

Climate Prediction and Information for Decision Making in Malaysia

presented at the

APEC Climate Symposium 2010
APEC Climate Center (APCC)

Busan, Korea

20 – 24 June 2010

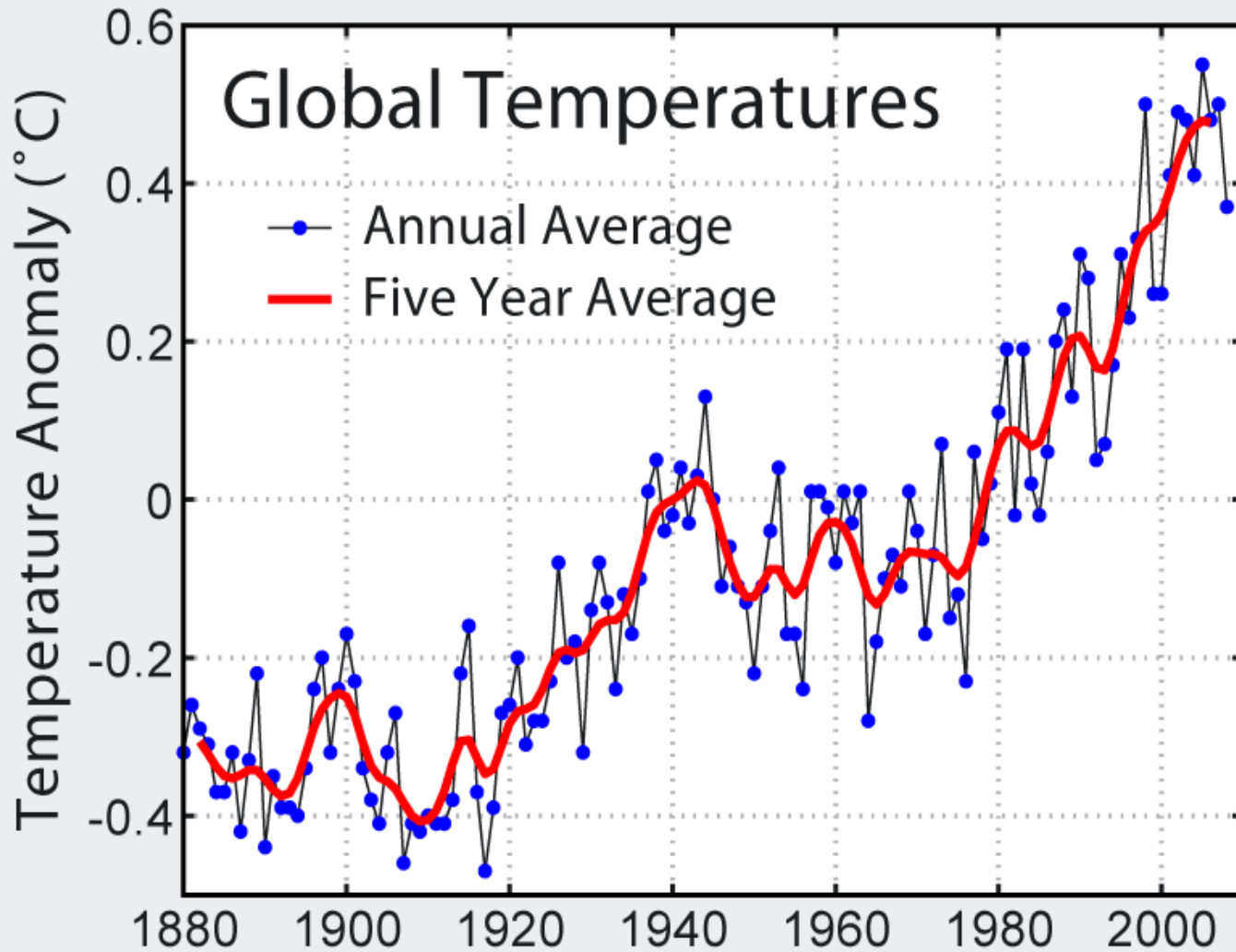
Kwan Kok Foo



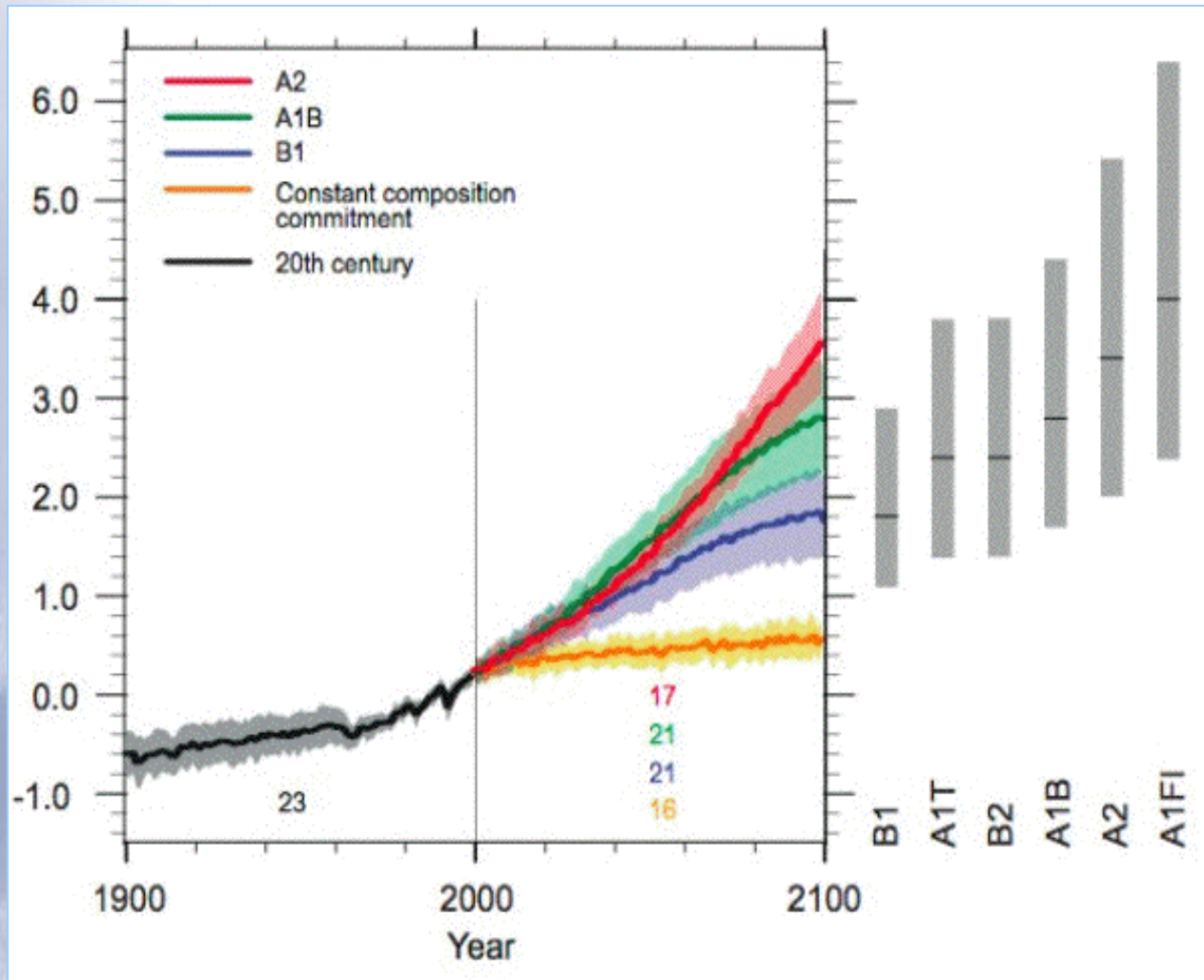
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2. Climate Trends of Malaysia
3. Simulations of Malaysian Climate
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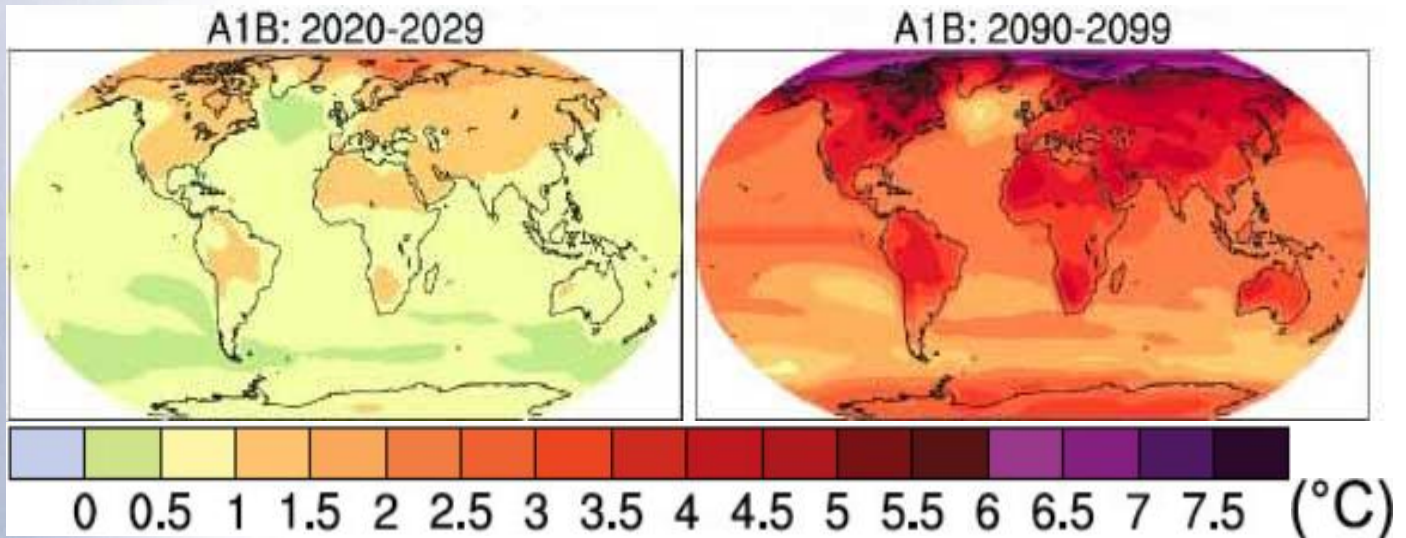
Global Climate



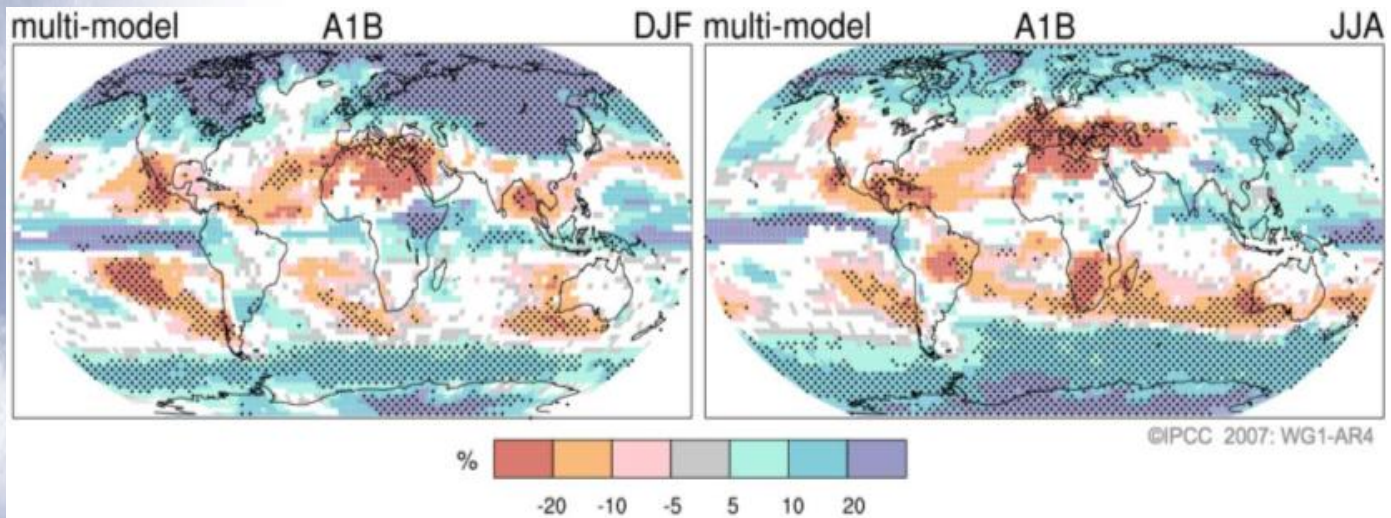
Global Average Surface Temperature Anomaly
(IPCC AR4 WG1: Physical Science Basis)



Annual Global Average Surface Air Temperature Increase from 1900 to 2100 for Different Emission Scenarios (IPCC AR4 WG1: Summary for Policy Makers)

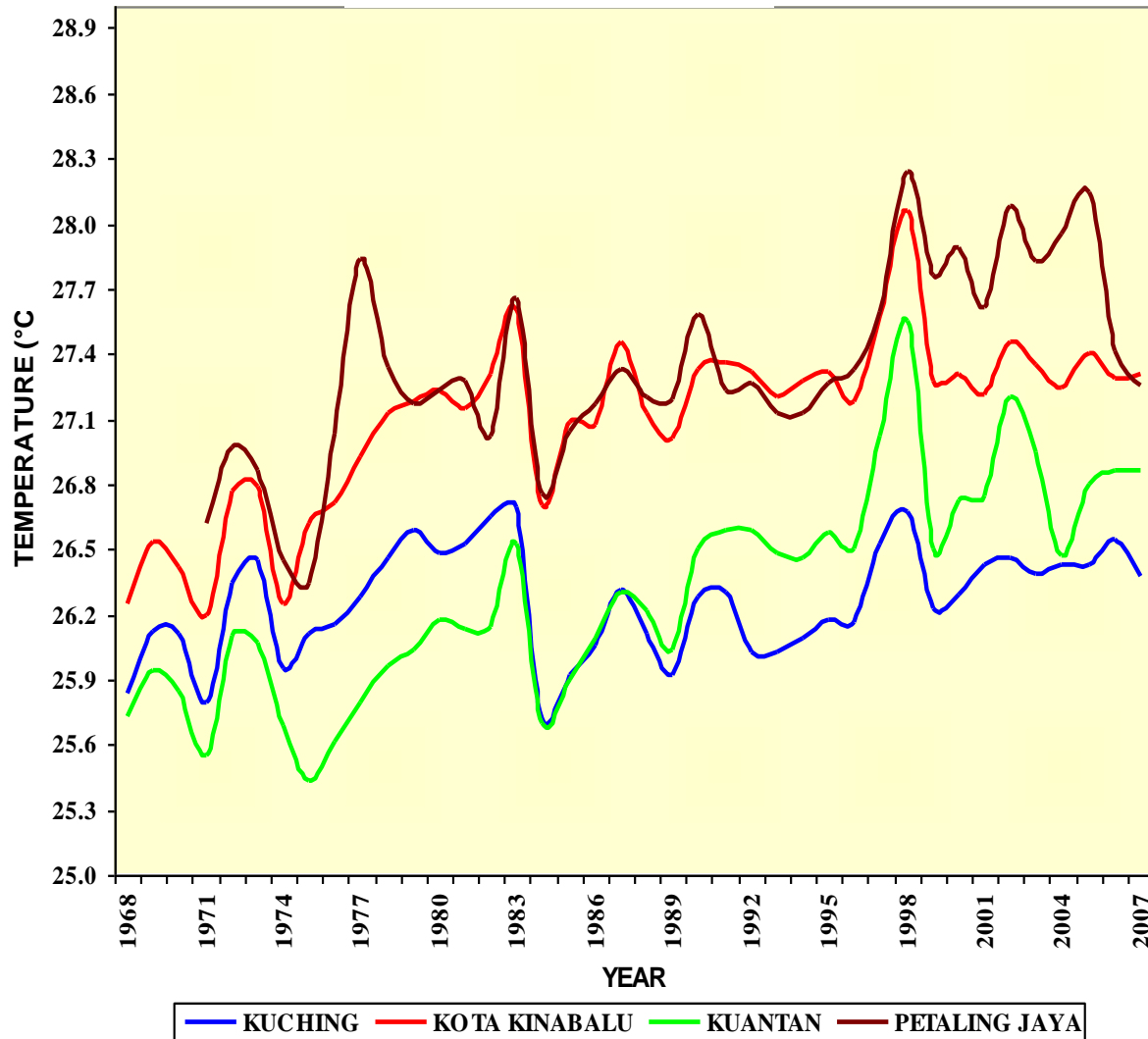


Projected Patterns of Temperature Change



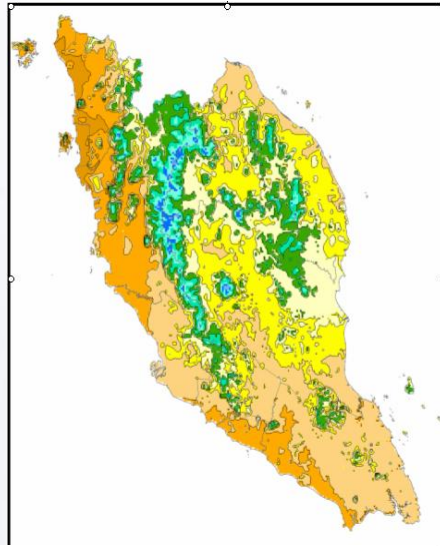
Projected Patterns of Precipitation Change

Climate Trends of Malaysia

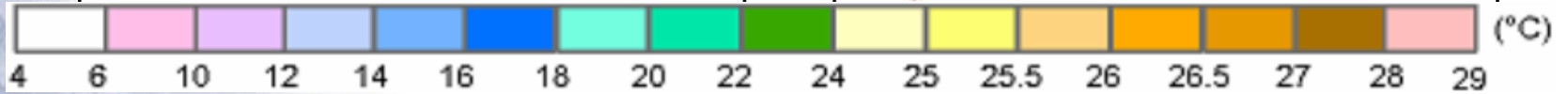
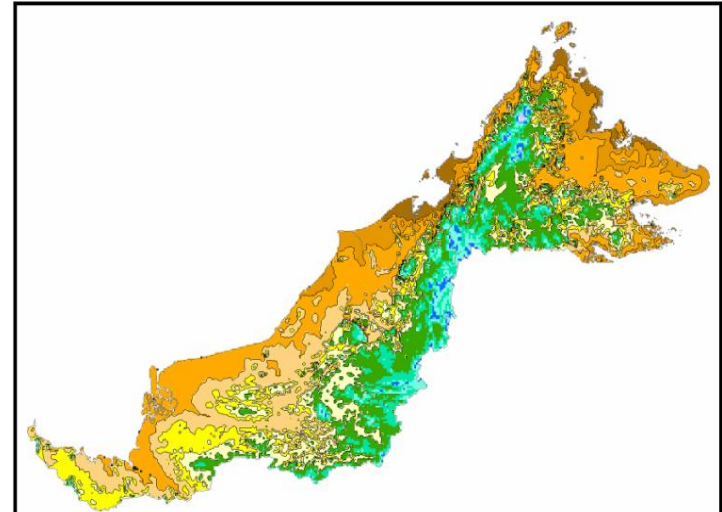
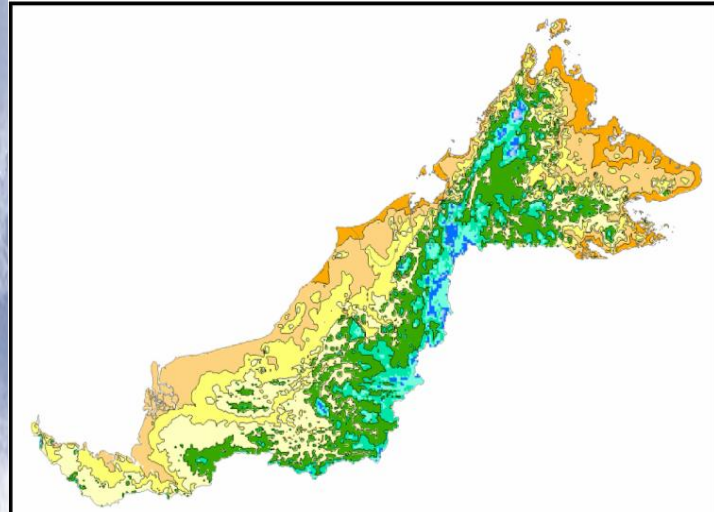
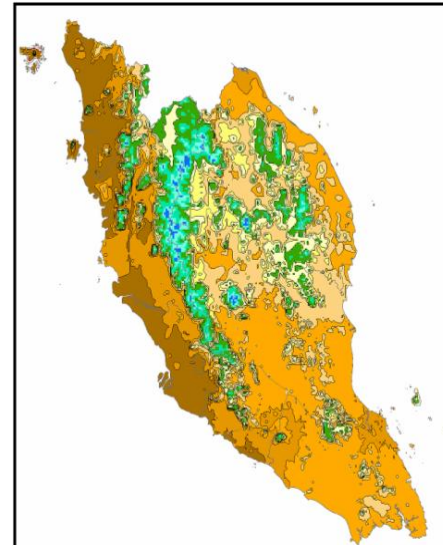


Annual Mean Temperature Trend of Four Meteorological Stations in Malaysia

1961 - 1990

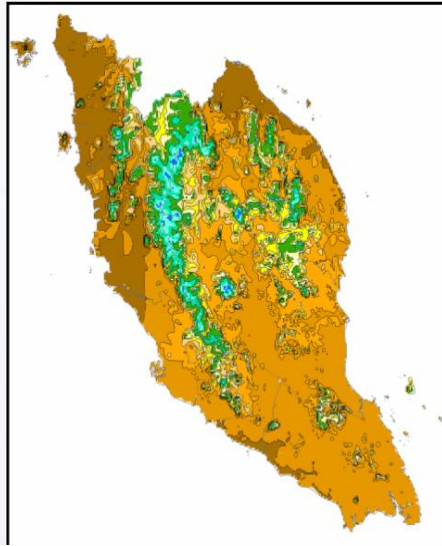


1998 - 2007

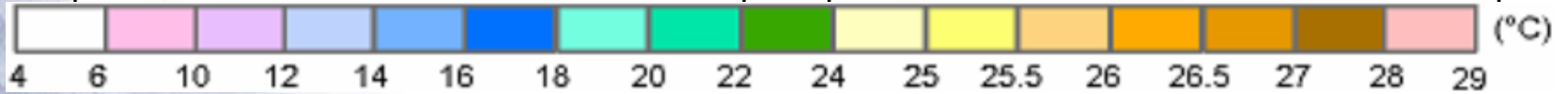
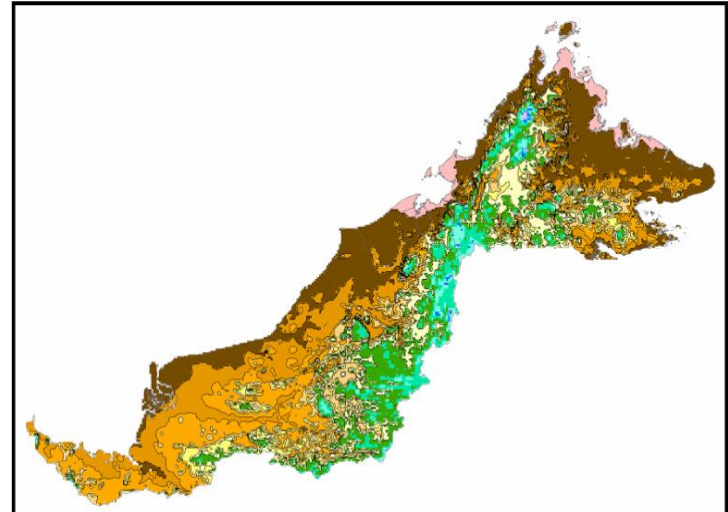
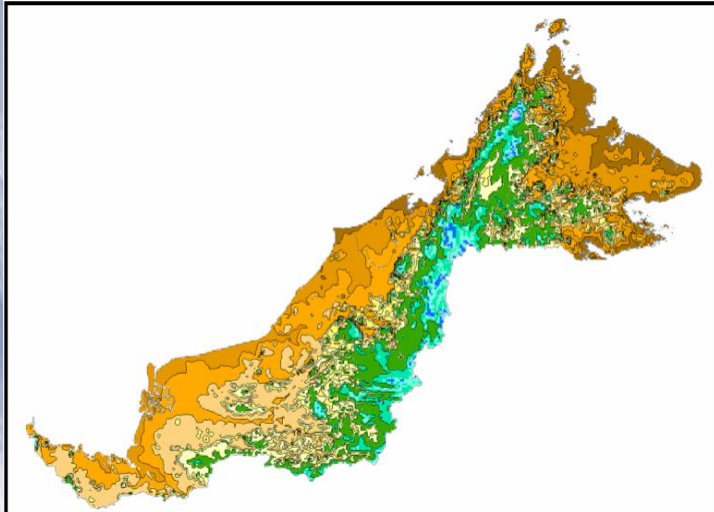
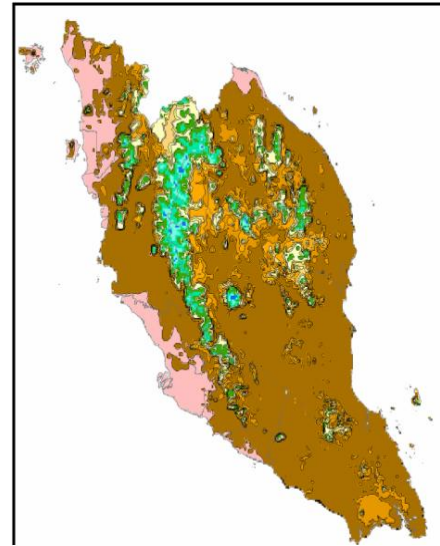


Long Term Mean Temperature for Dec-Jan-Feb

1961 - 1990

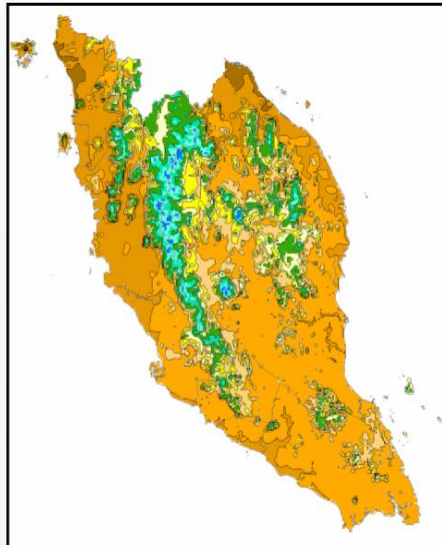


1998 - 2007

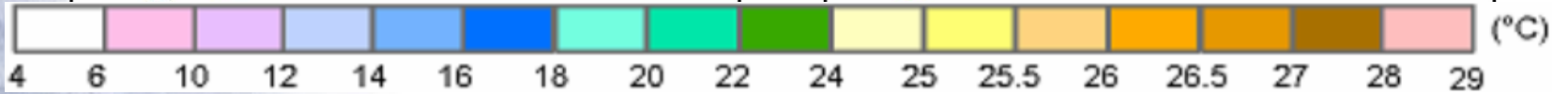
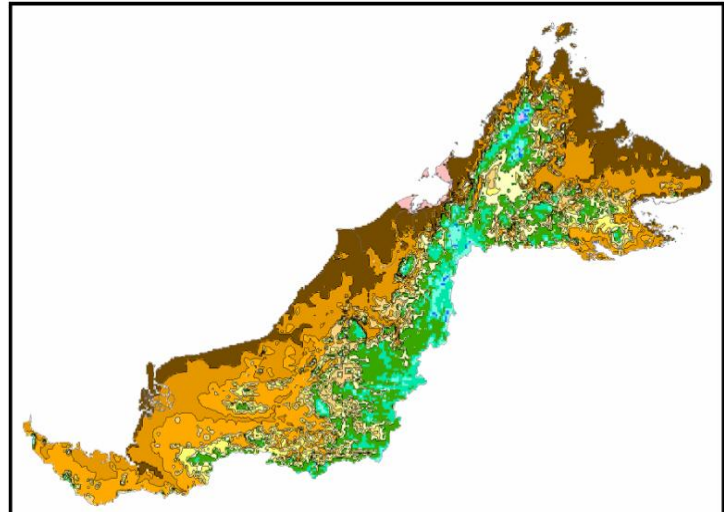
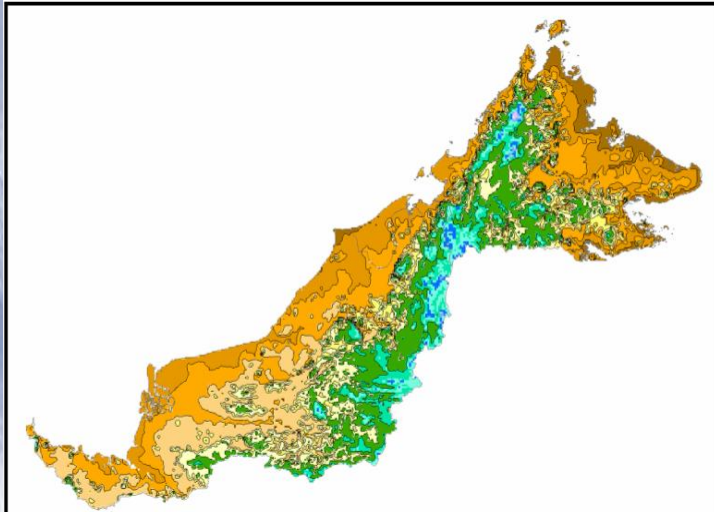
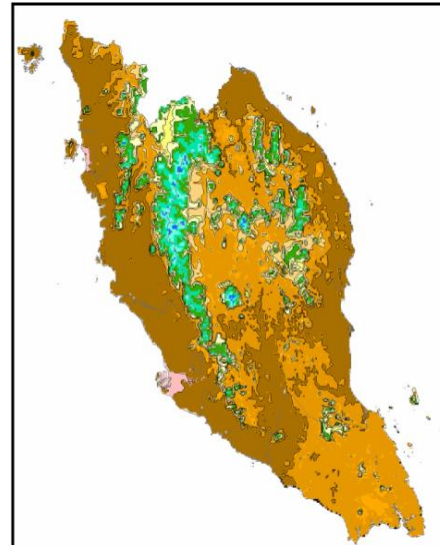


Long Term Mean Temperature for Mar-Apr-May

1961 - 1990

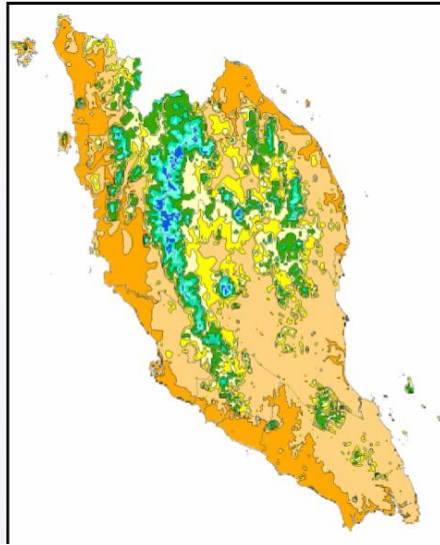


1998 - 2007

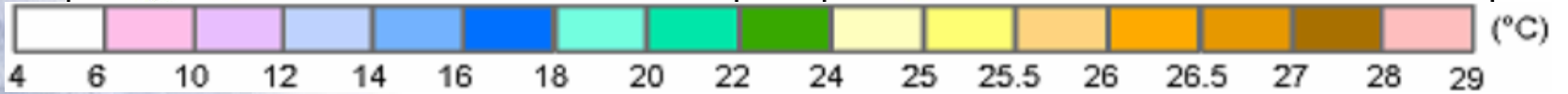
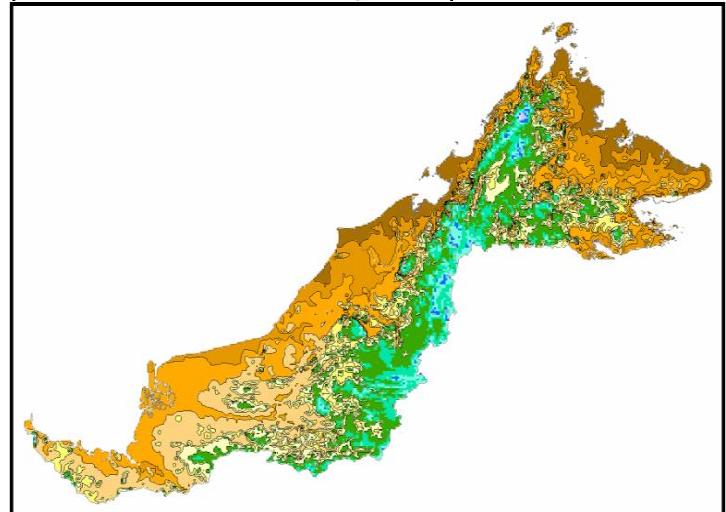
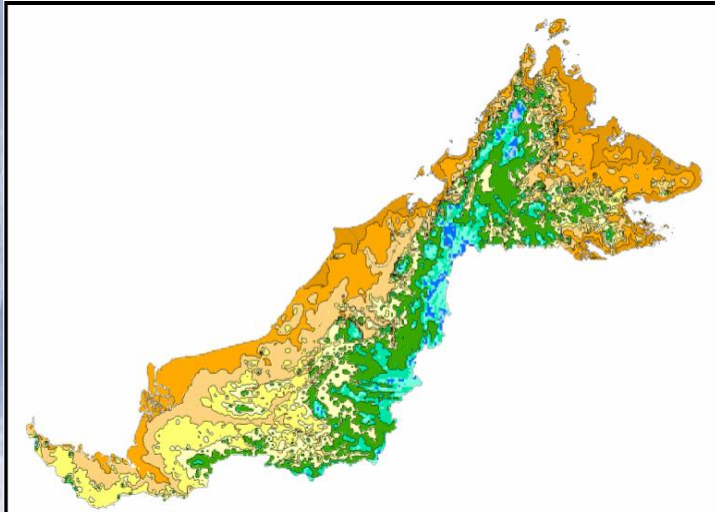
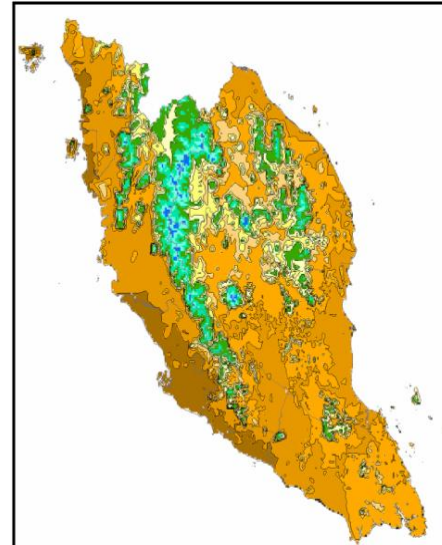


Long Term Mean Temperature for Jun-Jul-Aug

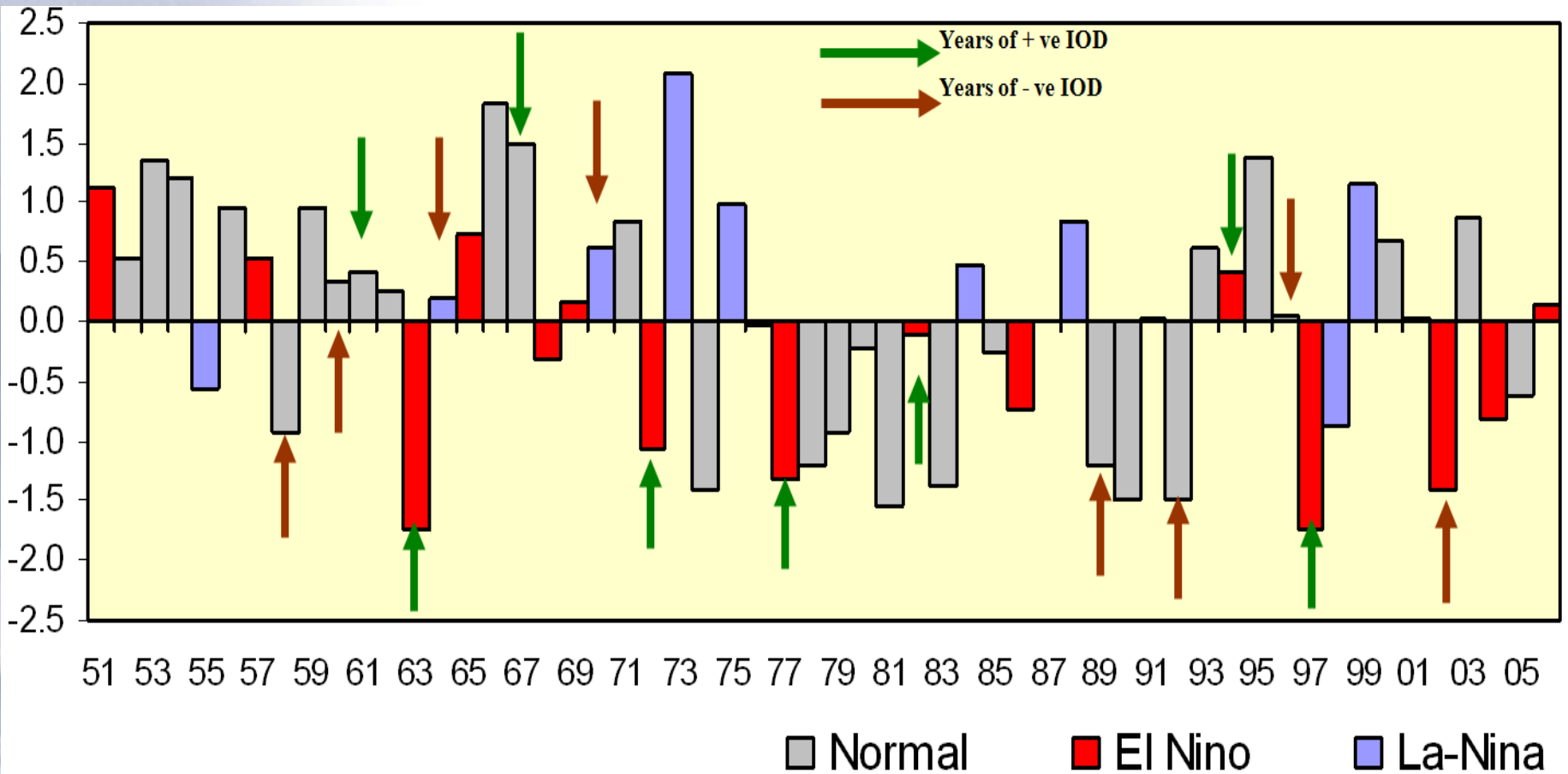
1961 - 1990



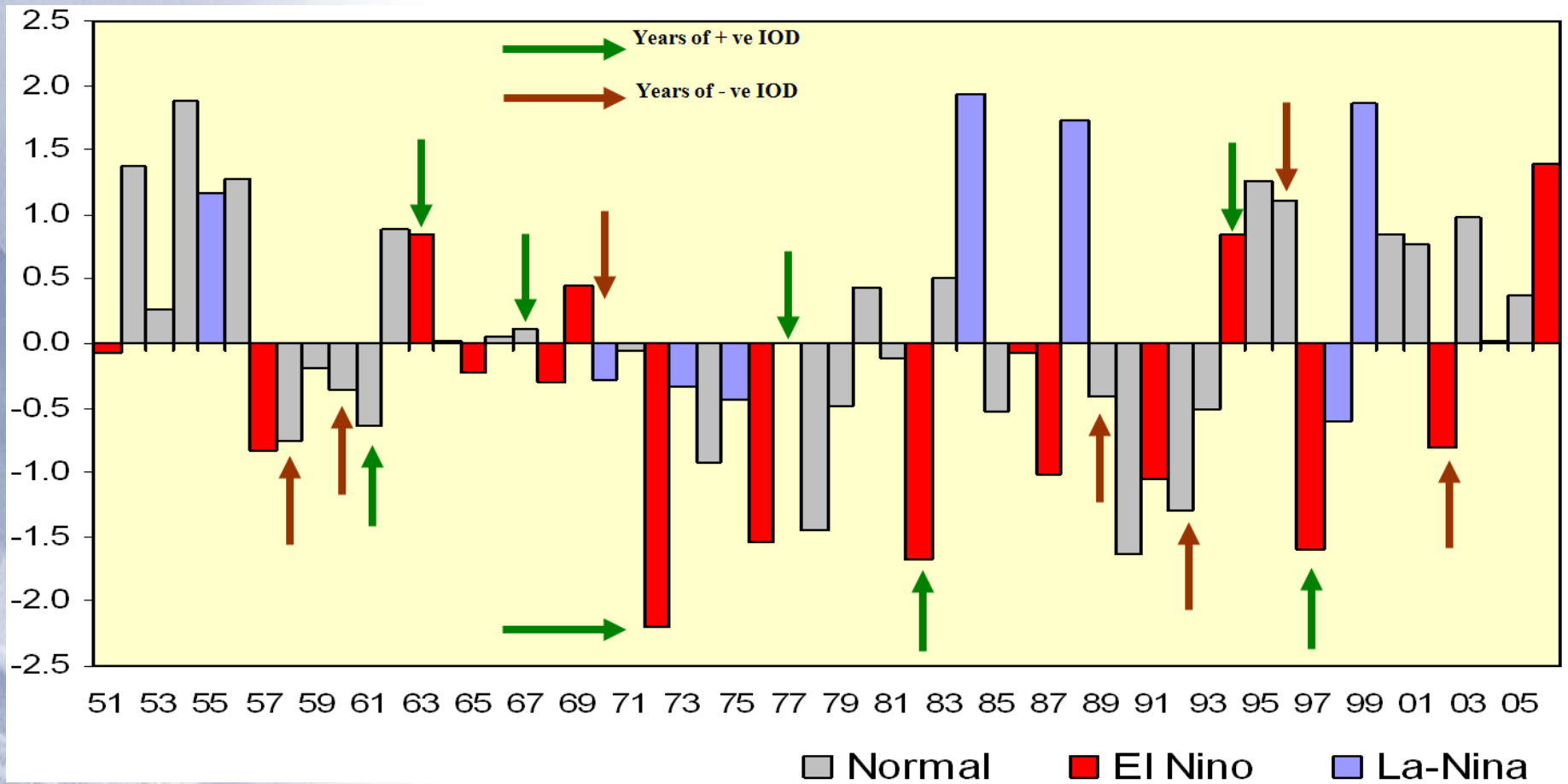
1998 - 2007



Long Term Mean Temperature for Sep-Oct-Nov

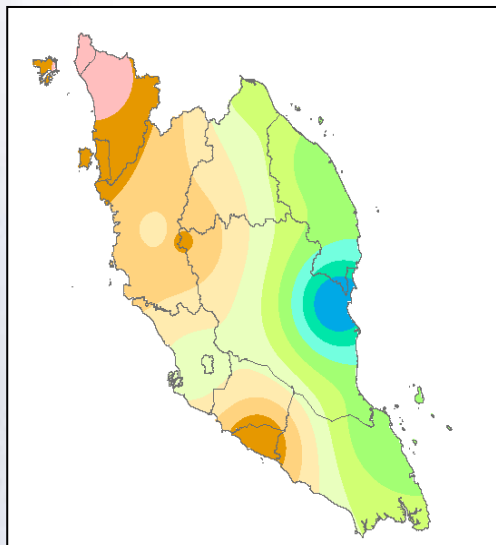


Standardized Rainfall Anomaly for Peninsular Malaysia

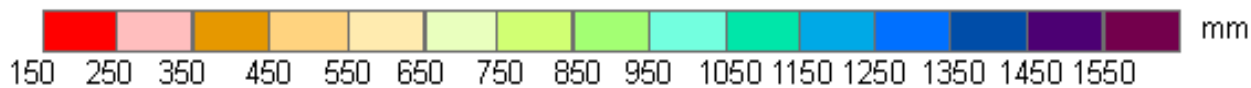
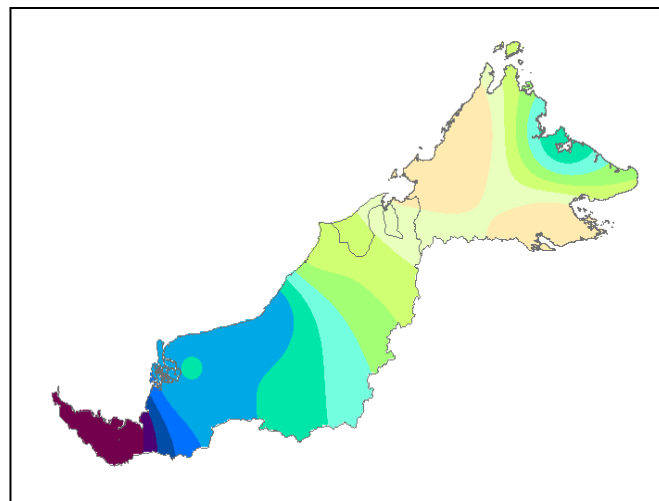
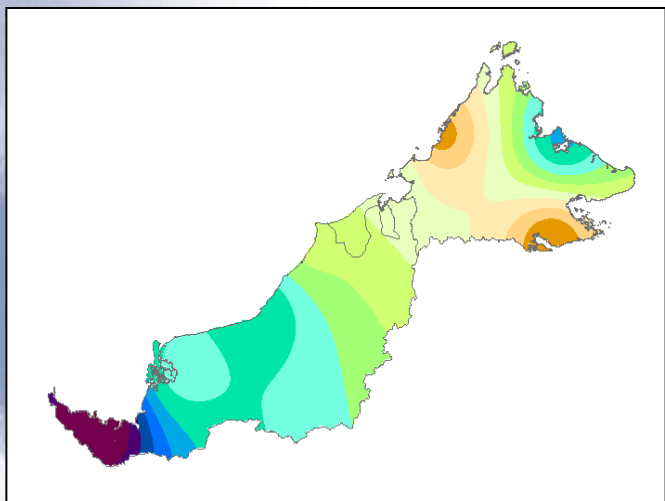
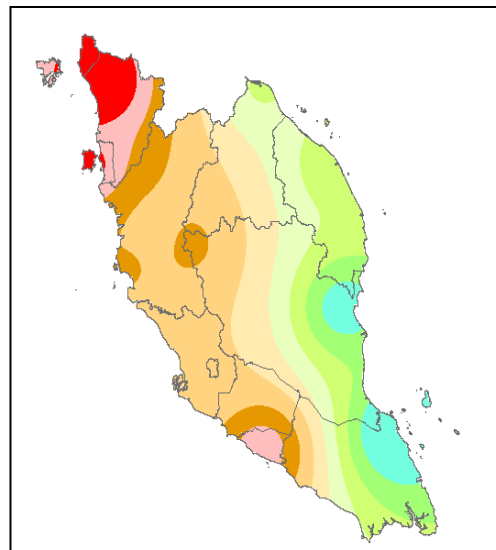


Standardized Rainfall Anomaly for Sarawak and Sabah

1961 - 1990

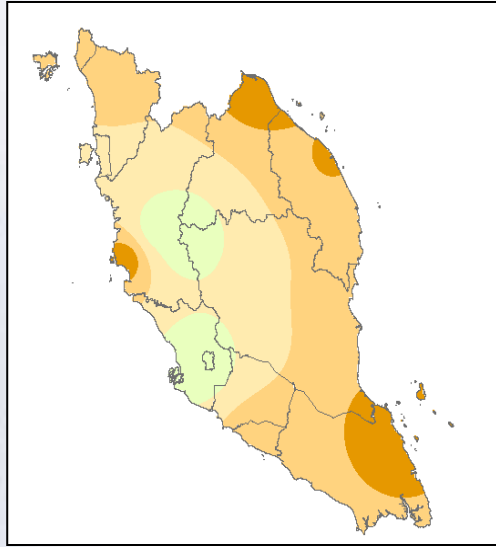


1998 - 2007

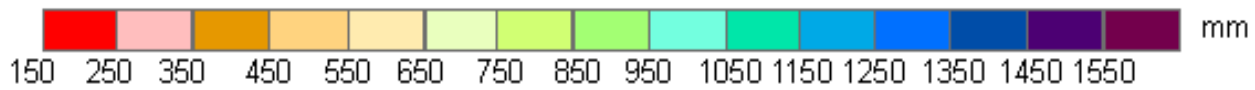
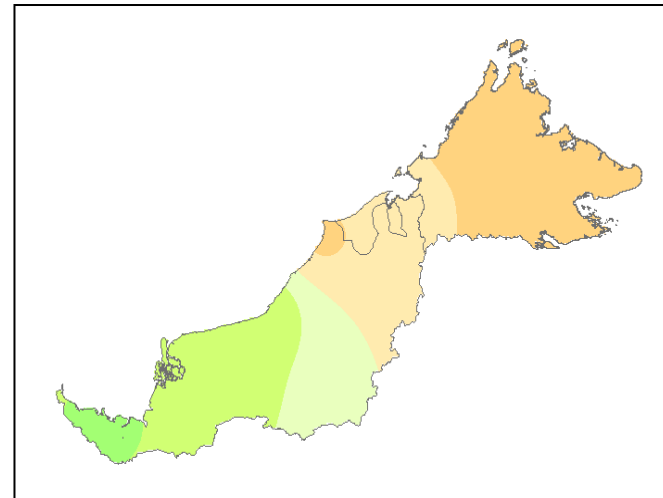
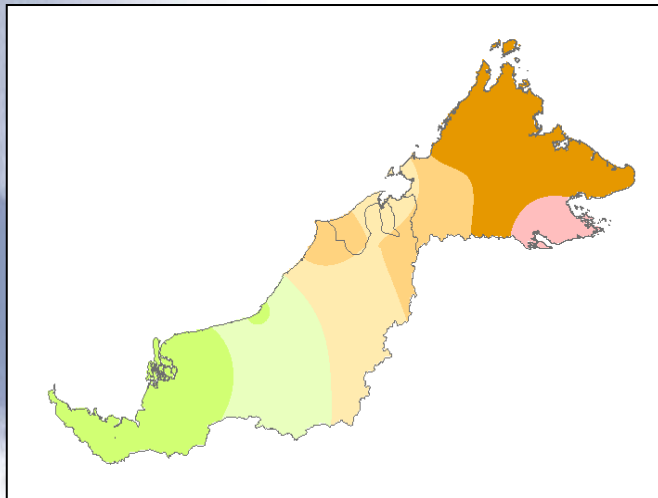
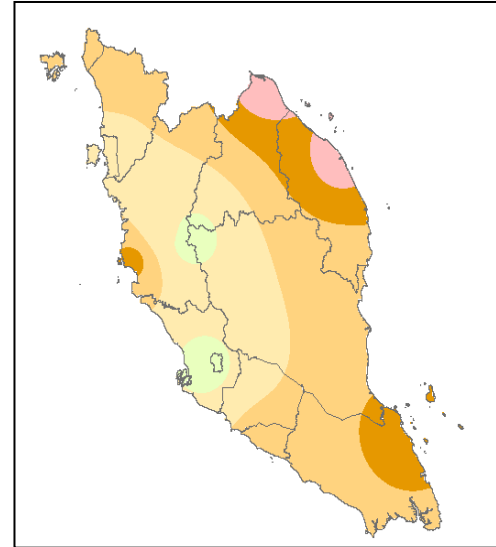


Long Term Mean Rainfall for Dec-Jan-Feb

1961 - 1990

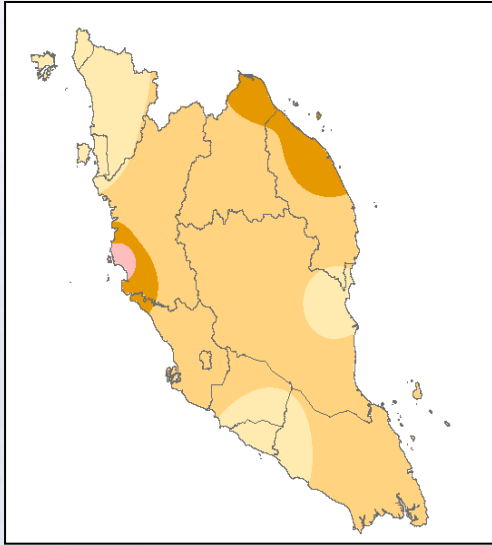


1998 - 2007

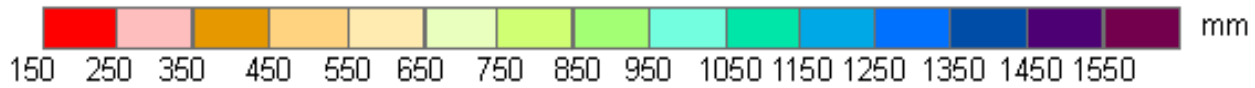
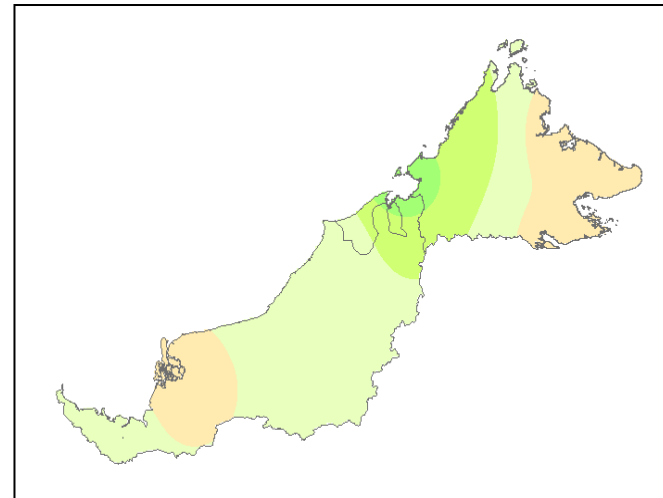
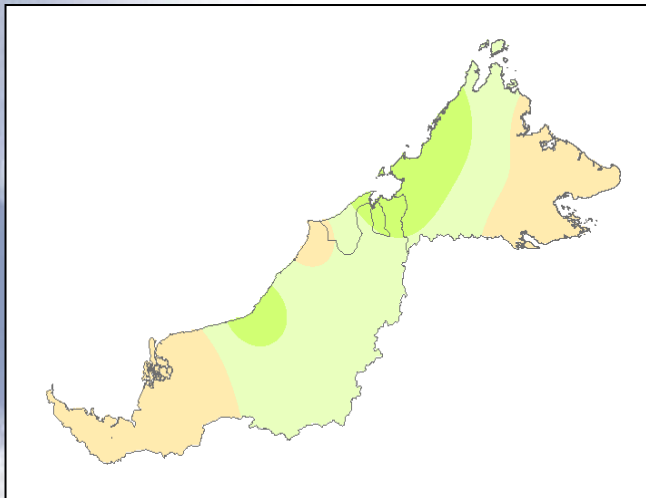
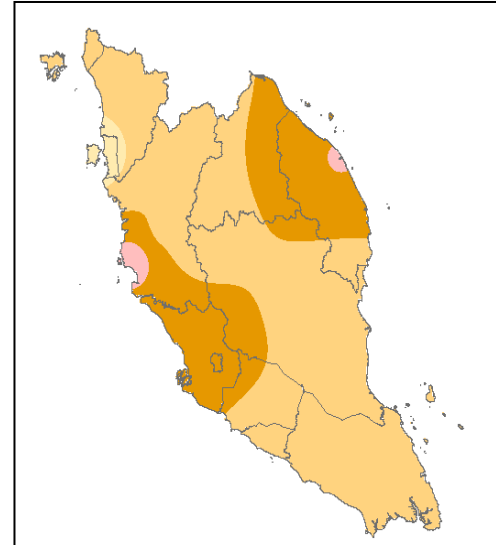


Long Term Mean Rainfall for **Mar-Apr-May**

1961 - 1990

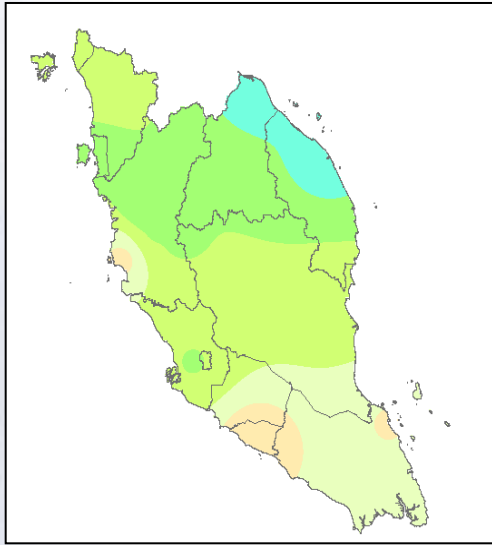


1998 - 2007

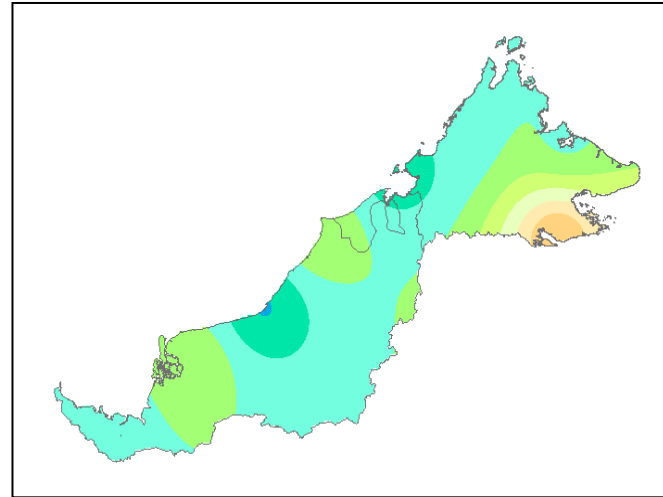
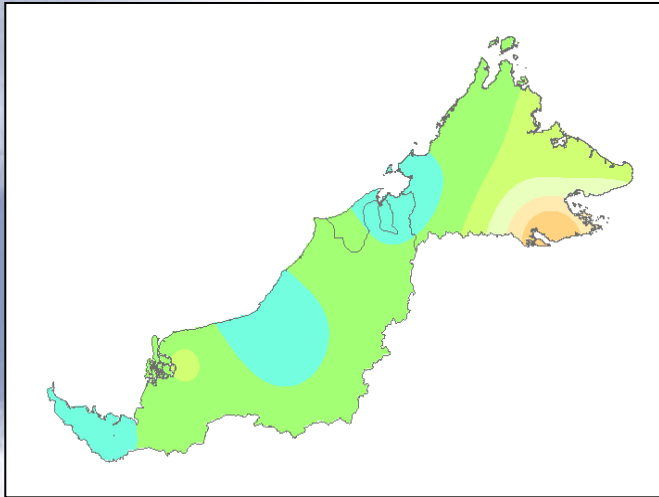
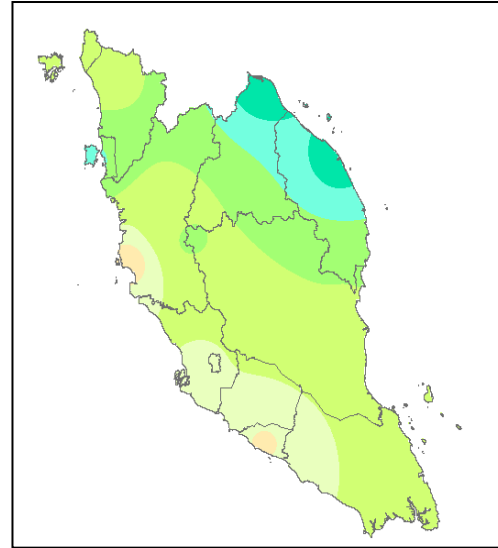


Long Term Mean Rainfall for Jun-Jul-Aug

1961 - 1990

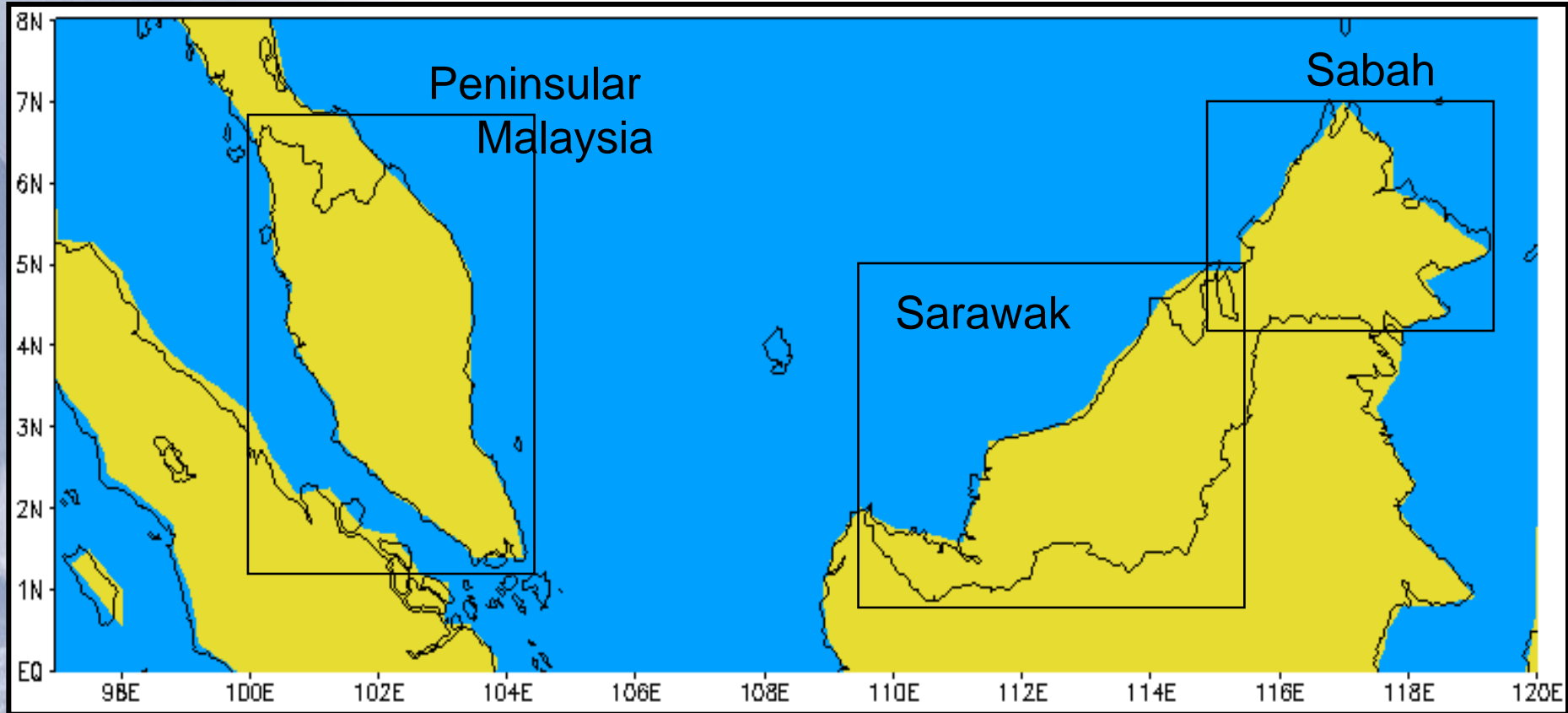


1998 - 2007

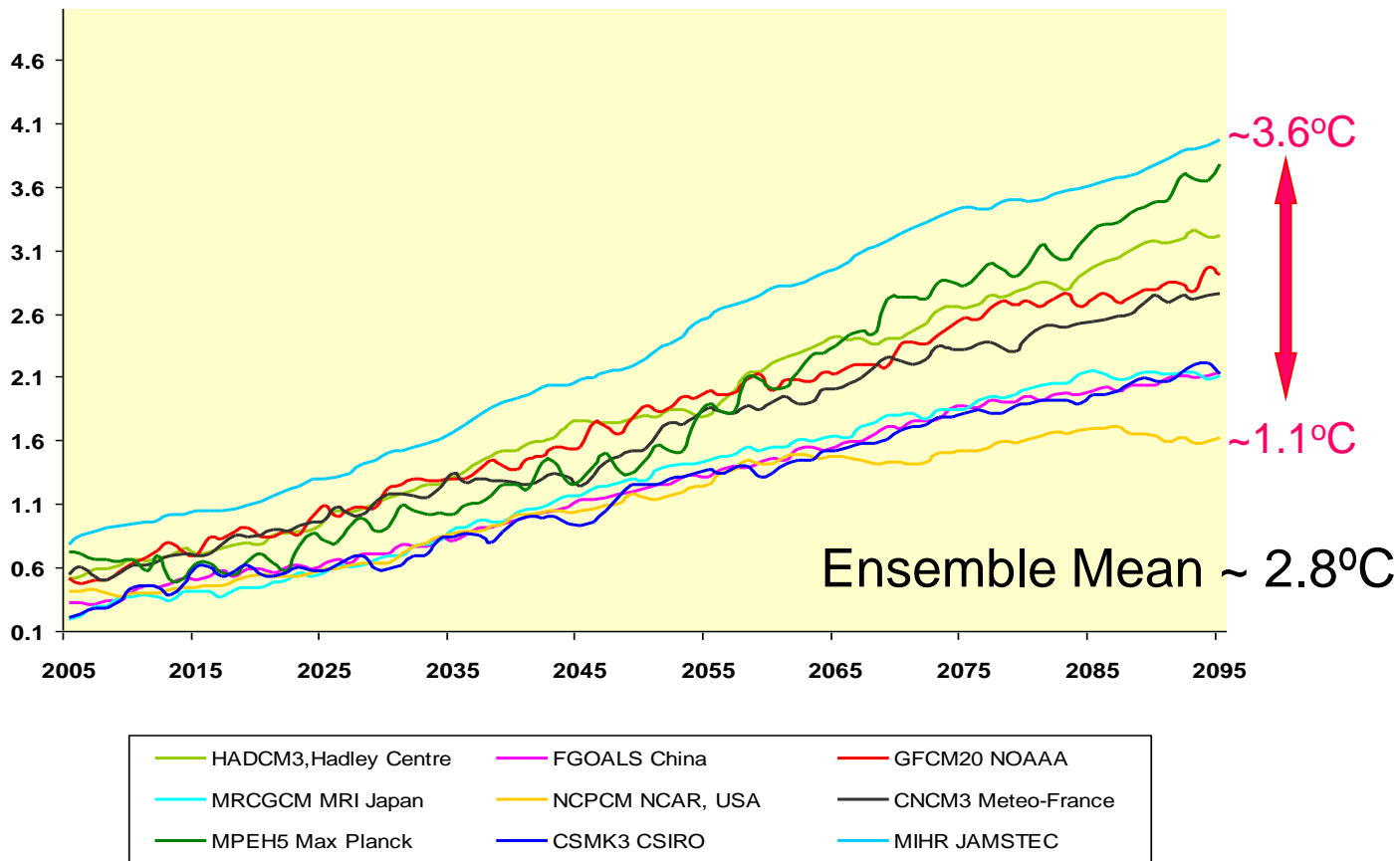


Long Term Mean Rainfall for **Sep-Oct-Nov**

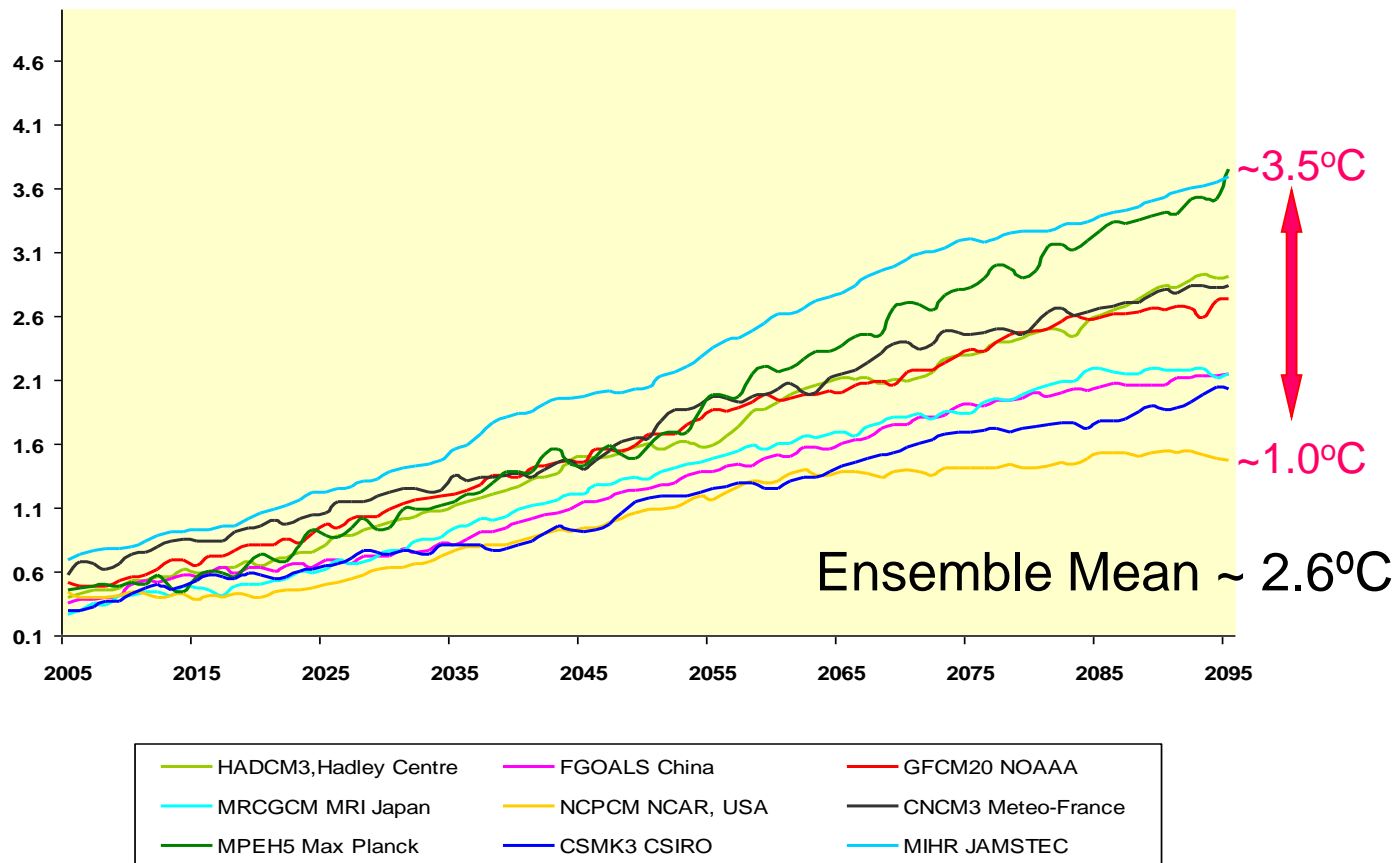
Simulations of Malaysian Climate



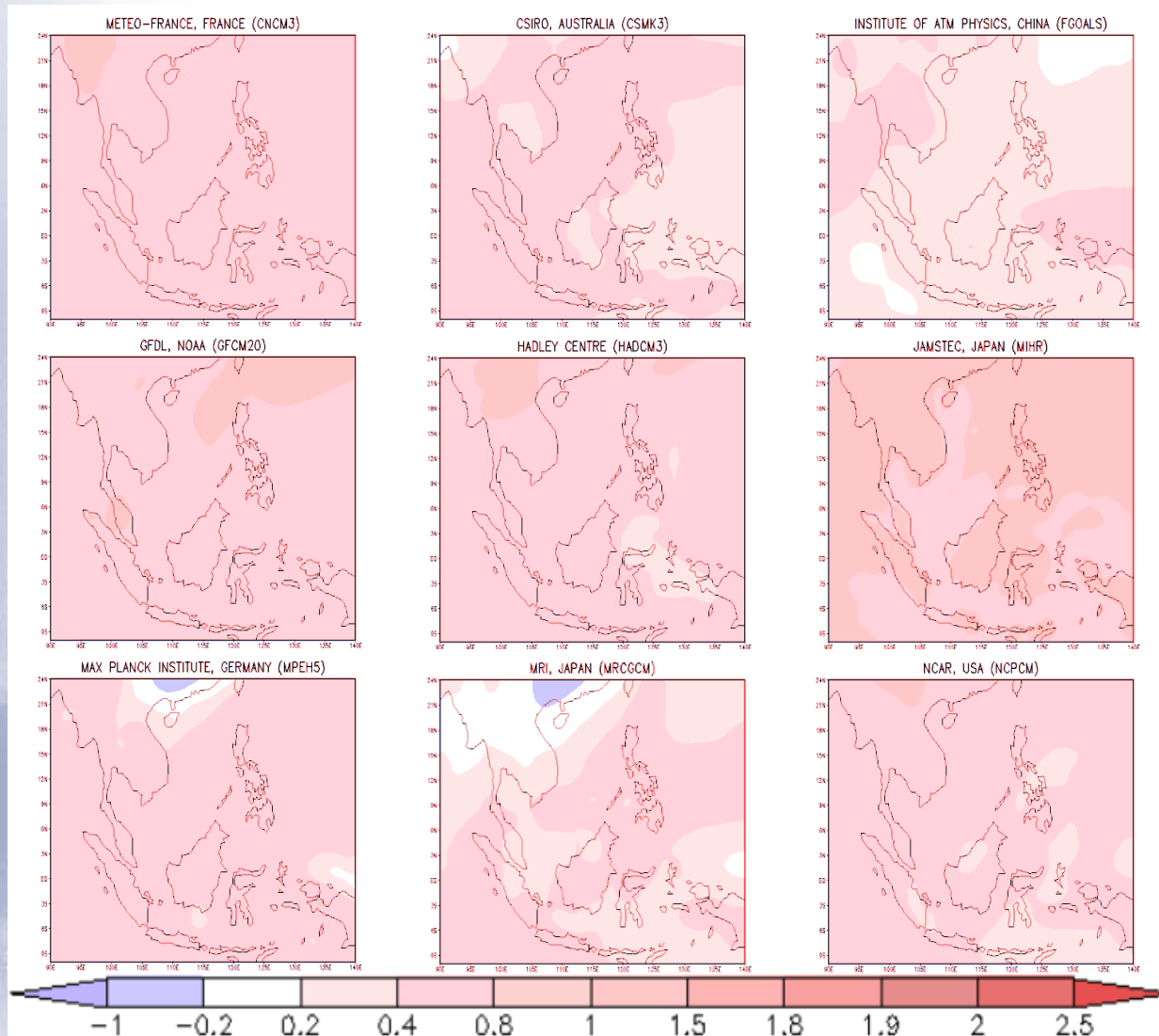
Model Domains for Malaysia



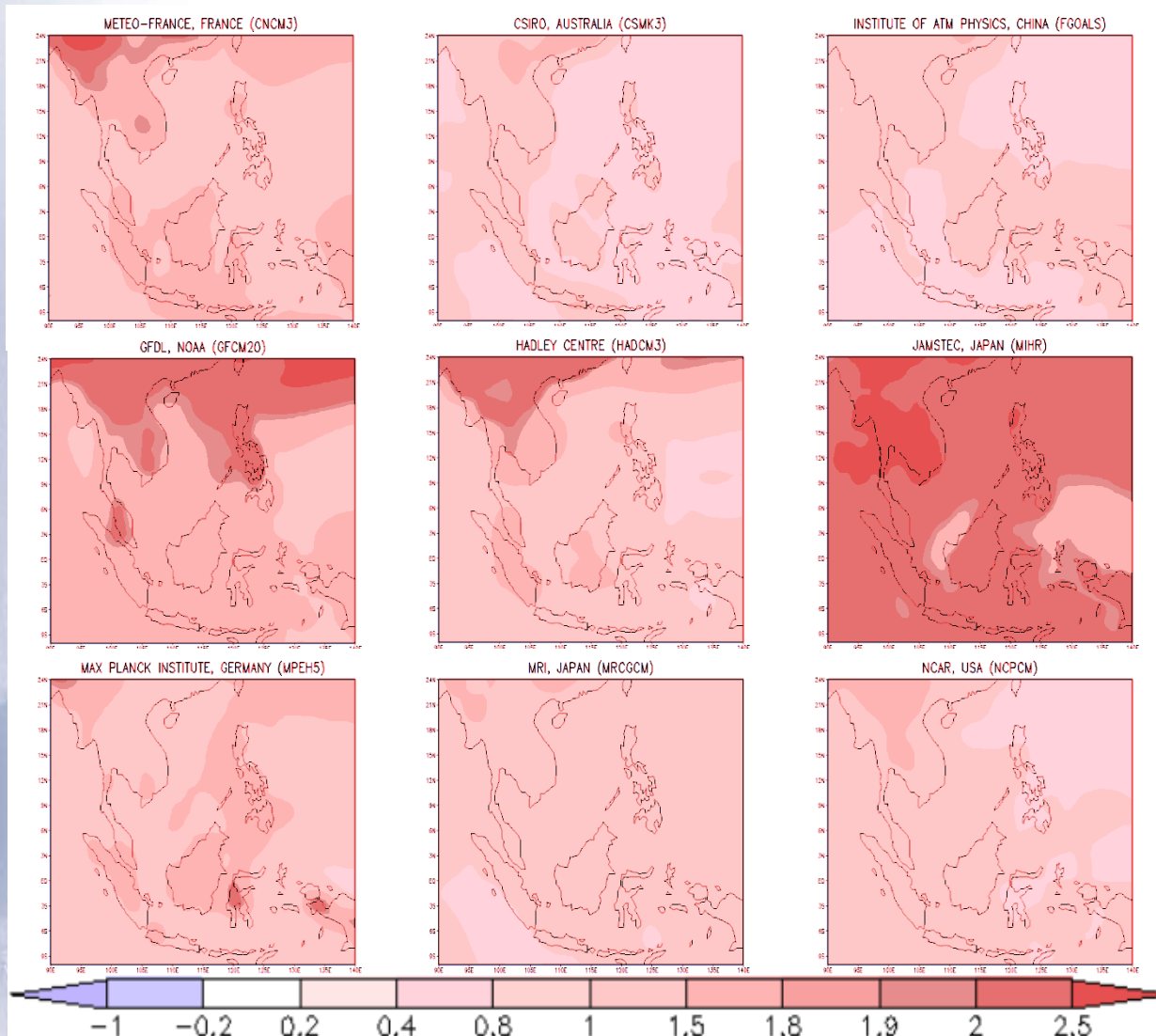
Projected Temperature Change ($^{\circ}\text{C}$) Relative to the 1961-1990 Baseline for Peninsular Malaysia Based on SRES A1B Scenario of Nine AOGCMs



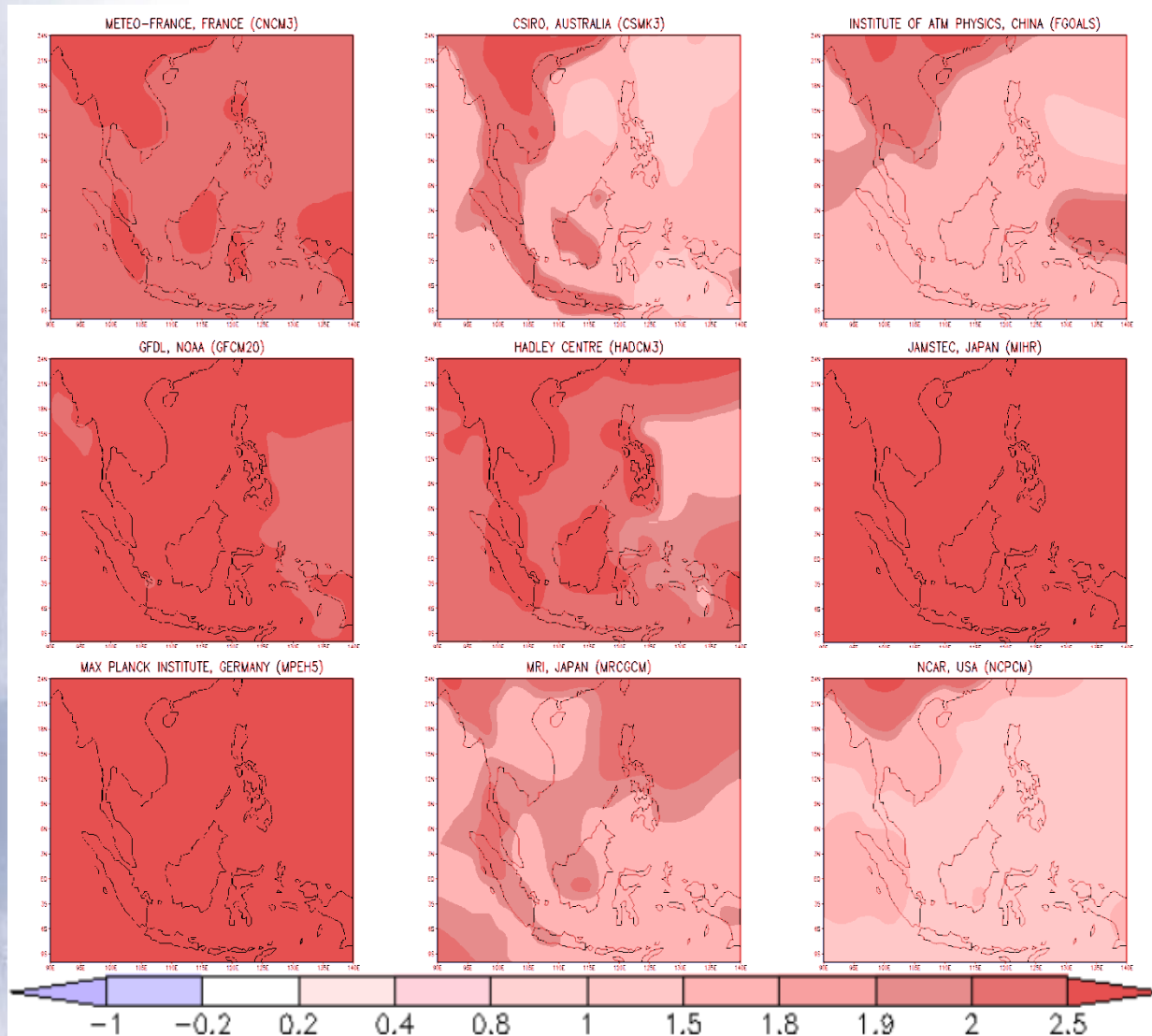
Projected Temperature Change (°C) Relative to the 1961-1990 Baseline for Sarawak and Sabah Based on SRES A1B Scenario of Nine AOGCMs



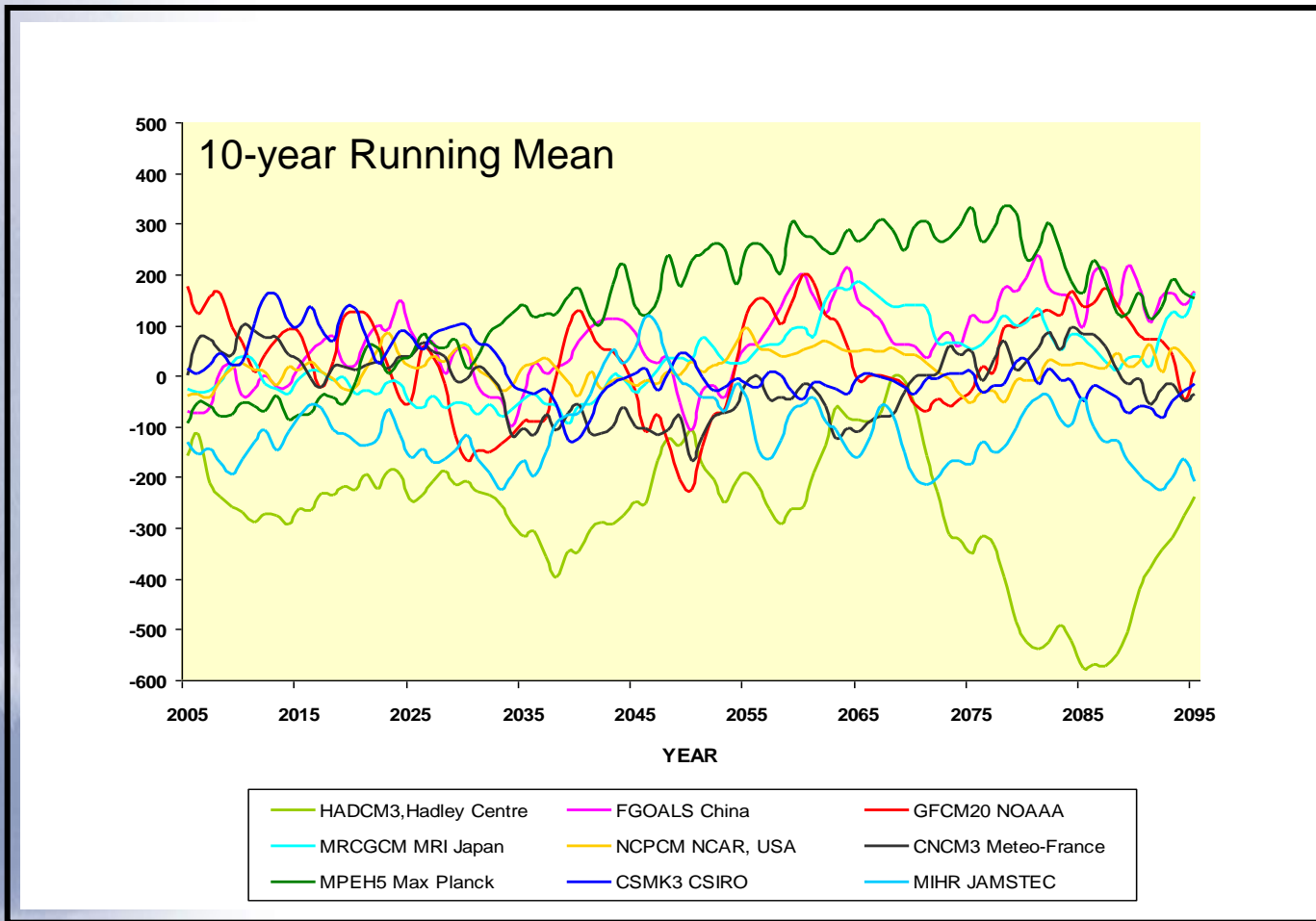
Projected Temperature Change ($^{\circ}\text{C}$) for the Period
2020 – 2029



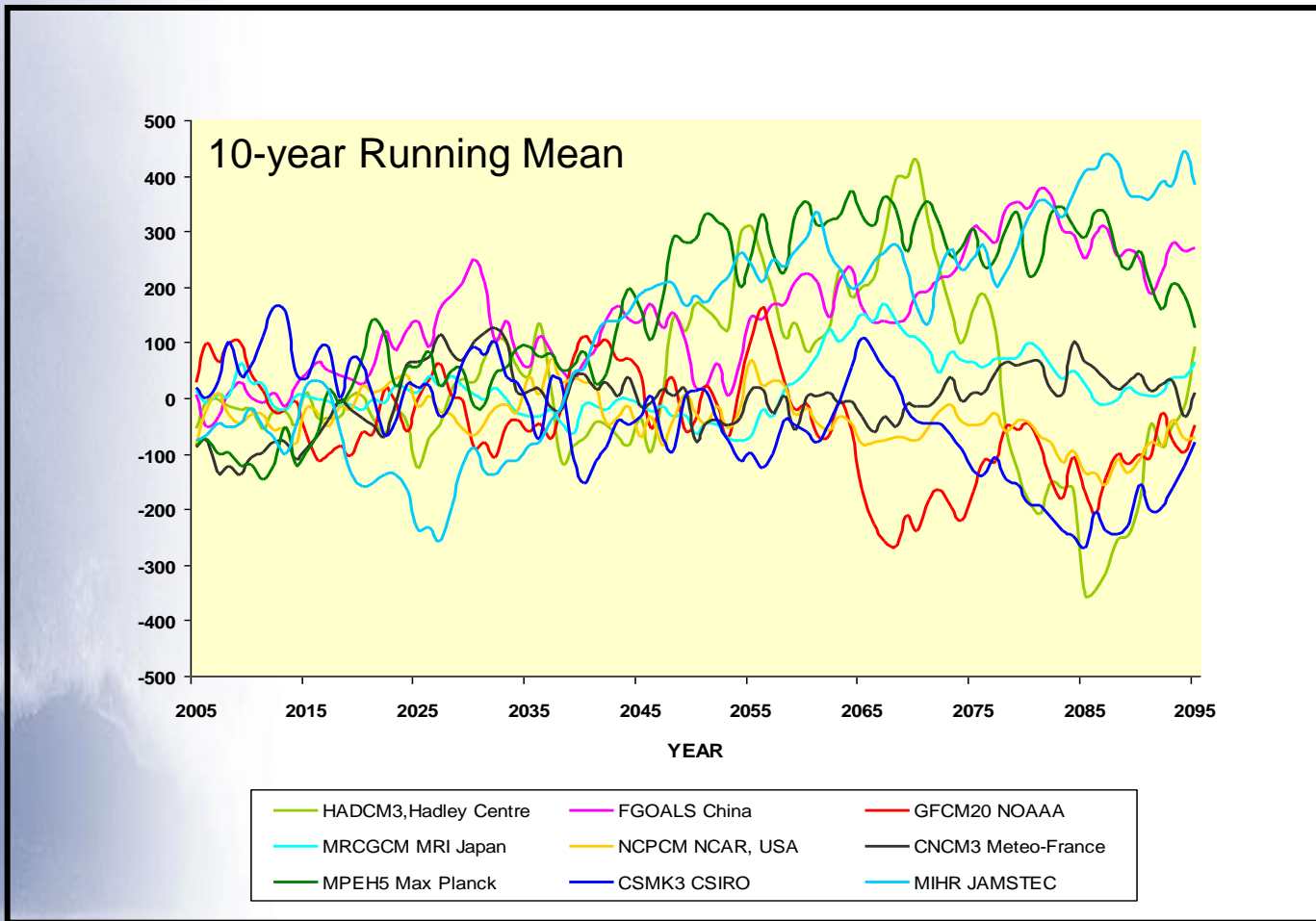
Projected Temperature Change ($^{\circ}\text{C}$) for the Period
2050 – 2059



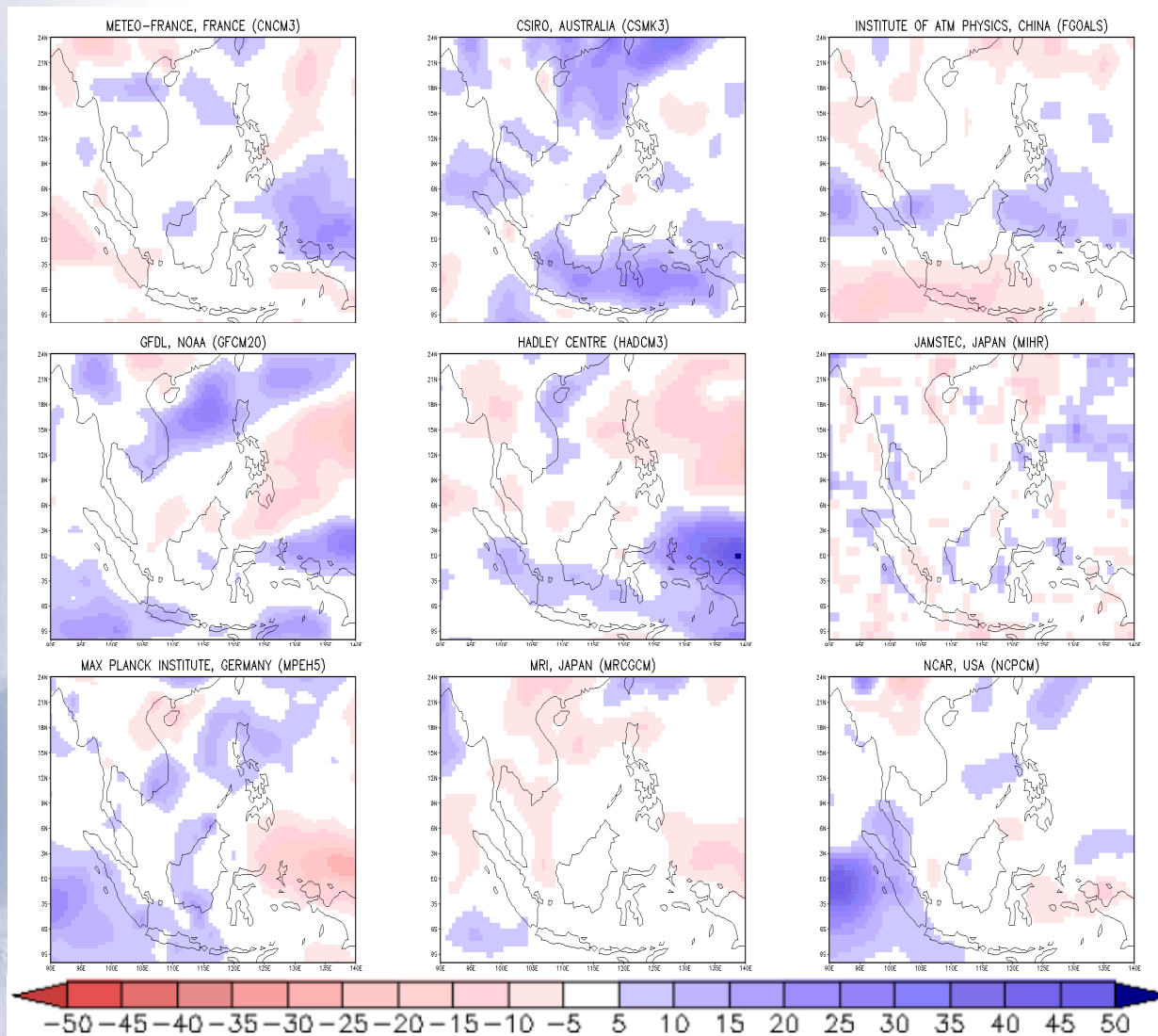
Projected Temperature Change (°C) for the Period 2090 – 2099



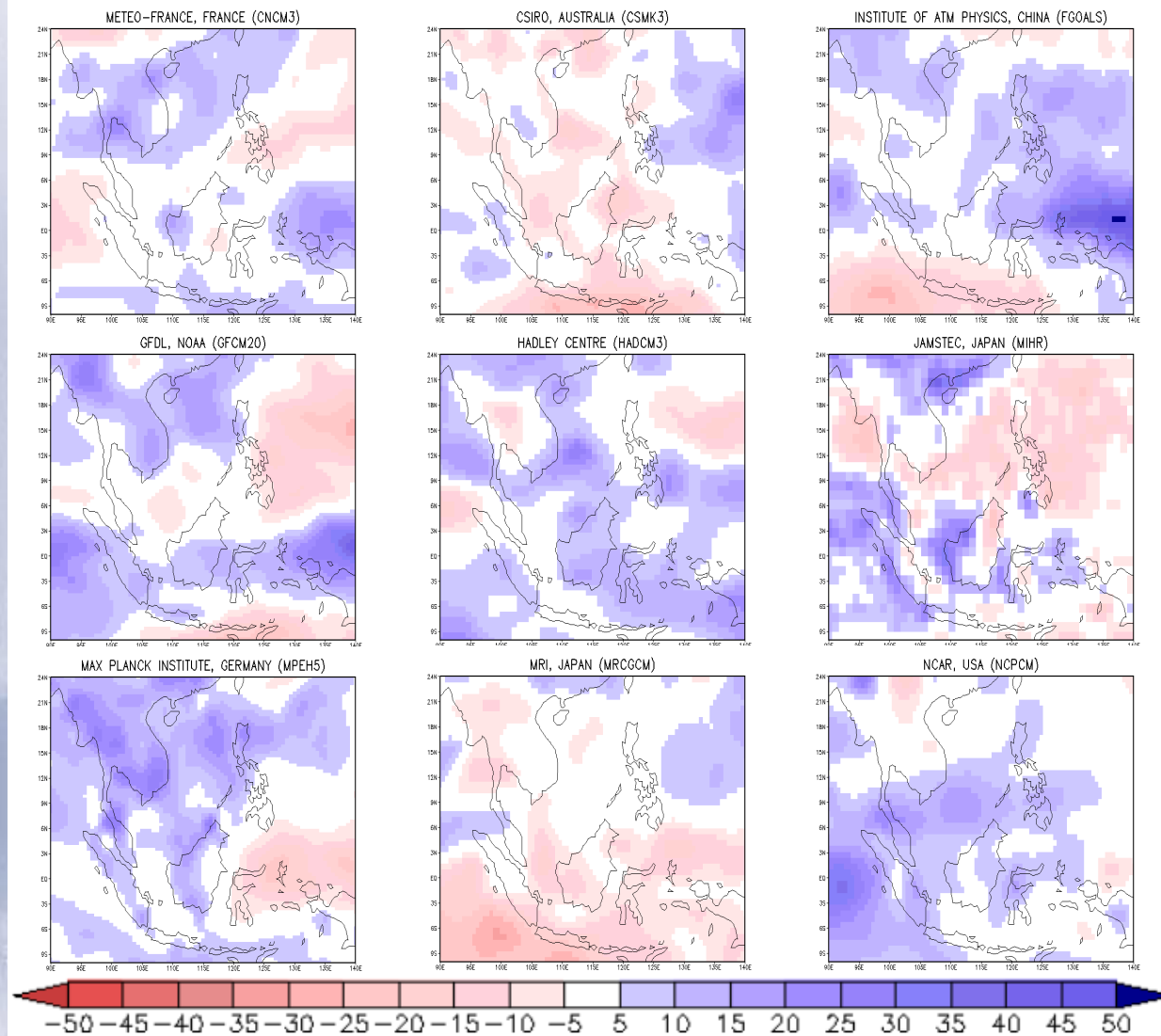
Projected Rainfall Change (mm) Relative to the 1961-1990 Baseline for Peninsular Malaysia Based on SRES A1B Scenario of Nine AOGCMs



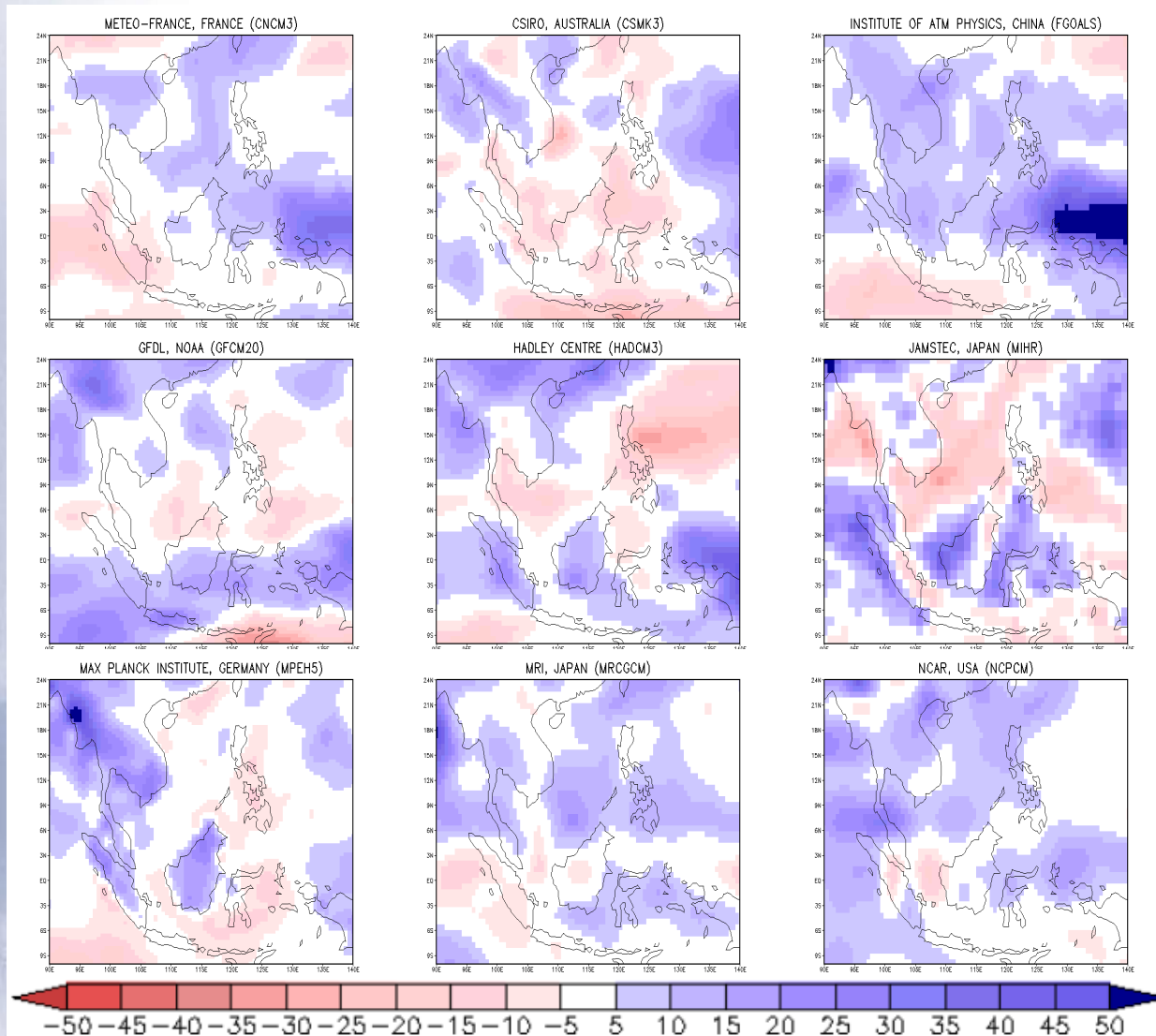
Projected Rainfall Change (mm) Relative to the 1961-1990 Baseline for Sarawak and Sabah Based on SRES A1B Scenario of Nine AOGCMs



Projected Rainfall Change (%) for the Period 2020 – 2029



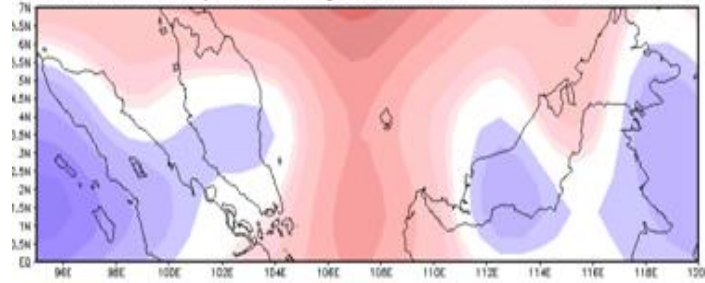
Projected Rainfall Change (%) for the Period 2050 – 2059



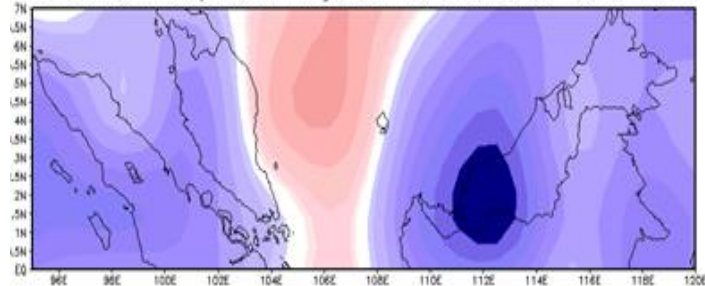
Projected Rainfall Change (%) for the Period
2090 – 2099



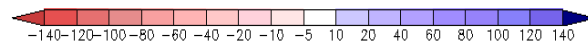
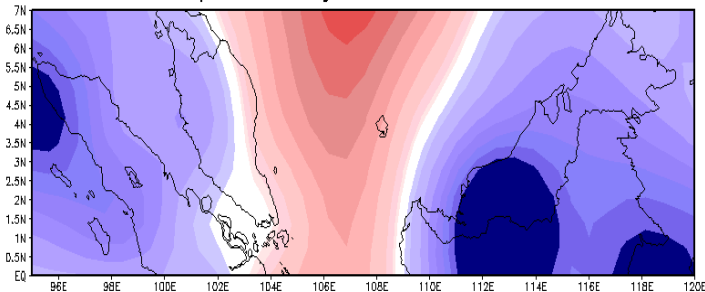
Ensemble Precipitation Projection for the Period 2020–2029



Ensemble Precipitation Projection for the Period 2050–2059

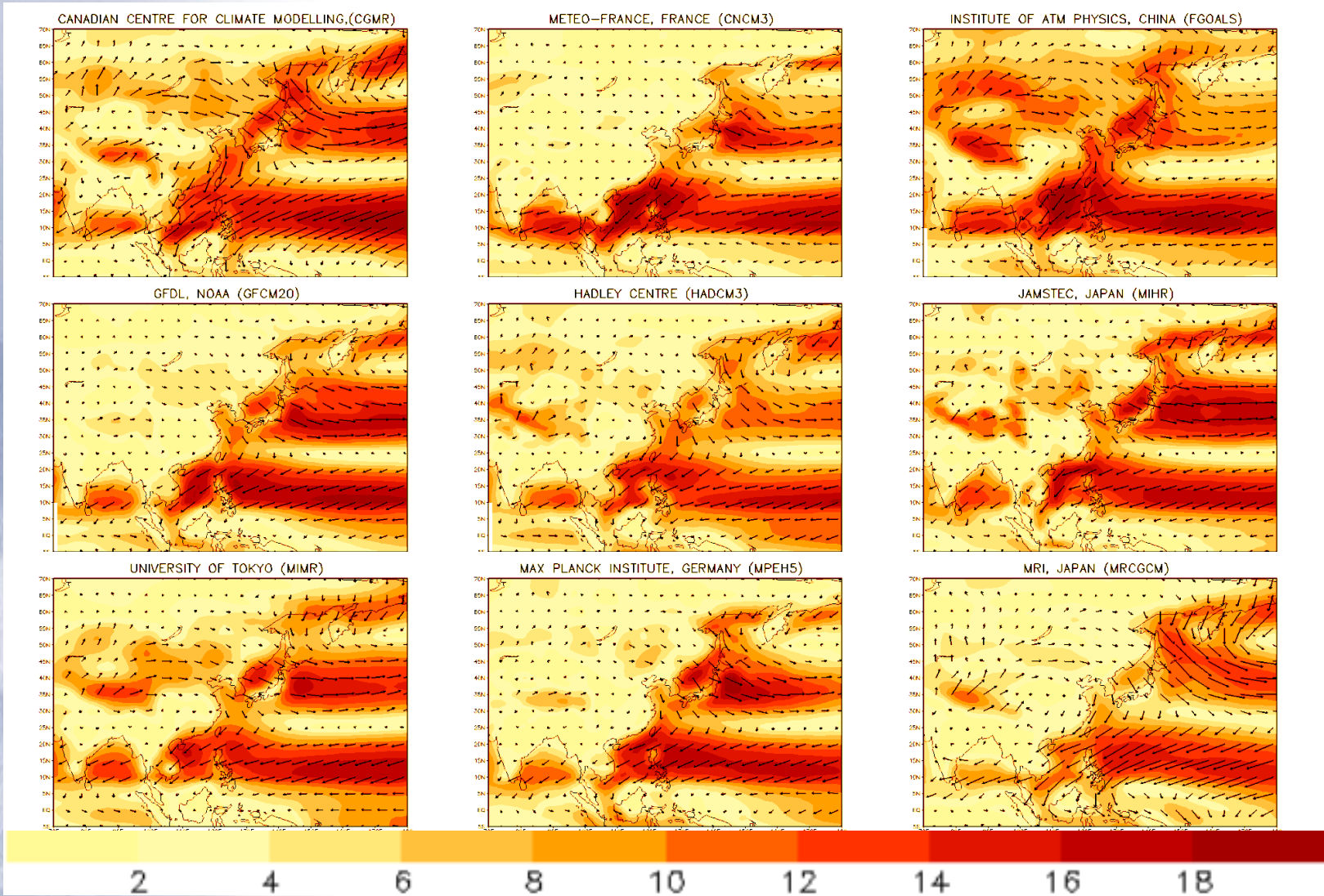


Ensemble Precipitation Projection for the Period 2090–2099

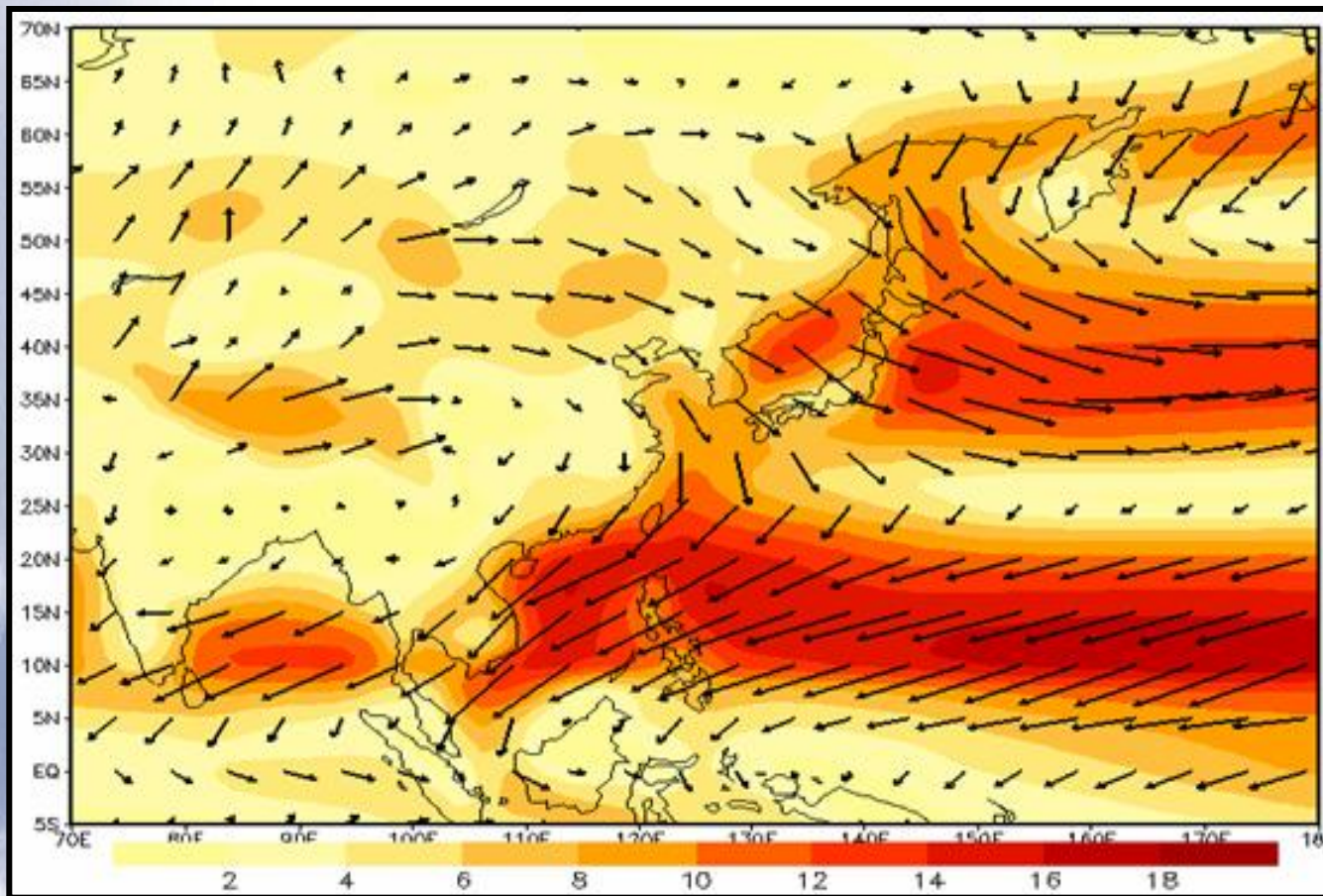


Projected Ensemble Rainfall Change (mm)

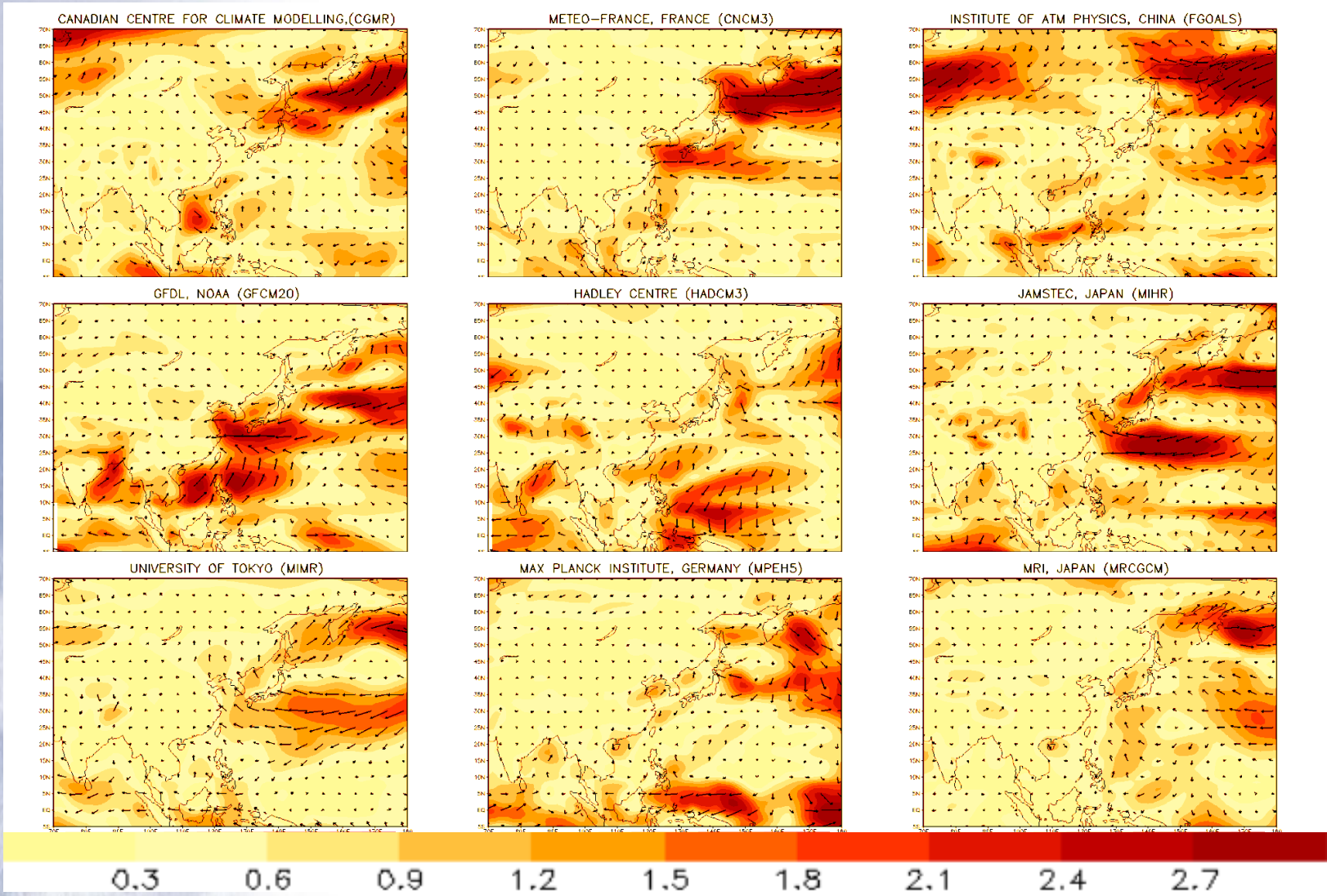
Asian Winter Monsoon Simulations



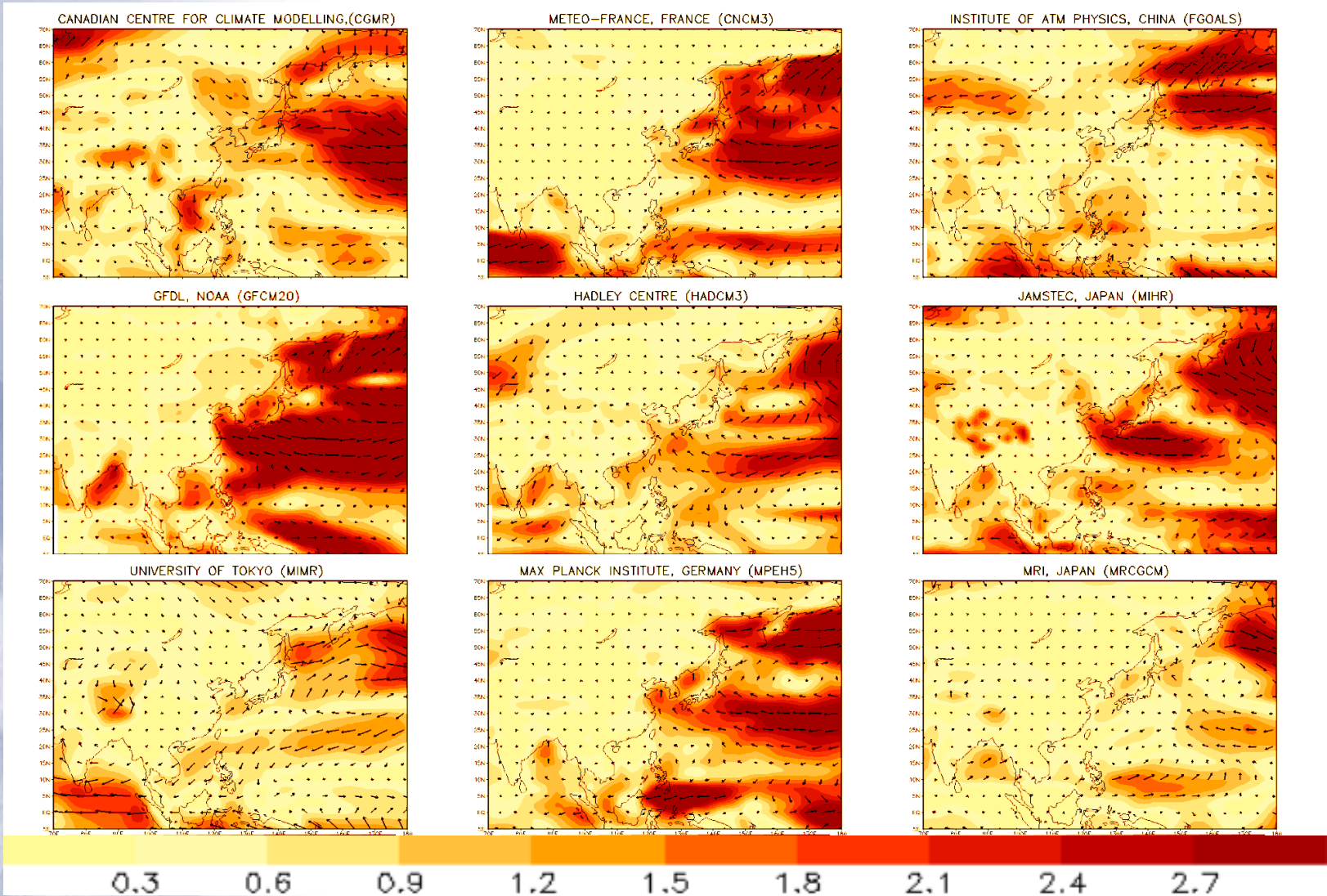
Winter Monsoon (DJF) 850hPa Mean Winds (ms^{-1}) for the Period 1961 – 1990



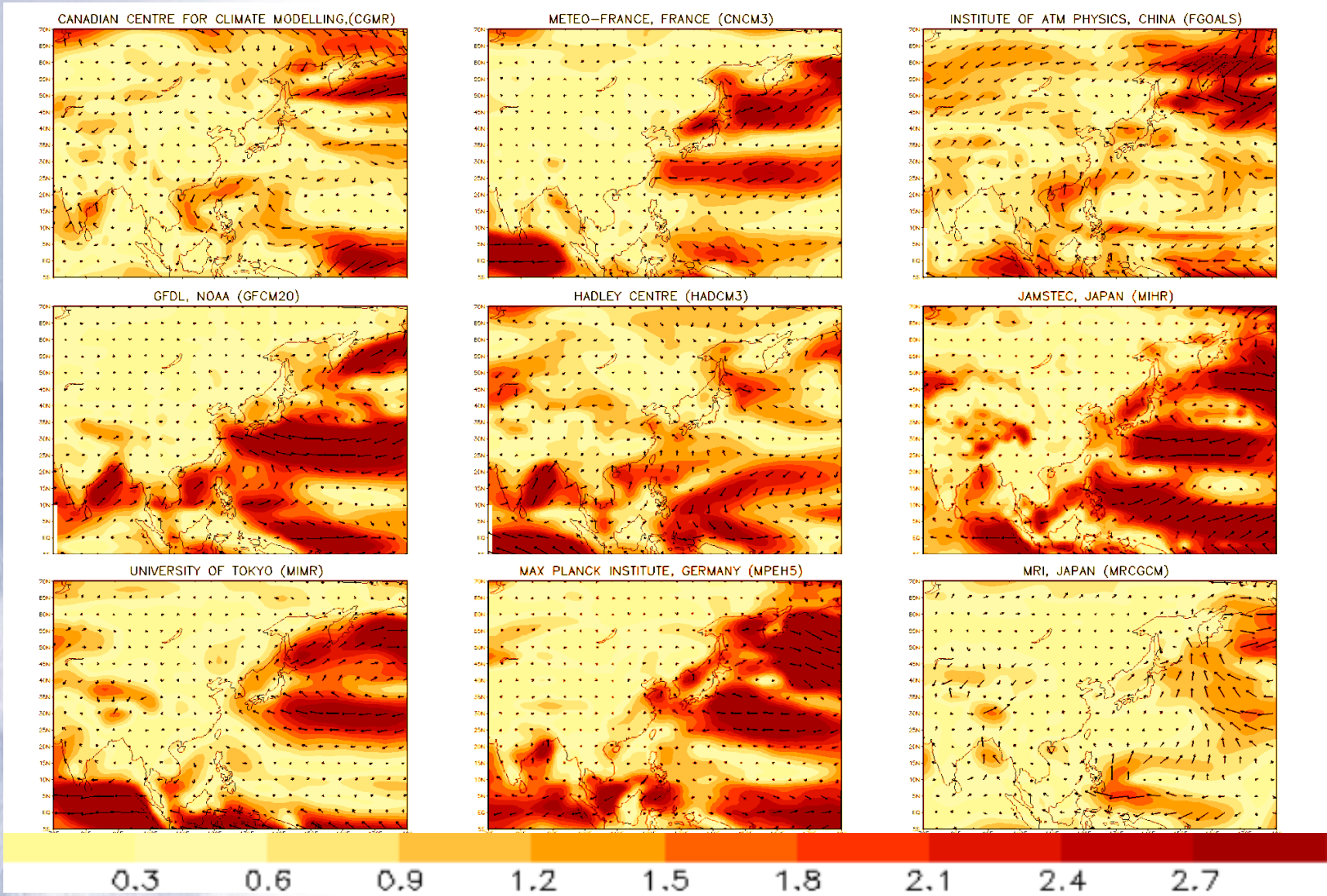
Winter Monsoon (DJF) 850hPa Ensemble Mean Winds
(ms^{-1}) for the Period 1961 – 1990



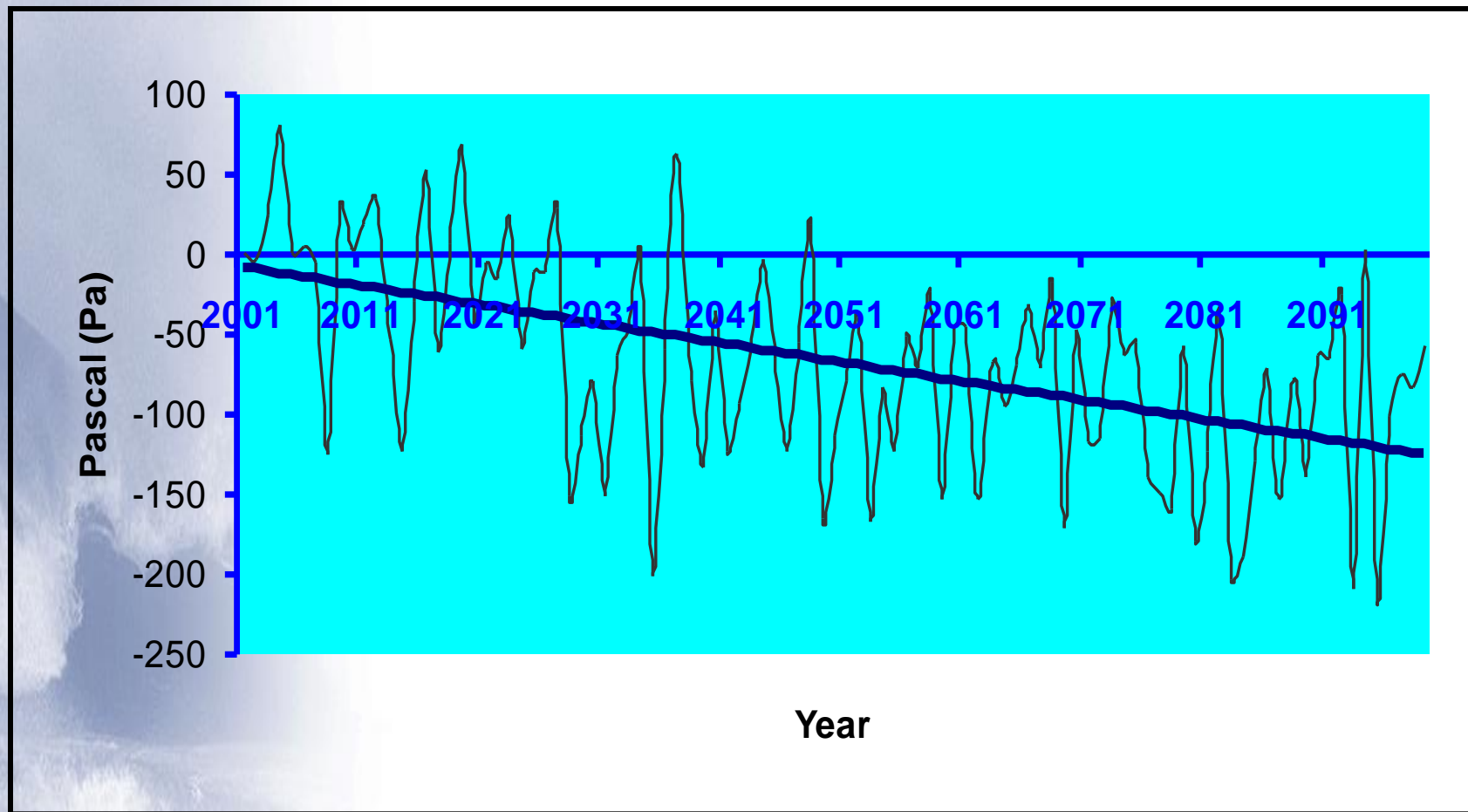
Projected DJF 850hPa Winds (ms^{-1}) for the Period 2020 – 2029



Projected DJF 850hPa Winds (ms⁻¹) for the Period 2050 – 2059

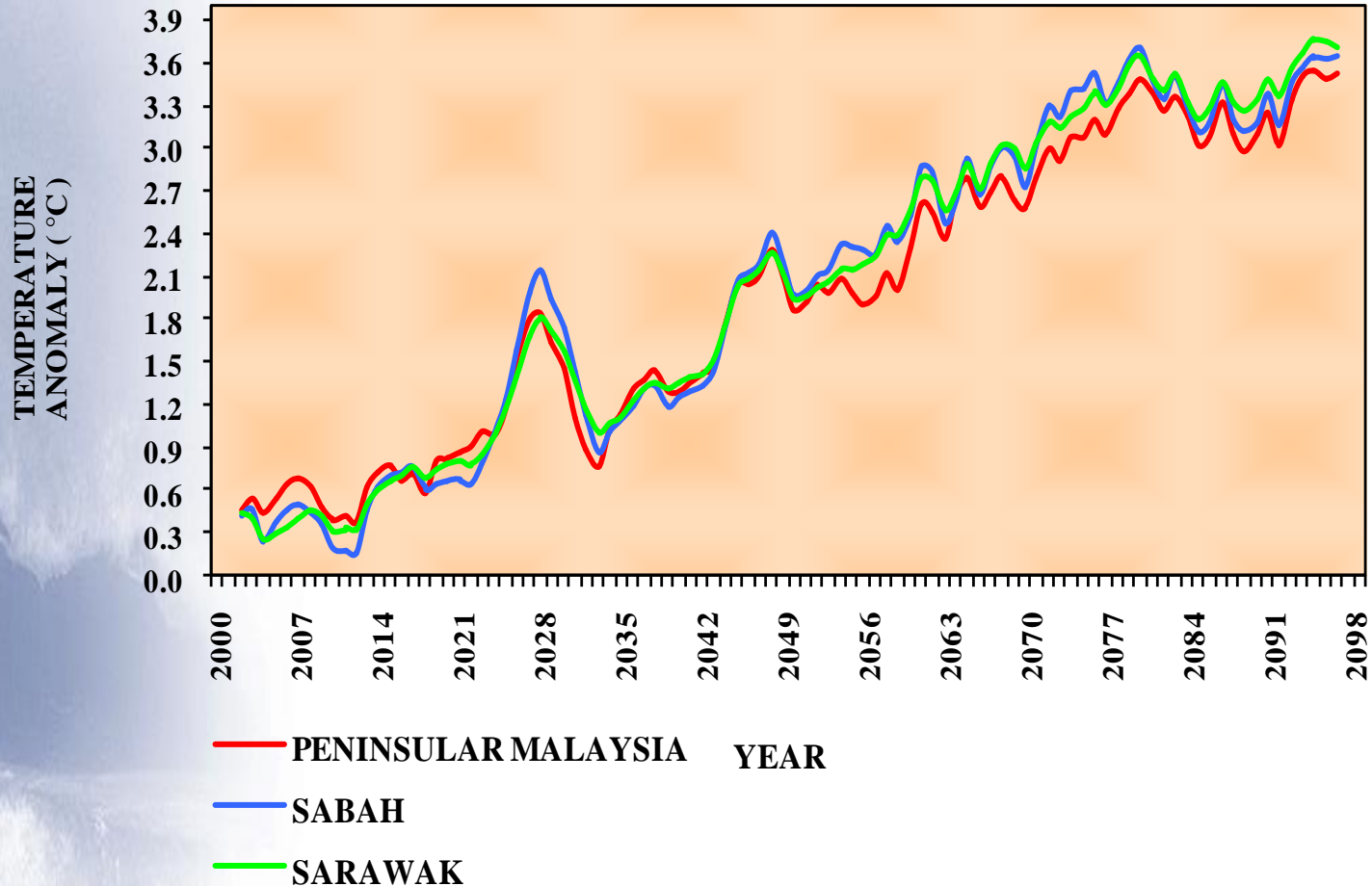


Projected DJF 850hPa Winds (ms^{-1}) for the Period 2090 – 2099



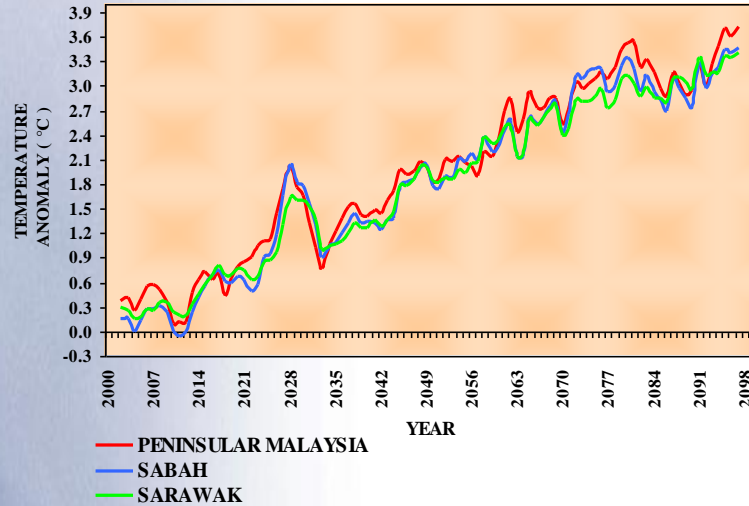
Ensemble Projection of Winter Monsoon Index

MALAYSIA - TEMPERATURE ANOMALY

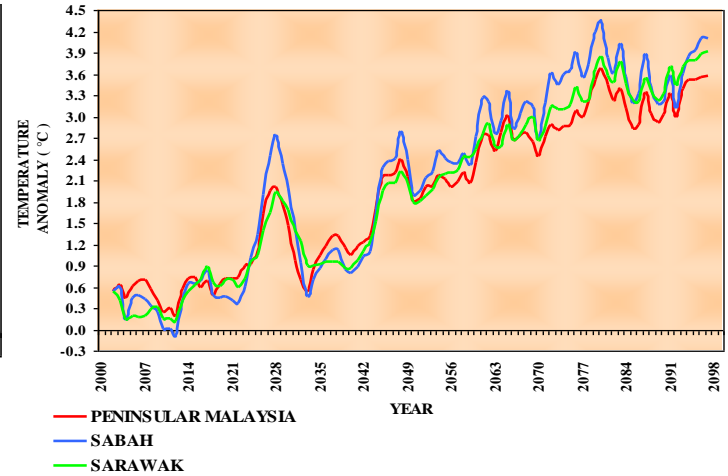


Annual Temperature Anomaly Simulated by PRECIS
(Providing Regional Climates for Impacts Studies)

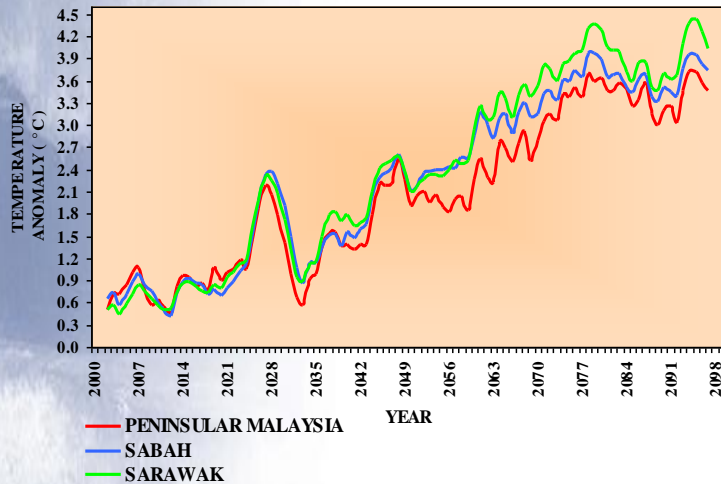
MALAYSIA - DJF TEMPERATURE ANOMALY



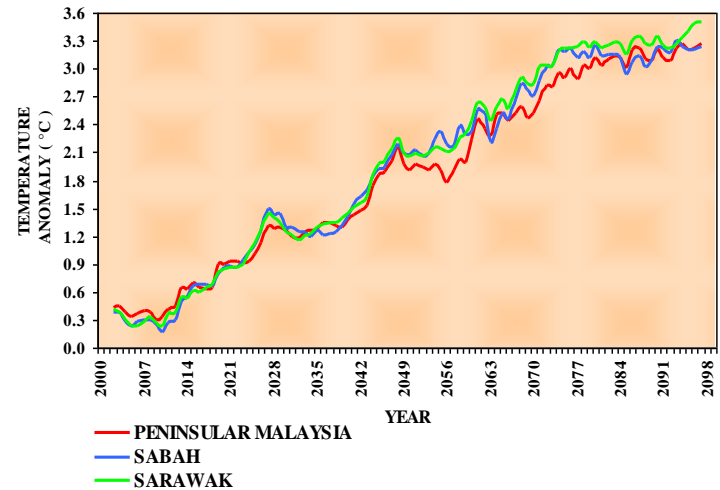
MALAYSIA - MAM TEMPERATURE ANOMALY



MALAYSIA - JJA TEMPERATURE ANOMALY

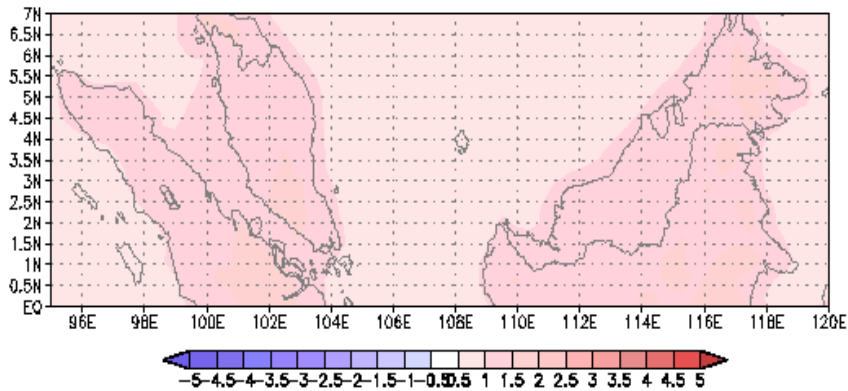


MALAYSIA - SON TEMPERATURE ANOMALY

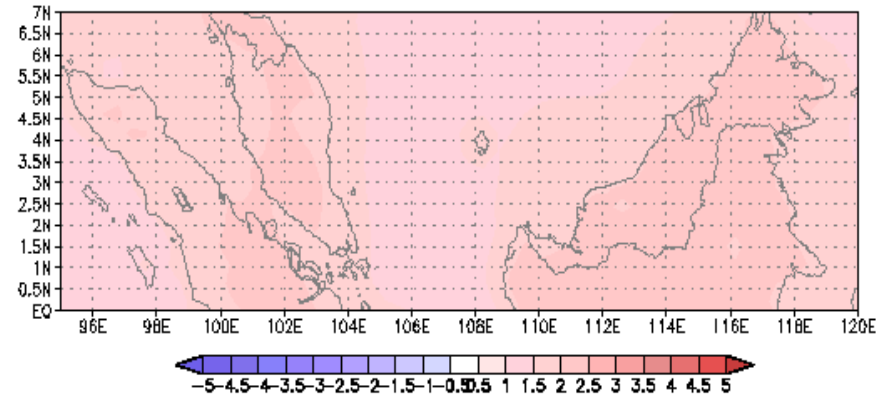


Seasonal Temperature Anomaly Simulated by PRECIS

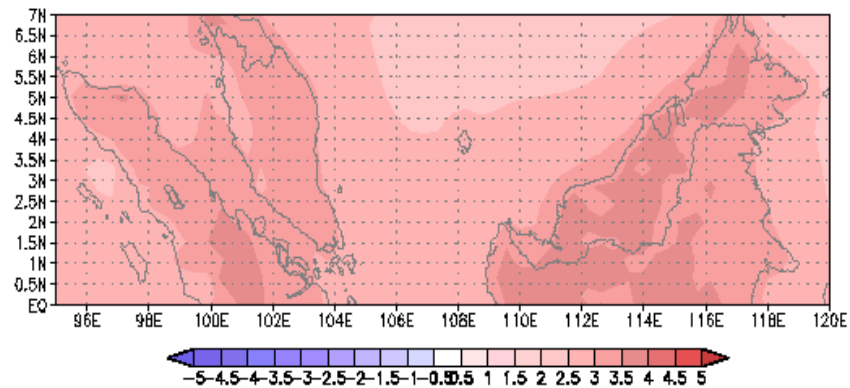
A1B ANNUAL Temperature Anomaly (deg. C) 2020–2029



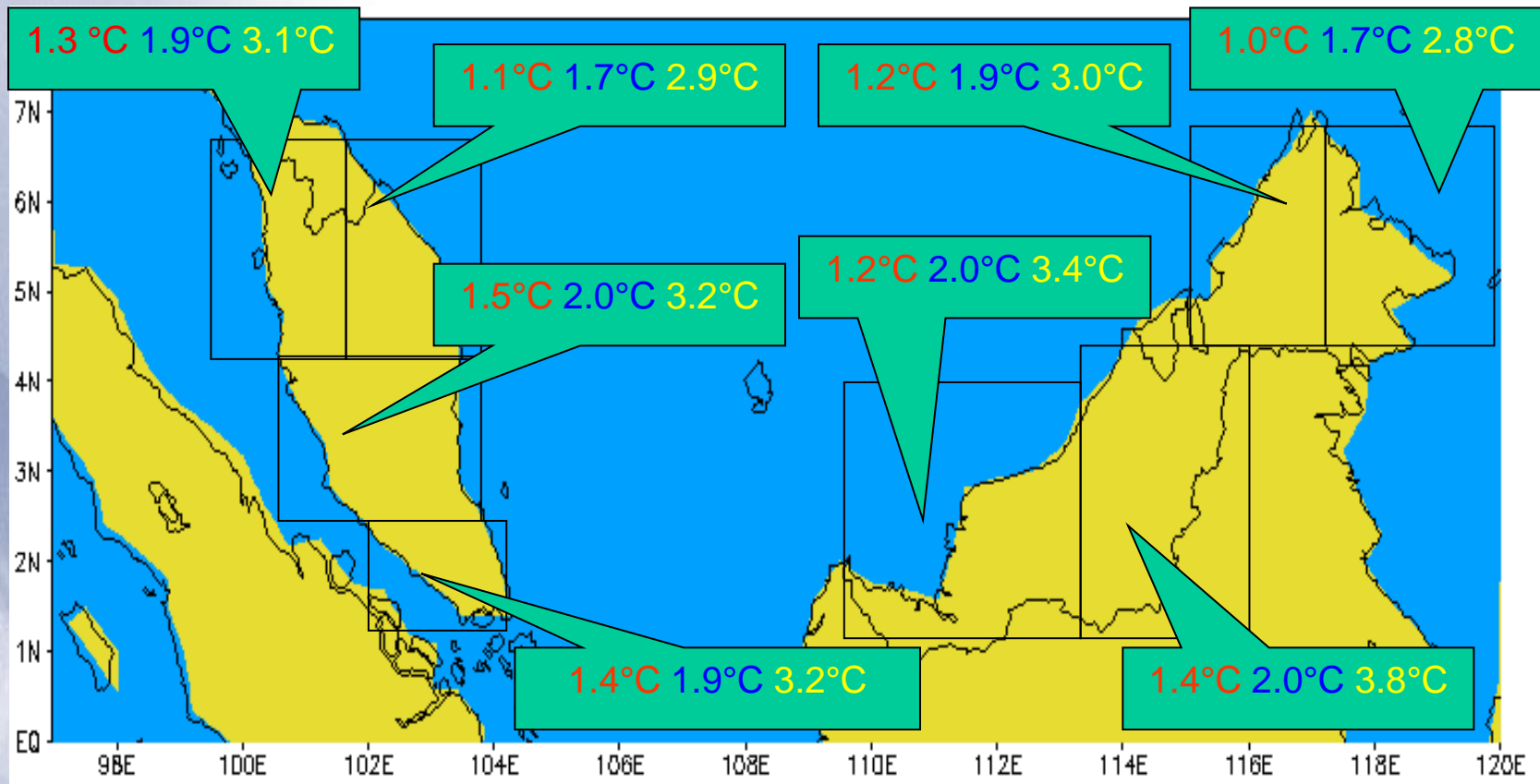
A1B ANNUAL Temperature Anomaly (deg. C) 2050–2059



A1B ANNUAL Temperature Anomaly (deg. C) 2090–2099



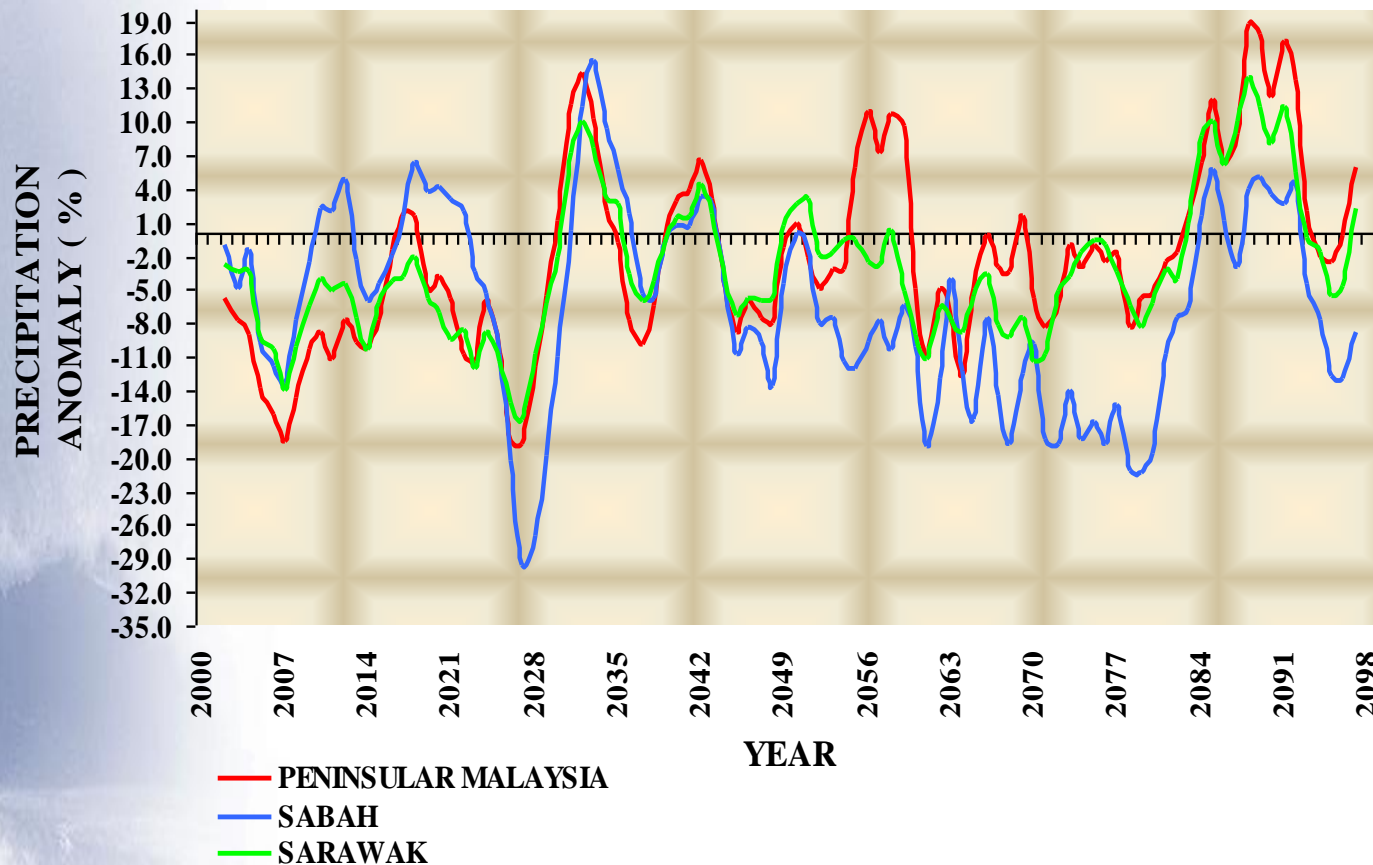
Projected Annual Mean Temperature Anomaly
Relative to 1990 – 1999



2020 - 2029
 2050 - 2059
 2090 - 2099

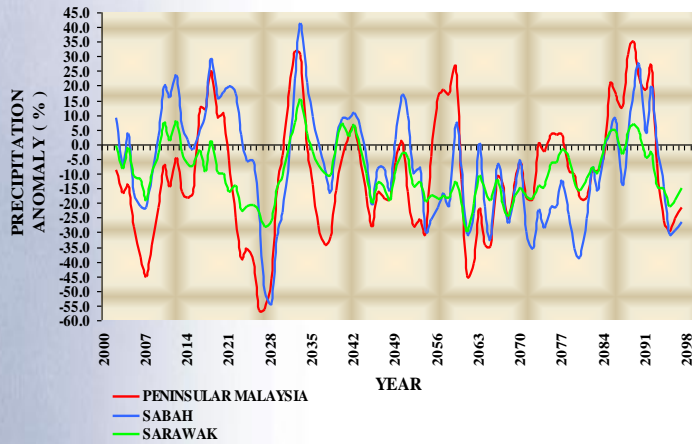
Projected Annual Mean Temperature Anomaly
Relative to 1990 – 1999

MALAYSIA - PRECIPITATION ANOMALY

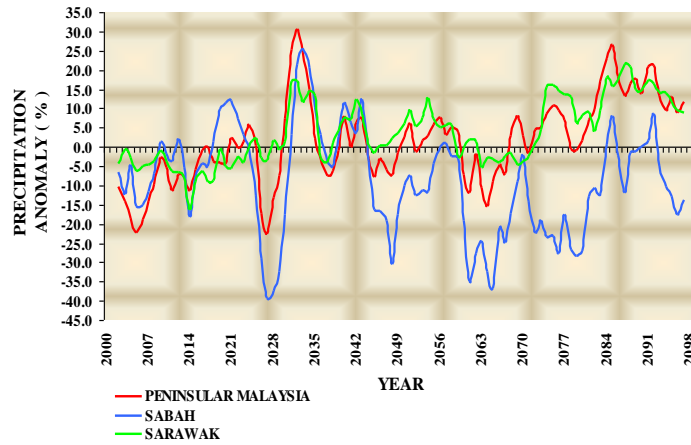


Annual Rainfall Anomaly Simulated by PRECIS

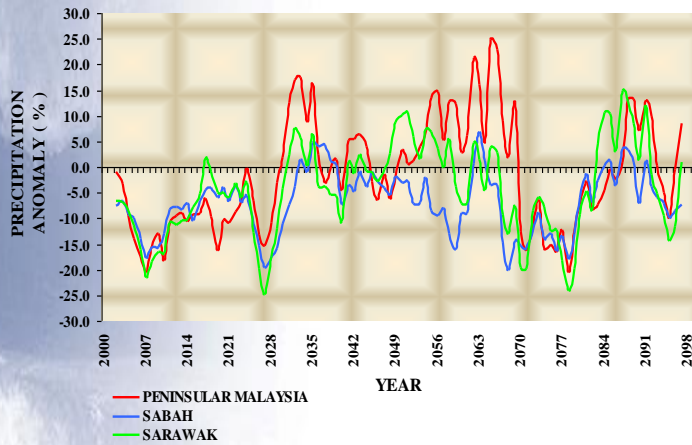
MALAYSIA - DJF PRECIPITATION ANOMALY



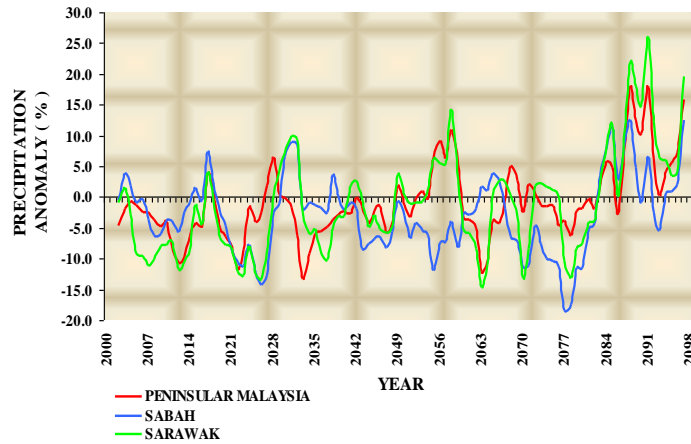
MALAYSIA - MAM PRECIPITATION ANOMALY



MALAYSIA - JJA PRECIPITATION ANOMALY

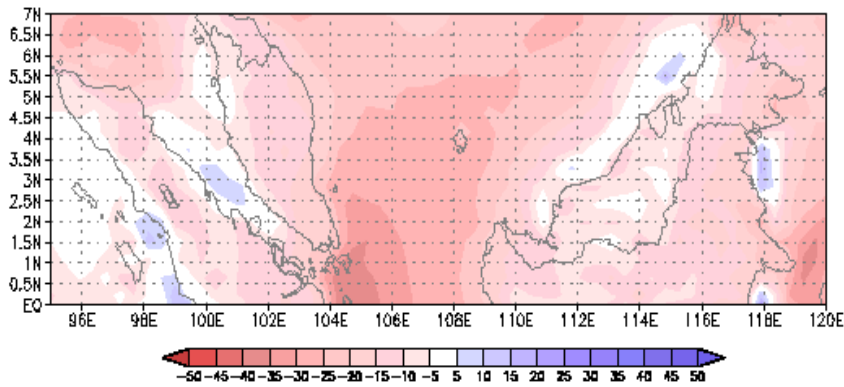


MALAYSIA - SON PRECIPITATION ANOMALY

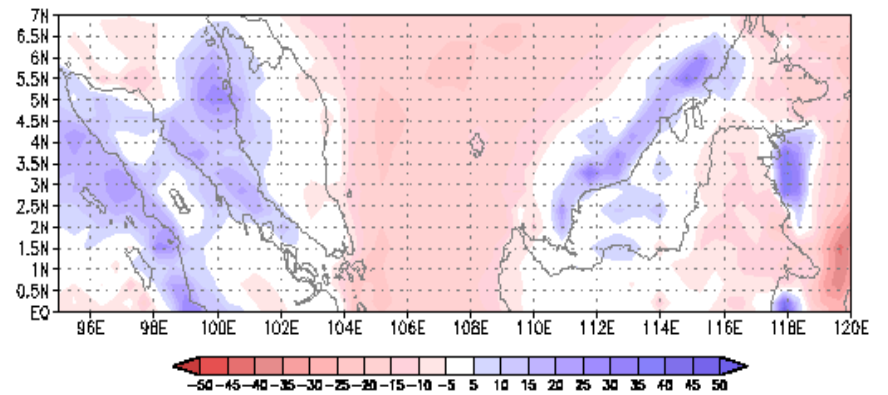


Seasonal Rainfall Anomaly Simulated by PRECIS

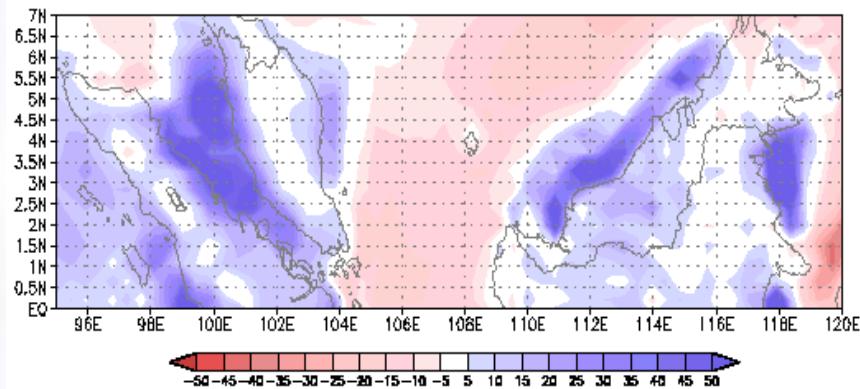
A1B ANNUAL Precipitation Anomaly 2020–2029



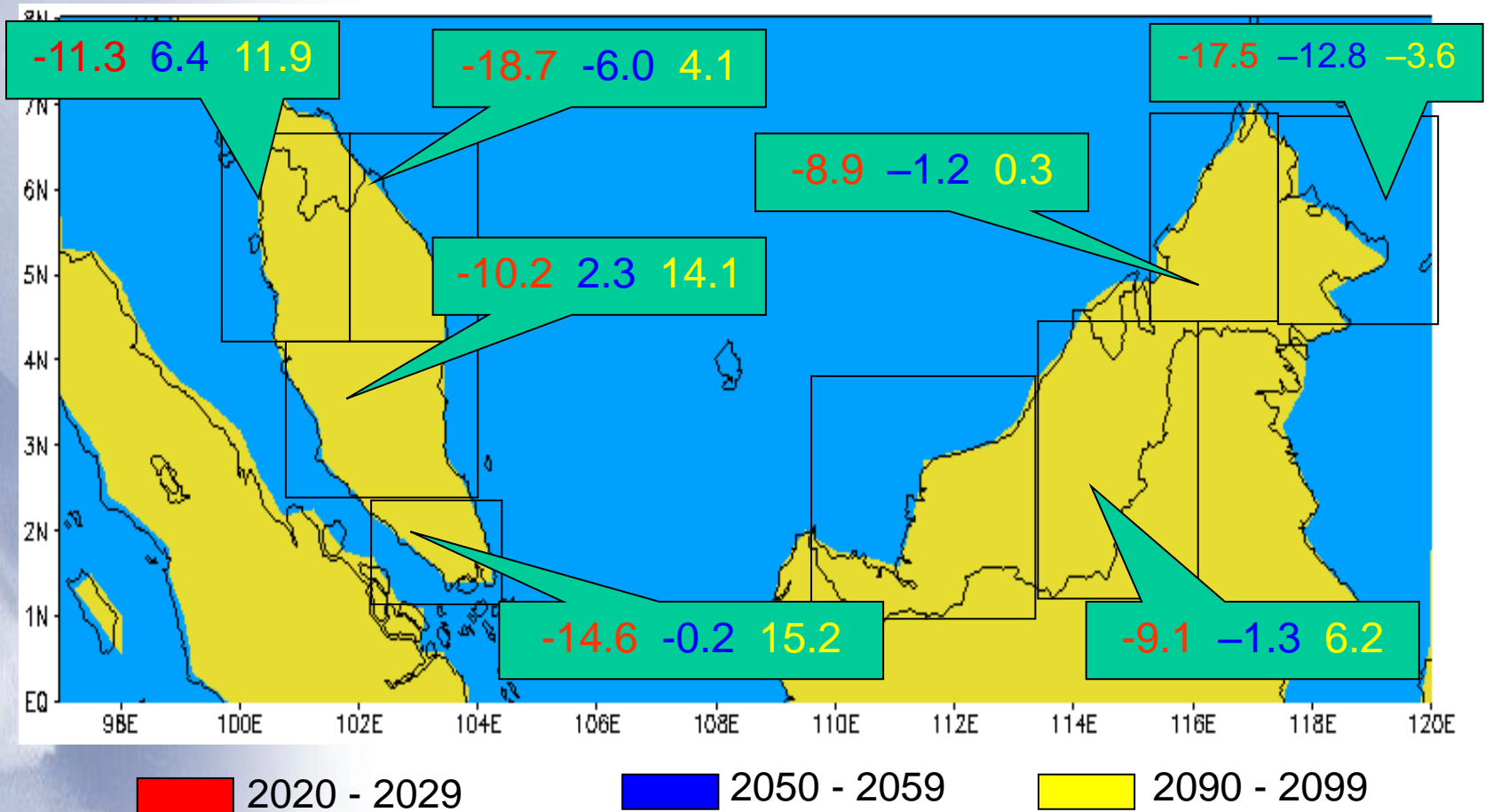
A1B ANNUAL Precipitation Anomaly 2050–2059



A1B ANNUAL Precipitation Anomaly 2090–2099



Projected Annual Mean Rainfall Anomaly Relative to 1990 – 1999



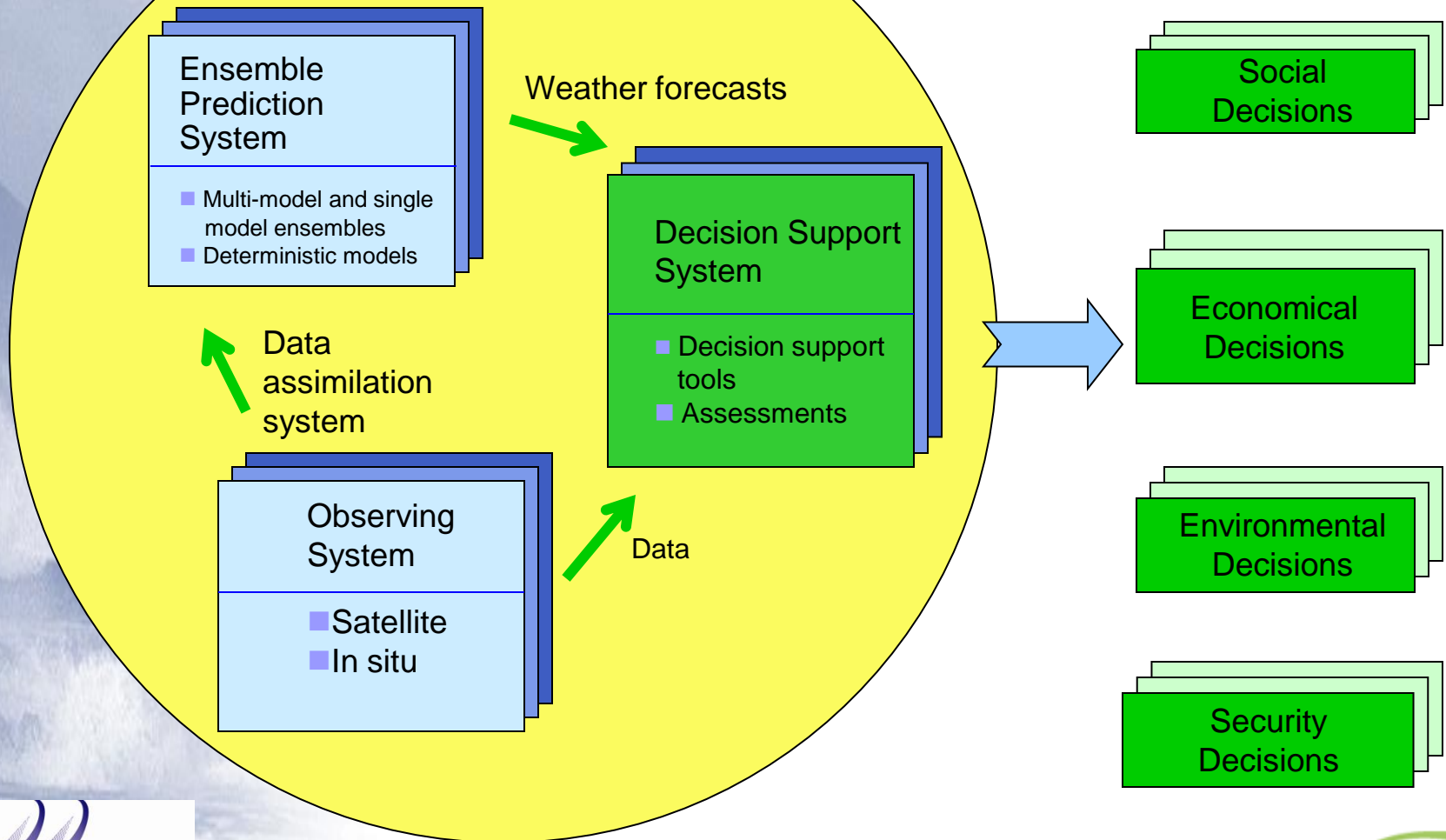
Projected Annual Mean Rainfall Anomaly (%)
Relative to 1990 – 1999

	2020-2029		2050-2059		2050
	Nine Global AOGCMs	MMD Regional (PRECIS)	Nine Global AOGCMs	MMD Regional (PRECIS)	NAHRIM Regional (RegHCM-PM)
Surface Temperature Change (°C)	0.5 – 1.5	1.1 – 1.5	1.5 – 2.0	1.7 – 2.0	1.5
Annual Rainfall (% Change)	-5% to +25% Pen. Malaysia	-11% to -19% Pen. Malaysia	-5% to +25% Pen. Malaysia	-6% to +6% Pen. Malaysia	-5% to +10% Pen. Malaysia
	-10% to +25% Sabah	-9% to -18% Sabah	-20% to +20% Sabah	-1% to -13% Sabah	n/a
	0% to +10% Sarawak	~ -9% Sarawak	-25% to +30% Sarawak	-1% to +4% Sarawak	n/a

Comparison of Results from Ensemble AOGCMs, Regional Climate Model (PRECIS run by MMD) & Regional Climate Model (RegHCM - PM run by NAHRIM)

Decisions Making

End-to-end Forecast System Require Decision Support Tools to Enhance Applications



Risk Management

Preparedness

Prediction and
Early Warning

Mitigation

Protection

Disaster

Reconstruction

Recovery

Impact
Assessment

Recovery

Response

Crisis Management

Disaster Management

The 10th Malaysian Plan Project (2011 – 2015)

- **Implementation of monthly and seasonal (4 times a year) regional forecast model operationally by 2013**
- **Request KMA to conduct an implementation program in the field of monthly and seasonal regional forecasting at MMD**
- **Proposed to use the WRF model at the MMD or any other dynamical downscaling models used at the KMA**
 - **Long range global forecast obtained from either the Global Data Assimilation and Prediction System (GDAPS) or the Global Climate Prediction System (GCPS) which are operational global spectral models at KMA**
- **Past 2 years, 2 officers trained at the NWP division of KMA in the areas of WRF fundamentals and data assimilation processes for three weeks each**

Conclusion

- As the world is facing growing challenges posed by environmental changes which will be with us through the 21st century, climate prediction and information are crucial, not only for Malaysia, but all member economies, for their decision- and policy-makers to come out with solutions in adapting and mitigating future threats due to natural disasters.
- Malaysia will continue to improve the capability to upgrade its climate prediction and information system, especially technological-wise and capacity development, so as to get a clearer picture of the future climate in the region.
- Increased cooperation to address common issues and enhanced international collaborations of all member economies are definitely required in order to meet the environmental challenges of the 21st century.

THANK YOU