Please Review Your Abstract. If The Abstract Is Final, Click "Submit Abstract" To Complete Your Submission.

Submit Abstract

LiDAR Uncertainty Quantification for Topo-Bathymetric Earth Science using Generalized Polynomial Chaos Expansion

Alexandra Katherine Wise, University of Colorado Boulder, Smead Aerospace Engineering Sciences, Boulder, CO, United States, Kevin W. Sacca, University of Colorado at Boulder, Smead Aerospace Engineering Sciences, Boulder, CO, United States and Jeffrey P Thayer, University of Colorado at Boulder, Smead Aerospace Engineering Sciences, Boulder, United States

Abstract Text:

Though precise, most LiDARs are vulnerable to position and pointing errors as deviations from the expected principal axis lead to projection errors on target. While fidelity of location/pointing solutions can be high, determination of uncertainty remains relatively limited. As a result, NASA's 2021 Surface Topography and Vegetation Incubation Study Report lists vertical (horizontal, geolocation) accuracy as an associated parameter for all (most) identified Science and Application Knowledge Gaps, and identifies maturation of Uncertainty Quantification (UQ) methodologies on the STV Roadmap for this decade. The presented generalized Polynomial Chaos Expansion (gPCE) based method has wide ranging applicability to improve positioning, geolocation uncertainty estimates for all STV disciplines, and is extended from the bare earth to the bathymetric lidar use case, adding complexity introduced by entry angle, wave structure, and sub-surface roughness.

This research addresses knowledge gaps in bathy-LiDAR measurement uncertainty through a more complete description of total aggregated uncertainties, from system level to geolocation, by applying a gPCE-UQ approach. Currently, the standard approach is the calculation of the Total Propagated Uncertainty, which is often plagued by simplifying approximations (e.g. strictly Gaussian uncertainty sources) and ignored covariances. gPCE intrinsically accounts for covariance between variables to determine uncertainty in a measurement, without manually constructing a covariance matrix, through a surrogate model of system response. Additionally, gPCE allows arbitrarily high order uncertainty estimates (limited only by the one-time computational cost of computing gPCE coefficients), accurate representation of non-Gaussian sources of error (e.g. wave height energy distributions), and direct integration of measurement requirements into the design of LiDAR systems, by trivializing the computation of global sensitivity analysis.

Session Selection:
GC076. Science and Technology towards Achieving Surface Topography and Vegetation Structure Measurements

Submitter's E-mail Address:

bewi2496@colorado.edu

Abstract Title:
LiDAR Uncertainty Quantification for Topo-Bathymetric Earth Science using Generalized Polynomial Chaos Expansion

Requested Presentation Type:
Assigned by Committee (Oral or Poster)

Virtual Participation:
In-person

Recording Permission Given?
Yes

Previously Published?:
No

Abstract Payment:
Paid (agu-fm22-1128505-0295-8807-6116-8909)

I do not want to be involved in the OSPA program as a judge (students will be able to opt-into the OSPA program in October).

First Presenting Author
Presenting Author

Alexandra Katherine Wise
Primary Email: bewi2496@colorado.edu

Affiliation(s):

University of Colorado Boulder
Smead Aerospace Engineering Sciences
Boulder CO 80303 (United States)

Second Author

Kevin W. Sacca
Primary Email: kevin.sacca@colorado.edu

Affiliation(s):

University of Colorado at Boulder
Smead Aerospace Engineering Sciences
Boulder CO 80303 (United States)

Third Author

Jeffrey P Thayer
Primary Email: jeffrey.thayer@colorado.edu

Affiliation(s):

University of Colorado at Boulder
Smead Aerospace Engineering Sciences
Boulder 80303 (United States)

FINAL STEPS

1. **Check spelling and contact information.**
2. **Make necessary corrections:**
   - Select the step in the Abstract Control Panel that you wish to edit (e.g., Authors, Abstract Details)
   - Edit the information and click the submit button.
3. **Click** here **to print this page now.**