What Is the Best Lagged Predictor of the Winter North Atlantic Oscillation?

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Talk Structure

- Motivation and Aims
- Data and Methods
- Results
- Physical Interpretation
- Summary and Conclusions

Motivation & Aims

- What is the NAO and why predict it?
- Recent NAO prediction studies employ different:
  - Predictors
  - Predictand NAO indices
  - Assessment time periods
  - Skill measures
- Study Aims:
  - To standardise these variables and judge which recent study has the best predictor of the NAO.
  - To evaluate NAO prediction skill over three extended time periods (where data available).

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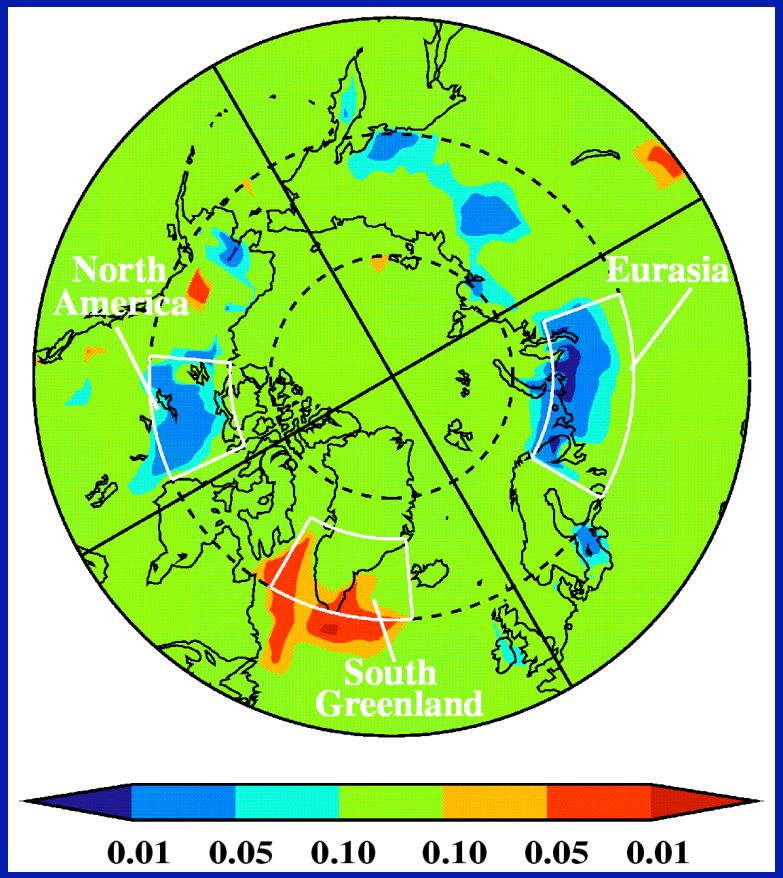
Published NAO Predictors

Lagged Predictor	Assessment Period	Reference
May North Atlantic SST (SVD)	1948-1998	Rodwell & Folland (2002)
JJASO North Atlantic SST (PC2)	1950-2001	Saunders & Qian (2002)
Oct Eurasian Snow Cover	1972-2001	Saito et. al (2001)
JJ NH Snow Cover	1972-2002	Saunders et. al (2003)

New Predictor: '$d_x T_{60N\text{-}70N}$'

$p(T_{2m}$, NH snow cover): JJ



From: Saunders et. al (2003)

- Three regions of summer (JJ) subpolar air temperature significantly linked to NH snow cover (1972-2001).
- Index represents summer temperature variations associated with changes in summer snow cover:

$$d_x T = \frac{(NA + EU)}{2} - GD$$

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NAO Indices 1901-2001

Index	Stations	Reference
CRU	Gibraltar Iceland	Jones et. al (1997)
Hurrell	Ponta Delgada Iceland	Hurrell (1995)
MSLP PC1	n/a	Hurrell (1995)

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NAO Indices 1901-2001

CRU

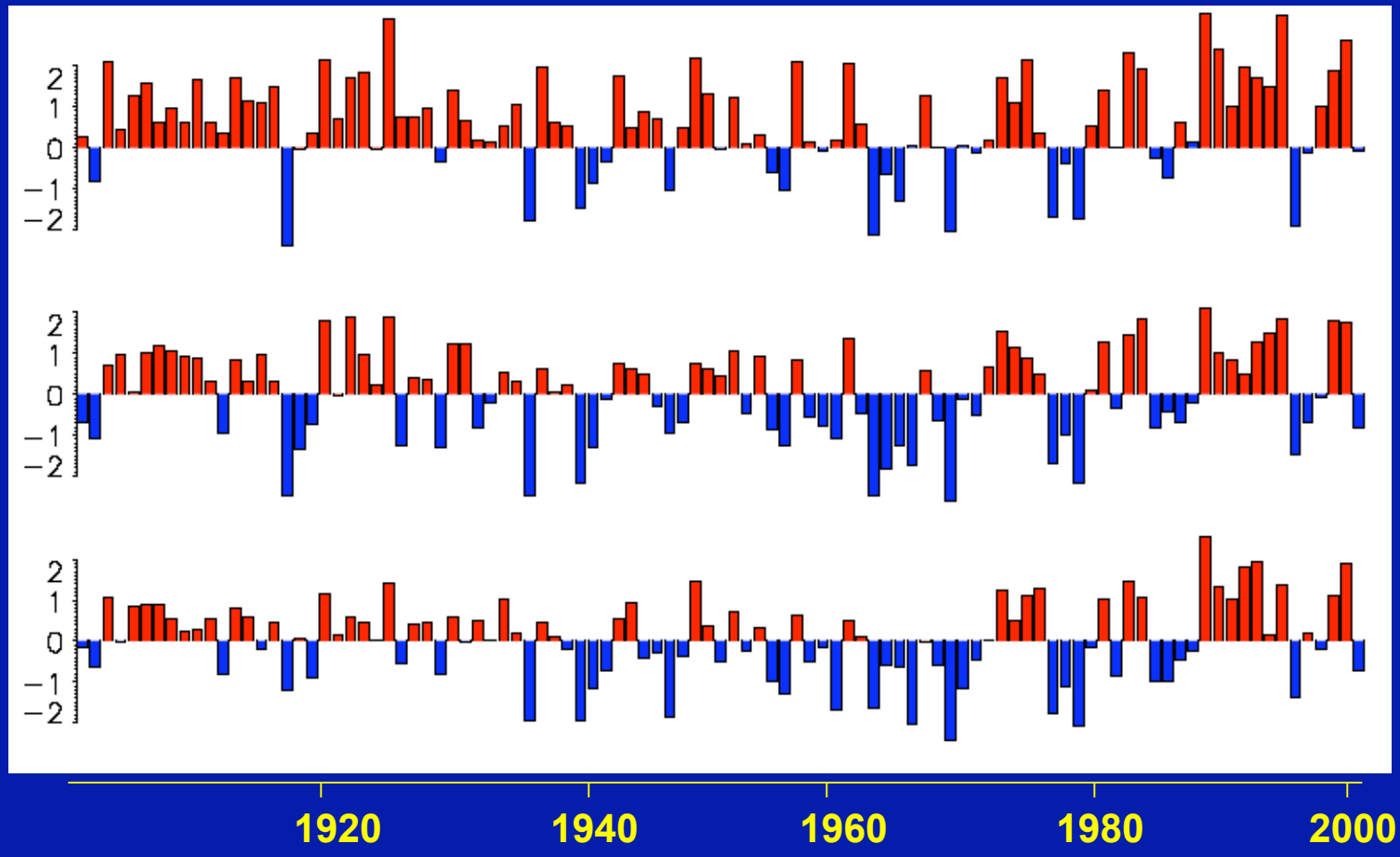
=0.56

Hurrell

=0.06

MSLP PC1

=0



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Hindcast Methodology

- Assessment periods:
  - 1900-2001
  - 1950-2001
  - 1972-2001
- Linear trend removed from all data.
- Linear regression models cross-validated using 5-year block elimination (predicted yr ± 2-yrs).
- Hindcasts referenced against fixed climatology.

Dual Skill Assessment

- Pearson correlation skill score:

$$r(NAO_{obs}, NAO_{pred})$$

- Mean-square skill score (WMO Standard):

$$MSSS = \left(1 - \frac{MSE_{PRED}}{MSE_{CLIM}}\right) 100\%$$

- Significance estimated using temporal randomisation and resampling, with correction for serial correlation.

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Results

Period	Lagged Predictor	Dataset	CRU NAO DJF		Hurrell NAO DJF		MSLP PC1 DJF	
			r	*MSSS*	*r*	*MSSS*	*r*	*MSSS*
1900-2001	May SST (SVD)	Had	0.19	3	0.20	3	0.20	3
	JJASO SST (PC2)	Had	0.19	3	0.21	4	0.17	2
	JJ $d_x T$	CRUTEM2	0.18	2	0.24	5	0.21	4
	MJJAS $d_x T$	CRUTEM2	0.26	6	0.31	9	0.28	7
	Oct EU Snow Cover	Brown/Rut	0.13	1	0.08	0	0.28	7
1950-2001	May SST (SVD)	Had	0.29	8	0.37	13	0.34	11
	JJASO SST (PC2)	NCEP	0.30	8	0.31	9	0.29	7
	JJ $d_x T$	NCEP	0.37	13	0.30	8	0.37	13
	MJJAS $d_x T$	NCEP	0.27	6	0.26	6	0.35	12
	Oct EU Snow Cover	Brown/Rut	0	0	0	0	0.15	0
1972-2001	JJ $d_x T$	NCEP	0.50	24	0.48	23	0.45	20
	JJ $d_x T$	CRUTEM2	0.54	29	0.57	32	0.51	25
	Oct EU Snow Cover	Rut	0.26	6	0.07	0	0.26	5
	JJ NH Snow Cover	Rut	0.53	28	0.51	24	0.53	27

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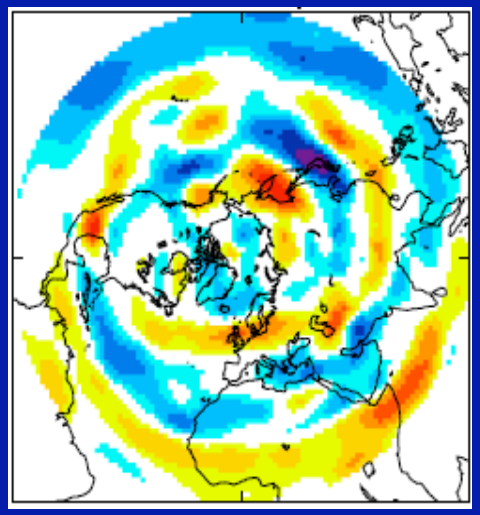
Results

Period	Lagged Predictor	JJASO PC2	JJ $d_x T$	MJJAS $d_x T$	Oct EU Snow Cover
1900-2001	May SST (SVD)	0.30	0.27	0.31	0.09
	JJASO SST (PC2)	-	0.54	0.52	0.23
	JJ $d_x T$	-	-	0.80	0.04
	MJJAS $d_x T$	-	-	-	0.02
1950-2001	JJASO SST (PC2)	-	0.52	0.50	0.01
1972-2001	JJASO SST (PC2)	-	0.52	0.35	0.02

- JJASO SST predictor significantly linked to summer $d_x T$ during all time periods.

Physical Interpretation



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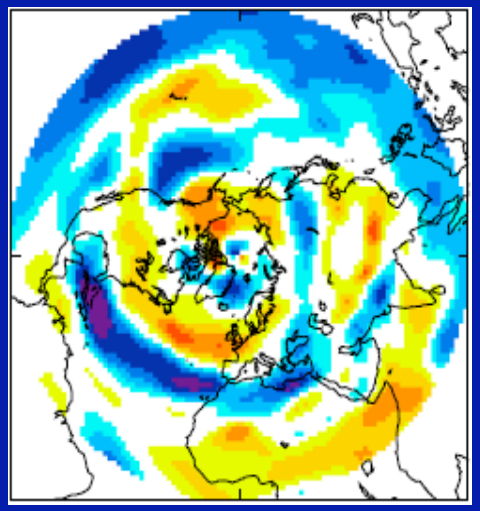

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- Variations in JJ $d_x T$ associated with significant changes in subsequent NH circulation.
- Link between JJ $d_x T$ and JJASO SST predictor suggests potential imprint on Atlantic SST and feedback to NAO.

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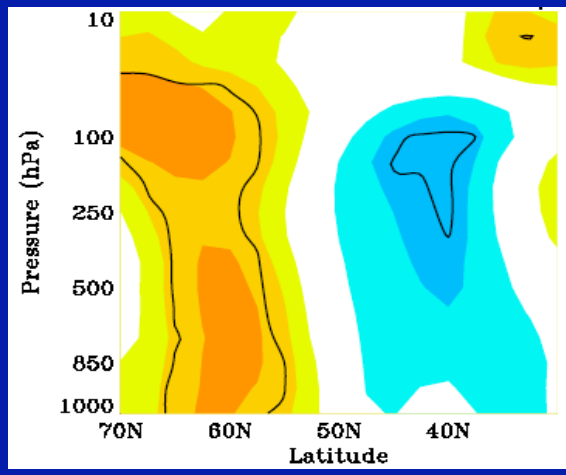
Physical Interpretation

Jun u-winds



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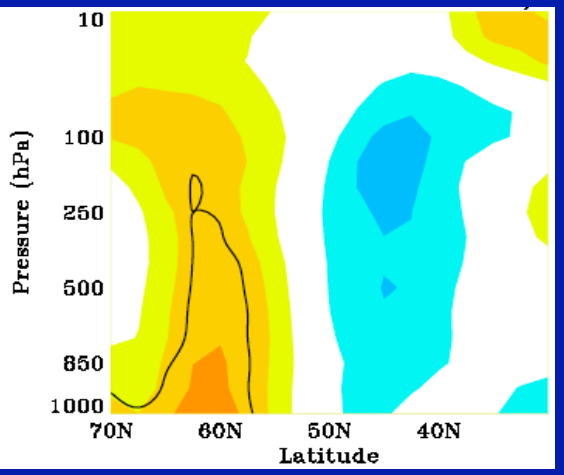

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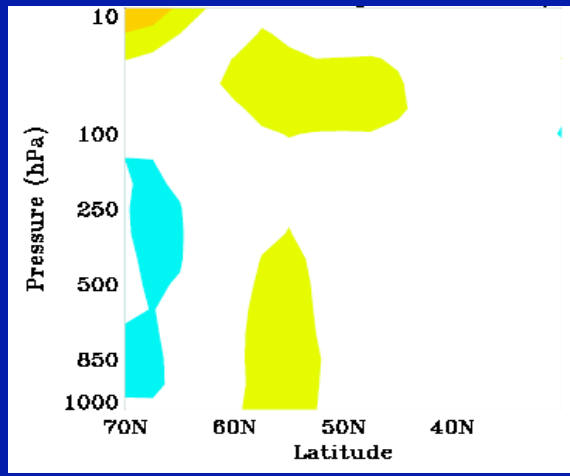
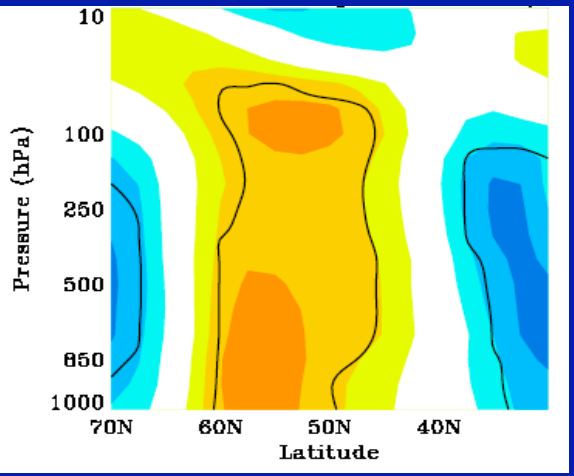


Sep u-winds



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Summary and Conclusions

- Thorough assessment of NAO predictability.
- Standardised skill assessments for a range of published NAO predictors over three extended time periods.
- Best predictor is gradient of summer subpolar zonal air temperature over all periods.
- Greater predictability over 100-years than thought previously.

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