An investigation of midlatitude circulation biases in a hierarchy of climate reanalysis and hindcast ensembles

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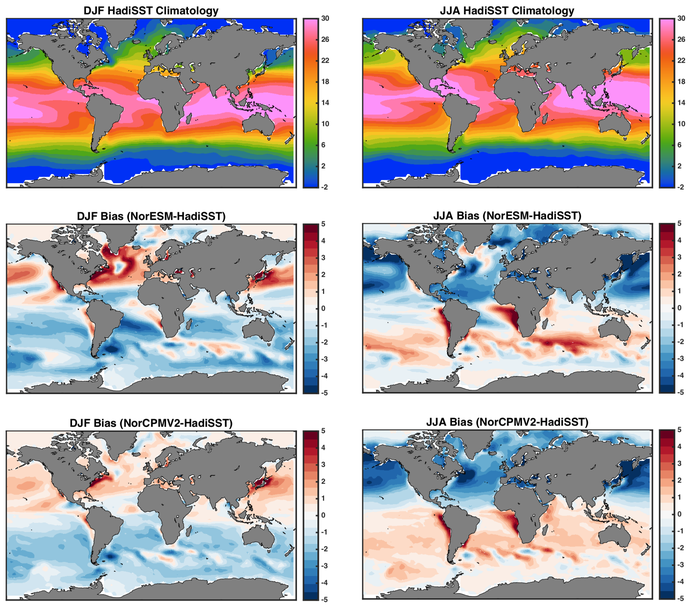
Stefan Sobolowski[1,3] *stefan.sobolowski@norceresearch.no*
Camille Li[2,3] *camille.li@uib.no*
Lilan Chen[4] *dz1428001@smail.nju.edu.cn*
Fumiaki Ogawa[2,3] *fumiaki.ogawa@gfi.uib.no*

We investigate circulation biases in large ensembles of climate reanalysis and hindcast (not shown) simulations performed by the Norwegian Earth System Model (NorESM). Biases have detrimental effects on predictive skill for dynamically driven fields at climate prediction time scales of seasons to decades. They also contribute to the large uncertainty in the circulation response to external forcing. We aim to better understand their physical drivers.

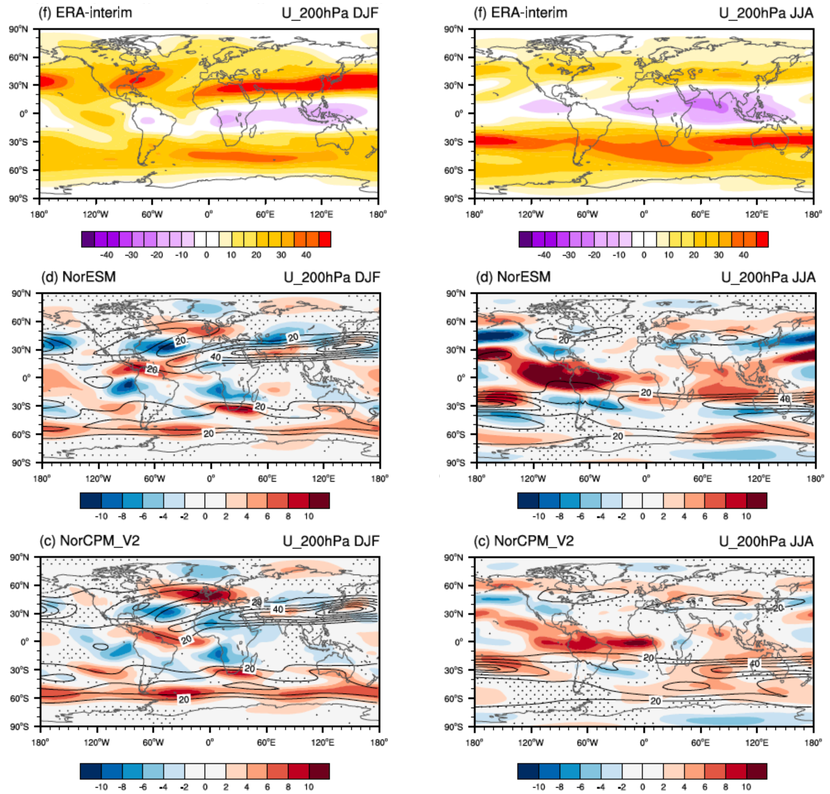
5 Key takeaways:

- **Key features of midlatitude circulation in ERA-I generally not covered by the ensemble spread (30 members)**
- **Largest improvements over North Pacific**
- **Large SST biases persist (>25%); pattern suggests too weak atmosphere-ocean interactions**
- **Biases are asymmetric in time and space; largest in summer(winter) over North Pacific(North Atlantic)**
- **However, NAO variability is reasonably well reproduced; though with large spread**

Winter(left) and summer(right) SST biases improve with assimilation but indicate strong dynamical feedbacks from the atmosphere



Biases in winter(left) and summer (right) upper level winds show some improvement over North Pacific/Tropics but little change over North Atlantic



"Reanalysis" simulations (monthly assimilation):

- NorCPM V0*: anomaly assimilation SST (HadI)
- NorCPM V1*: anomaly assimilation SST (HadI), temperature, salinity (EN4)
- NorCPM V2*: full field assimilation SST + SIC (HadI), temperature, salinity (EN4) [SHOWN HERE]
- NorESM: free run, no assimilation [SHOWN HERE]
- NorESM AMIP: 1985-2008 atmosphere only, only 5 ensemble members

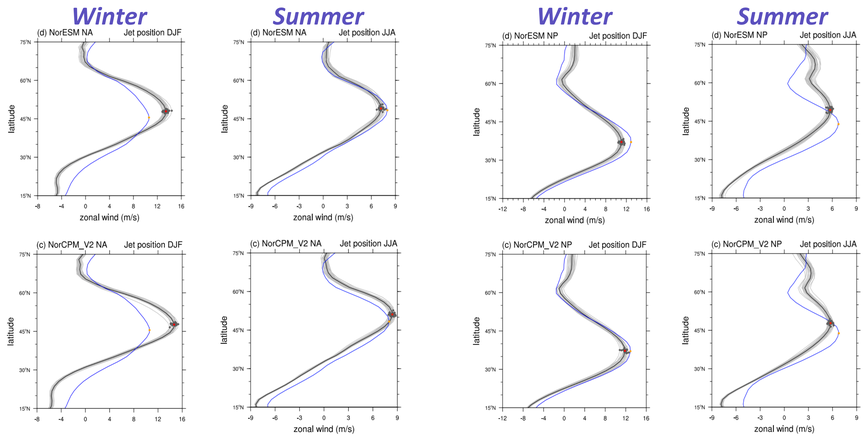
* 1985-2010, 30 members, NorCPM ME, monthly assimilation

Eddy driven jet biases in North Atlantic (60W-0)

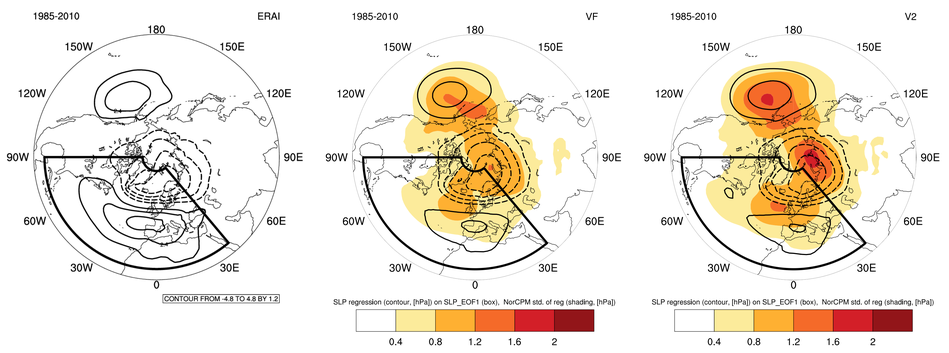
- Winter jet too strong/poleward; ERA-I not covered by the spread
- Summer jet much better; ERA-I mostly covered by the spread
- Both seasons are degraded by data assimilation

Eddy driven jet biases in North Pacific (135E-125W)

- Winter jet includes ERA-Interim through part of the jet core, but is too weak.
- Summer jet is poorly reproduced in both latitude, speed and width.
- Data assimilation appears to improve the simulation in both seasons



Despite large jet biases NAO is reproduced reasonably well



NAO calculated as the first EOF of DJF SLP in the black boxes of each panel. Contours (black lines) show SLP regressed onto the first EOF (contour interval +/- 1.2 hPa). Shading shows the uncertainty across all 30 members of each ensemble in the right two panels.

NORCE
Norwegian Research Centre AS
www.norceresearch.no

Affiliations: 1. NORCE Climate, 2. University of Bergen, 3. The Bjerknes Centre for Climate Research, 4. Nanjing University