

## Curriculum Vitae: Surendra Adhikari

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### Personal Information

A Nepali citizen ◦ Born in Lamjung, Nepal, on 2nd July 1983 ◦ Happily married to Sudha Shrestha ◦ Non-academic interests include sports, poetry, sanskrit, mathematics, Himalayas, and skygazing ◦ Can be reached @AlpineGlaciers on Twitter.

### Academic and Research Appointments

- 2013 onwards.** Postdoctoral Scholar in Geophysics, Division of Geological and Planetary Sciences, California Institute of Technology (Caltech), USA (Victor Tsai, advisor). Project: *Subglacial hydrology and hydrofracturing in a high water pressure regime.*
- 2013 onwards.** Postdoctoral Affiliate, Jet Propulsion Laboratory (JPL), Caltech, USA (Eric Larour and Erik Ivins, co-advisors). Project: *Understanding ice-sheet/solid-Earth/sea-level interactions for the Antarctic Ice Sheet.*
- 2008–2012.** Doctor of Philosophy in Glaciology, University of Calgary (UofC), Canada (Shawn Marshall, supervisor). Thesis: *Advances in Modelling of Valley Glaciers.*
- 2005–2007.** Masters of Science in Physical Land Resources (Engineering Geology, major), Universiteit Gent (UGent) and Vrije Universiteit Brussel (VUB), Belgium (Philippe Huybrechts, supervisor). Thesis: *Numerical Modelling of the Past and Future Evolution of Glacier AX010, Nepal Himalaya.*
- 2000–2004.** Bachelors of Engineering in Agricultural Engineering (Soil Conservation and Watershed Management Engineering, major), Tribhuvan University (TU), Nepal.

### Awards and Scholarships

- 2009, 2011, 2013.** Travel grants from NSF, NASA and Research Council of Norway to attend international workshops at the Portland State University, JPL, and Tromsø.
- 2012.** Community Surface Dynamics Modeling System (CSDMS) Student Modeler Award, University of Colorado Boulder, USA (for outstanding PhD research in geoscience).
- 2008–2012.** A combination of Geography Excellence Award (GEA) and Graduate Research Scholarship (GRS), UofC, Canada (\$25,000 per annum for five years).

- 2010.** Outstanding Doctorate Student Presentation Award, UofC, Canada.
- 2009.** Faculty of Graduate Studies (FGS) Open Scholarship, UofC, Canada (\$10,000).
- 2008.** Dean's Entrance Scholarship, UofC, Canada (\$6,000).
- 2005–2007.** The Vlaamse Interuniversitaire Raad (VLIR) Scholarship, UGent and VUB, Belgium (€12,000 per annum for two years).
- 2004, 2006.** University Faculty Topper, TU and UGent.
- 1999–2004.** TU Merit Scholarship, TU, Nepal (tuition fee waiver for six years).

## Research Overview

**Research interests.** In general, I remain interested in understanding the dynamics of Earth and Planetary ice masses. My specific research interests include, but certainly not limited to, the following (in no particular order):

- High-order modeling of glacial systems
- Decadal to millennia scale simulation of large ice sheets using a coupled system of ice-sheet, solid-Earth, and sea-level models
- Method of estimating global glaciers volume
- Glacial contribution to sea level rise
- Glacier/climate interactions
- Ice/ocean interactions
- Grounding line migration and marine ice sheet instability
- Theory for surging and calving events
- Subglacial processes (e.g., till deformation and erosion)
- Glacial hydrology and hydro-fracturing
- Glacial isostatic adjustments (GIA; both uplift and peripheral bulge migration)
- Dynamics of Mars ice caps
- Fractures on Europa surface.

**Valley glaciers.** During my six years of schooling under the guidance of Shawn Marshall and Philippe Huybrechts, I was mostly learning the fundamentals of glacier dynamics. I applied numerical models<sup>1</sup> of varying degrees of complexity to understand the dynamic behavior of valley glaciers. Key findings include the following.

- I have proposed a new hierarchy of 2-D and 3-D models based on the physical mechanisms by which the deformational flow is controlled (cf. published article, PA, #4). These models are useful to evaluate the effects of high-order mechanics (i.e., lateral and longitudinal drags) on englacial velocity fields, as well as on the glacier evolution in response to ongoing climate warming (PA #7). I have parameterized such high-order effects for simplified shear-deformational (PA #3) and plane-Stokes models (PA #6) as a function of geometry and sliding conditions of a glacier. This allows the simplified models to capture high-order mechanics in ad-hoc manner, without adding any numerical complexities. However, the reliability of proposed parameterizations for real world applications is yet to be tested and validated.
- Dynamic modeling of glacier ensembles may not be possible, partly due to the lack of necessary data to constrain the models and partly due to the associated computational cost. The volume-area scaling is the most viable alternative. I have provided new insights to this method by proposing the need for evolving scaling parameters as a

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<sup>1</sup>I adapted Elmer, open source finite element software for multiphysical problems, for glaciological applications, independent of the Elmer/Ice research group.

function of glacier geomorphology and ongoing climatic signals (PA #5). This work has received a great attention from the community. For more accurate global-scale applications, however, separate scaling-laws should be parameterized for ice caps, land-terminating and tide-water glaciers under ongoing climate warming.

**Ice sheets.** I am currently working with Eric Larour, Erik Ivins and Victor Tsai on some important problems of ice sheet dynamics. Key aspects of ongoing research include:

- I have recently finished integrating semi-analytical GIA solutions in the Ice Sheet System Model (ISSM) at JPL. This ice-sheet/solid-Earth model is applied to quantify the first-order estimates of future Antarctic bed topography and to evaluate the effect of solid Earth deformation on ice sheet dynamics (cf. submitted article, SA, #2). I am now working to calculate high-resolution GIA solutions in Amundsen Sea Sector, probably the most dynamic region of Antarctica. I have also started designing the model architecture for integrating self-gravitational sea-level model within ISSM.

- The formation and drainage of supraglacial lakes perturb the dynamics of Greenland Ice Sheet significantly. But, the viscoelastic response of ice during and after the lake drainage is poorly understood. It is this problem that I am hoping to explain through a process-based model of hydro-fracturing (SA #3).

## Publications and Presentations

### Published articles

7. Adhikari, S. and Marshall, S., 2013, Influence of high-order mechanics on simulation of glacier response to climate change: insights from Haig Glacier, Canadian Rocky Mountains, *The Cryosphere*, 7, 1527–1541, doi: 10.5194/tc-7-1527-2013.
6. Adhikari, S. and Marshall, S., 2012, Parameterization of lateral drag in flowline models of glacier dynamics, *J. Glaciol.*, 58, 212, 1119–1132, doi: 10.3189/2012JoG12J018.
5. Adhikari, S. and Marshall, S., 2012, Glacier volume-area relation for high-order mechanics and transient glacier states, *Geophys. Res. Lett.*, 39, L16505, doi: 10.1029/2012GL052712.
4. Adhikari, S. and Marshall, S., 2012, Modelling dynamics of valley glaciers, in Miidla, P. (ed.), *Numerical Modelling*, InTech Publ., 115–142, ISBN: 978-953-51-0219-9.
3. Adhikari, S. and Marshall, S., 2011, Improvements to shear-deformational models of glacier dynamics through a longitudinal stress factor, *J. Glaciol.*, 57, 206, 1003–1016, doi: 10.3189/002214311798843449.
2. Adhikari, S., Marshall, S. and Huybrechts, P., 2011, On characteristic timescales of Glacier AX010 in the Nepalese Himalaya, *Bull. Glaciol. Res.*, 29, 19–29, doi: 10.5331/bgr.29.19.
1. Adhikari, S. and Huybrechts, P., 2009, Numerical modelling of historical front variations and the 21st century evolution of Glacier AX010, Nepal Himalaya, *Ann. Glaciol.*, 50, 52, 27–34, doi: 10.3189/172756409789624346.

### Submitted articles (or in preparation)

3. Adhikari, S. and Tsai, V., 2014, Hydraulic fractures along a subglacial conduit, *J. Geophys. Res.*, (in advance stage of preparation).
2. Adhikari, S., Ivins, E., Larour, E., Seroussi, H. and Morlighem, M., 2013, Future Antarctic bed topography and its implications for ice sheet dynamics, *Solid Earth*, Ref #se-2013-92 (submitted to special issue on Lithosphere-Cryosphere Interactions).
1. Oerlemans, J., Adhikari, S., Anderson, B., Dunse, T., Giesen, R., Huybrechts, P., Leclercq, P. and Van Pelt, W., 2012, Modelling shrinkage of glaciers in the 21st century, *Nature Clim. Change*, Ref #NCLIM-12030191A (submitted).

### Conference presentations (partial list)

16. Adhikari, S., Ivins, E., Larour E., Seroussi, H. and Morlighem, M., 2013, Future Antarctic bed topography and its implications for ice sheet dynamics, *AGU Fall Meeting*, San Francisco, USA, 9–13 December (oral).
15. Adhikari, S., Ivins, E. and Larour E., 2013, Future evolution of the Antarctic bed topography, *Antarctic Ice Rises Workshop*, Tromsø, Norway, 26–29 August (poster).
14. Adhikari, S., 2013, Ice dynamics, GIA response, and subglacial hydrology, *CSDMS*, University of Colorado at Boulder, USA, 8–9 August (oral; invited).
13. Adhikari, S., 2012, Advances in modelling of valley glaciers, *PhD Public Talk*, University of Calgary, Canada, 30 August (oral; also presented at JPL and Caltech).
12. Adhikari, S. and Marshall, S., 2012, Glacier volume-area relation for high-order mechanics, *IGS symposium on Glaciers and Ice Sheets in a Warming Climate*, University of Alaska at Fairbanks, USA, 24–29 June (poster).
11. Adhikari, S. and Marshall, S., 2011, Dynamics of Haig Glacier: assessment of glacier physics, *AGU Fall Meeting*, San Francisco, USA, 5–9 December (poster).
10. Marshall, S. and Adhikari, S., 2011, Nested modelling of high-order ice dynamics in outlet glaciers of the Greenland Ice Sheet, *AGU Fall Meeting*, San Francisco, USA, 5–9 December (oral).
9. Adhikari, S. and Marshall, S., 2010, Introducing a longitudinal stress factor to improve shear-deformational models of valley glacier dynamics, *AGU Fall Meeting*, San Francisco, USA, 13–17 December (poster).
8. Adhikari, S. and Marshall, S., 2010, A method to improve shear-deformational models of glacier dynamics, *WC2N Meeting*, Prince George, Canada, 8–9 November (oral).
7. Adhikari, S. and Marshall, S., 2010, Role of longitudinal stress gradients on response sensitivity of valley glaciers to changing climate, *The University of Calgary Graduate Conference*, Calgary, Canada, 5–7 May (oral).

6. Adhikari, S. and Marshall, S., 2010, Diagnostic simulation of two-dimensional glacier domains, *The University of Calgary 47th Geography Department Annual Conference*, Canada, 12 March (oral; winner of Outstanding Student Presentation Award).
5. Adhikari, S. and Marshall, S., 2009, Englacial velocity fields: simulation of full-Stokes problem with finite-element approximations, *AGU Fall Meeting*, San Francisco, USA, 14–18 December (poster).
4. Bash, E., Adhikari, S. and Marshall, S., 2009, Summer field investigations at Haig Glacier, *IP3/WC2N Joint Meeting*, Lake Louise, Canada, 14–17 October (poster).
3. Adhikari, S. and Marshall, S., 2008, A three-dimensional numerical ice-flow model applied to alpine icefields and valley glaciers: theory, *WC2N Science Meeting*, University of Northern British Columbia, Canada, 2–4 October (oral).
2. Adhikari, S., Marshall, S. and Huybrechts, P., 2008, On understanding the response characteristics of a small valley glacier, Nepal Himalaya, *WC2N Science Meeting*, University of Northern British Columbia, Canada, 2–4 October (oral).
1. Adhikari, S. and Huybrechts, P., 2008, Numerical modeling of past and future evolution of Glacier AX010, Nepal Himalaya, *IGS symposium on Dynamics in Glaciology*, University of Limerick, Ireland, 17–22 August (oral).

## Teaching Experience (at UofC)

### Guest instructor

- Geog 503, Climate Change, Winter 2012.
- Geog 403, Oceanography and Climate Variability, Winter 2009.

### Lab instructor

- Geog 403, Oceanography and Climate Variability, Winter 2008 and Winter 2009.
- Geog 305, Weather and Climate, Fall 2008 and Fall 2009.

### Grader

- Geog 403, Final exam papers (30% of the course work), Winter 2009.
- Geog 403, Lab reports (40% of the course work), Winter 2008 and Winter 2009.
- Geog 305, Lab reports (40% of the course work), Fall 2008 and Fall 2009.

## Professional Activities

### Scientific editor/reviewer

- Editor, *Ann. Glaciol.*, IGS Kathmandu Symposium, March 2015 (assigned).
- Editor, *Ann. Glaciol.*, volume 55, issue 66, IGS China Symposium, July 2013.
- Reviewer, more than ten papers for *Science*, *J. Glaciol.*, *Cryosphere*, *Env. Res. Lett.*

## Field survey

- Ground penetrating radar (GPR) survey on Haig Glacier, Canada, 2009 (1 week).
- Geophysical survey on Haig and Opabian Glacier, Canada, 2008–2011 (6 times).
- Hydrogeological survey of Katunje Valley, Nepal, 2005 (6 months).
- Civil engineering camping for landscape and canal survey, Nepal, 2003 (1 month).

## Workshops, trainings, and summer schools

- International Workshop on Antarctic Ice Rises, Tromsø, Norway, August 2013.
- Ice Sheet System Model Workshop, JPL/Caltech, USA, December 2011.
- Summer School on Ice Sheet Modeling, Portland State University, USA, August 2009.
- Workshop on Glaciology and Paleoclimatology, Vancouver, Canada, January 2009.
- Effective Public Speaking Training, TU, Nepal, July 2004.
- Training on Soil and Water Engineering, G. B. Pant University, India, December 2003.

## Professional affiliations

- Member of European Geophysical Union (EGU), 2013 onwards.
- Member of American Geophysical Union (AGU), 2009 onwards.
- Member of International Glaciological Society (IGS), 2008 onwards.
- Member of Nepal Engineering Council (NEC), 2005 onwards.

## Advisors, Mentors, and Collaborators

Shawn Marshall (UofC) ○ Philippe Huybrechts (VUB) ○ Ashutosh Shukla (TU) ○ Eric Larour (JPL) ○ Erik Ivins (JPL) ○ Victor Tsai (Caltech) ○ Olivier Gagliardini (Joseph Furior University) ○ Douglas MacAyeal (University of Chicago) ○ Johannes Oerlemans (Utrecht University) ○ Stephen Price (LANL) ○ Weili Wang (NASA Goddard Space).

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