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Optimal ensemble size for subseasonal-to-seasonal (S2S) prediction system

The optimal number of ensemble members for effective subseasonal-to-seasonal (S2S) ensemble predictions is explored. It turns out that the prediction skill increases with increasing the number of ensemble members, but the skill improvement which is defined by the increase of mean squared skill score (MSSS) against the theoretical maximum (or infinite ensemble size) is independent of the prediction skill of individual members. In an idealized prediction system with a reliable ensemble spread to observed variance, 10 or 20 ensemble members lead to 90% or 95% of the prediction skill of the theoretical maximum.

This estimation is applied to ECMWF real-time S2S prediction system that consists of 51 ensemble members. The tropospheric prediction skill is in good agreement with the theoretical estimation, indicating that about 20 ensemble members are needed to gain the 95% prediction skill of the best ensemble prediction with an infinite number of ensemble members. However, the stratospheric prediction skill is substantially lower than the theoretical estimation. This is particularly true in the tropical stratosphere where the model prediction skill is 70-80% lower than the theoretical limit. This indicates that the model mean bias and ensemble spread need to be substantially improved in the stratosphere.

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