Summary of the Science of Climate Change

The following summary is taken directly from *The Science of Climate Change: Questions and Answers* an Australian Academy of Science publication, August 2010. The publication with all references can be found on-line at www.science.org.au/policy/climatechange2012.html

The earth's climate has changed. The global average surface temperature has increased over the last century and many other associated changes have been observed. The available evidence implies that greenhouse gas emissions from human activities are the main cause. It is expected that, if greenhouse gas emissions continue at business-as usual rates, global temperatures will further increase significantly over the coming century and beyond. The science behind these statements is supported by extensive studies based on four main lines of evidence:

Physical principles established more than a century ago tell us that greenhouse gases, such as carbon dioxide (CO^2), trap heat and keep the planet warmer than it would otherwise be. Increasing greenhouse gas levels raise the temperature of the Earth's surface.

The record of the *distant* past (millions of years) tells us that we cannot take a stable climate for granted. Climate has varied greatly through the Earth's history. It has, for example, gone through the Earth's history. It has, for example, gone through 10 major ice age cycles over approximately the past million years. The past few thousand years have been unusually stable. Together with our understanding of physical principles, evidence from the past shows that climate can be sensitive to small external influences.

Measurements from the *recent* past (the last 100 years) tell us that the Earth's surface is warming along with rising levels of greenhouse gases form human activities, and that this warming is leading to other environmental changes. Although climate varies from year to year and decade to decade, the overall upward trend of average global temperature over the last century is clear.

Climate models, together with physical principles and knowledge of past variations, tell us that, unless greenhouse gas emission are reduced and greenhouse gas emissions are reduced and greenhouse gas concentrations in the atmosphere are stabilised, global warming will continue.

Climate models estimate that, by 2100, the average global temperature will be between 2°C and 7°C higher than pre-industrial temperatures, depending on future greenhouse gas emissions and on the ways that models represent the sensitivity of climate to small disturbances. Models also estimate that this climate change will continue well after 2100.

A 2°C global warming would lead to a significantly different world from the one we now inhabit. Likely consequences would include more heat waves, fewer cold spells, changes to rainfall patterns and a higher global average rainfall, higher plant productivity in some places but decreases in others, disturbances to marine and terrestrial ecosystems and biodiversity, disruption to food production in some regions, rising sea levels, and decreases in Arctic ice cover. While aspects of these changes may be beneficial in some regions, the overall impacts are likely to be negative under the present structure of global society.

A warming of 7°C would greatly transform the world from the one we now inhabit, with all of the above impacts being very much larger. Such a large and rapid change in climate would likely be beyond the adaptive capacity of many societies and species.

There are uncertainties in climate science. For example, a precise value cannot be given for the likely range of warming because of uncertainties in climate sensitivity to small

disturbances, although climate models and evidence from past climate change provide a plausible range of values. Climate changes over small regions and changes in rainfall patterns are very hard to estimate. Tipping points or rapid climate transitions associated with overall global warming are possible but cannot yet be predicted with confidence. These uncertainties work in both directions: there is a chance that climate change will be less severe than the current estimates of climate science, but there is also a chance that it will be more severe.

The following is from the NASA's (National Aeronautics and Space Administration) website 'Global Climate Change' [http://climate.nasa.gov/effects/]

Global climate change has already had observable effects on the environment. Glaciers have shrunk, ice on rivers and lakes is breaking up earlier, plant and animal ranges have shifted and trees are flowering sooner.

Effects that scientists had predicted in the past would result from global climate change are now occurring: loss of sea ice, accelerated sea level rise and longer, more intense heat waves.

Scientists have high confidence that global temperatures will continue to rise for decades to come, largely due to greenhouse gasses produced by human activities. The Intergovernmental Panel on Climate Change (IPCC), which includes more than 1,300 scientists from the United States and other countries, forecasts a temperature rise of 2.5 to 10 degrees Fahrenheit over the next century.

According to the IPCC, the extent of climate change effects on individual regions will vary over time and with the ability of different societal and environmental systems to mitigate or adapt to change.

The IPCC predicts that increases in global mean temperature of less than 1.8 to 5.4 degrees Fahrenheit (1 to 3 degrees Celsius) above 1990 levels will produce beneficial impacts in some regions and harmful ones in others. Net annual costs will increase over time as global temperatures increase.

"Taken as a whole," the IPCC states, "the range of published evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time."

Below are some of the regional impacts of global change forecast by the IPCC:

- **North America:** Decreasing snowpack in the western mountains; 5-20 percent increase in yields of rain-fed agriculture in some regions; increased frequency, intensity and duration of heat waves in cities that currently experience them.[2]
- **Latin America:** Gradual replacement of tropical forest by savannah in eastern Amazonia; risk of significant biodiversity loss through species extinction in many tropical areas; significant changes in water availability for human consumption, agriculture and energy generation.
- **Europe:** Increased risk of inland flash floods; more frequent coastal flooding and increased erosion from storms and sea level rise; glacial retreat in mountainous areas; reduced snow cover and winter tourism; extensive species losses; reductions of crop productivity in southern Europe.
- **Africa:** By 2020, between 75 and 250 million people are projected to be exposed to increased water stress; yields from rain-fed agriculture could be reduced by up to 50 percent in some regions by 2020; agricultural production, including access to food, may be severely compromised.
- **Asia:** Freshwater availability projected to decrease in Central, South, East and Southeast Asia by the 2050s; coastal areas will be at risk due to increased flooding; death rate from disease associated with floods and droughts expected to rise in some regions.