

CMIP5気候モデルにおける三陸 沿岸のSSTの再現と将来予測

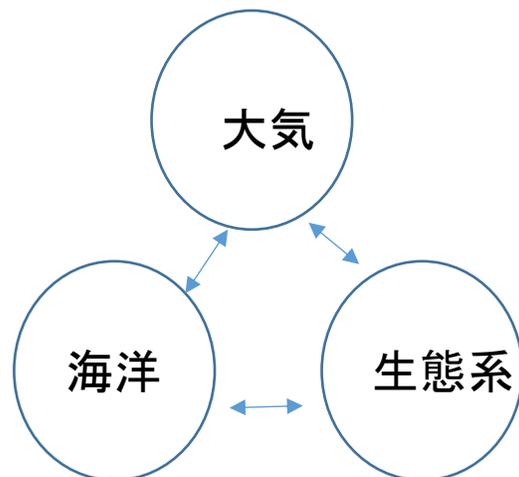
児玉安正・Ibnu Fathrio・佐々木実紀
(弘前大学大学院・理工学研究科)

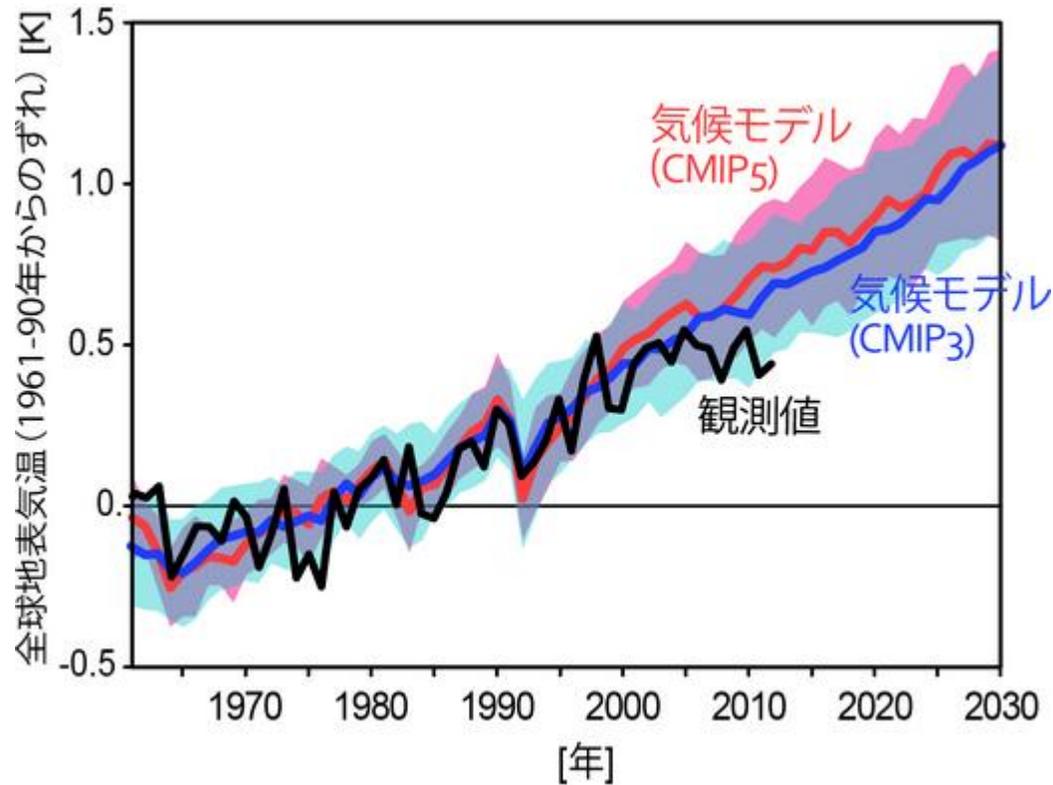
温暖化後のヤマセの予測

気候モデルによる予測

力学的ダウンスケーリング
→

東北地方の
ヤマセの温暖
化影響予測





Hiatus(空白、休止状況) (気温上昇の停滞状況)

モデル民主主義の限界？

図1: 全球平均地表気温の1960年から2030年までの変化。黒線は2012年までの観測値(英国ハドレーセンター作成の地表気温データセットにもとづく)、青線と赤線とそれぞれの陰影は、CMIP3とCMIP5の気候モデル群による平均値とそのばらつきを表している。2つの気候モデル群は、2000年頃までは観測される気温の長期変化傾向をよく再現していましたが、最近の10年ほどは温暖化傾向を過大に再現していることが分かります。

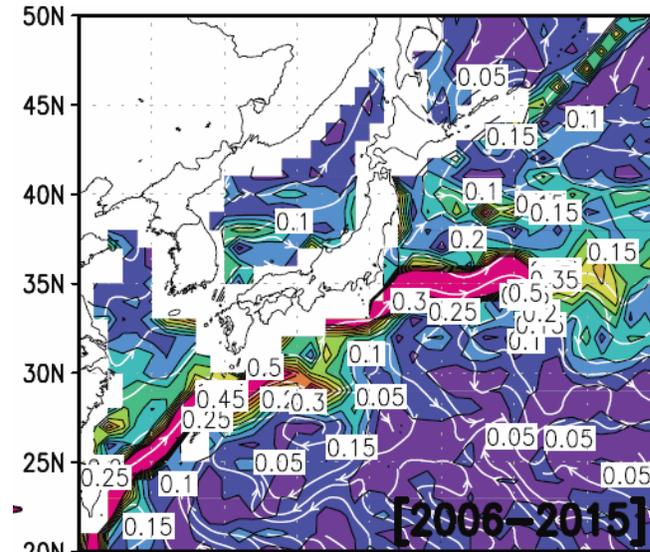
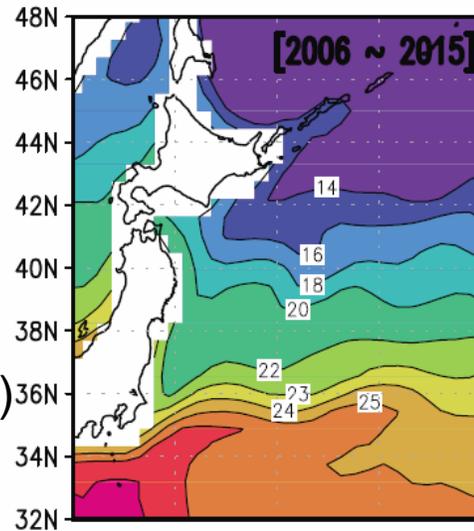
渡部 雅浩 (CCSR、Univ. of Tokyo)

CMIP5で用いられる中分解能の海洋モデルでは，黒潮の再現が不十分

MIROC4h

海洋モデル分解能
 0.28° (経度) $\times 0.19^\circ$ (緯度)

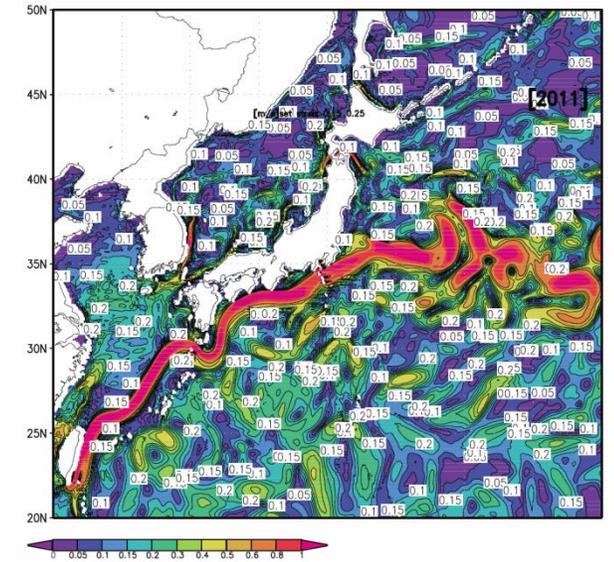
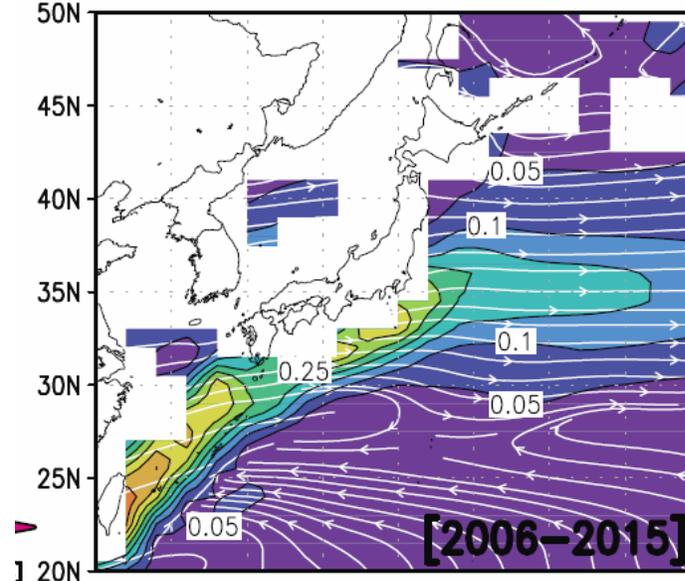
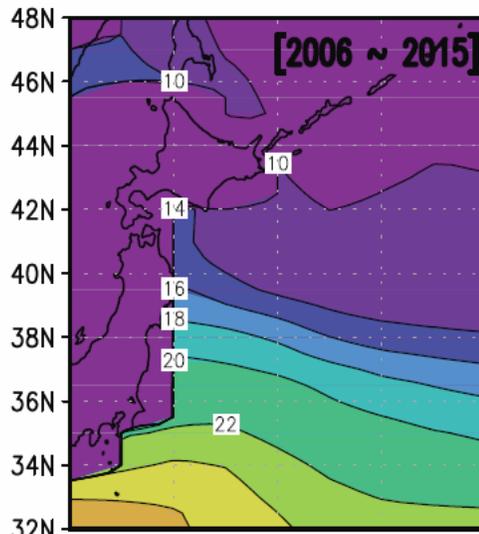
Eddy resolving



CMIP5モデル

MIROC5

海洋モデル分解能
 1.4° (経度) \times
 $(0.4\sim 1.4)^\circ$ (緯度)



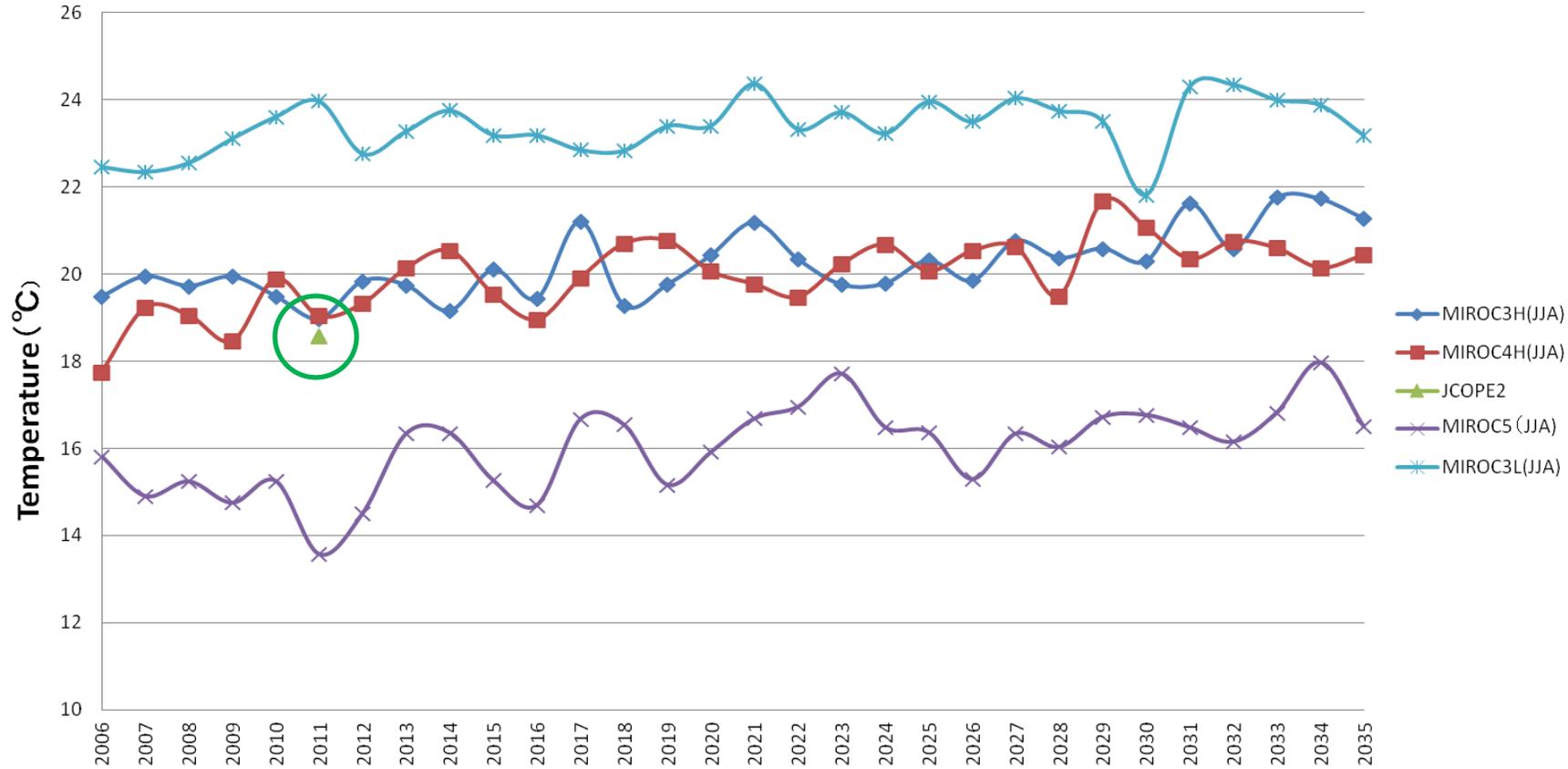
JCOPE2 July 2011

三陸沖の海面水温(SST) 温暖化実験(RCP4.5 2006~2035)

高分解能のモデル(MIROC4h)は観測に近い結果を示す。

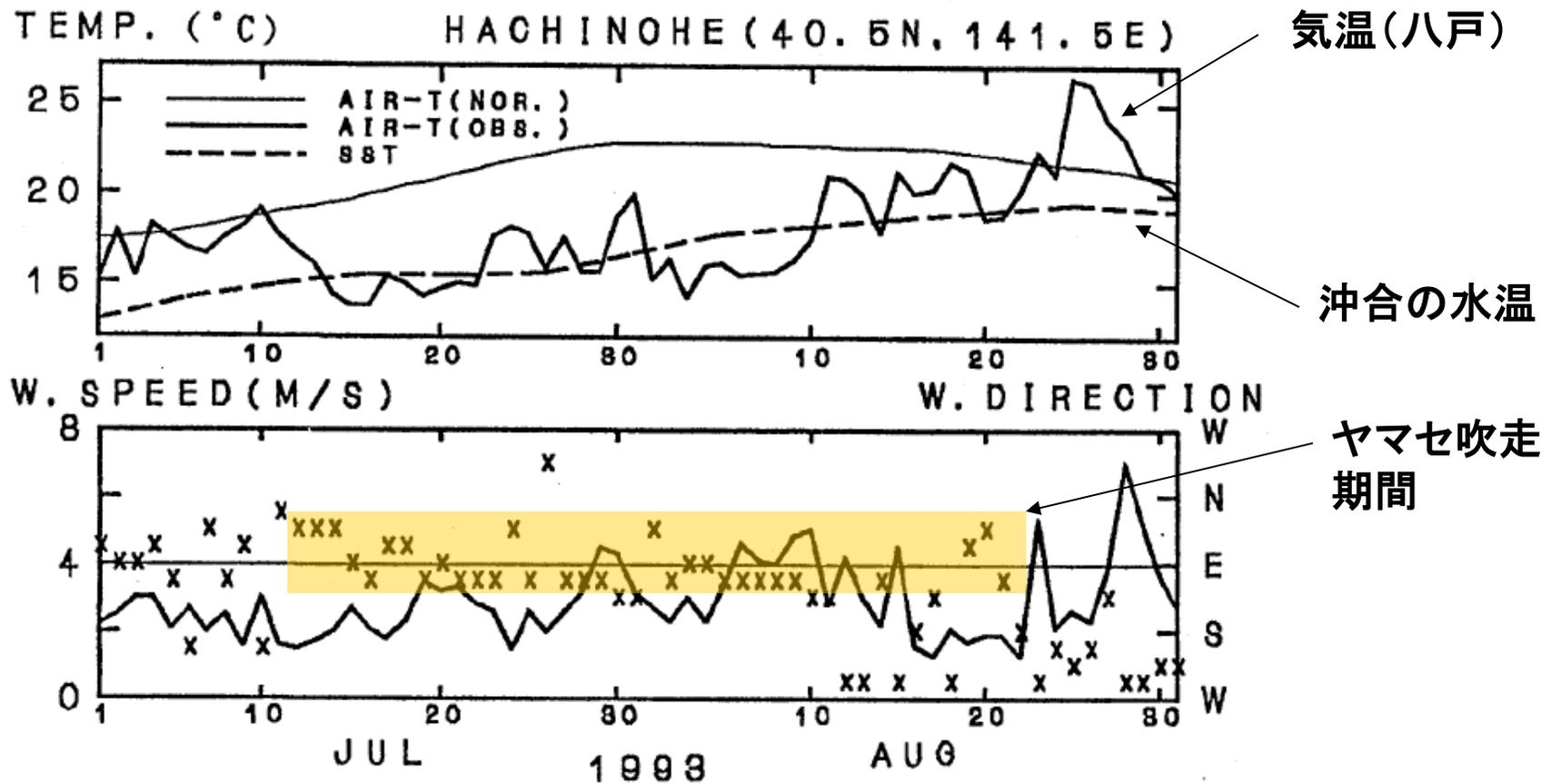
MIROC5は観測値よりも3°C低い

三陸沖 SST(40N-41N 141E-142E) 6~8月

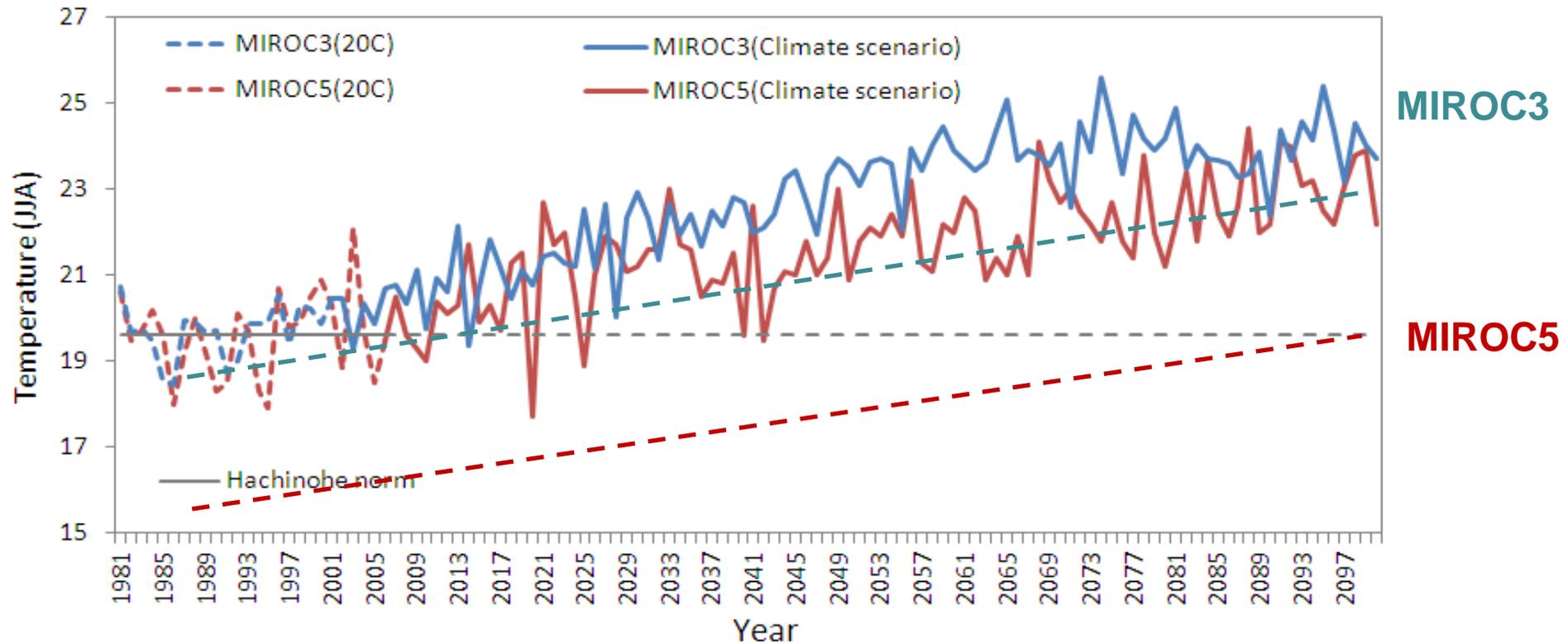


観測事実

観測されるヤマセ時の日平均気温の下限は沖合のSSTに規定される



平均気温と沿岸水温の将来予測(6~8月)



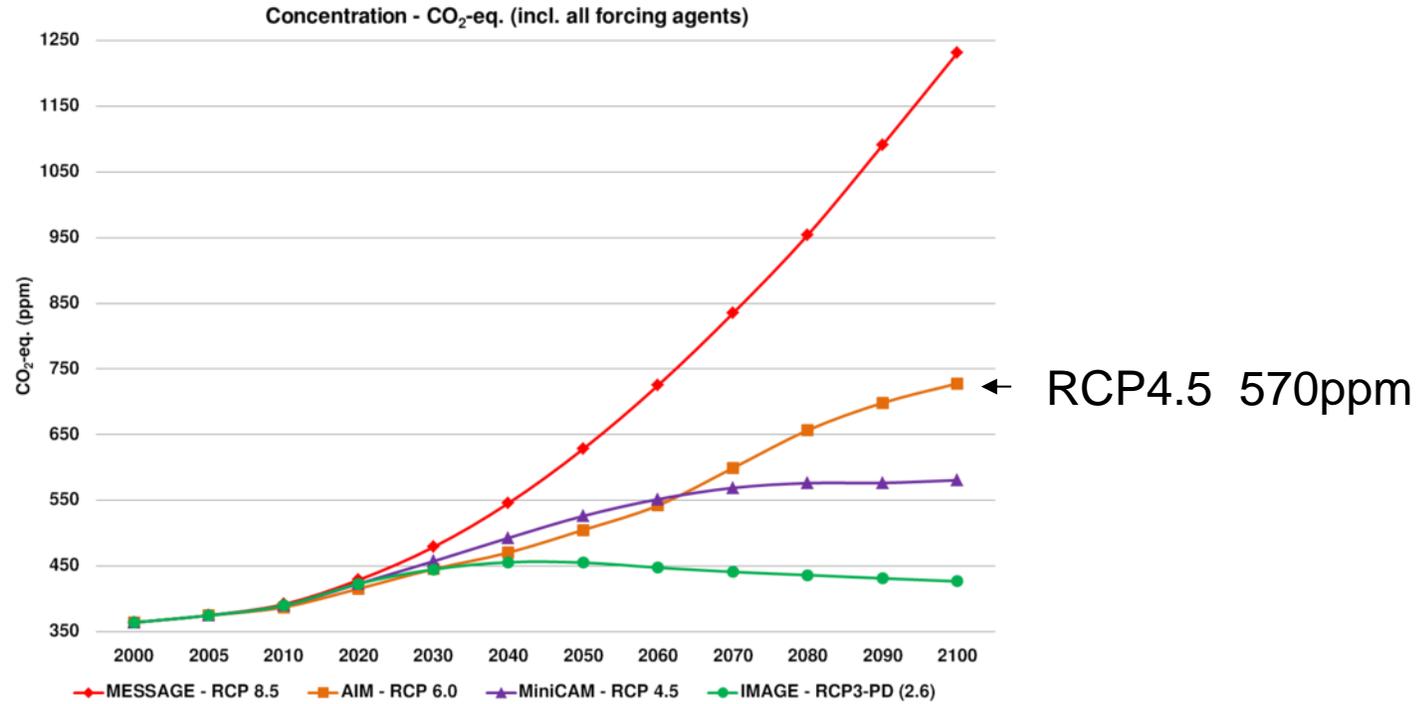
八戸の気温の将来予測

MIROC5によるヤマセの再現性について(菅野洋光・渡部雅浩 ヤマセ研究会2012)にSSTを加筆

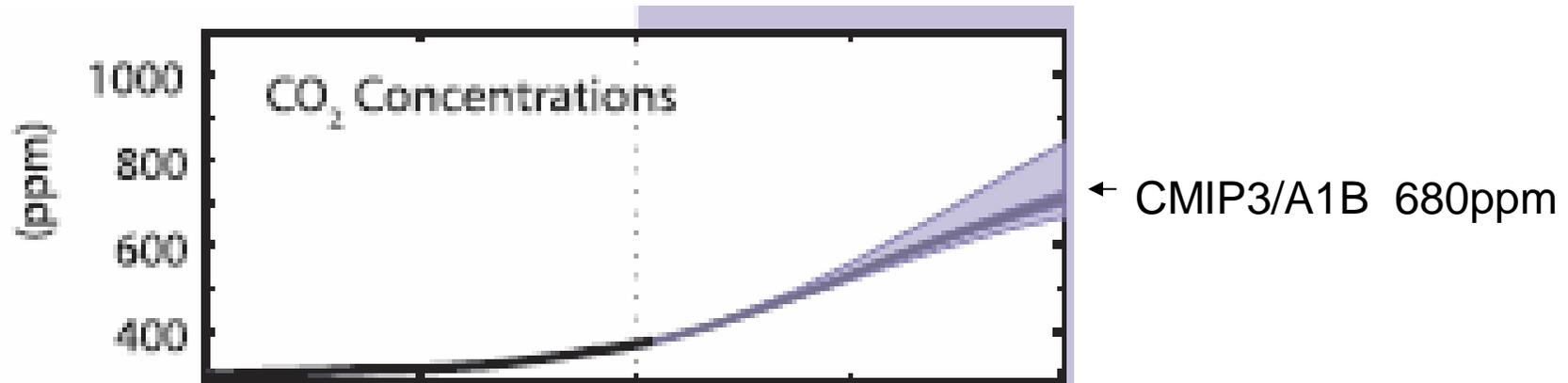
15個のCMIP5の20世紀runと21世紀温暖予測実験結果を比較

温暖化シナリオ: RCP4.5

CMIP5 放射強制力
シナリオ



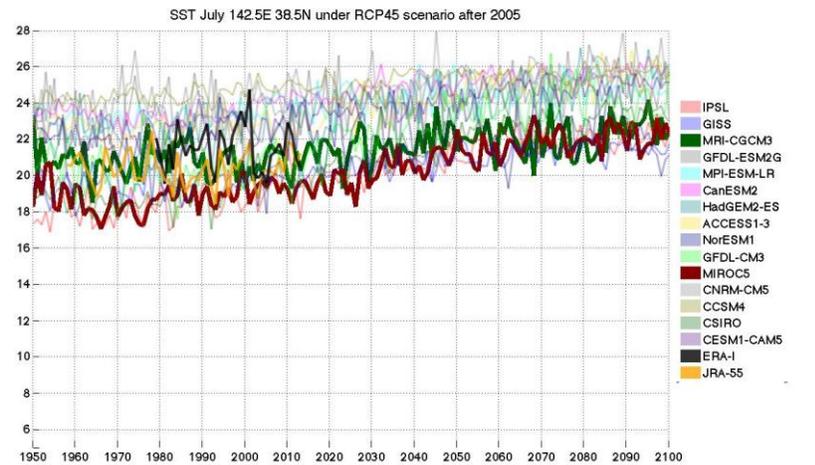
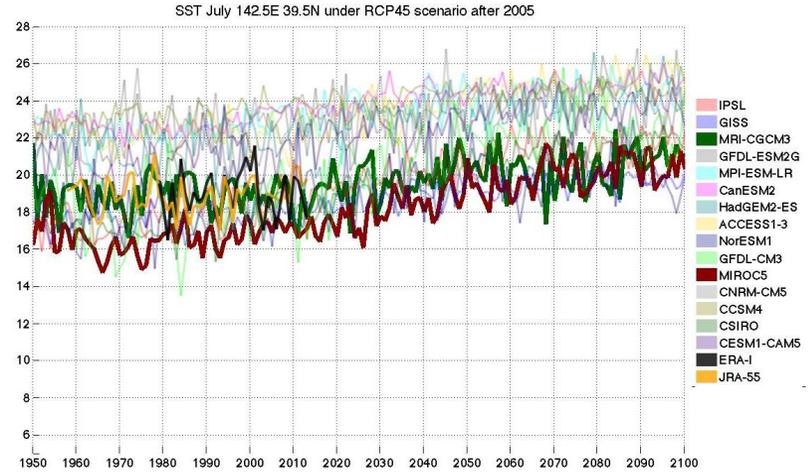
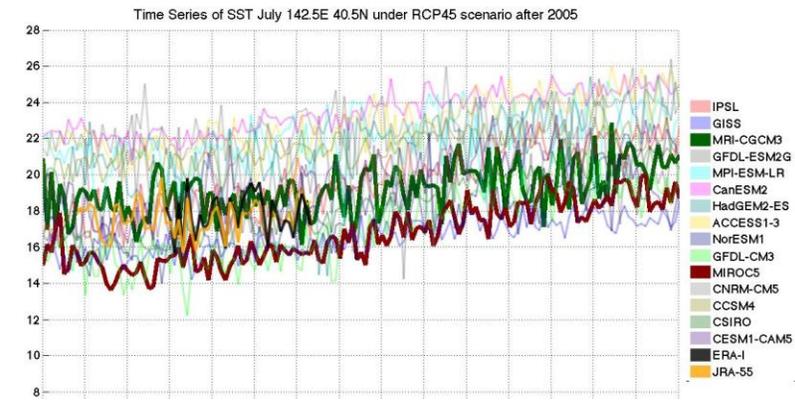
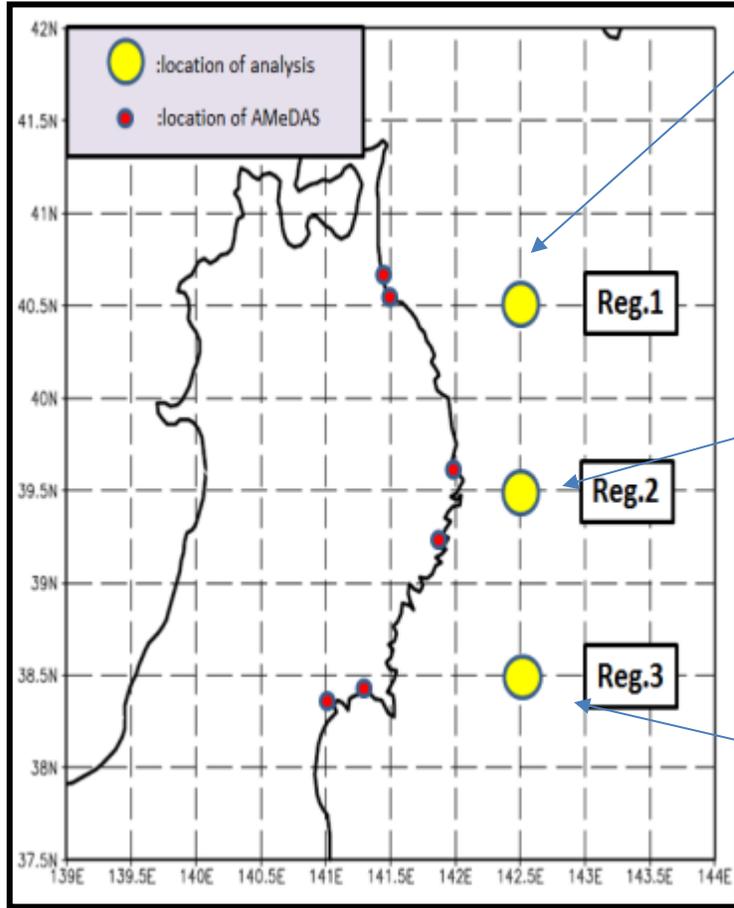
CMIP3 CO₂
排出量シナリオ



解析に用いたCMIP5モデルとアンサンブルメンバー数

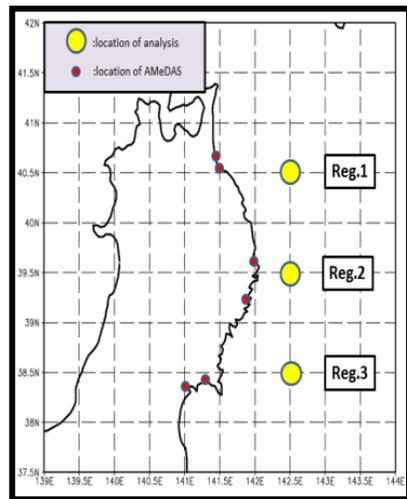
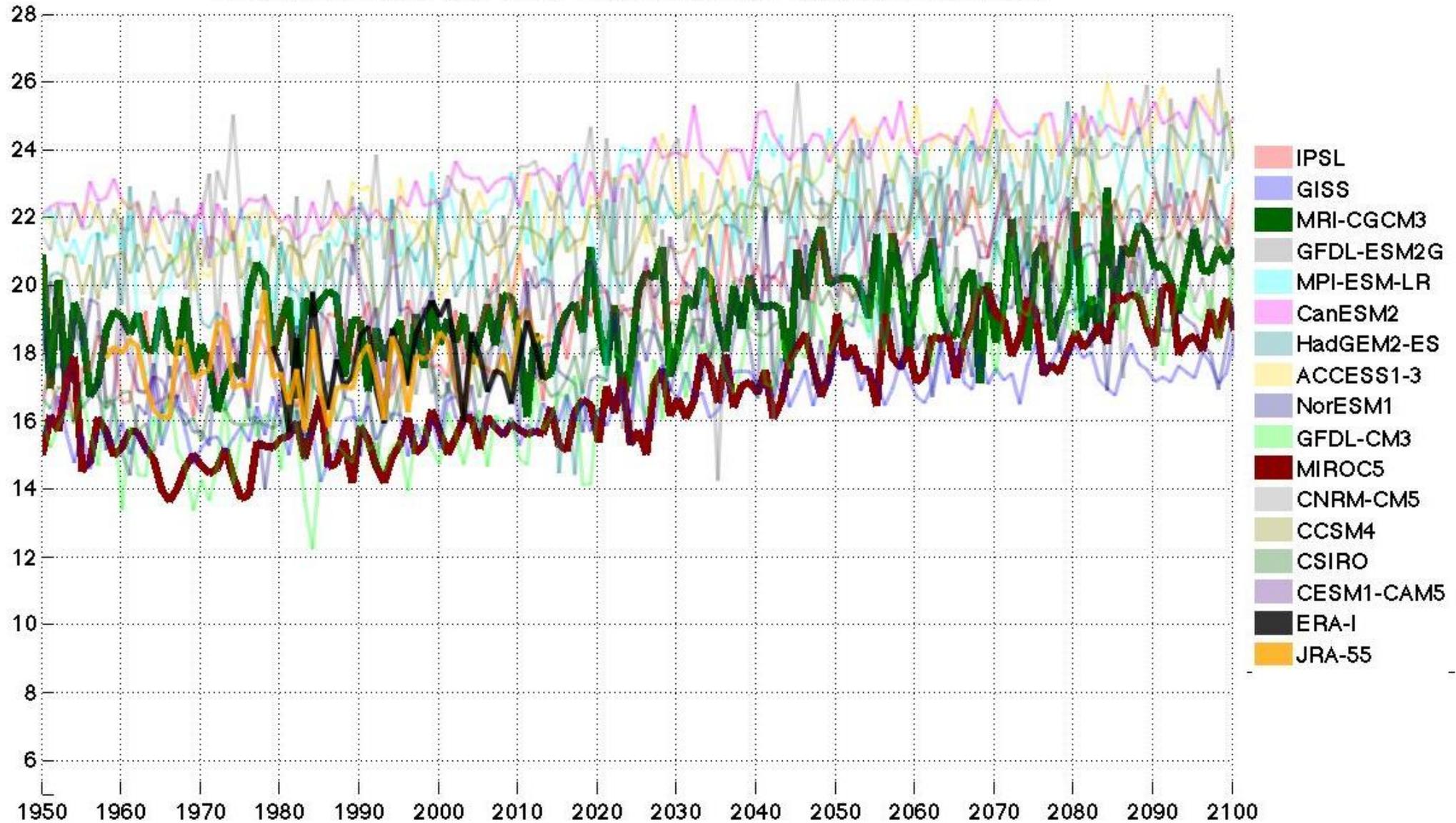
| Model | Institution | code | Number of ensemble members (past/future) | |
|--------------|---|------|--|------------------------------|
| | | | SST | Vertical temperature profile |
| ACCESS1.3 | CSIRO-BOM (Australia) | acc | 2/1 | 1/1 |
| CanESM2 | Canadian Centre for Climate Modeling and Analysis (CCCMA) | can | 5/5 | 3/3 |
| CCSM4 | National Center for Atmospheric Research | ccs | 5/5 | 3/3 |
| CESM1-CAM5 | NCAR (USA) | ces | 3/3 | 2/2 |
| CNRM-CM5 | Centre National de Recherches Meteorologiques / Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique (France) | cnr | 5/1 | 3/1 |
| CSIRO | CSIRO Atmospheric Research (Australia) | csi | 5/5 | 3/2 |
| GFDL-ESM2G | Geophysical Fluid Dynamic Laboratory (USA) | gd1 | 1/1 | 1/1 |
| GFDL-CM3 | Geophysical Fluid Dynamic Laboratory (USA) | gd2 | 5/1 | 3/1 |
| GISS-E2-R | NASA Goddard Institute for Space Studies (USA) | gis | 5/5 | 3/3 |
| HADGEM2-ES | Met Office Hadley Centre (UK) | had | 3/2 | 2/2 |
| IPSL-CM5A-LR | Institut Pierre-Simon Laplace (France) | ips | 5/4 | 3/3 |
| MIROC5 | Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology | mrc | 4/3 | 3/2 |
| MRI-CGCM3 | Meteorological Research Institute (Japan) | mri | 5/1 | 3/1 |
| MPI-ESM-LR | Max Planck Institute for Meteorology (MPI-M) | mpi | 3/3 | 3/3 |
| NorESM1-M | Norwegian Climate Centre (Norway) | nor | 3/1 | 3/1 |

参照領域と 各モデルのSST (historical/future)



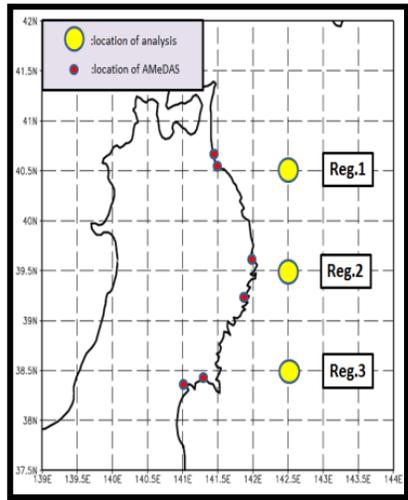
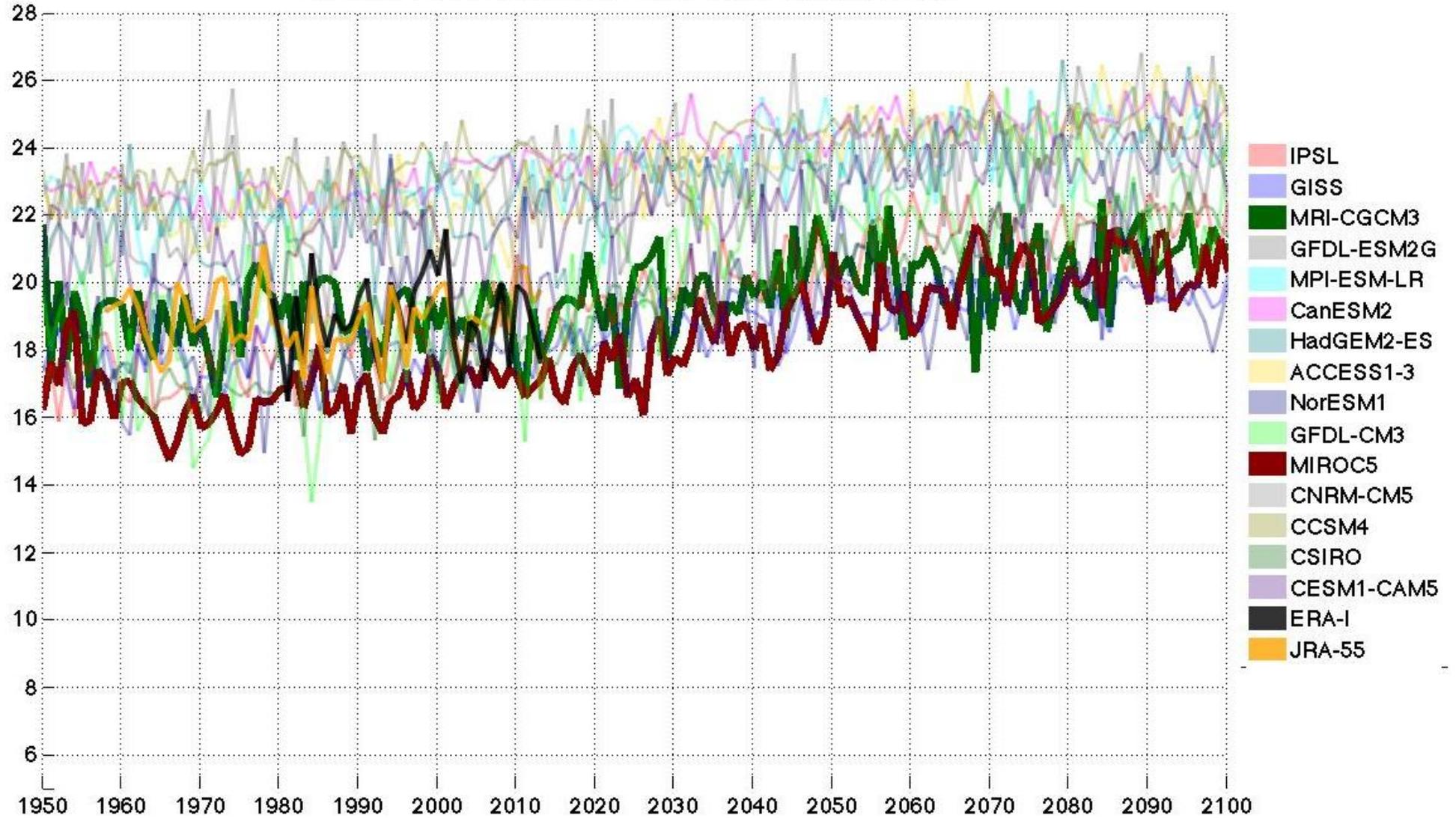
REG. 1

Time Series of SST July 142.5E 40.5N under RCP45 scenario after 2005



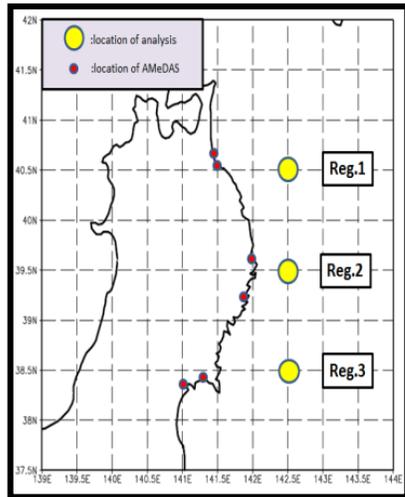
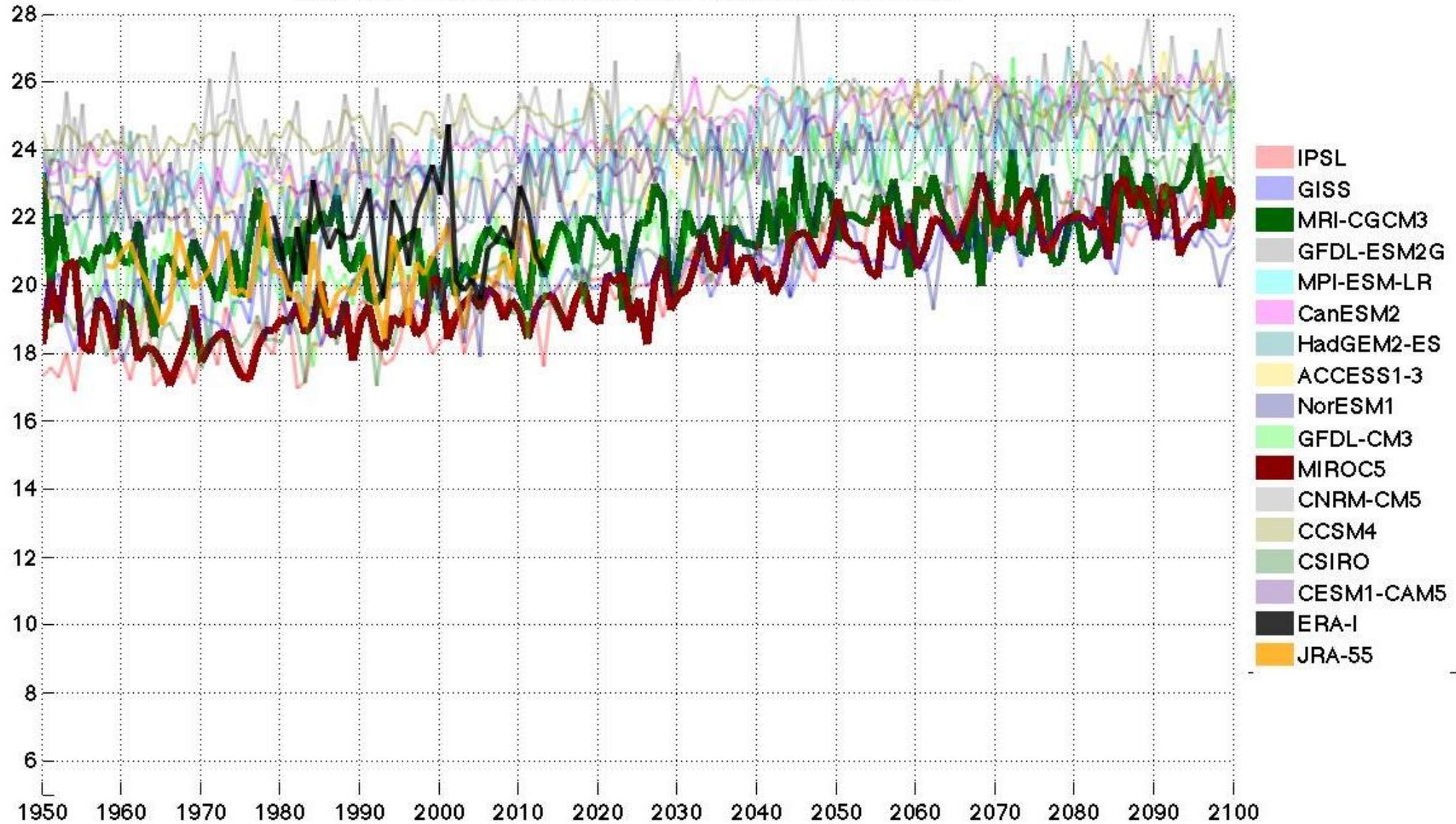
REG. 2

SST July 142.5E 39.5N under RCP45 scenario after 2005



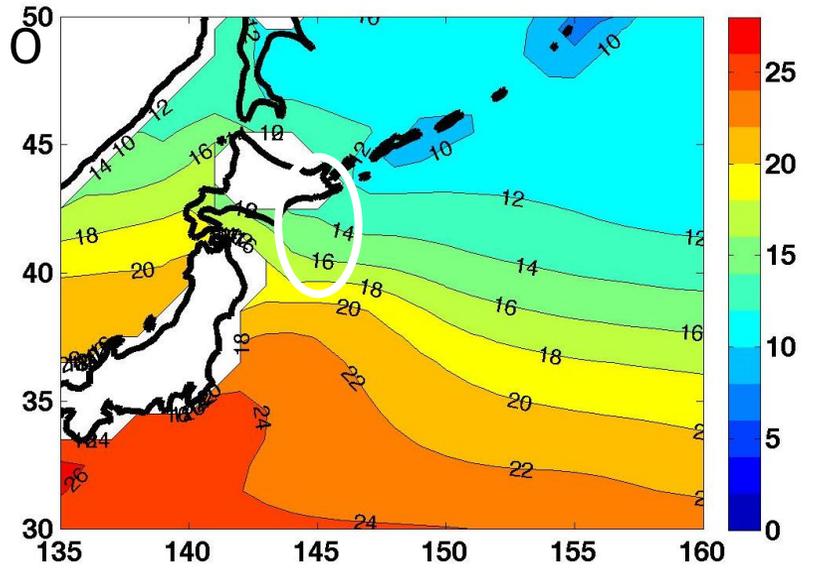
REG. 3

SST July 142.5E 38.5N under RCP45 scenario after 2005

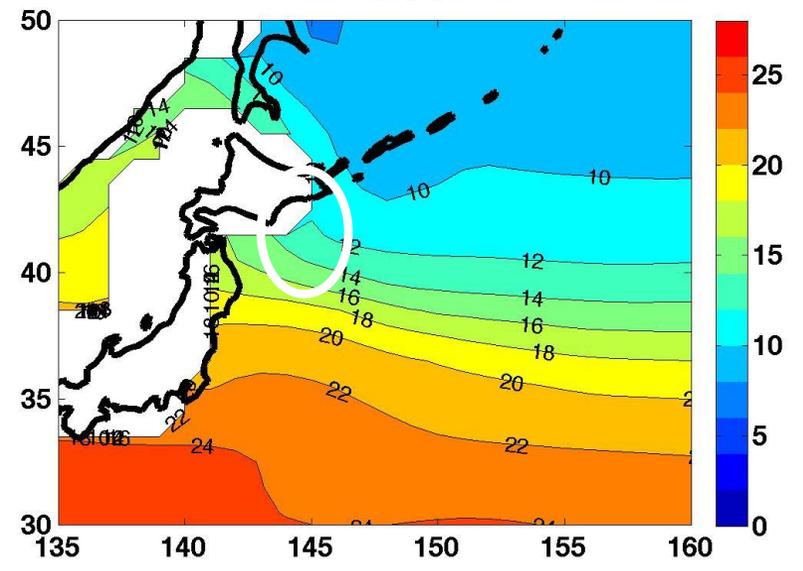


July
2001-2010

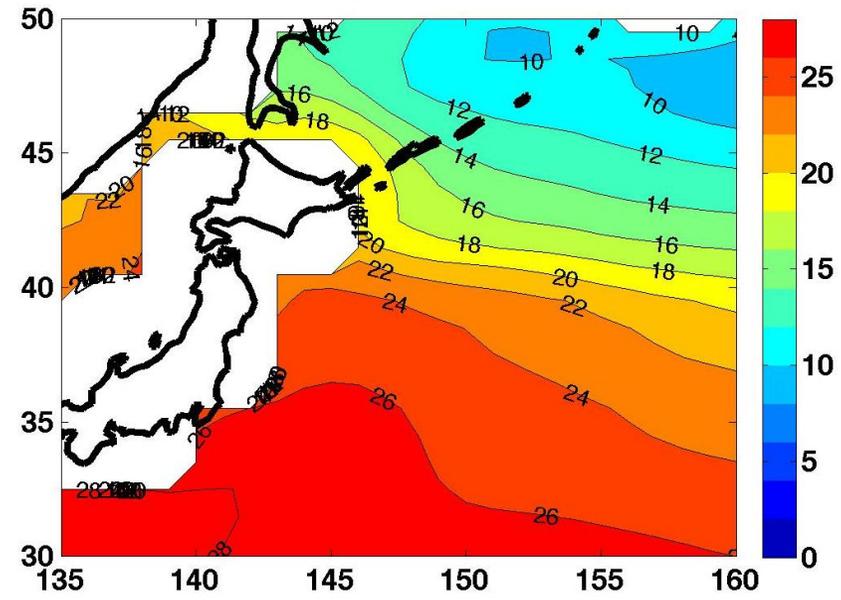
MRI-CGCM3



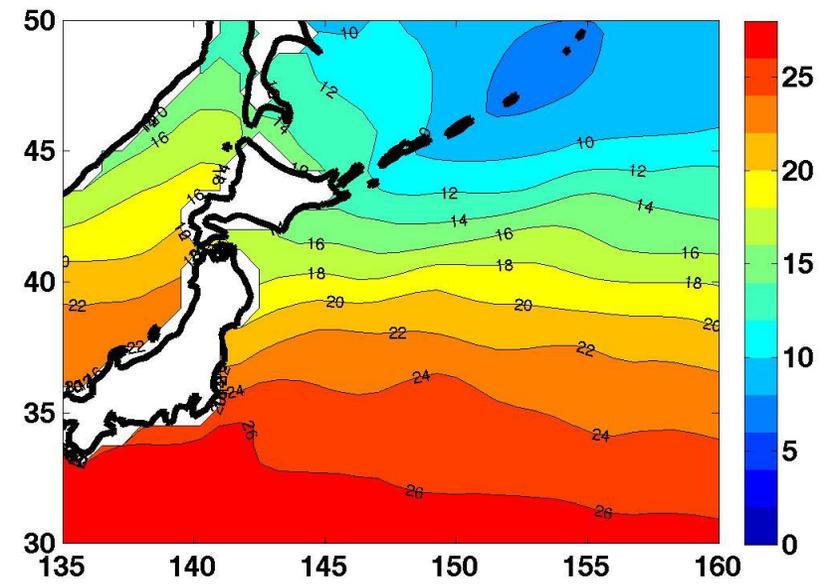
MIROC5



CanESM2

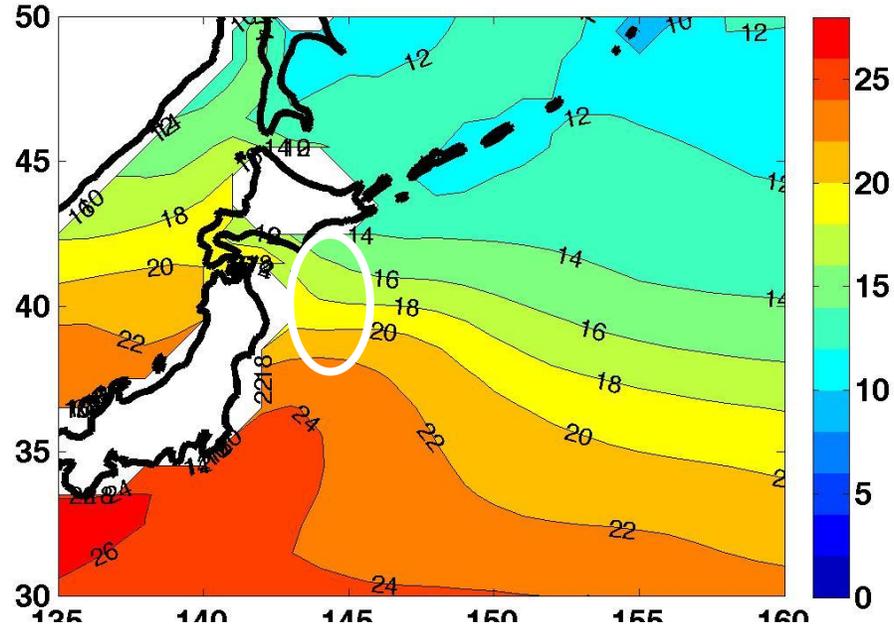


観測 (ERA-I 再解析データ)
ERA-I

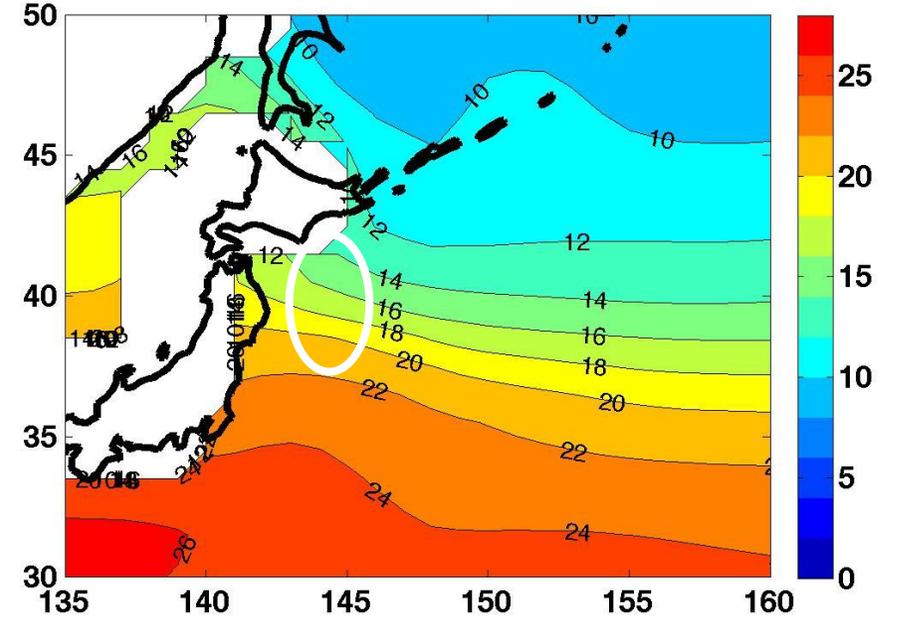


July
2031–2040

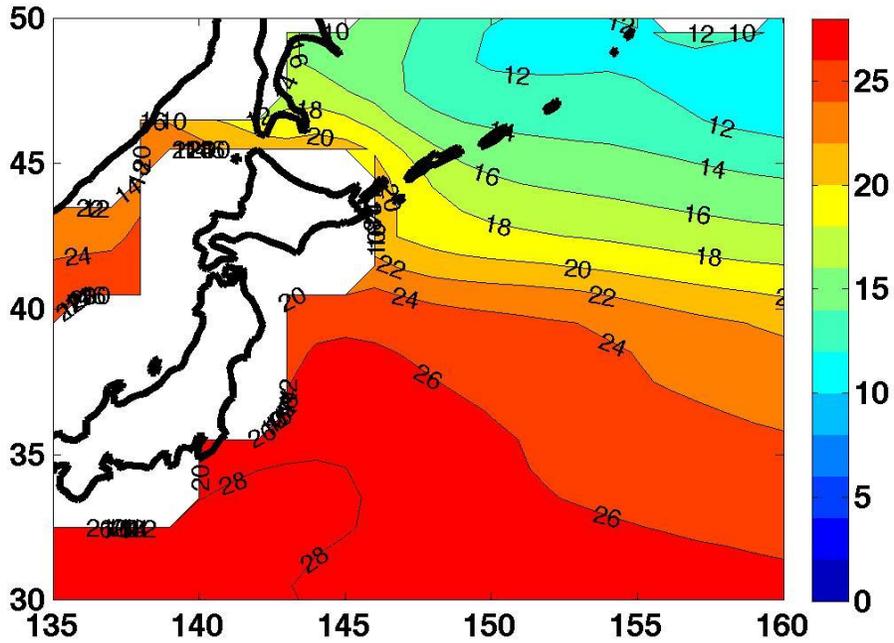
MRI-CGCM3



MIROC5

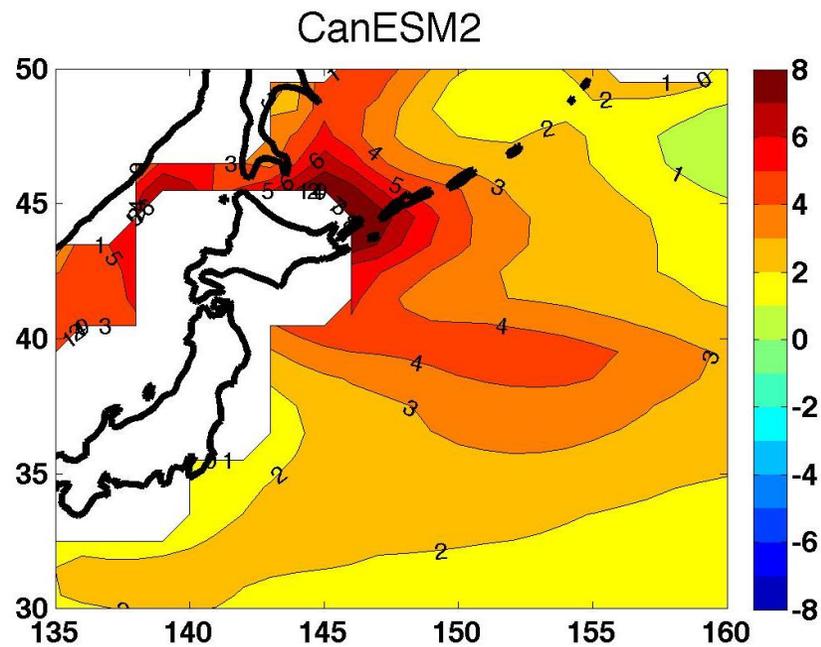
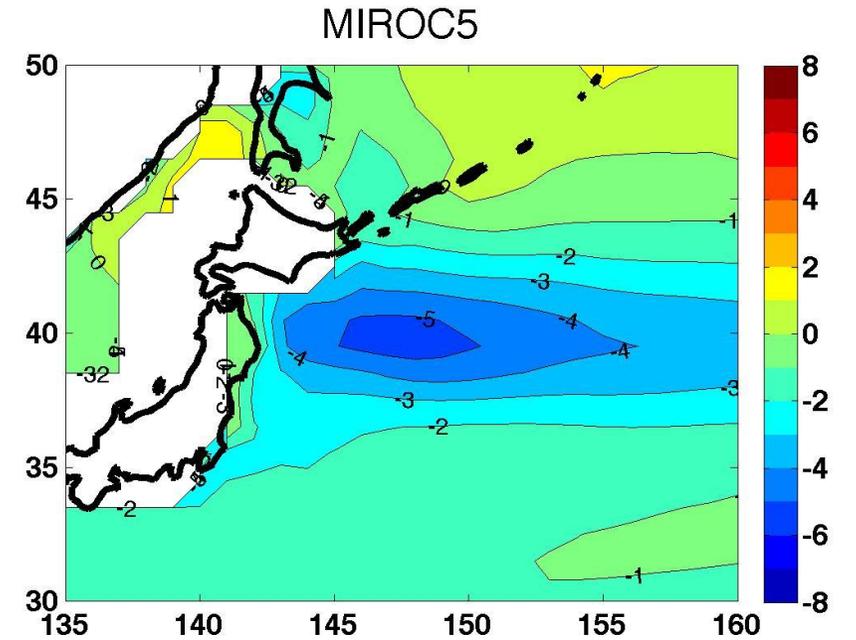
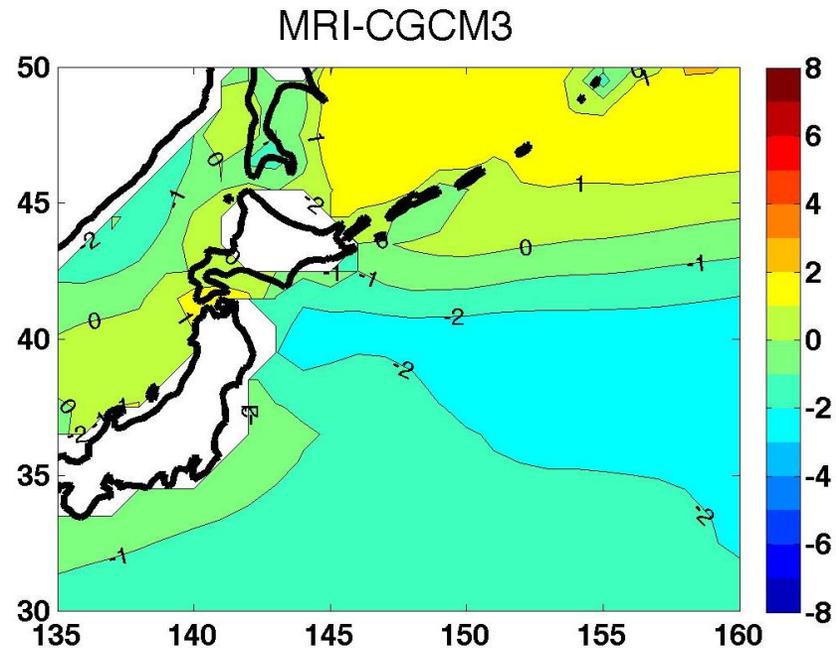


CanESM2

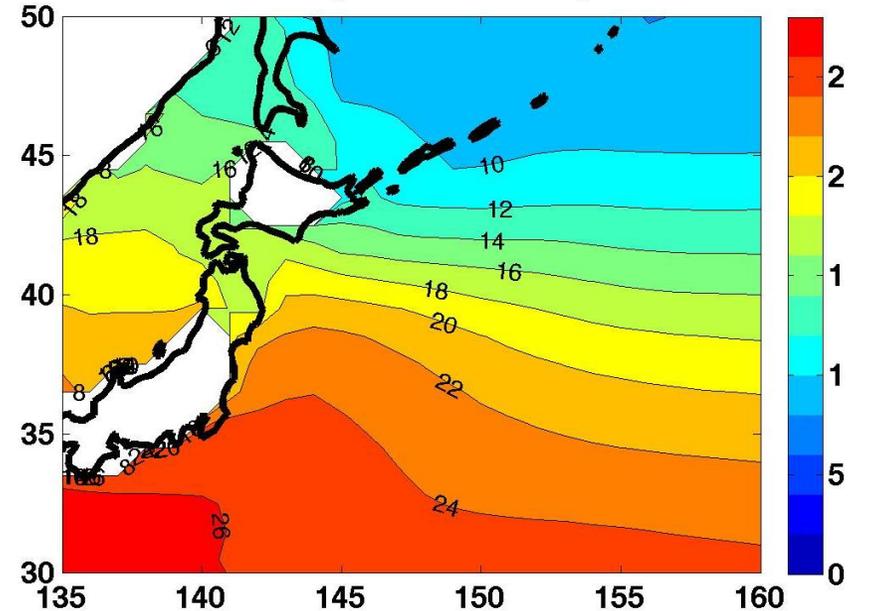


SST Anomaly
from CMIP5 climate
July 2001–2010

海面水温のモデル気候値からの偏差(現在)



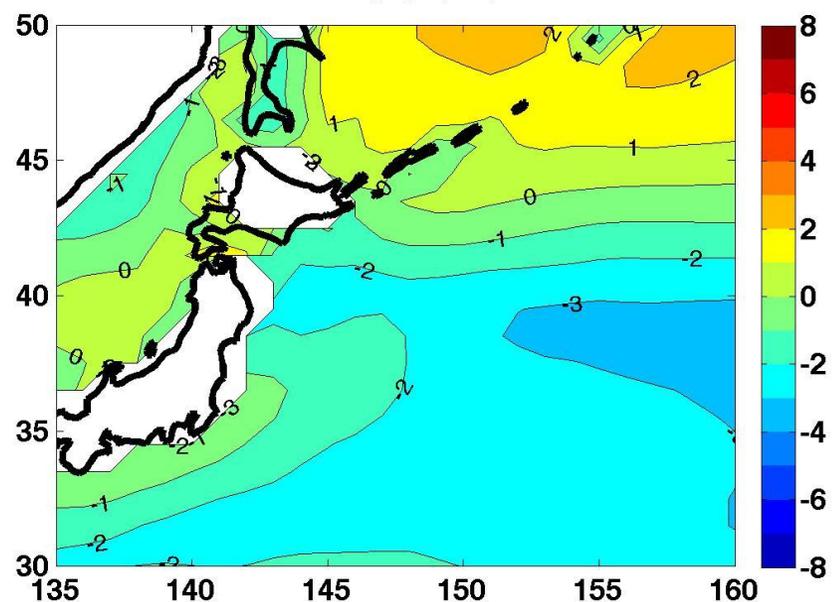
モデル気候値 Average of SST July



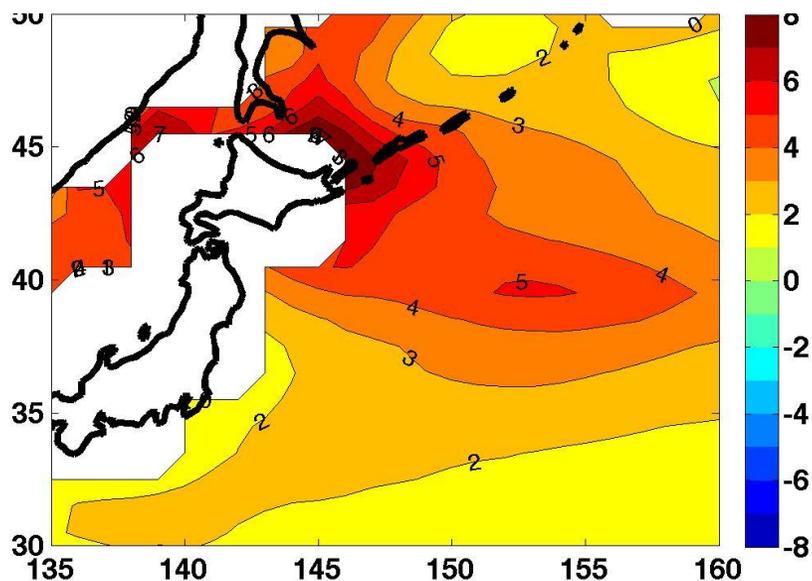
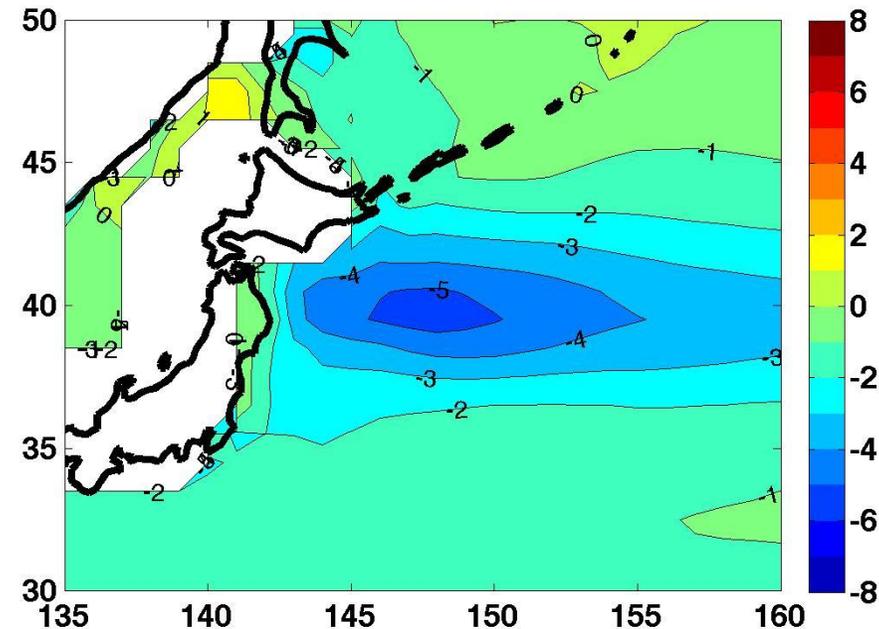
SST Anomaly
from CMIP5 climate
July 2031–2040

海面水温の偏差(温暖化後)

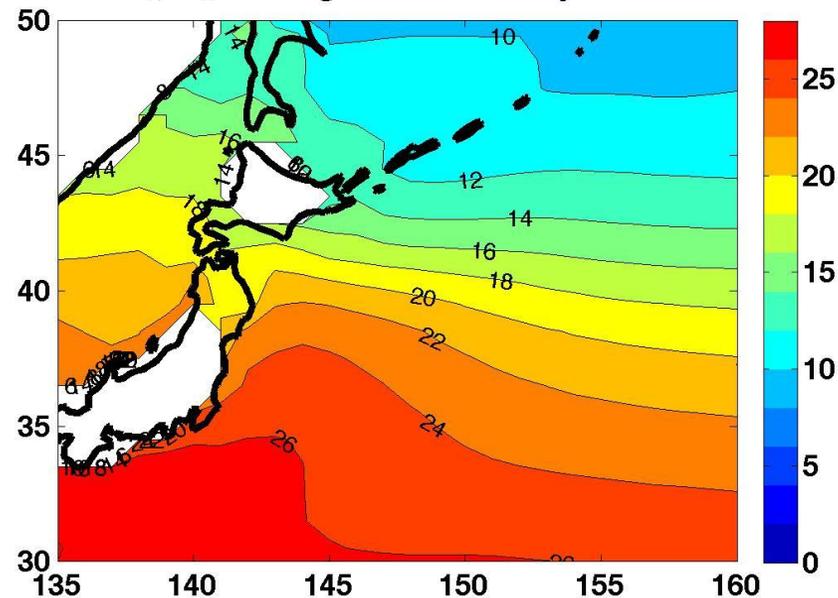
MRI-CGCM3



MIROC5

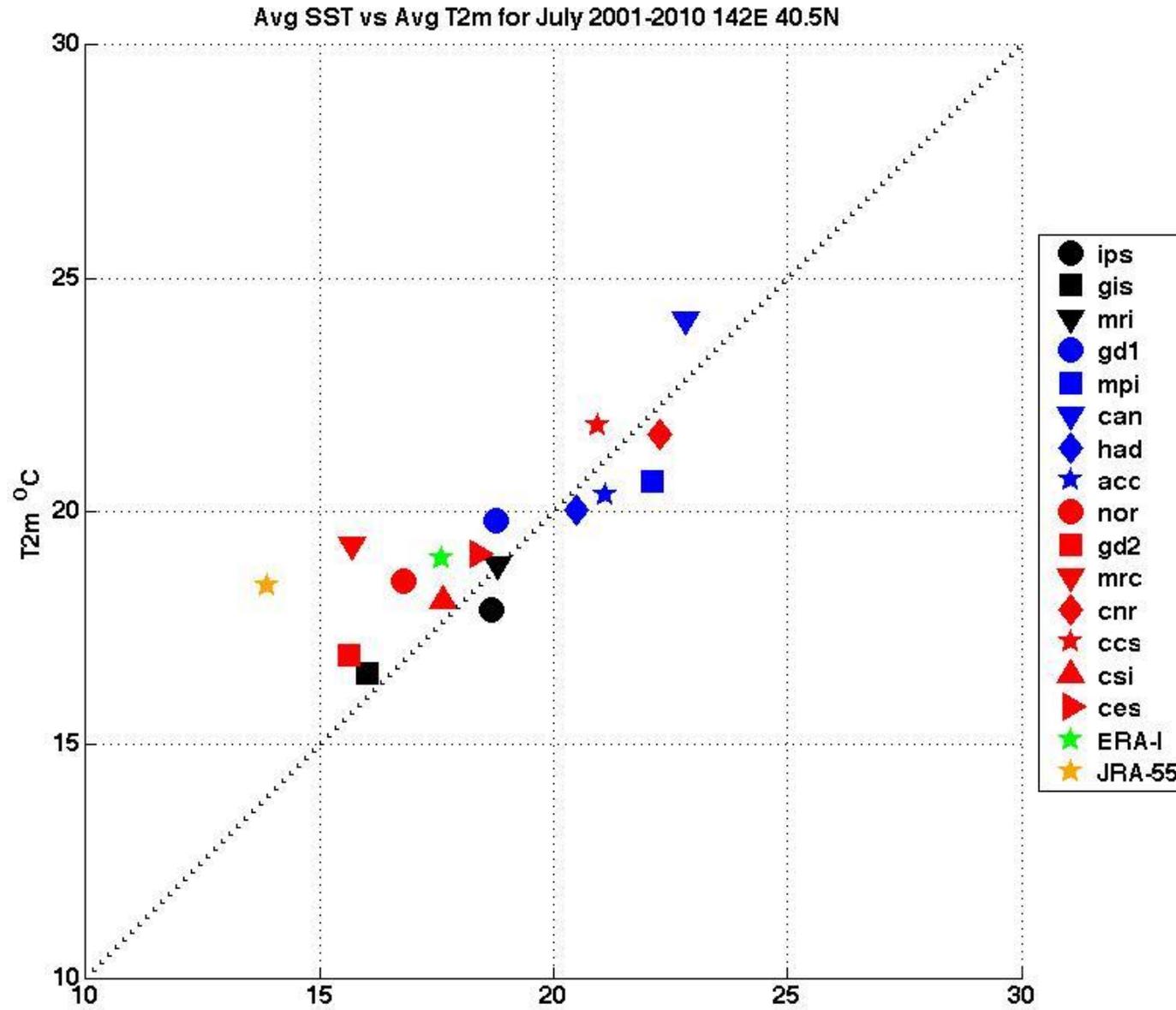


モデル気候値
Average of SST July



海面水温と海上気温の関係(現在)

SST - AirTemp
八戸沖
July 2001 - 2010



観測:再解析データ

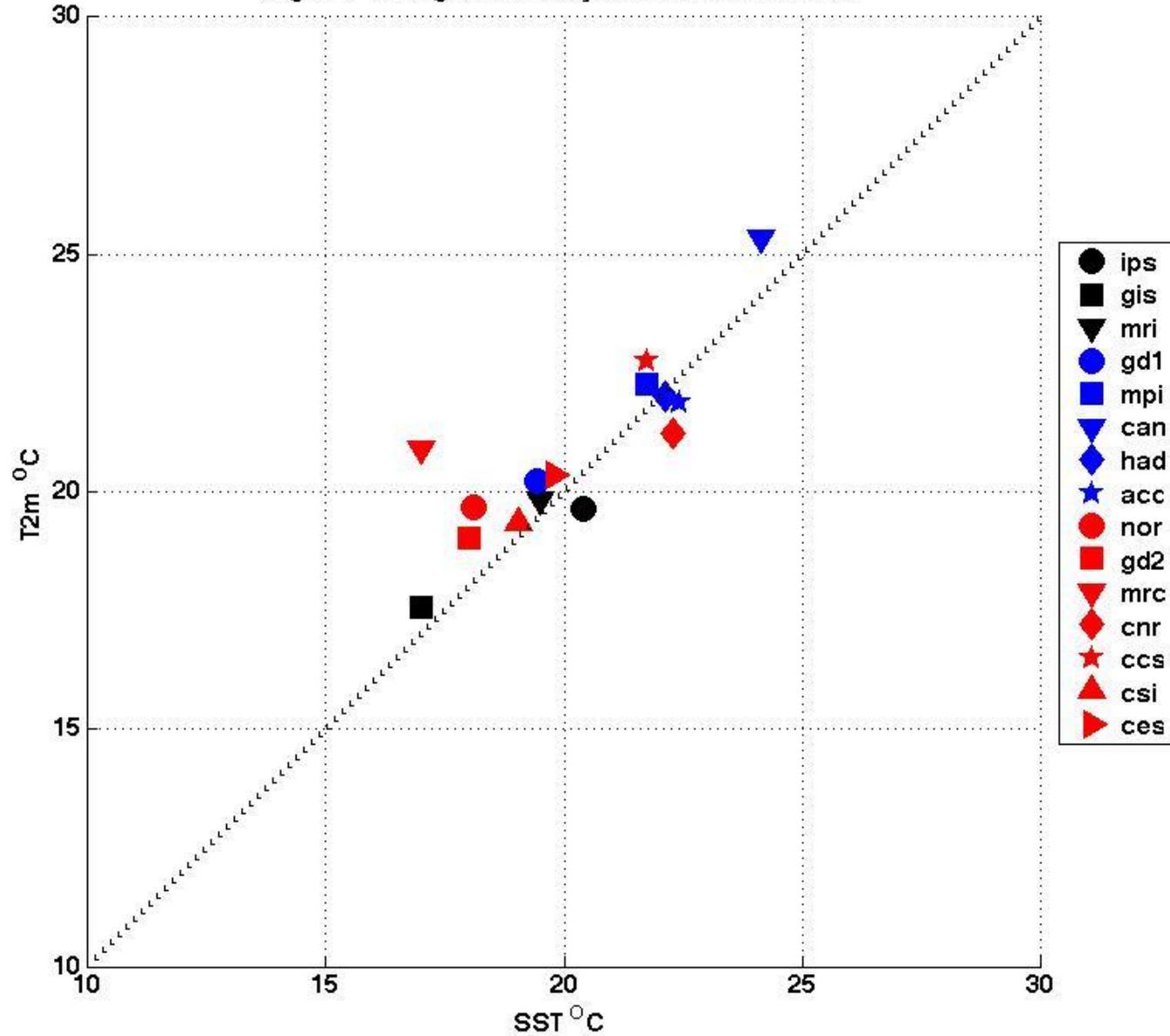
海面水温と海上気温の関係

Avg SST vs Avg T2m for July 2031-2040 142E 40.5N

SST - AirTemp

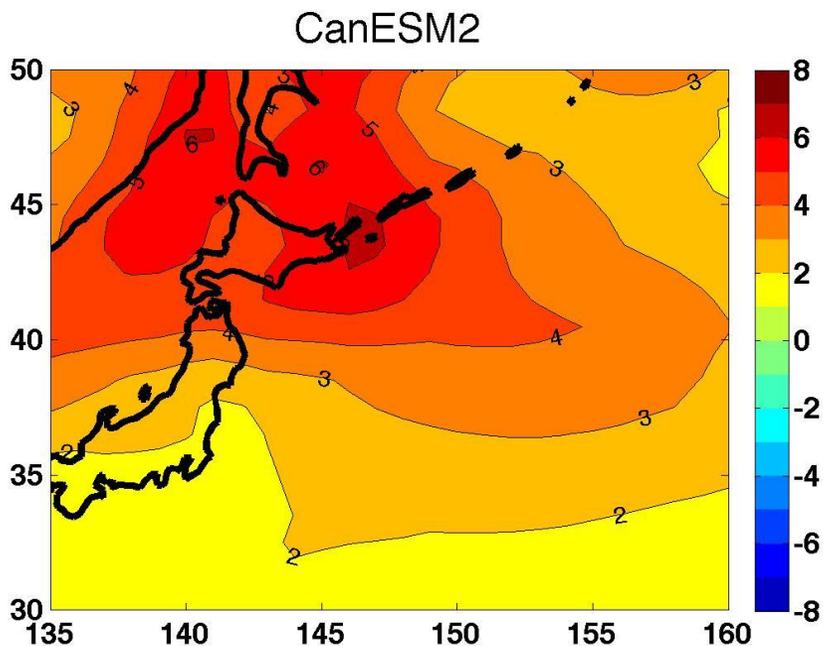
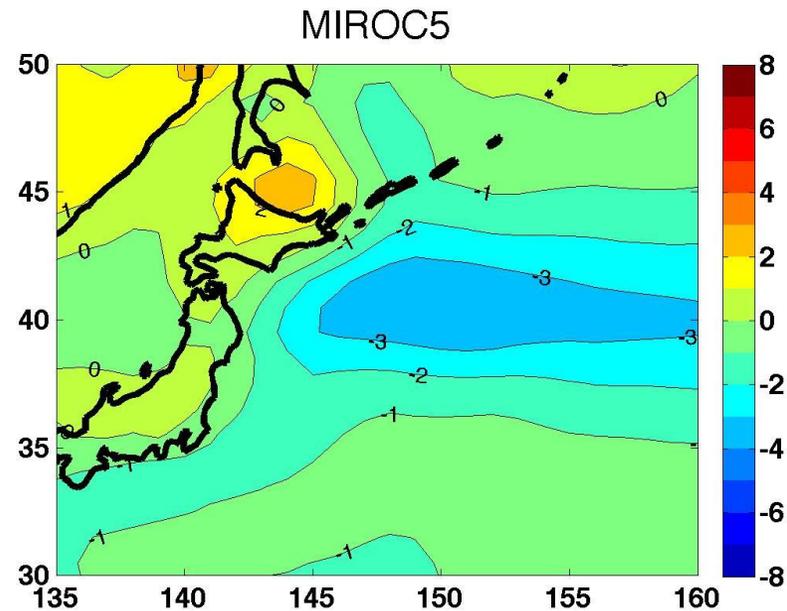
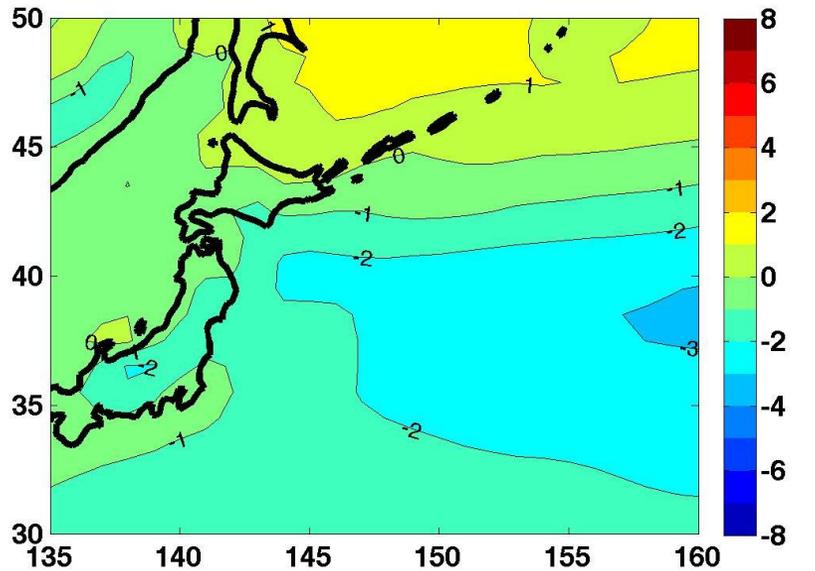
八戸沖

July 2031-2040

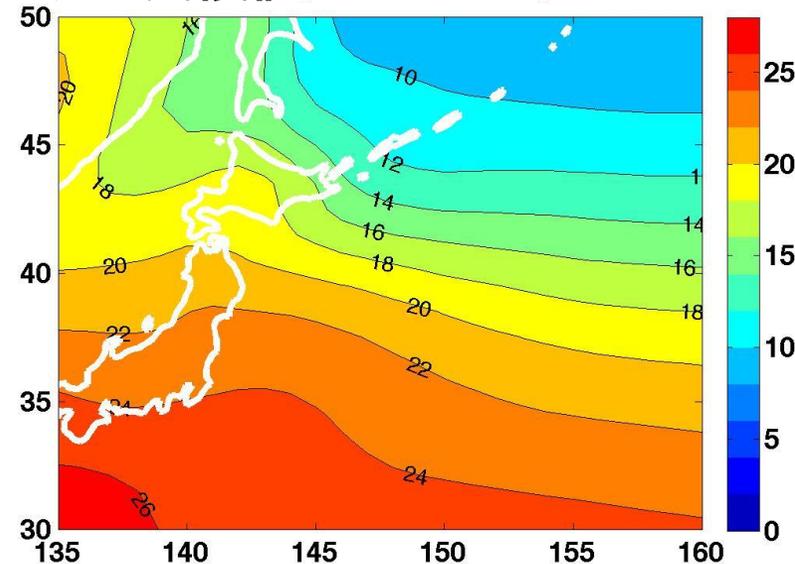


Air-temp. Anomaly
from CMIP5 climate
July 2001–2010

海上气温偏差(现在气候)



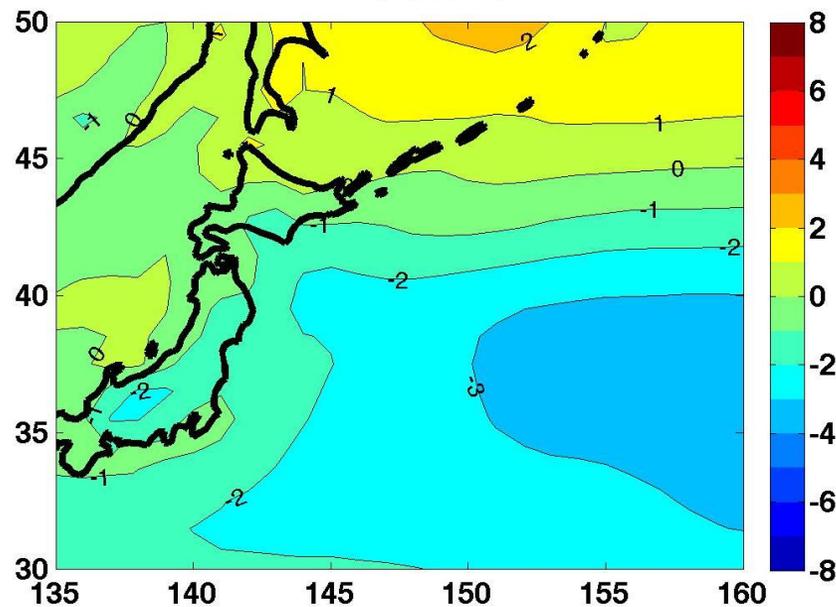
モデル気候値



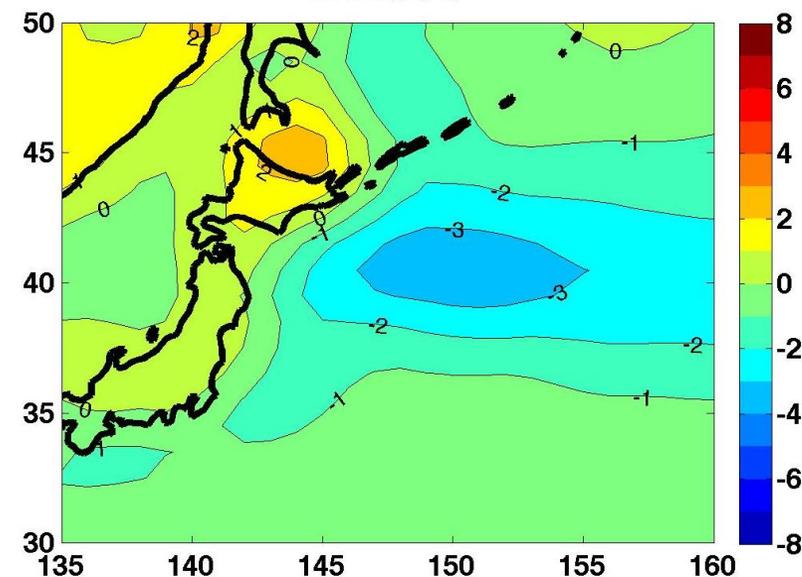
Air-temp. Anomaly
from CMIP5 climate
July 2031–2040

海上気温偏差(温暖化後)

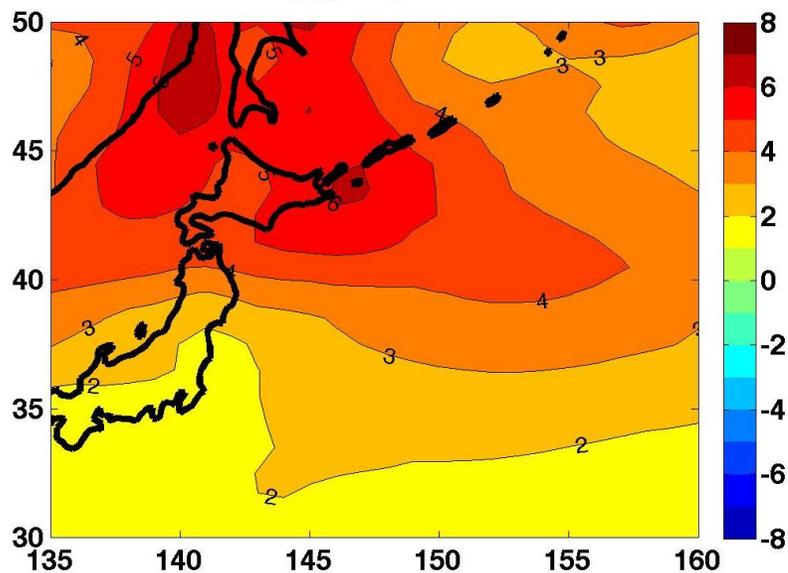
MRI-CGCM3



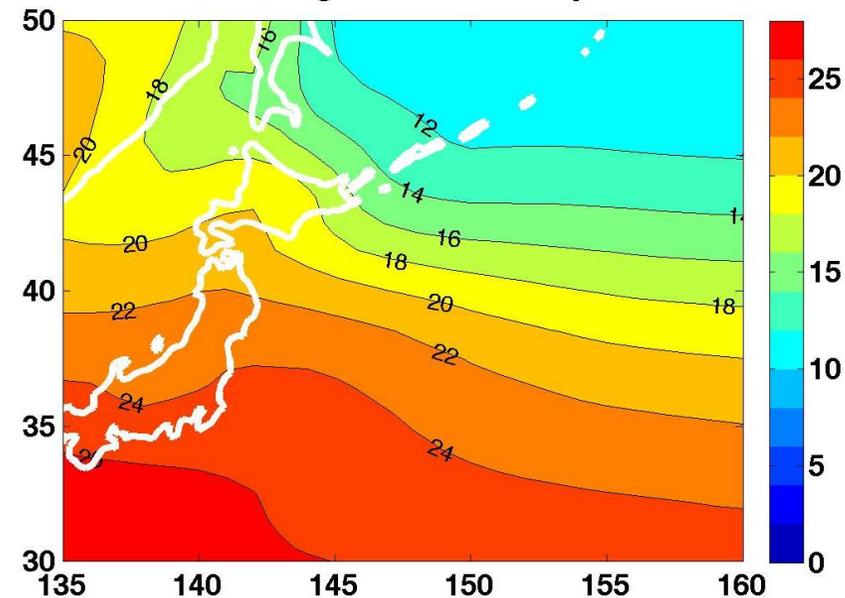
MIROC5

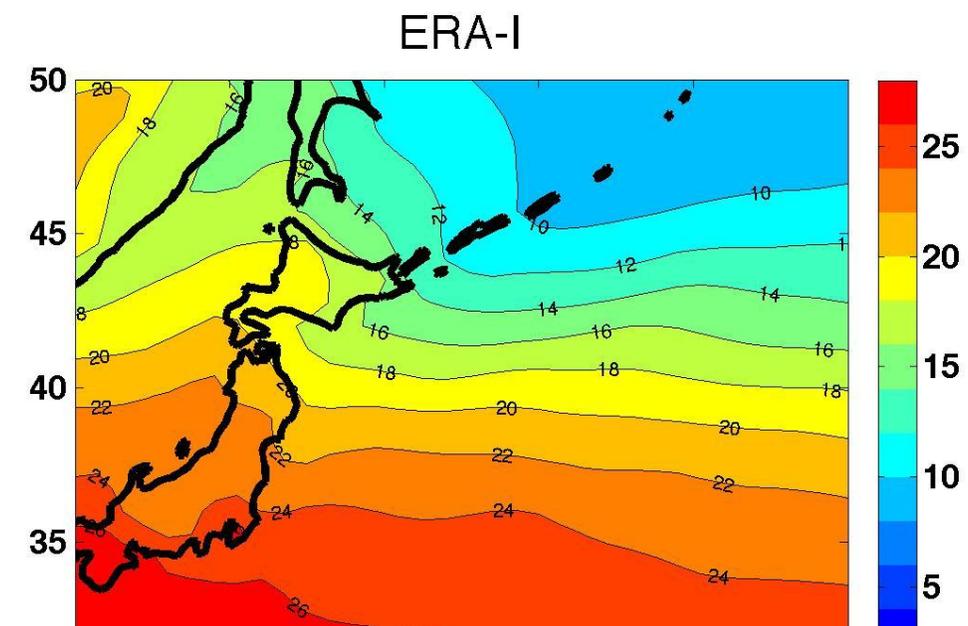
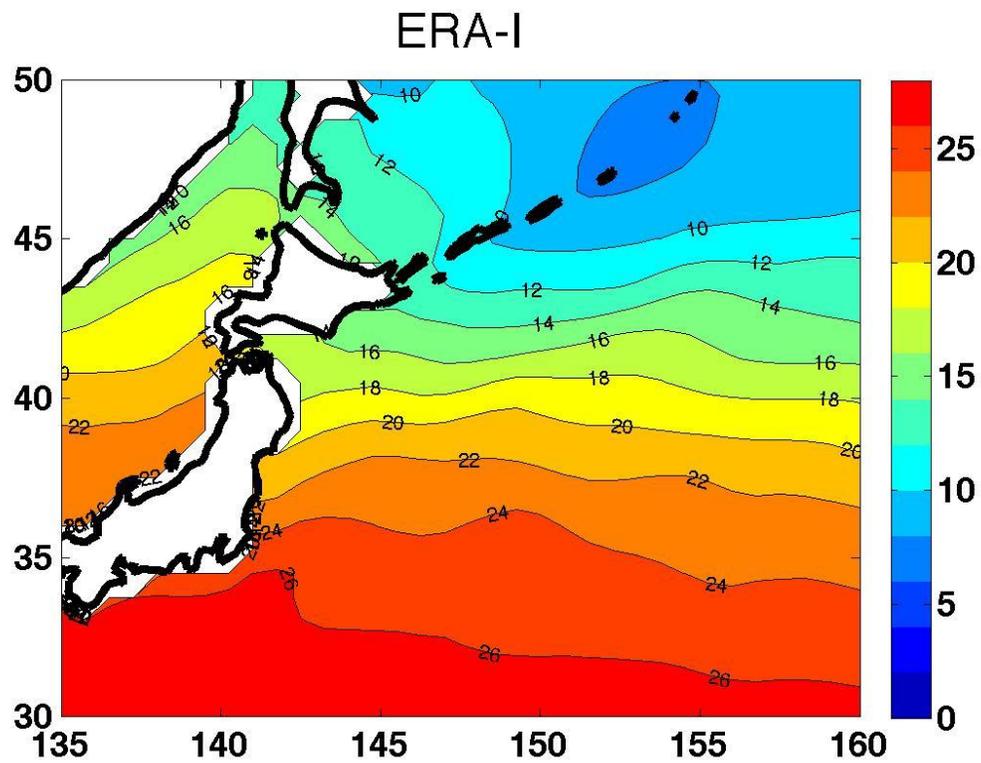


CanESM2



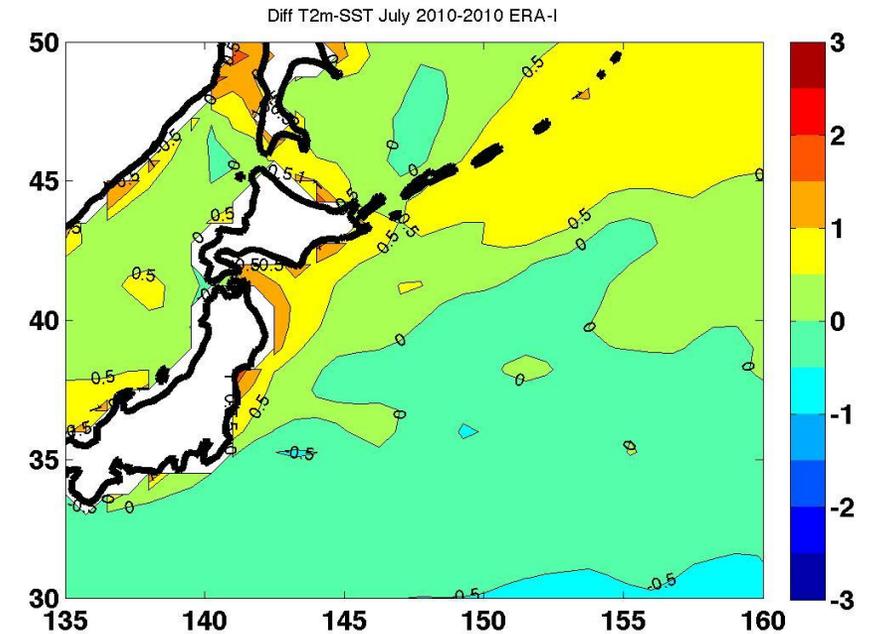
モデル気候値 Average of T2m July





海上気温—海面水温(SST) (観測: ERA-I再解析)

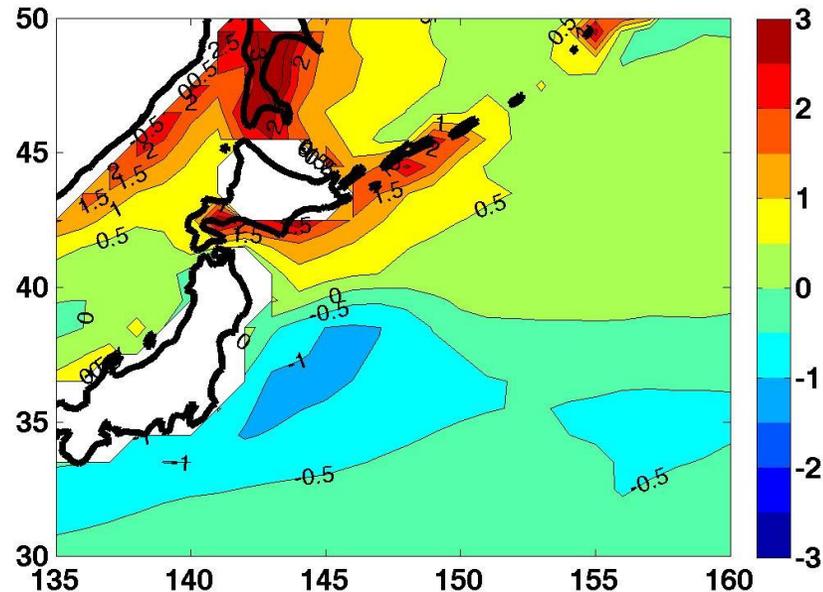
Air-temp - SST



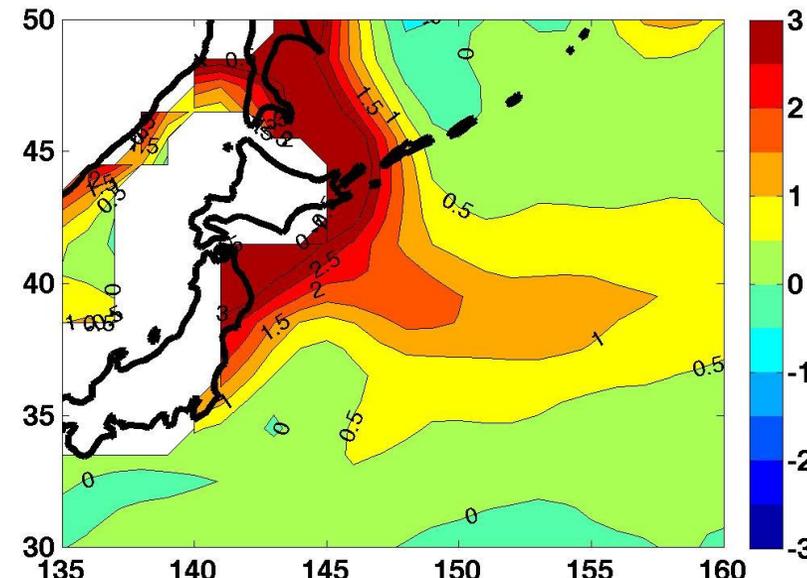
Air-Temp – SST
July 2001–2010

海上気温—海面水温 (SST) (現在気候)

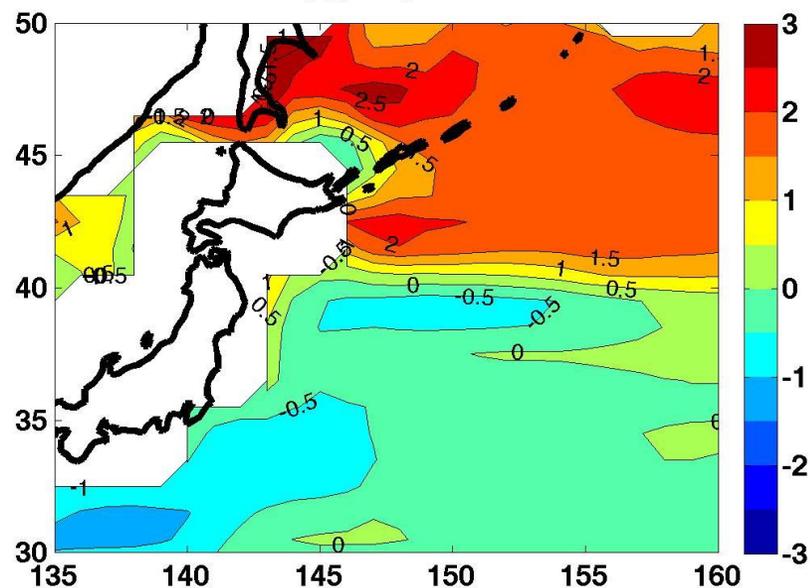
MRI-CGCM3



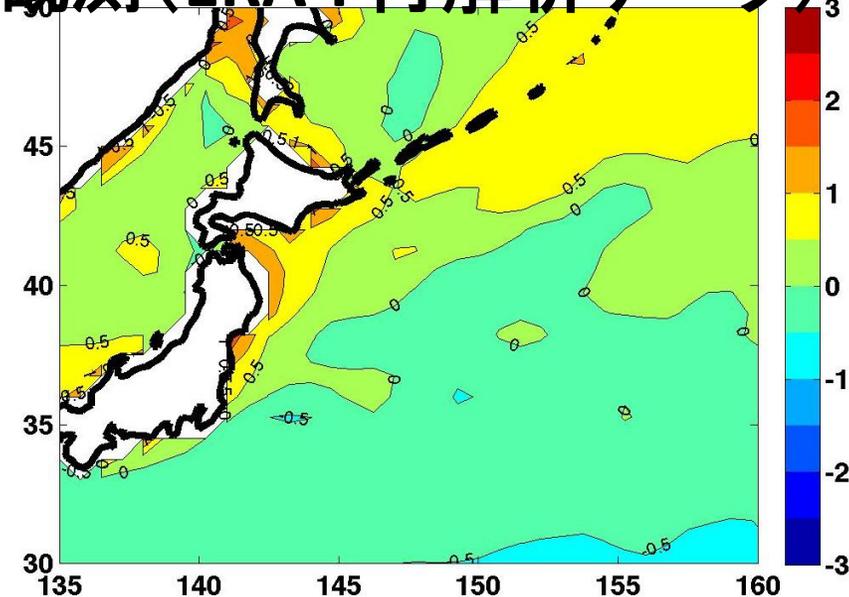
MIROC5



CanESM2



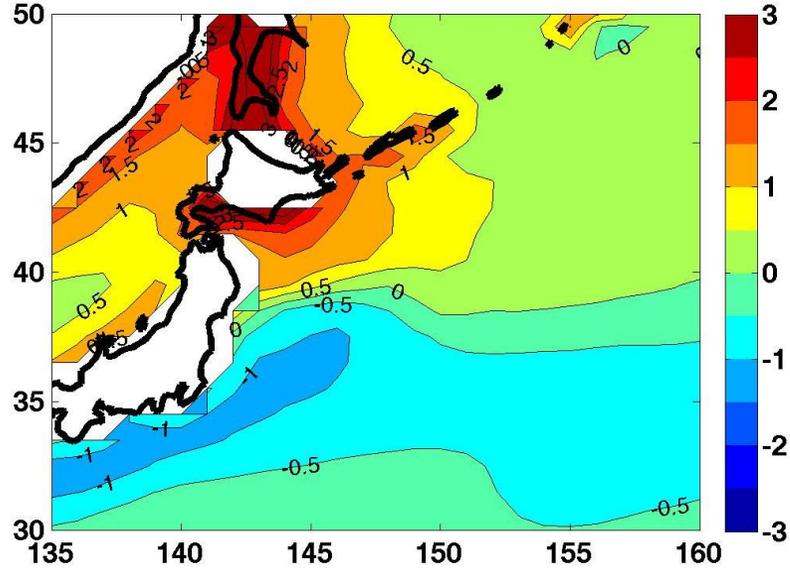
観測 (ERA-Interim 再解析データ)



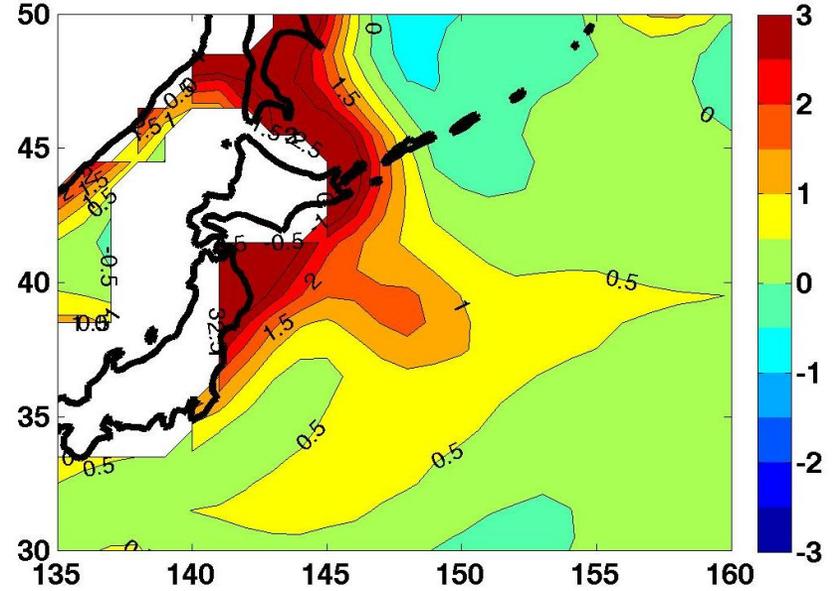
Air-Temp – SST
July 2031–2040

海上気温—海面水温(SST)(温暖化後)

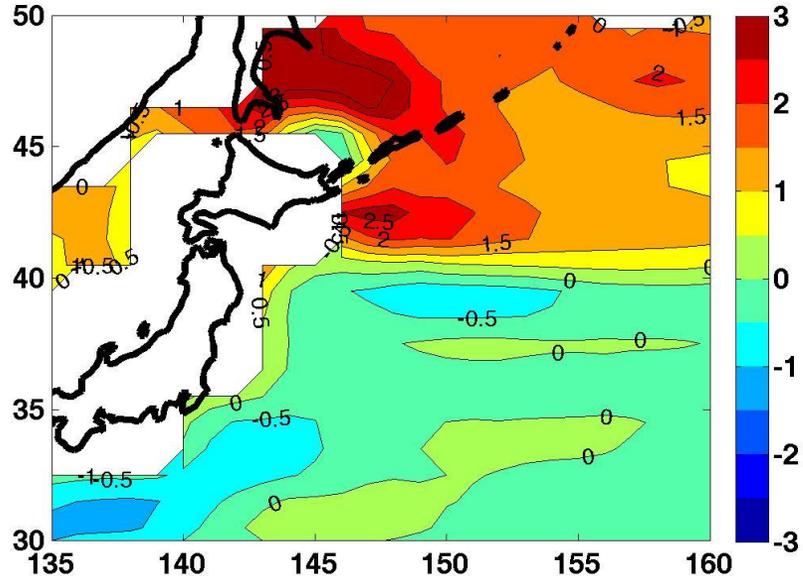
MRI-CGCM3



MIROC5



CanESM2



まとめ

- 海洋モデルの分解能は、三陸沖の黒潮や親潮、あるいは冷水渦や暖水渦の状況を解像するには不十分である。
- 15個のCMIP5モデルの、現在気候再現実験と将来予測実験(RCP4.5)結果を、2001-2010, 2031-2040の2期間について解析した。
- 八戸沖の水温は、モデル間でばらつきが大きく 8°C にも及ぶ(現在気候, 将来気候とも)。
- モデルの再現実験のSST分布に見られる‘くせ’は、温暖化後にも残る傾向がある。
- 観測値やモデル気候値(モデルアンサンブルの平均値)に比べて、MIR OC5は三陸沖の水温を低く再現する傾向が強い(現在気候, 将来気候とも)。MRI-CGCM3は観測値やモデル気候値に近い。