

Map Projections in Electronic Navigation and Artificial Intelligence

In March 2026, we asked ChatGPT, DeepSeek, Gemini, Grok and Perplexity the question: "Are nautical charts in the Mercator projection necessary in electronic navigation, or are charts in some other projections more advantageous?" In their response, everyone emphasized that maps in the Mercator projection are no longer necessary and partially explained why. In the parts of the quoted answers, we have replaced the bold letters with ordinary italics.

Explaining why the Mercator projection is no longer necessary, DeepSeek writes, "...modern Electronic Chart Display and Information System (ECDIS) allow the use of multiple projections to overcome its limitations." It adds, "...and in specific areas, especially polar regions, other projections are not only more convenient but also necessary for the accuracy and safety of navigation." For polar areas, it recommends the polar stereographic projection.

In his response, Gemini writes: "In electronic navigation, the answer is not black and white, but it leans towards the Mercator projection no longer being "necessary" in the way it was in paper navigation, although it is still the standard." It adds: "With the development of processing power, computers recalculate coordinates in real time. Therefore, other projections are often more favourable for specific needs." And further: "In electronic charts, when planning long

voyages (e.g. across the Pacific or Atlantic), the system may use the gnomonic projection." It recommends the Lambert Conformal Conic projection for areas in mid- and high latitudes. For polar regions, he recommends the stereographic projection.

Grok writes: "*No, the Mercator projection is not strictly necessary in electronic navigation, but it is still dominant and the most widespread in practice, especially in ECDIS systems.*" In conclusion it states:

- *For most navigation (tropical, subtropical and moderate latitudes, up to ~70°) → the Mercator is still the most favourable and most used → there is no need to change*
- *For polar and high latitudes → Mercator is bad → Polar Stereographic, Lambert Conformal Conic or dynamic projections are used (modern ECDIS already supports this)*
- *Transverse Mercator is often used for larger scale coastal charts (1:50.000 – 1:300.000)*

Our remark: In the Croatian text the English terms are used for polar stereographic, Lambert conformal conic and transverse Mercator projections.

Perplexity answers: "It is not necessary to have exclusively Mercator-projected charts; in electronic navigation (ECDIS/ENC) other projections are also permitted, and Mercator is dominant more out of tradition and practicality than a formal requirement."

We are publishing ChatGPT's response in its entirety because it is concise and most precise. We have not changed anything in the response except for replacing the bold letters with regular italics.

"Short answer: *they are not necessary, but the Mercator projection is still very practical for certain navigational tasks.*

Why the Mercator projection was the standard

In classic (paper) navigation, it dominated because:

- A rhumb line (a constant course line) is shown as a straightline → extremely easy to guide the ship on a constant course.
- Angles are preserved (conformal projection) → reliable for working with a compass.
- Lack:
- Large distortion of area and distances towards the poles

What is changing with electronic navigation

With the advent of systems such as the *Global Positioning System (GPS)* and *Electronic Chart Display and Information System (ECDIS)*:

- The computer automatically calculates the orthodrome (shortest path) and other routes.
- The course no longer has to be "drawn with a ruler".
- Navigation is based on geodetic calculations, not visual approximation.

Are other projections more favourable?

Yes, in some cases:

Kartografske projekcije u elektroničkoj navigaciji i umjetna inteligencija

U ožujku 2026. postavili smo ChatGPT-ju, DeepSeeku, Geminiju, Groku i Perplexityju pitanje: „Jesu li u elektroničkoj navigaciji nužne pomorske karte u Mercatorovoj projekciji ili su karte u nekim drugim projekcijama povoljnije?“ Svi su u odgovoru naglasili da karte u Mercatorovoj projekciji nisu više nužne i djelomično obrazložili zbog čega. U dijelovima citiranih odgovora zadebljana slova zamijenili smo običnim kurzivom.

Obrazlažući zašto Mercatorova projekcija nije više nužna DeepSeek piše „...suvremeni elektronički navigacijski sustavi (ECDIS) omogućuju korištenje više projekcija kako bi se prevladala njezina ograničenja.“ Dodaje: „...a u specifičnim područjima, posebno u polarnim regijama, druge projekcije su ne samo povoljnije nego i nužne za točnost i sigurnost plovidbe.“ Za polarna područja preporučuje polarnu stereografsku projekciju.

U svojem odgovoru Gemini piše: „U elektroničkoj navigaciji odgovor nije crno-bijeli, ali naginje prema tome da Mercatorova projekcija više nije *„nužna“* na način na koji je bila u papirnatij navigaciji, iako je i dalje standard.“ Dodaje: „S razvojem procesorske snage, računala u realnom vremenu pre-računavaju koordinate. Zbog toga su druge projekcije često povoljnije za specifične potrebe.“ I u nastavku: „U elektroničkim kartama, kada planirate duga putovanja (npr. preko Pacifika ili Atlantika), sustav može koristiti gnomonsku projekciju.“ Lambertovu

konformnu konusnu projekciju preporučuje za područja u srednjim i visokim geografskim širinama. Za polarna područja preporučuje stereografsku projekciju.

Grok piše: „*Ne, Mercatorova projekcija nije strogo nužna u elektroničkoj navigaciji, ali je i dalje dominantna i najraširenija u praksi, posebno u ECDIS-u.*“ U zaključku navodi:

- *Za većinu plovidbe (tropske, subtropske i umjerene širine, do ~70°) → Mercator je i dalje najpovoljniji i najkorišteniji → nema potrebe za promjenom*
- *Za polarne i visoke širine → Mercator je loš → koriste se Polar Stereographic, Lambert Conformal Conic ili dinamičke projekcije (suvremeni ECDIS to već podržava)*
- *Transverse Mercator se često koristi za karte većeg mjerila na obali (1:50.000 – 1:300.000)*

Naša primjedba: za polarnu stereografsku, Lambertovu konformnu konusnu i poprečnu Mercatorovu projekciju služi se engleskim nazivima. Umjesto „većeg mjerila“, uobičajeno je „krupnog mjerila“.

Perplexity odgovara: „Nisu nužne isključivo karte u Mercatorovoj projekciji; u elektroničkoj navigaciji (ECDIS/ENC) dopuštene su i druge projekcije, a Mercator je dominantan više iz tradicije i praktičnosti nego iz formalnog zahtjeva.“

Odgovor ChatGPT-ja donosimo u cijelosti jer je sažet i najprecizniji. Ništa u odgovoru nismo mijenjali osim

što smo zadebljana slova zamijenili običnim kurzivom.

„Kratak odgovor: *nisu nužne*, ali Mercatorova projekcija je i dalje vrlo praktična za određene navigacijske zadatke.

Zašto je Mercatorova projekcija bila standard

U klasičnoj (papirnatij) navigaciji dominirala je jer:

- *Loksodroma (linija stalnog kursa) prikazuje se kao pravac → izuzetno jednostavno za vođenje broda konstantnim kursom.*
- *Kutovi su očuvani (konformna projekcija) → pouzdano za rad s kompasom.*

Nedostatak:

- *Velika deformacija površina i udaljenosti prema polovima.*

Što se mijenja s elektroničkom navigacijom

S pojavom sustava kao što su *Global Positioning System (GPS)* i *Electronic Chart Display and Information System (ECDIS)*:

- *Računalo automatski računa ortodromu (najkraći put) i druge rute.*
- *Kurs više ne mora biti „crtan ravnomalom“.*
- *Navigacija se temelji na geodetskim računanjima, ne na vizualnoj aproksimaciji.*

Jesu li druge projekcije povoljnije?

Da, u nekim slučajevima:

- *Gnomonska projekcija*
 - o *Ortodrome su pravci → korisno za planiranje dugih oceanskih ruta.*
- *Lambertova konformna konusna projekcija*

- *Gnomonic projection*
 - o Orthodromes are straight lines
→ useful for planning long ocean routes.
 - *Lambert Conformal Conic projection*
 - o Less distortion in mid-latitudes
→ often used in aviation.
 - *Local area-optimized projections*
 - o Greater precision in smaller areas.
- Conclusion*
- *Mercator is not necessary* in electronic navigation.
 - Nevertheless, it is still very practical and widely used due to its intuitiveness and compatibility with traditional methods.
 - Modern systems like ECDIS can use different projections, depending on the purpose (route planning vs. operational navigation)."

Conclusion

The official adoption of ECDIS for marine navigation in the mid-1990s marked a revolutionary turning point in the development of electronic navigation methods. Its application on ships was initially optional, but in

2009 the *International Maritime Organization* (IMO) introduced the obligation to equip certain types of vessels with ECDIS by the end of 2018.

Since in ECDIS, navigational tasks are solved by computer on the surface of the WGS84 ellipsoid, and no longer on paper maps in the Mercator projection, this projection is no longer necessary for course determination in maritime navigation. Nautical charts in ECDIS primarily serve to visualize the ship's position in real time.

There are no official recommendations on the choice of map projection in ECDIS (Palikaris and Tsoulos 2010), but it is left to the users. This is probably because the choice of projection, even if not optimal, does not compromise navigational safety.

Despite this, cartographers are obliged to propose optimal projections for use in ECDIS. Based on the reviewed literature, Frančula (2020) provides a concise overview of relevant research. The results of the research of Palikaris and Mavraeidopoulos (2020) stand out here, who after analysing nine projections proposed three optimal solutions. For the areas between the

parallels of latitude $\varphi = -65^\circ$ and $\varphi = 65^\circ$, they recommend a modified Miller projection with standard parallels $\varphi_0 = \pm 30^\circ$, in which the deviation of the loxodrome from the direction on the map is not noticeable, while the length and area distortions are smaller than in the Mercator projection. For areas south of $\varphi = -65^\circ$ and north of $\varphi = 65^\circ$, an azimuth stereographic projection is recommended, while aloximuthal pseudocylindrical projection is recommended for displaying the whole world.

Note: In many places in the literature, the surname of Prof. Athanasios Palikaris is spelled Pallikaris. However, in ORCID it is spelled Palikaris, so we will spell it that way in this presentation.

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- o Manje deformacije u srednjim geografskim širinama → često u zrakoplovstvu.
 - Lokalne projekcije optimizirane za određeno područje
 - o Veća preciznost na manjim područjima.
- Zaključak*
- Mercator nije nužan u elektroničkoj navigaciji.
 - Ipak, i dalje je vrlo praktičan i široko korišten zbog intuitivnosti i kompatibilnosti s tradicionalnim metodama.
 - Moderni sustavi poput ECDIS-a mogu koristiti različite projekcije, ovisno o svrsi (planiranje rute vs. operativna navigacija).“

Zaključak

Službeno usvajanje ECDIS-a za pomorsku navigaciju sredinom 1990-ih označilo je revolucionarnu prekretnicu u razvoju metoda elektroničke navigacije. Njegova primjena na brodovima u početku je bila neobavezna,

no *International Maritime Organization* (IMO) je 2009. godine uveo obvezu opremanja određenih vrsta plovila ECDIS-om do kraja 2018. godine.

Budući da se u ECDIS-u navigacijski zadaci rješavaju računalno na plohi elipsoida WGS84, a ne više na papirnatim kartama u Mercatorovoj projekciji, ta projekcija više nije nužna za određivanje kursa u pomorskoj navigaciji. Pomorske karte u ECDIS-u primarno služe za vizualizaciju položaja broda u stvarnom vremenu.

O izboru kartografske projekcije u ECDIS-u nisu dane službene preporuke (Palikaris i Tsoulos 2010), već je on prepušten korisnicima. To je vjerojatno stoga što odabir projekcije, čak i ako nije optimalna, ne ugrožava sigurnost plovidbe.

Unatoč tome, kartografi su dužni predložiti optimalne projekcije za primjenu u ECDIS-u. Na temelju pregledane literature Frančula (2020) daje sažet prikaz relevantnih istraživanja. Ovdje se izdvajaju rezultati istraživanja Palikarisa i Mavraeidopoulou (2020), koji su nakon analize devet projekcija

predložili tri optimalna rješenja. Za područja između paralela geografskih širina $\varphi = -65^\circ$ i $\varphi = 65^\circ$ preporučuju modificiranu Millerovu projekciju sa standardnim paralelama $\varphi_0 = \pm 30^\circ$, u kojoj odstupanje loksodrome od pravca na karti nije zamjetljivo, dok su deformacije duljina i površina manje nego u Mercatorovoj projekciji. Za područja južno od $\varphi = -65^\circ$ i sjeverno od $\varphi = 65^\circ$ predlaže se azimutna stereografska projekcija, dok se za prikaz cijelog svijeta preporučuje loksimitna pseudocilindrična projekcija.

Napomena: Na mnogim mjestima u literaturi prezime prof. Athanasiosa Palikarisa piše se Pallikaris. Međutim, u ORCID-u piše Palikaris, pa ga i mi u ovom prikazu tako pišemo.

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