Ferjan Ormeling

Ptolemy's heritage, the atlas as an ordering device

Lecture addressed in the official ceremony for the *Doctor honoris causa* awarded to Prof. Ferjan Ormeling (Utrecht) by the Aristotle University of Thessaloniki, Faculty of Engineering, School of Rural and Surveying Engineering, Thessaloniki 7 May 2015

Mr Rector, Faculty Deans, students, ladies and gentlemen, I am most honoured by the distinction the Aristotle University has bestowed on me. In gratitude, I would like to highlight the bonds that exist in the field of cartography between Greece and the Low Countries on the North Sea, and so it seems inevitable that I should come up with Ptolemy and his Geography manual, the *Geographike Hyphegesis* or *Geographia*, which I consider to mark the beginning of atlas cartography.

The study of Ptolemy's work is of course the domain of Greek cartographers and historians of cartography, especially of what I would like to call the *e-Perimetron* school here in Thessaloniki,[1] which has devoted many studies to the accuracy of Ptolemy's coordinates and his projections. I admire their scholarship deeply and indeed could not compete, so I chose an altogether different, narrative, non-quantitative approach to Ptolemy. I find myself in a long line of Dutch admirers, one of which, Erasmus of Rotterdam, was the first to effectuate a printed edition **in Greek** of the *Geographia*. He edited the text, which was printed by Hieronymus Frobenius in Basle in 1533 (although without maps).

Atlas cartography

Atlas cartography can be defined as the creation or communication of spatial information by putting together an intentional combination of maps. Maps are combined in an atlas in order to enable comparisons between them. Atlases never are haphazard combinations of maps, there always should be a conscious choice regarding the maps to be selected, based on preconceived ideas about spatial relationships, or narratives. The maps to be combined must answer specific requirements regarding scale and level of generalisation, in order for their combination and comparison to be relevant and effective. Atlas production offers a framework for ordering knowledge, but is always based on a set of assumptions about the world itself.

Atlas production at a number of stages in human development has come as an answer to society's requirement of an overview of the suddenly increased geospatial information in an orderly and well-organised manner. Maps have the unique property that they show relationships between all objects rendered, and thus bring an extra dimension to any overview. In Ptolemy's time, Greek scientists for the first time produced overviews of the then available cartographical or geographic knowledge, and the most efficient way to render this knowledge proved to be the maps and lists of coordinates in Ptolemy's Geography manual. The next geo-information revolution occurred in the Age of Discoveries, when new worlds had to be integrated into the *Œcumene*, and the answer to that challenge was the production of **world atlases**, started by Ortelius and Mercator in the Low Countries.

The next geo-information revolution occurred during the 19th century, thanks to systematic gathering of physical and socio-economic data, especially in centralised states, and the reaction to

[1] *e-Perimetron*: the international web journal on sciences and technologies affined to history of cartography and maps; ISSN 1790-3769, *www.e-perimetron.org*

the challenge to present the multitudes of resulting data in an orderly fashion proved to be **national atlases**. The narrative used there was the thematic sequence of the *länderkundliches Schema*, starting with geology and ending with tourism, showing how people had used the physical environment. Finally, our last geo-information revolution, in which we are still immersed, is the digital revolution, and the current need for handling this present geo-data deluge is answered also by the production of **digital atlases,** often in the form of **web atlases**. Here we have not developed new, adequate structures as yet. But all these different types of atlases go back to the first model or standard, set by Ptolemy.

Ptolemy's contribution

Uniformity of coordinates

When I enumerate Ptolemy's contributions in the field of geography and cartography – these are all well known to you, of course – I should first mention his **uniform coordinate system**, indicating longitude and latitude for every object listed. This had not been done before, and his immediate predecessor and example, Marinos of Tyre, had not gone further than listing all objects on the same longitude or on the same latitude. Ptolemy and Marinos are shown together in figure 1, like caryatids carrying the building of geography, on the title page of the modern map section in the first complete edition of Mercator's 1595 world atlas.

Compilation and usability

Ptolemy's second contribution would be his **geographical compilation work**: he matched the inaccurate and often conflicting locational data and distances mentioned in travel accounts and official reports with the few known astronomically fixed positions. And this compilation work resulted in his list of towns – altogether some 10 000 topographical objects with their coordinate pairs are listed by him. Marinos also had produced a list of towns but without the coordinate pairs. In his manual Ptolemy stresses the importance of a well-organised and user-friendly (he used the terms *euchreston* or *procheiron*) presentation of these data, so he had the importance of **usability** in mind in our current jargon. He complains that in Marinos' book one has to go through the whole treatise in order to find both longitude and latitude of a place.
Ptolemy gives the construction principles of 3 different new world map projections; the most important of which is a simple conical projection in order to correct for the extreme distortion in higher latitudes. This projection was copied into most manuscripts, for a planimetric description of the *Œcumene*, and I would consider this his third contribution. The other two projections he devised are not commonly used.

Spatial subdivision

For me, Ptolemy's main contribution is his concept of the **subdivision** of the known world into regions, to be mapped separately. He calls them his *akribesteroi pinakes*, his more detailed maps. Here he opts for the rectangular cylindrical projection devised by Eratosthenes and also used by Marinos, but rectified for the true length of the parallels, by shortening the degrees of longitude comparatively. Ptolemy subdivides the known world into 26 maps, and he adjusts their scale to the amount of detail to be incorporated. And the objects that belong on these maps are rendered both in the text and on the map according to their coordinates. This principle, of storing data according to their geographic coordinates on regional maps that can be increased or decreased in

scale according to their data load, is still used all over the world, and especially so in new digital storage modes, like for example the photographs contained in *Google Earth* of *Flickr.com.* Here, the further one zooms in, the more information becomes available, in this case more pictures that have been uploaded with their coordinates by visitors.

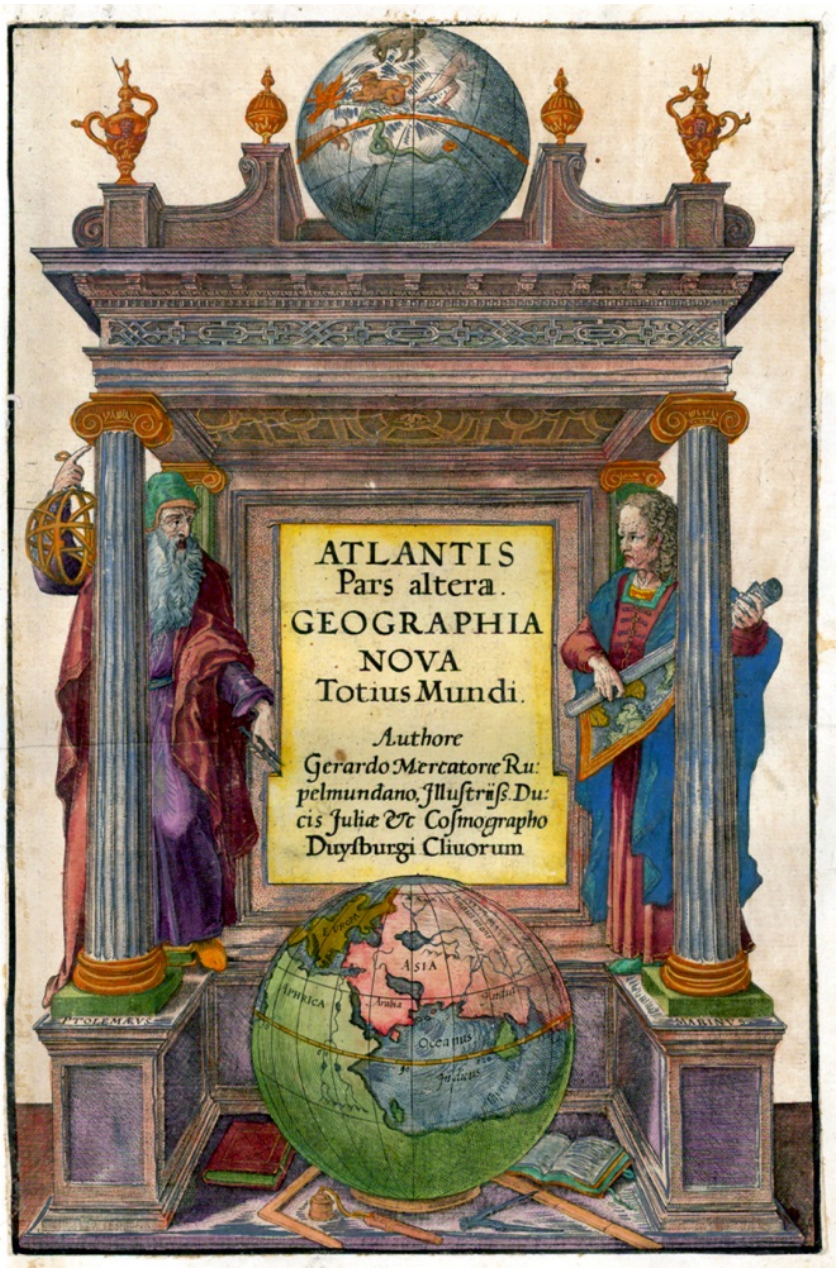

Figure 1. Title page of the modern map section in Mercator's 1595 atlas

There has been much discussion as to whether or not the original manuscripts of the *Geographike Hyphegesis* contained maps or not, but the following arguments may convince you, thus strengthening my case that Ptolemy indeed produced the first atlas, as he systematically covered the *Œcumene* with his regional maps (the counter-argument was that the original manuscript contained no maps, but that these were constructed later on the basis of Ptolemy's guidelines).

- In the remaining manuscripts there have been marginal annotations (*scholia*) that refer to older texts that did contain maps

- There are common correct characteristics of the maps that have been misrepresented in the texts
- There is information in the maps, which is not contained (any more) in the texts – such as the location of unnamed mountains where rivers originate.

There thus seems to have been a common archetype for the maps; most probably already contained in the original manuscript. All the maps in the various editions have the same colouring for countries, all have been inscribed by upper case letters, whereas this was no longer fashionable in the 12th century when Maximos Planudes in the Chora monastery, then outside Constantinople, copied the version that was used as a model for all later manuscripts, including the one in the Vatopedi monastery on the Holy Mountain. And maps in different manuscript strands bear the same town symbols, differentiated according to the nations that inhabited them. In figure 2 (Stückelberger 2006), we see maps from different manuscript editions, all showing two mouths for both the Guadalquivir (Anas) and the Guadiana (Betis) river in Spain; where in the text of the *Geographia* only one mouth, the easternmost one in both cases, is mentioned with its coordinates. So the maps give more information than the texts.
As to the chronology, the Swiss expert Stückelberger claims in his *Ptolemaios Handbuch der Geographie* that even if the maps were not part of the original edition, they at least had to be part of the manuscripts before 200 AD, when two manuscript versions diverged, so within 40 years of its first publication. Even if some editions show little crosses for the plotted coordinates, these do not occur everywhere, so that map models must have been available as well.
Throughout Ptolemy's *Geographia* there is a strict sequence in the entries for all provinces: first their circumferences (*periorismos*), delineation of the coastline and rivers, the relative positions of the more important nations living there, the towns, rivers and gulfs, mountains, and finally islands and other objects that may be entered on maps. The most important towns (*poleis episemoi*) have been highlighted, thus structuring the information.

Diagonalisation

Ptolemy takes much pain to describe the correct sequence for plotting the maps: in order to enable easy plotting of the maps one should proceed from upper left to lower right, as the hand of the draughtsman thus can go from the already plotted objects to those that have not been drawn as yet. So the northerly objects have to be drawn before the more southerly and the westerly objects before the more easterly situated. This structuring of the information can be called **diagonalisation**, and the major theoretical cartography manual, the *Sémiologie graphique* by Jacques Bertin, published in 1967, also calls for *diagonalisation* as a way for structuring graphical information.

Scale

Ptolemy's main legacy for cartography is the ability to organise geospatial data in its optimal geospatial reference frame, made possible by georeferencing in a clear way, and by supplying the means – his 26 regional maps – to accommodate the collected data and visualizing them clearly, without clutter, by manipulating the **scale** factor (see figure 3).
To show the impact of map scale in an atlas, I refer to the school atlases produced here at the Aristotle University by the cartography staff (Livieratos 1995): it is only by presenting the whole of Europe in regional maps at the same scale, that one gets a correct impression of the magni-

tudes involved, because readers are able to extrapolate the knowledge of their home area to other regions, rendered at the same scale and with the same symbology.

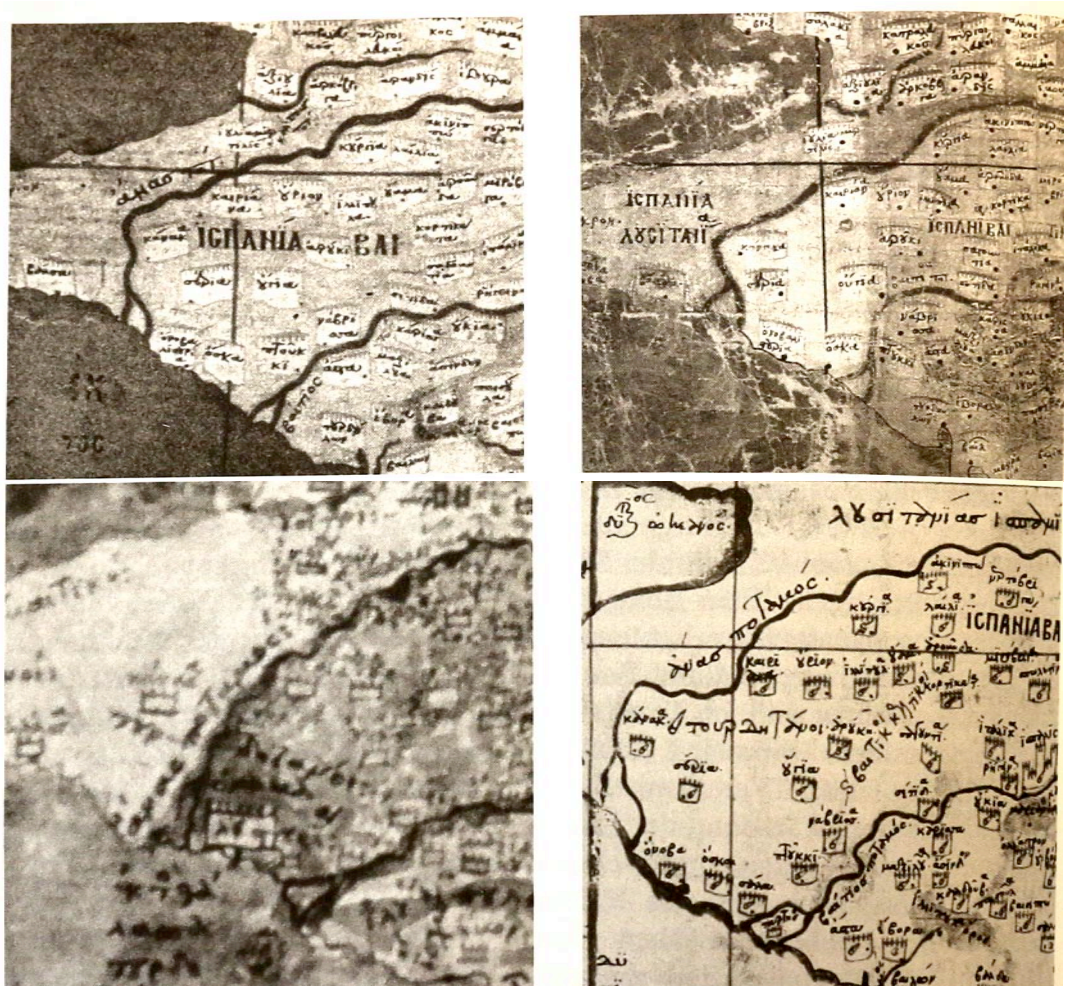

Figure 2. Maps from different Ptolemy's manuscript editions, all are showing two mouths for both the Guadalquivir (Anas) and the Guadiana (Betis) rivers in Spain. Stückelberger and Grasshoff (2006)

Sequence and emphasis

Whether intentional or not, Ptolemy added two factors to his presentation that I regard as characteristic for atlases: **sequence** and **emphasis**. It was especially the diagonal **sequence** he introduced that still is used in World atlases all over the world, two millennia after him: ranging the maps from Northwest to Southeast. The **emphasis** he applied can be deduced from the scale: on map sheets of the same size, such as in an atlas, the larger the scale, the smaller the area mapped and the more detail that could be inserted, so the more important the area must be for the cartographer: Ptolemy's largest scales are for Greece, Moesia, Italy and the Alpine countries and, surprisingly for Sardinia and Sicily. Then come, on a smaller scale, maps of the British Isles, France, Germany, Syria, Armenia and Anatolia. Further away to the East and the South the scale drops further. The smallest scale is the overview map of Africa. The presentation of maps at the same scale meant that by knowing **one** of the areas, one would be able to get a good idea of the distances and structure of the other areas at the same scale, the more so where the same symbols would have been used.

When we look at the art of storytelling, we find that in each story a number of events is told in a specific sequence, and some events are getting more attention than others, because they are considered more relevant for the story. As I claim a narrative characterizes each atlas as well, I can equate individual happenings in a story to the individual maps contained in a paper atlas, which by necessity are put in a specific sequence. This aspect of Ptolemy's work has not attracted much attention as yet, and I will elucidate it by referring to one of Ptolemy's epigones in the Low Countries by the North Sea.

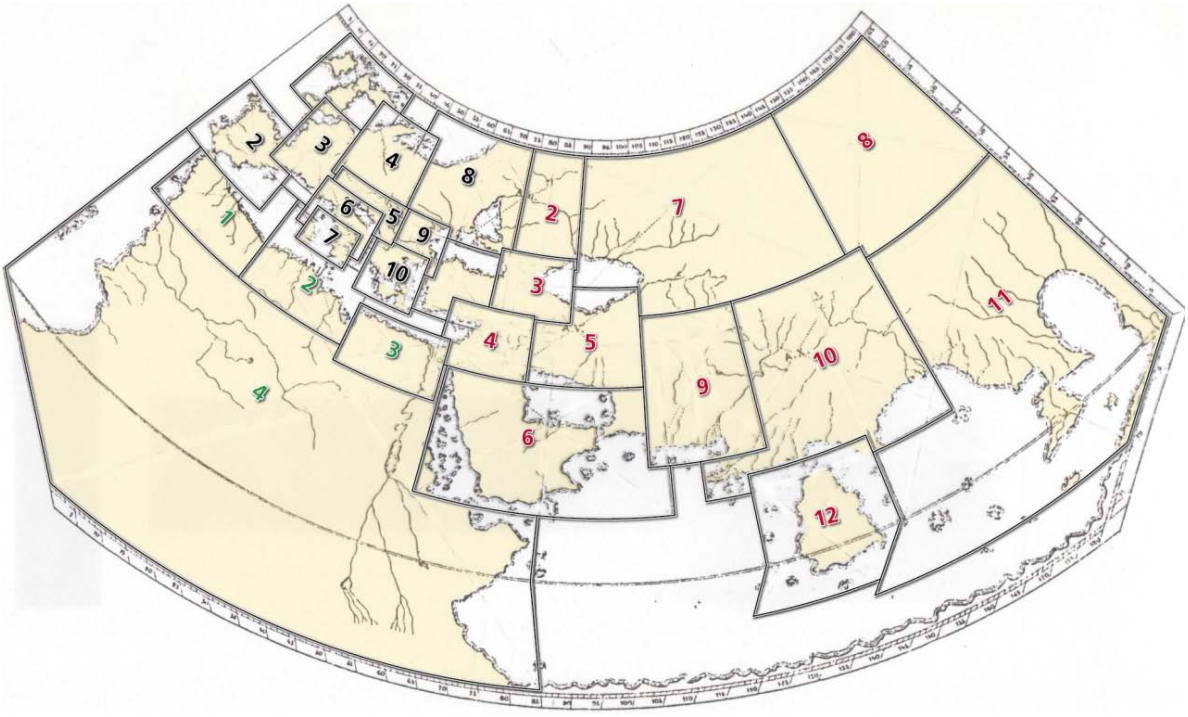

Figure 3. Sequence and emphasis as embodied in Ptolemy's regional maps:
10 for Europe (black), 4 for Africa (green) and 12 for Asia (red)

Wytfliet, Ortelius, Mercator and Waghenaer

Wytfliet – Ortelius

In 1597 Cornelis Wytfliet from Louvain produced an addendum to Ptolemy's Geography manual: the first atlas of the New World, titled *Descriptionis Ptolemaicae augmentum*. In figure 4 one also may see the effect of sequence and emphasis: after the overview map of the Americas the atlas starts in the south (map no. 2) in the Strait of Magellan and works upwards towards the north; the last map depicts Greenland and Iceland (map no. 19). So the Ptolemaic sequence starting in the Northwest and ending in the Southeast was reversed. Wytfliet states his reasons for this deviation: he proceeds from Ptolemy's work that leaves his readers in the Far East: He says: *For those that proceed from the easternmost Orient towards the south the Southland occurs. It is seemly, for the benevolent reader, carried away by the descriptions of ancient geographers, to start the description of the new world and its parts from there, subsequently progressing gradually towards the equator and the north, and to guide [him] back to his family and home as if it were on a distant pil-*

grimage.[2] So Wytfliet brings his readers home again from where Ptolemy left them, ending his sequence closest to Ptolemy's start: Ultima Thule.

Figure 4. Title page and map sheet index of Wytfliet's Descriptionis Ptolemaicae Augmentum (1597)

The **emphasis** in this atlas is even more to the point (see figure 4): as all maps have the same size, it is the smaller maps in this overview map index sheet at right that have the largest scale, and thus more detail. So it is the islands in the Caribbean: Cuba and Santo Domingo, that get most attention, followed by Panama and Central America and then the area of the Strait of Magellan, one of the gates to the Spice Islands. Alaska, Canada and Greenland have the smallest scale and therefore get the least attention; as they are in the end of the sequence as well, their relative position really is bleak!

A similar **hierarchy** can be worked out for Ptolemy, where China is penultimate and Ceylon comes last, even if it has a larger scale. In Wytfliet's atlas some areas are not rendered on a regional map altogether, so he provides no complete coverage, contrary to Ptolemy, who did present his chosen *Œcumene* completely.

Wytfliet just extended the scope of Ptolemy's coverage of the *Œcumene*, but what **concepts** have been added to Ptolemy's Geography manual in the 16th century Low Countries? Lafreri in Rome in the 1560s had popularized binding together existing maps to command in a book binding, following the order set by Ptolemy, thus providing the physical shape for combinations of maps, and a recognizable sequence, easy to handle and to remember. This can be called **unity of form**.

Ortelius in Antwerp in 1570 had the maps for his world atlas all printed at the same time in the same size and format (I call this '**unity of print**'), in order to be bound together. He was the first to provide a full cartographic coverage of the known world with **modern maps** – before him

[2] *Ex ultimo oriente per meridiem progredientibus, Australis terra occurrit. Inde novi orbis partiumque eius descriptione-mordiri visum est, deinde sensim aequatori, mox Septentrioni succedendo, benevolem lectorem, antiquorum Geoghraphorum desciptionibus abductum, tāquam ex longinquâ peregrinatione, ad proprios avitosque lares domum deducere.*

there had been map books that were reissues of Ptolemy's maps or combinations of Ptolemy's maps and modern maps.
A new aspect of **sequence** is that it is understood in cartography nowadays as providing **causal connections**. If a number of thematic maps of the same area are presented sequentially in an atlas, the patterns in each new map are automatically understood by the readers to have been caused by the phenomena displayed in the previous map. We cartographers are using such automatic reactions by readers for a better communication, as shown here in this atlas spread from a Canadian school atlas, where the sequence, in which the maps and graphics are to be read, is inferred by the numbers added to them (InterAtlas 1986). For example, the size of the wheat harvest is decided by the quality of the soils, the amount of precipitation and the length of the growing season, as shown in the preceding maps.
Back to Ortelius, we see that he furthermore took care to select existing regional maps from the best cartographers available, but he did not collate the information in these maps (see figure 5), so that the same area might be displayed differently on different map sheet, with different data and symbols. So his maps did display what I call **unity of form and print,** but not **unity of contents**. What he also contributed were explanatory texts for the maps, so in a way he combined Ptolemy with Strabo. But Ortelius' coverage of the whole known world with contemporary maps was no innovation compared to Ptolemy, because the latter had already done the same in his time.

Mercator - Waghenaer

The **unity of contents** (see also figure 6), the rendering of a specific area on different maps in the same way, with the same objects, locations and symbols, was for the first time achieved by Mercator (1598) and Waghenaer (1584) in their land and sea atlases respectively, at the end of the 16th century. This could only be achieved through an enormous amount of compilation work, and this is the reason why Mercator did not live to see his atlas printed, as he died aged 82, a year before his atlas was published. Of course there was much more geospatial information available at his time, but it also puts in perspective Ptolemy's compilation achievements. Conceptually Mercator's unity of contents implied an enormous step forwards in atlas cartography, together with the development of standard atlas legends, applicable to all maps, with the standard legend for Waghenaer's sea atlas). But, as was the case with Ortelius' contributions, this really is a rediscovery of Ptolemy's modus operandi as well, as the latter, because he first made a compilation and a concordance of the available information, was able to avoid any discrepancies between the information plotted on different map sheets.

Ptolemy's influence in the Low Countries

To strengthen the links with Ptolemy, I should mention that Mercator also republished Ptolemy's atlas, with corrections, as part of his cosmography project in 1578: under the title *Tabulae Geographicae C. Ptolemaei ad mentem autoris restitutae et emendatae.* His version, for which he engraved the maps himself, with its elegant and superbly readable script, is generally considered, the finest of the many versions of the maps from the *Geographia*. And a few years later, in 1584 he published a complete Latin edition of Ptolemy's Geography manual (*Cl. Ptolemaei Alexandrini Geographiae libri octo recogniti iam et diligenter emendati: cum tabulis geographicis ad mentem auctoris restitutis ac emendatis, per Gerardum Mercatorem*). Figure 7 shows a sample of Mercator's engravings of Ptolemy's maps, with the winds, like Boreas, Eurus and Notus, blowing from the heavens.

The links with Ptolemy are everywhere to be found in the work of the cartographers of the Low Countries, as Mercator, for both these editions, certainly used Ortelius' adaptation of Ptolemy's lists, added to the Latin edition of his atlas as the *Nomenclator Ptolemaicus*, a list of all toponyms contained in Ptolemy's manual and maps with their modern equivalents. A few years later (1605) Jodocus Hondius and Cornelis Claesz published a bilingual version of the *Geographia,* combining Mercator's Latin edition with a Greek version edited by Petrus Montanus. Thus Dutch cartographers produced their works and new atlas versions in a constant dialogue with Ptolemy.

Figure 5. Two details from Ortelius' atlas Theatrum Orbis Terrarum (1570), showing unity of content was lacking. Above: detail from map of England; below: detail from map of France.

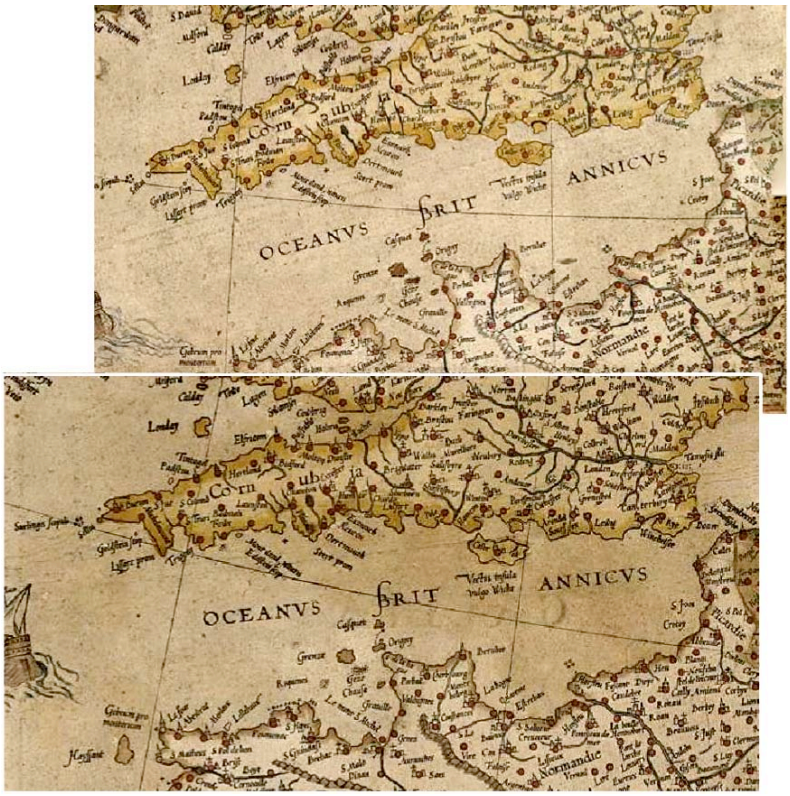

Figure 6. Two details from different atlas pages in Mercator's 1595 atlas; above: detail from map of England; below: detail from map of France.

The superior lettering of Mercator's atlases further improved the **usability** aspect Ptolemy had already strived for. Indeed Mercator even wrote a book on penmanship (*Literarum latinarum, quas italicas, cursoriasque vocant, scribendarum ratio*, 1540) and although he was not the first to use the Italic script for lettering his maps (Engelhart & Brand 1959), he provided unquestionable proof that Italic script was ideally suited to that purpose.
By the adaptation of the contents, size and shape of atlases to the functions they were supposed to perform – differentiating between land and sea atlases, and between large folio atlases for the wealthy and pocket atlases for those with more restricted means. Dutch cartographers also implemented again the concept of usability in cartography, and ultimately this led to the manifold manifestations of atlases we see today. But it is the formula provided by Ptolemy that allowed the atlas to accommodate new worlds, and exercise new functions.

Figure 7. Map of the *Œcumene*, from Mercator's 1578 edition of Ptolemy's atlas.

In conclusion…

I am proud of having been instrumental in furthering this atlas tradition over the years and also in facilitating the work of the (Greek) cartographic heritage research group within the International Cartographic Association, as they have contributed greatly to our knowledge of as well as the preservation of that cartographic tradition.
How much cartographers even in 18th century Netherlands regarded that heritage as originated in Greek Antiquity can be seen in figure 8, on the title page from an atlas by Ottens (1725) where sea-god Poseidon with his trident and earth-goddess Cybele with her lion and city-shaped headdress are dictating to Kleio what to write down about the Earth (Bischoff 2015). While Titan Atlas is standing by, carrying the celestial sphere, she, Kleio, in the guise of *Geographia*, has dropped her lyre in favour of measuring equipment, thus uniting the humanities with the engineering sciences.

Thank you.

Figure 8. Title page of Ottens' Atlas Major, Amsterdam ca.1725

References

Bischoff, Michael (2015) Zinnebeelden op titelpagina's van vroegmoderne atlassen. *Caert-Thresoor,* vol 34-1, pp 3-13.

Engelhart, Ben & Chris Brand (1954) *Naar beter handschrift*, Oudenbosch: Uitg. Parcival.

L'InterAtlas: les ressources du Québec et du Canada. Montréal, Centre éducatif en culturel, 1986.

Livieratos, Evangelos, Chrysoula Boutoura and Myron Myridis (1995) *Neos scholikos atlantas tis Europis,* Thessaloniki: Rekos.

Mercator, Gerard (1540) *Literarum latinarum, quas italicas, cursoriasque vocant, scribendarum ratio*, Leuven: Rutgerus Rescius

Mercator, Gerard (1572) *Atlas Europae*.

Mercator, Gerard (1578) *Tabulae Geographicae C. Ptolemaei ad mentem autoris restitutae et emendatae,* Duisburg.

Mercator, Gerard (1584) *Cl. Ptolemaei Alexandrini Geographiae libri octo recogniti iam et diligenter emendati : cum tabulis geographicis ad mentem auctoris restitutis ac emendatis,* Duisburg.

Mercator, Gerard (1595) *Atlantis pars altera. Geographia nova totius mundi*, Duisburg. (This is in fact part of the *Atlas sive cosmographicae meditationes de fabrica mundi et fabricati figura* issued that year).

Mercator, Gerard and Petrus Montanus (1605) *Claudii Ptolemaei Alexandrini Geographiae libri octo Graeco-Latini.* Uitgegeven door Jodocus Hondius en Cornelisz Claesz, Amsterdam.

Ortelius, Abraham (1570) *Theatrum Orbis Terrarum*, Antwerp: Plantin.

Ortelius, Abraham (1584) *Nomenclator Ptolemaicus*, Antwerp: Plantin.

Ottens, Reinier and Josua (ca. 1725) – *Atlas major, cum generales omnium totius orbis […] tabulas geographicas continens*, vol. 1, Amsterdam.

Ptolemaeus, Claudius (ca. 160) – *Geographia*, Alexandria.

Stückelberger, Alfred und Gerd Graßhoff (2006) *Ptolemaios Handbuch der Geographie,* Basel: Schwabe Verlag.

Waghenaer, Lucas Janszoon (1584) *Spieghel der Zeevaert*, Leiden: Plantin

Wytfliet, Cornelis (1597) *Descriptionis Ptolemaicae augmentum*, Leuven: Johannes Bogaard.

Ferjan Ormeling, Dr h.c. Aristotle University of Thessaloniki, 7 May 2015