

ERRORS IN NAVIGATION,

1 Error of two, or three whole points of the Compass, and more sometimes, by reason of making the sea-chart after the accustomed manner, with right lined rumbes, and equall degrees of latitude.

2 Error of one whole point, and more many times, by neglecting the variation of the Compass.

3 Error of a degree and more sometimes, in the use of the crosse staffe, especially by not regarding the eccentricitie of the eie.

4 Error of 11. or 12. minures in the declination of the Sunne, as it is set forth in the registments most commonly used among Mariners: and consequently error of halfe a degree in the place of the Sunne.

5 Error of halfe a degree, yea an whole degree and more many times in the declinations of the principall fixed starres, set forth to be observed by mariners at sea.

Detected and corrected by often and diligent observation.

Whereto is adioyned, the right H. the Earle of Cumberland his voyage to the Azores in the yeere 1589. wherin were taken 19. Spanish and Leaguers ships, together with the towne and platforme of Fayal.
By Edward Wright.

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To the right Honourable, George
Earle of Cumberland, Baron Clifford,
Lord Bromfler, Atton, Vescie, and Vipont,
Lord of Westmerland, and Knight of the
most noble Order of the
Garter.



Right Honourable, and my
very good Lord, being first
induced, by occasion of your
Lordships imployment of
me at sea, to apply my Ma-
thematicall studies to the
vse of Nauigation: I thought, these first fruits
of those my sea-labours, could not bee more
iustly due to any, then to your self: as by
whose beneficiall hand, they haue been chiefly
cherished, to growe thus farre for wardes
towards their ripenesse: and to whom the cau-
ses that most moued me thus vnseasonably (as
it were) to pluck the same before the time,
that is, the publishing of part hereof alreadie
by one: and the stealing of an other part by a
second man, and the daunger of publish-

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ing the whole by the third, are best knowne. For your Lordship can witness (though in a greater matter, meaner witness might serue) that not onely a part of this Booke was first set forth by one : and that an other part thereof is more lately published by another in his owne name, in his Mappes of the world, and of Europe: but that the whole also was in going to the presse, vnder the name of one of the skilfullest Nauigators (as he was by many reputed) of our time, and nation, of whome something more then ordinary, out of his many experiments, and obseruations at sea, was (at that time especially, when he was to leaue his life) expected to be brought to light, and left to posteritie, for their common good. But by good happe it was stayed, coming by the way into your Lo. hands : who presently (by comparing it with the originall copy thereof, which I had reserued to my self) knewe it to be the same booke worde for worde, which I had made, and presented vnto your L. almost ~~seauen~~ yeares before.

Having therefore (as I could for the present) made supply of such wants, as were in that Booke, I thought it best to follow your
Lo.

Dedicatorie.

Lo. aduise, rather by publishing it my self, to acknowledg mine own openly, with all faults, which quieter time, and more leisure (whereof I haue seldome had lesse store) might haue amended: then either to haue it by peecemeale dismembred, or vniustly chalenged by some other man as his owne: and so set forth to the view of all men, much worse then I made it.

Desiring therefor your Lo. to vouchsafe the same the safegarde of your honorable protection, both against these, and other iniuries that may be expected of ignorant, or malicious tongues: as not knowing whome better to flie vnto to be protected, both for your honourable fauours towards me, and for your noble authoritie, ioyned with no lesse skill, experience, and iudgement in these matters belonging vnto Nauigation: I beseech the Lord of lordes, to increase your Lo. with all true honour, and happinesse in this life: and after this life ended, with endlesse blisse, in the life that lasteth euer.

Your Lo. to command in the Lord.

Edw: Wright.

The Praeface



To the Reader.



The Art of Navigation (as it is called) though it hath now bene in use some thousands of yeeres, yet how far it is at this day, from the perfection which is and were to be desired, we would scarce beleene (as a wonder, that a thing of so great commoditie, should no more bee sought into, in so many ages:) but that, both the Bookes of the learned are extant, to testifie, and reason (approoved by often triall) dooth plainly shew, that the principall meanes, and instruments this Art useth, have bene thus long so farre from this perfection, that contrariwise they have bene, and are much stained, with many blots and blemishes of error, and imperfection.

1 The sea chart the best meane the mariner hath to knowe the course from place to place, (as it hath bene hitherto generally made) is so faulty in the very foundation and groundworke thereof (that is in the geometricall lineaments of the meridians, parallels, and rumbes described therein) that hereof there may arise so grosse error, as may cause the mariner to misse one, two, yea three whole points of the compasse (and more sometimes in a farre northerly navigation) in finding the course from place to place. Whereof it may al' be necessarily inferred, that following the direction of his chart in such sort as hath bene used for finding the distances of places, he may erre one half, yea three quarters and more sometimes in those northerne partes: in taking the distance to be twice, thrice, yea foure times greater then indeede it is.

2 The Compasse (the chiefest instrument for keeping the course shewed by the chart) by the variation neglected, as by some

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* some it hath bene may cause you erre an whole point or two in the courses of diverse places: and not rightly used hath bred much confusion in many parts of the chart in laying out many places in false courses: which must needs follow when the chart is made according to the direction shewed by the pointes of the Compasse without abatement or allowance answerable to the variation in every place. This may especially bee seene in those places where the variation is greatest, as upon the coast of Florida, Noua Francia, and New found land; where some also seeking to auoyd this inconuenience, haue fallen into an other as ill or worse than the former, in making a double scale of latitude. And thus one error as a fruitfull mother breeding another, and one absurditie admitted drawing many with it: it will manifestly appeare by exact discourse out of these groundes: what partly through the false proiection of the chart, and partly through neglecting, or not rightly using the variation of the Compasse) that it can not otherwise be but that the ordinary charts are in many places much like an inextricable labyrinth of error, out of which it will be very hard for a man easily to unwinde himself.

Hereto accord the often experiments and vsuall practise of many wel experienced and iudiciall mariners and sea men of our time, who confesse, that in sailing from the west Indies to the Azores, they haue often fallen with those Islands, when by their account according to the chart they should haue bene 150. or 200. leagues to the Westwards of them. The like hath bene found in sailing from the Azores for Vshent, as I haue also partly seene in the little experience I haue had at sea, where we were come within sight of that Island, when by account of the ordinary chart we should haue bene 50. leagues short of it.

And as concerning the courses from place to place, I haue obserued that some of our maisters take awie course, in not trusting to those courses which are shewed by their charts. But first getting the felues into the height or paralel of the place to which they are going: and withall, knowing assuredly whether they be more eastward or westward than that place; they then proceed

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M. Peter de
N. Medina, f.
booke, 3. chap.

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alwayes heedfully keeping them selves under that parallel till they come to the place desired. Then which way of sayling there is none indeed more certaine and in'allible for the iure finding of the place assigned: but it hath this inconuenience that it maketh the way longer then otherwise it should be, if the straight course were kept.

But to returne to that from whence we have a little digressed, by these experiments and practise of the skilfullest mariners it is manifest that they themselves do often find the imperfections of their charts, in shewing the courses and distances of many places each from other. Whereto we may adioyne the experience of the best Hydrographers of our time: who dayly making their Charts after the accustomed manner with straight-line & rumbes and degrees of latitude, euerie where equal, haue found such difficulties in labouring to bring their marine descriptions to some due correspondence of truth in the courses, heights and distances, that tyred herewith in the end, they haue holden it for impossible, to make the chart agree in all these with the globe. Wherein notwithstanding they erre, by making too generall a conclusion, in holding that to bee simply impossible, which cannot be done by such a way & means as they know and vse.

3 The Crosse-staffe (the principall instrument, that hath at sea bene most generally used, for obseruing the altitudes of the Sunne, or starres, thereby to know more assuredly the latitude, and so to examine and rectifie the account of the course, kept by direction of the Compasse upon the chart) if there be not abatement made answerable to the eccentricitie of the eye (that is to the distance wherewith the center or point wherein the sight beames concurre within the eye is further backward then the end of the staffe) may through neglect of this abatement cause error in taking the height obserued to be greater then indeed it is, by 10, 20, 30, min. yea. an whole degree and more sometimes, if the height be much, the staffe small, and the eccentricitie of the eye great.

4 But both this staffe, and all other instruments (though

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never so well made and used) can doe vs but small pleasure, for finding the latitude at sea, if the declination of the Sunne or starres which we obserue be not alow knowne. To this end therefore there haue bene made tables of the declinations, both of the Sunne and fixed starres: yet such as euen that which hath bene publickly commended as not differing from truth in any place about one minute (I meane the reuolvement of the Sunne, yet forth by R.N.) doth notwithstanding differ from truth in many places 10, 11, or 12, minutes. And as for the fixed starres, scarce one of them hath his declination truly set downe and agreeable to obseruation. Yea euen the Pole-starre itself, though it be better knowne, and more obserued by the most part of seamen then all the rest: and indeed as it might be used (being to be obserued at any time of the night all the yeare long) might stand them in as much stead for finding the latitude as most of the rest: yet in the bookes of navigation that are most common amongst English mariners, the distance thereof from the Pole is made to be 38 minutes more then it should be. No maruaile therefore if the mariners complaine (as I haue heard them sometimes) that they cannot make their obseruations of the latitude by the Sunne and this starre to agree.

Neither is there more truth to be looked for in the declinations of many other principall fixed starres, published in those bookes. Divers of them erring from truth one, two yea (some of them) three whole degrees and more, as in the treatise following shall be shewed. And these errors in the declinations of the Sunne and fixed starres, not onely I, but also the R.W. Sir Christopher Heydon knight, and the noble Lord of Kundstrupp, Tycho Brahe, founder of Vraniburg, with the gracious Prince William Landtgrau: of Haffia, father of him that now is, haue often found by many and most diligent obseruations with large and exact instruments, wherein both minutes and half minutes might be easily discerned. Notwithstanding, if any stand in doubt hereof, I wish that he himselfe would best in no lesse cost, time and diligence, to make often heedfull and exact obseruation then either the Prince of Haffia, or

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Tycho Brahe, or at least but as my self haue done, and then let him beleue that he shall see to be true with his owne eyes.

These errors therefore in the Chart, Compasse, Crosse staffe, and declinations of the Sunne and starres, I haue in the treatise following laboured to reforme to the utmost (yea rather beyond the utmost) of my poore abilitie, neglecting other studies and courses that might haue bene more beneficiall to mee: which may argue my good will to haue proceeded further, to the amendment of such other faultes and imperfections as yet remaine besides those that are already specified, and that especially in two pointes, that is, in the courses and longitudes of places.

The reforming of the Chart in reducing all places from those varying courses wherein now they are set downe to the true positions they haue each from other, by separating the variation (wherewith they are in the ordinarie Charts for the most part intermingled) were a busie peece of worke: yet such as were most worthie, and necessarie to be laboured in, as without which the Charts mappers, and globes, or any other Hydrographical, or Geographical descriptions, cannot be freed from many intricate absurdities, wherewith now they must needs in many parts be pestered: because the courses and positions of places are in them set downe as they were obserued by the varying Compasse, without separating the variation afterwards, that so the true courses and positions of places might be knowne.

The longitude also would well deserue both labour and cost to be both skilfully and liberally bestowed, for the finding thereof: whereby it were possible to bring it to that passe (the motions of the Sunne, and Moone, and places of the fixed starres being verified, whereof that noble Tycho Brahe affordeth great hope) that the industrious and willing minded mariner might be capable thereof, in such sort, that for the most part, when the moone and fixed starres appeare, hee might bee able hereby to know what longitude he is in (euen at sea) more truly then many haue done by their dead reckoning, in sayling out of the bay of Mexico to the Azores, or from Newfoundland to England

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England, or almost from the Azores to England. But on land, the longitude might by this meanes be found, as exactly as the latitude hath bene by many obseruers at sea. And so, opportunities of obseruation with meete instruments on shore not being neglected, (especially in long voyages surr Eastward or Westward) many most notorious errors in the longitudes of places would soone be corrected, where with the most excellent arts of Geographic & Navigation are verie much blemished. For who that loneth truth, can patiently endure to heare the Mariners common, and constant complaint of 150, or 200, leagues error in the distance betweene the bay of Mexico and the Azores: or (that which is yet most intollerable and monstrous) of 600 leagues difference in the distance betweene Cape Mendosino and Cape California, some making that distance to be 12 or 13 hundred leagues, where others will haue it, and that more probable, to be no more then sixe or seuen hundred.

But so far as the charge, though not great (to speake of) of providing meete meanes for supplie of these wants in the courses and longitudes, but chiefly in the latter, exceeds the meane abilitie of the most part of them that are most addicted to these vngainfull studies (I must not say vngratefull, albeit in these dayes they prone most vnprofitable to their greatest louers:) Therefore for my part they are like to rest, as they are vntouched, and onely commended vnto a kinde of hope (whether vaine or no I know not) of some Meccenas at length of munificent spirit to be raised vp, though not to do as that magnificall Tycho in his Vraniburg, as well by his owne high reach of wit and learning, as by a bountifull hand to his assistants and followers yet at least to haue some due consideration, both of these, and of such other wants and imperfections as yet remaine in so great and excellent an art as this of Navigation is, that it may haue some increas'e, like as Astronomie hath much advancement by Tycho Brahe alone, who for his deserued renowne cannot be too oft named.

Deubites there is no man considering that the art of Astronomy which mounteth vp vnto the heauens doth minister aid vnto

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this of Navigation, which courseth upon the waters) can denie the excellencie thereof, or the profitablenesse either. But if he will my purpose is not to stand upon it, nor to convince him by reasons, by records, or by the more wonderfull discoveries in this our age, made to the furthest parts of all the earth, and round about the whole compasse of the same, whereby we have bene made partakers of the most rare and richest commodities and treasures of the utmost Indies, and Landes of the world, and they likewise have participated with us (or els they have had the more wrong) in the most precious treasures of beavenly truth. All which and much more then can bee thought of, or now spoken, performed chiefly (next vnder Gods providence) by the rules and directions of this art, who seeth not that by how much the more excellent, and vnto mankind abundantly profitable it is, so much the lesse ought any notorious error to be tolerated therein, and so much the more ought all whome it may concerne (yea but in good will onely, if it may do good) to endeavour themselves that it may be brought to the highest pitch of perfection. I know not then if any one be vnto so excellent an enterprise drawne on, to give the best furtherrance in him heth, why he should for his labour fall into any danger of reprehension at all. Yet it may be, I shall be blamed by some, as being to busie a fault-finder myself. For when they shall see their Charts and other instruments controlled which so long time have gone for current, some of them perhaps will scarcely with patience endure it. But they may be pacified, if not by reason of the good that enueth hereupon, yet towards me at the least because the errors I point at in the chart, have bene heretofore pointed out by others, especially by Petrus Nonius, out of whom most part of the first Chapter of the Treatise following is almost worde for worde translated, I for my part desiring rather that faults should be found by others then by myself, and labouring much more, as for a thing much better, and farre more needfull, and profitable to be a fault-mender, then a fault-finder.

Or els I may so much the more be mistaked, because in seeking

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king to amend, some will thinke I take upon me too much: For some will say, and of this perhapes that haue bene employed in sea-affayres all their life long, that all this we go about is more then needs. For they without all this ado, haue euer performed their charge with good success, and are now too olde to give eare to these innovations. But other sea-aring men, who acknowledge the need hereof, are ashamed peraduenture to receive (as it were) either correction from the schooles, or direction from the land and therefore stuck not to condemne Vniuersities and all in comparison of their manifold experiments. Others also as more indifferent for the matter, will haue a sting yet at the person thinking this reformation which is professed, to spring out of other mens fountaines. Which all (because we are now about a worke of amendment) must also (if they will heare reason) amend their opinions. For the first which seeme most vnto reasonable, do not consider being addiēt to these vnreformed instruments, how like they are vnto those auuncient maisters of shippes, whom M. Bourne maketh report of, who not many yeares since, wedded likewise to their accustomed v'age, haue mocked them that haue v'ed Charts, or Crosse stanes, saying they cared not for their sheepes skynnes, they could keepe a better account vpon a board: and them that obserued the Sunne or starres for finding the latitude, they would call sun-shooters, and starre shooters, and aske if they had hit it. But marke what cometh hereof: for one of these maisters was he as I take it, of whom an ancient seaman yet liuing as I thinke) once tolde me, who hauing vnderaken the charge of conducting a shippe from England to Saint Michaels (the first of the Azores) and after long seeking, not able to find that Island, for shame and sorrow cast himselfe ouerboard. Wherefore these men if they consider it well, haue no cause to boast of success without skill, but to thanke God for both, that us, for their great and often good happe and safetic, and for their skill also were it matter then in deed it is. For I will do them no wrong, but do freely graunt and acknowledge, that from any one place to other, the course, height and distaunce may be truly set downe

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in the ordinarie Chart, wherein the Rumbes are right lines, and the degrees of latitude enery where a quall: and so by that Chart they may saile truly inough from hence to Ruffie or Island, or any other place. But if by the way they should crosse o-uer from the one to the other following the direction that their Chart sheweth them, they cannot but erre a great deale, either in course, or distance, or both, especially in those Northerly na- uigations. Why then should they where there is daunger of wan- dring, refuse help of any that is willing to shewe a better course? But to come vnto those that may object I do but actū agere, in doing no more then hath beene done already by Gerardus Mercator, in his vniuersal mappe many yeares since: and in publishing something already published by Iodocus Hondius, in his greater mappe of the world, and of Europe, now of late: I must answer, that indeed by occasion of that mappe of Mer- cator, I first thought of correcting so many and grosse errors and absurdities, as hereafter are shewed in the Sea chart, by in- creasing the distances of the Parallels, from the equinoctiall to- wards the Poles, in such sort, that at enery point of latitude in the Chart, a part of the Meridian might haue the same pro- portion to the like part of the Parallel, that it hath in the globe. But the way how this should be done, I learned neither of Mer- cator nor any man els. And in that point I wish I had beene as wise as he in keeping it more charily to my self. For so perhappes it might haue beene more benefisicall vnto me: neither should any man haue had cause to thinke at the first sight of the fourth Chapter of this booke, that all I haue there set downe is stolne out of one of the foresaid mappes of Iodocus Hondius. But were I brought before a Iudge, I should for my absolution, and Iodocus his condemnation, make the contrarie to appeare, and that by his owne confession in his letters to me, and to a friend of mine, which I haue to shewe written in Latine with his owne hand: To me his writing in English is thus much in effect.

I heare that you are somewhat offended with me, because I haue taken those fewe things out of your hand-written booke, whereas I promised you that I would not publish

viz. The booke of the Sea chart.

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it: which also I would in no wise doe without your leaue. For it something grudged my conscience, euen to publish this little, if the distance of places would haue suffered me conueniently to send letters vnto you. I was purposed to haue set this forth vnder your name: but I feared that you would be displeas'd therewith, because I haue but rudely and without elegancie translated it into Latine. Truly I tolde all my friends plainly that you are the Author thereof, and I tell them so still, &c.

And in his Letter to master Briggs now professor of Geo- metric in Gresham College, he writeth thus being turned into English. I haue written to M. Wright in excuse of my self, I am verie sorie that he is angrie with me for that cause. I pray you learne of him how he is affected towards me, and write back vnto me, and excuse me vnto him as much as you can. I would haue published his whole booke for the common good, if I might haue done it without breach of my faithfull promise. And surely my conscience grudged to publish euen this little which I haue taken out: but the profit thereof moued me, &c. At Amsterdam from the signe of the sick Pope. The truth is that at his owne instant request, when he wrought here at London, some of my friends also procured by his flatterie, perswading me thereto, I was content to let him haue this booke for a fewe dayes to per- use: he also assuring me upon his faith and credit, that he would not publish it, or any part thereof without my knowledge and consent. But how well and honestly he hath performed that protestation, grounded upon faith & credit, the world may now see: and how thankfull he hath beene to me for that which hath beene so profitable and gainfull vnto himself, as may ap- peare by so common sale of his mappes of the world, and of Eu- rope, Asia, Africa, and America, (at which had bene yet vn- hatch'd, had he not learned the right way to lay the ground- worke of them out of this booke) I my self know too well. But let him go as he is.

Now if any shall thinke it to be beyond a Land mans skill, to

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find faults in matters belonging to the sea-mans art and profession, they must know if they be yet to learne, that one that is but reasonable acquainted with Geometrical conceits, may as well, if not better then most sea-men, know the nature and properties of the spherical forme of the earth and sea, with all consequents and dependances thereof. By consideration of which, the true understanding and reason of the nautical plaine sphere or Sea-chart, may by him that hath bene but weanely conversant in Mathematicall meditations, be better apprehended, then otherwise it can by the sea-faring man, though he spend his whole life in sailing over all the seas in the world. The like may be said of the Crosse staffe, and Compasse, and of the registments or tables of declination of the Sunne and fixed starres, and of all other principall meanes and instruments serving for navigation. But it is strange to see, the difference of things that in this world is made by the difference of hands from which they are to be receyved, howsoever the things themselves be. For let Hannibal a Captaine discourse of warlike affaires, be it never so disorderly and out of reason or sea'on, yet all (for 'ooth) must needs be of great discretion and wisdom because he hath handled that which he speaketh of. But let Phormio a Philosopher speake of the same, at the least in the hearing of Hannibal be his Oration furnished & beautified with never so much reading, learning, iudgement and eloquence, yet must he (there is no remedie) be either a foole or a mad man for his hire. So by all likelihood, the case will stand with this poore Treatise of mine, which if it had come forth unto publike view, from out of the bosome (as once it was like) of a maister at sea, of great reputed excellencie, it had no doubt then found the favour, which like inough now it shall want: all winds then would have sweetly blowne it, into the pleasantest haven of euery mans (at least) of euery sea-mans; favourable entertainment. I shall therefore with they patience set downe the matter as it was, that none may mistake a truth, which is daughter, not onely of time, but of occasion, as hereby may appeare. It is not unknowne to some of good place and reckning, that one of the skillfullest

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navigators (as he was by many accounted) of our time and Nation, who died in Sir Frauncis Drakes last voyage, when he came to that extremitie of sicknesse, that he saw there was no other way but one with him, was reported to have gathered and bound together into a bundell all his nautical notes and observations, and to have cast them into the sea. But soone after notwithstanding that foresaid report, there came more comfortable newes by a Captaine that was familiarly acquainted and conversant with him in that voyage, and during the whole time of his sicknesse, in whose armes also he died: who moving some speech unto him touching something of sir Frauncis Drakes that might then after his death be looked for to be brought to light, concerning Navigation: Tush (saith he) for that matter there is not much to be looked for at his hands, hee had little skill in that art. Why? and will your self then do any thing? quoth that Captaine. Whereupon this great navigator drew forth a booke out of his bosome, and deliuered it unto this captaine not long before his death. This booke was shewed by the same Captaine to the R. Honourable the E. high Admirall of England in the Calles voyage, as being made by that famous Navigator, which his Lordship also (as it was reported) thought good should be perused and published. These newes moved some expectation of that booke: so as the right Honourable, and my verie good Lord the Earle of Cumberland, hearing of it, was desirous also to haue a sight thereof, and remembered me unto that Captaine, as one not insufficient to peruse and correct the same. And hereupon the booke was brought unto his Lordship, at the time and place appointed at Westminster, and was there also deliuered unto me, to be perused and corrected. Having therefor opened it, & beginning a litle to turne over the leaues, to take some generall view what matter might be conteyned therein: I first espied a Diagramme, the like whereof I knewe verie well I had made in a booke of mine. And herewithall I was the more moued, to see if there were any more that I could know as well as the former: turning over therefor two or three leaues more, I presently espied another Diagramme also, where-

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with I was as well acquainted, as with the former: for I found not onely the very same Diagramme, but (that which made me the more to marvaile for the present) following also in the same order as I well remembered it did in my booke. Being therefore yet more earnestly stirred up hereat, and wondering what the reason might be, that we should thus agree, I betooke my self to the reading of that booke. And looking first upon the first leafe thereof, and afterwards in many other places, I found it every where to agree with mine, and to be a copie of the same booke, worde for worde, which I made and presented unto his Lordship almost seven yeares before, as the next morning it plainly appeared both to his Lordship and to the captaine himself that brought it, by comparing it in all poynts with the originall exemplar of the same booke, which I then brought unto his Lordship.

One crime there remaineth which may seeme more iust then the rest, and yet had I almost forgot it: namely, in that I have had in this treatise no regard of the parallax of the Sunne, both in making and using the table of the Sunnes declination. But the refraction of the Sunne making him to appeare higher then he is, may stand answerable for it without error easily observable at sea. Notwithstanding, I graunt it to be the exactest way (especially on land) to have consideration both of parallax and refraction: but first there was found by observation, certaine rules of this refraction, (whereto leisure and other needfull meanes have not hitherto served me) for as good it is to have consideration of neyther, as of the parallax onely: and no great matter if both be neglected at sea, where (in mine opinion) he quites himselfe as a verie good observer, that shall not in observing the height of the Sunne, or starres, erre more then twice so much as can arise by neglect of both refraction and parallax together. But I feare that whilest I labour to satisfie all, I shall offend some, as making too long a Preface to so small a volume, I will therefore hasten to an end, onely shewing the summe of this treatise: which I thought good to offer unto your view, as a compendious representation of all that followeth, and rather to see

The summe of this treatise.

set it apart by it self, then to include it as I was purposed within this preface, which is beyond his bounds already: and therefore here I will commit the favourable reader as my self, unto the protection of the Almighty.

The summe of the Treatise following.

THe Treatise following containeth foure principall parts, whereof the first may be called Hydrographical, wherein are set downe the errors of the common Sea chart with right-lined rumbes and degrees of latitude every where equal: then the way to avoyd these errors is geometrically demonstrated, and out of this a Table is calculated, and the use thereof shewed, for the true and easie dividing of the Meridians in the Chart into tenues of minutes, or sixth parts of degrees of latitude, proportionally increasing towards the Pole. Whereto is adioyned as arising from thence the Table of Rumbes, shewing by what points of longitude and latitude each Rumb is to be drawne from the equinoctiall, till you come within a minute of the pole: with help of which Table, the Rumbes may in any Chart, Mappe, or Globe, much more truly be described, then by those mechanicall wayes long since published by Petrus Nonius, or lately practised by some Globe-makers in England. After this followeth, a most plaine and sensible demonstration of the disagreement of the common Sea-chart, and of the agreement of the Globe with the chart before described, the use of which chart is shewed in the Chapter next following: where also (the longitudes and latitudes of any two places being given) the way is set downe how to find their distance, measured either in the segment of the rumb, or in the arch of the great circle intercepted betweene them both mechanically with ruler and compasse, and mathematically by the doctrine of triangles, whereby it may without much difficultie be concerned, how navigation might by Arithmetical calculation onely, be performed without Chart or Globe, onely

The summe of this treatise.

the longitudes and latitudes of places being knowne.

The second principall part of this Treatise may be called *Magneticall*, because it intreateth of the variation of the *Compassse*, shewing how the same may be found at sea (the latitude being given) by one observation of the Sunnes height and point of the *Compassse* whereupon he is at the same instant, before or after noone, with help of the *Globe* or *Astrolabe*. Which way of finding the variation is also exemplified with a *Table* of such observations as I took both at sea and on shore, in the voyage of the right Honourable the Earle of Cumberland, in the yeare 1589. And because the *Globe* and *Astrolabe* are such instruments, as every one cannot easily have at Sea, I have also shewed how (by the Sunnes point of the *Compassse*, or *Magnetical Azimuth*, and altitude given by observation) the variation may be found, either mechanically, with ruler and compassse, or mathematically by the doctrine of triangles, and arithmetical calculation.

The third part may be called *Geometricall*, intreating of the *Crosse staffe*, and shewing how such errors may be avoided, as have beene commonly committed in the use thereof, either by reason of the *parallax*, or *eccentricitie* of the eie, or by the height of the eye above the water, or by the *parallax* of the Sunne.

The fourth and last part may be called *astronomical*, wherein my chief intent was to correct the errors that are in the ordinary *Tables* of declination of the Sunne, and fixed starres. To which end there is first set downe a table of the declination of every minute of the *eclipticke* in degrees, minutes & seconds, calculated for the greatest obliquitie of the *Zodiacke*, as it is found by observation in this age 23. deg. 30. min. Whereto is adioyned the use thereof for the readie finding of the place of the sunne by his declination given: or contrariwise for finding the sunnes declination, his place being first knowne. After this is shewed the way and meanes I used for exact observation of the sunnes *Meridian altitudes*: with a table of those observations, for foure yeares together, that so the more certaintie might be had of the declinations and places, and of the whole course and motion

The summe of this treatise.

motion of the sunne: and that by comparing together so many observations, the sunnes *eccentricitie* and *apogee* might more assuredly be knowne. By knowledge whereof, the way was layd open for making the *Ephemerides* of the sunne there set downe: without which the regimen of the sunne next following (which I may commend as free from error observable at sea, and seldom differing one minute from observation on land, and for which principally all the former paines was overtaken) could not so easily have beene made. Now if any shall thinke that most of this fourth part going before this regimen, might have beene omitted, as being impertinent to the use of mariners, and exceeding their capacitie: I answer, that it was not my purpose, neither could I in all places, apply my self to the most part of seamen's capacity: knowing many that would not be content with this regimen alone, but that desired more to know the root from whence this fruit grew: whose desire I was also willing to satisfie as I could for the present, having seldom had a more convenient season for such a purpose. Then followeth a table of 32 principall fixed starres about the *equinoctial*, that have beene most commonly knowne, and observed by seamen, with their declinations corrected: and another table of as many more of the notablest starres about the *Pole* is thereto annexed, with their distances from the pole corrected also, & verified by diligent observation on land. To these is added a table of the sunnes right ascensions (resolved into houres & minutes) for every day of the yeare, with the use thereof, for finding at what houre any of those starres cometh to the *Meridian* at any time of the yeare: that hereby the mariner might know at all times, when they come to the *meridian*, & so the easlier learne to know & observe them. Lastly, I thought it not impertinent to adioyne to this treatise, that which gave the first occasion of writing the same, that is the right honorable the Earle of Cumberland his voyage to the *Azores* performed in the yeare 1589 wherein his Lo. tooke the towne and platforme of *Fayall*. And so for further satisfaction in every one of these particulars, I referre the friendly reader to the treatise it selfe now following.

Fare well.

FAULTS

in the common

Sea Chart,

*With Rumbes expressed by right lines
and degrees of latitude, euery where
equall.*



The Sea Chart is one of the
especiall Instrumentes that
Mariners haue for theyr di-
rection in sailing, so there
is not any wherein there are
so great and daungerous er-
rours.

I For first, what places so-
euer are described therein, the length of them (from
East to West) hath a greater proportiō to the bredth
(from North to South) than indeede it ought to
haue (except it be at the æquinoctiall;) And so much
the more this errour increaseth, by howe much the
further distant those places are from the æquinocti-
all: euen as the proportion of the Meridian to the
Paralell, increaseth the more, the nearer you come
to either Pole; so that at the paralell of 60 degrees
latitude, the proportion of the length to the breadth

Errour in the
proportion of
the length &
breadth of
places in the
common sea
charte.

B
is

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F 4 b 14	27	31	37	Nn a a 96					
F 4 b 14	27	31	37	Nn a a 97					
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A detection of Errors

is twice greater than it should be; and that because the meridian is double to that paralell, and so in all the rest, the proportion of the length to the breadth shall be greater than the truth, in the same proportion, wherewith the meridian exceedeth the paralell.

As for example: in the common sea Chart, the proportion of the length of Friesland, to the breadth thereof, is two-fold greater than in the globe (which sheweth the true proportion of the length to the breadth) because the meridian is double to the paralell of that Island. In the Islands of Groenlant and Groclant, the length to the breadth hath a foure-fold greater proportion in the common Mariners chart, than it hath in the globe; because the meridian is fourefolde greater than the paralell of those places.

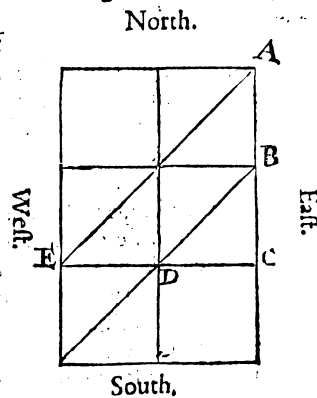
Error in finding out the difference of longitude by the common sea Chart.

2 The way to finde out the difference of longitude, by the common sea Chart, is true at the æquinoctiall onely, and neare about the same may be used without sensible error: because there only the meridian and paralell are equall. But on this side or beyond the æquinoctiall there is error committed proportionally to the difference of the meridian, & paralell, that is, the difference of longitude found out by the Chart hath the same proportion to the true difference of longitude, that the paralell hath to the meridian.

As for example: at the paralel of 60 degrees in the common mariners Chart (wherein the degrees of the meridians, and paralels are equall) admit B D be two places bearing each from other southwest and northeast differing in latitude so much as is the arke

in the Sea Chart.

arke of the meridian B C, which for example sake we will suppose to be one degree, therefore by the ordinary Chartes the difference of Longitude C D, shall be likewise one degree: but yet in truth, because the meridia is double to that paralel, and consequently, a degree of the meridian double to a degree of that paralell, therefore B differing a degree in latitude from D



should be placed twice so farre from C, that is at A, so as A B C may be counted but for one degree of the meridian, and so be equal to two degrees of the paralel, whereof shoulde followe that E C should be the difference of longitude, that is, two degrees, as the truth is in the globe, whereas the common Mariners Chart sheweth the difference of longitude to be but halfe so much. And yet notwithstanding if you go nearer to the poles, you shall erre by their Chart a great deale more, euen as the proportion of the meridian to the paralel increaseth more and more.

But this error in shewing the difference of longitude, shall yet further appeare by this example of *Petrus Nonius*.

A detection of Errors

In the Mariners Chart, the distance betwixt Lisbon and Tercera, is set downe to be 262. Spanish leagues (whereof 17 and one halfe make a degree of the Equinoctial or of any of the greatest Circles) for so much the Mariners doe finde that distance to be; not onely by estimation of the way that the shippes maketh, when they saile from East to West to that Island, but by another account which is much more certaine, and that is this. In sayling from Lisbon to Madera, they keepe their course south west, and from this Island to Tercera, they saile north west. Now because Lisbon & Tercera haue both almost the same latitude of 39. degrees: and in sayling from the northeast to southwest, and likewise from southeast to northwest, you alter the longitude as much as the latitude (because that in both those courses the angle that the way of the ship maketh with the meridian, is equall to halfe a right angle: and the Island of Madera hath almost 31. degrees and an halfe of latitude towards the north, so that the difference of the latitudes of Lisbon and Madera, as also of Madera and Tercera is about 7. degrees and $\frac{1}{2}$.) Therefore the difference of the longitudes of Lisbon and Madera, & likewise of Madera & Tercera shal be $7\frac{1}{2}$ of the same degrees of the meridian, both which added together make the whole difference of longitude betwixt Lisbon and Tercera, to be 15 degrees of the meridian, which are equall to 262, and one halfe Spanish leagues. But in the paralel that passeth by the 39 degree of latitude, wherein (almost) Lisbon and Tercera are situate, there are more degrees in the same space, according to that proportion where-

in the Sea Chart.

wherewith the meridian is greater than that paralel. Therefore the true difference of longitude betwixt Lisbon and Tercera, that is, the arke of the paralel or Equinoctiall contained betwixt the meridians of those places shall thus be found out.

It is a rule in Geometrie, that the diameters and peripheries, and consequently the semidiameters, and like arkes of circles haue the same proportion.

Also it is manifest that the sine of the complement of the distance of any paralel from the Equinoctiall is the semidiameter of the same paralel.

Now the distance of the paralel of Lisbon and Tercera from the Equinoctiall is about 39 degrees, the complement wherof is 51 degrees: whose sine is 777 which is the semidiameter of the foresaid paralel, in such parts whereof the whole sine containeth 1000, which is the semidiameter of the meridian. Therefore by the rule of proportion inuersed, if 262. Spanish leagues make 15. degrees in the meridian, whose semidiameter is 1000. parts: then in the paralel whose semidiameter is 777. of the same partes, they shal make 19 degrees, & $\frac{222}{1000}$ parts of one degree. that is, 18 min. & litle more: which (if it be true that the course from Lisbon to Madera is southwest, & from Madera to Tercera northwest: & that the latitude of Madera is 31. deg. 30. min. and the latitude of Lisbon and Tercera 39 deg.) shal be the difference of longitude betwixt Lisbon & Tercera. Whereas *Ortelius* & *Mercator* following as it seemeth the marine Chartes without correction in their vniuersall Maps, make them to differ in longitude scarce 15. degrees of their paralel, as if it were equall to the Equinoctiall.

B 3 3 More

A detection of Errors

Errors in the lying & bearing of places one from another in the common sea Charte.

3. Moreover, they are deceiued not onely in the situation of many places, which the marine Chart sheweth to be vnder the same Meridian: but also in the lying, or bearing of other places each from other. For the Meridian is a certaine rule of the positions of places. If therefore errour shall be committed in the situation of the Meridian, there must needs be errour in the inclinations of the other numbers, pointes or lines of the Compasse. And therefore not euery inclination, or respectiue position of place to place, which is set down in the marine Chart, is to be taken for true: but that position or inclination onely, by which some haue sayled from the one place to the other. This may be seene in sayling to India. For the marine Chart placeth that promontory of Africa, called the promontory of 3. pointes, being in latitude towards the North, 4. degrees and one halfe, and the Ilands of Tristan acugna (which haue 36. degrees of Southerne latitude, vnder the selfe same Meridian: Also the marine Charte sheweth the distance betweene these Ilands and the promontory of Good Hope, to be almost 400. leagues: both which notwithstanding cannot stand together. For if all the shore frō the promontory of 3. pointes vnto the promontory of Good Hope be rightly described, and the promontory of 3. pointes also lie vnder the same Meridian with those Ilands: it must needs be that the foresaid distance is much lesse: But if it be not lesse, it cannot be that they should haue the same Meridian with the promontory of 3. pointes, but must needs be more to the Westward. Heereof it commeth that

in the Sea Chart.

that the Marriners are very oft deceiued, whē they goe from one place to another, following that direction which the sea Chart sheweth them. Which place when they find not by that course, they think that the cause of that errour is either some twise current of the Sea, that carrieth them another way: or else the declination of the poles of the Loadstone, from the true poles of the world: although (perchance) they erred onely, for that becaue they knew not how those places did beare one frō another.

4. Neyther are they onely deceiued in that, because they thinke that the sea Chart can shew the situations of all places: but also because that when they will translate the sea coastes out of the Chart into the Globe, they doe it, hauing respecte onely to the numbers of the degrees of longitude and latitude found therein, and no otherwise then when they set in the fixed starres into a celestiall globe. So it commeth to passe, that not onely those errours are committed, which doe necessarily arise out of the common sea Charte: but other errours also, which might be auoyded, if they first turned into degrees, those distances of Longitude which they haue truely knowne, and then followed the Longitudes and latitudes of places.

5. In shewing the distances of places, there is as great errour committed, as in any of the former. For example: If you imagine 2. shippes to be vnder the Equinoctiall 100. leagues asunder, and that each of them should sayle from thence due North or South vnder his Meridian, vntill they come to the

Errour in setting of places out of the common sea Chart into the globe.

Errour in shewing the distances of places in the common sea Charte.

A detection of Errors

the paralell of 60. degrees latitude: they should be there but onely 50. leagues distant, because at that paralell the Meridians are distant but halfe so much one from another, as they were at the Equinoctiall; as it may most manifestly appeare by the globe: and yet the Charte will shewe, that those two shippes haue the selfe same distance of 100. leagues, being vnder the 60. paralell, that they had before, being vnder the Equinoctiall.

Errour in keeping alwayes the same point of the Compass.

6 There is yet another error remaining (though all the former were auoyded) which ariseth hereof, because that by the direction of the Compass they bend, and turne the shippe, in such sorte, that they constrain it alwayes to make the same angles with the Meridian. As when they sayle from Vshent to Cape Rasó, both lying vnder the same paralell, they guide the shippe in such sorte, that it maketh alwayes right angles with the Meridian, & so holding on their course due West, they keepe themselves alwaies vnder the same paralell; whereas notwithstanding, there is a more certaine course, whereby they may goe from one place to another, without that losse of way, which they must needs make that keepe themselves alwaies vnder the same paralell.

There is moreouer another commoditie in this kinde of sailing, that we may finde euery day by a more certaine accompt what way wee haue made, and know in what place we are.

But this way is not to bee defined by any of the lesser circles, but by a great Circle which is to bee drawne by those two places: and the arke of that
great

in the Sea Chart.

great Circle contained betwixte the same places is lesse than the arke of the paralell which lyeth betwene them, as may bee concluded by an euident and necessary reason out of the principles of Geometrie: much like as a straight line is shorter then a crooked, both being extended betwene the same prickes. Therefore this commoditie is also hereunto adioyned, that in sayling by a great Circle, the way is more short, and compendious. But he that entereth into this course of sayling, must knowe, that hee must change the pointe of the Compass (whereupon he guideth the shippe) not once onely, but very often: and that because of the variable, and inconstant inequality of the angles, which that great Circle maketh with euery new Meridian. Of which angles the inuention indeede (by the Chart especially) is very subtile, and consisteth herein (to wit) in knowing how much such kinde of angles doe decrease, or increase as the ship goeth forwards. And he that so shapeth his course, goeth the straight & nearest way. Otherwise it cannot be that a man should keepe a straight course, if he shal continually follow one and the same point, or line of the Compass, (except hee sayle vnder a Meridian, or vnder the Equinoctiall line:) but hee must change the poynte of the Compass so often as that straight course shall seeme to require.

And therefore it cannot bee by any means that the Marriners, when they goe perpetually towards the same part of the world, keeping the same angle of position in respect of the Meridian, or the same point of the Compass; should goe the shortest and
nearest way. C This

A correction of Errors

This kind of sayling vnder a great Circle, is of especial vse in our northerne Navigations, for the discouery of the northeast or northwest passage: which as it may most easily be performed by help of an hydrographical globe, with the helispherical lines drawne thereupon: so for the, that list not be troubled with the comberfom carriage & charge of the globe, it may be done (in a manner) with no lesse facilitie by a nautical planisphere, made after the projection of *Gemma Frisius* his astrolabe, wherof more hereafter when God shal giue leisure.

The expressing of the rumbes by right lines defended: which some hold for erroneous.

There be some also that hold it for erroneous, that the rumbes in the mariners Chart shoulde bee expressed by right lines, and consequently that the meridians shoulde bee paralleles, or equidistant euery where; which because it is but barely affirmed, and the contrary may bee proued, as well as that each rumb except the rumb of North and South maketh equall angles with euery meridian: we hold it not onely as true, but also as most meete and commodious for the Mariners common vse, that the meridians in the sea Chart should be euery where equidistant each from other, and consequently that the rumbes should be straight lines for these causes.

First because the rumbes or pointes of the Compass may to most easily be drawne in the nautical Planisphere, sely by a straight ruler. For seeing that any one and the same rumb (sauing onely the rumb of North and South, which is all one with the Meridian) maketh alwayes equall angles with euery meridian, without either sensible, numerable, or mensurable, though not without intelligible, er-

ror.

in the Sea Chart.

rour (for indeede those angles are lesse and lesse as they come nearer to the pole, much like as the angle of a little semicircle is lesse then the angle of a greater semicircle) all the rumbes must needs be straight lines; if the meridians be equidistant and right lines by the 27 and 28. prop. 1 *Euclid*.

Secondly the respectiue situation of any place to other in the Chart (which they commonly call the lying or bearing of one place from another according to the pointes of the Compass) may most easily be knowne by the nautical Planisphere with right lined rumbes and equidistant meridians. For that rumb from which both places are equidistant sheweth howe those two places lye or beare one frō another.

And for these two causes of so great facilitie, both in the making, & vsing of the mariners Chart with equidistant meridians, & straight-lined rumbes, it ought to be preferred before any other instrument heretofore published to that ende for the common vse of the mariner, at sea especially. And though the globe be commended by some as most absolute & perfect for all courses & climates whatsoever: yet for the chargeableness thereof, troublesome carriage, stowage and tedious vsage for the most part in nauigation, following any other course saue East or West, North or South: it will for the most part be found vnmeet and comberfome, and nothing so fit and ready for the mariners common vse at sea as the nautical planisphere truly made.

A correction of Errors

How the former errors may be auoyded.

Chap. II.



These errors notwithstanding they haue bene much complained of by diuerse, as namely by *Martine Cortese* in his third booke, and second chapter of the Arte of Navigation, but specially by *Petrus Nonius* in his second booke of Geometrical obseruations, rules, and instruments: And although *Gerardus Mercator* in his vniuersall Mappe of the worlde seemeth to correct them, by making the distances of the paralels greater and greater towards the poles: yet none of them teacheth any certaine way how to amend such grosse faults, whereby the poore Mariner may be deceiued many times an whole point of the Compasse, yea sometimes two or three poynts and more, in iudging by his ordinary Chart howe one place beareth from another: especially if he saile farre northwards, or southwards, whereby we may easily ghesse, how indiret a course he shall make to come to the desired hauens, that shall follow so false and erroneous direction with great danger (at the least) many times to loose shippes, goodes, liues and all.

The fountaine of all the errours aforesaide (the last onely excepted) is in the very foundation and groundworke of the Mariners Charte, that is, in the first Geometrical lineaments thereof: namely, because

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cause the meridians are not rightly diuided, (the diuisions being euery where equall:) nor the paralels rightly drawne (hauing in al places the same distances each from other that the meridians haue at the Equinoctiall:) Whereas the spaces betwixt the paralels shuld increase more and more as you go from the Equinoctiall towards either of the poles, which *Martin Cortese* also noteth in his 3 booke & 2 chapter of the Art of Navigation. But he omitteth that wherein all the difficultie lieth, that is, how much, or in what proportion those spaces should increase. Which, that it may the better be perceiued, I thinke it not vnmeet first to shew by what kinde of projection (or extension rather) the nautical planisphere may not vnfitly be conceiued to bee geometrically made after this maner.

Suppose a sphericall superficies with meridians, paralels, rumbes, and the whole hydrographical description drawne thereupon to bee inscribed into a concaue cylinder, their axes agreeing in one.

Let this sphericall superficies swell like a bladder, (whiles it is in blowing) equally alwayes in euerie part thereof (that is as much in longitude as in latitude) till it apply, and ioyn it selfe (round about, and all alongst also towards either pole) vnto the concaue superficies of the cylinder: each paralel vpon this sphericall superficies increasing successiuelly from the equinoctiall towards eyther pole, vntil it come to bee of equall diameter with the cylinder, and consequently the meridians stil widening them selues, til they come to be so far distant euery where each from other as they are at the Equinoctiall, Thus

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it may most easily be vnderstoode, how a spherical superficies may (by extension) be made a cylindrical, and consequently a plaine parallelogram superficies; because the superficies of a cylinder is nothing else but a plaine parallelogramme wound about two equall equidistant circles that haue one common axtree perpendicular vpon the centers of them both, and the peripheries of each of them equal to the length of the parallelogramme as the distance betwixt those circles, or height of the cylinder is equal to the breadth thereof. So as the nautical planisphere may be defined to be nothing else but a parallelogramme made of the spherical superficies of an Hydrographical globe inscribed into a concaue cylinder, both their axes concurring in ones & the spherical superficies swelling in euery part equally in longitude and latitude, til euery one of the paralels therupon be inscribed into the cylinder (each paralel growing as great as the equinoctial:) or til the whole spherical superficies, touch and apply it selfe euery where to the concauitie of the cylinder.

In this nautical planisphere thus conceiued to be made, all places must needs be situate in the same longitudes, latitudes, and directions or courses, and vpon the same meridians, paralels and rumbes that they were in the globe, because that at euery poynnt betweene the Equinoctial and the pole, wee vnderstand the spherical superficies whereof this planisphere is conceiued to be made, to swell equally as much in longitude as in latitude (til it ioynne it selfe vnto the concauitie of the cylinder, so as heereby no part thereof is any way distorted or displaced out of his

The definition of the nautical planisphere.

in the Sea Chart.

his true and natural situation vpon his meridian, paralel, or rumb, but only dilated & enlarged the meridians, also paralels, and rumbes dilating and enlarging themselues likewise, at euery point of latitude in the same proportion.

Now then let vs diligently consider of the Geometrical lineaments, that is, the meridians, rumbes, and paralels of this imaginary nautical planisphere, that we may in like maner expresse the same in the Mariners Chart. For so vndoubtedly we shall haue herein a true hydrographical description of all places, in their longitudes, latitudes, and directions, or respectiue situations each from other according to the points of the Compasse in all things correspondent to the globe, without cyther sensible, or explicable errour.

First therefore in this planisphere, because the paralels are euery where equall each to other (for euery one of them is equal to the Equinoctial or circumference of the circumscribing cylinder) the meridians also must needs be paralel & straight lines: & consequently the rumbes (making equal angles with euery meridian) must likewise be straight lines.

^{27. Prop 1.}
Euclid 17.

Secondly, because the spherical superficies whereof this planisphere is conceiued to be made, swelleth in euery part thereof equally, that is, as much in latitude, as in longitude, til it apply it selfe round about, to the concauitie of the cylinder: therefore at euery point of latitude in this planisphere, a part of the meridian, kepeth the same proportion to the like part of the paralel, that the like parts of the meridian, and paralel haue each to other in the globe, without explicable error.

Now

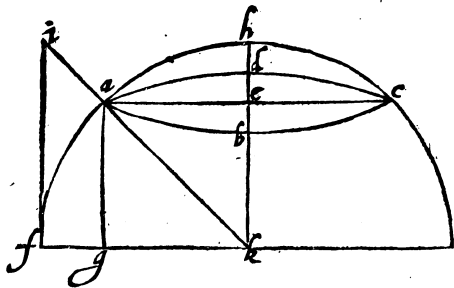
A correction of Errors

Nowe because like partes of wholes keepe the same proportion that their wholes haue, therefore the like partes of any paralell, and meridian of the globe haue the same propotion that the same paralell and meridian haue.

For example sake, as the meridian is double to the paralell of 60. degrees, so a degree of the meridian is double to a degree of that paralell, or a minute to a minute &c. and what proportion the paralell hath to the meridian, the same proportion haue their diameters and semidiameters each to other.

Papp. l. 5. c. 11. & 26. 18. c. 2. e. 15. Rami.

But the sine of the complement of the paralels latitude, or distance from the equinoctiall, is the semidiameter of the paralell.



As here you see, *ac* the sine of *ab* the complement of *af* the latitude or distance of the paralell *abcd*, from the Equinoctiall, is the semidiameter of the same paralell *abcd*.

And as the semidiameter of the meridian (or the whole

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whole sine (is to the semidiameter of the paralell, so is the Secans, or Hypotenusa of the paralels latitude (or of the paralels distance from the equinoctiall) to the semidiameter of the meridian, or to the whole sine; as *fk* (that is) *ak*, to *ac* (that is) *ek*; so is *ik*, to *kf*.

Therefor in his nauticall planisphere, the semidiameter of each paralell being equall to the semidiameter of the equinoctiall (that is) to the whole sine; the parts of the meridian at every poynt of latitude mult needs increase with the same proportion wherewith the Secantes or hypotenuse of the arke, intercepted betweene those pointes of latitude and the equinoctiall do increase.

Now then wee haue an easie way layde open for the making of a table (by help of the Canon of Triangles) whereby the meridians of the Mariners Chart may most easily and truly be divided into partes, in due proportion from the equinoctiall towards either pole.

For (supposing each distance of each poynt of latitude, or of each paralell from other, to containe so many parts as the Secans of the latitude of each poynt or paralell containeth) by perpetuall addition of the Secantes answerable to the latitudes of each poynt or paralell vnto the summe compounded of all the former secantes, beginning with the secans of the first parallels latitude, and thereto adding the secans of the second parallels latitude, and to the summe of both these adioyning the secans of the third parallels latitude, & so forth in all the rest, we may make a table which shall shew the sections and

D points

A correction of Errors

points of latitude in the meridians of the nautical planisphere: by which sections, the parallels are to be drawne.

As in the table following, we make the distance of each parallel from other, to be one minute: and wee suppose the space betweene any two parallels each next to other in the planisphere to containe so many parts as the secans answerable to the distance of the furthest of those parallels frō the æquinoctial: and so by perpetuall addition of the secans of each minute to the summe compounded of all the former secantes I make the whole table. As for example, the secans of one minute is 10,000,000. which also sheweth the section of one minute of the meridian from the æquinoctial in the nautical planisphere. Whereunto adde the secans of 2. minutes, that is 10,000,002, the summe is 20,000,002. which sheweth the section of the second minute of the meridian from the æquinoctial in the planisphere: to this summe adde the secans of 3. minutes, which is 10,000,004, the summe will be 30,000,006. which sheweth the section of the third min. of the meridian from the æquinoctial: and so forth in all the rest: sauing that in this table wee haue of purpose omitted in euery secans the 3 first ciphers next the right hand: not onely for the easer, but also for the truer making of the table, because that indeede at every poynt of latitude, a min. of the meridian in this nautical planisphere, hath somewhat lesse proportion to a minute of the parallel adioyning towards the æquinoctial, then the secans of that parallels latitude hath to the whole sine. But in
this

in the Sea Chart.

this table it was thought sufficient to vse such exactnesse as that thereby (in drawing the lineaments of the nautical planisphere) sensible error might be auoyded. He that listeth to be more precise may make the like table to decades or tennes of seconds out of *Ioachimus Rheticus* his *Canon magnus triangularum*. Notwithstanding the Geometrician that desireth exact truth, cannot be so satisfied neither, for whole sake and further satisfaction, I thought it not vnmeet to adioyne also this Geometricall conceit of diuiding a meridian of the nautical planisphere.

Let the æquinoctial and a meridian be drawne vpon a Globe: Let the meridian (diuided into degrees, minutes, seconds, &c.) roule vpon a streight line beginning at the æquinoctial, the Globe swelling in such sort as the semidiameter thereof may be alwayes equall to the secans of the angle, or arch contained betweene the æquinoctial and semidiameter insisting at right angles vpon the forelayde streight line: The degrees min. sec. &c. of the meridia noted in the streight line as they come to touch the same, are the diuisions of the meridian in the nautical planisphere. And this conceit of diuiding the meridian of the nautical planisphere may satisfie the curious exactnesse of the Geometrician: but for mechanicall vse, the table before mentioned which hereafter followeth may suffice.

A correction of Errors.

Till the Printer had thus farre proceeded, I was purposed to have published the whole Table before mentioned, in such sort as I had made it, (supposing a Meridian of the nauticall Planisphere to be divided, beginning at the equinoctial) into such parts whereof a minute of the equinoctial containeth 10. 000. and setting downe by which of these parts euerie minute of latitude is to be drawne, till you come within a minute of the Pole.

But upon further aduice it was thought more meet to abridge the same as followeth, to euerie tenth minute, & to cut off throughout the Table the three first figures towards the right hand, meaning not at this time to trouble thee with more then might be of use, for the true diuiding of the Meridian in the Sea Chart into degrees, and six parts of a degree, without sensible error which may be sufficient for the greatest sort of Sea Charts or Maps that hit herto have bene commonly vsed.

This Table is diuided into two columnes, whereof the first containeth degrees, and tennes of minutes, of the Meridian of the nauticall planisphere, beginning at the equinoctial. The second columnne containeth equal parts of the same Meridian, beginning likewise to be numbered from the equinoctial (of which parts euerie minute of the equinoctial is vnderstood to containe 10.) and sheweth how many of these parts are answerable to any degree or Decade of minutes of latitude, in the nauticall Planisphere or Sea Chart.

The vse hereof followeth after the Table.

A Table for the true diuiding

1 Col.	2 Col.	1 Col.	2 Col.	1 Col.	2 Col.	
De.	Min.			De.	Min.	
0	10	100		10	10	6132
0	20	200		10	20	6234
0	30	300		10	30	6335
0	40	400		10	40	6437
0	50	500		10	50	6539
1	0	600		11	0	6641
1	10	700		11	10	6743
1	20	800		11	20	6845
1	30	900		11	30	6947
1	40	1000		11	40	7049
1	50	1100		11	50	7151
2	0	1200		12	0	7253
2	10	1300		12	10	7355
2	20	1400		12	20	7458
2	30	1500		12	30	7560
2	40	1601		12	40	7662
2	50	1701		12	50	7765
3	0	1801		13	0	7868
3	10	1901		13	10	7970
3	20	2001		13	20	8073
3	30	2101		13	30	8176
3	40	2201		13	40	8279
3	50	2302		13	50	8382
4	0	2402		14	0	8485
4	10	2502		14	10	8588
4	20	2602		14	20	8691
4	30	2703		14	30	8794
4	40	2803		14	40	8897
4	50	2903		14	50	9001
5	0	3004		15	0	9104

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of the meridians in the sea Chart.

1. Col.	2. Col.	1. Col.	2. Col.	1. Col.	2. Col.
De Ms		De Ms		De Ms	
15 10	9208	20 10	12358	25 10	15610
15 20	9312	20 20	12464	25 20	15721
15 30	9415	20 30	12571	25 30	15832
15 40	9519	20 40	12678	25 40	15942
15 50	9623	20 50	12785	25 50	16053
16 0	9727	21 0	12892	26 0	16165
16 10	9831	21 10	12999	26 10	16276
16 20	9935	21 20	13105	26 20	16388
16 30	10039	21 30	13213	26 30	16499
16 40	10144	21 40	13321	26 40	16611
16 50	10248	21 50	13429	26 50	16723
17 0	10353	22 0	13537	27 0	16835
17 10	10457	22 10	13645	27 10	16947
17 20	10562	22 20	13753	27 20	17060
17 30	10667	22 30	13861	27 30	17173
17 40	10772	22 40	13969	27 40	17285
17 50	10877	22 50	14078	27 50	17398
18 0	10982	23 0	14186	28 0	17512
18 10	11087	23 10	14295	28 10	17625
18 20	11192	23 20	14404	28 20	17738
18 30	11298	23 30	14513	28 30	17852
18 40	11403	23 40	14622	28 40	17966
18 50	11509	23 50	14731	28 50	18080
19 0	11615	24 0	14840	29 0	18194
19 10	11720	24 10	14950	29 10	18309
19 20	11826	24 20	15060	29 20	18423
19 30	11932	24 30	15170	29 30	18538
19 40	12038	24 40	15280	29 40	18653
19 50	12145	24 50	15390	29 50	18768
20 0	12251	25 0	15500	30 0	18884

A table for the true diuiding

1. Col.	2. Col.	1. Col.	2. Col.	1. Col.	2. Col.
De Ms		De Ms		De Ms	
30 10	18999	35 10	22565	40 10	26358
30 20	19115	35 20	22688	40 20	26489
30 30	19231	35 30	22811	40 30	26621
30 40	19347	35 40	22934	40 40	26752
30 50	19464	35 50	23057	40 50	26884
31 0	19580	36 0	23180	41 0	27017
31 10	19697	36 10	23304	41 10	27149
31 20	19814	36 20	23428	41 20	27282
31 30	19931	36 30	23552	41 30	27416
31 40	20048	36 40	23677	41 40	27549
31 50	20166	36 50	23802	41 50	27683
32 0	20284	37 0	23927	42 0	27818
32 10	20402	37 10	24052	42 10	27953
32 20	20520	37 20	24178	42 20	28088
32 30	20639	37 30	24304	42 30	28223
32 40	20757	37 40	24430	42 40	28359
32 50	20876	37 50	24556	42 50	28495
33 0	20995	38 0	24683	43 0	28632
33 10	21115	38 10	24810	43 10	28769
33 20	21234	38 20	24938	43 20	28906
33 30	21354	38 30	25065	43 30	29044
33 40	21474	38 40	25193	43 40	29182
33 50	21594	38 50	25321	43 50	29320
34 0	21715	39 0	25450	44 0	29459
34 10	21836	39 10	25579	44 10	29598
34 20	21957	39 20	25708	44 20	29738
34 30	22078	39 30	25837	44 30	29878
34 40	22199	39 40	25967	44 40	30018
34 50	22321	39 50	26097	44 50	30159
35 0	22443	40 0	26228	45 0	30300

of the meridians in the sea Chart.

1 Col.	2 Col.	1 Col.	2 Col.	1 Col.	2 Col.
De.	Ms.	De.	Ms.	De.	Ms.
45	10	30442	50	10	34902
45	20	30584	50	20	35058
45	30	30726	50	30	35215
45	40	30869	50	40	35373
45	50	31013	50	50	35531
46	0	31156	51	0	35690
46	10	31301	51	10	35849
46	20	31445	51	20	36009
46	30	31590	51	30	36169
46	40	31736	51	40	36330
46	50	31882	51	50	36491
47	0	32028	52	0	36654
47	10	32175	52	10	36816
47	20	32322	52	20	36980
47	30	32470	52	30	37144
47	40	32618	52	40	37308
47	50	32767	52	50	37473
48	0	32916	53	0	37639
48	10	33066	53	10	37806
48	20	33216	53	20	37973
48	30	33367	53	30	38141
48	40	33518	53	40	38309
48	50	33670	53	50	38478
49	0	33822	54	0	38648
49	10	33975	54	10	38819
49	20	34128	54	20	38990
49	30	34282	54	30	39162
49	40	34436	54	40	39334
49	50	34591	54	50	39506
50	0	34746	55	0	39682
55	10	39857	55	10	40208
55	20	40032	55	20	40385
55	30	40208	55	30	40563
55	40	40385	56	0	40741
55	50	40563	56	10	40921
56	0	40741	56	20	41101
56	10	40921	56	30	41282
56	20	41101	56	40	41463
56	30	41282	56	50	41646
56	40	41463	57	0	41829
56	50	41646	57	10	42013
57	0	41829	57	20	42198
57	10	42013	57	30	42384
57	20	42198	57	40	42570
57	30	42384	57	50	42758
57	40	42570	58	0	42946
57	50	42758	58	10	43135
58	0	42946	58	20	43325
58	10	43135	58	30	43516
58	20	43325	58	40	43708
58	30	43516	58	50	43901
58	40	43708	59	0	44095
58	50	43901	59	10	44289
59	0	44095	59	20	44485
59	10	44289	59	30	44681
59	20	44485	59	40	44879
59	30	44681	59	50	45078
59	40	44879	60	0	45277
59	50	45078			
60	0	45277			

A table for the true dividing

1 Col.	2 Col.	1 Col.	2 Col.	1 Col.	2 Col.
De.	Ms.	De.	Ms.	De.	Ms.
50	10	45478	65	10	52030
60	20	46679	65	20	52269
60	30	45882	65	30	52510
60	40	46085	65	40	52752
60	50	46290	65	50	52995
61	0	46496	66	0	53241
61	10	46703	66	10	53487
61	20	46911	66	20	53736
61	30	47120	66	30	53986
61	40	47330	66	40	54237
61	50	47541	66	50	54491
62	0	47754	67	0	54746
62	10	47967	67	10	55003
62	20	48182	67	20	55262
62	30	48398	67	30	55522
62	40	48616	67	40	55784
62	50	48834	67	50	56049
63	0	49054	68	0	56315
63	10	49275	68	10	56583
63	20	49497	68	20	56853
63	30	49720	68	30	57124
63	40	49945	68	40	57398
63	50	50171	68	50	57674
64	0	50399	69	0	57953
64	10	50628	69	10	58233
64	20	50858	69	20	58515
64	30	51090	69	30	58800
64	40	51323	69	40	59086
64	50	51557	69	50	59375
65	0	51793	70	0	59667
70	10	59960			
70	20	60257			
70	30	60555			
70	40	60856			
70	50	61159			
71	0	61465			
71	10	61774			
71	20	62085			
71	30	62399			
71	40	62716			
71	50	63035			
72	0	63357			
72	10	63682			
72	20	64011			
72	30	64342			
72	40	64676			
72	50	65014			
73	0	65354			
73	10	65698			
73	20	66045			
73	30	66396			
73	40	66750			
73	50	67107			
74	0	67468			
74	10	67833			
74	20	68202			
74	30	68574			
74	40	68950			
74	50	69321			
75	0	69715			

