Snow Cover Monitoring in the Swiss Alps Using Webcam Images

Céline Dizerens, Fabia Hüsler, Stefan Wunderle
Institute of Geography and Oeschger Centre for Climate Change Research, University of Bern

8th EARSeL LISSIG workshop, 7-9 February 2017
INTRODUCTION
INTRODUCTION

- Huge number of freely available webcams
  - Worldwide: more than 60’000 webcams

www.webcams.travel
INTRODUCTION

- Huge number of freely available webcams
  - Worldwide: more than 60’000 webcams
  - Switzerland: more than 3‘000 webcams (swisswebcams.ch)
INTRODUCTION

- Huge number of freely available webcams
  - Worldwide: more than 60'000 webcams
  - Switzerland: more than 3'000 webcams (swisswebcams.ch)
  - Our archive: about 520 webcams (since 2011)
→ 296 webcams processed
INTRODUCTION

- Huge number of freely available webcams
- High spatial and temporal resolutions
INTRODUCTION

- Huge number of freely available webcams
- High spatial and temporal resolutions
- Provide additional information (often below cloud cover)
INTRODUCTION

- Huge number of freely available webcams
- High spatial and temporal resolutions
- Provide additional information (often below cloud cover)
- Allow detailed analyses of snow cover on steep slopes due to their oblique view on the mountains
INTRODUCTION

- Huge number of freely available webcams
- High spatial and temporal resolutions
- Provide additional information (often below cloud cover)
- Allow detailed analyses of snow cover on steep slopes due to their oblique view on the mountains

→ serve as a reference for improved validation of satellite-based approaches
→ complement satellite-based snow cover retrieval
WEBCAM PROCEDURE

Main issues:
- Only RGB information for snow classification
- Missing information: Almost no information about webcams available
  - Exact location
  - Orientation
  - Field of view
  - Camera/lens parameters
WEBCAM PROCEDURE

Existing rectification methods based on cam’s parameters, GCPs, few cameras

- Corripio 2004

→ too time-consuming for webcams: too many unknowns, large amount of manual user input required
WEBCAM PROCEDURE

- Preprocessing
- Image-to-DEM registration
- Image alignment
- Snow classification
WEBCAM PROCEDURE

WEBCAM

Webcam location

Preprocessing

Orthophoto SWISSIMAGE
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images

DEM

Image-to-DEM registration

Transformation matrix
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images

DEM

Image-to-DEM registration

Transformation matrix

8th EARSeL LISSIG workshop, 7-9 February 2017
WEBCAM PROCEDURE

(a) Red: 148 Green: 139 Blue: 134
Red: 67 Green: 90 Blue: 122
Red: 192 Green: 192 Blue: 192

(b) No snow
Snow

DEM

Image-to-DEM registration

Transformation matrix

Snow classification

algorithm of Salvatori et al. (2011)
WEBCAM PROCEDURE

Red: 55
Green: 56
Blue: 58

Red: 67
Green: 90
Blue: 122

Red: 148
Green: 139
Blue: 134

Red: 192
Green: 192
Blue: 192

principal component analysis (PCA) for separating shaded snow cover from sunlit rock surfaces (Härer et al., 2016)

algorithm of Salvatori et al. (2011)

snow classification
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images

DEM

Image-to-DEM registration

Transformation matrix

Snow classification

SNOW COVER MAPS
WEBCAM PROCEDURE
WEBCAM PROCEDURE

WEBCAM

Preprocessing

Webcam location

Master image(s)

Image mask

Remaining Images

Image alignment

Snow classification

DEM

Image-to-DEM registration

Transformation matrix

SNOW COVER MAPS
EVALUATION
EVALUATION
EVALUATION

For each webcam: between 5 and 15 manually selected GCPs (total: 130 GCPs)
EVALUATION

- (relative) pixel error (error in image space, #pixels)
- distance error (error in world coordinates, meters)
EVALUATION

- In general: closer to the webcam, bigger error distances
- Average distance error: 18.2 meters
- Huge differences between normal and wide-angle webcams
EVALUATION

- In general: closer to the webcam, bigger error distances
- Average distance error: 18.2 meters
- Huge differences between normal and wide-angle webcams
- Difference between silhouette GCPs and image border GCPs
CONCLUDING REMARKS

- Webcams offer a huge potential (widely unexplored)
- Feasibility of using webcams images to generate snow cover maps
- Evaluation allowed to identify limitations and possible improvements
- Evaluation and comparison with satellite-based snow cover maps (either as reference or as complement)
- Methodological improvements
  - Improved camera model (lens distortion)
  - Snow / cloud classification
  - Find ‘balance‘ between mapping accuracy and automation
Many thanks for your attention!