Synoptic conditions and atmospheric moisture pathways associated with virga and precipitation over coastal Adélie Land, Antarctica

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Motivations

- Advection of moisture towards Greenland and Antarctic ice sheets is driven by large synoptic circulation. Katabatic winds are fierce over both ice sheets.
- In Antarctica, **low level sublimation** is a frequent phenomenon happening in the katabatic layer: **up to 35% of the precipitation sublimates** over coastal region, which dramatically impacts surface mass balance.
- We investigate if **virga** and **precipitation** events are drived by **different synoptic conditions** and examine the **origin of the moisture** that precipitates or sublimates over Dumont d'Urville station – DDU – (Fig.1), coastal Adélie Land.

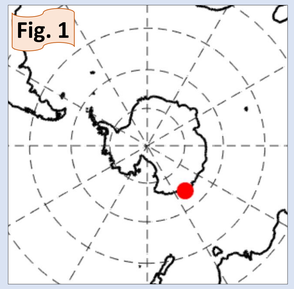


Fig. 1

Data and methods

- Identification of **virga** and **surface precipitation** using the K-band reflectivity from a **Micro Rain Radar** [1]
  - ➞ air parcel back trajectories from LAGRANTO [2]
  - ➞ moisture source diagnostic [3]
  - ➞ cyclone mask identification [4,5]
  - ➞ front detection algorithm [6,5]
- Select only the **precipitating air parcels** – threshold on the snow water content profile (Fig. 2)

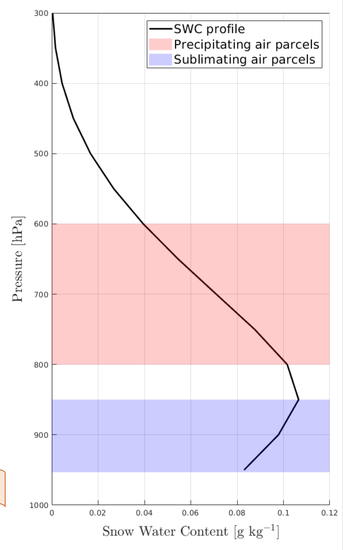
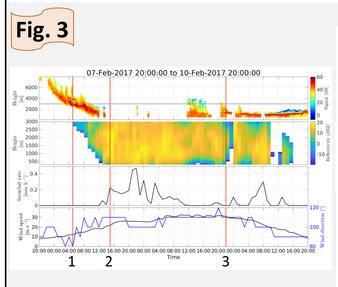


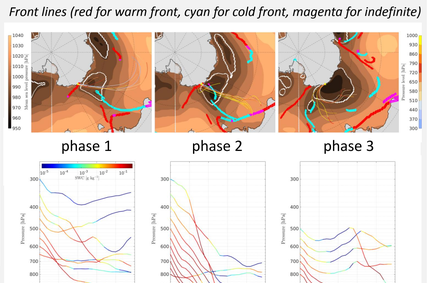
Fig. 2

Case study

Spot the differences in **lifting** and **trajectories** of the precipitating air parcels, and **the associated synoptic features** for the three events

Fig. 3





Results

1. Different trajectories between virga and precipitation:

Three distinct phases of the same system (Fig. 3 & Fig. 4)

Early lifting in virga compared to precipitation (Fig. 5)

(1) Pre-precipitation virga
⬇
(2) Surface precipitation
⬇
(3) Post-precipitation virga

Fig. 4

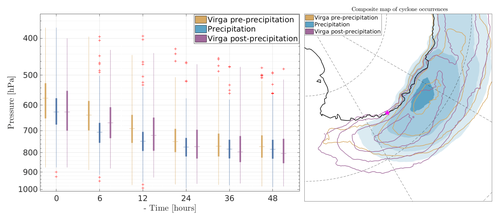


Fig. 5

Fig. 6

2. Related cyclone positioning:

Progress of the cyclone from the west to the east from pre-precipitation virga, to surface precipitation to post-precipitation virga periods (Fig. 6)

3. Frontal features:

Precipitation at DDU is associated with warm front (Fig. 7)

Distinct warm front positioning related to the different phases (Fig. 8)

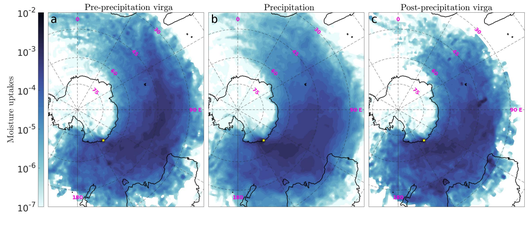


Fig. 9

4. Moisture origin:

West, resp. close and meridionally oriented, moisture picking-up (Fig. 9a, resp. b)

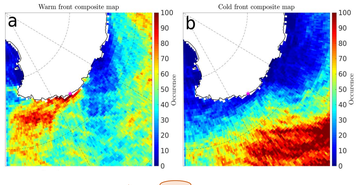


Fig. 7

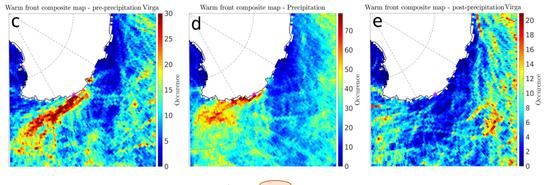


Fig. 8

Discussion and conclusion

- **Three phases** occur when a precipitating system associated with a warm front reaches DDU. Clear differences in terms of **lifting**, **trajectories**, **moisture uptakes** and **cyclone positioning**.
- Sea-ice extent influences moisture upatkes related to seasonal (not shown here).
- Low-level sublimation occurs in many places of coastal Antarctica. Could the same analysis be done over other places of coastal Antarctica ? Could the same pattern be observed over the Greenland ice sheet?

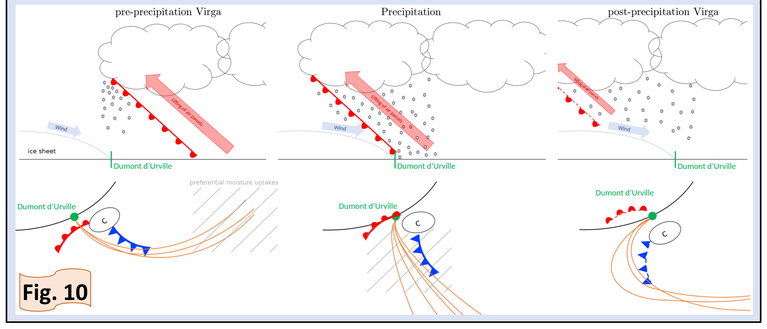


Fig. 10

References

Jullien et al., in The Cryopshere Discuss., in review (2019) [1] Durán-Alarcón et al., in The Cryosphere, 13, 247–264 (2019) [2] Sprenger and Wernli, in Geoscientific Model Development 8.8 (2015) [3] Aemisegger et al., in Atmospheric Chemistry and Physics, 14, 4029–4054 (2014) [4] Wernli and Schwierz, in Journal of the Atmospheric Sciences, 63, 2486–2507 (2006) [5] Sprenger et al., in Bulletin of the American Meteorological Society, 98, 1739–1748 (2017) [6] Jenkner et al., in Meteorological Applications, 17, 1–18 (2010)

Have a look at the paper