Underpredicted ENSO teleconnections in seasonal forecasts

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Motivation

- Improvement of seasonal forecasts requires improved representation of processes which act on seasonal timescales
- Predictable drivers imply potential predictability of their teleconnections
- The El Niño-Southern Oscillation (ENSO) is well predicted on seasonal timescales and has a global influence
- This work aims to understand how effective current seasonal forecasts are at capturing teleconnections between ENSO and the extratropical Northern Hemisphere, and what this means for predictability.

Data

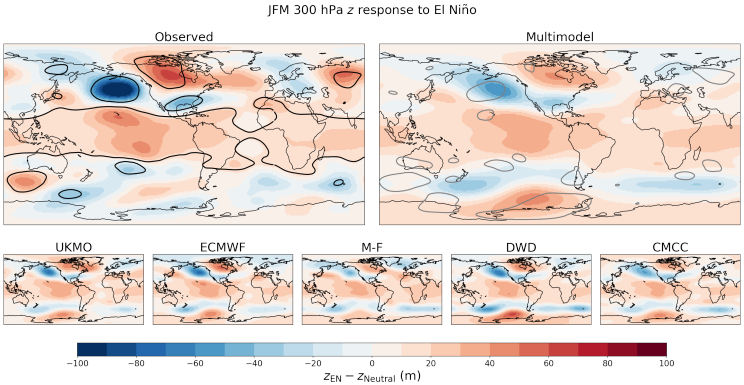
Hindcasts, 1993-2017

Centre	Model	Ensemble members	Start date(s)
UK Met Office	GloSea5	21	25 Oct, 01 Nov, 08 Nov (7 members per date)
ECMWF	SEAS5	25	01 Nov
Météo-France	System 8	25	01 Nov
DWD	GCFS 2	30	01 Nov
CMCC	CMCC-SPS3	40	01 Nov

- Compared to JRA-55 reanalysis (and GPCP for precipitation), 1979-2017
- DJFM means for SSTs, JFM for all other variables
- Winters classified as El Niño ($\Delta T > 0.5$ K), La Niña ($\Delta T <$ -0.5 K) or Neutral ($|\Delta T| < 0.5$ K) using reanalysis Niño 3.4 index

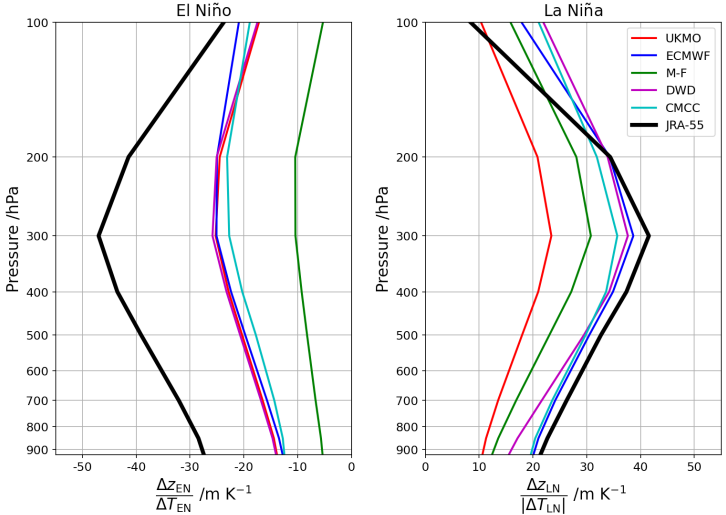
Extratropical response to El Niño

- 300 hPa geopotential height response to El Niño (EN years − Neutral years)
- The teleconnection pattern is generally accurate, particularly over the North Pacific and North America
- However the amplitude of the teleconnection is heavily underestimated - this is particularly clear around the Aleutian Low pressure centre in the North Pacific
- This holds for all 5 individual models



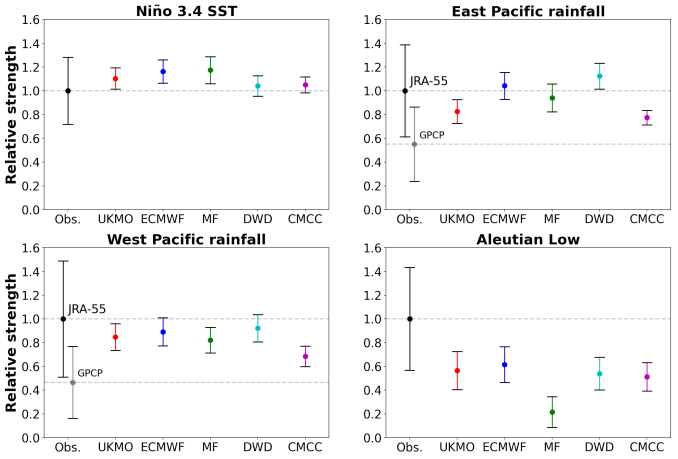
Vertical structure

- Response in geopotential height divided by average SST difference (to avoid SST biases)
- Aleutian Low response to El Niño is weak throughout the troposphere
- This also holds for all 5 models
- The La Niña response is also weak except around tropopause



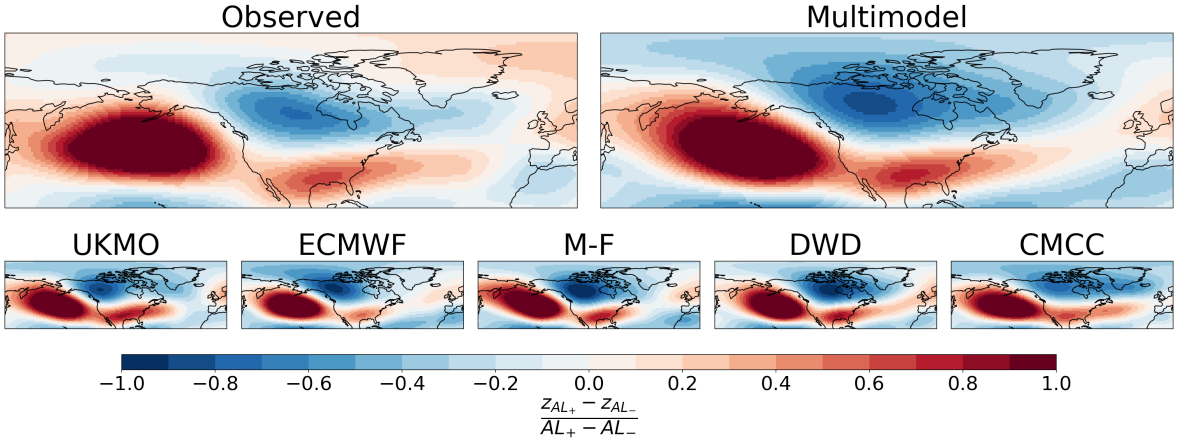
Where does the teleconnection fail?

- Mean $\pm$ 2 standard error for each model, relative to JRA-55 mean
- Reanalysis: samples are 1 EN year - Neutral mean
- Models: samples are 1 EN realisation (1 member from 1 year) - mean of 1 random member from each neutral year
- Pacific SST anomalies are slightly overestimated in all models
- Tropical Pacific precip. anomalies are within range of error in observations (JRA-55 and GPCP differ heavily)
- Aleutian Low response is weak with high significance - model means are near or outside of the observed 95% confidence interval



Extratropical response to Aleutian Low variability

- Composites of z with positive (AL_+) and negative (AL_-) Aleutian Low anomalies
- Composites divided by difference in mean AL_+ and AL_- (to remove effect of weak amplitude Aleutian Low)
- Forecasts accurately capture the link between the Pacific and Atlantic
- Therefore weak amplitude Aleutian Low $\rightarrow$ weak amplitude North Atlantic signals



Implications for prediction

- ENSO is an important and predictable driver of extratropical winter climate
- Teleconnections between ENSO and the extratropical troposphere are modelled with an accurate pattern but a weak amplitude
- The North Atlantic response to Aleutian Low variability is well captured in models
- Weak amplitude $\rightarrow$ low signal-noise ratio $\rightarrow$ high skill is achievable but requires a large ensemble - 'signal-noise paradox'

Any comments or feedback are greatly appreciated!

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