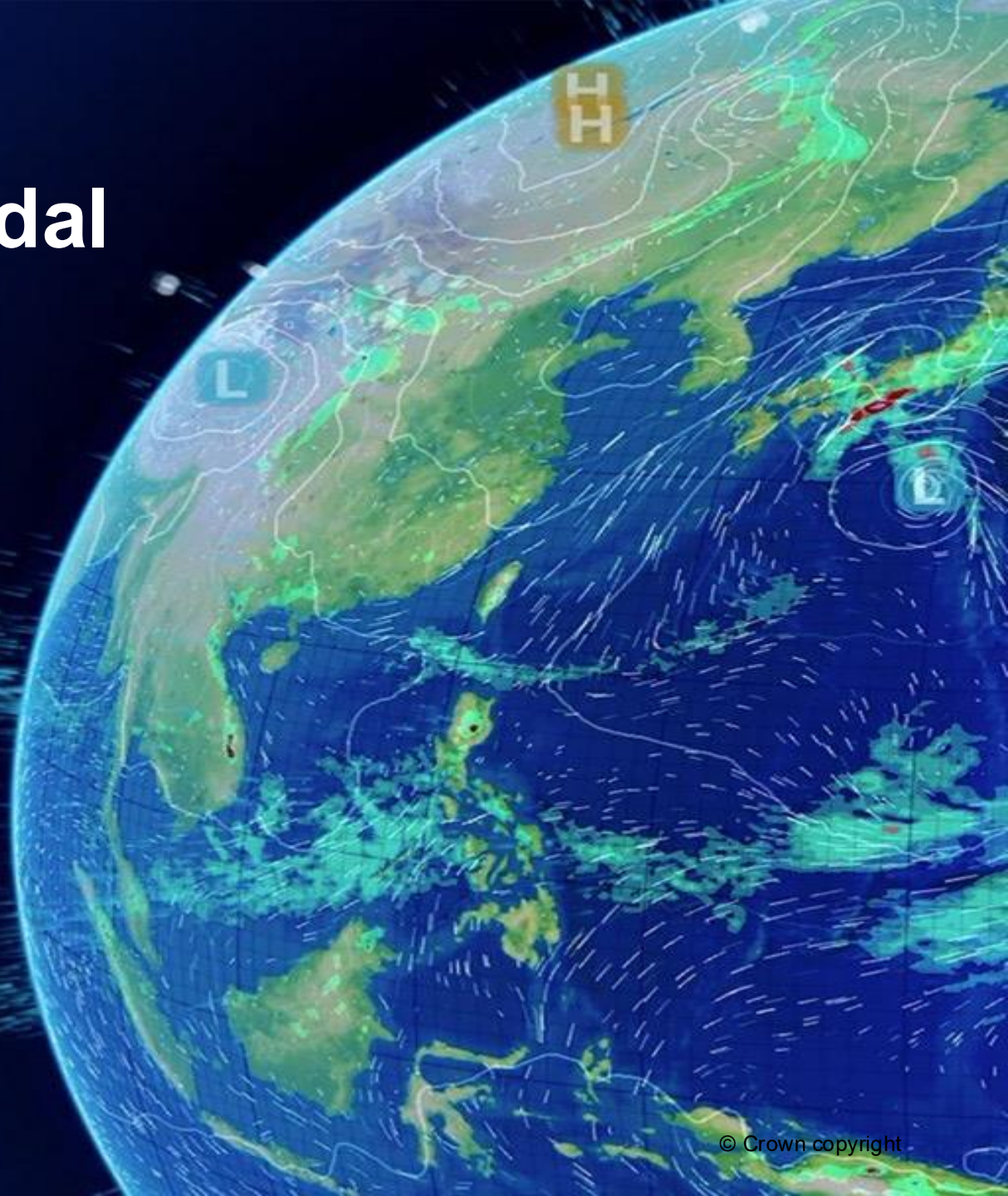
Operational annual-to-decadal updates



Doug Smith

Operational decadal predictions

Decadal predictions are now operational

Forecasts issued since 2010 □ www.wmolc-adcp.org

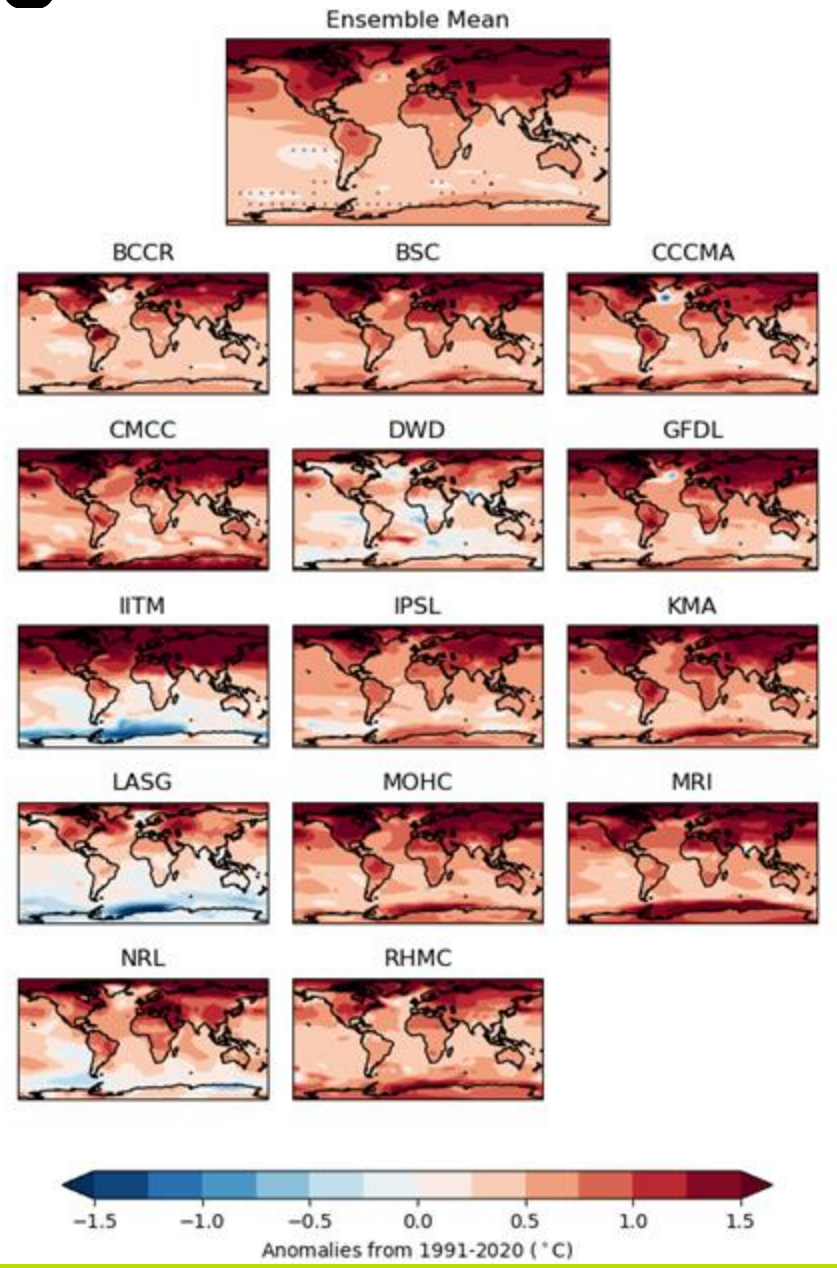
Along with available observations and skill estimates

Temperature, rainfall, sea level pressure, AMOC, sea ice

Coming year and 5 years (updated to 10 soon)

4 global producing centres, 1 lead centre

~10 contributions (14 for latest forecast)



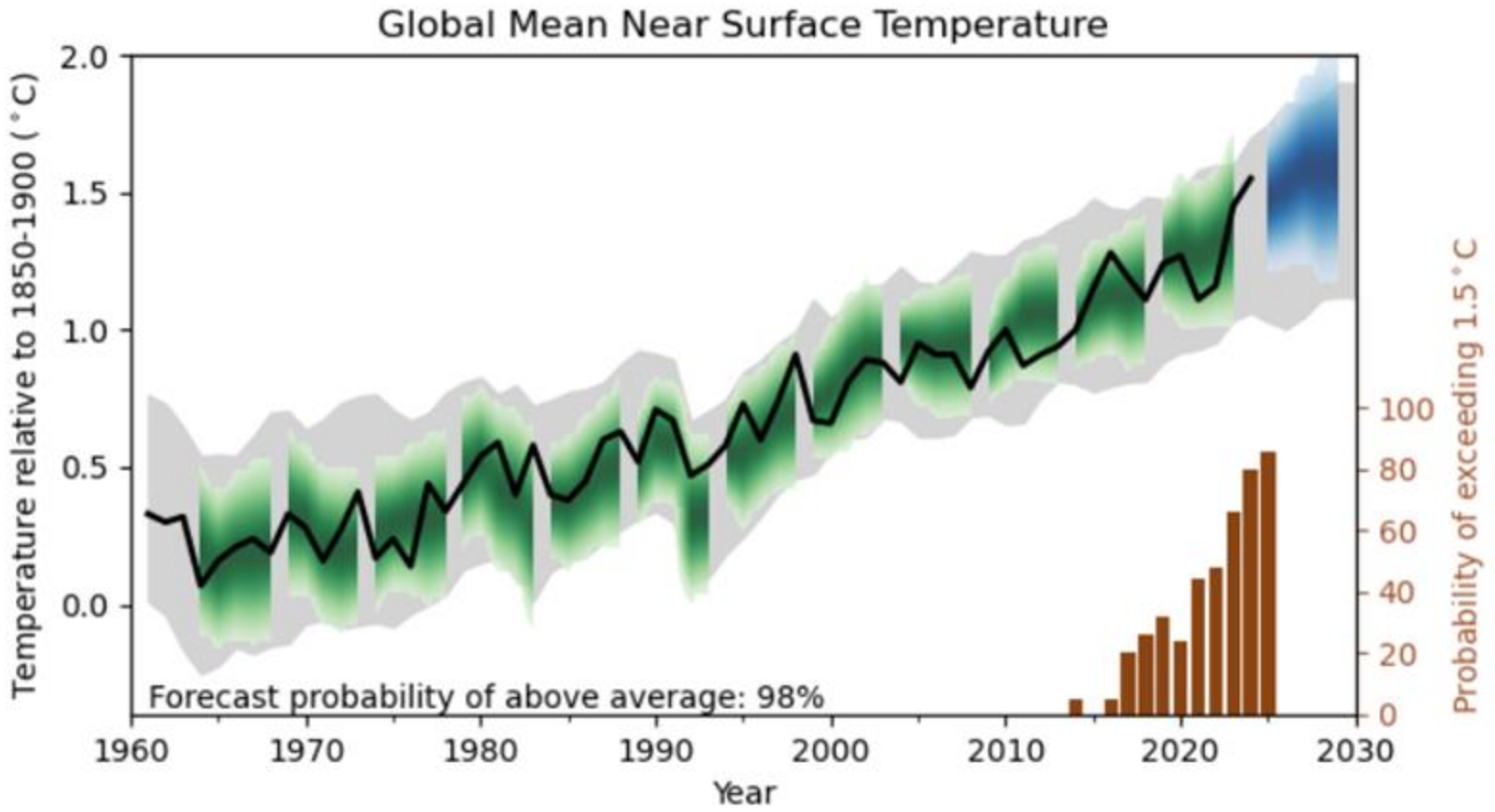
Operational decadal predictions

WMO global annual to decadal climate update (GADCU)

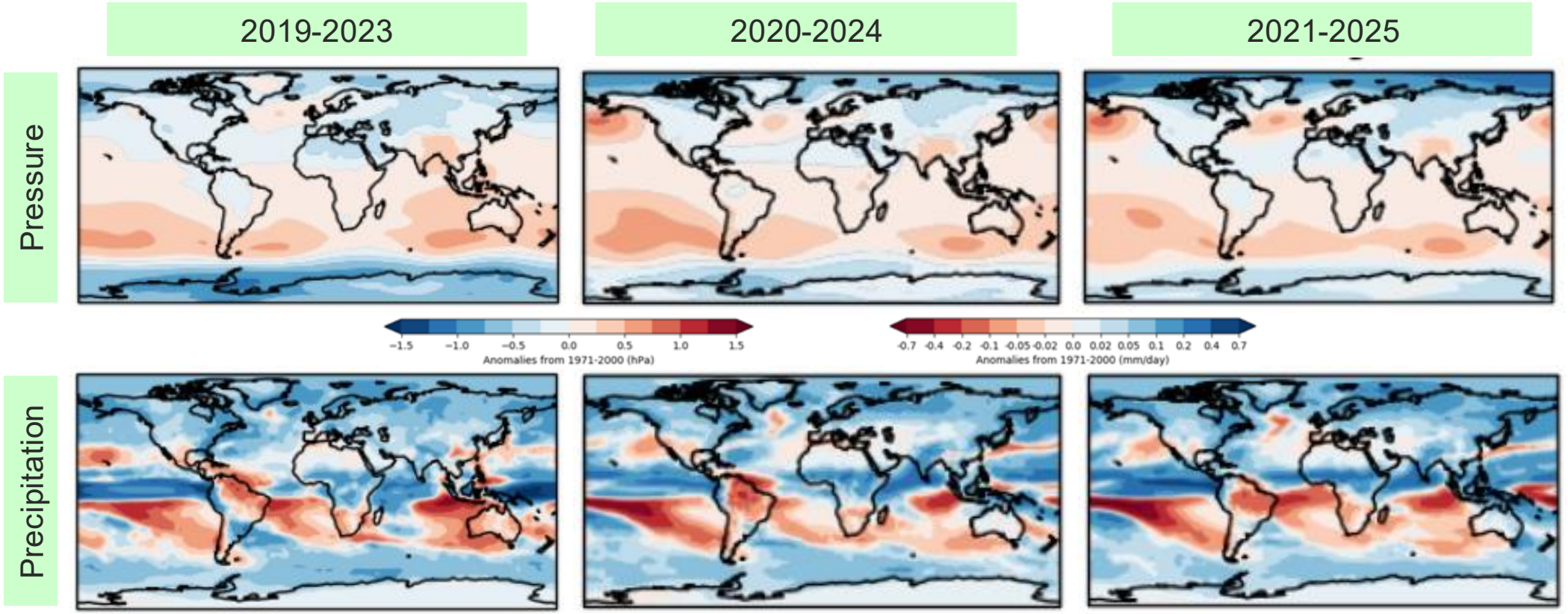
Synthesises the multi-model forecasts

Probability of exceeding 1.5 degrees, maps, timeseries

Much media attention!



Multi-annual predictions



Consistent forecasts for the coming 5 years

What drives the signals?

How much confidence do we have?

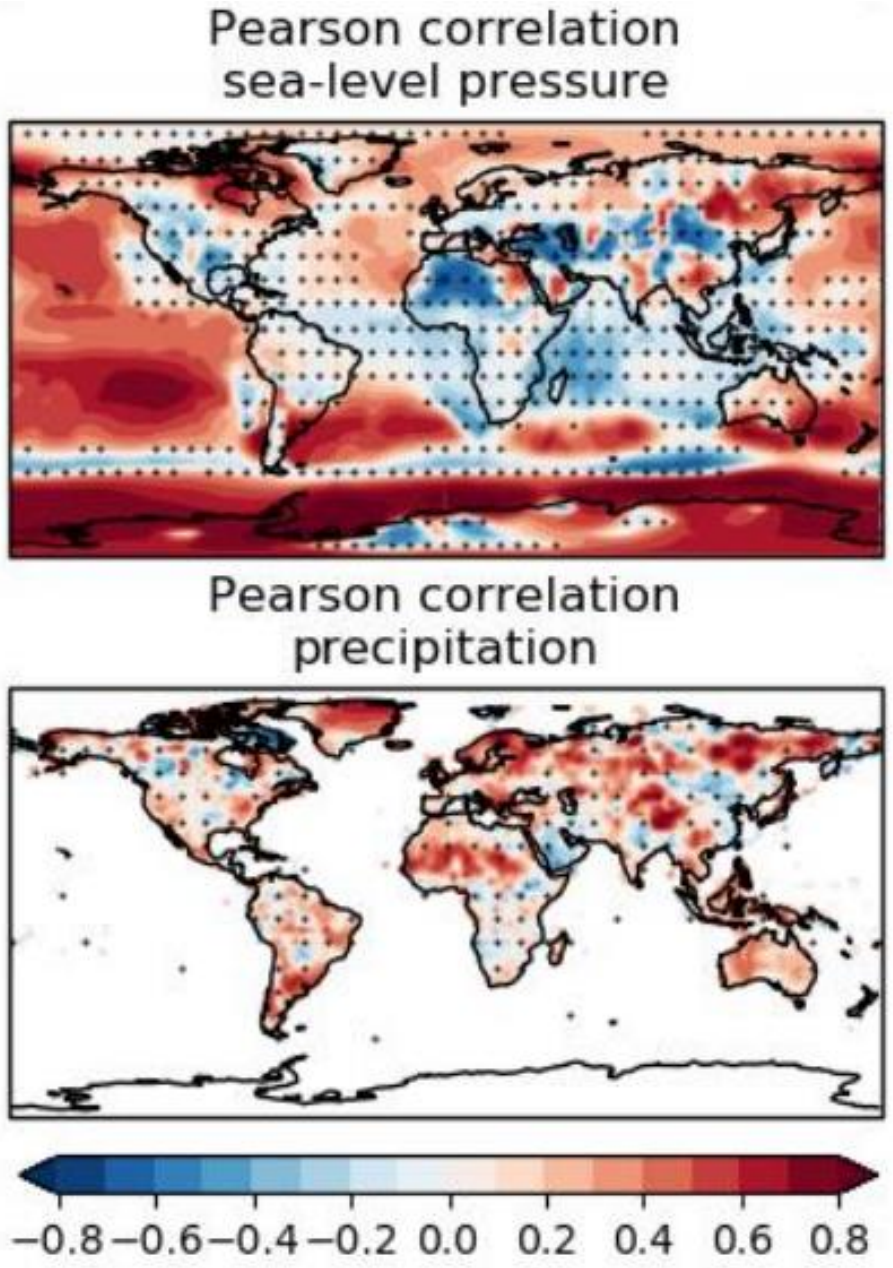
Historical skill

Some regions of significant skill

Hindcast skill does not necessarily mean forecast skill

Lack of hindcast skill does not necessarily mean lack of forecast skill

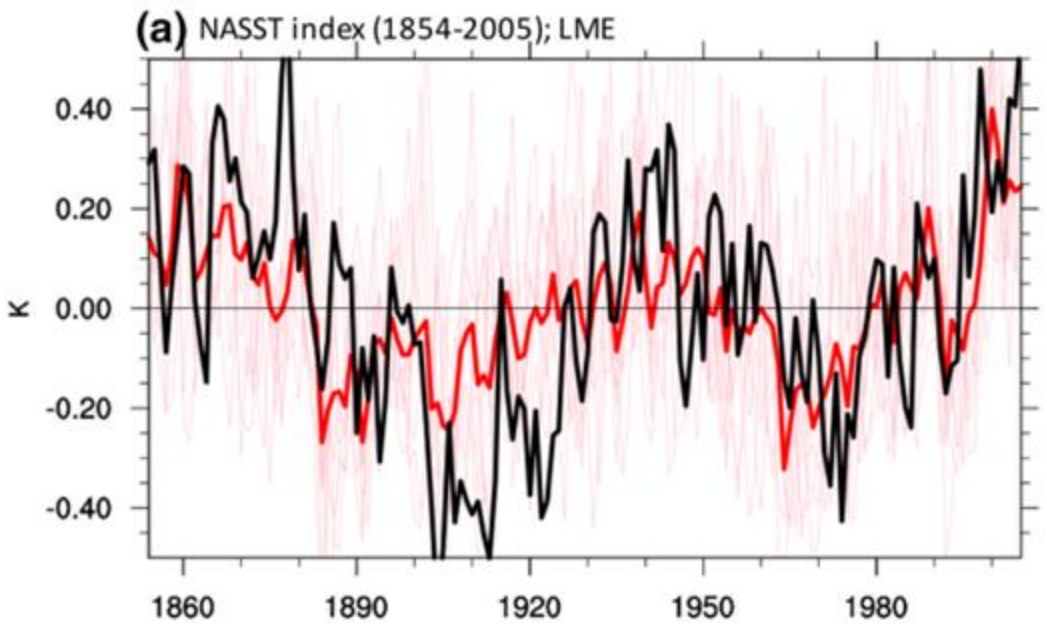
Need to understand the drivers



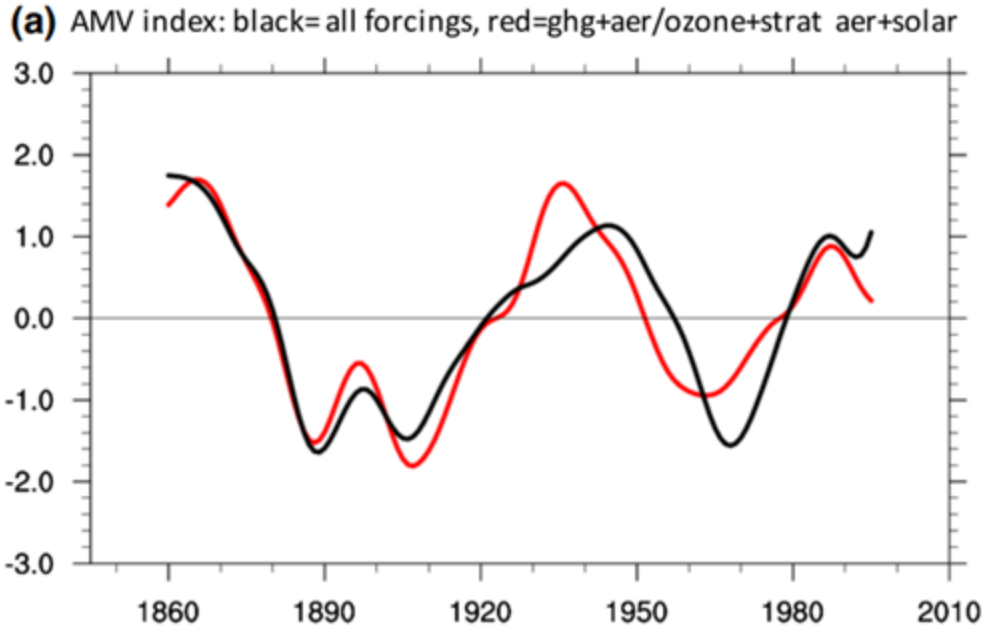
Hermanson et al 2022

Potential drivers: Atlantic

North Atlantic SST



GHG + aerosol + ozone + solar



Observed North Atlantic SST largely captured by ensemble mean

→ potentially externally forced

→ combination of GHG + aerosols + ozone + solar

Which forcings are important for the coming decade?

What is the role of atmosphere and ocean circulation (AMOC)?

Bellomo et al 2017; Mann and Emanuel 2006; Ottera et al. 2010; Terray 2012; Booth et al 2012; Knudsen et al 2014; Murphy et al 2017; Zhang et al 2019; Mann et al 2021

Large Ensemble Single Forcing MIP (LESFMIP)

Experiment name	Description	Tier	Start year	End year	Notes
1. Single forcing historical simulations					
1.1 hist-GHG	Well-mixed greenhouse-gas-only historical simulations	1	1850	2020	As DAMIP but with larger ensembles (10 members minimum with a target of 50 members). To fully capture the effects of volcanic forcing and solar forcing in models with prescribed ozone, ozone changes associated with solar and volcanic forcing should be prescribed in the hist-volc, hist-sol and hist-nat simulations, as in the DAMIP simulations. Note that ozone changes should not be prescribed in hist-GHG.
1.2 hist-aer	Anthropogenic-aerosol-only historical simulations	1	1850	2020	
1.3 hist-sol	Solar-only historical simulations	1	1850	2020	
1.4 hist-volc	Volcanic-only historical simulations	1	1850	2020	
1.5 hist-totalO3	Ozone-only historical simulations	1	1850	2020	
1.6 hist-lu	Historical simulations with only land use changes	1	1850	2020	New experiment

Historical + near-term future (1850-2035)

GHG, aerosols, solar, volcanoes, total ozone, land use

Target 50 ensemble members (minimum 10)

Operational projections with annually updated forcings

Additional runs to assess non-linearity and background state

Add attribution to GADCU, gain confidence in forecasts

Smith et al 2022

LESFMIP: status

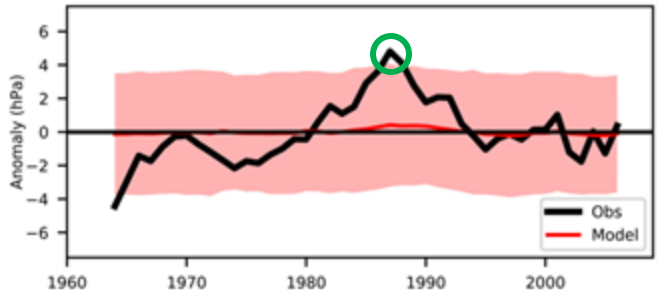
		1.1 hist-GHG	1.2 hist-aer	1.3 hist-sol	1.4 hist-volc	1.5 hist-totalO3	1.6 hist-lu	3.1 historical	3.2 hist-nat	4.1 All minus GHG	4.2 All minus aer	4.3 All minus sol	4.4 All minus volc	4.5 All minus totalO3	4.6 All minus lu
ACCESS-ESM1-5	Size	10-40	10-40	10-40	10-40	10-40	10-40	40	10-40						
	Target	Apr23	Apr23	Apr23	Apr23	Apr23	Apr23	Apr23	Apr23						
	ESGF														
CanESM5	Size	50	30	50	50	10		65	50						10
	Target	✓	✓	✓	✓	✓		✓	✓						✓
	ESGF	✓	✓	✓	✓	✓		✓	✓						✓
CESM2	Size	15	15		5			50			3				
	Target														
	ESGF														
CMCC-CM2-SR5	Size	10	10		10			10							
	Target														
	ESGF	Feb24	Feb24		Feb24			✓							
E3SM-2-1	Size	10	10	10	10	10	10	10							
	Target	Mar24	Mar24	Mar24	Mar24	Mar24	Mar24	Mar24							
	ESGF	Jun24	Jun24	Jun24	Jun24	Jun24	Jun24	Jun24							
FGOALS-g3	Size														
	Target														
	ESGF														
GISS-E2-1-G	Size	40	40	40	40										
	Target	✓	Oct23												
	ESGF	Sep23													
HadGEM3-GC31 -LL	Size	50	50	50	50	50	50	50	50		50		50		
	Target	✓	✓	✓	✓	✓	Mar24	✓	✓		✓		✓		
	ESGF	✓	✓	✓	✓	✓	Apr24	✓	✓		✓		✓		
IPSL-CM6A-LR	Size	14	13	0	0			32	14						
	Target	32	32					✓	32						
	ESGF														
MIROC6	Size	50	50	10	10	10	10	50	50						
	Target	✓	✓	✓	✓	✓	✓	✓	✓						
	ESGF	✓	Jul31	✓	✓	✓	Nov23?	✓	✓						
MPI-ESM1-2-LR	Size	30	30	30	30	30		50							
	Target	✓	✓	✓	✓	✓		✓							
	ESGF	✓	✓	✓	✓	✓		✓							
NorESM2-LM	Size	20	20	20	20	20	20	20	20						
	Target	✓	✓	✓	✓	✓	✓								
	ESGF	Nov23	Nov23	Nov23	Nov23	Nov23	Nov23	Mar24	Mar24						

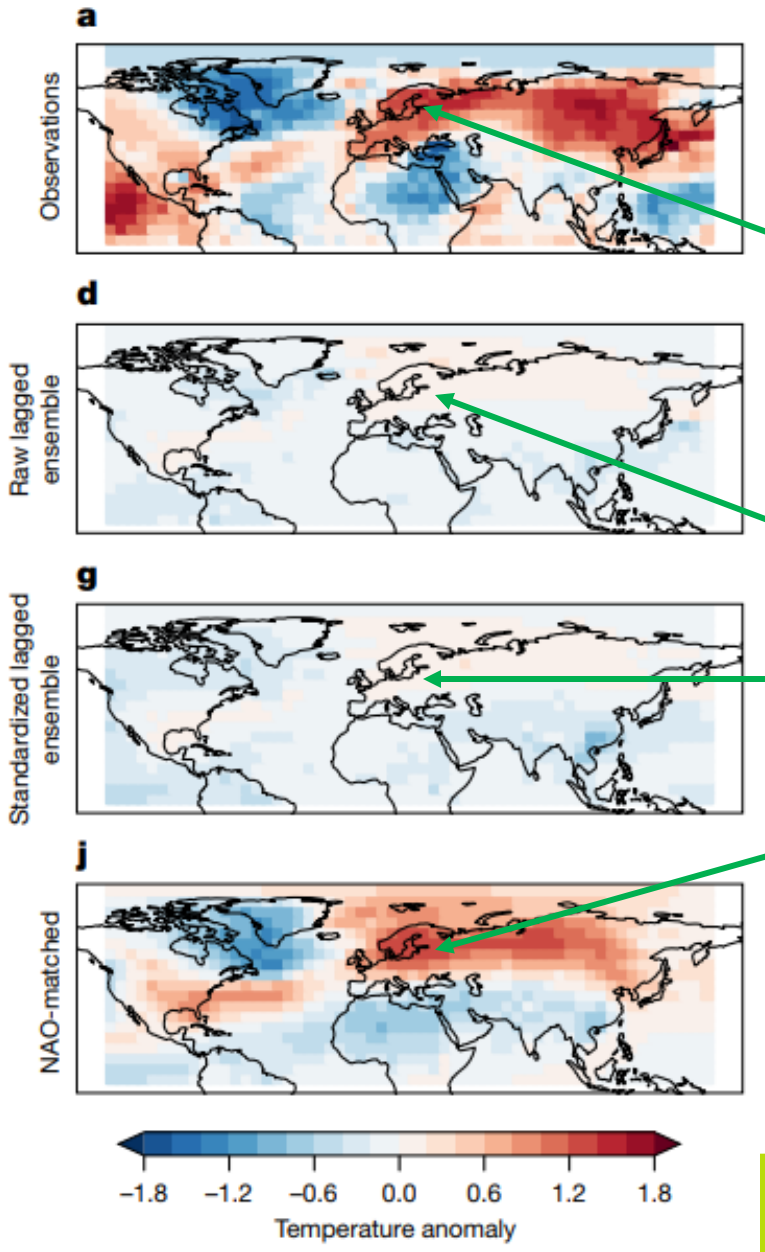
LESFMIP: analysis plan

1. For a given event or forecast signal, identify the relevant patterns of atmospheric circulation.
2. For each forcing develop emergent constraints to exploit model differences to diagnose the **true** response.
3. Perform “detection and attribution” analysis (multiple linear regression) on the atmospheric circulation patterns to obtain scaling factors for each driver.
4. Sub-select ensemble members, or obtain model or observed analogues, which match the real-world influence of each driver diagnosed in steps 2 and 3.
5. For the variable of interest compute the contribution of each driver using the sub-selected or analogue ensembles from step 4. Assign residuals to internal variability or model errors not accounted for in step 2.

Extra slides

Not overcome by scaling





$T = T_{DYN} + T_{THERMO} + \varepsilon$

Real world: $T_{DYN} >> T_{THERMO}$

Ensemble mean: $T_{DYN} << T_{THERMO}$ because NAO signal too small

Scaling retains the incorrect ratio T_{DYN}/T_{THERMO}

Can be overcome by selecting ensemble members with correct magnitude of NAO

Standard D&A approach will not work

Need to look at models in new ways

Smith et al 2020, 2022