

Influence of stratospheric and tropical teleconnections on signal, noise and skill in subseasonal forecasts

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Key points

- 11-member ensembles of free running (CTRL), stratospheric relaxation (STRAT) and tropical relaxation (TROP) forecasts by ECMWF model for 180 initial dates in Dec-Jan 1999-2019
- Tropical teleconnections increase sea level pressure (SLP) skill mostly over the sub-tropics and North America (**Fig.1**)
- Stratospheric teleconnections increase SLP skill mostly over the Arctic and the NAO region (**Fig.1**)
- Teleconnections increase ensemble mean variability (signal) and reduce spread (noise) but, in areas with low signal-noise ratio (SNR), the changes in SNR do not coincide with changes in skill (**Figs. 2-4**)
- The lack of correlation between changes in skill and in SNR suggests that sampling uncertainty masks the teleconnection signal
- In most extratropical regions, 20-50 or more ensemble members are required to extract the teleconnection signals at subseasonal timescales (**Figs. 2-4**)

1. Skill and signal-noise ratio

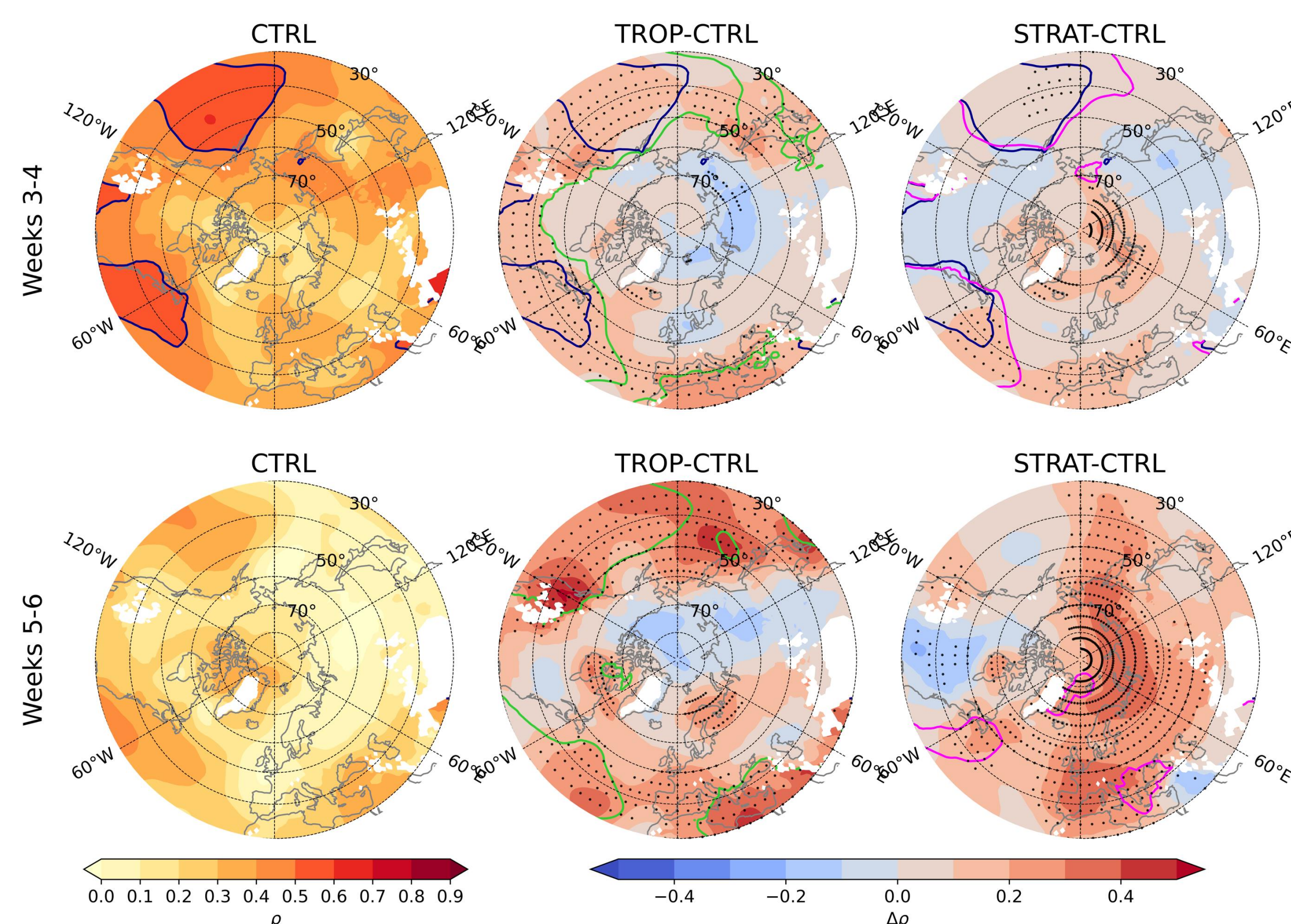


Fig.1: Anomaly correlation coefficients (ρ) for bi-weekly mean SLP anomalies for (left) CTRL; and the differences in ρ between (centre) TROP and CTRL and (right) STRAT and CTRL experiments. Dark blue line marks $\rho = 0.5$ contour in CTRL. Light green and magenta lines mark $\rho = 0.5$ contour in TROP and STRAT experiments respectively. Grid points with elevation above 2000m are masked in white. Stippling indicates significant differences ($p=0.05$) between CTRL and the respective relaxation experiments.

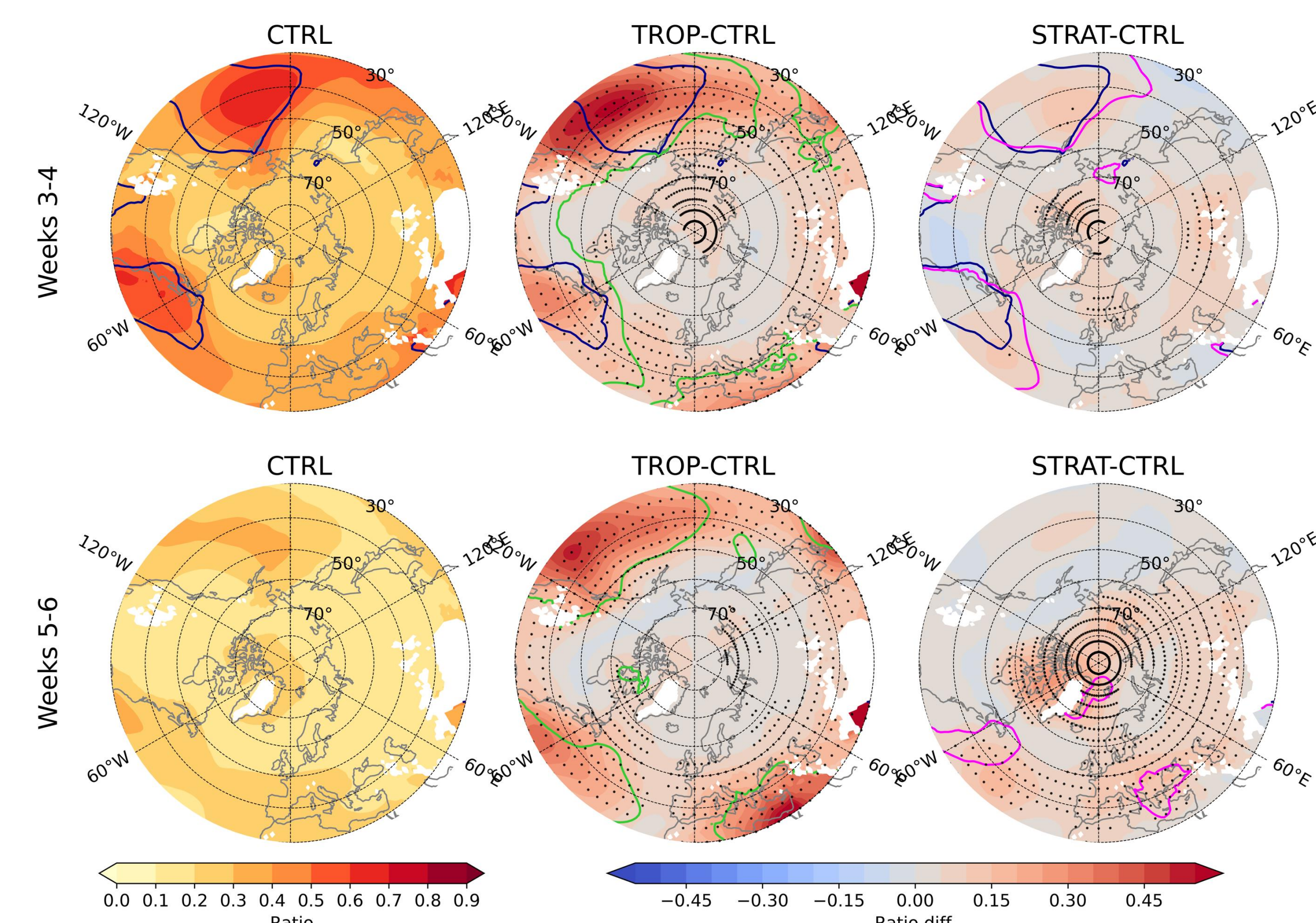


Fig.2: Same as in Fig. 1 but for signal-noise ratio.

2. Signal and noise

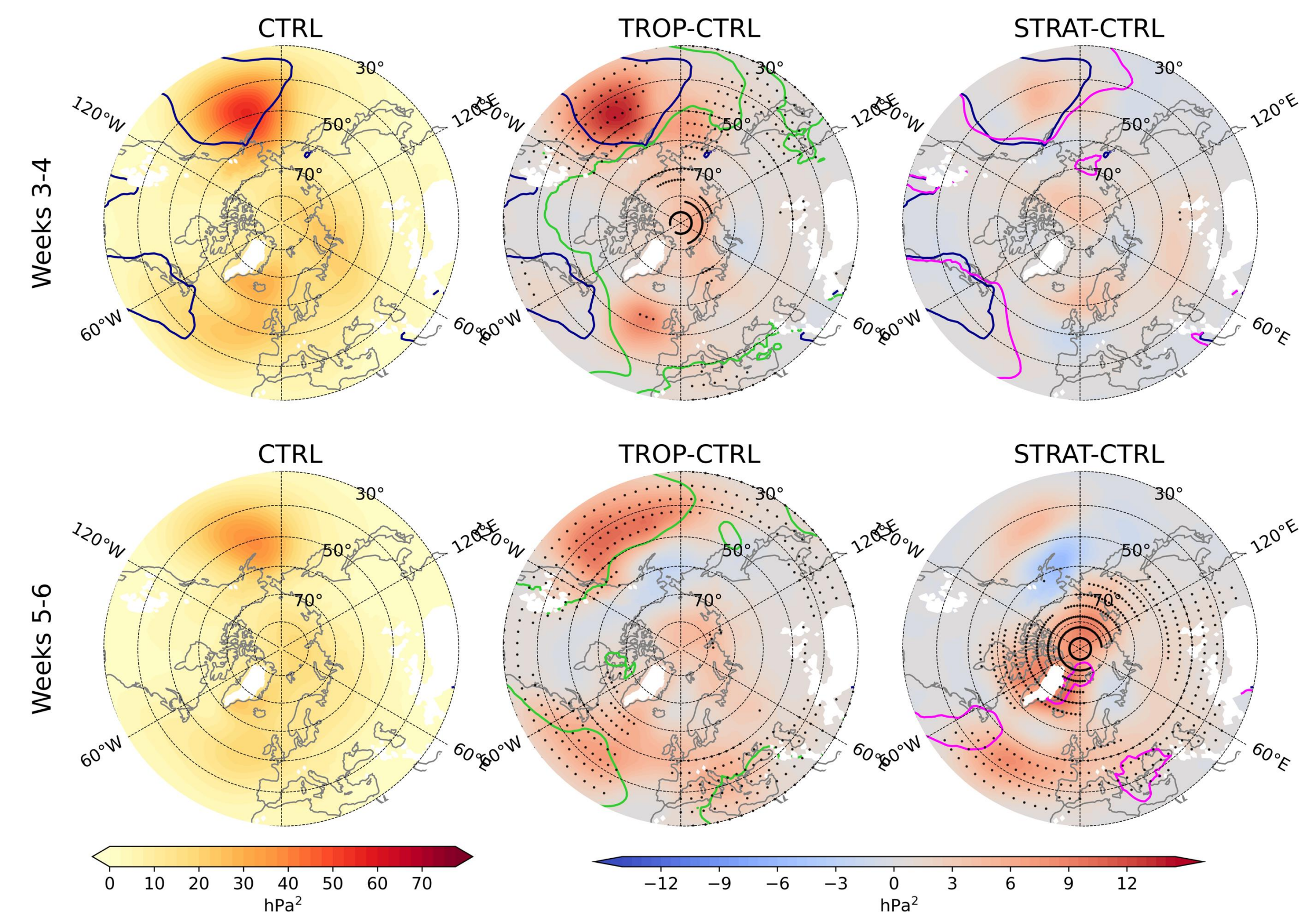


Fig.3: Same as in Fig. 1 but for ensemble mean variance (signal)

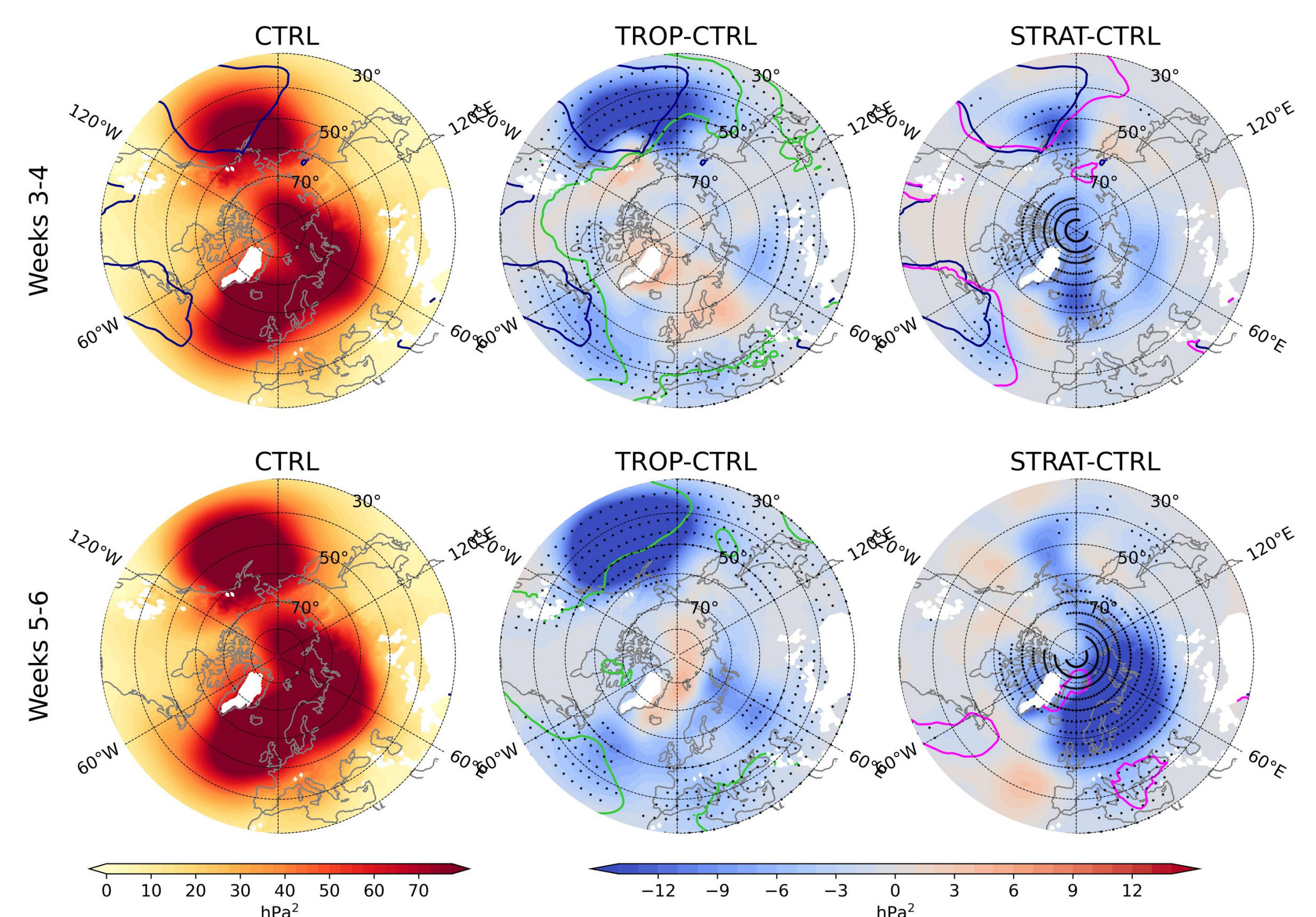


Fig.4: Same as in Fig. 1 but for mean ensemble spread (noise)

3. Ensemble size

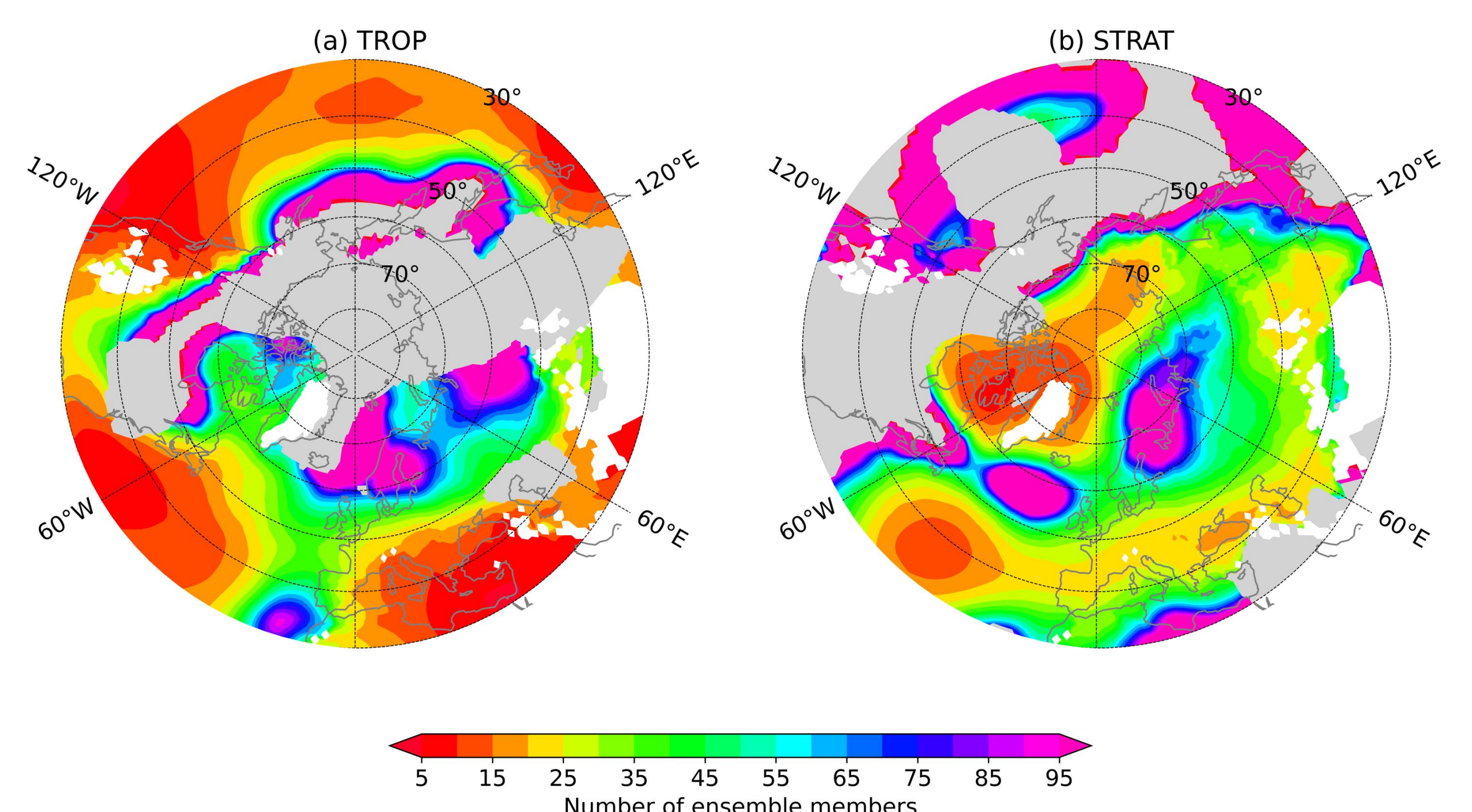


Fig.5: The number of ensemble members required for the teleconnection signal to account for at least 2/3 of the ensemble mean variance in SLP. (a) Tropical signal; (b) Stratospheric signal. Areas where the correlation skill increases by less than 0.05 between CTRL and the respective relaxation experiment are assumed to have no signal and therefore masked in grey. Grid points with elevation above 2000m are masked in white.

Reference: Karpechko, A. Yu., Butler, A. H., and Vitart, F.: Signal, noise and skill in sub-seasonal forecasts: the role of teleconnections, *Weather Clim. Dynam.*, 6, 1661–1681, <https://doi.org/10.5194/wcd-6-1661-2025>, 2025