Comparison of Rayleigh Wave Recoveries at Homestake

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Independent Parameters

- Detectors used:
 - 300, 800, A4100, C4100, D4100, B4850, C4850, D4850, ROSS, YATES
- Channels used:
 - HHE, HHN, HHZ
- Observation time: 100 sec.
 - GPS times: 1107416000 1107416100 sec.
- Recovery bin size: 5°

Structure of Slides

Left-hand Side

- Used plausible recovery parameters
- Used following relation to obtain α , where v_R is the wave speed, and f is the recovery frequency :

$$\alpha = \frac{v_R}{2f}$$

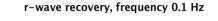
Right-hand side

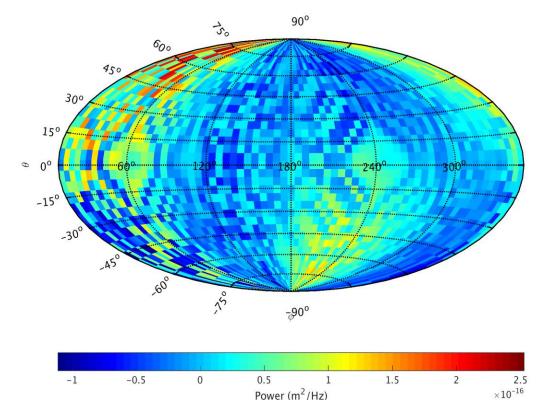
 Parameters were estimated based on geologic composition
[1] of terrain surrounding Homestake Mine, i.e. shale

$$v_R = 0.6 \left(\frac{4,900\frac{m}{s} + 1,800\frac{m}{s}}{2}\right) = 3,350 \ m/s$$

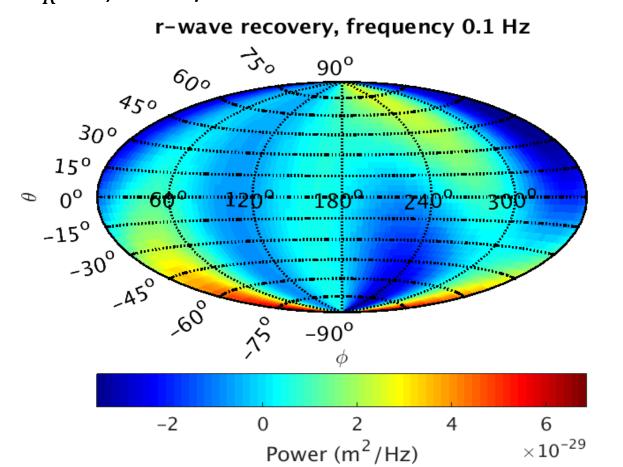
 $\alpha = 15,500 \text{ m}, \ \epsilon = 0.7$

 v_R = 3,100 m/s



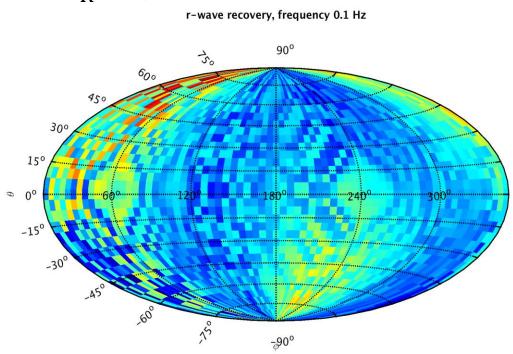


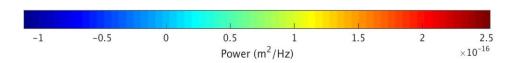
 $\alpha = 100 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$



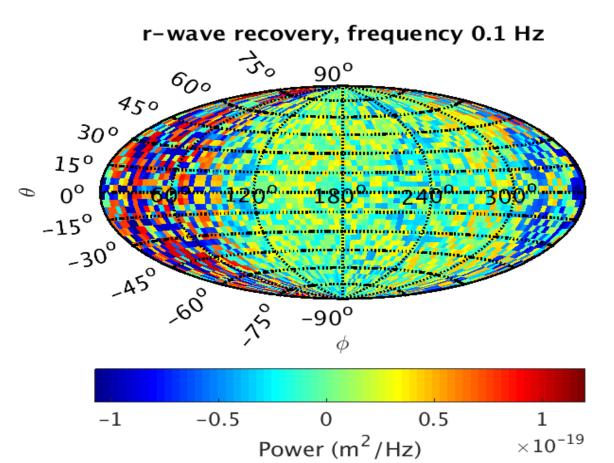
 $\alpha = 15,500 \text{ m}, \epsilon = 0.7$

 v_R = 3,100 m/s



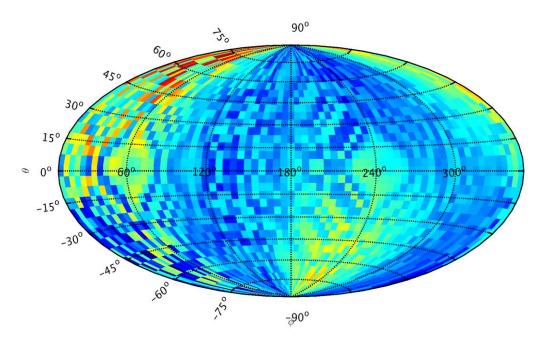


 $\alpha = 250 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$

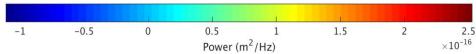


 $\alpha = 15,500 \text{ m}, \ \epsilon = 0.7$

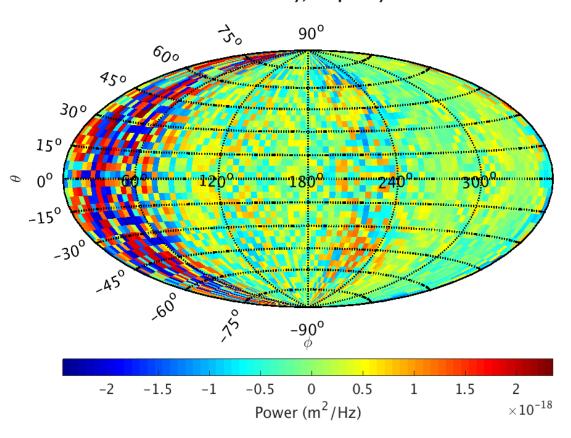
 v_R = 3,100 m/s



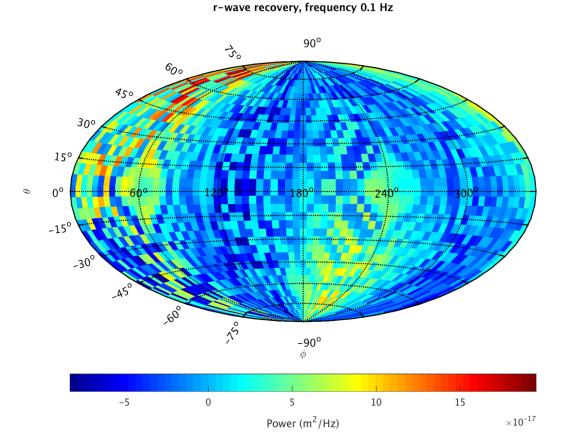
r-wave recovery, frequency 0.1 Hz



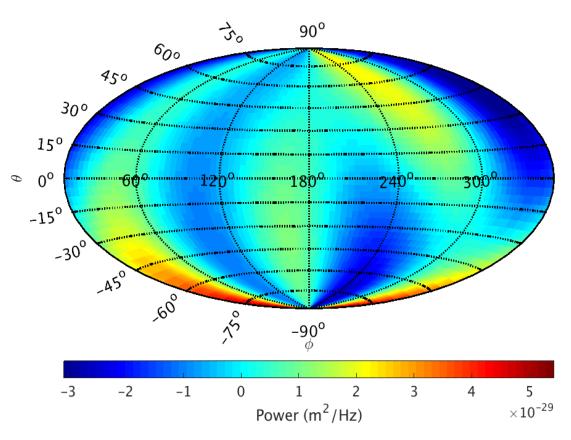
 $\alpha = 400 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$



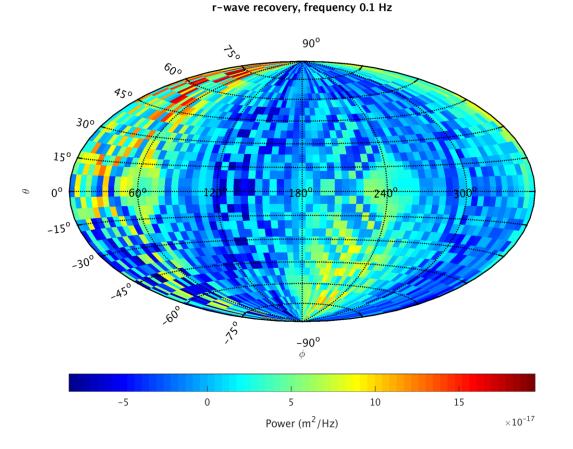
 $\alpha = 15,500 \text{ m}, \epsilon = 1.0$ $v_R = 3,100 \text{ m/s}$



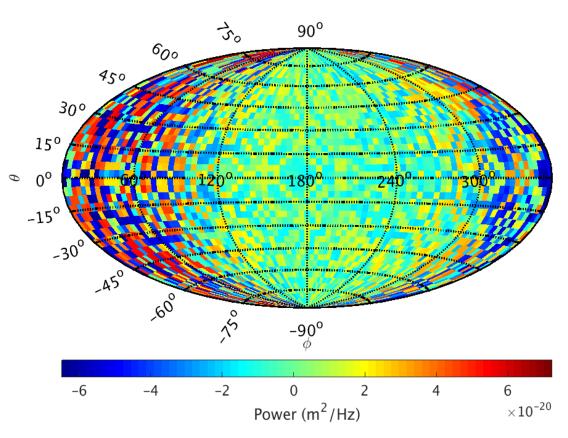
 $\alpha = 100 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}$



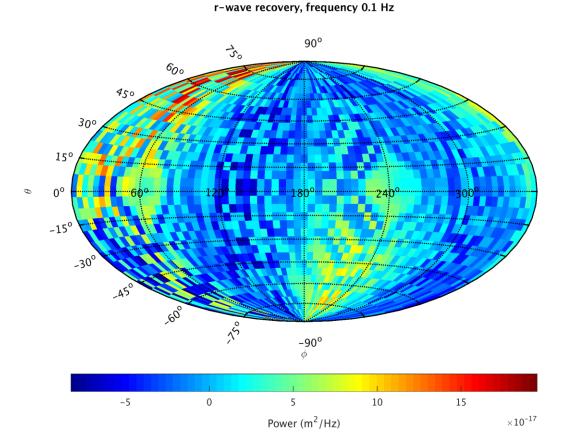
 $\alpha = 15,500 \text{ m}, \epsilon = 1.0$ $v_R = 3,100 \text{ m/s}$



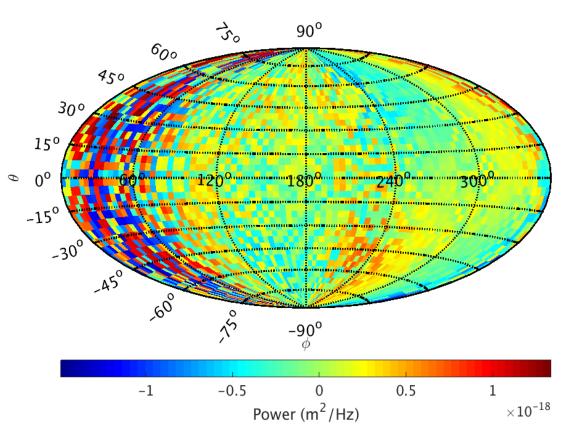
 $\alpha = 250 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}$



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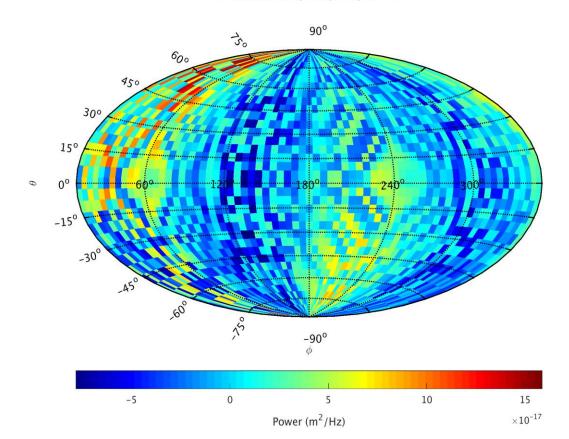


 $\alpha = 400 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}$

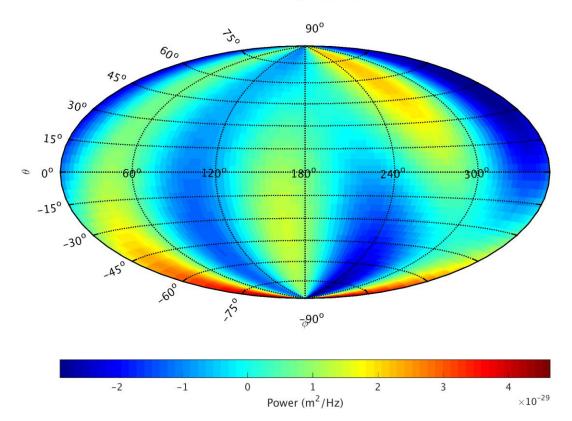


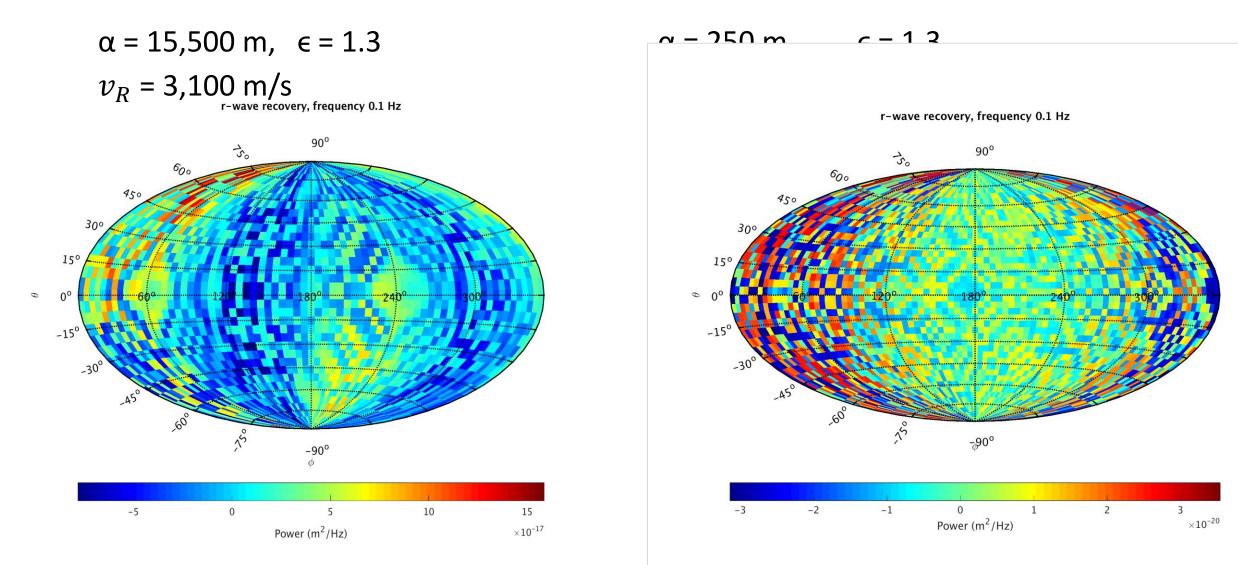
 $\alpha = 15,500 \text{ m}, \epsilon = 1.3$

 $v_R = 3,100 \text{ m/s}_{r-\text{wave recovery, frequency 0.1 Hz}}$



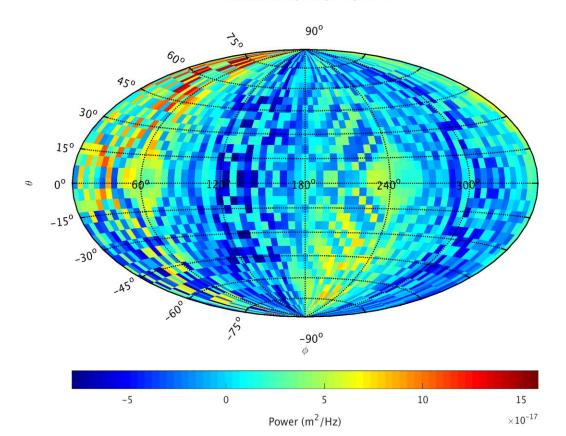
 $\alpha = 100 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$



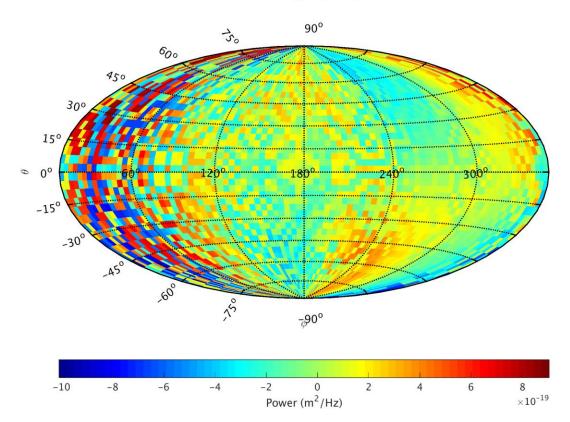


 $\alpha = 15,500 \text{ m}, \epsilon = 1.3$

 $v_R = 3,100 \text{ m/s}_{r-\text{wave recovery, frequency 0.1 Hz}}$



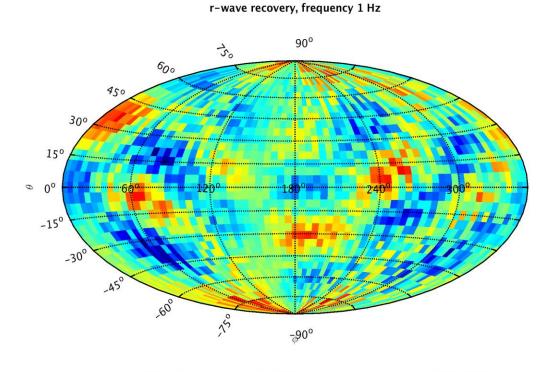
 $\alpha = 400 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$

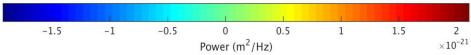


θ

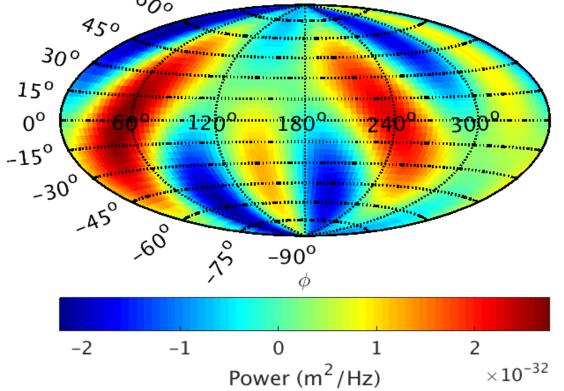
 α = 650 m, ϵ = 0.7

 v_R = 1,300 m/s



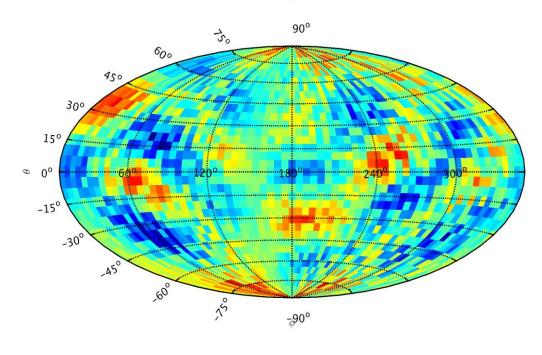


 $\alpha = 100 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$ **r-wave recovery, frequency 1 Hz** $\epsilon_{00} = 500^{\circ}$

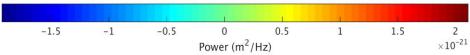


$$\alpha = 650 \text{ m}, \quad \epsilon = 0.7$$

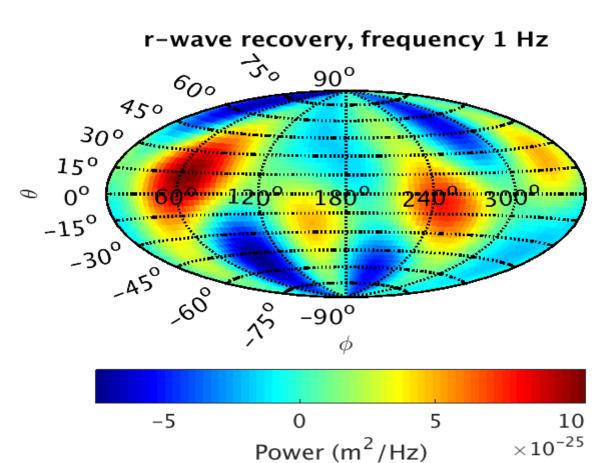
 $v_R = 1,300 \text{ m/s}$



r-wave recovery, frequency 1 Hz

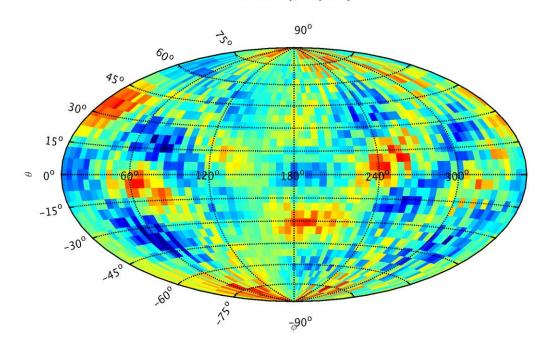


 $\alpha = 250 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$

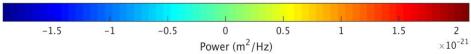


 α = 650 m, ϵ = 0.7

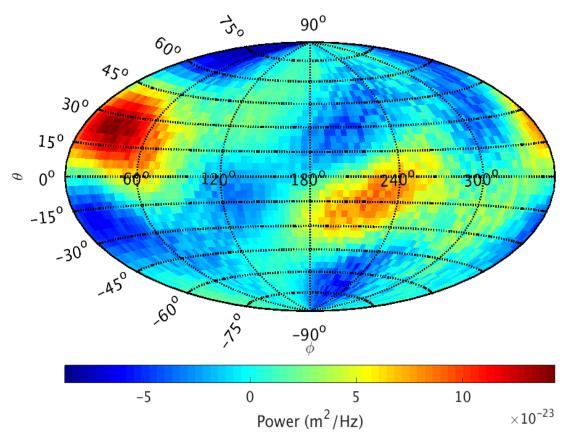
 v_R = 1,300 m/s



r-wave recovery, frequency 1 Hz

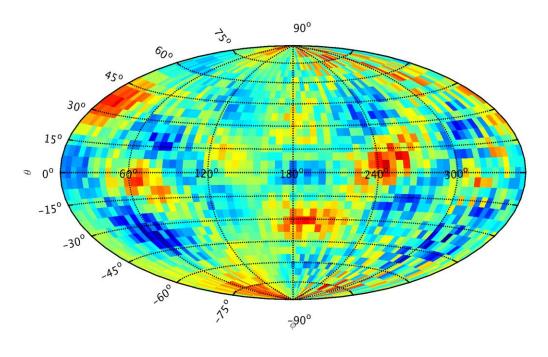


 $\alpha = 400 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 1 Hz}$

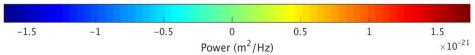


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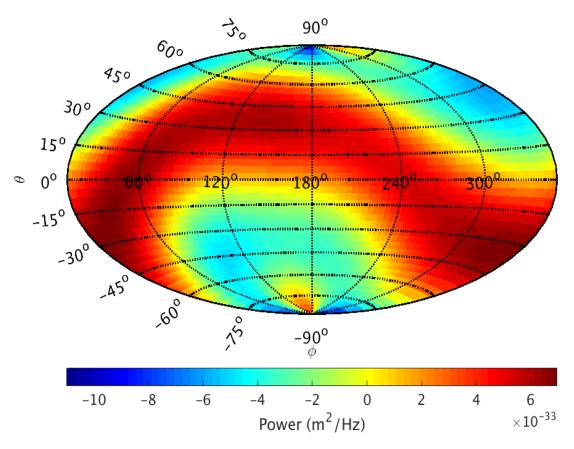
 v_R = 1,300 m/s



r-wave recovery, frequency 1 Hz

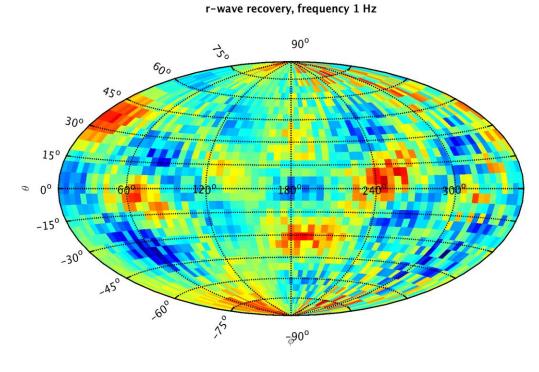


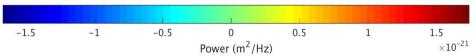
 $\alpha = 100 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 1 Hz}$



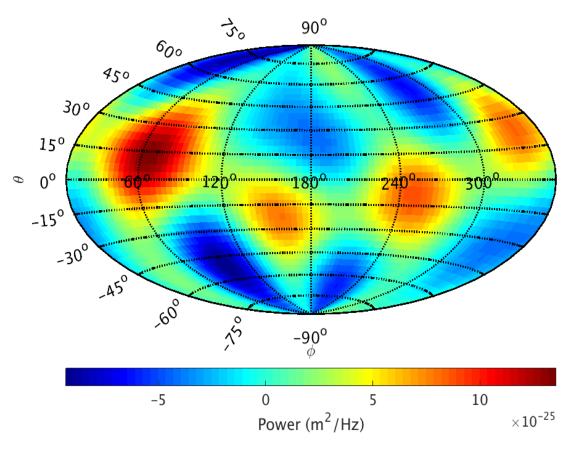
 α = 650 m, ϵ = 1.0

 v_R = 1,300 m/s



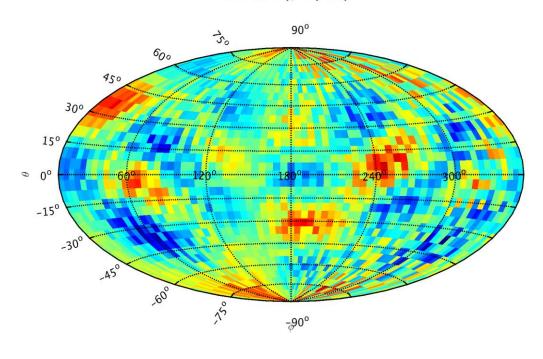


 $\alpha = 250 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 1 Hz}$

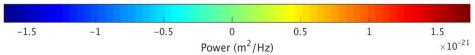


$$\alpha$$
 = 650 m, ϵ = 1.0

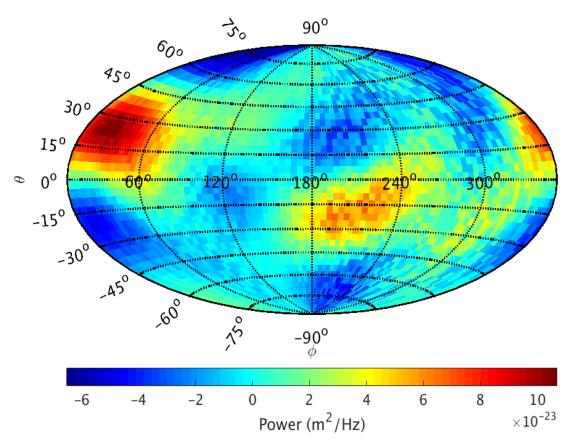
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v_R = 1,300 m/s
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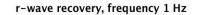
r-wave recovery, frequency 1 Hz

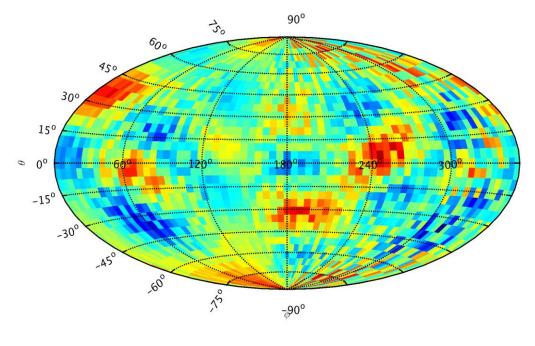


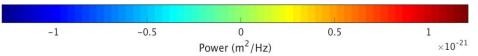
 $\alpha = 400 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 1 Hz}$



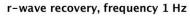
 $\alpha = 650 \text{ m}, \quad \epsilon = 1.3$ $v_R = 1,300 \text{ m/s}$

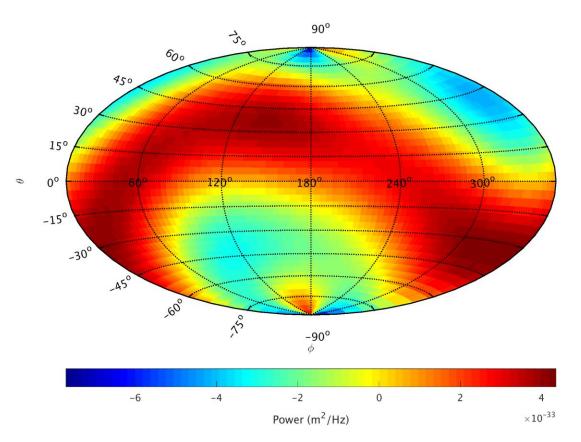




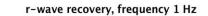


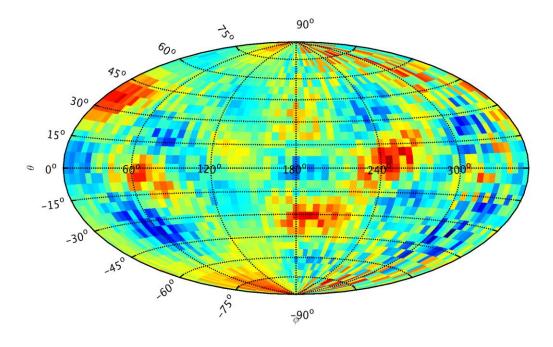
 $\alpha = 100 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$

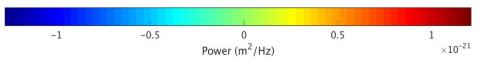




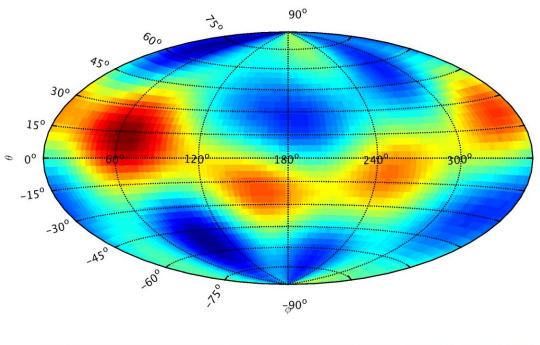
 $\alpha = 650 \text{ m}, \quad \epsilon = 1.3$ $v_R = 1,300 \text{ m/s}$

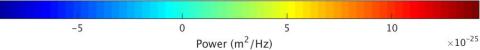




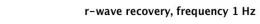


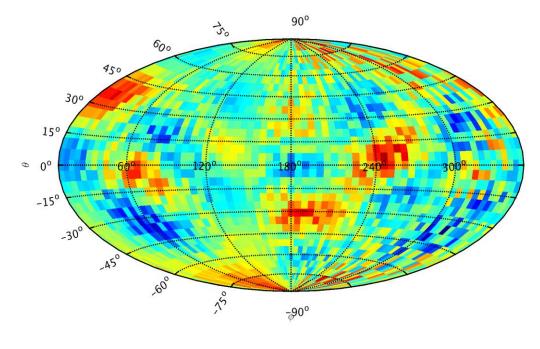
 α = 250 m, ϵ = 1.3 v_R = 3,350 m/s

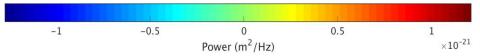




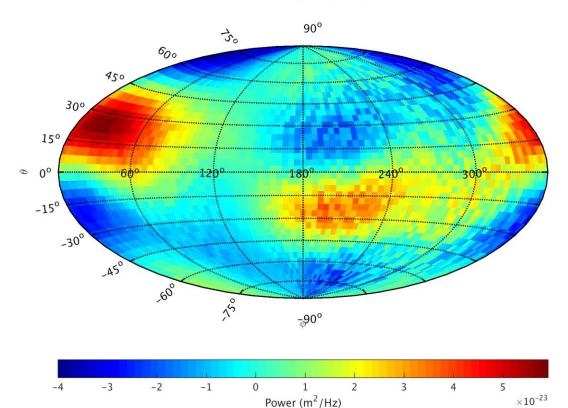
 $\alpha = 650 \text{ m}, \quad \epsilon = 1.3$ $v_R = 1,300 \text{ m/s}$





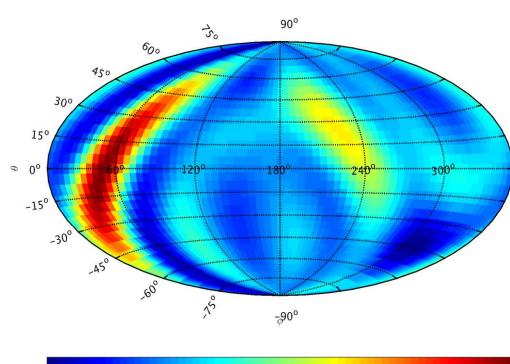


 $\alpha = 400 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$



 $\alpha = 144$ m, $\epsilon = 0.7$

 v_R = 862 m/s



r-wave recovery, frequency 3 Hz

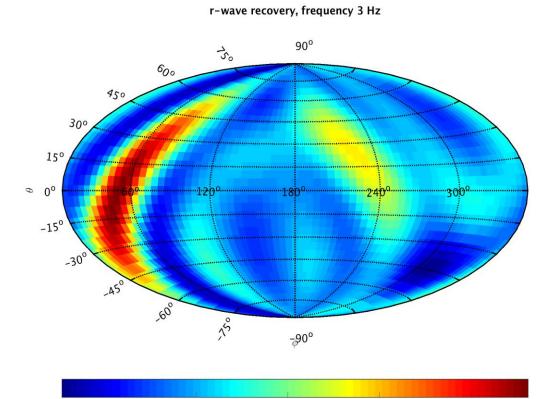
–5 0 5 10 15 Power (m²/Hz) ×10⁻³¹ $\alpha = 100 \text{ m}, \quad \epsilon = 0.7$ v_R = 3,350 m/s r-wave recovery, frequency 3 Hz 50 90° 600 450 300 15° 0° θ The state of the s -15° -30° _45° *6*0° ŝ -90° Ф -0.5 0 0.5 -1 1 1.5 $imes 10^{-34}$ Power (m^2/Hz)

 α = 144 m, ϵ = 0.7

 v_R = 862 m/s

-5

0



5

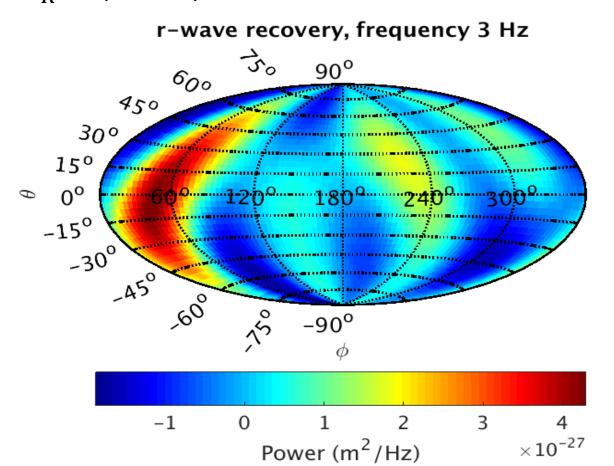
Power (m²/Hz)

10

15

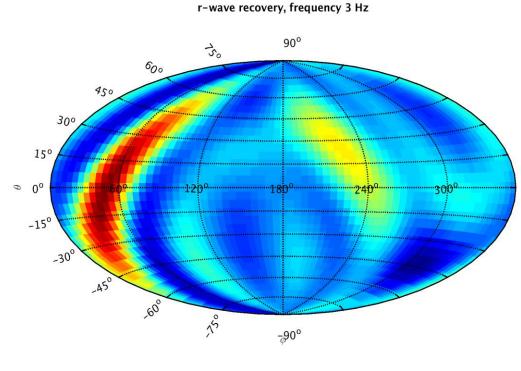
 $\times 10^{-31}$

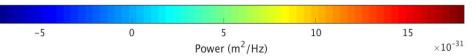
 $\alpha = 250 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}$



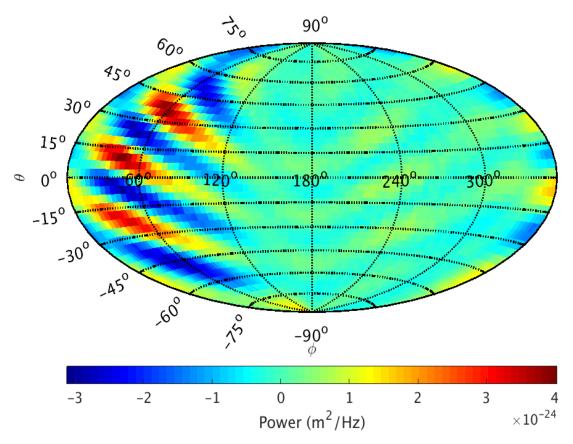
 α = 144 m, ϵ = 0.7

 v_R = 862 m/s



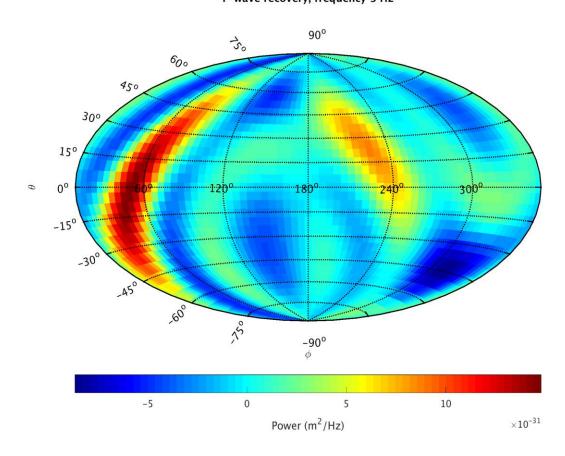


 $\alpha = 400 \text{ m}, \quad \epsilon = 0.7$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 3 Hz}$

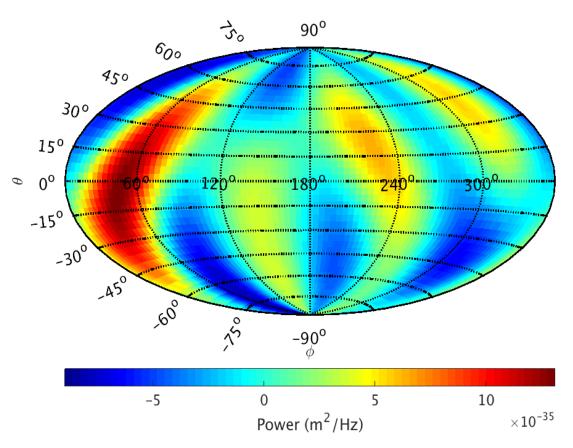


 α = 144 m, ϵ = 1.0

 $v_R = 862 \text{ m/s}_{r-\text{wave recovery, frequency 3 Hz}}$

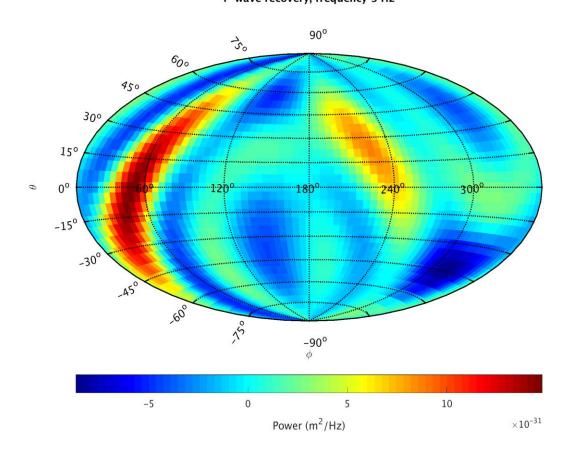


 $\alpha = 100 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}_{r-\text{wave recovery, frequency 3 Hz}}$

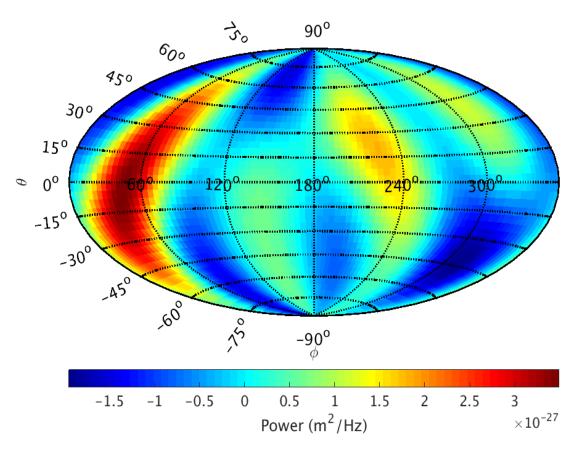


 α = 144 m, ϵ = 1.0

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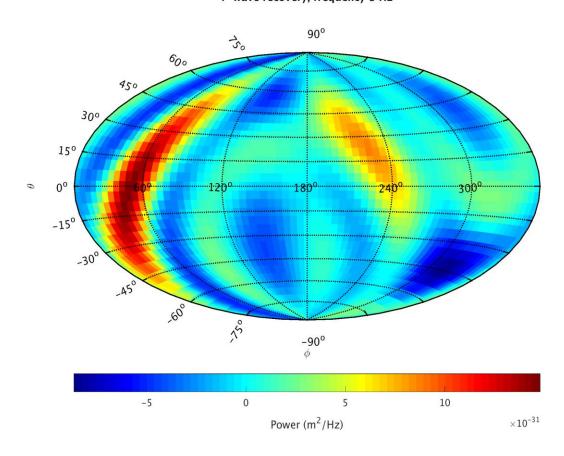


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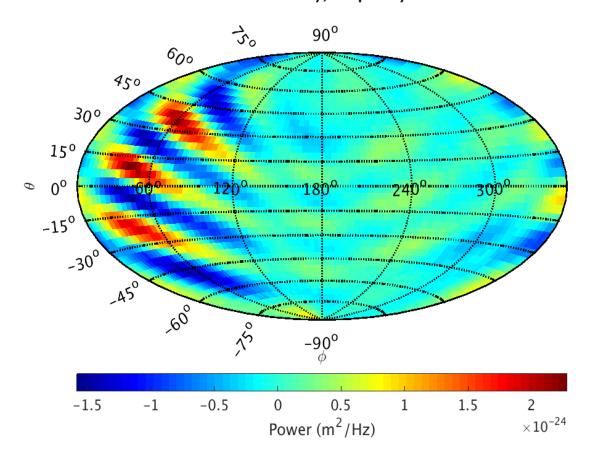


 α = 144 m, ϵ = 1.0

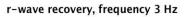
 $v_R = 862 \text{ m/s}_{r-\text{wave recovery, frequency 3 Hz}}$

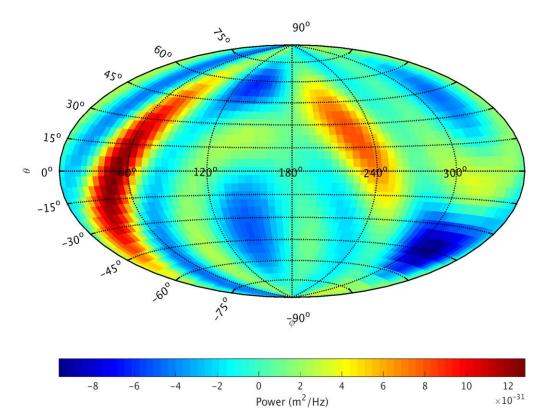


 $\alpha = 400 \text{ m}, \quad \epsilon = 1.0$ $v_R = 3,350 \text{ m/s}_{r-wave recovery, frequency 3 Hz}$

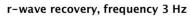


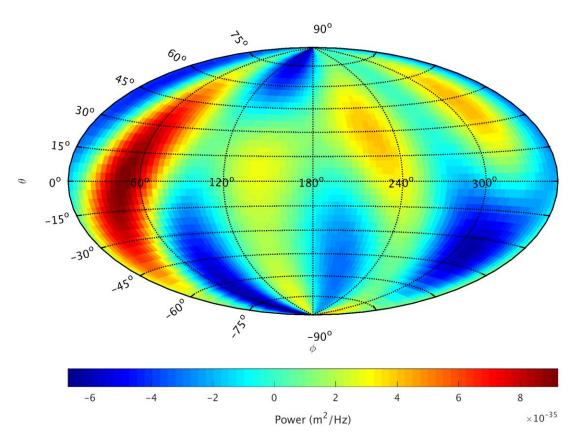
 α = 144 m, ϵ = 1.3 v_R = 862 m/s



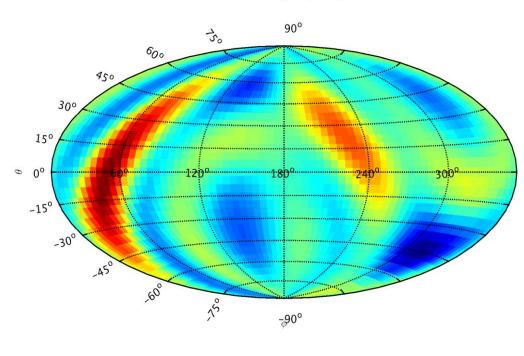


 $\alpha = 100 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$

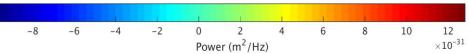




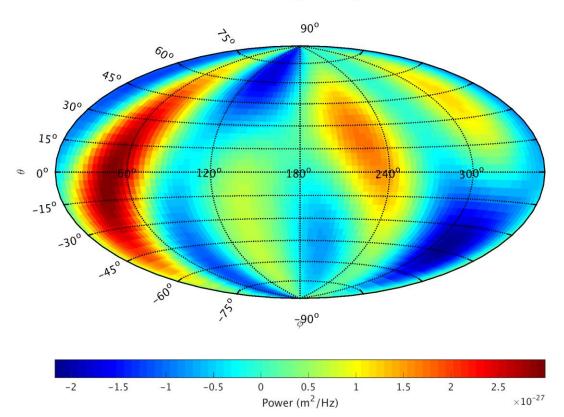
 $\alpha = 144 \text{ m}, \quad \epsilon = 1.3$ $v_R = 862 \text{ m/s}$



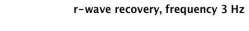
r-wave recovery, frequency 3 Hz

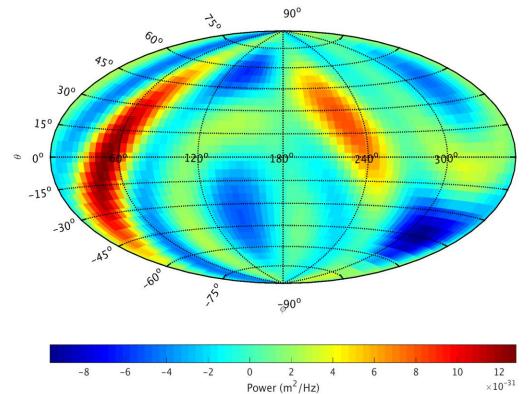


 α = 250 m, ϵ = 1.3 v_R = 3,350 m/s

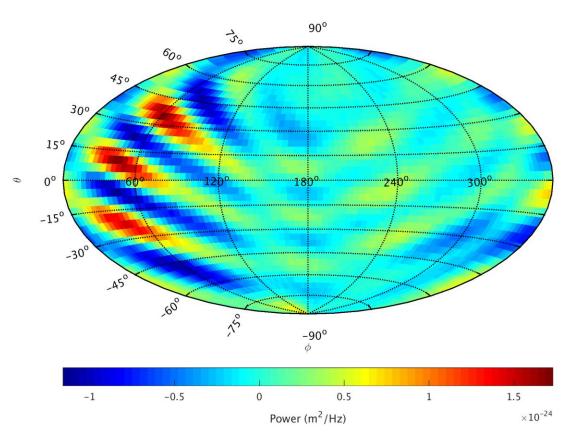


 α = 144 m, ϵ = 1.3 v_R = 862 m/s





 $\alpha = 400 \text{ m}, \quad \epsilon = 1.3$ $v_R = 3,350 \text{ m/s}$



Future Directions and Questions

- Perform Rayleigh recoveries with $1.3 < \epsilon < 5$
 - Learn the boundary between relevant and irrelevant recoveries
- Construct time series of data and do a sanity check
 - Use wave speed and detector location to try and see if recoveries are consistent with our current understanding
- Why is the power recovered so small?
 - Why, if the power is so small, do we get well-defined structures on some but not all recoveries?

References

[1] <u>"Acoustic Logging"</u>. epa.gov. 2011-12-12. Retrieved2015-02-03.