Nature vs Nurture: Relative Influence of Inherited and Environmental Factors for Spread

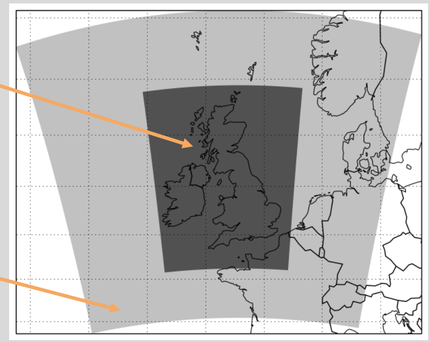
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UK Convective-Scale Model Domain

Fixed resolution inner domain (~900 x 1200 km)

Deterministic: 1.5 km grid spacing
Ensemble: 2.2 km grid spacing

Coarser resolution outer domain (full domain size ~2400 x 1700 km)

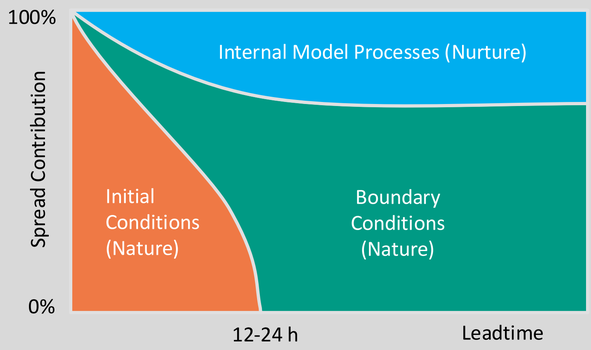


Hagelin et al, 2017, The MOGREPS ensemble predictions system

Spatial Spread Attribution

- Convection-permitting ensembles are underspread
- This is especially true for the spatial spread of precipitation patterns

- Three main sources of spread:



- Many studies have examined spatial spread behaviour from internal sources (i.e., “nurture” over “nature”)
- Fewer studies have considered the impact of the driving ensemble (i.e., “nature” over “nurture”)

- We want to assess that the relationship above also holds for the spatial spread of precipitation patterns

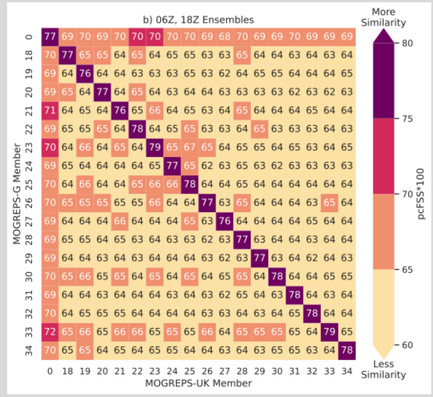
Evaluation Metrics and Trial Period

Trial Period

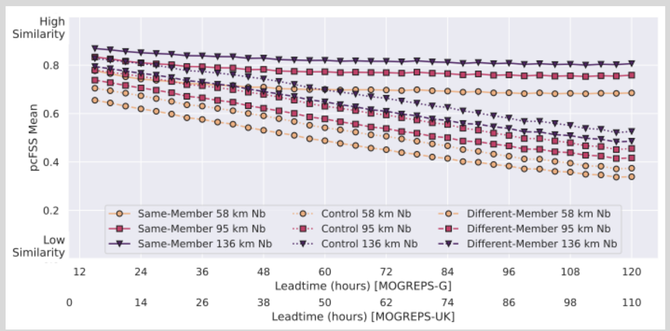
- Analysis performed over Summer (JJA) 2023 using operational Met Office Global (MOGREPS-G) and regional (MOGREPS-UK) data
- Forecasts with insufficient precipitation totals across the domain are filtered out

Parent-Child Fractions Skill Score (pcFSS)

- Our new method for comparing similarity between the ensemble pair
- Based on the FSS framework
- Larger scores -> driving ensemble has larger influence on precipitation patterns in nested ensemble -> ”nature” has more influence than “nurture”



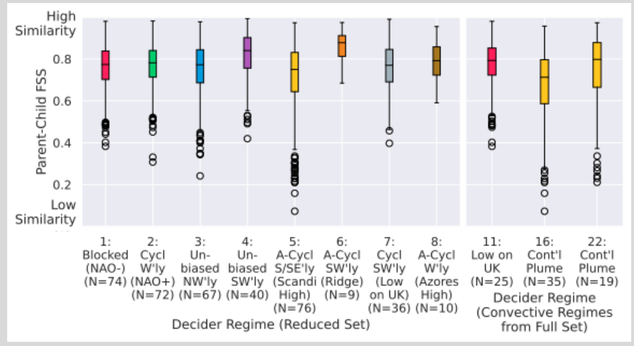
pcFSS Leadtime Series



Different-member profiles (dashed lines)
- Decreases at steady rate as ensemble spread grows in both ensembles

Same-member profiles (solid lines)
- Initially decreases at same rate as different-member profiles
- Asymptotes as boundary information from driving ensemble becomes dominant source of spread in nested ensemble.
- Separate analysis implies transition occurs ~T+21 h

pcFSS Regime Trends



- pcFSS distributions categorised by representative synoptic regime sets (left) and by regimes most associated with thundery activity (right)

- Regime Set 4:
  - Set comprising of strong westerly winds
  - Larger similarity between ensemble pair -> “nurture” dominates

- Regime Set 5:
  - Set comprising southerly winds, bringing air with high wet-bulb potential temperature into domain
  - Largest potential for dissimilarity between ensembles due to different representation of convection
  - Supported by the analysis of thundery regimes in right panel

Summary

- “Nurture” dominates during the first ~21 hours of the forecast and during convective events
  - “Nurture” is also associated with better spread in the child ensemble compared to the parent ensemble
- “Nature” dominates after ~21 hours and during mobile periods
  - “Nature” shows similar spread and spread-skill relationship between ensembles
- pcFSS can be a useful tool for signalling periods of divergence and degeneracy within the ensemble pair

- Roberts and Lean, 2008, Scale-Selective Verification of Rainfall Accumulations from High-Resolution Forecasts…, AMS MWR
- Dey et al, 2014, A Spatial View of Ensemble Spread in Convection Permitting Ensembles, AMS MWR