The climatology of seiche-inducing winds in a large intermontane lake: Quesnel Lake, British Columbia

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Plato Point data collection, Quesnel Lake. Courtesy of J. Morris, UNBC.

Introduction

A morphometrically complex basin nestled into the eastern flank of the Cariboo Mountains (Fig. 1), Quesnel Lake provides habitat for salmon, trout, and an abundance of invertebrate species.

A large driver of physical processes in the lake is the flux of turbulent kinetic energy from wind at the lake surface. This wind forcing can induce deflections (with resultant oscillations) of the thermocline when the lake is thermally stratified (Fig. 2). However, the seasonal nature of this forcing (and the subsequent seiching) is poorly understood.

Figure 1. Quesnel Lake and select CAMnet meteorological station locations. Also indicated is the direction to Williams Lake. **Inset:** Quesnel Lake's location within British Columbia, Canada.

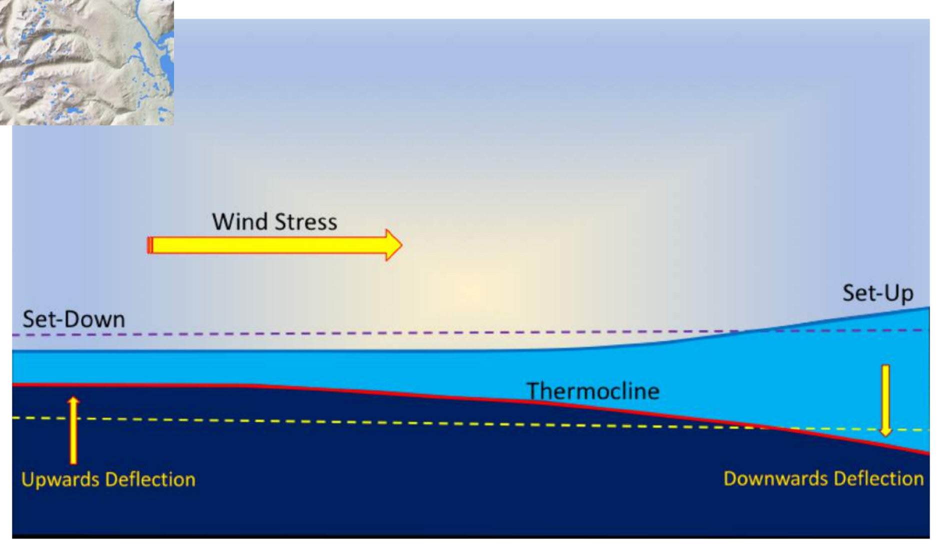

Figure 2. Surface set-up and the deflection of a lake's thermocline by wind stress at the surface. The resulting baroclinic wave of the thermocline is also known as an internal seiche.

Surface Meteorological Data

The Northern Hydrometeorology Group's Cariboo Alpine Mesonet (CAMnet) array of meteorological stations provided a ten year data record (2007 – 2017) of data from Browntop Mountain (2033 m.a.s.l) station, and 21 months (August 2016 – May 2018) from Plato Point (728 m.a.s.l) (both in 15 min intervals) (Fig. 1).

A longer timeseries of hourly wind and barometric pressure data to construct a 'climatology' (30 years, 1987 – 2017) was obtained from Environment and Climate Change Canada's station at Williams Lake airport, 90 km southwest of Quesnel Lake.

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Wind Seasons

The scale parameter (C), of the Weibull distribution (see Fig. 3), was shown to be strongly correlated between wind speed datasets, and with mean station barometric pressure.

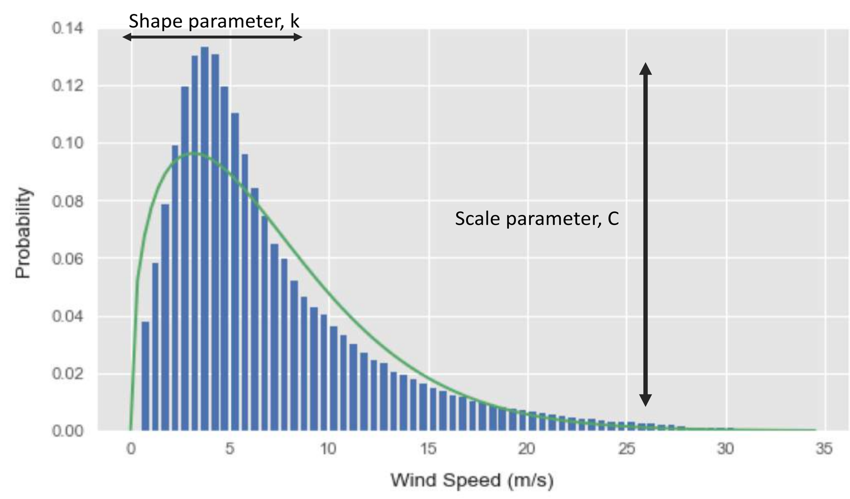

Figure 3. The distribution of mean 15 minute wind speeds from Browntop Mountain (2007 – 2017). The ideal Weibull distribution for the dataset is plotted in green.

We define the 'wind seasons' by periods either above or below the mean annual C value (represented by 1.0 in Fig. 4). However, we also included the distinct signal observed during winter (compared to fall and spring)

This resulted in four self-defining seasons being identified using the scale parameter (Fig. 4).

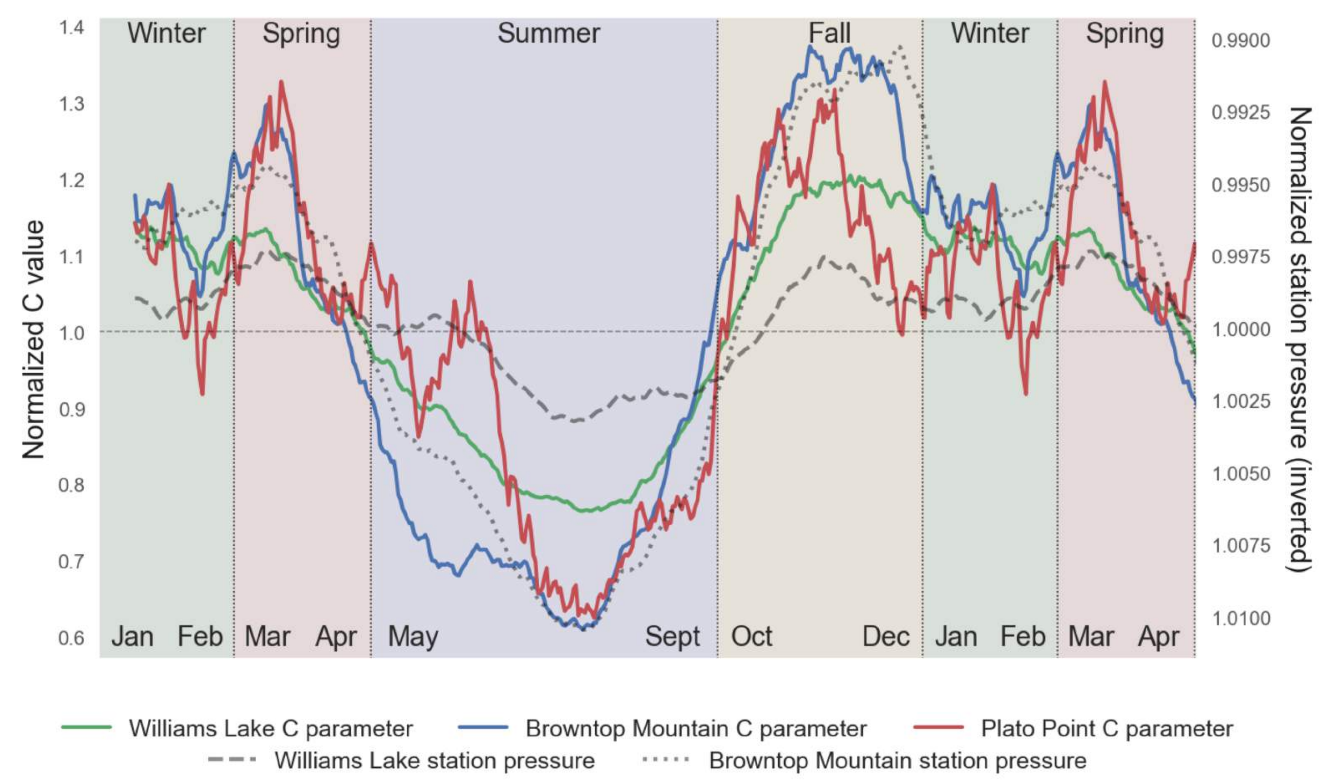

Figure 4. 30-day running-mean of day-of-year C values (normalized by each dataset's mean annual C value), are plotted for three wind speed datasets from the Quesnel Lake region. Also shown is the correlation with pressure from two of the three stations (also a 30-day running-mean). Higher/lower C values indicate higher/lower wind speeds.

NSERC CRSNG

QRRC Quesnel River Research Centre

Environment and Climate Change Canada / Environnement et Changement climatique Canada

Synoptic Climatology

Seasonal composites of mean sea level pressure (MSLP) from monthly North American Regional Reanalysis data (1987 – 2017) highlight the dominance of the Aleutian low in the Gulf of Alaska during the windiest seasons, fall and spring (Fig. 5).

Winter sees the westward migration of the center of the low. Summertime features a broad ridge extending northeast from the semi-permanent Pacific high.

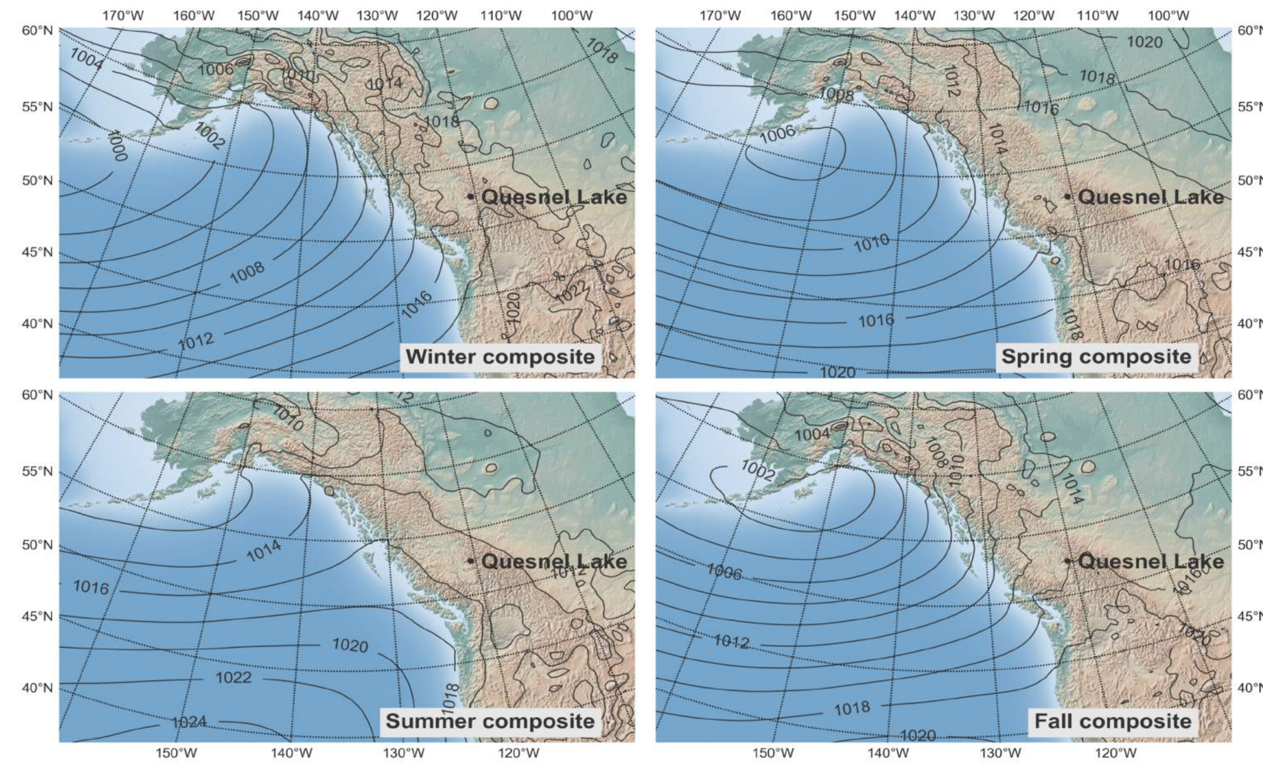

Figure 5. Synoptic climatology (MSLP) composites organized by wind season

Strong-Wind Episodes

The largest cluster (53%) of strong wind episodes (defined by taking the 95th percentile of mean daily wind speeds at Plato Point) were easterly winds during fall. Figure 6. shows the strong east-to-west pressure gradient caused by low pressure systems tracking towards the coast of British Columbia.

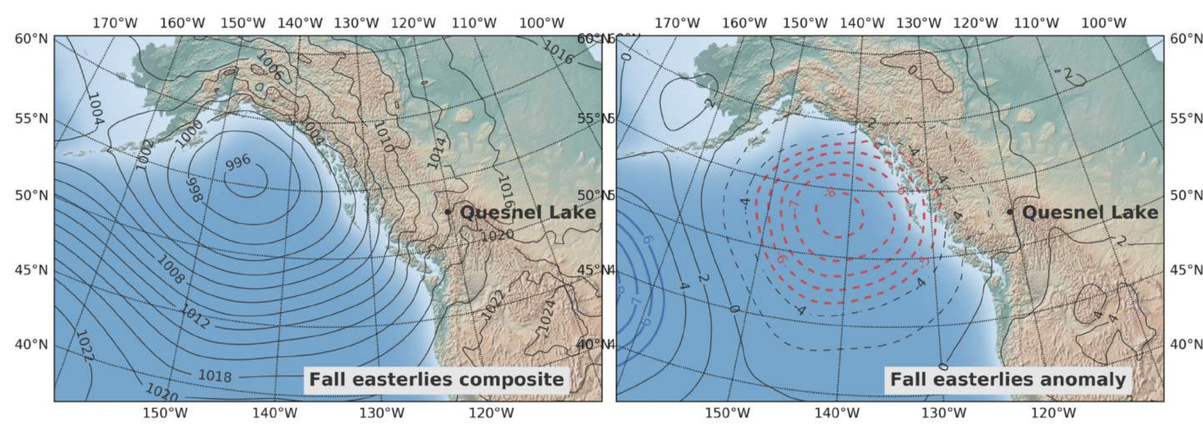

Figure 6. The synoptic composite and anomaly that results in strong easterly winds during fall at Quesnel Lake. Red/blue contours represent regions of lower/higher MSLP greater than two standard deviations from the mean.

Conclusions and Future Work

- Seasonality of winds can be identified by changes in wind speed distributions.
- Wind seasons at Quesnel Lake are strongly influenced by the synoptic MSLP pattern for each season. This could in-turn influence seiche timing.
- Easterly winds (aligned with the lake's main basin) in fall comprise the largest cluster of strong wind episodes observed at lake-level.
- Investigations continue into the synoptic forcing for other notable wind episodes observed during the year at Quesnel Lake – with the potential to use longer timeseries' from other CAMnet stations.