Preliminary Love Wave Recoveries

Levi Walls

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Overview

- Formalism:
  - Assuming fundamental modes dominate
  - Using eigenfunction approximation modified from Haney and Tsai, 2015:

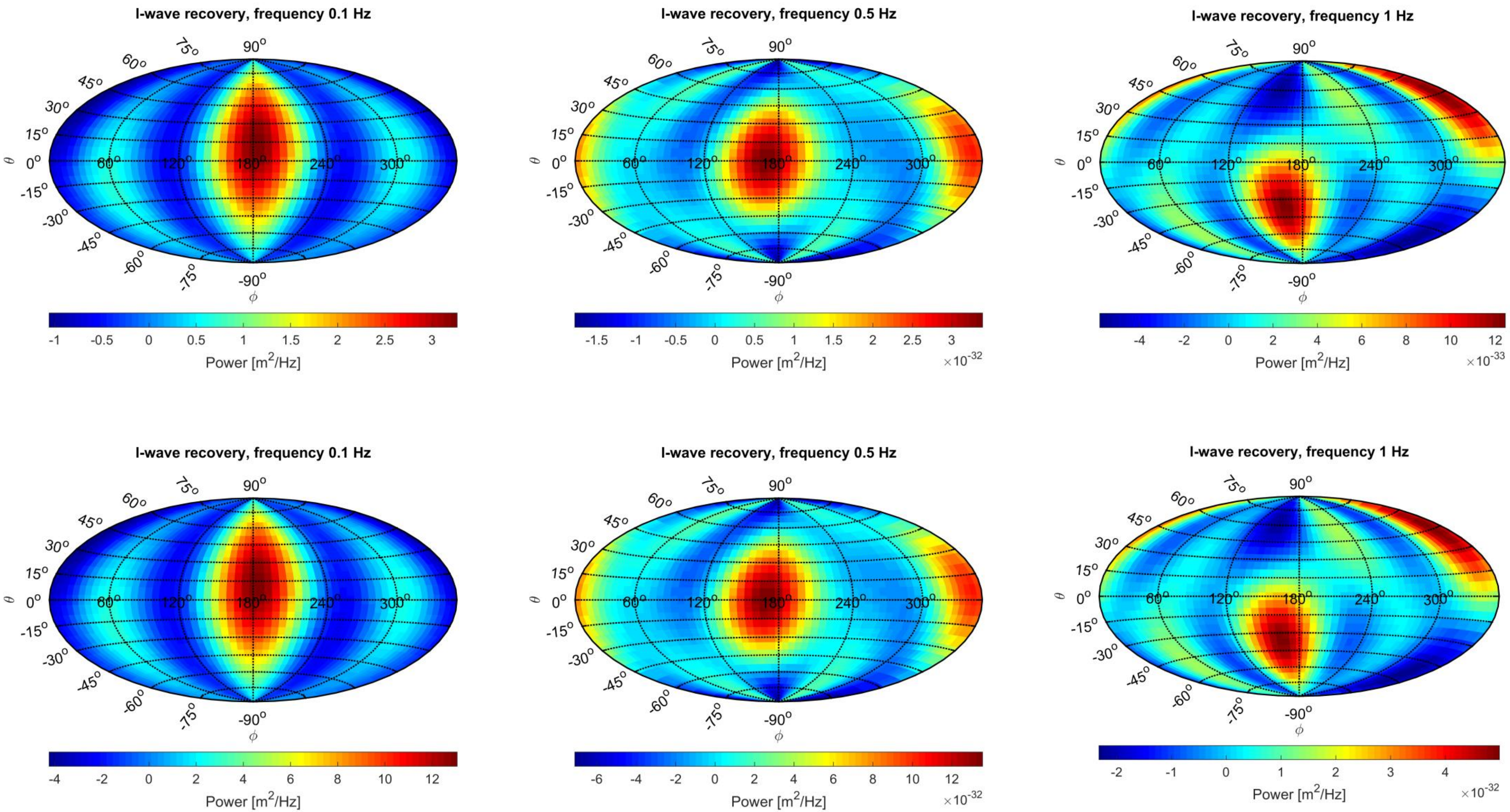
$$l_1(z,\omega,k) \sim l_1(z,f,v_l) = e^{-2\pi a\frac{fz}{v_l}} \quad (1)$$

- Simulations done surveying effects of amplitude and injected/recovery frequency variation on recovery ability

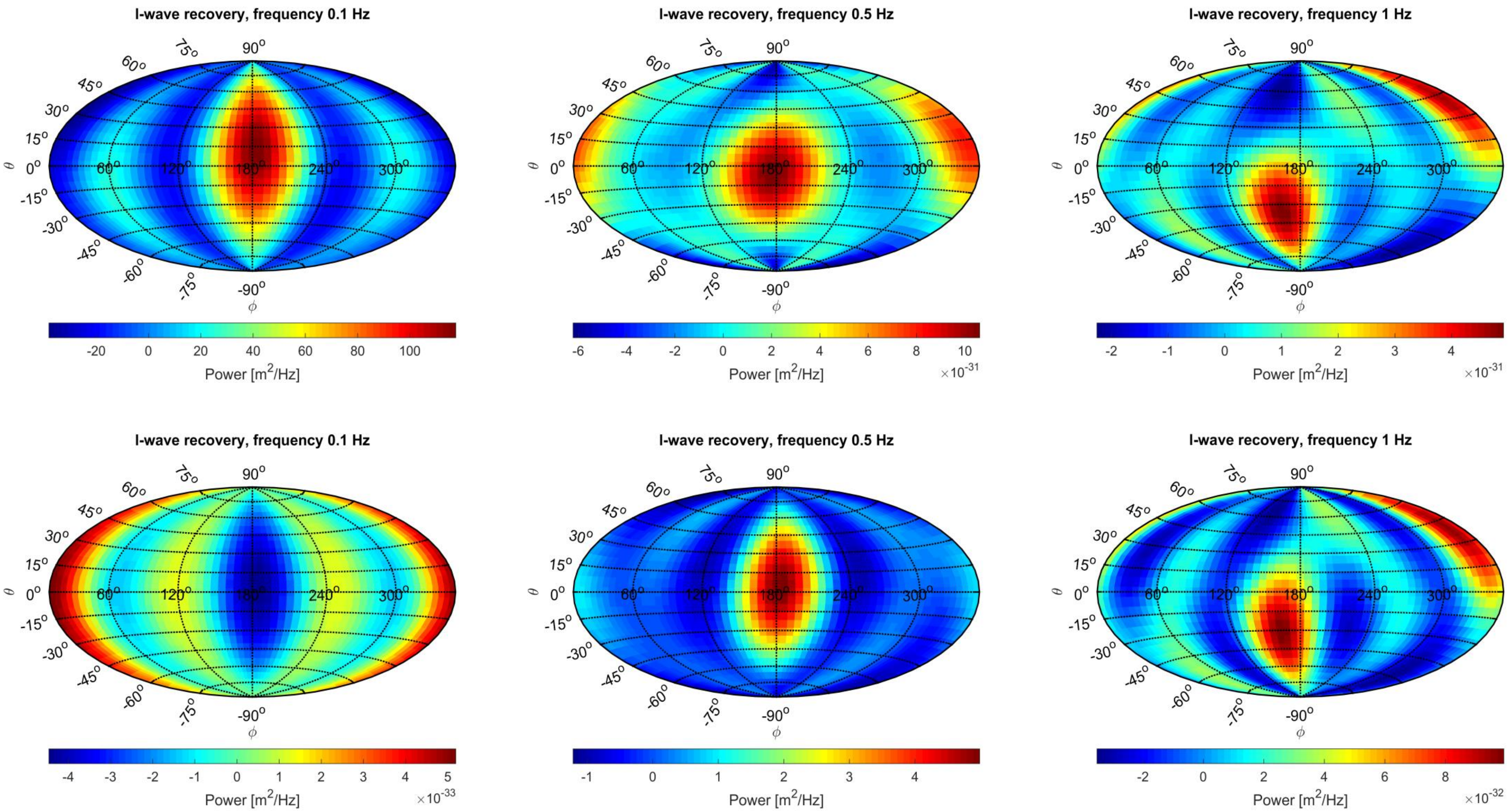
Simulation Parameters

- Attenuation factor (Haney & Tsai, 2015) : $a = 0.85$
- Love wave speed: $v_l = 3{,}240\,\frac{m}{s}$
- Amplitude: A $\in$ [0.5 1 3]
- Injection/recovery frequency: $f \in$ [0.1 0.3 0.5 0.7 1]
- Phase: $\delta = 0$
- Latitude & longitude: $(\phi, \theta) = (180°, 0°)$
  - Note the code is designed to force surface waves to be at $\theta = 0°$; i.e. we suppress the coordinate.

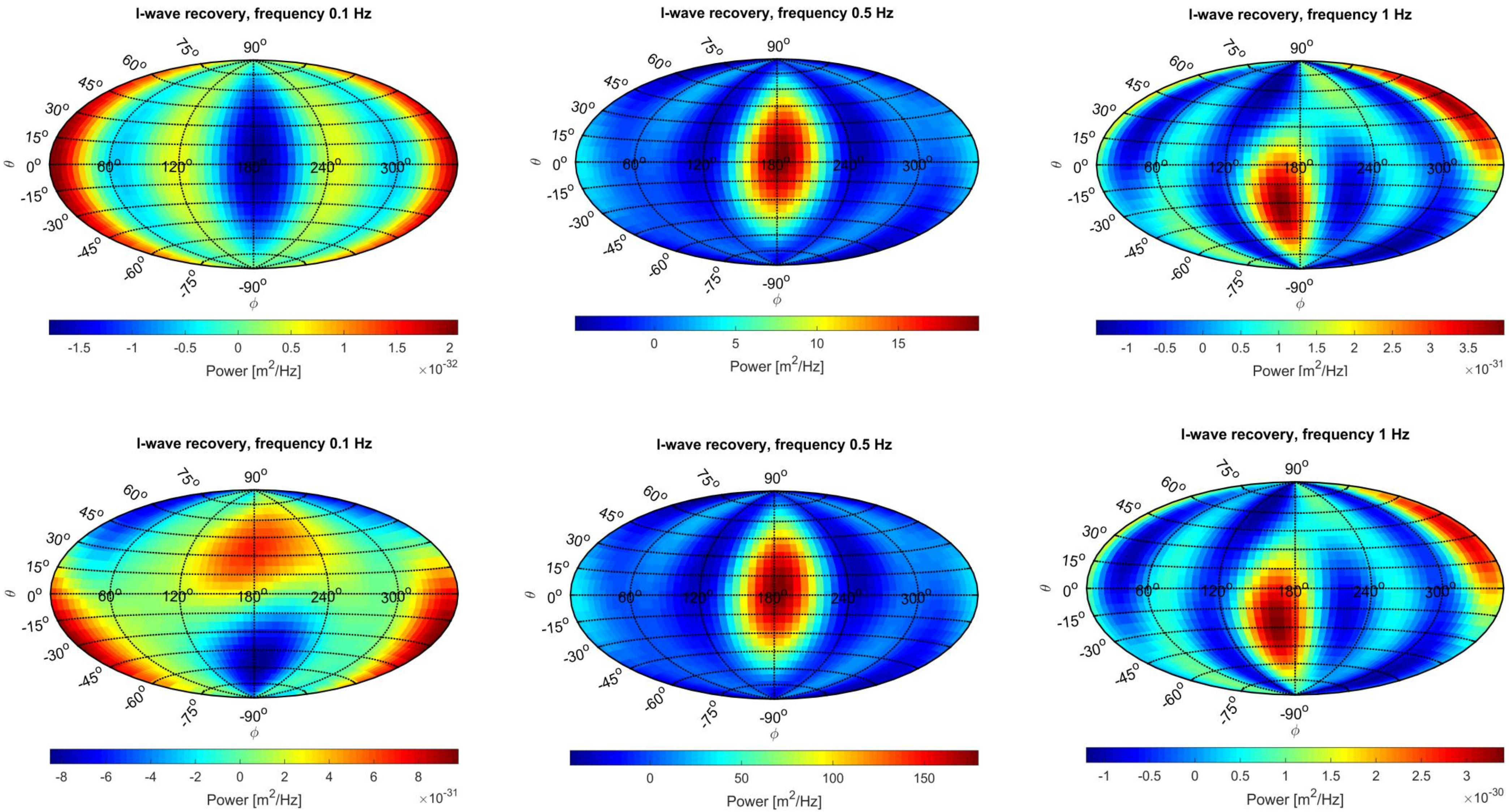
$f_{inj} = 0.1$ Hz; $A = 0.5$ (top), 1 (bottom)



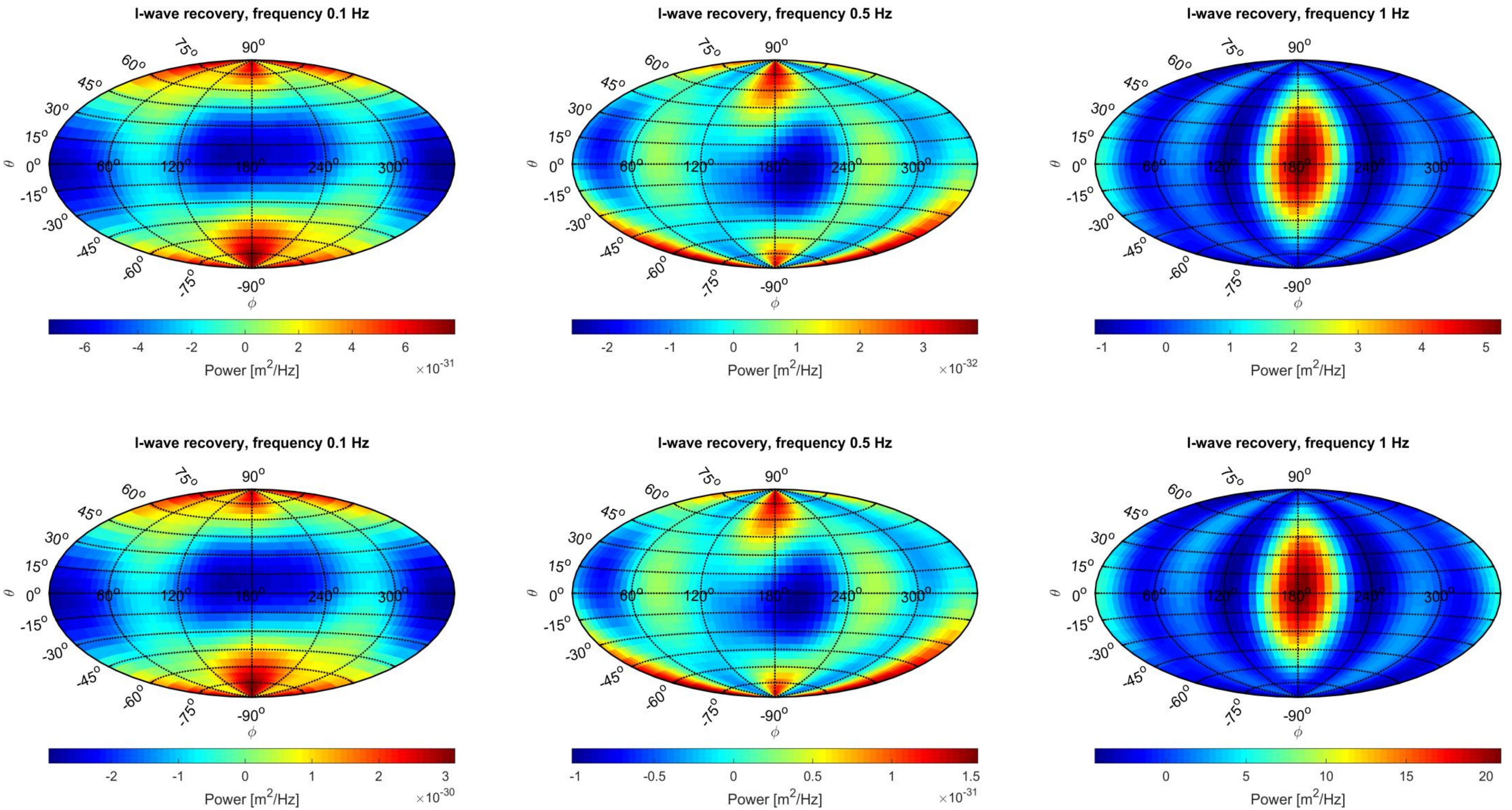
$f_{inj} = 0.1$ Hz (top), 0.5 Hz (bottom) ; $A = 3$ (top), 0.5 (bottom)



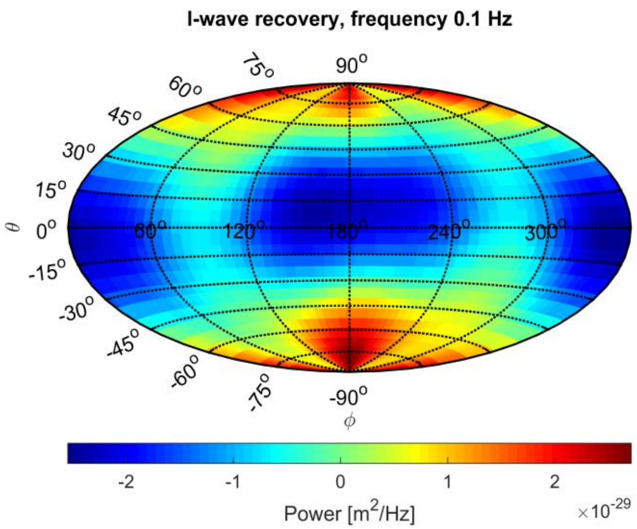
$f_{inj} = 0.5$ Hz; $A = 1$ (top), 3 (bottom)

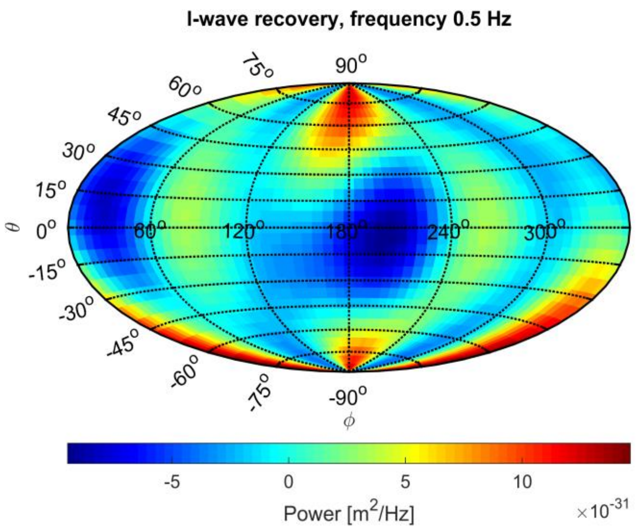


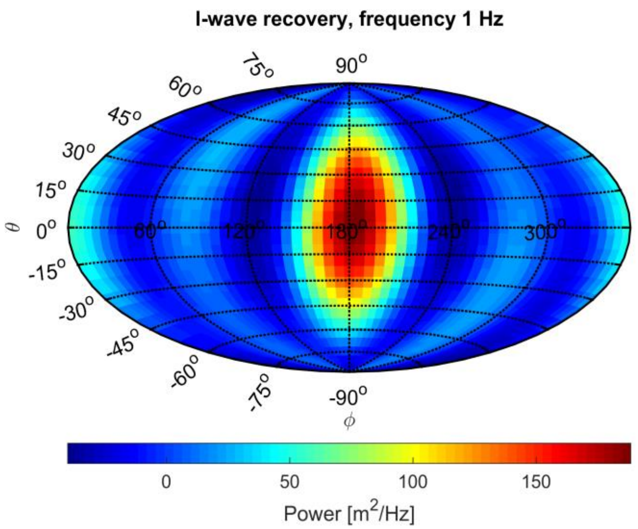
f_{inj} =1 Hz ; $A = 0.5$ (top), 1 (bottom)



$f_{inj} = 1$ Hz; $A = 3$







Clearly there is more data, but it is becoming a bit overwhelming (Uffda!) at this point, so I decided to leave it out. However, I do comment in Slide 9 on any trends, which includes the data not seen here.

Observations

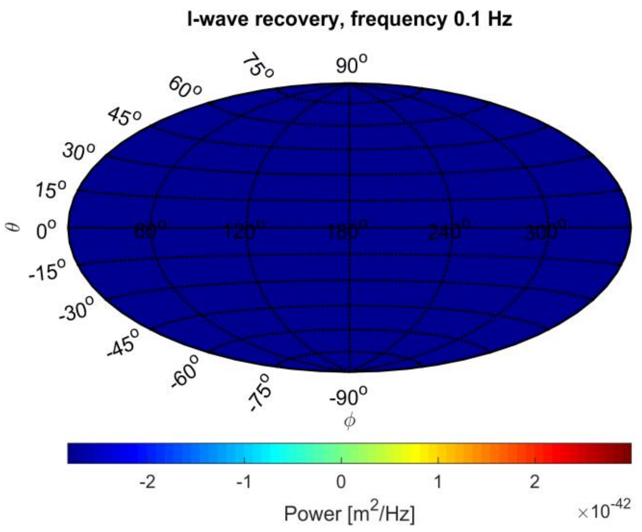
- Fix frequency, vary amplitude
  - There seems to be little to no structural variation among samples
  - In other words, any structures in a skymap for (A, f) = (0.5, 0.7) will be nearly identical to structures in a skymap with (A', f) = (3, 0.7)
    - Save for extremes—e.g. A = 1e-6—where plotting fails (cf. Slide 11 for example)
  - The magnitude of recovered power does not follow this trend
    - It follows as it should, i.e. $A^2 \simeq \frac{P_{tot}}{T_{obs}}$
- Fix amplitude, vary frequency
  - Clearly when $f_{inj} = f_{rec}$, the expected power and structure is seen
  - For $f_{inj} < f_{rec}$, structure is seen, but probably meaningless
  - There seems to be a 0.25 Hz window above f_{rec} where the skymap looks similar to that when $f_{inj} = f_{rec}$

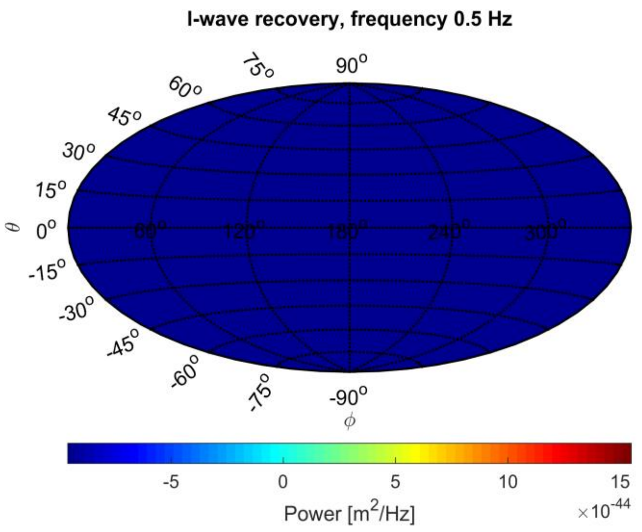
Appendix: Array

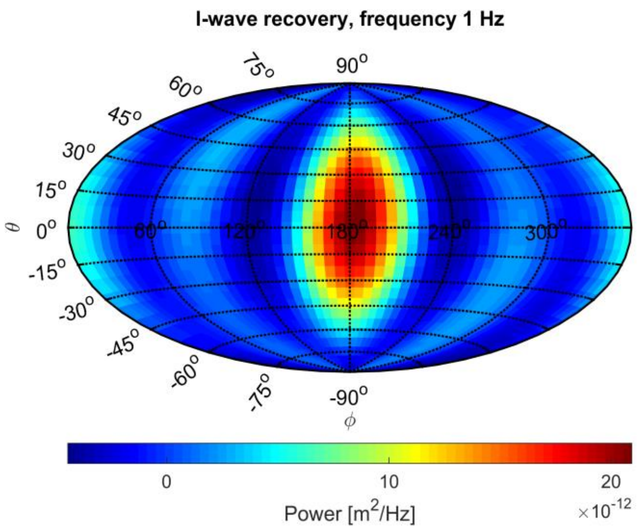
- Using randomly generated array of 8 seismometers—used in past simulations (to the right)
  - Format: columns represent [x y z] position of seismometer in meters

{[235.6 225.6 225.6],
[225.7 297.8 135.0],
[537.5 983.3 439.6],
[989.1 89.2 175.5],
[897.0 728.6 950.1],
[816.3 891.4 231.3],
[151.4 520.9 708.4],
[126.4 503.7 812.4]}

$f_{inj} = 1\ \mathrm{Hz};\ A = 1e-6$







Resources

- Matthew M. Haney and Victor C. Tsai. Nonperturbational surface-wave inversion: A Dix-type relation for surface waves. Geophysics, 80(6):EN167– EN177, 2015. URL doi:10.1190/geo2014-0612.1.