

Coastal Margins Kachemak Bay Stream Characterization Using Fourier Analysis

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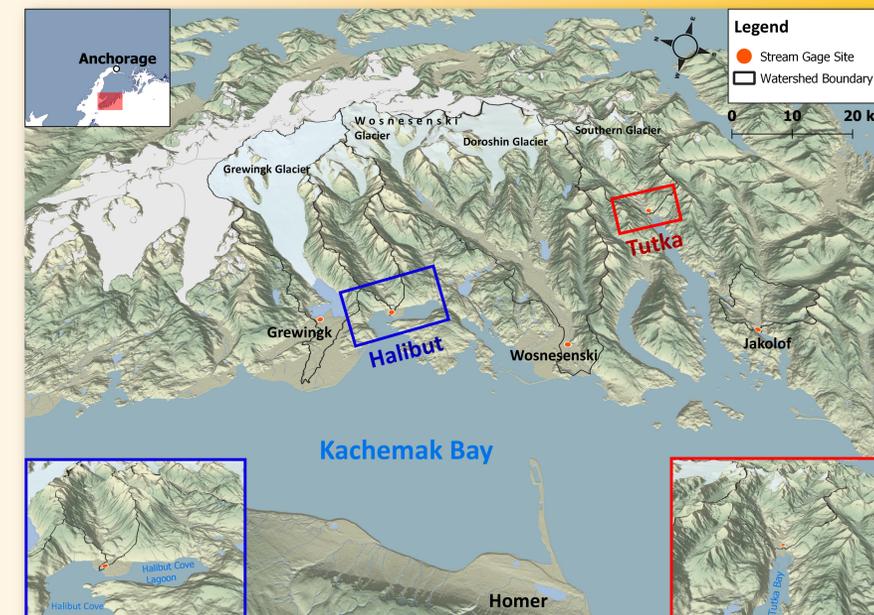


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Introduction: The goal of this research is to characterize streams within the Coastal Margins component of EPSCoR "Fire and Ice" project to define the physical framework for interpreting chemical and water flux data. This work is done by analyzing 1) stream level, and 2) stream water specific conductivity as a function of time (season). Application of the Fourier Analysis method compares the stream level and specific conductivity in the time domain and calculates the correlation resulting in a detailed representation of these two important stream water variables. The discrete time values for each characteristic are transformed to the frequency domain which establishes frequency-dependent hydrologic and oceanographic events.

Methods

- Two stream locations were chosen based on their relative amount of glacial coverage in their respective watersheds to compare and contrast watershed types (Halibut and Tutka Streams).
- Continuous-time sensor data was collected.
- Analyze the time domain data for stream level and conductivity to calculate the correlation.
- Calculate the Fourier transform for stream level and conductivity at each stream.
- Compare the frequency-domain values for both variables at each stream.
- Interpret the results in a hydrogeologic and oceanographic context.



Tutka Stream - 8% glaciated watershed

Stream level, SC, T, pH logged continuously at stream gage site. Water level and SC data presented below. Long term seasonal trends influenced by groundwater, precipitation, and amount of glacial melt are evident.

Precipitation data recorded at Kasitsna Bay Lab and reported as daily values below.

Fourier transform reveals significant hydrologic events that respond to climatic and watershed variables.

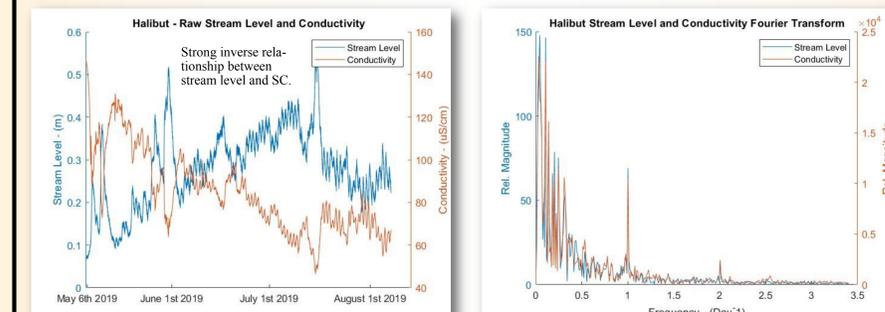
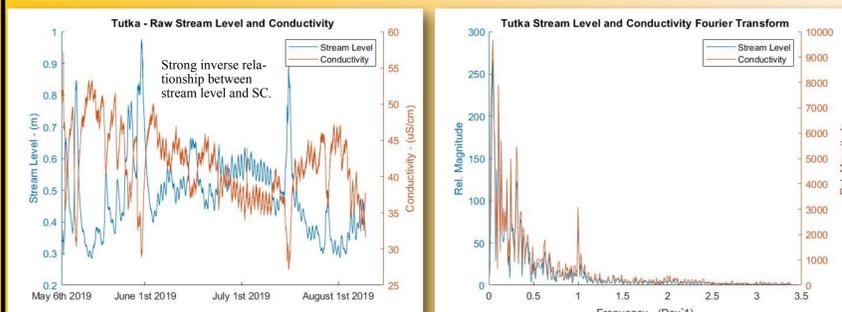
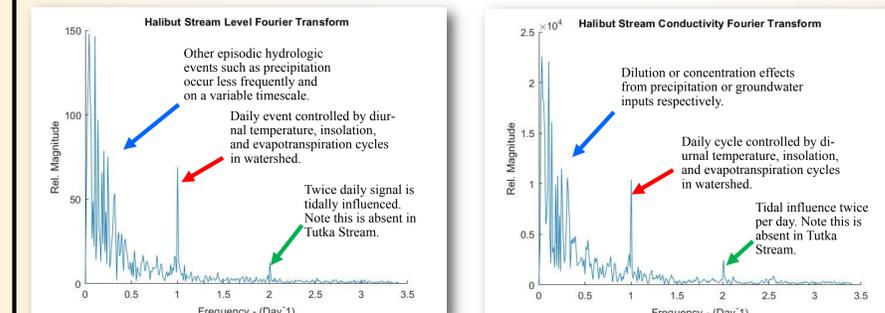
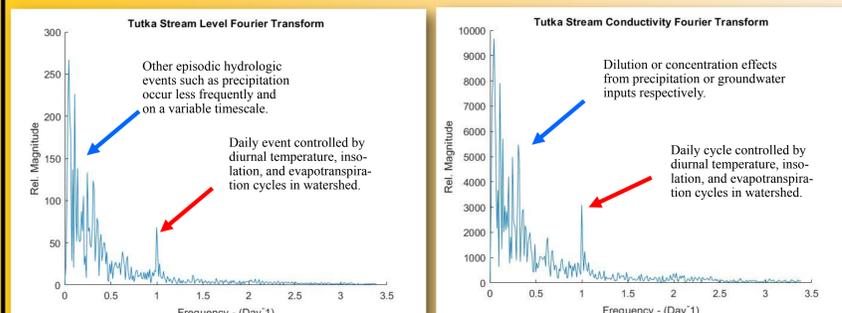
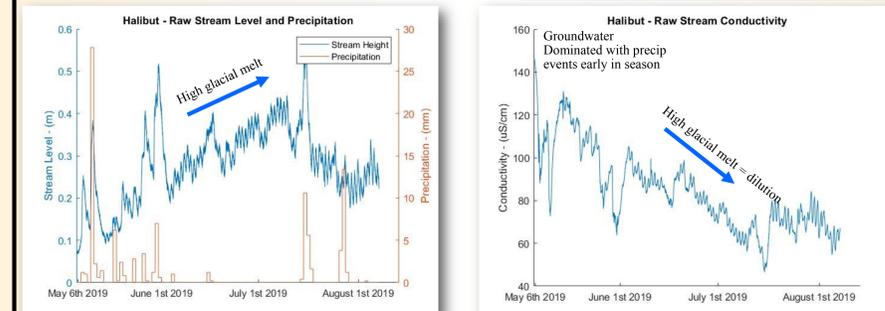
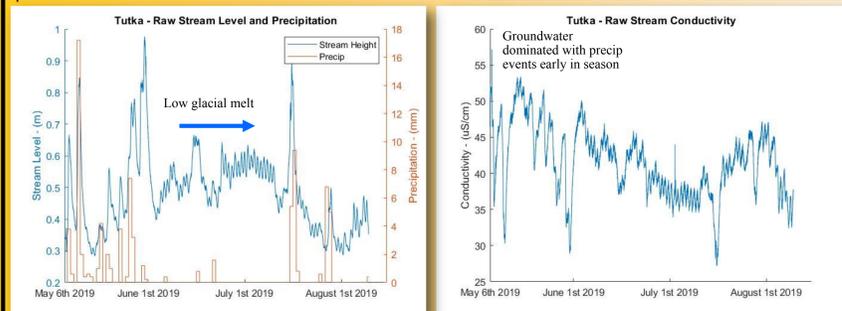


Halibut Stream - 16% glaciated watershed

Stream level, SC, and T recorded continuously at stream gage site. Water level and SC presented below. Long term seasonal trends influenced by groundwater, precipitation and amount of glacial melt are evident.

Precipitation data recorded at Grewingk Lake site and reported as daily values below.

Fourier transform reveals significant hydrologic events that respond to climatic and watershed variables.



Location map for the Coastal Margins Kachemak Bay stream sampling sites highlighting the Halibut and Tutka areas.

Analysis and Summary

Stream:	Correlation:
Tutka	-0.9345
Halibut	-0.9126

Correlation (Time-Domain)

Cross correlation is the measure of similarity between two signals. The value calculated falls between -1 and +1, with -1 representing an inverse correlation, +1 representing correlation, and 0 representing no correlation. For this project, the correlation is calculated between the time-domain values for stream level and the specific conductivity at each stream. In both cases there is a strong negative correlation between stream level and conductivity which is expected because higher stream levels indicate dilution of solutes in the stream.

Fourier (Frequency-Domain)

A Fourier transform is the decomposition of a time-dependent signal into its constituent frequency values. Plotting the Fourier transform of a signal allows you to see the major frequency components that make up the signal. The large/pronounced spikes on the plots represent the frequency of major (measurable) hydrologic and oceanographic events that occur as indicated on each graph.

At both stream sites there is a noticeable spike at a frequency of once per day which is controlled by climatic factors and evapotranspiration in the watershed on a daily cycle. A pronounced twice per day signal is apparent in the Halibut watershed as compared to the Tutka watershed which is controlled by the tidal cycle. The configuration of each watershed and the placement of the stream gages in terms of distance from the ocean explains why the tidal cycle is prevalent at Halibut and not at Tutka. (see map). This signal is being analyzed further for hydrogeologic context.

The less than once per day frequency components are attributed to events such as precipitation that occur episodically and on variable timescales.

References

Rantz, R.E., et al., 1982. Measurement and computation of stream flow vol. 1 and 2. Geological Water

Acknowledgements

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