

Development of Multi-Variable Regression Models for Hindcasting Arctic Summer Sea Ice Extent Using Six Teleconnection Patterns

Jia Wang¹, Andrew Reiser^{2,3}, Ayumi Fujisaki-Manome^{2,4}, and Philip Chu¹

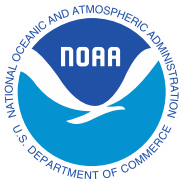
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UNITED STATES
DEPARTMENT OF COMMERCE

Gina M. Riamondo, Secretary

NATIONAL OCEANIC AND
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Development of Multi-Variable Regression Models for Hindcasting Arctic Summer Sea Ice coverage Using Six Teleconnection Patterns

Jia Wang, Andrew Reiser, Ayumi Fujisaki-Manome, Philip Chu, Ting-Yi Yang, Matthew Trumper

1 ABSTRACT

This report investigates the relationships between Arctic summer ice coverage in six different regions of the Arctic and six teleconnection patterns. This study is built upon previous studies that show that both interannual and decadal variability in Arctic summer sea ice is associated with atmospheric teleconnection patterns (Cai et al. 2021a, b) such as the Arctic Oscillation (AO) and Dipole Anomaly (DA), El Nino Southern Oscillation (ENSO) and North Atlantic Oscillation (NAO) for interannual variation, and Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation (AMO) for decadal and multidecadal variations. The methods used are exactly same as Wang et al. (2018), who developed multi-variable regression models using four teleconnection pattern indices (NAO, ENSO, AMO, and PDO) to hindcast Great Lakes annual maximum ice cover, which has been used for projection of seasonal ice cover in the Great Lakes since 2010. The model development was as follows step by step: 1) scatter plots between individual teleconnection patterns and summer ice cover is derived to show which relationship they have, linear, nonlinear, or both; 2) models were trained using (linear, nonlinear or both) the individual predictors whose relationships were derived from the scatter plots; 3) interacting, interfering or competing effects between the interannual predictors such as AO, DA, NAO, and ENSO, between the decadal predictors such as AMO and PDO, and between the interannual and decadal predictors (crossing time scales) were added to the models.

2 INTRODUCTION

Arctic sea ice variability has long been recognized as important indicator and player of the climate system, e.g., Arctic amplification and its seasonality (Stroeve et al., 2007; Serreze and Barry 2011; Schweiger et al., 2019). It modulates the seawater salinity flux, deep water formation, and the intensity of large-scale ocean overturning (Aagaard and Carmack 1994). Sea ice has widespread influences on the atmospheric energy budget through latent heat release during freezing and absorption during the melting of sea ice (Walsh 1983). It also affects the exchange of heat, moisture, and momentum between the atmosphere and ocean (Randall et al., 1998; Holland et al., 2001), and further modifies ice-ocean-atmosphere interaction by altering surface albedo (Lei et al., 2016). The effects of Arctic sea-ice loss are not limited to the northern high latitudes, but reach deep into the mid-latitude and tropics: the entire troposphere warms, the global hydrological cycle strengthens, the intertropical convergence zones shift equatorward and a reduction in strength and southward shift of the mid-latitude westerly winds in winter (Deser et al., 2015; Screen et al., 2018; England et al., 2020).

The pronounced decline in summer Arctic sea ice cover that began in the late twentieth century is unprecedented in both magnitude and duration for at least the past 1,450 years (Kinnard et al., 2011). Acceleration of ice decline is also evident as trends in yearly extent have increased from about $-0.23 \cdot 10^6 \text{ km}^2/\text{decade}$ in 1979–1986 to $-0.55 \cdot 10^6 \text{ km}^2/\text{decade}$ over the period 1979–2017 (Parkinson and Cavalieri 1989; Wang and Ikeda 2000, 2001; Brennan et al., 2020). The seasonal daily minimum extent hit a record low in 2012, and in 2020 as the second lowest extent in the satellite record (Wang et al., 2009, 2015; Parkinson and Comiso, 2013; Meier et al., 2020).

Previous studies suggest that there are certain teleconnections and feedbacks between the Arctic sea ice and the internal variabilities of the climate system on the interannual to decadal time scales such as Arctic Oscillation (AO) (Thompson and Wallace, 1998; Wang and Ikeda, 2000) and Arctic Dipole Anomaly (DA) (Wu et al., 2006; Wang et al., 2009; Wang et al., 2005).

Cai et al. (2021a, b) further investigated the interannual and decadal variability of summer Arctic sea ice using the Arctic longest reconstruction (1850–2017) of Arctic sea ice available and its relationship with the dominant modes of climate variability is further investigated quantitatively. The in-phase fluctuation as the leading empirical orthogonal function (EOF) mode of summer Arctic sea ice variability, nearly one-half of it is due to the internal climate variability: the Atlantic Multidecadal Oscillation (AMO), North Atlantic Oscillation (NAO), Arctic Oscillation (AO), Pacific Decadal Oscillation (PDO) and Dipole Anomaly (DA) with descending order of importance. The second EOF mode can explain the dipolar pattern with out-of-phase variabilities between the Pacific Arctic and the Atlantic Arctic, which is more associated with NAO and AMO. It is found that the increasingly greater reduction of Arctic summer sea ice during the recent decades was enhanced by the Arctic temperature amplification, contributed partly by the increasingly intensified atmospheric thermodynamical forcing from each dominant atmospheric pattern and by the dynamical transpolar sea ice drift driven mainly by DA's and AMO's stronger meridional wind anomaly. Therefore, the positive ice/ocean albedo feedback loop was accelerated by the Arctic temperature amplification, leading to accelerated decline in the Arctic summer sea ice in the recent decades.

Built upon on recent Cai et al.'s findings, the objective of this study is to develop multi-variable regression models to hindcast summer sea ice cover following the approach of Wang et al. (2018). The eventual goal is to use this hindcast model to project seasonal summer sea ice using these projected indices of the teleconnection patterns.

3 METHODS

3.1 DATA

Please refer to the Data and Methods section of Cai et al. (2021a).

3.2 STATISTICAL ANALYSIS, DESCRIPTION OF TABLES AND FIGURES

To link arctic ice coverage to multiple teleconnection forcings, we follow the approach of Wang et al. (2018) to develop linear, nonlinear and multivariable regression models to quantitatively hindcast ice coverage in a given area, say the Greenland Sea, using both physically and statistically significant, teleconnection patterns.

The methods used in this research include correlation analysis, scatterplot visualization, and multivariable regression. Model selection and model fit was determined using the commonly used R statistic as well as p values to determine significance values.

For the production of the models, two figures are shown in this report. The first figure shows a matrix of scatter plots showing the correlation between ice coverage in a given area in the arctic and the index level of a certain teleconnection. Each plot in the matrix shows the correlation coefficient and p value of each type of regression that would be used in the predictor model. The plots also include the 90% significance level to find the significant teleconnection impacts. The other figure is the model's prediction compared to the observations as well as showing the correlation coefficient, p value of the overall model, and the 95% and 90% significance levels. Each model is also accompanied with its respective equation. For the comparisons of the models on different data, three figures are included. The figures, in order, are training data, data reconstruction from Walsh et al. (2017), and data reconstruction from Brennan et al. (2020) followed by its associated equation. Each figure shows the model predictions compared to the different data observation. These figures also include all of the same statistics as the model plots from the prior section.

4 STANDARD MODELS, 1948-2017

Period 1 is defined by the model as the period of 1948 through 1978. We decided to use the maximum amount possible data for finding the correlations. Because of this and the different start date of data collection for each of the indices, the indices are grouped in pairs. AO and DA start in 1948. ENSO and NAO start in 1865. PDO and AMO start in 1850.

4.1 PERIOD 1 1948-1978

4.1.1 Chukchi and Beaufort Seas, Period 1 1948-1978

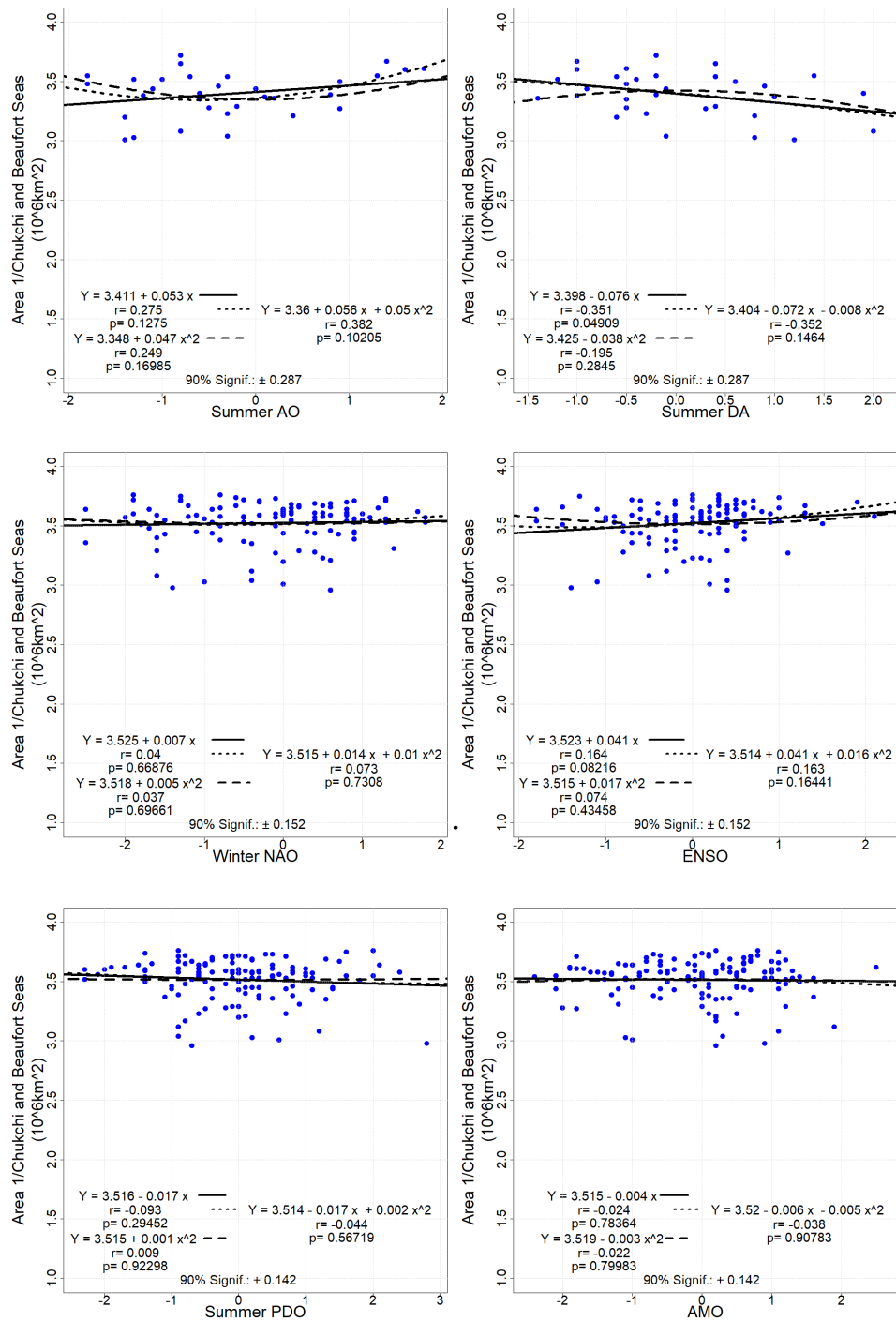


Figure 4.1.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 4.1.1-1 Table summarizing the correlation and significance levels of the teleconnections' impact on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.275	0.128	87.2	0.287
AO ²	0.249	0.170	83.0	0.287
DA	-0.351	0.049	95.1	0.287
DA ²	-0.195	0.285	71.5	0.287
NAO	0.040	0.669	33.1	0.152
NAO ²	0.037	0.697	30.3	0.152
ENSO	0.164	0.082	91.8	0.152
ENSO ²	0.074	0.435	56.6	0.152
PDO	-0.093	0.295	70.5	0.142
PDO ²	0.009	0.923	7.7	0.142
AMO	-0.024	0.784	21.6	0.142
AMO ²	-0.022	0.800	20.0	0.142

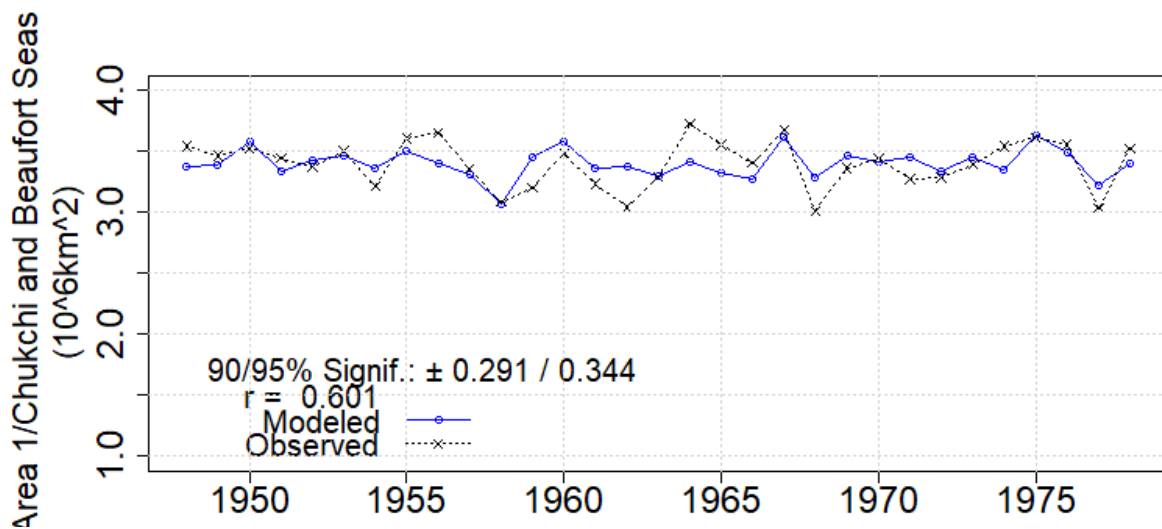


Figure 4.1.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.34 + 0.07AO + 0.08AO^2 - 0.07DA + 0.03DA^2 + 0.4ENSO \\
 & + 0.02AO*DA - 0.05AO*ENSO - 0.01DA*ENSO \\
 & - 0.03PDO \\
 & + 0.03AO*PDO - 0.06DA*PDO + 0.03 ENSO*PDO
 \end{aligned}$$

Equation 4.1.1-1

4.1.2 East Siberian and Laptev Seas, Period 1 1948-1978

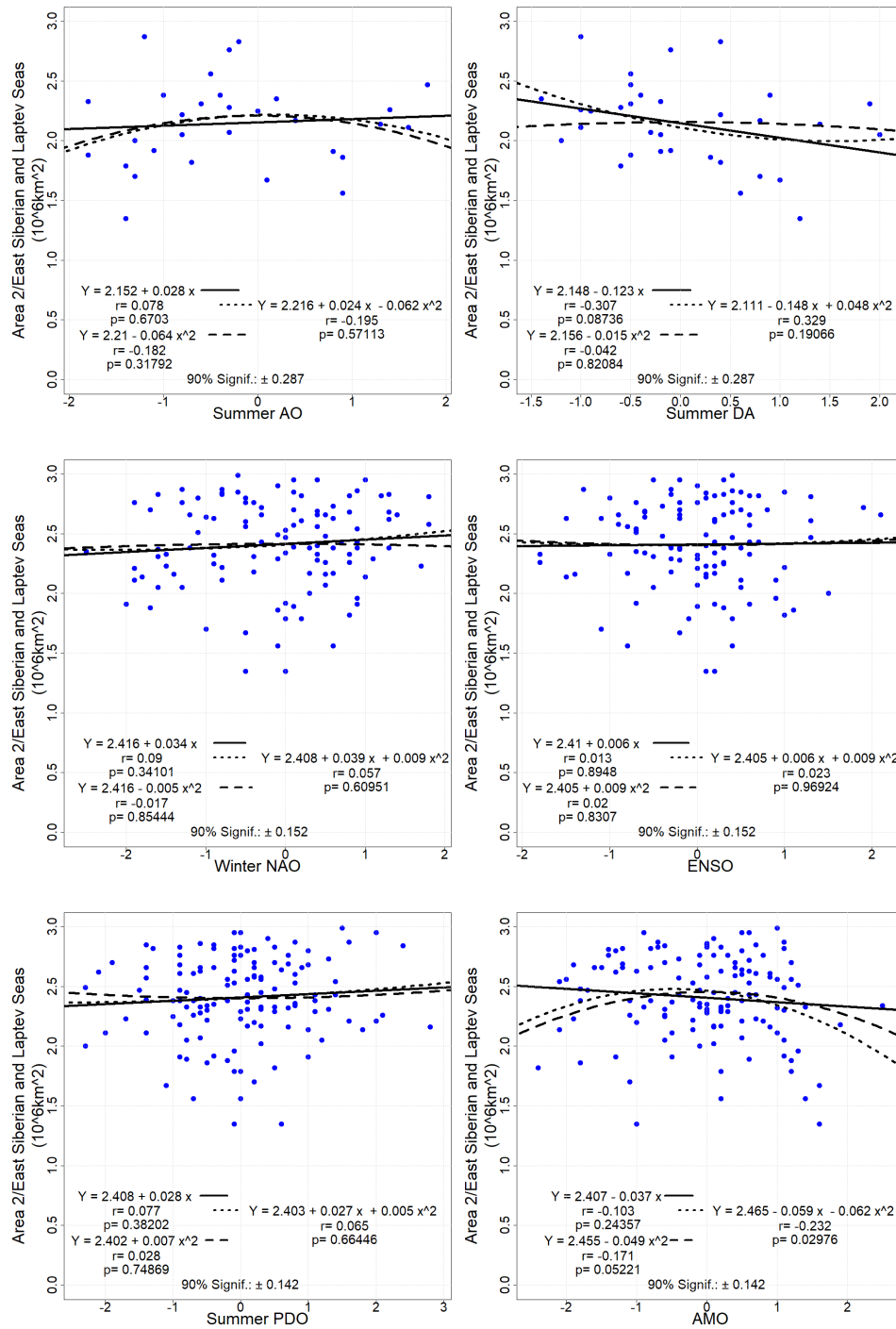


Figure 4.1.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 4.1.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.078	0.670	33.0	0.287
AO ²	-0.182	0.318	60.2	0.287
DA	-0.307	0.087	91.3	0.287
DA ²	-0.042	0.821	17.9	0.287
NAO	0.090	0.341	65.9	0.152
NAO ²	-0.017	0.854	14.6	0.152
ENSO	0.013	0.895	10.5	0.152
ENSO ²	0.020	0.831	16.9	0.152
PDO	0.077	0.382	61.8	0.142
PDO ²	0.028	0.749	25.1	0.142
AMO	-0.103	0.244	75.6	0.142
AMO ²	-0.171	0.052	94.8	0.142

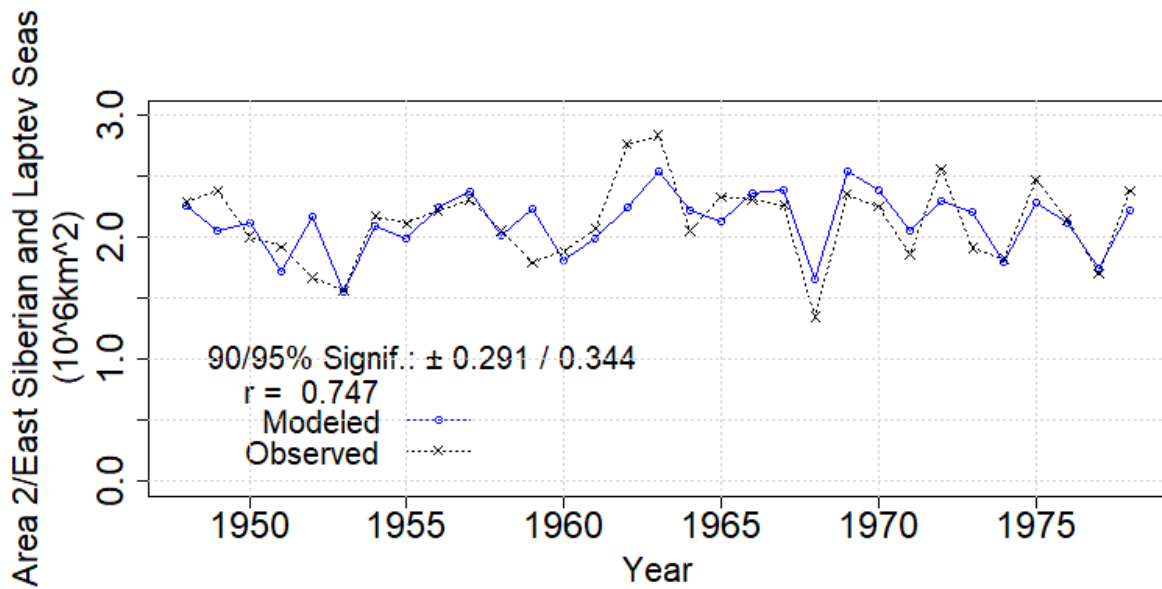


Figure 4.1.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.32 + 0.08AO - 0.02AO^2 - 0.09DA - 0.16NAO \\
 & + 0.11AO*DA - 0.09AO*NAO - 0.07DA*NAO \\
 & + 0.08PDO - 0.37AMO - 0.23AMO^2 \\
 & - 0.25AMO*PDO \\
 & + 0.03PDO*AO - 0.10PDO*DA - 0.10AMO*DA + 0.27AMO*DA - 0.14AMO*NAO
 \end{aligned}$$

Equation 4.1.2-1

4.1.3 Central Arctic, Period 1 1948-1978

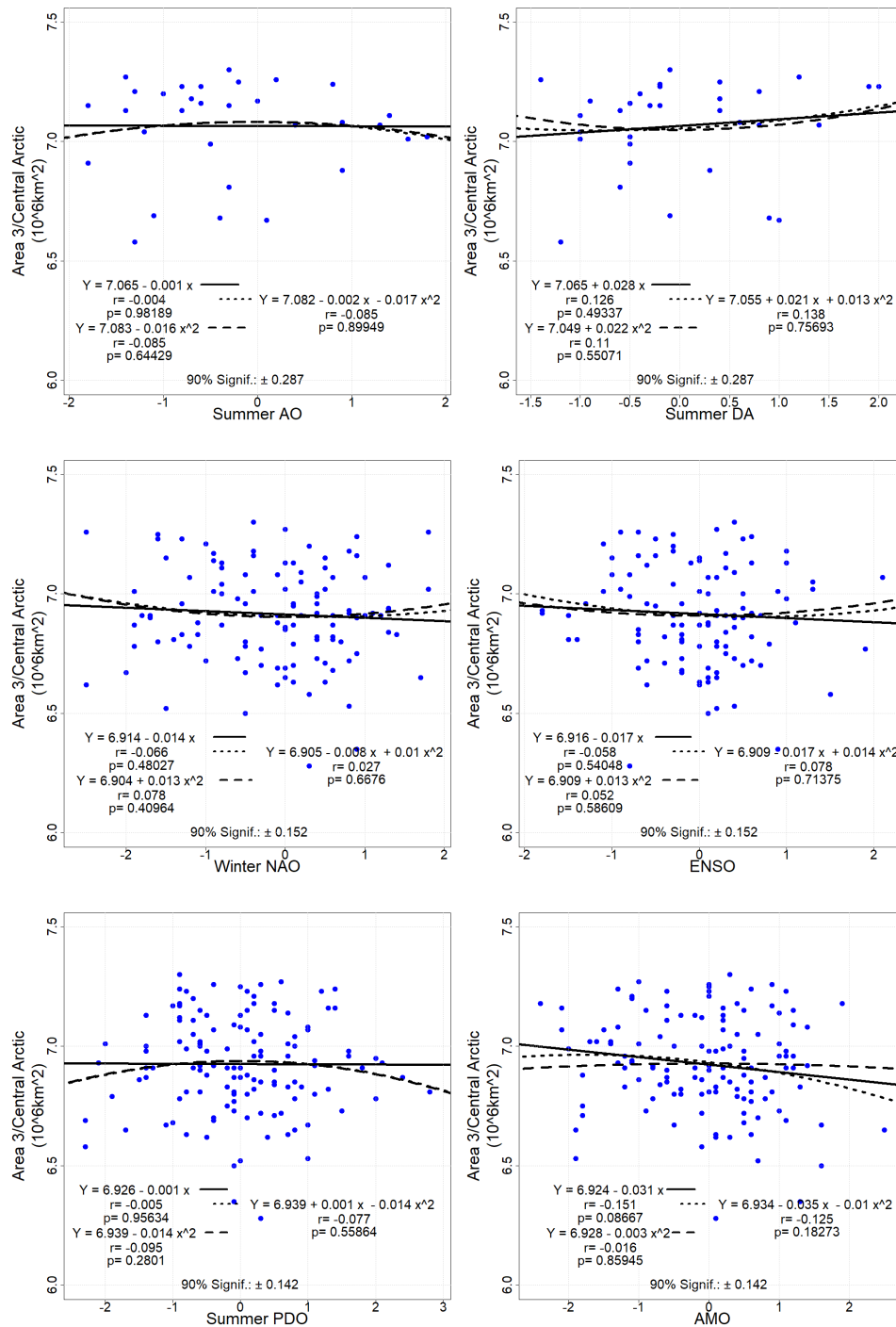


Figure 4.1.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 4.1.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.004	0.982	1.8	0.287
AO ²	-0.085	0.644	35.6	0.287
DA	0.126	0.493	50.7	0.287
DA ²	0.110	0.551	44.9	0.287
NAO	-0.066	0.480	52.0	0.152
NAO ²	0.078	0.410	59.0	0.152
ENSO	-0.058	0.540	46.0	0.152
ENSO ²	0.052	0.586	41.4	0.152
PDO	-0.005	0.956	4.4	0.142
PDO ²	-0.095	0.280	72.0	0.142
AMO	-0.151	0.087	91.3	0.142
AMO ²	-0.016	0.859	14.1	0.142

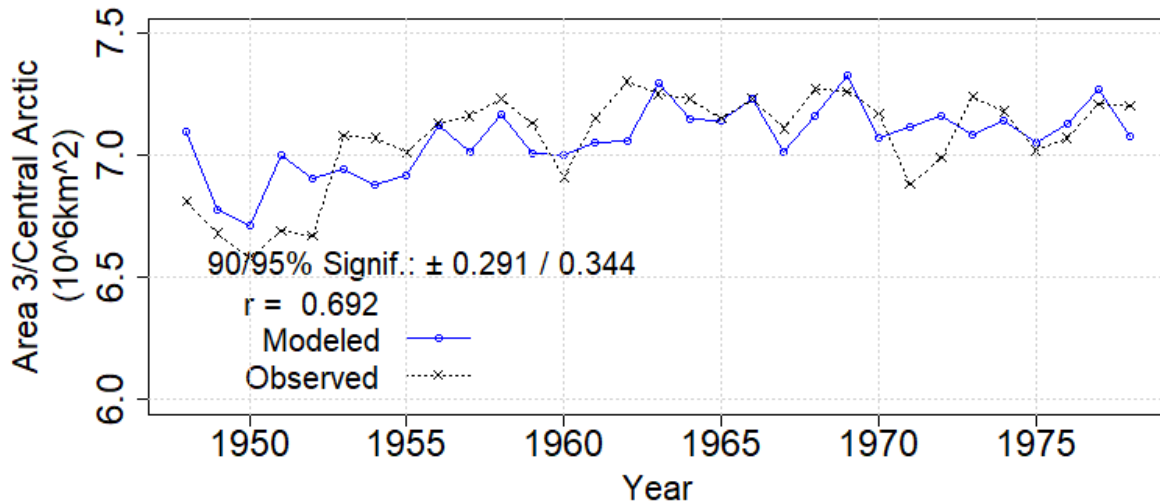


Figure 4.1.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.06 - 0.002AO^2 - 0.12DA - 0.04DA^2 - 0.07NAO + 0.05NAO^2 \\
 & + 0.09DA*AO^2 + 0.02NAO*AO^2 - 0.08DA*NAO \\
 & - 0.07PDO^2 - 0.02AMO \\
 & + 0.03AMO*PDO^2 \\
 & + 0.01AO^2*PDO^2 - 0.03AMO*AO^2 - 0.03AMO*DA - 0.04AMO*NAO
 \end{aligned}$$

Equation 4.1.3-1

4.1.4 Kara and Barents Seas, Period 1 1948-1978

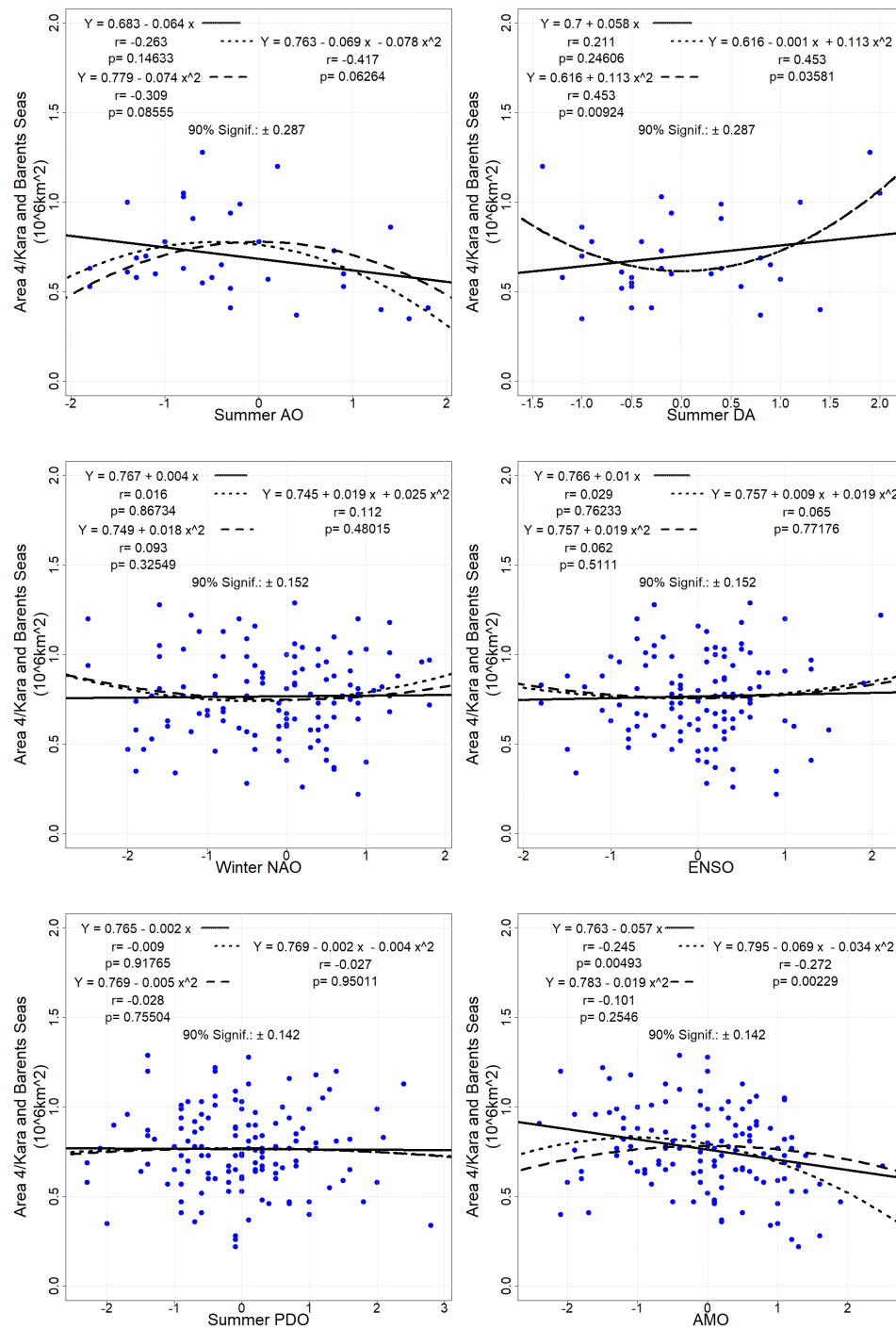


Figure 4.1.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 4.1.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.263	0.146	85.4	0.287
AO ²	-0.309	0.086	91.4	0.287
DA	0.211	0.246	75.4	0.287
DA ²	0.453	0.009	99.1	0.287
NAO	0.016	0.867	13.3	0.152
NAO ²	0.093	0.325	67.5	0.152
ENSO	0.029	0.762	23.8	0.152
ENSO ²	0.062	0.511	48.9	0.152
PDO	-0.009	0.918	8.2	0.142
PDO ²	-0.028	0.755	24.5	0.142
AMO	-0.245	0.005	99.5	0.142
AMO ²	-0.101	0.255	74.5	0.142

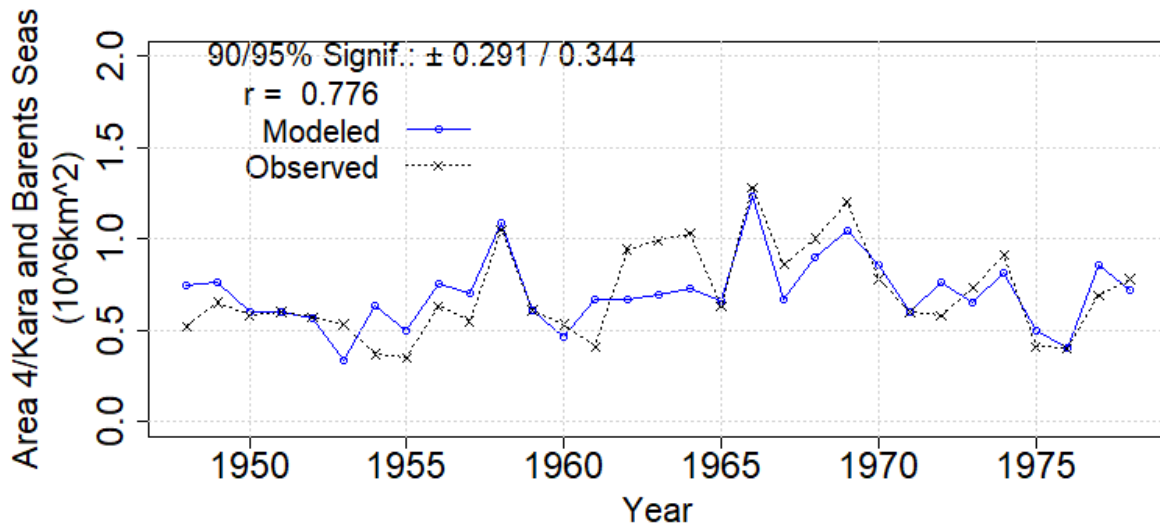


Figure 4.1.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.66 - 0.08AO - 0.05AO^2 - 0.04DA + 0.16DA^2 \\
 & - 0.11AO*DA - 0.08AO^2*DA^2 \\
 & - 0.07AMO - 0.02AMO^2 \\
 & - 0.004AMO*AO - 0.03AMO*DA
 \end{aligned}$$

Equation 4.1.4-1

4.1.5 Greenland Sea, Period 1 1948-1978

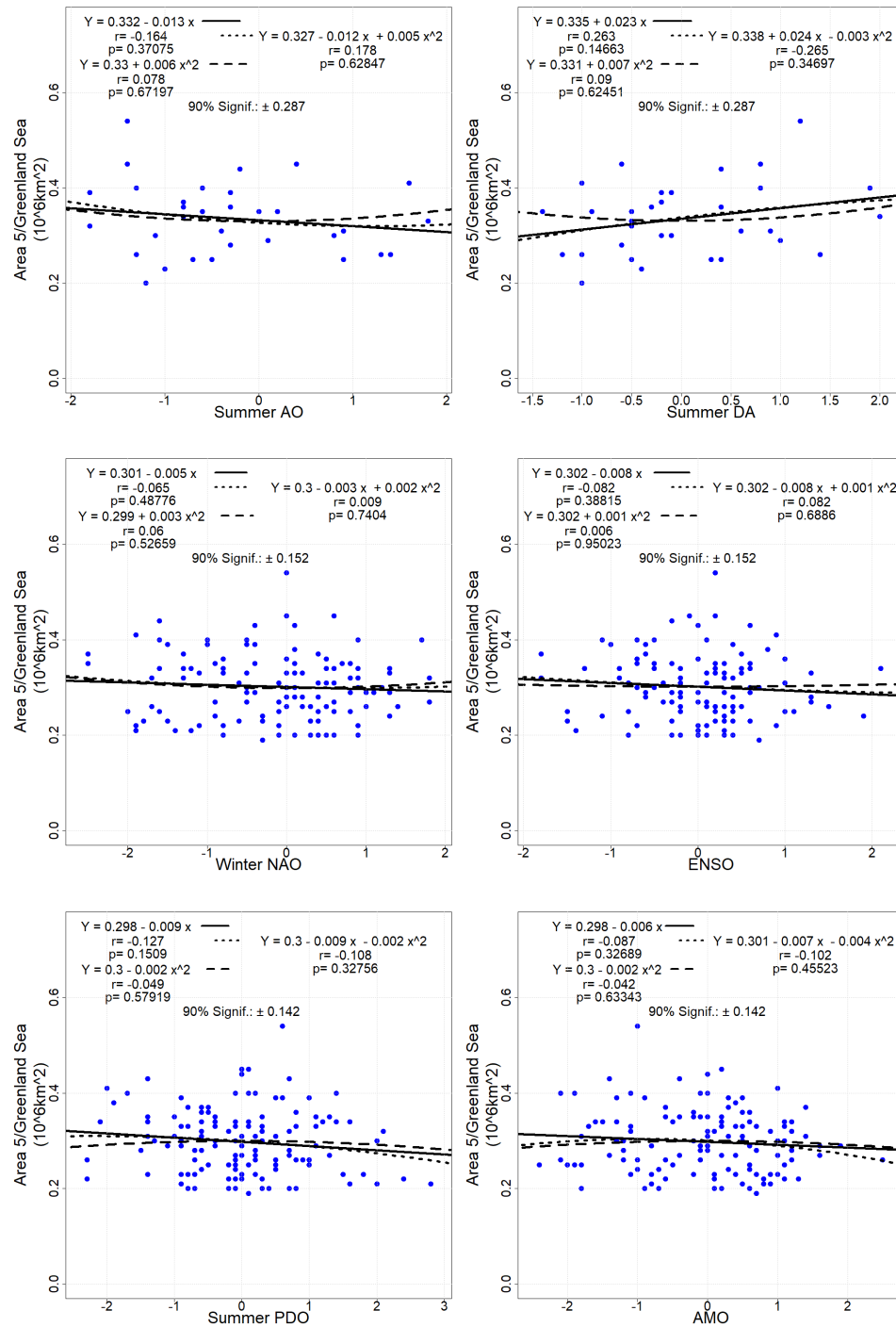


Figure 4.1.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 4.1.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.164	0.371	62.9	0.287
AO ²	0.078	0.672	32.8	0.287
DA	0.263	0.147	85.3	0.287
DA ²	0.090	0.625	37.5	0.287
NAO	-0.065	0.488	51.2	0.152
NAO ²	0.060	0.527	47.3	0.152
ENSO	-0.082	0.388	61.2	0.152
ENSO ²	-0.006	0.950	5.0	0.152
PDO	-0.127	0.151	84.9	0.142
PDO ²	-0.049	0.579	42.9	0.142
AMO	-0.087	0.327	67.3	0.142
AMO ²	-0.042	0.633	36.7	0.142

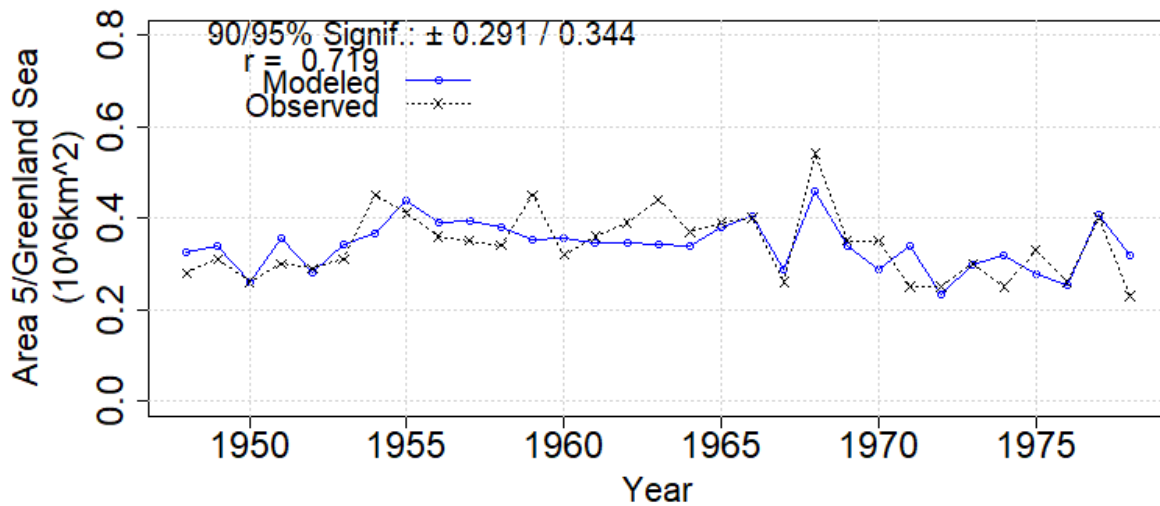


Figure 4.1.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.34 - 0.01AO + 0.004 AO^2 + 0.01DA + 0.01DA^2 + 0.03ENSO \\
 & - 0.02AO*DA + 0.02AO*ENSO + 0.03DA*ENSO \\
 & + 0.01PDO + 0.05AMO \\
 & + 0.04AMO*PDO \\
 & - 0.01PDO*ENSO - 0.01PDO*DA + 0.03AMO*AO - 0.05AMO*DA
 \end{aligned}$$

Equation 4.1.5-1

4.1.6 Baffin Bay, Period 1 1948-1978

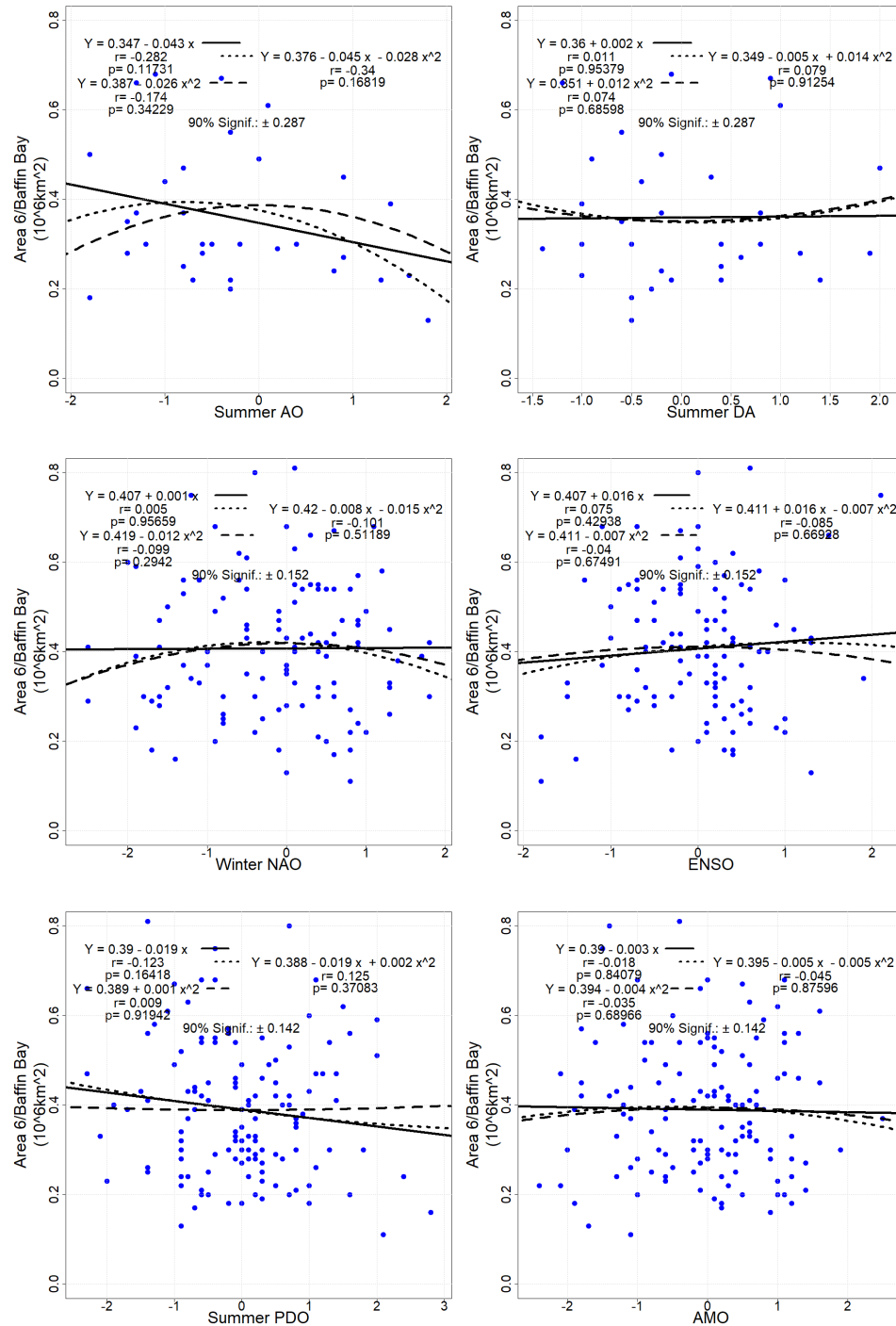


Figure 4.1.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 4.1.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.282	0.117	88.3	0.287
AO ²	-0.174	0.342	65.8	0.287
DA	0.011	0.954	4.6	0.287
DA ²	0.074	0.686	31.4	0.287
NAO	0.005	0.957	4.3	0.152
NAO ²	-0.099	0.294	70.6	0.152
ENSO	0.075	0.429	57.1	0.152
ENSO ²	-0.040	0.675	32.5	0.152
PDO	-0.123	0.164	83.6	0.142
PDO ²	0.009	0.919	8.1	0.142
AMO	-0.018	0.841	15.9	0.142
AMO ²	-0.035	0.690	31.0	0.142

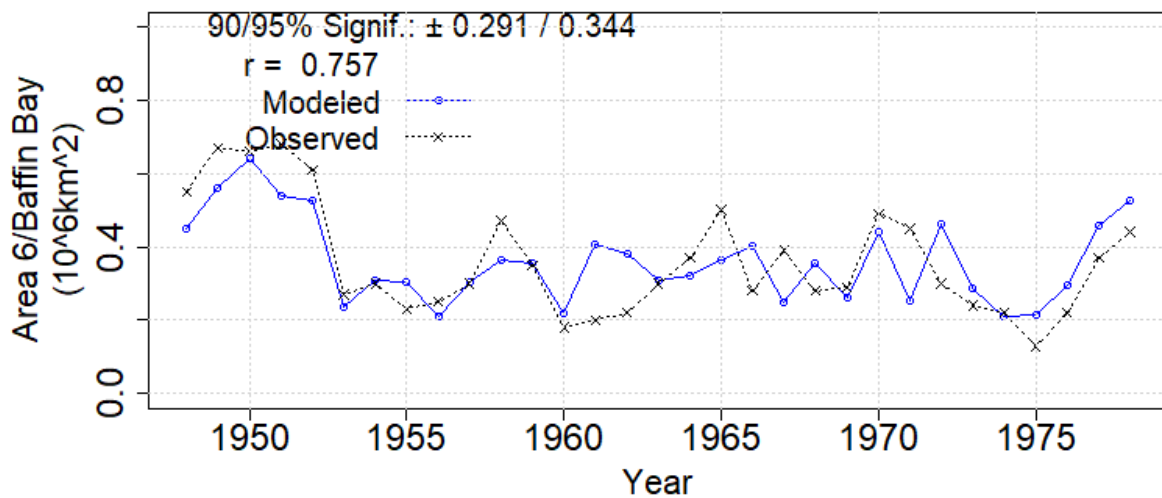


Figure 4.1.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.33 - 0.07AO - 0.05AO^2 + 0.08DA^2 - 0.02NAO^2 - 0.09ENSO \\
 & - 0.002AO*DA^2 + 0.09AO*ENSO + 0.13ENSO*DA^2 \\
 & - 0.10PDO \\
 & + 0.02PDO*ENSO + 0.03AO*PDO + 0.01PDO*DA^2
 \end{aligned}$$

Equation 4.1.6-1

4.1.7 Whole Arctic, Period 1 1948-1978

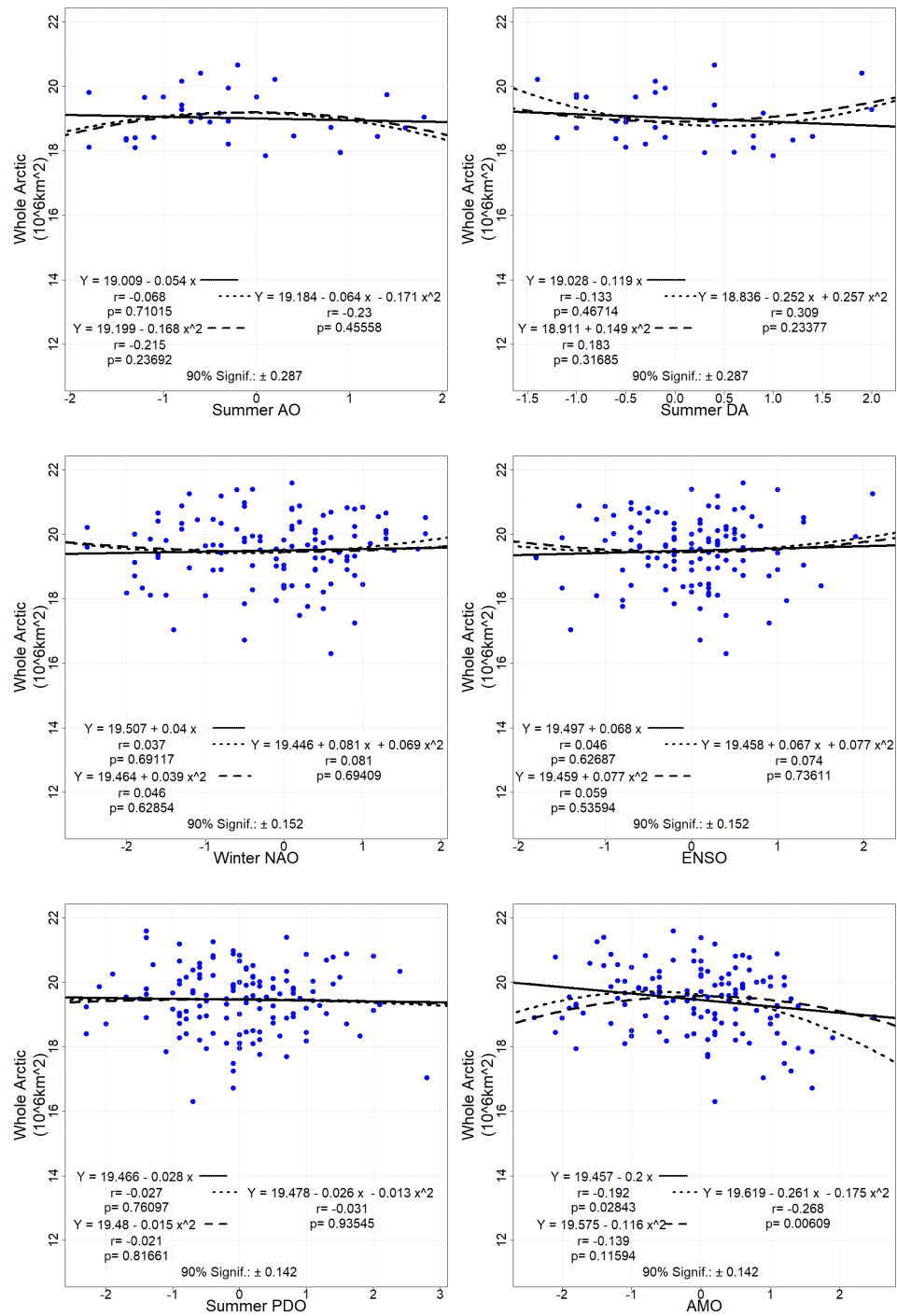


Figure 4.1.7-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 4.1.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.068	0.710	29.0	0.287
AO ²	-0.215	0.237	76.3	0.287
DA	-0.133	0.467	53.5	0.287
DA ²	0.183	0.317	68.3	0.287
NAO	0.037	0.691	30.9	0.152
NAO ²	0.046	0.629	37.1	0.152
ENSO	0.046	0.627	37.3	0.152
ENSO ²	0.059	0.536	46.4	0.152
PDO	-0.027	0.761	23.9	0.142
PDO ²	-0.021	0.817	19.3	0.142
AMO	-0.192	0.028	97.2	0.142
AMO ²	-0.139	0.116	88.4	0.142

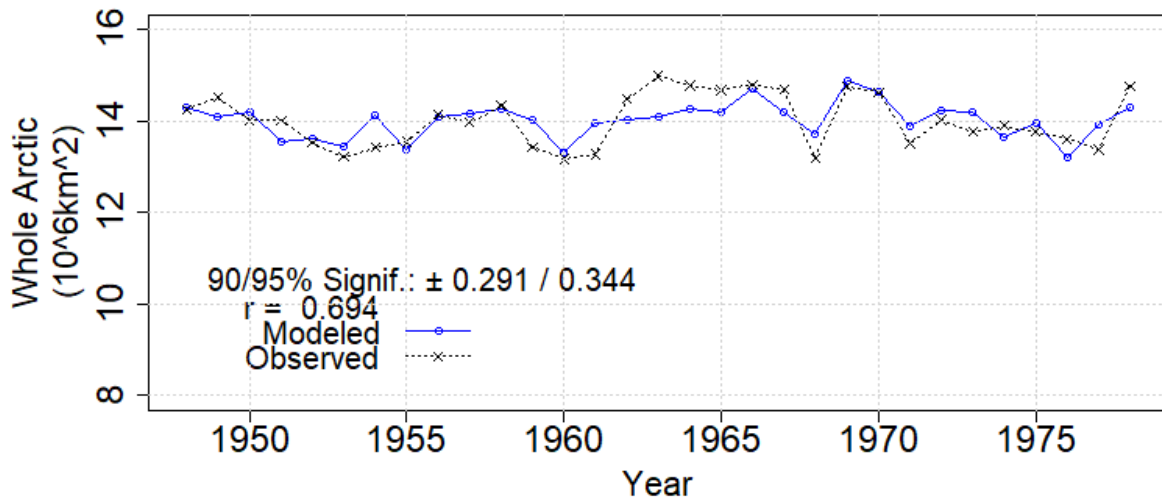


Figure 4.1.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.10 - 0.003AO - 0.03AO^2 - 0.13DA + 0.32DA^2 \\
 & + 0.01AO*DA - 0.22AO^2*DA^2 \\
 & - 0.27AMO - 0.17AMO^2 \\
 & + 0.02AMO*AO + 0.11AMO*DA
 \end{aligned}$$

Equation 4.1.7-1

4.1.8 Chukchi and Beaufort Seas, Period 2 1979-2017

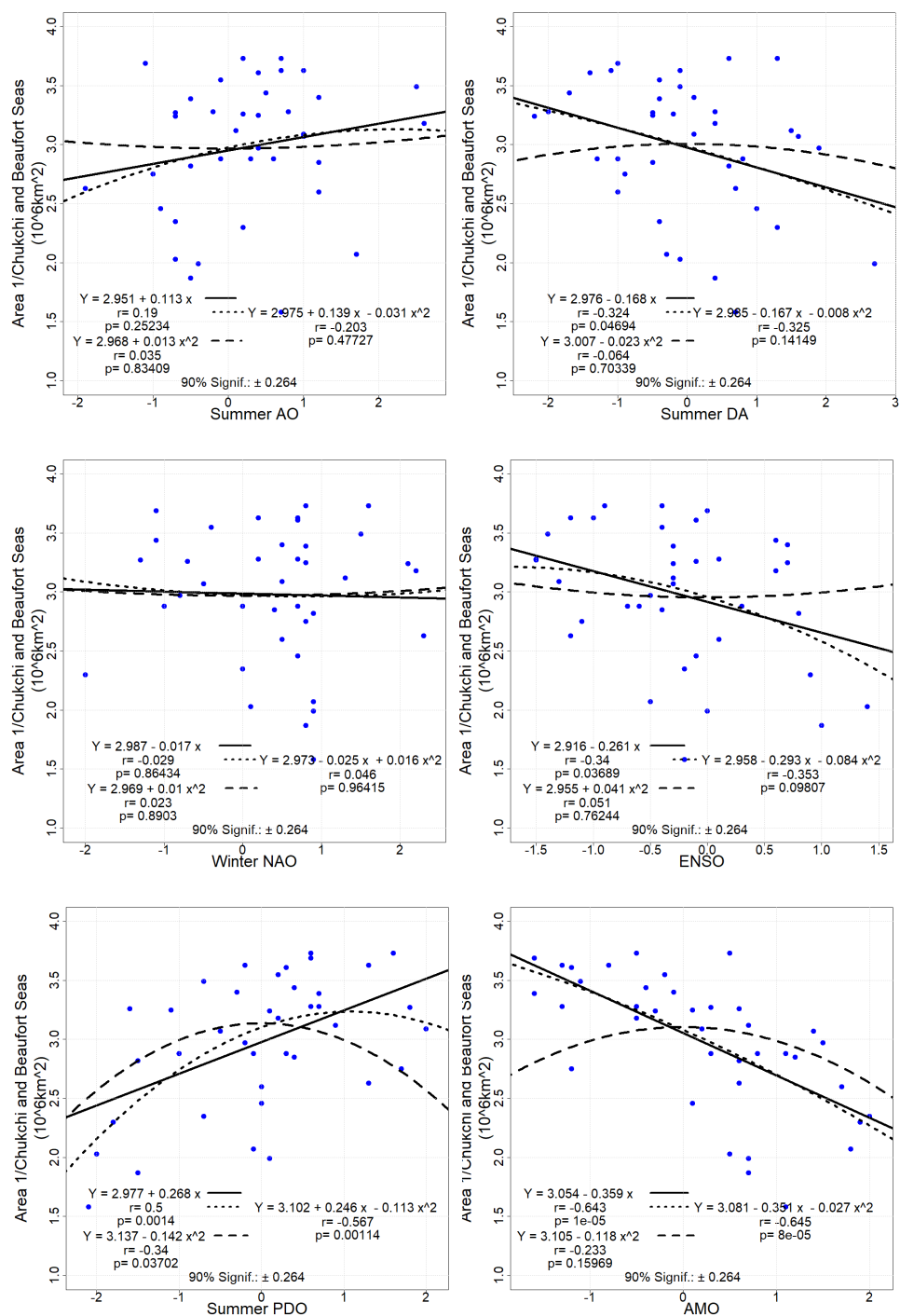


Figure 4.1.7-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 4.1.8-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.190	0.252	74.8	0.264
AO ²	0.035	0.834	16.6	0.264
DA	-0.324	0.047	95.3	0.264
DA ²	-0.064	0.703	29.7	0.264
NAO	-0.029	0.864	13.6	0.264
NAO ²	0.023	0.890	11.0	0.264
ENSO	-0.340	0.037	96.3	0.264
ENSO ²	0.051	0.762	23.8	0.264
PDO	0.500	0.001	99.9	0.264
PDO ²	-0.340	0.037	96.3	0.264
AMO	-0.643	0.000	100.0	0.264
AMO ²	-0.233	0.160	84.0	0.264

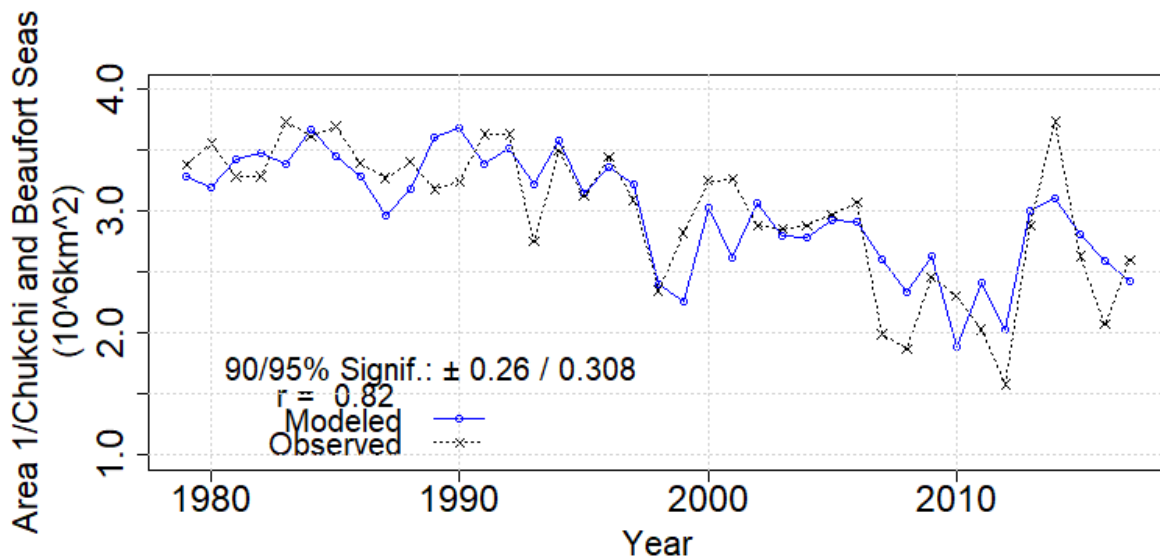


Figure 4.1.8-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.05 + 0.15AO - 0.18DA - 0.07ENSO \\
 & + 0.14AO*DA + 0.01AO*ENSO - 0.02DA*ENSO \\
 & + 0.10PDO - 0.10PDO^2 - 0.17AMO - 0.05AMO^2 \\
 & - 0.01AMO*PDO \\
 & - 0.07PDO*ENSO + 0.18PDO*DA - 0.05AMO*AO + 0.17AMO*DA
 \end{aligned}$$

Equation 4.1.8-1

4.2 PERIOD 2 1979-2017

4.2.1 East Siberian and Laptev Seas

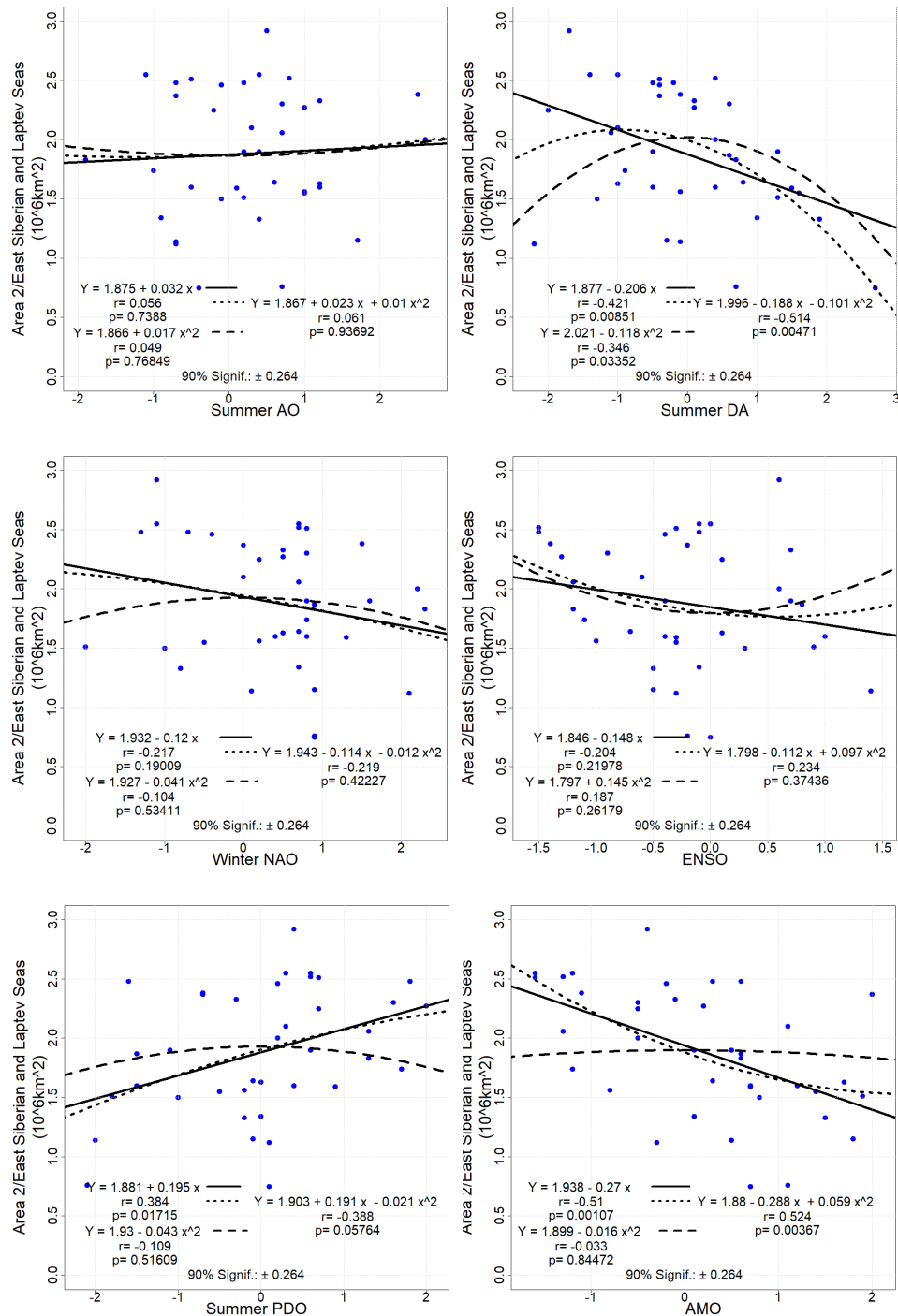


Figure 4.2.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 4.2.1-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.056	0.252	74.8	0.264
AO ²	0.049	0.834	16.6	0.264
DA	-0.421	0.047	95.3	0.264
DA ²	-0.346	0.703	29.7	0.264
NAO	-0.217	0.864	13.6	0.264
NAO ²	0.104	0.890	11.0	0.264
ENSO	-0.204	0.037	96.3	0.264
ENSO ²	0.187	0.762	23.8	0.264
PDO	0.384	0.001	99.9	0.264
PDO ²	-0.109	0.037	96.3	0.264
AMO	-0.510	0.000	100.0	0.264
AMO ²	-0.033	0.160	84.0	0.264

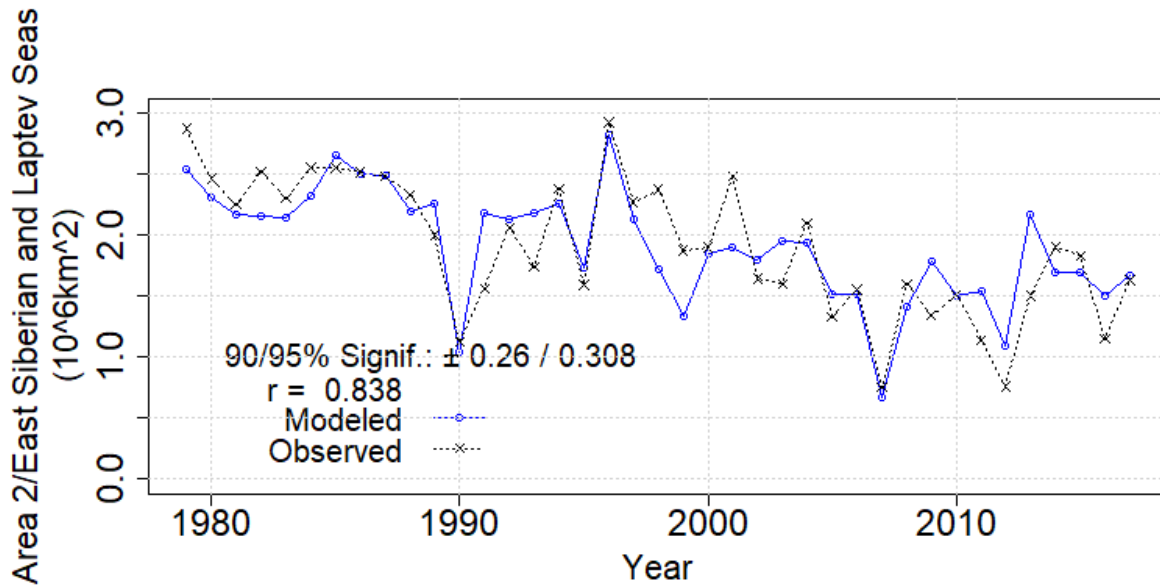


Figure 4.2.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.20 - 0.19DA - 0.17DA^2 - 0.16NAO - 0.003NAO^2 + 0.20ENSO + 0.12ENSO^2 \\
 & + 0.11DA*NAO - 0.09DA*ENSO + 0.01ENSO*NAO \\
 & + 0.28PDO + 0.01PDO^2 - 0.08AMO \\
 & + 0.06AMO*PDO \\
 & + 0.20PDO*ENSO + 0.03PDA*DA - 0.15AMO*NAO + 0.11AMO*DA
 \end{aligned}$$

Equation 4.2.1-1

4.2.2 Central Arctic, Period 2 1979-2017

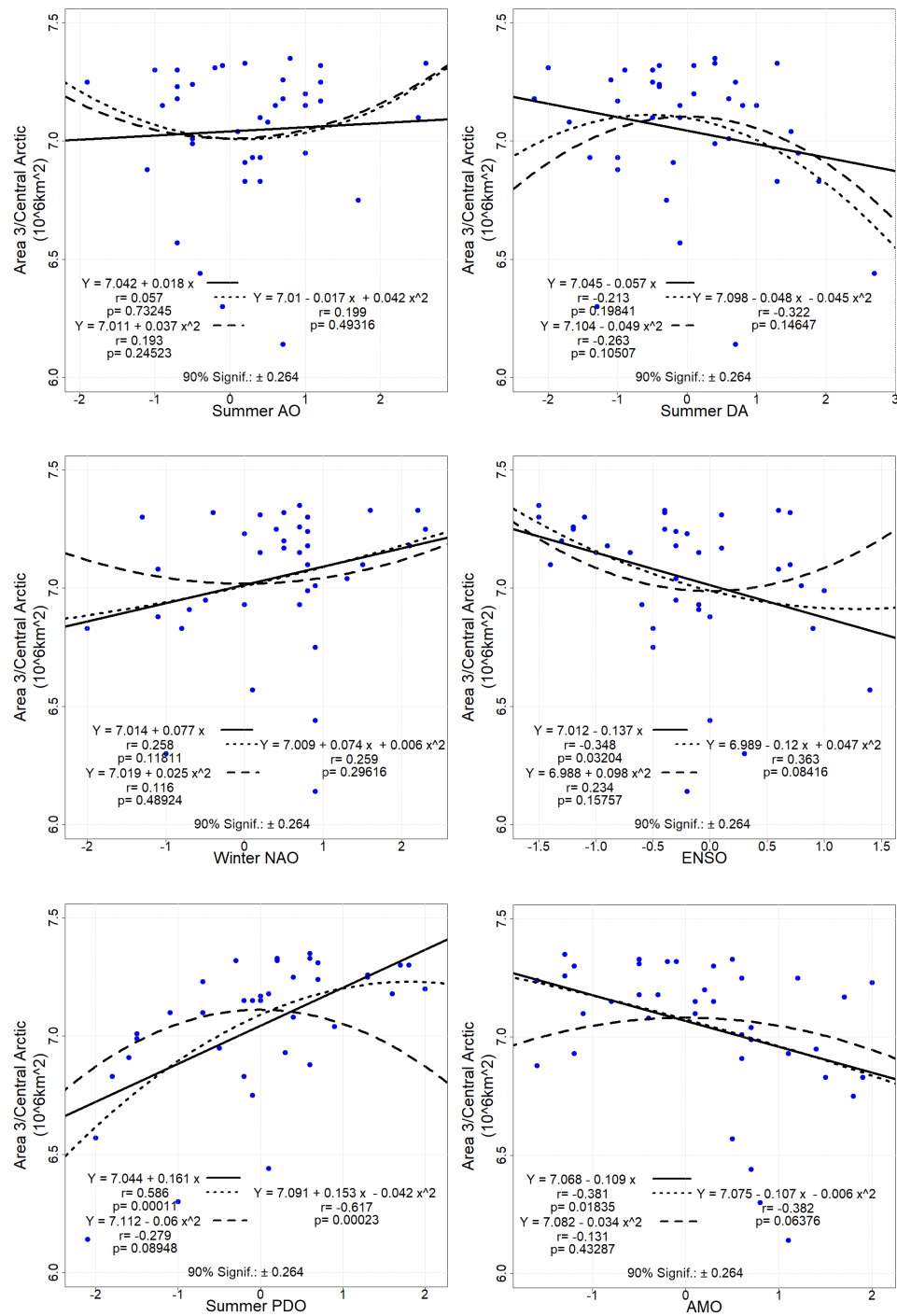


Figure 4.2.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 4.2.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.057	0.732	26.8	0.264
AO ²	0.193	0.245	75.5	0.264
DA	-0.213	0.198	80.2	0.264
DA ²	-0.263	0.105	89.5	0.264
NAO	0.258	0.118	88.2	0.264
NAO ²	0.116	0.489	51.1	0.264
ENSO	-0.348	0.032	96.8	0.264
ENSO ²	0.234	0.158	84.2	0.264
PDO	0.586	0.000	100.0	0.264
PDO ²	-0.279	0.089	91.1	0.264
AMO	-0.381	0.018	98.2	0.264
AMO ²	-0.131	0.433	56.7	0.264

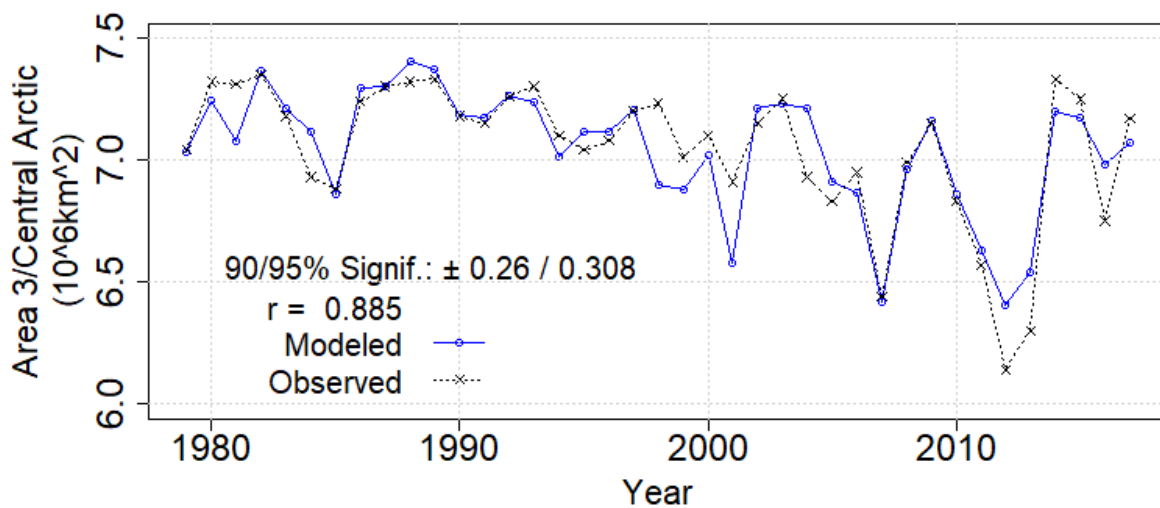


Figure 4.2.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.32 - 0.09AO^2 + 0.03DA - 0.13DA^2 + 0.07NAO + 0.04NAO^2 + 0.25ENSO + 0.28ENSO^2 \\
 & + 0.01DA*AO^2 - 0.06DA*NAO + 0.02DA*ENSO + 0.01ENSO*NAO \\
 & + 0.33PDO - 0.08PDO^2 + 0.07AMO - 0.05AMO^2 \\
 & - 0.01AMO*PDO \\
 & + 0.21PDO*ENSO - 0.07PDO*DA - 0.04AMO*NAO + 0.002AMO*DA
 \end{aligned}$$

Equation 4.2.2-1

4.2.3 Kara and Barents Seas, Period 2 1979-2017

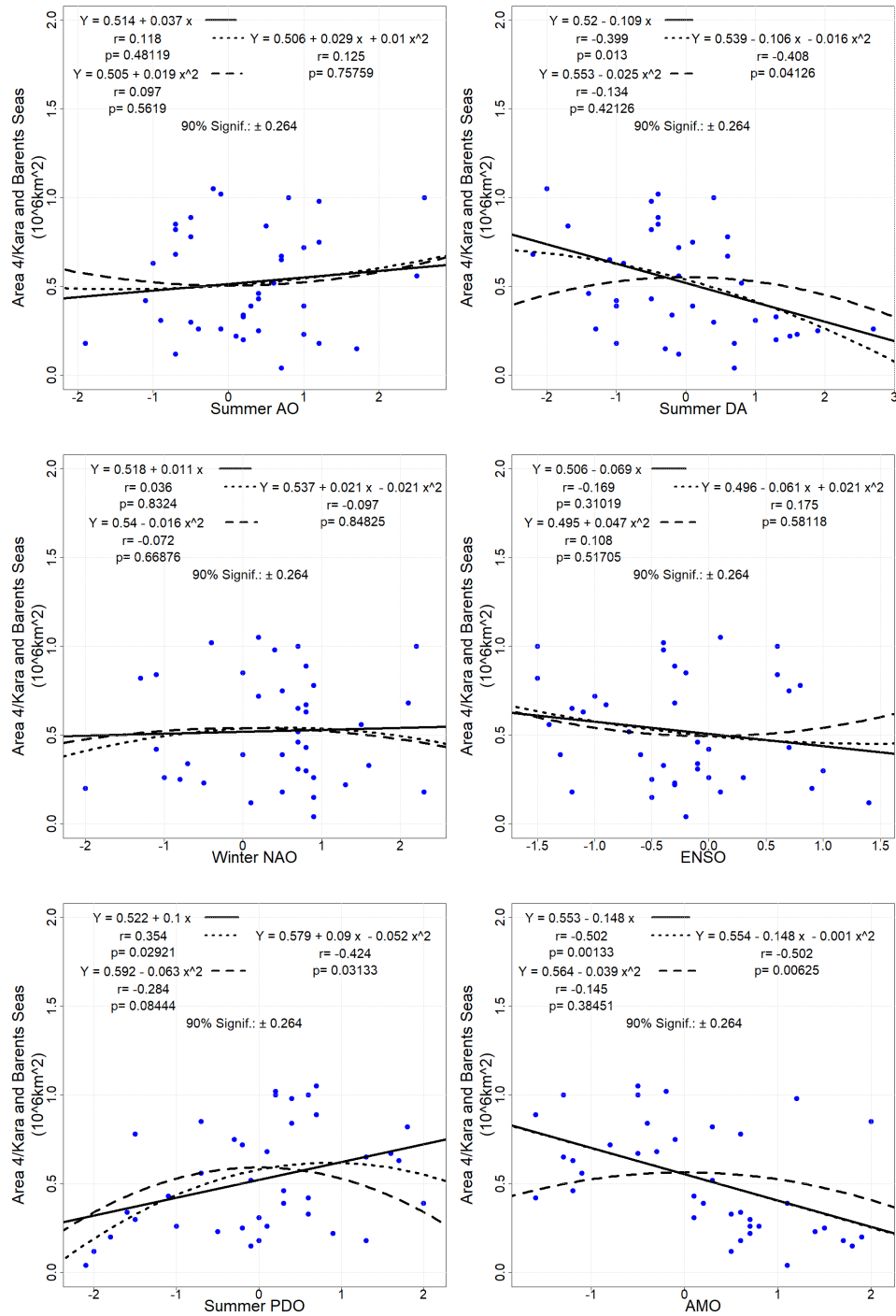


Figure 4.2.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 4.2.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.118	0.481	51.9	0.264
AO ²	0.097	0.562	43.8	0.264
DA	-0.399	0.013	98.7	0.264
DA ²	-0.134	0.421	57.9	0.264
NAO	0.036	0.832	16.8	0.264
NAO ²	-0.072	0.669	33.1	0.264
ENSO	-0.169	0.310	69.0	0.264
ENSO ²	0.108	0.517	48.3	0.264
PDO	0.354	0.029	97.1	0.264
PDO ²	-0.284	0.084	91.6	0.264
AMO	-0.502	0.001	99.9	0.264
AMO ²	-0.145	0.385	61.5	0.264

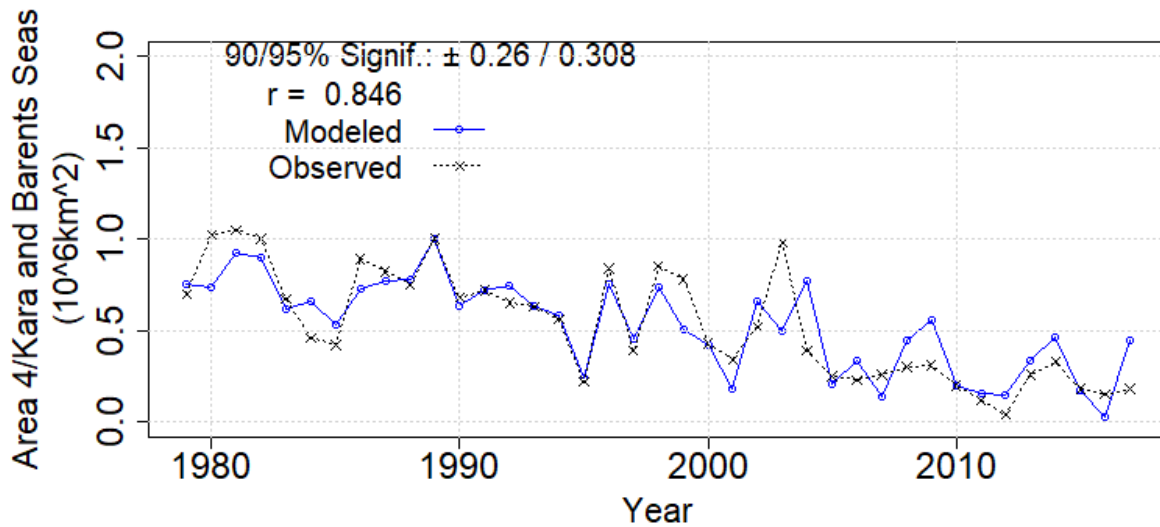


Figure 4.2.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.75 + 0.04AO - 0.04AO^2 + 0.02DA - 0.02DA^2 - 0.01NAO^2 + 0.06ENSO - 0.11ENSO^2 \\
 & + 0.13AO*DA + 0.02AO*ENSO - 0.05DA*ENSO \\
 & + 0.10PDO - 0.08PDO^2 - 0.09AMO + 0.03AMO^2 \\
 & + 0.05AMO*PDO \\
 & - 0.07PDO*ENSO - 0.26PDO*DA - 0.16AMO*AO - 0.17AMO*DA
 \end{aligned}$$

Equation 4.2.3-1

4.2.4 Greenland Sea, Period 2 1979-2017

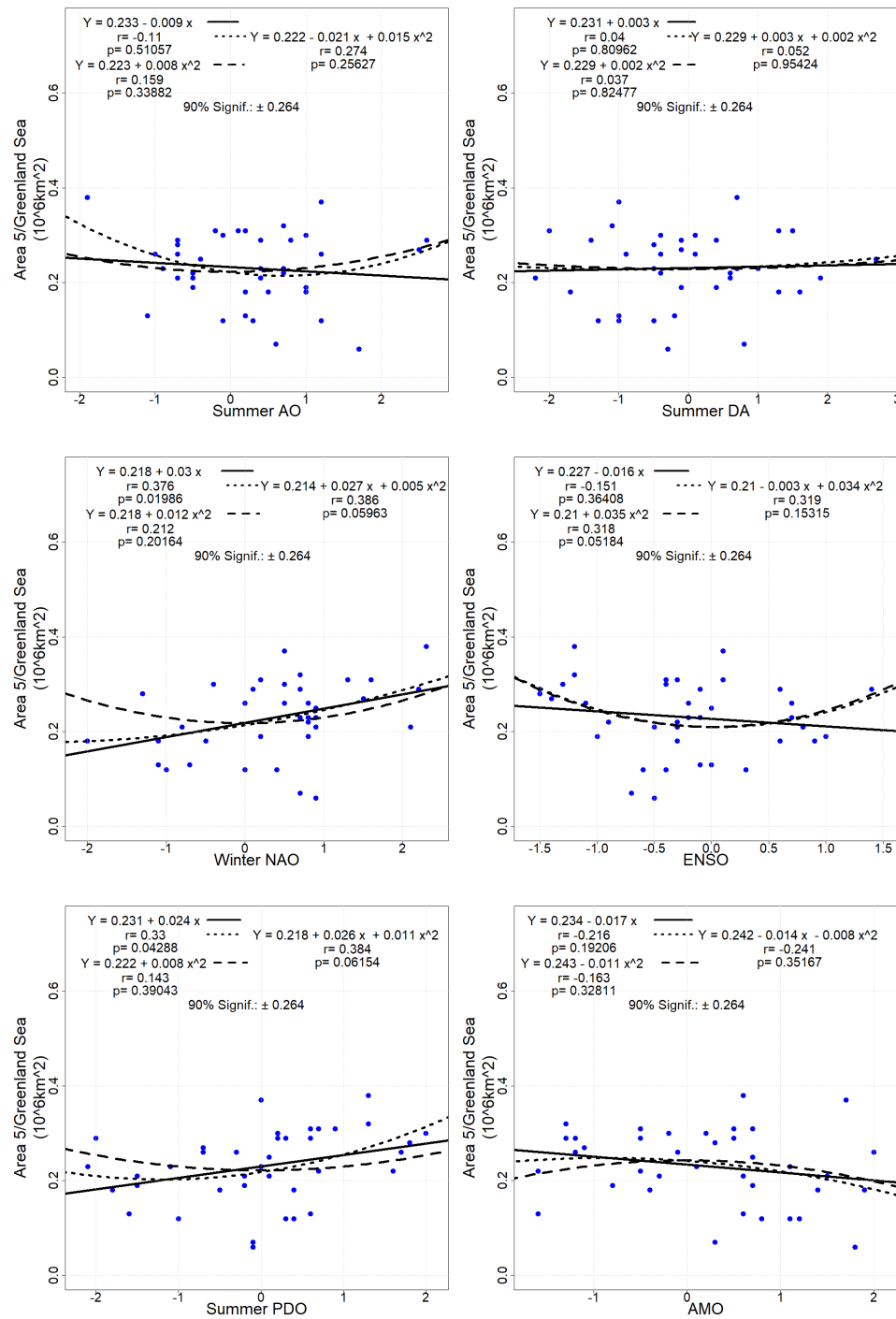


Figure 4.2.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 4.2.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.110	0.511	48.9	0.264
AO ²	0.159	0.339	66.1	0.264
DA	0.040	0.810	19.0	0.264
DA ²	0.037	0.825	17.5	0.264
NAO	0.376	0.020	98.0	0.264
NAO ²	0.212	0.202	79.8	0.264
ENSO	-0.151	0.364	63.6	0.264
ENSO ²	0.318	0.052	94.8	0.264
PDO	0.330	0.043	95.7	0.264
PDO ²	0.143	0.390	61.0	0.264
AMO	-0.216	0.192	80.8	0.264
AMO ²	-0.163	0.328	67.2	0.264

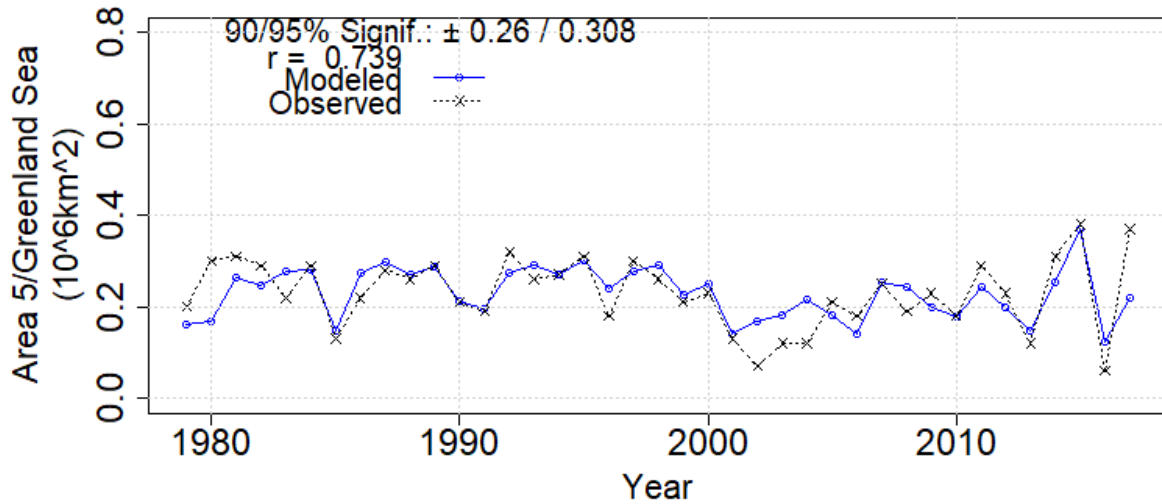


Figure 4.2.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.20 + 0.01AO - 0.01AO^2 + 0.04NAO - 0.01NAO^2 + 0.07ENSO + 0.03ENSO^2 \\
 & - 0.002AO*NAO + 0.01AO*ENSO - 0.004ENSO*NAO \\
 & + 0.06PDO + 0.03PDO^2 + 0.01AMO + 0.03AMO^2 \\
 & + 0.03AMO*PDO \\
 & + 0.02PDO*ENSO - 0.02PDO*AO - 0.04AMO*AO - 0.01AMO*NAO
 \end{aligned}$$

Equation 4.2.4-1

4.2.5 Baffin Bay, Period 2 1979-2017

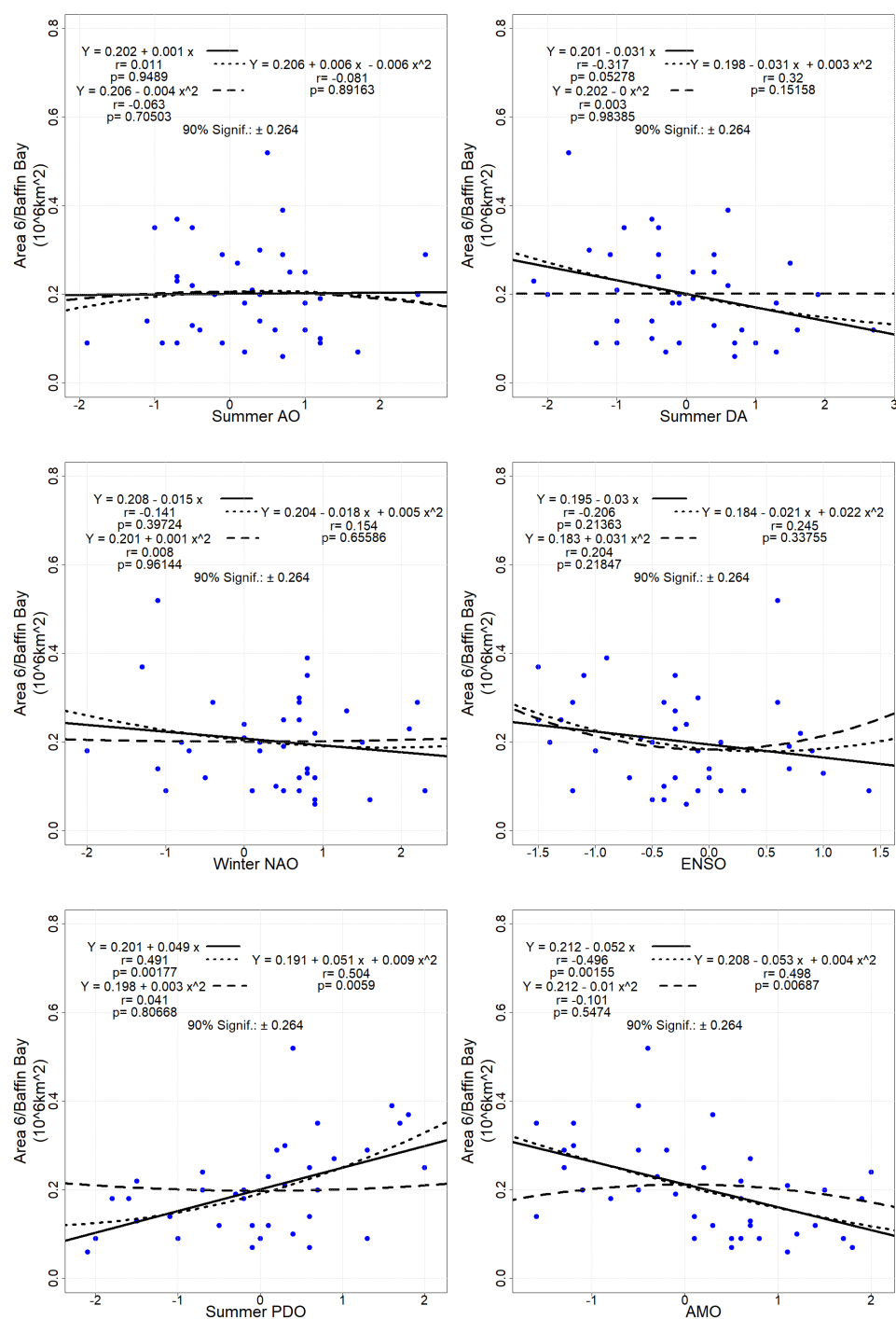


Figure 4.2.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 4.2.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.011	0.949	5.1	0.264
AO ²	-0.063	0.705	29.5	0.264
DA	-0.317	0.053	94.7	0.264
DA ²	0.003	0.984	1.6	0.264
NAO	-0.141	0.397	60.3	0.264
NAO ²	0.008	0.961	3.9	0.264
ENSO	-0.206	0.214	78.6	0.264
ENSO ²	0.204	0.218	78.2	0.264
PDO	0.491	0.002	99.8	0.264
PDO ²	0.041	0.807	19.3	0.264
AMO	-0.496	0.002	99.8	0.264
AMO ²	-0.101	0.547	45.3	0.264

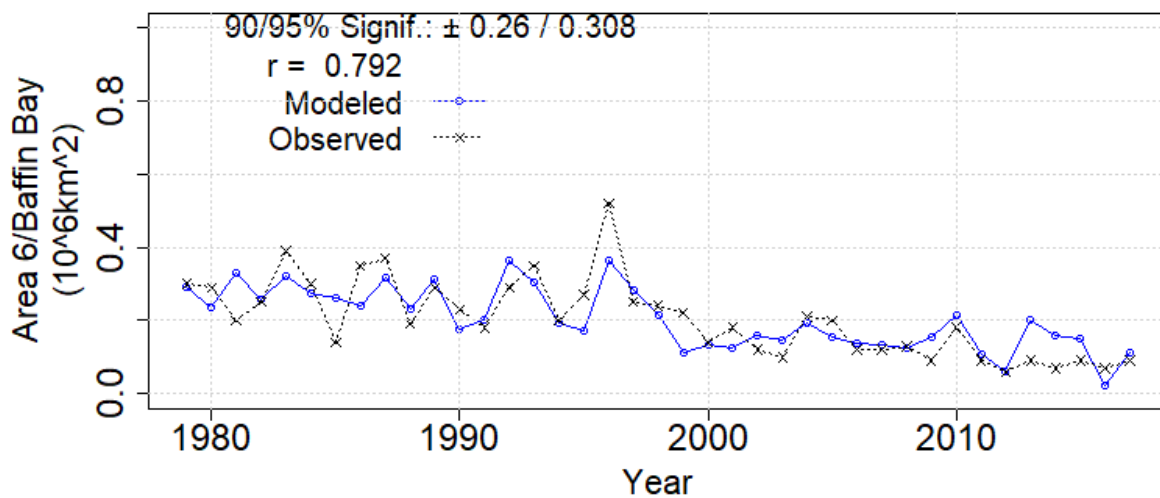


Figure 4.2.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.22 + 0.02AO - 0.01DA - 0.03NAO + 0.04ENSO - 0.01ENSO^2 \\
 & + 0.01AO*DA + 0.003AO*ENSO - 0.01DA*ENSO \\
 & + 0.08PDO - 0.01AMO - 0.01AMO^2 \\
 & - 0.03AMO*PDO \\
 & + 0.004PDO*ENSO - 0.01PDO*DA - 0.05AMO*AO - 0.003AMO*DA
 \end{aligned}$$

Equation 4.2.5-1

4.2.6 Whole Arctic, Period 2 1979-2017

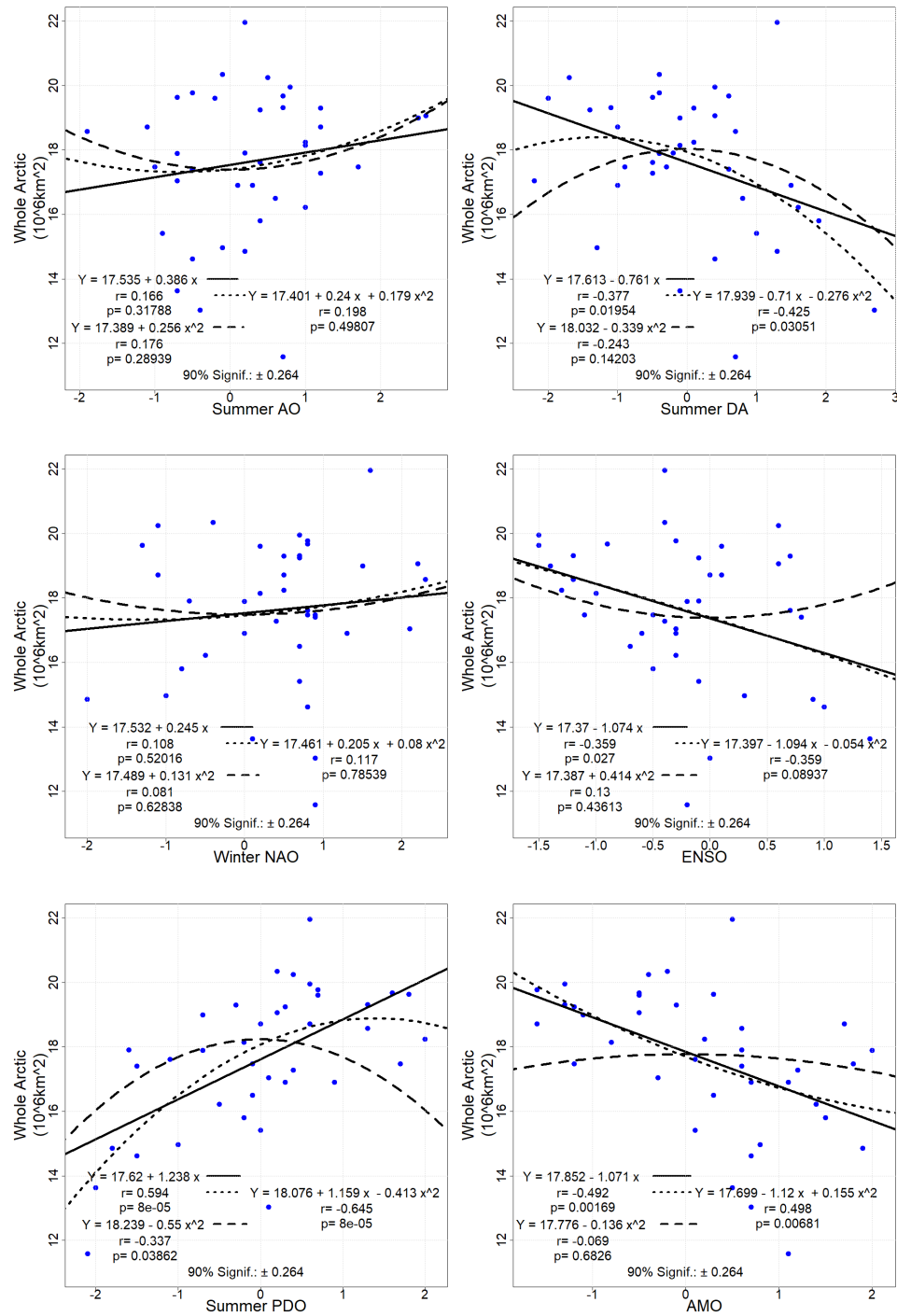


Figure 4.2.5-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 4.2.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.166	0.318	68.2	0.264
AO ²	-0.176	0.289	70.1	0.264
DA	-0.377	0.020	98.0	0.264
DA ²	-0.243	0.142	85.8	0.264
NAO	0.108	0.520	48.0	0.264
NAO ²	0.081	0.628	47.2	0.264
ENSO	-0.359	0.027	97.3	0.264
ENSO ²	0.130	0.436	56.4	0.264
PDO	0.594	0.000	100.0	0.264
PDO ²	-0.337	0.039	96.1	0.264
AMO	-0.492	0.002	99.8	0.264
AMO ²	-0.069	0.683	41.7	0.264

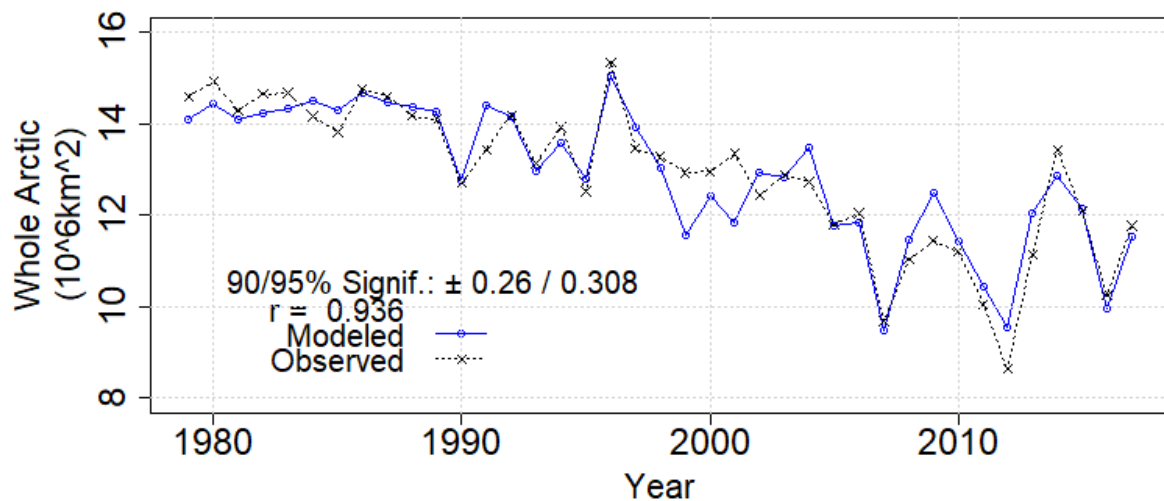


Figure 4.2.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.38 + 0.51AO - 0.30AO^2 - 0.02DA - 0.44DA^2 - 0.51NAO + 0.18NAO^2 + 0.81ENSO - \\
 & 0.43ENSO^2 \\
 & + 0.53AO*DA - 0.25AO*NAO - 0.06AO*ENSO - 0.05DA*NAO + 0.004DA*ENSO \\
 & + 1.15PDO - 0.04PDO^2 - 0.64AMO + 0.25AMO^2 \\
 & + 0.60AMO*PDO \\
 & + 0.24PDO*ENSO - 0.46PDO*DA - 0.82AMO*AO + 0.01AMO*NAO - 0.21AMO*DA
 \end{aligned}$$

Equation 4.2.6-1

4.3 PERIOD 3 1948-2017

4.3.1 Chukchi and Beaufort Seas, Period 3 1948-2017

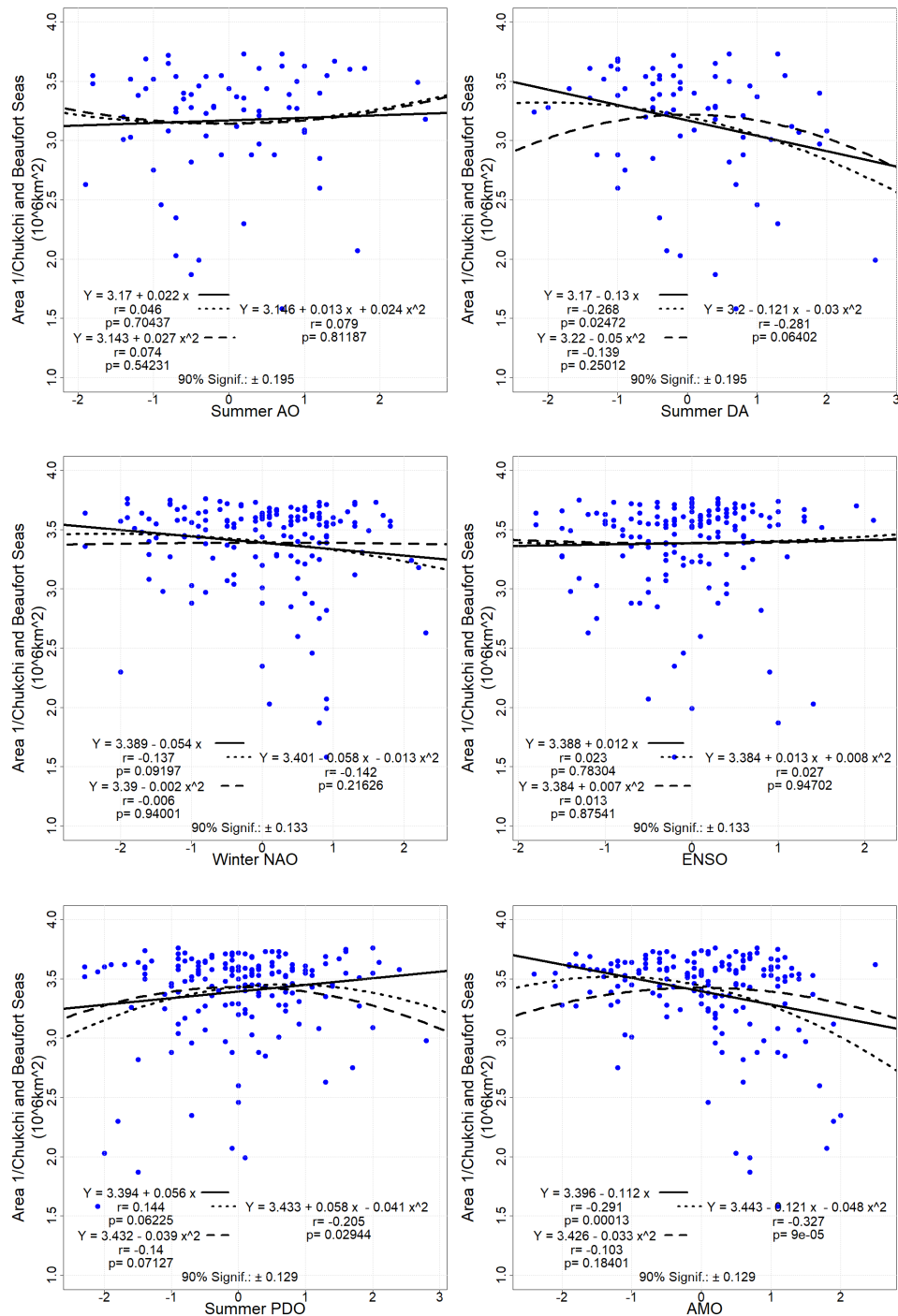


Figure 4.3.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 4.3.1-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.046	0.704	29.6	0.195
AO ²	0.074	0.542	45.8	0.195
DA	-0.268	0.025	97.5	0.195
DA ²	-0.139	0.250	75.0	0.195
NAO	-0.137	0.092	90.8	0.133
NAO ²	-0.006	0.940	6.0	0.133
ENSO	0.023	0.783	21.7	0.133
ENSO ²	0.013	0.875	12.5	0.133
PDO	0.144	0.062	93.8	0.129
PDO ²	-0.140	0.071	92.9	0.129
AMO	-0.291	0.000	100.0	0.129
AMO ²	-0.103	0.184	81.6	0.129

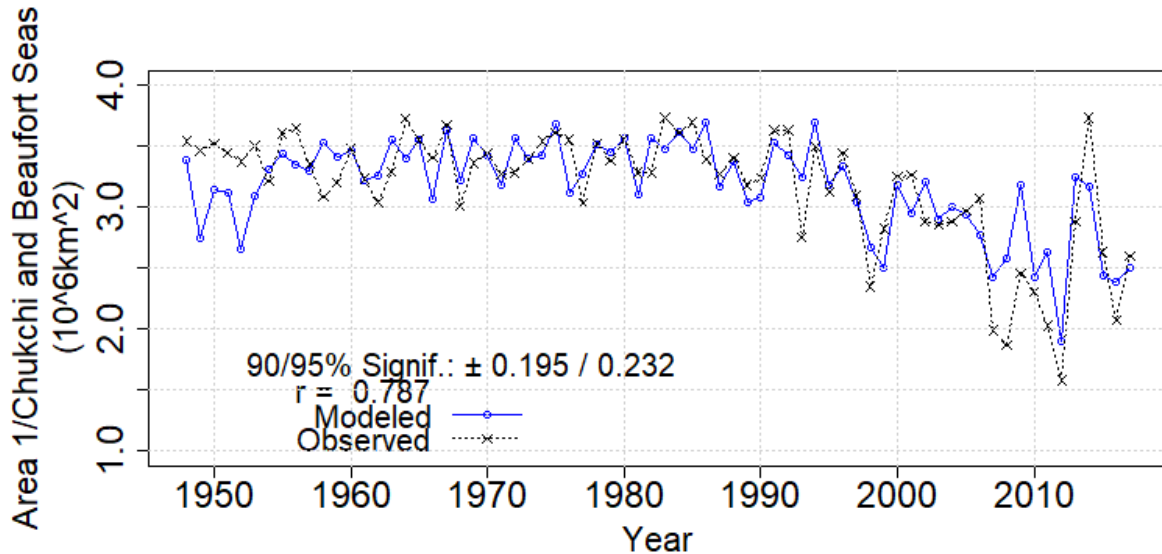


Figure 4.3.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.49 - 0.02AO^2 - 0.07DA - 0.12DA^2 - 0.07NAO \\
 & - 0.03DA*AO^2 - 0.02NAO*AO^2 + 0.001DA*NAO \\
 & + 0.17PDO - 0.14PDO^2 - 0.14AMO - 0.09AMO^2 \\
 & - 0.04AMO*PDO \\
 & - 0.07PDO*AO^2 + 0.20PDO*DA - 0.03AMO*AO^2 - 0.12AMO*NAO + 0.12AMO*DA
 \end{aligned}$$

Equation 4.3.1-1

4.3.2 East Siberian and Laptev Seas, Period 3 1948-2017

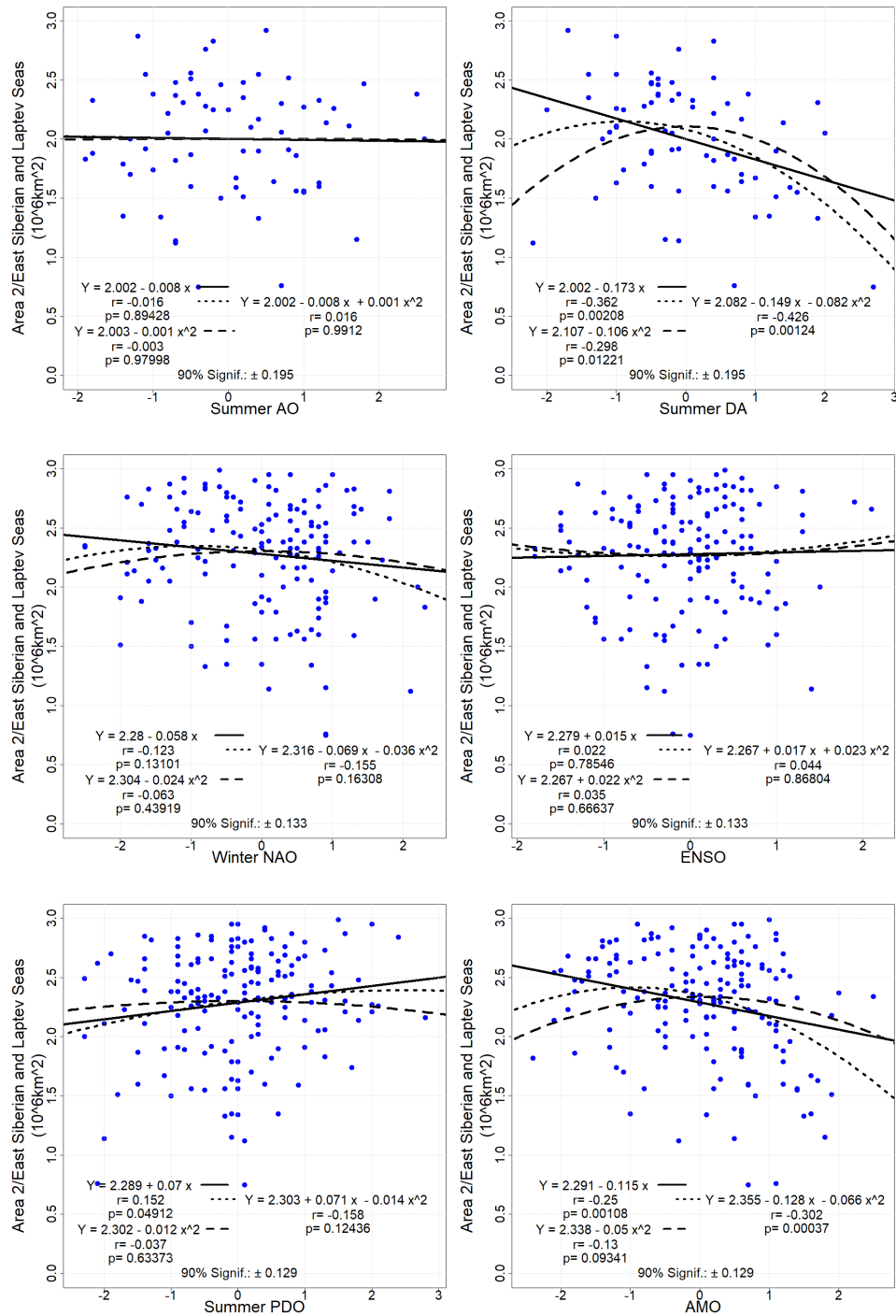


Figure 4.3.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 4.3.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.016	0.894	10.6	0.195
AO ²	-0.003	0.980	2.0	0.195
DA	-0.362	0.002	99.8	0.195
DA ²	-0.298	0.012	98.8	0.195
NAO	-0.123	0.131	86.9	0.133
NAO ²	-0.063	0.439	56.1	0.133
ENSO	0.022	0.785	21.5	0.133
ENSO ²	0.035	0.666	33.4	0.133
PDO	0.152	0.049	95.4	0.129
PDO ²	-0.037	0.634	36.6	0.129
AMO	-0.250	0.001	99.9	0.129
AMO ²	-0.130	0.093	90.7	0.129

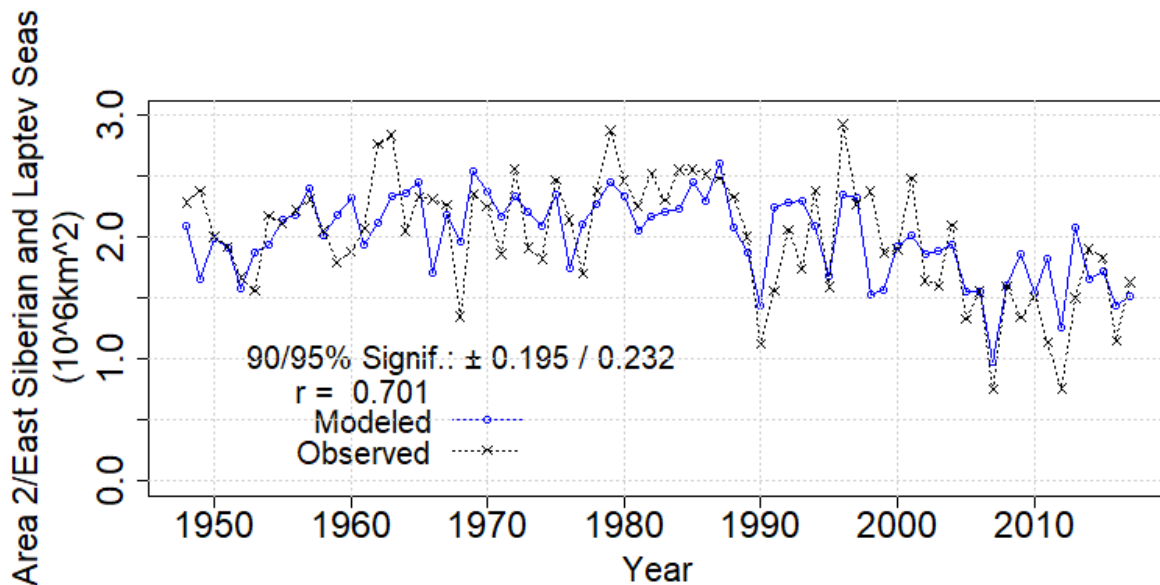


Figure 4.3.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.19 - 0.11DA - 0.11DA^2 - 0.16NAO - 0.02NAO^2 \\
 & + 0.04DA*NAO \\
 & + 0.12PDO - 0.14AMO - 0.05AMO^2 \\
 & + 0.05AMO*PDO \\
 & + 0.04PDO*DA - 0.08AMO*NAO + 0.07AMO*DA
 \end{aligned}$$

Equation 4.3.2-1

4.3.3 Central Arctic, Period 3 1948-2017

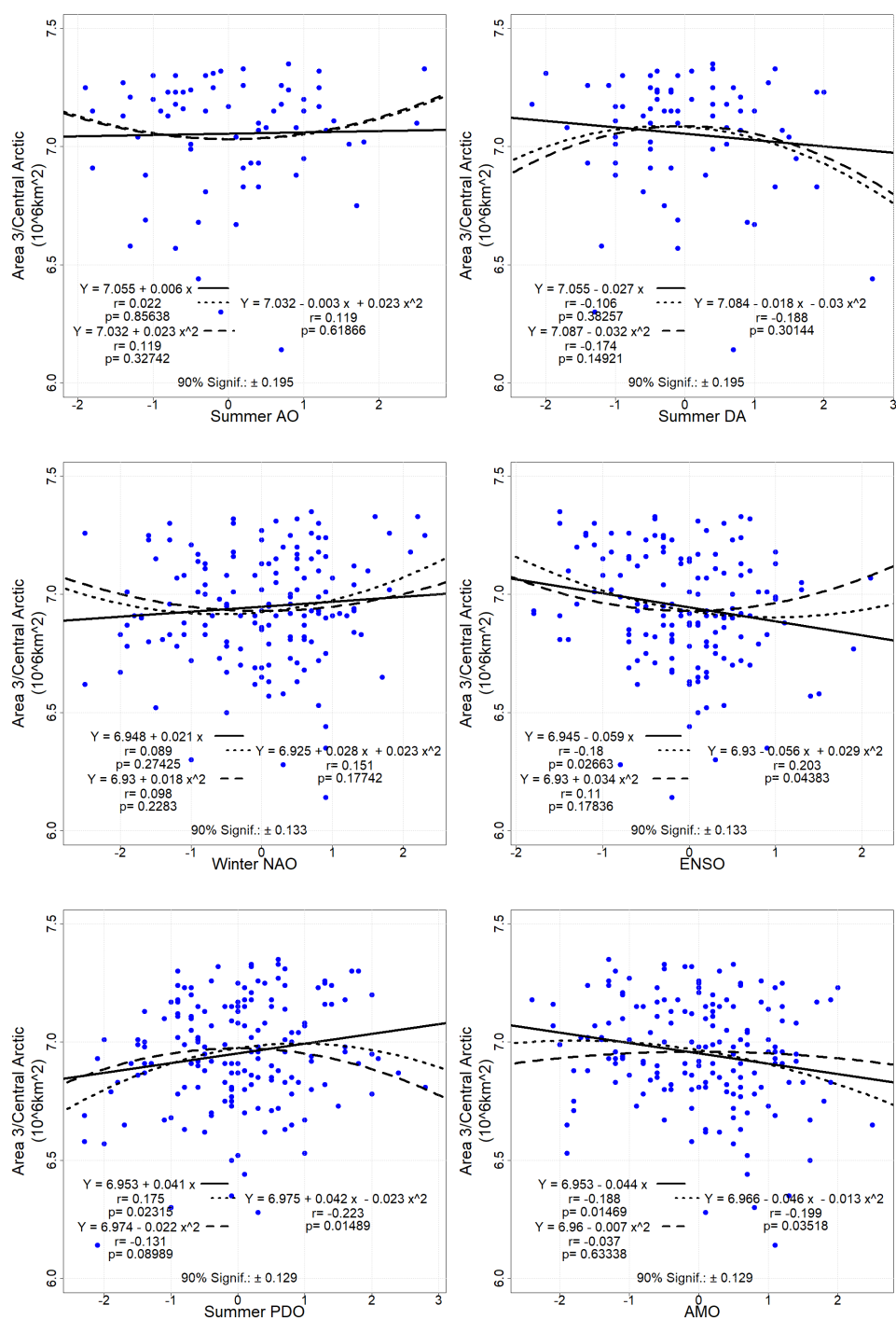


Figure 4.3.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 4.3.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.022	0.856	14.4	0.195
AO ²	0.119	0.327	67.3	0.195
DA	-0.106	0.383	61.7	0.195
DA ²	-0.174	0.149	85.1	0.195
NAO	0.089	0.274	72.6	0.133
NAO ²	0.098	0.228	77.2	0.133
ENSO	-0.180	0.026	97.4	0.133
ENSO ²	0.110	0.178	82.2	0.133
PDO	0.175	0.023	97.7	0.129
PDO ²	-0.131	0.090	91.0	0.129
AMO	-0.188	0.015	98.5	0.129
AMO ²	-0.037	0.633	36.7	0.129

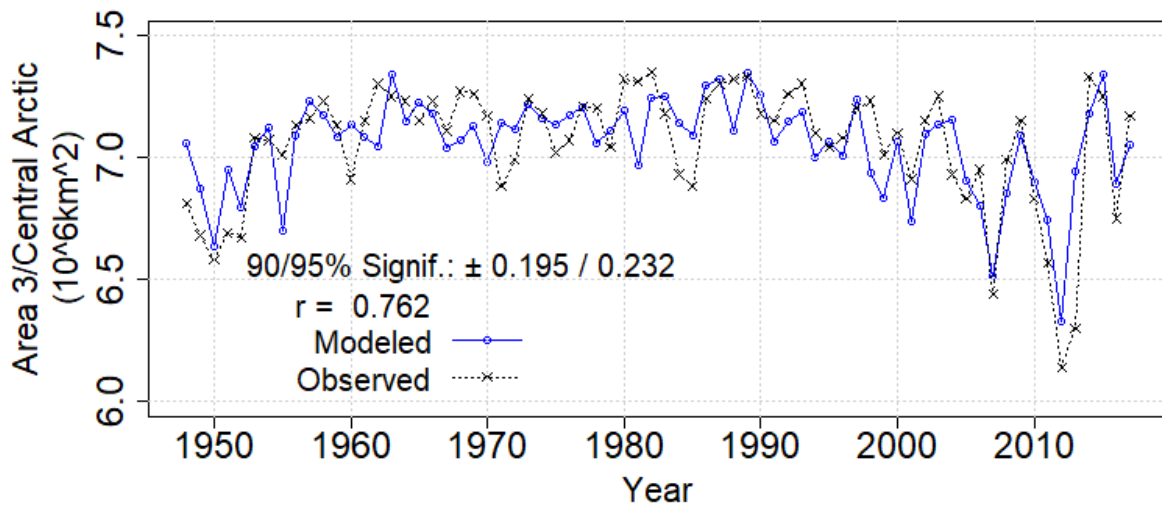


Figure 4.3.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.19 - 0.04AO^2 - 0.01DA - 0.07DA^2 + 0.01NAO + 0.06NAO^2 - 0.002ENSO - 0.08ENSO^2 \\
 & + 0.004DA*AO^2 + 0.001NAO*AO^2 - 0.03DA*NAO - 0.06DA*ENSO \\
 & + 0.11PDO - 0.10PDO^2 - 0.01AMO \\
 & + 0.04AMO*PDO \\
 & - 0.13PDO*ENSO - 0.02PDO*DA - 0.03AMO*AO^2 - 0.03AMO*NAO - 0.03AMO*DA
 \end{aligned}$$

Equation 4.3.3-1

4.3.4 Kara and Barents Seas, Period 3 1948-2017

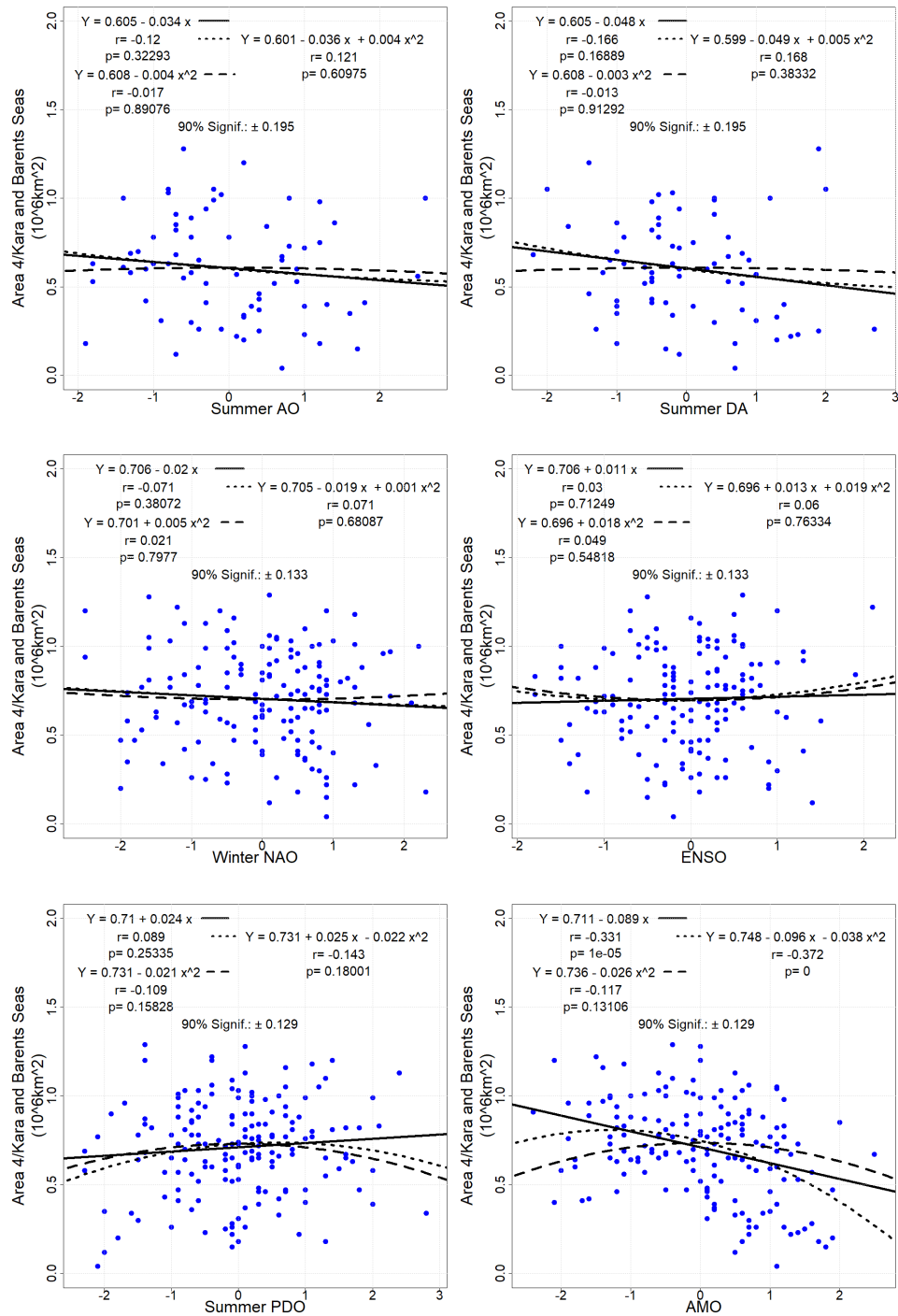


Figure 4.3.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 4.3.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.120	0.856	14.4	0.195
AO ²	-0.017	0.327	67.3	0.195
DA	-0.166	0.383	61.7	0.195
DA ²	-0.013	0.149	85.1	0.195
NAO	-0.071	0.274	72.6	0.133
NAO ²	0.021	0.228	77.2	0.133
ENSO	0.030	0.026	97.4	0.133
ENSO ²	0.049	0.178	82.2	0.133
PDO	0.089	0.023	97.7	0.129
PDO ²	-0.109	0.090	91.0	0.129
AMO	-0.331	0.015	98.5	0.129
AMO ²	-0.117	0.633	36.7	0.129

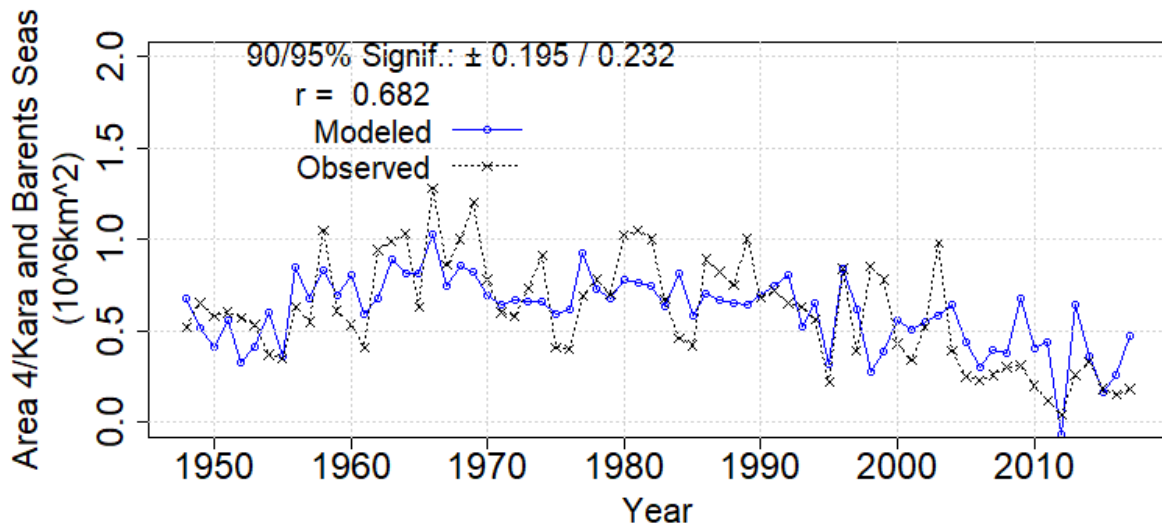


Figure 4.3.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.73 - 0.01AO - 0.02DA - 0.08NAO \\
 & - 0.07AO*DA + 0.02AO*NAO - 0.04DA*NAO \\
 & + 0.04PDO - 0.05PDO^2 - 0.10AMO - 0.06AMO^2 \\
 & + 0.01AMO*PDO \\
 & + 0.05PDO*AO - 0.01PDO*DA + 0.001AMO*AO - 0.03AMO*DA - 0.06AMO*NAO
 \end{aligned}$$

Equation 4.3.4-1

4.3.5 Greenland Sea, Period 3 1948-2017

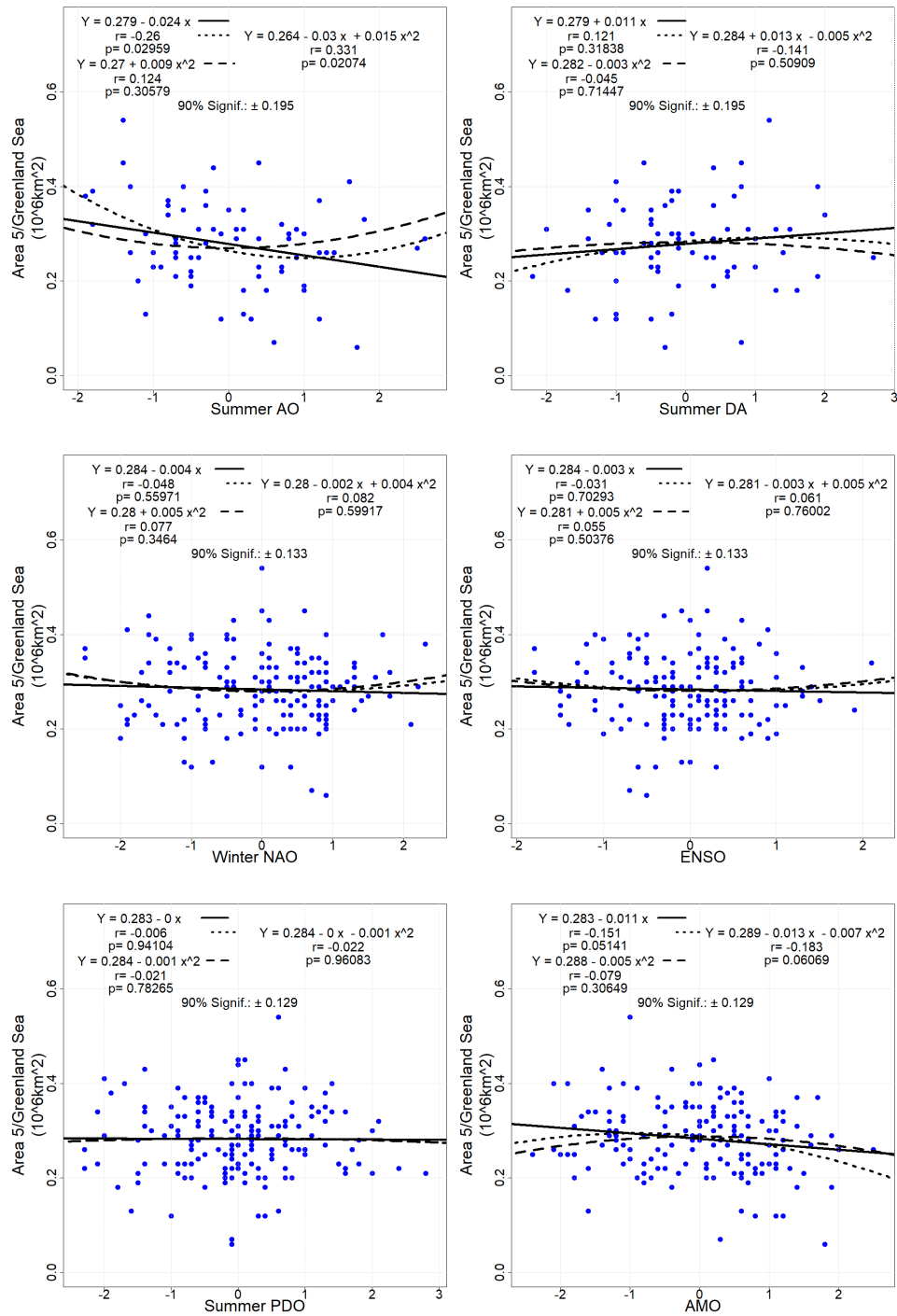


Figure 4.3.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 4.3.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.260	0.030	97.0	0.195
AO ²	0.124	0.306	69.4	0.195
DA	0.121	0.318	68.2	0.195
DA ²	-0.045	0.714	28.6	0.195
NAO	-0.048	0.560	44.0	0.133
NAO ²	0.077	0.346	65.4	0.133
ENSO	-0.031	0.703	29.7	0.133
ENSO ²	0.055	0.504	49.6	0.133
PDO	-0.006	0.941	5.9	0.129
PDO ²	-0.021	0.783	21.7	0.129
AMO	-0.151	0.051	94.1	0.129
AMO ²	-0.079	0.306	69.4	0.129

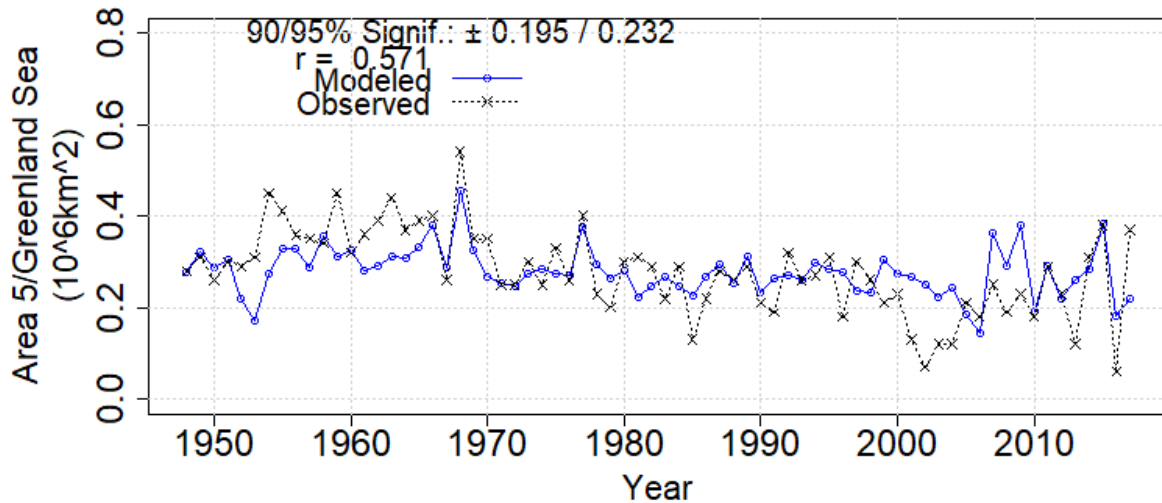


Figure 4.3.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.29 - 0.04AO + 0.01AO^2 + 0.02DA + 0.01NAO^2 - 0.01ENSO^2 \\
 & - 0.04AO*DA + 0.01AO*NAO^2 - 0.003DA*NAO^2 - 0.02DA*ENSO^2 \\
 & - 0.02AMO - 0.01AMO^2 \\
 & - 0.01AMO*AO - 0.01AMO*DA + 0.003AMO*NAO^2
 \end{aligned}$$

Equation 4.3.5-1

4.3.6 Baffin Bay, Period 3 1948-2017

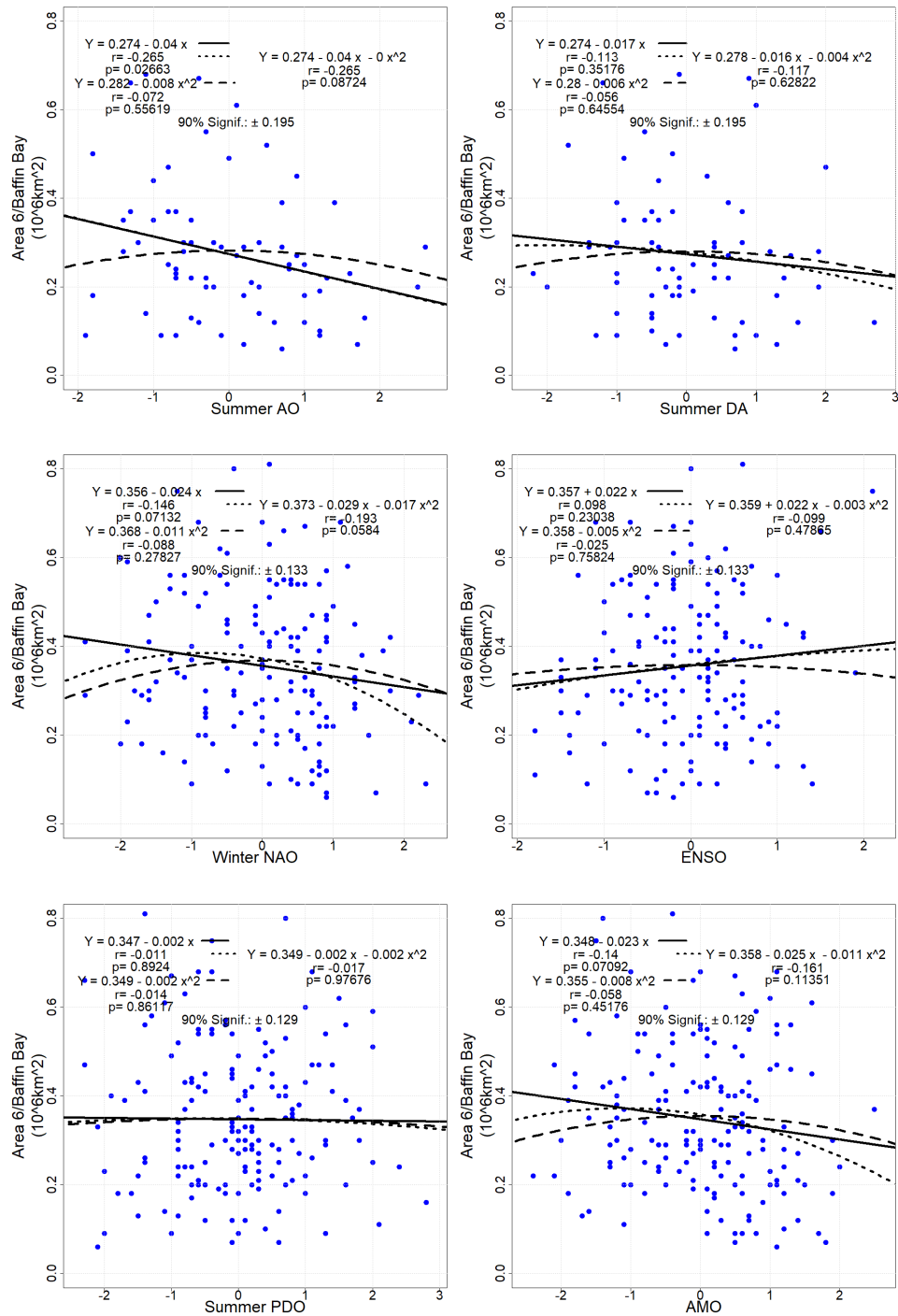


Figure 4.3.5-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 4.3.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.265	0.027	97.3	0.195
AO ²	-0.072	0.556	44.4	0.195
DA	-0.113	0.352	64.8	0.195
DA ²	-0.056	0.646	35.4	0.195
NAO	-0.146	0.071	92.9	0.133
NAO ²	-0.088	0.278	72.2	0.133
ENSO	0.098	0.230	77.0	0.133
ENSO ²	-0.025	0.758	24.2	0.133
PDO	-0.011	0.892	10.8	0.129
PDO ²	-0.014	0.861	13.9	0.129
AMO	-0.140	0.071	92.9	0.129
AMO ²	-0.058	0.452	54.8	0.129

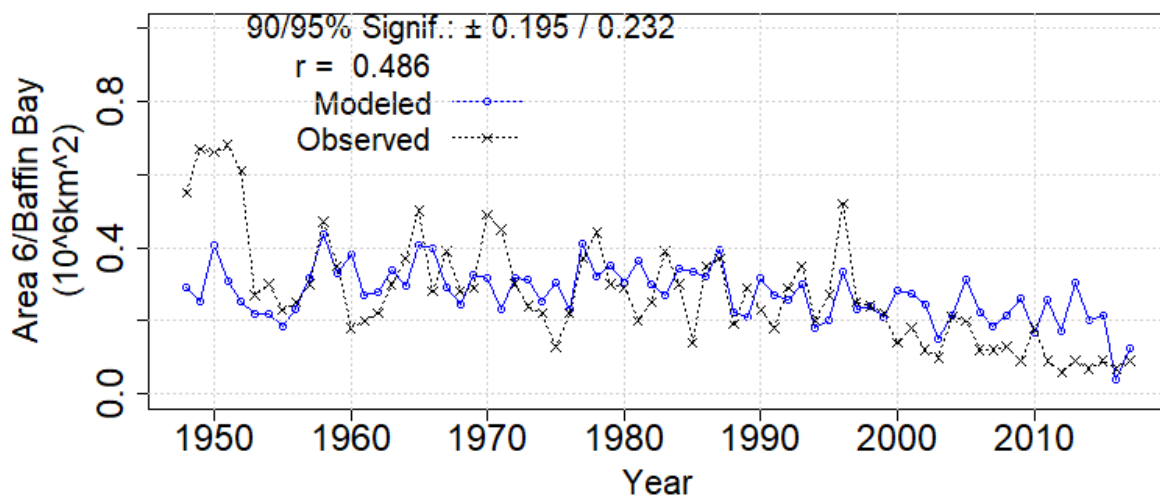


Figure 4.3.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.30 - 0.03AO + 0.01AO^2 - 0.02DA - 0.02NAO - 0.02NAO^2 - 0.03ENSO \\
 & + 0.004AO*DA + 0.003AO*NAO + 0.02AO*ENSO - 0.004DA*NAO - 0.05DA*ENSO + \\
 & 0.03ENSO*NAO \\
 & - 0.02AMO - 0.01AMO^2 \\
 & - 0.01AMO*AO + 0.01AMO*DA - 0.03AMO*NAO
 \end{aligned}$$

Equation 4.3.6-1

4.3.7 Whole Arctic, Period 3 1948-2017

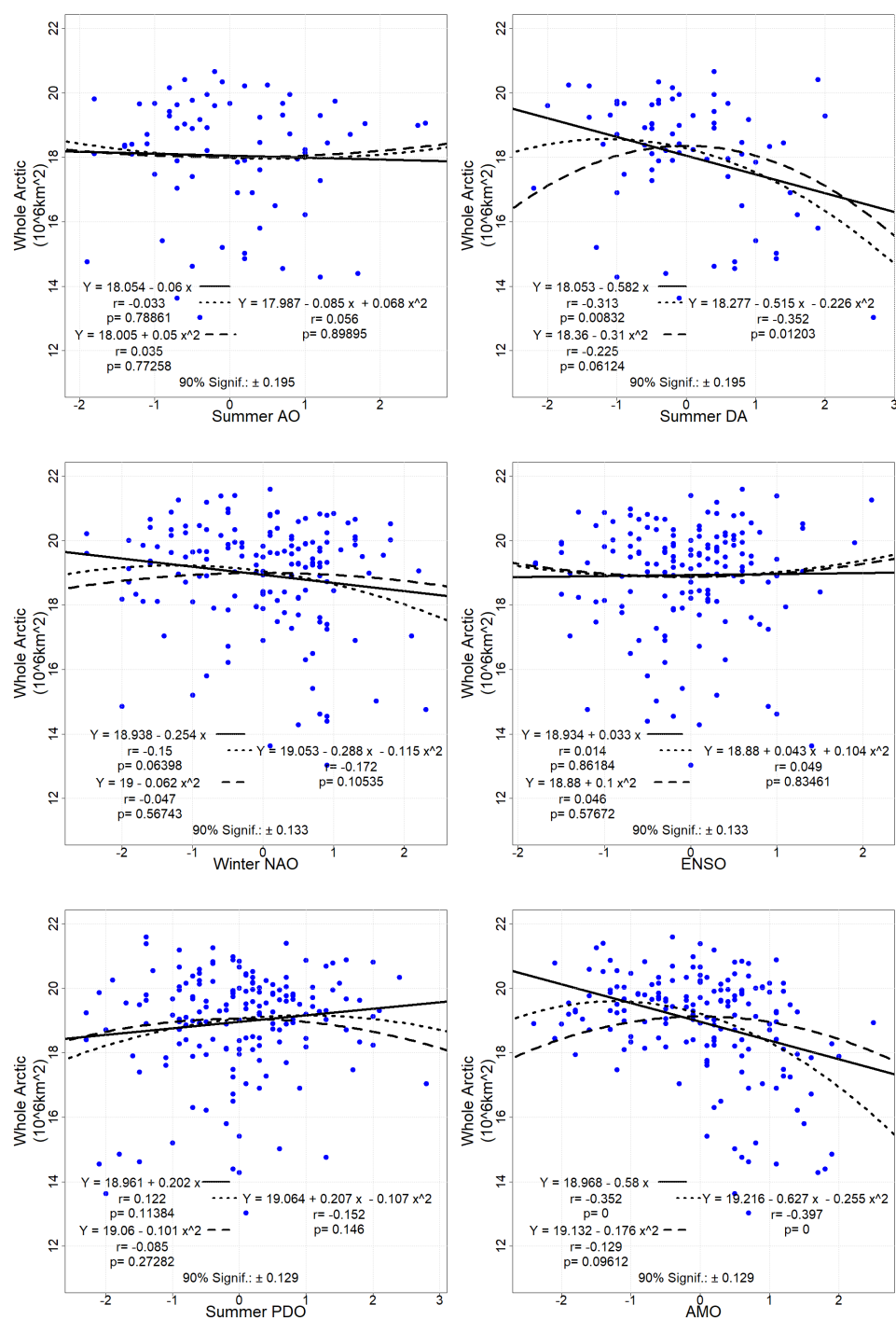


Figure 4.3.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 4.3.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.033	0.027	97.3	0.195
AO ²	0.035	0.556	44.4	0.195
DA	-0.313	0.352	64.8	0.195
DA ²	-0.225	0.646	35.4	0.195
NAO	-0.150	0.071	92.9	0.133
NAO ²	-0.047	0.278	72.2	0.133
ENSO	0.014	0.230	77.0	0.133
ENSO ²	0.046	0.758	24.2	0.133
PDO	0.122	0.892	10.8	0.129
PDO ²	-0.085	0.861	13.9	0.129
AMO	-0.352	0.071	92.9	0.129
AMO ²	-0.129	0.452	54.8	0.129

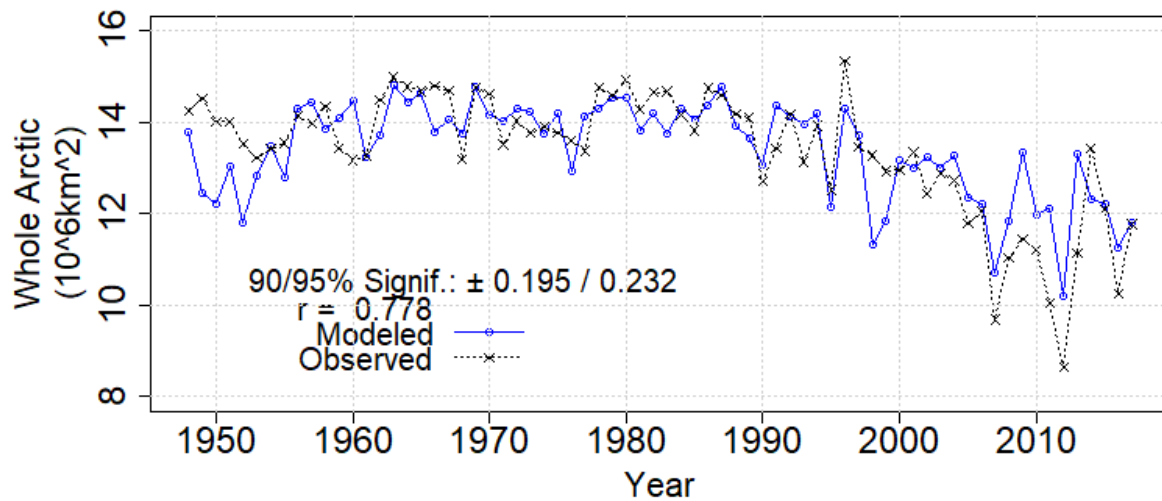


Figure 4.3.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.19 - 0.19DA - 0.26DA^2 - 0.45NAO \\
 & - 0.04DA*NAO \\
 & + 0.33PDO - 0.20PDO^2 - 0.52AMO - 0.29AMO^2 \\
 & + 0.22AMO*PDO \\
 & + 0.06AMO*DA - 0.36AMO*NAO
 \end{aligned}$$

Equation 4.3.7-1

5 FOUR-INDEX MODELS, 1948-2017

5.1 PERIOD 1 1948-1978

5.1.1 Chukchi and Beaufort Seas, Period 1 1948-1978

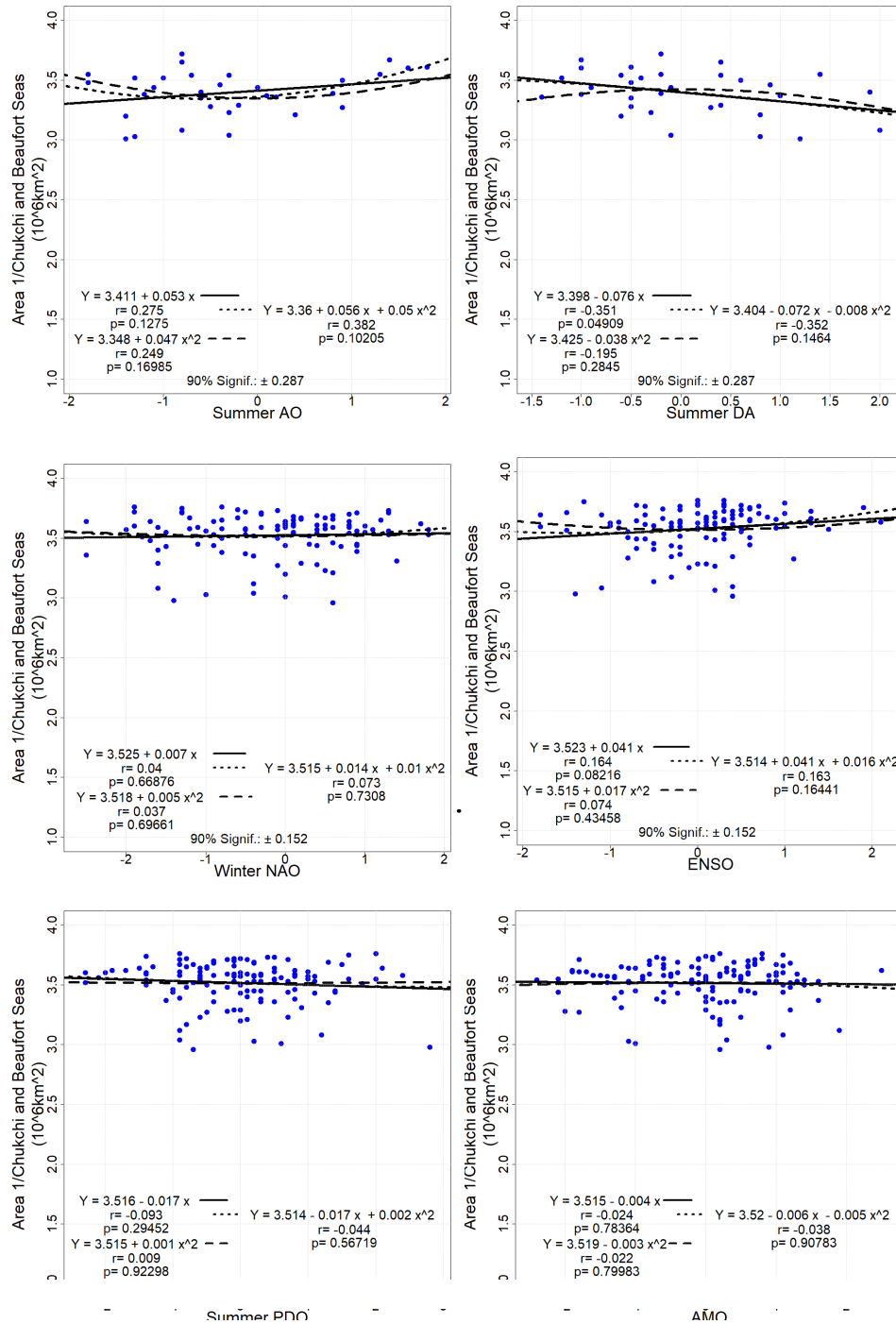


Figure 5.1.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 5.1.1-1 Table summarizing the correlation and significance levels of the teleconnections' impact on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.275	0.128	87.2	0.287
AO ²	0.249	0.170	83.0	0.287
DA	-0.351	0.049	95.1	0.287
DA ²	-0.195	0.285	71.5	0.287
NAO	0.040	0.669	33.1	0.152
NAO ²	0.037	0.697	30.3	0.152
ENSO	0.164	0.082	91.8	0.152
ENSO ²	0.074	0.435	56.6	0.152
PDO	-0.093	0.295	70.5	0.142
PDO ²	0.009	0.923	7.7	0.142
AMO	-0.024	0.784	21.6	0.142
AMO ²	-0.022	0.800	20.0	0.142

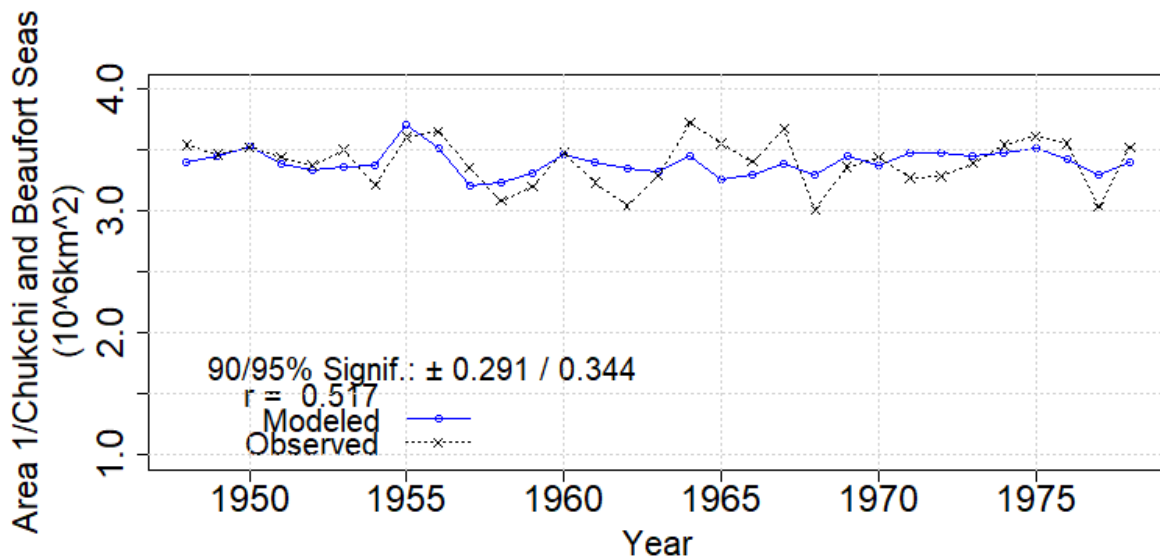


Figure 5.1.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.31 + 0.08\text{NAO} + 0.07\text{NAO}^2 + 0.01\text{ENSO} + 0.12\text{ENSO}^2 \\
 & - 0.11\text{ENSO}*\text{NAO} \\
 & - 0.05\text{PDO} \\
 & + 0.05\text{PDO}*\text{ENSO}
 \end{aligned}$$

Equation 5.1.1-1

5.1.2 East Siberian and Laptev Seas, Period 1 1948-1978

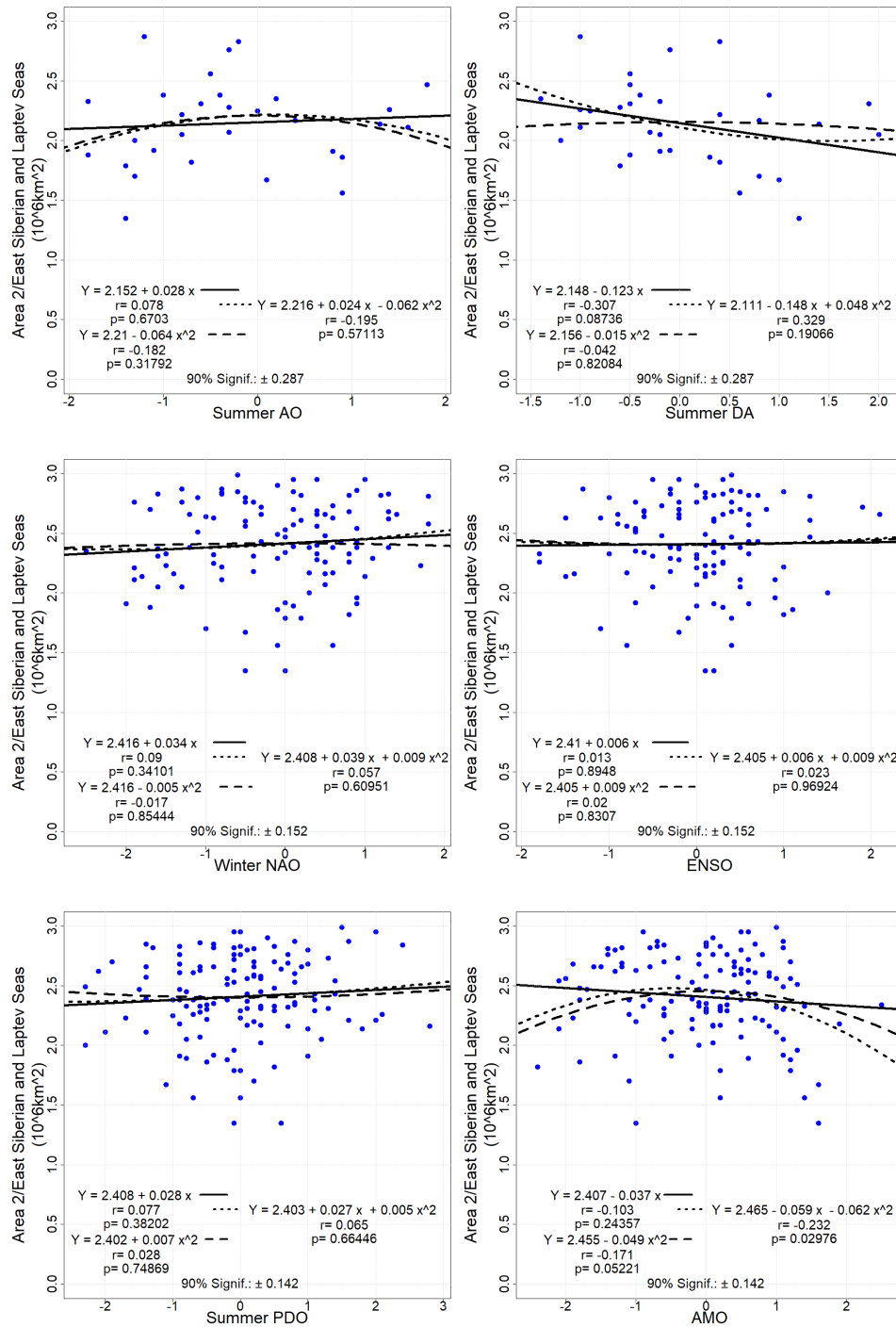


Figure 5.1.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 5.1.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.078	0.670	33.0	0.287
AO ²	-0.182	0.318	60.2	0.287
DA	-0.307	0.087	91.3	0.287
DA ²	-0.042	0.821	17.9	0.287
NAO	0.090	0.341	65.9	0.152
NAO ²	-0.017	0.854	14.6	0.152
ENSO	0.013	0.895	10.5	0.152
ENSO ²	0.020	0.831	16.9	0.152
PDO	0.077	0.382	61.8	0.142
PDO ²	0.028	0.749	25.1	0.142
AMO	-0.103	0.244	75.6	0.142
AMO ²	-0.171	0.052	94.8	0.142

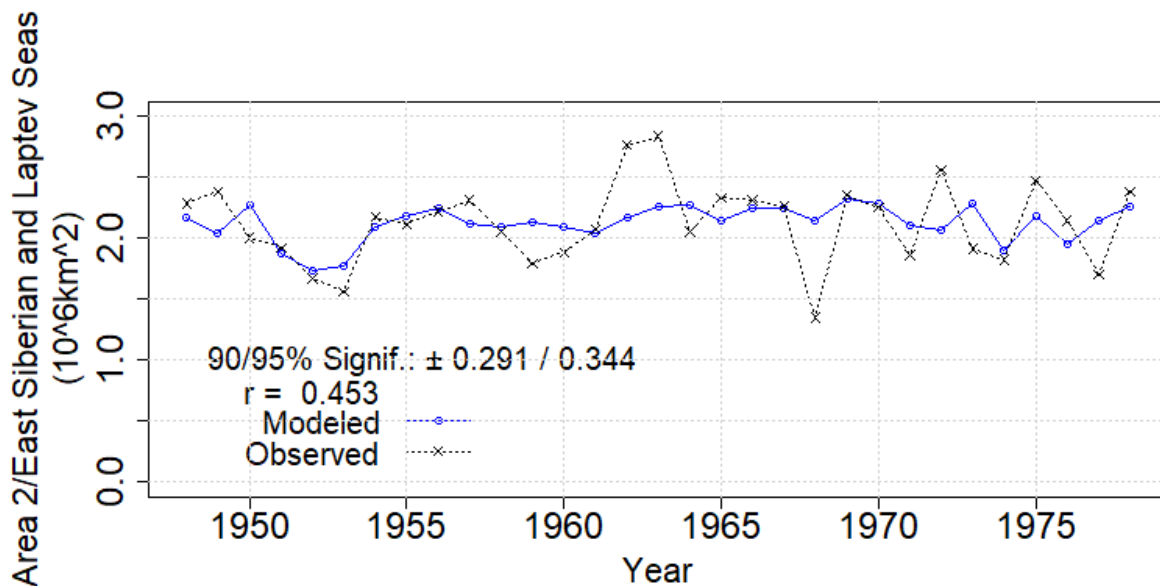


Figure 5.1.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.15 - 0.06\text{NAO} \\
 & - 0.04\text{PDO} - 0.14\text{AMO} - 0.11\text{AMO}^2 \\
 & + 0.04\text{AMO}*\text{PDO} \\
 & - 0.08\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.1.2-1

5.1.3 Central Arctic, Period 1 1948-1978

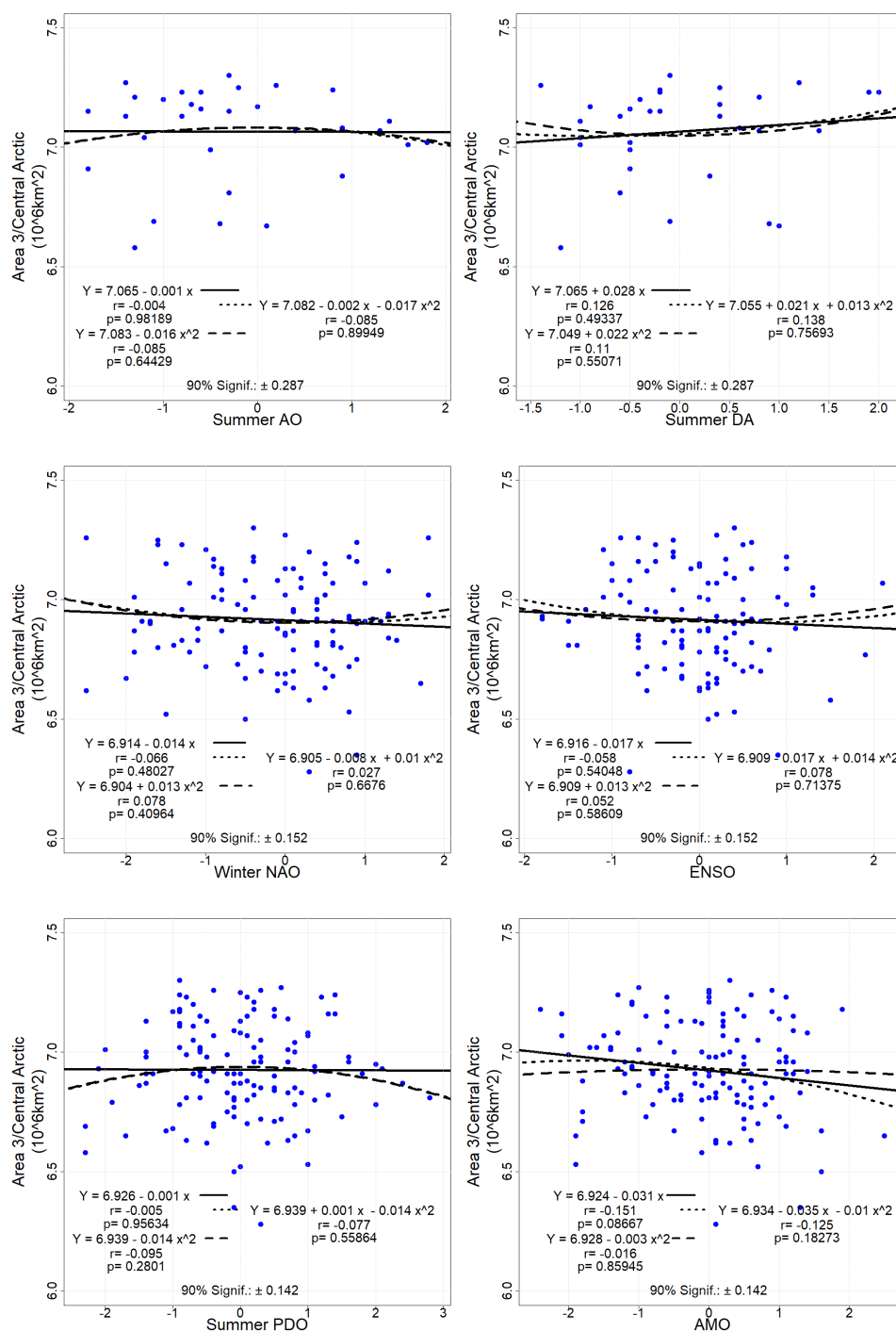


Figure 5.1.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 5.1.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.004	0.982	1.8	0.287
AO ²	-0.085	0.644	35.6	0.287
DA	0.126	0.493	50.7	0.287
DA ²	0.110	0.551	44.9	0.287
NAO	-0.066	0.480	52.0	0.152
NAO ²	0.078	0.410	59.0	0.152
ENSO	-0.058	0.540	46.0	0.152
ENSO ²	0.052	0.586	41.4	0.152
PDO	-0.005	0.956	4.4	0.142
PDO ²	-0.095	0.280	72.0	0.142
AMO	-0.151	0.087	91.3	0.142
AMO ²	-0.016	0.859	14.1	0.142

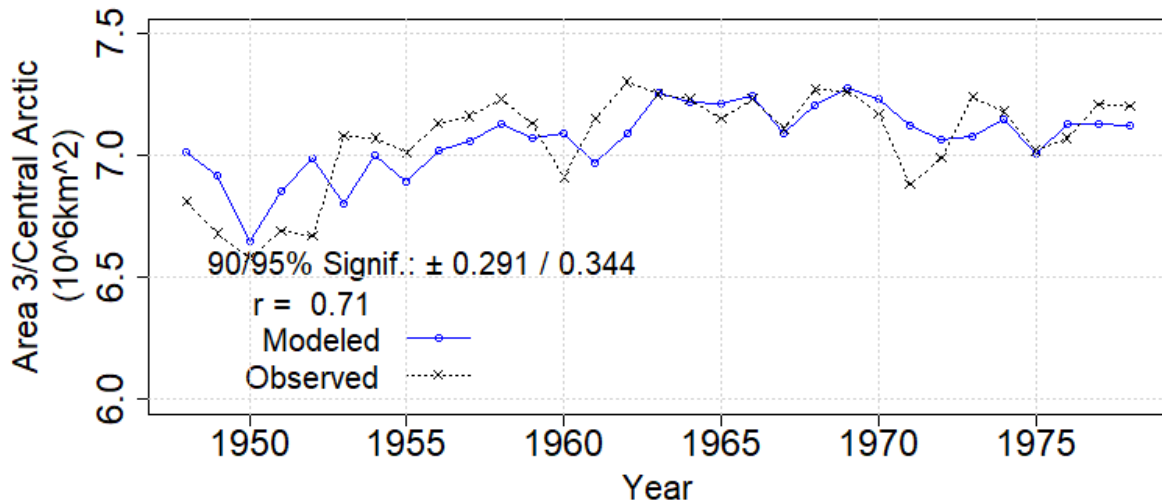


Figure 5.1.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.10 - 0.14\text{NAO} - 0.03\text{NAO}^2 + 0.06\text{ENSO} - 0.19\text{ENSO}^2 \\
 & + 0.08\text{ENSO}*\text{NAO} \\
 & - 0.01\text{PDO}^2 - 0.11\text{AMO} \\
 & + 0.01\text{AMO}*\text{PDO}^2 \\
 & - 0.004\text{PDO}^2*\text{ENSO} - 0.001\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.1.3-1

5.1.4 Kara and Barents Seas, Period 1 1948-1978

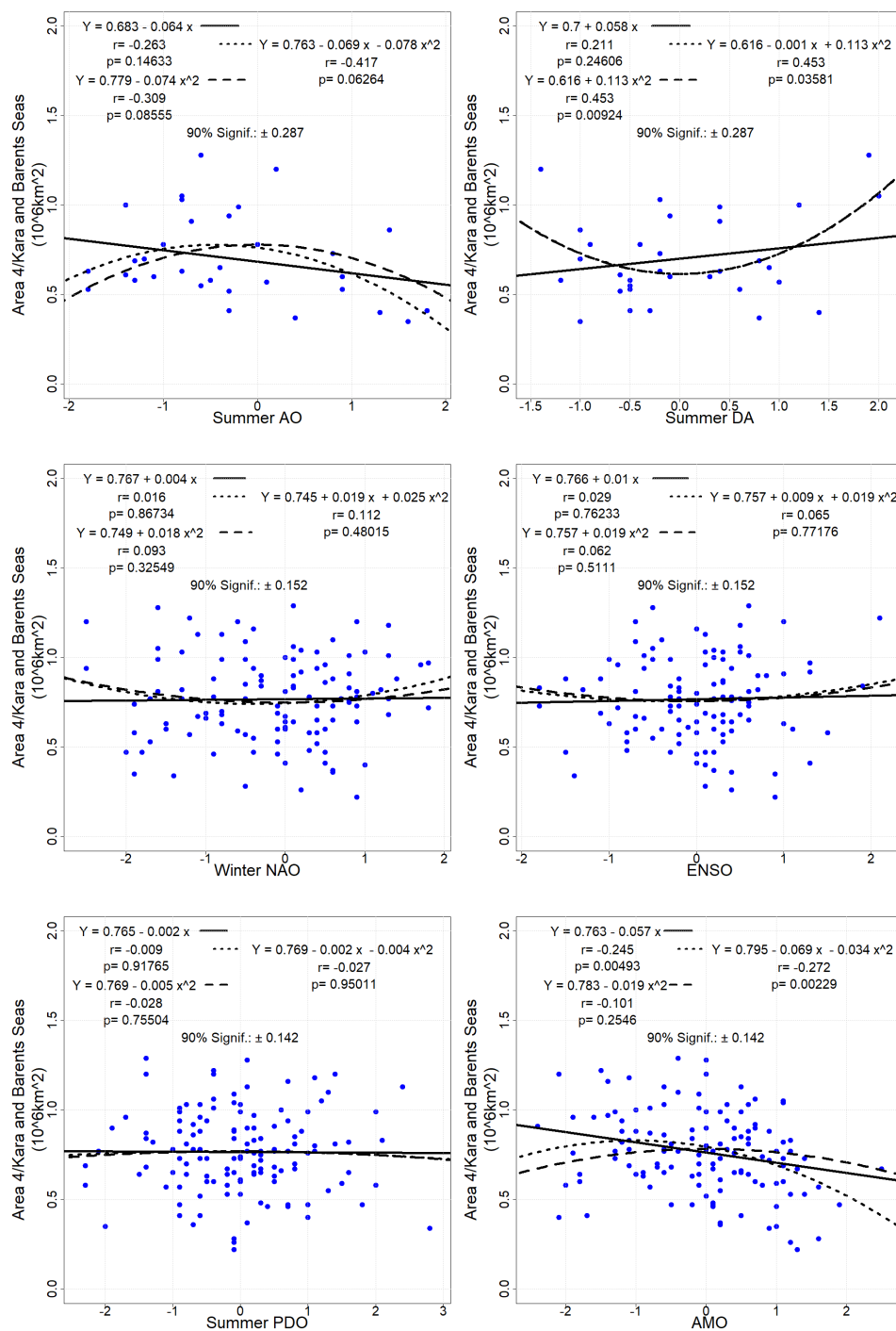


Figure 5.1.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 5.1.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.263	0.146	85.4	0.287
AO ²	-0.309	0.086	91.4	0.287
DA	0.211	0.246	75.4	0.287
DA ²	0.453	0.009	99.1	0.287
NAO	0.016	0.867	13.3	0.152
NAO ²	0.093	0.325	67.5	0.152
ENSO	0.029	0.762	23.8	0.152
ENSO ²	0.062	0.511	48.9	0.152
PDO	-0.009	0.918	8.2	0.142
PDO ²	-0.028	0.755	24.5	0.142
AMO	-0.245	0.005	99.5	0.142
AMO ²	-0.101	0.255	74.5	0.142

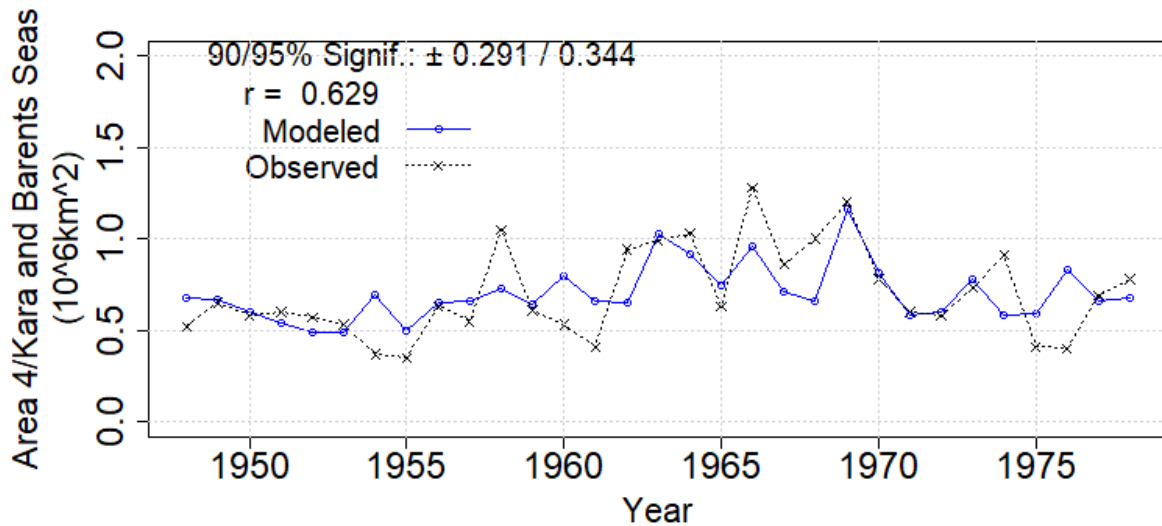


Figure 5.1.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.66 + 0.16\text{NAO}^2 - 0.02\text{ENSO}^2 \\
 & - 0.16\text{ENSO}^2 * \text{NAO}^2 \\
 & - 0.05\text{AMO} - 0.04\text{AMO}^2 \\
 & - 0.05\text{AMO} * \text{NAO}^2
 \end{aligned}$$

Equation 5.1.4-1

5.1.5 Greenland Sea, Period 1 1948-1978

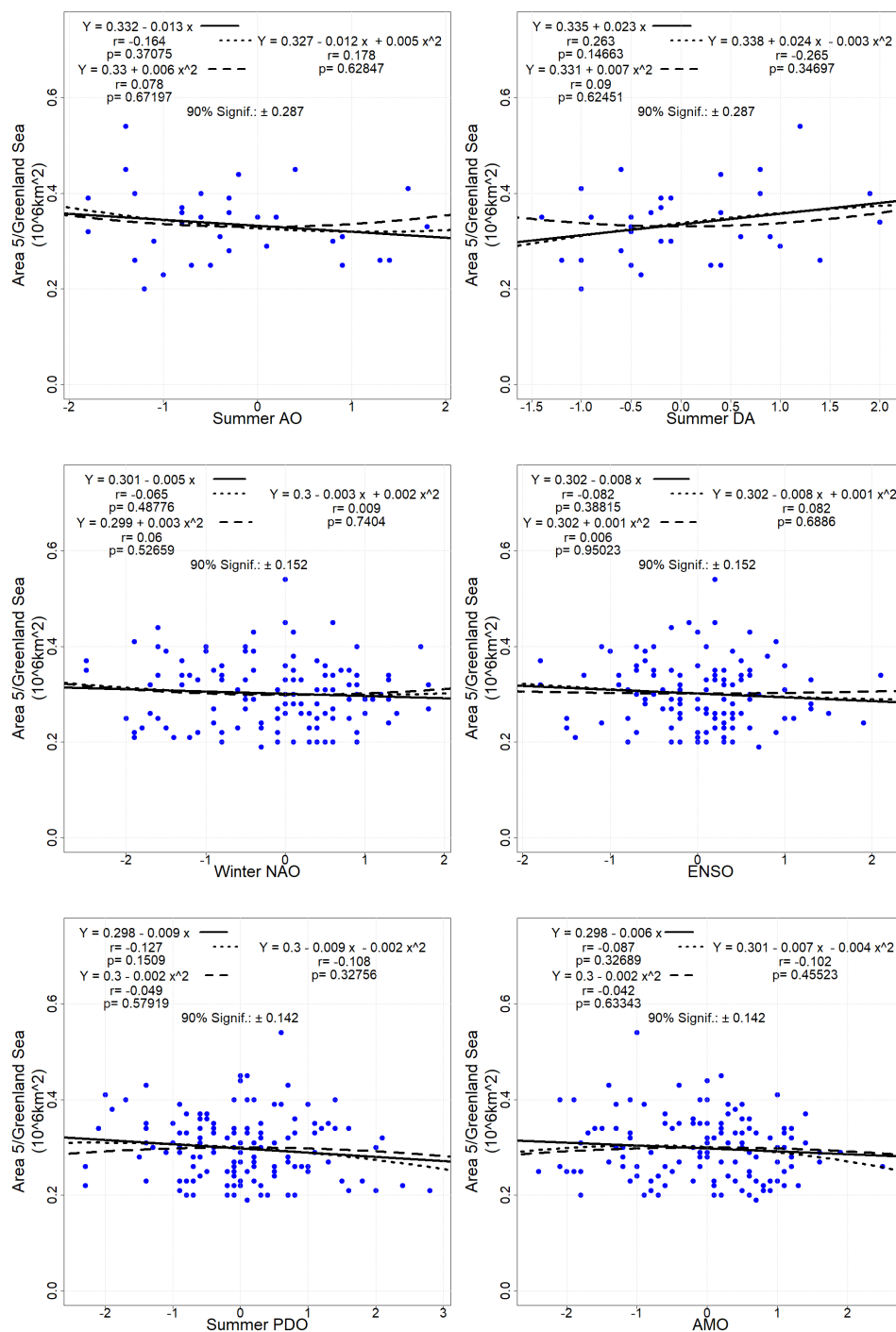


Figure 5.1.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 5.1.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.164	0.371	62.9	0.287
AO ²	0.078	0.672	32.8	0.287
DA	0.263	0.147	85.3	0.287
DA ²	0.090	0.625	37.5	0.287
NAO	-0.065	0.488	51.2	0.152
NAO ²	0.060	0.527	47.3	0.152
ENSO	-0.082	0.388	61.2	0.152
ENSO ²	-0.006	0.950	5.0	0.152
PDO	-0.127	0.151	84.9	0.142
PDO ²	-0.049	0.579	42.9	0.142
AMO	-0.087	0.327	67.3	0.142
AMO ²	-0.042	0.633	36.7	0.142

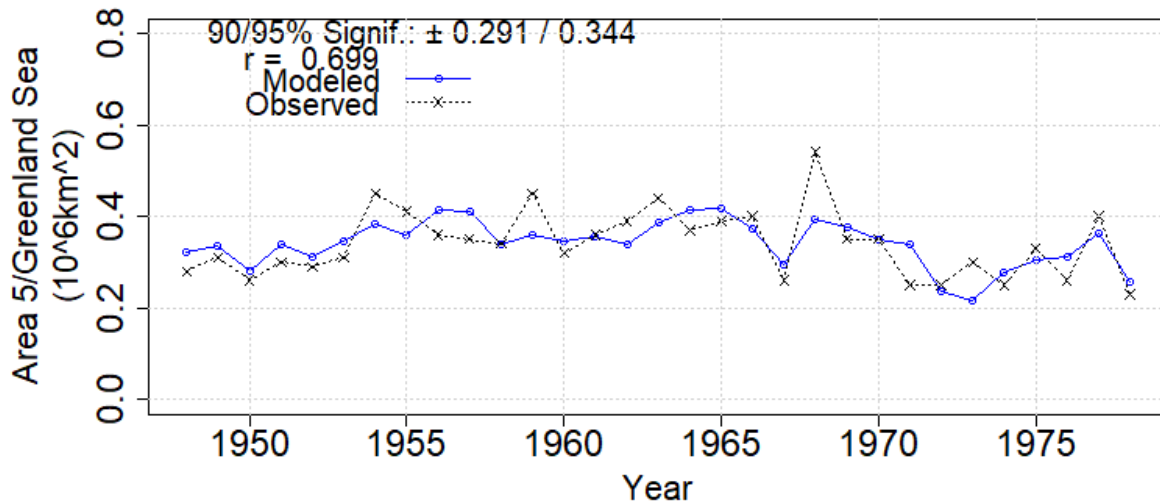


Figure 5.1.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is in

$$\begin{aligned}
 Y = & 0.36 - 0.004\text{NAO} + 0.02\text{NAO}^2 + 0.04\text{ENSO} \\
 & - 0.03\text{ENSO}*\text{NAO} \\
 & + 0.06\text{PDO} + 0.02\text{AMO} \\
 & - 0.02\text{AMO}*\text{PDO} \\
 & - 0.004\text{PDO}*\text{ENSO} + 0.06\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.1.5-1

5.1.6 Baffin Bay, Period 1 1948-1978

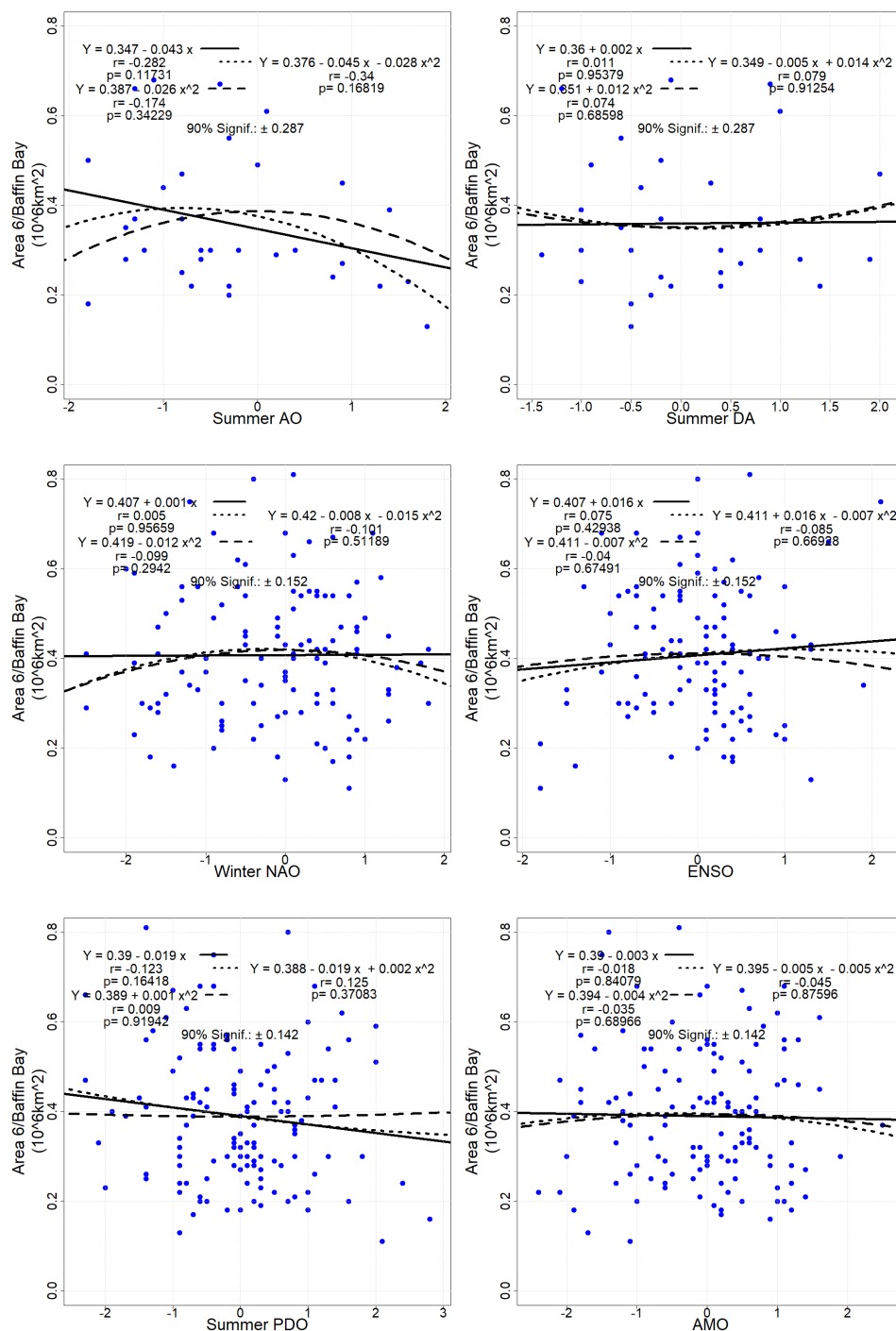


Figure 5.1.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 5.1.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.282	0.117	88.3	0.287
AO ²	-0.174	0.342	65.8	0.287
DA	0.011	0.954	4.6	0.287
DA ²	0.074	0.686	31.4	0.287
NAO	0.005	0.957	4.3	0.152
NAO ²	-0.099	0.294	70.6	0.152
ENSO	0.075	0.429	57.1	0.152
ENSO ²	-0.040	0.675	32.5	0.152
PDO	-0.123	0.164	83.6	0.142
PDO ²	0.009	0.919	8.1	0.142
AMO	-0.018	0.841	15.9	0.142
AMO ²	-0.035	0.690	31.0	0.142

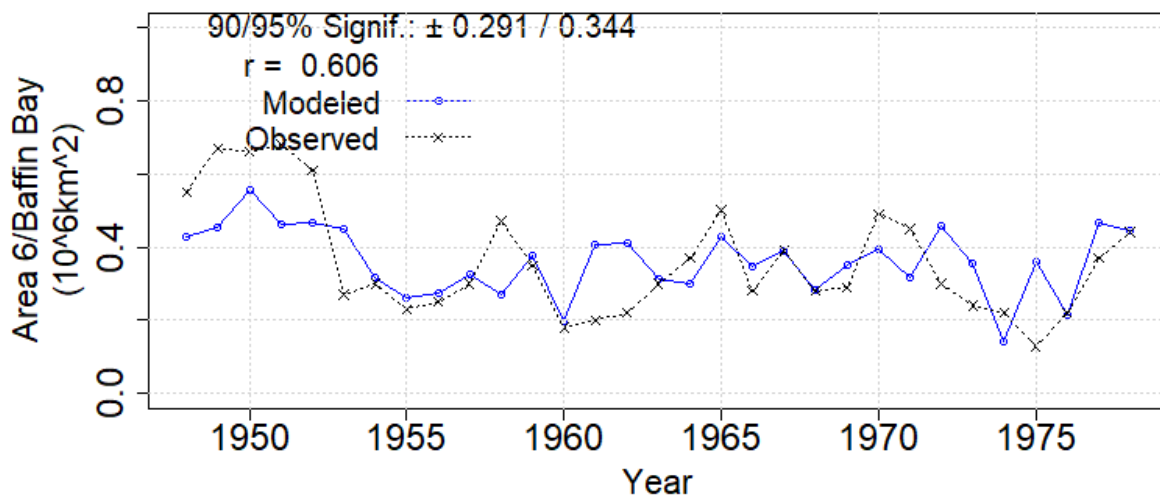


Figure 5.1.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.36 - 0.04\text{NAO}^2 - 0.11\text{ENSO} \\
 & - 0.04\text{ENSO}*\text{NAO}^2 \\
 & - 0.09\text{PDO} \\
 & - 0.04\text{PDO}*\text{ENSO}
 \end{aligned}$$

Equation 5.1.6-1

5.1.7 Whole Arctic, Period 1 1948-1978

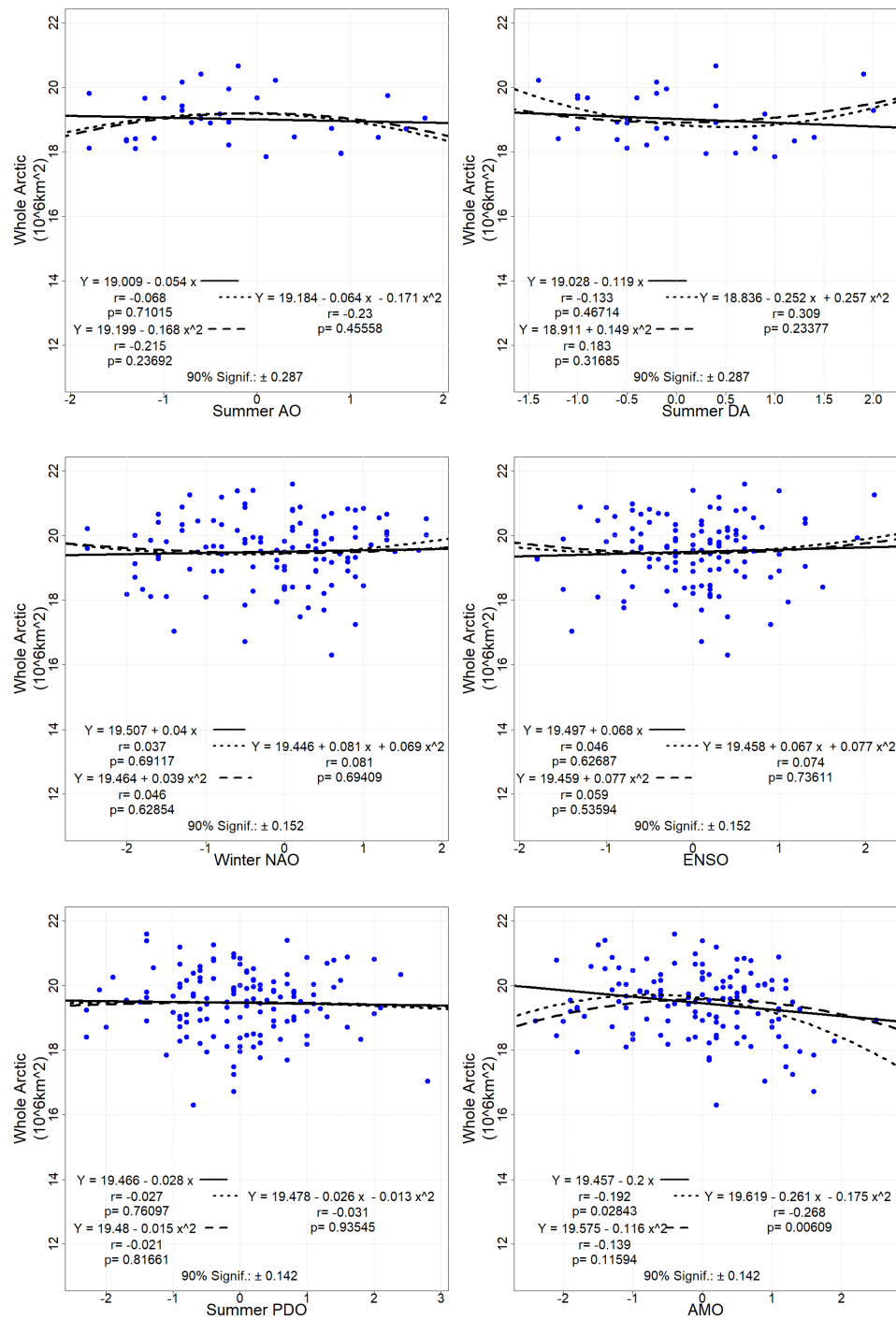


Figure 5.1.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 5.1.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.068	0.710	29.0	0.287
AO ²	-0.215	0.237	76.3	0.287
DA	-0.133	0.467	53.5	0.287
DA ²	0.183	0.317	68.3	0.287
NAO	0.037	0.691	30.9	0.152
NAO ²	0.046	0.629	37.1	0.152
ENSO	0.046	0.627	37.3	0.152
ENSO ²	0.059	0.536	46.4	0.152
PDO	-0.027	0.761	23.9	0.142
PDO ²	-0.021	0.817	19.3	0.142
AMO	-0.192	0.028	97.2	0.142
AMO ²	-0.139	0.116	88.4	0.142

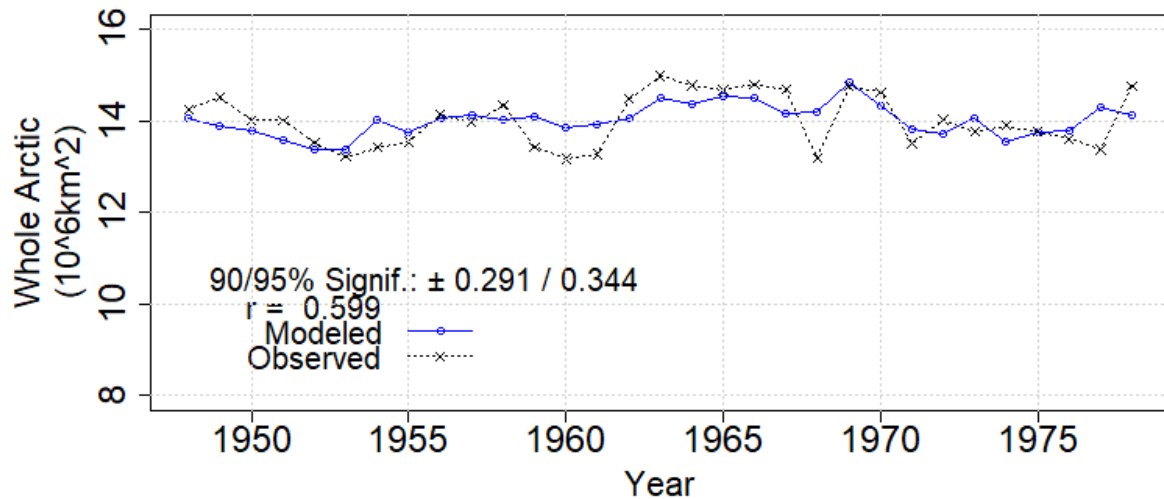


Figure 5.1.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.13 - 0.15\text{NAO} + 0.03\text{NAO}^2 + 0.002\text{ENSO} - 0.18\text{ENSO}^2 \\
 & + 0.12\text{ENSO}*\text{NAO} \\
 & - 0.25\text{AMO} - 0.17\text{AMO}^2 \\
 & + 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.1.7-1

5.2 PERIOD 2 1979-2017

5.2.1 Chukchi and Beaufort Seas, Period 2 1979-2017

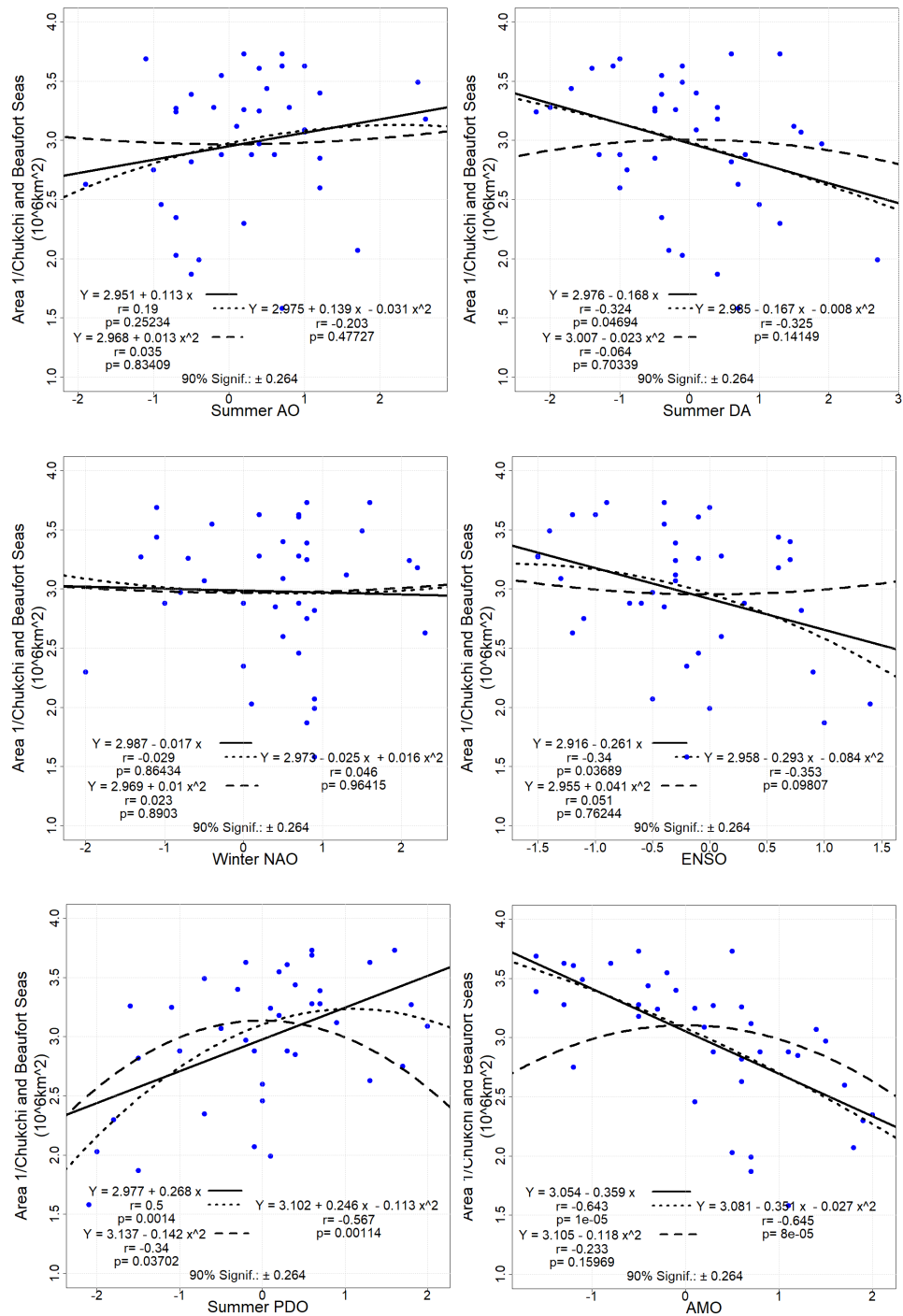


Figure 5.2.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 5.2.1-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.190	0.252	74.8	0.264
AO ²	0.035	0.834	16.6	0.264
DA	-0.324	0.047	95.3	0.264
DA ²	-0.064	0.703	29.7	0.264
NAO	-0.029	0.864	13.6	0.264
NAO ²	0.023	0.890	11.0	0.264
ENSO	-0.340	0.037	96.3	0.264
ENSO ²	0.051	0.762	23.8	0.264
PDO	0.500	0.001	99.9	0.264
PDO ²	-0.340	0.037	96.3	0.264
AMO	-0.643	0.000	100.0	0.264
AMO ²	-0.233	0.160	84.0	0.264

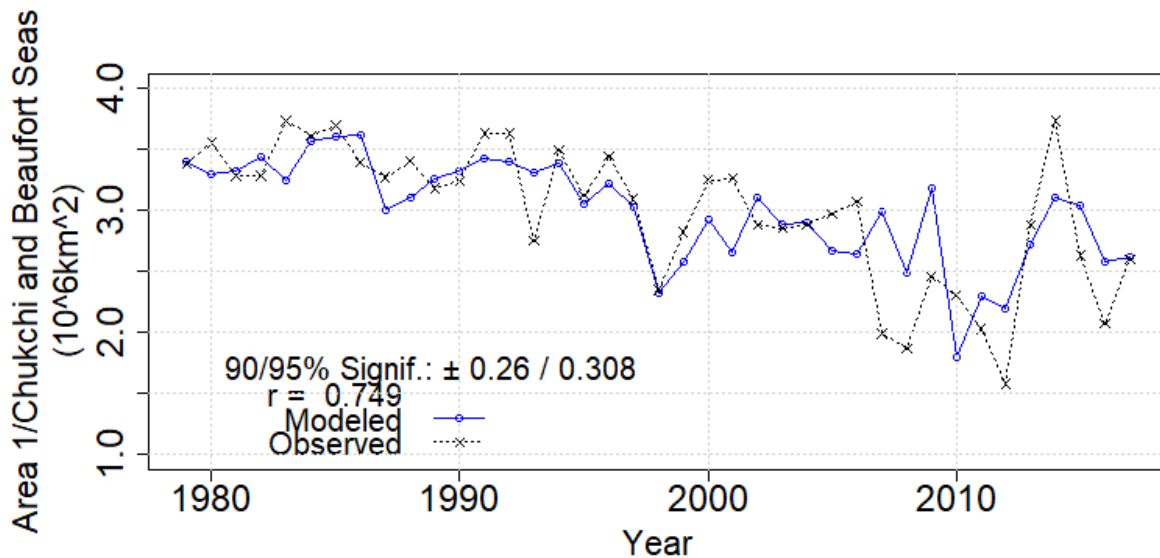


Figure 5.2.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.21 - 0.10\text{ENSO} - 0.12\text{ENSO}^2 \\
 & + 0.05\text{PDO} - 0.07\text{PDO}^2 - 0.32\text{AMO} - 0.01\text{AMO}^2 \\
 & + 0.09\text{AMO}*\text{PDO} \\
 & - 0.04\text{PDO}*\text{ENSO}
 \end{aligned}$$

Equation 5.2.1-1

5.2.2 East Siberian and Laptev Seas, Period 2 1979-2017

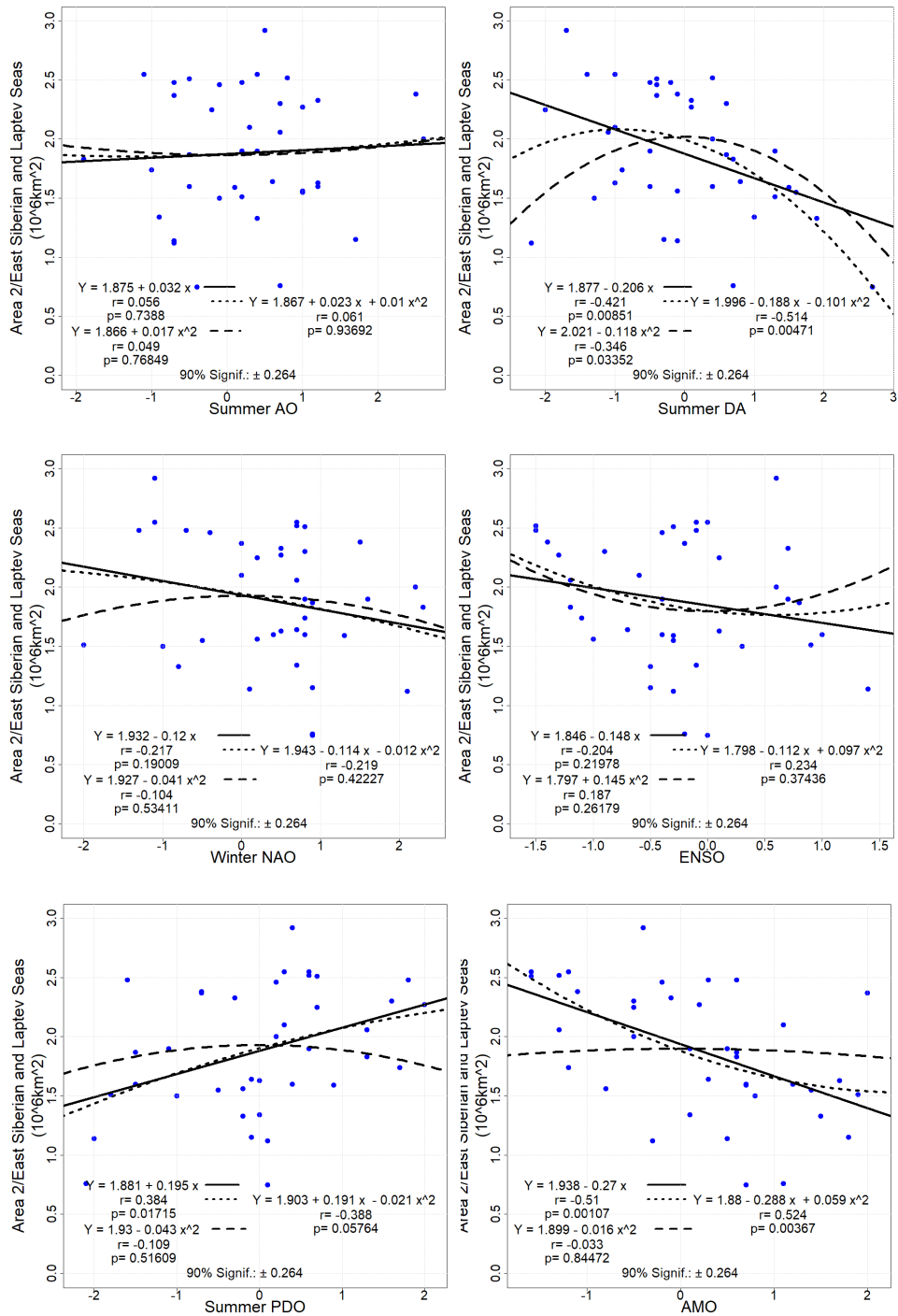


Figure 5.2.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 5.2.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.056	0.252	74.8	0.264
AO ²	0.049	0.834	16.6	0.264
DA	-0.421	0.047	95.3	0.264
DA ²	-0.346	0.703	29.7	0.264
NAO	-0.217	0.864	13.6	0.264
NAO ²	0.104	0.890	11.0	0.264
ENSO	-0.204	0.037	96.3	0.264
ENSO ²	0.187	0.762	23.8	0.264
PDO	0.384	0.001	99.9	0.264
PDO ²	-0.109	0.037	96.3	0.264
AMO	-0.510	0.000	100.0	0.264
AMO ²	-0.033	0.160	84.0	0.264

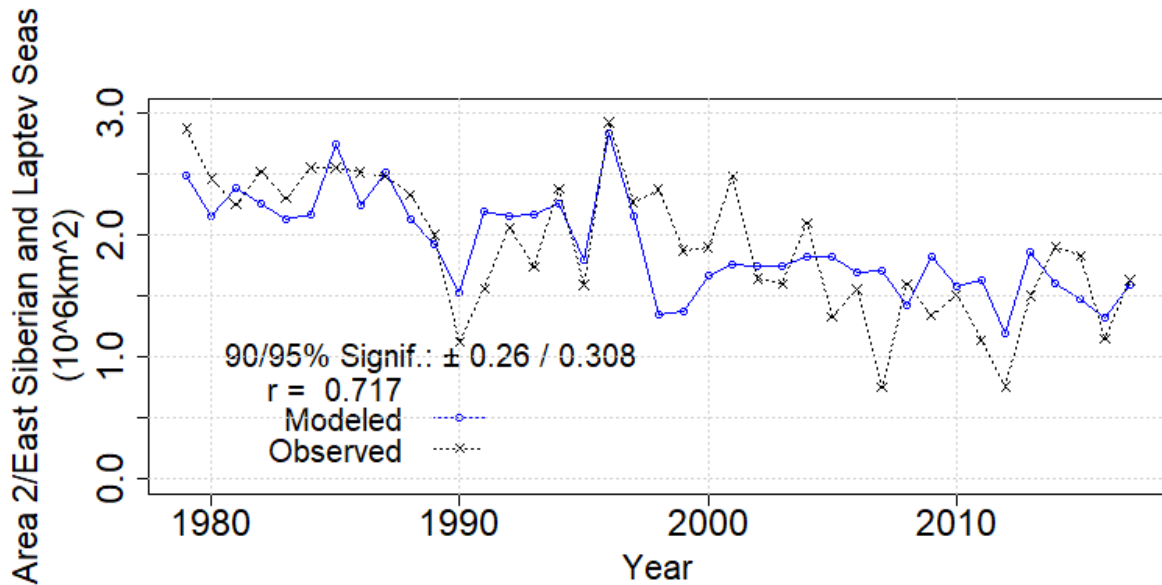


Figure 5.2.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.05 - 0.24\text{NAO} - 0.01\text{NAO}^2 + 0.27\text{ENSO} + 0.28\text{ENSO}^2 \\
 & - 0.003\text{ENSO}*\text{NAO} \\
 & + 0.30\text{PDO} + 0.07\text{PDO}^2 - 0.21\text{AMO} \\
 & + 0.07\text{AMO}*\text{PDO} \\
 & + 0.30\text{PDO}*\text{ENSO} - 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.2.2-1

5.2.3 Central Arctic, Period 2 1979-2017

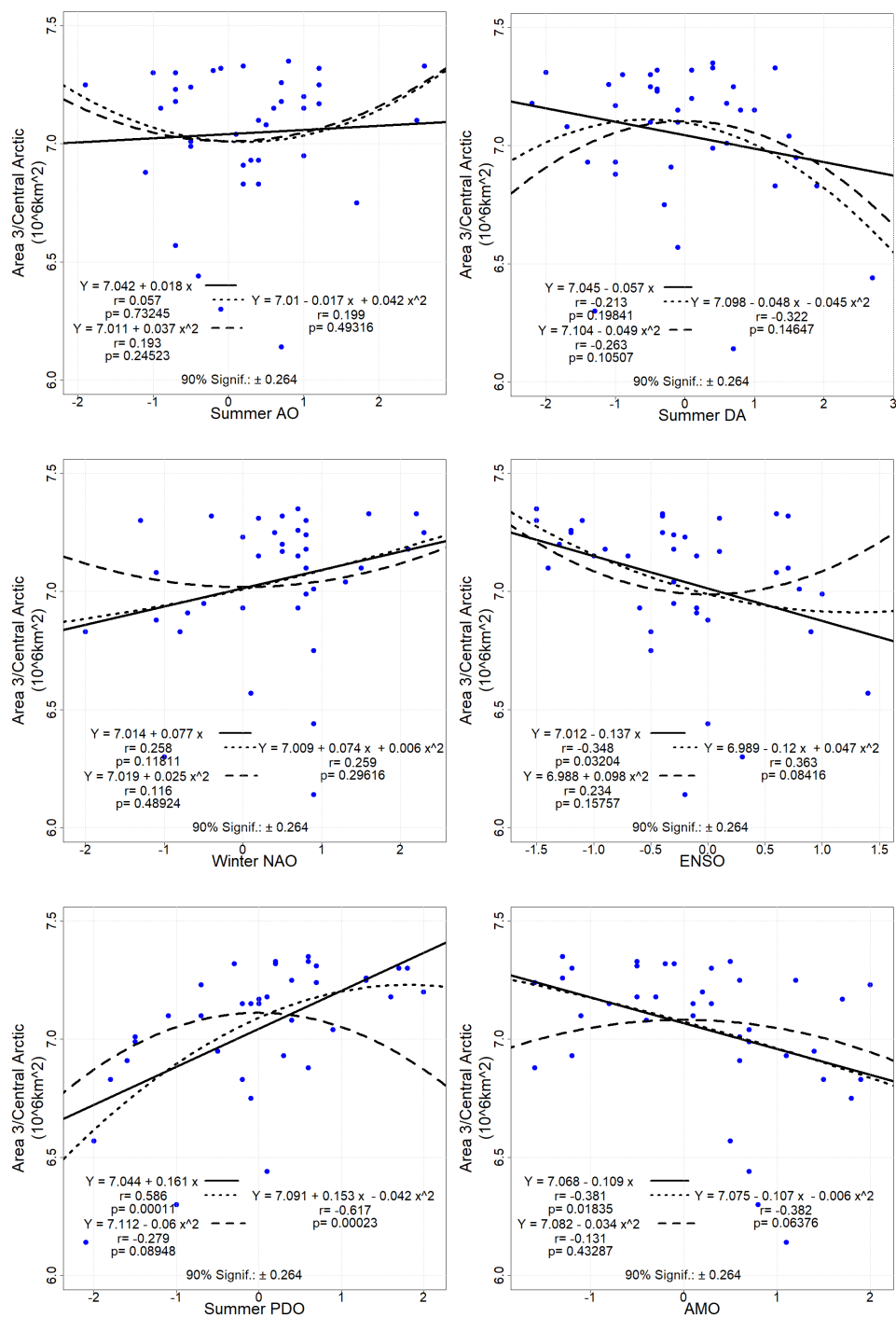


Figure 5.2.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 5.2.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.057	0.732	26.8	0.264
AO ²	0.193	0.245	75.5	0.264
DA	-0.213	0.198	80.2	0.264
DA ²	-0.263	0.105	89.5	0.264
NAO	0.258	0.118	88.2	0.264
NAO ²	0.116	0.489	51.1	0.264
ENSO	-0.348	0.032	96.8	0.264
ENSO ²	0.234	0.158	84.2	0.264
PDO	0.586	0.000	100.0	0.264
PDO ²	-0.279	0.089	91.1	0.264
AMO	-0.381	0.018	98.2	0.264
AMO ²	-0.131	0.433	56.7	0.264

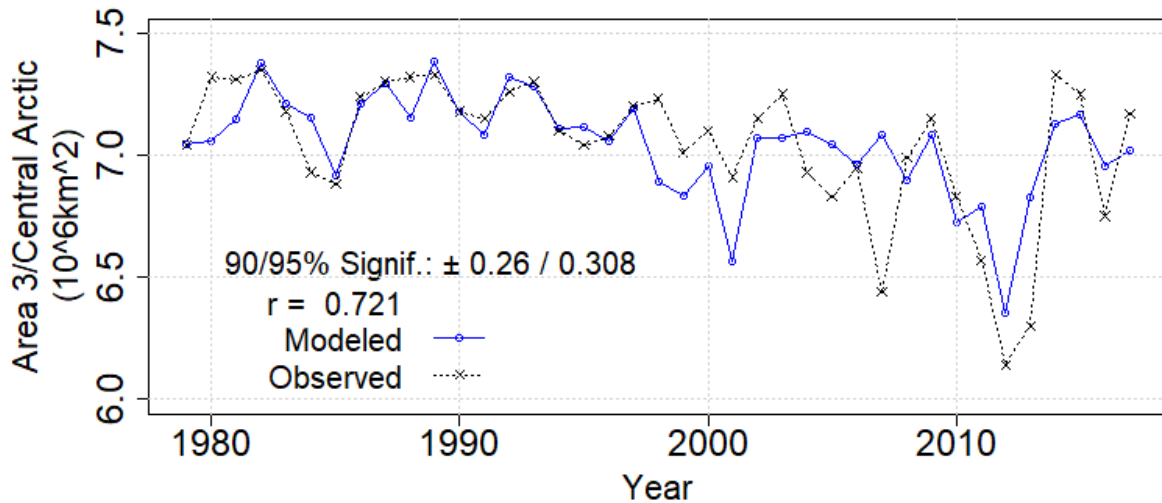


Figure 5.2.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.05 + 0.06\text{NAO} - 0.01\text{NAO}^2 + 0.06\text{ENSO} + 0.13\text{ENSO}^2 \\
 & + 0.04\text{ENSO}*\text{NAO} \\
 & + 0.16\text{PDO} - 0.09\text{PDO}^2 + 0.01\text{AMO} - 0.01\text{AMO}^2 \\
 & - 0.03\text{AMO}*\text{PDO} \\
 & - 0.01\text{PDO}*\text{ENSO} - 0.06\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.2.3-1

5.2.4 Kara and Barents Seas, Period 2 1979-2017

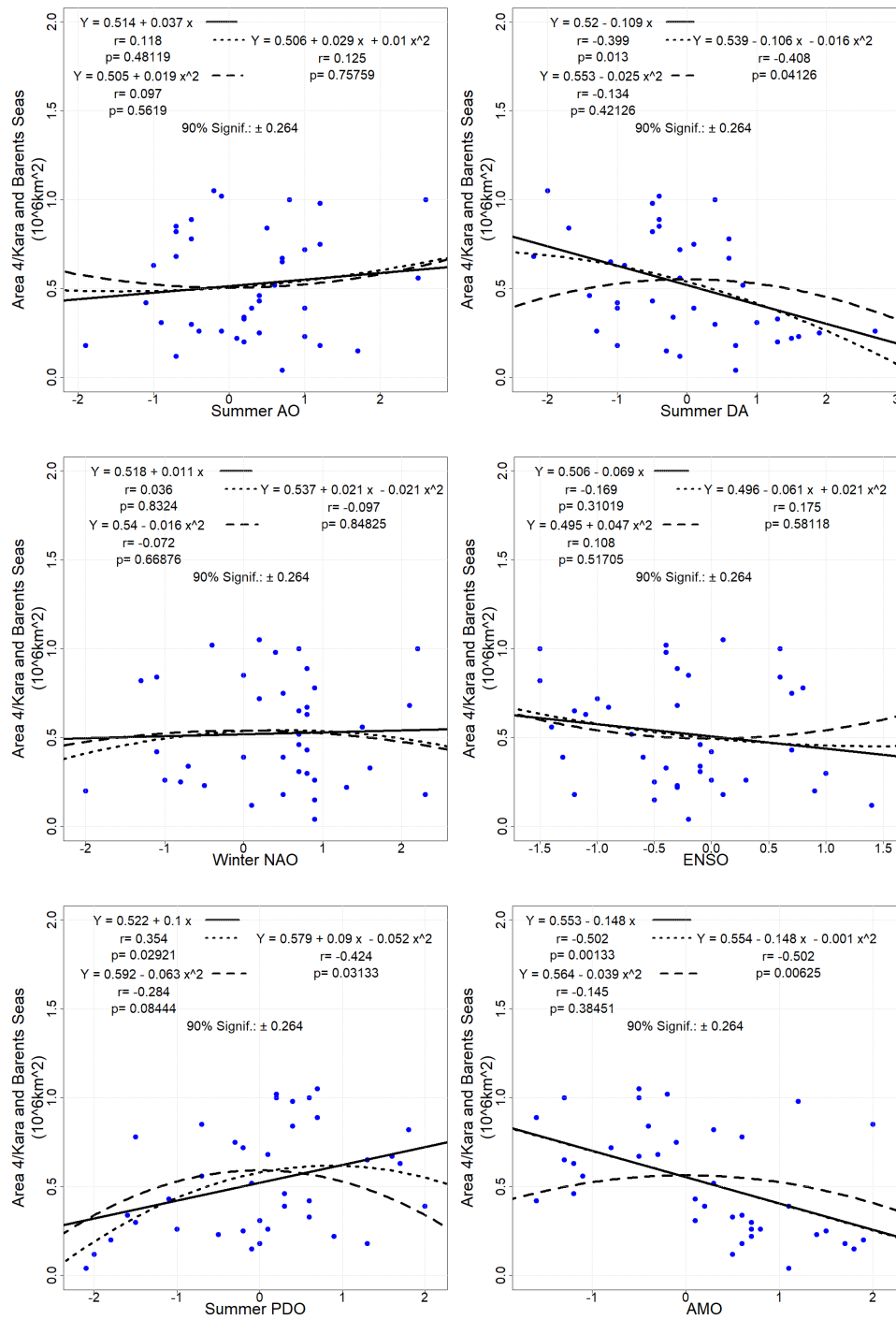


Figure 5.2.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 5.2.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.118	0.481	51.9	0.264
AO ²	0.097	0.562	43.8	0.264
DA	-0.399	0.013	98.7	0.264
DA ²	-0.134	0.421	57.9	0.264
NAO	0.036	0.832	16.8	0.264
NAO ²	-0.072	0.669	33.1	0.264
ENSO	-0.169	0.310	69.0	0.264
ENSO ²	0.108	0.517	48.3	0.264
PDO	0.354	0.029	97.1	0.264
PDO ²	-0.284	0.084	91.6	0.264
AMO	-0.502	0.001	99.9	0.264
AMO ²	-0.145	0.385	61.5	0.264

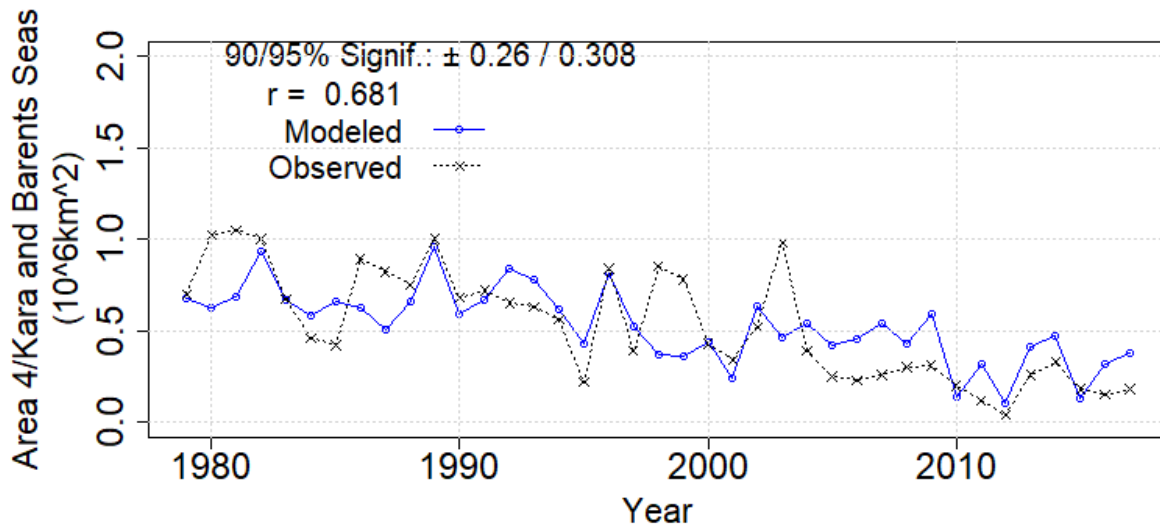


Figure 5.2.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.60 - 0.004\text{NAO}^2 + 0.04\text{ENSO} + 0.20\text{ENSO}^2 \\
 & + 0.05\text{ENSO}*\text{NAO}^2 \\
 & + 0.14\text{PDO} - 0.09\text{PDO}^2 + 0.01\text{AMO} - 0.07\text{AMO}^2 \\
 & - 0.13\text{AMO}*\text{PDO} \\
 & + 0.07\text{PDO}*\text{ENSO} - 0.05\text{AMO}*\text{NAO}^2
 \end{aligned}$$

Equation 5.2.4-1

5.2.5 Greenland Sea, Period 2 1979-2017

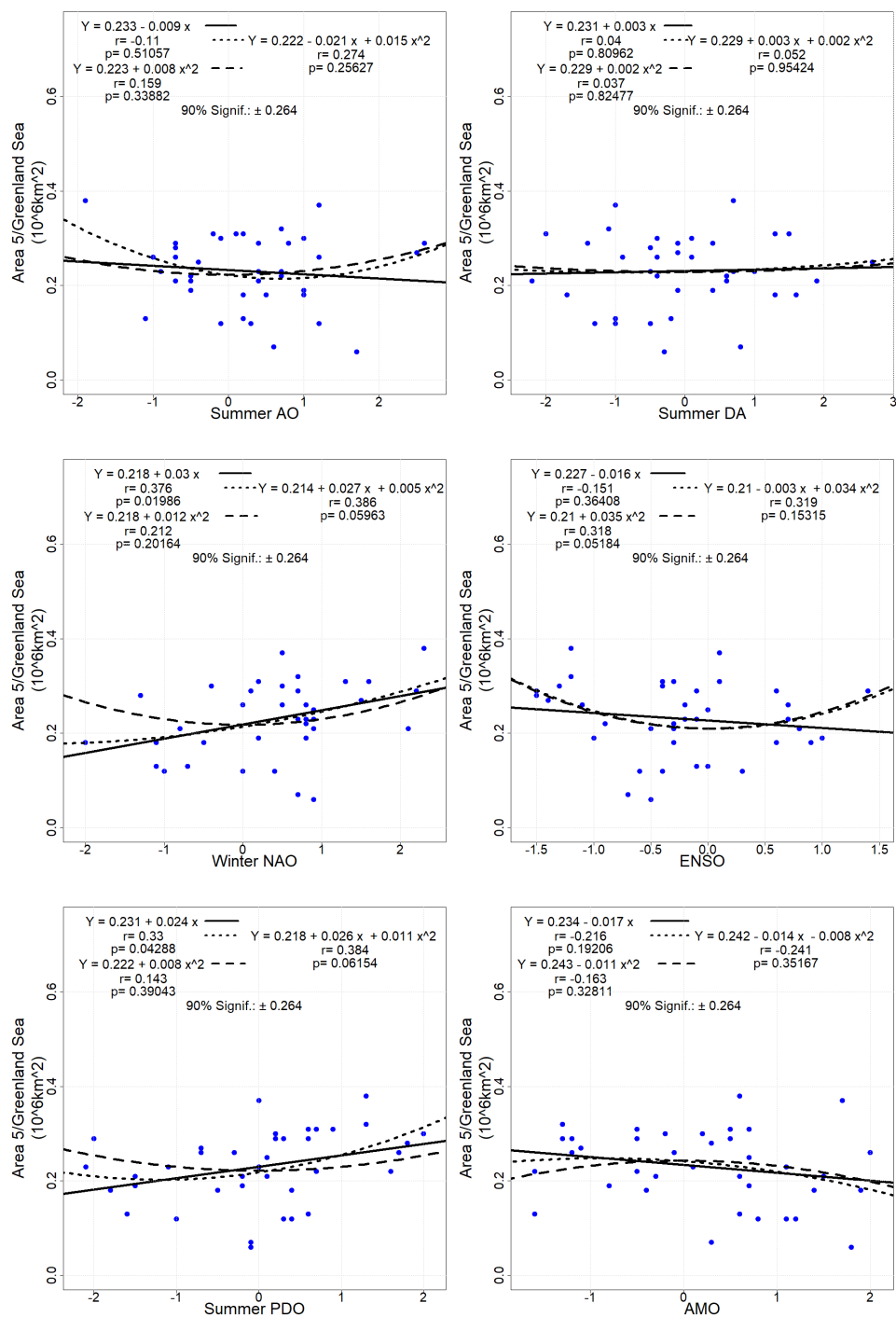


Figure 5.2.5-1 scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 5.2.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.110	0.511	48.9	0.264
AO ²	0.159	0.339	66.1	0.264
DA	0.040	0.810	19.0	0.264
DA ²	0.037	0.825	17.5	0.264
NAO	0.376	0.020	98.0	0.264
NAO ²	0.212	0.202	79.8	0.264
ENSO	-0.151	0.364	63.6	0.264
ENSO ²	0.318	0.052	94.8	0.264
PDO	0.330	0.043	95.7	0.264
PDO ²	0.143	0.390	61.0	0.264
AMO	-0.216	0.192	80.8	0.264
AMO ²	-0.163	0.328	67.2	0.264

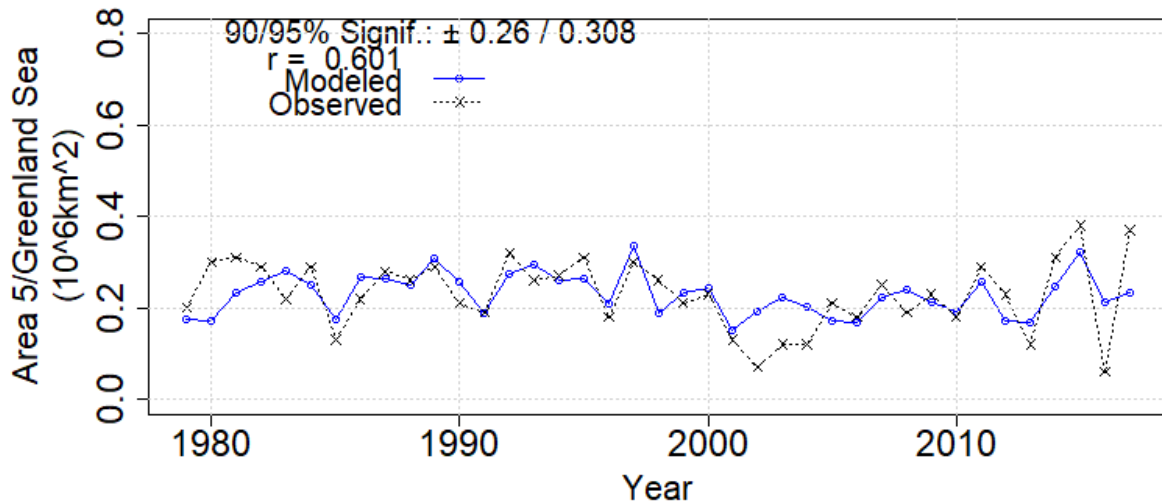


Figure 5.2.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.20 + 0.03\text{NAO} - 0.003\text{NAO}^2 + 0.05\text{ENSO} + 0.02\text{ENSO}^2 \\
 & - 0.01\text{NAO}*\text{ENSO} \\
 & + 0.02\text{PDO} + 0.01\text{PDO}^2 - 0.01\text{AMO} + 0.01\text{AMO}^2 \\
 & + 0.02\text{AMO}*\text{PDO} \\
 & + 0.01\text{PDO}*\text{ENSO}^2 - 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.2.5-1

5.2.6 Baffin Bay, Period 2 1979-2017

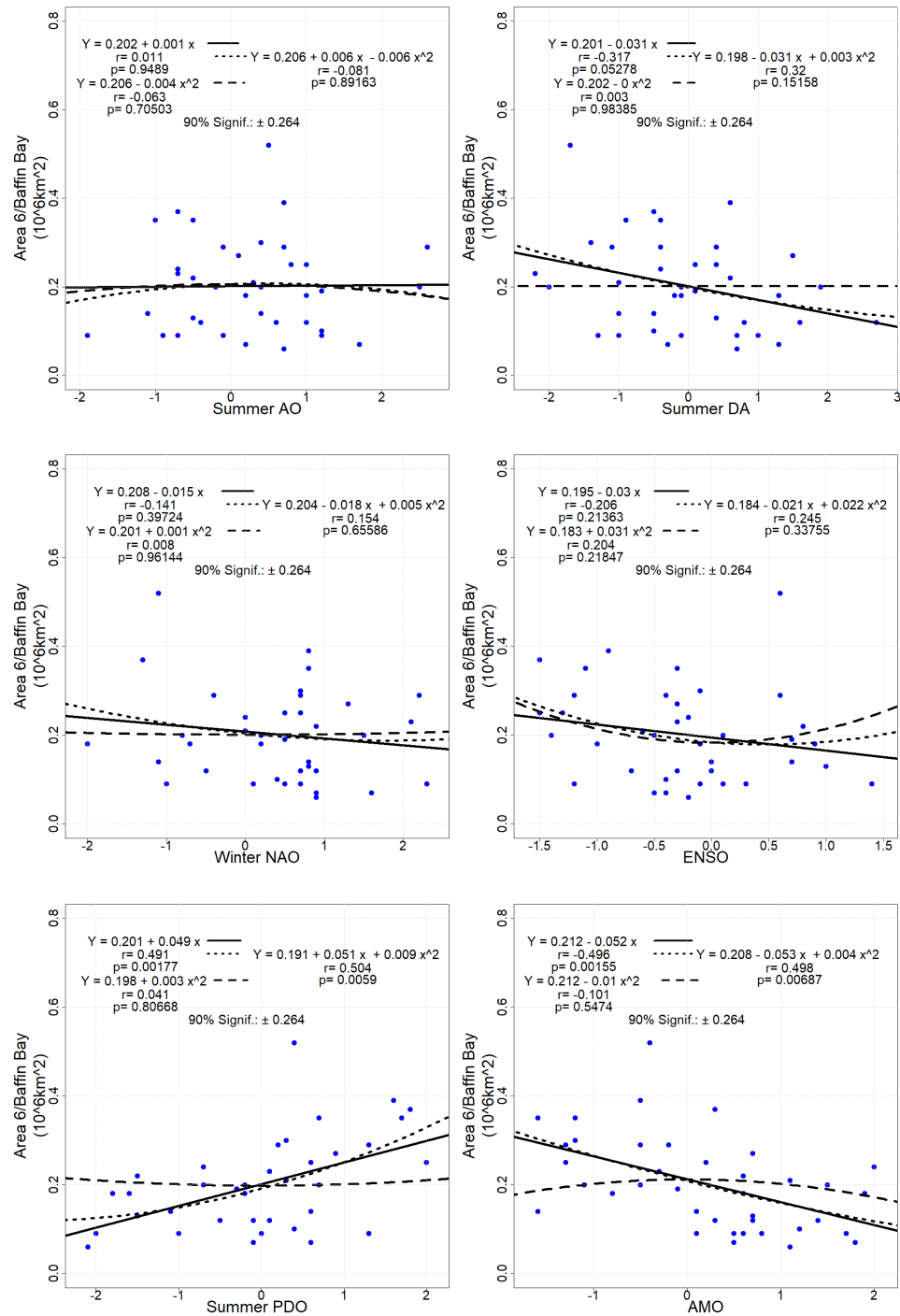


Figure 5.2.5-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 5.2.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.011	0.949	5.1	0.264
AO ²	-0.063	0.705	29.5	0.264
DA	-0.317	0.053	94.7	0.264
DA ²	0.003	0.984	1.6	0.264
NAO	-0.141	0.397	60.3	0.264
NAO ²	0.008	0.961	3.9	0.264
ENSO	-0.206	0.214	78.6	0.264
ENSO ²	0.204	0.218	78.2	0.264
PDO	0.491	0.002	99.8	0.264
PDO ²	0.041	0.807	19.3	0.264
AMO	-0.496	0.002	99.8	0.264
AMO ²	-0.101	0.547	45.3	0.264

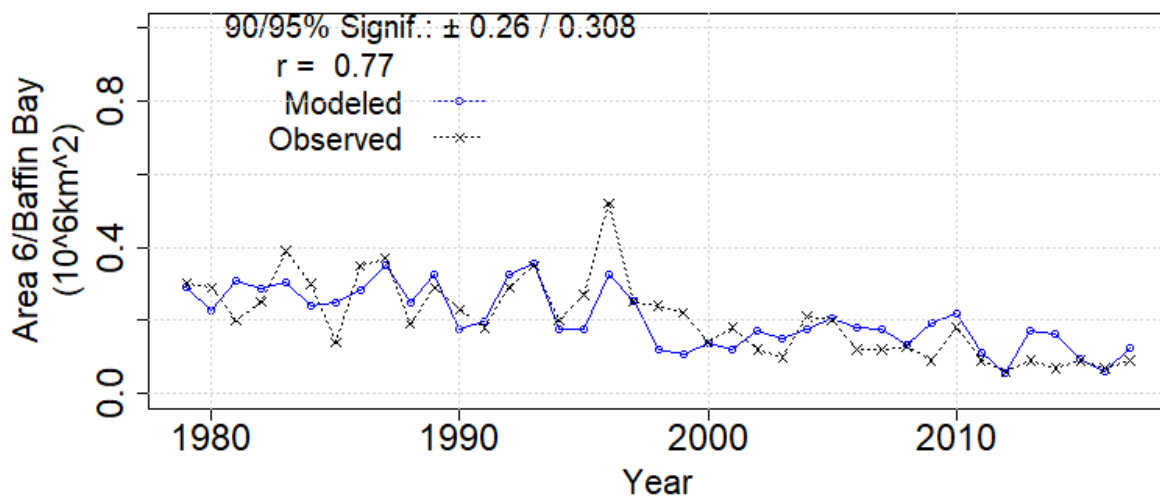


Figure 5.2.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.21 - 0.02\text{NAO} + 0.06\text{ENSO} + 0.07\text{ENSO}^2 \\
 & + 0.02\text{ENSO}*\text{NAO} \\
 & + 0.10\text{PDO} - 0.01\text{AMO} - 0.02\text{AMO}^2 \\
 & - 0.05\text{AMO}*\text{PDO} \\
 & + 0.06\text{PDO}*\text{ENSO} - 0.03\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.2.6-1

5.2.7 Whole Arctic, Period 2 1979-2017

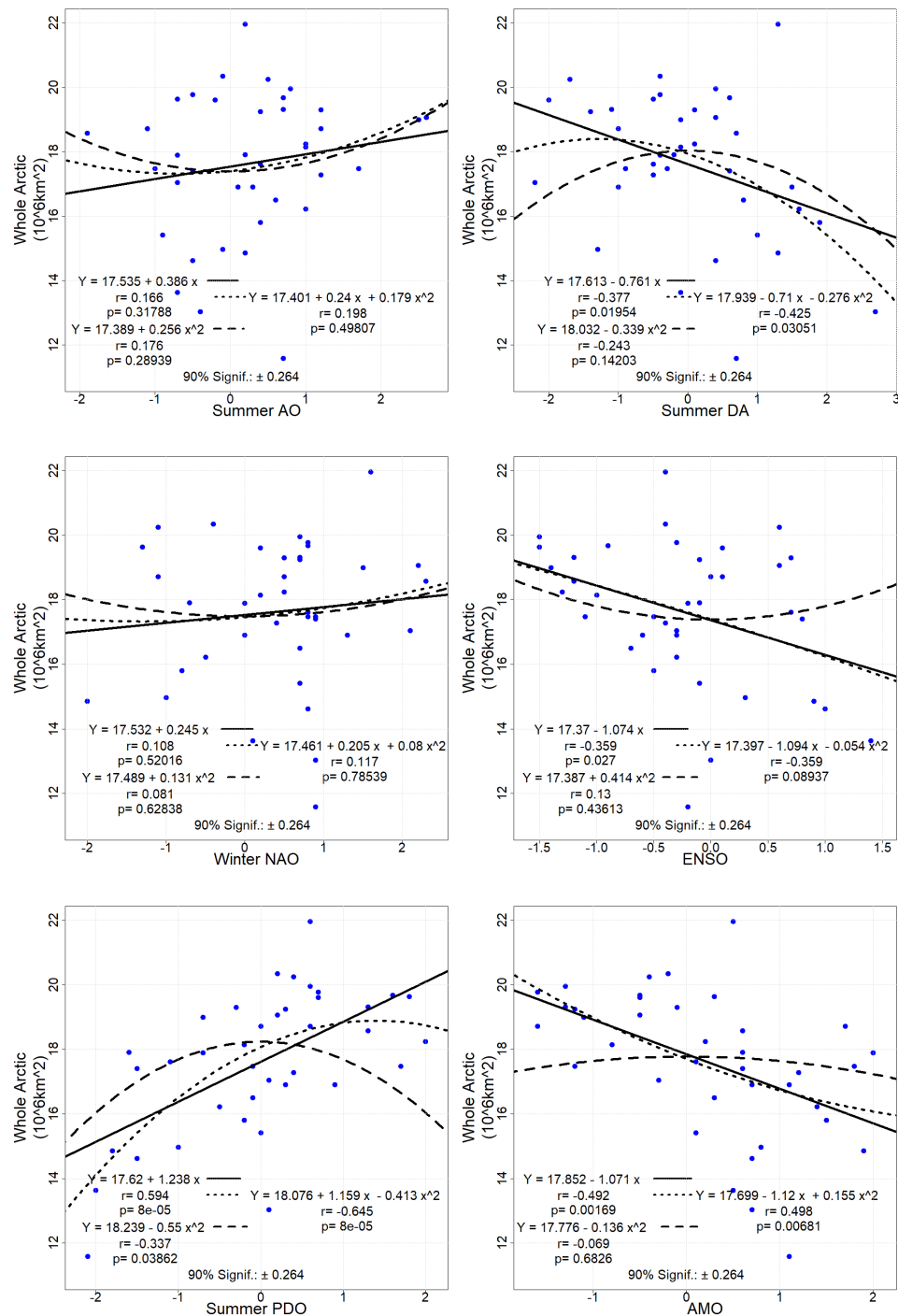


Figure 5.2.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 5.2.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.166	0.318	68.2	0.264
AO ²	-0.176	0.289	70.1	0.264
DA	-0.377	0.020	98.0	0.264
DA ²	-0.243	0.142	85.8	0.264
NAO	0.108	0.520	48.0	0.264
NAO ²	0.081	0.628	47.2	0.264
ENSO	-0.359	0.027	97.3	0.264
ENSO ²	0.130	0.436	56.4	0.264
PDO	0.594	0.000	100.0	0.264
PDO ²	-0.337	0.039	96.1	0.264
AMO	-0.492	0.002	99.8	0.264
AMO ²	-0.069	0.683	41.7	0.264

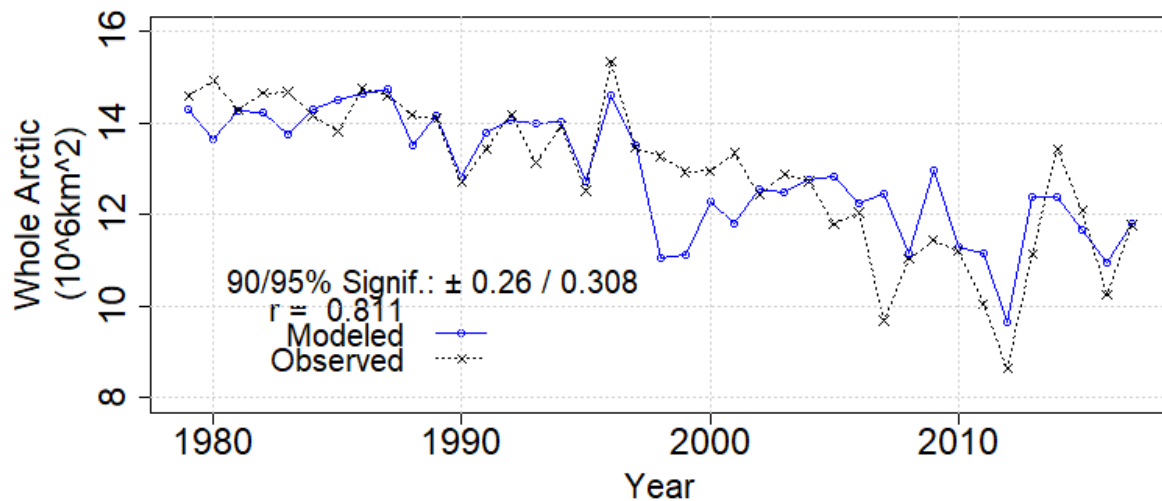


Figure 5.2.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 13.36 - 0.37\text{NAO} - 0.003\text{NAO}^2 + 0.47\text{ENSO} + 0.44\text{ENSO}^2 \\
 & + 0.20\text{ENSO}*\text{NAO} \\
 & + 0.85\text{PDO} + 0.002\text{PDO}^2 - 0.68\text{AMO} + 0.01\text{AMO}^2 \\
 & + 0.28\text{AMO}*\text{PDO} \\
 & + 0.51\text{PDO}*\text{ENSO} - 0.34\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.2.7-1

5.3 PERIOD 3 1948-2017

5.3.1 Chukchi and Beaufort Seas, Period 3 1948-2017

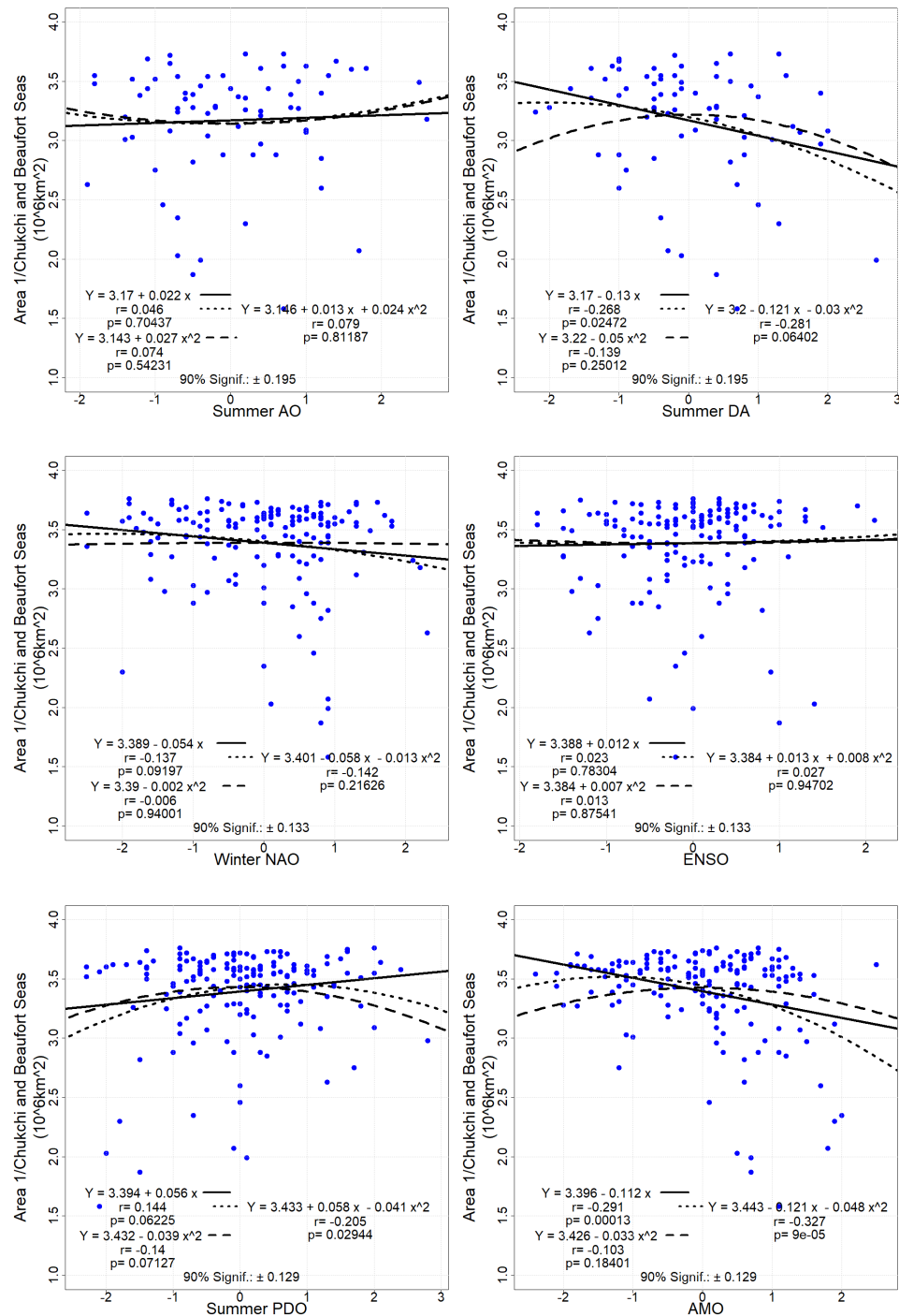


Figure 5.3.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 5.3.1-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	0.046	0.704	29.6	0.195
AO ²	0.074	0.542	45.8	0.195
DA	-0.268	0.025	97.5	0.195
DA ²	-0.139	0.250	75.0	0.195
NAO	-0.137	0.092	90.8	0.133
NAO ²	-0.006	0.940	6.0	0.133
ENSO	0.023	0.783	21.7	0.133
ENSO ²	0.013	0.875	12.5	0.133
PDO	0.144	0.062	93.8	0.129
PDO ²	-0.140	0.071	92.9	0.129
AMO	-0.291	0.000	100.0	0.129
AMO ²	-0.103	0.184	81.6	0.129

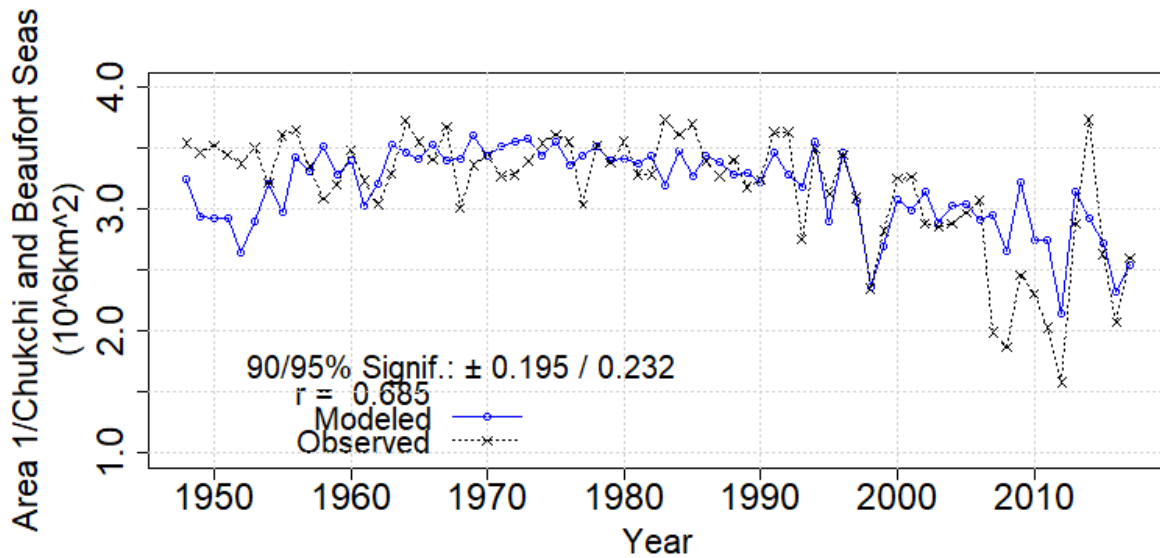


Figure 5.3.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.33 - 0.12\text{NAO} \\
 & + 0.04\text{PDO} - 0.06\text{PDO}^2 - 0.022\text{AMO} - 0.08\text{AMO}^2 \\
 & + 0.10\text{AMO*PDO} \\
 & - 0.14\text{AMO*NAO}
 \end{aligned}$$

Equation 5.3.1-1

5.3.2 East Siberian and Laptev Seas, Period 3 1948-2017

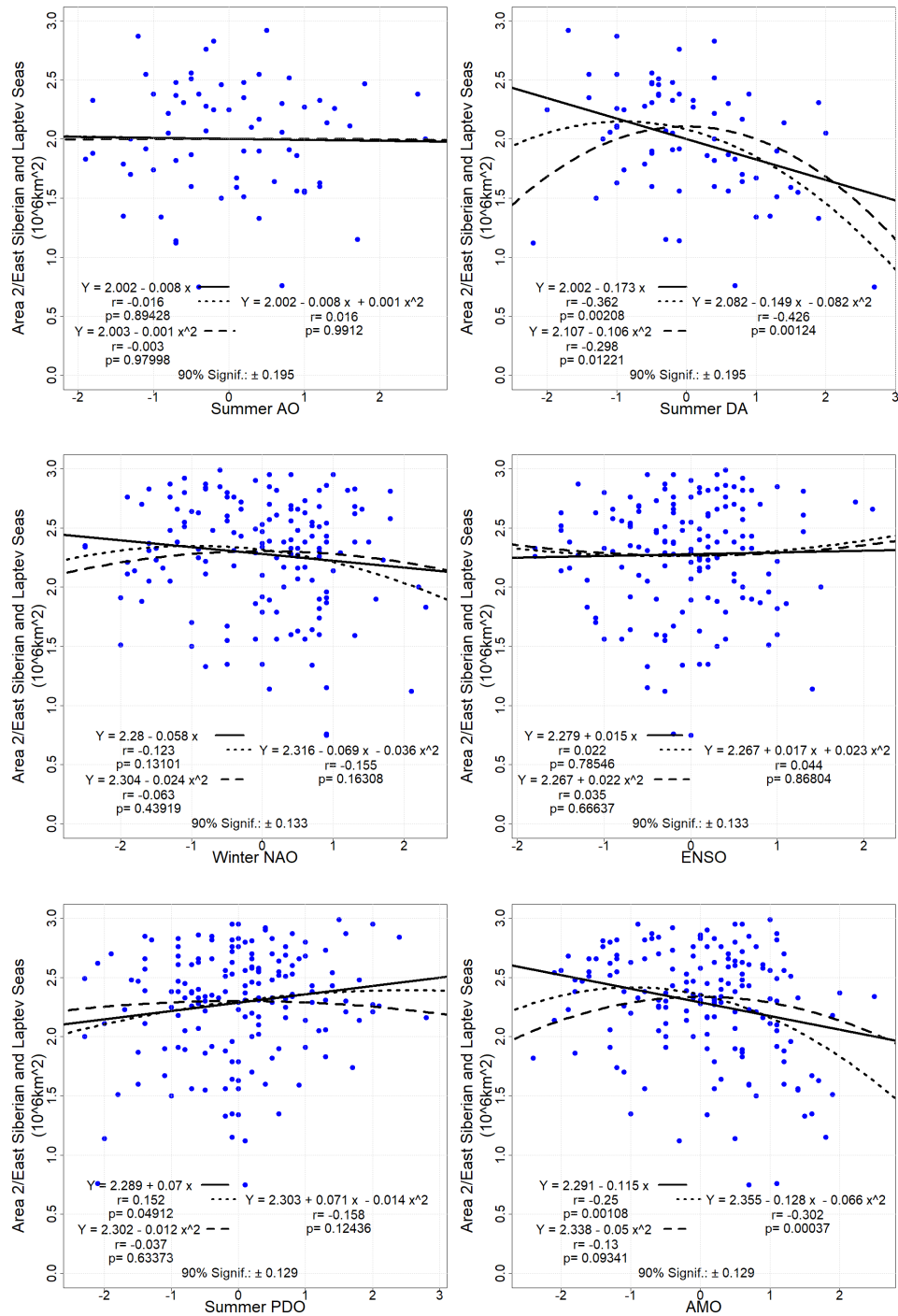


Figure 5.3.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 5.3.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.016	0.894	10.6	0.195
AO ²	-0.003	0.980	2.0	0.195
DA	-0.362	0.002	99.8	0.195
DA ²	-0.298	0.012	98.8	0.195
NAO	-0.123	0.131	86.9	0.133
NAO ²	-0.063	0.439	56.1	0.133
ENSO	0.022	0.785	21.5	0.133
ENSO ²	0.035	0.666	33.4	0.133
PDO	0.152	0.049	95.4	0.129
PDO ²	-0.037	0.634	36.6	0.129
AMO	-0.250	0.001	99.9	0.129
AMO ²	-0.130	0.093	90.7	0.129

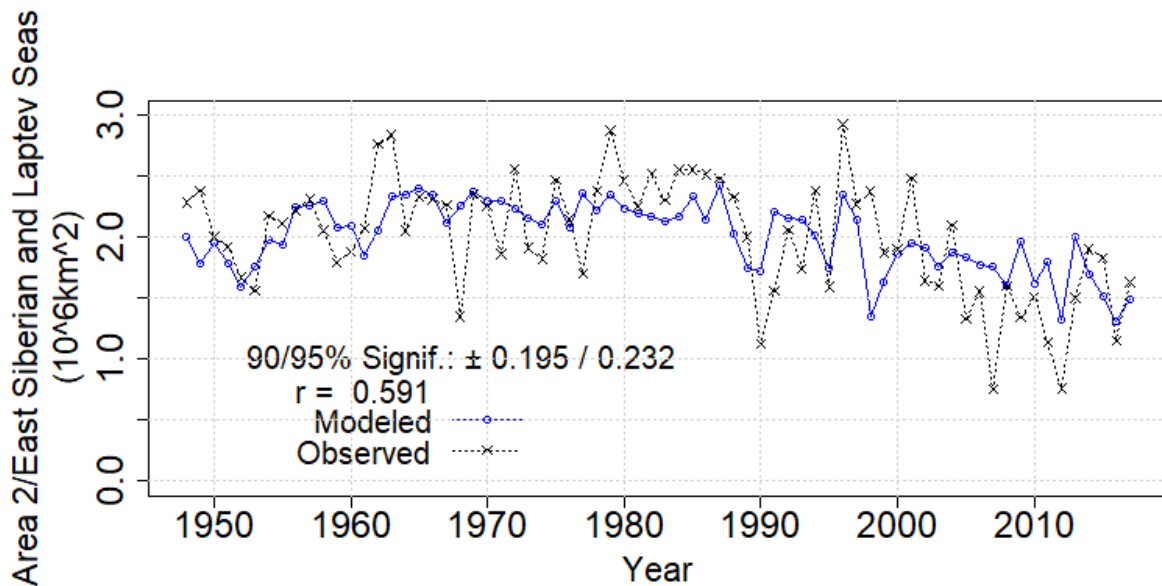


Figure 5.3.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.12 - 0.18\text{NAO} - 0.03\text{NAO}^2 \\
 & + 0.07\text{PDO} - 0.19\text{AMO} - 0.06\text{AMO}^2 \\
 & + 0.06\text{AMO}*\text{PDO} \\
 & - 0.04\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.3.2-1

5.3.3 Central Arctic, Period 3 1948-2017

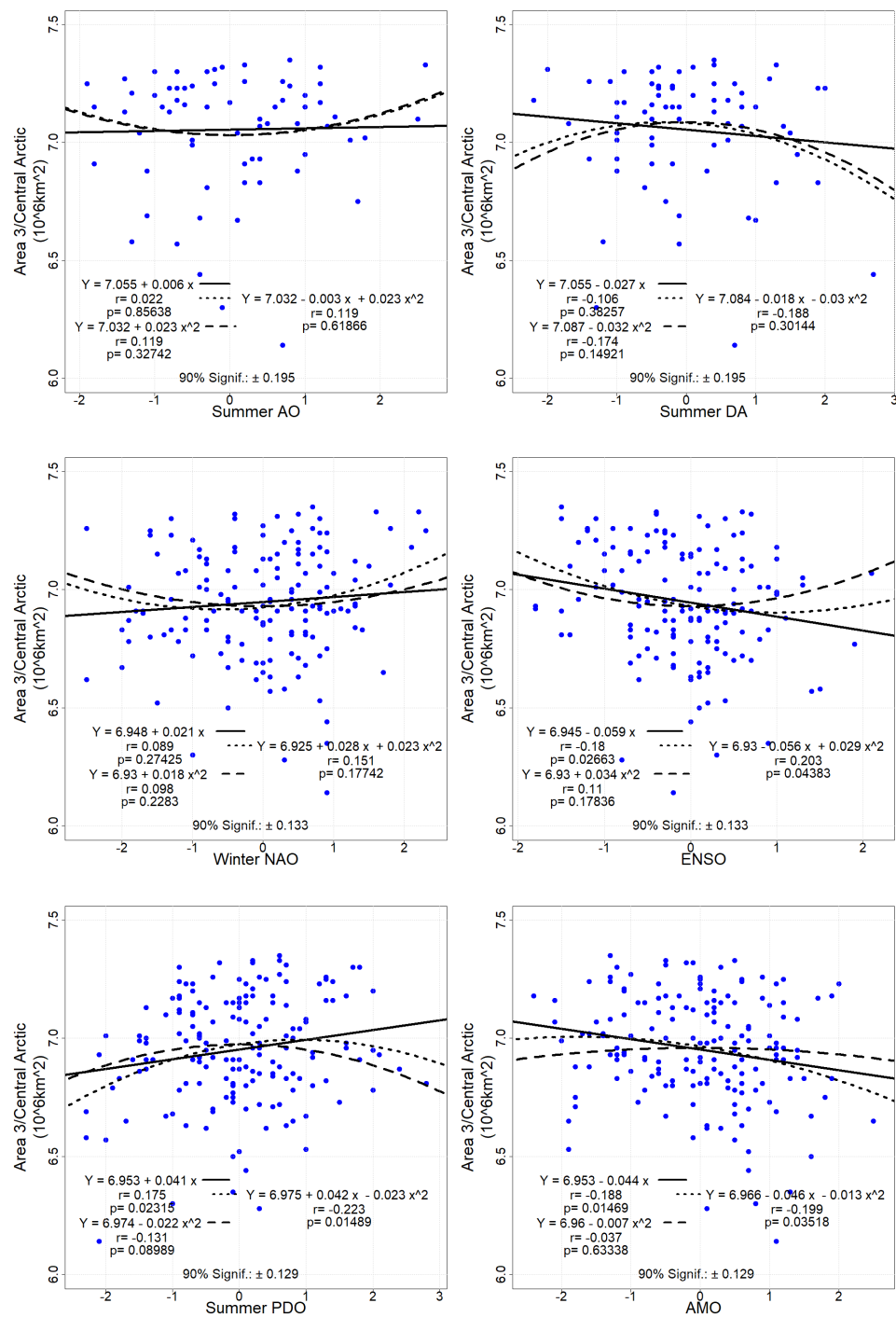


Figure 5.3.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 5.3.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.022	0.856	14.4	0.195
AO ²	0.119	0.327	67.3	0.195
DA	-0.106	0.383	61.7	0.195
DA ²	-0.174	0.149	85.1	0.195
NAO	0.089	0.274	72.6	0.133
NAO ²	0.098	0.228	77.2	0.133
ENSO	-0.180	0.026	97.4	0.133
ENSO ²	0.110	0.178	82.2	0.133
PDO	0.175	0.023	97.7	0.129
PDO ²	-0.131	0.090	91.0	0.129
AMO	-0.188	0.015	98.5	0.129
AMO ²	-0.037	0.633	36.7	0.129

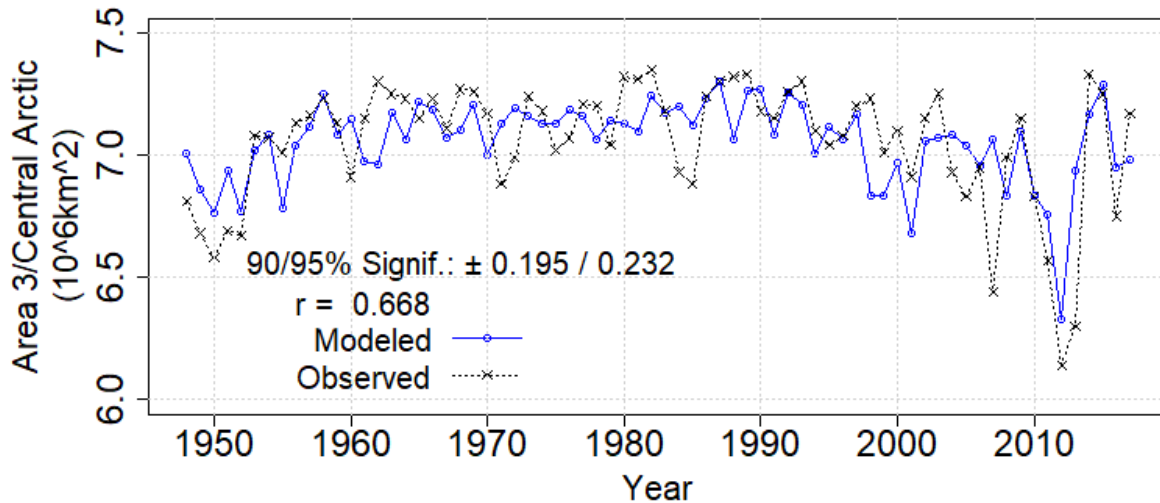


Figure 5.3.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 7.09 + 0.001\text{NAO} + 0.03\text{NAO}^2 - 0.03\text{ENSO} - 0.04\text{ENSO}^2 \\
 & + 0.01\text{ENSO}*\text{NAO} \\
 & + 0.07\text{PDO} - 0.10\text{PDO}^2 - 0.05\text{AMO} \\
 & + 0.03\text{AMO}*\text{PDO} \\
 & - 0.14\text{PDO}*\text{ENSO} - 0.03\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.3.3-1

5.3.4 Kara and Barents Seas, Period 3 1948-2017

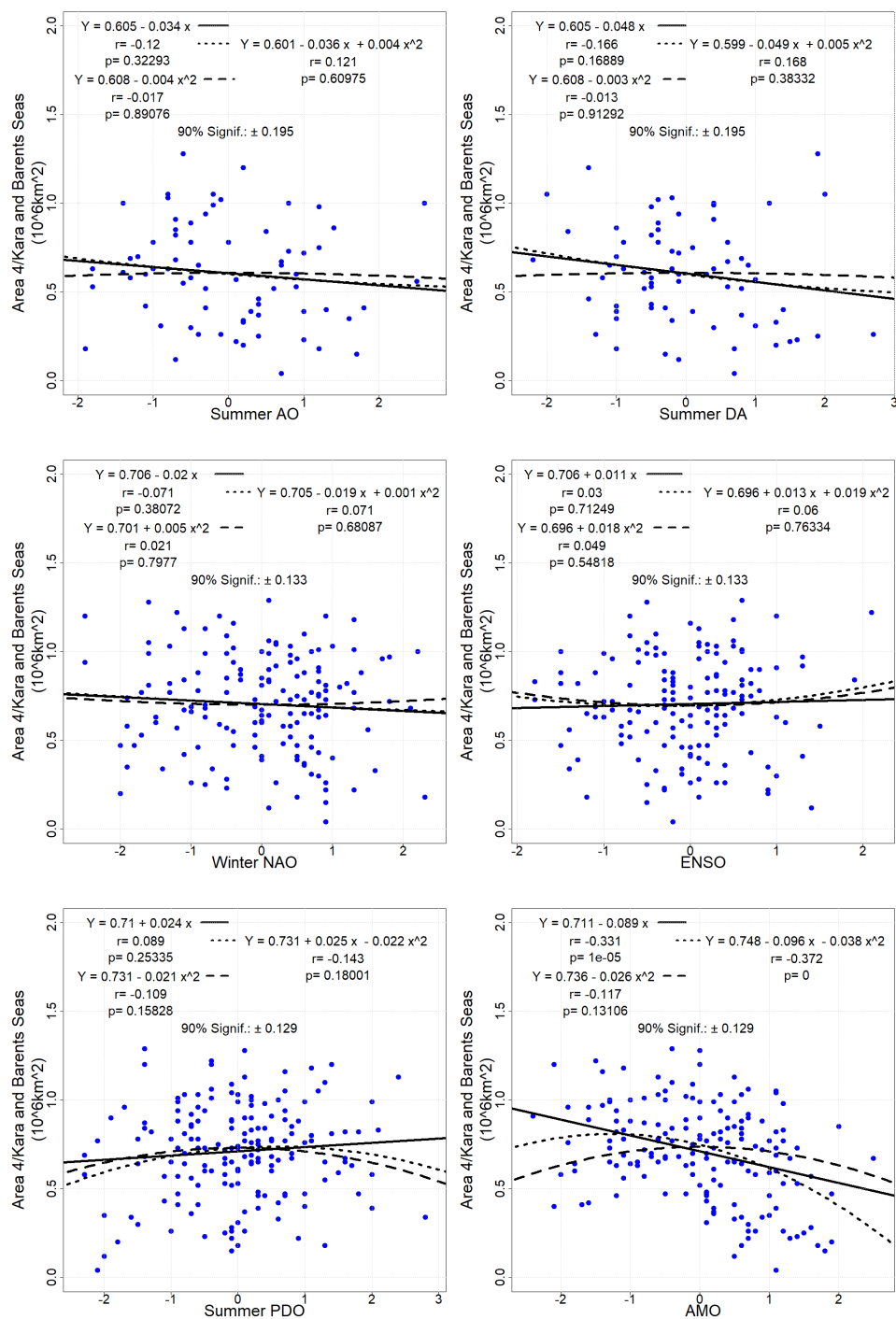


Figure 5.3.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 5.3.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.120	0.856	14.4	0.195
AO ²	-0.017	0.327	67.3	0.195
DA	-0.166	0.383	61.7	0.195
DA ²	-0.013	0.149	85.1	0.195
NAO	-0.071	0.274	72.6	0.133
NAO ²	0.021	0.228	77.2	0.133
ENSO	0.030	0.026	97.4	0.133
ENSO ²	0.049	0.178	82.2	0.133
PDO	0.089	0.023	97.7	0.129
PDO ²	-0.109	0.090	91.0	0.129
AMO	-0.331	0.015	98.5	0.129
AMO ²	-0.117	0.633	36.7	0.129

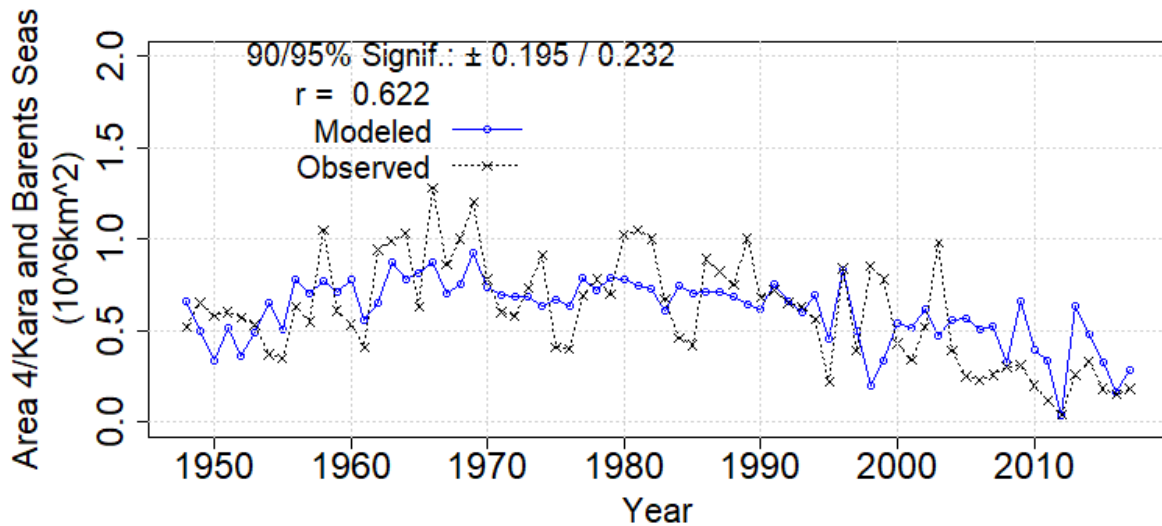


Figure 5.3.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.73 - 0.09\text{NAO} \\
 & + 0.03\text{PDO} - 0.06\text{PDO}^2 - 0.10\text{AMO} - 0.06\text{AMO}^2 \\
 & + 0.02\text{AMO}*\text{PDO} \\
 & - 0.06\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.3.4-1

5.3.5 Greenland Sea, Period 3 1948-2017

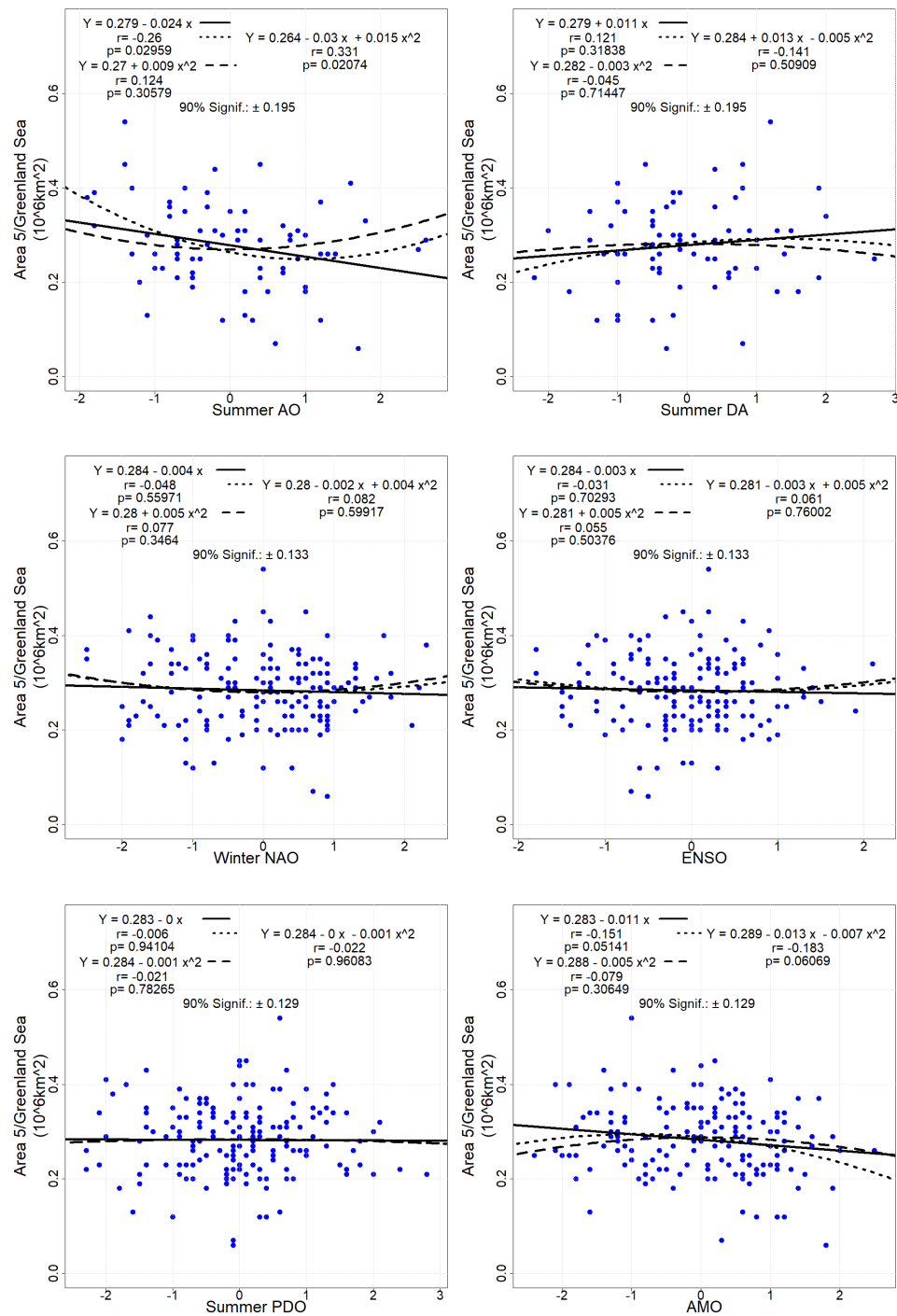


Figure 5.3.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 5.3.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.260	0.030	97.0	0.195
AO ²	0.124	0.306	69.4	0.195
DA	0.121	0.318	68.2	0.195
DA ²	-0.045	0.714	28.6	0.195
NAO	-0.048	0.560	44.0	0.133
NAO ²	0.077	0.346	65.4	0.133
ENSO	-0.031	0.703	29.7	0.133
ENSO ²	0.055	0.504	49.6	0.133
PDO	-0.006	0.941	5.9	0.129
PDO ²	-0.021	0.783	21.7	0.129
AMO	-0.151	0.051	94.1	0.129
AMO ²	-0.079	0.306	69.4	0.129

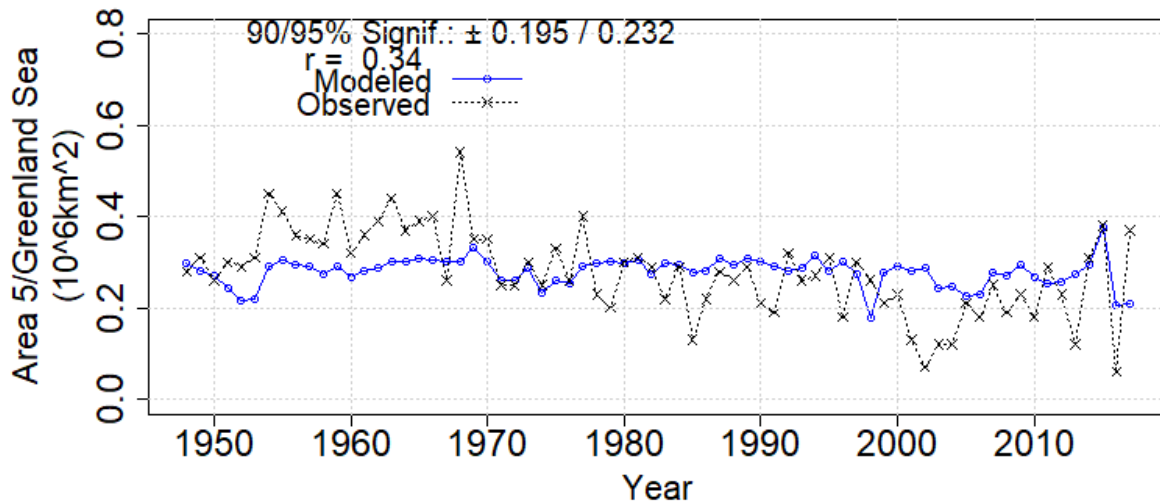


Figure 5.3.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.30 + 0.0004\text{NAO}^2 - 0.01\text{ENSO}^2 \\
 & + 0.01\text{ENSO}^2 * \text{NAO}^2 \\
 & - 0.02\text{AMO} - 0.02\text{AMO}^2 \\
 & + 0.01\text{AMO} * \text{NAO}^2
 \end{aligned}$$

Equation 5.3.5-1

5.3.6 Baffin Bay, Period 3 1948-2017

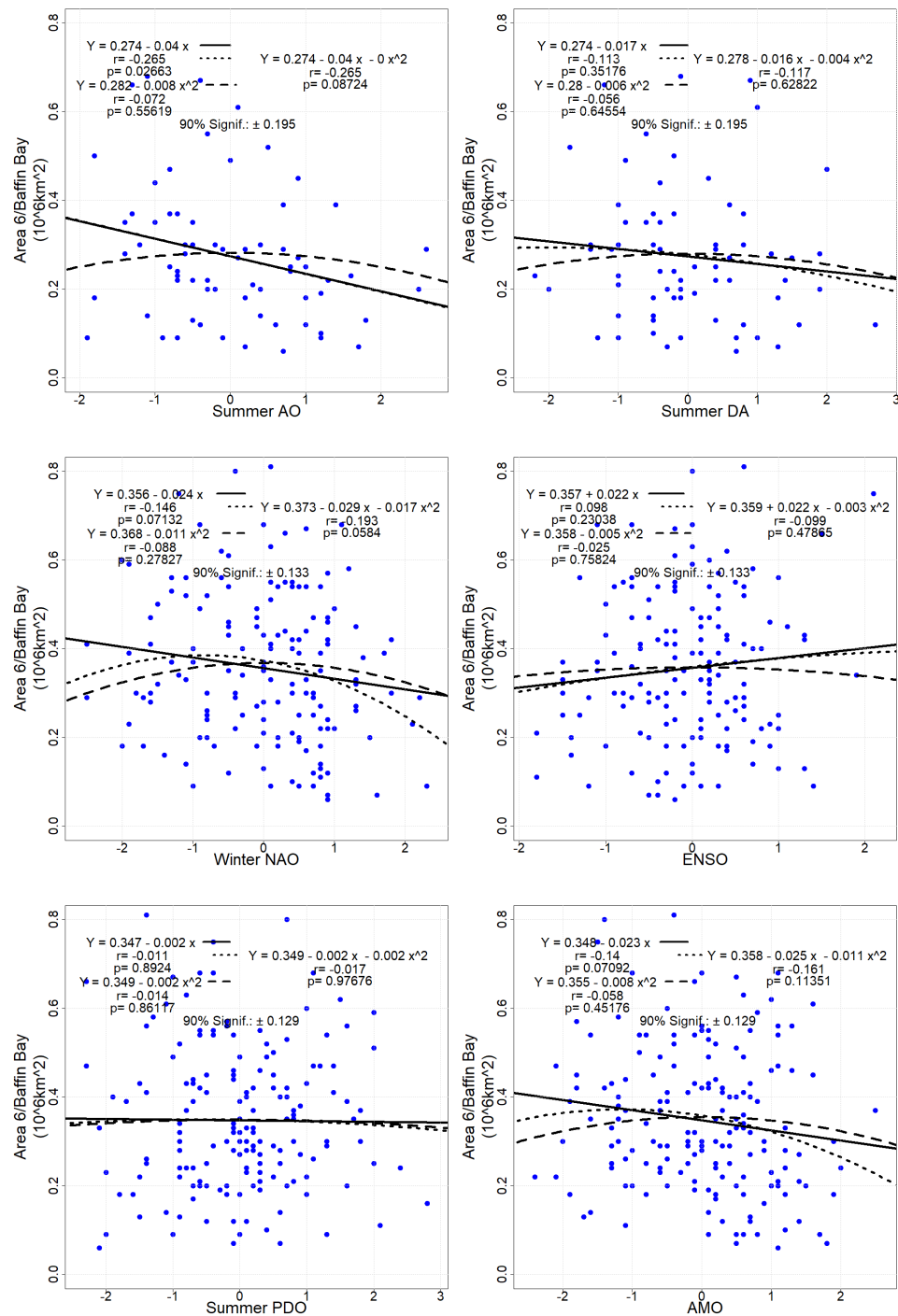


Figure 5.3.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 5.3.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.265	0.027	97.3	0.195
AO ²	-0.072	0.556	44.4	0.195
DA	-0.113	0.352	64.8	0.195
DA ²	-0.056	0.646	35.4	0.195
NAO	-0.146	0.071	92.9	0.133
NAO ²	-0.088	0.278	72.2	0.133
ENSO	0.098	0.230	77.0	0.133
ENSO ²	-0.025	0.758	24.2	0.133
PDO	-0.011	0.892	10.8	0.129
PDO ²	-0.014	0.861	13.9	0.129
AMO	-0.140	0.071	92.9	0.129
AMO ²	-0.058	0.452	54.8	0.129

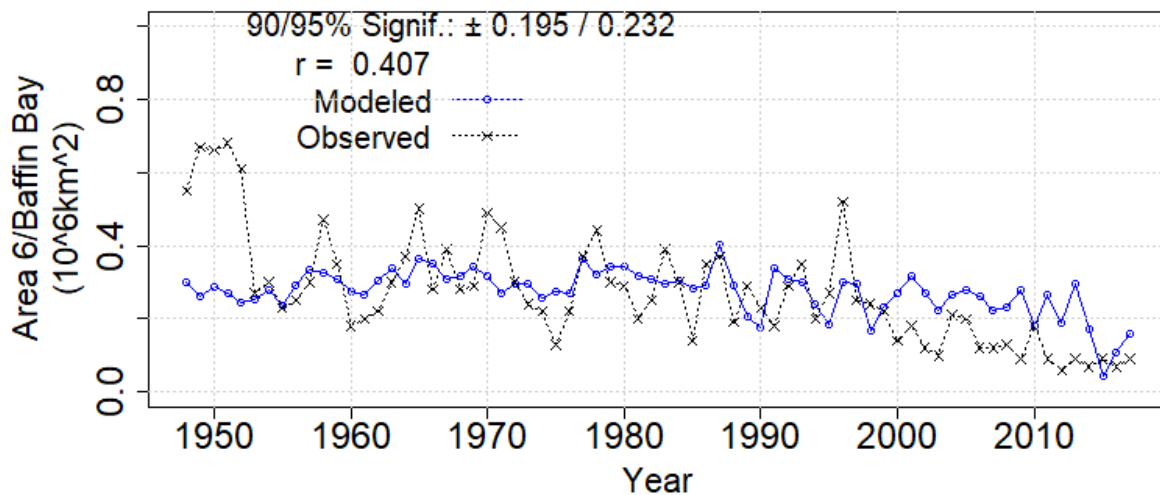


Figure 5.3.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.32 - 0.03\text{NAO} - 0.02\text{NAO}^2 - 0.02\text{ENSO} \\
 & + 0.02\text{ENSO}*\text{NAO} \\
 & - 0.03\text{AMO} - 0.02\text{AMO}^2 \\
 & - 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.3.6-1

5.3.7 Whole Arctic, Period 3 1948-2017

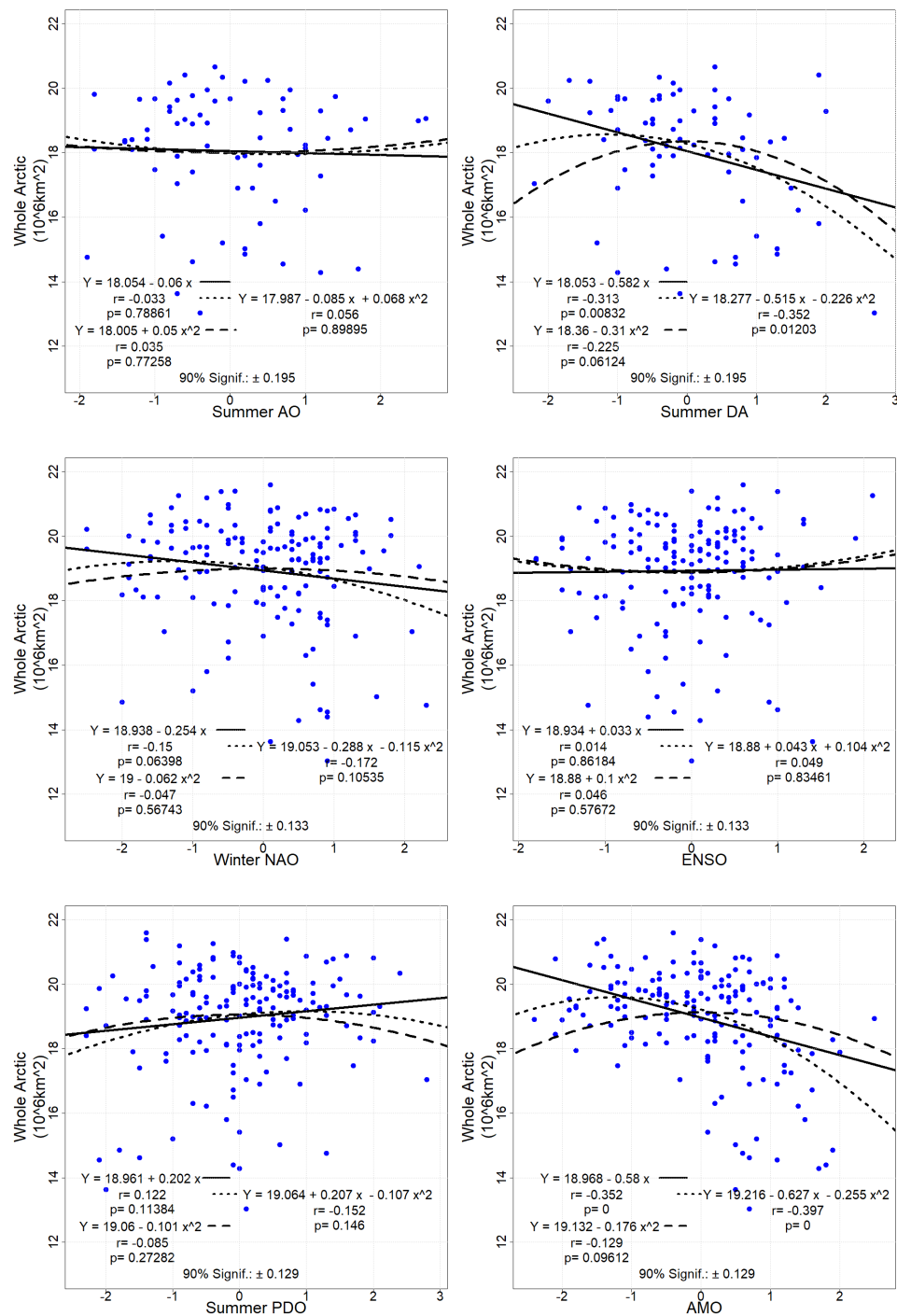


Figure 5.3.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 5.3.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.033	0.027	97.3	0.195
AO ²	0.035	0.556	44.4	0.195
DA	-0.313	0.352	64.8	0.195
DA ²	-0.225	0.646	35.4	0.195
NAO	-0.150	0.071	92.9	0.133
NAO ²	-0.047	0.278	72.2	0.133
ENSO	0.014	0.230	77.0	0.133
ENSO ²	0.046	0.758	24.2	0.133
PDO	0.122	0.892	10.8	0.129
PDO ²	-0.085	0.861	13.9	0.129
AMO	-0.352	0.071	92.9	0.129
AMO ²	-0.129	0.452	54.8	0.129

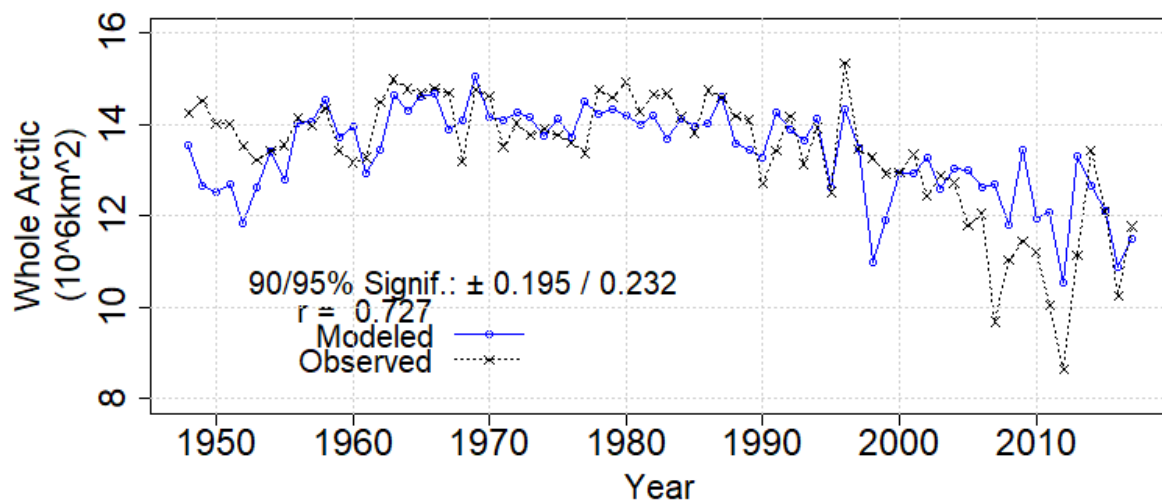


Figure 5.3.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 13.84 - 0.45\text{NAO} - 0.12\text{ENSO} \\
 & + 0.04\text{NAO}*\text{ENSO} \\
 & + 0.18\text{PDO} - 0.14\text{PDO}^2 - 0.64\text{AMO} - 0.27\text{AMO}^2 \\
 & + 0.25\text{AMO}*\text{PDO} \\
 & + 0.001\text{PDO}*\text{ENSO} - 0.31\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 5.3.7-1

6 FOUR-INDEX MODELS, 1865-2017

6.1 PERIOD 1 1865-1978

6.1.1 Chukchi and Beaufort Seas, Period 1 1865-1978

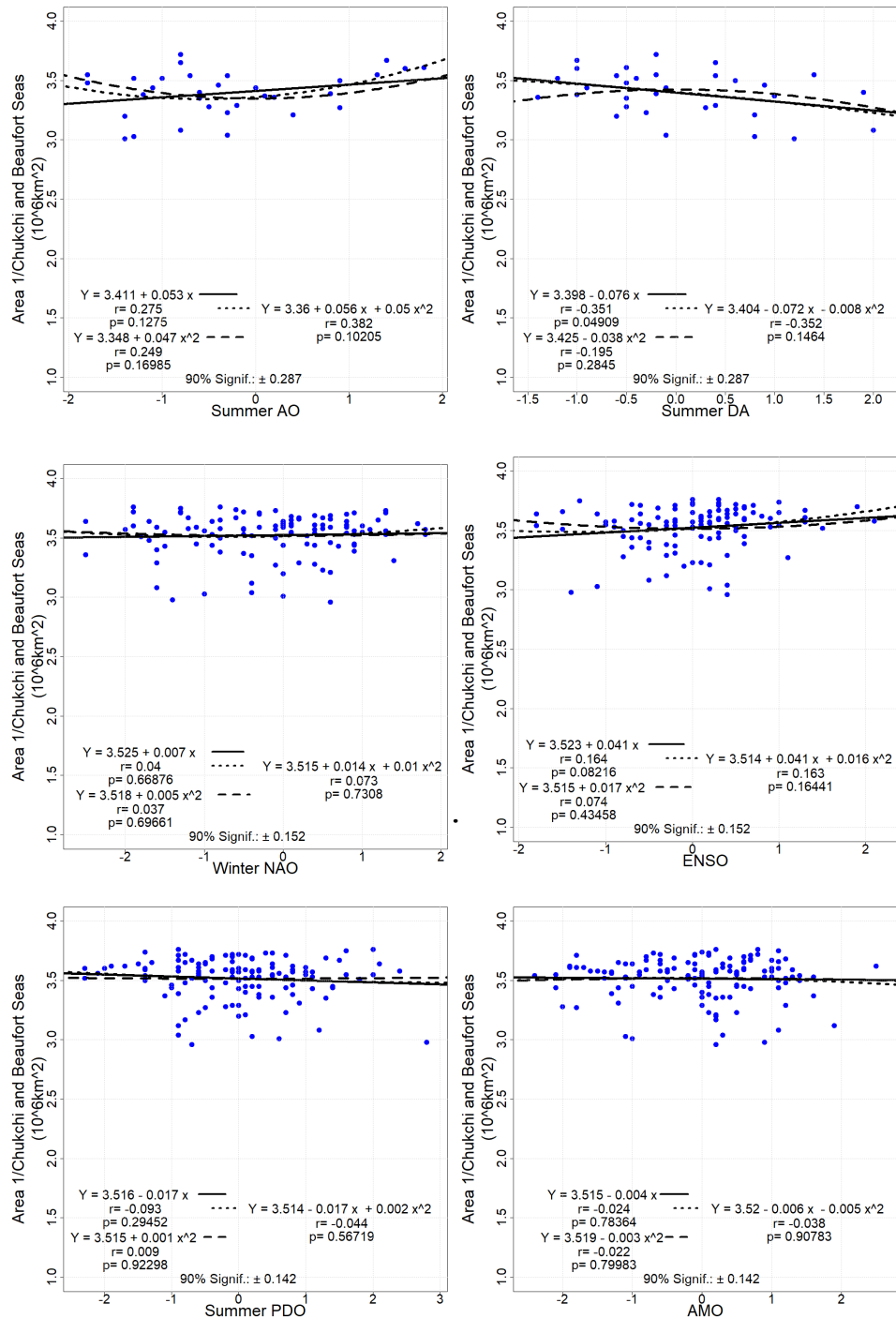


Figure 6.1.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 6.1.1-1 Table summarizing the correlation and significance levels of the teleconnections' impact on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.275	0.128	87.2	0.287
AO ²	0.249	0.170	83.0	0.287
DA	-0.351	0.049	95.1	0.287
DA ²	-0.195	0.285	71.5	0.287
NAO	0.040	0.669	33.1	0.152
NAO ²	0.037	0.697	30.3	0.152
ENSO	0.164	0.082	91.8	0.152
ENSO ²	0.074	0.435	56.6	0.152
PDO	-0.093	0.295	70.5	0.142
PDO ²	0.009	0.923	7.7	0.142
AMO	-0.024	0.784	21.6	0.142
AMO ²	-0.022	0.800	20.0	0.142

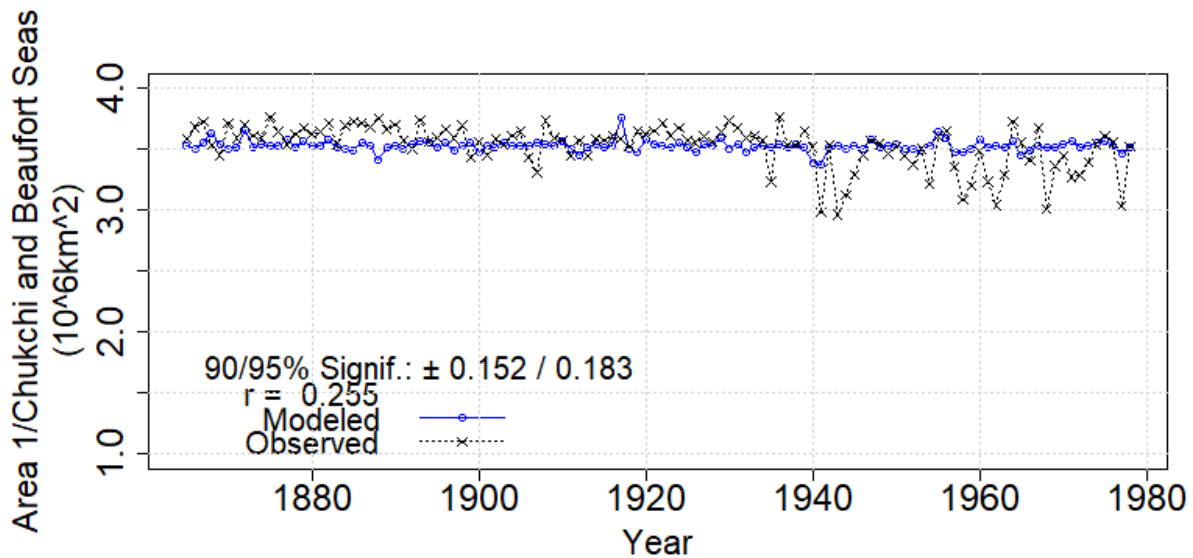


Figure 6.1.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.51 + 0.01\text{NAO} + 0.02\text{NAO}^2 + 0.03\text{ENSO} + 0.02\text{ENSO}^2 \\
 & - 0.04\text{ENSO}*\text{NAO} \\
 & - 0.01\text{PDO} \\
 & + 0.02\text{PDO}*\text{ENSO}
 \end{aligned}$$

Equation 6.1.1-1

6.1.2 East Siberian and Laptev Seas, Period 1 1865-1978

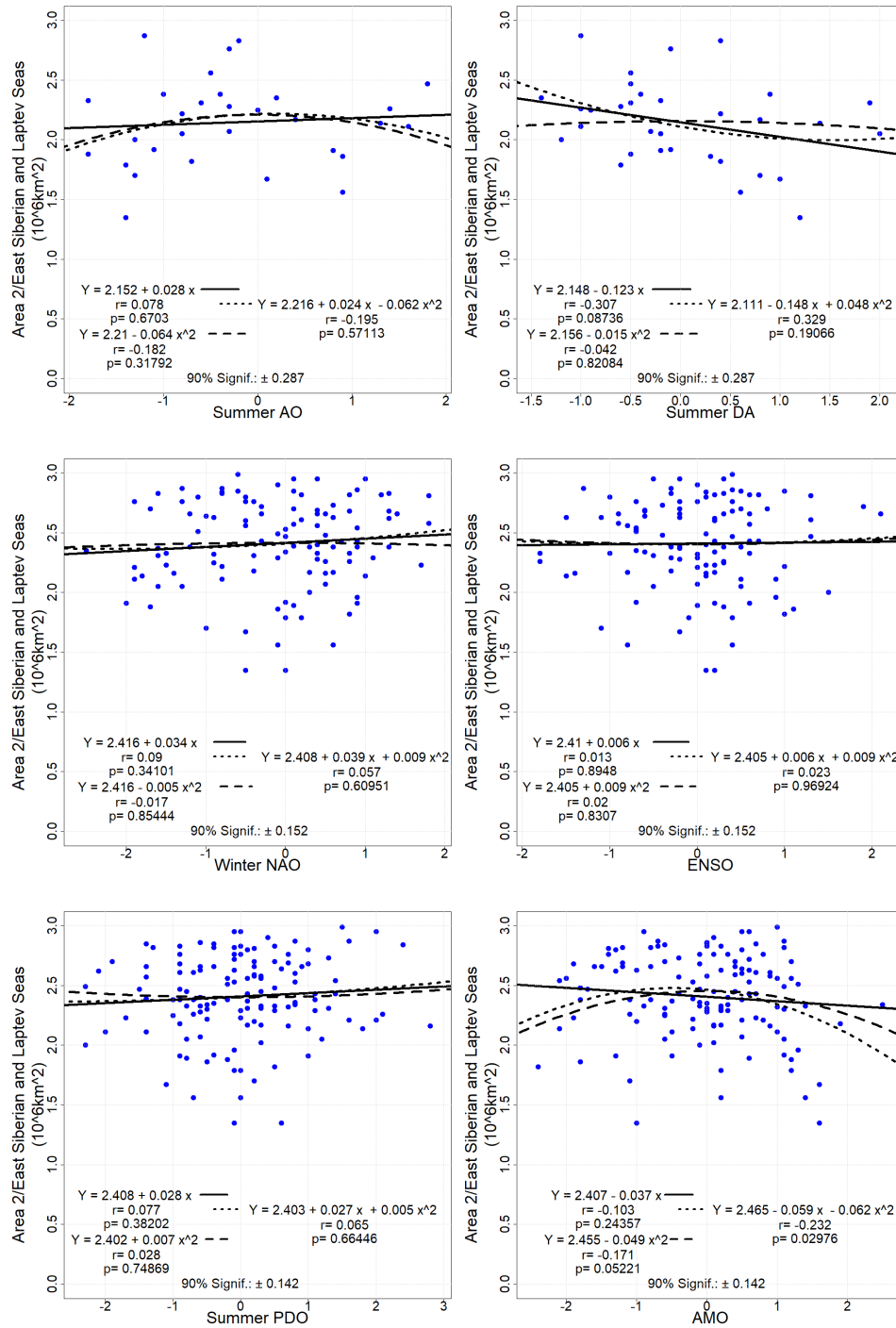


Figure 6.1.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 6.1.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.078	0.670	33.0	0.287
AO ²	-0.182	0.318	60.2	0.287
DA	-0.307	0.087	91.3	0.287
DA ²	-0.042	0.821	17.9	0.287
NAO	0.090	0.341	65.9	0.152
NAO ²	-0.017	0.854	14.6	0.152
ENSO	0.013	0.895	10.5	0.152
ENSO ²	0.020	0.831	16.9	0.152
PDO	0.077	0.382	61.8	0.142
PDO ²	0.028	0.749	25.1	0.142
AMO	-0.103	0.244	75.6	0.142
AMO ²	-0.171	0.052	94.8	0.142

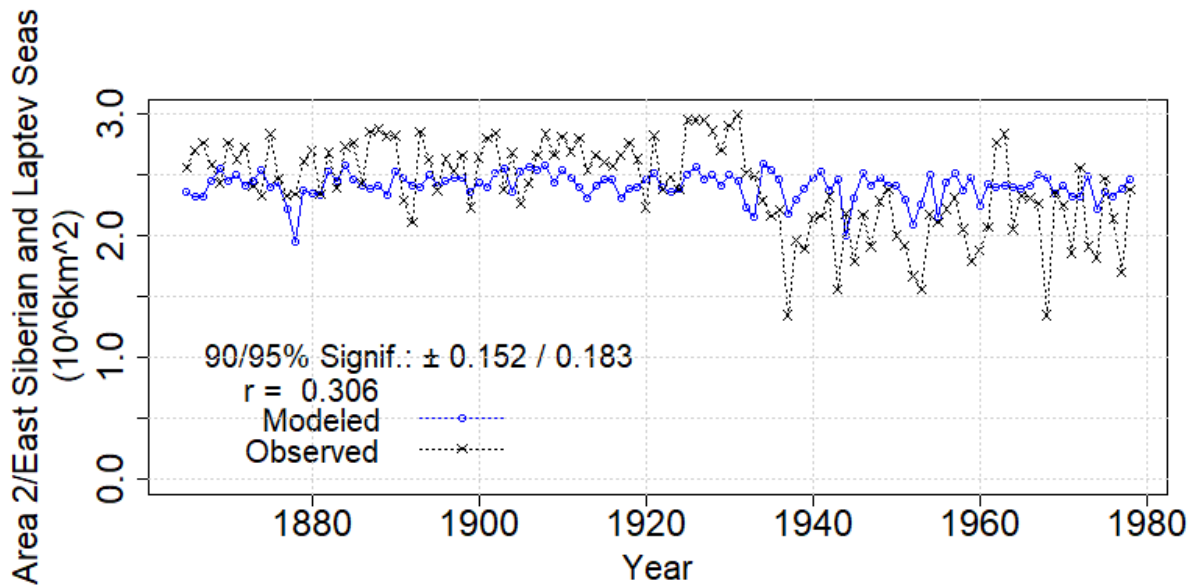


Figure 6.1.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.49 + 0.05\text{NAO} \\
 & + 0.04\text{PDO} - 0.05\text{AMO} - 0.08\text{AMO}^2 \\
 & + 0.03\text{AMO}*\text{PDO} \\
 & - 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.1.2-1

6.1.3 Central Arctic, Period 1 1865-1978

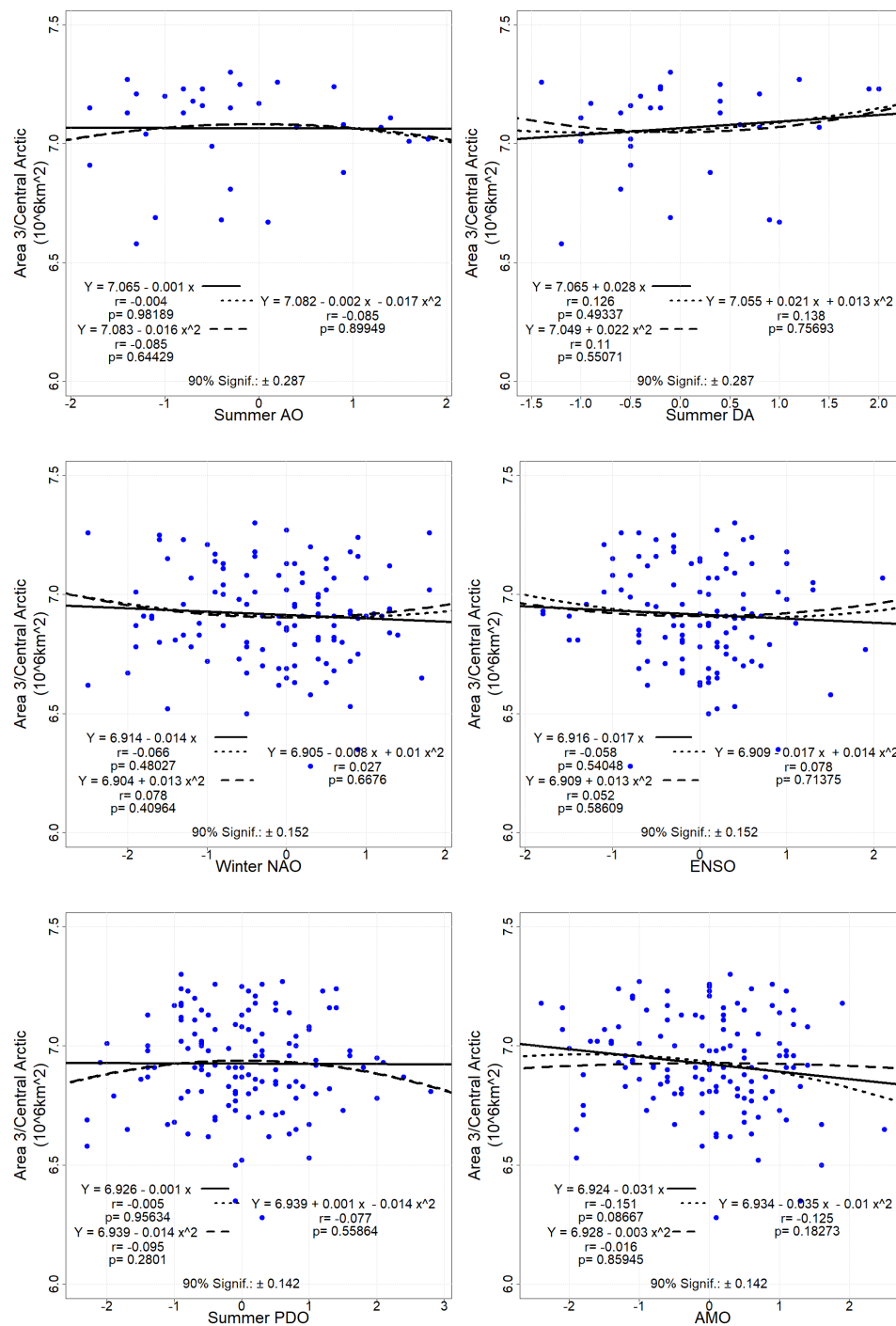


Figure 6.1.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 6.1.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.004	0.982	1.8	0.287
AO ²	-0.085	0.644	35.6	0.287
DA	0.126	0.493	50.7	0.287
DA ²	0.110	0.551	44.9	0.287
NAO	-0.066	0.480	52.0	0.152
NAO ²	0.078	0.410	59.0	0.152
ENSO	-0.058	0.540	46.0	0.152
ENSO ²	0.052	0.586	41.4	0.152
PDO	-0.005	0.956	4.4	0.142
PDO ²	-0.095	0.280	72.0	0.142
AMO	-0.151	0.087	91.3	0.142
AMO ²	-0.016	0.859	14.1	0.142

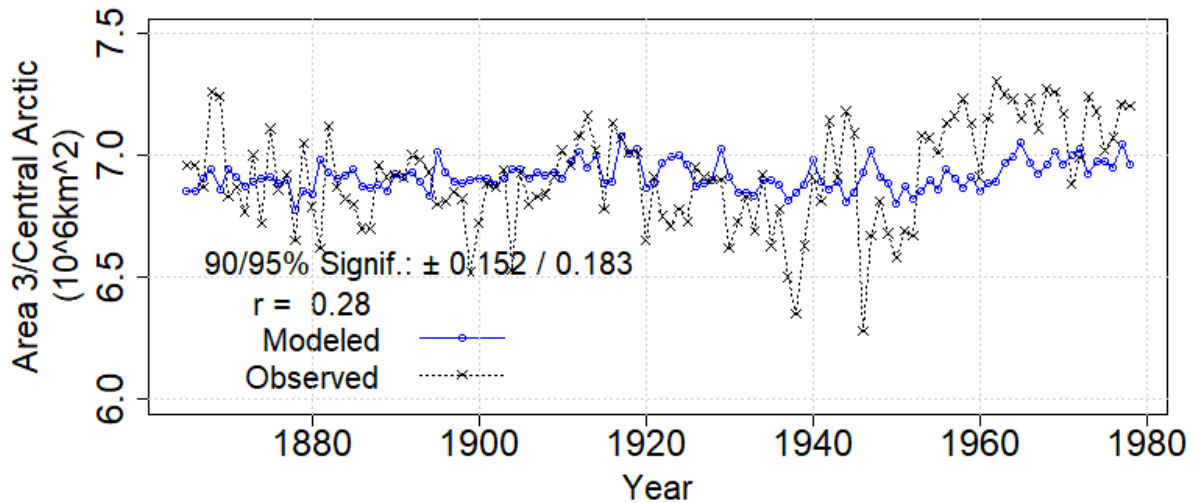


Figure 6.1.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 6.92 - 0.01\text{NAO} + 0.01\text{NAO}^2 - 0.02\text{ENSO} + 0.004\text{ENSO}^2 \\
 & - 0.01\text{ENSO}*\text{NAO} \\
 & - 0.01\text{PDO}^2 - 0.06\text{AMO} \\
 & + 0.01\text{AMO}*\text{PDO}^2 \\
 & - 0.003\text{PDO}^2*\text{ENSO} + 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.1.3-1

6.1.4 Kara and Barents Seas, Period 1 1865-1978

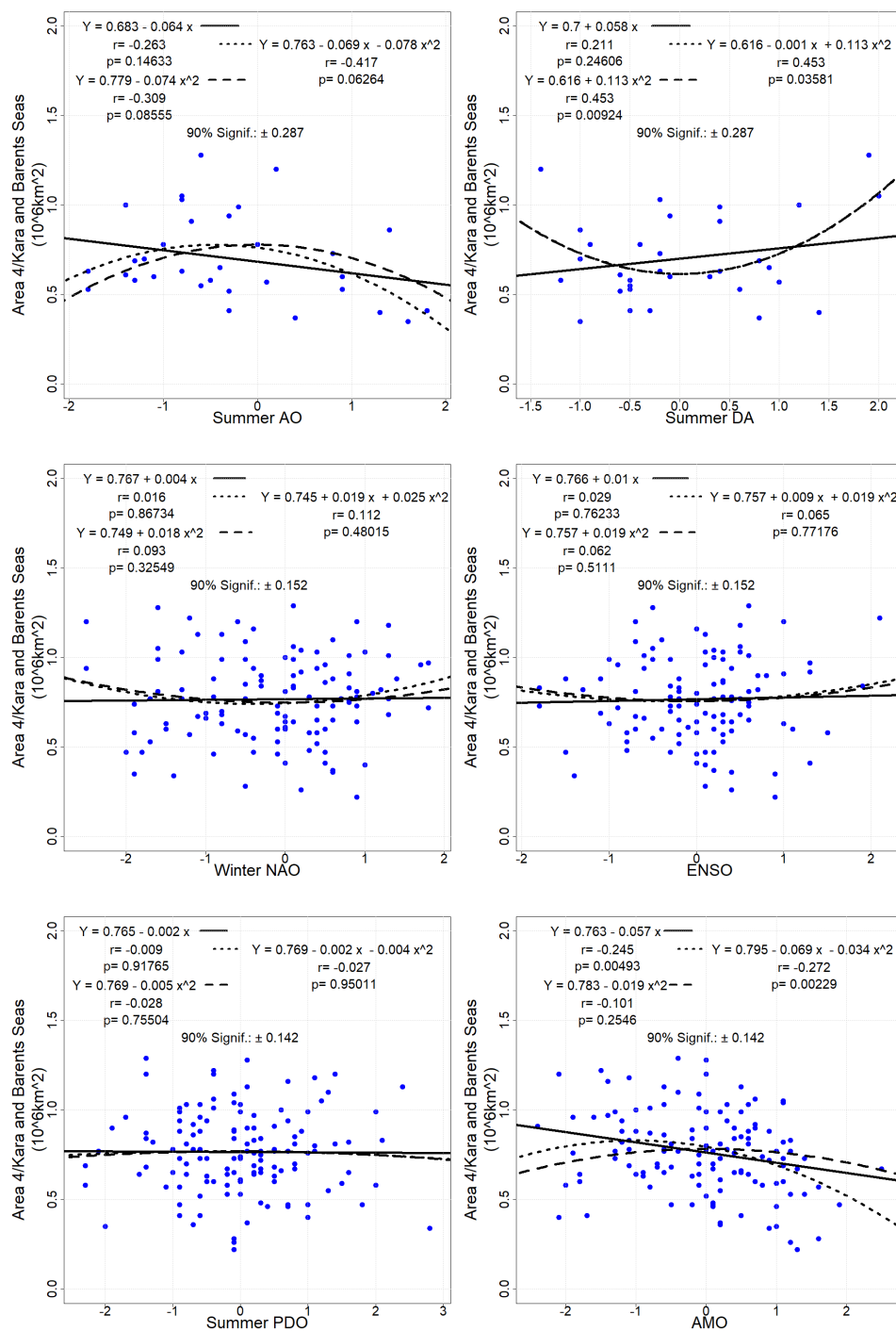


Figure 6.1.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 6.1.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.263	0.146	85.4	0.287
AO ²	-0.309	0.086	91.4	0.287
DA	0.211	0.246	75.4	0.287
DA ²	0.453	0.009	99.1	0.287
NAO	0.016	0.867	13.3	0.152
NAO ²	0.093	0.325	67.5	0.152
ENSO	0.029	0.762	23.8	0.152
ENSO ²	0.062	0.511	48.9	0.152
PDO	-0.009	0.918	8.2	0.142
PDO ²	-0.028	0.755	24.5	0.142
AMO	-0.245	0.005	99.5	0.142
AMO ²	-0.101	0.255	74.5	0.142

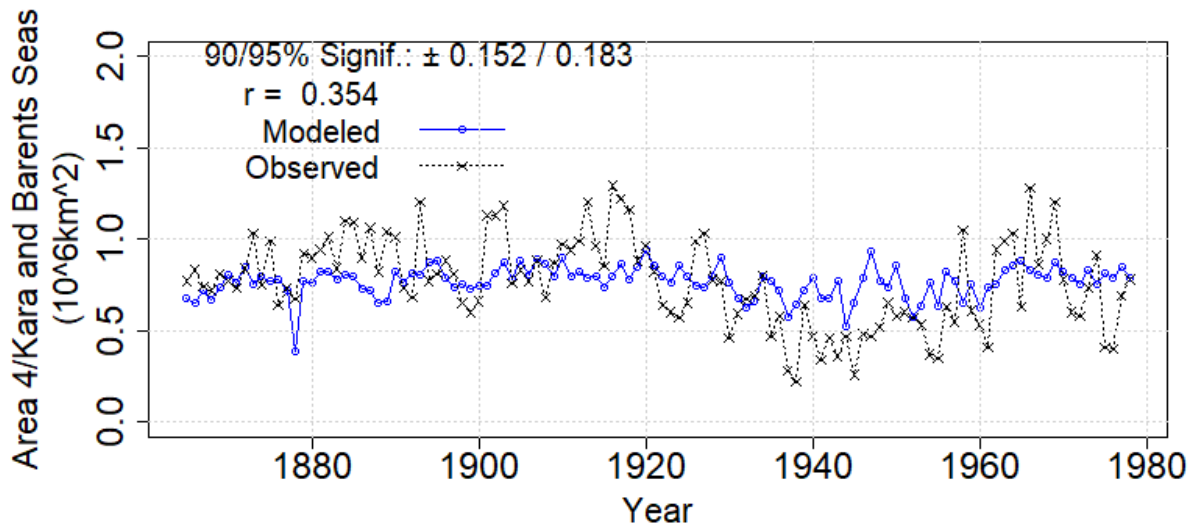


Figure 6.1.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.77 + 0.03\text{NAO}^2 + 0.04\text{ENSO}^2 \\
 & - 0.02\text{ENSO}^2 * \text{NAO}^2 \\
 & - 0.06\text{AMO} - 0.04\text{AMO}^2 \\
 & - 0.03\text{AMO} * \text{NAO}^2
 \end{aligned}$$

Equation 6.1.4-1

6.1.5 Greenland Sea, Period 1 1865-1978

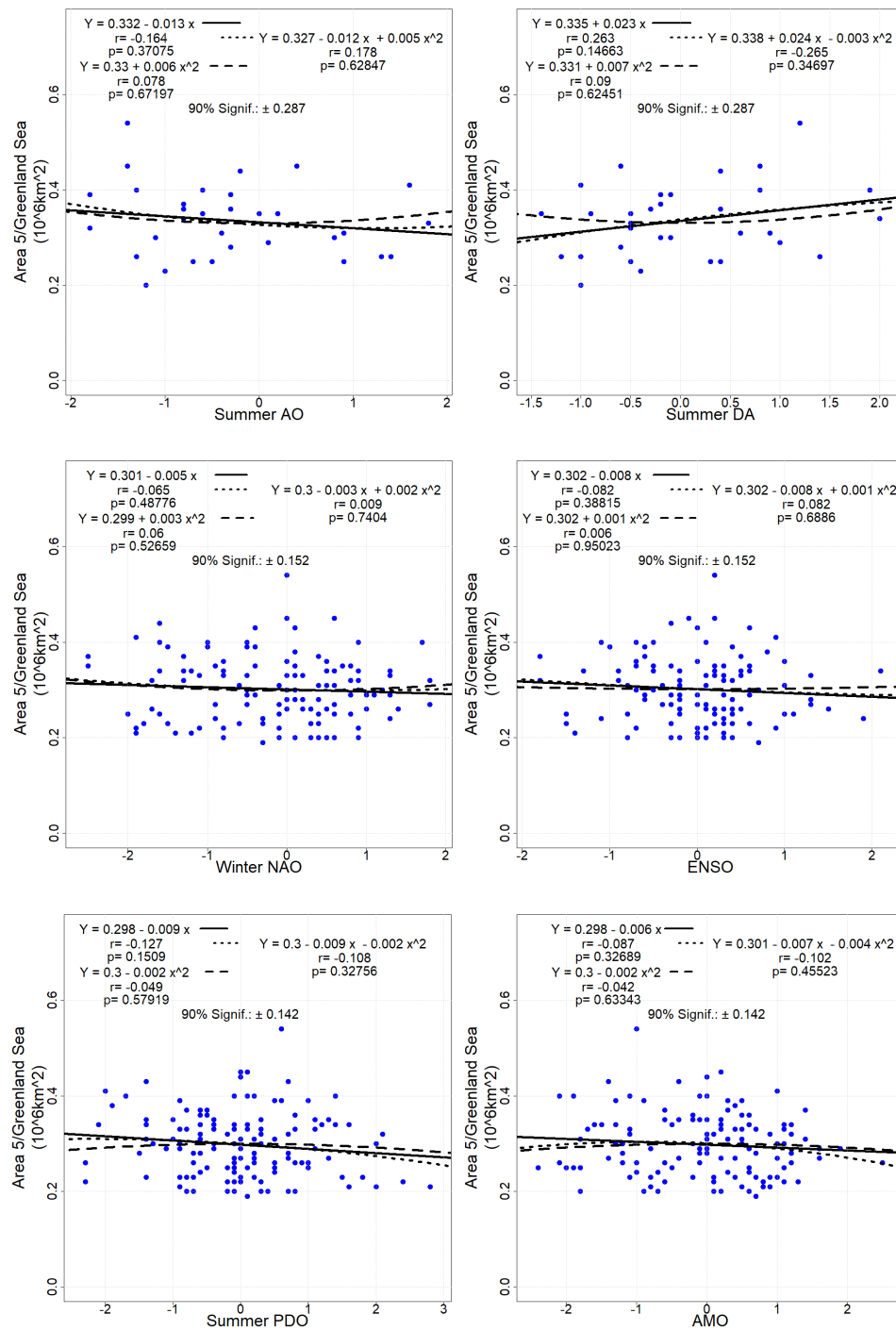


Figure 6.1.4-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 6.1.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.164	0.371	62.9	0.287
AO ²	0.078	0.672	32.8	0.287
DA	0.263	0.147	85.3	0.287
DA ²	0.090	0.625	37.5	0.287
NAO	-0.065	0.488	51.2	0.152
NAO ²	0.060	0.527	47.3	0.152
ENSO	-0.082	0.388	61.2	0.152
ENSO ²	-0.006	0.950	5.0	0.152
PDO	-0.127	0.151	84.9	0.142
PDO ²	-0.049	0.579	42.9	0.142
AMO	-0.087	0.327	67.3	0.142
AMO ²	-0.042	0.633	36.7	0.142

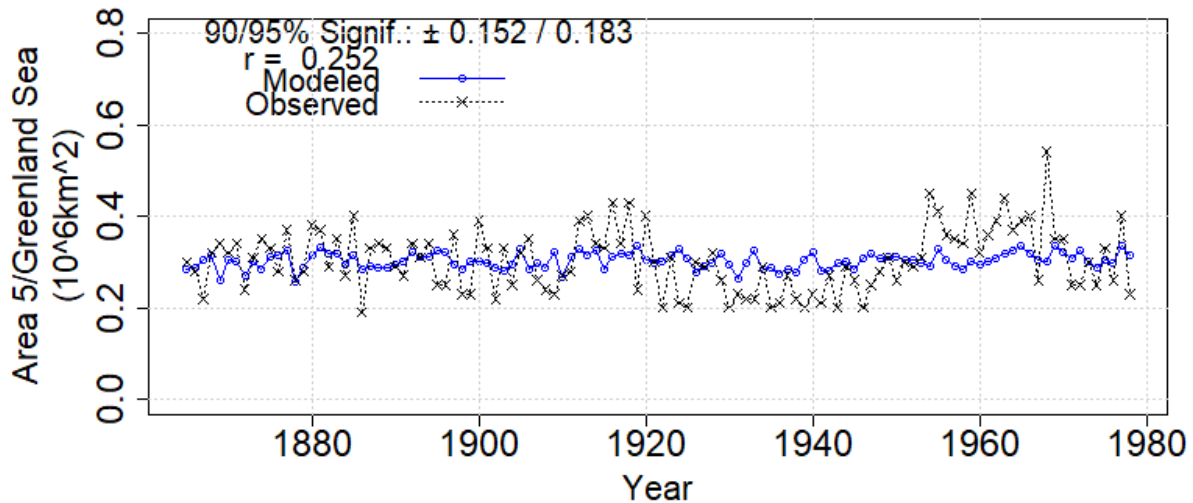


Figure 6.1.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.30 - 0.01\text{NAO} + 0.003\text{NAO}^2 - 0.01\text{ENSO} \\
 & - 0.004\text{ENSO}*\text{NAO} \\
 & - 0.01\text{PDO} - 0.01\text{AMO} \\
 & - 0.004\text{AMO}*\text{PDO} \\
 & - 0.003\text{PDO}*\text{ENSO} + 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.1.5-1

6.1.6 Baffin Bay, Period 1 1865-1978

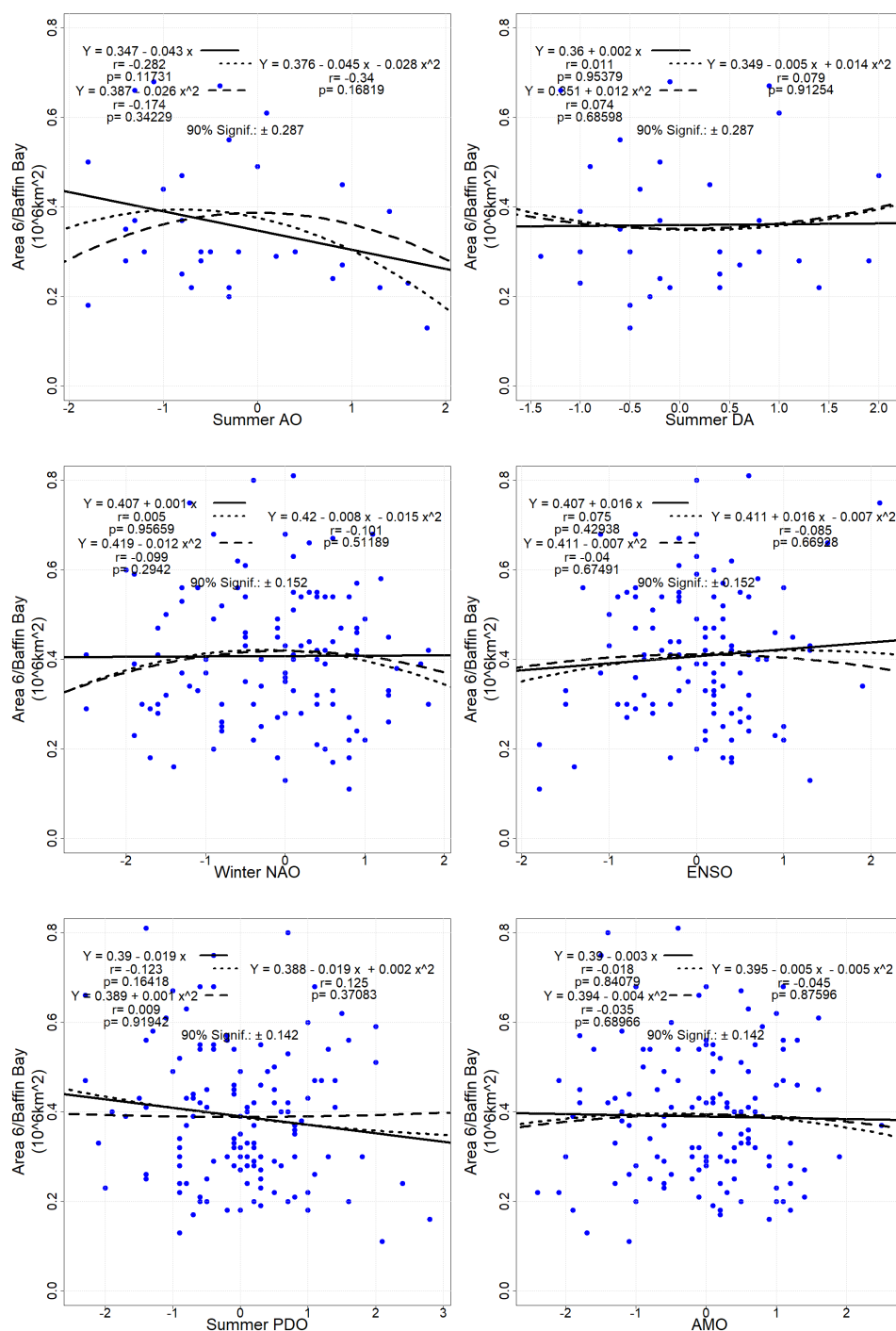


Figure 6.1.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6)

Table 6.1.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.282	0.117	88.3	0.287
AO ²	-0.174	0.342	65.8	0.287
DA	0.011	0.954	4.6	0.287
DA ²	0.074	0.686	31.4	0.287
NAO	0.005	0.957	4.3	0.152
NAO ²	-0.099	0.294	70.6	0.152
ENSO	0.075	0.429	57.1	0.152
ENSO ²	-0.040	0.675	32.5	0.152
PDO	-0.123	0.164	83.6	0.142
PDO ²	0.009	0.919	8.1	0.142
AMO	-0.018	0.841	15.9	0.142
AMO ²	-0.035	0.690	31.0	0.142

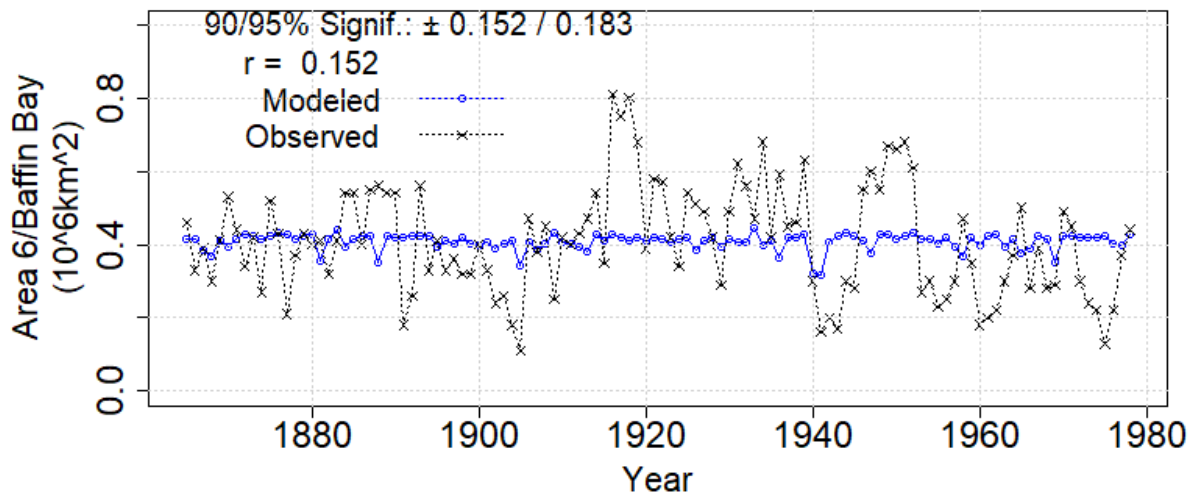


Figure 6.1.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.42 - 0.01\text{NAO}^2 + 0.004\text{ENSO} \\
 & + 0.003\text{ENSO}*\text{NAO}^2 \\
 & - 0.01\text{PDO} \\
 & + 0.01\text{PDO}*\text{ENSO}
 \end{aligned}$$

Equation 6.1.6-1

6.1.7 Whole Arctic, Period 1 1865-1978

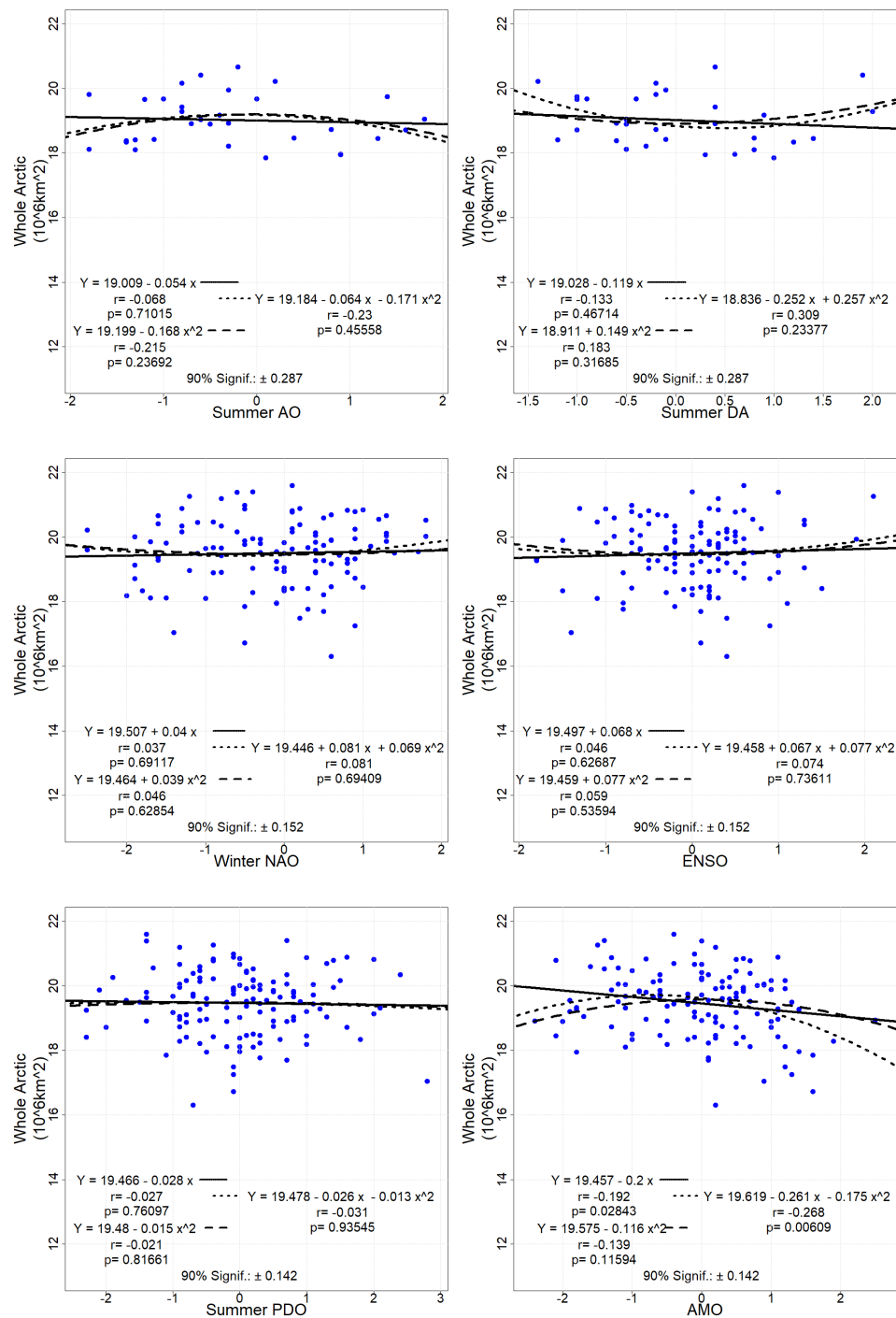


Figure 6.1.7-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 6.1.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.068	0.710	29.0	0.287
AO ²	-0.215	0.237	76.3	0.287
DA	-0.133	0.467	53.5	0.287
DA ²	0.183	0.317	68.3	0.287
NAO	0.037	0.691	30.9	0.152
NAO ²	0.046	0.629	37.1	0.152
ENSO	0.046	0.627	37.3	0.152
ENSO ²	0.059	0.536	46.4	0.152
PDO	-0.027	0.761	23.9	0.142
PDO ²	-0.021	0.817	19.3	0.142
AMO	-0.192	0.028	97.2	0.142
AMO ²	-0.139	0.116	88.4	0.142

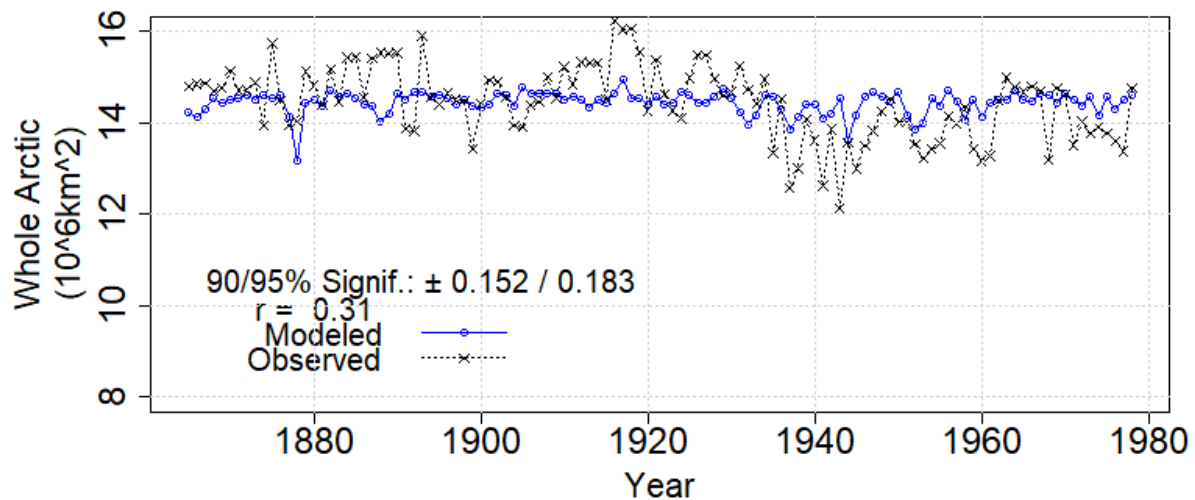


Figure 6.1.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.55 + 0.03\text{NAO} + 0.02\text{NAO}^2 + 0.04\text{ENSO} + 0.04\text{ENSO}^2 \\
 & - 0.08\text{ENSO}*\text{NAO} \\
 & - 0.19\text{AMO} - 0.15\text{AMO}^2 \\
 & + 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.1.7-1

6.2 PERIOD 2 1879-2017

See Standard Models Period 2: 1979-2017 on page 23.

6.3 PERIOD 3 1865-2017

6.3.1 Chukchi and Beaufort Seas, Period 3 1865-2017

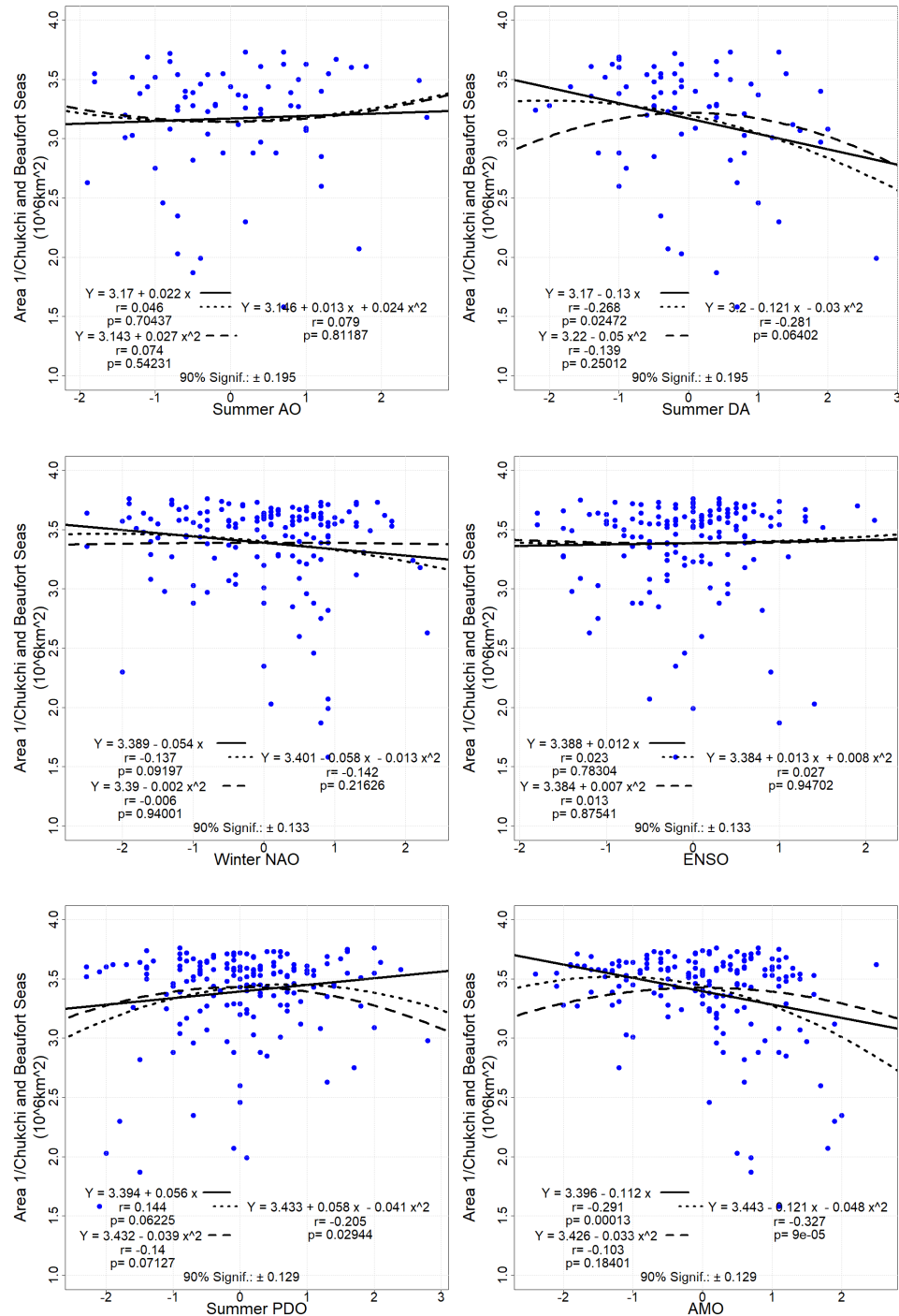


Figure 6.3.1-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Chukchi and Beaufort Seas (Area 1).

Table 6.3.1-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.046	0.704	29.6	0.195
AO ²	0.074	0.542	45.8	0.195
DA	-0.268	0.025	97.5	0.195
DA ²	-0.139	0.250	75.0	0.195
NAO	-0.137	0.092	90.8	0.133
NAO ²	-0.006	0.940	6.0	0.133
ENSO	0.023	0.783	21.7	0.133
ENSO ²	0.013	0.875	12.5	0.133
PDO	0.144	0.062	93.8	0.129
PDO ²	-0.140	0.071	92.9	0.129
AMO	-0.291	0.000	100.0	0.129
AMO ²	-0.103	0.184	81.6	0.129

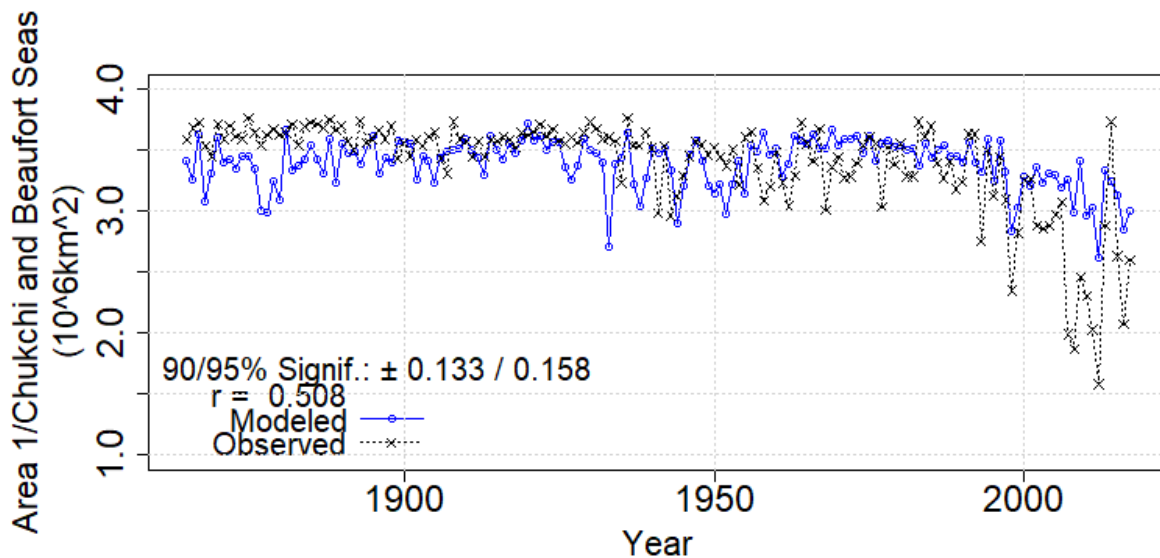


Figure 6.3.1-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 3.51 - 0.03\text{NAO} \\
 & - 0.01\text{PDO} - 0.01\text{PDO}^2 - 0.04\text{AMO} - 0.02\text{AMO}^2 \\
 & - 0.03\text{AMO*PDO} \\
 & - 0.02\text{AMO*NAO}
 \end{aligned}$$

Equation 6.3.1-1

6.3.2 East Siberian and Laptev Seas, Period 3 1865-2017

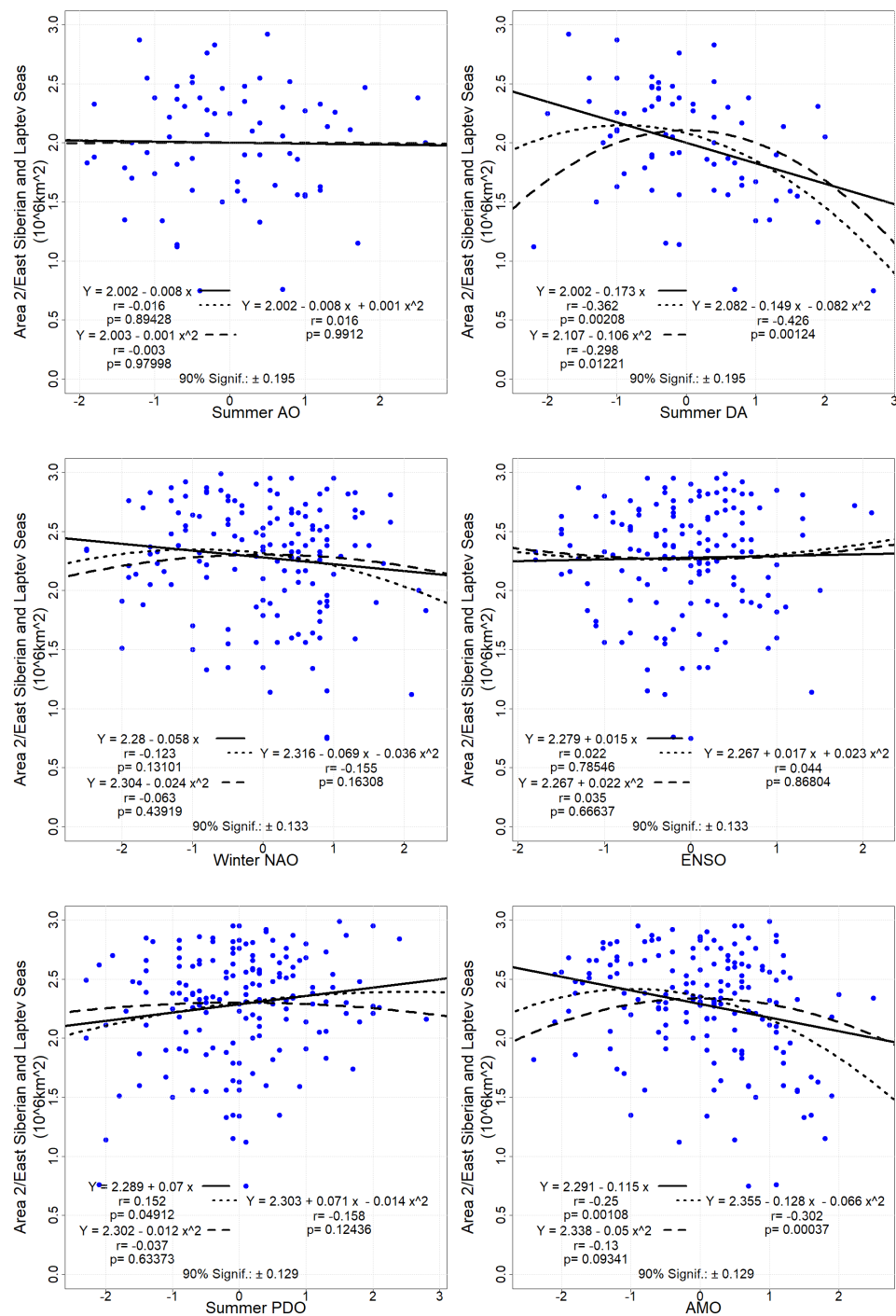


Figure 6.3.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the East Siberian and Laptev Seas (Area 2).

Table 6.3.2-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.016	0.894	10.6	0.195
AO ²	-0.003	0.980	2.0	0.195
DA	-0.362	0.002	99.8	0.195
DA ²	-0.298	0.012	98.8	0.195
NAO	-0.123	0.131	86.9	0.133
NAO ²	-0.063	0.439	56.1	0.133
ENSO	0.022	0.785	21.5	0.133
ENSO ²	0.035	0.666	33.4	0.133
PDO	0.152	0.049	95.4	0.129
PDO ²	-0.037	0.634	36.6	0.129
AMO	-0.250	0.001	99.9	0.129
AMO ²	-0.130	0.093	90.7	0.129

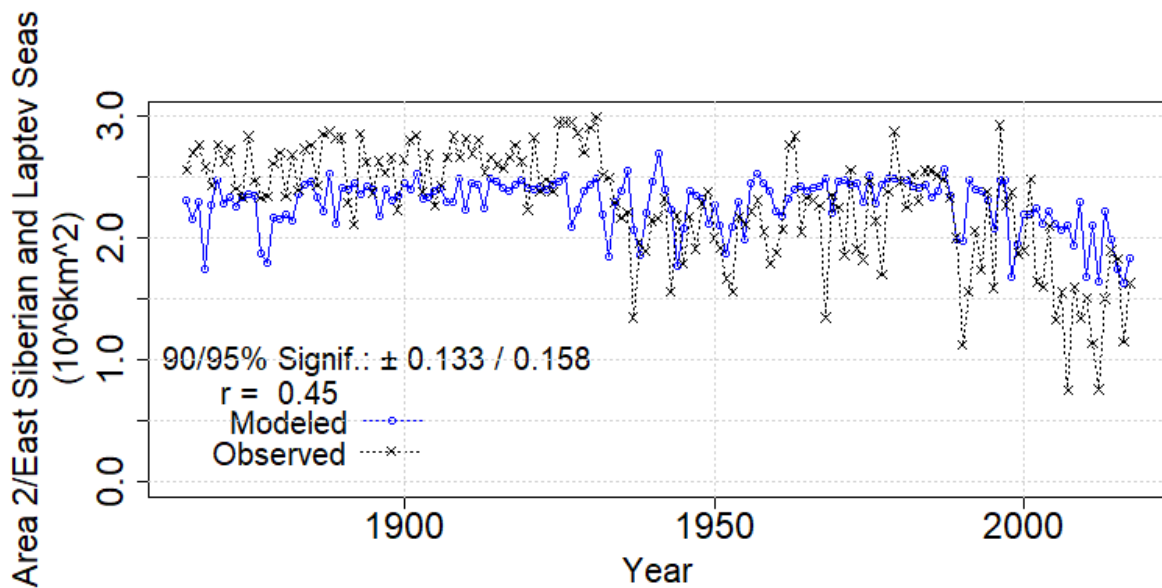


Figure 6.3.2-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 2.46 - 0.07\text{NAO} - 0.06\text{NAO}^2 \\
 & + 0.03\text{PDO} - 0.07\text{AMO} - 0.05\text{AMO}^2 \\
 & + 0.04\text{AMO}*\text{PDO} \\
 & - 0.04\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.3.2-1

6.3.3 Central Arctic, Period 3 1865-2017

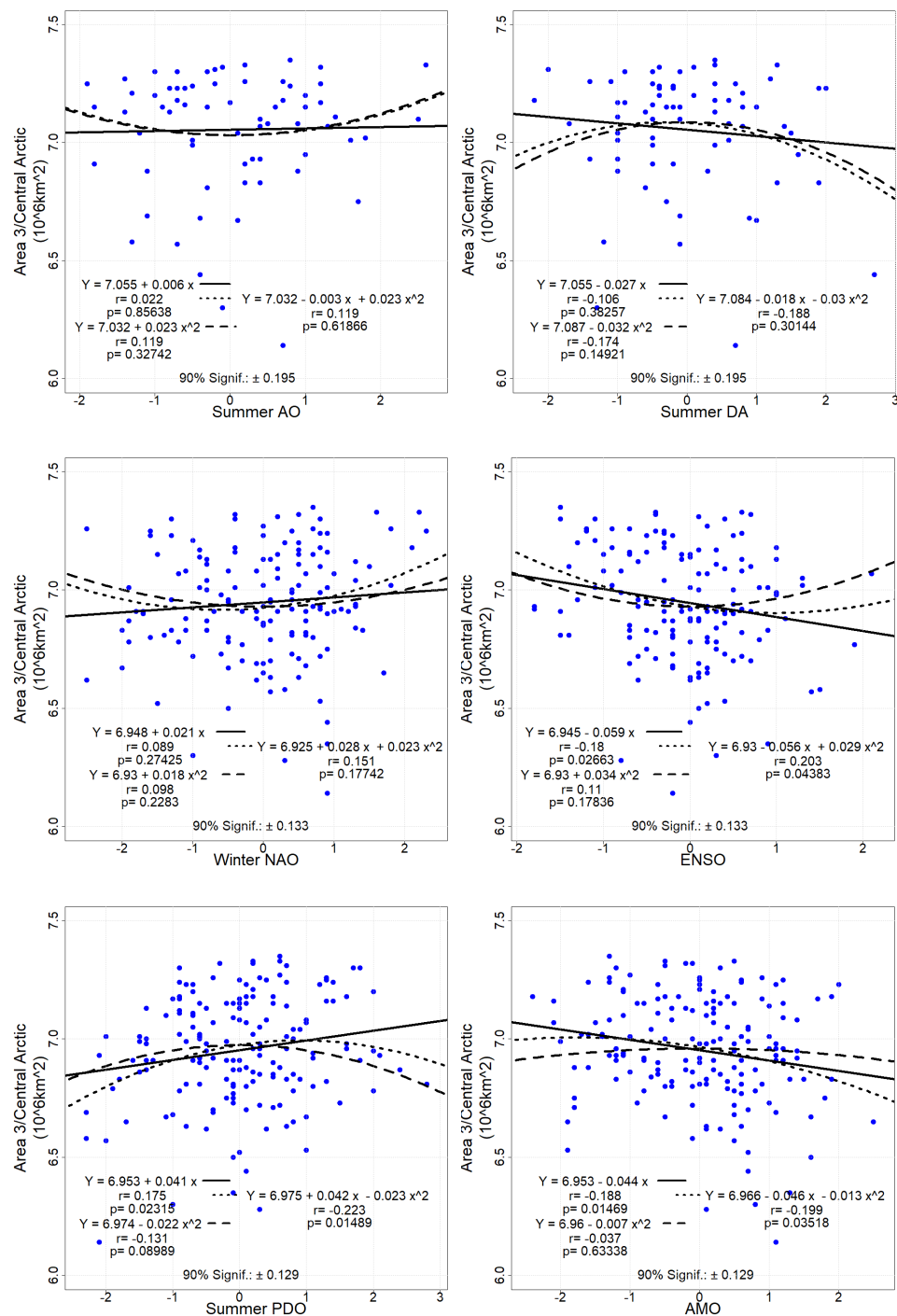


Figure 6.3.2-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Central Arctic Region (Area 3).

Table 6.3.3-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	0.022	0.856	14.4	0.195
AO ²	0.119	0.327	67.3	0.195
DA	-0.106	0.383	61.7	0.195
DA ²	-0.174	0.149	85.1	0.195
NAO	0.089	0.274	72.6	0.133
NAO ²	0.098	0.228	77.2	0.133
ENSO	-0.180	0.026	97.4	0.133
ENSO ²	0.110	0.178	82.2	0.133
PDO	0.175	0.023	97.7	0.129
PDO ²	-0.131	0.090	91.0	0.129
AMO	-0.188	0.015	98.5	0.129
AMO ²	-0.037	0.633	36.7	0.129

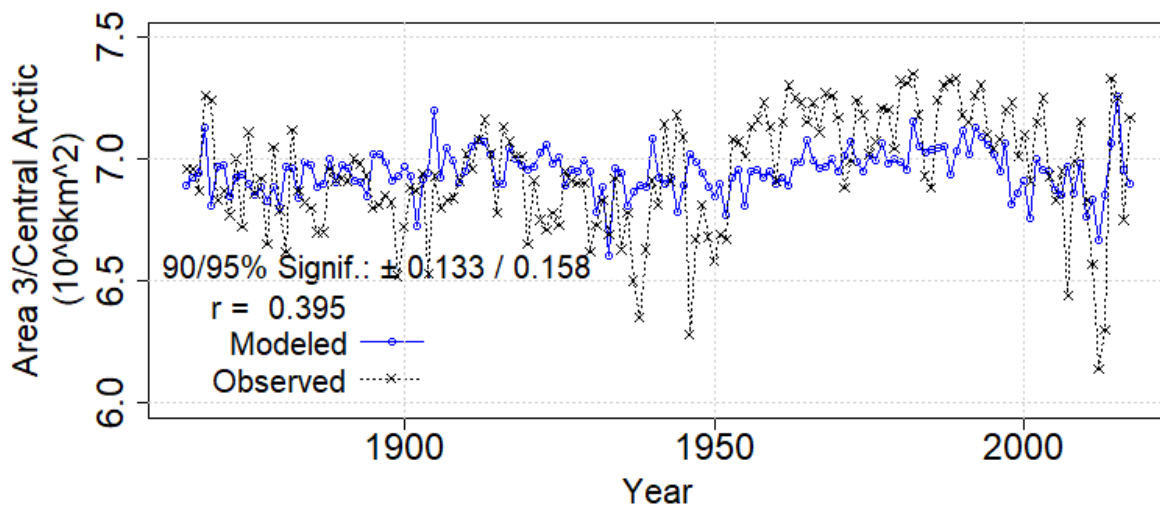


Figure 6.3.3-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is in

$$\begin{aligned}
 Y = & 6.95 + 0.02\text{NAO} + 0.02\text{NAO}^2 - 0.05\text{ENSO} + 0.001\text{ENSO}^2 \\
 & - 0.01\text{ENSO}*\text{NAO} \\
 & - 0.001\text{PDO} - 0.03\text{PDO}^2 - 0.04\text{AMO} \\
 & - 0.01\text{AMO}*\text{PDO} \\
 & - 0.05\text{PDO}*\text{ENSO} + 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.3.3-1

6.3.4 Kara and Barents Seas Period 3 1865-2017

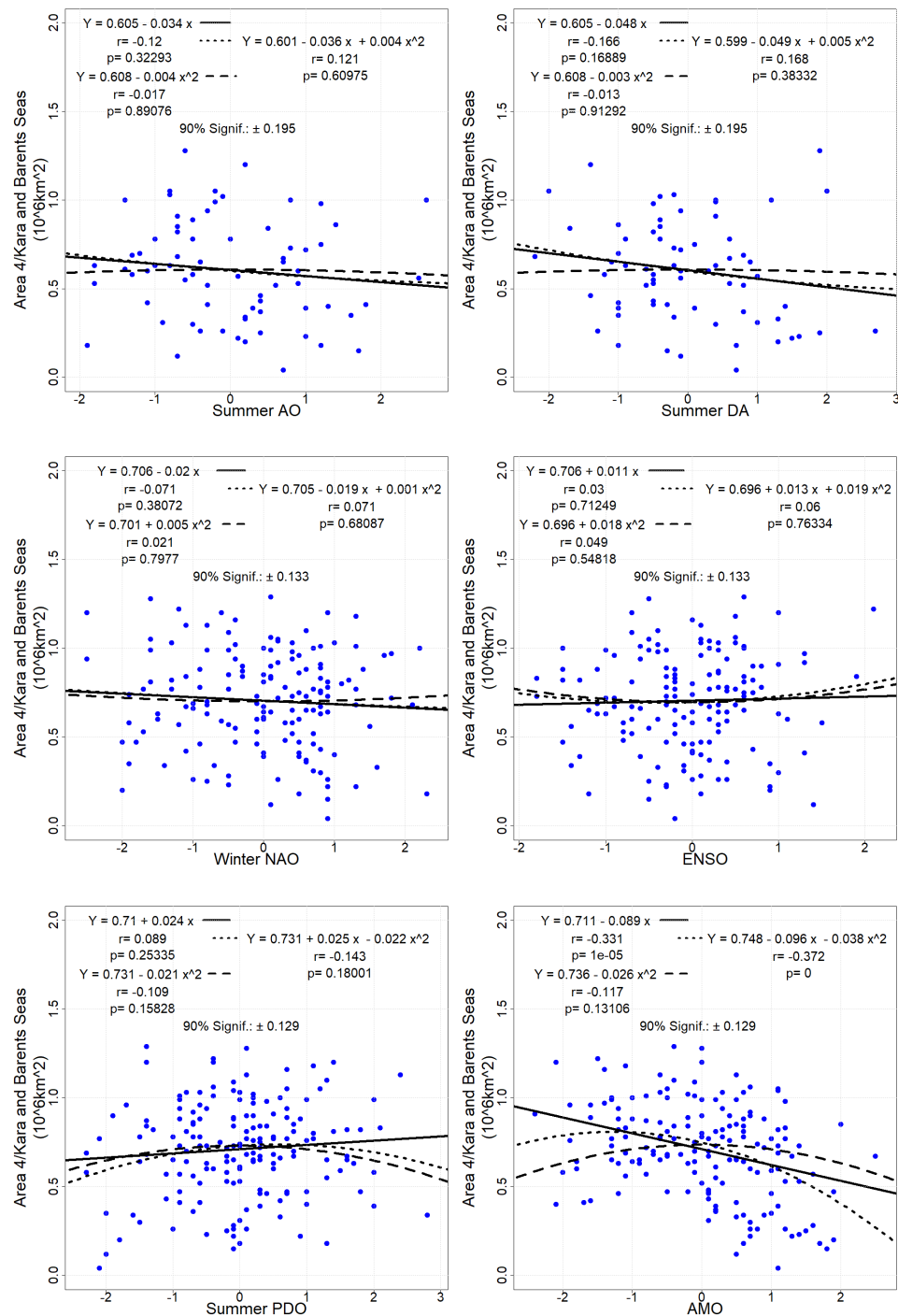


Figure 6.3.3-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Kara and Barents Seas (Area 4).

Table 6.3.4-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.120	0.856	14.4	0.195
AO ²	-0.017	0.327	67.3	0.195
DA	-0.166	0.383	61.7	0.195
DA ²	-0.013	0.149	85.1	0.195
NAO	-0.071	0.274	72.6	0.133
NAO ²	0.021	0.228	77.2	0.133
ENSO	0.030	0.026	97.4	0.133
ENSO ²	0.049	0.178	82.2	0.133
PDO	0.089	0.023	97.7	0.129
PDO ²	-0.109	0.090	91.0	0.129
AMO	-0.331	0.015	98.5	0.129
AMO ²	-0.117	0.633	36.7	0.129

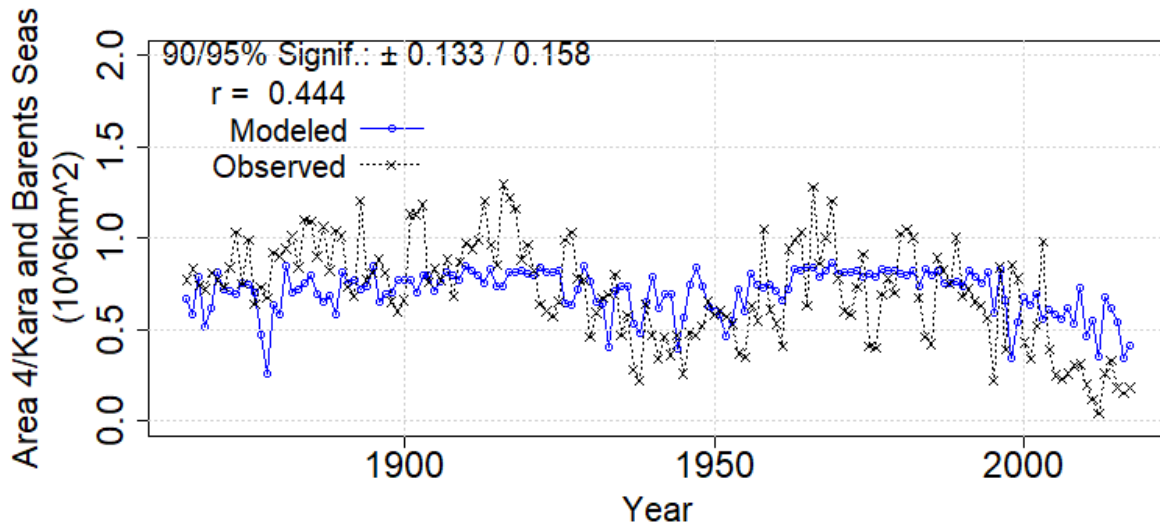


Figure 6.3.4-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is decadal variability. The third line is decadal interactions. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.78 - 0.02\text{NAO} \\
 & - 0.004\text{PDO} - 0.01\text{PDO}^2 - 0.07\text{AMO} - 0.03\text{AMO}^2 \\
 & - 0.01\text{AMO}*\text{PDO} \\
 & - 0.02\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.3.4-1

6.3.5 Greenland Sea, Period 3 1865-2017

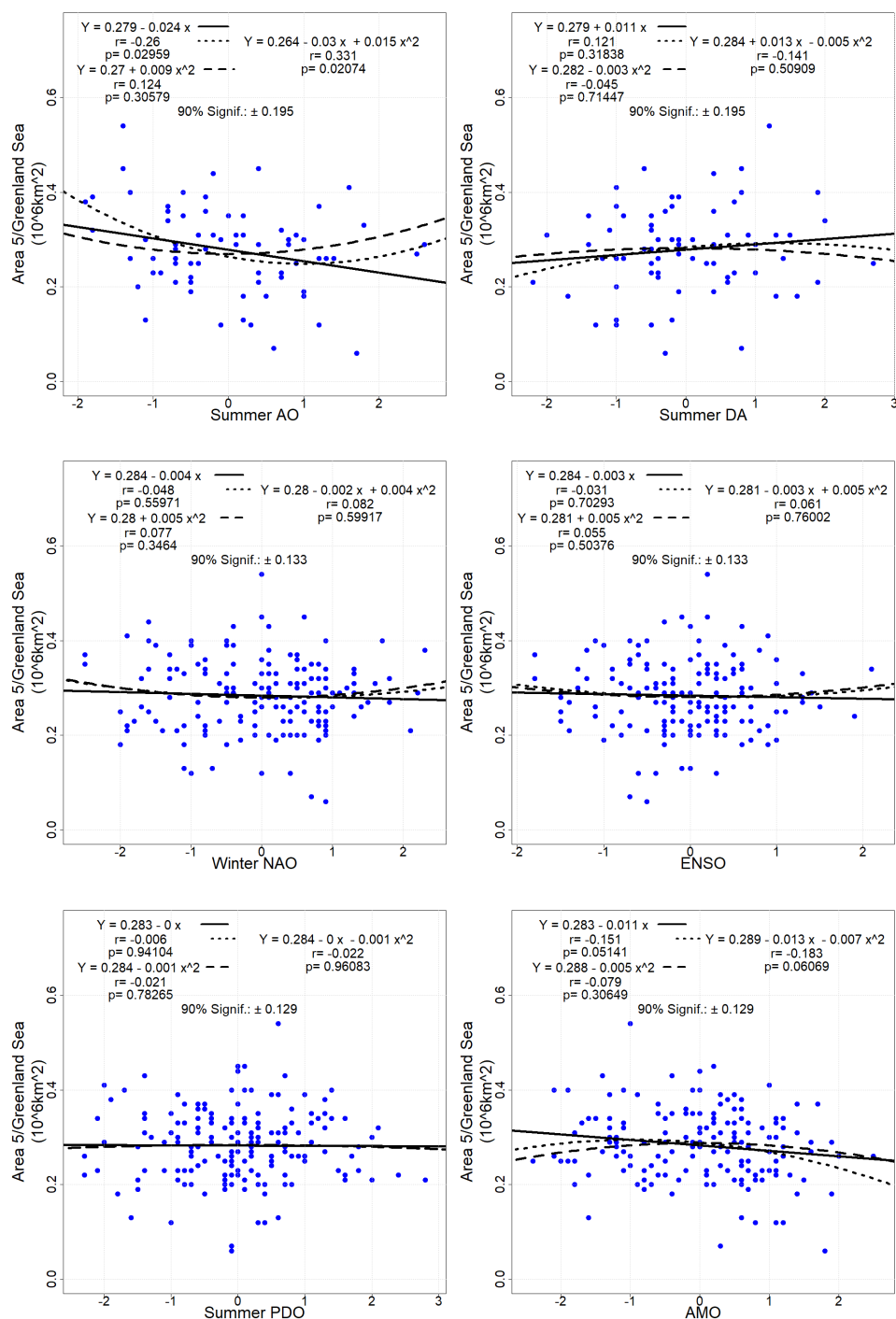


Figure 6.3.5-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Greenland Sea (Area 5).

Table 6.3.5-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	R	P-Value	Significance (%)	Critical Value
AO	-0.260	0.030	97.0	0.195
AO ²	0.124	0.306	69.4	0.195
DA	0.121	0.318	68.2	0.195
DA ²	-0.045	0.714	28.6	0.195
NAO	-0.048	0.560	44.0	0.133
NAO ²	0.077	0.346	65.4	0.133
ENSO	-0.031	0.703	29.7	0.133
ENSO ²	0.055	0.504	49.6	0.133
PDO	-0.006	0.941	5.9	0.129
PDO ²	-0.021	0.783	21.7	0.129
AMO	-0.151	0.051	94.1	0.129
AMO ²	-0.079	0.306	69.4	0.129

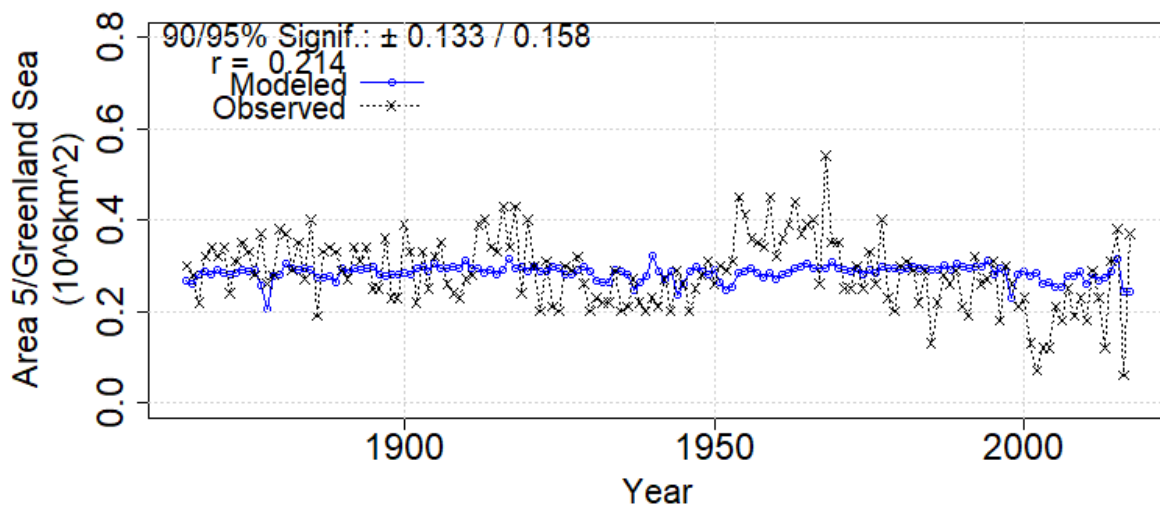


Figure 6.3.5-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.29 + 0.002\text{NAO}^2 + 0.0004\text{ENSO}^2 \\
 & + 0.003\text{ENSO}^2 * \text{NAO}^2 \\
 & - 0.01\text{AMO} - 0.01\text{AMO}^2 \\
 & + 0.001\text{AMO} * \text{NAO}^2
 \end{aligned}$$

Equation 6.3.5-1

6.3.6 Baffin Bay, Period 3 1865-2017

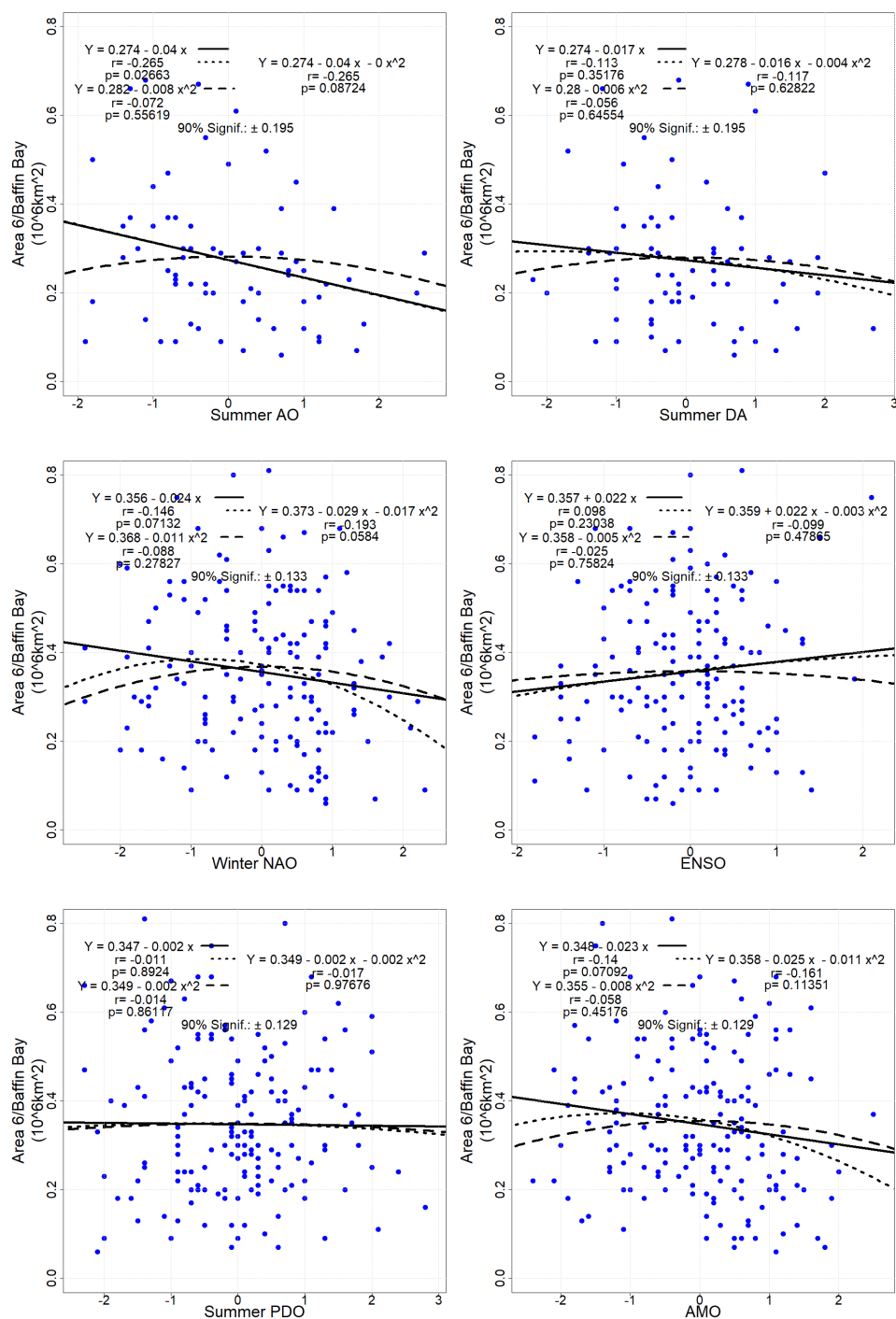


Figure 6.3.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Baffin Bay (Area 6).

Table 6.3.6-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.265	0.027	97.3	0.195
AO ²	-0.072	0.556	44.4	0.195
DA	-0.113	0.352	64.8	0.195
DA ²	-0.056	0.646	35.4	0.195
NAO	-0.146	0.071	92.9	0.133
NAO ²	-0.088	0.278	72.2	0.133
ENSO	0.098	0.230	77.0	0.133
ENSO ²	-0.025	0.758	24.2	0.133
PDO	-0.011	0.892	10.8	0.129
PDO ²	-0.014	0.861	13.9	0.129
AMO	-0.140	0.071	92.9	0.129
AMO ²	-0.058	0.452	54.8	0.129

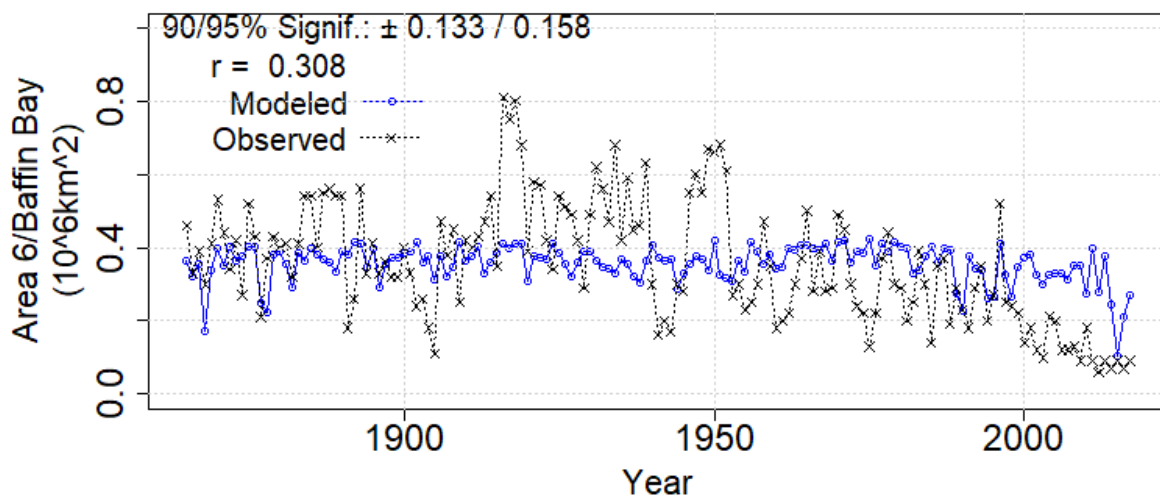


Figure 6.3.6-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 0.40 - 0.02\text{NAO} - 0.01\text{NAO}^2 + 0.03\text{ENSO} \\
 & + 0.01\text{ENSO}*\text{NAO} \\
 & - 0.003\text{AMO} - 0.01\text{AMO}^2 \\
 & + 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.3.6-1

6.3.7 Whole Arctic, Period 3 1865-2017

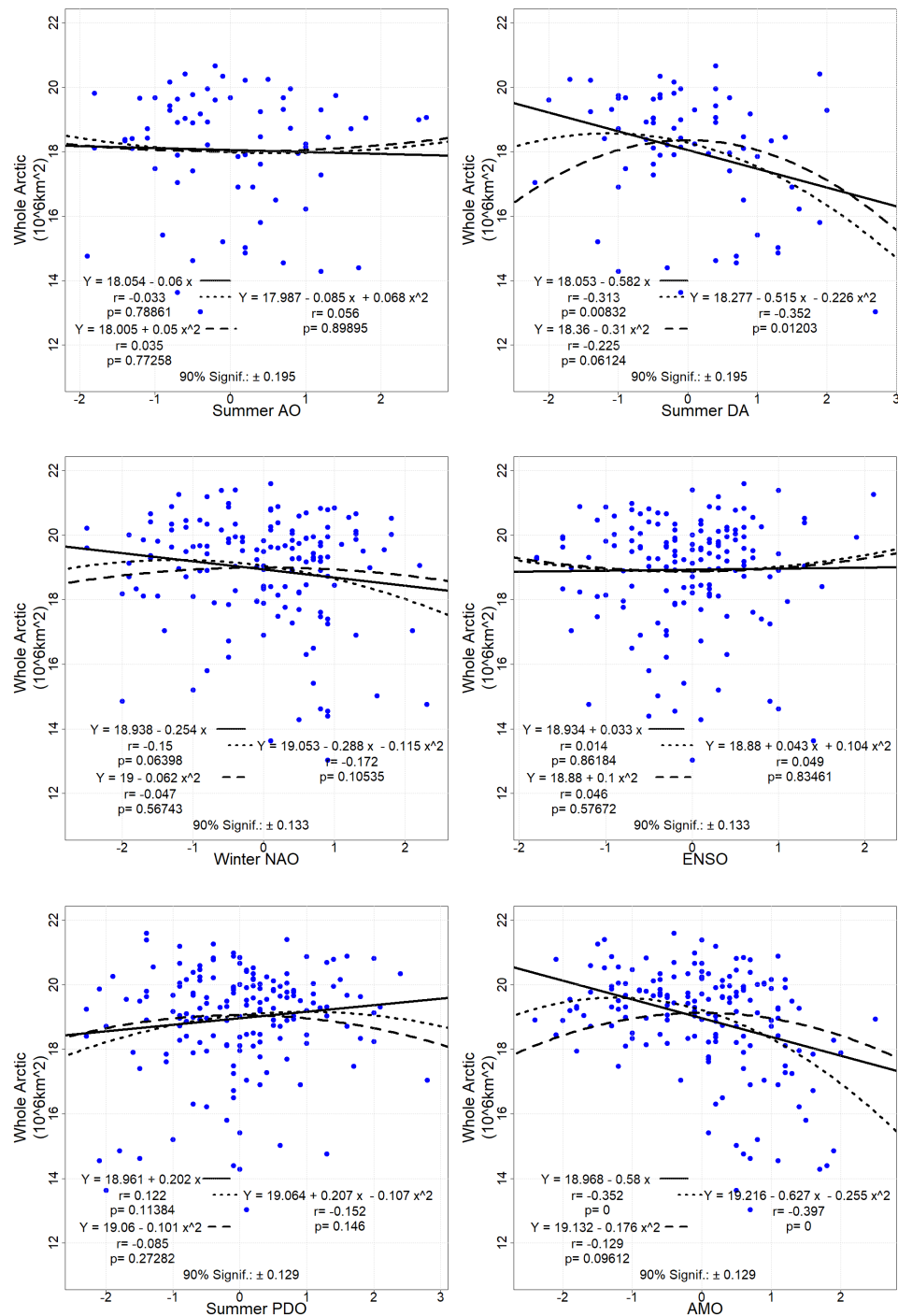


Figure 6.3.6-1 Scatter plots showing linear, quadratic, and combination regression lines for ice coverage in the Whole Arctic Region (Area 7).

Table 6.3.7-1 Table summarizing the correlation and significance levels of the teleconnections' impacts on ice coverage.

Index	<i>R</i>	<i>P</i> -Value	Significance (%)	Critical Value
AO	-0.033	0.027	97.3	0.195
AO ²	0.035	0.556	44.4	0.195
DA	-0.313	0.352	64.8	0.195
DA ²	-0.225	0.646	35.4	0.195
NAO	-0.150	0.071	92.9	0.133
NAO ²	-0.047	0.278	72.2	0.133
ENSO	0.014	0.230	77.0	0.133
ENSO ²	0.046	0.758	24.2	0.133
PDO	0.122	0.892	10.8	0.129
PDO ²	-0.085	0.861	13.9	0.129
AMO	-0.352	0.071	92.9	0.129
AMO ²	-0.129	0.452	54.8	0.129

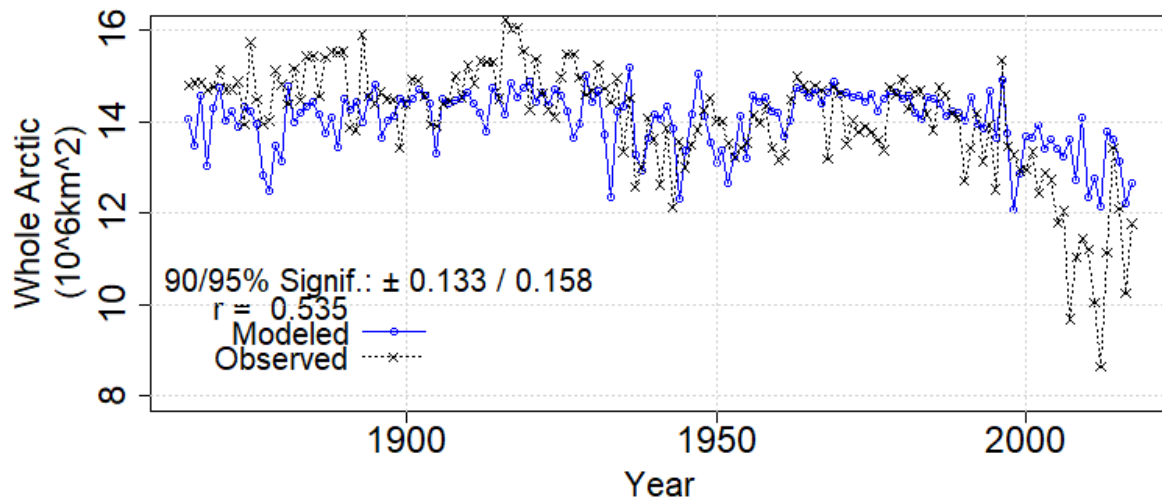


Figure 6.3.7-2 Model produced with its associated equation below. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

$$\begin{aligned}
 Y = & 14.35 - 0.26\text{NAO} + 0.11\text{ENSO} \\
 & - 0.04\text{NAO}*\text{ENSO} \\
 & + 0.20\text{PDO} - 0.04\text{PDO}^2 - 0.49\text{AMO} - 0.21\text{AMO}^2 \\
 & + 0.23\text{AMO}*\text{PDO} \\
 & + 0.23\text{PDO}*\text{ENSO} - 0.16\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 6.3.7-1

7 MODEL COMPARISONS

7.1 STANDARD MODELS

7.1.1 Period 1 (1948-1978)

The following graphics are comparisons of the model for period 1 (1948-1978) with the same base equations using different data sets. The associated equations follow each model. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

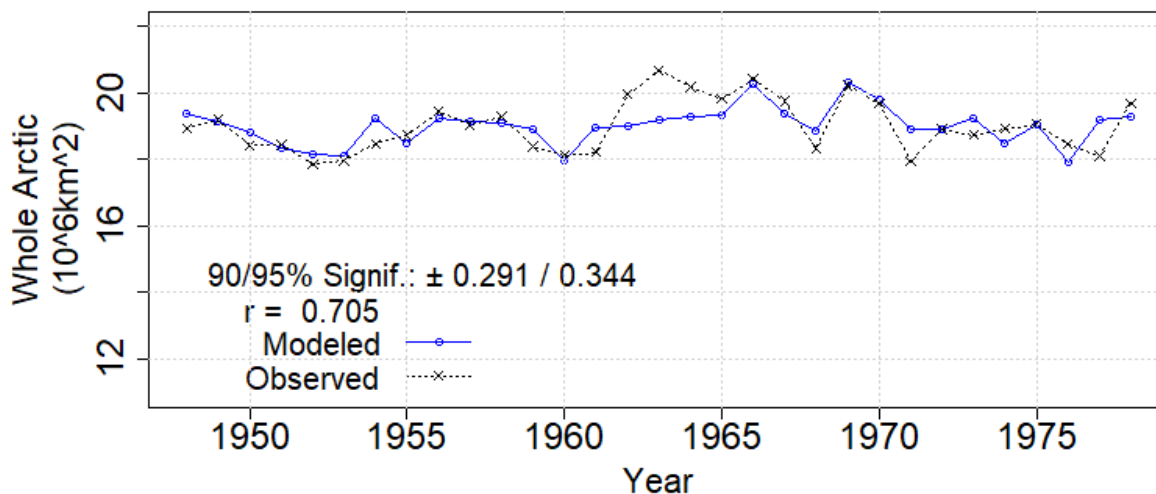


Figure 7.1.1-1 Comparison of model for period 1 (1948-1978) produced from the training data.

$$\begin{aligned}
 Y = & 19.15 + 0.07AO + 0.06AO^2 - 0.12DA + 0.49DA^2 \\
 & - 0.11AO*DA - 0.44AO^2*DA^2 \\
 & - 0.38AMO - 0.29AMO^2 \\
 & + 0.05AMO*AO - 0.01AMO*DA
 \end{aligned}$$

Equation 7.1.1-1

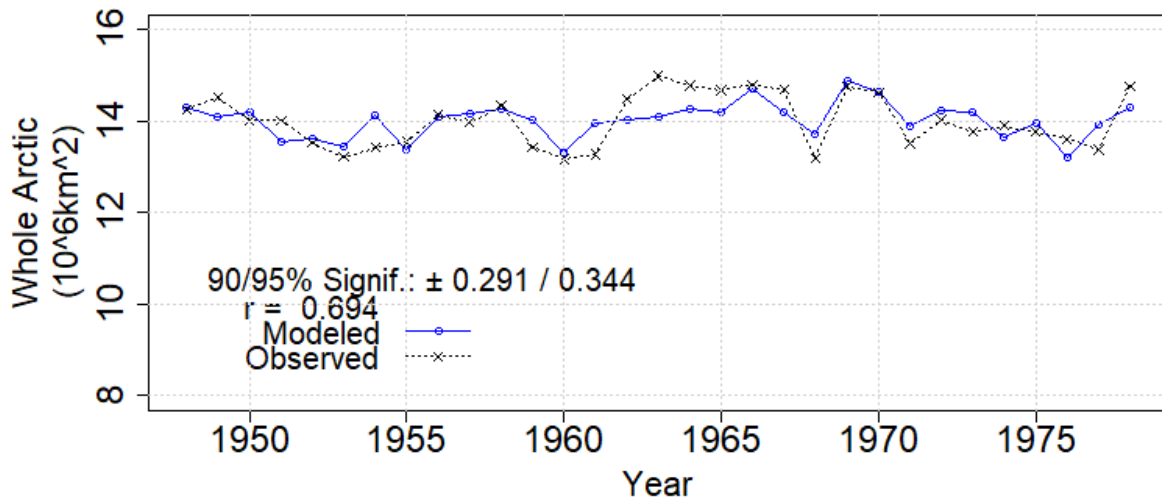


Figure 7.1.1-2 Comparison of model for period 1 (1948-1978) using data from Walsh et al. (2017).

$$\begin{aligned}
 Y = & 14.10 - 0.003\text{AO} - 0.03\text{AO}^2 - 0.13\text{DA} + 0.32\text{DA}^2 \\
 & + 0.01\text{AO}*\text{DA} - 0.22\text{AO}^2*\text{DA}^2 \\
 & - 0.27\text{AMO} - 0.17\text{AMO}^2 \\
 & + 0.02\text{AMO}*\text{AO} + 0.11\text{AMO}*\text{DA}
 \end{aligned}$$

Equation 7.1.1-2

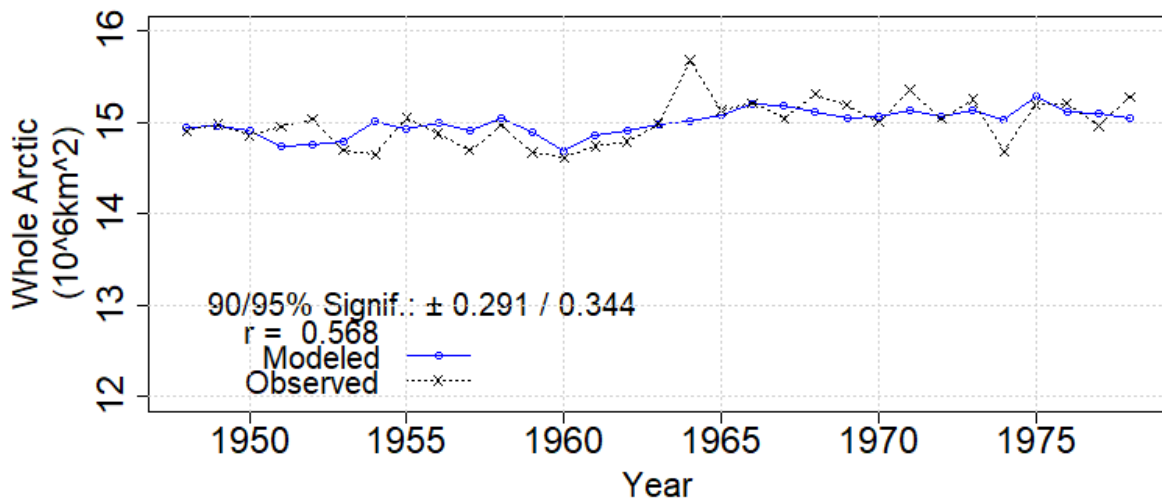


Figure 7.1.1-3 Comparison of model for period 1 (1948-1978) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
 Y = & 14.96 + 0.05\text{AO} + 0.04\text{AO}^2 + 0.03\text{DA} + 0.06\text{DA}^2 \\
 & - 0.03\text{AO}*\text{DA} - 0.03\text{AO}^2*\text{DA}^2 \\
 & - 0.14\text{AMO} - 0.05\text{AMO}^2 \\
 & + 0.001\text{AMO}*\text{AO} + 0.02\text{AMO}*\text{DA}
 \end{aligned}$$

Equation 7.1.1-3

7.1.2 Period 2 (1979-2017)

The following graphics are comparisons of the model for period 2 (1979-2017) with the same base equations using different data sets. The associated equations follow each model. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

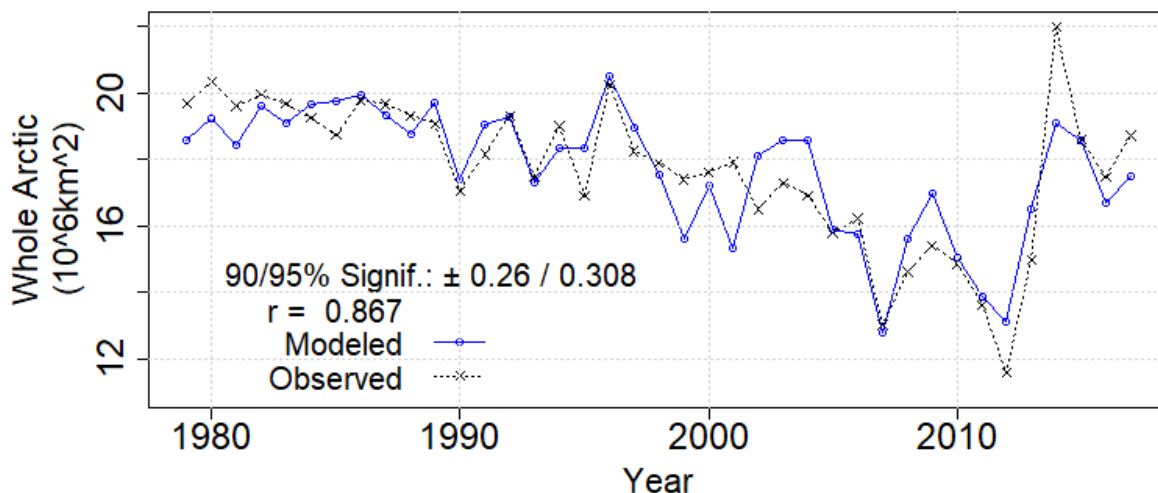


Figure 7.1.2-1 Comparison of model for period 2 (1979-2017) produced from the training data.

$$\begin{aligned}
 Y = & 19.06 + 0.59AO - 0.54AO^2 - 0.39DA - 0.74DA^2 - 0.21NAO + 0.57NAO^2 + 0.68ENSO - \\
 & 0.29ENSO^2 \\
 & + 0.27AO*DA - 0.12AO*NAO - 0.20AO*ENSO + 0.14DA*NAO - 0.38DA*ENSO \\
 & + 1.38PDO - 0.42PDO^2 - 0.41AMO + 0.37AMO^2 \\
 & + 0.61AMO*PDO \\
 & + 0.04PDO*ENSO - 0.49PDO*DA - 0.56AMO*AO + 0.06AMO*NAO + 0.02AMO*DA
 \end{aligned}$$

Equation 7.1.2-1

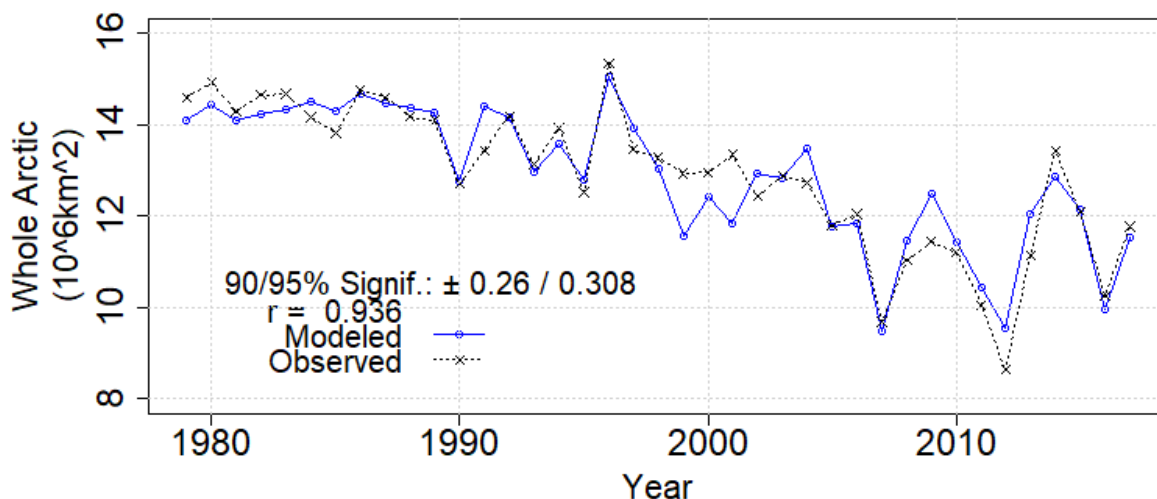


Figure 7.1.2-2 Comparison of model for period 2 (1979-2017) is using data from Walsh et al. (2017).

$$\begin{aligned}
Y = & 14.38 + 0.51AO - 0.30AO^2 - 0.02DA - 0.44DA^2 - 0.51NAO + 0.18NAO^2 + 0.81ENSO - \\
& 0.43ENSO^2 \\
& + 0.53AO*DA - 0.25AO*NAO - 0.06AO*ENSO - 0.05DA*NAO + 0.004DA*ENSO \\
& + 1.15PDO - 0.04PDO^2 - 0.64AMO + 0.25AMO^2 \\
& + 0.60AMO*PDO \\
& + 0.24PDO*ENSO - 0.46PDO*DA - 0.82AMO*AO + 0.01AMO*NAO - 0.21AMO*DA
\end{aligned}$$

Equation 7.1.2-2

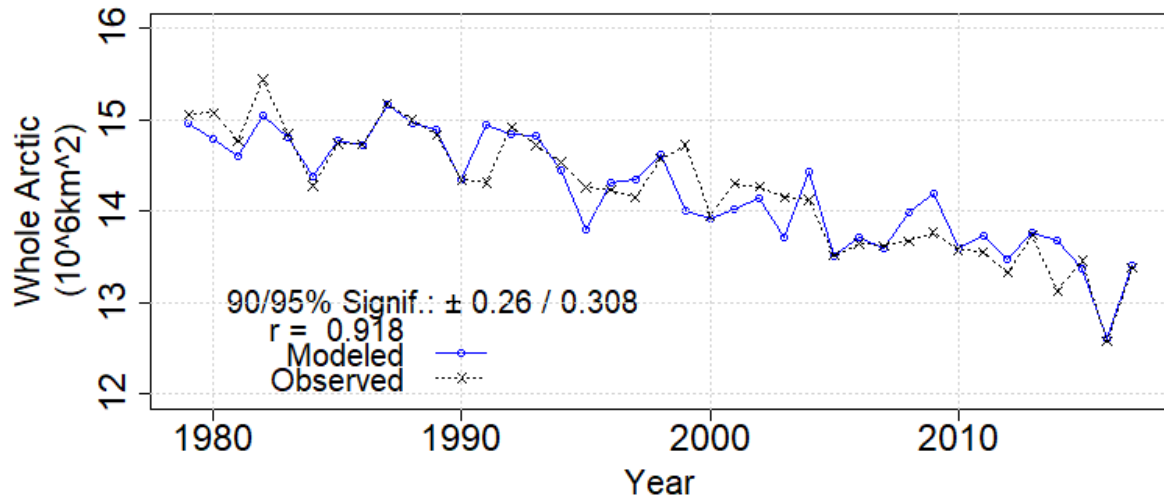


Figure 7.1.2-3 Comparison of model for period 2 (1979-2017) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
Y = & 14.74 + 0.09AO - 0.05AO^2 + 0.23DA - 0.01DA^2 - 0.26NAO - 0.08NAO^2 + 0.27ENSO - \\
& 0.05ENSO^2 \\
& + 0.32AO*DA - 0.05AO*NAO + 0.15AO*ENSO - 0.14DA*NAO + 0.31DA*ENSO \\
& + 0.34PDO + 0.06PDO^2 - 0.41AMO + 0.07AMO^2 \\
& + 0.07AMO*PDO \\
& + 0.22PDO*ENSO - 0.15PDO*DA - 0.41AMO*AO + 0.16AMO*NAO - 0.33AMO*DA
\end{aligned}$$

Equation 7.1.2-3

7.1.3 Period 3 (1948-2017)

The following graphics are comparisons of the models for period 3 (1948-2017) with the same base equations using different data sets. The associated equations follow each model. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is decadal interactions. The fifth line is interannual and decadal interactions.

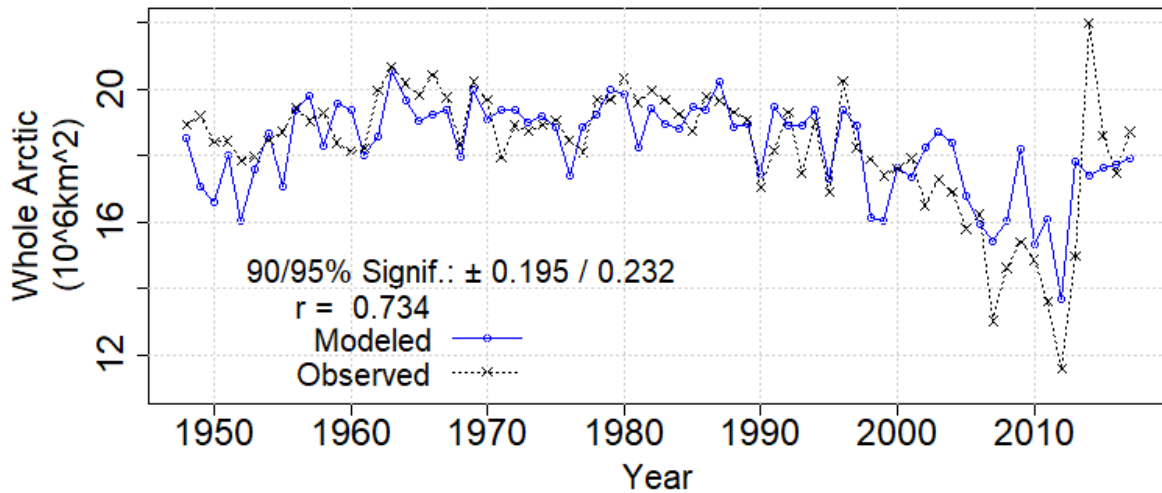


Figure 7.1.3-1 Comparison of model for period 3 (1948-2017) produced from the training data.

$$\begin{aligned}
 Y = & 19.31 - 0.28\text{DA} - 0.34\text{DA}^2 - 0.46\text{NAO} \\
 & - 0.02\text{DA}*\text{NAO} \\
 & + 0.58\text{PDO} - 0.29\text{PDO}^2 - 0.44\text{AMO} - 0.23\text{AMO}^2 \\
 & + 0.42\text{AMO}*\text{PDO} \\
 & - 0.04\text{AMO}*\text{DA} - 0.27\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.1.3-1

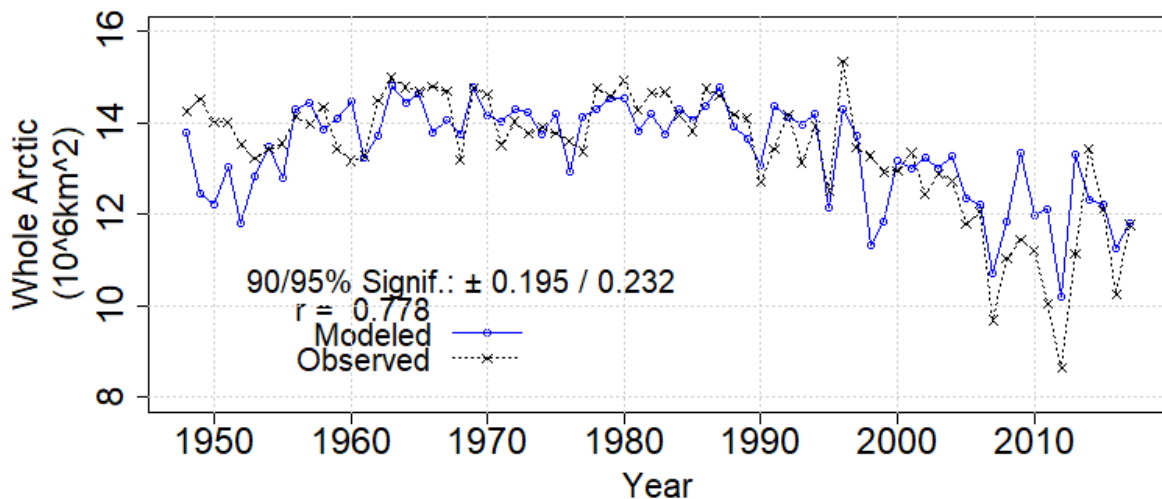


Figure 7.1.3-2 Comparison of model for period 3 (1948-2017) using data from Walsh et al. (2017).

$$\begin{aligned}
Y = & 14.19 - 0.19DA - 0.26DA^2 - 0.45NAO \\
& - 0.04DA*NAO \\
& + 0.33PDO - 0.20PDO^2 - 0.52AMO - 0.29AMO^2 \\
& + 0.22AMO*PDO \\
& + 0.06AMO*DA - 0.36AMO*NAO
\end{aligned}$$

Equation 7.1.3-2

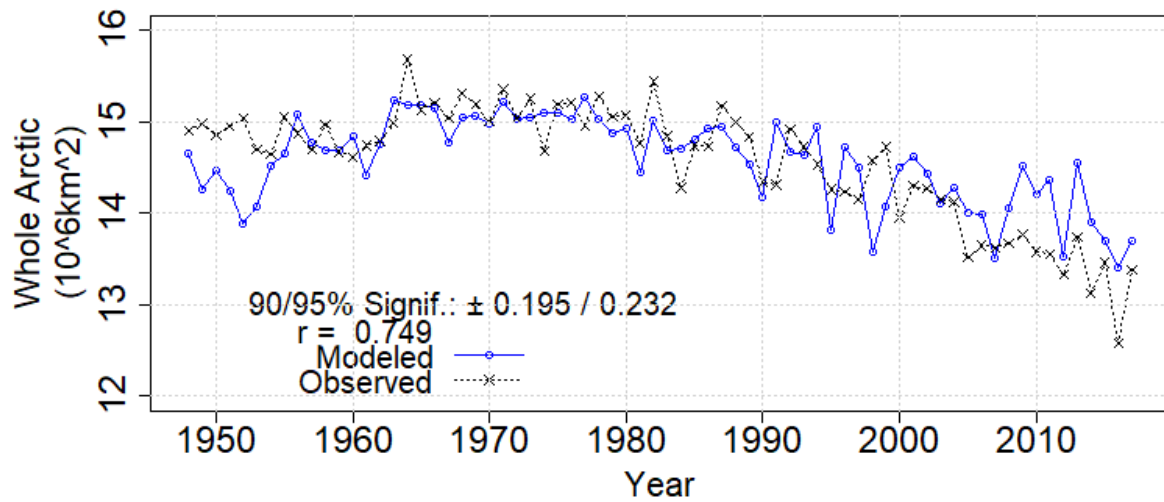


Figure 7.1.3-3 Comparison of model for period 3 (1948-2017) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
Y = & 14.80 + 0.04DA - 0.07DA^2 - 0.25NAO \\
& - 0.05DA*NAO \\
& + 0.002PDO - 0.03PDO^2 - 0.36AMO - 0.10AMO^2 \\
& + 0.07AMO*PDO \\
& - 0.08AMO*DA - 0.12AMO*NAO
\end{aligned}$$

Equation 7.1.3-3

7.2 FOUR-INDEX MODELS 1948-2017

The following graphics are comparisons of the four-index model with the same base equations using different data sets. The associated equations follow each model. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

7.2.1 Period 1 (1948-1978)

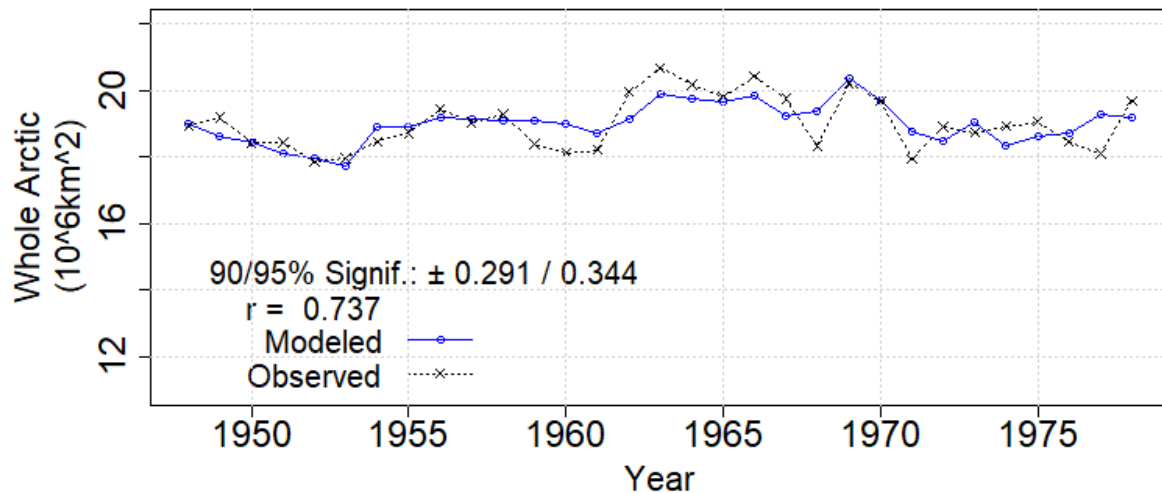


Figure 7.2.1-1 Comparison of the four-index model for period 1 (1948-1978) produced from the training data.

$$\begin{aligned}
 Y = & 19.19 - 0.36\text{NAO} + 0.05\text{NAO}^2 + 0.11\text{ENSO} - 0.42\text{ENSO}^2 \\
 & + 0.14\text{ENSO}*\text{NAO} \\
 & - 0.45\text{AMO} - 0.27\text{AMO}^2 \\
 & - 0.03\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.1-1

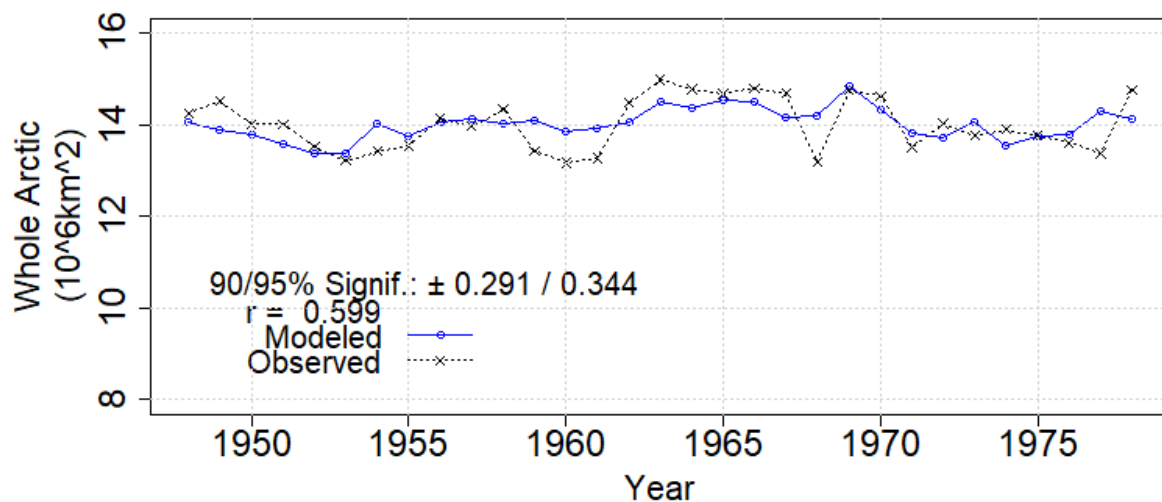


Figure 7.2.1-2 Comparison of the four-index model for period 1 (1948-1978) using data from Walsh et al. (2017).

$$\begin{aligned}
 Y = & 14.13 - 0.15\text{NAO} + 0.03\text{NAO}^2 + 0.002\text{ENSO} - 0.18\text{ENSO}^2 \\
 & + 0.12\text{ENSO}*\text{NAO} \\
 & - 0.25\text{AMO} - 0.17\text{AMO}^2 \\
 & + 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.1-2

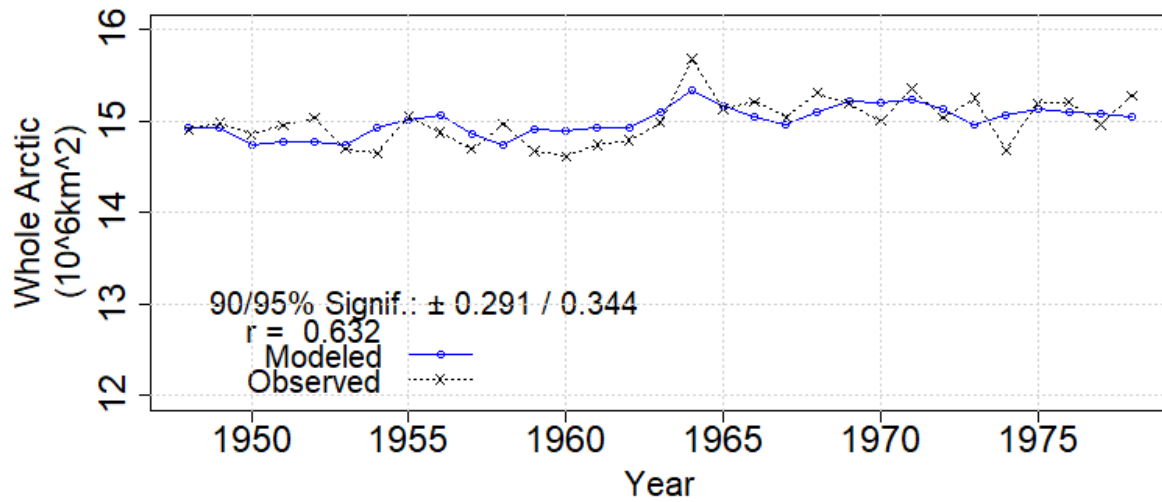


Figure 7.2.1-3 Comparison of the four-index model for period 1 (1948-1978) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
 Y = & 14.93 - 0.04\text{NAO} + 0.07\text{NAO}^2 + 0.05\text{ENSO} - 0.11\text{ENSO}^2 \\
 & - 0.08\text{ENSO}*\text{NAO} \\
 & - 0.11\text{AMO} + 0.04\text{AMO}^2 \\
 & + 0.13\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.1-3

7.2.2 Period 2 (1979-2017)

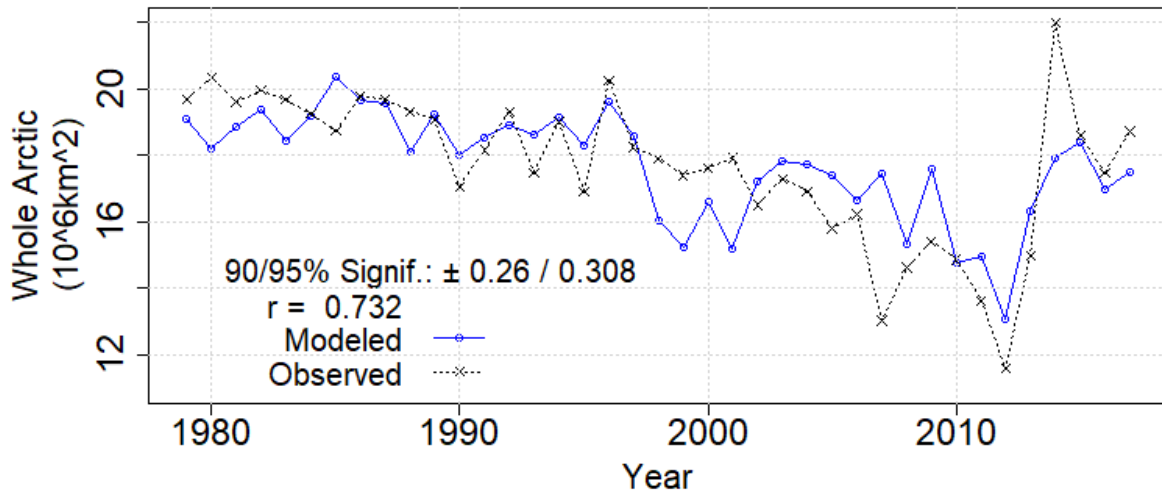


Figure 7.2.2-1 Comparison of the four-index model for period 2 (1979-2017) produced from the training data.

$$\begin{aligned}
 Y = & 17.86 - 0.30\text{NAO} + 0.13\text{NAO}^2 + 0.60\text{ENSO} + 0.55\text{ENSO}^2 \\
 & + 0.07\text{ENSO}*\text{NAO} \\
 & + 1.12\text{PDO} - 0.13\text{PDO}^2 - 0.73\text{AMO} + 0.34\text{AMO}^2 \\
 & + 0.58\text{AMO}*\text{PDO} \\
 & + 0.42\text{PDO}*\text{ENSO} - 0.05\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.2-1

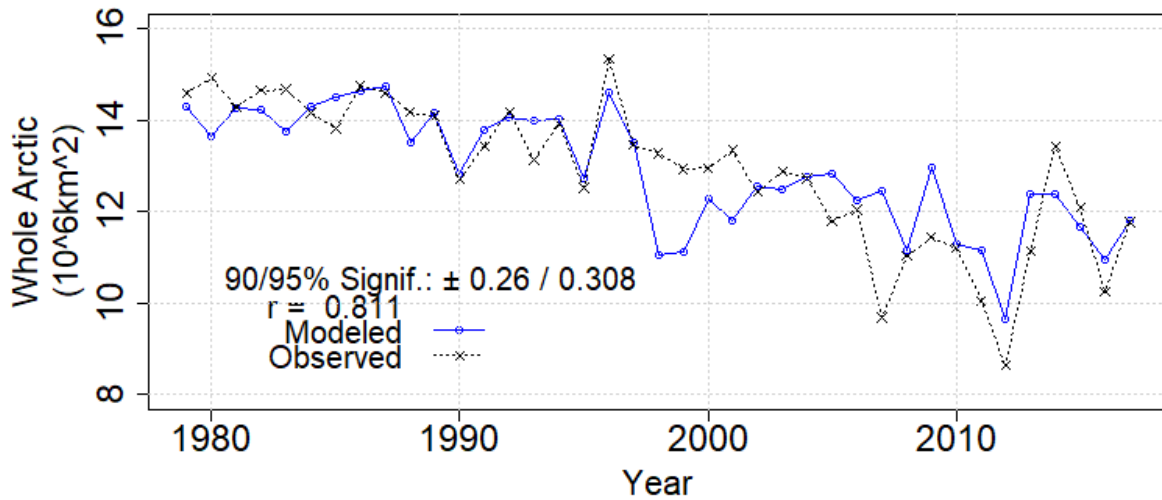


Figure 7.2.2-2 Comparison of the four-index model for period 2 (1979-2017) using data from Walsh et al. (2017).

$$\begin{aligned}
 Y = & 13.36 - 0.37\text{NAO} - 0.003\text{NAO}^2 + 0.47\text{ENSO} + 0.44\text{ENSO}^2 \\
 & + 0.20\text{ENSO}*\text{NAO} \\
 & + 0.85\text{PDO} + 0.002\text{PDO}^2 - 0.68\text{AMO} + 0.01\text{AMO}^2 \\
 & + 0.28\text{AMO}*\text{PDO} \\
 & + 0.51\text{PDO}*\text{ENSO} - 0.34\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.2-2

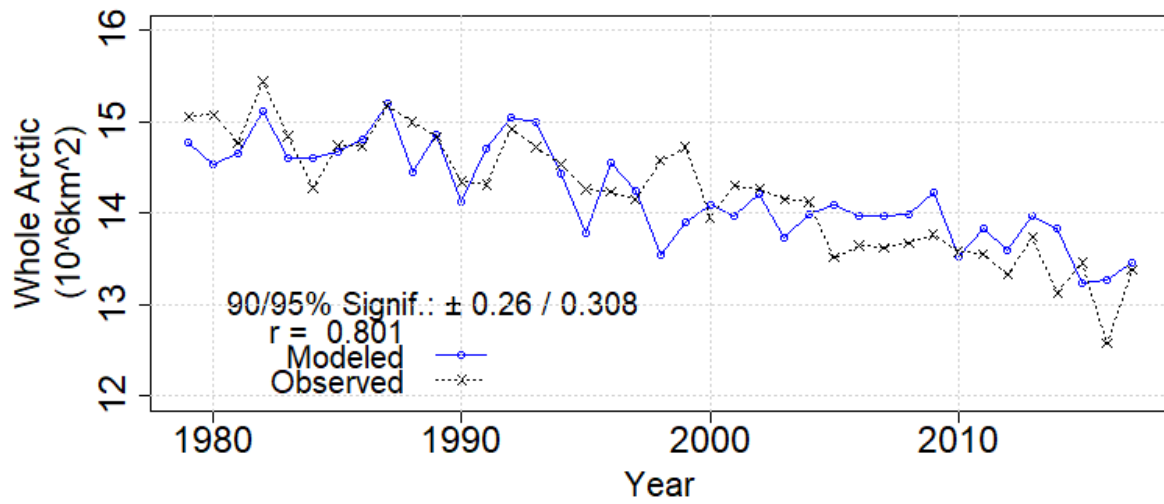


Figure 7.2.2-3 Comparison of the four-index model for period 2 (1979-2017) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
 Y = & 14.32 - 0.07\text{NAO} - 0.01\text{NAO}^2 - 0.01\text{ENSO} + 0.35\text{ENSO}^2 \\
 & + 0.27\text{ENSO}*\text{NAO} \\
 & + 0.23\text{PDO} - 0.06\text{PDO}^2 - 0.25\text{AMO} - 0.12\text{AMO}^2 \\
 & - 0.24\text{AMO}*\text{PDO} \\
 & + 0.21\text{PDO}*\text{ENSO} - 0.09\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.2.2-3

7.2.3 Period 3 (1948-2017)

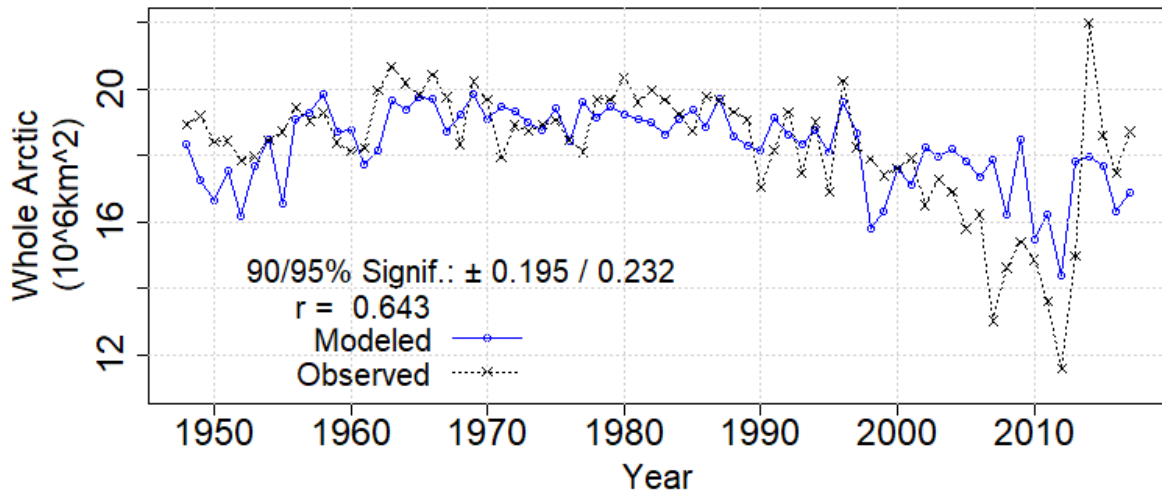


Figure 7.2.3-1 Comparison of the four-index model for period 3 (1948-2017) produced from the training data.

$$\begin{aligned}
 Y = & 18.87 - 0.52\text{NAO} - 0.04\text{ENSO} \\
 & - 0.19\text{NAO} * \text{ENSO} \\
 & + 0.41\text{PDO} - 0.30\text{PDO}^2 - 0.63\text{AMO} - 0.20\text{AMO}^2 \\
 & + 0.44\text{AMO} * \text{PDO} \\
 & - 0.12\text{PDO} * \text{ENSO} - 0.16\text{AMO} * \text{NAO}
 \end{aligned}$$

Equation 7.2.2-1

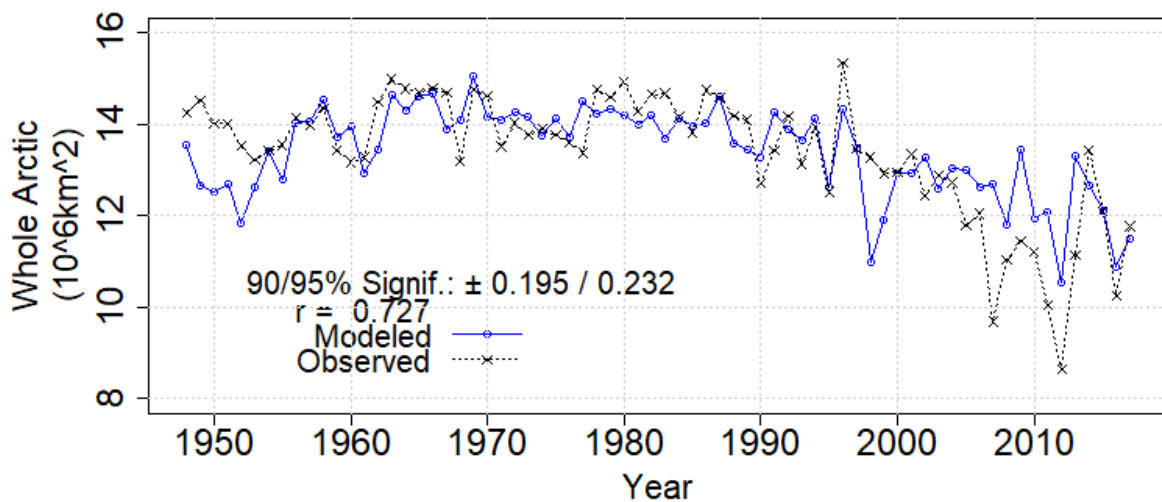


Figure 7.2.3-2 Comparison of the four-index model for period 3 (1948-2017) using data from Walsh et al. (2017).

$$\begin{aligned}
Y = & 13.84 - 0.45\text{NAO} - 0.12\text{ENSO} \\
& + 0.04\text{NAO}*\text{ENSO} \\
& + 0.18\text{PDO} - 0.14\text{PDO}^2 - 0.64\text{AMO} - 0.27\text{AMO}^2 \\
& + 0.25\text{AMO}*\text{PDO} \\
& + 0.001\text{PDO}*\text{ENSO} - 0.31\text{AMO}*\text{NAO}
\end{aligned}$$

Equation 7.2.2-2

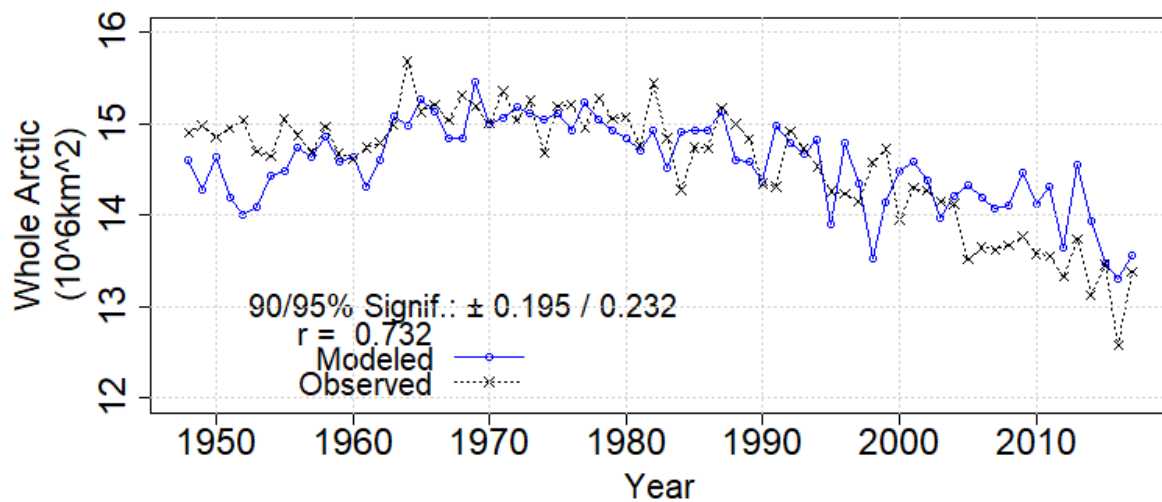


Figure 7.2.3-3 Comparison of the four-index model for period 3 (1948-2017) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
Y = & 14.65 - 0.21\text{NAO} - 0.09\text{ENSO} \\
& + 0.12\text{ENSO}*\text{NAO} \\
& - 0.06\text{PDO} - 0.03\text{PDO}^2 - 0.38\text{AMO} - 0.08\text{AMO}^2 \\
& + 0.07\text{AMO}*\text{PDO} \\
& - 0.03\text{PDO}*\text{ENSO} - 0.14\text{AMO}*\text{NAO}
\end{aligned}$$

Equation 7.2.2-3

7.3 FOUR-INDEX MODELS 1865-1978

The following graphics are comparisons of the four-index model during 1865-1978 with the same base equations using different data sets. The associated equations follow each model. The first line of the equation is interannual variability. The second line is the interannual interactions. The third line is decadal variability. The fourth line is interannual and decadal interactions.

7.3.1 Period 1 (1865-1978)

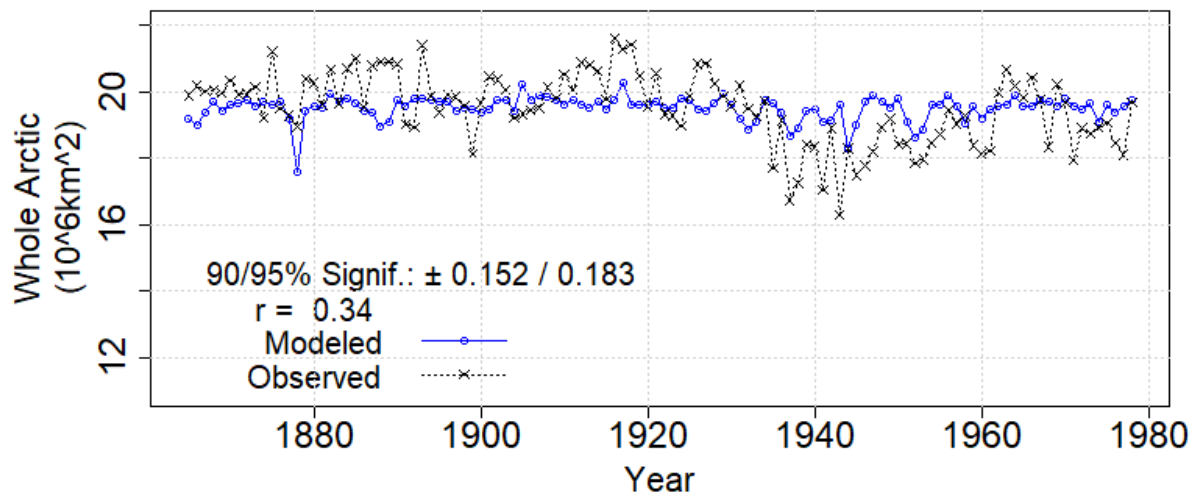


Figure 7.3.1-1 Comparison of the four-index model for period 1 (1865-1978) produced from the training data.

$$\begin{aligned}
 Y = & 19.64 + 0.04\text{NAO} + 0.05\text{NAO}^2 + 0.01\text{ENSO} + 0.07\text{ENSO}^2 \\
 & - 0.16\text{ENSO}*\text{NAO} \\
 & - 0.28\text{AMO} - 0.22\text{AMO}^2 \\
 & - 0.01\text{AMO}*\text{NAO}
 \end{aligned}$$

Equation 7.3.1-1

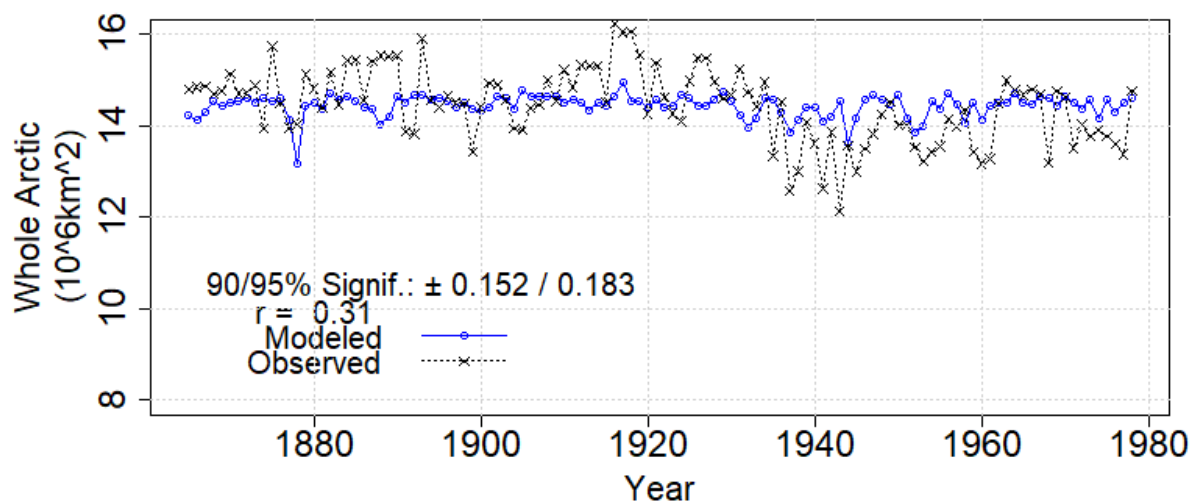


Figure 7.3.1-2 Comparison of the four-index model for period 1 (1865-1978) is using data from Walsh et al. (2017).

$$Y = 14.55 + 0.03\text{NAO} + 0.02\text{NAO}^2 + 0.04\text{ENSO} + 0.04\text{ENSO}^2 \\ - 0.08\text{ENSO}*\text{NAO} \\ - 0.19\text{AMO} - 0.15\text{AMO}^2 \\ + 0.02\text{AMO}*\text{NAO}$$

Equation 7.3.1-2

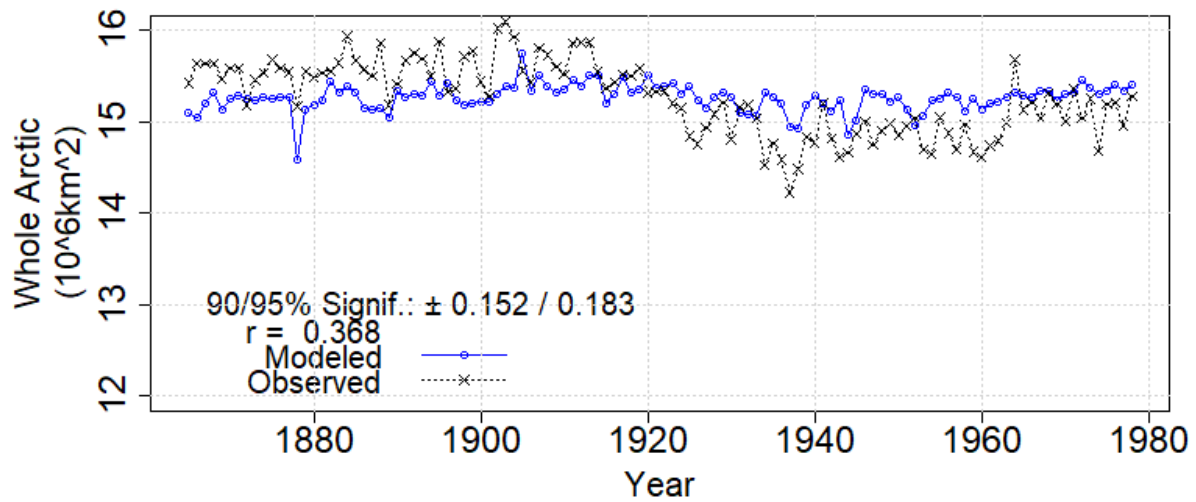


Figure 7.3.1-3 Comparison of the four-index model for period 1 (1865-1978) using a data reconstruction from Brennan et al. (2020).

$$Y = 15.27 + 0.02\text{NAO} + 0.01\text{NAO}^2 - 0.06\text{ENSO} + 0.04\text{ENSO}^2 \\ - 0.07\text{ENSO}*\text{NAO} \\ - 0.13\text{AMO} - 0.06\text{AMO}^2 \\ - 0.04\text{AMO}*\text{NAO}$$

Equation 7.3.1-3

7.3.2 Period 3 (1865-2017)

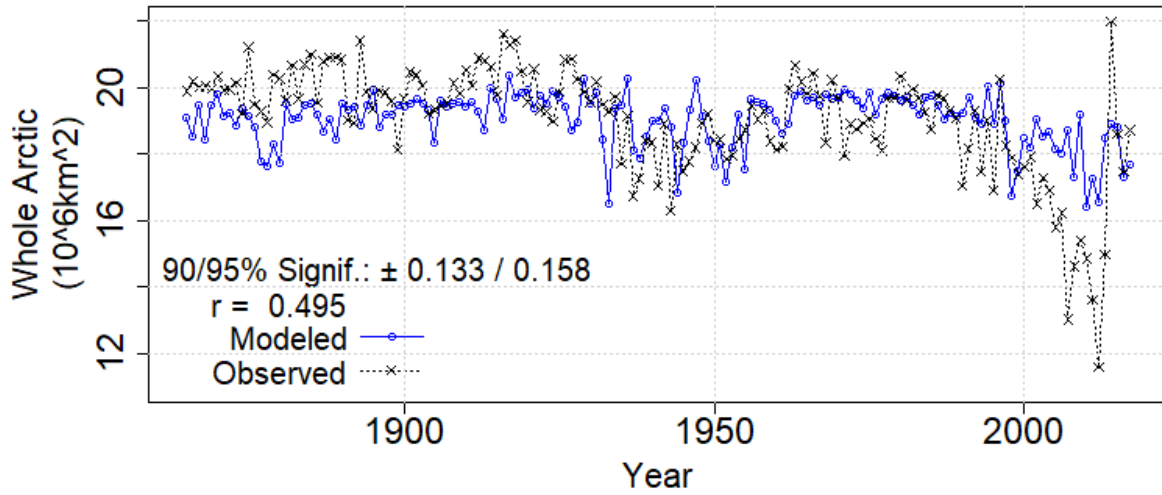


Figure 7.3.2-1 Comparison of the four-index model for period 3 (1865-2017) produced from the training data.

$$\begin{aligned}
 Y = & 19.43 - 0.25\text{NAO} + 0.08\text{ENSO} \\
 & - 0.14\text{NAO} * \text{ENSO} \\
 & + 0.30\text{PDO} - 0.09\text{PDO}^2 - 0.57\text{AMO} - 0.21\text{AMO}^2 \\
 & + 0.35\text{AMO} * \text{PDO} \\
 & + 0.22\text{PDO} * \text{ENSO} - 0.09\text{AMO} * \text{NAO}
 \end{aligned}$$

Equation 7.3.2-1

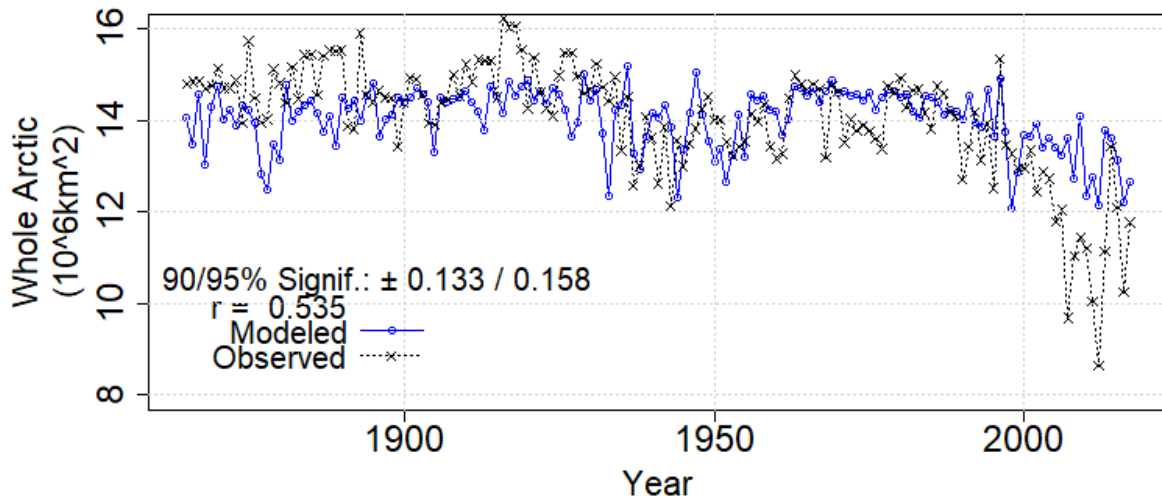


Figure 7.3.2-2 Comparison of the four-index model for period 3 (1865-2017) using data from Walsh et al. (2017).

$$\begin{aligned}
Y = & 14.35 - 0.26\text{NAO} + 0.11\text{ENSO} \\
& - 0.04\text{NAO}*\text{ENSO} \\
& + 0.20\text{PDO} - 0.04\text{PDO}^2 - 0.49\text{AMO} - 0.21\text{AMO}^2 \\
& + 0.23\text{AMO}*\text{PDO} \\
& + 0.23\text{PDO}*\text{ENSO} - 0.16\text{AMO}*\text{NAO}
\end{aligned}$$

Equation 7.3.2-2

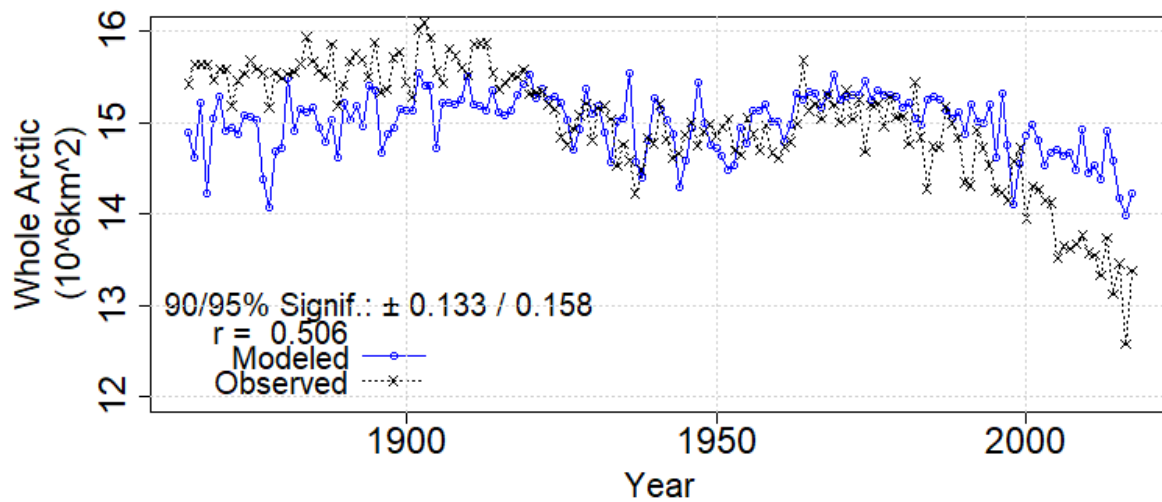


Figure 7.3.2-3 Comparison of the four-index model for period 3 (1865-2017) using a data reconstruction from Brennan et al. (2020).

$$\begin{aligned}
Y = & 15.07 - 0.14\text{NAO} + 0.04\text{ENSO} \\
& + 0.06\text{ENSO} \\
& + 0.06\text{PDO} + 0.03\text{PDO}^2 - 0.27\text{AMO} - 0.08\text{AMO}^2 \\
& + 0.05 \text{AMO}*\text{PDO} \\
& + 0.13\text{PDO}*\text{ENSO} - 0.10 \text{AMO}*\text{NAO}
\end{aligned}$$

Equation 7.3.2-3

8 SUMMARY

This report builds on the work of Cai et al. (2021a, b) to further develop statistical hindcast models for sea ice coverage in the Arctic by linking ice coverage to teleconnection patterns following the approach of Wang et al. (2018). Observed relationships between ice coverage and environmental forcings were used to develop multi-variable regression equations to predict ice coverage in six areas of the Arctic. The teleconnection patterns were added as a possibility of linear, quadratic, or both depending on their relationship to ice coverage. The majority of the statistical models used predictors from the summer, allowing for the prediction of ice coverage in the same season.

Prediction models are accompanied by one table, one equation, and two figures that summarize the model output as well as model skill. The table shows the importance of each teleconnection using a *p-value* of at most 0.1 to show 90% significance. *P-values* were also included on the models themselves to help show their significance. In addition to the models with different criteria, there is a model comparison section which is meant to demonstrate the capability of the model on different constructions of the same data.

Based on the investigation, the following conclusions can be drawn:

1. All the models were able to exceed the goal of the 90% significance levels on the training data. This baseline of high skilled allows us to expand our investigation into changing up the base models to see if there were any better ways to tune the models
2. Using all six teleconnections led to overall higher skill. This is compared to the models that omitted AO and DA, due to the fact they only start to be recorded in 1949. Even though there was more historical data for the other four teleconnections, it likely hinders them due to the increased variability in ice coverage in the last three decades, especially considering how AO and DA are able to capture that variability better.

Same base models work just as well on different reconstructions of the data. This step was to show off the validity of the models. If the models were not able to reproduce to a similar degree of significance, then the base models would have needed to be tuned for specific data. Fortunately, all of them show very similar significance values to the training data.

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