PPgp Group Meeting

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December 7, 2017

1 Summary Since Last Meeting

- Summer: Intern @amazon.
- TFR projection paper writing.
- CO2 emission paper maintainance.
- New project for climate change.

2 Work done

2.1 Summer Internship

During the summer internship, I have learned a few tools that might be useful for our group.

- RShiny. We can use RShiny to build an interactive App with R to show interactive plots, tables, etc.
- 'plotly'. I was using this as a complimentary of ggplot2.

2.2 TFR projection paper writing

I have finished the first draft of TFR projection paper except for the bibtex part. Next step we will start editing it.

2.3 New project for climate change

The CO2 emission projection and temperature change project was published on Nature Climate Change and got a huge response. In that paper, the final step (from CO2 emissions to temperature change) are not considered and modeled very carefully. Thus, we want to improve the way we take account of the uncertainty about the climate model structure.

Currently, we are at the stage of collecting and cleaning data. For historical temperature changes, global warming observations are collected in HadCRUT4. Moreover, there are another resource from CMIP5, which collects global-mean surface temperature calculated for a bunch of different models and scenarios (based on some differential equations). We should clean these data and start getting some insight from it.

2.3.1 Basic introduction of the dataset

- HadCRUT4: It includes observations from 1850 to 2016 of the temperature difference to a certain level. To use that: we match the difference with the temperature observations in year 2005 (14.7 Celsius).
- For CMIP5 data: each data set is named like global_ tas_Amon_ACCESS1-0_ rcp45_r1i1p1.dat, where Global = global mean, Tas = surface air temperature, Amon = Atmospheric field, monthly average, ACCESS1-0 = the name of a particular model, rcp45 = the RCP4.5 emission scenario (It looks like these files include the response to historical forcing over years 1850-2005), and r1i1p1 = one particular simulation of this model.

  For a particular model, historical fits are the same for same particular simulation even if the emission scenarios are different.

2.3.2 Historical temperature from models

I have calculated the average annual temperatures for each model/scenario/trajectory. Here are some findings.

- HistoricalNat is different from real records. Maybe it is based on simulated results with no greenhouse gas emissions.
- For historical observations with same **model and trajectory**, the model fits are the same.
- For historical observations with same **model** but different trajectory, the model fits are **not** the same.
- Thus I guess the CMIP models are one kind of simulated fits.

All models and HadCRUT4 records of historical temperatures are as follows:
Compared to plots I presented in the last week, I have made the following changes this time.

- All models are included.
- For each model, there can be multiple trajectories in the data set. In this plot, I only pick one for each model.
- Rules in selection are as follows:
  - For model with only one trajectory (possibly with multiple scenarios), pick a single line randomly.
  - For model with multiple trajectories, take the **Average** of all trajectories with same scenario, and then choose an arbitrary scenario.

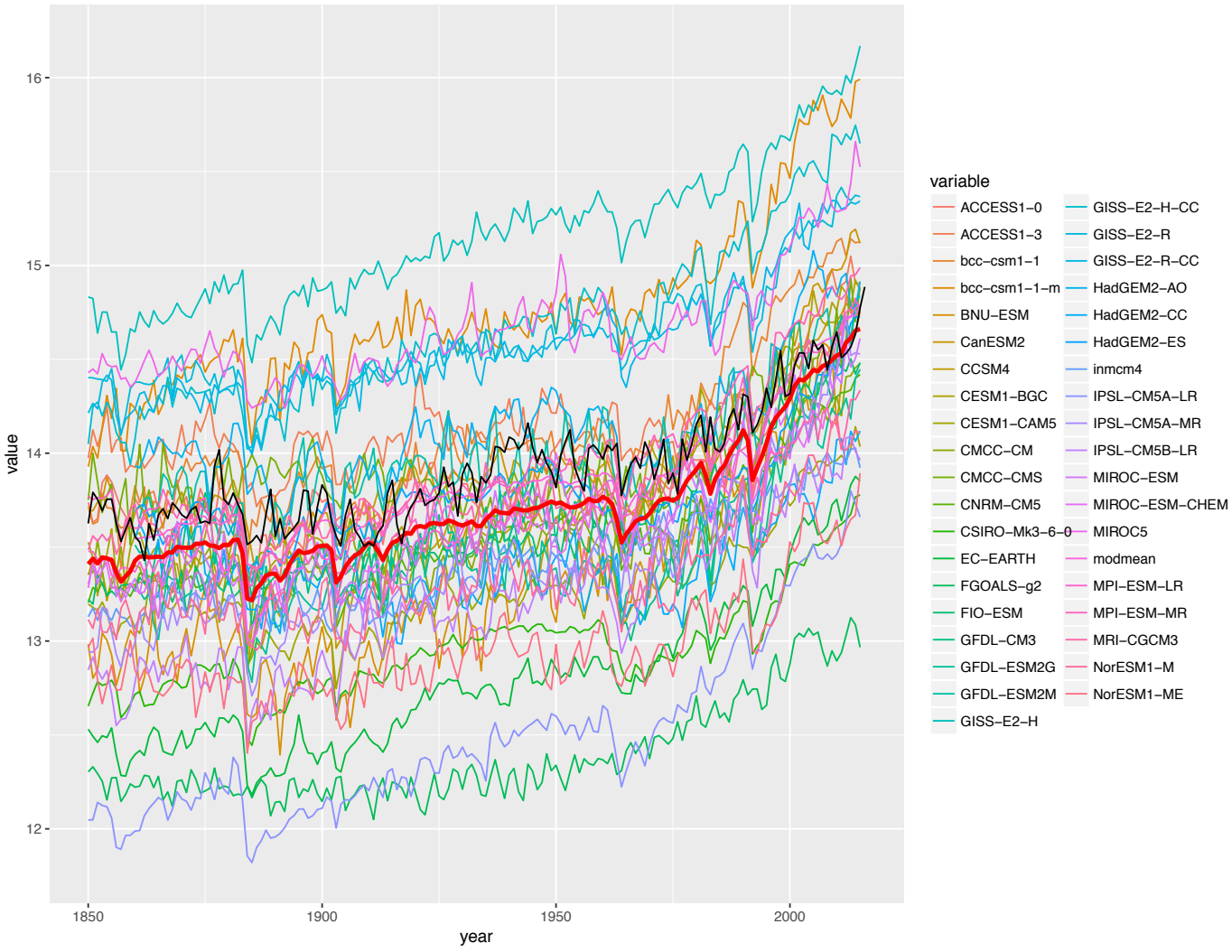
2.3.3 Model details

We treat the HadCRUT4 observations as actual observations, and have calculated the mean absolute error, mean squared error and auto-correlation functions. The MAE and MSE can be summarized as follows (Where year 1850 means the calculation was based on data from 1850 to 2005, similar for year 1880 and 1910):

The auto-correlation functions will be an 3-D array. We just get the auto-correction function with lag 1 as follows:

3 Plan

- We will finish writing soon and make more efforts on editing.
- Talk with our collaborator about modeling.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BNU−ESM
CanESM2
CCSM4
CESM1−BGC
CESM1−CAM5
CMCC−CM
CMCC−CMS
CNRM−CM5
CSIRO−Mk3−6−0
EC−EARTH
FGOALS−g2
FIO−ESM
GFDL−CM3
GFDL−ESM2G
GFDL−ESM2M
GISS−E2−H
GISS−E2−H−CC
GISS−E2−R
GISS−E2−R−CC
HadGEM2−AO
HadGEM2−CC
HadGEM2−ES
inmcm4
IPSL−CM5A−LR
IPSL−CM5A−MR
IPSL−CM5B−LR
MIROC−ESM
MIROC−ESM−CHEM
MIROC5
modmean
MPI−ESM−LR
MPI−ESM−MR
MRI−CGCM3
NorESM1−M
NorESM1−ME

Table 1: MAE

	year1850	year1880	year1910
ACCESS1-0	0.15	0.16	0.16
ACCESS1-3	0.25	0.22	0.20
bcc-csm1-1	0.18	0.19	0.20
bcc-csm1-1-m	0.82	0.87	0.89
BNU-ESM	0.65	0.63	0.57
CanESM2	0.11	0.12	0.13
CCSM4	0.28	0.27	0.23
CESM1-BGC	0.22	0.22	0.21
CESM1-CAM5	0.63	0.66	0.67
CMCC-CM	0.33	0.34	0.38
CMCC-CMS	0.18	0.19	0.18
CNRM-CM5	0.37	0.37	0.36
CSIRO-Mk3-6-0	0.96	0.96	0.97
EC-EARTH	1.13	1.11	1.08
FGOALS-g2	1.52	1.54	1.56
FIO-ESM	0.32	0.31	0.31
GFDL-CM3	0.37	0.40	0.43
GFDL-ESM2G	0.46	0.47	0.48
GFDL-ESM2M	0.16	0.15	0.15
GISS-E2-H	1.22	1.26	1.30
GISS-E2-H-CC	0.73	0.77	0.82
GISS-E2-R	0.68	0.67	0.67
GISS-E2-R-CC	0.65	0.66	0.66
HadGEM2-AO	0.22	0.21	0.20
HadGEM2-CC	0.52	0.56	0.63
HadGEM2-ES	0.18	0.19	0.21
inmcm4	0.49	0.49	0.50
IPSL-CM5A-LR	1.45	1.43	1.38
IPSL-CM5A-MR	0.53	0.52	0.49
IPSL-CM5B-LR	0.73	0.70	0.66
MIROC-ESM	0.29	0.28	0.26
MIROC-ESM-CHEM	0.34	0.33	0.32
MIROC5	0.74	0.73	0.72
modmean	0.11	0.11	0.11
MPI-ESM-LR	0.23	0.23	0.20
MPI-ESM-MR	0.11	0.12	0.12
MRI-CGCM3	0.17	0.18	0.19
NorESM1-M	0.57	0.59	0.60
NorESM1-ME	0.96	0.98	0.99

Table 2: MSE

	year1850	year1880	year1910
ACCESS1-0	0.15	0.16	0.16
ACCESS1-3	0.25	0.22	0.20
bcc-csm1-1	0.18	0.19	0.20
bcc-csm1-1-m	0.82	0.87	0.89
BNU-ESM	0.65	0.63	0.57
CanESM2	0.11	0.12	0.13
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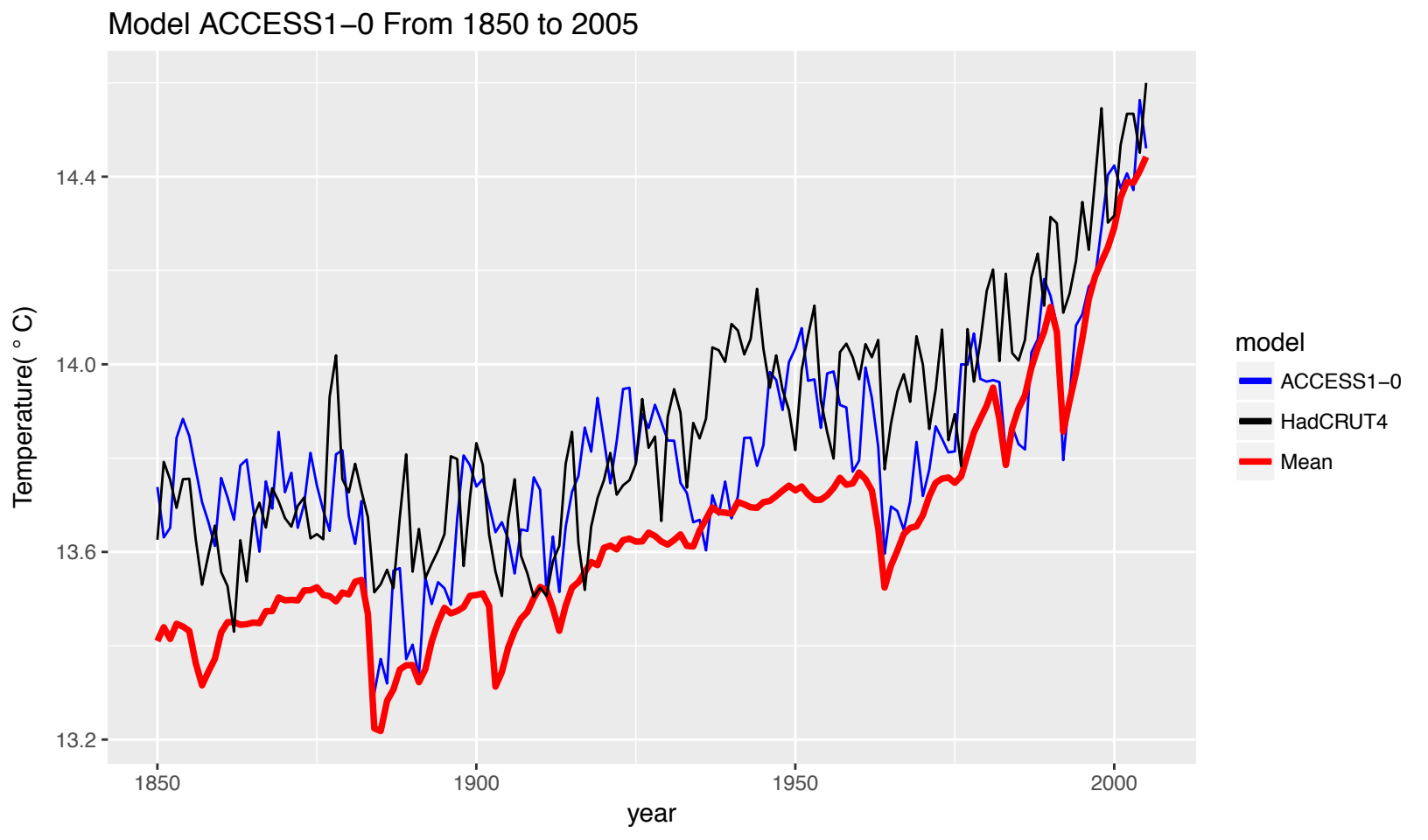
CESM1-BGC	0.22	0.22	0.21
CESM1-CAM5	0.63	0.66	0.67
CMCC-CM	0.33	0.34	0.38
CMCC-CMS	0.18	0.19	0.18
CNRM-CM5	0.37	0.37	0.36
CSIRO-Mk3-6-0	0.96	0.96	0.97
EC-EARTH	1.13	1.11	1.08
FGOALS-g2	1.52	1.54	1.56
FIO-ESM	0.32	0.31	0.31
GFDL-CM3	0.37	0.40	0.43
GFDL-ESM2G	0.46	0.47	0.48
GFDL-ESM2M	0.16	0.15	0.15
GISS-E2-H	1.22	1.26	1.30
GISS-E2-H-CC	0.73	0.77	0.82
GISS-E2-R	0.68	0.67	0.67
GISS-E2-R-CC	0.65	0.66	0.66
HadGEM2-AO	0.22	0.21	0.20
HadGEM2-CC	0.52	0.56	0.63
HadGEM2-ES	0.18	0.19	0.21
inmcm4	0.49	0.49	0.50
IPSL-CM5A-LR	1.45	1.43	1.38
IPSL-CM5A-MR	0.53	0.52	0.49
IPSL-CM5B-LR	0.73	0.70	0.66
MIROC-ESM	0.29	0.28	0.26
MIROC-ESM-CHEM	0.34	0.33	0.32
MIROC5	0.74	0.73	0.72
modmean	0.11	0.11	0.11
MPI-ESM-LR	0.23	0.23	0.20
MPI-ESM-MR	0.11	0.12	0.12
MRI-CGCM3	0.17	0.18	0.19
NorESM1-M	0.57	0.59	0.60
NorESM1-ME	0.96	0.98	0.99

Table 3: Auto-correlation

	year1850	year1880	year1910
ACCESS1-0	0.56	0.29	0.17
ACCESS1-3	0.66	0.43	0.35
bcc-csm1-1	0.54	0.44	0.37
bcc-csm1-1-m	0.68	0.36	0.27
BNU-ESM	0.62	0.51	0.40
CanESM2	0.55	0.31	0.18
CCSM4	0.70	0.52	0.41
CESM1-BGC	0.59	0.28	0.37
CESM1-CAM5	0.52	0.18	0.17
CMCC-CM	0.56	0.36	0.01
CMCC-CMS	0.66	0.51	0.35
CNRM-CM5	0.35	0.04	0.01
CSIRO-Mk3-6-0	0.62	0.53	0.43
EC-EARTH	0.65	0.43	0.27
FGOALS-g2	0.53	0.42	0.29
FIO-ESM	0.58	0.41	0.51
GFDL-CM3	0.67	0.39	0.29
GFDL-ESM2G	0.65	0.35	0.31
GFDL-ESM2M	0.48	0.37	-0.04
GISS-E2-H	0.61	0.27	-0.04
GISS-E2-H-CC	0.68	0.50	0.22
GISS-E2-R	0.53	0.21	0.02
GISS-E2-R-CC	0.49	0.19	0.09
HadGEM2-AO	0.65	0.23	0.14
HadGEM2-CC	0.72	0.51	0.30
HadGEM2-ES	0.73	0.55	0.47
inmcm4	0.35	0.14	0.27
IPSL-CM5A-LR	0.73	0.57	0.32
IPSL-CM5A-MR	0.50	0.21	0.19
IPSL-CM5B-LR	0.65	0.35	0.11
MIROC-ESM	0.43	0.08	-0.13
MIROC-ESM-CHEM	0.38	0.06	0.10
MIROC5	0.53	0.20	0.08
modmean	0.44	0.21	0.14
MPI-ESM-LR	0.67	0.49	0.48
MPI-ESM-MR	0.63	0.45	0.33
MRI-CGCM3	0.58	0.33	0.38
NorESM1-M	0.44	0.16	0.16
NorESM1-ME	0.53	0.33	0.02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13.2
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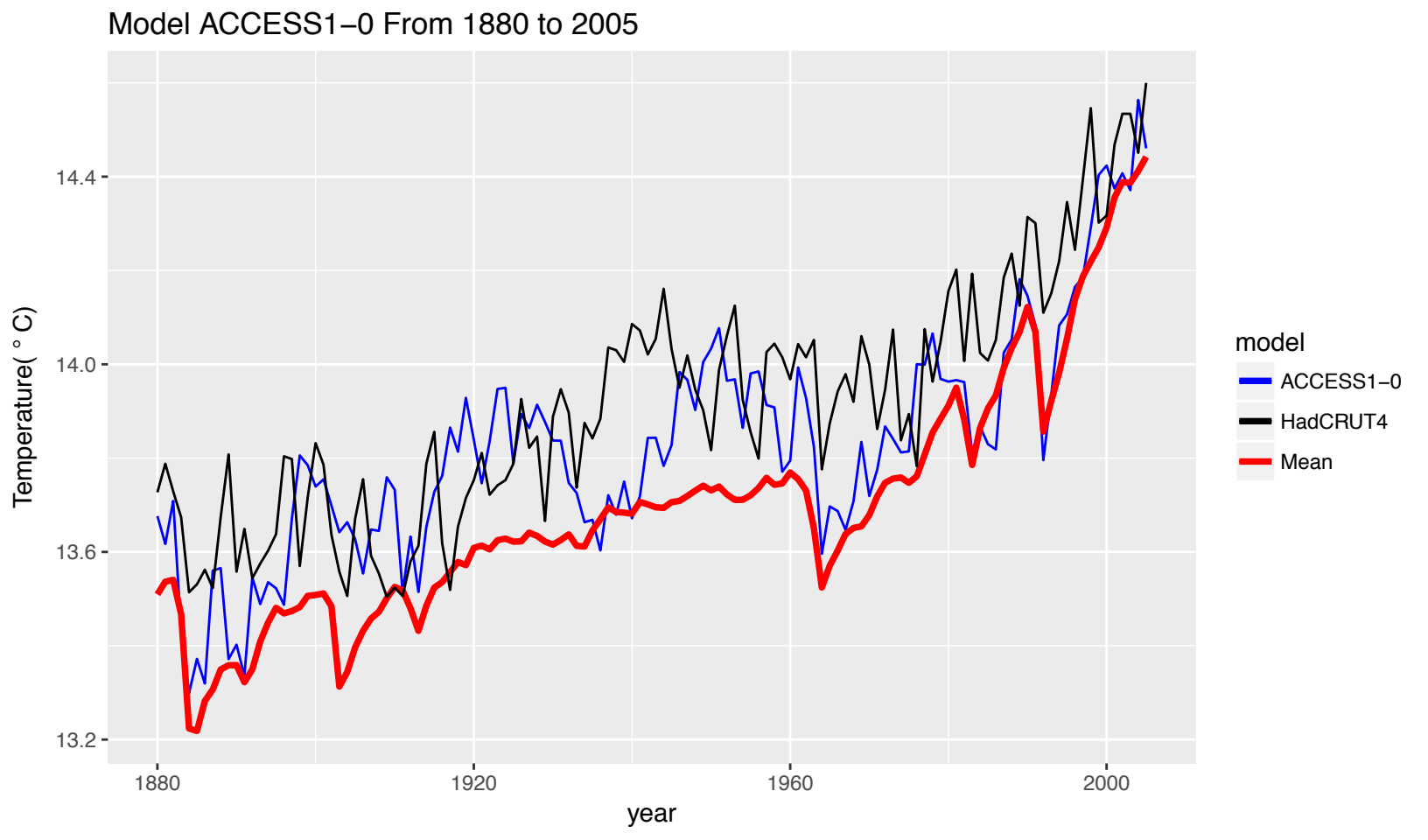
ACCESS1−0
HadCRUT4
Mean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Temperature(° C)
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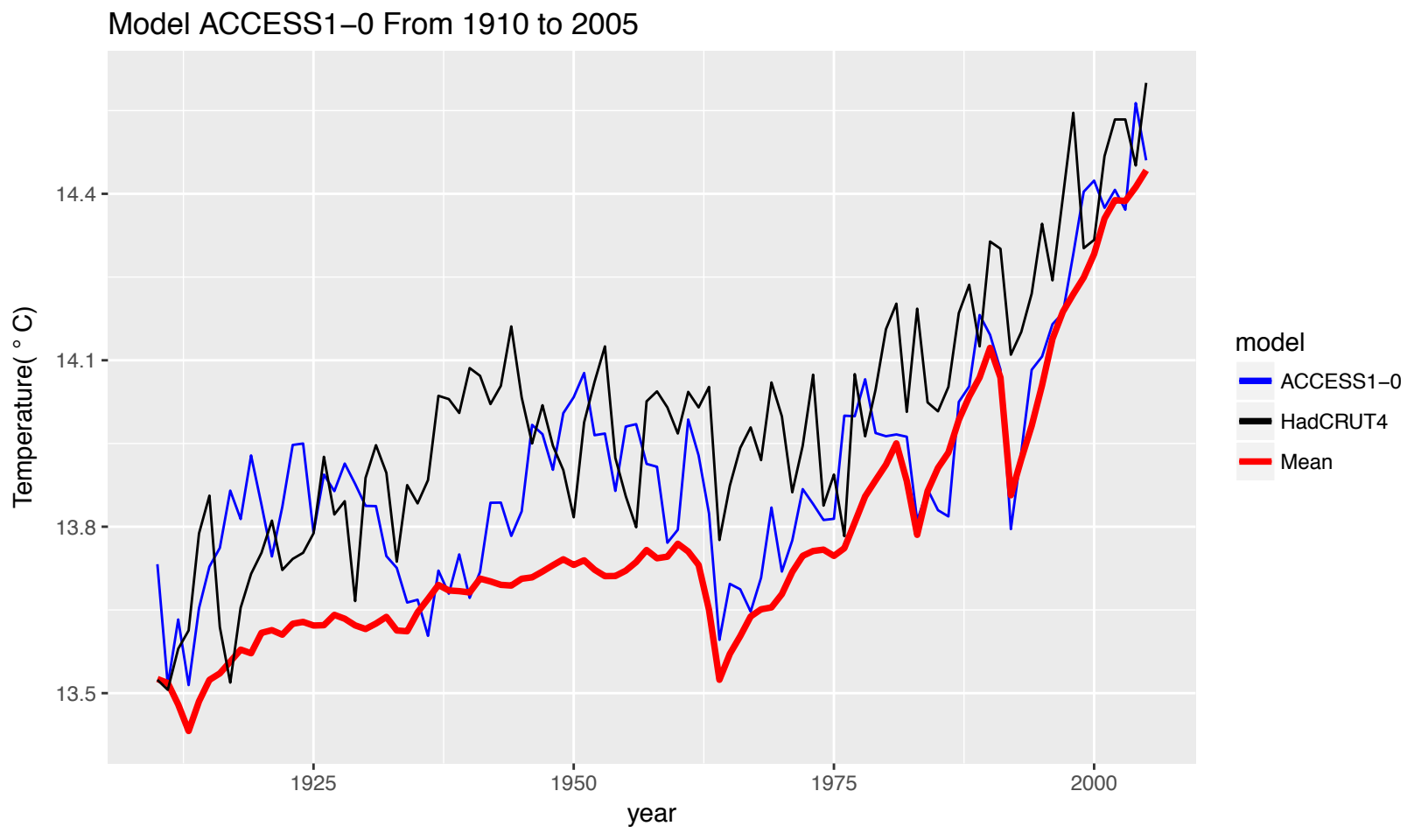
Mean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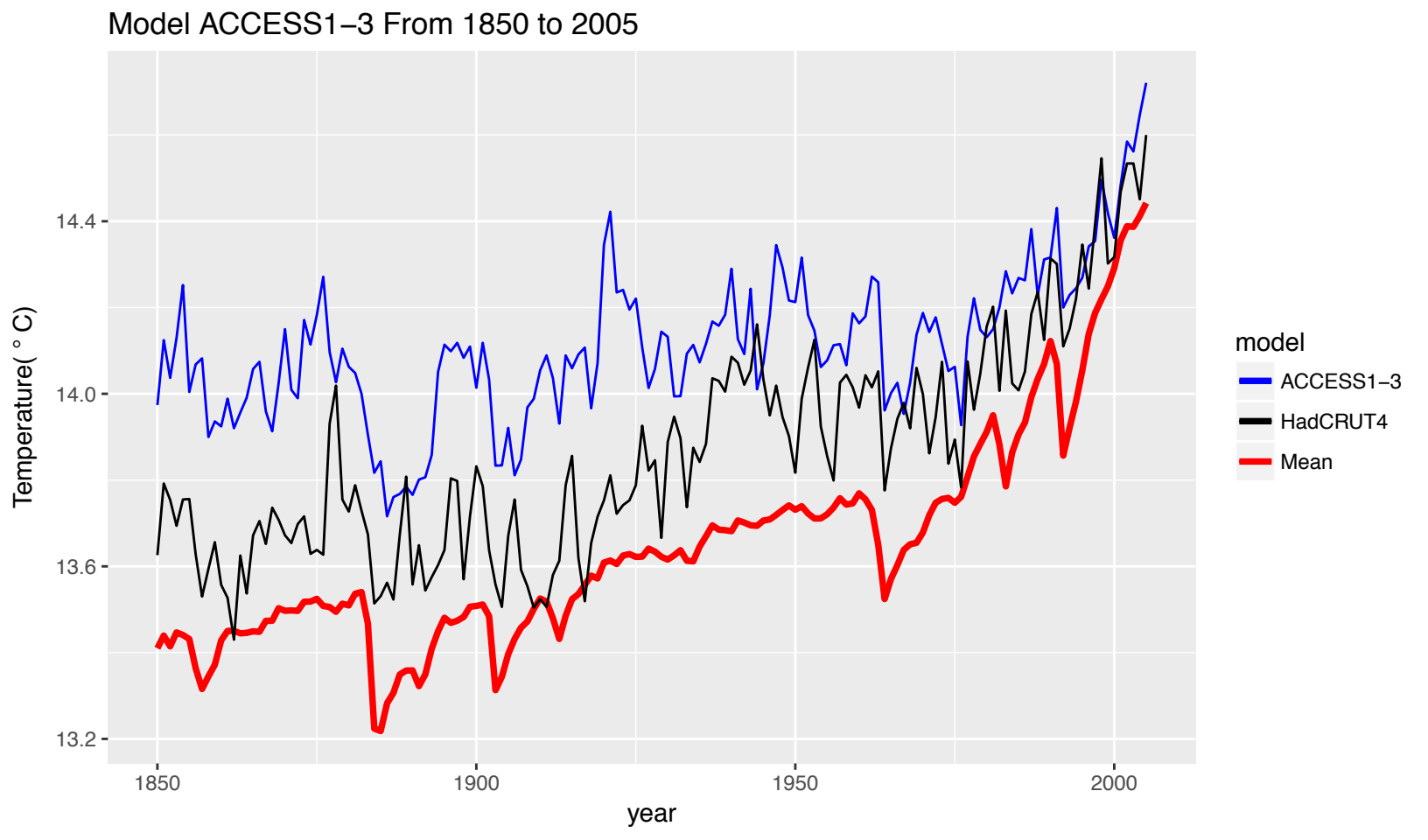
year
model
ACCESS1−0
HadCRUT4
Mean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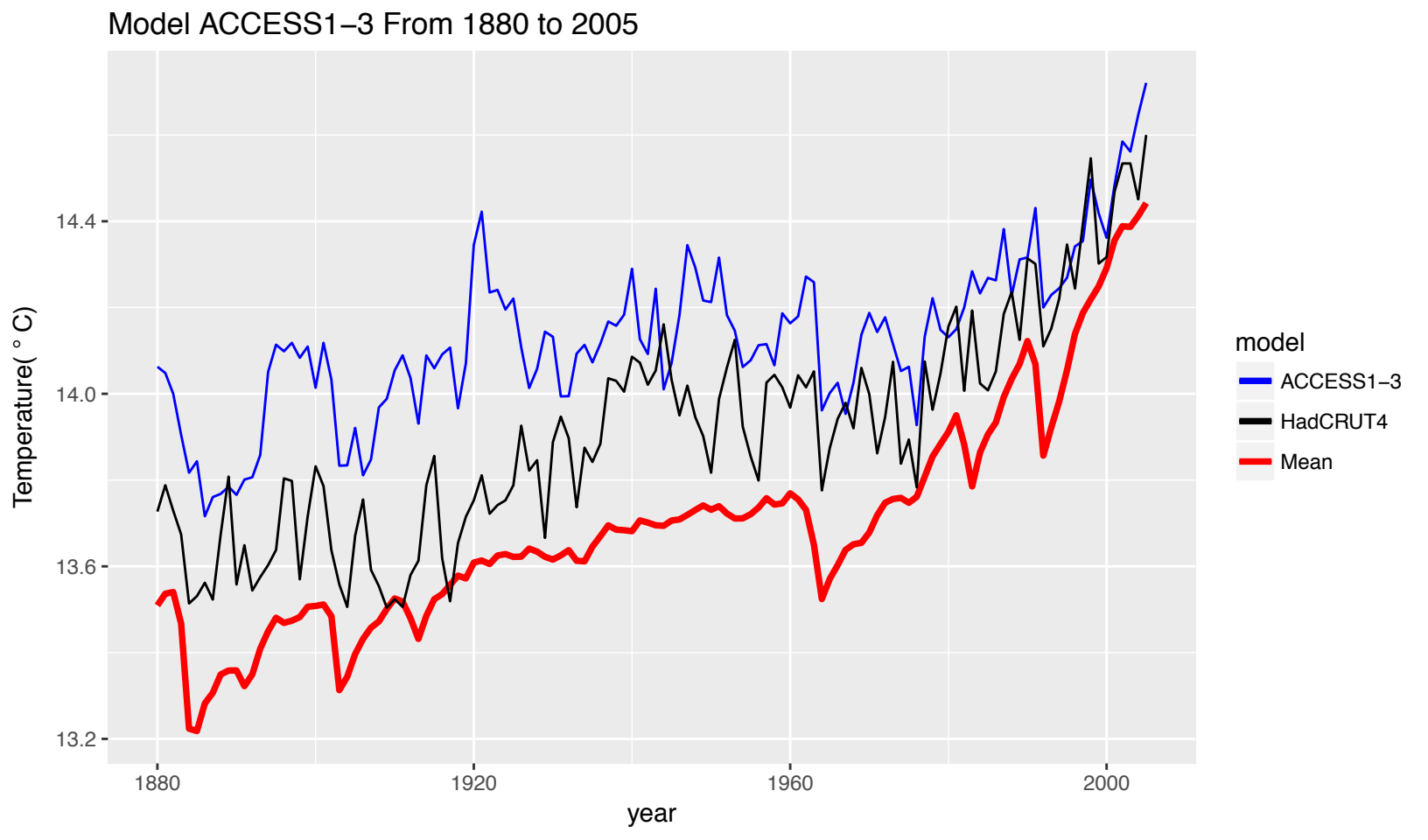
1950
2000
year
model
ACCESS1−3
HadCRUT4
Mean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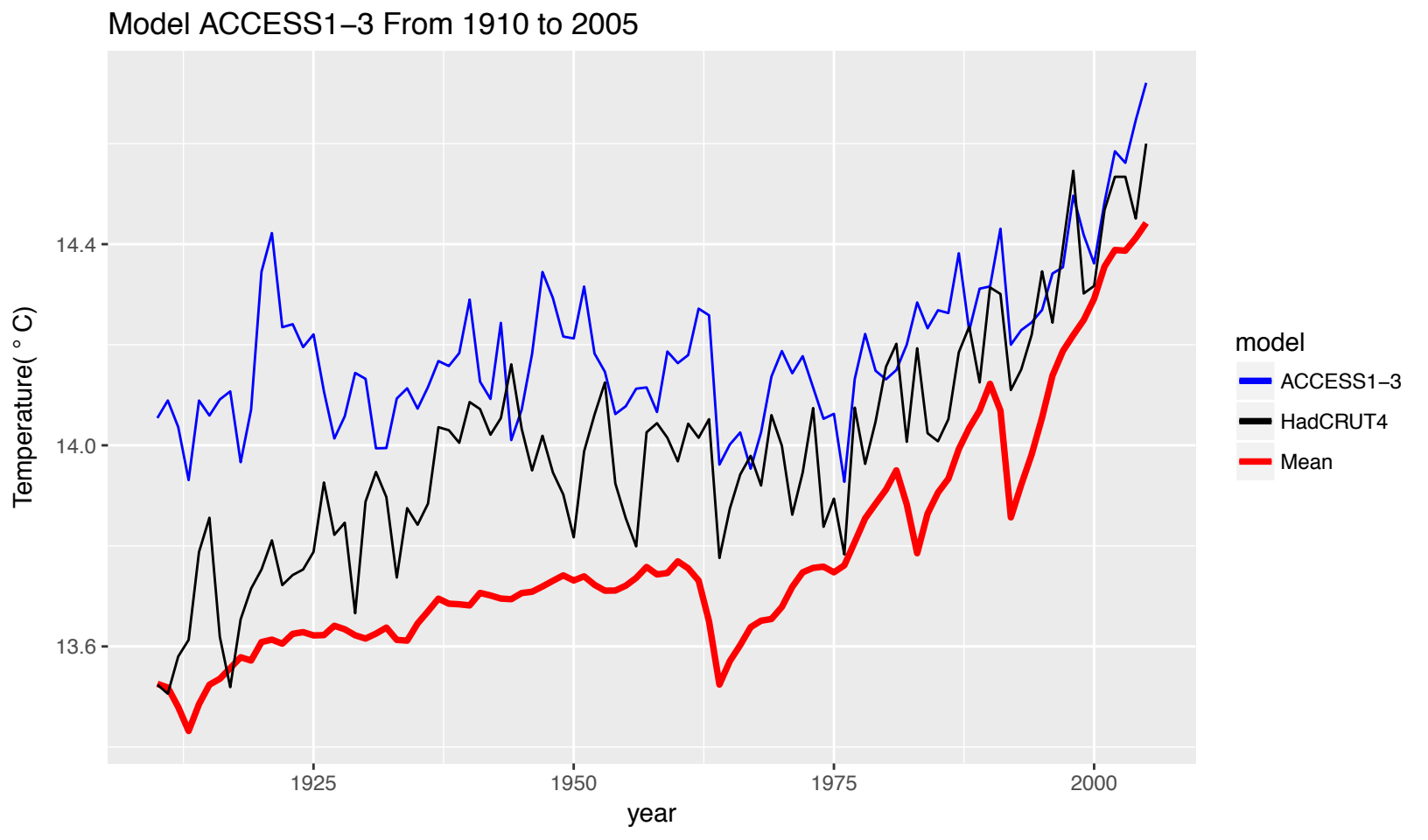
HadCRUT4
Mean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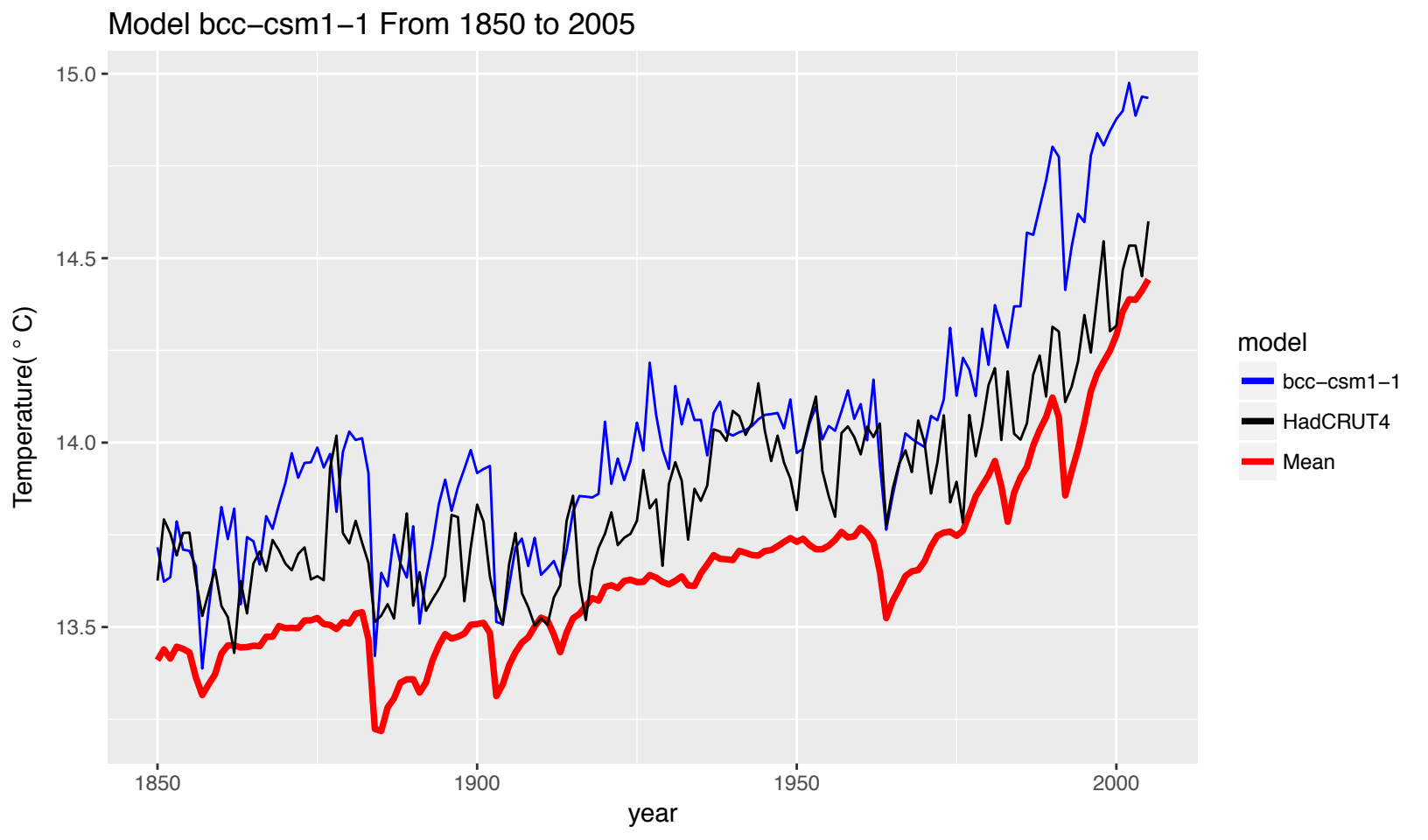
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Temperature(° C)
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1950
2000
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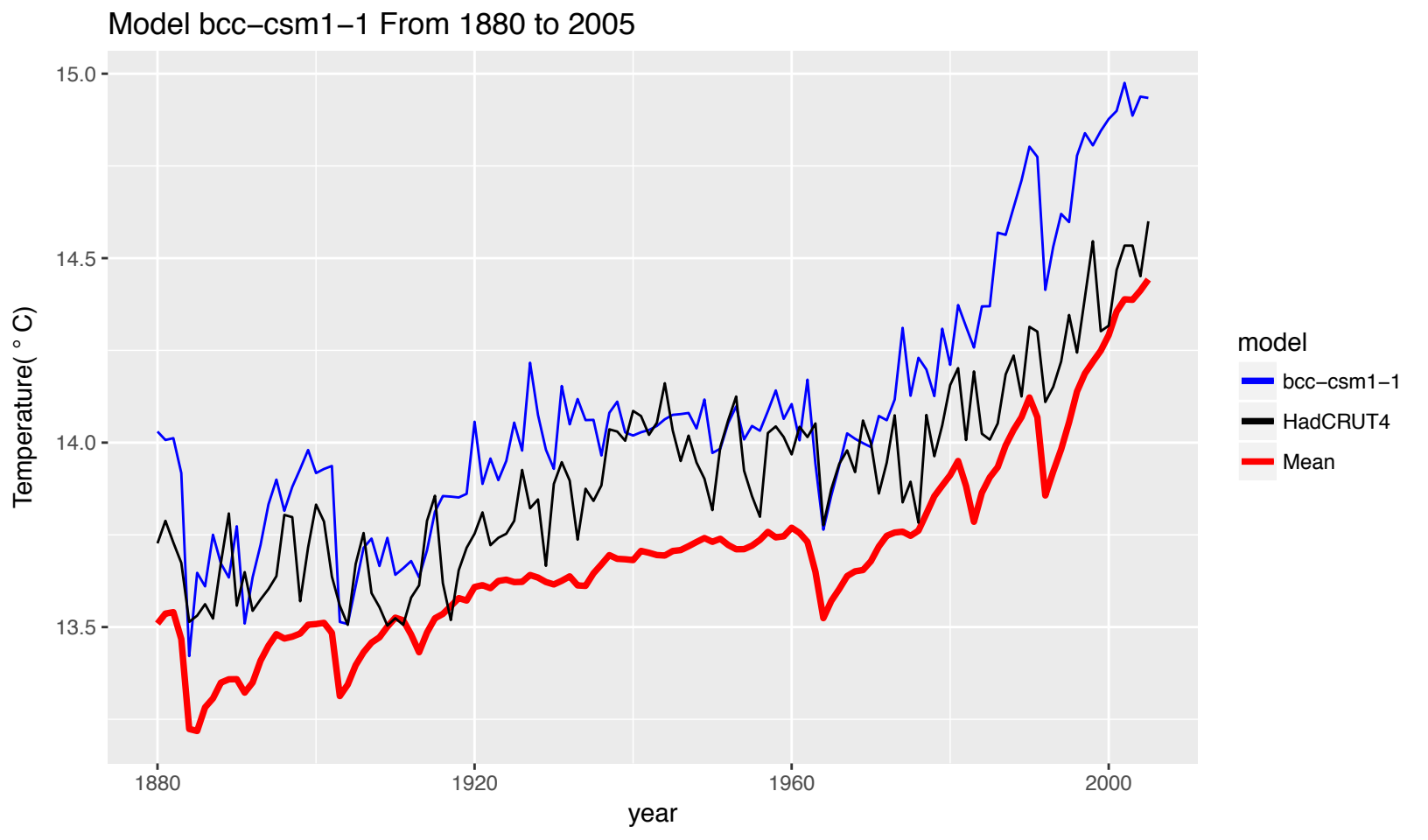
bcc−csm1−1
HadCRUT4
Mean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14.5
14.0
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Temperature(° C)
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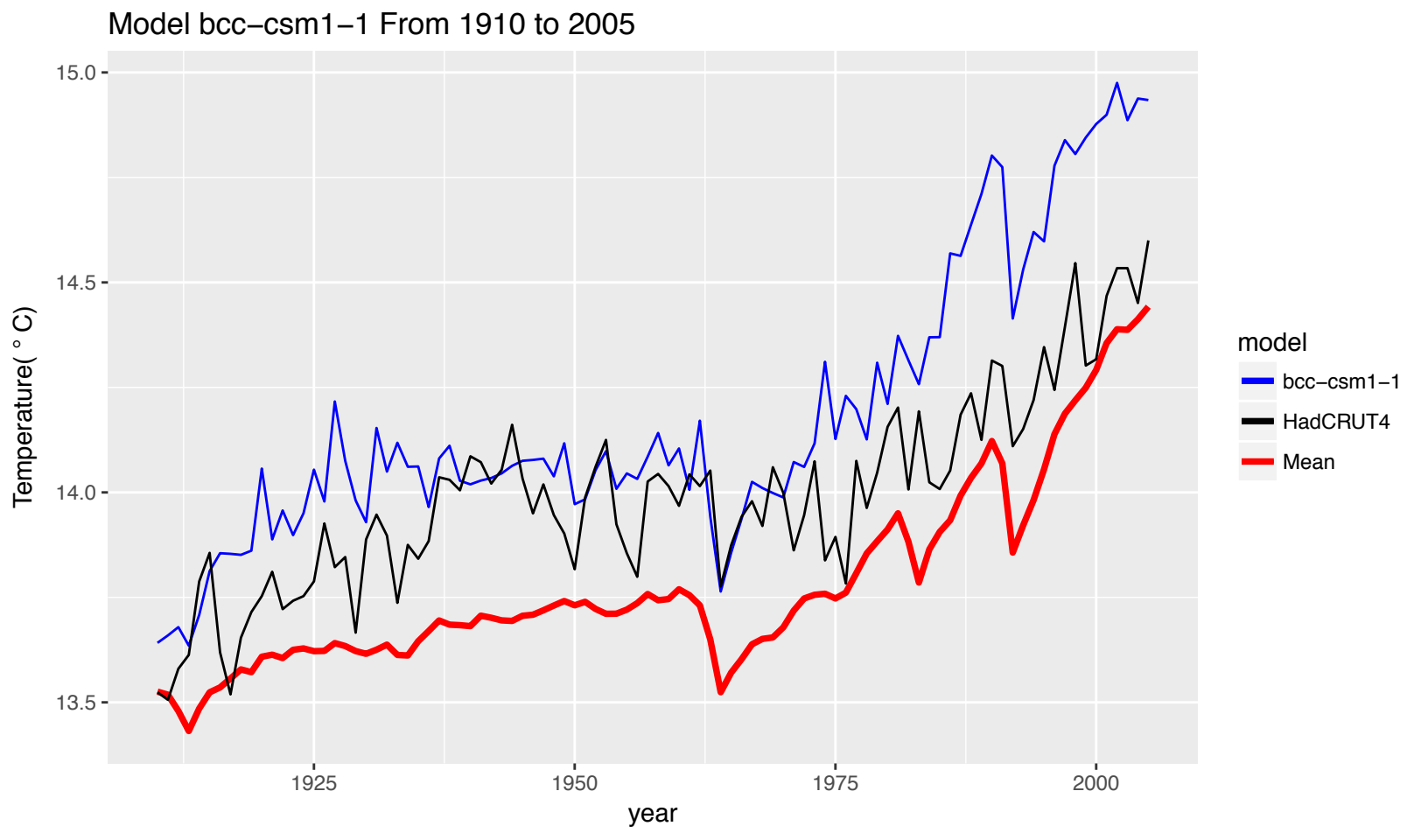
1920
1960
2000
year
model
bcc−csm1−1
HadCRUT4
Mean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14.0
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Temperature(° C)
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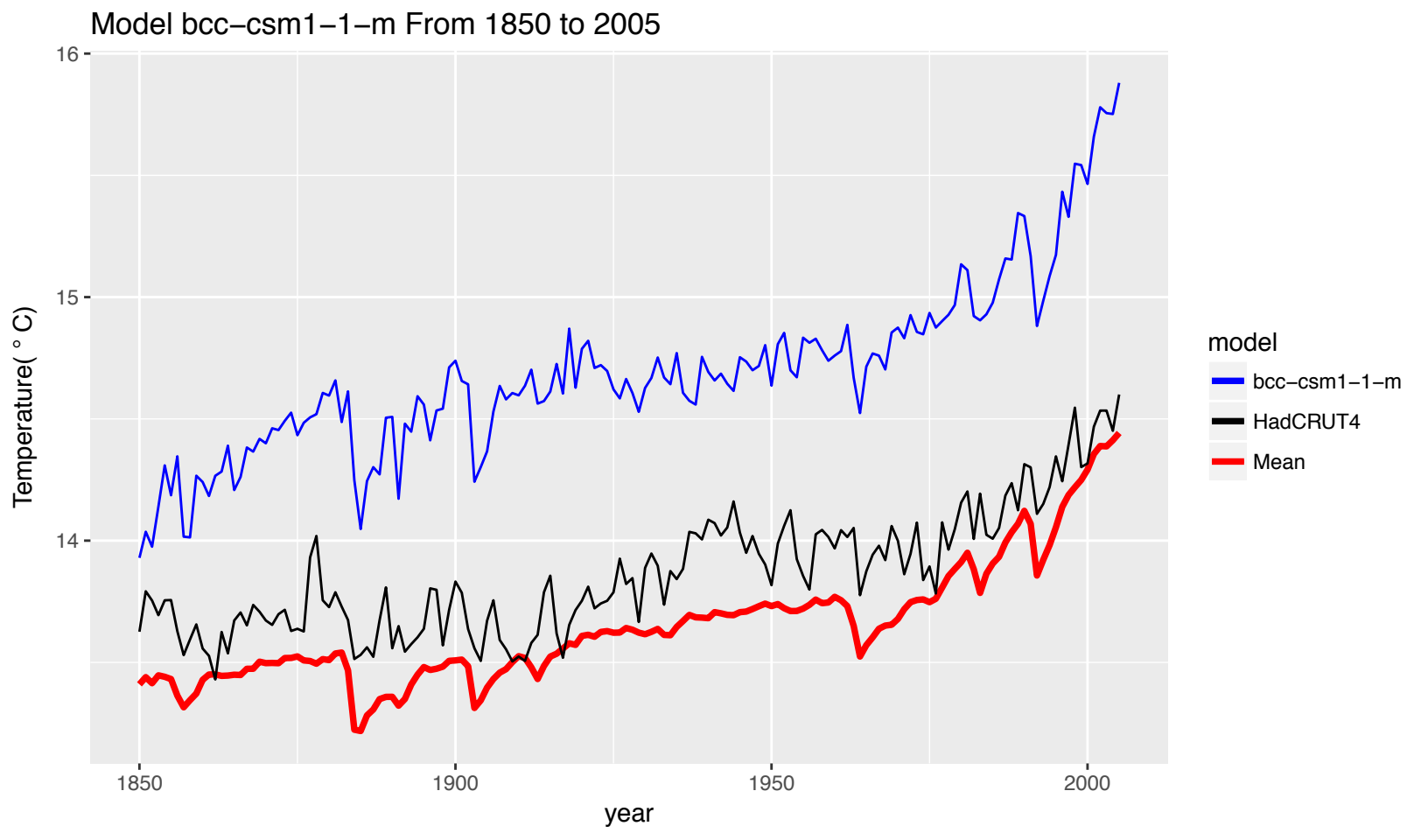
year
model
bcc−csm1−1
HadCRUT4
Mean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Temperature(° C)
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1900
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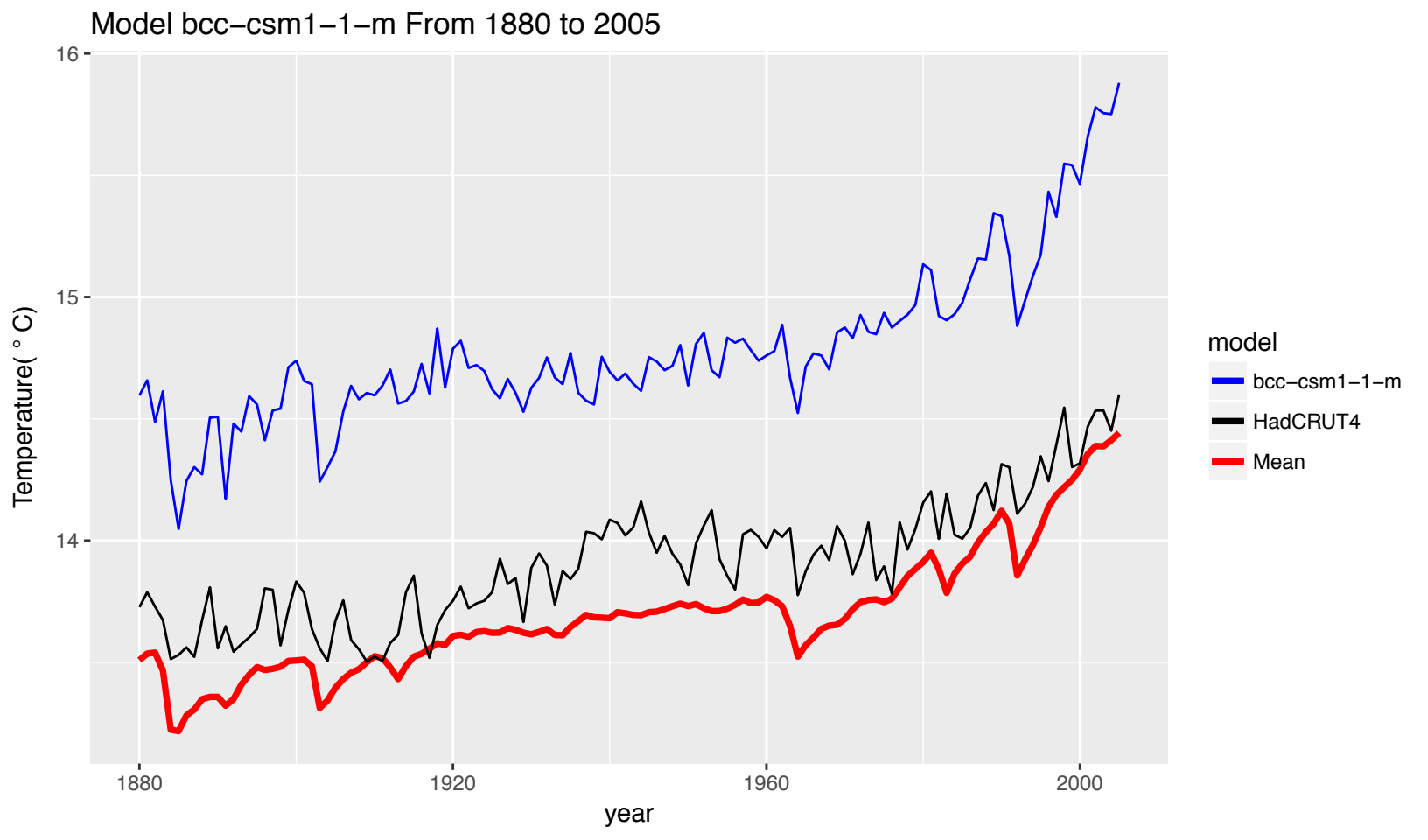
year
model
bcc−csm1−1−m
HadCRUT4
Mean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Temperature(° C)
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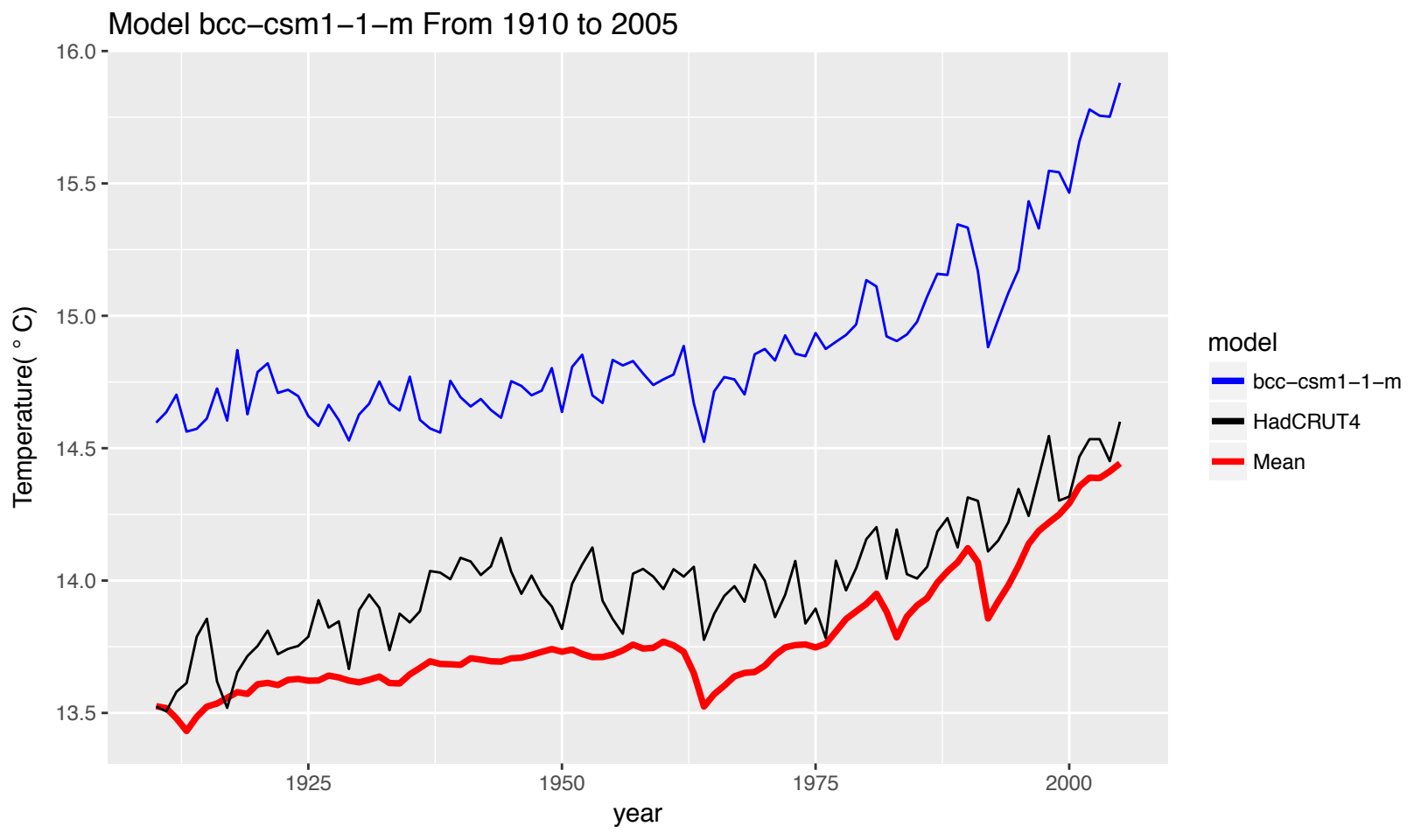
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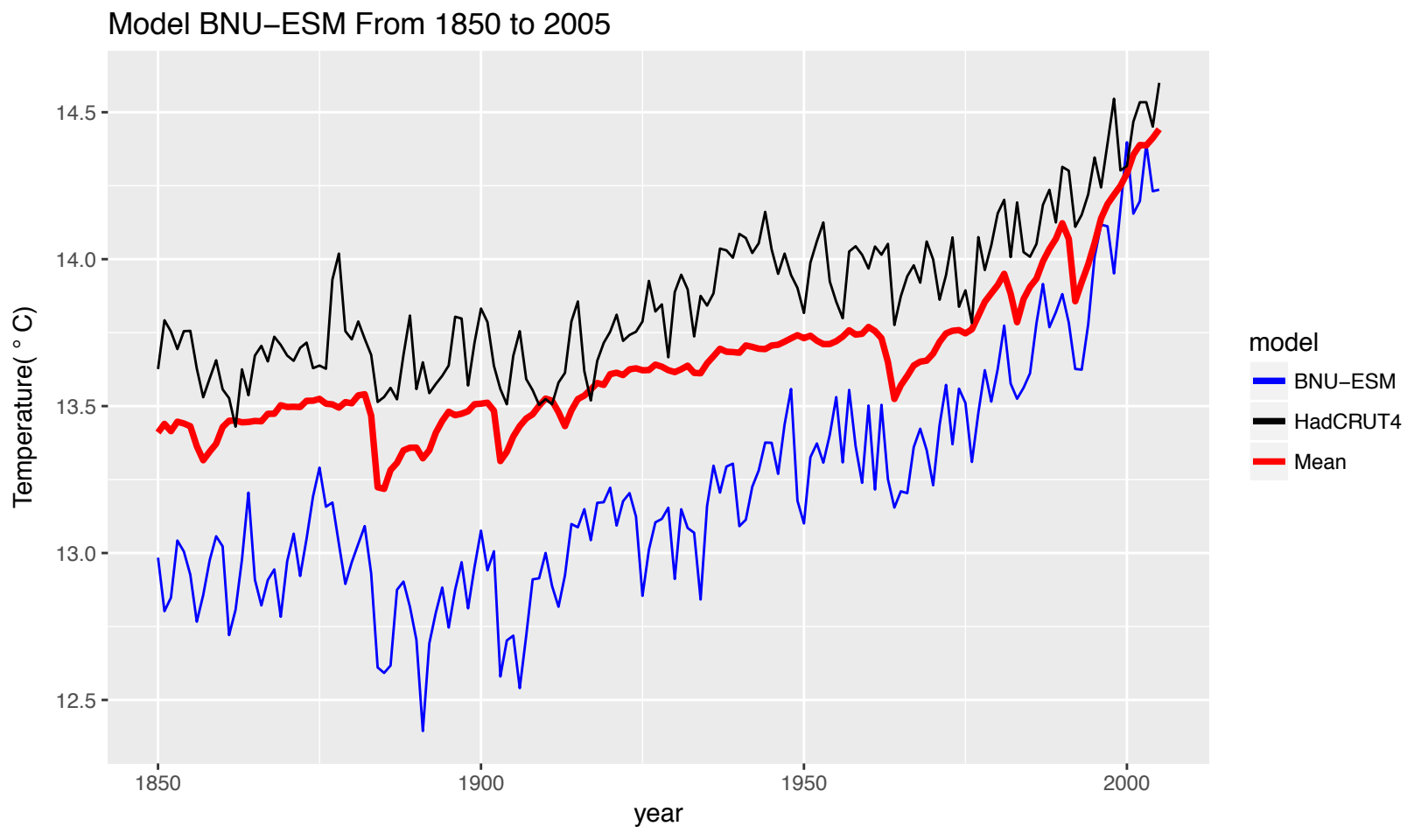
HadCRUT4
Mean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year
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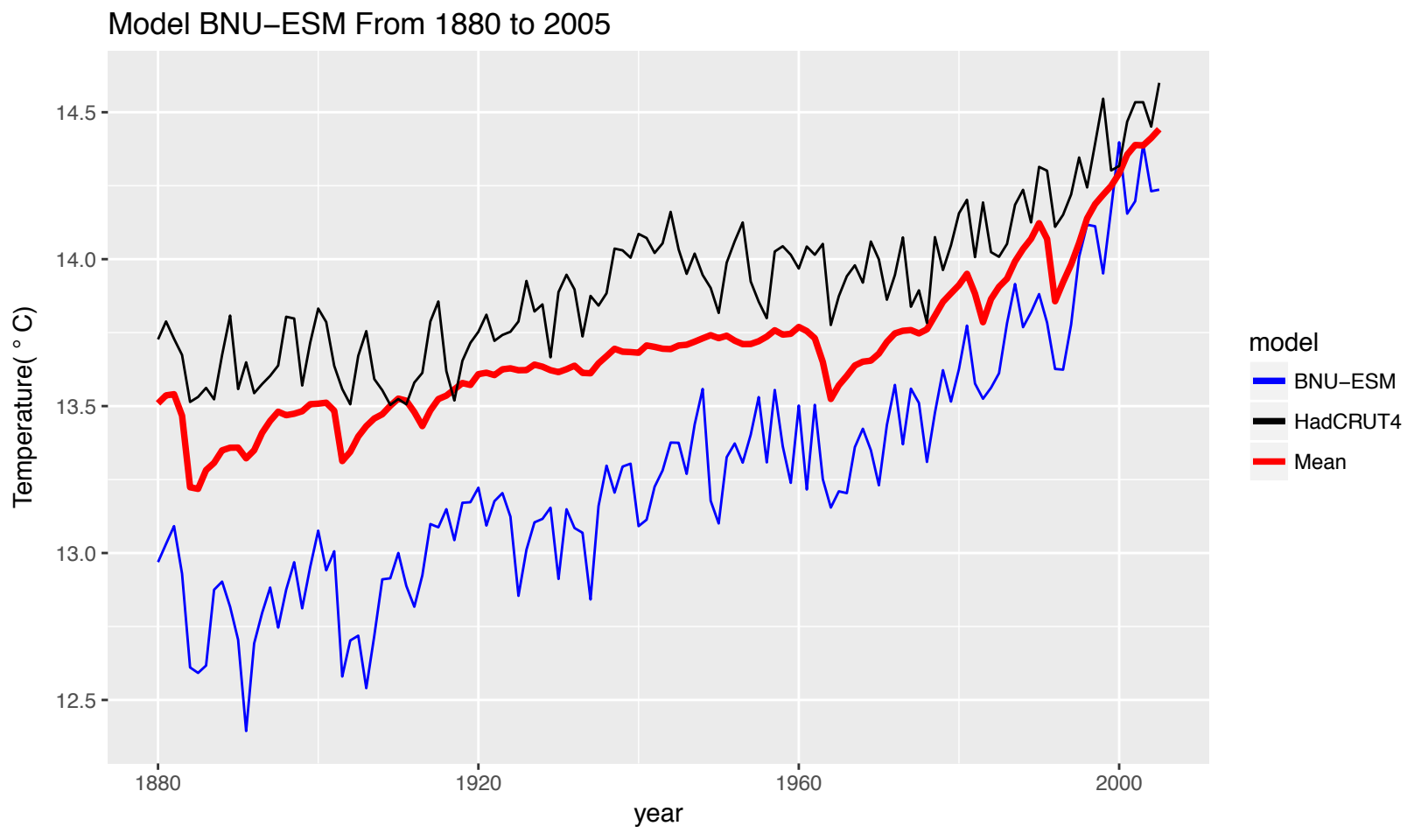
BNU−ESM
HadCRUT4
Mean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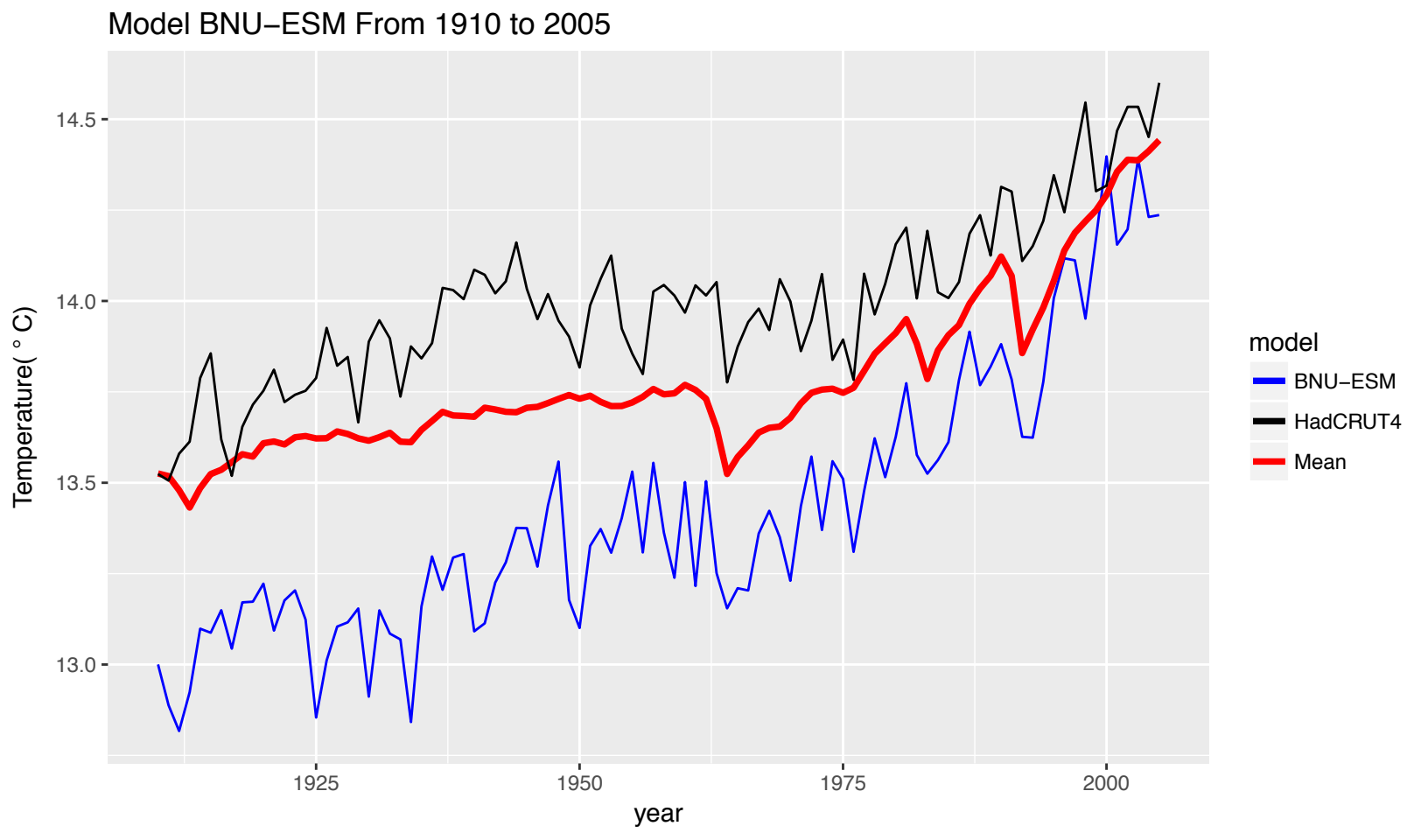
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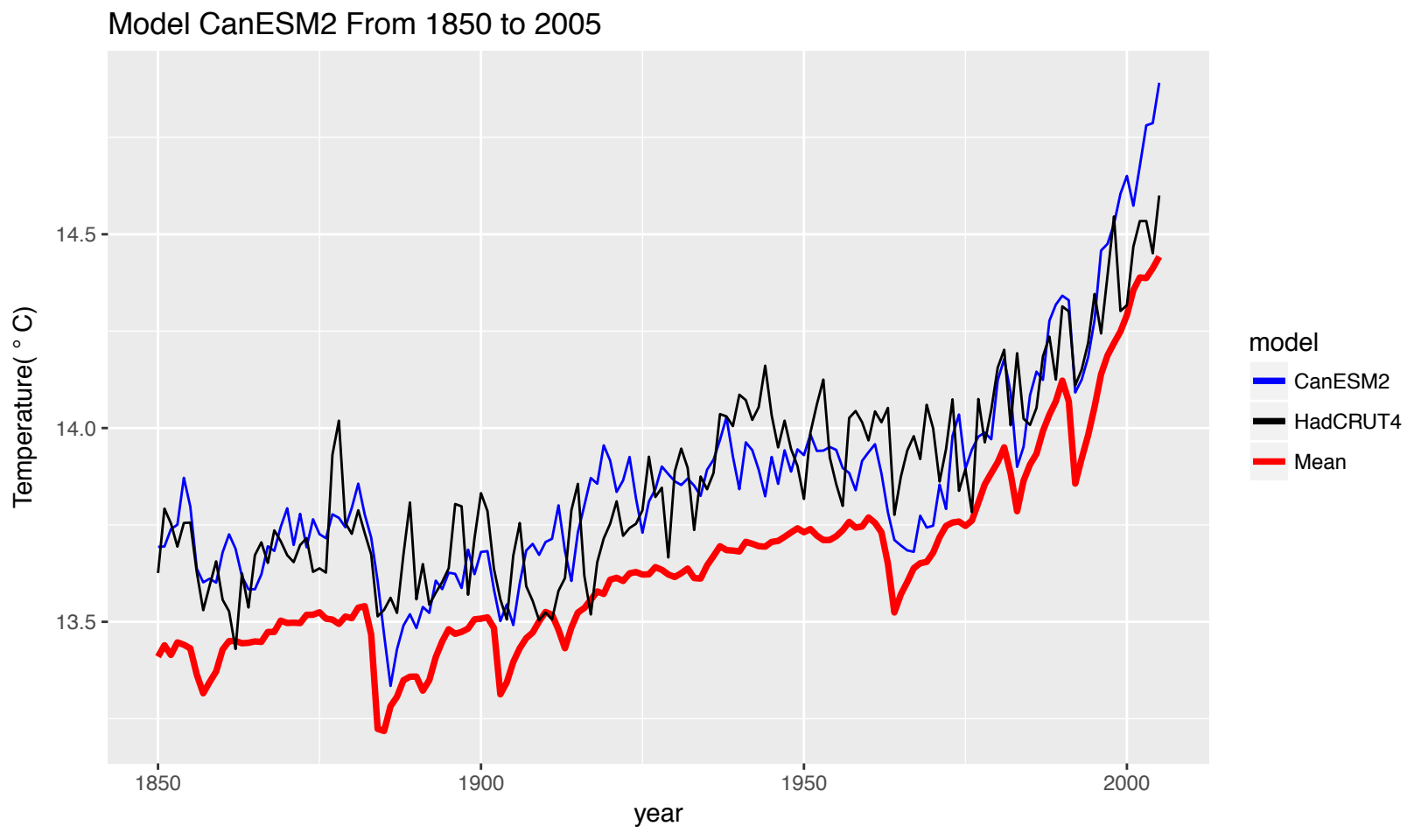
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Temperature(° C)
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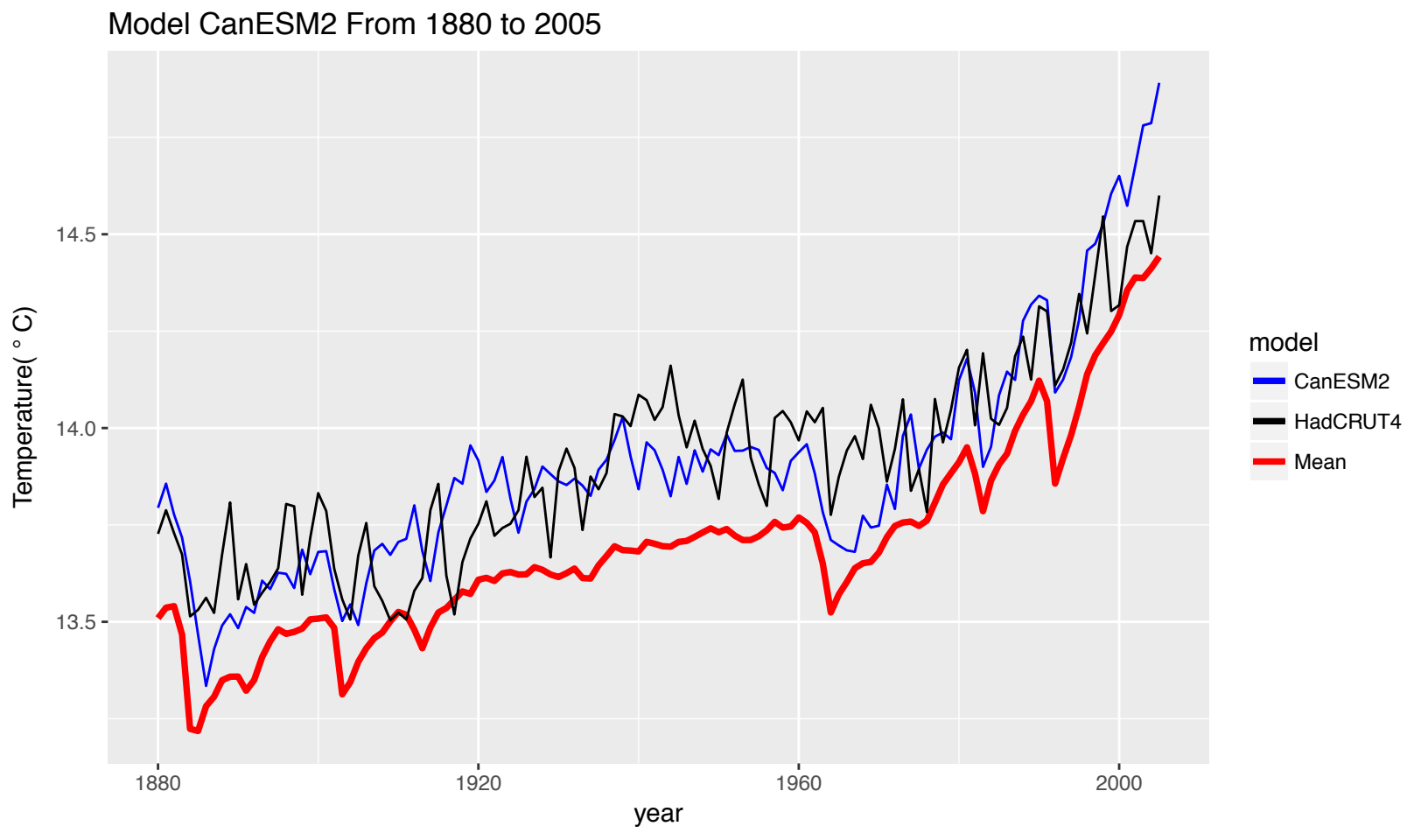
14.0
13.5
1850
1900
1950
2000
year
model
CanESM2
HadCRUT4
Mean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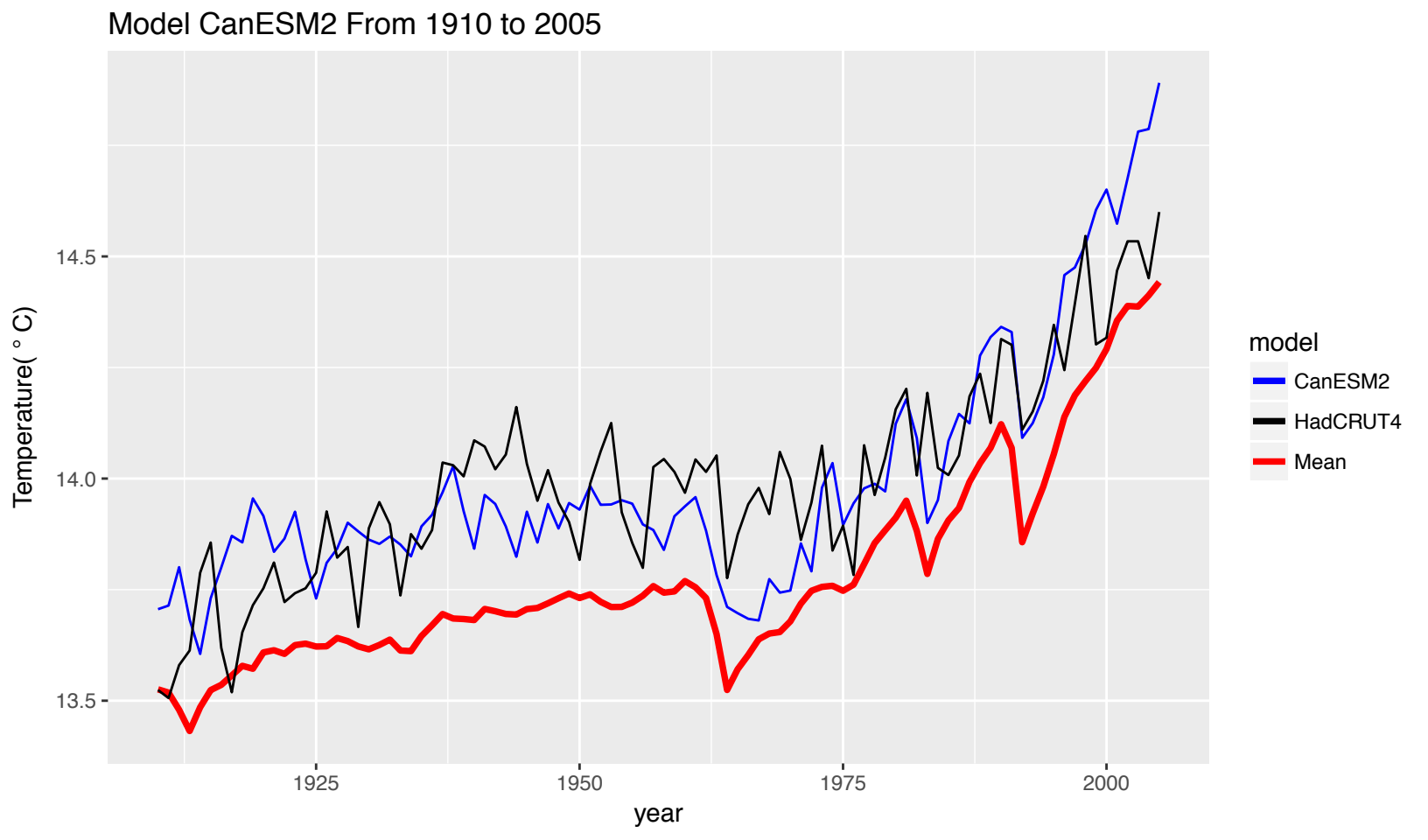
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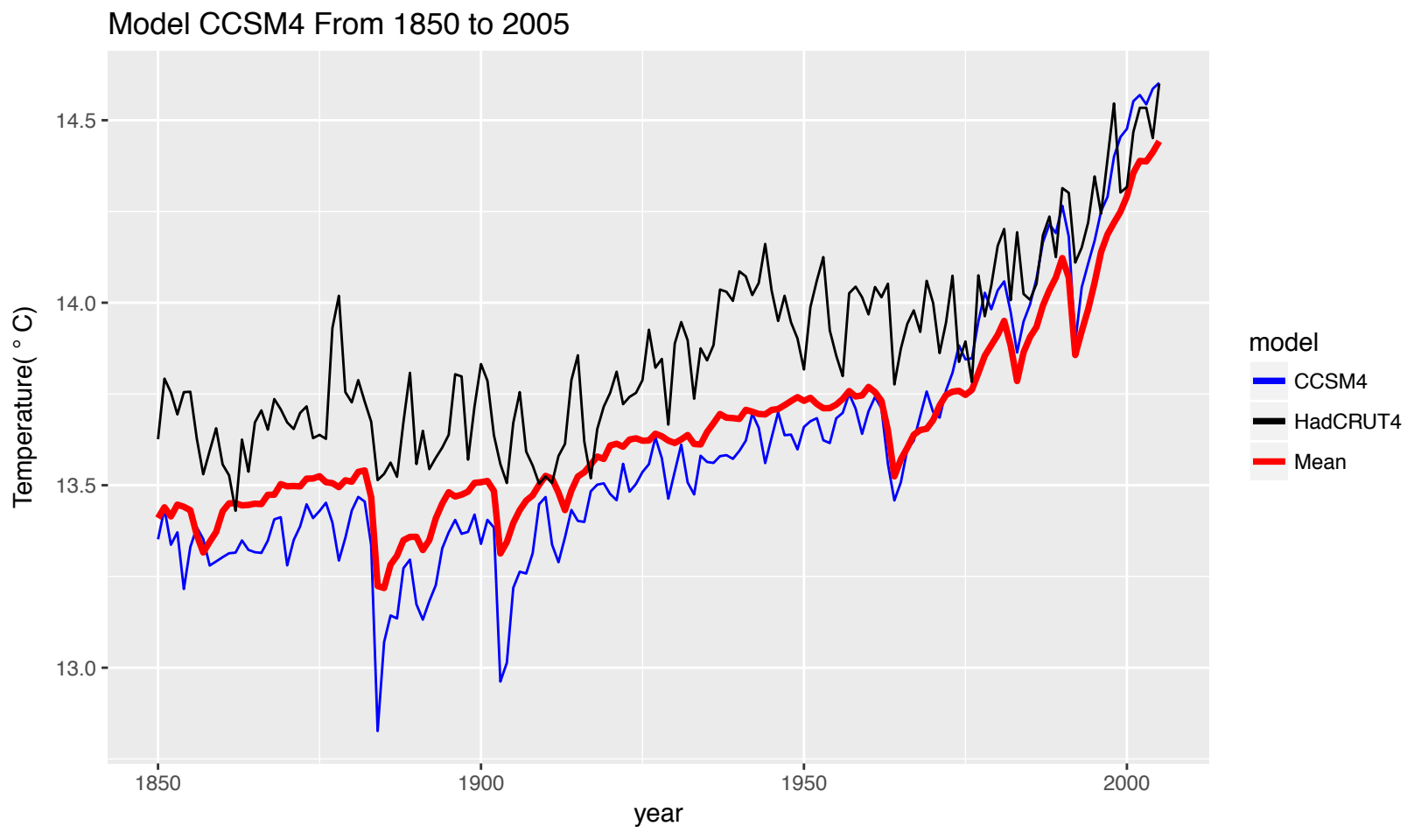
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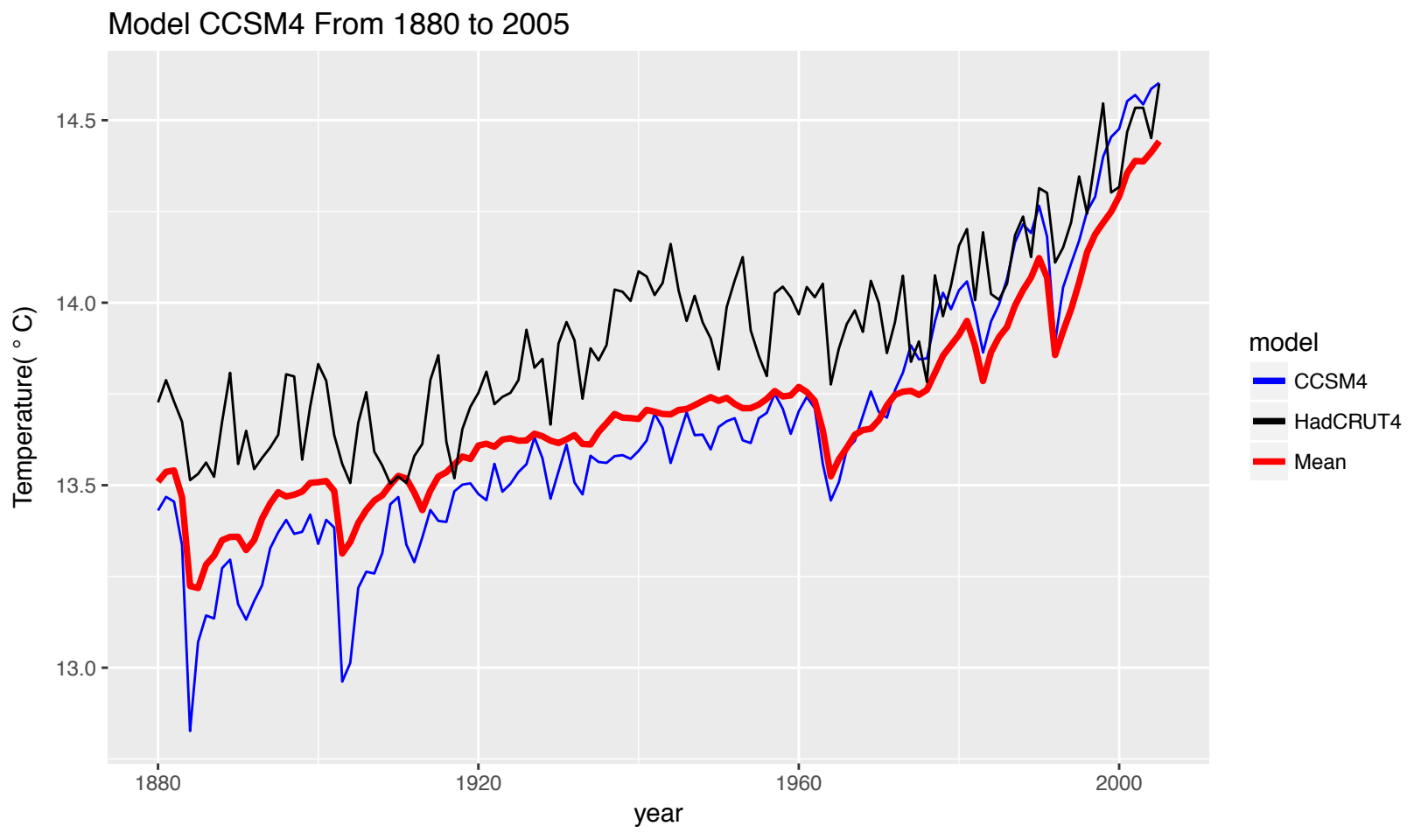
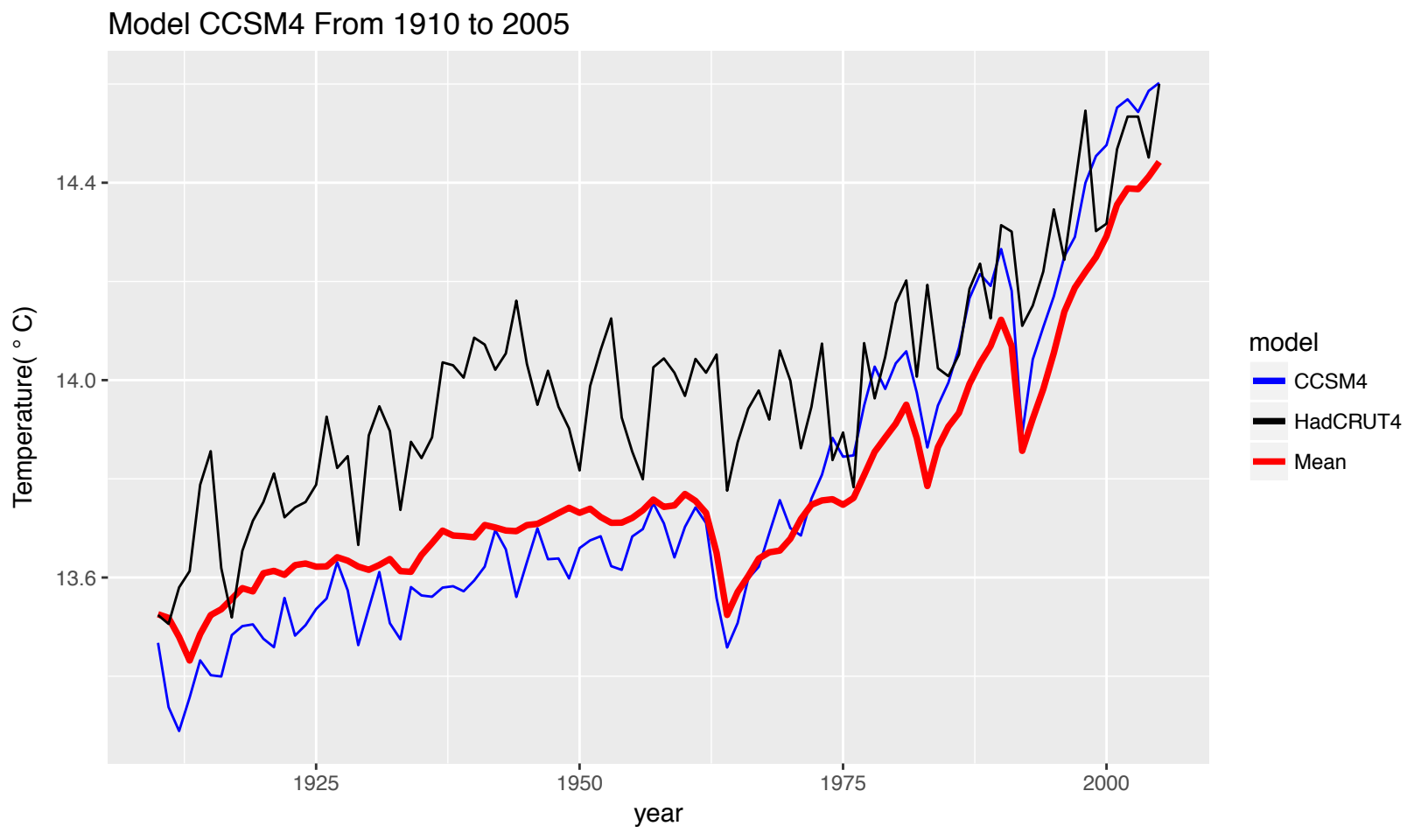
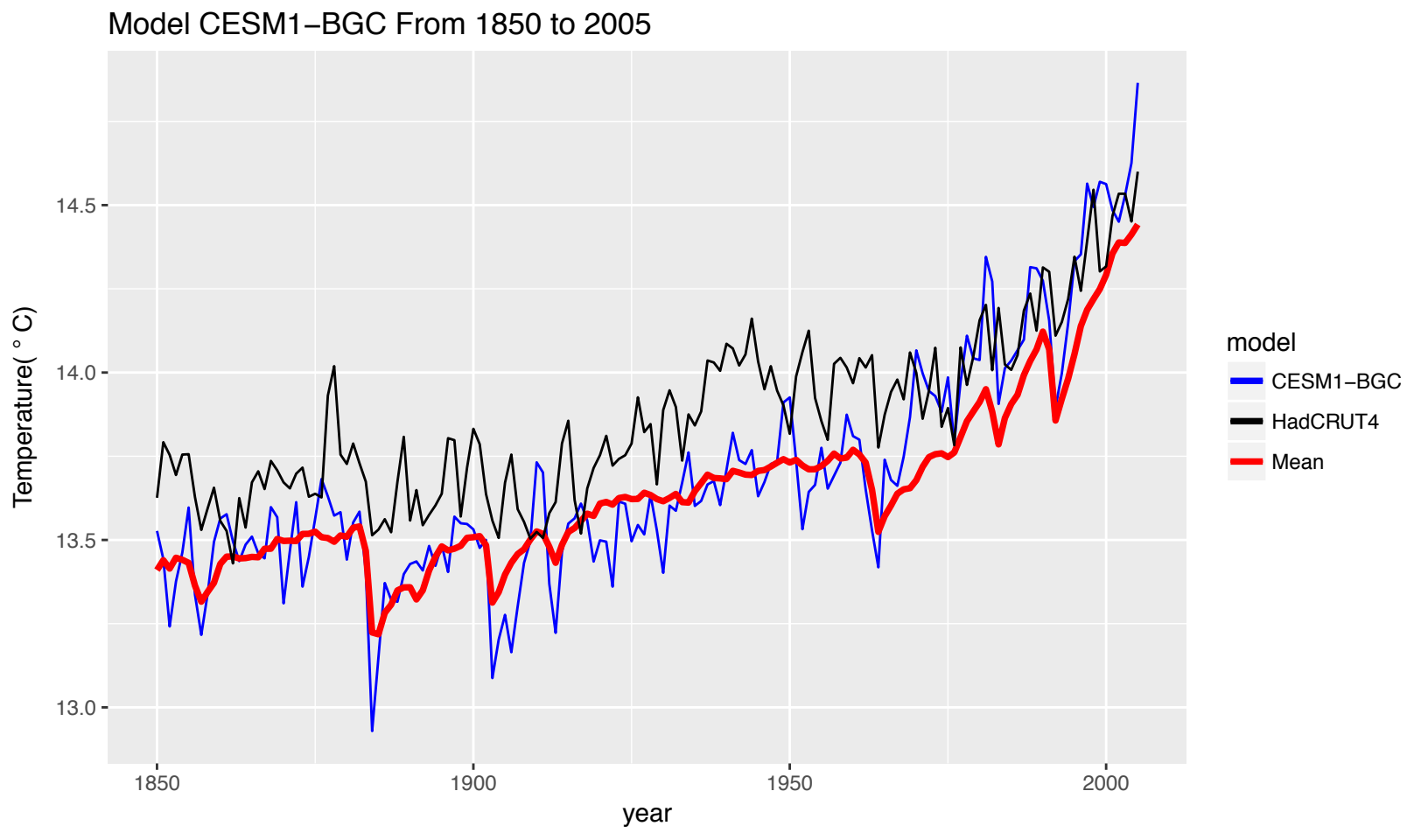
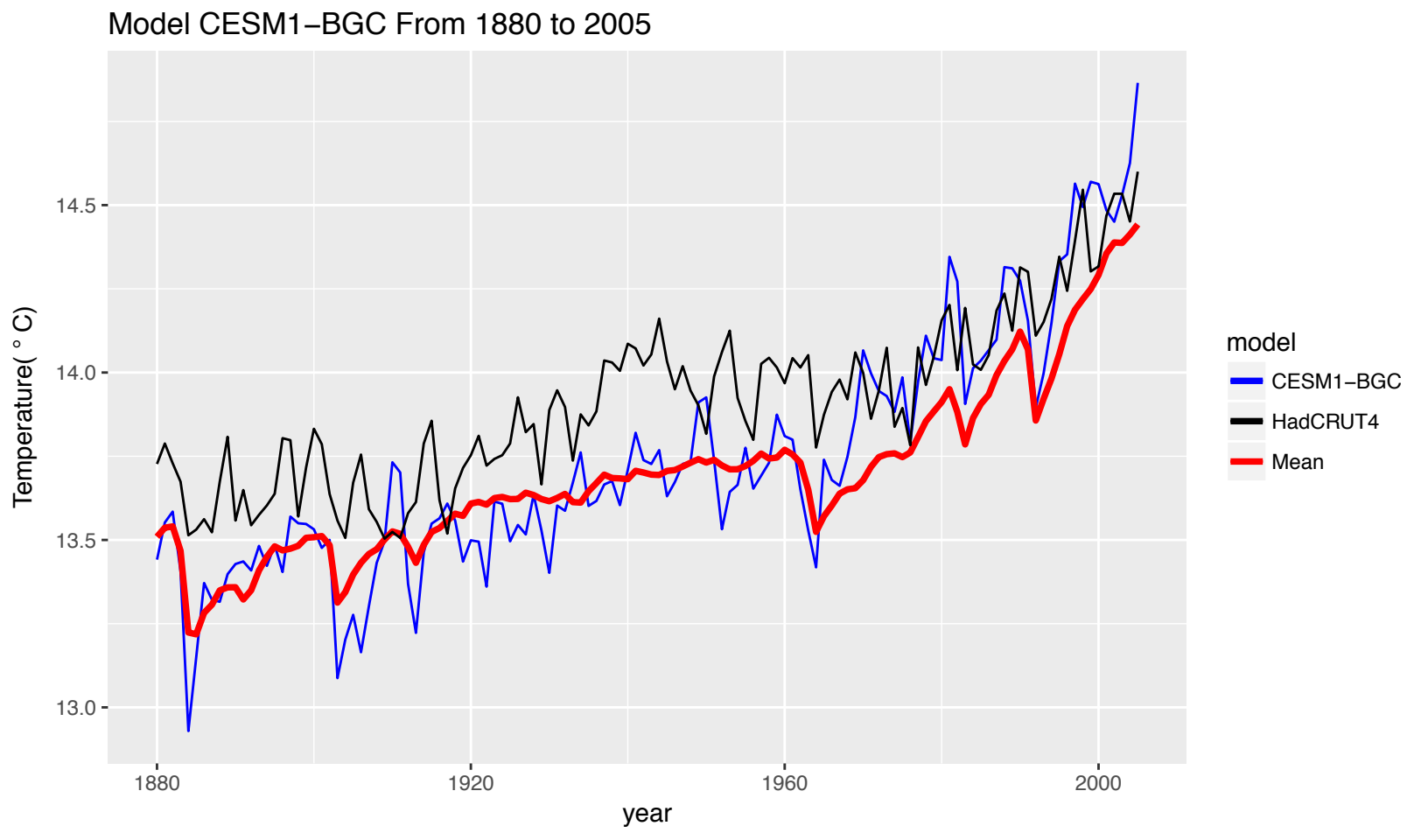
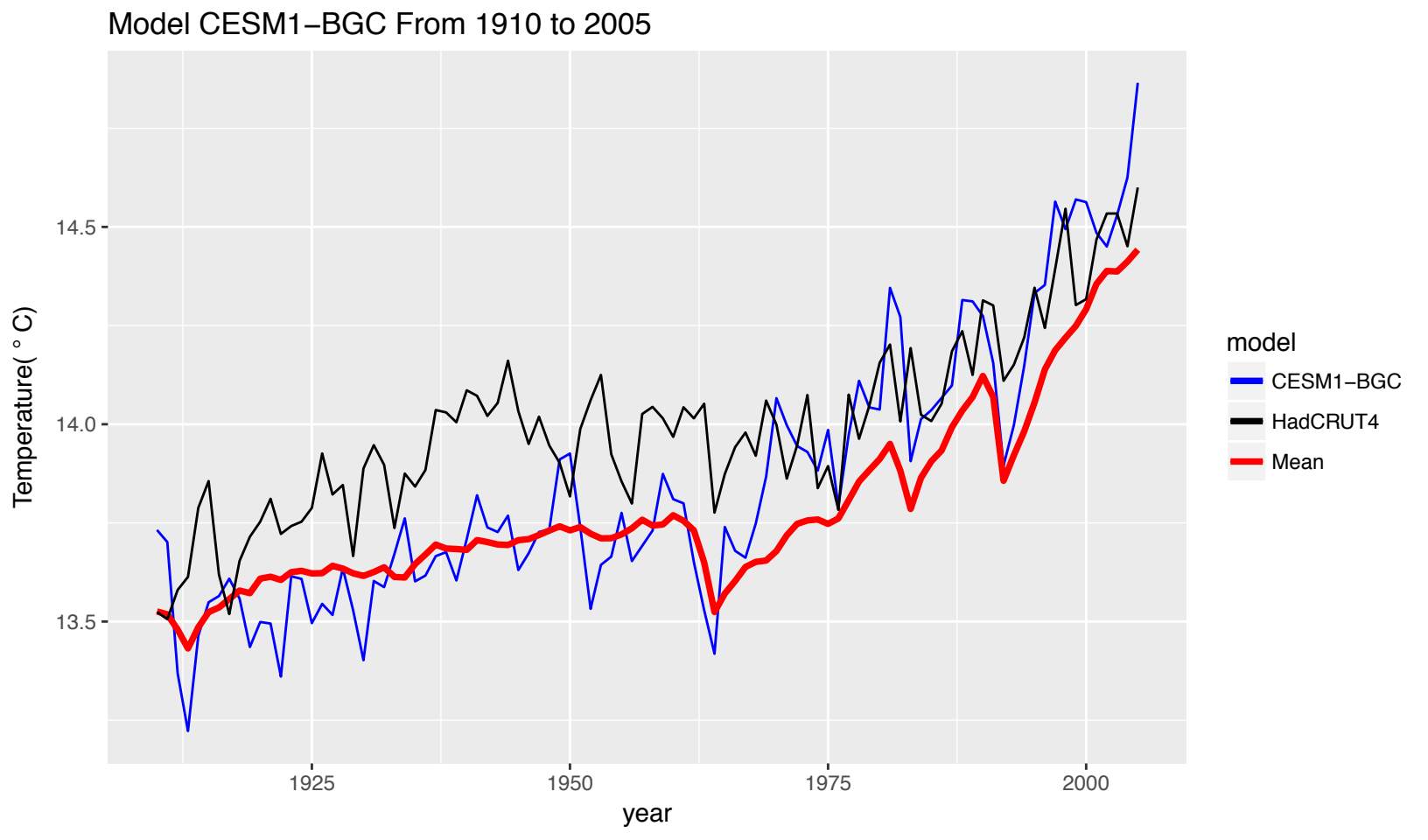
1950
2000
year
model
CCSM4
HadCRUT4
Mean

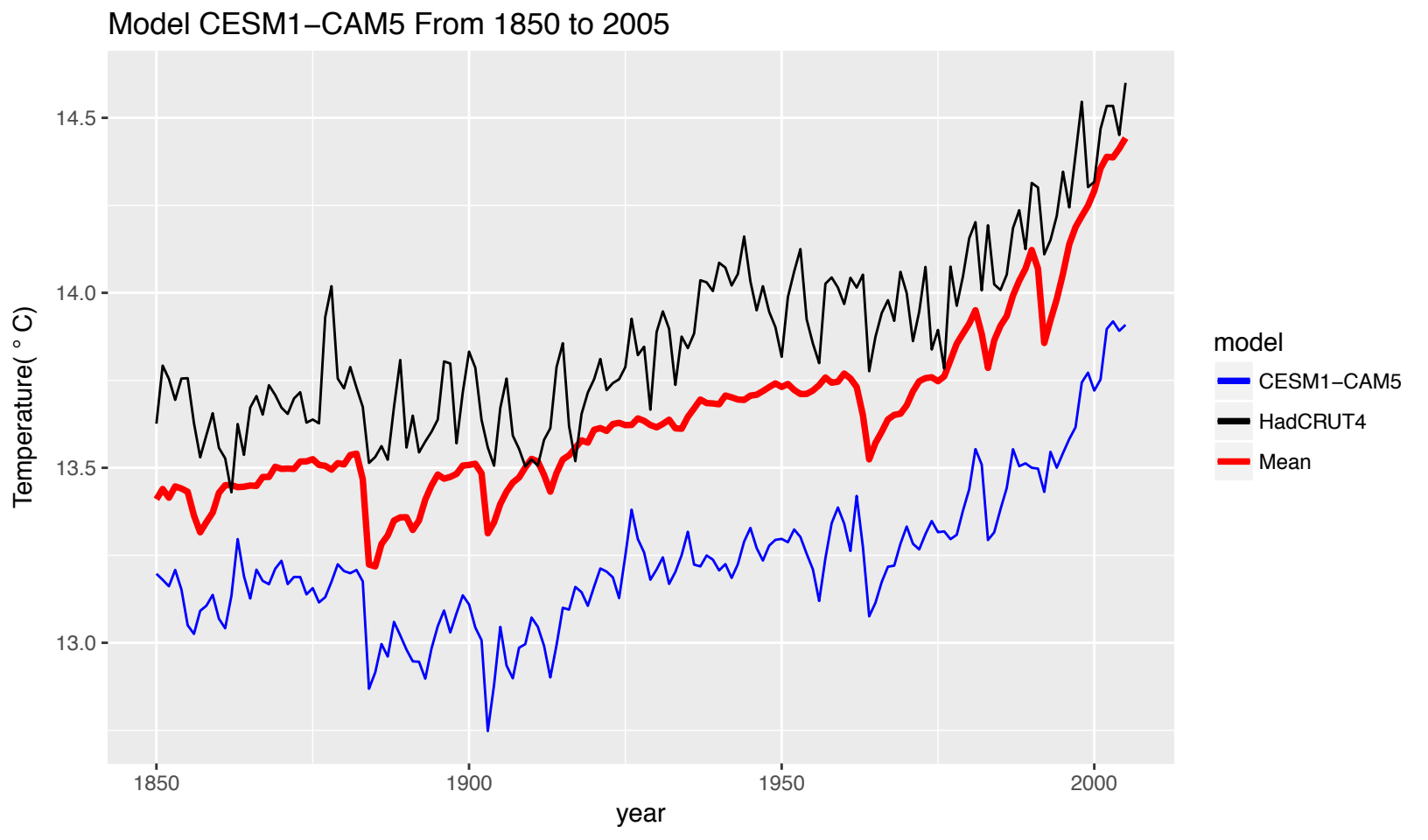

Model CCSM4 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
CCSM4
HadCRUT4
Mean

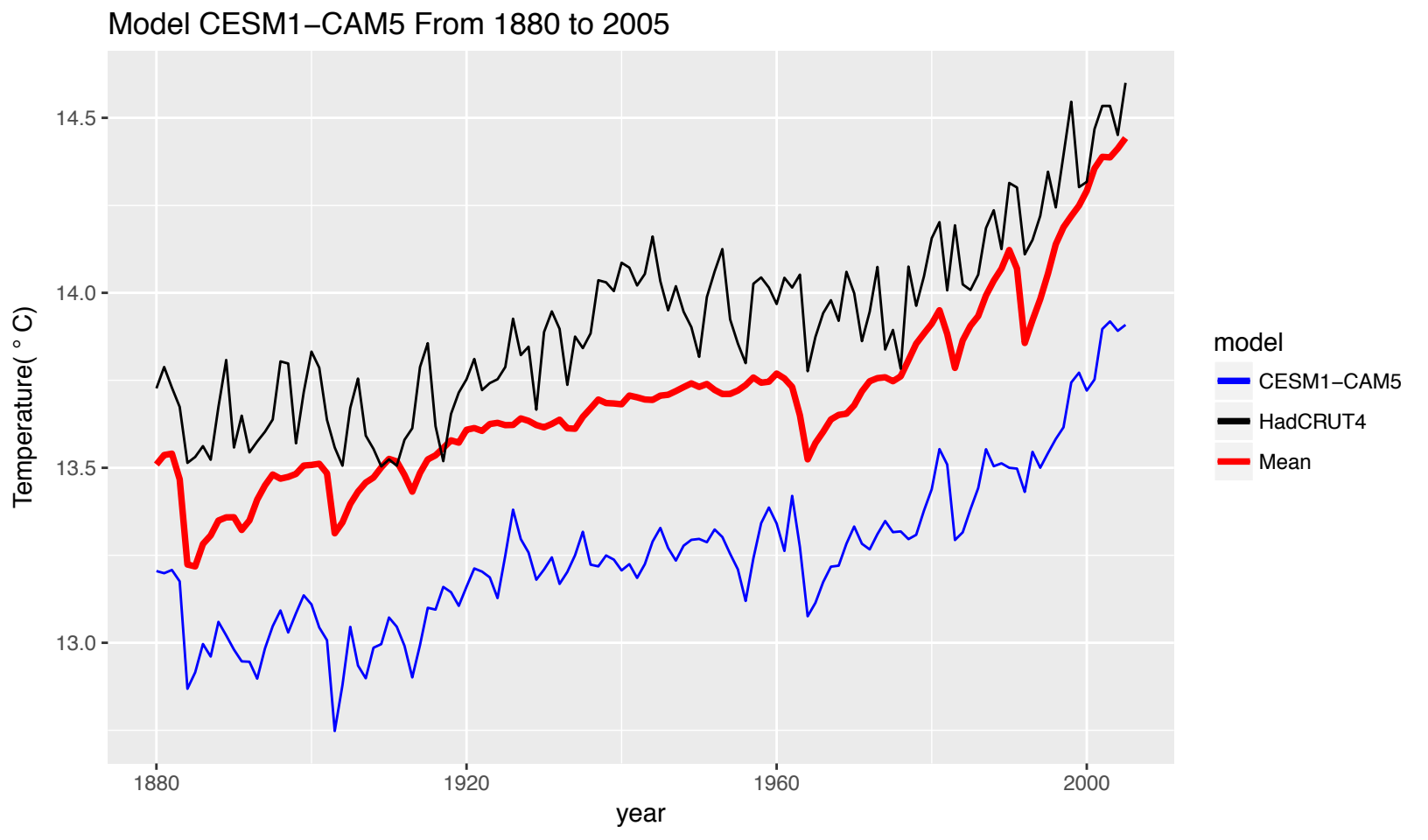

Model CCSM4 From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
1925
1950
1975
2000
year
model
CCSM4
HadCRUT4
Mean

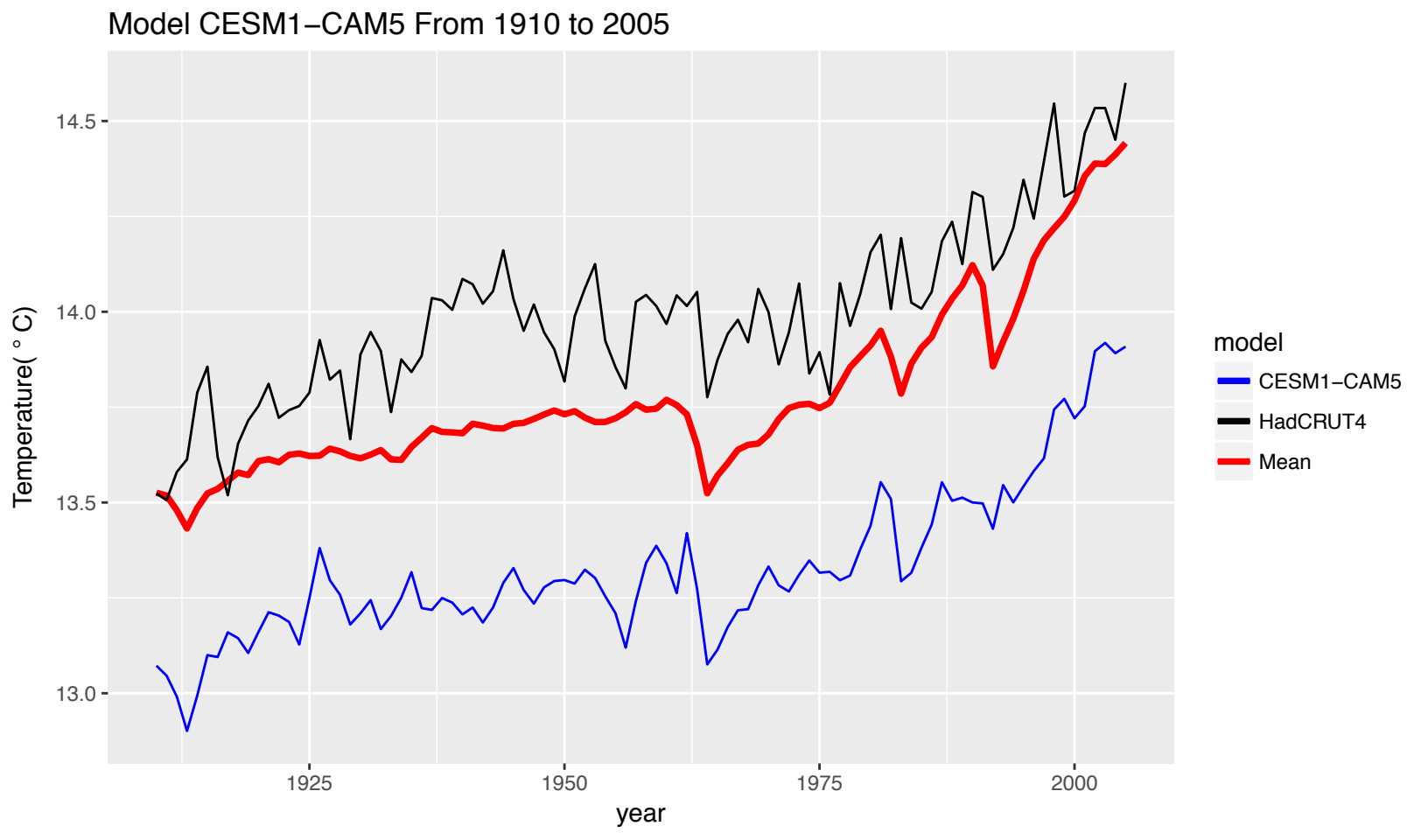

Model CESM1−BGC From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
CESM1−BGC
HadCRUT4
Mean

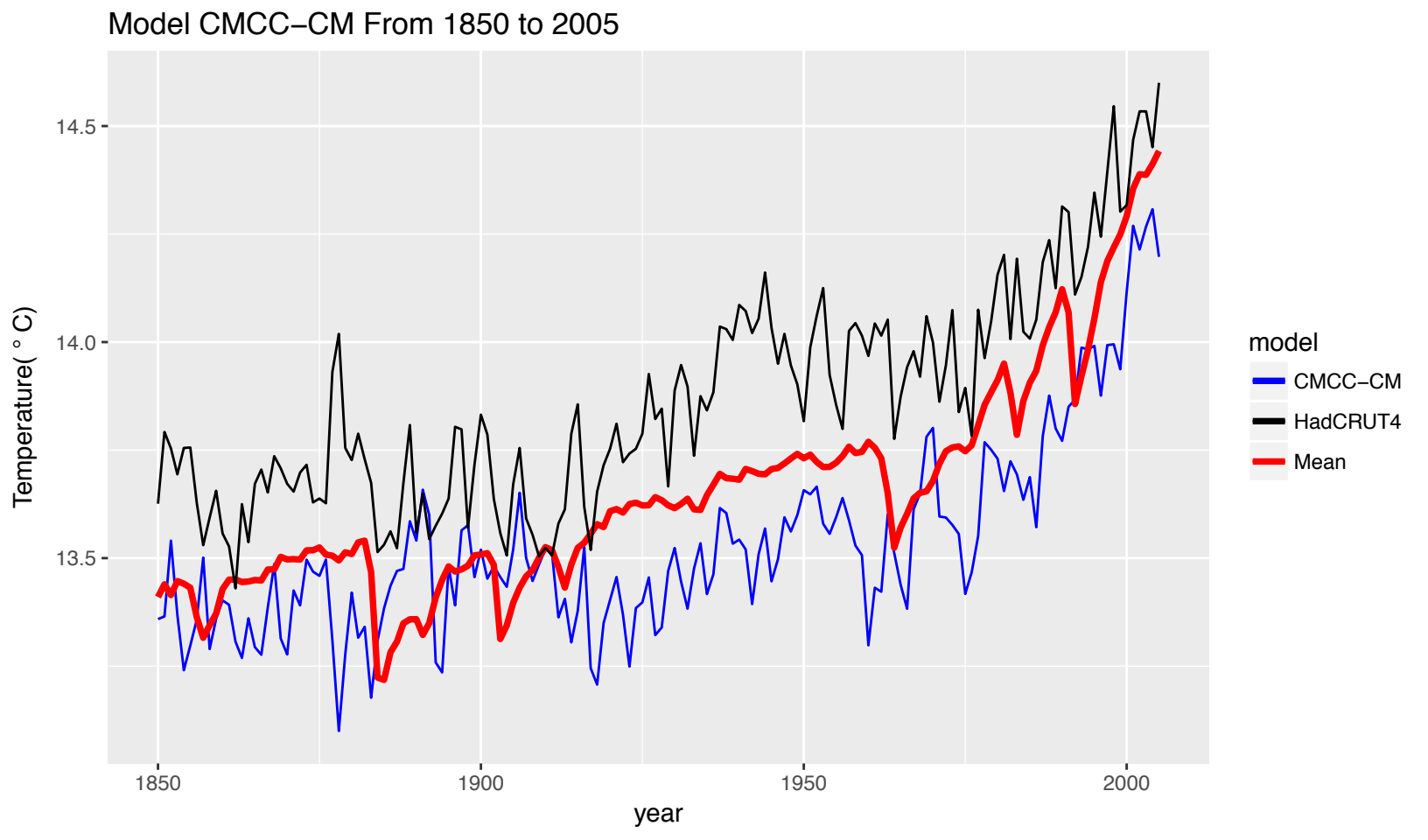

Model CESM1−BGC From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
CESM1−BGC
HadCRUT4
Mean

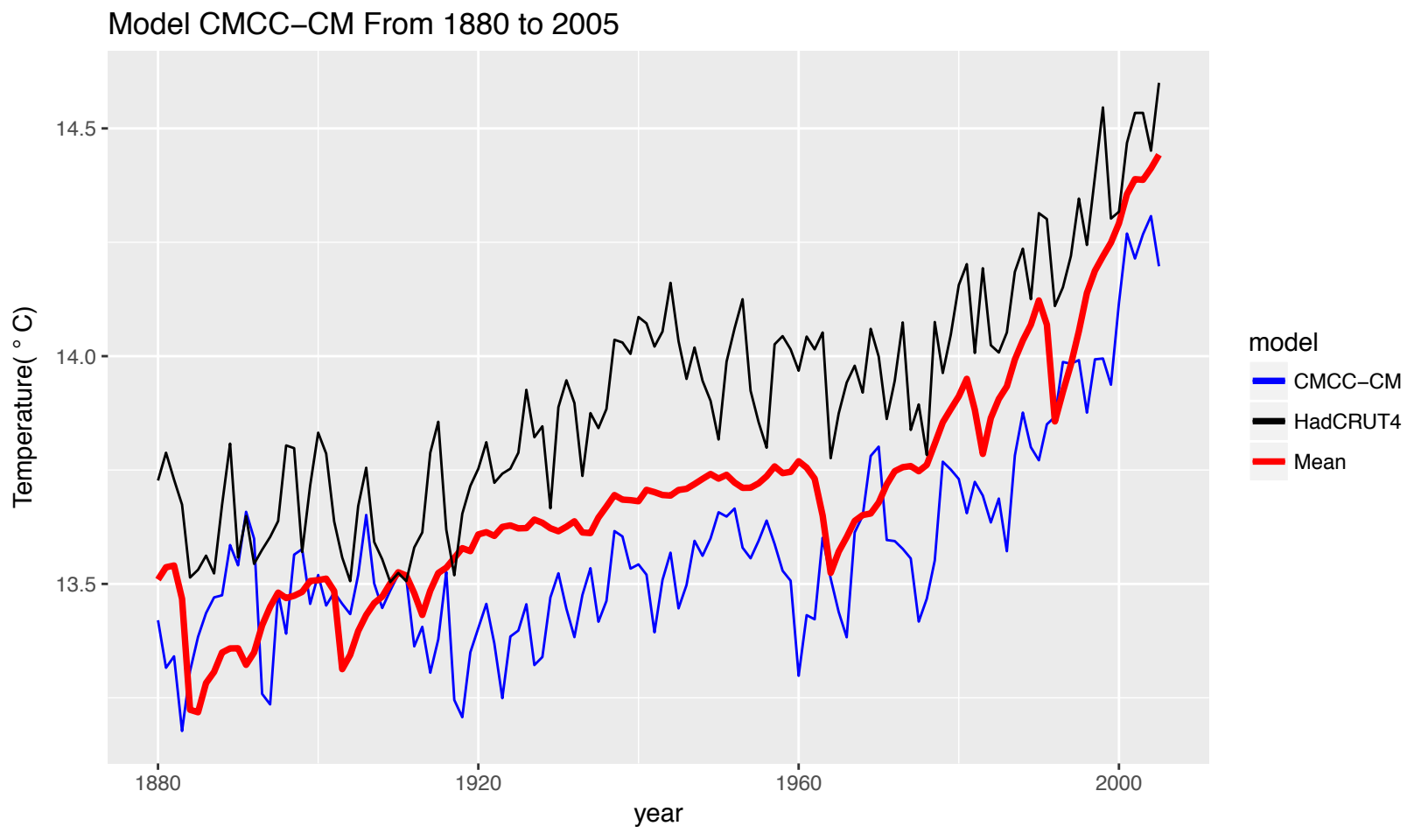

Model CESM1−BGC From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
1925
1950
1975
2000
year
model
CESM1−BGC
HadCRUT4
Mean

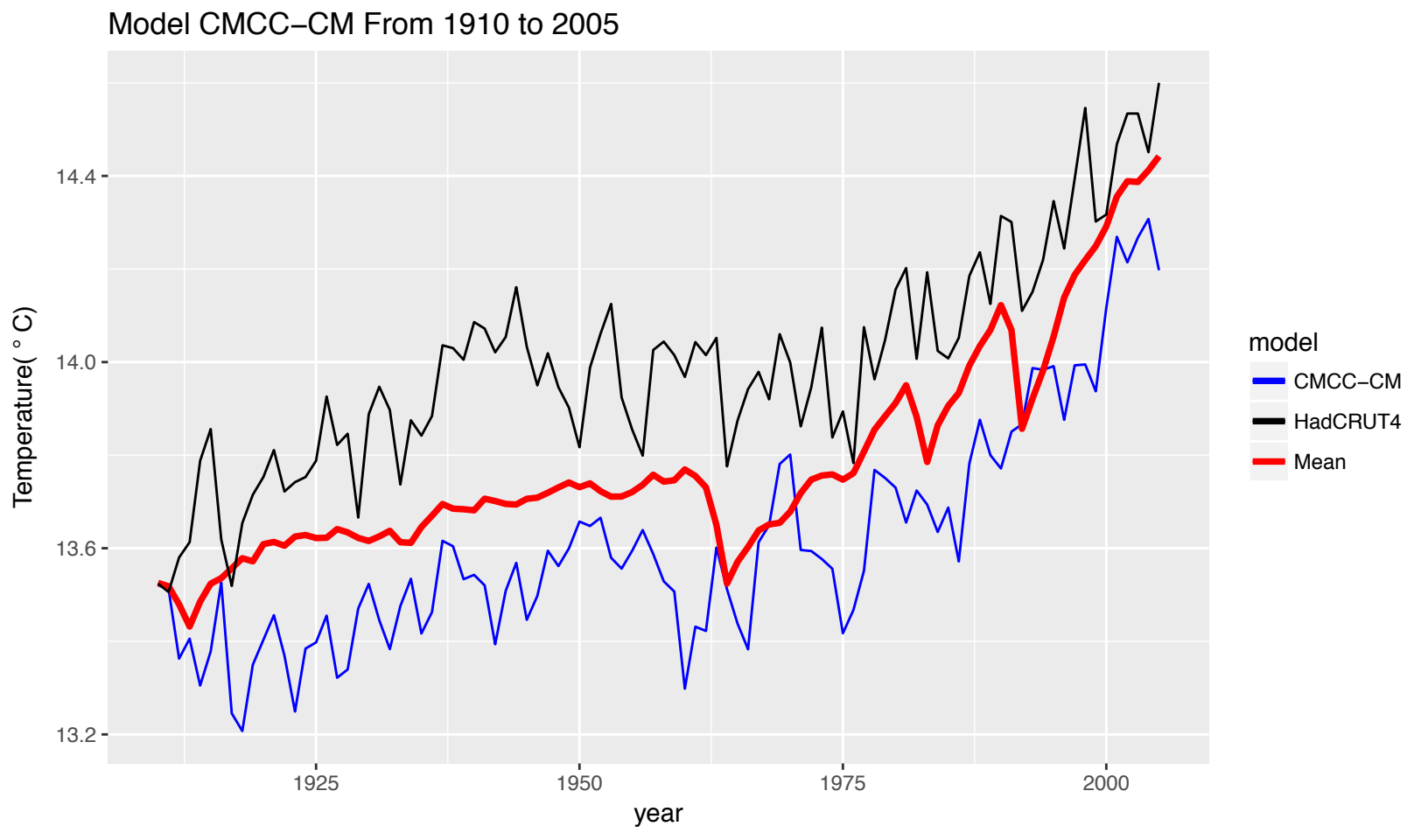

Model CESM1−CAM5 From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
CESM1−CAM5
HadCRUT4
Mean

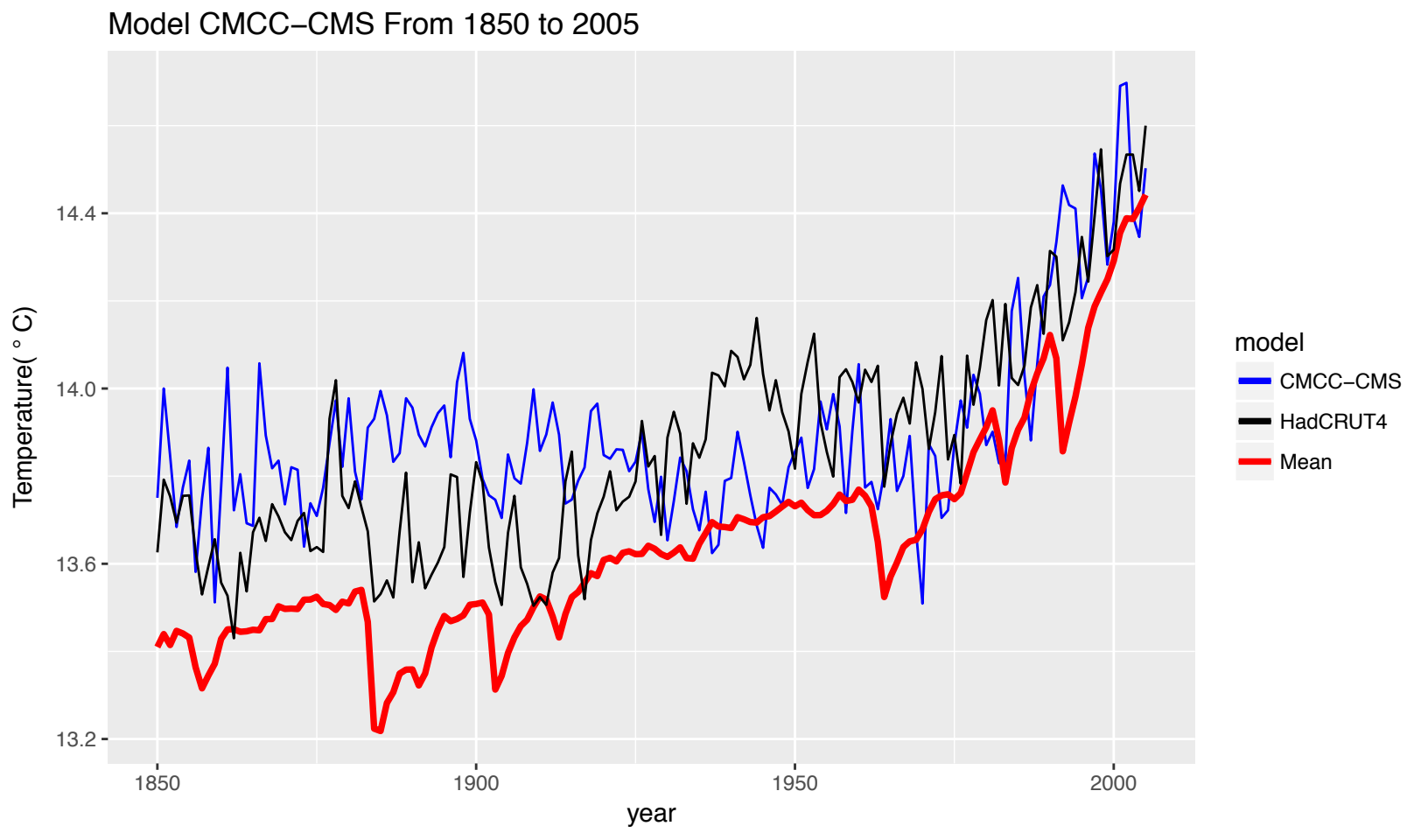

Model CESM1−CAM5 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
CESM1−CAM5
HadCRUT4
Mean

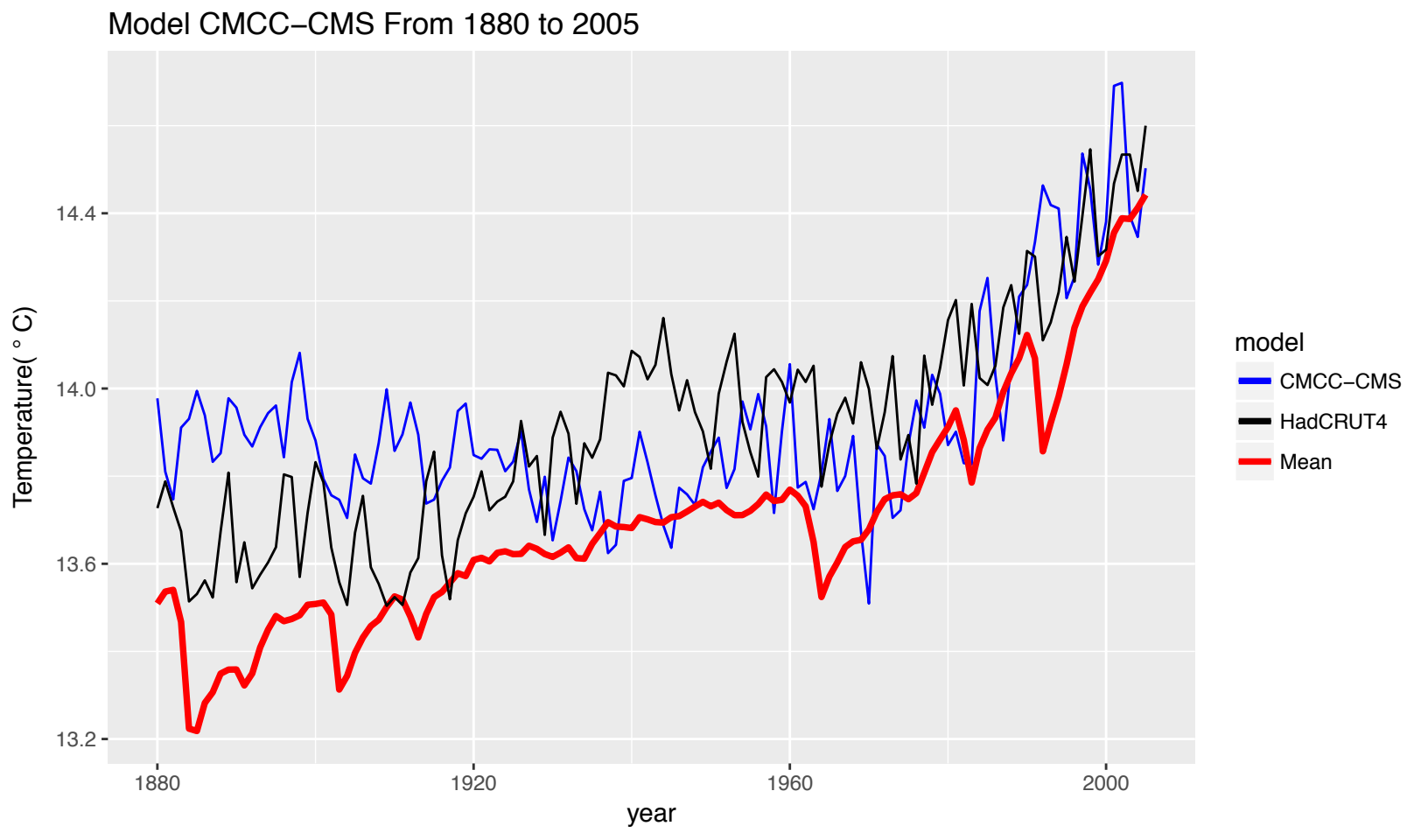

Model CESM1−CAM5 From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
CESM1−CAM5
HadCRUT4
Mean

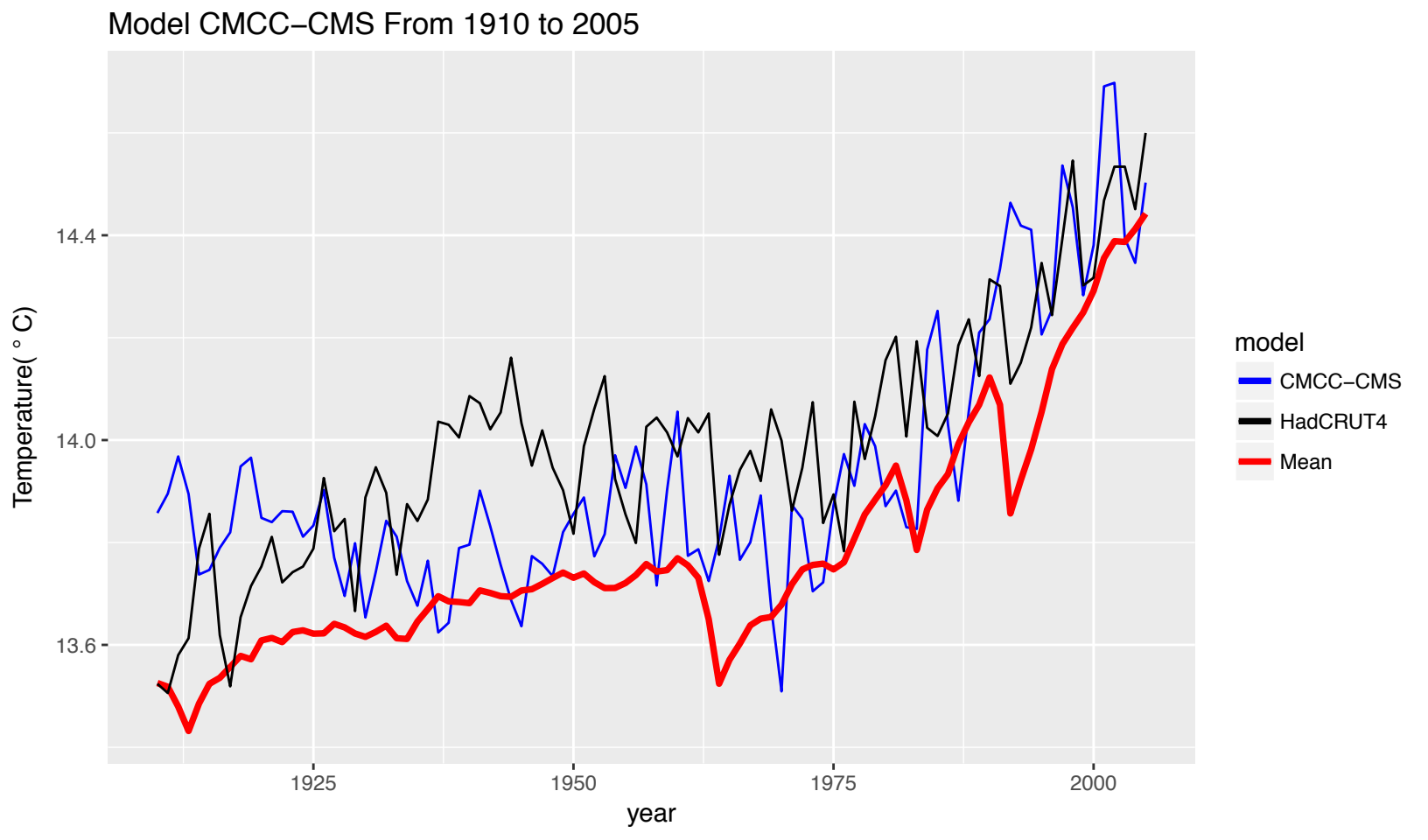

Model CMCC−CM From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
1850
1900
1950
2000
year
model
CMCC−CM
HadCRUT4
Mean

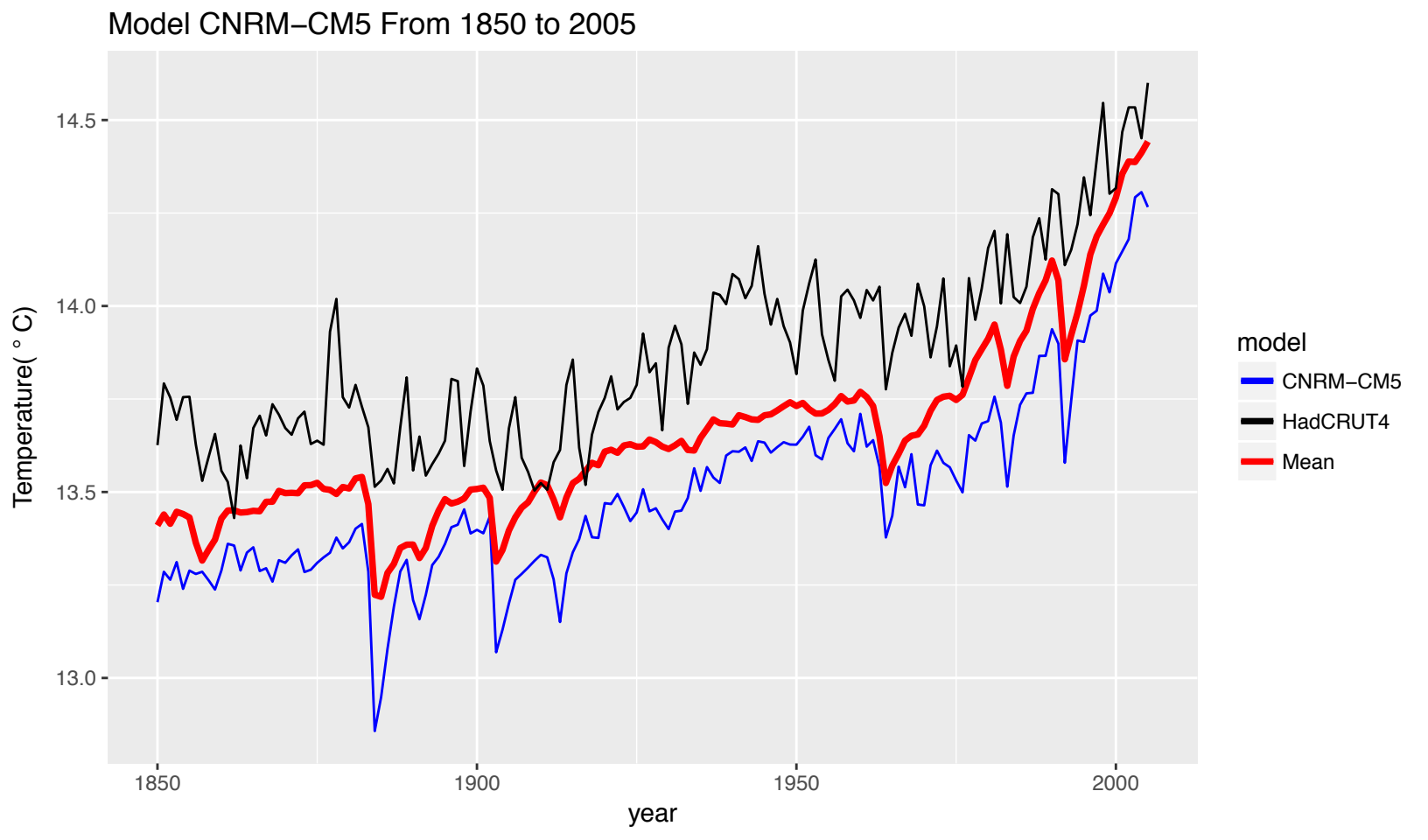

Model CMCC−CM From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
1880
1920
1960
2000
year
model
CMCC−CM
HadCRUT4
Mean

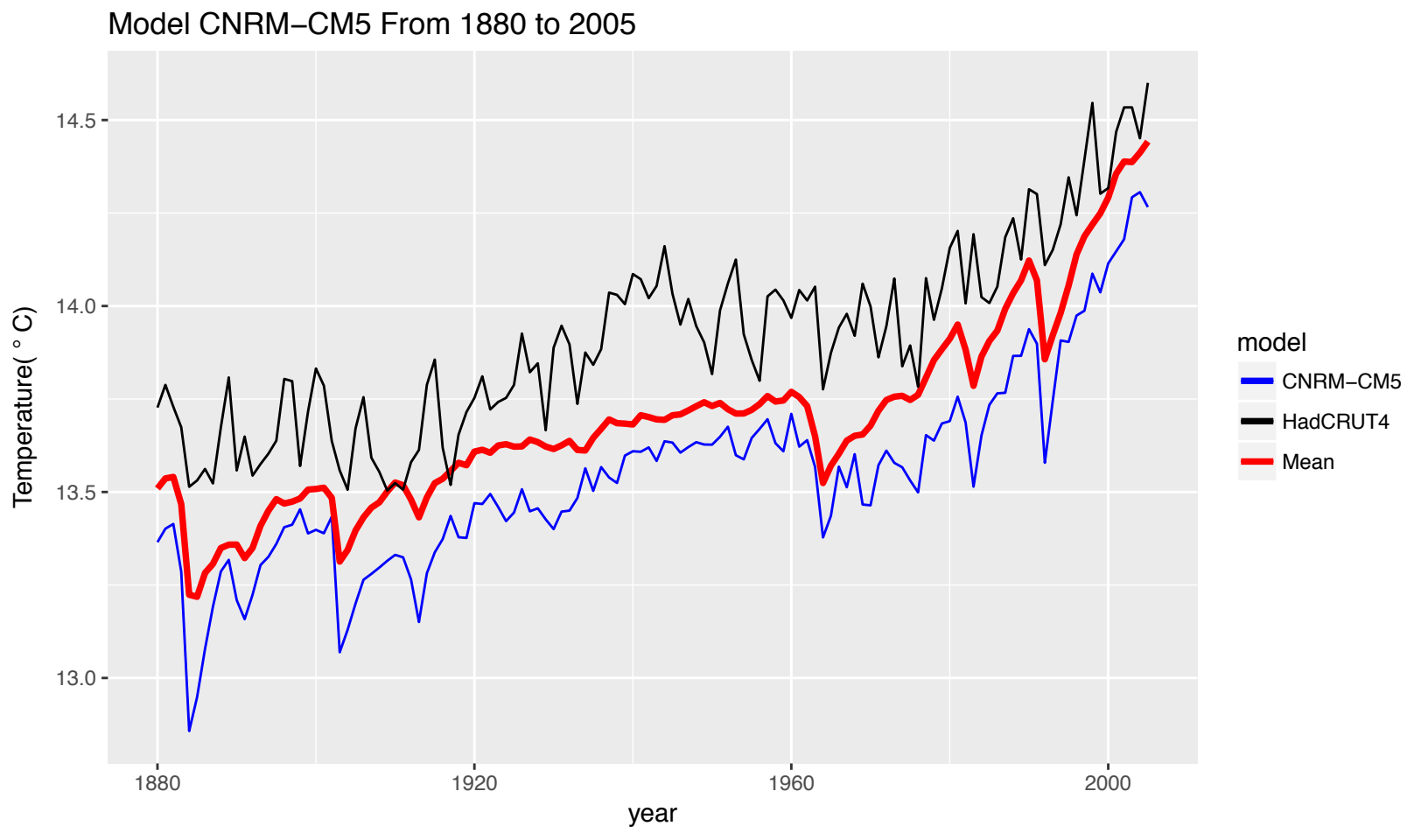

Model CMCC−CM From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1925
1950
1975
2000
year
model
CMCC−CM
HadCRUT4
Mean

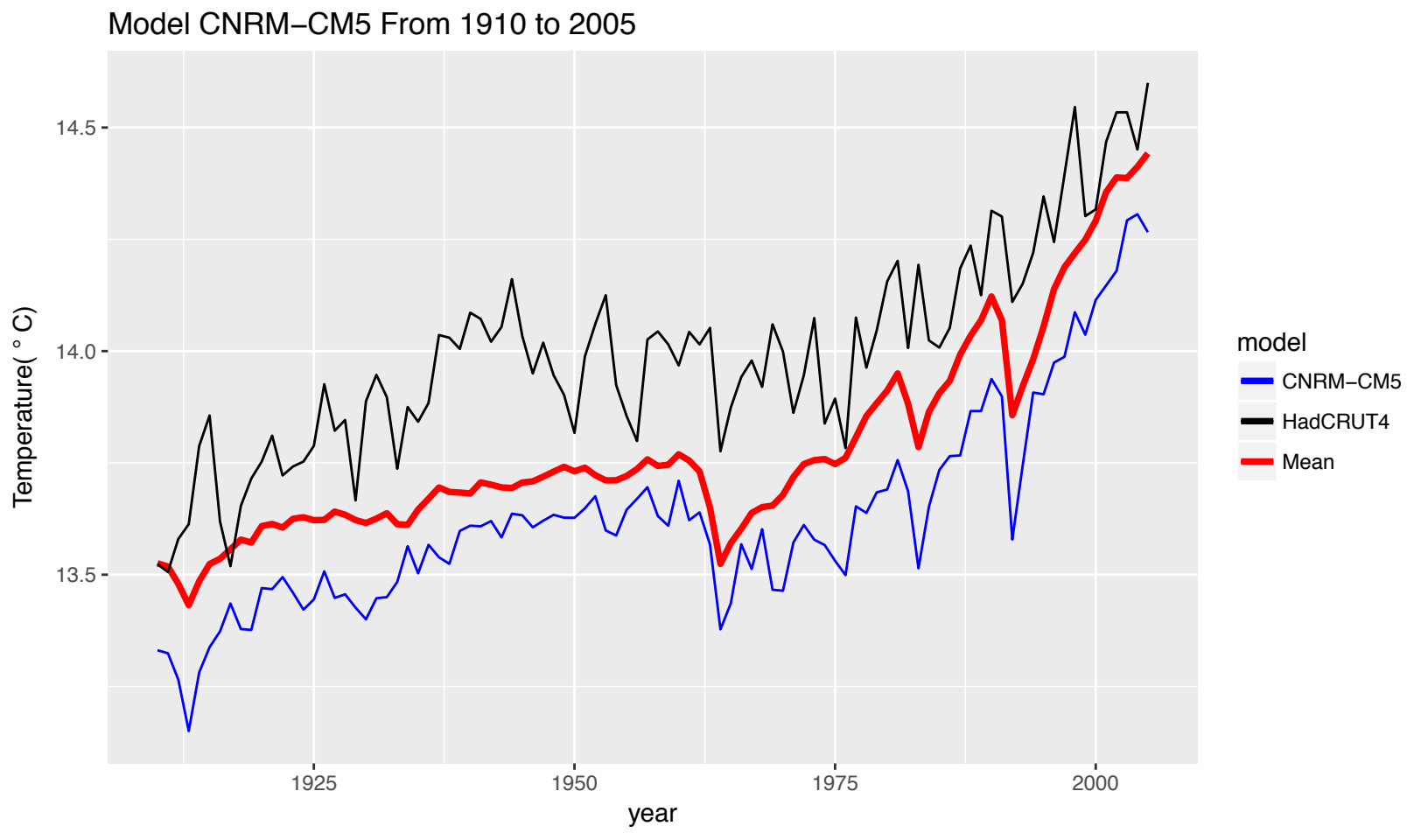

Model CMCC−CMS From 1850 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1850
1900
1950
2000
year
model
CMCC−CMS
HadCRUT4
Mean

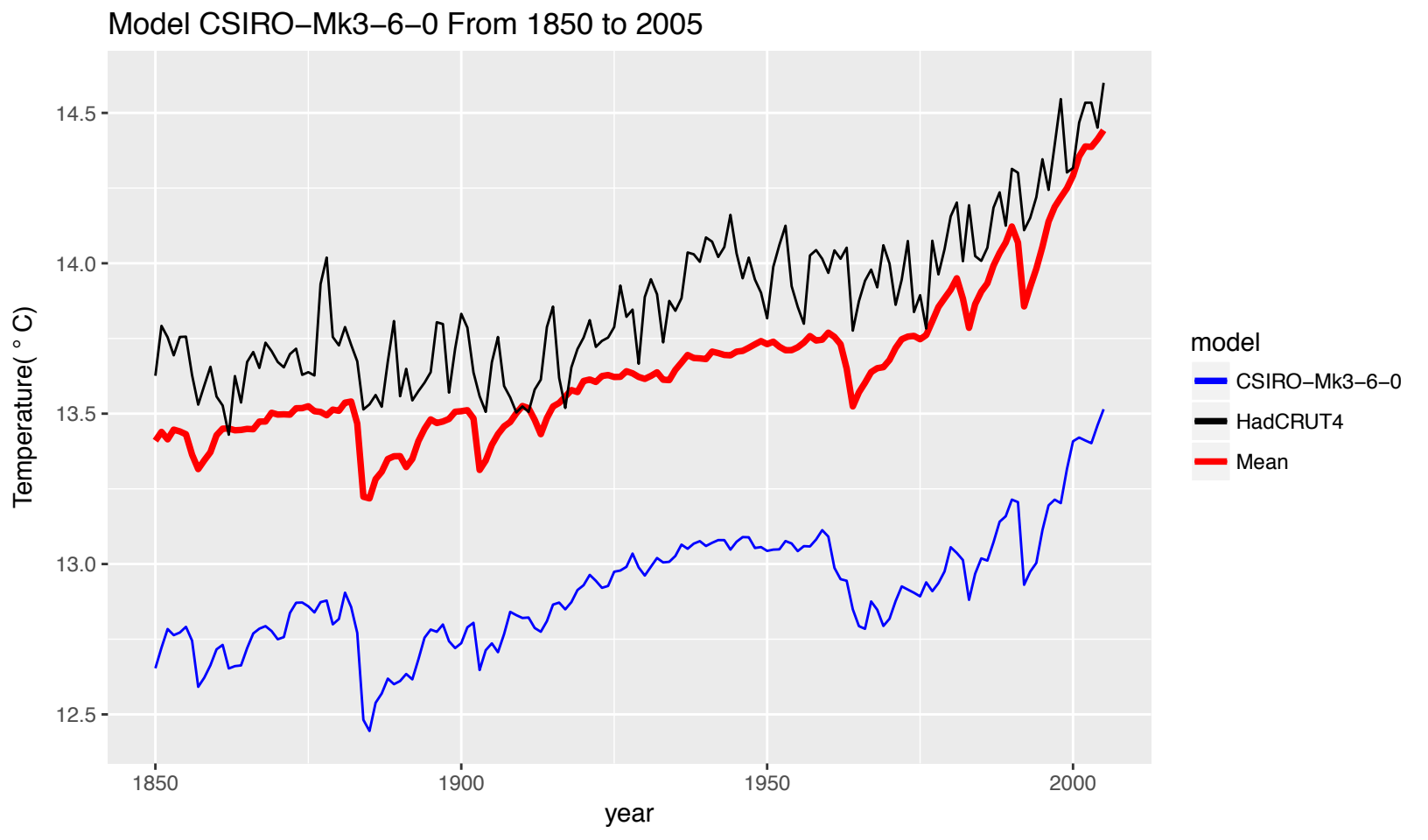

Model CMCC−CMS From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
CMCC−CMS
HadCRUT4
Mean

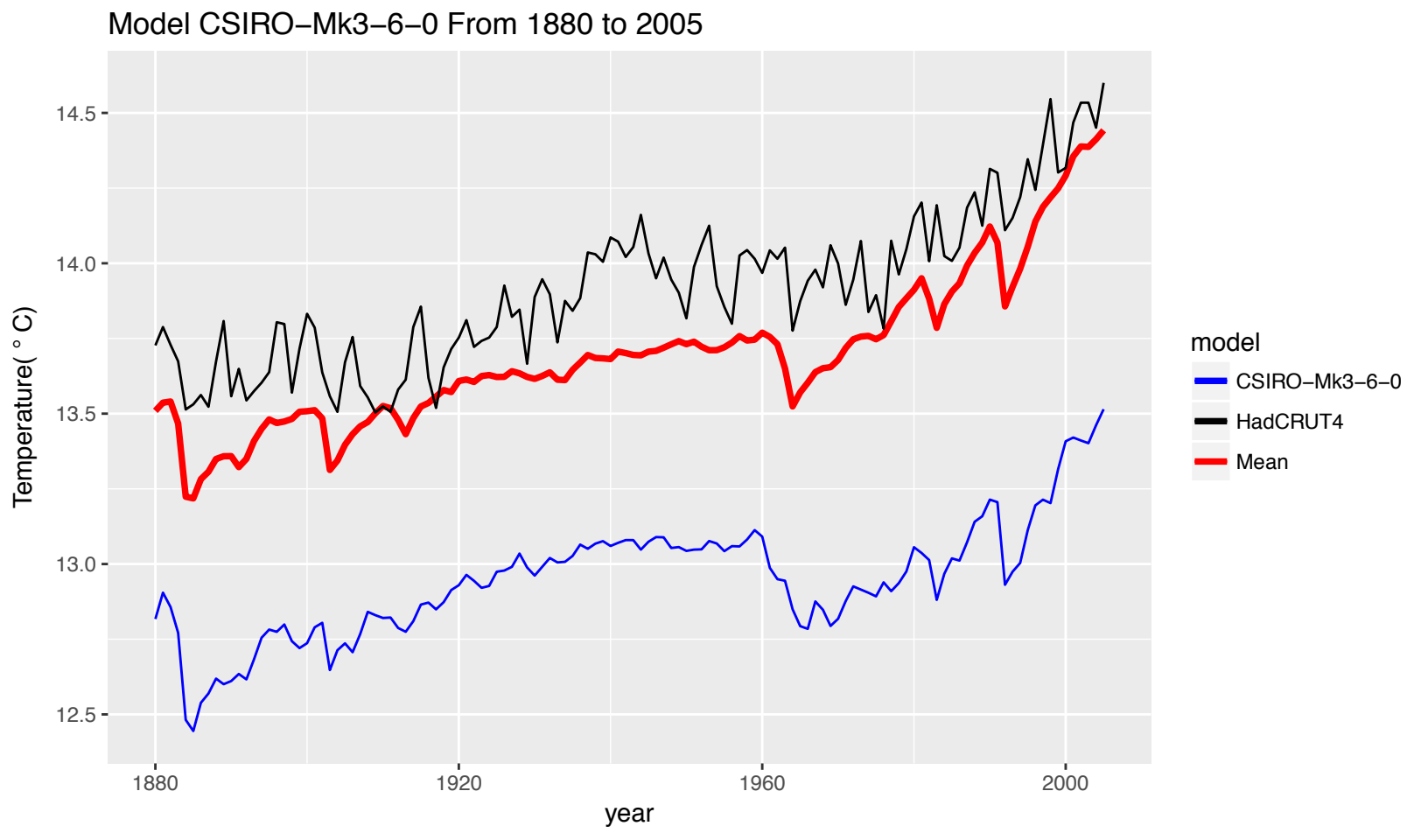

Model CMCC−CMS From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
1925
1950
1975
2000
year
model
CMCC−CMS
HadCRUT4
Mean

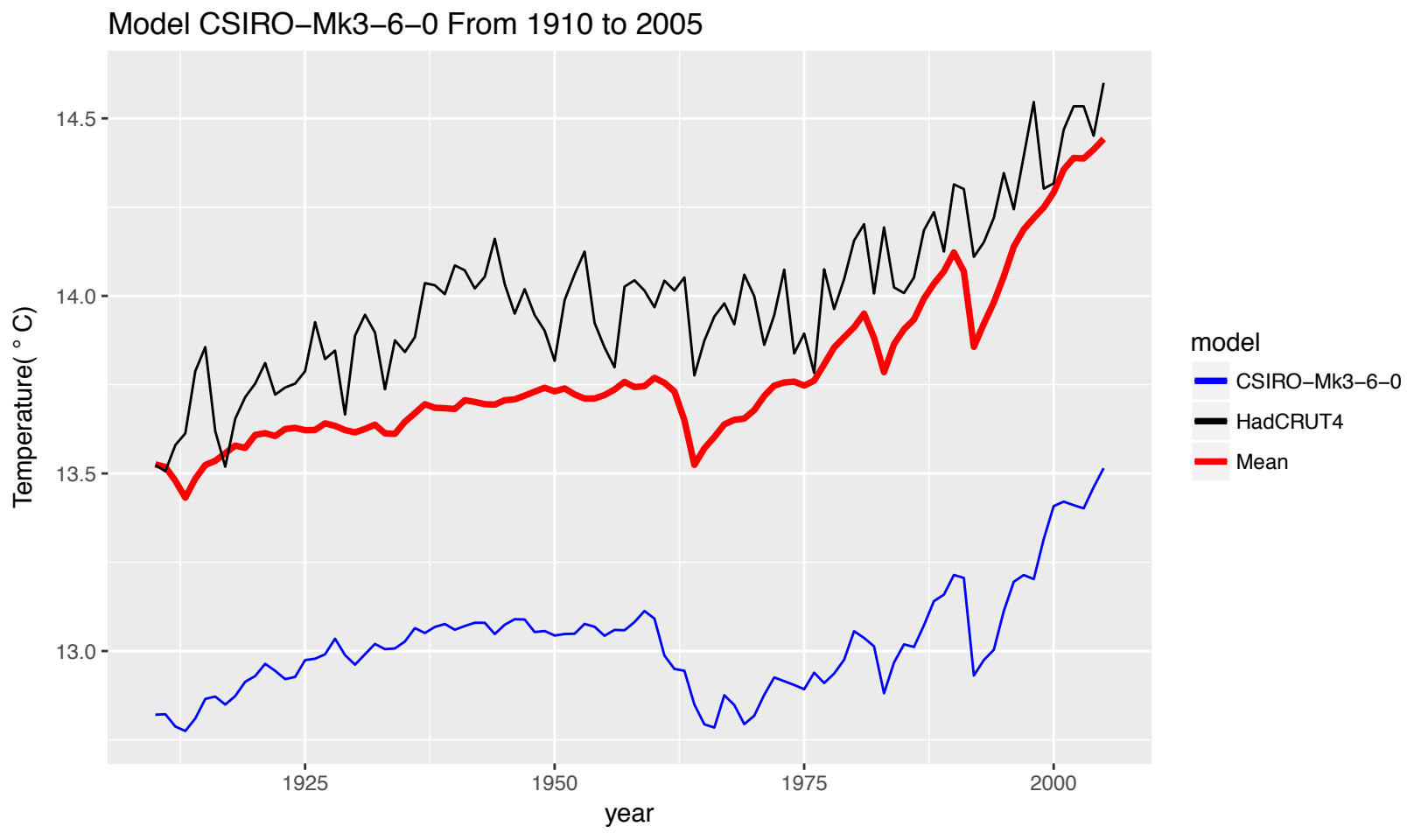

Model CNRM−CM5 From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
CNRM−CM5
HadCRUT4
Mean

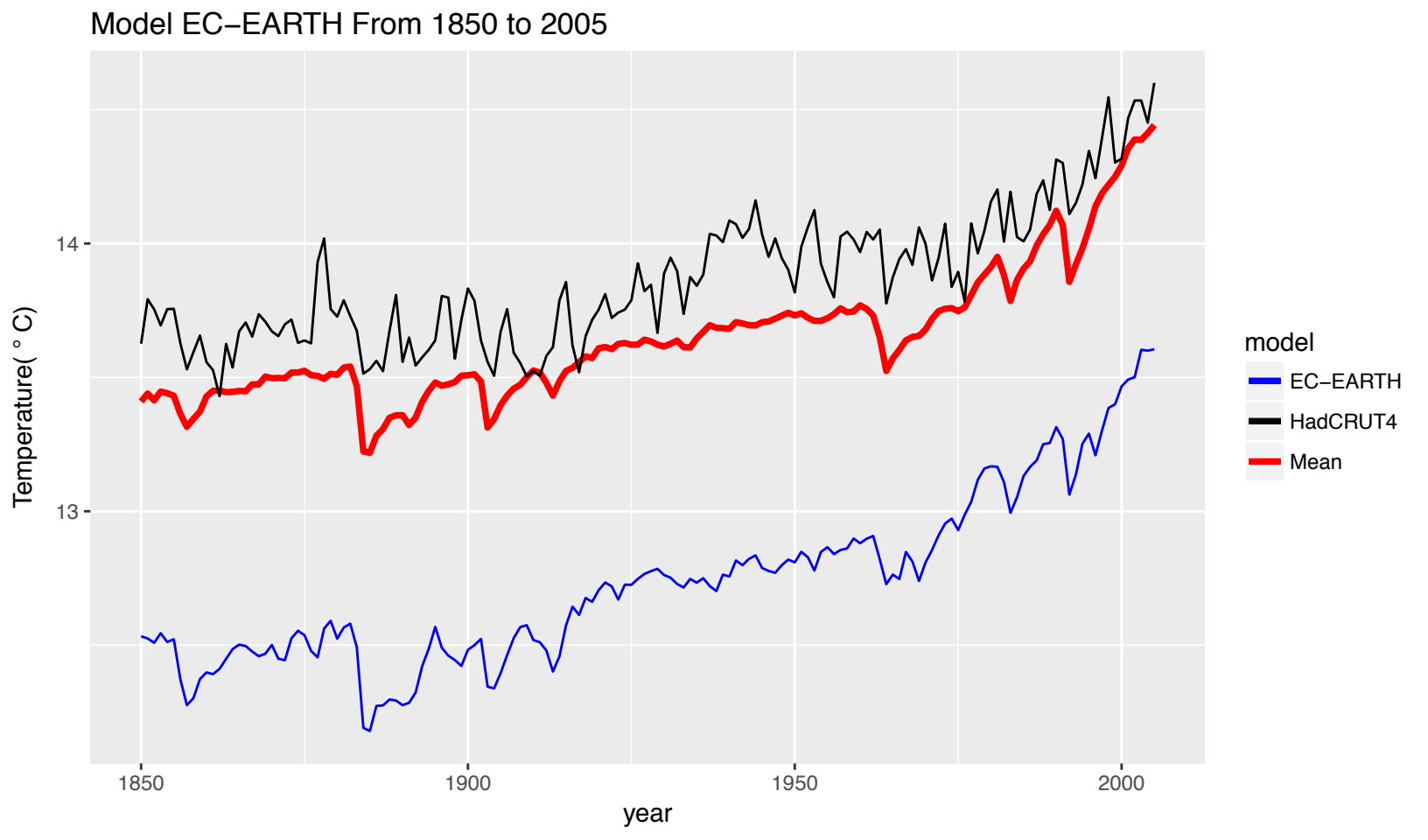

Model CNRM−CM5 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
CNRM−CM5
HadCRUT4
Mean

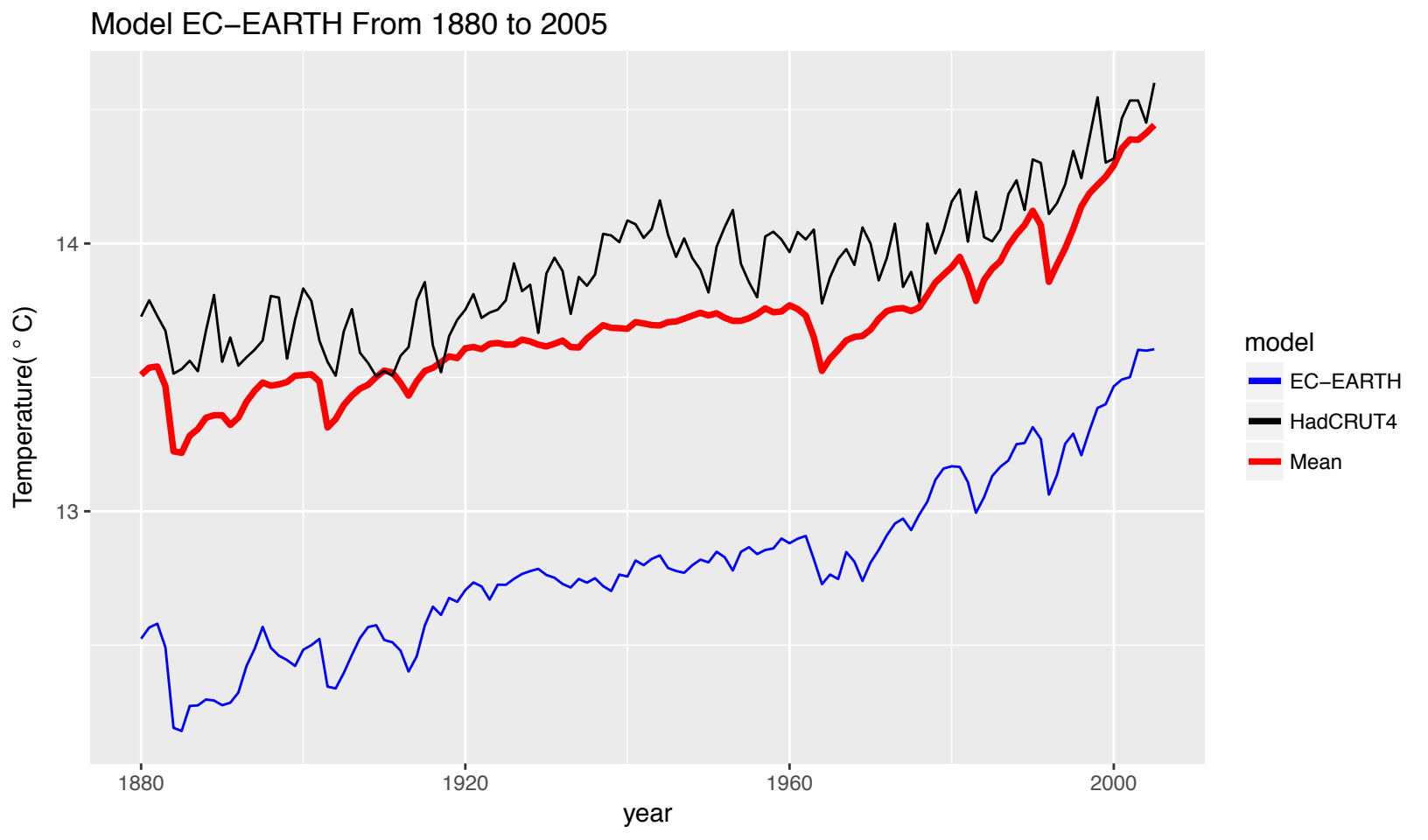

Model CNRM−CM5 From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
1925
1950
1975
2000
year
model
CNRM−CM5
HadCRUT4
Mean

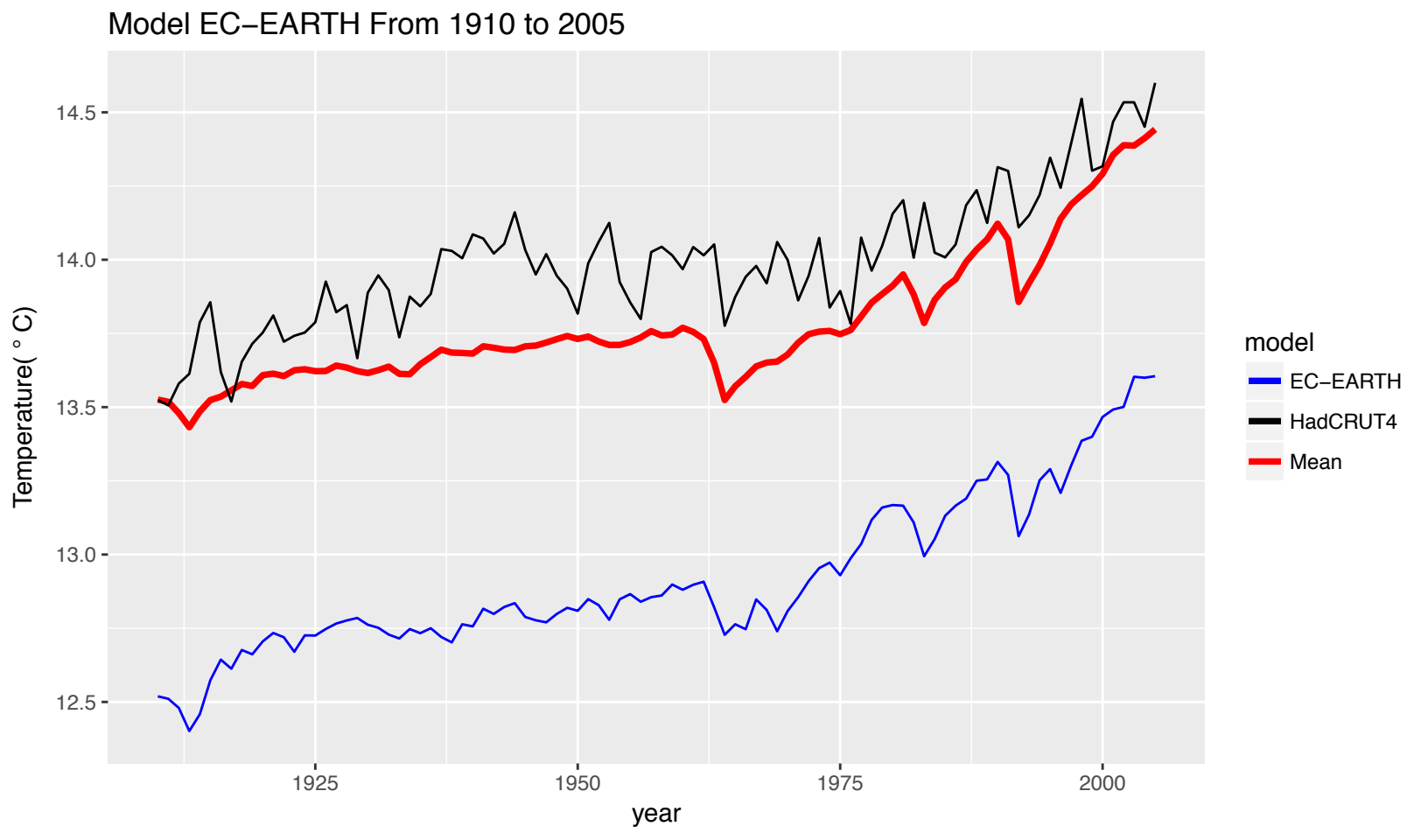

Model CSIRO−Mk3−6−0 From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1850
1900
1950
2000
year
model
CSIRO−Mk3−6−0
HadCRUT4
Mean

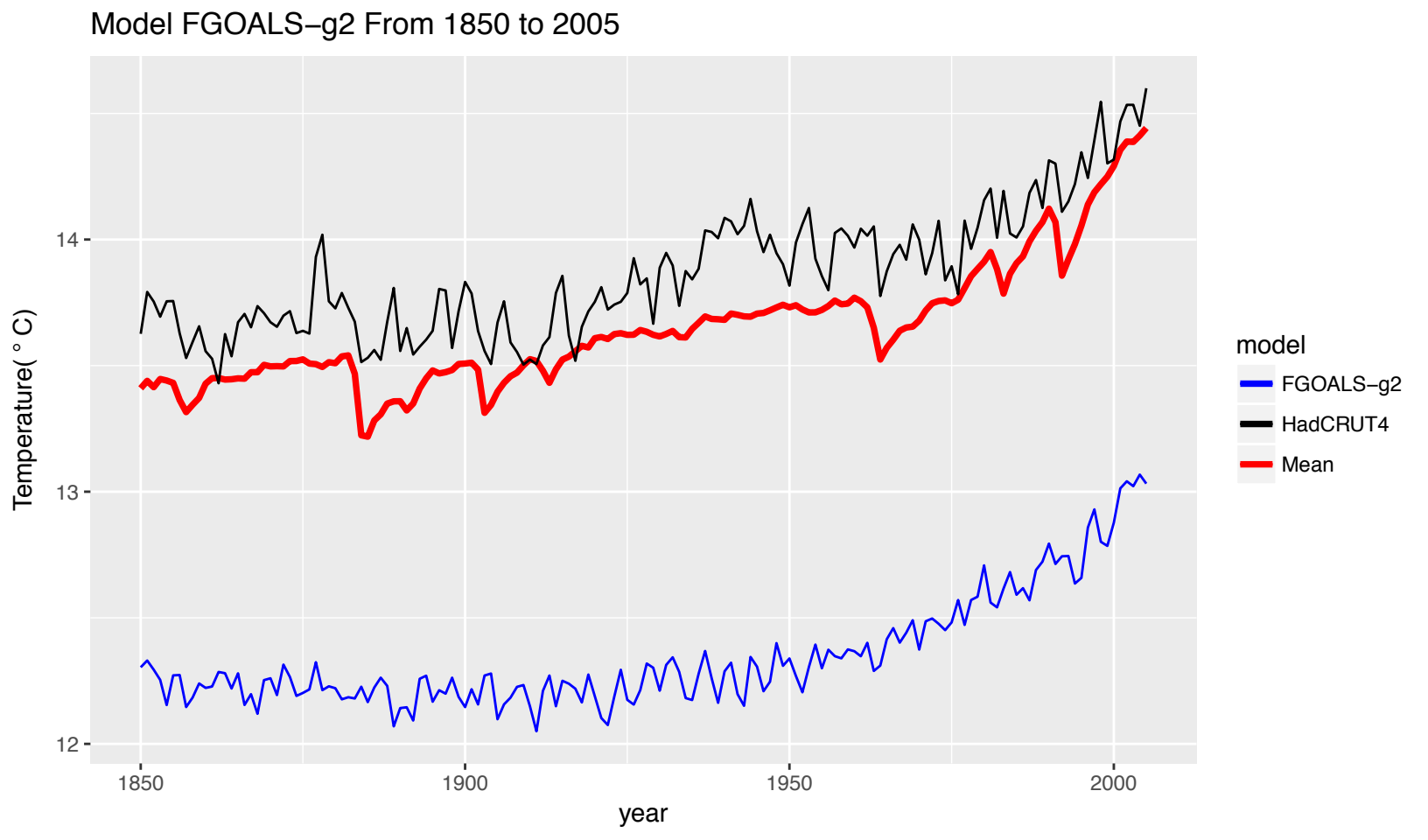

Model CSIRO−Mk3−6−0 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1880
1920
1960
2000
year
model
CSIRO−Mk3−6−0
HadCRUT4
Mean

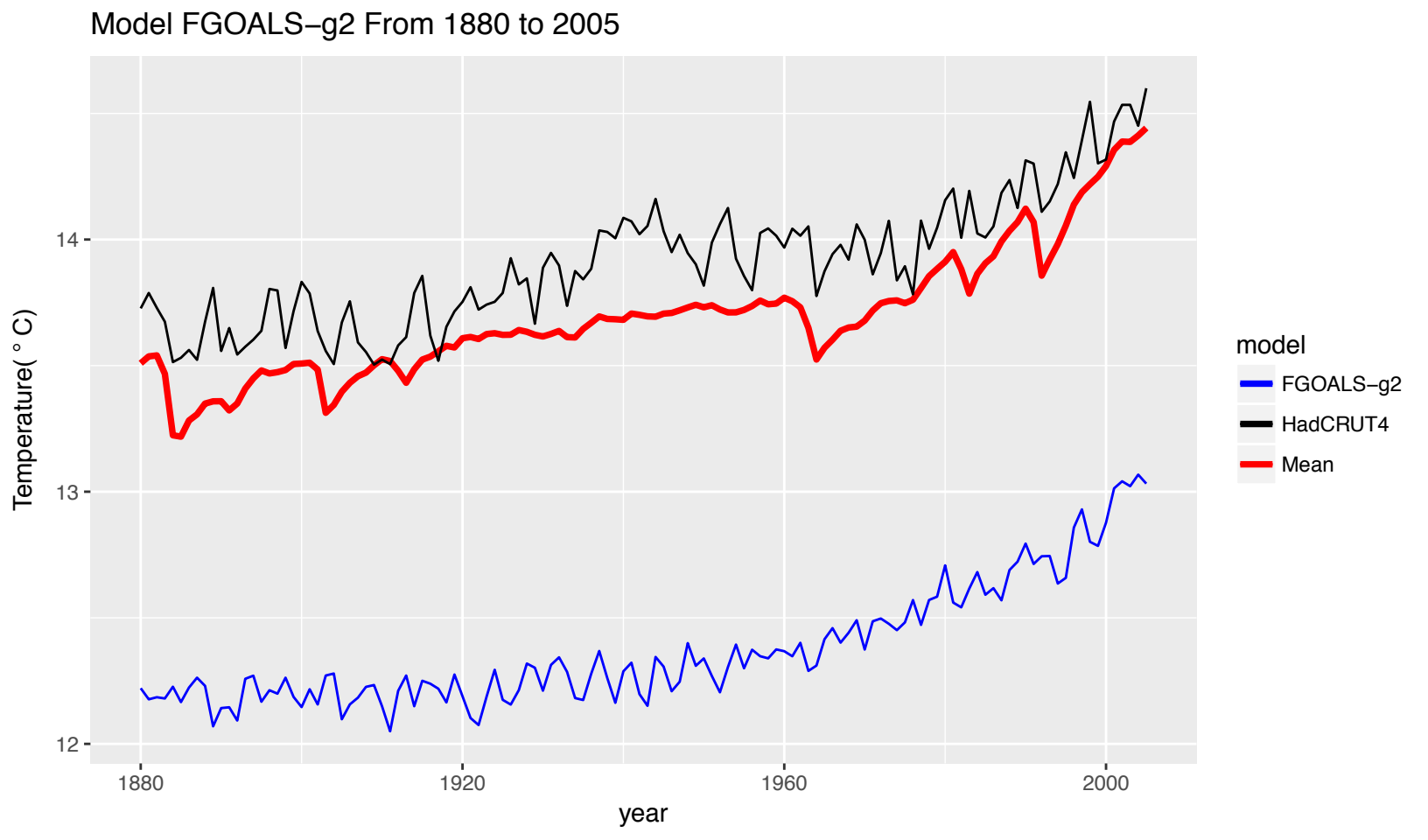

Model CSIRO−Mk3−6−0 From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
CSIRO−Mk3−6−0
HadCRUT4
Mean

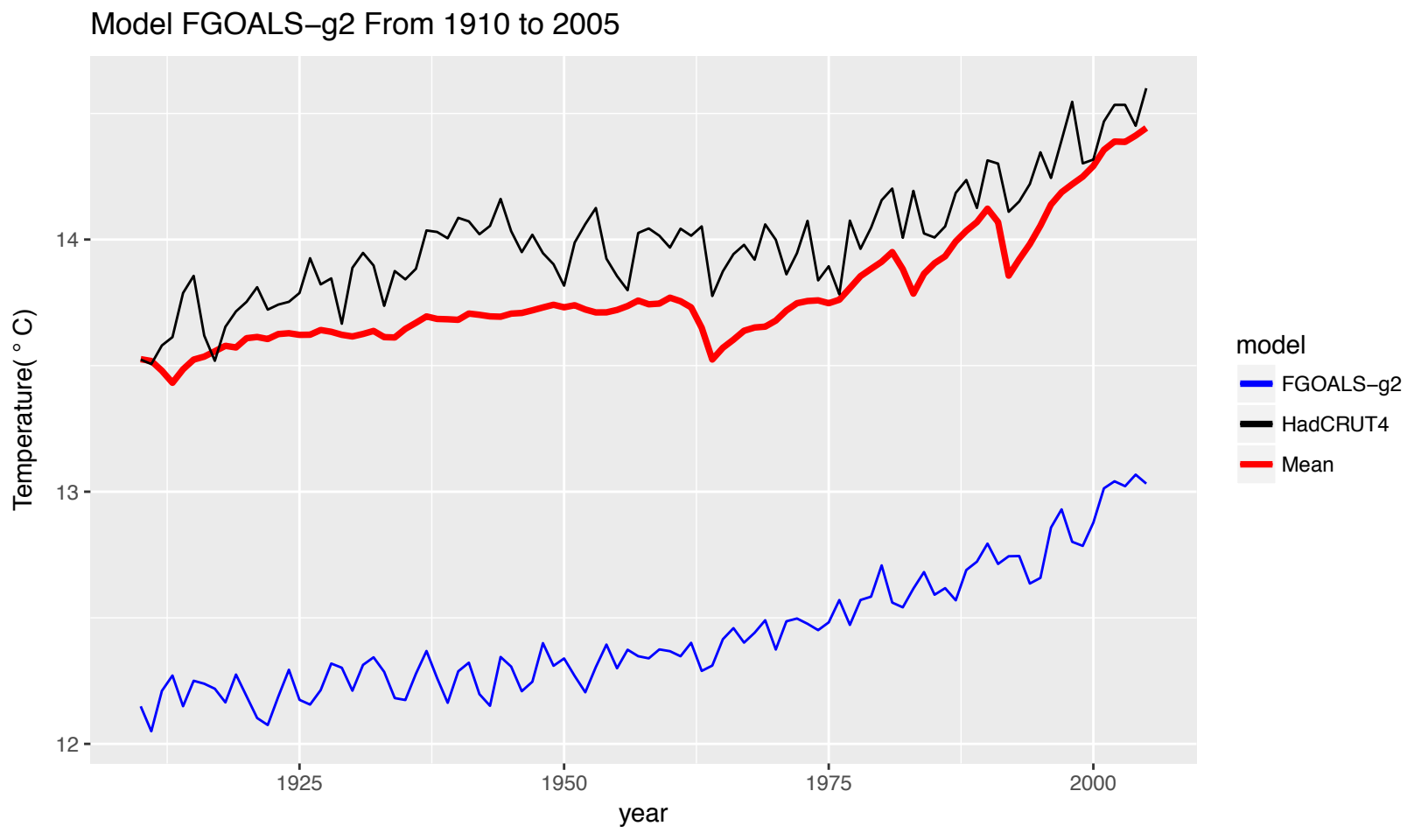

Model EC−EARTH From 1850 to 2005
Temperature(° C)
14
13
1850
1900
1950
2000
year
model
EC−EARTH
HadCRUT4
Mean

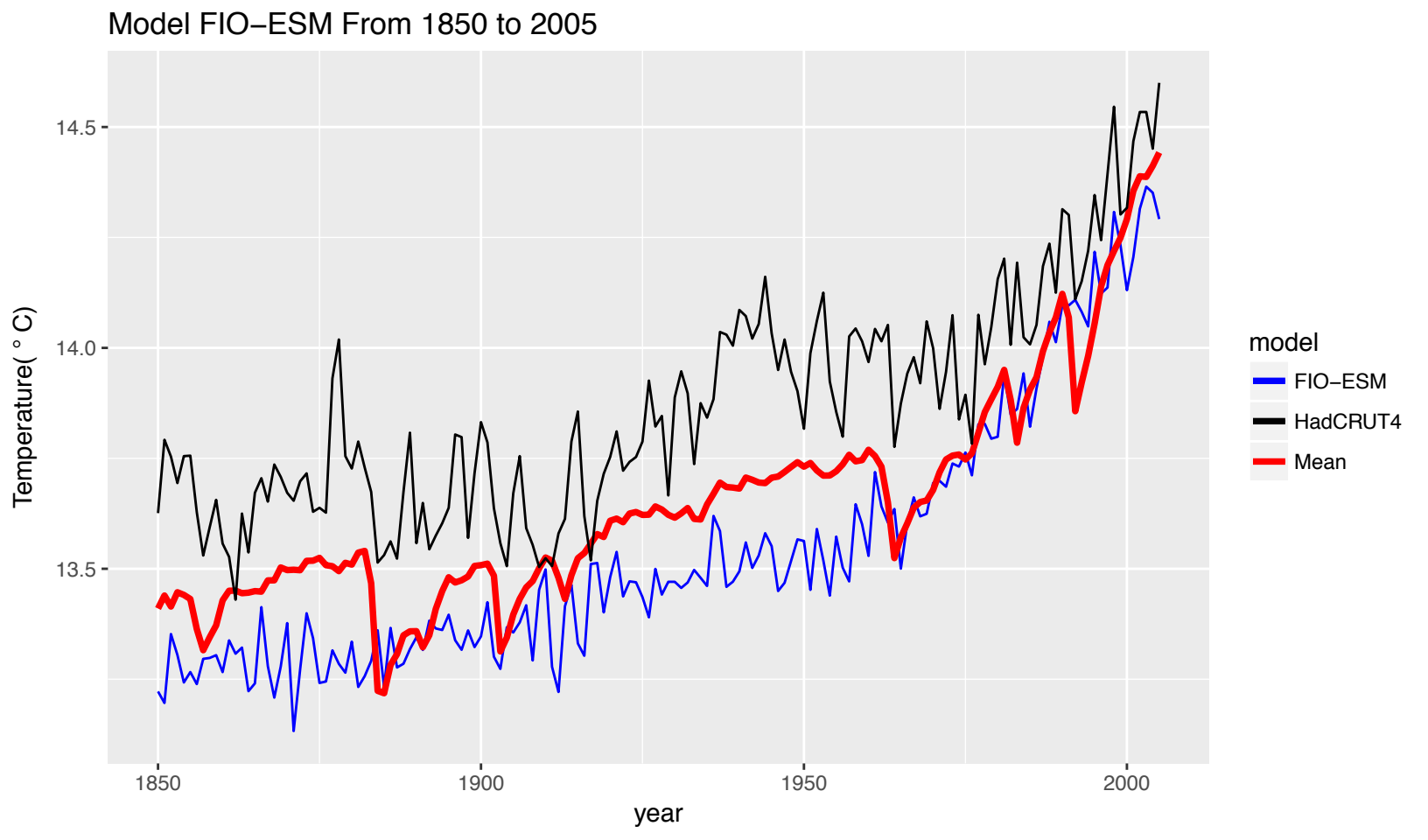

Model EC−EARTH From 1880 to 2005
Temperature(° C)
14
13
1880
1920
1960
2000
year
model
EC−EARTH
HadCRUT4
Mean

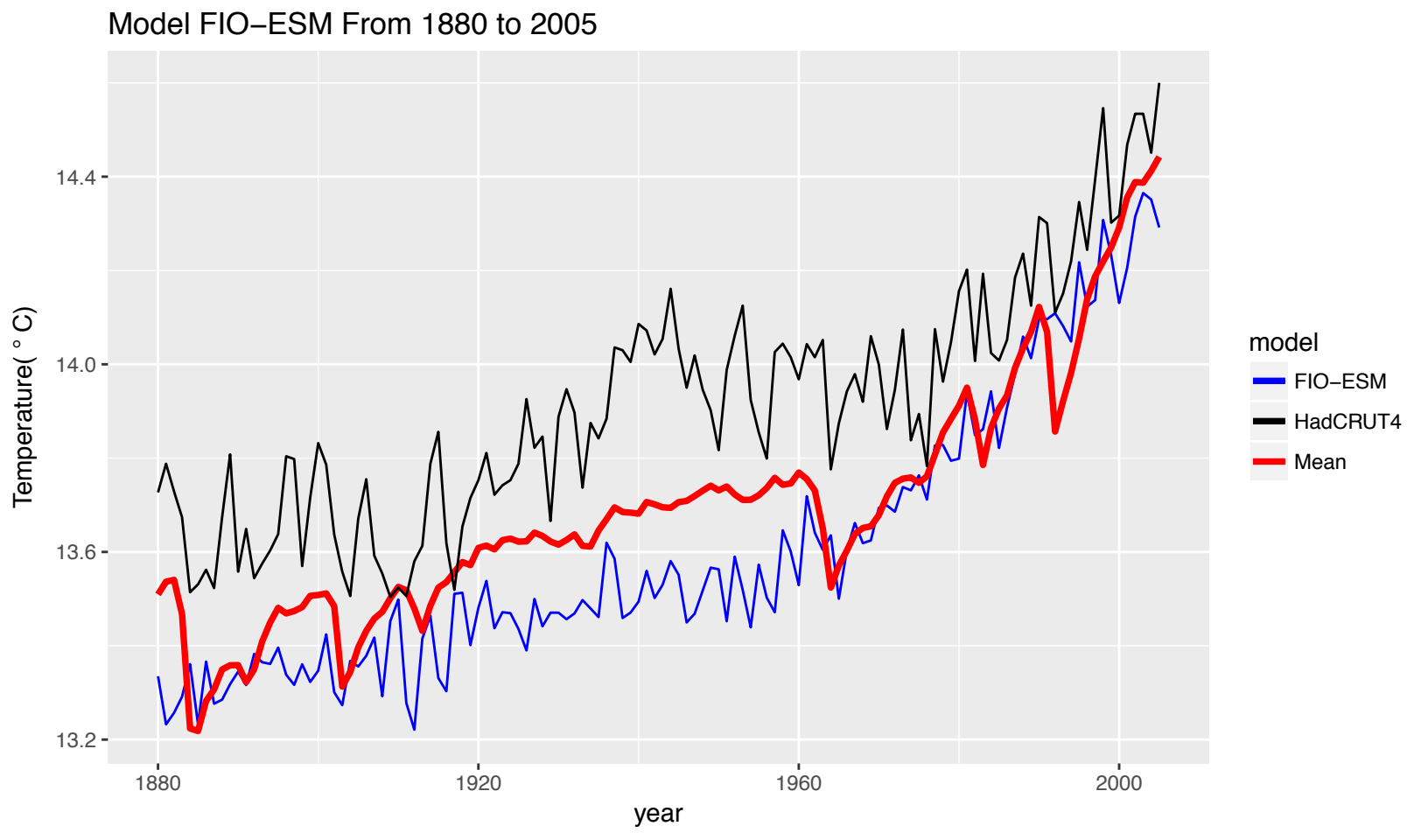

Model EC−EARTH From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1925
1950
1975
2000
year
model
EC−EARTH
HadCRUT4
Mean

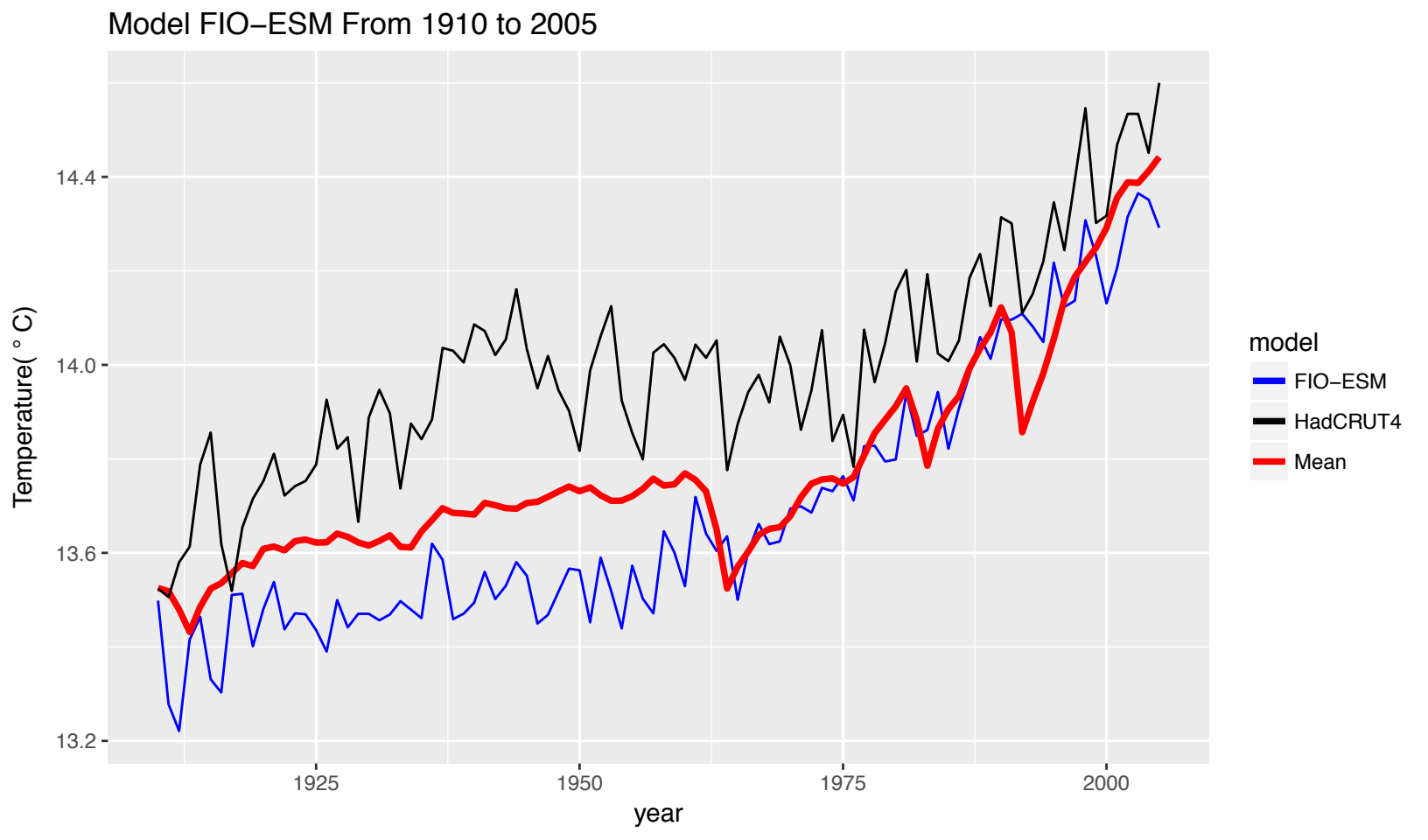

Model FGOALS−g2 From 1850 to 2005
Temperature(° C)
14
13
12
1850
1900
1950
2000
year
model
FGOALS−g2
HadCRUT4
Mean

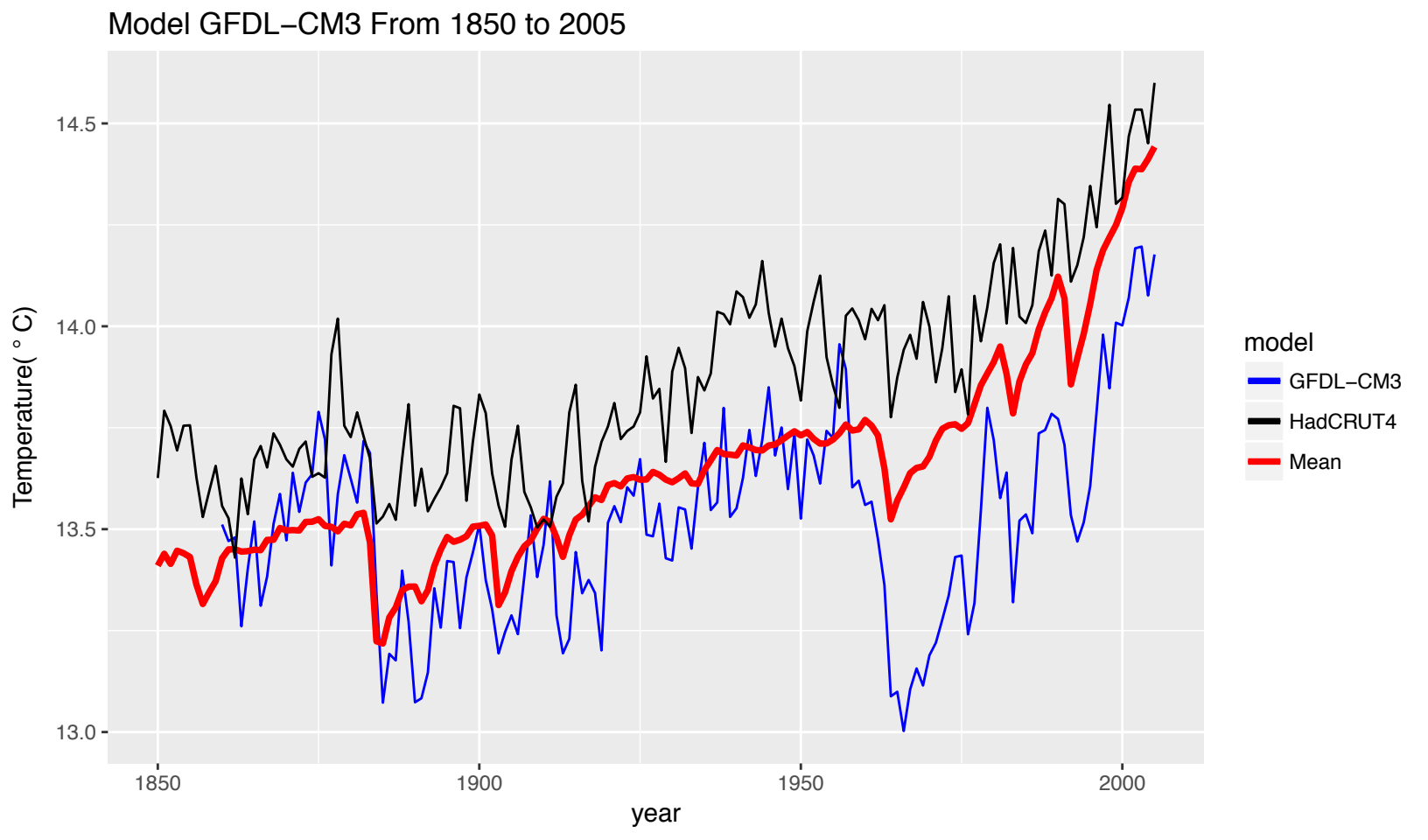

Model FGOALS−g2 From 1880 to 2005
Temperature(° C)
14
13
12
1880
1920
1960
2000
year
model
FGOALS−g2
HadCRUT4
Mean

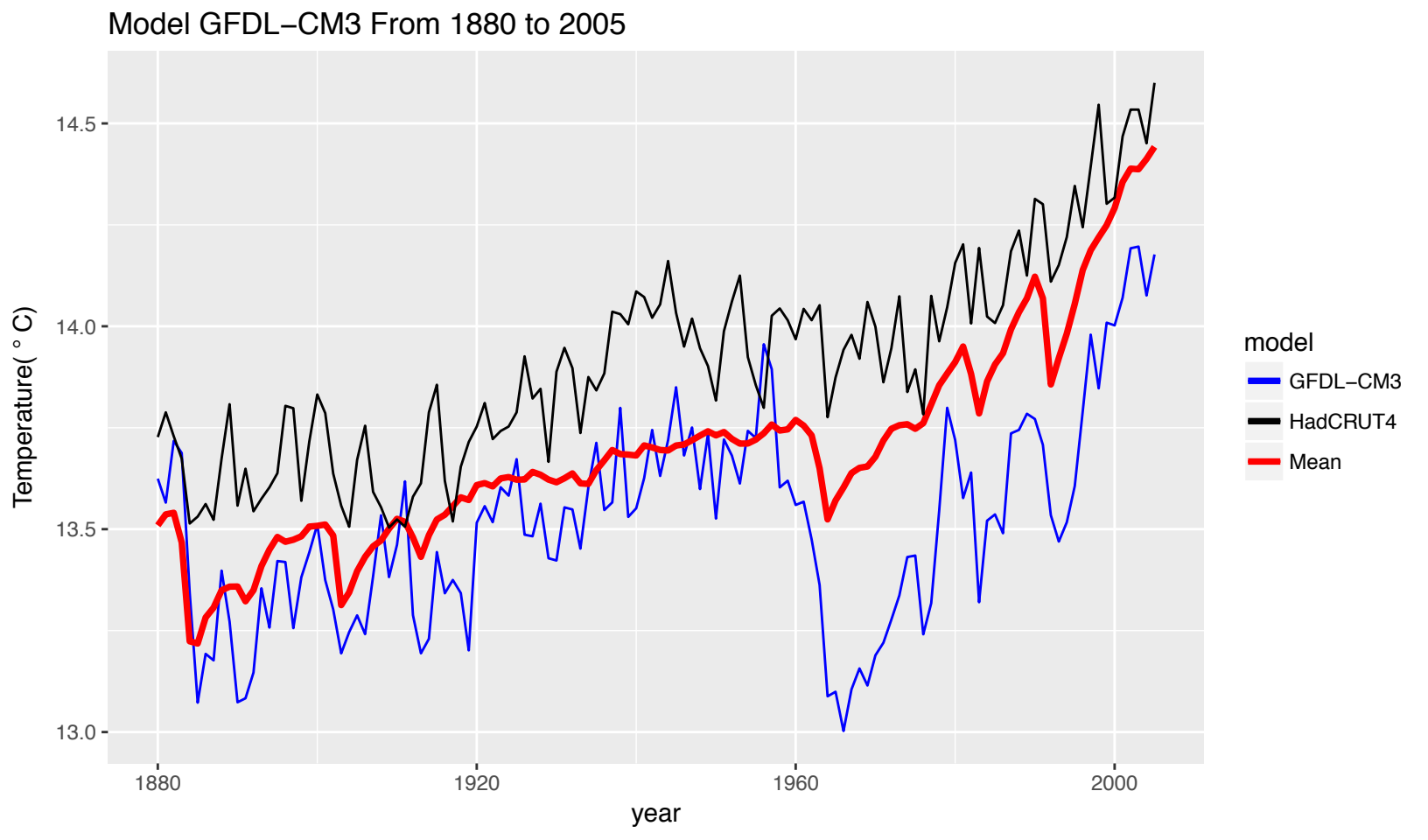

Model FGOALS−g2 From 1910 to 2005
Temperature(° C)
14
13
12
1925
1950
1975
2000
year
model
FGOALS−g2
HadCRUT4
Mean

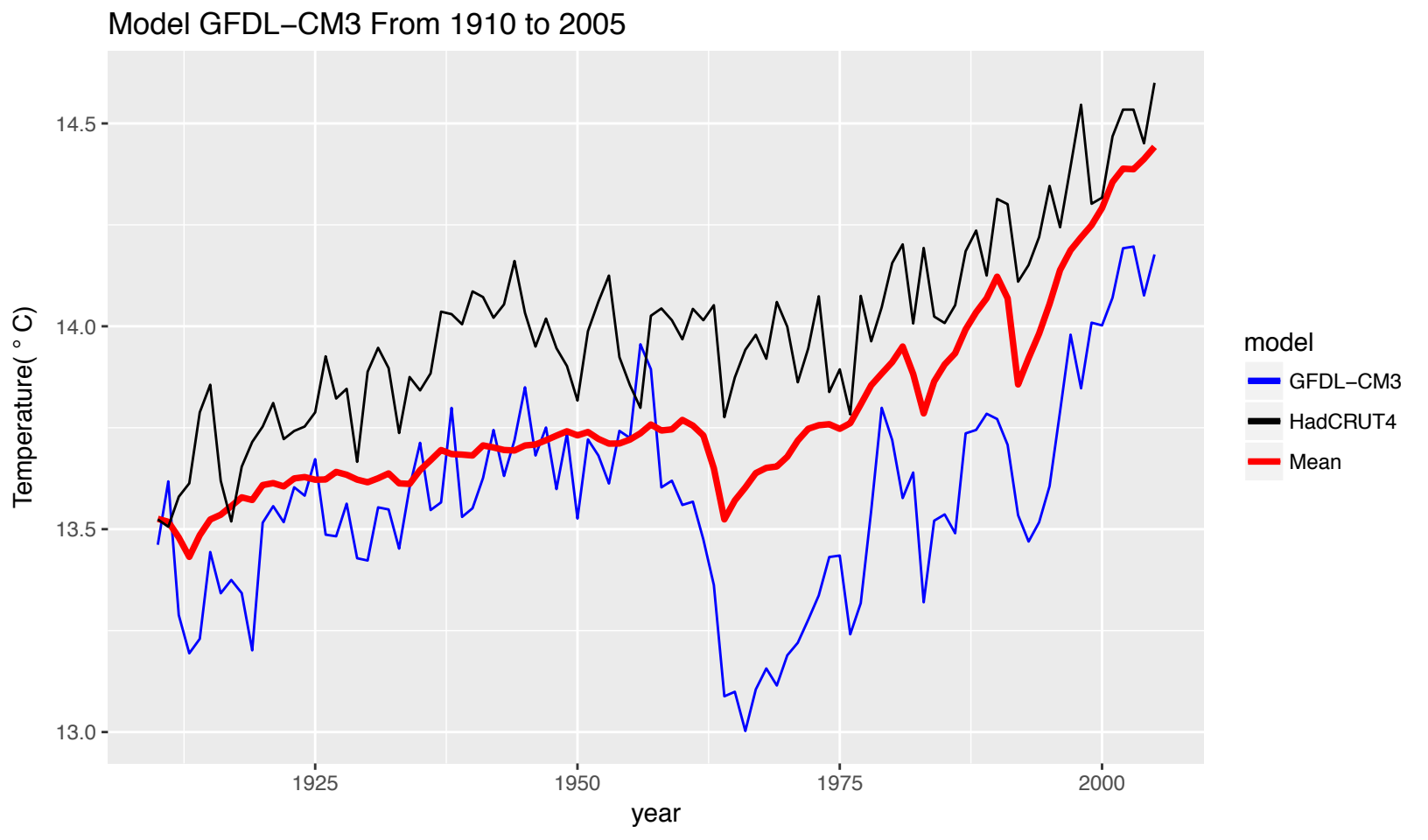

Model FIO−ESM From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
1850
1900
1950
2000
year
model
FIO−ESM
HadCRUT4
Mean

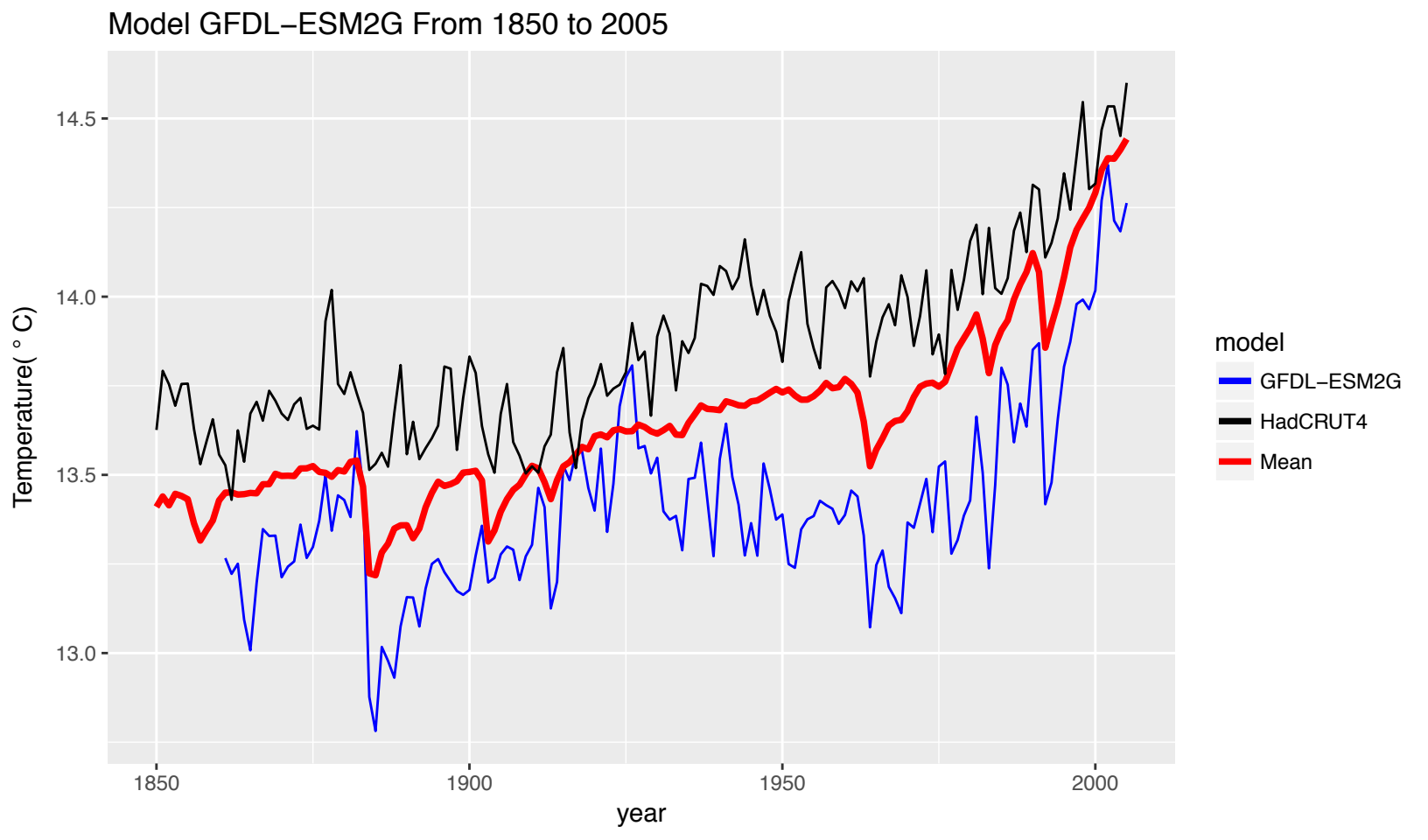

Model FIO−ESM From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
FIO−ESM
HadCRUT4
Mean

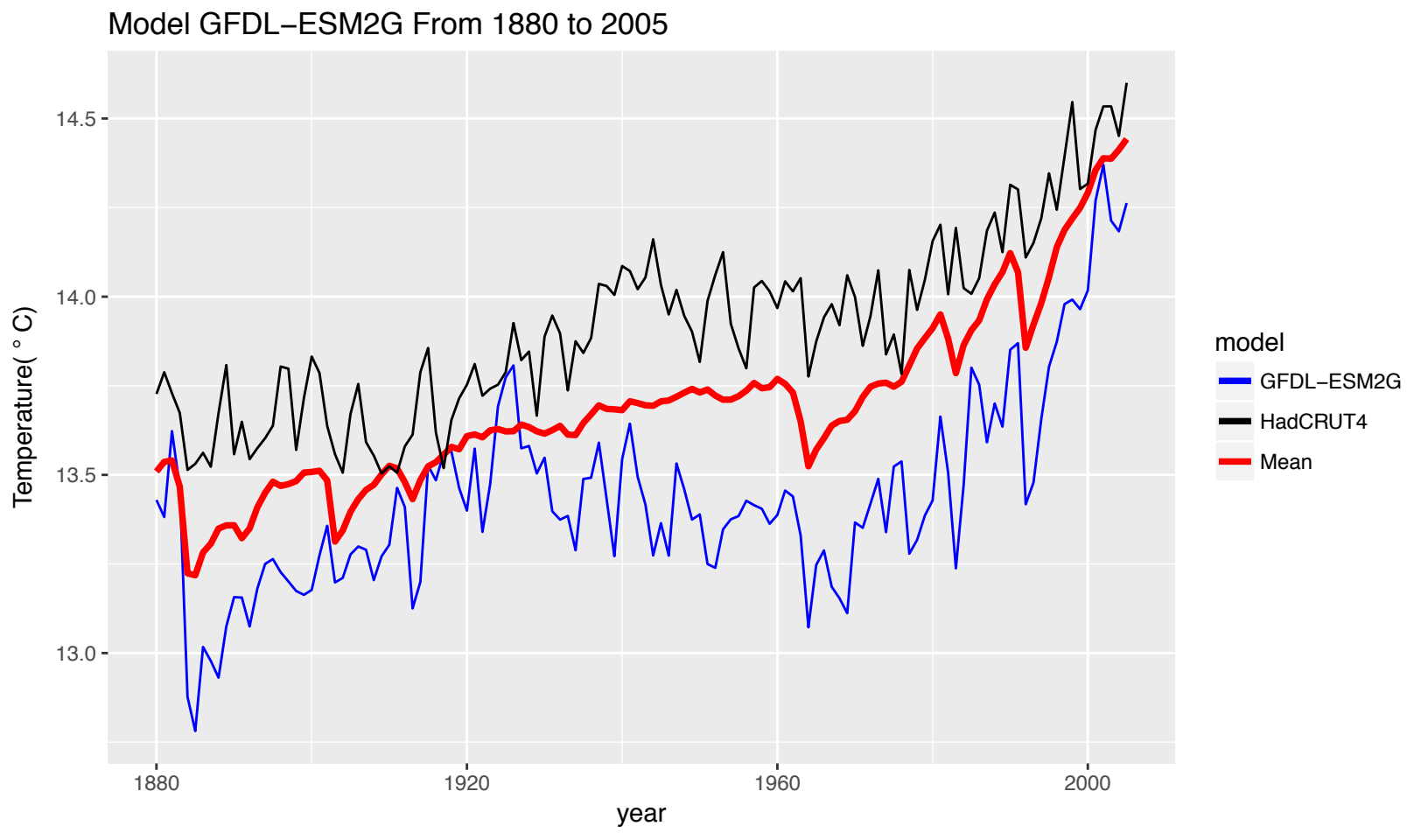

Model FIO−ESM From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1925
1950
1975
2000
year
model
FIO−ESM
HadCRUT4
Mean

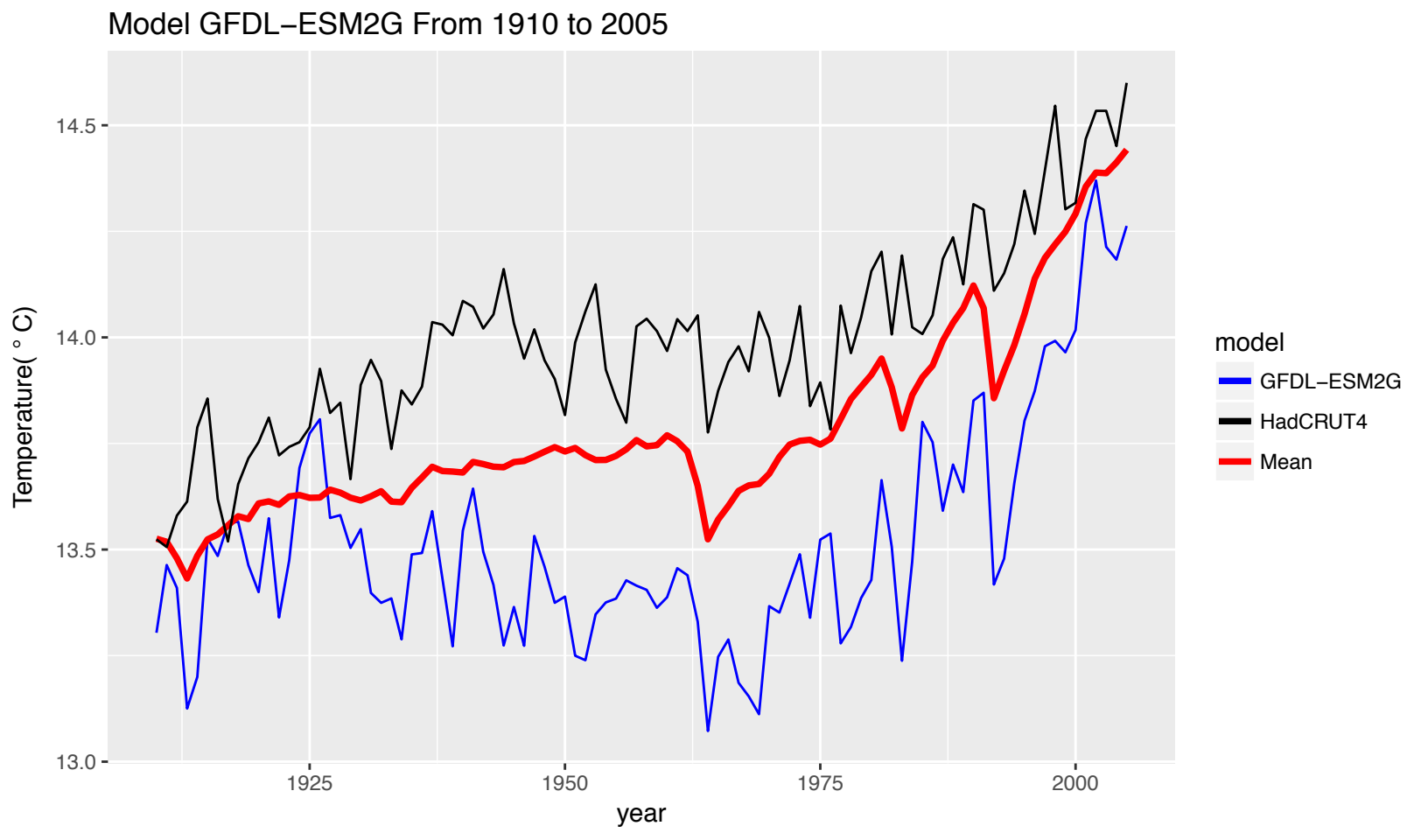

Model GFDL−CM3 From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
GFDL−CM3
HadCRUT4
Mean

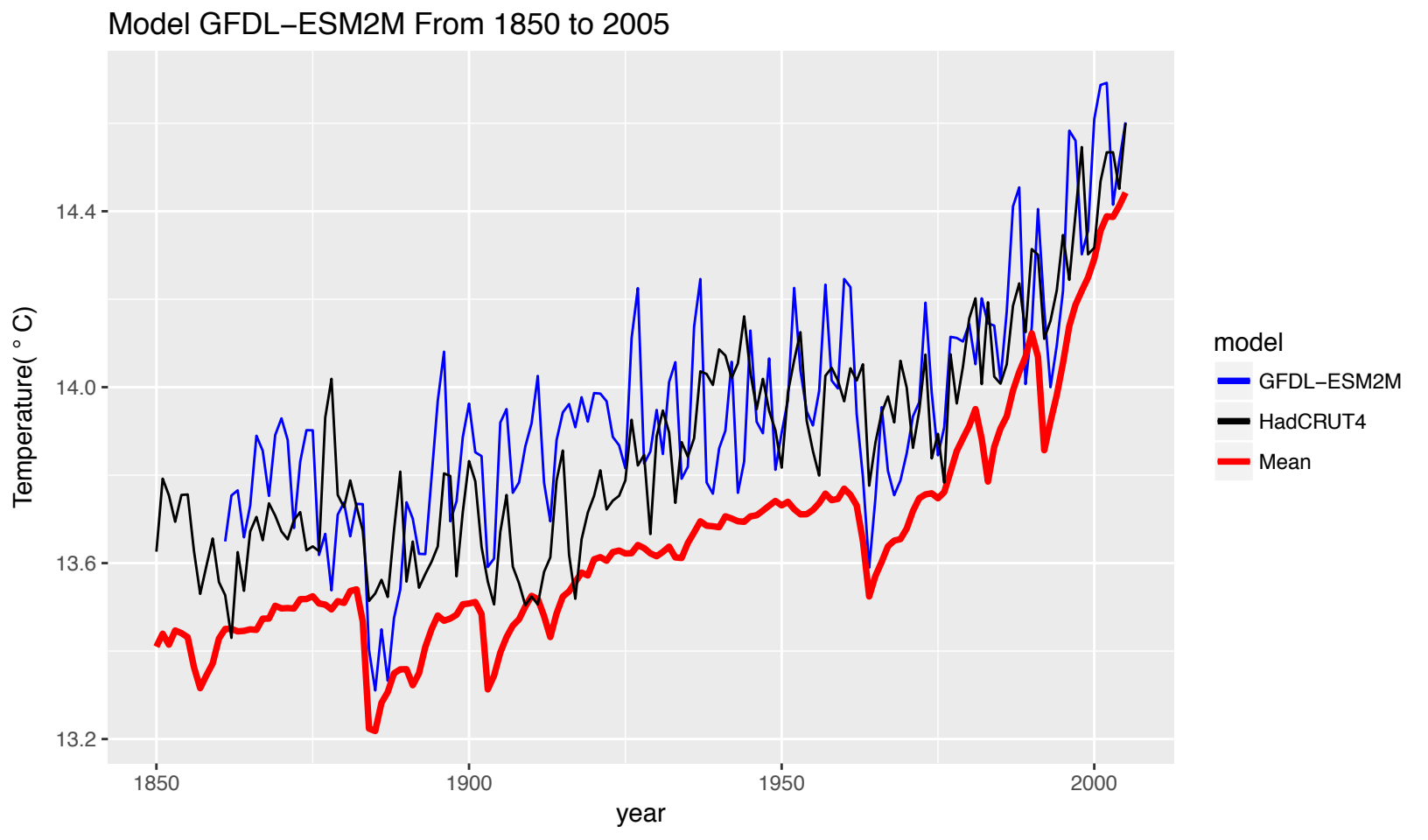

Model GFDL−CM3 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
GFDL−CM3
HadCRUT4
Mean

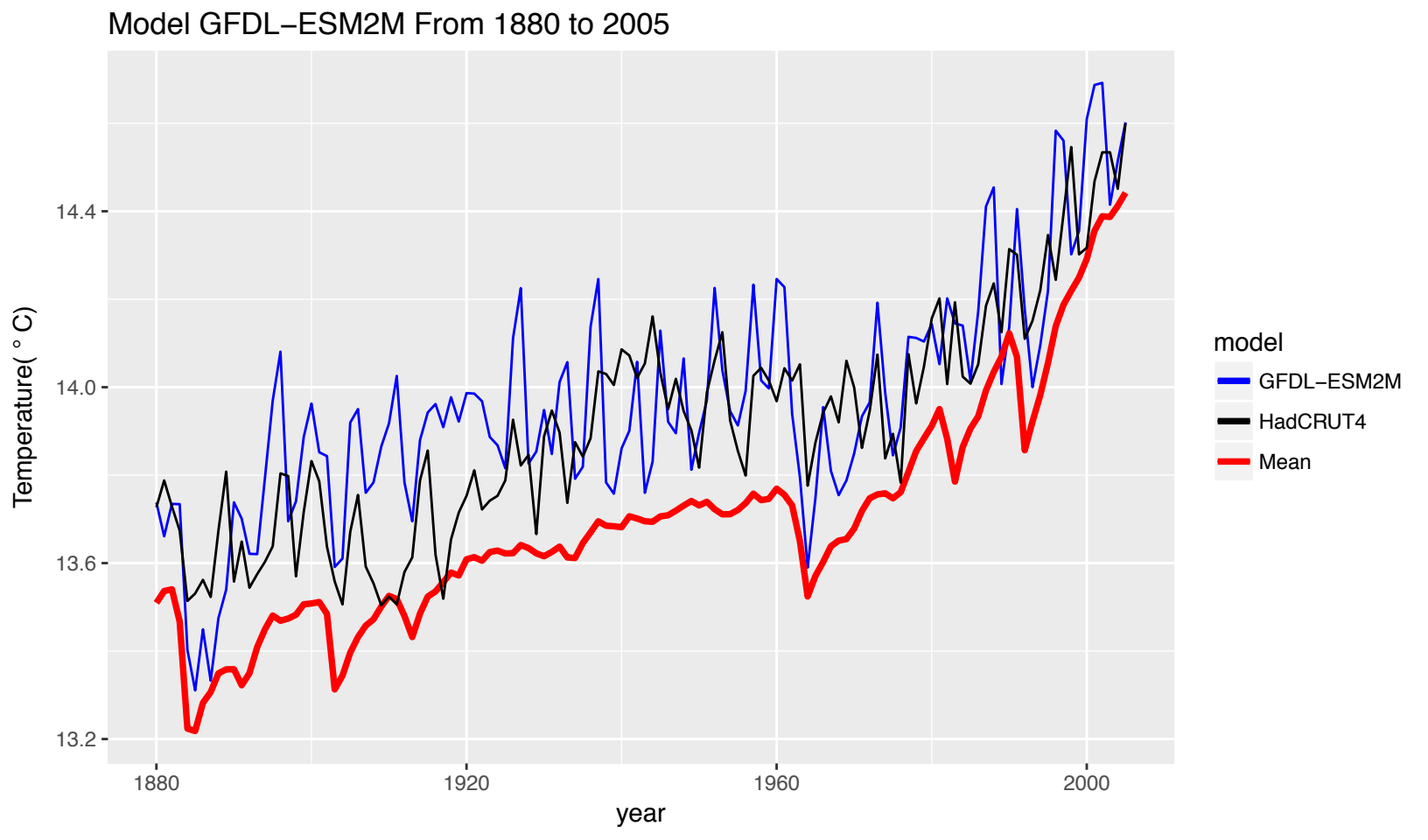

Model GFDL−CM3 From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
GFDL−CM3
HadCRUT4
Mean

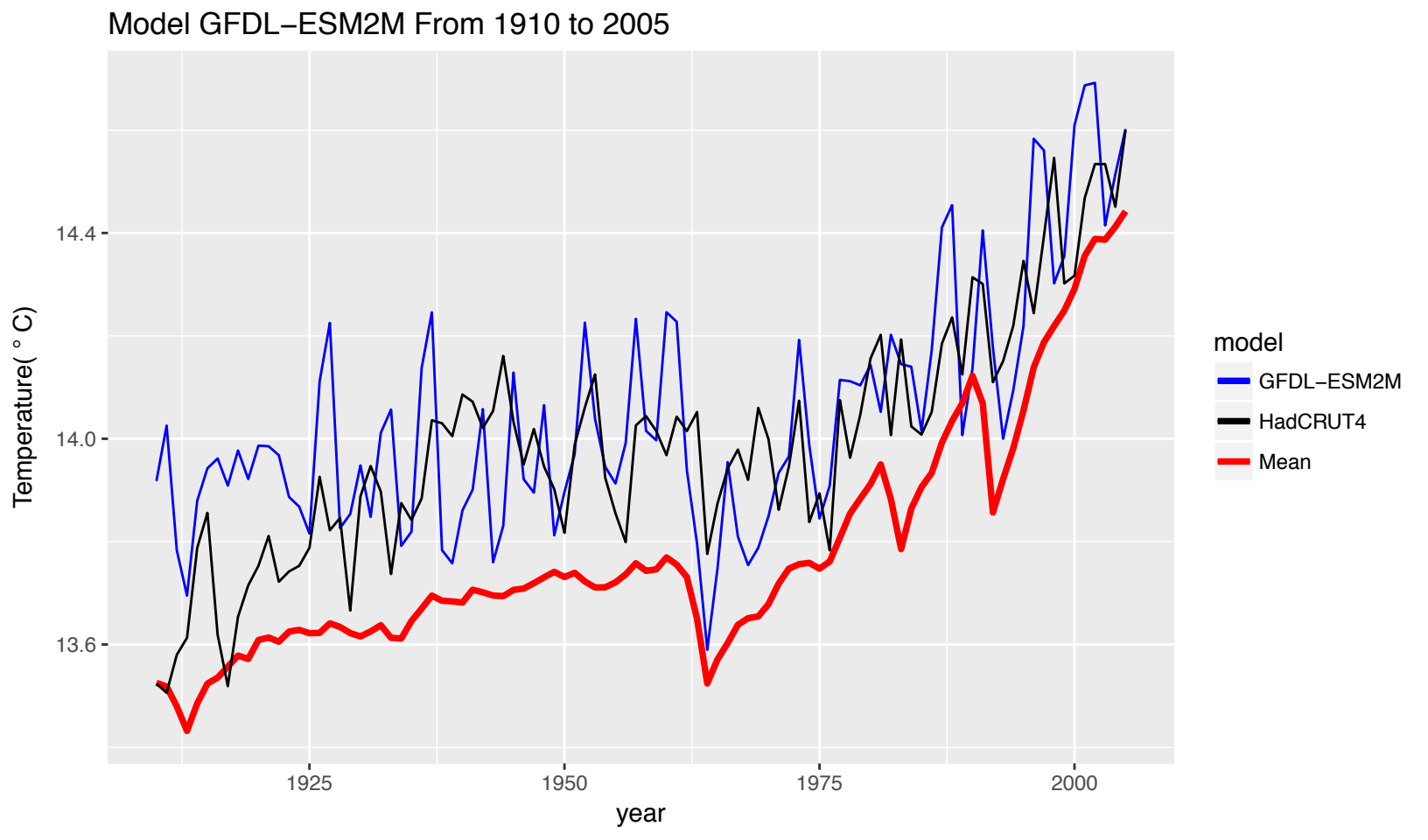

Model GFDL−ESM2G From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
GFDL−ESM2G
HadCRUT4
Mean

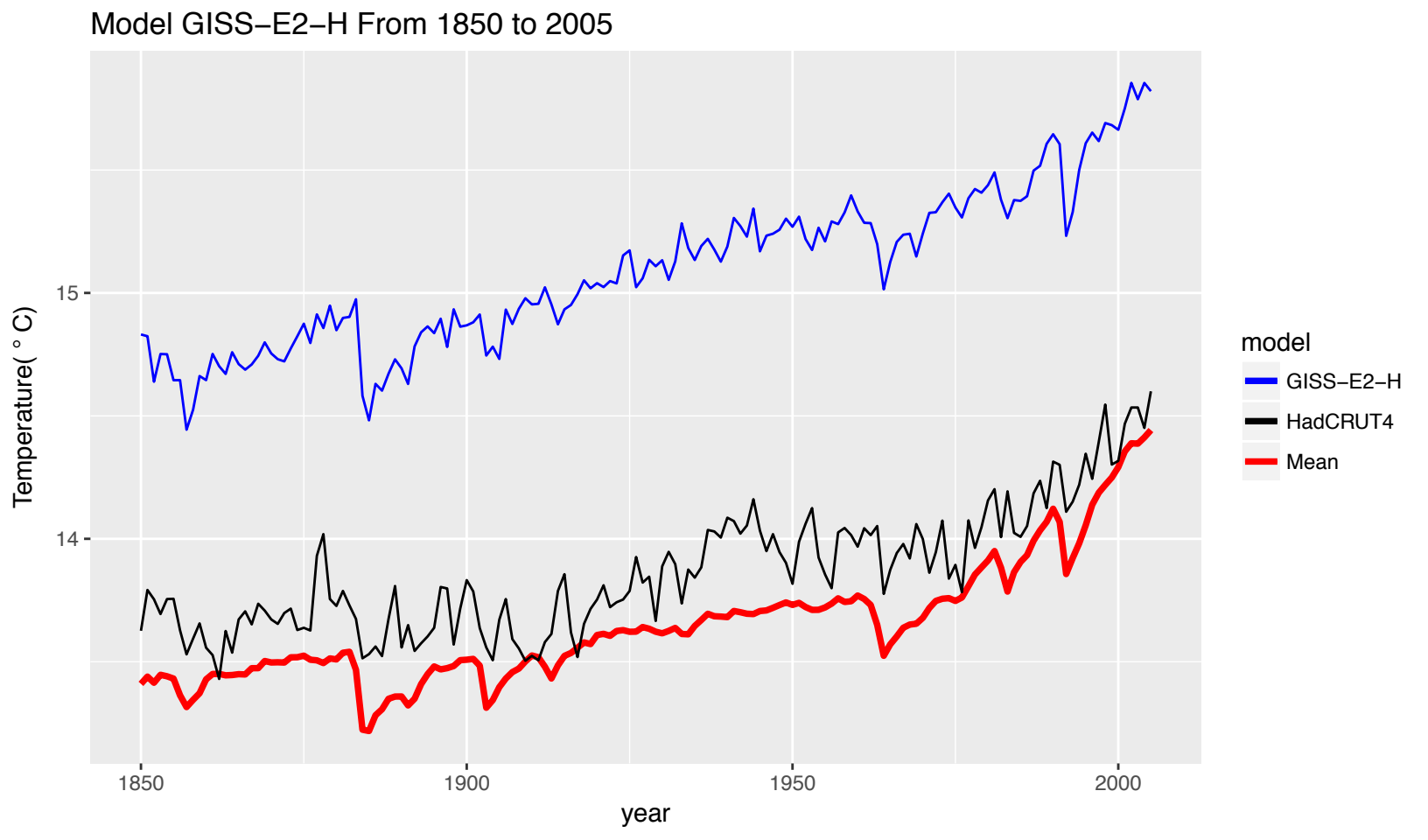

Model GFDL−ESM2G From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
GFDL−ESM2G
HadCRUT4
Mean

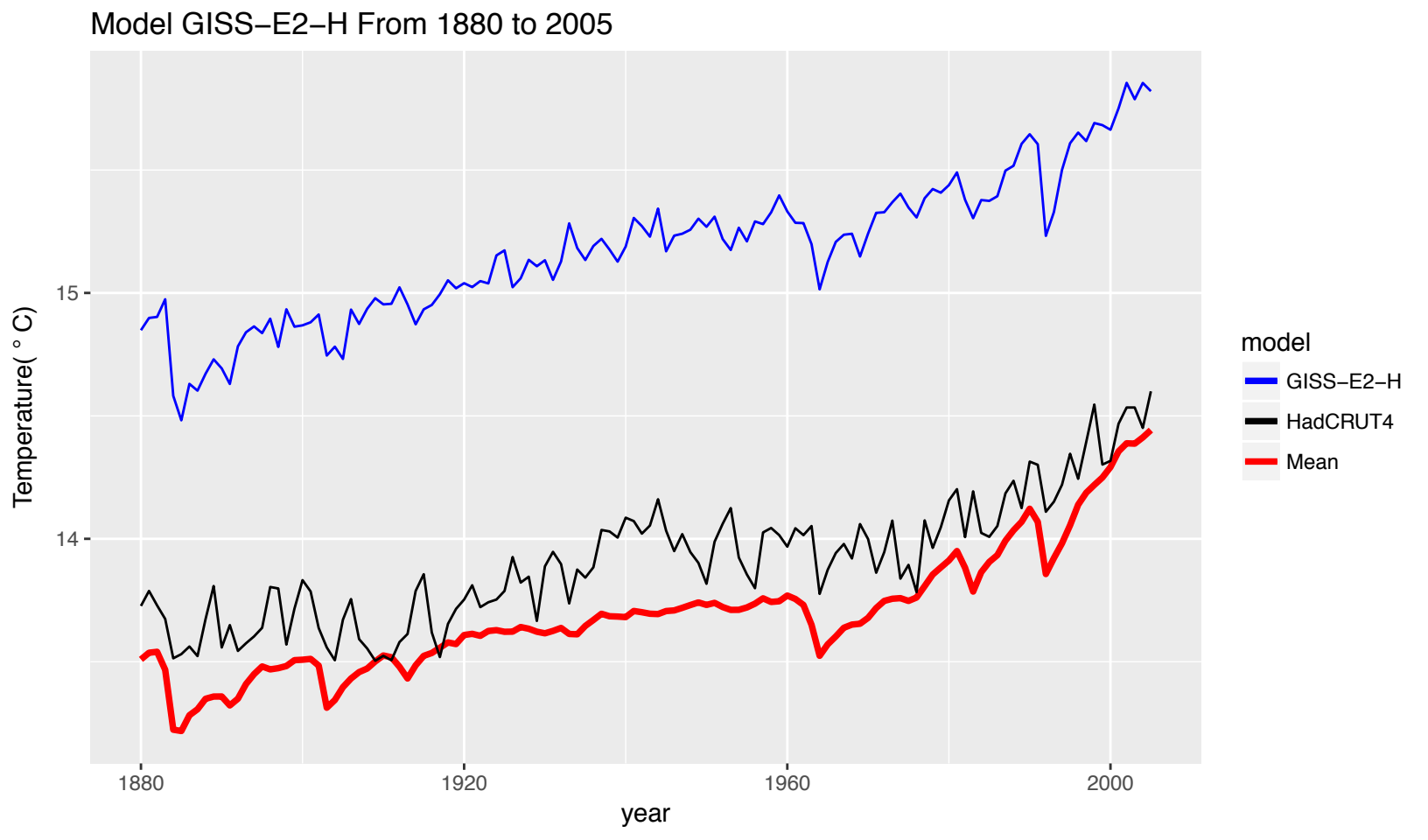

Model GFDL−ESM2G From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
GFDL−ESM2G
HadCRUT4
Mean

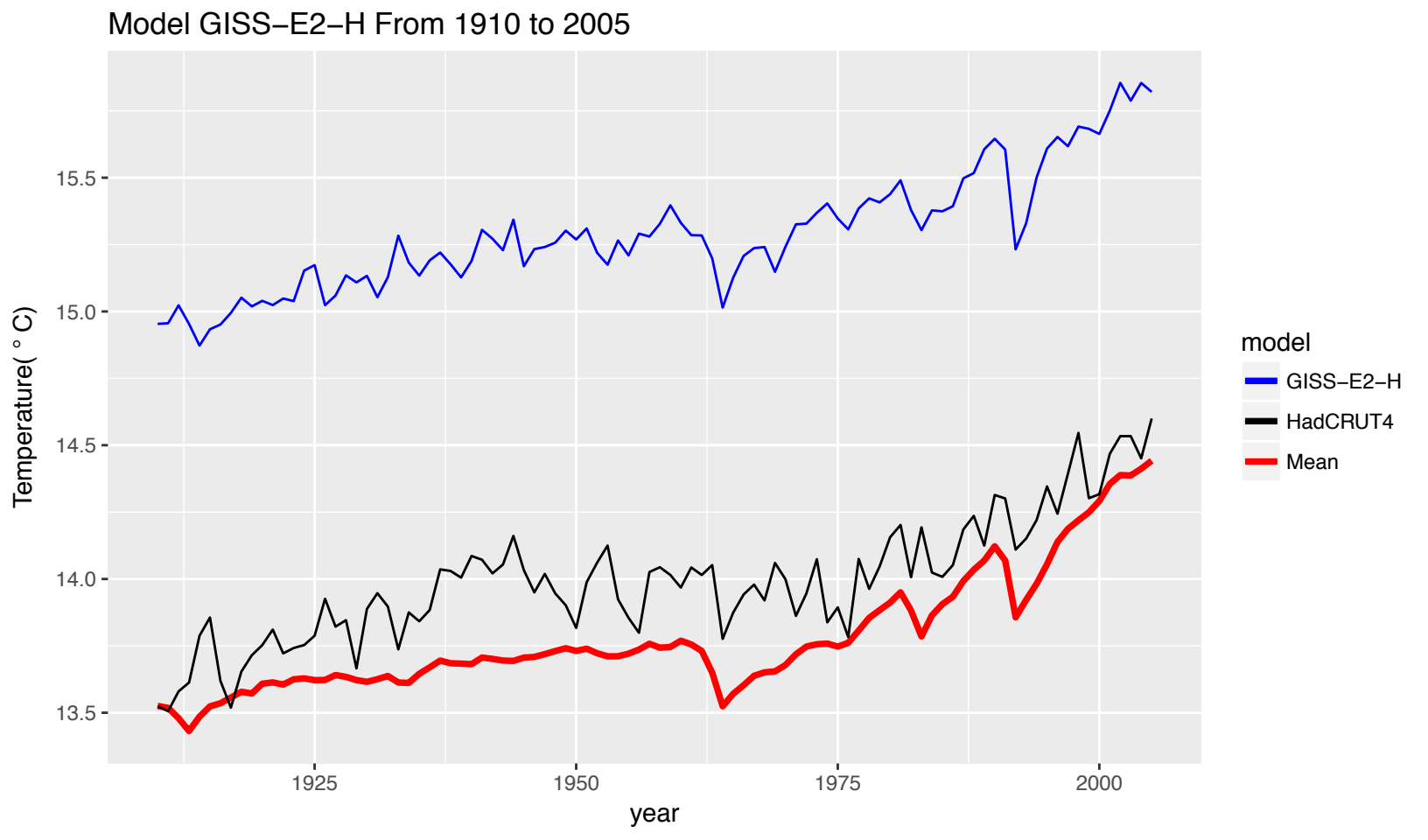

Model GFDL−ESM2M From 1850 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1850
1900
1950
2000
year
model
GFDL−ESM2M
HadCRUT4
Mean

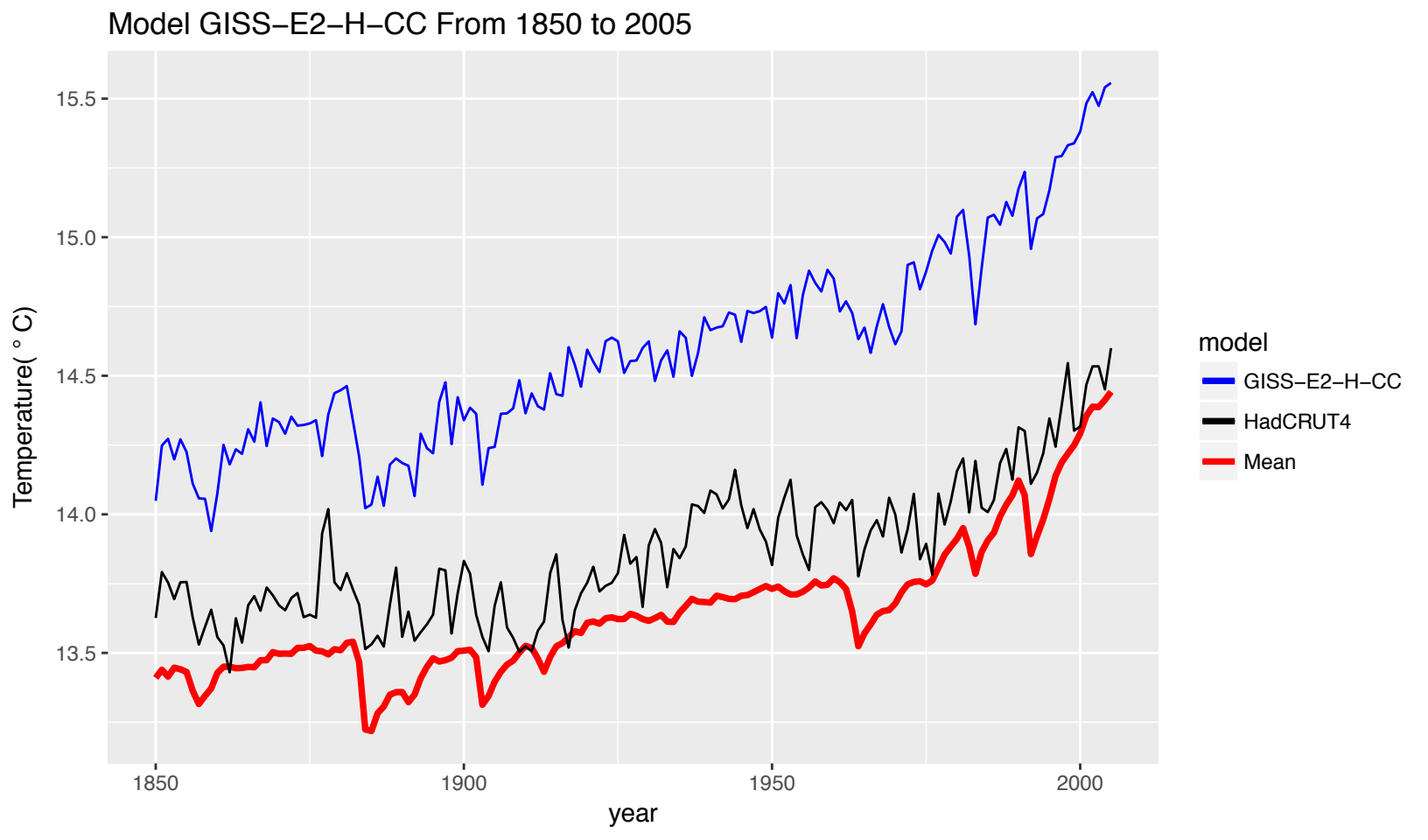

Model GFDL−ESM2M From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
GFDL−ESM2M
HadCRUT4
Mean

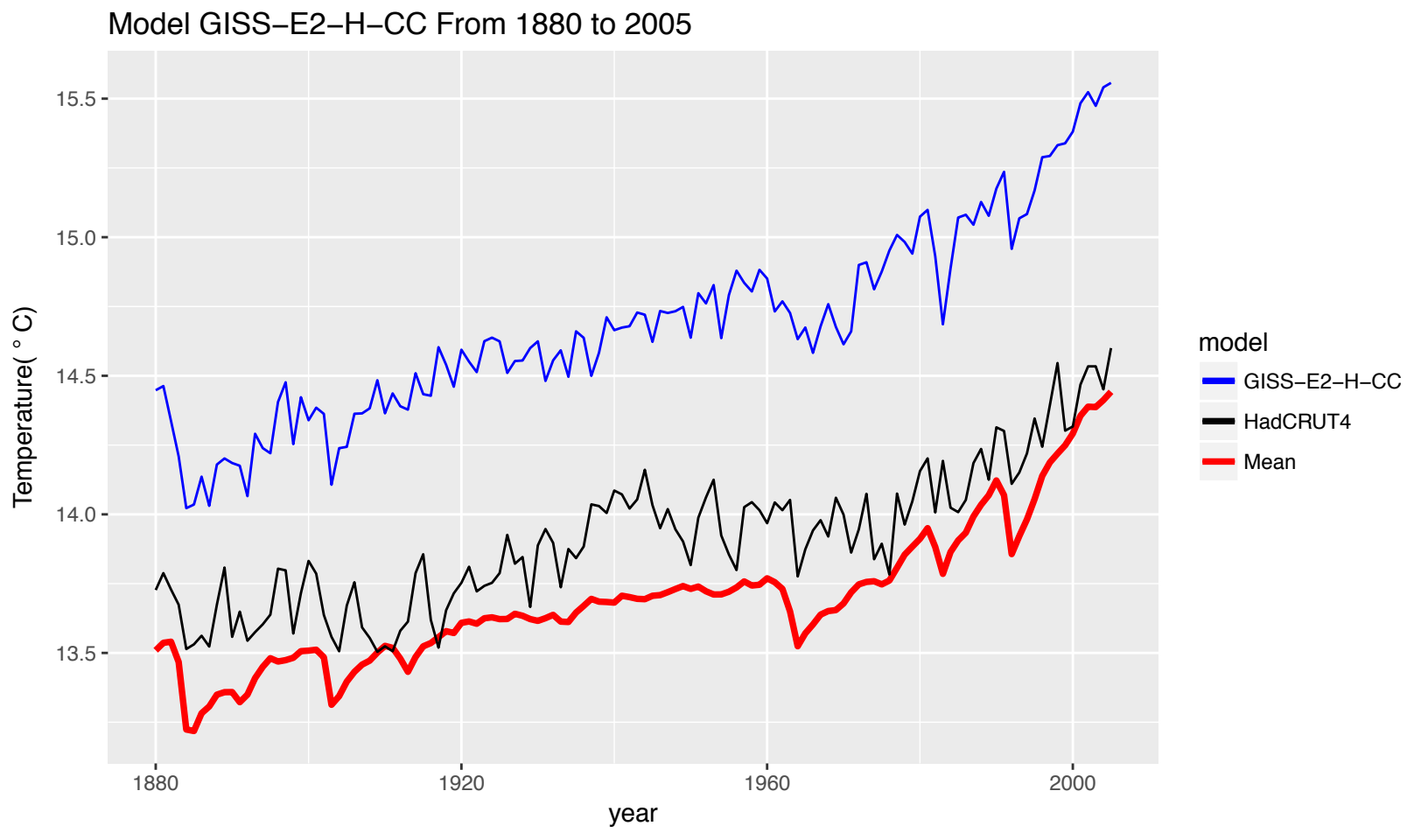

Model GFDL−ESM2M From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
1925
1950
1975
2000
year
model
GFDL−ESM2M
HadCRUT4
Mean

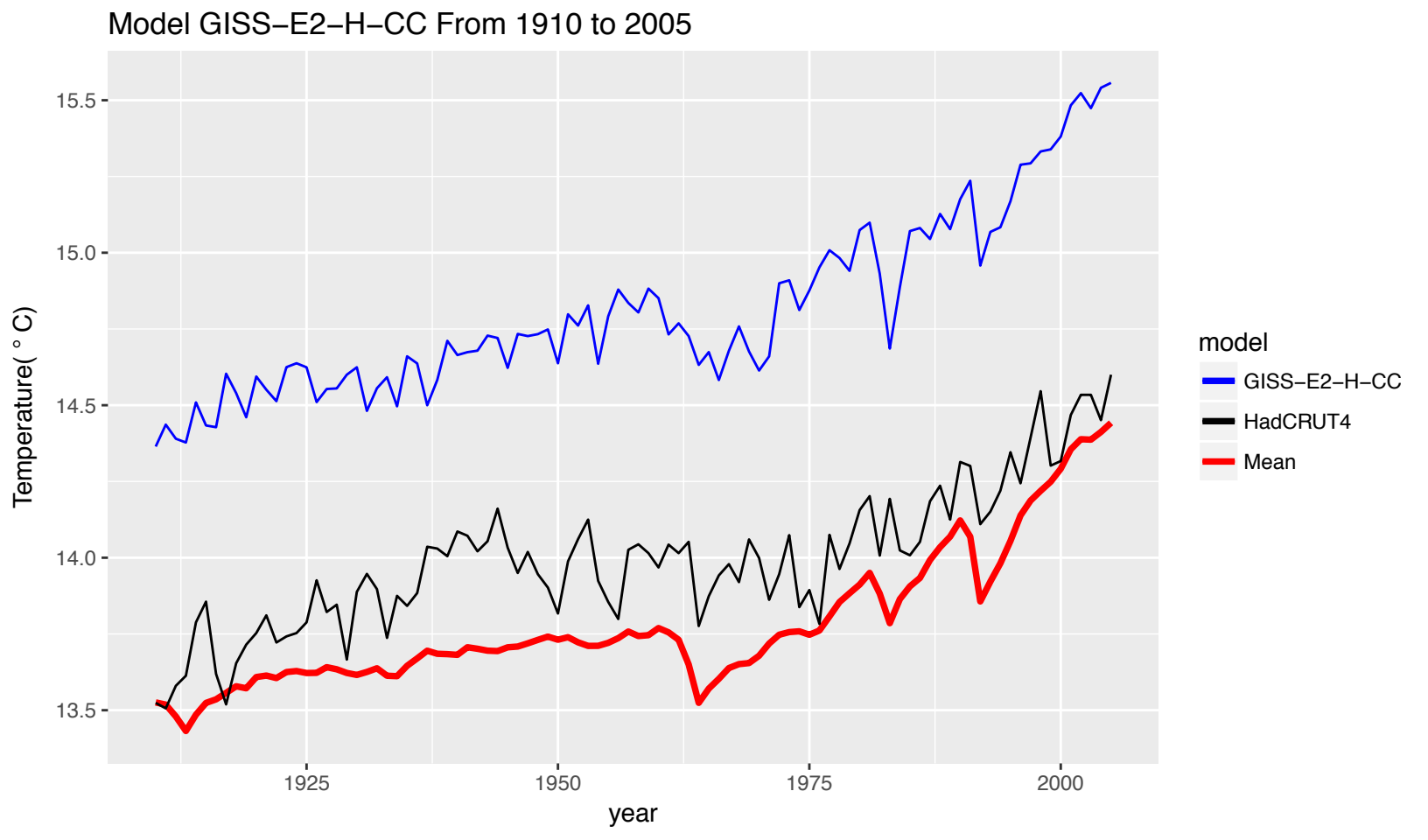

Model GISS−E2−H From 1850 to 2005
Temperature(° C)
15
14
1850
1900
1950
2000
year
model
GISS−E2−H
HadCRUT4
Mean

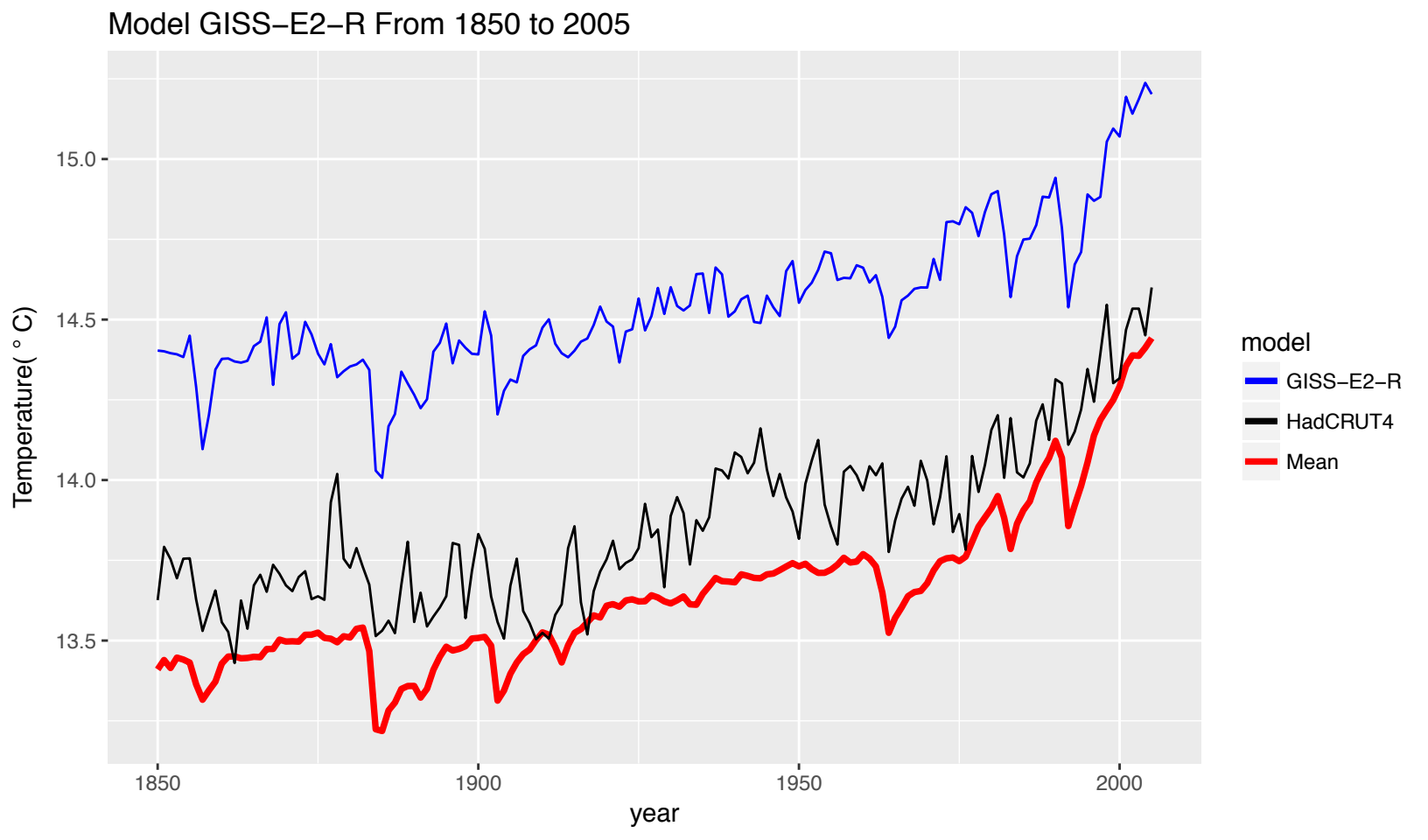

Model GISS−E2−H From 1880 to 2005
Temperature(° C)
15
14
1880
1920
1960
2000
year
model
GISS−E2−H
HadCRUT4
Mean


Model GISS−E2−H From 1910 to 2005
Temperature(° C)
15.5
15.0
14.5
14.0
13.5
1925
1950
1975
2000
year
model
GISS−E2−H
HadCRUT4
Mean


Model GISS−E2−H−CC From 1850 to 2005
Temperature(° C)
15.5
15.0
14.5
14.0
13.5
1850
1900
1950
2000
year
model
GISS−E2−H−CC
HadCRUT4
Mean


Model GISS−E2−H−CC From 1880 to 2005
15.5
15.0
14.5
14.0
13.5
Temperature(° C)
1880
1920
1960
2000
year
model
GISS−E2−H−CC
HadCRUT4
Mean


Model GISS−E2−H−CC From 1910 to 2005
15.5
15.0
14.5
14.0
13.5
Temperature(° C)
1925
1950
1975
2000
year
model
GISS−E2−H−CC
HadCRUT4
Mean


Model GISS−E2−R From 1850 to 2005
Temperature(° C)
15.0
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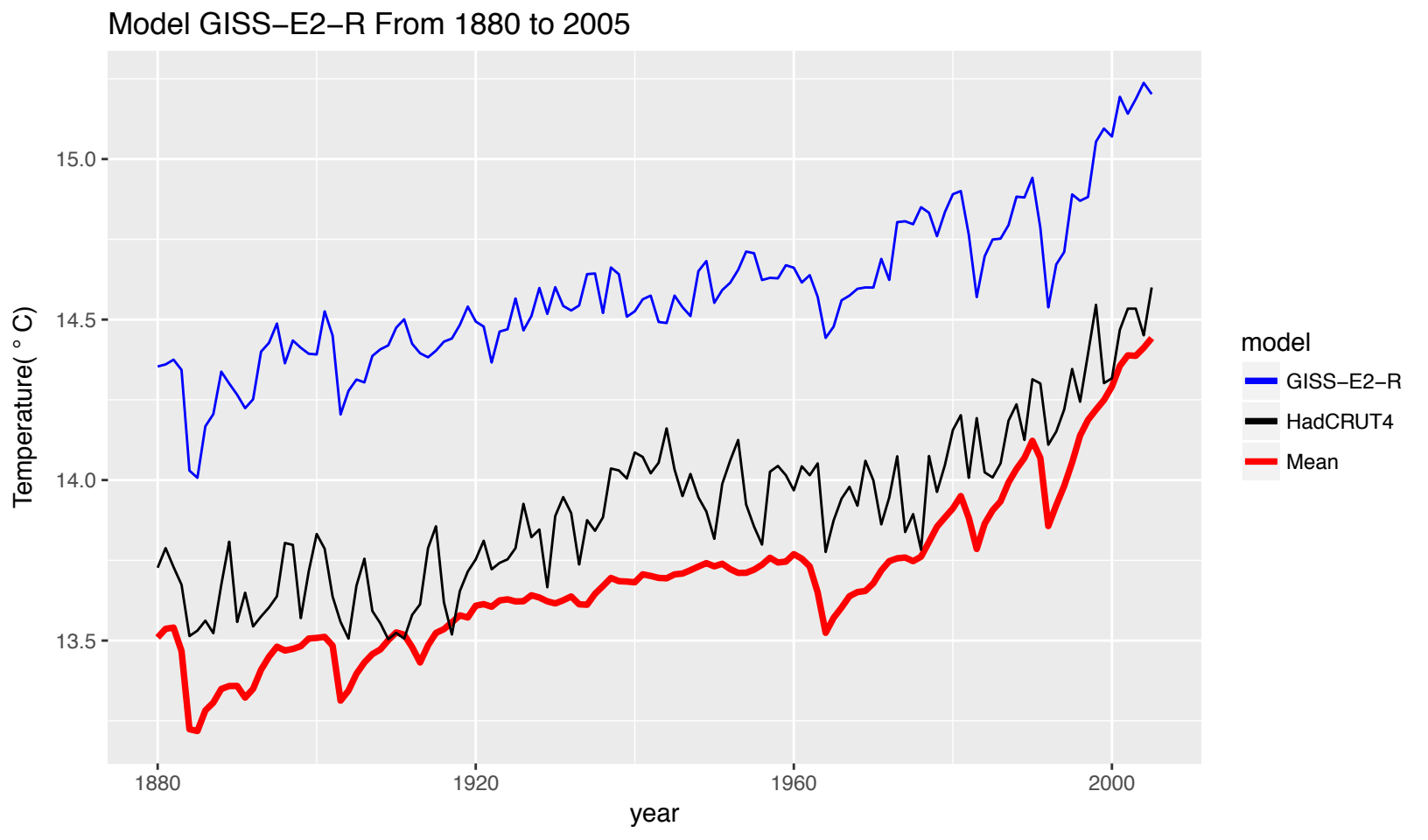
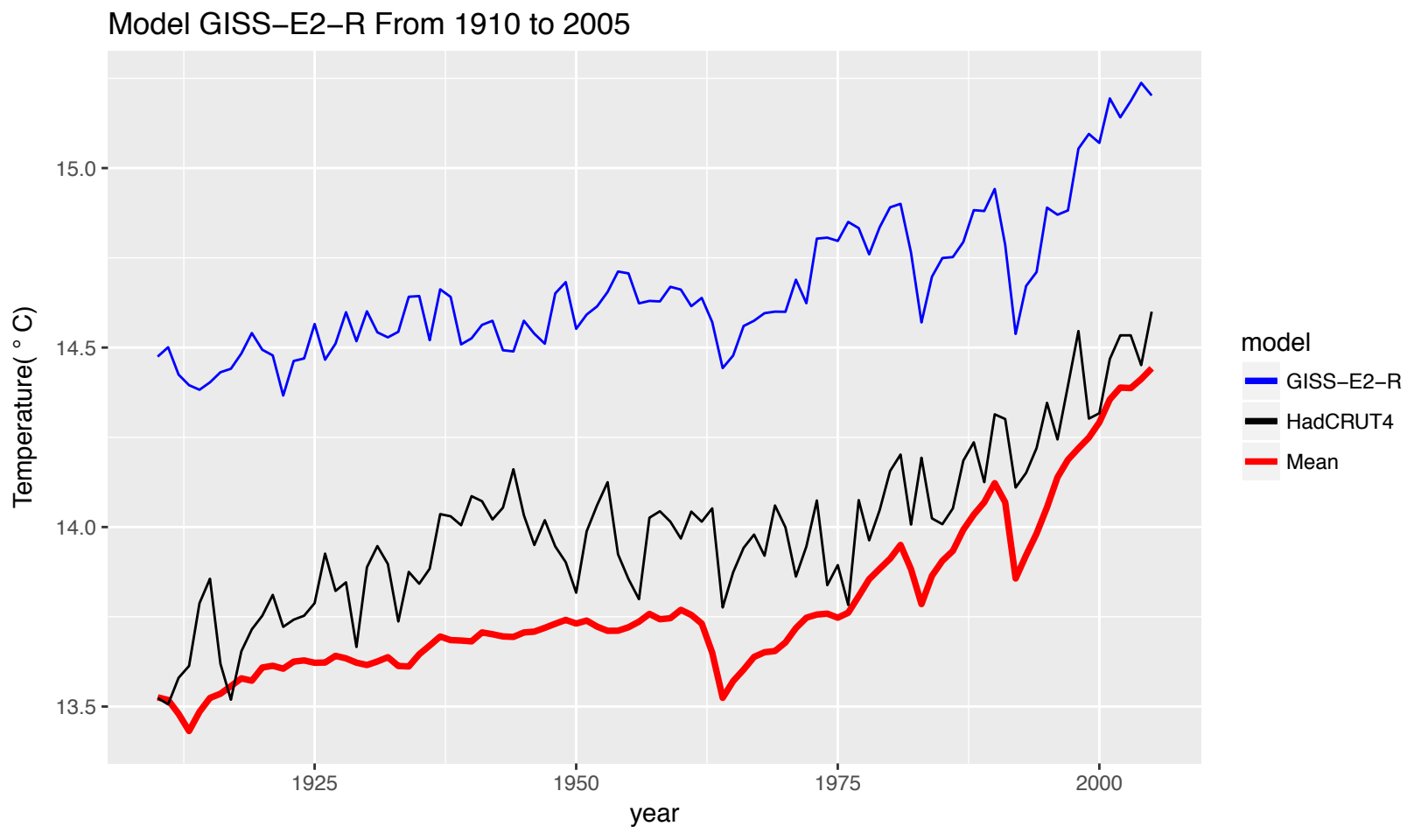
14.0
13.5
1850
1900
1950
2000
year
model
GISS−E2−R
HadCRUT4
Mean


Model GISS−E2−R From 1880 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1880
1920
1960
2000
year
model
GISS−E2−R
HadCRUT4
Mean


Model GISS−E2−R From 1910 to 2005
Temperature(° C)
15.0
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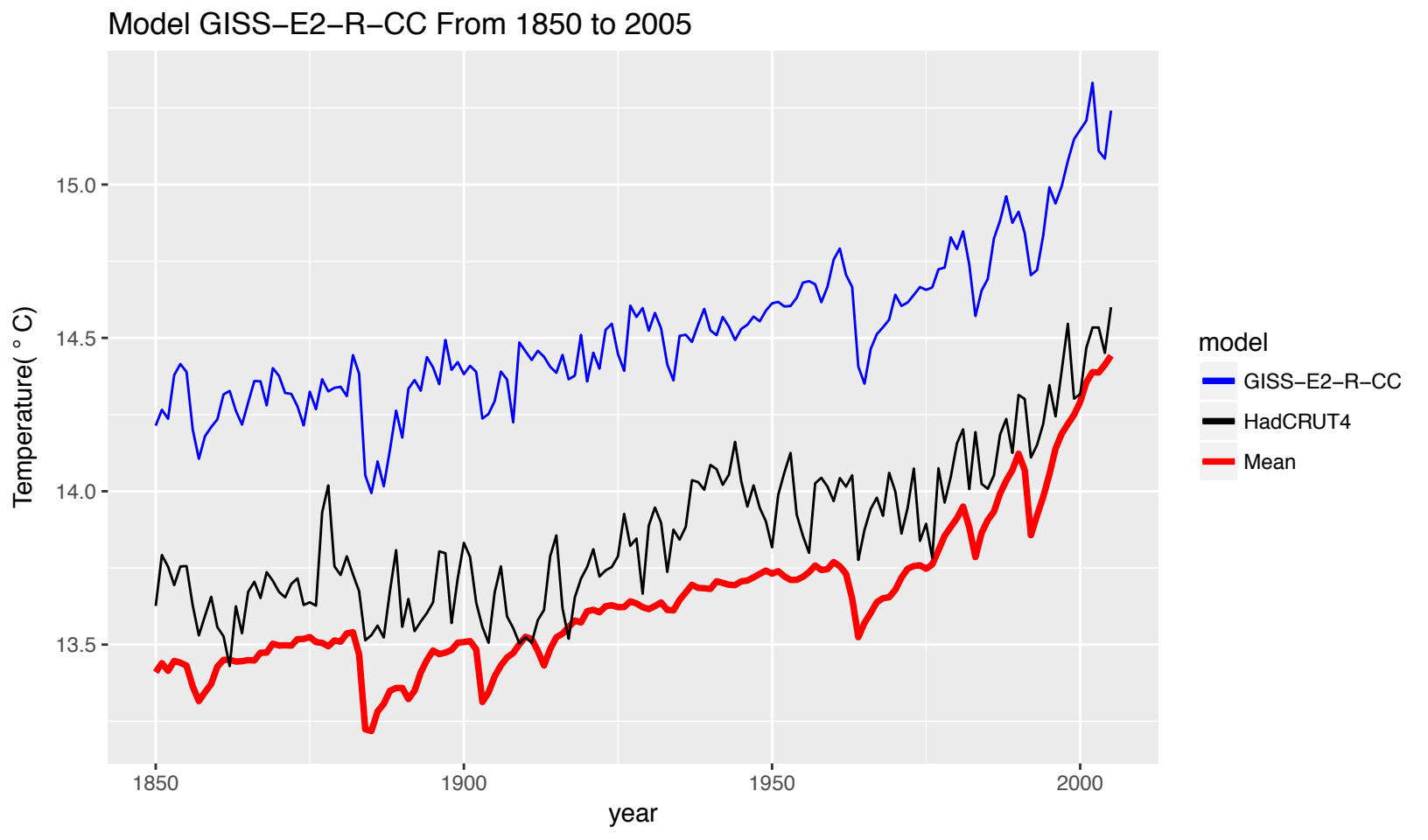
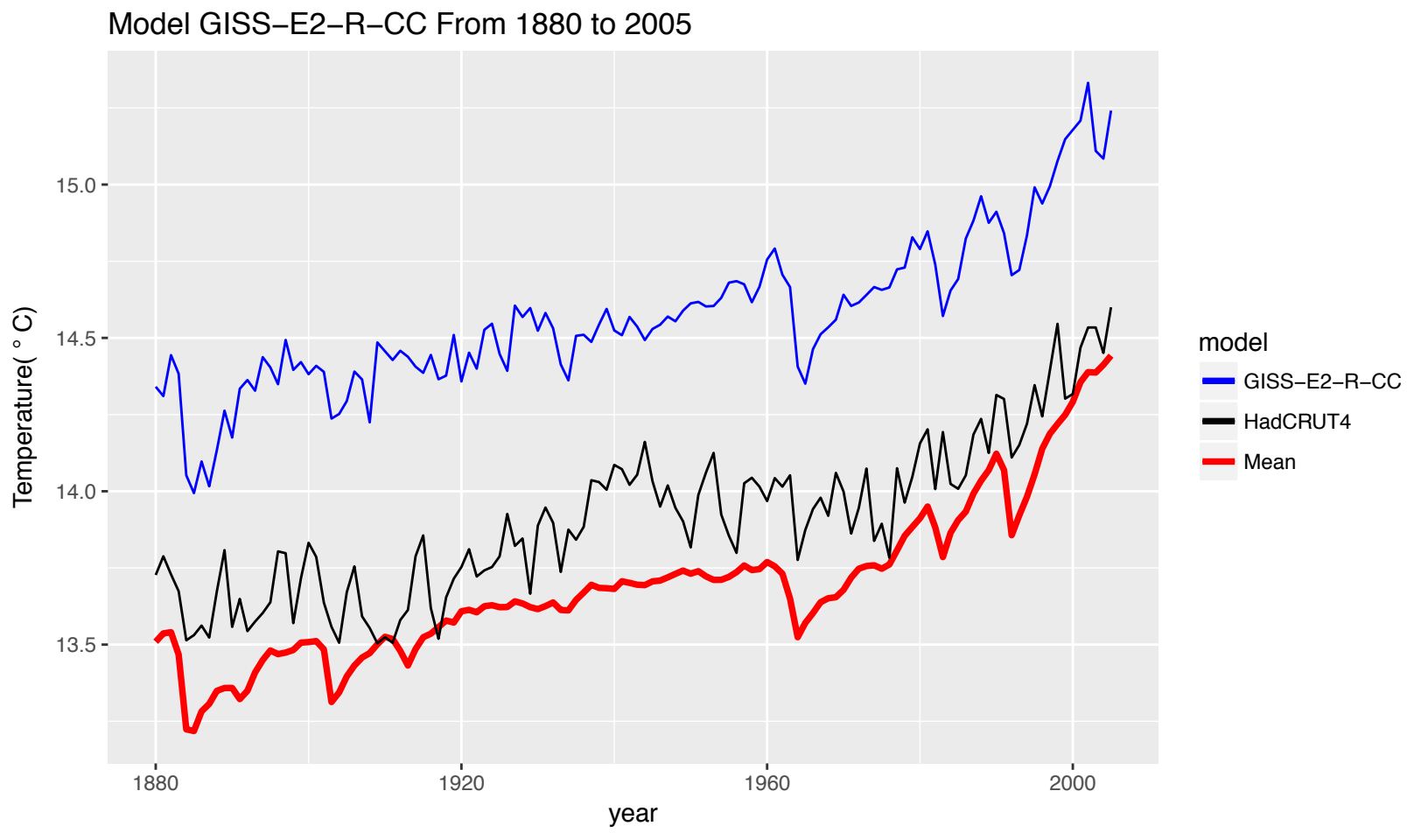
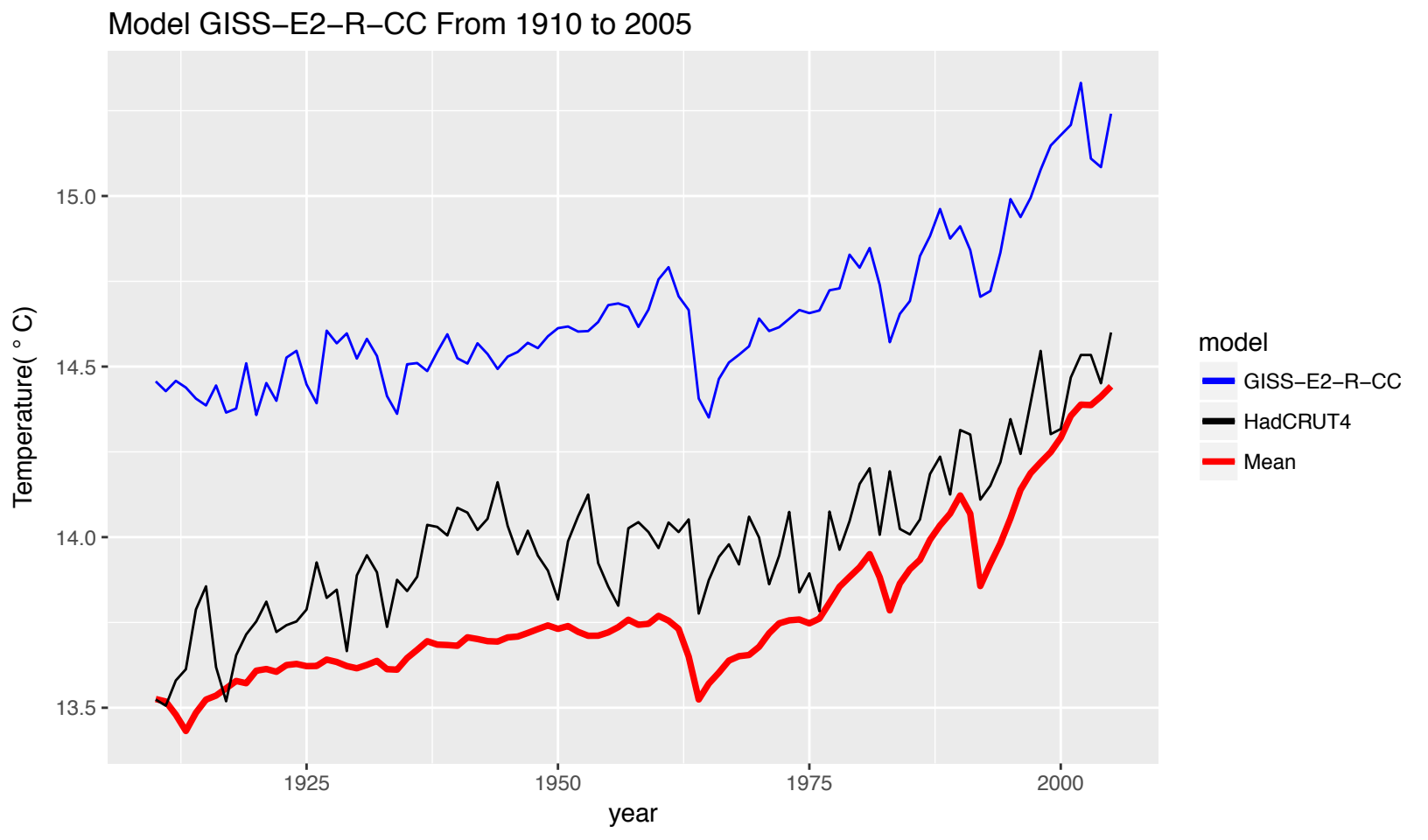
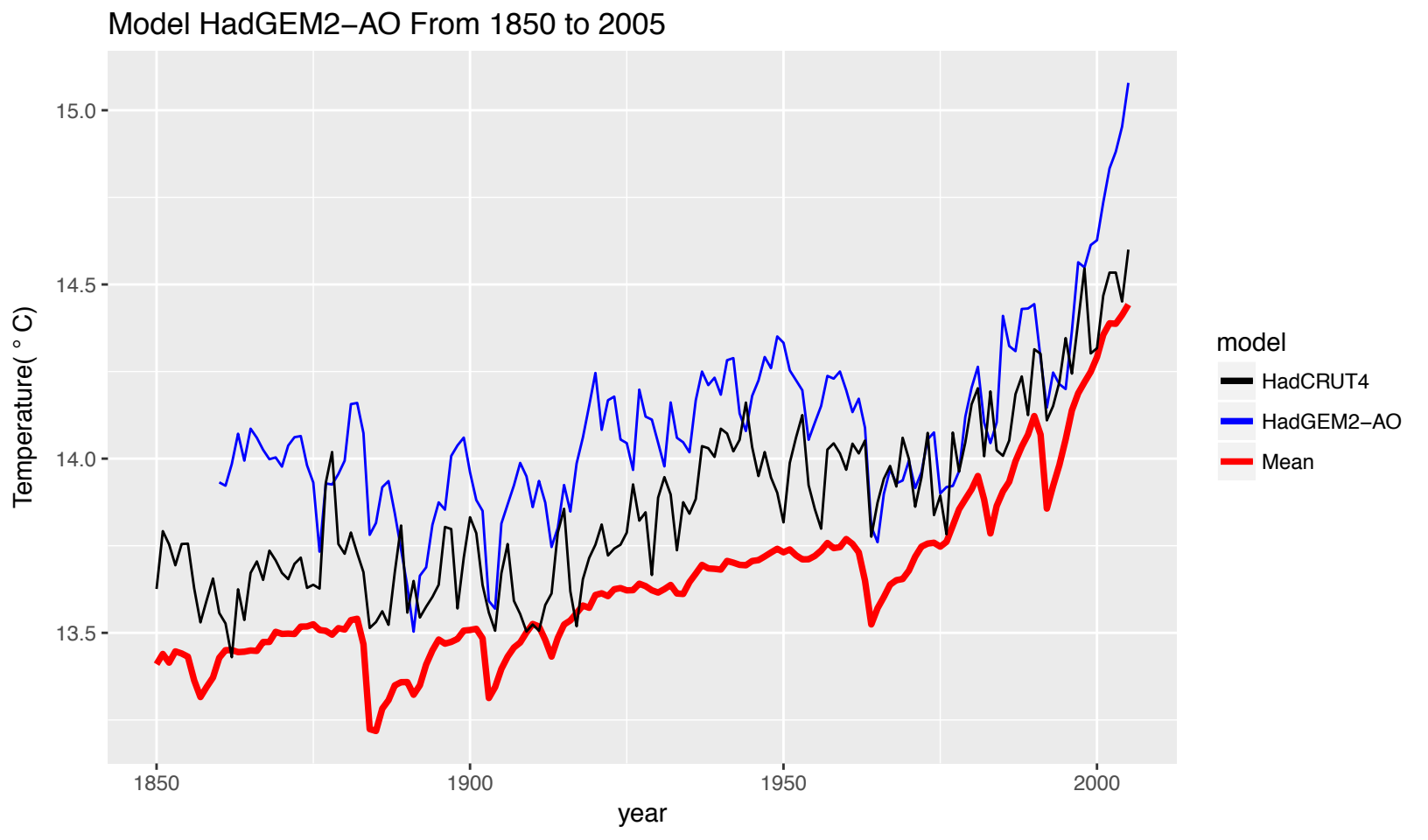
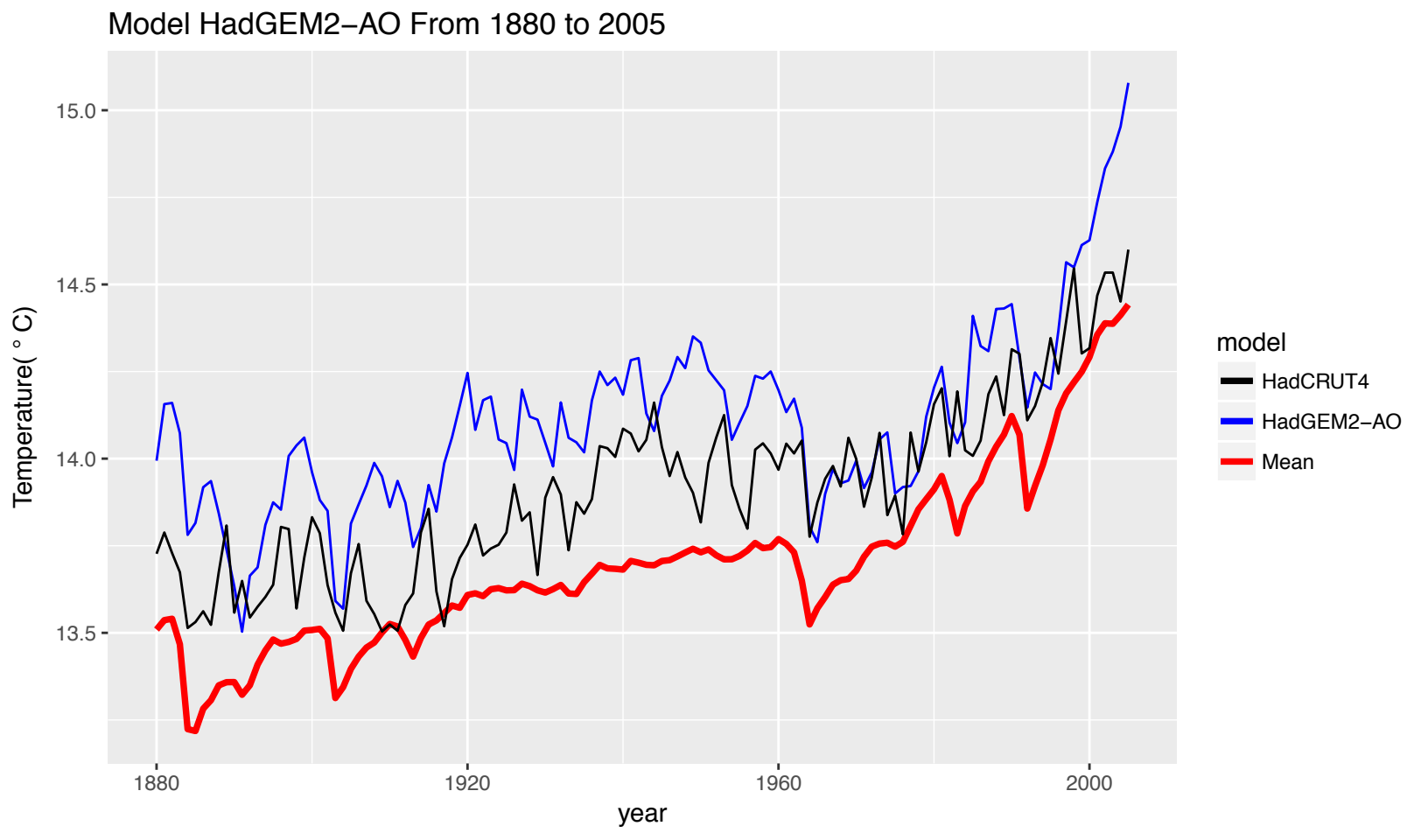
14.0
13.5
1925
1950
1975
2000
year
model
GISS−E2−R
HadCRUT4
Mean

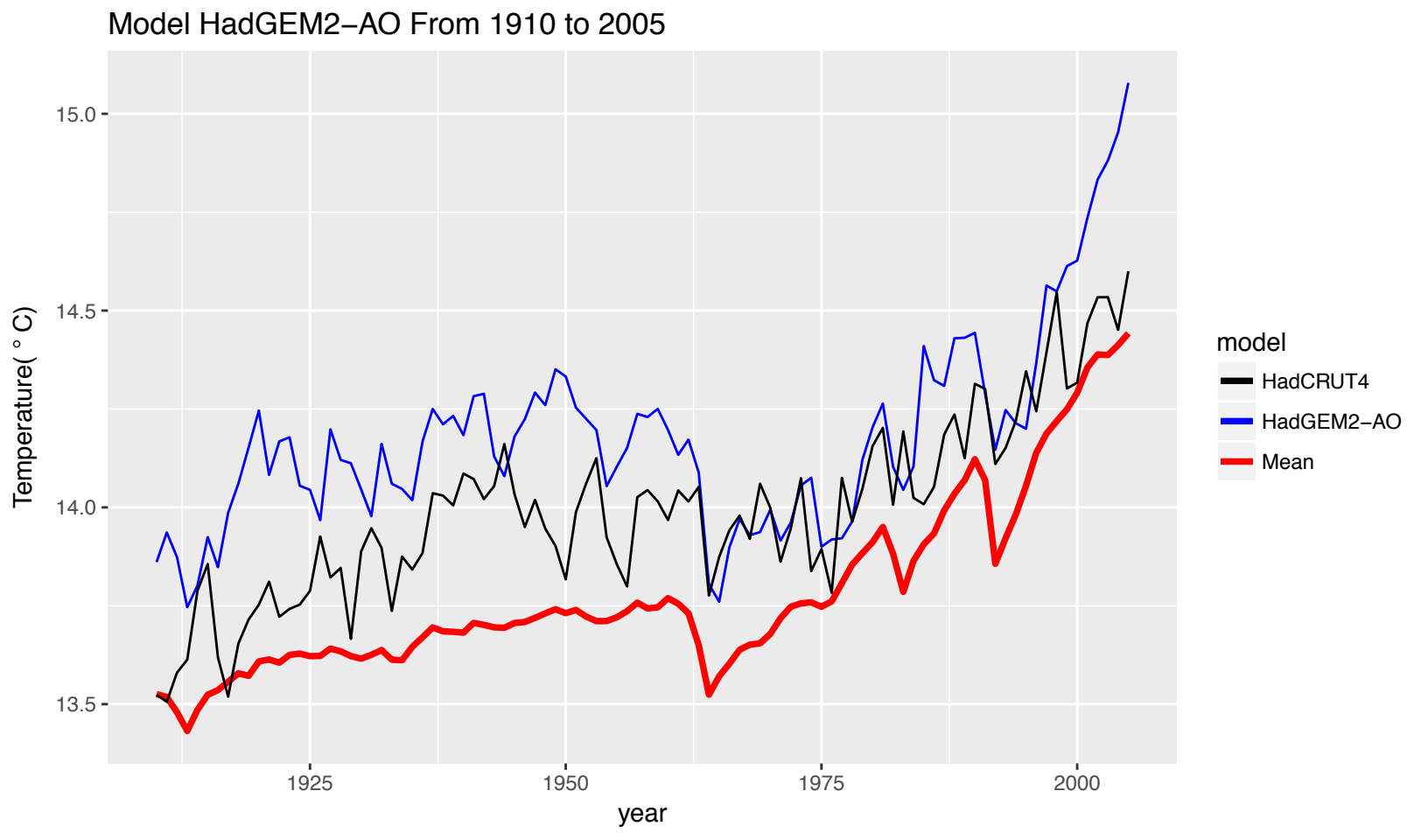

Model GISS−E2−R−CC From 1850 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1850
1900
1950
2000
year
model
GISS−E2−R−CC
HadCRUT4
Mean

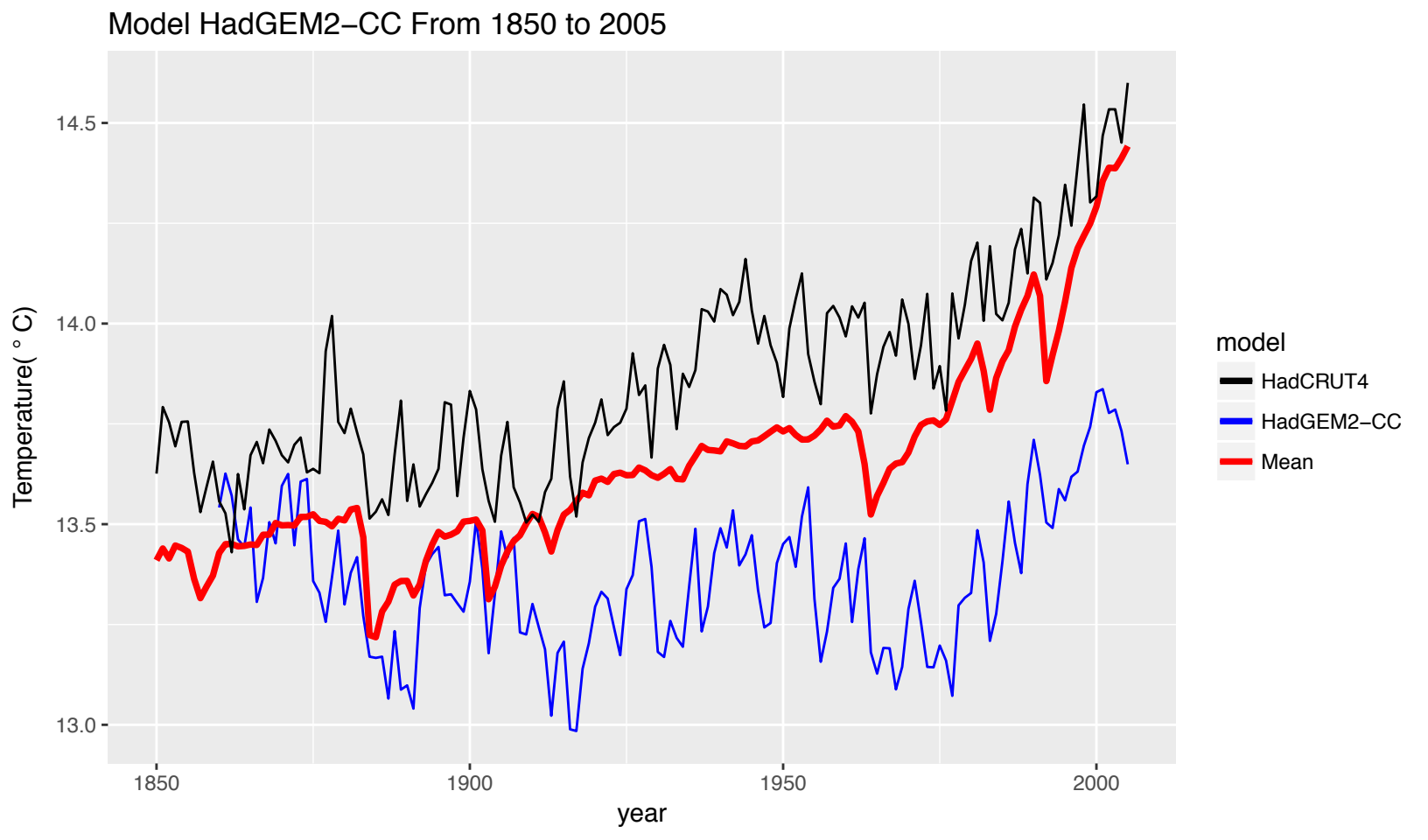

Model GISS−E2−R−CC From 1880 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1880
1920
1960
2000
year
model
GISS−E2−R−CC
HadCRUT4
Mean

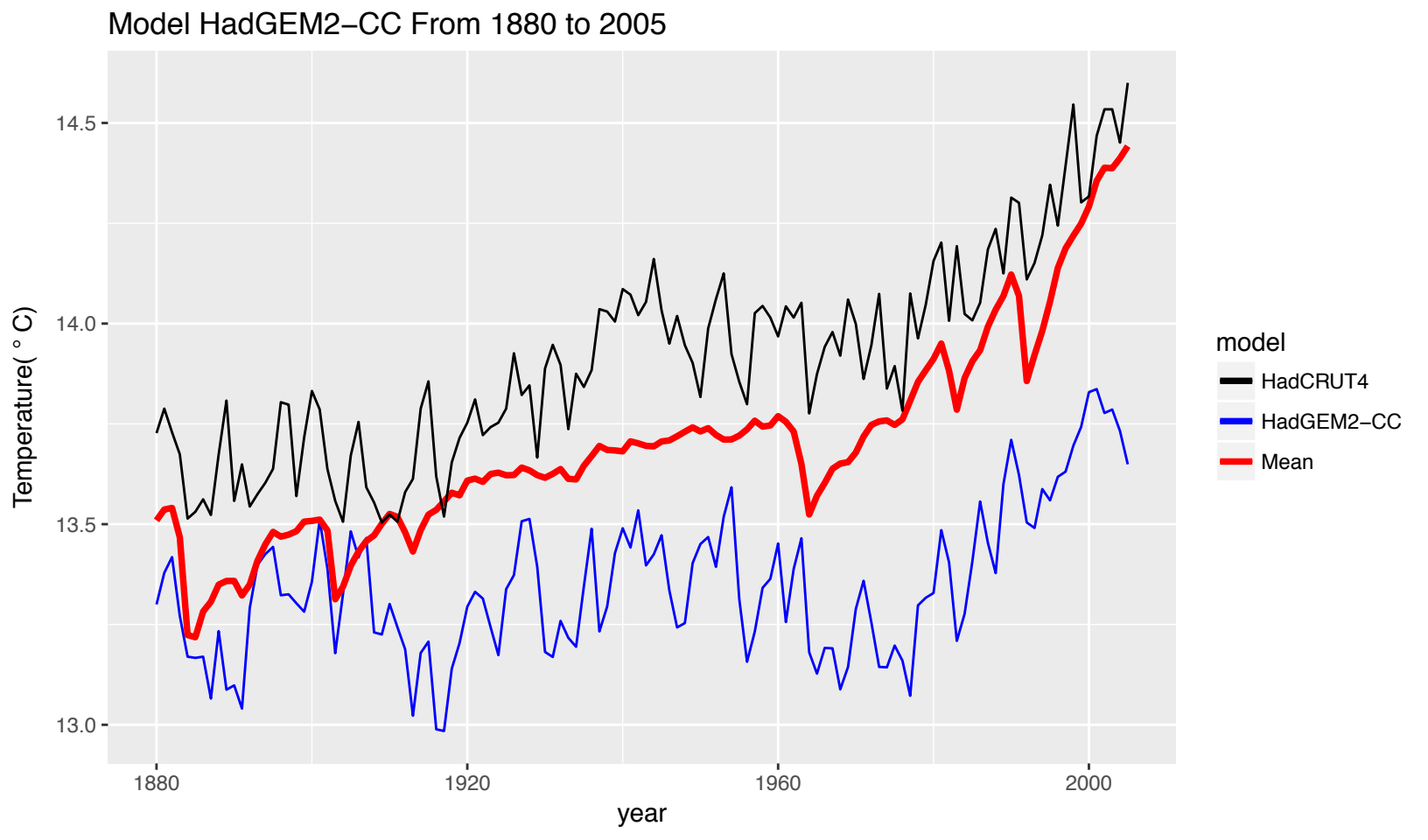

Model GISS−E2−R−CC From 1910 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1925
1950
1975
2000
year
model
GISS−E2−R−CC
HadCRUT4
Mean

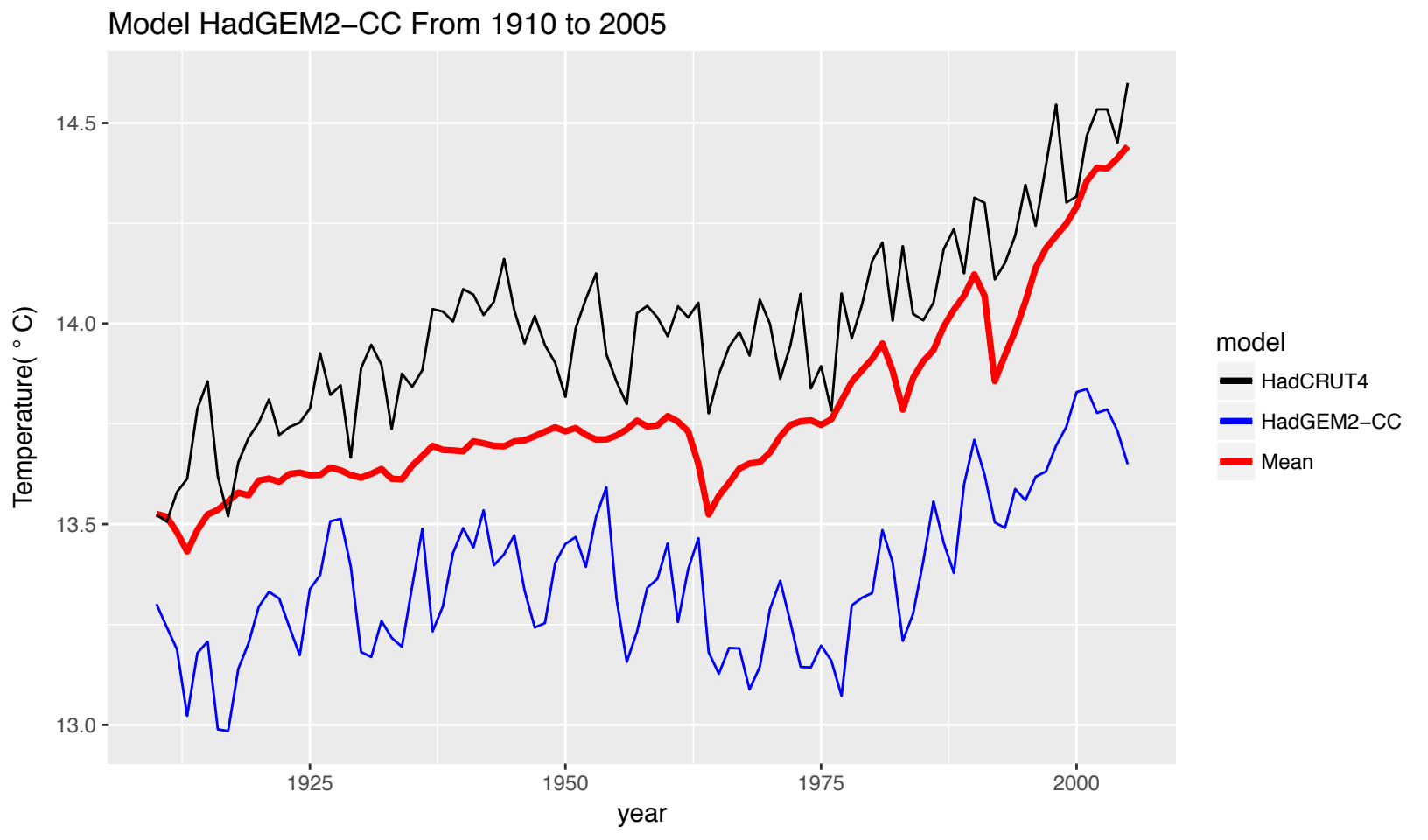

Model HadGEM2−AO From 1850 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1850
1900
1950
2000
year
model
HadCRUT4
HadGEM2−AO
Mean

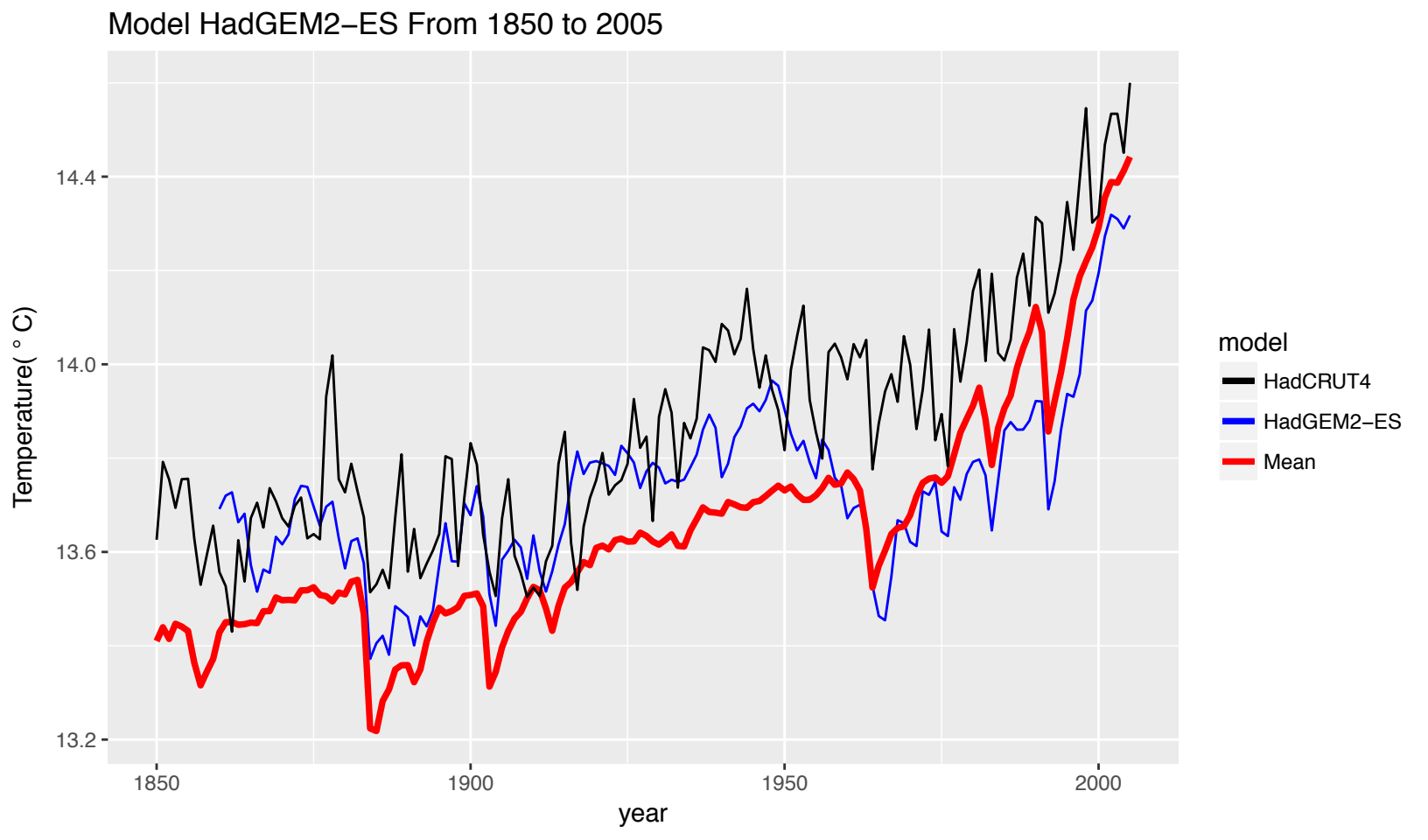

Model HadGEM2−AO From 1880 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1880
1920
1960
2000
year
model
HadCRUT4
HadGEM2−AO
Mean

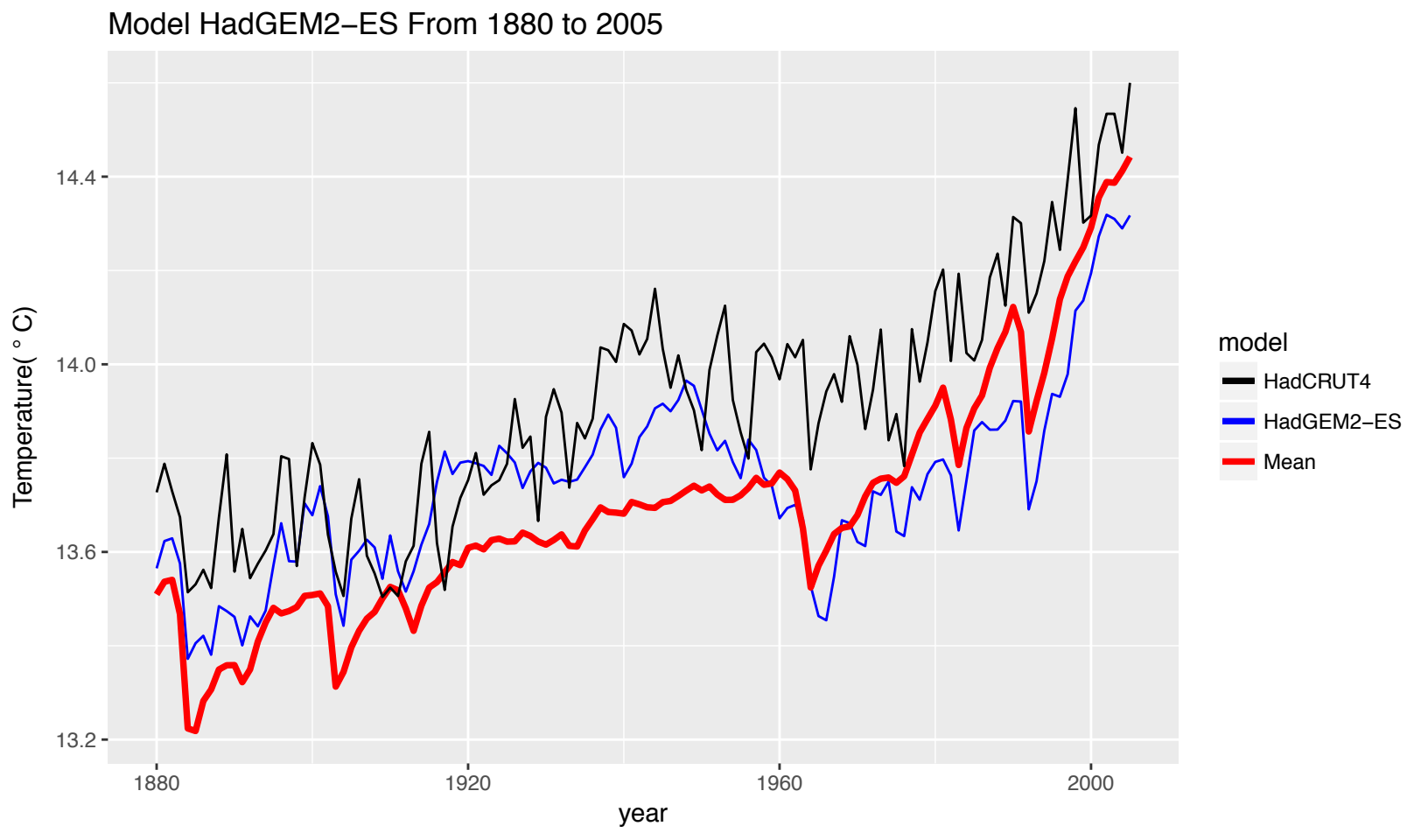

Model HadGEM2−AO From 1910 to 2005
15.0
14.5
14.0
13.5
Temperature(° C)
1925
1950
1975
2000
year
model
HadCRUT4
HadGEM2−AO
Mean

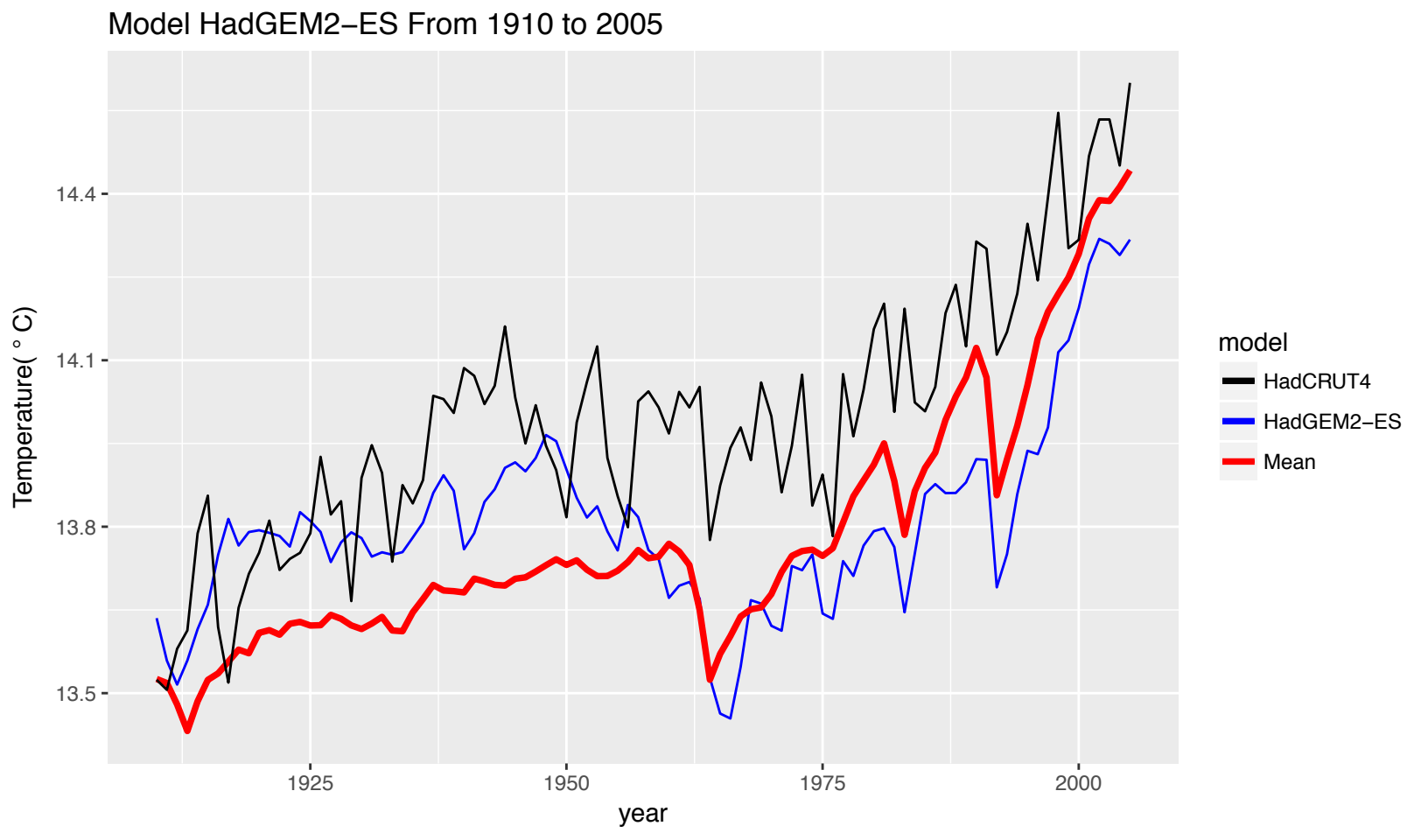

Model HadGEM2−CC From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
HadGEM2−CC
Mean

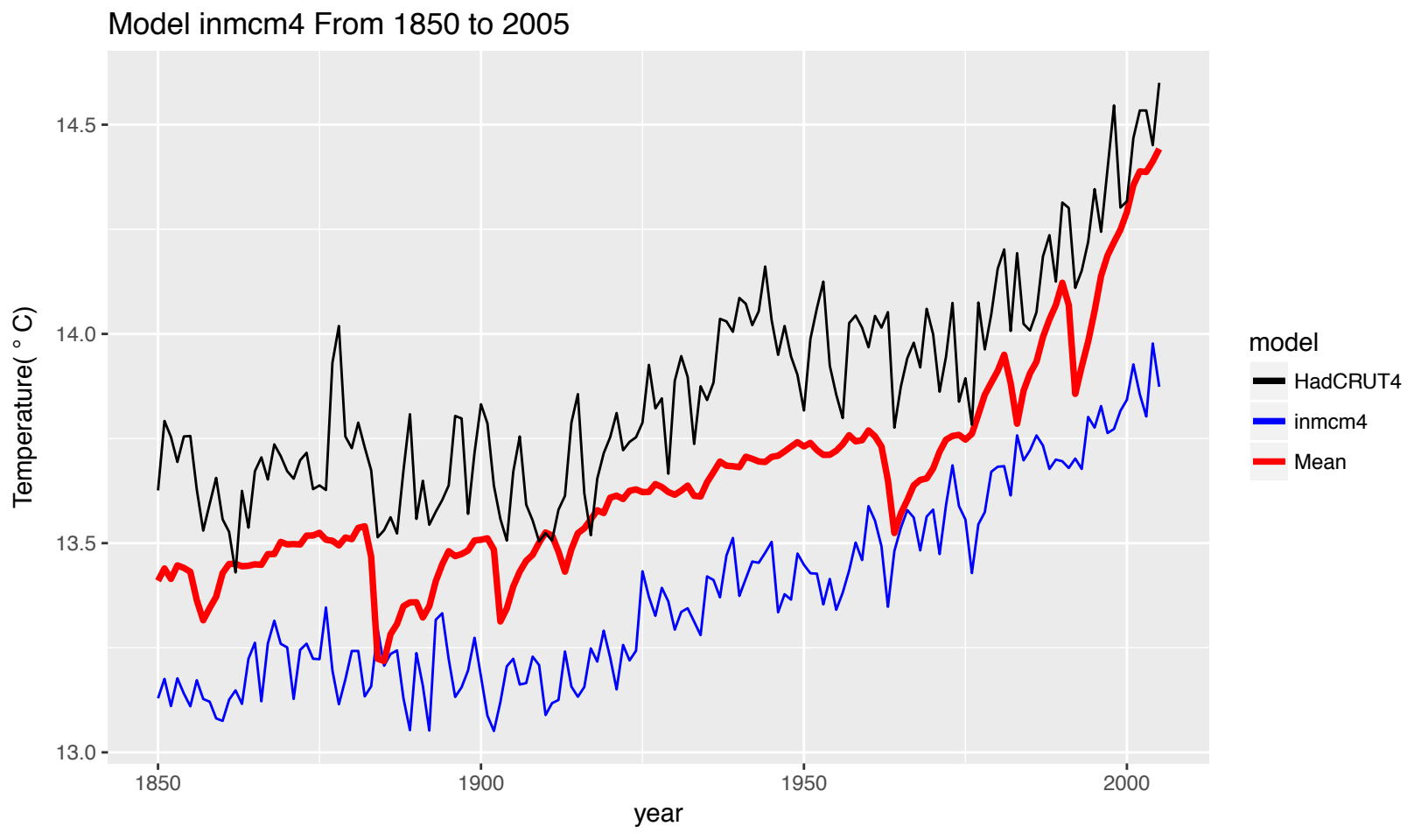

Model HadGEM2−CC From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
HadGEM2−CC
Mean

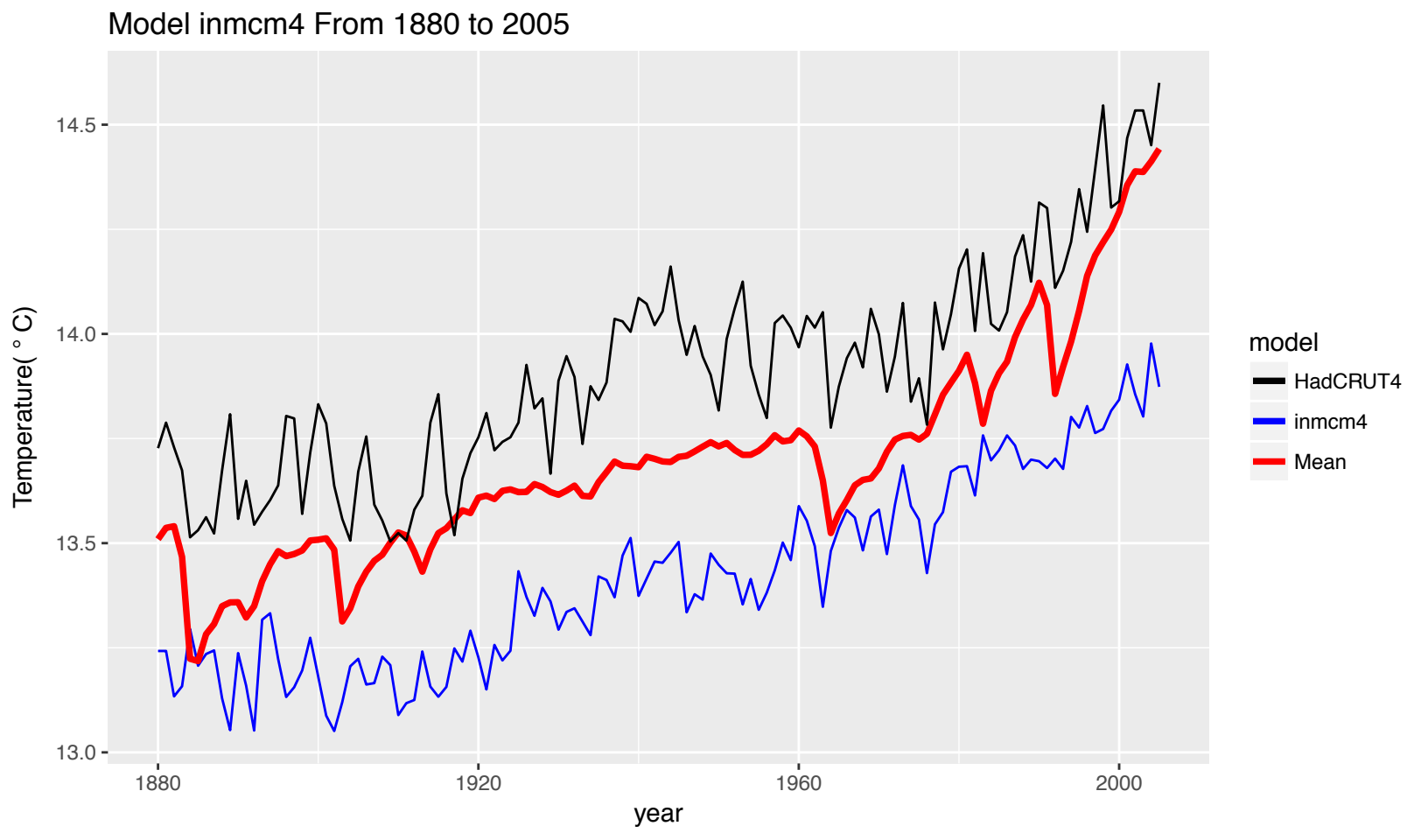

Model HadGEM2−CC From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
HadCRUT4
HadGEM2−CC
Mean

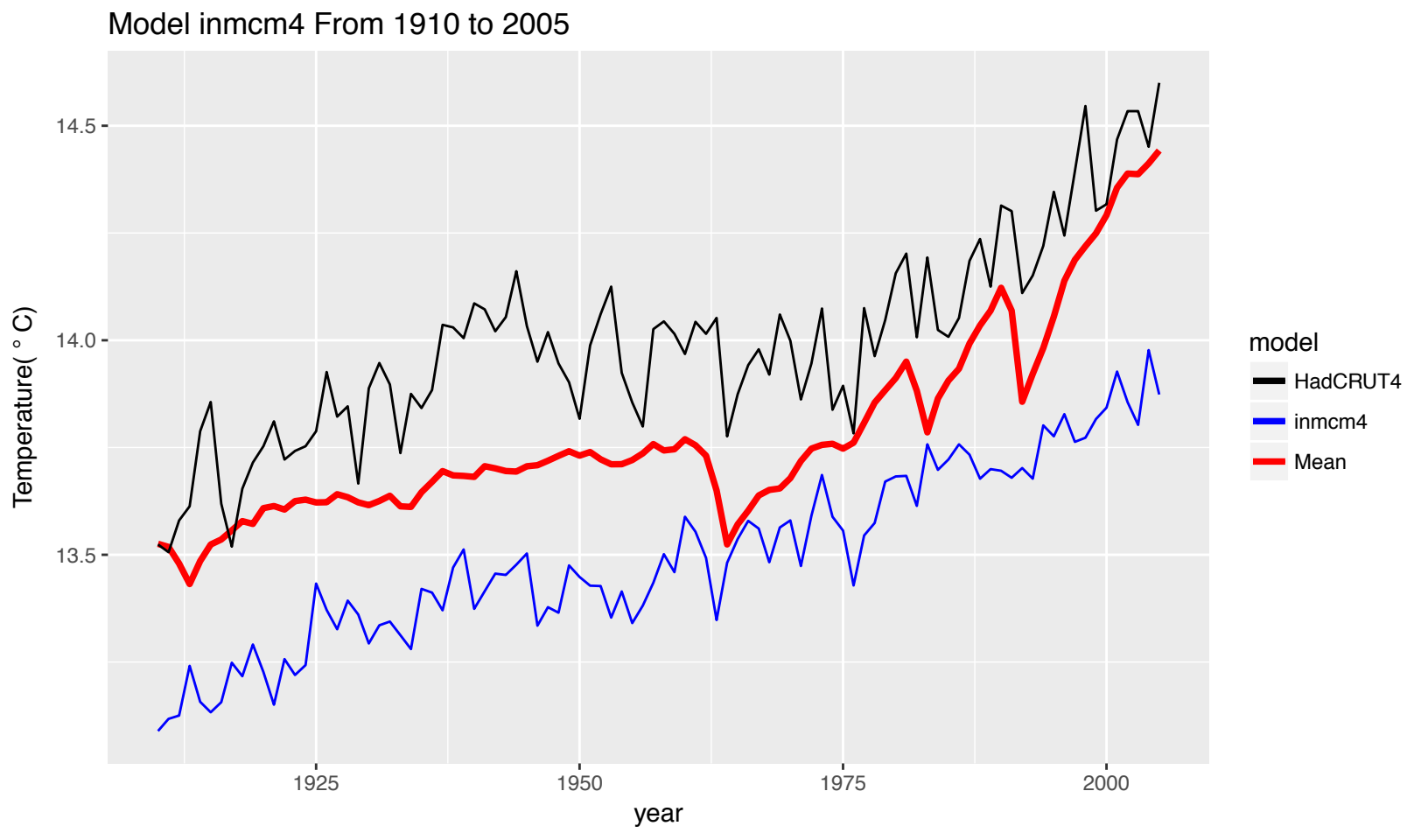

Model HadGEM2−ES From 1850 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1850
1900
1950
2000
year
model
HadCRUT4
HadGEM2−ES
Mean

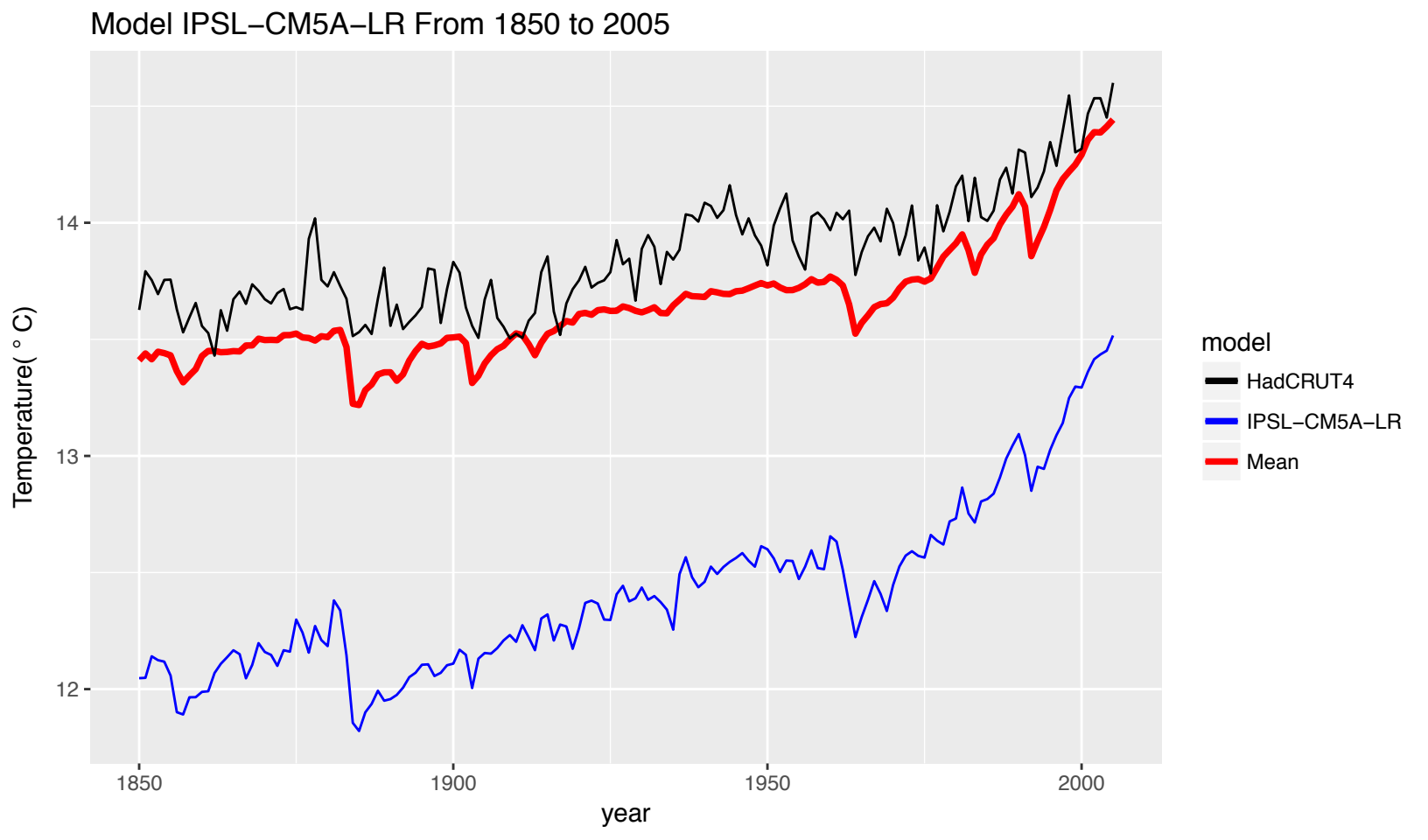

Model HadGEM2−ES From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
HadCRUT4
HadGEM2−ES
Mean

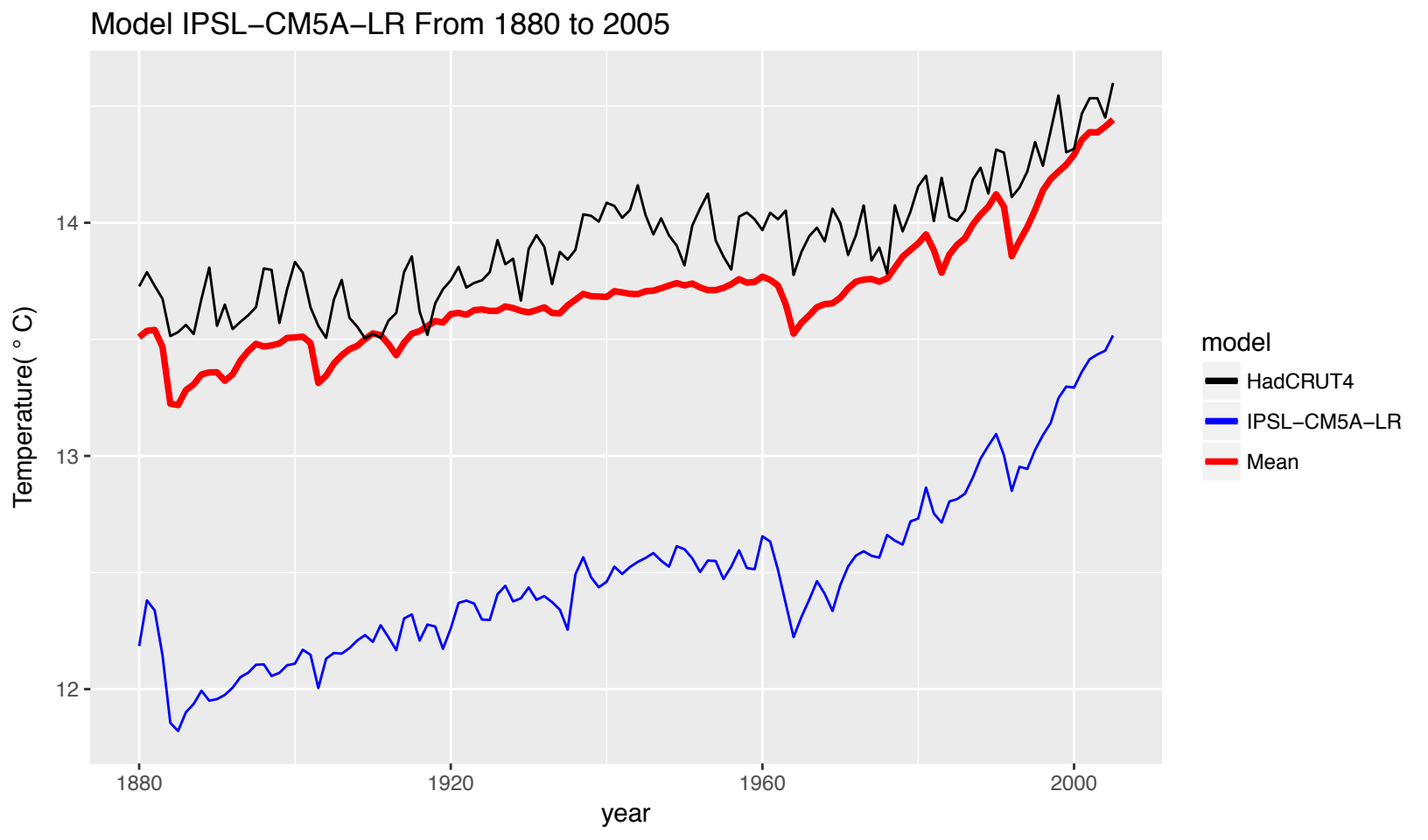

Model HadGEM2−ES From 1910 to 2005
Temperature(° C)
14.4
14.1
13.8
13.5
1925
1950
1975
2000
year
model
HadCRUT4
HadGEM2−ES
Mean

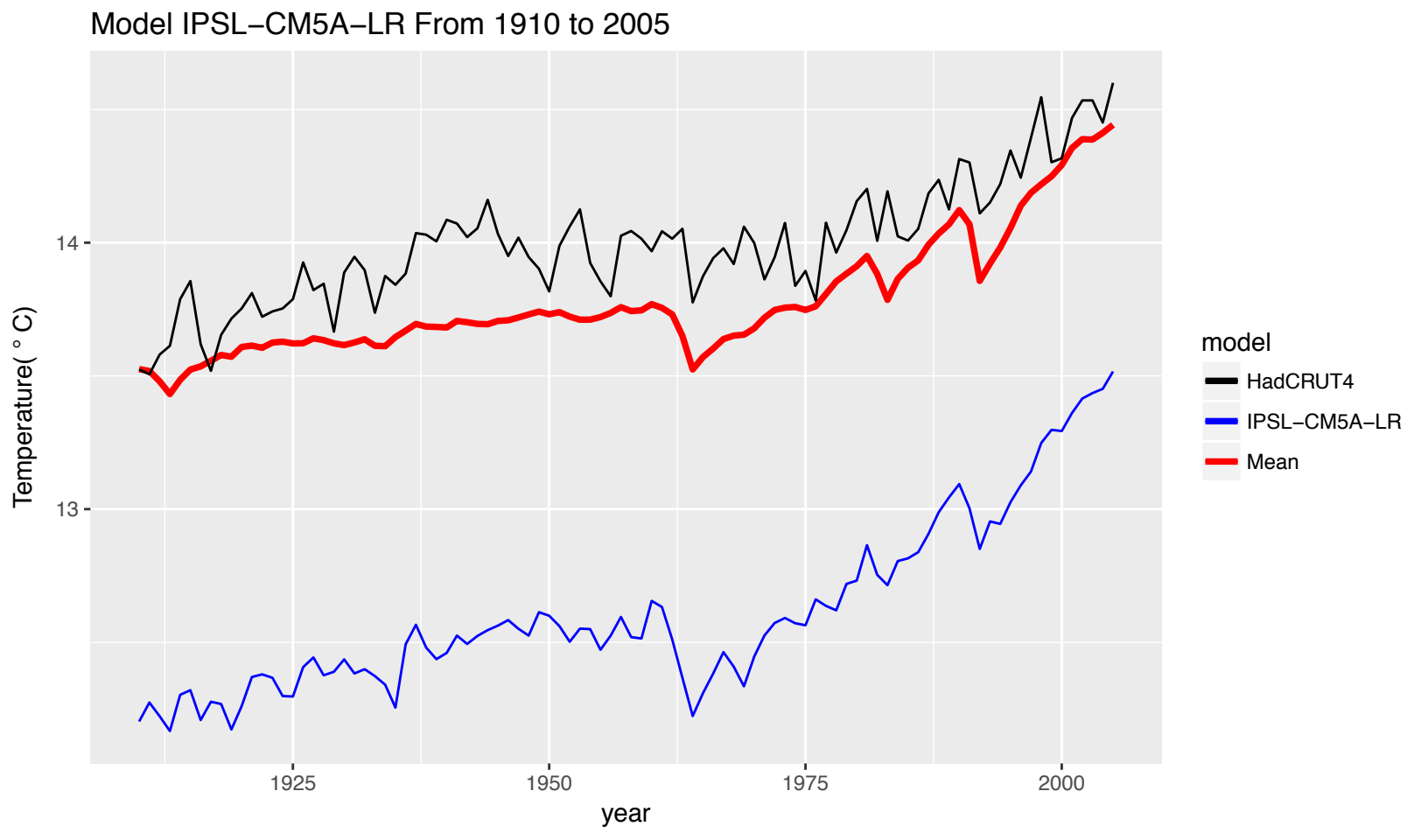

Model inmcm4 From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
inmcm4
Mean

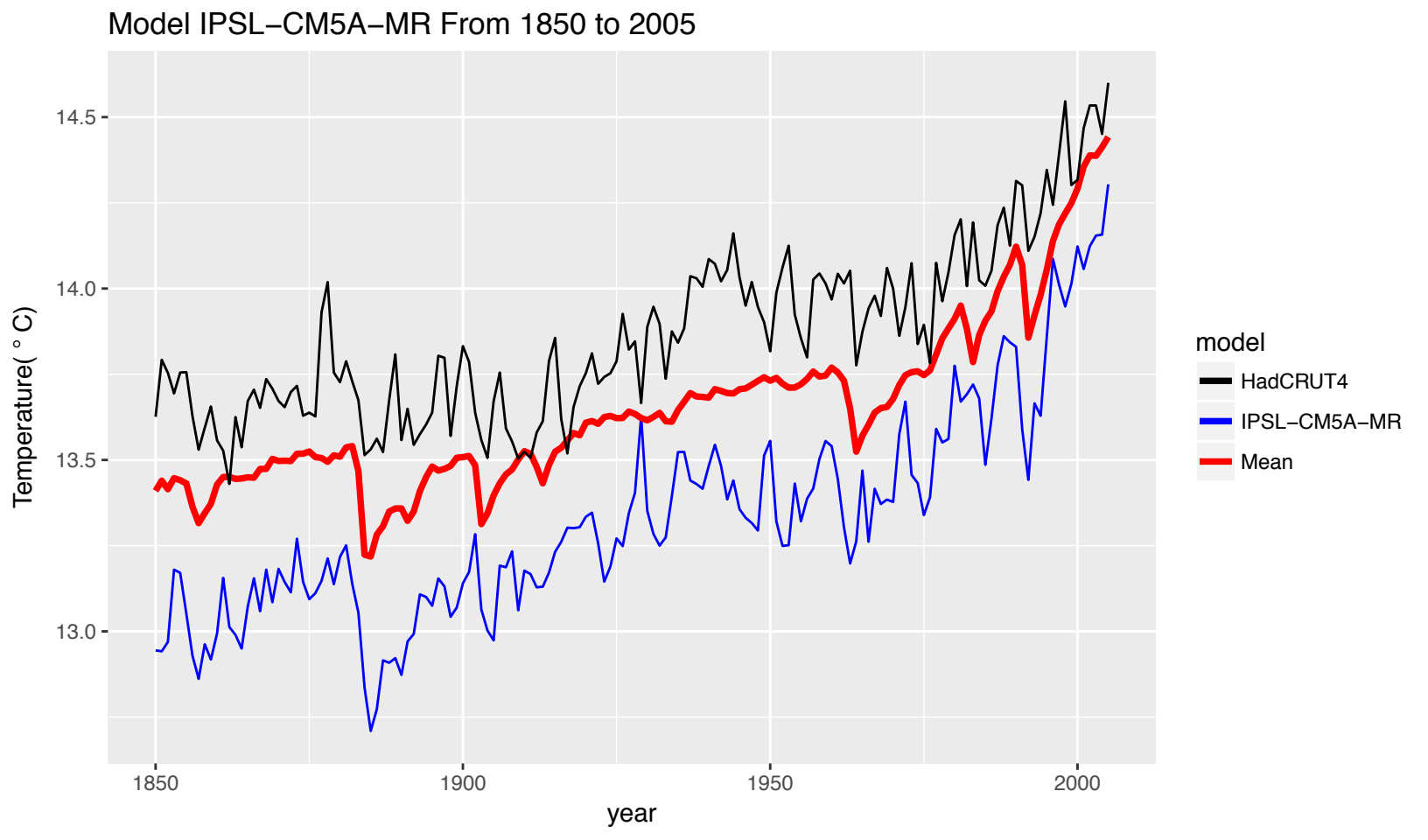

Model inmcm4 From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
inmcm4
Mean

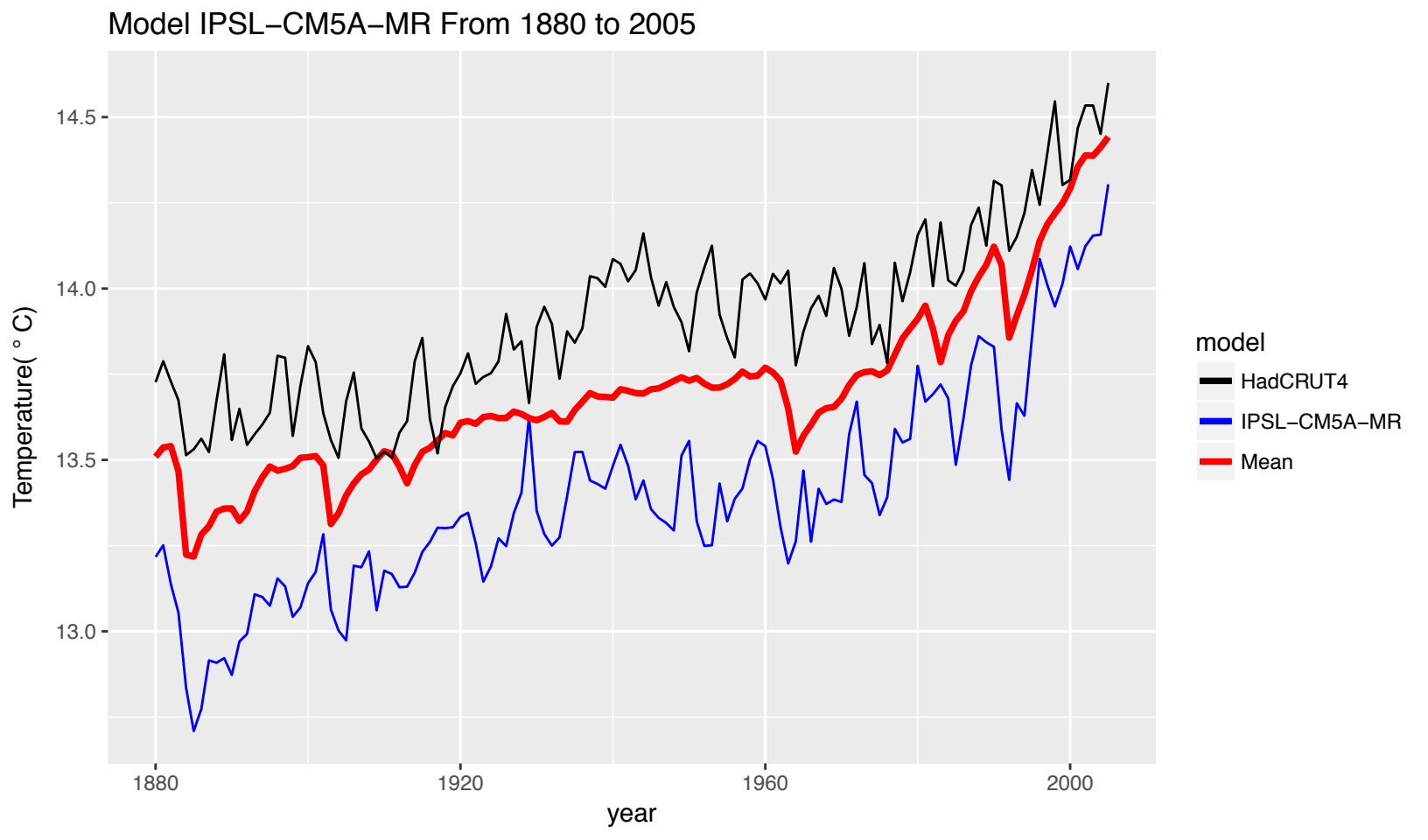

Model inmcm4 From 1910 to 2005
14.5
14.0
13.5
Temperature(° C)
1925
1950
1975
2000
year
model
HadCRUT4
inmcm4
Mean

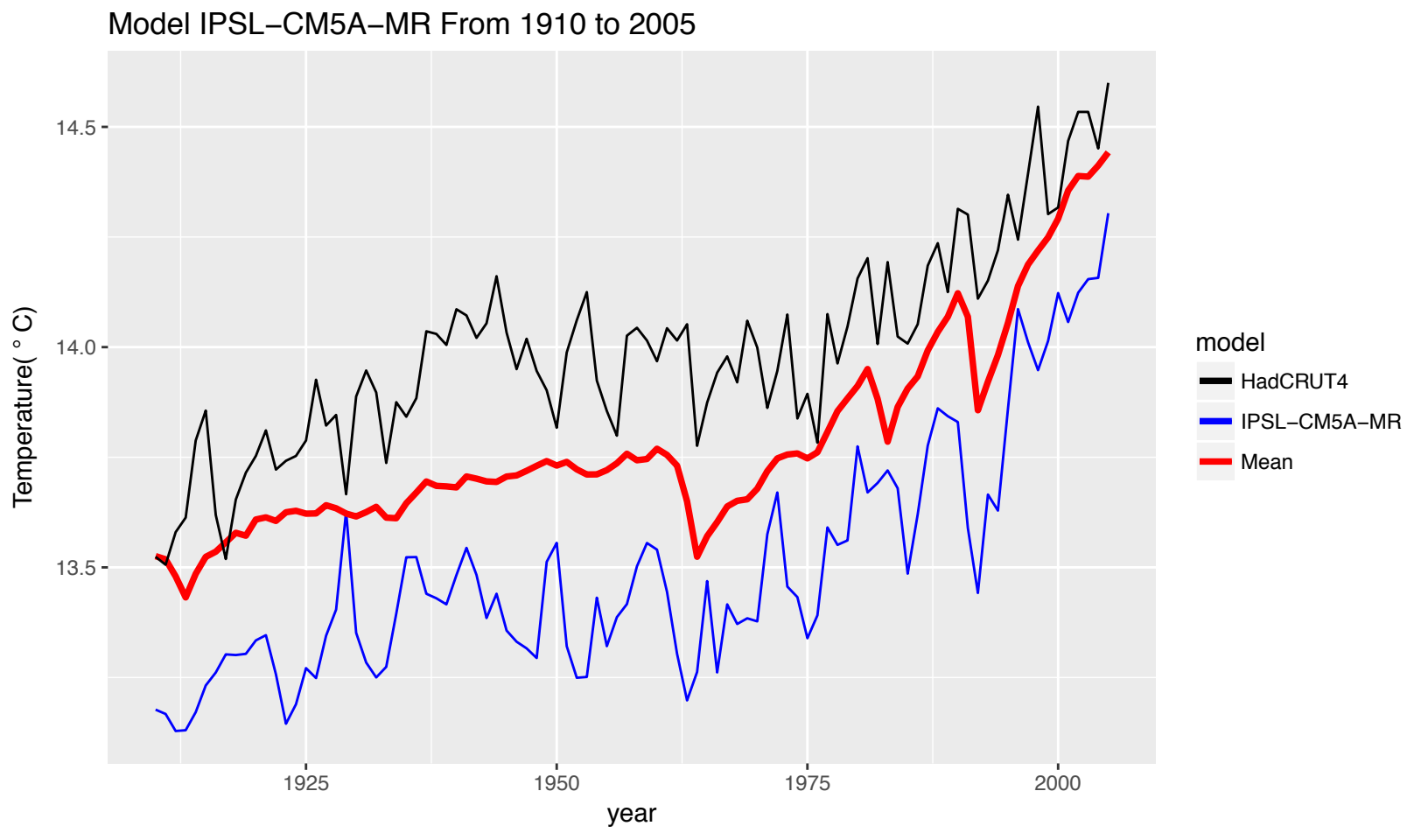

Model IPSL−CM5A−LR From 1850 to 2005
Temperature(° C)
14
13
12
1850
1900
1950
2000
year
model
HadCRUT4
IPSL−CM5A−LR
Mean

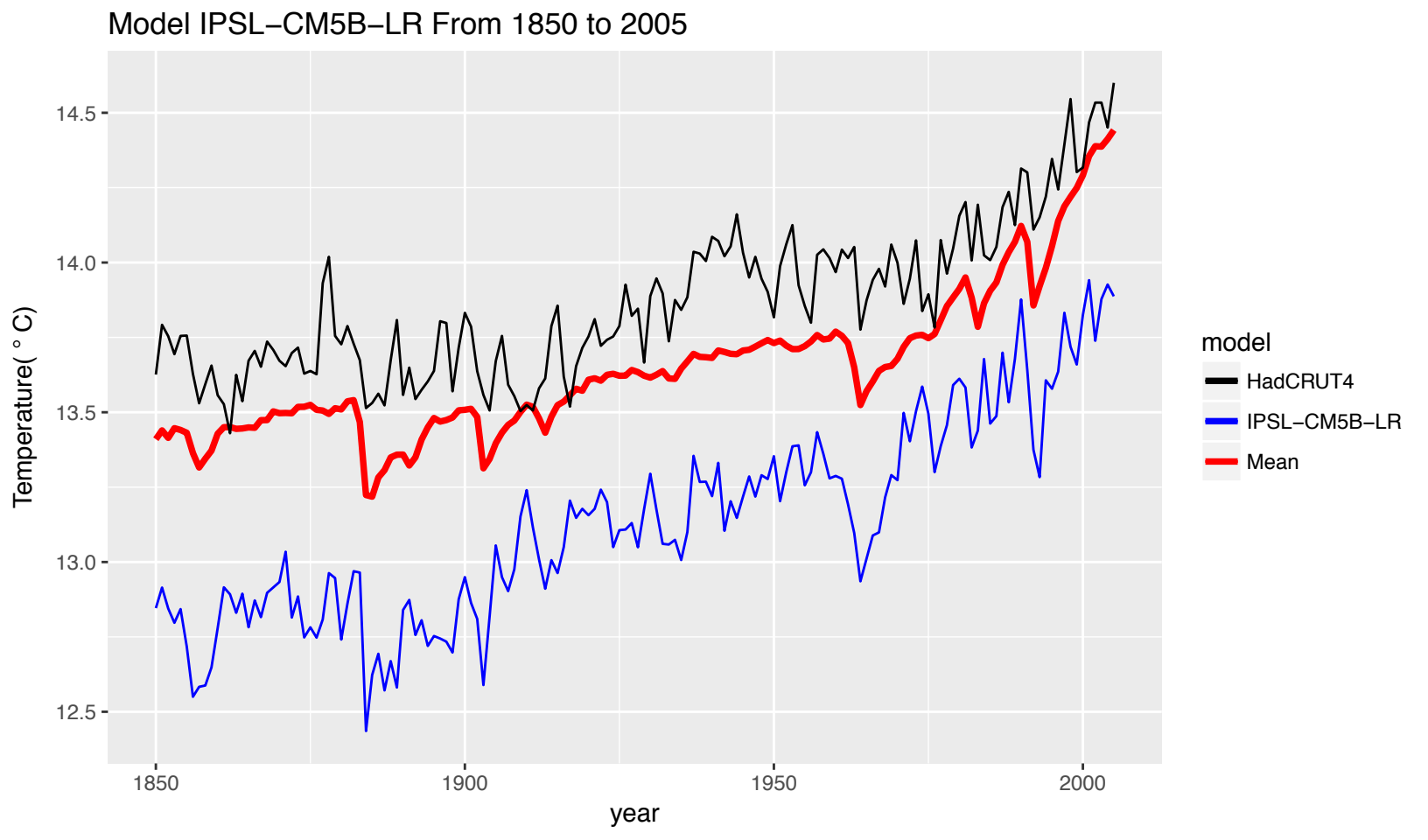

Model IPSL−CM5A−LR From 1880 to 2005
Temperature(° C)
14
13
12
1880
1920
1960
2000
year
model
HadCRUT4
IPSL−CM5A−LR
Mean

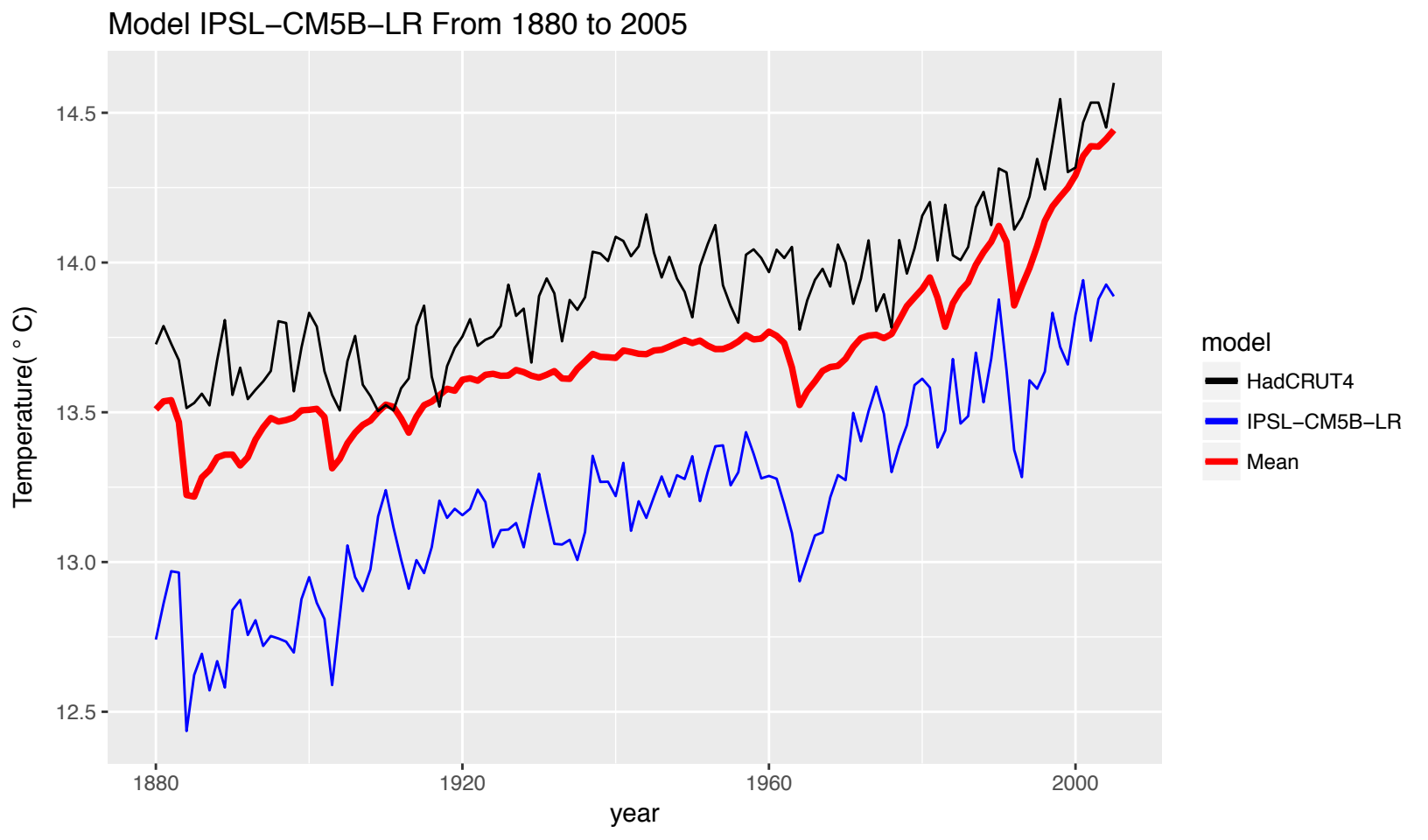

Model IPSL−CM5A−LR From 1910 to 2005
Temperature(° C)
14
13
1925
1950
1975
2000
year
model
HadCRUT4
IPSL−CM5A−LR
Mean

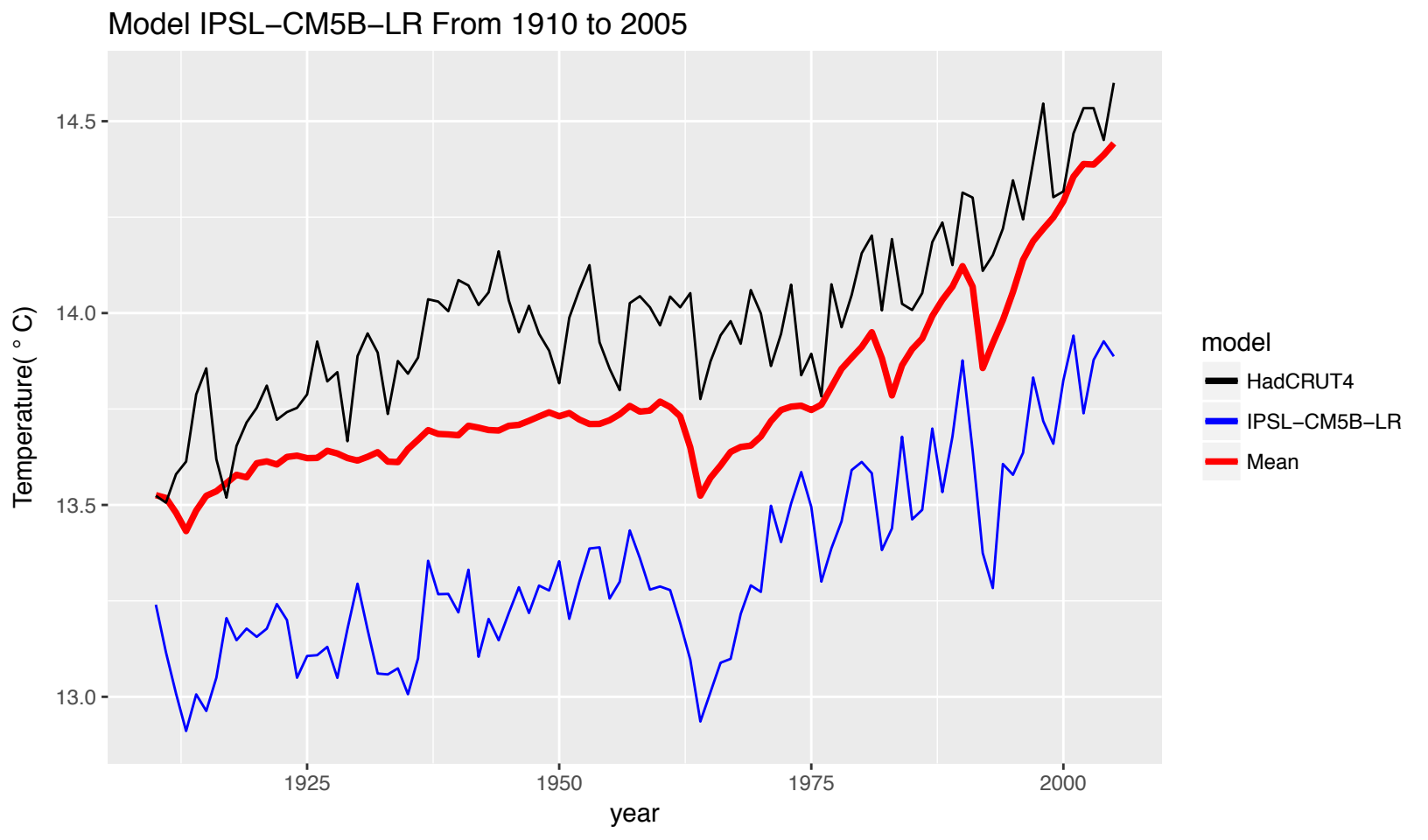

Model IPSL−CM5A−MR From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
IPSL−CM5A−MR
Mean

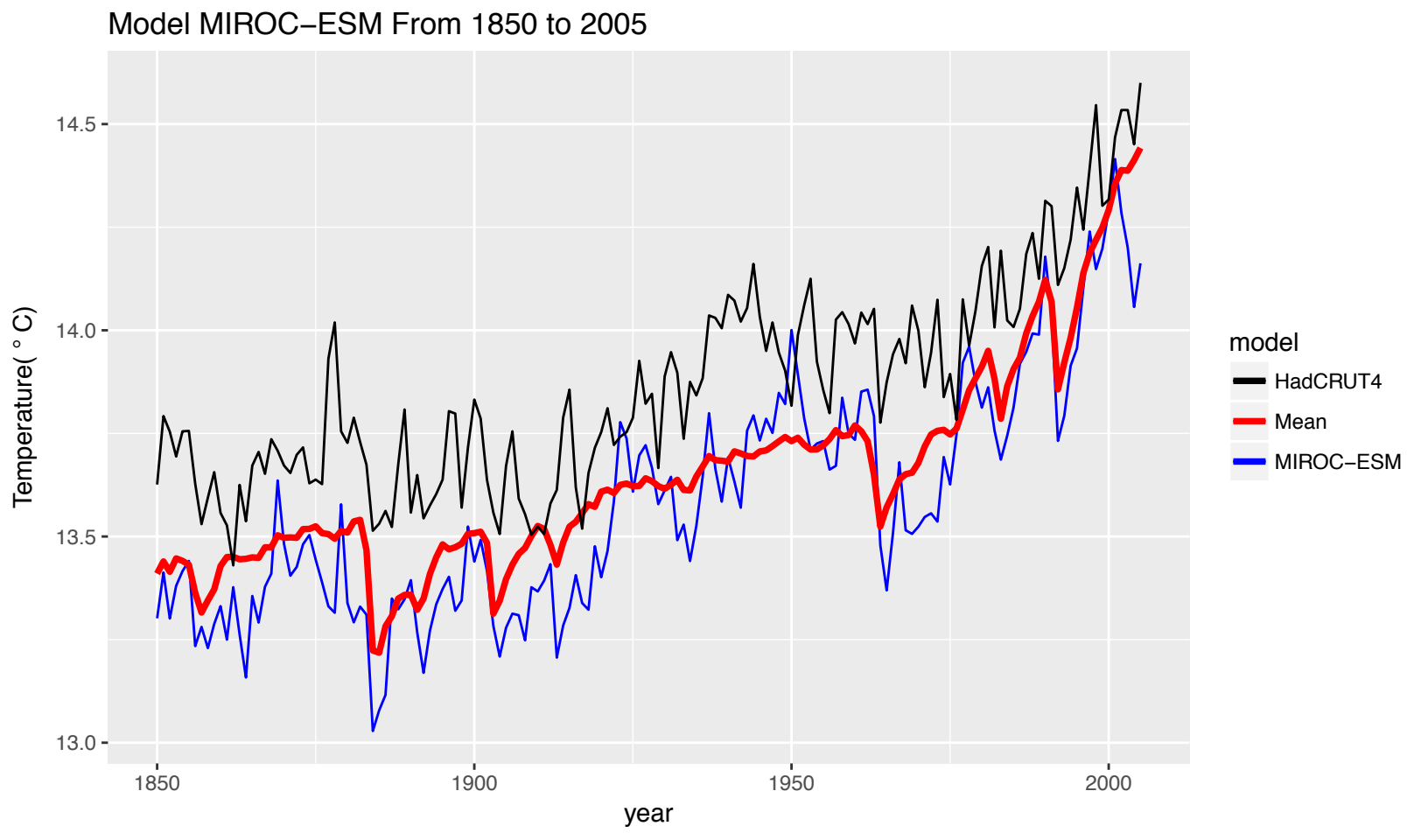

Model IPSL−CM5A−MR From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
IPSL−CM5A−MR
Mean

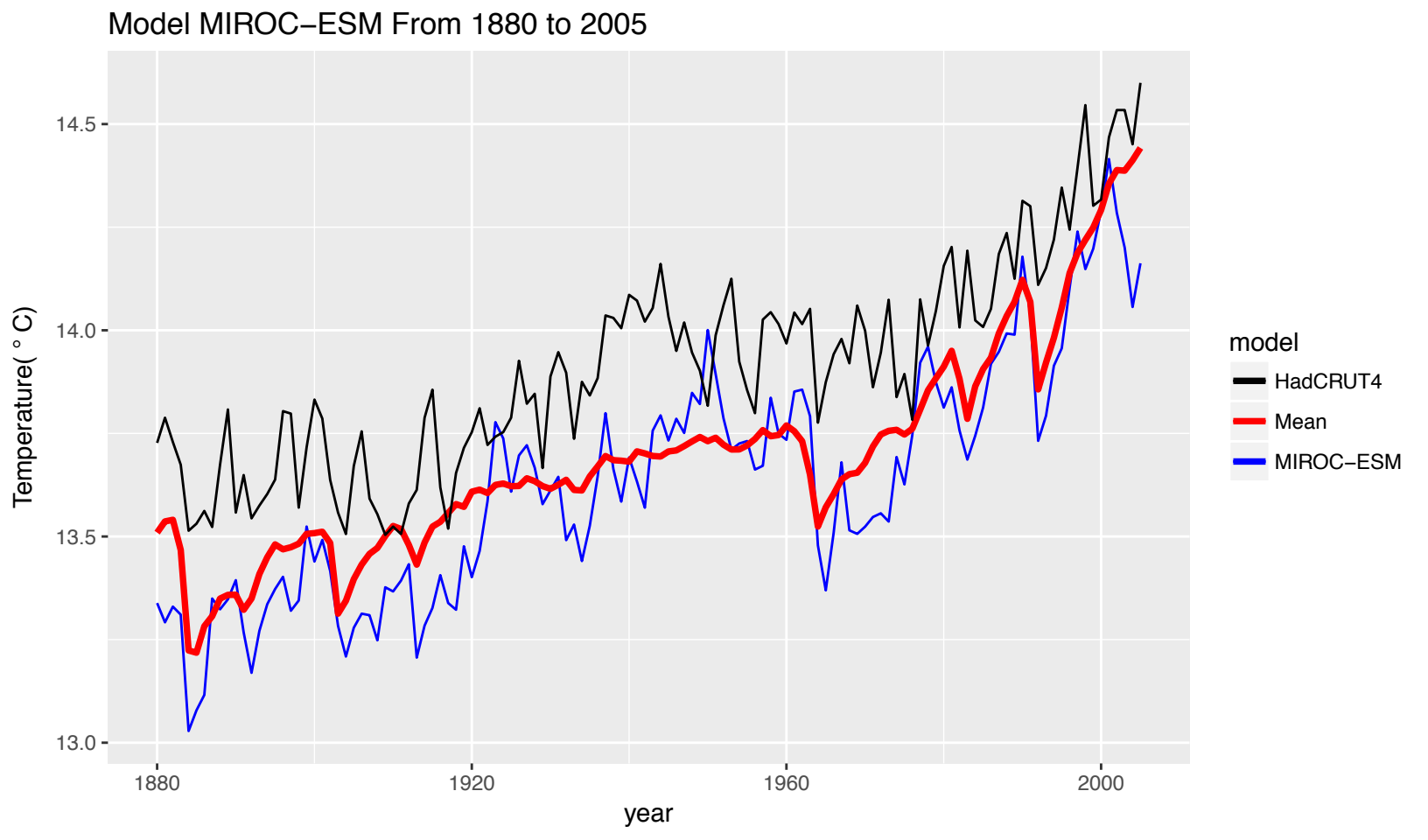

Model IPSL−CM5A−MR From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
1925
1950
1975
2000
year
model
HadCRUT4
IPSL−CM5A−MR
Mean

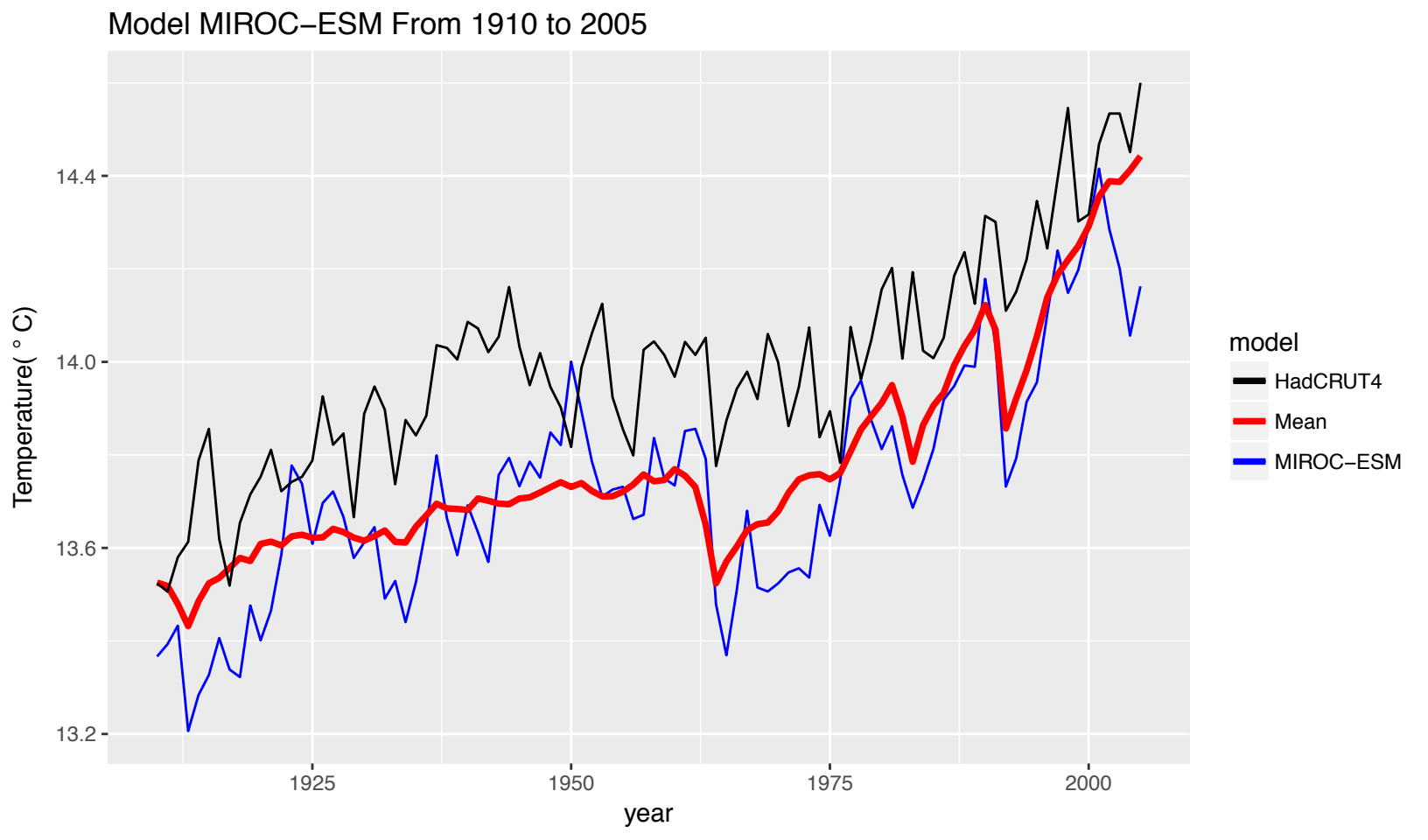

Model IPSL−CM5B−LR From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1850
1900
1950
2000
year
model
HadCRUT4
IPSL−CM5B−LR
Mean

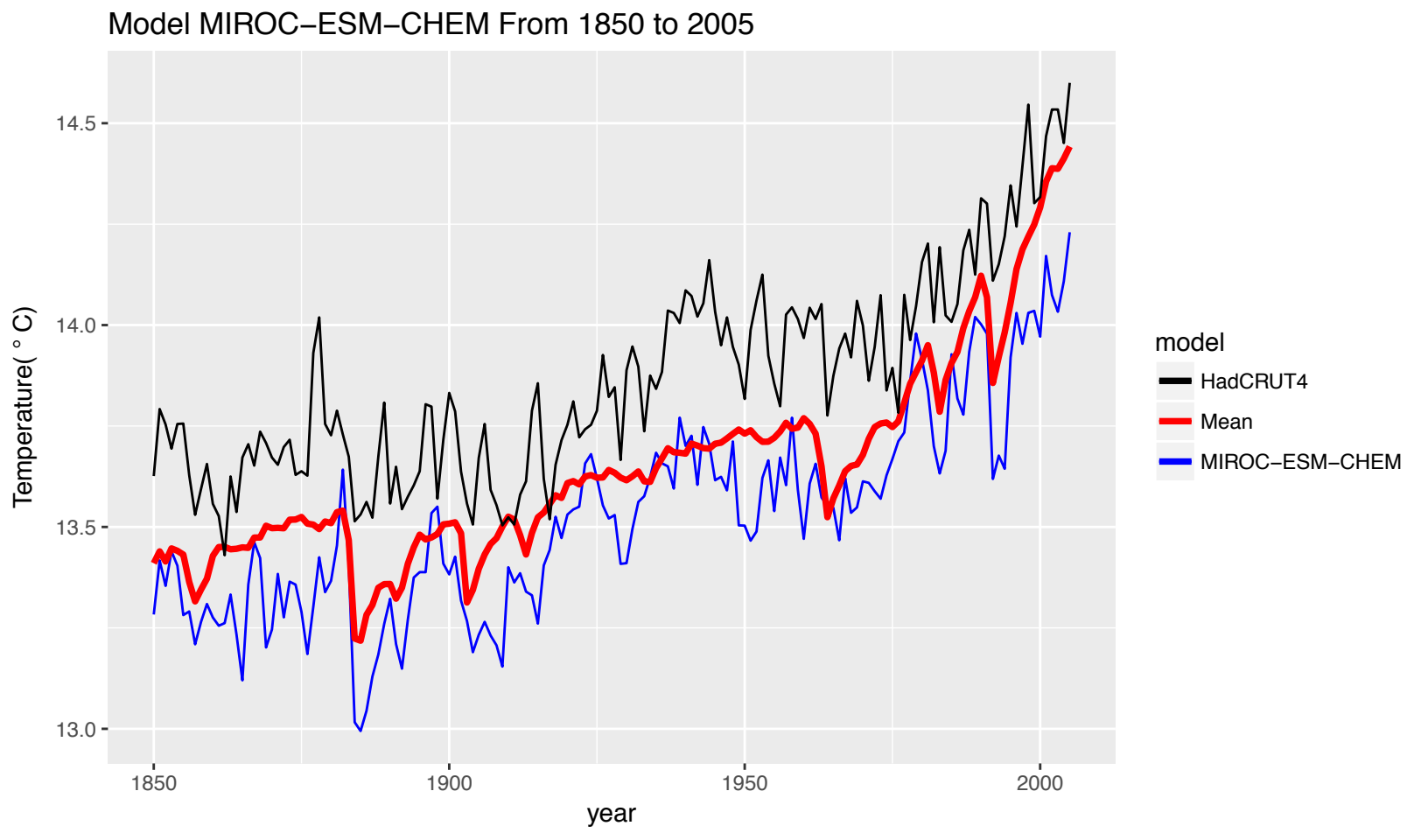

Model IPSL−CM5B−LR From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1880
1920
1960
2000
year
model
HadCRUT4
IPSL−CM5B−LR
Mean

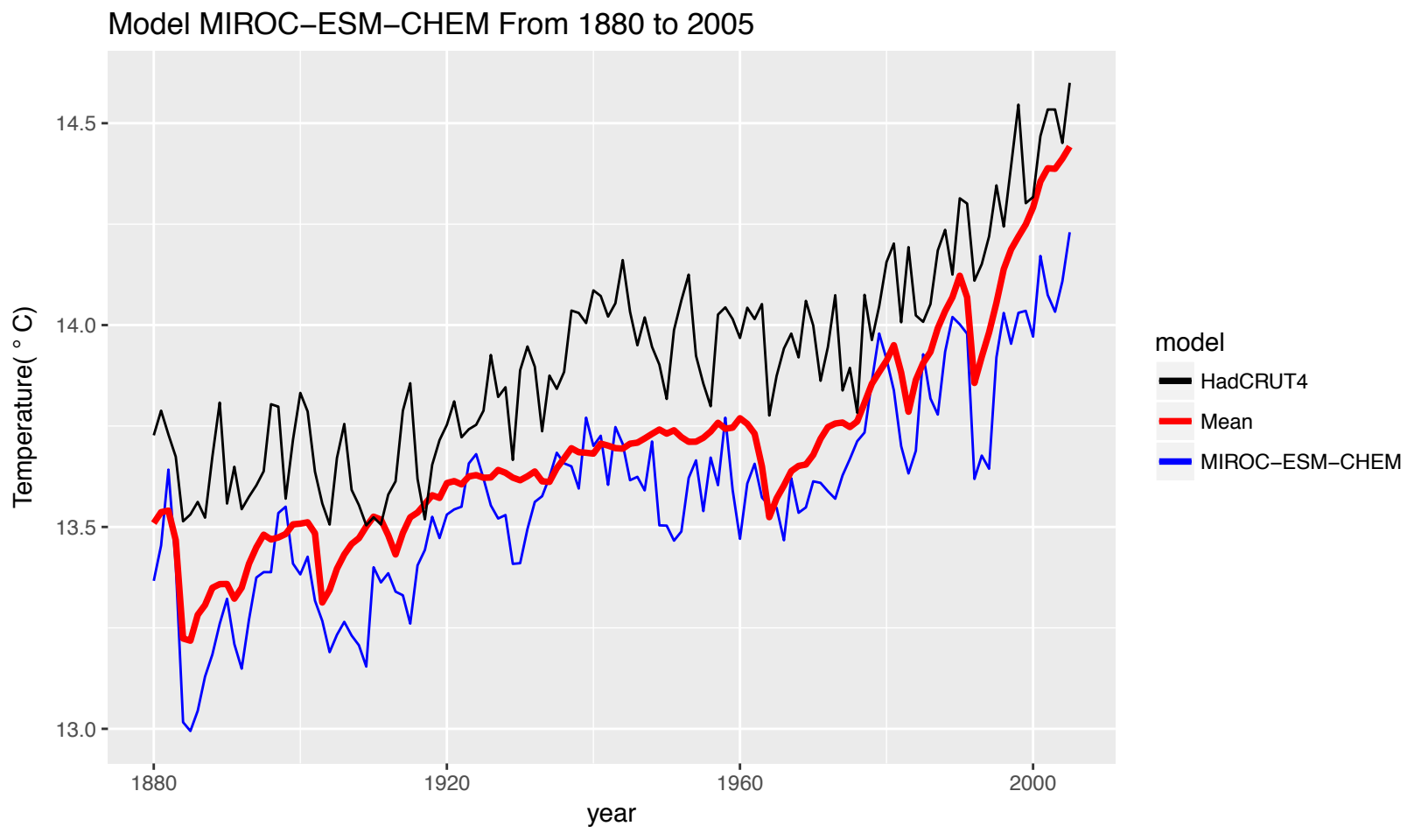

Model IPSL−CM5B−LR From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
HadCRUT4
IPSL−CM5B−LR
Mean

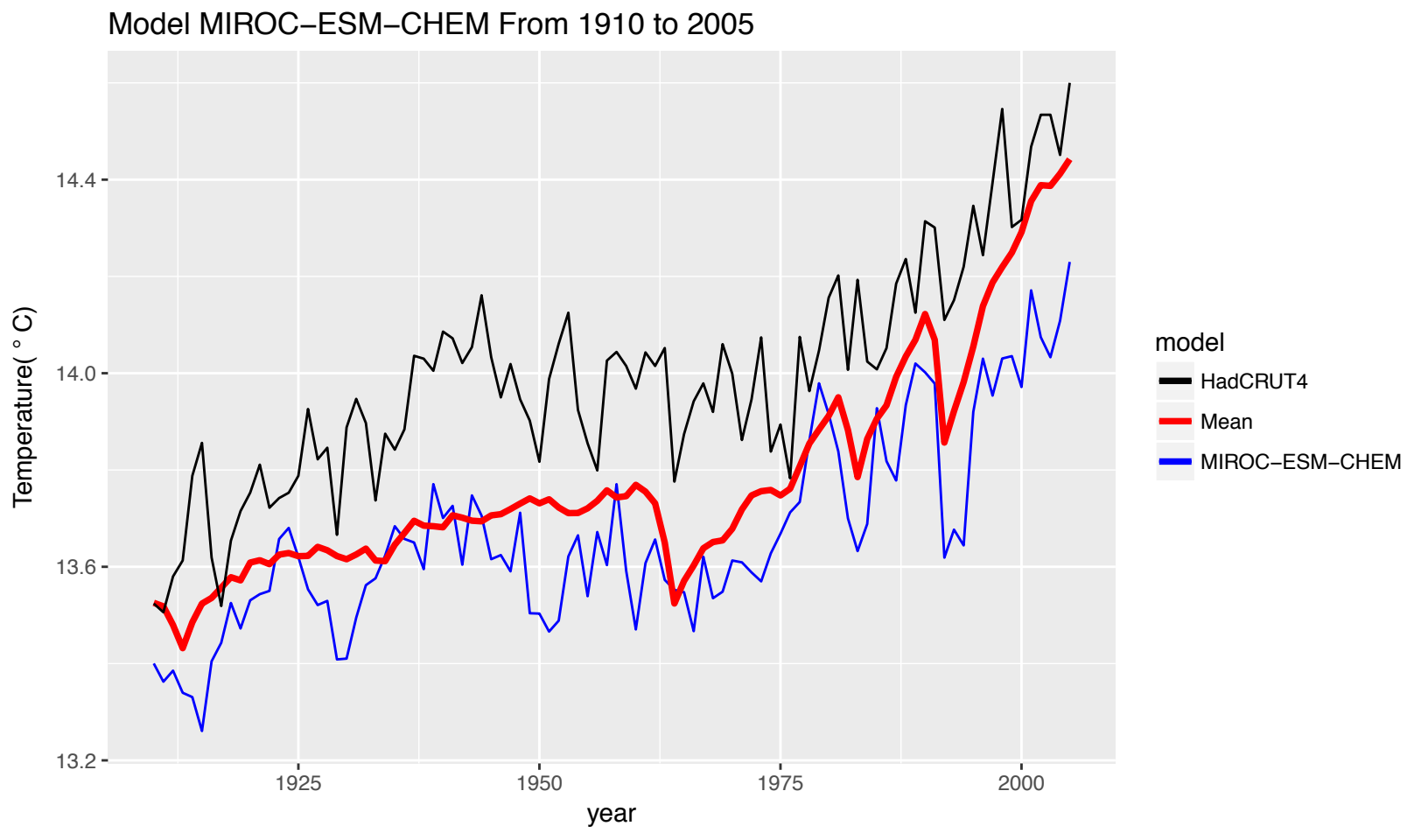

Model MIROC−ESM From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MIROC−ESM

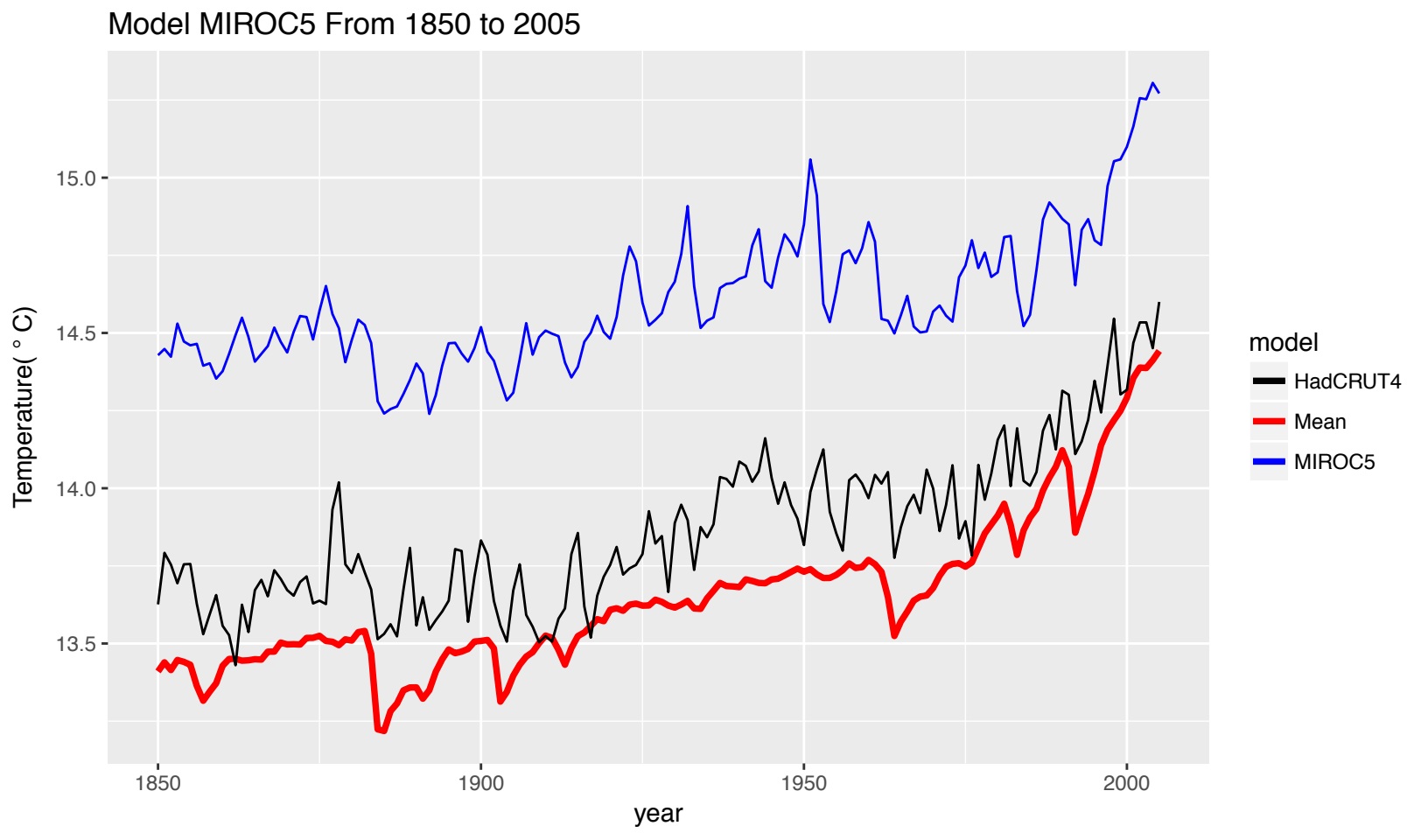

Model MIROC−ESM From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MIROC−ESM

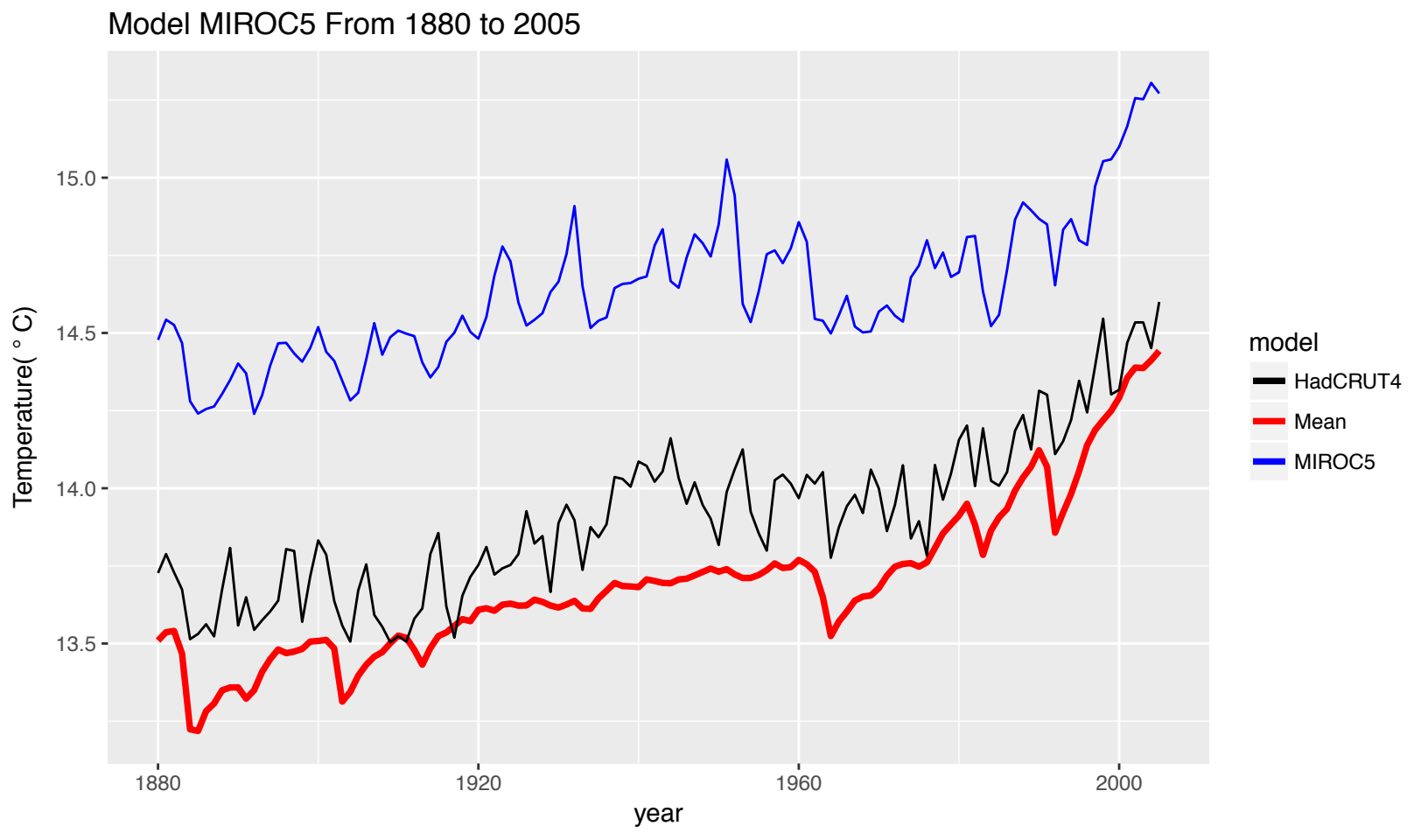

Model MIROC−ESM From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MIROC−ESM

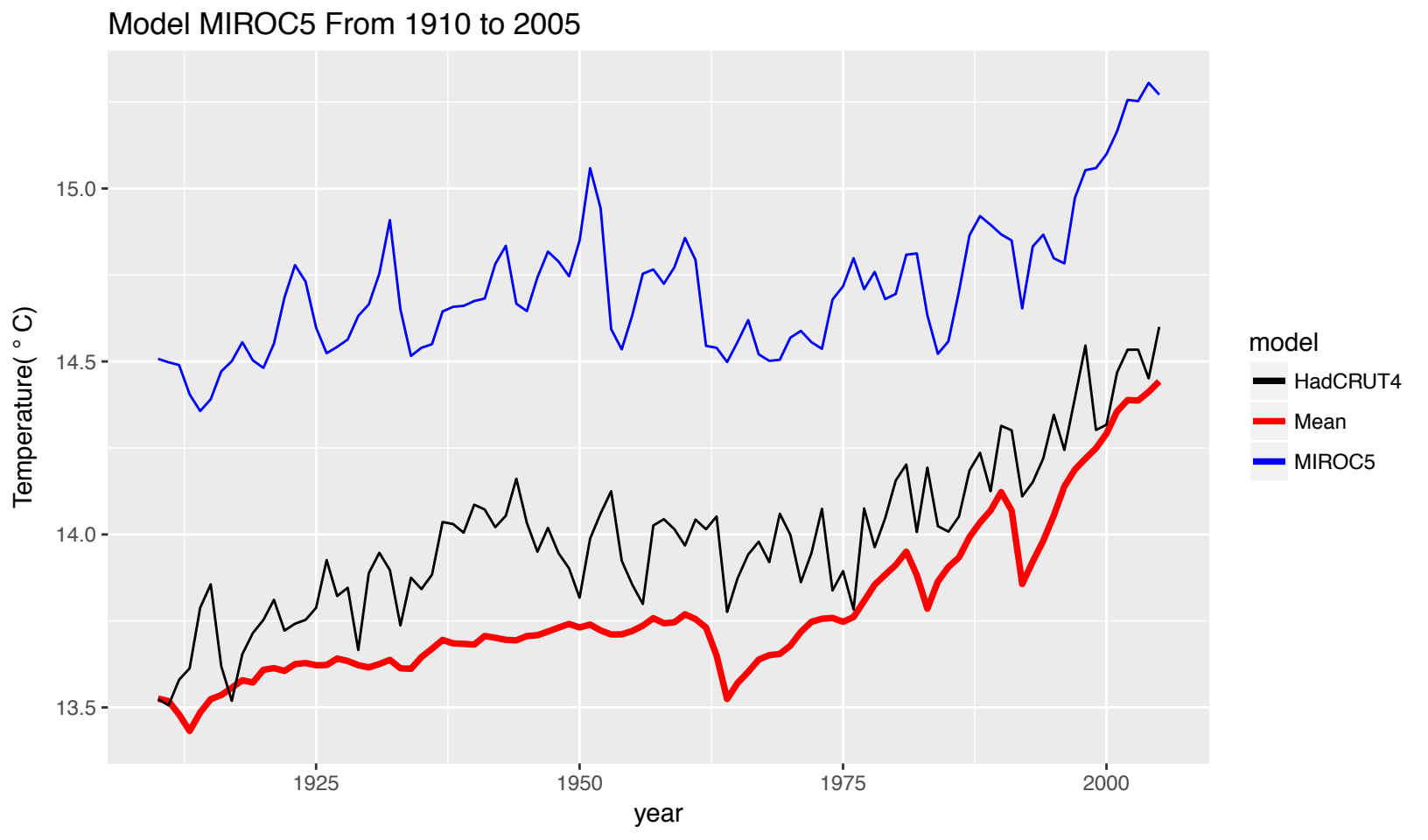

Model MIROC−ESM−CHEM From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MIROC−ESM−CHEM

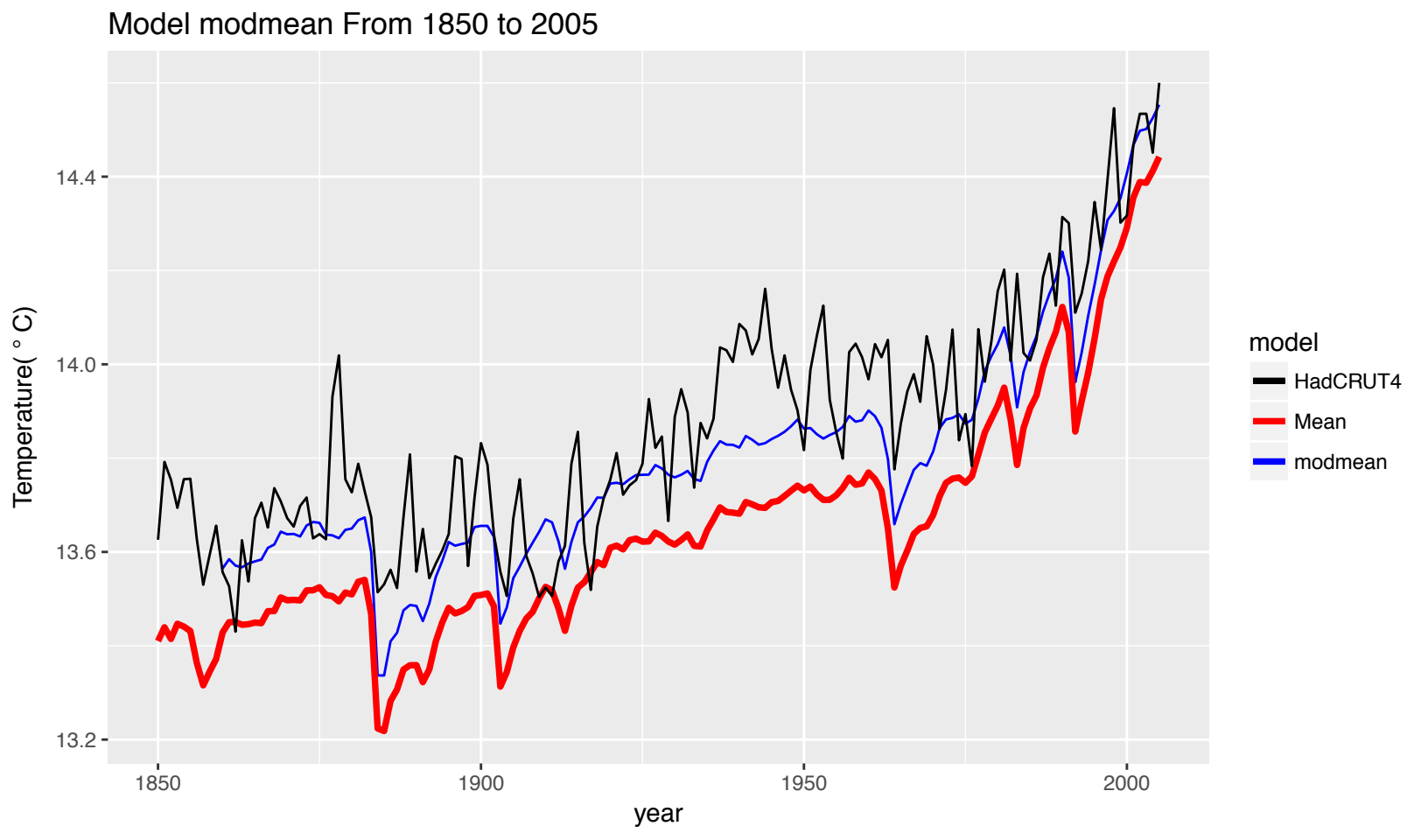

Model MIROC−ESM−CHEM From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MIROC−ESM−CHEM

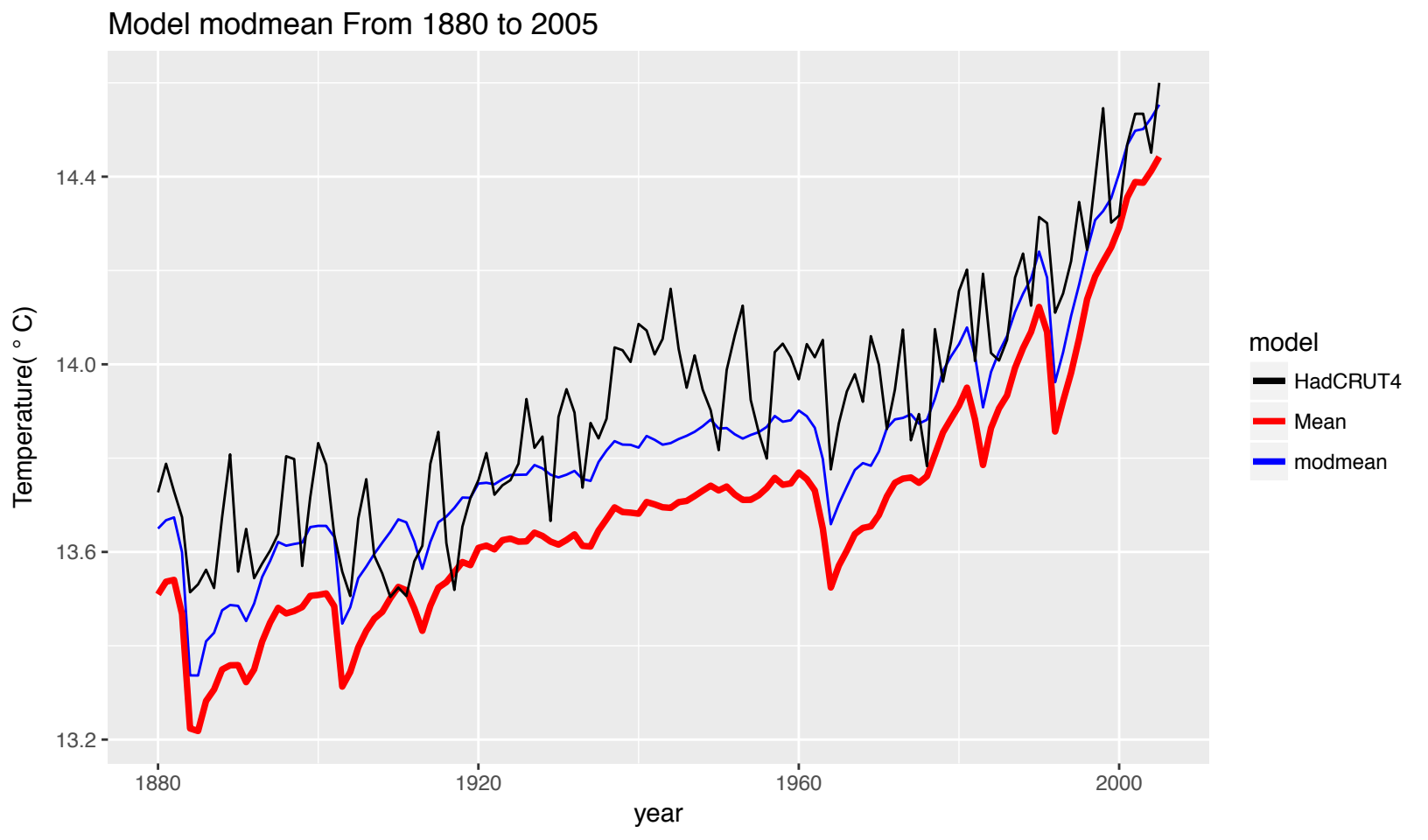

Model MIROC−ESM−CHEM From 1910 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MIROC−ESM−CHEM

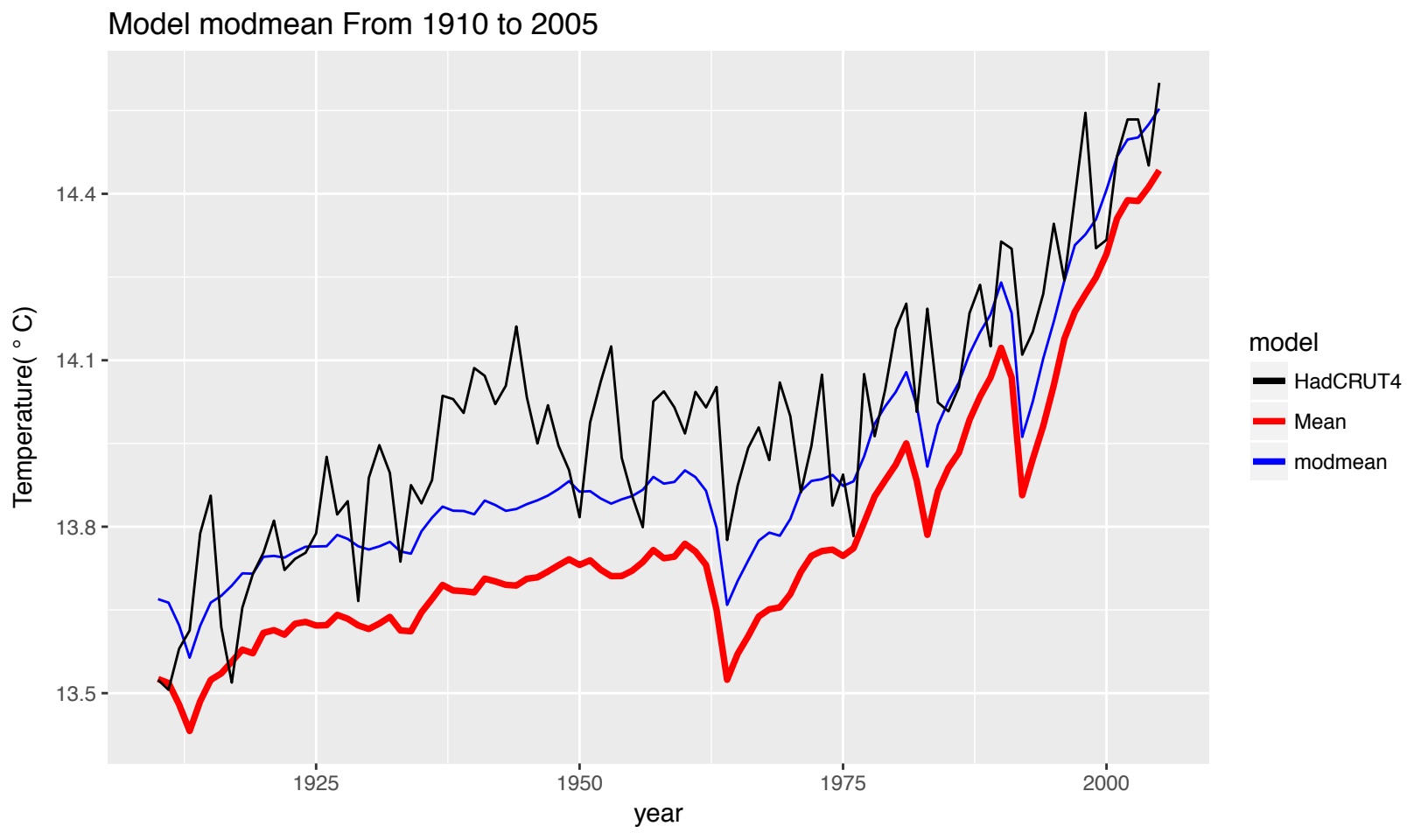

Model MIROC5 From 1850 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MIROC5

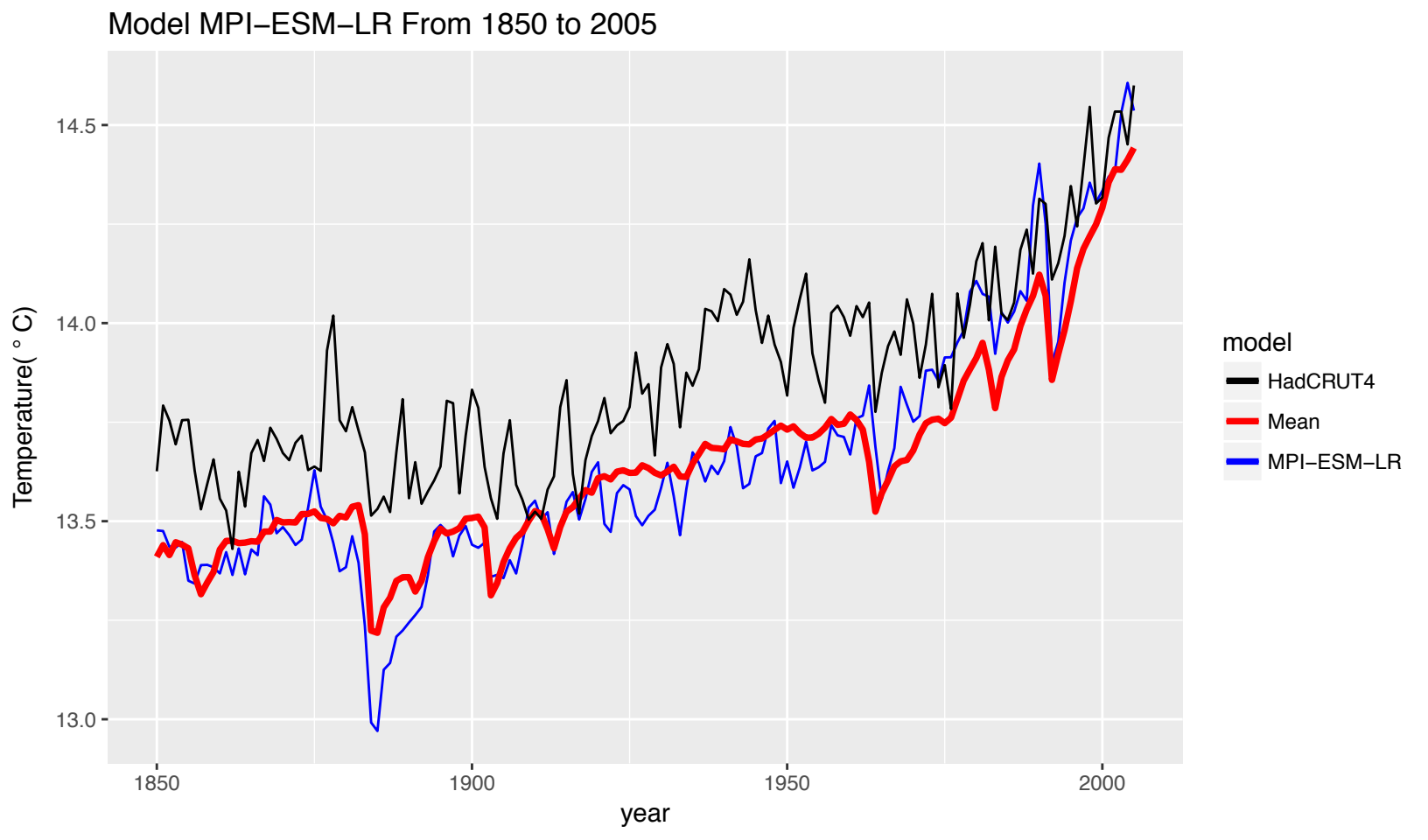

Model MIROC5 From 1880 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MIROC5

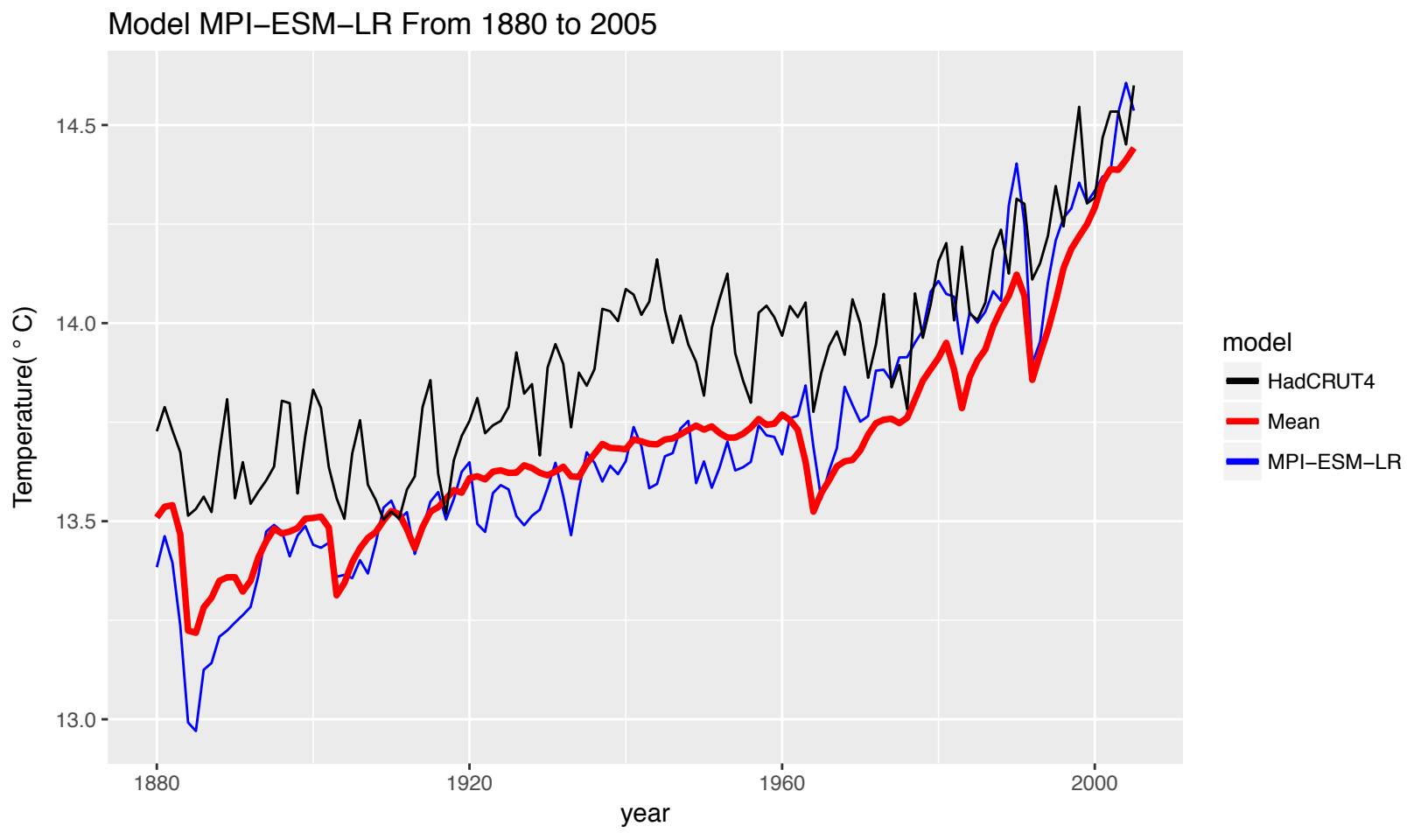

Model MIROC5 From 1910 to 2005
Temperature(° C)
15.0
14.5
14.0
13.5
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MIROC5

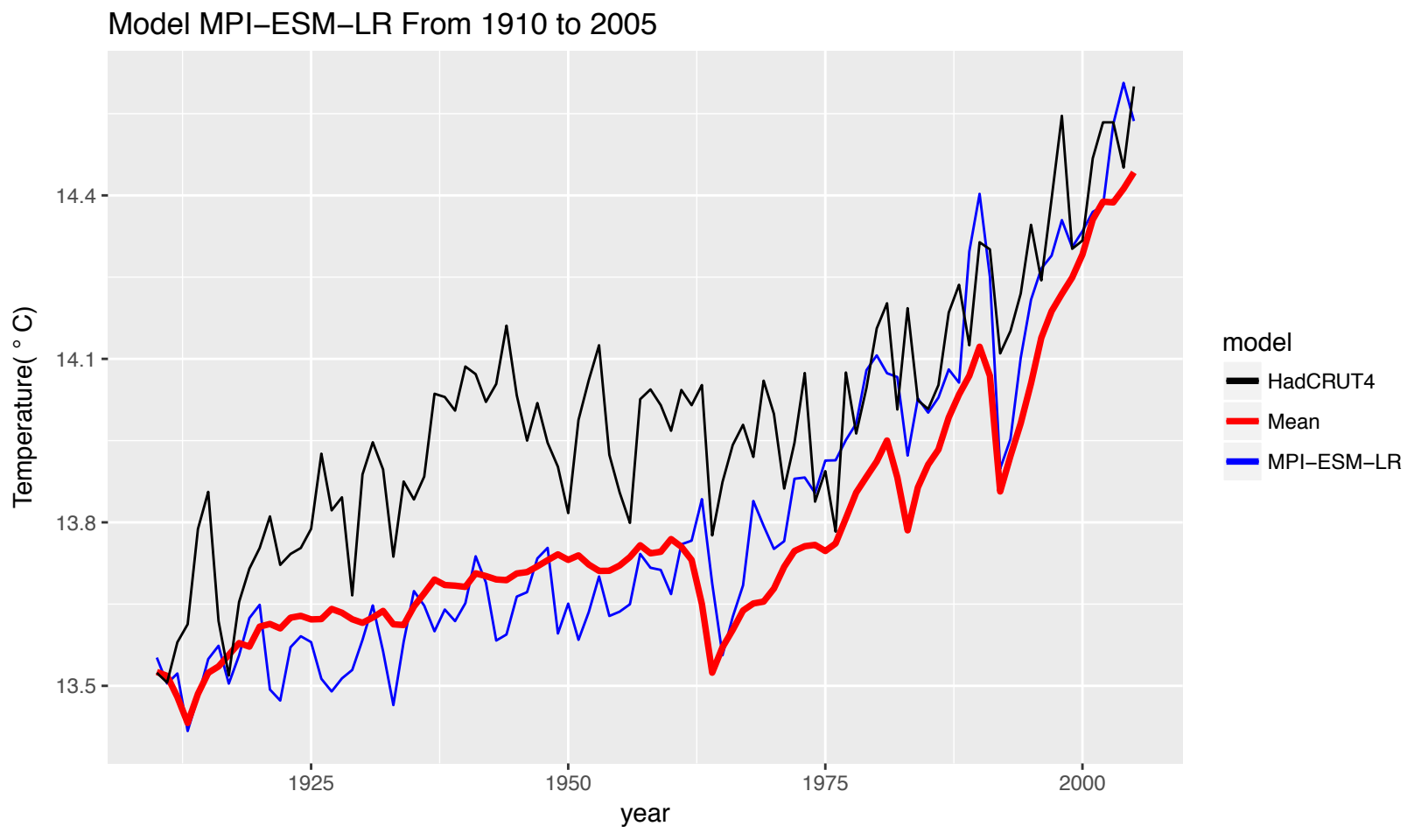

Model modmean From 1850 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1850
1900
1950
2000
year
model
HadCRUT4
Mean
modmean

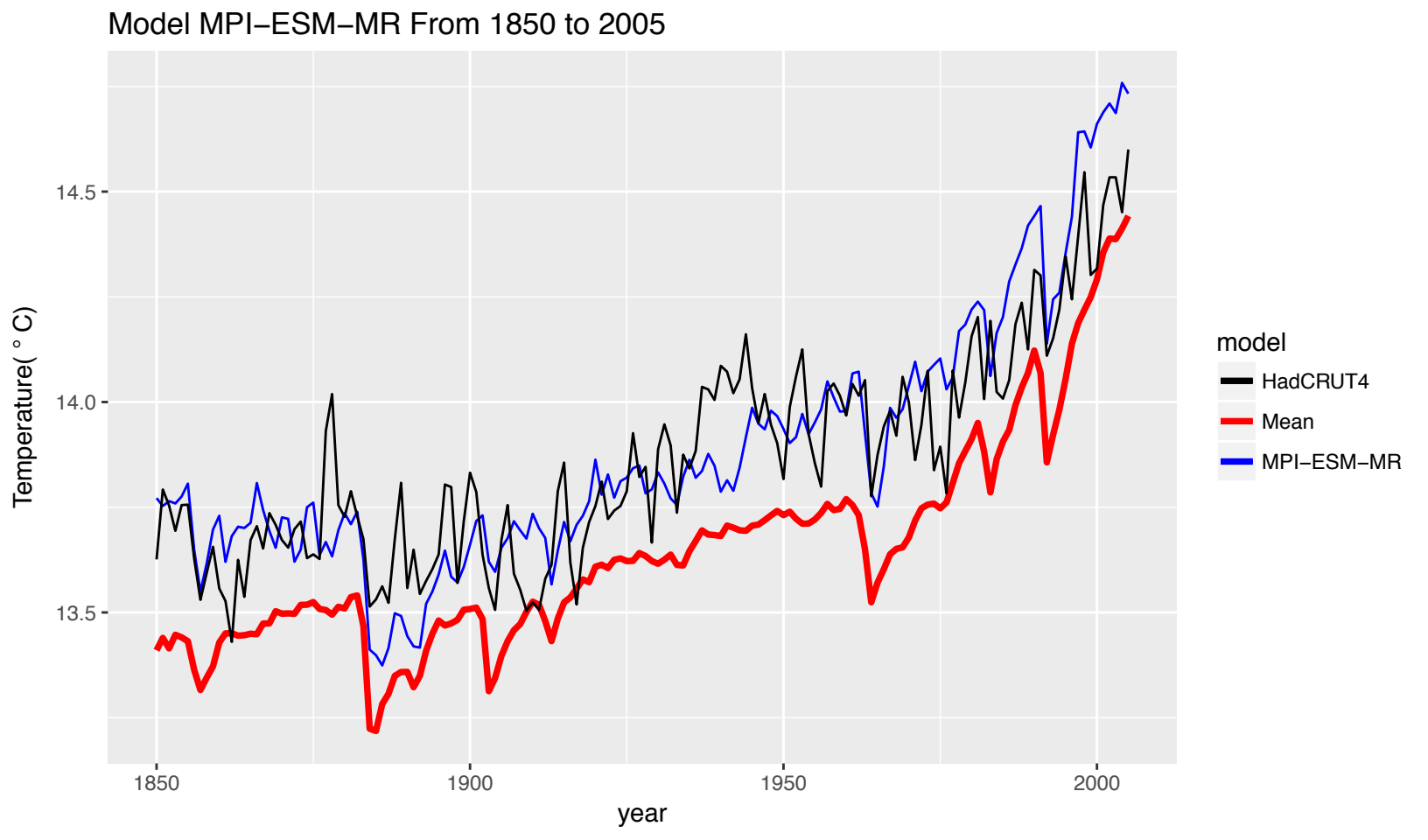

Model modmean From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
HadCRUT4
Mean
modmean


Model modmean From 1910 to 2005
Temperature(° C)
14.4
14.1
13.8
13.5
1925
1950
1975
2000
year
model
HadCRUT4
Mean
modmean


Model MPI−ESM−LR From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MPI−ESM−LR


Model MPI−ESM−LR From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MPI−ESM−LR


Model MPI−ESM−LR From 1910 to 2005
Temperature(° C)
14.4
14.1
13.8
13.5
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MPI−ESM−LR


Model MPI−ESM−MR From 1850 to 2005
Temperature(° C)
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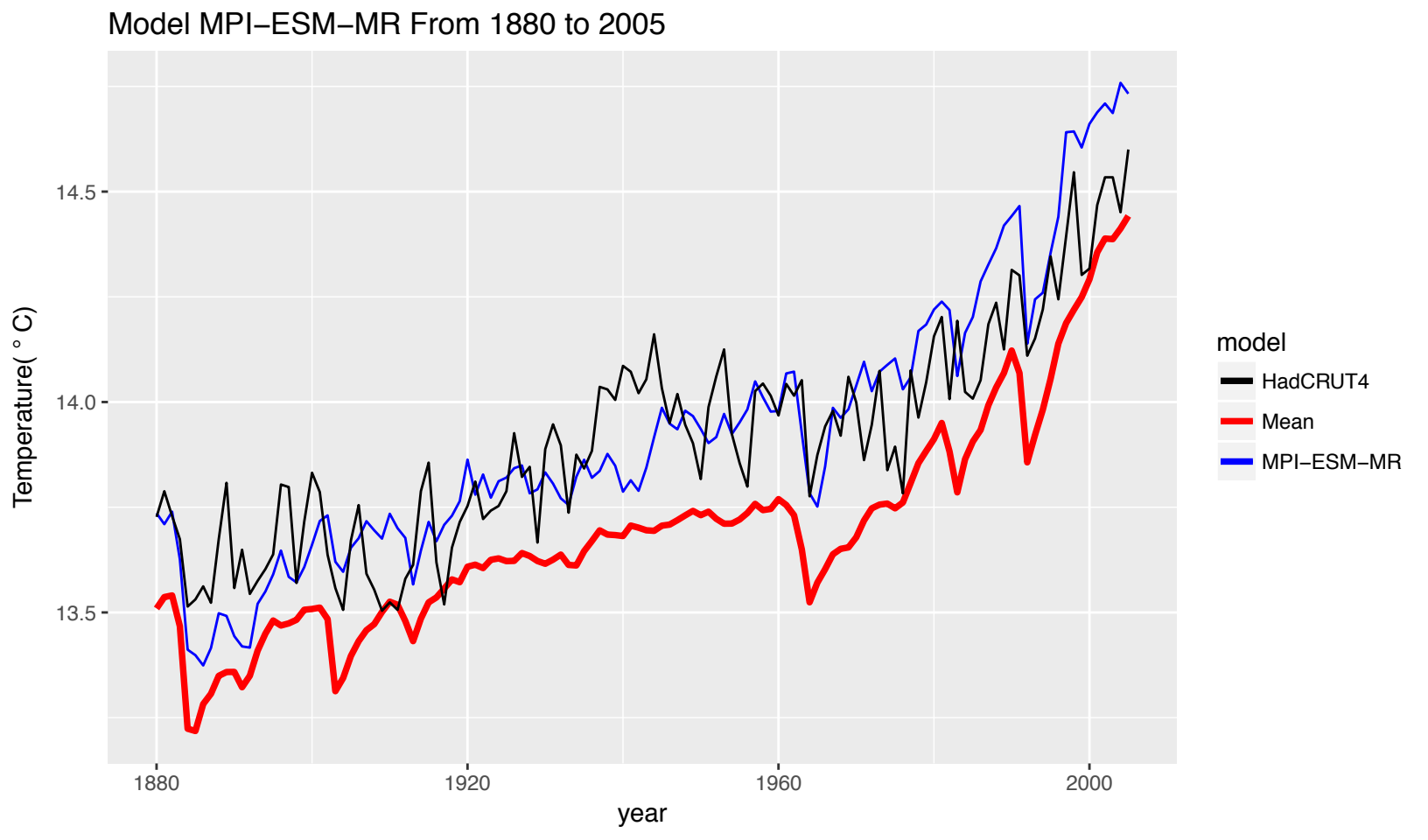
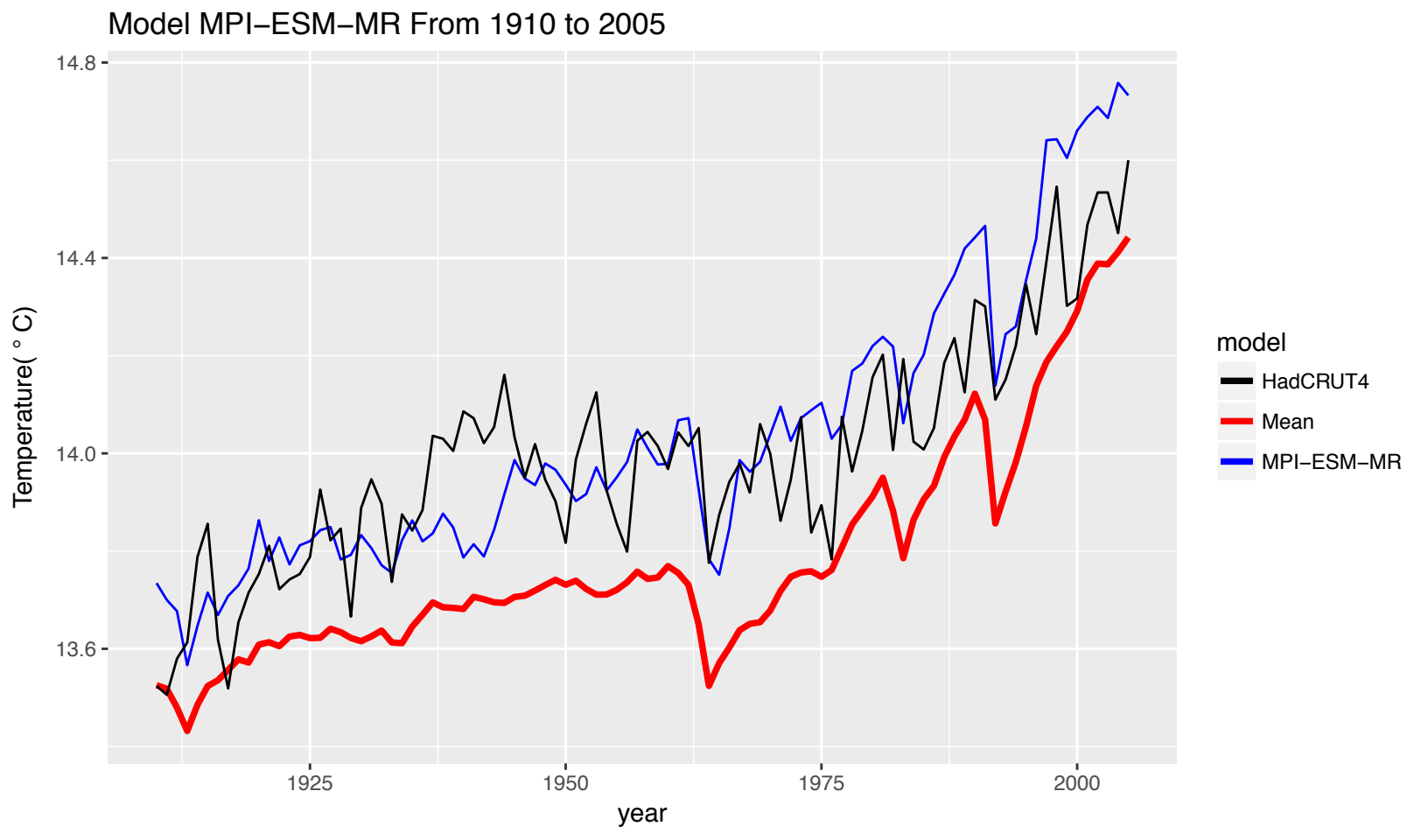
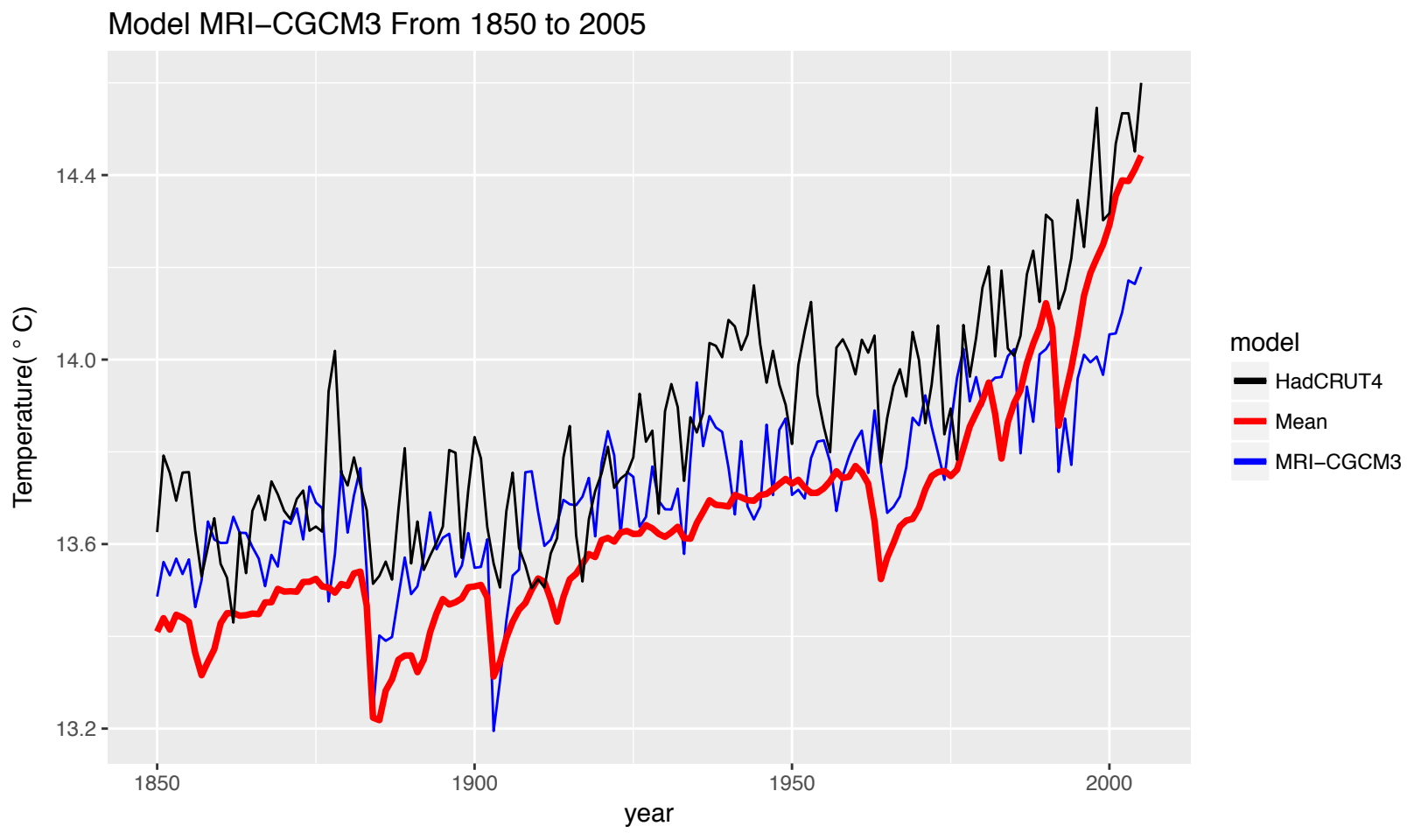
14.0
13.5
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MPI−ESM−MR


Model MPI−ESM−MR From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MPI−ESM−MR


Model MPI−ESM−MR From 1910 to 2005
14.8
14.4
14.0
13.6
Temperature(° C)
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MPI−ESM−MR


Model MRI−CGCM3 From 1850 to 2005
Temperature(° C)
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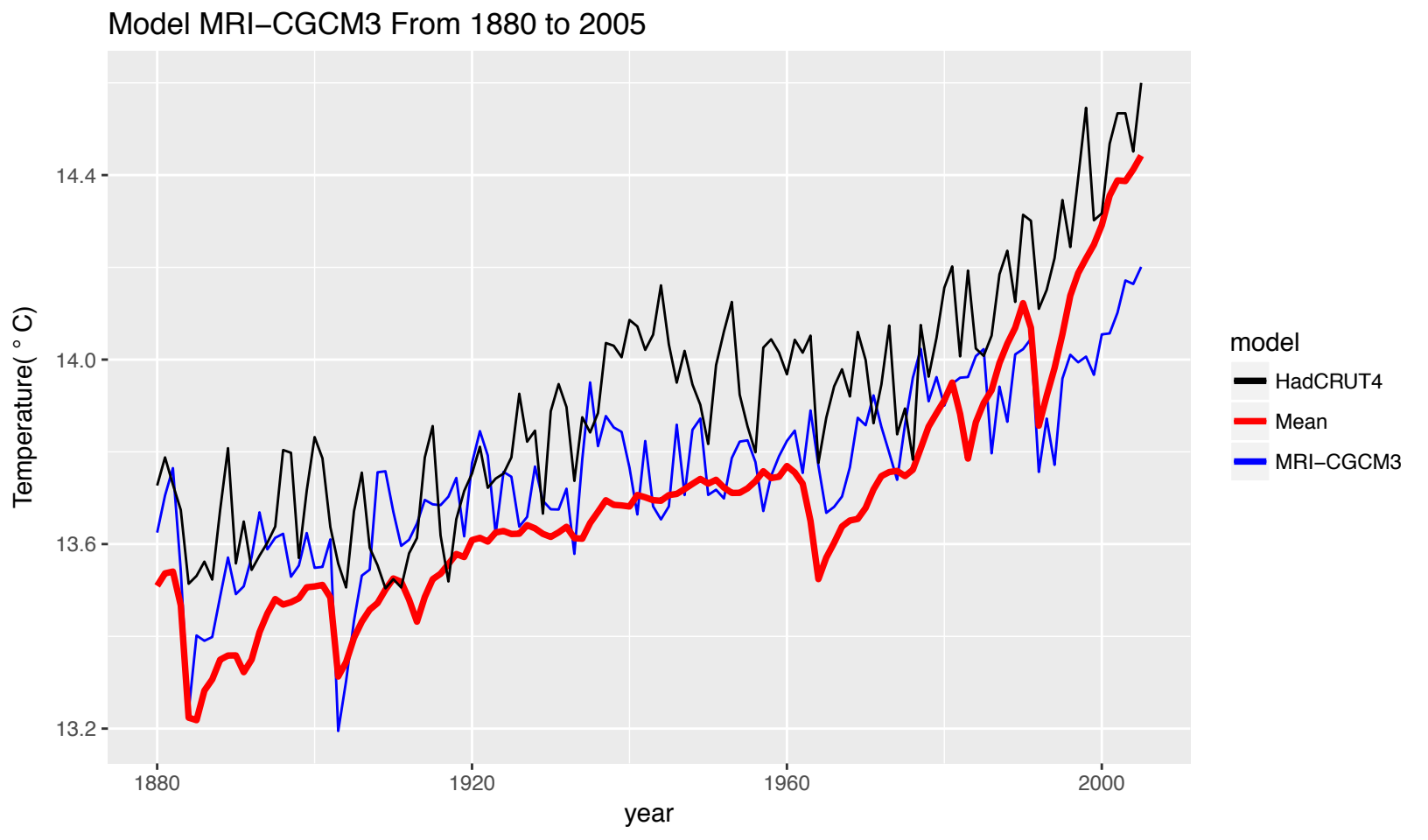
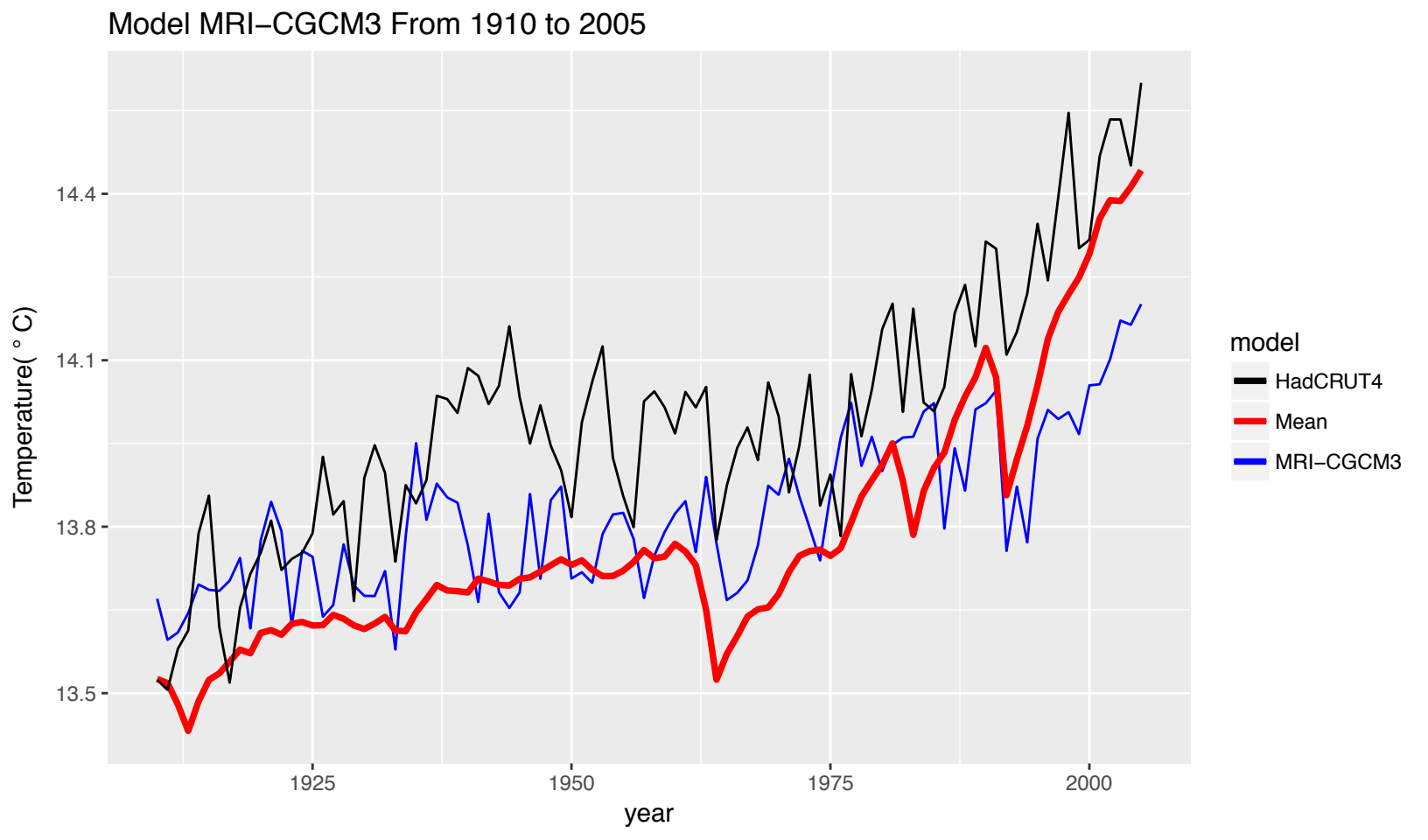
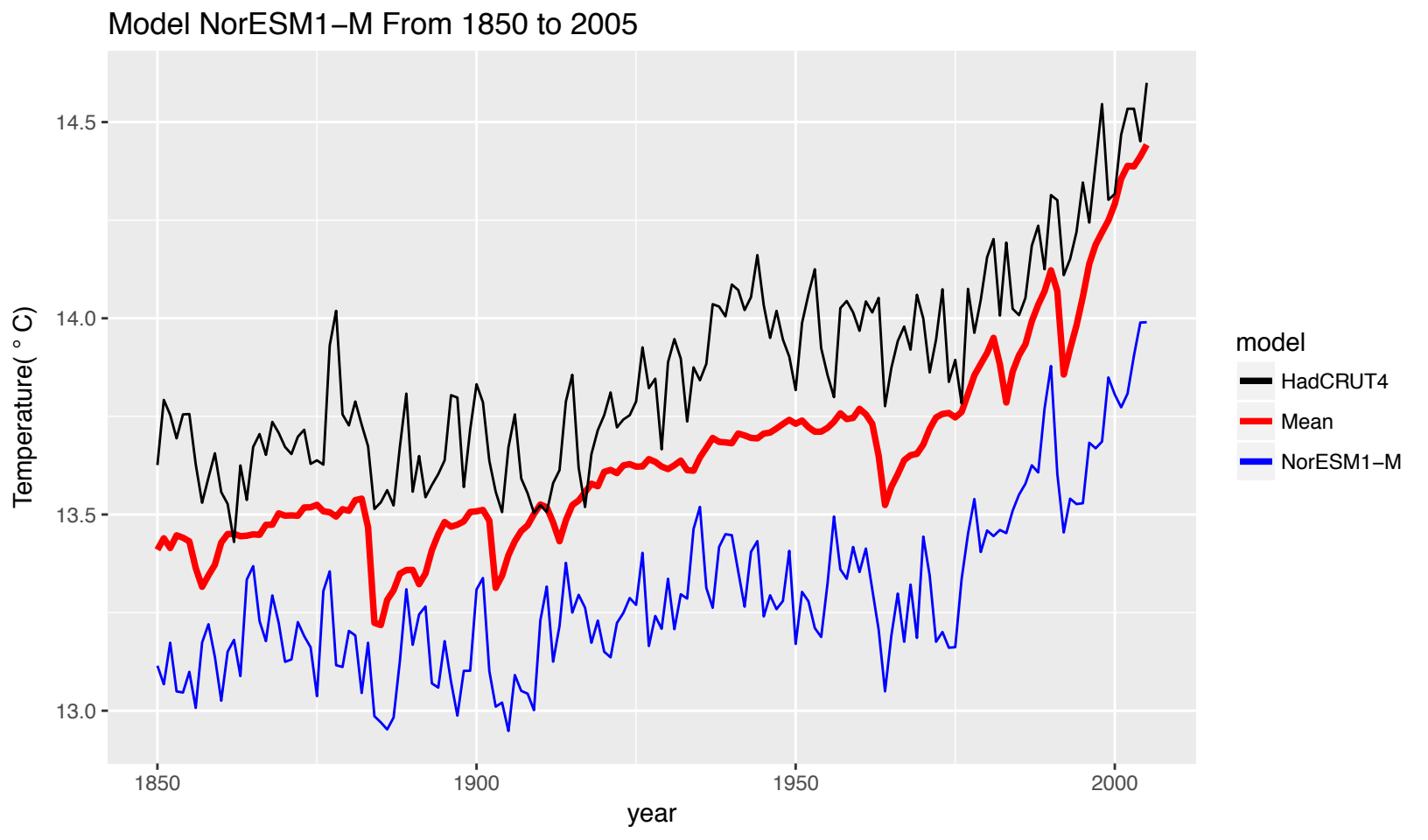
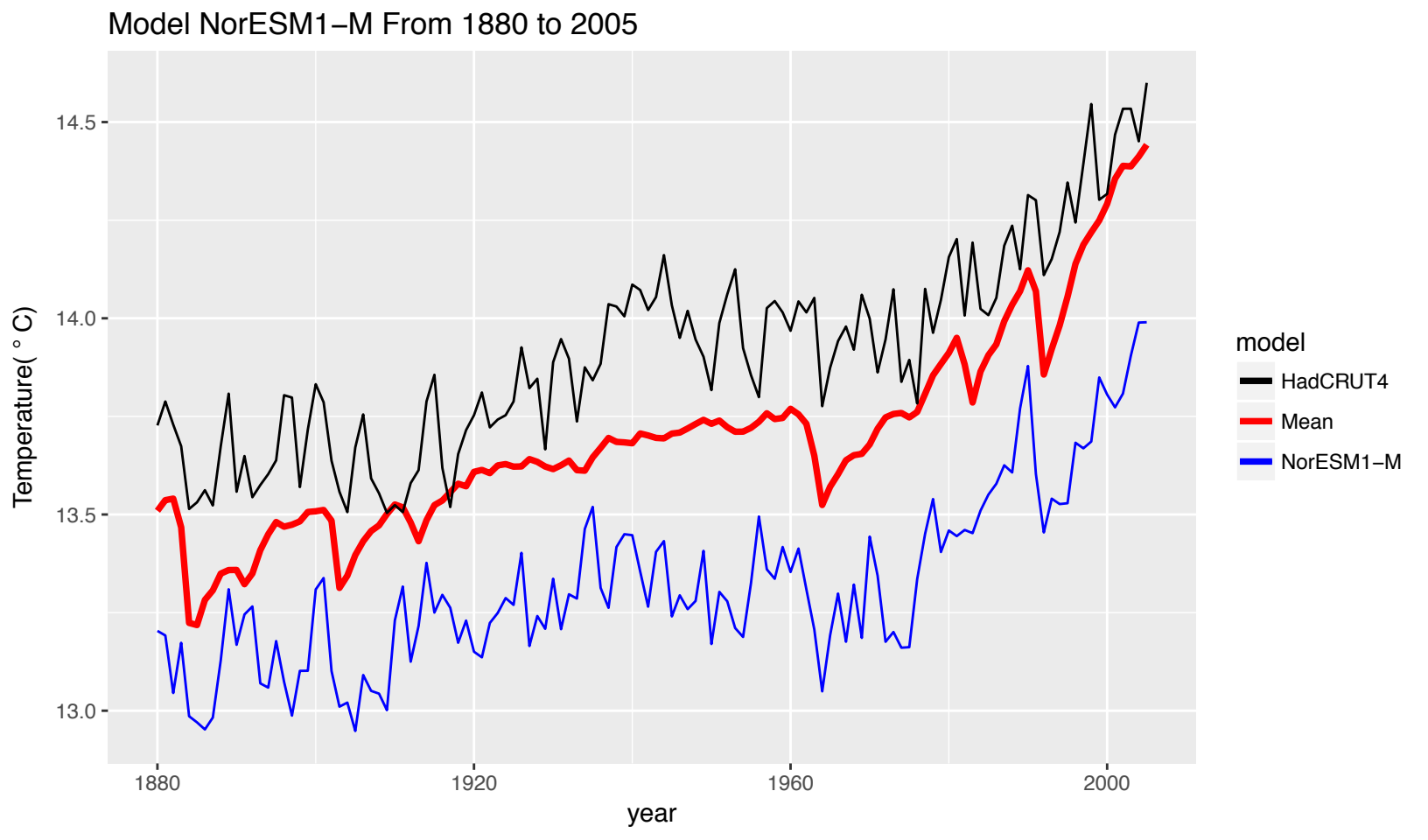
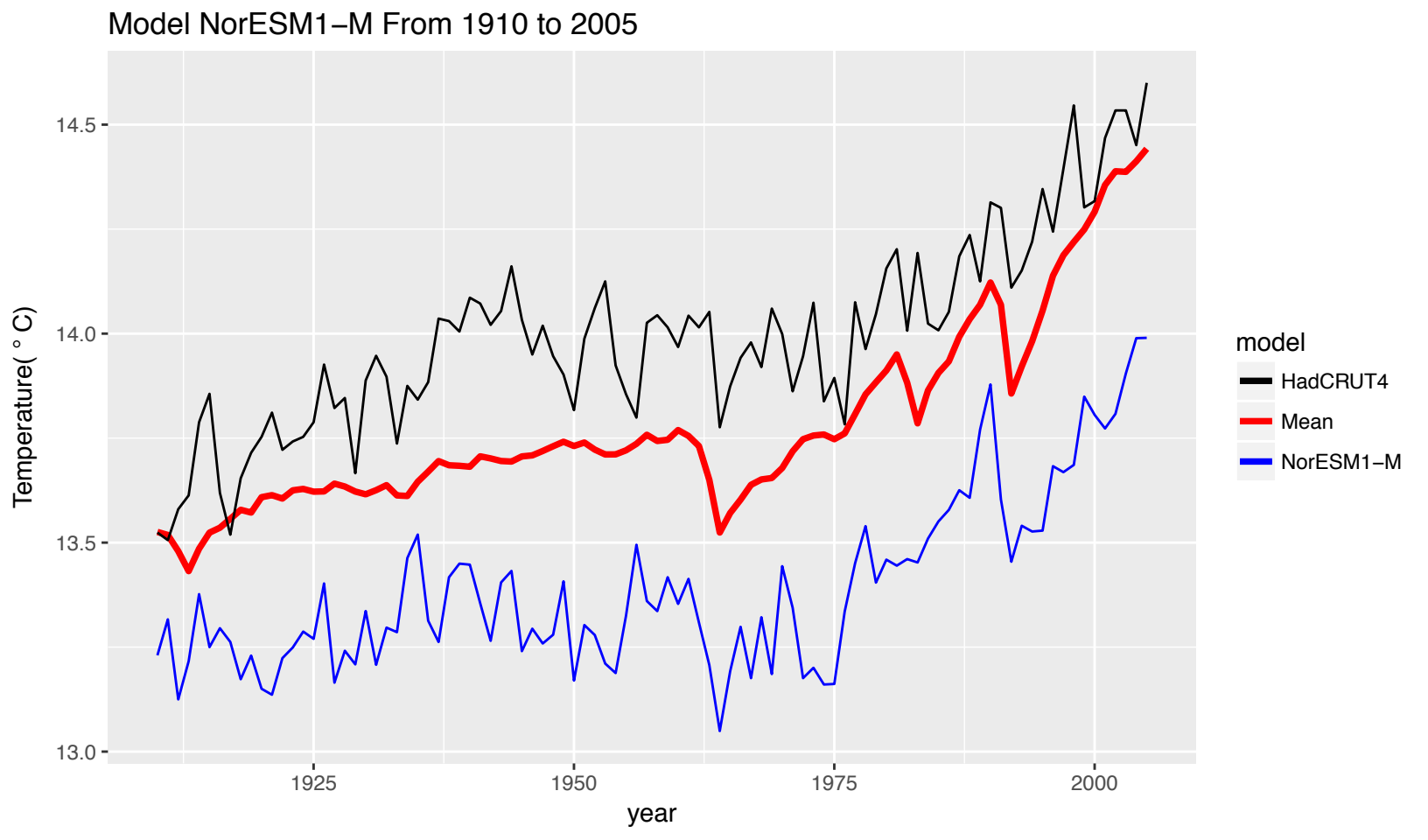
14.0
13.6
13.2
1850
1900
1950
2000
year
model
HadCRUT4
Mean
MRI−CGCM3

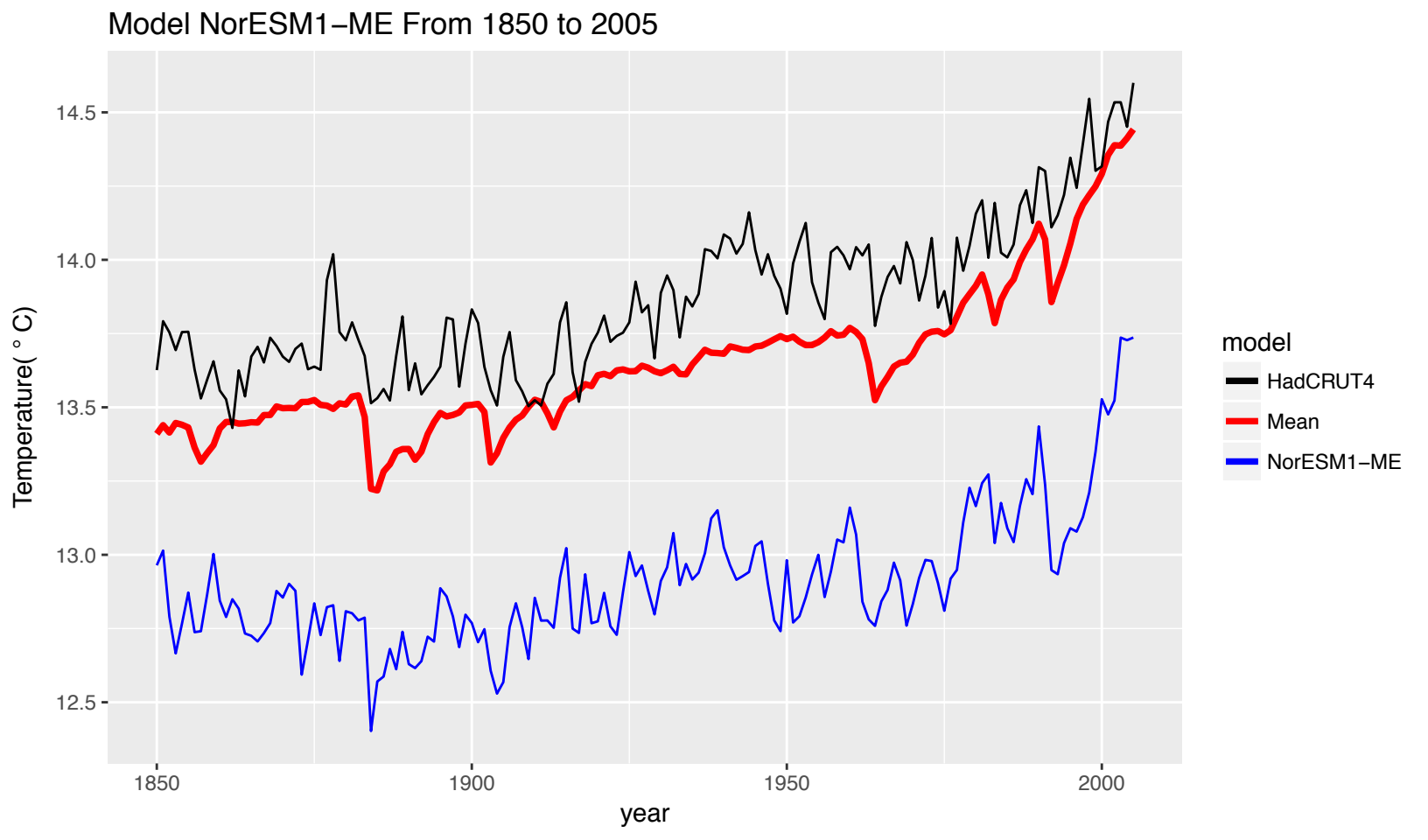

Model MRI−CGCM3 From 1880 to 2005
Temperature(° C)
14.4
14.0
13.6
13.2
1880
1920
1960
2000
year
model
HadCRUT4
Mean
MRI−CGCM3


Model MRI−CGCM3 From 1910 to 2005
Temperature(° C)
14.4
14.1
13.8
13.5
1925
1950
1975
2000
year
model
HadCRUT4
Mean
MRI−CGCM3


Model NorESM1−M From 1850 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1850
1900
1950
2000
year
model
HadCRUT4
Mean
NorESM1−M


Model NorESM1−M From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1880
1920
1960
2000
year
model
HadCRUT4
Mean
NorESM1−M


Model NorESM1−M From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
HadCRUT4
Mean
NorESM1−M


Model NorESM1−ME From 1850 to 2005
Temperature(° C)
14.5
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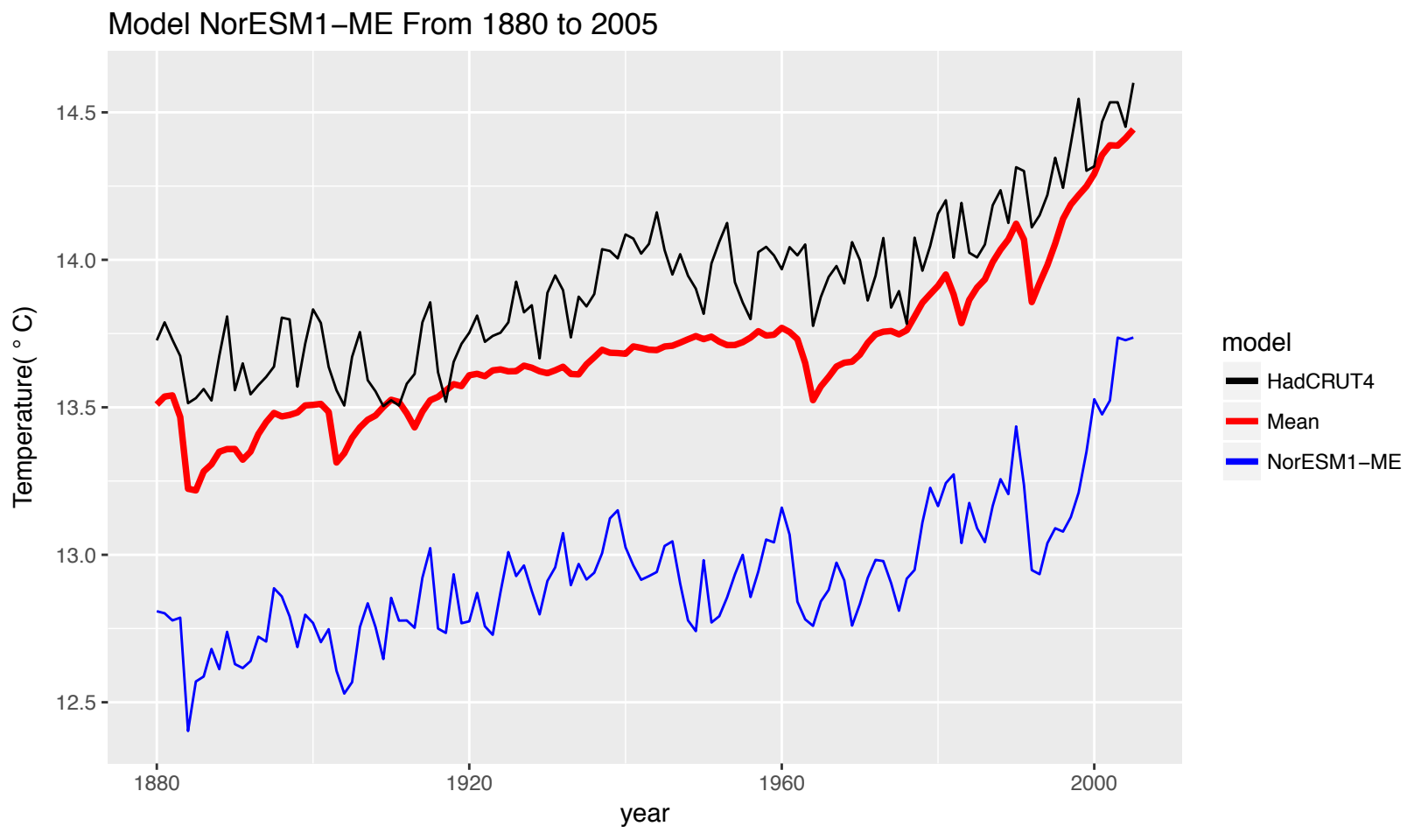
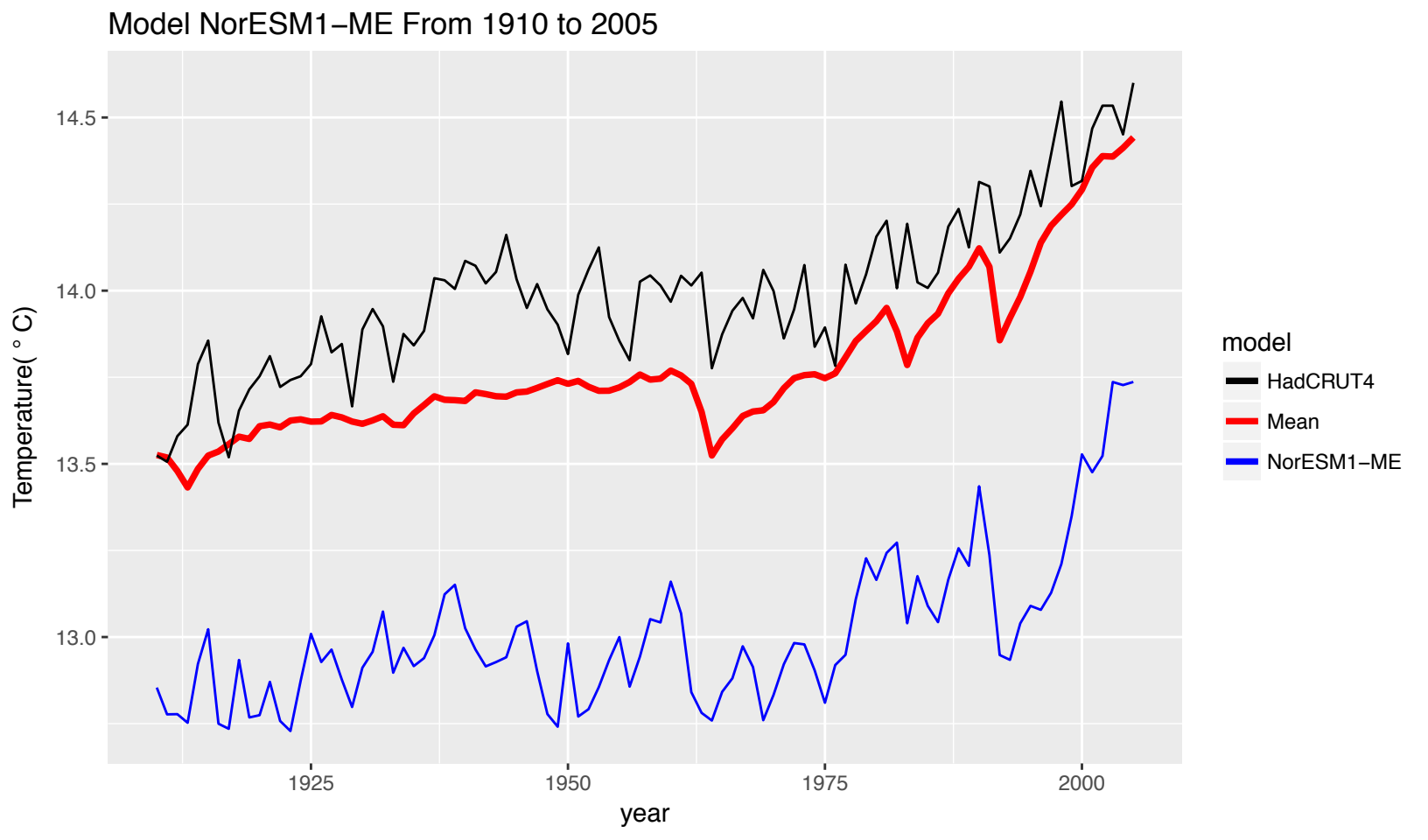
13.5
13.0
12.5
1850
1900
1950
2000
year
model
HadCRUT4
Mean
NorESM1−ME


Model NorESM1−ME From 1880 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
12.5
1880
1920
1960
2000
year
model
HadCRUT4
Mean
NorESM1−ME


Model NorESM1−ME From 1910 to 2005
Temperature(° C)
14.5
14.0
13.5
13.0
1925
1950
1975
2000
year
model
HadCRUT4
Mean
NorESM1−ME