

ROSSBY WAVE BREAKING THROUGH THE 21ST CENTURY IN A GLOBAL CLIMATE MODEL

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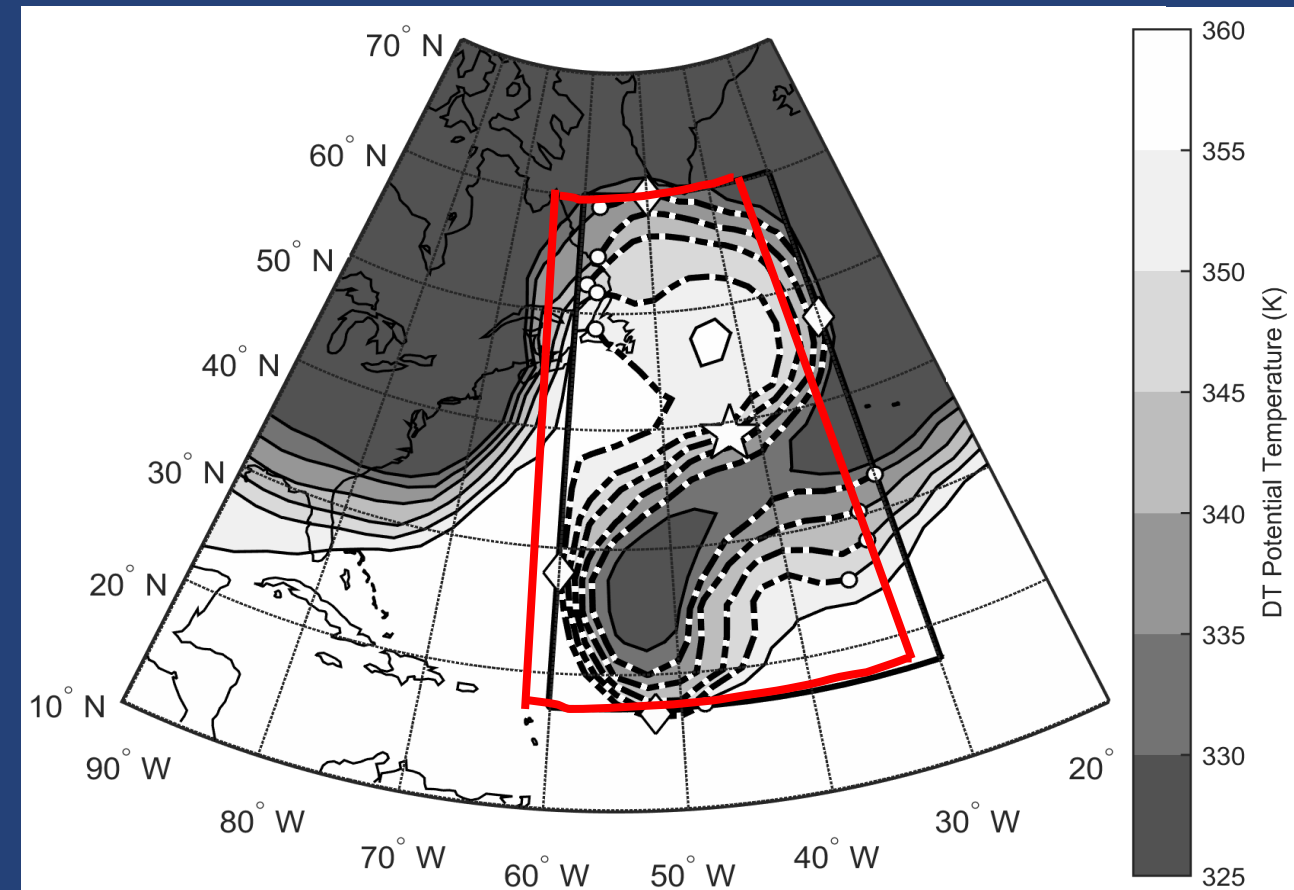
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ROSSBY WAVE BREAKING IDENTIFICATION

- **Research Question:**
 - How well are Rossby wave breaks represented in GCMs, and will the frequency of Rossby wave breaking change in the future climate
- **Method:**
 - Wave breaking event region (red box) identified on dynamic tropopause following technique of Bowley et al. 2019a
 - Events identified in:
 - NCEP Reanalysis 2 dataset (Kanamitsu et al. 2002)
 - CAM-LE Community Earth System Model Simulations (25 member ensemble)
 - “Atmosphere-only” configuration with prescribed sea ice and SST
 - Sea ice and SST boundary conditions from the CESM large ensemble (Kay et al. 2015)



Bowley et al., 2019a

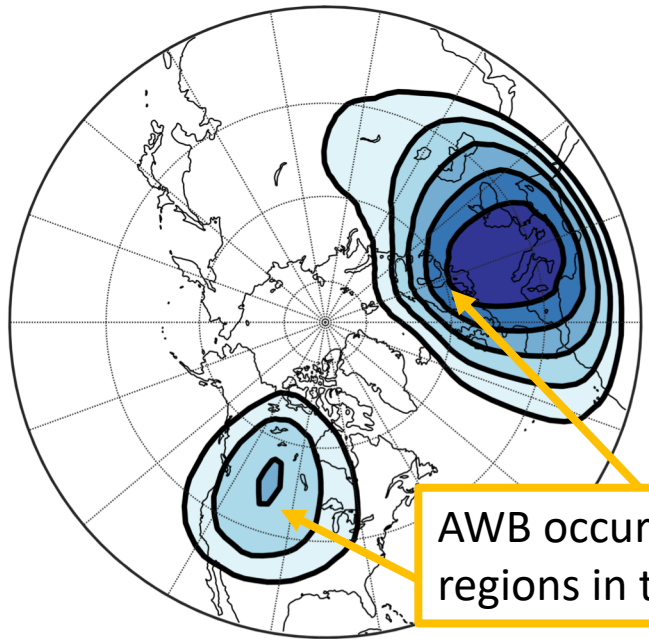
MODEL VALIDATION DJF

AWB ON THE DYNAMIC TROPOPAUSE

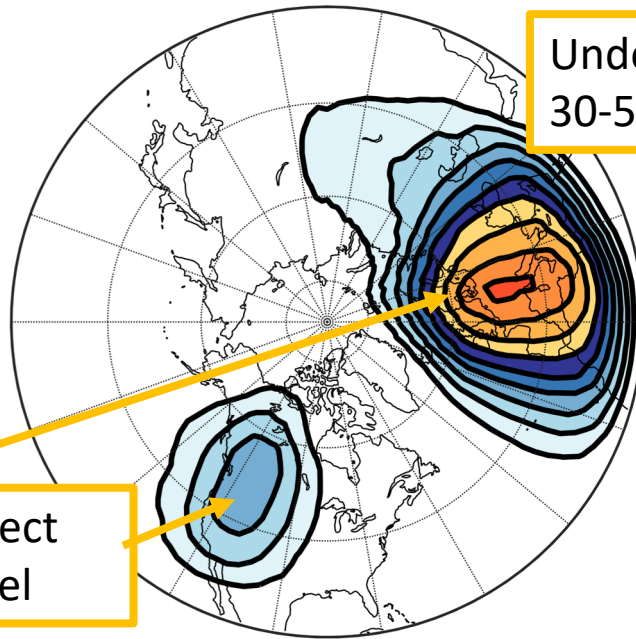
CAM-LE_{REGRIDDED to NCEP resolution-2010-2019}

NCEP-R2₁₉₇₉₋₂₀₁₈

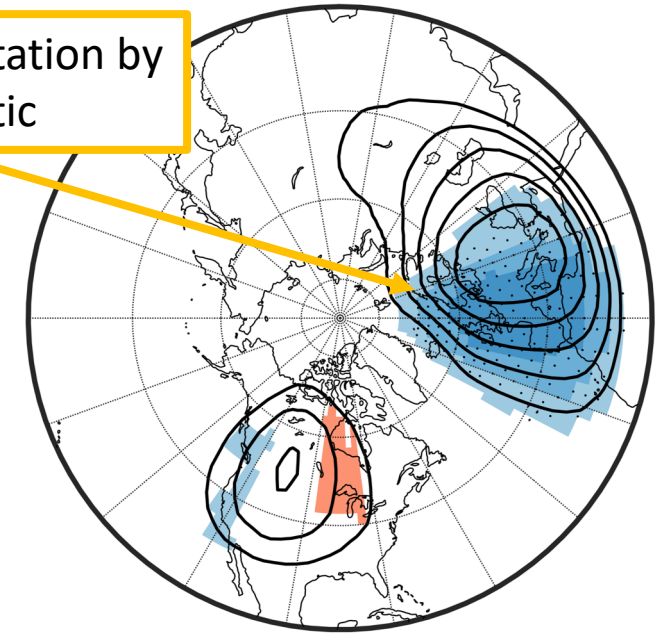
CAM-LE_{REGRID} – NCEP-R2



AWB occurs in correct regions in the model



Under representation by 30-50% in Atlantic



— AWB Freq. (% , 1.5% contour interval)



3 6 9 12 15 18

AWB Frequency (%)

— AWB Freq. (% , 1.5% contour interval)



3 6 9 12 15 18

AWB Frequency (%)

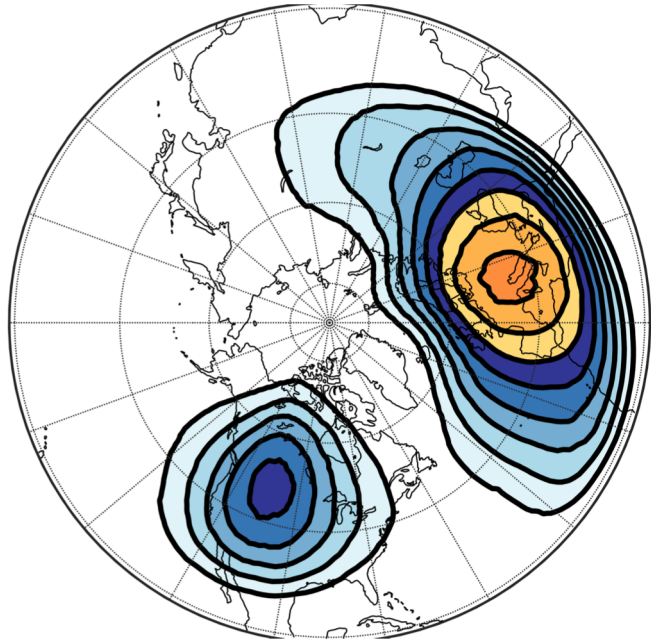
— AWB Freq. (% , 1.5% contour interval)



-9 -6 -3 0 3 6 9

AWB Frequency Difference (%)

CAM-LE: 2010-2019 (EARLY)



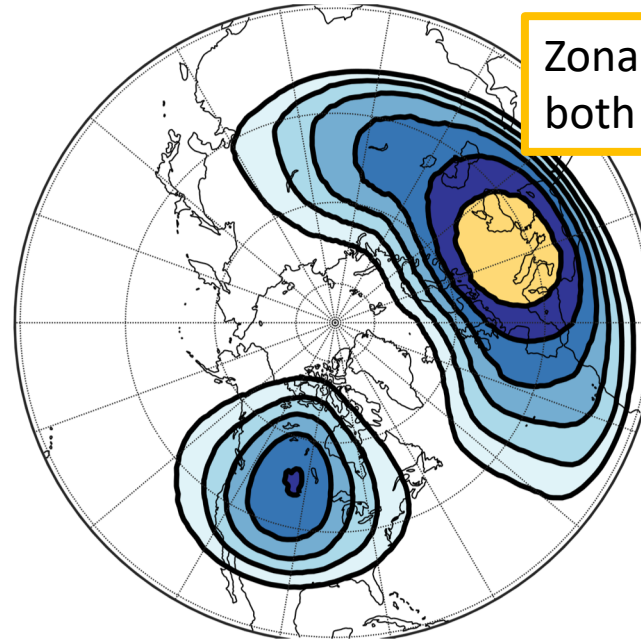
— AWB Freq. (% , 1.5% contour interval)



3 6 9 12 15 18

AWB Frequency (%)

CAM-LE: 2090-2099 (LATE)



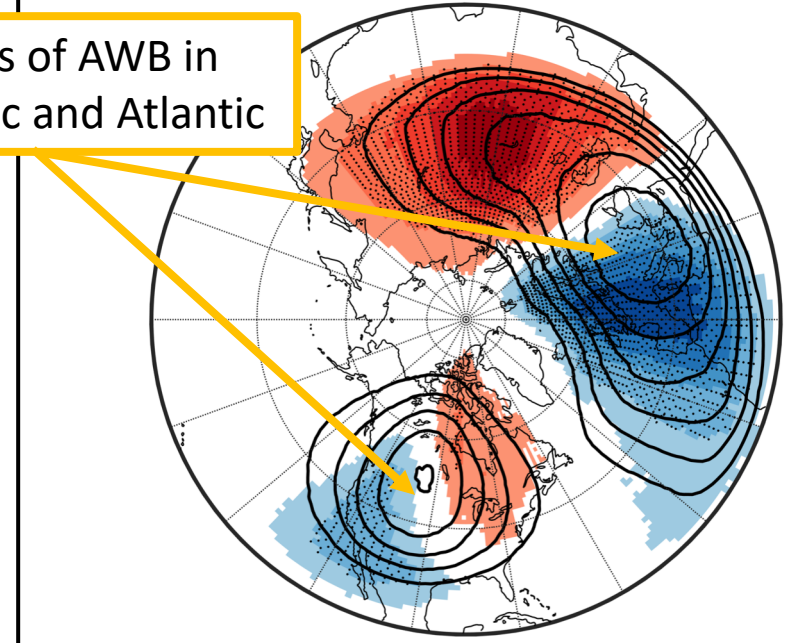
— AWB Freq. (% , 1.5% contour interval)



3 6 9 12 15 18

AWB Frequency (%)

CAM-LE LATE minus CAM-LE EARLY



— LATE AWB Freq. (% , 1.5% contour interval)



-1.5 -1.0 -0.5 0 0.5 1.0 1.5

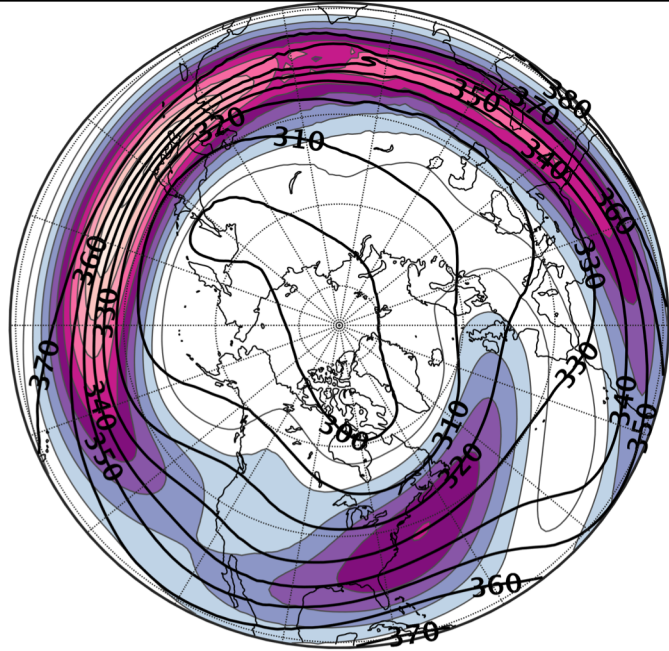
AWB Frequency Difference (%)

Zonal shifts of AWB in
both Pacific and Atlantic

CAM-LE PROJECTIONS: DJF

ZONAL WIND ON THE DYNAMIC TROPOPAUSE

CAM-LE: 2010-2019 (EARLY)



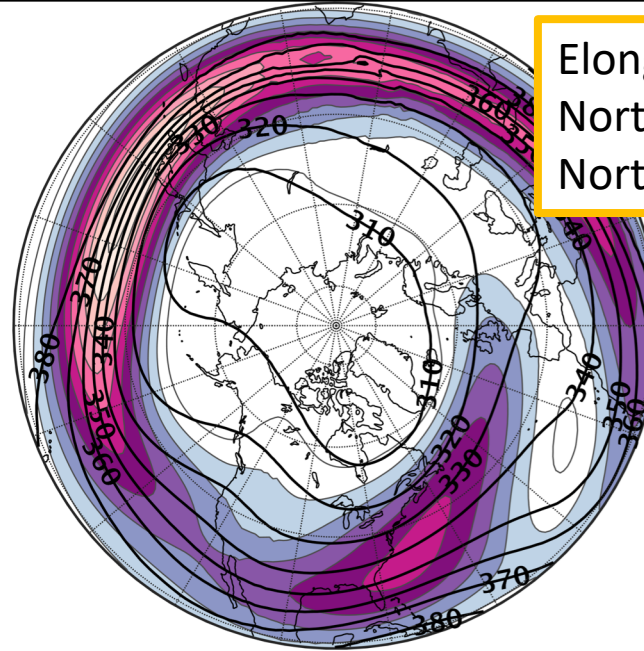
— DT Θ (K, 10 K contour interval)



20 30 40 50 60

Dynamic Tropopause U (knots)

CAM-LE: 2090-2099 (LATE)



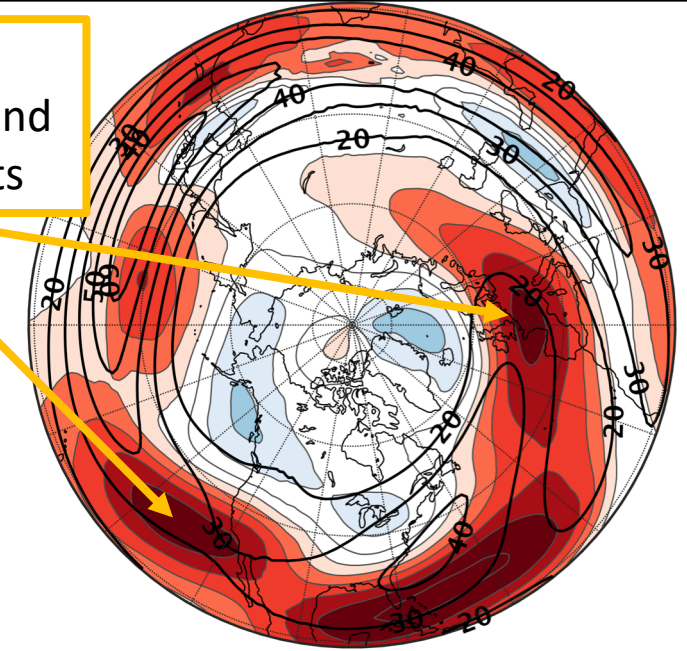
— DT Θ (K, 10 K contour interval)



20 30 40 50 60

Dynamic Tropopause U (knots)

CAM-LE LATE minus CAM-LE EARLY



— LATE DT U (knots, 10 knot contour interval)



-6 -4 -2 0 2 4 6

Dynamic Tropopause U Difference (knots)

Elongation of
North Atlantic and
North Pacific jets

- CAM-LE experiments show **downstream shift in AWB**
- North Pacific shift associated with elongation of subtropical jet in the Pacific likely attributable to tropical upper-tropospheric warming - eg. Shaw et al. 2016
- North Atlantic shift associated with elongation of the North Atlantic eddy-driven jet. Gervais et al. 2019 demonstrated the important role of the North Atlantic Warming hole in producing this elongation.
- These impacts would not be seen in zonal mean metrics highlighting the need to examine spatial patterns in future changes in Rossby wave breaking

- Bowley et al. 2019a – Mon. Wea. Rev. -- DOI: 10.1175/MWR-D-18-0131.1
- Gervais et al. 2019 – J. Climate - DOI: 10.1175/JCLI-D-18-0647.1
- Kay et al. 2015 – Bull. Amer. Met. Soc. – DOI: 10.1175/BAMS-D-13-00255.1
- Kanamitsu et al. 2002 – Bull. Amer. Met. Soc. – DOI: 10.1175/BAMS-83-11-1631
- Shaw et al. 2016 -- Nat. Geosciences – DOI: 10.1038/ngeo2783