Arctic Ice and Cloud Feedbacks in CMIP5 Models

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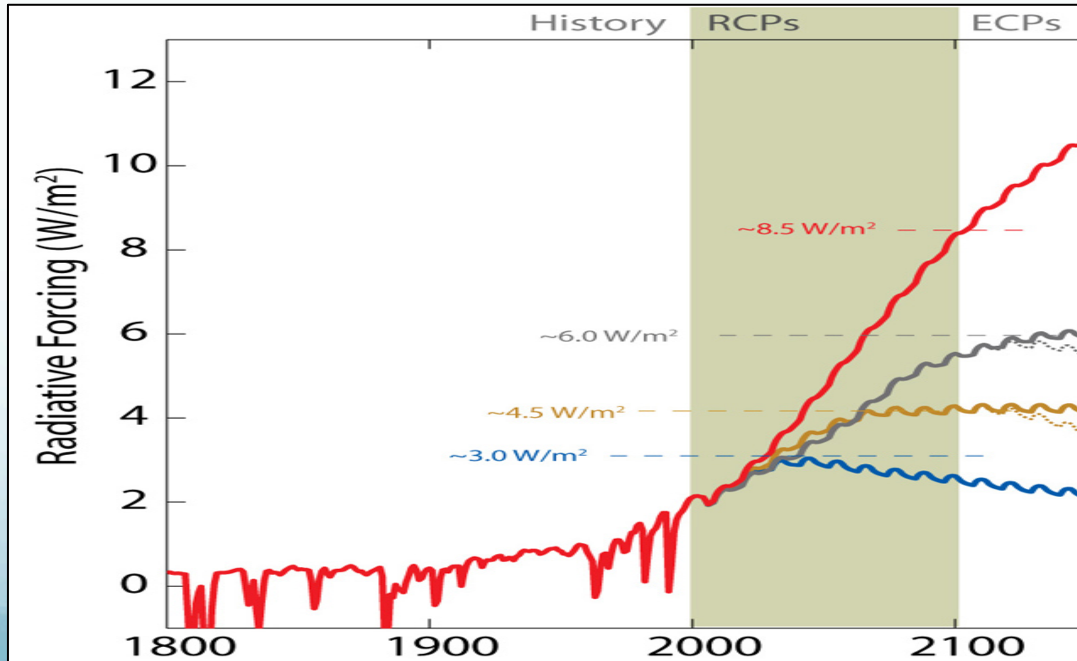
CMIP5 and Climatic Feedbacks

- CMIP5: Coupled Model Intercomparison Project Phase 5
- Chose 3 models – CCSM4, HadGEM2-CC, MIROC5
- Fully coupled models



http://www.pik-potsdam.de/~mmalte/rcps/

What’s happening in the Arctic and why do we care?

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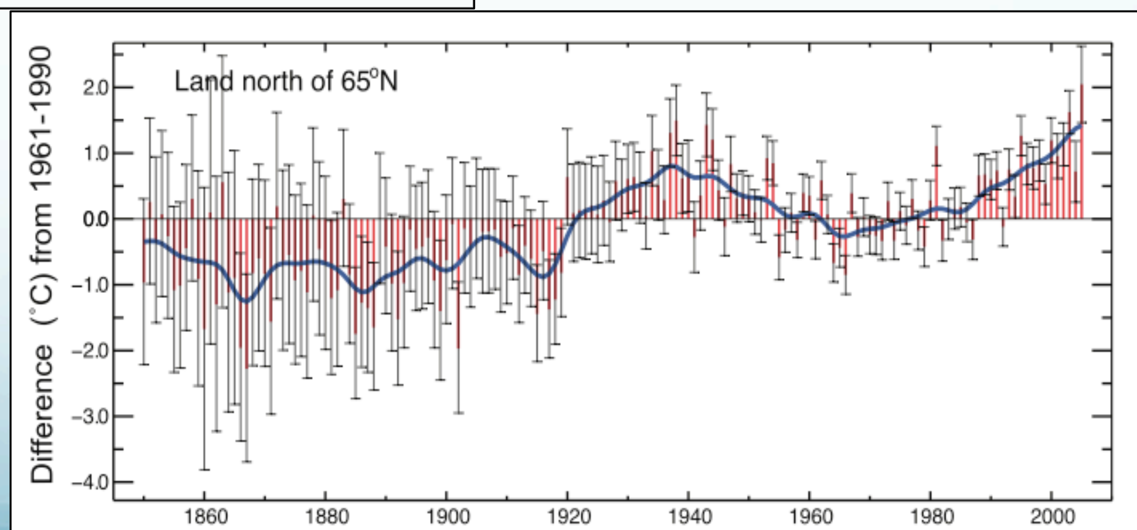
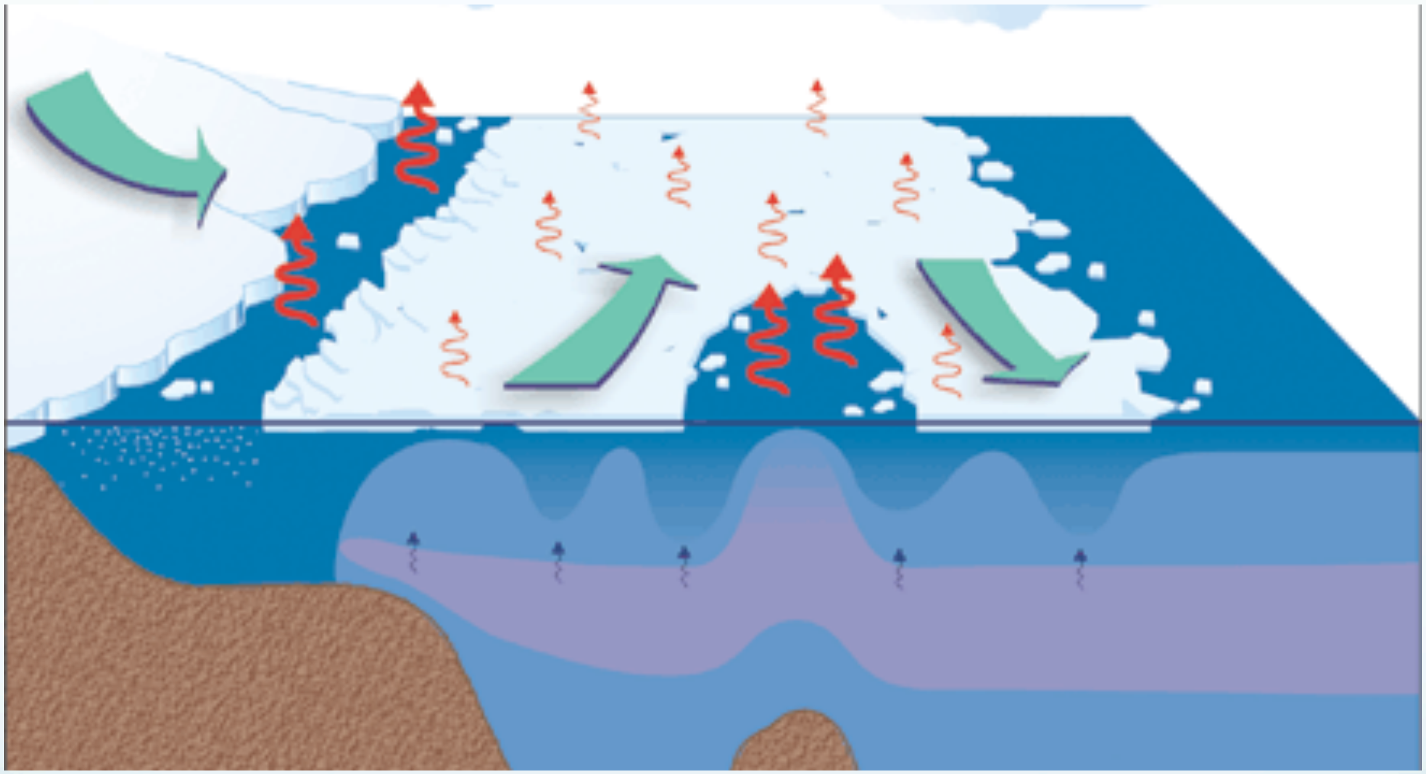
Warming in the Arctic is occurring almost twice that of global warming.



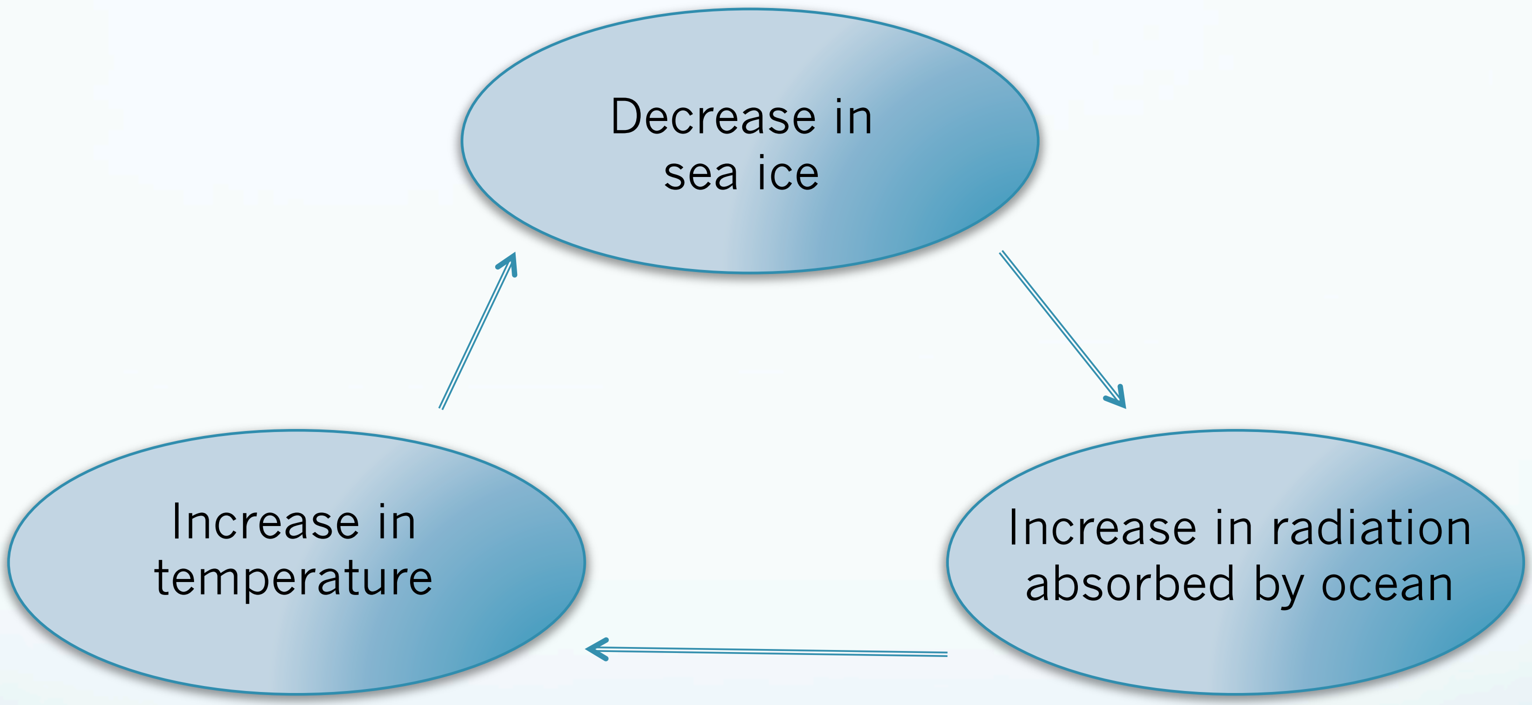
What is the role of Arctic sea ice?



Sea ice is an insulator.

Lemke (2001)

Sea ice has a large albedo



Objective

Assess predictions of changes in Arctic sea ice cover and determine the main drivers behind these changes.

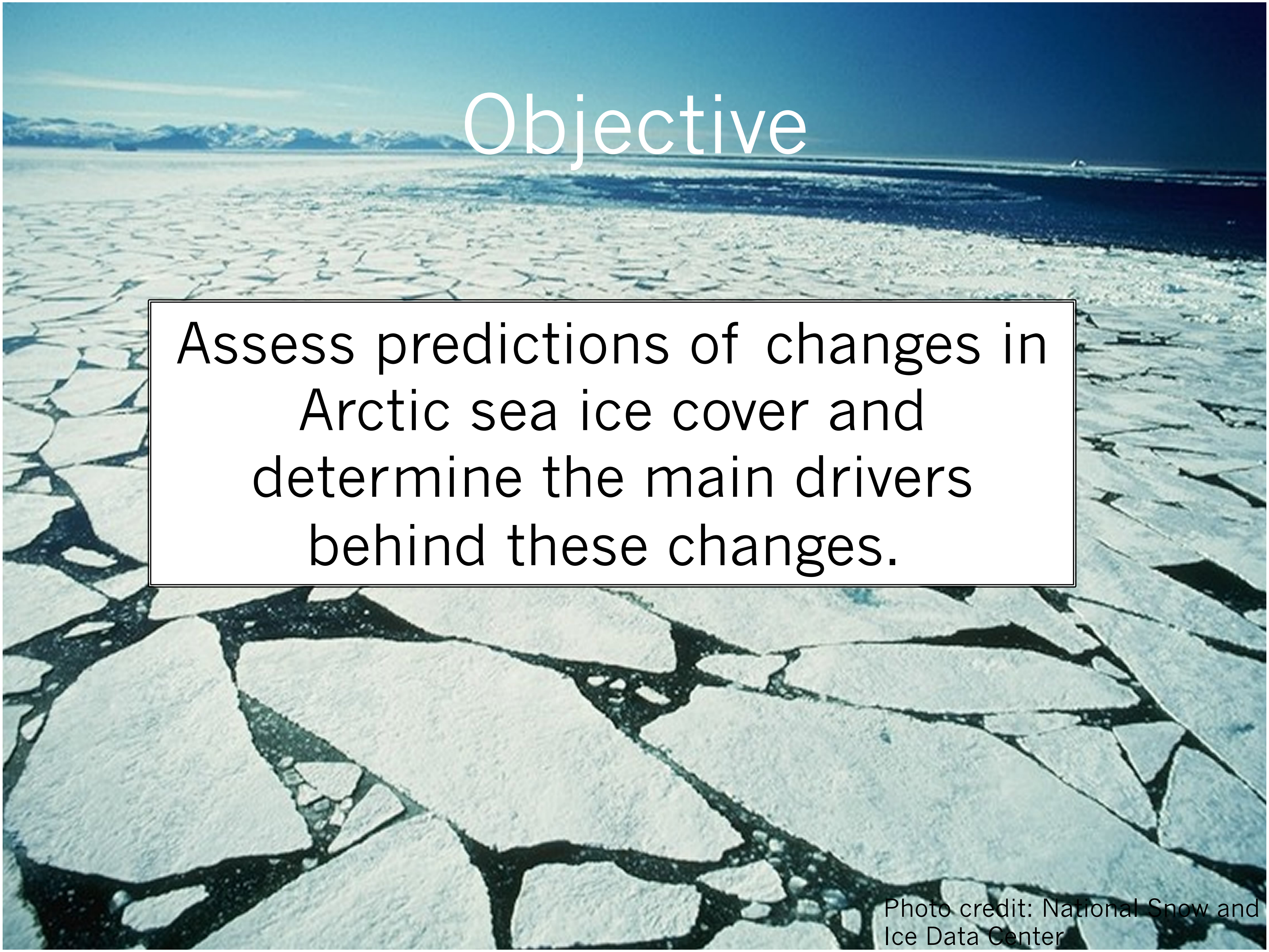
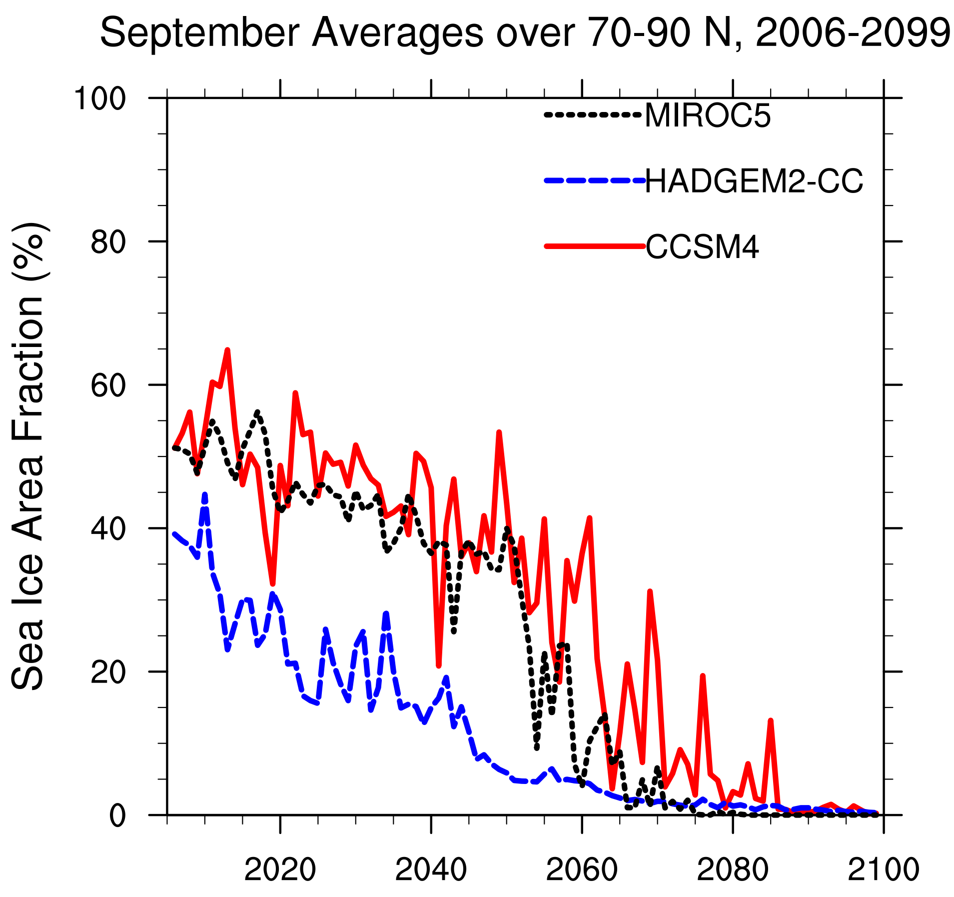


Photo credit: National Snow and Ice Data Center

Arctic Sea Ice



September Sea Ice Fraction

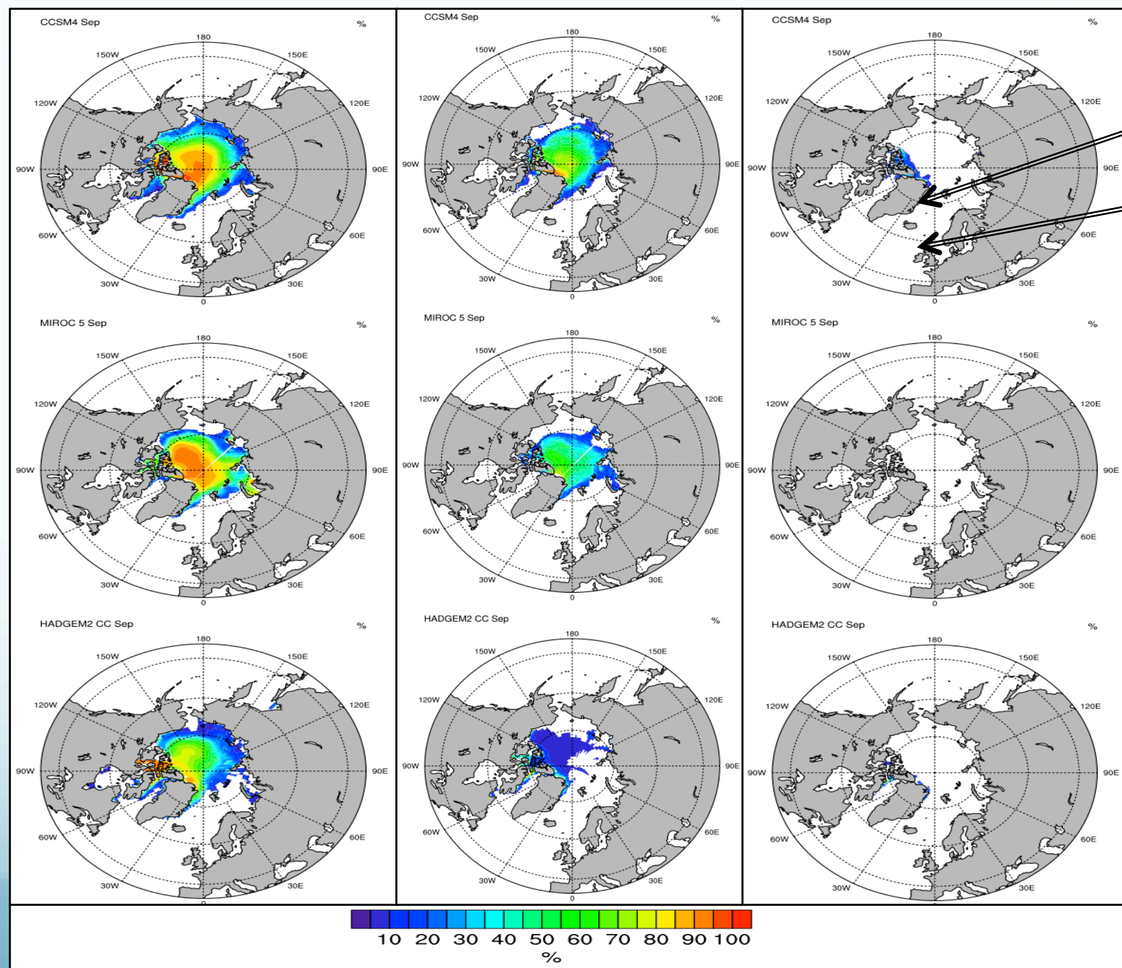
Sea Ice Area Fraction

2006-2025 2046-2065 2086-2098

CCSM4

HadGEM2-CC

MIROC5

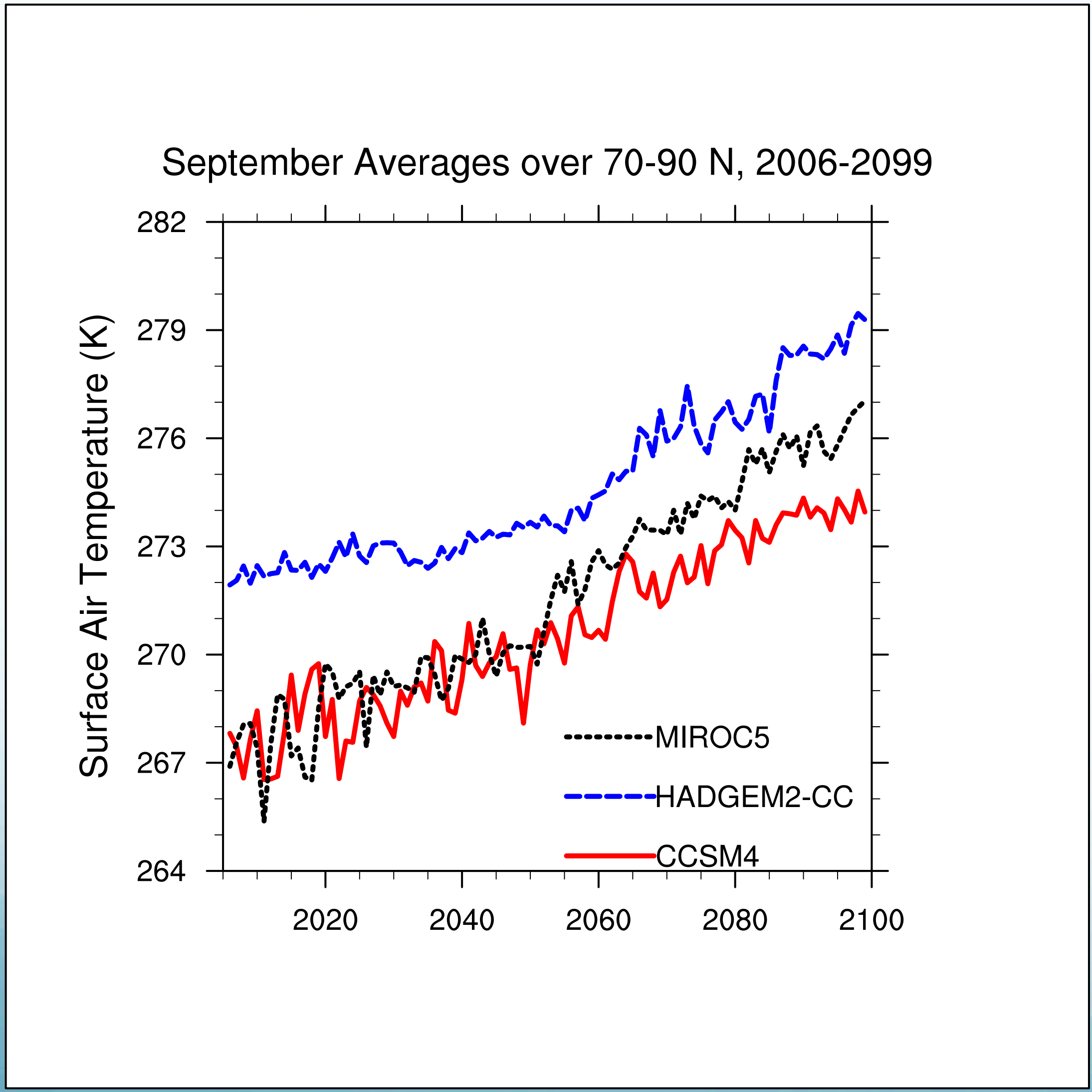


75°N

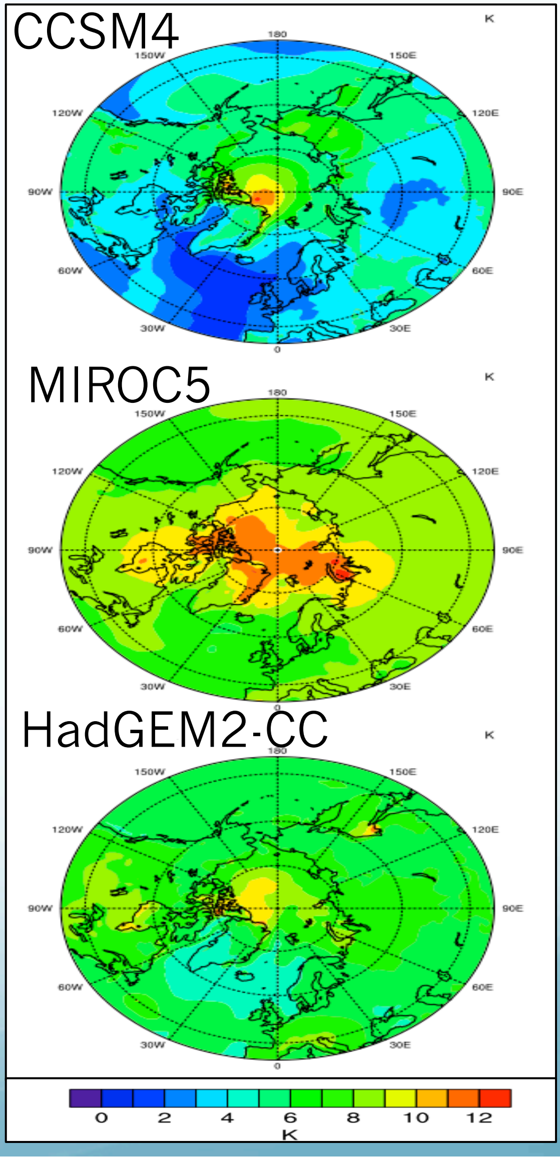
60°N

- 3 models similar, but not the same

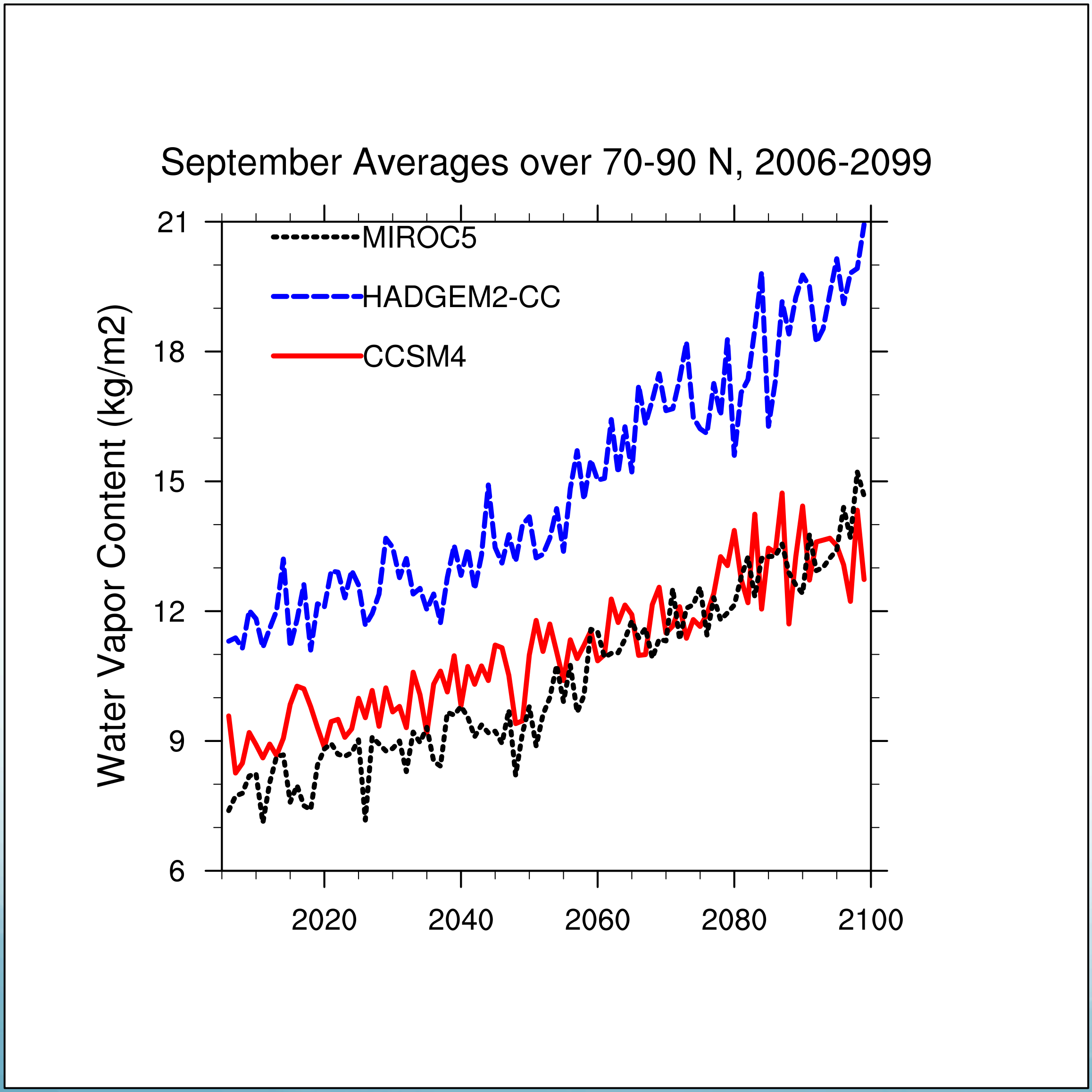
Increasing surface air temperature



September Averages
2080-2099 Minus 2006-2025



Increasing water vapor content



September Averages
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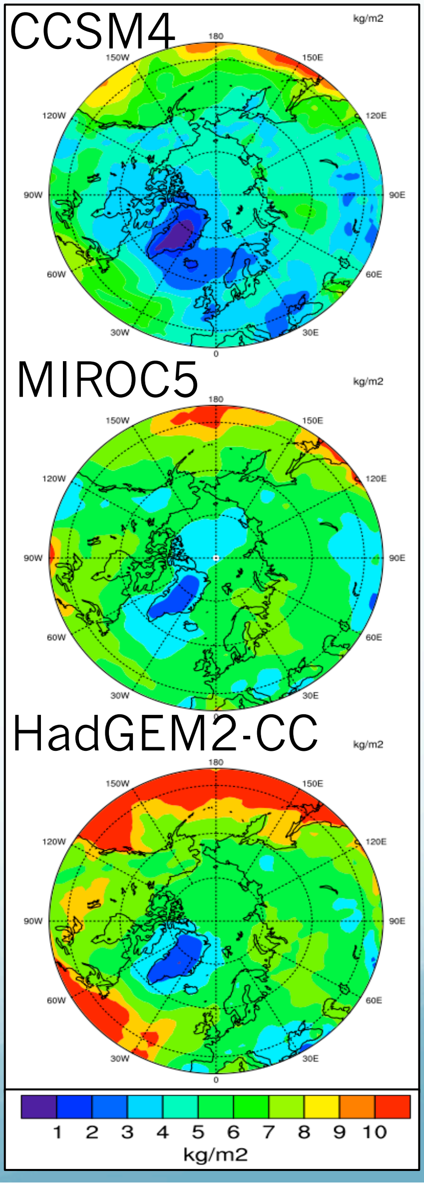
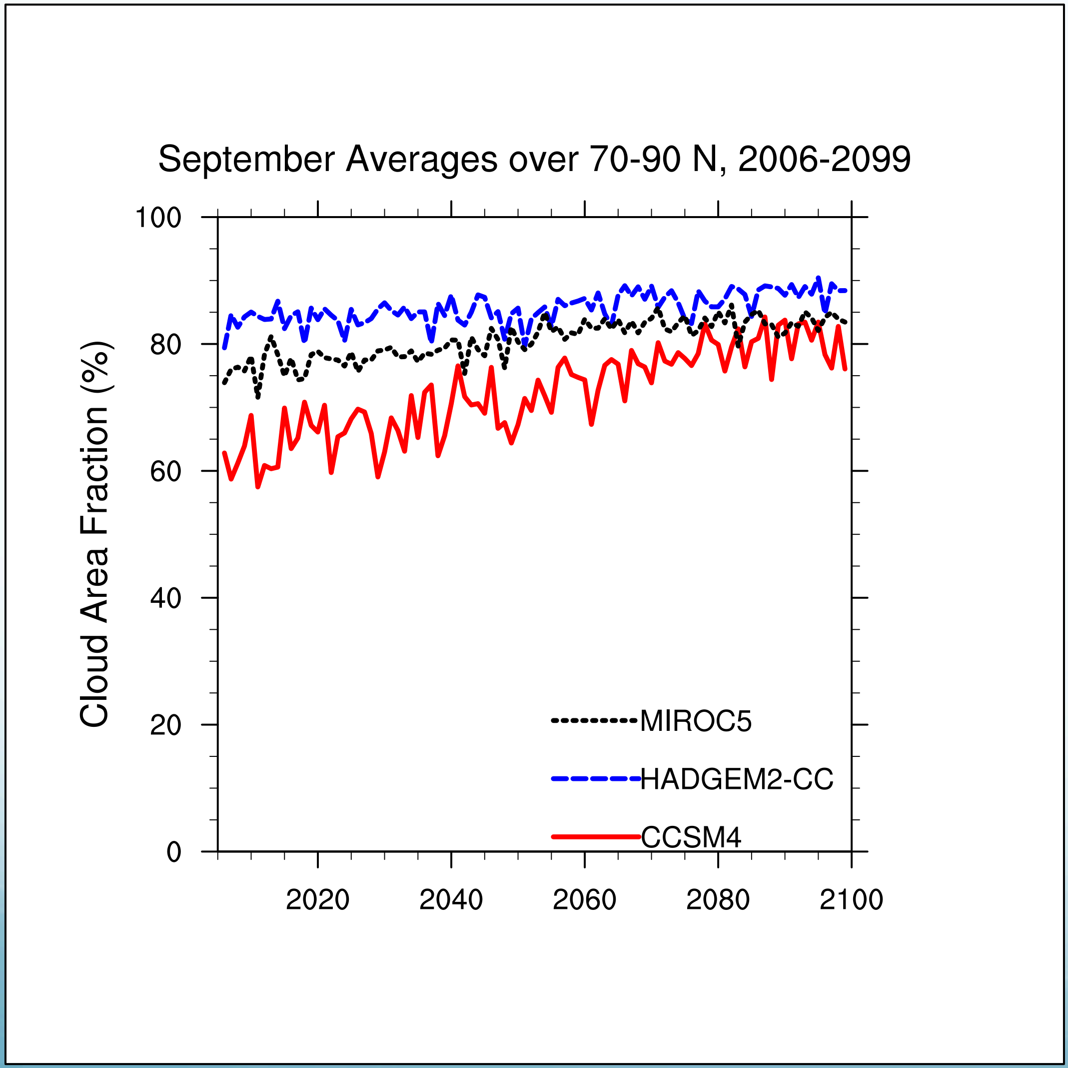


Increase in total cloud fraction over ice, decrease over land



September Averages
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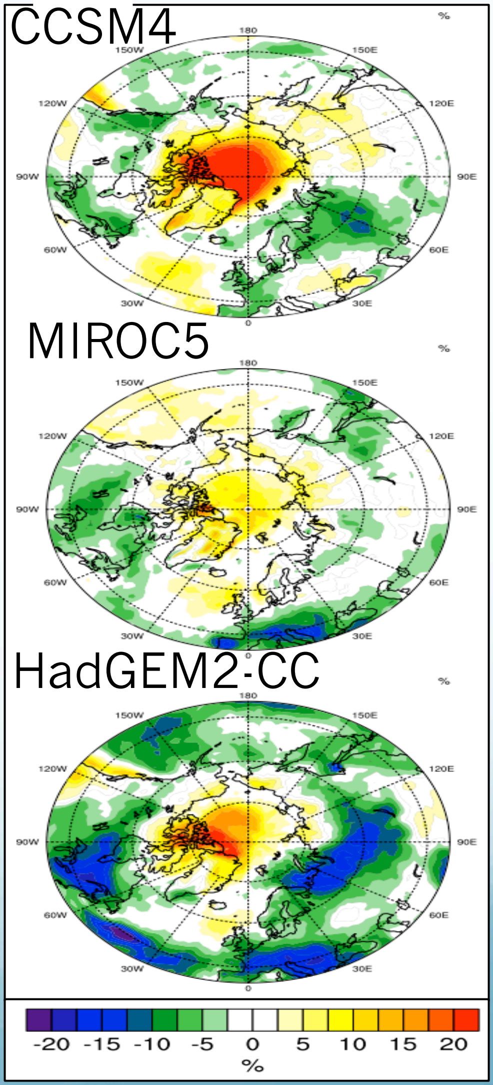
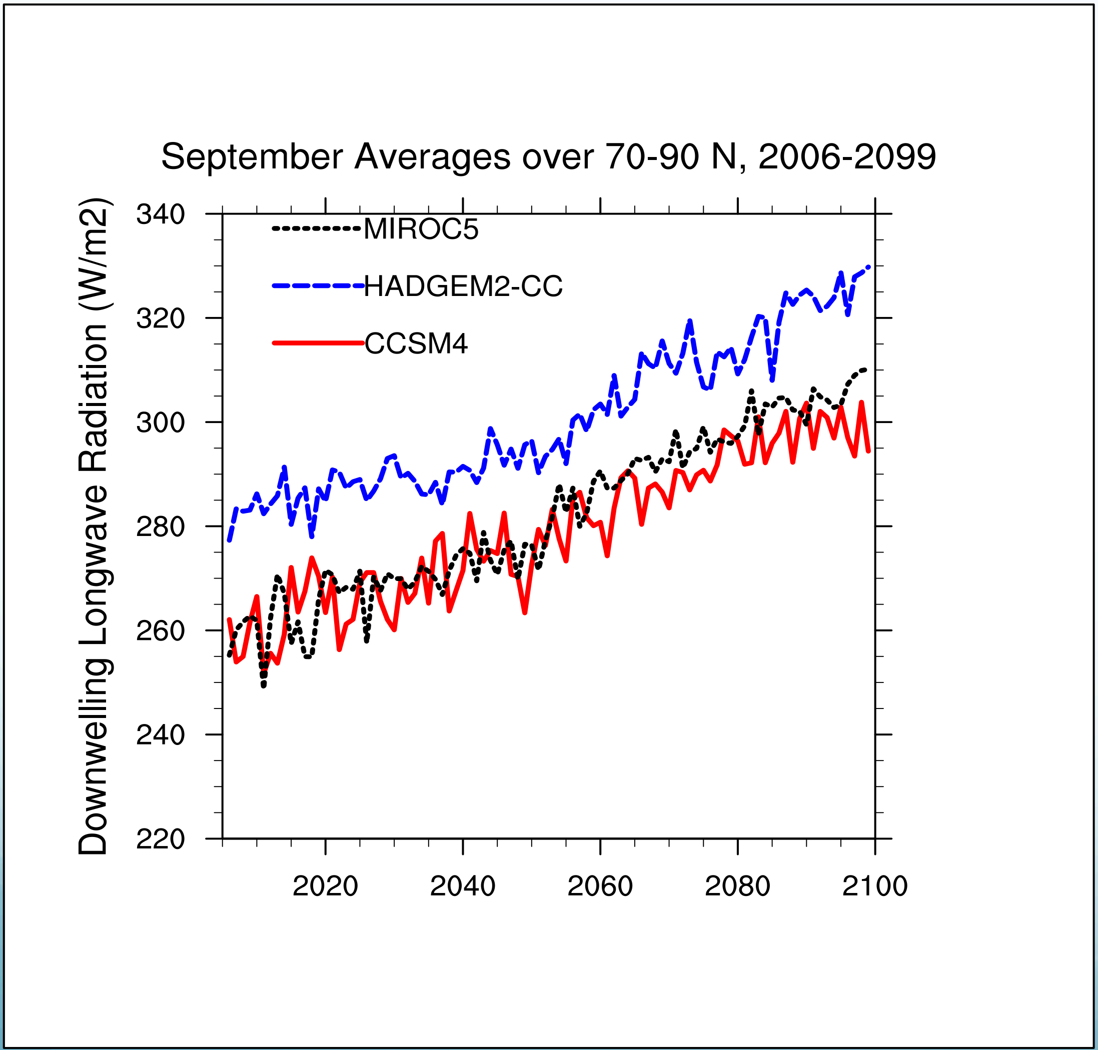
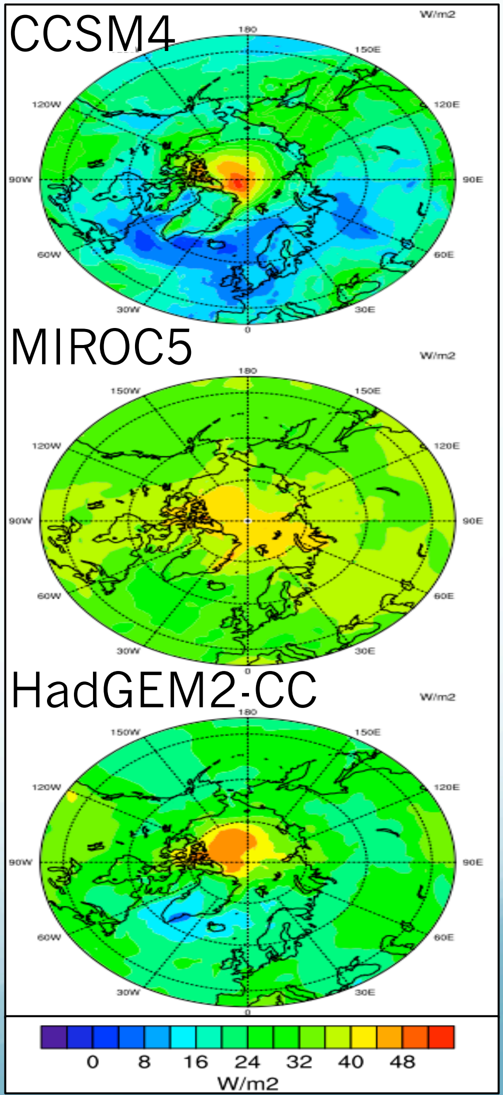


Increase in downwelling longwave radiation

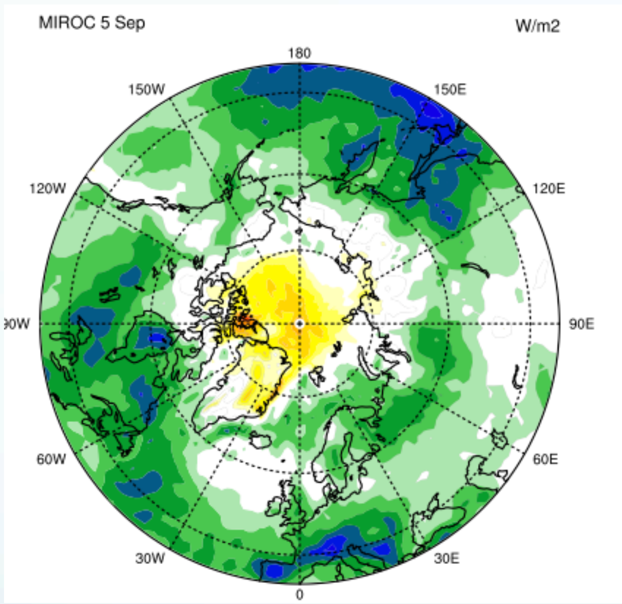


September Averages
2080-2099 Minus 2006-2025

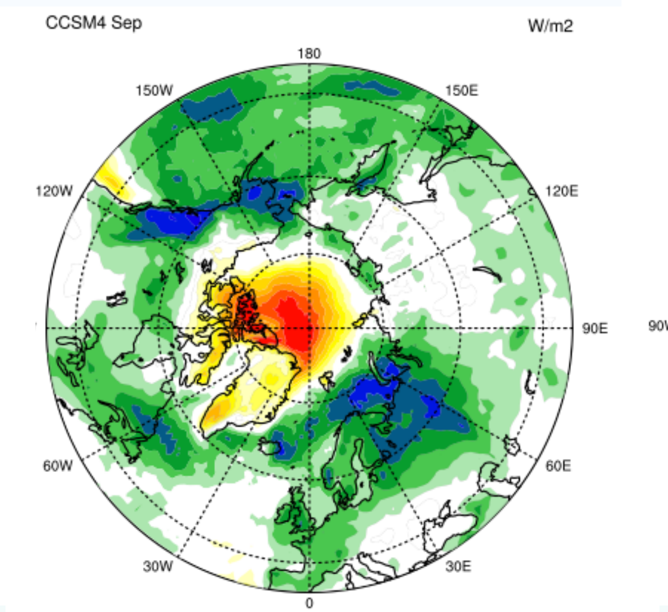


Longwave cloud radiative effect

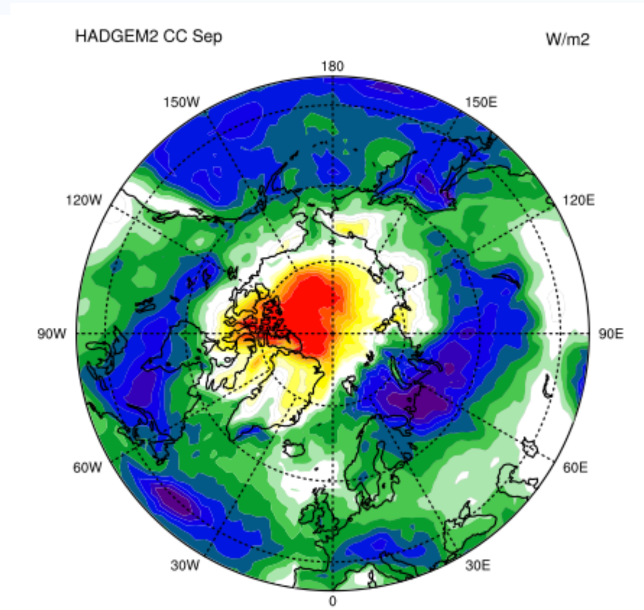
September Averages
2080-2099 Minus 2006-2025



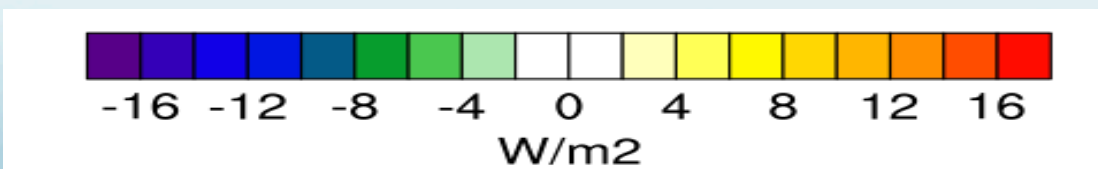
MIROC5



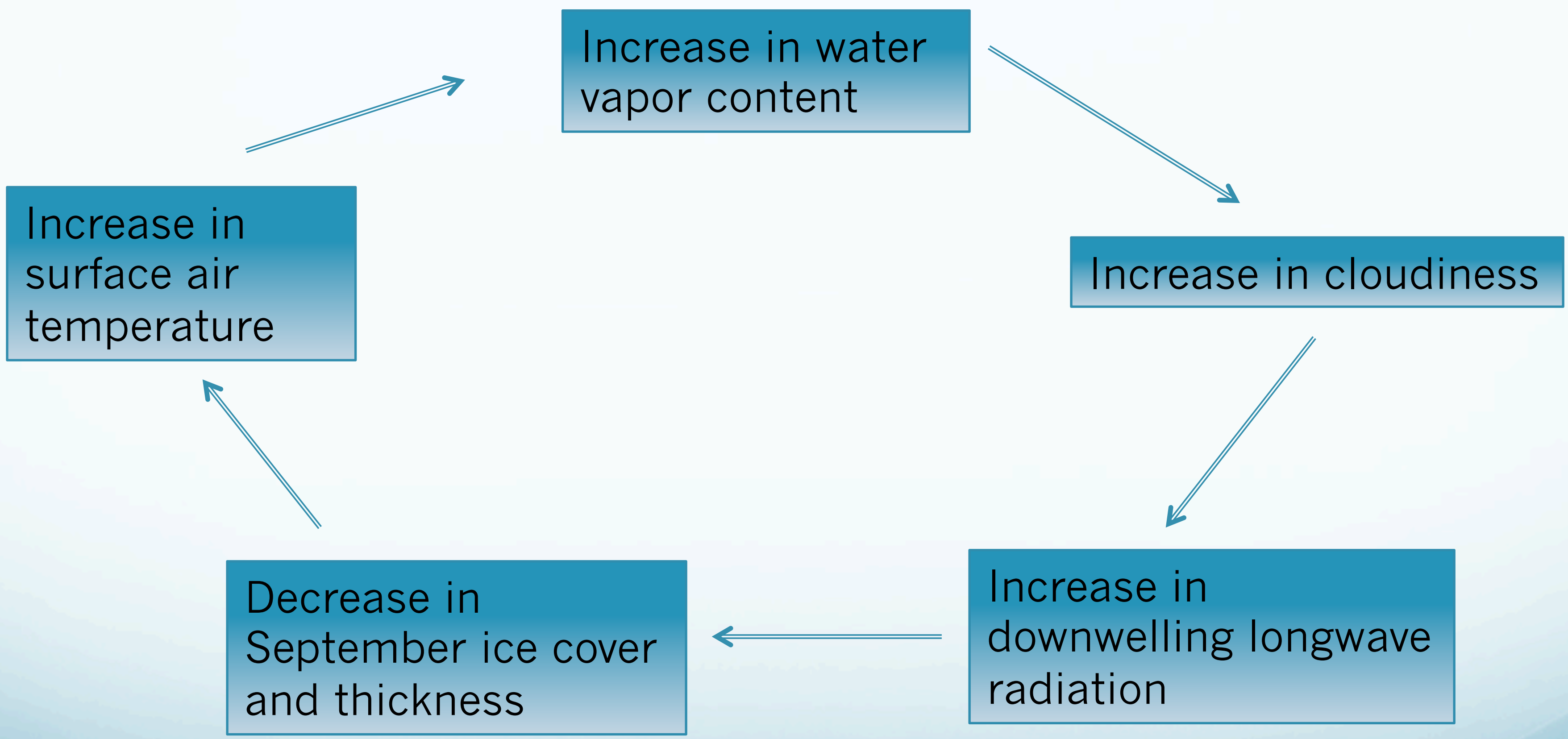
CCSM4



HadGEM2-CC



Cloud feedback impacting September ice melt



Summary

- CMIP5 models support a cloud feedback that is contributing to sea ice melt in September
- Increases in surface air temperature, water vapor content, and downwelling longwave radiation over the Arctic help drive this feedback
- There are contrasting cloud changes between land and ocean

Future Work

- Perform this analysis on the other CMIP5 models
- Conduct a statistical comparison to examine the relative importance behind driving mechanisms
- Examine in depth other cloud properties

Questions?

Thank you very much to

- Dr. Dave Randall
- Melissa Burt
- CMMAP Internship Program
- National Science Foundation

Photo credit: Derdento