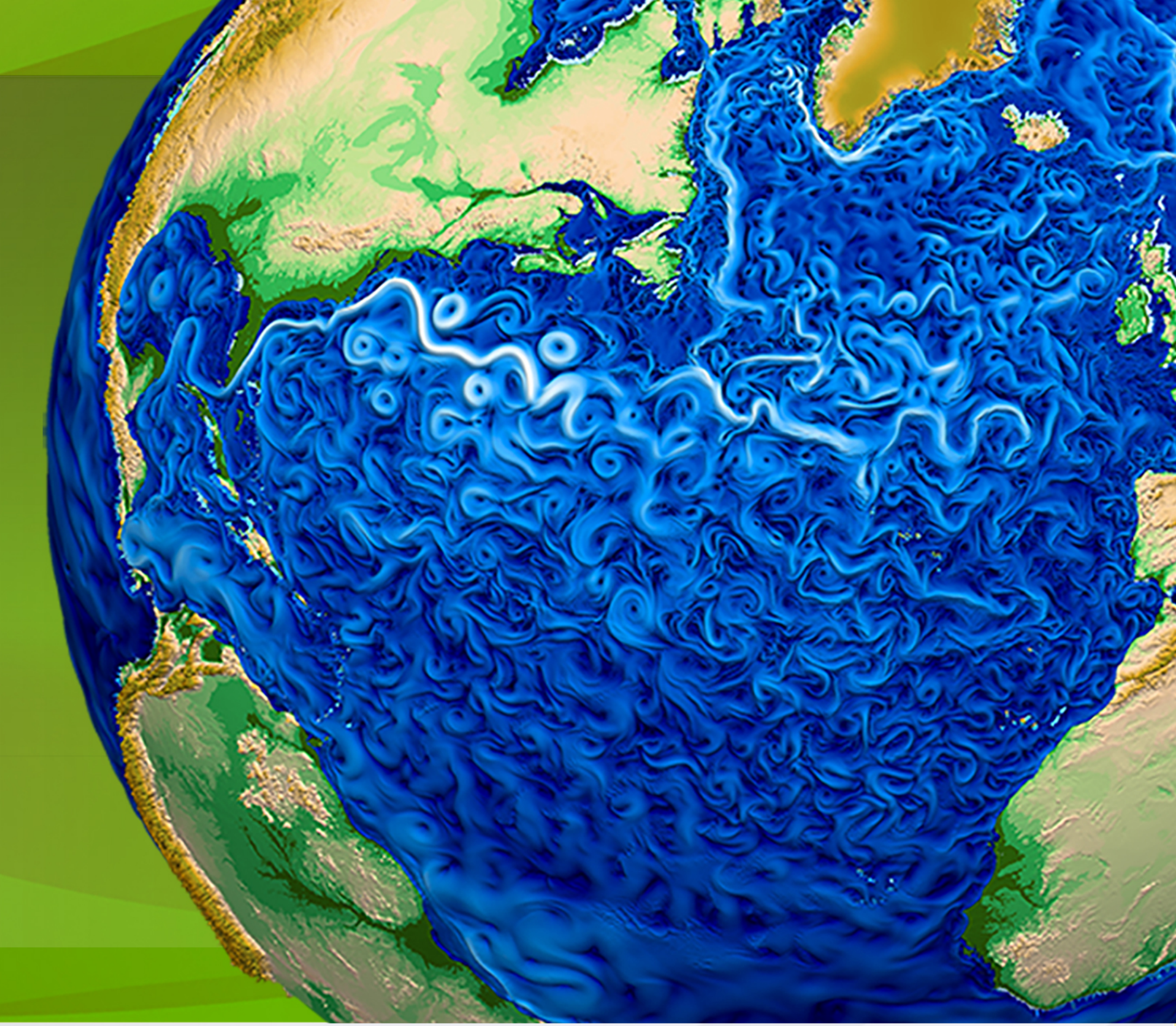


R:

Sea Ice Trends in Fully Coupled High-Resolution ACME V0.1 Approximate Present Day Transients

Detelina Ivanova, Julie McClean, David Bader, Mark Taylor, Qi Tang, Mathew Maltrud, Milena Veneziani, Marcia Branstetter, Kate Evans, Salil Mahajan



Objective

We evaluate the fidelity of the sea ice simulation in the high-resolution ACME V0.1 (featuring POP-CICE4) ensemble of transients initialized with a variety of initial conditions (see McClean et al, poster #03). The Arctic and Antarctic mean state, annual cycle and trends of total sea ice area (TSIA), are examined via comparison with commonly used satellite data sets produced by NASATEAM (NT) and BOOTSTRAP (BT) algorithms. The special focus of our study is the ability of the model to reproduce the observed trends of the Arctic and Antarctic TSIA and its sensitivity to the model initialization.

Approach

Model

ACME V0.1: 0.25deg CAM5/CLM4, 0.1deg POP2/CICE4

Initialization

V0.1TR1, V0.1TR2, V0.1TR3, V0.1TR5 – initialized from forced POPCICE simulation

V0.2TR4, V0.1TR6 – initialized from 1850 pre-industrial control run

Integration period

Approximate 2000 Present Day Transients

V0.1TR1, V0.1TR2, V0.1TR3 - 1970-2015

V0.1TR4, V0.1TR5, 1970-2003

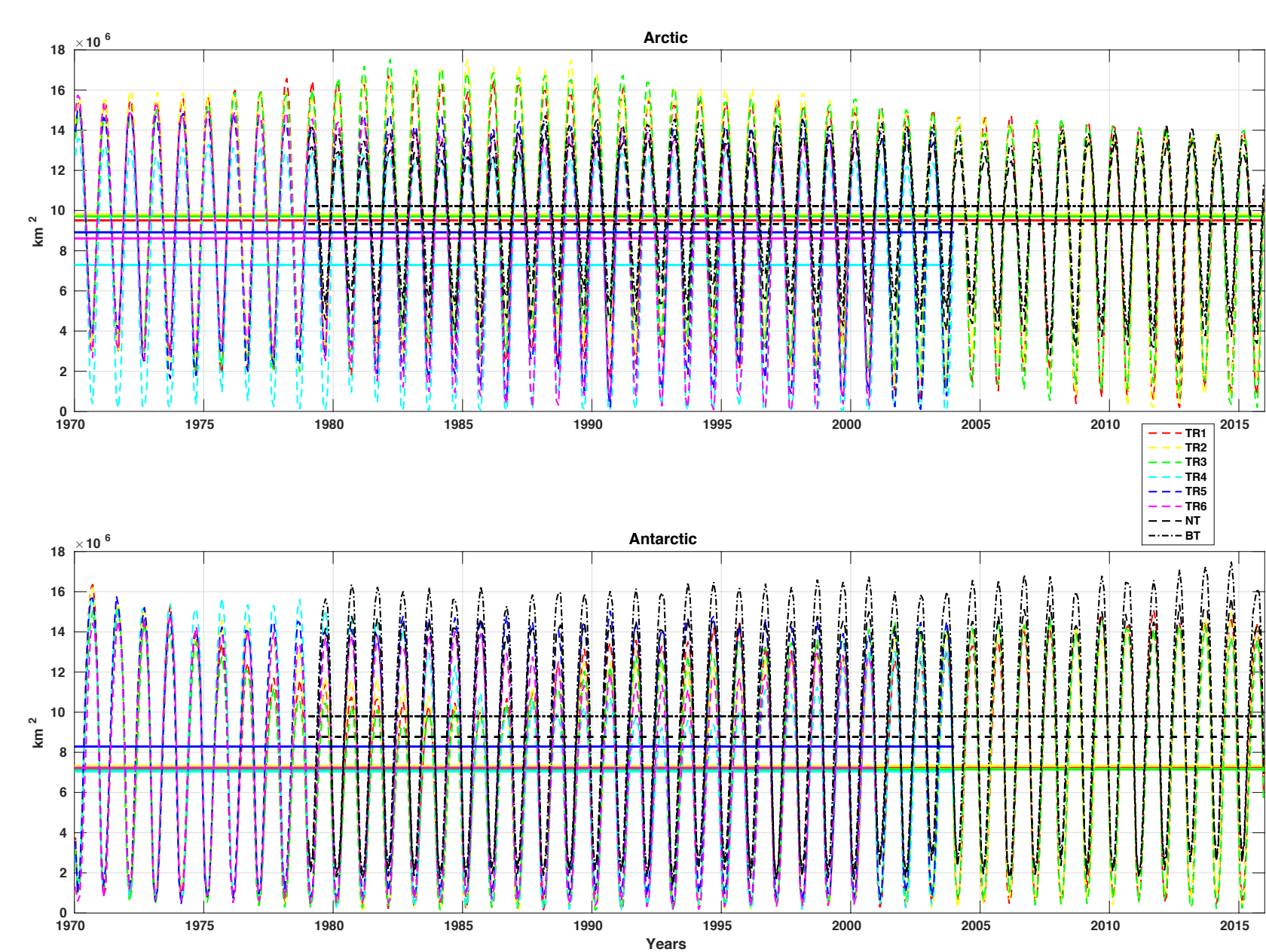
V0.1TR6 - 1970-2000

For further details see McClean et al. poster #3.

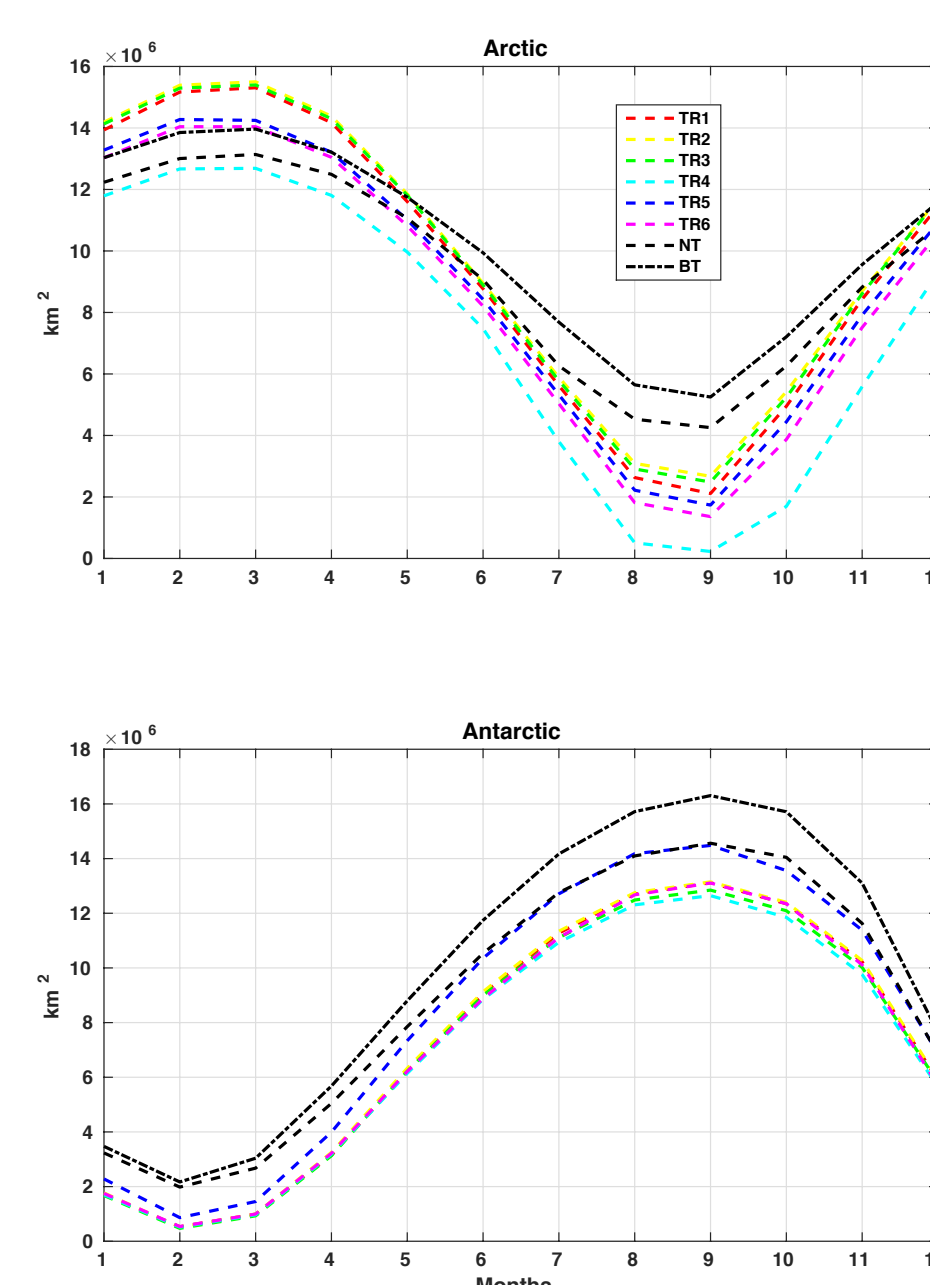
RESULTS

Total Sea Ice Area Mean State and Annual cycle

Arctic and Antarctic Time Series of TSIA



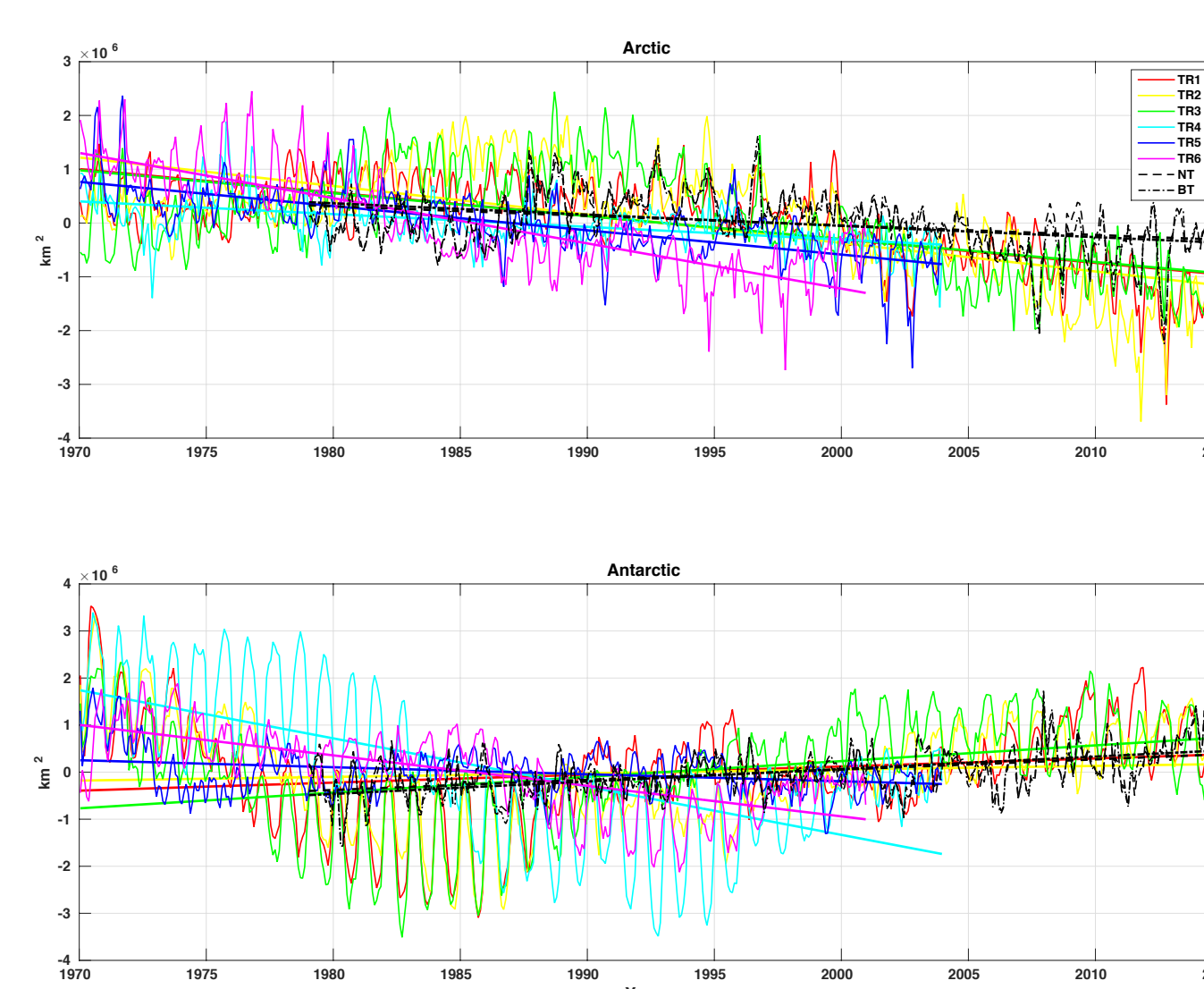
Arctic and Antarctic TSIA Annual Cycles



The Arctic mean state is well simulated by almost all of the ensemble members (except TR4) with better agreement to the observations in TR1-3. All of the ensemble members overestimate the summer Arctic melt. With exception of TR5 which is close to the observational estimates the ensemble is underestimating the mean and the seasonal amplitude of TSIA in the Antarctic.

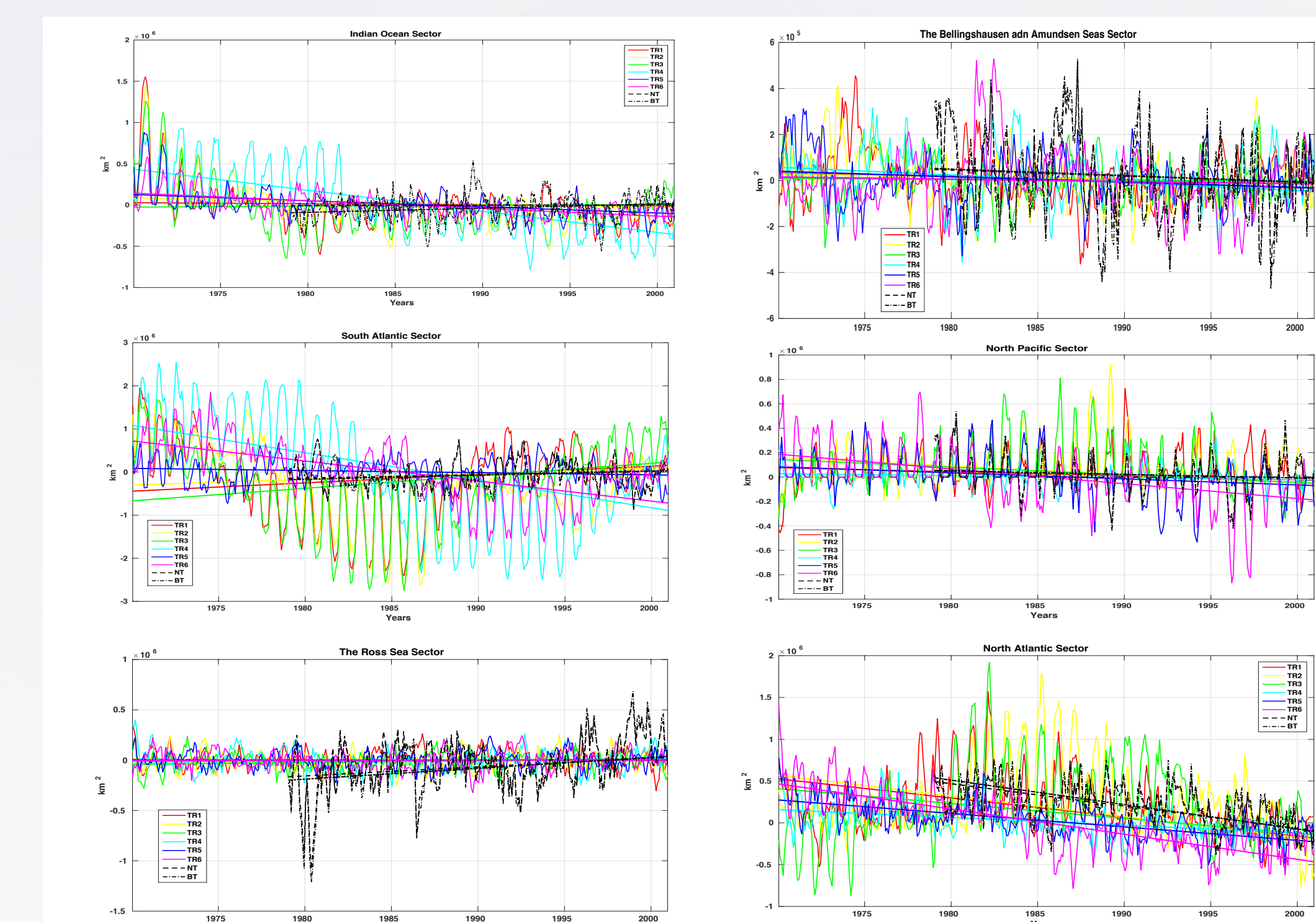
Total Sea Ice Area Trends

Arctic and Antarctic TSIA Anomalies and Trends



Above are presented the linear square fit trends of the Arctic and Antarctic TSIA. The current observational trends show Arctic decline of 13%/decade and Antarctic expansion of 1.1% / decade. All of the transients reproduce the Arctic decline with closest to the observed in TR1-3. In Antarctic the ensemble spread is large, with TR1-3 members being able to reproduce the positive Antarctic trends.

Regional TSIA Anomalies and Trends



Regional look at the simulated sea ice area gives a further validation of the quality of the model performance since the hemispheric TSIA quantities hinder an error compensation. Despite the overall positive trend, Antarctic TR1-3 successfully simulate the regional negative trend in the Bellingshausen and Amundsen Seas Sector in Southern Ocean.

Impact

Current generation climate models used in the Intergovernmental Panel for Climate Change evaluation reports are struggling to reproduce the observed positive trends in the Southern ocean sea ice extent or the asymmetry between the Arctic and Antarctic trends. The major argument is that this uncertainty in the model solution is due to the internal variability.

Our preliminary results from the fully coupled high-resolution ACME V0.1 ensemble of transients show an encouraging agreement with the observed trends, in both Arctic and Antarctic, in three members of the ensemble. The later are initialized with restarts from ocean-ice simulation forced with atmospheric re-analysis. This might indicate a new way forward for the initialization of future climate model predictions.

Ongoing analysis of the atmospheric and ocean precursors will give further insights on the mechanisms in control of the simulated sea ice area trends.