



SMHI

Presenter: Jose Faundez

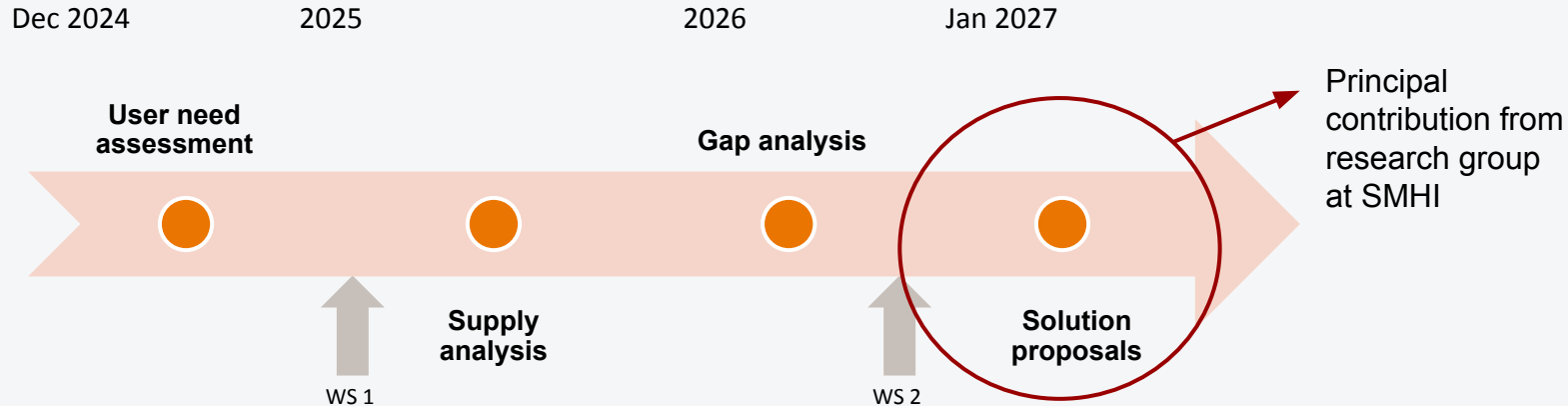
Quality and use of UAS observations (Bäver project - Sweden)

Helene Alpfjord Wylde, helene.alpfjord.wylde@lfv.se
Jelena Bojarova, jelena.bojarova@smhi.se
Jose Faundez, josemanuel.faundezalarcon@smhi.se
Metodija Shapkalijevski, metodija.shapkalijevski@smhi.se

BÄVER

Improved weather services for unmanned aviation (**BÄ**ttre **V**ädertjänst**ER** för obemannat flyg).

The main focus is on UAS needs in terms of weather services, and how they can be used as **sensor carriers to improve weather forecast**.



Motivation

The increasing amount of UAV flights offers new possibilities regarding availability of observations, especially within the boundary layer.

Potential of improved forecast due to more observations in the altitudes of interest for UAV users.

Today's talk:

- Data collected from test flights
- Can we use these observations in our data assimilation system ?

Pilot study: data collection

Flights performed by Lund University.

Drones mounted with sensors measuring temperature and relative humidity.

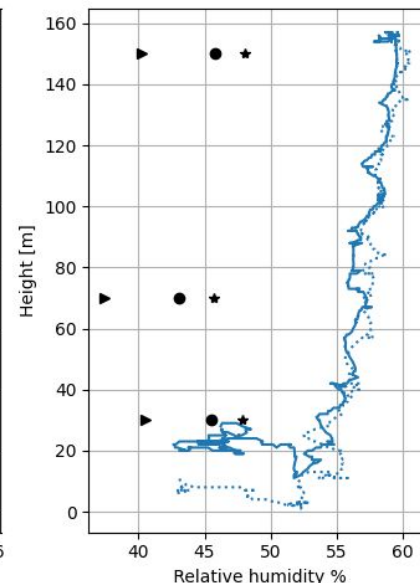
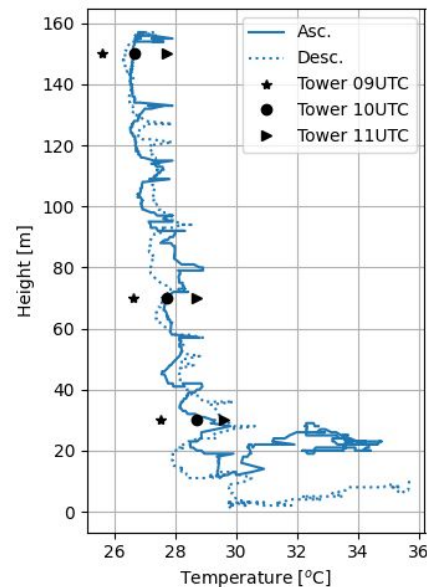


First data set

Data collected from drone flight
@2021/06/18-09:45

Flight next to tower station at
Hyltemossa¹, so we can compare
against the tower measurements.

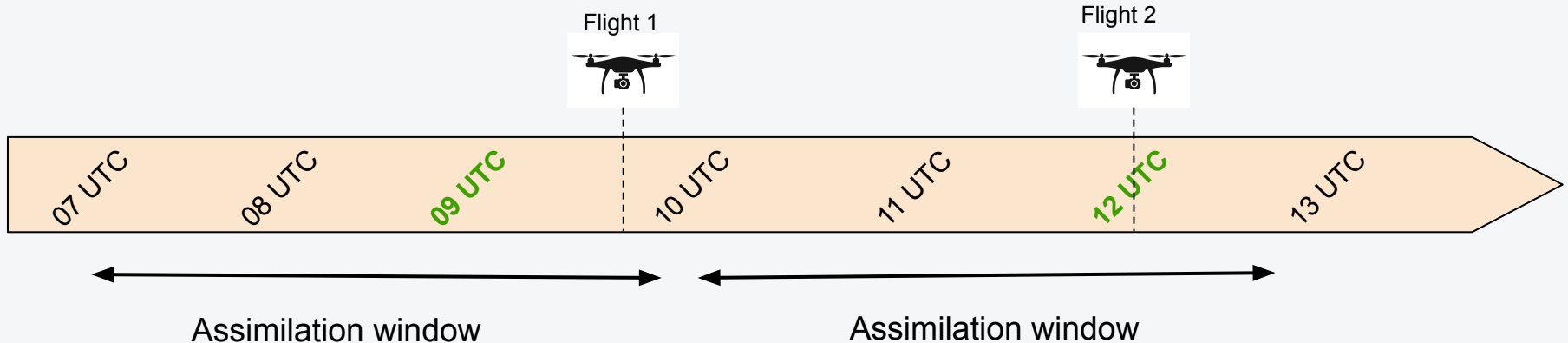
We see a good agreement in
temperature, but bigger
discrepancies in relative humidity



Two new flights under study

More recent flights (2025-11-07) at Campus Ljungbyhed flying at higher altitudes.

The drone was mounted with two sensors, both measuring temperature and relative humidity.

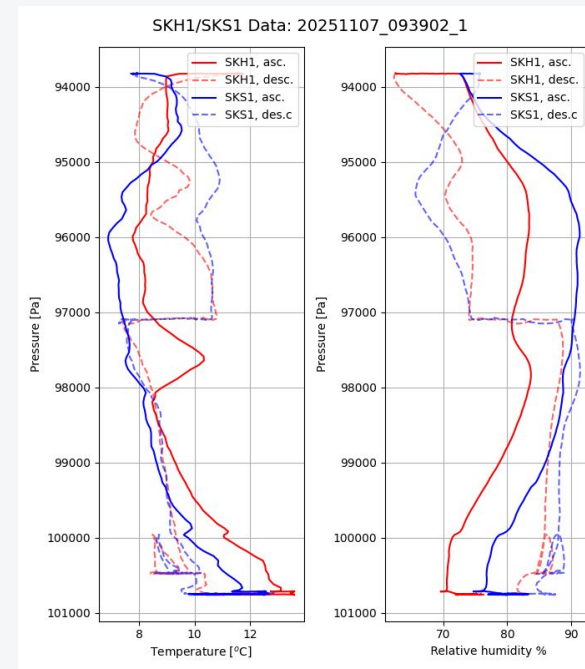
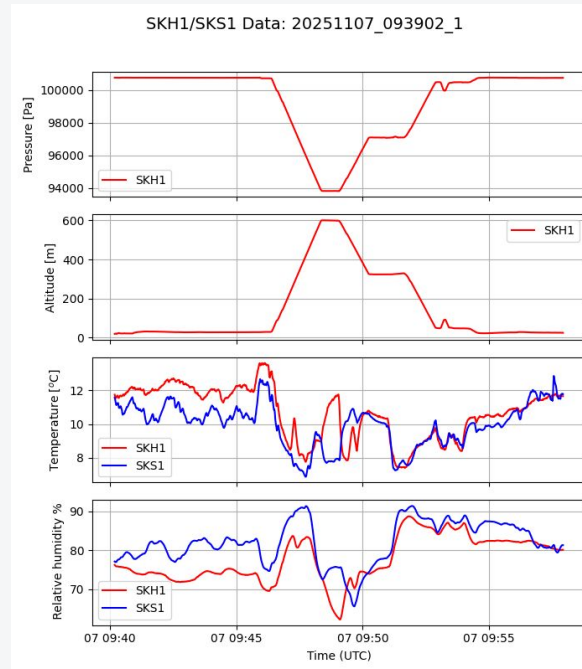


Flight 1: Measurements

Measurements showing some discrepancies between the two instruments for both quantities.

There is also a difference in the ascending and descending path, and a discontinuity after stopping on the way down.

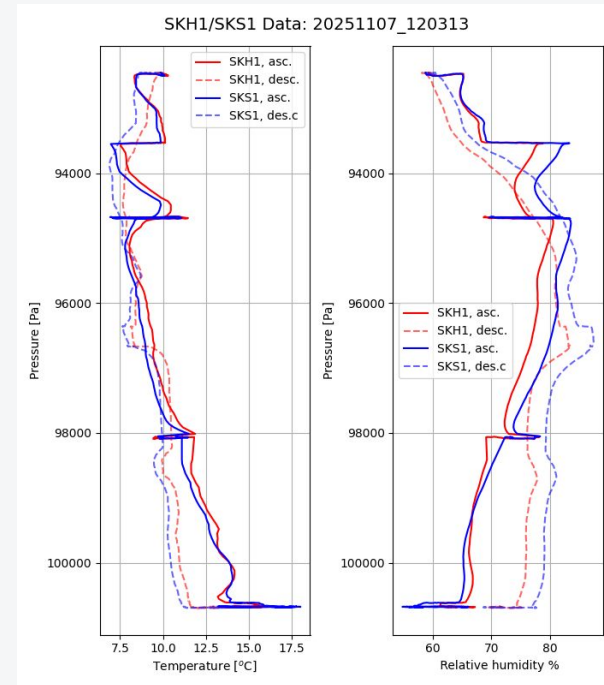
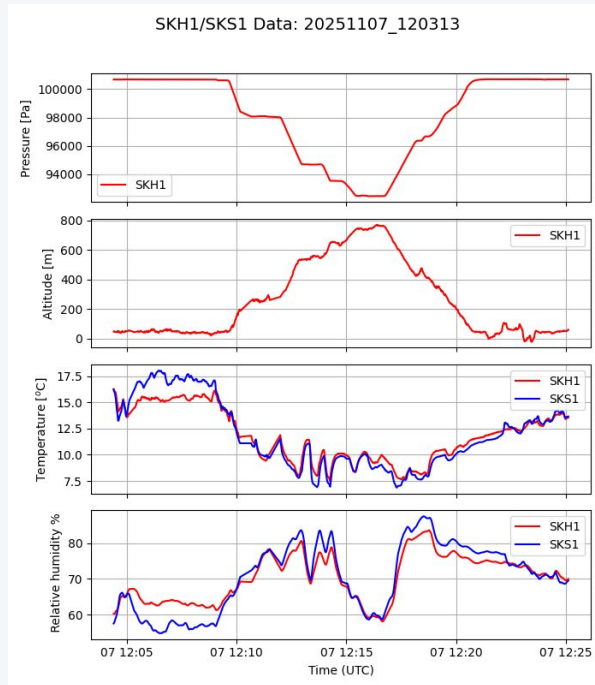
Different instruments might need different time to be exposed to the environment to measure temperature confidently.



Flight 2: Measurements

In general a good agreement between the two instruments.

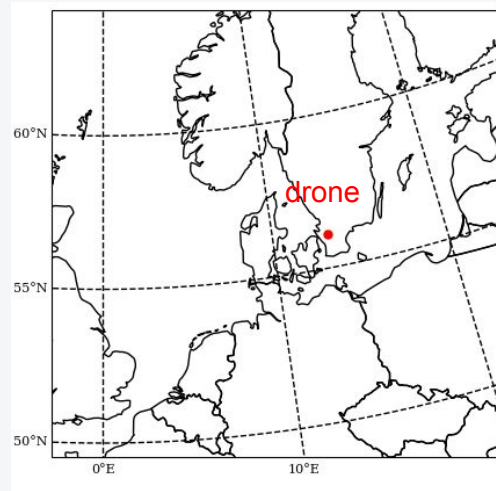
But we still see differences in ascending and descending paths, which could be explained by the different operating conditions causing heat emissions.



Data Assimilation

- Experiments performed in the HARMONIE-AROME system
- 2.5km horizontal resolution, 65 vertical levels
- Drone measurements taken as radiosondes (T,RH)
- Performed four different configurations

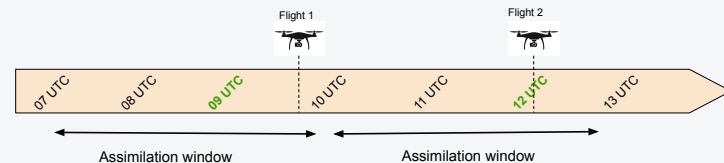
Experiment	DA scheme	Observations
1	3DVAR	SYNOP + Drone
2	3DVAR	SYNOP
3	4DVAR	SYNOP + Drone
4	4DVAR	SYNOP



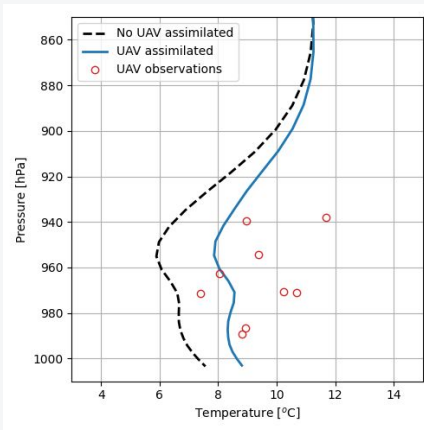
Data Assimilation: Flight 1

Profiles at flight location showing the effect of drone observations.

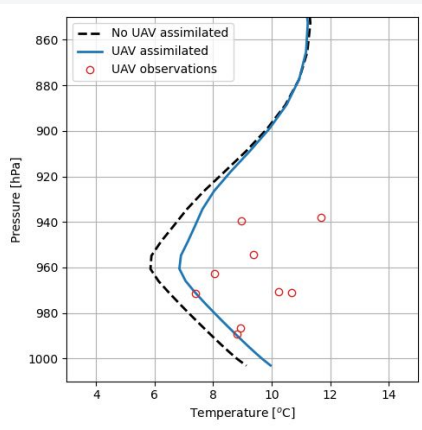
At analysis time, a larger impact with 3DVAR. However, 4DVAR shows a larger impact at 10UTC (closer to flight time)



3DVAR

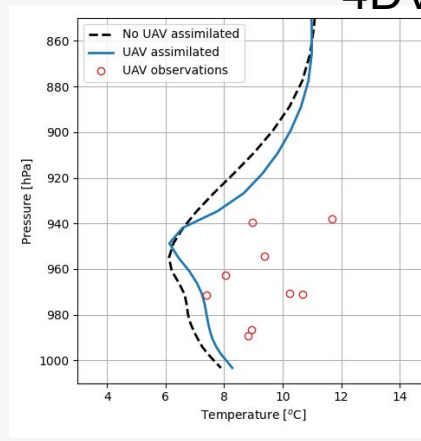


Analysis time 09UTC

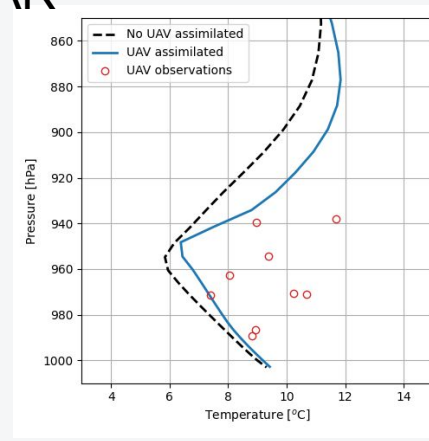


1h Forecast

4DVAR



Analysis time 09UTC

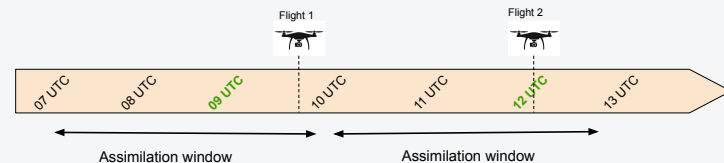


1h Forecast

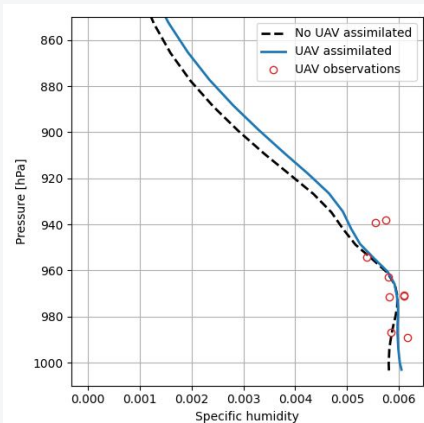
Data Assimilation: Flight 1

Profiles at flight location showing the effect of drone observations.

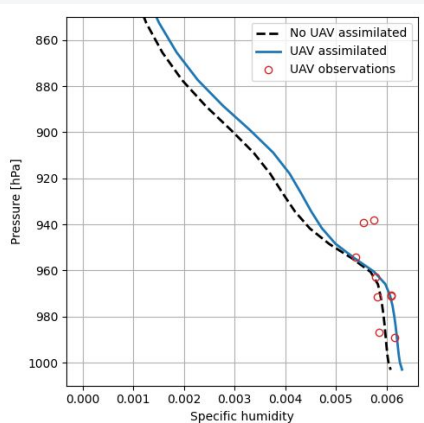
For humidity, larger differences with 4DVAR



3DVAR

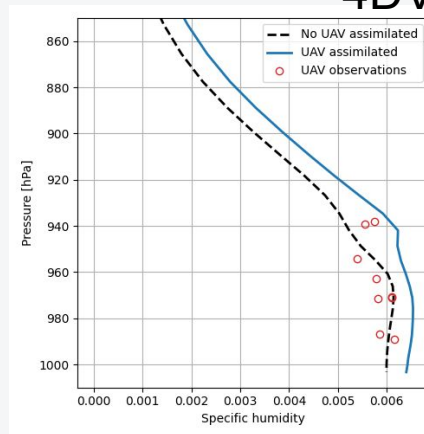


Analysis time 09UTC

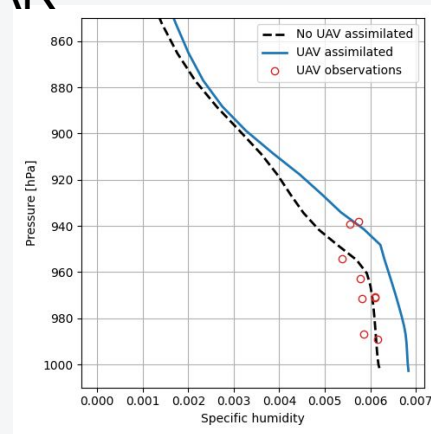


1h Forecast

4DVAR



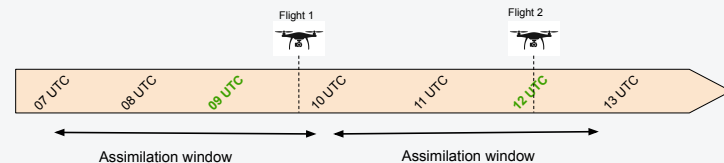
Analysis time 09UTC



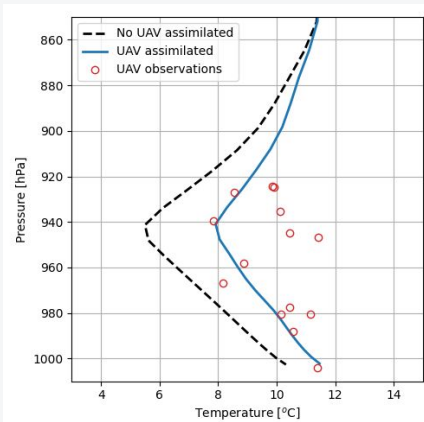
1h Forecast

Data Assimilation: Flight 2

Profiles at flight location showing the effect of drone observations.

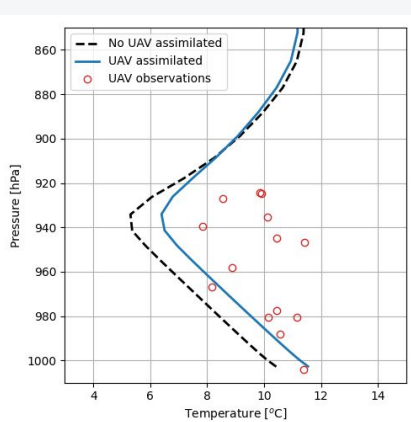


3DVAR

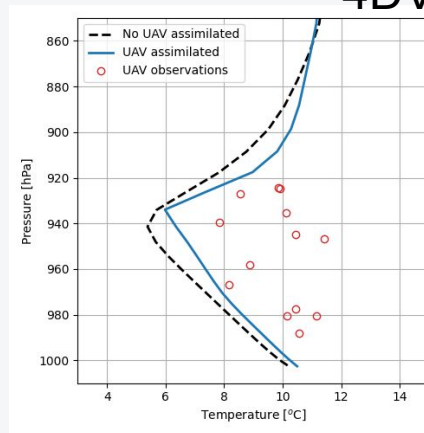


Analysis time 12UTC

1h Forecast

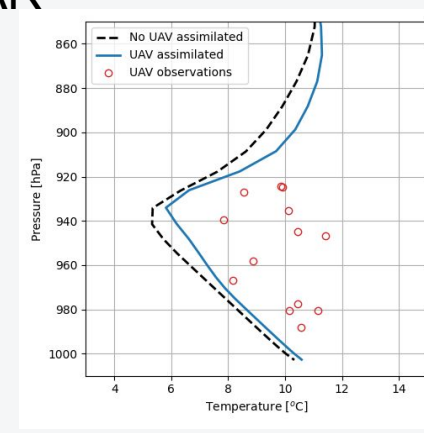


4DVAR



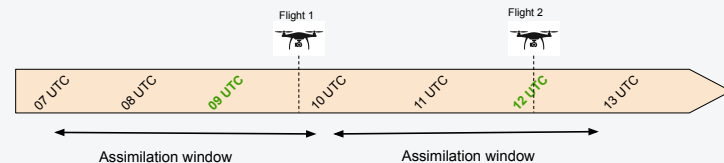
Analysis time 12UTC

1h Forecast

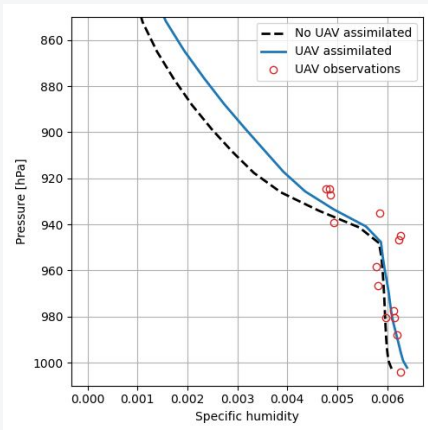


Data Assimilation: Flight 2

Profiles at flight location showing the effect of drone observations.

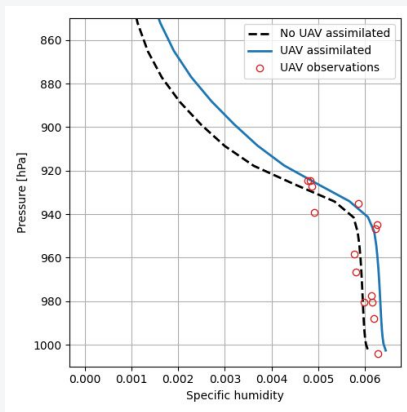


3DVAR

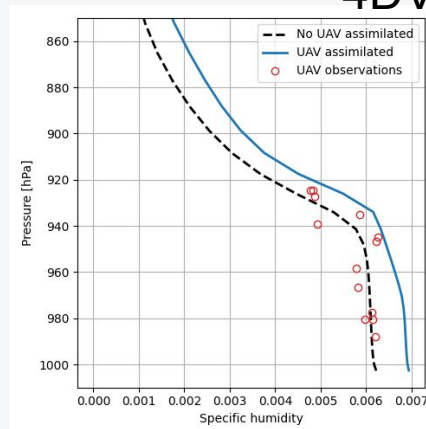


Analysis time 12UTC

1h Forecast

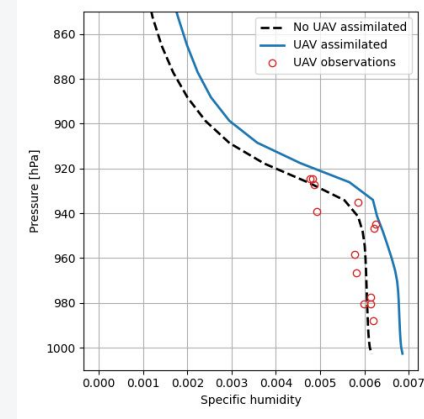


4DVAR



Analysis time 12UTC

1h Forecast



Concluding remarks

- Preliminary studies on the use of drone observations in our system
- Promising results regarding observations quality of atmospheric quantities
- Shown the capability of assimilating the observations in HARMONIE-AROME using different DA schemes

Outlook

- Explore use of WMO NetCDF standard for drones (<https://github.com/synoptic/wmo-uasdc/tree/main>)
- More data is needed to assess observations quality confidently
- Introduce some scheme for bias correction. Likely dependent on operating conditions (ascending, descending, drone properties,...)

Thank you for your attention!

