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## Using repeat oblique aerial photography and satellite imagery to detect glacial change in the Cordillera Vilcanota, Peru, since 1931

Ulrich Kamp<sup>1</sup>, Karina Yager<sup>2</sup>, Elise Arnett<sup>1</sup>, Krysten Bowen<sup>1</sup>, Kate Truitt<sup>1</sup>, Anton Seimon<sup>3</sup>, Tracie Seimon<sup>4</sup>, and Alvaro Ivanoff<sup>5</sup>

<sup>1</sup>Department of Natural Sciences, University of Michigan-Dearborn, Dearborn, MI, U.S.A. (ukamp@umich.edu)

<sup>2</sup>School of Marine and Atmospheric Sciences, Stony Brooks University, Stony Brook, U.S.A.

<sup>3</sup>Department of Geography and Planning, Appalachian State University, Boone, NC, U.S.A.

<sup>4</sup>Zoological Health Program, Wildlife Conservation Society, Bronx, NY, U.S.A.

<sup>5</sup>ADENT Systems, Inc., NASA Goddard Space Flight Center, Greenbelt, MD, U.S.A.

Terrestrial and aerial image analysis has proven to be a valuable survey method for documenting terrestrial landscape change related to, for example, biodiversity, urbanization, and environmental services such as land vegetation or forest cover and use, glacier extent, and water resources. Historical oblique aerial photographs offer exceptional opportunities to extend the observational record beyond the period covered by traditional nadir aerial surveys and satellite imagery. Here we apply these methods in the Cordillera Vilcanota of Southern Peru, home to the largest high alpine lake, Sibinacocha, in the Andes, a primary source of the Amazon River. The Shippee-Johnson aerial expedition of 1931 produced oblique photographs of glaciated peaks of the Cordillera Vilcanota. To determine the extent of glacial loss, we compared the 1931 glacier extents with more recent ones derived from satellite imagery analyses using Agisoft Metashape and Pixcavator. The identification of the flight camera positions from 1931 proved to be challenging, since the original photographs come with only rudimentary information. For three test glaciers, the Metashape analysis showed a glacier recession of between 50% and 95% from 1931 to 2018. Preliminary Pixcavator analysis results demonstrated a area decrease of 62% at two glacier termini between 1931 and 2020. Future studies will include repeating the oblique aerial photographs across the Vilcanota and other Andean mountain ranges, and also include ground truth and UAS imagery analysis.