The influence of mountain-ridge scale snow precipitation processes on the local snow distribution

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IUGG, July 12, 2019
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Mountain ridge-scale snow precipitation processes

- Small-scale/Local orographic enhancement

  e.g. Seeder-Feeder mechanism
Mountain ridge-scale snow precipitation processes

- Small-scale/Local orographic enhancement
- Preferential deposition

- e.g. Seeder-Feeder mechanism
- e.g. Preferential deposition

Mountain Ridge

Small-scale/Local orographic enhancement

- Reduced fall velocity
- Increased fall velocity

Preferential deposition

Mountain Ridge
Mountain ridge-scale snow precipitation processes

- Small-scale/Local orographic enhancement
- Preferential deposition

Combined effect – Asymmetric snow distribution across mountain ridge

Franziska Gerber (gerberf@slf.ch)
Motivation

Tourism  
Avalanches  
Ecology  
Hydropower  
Drinking water
Motivation

Tourism
Avalanches
Ecology
Hydropower
Drinking water

Model validation

Climate Change → Modified atmospheric circulation? → Modified snow accumulation?
Simulation setup

- WRF at very high resolution
- Large eddy simulation (LES) mode
- Driven by COSMO-2 (2 km resolution)
- 2 case studies
  - January 31/March 5, 2016

WRF: Weather Research and Forecasting model
COSMO: Consortium for Small-Scale Modeling
Process distinction

Assumption:
• Cloud dynamics → negligible in the lowest 90 m ag
• Preferential deposition → dominant in lowest 90 m ag
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Resolution dependency

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Resolution dependency

"Cloud dynamics + mean advection"

"All effects"

"Near-surface Preferential deposition"

Vertical velocity (m/s)
Resolution dependency

450 m

150 m

50 m

“Cloud dynamics + mean advection”

“All effects”

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Resolution dependency

“Cloud dynamics + mean advection”

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Vertical velocity (m/s)
Snow precipitation anomalies

31 January 2016

“Cloud dynamics + mean advection”

“All effects”

“Near-surface Preferential deposition”

Vertical velocity (m/s)

Comola et al., 2019: Preferential deposition of snow and dust over hills: governing processes and relevant scales, JGR Atmospheres, accepted.
31 January 2016

“Cloud dynamics + mean advection”

“All effects”

“Near-surface Preferential deposition”

31 January 2016

14-21 %

26-28 %

8-12 %
Processes

Snow precipitation anomalies

31 January 2016
- Snow: 1.35 mm
- Snow: 1.34 mm
- Snow: 2.24 mm

5 March 2016
- Snow: 2.26 mm

“Cloud dynamics + mean advection”
14-21 %  0.5-7 %

“All effects”
26-28 %  -2.2-6 %

“Near-surface Preferential deposition”
8-12 %  3 %

Vertical velocity (m/s)

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Processes

Snow precipitation anomalies

31 January 2016

5 March 2016

“Cloud dynamics + mean advection”

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This case study
Drier atmosphere = weaker effect

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Processes

Snow precipitation anomalies

31 January 2016

5 March 2016

“Cloud dynamics + mean advection”

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31 January 2016

5 March 2016

14-21 %

0.5-7 %

26-28 %

-2.2-6 %

8-12 %

3%

This case study
Drier atmosphere = weaker effect

• Model validation with measurements
• Passive tracer experiment

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Conclusion

- Mountain-ridge scale precipitation: \( \leq 50 \text{ m res.} \)


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Conclusion

- Mountain-ridge scale precipitation: \( \leq 50 \text{ m res.} \)
- Cloud dynamics and mean advection: \( O(20 \%) \)
- Near-surface preferential deposition: \( O(5-10 \%) \)

26-28 % enhanced precipitation on leeward side

(depending on the event)


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Questions?

- Mountain-ridge scale precipitation: $\leq 50$ m res.
- Cloud dynamics and mean advection: $O(20\%)$
- Near-surface preferential deposition: $O(5\text{-}10\%)$

26-28% enhanced precipitation on leeward side
(depending on the event)


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