What drives the day-to-day variability of forecast uncertainty over the North Atlantic?

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MOTIVATION, MAIN QUESTIONS and CONCLUSIONS

- Growth and propagation of **forecast uncertainty** is **flow dependent** and **distinct flow features relevant for "forecast busts"**, e.g. warm conveyor belts (WCBs), Mesoscale convective systems, recurving tropical cyclones (Rodwell et al. 2013, Lillo and Parsons 2016, Grams et al. 2018, Berman and Torn 2019)
- **Day-to-day variability** of forecast uncertainty has not received much attention

1 Which synoptic situations lead to the largest/lowest forecast uncertainty over the North Atlantic at day 4?

Strong poleward moisture transport at the US east coast and high WCB activity and ridge building over the NA result in large forecast uncertainty.

2 Is forecast uncertainty higher when strong WCBs are present?

Yes, on average by ~10% one day later over the North Atlantic (NA) and 3 days later over the Mediterranean (Med)

1

(a) high spread

- ridge over NA
- cyclones over northeastern North America and central NA
- high WCB activity
- poleward moisture transport at US east coast
- followed by enhanced spread and cyclogenesis over the Med.

(b) low spread

- zonal pattern over western NA
- cyclone south of Greenland
- low WCB activity
- no/weak moisture transport

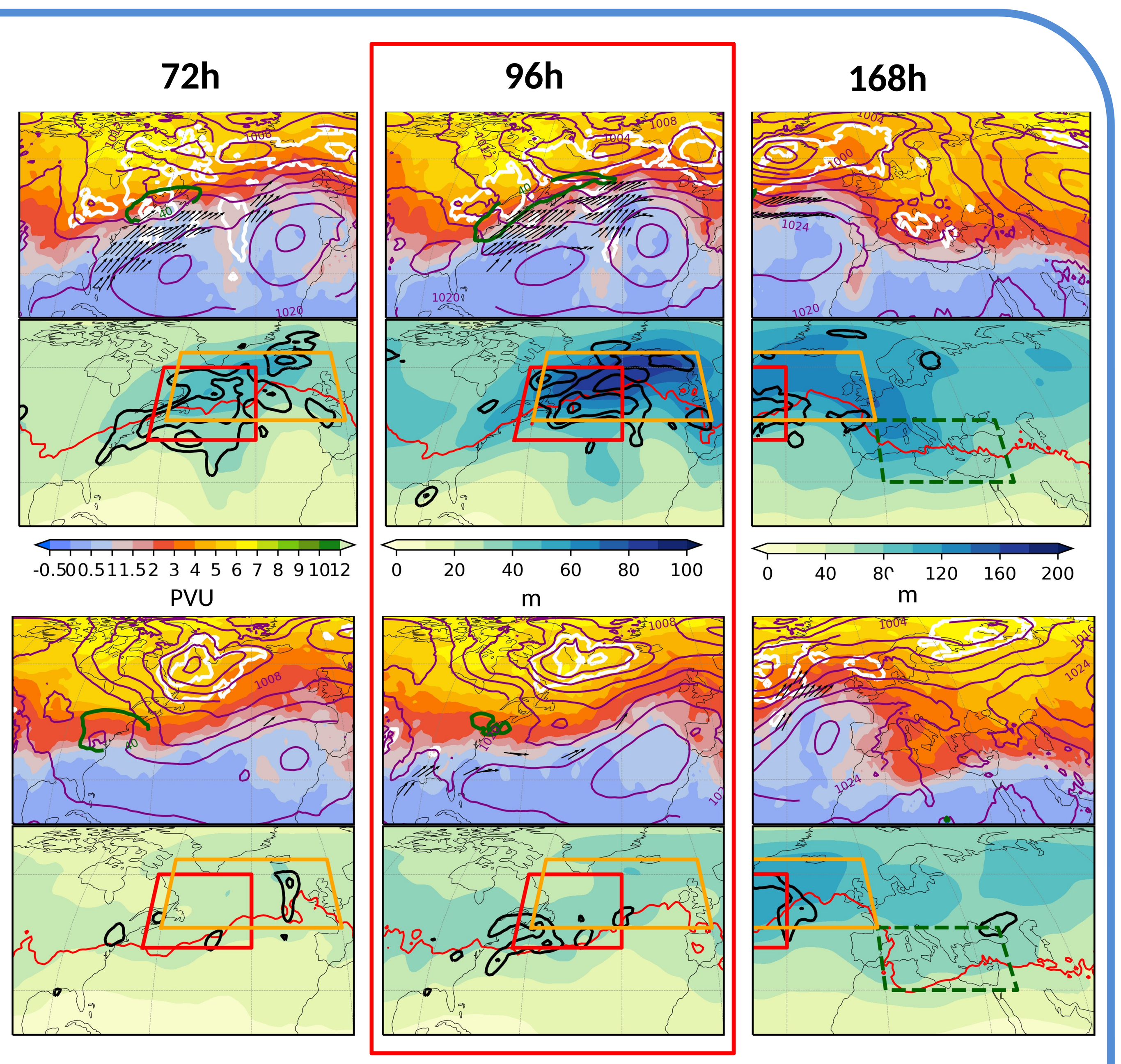

Figure 1 : Composites of (top rows) PV on 320 K (shading, in PVU), wind speed at 250hPa (green contour, in ms^{-1}), cyclone frequencies (white contours, 25 and 50 %), IVT vectors (black arrows, > 300 $kgm^{-1}s^{-1}$), and SLP (purple contours, hPa) and (bottom rows) ensemble spread of Z at 250 hPa (shading, in m), and WCB outflow (black contours, 8 and 16·10E-5 traj/km²). Colored boxes see caption of Fig. 3.

2

After strong WCB outflow ensemble spread is ~10% higher than for random situations

1 day later over the NA

3-4 days later over the Mediterranean

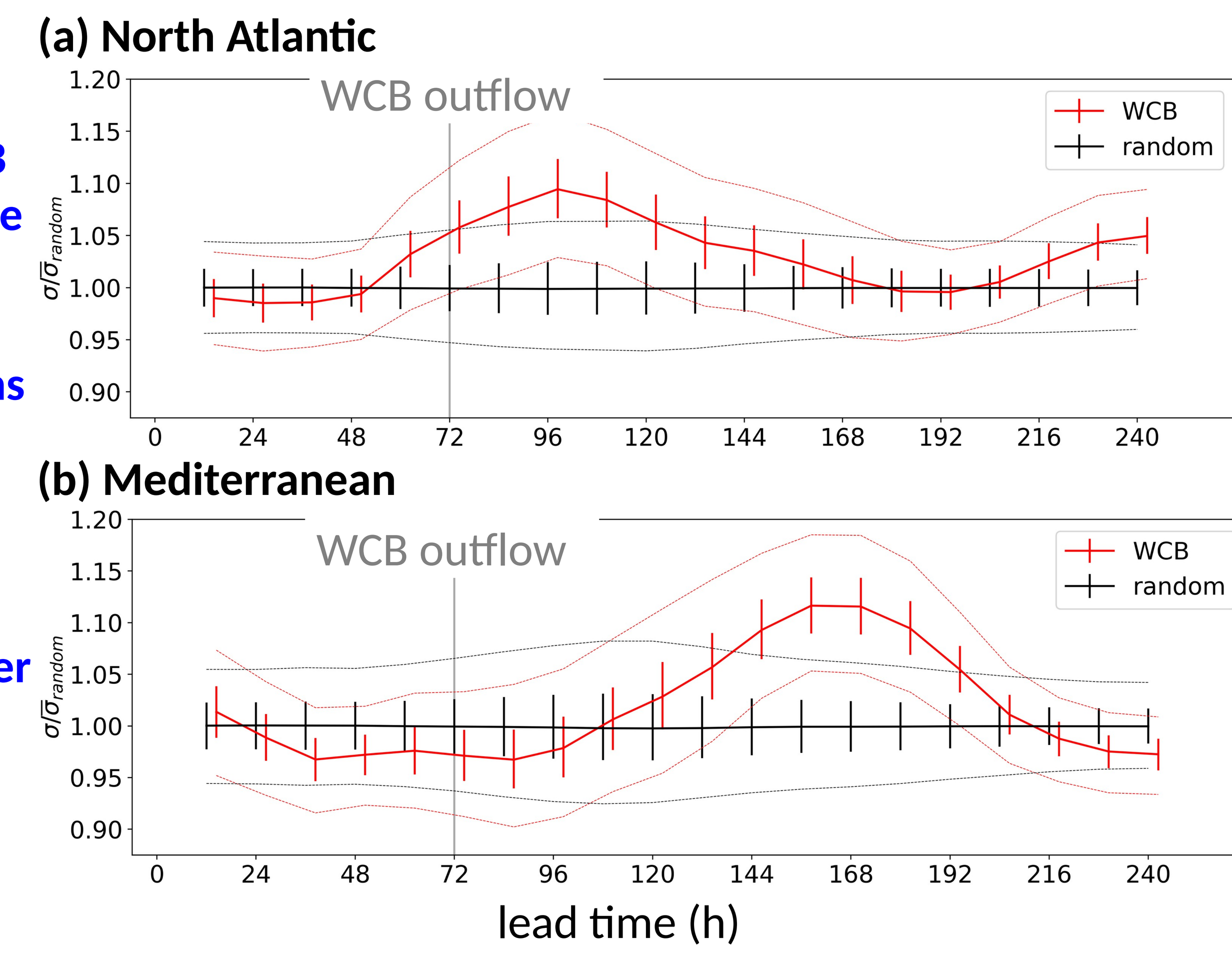

Figure 2 : Temporal evolution of median (solid), interquartile range (vertical lines), 10th and 90th percentile (dotted) of the bootstrapped distributions of ensemble spread for forecasts with strong WCBs occurring in the analysis at lead time 72 h (red) and random samples (black) normalized with respect to the mean of the random samples for (a) NA and (b) Med.

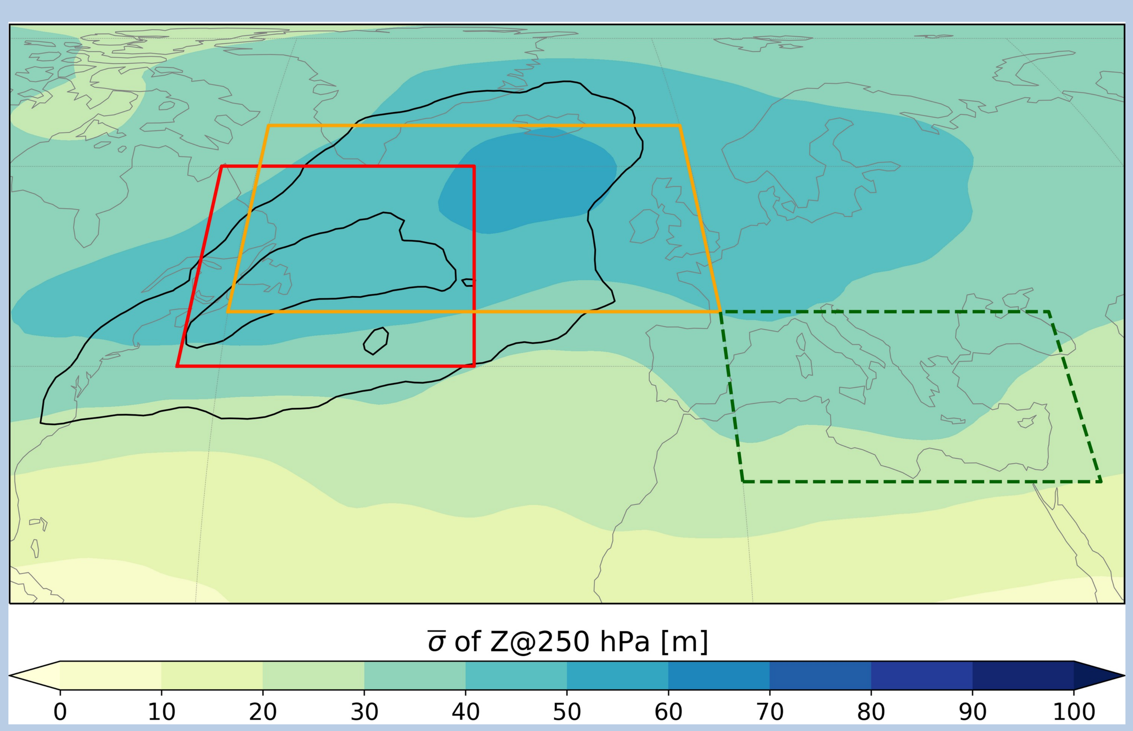

Figure 3: Climatological ensemble spread of Z at 250 hPa at 96 h leadtime (shading, in m) and WCB outflow density (black contours; 4 and 8·10E-5 traj/km²) averaged over all IFS ENS forecast in winters 2017/18 and 2018/19. Averaging regions for WCB outflow (red box) and ensemble spread (orange and green), appear also in Fig. 2.

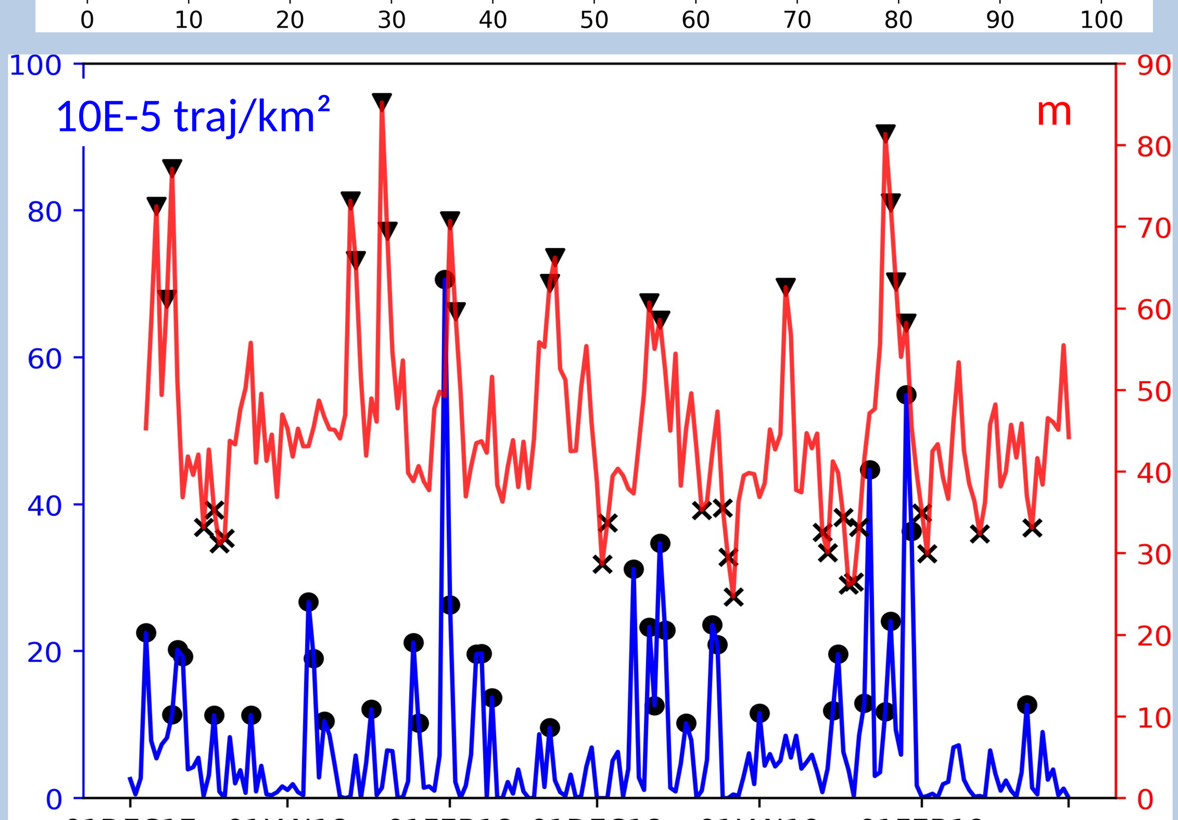

Figure 4 : Time series of WCB outflow density over NA (blue, in 10E-5 traj/km²) and ensemble spread (red, in m) at 96 h for the forecasts initialized 72 h before the indicated date

DATA AND METHODS

ECMWF data

- Two winters (DJF 2017/18, 2018/19) of daily (init. 12 UTC) operational ensemble forecasts of geopot. height (Z) at 250hPa, 12-hourly timesteps
- operational analysis, 6-hourly timesteps

A) Time series based on climatological link between ensemble spread and WCB outflow (see Figs. 3 and 4)

- Area averaged ensemble spread of Z at 250hPa over NA (orange box in Fig. 3) and Med (green dashed box) for lead times 12-240h
- Area averaged WCB outflow density daily at 12 UTC (red box)

B) Composites of 20 forecasts with highest/lowest (▼/ × in Fig. 4) 96 h ensemble spread over NA (see 1)

C) Select times of 20% strongest WCB outflows (● in Fig. 4) and perform bootstrapping to quantify differences between WCB situations and random situations (see 2)

References

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