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A Measured Energy Transformation Application (META) For Los Angeles Harbor, Site 10 Using A Statistical Relationship

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This discussion compares prototype and computed spectral results for gages located at Los Angeles Harbor, CA. Comparisons are made by examining the differences in the prototype and computed harbor total energy, E_t, very long period energy between 200 and 30 seconds, E_{200-30}, and energy spectrums. Spectral analysis allows the energy of the total wave record to be broken down into discrete frequency bands. Spectral results from an incident gage, LA5, located at Angels Gate and Los Angeles Site 10, A10, were used to calculate an energy transfer spectrum for A10.

Wave records were collected every 4 hours using subsurface pressure sensors. The sample rate for these sensors was 0.5 H_z and the burst length was 8096 seconds.

The analysis utilized the Welch, [1], spectral analysis method with 50% overlapping segments. Since the raw time series were obtained using sub-surface systems, a depth determined high frequency cutoff was applied. The averaged co-and quad-spectra from each analyzed record were used to calculate E_t, E_{200-30}, and energy spectrums.

To provide a direct comparison of incident and transferred energy, a transfer coefficient spectrum, S_x, was calculated by dividing the transferred energy at each frequency by the corresponding incident energy, eqn.1.

$$E_{xf} = \frac{E_{tf}}{E_{if}} \tag{1}$$

where E_{tf} is the energy per frequency transferred at A10 and E_{if} is the incident energy per frequency from LA5. For this simple analysis, concurrent records when the LA5 $E_{200-30}>$ 5.0 cm^2 were selected to compute S_x.

Plots of the yearly S_x spectrums for 1998 - 2002 are provided. See figures 1 thru 5.

An estimated energy spectrum, S_{est} at A10 was calculated for each incident spectrum, S_i, using equation, eqn.2.

$$S_{est} = S_x S_i \tag{2}$$

Figure 6 shows plots of prototype and estimated energy spectrums for A10 for February 11 & 12, 2000. It is interesting that the part of the spectrums below 0.05 H_z are similar. E_{200-30} and E_t where calculated from the S_{est} for each record. Figure 7 show simultaneous plots of E_t and E_{200-30} for the prototype and estimated results. The scatter plots at the bottom of the page contain the same information. The overall average % error for E_{200-30} was 30.0% and was 37.0% for E_t.

For more information, contact: James P. McKinney or William D. Corson, CEERD-HC-SO.

References

[1] P. D. Welch, "The Use of Fast Fourier Transform for the Estimation of Power Spectrum: A Method Based on Time Averaging Over Short, Modified Periodogams," *IEEE Transactions on Audio and Electroacoustics*, June 1967.

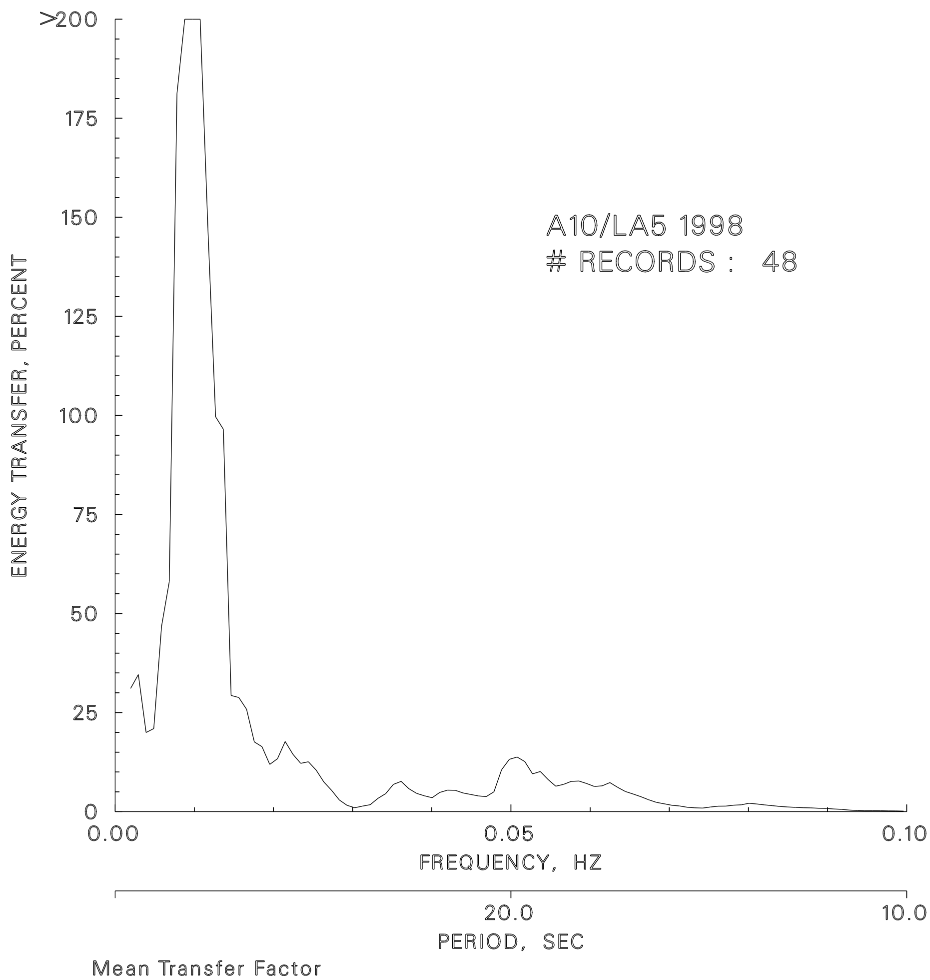

Figure 1: Average transfer spectrum, S_x, when incident E_{200-30}>5.0 cm^2 for 1998.

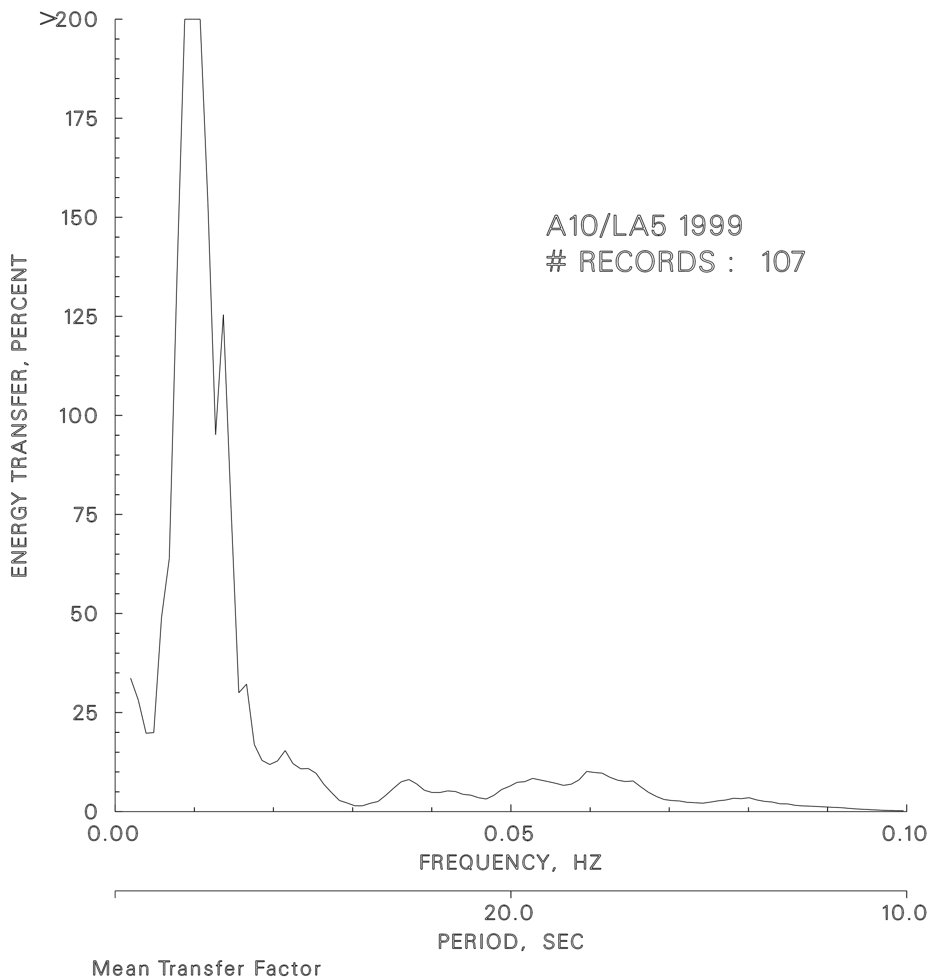

Figure 2: Average transfer spectrum, S_x, when incident E_{200-30}>5.0 cm^2 for 1999.

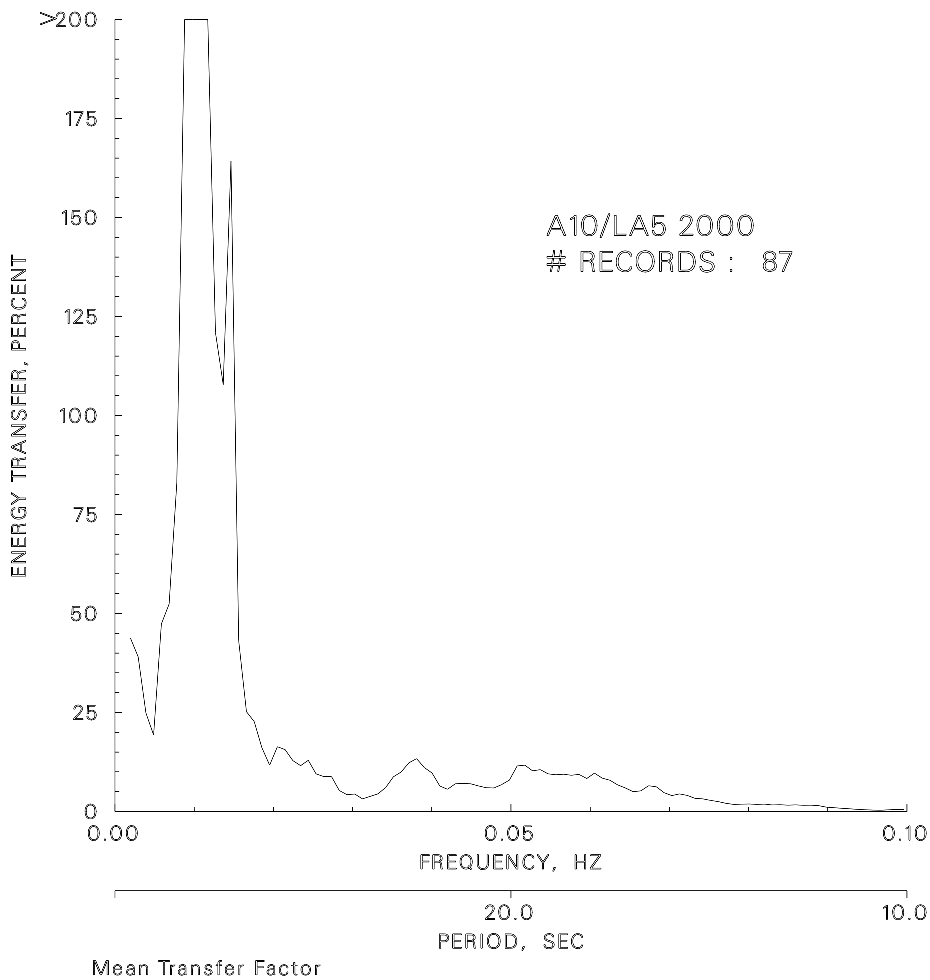

Figure 3: Average transfer spectrum, S_x, when incident E_{200-30}>5.0 cm^2 for 2000.

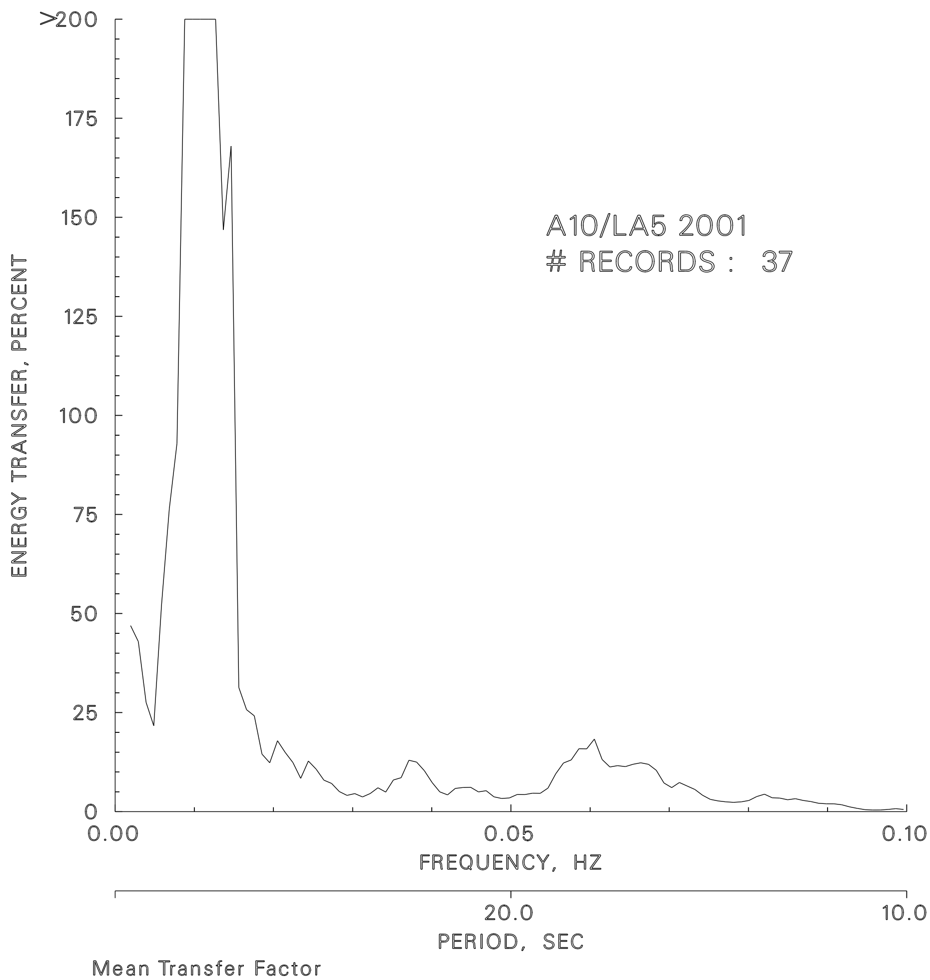

Figure 4: Average transfer spectrum, S_x, when incident E_{200-30}>5.0 cm^2 for 2001.

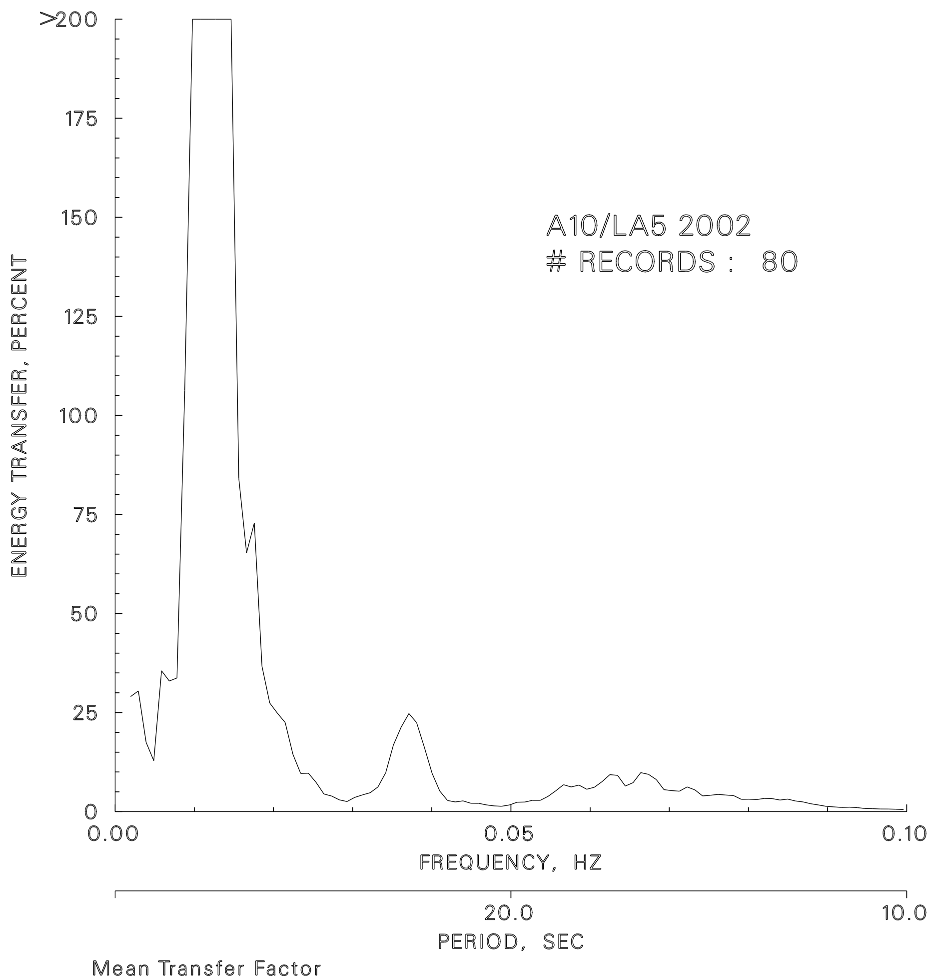

Figure 5: Average transfer spectrum, S_x, when incident E_{200-30}>5.0 cm^2 for 2002.

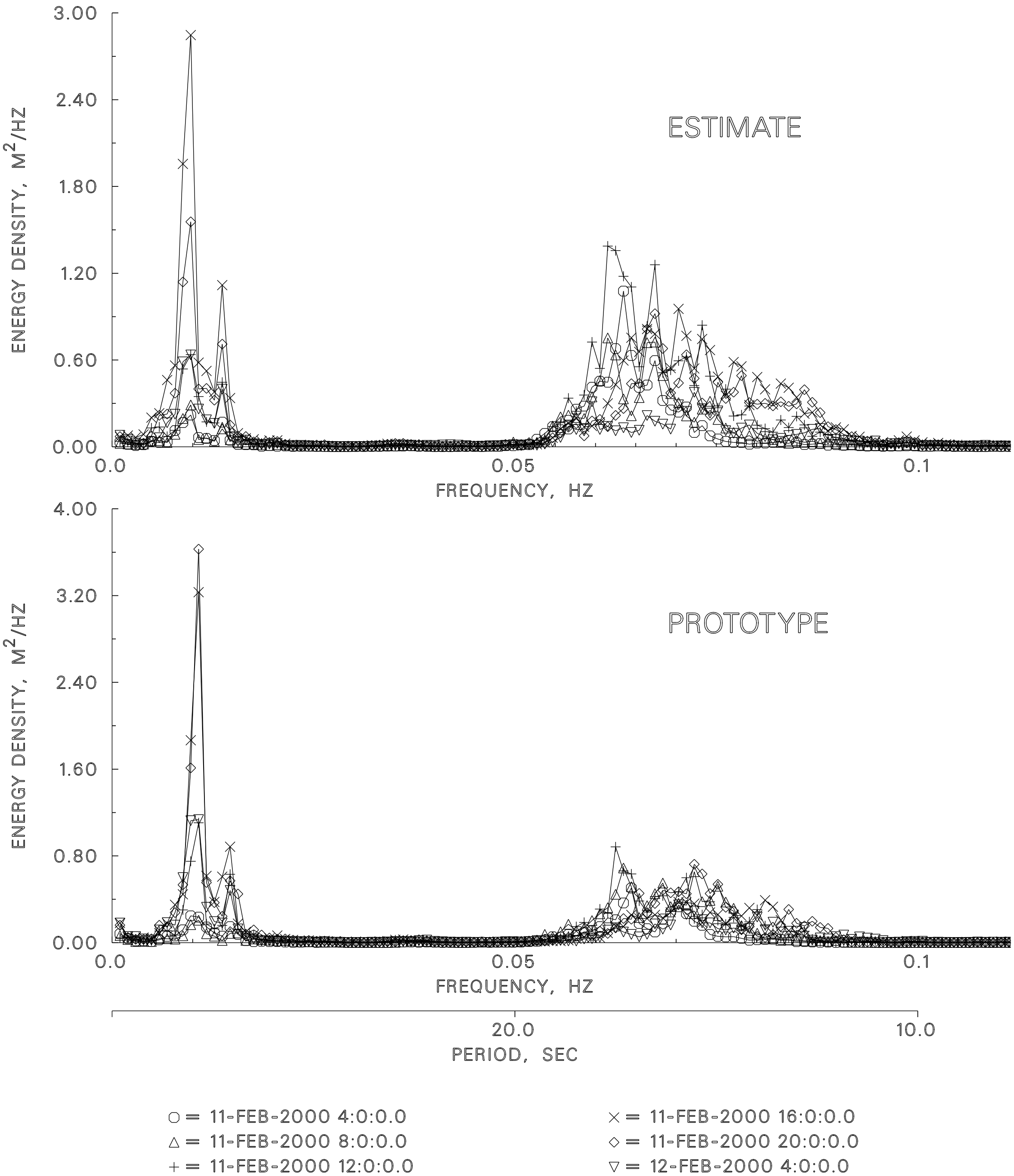

Figure 6: Prototype and estimated energy spectrums for May 11 & 12, 2000. Long period energies are similar.

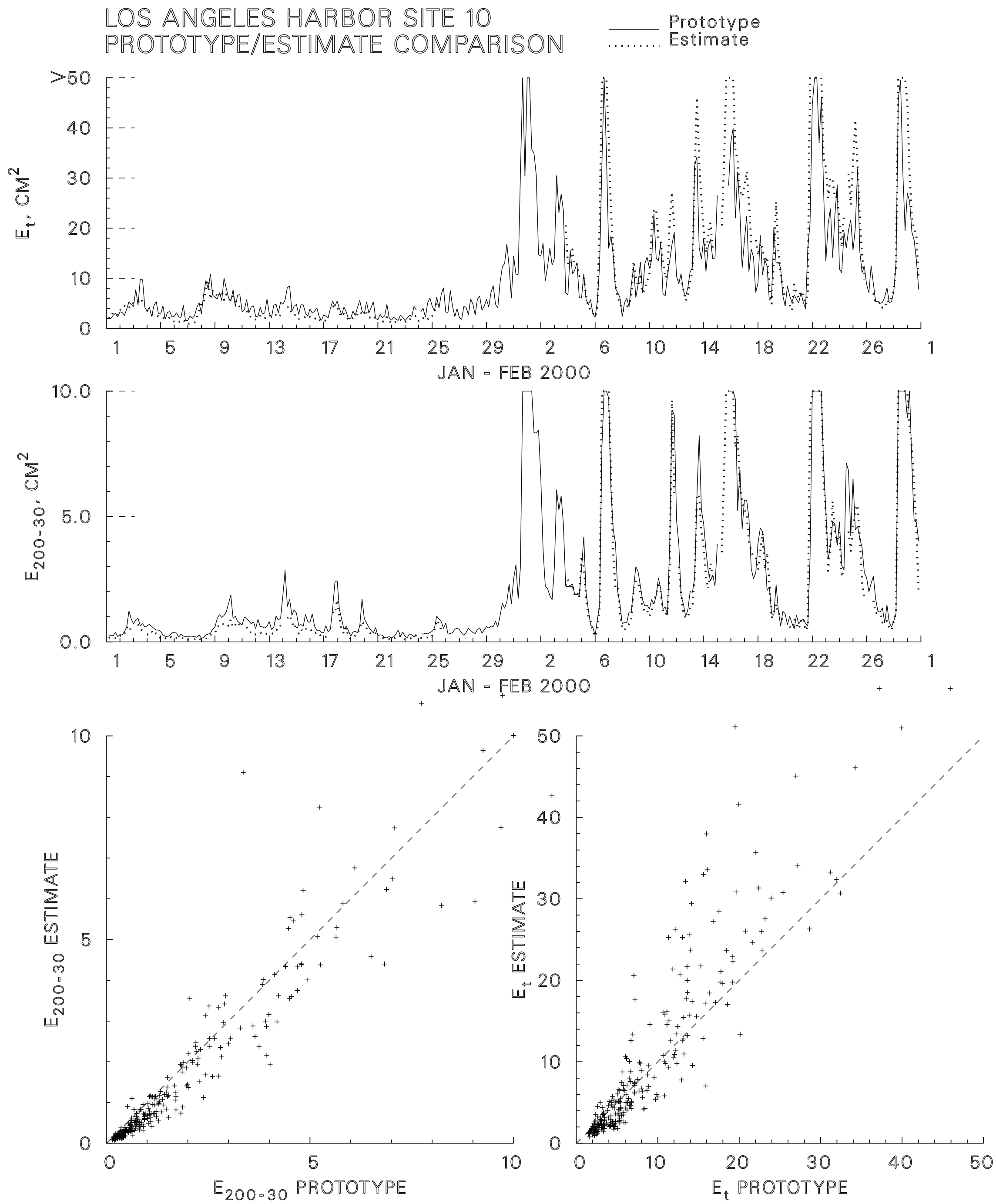

Figure 7: Prototype and estimated total energy, E_t, and very long period energy, E_{200-30}.