The Boreal Winter El Niño Precipitation Response over North America: Insights into why January is more difficult to predict than February

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Motivation and goal: Many operational seasonal forecast models, including NASA GEOS model, show that prediction skill of boreal winter El Niño precipitation over North America is quite low in January while it is high in February. This study aims to understand why there is a significant difference in prediction skill between January and February during El Niño.

Experiment and analysis: Experiments using GEOS AGCM & coupled model are carried out. Global stationary wave model experiments are conducted to understand the planetary-scale wave response to tropical heat forcing with different basic states. MERRA-2 reanalysis is used to analyze the observed patterns and compare them with the model results.

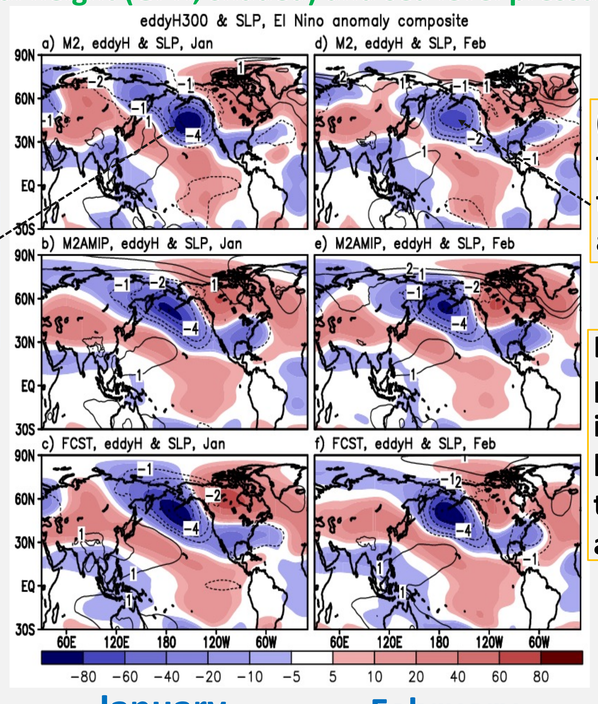
Findings: 1) The model does not realistically represent the observed zonal shift of circulation/pressure anomalies over NE Pacific during January and February (**Figure 1**)
2) This zonal shift is controlled by the changes in the observed basic state in two months. The role of changes in the tropical Pacific heat forcing is not significant (**Figure 2**)
3) The model does not reproduce well these observed changes in the climatological state, resulting in notable biases in circulation/pressure anomalies in January (**Figure 3**)

Significance: This study suggests possible directions for further improvement in seasonal prediction skill of El Niño precipitation over North America

Why does the model imperfectly represent the precipitation over the west NA in January?

300hPa geopotential height (GPH, shaded) and sea level pressure (SLP, contoured)

Figure 1



MERRA-2

Strong (-) anomalies quite close to the coast in observatioin

AGCM

Forecast (coupled model)

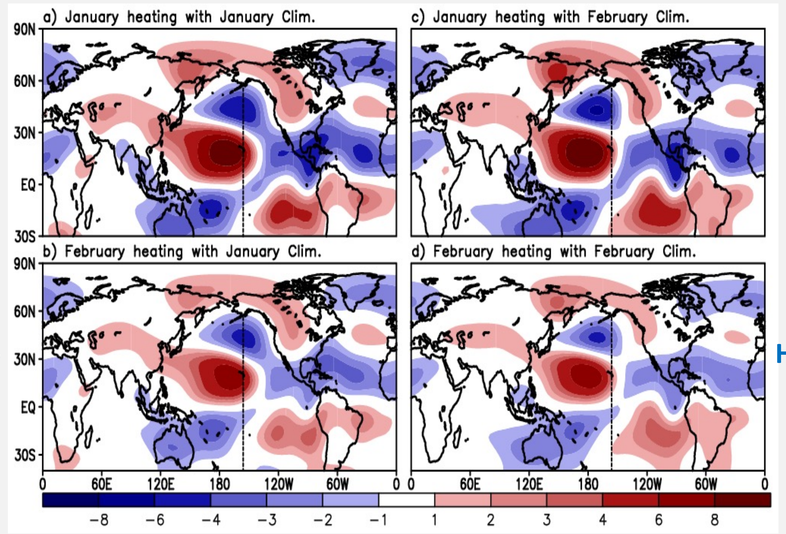
(-) anomalies retreat to the west : unfavorable for precip. in the W. US and Canada.

Location of the model-produced (-) anomalies is off the west coast in both months, similar to the observed February anomalies

January **February**

Is observed zonal shift in circulation anomalies over the NE Pacific the result of tropical heating differences or differences in the basic state between January/February?

Figure 2



Heating: January, Basic state: January

Heating: January, Basic state: February

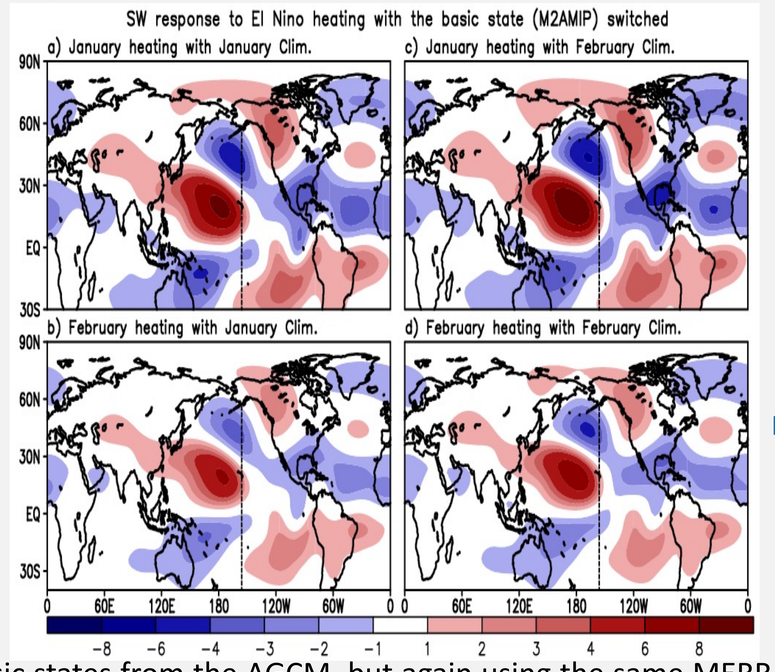
Heating: February, Basic state: January

Heating: February, Basic state: February

Jan./Feb. zonal shift of the geopotential height anomalies is to a large extent controlled by the changes in the basic state, rather than changes in the central-eastern tropical Pacific heat forcing.

Stationary wave response to the model (AGCM)-produced basic state

Figure 3



Heating: January, Basic state: January

Heating: January, Basic state: February

Heating: February, Basic state: January

Heating: February, Basic state: February

Experiment: basic states from the AGCM, but again using the same MERRA-2 estimates of heating. The runs with the January basic state (*left*) fail to shift the anomalies eastward closer to the coast → model problem.

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