EIGENOR

SAME MEASUREMENTS - BETTER RESULTS

Triple-PRT Bird Migration

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Introduction

Measurements:

- Kumpula Radar (C-band)
- dual-polarization
- operational-like scans
  - 10 degrees/s
  - 260 km range
  - real-time processing

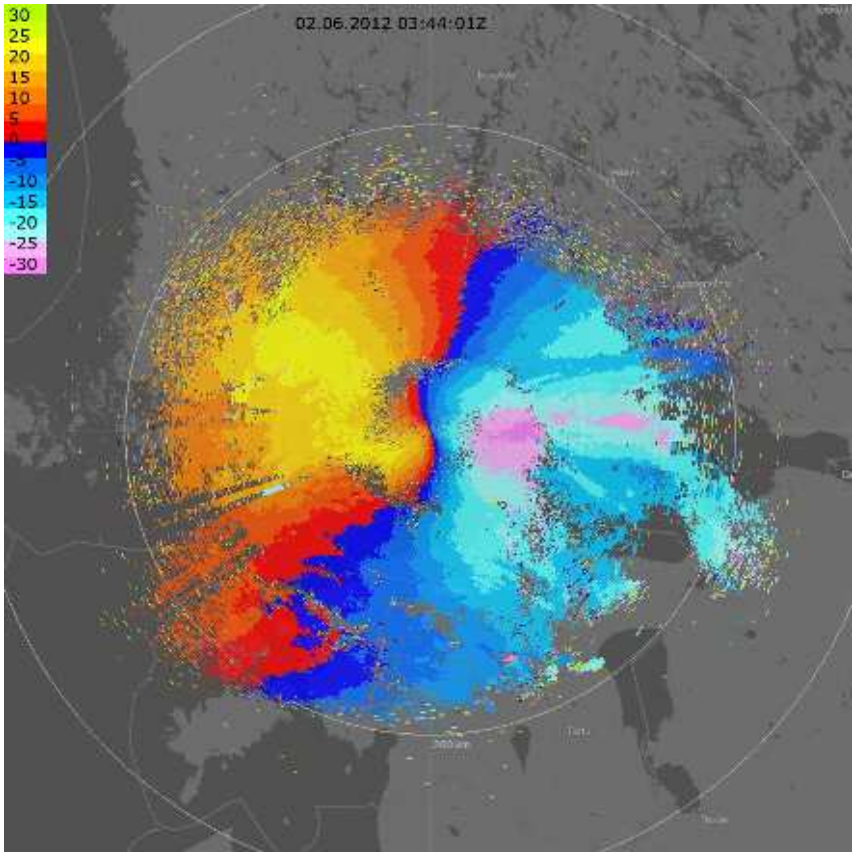
Key Points:

- products from single bin (1° x 150 m)
- velocities up to 53.5 m/s
- velocity based on ACF matching
- ground clutter removal

Slides based mainly on:

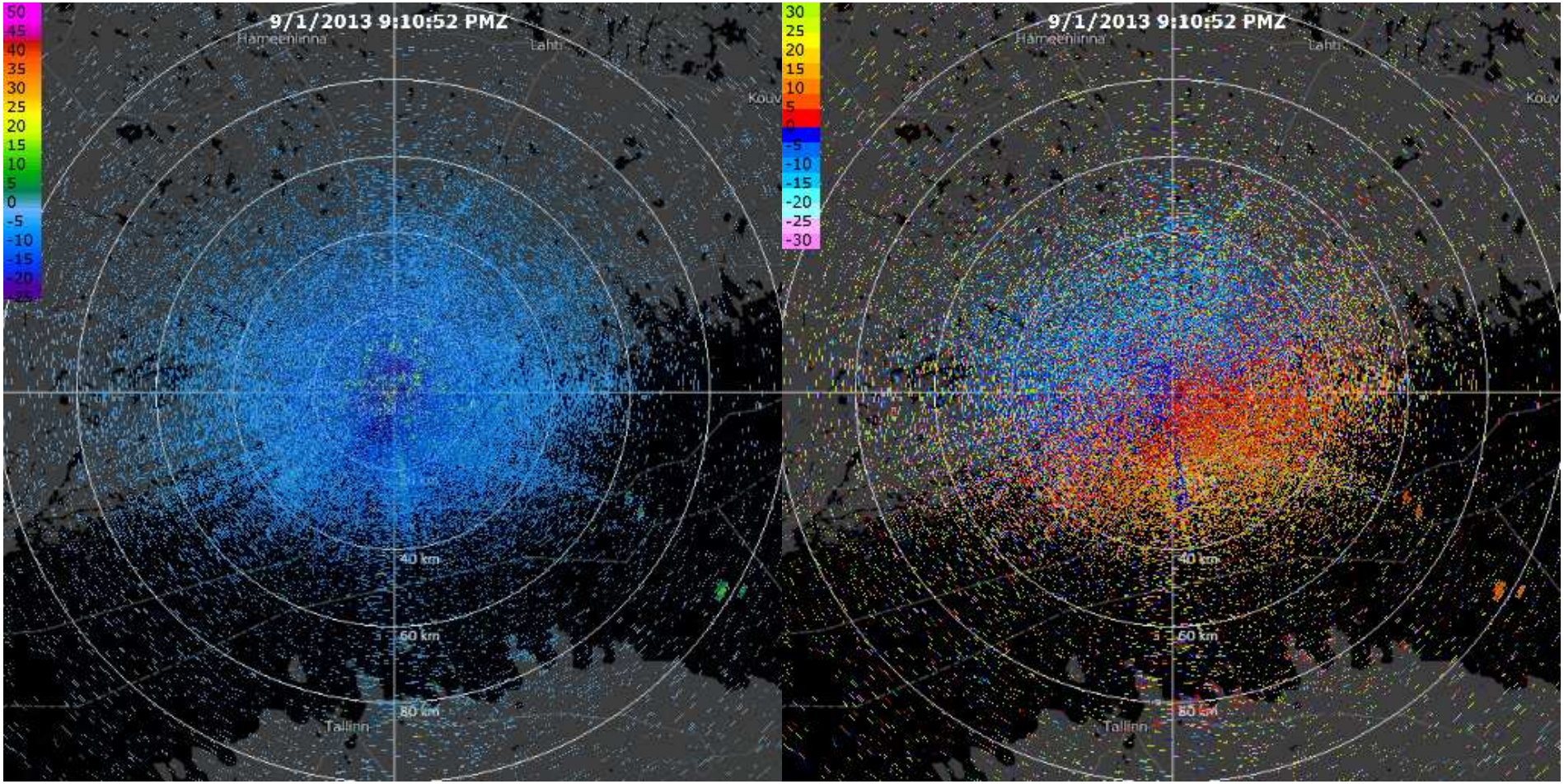
- measurements at Kumpula
- Zhang *et al.* 2004

Velocity: rainstorm June 2012



0.5° elevation scan using triple-PRT: precipitation with speed >30 m/s and range ~250 km

September 2013: Z & V



1.-3.9.2013: migrating birds, insects, sea clutter, ships and heavy rain reflectivity (left) and velocity (right)

September 2013: Z & V

1.-3.9.2013: migrating birds, insects, sea clutter, ships and heavy rain
reflectivity (left) and velocity (right)

Biological Scatterers

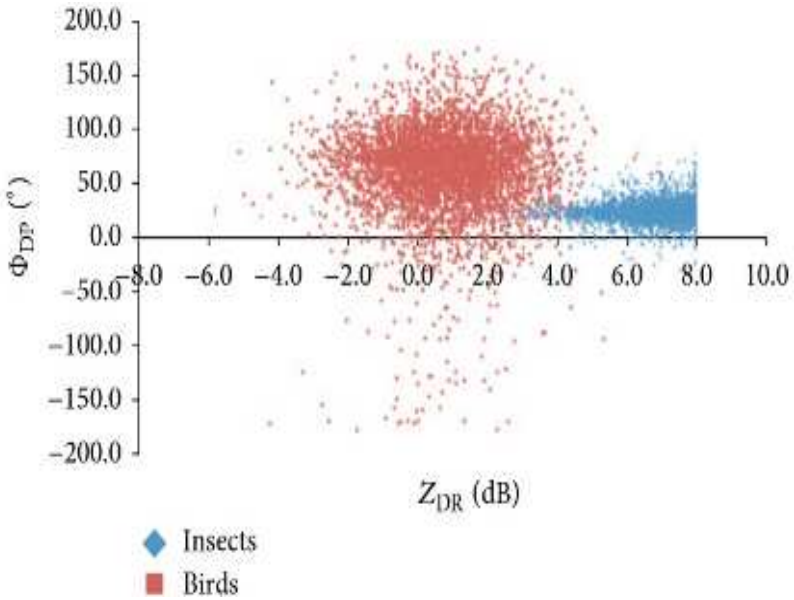
Birds:

- higher ψ_{dp}
- lower Z_{dr}
- most visible during night
- travel speed ~10 m/s

Insects:

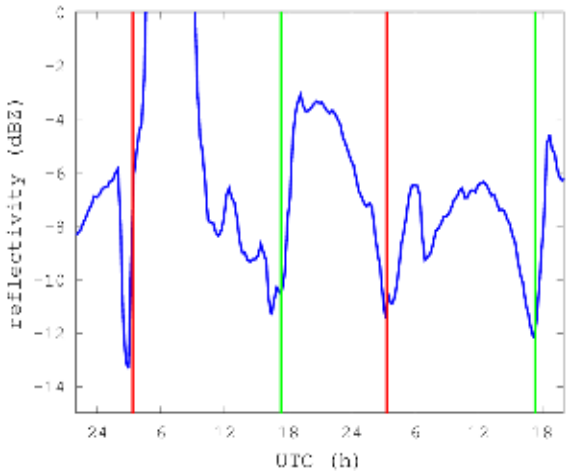
- lower ψ_{dp}
- higher Z_{dr}
- most visible during day
- passive travellers

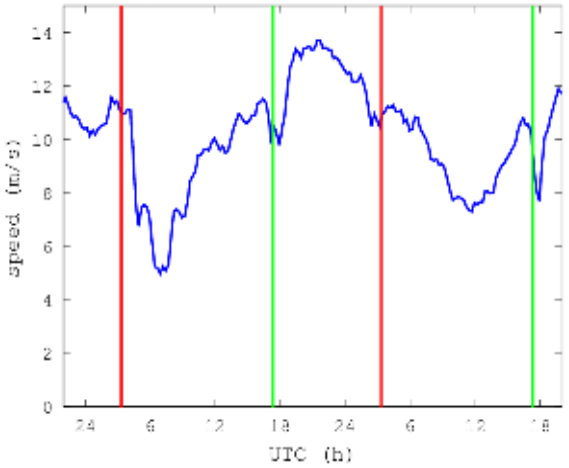
Bio dual-pol scattergram

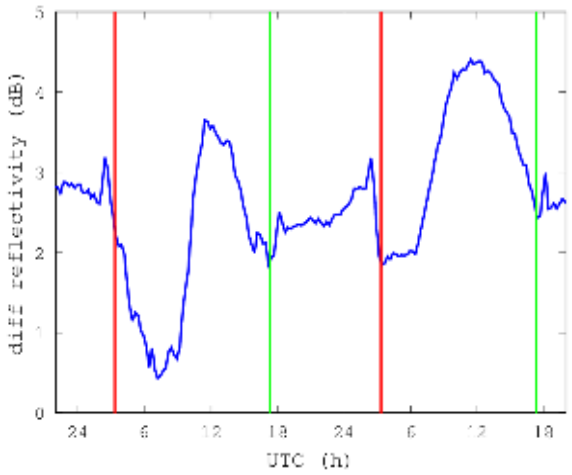


Jiang *et al*. (2013)

Averages vs Time: Sept. 2013

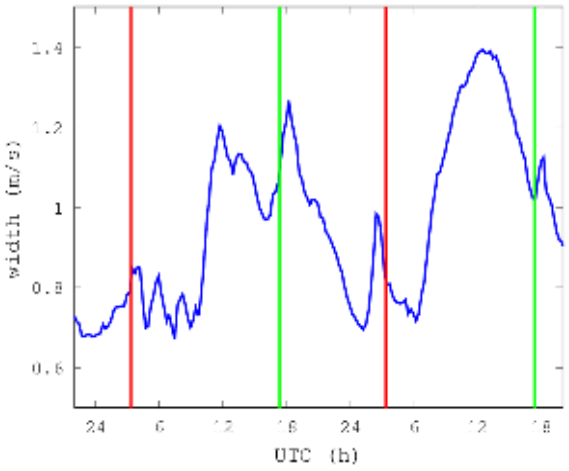


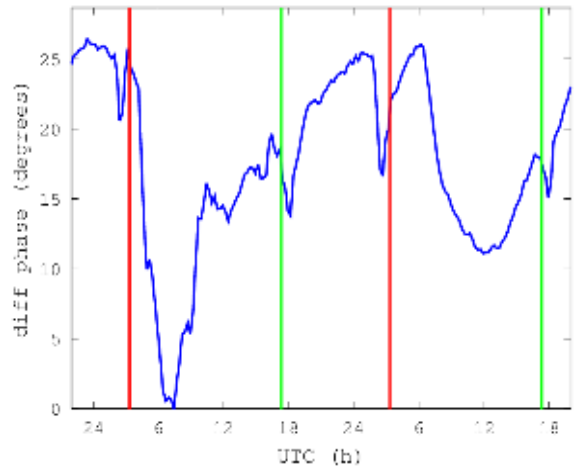




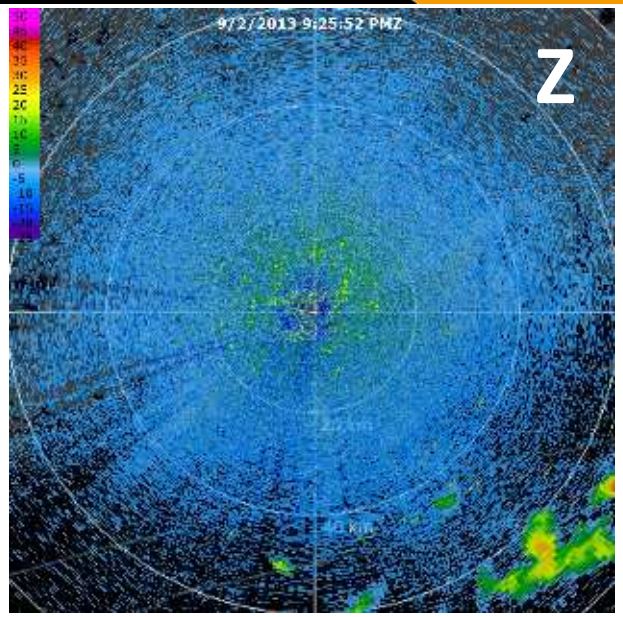
Curves in pictures:

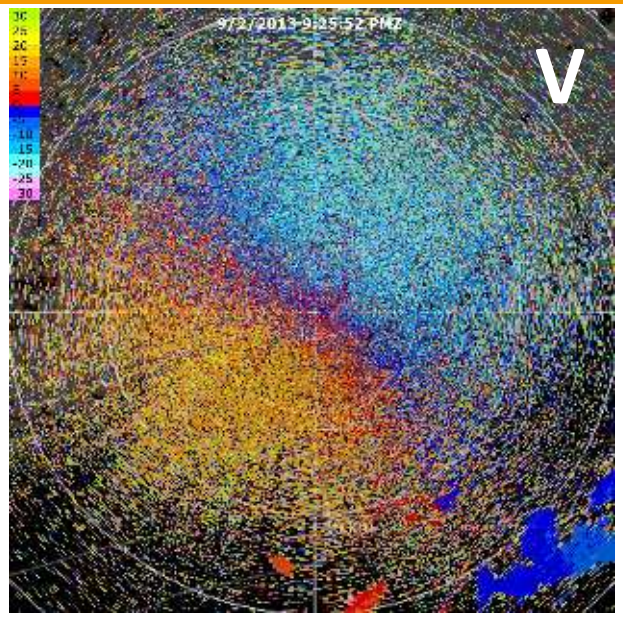
- averaged quantity
- sunrise
- sunset
- average over PPI within 40 km range

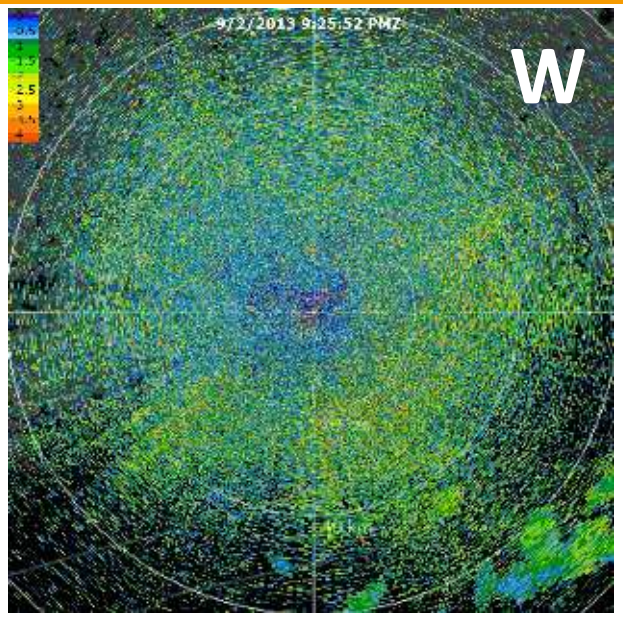


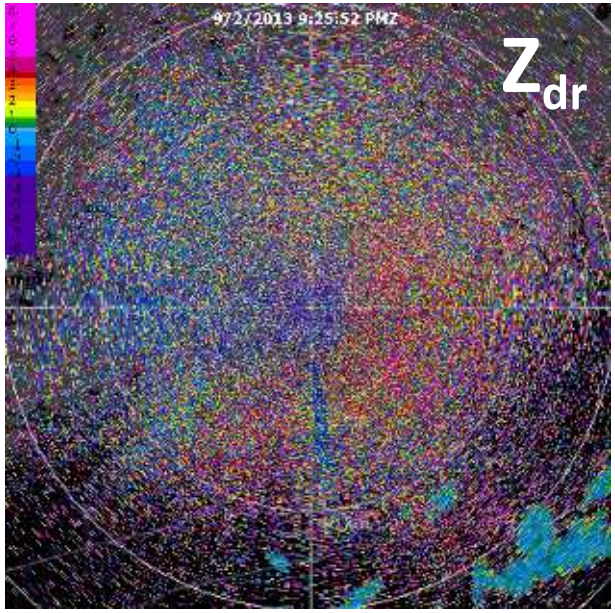


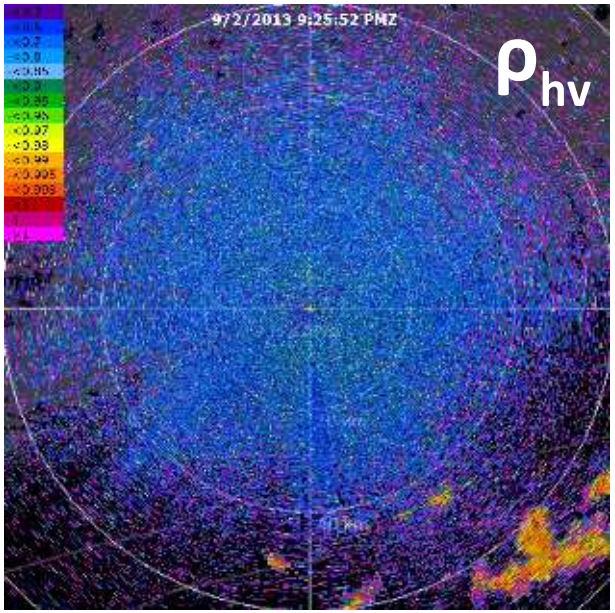
Birds 2.9.2013, 0.5° elevation

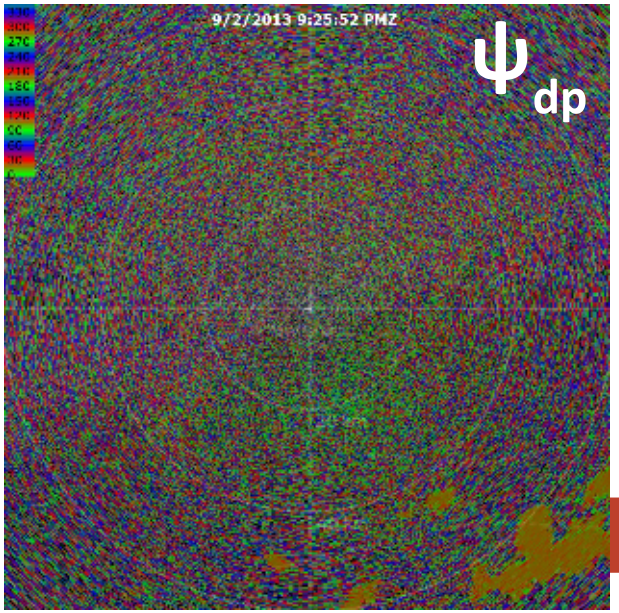




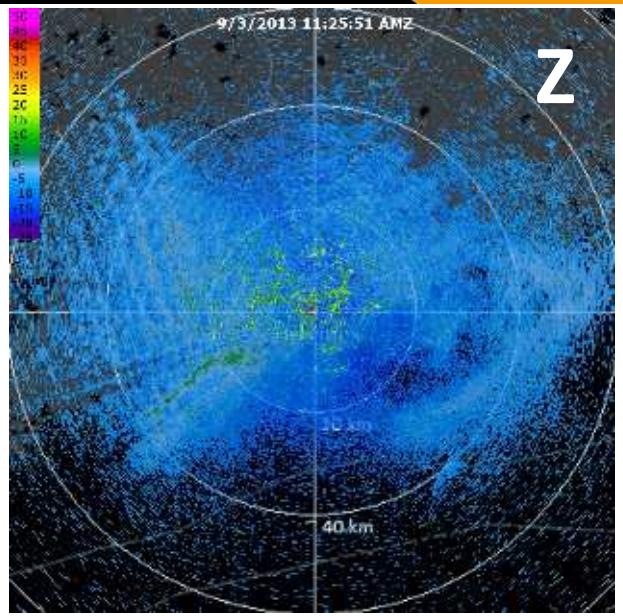


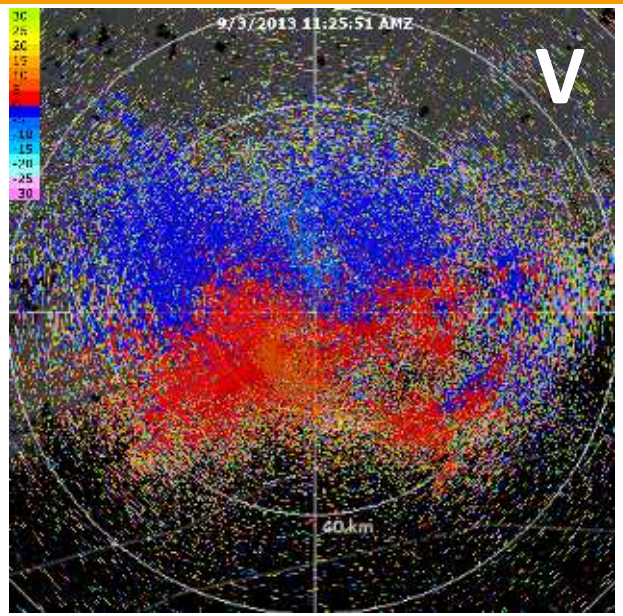


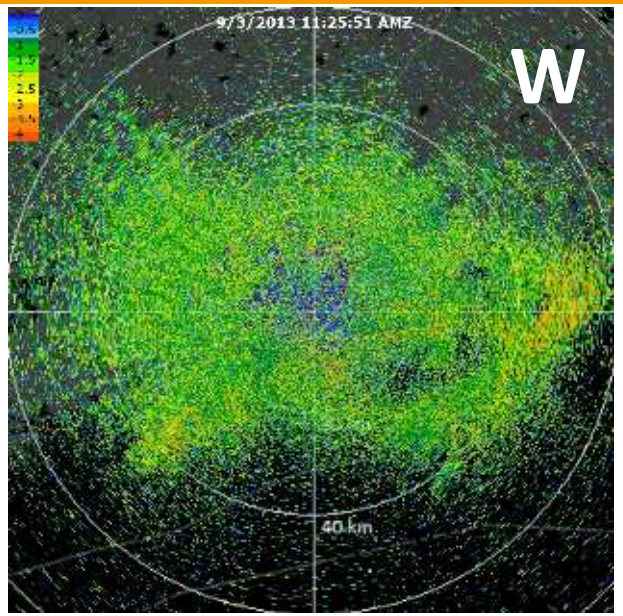


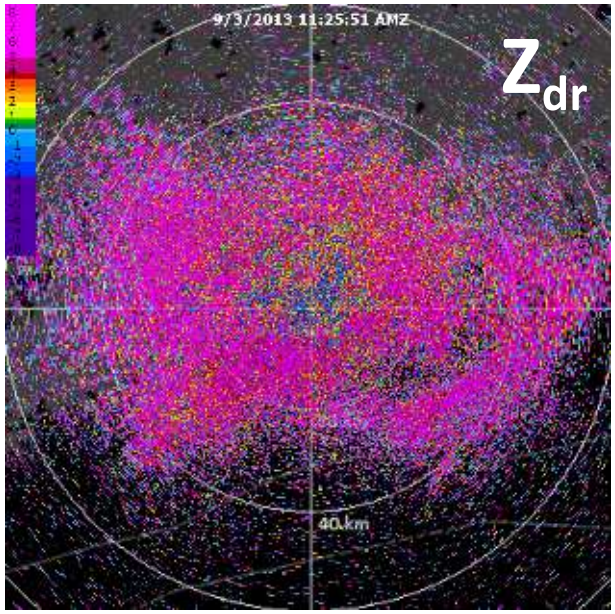


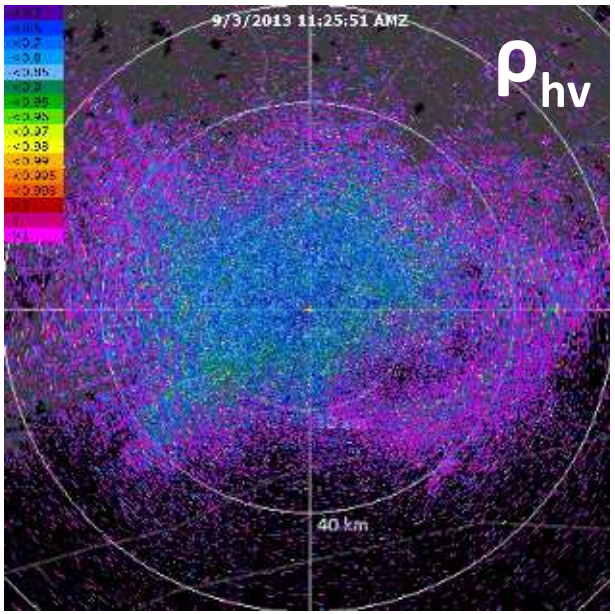
Insects 3.9.2013, 0.5° elevation

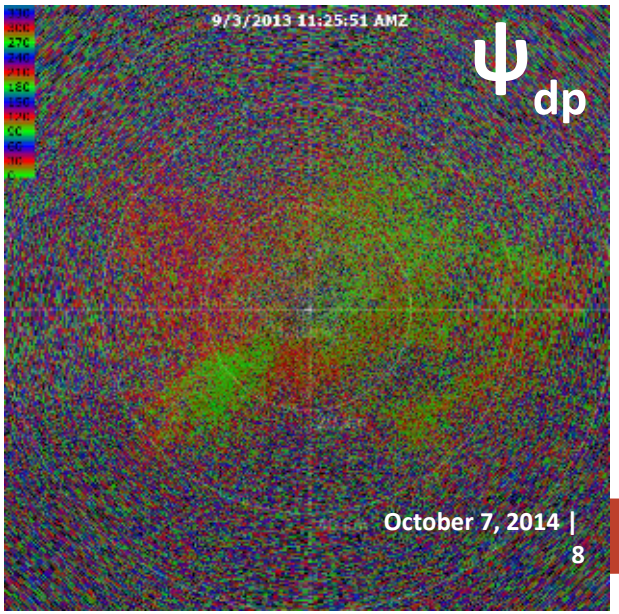




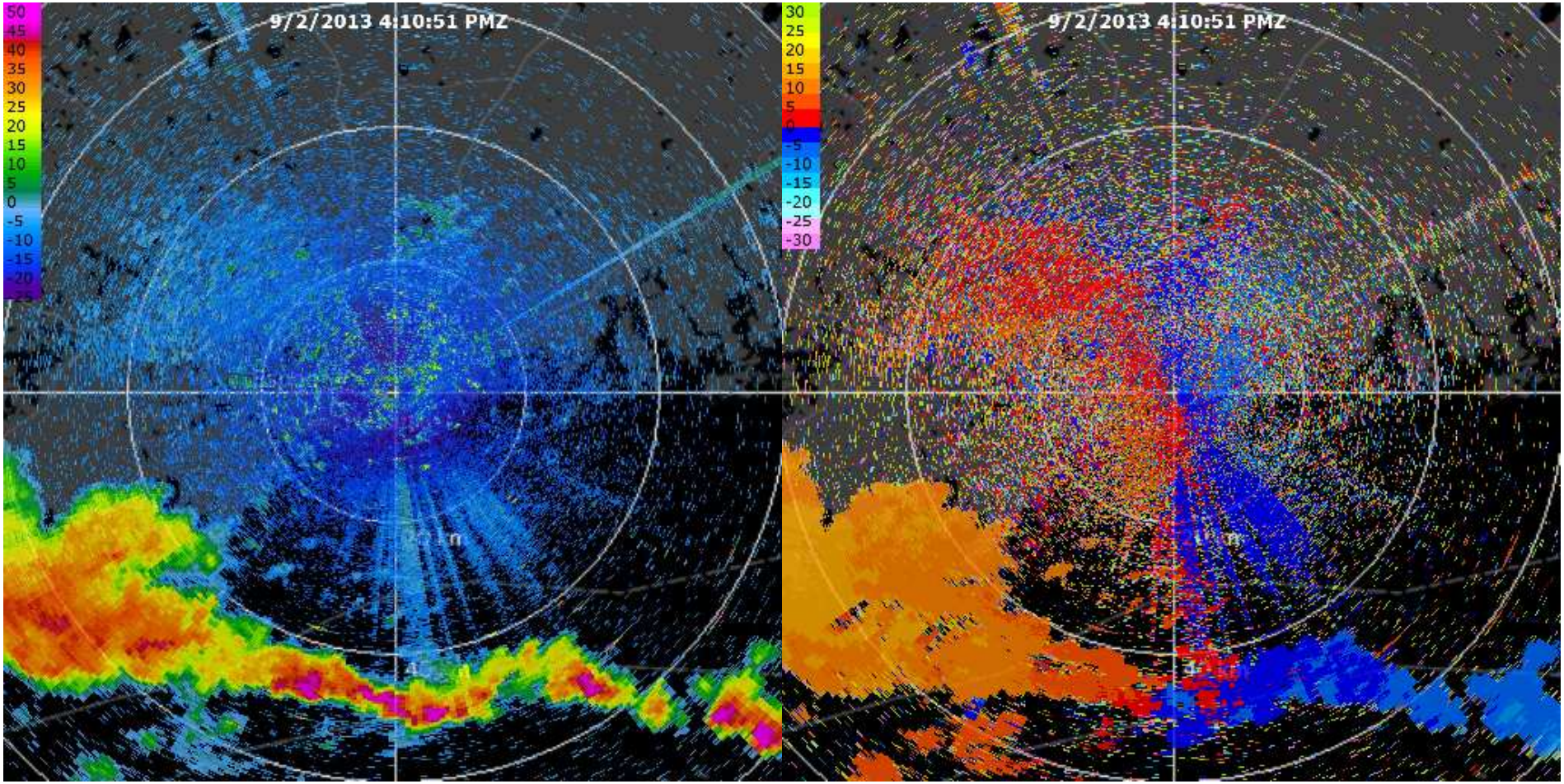








Birds: 0.5° elevation, Z & V

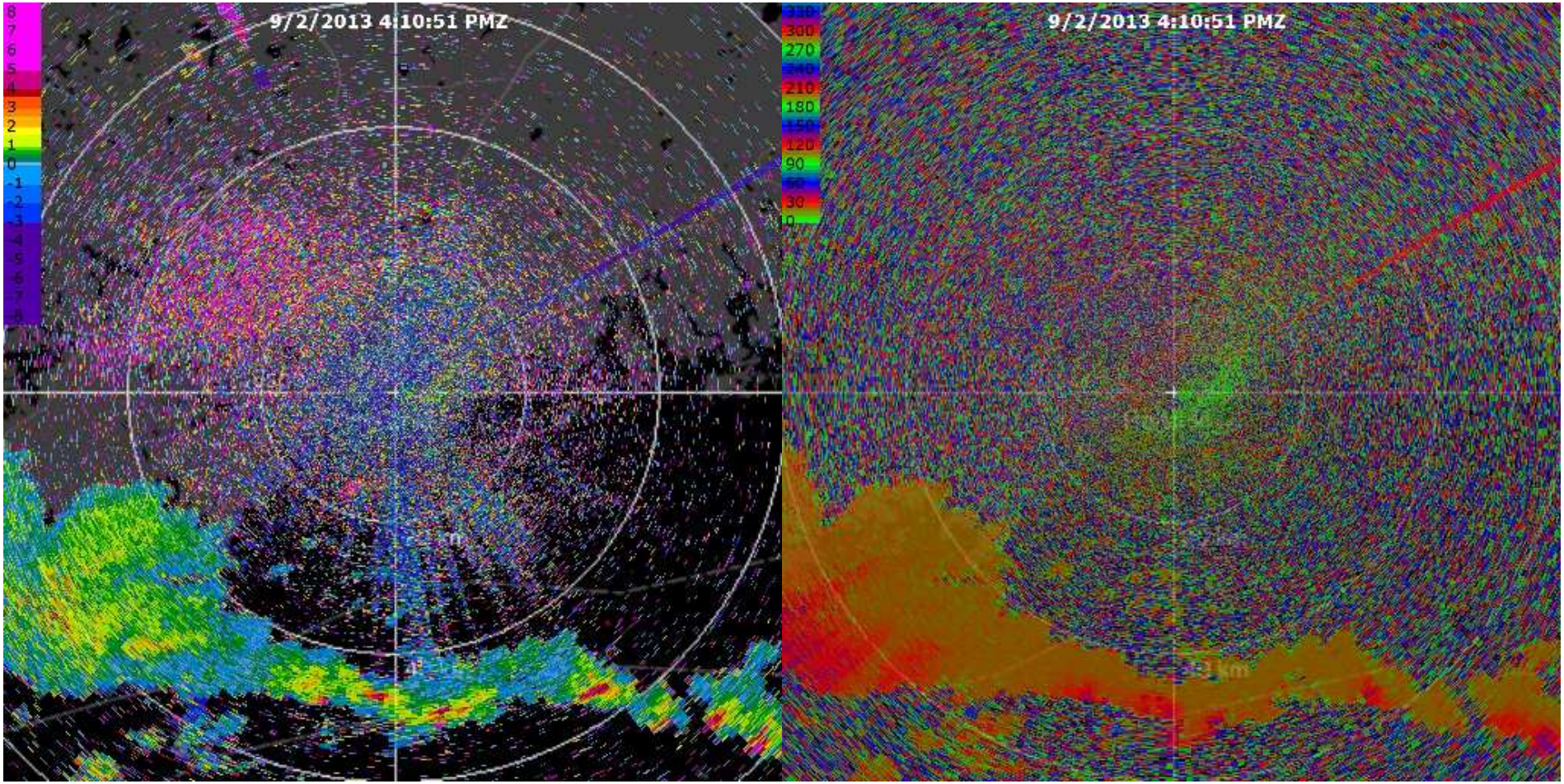


2.9.2013: migrating birds, reflectivity (left) and velocity (right)

Birds: 0.5° elevation, Z & V

2.9.2013: migrating birds, reflectivity (left) and velocity (right)

Birds: 0.5° elevation, Z_{dr} & ψ_{dp}

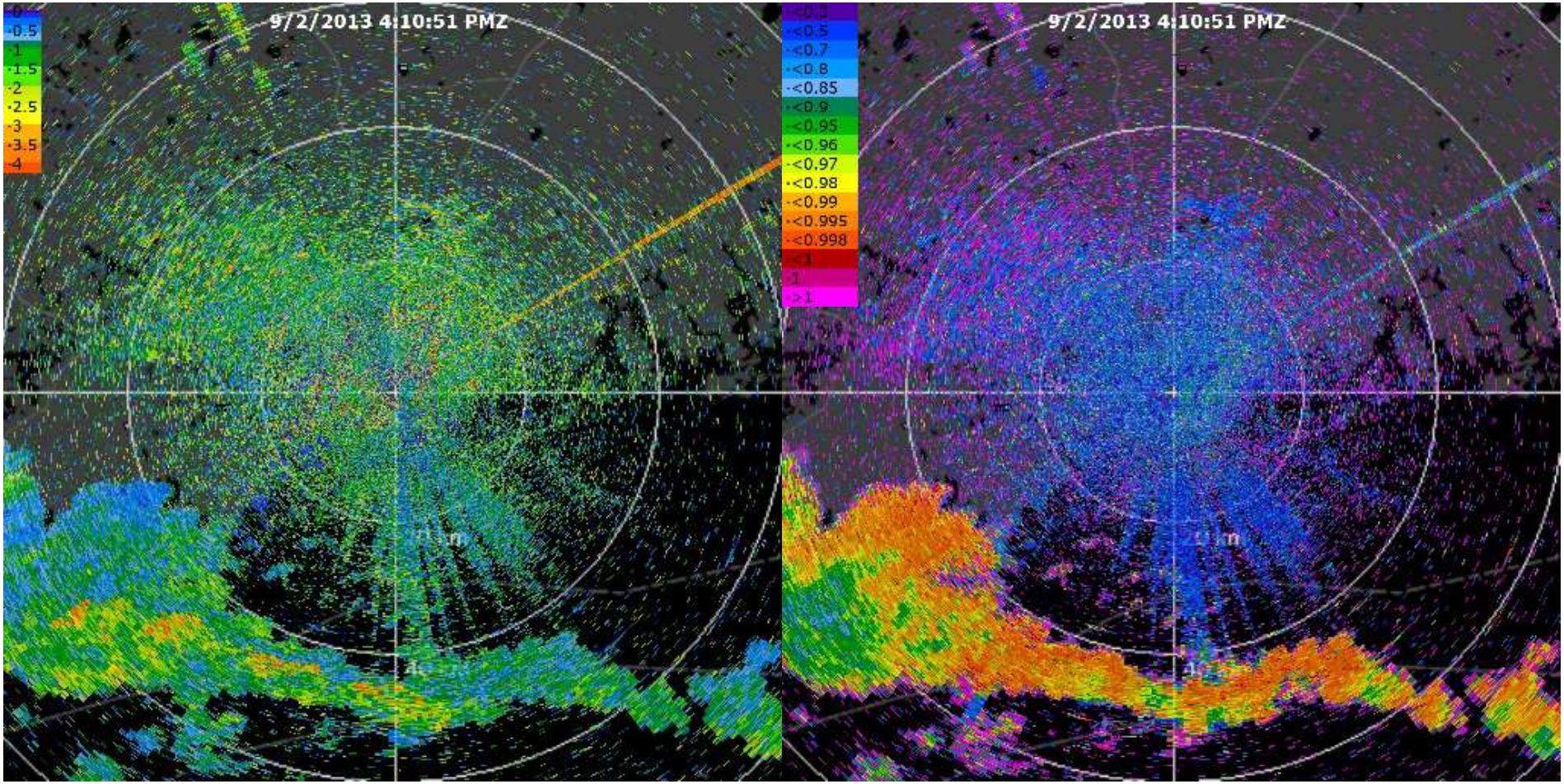


2.9.2013: migrating birds, differential reflectivity (left) and phase (right)

Birds: 0.5° elevation, Z_{dr} & ψ_{dp}

2.9.2013: migrating birds, differential reflectivity (left) and phase (right)

Birds: 0.5° elevation, σ & ρ

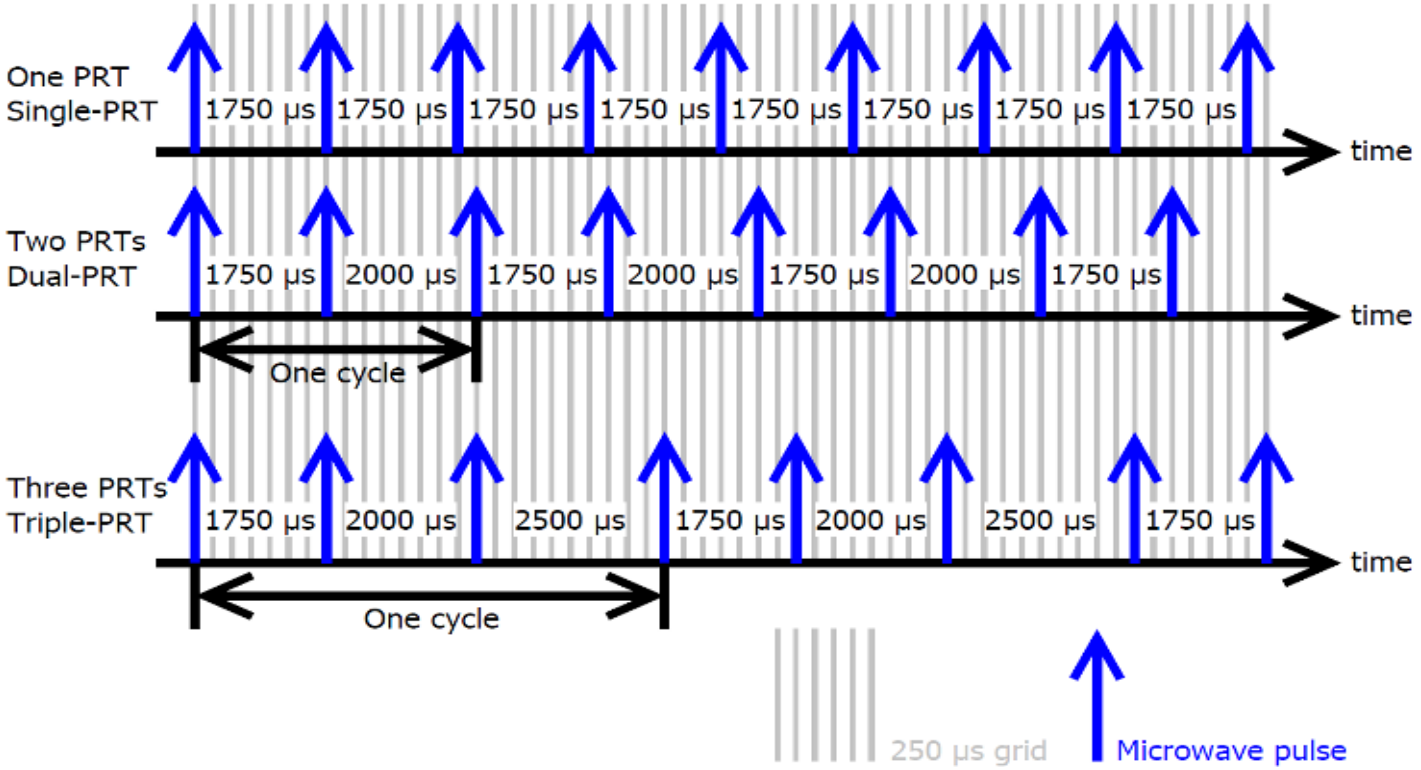


2.9.2013: migrating birds, width (left) and copolar correlation (right)

Birds: 0.5° elevation, σ & ρ

2.9.2013: migrating birds, width (left) and copolar correlation (right)

Non-Uniform Pulsing



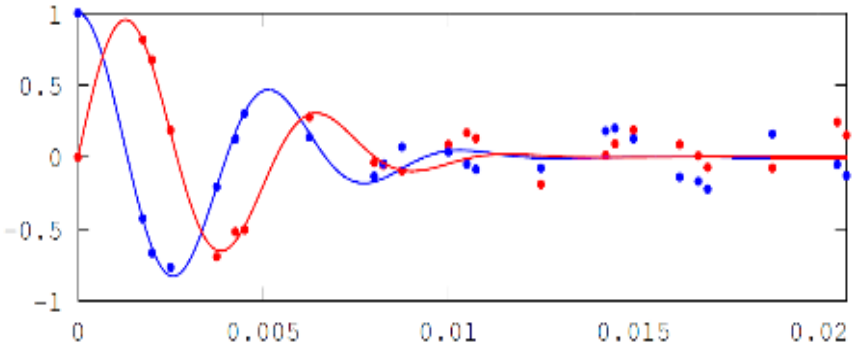
- shortest interval determines range (1750 µs)
- greatest common divisor determines maximum velocity (250 µs)
- triple-PRT works well for noisy data
- triple-PRT works well if ground clutter has to be removed

Velocity and Width from ACFs

Velocity and width estimation:

- choose a bin and take its I/Q as input
- calculate ACF from the I/Q data
- precompute a whole bunch of model ACFs each corresponding to some **v** and **σ**
- choose the model which is closest to the measured ACF

model ACF (solid) and measurement (dots) real (blue) and imag (red)



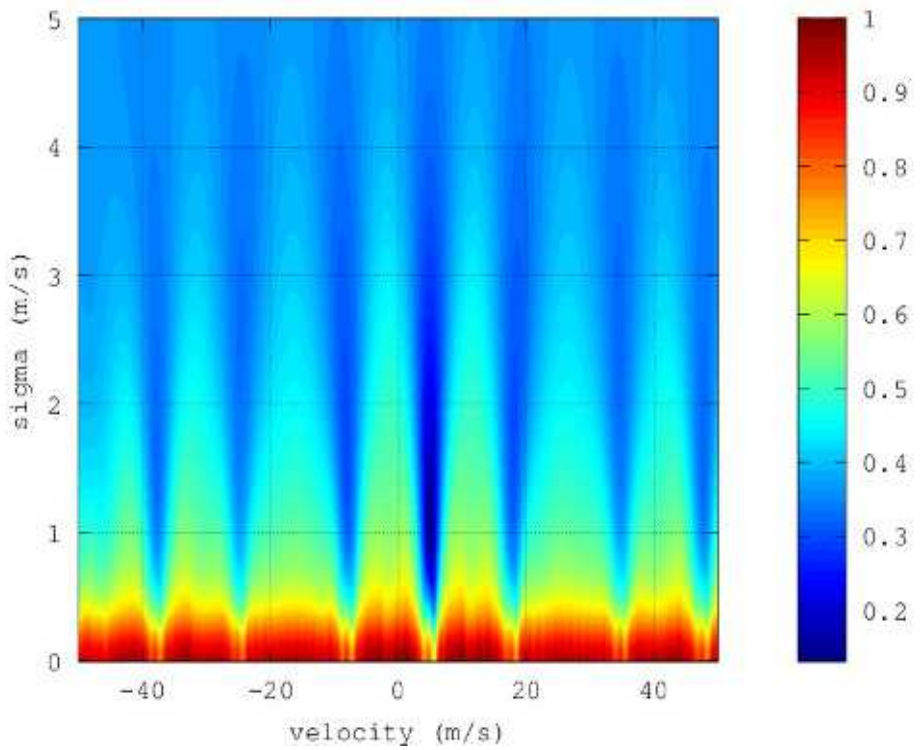
ACF lag (s)

Velocity and Width from ACFs

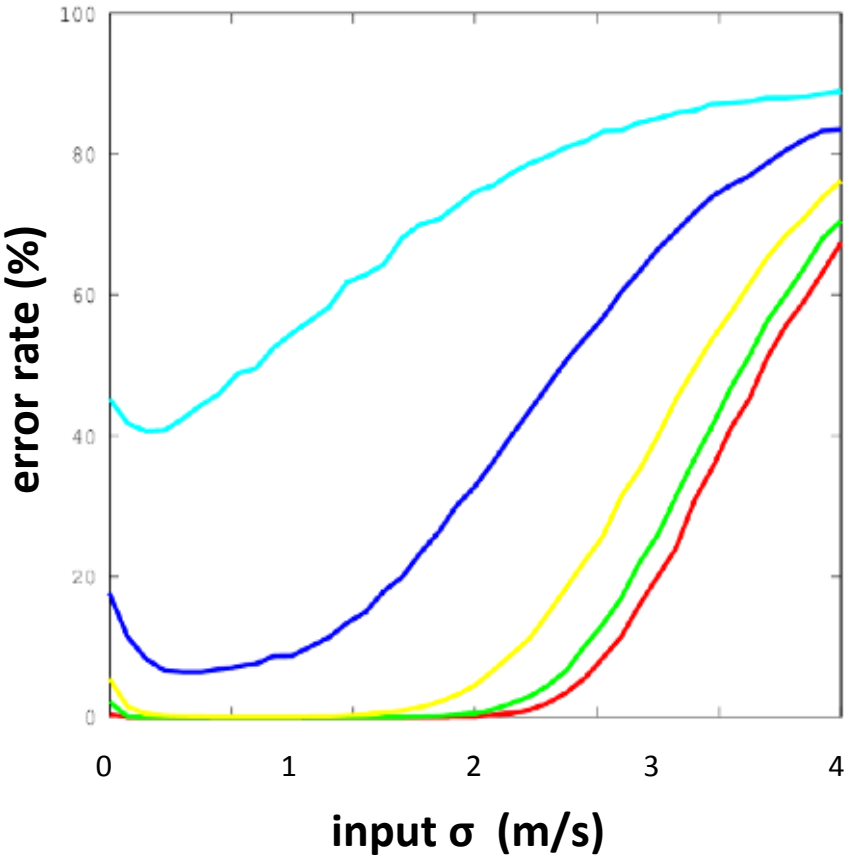
Example:

- Input ACF has **v** = 5.0 m/s and **σ** = 1.0 m/s
- model ACFs are calculated in the range **v** ∈ [-50, 50] m/s and **σ** ∈ [0, 5.0] m/s
- figure shows the distance of measured and model ACFs

Distance of measured and model ACFs

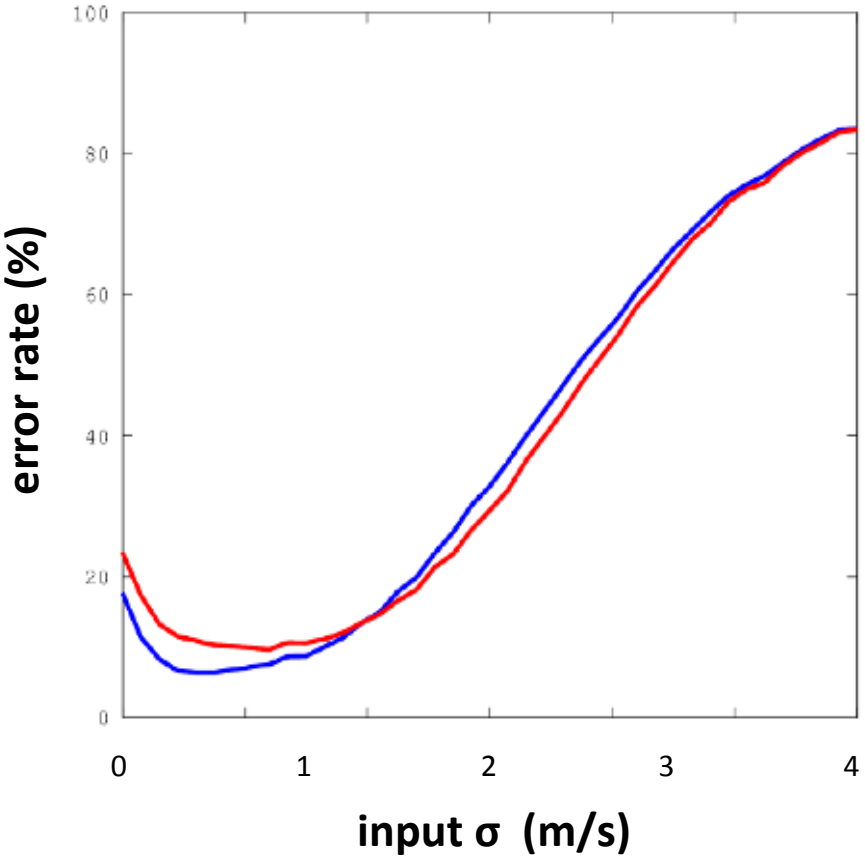


Velocity Estimation: Simulations



Error rates:

- SNR = 20, 10, 5, 0, -5 dB



Error rates:

- SNR = 0 dB
- 4 ACF lags
- 12 ACF lags

The End

Thank you!