11. Lecture and Exercise: Uncertainty Check of the Results

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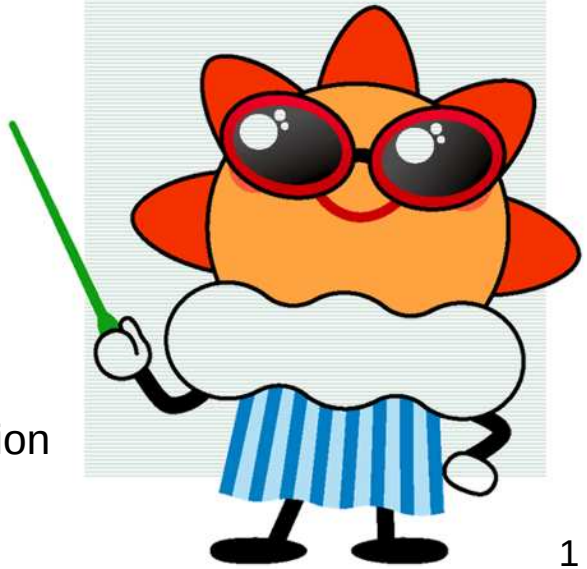


TCC Training Seminar on , Global Warming Projection Information
27 January 2015 (Tokyo, Japan)

Uncertainties in global warming projection

- Climate models have improved since the AR4. Models reproduce observed continental-scale surface temperature patterns and trends over many decades, including the more rapid warming since the mid-20th century and the cooling immediately following large volcanic eruptions. (WG1 AR5 SPM)

Uncertainties in global warming projection

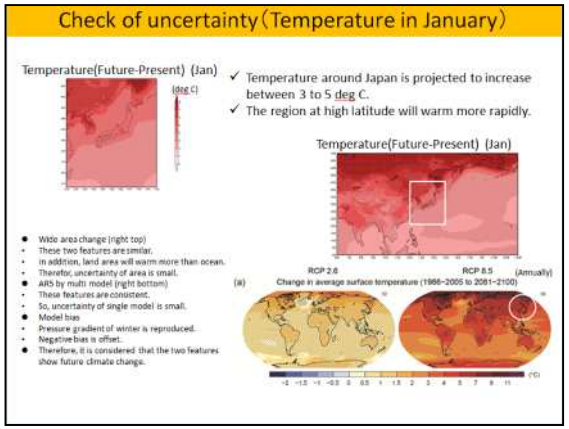
- However, the global warming projection contains many uncertainties.

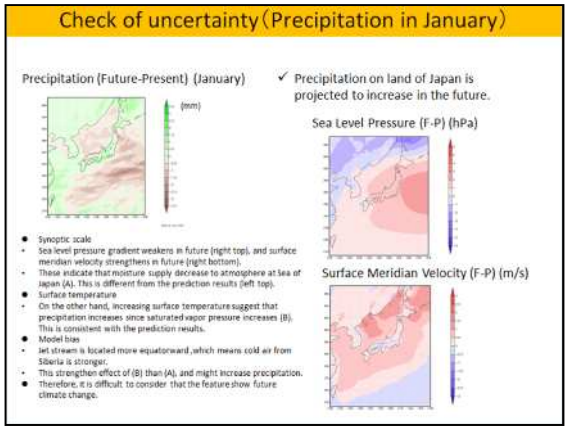
- Therefore, we cannot say the results are correct projections without considering the uncertainties.

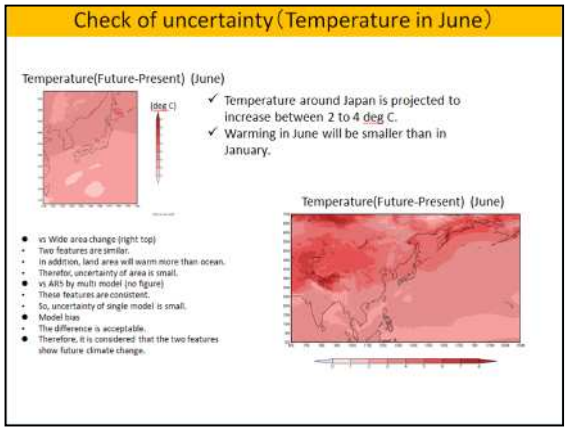
It is necessary to consider the uncertainties !!

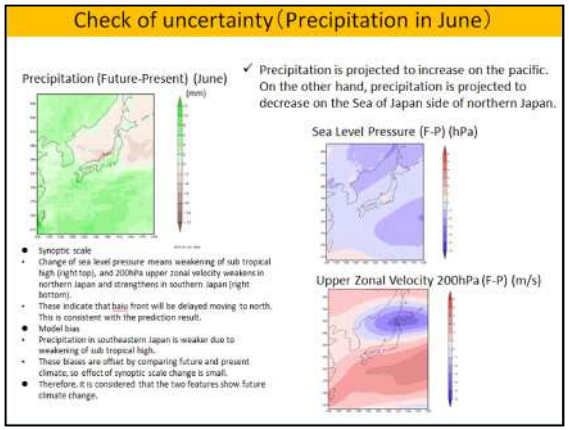
Sample (Global warming projection for Japan)

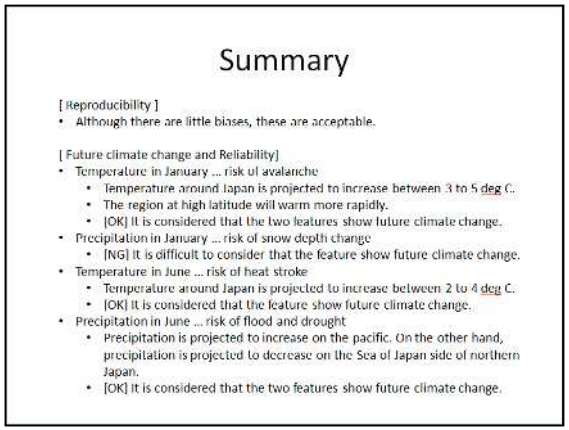
Check of uncertainty (*)











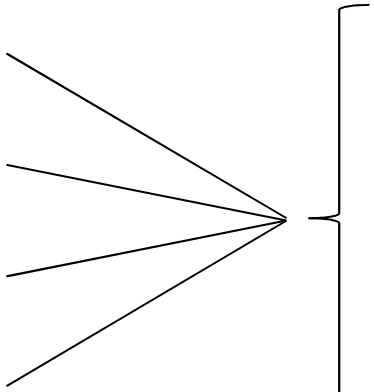
▸ Computer ▸ Local Disk (C:) ▸ TCC_2015 ▸ Doc ▸ Lecture ▸ 12 ▸ GWP_Sample.pptx

Uncertainties in global warming projection

Check of uncertainty (*)

Element and period

- Temperature in January
- Precipitation in January
- Temperature in June
- Precipitation in June



Uncertainty

- Natural climate variability
- Regional scale
- Incompleteness of climate model
- Short period for calculation

Uncertainties in global warming projection

Uncertainty

- Natural climate variability
- Regional scale
- Incompleteness of climate model
- Short period for calculation

How to check ?

Check !

Feature of projection results

- Wide scale → Low uncertainty
- AR5 used multi model → Low uncertainty
- Synoptic scale and other element
- Model bias

Synoptic scale and other element, Model bias → Check consistency in results.

1. Features are similar or not.
2. Can you explain reason of the difference ?

Preparation

1. Copy sample scripts to your working folder.

▸ Computer ▸ Local Disk (C:) ▸ TCC_2015 ▸ Doc ▸ Lecture ▸ 11 ▸ Script

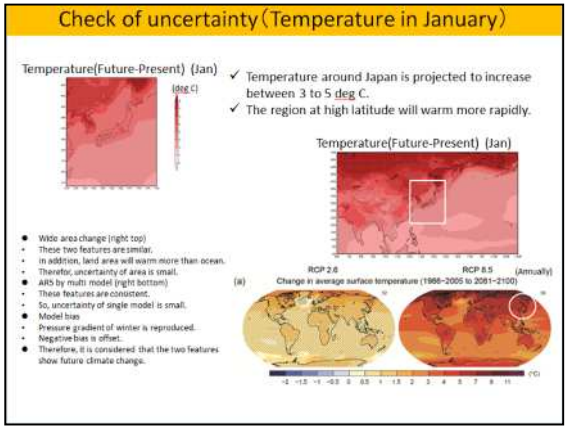
▸ Computer ▸ Local Disk (C:) ▸ TCC_2015 ▸ User ▸ 11 ▸ Script

2. Click icon of “Notepad” and “OpenGrADS” on your desktop.

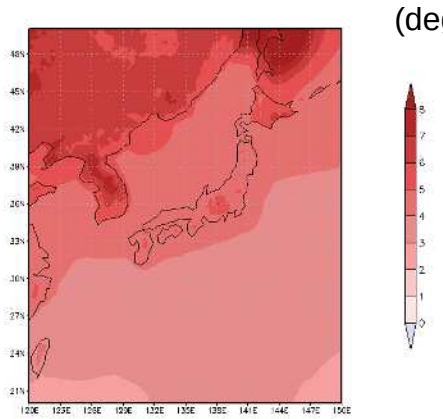
3. Move to working folder on OpenGrADS console.

```
ga-> cd /cygdrive/c/TCC_2015/User/11/Script/
```

Sample 1 (Temperature in January)



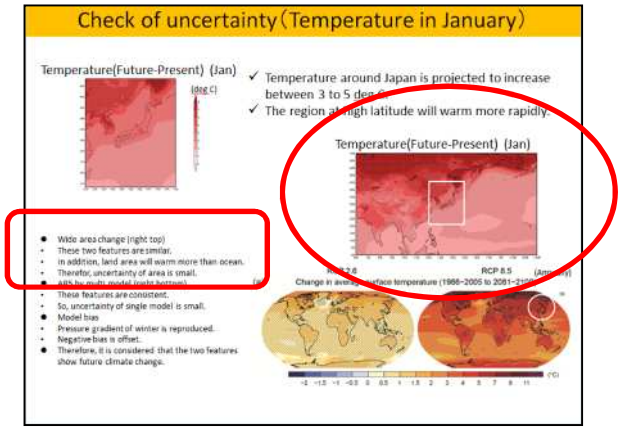
Temperature(Future-Present) (Jan)



- ✓ Temperature around Japan is projected to increase between 3 to 5 deg C.
- ✓ The region at high latitude will warm more rapidly.

Sample 1 (Temperature in January)

Check wide scale



1. Open “Temp_January.gs” by Notepad.

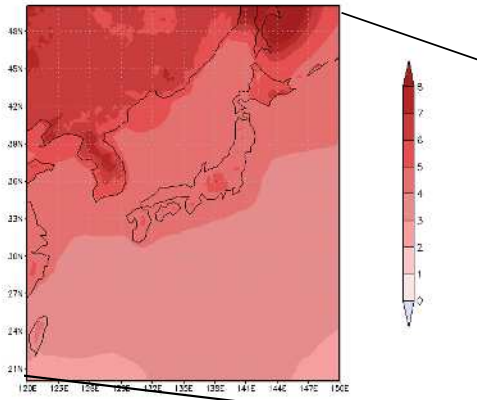
```
function main (args)
  ;* Temperature
  'open ../../../Data/AGCM/ta-P.ctl'
  'open ../../../Data/AGCM/ta-F.ctl'
  ......
  'printim ta_fp_jan.png white'
return
```

2. Run script by OpenGrADS.

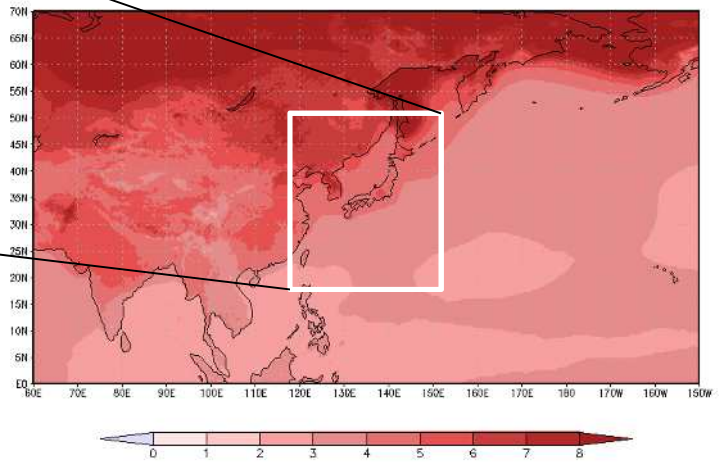
```
ga-> Temp_January
```

3. Open image file.

Sample 1 (Temperature in January)



- ✓ Temperature around Japan is projected to increase between 3 to 5 deg C.
- ✓ The region at high latitude will warm more rapidly.



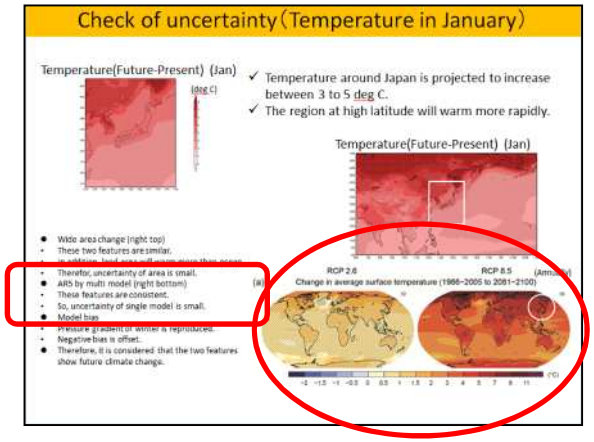
1. Features are similar or not.
2. Can you explain reason of the difference ?

Check wide scale

- These two features are similar.
- In addition, land area will warm more than ocean.
- Therefore, uncertainty of small area is small.

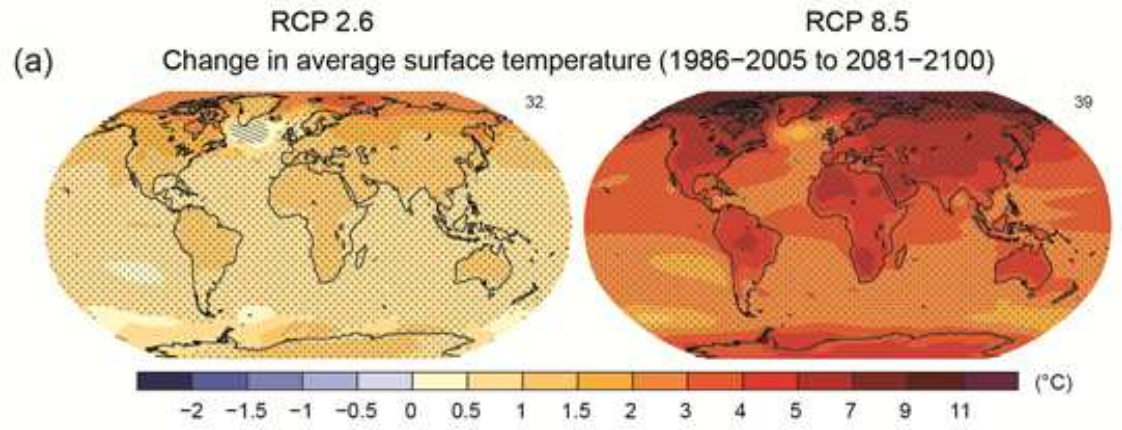
Sample 1 (Temperature in January)

Check AR5 by multi model



1. Open AR5 image file.

▸ Computer ▸ Local Disk (C:) ▸ TCC_2015 ▸ Doc ▸ IPCC_AR5 ▸ WG1 ▸ graphics ▸ SPM ▸ WGI_AR5_FigSPM-8.jpg

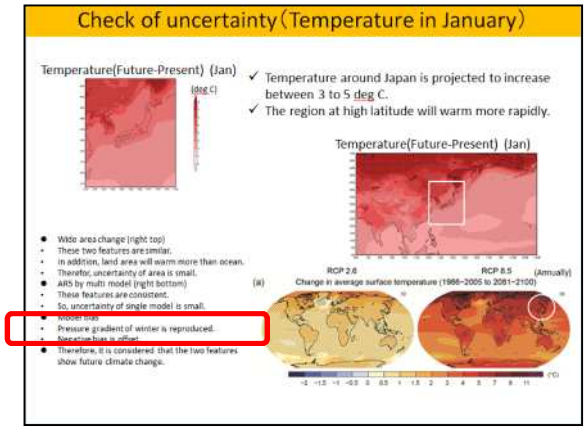


- These features are consistent.
- So, uncertainty of single model is small.

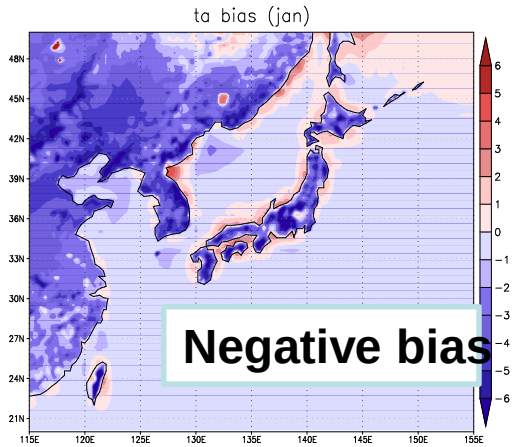
WG1 AR5 Figure SPM.8

Sample 1 (Temperature in January)

Check model bias

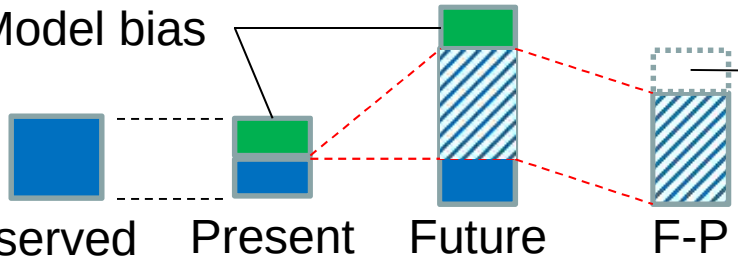


2m Temperature (℃)



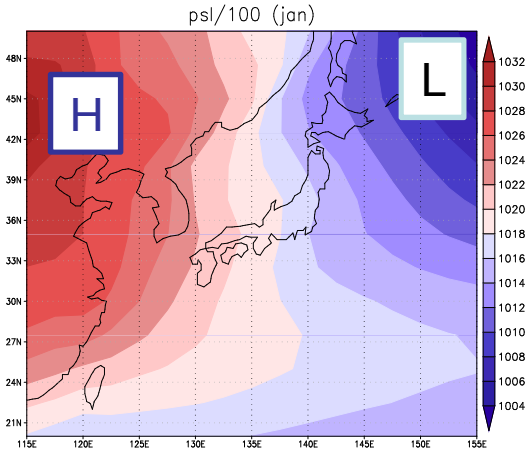
The result of AGCM is very colder than that of JRA55.

Model bias



Bias is offset !

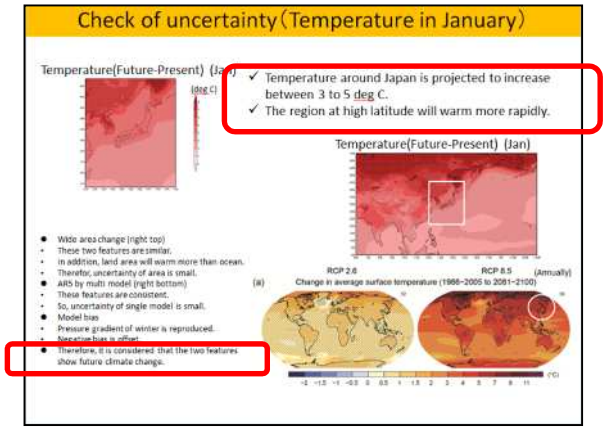
Sea Level Pressure (hPa)



- Pressure gradient of winter is reproduced.
- Negative bias is offset.

Sample 1 (Temperature in January)

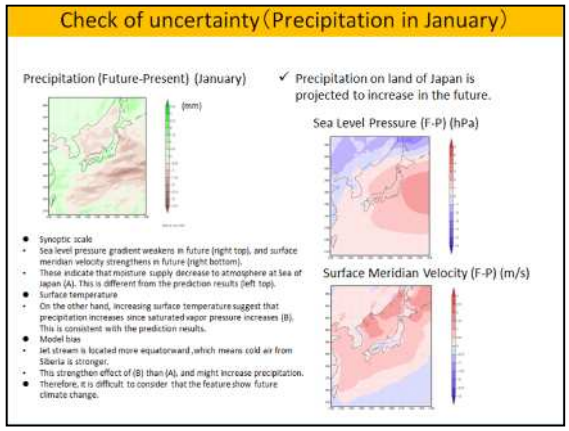
Conclusion



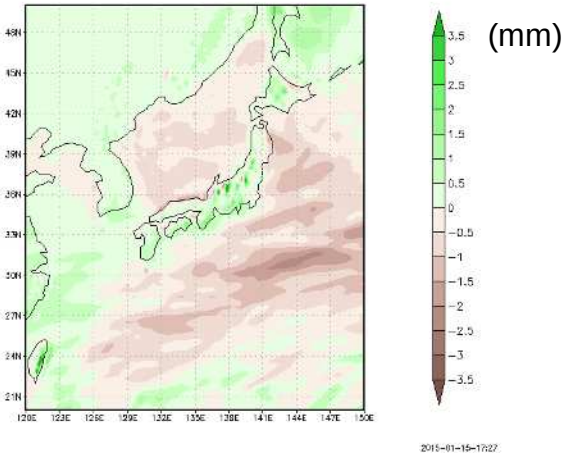
- ✓ Temperature around Japan is projected to increase between 3 to 5 deg C.
- ✓ The region at high latitude will warm more rapidly.

- Therefore, it is considered that the two features show future climate change.

Sample 2 (Precipitation in January)



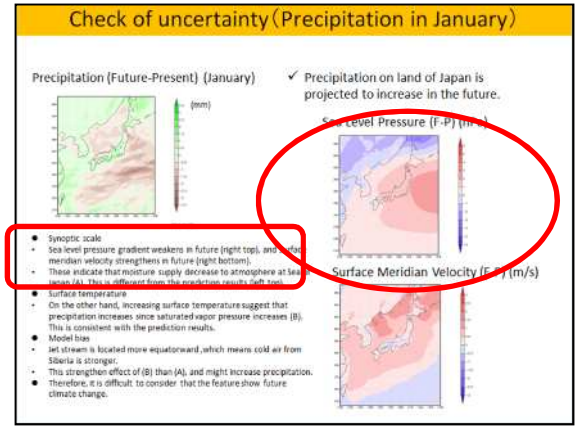
Precipitation (Future-Present) (January)



✓ Precipitation on land of Japan is projected to increase in the future.

Sample 2 (Precipitation in January)

Check synoptic scale



1. Open “Prec_January.gs” by Notepad.

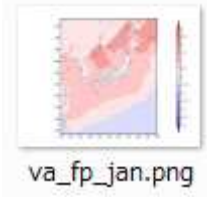
```
function main (args)
  ;* Sea Level Pressure
  'open ../../../Data/AGCM/slp-P.ctl'
  'open ../../../Data/AGCM/slp-F.ctl'
  ;* Surface Meridian Velocity
  ;* 'open ../../../Data/AGCM/va-P.ctl'
  ;* 'open ../../../Data/AGCM/va-F.ctl'
  ......
return
```

Comment out

2. Run script by OpenGrADS.

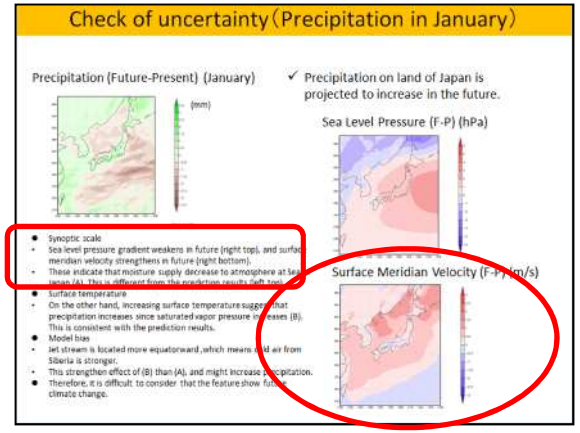
```
ga-> reinit
ga-> Prec_January
```

3. Open image file.



Sample 2 (Precipitation in January)

Check synoptic scale



1. Edit “Prec_January.gs”

```
function main (args)
  ;* Sea Level Pressure
  ;* 'open ../../../Data/AGCM/slp-P.ctl'
  ;* 'open ../../../Data/AGCM/slp-F.ctl'
  ;* Surface Meridian Velocity
  'open ../../../Data/AGCM/va-P.ctl'
  'open ../../../Data/AGCM/va-F.ctl'
  ......
return
```

Comment out

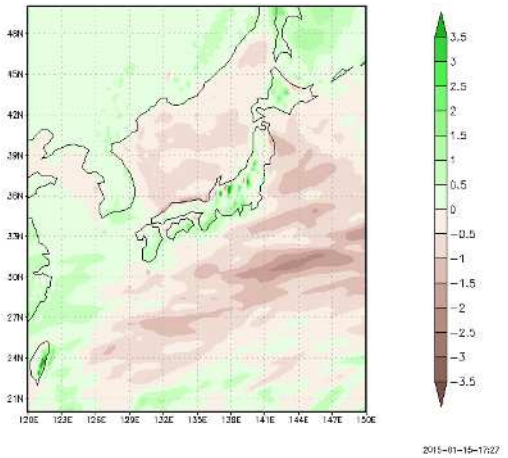
2. Run script by OpenGrADS.

```
ga-> Prec_January
```

3. Open image file.

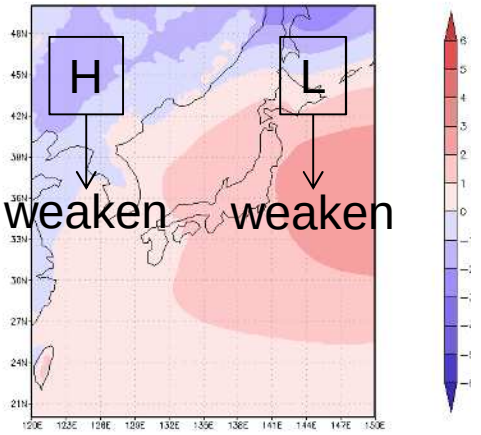
Sample 2 (Precipitation in January)

Precipitation (Future-Present) (January)

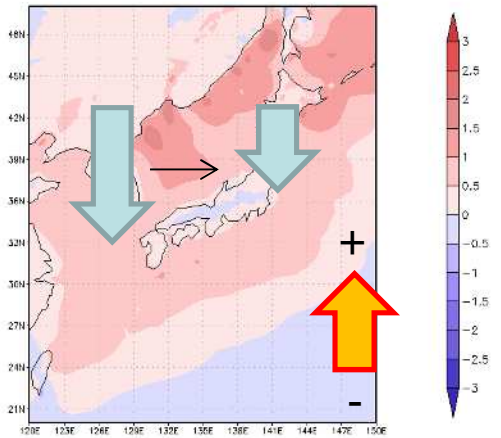


✓ Precipitation on land of Japan is projected to increase in the future.

Sea Level Pressure (F-P) (hPa)



Surface Meridian Velocity (F-P) (m/s)

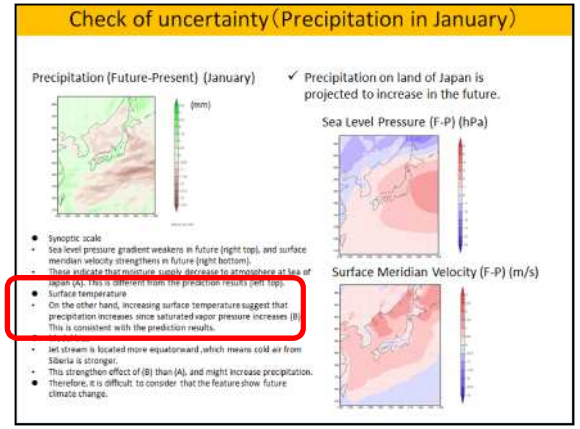


Check synoptic scale

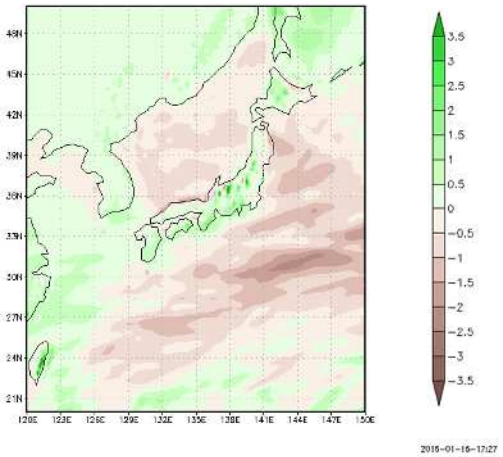
- Sea level pressure gradient weakens in future, and surface meridian velocity strengthens in future.
- These indicate that moisture supply decrease to atmosphere at Sea of Japan (A). This is different from the projection results.

Sample 2 (Precipitation in January)

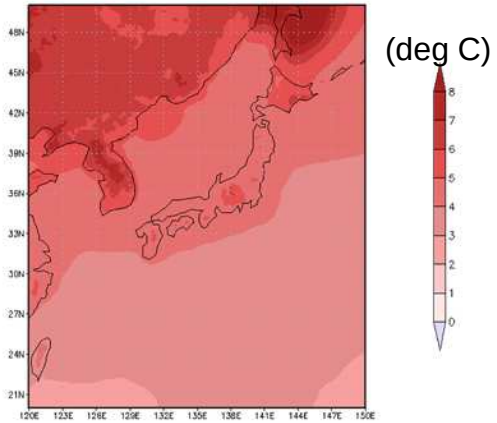
Check other element



Precipitation (F-P) (Jan)



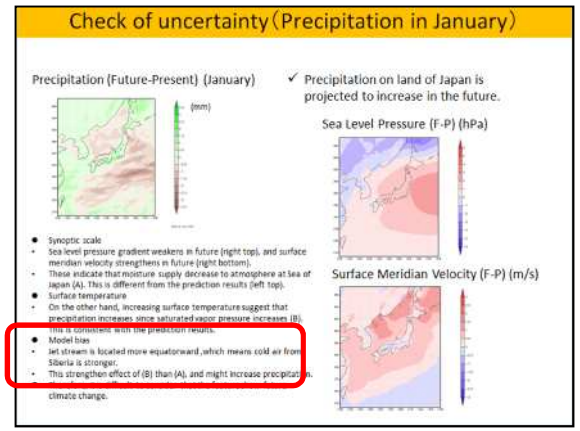
Temperature (F-P) (Jan)



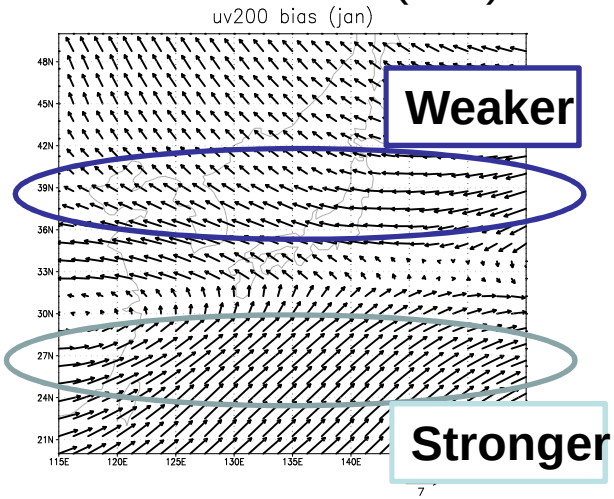
- On the other hand, increasing surface temperature suggest that precipitation increases because saturated vapor pressure increases (B). This is consistent with the prediction results.

Sample 2 (Precipitation in January)

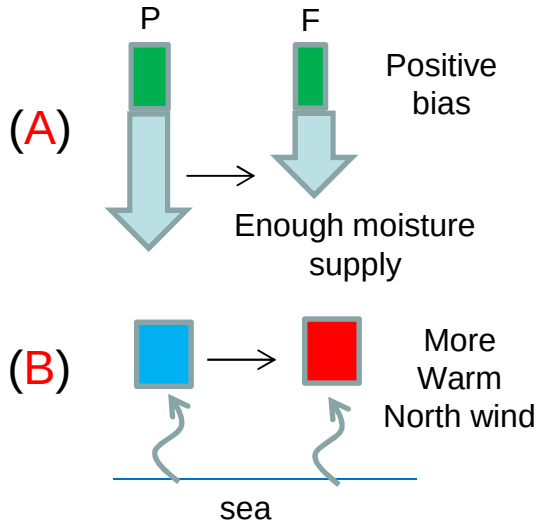
Check model bias



200hPa Wind (m/s)



Cold air

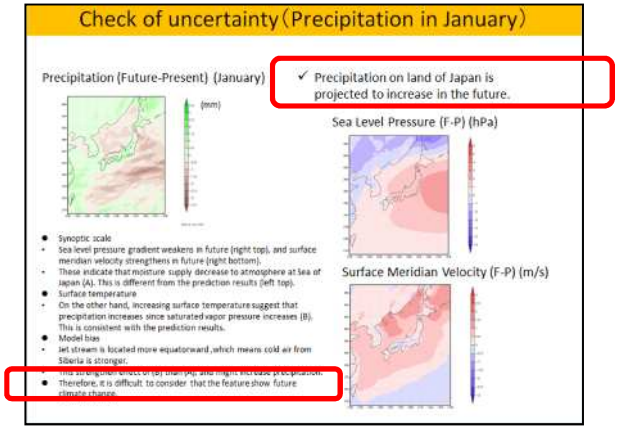


- Jet stream is located more equatorward, which means cold air from Siberia is stronger.
- This strengthen effect of (B) than (A), and might increase precipitation.

- Moisture supply decrease to atmosphere at Sea of Japan (A). This is different from the prediction results.
- Increasing surface temperature suggest that precipitation increases since saturated vapor pressure increases (B). This is consistent with the prediction results.

Sample 2 (Precipitation in January)

Conclusion

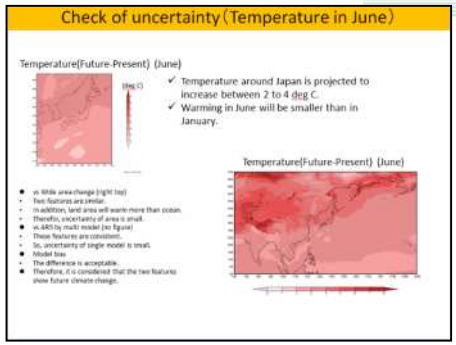


✓ Precipitation on land of Japan is projected to increase in the future.

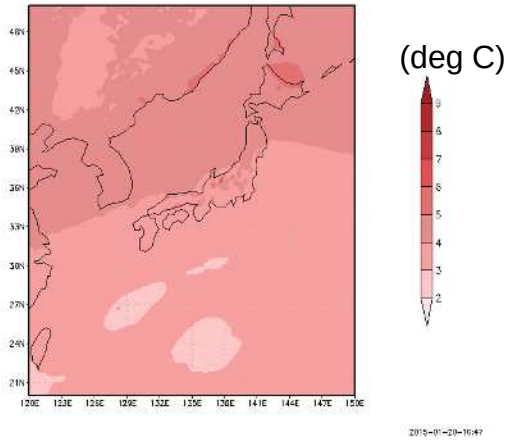
- Therefore, it is difficult to consider that the feature show future climate change.

- Uncertainty of Precipitation is larger than temperature.
- This feature may be the influence of the bias.

Sample 3 (Temperature in June)



Temperature(Future-Present) (June)



- ✓ Temperature around Japan is projected to increase between 2 to 4 deg C.
- ✓ Warming in June will be smaller than in January.

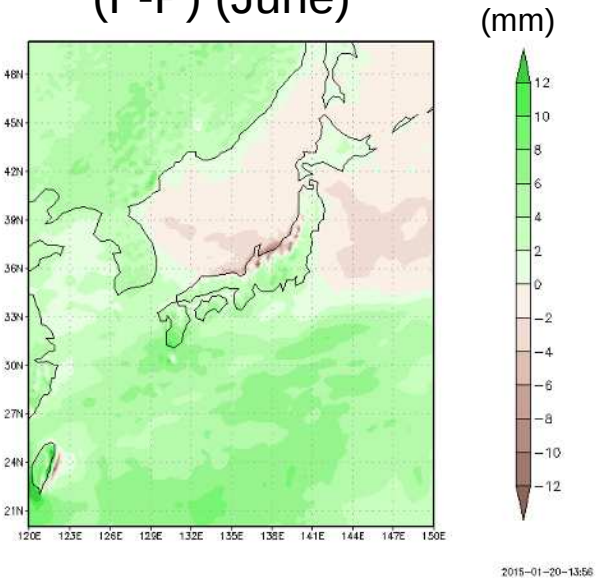
- “Temp_June.gs”

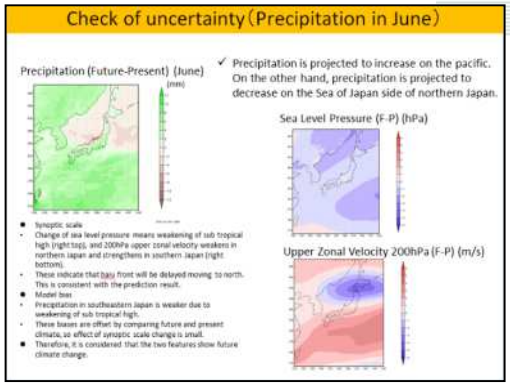
- Uncertainty of area is small.
- Uncertainty of single model is small.
- Model bias is acceptable.

- Therefore, it is considered that the two features show future climate change.

Sample 4 (Precipitation in June)

Precipitation
(F-P) (June)





✓ Precipitation is projected to increase on the pacific. On the other hand, precipitation is projected to decrease on the Sea of Japan side of northern Japan.

- “Prec_June.gs”

- Baiu front will be delayed moving to north. This is consistent with the prediction result.
- Model bias is acceptable.

- Therefore, it is considered that the two features show future climate change.

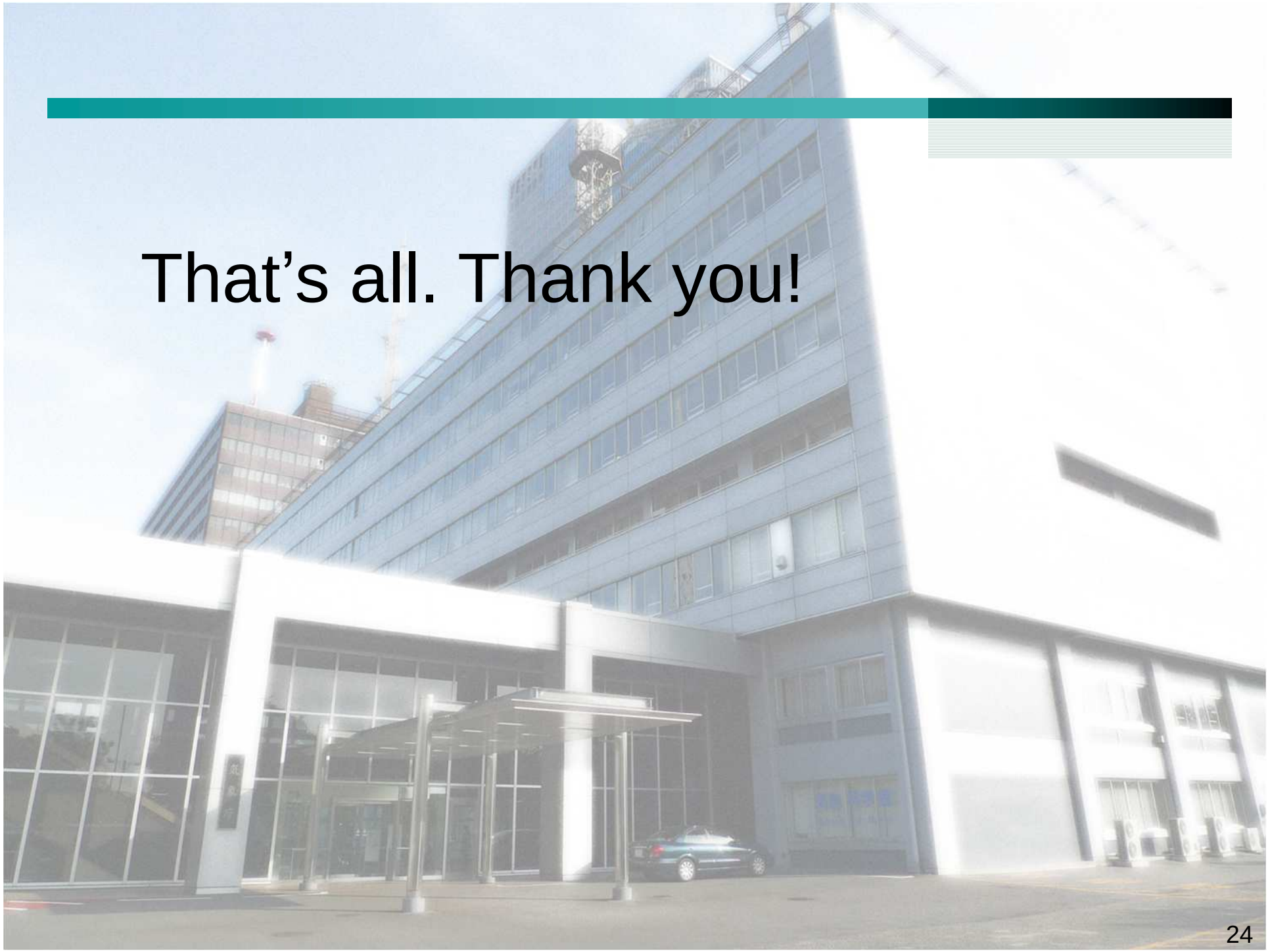
Sample 5 (Summary)

[Reproducibility]

- Although there are little biases, these are acceptable.

[Future climate change and Reliability]

- Temperature in January … risk of avalanche
  - Temperature around Japan is projected to increase between 3 to 5 deg C.
  - The region at high latitude will warm more rapidly.
  - [OK] It is considered that the two features show future climate change.
- Precipitation in January … risk of snow depth change
  - [NG] It is difficult to consider that the feature show future climate change.
- Temperature in June … risk of heat stroke
  - Temperature around Japan is projected to increase between 2 to 4 deg C.
  - [OK] It is considered that the feature show future climate change.
- Precipitation in June … risk of flood and drought
  - Precipitation is projected to increase on the pacific. On the other hand, precipitation is projected to decrease on the Sea of Japan side of northern Japan.
  - [OK] It is considered that the two features show future climate change.



That’s all. Thank you!