Gravity wave excitation during the coastal transition of an extreme katabatic flow in Antrarctica

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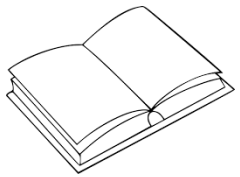
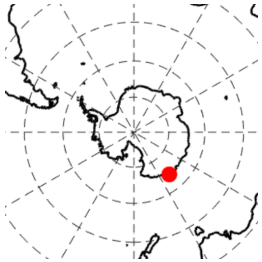


Vignon, É., G. Picard, C. Durán-Alarcón, S.P. Alexander, H. Gallée, and A. Berne, 2020: Gravity Wave Excitation during the Coastal Transition of an Extreme Katabatic Flow in Antarctica. J. Atmos. Sci., 77, 1295–1312, https://doi.org/10.1175/JAS-D-19-0264.1

Visit the LTE website



Looking at clouds above Dumont d'Urville station (DDU), Antarctic coast ...

APRES3

Looking for clouds above Dumont d'Urville station (DDU), with a lidar

9-10 August 2017

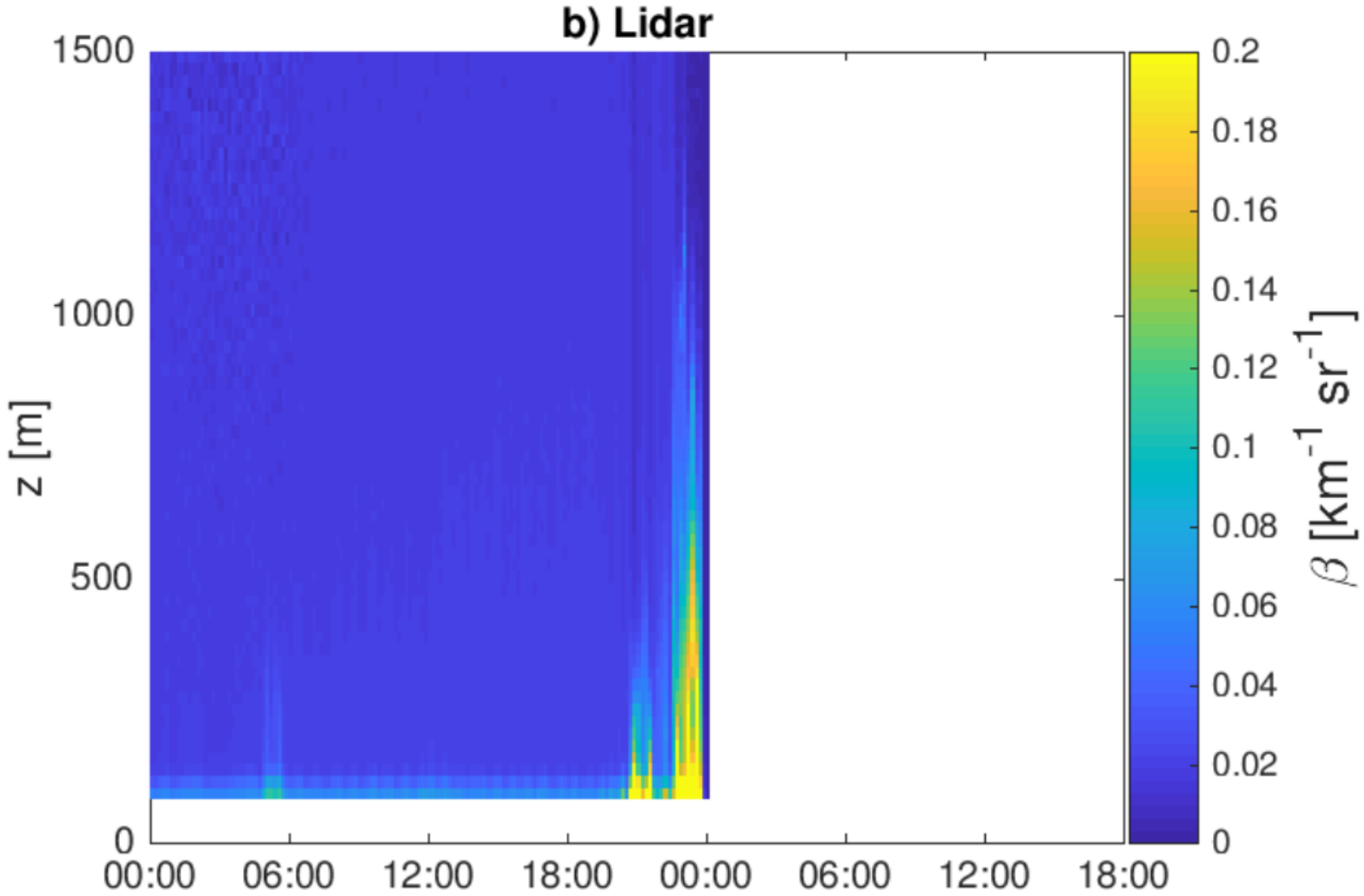
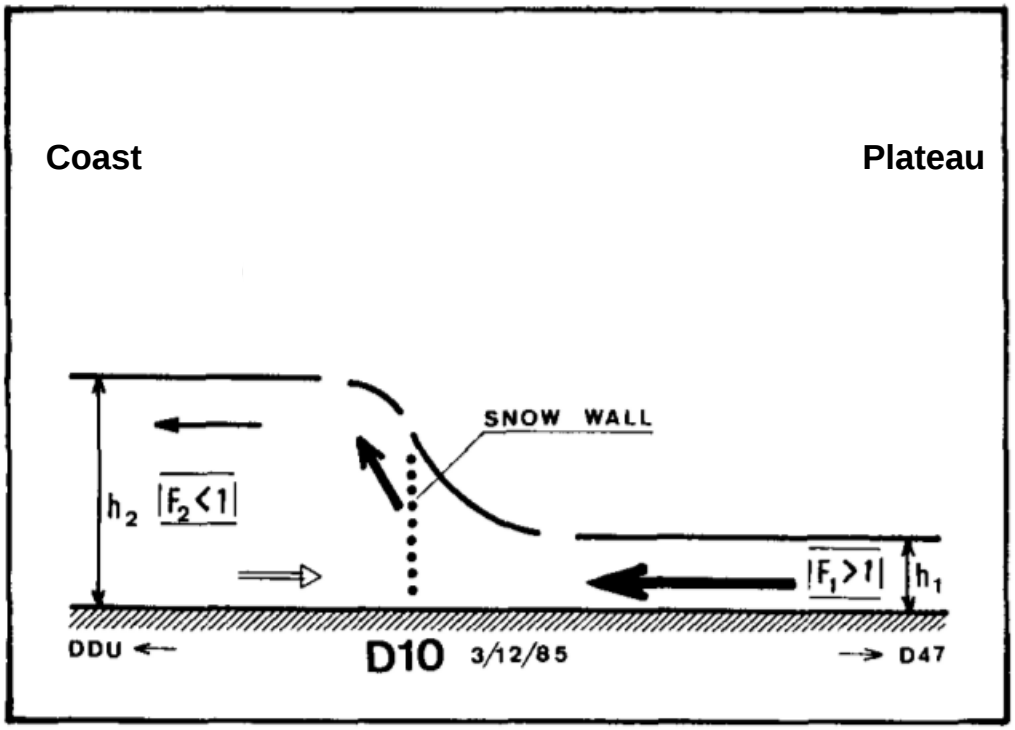
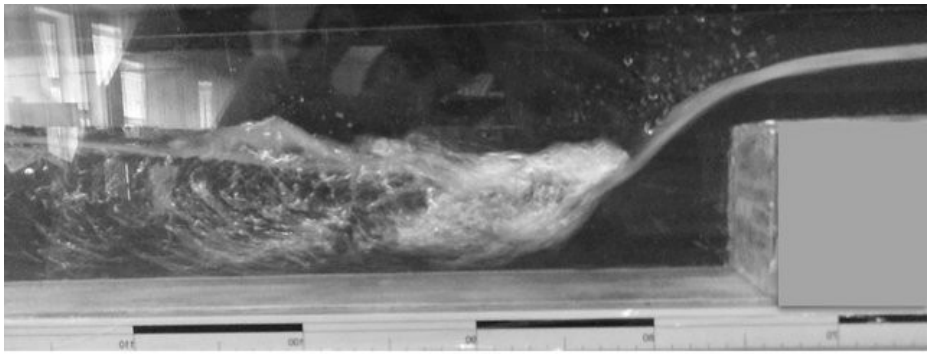


Photo by F. Mariotti

Snow wall are due to
Katabatic jump ↔ hydraulic jump



Pettré et al. (1991)
(see also Gallée et al. 1996, 1998)



→ katabatic jump and snowwall: **first time** sampled with remotely-sensed instruments

→ **Unique opportunity** to gain further **insights** into the transition of extreme katabatic flows at the coast

→ using a combination of:

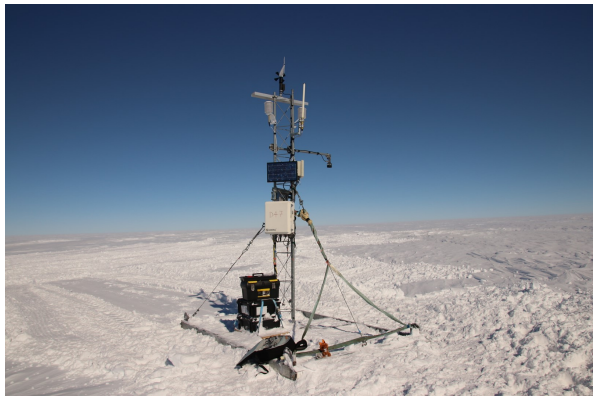
Satellite images (VIIRS + MODIS)

Source: NASA

Regional simulations with WRF
1-km resolution

Doppler K-band Radar + Lidar at DDU

In situ observations

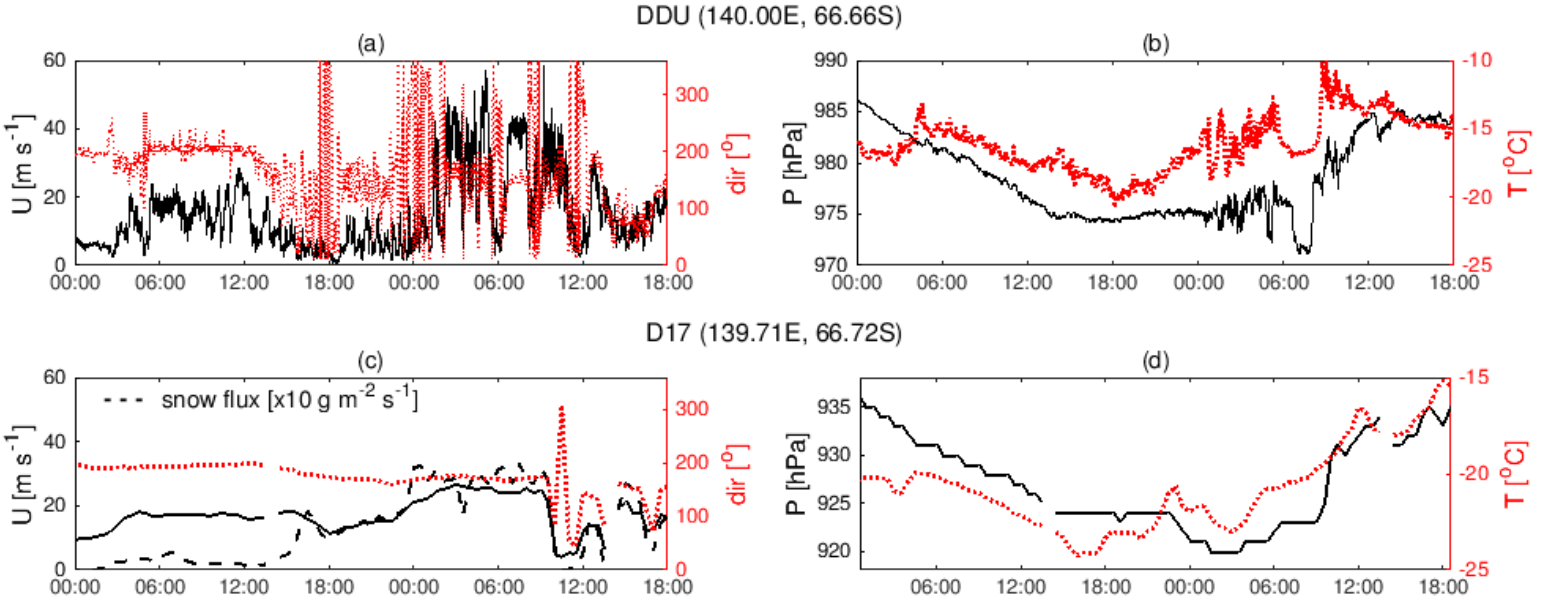


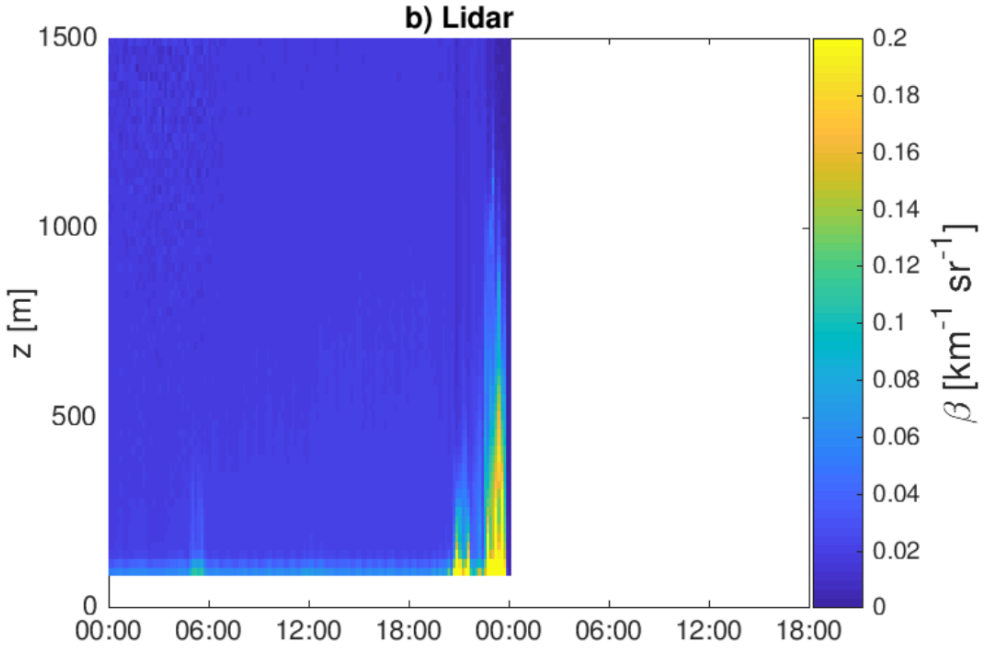
→ How important are such **extreme** events for the Antarctic atmospheric dynamics?

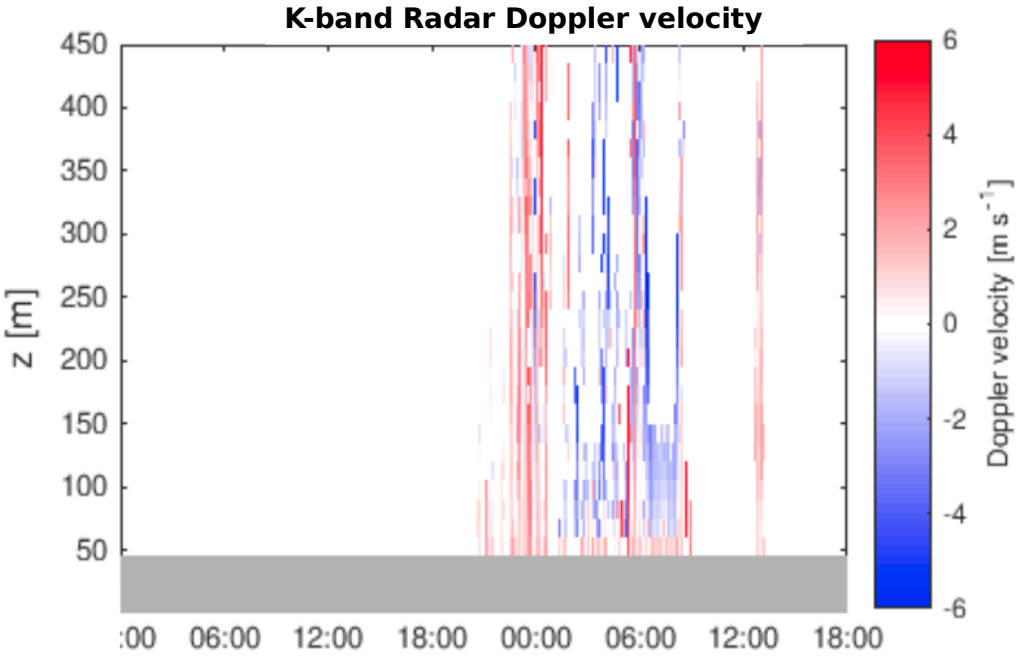
Coast

Plateau

9-10 August 2017 time series

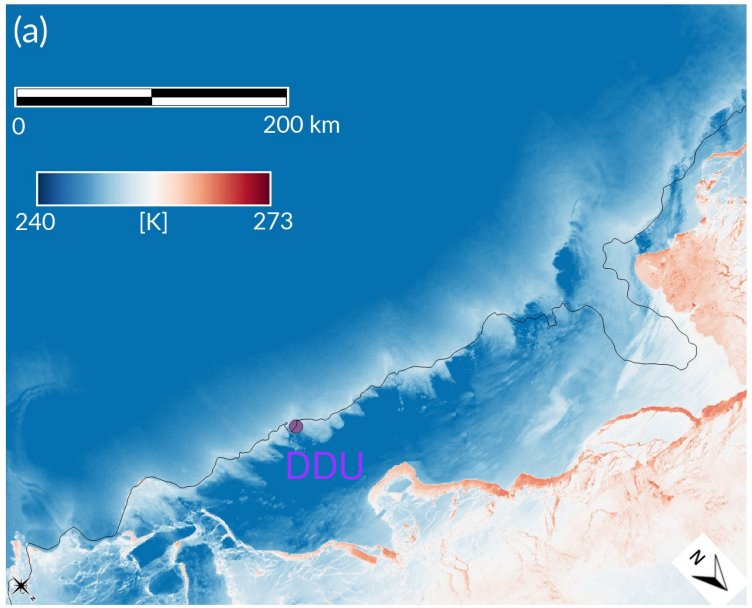


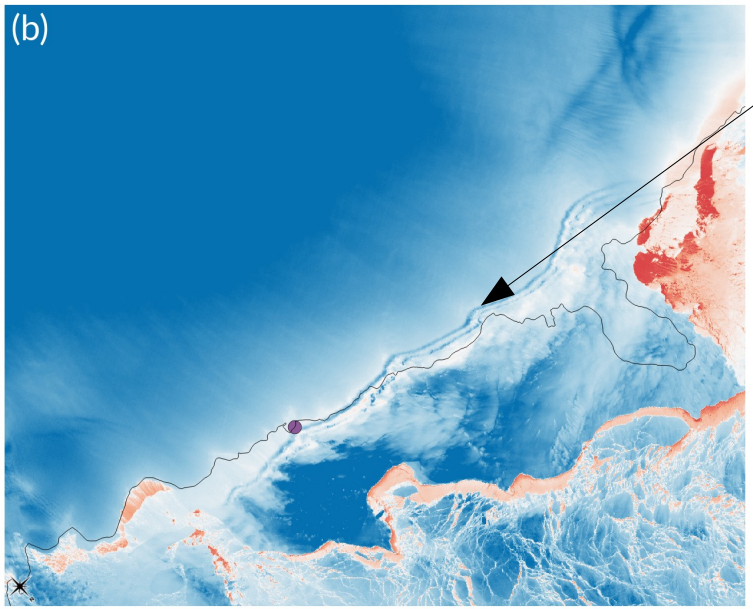




Snowwall formation followed by trapped gravity wave excitation from brightness temperature VIIRS images

16:28 UT
9 August

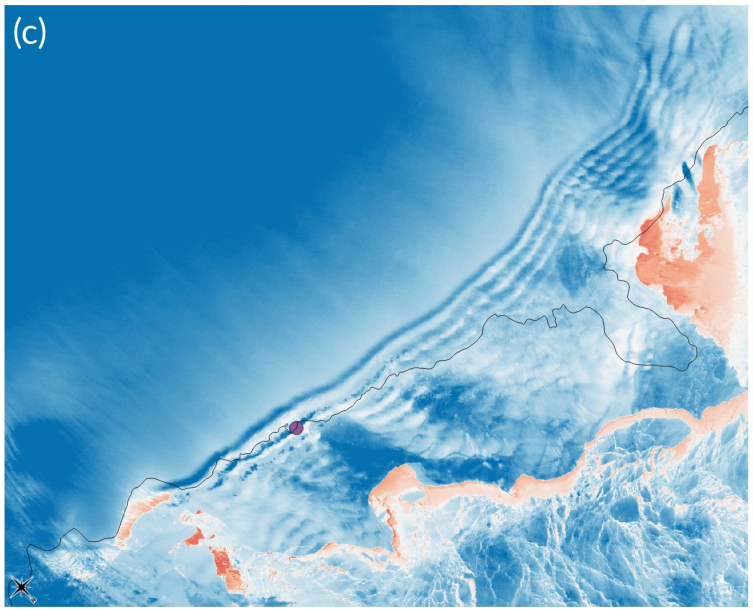


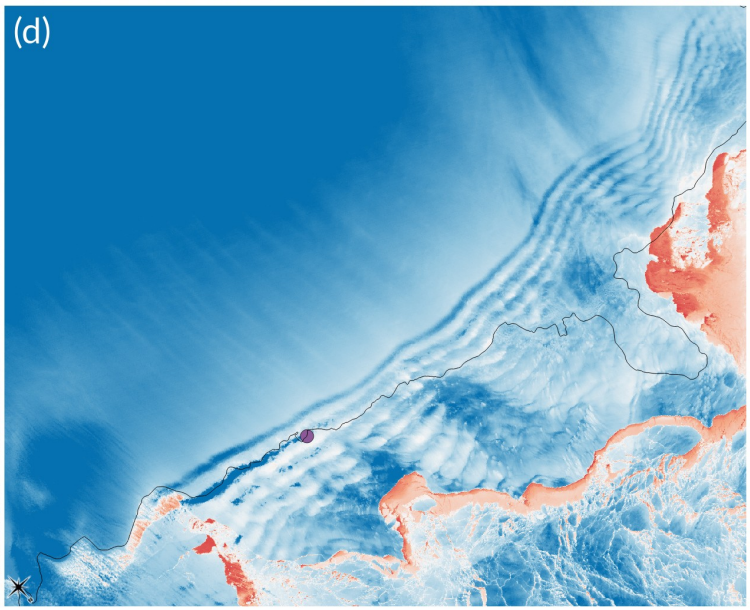


Cold blue band
= jump

06:13 UT
10 August

12:52 UT
10 August

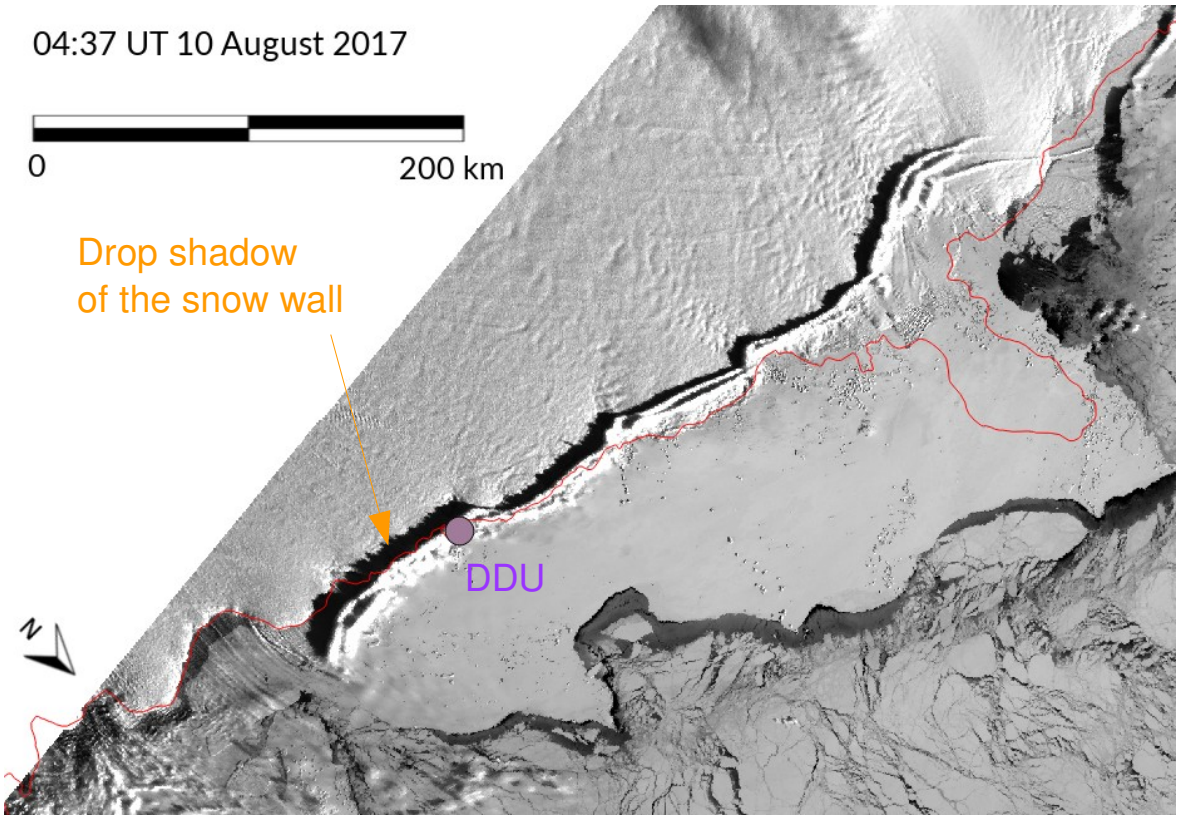




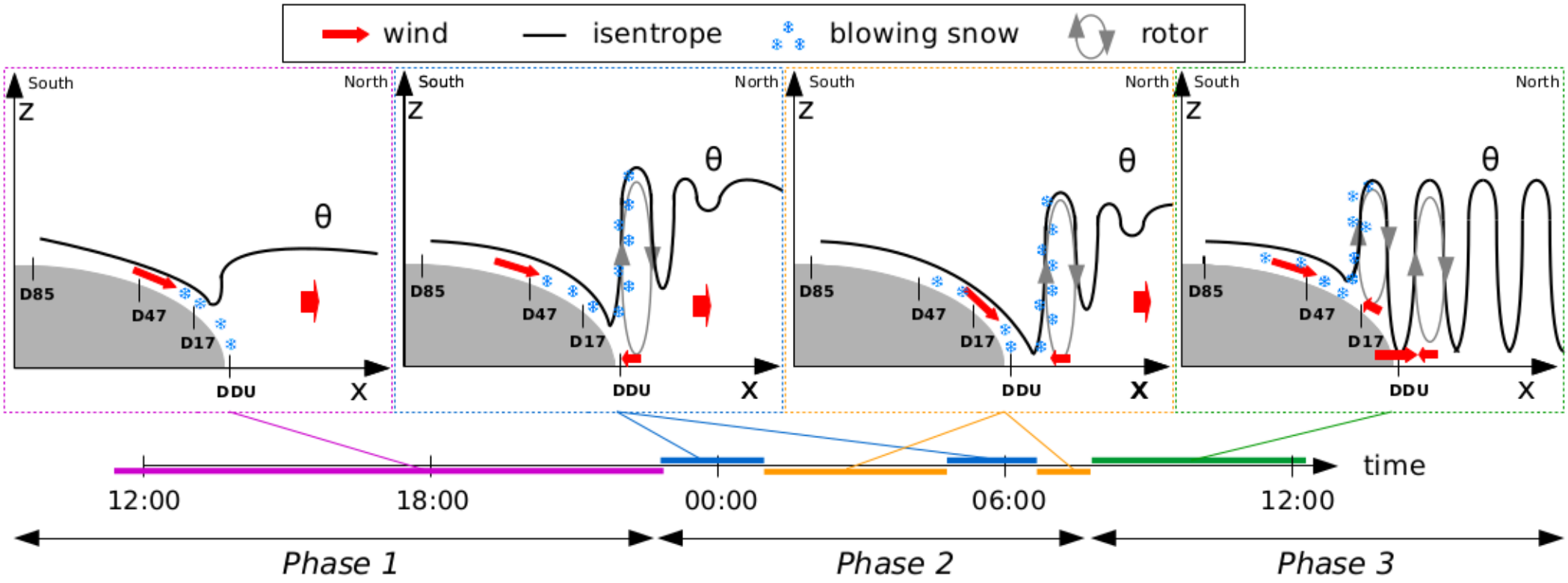
14:28 UT
10 August

Near Infrared MODIS image
(1-km resolution)

H shadow~1040 m H lidar>1050 m



Conceptual view of the katabatic jump and trapped gravity wave development from obs + WRF simulations



Dynamical arguments:
wave trapping is favoured by the destabilization of the upstream flow by the jump
Thanks to WRF simulations:
gravity wave momentum flux → slow-down of the outflow

Discussion - beyond the case study:
How frequent are katabatic jumps at Dumont d'Urville ?

→ Daily meteorological reports (2012-2017)
→ visual examination of all available MODIS images above DDU during 1 year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year
Lidar DDU	/	0	2	1	5	0	1	3					
Obs DDU	0[0,0]	0[0,0]	0.7[0,3]	1[0,2]	2.3[0,5]	1.7[0,6]	1.2[0,3]	3.8[2,10]	4.3[1,11]	1[0,3]	0[0,0]	0[0,0]	16[1,41]
Obs continent	0[0,0]	1[0,3]	5.2[0,11]	9.5[6,16]	5.7[1,12]	4.8[1,11]	5.7[3,11]	12.7[7,19]	10.7[3,24]	5.8[1,12]	0.8[0,2]	0.37[0,4]	62.5[29,114]
MODIS	5/4	4/2	2/1	4/2	7/3	4/2	13/9	2/0	5/3	3/3	4/3	3/3	56/38

→ jumps mostly in winter
→ jumps often associated with waves
→ important (frequent)process to explain the coastal transition of extrene katabatic flows in Adélie Land

Conclusions

- Satellite images + in situ and remotely-sensed measurements + model simulations
  → different steps of the coastal transition of an extreme katabatic flow
-
- “Wall” of blowing snow associated to a **katabatic jump**
- Excitation of a **gravity wave train** by the jump that remains trapped in a second phase
- The drag exerted by the trapped waves considerably slows down the low-level flow

Outlook

- Other regions in Antarctica? Frequency?
- Blowing snow evolution?

Reference

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