Long duration and high frequency of Dense Fog occurrences along Indo-Gangetic Plains -A totally new extreme weather phenomenon started somewhere in mid of 1990s and now an Unusual January 2010 –Why? and What are its climatic impacts?

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Prevalence of large-scale intense fog conditions for very long durations along vast areas of Indo-Gangetic Plains from day to day during last January 2010 have become so unusually high that it does not only rise various important basic scientific questions related to formation and mechanics of such newly large-scale weather events, further intensification, persistence and dissipation mechanisms over such large part of the Globe but also, its socioeconomic impact on the region no doubt has been making it well comparable to any other severe weather event those affects India. With the blanket of dense fog remaining extended during respective months over the huge area in the region from Pakistan to Bangladesh across north India from west to east running almost parallel to south of Himalayan Plateau which has roughly length 2500km and width of 500m, it has now become part of an annual winter ritual for the people living in this vast region to severely struggle to get a safe and dependable communication system as it routinely leaves air, rail and road travelers stranded, their safety endangered, holidays busted and business meetings scrambled. Besides 217 diversion flights alone at IGI Airport with cancellation and delaying of 1000s flights during last Jan 2010, Indian railway has three train mishaps in Utter Pradesh leaving 10 dead during when the first spell of the dense fog affected region in the first week of Jan 2010 after which the authority was forced to issue order to control speeds to unusual low when even all fast moving trains of the region has to move to a bare minimum when it moves in fog affected region. Later also cancelled and delayed 1000s of train causing severe problems to passengers in severe cold conditions. For a country that's being seen as an emerging regional leader, India is vet to put in place an efficient system in various transport sectors to ensure glitch-free transportation in inclement weather like fog.

In the present study we have carried out fog duration and intensity analysis using fog data at various visibility ranges available for Delhi since 1960s and other airports in the region with data since 1990s to find whether long duration intense fog conditions as observed during last Jan 2010 was ever observed before across whole Indo-Gagetic plains across these stations. We have also analysed satellite imageries since 1990s of INSAT and MODIS imageries of recent months to find how their spatial extent were before and how unusual was Jan 2010. The present study shows that occurrences of such high duration and high frequency dense fog in very large-scale spatially simultaneously over such a vast region have been totally a new weather phenomenon started somewhere in mid of 1990s when satellite imageries also showing it was started predominantly observed earlier only in some selective months during Dec 1997-1998, Dec 2004 and Jan 1999-2003 and now again predominant in Jan 2009-2010. The present study also shows Unusual Fog was occurred along western parts of Indo-Gangetic Plains for January 2010. To find out Why such large-scale intense fog in mid 1990s started over such a vast region of globe, one has to study both changes in meteorological and pollutions factors responsible for fog formation over the period for the region. In the absence long period reliable pollution data and presuming that pollution has been one of the influential factors, we have studied interdecadal and interannual variation anomalies of regional circulation pattern, geopotential heights, air temperatures at various standard pressure levels and surface pressure using NCEP reanalysis data of Dec and Jan since 1960s. We have considered composite anomalies of two basic decades i.e. 1961-1970 when few dense fog hours observed and very high dense fog formation decades of 1997-2006 and documented significant changes of large-scale atmospheric features between them to which factors favor fog formation over the region. We have also considered their monthly composites by plotting their monthly time series of dense fog hours since 1990s of IGI which has longer period reliable data set only and then selecting respective contrasting months as an ever lowest three fog months against an ever highest fog months for Dec and Jan separately e.g. for Dec, it was 1997, 1998, 2003-very high dense fog hours month of > 72 hours vis-à-vis 2000, 2007, 2009-almost zero dense fog hours months and for Jan it was 2001, 2003 and 2010-very high dense fog hours month month of > 112 hours vis-à-vis 2006, 2007, 2008-almost few dense fog hours months. Results bring new and very interesting and encouraging results from meteorological prospective which normally and primarily responsible for any large scale fog formation besides increasing pollution and change in land use patterns which runs in high irrigation resulting availability of high moistures and decreasing surface air temperatures over the region discussed in Jenamani, 2007, supporting why the region has experienced now newly large -scale high fog formation since mid 1990s. It shows formation of a totally new intense mid-latitude anomalous anticyclone over extreme Pakistan, Afghanistan, Iran and adjoining region extended west-east to wards Indian region, during both the months during very high hours of dense fog decades i.e. 1997-2006 in contrast absence of such system in the anomailes of decades of no dense fog hours when composite anomalies prepared for respective moths separately - a very similar features which was experienced while doing monthly composite anomalies in interannual time scale study by comparing extremely very high duration and intense foggy months composites anomalies for Dec and Jan against their almost no fog months.

It has been well established that the Indo-Gangetic(IG) Plains suffers most from increasing aerosol contents and other pollutants in the atmosphere in 1990s which may

severely affect regional climates through dimming effect. It may have different impact if we consider season-wise separately. While analysis from remote sensing data and climate models carried out before reveals serious impact of their rise on future monsoon climates, this high rise pollutions across the region together with presently found forming and spreading high dense fog hours from mid 1990s during winter may further complicate the dimming effect. To find whether such impact can cause cooling or warming across the region whether it is for day and night temperature, the present study analyzed maximum and minimum temperature which are most sensitive to such change by using their daily data of December and January for 14 Stations uniformly distributed over the western part of the region for the period of 1969-2003.

Jenamani Rajendra Kumar, 2007, "Alarming rise of Fog and Pollutions causing fall of Maximum Temperature over CNG City Delhi", **Curr. Sci., 10th August, 93, 3, 314-321**