Very interesting paper. However, we at ECMWF would like some clarifications regarding the use of the ECMWF vertical wind component, which is compared to the lidar observations.

Vertical wind is not something we would expect the ECMWF IFS (normal set-up) to capture well, especially in the hydrostatic model that diagnoses it from vertical derivative of the horizontal divergence of the wind field.

*Could you confirm how you calculate the vertical wind in [m/s] as we provide it in MARS as omega (so in units of [Pa/s]). Do you use the hydrostatic approximation to say w=-omega/(rho*g)?*

And most importantly, do you make sure that you retrieve the full resolution data from MARS at 9 km rather than the truncated field (this is a common mistake by many). For horizontal wind this should not matter too much as it has a lot of power in low wavenumbers, but for the vertical winds this will most likely lead to a severe under-estimation as most of the power is in large wavenumbers that will be ignored by truncation.

Kind regards

Thank you for looking into this, we are very happy to share details that we may want to include in a revised manuscript.

*Could you confirm how you calculate the vertical wind in [m/s] as we provide it in MARS as omega (so in units of [Pa/s]). Do you use the hydrostatic approximation to say w=-omega/(rho*g)?*
Yes we confirm that w is calculated as you describe.

In Detail:

```
modlevel = ncv["level"][:]
surface_geop = ncv["z"][:][0, 0, IDX, :]
lnsp = ncv["lnsp"][:][tstep, 0, IDX, :]
T = ncv["t"][tstep, :, IDX, :]
Q = ncv["q"][tstep, :, IDX, :]
wpress = ncv["w"][tstep, :, IDX, :]

plevel, phlevel = calc_ECMWF_press_3d(lnsp, modlevel=modlevel)

geop = calc_ECMWF_geop_3d(phlevel, T, Q, surface_geop)
Tv = T_virtual(T, Q)

z, g = calc_ECMWF_altitude_g_3d(geop, latitude)

rho = calc_density(plevel, Tv)

w = wpress / (-rho * g)
```

Where „wpress“ is „omega“ in [Pa/s]

And most importantly, do you make sure that you retrieve the full resolution data from MARS at 9 km rather than the truncated field:

We specify the full spectral resolution with „res=1279“ statement.
However we noticed that the keyword may have changed to „resol“
https://confluence.ecmwf.int/pages/viewpage.action?pageId=171422484

Please find below the complete retrieve statements:

```
 server = ecmwfapi.ECMWFService("mars")
…
 basepar={
        "stream"  : "oper",
        "class"   : "od",
        "type"    : "an",
        "expver"  : "1",
        "date"    : "{}".format(date),
        "time"    : "0",
        "grid"    : "0.25/0.25",
        "levtype" : "ml",
        "levelist": "1",
        "area"    : "{}/{}/{}/{}".format(latlim[1], lonlim[0], latlim[0], lonlim[1]),
        "domain"  : "A",
        "res"     : "1279",
        "param"   : "129.128",
        }
 b=basepar.copy()

 execute(server, basepar, filekey + "_1.grb")

 b["param"]="152.128"
 b["type"]="fc"
 b["time"]="0/12"
 b["step"]="0/1/2/3/4/5/6/7/8/9/10/11"

 execute(server, b, filekey + "_2.grb")

 b["param"]="T/U/V/W/O3/155.128/138.128/133.128/248.128"
 b["levelist"]="1/to/{}".format(levno)

 execute(server, b, filekey + "_3.grb")

 combine_forecast_modlev(filekey)
```

We like to mention that the downsampling to the 0.25° grid (to save space) lead to sligtly uncertain results.
We repeated the retrieval and sampled on a 0.125/0.0625 grid and observed differences of less than 0.1 m/s in the vertical wind.

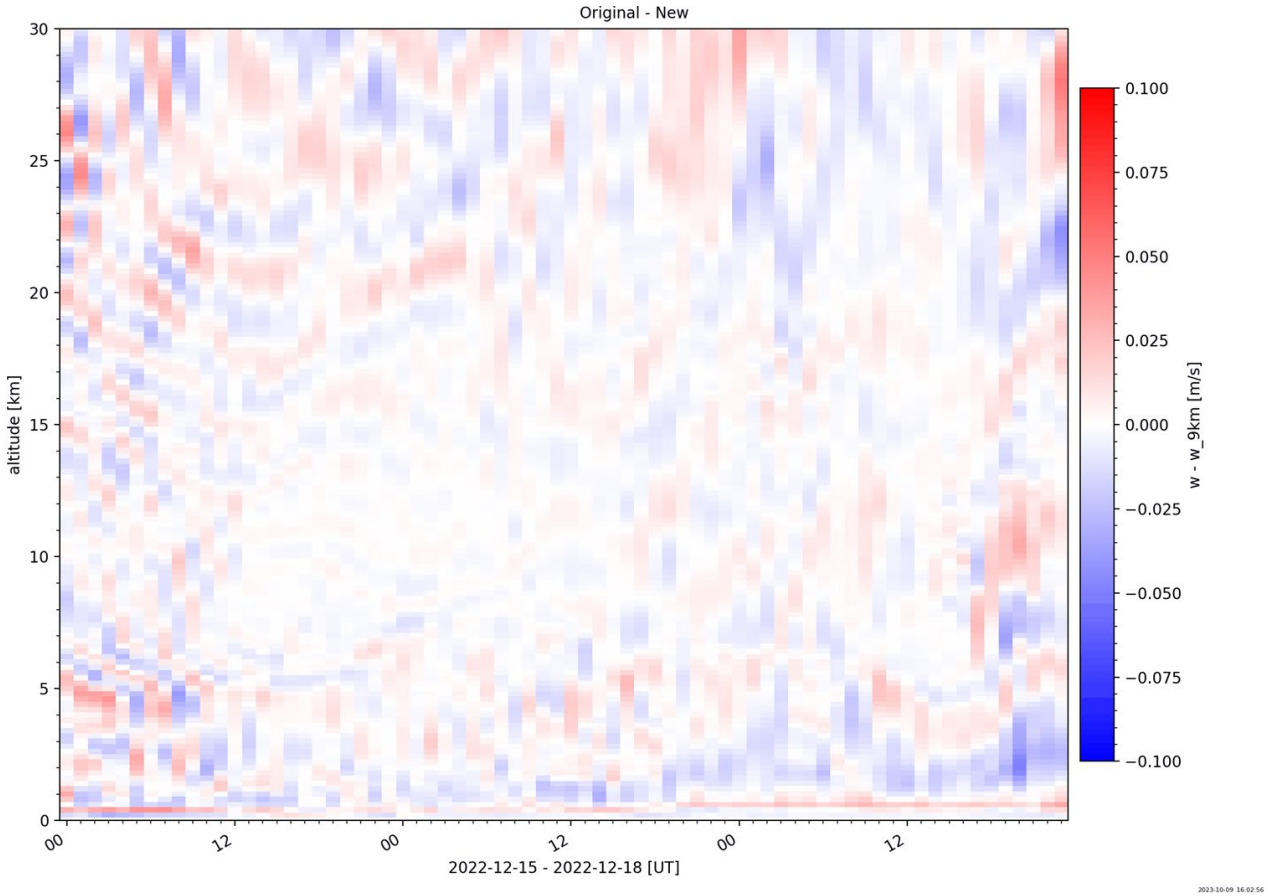

Fig. 1: Vertical wind differences of data sampled on a 0.25/0.25 grid minus 0.125/0.0625 grid.

For the meridional wind gradient we find most often differences of less than 1 m/s

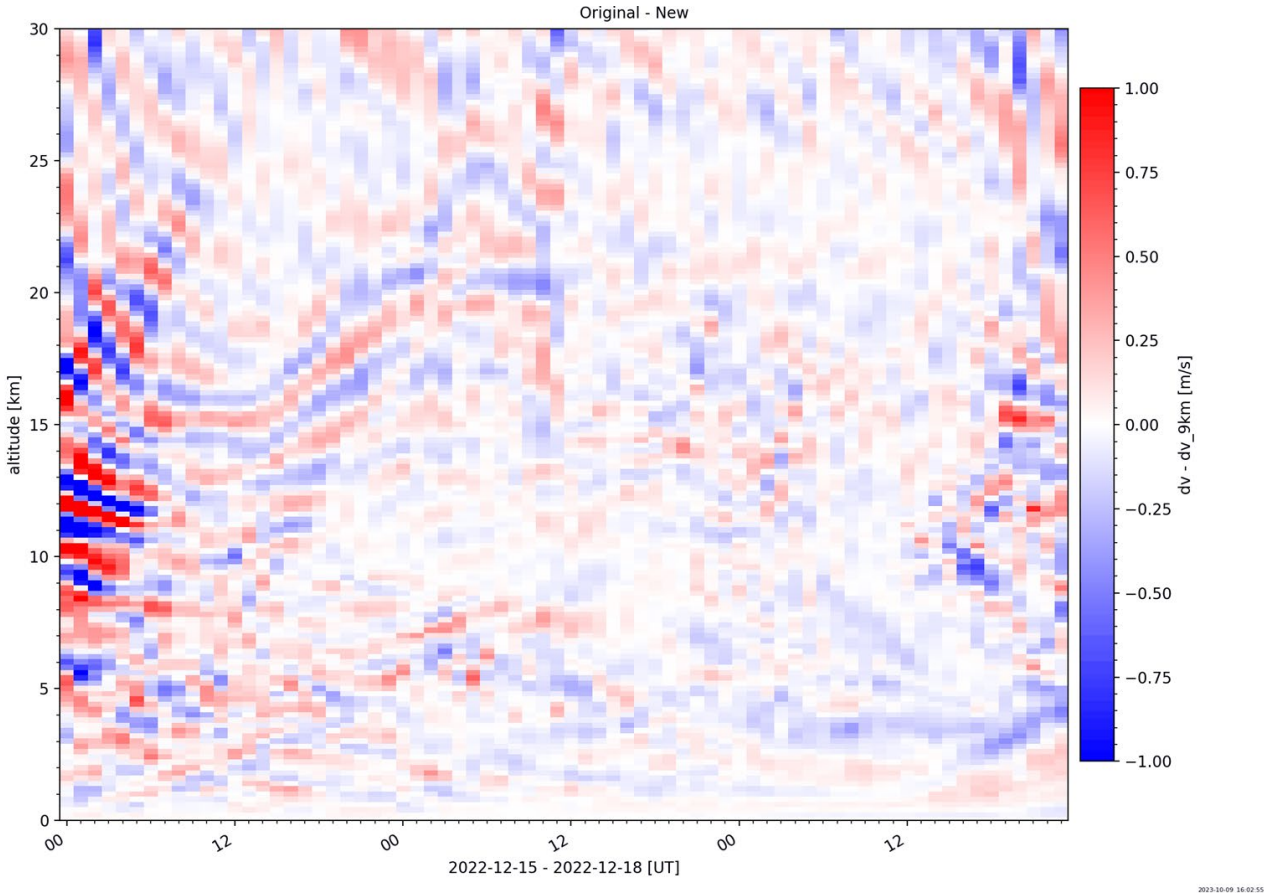

Fig. 2: Meridional wind gradient differences of data sampled on a 0.25/0.25 grid minus 0.125/0.0625 grid.

We can also confirm, that the effect on the horizontal winds and especially on the observation of the wind gradient is not affected by this.

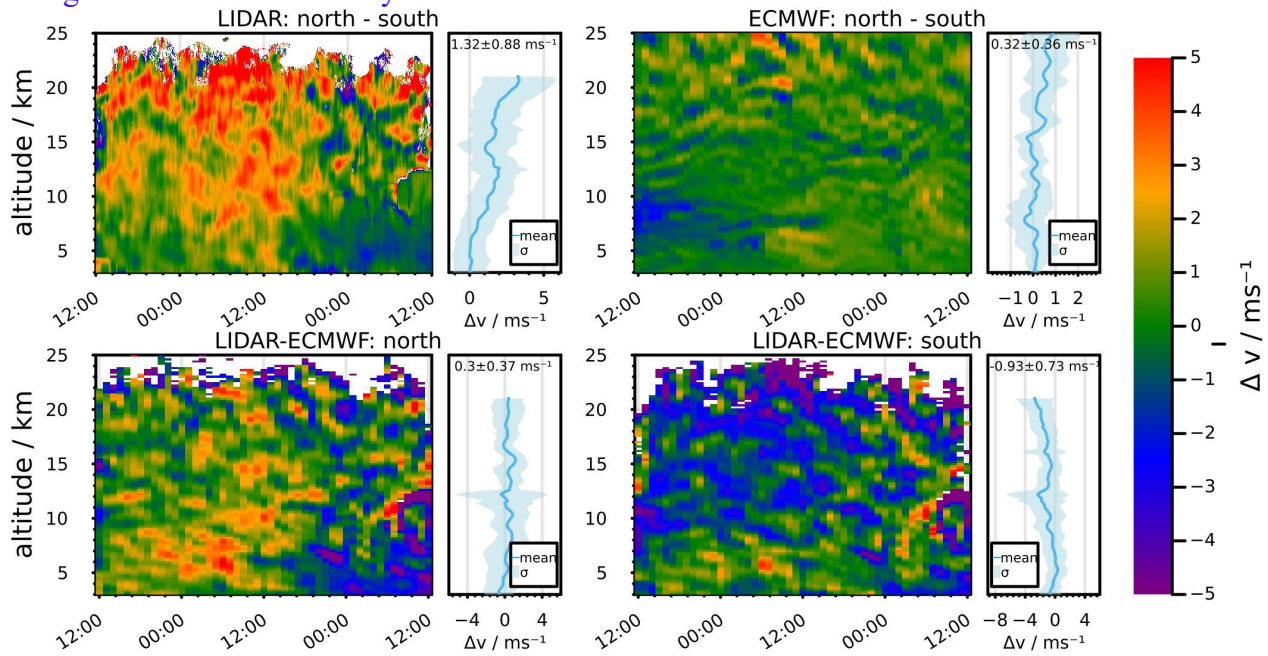

Fig. 3: Same as Figure 9 in the Paper, but with the updated ECMWF retrieval. No significant difference is visible.

During our investigation of Figure 9, we realised, that a software error caused the observational filter to not be correctly applied. We corrected this, leading to a slightly changed figure 9. The conclusions drawn from the figure remain the same.

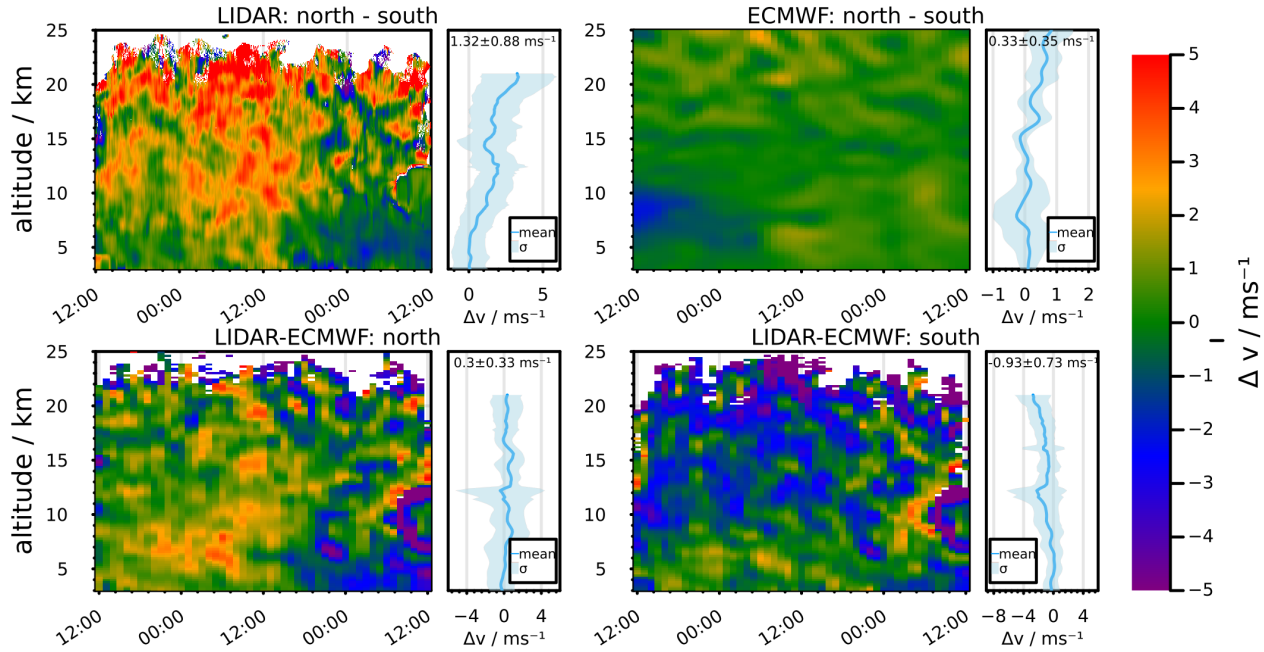

Fig. 4: Updated figure 9, with corrected observational filtering applied to the ECMWF data.