The Abdus Salam
International Centre for Theoretical Physics

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Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

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17 - 20 November 2008

The roles of external forcings and internal variabilities in the Northern hemisphere atmosphere circulation change from the 1960s to 1990s

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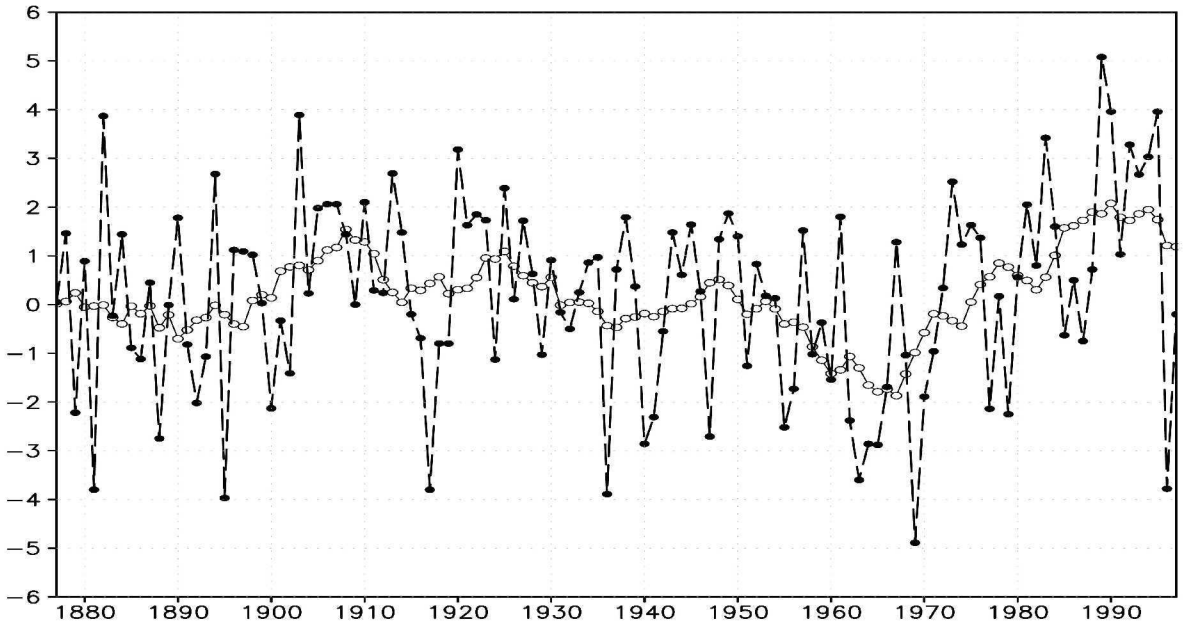
The roles of external forcings and internal variabilities in the Northern Hemisphere circulation change 1960s to the 1990s

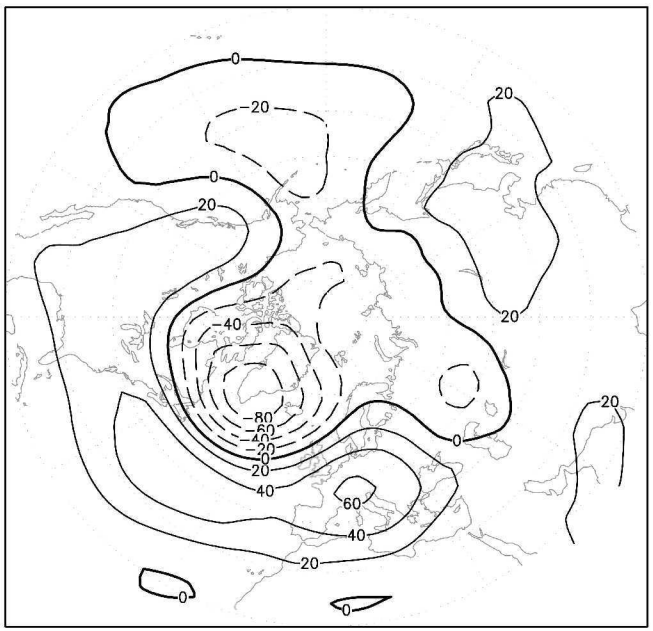
Martin King
Monash University

in collaboration with
Fred Kucharski (ICTP) and Franco Molteni (ECMWF)

also a contribution to CLIVAR C20C
www.iges.org/c20c



DJFM NAO (Hurrell) Index



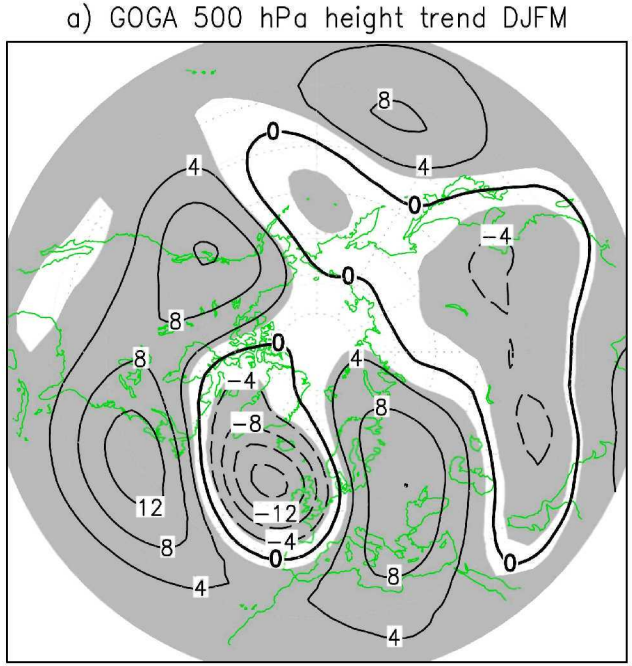
Observed trend in Z_{500}, 1958-69 to 1985-95. (NCEP reanalysis)

ICTPAGCM

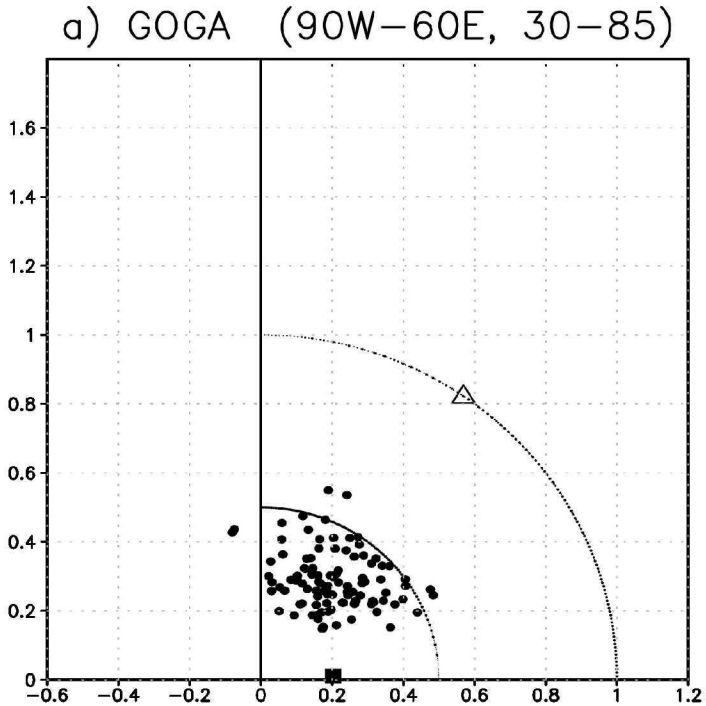
http://users.ictp.it/~moltenif

T30 L8.
GFDL dynamical core.
Top two layers approximate the stratosphere.

Parameterizations for:
1. convection
2. large-scale condensation
3. clouds and shortwave radiation (ozone, visible, near-IR)
4. longwave radiation (dry air, clouds, CO2, weak water vapour, strong water vapour).
5. surface fluxes and vertical diffusion



GOGA 100-member ensemble



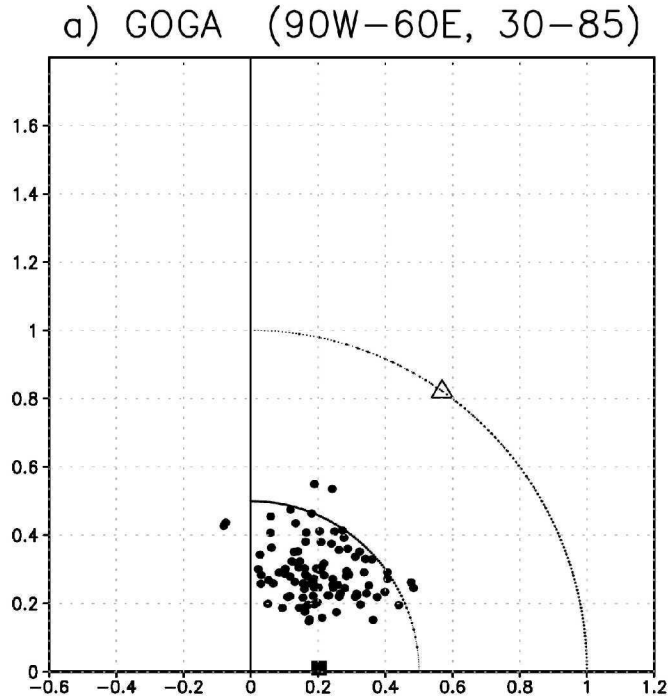
Taylor diagram

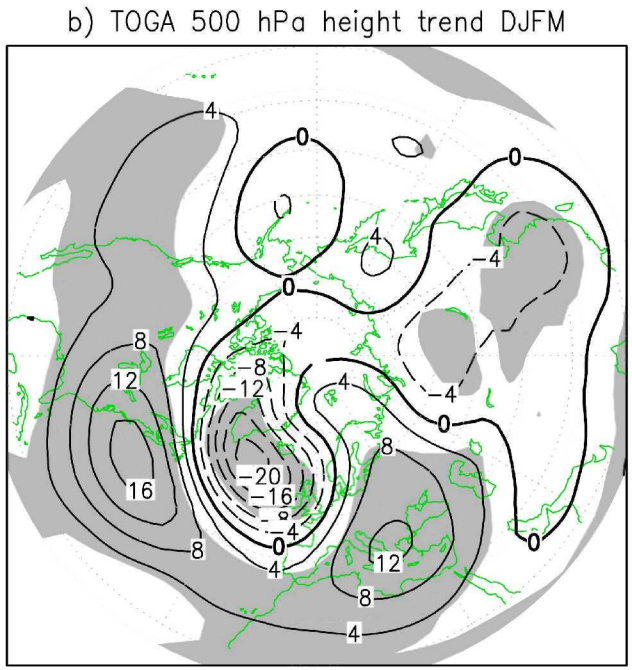
$r=|T_j|/|T_o|$

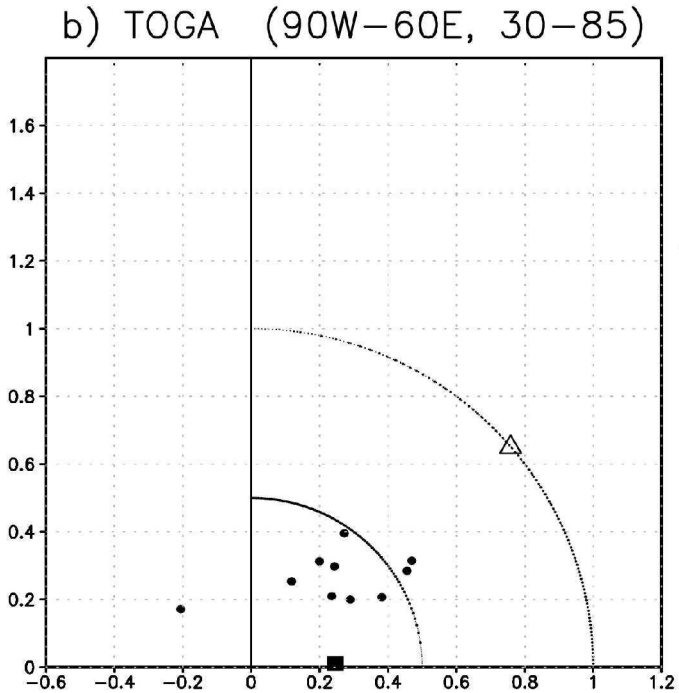
$\cos(a)=T_j.T_{EM}/|T_j||T_{EM}|$

Observed trend

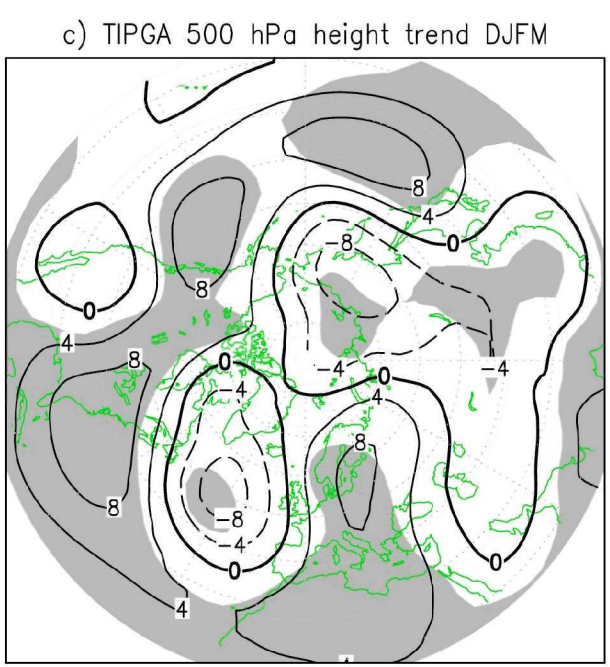
GOGA Taylor diagram (again)

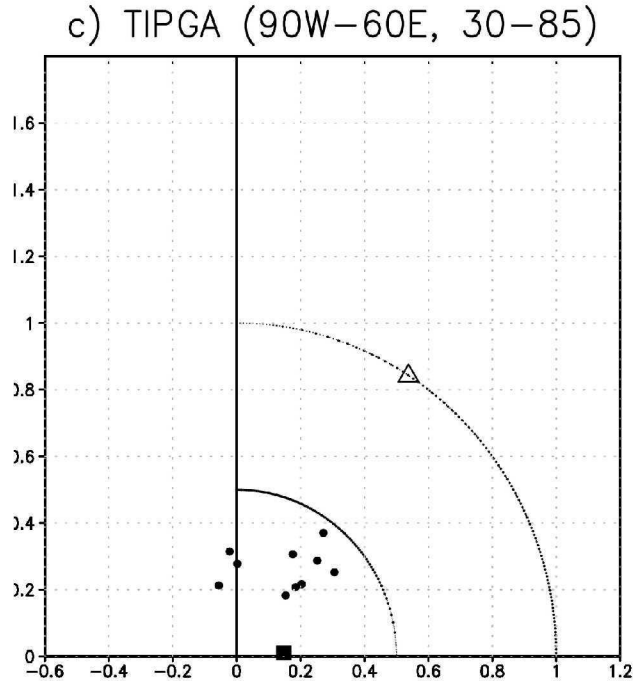




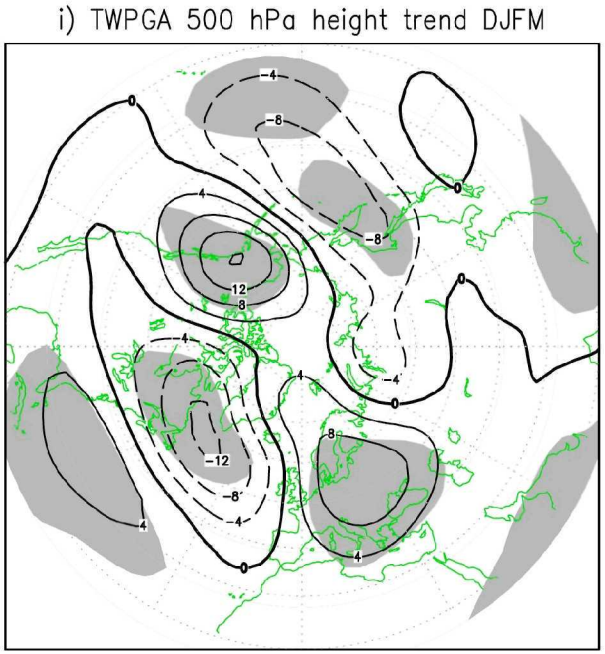


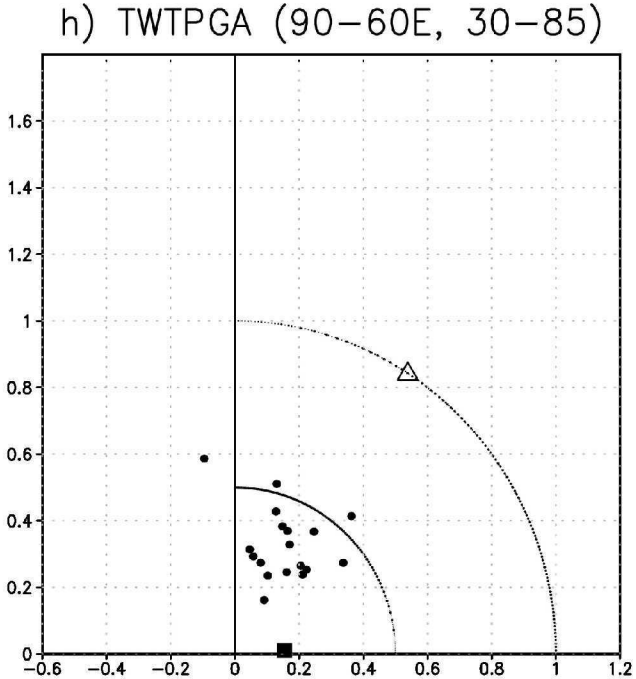
TOGA Ensemble



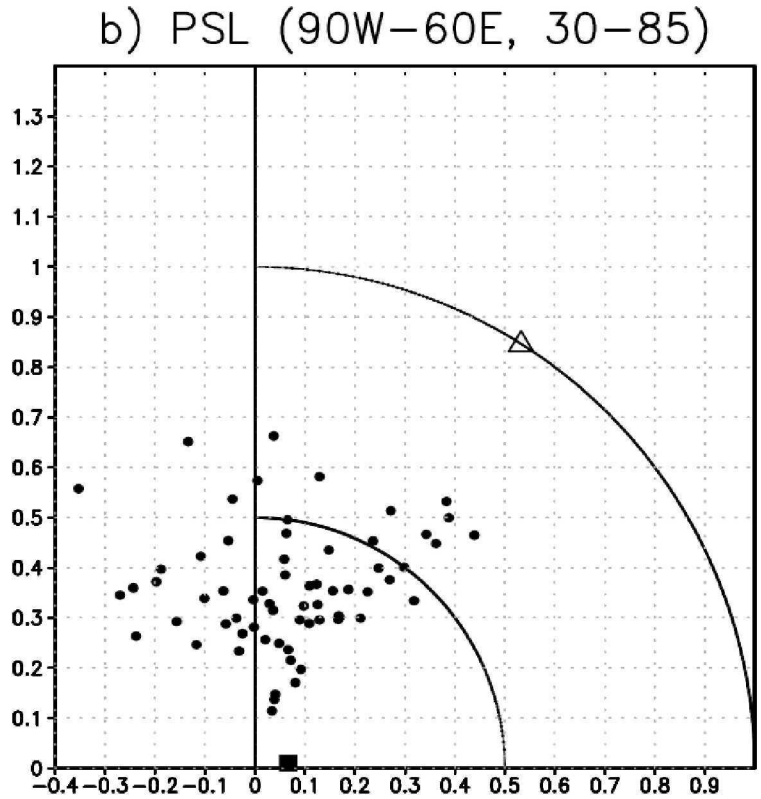


TIPGA (Tropical-Indo Pacific Global Atmosphere) Ensemble

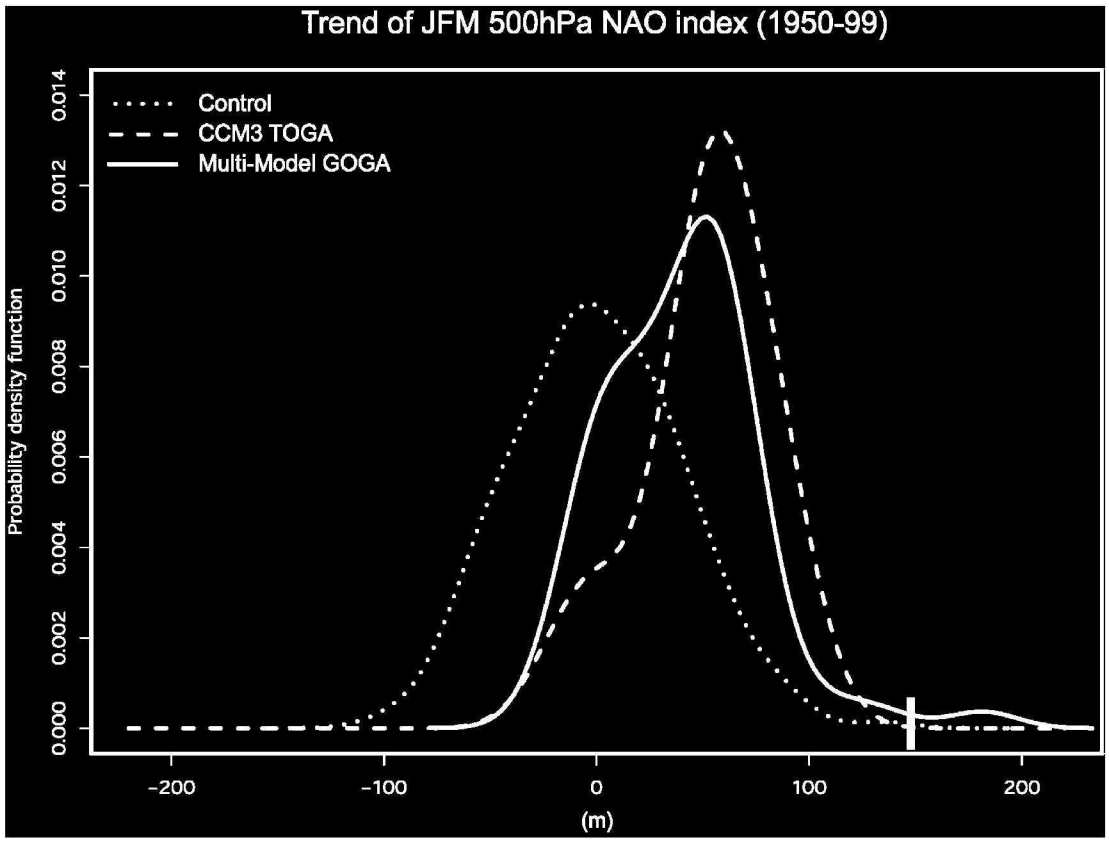




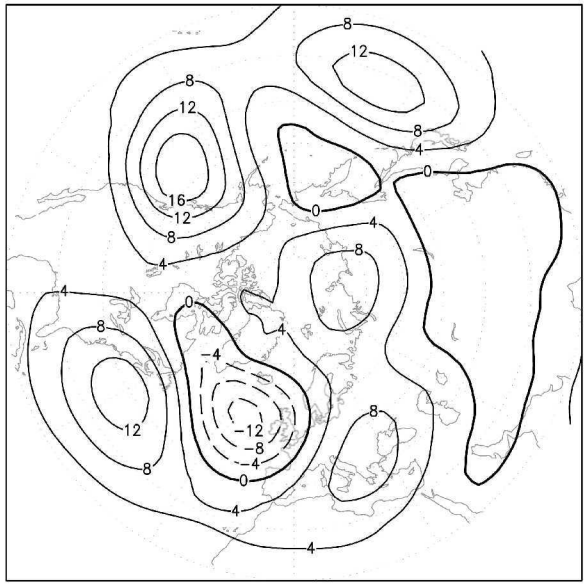
TWPGA (Tropical-West Pacific Global Atmosphere) Ensemble. 140-190E, 20S-20N.

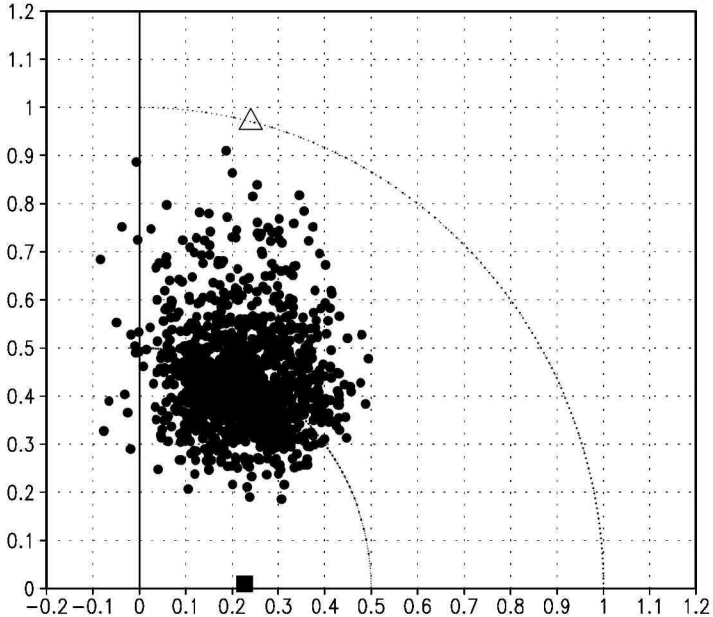


CMIP3 Integrations (65 members)

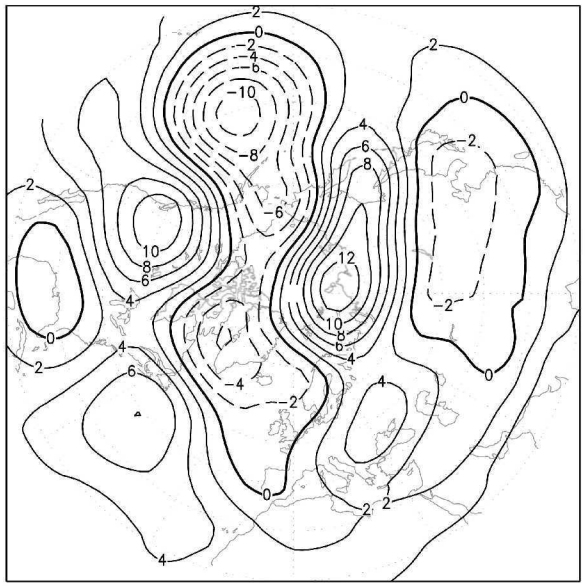


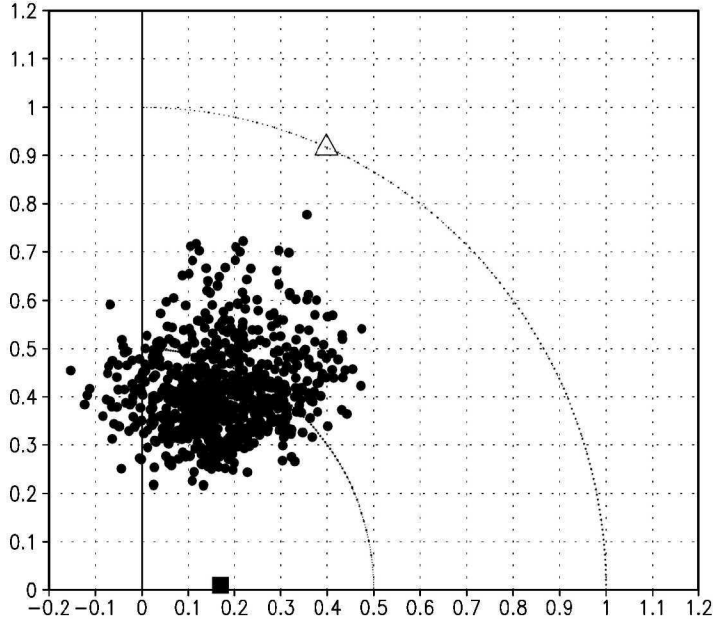
Hurrell et al (2004) Clim. Dyn.





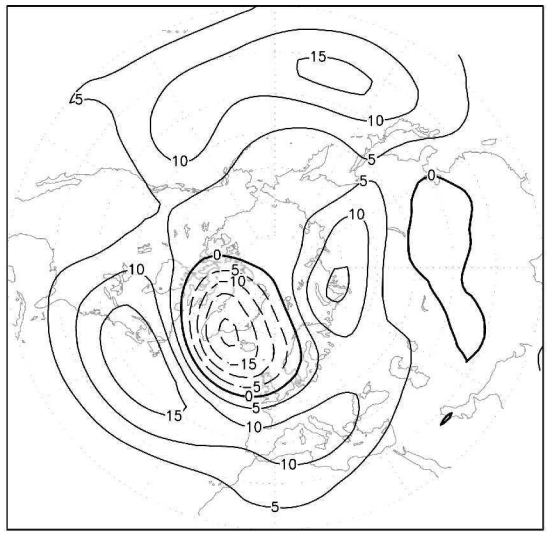
EXP(hsst1985-96)-
EXP(hsst1958-96)

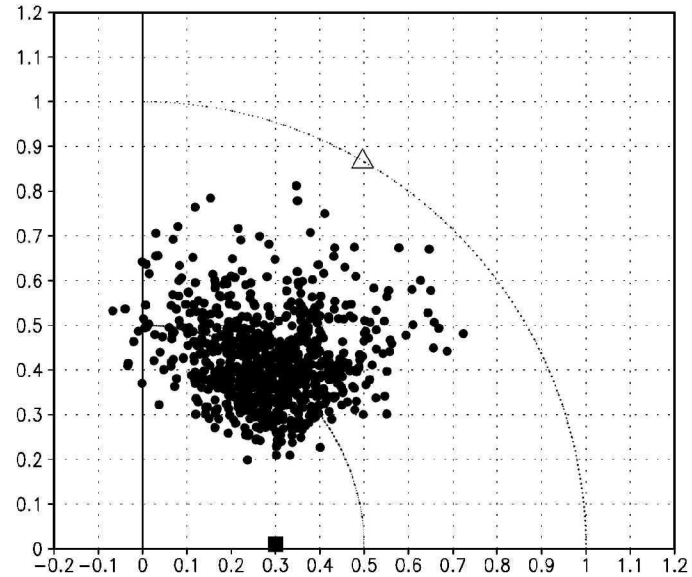




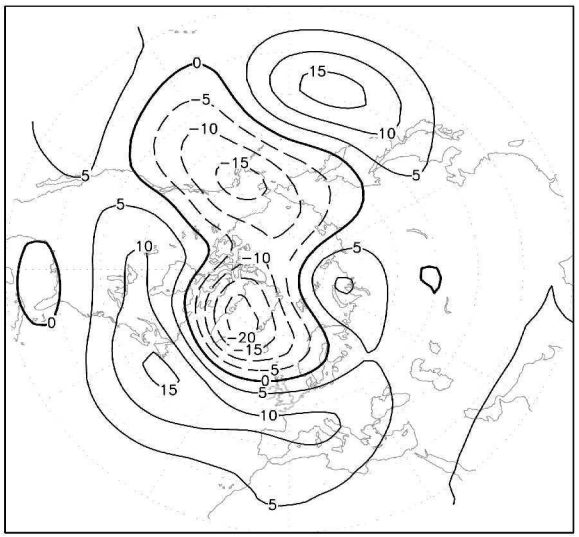
EXP(nsst1985-96)-
EXP(nsst1958-96)

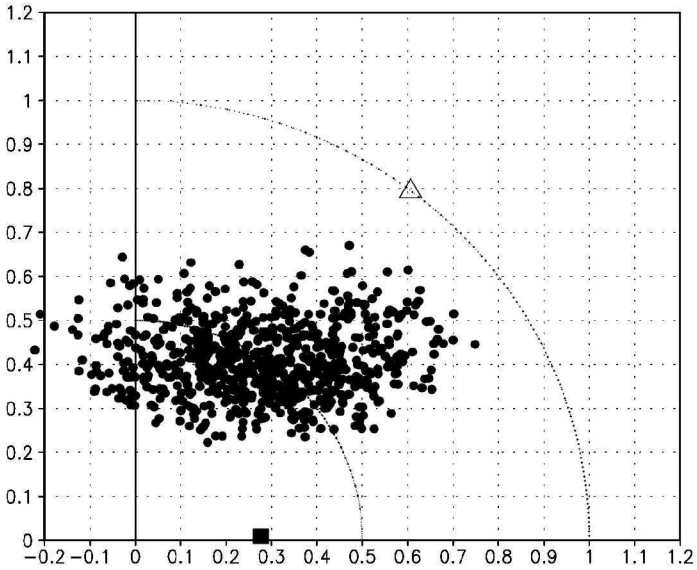
EXP(hsst1985-96,A_{co2}=6)-EXP(hsst1958-69)

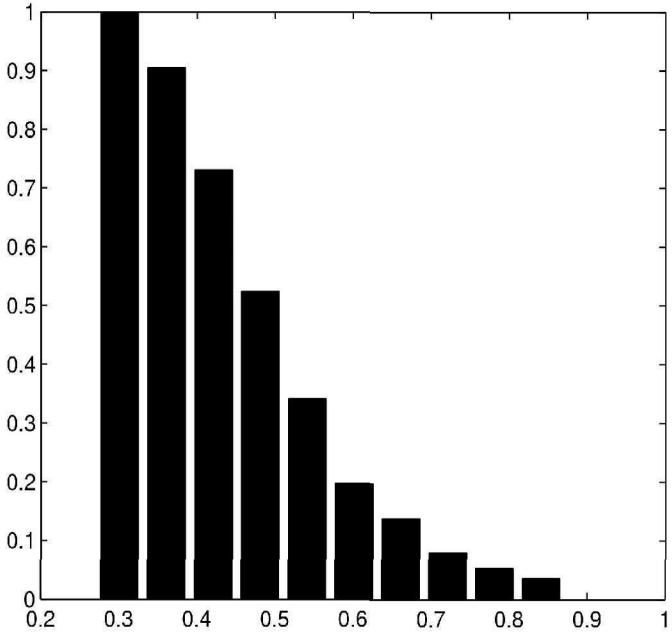




EXP(nsst1985-96,A_{co2}=6)-EXP(nsst1958-69)

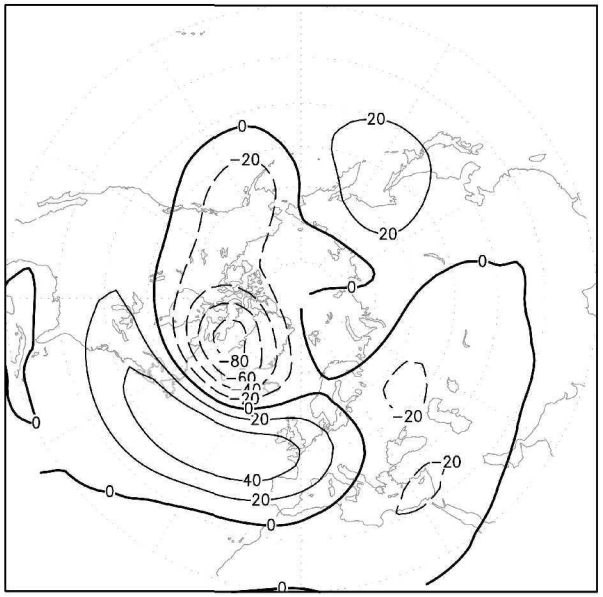




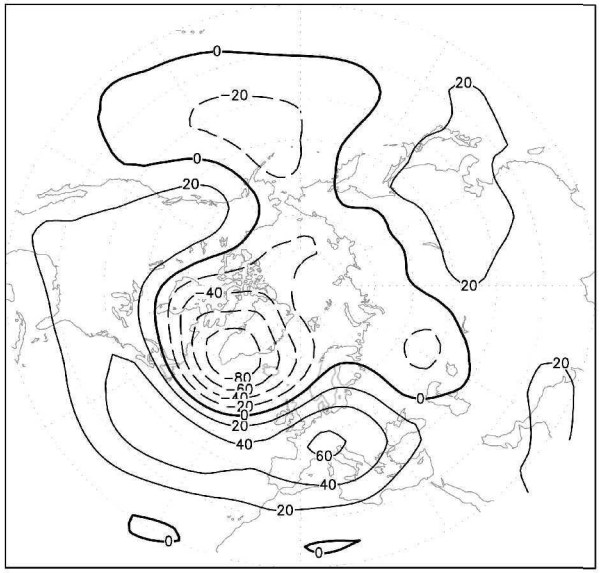


EXP(nsst1985-96,A_{co2}=6)-EXP(nsst1958-69): cumulative probability for normalised trend amplitudes.

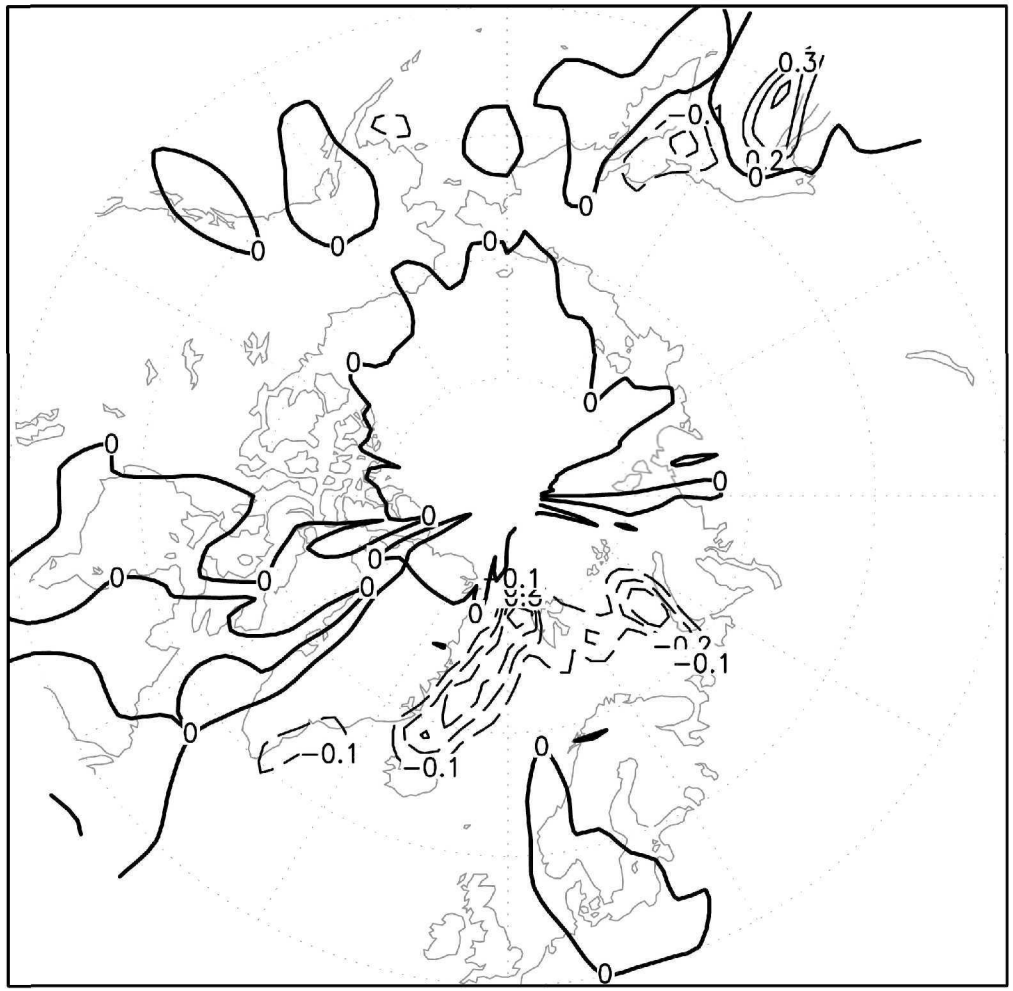
best member vs. obs trend

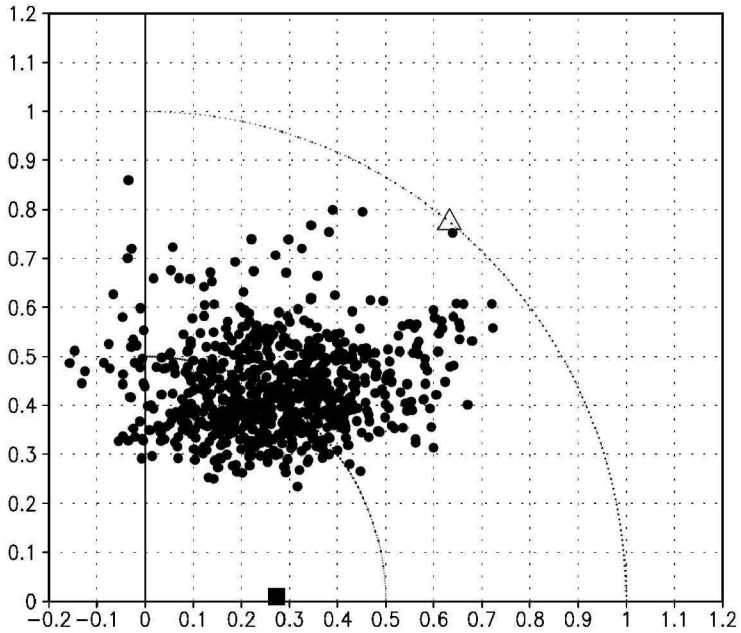


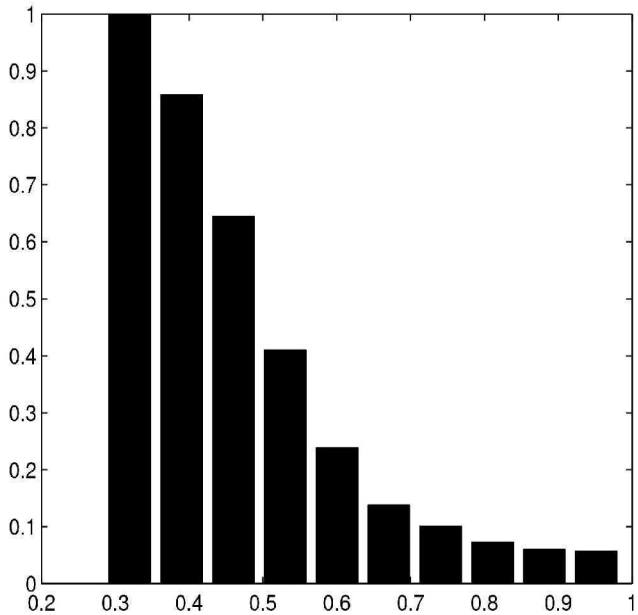
cos(a)=0.7
r=0.83



obs. sea ice trend 1958-69 to 1985-96

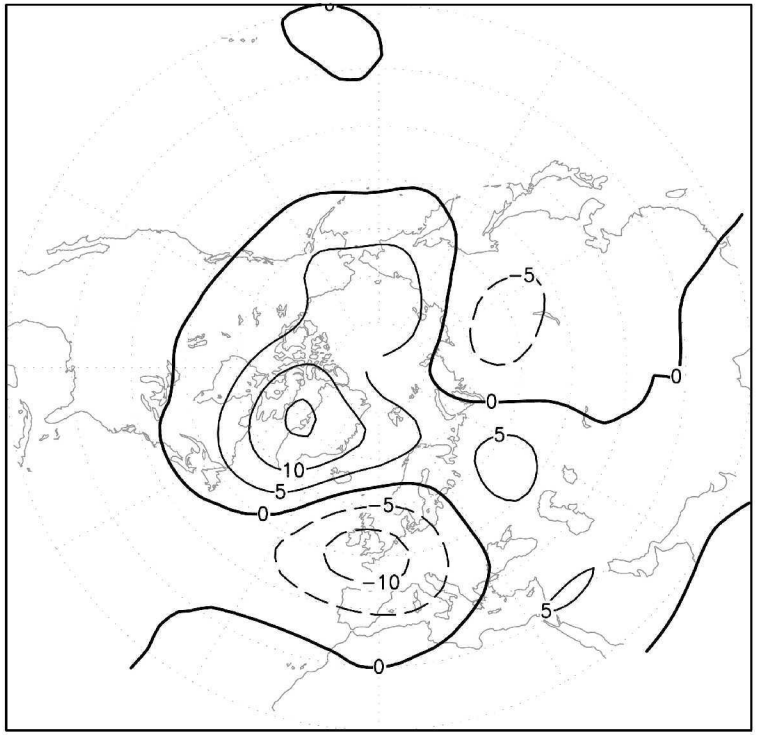




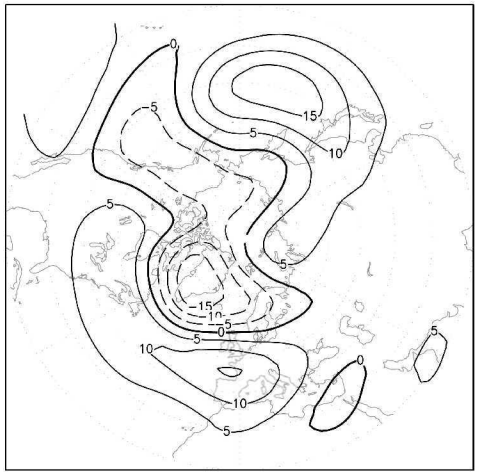


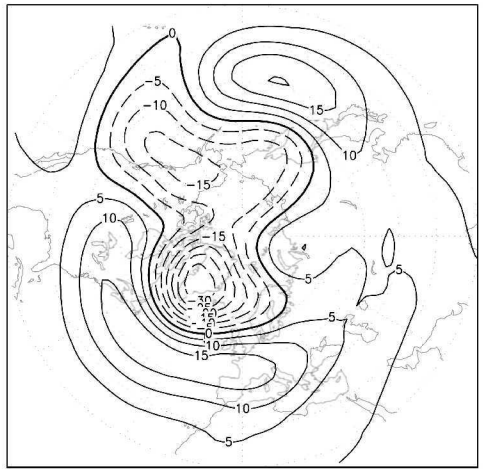
EXP(nsst1985-96,A_{co2}=6,hadice1985-96,SISO)-
EXP(nsst1958-69,hadice1958-96,SISO)

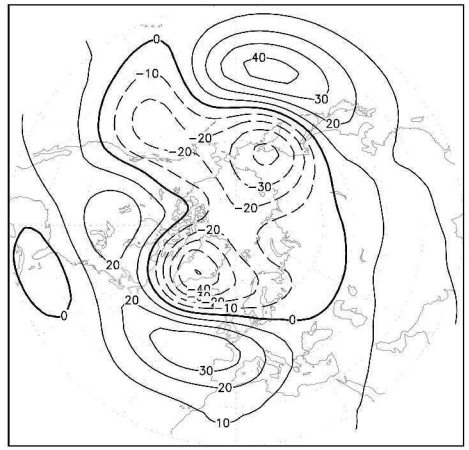
Sea ice model: Bitz and Lipscomb (1999) JGR

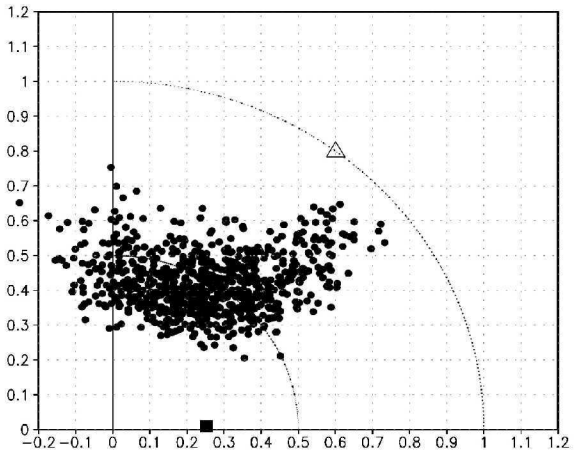


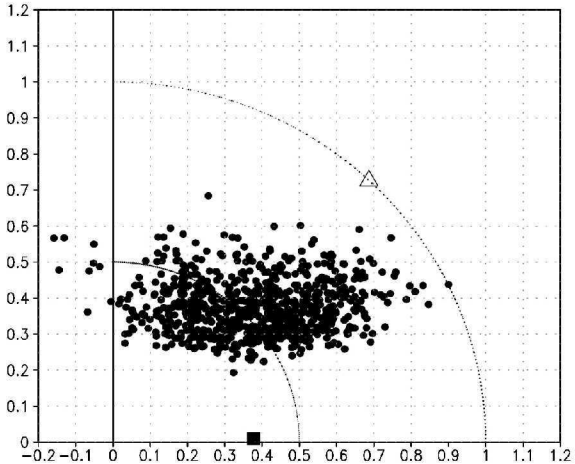
EXP(nsst1985-96,hadice1985-96,SI)
-
EXP(nsst1958-69,hadice1958-69,SI)

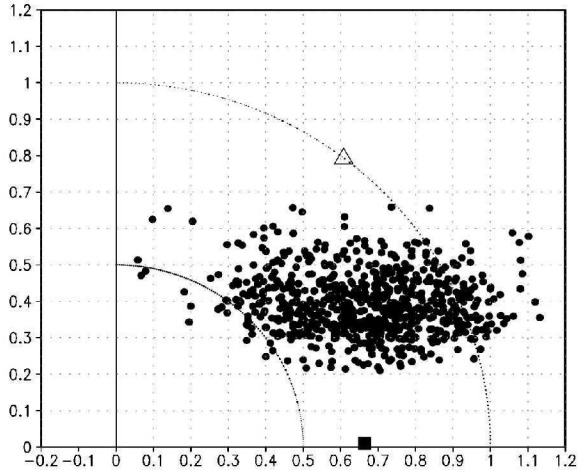










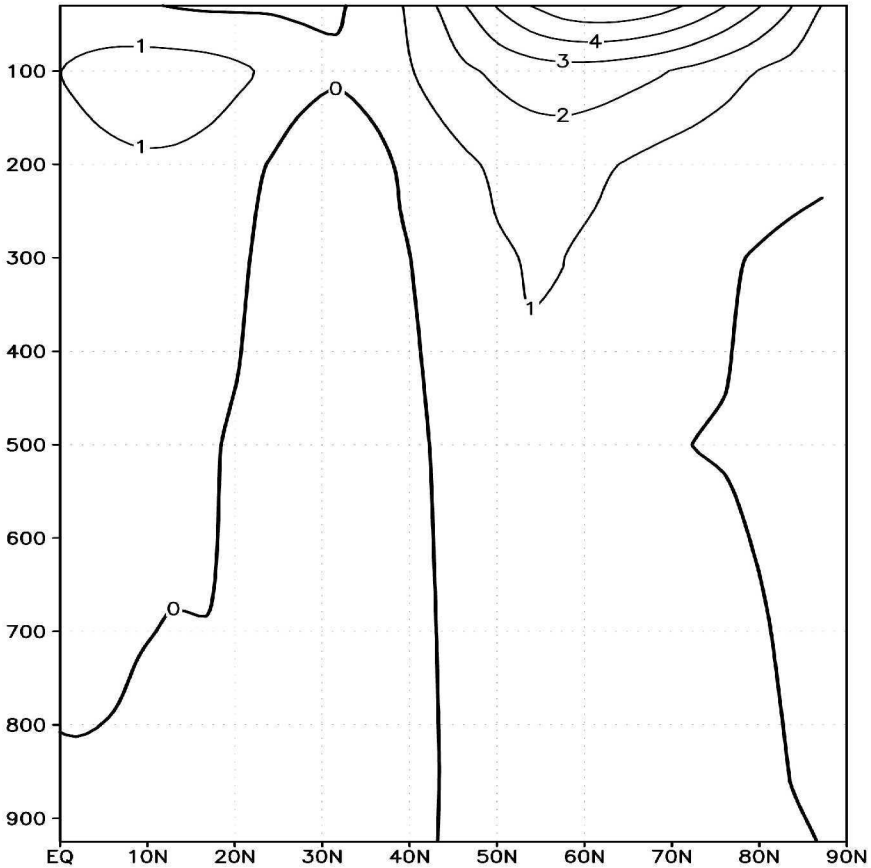


EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.023)-
EXP(nsst1958-69)

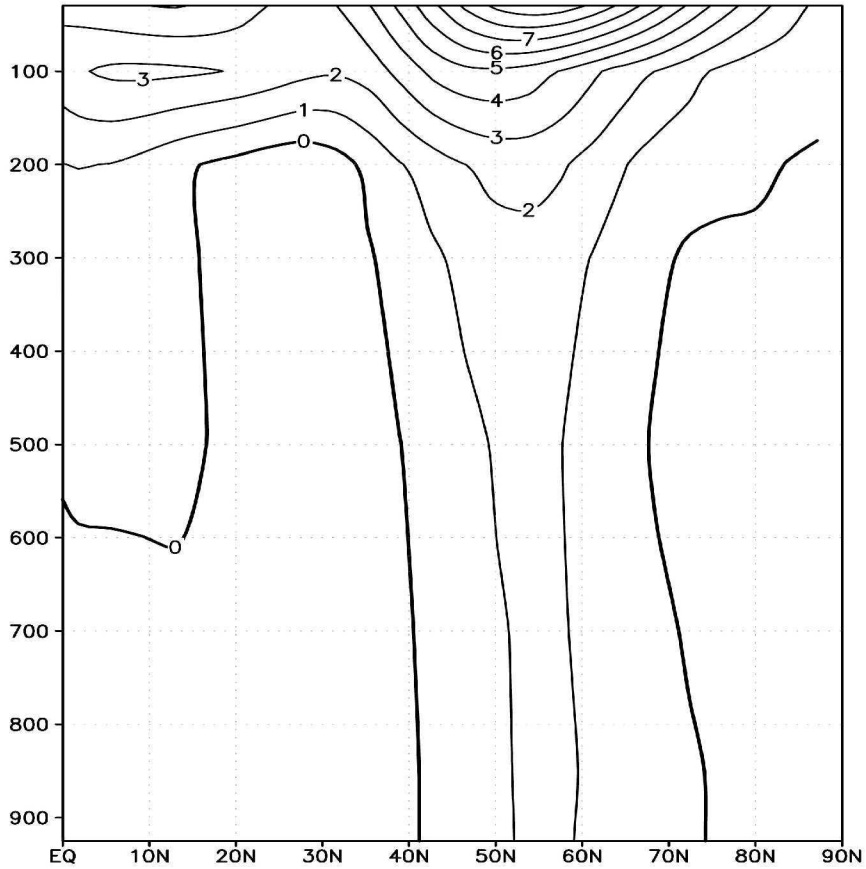
EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.021)-
EXP(nsst1958-69)

EXP(nsst1985-96,Aco2=6,E_{oz}=0.019)-
EXP(nsst1958-69)

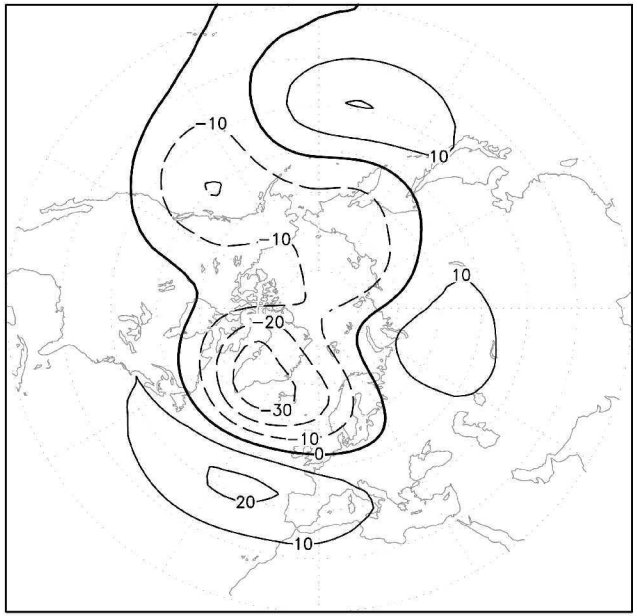
Zonal-mean u-wind trend

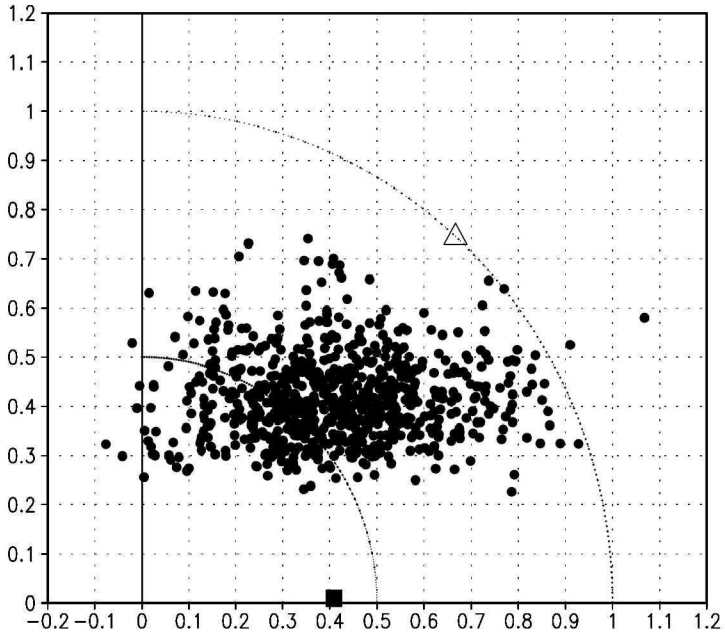


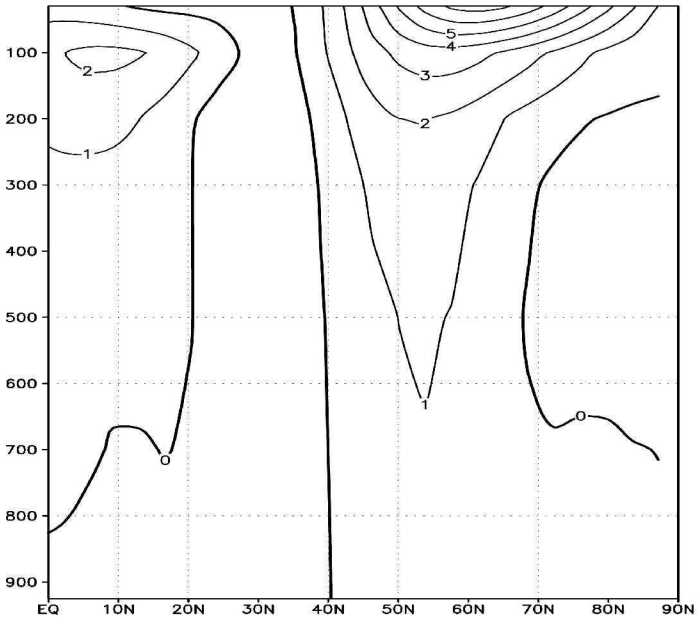
EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.021)-EXP(nsst1958-69)



EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.019)-EXP(nsst1958-69)

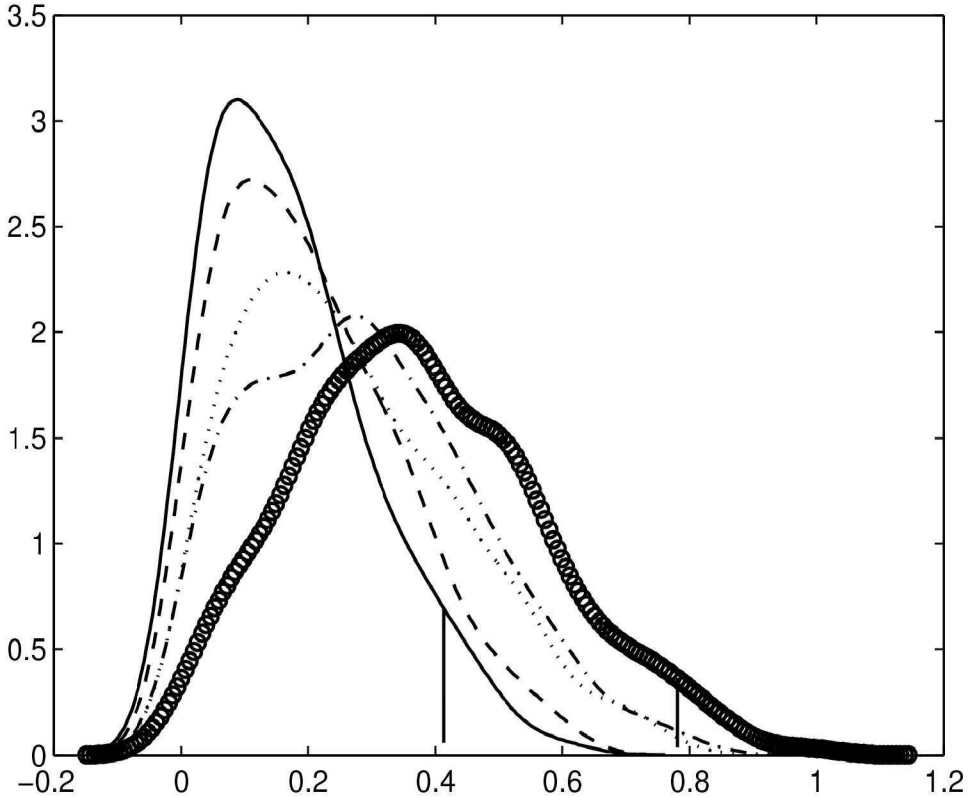






'Best-scenario' forcings experiment:

EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.020,SISO)-
EXP(nsst1958-69,SISO)



PDFs for Normalised NAO:

———— Control EXP(nsst1985-96)

– – – EXP(nsst1985-96)-EXP(1958-69)

-.- EXP(nsst1985-96,A_{co2}=6)-EXP(nsst1958-69)

· · · · · EXP(nsst1985-96,A_{co2}=6,SISO)-EXP(nsst1958-69,SISO)

ooo EXP(nsst1985-96,A_{co2}=6,E_{oz}=0.02,SISO)-EXP(nsst1958-69,SISO)

Conclude with questions:

1. What are missing from the experiments?

2. What are missing in the models? (e.g. dynamics, parameterisations, chemistry, roles of oceans, resolutions)

3. Are models representing in the correct regimes of climate variabilities across different timescales?

4. Inability of models to maintain weak meridional temperature gradients (in global warming) (?)