FIRE: THE FIRST-YEAR INNOVATION & RESEARCH EXPERIENCE

CLIMATE COMPUTING

IMPACT OF WRF-ARW CLOUD FRACTION ON ARCTIC ALBEDO FOLLOWING EXTREME SEPTEMBER SEA ICE CONDITIONS

Ishaan Chakraborty, Divya Lingala, Sophiya Mehra, Dr. ST Strey

INTRODUCTION

This study investigates the impact of sea ice on Arctic albedo using regional climate simulations of cases with High, Low, and Median summer sea ice extent during September. We compare upward latent heat fluxes and cloud fraction between cases to begin to ascertain information on changes in cloud cover and subsequent changes in albedo.

TOOLS AND DATA

- Weather and Research and Forecast Model (WRF-ARW v 4.5.2)
- European Reanalysis 5 (ERA5) 31 km input data
- Simulations at 6 km resolution using the following physics parameters shown in Table 1

Process	Parameterization Scheme
Microphysics	Morrison-Double Moment
Convective Parametrization	Kain-Fristch
Long wave Radiation	RRTM
Short wave Radiation	Dudhia
Planetary Boundary Layer	Yonsei University
Surface Layer	MM5
Land Surface	Noah Land Surface

Table 1 - Physics Parameters

METHODS

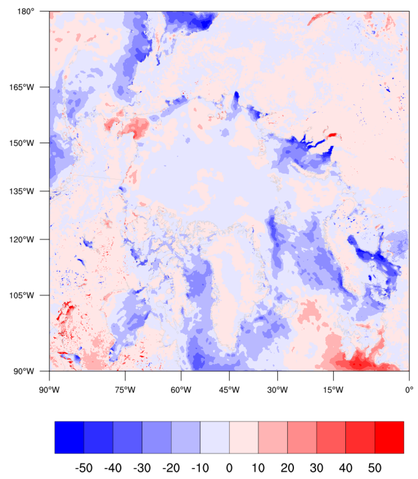
- Control: Median ice years
- Test: Cloud fraction following extreme sea ice conditions
- Years: Highest and lowest NSIDC September sea ice extent shown in Table 2

Lowest Extent	Median Extent	Highest Extent
2012	2004*	1980
2020	1995	1996
2007	2003	1992
2019	1999	1986
2023	1990	1983

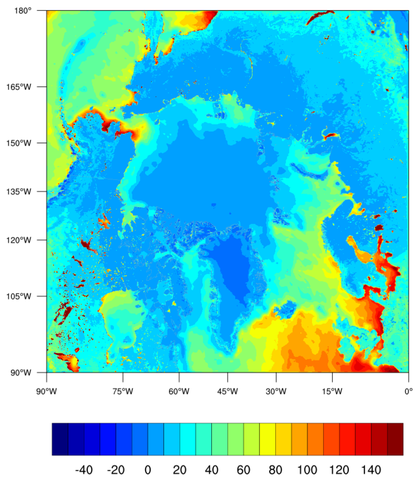
Table 2 - September Sea Ice Extent
*2004 data is not included in the median case

RESULTS

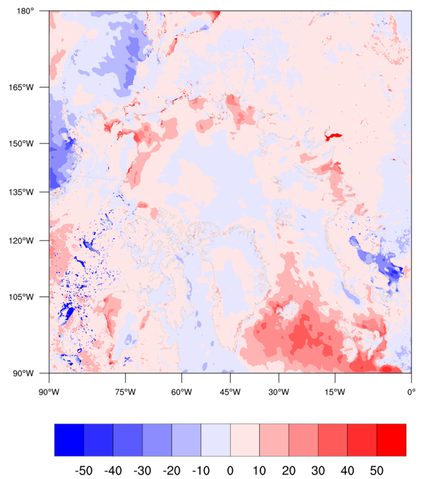
Latent Heat Median minus Low (W m^2)



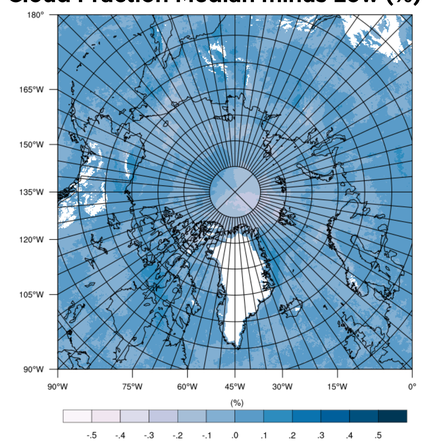
Latent Heat Median (W m^2)



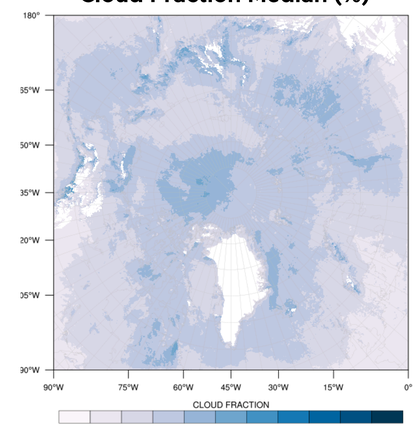
Latent Heat Median minus High (W m^2)



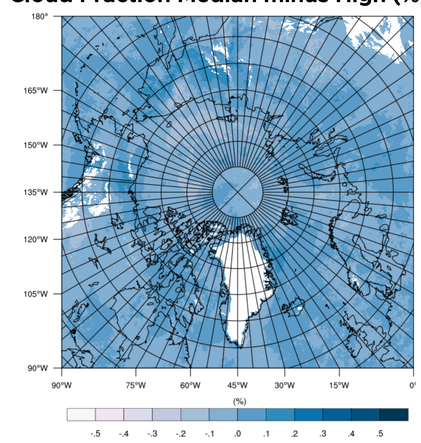
Cloud Fraction Median minus Low (%)



Cloud Fraction Median (%)



Cloud Fraction Median minus High (%)



DISCUSSION

Latent Heat over the Arctic Ocean

- When ice covers the ocean, upward latent heat fluxes are smaller as shown by the difference between Median and Low ice.
- The magnitude of the difference between the Median and High ice is smaller as both sets have ice covering the ocean surface

850 mb Cloud Fraction

- Cloud fraction simulated at 850 hPa, approximately 1.5 km above sea level.
- Cloud fraction in low ice years appear similar to cloud fraction in high ice years as the Arctic is generally cloudy in the warm season, but minute differences persist
- Key differences between the Median , Low, and High ice cases are notable north of Alaska where the ice coverage varies the most between cases.

FUTURE WORK

- Re-run 2004 due to errors in the model output that rendered it unusable.
- Run further experiments on the direct and indirect effects of cloud fraction on Arctic albedo.

ACKNOWLEDGEMENTS

We would like to acknowledge high-performance computing support from Derecho (https://doi.org/10.5065/qx9a-pg09) provided by NCAR's Computational and Information Systems Laboratory, sponsored by the National Science Foundation. We would like to thank Himani Majithia and Sujay Srinivasan for contributing to the project.