International Cartographic Association
Association Cartographique Internationale

Choosing World Map Projections

When Equal-Area Is Appropriate (and Why There Is No Single "Correct" Projection)

International Cartographic Association (ICA) — Commission on Map Projections (CoMP)

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Key messages

- No single world map projection is "correct" for all purposes.
- Equal-area projections are appropriate when communicating geographic area or quantities closely related to area (e.g., land cover or climate).
- Even among equal-area projections, there is no single correct choice; different projections trade off shape, angles, distances, and overall appearance differently.
- The Mercator projection preserves angles (a property referred to as "conformality"). However, at world scale, the Mercator projection strongly distorts areas. Therefore, it should not be treated as the default for the display of world maps.

Since the popularization of the Equal Earth projection (Fig. 1a)—developed by Bojan Šavrič, Tom Patterson, and Bernhard Jenny (2019)—there has been renewed public discussion about the choice of map projections for world maps. In response to recent public campaigns and media interest regarding map accuracy, the ICA Commission on Map Projections aims to offer clear but nuanced guidance on choosing world map projections, including when equal-area projections are appropriate.

The Earth is a three-dimensional, approximately spherical body, and any attempt to represent it on a two-dimensional plane inevitably involves distortions. Ideally, a flat map would preserve area, shape, distance, and direction simultaneously. However, flattening a curved surface necessarily introduces compromises.

No single projection is ideal for all purposes; therefore, mapmakers should choose a projection based on the map's intended use. In many cases, preserving area proportions is desirable—especially when a map's theme involves quantities that relate to area, such as land cover, climate, or population density. This principle is consistent with a core guideline of graphical integrity articulated by Edward Tufte (1983): "The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numerical quantities represented."

The Equal Earth projection satisfies this principle when the display of geographic area proportions is a primary focus. However, many other projections also preserve area, and depending on context they may be preferable. For example, the Equal Earth projection represents the poles as lines, whereas some users prefer

projections in which the poles are points—a design choice used, for example, in the Mollweide (Fig. 1b) projection.

With these caveats in mind, the Equal Earth projection is often a good choice for maps at the world scale because it preserves area while offering an aesthetically pleasing overall appearance (including moderately curved meridians and an approximately 2:1 aspect ratio). However, it distorts various other properties, such as angles or distances. By contrast, the widely used Mercator projection (Fig. 2) is conformal (i.e., it preserves angles) and North is up at every point of the map but, while useful for field or sea navigation, it greatly enlarges areas toward the poles. For this reason, Mercator is generally a poor default choice for world maps intended to communicate relative area or to enable global comparisons.

At the same time, not all thematic variables are meaningfully related to geographic area. For example, population totals, economic output, and carbon emissions are not proportional to land area. In such cases, an equal-area projection does not by itself solve a broader cartographic problem: totals mapped by country can easily mislead, regardless of projection choice. Depending on the message and audience, cartograms (maps in which areas are scaled to a quantitative variable that adds to a meaningful total when regions are aggregated) might be preferable.

Other map types might not get any advantage from an equal-area representation. On general-purpose physical maps, the overall shapes of geographic features are important, a property which is usually best fit by map projections that balance areal and angular distortions. A widespread example is the Winkel Tripel projection (Fig. 3). Such map projections, when given careful consideration, are also encouraged. Some specific map themes require special properties (displaying time zones as vertical zones, showing distance from a special point, etc.) that may even impede equal-area representations.

In conclusion, the ICA Commission on Map Projections encourages mapmakers to choose map type and projection deliberately, based on a map's purpose. Equal-area projections—including Equal Earth—are valuable tools for area-related themes, but they are not one-size-fits-all solutions. The Commission neither endorses any single projection as universally "correct" nor supports portraying the Mercator projection as "incorrect" without appropriate qualification. Instead, we advocate informed, purpose-driven choices in map design.

Furthermore, the ICA Commission on Map Projections encourages software developers of GIS to support mapmakers by providing a wide range of supported map projections and arrangements. Instead of hard-wiring any "default" map projection to display maps, a choice of map projections should always be presented to the mapmaker.

Common misconceptions

- "Equal Earth is the only equal-area projection (and the first of its kind)." Many equal-area projections exist and long predate 2019. The oldest equal-area projection, the Bonne, has been in use since the sixteenth century.
- "Mercator is inaccurate." Map projections are mathematical transformations; the key question is which properties they preserve and which distortions they introduce. For example, the Mercator projection

accurately preserves angles and maps rhumb lines as straight lines. Furthermore, the distortions of map projections are perfectly predictable; they are not errors, as their pattern is accurately known.

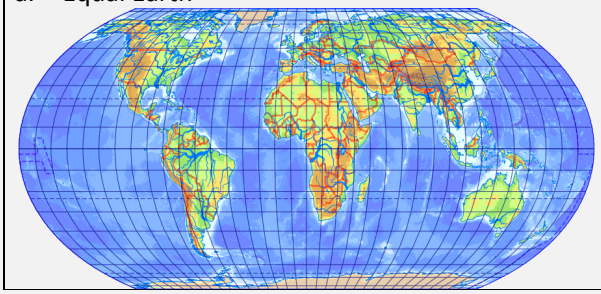
- "Choosing an equal-area projection automatically produces a fair world map." Projection choice cannot compensate for an inappropriate map type (e.g., choropleth maps where colors are used to represent totals rather than rates). Moreover, the angular distortions of equal-area maps are usually distributed unevenly: the shapes of some countries are inevitably displayed more accurately, while others are more distorted. Thus, a completely "fair" map is never possible in a strict sense.

Illustrations (examples, not endorsements)

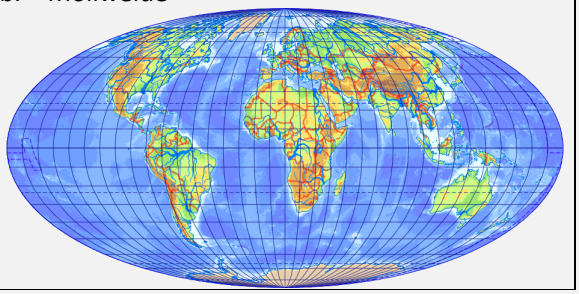
These figures are illustrative only and should not be interpreted as an endorsement of any specific projection.

1. Examples of equal-area projections (suitable for area comparison):

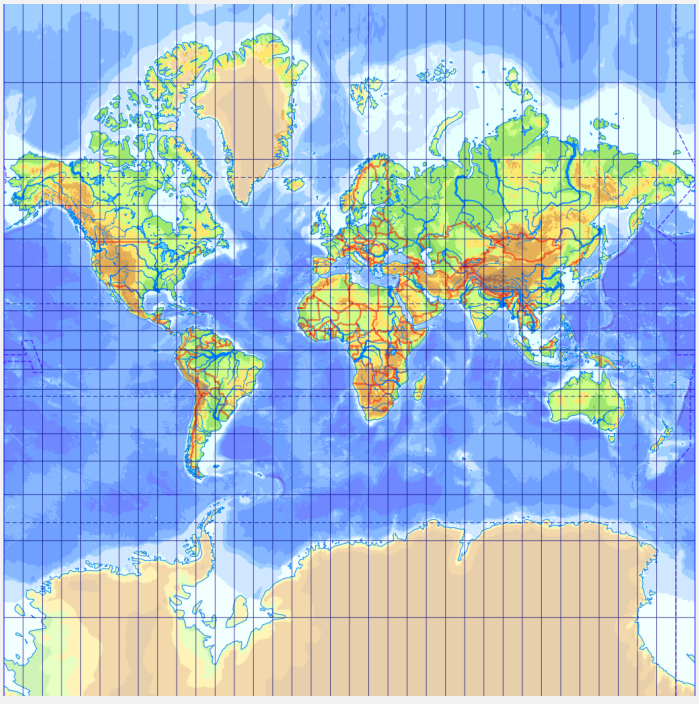
a. Equal Earth



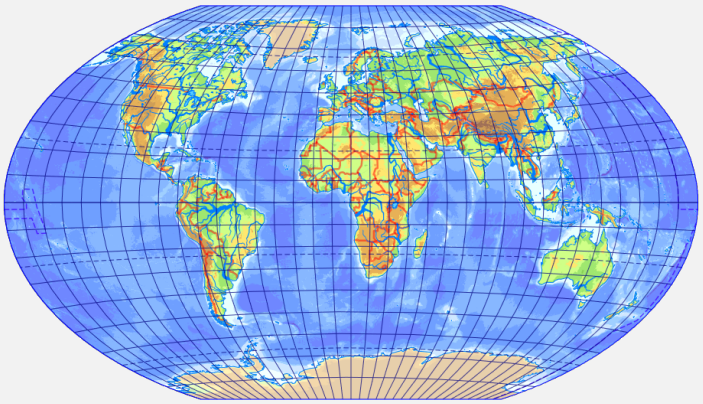
b. Mollweide



2. Mercator projection (conformal)



3. Winkel Tripel projection (neither equal-area, nor conformal)



Imprint and contact

- ICA Commission on Map Projections (CoMP) — https://mapprojections.icaci.org/

  CoMP connects researchers working on map projections and supports dissemination of map-projection knowledge.
  - **Chair:** Kerkovits Krisztián — kerkovits@map.elte.hu
  - **Vice-Chair:** Michael T. Gastner — michael.gastner@singaporetech.edu.sg

- Executive Committee of the International Cartographic Association (ICA) — https://icaci.org/executive-committee/
  - **President:** Georg Gartner — president@icaci.org
  - **Secretary-General:** Thomas Schulz — secgeneral@icaci.org

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