Vita

Candidate's name: Emanuel de Gante Carrillo

Universities Attended:

Tecnologico de Monterrey (2011)
Bachelors of Science in Engineering

University of Southern California (2019)
Masters of Science

University of New Brunswick (2025)
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Earth Science

Presentations:

de Gante Carrillo, E., Butler, K. E., MacQuarrie, K.T.B., 2022, Time Series Analysis for Temperature Anomaly Detection at Mactaquac Dam, *2022 GAC-MAC-IAHCNC-CSPG Joint Meeting*, Geological Association of Canada, Halifax, Canada.

de Gante Carrillo. E., Butler, K. E., MacQuarrie, K.T.B., 2025, Extracting Subtle Anomalies from Distributed Temperature Sensing Data for Dam Seepage Investigations. *Mactaquac Review Board Meeting 46A,* NB Power, Fredericton, Canada.

Danchenko, D., Butler, K. E., de Gante Carillo, E., Boulay, D., Yun, T., MacQuarrie, K. T. B., Campbell, I. and McLean, D. B. 2023, Towards quantitative, spatially resolved estimates of dam seepage by time-lapse electrical resistivity imaging (ERI), *Near Surface Geoscience Conference & Exhibition 2023, Extended abstract*, European Association of Geoscientists and Engineers, Edinburgh, UK, pp. 1–5

Butler, K. E, MacQuarrie, K. T. B., Danchenko, D. and de Gante Carillo, E. 2023, Seepage Monitoring Research at Mactaquac Generating Station (Diversion Sluiceway SEP interface region), *Mactaquac Review Board Meeting 45*, NB Power, Fredericton, Canada.

Extracting Subtle Anomalies from Distributed Temperature Sensing Data for Dam Seepage Investigations

UNIVERSITY OF NEW BRUNSWICK

THESIS DEFENCE AND EXAMINATION

in Partial Fulfillment

of the Requirement for the Degree of
Master of Science

by

Emanuel de Gante Carrillo

in the Department of Earth Science

U.N.B., Fredericton, N.B.

Thursday, August 21st, 2025
1:00 p.m.

Forestry/Geology Building, Room F23

Examining Committee

Dr. Karl Butler	Co-Supervisor
Dr. Kerry MacQuarrie	Co-Supervisor
Dr. John Spray	Internal Examiner
Dr. Brent Petersen	External Examiner
Dr. David Lentz	Chair of Oral Examination

Abstract

Fibre Optic Distributed Temperature Sensing (DTS) systems have been installed in water-retaining dams throughout the world to measure temperature and detect leaks or concentrated seepage. Where concentrated water seepage occurs temperature anomalies will be transported into the dam structure by advection, distorting the normal temperature pattern.

In this research, data visualization and data processing techniques are developed to analyze temperature anomalies—suggestive of leakage—from over 10 years of DTS data acquired at the Mactaquac Dam. These data exhibit strong seasonality due to conductive heat exchange with nearby surfaces exposed to air and the reservoir. Two key approaches are demonstrated to extract subtle temperature anomalies. The first involves calculating the temperature gradient along the DTS cable, followed by median filtering to suppress systematic noise—an effective method for amplifying sharp or short-wavelength variations. The second, more novel approach—the DBM (deGante-Butler-MacQuarrie) algorithm—applies a modified Karhunen-Loève (KL) Transform, adapted from seismic data processing. Based on theory similar to Principal Component Analysis, this method estimates and suppresses surface seasonality as a function of depth, enabling the extraction of more subtle patterns within the DTS data. New visualization techniques, including an offset temperature–depth and gradient–depth display inspired by seismic traces displays and a novel approach to plotting time series as a function of depth, further enhance seasonal pattern analysis.

These analytical methods have been applied to identify spatial and temporal temperature anomalies indicative of seepage at the NB Power Mactaquac dam, highlighting their potential for long-term monitoring using advanced data analysis techniques.