Multitemporal Error Analysis of LiDAR Data for Geomorphological Feature Detection

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(1) Introduction

> Hintereisferner
> airborne LiDAR measurements from 2001 to 2008

(2) Error Analysis

> test areas
> results

(3) Multitemporal LiDAR Data Analysis

> selected geomorphological features
  - erosion / accumulation
  - dead ice
  - slope failure
  - permafrost

(4) Conclusions
(1) Introduction

**Hintereisferner (HEF)**

- 6.5 km
- 3700 to 2450 m a.s.l.
- 6.3 km²

*observations since many decades*

- length variations 1847  
  (Span et al. 1997)

- mass balance 1952  
  (Kuhn et al. 1999)

100 years of ice dynamics of Hintereisferner,  
Central Alps, Austria.  
Annals of Glaciology, 24, 297-302.

Kuhn, M. et al., 1999. Measurements and  
models of the mass balance of Hintereisferner.  
# Introduction

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(1) Introduction


EGU 2009 - Remote sensing of cryosphere
18:45–19:00 EGU2009-7405
*The Hintereisferner - eight years of experience in method development for glacier monitoring with airborne LiDAR*
Room 20 / Mon, 20 Apr, 15:30–17:00 / Room 33 / 17:30–19:00

Poster Programme / Halls X/Y / Mon, 20 Apr, 08:00–19:30
XY309 EGU2009-4665
*Glacier surface feature detection and classification from airborne LiDAR data*
**B. Höfle**, R. Sailer, M. Vetter, M. Rutzinger, and N. Pfeifer
(2) Error Analysis

for error analysis

exclusion of:
- snow / firn
- glacier ice
- dead ice
- permafrost
- erosion / accumulation
- vegetation
- anthropogenic influence
(2) Error Analysis

- absolut STD error
- difference to optimum value
- optimum value
- mean difference per slope class

![Graph showing error analysis with axes labeled in degrees and meters.](image-url)
(2) Error Analysis

mean of absolute differences = 0.08 m
STD = 0.01 m
(3) Multitemporal LiDAR Analysis
(3) Results

- **Dead Ice**
- **Slope Failure / Debris Flow**
- **Regressive Erosion / Deposition**
- **Permafrost?**

![Graphs showing results for different processes and phenomena.](image-url)
(3) Results

Profile RG01 – point 67 [~27°]

Profile FE_Q01 – point 22 [~40°]

Profile G01 – point 268 [~10°]
(4) Conclusions

(a) empirical slope dependent error
< 0.1 m on slopes < 60°
(4) Conclusions

(a) empirical slope dependent error

(b) analysed processes
- multi process features
- singular processes
- discontinuous processes
- continuous processes
(4) Conclusions

(a) empirical slope dependent error

(b) analysed processes
- multi process features
- singular processes
- discontinuous processes
- continuous processes
(4) Conclusions

c) high significance on annual base
[ Δz a\(^{-1}\) >> ± absolute STD error ]

- slope failure (shear slide)
- dead ice / stagnant ice
- glacier retreat / advance
(4) Conclusions

c) high significance on annual base
[ \Delta z a^{-1} >> \pm \text{absolute STD error} ]

- slope failure (shear slide)
- dead ice / stagnant ice
- glacier retreat / advance

moderate significance on annual base
[ \Delta z a^{-1} >= \pm \text{absolute STD error} ]

- gravitative processes (erosion / deposition)
(4) Conclusions

c) **High significance on annual base**

\[ \Delta z \, a^{-1} \gg \pm \text{absolute STD error} \]

- slope failure (shear slide)
- dead ice / stagnant ice
- glacier retreat / advance

**Moderate significance on annual base**

\[ \Delta z \, a^{-1} \geq \pm \text{absolute STD error} \]

- gravitative processes (erosion / deposition)

**Low significance on annual base**

\[ \Delta z \, a^{-1} \approx \pm \text{absolute STD error} \]

- permafrost (without xy displacement)
  - \( \Delta z \) exceeds continuously absolute STD error
  - trend of \( \Delta z \) to be considered