7. Couplings Between Changes in the Climate System and Biogeochemistry

7.1 Introduction to Biogeochemical Cycles
(Discuss purpose, evolution from TAR to consider coupled system with biogeochemistry, affected by human activities; adds to understanding by replacing parameterized features previously linked to observations (e.g. of CO_2 concentrations) to become fully predictive as the climate system changes; prompted by increasing numerical capacity, complexity of models, and evolution of understanding; emphasis on chains of events;include brief tutorial on biogeochemical cycles).

7.2 The Carbon Cycle and the Climate System
(Assess range of carbon cycle processes, controls, budgets, sources, sinks; evaluate progress in simulating/understanding inter-annual variability; consider effect of carbon coupling on future climate (e.g., potential for large carbon source if changes in ENSO or drought occur, etc.; evaluation of respiration in altered climates); include possible connections of carbon to nitrogen cycle (fertilization, N2O emissions); inversion analysis and implications for source/sink distributions; include ocean source/sinks,; assess results of C4MIP model intercomparisons;consider implications for scenarios and for stabilization).

7.3 Global Atmospheric Chemistry and Climate Change
(Discuss processes, controls, budgets, sources, sinks of each key trace gas; feedbacks with climate change; projections for each of CH_4 and N_2O; O_3, and Sulfur. Consider possible coupling of stratospheric ozone changes to surface climate (bring forward relevant information from Special Report ozone/climate); assess lifetime changes due to chemical/dynamical feedbacks (eg., CH_4); role of nitrogen and sulfur cycles, etc.; implications for scenarios and stabilization for CH_4, N_2O, and other gases; implications for scenarios for trop and strat ozone futures).

7.4 Air Quality and Climate Change
(Trends in air quality and their influence on radiative forcing (e.g., from tropospheric ozone and aerosol increases), links of climate to sources, budgets; controls over sources and sinks, e.g., possible climate effects on isoprene emissions from vegetation; role of long-range transport; role of megacities; effects of climate change on chemical processing (e.g., changes in water vapor, temperature, and OH); direct and indirect feedbacks of air quality to climate; emissions of SO_2 and relation to air-quality regulations).

7.5 Aerosols and Climate Change
(Assess climate linkages for aerosols on larger scales; hydrologic cycle feedbacks; special issues relating to absorbing aerosols, i.e., soot; effects on surface energy budget; possible links of aerosols/diffuse flux to carbon cycle; range of aerosol/climate/chemistry interactions including influences on circulation patterns; regional-scale analyses of coupled aerosol/chemistry/climate simulations; effects of climate change on natural aerosol and aerosol precursor emissions).

7.6 The Changing Land Surface and Climate
(Assessment of process understanding of the role of human land use in climate change using increasingly sophisticated land models; evaluation of coupling of land-surface hydrology (not water cycle) to the climate system and its relevance; links to vegetation dynamics; evaluation of role of disturbances such as major fires).

7.7 Synthesis: Interactions among Cycles and Processes
(Implications of past changes for attribution and projections of future in a rapidly-evolving and fully coupled system; likely evolution of carbon, nitrogen, aerosols, chemistry, and land surface/hydrology in the 21st century; potential for 'surprises').