Abstract

River discharge can affect ocean surface temperature by altering stratification within the oceanic mixed layer. A hitherto unexplored aspect of present climate is the feedback of river runoff onto climate. This thesis presents an investigation of the impact of global river runoff on oceans and climate using a fully coupled global climate model, Community Climate System Model (CCSM). Two model simulations for a period of 100 years have been carried out: 1) a reference run (CTRL) that incorporates all the features of a global coupled model with river runoff into the ocean embedded in it, and 2) a sensitivity run (NoRiv) in which the global river runoff into the ocean is blocked. Comparison of model climate devoid of fluvial discharge with the reference run reveals the significance of fluvial discharge in the present climate.

By the end of 50 years of NoRiv experiment, salinity growth slows down and reaches a quasi-stable state. Regions close to river mouths exhibited maximum salinity rise that can potentially alter local density and stratification. On an average, denser and saltier waters in the NoRiv run annihilate barrier layer and form a deeper mixed layer, compared to CTRL run. Density gradient created by the modulation in salinity set forth anomalous currents and circulation across coastlines that carries coastal anomalies to open ocean, preventing local salinity buildup. Arctic Ocean, Bay of Bengal, northern high latitude Pacific and the Atlantic are the most affected regions in terms of changes in salinity and temperature. Model simulations demonstrate that major transformation in Arctic freshwater budget can have potential impact on northern Pacific and Atlantic climate. In the absence of runoff, global average sea surface temperature (SST) rise by about $\sim$0.5^{o}C, with major contribution from northern

higher latitude oceans. In the Pacific, high latitude warming is related to deepening of mixed layer as well as the northward transport of low latitude warmer waters. Substantial cooling in the central equatorial Pacific ($\sim 1^o$C during winter) can alter large-scale ocean-atmosphere circulation, including El Niño-Southern Oscillation (ENSO). The reinforcement of Pacific and Atlantic western boundary currents aids the transport of warm saline water from low latitudes to higher latitudes. The results suggest that the river runoff can have potential impact on oceanic climate.

Response of Indian summer monsoon rainfall to global continental runoff is also examined. In the NoRiv run, average summer monsoon rainfall over India increased by $\sim$0.55 mm day^{-1}. Consistent with the increase in annual average Indian monsoon rainfall, all other northern hemispheric monsoon systems showed an increase, while southern hemispheric monsoons weakened. Associated with enhanced monsoon, the periodicity of ENSO in the NoRiv run changes as a result of cooling tendency in the equatorial Pacific, a sign of consistent La Niña. Equatorial Pacific cooling, in spite of a global ocean warming trend, is found to be primarily because of the enhanced local easterly winds and resultant strong equatorial upwelling. Cold anomaly due to upwelling spread entire equatorial Pacific basin within a span of 50 years. The La Niña situation in the Pacific favored increased monsoon rainfall over Indian subcontinent.

Another surprising result of this study is the strengthening of ENSO-monsoon relationship in the NoRiv run. This suggests that the river discharge can be considered as a dampening force in the ENSO-monsoon relationship. Northern hemisphere showed a clear warming in the NoRiv simulation compared to CTRL, the result of which is an enhanced trans-hemispheric gradient. Cross-equatorial winds triggered by this gradient blow from southern hemisphere and shift the Inter Tropical Convergence Zone (ITCZ) northward, increasing the precipitation in the northern hemisphere. The cooling in the eastern equatorial Indian Ocean and the warming in the west, reflected in the increase in number of positive Indian Ocean Dipole (IOD) events (9 positive and 5 negative IOD events in the last 50 years), also favored summer-time rainfall over India.