Ship Motion Corrections for Cloud Radars
Phase I

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ASR Science Team Meeting
MAGIC Breakout
3/2013

Radars and Ship Motions

KAZR

Ka-band ARM Zenith Radar

NOT stabilized

MWACR

Marine ARM Cloud Radar

On stabilized platform

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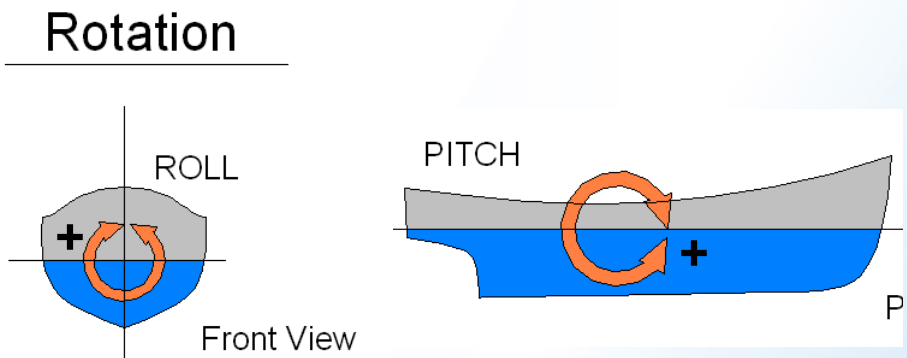
NOT stabilized



MWACR

Marine ARM Cloud Radar
On stabilized platform

Roll and pitch cause:

- Radar beam to be off-zenith
- Vertical range to vary with time

Radars and Ship Motions

KAZR

Ka-band ARM Zenith Radar

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Marine ARM Cloud Radar
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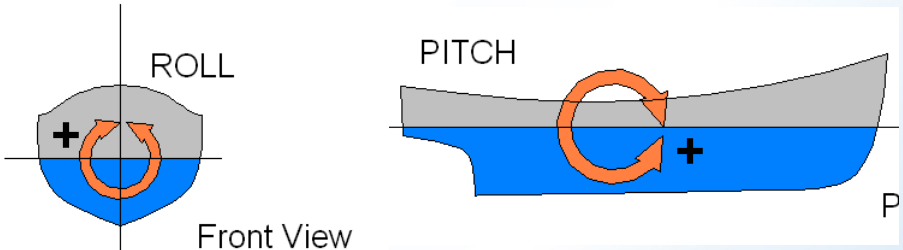
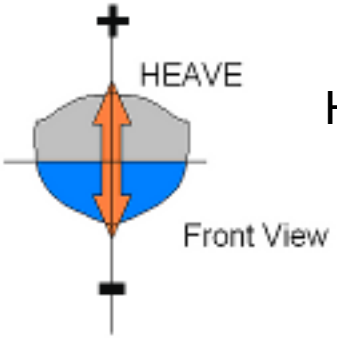
Rotation



Translations



Roll and pitch cause:

- Radar beam to be off-zenith
- Vertical range to vary with time

Heave causes:

- Vertical velocity offset
- Vertical range to vary with time

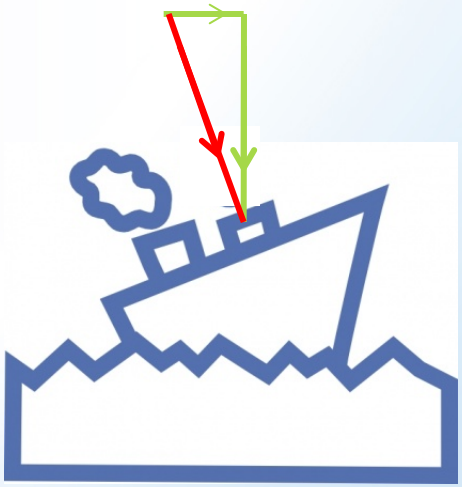
From Ship-based to Earth-based Vertical Velocity

$$V_{3,ship} = -(\cos\phi \sin\theta \cos\psi + \sin\phi \sin\psi)\, V_1 \quad \textit{E-W}$$
$$+ (-\cos\phi \sin\theta \sin\psi + \sin\phi \cos\psi)\, V_2 \quad \textit{N-S}$$
$$+ \cos\phi \cos\theta\, V_3 \quad \textit{upward}$$

Radar measures this

Observed by a Stabilized radar

Where…
- ϕ = Pitch
- θ = Roll
- Ψ = Yaw



See KAZRSHIPCOR Implementation Plan for details (ECO-00957)

From Ship-based to Earth-based Vertical Velocity

$$V_{3,ship} = -(\cos\phi \sin\theta \cos\psi + \sin\phi \sin\psi)\, V_1 \quad \textit{E-W}$$
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Radar measures this

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Where…
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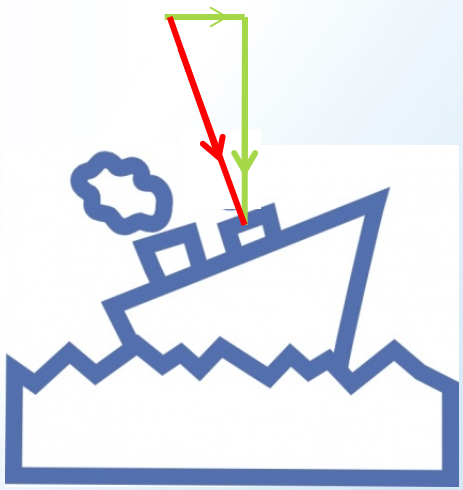
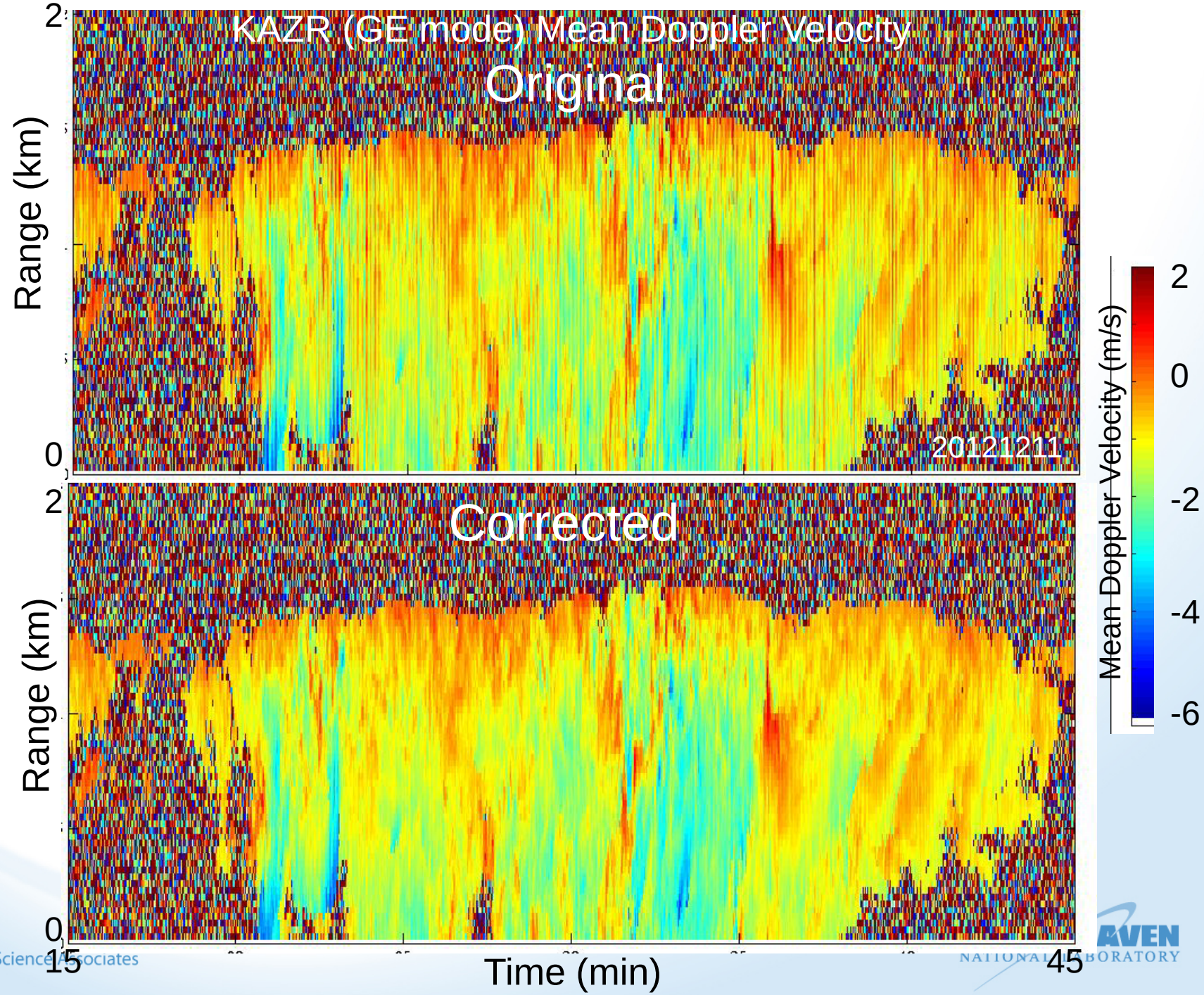


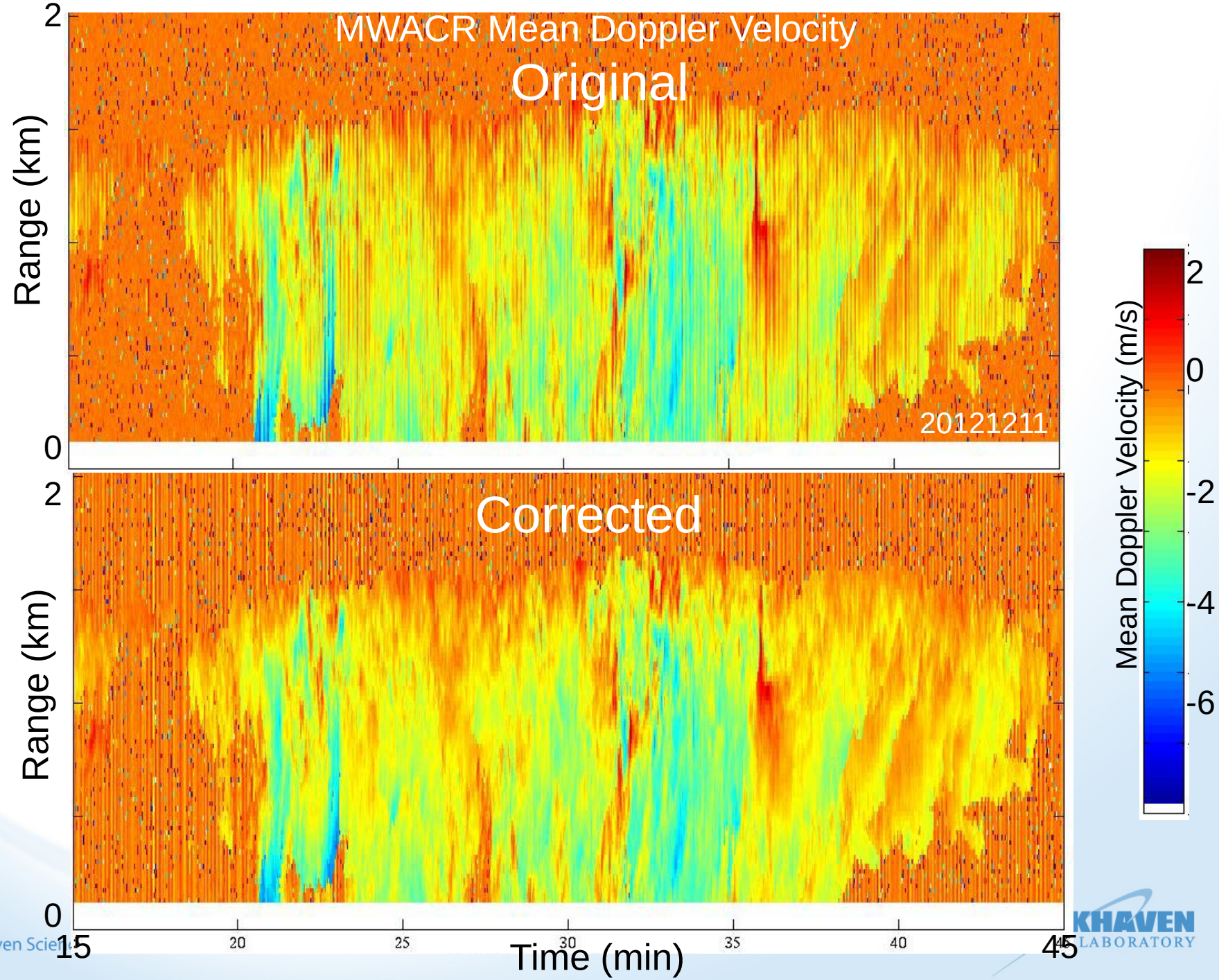
Solving for V_3:

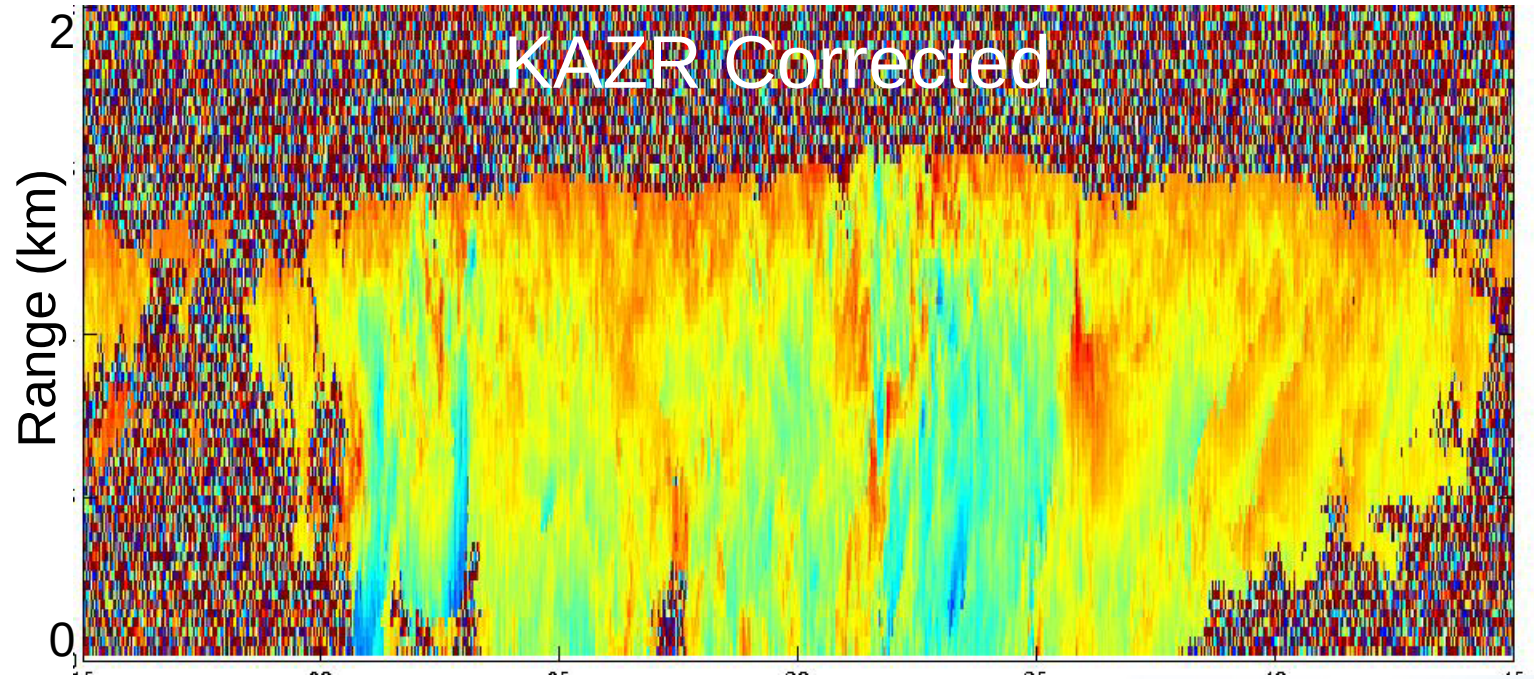
$$V_3 = (V_{3,ship} + (\cos\phi \sin\theta \cos\psi + \sin\phi \sin\psi)\, V_1 + (\cos\phi \sin\theta \sin\psi - \sin\phi \cos\psi)\, V_2\,) / (\cos\phi \cos\theta\,)$$

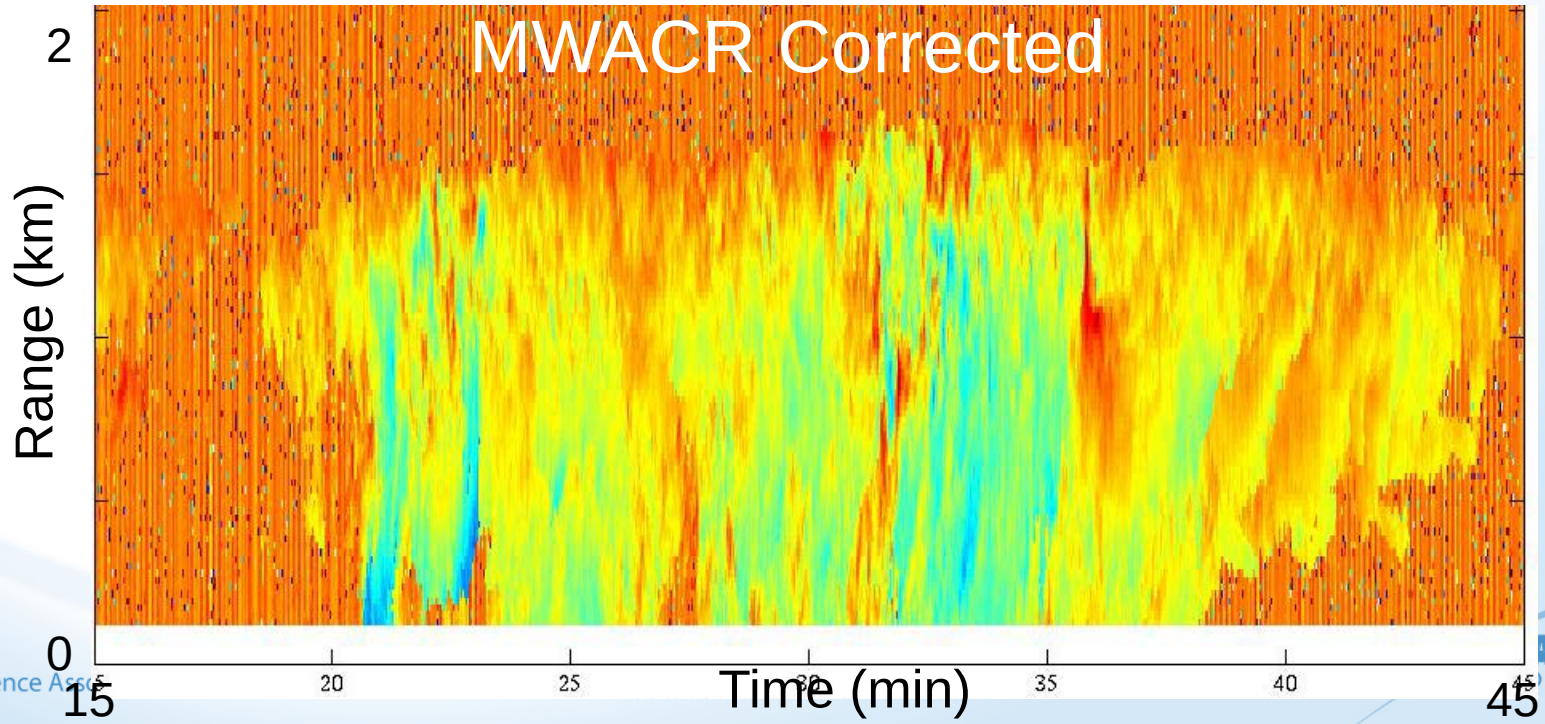
Finally, $\boxed{V_{hydrometeor} = V_3 + V_{ship_heave}}$

See KAZRSHIPCOR Implementation Plan for details (ECO-00957)


KAZR (GE mode) Mean Doppler Velocity
Original
Corrected
20121211
Range (km)
Range (km)
2
0
2
0
15
45
Time (min)
Mean Doppler Velocity (m/s)
2
0
-2
-4
-6


MWACR Mean Doppler Velocity
Original
Corrected
20121211
Range (km)
2
0
Time (min)
15
20
25
30
35
40
45
Mean Doppler Velocity (m/s)
2
0
-2
-4
-6


KAZR Corrected
Range (km)
2
0


MWACR Corrected
Range (km)
2
0
15
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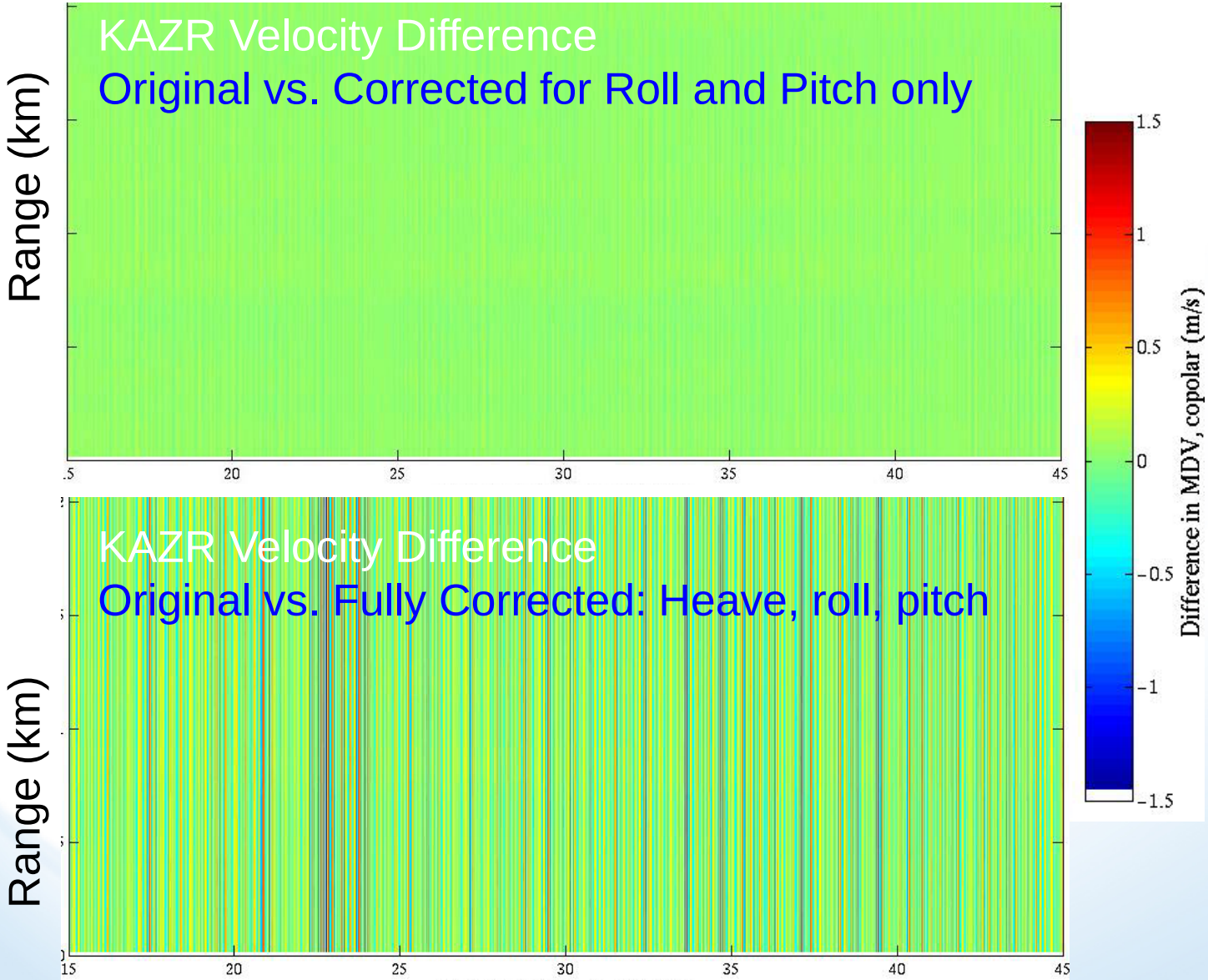
Time (min)



Heave is the major correction!