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From Tissot to Google Earth: Sampling the Earth's Graticule

Sandra L. Arlinghaus and Joseph Kerski

Associated .kmz download.

Sampling Projection Distortion: Tissot's Indicatrix

Classical Approach: Mercator and Sinusoidal Projections

The Tissot Indicatrix, is the classical way to sample projection distortion. A sequence of circles of constant radius are centered on graticule intersection points. The greater the associated distortion in mapping the globe to the plane, the greater the distortion of the circle, either as an enlarged circle, or as an ellipse with long major axis in relation to its minor axis. Figure 1 shows a typical illustration indicating this idea with simple enlargement on a Mercator projection and Figure 2 shows circular elongation on a sinusoidal projection.

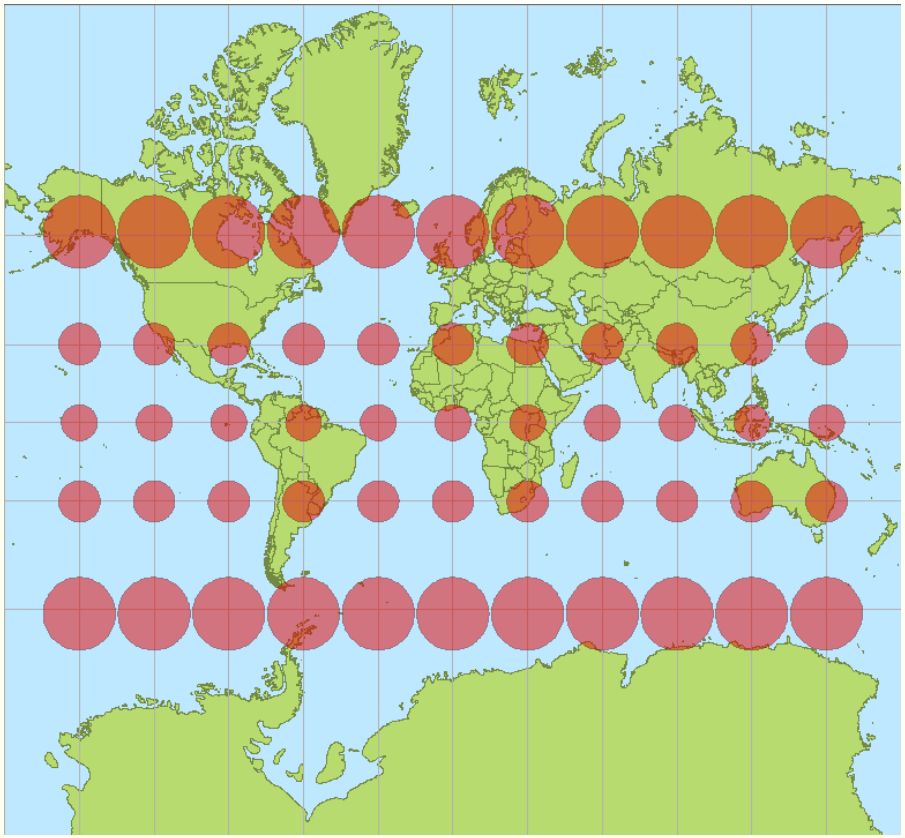


Figure 1. Tissot Indicatrix, Mercator projection
Source: Wikipedia--http://en.wikipedia.org/wiki/File:Tissot_mercator.png

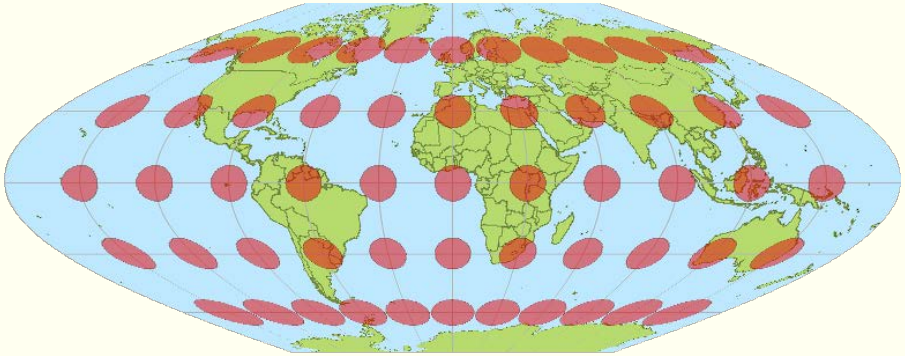


Figure 2. Tissot Indicatrix, Sinusoidal projection.
Source: Wikipedia--http://en.wikipedia.org/wiki/File:Sinusiodal_earth_circles.png

Figure 1 illustrates quite clearly the way in which landmasses become exaggerated in area as one moves toward the poles while Figure 2 illustrates a change in shape, rather than in area, as one moves poleward. While the visual evidence is compelling, it is difficult to see simultaneously in the mind's eye how the graticule distortion might distort a variety of globe features. One reason for this difficulty is that these models are visually static. Indeed, usually, as in Figures 1 and 2, one sees only simple country-level boundary distortion in association with ellipse elongation.

Contemporary Approach: Web Mercator Auxiliary Sphere projection

Software in which one can traverse an image of the globe, such as Google Earth, offers a dynamic way to both see Tissot-style distortion and simultaneously consider an inventory of what is available on the globe through digital imagery. Figure 3 shows an approach to an alternative visual sampling of projection distortion; here, of the Web Mercator Auxiliary Sphere projection.

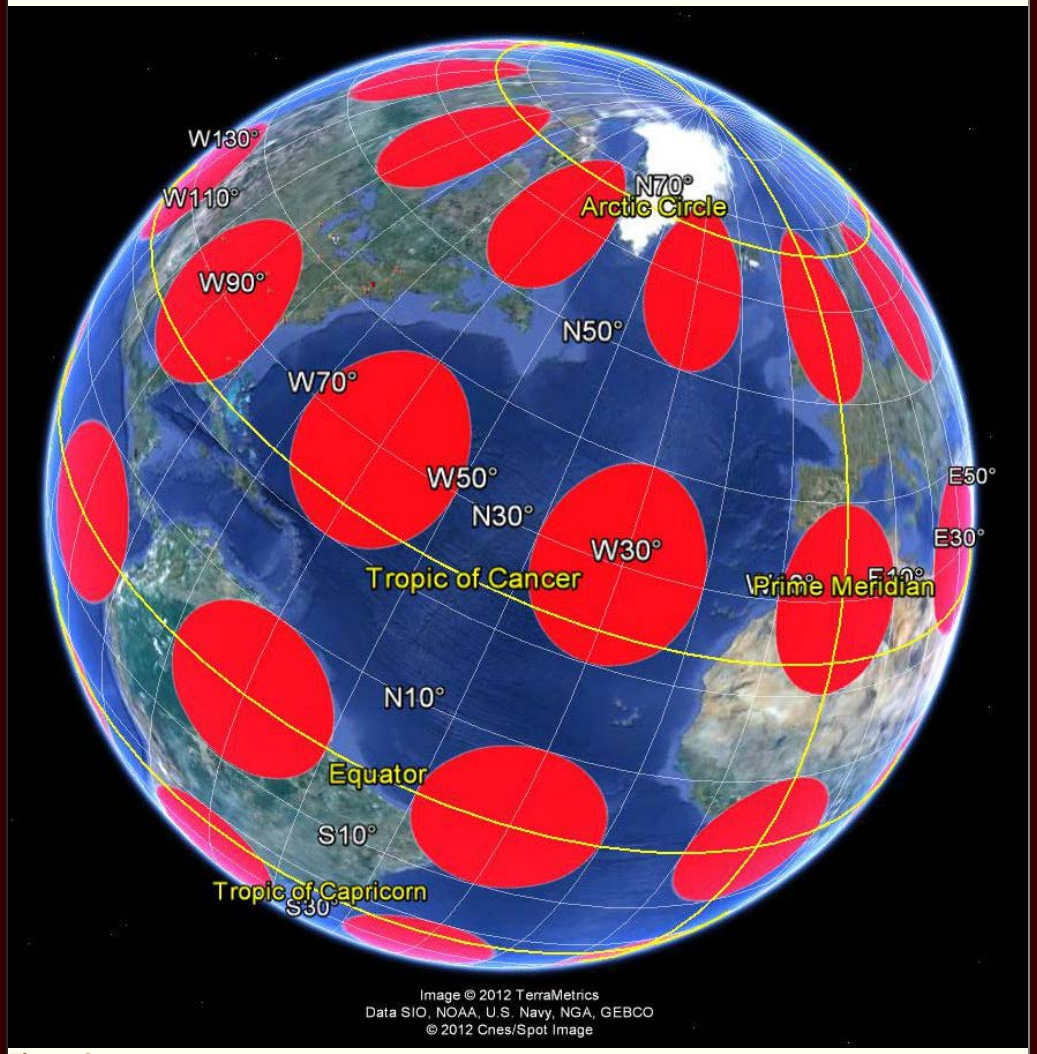


Figure 3.
Tissot Indicatrix of Web Mercator Auxiliary Sphere projection with distortion realized in Google Earth.

Screen captures, and animations of screen captures, show less than half the Google globe. To see it all, download the associated .kmz file and open it in Google Earth.

One advantage, in addition to being able to spin the globe, is to adjust the opacity of the ellipses, the elevation of the ellipses, the scale of visualization, and a host of other factors. The following

visual sequence suggests a number of different possibilities. No doubt the interested reader will find others!

The animation in Figure 4 suggests that when looking at a broad region, the elongation of the ellipse might matter when looking at global patterns, such as weather fronts. The radar imagery may be stretched a bit in the north-south direction so care must be taken to interpret the pattern in relation to existing boundaries or benchmarks rather than simply on sheer apparent length of the front. The animation in Figure 5 suggests, however, that local scale studies suffer few effects from the distortion. In fact, the semi-transparent overlay of the ellipse offers no information and simply clouds the wealth of default information available in the mapping software.

Figure 6 returns again to a global view and raises the ellipses above the surface of the globe so that one might walk between the globe and the Tissot layer to view simultaneously the terrain and the superimposed polygons from within the abstract structure. This Tissot umbrella offers unusual vantange points; again, the reader might try this construction, and similar ones, for him or herself using the downloaded .kmz file. This sort of approach, to integrating geometry and geography, is a small sample of what is to come in our forthcoming book on spatial mathematics...stay tuned.

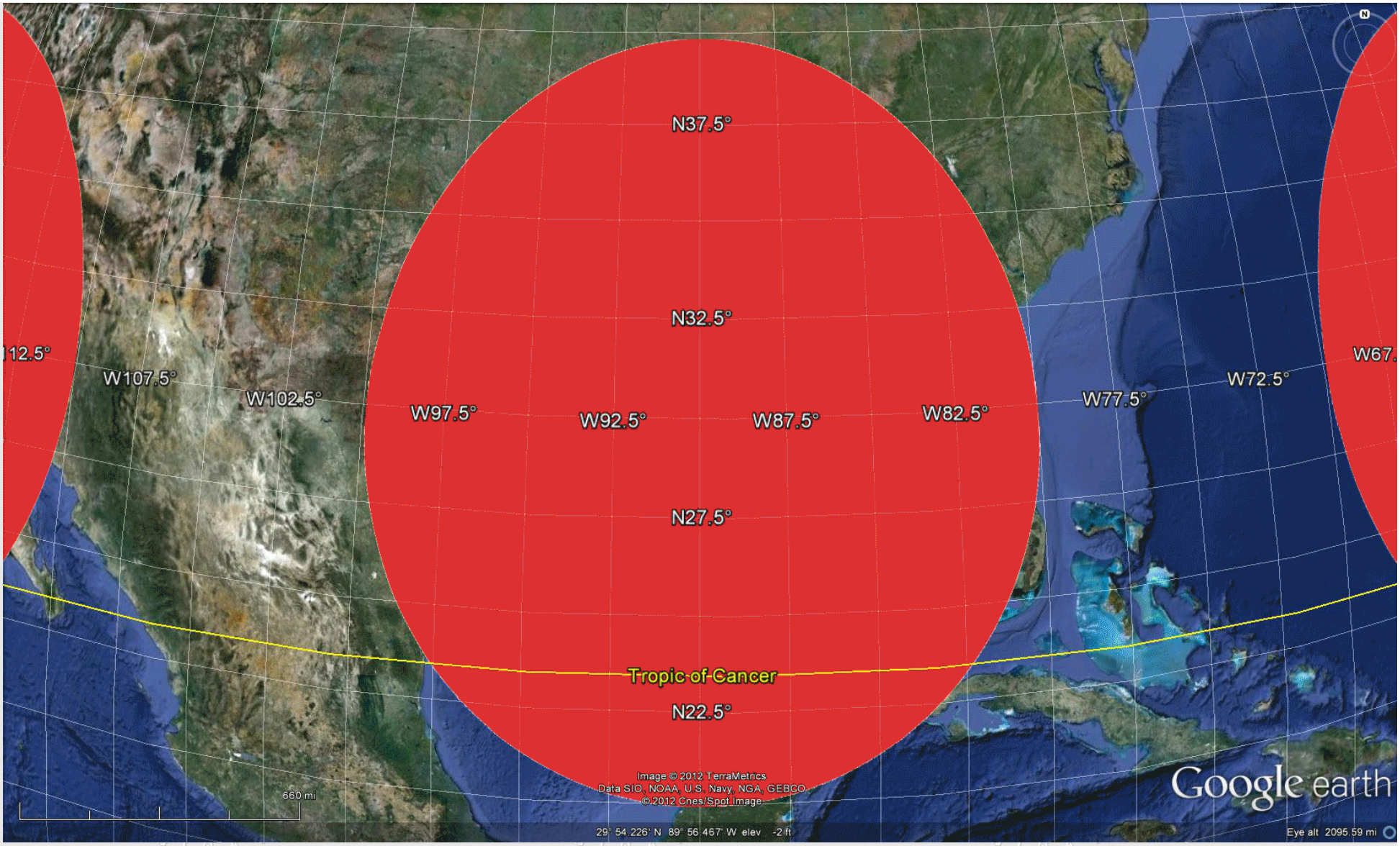


Figure 4.
Google Earth permits simultaneous visualization roads and other features within a Tissot ellipse.
Notice elongation in the weather pattern that comes in east of Florida.

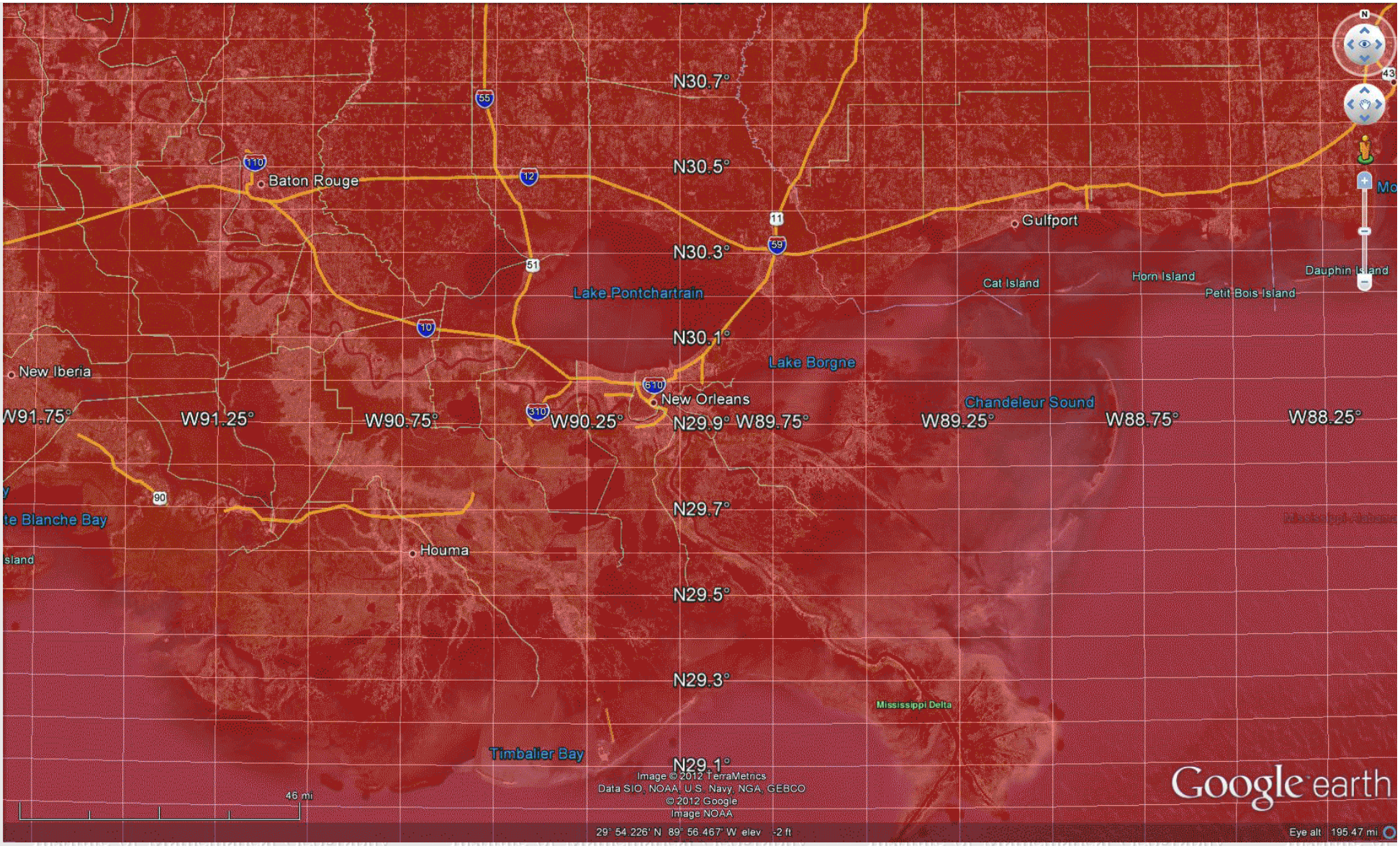


Figure 5. At a scale this local and at this latitude on this projection, distortion makes little difference in general.

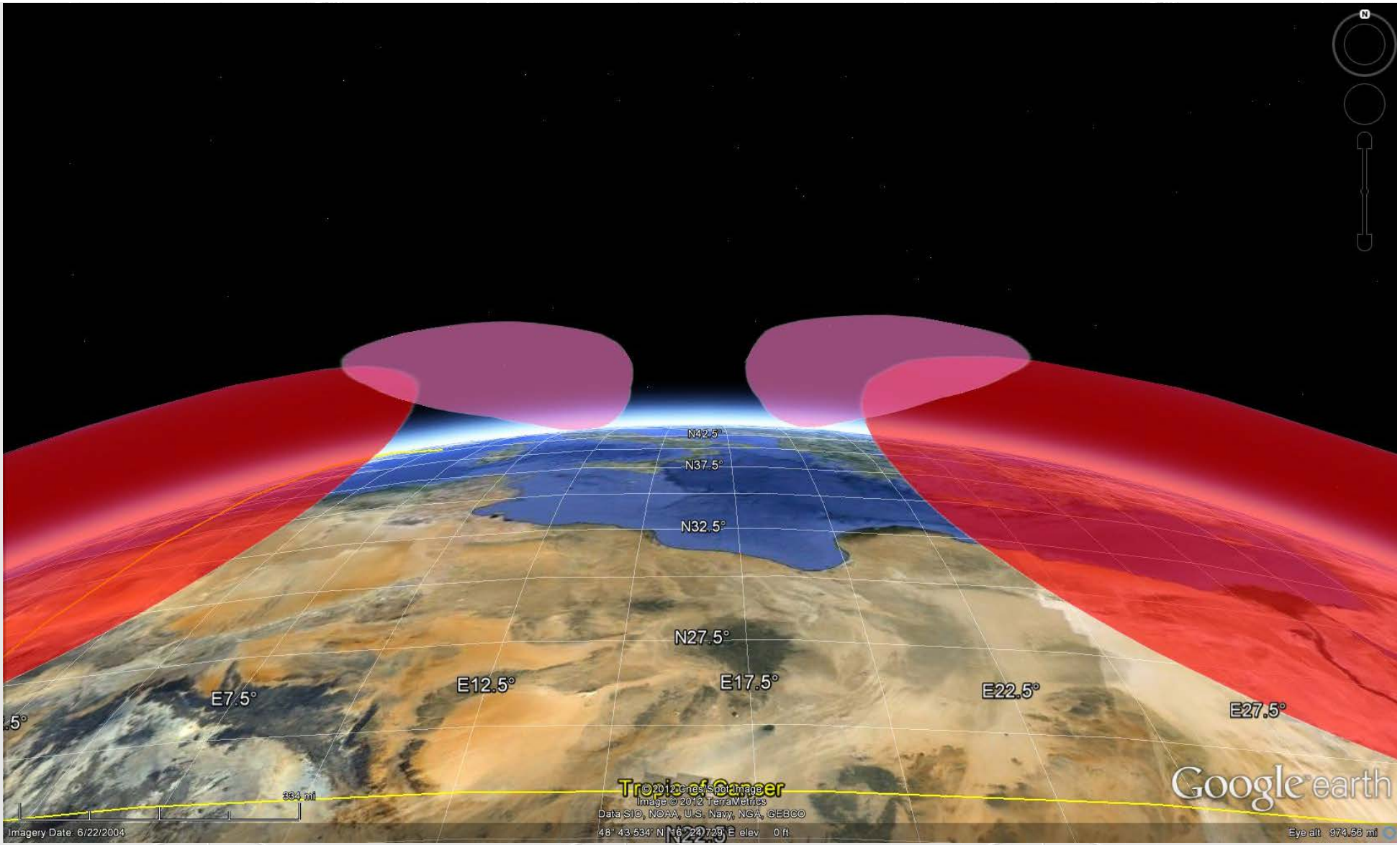


Figure 6. Tissot umbrella. Ellipses are set at successively higher altitudes above the sphere as one moves poleward.

Sampling the Environment: the Degree Confluence Project

The Tissot Indicatrix samples the graticule at the global, or at least, small scale level. A more recent project, called the Degree Confluence Project, photographically samples the Earth's graticule at integer locations of parallels and meridians in order to create an archived inventory at these locations. Try the worldwide confluence navigation tool posted on the DCP website: http://confluence.org/worldwide.php . Consider individual photos and reports of the set of discrete locations (Kerski Confluence visit at 42N, 84W, a sample

typical of such visits) . Each one gives an amount of geographic information confined by latitude and longitude within a small capsule, much as postage stamps have done so in the past. Indeed, the collection digital photographs, mounted in an "album" of Google Maps is much like the archives of the journal The CartoPhilatelist that emphasizes maps on stamps and associated stories; here, the compact stories are mounted digitally and are fashioned from virtual images--as perhaps a different contemporary view of cartophilately!

References

Arlinghaus, S. and Kerski, J. *Spatial Mathematics: Theory and Practice Through GIS*. CRC Press, Forthcoming, 2012.

The CartoPhilatelic Society. http://www.mapsonstamps.com/

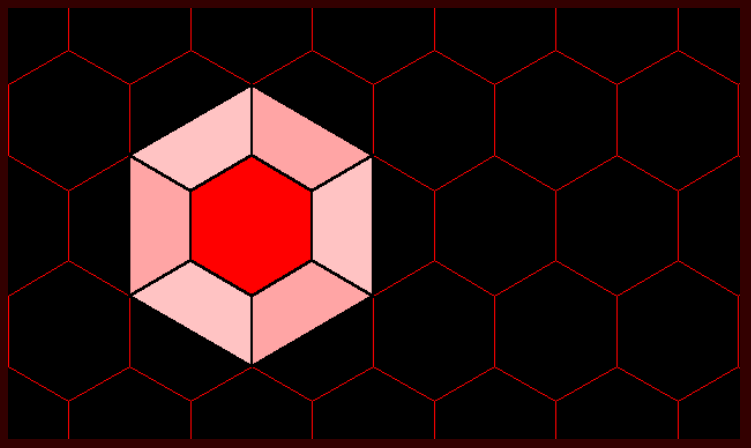
Degree Confluence Project, http://confluence.org/

Kerski, Joseph. 2012. Confluences.

Stefan Kühn. 2004. *Wikipedia*, Tissot's Indicatrix by Mercator-Projection. http://en.wikipedia.org/wiki/File:Tissot_mercator.png

Gregory F. Maxwell. 2006. *Wikipedia*, A sinusiodal reprojection of Image:Tissot_mercator.png by Stefan Kühn. http://en.wikipedia.org/wiki/File:Sinusiodal_earth_circles.png

Tissot's Indicatrix, *Wikipedia*, http://en.wikipedia.org/wiki/Tissot%27s_indicatrix



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One article in Solstice was a Pirelli INTERNETional Award Semi-Finalist, 2003 (Spatial Synthesis Sampler).

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Congratulations to all *Solstice* contributors.

Remembering those who are gone now but who contributed in various ways to *Solstice* or to IMaGe projects, directly or indirectly, during the first 25 years of IMaGe:

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1964 Boulder Drive,
Ann Arbor, MI 48104
734.975.0246

sarhaus@umich.edu