PennState College of Earth and Mineral Sciences

NSF Project: The dynamics of jets and waves in the atmosphere and Southern Ocean

PennState College of Education

Testing Arctic Sea Ice Change Mechanisms Using Satellite Observed Solar and Terrestrial Radiation

Department of Meteorology and Atmospheric Science

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Abstract

The relationships between reflected solar radiation, outgoing longwave radiation, and sea ice cover in the Arctic (75º-90ºN) are being investigated using satellite data from NASA. In the Arctic, satellite data show a significant decrease in reflected solar radiation, while reflected solar radiation and sea ice cover appear to be highly correlated in this region. However, outgoing longwave radiation has a much weaker association with sea ice cover when looking at the entire Arctic region. To see if location in the Arctic influences the relationship between outgoing longwave radiation and sea ice cover, winter (DJF) outgoing longwave radiation (OLR) was compared to seasonal sea ice cover in the Barents, Kara, and Chukchi Seas.

Data Description

Solar and terrestrial radiation data obtained from NASA's CERES (Clouds and the Earth's Radiant Energy System) instruments on the Terra, Aqua, and Suomi NPP satellites. Sea ice cover data was obtained from ECMWF's ERA-Interim climate reanalysis, which is produced by combining models and observations. Data ranges from 2000-2016.

Reflected Solar Radiation (RSR) Observations in the Arctic

Fig 1.

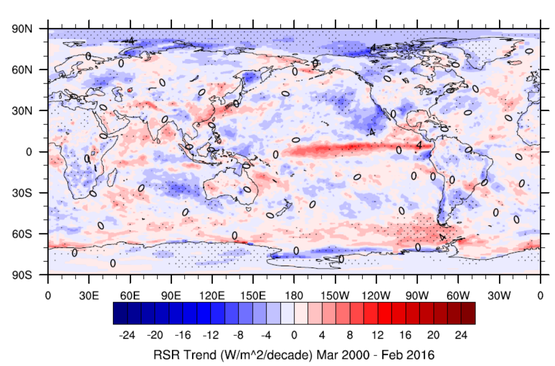


Figure 1. Linear trend of ***CERES*** annual-mean reflected solar radiation (*RSR*) computed for each 1º x 1º region of the globe (*W m^{-2} decade^{-1}*) including areas of significance.

Fig 2.

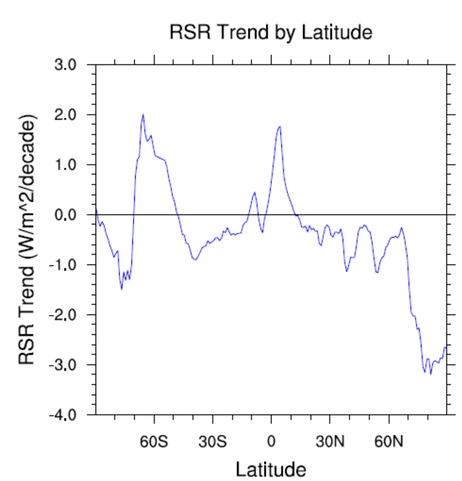


Figure 2. Trend in reflected solar radiation computed from annual mean data and plotted as a function of latitude. The line shows the linear trend difference over the period 2000–2016 for the zonal- and annual-mean reflected solar radiation.

RSR vs. Sea Ice Cover in the Arctic

Fig 4.

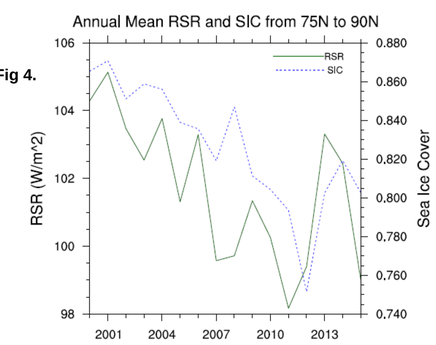
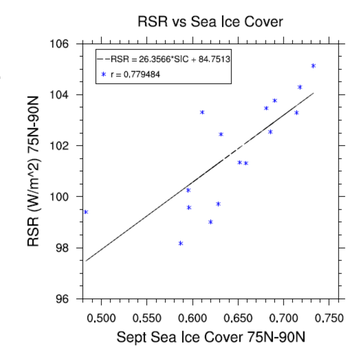


Figure 4. Annual-mean ***CERES*** reflected solar radiation (***solid line***) area averaged from 75º to 90ºN for each (*March–February average*) vs. the annual sea ice cover (*proportion of area covered by sea ice*) in the same year (***dotted line***).

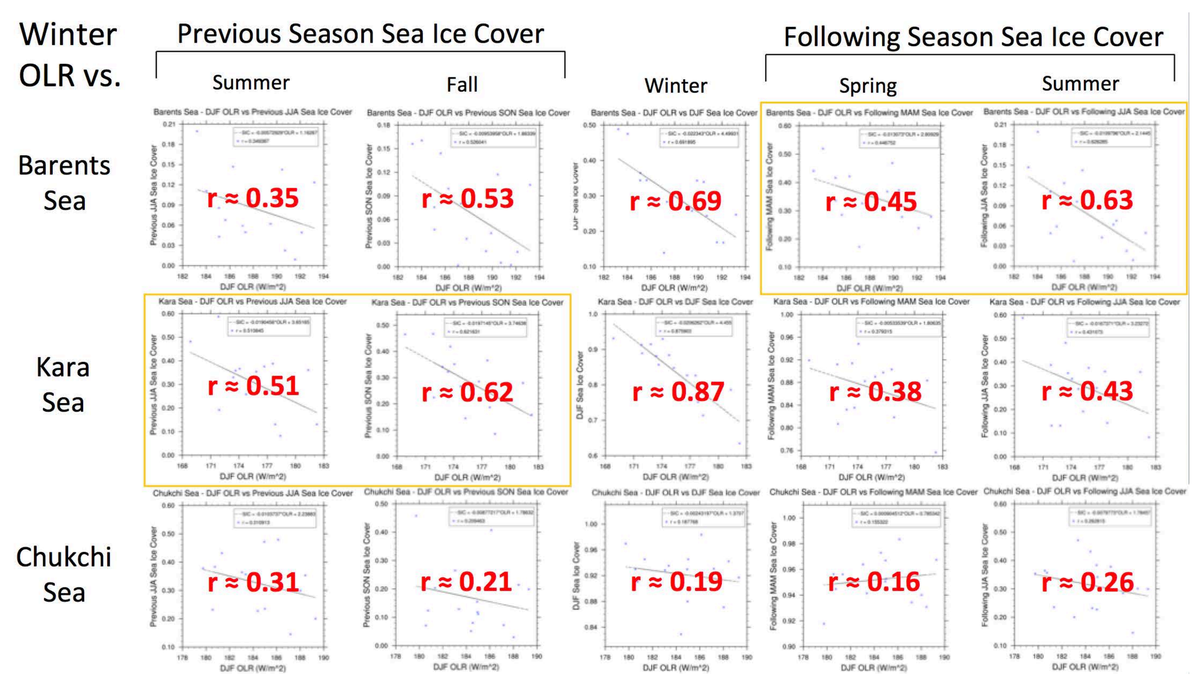
Figure 5. Scatterplot of annual-mean ***CERES*** reflected solar radiation averaged from 75º to 90ºN vs arctic sea ice cover in September for 2000-2015. Corresponding correlation coefficient (r) is indicated.

Fig 5.



Winter OLR vs. Sea Ice Cover in the Barents, Kara, and Chukchi Seas

Fig 6.



Conclusion

Depending on the region of the Arctic being observed, winter OLR may be a good predictor of summer sea ice cover (Barents Sea), summer sea ice cover may be a good predictor of winter OLR (Kara Sea), or little correlation between winter OLR and summer sea ice cover may be present (Chukchi Sea).

Acknowledgments

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References

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