

# 21st Century Arctic Climate Change in CCSM4

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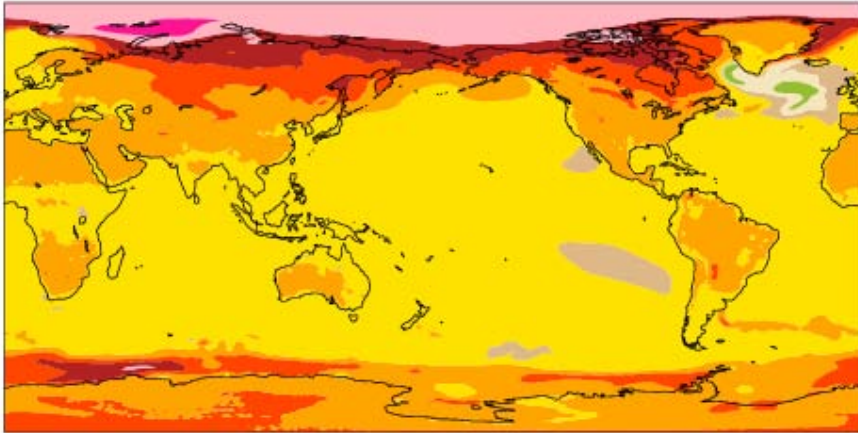
# Overview

- Transient ensemble simulations from 2005 to 2100
  - RCPs (Representative Concentration Pathways) instead of SRES emissions scenarios: **RCP8.5** (~ SRES A2)
  - Temperature, Precipitation, SLP, Clouds, Sea ice, Ocean
- (details in Vavrus et al., 2011--- *J. Climate*, special issue)



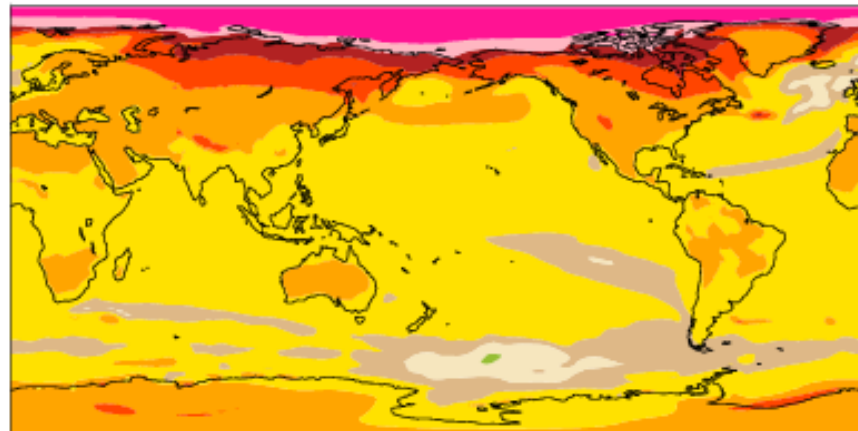
# Annual Change in Surface Temperature (late 21st century)

## CCSM4 RCP8.5



<u>Global</u>	<u>70°-90°N</u>	<u>Arctic Amplification</u>
4.03 K	9.57 K	2.37

## CCSM3 A2



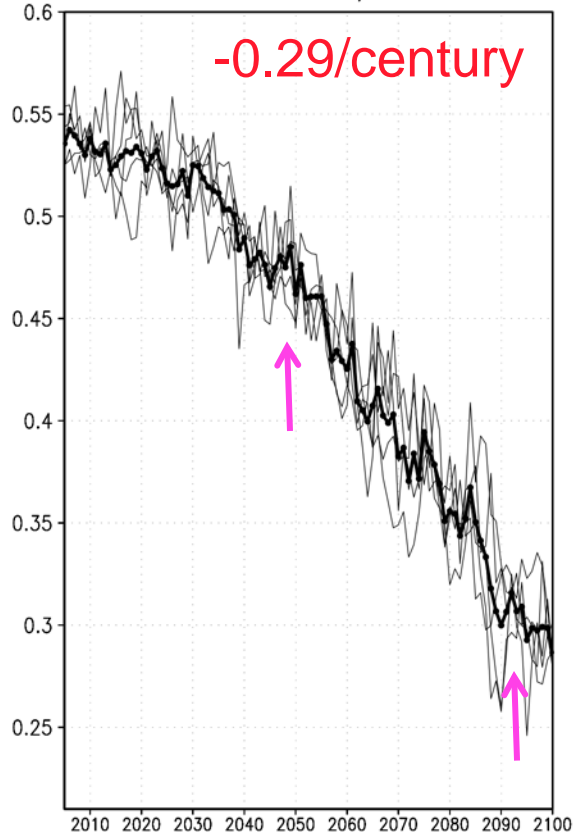
<u>Global</u>	<u>70°-90°N</u>	<u>Arctic Amplification</u>
3.53 K	9.74 K	2.76

Min = -0.13 Max = 16.53



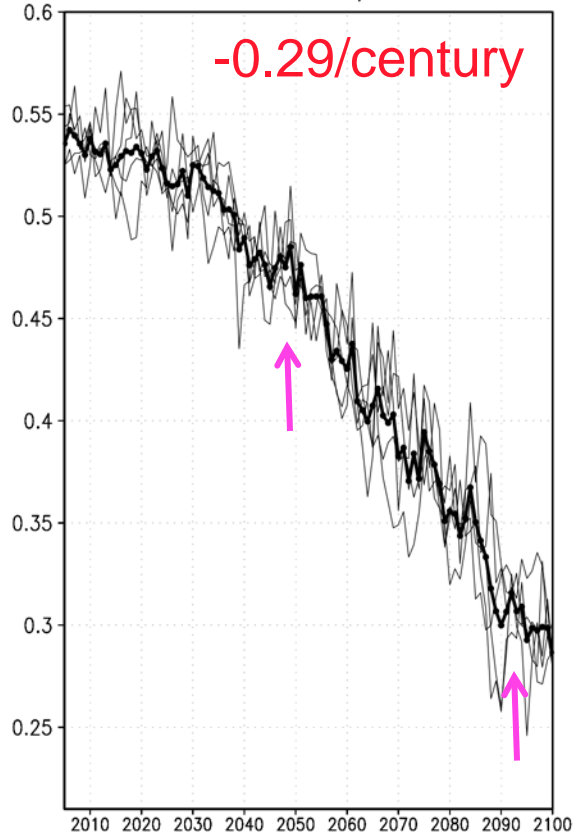
# 21<sup>st</sup> Century Sea Ice Concentration

Arctic annual ICEFRAC RCP8\_5 (70–90N)  
5 ensemble members, 2005–2100

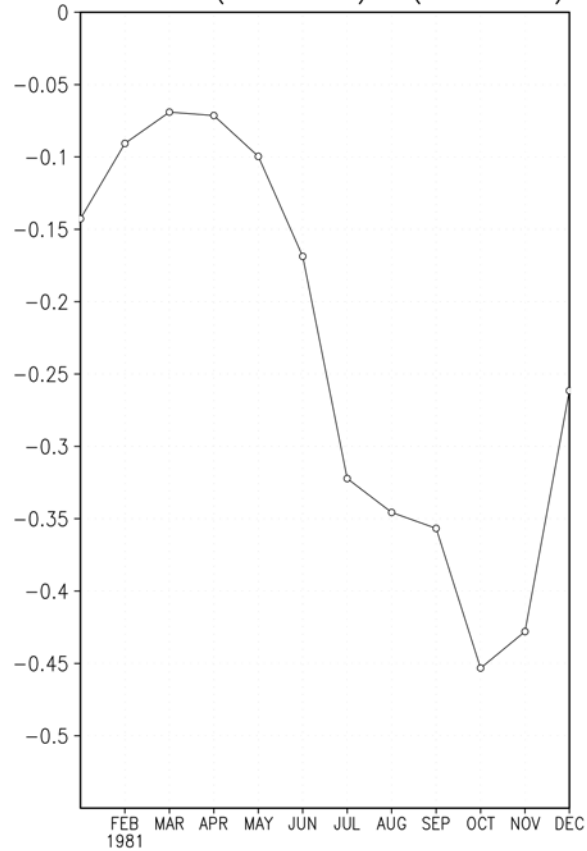


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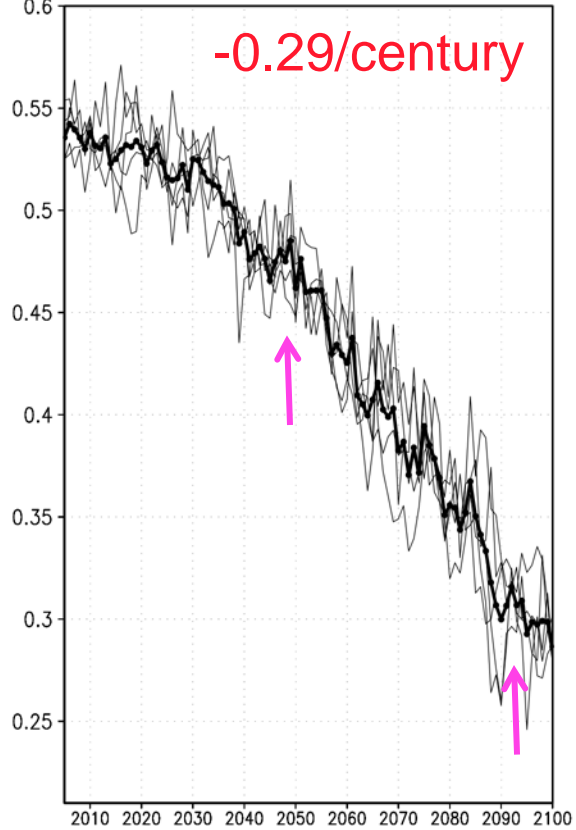
Delta Arctic ICEFRAC RCP8\_5  
Ens. Mean (2081–2100) – (1981–2005)



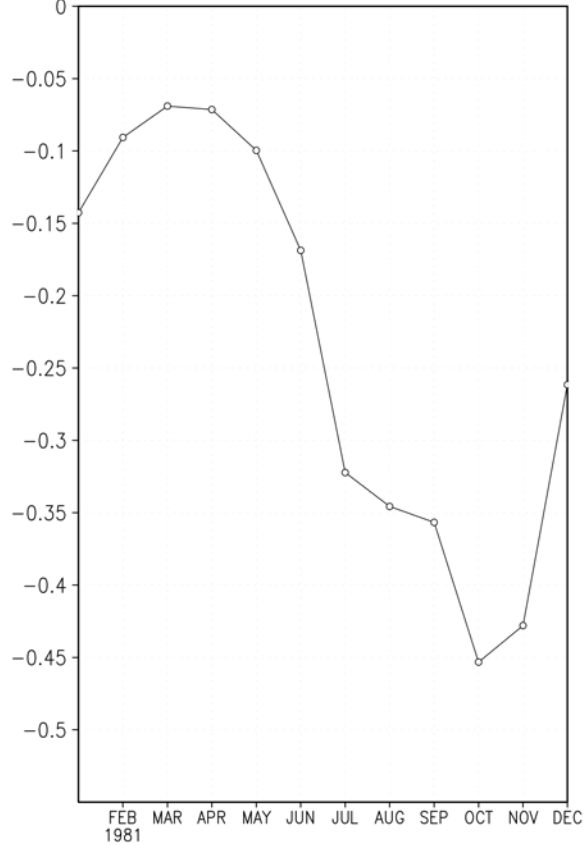


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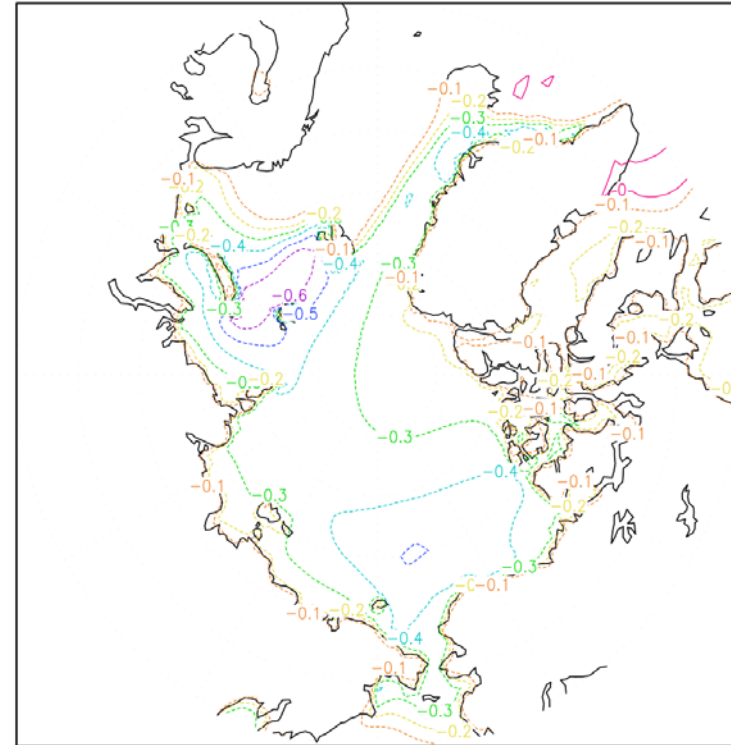
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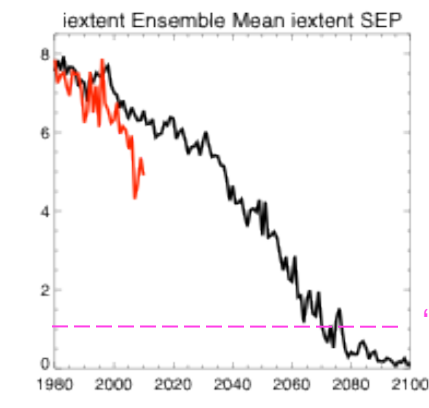
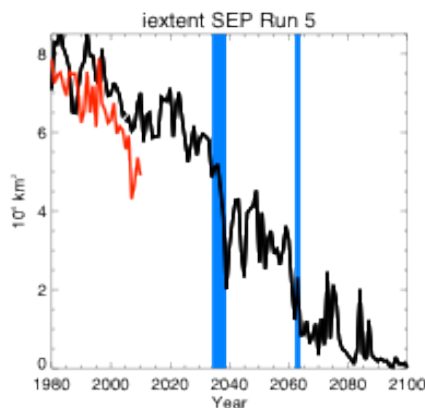
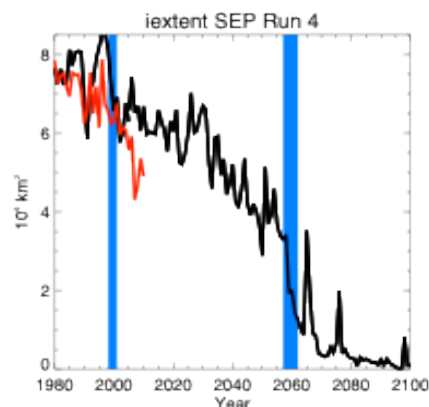
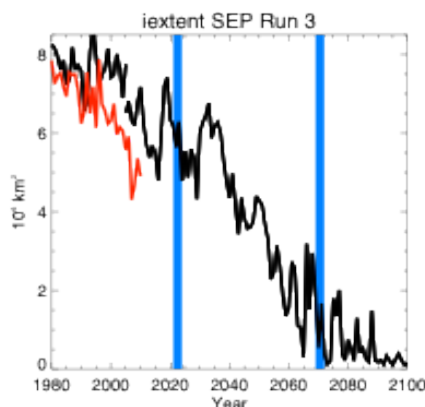
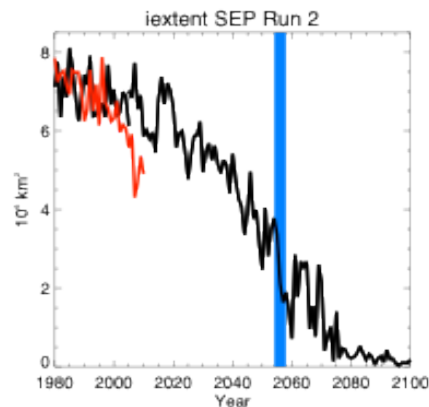
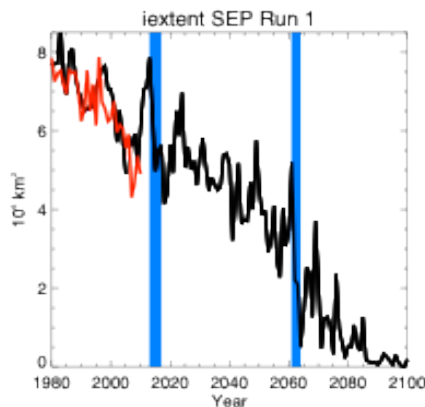
Delta Arctic ICEFRAC RCP8\_5 (annual)  
Ens. Mean (2081–2100) – (1981–2005)



# September Sea Ice Extent

Observed (red)

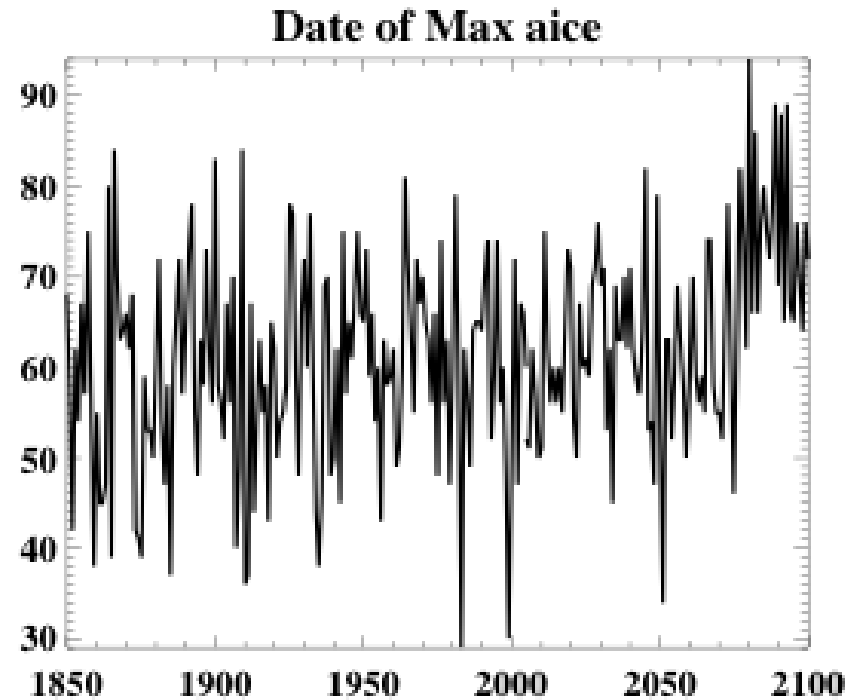
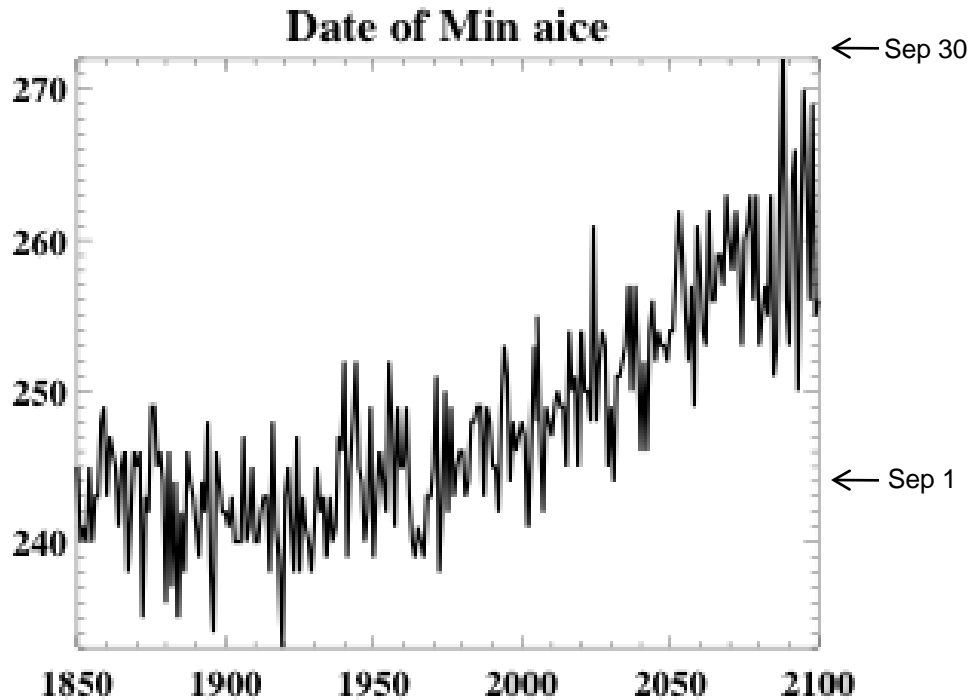
RILEs (blue)



**Ensemble Mean**

“Ice Free Threshold” (2070)

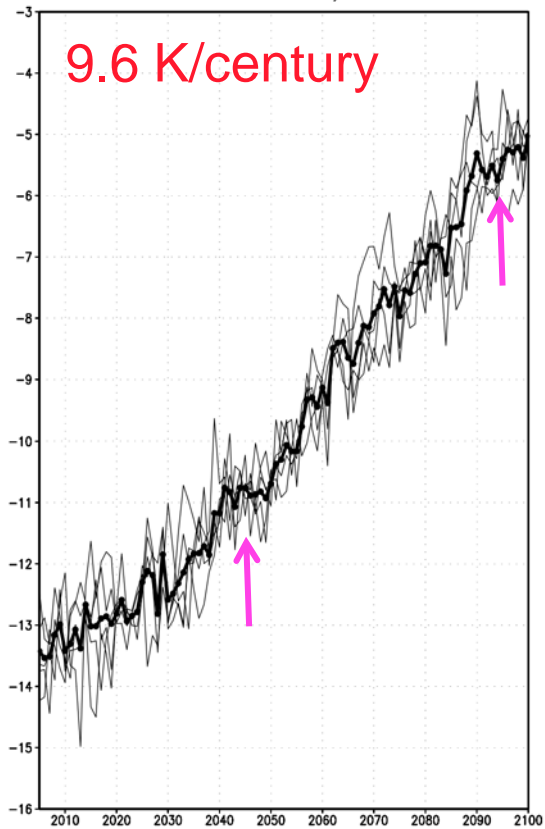
# Timing of Minimum and Maximum Ice Extent





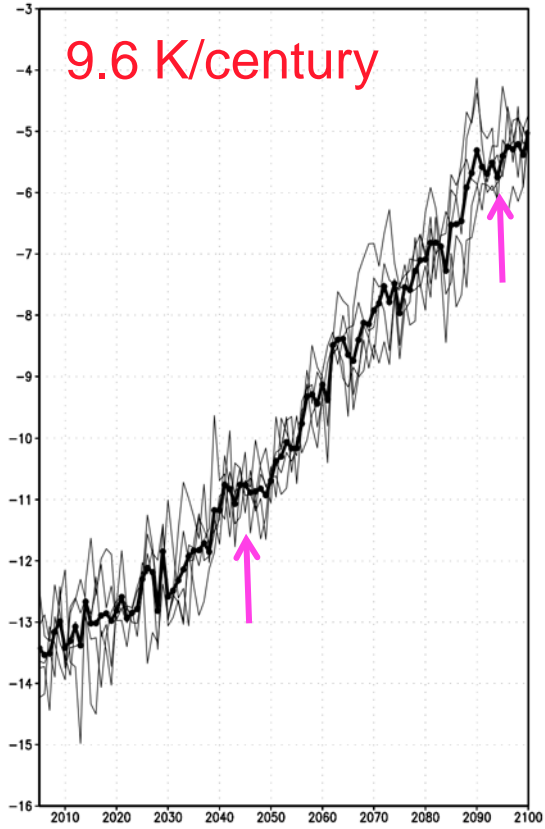
# 21<sup>st</sup> Century Surface Air Temperature

Arctic annual TREFHT RCP8.5 (70–90N)  
5 ensemble members, 2005–2100

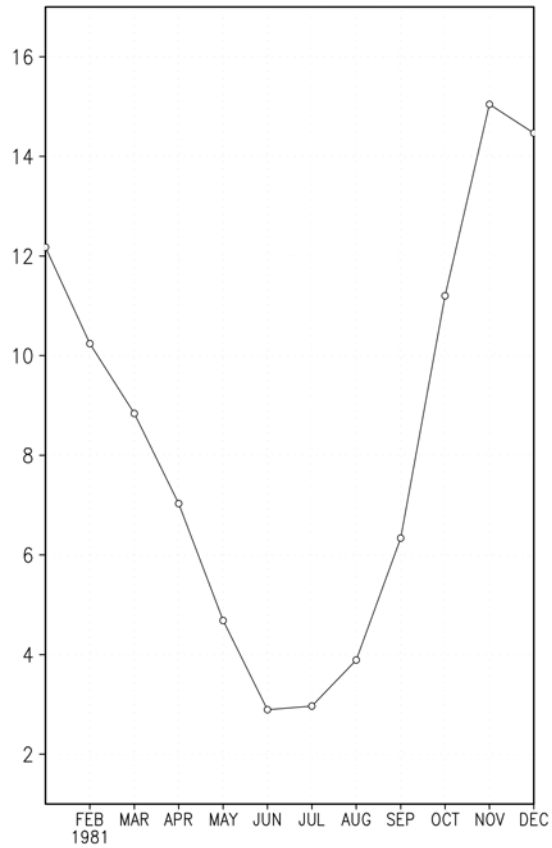


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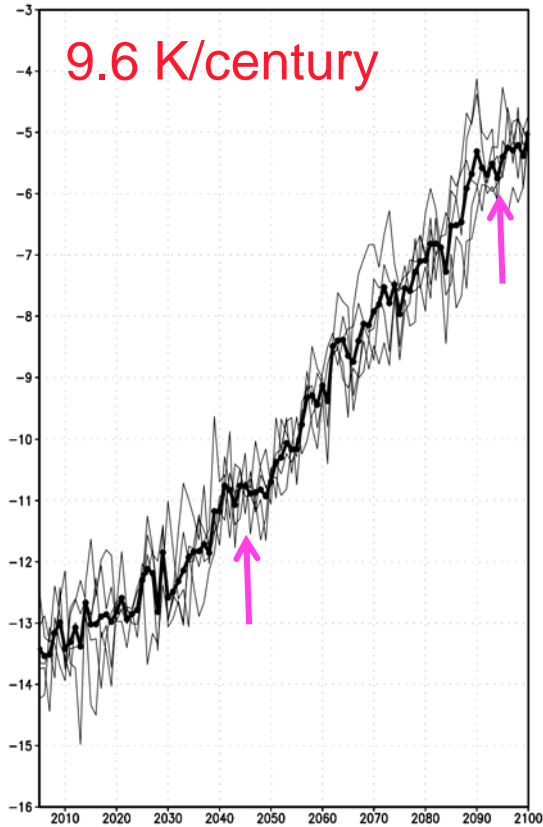


Delta Arctic Sfc Air Temp RCP8.5  
Ens. Mean (2081–2100) – (1981–2005)

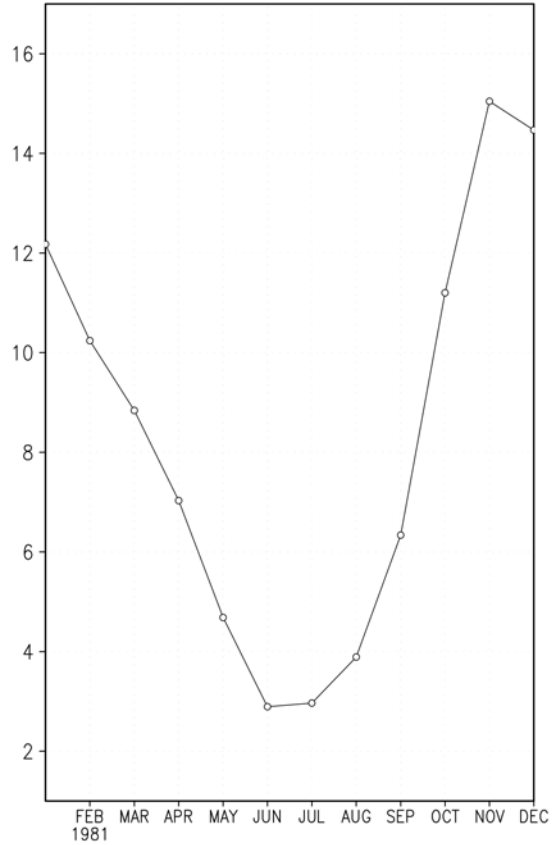


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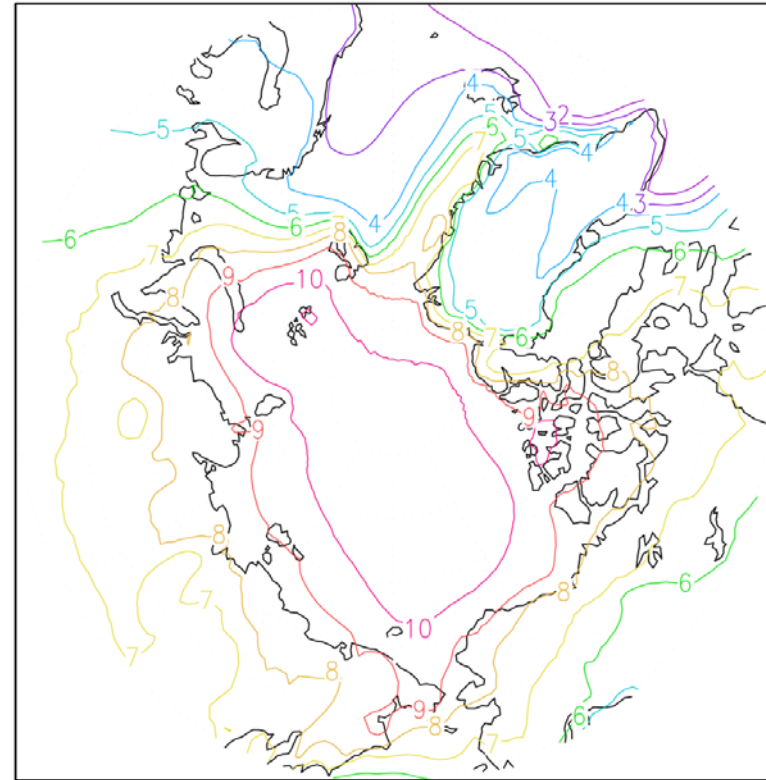
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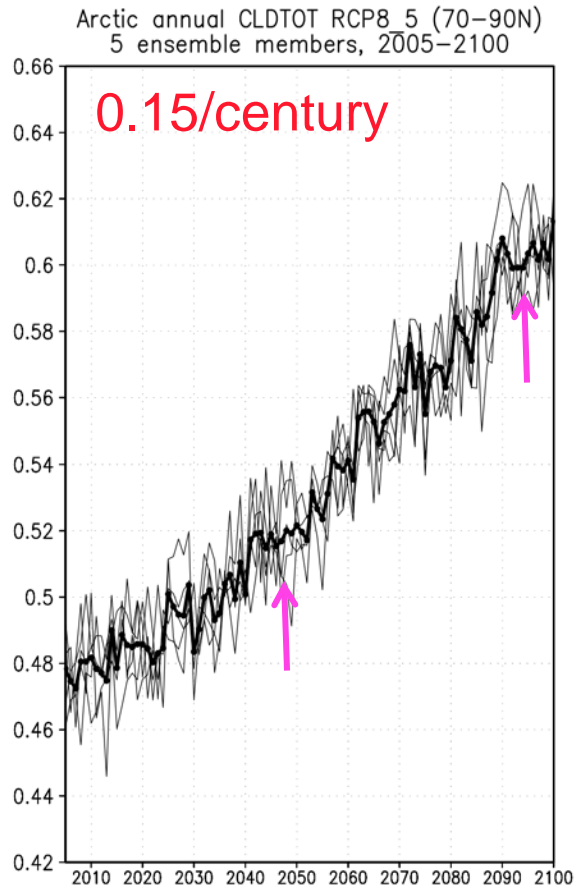
Delta Arctic Sfc Air Temp RCP8.5  
Ens. Mean (2081–2100) – (1981–2005)



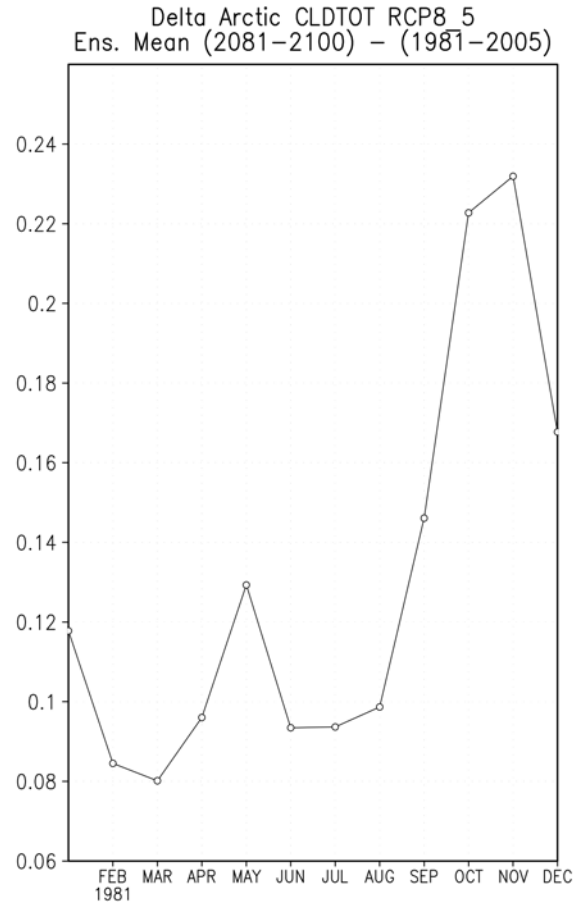
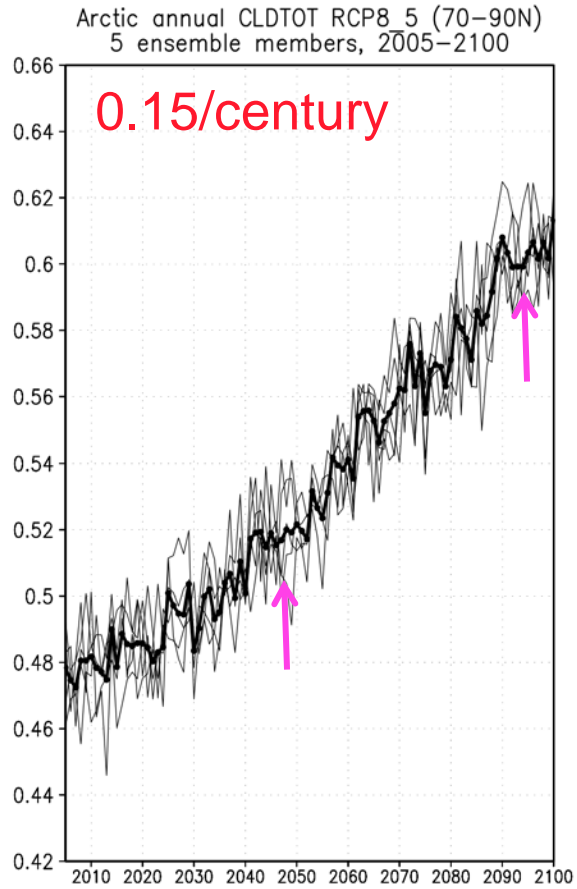
Delta Arctic Sfc Air Temp RCP8.5 (annual)  
Ens. Mean (2081–2100) – (1981–2005)



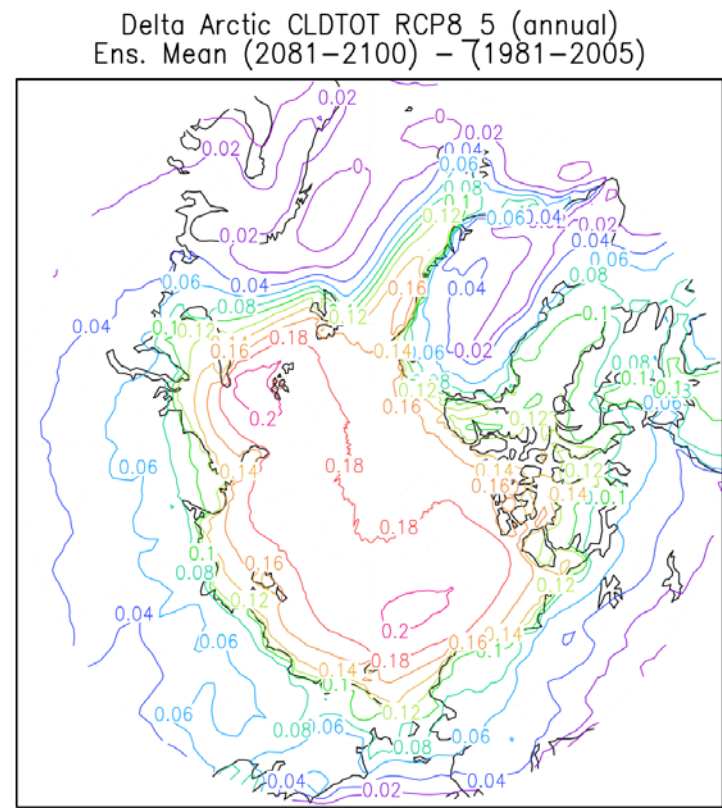
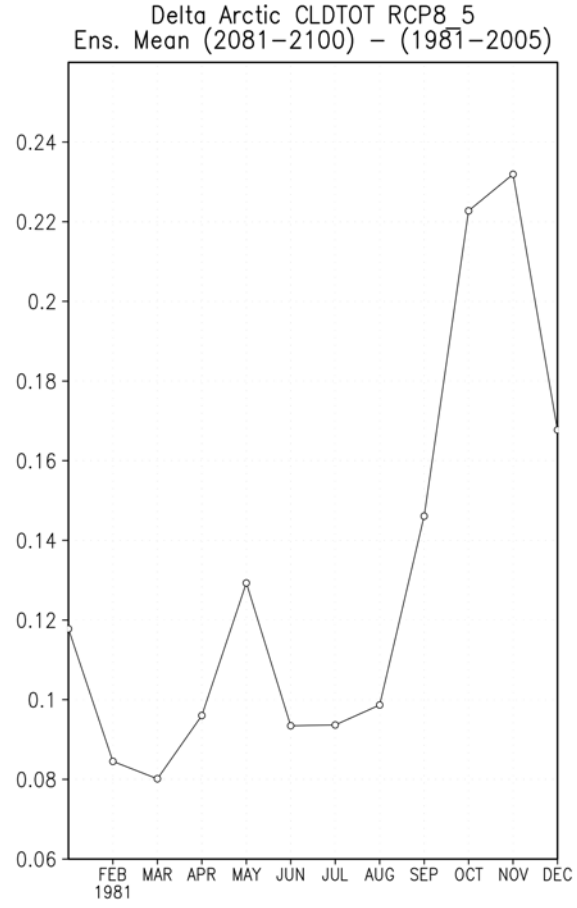
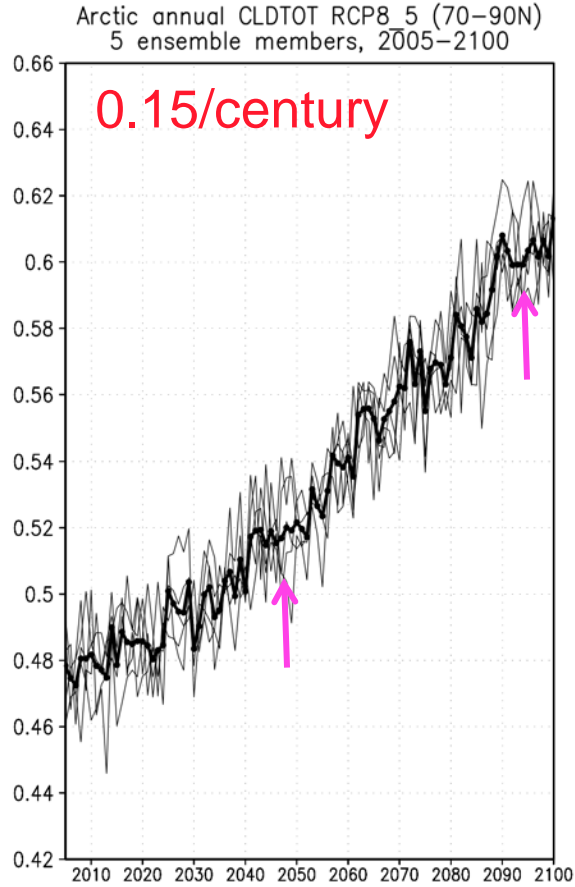
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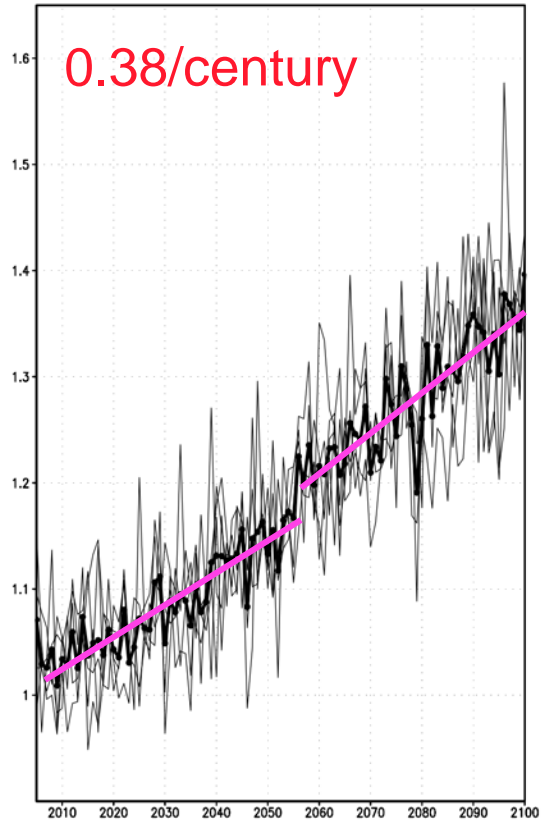
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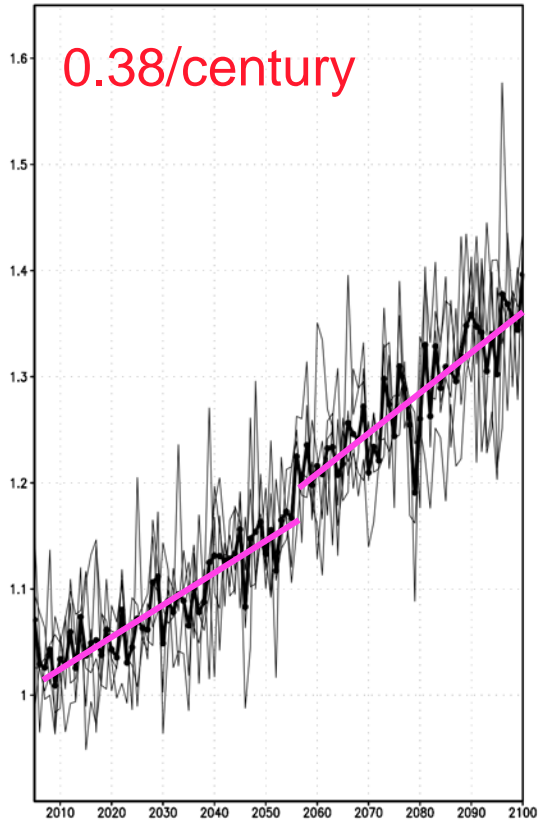
# 21<sup>st</sup> Century Precipitation

Arctic annual Precip RCP8.5 (70–90N)  
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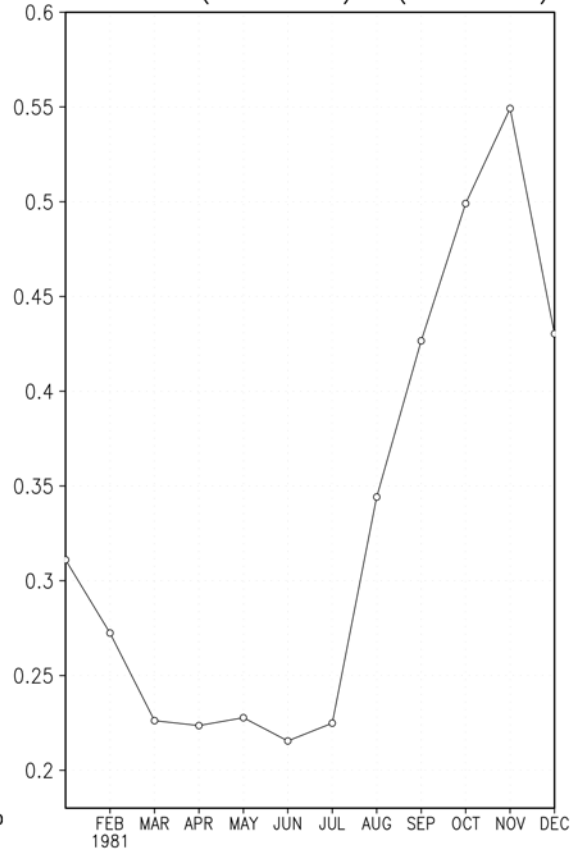


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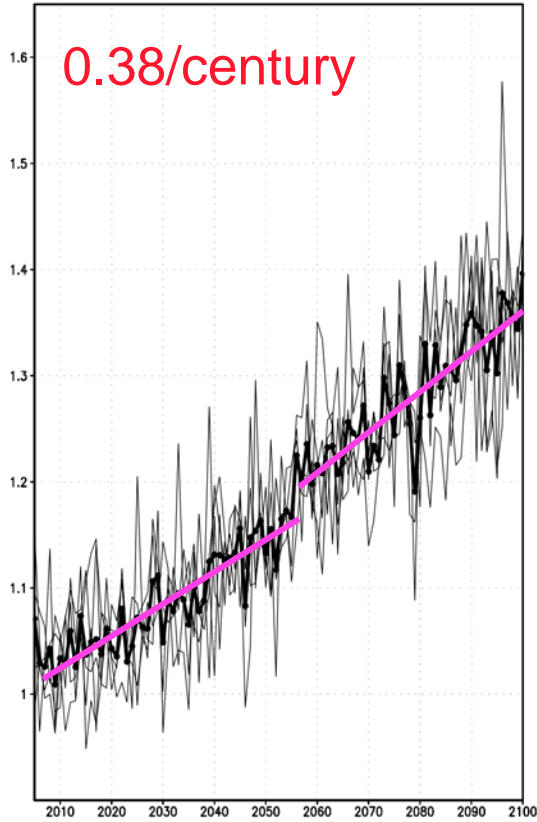


Delta Arctic Precip RCP8\_5  
Ens. Mean (2081–2100) – (1981–2005)

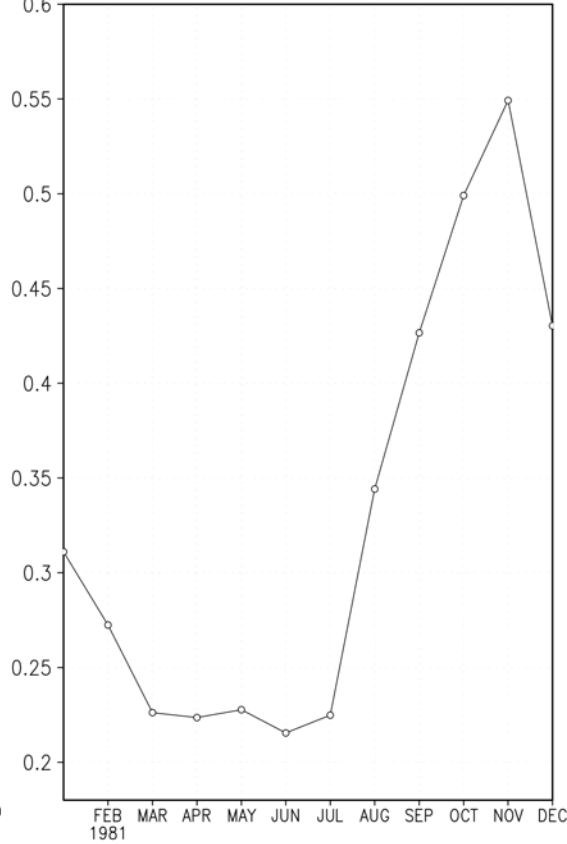


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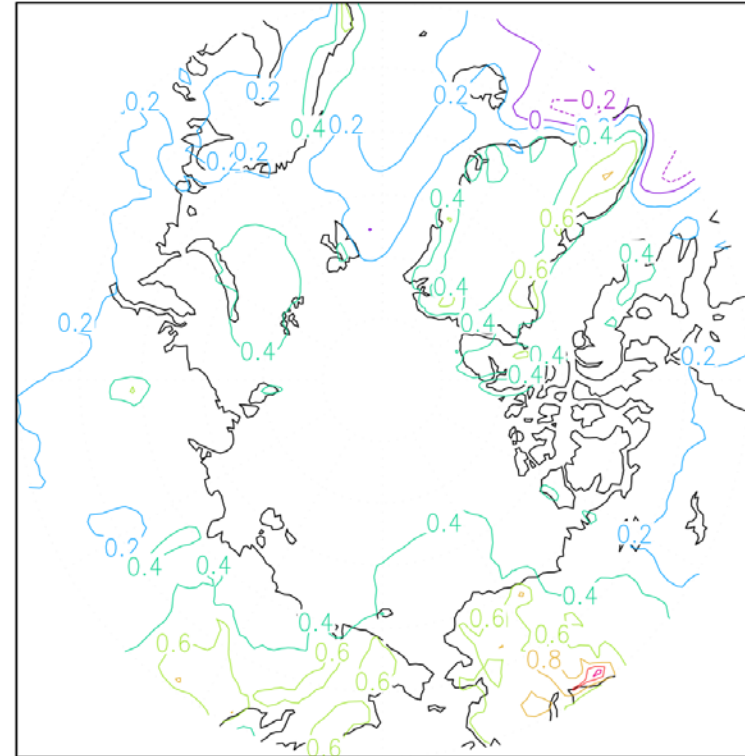
Arctic annual Precip RCP8\_5 (70–90N)  
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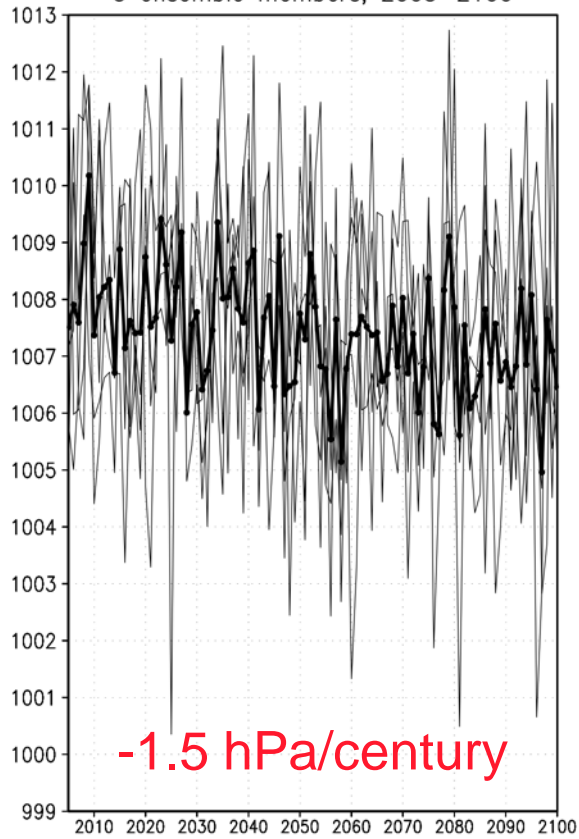


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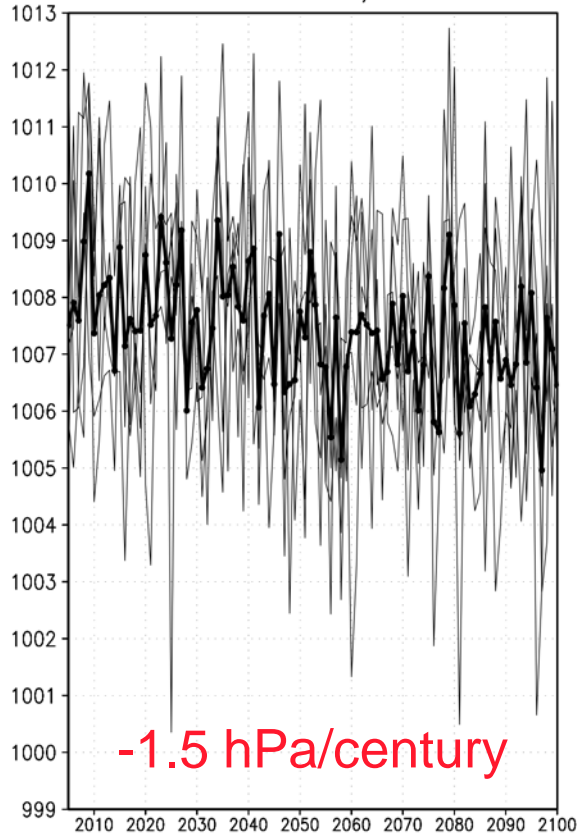
# 21<sup>st</sup> Century Sea Level Pressure

Arctic annual PSL RCP8.5 (70–90N)  
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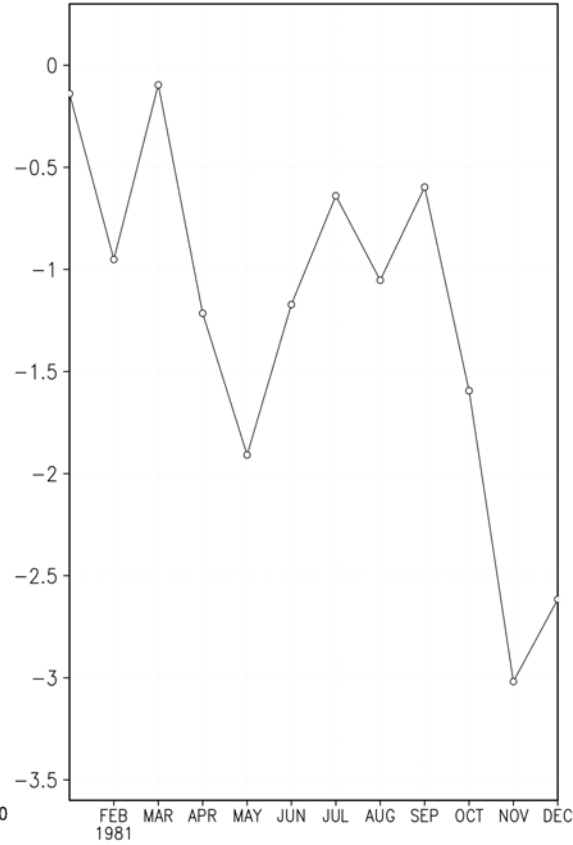


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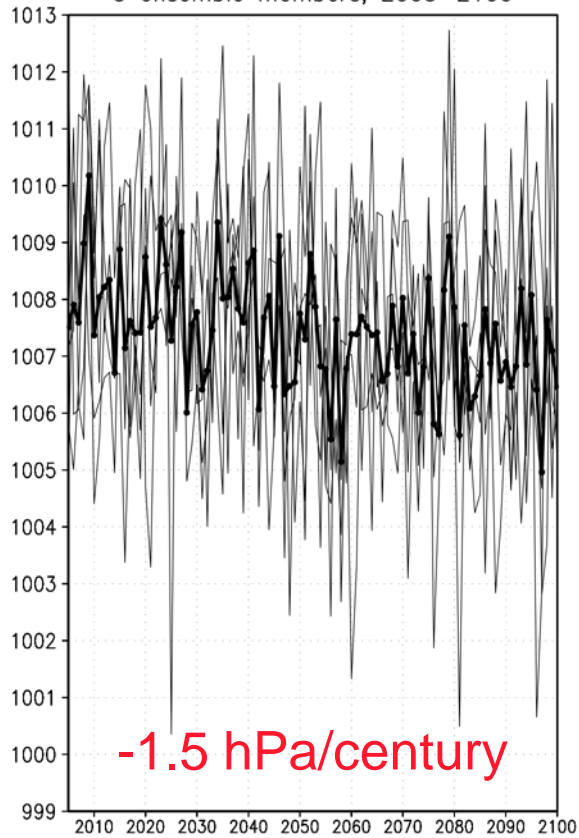


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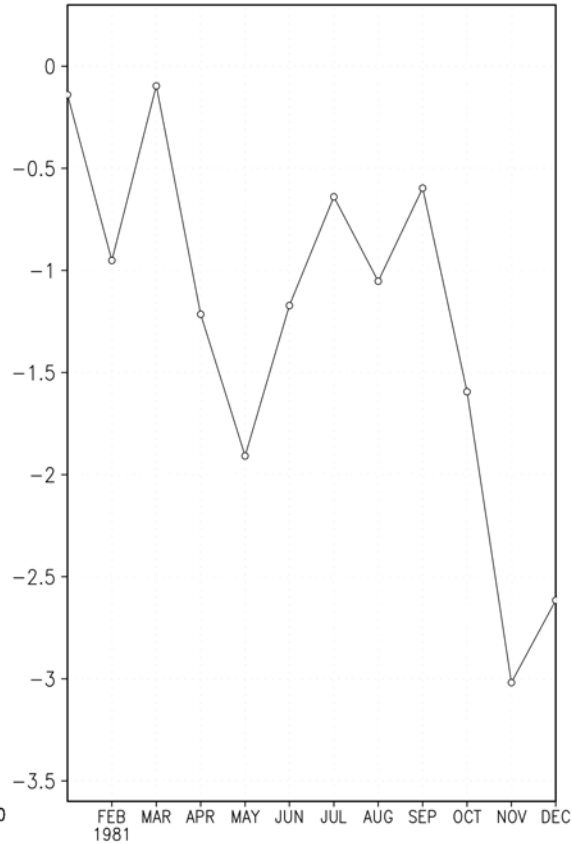


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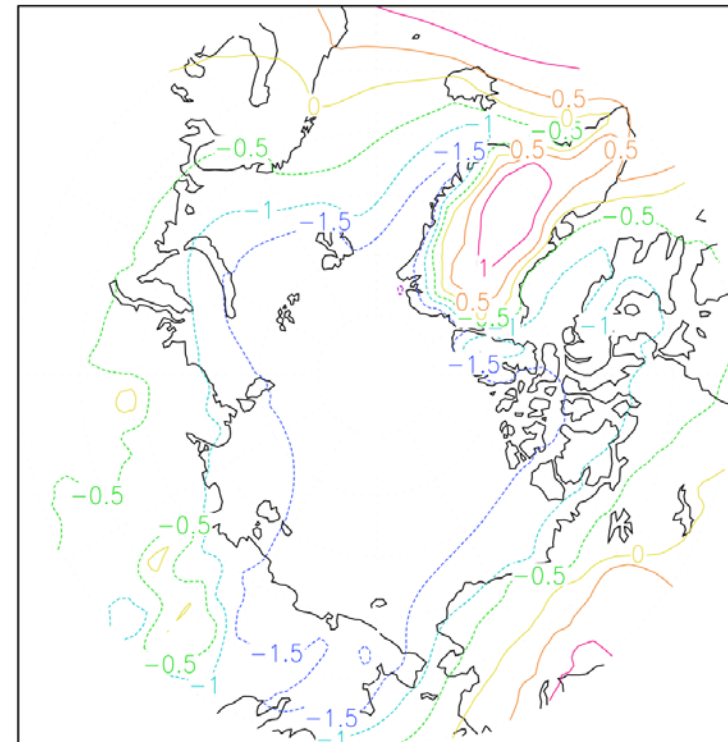
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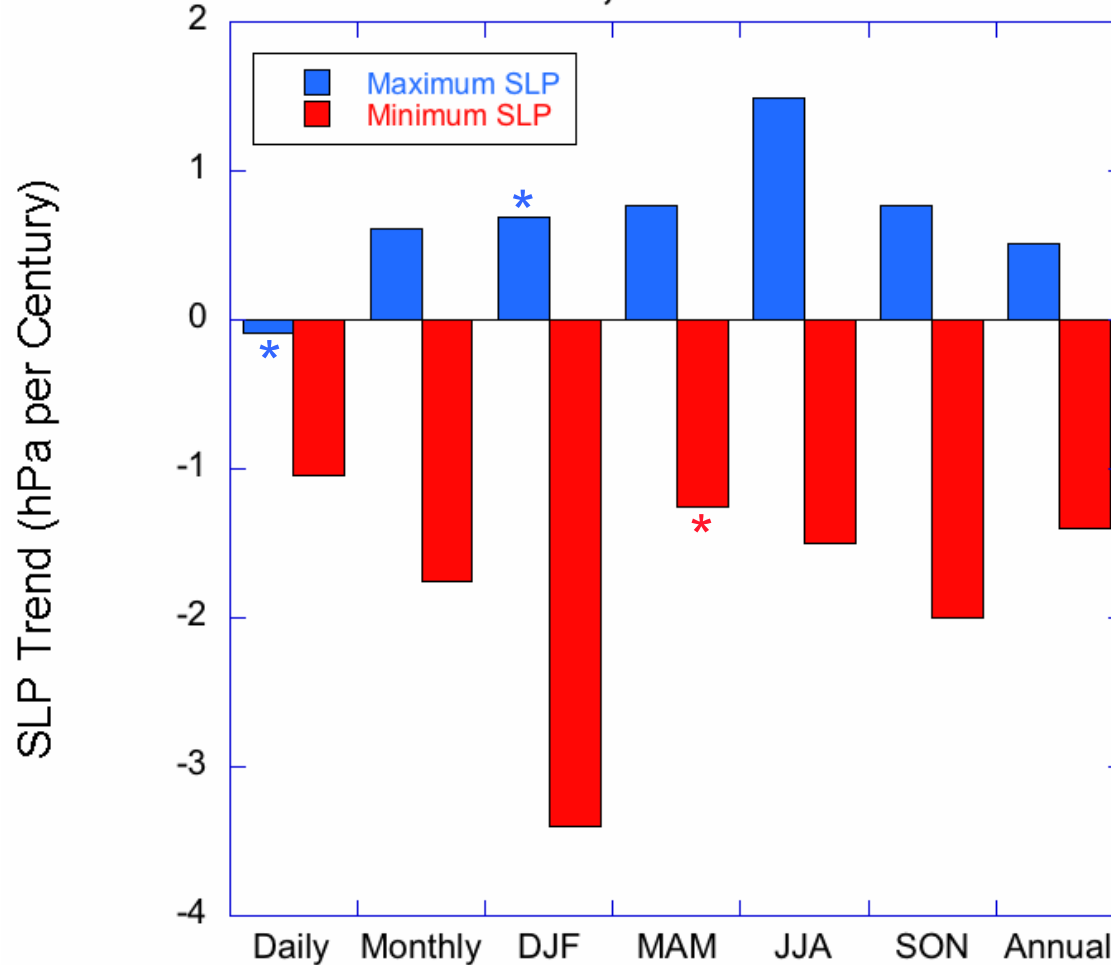
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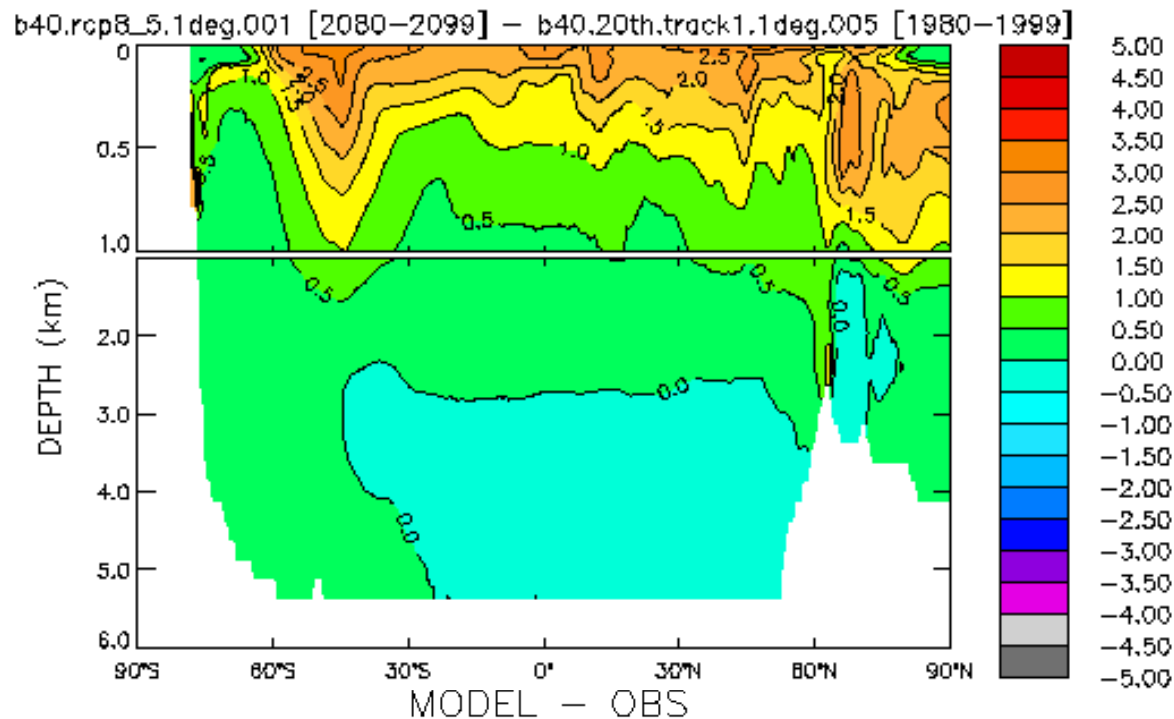
## Trends in Extreme Cyclones and Anticyclones 2005-2100, Poleward of 50N



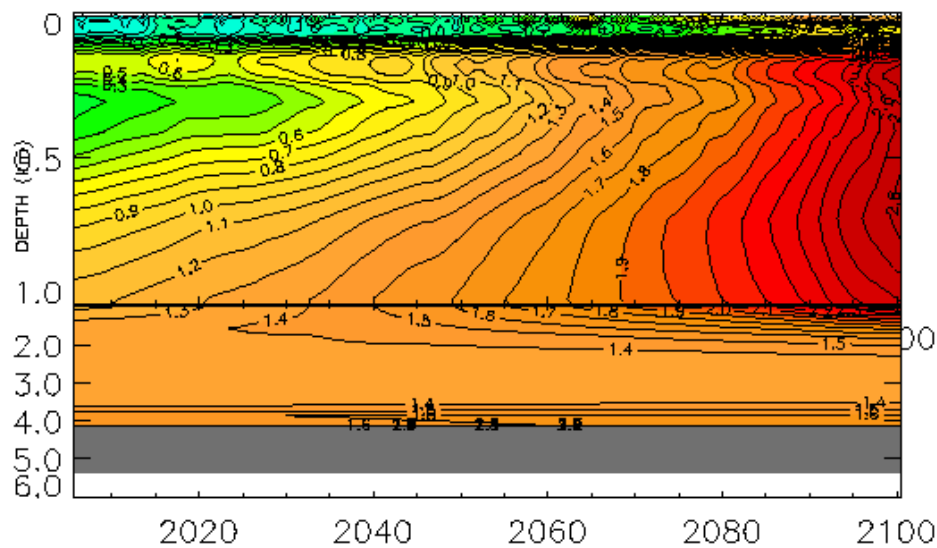
\* Not significant at 95% level

# 21<sup>st</sup> Century Ocean Temperature

Global

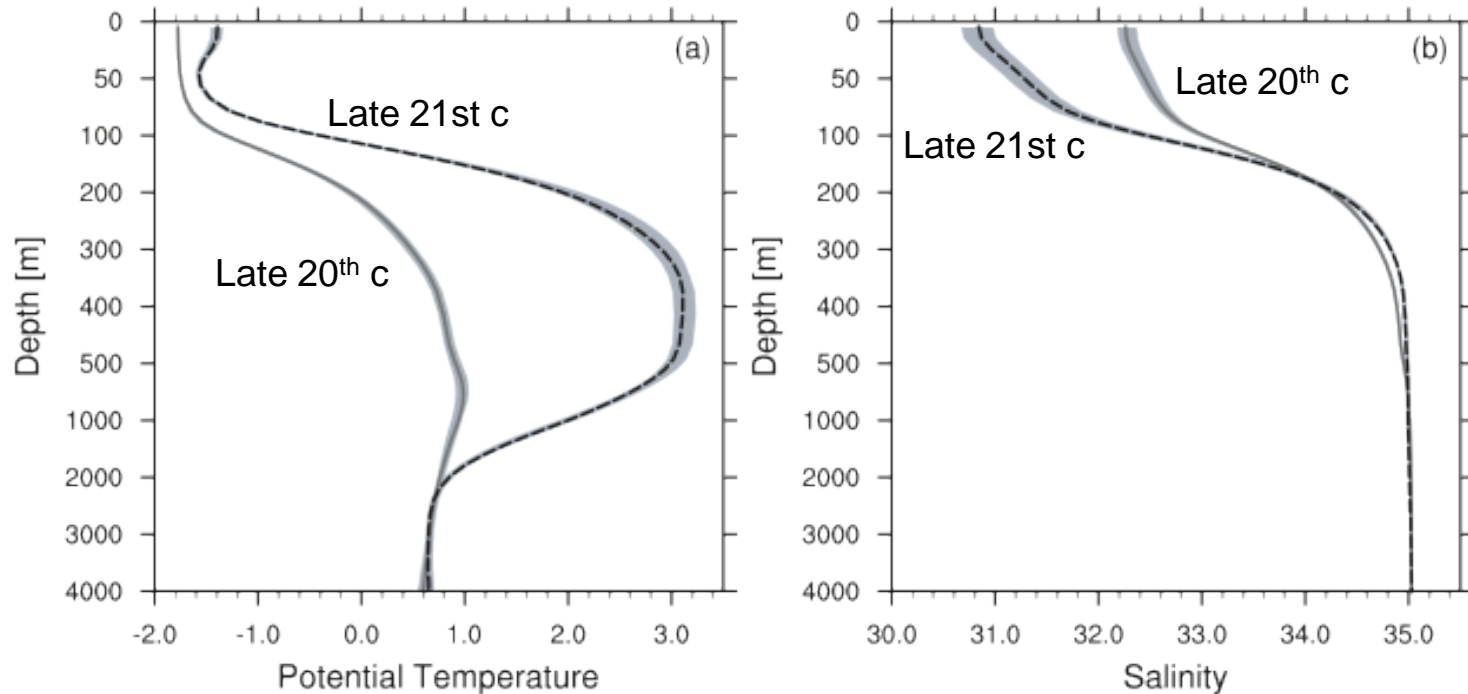


Arctic

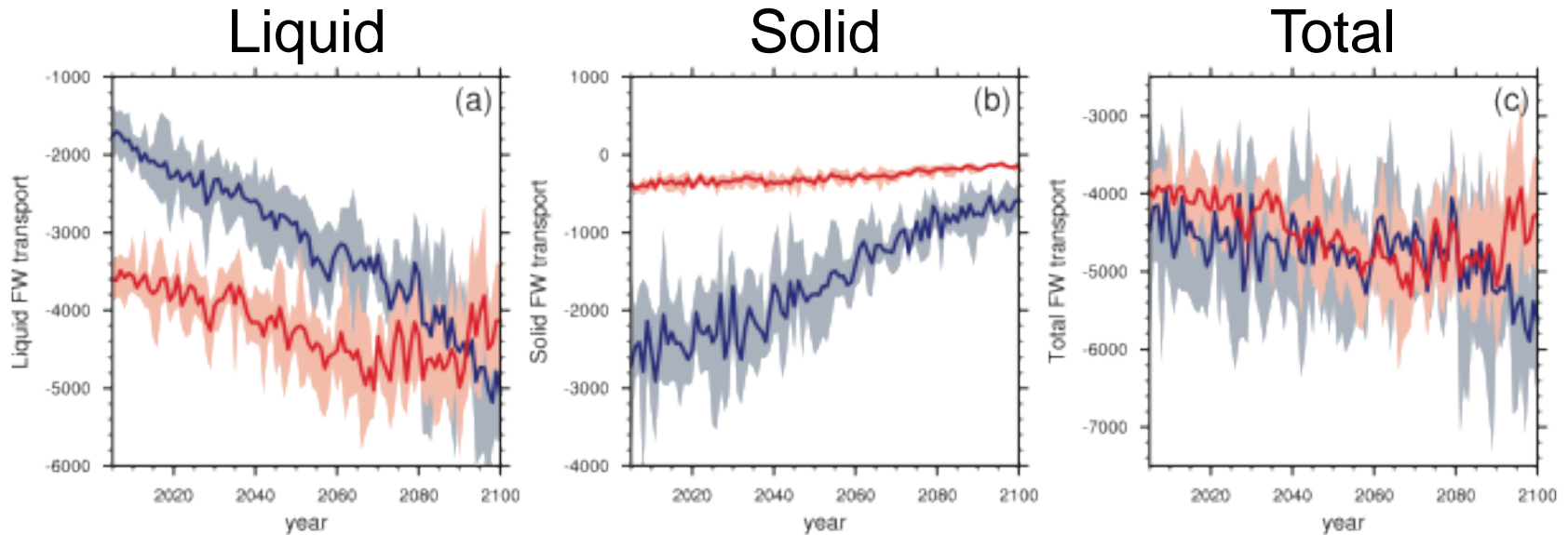


# Central Arctic Ocean Temperature and Salinity Profiles

Late 20<sup>th</sup> Century (1981-2005), Late 21<sup>st</sup> Century (2081-2100)



# Freshwater Export through Fram Strait and Canadian Archipelago



Blue = Fram Strait

Red = Canadian Archipelago

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- More liquid FW export, less ice export → greater net FW export