Filter Choices for Matched Filtering with Oasis Montaj and the USGS Extensions

How do you choose a magnetic dipole layer versus magnetic half space when designing matched filters in the USGS Oasis Montaj extensions, and why?

First, go back to the basic linear filtering equation for calculating a forward magnetic anomaly from a randomly magnetized layer with vertical magnetization:

$$F(\Delta T(x,y)) = F(M(x,y))*Cm*(\exp(-k*d)*(1-\exp(-k*t)) \qquad \text{(layer)}$$

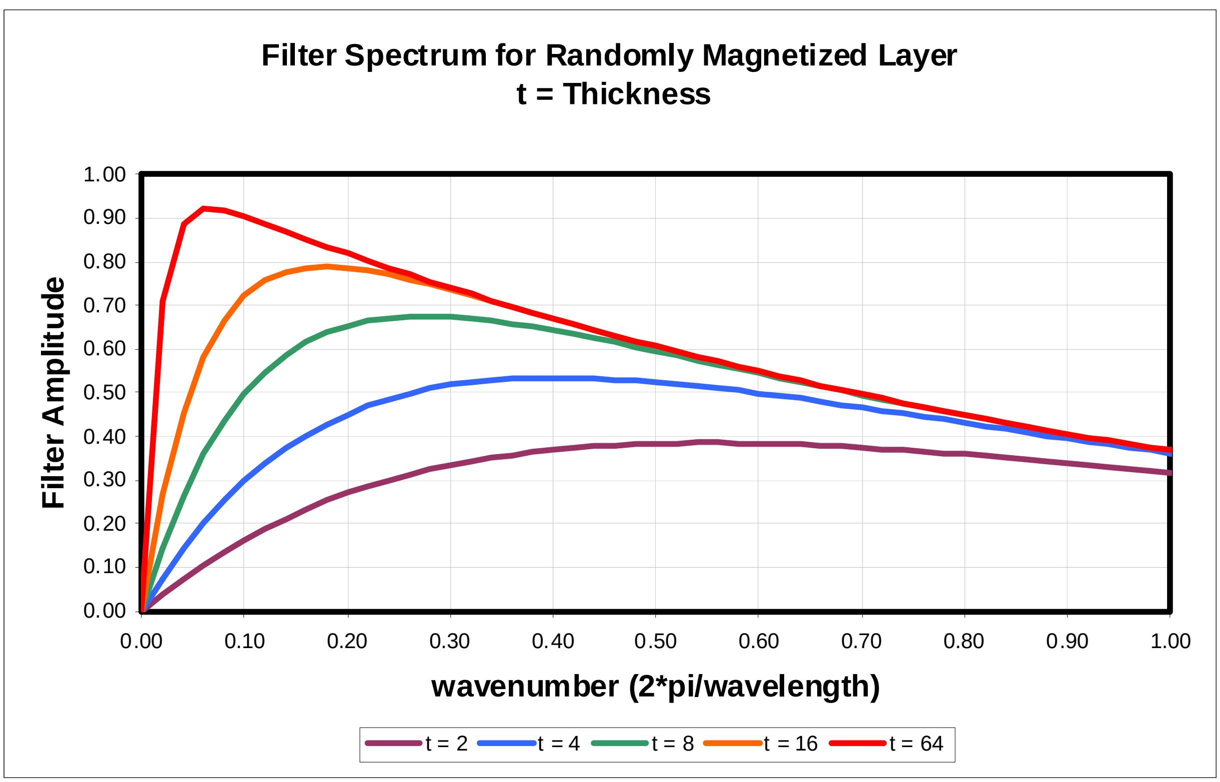
Now, let t increase to infinity to get a randomly magnetized half space

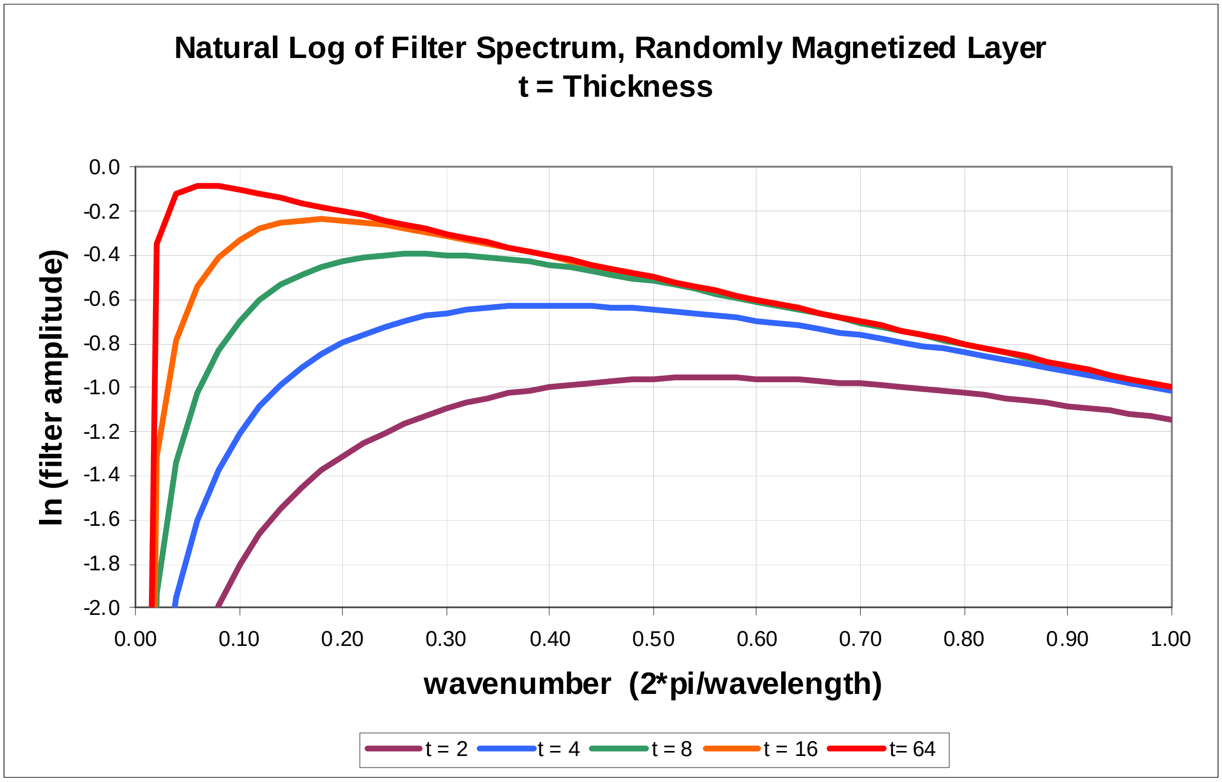
$$F(\Delta T(x,y)) = F(M(x,y))*Cm*\exp(-k*d) \qquad \text{(half space)}$$

Here:

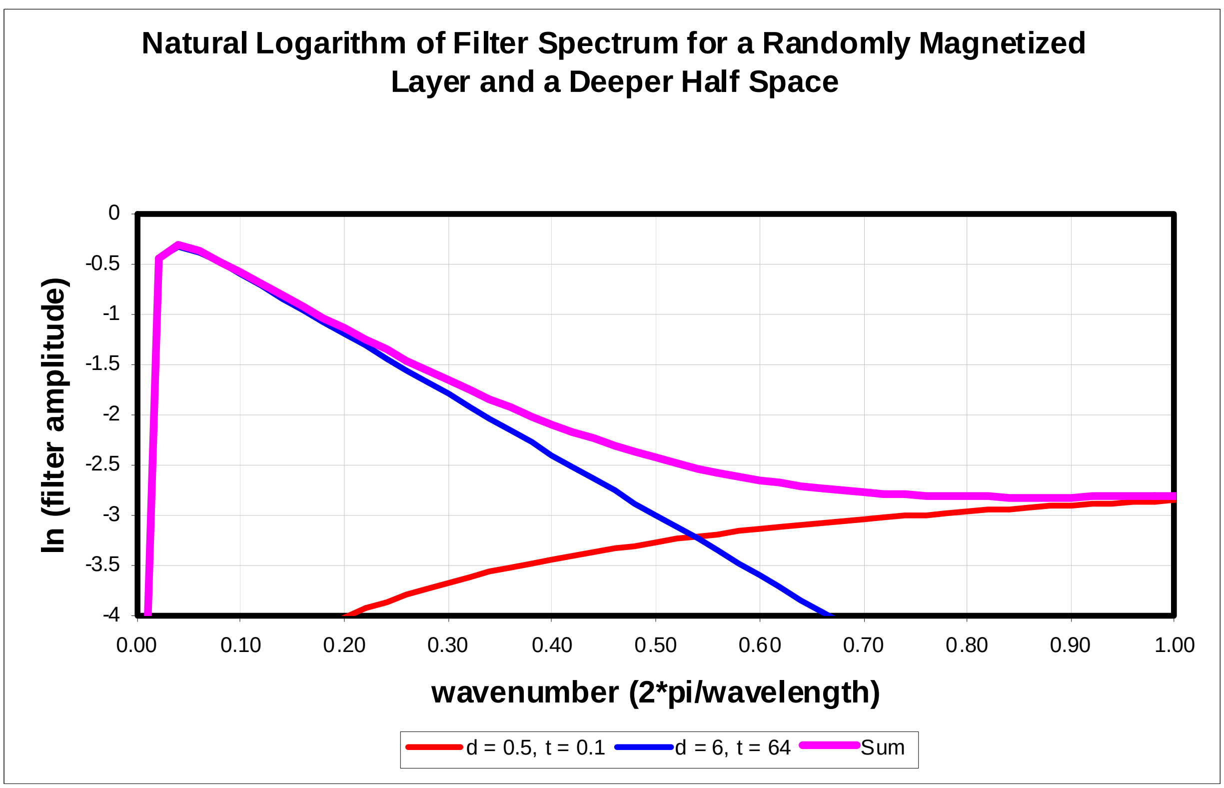
$F(\Delta T\ (x,y))$ = Fourier transform of the forward (modeled) result in 2D
F(M) = Fourier transform of the random distribution of susceptibility in the layer
Cm = constant (units, magnetic directions)
$k = \sqrt{kx^2 + ky^2}$, (kx, ky are wavenumbers (2* pi /wavelength) in the x & y directions)
d = depth to the top of the layer
t = thickness of the layer.

In this equation, when thickness (t) is close to depth (d), the natural logarithm of the radially averaged power spectrum of a thin magnetic dipole layer (code = 0) will be concave down at low wave numbers and linear at high wavenumbers. As the thickness increases, the concave down segment gets narrower and closer to the smallest wavenumbers. As thickness goes to infinity, and you are modeling a magnetic half space (code = 1), the natural log of the radially averaged power spectrum becomes linear at all wavenumbers.





Now, combine a thin shallow layer with a deeper half space:



So, when you select a layer versus half space you are fitting parameters to a different equation. A radially averaged spectrum produced by several equivalent source layers may have linear, concave up, and/or concave down segments.