Role of external forcings on the SAM & implications for Southern Ocean SSTs

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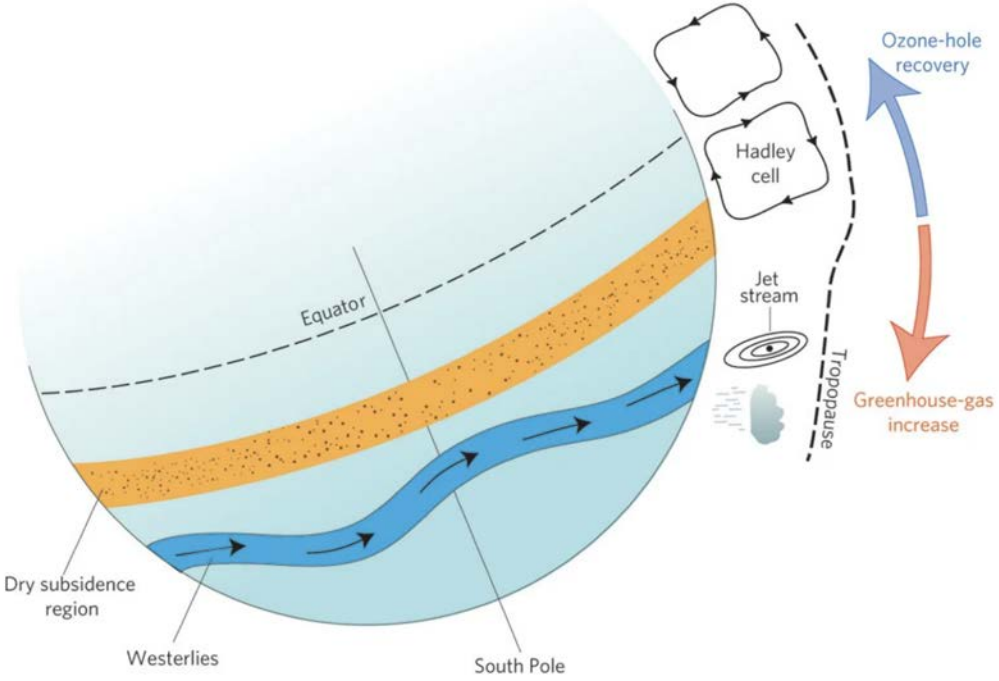
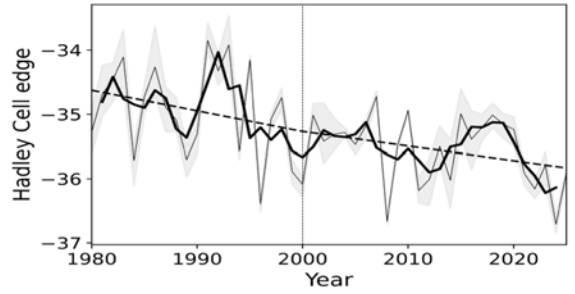
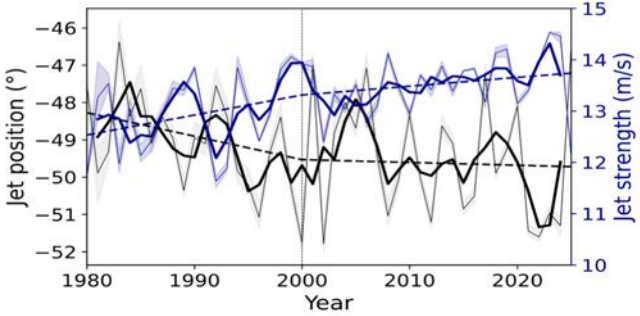
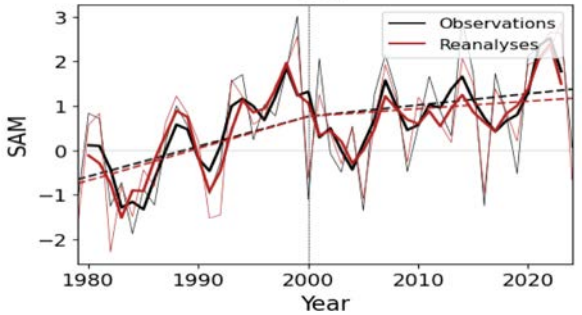
Observed changes in Southern Hemisphere circulation

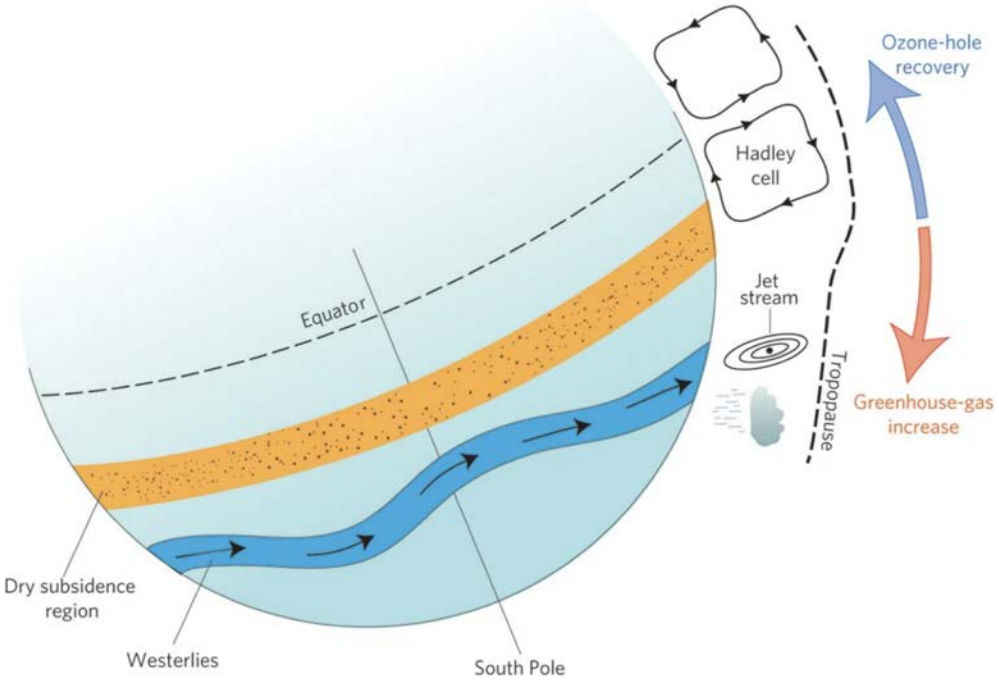








Observed changes in Southern Hemisphere circulation

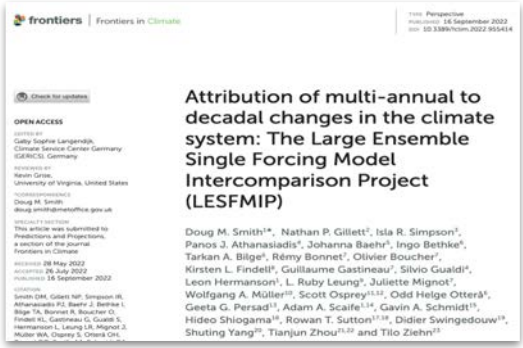


- Can models represent these changes?
- What is the role of external forcings (e.g. GHGs, Ozone, Aerosols) *vs*. internal variability?
- What are the implications for Southern Hemisphere climate?

LESFMIP: Large Ensemble Single Forcings MIP

Models	Experiments			
	Historical	hist-GHG	hist-totalO3	hist-aer
ACCESS-ESM1-5	40	10		3
CanESM5	65	50	10	30
CMCC-CM2-SR5	11	10		10
FGOALS-g3	6	3		3
GISS-E2-1-G	46	44	5	45
HadGEM3-GC31-LL	50	50	50	50
IPSL-CM6A-LR	33	10		10
MIROC6	50	50	10	10
MPI-ESM1-2-LR	51	30	30	30
NorESM2-LM	44	23	20	23

Models with number of runs available for each experiment


frontiers | Frontiers in Climate

Attribution of multi-annual to decadal changes in the climate system: The Large Ensemble Single Forcing Model Intercomparison Project (LESFMIP)

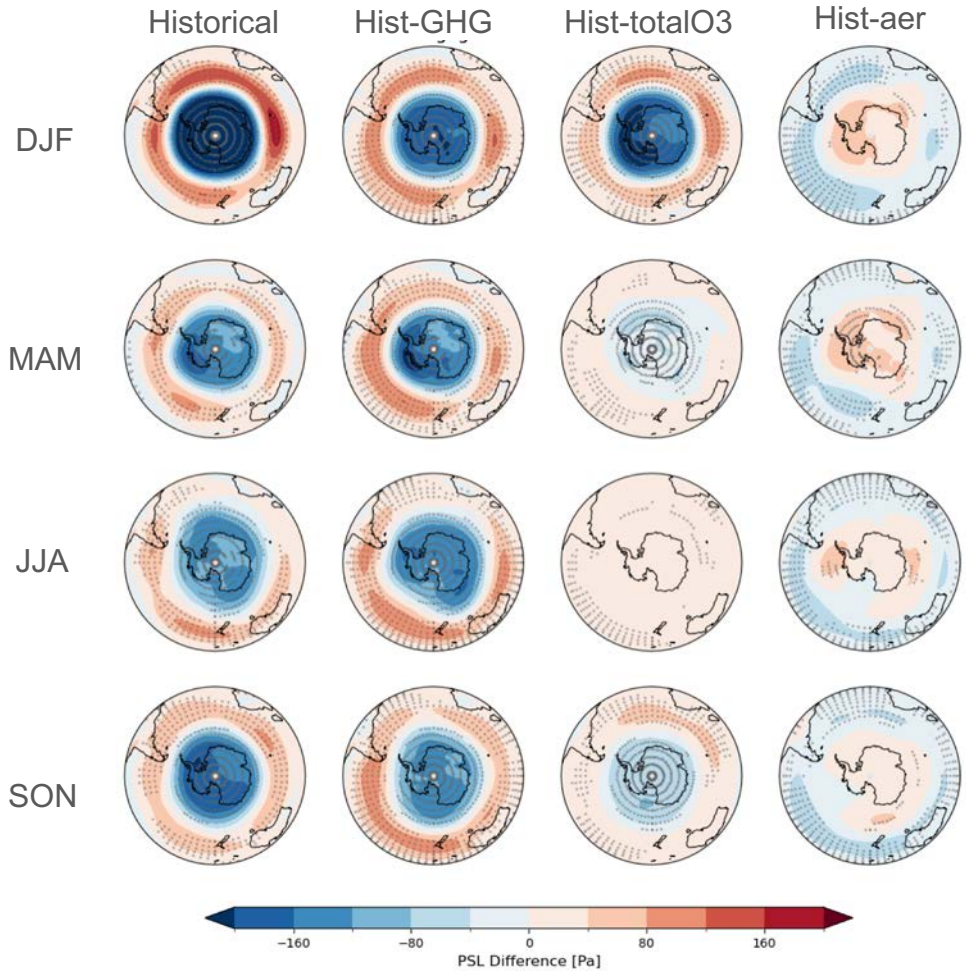
Doug M. Smith[1*], Nathan P. Gillett[2], Isla R. Simpson[3], Panos J. Athanasiadis[4], Johanna Baehr[5], Ingo Bethke[6], Tarkan A. Bilge[6], Rémy Bonnet[7], Olivier Boucher[7], Kirsten L. Findell[8], Guillaume Gastineau[7], Silvio Gualdi[4], Leon Hermanson[1], L. Ruby Leung[9], Juliette Mignot[7], Wolfgang A. Müller[10], Scott Osprey[11,12], Odd Helge Otterå[6], Geeta G. Persad[13], Adam A. Scaife[1,14], Gavin A. Schmidt[15], Hideo Shiogama[16], Rowan T. Sutton[17,18], Didier Swingedouw[19], Shuting Yang[20], Tianjun Zhou[21,22] and Tilo Ziehn[23]

Analyses over 1850-2014 for 10 LE models for historical, hist-GHG and hist-aer experiments.

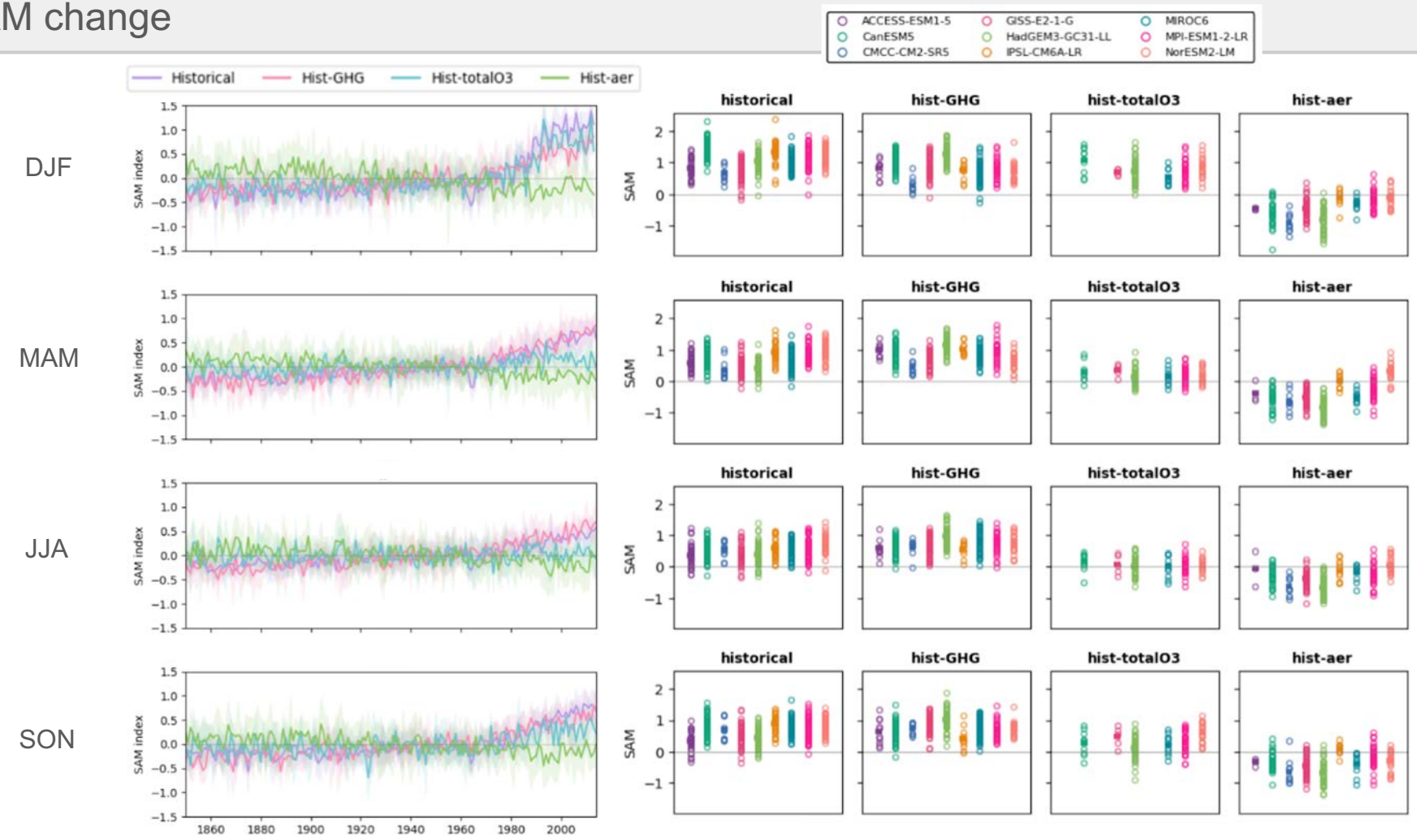
Note that only 6 models have data for hist-totalO3

Simulated MSLP change

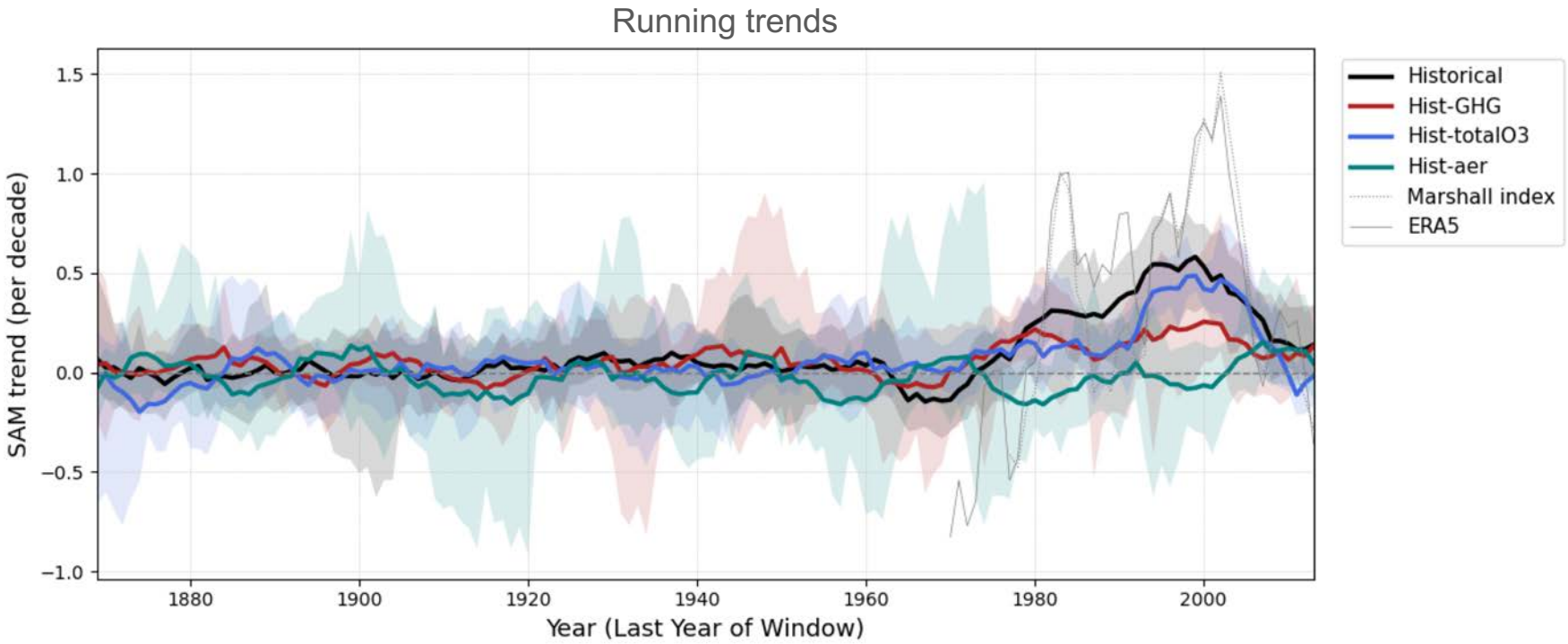
PSL difference:
(1980-2014) - (1850-1884)



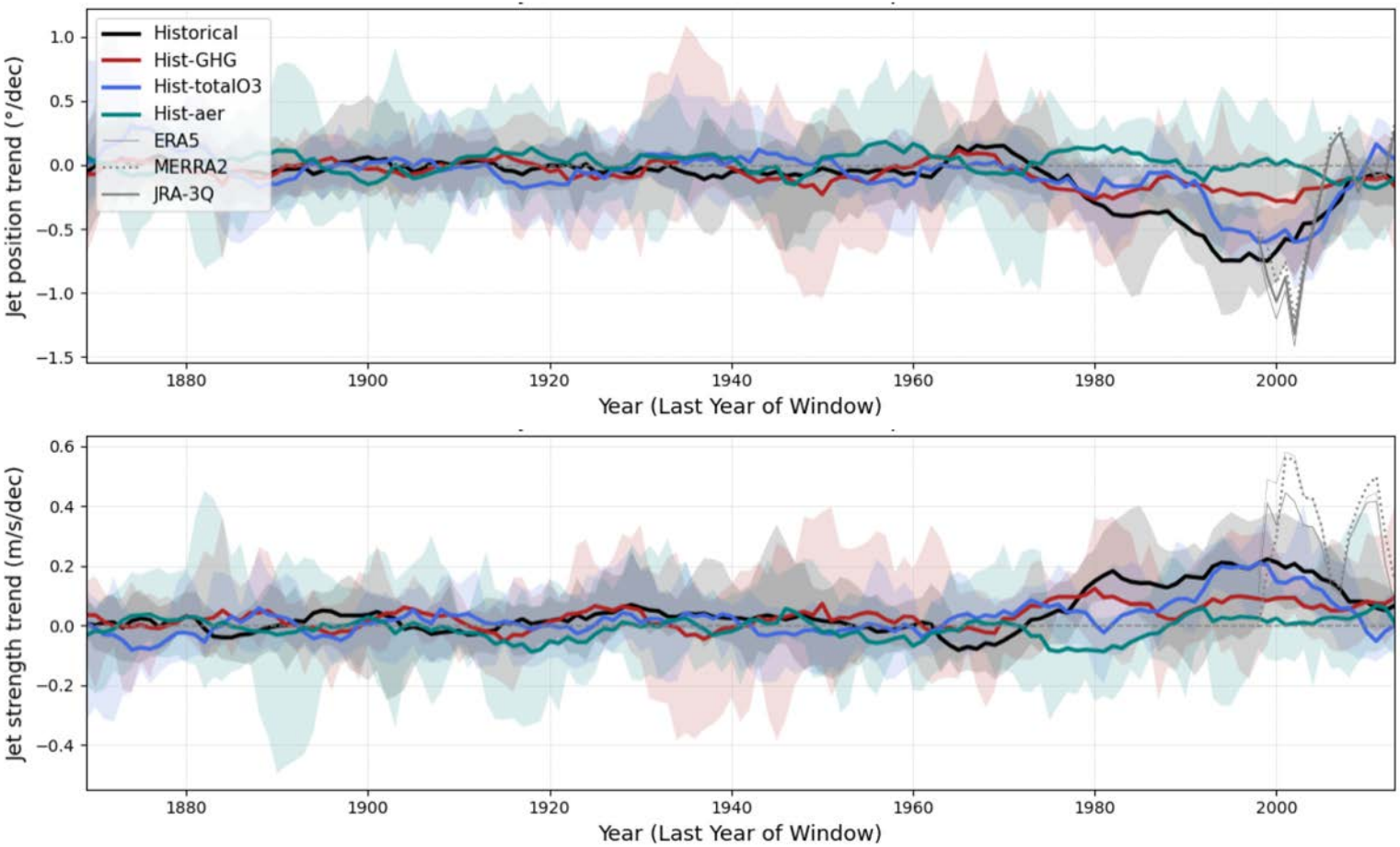
SAM change


ACCESS-ESM1-5
CanESM5
CMCC-CM2-SR5
GISS-E2-1-G
HadGEM3-GC31-LL
IPSL-CM6A-LR
MIROC6
MPI-ESM1-2-LR
NorESM2-LM
Historical
Hist-GHG
Hist-totalO3
Hist-aer
DJF
MAM
JJA
SON
SAM index
SAM
historical
hist-GHG
hist-totalO3
hist-aer
1860
1880
1900
1920
1940
1960
1980
2000

SAM change in DJF



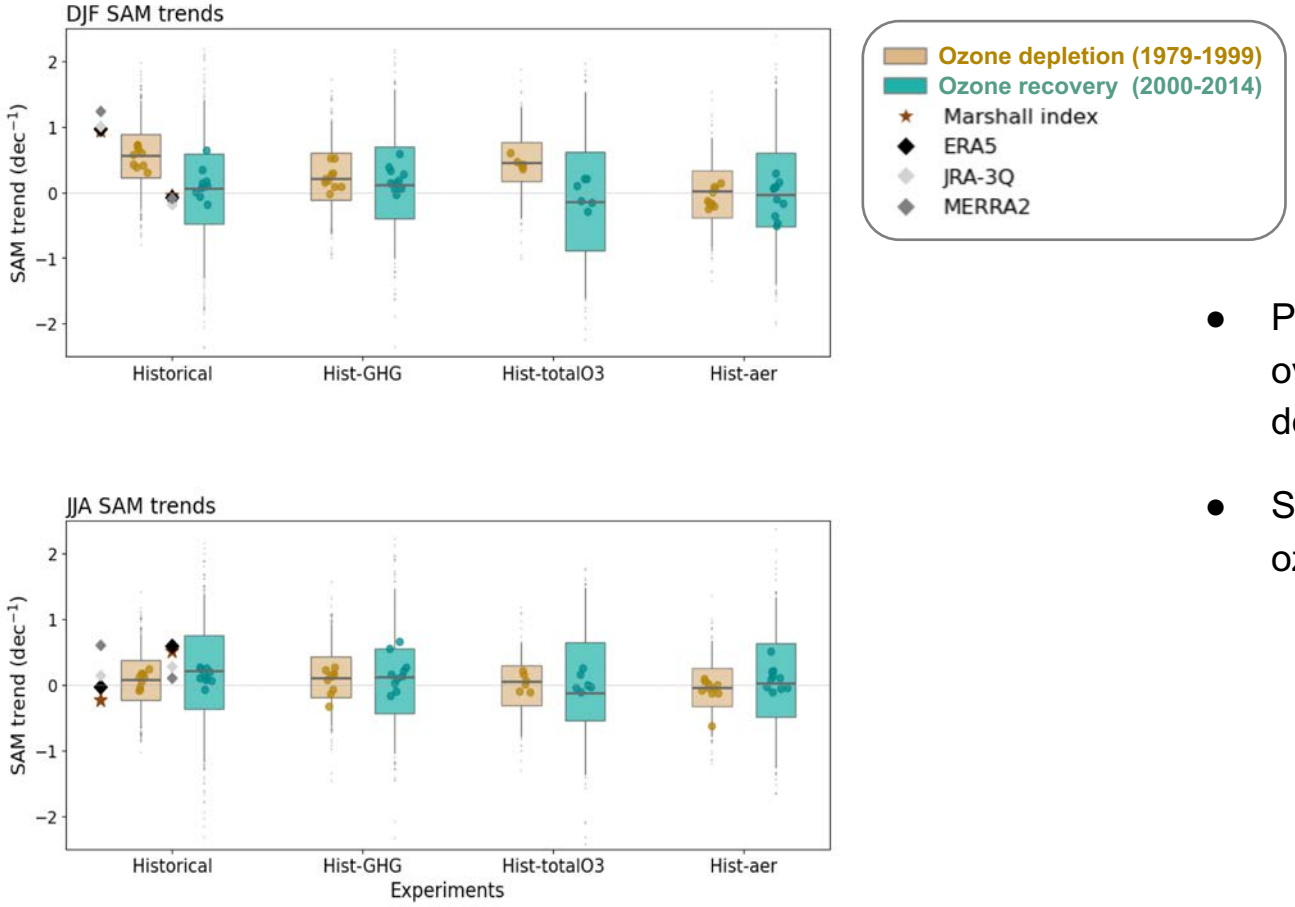
Jet change in DJF



Poleward shift

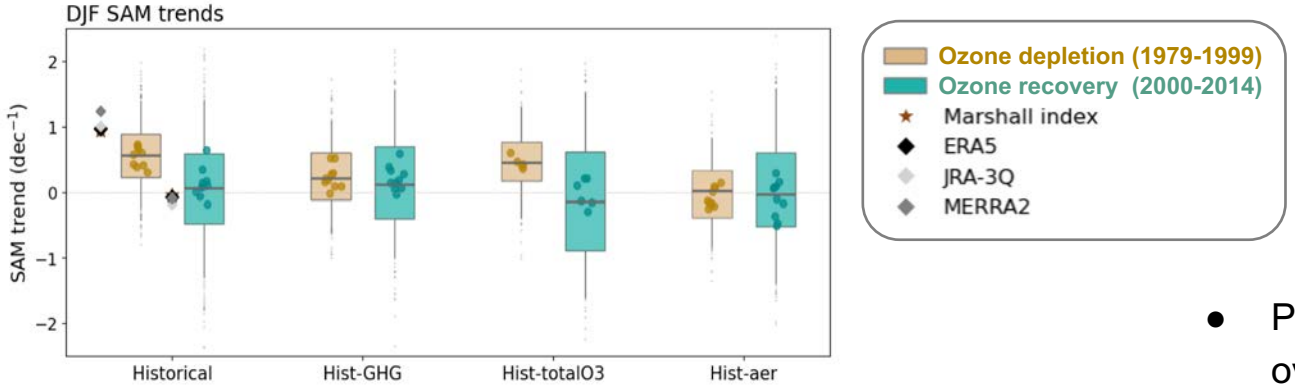
Intensification

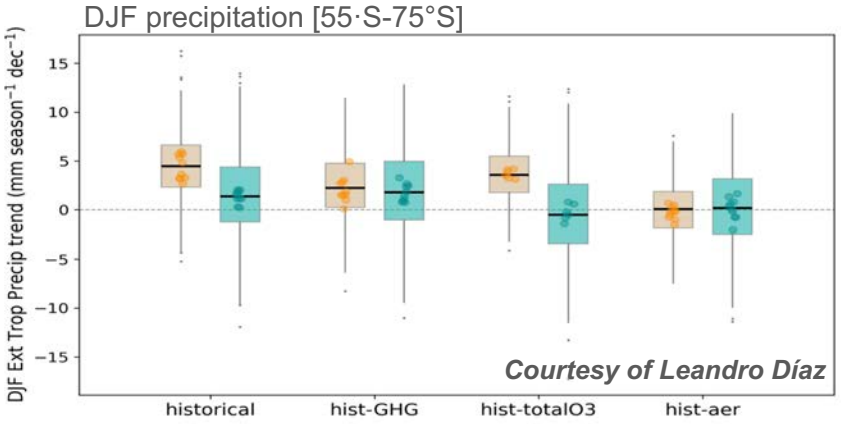
SAM trends during ozone depletion and recovery periods



- Positive trends in DJF SAM over 1979-1999 due to ozone depletion
- Slow down/reversal due to ozone recovery from ~2000

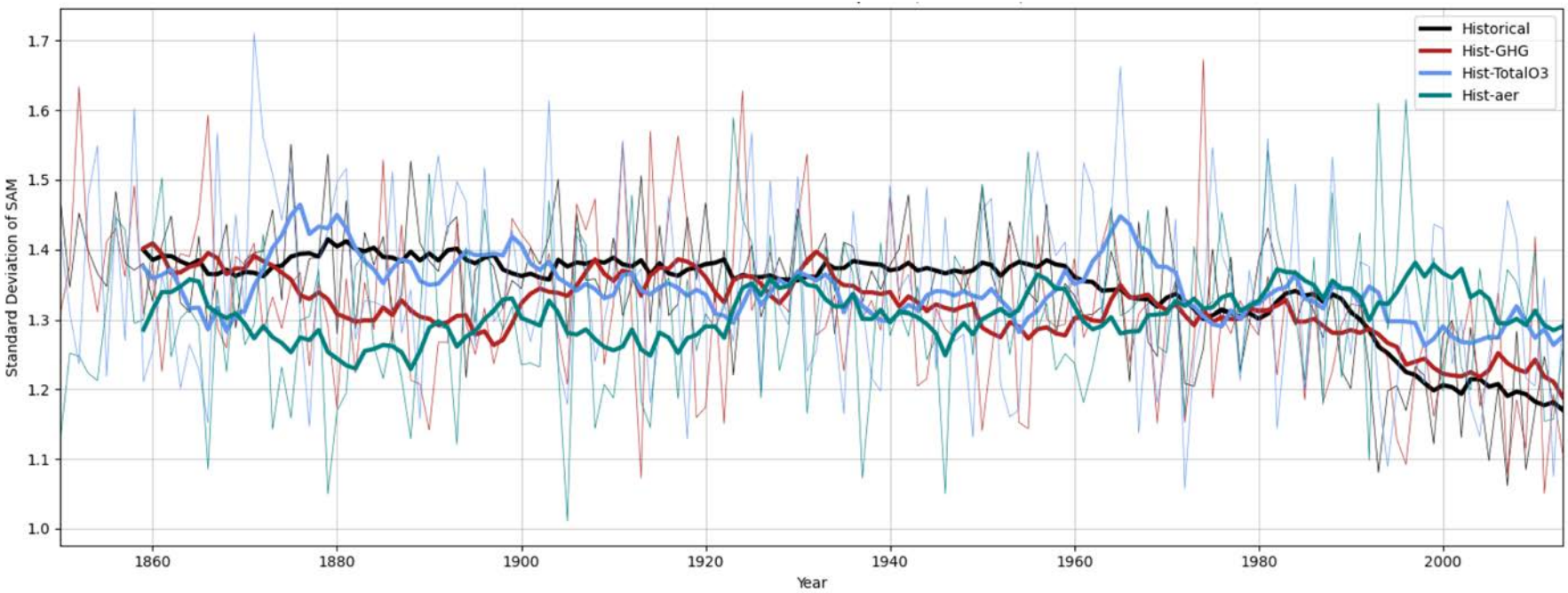
SAM trends during ozone depletion and recovery periods



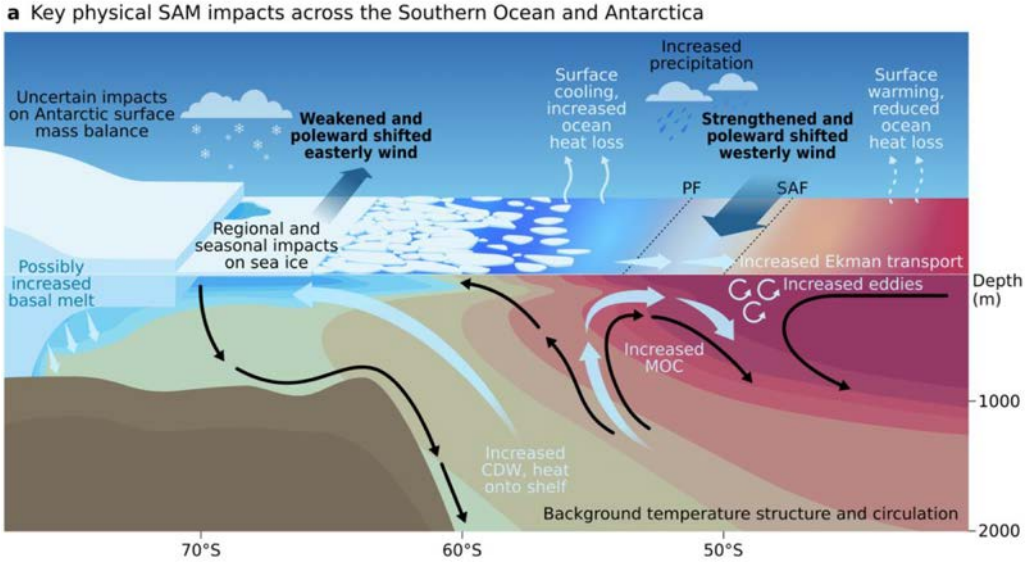


- Positive trends in DJF SAM over 1979-1999 due to ozone depletion
- Slow down/reversal due to ozone recovery from ~2000
- Consistent trends in high-latitude precipitation

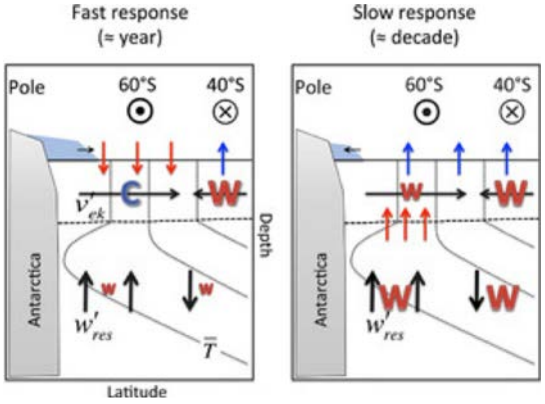
Changes in SAM variability



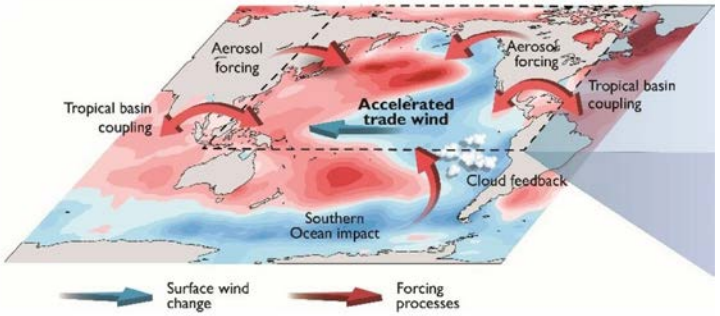
Relationship between SAM and Southern Ocean SSTs



(Purich et al., NREE accepted)



(Ferrera et al. 2015)



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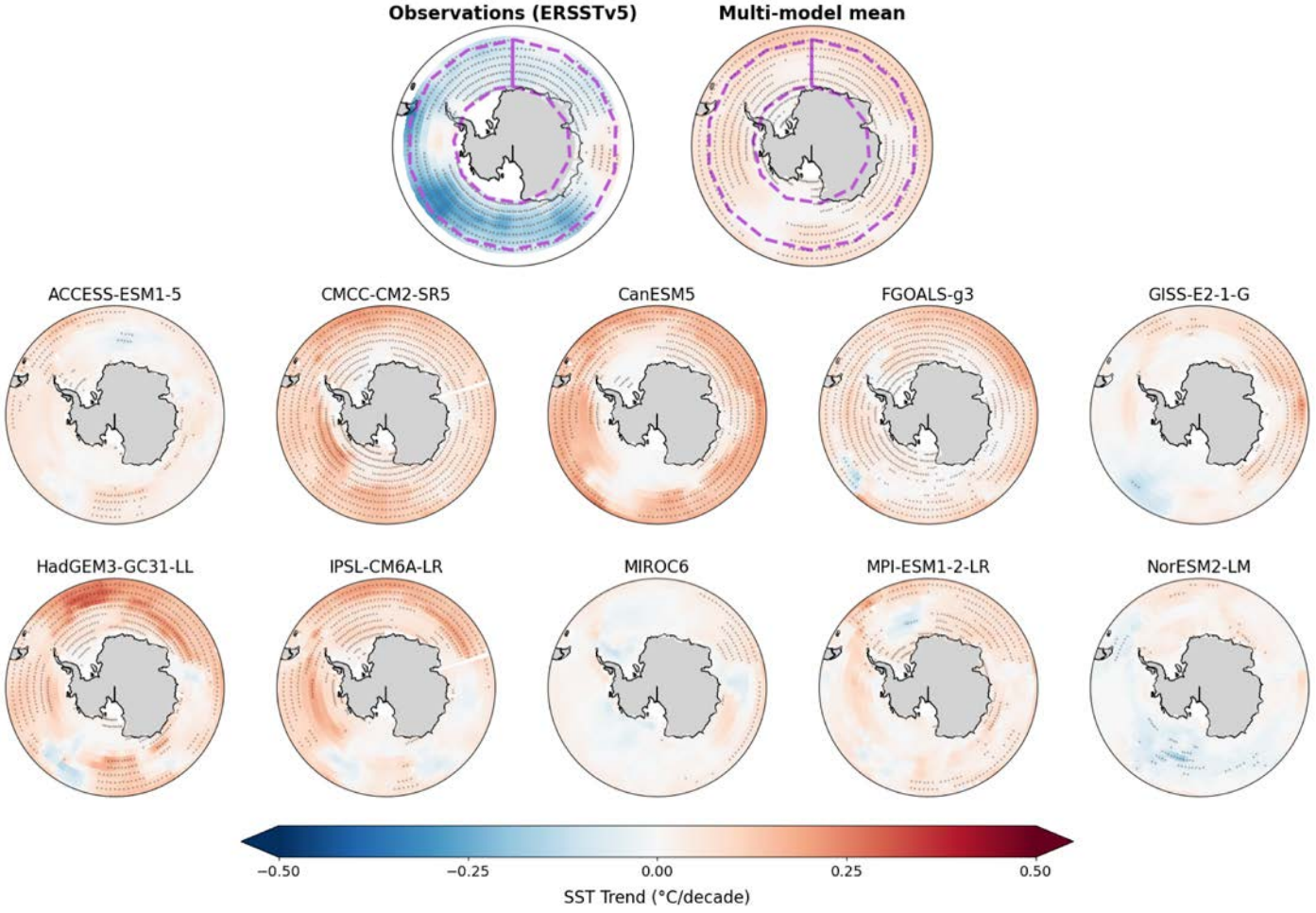

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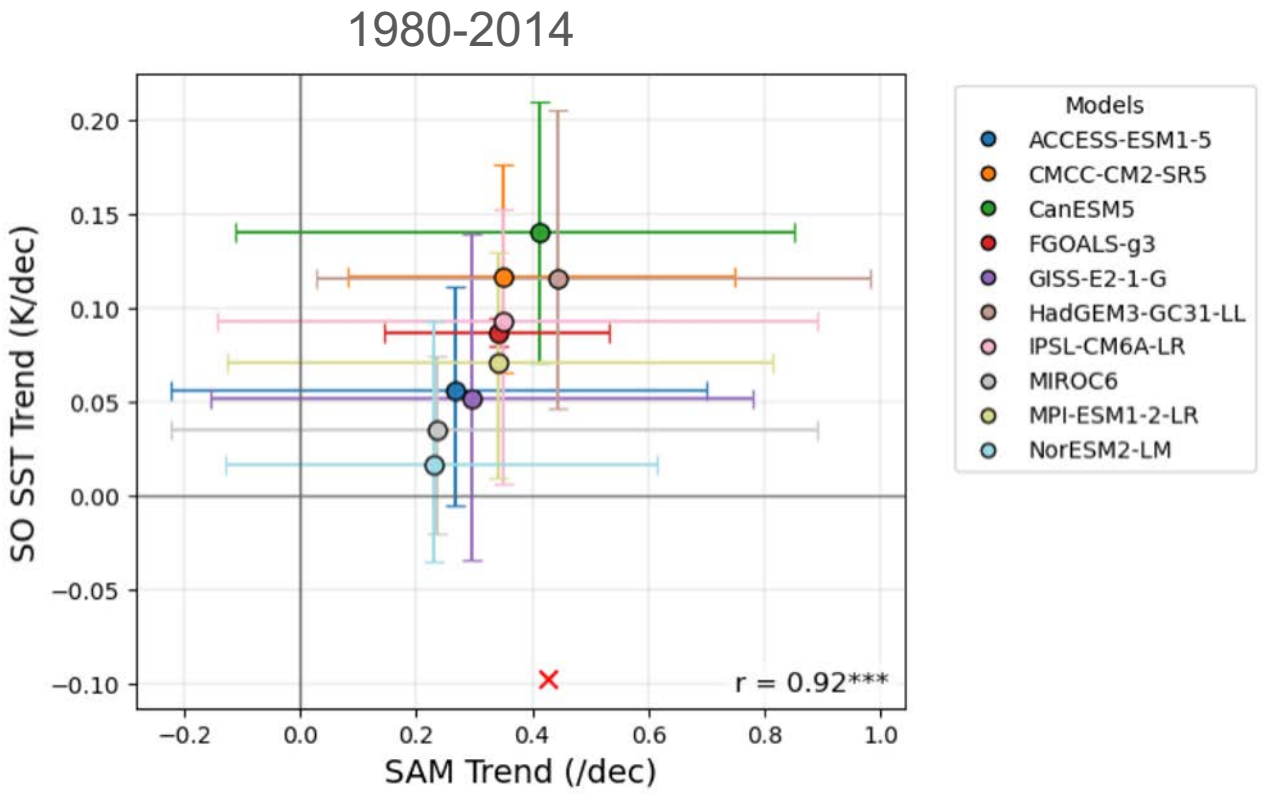
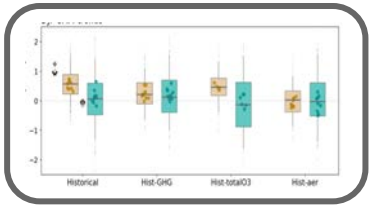
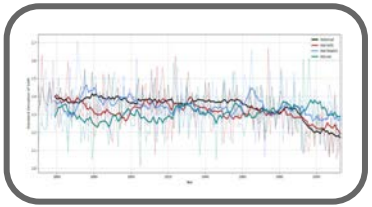


Boschat et al., in prep

Concluding remarks

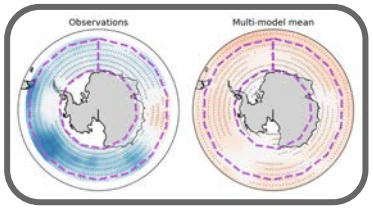


- Ozone depletion and ↑GHG have led to significant large-scale circulation trends in the Southern Hemisphere, including a positive SAM trend, poleward shift and intensification of the eddy-driven jet.
  Ozone recovery is slowing down/reversing some of these trends since ~2000.



- These trends are accompanied by a possible decline in SAM variability over recent decades - further research is needed to understand this.

- Most models simulate a warming of Southern Ocean SSTs during 1980-2014, as opposed to the observed cooling trend.



- Understanding SAM changes and its influence on Southern Ocean SST is important, given the implications for Antarctic sea ice and tropical Pacific teleconnections.

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