Remote monitoring of near real time glacier mass changes at Sonnblick Observatory

Results from traditional monitoring and
Development of a remote mass balance measurement system

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4 glaciers - 2 projects

Global Cryosphere Watch Sonnblick – Gletscher- u. Schneedeckenmonitoring

- **Long term monitoring** of glacier mass balance, snow cover, surface energy balance, glacial runoff, and snow chemistry
- Funded by the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management

Glacio-Live

- **Development of a remote mass balance measurement system**, that delivers results in near real time
- Cooperation with Univ. of Graz, TGM, GEUS
- Funded by the Austrian Federal Ministry of Science, Research and Economy within Sparkling Science
mass balance time series

- **Goldbergkees 1.3 km²**
  - 1980: 0
  - 1985: 0
  - 1990: -0.7 m/a
  - 1995: -1.1 m/a

- **Kleinfließkees 0.8 km²**
  - 1980: 0
  - 1985: 0
  - 1990: -0.7 m/a
  - 1995: -0.8 m/a

- **Pasterze 16.3 km²**
  - 1980: 0
  - 1985: 0
  - 1990: -0.8 m/a
  - 1995: -1.2 m/a

- **Freya Glacier 5.3 km²**
  - 1980: 0
  - 1985: 0
  - 1990: -0.4 m/a
  - 1995: 0
  - 2000: 0
  - 2005: 0
  - 2010: 0
  - 2015: 0
annual mass balance measurements – the direct method
Elevation changes

1969-1998
-0.65 m

1998-2012
-1.41 m

2012-2015
-4.3 m

Elevation change of Pasterze in meters per year

Mean values for:
- total glacier
- glacier tongue
Annual ablation rates 2017 and surface elevation changes at Pasterze
5 years of elevation changes and frontal glacier retreat
2012 - 2017
Development of the remote monitoring system

Mass Balance Measurements at one point

Automatic Cameras measure Snow covered Area

Operational Mass Balance Model

18.7.2012

2.8.2012

6.8.2012

AWS FLK

AWS GOK

Operational Mass Balance Model

Mass balance (m w.e.)

b
Station Network:

- Goldbergkees, 1 km², seit 1986
- Freya Gletscher, 5 km², seit 2007
- Pasterze, 17 km², seit 2004
- Kleinfleißkees, 1 km², seit 1999
Pasterze [2202m] & Goldbergkees (SBO) [2625m]

Change of winter snow cover and ice melting
Maintainence of stations on moving ice is time-consuming...
Station Network: 10 Cameras

- SBK Goldbergkees
- SBK Gipfel
- SBK Kleinfleißkees
- PAS Freiwandeck
- PAS Großglockner
- PAS Fuscherkarkopf
- PAS Hufeisenbruch
- PAS Zunge
- FREYA upstream
- FREYA downstream

foto-webcam.eu
Cooperation with foto-webcam.eu / 1. Kamera Kleinfleißkees

- High quality and resolution (DSLR)
- High frequency: 10 Minutes
- Powered by solar panel
- Wireless data transmission via radio to Sonnblick
Results of surface classification: Kleinfleißkees

Software practise (matlab), Härer et al., 2013, GeoSciMoDev), DA I. Rojs, Uni Graz

17.7.2015

4.8.2015

27.8.2015

9.9.2015

Legend:
- Red: Snow
- Blue: Ice Snow
Outlook

1. Data assimilation into an operational distributed mass balance model
2. Presentation of the real time mass change via glacio-live.at and zamg.ac.at
3. Provide actual model results in a similar way for all glaciers of Austria

Example: Mass changes of the Greenland Ice Sheet. Source: dmi.dk
Thank you!