# Prospects for near-term Antarctic sea ice prediction and implications for biological systems

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US CLIVAR Workshop Societally-Relevant Multi-Year Climate Predictions



## Antarctic Sea Ice













Observations suggest ice predictability on seasonal+ timescales



## Observations suggest ice predictability on seasonal+ timescales



Relationship of sea ice to Amundsen Sea Low variability (Holland et al, 2018)



## Climate model experiments

Sets of "perfect model" initialized predictions

- CESM2 simulations
- 2-year "predictions"
- Initializations performed for the first of Jan, March, May, July, Sept, and Nov



## Daily Ice Area Predictability Prediction runs initialized in January

- High predictability for ice area around Antarctica for many months, which is especially high in Ross/B&A regions
- Predictability lost ~January 1
- Predictability re-emerges ~May 1 in the Ross/B&A regions and remains high through Year2

Longitude

lan

100

100

200 Lonaitude

Day

Common Predictability Characteristics regardless of initialization timing

• Loss of predictability in Jan

0.4

0.2

0.0

1.0

0.8

0.6

0.2

0.0

300

300

Longitude

- Return of predictability in May – especially in Ross and B&A region
- This occurs over multiple years, suggesting predictability at least 2 years out



#### January Forecast SST ACC



#### Factors Influencing Predictability September Initialization Example

#### Loss of predictability in January:

- In January, SST is predictable along ice edge and further north
- As ice melts back from December to Januaray, it encounters an ocean surface that is less predictable

#### September Initialized Predictions



#### January Forecast SST ACC



#### April Forecast SST ACC



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 As ice grows and advances equatorward, it encounters SSTs that are predictable

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#### **April Forecast SST ACC**



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High ice predictability aligns with high predictability in SST along ice edge

September Initialized Predictions

## Implications for biology

Predictability of Net Primary Productivity in December of Year 2

• Areas of significant predictability coincide with regions of ice concentration predictability

Net Primary Productivity in Shading Ice Concentration in lined contours



Anomaly Correlation Coefficient September Initialized Predictions

# Implications for biology

Predictability of Net Primary Productivity in December of Year 2

- Areas of significant predictability coincide with regions of ice concentration predictability
- Related to the influence of sea ice on SW absorption and light availability

Net Primary Productivity in Shading Ice Concentration in lined contours



Mixed Layer SW Absorption in Shading Ice Concentration in lined contours



Anomaly Correlation Coefficient September Initialized Predictions





# Implications for biology

- Ultimate goal to understand how these aspects of predictability transition through the ecosystem
- How these relationships will change in a warming climate
- What that implies for planning for Antarctic marine protected areas

\*CAMMLR=Commission for the Conservation of Antarctic Marine Living Resources

## Surprises in the Antarctic System



Observed Southern Hemisphere Ice Area in

## Observed Maximum Daily Air Temperatures at Concordia Station



From The Washington Post

From NSIDC Sea Ice Index

Thanks for your attention!

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## Methods: Climate model experiments

## Sets of "perfect model" predictions

- Ensemble predictions initialized from the CESM2 historical simulations
- Initializations are performed for the first of Jan, March, May, July, Sept, and Nov
- 15 members initialized from 5 different CESM2 members (so 75 members)
- Run 2-year "predictions"