Data Set Citation

When using this data, please cite the data package

Badgeley J , Steig E , Hakim G , and Fudge T. 2020.
Reconstructions of mean-annual Greenland temperature and precipitation for the past 20,000 years and the ice-core records used to create the reconstructions 2020
doi:10.18739/A2599Z26M (https://arcticdata.io/metacat/metacat/doi:10.18739/A2599Z26M/default)

General Information

Title:	**Reconstructions of mean-annual Greenland temperature and precipitation for the past 20,000 years and the ice-core record used to create the reconstructions 2020**
Identifier:	autogen.20200707112714536 26.1
Abstract:	This dataset provides mean-annual surface temperature and precipitation reconstructions for Greenland over the past 20,000 years the proxy records used to create the reconstructions. For each reconstruction, ice-core records were assimilated with a transient clim simulation using the ensemble Kalman filter. The reconstructions differ by assumptions made during preparation of the ice-core reco and parameters set in the assimilation process. The temperature values are anomalies with respect to the reference period, 1850-20 CE, while the precipitation values are fractional precipitation rates with respect to the same reference period. The ice-core data was previously published except for the accumulation rate records from Dye3, Greenland Ice Core Project (GRIP), and North Greenland Core Project (NGRIP). To extract the accumulation signal from layer-thickness, the layers were destrained using assumptions about history of ice flow. Here, a one-dimensional ice-flow model was used to calculate the cumulative vertical strain the layers have experienced at each core site. Based on a range of plausible ice-flow parameters, three scenarios were developed for each site: 'low 'moderate', and 'high', where the names reflect the relative magnitude of accumulation in the glacial and early Holocene. More inform on both the reconstructions and the ice-core records is provided in the following paper: Badgeley, J. A., Steig, E. J., Hakim, G. J. and Fudge, T. J.: Greenland temperature and precipitation over the last 20,000 years using data assimilation, Climate of the Past, in pres 2020 (preprint: https://doi.org/10.5194/cp-2019-164). Please cite this paper if you use the climate reconstructions or the accumulatio records for GRIP, NGRIP, or Dye3.
Keywords:	NASA Global Change Master Directory (GCMD): ○ air temperature reconstruction ○ precipitation reconstruction None: ○ Greenland ○ ice core records ○ water isotopes ○ accumulation rate ○ data assimilation ○ paleoclimate
Publication Date:	2020

Data Table, Image, and Other Data Details:

Metadata download	Ecological Metadata Language (EML) File

Data Table:

Name:	**Accumulation_Rate_Records_for_High_Precipitation_Scenario_Assimilated.csv**
Description:	This file contains the accumulation rate records for Dye3, Greenland Ice Sheet Project 2 (GISP2), GRIP, North Greenland Eemian ice drilling (NEEM), and NGRIP that were assimilated into the high precipitation reconstruction. They differ from the Accumulation_Rate_Records_for_High_Precipitation_Scenario_Raw.csv records as they are fractions with respect to present accumula

rates and they are averaged to 50-year resolution.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_High_Precipitation_Scenario_Assimilated.csv
Size:	27260 bytes
Authentication:	a49c3e19ce6b46381194b79f71d41299 Caculated By MD5
Text Format:	Number of Header Lines: 16 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:741c50d2-2586-4d2a-b5fb-def6a2883181

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Age		Ice core ages averaged to 50-year resolution		ratio	**Unit** nominalYear **Type** integer					
GISP2.Accumulation.Rate		GISP2 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Accumulation.Rate		NEEM fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Accumulation.Rate		GRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Accumulation.Rate		NGRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Accumulation.Rate		Dye3 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No available high-resolution depth-age scale for the Dye3 ice core prior to 11.7 ka				

Data Table:

Name:	**Accumulation_Rate_Records_for_High_Precipitation_Scenario_Raw.csv**
Description:	This file contains the accumulation rate records for Dye3, GISP2, GRIP, NEEM, and NGRIP that were used to derived the records assimilated into the high precipitation reconstruction.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_High_Precipitation_Scenario_Raw.csv
Size:	397804 bytes
Authentication:	7dd8330152798b1922eac5be09f569de Caculated By MD5
Text Format:	Number of Header Lines: 14 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:f3dca09b-5b01-4a48-8b2f-beee192f537e

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
GISP2.Age		GISP2 age		ratio	**Unit** nominalYear **Type** real					
GISP2.Accumulation.Rate		GISP2 snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Age		NEEM age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NEEM.Accumulation.Rate		NEEM snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Age		GRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
GRIP.Accumulation.Rate		GRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Age		NGRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NGRIP.Accumulation.Rate		NGRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Age		Dyes age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Dye3.Accumulation.Rate		Dyes snow accumulation rates		ratio	**Unit** dimensionless **Type** real					

Data Table:

Name:	**Accumulation_Rate_Records_for_Low_Precipitation_Scenario_Assimilated.csv**
Description:	This file contains the accumulation rate records for Dye3, GISP2, GRIP, NEEM, and NGRIP that were assimilated into the low precipitat reconstruction. They differ from the Accumulation_Rate_Records_for_Low_Precipitation_Scenario_Raw.csv records as they are fractior with respect to present accumulation rates and they are averaged to 50-year resolution.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_Low_Precipitation_Scenario_Assimilated.csv
Size:	27247 bytes
Authentication:	8b465814b657c64c9e6933858a502b28 Caculated By MD5
Text Format:	Number of Header Lines: 16 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:1772a8ca-319d-4050-81d7-311b7028cadc

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Age		Ice core ages averaged to 50-year resolution		ratio	**Unit** nominalYear **Type** integer					
GISP2.Accumulation.Rate		GISP2 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Accumulation.Rate		NEEM fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Accumulation.Rate		GRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Accumulation.Rate		NGRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Accumulation.Rate		Dye3 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No available high-resolution depth-age scale for the Dye3 ice core prior to 11.7 ka				

Data Table:

Name:	**Accumulation_Rate_Records_for_Low_Precipitation_Scenario_Raw.csv**
Description:	This file contains the accumulation rate records for Dye3, GISP2, GRIP, NEEM, and NGRIP that were used to derive the records assimi into the low precipitation reconstruction.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_Low_Precipitation_Scenario_Raw.csv
Size:	397756 bytes
Authentication:	641ccc75ea5318faae9be45bea9248f3 Caculated By MD5
Text Format:	Number of Header Lines: 14 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:ae9996cf-53d8-4d78-8ec4-f7f280ef3794

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
GISP2.Age		GISP2 age		ratio	**Unit** nominalYear **Type** real					
GISP2.Accumulation.Rate		GISP2 snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Age		NEEM age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NEEM.Accumulation.Rate		NEEM snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Age		GRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
GRIP.Accumulation.Rate		GRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Age		NGRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NGRIP.Accumulation.Rate		NGRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Age		Dyes age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Dye3.Accumulation.Rate		Dyes snow accumulation rates		ratio	**Unit** dimensionless **Type** real					

Data Table:

Name:	**Accumulation_Rate_Records_for_Moderate_Precipitation_Scenario_Assimilated.csv**
Description:	This file contains the accumulation rate records for Dye3, GISP2, GRIP, NEEM, and NGRIP that were assimilated into the main (modera precipitation reconstruction. They differ from the Accumulation_Rate_Records_for_Moderate_Precipitation_Scenario_Raw.csv records a they are fractions with respect to present accumulation rates and they are averaged to 50-year resolution.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_Moderate_Precipitation_Scenario_Assimilated.csv
Size:	27253 bytes
Authentication:	020f9fbe97b61389d630827738be3e9a Caculated By MD5
Text Format:	Number of Header Lines: 16 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:eb066014-3788-46de-94cd-7655ac9c05ca

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Age		Ice core ages averaged to 50-year resolution		ratio	**Unit** nominalYear **Type** integer					
GISP2.Accumulation.Rate		GISP2 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Accumulation.Rate		NEEM fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Accumulation.Rate		GRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Accumulation.Rate		NGRIP fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Accumulation.Rate		Dye3 fractional snow accumulation rates with respect to present accumulation rates		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No available high-resolution depth-age scale for the Dye3 ice core prior to 11.7 ka				

Data Table:

Name:	**Accumulation_Rate_Records_for_Moderate_Precipitation_Scenario_Raw.csv**
Description:	This file contains the raw accumulation rate records for Dye3, GISP2, GRIP, NEEM, and NGRIP that were used to derive the assimilate records for the main (moderate) precipitation reconstruction.

Physical Structure Description:

Object Name:	Accumulation_Rate_Records_for_Moderate_Precipitation_Scenario_Raw.csv
Size:	397735 bytes
Authentication:	b6aa6fc5ea46d305ea0021471b7c51c5 Caculated By MD5
Text Format:	Number of Header Lines: 14 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:be74ad16-5382-47be-9a78-de41a39e5062

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
GISP2.Age		GISP2 age		ratio	**Unit** nominalYear **Type** real					
GISP2.Accumulation.Rate		GISP2 snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NEEM.Age		NEEM age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NEEM.Accumulation.Rate		NEEM snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
GRIP.Age		GRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
GRIP.Accumulation.Rate		GRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
NGRIP.Age		NGRIP age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NGRIP.Accumulation.Rate		NGRIP snow accumulation rates		ratio	**Unit** dimensionless **Type** real					
Dye3.Age		Dyes age averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Dye3.Accumulation.Rate		Dyes snow accumulation rates		ratio	**Unit** dimensionless **Type** real					

Data Table:

Name:	**Corrections_for_Oxygen_Isotope_Records.csv**
Description:	This file contains the corrections for the oxygen isotope (d18O) records.

Physical Structure Description:

Object Name:	Corrections_for_Oxygen_Isotope_Records.csv

Size:	248806 bytes
Authentication:	6ddd5a19af2bf03d213aacaf3b64e5ae Caculated By MD5
Text Format:	Number of Header Lines: 20 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:31d07935-943f-4e51-baf1-f795b01f659e

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Sea.water.Age		Sea water ages averaged to 100-year resolution		ratio	**Unit** nominalYear **Type** integer					
Sea.water.Correction		Change in sea water mean oxygen isotope ratio (d18O) through time		ratio	**Unit** dimensionless **Type** real					
NEEM.latitude.flow.Age		NEEM latitude flow ages		ratio	**Unit** nominalYear **Type** real					
NEEM.latitude.flow.Correction		Latitude difference between the site of snow deposition and the ice-core site		ratio	**Unit** dimensionless **Type** real					
NEEM.elevation.flow.Age		NEEM elevation flow ages		ratio	**Unit** nominalYear **Type** real					
NEEM.elevation.flow.Correction		Elevation difference between the site of snow deposition and the ice-core site		ratio	**Unit** meter **Type** real					
Camp.Century.elevation.flow.Age		Camp Century elevation flow Ages		ratio	**Unit** nominalYear **Type** real					
Camp.Century.elevation.flow.Correction		Elevation difference between the site of snow deposition and the ice-core site		ratio	**Unit** meter **Type** real					
Dye3.elevation.flow.Age		Dye3 elevation flow ages		ratio	**Unit** nominalYear **Type** real					
Dye3.elevation.flow.Correction		Elevation difference		ratio	**Unit** meter **Type** real					

		between the site of snow deposition and the ice-core site								

Data Table:

Name:	**Oxygen_Isotope_Records_Assimilated.csv**
Description:	This file contains the oxygen isotope (d18O) records for Agassiz, Camp Century, Dye3, GISP2, GRIP, NEEM, NGRIP, and Renland that were assimilated into the main, S1, S2, S3, and S4 temperature reconstructions. These records differ from the Oxygen_Isotope_Records_Raw.csv file as they are corrected, turned into anomalies, and averaged to a 50-year resolution.

Physical Structure Description:

Object Name:	Oxygen_Isotope_Records_Assimilated.csv
Size:	43920 bytes
Authentication:	898caae164366fc14f963548f90809e9 Caculated By MD5
Text Format:	Number of Header Lines: 28 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:b74a30b2-9c8d-4511-91b1-6cbd3fe2914c

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Age		Ice core ages averaged to 50-year resolution		ratio	**Unit** nominalYear **Type** integer					
Agassiz_SMOW.d18O		Agassiz standard mean ocean water (SMOW) oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No depth-age scale information or the corresponding raw data is missing				
Camp.Century_SMOW_elevflow.d18O		Camp Century SMOW elevation flow oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No depth-age scale information or the corresponding raw data is missing				
Dye3_SMOW_elevflow.d18O		Dye3 SMOW elevation flow		ratio	**Unit** dimensionless **Type** real					

		oxygen isotope ratios								
GISP2_SMOW.d18O		GRIP2 SMOW oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No depth-age scale information or the corresponding raw data is missing				
GRIP_SMOW.d18O		GRIP SMOW oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
NEEM_SMOW_elevflow_latflow.d18O		NEEM SMOW elevation flow oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
NGRIP_SMOW.d18O		NGRIP SMOW oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
Renland_SMOW.d18O		Renland SMOW oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real	**Code** -999999 **Expl** No depth-age scale information or the corresponding raw data is missing				

Data Table:

Name:	**Oxygen_Isotope_Records_Raw.csv**
Description:	This file contains the raw oxygen isotope (d18O) records for Agassiz, Camp Century, Dye3, GISP2, GRIP, NEEM, NGRIP, and Renland

Physical Structure Description:

Object Name:	Oxygen_Isotope_Records_Raw.csv
Size:	336390 bytes
Authentication:	a7dc57fe74fe548cbcc5df5c629ea66d Caculated By MD5
Text Format:	Number of Header Lines: 21 Record Delimiter: Attribute Orientation: column Simple Delimited: Field Delimeter: ,

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:9e75bd7a-84b1-4855-8e16-e2d625ea208c

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
Agassiz.Age		Agassiz ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Agassiz.d18O		Agassiz oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
Camp.Century.Age		Camp Century ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Camp.Century.d18O		Camp Century oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
Dye3.Age		Dye3 ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Dye3.d18O		Dye3 oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
GISP2.Age		GISP2 ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
GISP2.d18O		GISP2 oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
GRIP.Age		GRIP ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
GRIP.d18O		GRIP oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
NEEM.Age		NEEM ice core ages		ratio	**Unit** nominalYear **Type** real					
NEEM.d18O		NEEM oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
NGRIP.Age		NGRIP ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
NGRIP.d18O		NGRIP oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					
Renland.Age		Renland ice core ages averaged to 20-year resolution		ratio	**Unit** nominalYear **Type** integer					
Renland.d18O		Renland oxygen isotope ratios		ratio	**Unit** dimensionless **Type** real					

Data Table:

Name:	**pr_high_Badgeley_etal_2020.nc**
Description:	This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the high precipitatior reconstruction.

Physical Structure Description:

Object Name:	pr_high_Badgeley_etal_2020.nc

Size:	2237392 bytes
Authentication:	89cbcb7db463e9f178865f97947b355f Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:c5e3fa59-7117-4fee-8163-07aae8519886

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name: **pr_low_Badgeley_etal_2020.nc**

Description: This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the low precipitation reconstruction.

Physical Structure Description:

Object Name:	pr_low_Badgeley_etal_2020.nc
Size:	2237390 bytes
Authentication:	e172abedba822baaff0c56e0eeed70d3 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:64b58bc8-0cf6-4e6b-95fd-7ee8d5e7d481

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name: **pr_main_Badgeley_etal_2020.nc**

Description: This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the main (moderate) precipitation reconstruction.

Physical Structure Description:

Object Name:	pr_main_Badgeley_etal_2020.nc
Size:	2237402 bytes
Authentication:	ccb8383eb515b8178cc5815b61fb2f63 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:6889d480-65c8-4b21-949e-7a1f81d18c42

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					

prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name:	**tas_main_Badgeley_etal_2020.nc**
Description:	This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the main temperatur reconstruction.

Physical Structure Description:

Object Name:	tas_main_Badgeley_etal_2020.nc
Size:	2237412 bytes
Authentication:	da49b3f9fa5ea7a05d9bd784b5f4c324 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:4a846c8d-5bd7-4e7c-a3c2-42be36ac0595

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the		ratio	**Unit** dimensionless					

		posterior ensemble			**Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name: **tas_S1_Badgeley_etal_2020.nc**

Description: This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the S1 temperature reconstruction.

Physical Structure Description:

Object Name:	tas_S1_Badgeley_etal_2020.nc
Size:	2237404 bytes
Authentication:	9245f6d1e1a16ef0f492ae63b6130cad Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:6325a073-9554-47de-b9a1-a364a0804930

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name:	**tas_S2_Badgeley_etal_2020.nc**
Description:	This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the S2 temperature reconstruction.

Physical Structure Description:

Object Name:	tas_S2_Badgeley_etal_2020.nc
Size:	2237402 bytes
Authentication:	53264ee88769cb900fab4a3d386d1691 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:8c52f2a3-9849-4105-9ec2-61c3d6edece5

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name:	**tas_S3_Badgeley_etal_2020.nc**
Description:	This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the S3 temperature reconstruction.

Physical Structure Description:

Object Name:	tas_S3_Badgeley_etal_2020.nc

Size:	2237406 bytes
Authentication:	f5f56e17986039cd8175285bcea429c7 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:53de09a9-29f9-4fae-ba78-8b6dfe4a3856

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
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prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

Data Table:

Name:	**tas_S4_Badgeley_etal_2020.nc**
Description:	This file contains the prior (initial guess) and posterior (reconstruction) mean, 5th percentile, and 95th percentile for the S4 temperature reconstruction.

Physical Structure Description:

Object Name:	tas_S4_Badgeley_etal_2020.nc
Size:	2237444 bytes
Authentication:	af71c6c8db2ab6aa31bff97ad7e54d06 Caculated By MD5
Externally Defined Format:	Format Name: netCDF-3

Online Distribution Info:

https://cn.dataone.org/cn/v2/resolve/urn:uuid:a12e0199-f72a-430c-bf9d-46db4fe5704c

Attribute(s) Info:

Name	Column Label	Definition	Type of Value	Measurement Type	Measurement Domain	Missing Value Code	Accuracy Report	Accuracy Assessment	Coverage	Met
prior_mean		Mean over the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_5		5th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
prior_95		95th percentile of the prior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_mean		Mean over the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_5		5th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
posterior_95		95th percentile of the posterior ensemble		ratio	**Unit** dimensionless **Type** real					
lat		Latitude		interval	**Unit** degree **Type** real					
lon		Longitude		interval	**Unit** degree **Type** real					
time		Number of years before 1950 CE		ratio	**Unit** kiloannum **Type** real					

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Data Set Characteristics

Geographic Region:

Geographic Description:	Greenland	
Bounding Coordinates:	West:	-86.25 degrees
	East:	-3.75 degrees

North:	87.16 degrees
South:	53.81 degrees

Geographic Region:

Geographic Description:	Agassiz ice-core site, Greenland
Bounding Coordinates:	
West:	-73.1 degrees
East:	-73.1 degrees
North:	80.7 degrees
South:	80.7 degrees

Geographic Region:

Geographic Description:	Camp Century ice-core site, Greenland
Bounding Coordinates:	
West:	-61.12 degrees
East:	-61.12 degrees
North:	77.18 degrees
South:	77.18 degrees

Geographic Region:

Geographic Description:	Dye3 ice-core site, Greenland
Bounding Coordinates:	
West:	-43.82 degrees
East:	-43.82 degrees
North:	65.18 degrees
South:	65.18 degrees

Geographic Region:

Geographic Description:	GISP2 ice-core site, Greenland
Bounding Coordinates:	
West:	-38.8 degrees
East:	-38.8 degrees
North:	72.97 degrees
South:	72.97 degrees

Geographic Region:

Geographic Description:	GRIP ice-core site, Greenland
Bounding Coordinates:	
West:	-37.6 degrees
East:	-37.6 degrees
North:	72.6 degrees
South:	72.6 degrees

Geographic Region:

Geographic Description:	NEEM ice-core site, Greenland
Bounding Coordinates:	
West:	-51.06 degrees
East:	-51.06 degrees
North:	77.45 degrees

	South: 77.45 degrees

Geographic Region:

Geographic Description:	NGRIP ice-core site, Greenland
Bounding Coordinates:	West: -42.3 degrees East: -42.3 degrees North: 75.1 degrees South: 75.1 degrees

Geographic Region:

Geographic Description:	Renland ice-core site, Greenland
Bounding Coordinates:	West: -26.73 degrees East: -26.73 degrees North: 71.27 degrees South: 71.27 degrees

Time Period:

Begin:	2019
End:	2020

Sampling, Processing and Quality Control Methods

Step by Step Procedures

Step 1:

Description: The following methods have been modified from Badgeley et al. (2020).

The paleoclimate reconstructions were made by assimilating oxygen isotope ratios and accumulation from ice cores with a transient climate-model simulation. In the following steps, we briefly describe the ice-core data, the climate-model simulation, the details of our paleoclimate data assimilation approach, and the rationale behind the sensitivity experiments included in this dataset. Then we describe methods used to create the new accumulation records for GRIP, NGRIP, and Dye3.

Step 2:

Description: Ice-core data:

We use proxy records from eight ice cores from the Greenland Ice Sheet and nearby ice caps (Agassiz, Camp Century, Dye3, GISP2, G NEEM, NGRIP, and Renland). As a proxy for temperature, we use previously-published measurements of oxygen isotope ratios from the (Î´18O). Because records from the Dye3 ice core are our only source of information in southern Greenland, we extend the depth-age sca 20 kiloannum (ka) to take advantage of the glacial portion of the Î´18O record. The accumulation history has been estimated for five of th cores (Dye3, GISP2, GRIP, NEEM, and NGRIP) from layer thickness corrected for vertical ice-thinning due to dynamical strain in the ice sheet.

Where possible, we account for non-local effects on the ice-core records, including fluctuations in the global-mean Î´18O and horizontal advection that brings ice from other elevations and latitudes. We do not correct Î´18O or accumulation for changing elevation at the ice-c site; our goal is to reconstruct conditions at the surface, rather than at a constant reference elevation. We take the anomaly of each corre Î´18O record and the ratio of each accumulation record relative to the mean of all data in the record that falls within the time period 1850- CE. We then average each record to 50-year resolution. It is these corrected, averaged records that we use in the data assimilation.

Step 3:

Description: Climate-model simulation:

We use TraCE-21ka, a simulation of the last 22,000 years of climate (22 ka to -.04 ka), which was run using the fully-coupled CCSM3 at

resolution (approximately 3.75 degrees horizontally) with transient ice-sheet, orbital, greenhouse gas, and meltwater flux forcings (Liu et 2009, 2012; He et al., 2013). From TraCE-21ka, we use two-meter air temperature for temperature (T) and the sum of large-scale stable precipitation and convective precipitation for precipitation (P). To correct for model bias in TraCE-21ka, we assume that the bias is statio in time and apply the delta-change method (Teutschbein and Seibert, 2012) by taking the anomaly of temperature and the fraction of precipitation relative to the mean of our reference period (1850-2000 CE). After the bias correction, we average the TraCE-21ka variable (which originally have monthly resolution) to 50-year resolution, as we did for the ice-core records.

References:

- He, F., Shakun, J. D., Clark, P. U., Carlson, A. E., Liu, Z., Otto-Bliesner, B. L., and Kutzbach, J. E.: Northern Hemisphere forcing of Sou Hemisphere climate during the last deglaciation, Nature, 494, 81, 2013.

- Liu, Z., Otto-Bliesner, B., He, F., Brady, E., Tomas, R., Clark, P., Carlson, A., Lynch-Stieglitz, J., Curry, W., Brook, E., et al.: Transient simulation of last deglaciation with a new mechanism for Bølling-Allerød warming, Science, 325, 310–314, 2009.

- Liu, Z., Carlson, A. E., He, F., Brady, E. C., Otto-Bliesner, B. L., Briegleb, B. P., Wehrenberg, M., Clark, P. U., Wu, S., Cheng, J., et al.: Younger Dryas cooling and the Greenland climate response to CO2, Proceedings of the National Academy of Sciences, 109, 11 10111 1 2012.

- Teutschbein, C. and Seibert, J.: Bias correction of regional climate model simulations for hydrological climate-change impact studies: R and evaluation of different methods, Journal of hydrology, 456, 12–29, 2012.

Step 4:

Description: Paleoclimate data assimilation:

To combine the ice-core and climate-model data, we use an offline version of the ensemble Kalman filter. This data assimilation framewo uses ensembles for the initial (prior) and final (posterior) estimates of the climate state, providing a probabilistic framework for interpretin evaluating the results.

The prior ensemble is an initial estimate of possible climate states, which we form using 100 randomly-chosen 50-year averages from the TraCE-21ka simulation. States from both the glacial and the Holocene make up a prior ensemble. The same prior is used for all time step the reconstruction, leading to a prior that is constant in time. Proxy records are assimilated into the prior, which produces the posterior ensemble, a new estimate of possible climate states. We assimilate Î´18O to reconstruct temperature and separately assimilate accumul to reconstruct precipitation.

We repeat the data assimilation process over multiple iterations, with each iteration using one of ten different 100-member prior ensembl and excluding one proxy record. Each of the ten prior ensembles is made up of a different random selection of 50-year averages from TraCE-21ka. Each proxy record is excluded from a total of ten iterations, where each of these iterations uses a different one of the ten pr options. A reanalysis is a compilation of the 100-member posterior ensembles from these iterations, resulting in a temperature reanalysis having 8,000 ensemble members and a precipitation reanalysis having 5,000 ensemble members.

For the assimilation of each Î´18O record, we use an estimated total error variance of 1.3 ‰2, which is a sum of the measurement, spatia representation, and proxy system model error variances. For the assimilation of each accumulation record, we use an estimated total err variance of 0.0038, which is a sum of the measurement and spatial representation error variances.

To remove mean bias from temperature, we subtract out the reference-period mean. For precipitation, we divide by the reference-period mean. It is these bias-corrected results that are referred to unless noted otherwise.

Step 5:

Description: Î´18O proxy system model:

For our Î´18O proxy system model (PSM), we use a linear relationship with temperature at the ice-core drill site (Tsite) that has a slope o 0.67. We use TraCE-21ka to estimate the site-specific effects of precipitation seasonality on the Î´18O-Tsite relationship by replacing Tsi the linear Î´18O PSM with T*site, the precipitation-weighted temperature at the model grid-cell closest to the ice-core drill site. This is the used in the main temperature reconstruction.

Accumulation proxy system model:

Accumulation is closely related to total precipitation at our ice-core sites, which have limited surface melting and evaporation. For this rea and because TraCE-21ka lacks process-based ablation variables, our PSM is a direct-comparison between ice-core accumulation and simulated precipitation at the model grid-cell closest to the ice-core site.

Step 6:

Description: Temperature scenarios:

To evaluate the sensitivity of our results to the choice of Î´18O PSM, we produce four other reconstructions (S1-S4). The S1 scenario use PSM, Î´18O=0.67Tsite, which is the modern (high-frequency) relationship and does not account for precipitation seasonality. The S2 scen uses Î´18O=0.5Tsite, the mean of the high-frequency and low-frequency temporal slopes. The S3 scenario uses Î´18O=0.335Tsite, which similar to published estimates of the glacial-interglacial temporal slope. The S4 scenario uses the same PSM as in the main reanalysis,

	Î´18O=0.67T*site, but we adjust the strength of the precipitation seasonality in TraCE-21ka such that the average Î´18O-Tsite slope arou Greenland is approximately 0.335 ‰°C-1. The S4 scenario thus has the same spatially-variable Î´18O-Tsite relationship as in the main reanalysis, but a greater influence of precipitation seasonality.
Step 7:	
Description:	Precipitation scenarios: To extract the accumulation signal from layer-thickness, the layers must be destrained using assumptions about the history of ice flow. B on a range of plausible ice-flow parameters, we develop three scenarios for each site: "low", "moderate", and "high", where the names re the relative magnitude of accumulation in the glacial and early Holocene. We assimilate the intermediate-value ("moderate") accumulatio records to produce our main precipitation reanalysis, while we assimilate the high and low accumulation records into high and low sensiti scenarios, respectively, to provide a conservative estimate of uncertainty.
Step 8:	
Description:	New accumulation records: We use a transient, one-dimensional, ice-flow model to calculate the cumulative vertical strain, termed the thinning function. We represer vertical velocity profile using the (Dansgaard and Johnsen, 1969) formulation. We assume there is no ice thickness change and that the r rate and the basal sliding contribution to horizontal surface velocity are constant in time with accumulation rate and kink height being func of time. The model is initially run with a constant accumulation history at the modern accumulation rate, and a thinning function is produced. The thinning function is then used with the measured layer thickness to infer a temporally-variable accumulation history. The model is then ru with the temporally-variable accumulation history to produce an updated thinning function. This thinning function is then used with the measured layer thickness to infer the final accumulation history. The solution converges without additional iterations needed. References: - Dansgaard, W. and Johnsen, S.: A ï¬ow model and a time scale for the ice core from Camp Century, Greenland, Journal of Glaciology, 215–223, 1969.
Step 9:	
Description:	GRIP accumulation records: Because GRIP is not directly beneath the ice divide and the divide position has likely not been stable, we use a vertical velocity profile th transitional between a typical flank profile and a divide profile; this is represented with a Dansgaard-Johnsen kink height of 0.4, which we from 5 ka to present. Prior to 5 ka, we use a typically flank flow value of 0.1 assuming that the divide position is more than one ice thickne km) away. The melting term in the vertical velocity calculation is neglected. We use this as our moderate accumulation history and note t is not sensitive to 1,000 year changes in the onset times of the divide flow. To develop the high and low scenarios, we use the divide-like height of 0.4 and the flank-like kink height of 0.1, respectively.
Step 10:	
Description:	NGRIP accumulation records: For all scenarios, we use a melt rate of 7.7 mm a-1. We use a kink height of 0.2 for our moderate scenario, as it reproduces the thinning function inferred by Gkinis et al. (2014). For the high scenario, we use the original values of Dahl-Jensen et al. (2003), which includes a k height of 0.45. For the low scenario, we use a kink height of 0, which is equivalent to using a basal sliding fraction of 1. References: - Dahl-Jensen, D., Gundestrup, N., Gogineni, S. P., and Miller, H.: Basal melt at NorthGRIP modeled from borehole, ice-core and radio-e sounder observations, Annals of Glaciology, 37, 207–212, 2003. - Gkinis, V., Simonsen, S. B., Buchardt, S. L., White, J., and Vinther, B. M.: Water isotope diffusion rates from the NorthGRIP ice core for last 16,000 years–Glaciological and paleoclimatic implications, Earth and Planetary Science Letters, 405, 132–141, 2014.
Step 11:	
Description:	Dye3 accumulation records: To develop the thinning function, we first compute the vertical velocity profile based on the horizontal strain measured with borehole tilt observations (Gundestrup and Hansen, 1984). These produced an accumulation history with an accumulation rate at the onset of the Holocene (11.7 ka) that is less than half of the modern accumulation rate. We consider this to be a low estimate, as the current velocity p is strongly influenced by the location of the transition between the glacial and Holocene ice. We create a moderate scenario by approxim matching the accumulation rate around 7 ka with the past 1 ka accumulation rate; this uses a kink height of 0.2 which is typical for flank s We create a high scenario where we set the accumulation history at 11 ka approximately equal to the past 1 ka. The resulting accumulat histories vary significantly more than those for the interior cores because of the much greater uncertainty in the flow model.

References:
- Gundestrup, N. and Hansen, B. L.: Bore-hole survey at Dye 3, south Greenland, Journal of Glaciology, 30, 282–288, 1984.

Data Set Usage Rights

Additional Metadata

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