Decadal Climate Prediction Project (DCPP): Overview and Future Plans

Jon Robson and Steve Yeager (DCPP Co-Chairs)

DCPP: a brief history

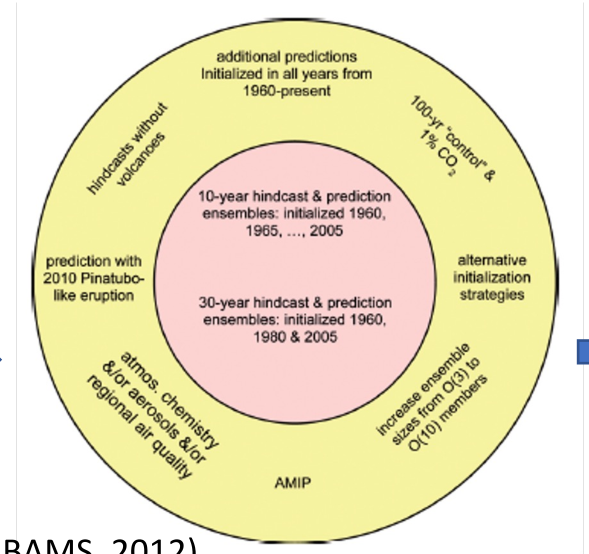
DCPP is CMIP6 endorsed MIP

The DCPP panel is a WCRP panel which focuses on coordinating international research activities on decadal climate prediction – it is a sub-panel of WGSIP

Links to the WMO A2DCU

Disparate uncoordinated DP efforts

CMIP5



Taylor et al. (BAMS, 2012)

DCPP Panel: coordinate the scientific and practical aspects of decadal climate prediction research within WCRP

CMIP6 Boer et al. (GMD, 2016)

	Expmt	experiment_id	Tier	Years	Description
Component A: Decadal Hindcasts	A1	dcppA-hindcast	1	3000	Five-year hindcasts every year from 1960. Note that the first forecast year is 1961 from initialization toward the end of 1960.
	A2.1		2	3000	Extend A1 hindcast duration to 10 years
	A2.2	dcppA-historical	2	1700	Ensemble of uninitialized historical/future simulations
	A2.3	dcppA-assim	2	(60-600)	Ensemble of "assimilation" run(s) (if available). These are simulations used to incorporate observation-based data into the model in order to generate initial conditions for hindcasts. They parallel the historical simulations and use the same forcing. The number of years depends on the number of independent assimilation runs.
	A3.1	dcppA-hindcast	3	300m	Increase ensemble size by *m* for A1
	A3.2		3	300m	Increase ensemble size by *m* for A2.1
	A4.1	dcppA-hindcast-niff	4	3000	As A1 but no forcing information from the future (niff) with respect to the hindcast. Forcing from persistence or other estimate.
	A4.2	dcppA-historical-niff	4	3000	As A4.1 but initialized from historical simulations
Component B: Decadal Forecasts	B1	dcppB-forecast	1	50	Ongoing near-real-time forecasts
	B2.1		2	5m	Increase ensemble size by *m* for B1
	B2.2		2	50	Extend forecast duration to 10 years for B1
Component C: Hiatus+	C1.1	dcppC-atl-control	1	250	Idealized Atlantic control
	C1.2	dcppC-amv-pos	1	250	Idealized impact of AMV+
	C1.3	dcppC-amv-neg	1	250	Idealized impact of AMV-
	C1.4	dcppC-pac-control	1	100	Idealized Pacific control
	C1.5	dcppC-ipv-pos	1	100	Idealized impact of IPV+
	C1.6	dcppC-ipv-neg	1	100	Idealized impact of IPV-
	C1.7	dcppC-amv-ExTrop-pos dcppC-amv-ExTtrop-neg	2	500	Idealized impact of extratropical AMV+ and AMV-
	C1.8	dcppC-amv-Trop-pos dcppC-amv-Trop-neg	2	500	Idealized impact of tropical AMV+ and AMV-
	C1.9	dcppC-ipv-NexTrop-pos dcppC-ipv-NexTtrop-neg	2	200	Idealized impact of northern extratropical IPV+ and IPV-
	C1.10	dcppC-pac-pacemaker	3	650	Pacemaker Pacific experiment

CMIP7 (and beyond?)

DCPP: Current panel

Decadal Climate Prediction Project Panel

Jon Robson (co-Chair)	University of Reading	UK
Steve Yeager (co-Chair)	NCAR	USA
Panos Athanasiadis	CMCC	Italy
Ingo Bethke	University of Bergen	Norway
C. Gnanaseelan	IITM	India
Tatiana Ilyina	MPI-M	Germany
Yukiko Imada	MRI/JMA	Japan
Jerry Meehl	NCAR	USA
Bill Merryfield	ECCC	Canada
Juliette Mignot	IPSL/LOCEAN	France
Wolfgang Müller	MPI-M	Germany
Pablo Ortega	BSC	Spain
Doug Smith	Met Office	UK
Liping Zhang	NOAA	USA

- DCPP panel recently refreshed with a view towards an updated CMIP7 protocol
  - includes most of the centers with capacity to produce initialised predictions

Overview of the CMIP6 DCPP Protocol

	Expmt	experiment_id	Tier	Years	Description
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Component B: Decadal Forecasts	B1	dcppB-forecast	1	50	Ongoing near-real-time forecasts
	B2.1		2	5m	Increase ensemble size by *m* for B1
	B2.2		2	50	Extend forecast duration to 10 years for B1

Component A

- 5/10 year hindcasts every year from 1960
- 10+ member ensembles
- CMIP6 historical forcings + SSP2-4.5
- 10+ member set of uninitialized hist+ssp

Component B

- Real-time forecasts

10 models took part. ~150 members

~80,000 model-years

Boer et al. (GMD, 2016)

Overview of the CMIP6 DCPP Protocol

Component C: Hiatus+	C1.1	dcppC-atl-control	1	250	Idealized Atlantic control
	C1.2	dcppC-amv-pos	1	250	Idealized impact of AMV+
	C1.3	dcppC-amv-neg	1	250	Idealized impact of AMV-
	C1.4	dcppC-pac-control	1	100	Idealized Pacific control
	C1.5	dcppC-ipv-pos	1	100	Idealized impact of IPV+
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	C1.10	dcppC-pac-pacemaker	3	650	Pacemaker Pacific experiment
	C1.11	dcppC-atl-pacemaker	3	650	Pacemaker Atlantic experiment
Component C: Atlantic gyre	C2.1	dcppC-atl-spg	3	200-400	Predictability of 1990s warming of Atlantic gyre
	C2.2		3	200-400	Additional start dates
Component C: Volcano	C3.1	dcppC-hindcast-noPinatubo	1	50-100	Repeat 1991 hindcast but without Pinatubo forcing
	C3.2	dcppC-hindcast-noElChichon	2	50-100	Repeat 1982 hindcast but without El Chichon forcing
	C3.3	dcppC-hindcast-noAgung	2	50-100	Repeat 1963 hindcast but without Agung forcing
	C3.4	dcppC-forecast-addPinatubo	1	50-100	Repeat 2015 forecast with added Pinatubo forcing
	C3.5	dcppC-forecast-addElChichon	3	50-100	Repeat 2015 forecast with added El Chichon forcing
	C3.6	dcppC-forecast-addElChichon	3	50-100	Repeat 2015 forecast with added Agung forcing

Component C

Predictability, mechanisms, & Case Studies

(Process attribution experiments)

- Idealized AMV and PDV experiments
- Atlantic & Pacific pacemaker experiments
- *Allows participation from groups not doing initialized prediction*

- Perturbed initialization experiments *(no Subpolar North Atlantic)*
- Hindcasts with/without volcanic forcing

Boer et al. (GMD, 2016)

Select CMIP6 DCPP Results

North Atlantic climate far more predictable than models imply

Nature 2020

https://doi.org/10.1038/s41586-020-2525-0
Received: 23 December 2019
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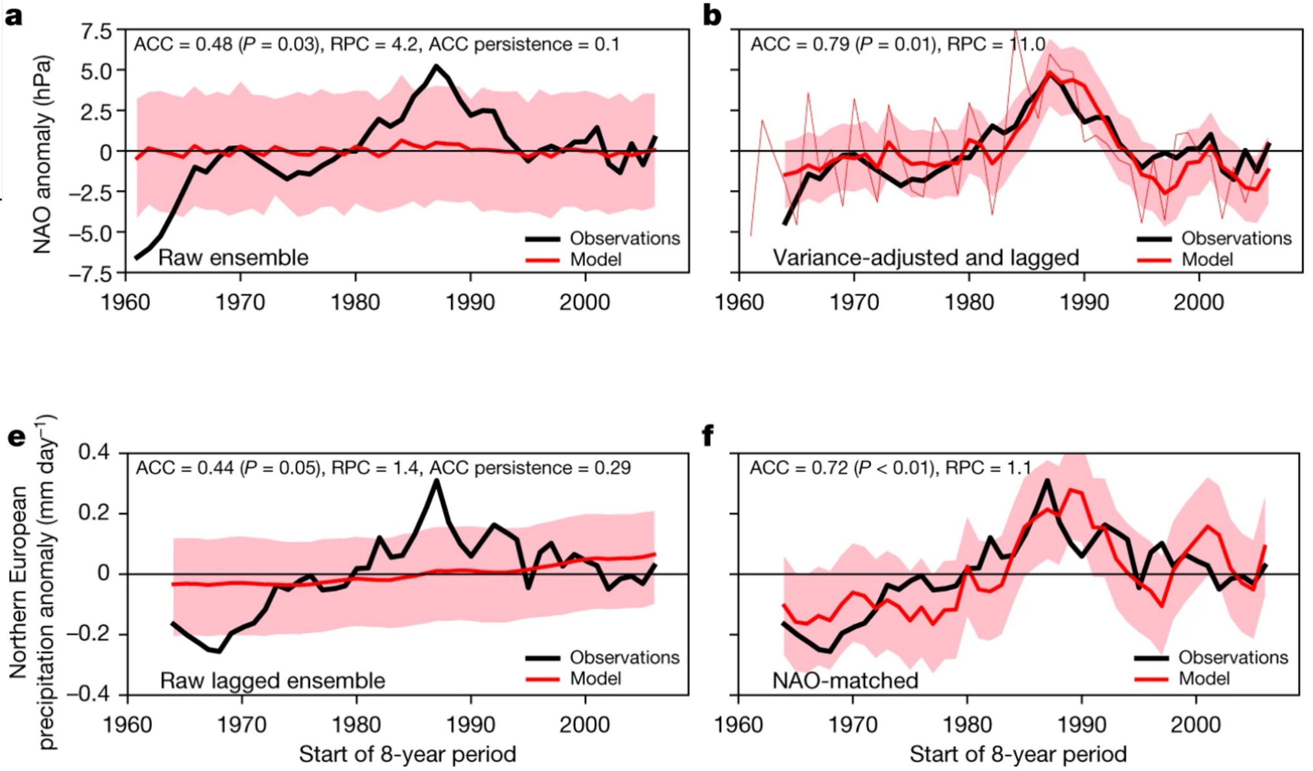
Published online: 29 July 2020
Check for updates

D. M. Smith[1✉], A. A. Scaife[1,2], R. Eade[1], P. Athanasiadis[3], A. Bellucci[3], I. Bethke[4], R. Bilbao[5], L. F. Borchert[6], L.-P. Caron[5], F. Counillon[4,7], G. Danabasoglu[8], T. Delworth[9], F. J. Doblas-Reyes[5,10], N. J. Dunstone[1], V. Estella-Perez[6], S. Flavoni[6], L. Hermanson[1], N. Keenlyside[4,7], V. Kharin[11], M. Kimoto[12], W. J. Merryfield[11], J. Mignot[6], T. Mochizuki[13,14], K. Modali[15,19], P.-A. Monerie[16], W. A. Müller[15], D. Nicolí[3], P. Ortega[5], K. Pankatz[17], H. Pohlmann[15,17], J. Robson[16], P. Ruggieri[3], R. Sospedra-Alfonso[11], D. Swingedouw[18], Y. Wang[7], S. Wild[5], S. Yeager[8], X. Yang[9] & L. Zhang[9]

- 169-member ensemble
- Lagged ensemble (676-member) yields high skill for decadal NAO (ACC ~ 0.8) & related impacts over Europe, N. America after calibration
- Unrealistically low signal-to-noise (RPC>10!) where ACC shows skill
- High decadal NAO skill also seen in some individual systems (e.g., CESM1-DPLE; Athanasiadis et al. 2020)

FY2-9 DJFM SLP



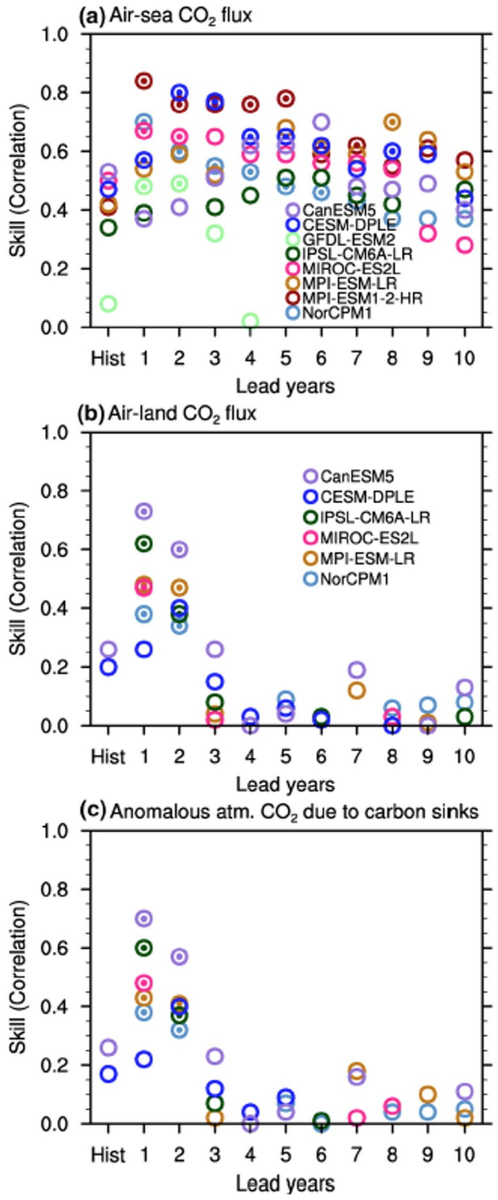
Select CMIP6 DCPP Results

Predictable Variations of the Carbon Sinks and Atmospheric CO_2 Growth in a Multi-Model Framework

T. Ilyina[1], H. Li[1], A. Spring[1,2], W. A. Müller[1], L. Bopp[3], M. O. Chikamoto[4], G. Danabasoglu[5], M. Dobrynin[6], J. Dunne[7], F. Fransner[8], P. Friedlingstein[9], W. Lee[10], N. S. Lovenduski[11], W.J. Merryfield[10], J. Mignot[12], J.Y. Park[13], R. Séférian[14], R. Sospedra-Alfonso[10], M. Watanabe[15], and S. Yeager[5]

GRL 2021

- Advent of Earth system model contributions to DCPP permits assessment of carbon cycle predictability
- Essential for carbon monitoring programs in the presence of internal variability
- Multi-year skill also found for ocean acidification (Brady et al., 2020) & ocean net primary productivity (Krumhardt et al., 2020)



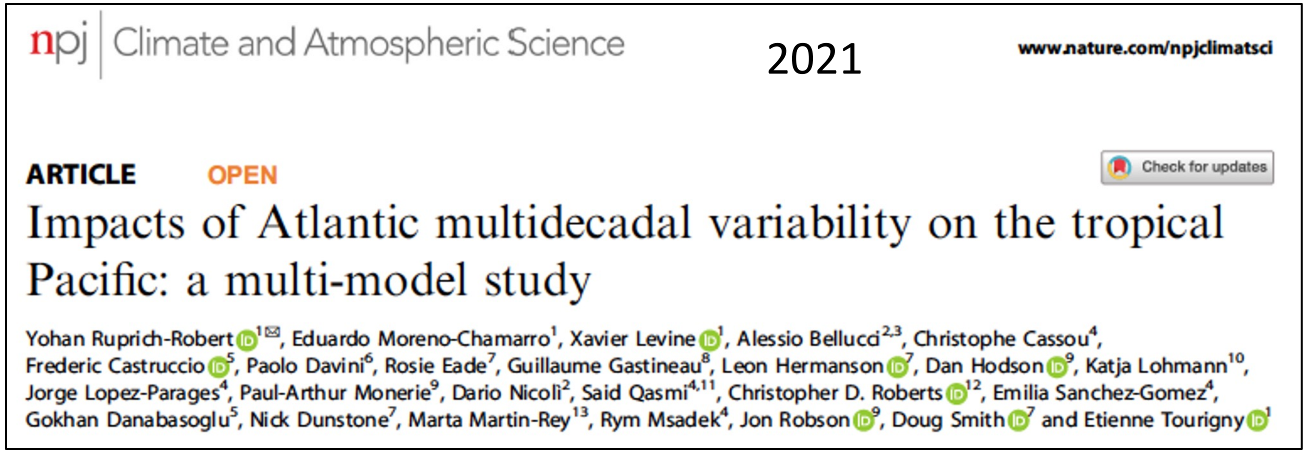
Skill due to initialization:

← Up to 6 years

← Up to 2 years

← Up to 2 years

Select CMIP6 DCPP Results


npj Climate and Atmospheric Science

2021

www.nature.com/npjclimatsci

ARTICLE OPEN

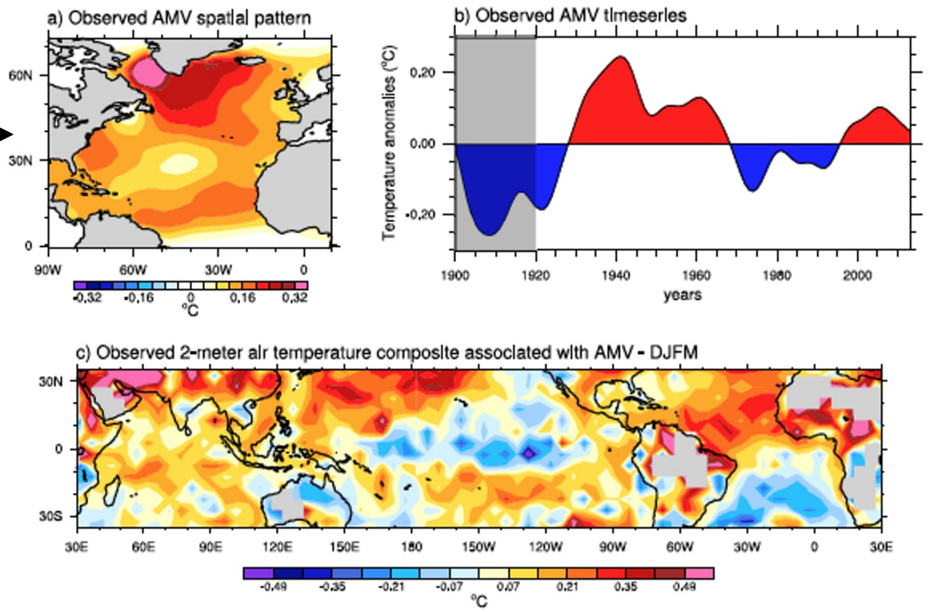
Check for updates

Impacts of Atlantic multidecadal variability on the tropical Pacific: a multi-model study

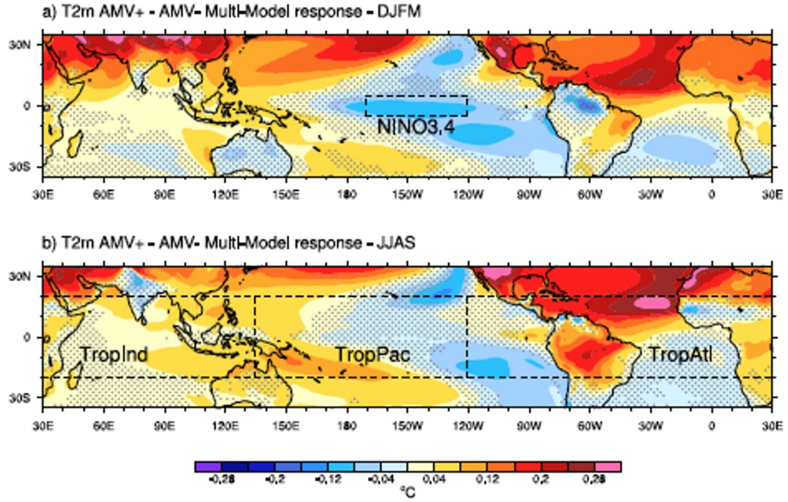
Yohan Ruprich-Robert[1✉], Eduardo Moreno-Chamarro[1], Xavier Levine[1], Alessio Bellucci[2,3], Christophe Cassou[4], Frederic Castruccio[5], Paolo Davini[6], Rosie Eade[7], Guillaume Gastineau[8], Leon Hermanson[7], Dan Hodson[9], Katja Lohmann[10], Jorge Lopez-Parages[4], Paul-Arthur Monerie[9], Dario Nicoli[2], Said Qasmi[4,11], Christopher D. Roberts[12], Emilia Sanchez-Gomez[4], Gokhan Danabasoglu[5], Nick Dunstone[7], Marta Martin-Rey[13], Rym Msadek[4], Jon Robson[9], Doug Smith[7] and Etienne Tourigny[1]

- AMV warming linked to tropical Pacific cooling
- Other recent DCPP-C AMV studies:
  - Global monsoons (Monerie et al. 2019)
  - N. Atlantic storm track (Ruggieri et al. 2020)
  - Arctic sea ice (Castruccio et al. 2019)
- Ongoing debate regarding validity of experimental design (e.g., Kim et al. 2020; O'Reilly et al. 2022)

DCPP-C Imposed SST →



Multi-model response →



Looking forward…

- DCPP's primary mission is to define co-ordinated multi-model experiments that further decadal prediction science.
  - But wider interests … currently working out where DCPP fits within the new WCRP structure…

CMIP7 is the major focus going forwards

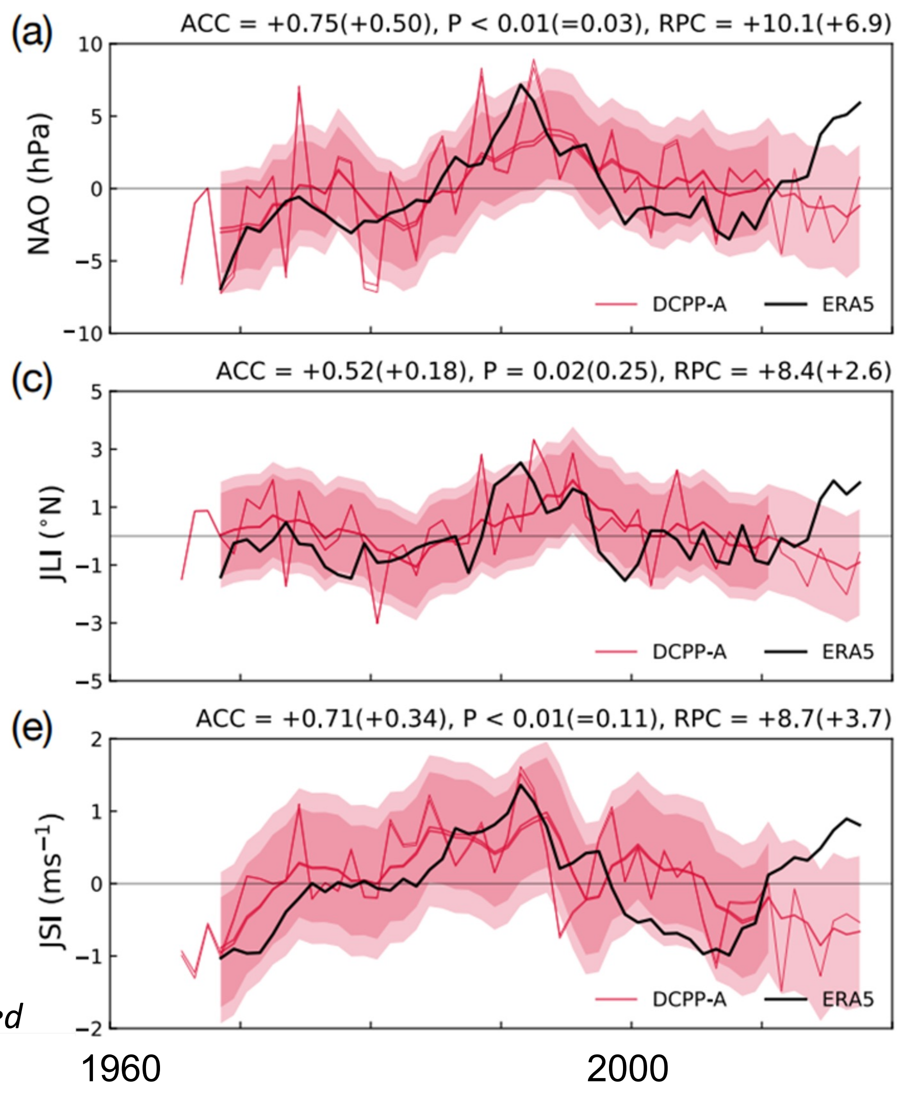
Some, ideas for updates to DCPP protocol

- DCPP-A to include seasonal-to-interannual hindcasts in addition to decadal (e.g., CESM2-SMYLE; Yeager et al., *GMD*, 2022)?
- DCPP-A to include explicit protocol for high-resolution (0.1° ocean, 0.25° atmosphere) hindcasts to facilitate multi-model comparison/analysis?
- Increased emphasis (higher tier) for "niff" (no information from the future) & single-forcing hindcasts sets to better understand predictability mechanisms?
- DCPP-C pacemaker experiments to utilize emerging techniques that circumvent SST restoring?
- Initialized forecasts with geoengineering? (in coordination with GeoMIP)
- Multidecadal (30-year hindcasts) protocol?

Looking forward…

- …but, more broadly, DCPP wants to understand prediction skill and the processes that lead to successful predictions on multi-annual to decadal timescales…

- strong overlap with EPESC for understanding predictability on these timescales…
- ...but also in attribution in general (process attribution important for understanding potential for successful predictions…)



Marcheggiani et al, GRL, resubmitted

Potential future links with EPESC

At the very least we need to be aware of each others plans for experiments and are broadly interested in sharing science / ideas

- coordinated analysis of DCPP hindcast datasets….
- Joint workshops / meetings etc…

…but potential to have deeper synergy?

- Scope for collaborative analysis of DCPP (and other) hindcast data-sets?
- Common advocacy for real-time forcing updates

- Potential for EPESC to feed into DCPP protocol for CMIP7
    - Next hindcast protocol…interannual predictions or high resolution?
    - Co-design of DCPP component-C for CMIP7
        - e.g., specific case studies,
        - idealized experiments for process evaluation
        - Build on DCPP-A hindcast sets for initialized attribution studies (e.g., with/without Australian wildfires; Fasullo et al. 2023)?