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Impact of Himalayas over the Present and Future Climatic Scenario using Global Climate Model

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***Abstract*— The Himalayas play a vital role in the natural physical processes like evaporation, precipitation, snow cover, surface runoff, snow depth, etc. The existence of biological cosmos is dependent upon such processes. The environment is very dynamic and ever-changing in nature, surviving by dint of the balance maintained with all components. Any drastic increase in any component can prove to be destructive for all components.**

Fortunately, advanced scientific modeling tools and techniques, such as GCMs (Global Circulation Models) and Downscaled RCMs (regional climate models), are available, allowing us to simulate plausible future scenarios of climatic change. These projections will help us understand the broad array of impacts that climatic changes are likely to have - from hydrological to social, ecological to economic. With this knowledge, policy makers and planners will, with less uncertainty, be able to make decisions to implement adaptive measures to address some of these impacts. Here we have attempted to understand the relationship between these components and the kind of feedback that is generated.

Keywords*— Evaporation, Precipitation, Snow cover. Surface runoff, Biological cosmos.

I. INTRODUCTION

The Himalayas have the largest concentration of glacier outside the polar region. These glaciers are the fresh water reserve. Almost half of the world population gets its water from glacier melt and rainfall in the Himalayas. Himalaya also plays a major role in maintaining the physical processes, temperature, air circulation, monsoon and also help to determine the meteorological conditions in the Indian subcontinent and the Central Asia. According to the Intergovernmental Panel on Climate Change (IPCC), “glaciers in the Himalayas are receding faster than in any other part of the world and if the present rate continues, the likelihood of them disappearing by the year 2035 and perhaps sooner is very high if the earth keep getting warmer at the current rate”. According to the IPCC report the total area of glaciers in the Himalaya will shrink from 1930051 square miles to 38,000 square miles by 2035.

As billions of lives are at stake, we need to start a participatory process for Himalayan communities to engage in the discussion on climate change, including issues of climate justice, adaptation and disaster preparedness. In terms of numbers of people impacted, climate change at the Third Pole is the most far reaching. And no climate change policy or treaty will be complete without including the Himalayan communities.

With the help of Global Climate models, we are trying to understand the reason of what Himalaya plays to maintain the livelihood of the area and how it maintains the physical processes happening in the world.

II. SETUP

To ensure the climatic aspect of study, the time scale used was from 2010 to 2140. The input file for topography was specially coded to have no Himalayas in the model under study. All other values of greenhouse gases were held constant at 2010 values. No trends were enabled. The ocean temperatures were set as specified sea surface temperatures.
Under the normal model or un-disturbed climate model was run on default setting with no change in topography, and values of greenhouse gases held constant at 2010.

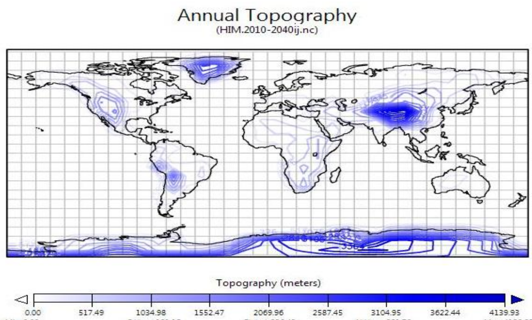

Fig. 2.1 Annual topography (With Himalayas)

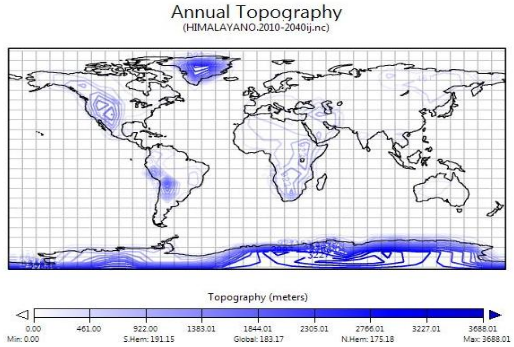

Fig. 2.2 Annual topography (No Himalayas)

The figure 2.1 here represents the topography where the brightness of the blue contour lines represents increasing elevation.

As clearly seen in the figure 2.1 with the presence of Himalayas, strong contour representing the peaks of elevations are distinctly observed over Northern India and Tibetan plateau.

In no Himalayan topography as shown in the

III. OBSERVATIONS

A. *Temperature*

One of the foremost changes that occurred is with the temperatures. With no Himalayas, and decrease in ground albedo, the radiations falling on the surface will be absorbed rather than reflected back to space. Also with no snow cooling the ground the increase in temperature was expected. However, again the magnitude of change was not anticipated to be so high. The change in the Chinese region came out staggering 17 degree Celsius. Temperature change over northern, north-eastern India and eastern China are around 10 degree Celsius. Rest of the world (on continents) experienced higher temperature by about 1 degree Celsius. Surprisingly the Middle East experienced decrease in temperature by almost -4 degree Celsius. Perhaps Himalayas acted as a kind of barrier to cold winds that prevented them to reach Middle East.

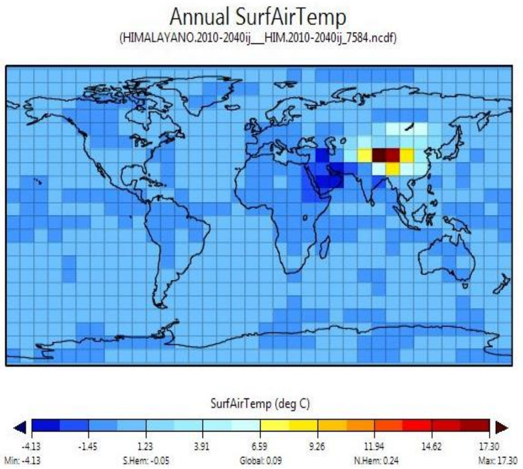

Fig 3.1 Annual max surface air temp.

B. *Maximum Surface Air Temperature*

The data is consistent with the findings of temperature. The maximum change is seen in China, some negative effect is seen over the Middle East. Annual net heat surface follows similar fashion.

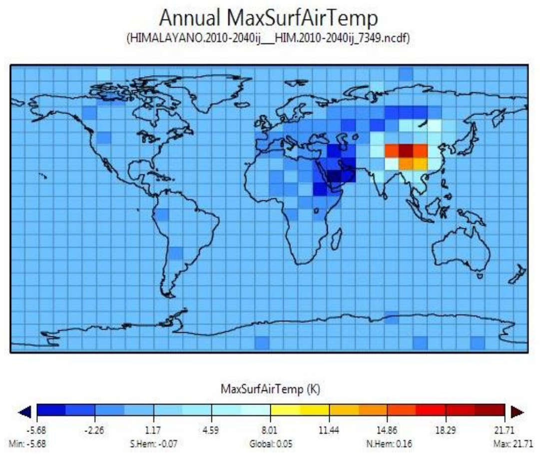

Fig 3.2 Annual max surface air temp.

C. *Evaporation*

There was an annual decrease in precipitation around the world. However, a significant decrease in annual evaporation is distinctly observed over the south-eastern part of China by about -2mm. On the other hand Middle East will experience stronger evaporation by about 3mm. Overall Middle East has a higher reflective albedo and evaporation rate in this scenario.

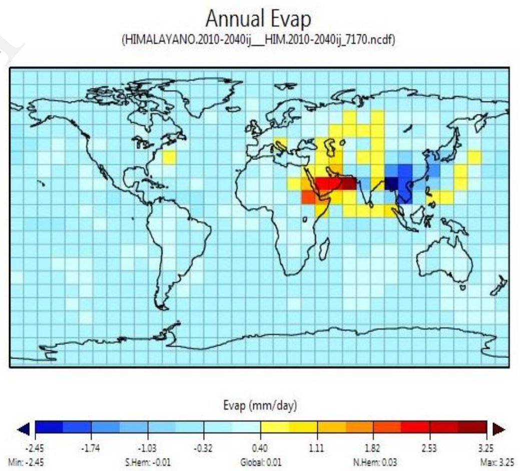

Fig 3.3 Annual evaporation

D. *Precipitation*

One of the most important relationships of Himalayas is with Indian Monsoon. For precipitation, both increasing and decreasing trends in Eastern Himalayas, lack of a consistent trend in Central Himalayas, and decreasing trends in Western Himalayas have been reported. IPCC 2007 describes increasing trends of precipitation in northern and central Asia.
In our case, there is a decrease in annual precipitation in the in the south-eastern Asian continent including India, China, Myanmar, Thailand, Vietnam, Cambodia. Decrease was observed in the range from –3 to -7mm per day. However in the contrast an increase in precipitation was observed over Middle East, parts of Africa, Russia and even Srilanka. Thus presence of Himalayas is one of the key players in restoring precipitation over almost entire South-east Asia.

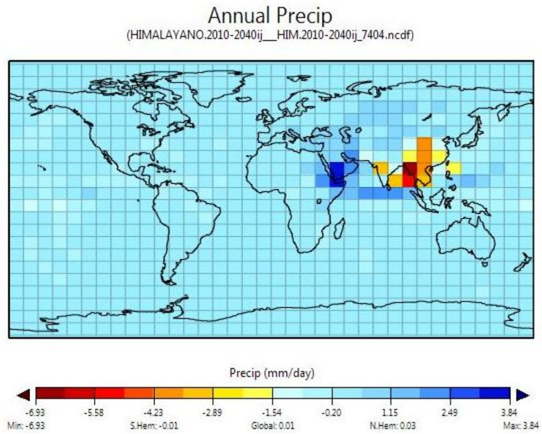

Fig 3.4 Annual precipitation

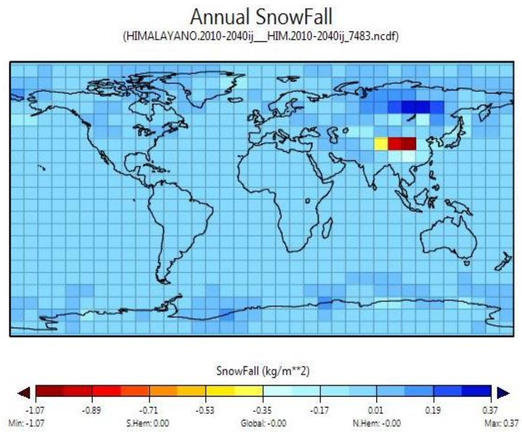

Fig 3.5.2 Annual snowfall

E. Snow cover and Snowfall

Another important characteristic whose behavior is dictated by presence of Himalayas is snow cover. Model calculations suggest a massive decrease in snow cover over the central regions of China by as much as 45%.

Over rest of the China change in snow cover varied from -8 to -30%. An overall 10% decrease in snow cover was also cited in the southern regions of Russia, with a mild 4% increase in snow cover over a small portion of northern Russia. This observation is a reflection of close relationship between snow cover over Asia and Himalayas. Rest of the world saw an increase in snow cover by 4%.

The result is consistent with the pattern of snowfall with a decrease in 1kg/m^2 over China and a slight 0.37% increase over a small region of northern Russia.

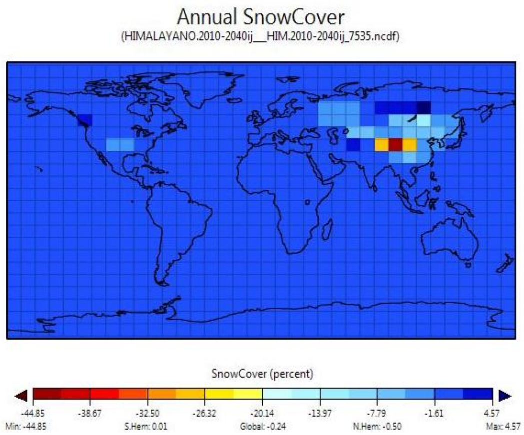

Fig 3.5.1 Annual snow cover

F. Ground Albedo

Perhaps one of the most striking and distinct changes observed was regarding the change occurring in the two scenarios with ground albedo. Snow is more reflective surface than water and hence a slight change in albedo was expected. However with the intuition that most of the snow melts away in the tropical heat the actual change wouldn't be much significant. However by running the model with no Himalayas and comparing it with normal topographic conditions, we found the magnitude of change in albedo was as high as 14%. Such high changes were especially located in regional China. Another surprising aspect was an overall global decrease in albedo by an average -0.15%. Yet another significant change was observed over Middle-east with albedo falling to -4%. These changes can be attributed to change in weather pattern that happened when Himalayas was removed. Decreased in albedo suggests that, there will be lesser snow coverage overall in the world. Some parts of Middle East that receive snow like in Iran, Lebanon, Syria, their snow cover is going to decrease resulting in a greater decrease in albedo.

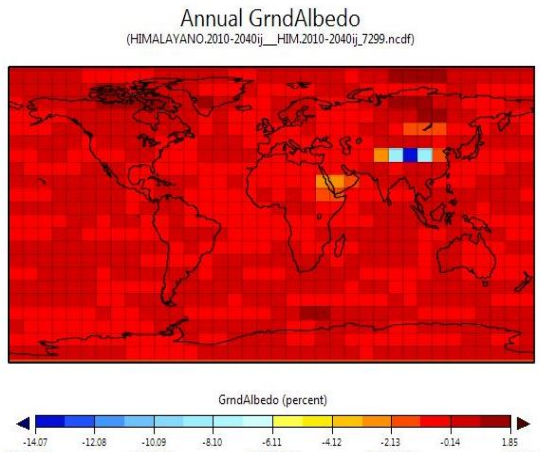

Fig 3.6 Annual ground albedo

IV. CONCLUSION

The Himalayan region contains one of the most dynamic and complex mountain systems in the world. The Himalayas is vulnerable to climate change due to its ecological fragility and economic marginality. Recent studies confirm its vulnerability, with analysis and predictions showing increasing magnitude of change with elevation, both in mean shifts in temperature and in greater stretch in precipitation variation. The diversity in ecosystems and the variability in environmental factors like weather, climate, and water interact in a mutually reinforcing manner to create the diversity of life and the huge variety of ecosystem services, which is being rapidly eroded by human interference with the climate system. Here, by going through the model deeply and analyzing it, we were able to find the importance of Himalaya in maintaining many processes in the region. With the help of GCM, we are able to find a significant impact that Himalaya creates in controlling the climate and hence able to predict the future scenario of the worldwide climatic changes may occur without Himalayas.

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