

Cloudy with a chance of sensitivity

Exploring total cloud cover
in Arctic and Antarctica

PolaRES-PISCO Hackathon 2025

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[Available code](#)

Objective

evaluate RCMs
using satellite
products

explore how they
respond to
warmer
conditions

Satellite Data

Cloud CCI

Cloud component of ESA's Climate Change Initiative

- 50 km Δx
- It uses multiple sensors (AVHRR, AATSR, MODIS, SLSTR, SEVIRI etc)
- Cloud CCI (1982-2016) includes cloud fraction, cloud top height/pressure/temperature, cloud phase, optical thickness, effective radius and water content

CLARA-A3

Cloud, Albedo and surface Radiation

- 25 km Δx
- The input sensor family is AVHRR (Advanced Very High Resolution Radiometer) on polar orbiting satellites
- CLARA-A3 (1979-2020) includes cloud fraction, surface albedo and surface radiation terms

Data

Arctic

- ICON:
 - ERA5
 - CNRM, NorESM Storylines
- RACMO:
 - ERA5
 - CNRM, NorESM Storylines
- HCLIM:
 - ERA5
- WRF:
 - ERA5

Antarctica

- HCLIM:
 - ERA5
 - CESM
 - MPI
- RACMO:
 - ERA5
 - CESM
 - MPi

Variable: total cloud fraction (%)

Arctic Regional Domains

150°W

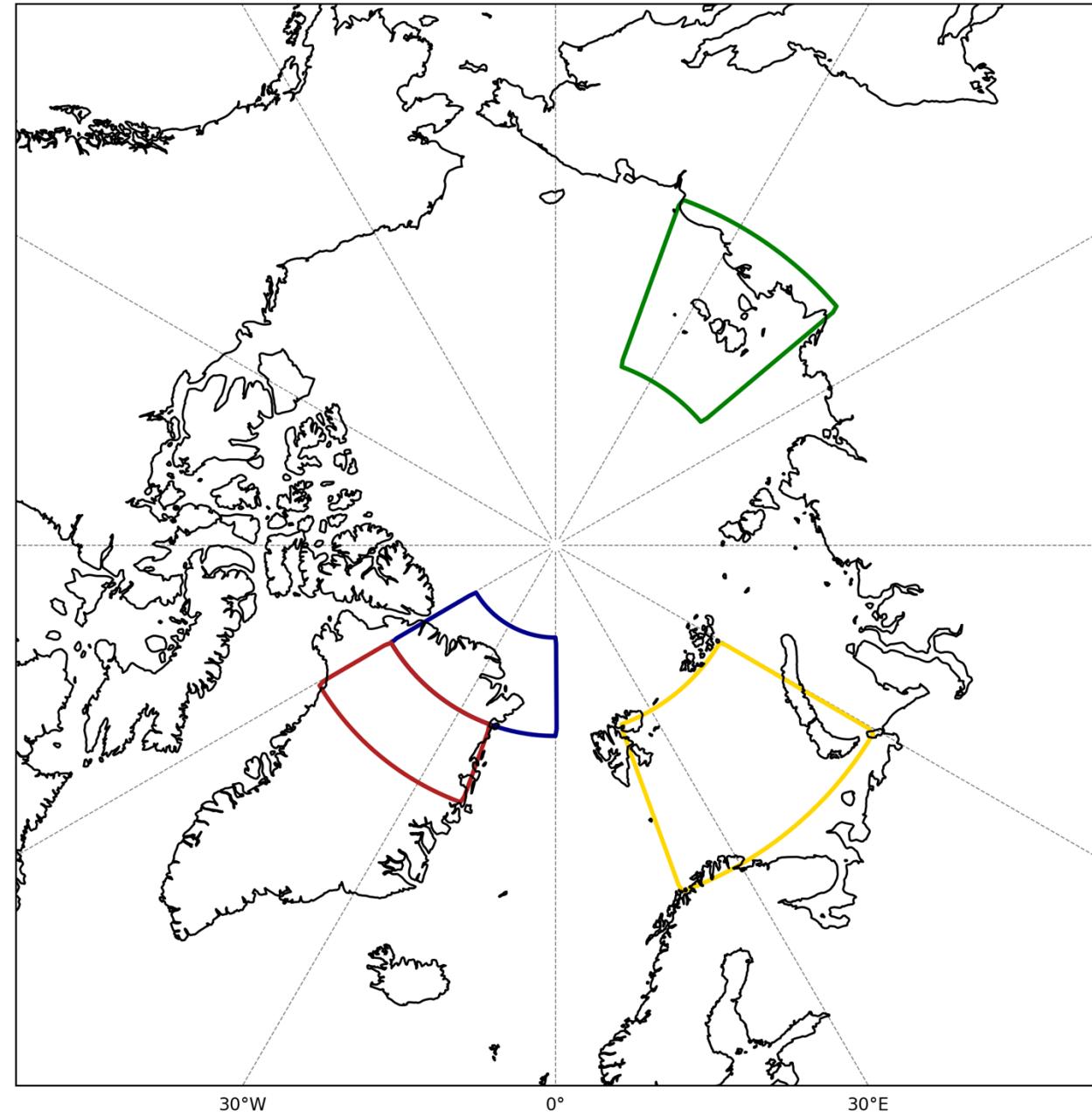
180°

150°E

30°W

0°

30°E



Antarctic Regional Domains

30°W

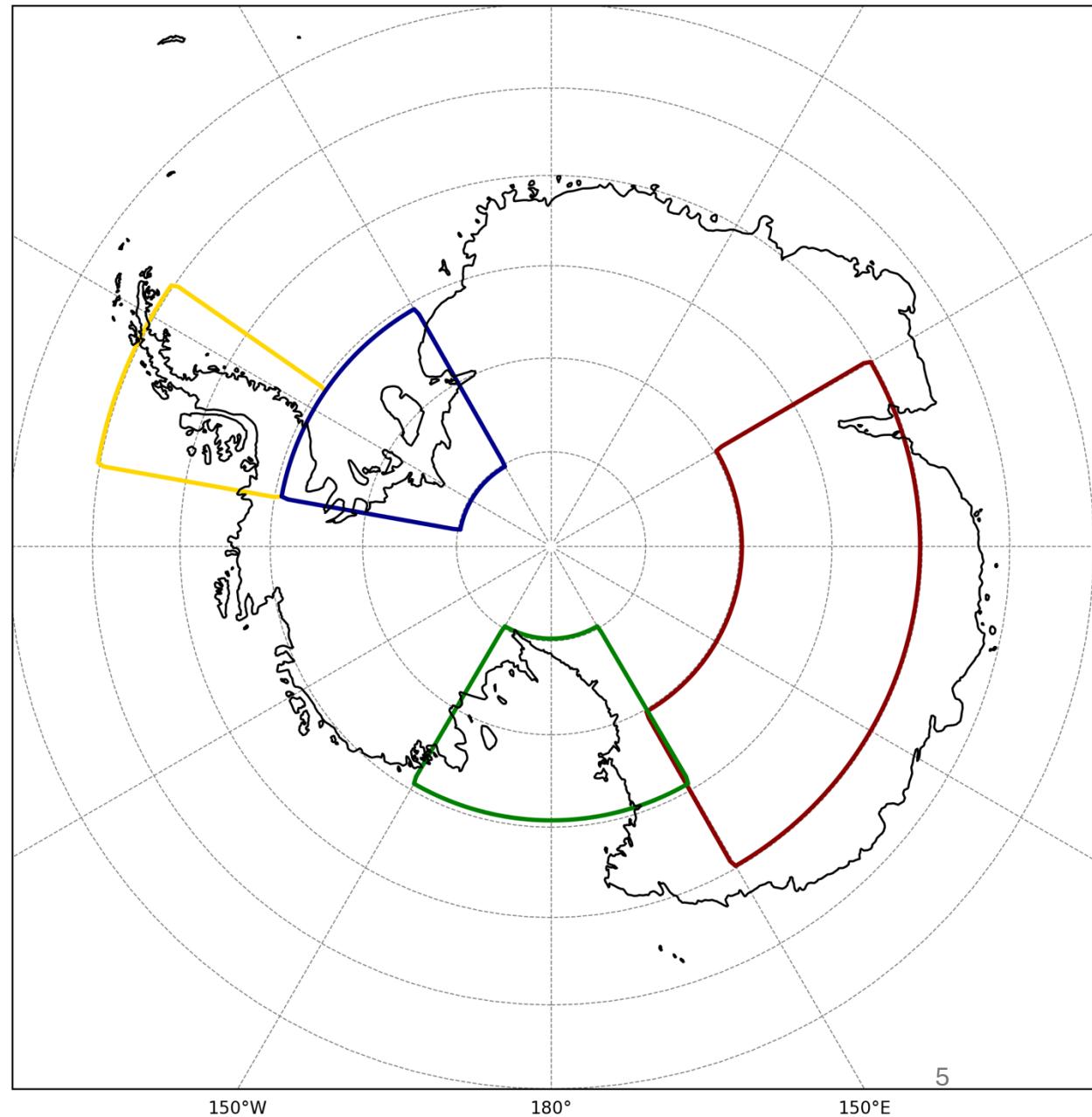
0°

30°E

150°W

180°

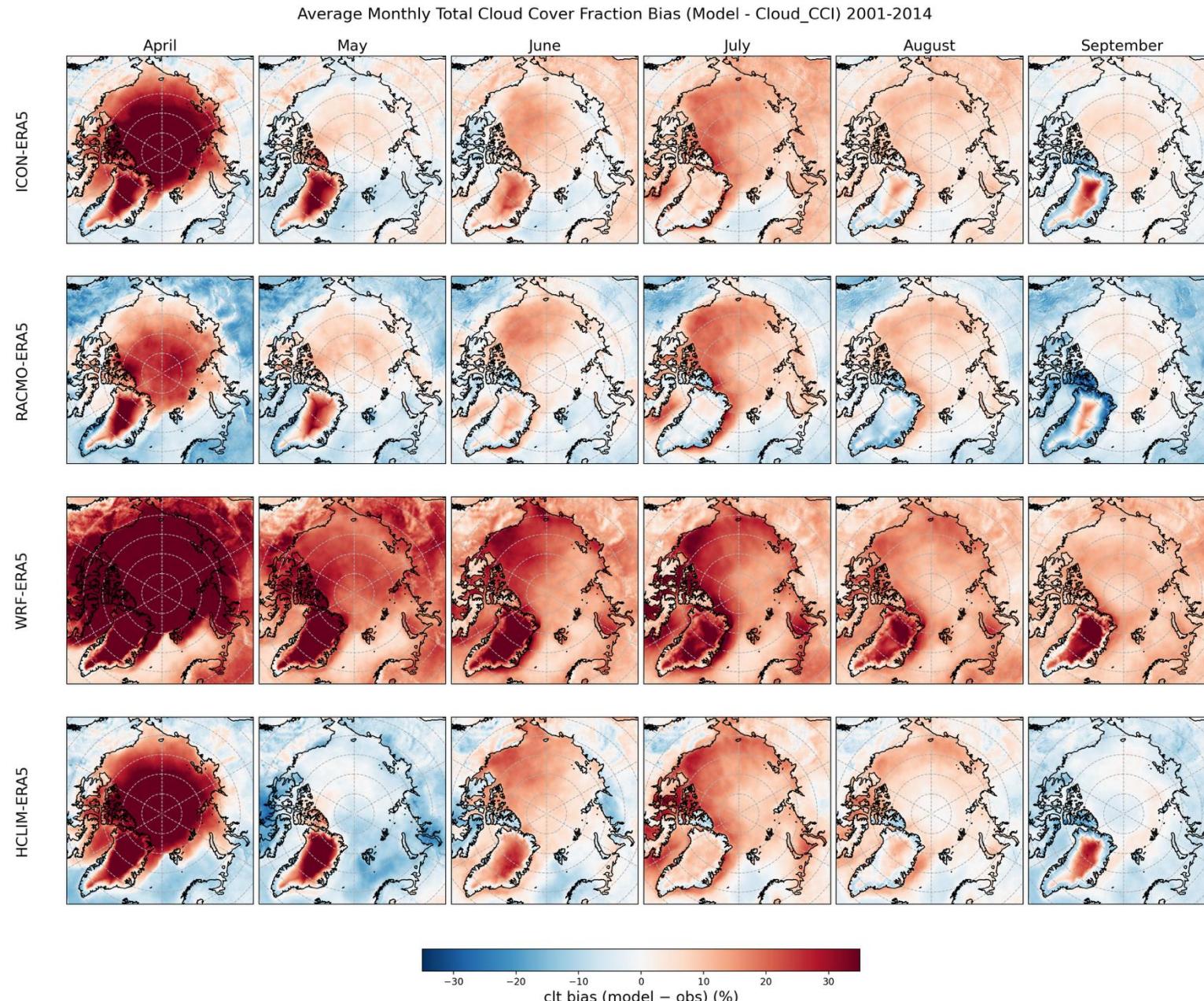
150°E



Arctic

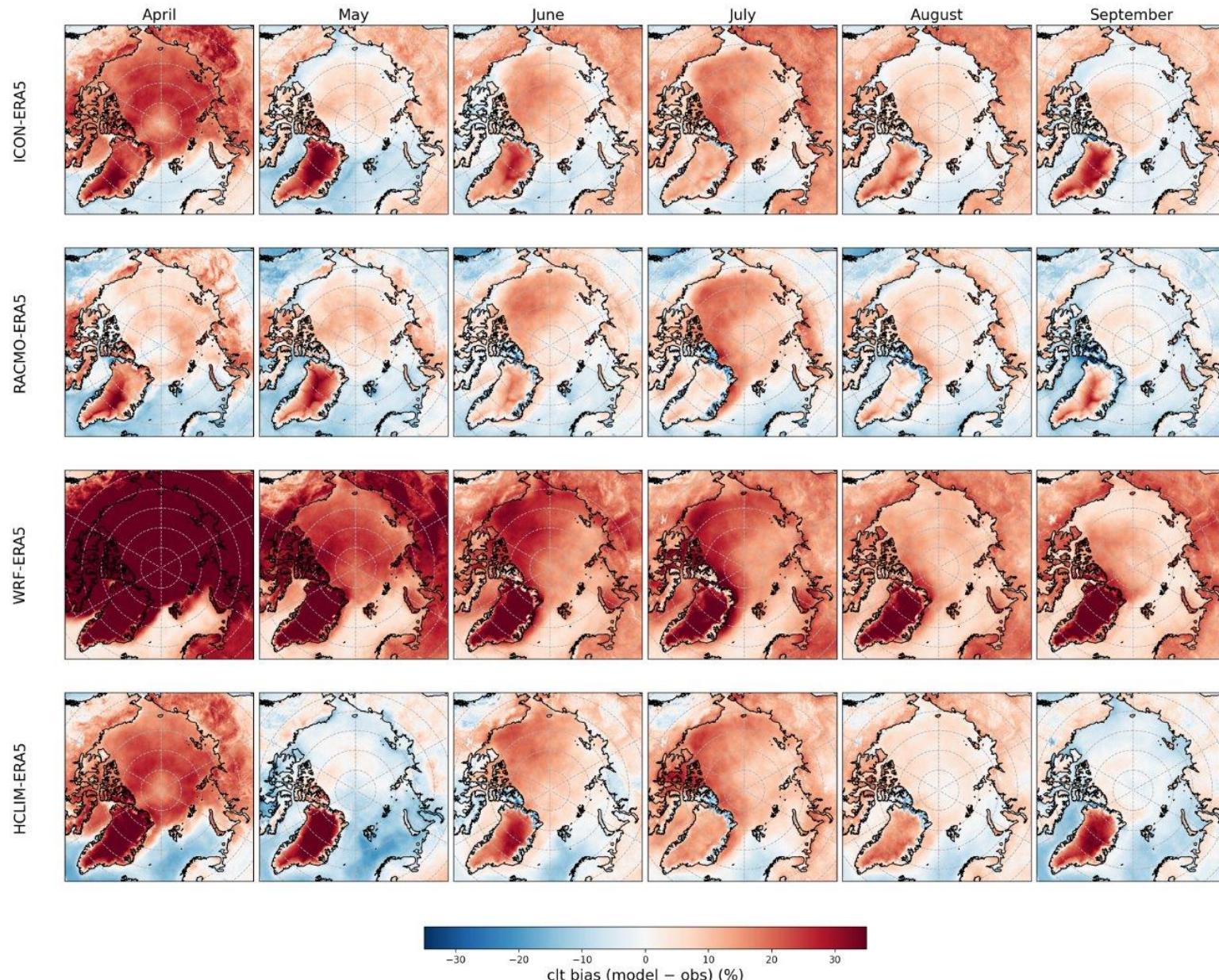


Total cloud cover comparison: RCM comparison to CloudCCI



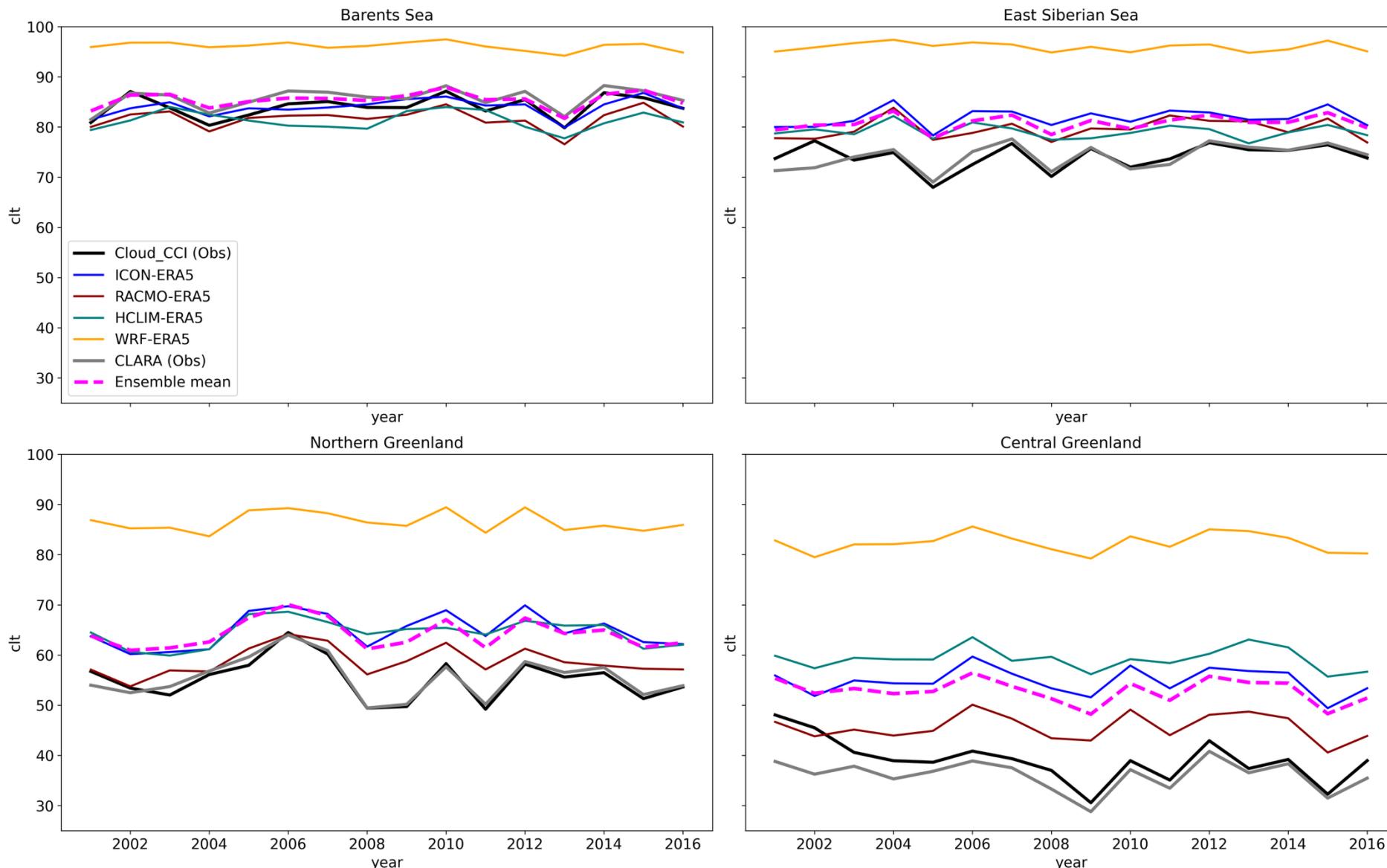
Total cloud cover comparison: RCM comparison to CLARA

Average Monthly Total Cloud Cover Fraction Bias (Model - CLARA) 2001-2014



Time series: total cloud cover (%)

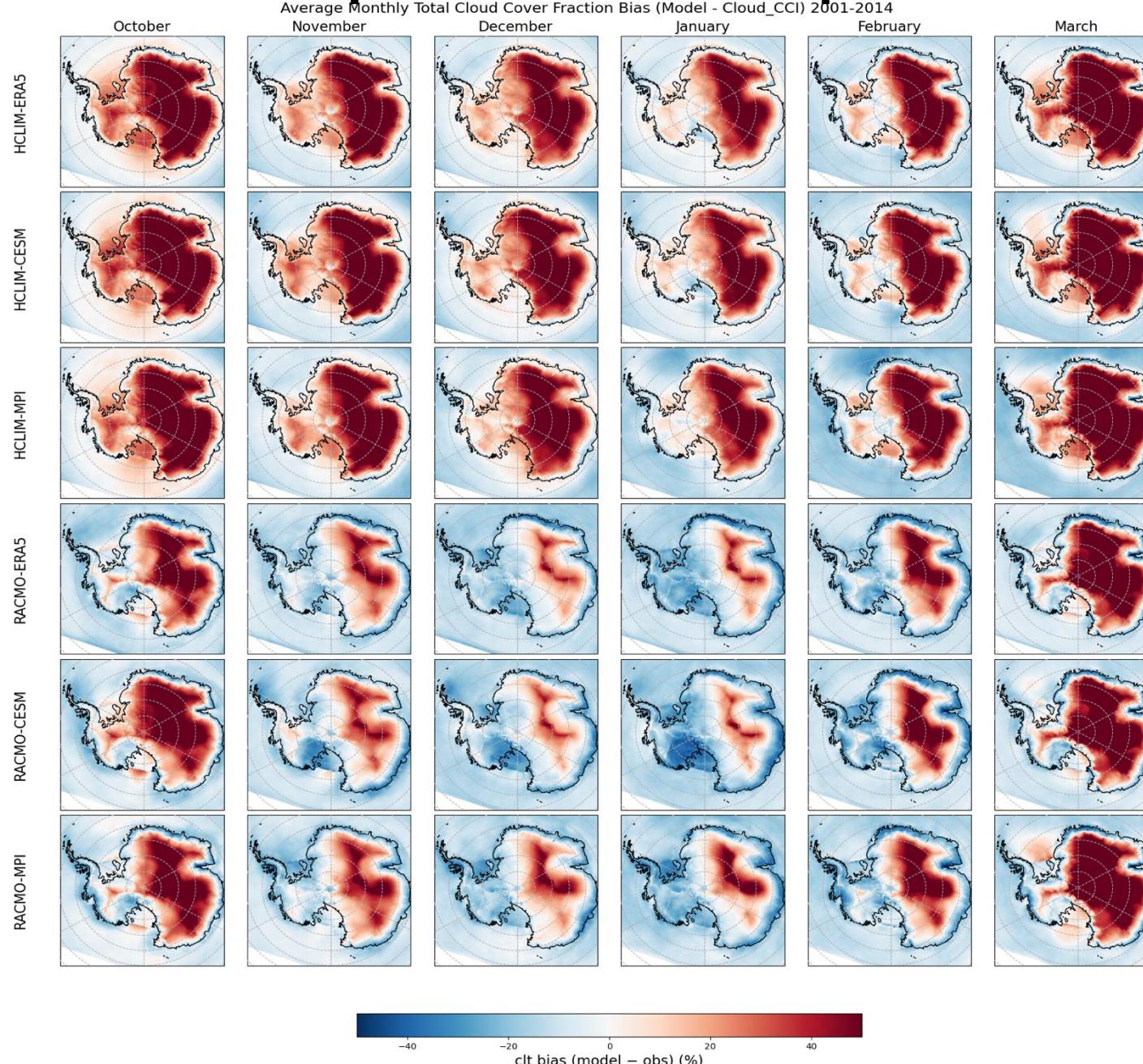
Timeseries Total Cloud Fraction (%) 2001-2016 Polar Day



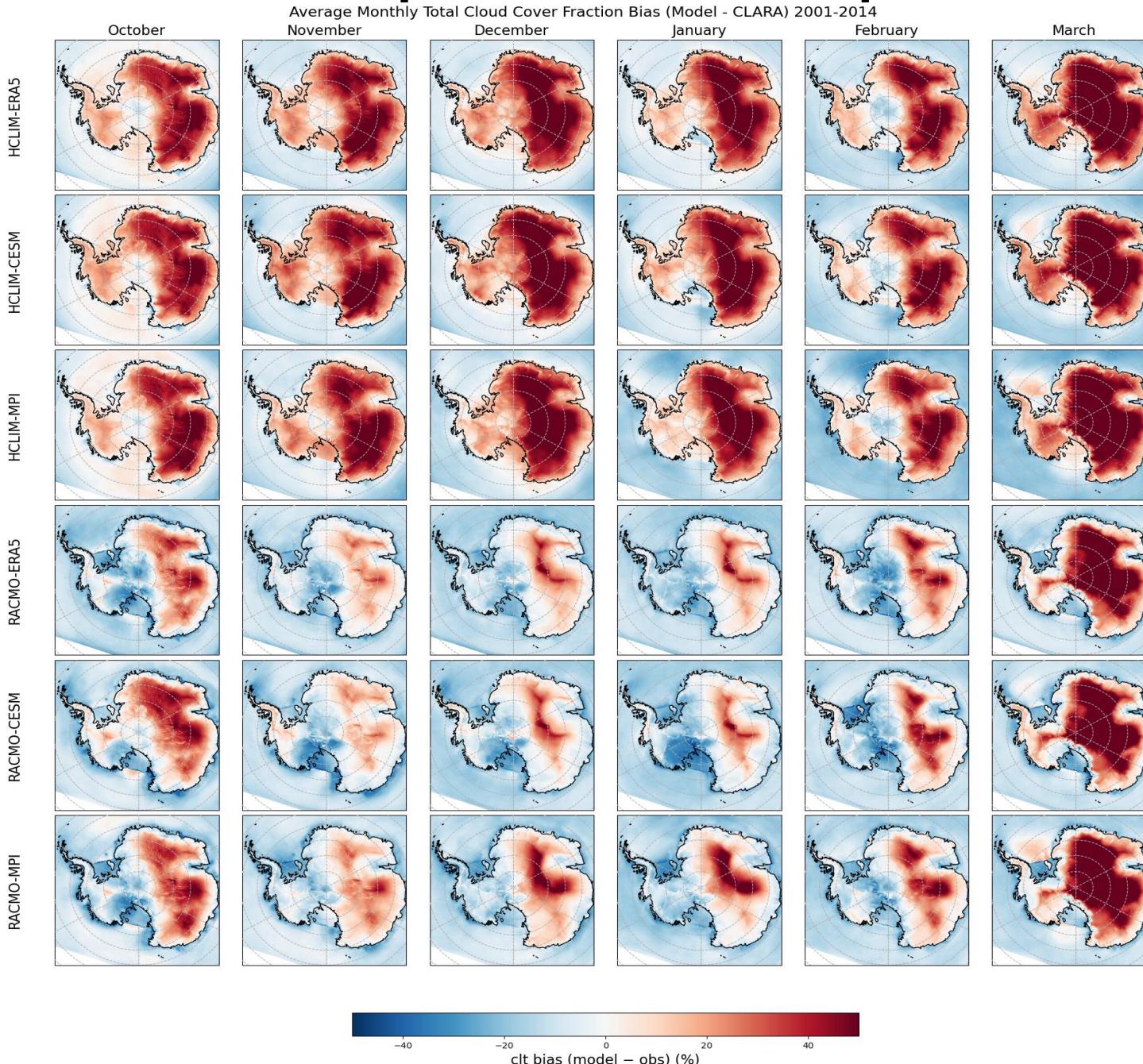
Antarctica



Total cloud cover comparison: RCM comparison to CloudCCI

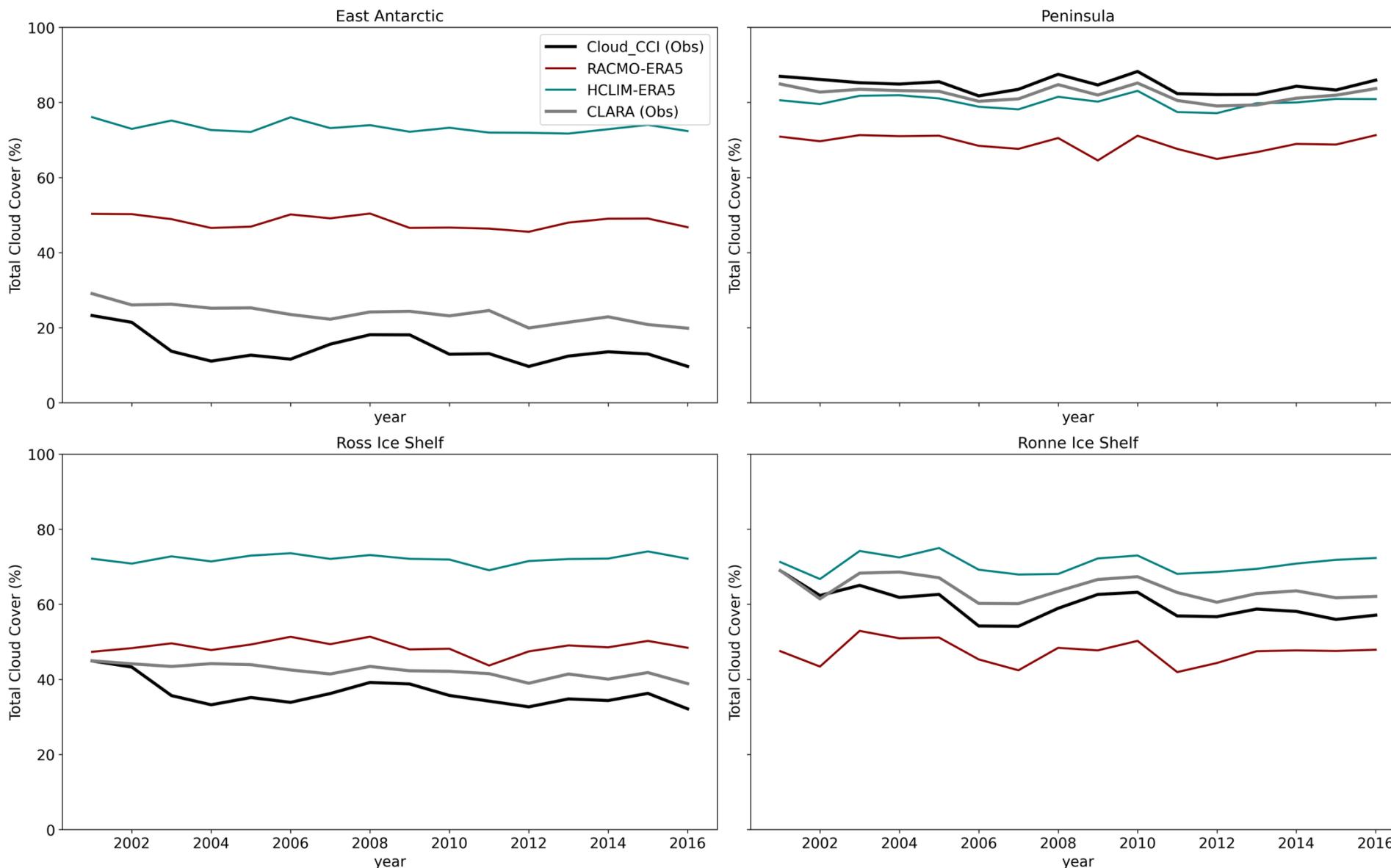


Total cloud cover comparison: RCM comparison to CLARA



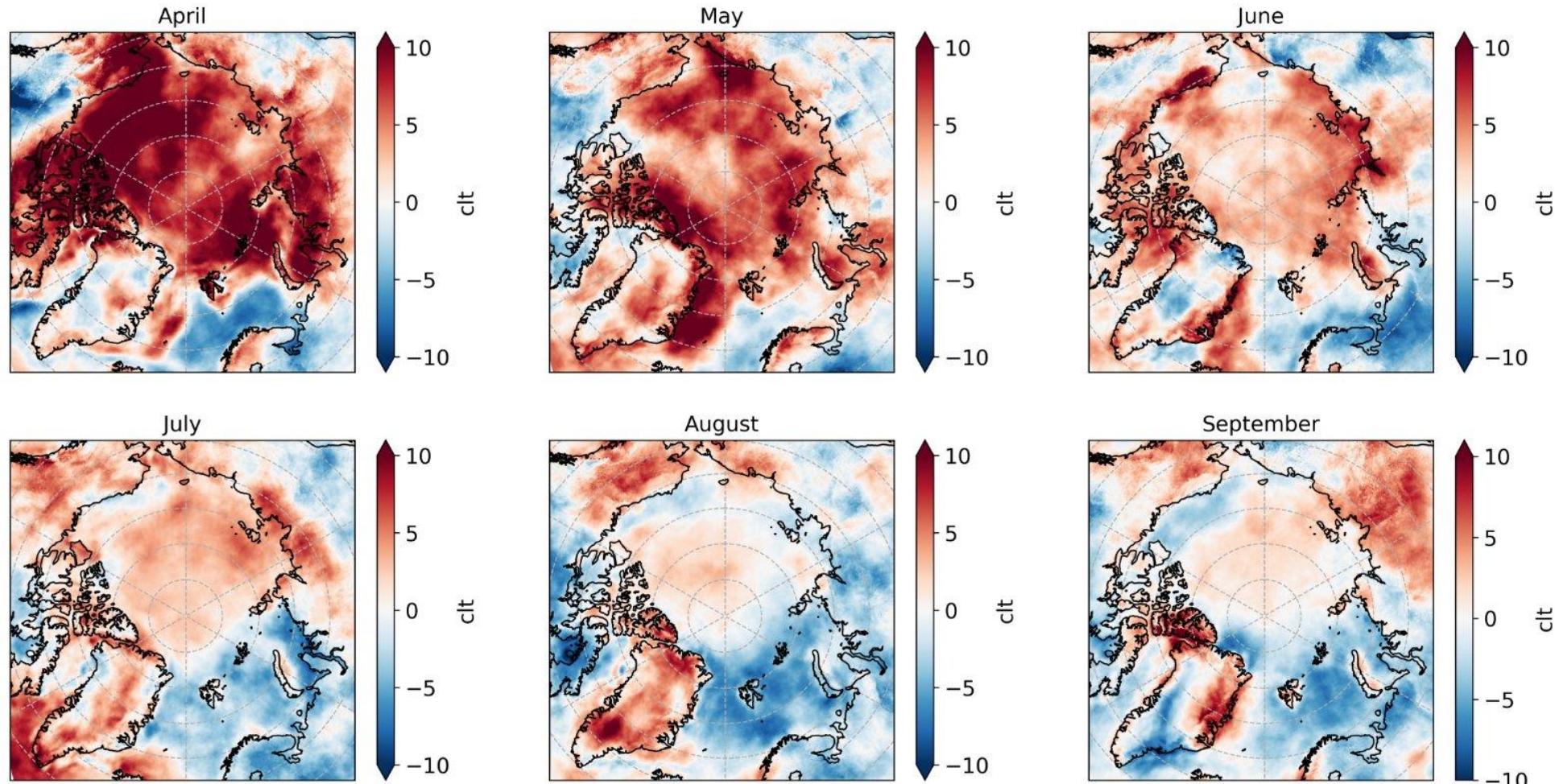
Time series: total cloud cover (%)

Timeseries Total Cloud Fraction (%) 2001-2016 Polar Day



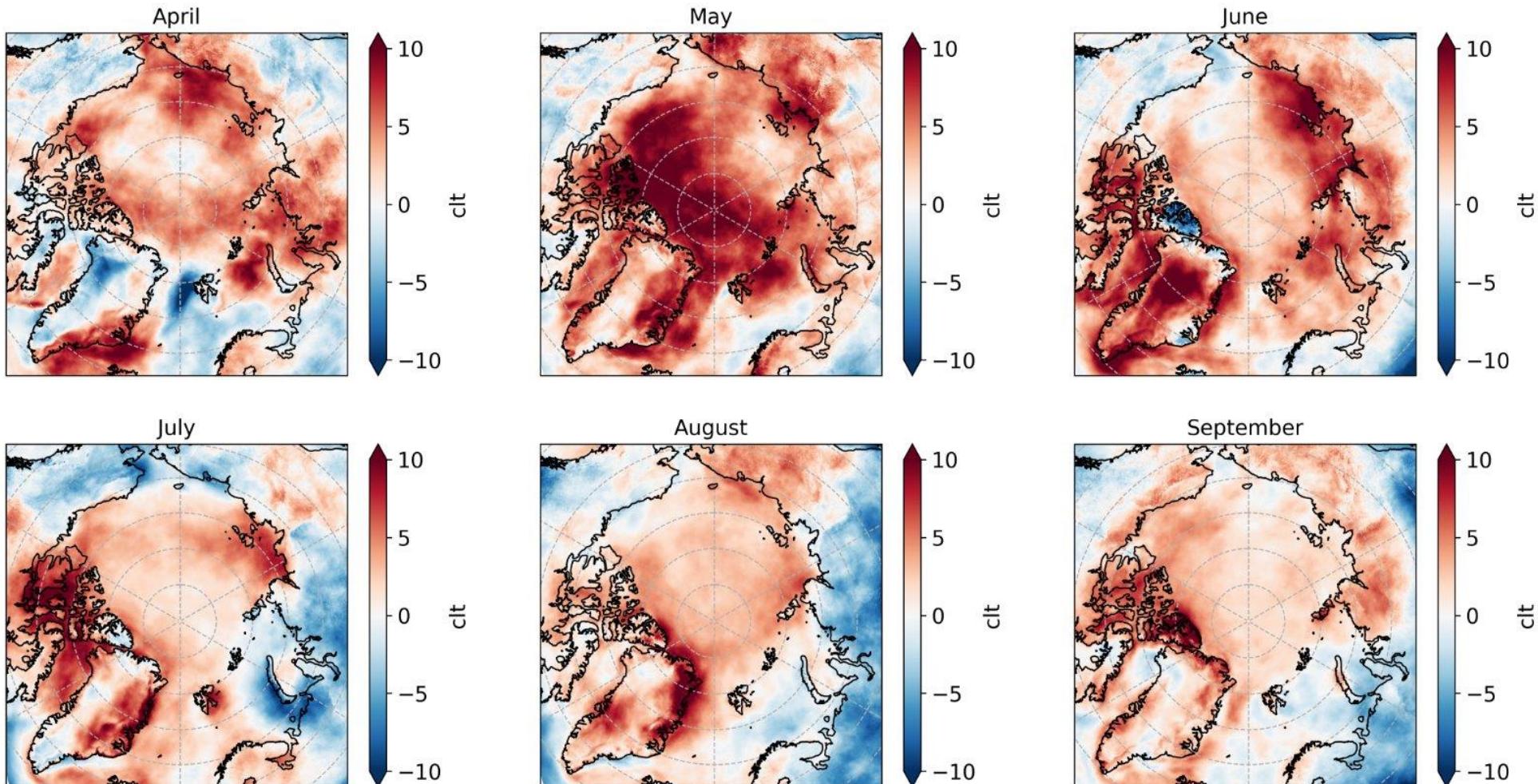
Projections

Total Cloud Cover (%) ICON-CNRM Late Century - Historical (2083-2099) - (1999-2014)



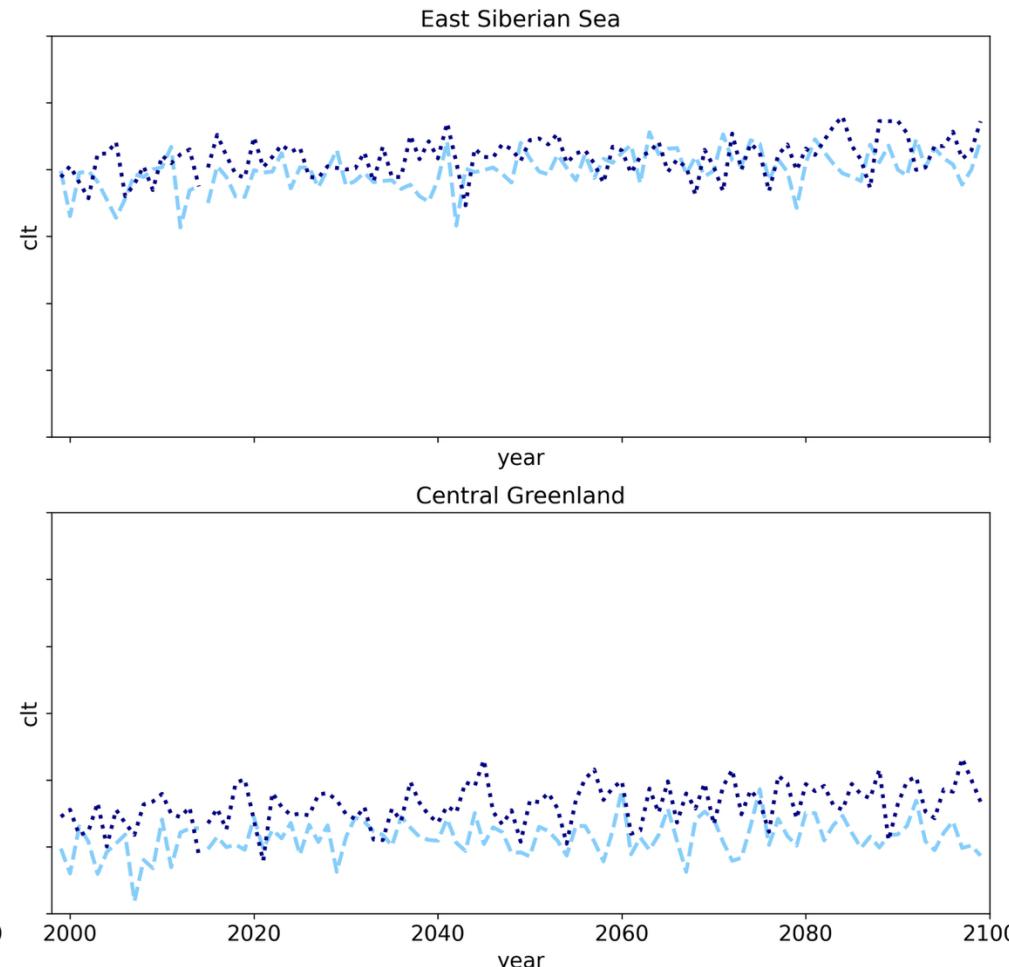
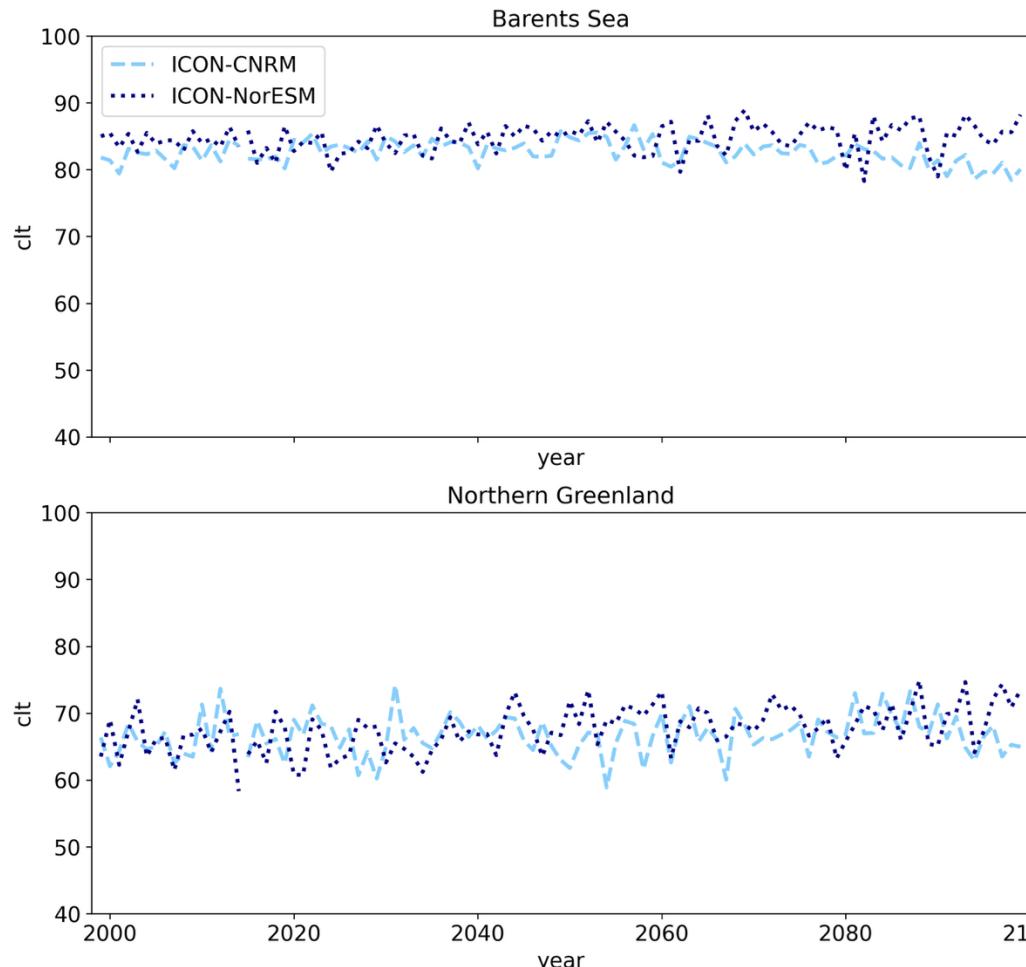
Projections

Total Cloud Cover (%) ICON-NorESM Late Century - Historical (2083-2099) - (1999-2014)



Projections

Timeseries Total Cloud Fraction (%) 1999-2099 Polar Day



Key messages



RCMs generally overestimate cloud cover in Arctic and Antarctica

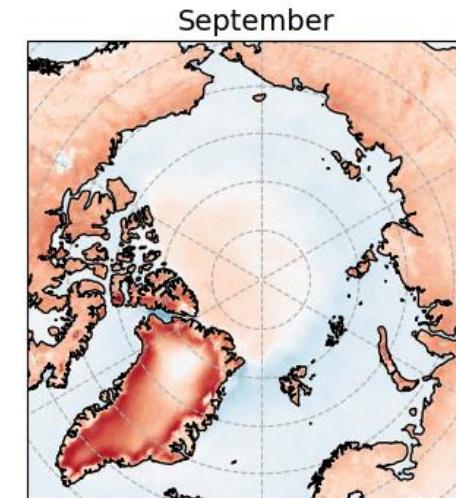
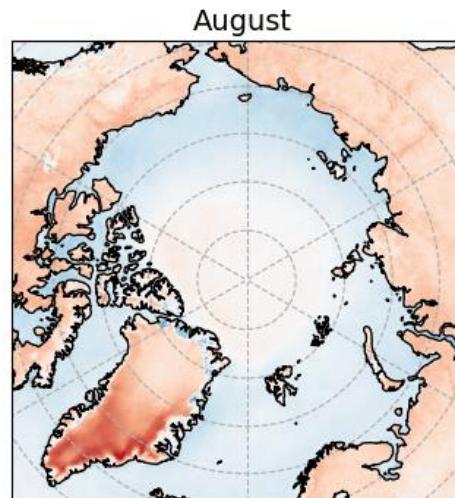
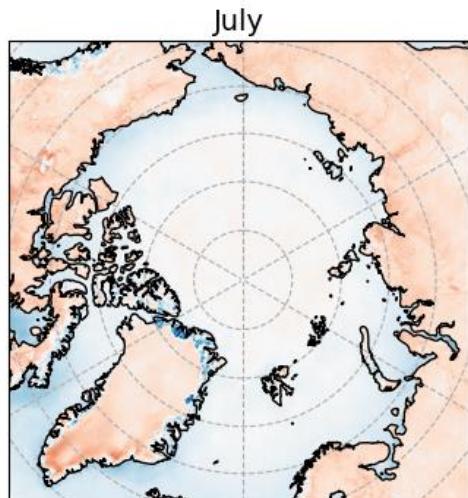
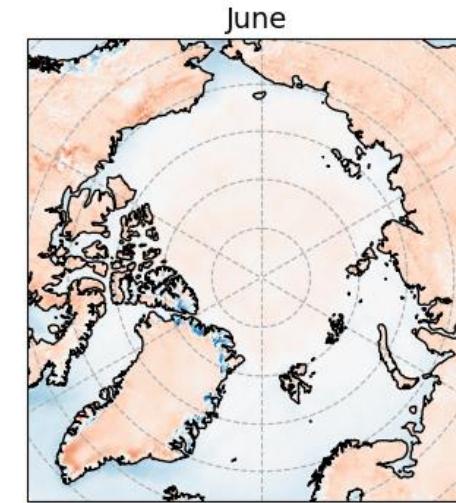
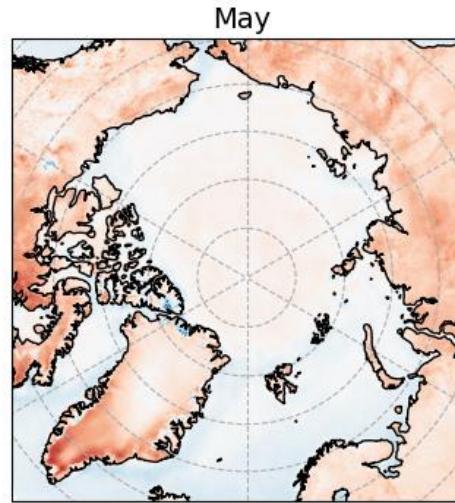
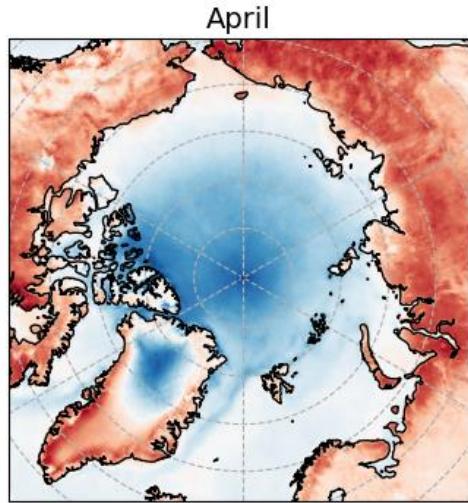
RACMO performs better in the Arctic and Antarctica

Next steps

- Include MAR model in the ensemble for both domains
- Add Liquid Water Path (LWP) and Ice Water Path (IWP) to the analysis
- Analyse projected future changes in these variables
- Integrate surface observations to evaluate the models

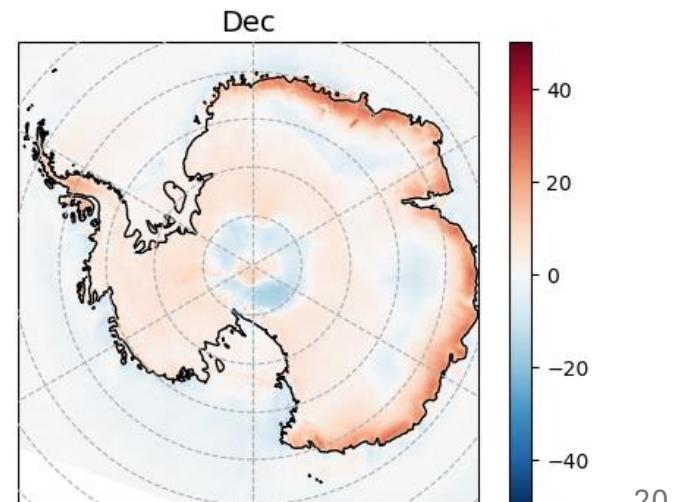
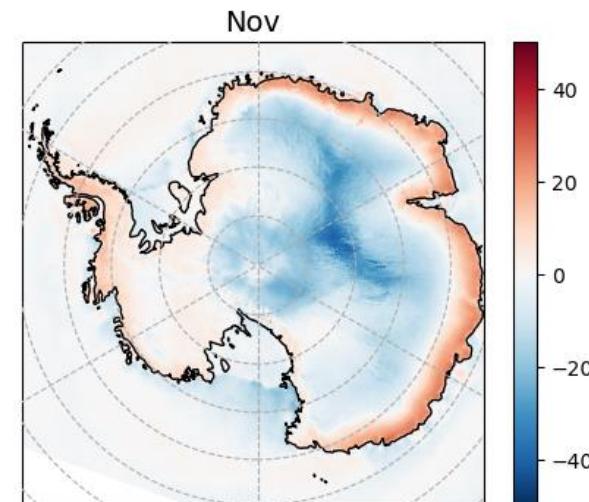
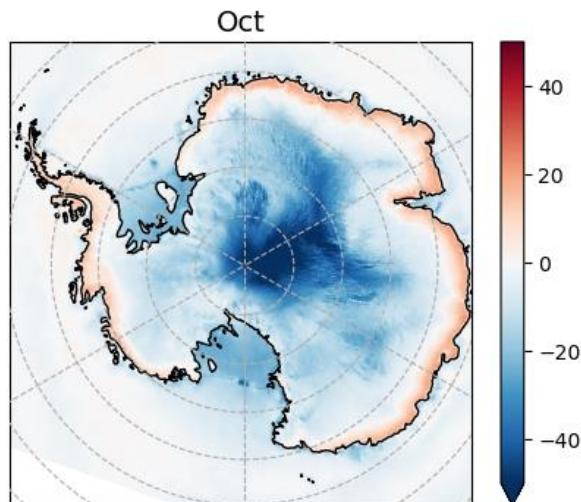
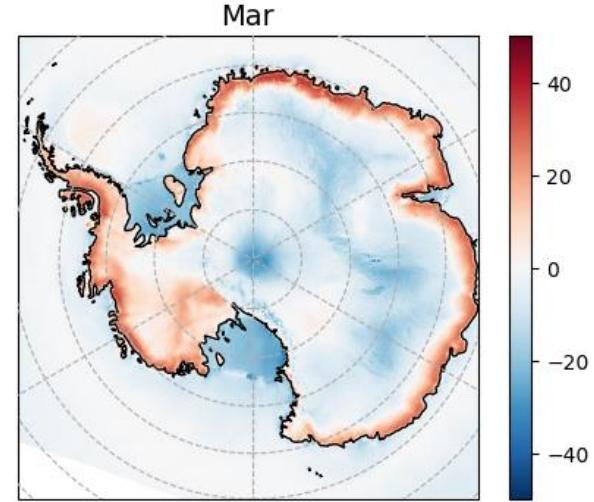
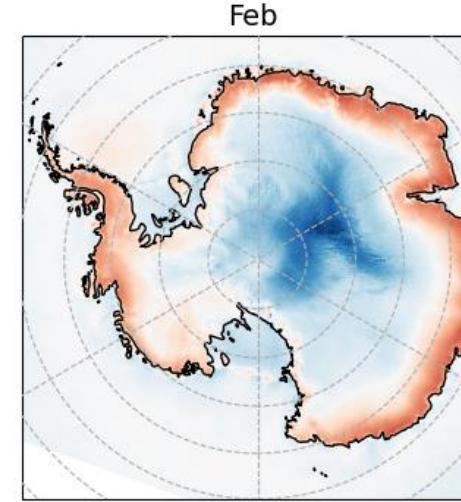
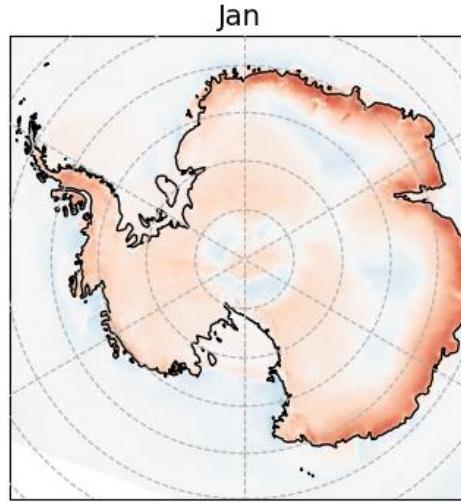
Satellite Differences - Arctic

Averaged Monthly Total Cloud Fraction Difference (CloudCCI-Clara) (%) 2001-2016

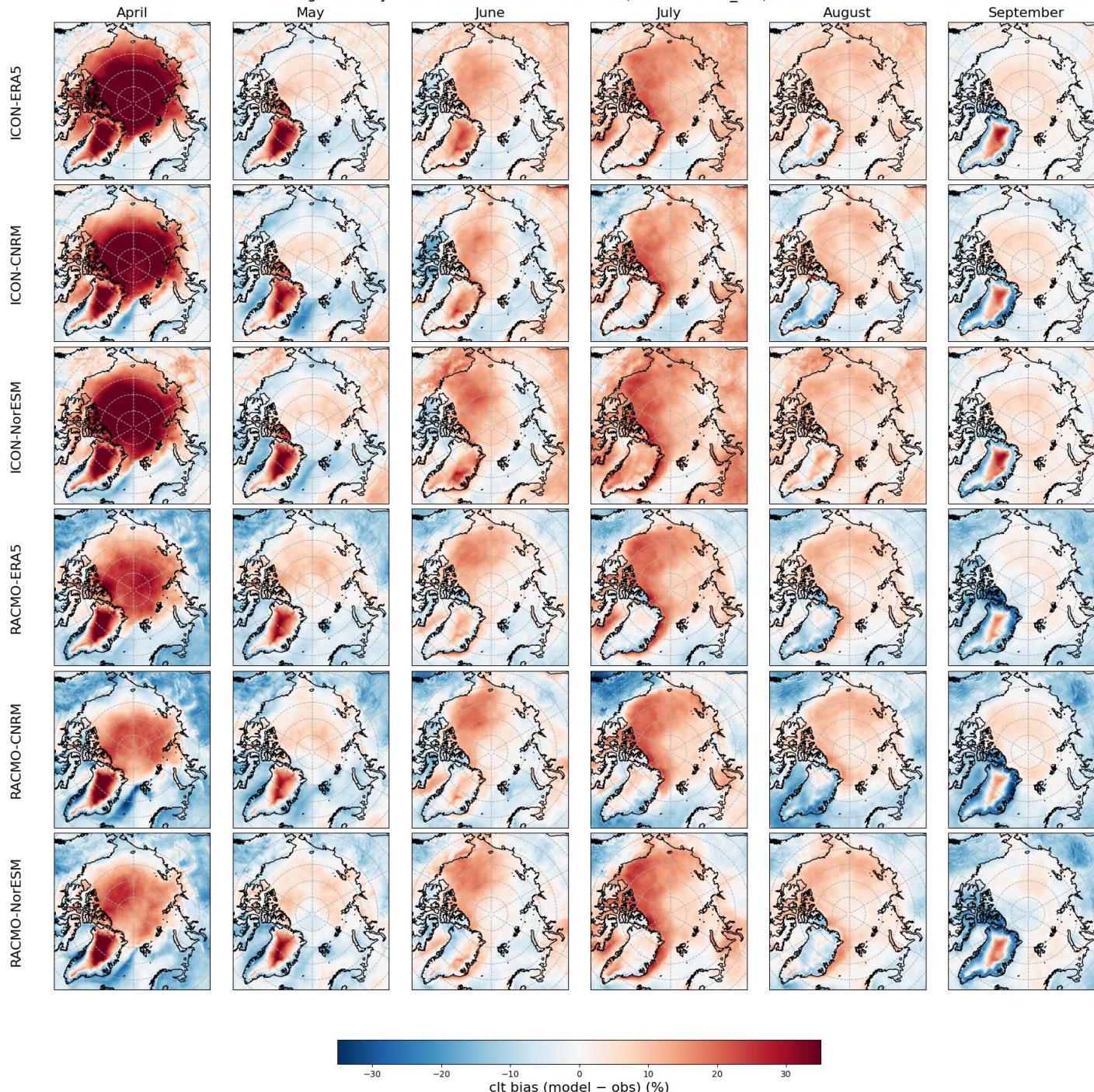


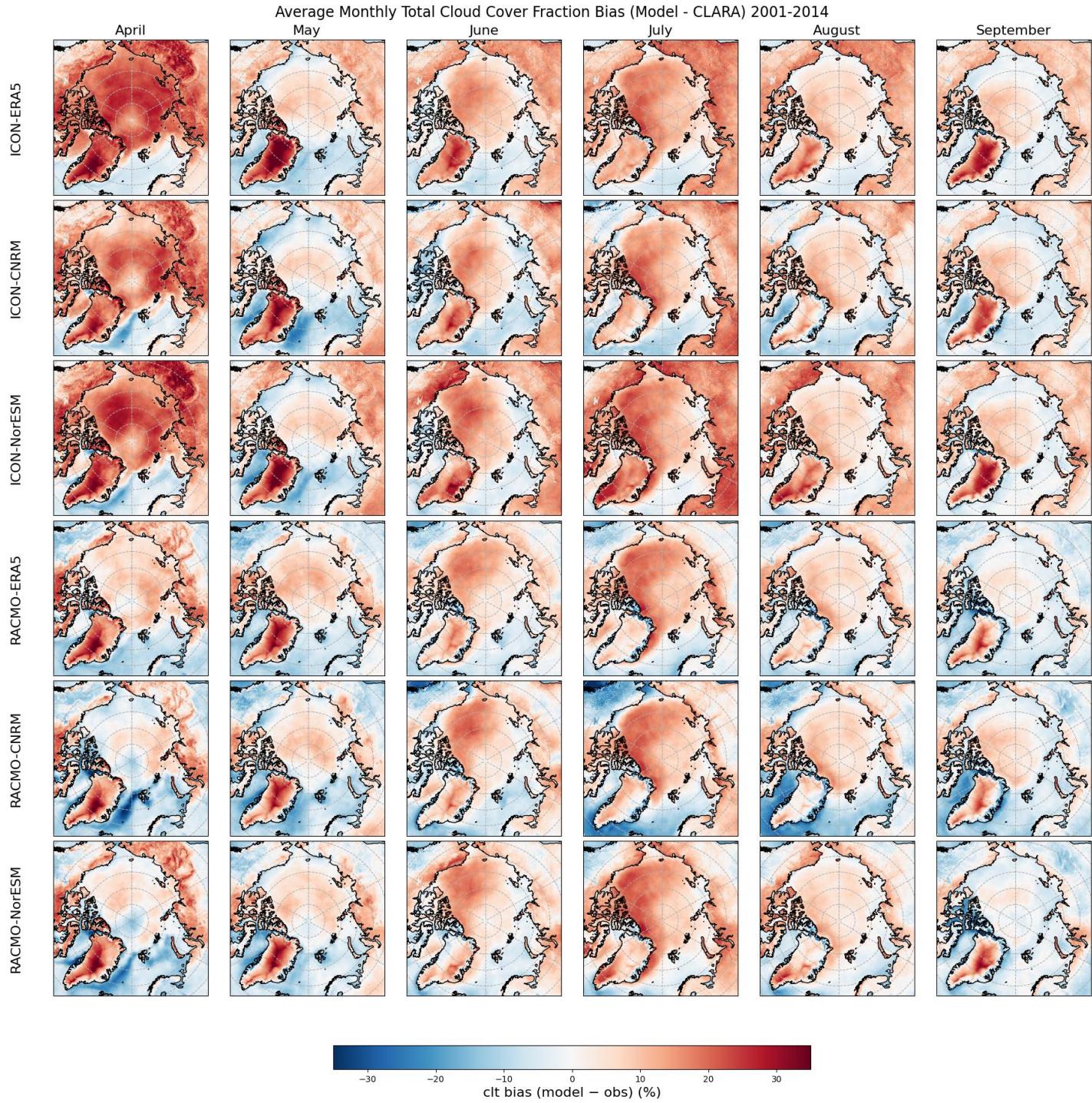
Satellite Differences – Antarctica

Averaged Monthly Total Cloud Fraction Difference (CloudCCI-CLARA) (%) 2001-2016



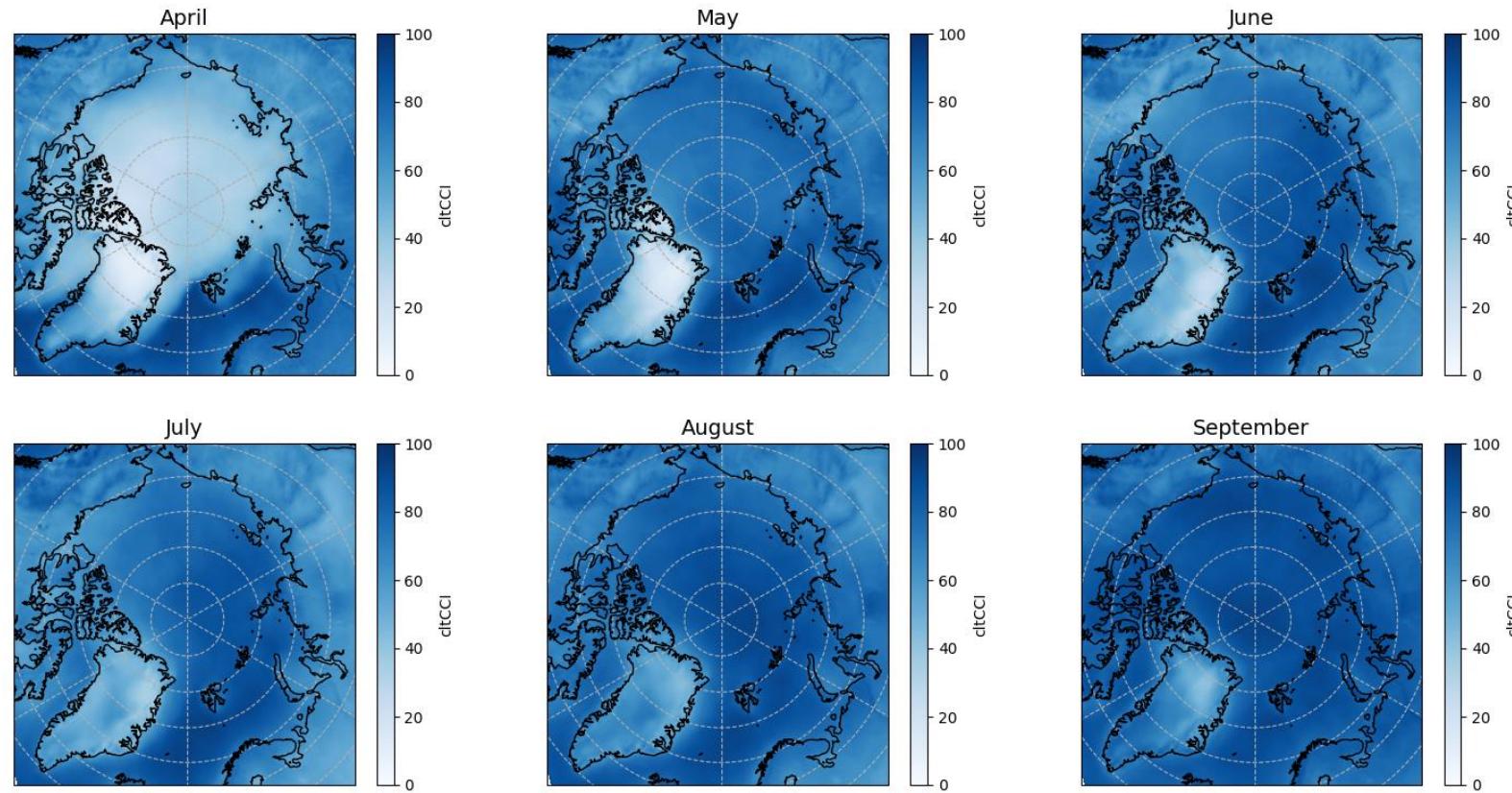
Average Monthly Total Cloud Cover Fraction Bias (Model - Cloud_CCI) 2001-2014





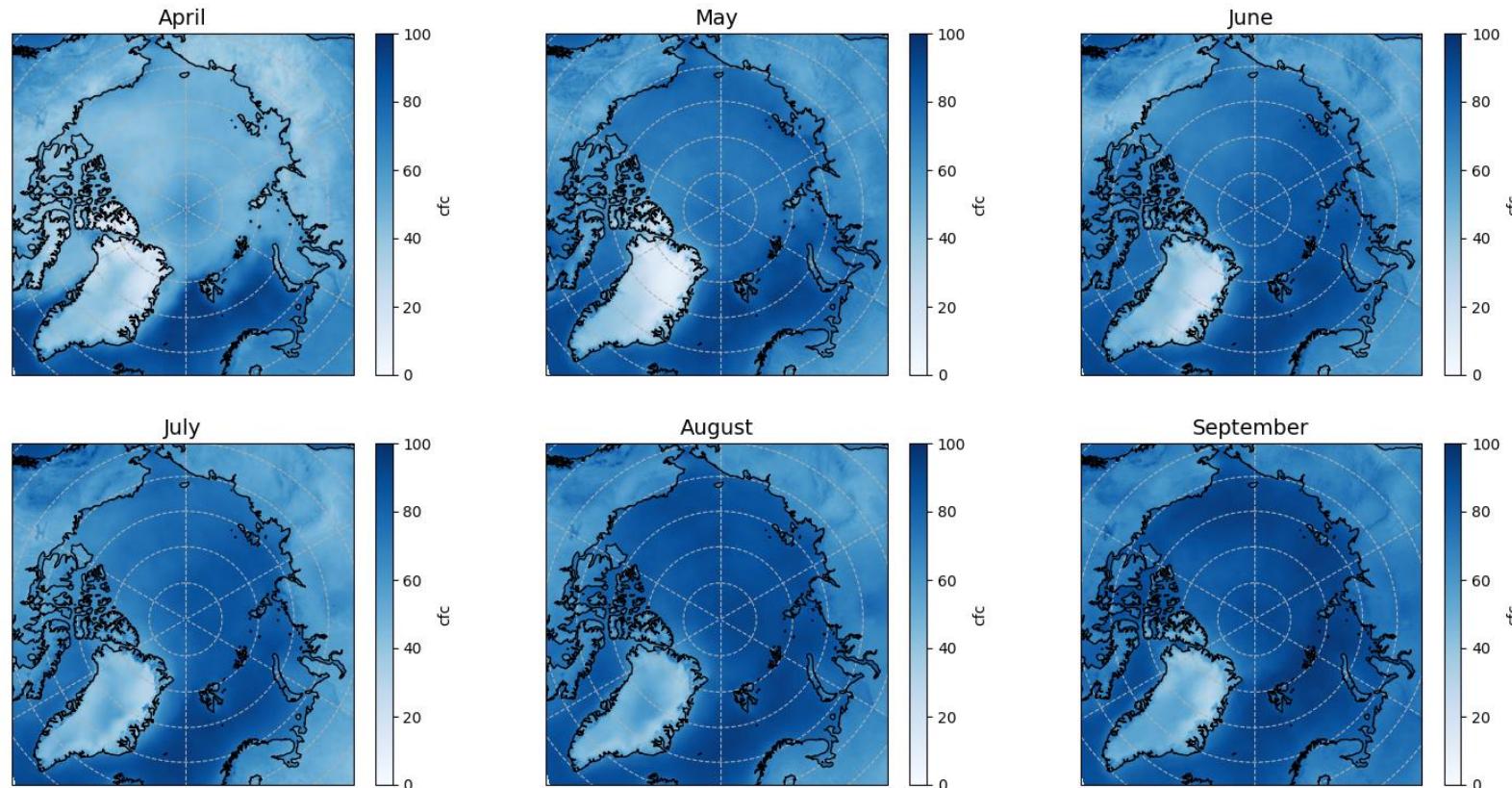
Arctic Cloud_CCI Data

Averaged Monthly Total Cloud Fraction (%) 2001-2016 Cloud_CCI

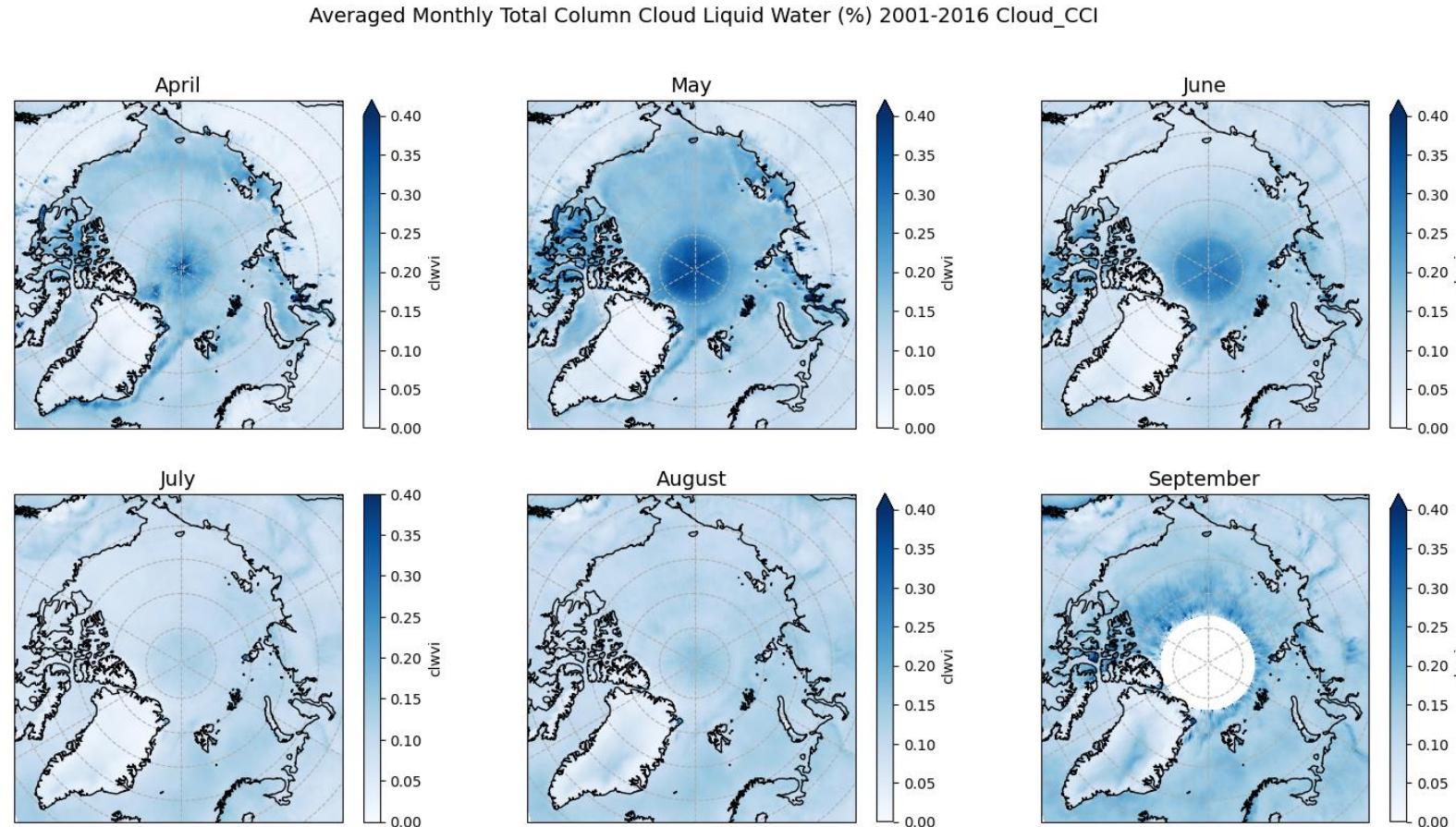


Arctic Cloud_CCI Data

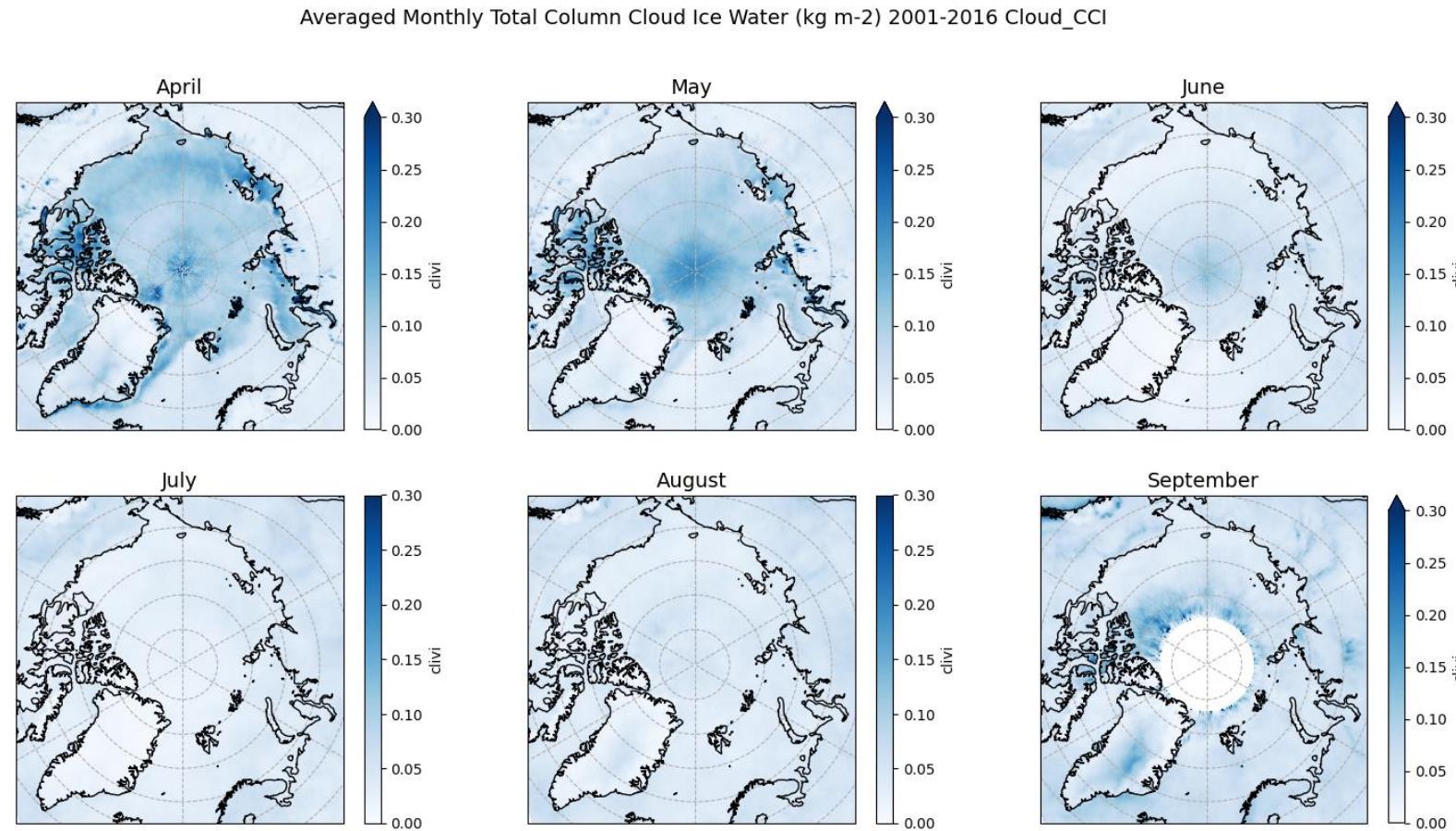
Averaged Monthly Total Cloud Fraction (%) 2001-2016 CLARA



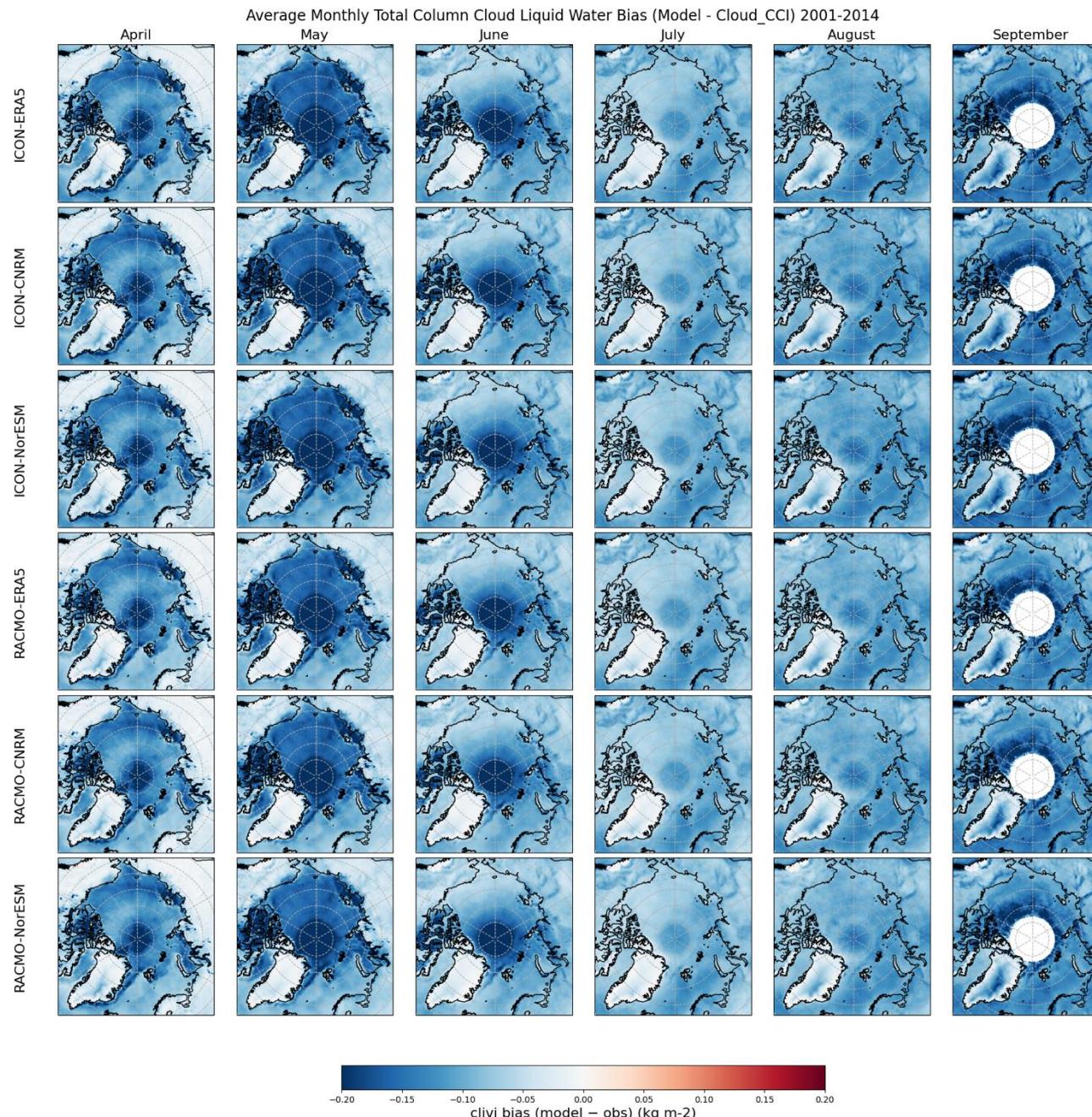
Arctic Cloud_CCI Data



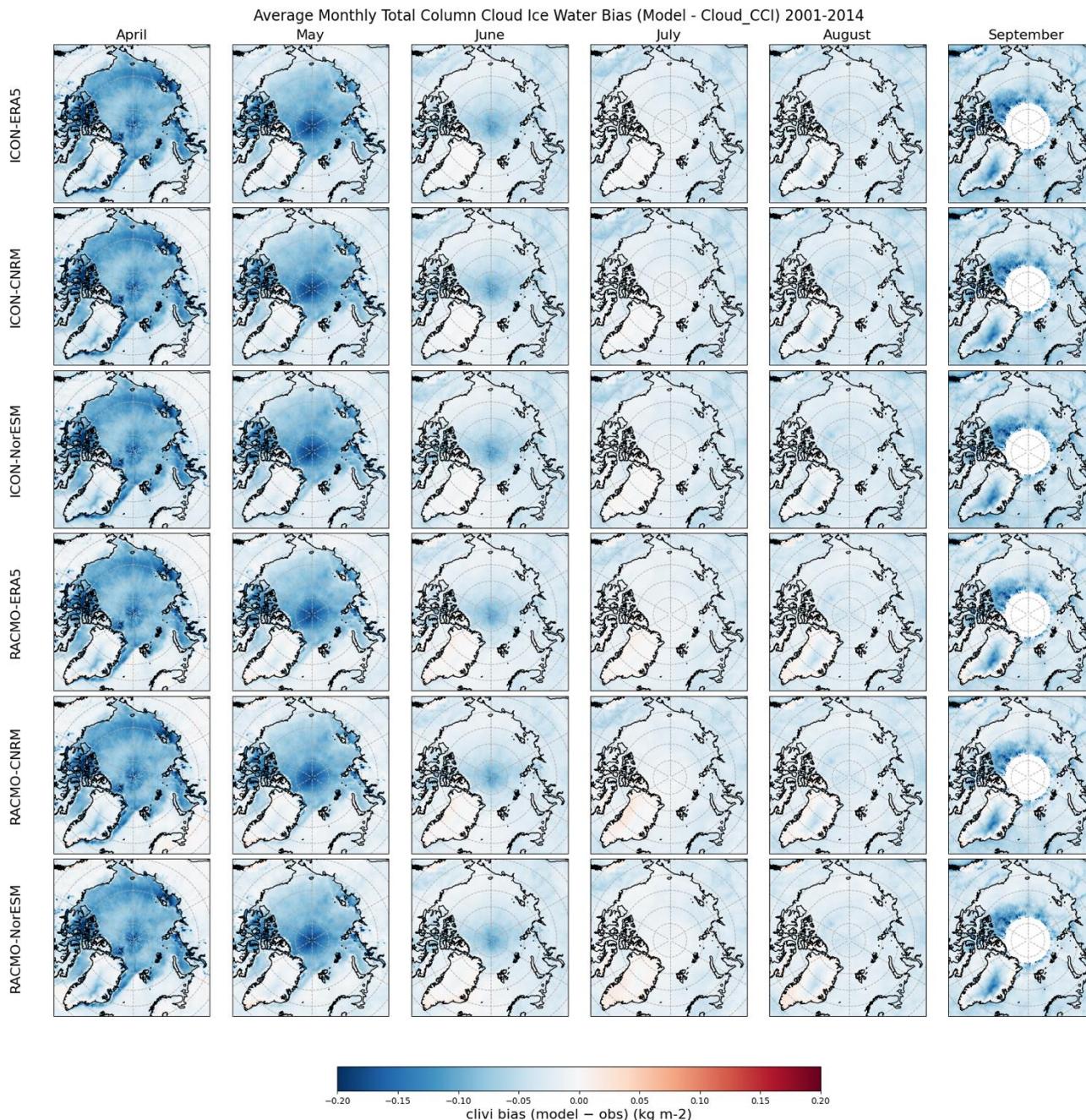
Arctic Cloud_CCI Data



Total column cloud liquid water path RCM comparison to CloudCCI



Total column cloud icewater path RCM comparison to CloudCCI



Antarctica Cloud_CCI Data

Averaged monthly column cloud liquid water [%], 2001-2016

