Signatures of Evaporation of Artificial Snow in the Alpine Lower Troposphere

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Abstract

The SEASALT project is a student's research campaign within the Education & Training programme of the EUropean Fleet for Airborne Research (EUFAR). The project is an application of airborne in-situ measurement techniques in an Alpine valley atmosphere altered by man-made snow production. The efforts are influenced by the ongoing endeavours to link the climate and water-budget related issues with the increasing use of artificial snow. The deployment of an instrumented aircraft (the ENDURO ultralight trike operated by the Forschungszentrum Karlsruhe) is aimed at capturing signatures of snow production within the regional water vapour budget and other related microphysical parameters by means of measurements of atmospheric composition as well as dynamic and thermodynamic properties. A summary of the experiment carried out during the two-week field campaign in Austria in February/March 2008 is presented.

Methodology

- constant-level flight legs along the valley axis
  ⇝ comparison of ski-resort surroundings with the rest of the valley
- vertical profiling by sounding-like flight legs (up to 2000 m)
  ⇝ description of Boundary Layer structure
- intensified ground-based measurements
  ⇝ reference for the 10-hour long airborne data-set

Time and location

- Enns river valley, Austria
- 2 weeks between Feb 23^{th} and Mar 8^{th} 2008

Figure 6: Snow-production in Haus (photo taken during rf03)

Selected instruments

- airborne (see fig. 1)
  - two aerosol size spectrometers covering $5nm$ – $20\mu m$ range (GRIMM WRAS system)
  - aerosol particle counter (TSI 3010)
  - two water vapour sensors: chilled mirror and IR absorption hygrometers
- ground-base (see fig. 7)
  - four meteorological stations along the valley: Niederoeblarn, Groebming, Ramsau, Radstadt
  - eddy-covariance flux measurement station deployed in Niederoeblarn

Figure 4: FZK-ENDURO ultralight trike

	date (2008)	take-off	landing	duration
tf01	Feb 24^{th}	14:39 UTC	15:31 UTC	0h 52m
rf01	Feb 25^{th}	13:16 UTC	15:41 UTC	2h 25m
rf02	Feb 26^{th}	09:15 UTC	12:07 UTC	2h 51m
rf03	Mar 6^{th}	06:58 UTC	09:21 UTC	2h 23m
rf04	Mar 6^{th}	11:50 UTC	13:12 UTC	1h 21m
				9h 54m

Table 1: Flights performed during the SEASALT campaign (tf – test flight, rf – research flights)

Few facts on snow-production

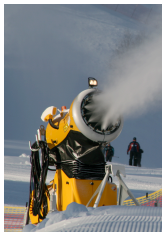

Figure 5: A snow-gun in Haus (photo taken during rf03)

- snow produced by spraying water, containing crystallization nuclei, into atmosphere
- production efficient only in cold enough environment (dewpoint below $-4°C$)
- snow-production in Enns river valley: 581 snow-guns in Planai and 110 in Haus

Preliminary quick-look data (rf03)

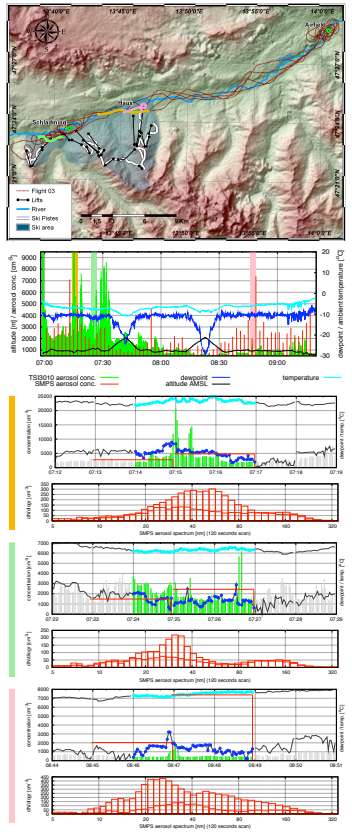

Figure 1: Aerosol and water vapour measurements (rf03): 07:14–07:17 UTC (overflying Haus, snow production running), 07:24–07:27 UTC (overflying Schladming, snow production running), 08:46–08:49 UTC (overflying Haus, no snow production for at least 40 minutes)

Figure 2: Photo of the FZK-ENDURO overflying a snow-gun in Haus taken at 07:15:22 UTC

Figure 3: Photo of the FZK-ENDURO overflying a snow-gun in Schladming taken at 07:46:52 UTC

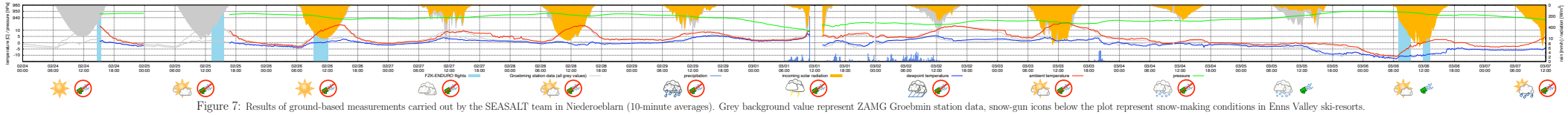

Figure 7: Results of ground-based measurements carried out by the SEASALT team in Niederoeblarn (10-minute averages). Grey background value represent ZAMG Groebmin station data, snow-gun icons below the plot represent snow-making conditions in Enns Valley ski-resorts.

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