# Preliminary Wavelet Analysis of LongEZ Flights from November 1998

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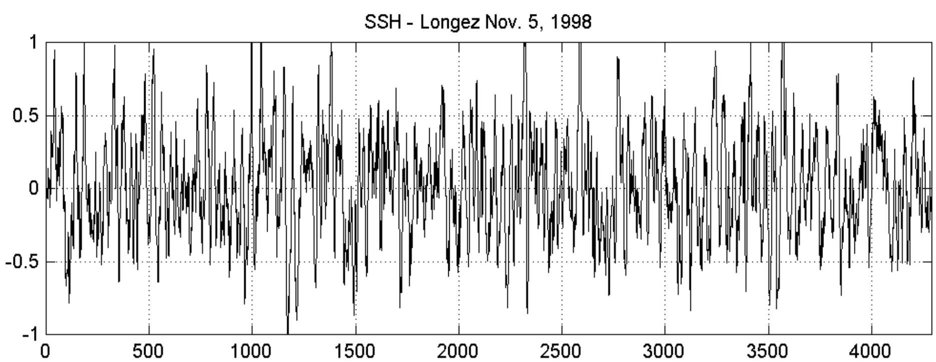
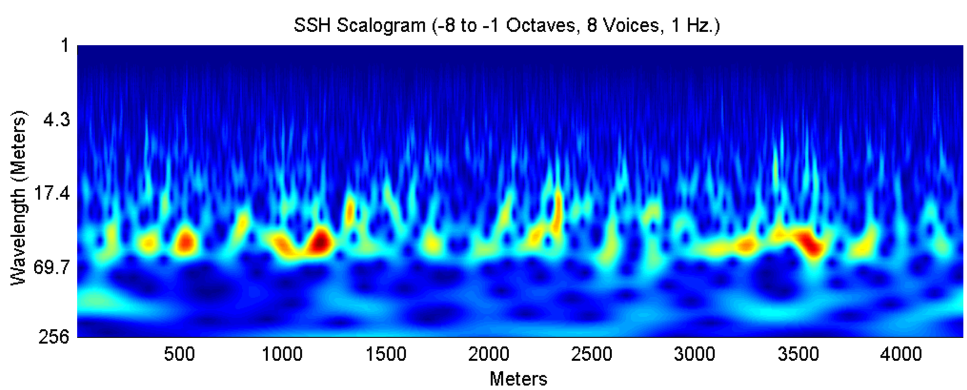
## 3/2/99



This report does a comparison between flights on November 2 and November 5, 1998 onboard the LongEZ out of Manteo, NC. Like the previous analysis, the continuous wavelet transform (CWT) was used using the Morlet wavelet.

In this study, wavelet analysis is used for 2 purposes. The first purpose is identification of geophysical wave packets on the sea surface. We found the squared modulus (magnitude) of wavelet coefficients provided these details with the scalogram (Figures 1, 2, 4, 5, 6, and 8).

On the November 5 flight, we can see dominant wave packets (wind driven waves) around the 45 meter wavelength (Figure 1). There was virtually no swell on this particular data segment. On November 2nd, there is a mix of both wind waves (32 meters) and swell (140 meters). For both days, the 'Scalogram Energy Distribution' is simply the mean across each scale of the scalogram.

Figure 2 shows a strong correlation between radar pointing angle and the radar/tilt correlation coefficient. As the aircraft pitches, the radar and tilt become less correlated. Figure 6 shows correlations, but in the opposite sense. For both these figures, tilt was calculated from the normal of 3 laser ranges.

Phase angle determination was our second purpose for wavelet analysis. Specifically, we use the real and imaginary components from our wavelet decomposition to computed phase angle from our SSH measurement. Phase angle is calculated by:

$$\theta(t) = \tan^{-1}\left(\frac{iw(t)}{w(t)}\right)$$

This phase angle is then used as an index into other recorded signals like radar return, normal laser tilt, and short wave slope from SSH. The top plot of Figure 3 shows a strong correlation between inverse radar return and phase angle. Tilt (middle plot) shows a correlation as well. The bottom plot shows that the slope calculated between Scalogram wavelengths from 11.3 to 6.7 meters indexed by phase angle is correlated. The correlation was found to be strongest between these wavelengths.

Figure 7 from November 2 also shows a strong correlation between inverse radar return and phase angle. However, tilt and SSH slope show no correlation. We speculate the swell present in this data set has something to do with this lack of correlation.

Figures 4 and 8 essentially show the same thing. They both verify that the wavelet coefficients found below the 2 meter level become white noise. This is due to the Nyquist sampling interval which states we must sample at twice the frequency level (at least) of interest in order to resolve that frequency without aliasing. Since our sample interval is 1 meter, we can then accurately resolve wavelengths of 2 meters or longer.

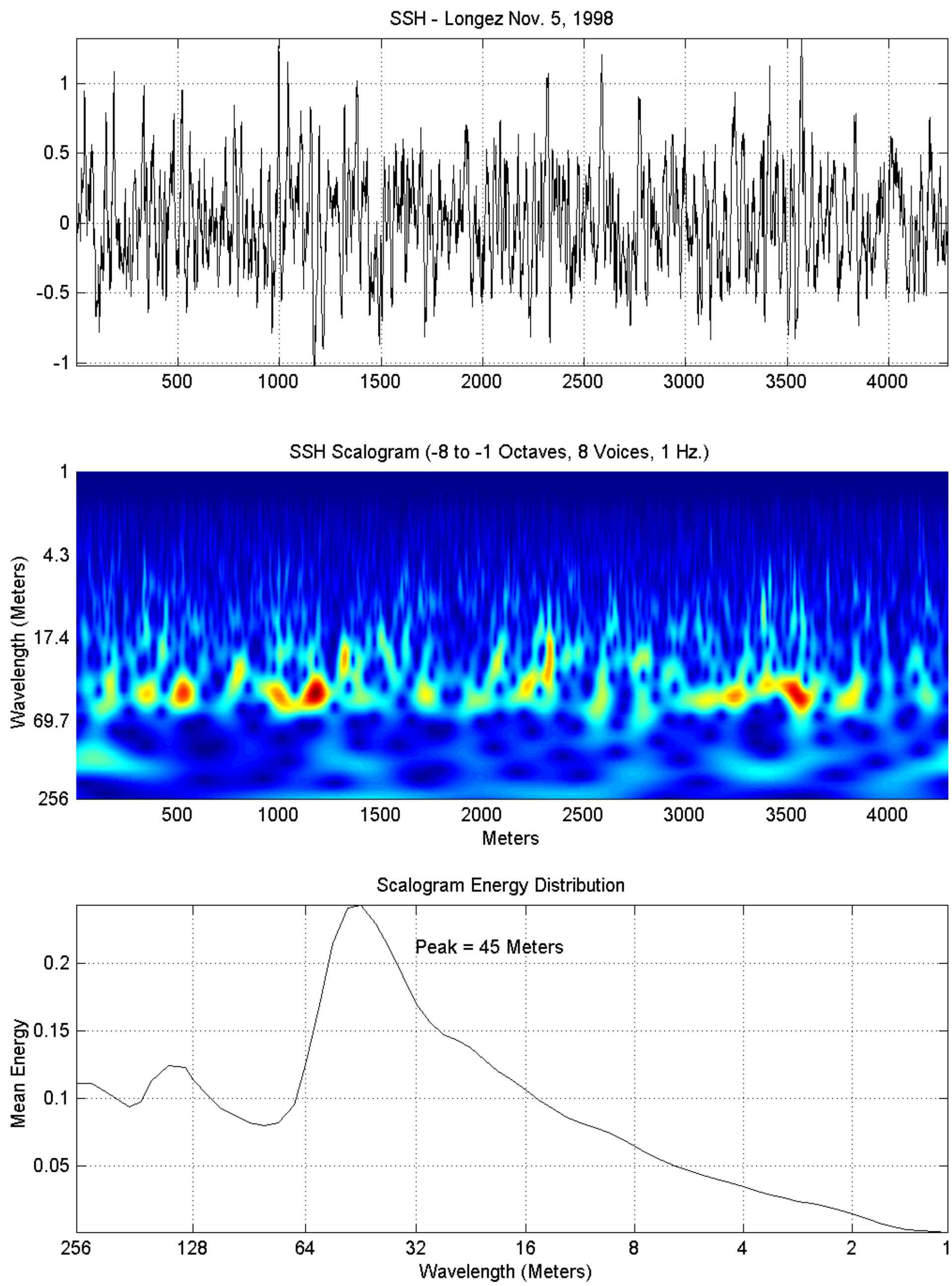



**Figure 1 - SSH vs. Scalogram vs. Energy Distribution**

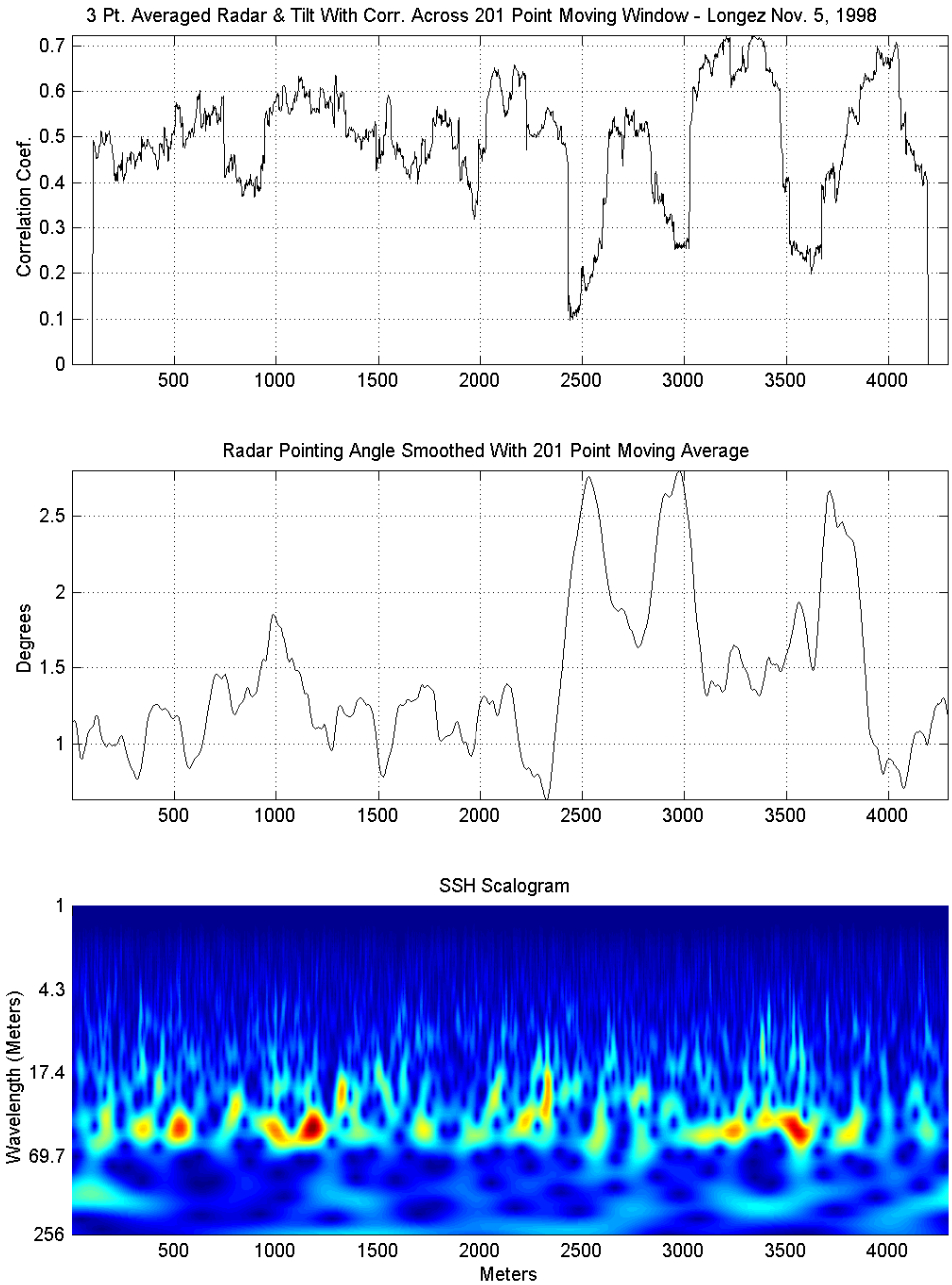



**Figure 2 - Correlation Coeff. vs. Radar Pointing Angle vs. Scalogram**

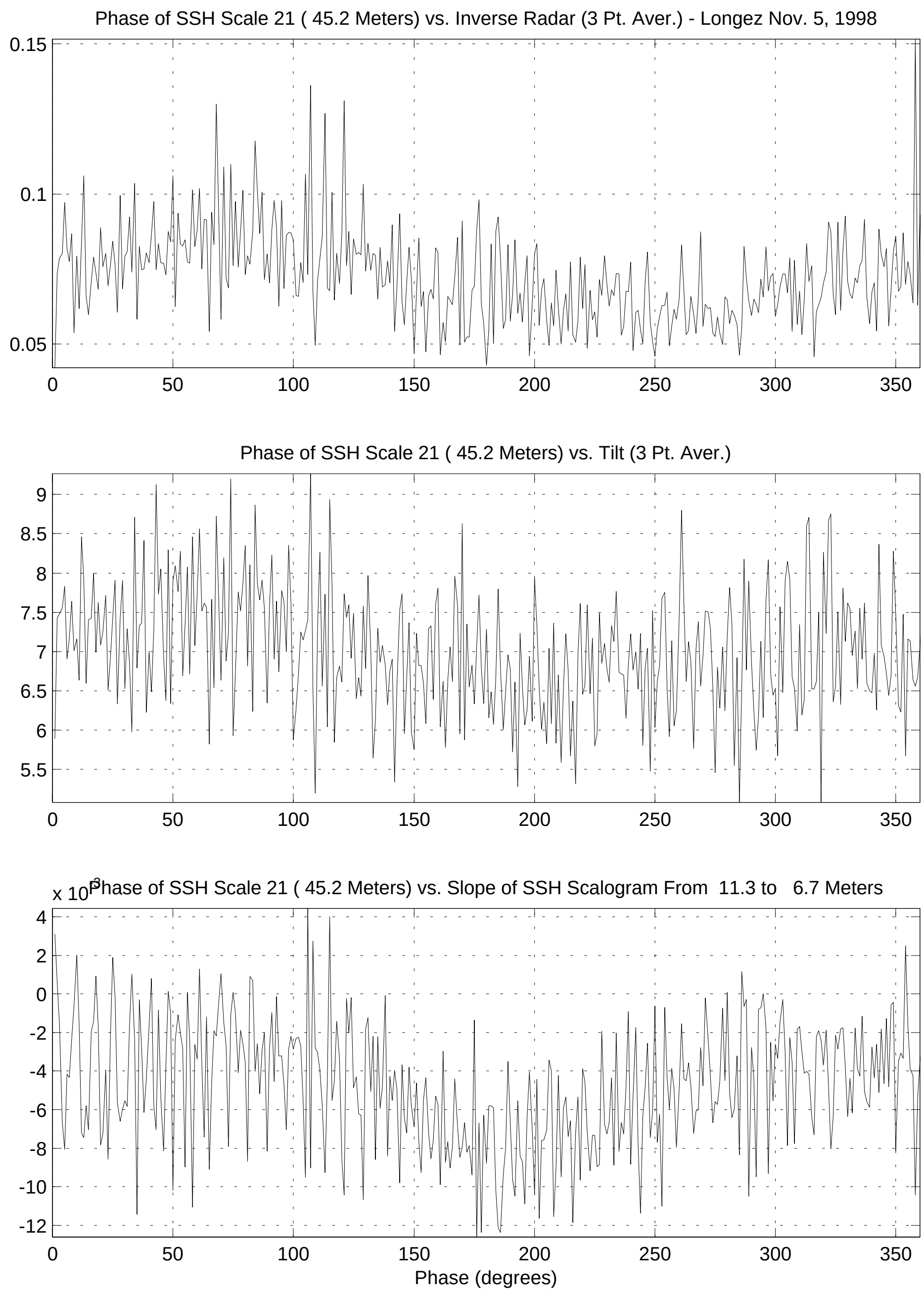



**Figure 3 - Phase Comparisons**

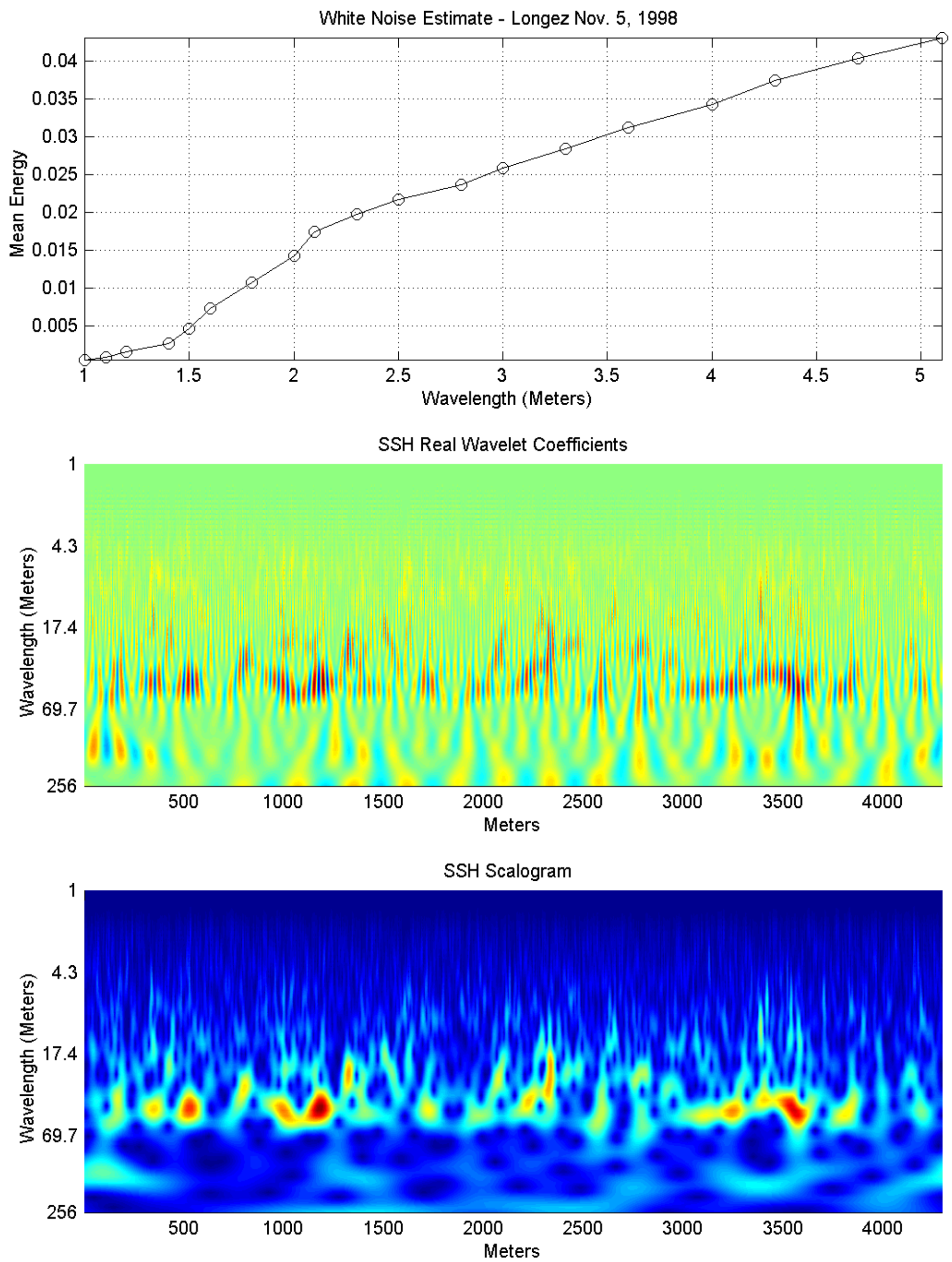



**Figure 4 - White Noise Estimate vs. Wavelet Real Coefficients vs. Scalogram**

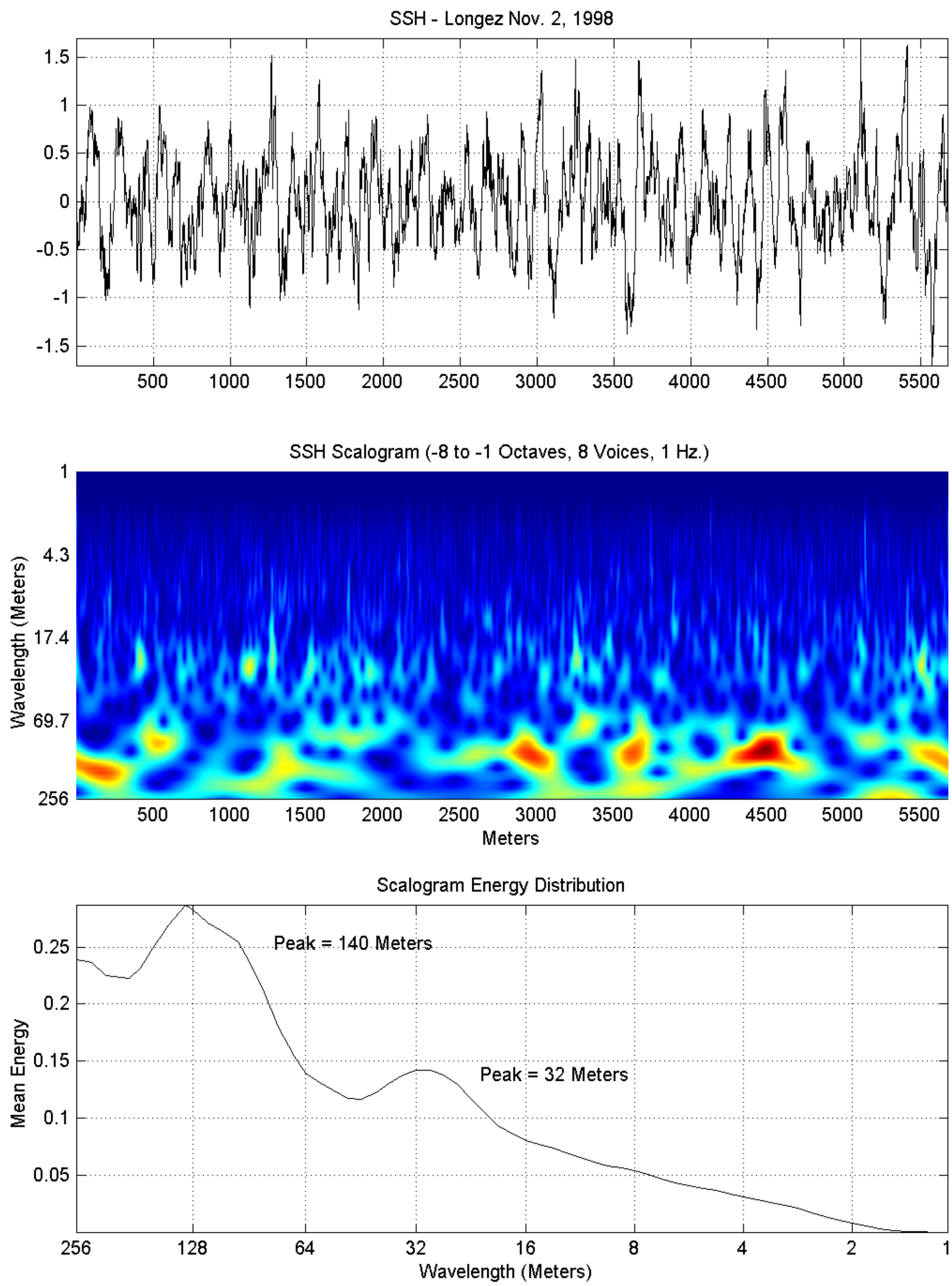



**Figure 5 - SSH vs. Scalogram vs. Energy Distribution**

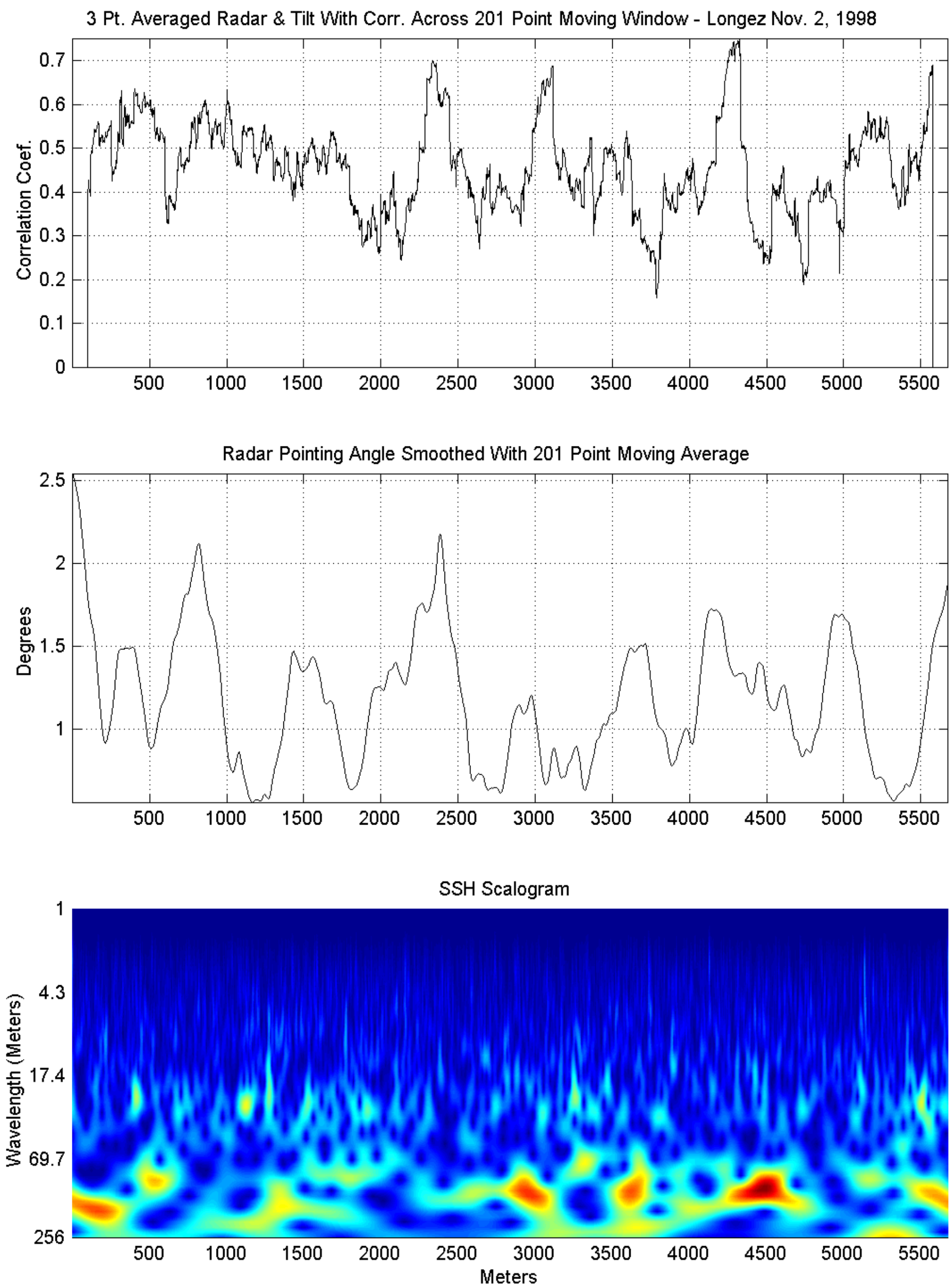



**Figure 6 - Correlation Coeff. vs. Radar Pointing Angle vs. Scalogram**

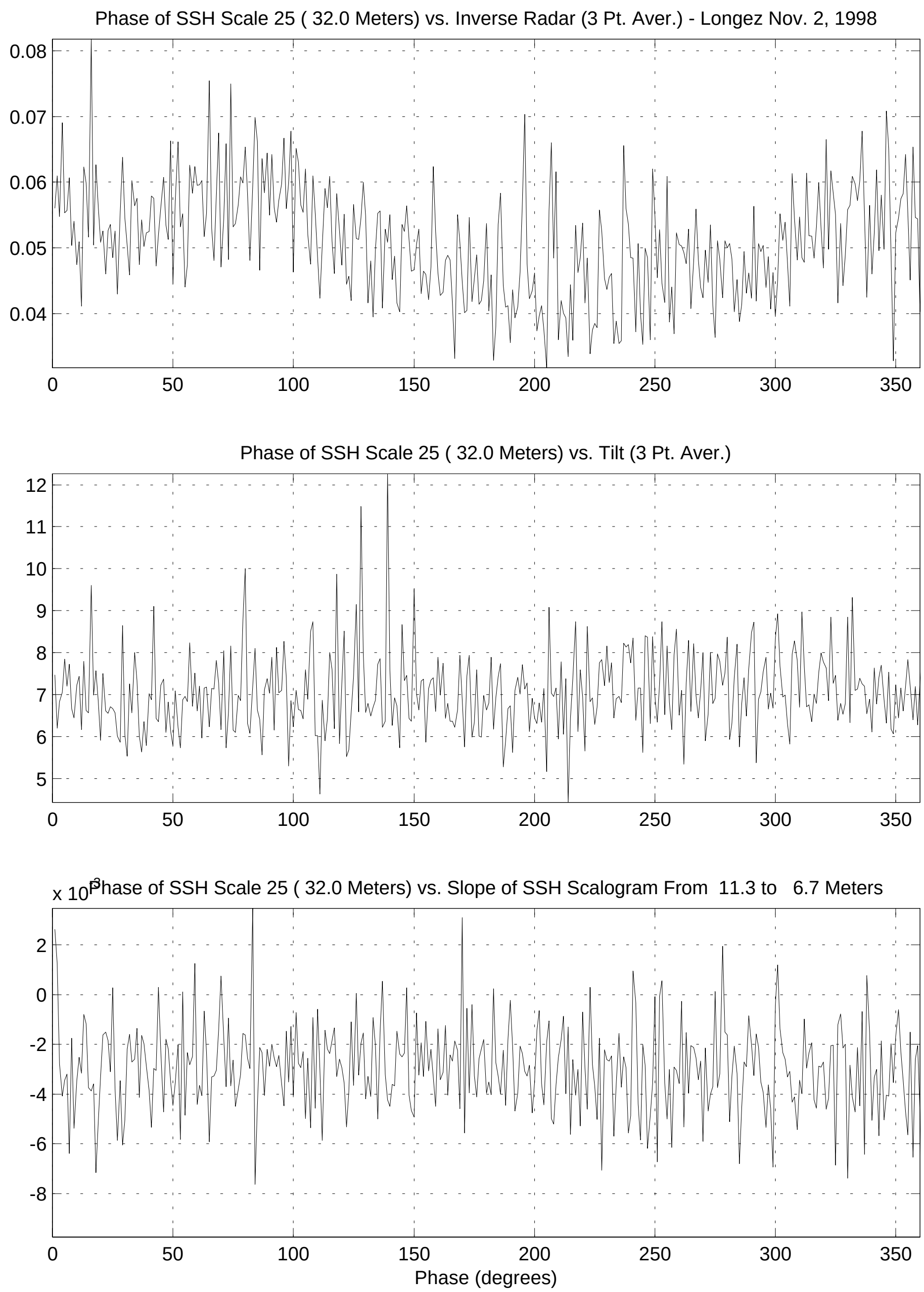



**Figure 7 - Phase Comparisons**

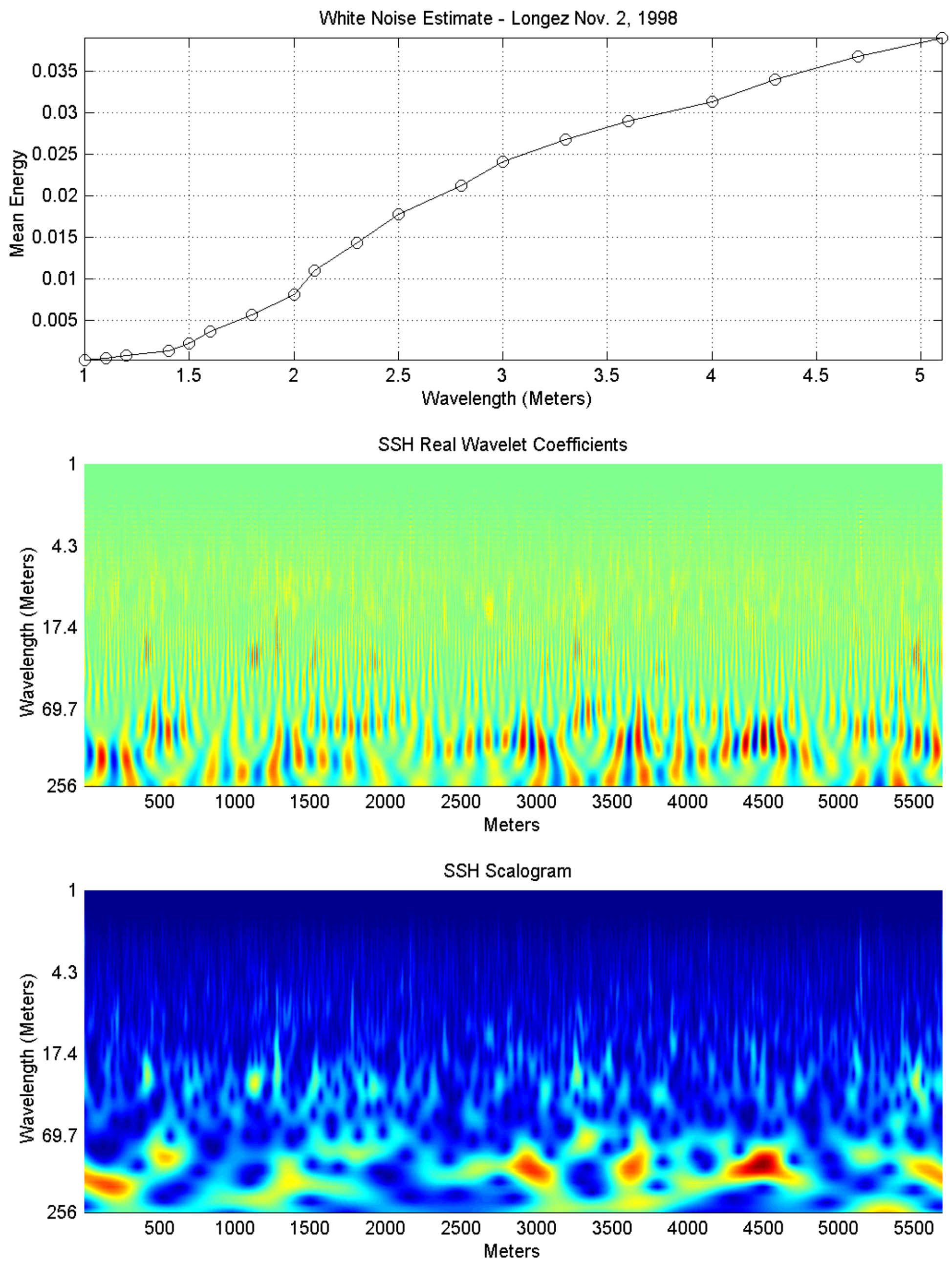



**Figure 8 - White Noise Estimate vs. Wavelet Real Coefficients vs. Scalogram**