**Appendix S1** Abbreviations

20CRv2c – 20th Century Reanalysis ver. 2. of NOAA and CIRES

AHCCD – Adjusted Historical Canadian Climate Database

ATLR – Atlantic region

BAFR – Baffin Bay region

CANR – Canadian region

CFSR – Climate Forecast System Reanalysis of NCEP

CGW – contemporary global warming

CERA-20C – ECMWF climate reanalysis dataset of the period 1901 to 2010

CIRES – Cooperative Institute for Research in Environmental Sciences (NOAA and University of Colorado, Boulder)

DISC – Data and Information Services Center of NASA

DOE – Department of Energy

GES – Goddard Earth Sciences of NASA

GHCN – Global Historical Climatology Network

GMFD ­– Global Meteorological Forcing Dataset for Land Surface Modeling

ECMWF – European Centre for Medium-Range Weather Forecasts

ERA-40 – ECMWF 40-year reanalysis

ERA-Int – ECMWF interim reanalysis

ESRL – Earth System Research Laboratory of NOAA

GMAO – Global Modeling and Assimilation Office of NASA

GMFD – Global Meteorological Forcing Dataset for Land Surface Modeling

JMA – Japan Meteorological Agency

JRA-25 – Japanese 25-year Reanalysis

JRA-55 – Japanese 55-year Reanalysis

ICR5 – 5th International Conference on Reanalysis

MERRA – Modern-Era Retrospective Analysis for Research and Applications

MERRA-2 – Modern-Era Retrospective Analysis for Research and Applications version 2

NASA – National Aeronautics and Space Administration

NCAR – National Center for Atmospheric Research

NCEP – National Centers for Environmental Prediction of the NOAA

NCEP-R1 – NCEP-NCAR Reanalysis 1

NCEP-R2 – NCEP-NCAR Reanalysis 2

NH – Northern Hemisphere

NOAA – National Oceanic and Atmospheric Administration

N-PA – Non-polar Amplification

PA – Polar Amplification

PACR – Pacific region

PSD – Physical Science Division of ESRL NOAA

r – correlation coefficient

RA – real (or high) Arctic

RDA – Research Data Archive of NCAR UCAR

RMSE – root mean square error

RRAW – recent rapid Arctic warming

SAT – surface (2m a.g.l.) air temperature

SIBR – Siberian region

SIRTA – Systematic Improvements of Reanalyses in the Arctic

SLP – sea level pressure

SST – sea surface temperature

UCAR – University Corporation for Atmospheric Research

**Table S1** Main characteristics of reanalyses used in this study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Dataset (reference) | Class of reanalysis system (Fujiwara et al. 2017) | Source | Full reanalysed period | Spatial resolution |
| 20CRv2c (Compo et al. 2011 | Surface-input | Centre: NOAA CIRES  Download: NOAA ESRL PSD  https://www.esrl.noaa.gov/  psd/data/20thC\_Rean/ | 1851–2014 | 2° × 2° |
| CERA-20C (Laloyaux et al. 2016) | Surface-input | Centre: ECMWF  Download: https://www.ecmwf.int/en/forecasts  /datasets/archive-datasets/  browse-reanalysis-datasets | 1901–2010 | 1.25° × 1.25° |
| ERA-Int (Dee et al. 2011) | Full-input | Centre: ECMWF  Download: https://www.ecmwf.int/en/forecasts/  datasets/archive-datasets/  browse-reanalysis-datasets | 1979–present | 0.75° × 0.75° |
| JRA-55 (Kobayashi et al. 2015) | Conventional-input (1958-1978), Full-input (1979–present) | Centre: JMA  Download: NCAR UCAR RDA  https://rda.ucar.edu/  Dataset: 628.1 | 1958–present, 1958–2013 available at RDA | 1.25° × 1.25° |
| MERRA-2, (Gelaro et al. 2017) | Full-input | Centre: NASA GMAO  Download: GES DISC  https://disc.gsfc.nasa.gov  Dataset: M2IMNXASM | 1980–present | 0.5° × 0.625° |
| NCEP-CFSR, (Saha et al. 2010) | Full-input | Centre: NOAA/NCEP  Download: NCAR UCAR RDA  https://rda.ucar.edu/  Dataset: 093.2 | 1979–2010 | 5° × 5°  and  2.5° × 2.5° |

Explanations: Full-input – assimilation of surface, upper-air conventional and satellite data; Conventional-input – assimilation of surface and upper-air conventional data but not satellite data; Surface-input – assimilation surface data only, with upper-air excluded.

**Table S2** Seasonal and annual SAT trends (°C/10 years) in the Arctic. Trends statistically significant at the level 0.05 are shown in bold font

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Region | Trends °C/ 10 years | | | | | | | | | | | | | | |
| 1951–1990 (Przybylak 1996) | | | | | 1951–1995 (Przybylak 2000) | | | | | 1951–2000 (Przybylak 2002) | | | | |
| DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR |
| ATLR | -0.25 | 0.11 | 0.00 | -0.23 | -0.12 | -0.19 | 0.19 | -0.06 | -0.24 | -0.07 | -0.08 | 0.26 | -0.09 | -0.07 | 0.00 |
| SIBR | 0.15 | 0.10 | -0.10 | -0.14 | -0.01 | 0.15 | 0.15 | -0.17 | -0.04 | 0.04 | 0.06 | 0.10 | 0.04 | -0.03 | 0.04 |
| PACR | 0.53 | 0.12 | 0.12 | -0.14 | 0.15 | **0.55** | 0.31 | **0.36** | -0.02 | **0.31** | **0.38** | **0.41** | **0.29** | 0.15 | **0.33** |
| CANR | 0.02 | -0.35 | -0.04 | -0.13 | -0.13 | -0.06 | -0.11 | 0.02 | 0.00 | -0.03 | 0.13 | 0.16 | 0.12 | 0.24 | 0.17 |
| BAFR | -0.25 | -0.57 | **-0.24** | -0.18 | **-0.32** | -0.66 | **-0.65** | **-0.19** | -0.13 | **-0.40** | -0.28 | **-0.36** | -0.12 | 0.00 | -0.19 |
| HA | -0.06 | -0.08 | -0.04 | **-0.18** | -0.10 | -0.10 | 0.04 | 0.01 | -0.12 | -0.04 | 0.04 | 0.15 | 0.04 | 0.06 | 0.08 |
| Region | 1951–2005 (Przybylak 2007) | | | | | 1951–2010 (Przybylak 2016) | | | | | 1951–2015 | | | | |
| DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR |
| ATLR | 0.09 | **0.29** | **0.10** | 0.09 | 0.15 | 0.29 | **0.35** | **0.13** | **0.22** | **0.25** | **0.46** | **0.45** | **0.17** | **0.32** | **0.35** |
| SIBR | 0.12 | **0.29** | 0.04 | 0.17 | **0.16** | **0.24** | **0.34** | 0.10 | **0.39** | **0.27** | **0.31** | **0.48** | **0.15** | **0.50** | **0.36** |
| PACR | **0.45** | **0.46** | **0.25** | 0.26 | **0.35** | **0.44** | **0.35** | **0.25** | **0.42** | **0.37** | **0.48** | **0.37** | **0.26** | **0.45** | **0.39** |
| CANR | 0.16 | 0.12 | **0.14** | **0.30** | **0.18** | **0.35** | **0.26** | **0.20** | **0.41** | **0.31** | **0.41** | **0.25** | **0.23** | **0.44** | **0.34** |
| BAFR | -0.20 | -0.10 | 0.00 | 0.15 | 0.02 | 0.18 | 0.09 | 0.10 | **0.19** | 0.16 | 0.26 | 0.08 | **0.16** | **0.20** | **0.17** |
| HA | **0.16** | **0.21** | **0.12** | **0.20** | **0.18** | **0.32** | **0.29** | **0.17** | **0.33** | 0.28 | **0.38** | **0.33** | **0.19** | **0.38** | **0.32** |

**Table S3** Seasonal and annual standard deviations (°C) of SAT in the Arctic

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Area | 1951–2015 | | | | | 1976–2015 | | | | | 1996–2015 | | | | |
| DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR | DJF | MAM | JJA | SON | YEAR |
| Arctic 1 (HA) | 1.23 | 1.07 | 0.61 | 1.13 | 0.89 | 1.34 | 1.05 | 0.64 | 1.22 | 0.96 | 1.17 | 0.67 | 0.49 | 0.80 | 0.67 |
| Arctic 2 (land+ocean) | 1.07 | 0.93 | 0.54 | 0.77 | 0.68 | 1.09 | 0.82 | 0.57 | 0.75 | 0.63 | 0.94 | 0.69 | 0.43 | 0.45 | 0.53 |
| Arctic 3 (land only) | 1.28 | 1.17 | 0.53 | 1.18 | 0.90 | 1.32 | 1.14 | 0.56 | 1.20 | 0.93 | 1.19 | 0.91 | 0.46 | 0.76 | 0.71 |
| Arctic 4 (land+ocean) | 1.00 | 0.97 | 0.45 | 0.95 | 0.75 | 0.98 | 0.93 | 0.48 | 0.77 | 0.98 | 0.83 | 0.67 | 0.38 | 0.67 | 0.55 |
| Arctic 5 (land only) | 1.06 | 1.03 | 0.51 | 0.92 | 0.76 | 0.98 | 0.94 | 0.55 | 0.96 | 0.75 | 0.75 | 0.72 | 0.43 | 0.60 | 0.52 |
| NH 1 (land+ocean) | 0.34 | 0.33 | 0.31 | 0.34 | 0.31 | 0.31 | 0.31 | 0.31 | 0.35 | 0.30 | 0.20 | 0.18 | 0.17 | 0.22 | 0.17 |
| NH 2 (land+ocean) | 0.36 | 0.36 | 0.30 | 0.37 | 0.34 | 0.33 | 0.34 | 0.30 | 0.38 | 0.33 | 0.20 | 0.19 | 0.17 | 0.24 | 0.18 |

Key: Arctic 1 – areally averaged temperature based on data from 37 Arctic stations, Arctic 2 – areally averaged temperature for 60–90°N latitude band (HadCRUT4, land + ocean, after Morice et al. 2012, updated), Arctic 3 – areally averaged temperature for 60–90°N latitude band (CRUTEM4, land only, after Jones et al. 2012, updated), Arctic 4 – areally averaged temperature for 60–90°N latitude band (BEST, land + ocean, after Rohde et al. 2013, updated), Arctic 5 – areally averaged temperature for 60–90°N latitude band (BEST, land only, after Rohde et al. 2013, updated), NH 1 (land + ocean) – areally averaged temperature for Northern Hemisphere (HadCRUT4, after Morice et al. 2012, updated), NH 2 (BEST, land + ocean) – areally averaged temperature for Northern Hemisphere (BEST, after Rohde et al. 2013, updated).

**Table S4** Differences in seasonal and annual SAT trends (°C decade-1) between individual reanalyses and observations in the Arctic. These differences were obtained by subtracting observational data from reanalysis values

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dataset | 1951–2015 | | | | | Dataset | 1976–2015 | | | | |
| DJF | MAM | JJA | SON | Year | DJF | MAM | JJA | SON | Year |
| 20CRv2ca | -0.20 | -0.01 | -0.01 | -0.11 | -0.08 | 20CRv2ca | -0.56 | -0.21 | -0.03 | -0.22 | -0.25 |
| CERA-20Cb | 0.15 | -0.02 | -0.04 | 0.19 | 0.08 | CERA-20Cb | -0.07 | -0.06 | -0.01 | 0.22 | 0.04 |
| JRA-55c | 0.26 | 0.20 | 0.01 | 0.35 | 0.20 | JRA-55d | 0.05 | 0.02 | -0.07 | 0.08 | 0.02 |
| ERA-Int | x | x | x | x | x | ERA-Int | 0.27 | 0.18 | -0.01 | 0.08 | 0.13 |
| MERRA-2 | x | x | x | x | x | MERRA-2 | -0.57 | -0.43 | -0.11 | -0.32 | -0.37 |
| NCEP-CFSR | x | x | x | x | x | NCEP-CFSRe | -0.14 | 0.02 | -0.09 | 0.02 | -0.04 |
| Mean Rean. | 0.05 | 0.04 | 0.02 | 0.11 | 0.06 | Mean Rean. | -0.17 | -0.05 | 0.03 | 0.00 | -0.04 |
| Dataset | 1981–2010 | | | | | Dataset | 1996–2015 | | | | |
| DJF | MAM | JJA | SON | Year | DJF | MAM | JJA | SON | Year |
| 20CRv2c | -0.56 | -0.22 | 0.00 | -0.20 | -0.24 | 20CRv2ca | -0.05 | -0.27 | -0.02 | -0.01 | -0.08 |
| CERA-20C | 0.00 | -0.10 | 0.02 | 0.21 | 0.04 | CERA-20Cb | 0.74 | 0.02 | 0.12 | 1.14 | 0.56 |
| JRA-55 | -0.04 | 0.01 | -0.08 | -0.07 | -0.04 | JRA-55d | 0.25 | -0.10 | -0.07 | 0.12 | 0.06 |
| ERA-Int | 0.23 | 0.27 | -0.06 | 0.02 | 0.12 | ERA-Int | 0.04 | -0.11 | -0.03 | -0.06 | -0.05 |
| MERRA-2 | -0.56 | -0.36 | -0.15 | -0.36 | -0.36 | MERRA-2 | -1.75 | -1.14 | -0.15 | -0.70 | -0.93 |
| NCEP-CFSR | -0.21 | -0.06 | -0.13 | -0.12 | -0.13 | NCEP-CFSRb | 0.36 | 0.08 | 0.19 | 0.51 | 0.32 |
| Mean Rean. | -0.19 | -0.08 | -0.07 | -0.09 | -0.10 | Mean Rean. | -0.22 | -0.12 | 0.25 | 0.12 | 0.01 |

Key: a – until 2014, b – until 2010, c – 1958–2013, d – until 2013, e – 1979–2010

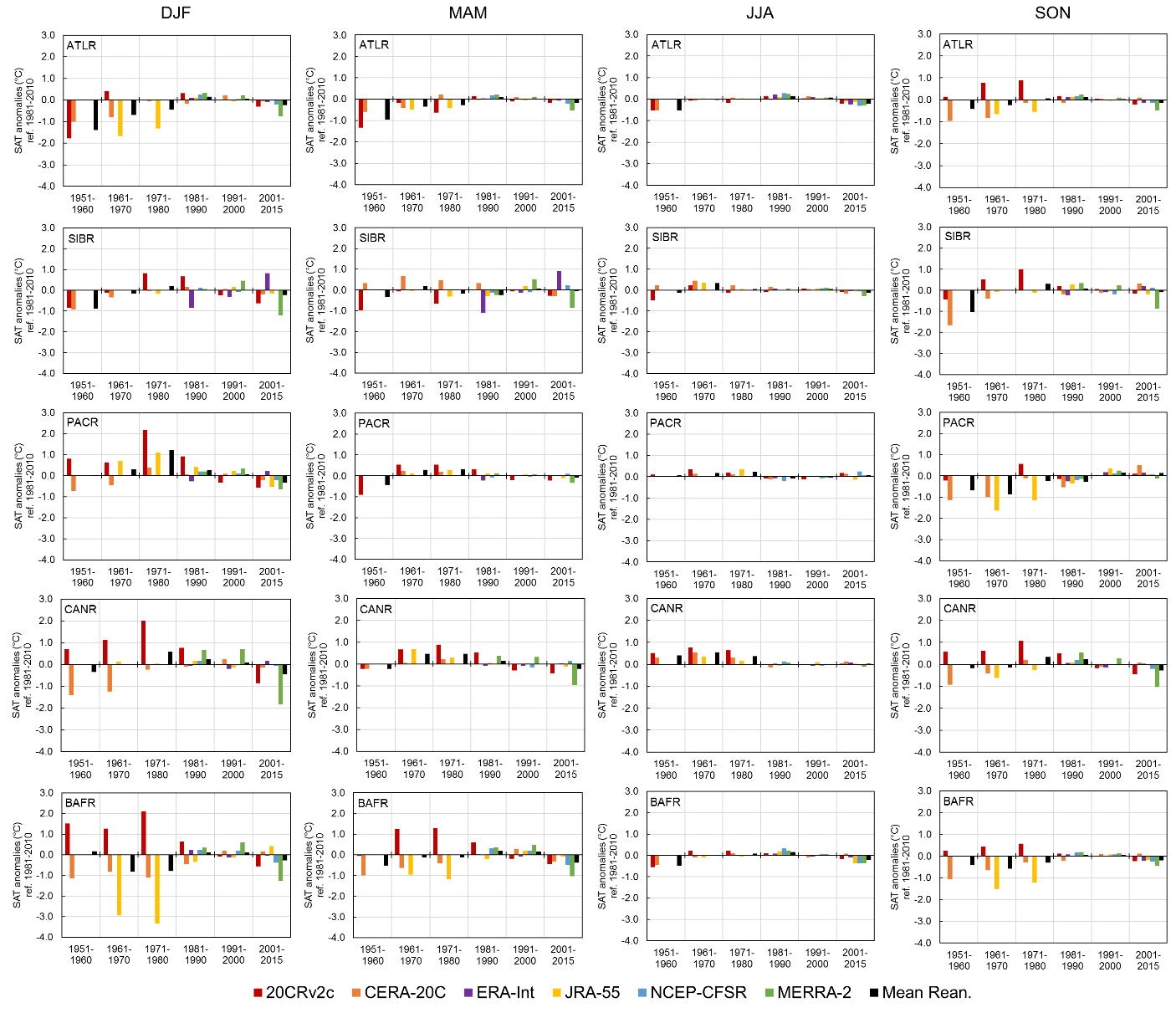
**Table S5** Differences in seasonal and annual SAT trends (°C decade-1) between individual reanalyses and observations in the Arctic climatic regions.   
These differences were obtained by subtracting observational data from reanalysis values

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Region | Dataset | 1951–2015 | | | | | 1976–2015 | | | | | 1981–2010 | | | | | 1996–2015 | | | | |
| DJF | MAM | JJA | SON | Year | DJF | MAM | JJA | SON | Year | DJF | MAM | JJA | SON | Year | DJF | MAM | JJA | SON | Year |
| ATLR | 20CRv2c | 0.13 | 0.13 | 0.05 | -0.16 | 0.04 | -0.16 | -0.01 | -0.08 | -0.27 | -0.13 | -0.26 | -0.08 | -0.14 | -0.22 | -0.17 | 0.07 | -0.46 | -0.14 | -0.21 | -0.19 |
| CERA-20C | 0.06 | 0.01 | 0.04 | 0.13 | 0.06 | -0.08 | -0.18 | -0.03 | 0.02 | -0.08 | 0.05 | 0.02 | 0.00 | 0.14 | 0.05 | 0.94 | -0.22 | 0.20 | 0.28 | 0.23 |
| ERA-Int |  |  |  |  |  | -0.08 | 0.01 | -0.12 | -0.02 | -0.03 | -0.05 | -0.03 | -0.24 | -0.11 | -0.11 | -0.07 | -0.11 | -0.09 | -0.16 | -0.11 |
| JRA-55 | 0.76 | 0.23 | 0.05 | 0.32 | 0.33 | 0.18 | -0.04 | -0.05 | 0.04 | 0.02 | -0.06 | -0.02 | -0.13 | -0.11 | -0.08 | 0.68 | -0.15 | 0.09 | 0.30 | 0.20 |
| MERRA-2 |  |  |  |  |  | -0.46 | -0.43 | -0.17 | -0.22 | -0.33 | -0.43 | -0.33 | -0.26 | -0.30 | -0.33 | -1.18 | -0.88 | -0.10 | -0.52 | -0.66 |
| NCEP-CFSR |  |  |  |  |  | -0.37 | -0.25 | -0.24 | -0.19 | -0.25 | -0.24 | -0.19 | -0.29 | -0.16 | -0.23 | 0.41 | -0.80 | 0.08 | -0.12 | -0.19 |
| Mean Rean. | 0.21 | 0.14 | 0.07 | 0.08 | 0.13 | -0.03 | 0.01 | -0.04 | -0.02 | -0.02 | -0.17 | -0.11 | -0.18 | -0.13 | -0.14 | -0.10 | -0.02 | 0.17 | 0.17 | 0.06 |
| SIBR | 20CRv2c | -0.01 | 0.08 | 0.03 | -0.06 | 0.00 | -0.57 | -0.01 | 0.03 | -0.24 | -0.19 | -0.57 | 0.00 | 0.06 | -0.29 | -0.20 | -0.42 | -0.60 | -0.17 | 0.00 | -0.28 |
| CERA-20C | 0.07 | -0.30 | -0.14 | 0.17 | -0.05 | -0.30 | -0.55 | -0.16 | 0.13 | -0.20 | -0.22 | -0.33 | -0.18 | 0.13 | -0.15 | 0.38 | -0.48 | -0.29 | 1.77 | 0.38 |
| ERA-Int |  |  |  |  |  | 0.50 | 0.82 | 0.02 | 0.22 | 0.40 | 0.90 | 1.07 | -0.05 | 0.20 | 0.53 | 0.05 | 0.01 | -0.12 | -0.12 | -0.05 |
| JRA-55 | 0.12 | 0.14 | 0.00 | 0.17 | 0.11 | -0.08 | 0.05 | -0.02 | -0.17 | -0.04 | -0.07 | 0.19 | 0.01 | -0.30 | -0.05 | -0.31 | -0.20 | -0.08 | 0.11 | -0.07 |
| MERRA-2 |  |  |  |  |  | -0.91 | -0.41 | -0.15 | -0.62 | -0.53 | -0.35 | -0.09 | -0.14 | -0.54 | -0.29 | -2.58 | -2.01 | -0.56 | -1.37 | -1.65 |
| NCEP-CFSR |  |  |  |  |  | -0.42 | -0.06 | 0.00 | 0.02 | -0.08 | -0.10 | 0.16 | -0.06 | -0.05 | -0.02 | 0.13 | 0.01 | 0.09 | 1.08 | 0.35 |
| Mean Rean. | 0.10 | 0.03 | 0.01 | 0.12 | 0.05 | -0.15 | 0.06 | 0.05 | -0.04 | -0.01 | -0.07 | 0.17 | -0.06 | -0.14 | -0.03 | -0.48 | -0.37 | 0.06 | 0.00 | -0.19 |
| PACR | 20CRv2c | -0.33 | 0.01 | -0.03 | 0.03 | -0.08 | -0.85 | -0.29 | 0.08 | 0.03 | -0.24 | -0.68 | -0.22 | 0.18 | 0.11 | -0.13 | -0.20 | -0.18 | 0.04 | 0.24 | 0.02 |
| CERA-20C | 0.08 | -0.05 | 0.00 | 0.29 | 0.08 | -0.39 | 0.01 | 0.05 | 0.62 | 0.09 | -0.11 | 0.00 | 0.11 | 0.61 | 0.17 | 0.00 | -0.78 | 0.19 | 2.17 | 0.46 |
| ERA-Int | -0.52 | 0.04 | -0.05 | 0.54 | 0.01 | 0.20 | -0.10 | 0.11 | 0.34 | 0.12 | 0.22 | 0.18 | 0.07 | 0.14 | 0.16 | 0.12 | -0.14 | 0.03 | 0.26 | 0.07 |
| JRA-55 |  |  |  |  |  | -0.72 | -0.17 | -0.13 | 0.32 | -0.15 | -0.45 | -0.15 | -0.05 | 0.17 | -0.11 | -1.10 | -0.44 | -0.16 | 0.01 | -0.33 |
| MERRA-2 |  |  |  |  |  | -0.47 | -0.33 | 0.14 | 0.23 | -0.09 | -0.38 | -0.15 | 0.03 | 0.00 | -0.12 | -0.83 | -0.24 | 0.20 | -0.03 | -0.22 |
| NCEP-CFSR |  |  |  |  |  | -0.49 | -0.08 | 0.28 | 0.45 | 0.01 | -0.26 | 0.09 | 0.21 | 0.10 | 0.05 | -0.42 | -0.60 | 0.64 | 0.93 | 0.15 |
| Mean Rean. | -0.08 | 0.03 | 0.03 | 0.25 | 0.05 | -0.33 | -0.05 | 0.14 | 0.28 | 0.02 | -0.28 | -0.04 | 0.09 | 0.19 | 0.00 | 0.04 | 0.17 | 0.45 | 0.48 | 0.30 |
| CANR | 20CRv2c | -0.37 | -0.12 | -0.13 | -0.23 | -0.22 | -0.76 | -0.41 | -0.06 | -0.50 | -0.43 | -0.68 | -0.35 | 0.03 | -0.44 | -0.35 | -0.20 | -0.20 | 0.14 | -0.15 | -0.11 |
| CERA-20C | 0.28 | 0.03 | -0.10 | 0.15 | 0.10 | 0.04 | 0.11 | 0.07 | 0.06 | 0.09 | 0.01 | -0.04 | 0.12 | 0.01 | 0.03 | 1.20 | 0.61 | -0.03 | 0.72 | 0.71 |
| ERA-Int |  |  |  |  |  | 0.21 | 0.03 | -0.03 | -0.03 | 0.05 | 0.16 | 0.07 | -0.02 | -0.04 | 0.04 | 0.11 | -0.13 | 0.14 | 0.08 | 0.03 |
| JRA-55 | 0.03 | 0.03 | 0.01 | 0.26 | 0.07 | 0.08 | -0.06 | 0.05 | 0.08 | 0.03 | -0.08 | -0.11 | 0.00 | -0.07 | -0.06 | 0.88 | -0.01 | 0.17 | 0.34 | 0.30 |
| MERRA-2 |  |  |  |  |  | -1.03 | -0.65 | -0.16 | -0.69 | -0.64 | -1.02 | -0.62 | -0.11 | -0.71 | -0.63 | -2.57 | -1.33 | -0.02 | -1.13 | -1.26 |
| NCEP-CFSR |  |  |  |  |  | 0.10 | 0.27 | -0.16 | -0.09 | 0.06 | -0.15 | 0.03 | -0.10 | -0.26 | -0.12 | 0.84 | 0.73 | 0.12 | 0.20 | 0.52 |
| Mean Rean. | -0.05 | -0.05 | -0.06 | 0.00 | -0.04 | -0.30 | -0.16 | 0.06 | -0.20 | -0.15 | -0.29 | -0.17 | -0.01 | -0.25 | -0.18 | -0.31 | -0.11 | 0.39 | -0.05 | -0.02 |
| BAFR | 20CRv2c | -0.41 | -0.17 | 0.02 | -0.11 | -0.17 | -0.45 | -0.32 | -0.09 | -0.14 | -0.24 | -0.59 | -0.44 | -0.12 | -0.15 | -0.33 | 0.50 | 0.08 | 0.03 | 0.06 | 0.17 |
| CERA-20C | 0.24 | 0.21 | 0.02 | 0.23 | 0.19 | 0.35 | 0.30 | 0.04 | 0.29 | 0.29 | 0.27 | -0.17 | 0.05 | 0.15 | 0.09 | 1.19 | 0.95 | 0.55 | 0.73 | 1.03 |
| ERA-Int |  |  |  |  |  | 0.51 | 0.14 | -0.03 | -0.13 | 0.08 | -0.06 | 0.03 | -0.05 | -0.07 | -0.04 | -0.01 | -0.18 | -0.13 | -0.36 | -0.19 |
| JRA-55 | 0.91 | 0.55 | 0.07 | 0.45 | 0.48 | 0.82 | 0.32 | -0.18 | 0.12 | 0.25 | 0.48 | 0.12 | -0.24 | -0.03 | 0.08 | 1.07 | 0.31 | -0.39 | -0.13 | 0.20 |
| MERRA-2 |  |  |  |  |  | 0.00 | -0.34 | -0.22 | -0.32 | -0.27 | -0.62 | -0.61 | -0.27 | -0.27 | -0.46 | -1.59 | -1.24 | -0.26 | -0.47 | -0.89 |
| NCEP-CFSR |  |  |  |  |  | 0.47 | 0.20 | -0.32 | -0.09 | 0.05 | -0.31 | -0.40 | -0.41 | -0.23 | -0.34 | 0.81 | 1.08 | 0.04 | 0.48 | 0.76 |
| Mean Rean. | 0.08 | 0.07 | 0.06 | 0.11 | 0.08 | -0.01 | -0.10 | -0.03 | -0.02 | -0.04 | -0.14 | -0.24 | -0.17 | -0.10 | -0.17 | -0.24 | -0.27 | 0.19 | -0.01 | -0.08 |

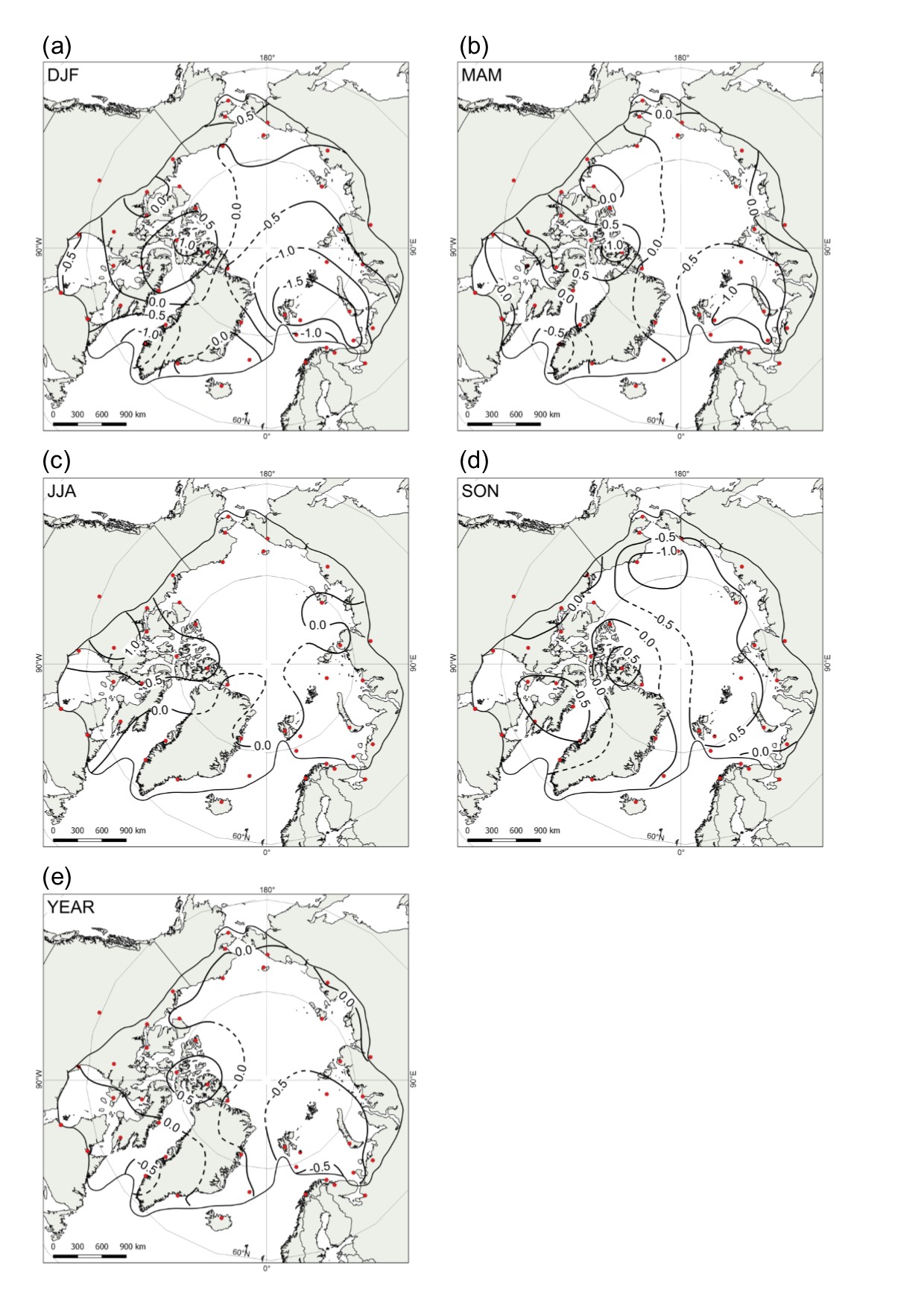
Explanations: for 20CRv2c, CERA20C, NCEP-CFSR, JRA-55 trends and differences were calculated until 2014, 2010, 2010 and 2013 respectively, except the 1981–2010 column.

Moreover, trends and differences for JRA-55 in the 1951–2015 column were calculated for the period 1958–2013 only.

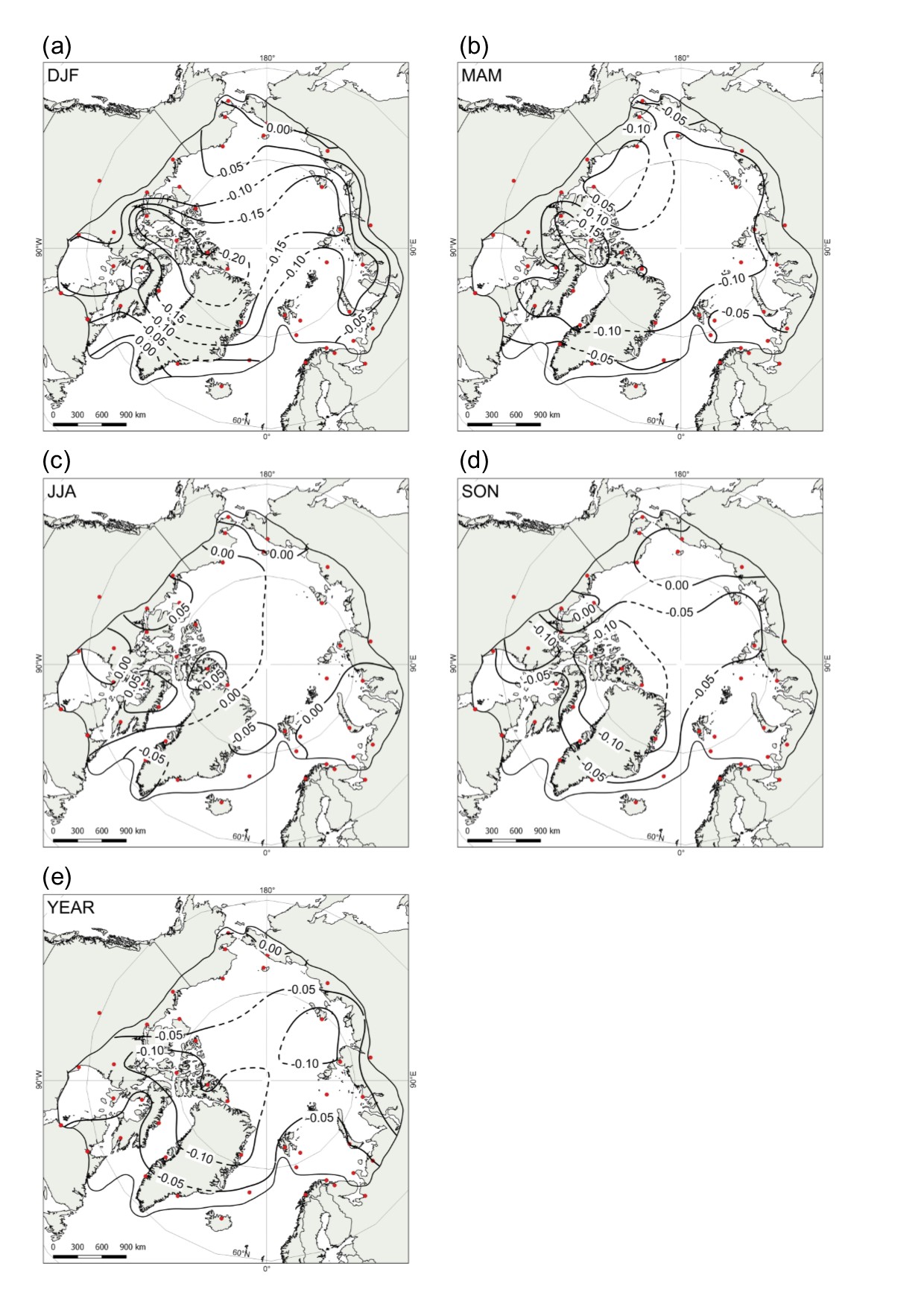
For NCEP-CFSR, trends and differences in the columns 1951–2015 and 1976–2015 were calculated for the period 1979–2010 only.



**Fig. S1** Decadal differences in seasonal SAT anomalies (°C, relative to 1981–2010 mean) between observations and reanalyses in the Arctic regions in 1951–2015. These differences were obtained by subtracting observational data from reanalysis values. Note that the last period includes a 15-year mean

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**Fig. S2**  Spatial distribution of (a–d) seasonal and (e) annual differences between mean reanalysis and observations in 1951–1978. These differences were obtained by subtracting observational data from mean reanalysis values



**Fig. S3** Spatial distribution of (a–d) seasonal and (e) annual differences between mean reanalysis and observations in 1979–2015. These differences were obtained by subtracting observational data from mean reanalysis values