In FY 2011 the Global Carbon Cycle (GCC) component of the Earth System Science (ESS) Program, invites proposals in four priority research areas:

i) Causes of Variability in Sources and Sinks
The rate of increase of carbon dioxide in the atmosphere can vary significantly on interannual and decadal time-scales. The causes of this variability are largely unknown: while a small amount is a result of variations in emissions, the majority is due to variability in uptake by the oceans and terrestrial biosphere. Studies are needed which investigate how various factors influence variability in the ocean and terrestrial carbon sinks over a variety of temporal scales, and identify which factors are the most important.

ii) Future Atmospheric Carbon Dioxide Concentrations
Current models used to project future atmospheric carbon dioxide concentrations assume that the carbon cycle will continue to operate in the same way it has operated in the recent past. These models do not take into account the limitations of the carbon sink on land, or how biological, chemical and physical processes in the ocean and land might change either due to natural variability or external forcing. By examining the carbon cycle as an integrated system, identifying how it interacts with climate and other influences such as land use patterns, and incorporating the carbon cycle into dynamic earth system models, more realistic predictions of future atmospheric carbon dioxide concentrations and potential abrupt changes in growth rate can be made.

iii) Ocean Carbon Cycling and Biogeochemical and Ecosystem Dynamics There is an increasing need to understand the interactions between ocean carbon cycling and ecosystem and biogeochemical dynamics in response to increased levels of CO2. Despite increased efforts to understand the important controlling processes, significant discrepancies still exist between models and observations, and a number of key processes remain poorly quantified. The goal is to conduct research to resolve limitations and discrepancies in our understanding and prediction of ecosystems, biogeochemical cycles and carbon uptake. Examples of specific areas of research are i) Biogeochemical Cycling and Carbon Production/Export, ii) Marine Food Webs and Ecosystems and iii) Ocean Acidification.

iv) North American Carbon Monitoring
Atmospheric and oceanic data and models have produced varying estimates of the magnitude and variability of the Northern American carbon sink. In addition, experience has shown that inventory estimates of emissions are often quite far off from actual emissions when they are confronted with atmospheric data. There is considerable debate over the methods for improving these estimations and the processes controlling them. The initial focus of this research theme is to identify responsible mechanisms using ocean and atmospheric field experiments, observations, models, or combinations thereof, as for example in CarbonTracker, to constrain estimates of the Northern Hemisphere carbon emissions and sinks.