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# EVALUATING SOME NUMERICAL PARAMETERIZATION IN THE EARLY FRENCH CARTOGRAPHY OF THE AEGEAN SEA

*BOUTOURA C., TSORLINI A., DANIIL M., LIVIERATOS E.*
*Aristotle University of Thessaloniki, THESSALONIKI, GREECE*

## SUMMARY

In this paper, we visit the representative French cartography of the Aegean Sea in the period between the late seventeenth and early 18th c., using for the key-study three selected maps of this specific period characterized by the French efforts for supremacy in the Seas and especially in the Mediterranean and the Aegean Archipelago. The first map (1695) belongs to the period after the year 1685 when the French hydrographic missions in the Mediterranean are intensified. The second map is published in 1715, date which coincides with the year when the first French Atlas of the Archipelago is revised and updated. The third map dated 1738, is published after the establishment of the hydrographic service of the French navy, the *Dépôt [Depost des cartes, plans et journaux] de la marine*, in 1720 and after the second revision and updating of the Archipelago Atlas in 1730.

The three maps, characteristic of certain periods in mapping of the Aegean Sea and of certain technologies involved in the mapping, are put in a numerical comparison process using digital methods, showing how the advancement in astrogeodetic positioning as applied to mapping, resulted relevant advancement in the mapping quality especially concerning the longitudinal consistency of the cartographic representations.

## INTRODUCTION

The intense French maritime interests in the Aegean Sea and its coasts, in the second half of 16th c., were associated with the famous *Capitulations*, i.e. the clearance agreements on custom, navigation and mooring with the Sublime Porte. The French navigation interest of commercial nature in the early stage obviously became soon of geo-strategic character and the straightforward consequence of this was soon reflected on cartography and maps. The huge French map production, of various types, concerning the sea areas and the coastlines of the Aegean was constant for the coming centuries, culminated with the famous mapping of the New Greek state started from 1828 in the frame of the *Expédition de Morée* (see Livieratos 2009, with the relevant reported bibliography).

In the first phase of the French cartographic activity in the Aegean Sea and in the surrounding territories, the role of the hydrographers and experts in astronomic determination of positions is important. An elaborated report, referring to persons, facts, actions and mappings involved in this activity, is given in by Barbié du Bocage in 1807. In this scheme, the astronomic determination of latitudes and longitudes along the coasts is reported also as an important constraint in mapping and in correcting or adjusting the geometry of extant maps. It is known the interesting example of the use of the determined astrogeographic coordinates of Thessaloniki as reference figures (or constraints) in order to adjust the projected positions of the "measured" sites in previous mappings or in maps under construction.

In the paper, using properly digitized copies of historic maps related to the area of interest, we apply analytical techniques in order to study the quality of the assigned positioning figures, their consistency and the induced relevant deformations with respect to referencing to today's figures.

The results intend to contribute to the evaluation and classification of maps in this category, with respect to coordinate consistency and the overall underlying map geometry as well as to the study of the possible improvements in time due to the quality of the measurements and their treatment. The analysis of this type gives new insights in understanding better historical maps, not only as subjects of historical interest but also as carriers of technological innovation in the service of mapping and cartography.

## ON THE LATE 17TH - EARLY 18TH C. FRENCH CARTOGRAPHY OF THE AEGEAN SEA

The French cartographic interest for the Aegean Sea, as well as the much later relevant British and Dutch, goes back to the second half of the 16th c. and it is associated to the commercial relations of the European naval powers with the Sublime Porte, generally known under the general term *Capitulations* (for this trade issue see e.g. Eldem, 2006).

In continuous and firm competition with the British and the Dutch, who intensify at that time their own naval activities, the French made more systematic naval missions in the Mediterranean, especially from 1679, targeting at geo-strategic and economic goals, in relation to the affairs with the Sublime Porte, which are very active during the whole of the 18th c. In the frame of the well known project *Neptune (François),*

developed in order to give the French supremacy in the Seas, the year 1685 is richer in hydrographic missions in the Mediterranean. In the Archipelago, with its high commercial value acting also against the piracy which is flourishing in these waters, Pétré surveys the seas of the Cycladic islands. Du Mené and Plantier do the same in the Dardanelles and in Cyprus. The result of this mapping in the Aegean Sea is an Atlas of fifteen map-sheets, plans and coastal views of high aesthetic value (Morgat, 2003).

This Atlas is revised and updated in 1715 and in 1730 after the establishment of the hydrographic service, the *Dépôt [Depost des cartes, plans et journaux] de la marine,* in 1720. In 1729, the map of the Aegean Sea by van der Aa is in circulation. In the same year in Paris, Delisle publishes the popular Geographic Atlas, including a map of Greece and the Archipelago. This Atlas will be published also in Amsterdam (1733) and in Venice (1740, 1750). Later, in 1756, D'Anville publishes the map of the coasts of the Aegean and in 1764, Joseph Roux the maps of its northern and southern parts.

As Livieratos (2009) reports, Bon-Joseph Dacier, in reviewing the pre-revolutionary cartography before the French King in 1808, states that many places of Greece and of territories in Bosporus have been mapped in detail on behalf of France during the last quarter of 18th c. In this period, the activity of Choiseul-Gouffier is well known. In 1776, he starts his major mission in the Aegean with de Chabert, astronomer and member of the *Académie* (1758) and of the *Bureau des Longitudes* (1803). The result of Gouffier's activities is the exceptional three-volume work *Voyage pittoresque de la Grèce*. The first volume published in 1782, the second in 1809, including important maps edited by Barbié, and the third in 1822.

Six years after the publication of the first volume of Gouffier's *Voyage*, the classical scholar Jean Jacques Barthelemy publishes in 1788 his monumental four-volume work *Les Voyages du jeune Anacharsis en Grèce.* The cartographic support of this important writing was edited again, as in Gouffier's second volume, by Barbié du Bocage. In a fifth volume which complements Barthelemy's work, Barbié (see, e.g., the 1807 edition, *Recueil de Cartes Géographiques…*) gives an extraordinary documentation of all cartographic, geographic, astronomic, historic and travelling sources which are used in compiling his maps included in the *Anacharsis*. Barbié calls this documentation *"Analyse critique des cartes..."* elaborating critically an exhausting reference of the sources he uses, in constructing his derived maps (Livieratos, 2009 for the relevant details). These sources, referred to the Greek territories, are numerous and of various types, classified by the author in chronological and geographic order. The territories under classification and analysis cover the space from the Illyrian coasts and the western Greece to Bosporus and the coasts of Asia Minor, from Macedonia and Thessaloniki to the islands of eastern Aegean Sea, the Sporades, Euboea, the Cyclades, the Dodecanese and Crete and from Epirus, Thessaly and the Central Greece to the Peloponnese (the historically permanent subject of highest interest to the great European powers).

Barbié, in his *Recueil*, among his sources refers to the 17th c. cartography, especially the hydrographic mapping of the Dutch (e.g. Dapper, van Keulen) and the French (e.g. de Tournefort, Bellin). He is also aware of the original work by Abbé Michel Fourmont concerning his travel to Greece (1729-1730), of the D'Anville's archive (*Annales des côtes de la Grèce*, 1757) and of the geographic collection of the Foreign Ministry (*Collection géographique des Affaires-éntrangères*). Barbié's strong data collection, concerning the Greek seas and coastlines, are derived from the work of geodesists, surveyors, hydrographers and astronomers who follow the French naval missions in the Aegean and its adjacent seas in 18th c., especially in its second quarter, like e.g. Olivier and Niebuhr (1731), Vidal (1734, 1735), Varguin (1735), Gauthier (1738), Le Roy (1738). He also uses material from relevant archives of the *Dépôt de la marine* (1738). It is worth mentioning that, in the turning of 17th to 18th c., the prominent astronomer at that time Louis Éconches Feuillée (Feuillet) made a series of astronomic determinations of geographic latitude and longitude, the latter by observing the eclipses of the Moon and Jupiter's satellites, in some strategic, for the mapping of the Archipelago, coastal sites, as it is e.g. Thessaloniki, Smyrna, Candia and Chanea in Crete. At the same period, Feuillée's teacher, the hydrographer de Chazelles is performing astronomic positioning measurements in the southeast Aegean (Dodecanese and Rhodes), sometimes in association with Feuillée. Concerning the second half of 18th c. data sources, Barbié is very detailed in his *Recueil*, adding also some more data in the new introduction of the English edition (1796) of this exceptional work.

Barbié du Bocage is the standard reference of all sources used for the French mapping of Greece before the extraordinary scientific mapping project in the frame of the *Expédition de Morée* in the first half of 19th c. The French naval mapping in the Archipelago, continuous during the whole of 18th c. is the basis for Barbié's maps in the *Anacharsis* published in a volume by the end of the first quarter of 19th c. The maps of *Anacharsis*, together with his classified map *semi-topographique* of Peloponese (1803-1807) and his general map of Greece (1810-1811) characterize an important part of the representation of the Greek

territories in the early 19th c. before Lapie's 1822 and 1826 maps, preceding the scientific mapping of 1828 (Livieratos, 2009).

## REPRESENTING THE ACHIPELAGO IN THREE KEY MAPS OF THE PERIODS, 1695-1738

The cartographic representation of the Aegean Sea, the Archipelago, is a fascinating subject in the history of cartography related to the legacy of the nautical charts and the portolans of the late medieval and the renaissance period (e.g., de La Roncière, Mollat du Jourdin, 1984; Tolias, 1999). Reflections of this typology of maps, are also the relevant maps and charts published in a great variety and numbers during the 17th and 18th c.

The major problem in this type of cartography, as in any cartography where the coast-line is the foundation of the geographic figures to be represented (for a discussion see Livieratos, 2010), is on one hand, the design of the coast-line and on the other the consistency of the features related to the determination of longitude and of the longitudinal spatial widths. The effect of the weak determination of the longitude before the sea clock-measurements era was always a major problem in mapping and in cartographic representations. As it is mentioned above, the French pay attention in improving their nautical representations of the Archipelago, from the late 17th c. onwards, especially after the introduction of the *Dépôt de la marine.*

Following the above narration about the late 17th and early 18th c. French cartography of the Archipelago, we comparatively analyze here three representative maps of this period (Figure 1): A map from the late 17th c. (1695) by Berthelot, a map published little before the establishment of the *Dépôt de la marine*, by Michelot and Bremont (1715) and a map from almost twenty years after the introduction of the *Dépôt* by Bellin (1738). All three maps are separated by two decades of each other and reflect obviously the technological state of the art of each period. The first map (1695) belongs to the period inaugurated in 1685 when the French hydrographic missions in the Mediterranean are much richer than before. The date of the second map (1715) coincides with the year of the updating and revision of the fifteen map-sheets Atlas of the Aegean Sea and the third, the Bellin's map (1738), is made during the first decades after the establishment of the *Dépôt de la marine*, where, a year later (1721) the eighteen-year old Bellin was appointed as chief cartographer-hydrographer. Bellin's career culminated three years after the publishing of the map used in this study in 1741, becoming the first *Ingénieur de la Marine* of the *Dépôt* named Official Hydrographer of the King.

Concerning the longitude issue, only the Bellin map is equiped by the complete longitude and latitude framing whilst the Berthelot and Michelot / Bremont maps carry the latidute division only.

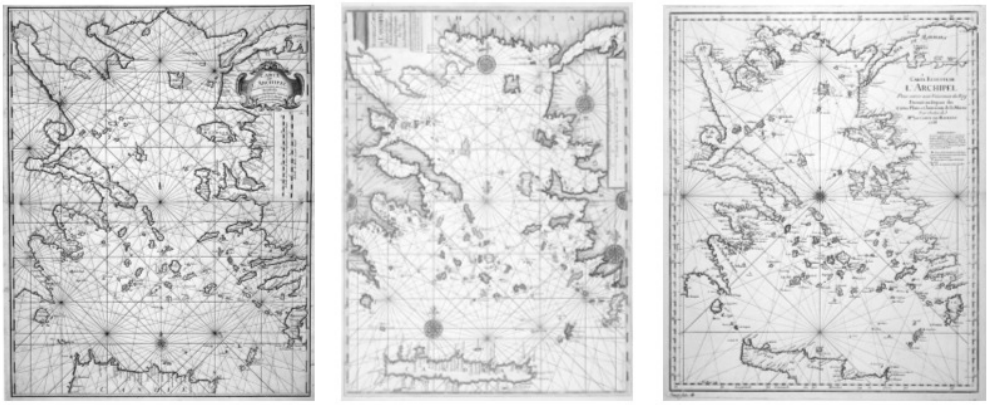


*Figure 1. Left: Berthelot (1695). Middle: Michelot / Bremonte (1715). Right: Bellin (1738). Courtesy: Margarita Samourka Map Collection.*

## THE DIGITAL COMPARATIVE ANALYSIS

The French cartographic image of the Archipelago, the two decades from 1695 to 1715, is shown in Figure 2, using the technique of the digital transparency (Livieratos, 2006; Daniil, 2006) after applying an optimal second order polynomial transformation fitting (Boutoura and Livieratos, 2006) on the relevant maps by Berthelot and Michelot / Bremont.

As expected, the general disagreement of the two maps belonging to the turn of the 17th to the 18th c. is evident, generally less in latitude than in longitude. Nevertheless, it is important to underline that except for some local shape dissimilarities there is an impressing regional representational consistency in the eastern part of the Archipelago, concerning the coasts of Asia Minor and the neighboring islands. This means that the use of the positioning data in this part of the Sea (especially the longitude determination) is

much more consistent in the two decades time span separating the two maps, which is not the case for the north, west and south coastlines where the discrepancies are much larger. The same holds for the insular central part of the Archipelago with the spectacular latitudinal deviation of the Sporades islands and the southern islands of Cyclades. Comparing the widths of the sea separating the west and the east coasts of the Archipelago, along the direction of the longitude we can say that the relevant width-figures in various latitudes (from about 36 degrees to 40 degrees latitude) are systematically less in the 1695 map by Berthelot than in the 1715 map by Michelot / Bremonte, reaching a mean value of about -12.2 primes of degree, which correspond to about -15 kilometres on the terrestrial surface, with almost the same order in standard deviation form the mean value.

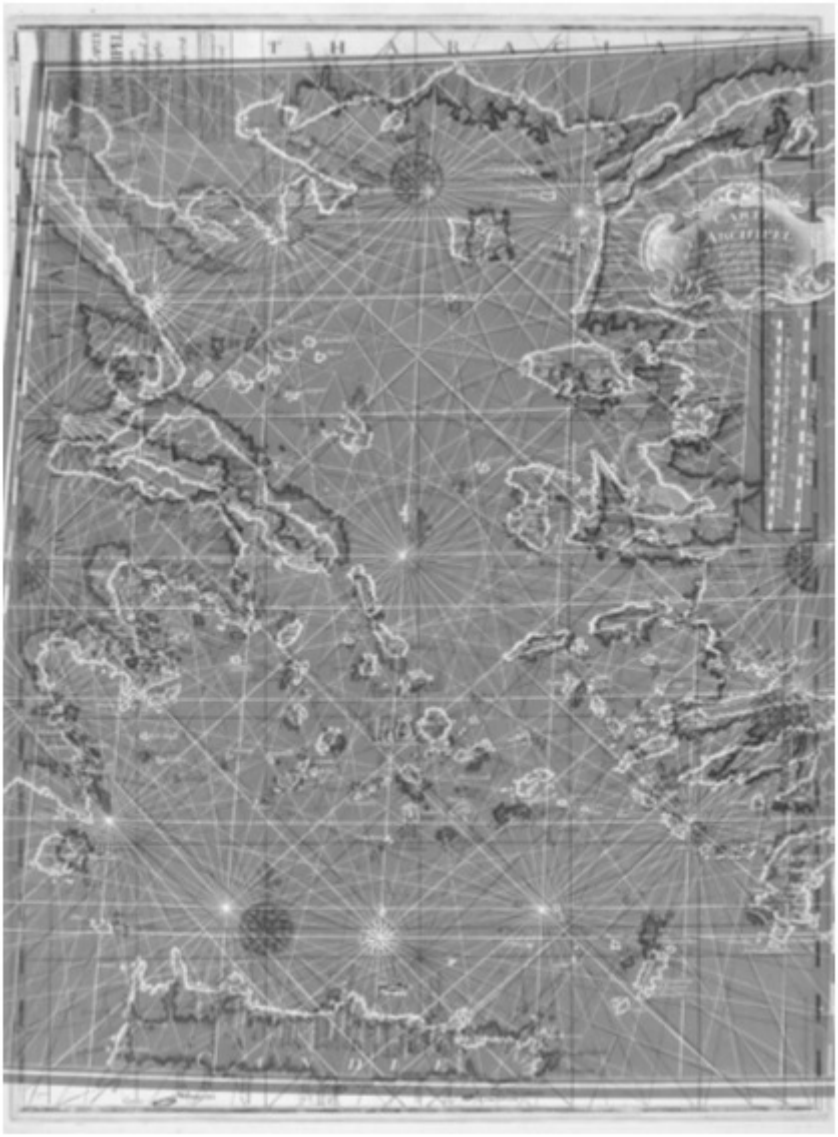


*Figure 2. The best fitting of the 1695 Berthelot map, in white outline, onto the 1715 Michelot / Bremonte map, in black outline (see text).*

The astronomic determinations of geographic latitude and longitude made by Feuillée had no impact in Berthelot's map because the first made these observations in the area starting in 1699 up to 1703 when he left for similar works overseas. It is also doubtful that Michelot / Bremonte used Feuillée's values because of the great discrepancy we observe in the longitude and latitude of Thessaloniki, given by Feuillée respectively as 20 degrees and 48 primes east of the Paris meridian and 40 degrees 41 primes and 10 seconds from the Equator. On the other hand it is obviously evident that Bellin uses, at least, this specific geographic positioning figures placing Thessaloniki exactly there, in the 1738 map. It is also known that the results of the measurements made for the positioning of Thessaloniki made by Feuillée, are used later by Barbié for the general reduction of longitudes in his map of Greece.

The Bellin map is obviously a step ahead in the French mapping of the Archipelago, in the first half of 18th c., because among other things it belongs to the mapping era after the establishment, of the *Dépôt de la marine*. It is based on new data which change considerably the cartographic image of the Archipelago, compared to the previous images of one to two decades before. Bellin is using the division of longitudes (from the Paris meridian) in his geographic map framing, correcting considerably the longitudinal width of the north part of the Archipelago representation, as it is shown in Figure 3.

Bellin is using astronomic measurements of longitude and latitude, most probably those by Feuillée, at six points in the spatial area of the map, namely Thessaloniki, Constantinople, Smyrne, Mylos Island, Candia and Chanea (all marked with a star symbol on his map). But even with this astronomic control in the periphery of the map, the latitudinal and longitudinal placement of the coastlines is still poor, as it is shown in the Figure 4 where a modern map is best fitted to the Bellin's map by applying to the modern graticule a second order polynomial transformation onto the relevant Bellin's graticule, taking of course into account the additional 23 primes difference between Ferro and Paris zero meridian used at that time, to the 20 degrees longitude.

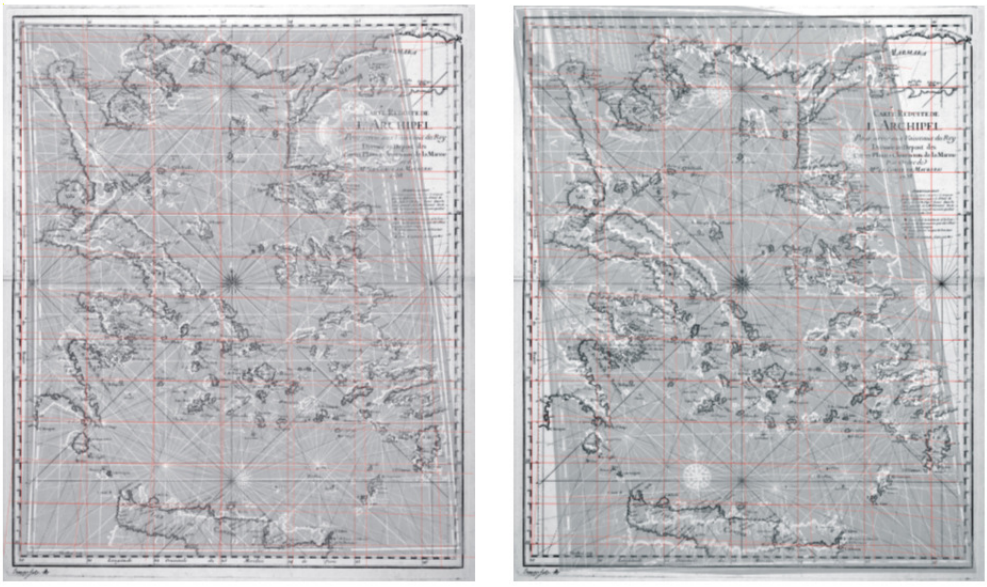


*Figure 3. Left: The best fitting of the 1695 Berthelot map, in white outline, onto the 1738 Bellin map, in black outline. Right: The best fitting of the 1715 Michelot / Bremonte map, in white outline, onto the 1738 Bellin map, in black outline.*

Observing the differences of the Bellin's representation, with respect to a modern map, one has to stress a dominant feature which comes out having to do with the longitude differences which are apparent even in places where the longitude was given by astronomic determinations at the time when the observations of the eclipses of the Moon and Jupiter's satellites used as the main method in the determination of longitude. The latitude is much better determined in the central part of the Archipelago with large discrepancies in the northern and southern parts. Of course, the determination of longitudes became comparable in accuracy to those of latitudes in the last quarter of 18th c. when it was definitively assured the reliability of the chronometer in the longitude sea measurements.

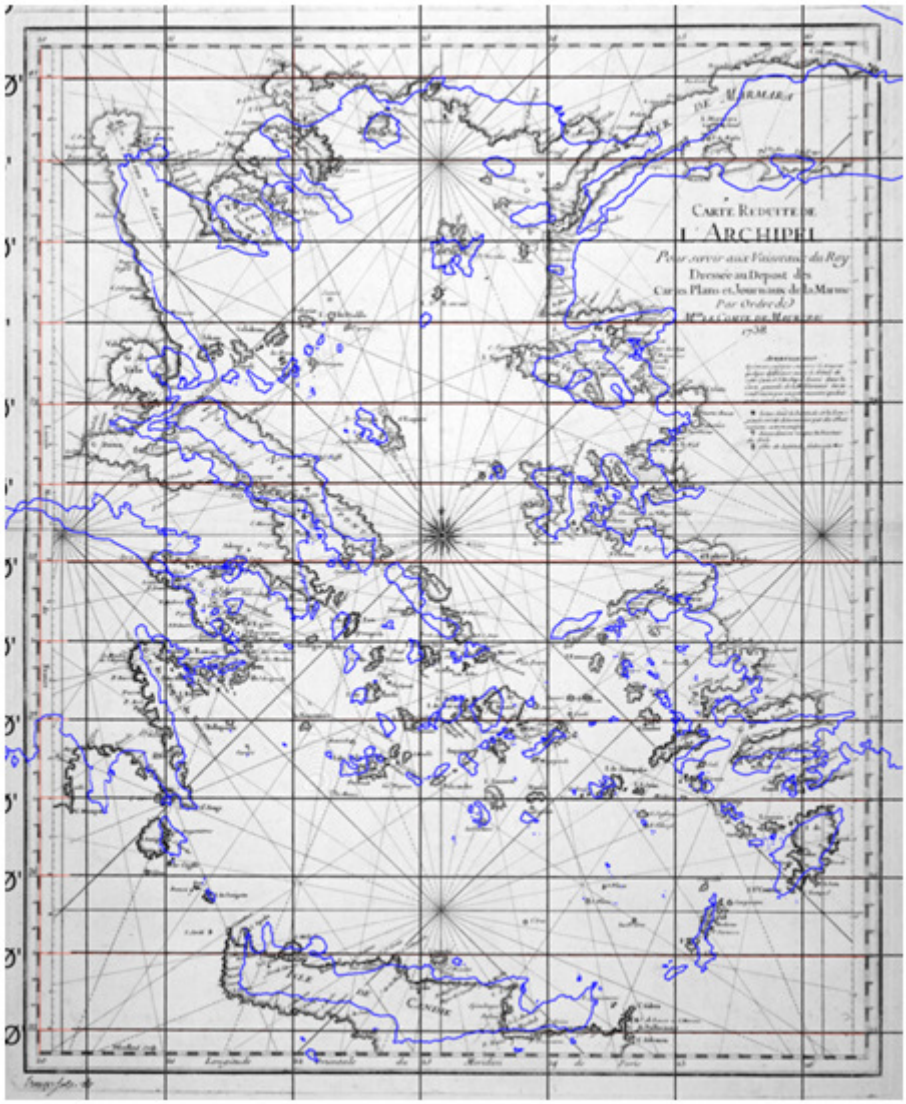
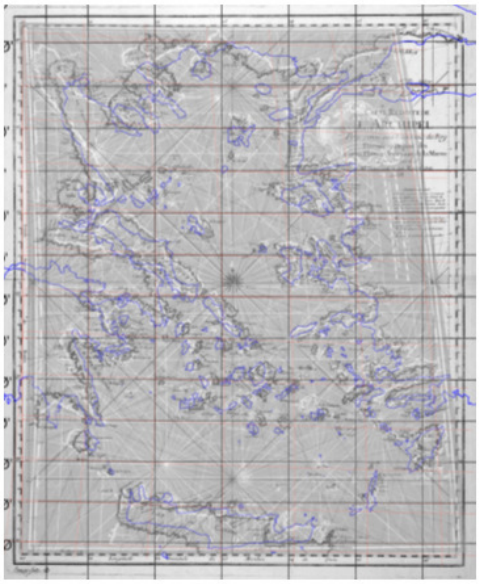



*Figure 4. The second order polynomial best fitting of a modern map (blue coastline) into Bellin's map gradicule.*



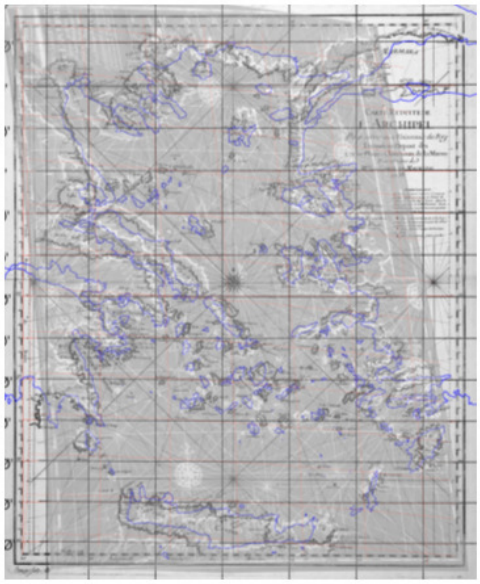


*Figure 5. Left: The best fitting of the 1695 Berthelot map (white outline) onto the 1738 Bellin map (black outline) fitted in a modern map (blue coastline). Right: The best fitting of the 1715 Michelot / Bremonte map (white outline) onto the 1738 Bellin map (black outline) fitted in a modern map (bluee coastline).*

It is interesting to point out here that comparing now the Berthelot map fitted on Bellin's map (Figure 3, Left) fitted then on the modern coastline (as in Figure 4), we get the image in Figure 5 (Left) in which we observe that in some few local cases Berthelot map is closer to the modern map layout, both latitudinally and longitudinally, which it is not the case in the relevant comparison between the maps by Michelot / Bremonte and Bellin! These few local cases in Berthelot map concern the representation of e.g. the Sporades islands, the Ikaria Island and the Karpathos – Kasos islands, just to mention some more evident examples. This means that Michelot / Bremonte and Bellin, whose maps are in any way closer, had not used the relevant data used by Berthelot, which in the cases mentioned were better than the later data.

## CONCLUSIONS

The French hydrographic mapping of the Archipelago in the late 17th and in the major part of 18th c. is a large and interesting chapter in the history of cartography in that area, almost an epopee, succeeding the previous Venetian mapping in the area. It culminated in the early 19th c. with the mapping of Greece's mainland and it is related to the strategic interests of France which are more intense compared to the antagonist powers at the time. The advances in mapping the Archipelago is evident and fast in the almost forty years period covered by the maps used in this study, characterizing the first half of 18th c. and the "pre-clock" era of the longitude determination in the sea. The qualitative step forward of the mapping after the establishment of the *Dépôt de la marine* is evident especially concerning the determination of longitudes, using the pre-clock methods.

The digital methods applied in the study of historic maps allow the disclosure of elements inherent in the internal geometry of maps concerning the consistency of the representation and the quality of the applied mapping techniques at the time. It shows also that, in some cases, older representations are better depicted with respect to modern ones, as it is the case of the Berthelot map (1695) concerning e.g. the Sporades islands, compared with the poorer relevant results in the newer maps of Michelot / Bremonte and Bellin.

A future work which could give a better view in the comparative analysis is on one hand the inclusion of more maps from the same period and on the other the embedding of available point numerical values of astronomic coordinates, measured at that time, into the unified digital environment of the analytical and graphical tools used today for the modern studies of cartographic heritage issues.

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