



Royal Netherlands  
Meteorological Institute  
*Ministry of Infrastructure and the  
Environment*



## Bird migration monitoring across Europe using weather radar

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FINNISH METEOROLOGICAL  
INSTITUTE



# Bird migration monitoring across Europe using weather radar



Introduction

OPERA Network participants

Bird retrieval algorithm

Clutter

Conclusion

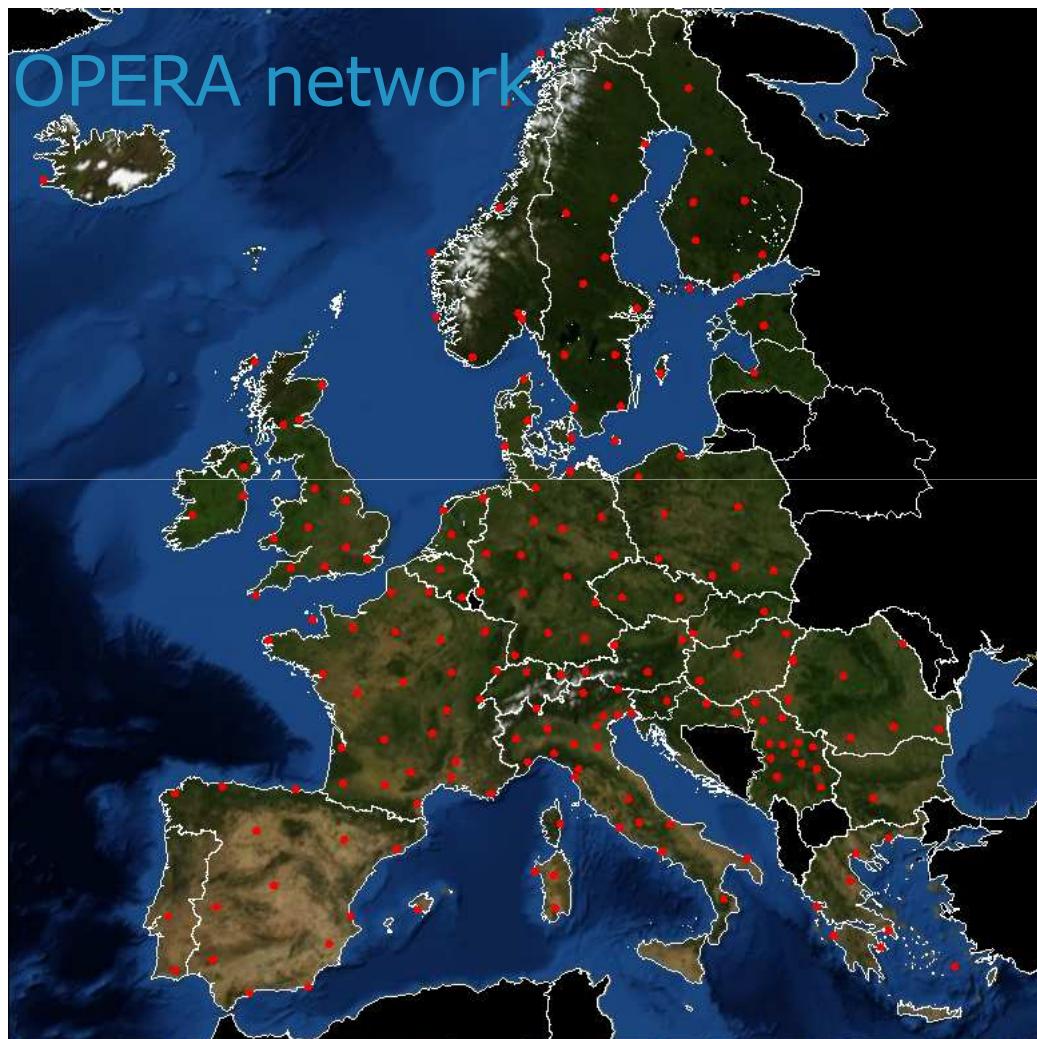


# Introduction

## Flysafe 2:

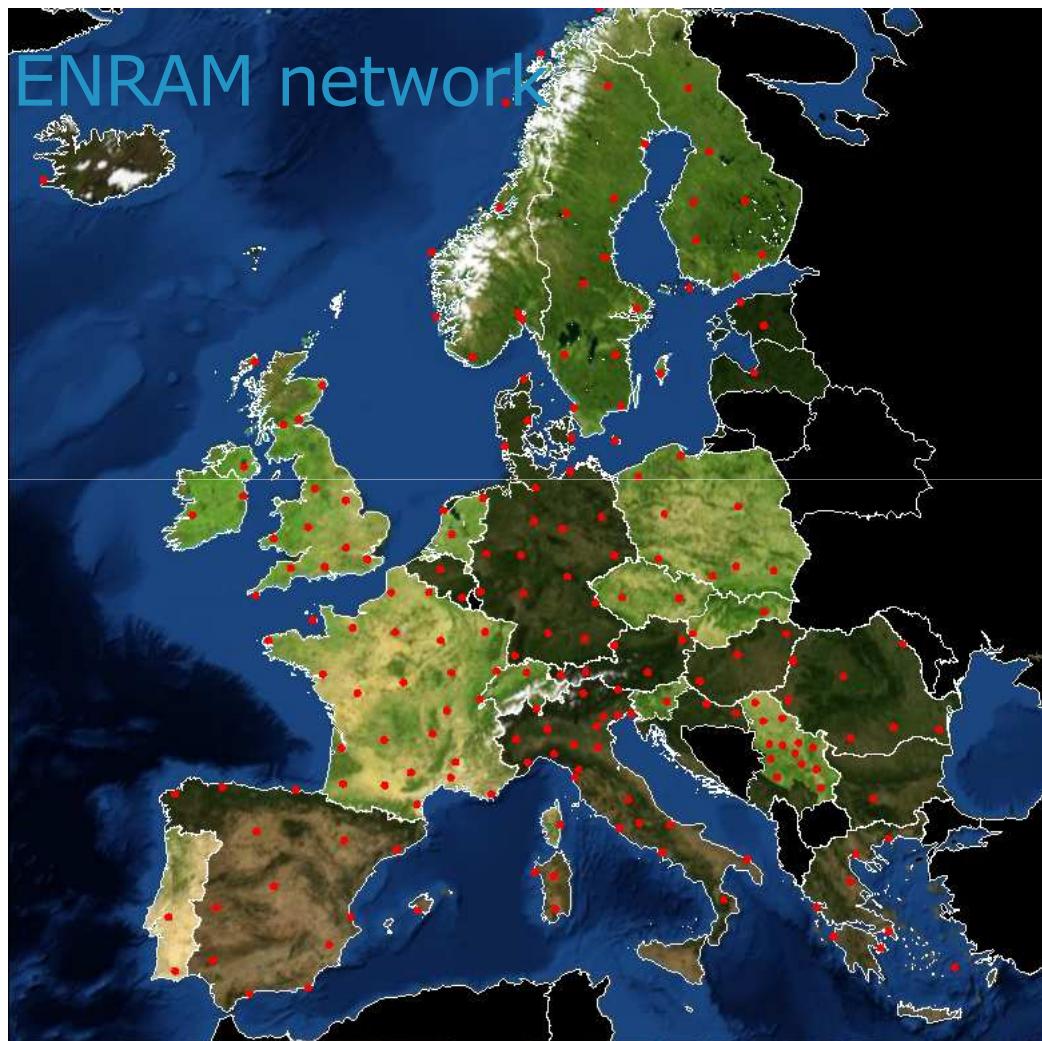
- Build on Flysafe: Bird strike avoidance for civil and military aviation
- Financed by the Dutch Royal Airforce
- Extend bird retrieval algorithm to European partner radar stations
- Collaboration with ecological and meteorological institutes from Finland, the UK, Germany, Sweden, Denmark and Switzerland within ENRAM (European Network for the Surveillance of Animal Movement)





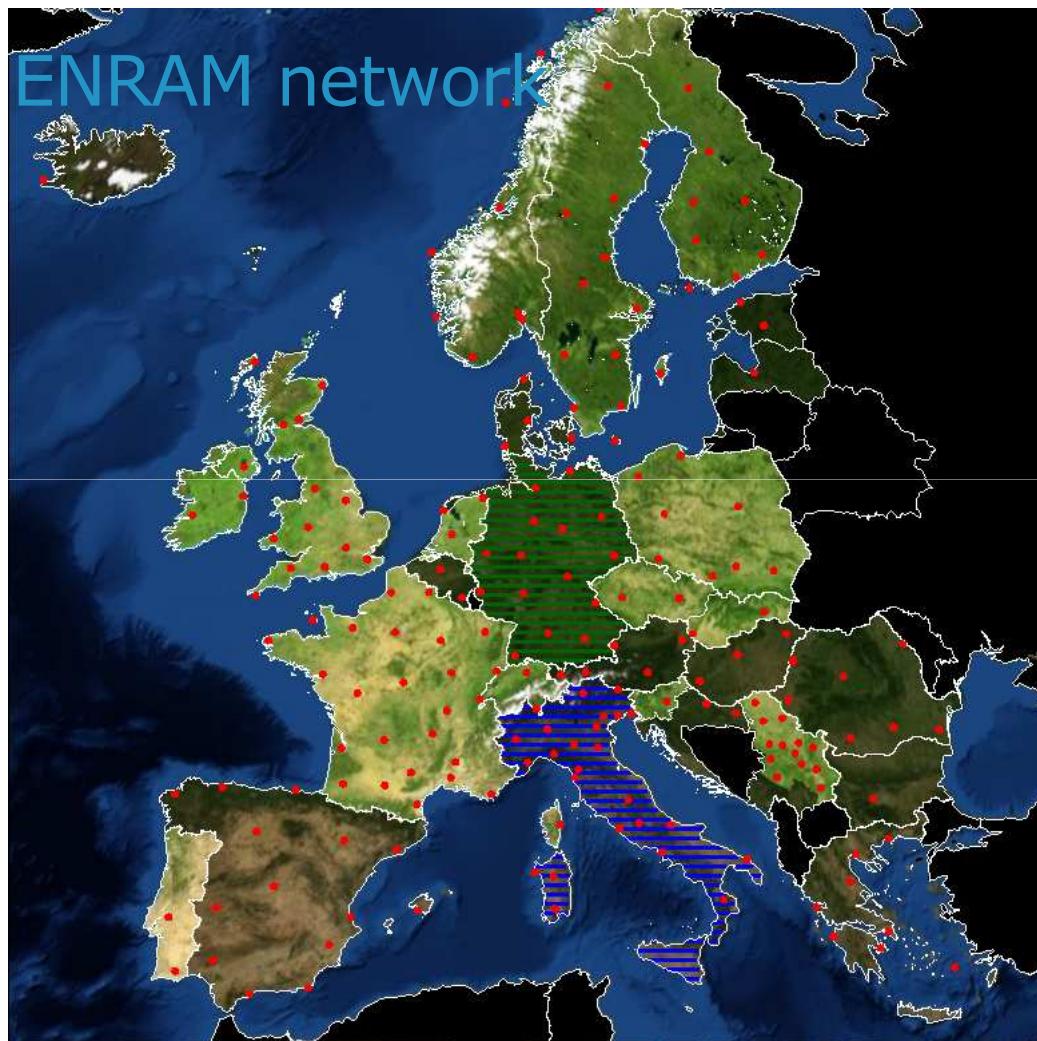
## Flysafe2:

Expand the network by including more operational European weather radars to monitor and predict migratory bird movements over a large area



European Network for the Radar Surveillance of Animal Migration (ENRAM)  
Radar data from 15 Aug – 15 Sep 2011 was supplied by:

Czech Republic  
Finland  
Ireland  
France  
United Kingdom  
Norway  
Netherlands  
Poland  
Portugal  
Slovakia  
Slovenia  
Switzerland  
Sweden



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Switzerland  
Sweden

Germany: test set provided  
Italy: Restrictive data policy



## Bird retrieval algorithm

C-band Doppler weather radar (5-25 km distance, 0-6 km altitude)

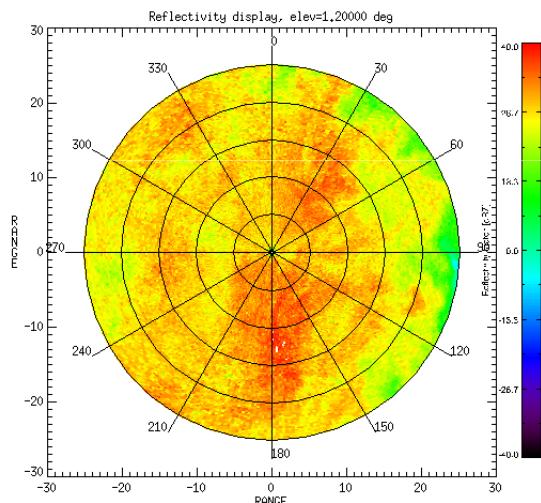
- Filter clutter (velocity  $< \pm 1 \text{ ms}^{-1}$  and static clutter map)
- Filter precipitation (0 dBZ threshold and uniform filling)
- Find high velocity variations

	Precipitation	Insects	Birds
Reflectivity	++	--	--
Refl. uniformity	++	-	--
Velocity	+	+	+
Vel. homogeneity	++	+	--

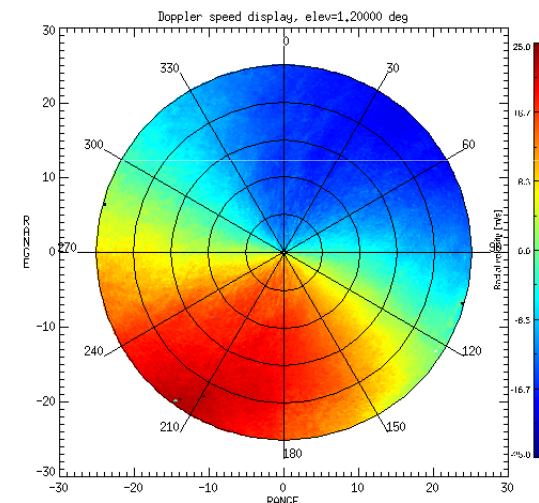


# Bird retrieval algorithm

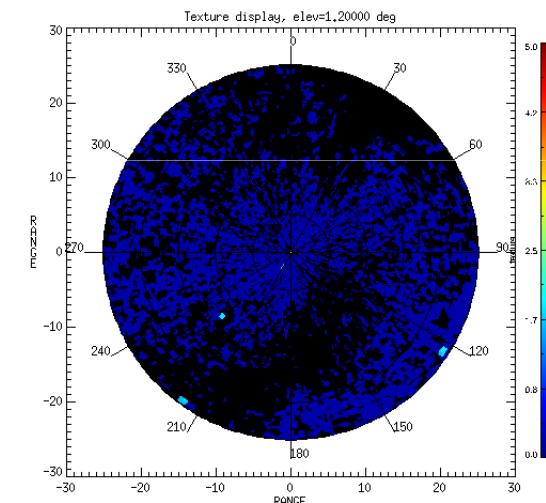
Precipitation



Reflectivity factor  $Z$



Radial velocity  $v_r$

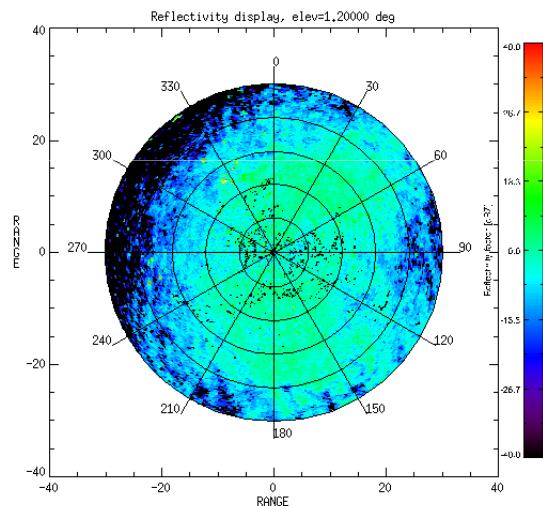


Velocity variation  $\sigma_v$

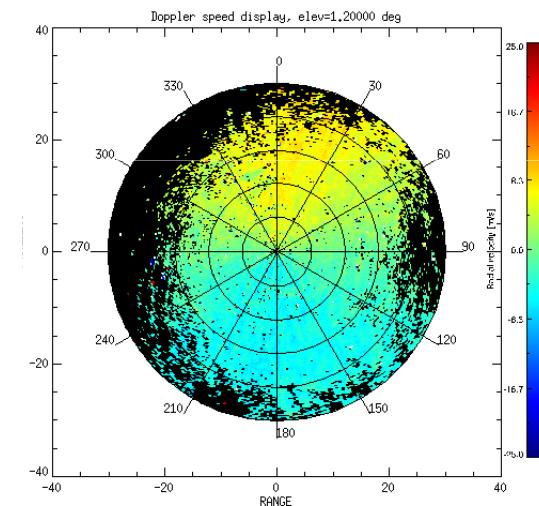


# Bird retrieval algorithm

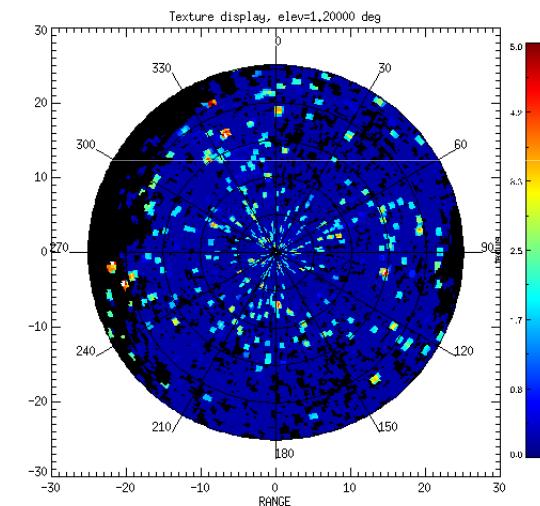
Clear air (insects)



Reflectivity factor  $Z$



Radial velocity  $v_r$



Velocity variation  $\sigma_v$

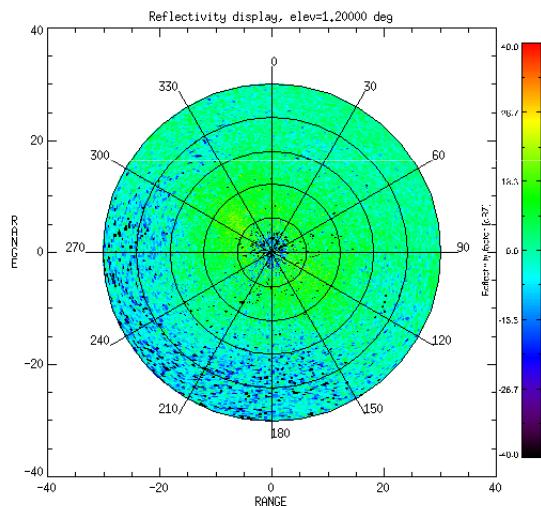
23 Sep. 2007, 22:23 UTC



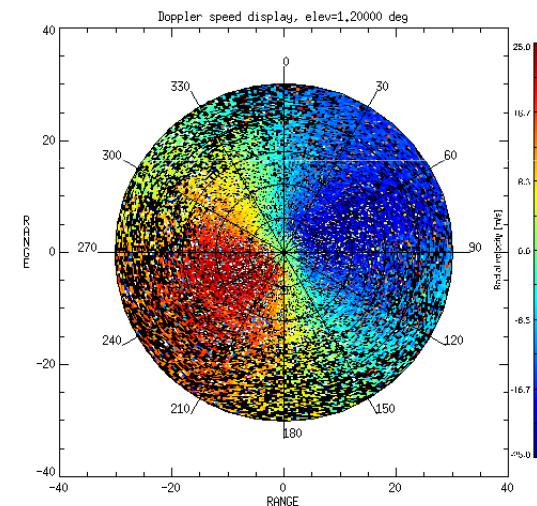
# Bird retrieval algorithm

Birds

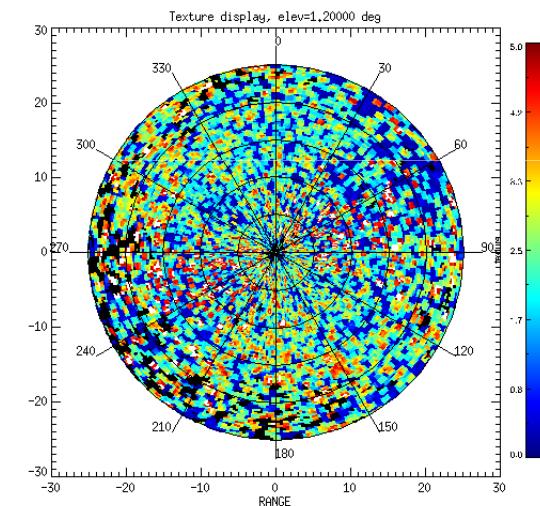
5 Oct. 2007, 22:23 UTC



Reflectivity factor  $Z$



Radial velocity  $v_r$



Velocity variation  $\sigma_v$



## Velocity variation

Birds  
Convective precipitation

Wideumont



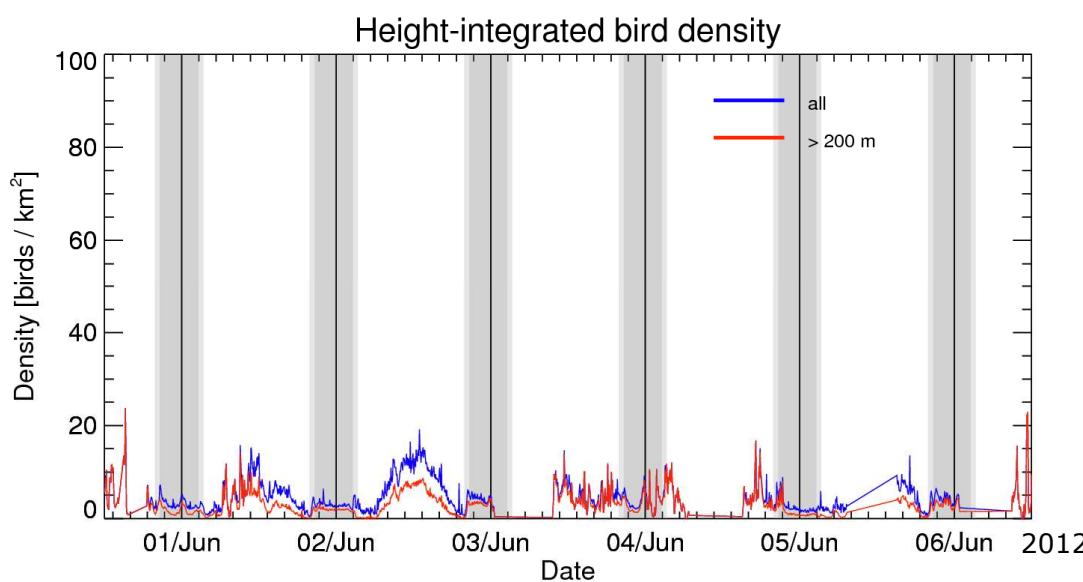
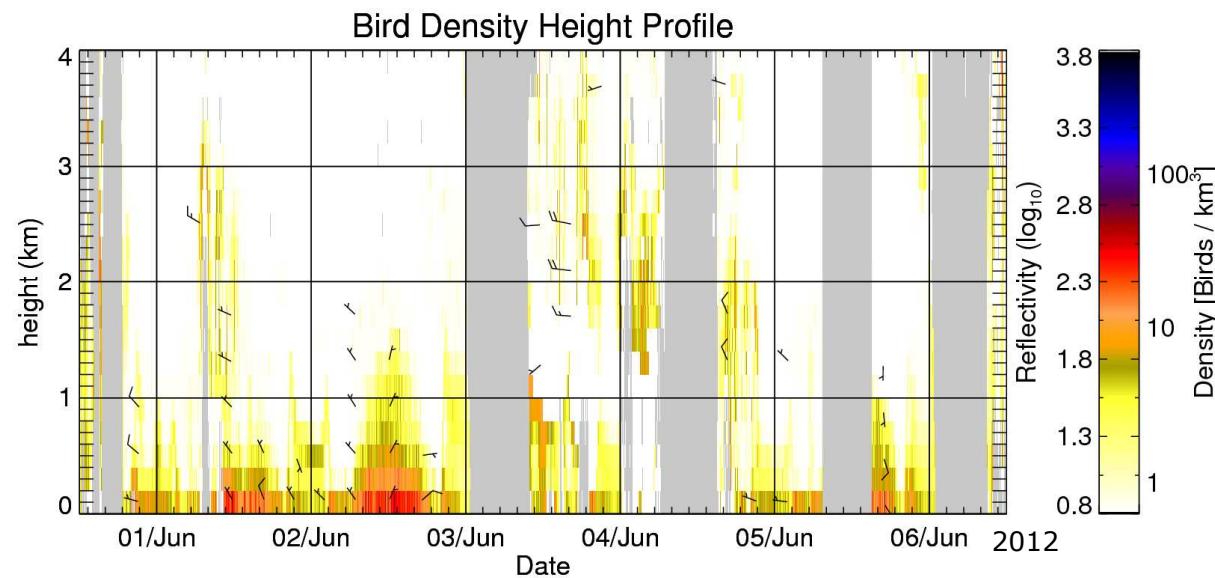
## Velocity variation

Wideumont

Smaller range resolution

De Bilt

Larger range resolution  
Stronger clutter



De Bilt  
1-6 June 2012



## Clutter

Clutter filtering is very important for retrieval of small bird echoes

- Depends strongly on location
- Depends on weather conditions
- Depends on the ground conditions



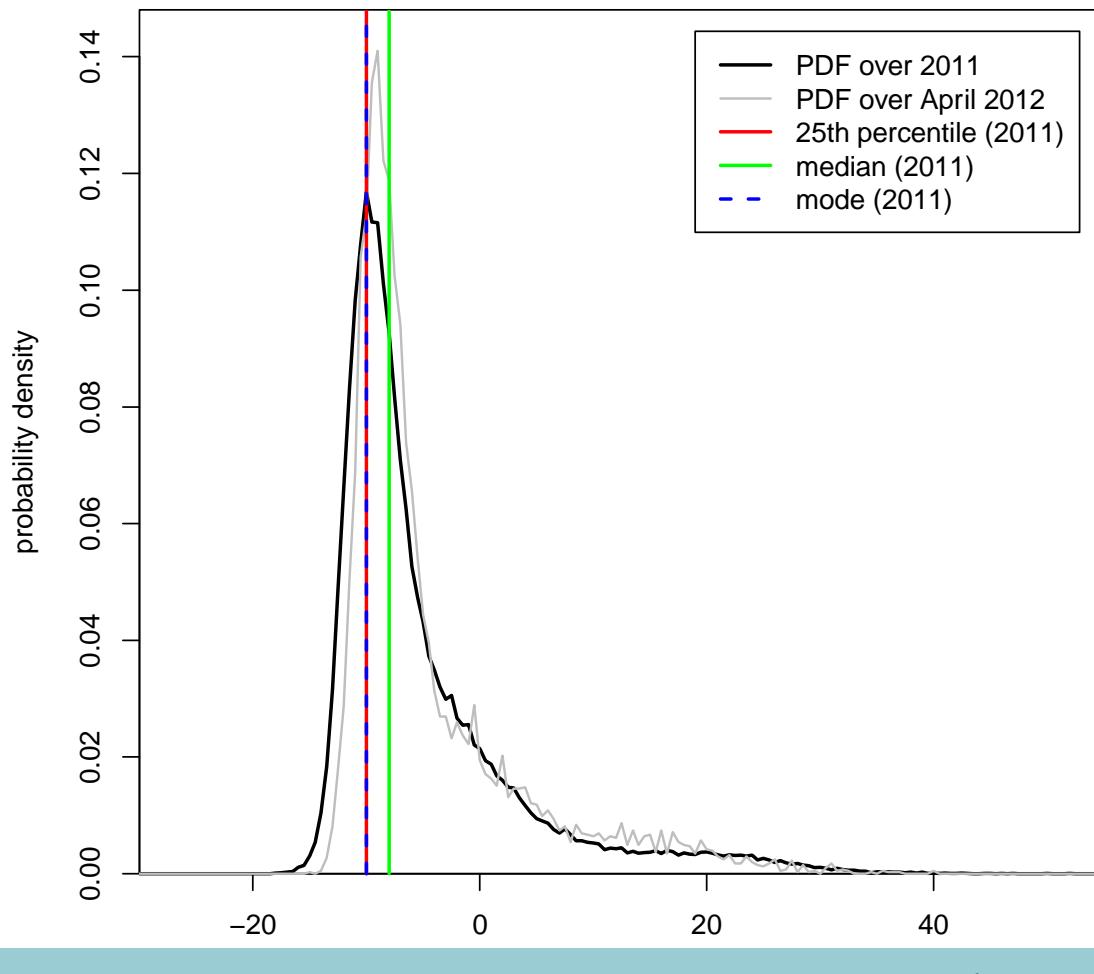
## Clutter filter 1

- Find a few days in winter w/o birds and precipitation, and average. Define all pixels with reflectivity above threshold as clutter

threshold = -10 dBZ



## Clutter filter 2

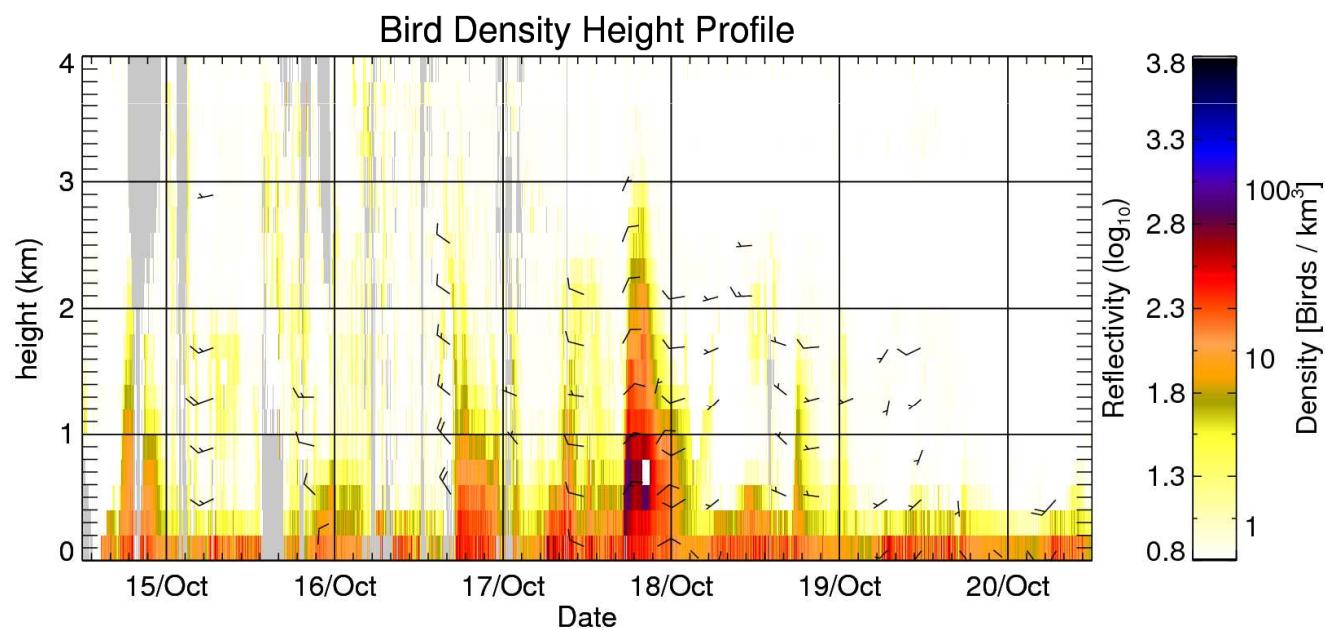


- Use statistics of e.g. yearly or monthly data



## De Bilt radar

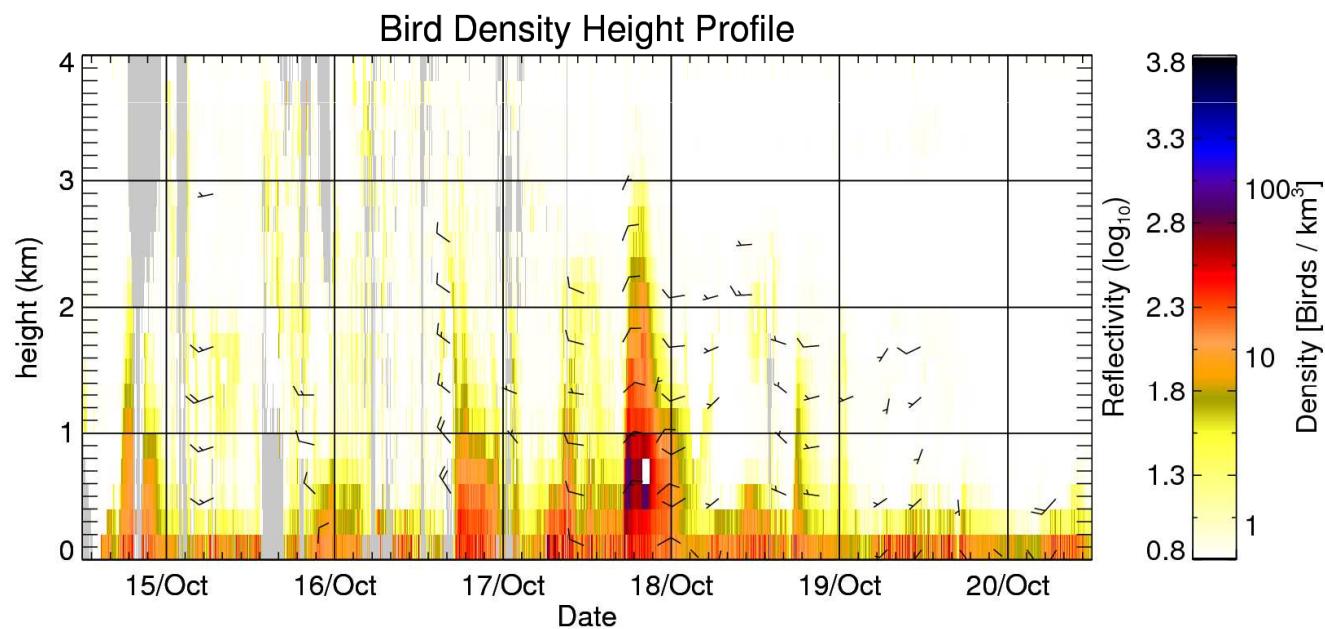
5 % clutter definition





De Bilt radar

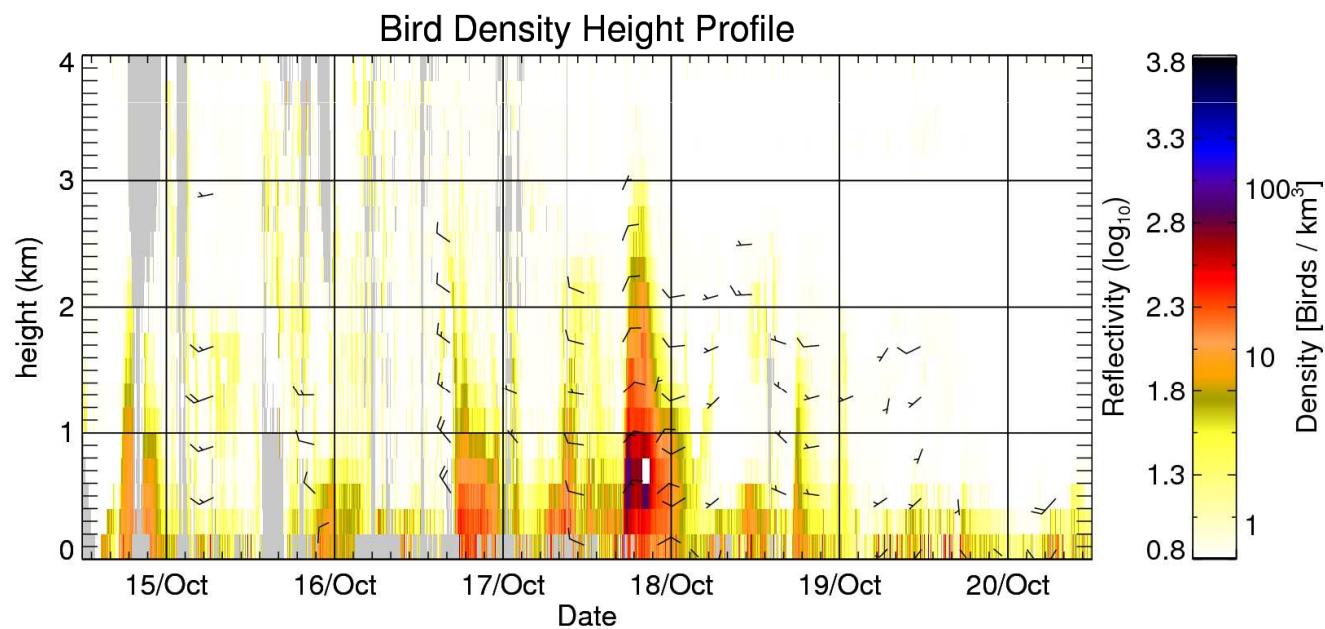
25 % clutter definition

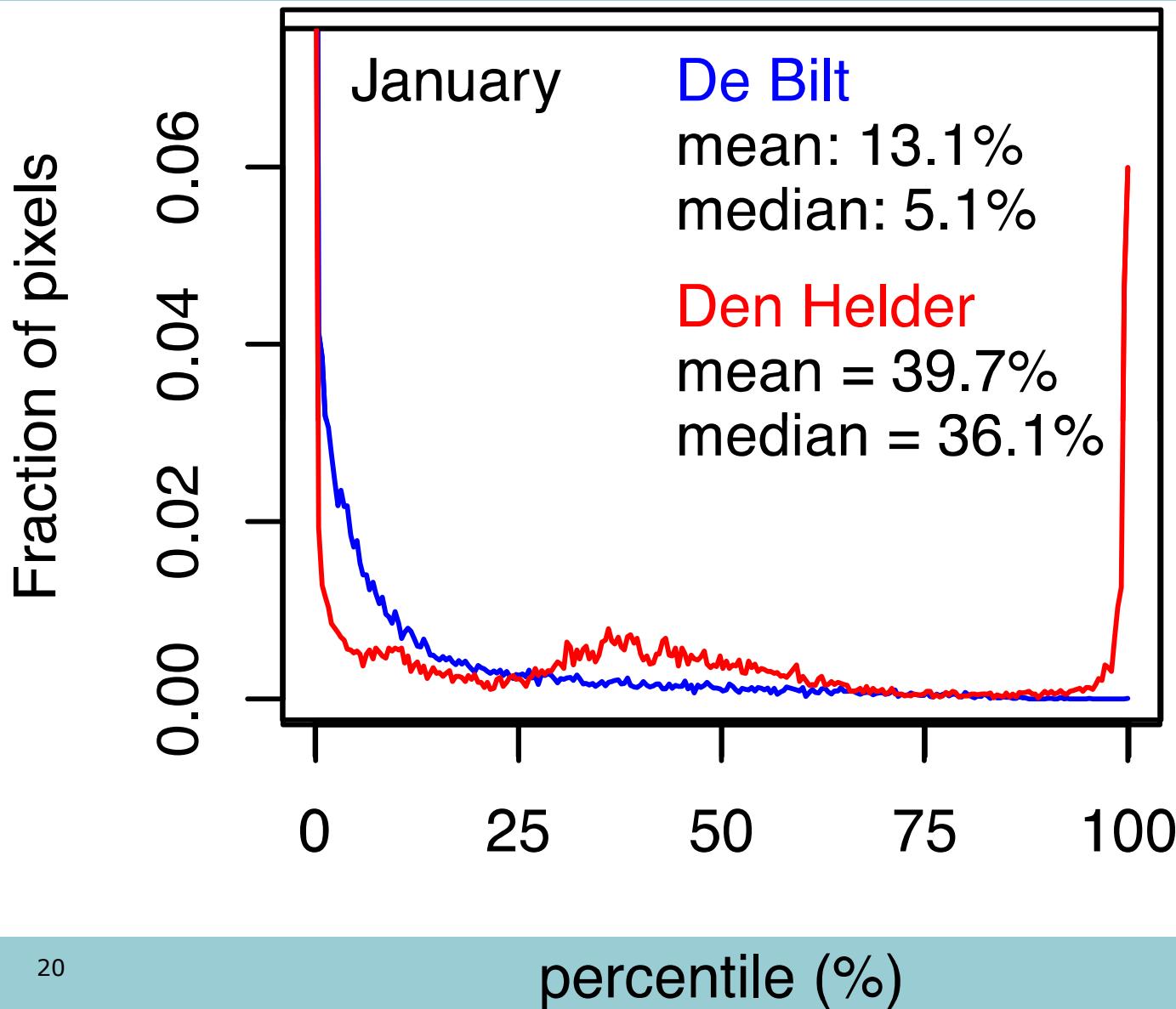


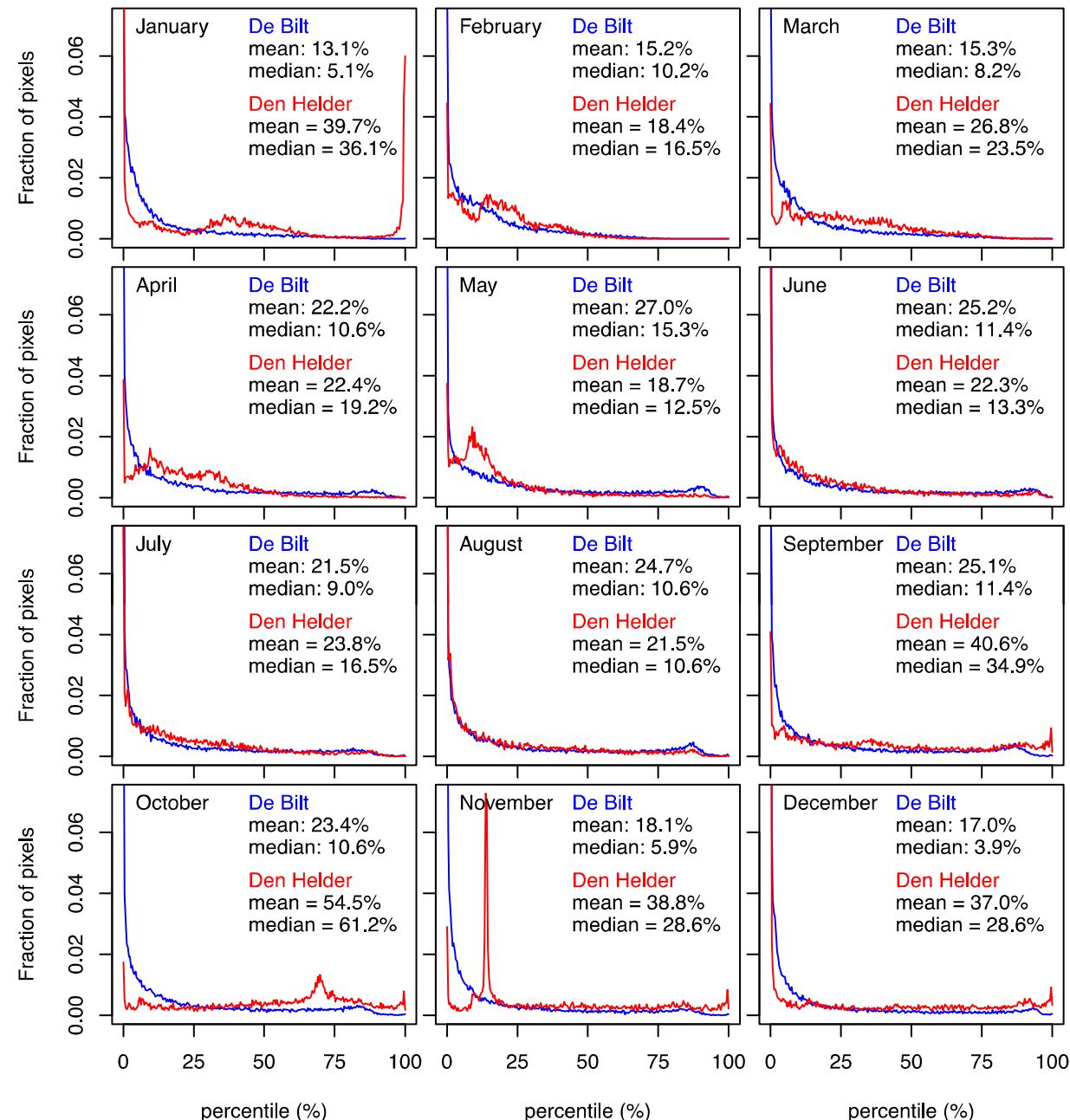


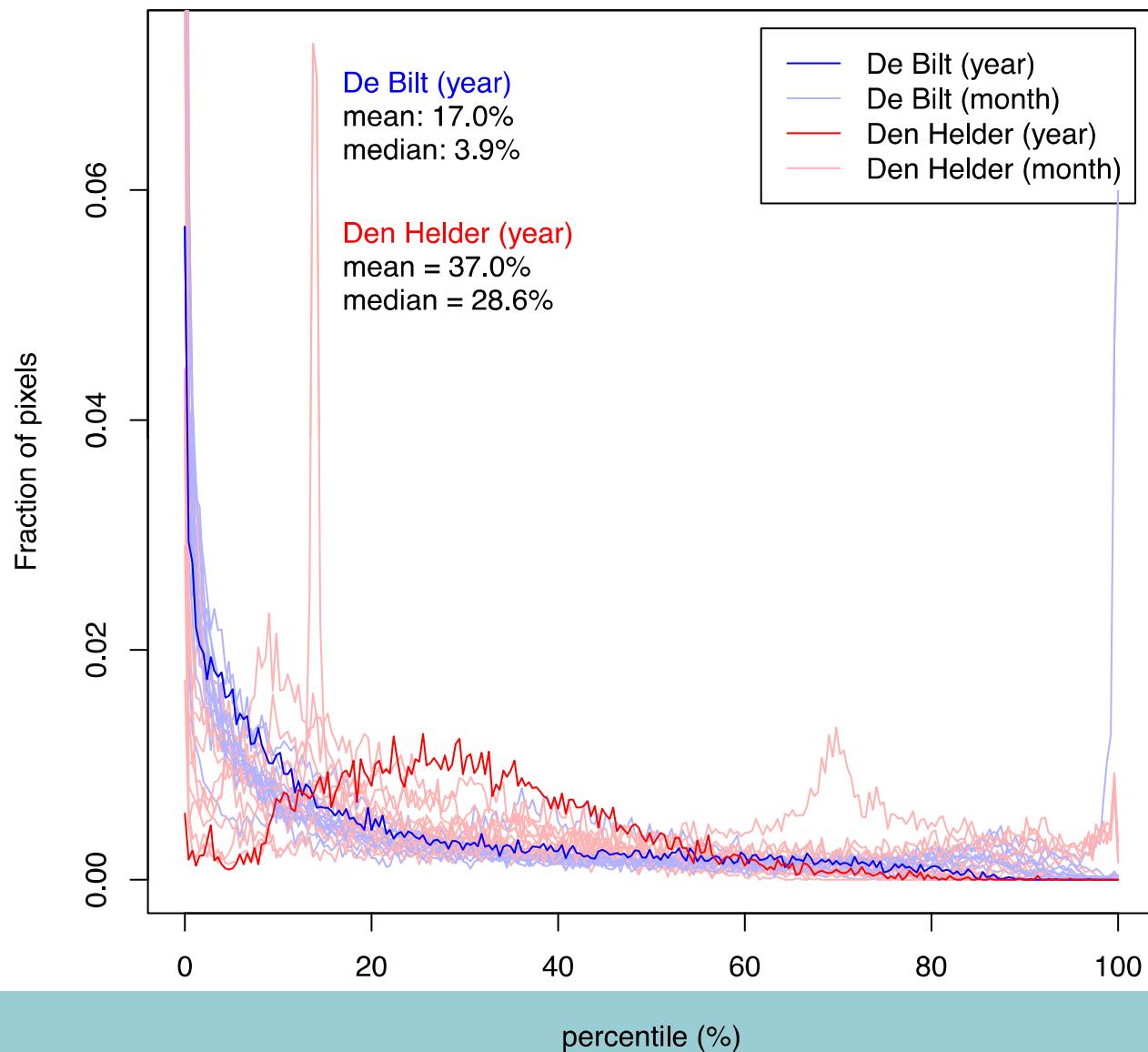
De Bilt radar

50 % clutter definition









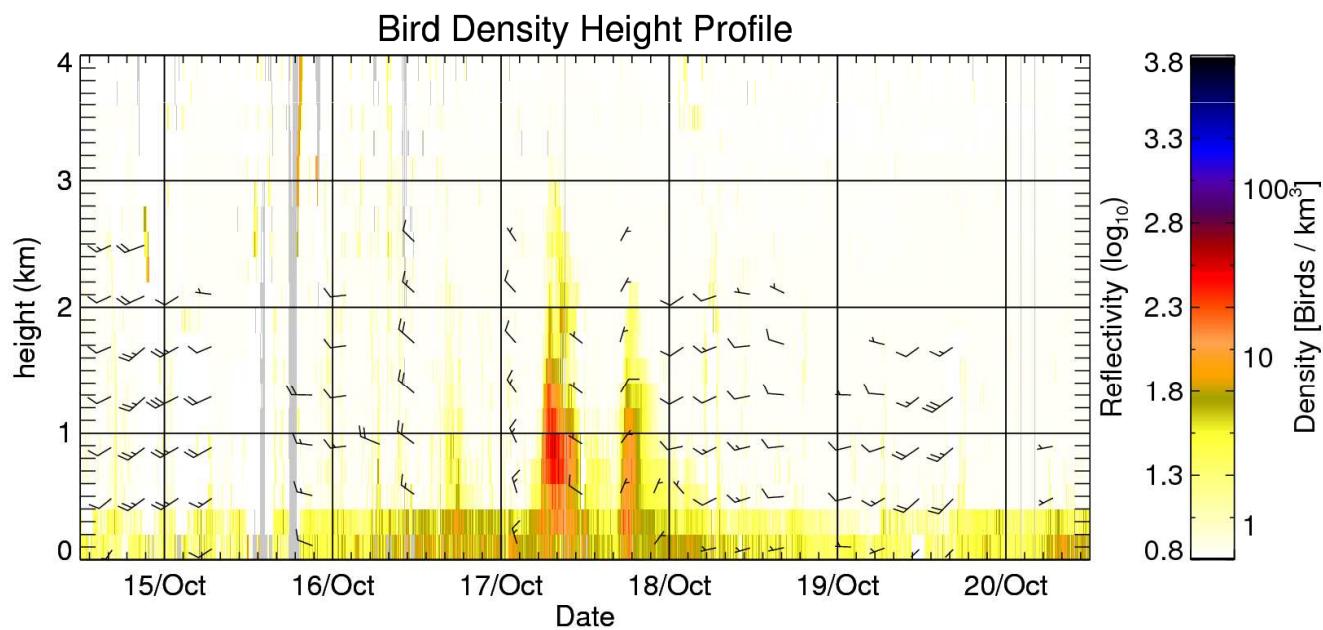


## Conclusions

- Aerial bird densities from Doppler radar can be retrieved operationally
- ENRAM network will work toward European-wide aerial bird density estimates
- Dynamic and automated clutter removal is important



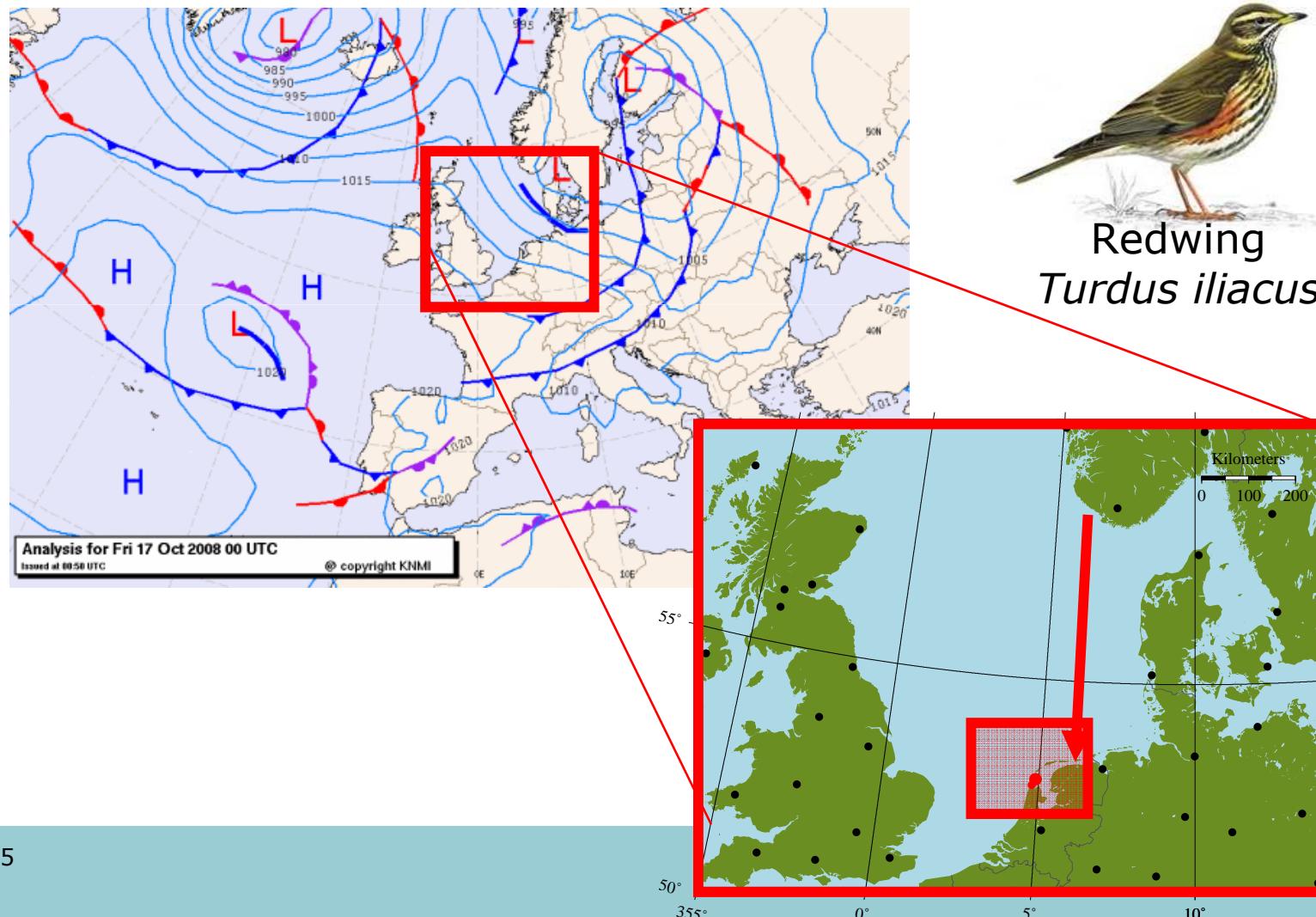
# Den Helder radar





# Bird migration on weather radar

Example 17 October 2008

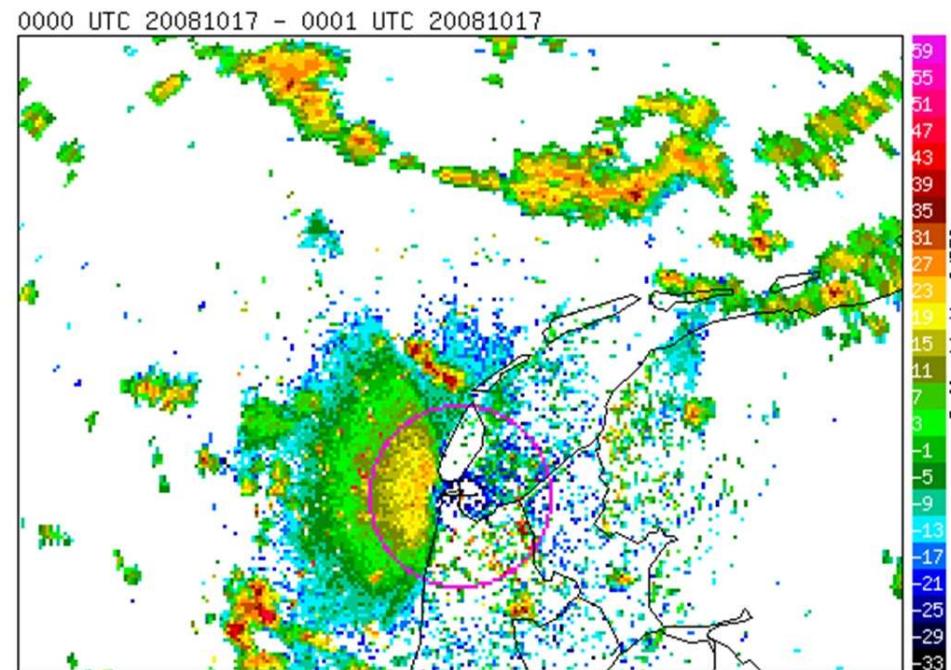




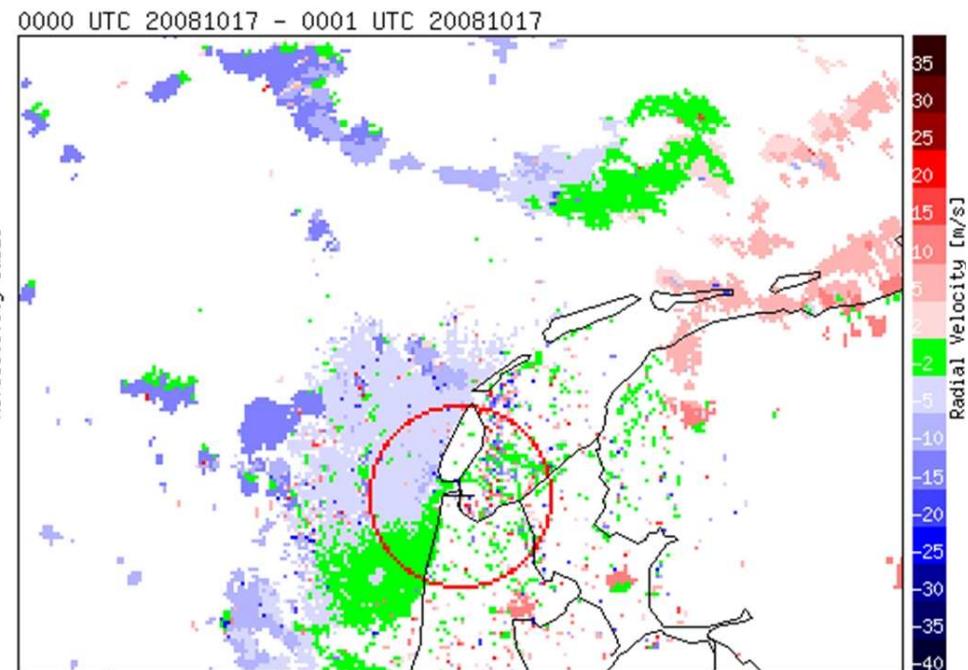
# Bird migration on weather radar

Example 17 October 2008

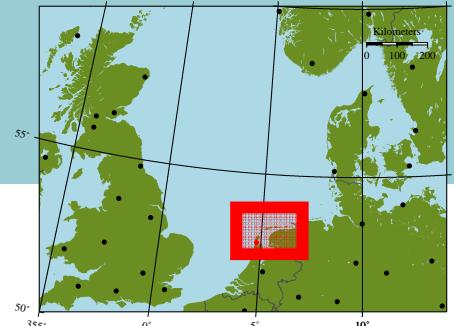
reflectivity factor



radial velocity



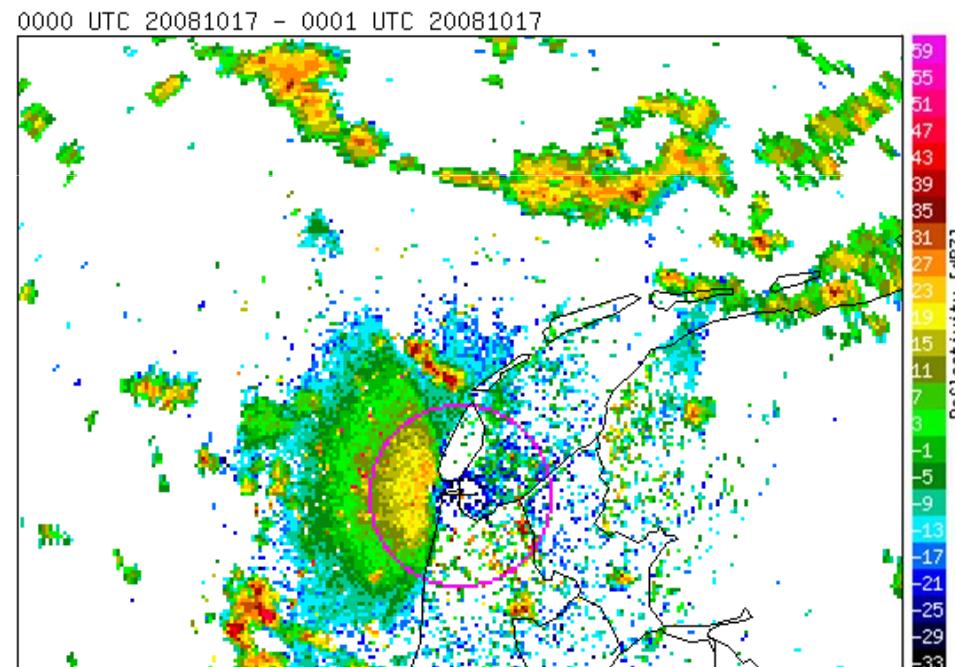
— 50 km



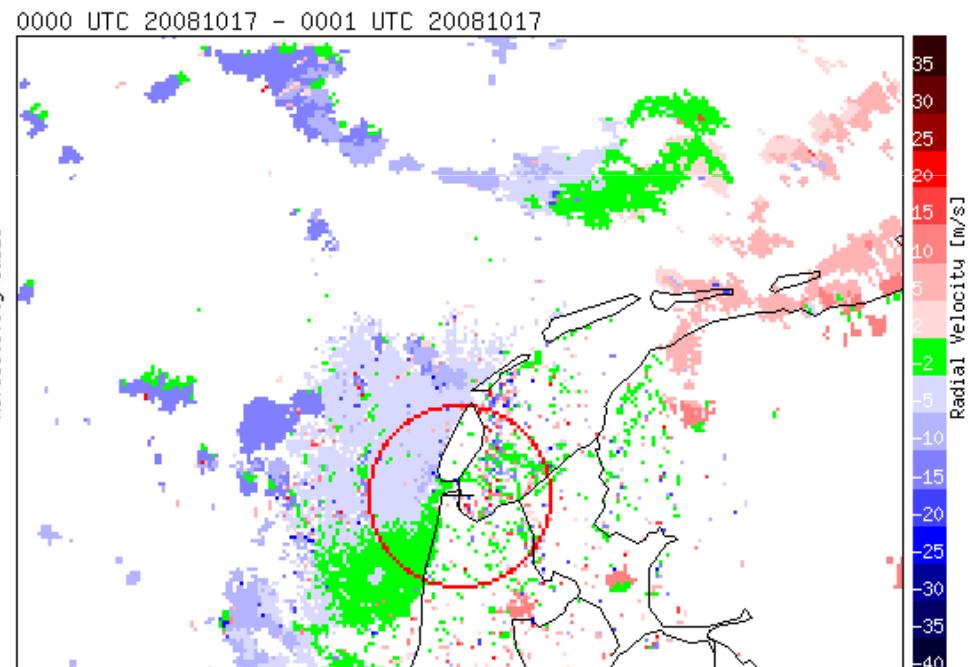
# Bird migration on weather radar

Example 17 October 2008

reflectivity factor



radial velocity



— 50 km



Thank you

