

We can eliminate the major tornado threat in Tornado Alley

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When a strong warm moist air flow comes to Tornado Alley, the violent clashes with the cold air flow can extend several states, making tornado outbreaks at several places in a very short period.

The annually recurring devastating tornado attacks in US Tornado Alley raise an important question: Can we eliminate the major tornado threat in Tornado Alley? Some people may claim that such a question is beyond imagination as people are powerless in facing violent tornadoes. However, according to Professor Rongjia Tao's recent publication in *IJMPB*, human beings are not powerless on this issue: if we build three east-west great walls in Tornado Alley, we will eliminate major tornado

threat there forever. These walls can be built locally at high tornado risk areas to eliminate tornado threat there first, then gradually extended.

In the US, most devastating tornadoes occur in Tornado Alley, which is a strip of land between the Appalachian Mountains and the Rocky Mountains, including most American Midwest states. In 2013, there were 811 confirmed tornadoes in USA, 57 in Europe and 3 in China. Among 811 tornadoes in USA, most of them, especially the most devastating ones, occurred in Tornado Alley. What causes such huge differences?

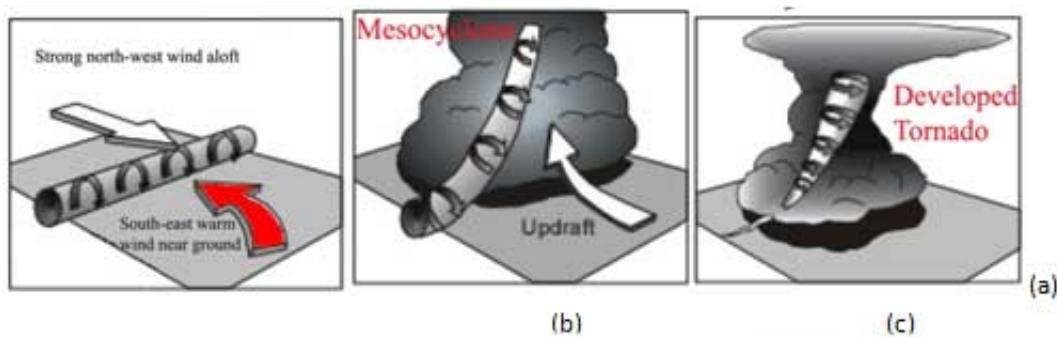
From the atmospheric circulation point of view, Tornado Alley is inside the "zone of mixing", where the warm and moist air flows northbound and cold air flows southbound. At a certain season, the warm air flow front clashes with the [cold air](#) flow front at some place in Tornado Alley. Major tornadoes in Tornado Alley all start with such clashes (Fig.1). Especially as there is no east-west mountain in Tornado Alley to weaken or block the air flows, some clashes are violent, creating vortex turbulence. Such violent vortexes, supercells, are initially in horizontal spinning motion at the lower atmosphere, then tilt as the air turns to rise in the storm's updraft, creating a component of spin around a vertical axis. If the vortex stretching during the vortex tilting intensifies the vertical vorticity enough to create a tornado, the vortex size is getting much smaller as the rotation speed gets much faster. About 30% of supercells lead to tornadoes (Fig.2).

Calculations show that the chance to produce tornadoes depends on the wind speeds during the clashes. For example, if both cold wind and warm wind have speed 30 miles/h (13.3m/s), the chance to develop tornados from the clash is very high. On the other hand, if the both winds have speed below 15 miles/h, there is almost no chance for the clash to develop into tornadoes. Hence reducing the wind speed and eliminating the violent air mass clashes are the key to prevent tornado

formation in Tornado Alley. We can learn from the Nature how to do so.

United States and China have similar geographic locations. In particular, the Northern China Plain and the Eastern China Plain is also in the zone of mixing, similar to Tornado Alley. However, very few violent tornadoes occur in this region of China because there are three east-west mountain ranges to protect these plains from tornado threat. The first one is 300km long Yan Mountain which lies at the northern boundary of these plains. The second one is 600km long Nanling (Nan Mountains) at the south boundary of these plains. The third one is 800km long Jiang-Huai Hills through the middle of the plains. Especially, Jiang-Huai Hills are only about 300 meters above sea level, but effectively eliminate the major tornado threat for the areas. This is evidenced by the following fact.

Jiang-Huai Hills do not extend to Pacific ocean, leaving a small plain area, north part of Jiangsu province, unprotected. This small area, similar to US Tornado Alley, has annually recurring tornado outbreaks. For example, the city Gaoyou in this area has a nickname "Tornado hometown", which has tornado outbreaks once in two years on average. It is thus clear that Jiang-Huai Hills are extremely effectively in eliminating tornadoes formation. Without Jiang-Huai Hills, a quite big area in China would become "Tornado Hometown"



The intensive clash between the winds from the south and the winds from the north is the source for formation of tornados in Tornado Alley. (a) Violent clash creates a vortex-supercell. (b) Tilt and updraft creates a spin about a vertical axis leading to mesocyclone. (C) Further stretching and strong vertical vorticity may lead to tornado.

While there are no mountains in Tornado Alley to play the same role as Jiang-Huai Hills etc in China, there are two small mountains, Ozarks Mountains and Shawnee Hills, which significantly reduce tornado risk for some local areas.

Ozark Mountain consists of high and deeply dissected plateaus; the mountain hills are south-north ranged. Most parts of these north-south hills cannot block or weaken air mass flow between north and south. Therefore, for example, Joplin has very high tornado risk as it faces the north-south deeps and valleys formed by these hills, the winds get more strength as they pass these valleys and deeps. On the other hand, some small sections of St. Francois Mountains and Boston Mountains have the hills east-west connected. Therefore, for example, Rolla, Missouri has very low tornado risk, as analyzed by <http://www.homefact.com/tornadoes/>.

The devastating tornado outbreak in Washington County, IL on November 17, 2013 also reminds us about Shawnee Hills, which is a small mountain, 60 miles east from Washington County. Most Shawnee Hills are along the south - north direction, but some sections are east-west connected, located at the south border of Gallatin County. Therefore, Gallatin County has very low tornado risk, although the most land in Gallatin County is flat farm land, same as Washington county.

According to Dr. Tao, the above information learned from Nature is

very encouraging. Although there are no east-west mountains in Tornado Alley, we can build some east-west great walls to play the same role. Also learned from Jiang-Huai Hills and Shawnee Hills, the wall needs about 300 meter high and 50 meter wide.

To eliminate the tornado threat for the entire Tornado Alley, we may need to build three great walls. The first one should be close to the northern boundary of the Tornado Alley, maybe in North Dakota. The second one should be in the middle, maybe in the middle of Oklahoma and going to east. The third one can be in the south of Texas and Louisiana.

Such great walls may affect the weather, but their effect on the weather will be minor, as evidenced by Shawnee Hills in Illinois. In fact, with scientific design, we may also use these walls to improve the local climate.

In Philadelphia, there is one skyscraper building, Comcast Center, about 300 meter high. From the cost of Comcast Center, we estimate that to build one mile such wall, we need about \$160 million. On the other hand, the damages caused by single tornado attack in Moore, Oklahoma on May 20, 2013 alone were multi billion dollars. Therefore, it seems that the cost for building such a wall is affordable.

While building the three great walls will eventually eliminate major tornadoes in the entire Tornado Alley, we do not expect to start such a huge project in the near future. On the other hand, it is more realistic to build such great walls locally at high tornado risk areas first, then connect them piece by piece. To do so locally, we must remember that from air fluid dynamics, the area protected by the wall is roughly a circle with the wall as its diameter.

Also in developing any new city in Tornado Alley in future, we may

consider to build east-west skyscraper buildings first, then allocate the other parts of the city surrounding the skyscraper buildings. In such a way, the skyscraper buildings will serve as a wall, eliminating major tornado formation in their surroundings to protect the whole city.

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