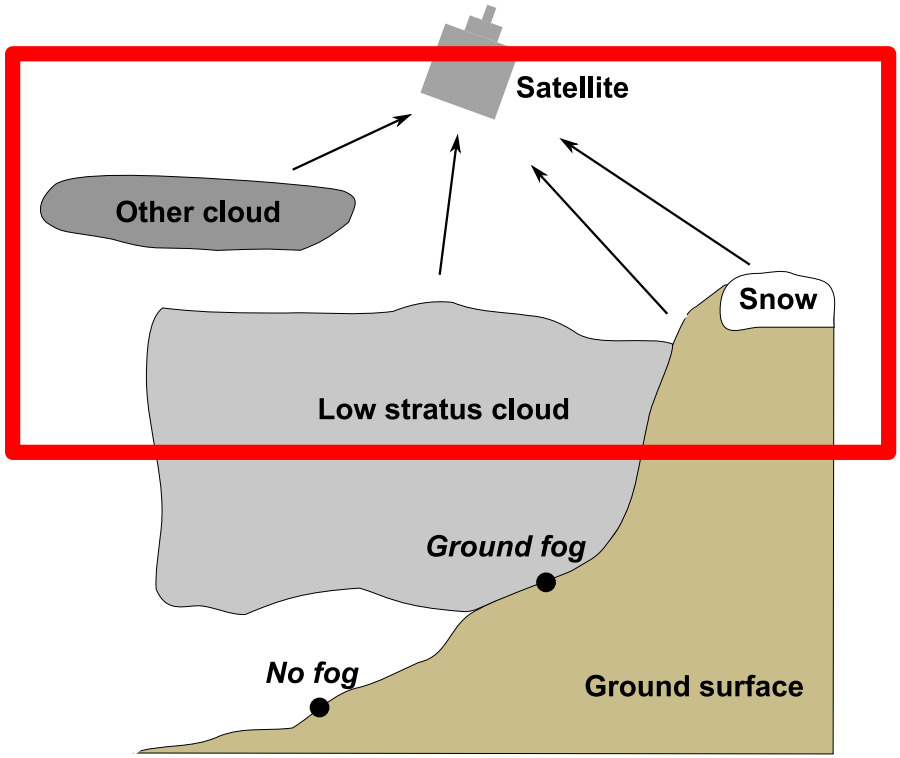

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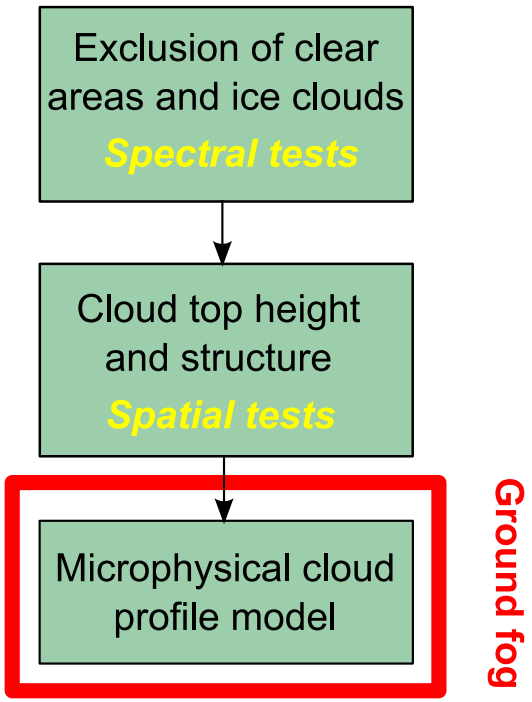
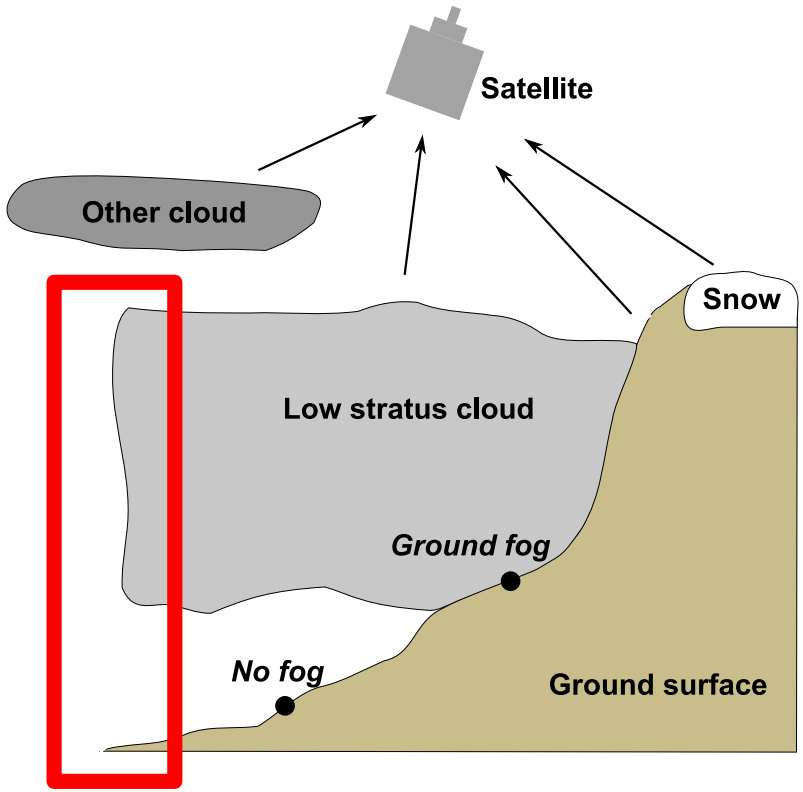


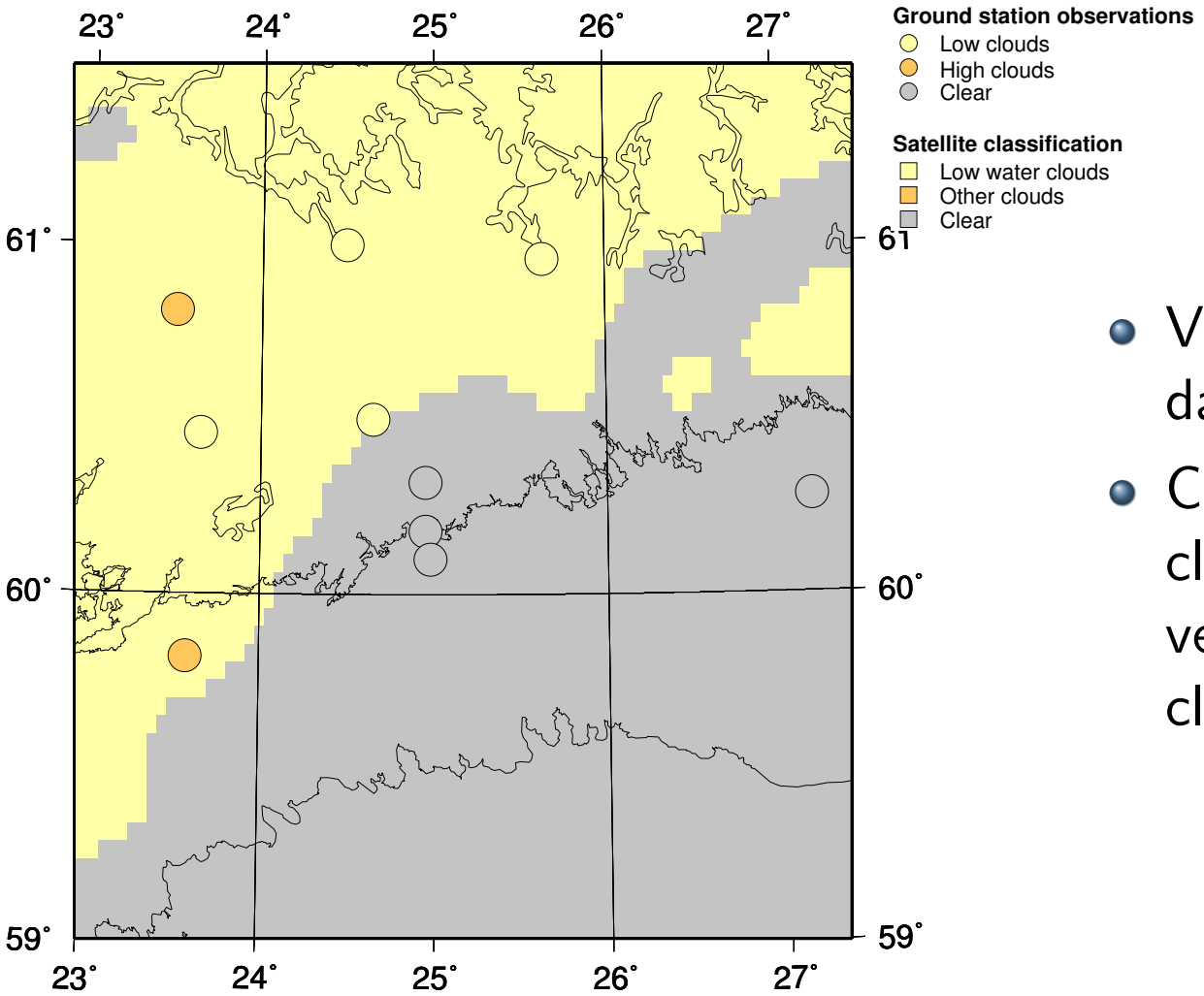


Test Procedure: Data Selection

12 days, November 2005 – February 2006

- Data availability
- Data quality
- Includes fog / low stratus situations

Test Procedure: Point/Pixel Comparisons



- Visibility and ceilometer data for low cloud presence
- Compared with satellite classification (no cloud / very low stratus cloud / high cloud)

Test Procedure: Contingency Tests

	Observation Yes	Observation No
Classification Yes	A	B
Classification No	C	D

Hit Rate: $HR = \frac{A}{A+C} \quad [0 \cdots 1]$

False Alarm Rate: $FAR = \frac{B}{A+B} \quad [0 \cdots 1]$

Critical Success Index: $CSI = \frac{A}{A+B+C} \quad [0 \cdots 1]$

Test Results: By Day

Indicator	Value	Best	Worst
HR	0.66	1.00	0.52
FAR	0.25	0.00	0.67
CSI	0.54	1.00	0.31
n	9374		

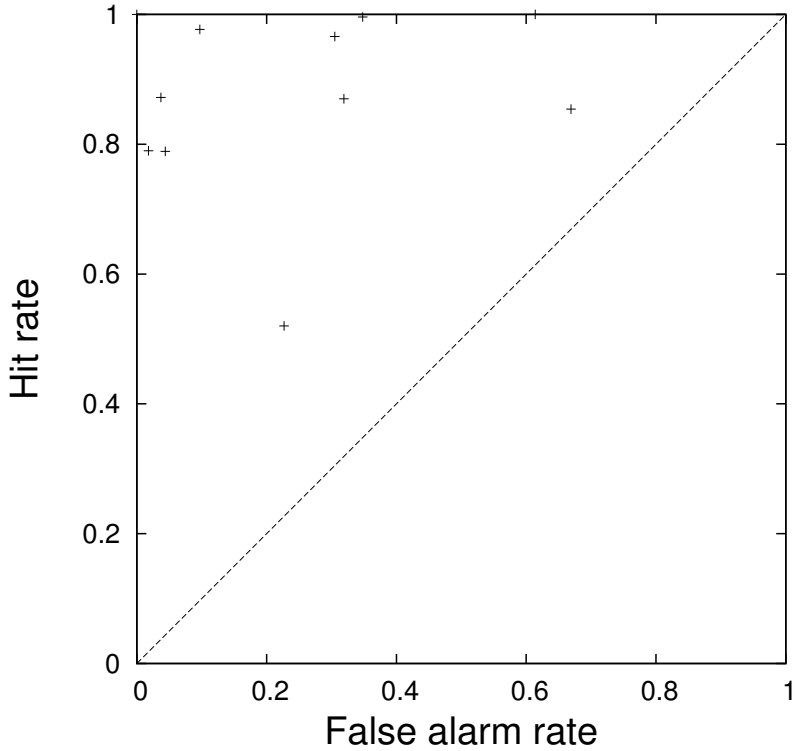


Figure: Results by day

Test Results: By Station

Indicator	Value	Best	Worst
HR	0.66	0.78	0.51
FAR	0.25	0.00	0.60
CSI	0.54	0.77	0.36
n	9374		

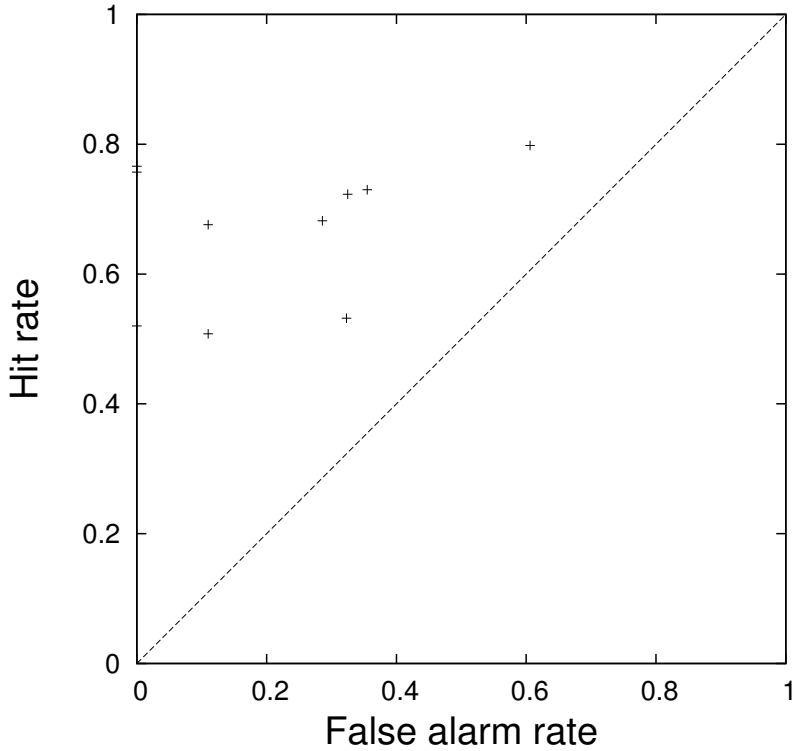


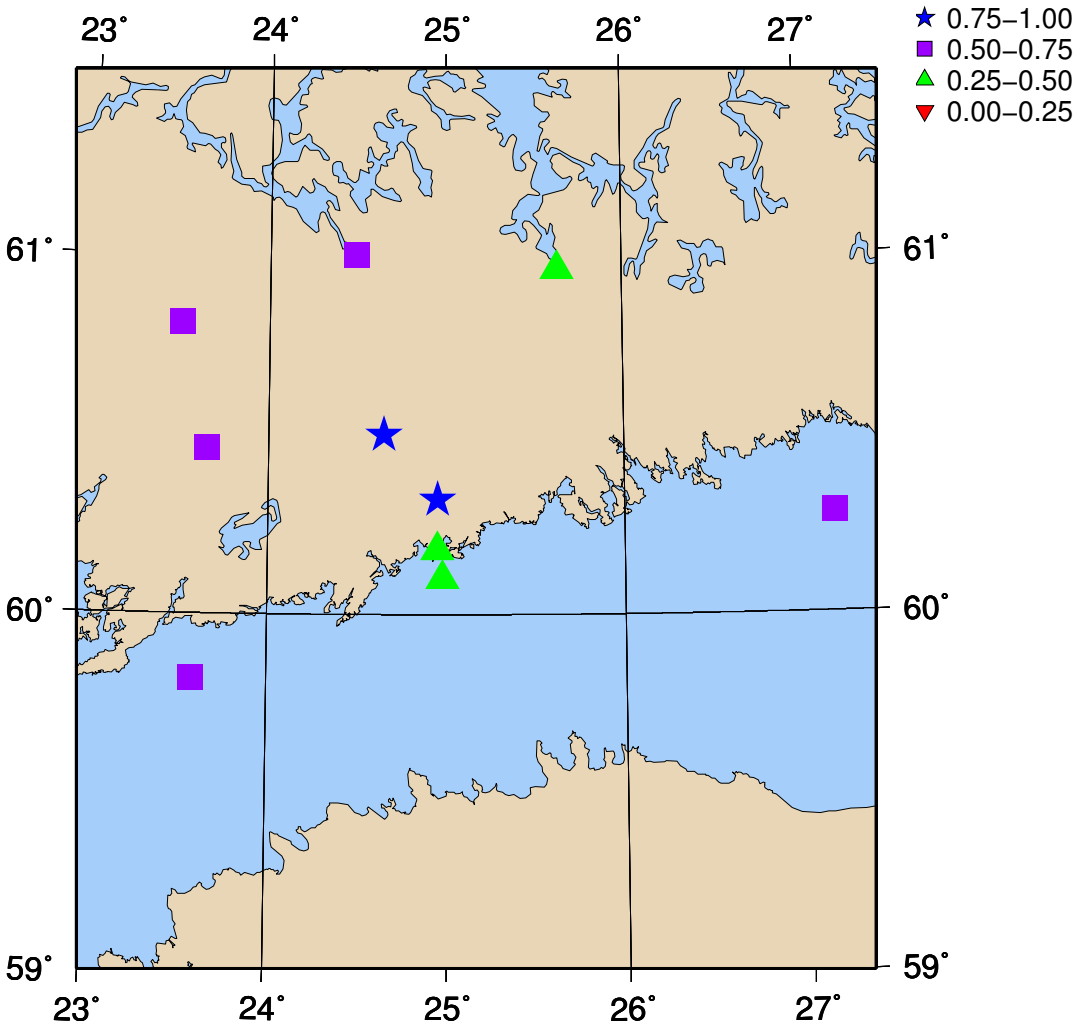
Figure: Results by station

Analysis

Possible reasons for misclassifications:

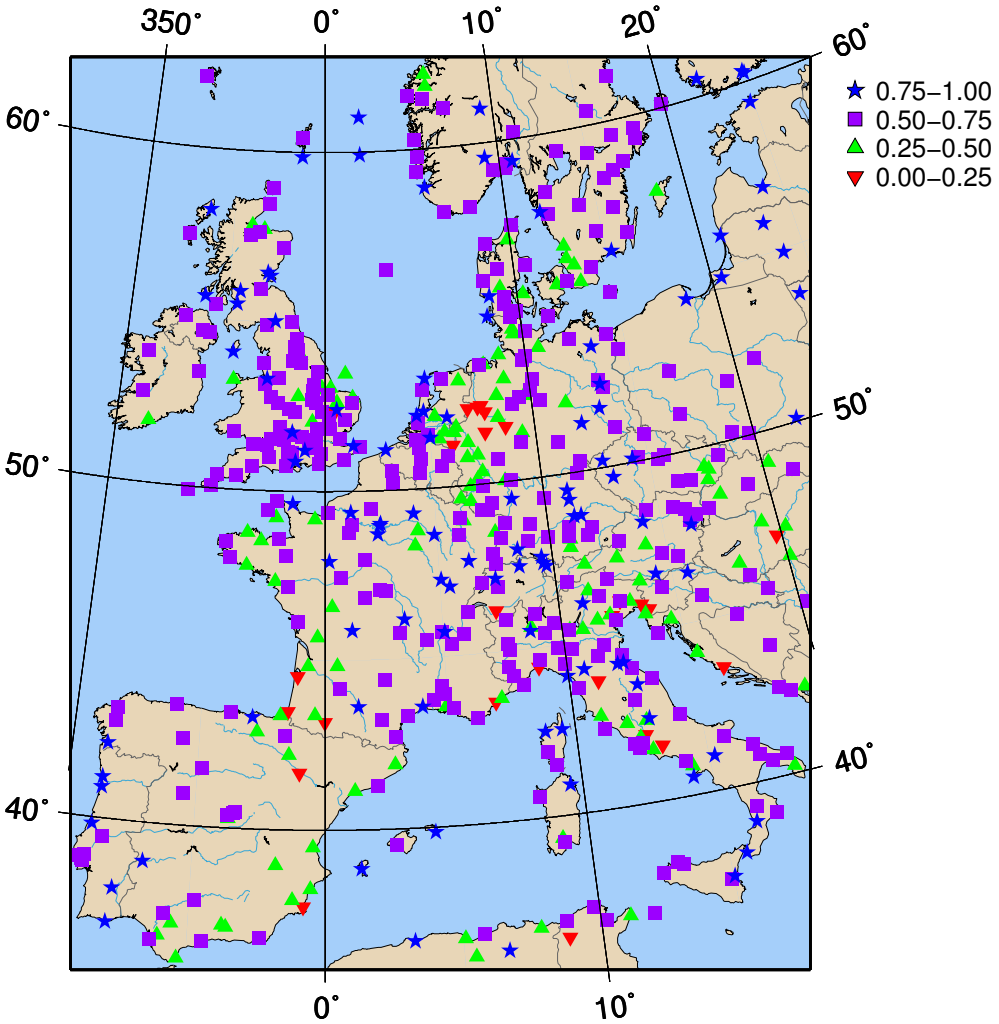
- Missed situations:
  - Cloud overlap
  - Low cloud cover
- False alarms: Station data not representative of pixel
- Station data quality (Visibility and ceiling don't always agree)

Test Results: CSI Distribution



- Lowest category not present
- No obvious spatial pattern

European Context: CSI Distribution

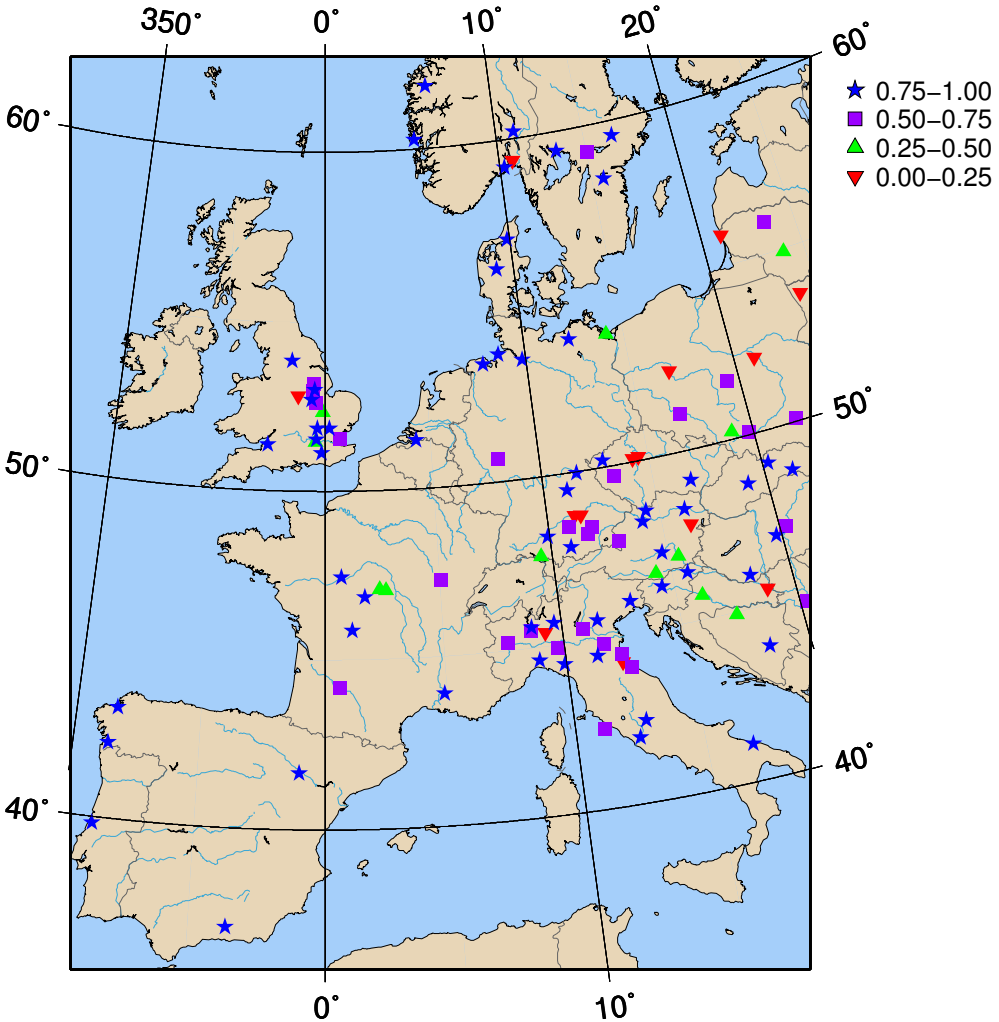


- 583 METAR stations
- 24 days 2^{nd} half 2005
- 1030 satellite scenes
- *No latitudinal effect!*

Conclusions

- High latitude detection of very low stratus works well
- Small-scale situations may be missed
- Coordinated measurement efforts useful

Outlook



- Ground fog will be tested for Helsinki testbed
- Qualitative analysis of cases to follow

Contact

Helsinki Testbed:
www.fmi.fi/testbed

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