Arctic Ice and Cloud Feedbacks in CMIP5 Models

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Introduction

As CO_2 emissions rise, warming in the Arctic is almost twice that of the entire globe. This dramatic warming is directly related to the decrease in September sea ice cover and thickness. Arctic ice acts as an insulator that keeps the ocean from warming the overlying atmosphere. Sea ice melt is driven by the ice-albedo feedback and potentially by changes in the radiative forcing of clouds. It is important to understand how ice and cloud feedbacks are related to better predict sea ice cover and thickness in future warmer climates.

Objective

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

September Sea Ice Area

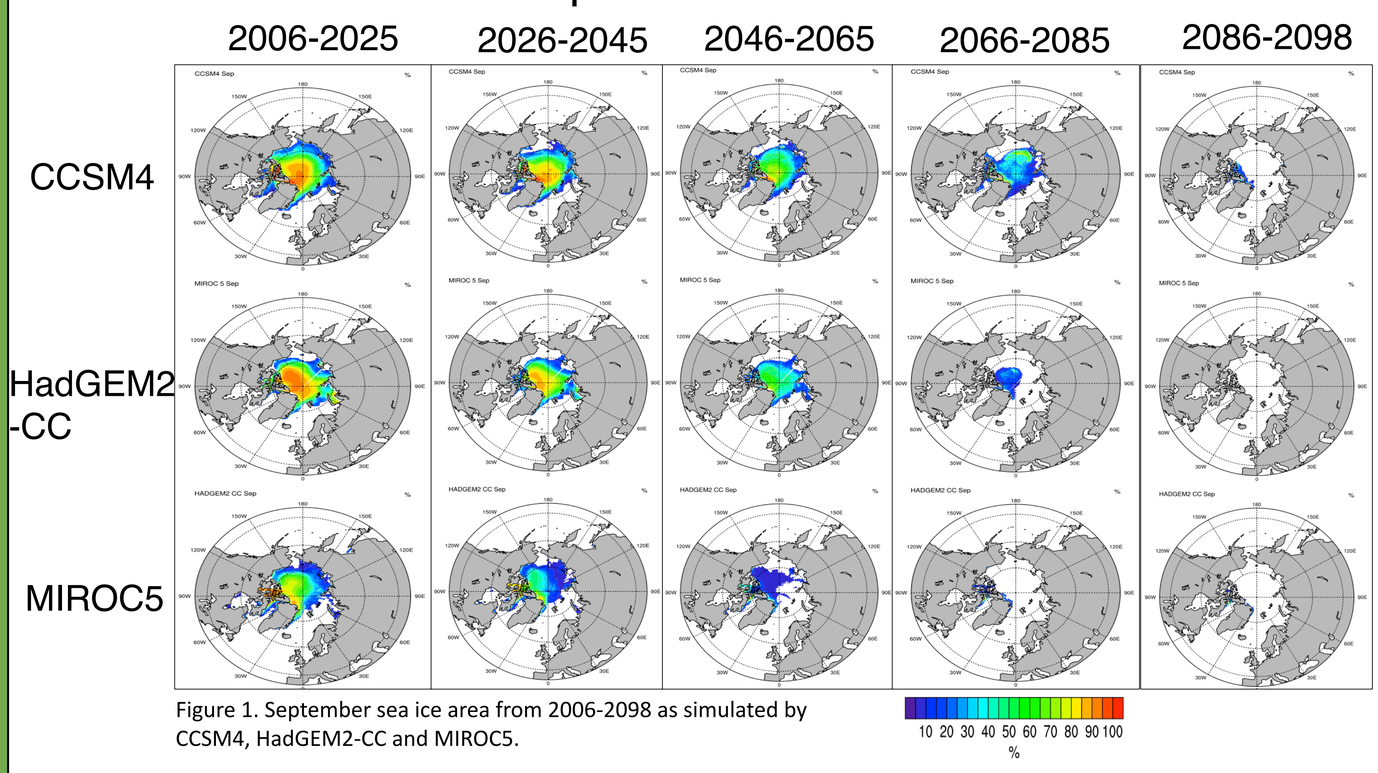


Figure 1. September sea ice area from 2006-2098 as simulated by CCSM4, HadGEM2-CC and MIROC5.

CMIP 5 RCP 8.5

- CMIP5: Coupled Model Intercomparison Project Phase 5
- Chose 3 models – CCSM4, HadGEM2-CC, MIROC5 run on Representative Concentration Pathway 8.5
- Fully coupled models

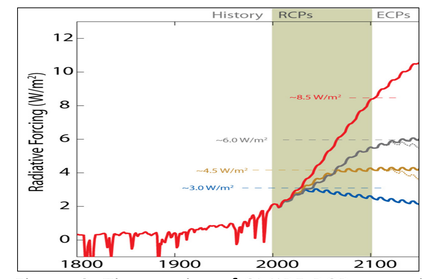
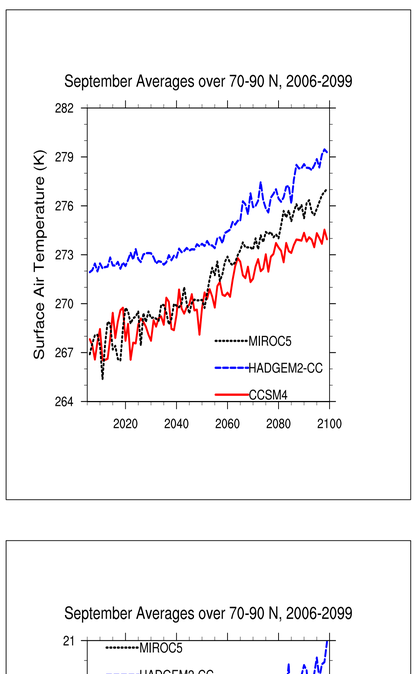
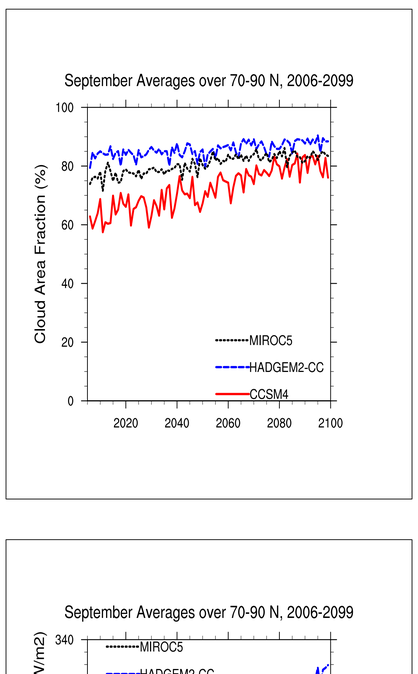
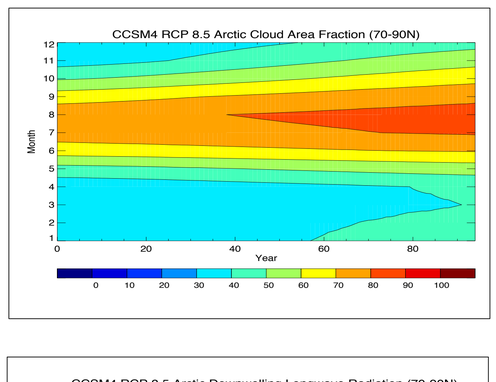
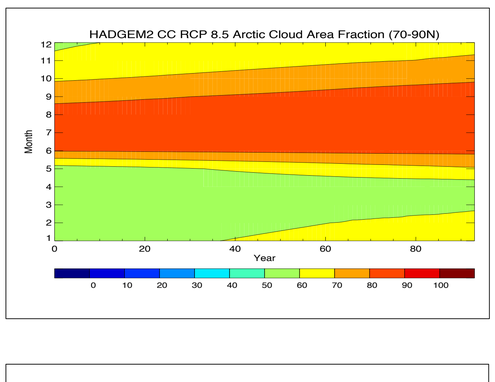


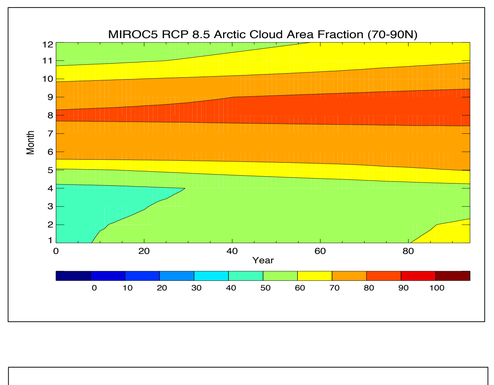
Figure 2. Time series of CMIP5 RCP scenarios. http://www.pik-potsdam.de/~mmalte/rcps/

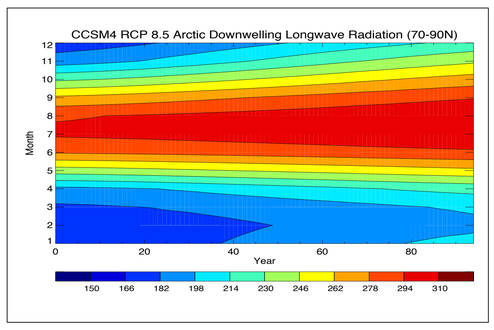


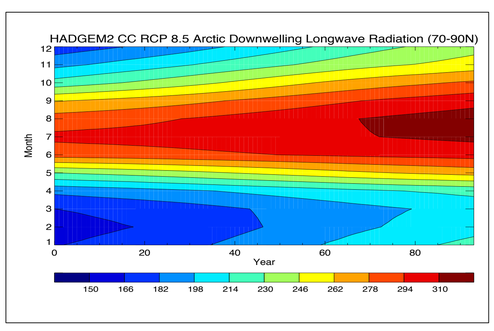












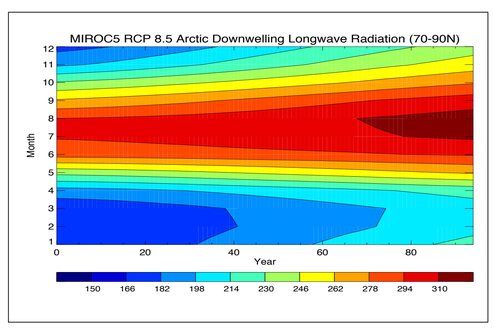
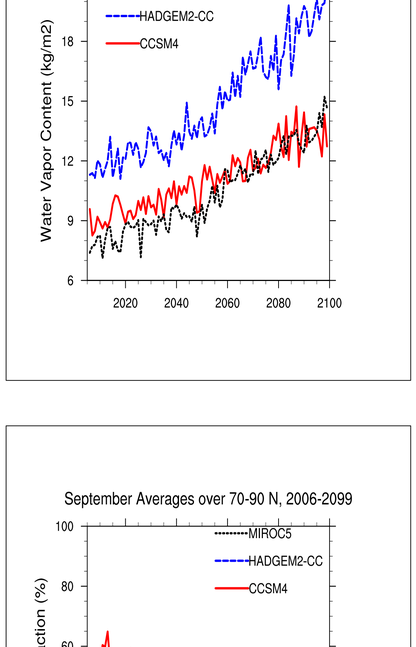


Figure 4. Seasonal trend plots of cloud fraction and downwelling longwave radiation.



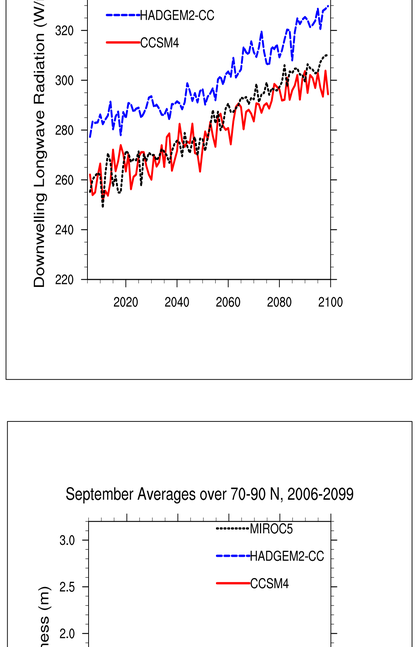


Figure 3. September means averaged over 70-90 N over time for multiple variables.

September Averages 2080-2099 Minus 2006-2025

Figure 5. Polar stereographic maps for the time period 2080-2099 minus 2006-2025.

Conclusions

- 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

Figure 6. Cloud-ice feedback schematic.

Next Steps

- 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

Acknowledgements

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