MEASURING AND MODELING ICE SUPERSATURATION AT DOME C

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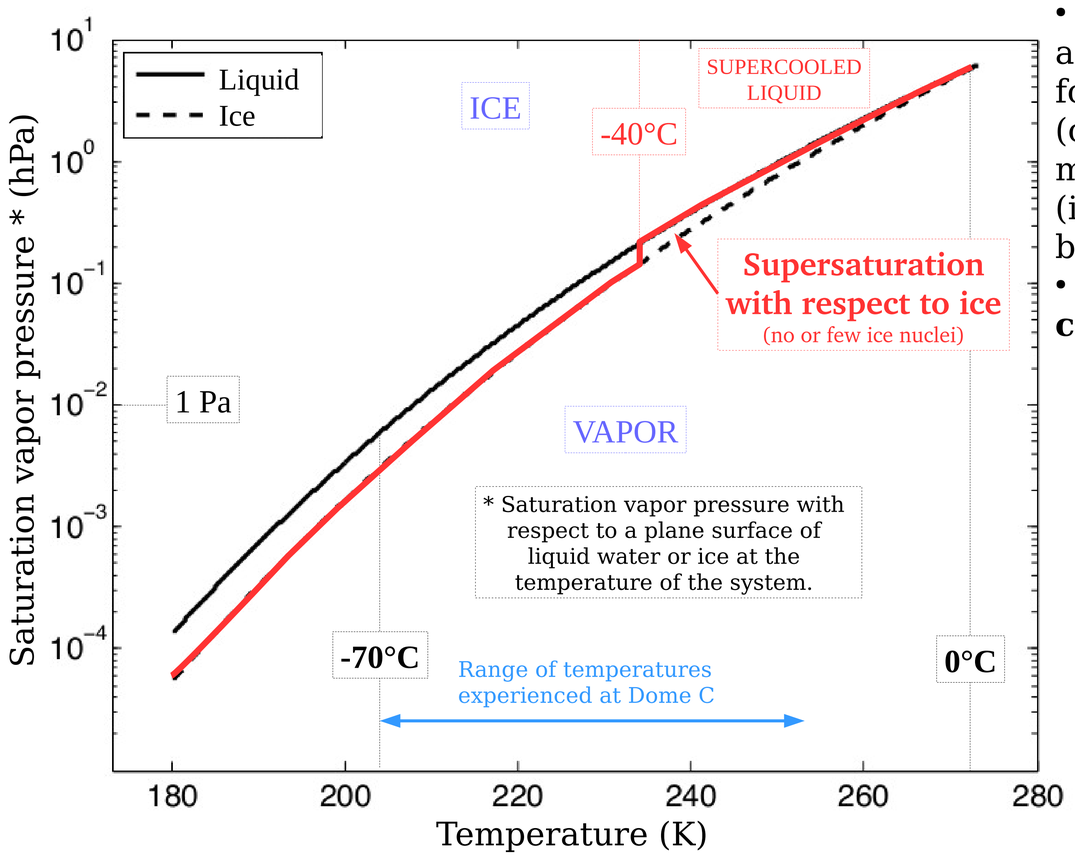
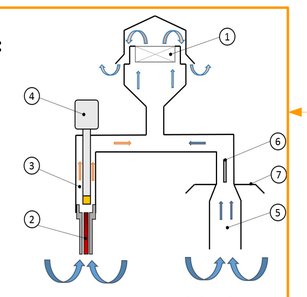
Science objectives



• **Ice supersaturation** is a crucial process but is found at high altitude (cirrus clouds) where measures are difficult (instrumented planes or balloons, moving frame).
• Supersaturation is **also common in Antarctica**.
→ Access to **detailed microphysical conditions** in a fixed frame and over long and continuous periods of time.
→ **Quasi-ideal site** for climate modeling.
→ Opportunity to better understand this process and **improve physical parameterizations** in climate models.

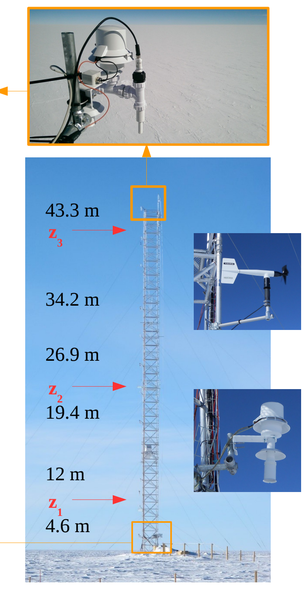
Instruments

Modified HMP:
1: Fan
2: Heating tube
3: Heated air
4: HMP155 (p_{vap} and T°C)
5: Unheated air
6: PT100 (T°C)
7: Shaded inlet

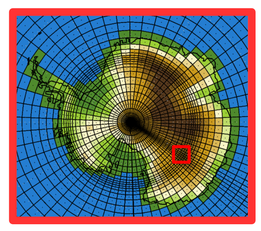


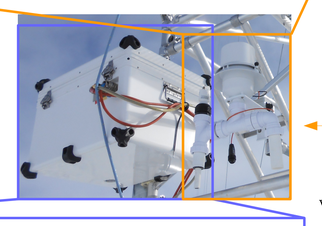
Inexpensive, compact and light, measures down to -80°C.

Might also pump small hydrometeors into the inlet.



Above: Instrumented levels (**black**) and vertical levels (**red**; 6, 22, and 39m) of the LMDz climate model. *Below:* Model grid.



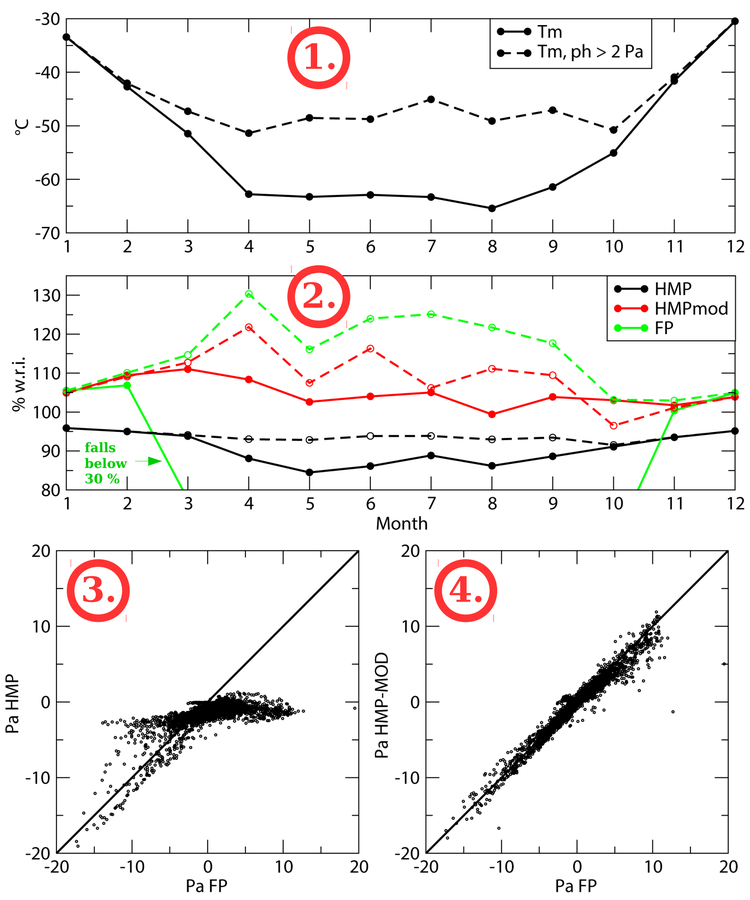


FP: Mirror Frost-Point hygrometer
(Meteolabor VTP 6 Thygan)

Performant at low temperatures and at low specific humidities. Measures supersaturations.

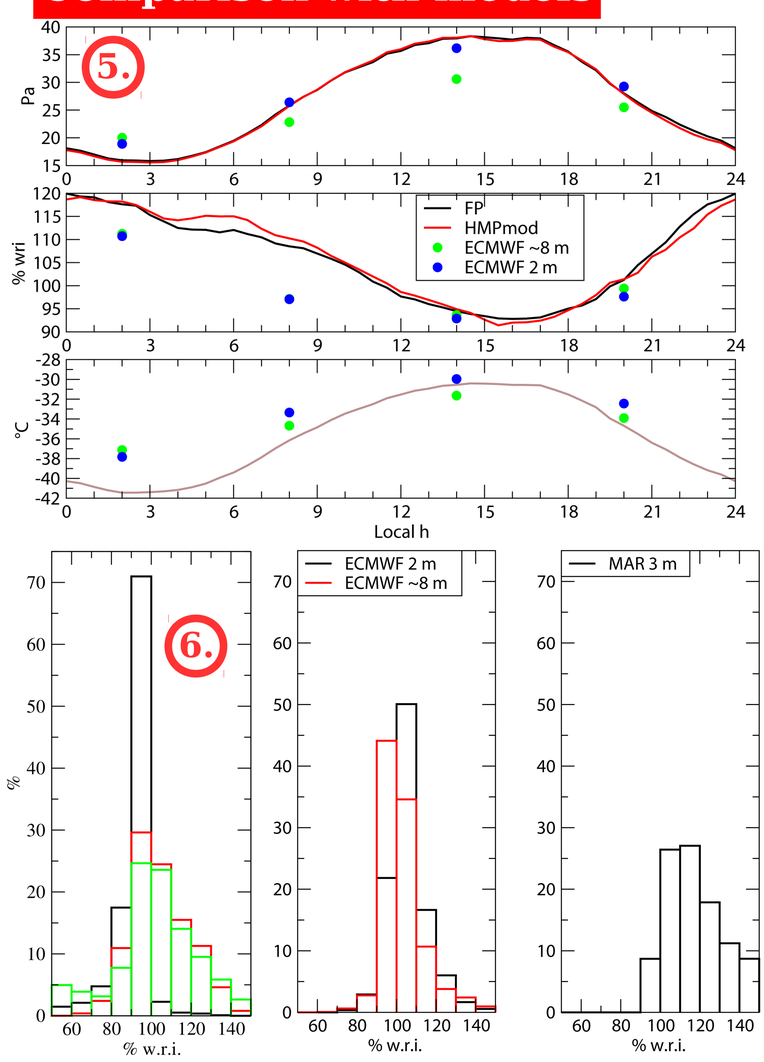
Expensive. heavy, fails below -55°C.

2015 full-year data



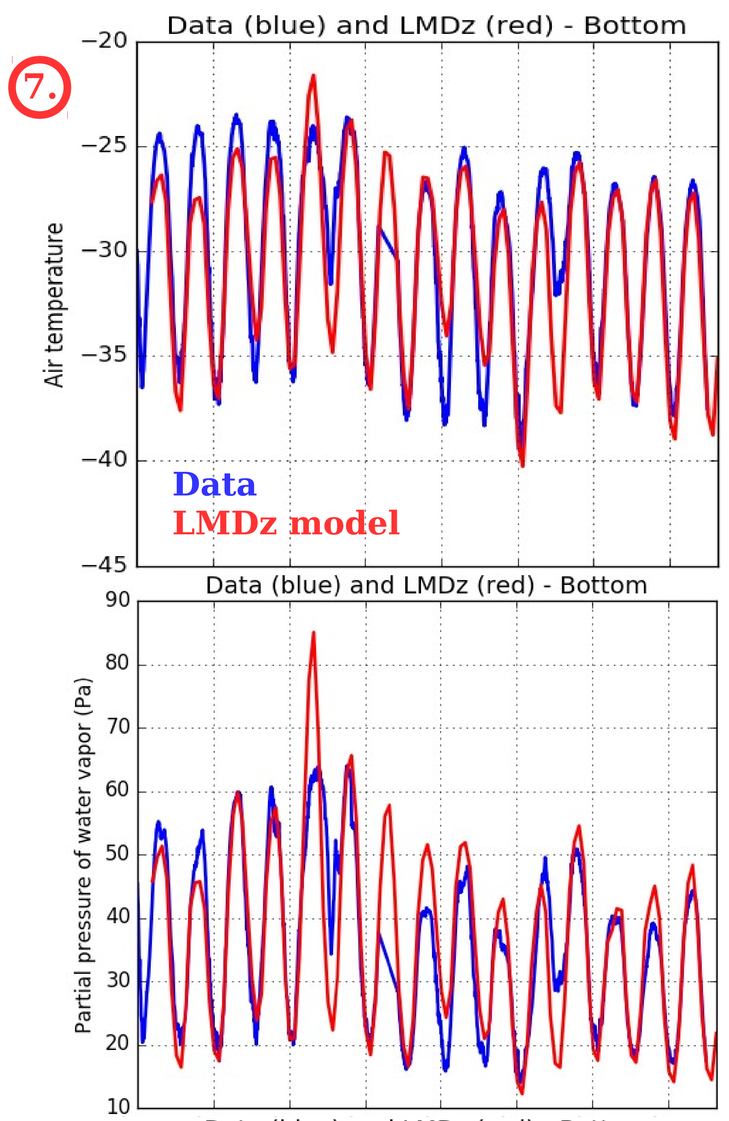
→ **1.** Seasonal variability of monthly-mean temperature and **2.** RH_i. *Solid line:* all data. *Dashed line:* data for partial pressures above 2 Pa only.
→ **3.** Regression of anomaly of saturation vapor pressure from the HMP and modified HMP (HMPmod, **4.**) instruments. The FP (frost-point) hygrometer is taken as reference. Correlation in panel 3. is good below saturation but very poor above, since the unmodified HMP fails to capture supersaturations (see [1]).

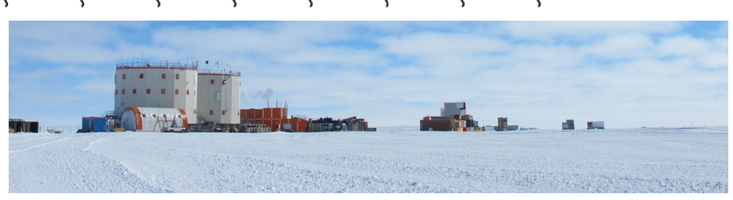
Comparison with models

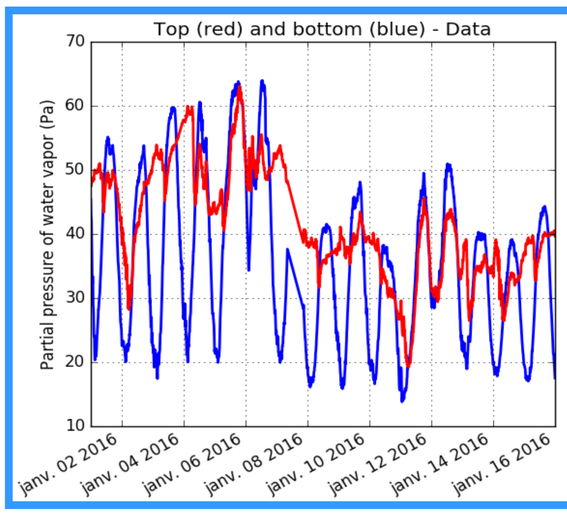


5. Mean DJF diurnal cycle of observed (plain lines) and modeled (dots) water vapor partial pressure (top), relative humidity with respect to ice (middle) and temperature (bottom).
6. Observed distributions of RH_i (left) and comparison to the distributions of the ECMWF reanalyses (middle, see [2]) and MAR model (right, see [3]).

Toward a new parameterization







Partial pressures measured at the top (**red**) and bottom (**blue**) of the mast. The HMPmod is light and can be deployed at multiple levels. This gives access to the vertical gradient and fluxes of water vapor, which is also a precious information for climate models and the modeling of the surface mass balance.

7. Results of a nudged simulation zoomed over Dome C (development version of LMDz, see [4]). The good agreement between the observations (**blue**) and the model (**red**) allows the development of a new parameterization of ice supersaturation (which is underway and not implemented yet, see the bottom panel).

References

[1] C. Genthon et al. (2017) Atmospheric moisture supersaturation in the near-surface atmosphere at Dome C, Antarctic Plateau. *ACP, Vol. 17, Pages 691-704, January 2017.* [2] Tompkins et al. (2007) Ice supersaturation in the ECMWF integrated forecast system. [3] H. Gallée and I. V. Gorodetskaya [2010] Validation of a limited area model over Dome C, Antarctic Plateau, during winter. [4] E. Vignon et al. (2017) Antarctic Boundary-Layer Parametrization in a General Circulation Model: 1D simulations facing summer observations at Dome C.