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# METEOROGRAPHICA,

OR

## METHODS OF MAPPING THE WEATHER;

ILLUSTRATED BY UPWARDS OF 600 PRINTED AND LITHOGRAPHED DIAGRAMS

REFERRING TO

## THE WEATHER OF A LARGE PART OF EUROPE,

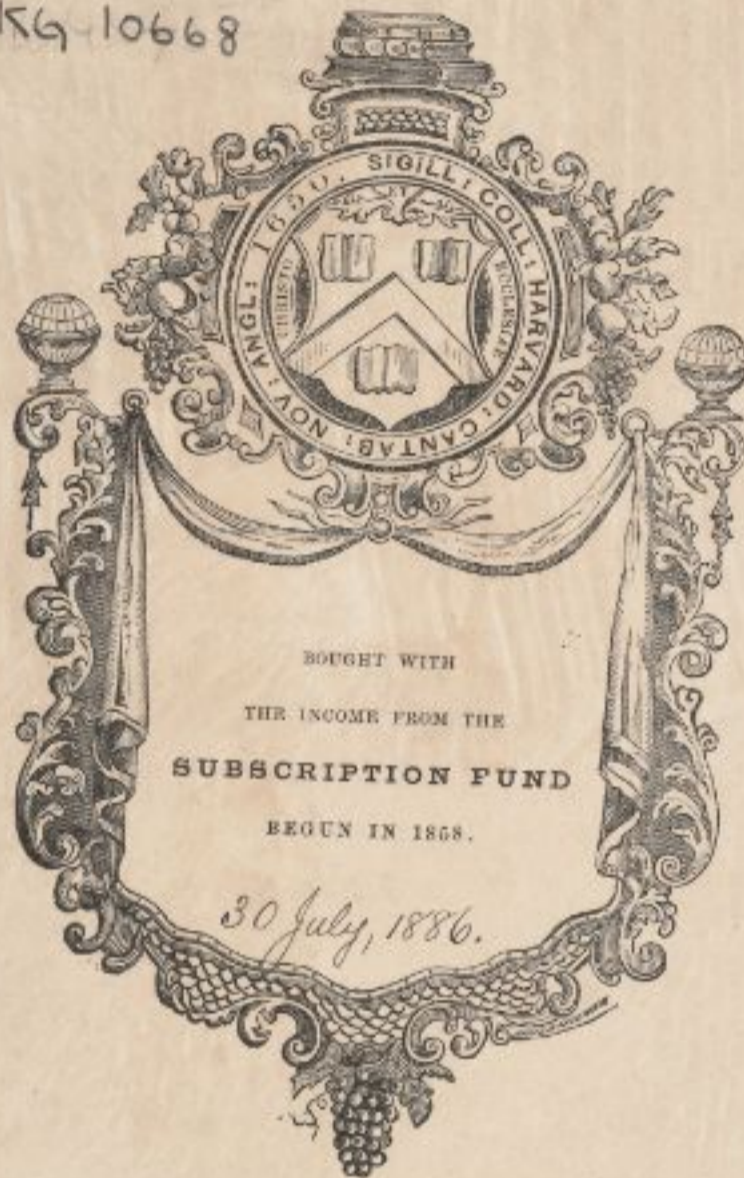
During the Month of December 1861.

By FRANCIS GALTON, F.R.S.

London and Cambridge:  
MACMILLAN AND Co.

MDCCLXIII.

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METEOROGRAPHICA

METHODS OF MAPPING THE WEATHER

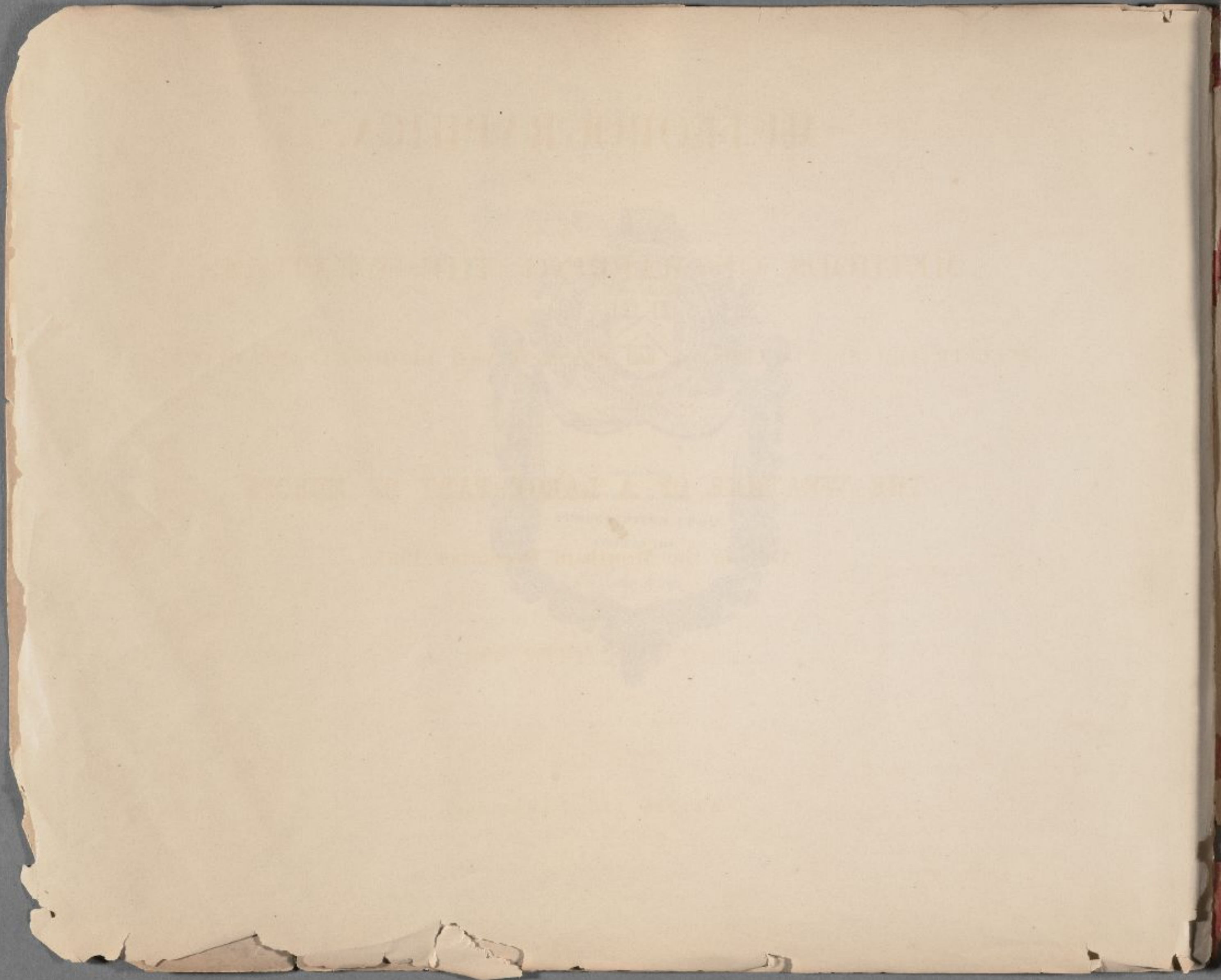
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## METEOROGRAPHICA.

THE accompanying Charts and Maps are contributions to a branch of Meteorology which is theoretically divisible into two separate portions, though they may be more or less united in practice, and it is convenient to class them under a single term,—Meteorography.

I mean by that phrase, 1st, the art and practice of tabulating Observations which have been made simultaneously at numerous stations, each record being inscribed in the geographical position of the place where it was made; and, 2ndly, the subsequent step of delineating the General Results of the Observations in a pictorial form.

When lists of observations are printed in line and column, they are in too crude a state for employment in weather investigations; after their contents have been sorted into Charts, it becomes possible to comprehend them; but it requires meteorographic Maps to make their meaning apparent at a glance.

The necessity and character of the double process I have described, may be illustrated by the well-known methods employed in Geography. If lists of latitudes, longitudes, altitudes, angles, and itineraries are laid before a Map Maker, he is able to elaborate the shapes of mountain ranges, the courses of rivers, and the irregularities of coast; but to arrive at these desired results he must *protract* his materials, by placing each datum upon a chart in its proper geographical position. His next labour is critical and artistic; he has to weigh conflicting observations, to make the best of omissions and obvious irregularities, and, finally, after deducing his results, to delineate them in a map, in order to give permanence to his ideas, and to make them intelligible to others.

A scientific study of the weather on a worthy scale, seems to me an impossibility at the present time from want of accessible data. We need meteorographic representations of large areas, as facts to reason upon, as urgently as experimental data are required by students of physical philosophy.

Meteorologists are strangely behindhand in the practice of combining the materials they possess. There are more than 300 skilled observers, using excellent instruments, scattered over Britain and the Continent, who transmit observations taken thrice daily, to Meteorological Societies or Government Institutes. Besides these, are the same number of Lighthouse keepers, who transmit good returns, of at least wind and cloud, to one or other of the three great Lighthouse Boards of Britain. Lastly, many observers publish independently. Yet throughout this mass of labour that practice of general combination is absent, which is required to utilize it as it deserves. No means exist of obtaining access to any considerable portion of these observations, without great cost, delay, and uncertainty; much less are they to be obtained in a "reduced" and never in a meteorographic form. The labour of a meteorologist who studies the changes of the weather is enormous before he can even get his materials into hand and arrive at the starting point of his investigations. In the ordinary course he has to apply, with doubtful chance of success, to upwards of 10 Meteorological Institutes in Britain and Europe, for the favour of access to the original documents received by them, and to fully 30 individuals besides. He has next to procure copies, then to reduce the barometer and thermometer readings to a common measure, and, finally, to protract them on a map.

I feel that all this dry, laborious, and costly work, which has to be undergone independently by every real student before he can venture a step into the scientific part of his work, is precisely that which should be undertaken by Institutes established for the advance of Meteorology. A debt of gratitude is due to Admiral Fitz Roy for his methodical daily reports of observa-

tions made at 20 English and 5 Foreign stations, but I believe them to be insufficiently numerous, extended, or frequent to afford a just knowledge of the winds even of a general kind; and I think it would have been a most valuable addition to the octavo Blue Book (I trust it will be annual) published by the Board of Trade if it had included an extended list of observations collected at leisure, instead of a mere reproduction of the telegraphed weather reports. The materials existed in readiness for use, and the expense of printing them would certainly not have been more considerable than that of the copious extracts from logbooks, which were inserted, and which they would have advantageously superseded. Records of this description would be many times increased in value if, instead of being printed in lines, they were printed compactly in squares so as to fall in some degree under my first division of meteorographic charts.

Thus, 

London
29.27
N.N.W.
2. VI.
34.1.

 to stand for { Bar. 29.27. Wind N.N.W. Force 2. Clouds VI.  
Therm. 34°. Excess above Wet Bulb 1°. At London.

Or better still, if an arrow head replaced the letters N.N.W. I am supposing the tables to be printed in line and column, each square containing the observations made at a station whose position is *somewhere or other* within the square, and more accurately determinable by a standard chart of reference, or by the inscription of latitudes and longitudes, instead of a name, in the case of sea observations. Still more desirable would it be if, in addition to numerical tables, the Board of Trade were to publish a series of small meteorographic Maps, like those I append, and which I will shortly describe.

A sustained series of publications of this kind, extending over two or three years, would give an extraordinary impetus to the scientific study of Meteorology. They would supply the necessary materials in a manageable form, for arriving at a general knowledge of the distribution of the various elements of the weather; they would afford means of testing the extant theory of "forecasts" with a rigour impossible at the present time, and they would necessarily improve it.

If extensive tables of reduced observations were issued in England, we might look for the co-operation of Meteorological Institutes on the continent (who already publish voluminously) in following our example. The conflict of different Measures would create no serious difficulty. All Germany uses Reaumur and Paris Feet, as France, Belgium, Holland, and Switzerland use Centigrade and Metres. Europe is thus divided into three great sections, each maintaining a common system of Measures throughout its whole area, and so far complete in itself. Each section might therefore be represented by separate tables, and it would be no serious trouble to collate the three together, if they were printed on the same scales and projections. A Meteorological, like a Geographical, Map is independent of Units of Measurement.

Entertaining the views I have expressed on the necessity of meteorological Charts and Maps, and feeling confident that no representation of what *might* be done would influence Meteorologists to execute what I have described, so strongly as a practical proof that it *could* be done, I determined to make a trial by myself, and to chart the entire area of Europe, so far as meteorological stations extend, during one entire month, and I now publish my results. They consist, 1st, of a printed series of morning, afternoon, and evening weather charts, of each of the 31 days of December 1861, making 93 maps in all, each of which contains about 80 stations. 2d. A printed series of 14 maps on a fourfold scale, one to each open page of the book, with the object of illustrating in greater detail some portion of the weather changes there represented.

3d. A printed summary of the barometric heights corresponding to each of the 93 maps, also included in the body of the book. These are followed by—4th. A lithographed map in red and black of the barometer, thermometer, rain, and wind, corresponding to each of the 93 maps. 5th. A photo-lithographic reduction of a tentative MS. diagram, showing the wind currents during each of the 93 epochs of observation. This is based on the printed materials alone. 6th. A photo-lithographic reduction of seven maps, showing the nature of the changes of the wind in Britain during a gale that occurred in the course of the month, which happen to be imperfectly represented in the ordinary charts. 7th. A photo-lithographic reduction of four of my ordinary MS. wind charts, to illustrate what I shall hereafter describe as "anti-cyclones." With the exception of the 2d and 6th of the above series, every map includes the same area. The maps and charts have been drawn on various scales, but each separate set has a map of Europe annexed to it, on the scale used throughout the set.

*Sources of Information.*—After communication with most of the leading meteorologists of the continent (to many of whom, especially Professors Quetelet, and Buys Ballot, and the late Professor Kreil, I am under great obligations), I forwarded circulars and blank schedules to their separate stations, asking for reduced observations during the then coming month of December, and promising in return, to those who fulfilled the conditions of my circular, a copy of the resultant charts. Observers are scattered unequally over Europe, and in the case of those who promised me returns, the inequality was still more conspicuous. I had therefore to supplement deficiencies as I best could, partly by the special kindness of men of science and partly by copies of documents transmitted, not to me, but to the different meteorological Institutes.

The result was, that I could not find enough stations to fill every part of a chart of Europe, if it were printed on a larger scale than that which I have adopted, but I had materials for a four-fold (superficial) scale in the case of Germany and about a six-fold in that of Britain. I therefore compromised the difficulty of disposing my numerical materials to the best advantage, by issuing a complete series of small general Charts and occasional illustrations of portions of their area on a larger scale, instead of a few large comprehensive sheets, as I had originally intended. I also issued the numerous lithographs which I have already described, in which the whole of my materials, whether published or unpublished, has been more or less utilised. I think the stations in my main series of printed charts are close enough, if the vacant areas were filled up, to give a just general idea of the barometer and thermometer; and that the scale of the 14 side maps is nearly, if not quite sufficient for wind and rain.

It may interest those who are not acquainted with the present activity of Meteorologists, to learn the number and distribution of regular stations in Europe, where accurate observations are made thrice a day. In addition to those mentioned in the following list, are a large number of individuals who observe regularly and publish occasionally, but do not transmit their observations to any Institute. This list is approximative only.

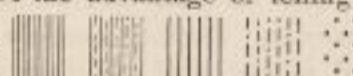
Number of Observers.	
62	British Meteorological Society includes England and Wales, but neither Ireland nor Scotland.
65	Scotch Meteorological Society.
Lighthouses	Trinity House, for English lighthouses,
	Northern Lights, Edinburgh, for the Scotch,
	Ballast Board, Dublin, for the Irish,
6	Royal Observatory, Brussels. Professor Quetelet.
6	Royal Observatory of Utrecht. Professor Buys Ballot.
80	Meteorological Society (The Government Statistical Office), Berlin. Prof. Dove.
120	Meteorological Institute of Vienna. (The late Professor Kreil.)
None within the area of my Charts	Meteorological Institute of St. Petersburg. Professor Kupffer. <small>{ 35 Stations in Europe and Asia.</small>

The 25 returns issued by the Board of Trade, and the 50 others, printed for private circulation by M. le Verrier, are only made once a day, and are therefore excluded from this list; neither do I mention the continental lighthouses, for I do not know how far the weather is observed with regularity in any of them. I might have added the logs of ships, of which many are forwarded to the Board of Trade.

There was no central institute in Switzerland, though there are many excellent observers, and there were schemes for instituting a wide system of Swiss simultaneous observations; neither was there any recognized Institute in Denmark or Norway. Whether by accident or misunderstanding, several promised communications from Denmark have never reached me, to my great regret, for its weather was closely linked with our own. From Sweden I could obtain nothing, from France next to nothing, from Bavaria only the valuable observations made at Munich. From Italy I had considerable hopes held out to me, but little fruit. The interior of Ireland is wretchedly represented, and would have presented a gap, like France, were it not for two eminent astronomers and some chance assistance besides. This is a serious deficiency, for Ireland holds a very important meteorological position in respect to England. I was also unfortunate in the accidental absence of reports from lighthouses on its eastern coast.

Every schedule of returns bears, as Meteorologists are aware, some intrinsic evidence as to its own value, which is strengthened almost to certainty by collating it with returns from adjacent stations. Now, I can most gladly testify, that of the numerous light-keepers whose returns, by the especial kindness of the Irish and Scotch Boards, were transmitted to me, and to which, by the favour of the Trinity House, I was permitted access, the great majority were distinguished by a most painstaking exactness. I believe they would make valuable observers of all the elements if their barometers were put in order, their thermometers properly exposed, and instructions given them to reduce their barometric readings to the nearest hundredth of an inch. I have used several of their barometric returns in compiling my symbolic tables, though they were not sufficiently accurate to print in the charts.

The lighthouses on the French coast (whose returns failed me at the last), and those of the North Sea and Baltic, ought to supply a valuable cordon of meteorological observers.

*Charts of Numerical Record.*—My 93 printed charts contain a selection from my materials, printed in their proper geographical positions; and they do a little more than this, because I have represented pictorially two of the weather data which admit of being accurately expressed by symbols. It is evidently quite as precise to use the symbols  $\cup$ ,  $\cup$ ,  $\cup$ , as the letters N, NNW, and NW, while the former have the advantage of telling their tale directly to the eye. With similar precision do the series  express five states of the

sky,—entirely clouded, mostly, half, a few clouds, and none at all; and these are as many varieties as I cared to insert. The difficulty is greater with the other records. We want to depict the barometer to the nearest hundredth of an inch, while its range exceeds  $2\frac{1}{2}$  inches; in other words, we have upwards of 250 possible variations to register. As these are far too numerous to be attempted by depths of shading or differences of colour, we have no other option than to make use of numerals. As with the barometer, so in a less degree with the thermometer; the distribution of moisture is perhaps to be managed graphically. Again, the size of the chart increases in direct proportion to the space occupied by the individual symbols, and a volume of large maps is a serious inconvenience, it is too embarrassing for frequent use, it requires space to be spread out upon, trouble and even strength to handle it, and the maps cannot be examined without standing and bending over them. I concluded, from these considerations, that my problem was to fix upon cloud and wind symbols, and to print the rest in figures with the utmost compactness. After many experiments I adopted the present system, and had types cut on purpose. I gratefully acknowledge the assistance of my friend Mr. William Spottiswoode, Her Majesty's Printer, in bringing these typographical attempts to a successful conclusion.



*Meteorographical Maps.*—We will now leave the subject of charts of mere record, and consider the method of embodying their results. It takes a vast number of co-ordinates to determine the course of any irregular line, and a still greater number of pieces of mosaic or stitches of tapestry to express a very simple picture; so, conversely, a few judicious sweeps and shadings of a draughtsman's pen, may embody the simultaneous observations of hundreds of meteorologists. The ultimate condensation of bulky reports into small intelligible maps is the object we must keep stedfastly in view.

Our first difficulty is to map five elements which refer to the same area and mutually affect each other; viz., wind, cloud, barometer, thermometer, and moisture. I should fear it was hopeless to expect to combine them all without confusion in one or even into two maps; but, let that be as it may, we have first to consider good plans of delineating them separately. The course of the wind (on the earth's surface) affords no difficulty, and the principles on which I have treated it are pretty satisfactory. First, there are the photo-lithographic maps of two gales, and of four selected epochs, reduced from my own manuscript; they contain, in a small though legible form, the original observations, as a justification for the bold lines drawn through them, which represent the course of the wind currents, such as I interpret them to be. Secondly, there are the red and black maps, reduced coarsely by hand, from my own manuscript charts, which contain about 200 observations. Thirdly, there are the photo-lithographs of all the 93 days in a separate map. I drew these last, from my printed materials alone; they are of interest as showing the class of errors into which one is liable to be led by the employment of too limited a number of observations, and are intended to be compared with the far more trustworthy red and black maps. These are accompanied by arrows that refer to *groups* of observations, in justification of my lines of wind currents.

Considering the remarkable interest now testified by the English public in the law of gales, the lengthened and repeated notices in the Journals during the progress of each of them, and the energy which the Meteorological Department of the Board of Trade shows on those occasions, I should think that miniature diagrams like those I have given, would be very proper subjects for publication; they would be more intelligible and precise than columns of verbal explanation, and the justificatory charts of observations might be published at leisure. As an example of what I mean, the following miniature woodcut, which was reduced from my MS. chart by Photography—



embodies all I have been able to conclude from the observations of about 150 stations concerning the change of the wind during the December gale of 1861. It would only require some previous organization, to secure the necessary returns by post long before the interest of the event had passed by.

It requires practice before the lines on the diagrams can be drawn in an effective manner. I proceed by laying short heavy marks on my manuscript chart, wherever the general direction of the wind is unmistakable; next I push about the marks, as freely as the conditions admit, until they stand at convenient distances apart, and tell their tale clearly, then I mark the places where they stand, and afterwards brush them away. This, however, is not all; for attention has to be paid to the convenience of comparing one map with another, and the lines in each of them should have a distinct relation, wherever it is possible, with those of the map that preceded it. Where the wind is wholly unchanged, the lines employed to represent it should be the same in number, and occupy the same position as in the previous map. Where, as is more usually the


case, the direction is somewhat altered, the lines should be made to differ no more than the alteration requires.

In studying the wind in my 93 photo-lithographs, it should be recollected that as the weather is often slow in change, the printed charts which precede and follow the one under examination will throw fresh light upon it; secondly, the side charts will be found very valuable; and lastly, the wind in the mountainous parts of Europe (which is to be made out from the diagram A. 1 on the first page,) is so complicated that it had better be altogether ignored.

I must warn persons who may hastily compare my deductions with the original charts, that it requires patience and some training of the eye to interpret the wind currents satisfactorily. Had the stations been more numerous, local deviations would have balanced each other, and been lost in the mass; but here, with only 80 stations, they confuse the eye. With the still fewer, and less frequent observations that meteorologists commonly employ, and the more limited areas they deal with, there is wide room for fancy, especially when the air is much disturbed and thrown into eddies. The direction given by one station will often be so flatly contradicted by an adjacent one, that obviously both cannot be indications of the same great system. Then arises the question, which of the two is to be ignored? Exercising the right of occasional suppression and slight modification, it is truly absurd to see how plastic a limited number of observations become, in the hands of men with preconceived ideas. If they wish to see cyclones, they will find them everywhere; so with winds blowing to centres, or winds blowing from centres. The advantage of numerous stations in the case of wind, is well seen by comparing the photo-lithographs of the 200 stations with the Charts of only 80 stations that refer to the same days. Not only is there a delicacy of curve to be deduced from the former, which is wholly invisible in the Charts, but the very essence of the mode in which the wind has made its changes, is hidden or even misrepresented in the latter.

The original MS. charts of the winds will be deposited in the library of the British Meteorological Society, where any member of that Society, who might care to do so, would be able to satisfy himself of the data upon which I have founded my representation of the currents.

We have now seen that the direction of the wind (neglecting the depth of its current and other winds moving in various directions at higher altitudes), can be easily represented. I also see that I could have indicated its force by varying the thickness of the lines, and its irregularity by drawing them with an unsteady stroke. The movements of the wind are on the plane of the earth, and can, therefore, be described by directive marks on the plane of our paper; but the other meteorological elements are of a different character, and introduce a "third dimension." They require a similar pictorial treatment to that employed for geographical elevations; in other words, areas of elevation and depression of the barometer, &c., must be pictured by contour lines and shadings, on the same principles as mountains and valleys. I have used shaded types, ●, ✱, ○, ○, in the printed Barometrical tables, the intensity of shade representing the divergence from an average; and two colours, the one for excess, and the other for deficiency. They seem to me to be clear so far as they go, but the curves of nature are represented at a serious disadvantage by the mosaic work of types. Far better are the red and black lithographed

maps of barometer and thermometer, drawn upon this principle  though with different

shading. They were compiled by placing marks like small chessmen, on the printed charts and drawing contour lines round the areas on which I found them grouped. In doubtful cases, I referred to my unpublished materials, and in the outlying corners of Ireland and England was able to make considerable though critical use of lighthouse returns. I have taken the total barometric pressure, *not subtracting the vapour tension*, reduced to the level of the sea and to 32° Fahr.; and the thermometer, as reduced to the level of the sea, allowing 1° for each 300 ft.

I imagine the new art of photo-zincography (or -lithography) as practised with such remarkable success by Sir Henry James in the Ordnance map office, and more recently by others, is likely to be of important service to meteorology. It is not to be expected that the meteorologist should work delicately, like an artist, nor is it advisable he should waste his time in making fine strokes. He naturally writes with a free hand, draws his lines boldly, and ultimately produces a large chart, from which a clean tracing is readily made, that looks well enough at a distance, but would be too coarse and far too bulky to lithograph in fac-simile. At this stage the new process comes in most helpfully; for it throws the rude outlines and thick touches of the manuscript into a delicate miniature on a sheet of zinc, or on a lithographic stone, ready for the printer to cover with ink, and throw off his impressions, exactly as from any other lithograph. One matter is, however, essential, which I am sorry I did not attend to sufficiently in the maps I annex, namely, to draw or stamp the marks with a sharp and densely black stroke on perfectly clean paper. Therefore, though the results are perfectly effective, they are coarse and do not exemplify the process in the way it deserves.

I may state that on enquiry of the artist (Mr. Ramage, 8, West Brighton Crescent, Portobello, near Edinburgh,) who made two of my photo-lithographs, I found the cost of producing 100 copies

of a reduction from a clear chart, was at a less rate than 3*d.* a square inch, every expense included. But while praising photo-lithography, I know to my cost that this art is by no means so matured, as to be universally practised with success. The black and red sheet was to have been made by a London photo-lithographer of considerable pretension, who, after detaining the MSS. for half a year sent me his results so ill executed as to be wholly unfit for publication. I was ultimately obliged to have the maps lithographed in the ordinary way, as they now appear. I regret the absence of delicacy of outline, which photographic reductions from my original MS. would have shared with the little woodcuts, I have inserted above.

*Errata.*—I had intended drawing up a table of *errata*, and am sorry to acknowledge they would have been numerous; but reflecting that the observations I received are all liable to error, I thought it best to let the charts tell their own tale. Whoever works at them will find obvious irregularities to the extent say of one in ten records. These, whether due to errors of the press, or of record, or to local peculiarities, must be thrown out of consideration. Some barometric readings have a constant error, but the *errata* are not numerous enough to create real difficulty.

### METEOROLOGICAL RESULTS.

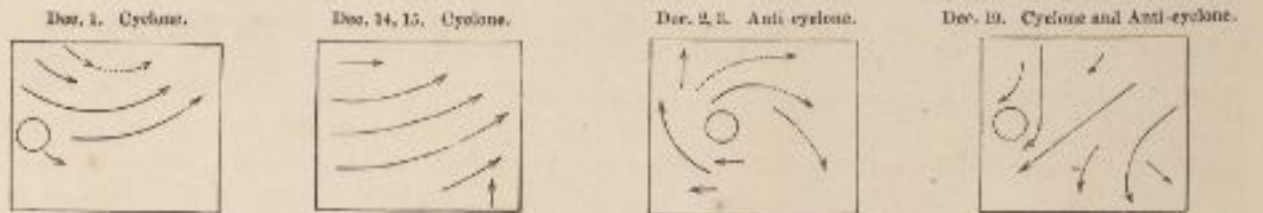
Those which I have to offer on the present occasion lie comparatively on the surface ; for my aim thus far has been mainly meteorographic. I may claim credit for myself in having issued, at considerable cost and labour, as many observations relative to this one month of December, 1861, as are published in the Weather Reports of the Meteorological Department of the Board of Trade, during an entire year, to say nothing of the numerous forms under which these, and still more abundant materials, are illustrated.

The surface that is mapped in these Charts, is inconsiderable when compared to the area of the whole earth, but is far from inconsiderable when compared to a strip reaching from the Equator to the Pole, and therefore containing every climate and nearly every meteorological phenomenon which the earth affords. The space they include, extends from the 42d to the 62d degree of north latitude ; consequently a similar area added to the north would include the remotest Arctic regions, while one to the south would dip far into the trade winds, and another still further to the south would almost include the Equator.

Bearing in mind the vastness of these areas, it may well astonish us to find frequent wind currents sweeping with an unbroken flow across our Charts, being obviously portions of enormous systems which far overpass their limits, and probably connect the winds of the tropics on the one hand with those of the Arctic circle on the other. Still more surprising is it to remark the simultaneity of the wind changes. We may see systems of currents converting themselves into entirely different combinations, with perfect unanimity throughout the whole area over which our observations extend, showing the rapidity and the distance to which every aerial impulse is communicated, or, in other words, testifying to the remarkable mobility of the air. It is difficult not to conclude, even from these limited series of weather maps, that ordinary changes of wind and sky have their sources in far more numerous and distant regions than is commonly supposed.

These maps bear testimony to the shallowness of that lowest stratum of the atmosphere, the movement of which causes our winds. We observe that the Alps form a barrier which the winds rarely overleap without change of direction, and that the mountains of Eastern Germany usually divert them. No ordinary liquid can give an idea of that combination of mobility and thinness that characterizes the aerial strata, unless it be a film of oil lying on a pool of water.

Many meteorologists will refer with eagerness to these wind Charts, to see how far they may confirm or oppose the theory of cyclones. I deduced from them, as was explained in a short memoir read before the Royal Society, (*see Proceedings 1863, p. 385*) that they testified to the existence, not only of cyclones, but of what I ventured to call "anti-cyclones." If the lines of wind currents, in the black and red lithographs, are compared with the barometrical charts immediately above them, one universal fact will be found throughout the entire month. It is that on a line being drawn from the locus of highest to the locus of lowest barometer ; it will invariably be cut more or less at right angles, by the wind ; and, especially, that the wind will be found to strike the *left* side of the line, as drawn *from* the locus of highest barometer. In short, as by the ordinary well-known theory, the wind (in our hemisphere) when indraughted to an area of light ascending currents, whirls round in a *contrary* direction to the movements of the hand of a watch, so, conversely, when the wind disperses itself *from* a central area of dense descending currents, or of heaped up atmosphere, it whirls round in the *same* direction as the hand of a watch. I confidently appeal to these maps, and especially to the original MSS. whence these charts have been reduced, to confirm the theory. I annex four woodcuts that I had made before the idea of anti-cyclones had occurred to me. They were intended to illustrate the different systems of winds that blew during the month. They are not so accurate as might be now deduced from the red and black charts, for they were only based on the printed observations. Nevertheless they will serve our purpose.



Many of the charts during the continuance of the gales, and especially the side maps of December 10th and 11th, show gentle winds and clear sky in close proximity with violent storms. They testify to the value of warnings telegraphed to a whole line of coast from a central office, whenever gales are known to be blowing at particular stations.

The areas of barometric elevation and depression are enormous, and in their main features very regular. They are easily recognized by the lithographed maps, in black and red. There is no case in which the Charts include the whole breadth or length of any one of these areas, and there are cases where clearly not one-half of them is included, yet the map is about 1,200 geographical miles in height, and 1,500 in breadth. They do not move with regularity, ridge behind ridge, like waves of the sea, but they are ever changing their contours and their sections. They also vary in the speed and directions of their movement of translation.

In addition to these great fluctuations, there are numerous smaller ones, and it occasionally happens that the barometric readings have a widely-spread tendency to show marked though minor irregularities in adjacent places ; or, to use an intelligible though inaccurate metaphor, there are violent ripples on the great barometric waves. My data are wholly insufficient to do justice to these minutiae. In Switzerland, where the mountains retard aerial equilibrium, the barometer seems very irregular in respect to those few stations which I have had space to insert in my maps. I fear, however, there has been some misunderstanding here, as to my request to have the barometric observations reduced to the sea level, and to the temperature of 32° Fahrenheit. No doubt when the Swiss meteorologists have set in action their purposed 80 stations, such irregularities as may really exist, will become peculiarly instructive.

I cannot see in the maps before us that surface winds have always had much influence in causing or remedying the great barometric variations, and conclude they were frequently effected in the regions above our ken. The areas of calm are generally those of highest barometer, never those of very low barometer. They are invariably the centres of partial whorls of wind, or are situated between conflicting currents. The winds adjacent to calms are nearly always gentle and capricious.

The westing of what was originally a South wind and the easting of North winds, due to the "convergence of meridians," is apparent, but only in a slight degree. It is masked by the cyclonic and anti-cyclonic curves.

I do not find the temperature of the same wind to be so uniform as I should have expected. There is, however, one marked condition of temperature and cloud in connection with the wind, which is persistent, beautifully marked, and full of interest. During the latter third of the month a phase of weather prevails with much variety of detail, but steady in its main features, and is well illustrated by the side maps of December 21st and 25th. A westerly wind sweeps across the North Sea over Belgium, Denmark, and Germany east of the Elbe ; it is accompanied with a sky that is invariably overcast, and with a warm temperature. This is sharply bounded by an area of confused wind, of perhaps 100 miles wide and 500 miles long, that shifts its position in the land between the Rhine and the Elbe. Here the sky clears considerably, and the air is much colder. West of this again is another area also sharply bounded, where the sky is absolutely pure, the cold intense, and an east or north-east wind has plunged down upon the earth.



June 1863.



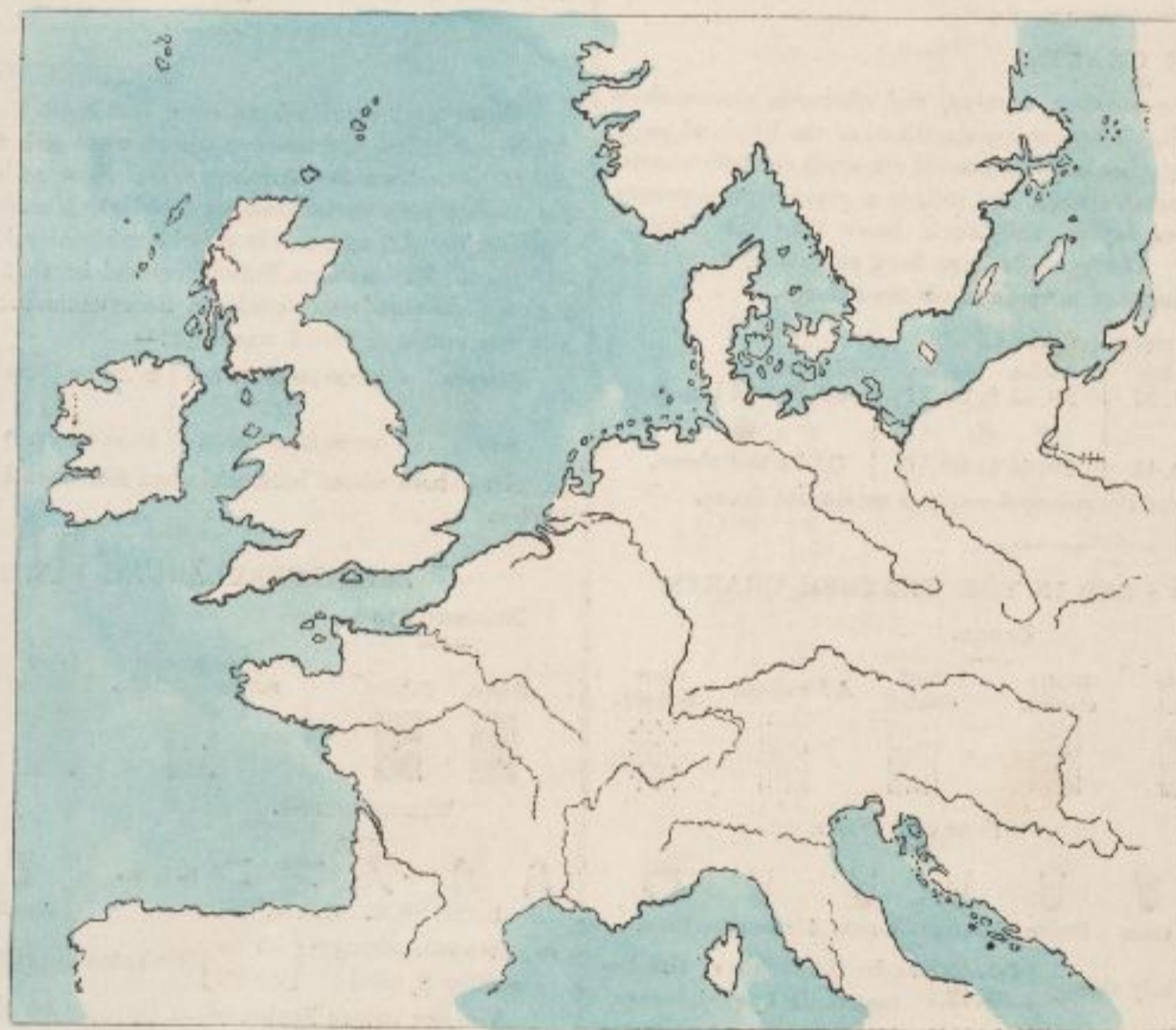
# WEATHER CHARTS

OF

## BRITAIN AND PART OF EUROPE,

During December 1861.

By FRANCIS GALTON, F.R.S.



### INDEX MAPS.

On the opposite page are four Index Maps, which show the names and other data of the meteorological stations selected.

A1 and A2 refer to the General Maps, which represent the weather on the morning, afternoon, and evening of each of the 31 days of December 1861.

B and C refer severally to enlarged maps of Britain and the Continent, one or other of which occupies the lowest corner of each right-hand page, and is intended to illustrate some interesting occurrence during one of the six adjacent epochs.

As an example of the meaning of the symbols in A2, we will take those corresponding to North Unst Light. They are printed  $\begin{matrix} 235 \\ 1 \\ 9 \\ 3 \\ 9 \end{matrix}$ ; that is to say, 1st, the elevation of that station above the sea is 235 feet; on that account, 2dly, 1° Fahrenheit has to be added to the thermometrical record, if it be desired to reduce the registered temperature to the sea level; and 3dly, 9 A.M., 3 P.M., and 9 P.M. are the hours of observation, in approximate local time. The symbol  $\begin{matrix} \text{|||||} \\ \text{|||||} \\ \text{|||||} \end{matrix}$  that is printed over the figures is merely another way of expressing the 1° and is a rude measure of the height of the station; 0°, 1°, 2°, 3°, 4°, and 5° being represented respectively by the symbols  $\begin{matrix} \bullet & \circ & \circ & \circ & \circ & \circ \\ \bullet & \circ & \circ & \circ & \circ & \circ \\ \bullet & \circ & \circ & \circ & \circ & \circ \end{matrix}$ . My object was to give, at a glance, a general notion of the elevation of the area under observation, by the intensity of the shade employed.

### WEATHER CHARTS.

On opening the book at any place, we see the morning, evening, and afternoon observations of two consecutive days, making six epochs in all. They occupy the whole of the left-hand page, and the left half of the right-hand one. On the other half are printed six small symbolic charts, each of which corresponds to one of the foregoing epochs, and affords a convenient summary of its barometrical peculiarities. Red signifies *higher*, and Black *lower* than the average barometrical height (assumed at 29.95 inches). The symbols have been so arranged that the intensity of the shade is proportionate to the amount of deviation from the average.

#### Symbols in Barometrical Charts.

	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
Black	- 29.95 to 29.71	29.70 to 29.46	29.45 to 29.21	29.20 and below.		
	○	○	*	●		
Red	- 29.96 to 30.20	30.21 to 30.45	30.46 to 30.70	30.71 and above.		

Below the barometric tables, is printed one of the enlarged maps, as mentioned above.

### EXPLANATION OF THE SYMBOLS USED IN THE WEATHER CHARTS.

RAIN.		CLOUD.					
Rain.	Snow.	Entirely and heavily clouded.	Entirely clouded.	Mostly clouded.	Half clouded.	A few clouds.	Clear blue sky.
DIRECTION OF WIND.			FORCE OF WIND.				
S. S.S.W. S.W. W.S.W. W.						Gale. Strong. Moderate. Gentle. Almost calm. Calm.	

In each compound symbol  $\begin{matrix} 30 & 39 \\ 29 & 72 \end{matrix}$  respectively signify  $\begin{matrix} 30.39 \\ 29.72 \end{matrix}$  to be the height of the barometer in English inches. The lower figures 34—1 mean 34° is the height of Fahrenheit thermometer, and 1° is its excess over the thermometer with a moistened bulb.

### ÜBERSICHTSKÄRTCHEN.

Die vier Uebersichtskärtchen auf der gegenüberstehenden Seite enthalten Namen der gewählten Stationen und einige weitere Angaben.

A1 und A2 haben Bezug auf die General-Karten, auf welchen die Witterung am Morgen, Nachmittag und Abend jedes der 31 Tage des Decembers 1861 angegeben ist.

B und C haben Bezug auf die Spezialkarten von Britannien und dem Continent, von welchen je eine die untre rechte Ecke einer Seite einnimmt; auf ihnen sind bemerkenswerthe Erscheinungen niedergelegt, welche sich während einer der sechs nebenstehenden Epochen ereignet haben.

Die auf A2 angebrachten Abkürzungen und Symbole erklären wir mit Hinweisung auf die Station North Unst Light. Dort steht  $\begin{matrix} 235 \\ 1 \\ 9 \\ 3 \\ 9 \end{matrix}$ . Es heisst dies 1.) die Station liegt 235 Fuss über dem Meeresspiegel; 2.) um die Temperatur auf den Meeresspiegel zu reduciren muss 1° F. der beobachteten Temperatur zugezählt werden; und 3.) die Beobachtungszeit war 9 A.M., 3 P.M. und 9 P.M. in der ungefähren Zeit des Ortes. Das über die Zahlen gedruckte Symbol  $\begin{matrix} \text{|||||} \\ \text{|||||} \\ \text{|||||} \end{matrix}$  zeigt die annähernde Höhe der Stationen, und drückt auf andere Art den 1° F. aus. 0°, 1°, 2°, 3°, 4°, und 5° sind beziehungsweise durch die Symbole  $\begin{matrix} \bullet & \circ & \circ & \circ & \circ & \circ \\ \bullet & \circ & \circ & \circ & \circ & \circ \\ \bullet & \circ & \circ & \circ & \circ & \circ \end{matrix}$  ausgedrückt. Es wurde durch diese stufenweise Schattirung bezweckt auf einen Blick die annähernde Höhe des Beobachtungs-Areals zu geben.

### WITTERUNGS-KARTE.

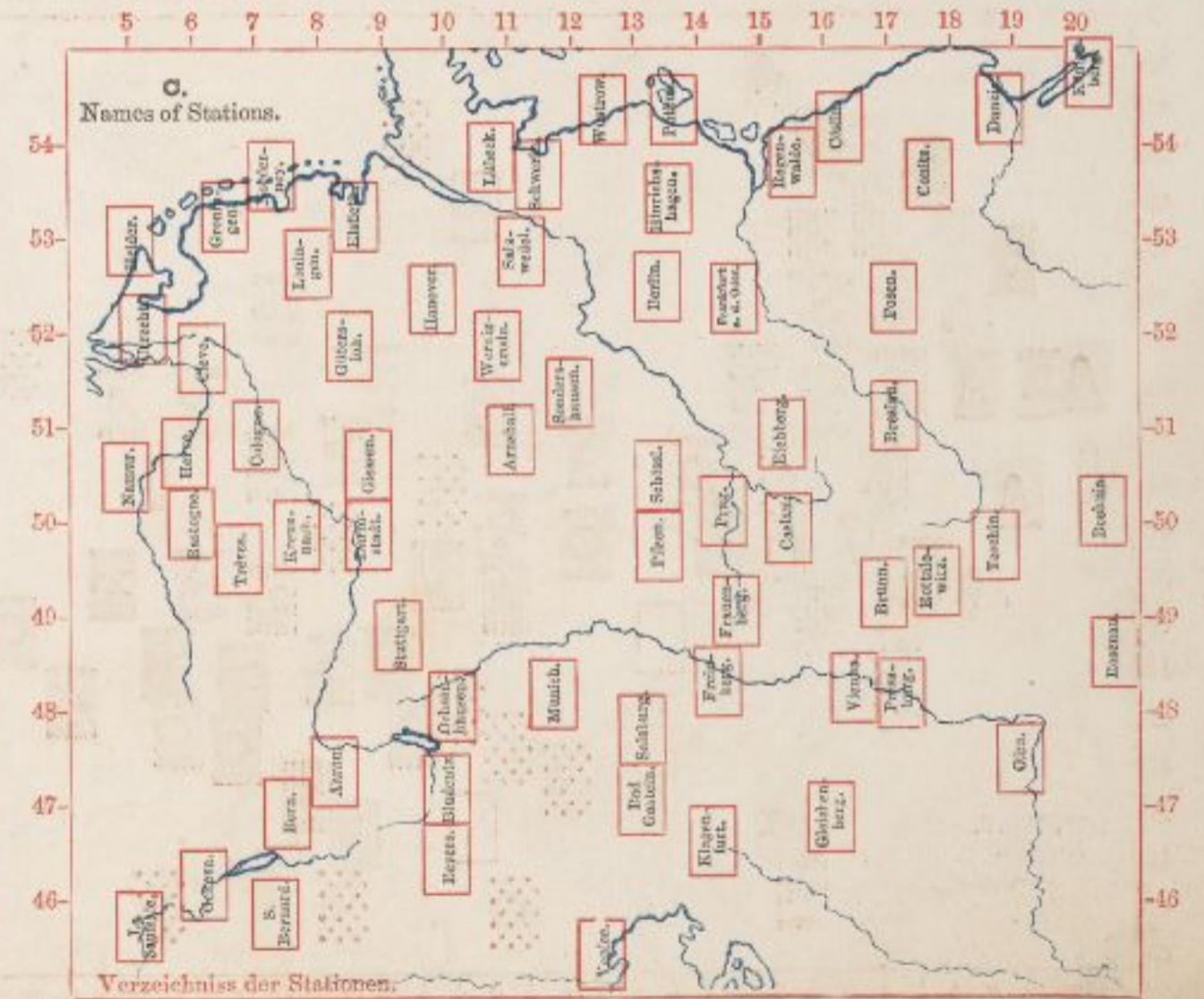
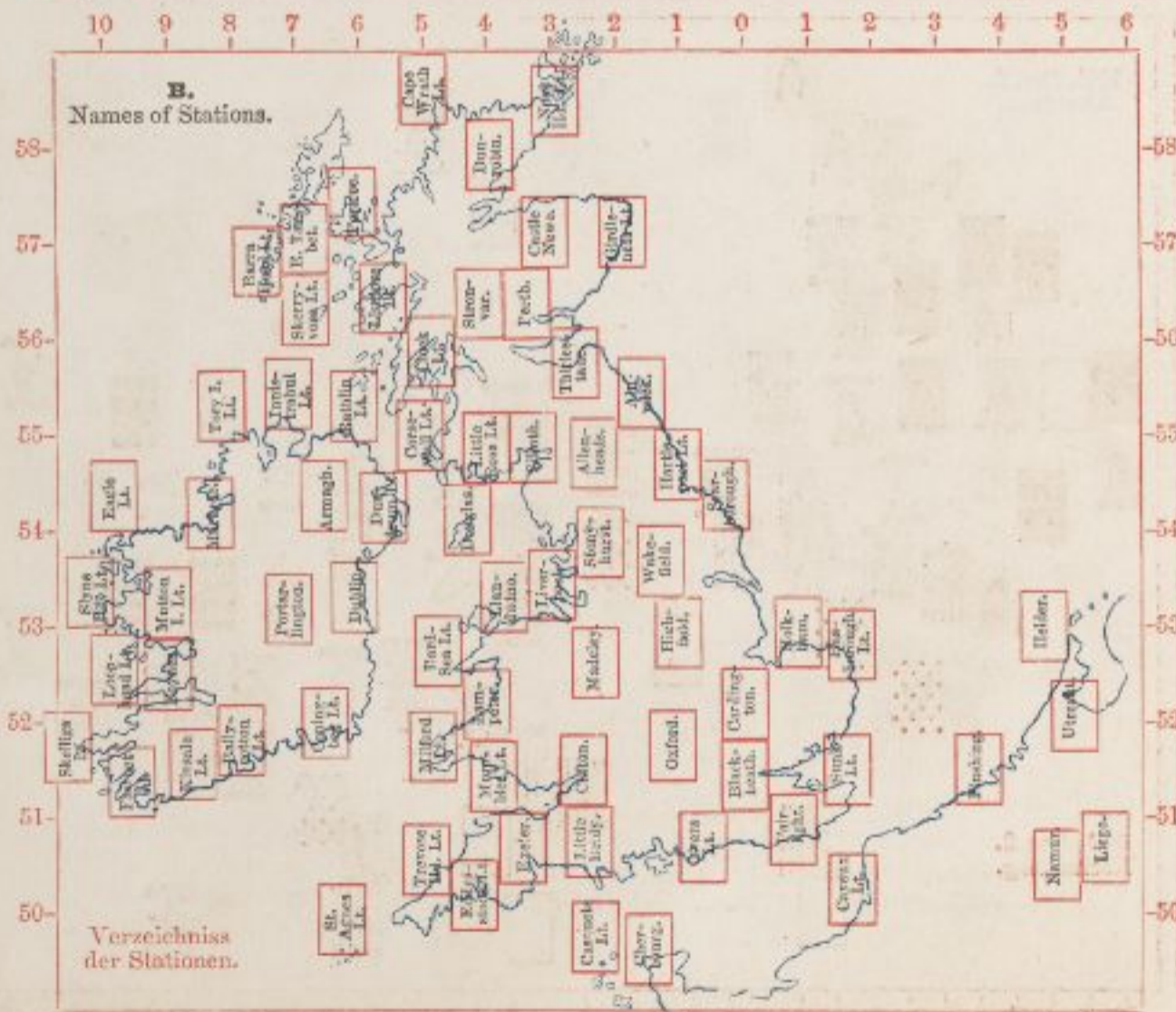
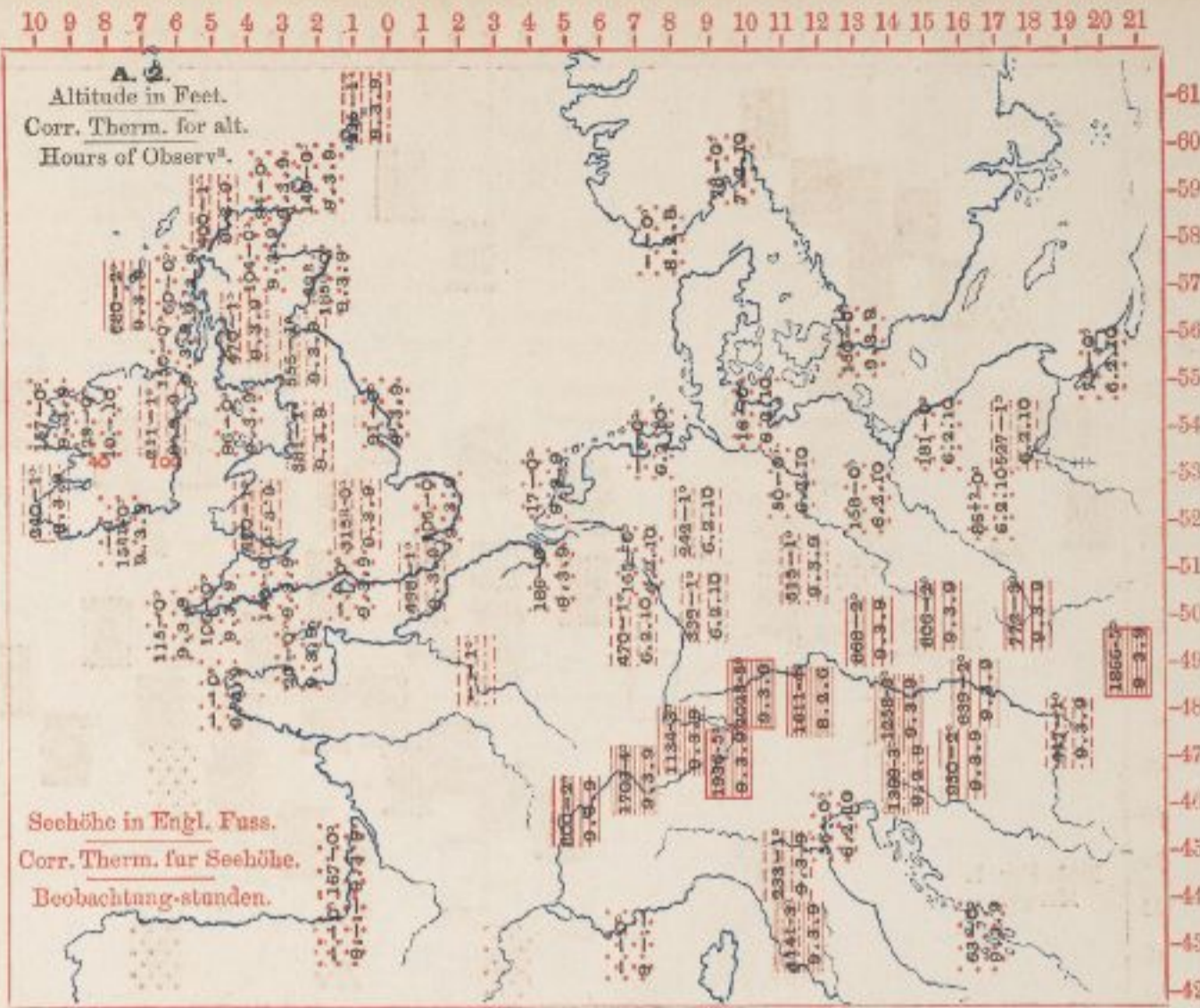
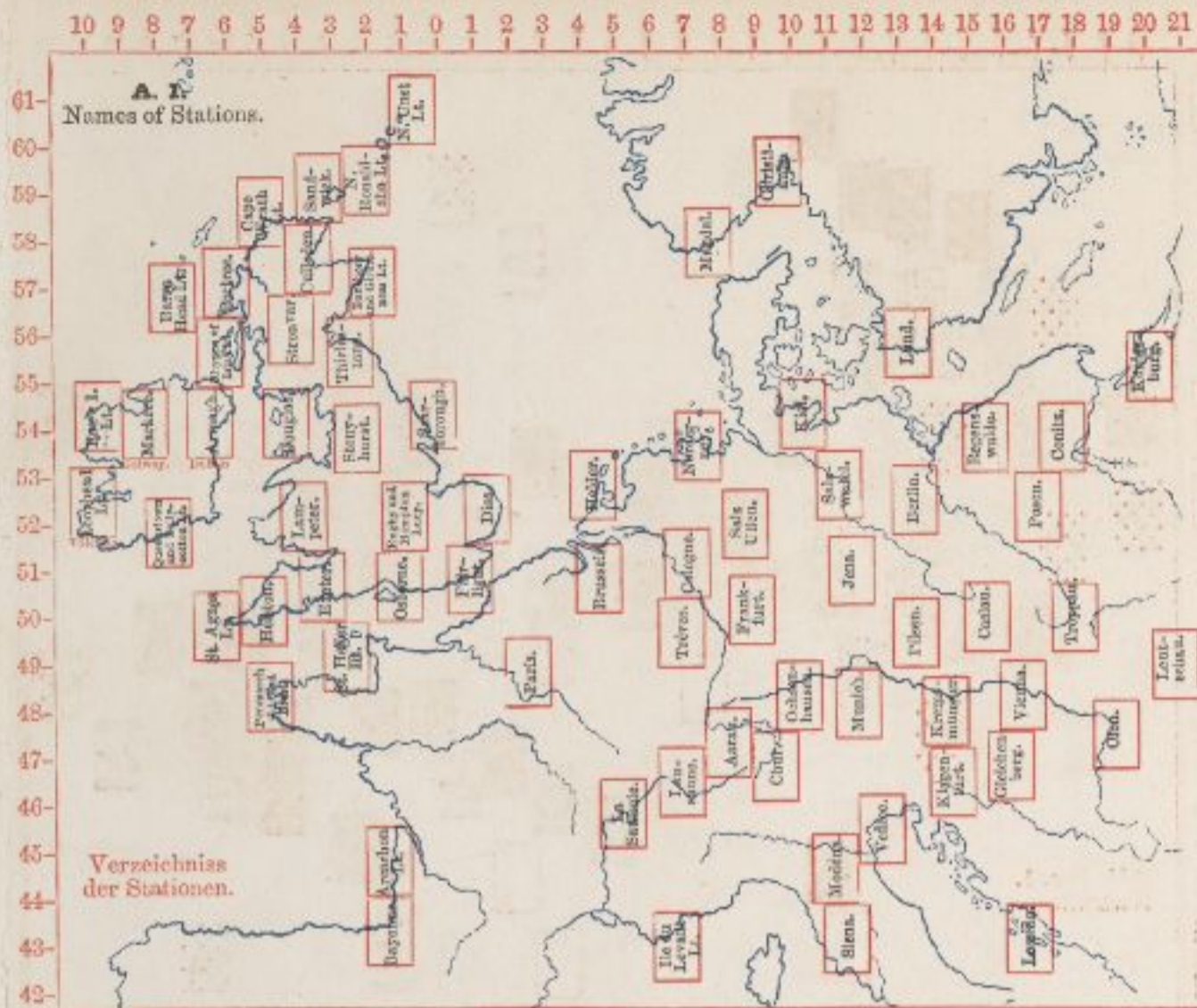
Oeffnen wir das Buch an einer beliebigen Stelle, so finden wir auf der ersten Seite und auf der linken Hälfte der zweiten die an zwei sich folgenden Tagen am Morgen, Nachmittag, und Abend gemachten Beobachtungen (in allem sechs Epochen) niedergelegt. Die rechte Hälfte der zweiten Seite enthält sechs symbolische Kärtchen, deren je eins sich auf eine der beistehenden Epochen bezieht, und welche eine übersichtliche Zusammenstellung barometrischer Erscheinungen enthalten. Der mittlere Barometerstand ist zu 29.95 Zoll angenommen; roth bedeutet einen höheren, schwarz einen niederen Barometerstand. Die Symbole bezeichnen die Abweichung von dem mittleren Stand, wie folgt:—

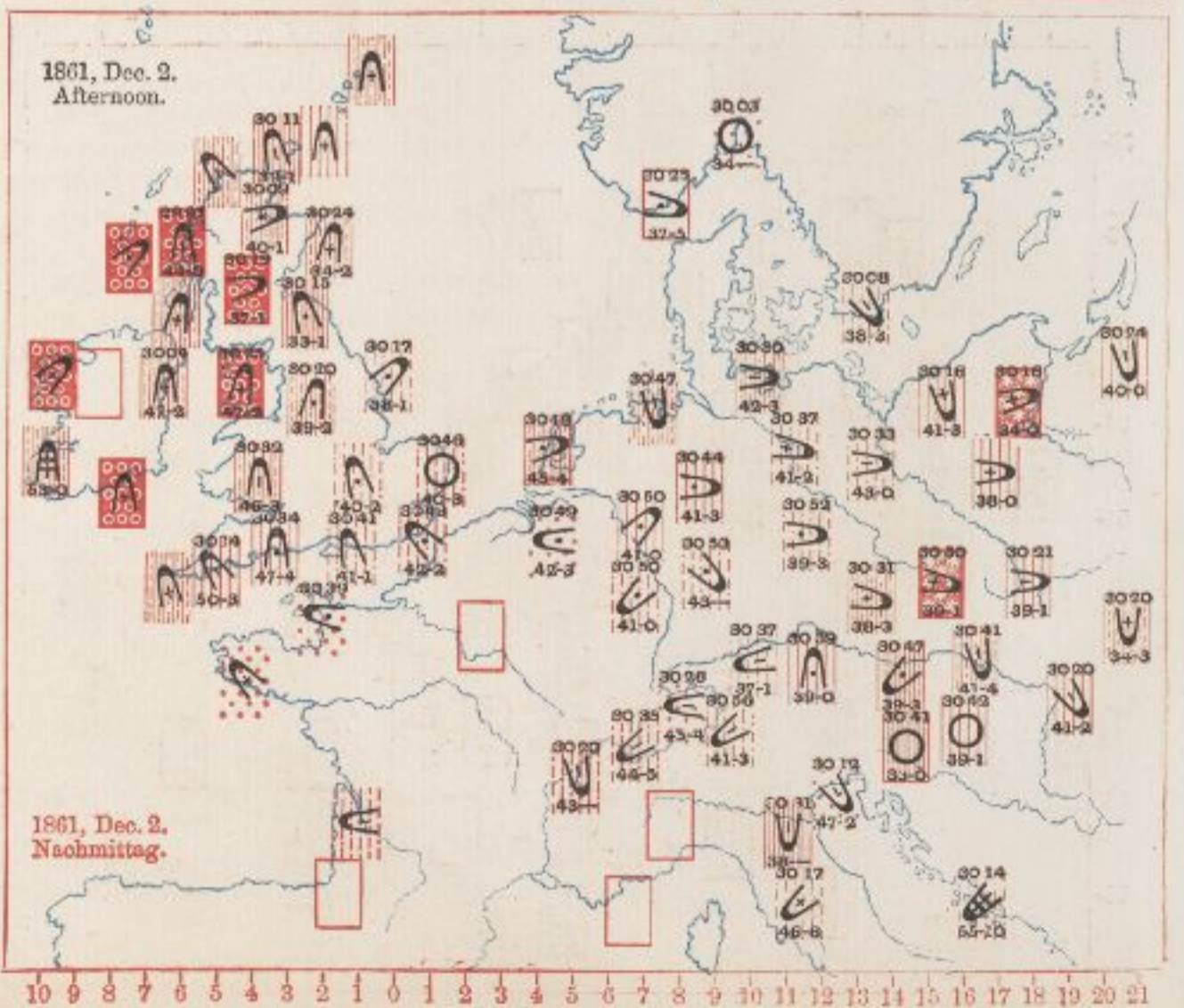
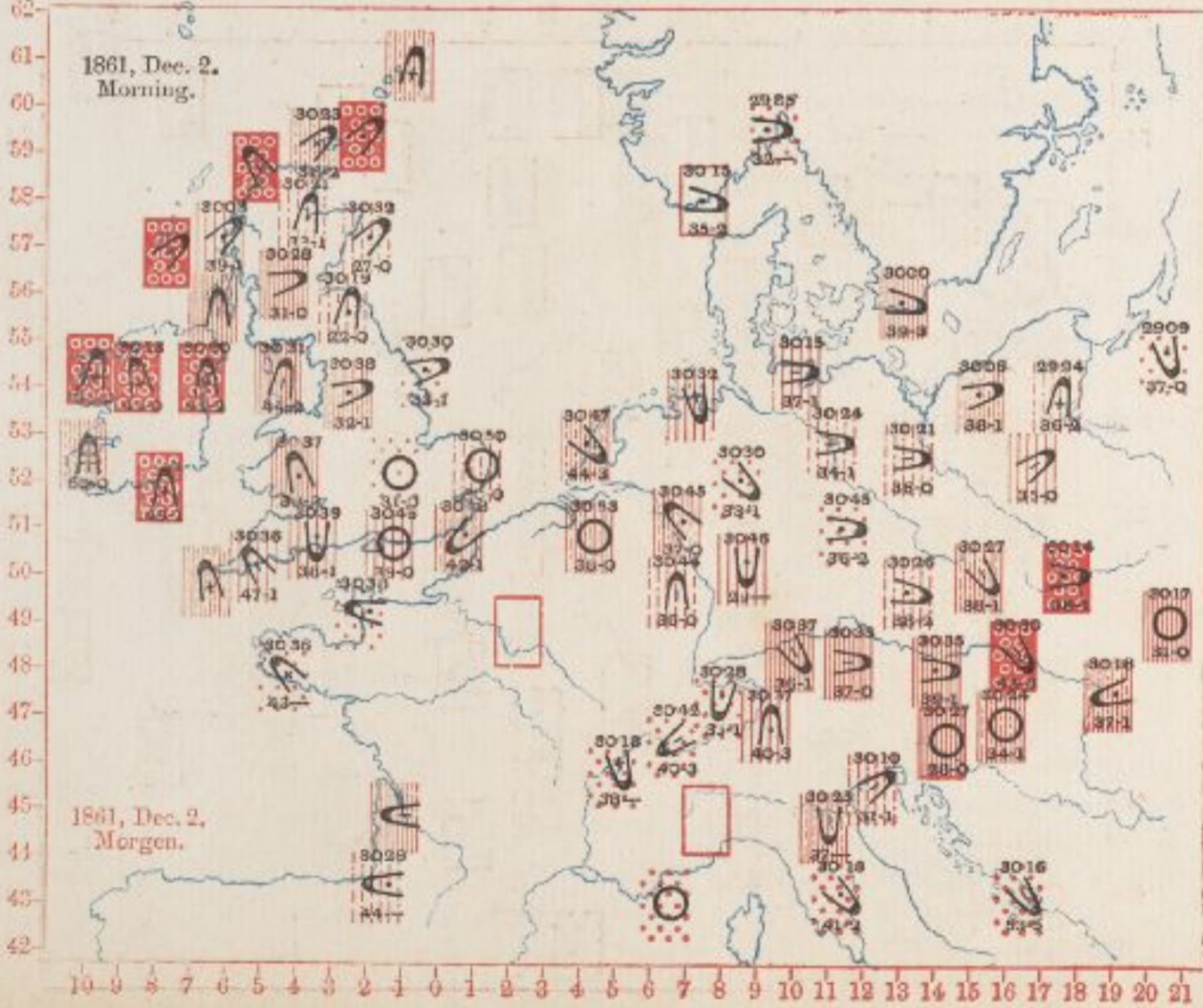
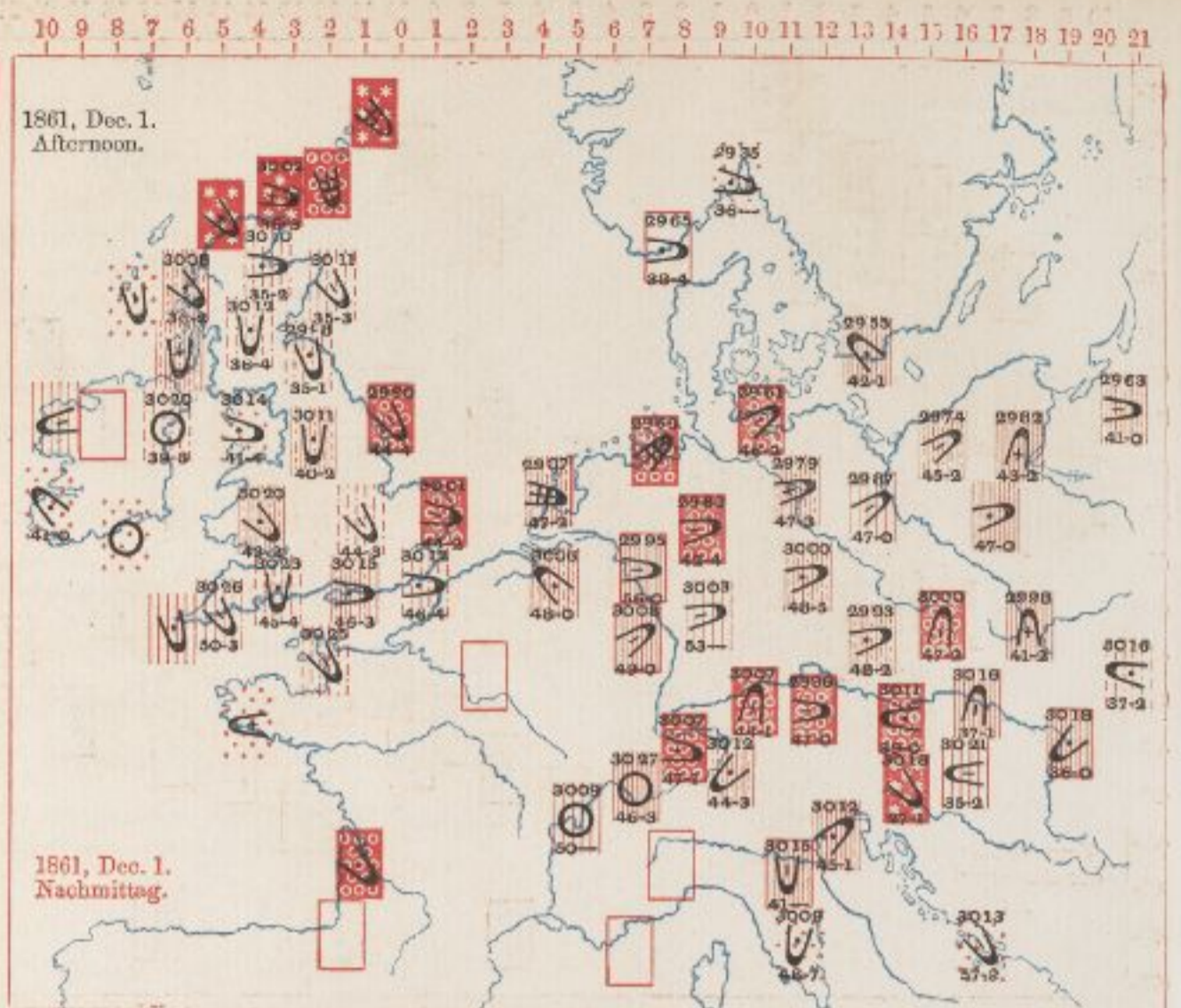
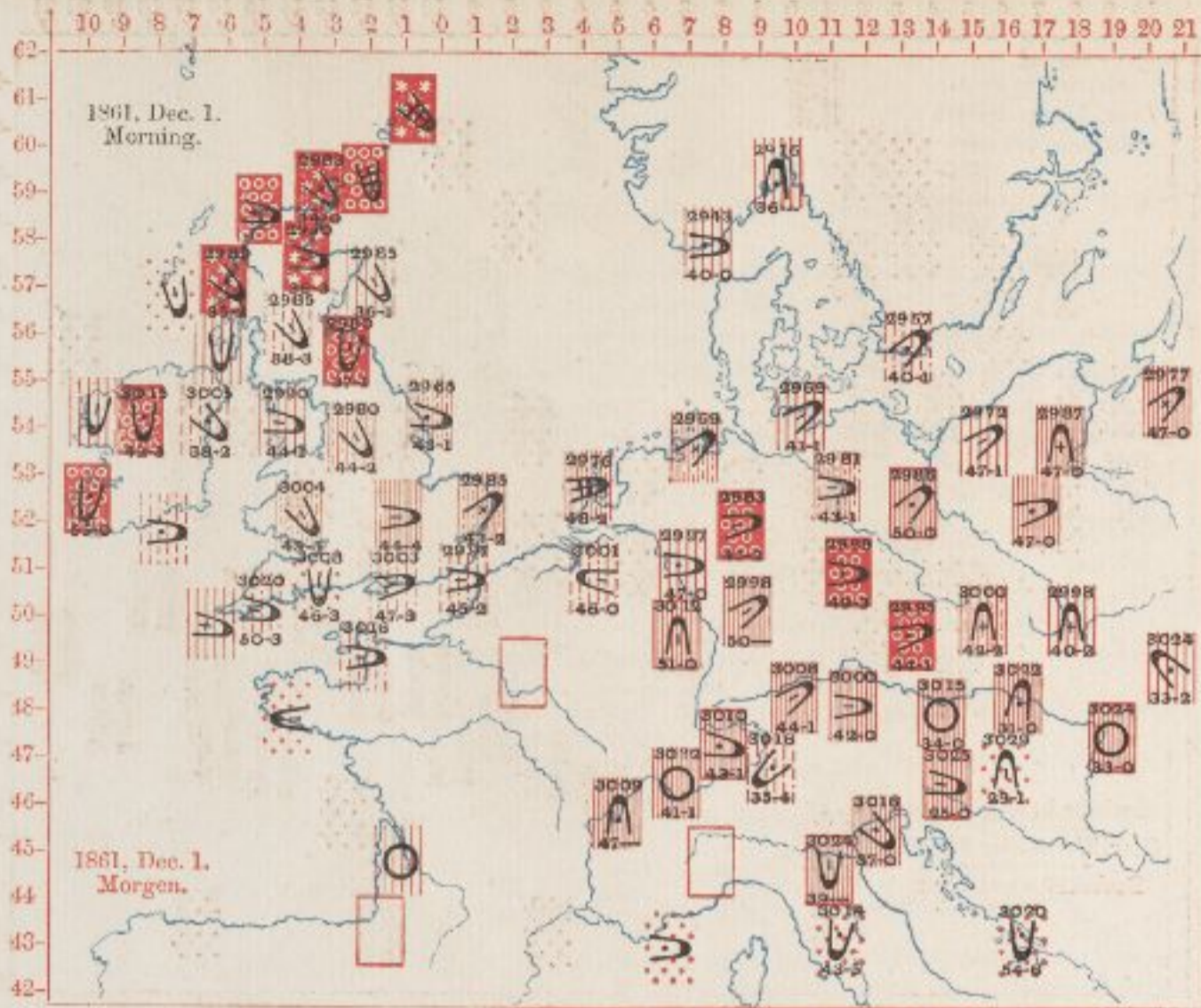
Schwarz	- 29.95 bis 29.71 Zoll	29.70 bis 29.46 Zoll	29.45 bis 29.21 Zoll	29.20 und niedriger.
	○	○	*	●
Roth	- 29.96 bis 30.20 „	30.21 bis 30.45 „	30.46 bis 30.70 „	30.71 und höher.

Unterhalb dieser barometrischen Kärtchen befindet sich eine der oben erwähnten Spezialkarten.

### ZEICHENERKLÄRUNG FÜR DIE WITTERUNGSKARTEN.

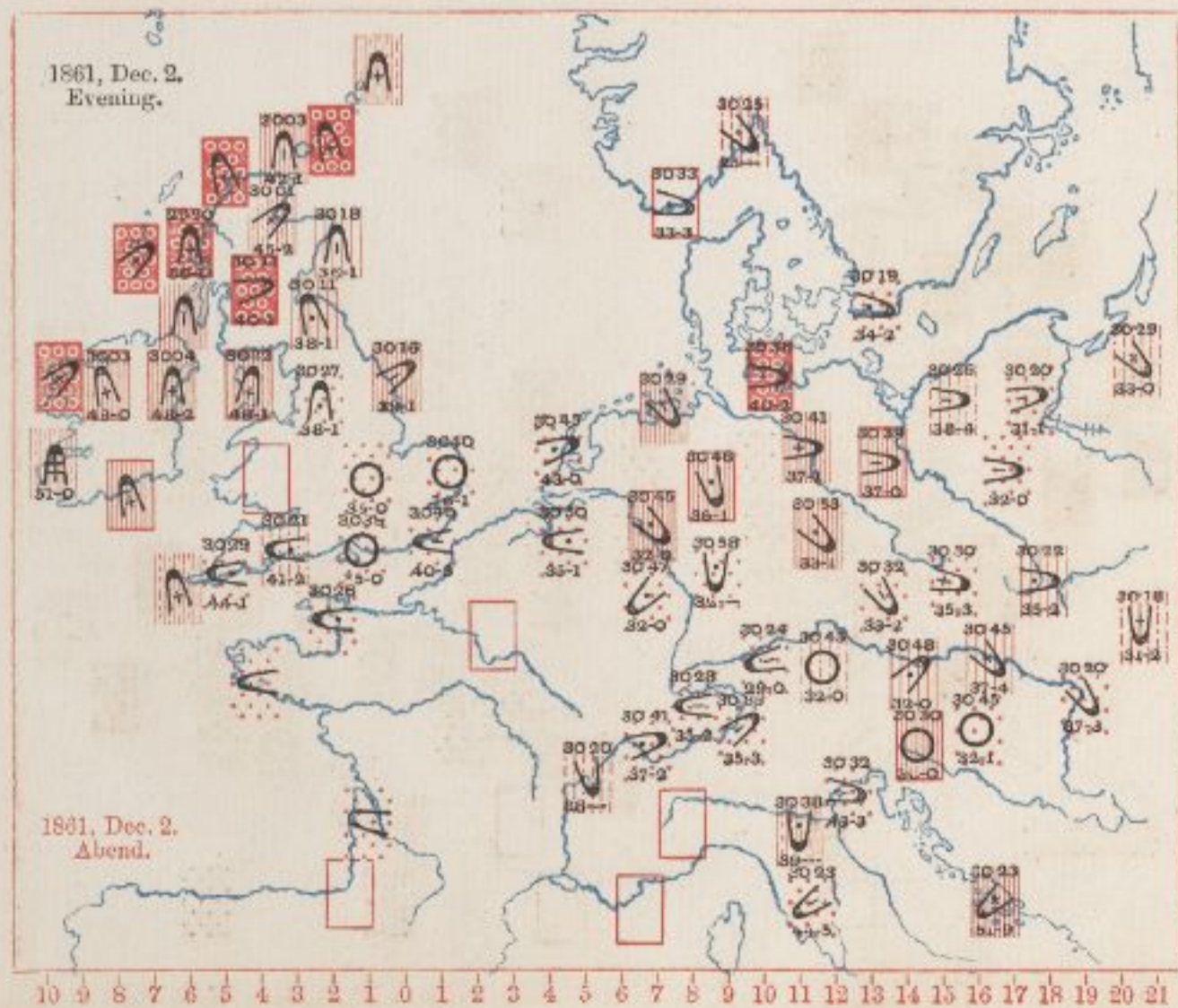
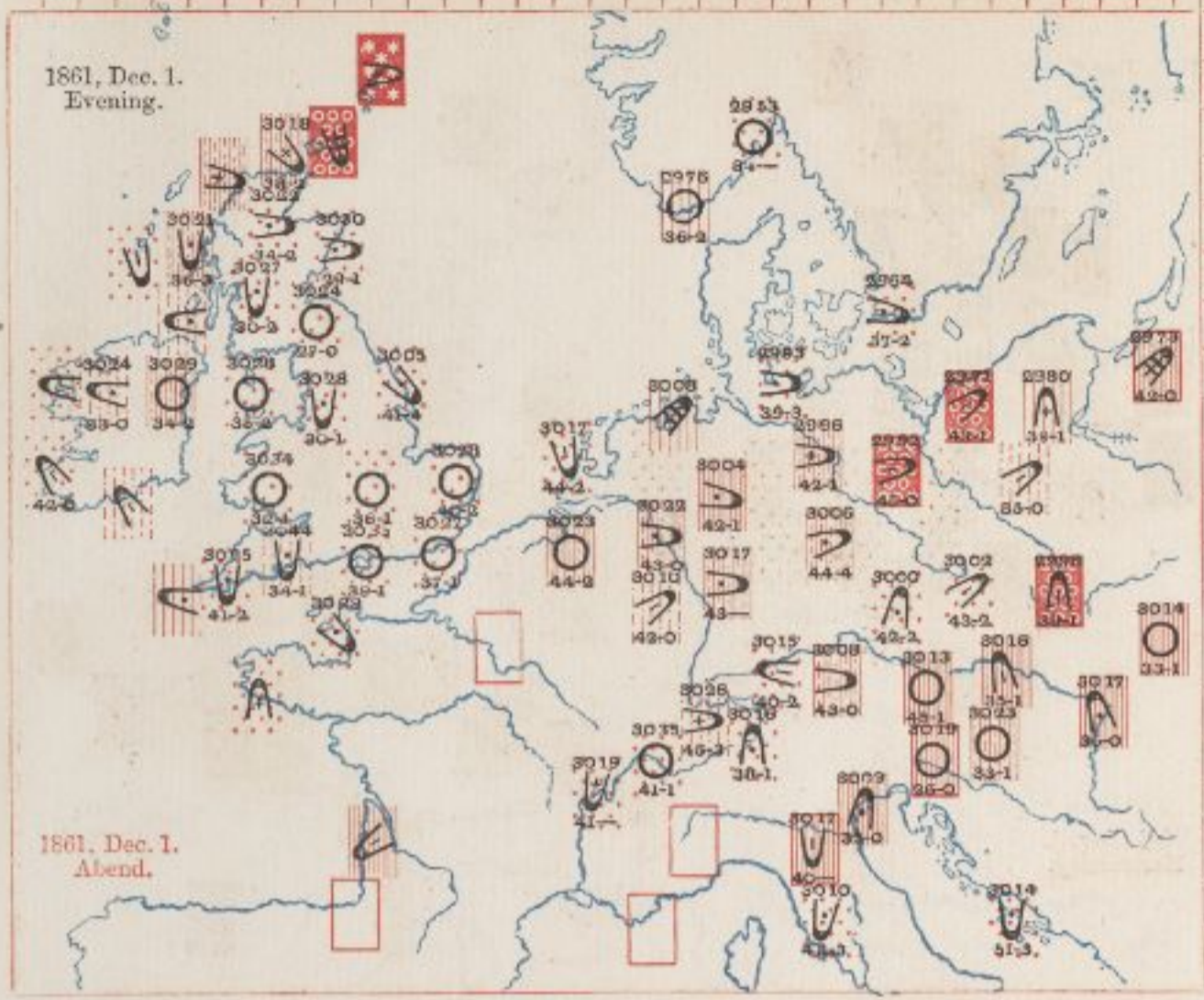
NIEDERSCHLAG.		WOLKEN.					
Regen.	Schnee.	Ganz bedeckt, schweres Gewölk.	Ganz bewölkt.	Zum grössten Theil bewölkt.	Halb bewölkt.	Wenige Wolken.	Helle, klare Luft.
WINDRICHTUNG.		STÄRKE DES WINDES.					
S. S.S.W. S.W. W.S.W. W.							Sturm. Stark. Mässig. Sanft. Fast windstill. Windstill.
In jedem zusammengesetzten Symbol $\begin{matrix} 30 & 39 \\ 29 & 72 \end{matrix}$ bedeuten die oberen Zahlen $\begin{matrix} 30.39 \\ 29.72 \end{matrix}$ die Barometerhöhe in Englischen Zollen.							
Von den untern Zahlen 34—1 bedeutet 34 die Thermometerhöhe in Graden Fahrenheit, und 1 den Excess derselben über den Thermometer mit befeuchteter Kugel.							







10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

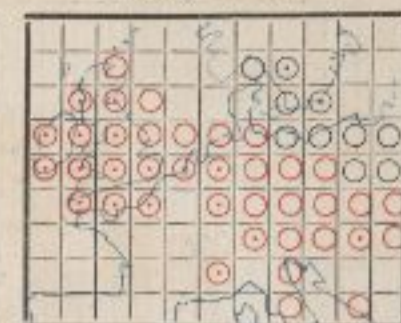
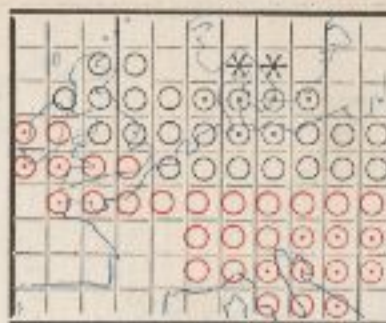


10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Dec. 1. Morning. Morgen.

Afternoon. Nachmittag.

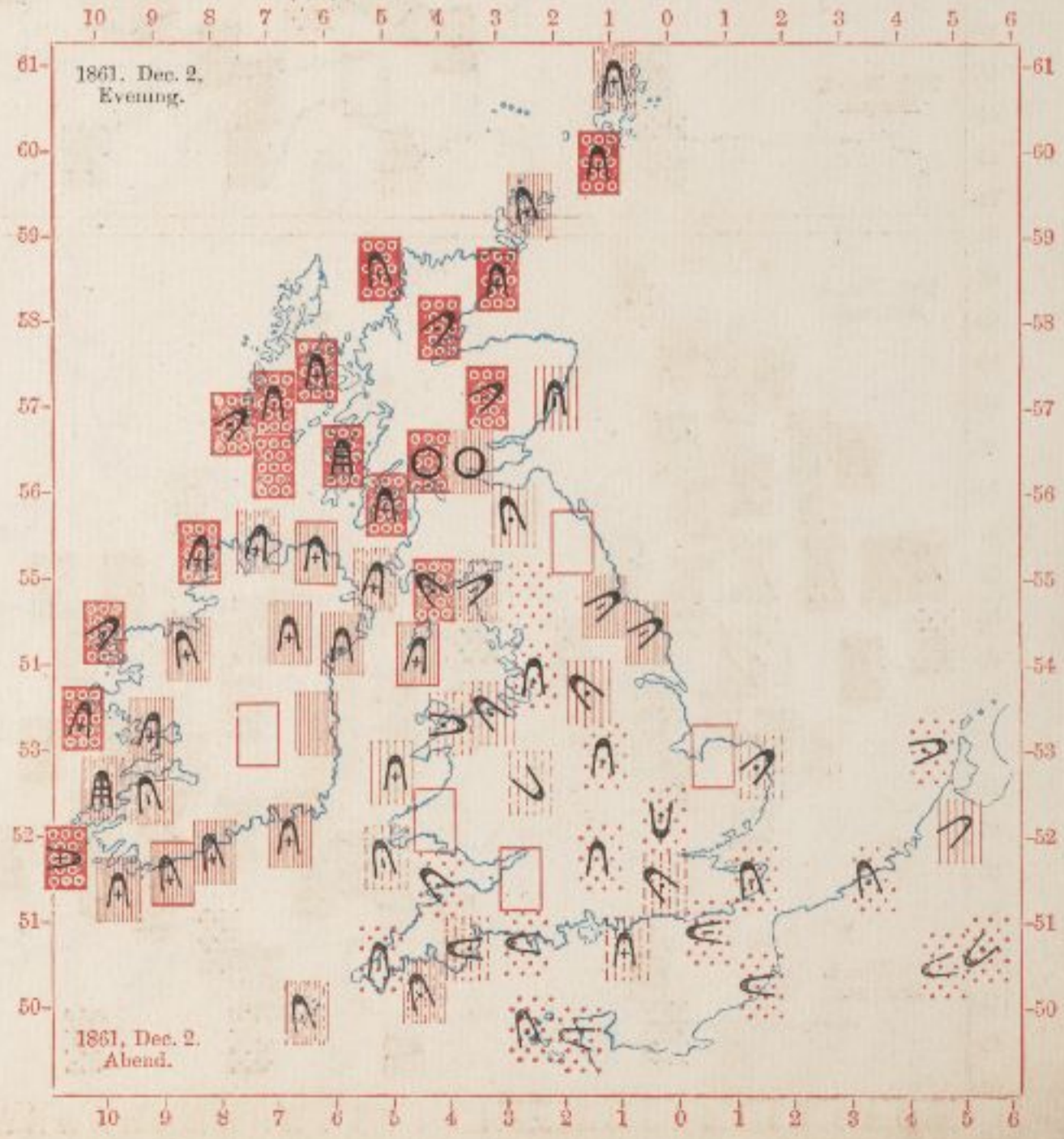
Evening. Abend. Dec. 1.



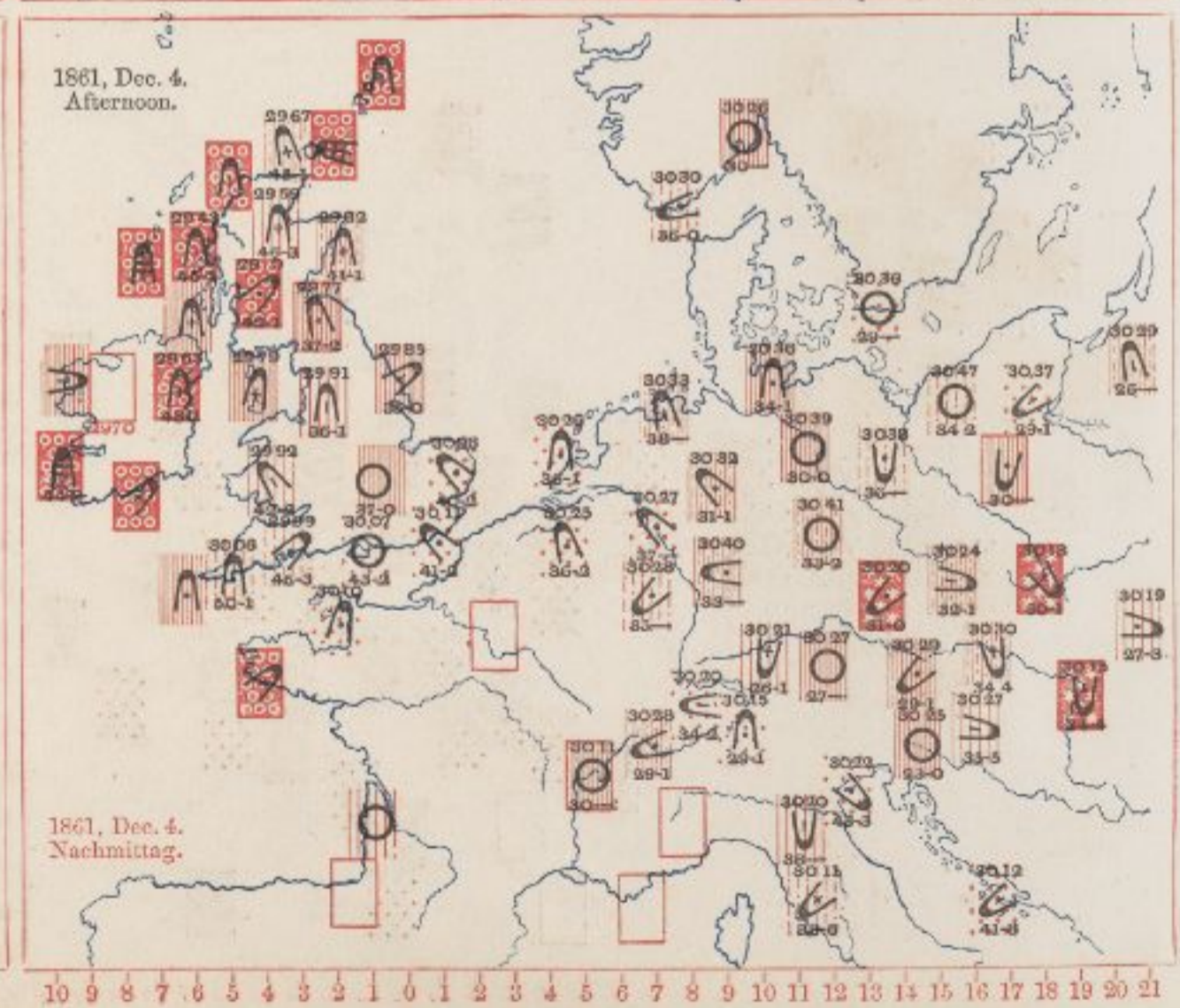
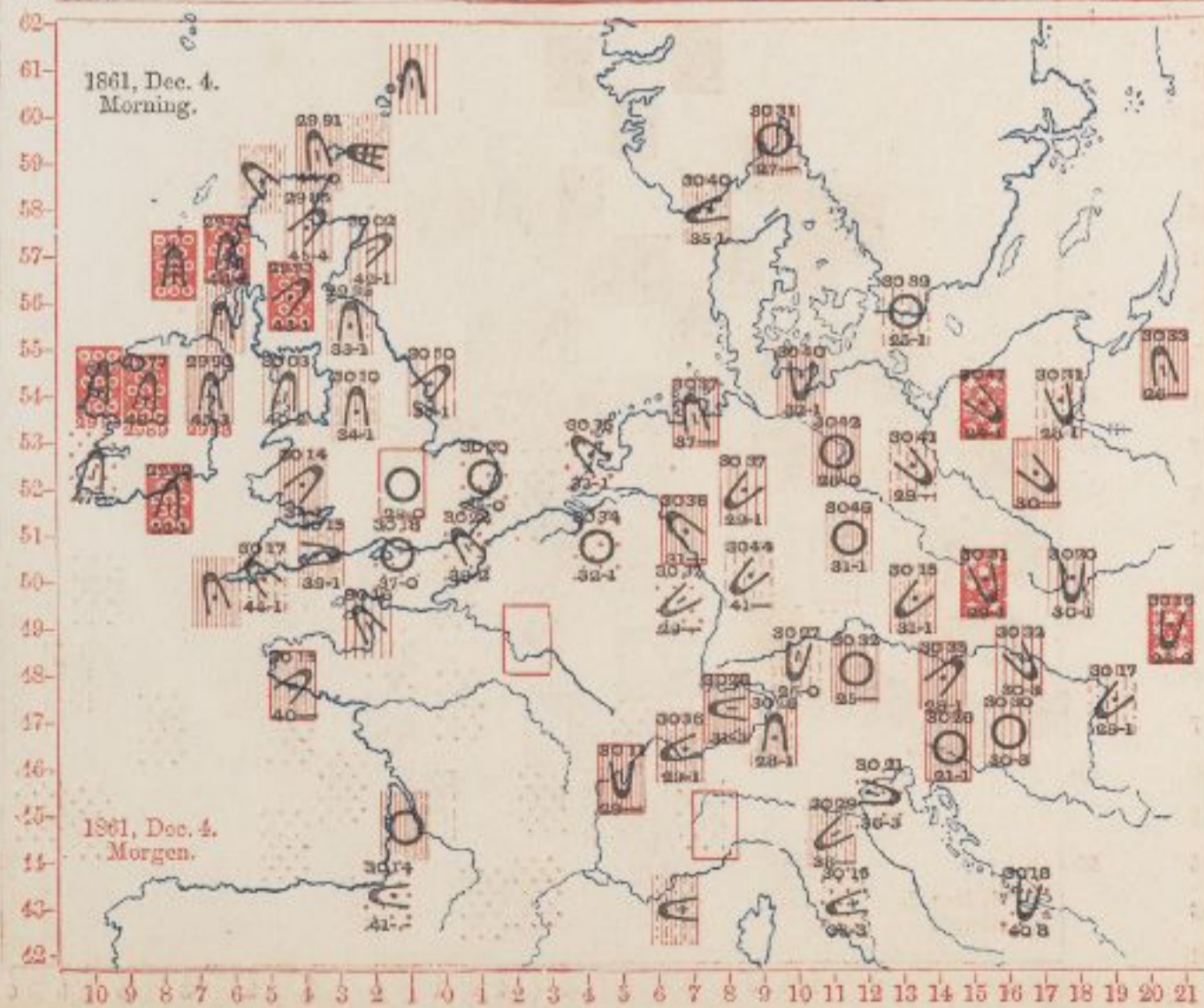
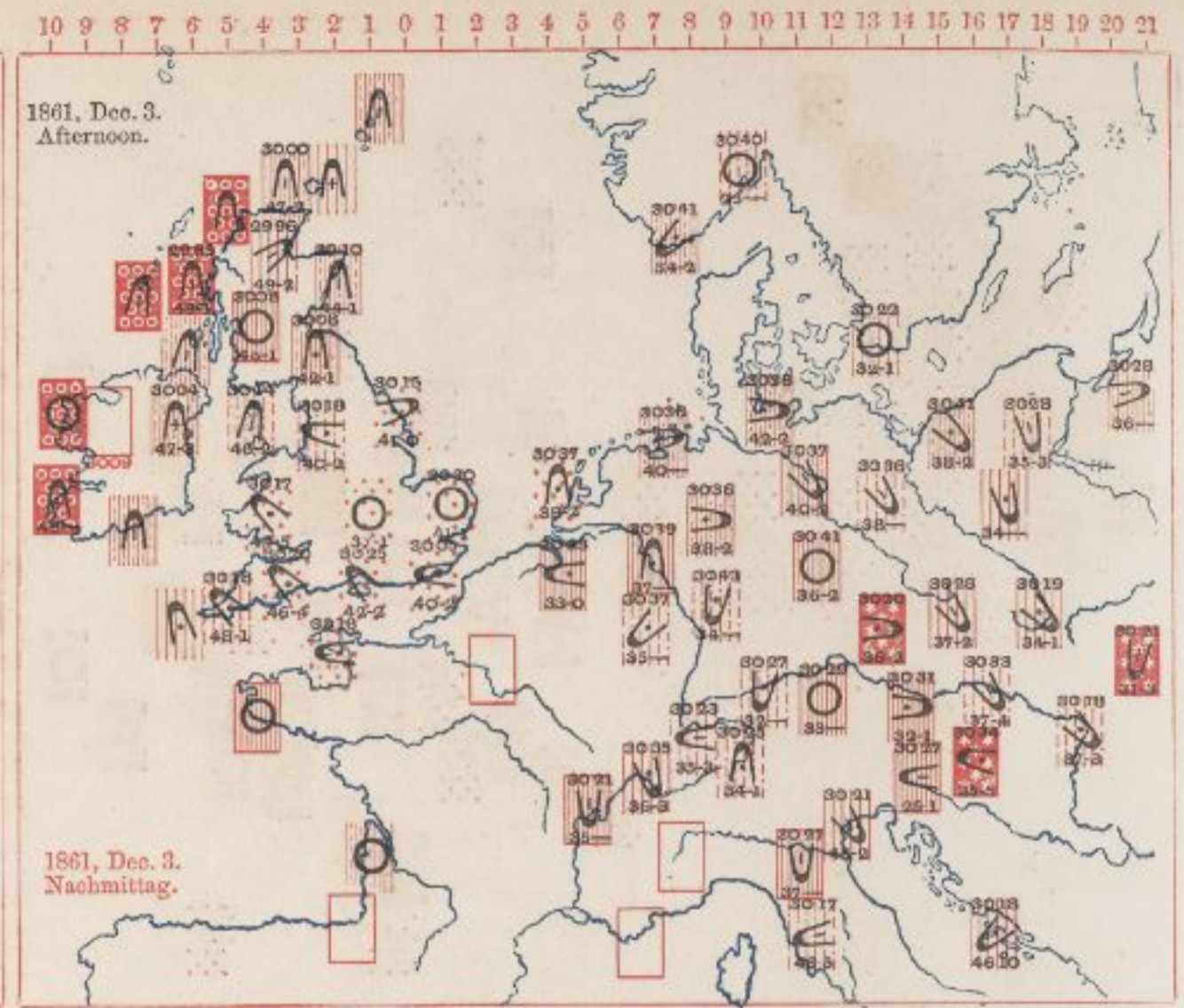
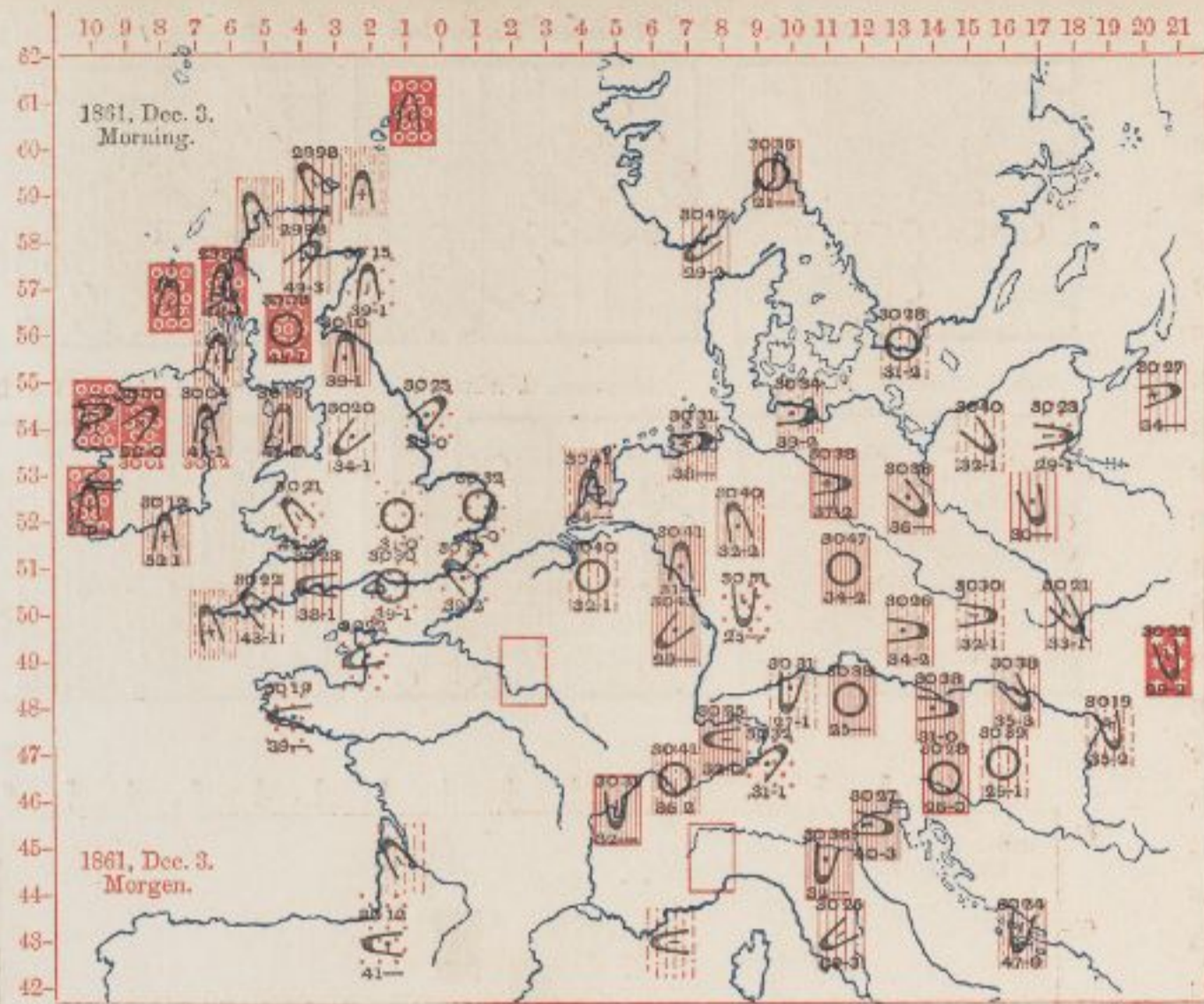
Dec. 2. Morning. Morgen.

Afternoon. Nachmittag.

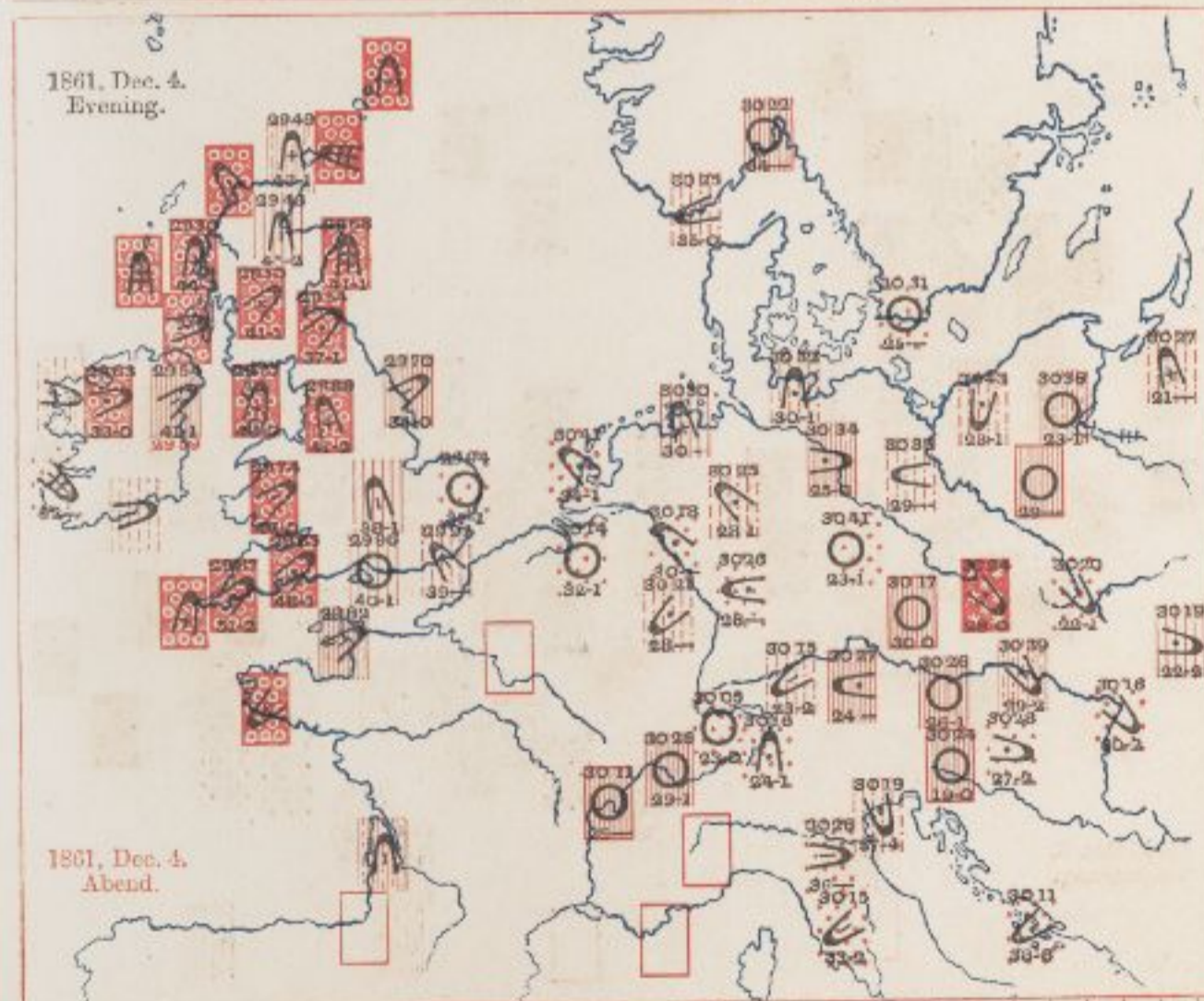
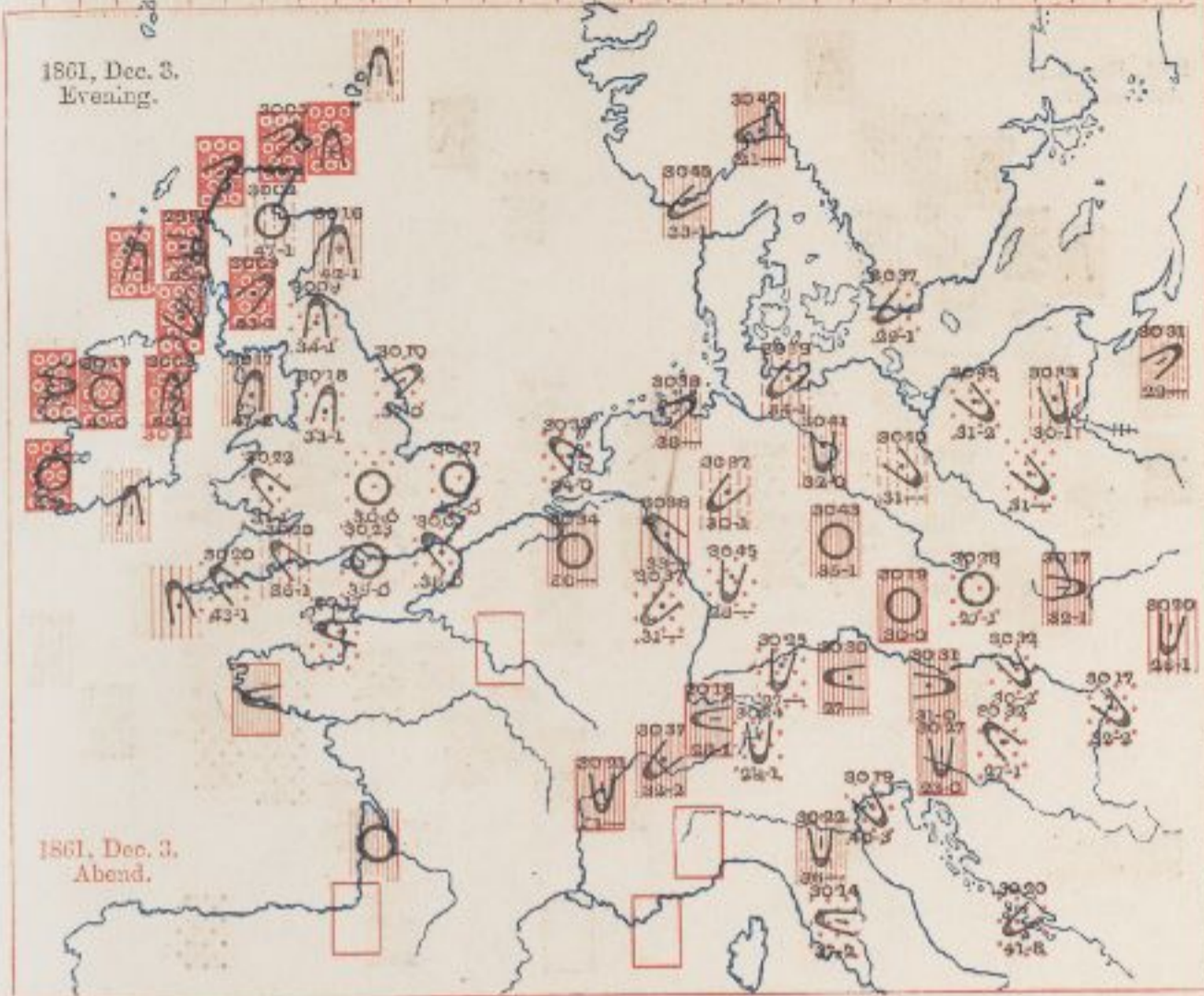
Evening. Abend. Dec. 2.



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

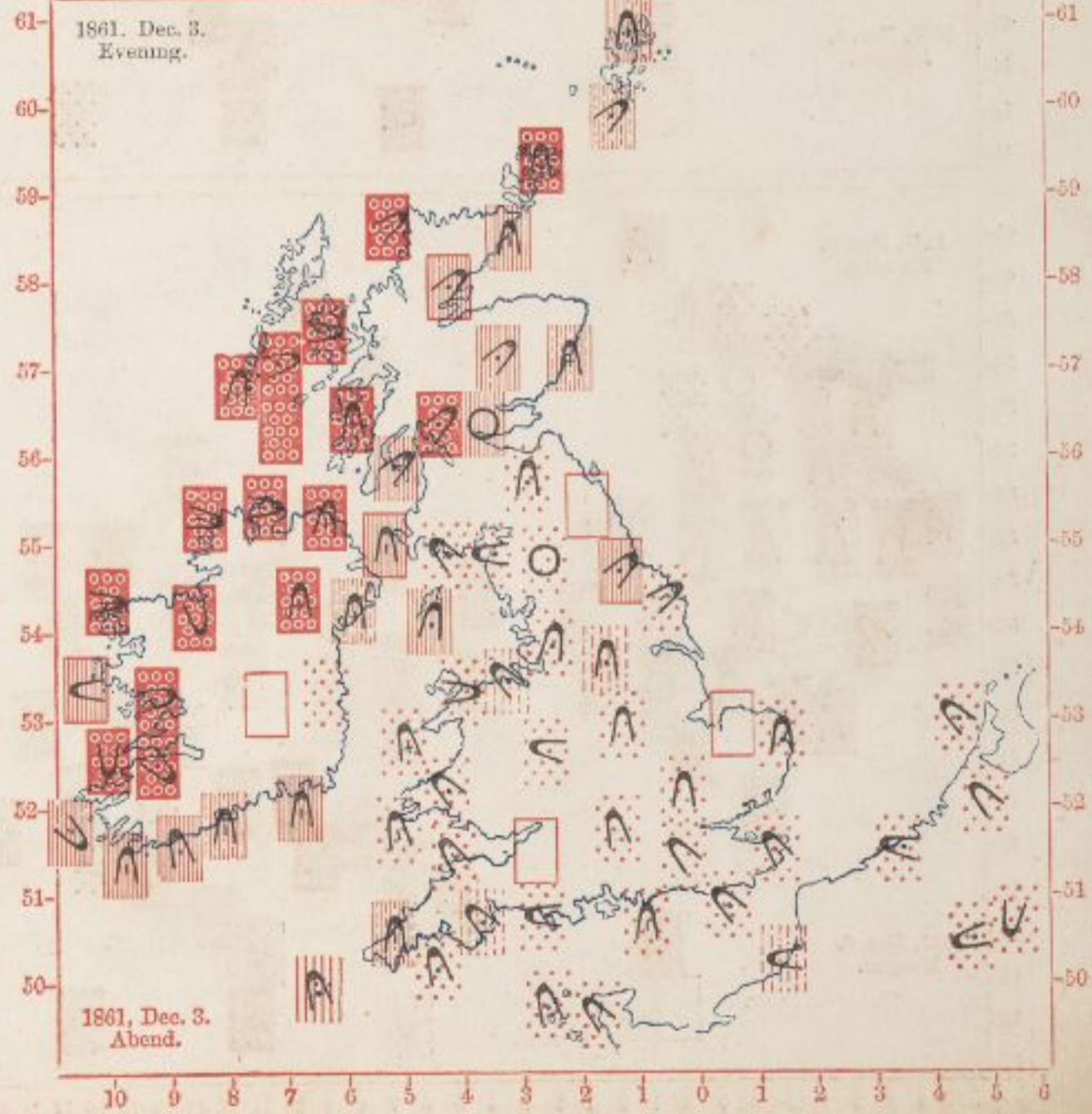
Dec. 3. Morning. *Morgen.* Afternoon. *Nachmittag.* Evening. *Abend.* Dec. 3.



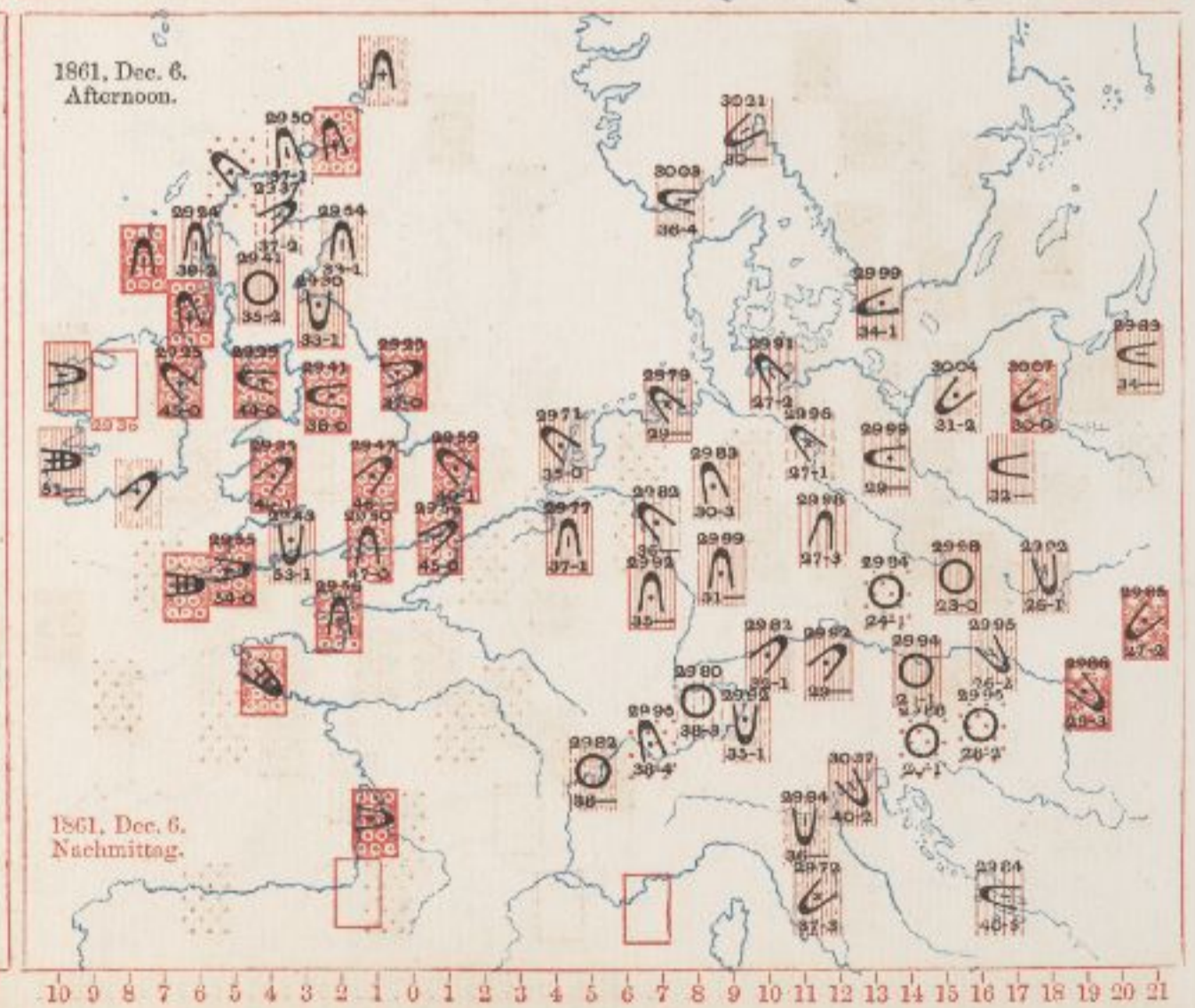
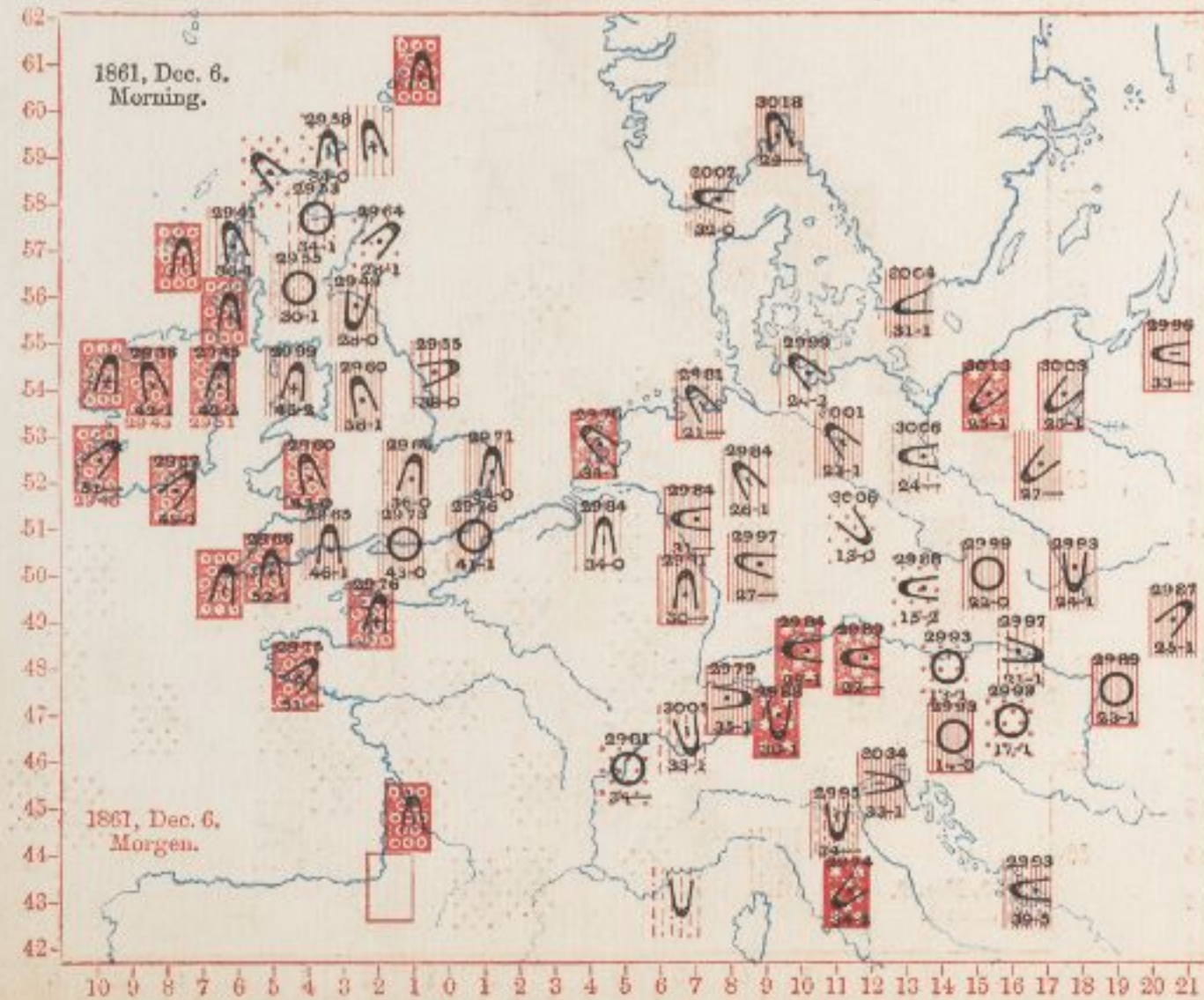
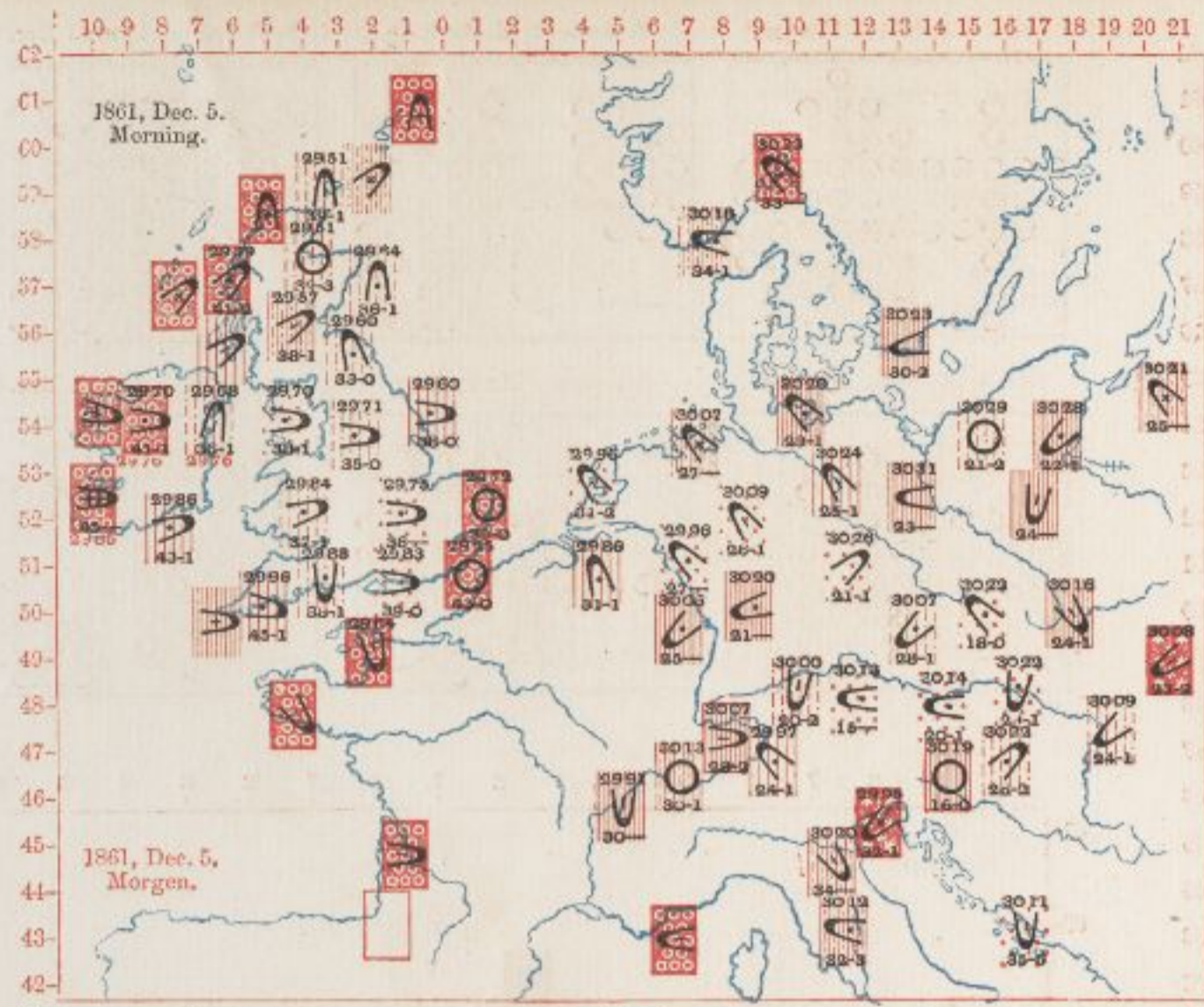
Dec. 4. Morning. *Morgen.* Afternoon. *Nachmittag.* Evening. *Abend.* Dec. 4.



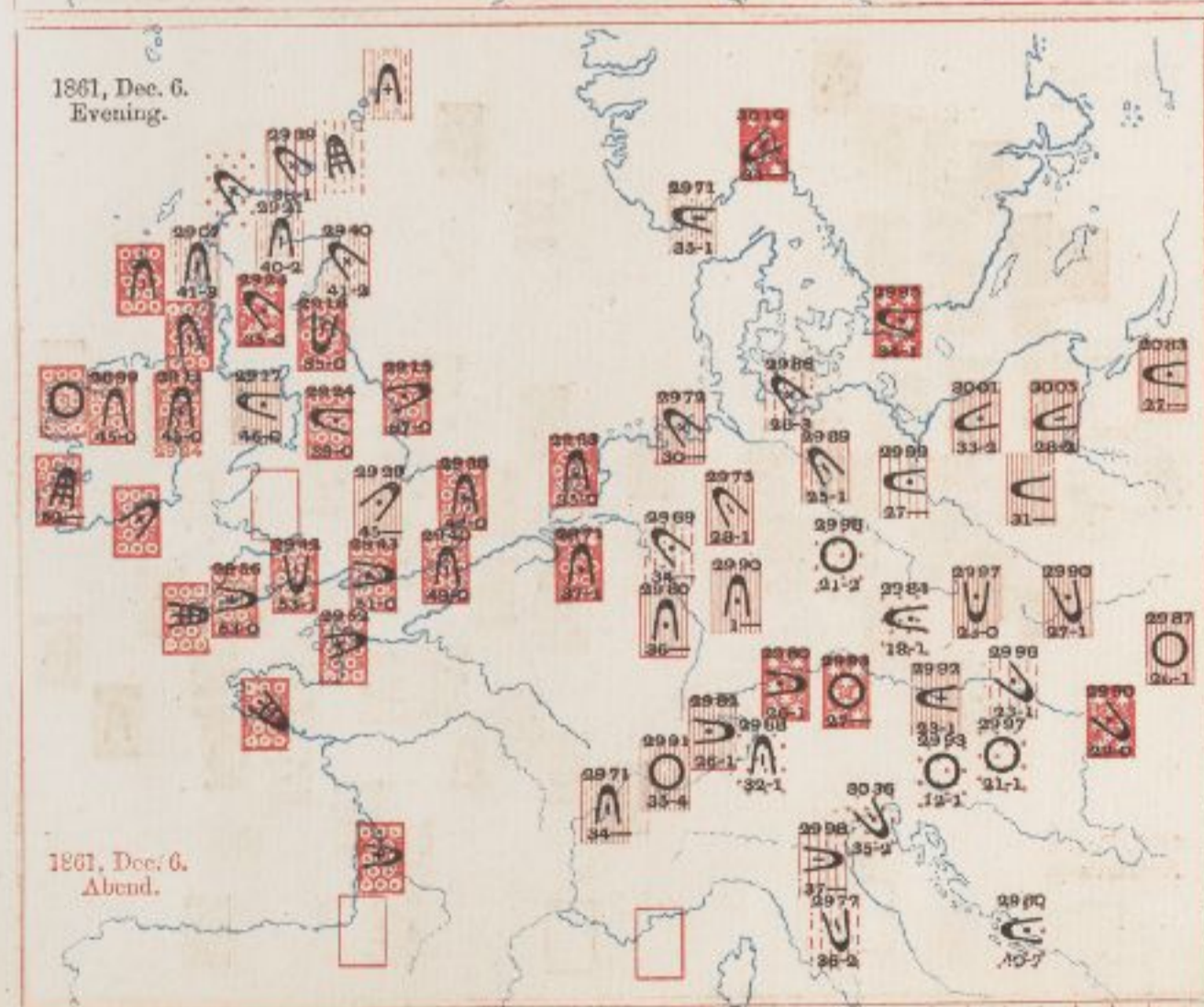
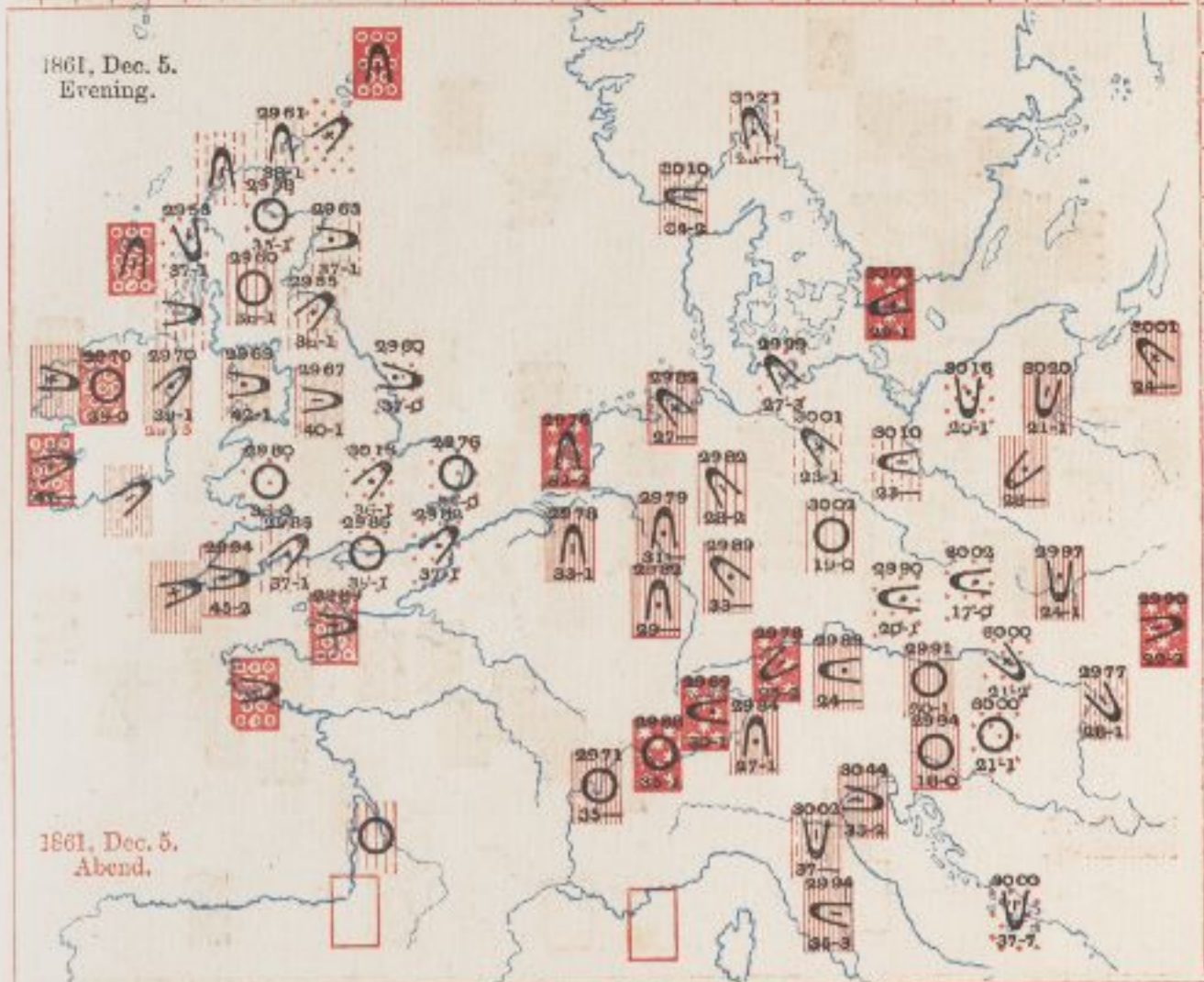
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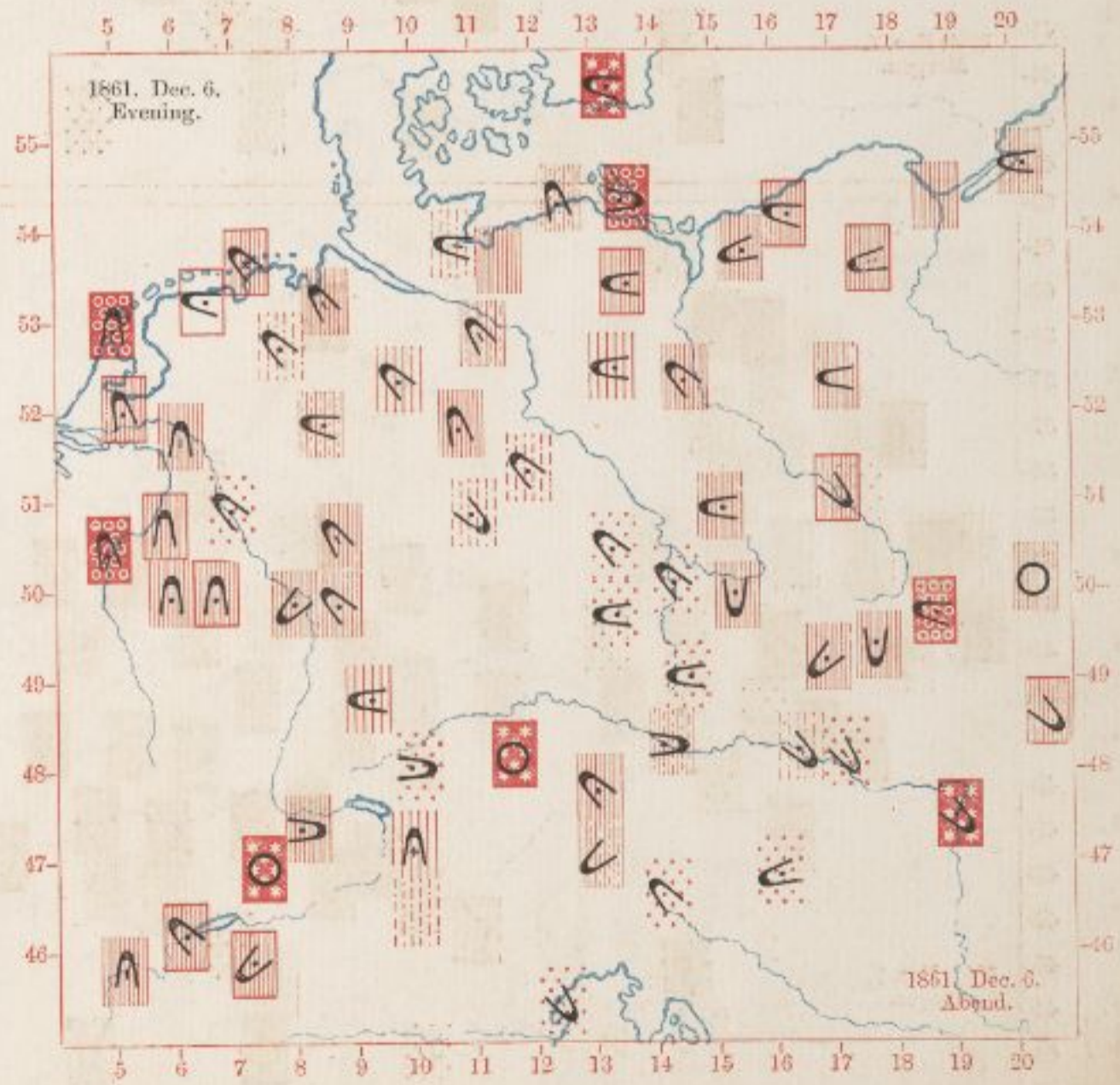
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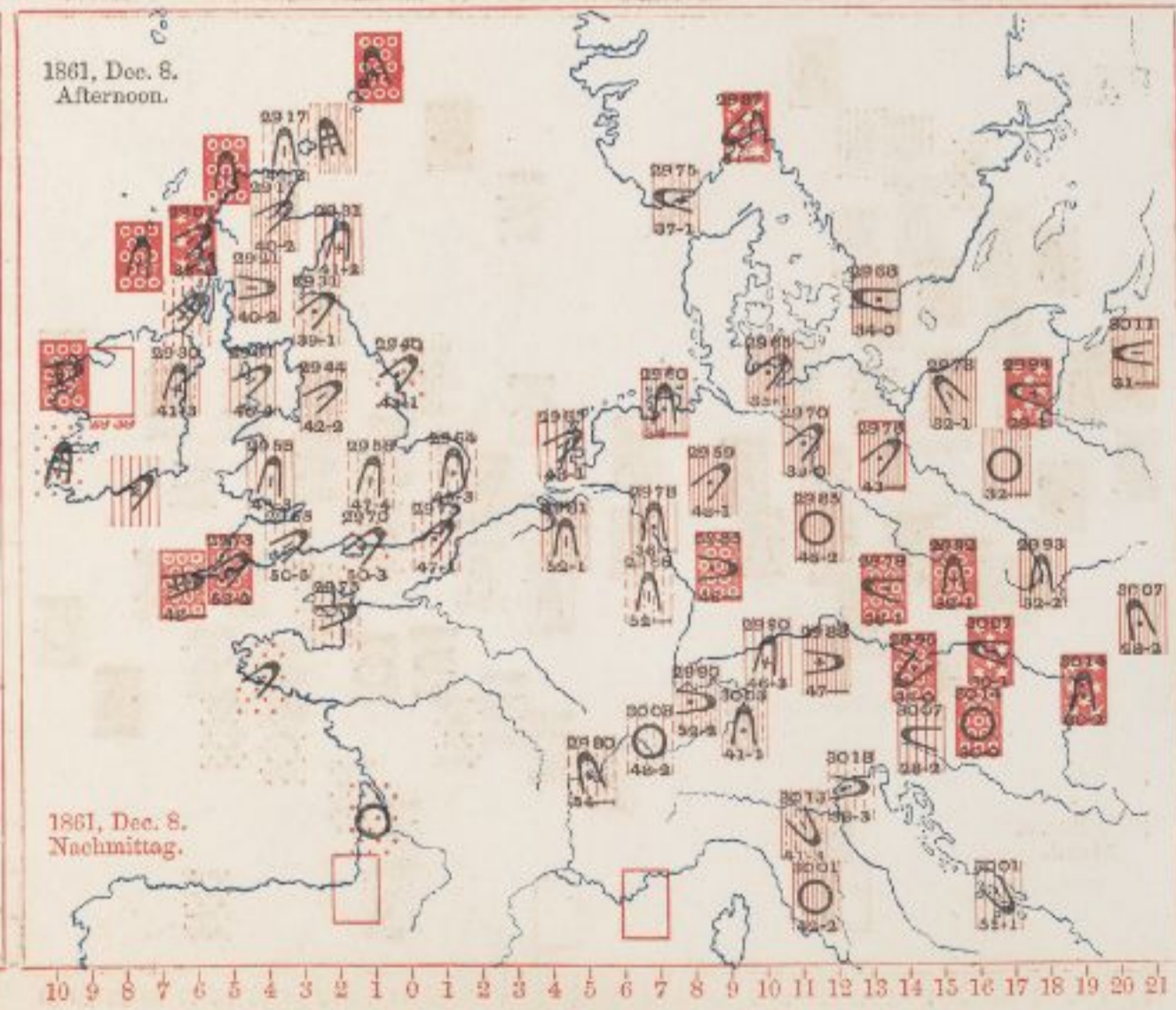
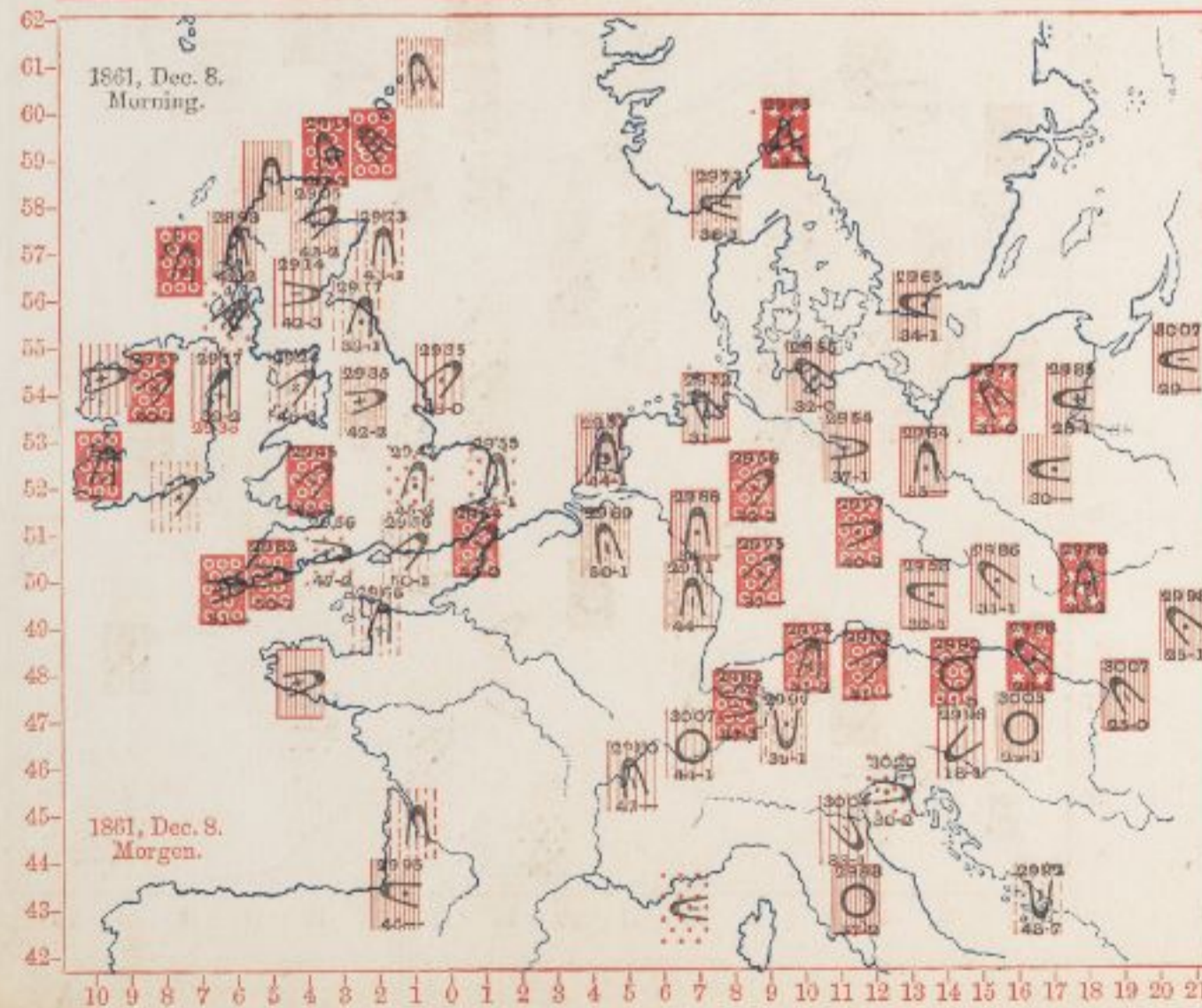
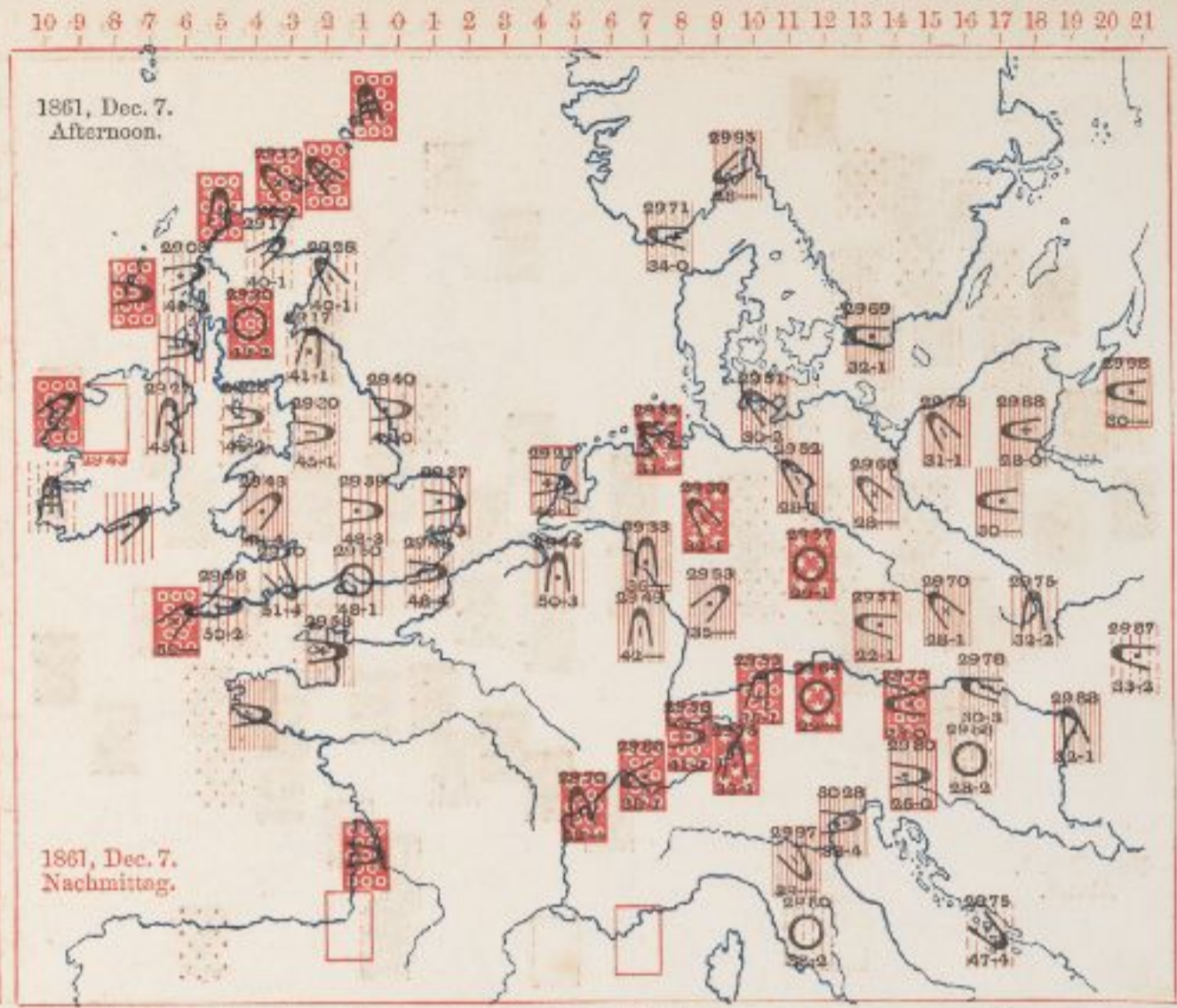
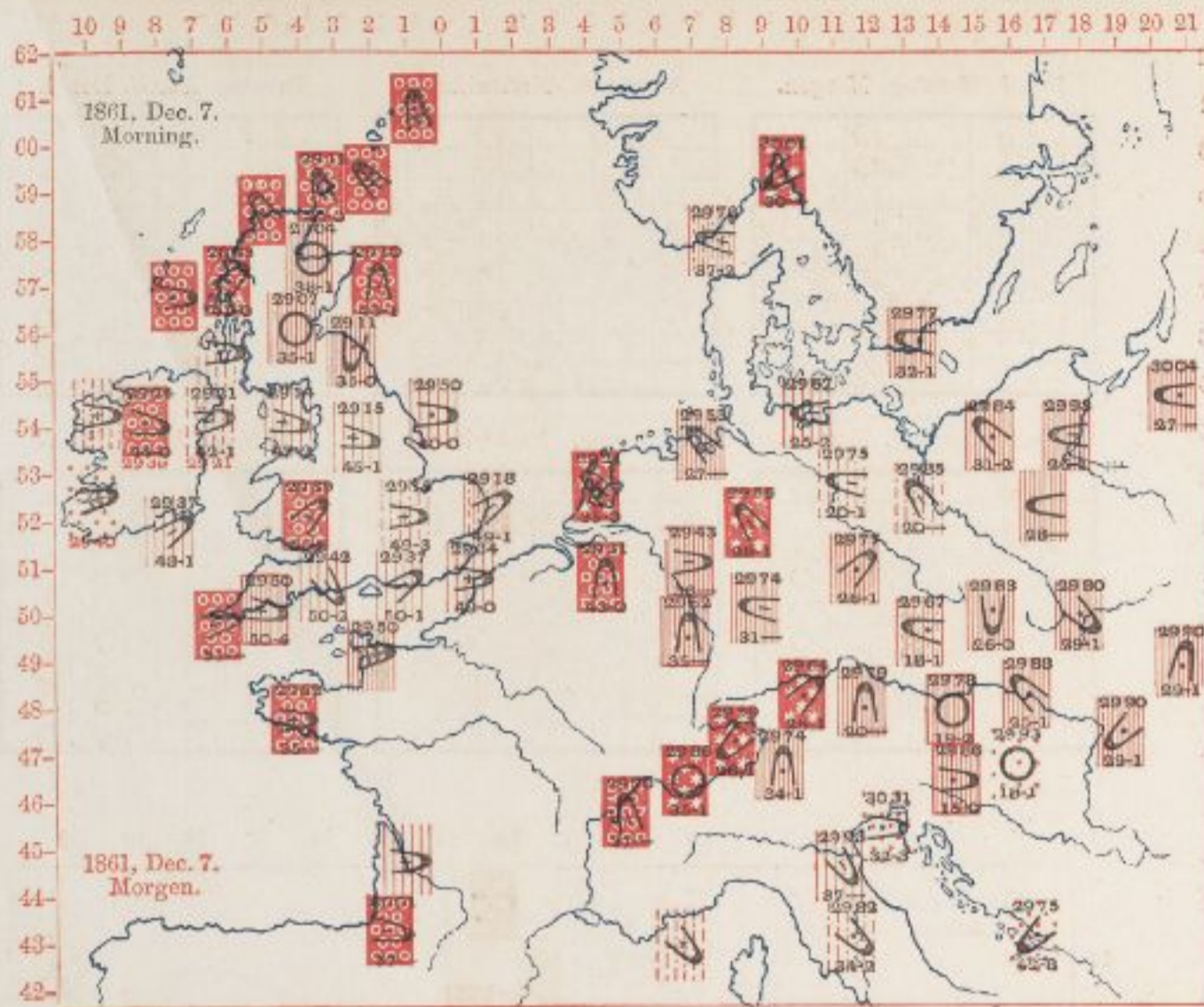
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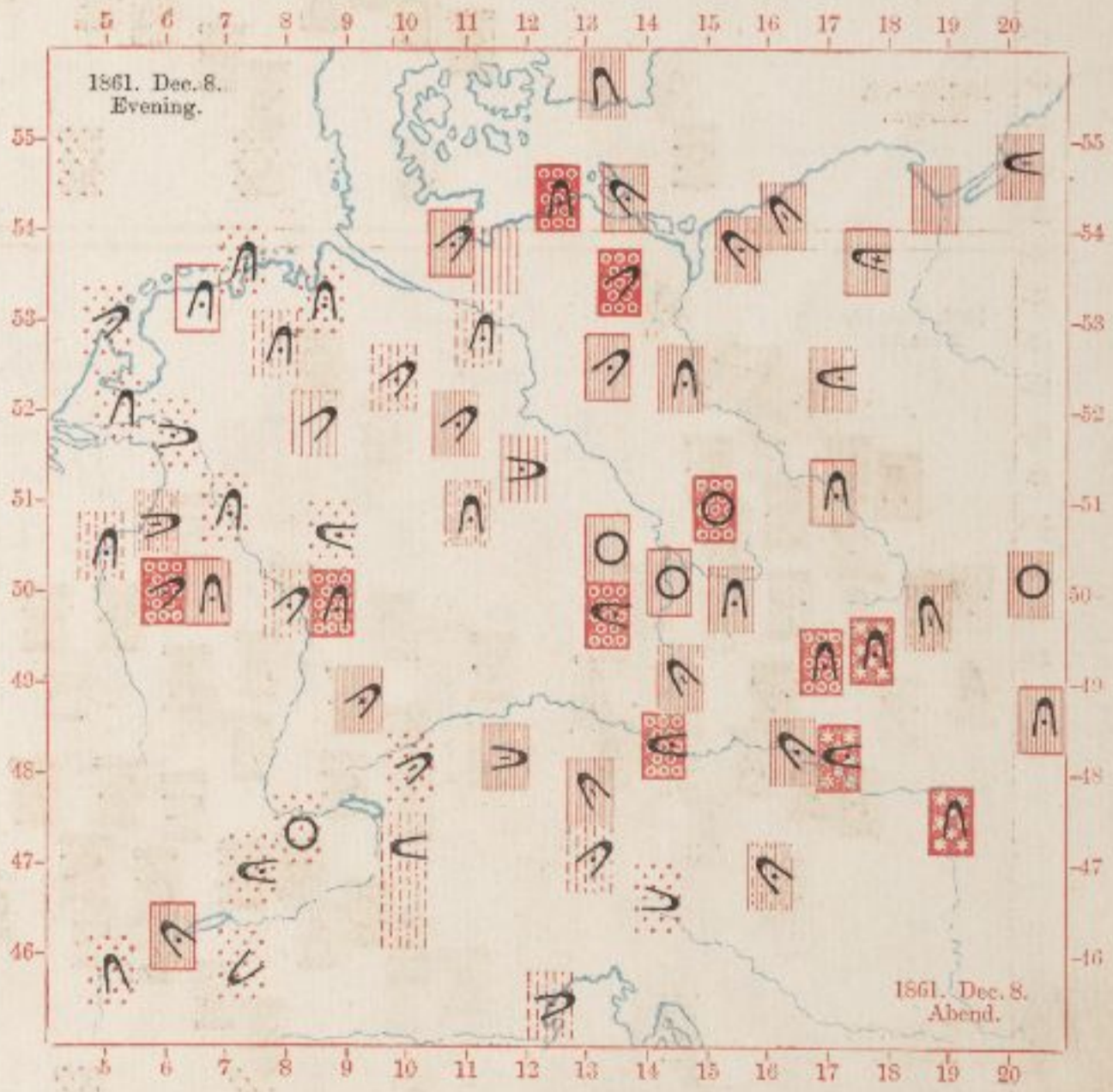
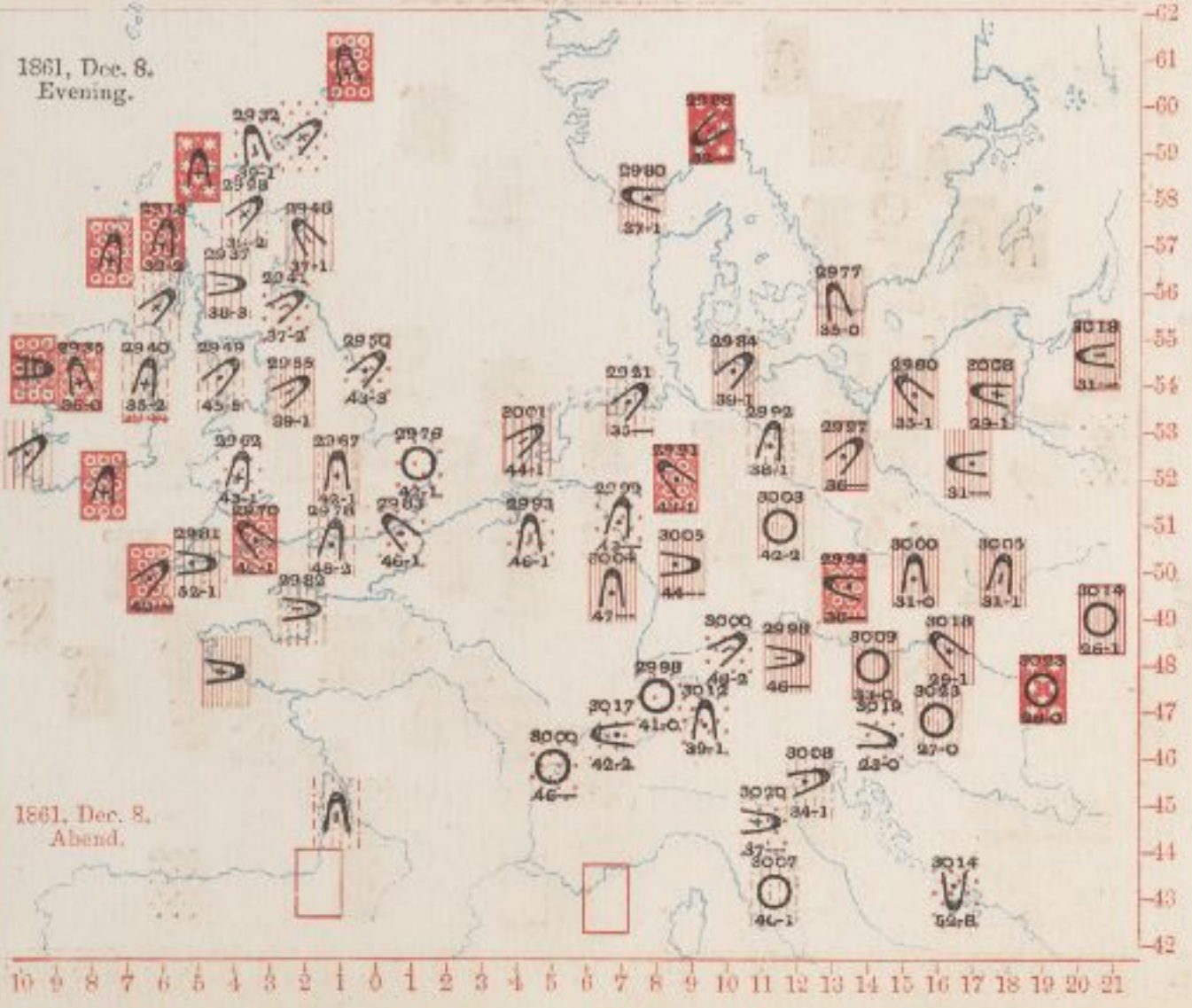
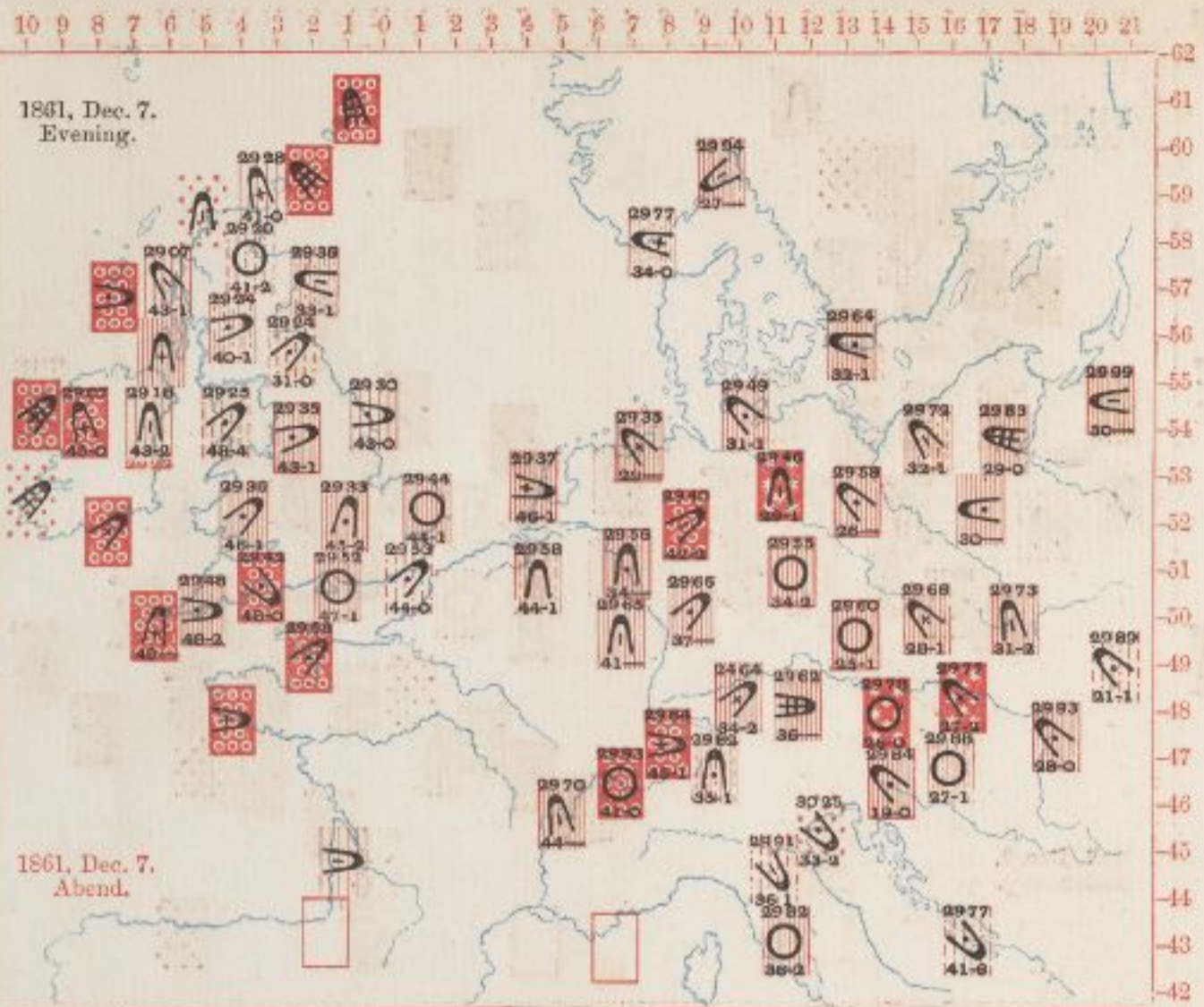


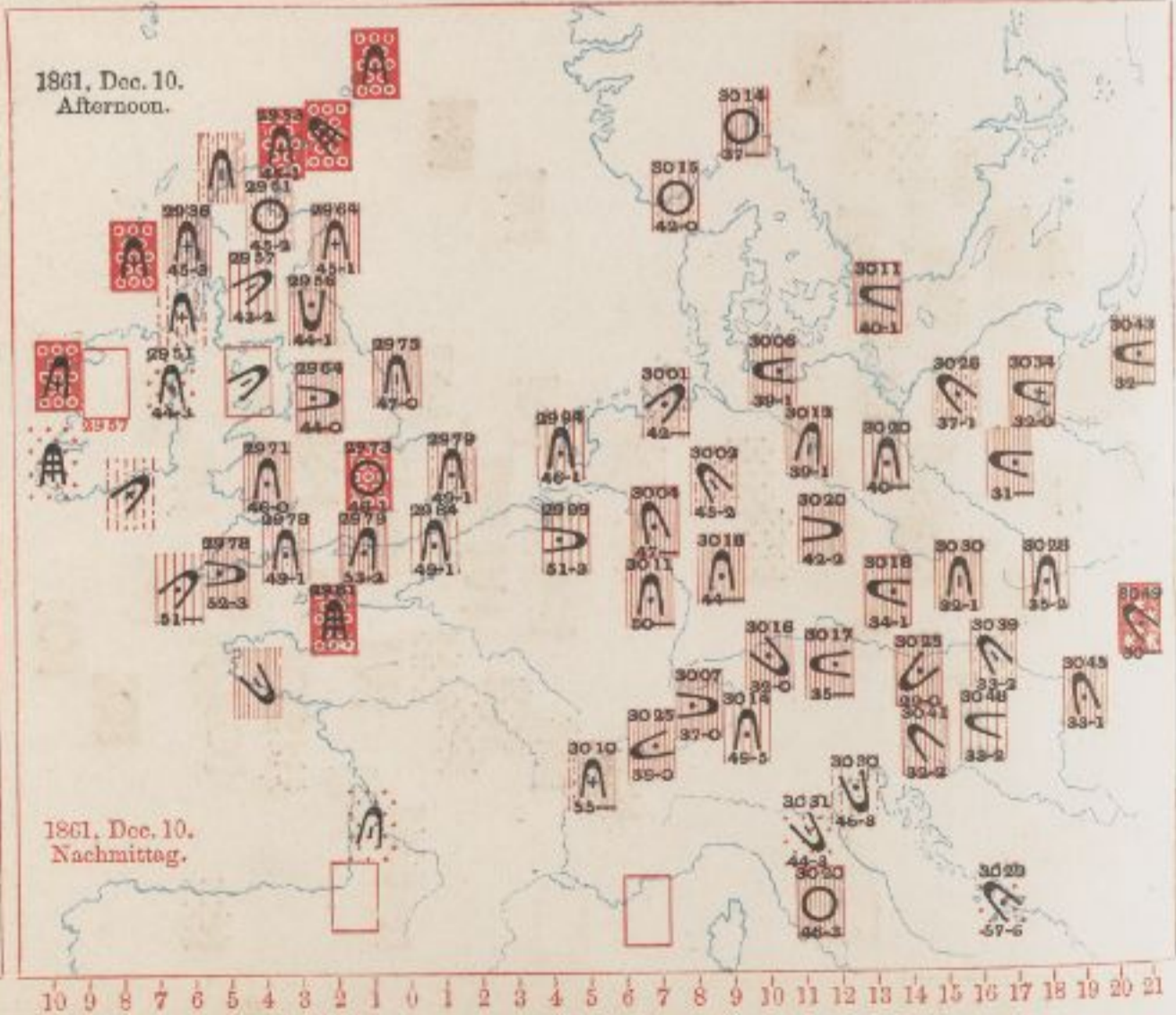
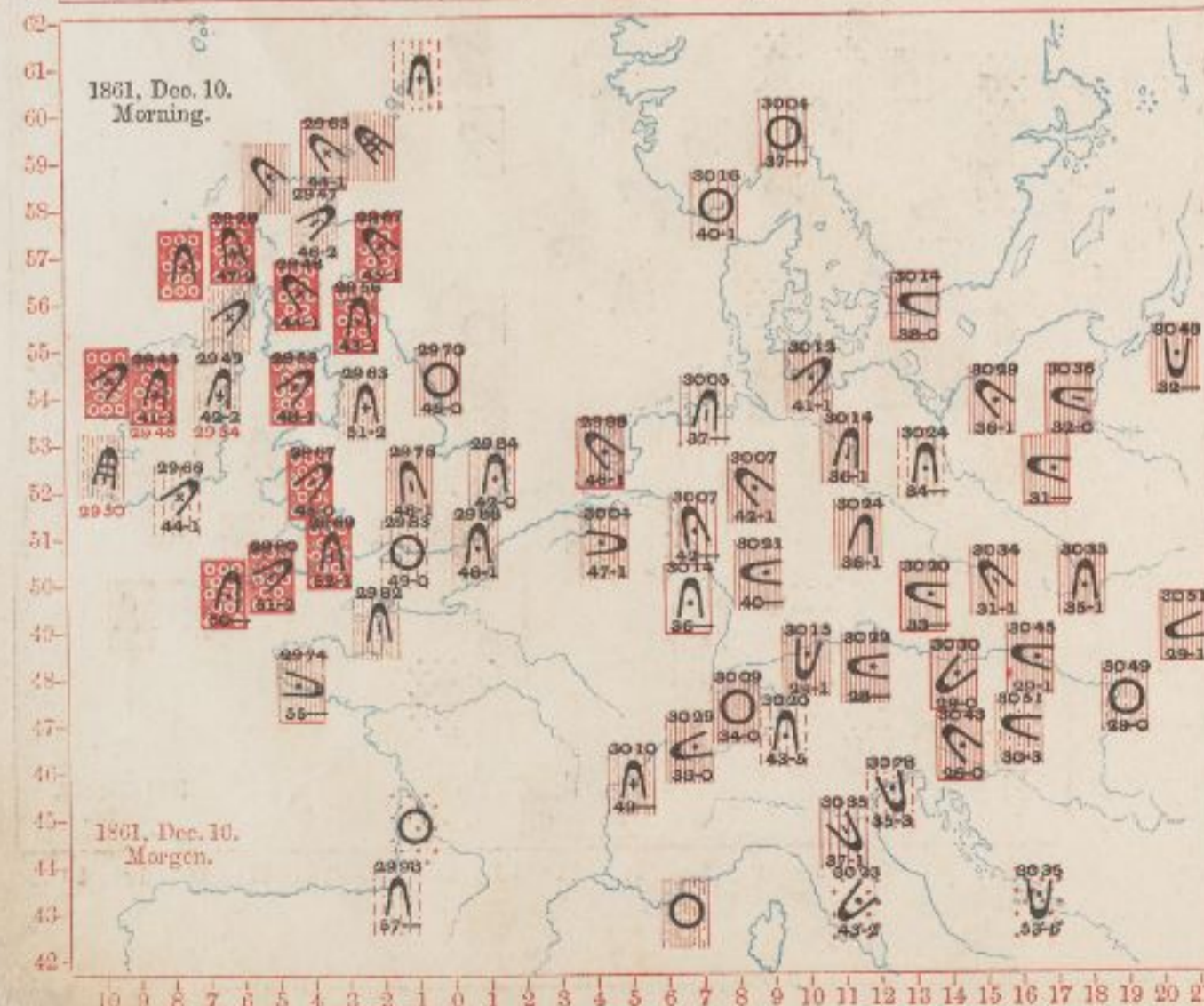
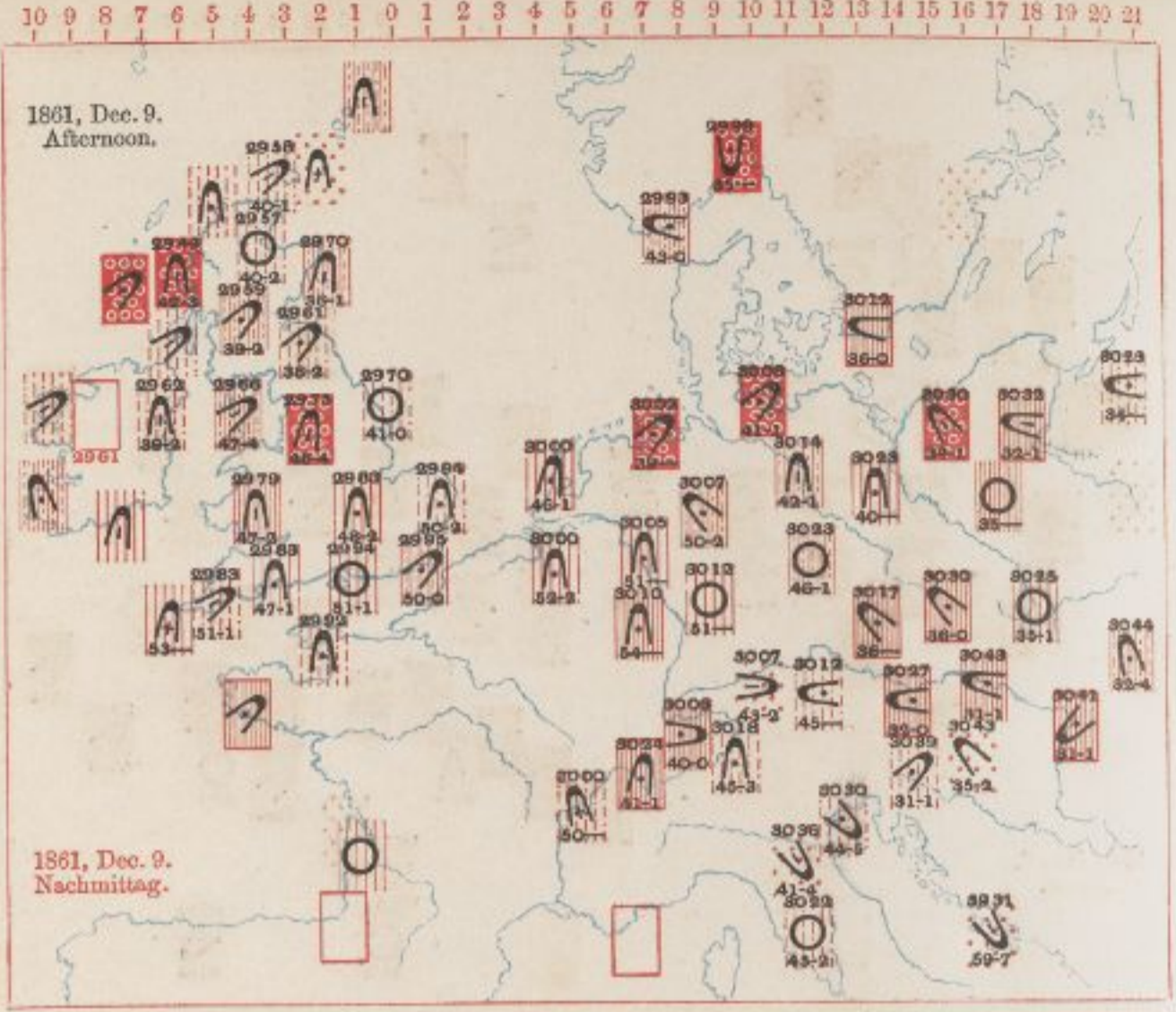
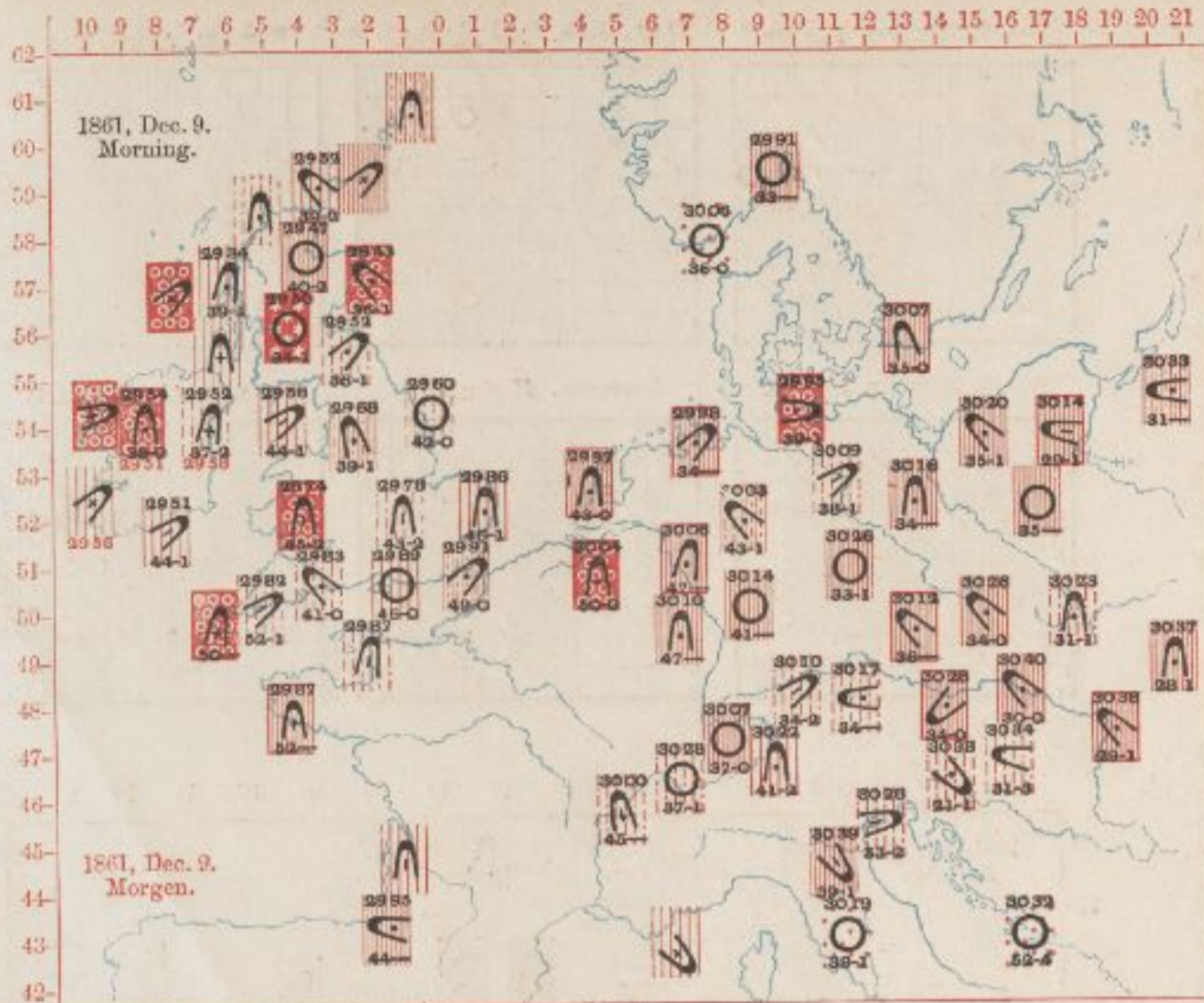
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5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

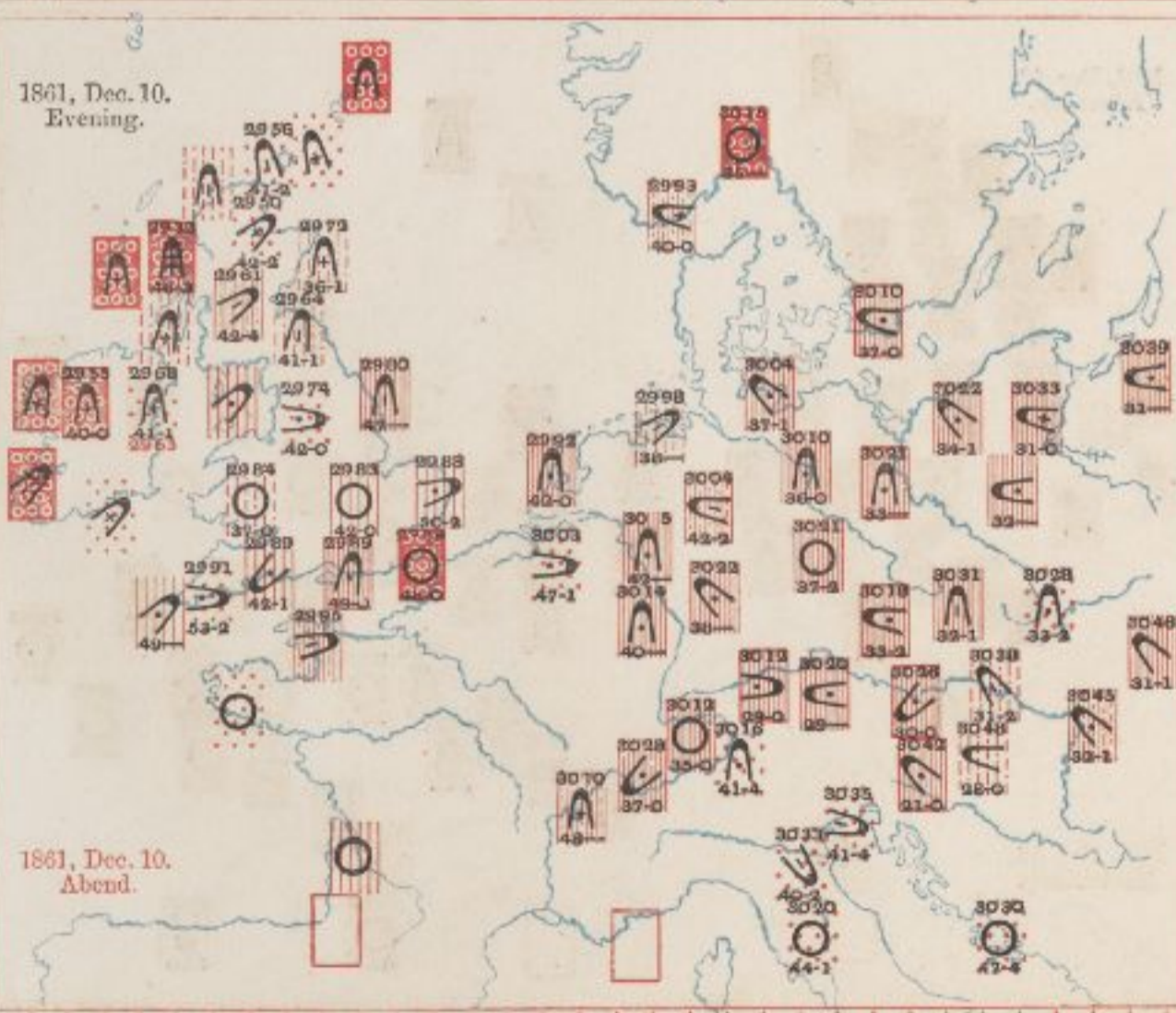
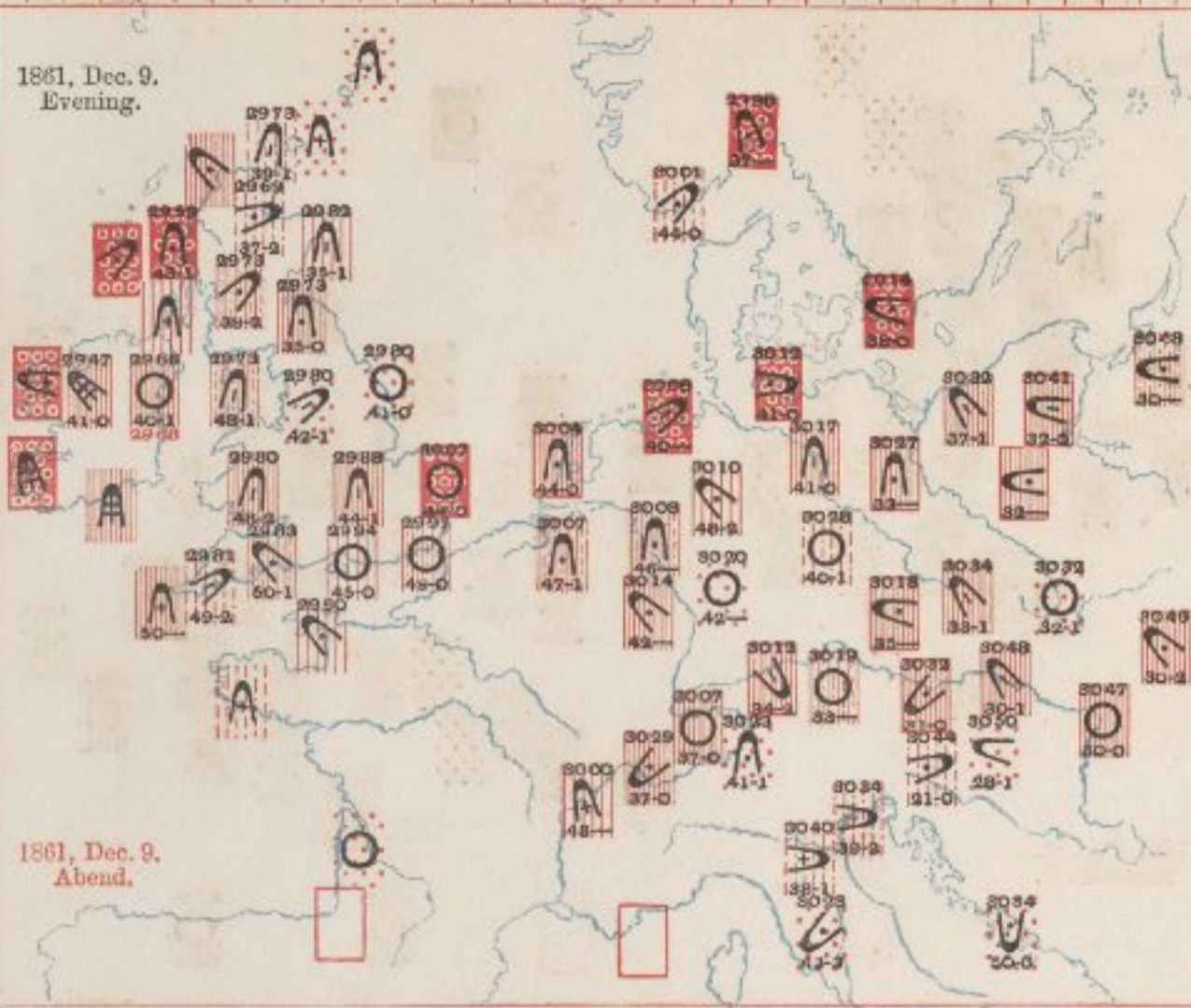








10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

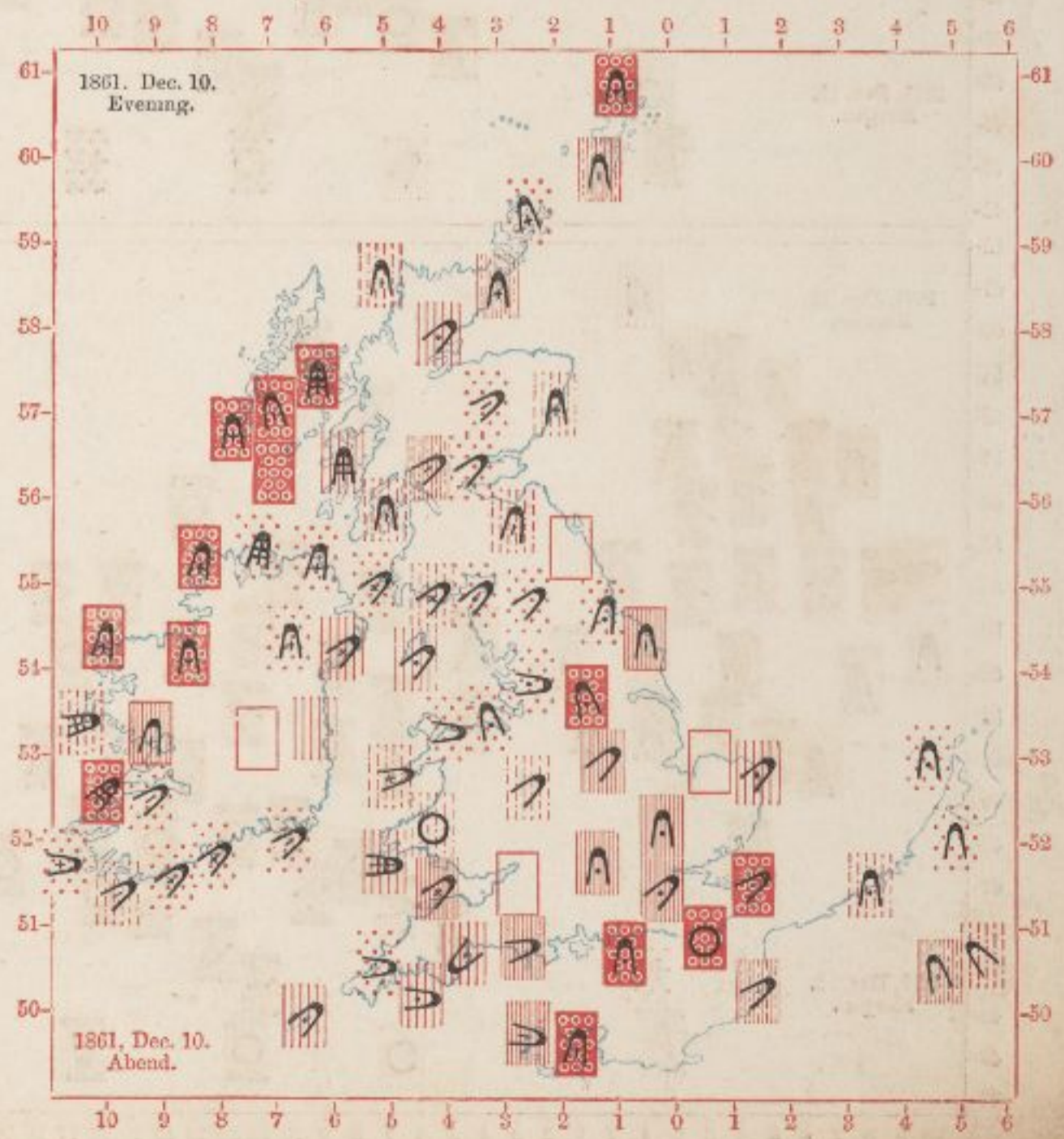


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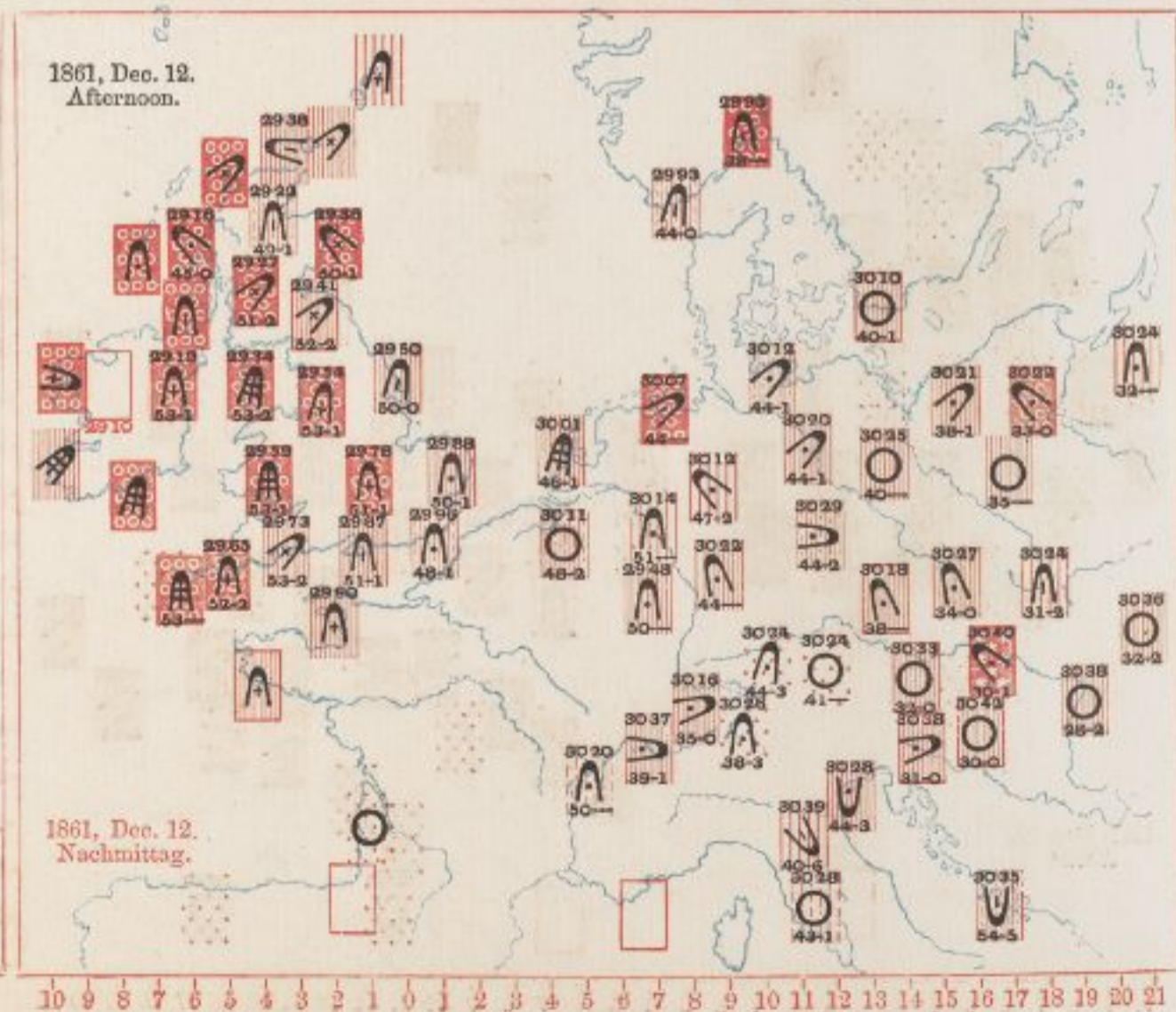
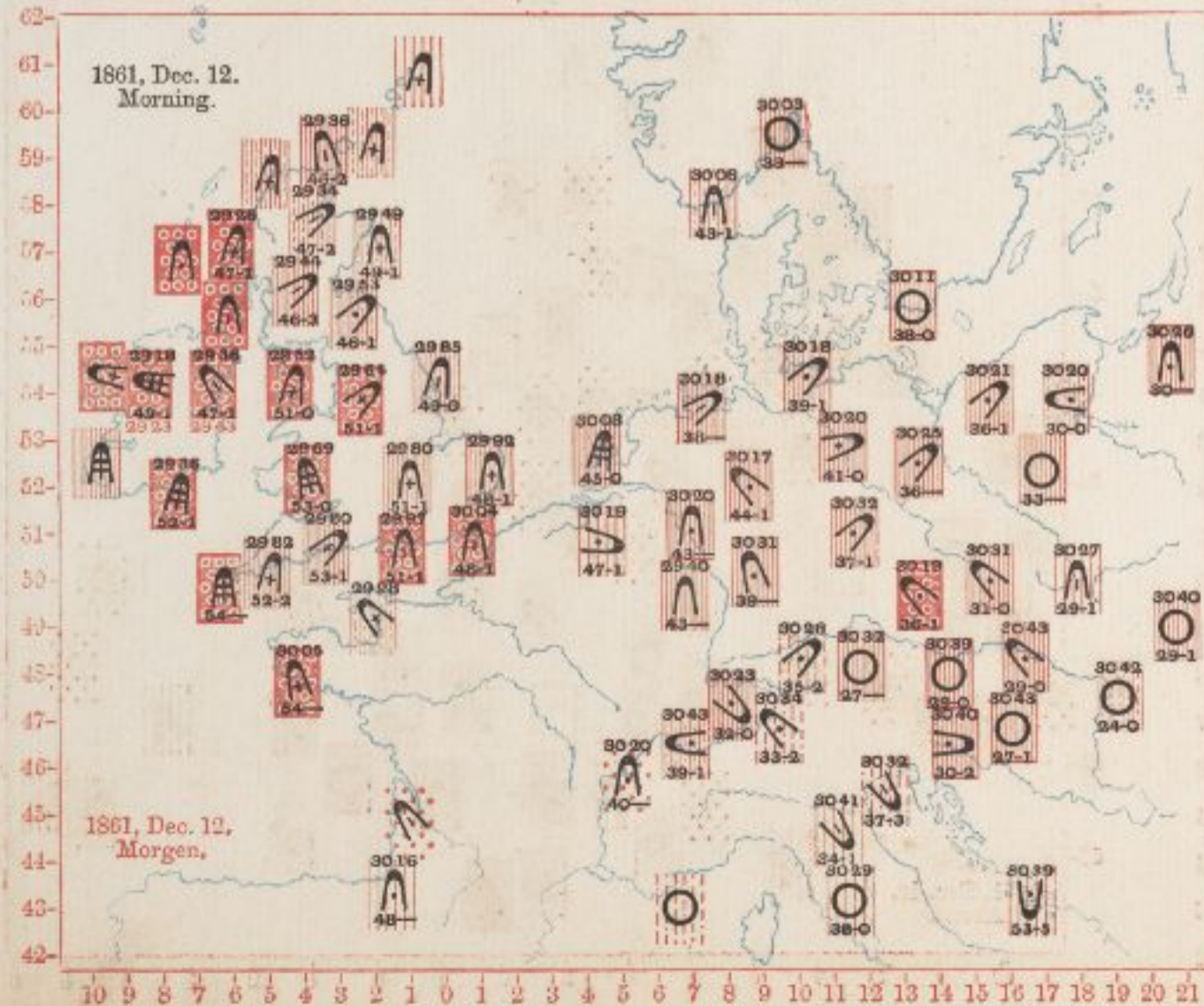
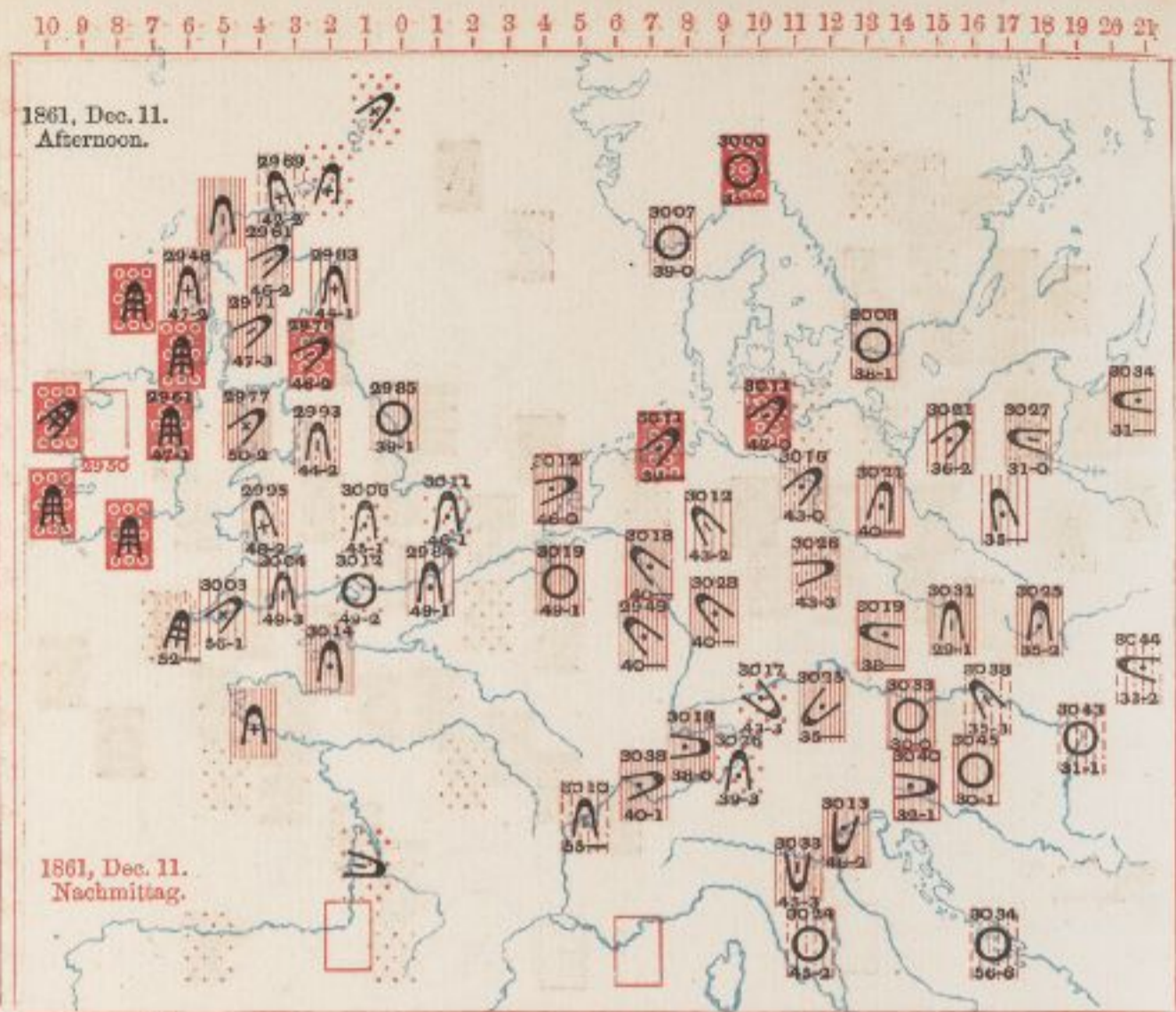
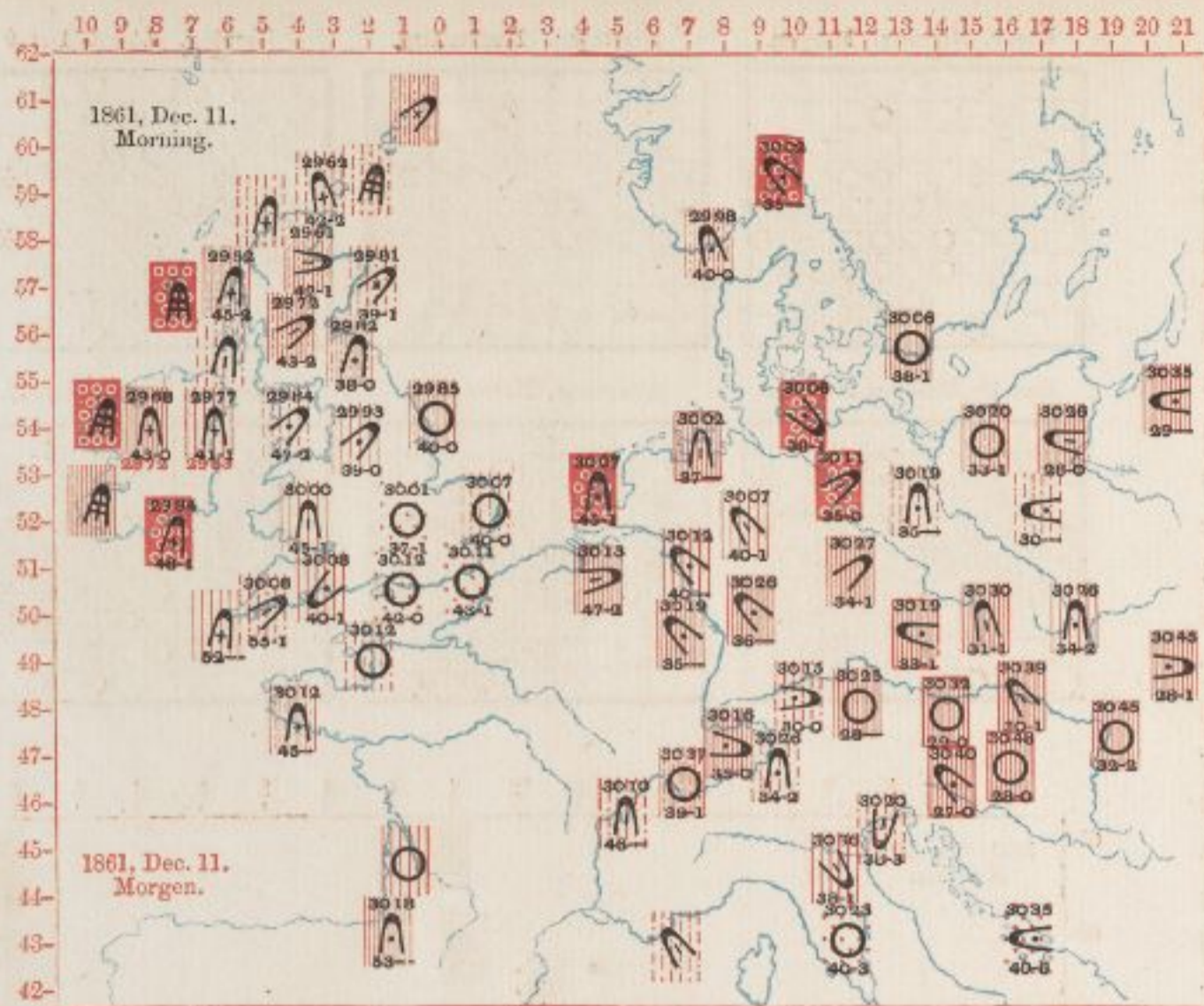
Dec. 9. Morning. *Morgen.* Afternoon. *Nachmittag.* Evening. *Abend.* Dec. 9



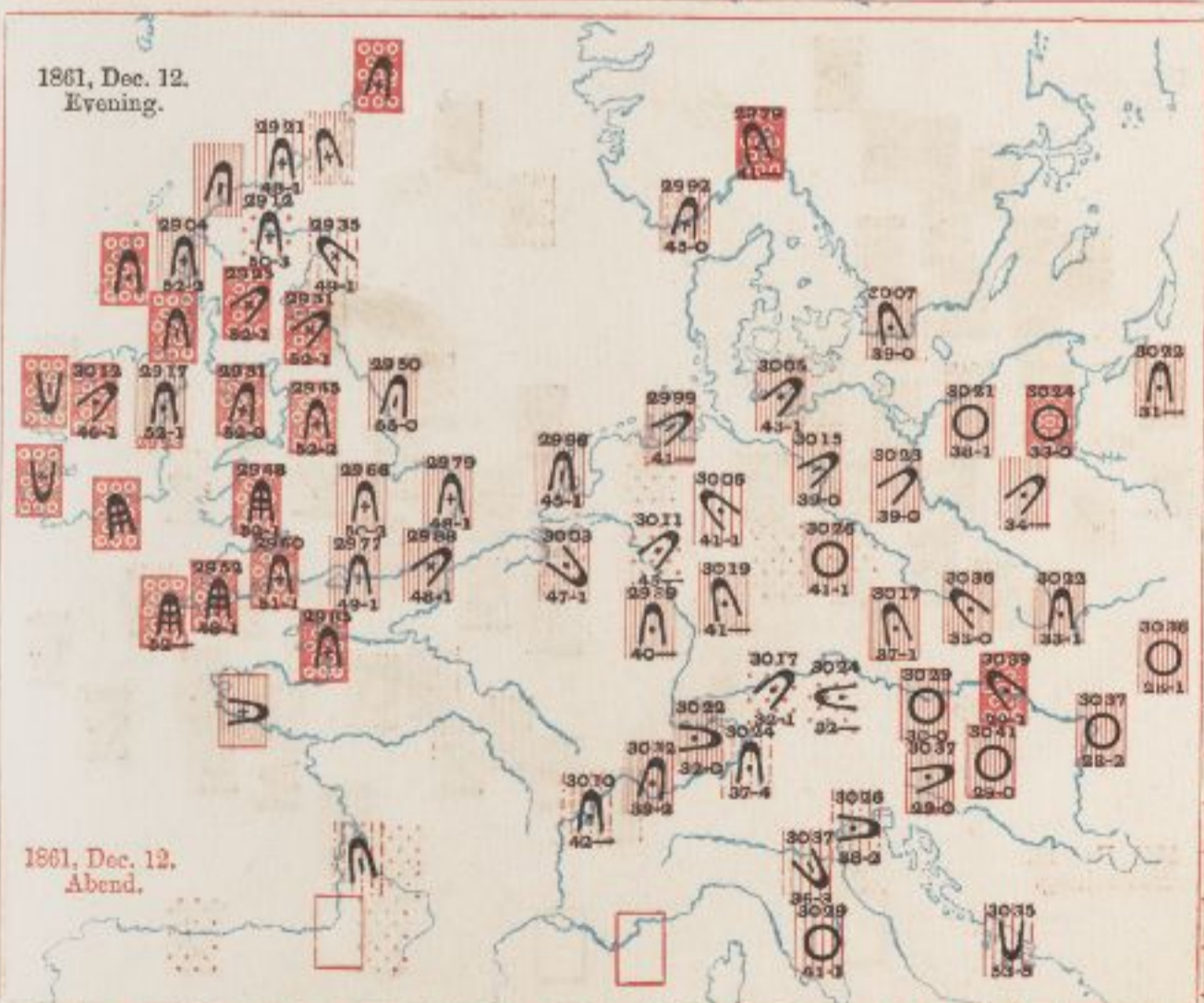
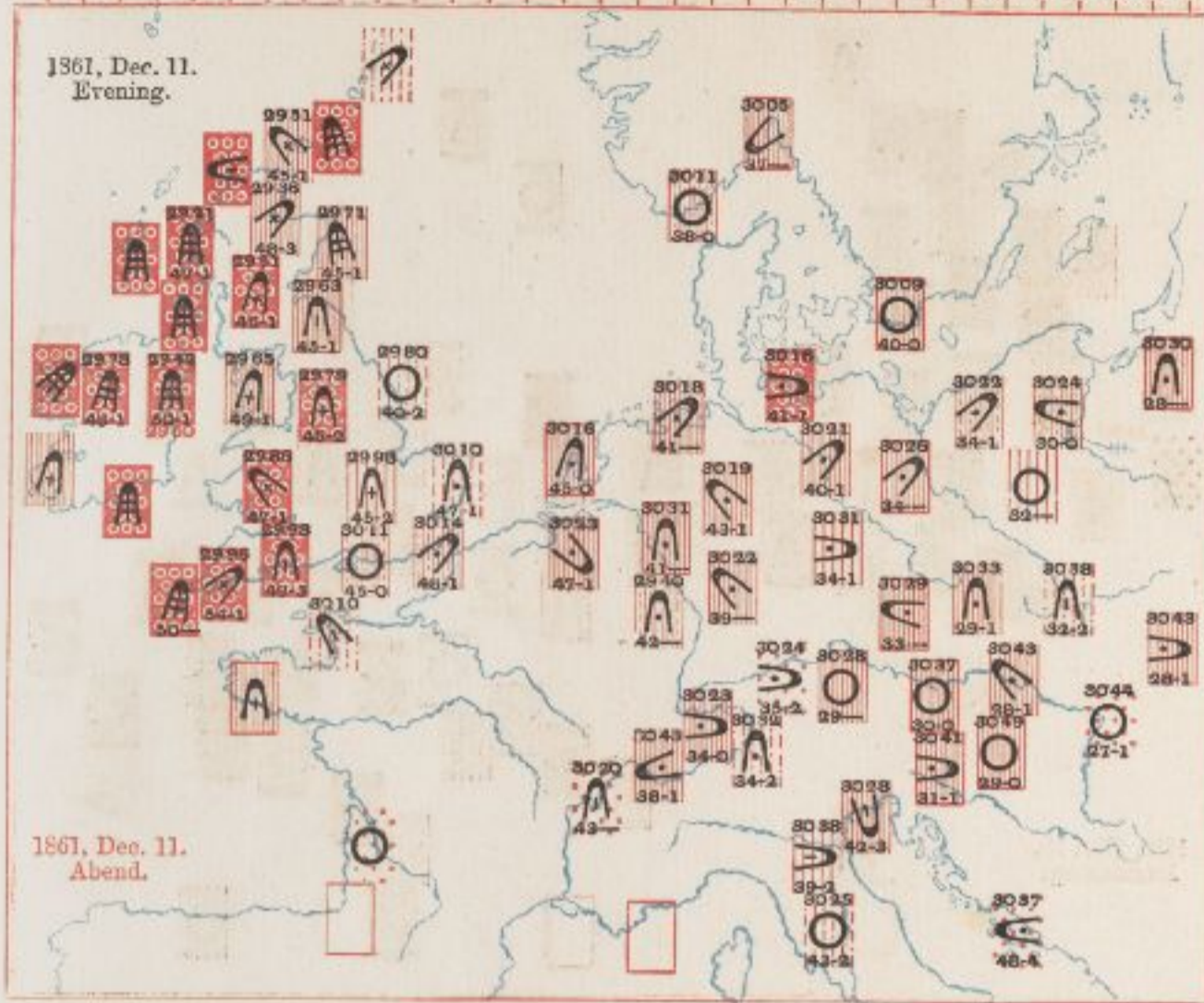
Dec. 10. Morning. *Morgen.* Afternoon. *Nachmittag.* Evening. *Abend.* Dec. 10.



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Dec. 11. Morning. Morgen.

Afternoon. Nachmittag.

Evening. Abend. Dec. 11.



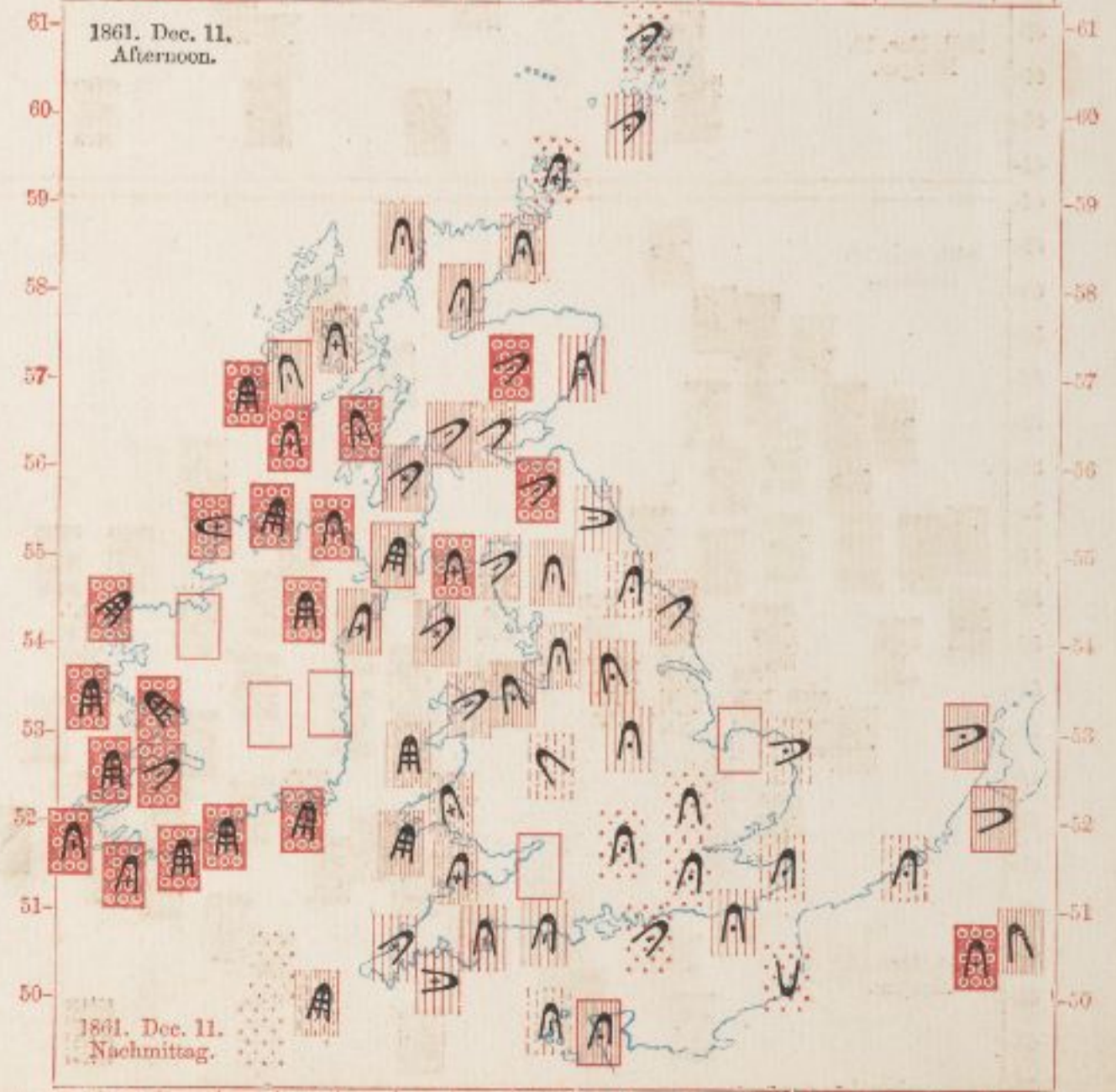
Dec. 12. Morning. Morgen.

Afternoon. Nachmittag.

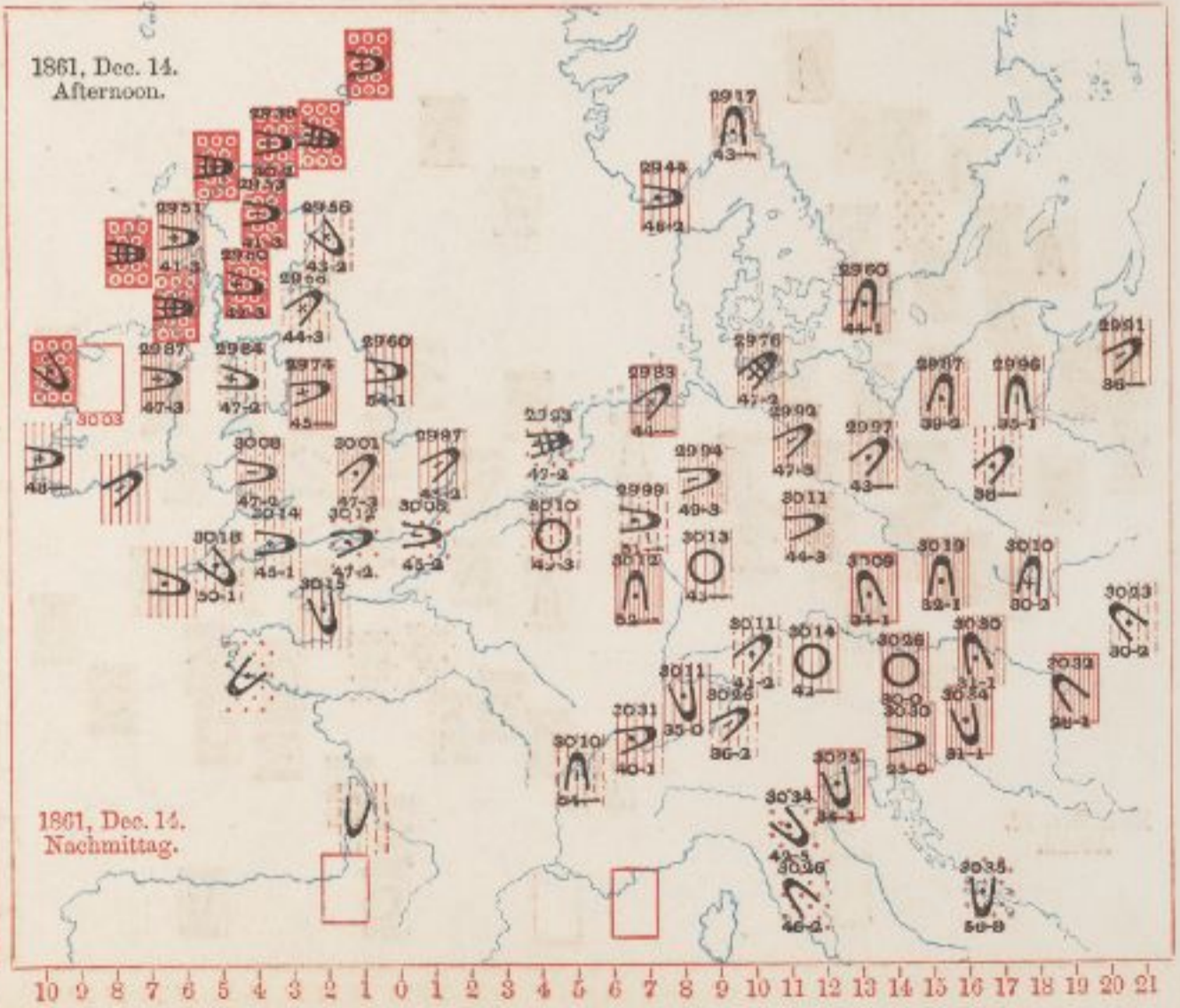
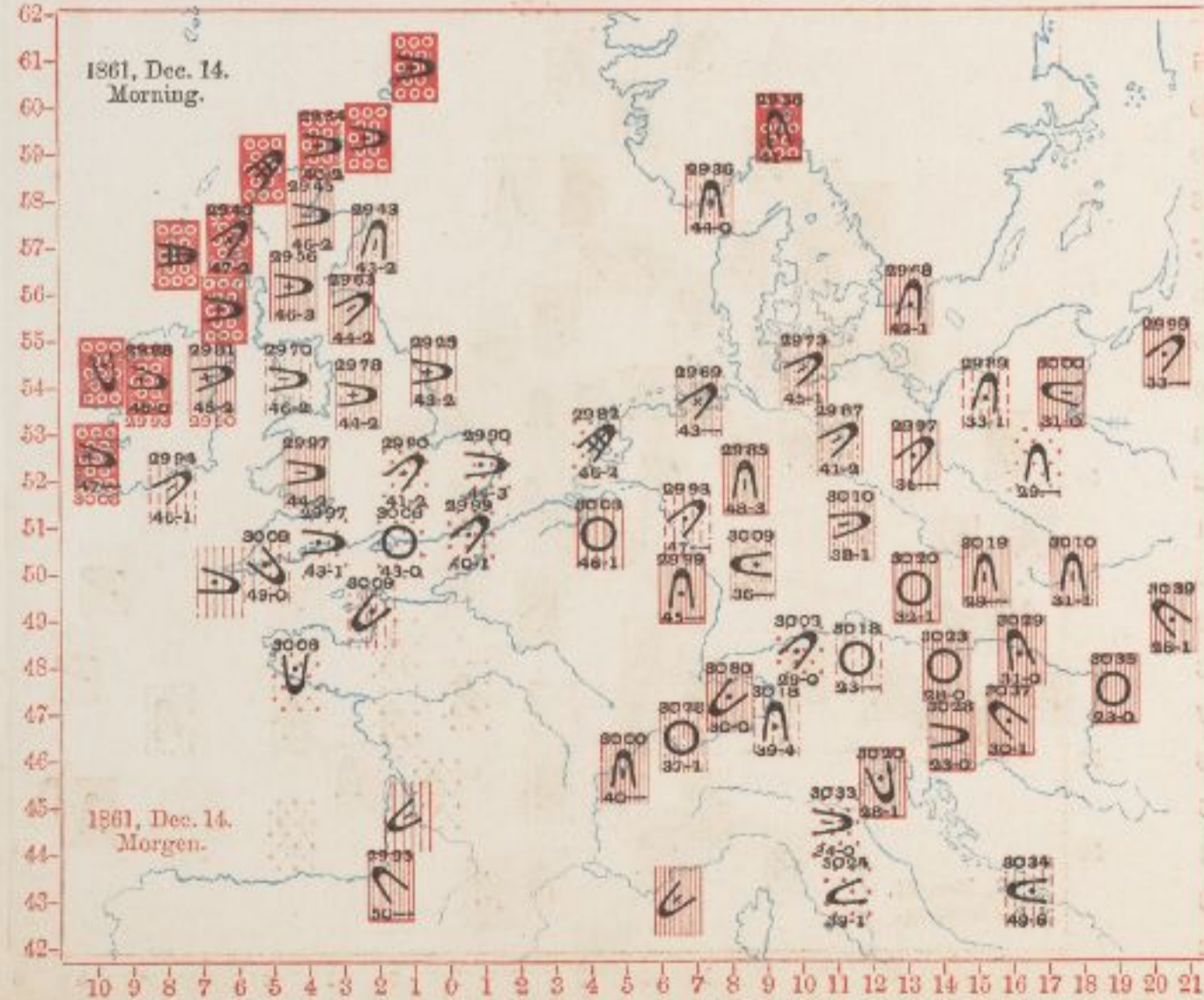
Evening. Abend. Dec. 12.



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6

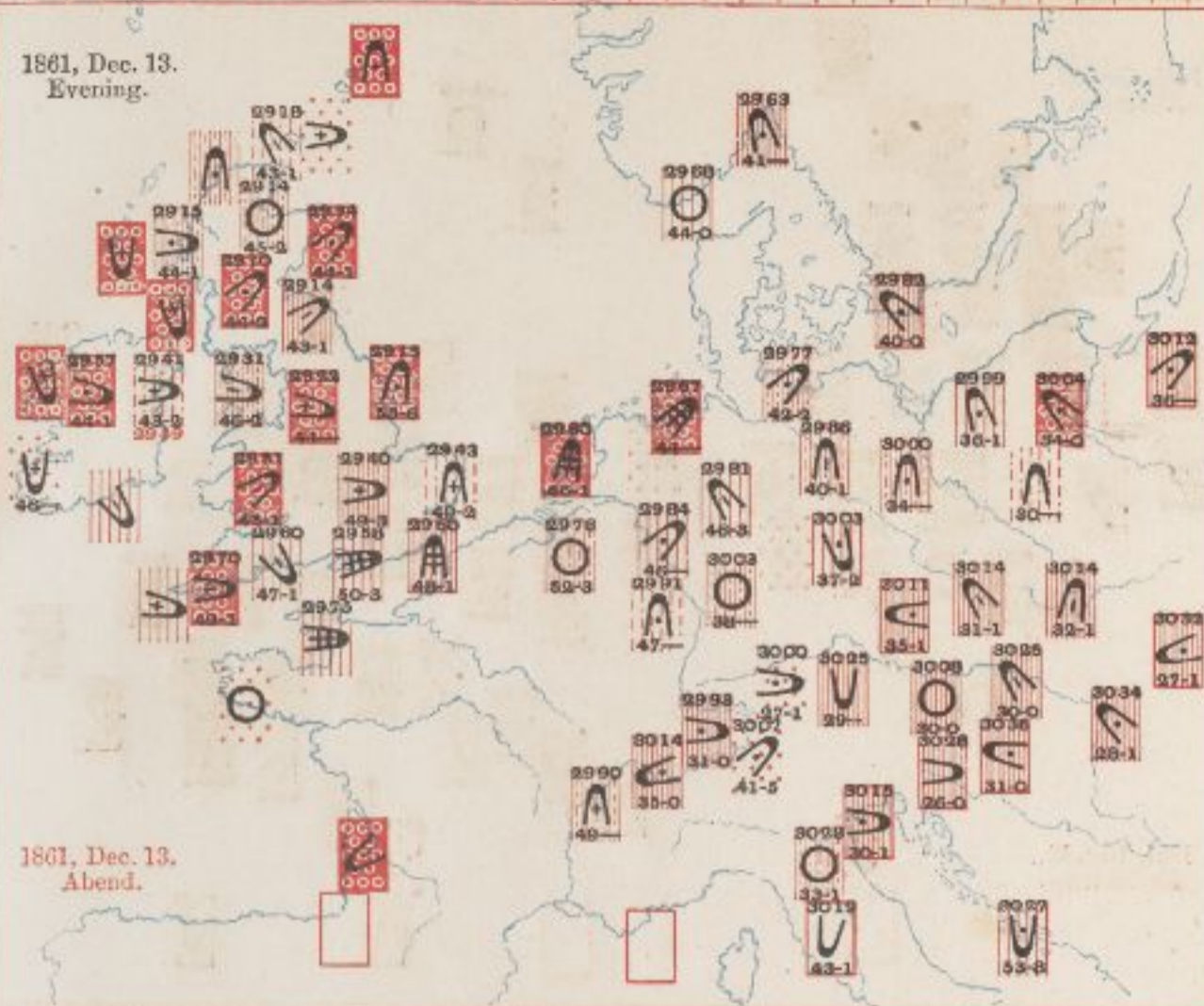


10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6



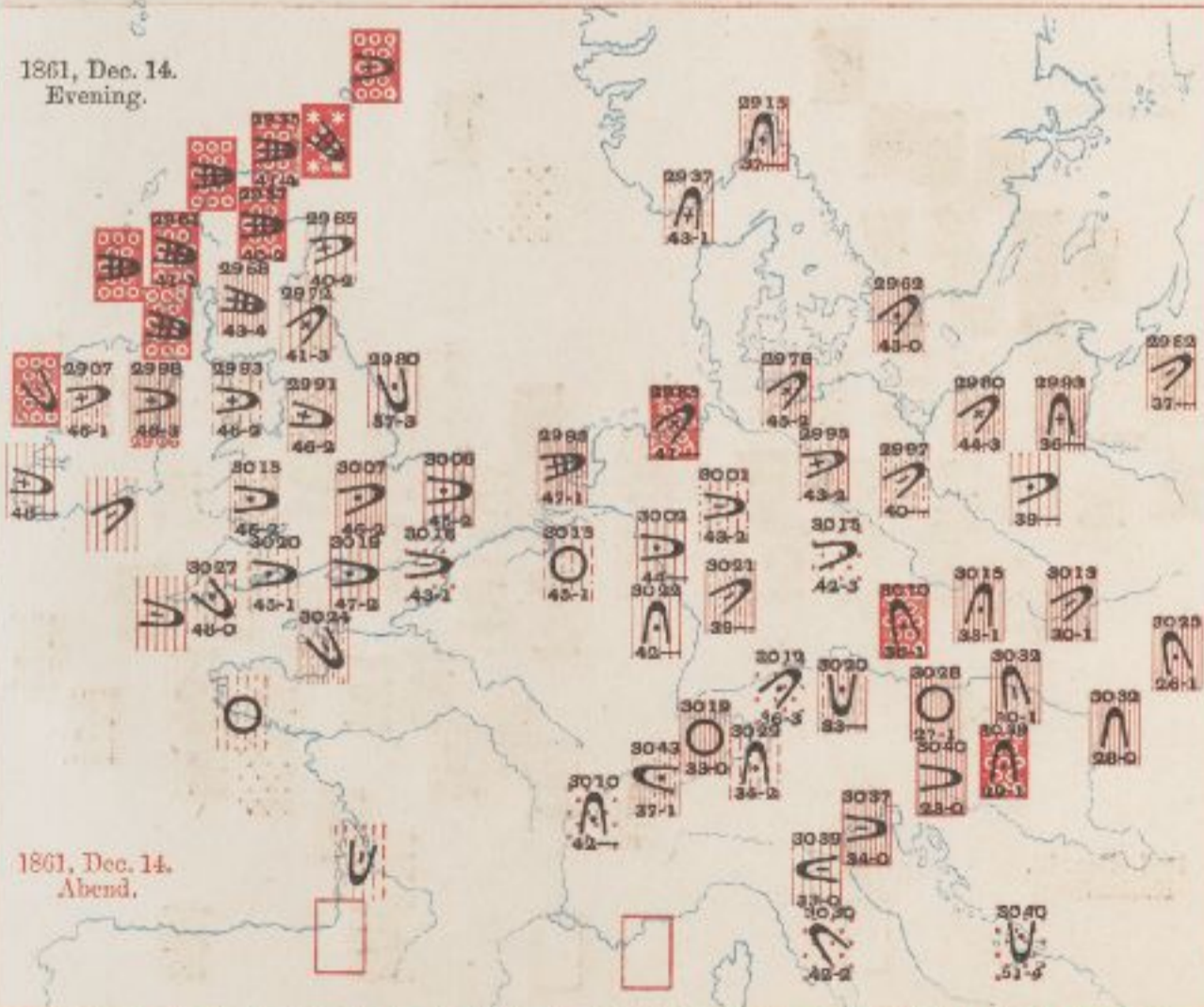
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

1861, Dec. 13.  
Evening.



1861, Dec. 13.  
Abend.

1861, Dec. 14.  
Evening.



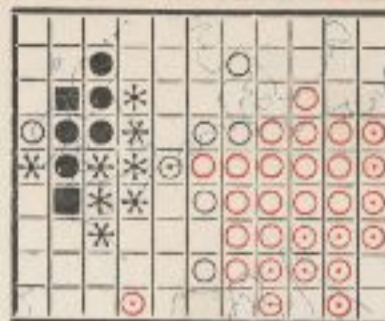
1861, Dec. 14.  
Abend.

10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Dec. 13. Morning. Morgen.

Afternoon. Nachmittag.

Evening. Abend. Dec. 13.



Dec. 14. Morning. Morgen.

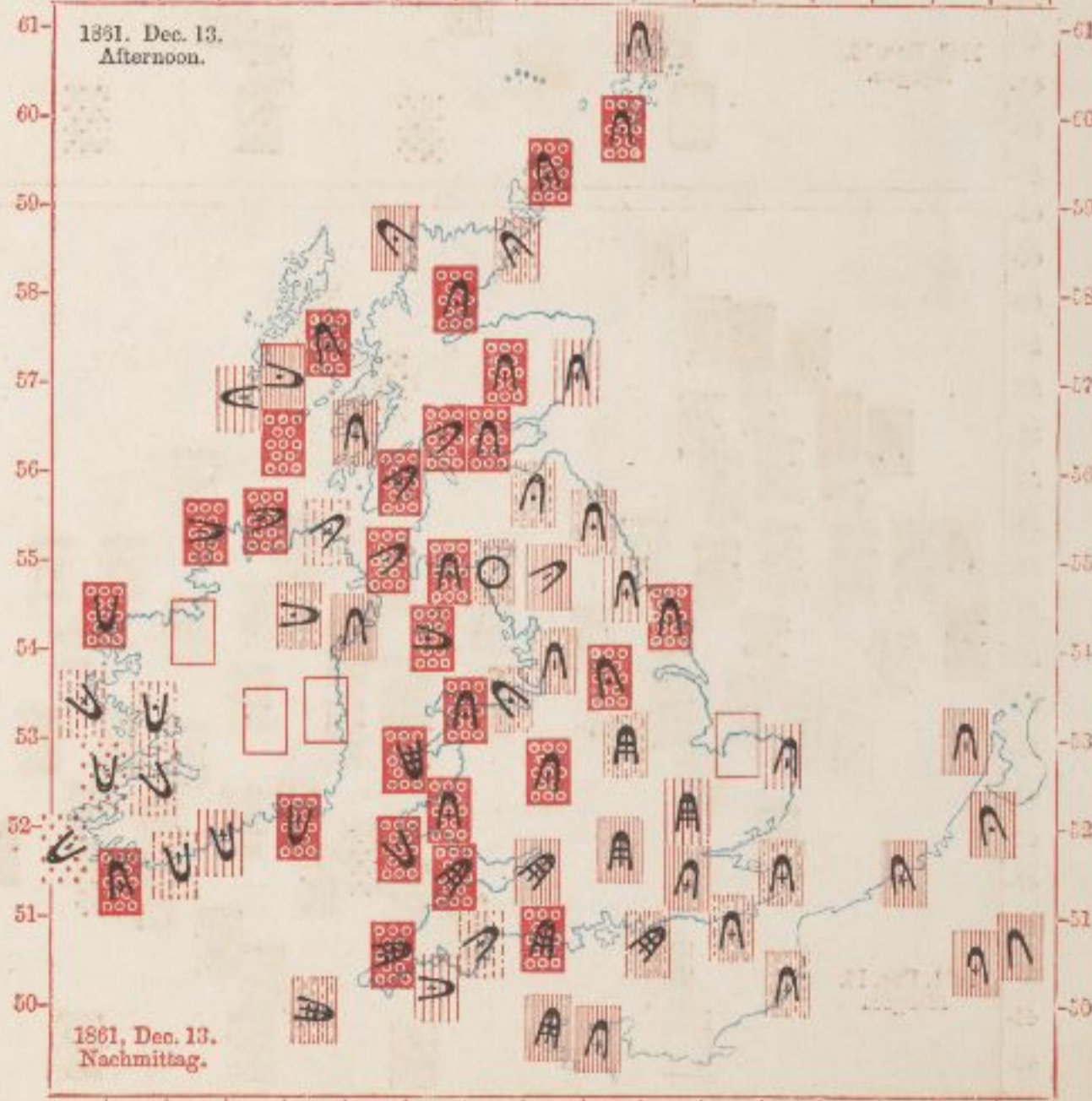
Afternoon. Nachmittag.

Evening. Abend. Dec. 14.



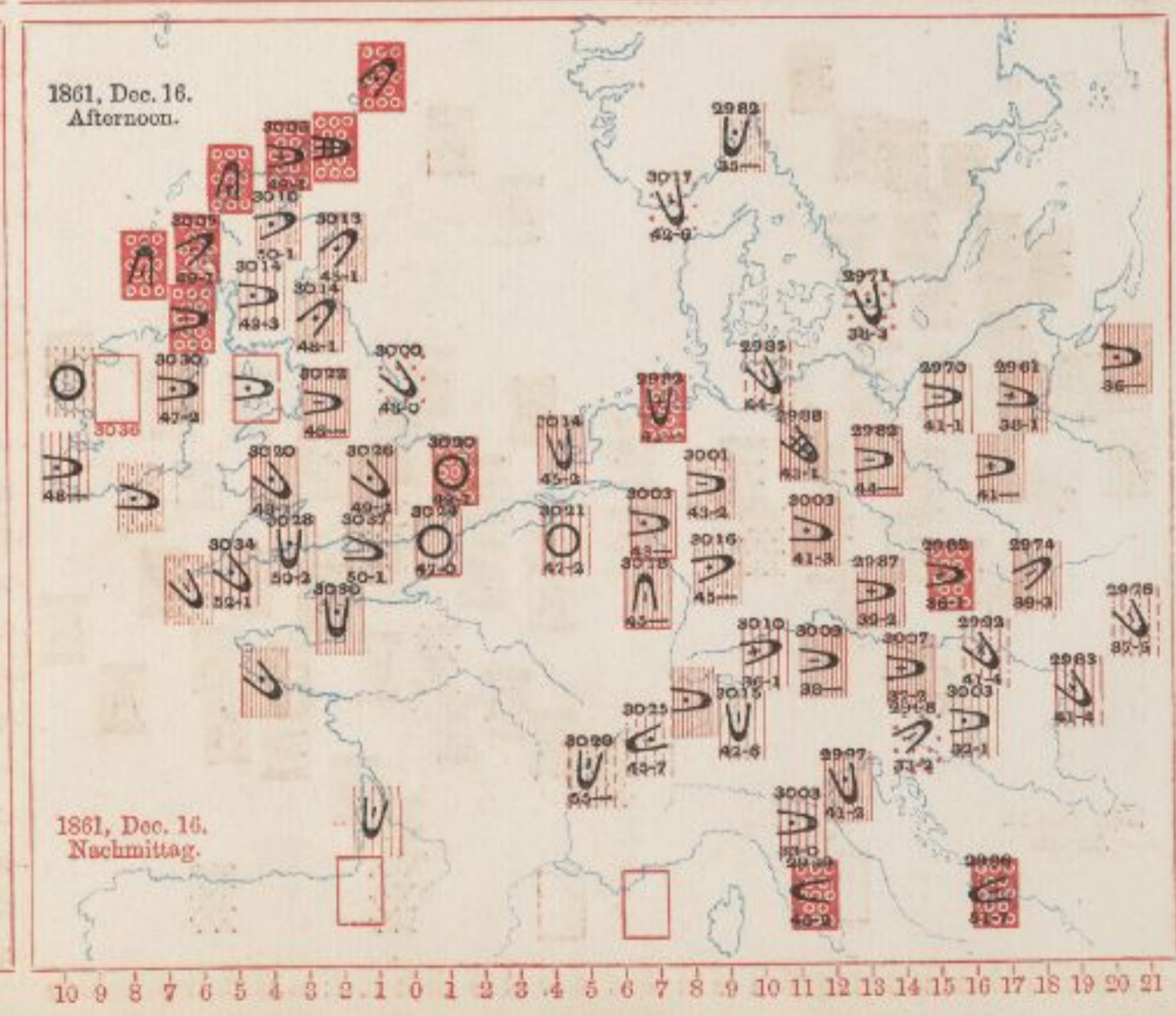
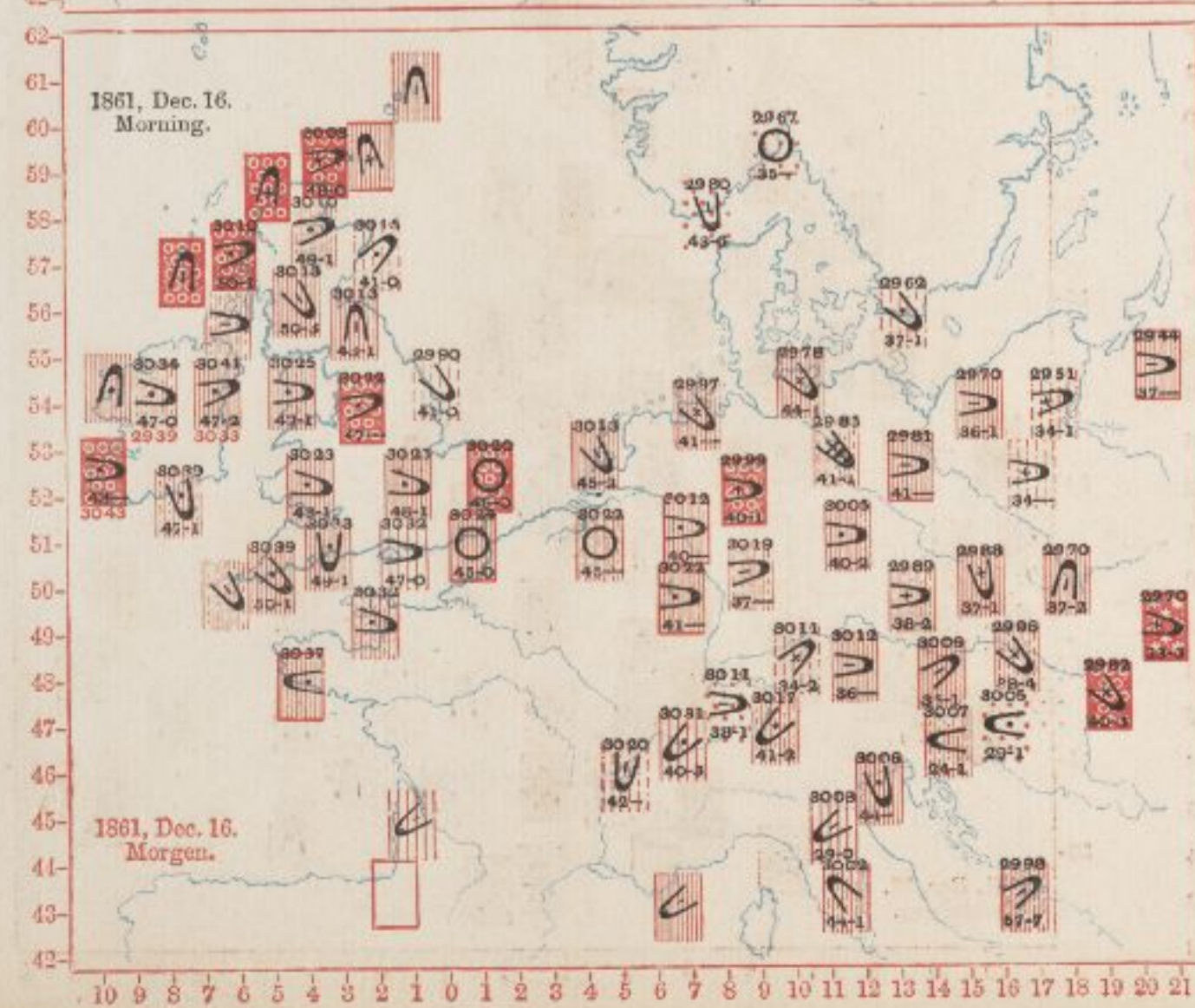
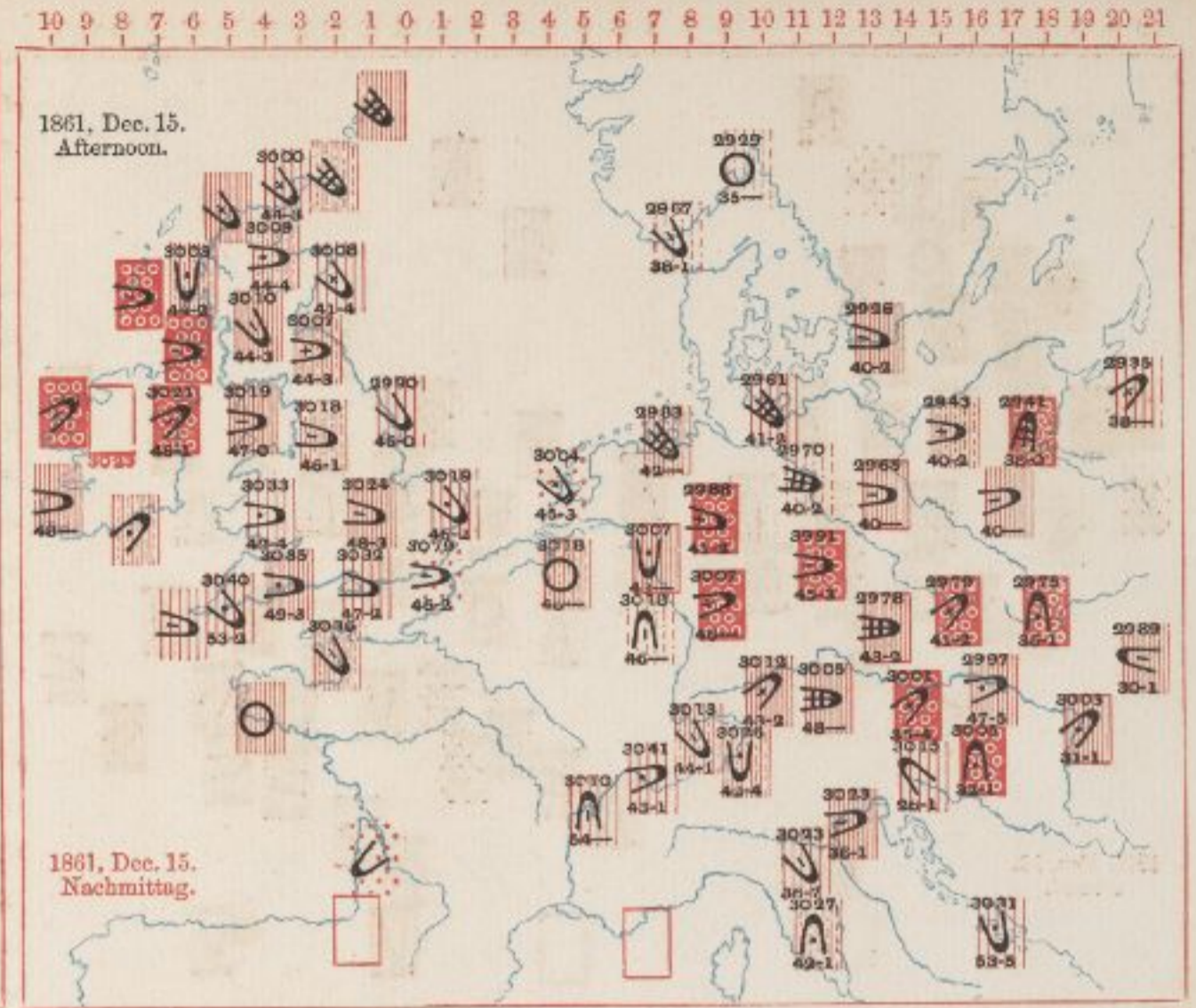
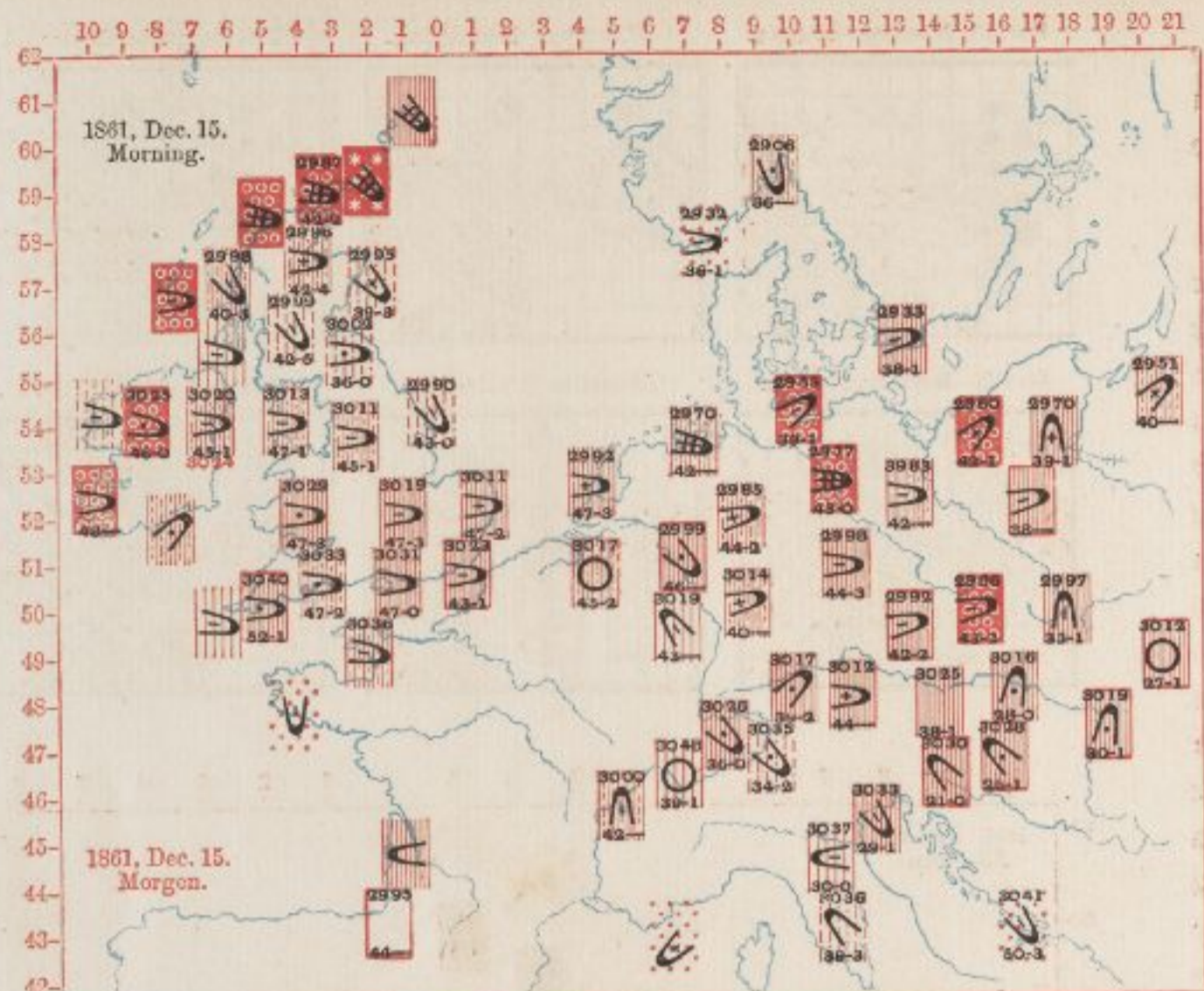
10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6

1861, Dec. 13.  
Afternoon.

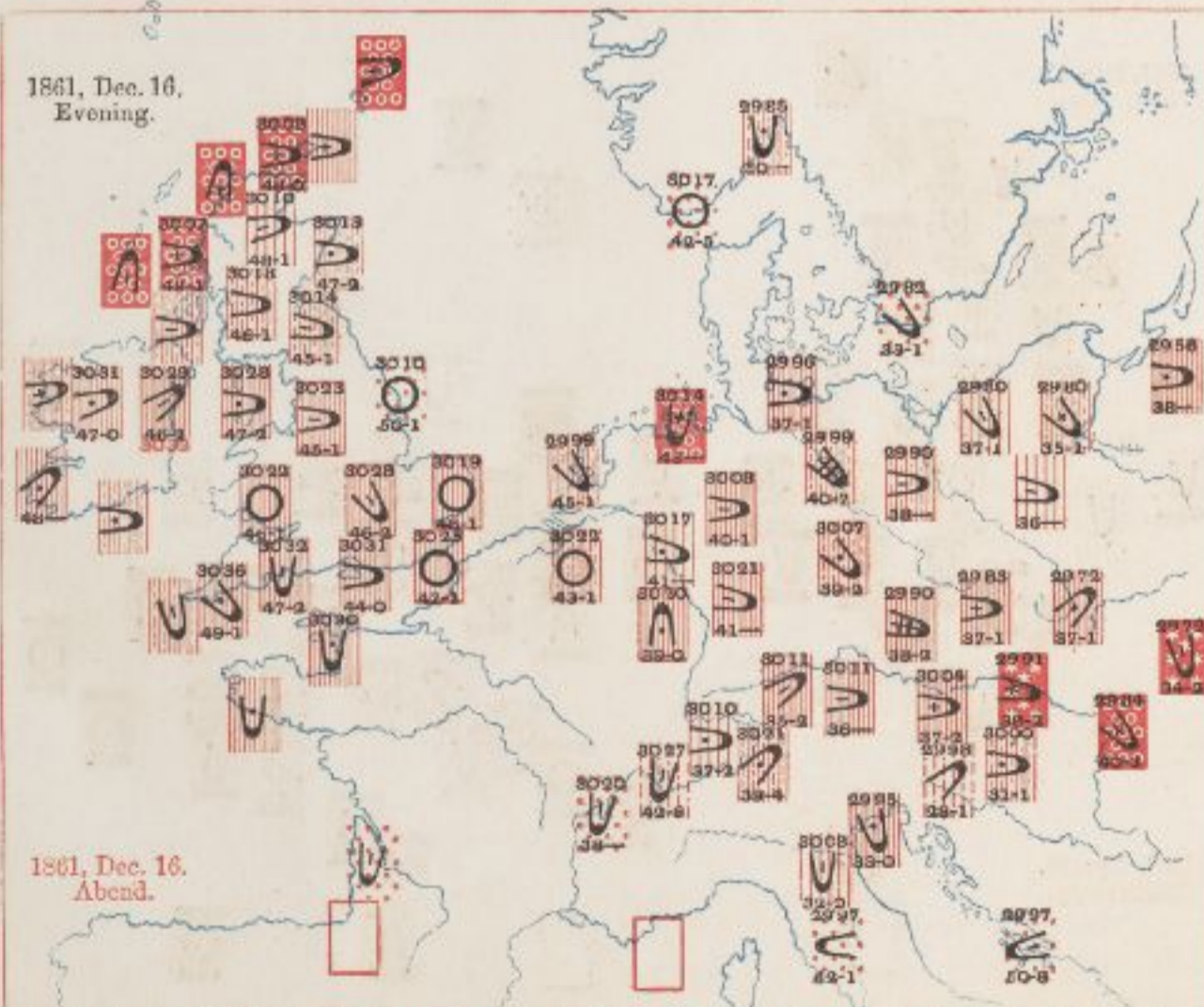
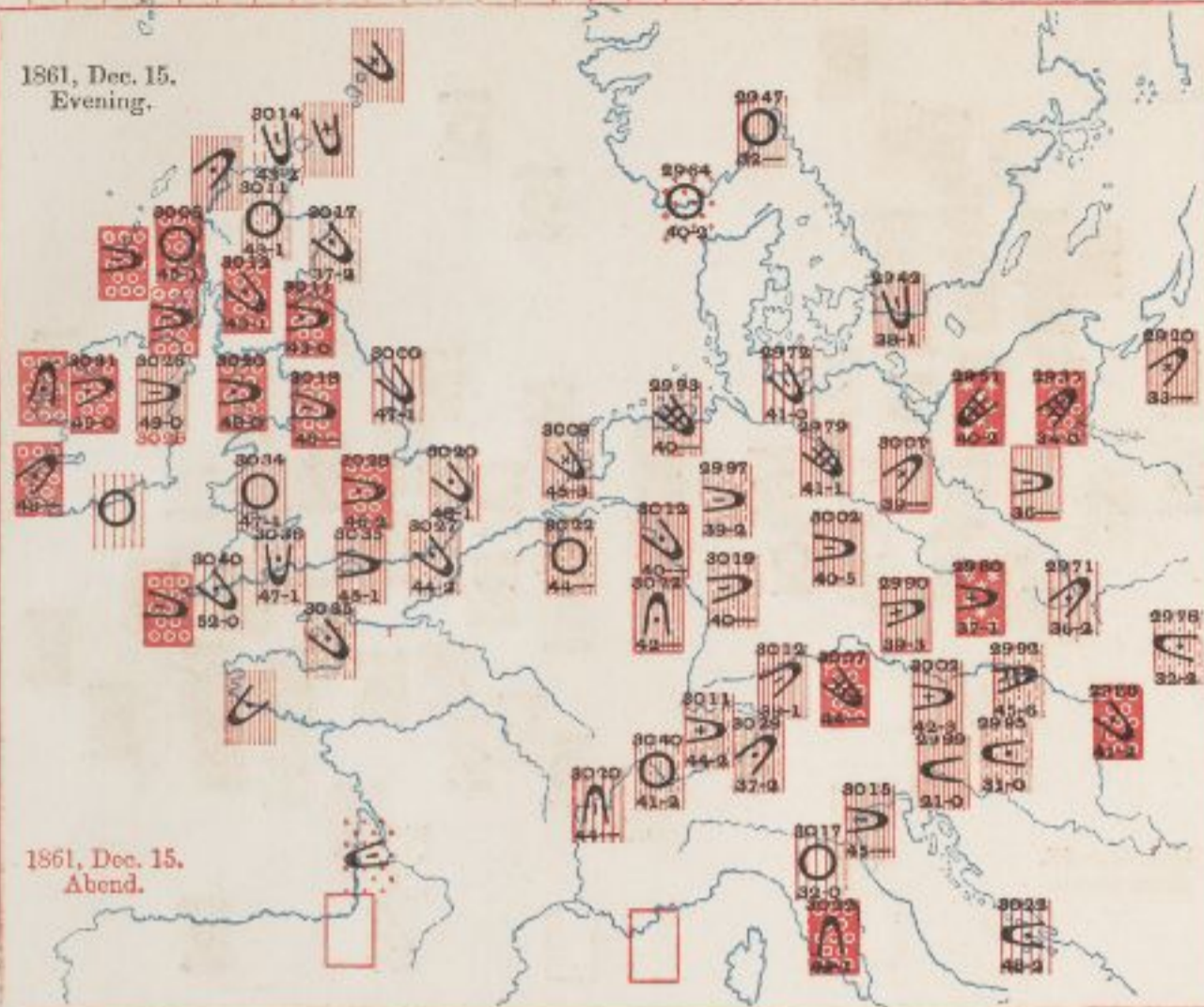


1861, Dec. 13.  
Nachmittag.

10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21



10 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

Dec. 15. Morning. *Morgen.*

Afternoon. *Nachmittag.*

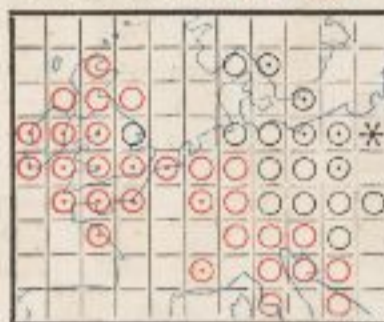
Evening. *Abend.* Dec. 15.



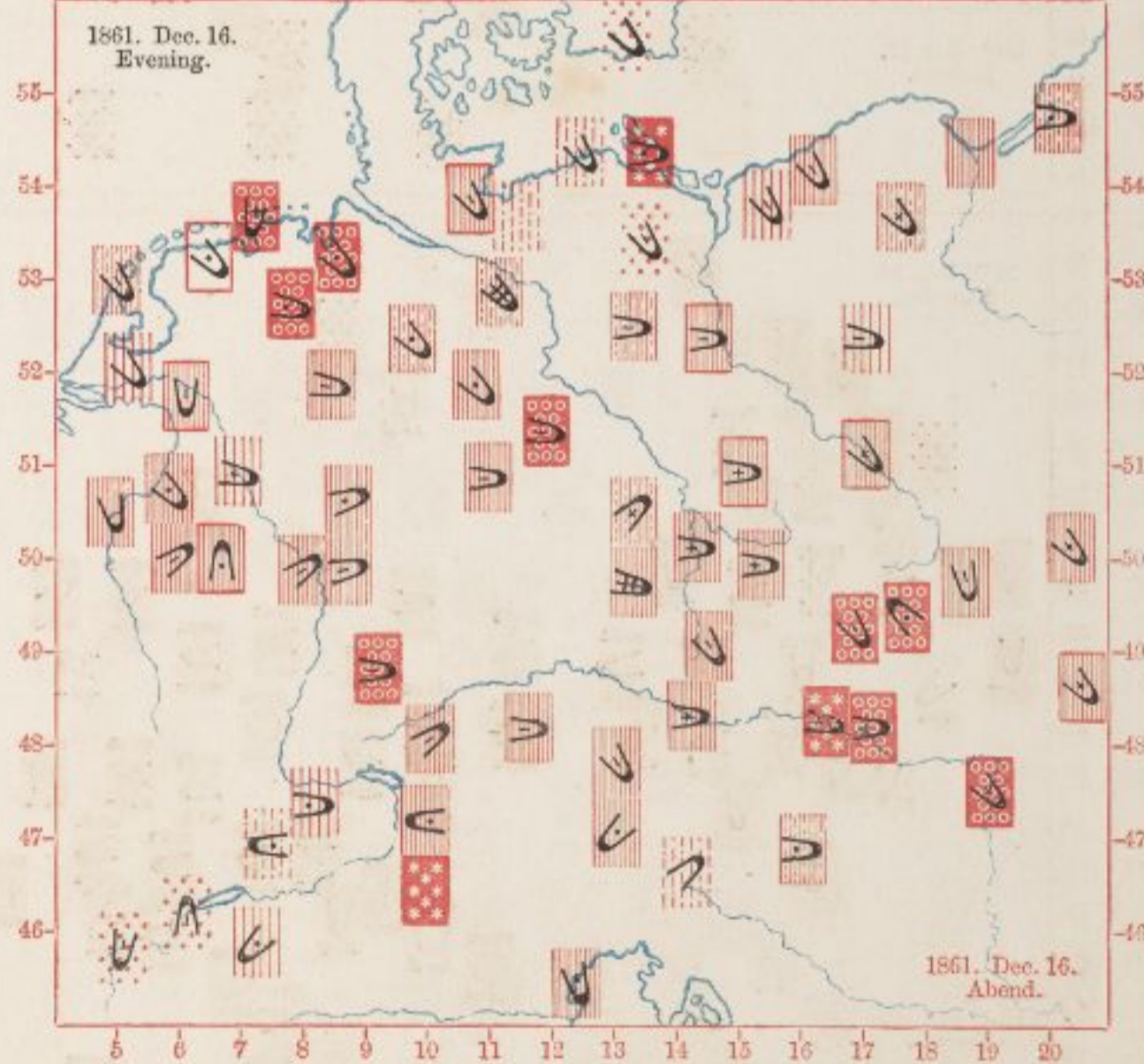
Dec. 16. Morning. *Morgen.*

Afternoon. *Nachmittag.*

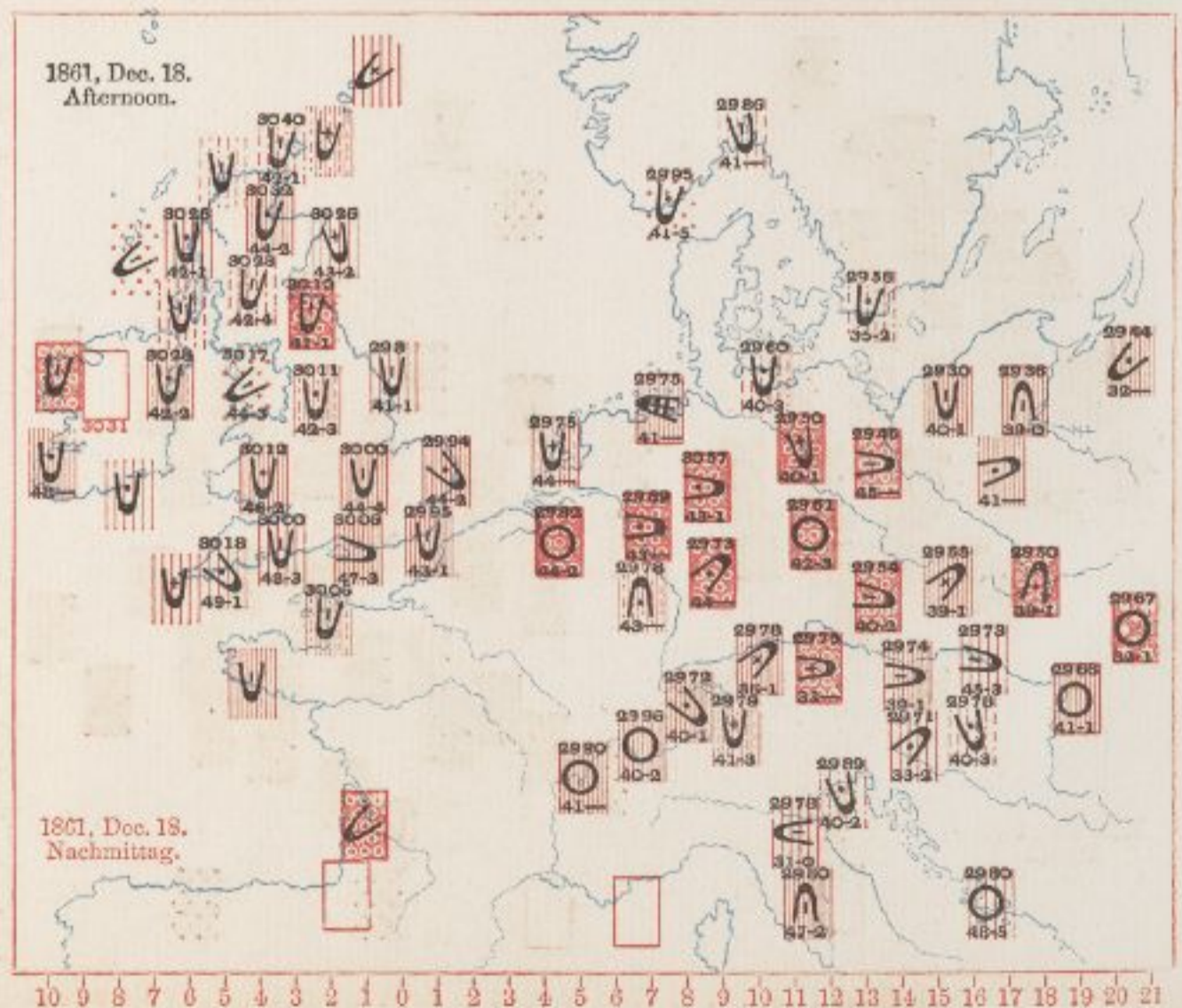
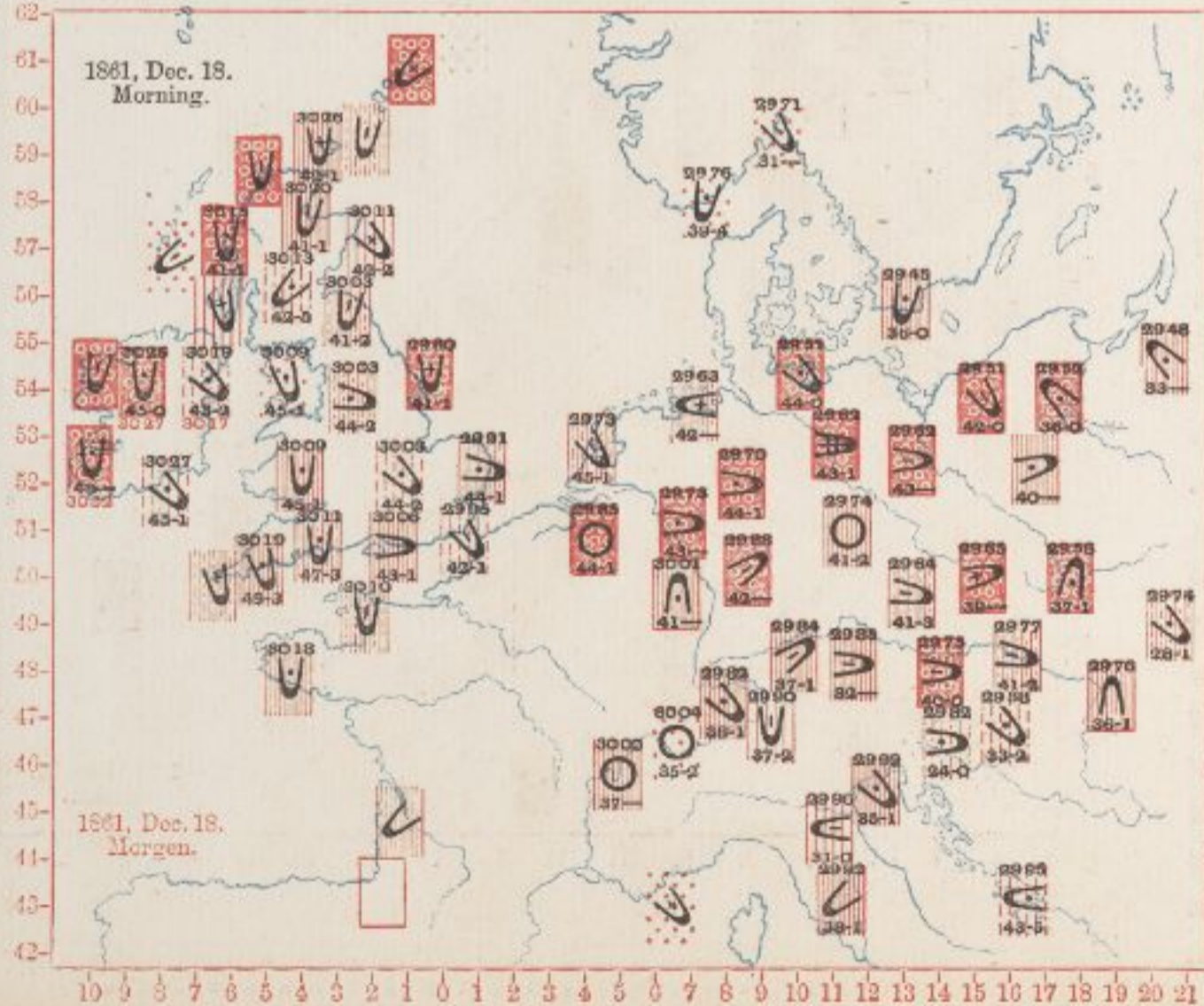
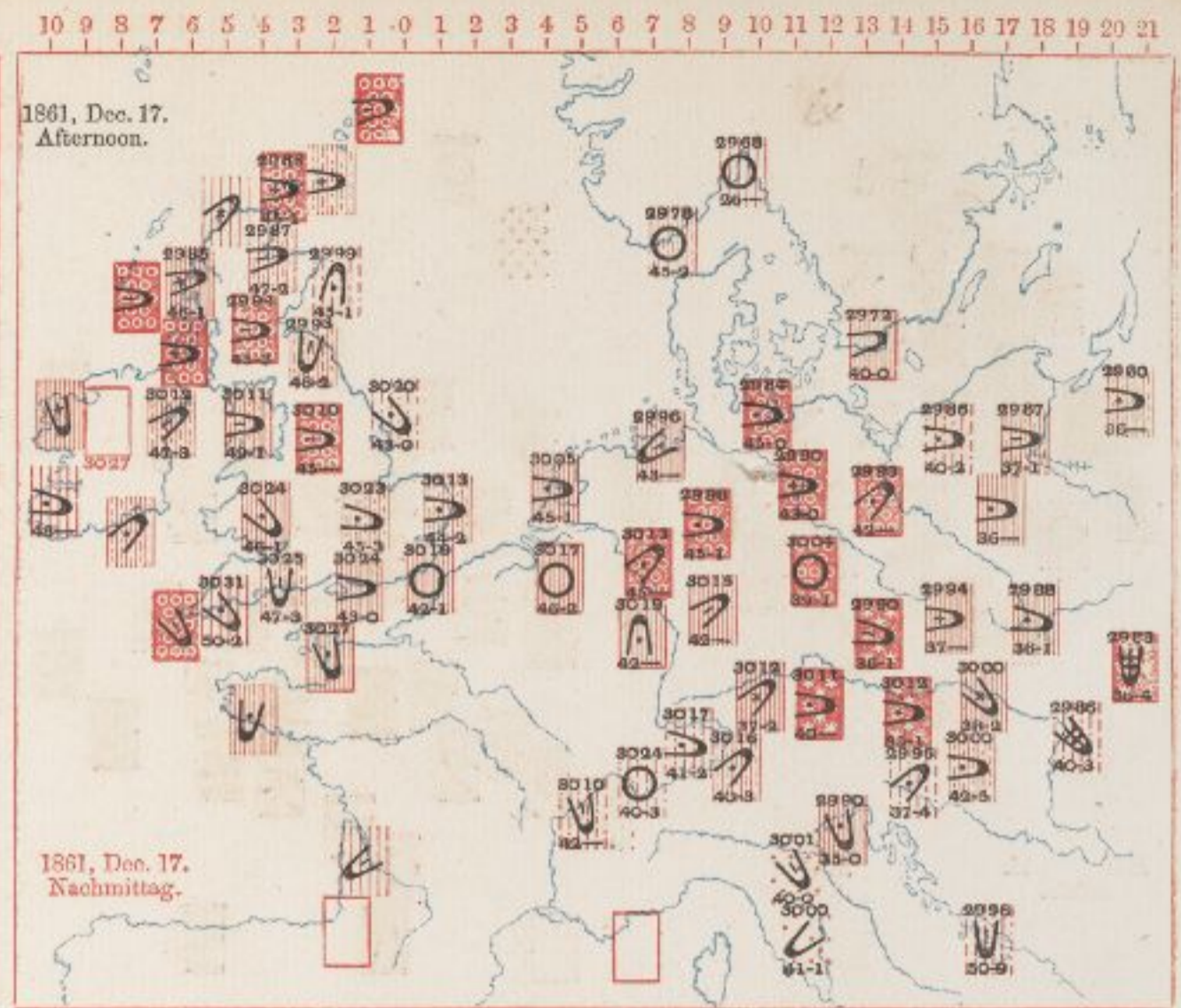
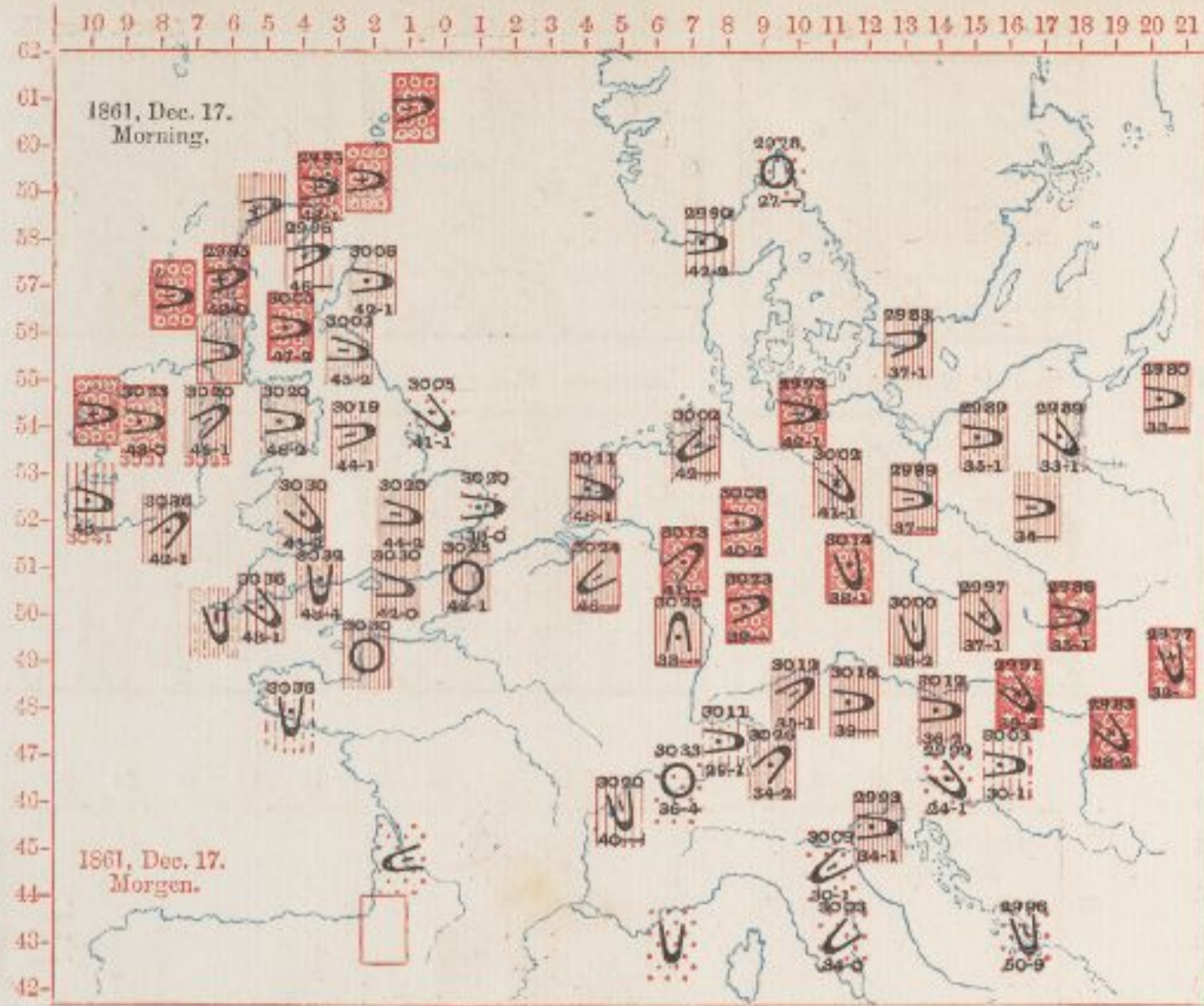
Evening. *Abend.* Dec. 16.



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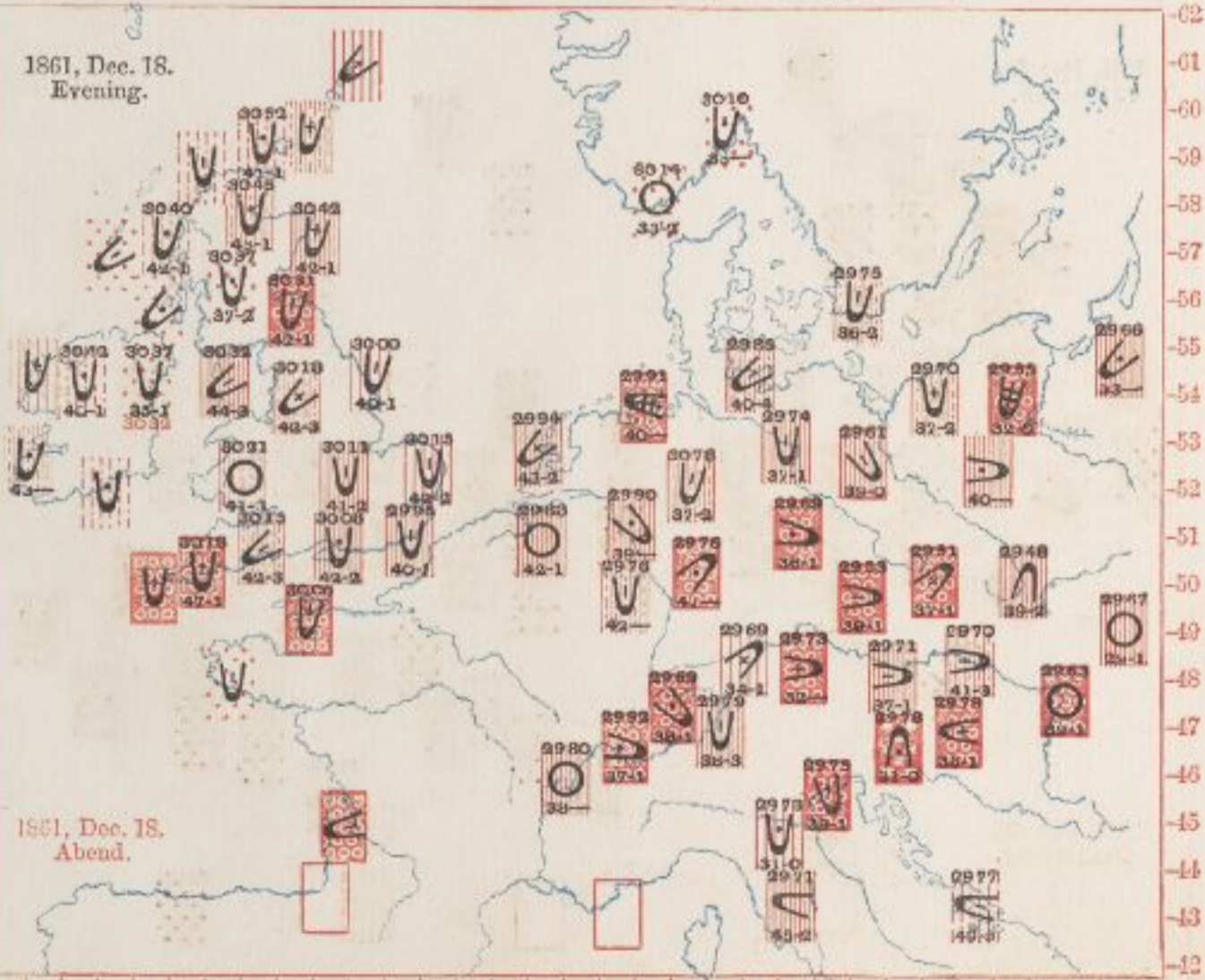
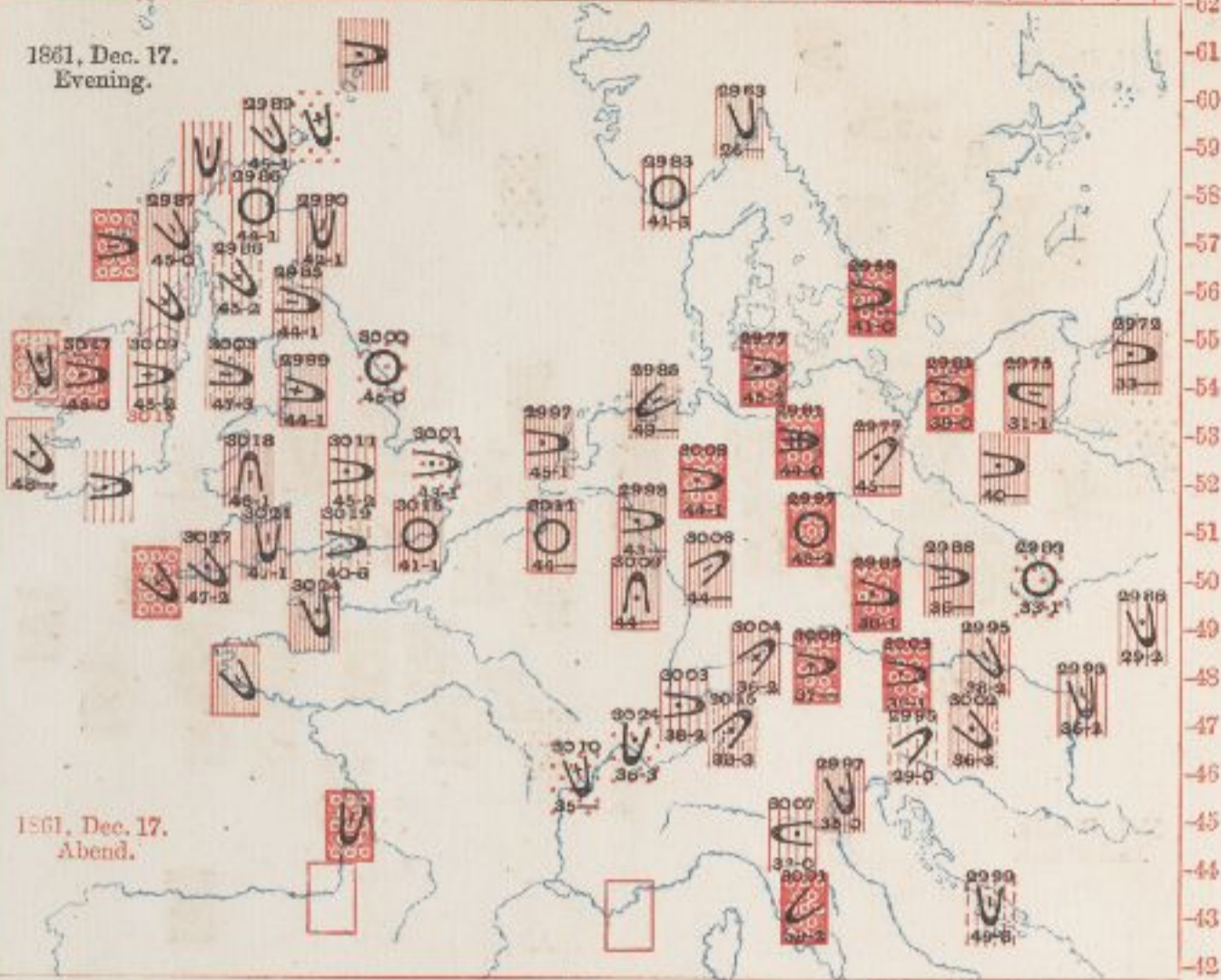


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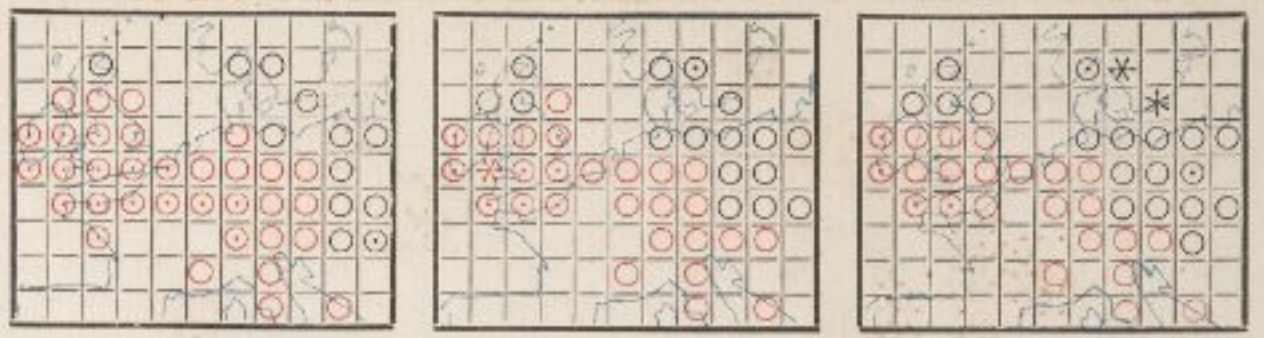


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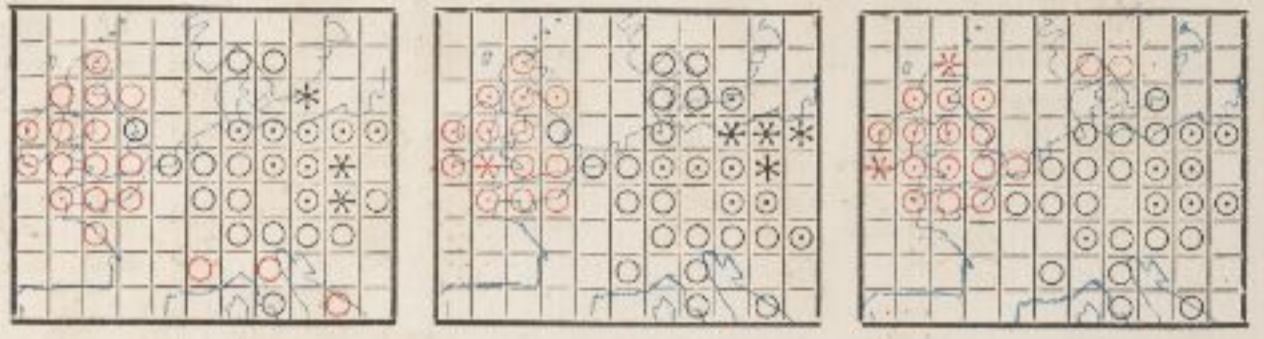


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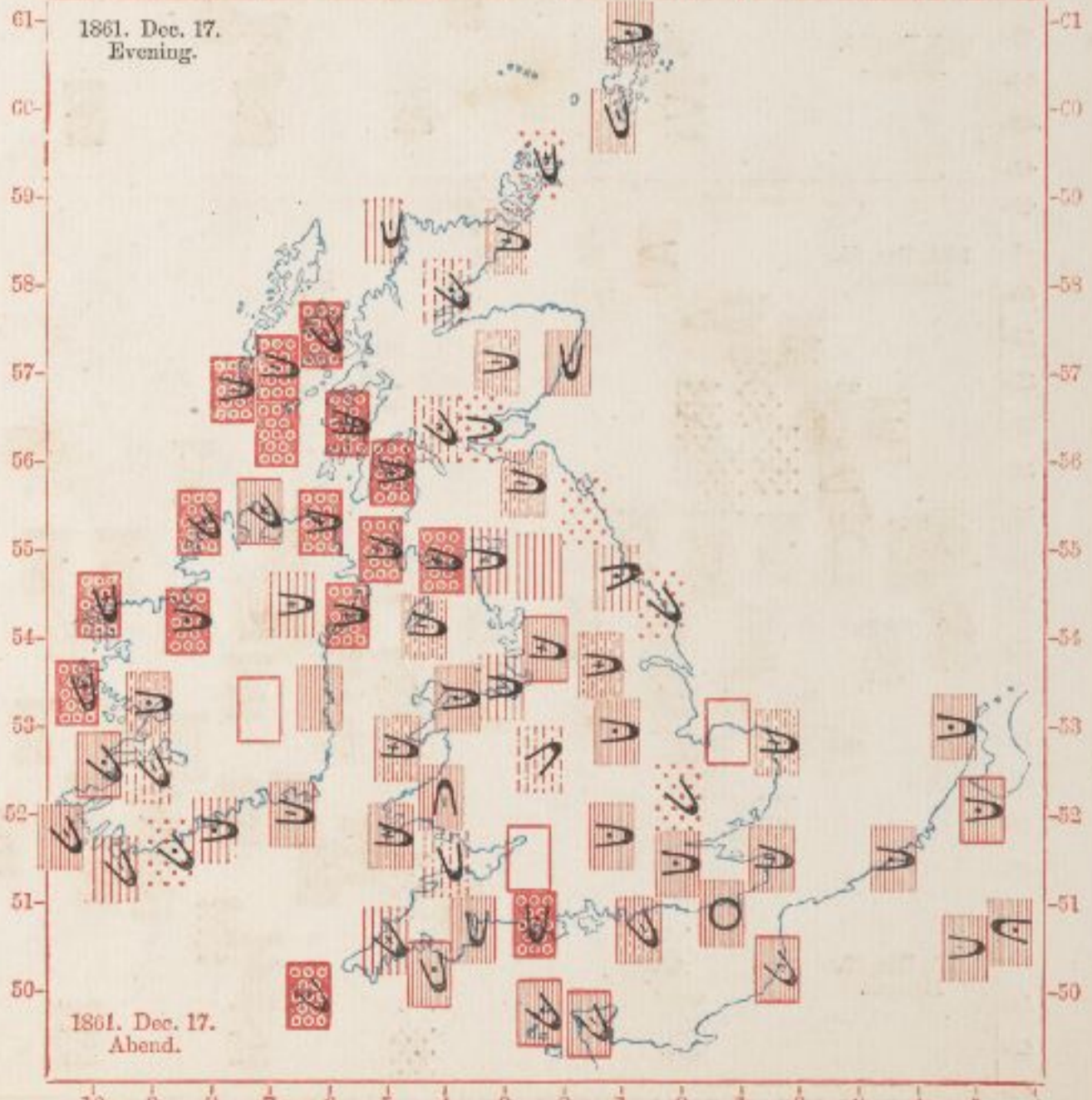
Dec. 17. Morning. Morgen. Afternoon. Nachmittag. Evening. Abend. Dec. 17.



Dec. 18. Morning. Morgen. Afternoon. Nachmittag. Evening. Abend. Dec. 18.

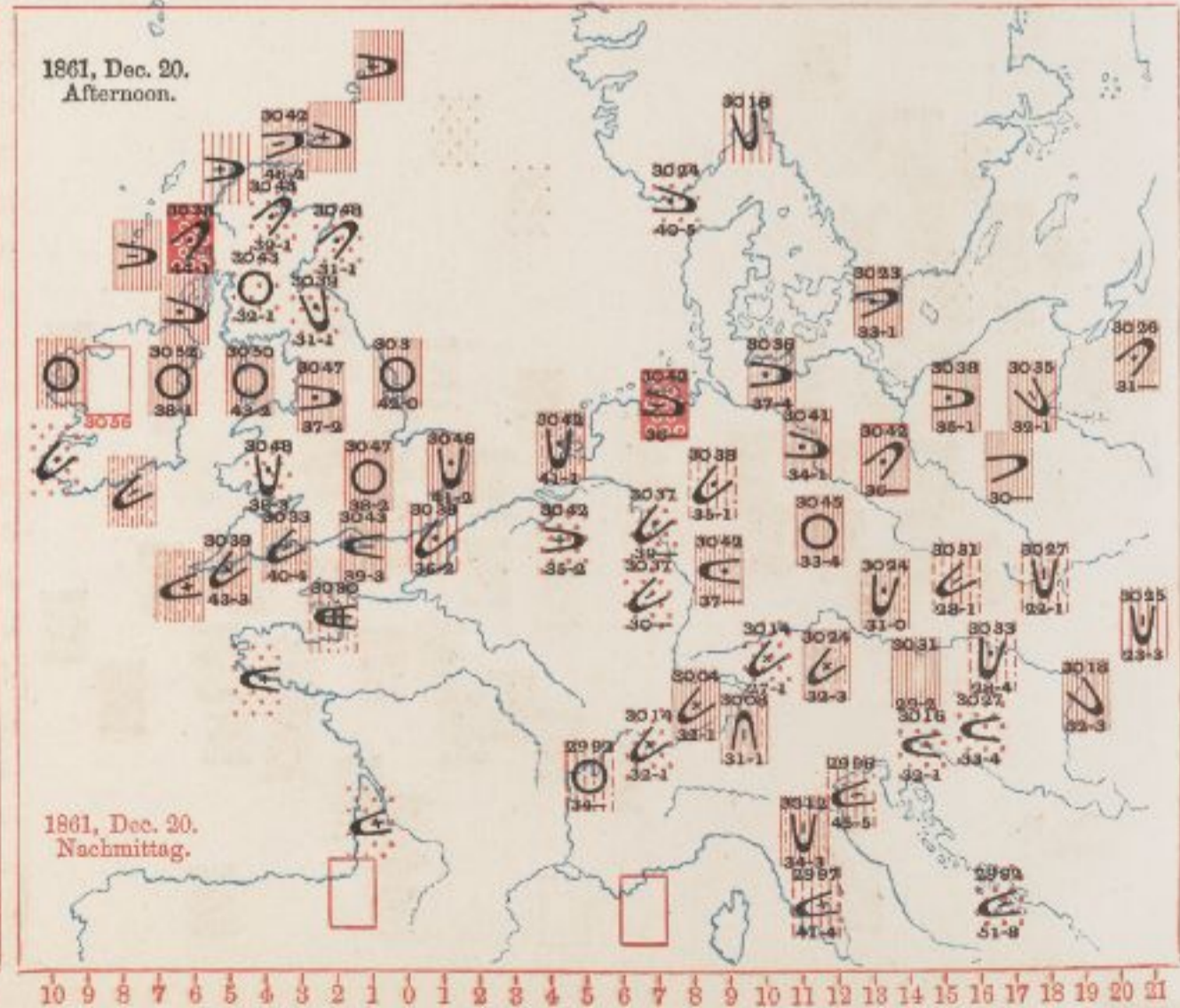
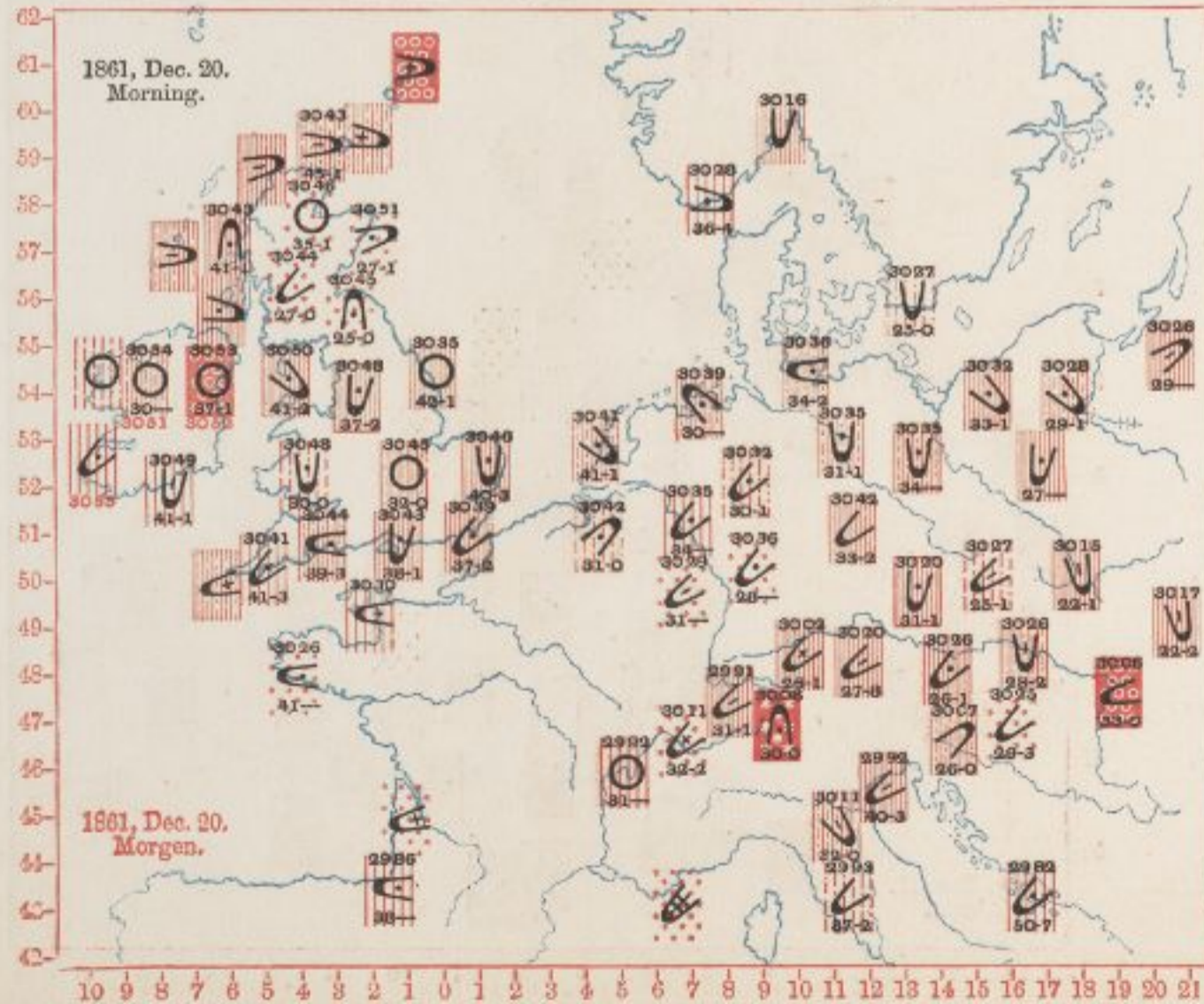
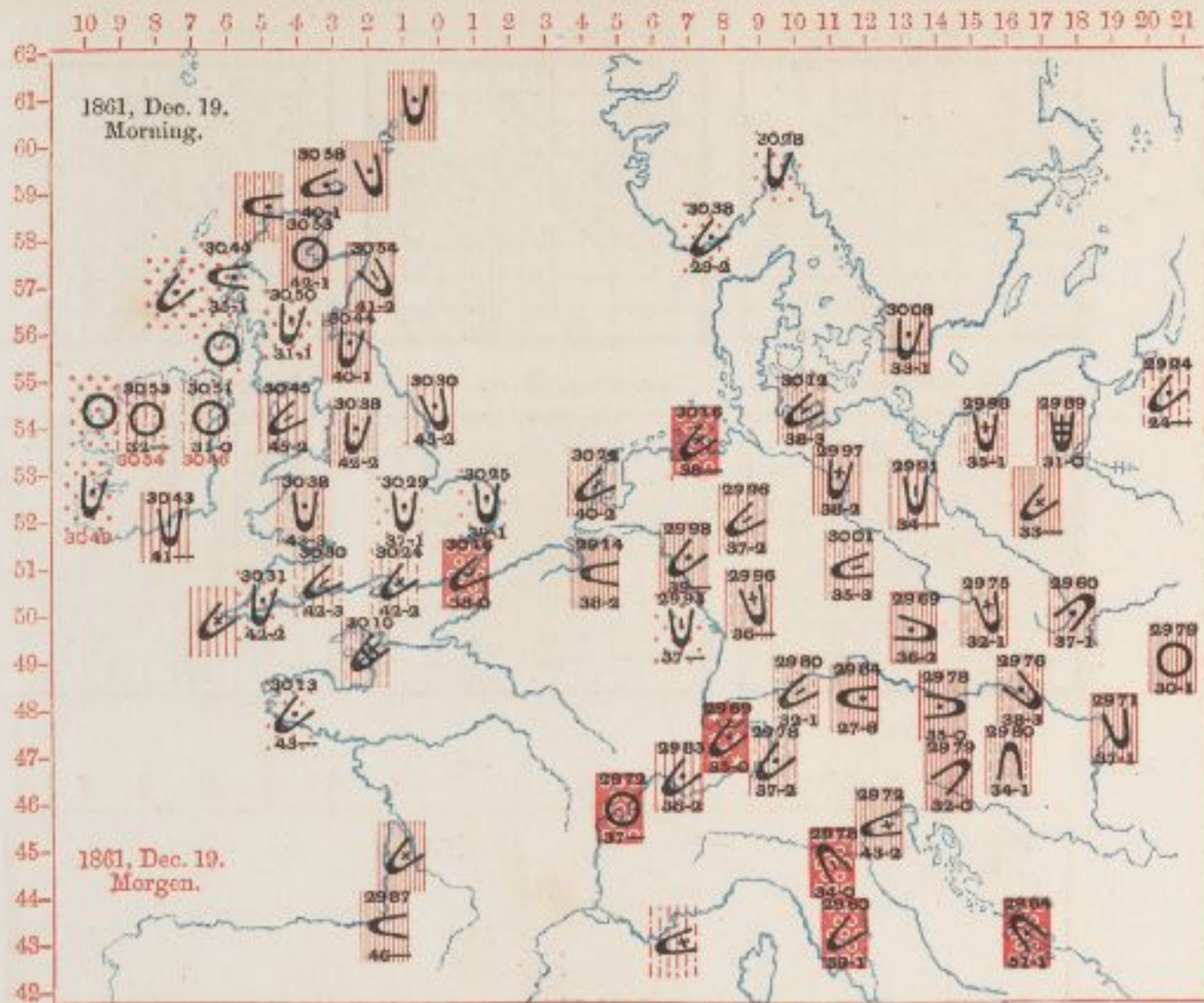


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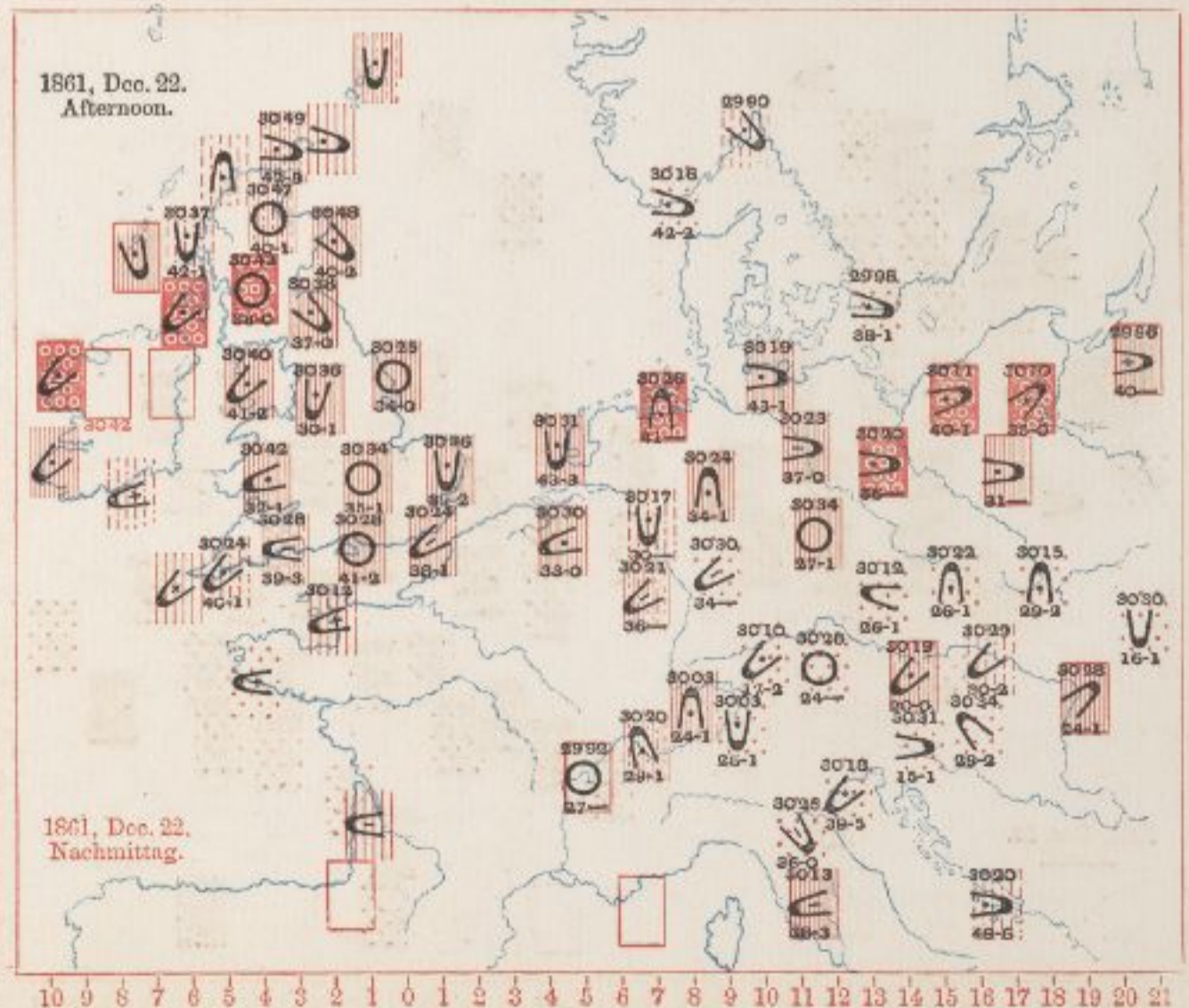
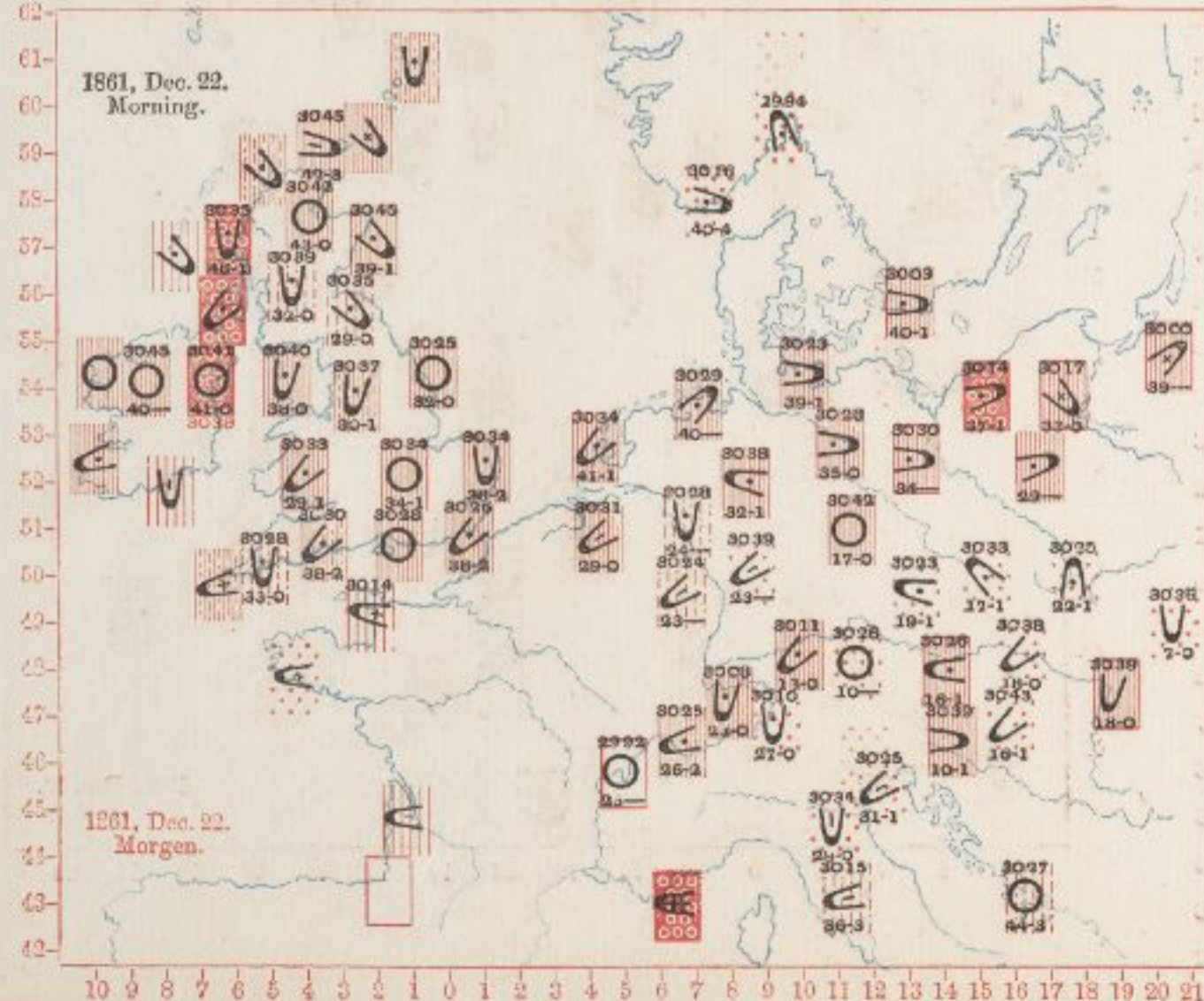
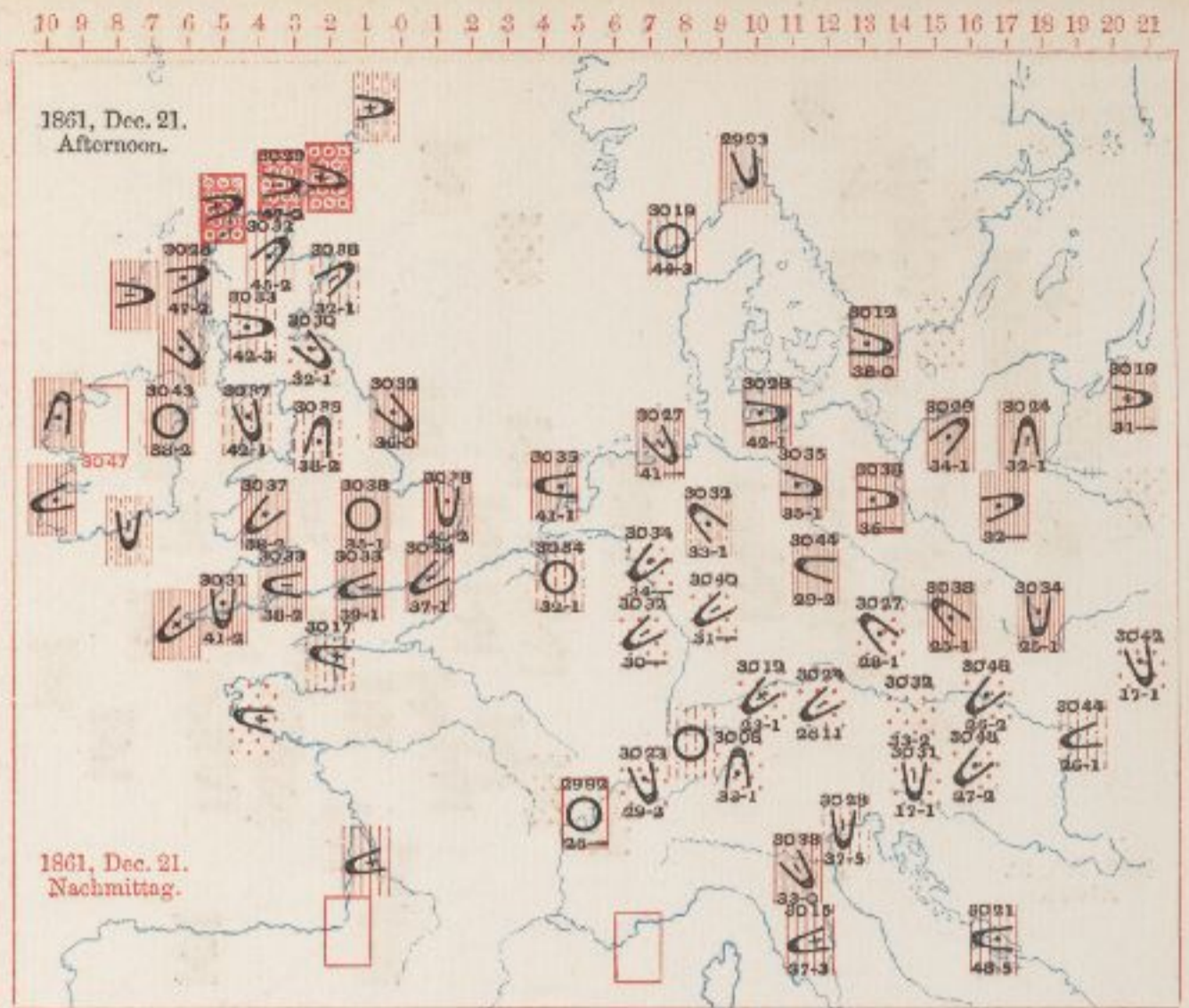
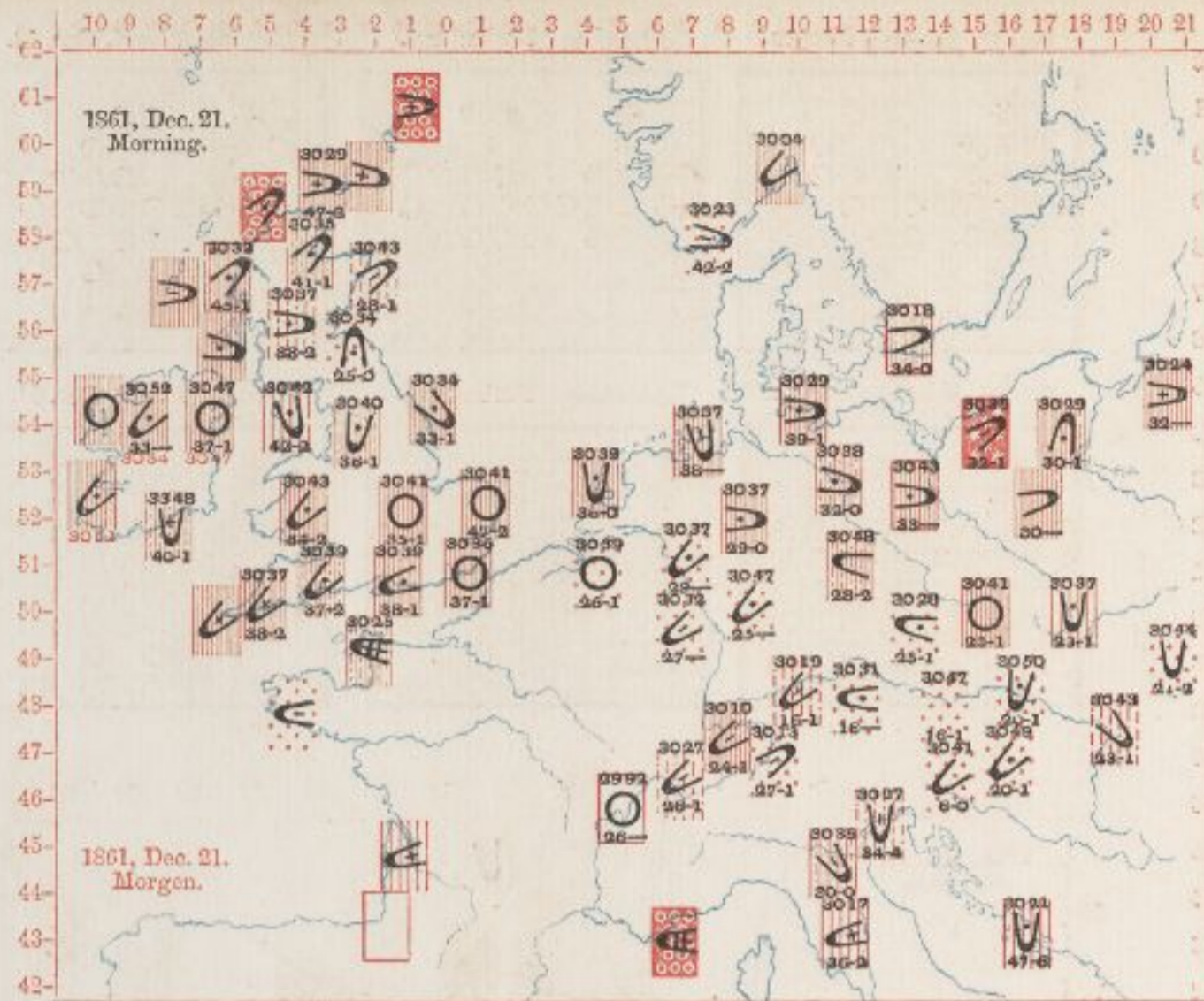


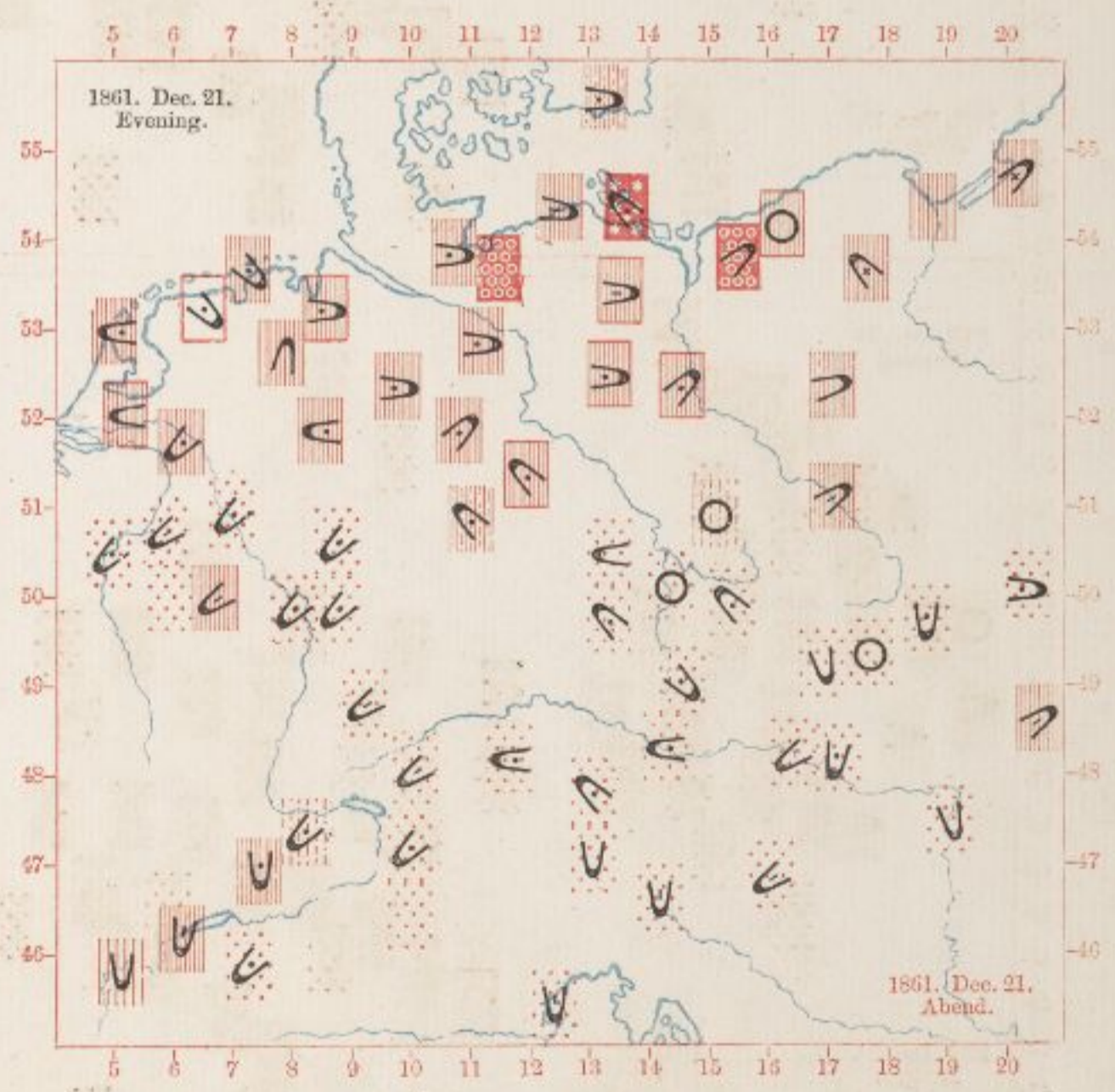
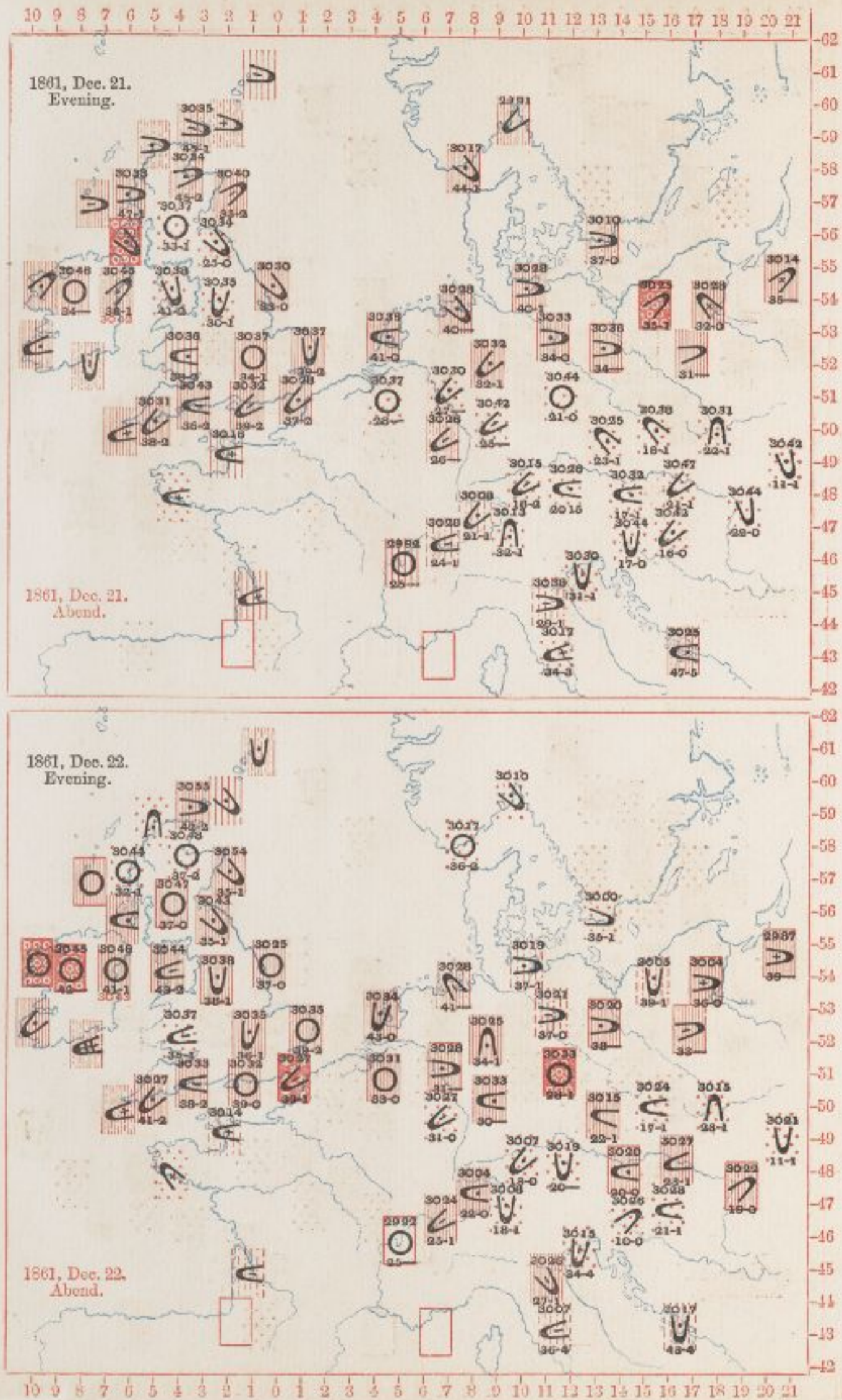
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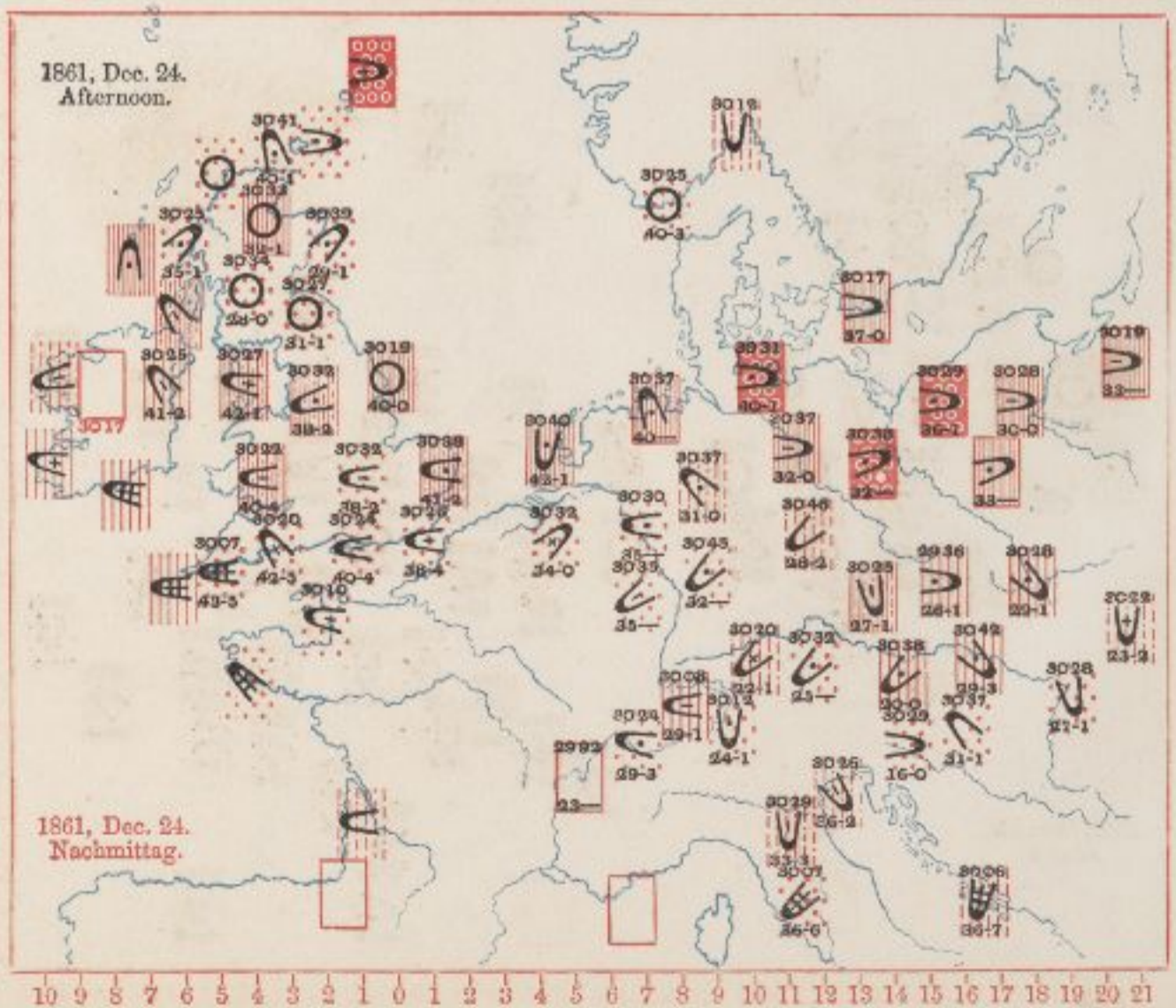
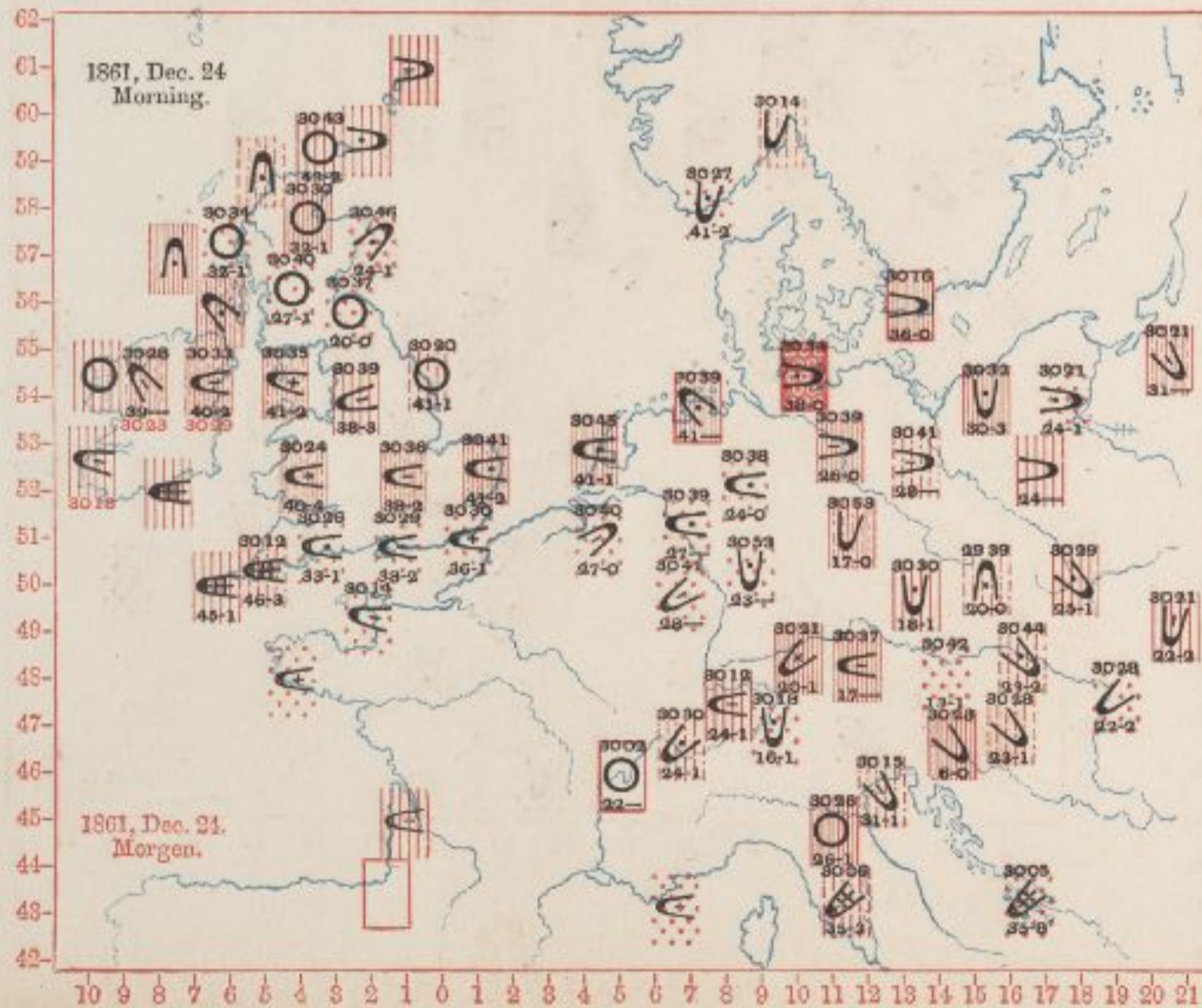
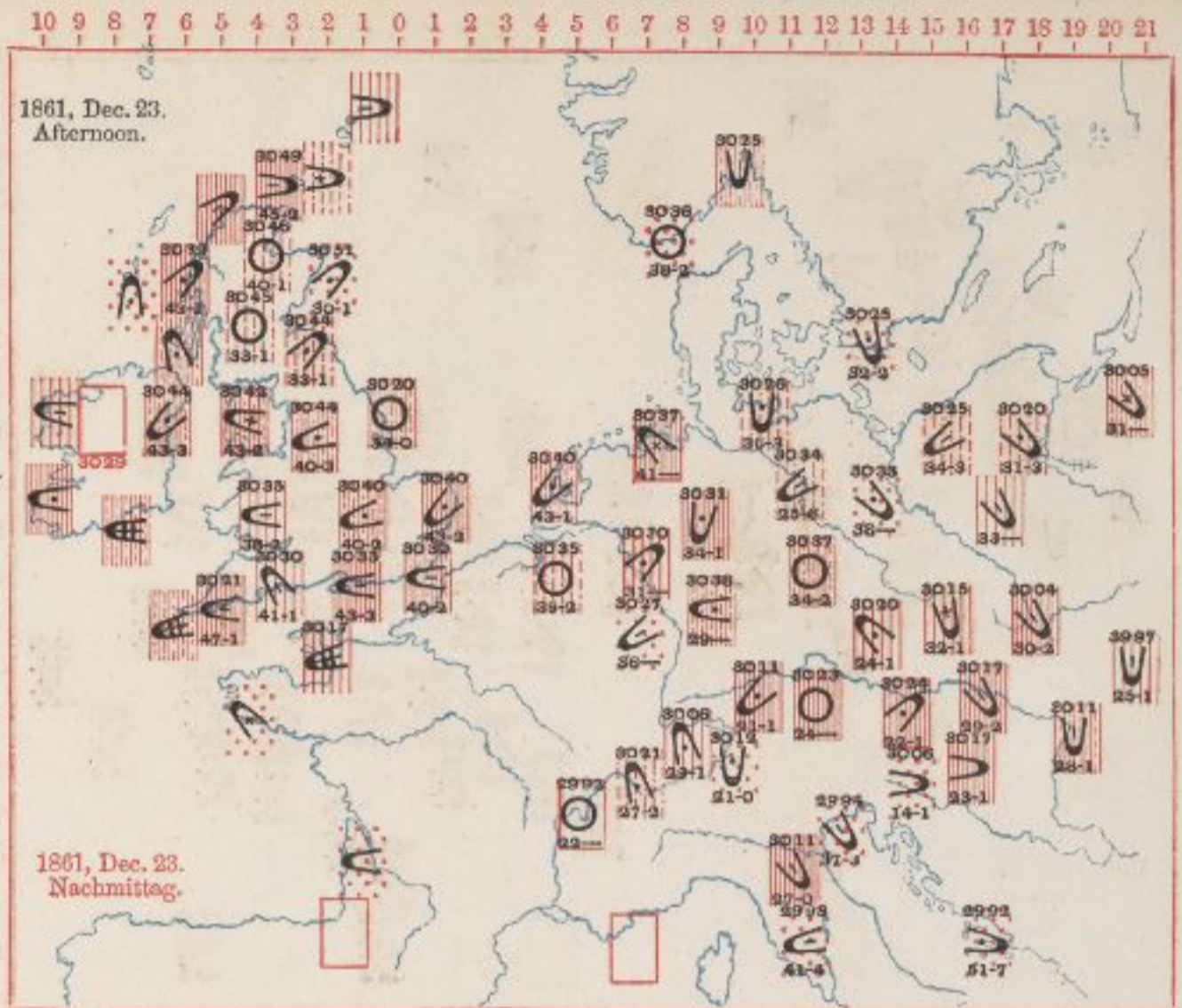
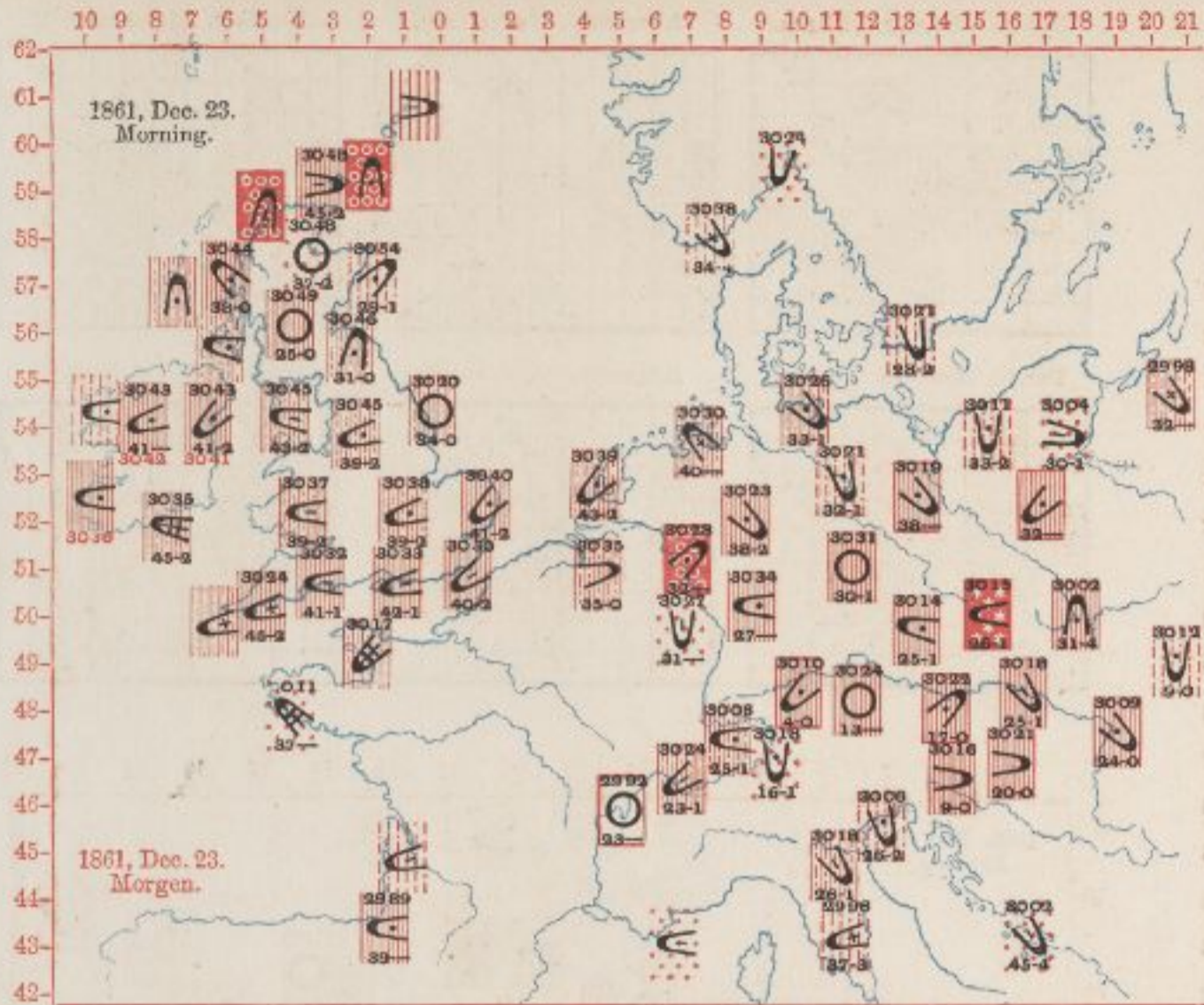
Harvard University - Collection Development Department, Widener Library, HCL / Galton, Francis. Meteorographica, or, Methods of mapping the weather :illustrated by upwards of 600 printed and lithographed diagrams referring to the weather of a large part of Europe, during the month of December 1861. London ; Cambridge : Macmillan, 1863.



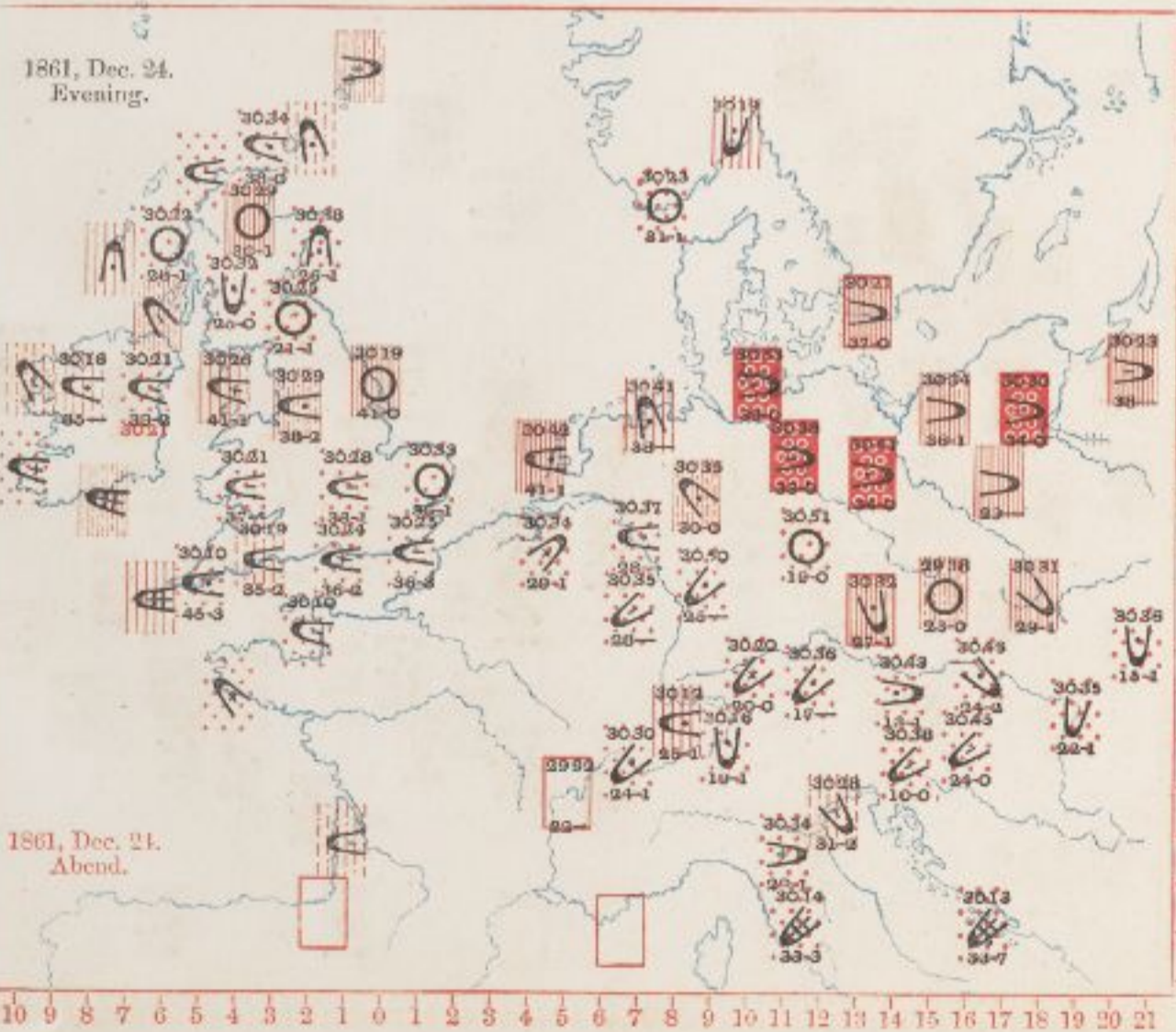
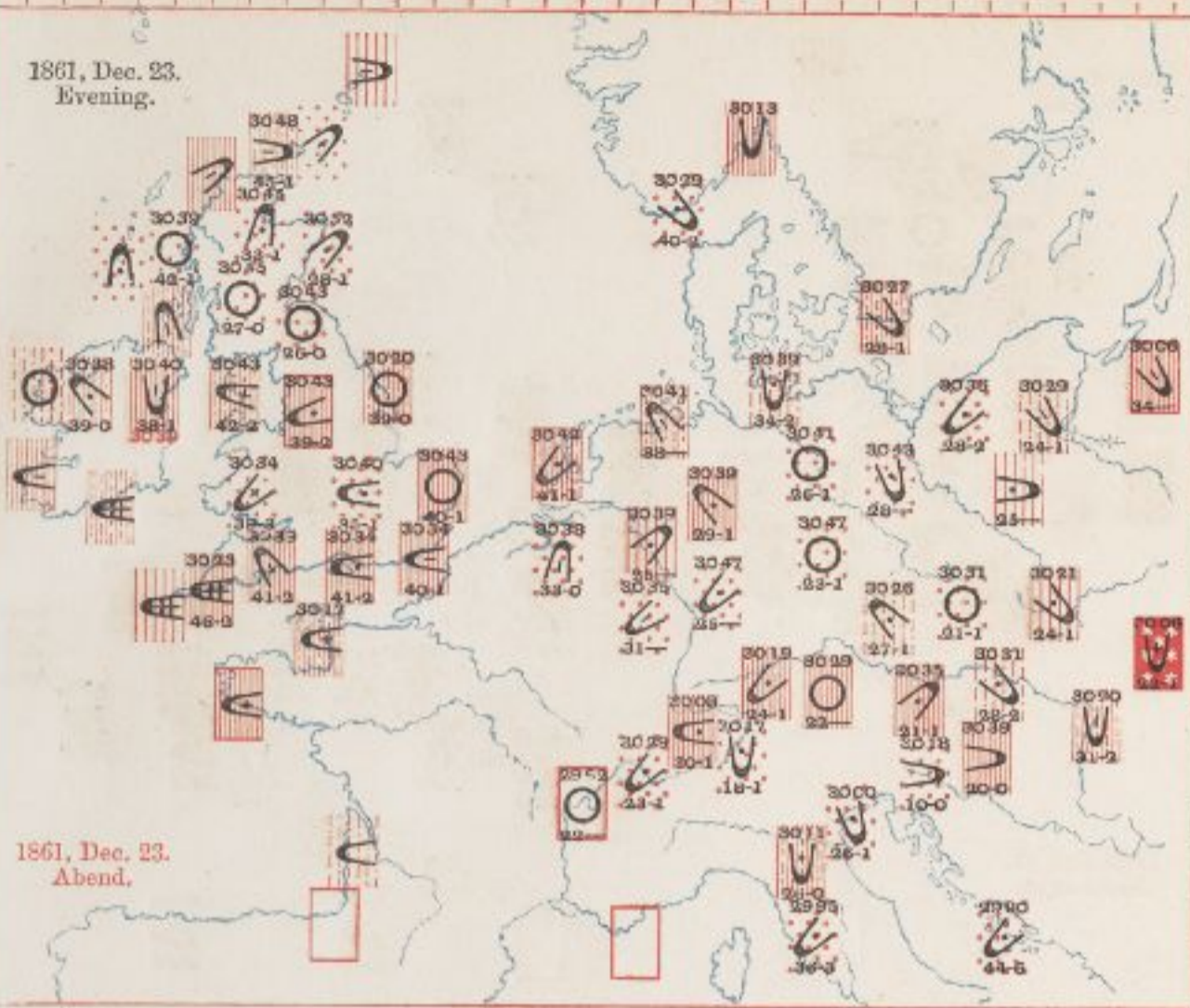






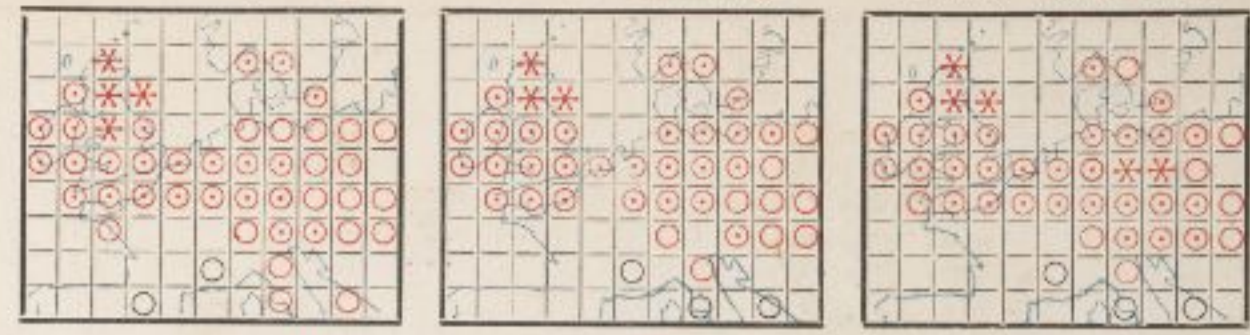


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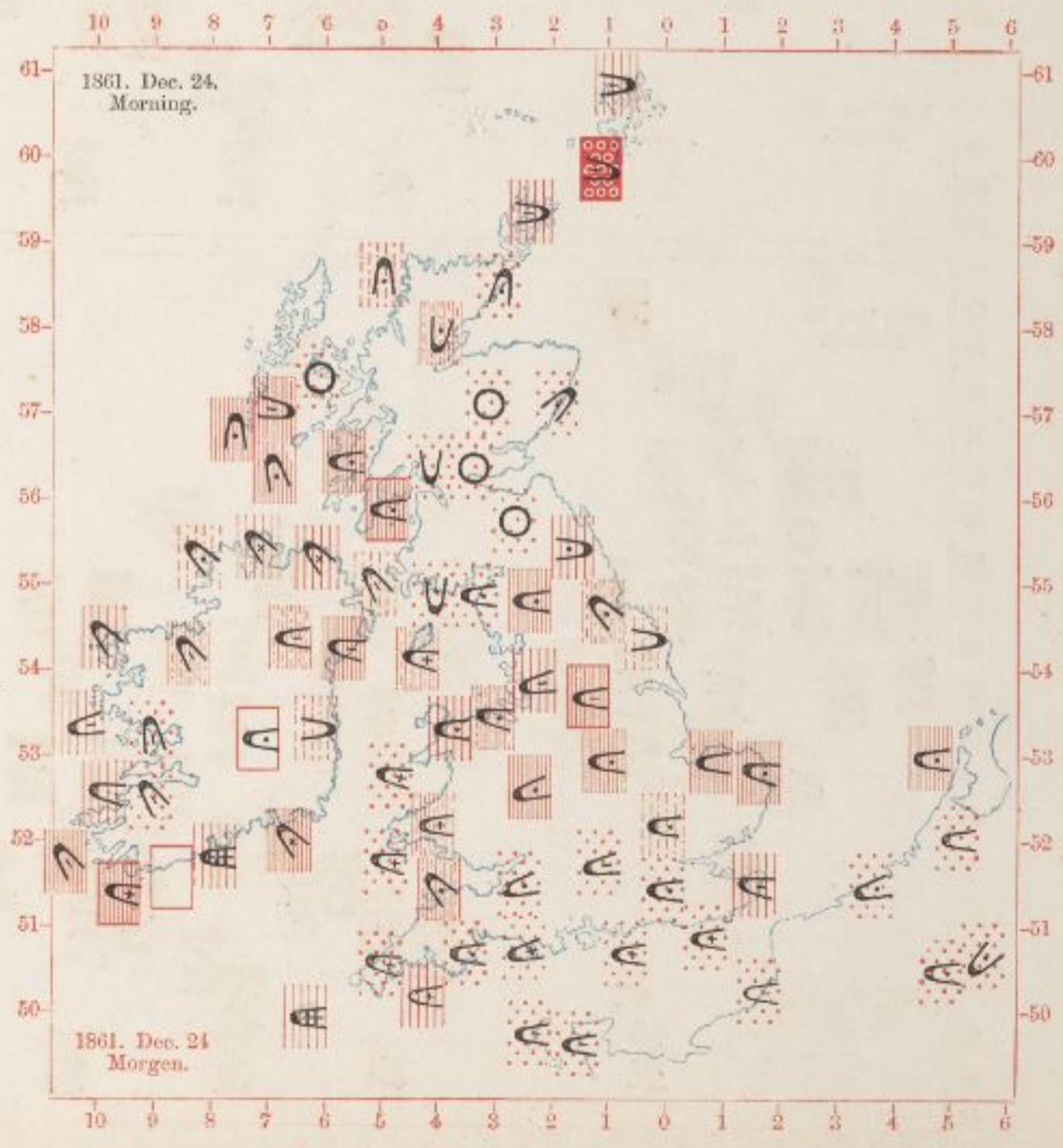


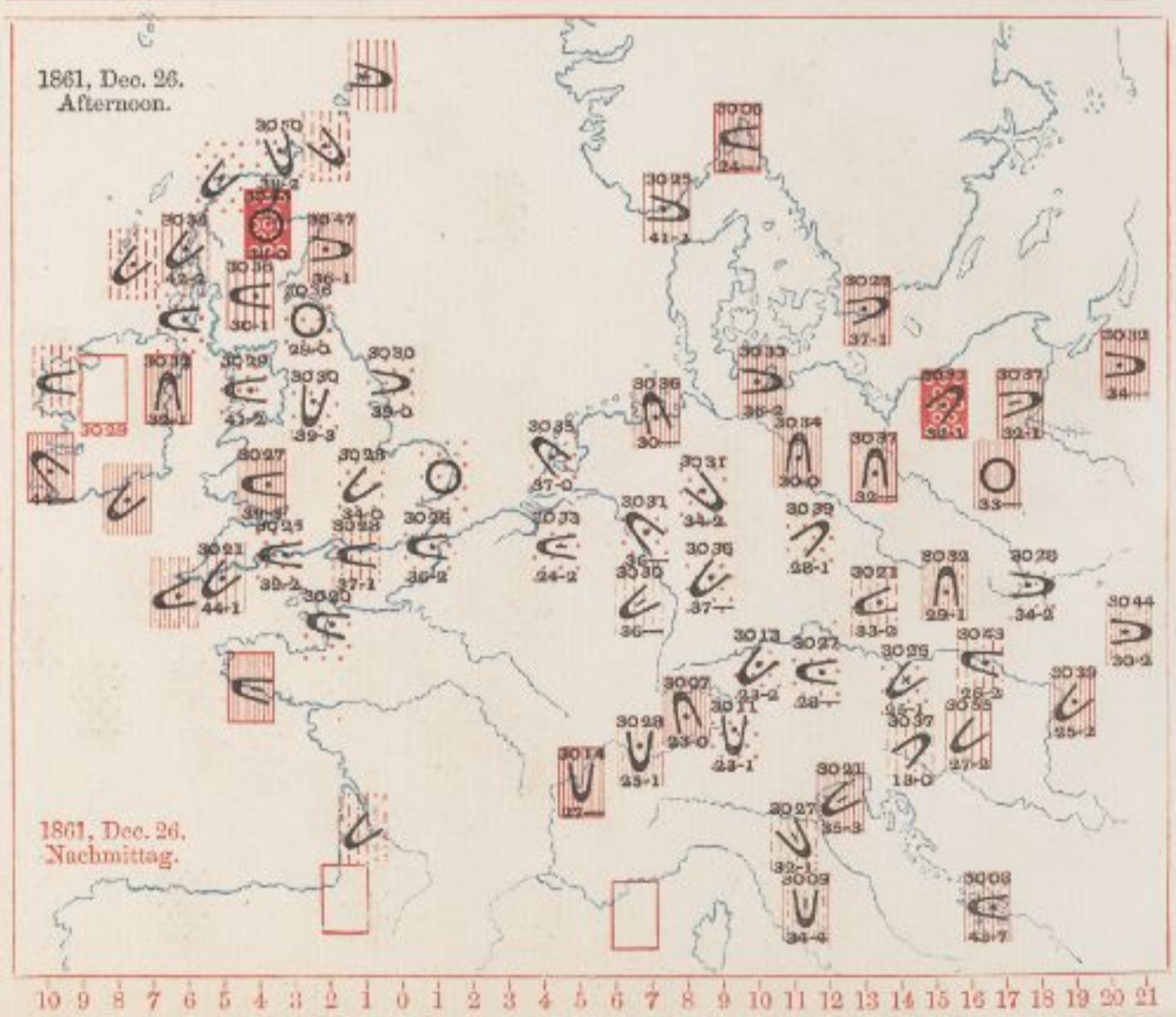
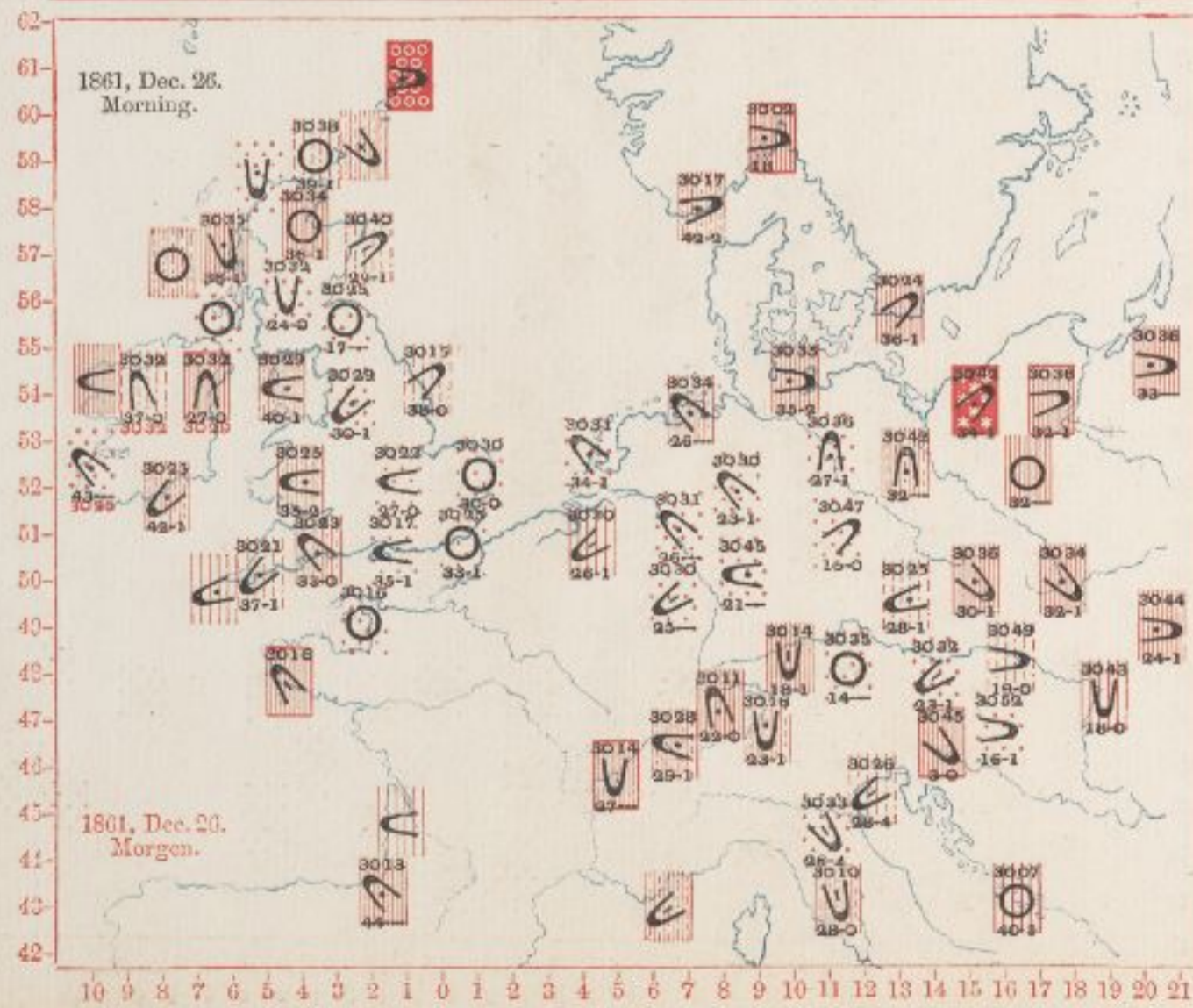
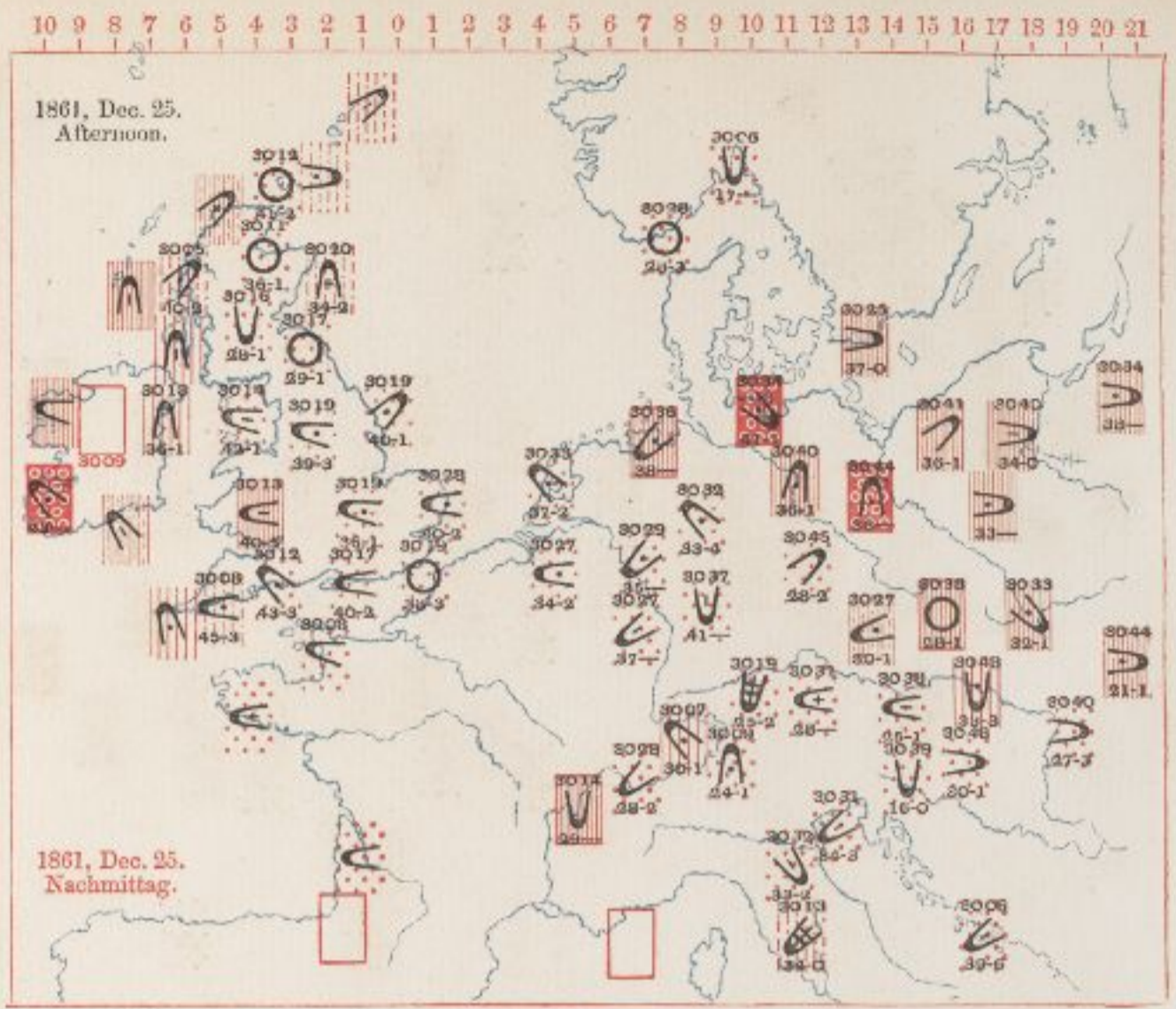
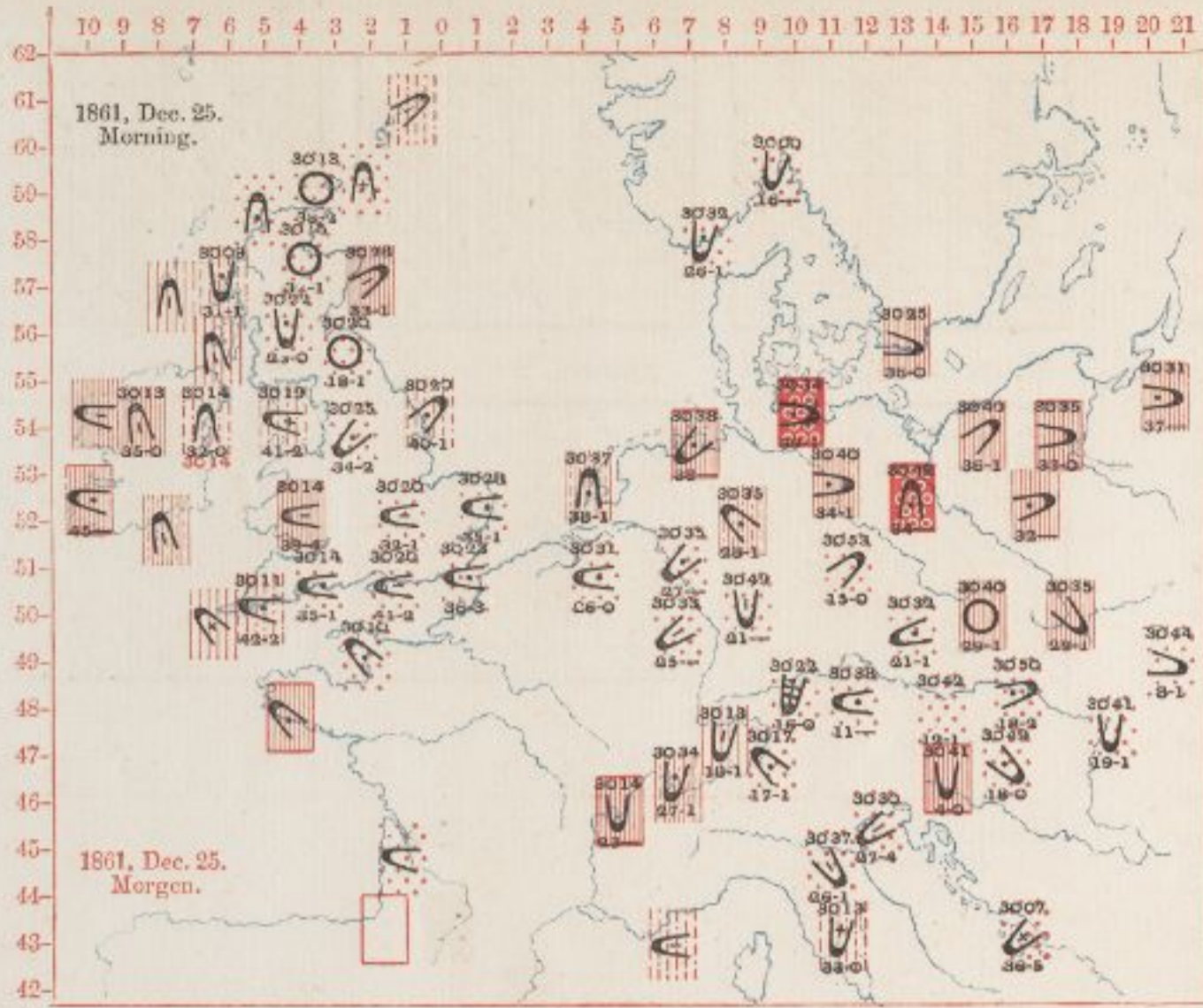
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Dec. 23. Morning. Morgen. Afternoon. Nachmittag. Evening. Abend. Dec. 23.

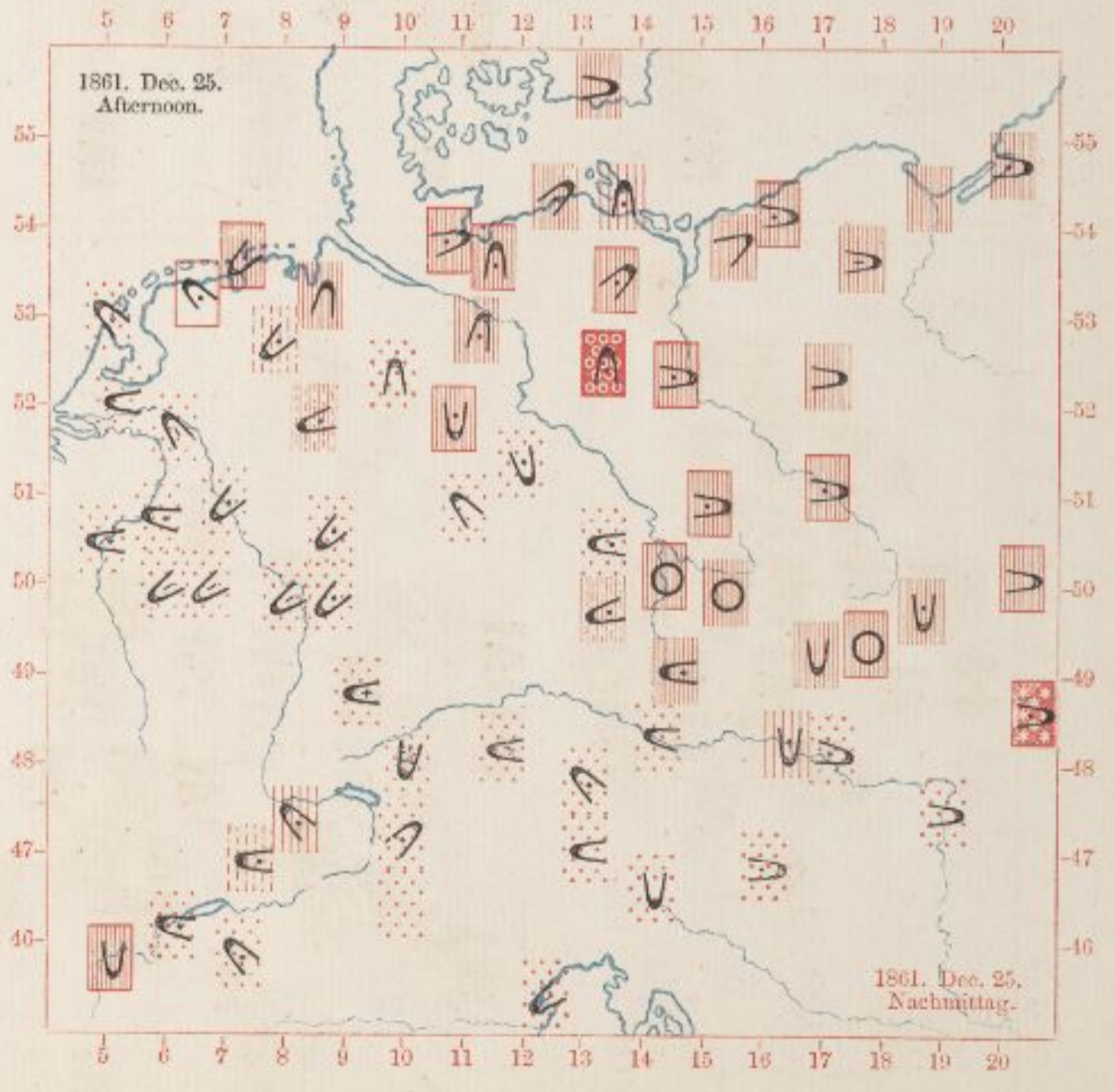
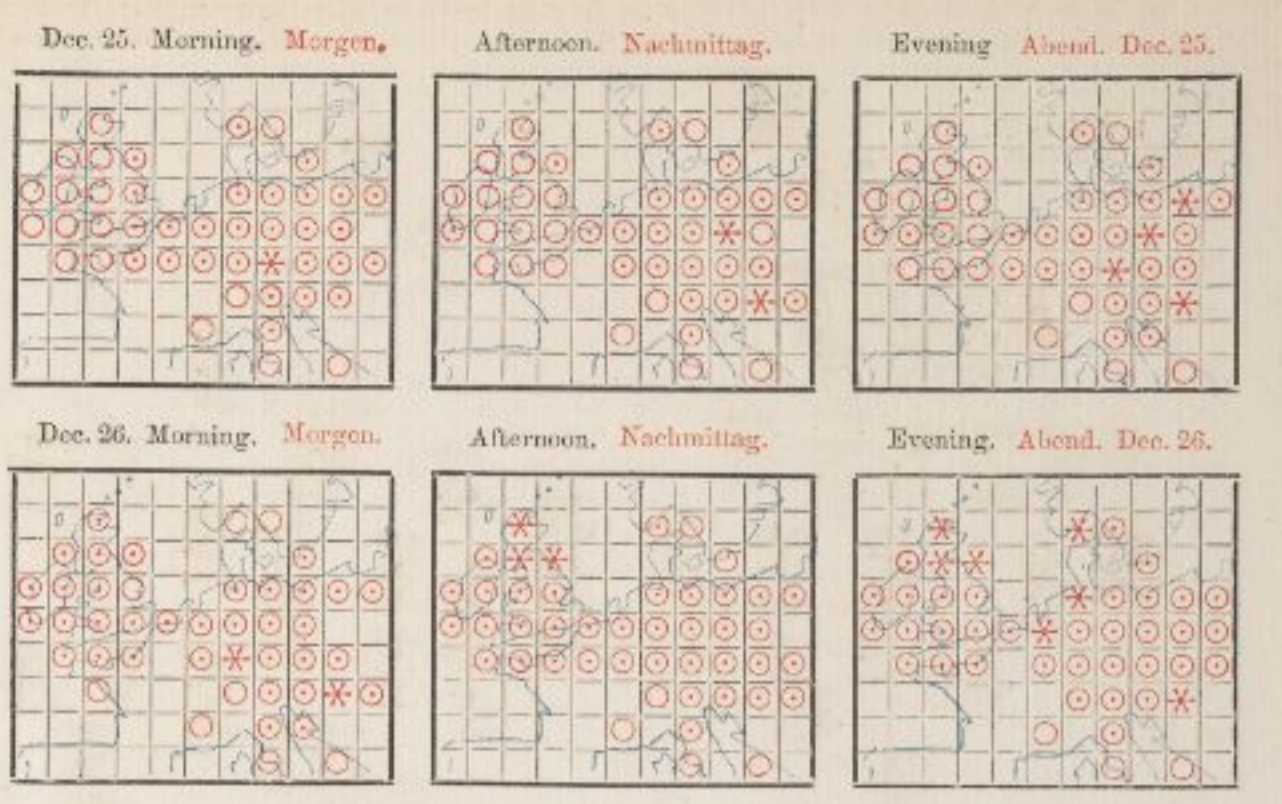
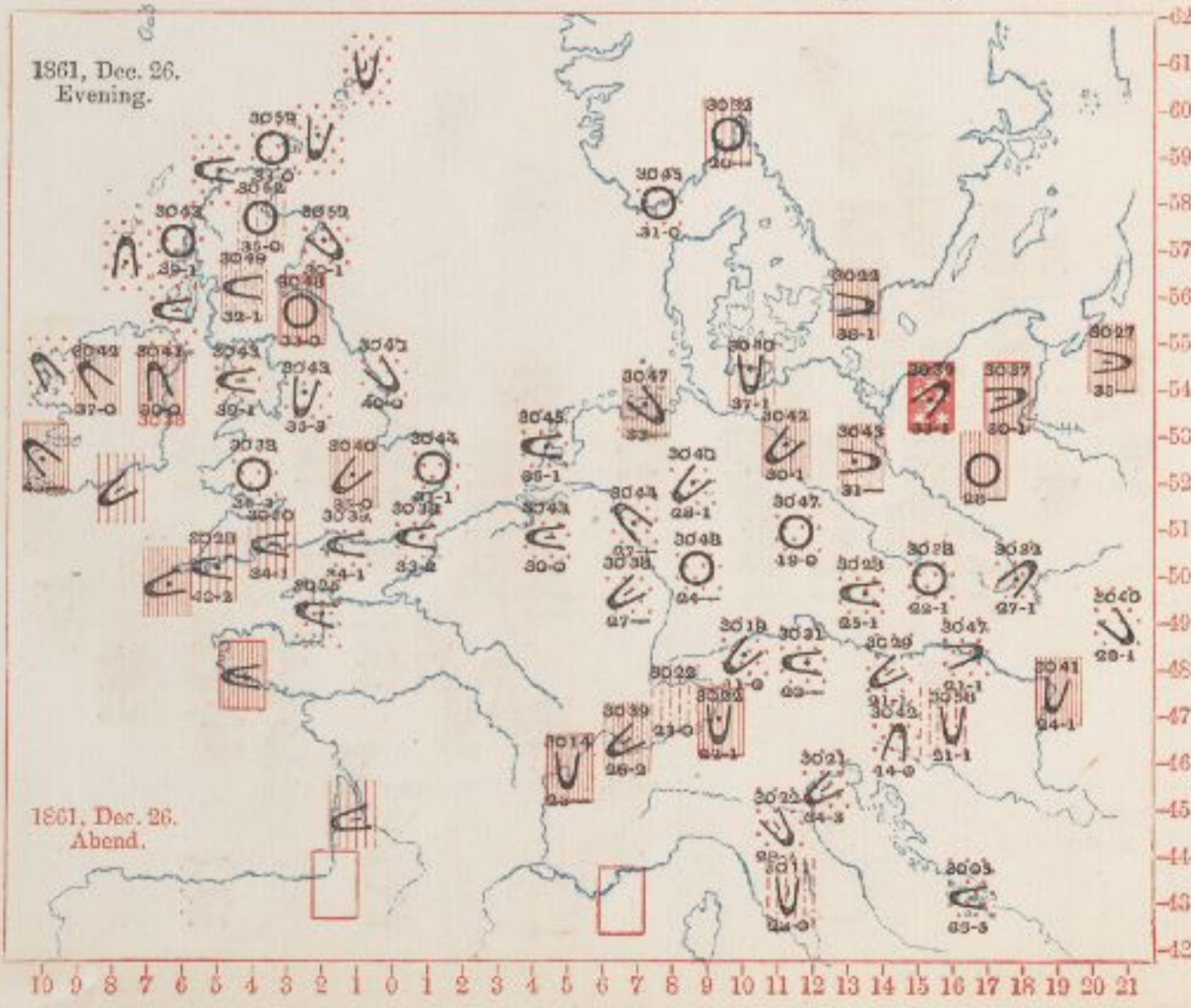
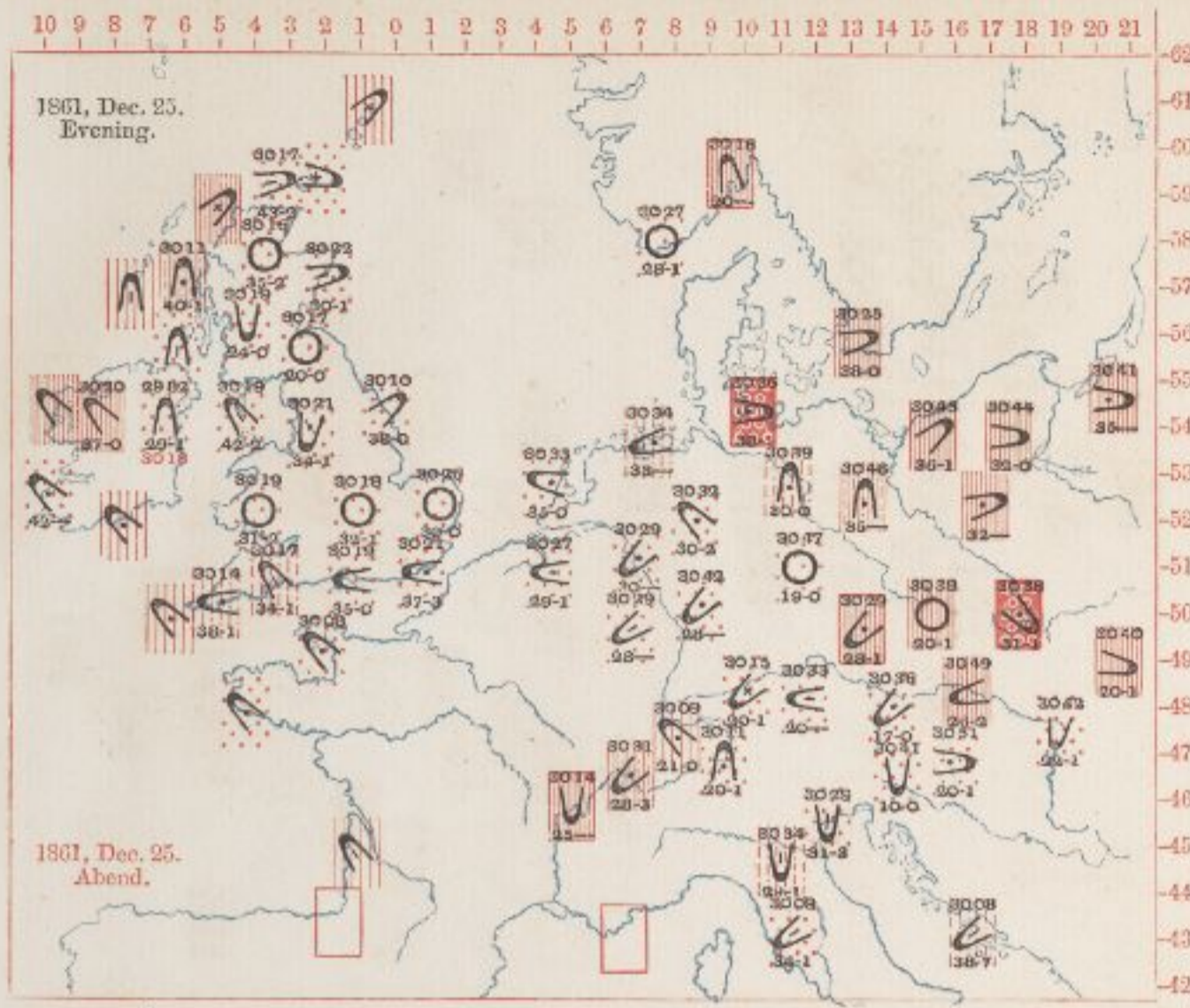


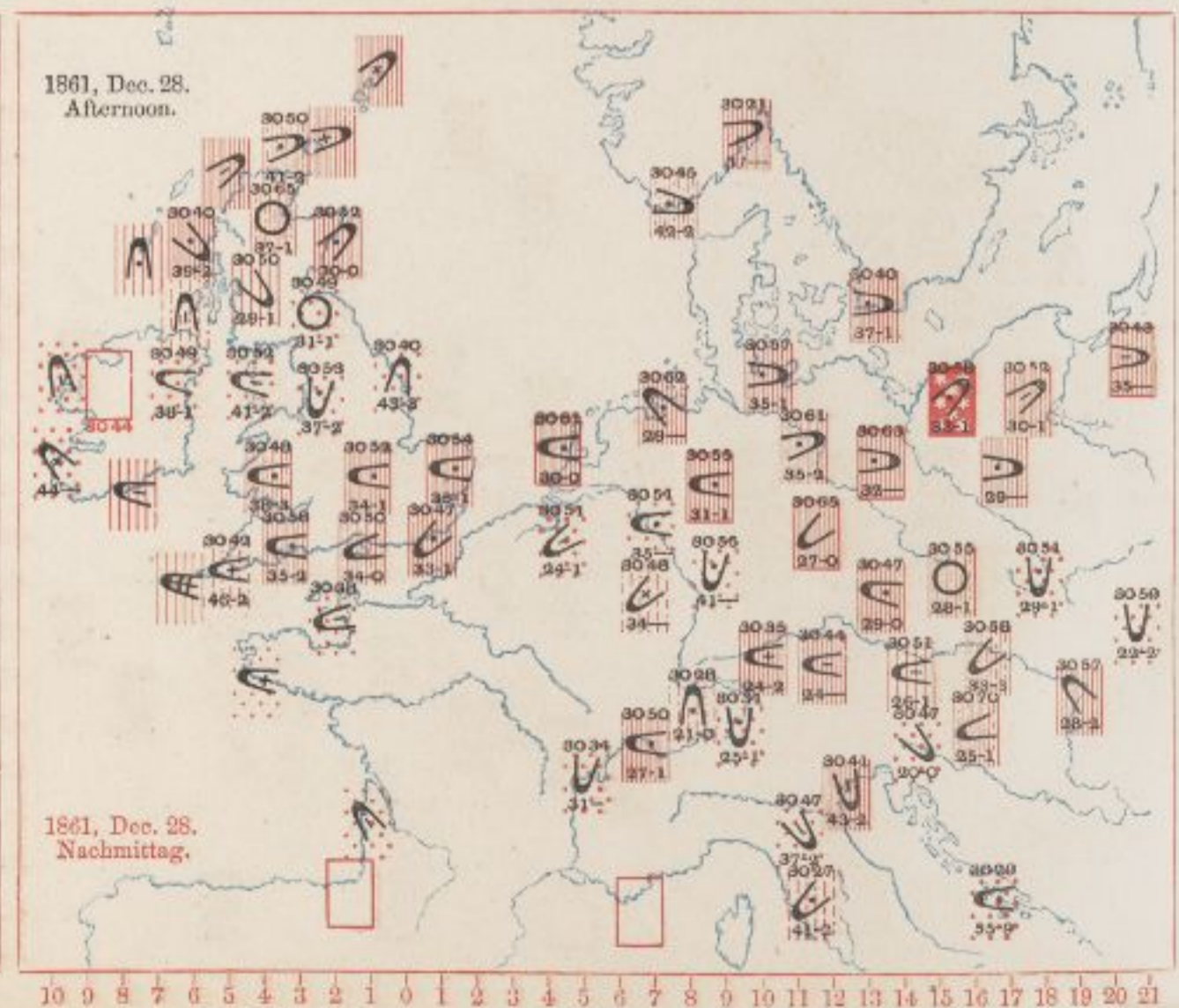
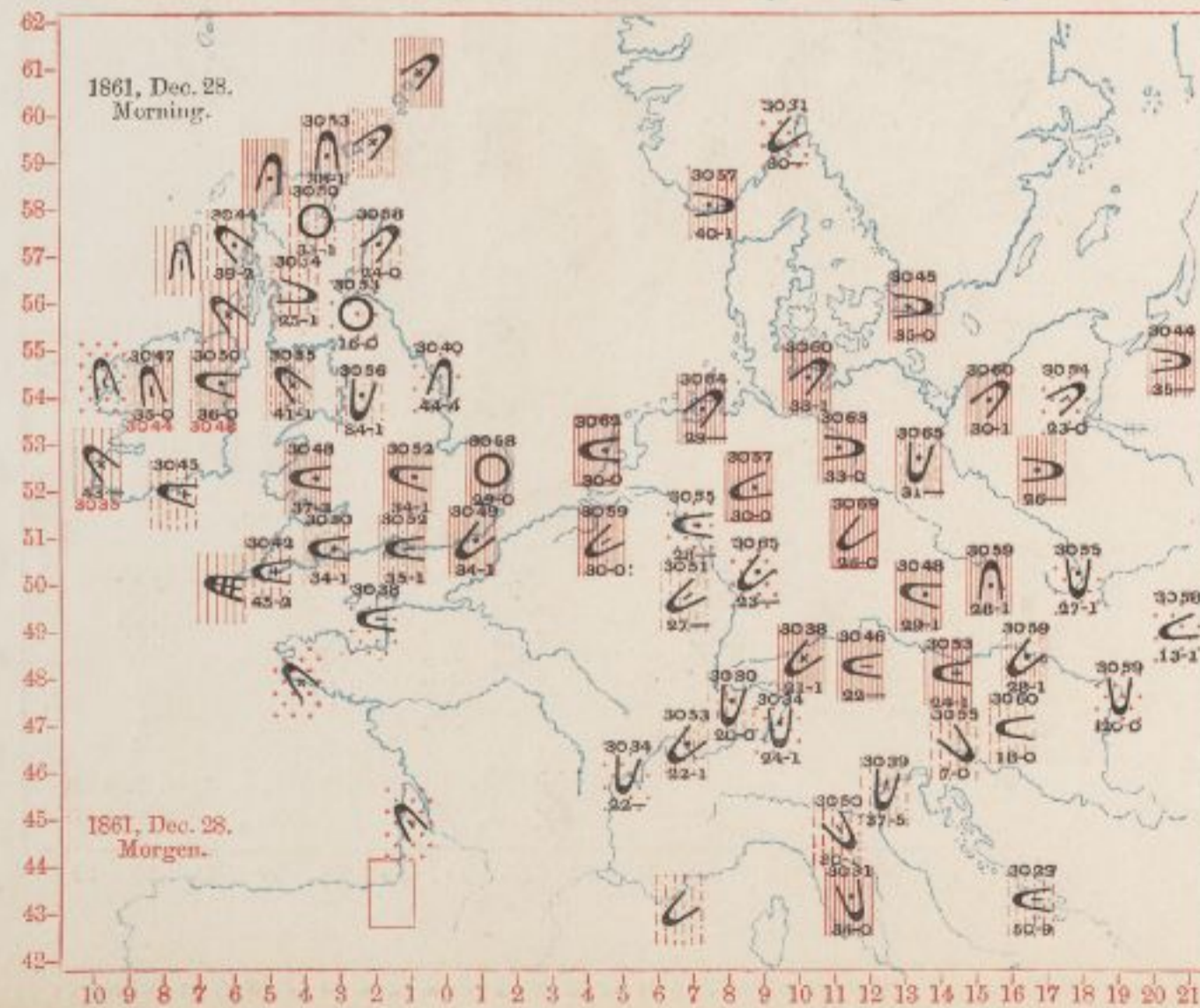
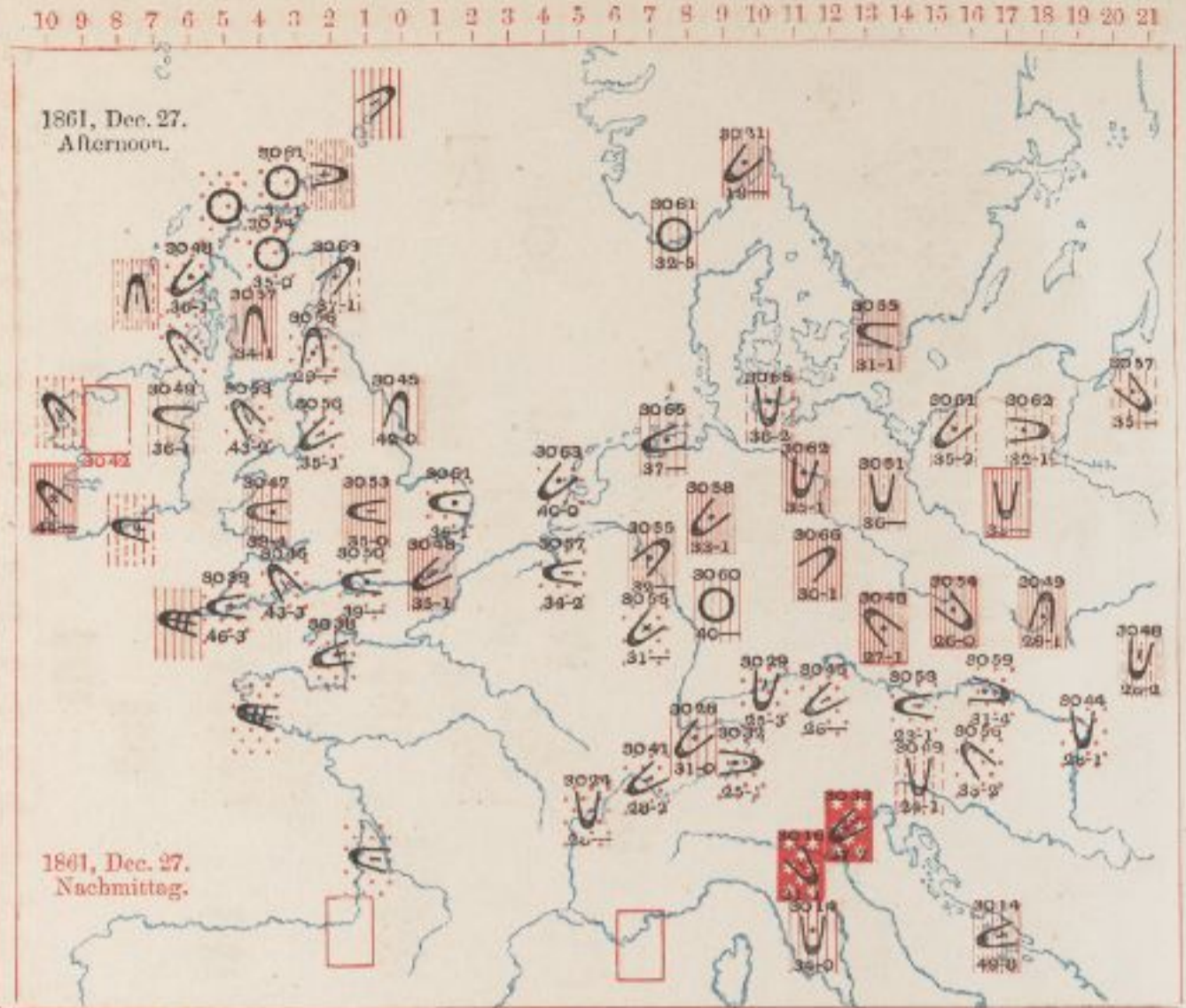
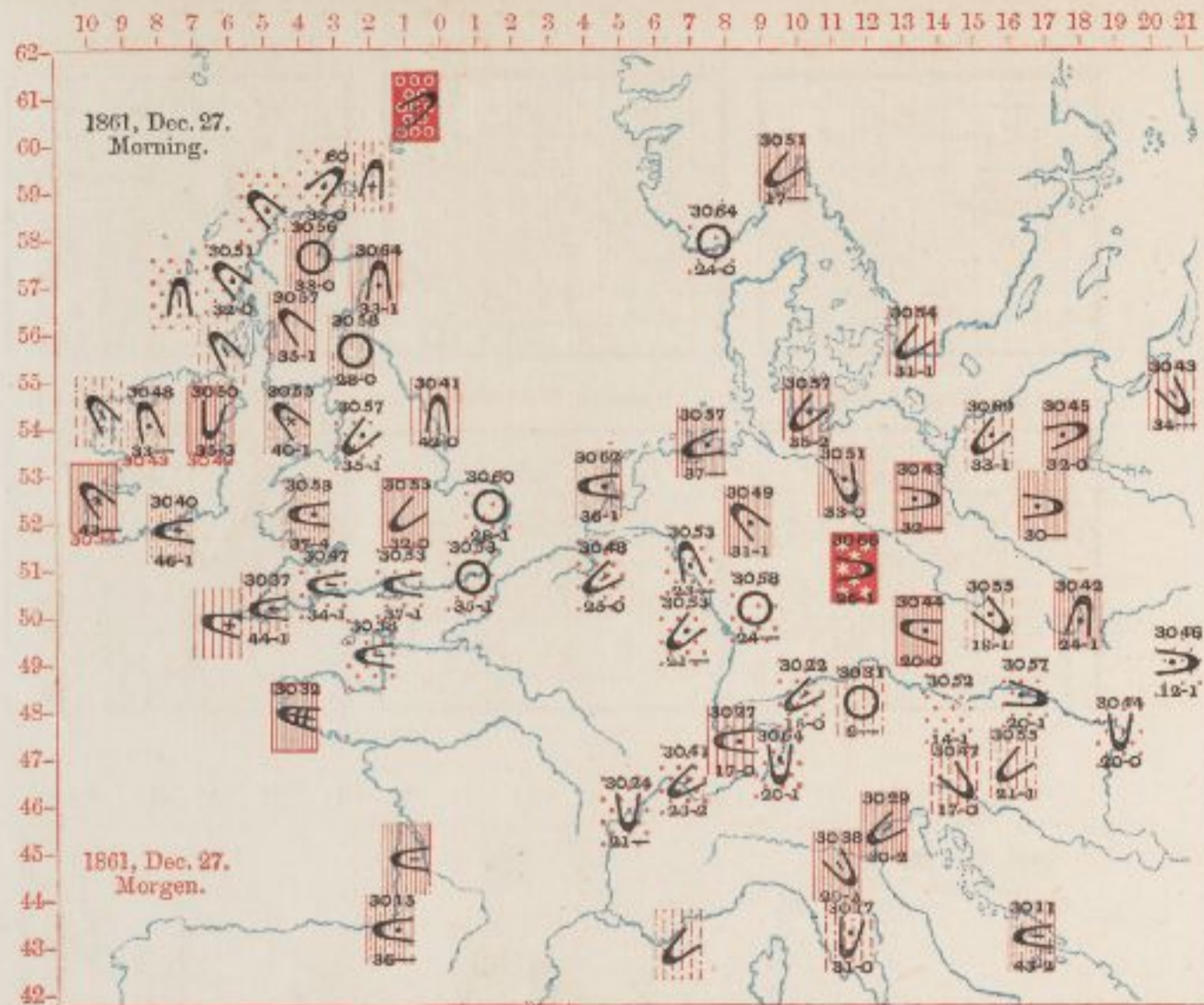
Dec. 24. Morning. Morgen. Afternoon. Nachmittag. Evening. Abend. Dec. 24.

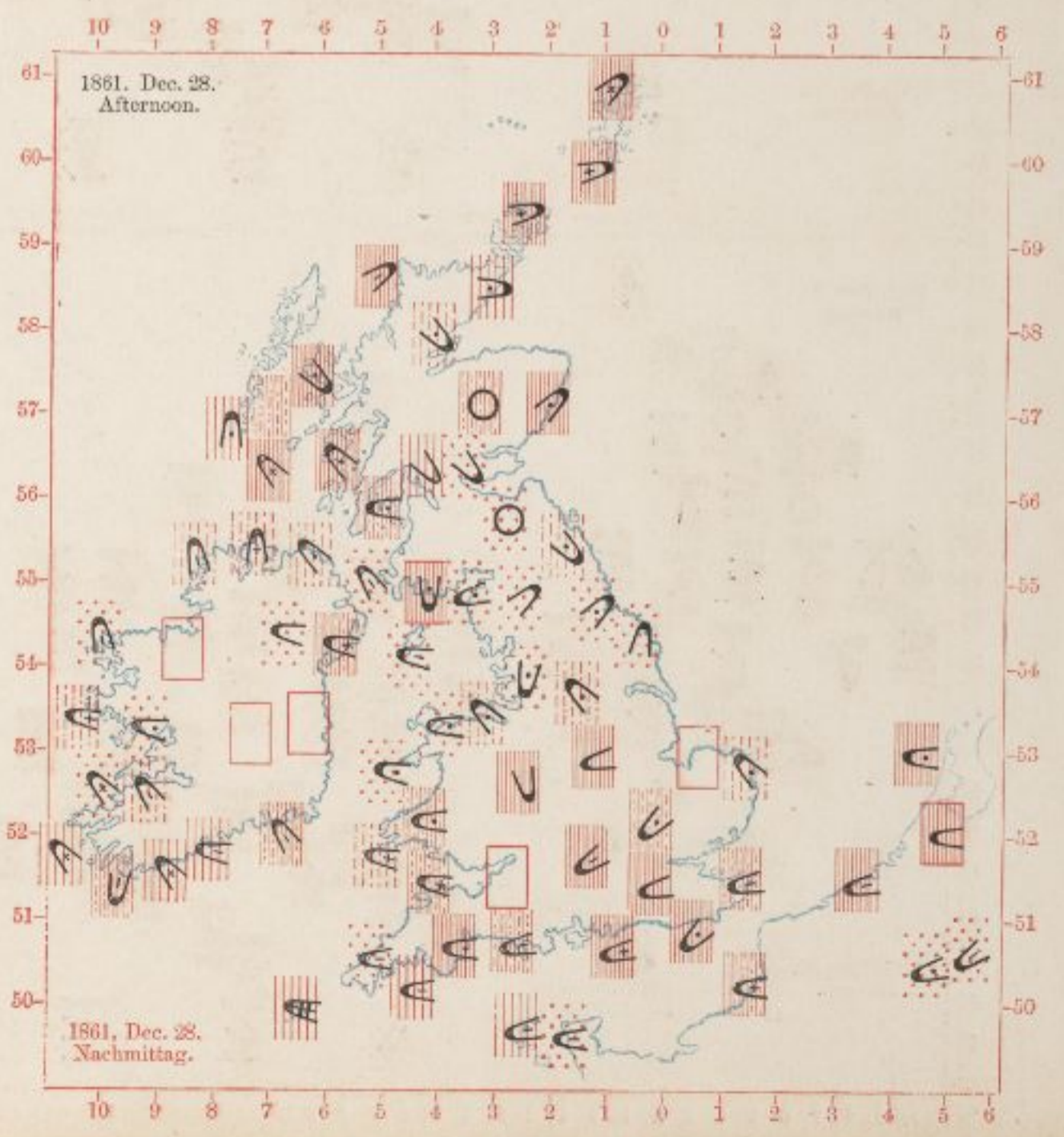
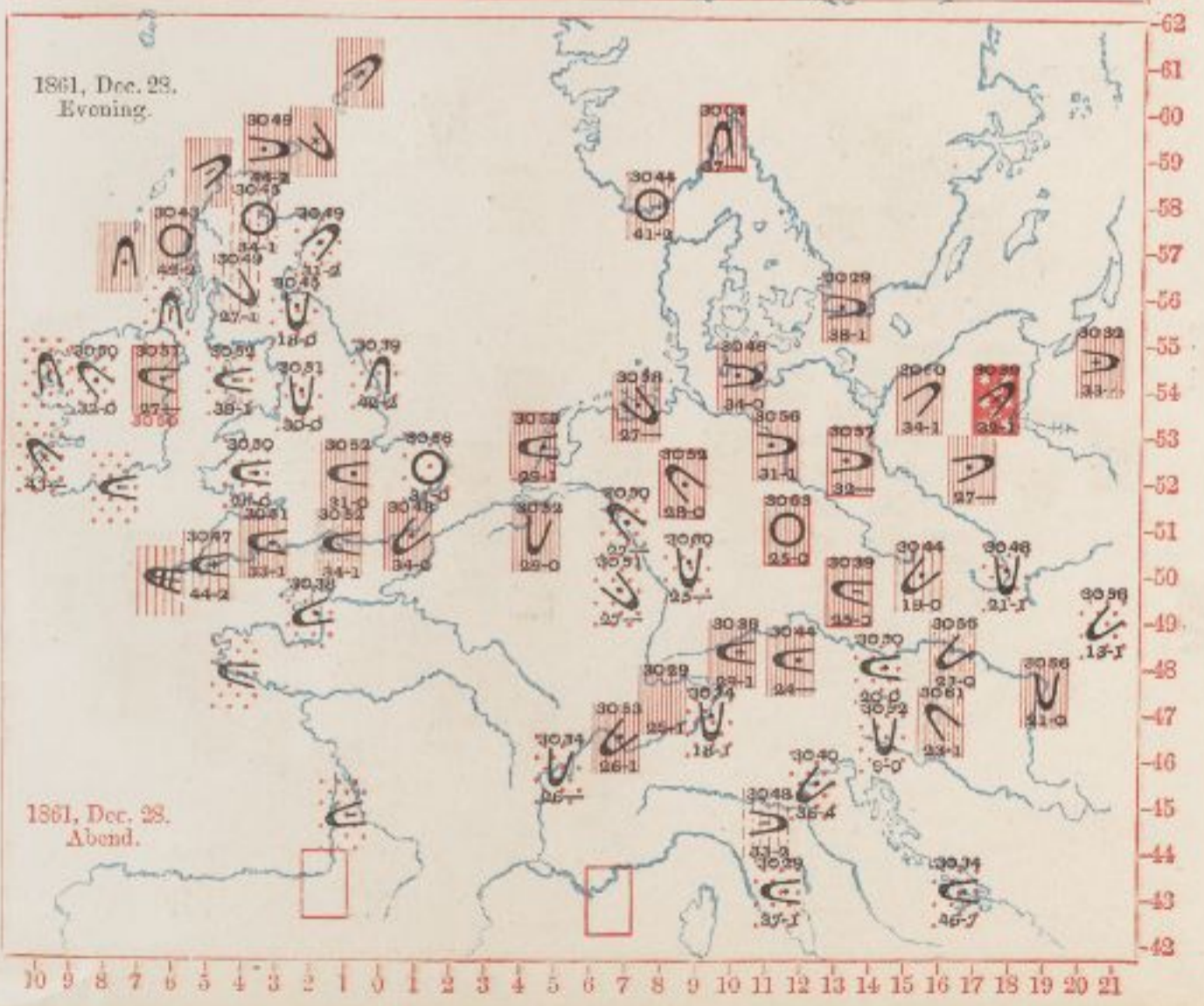
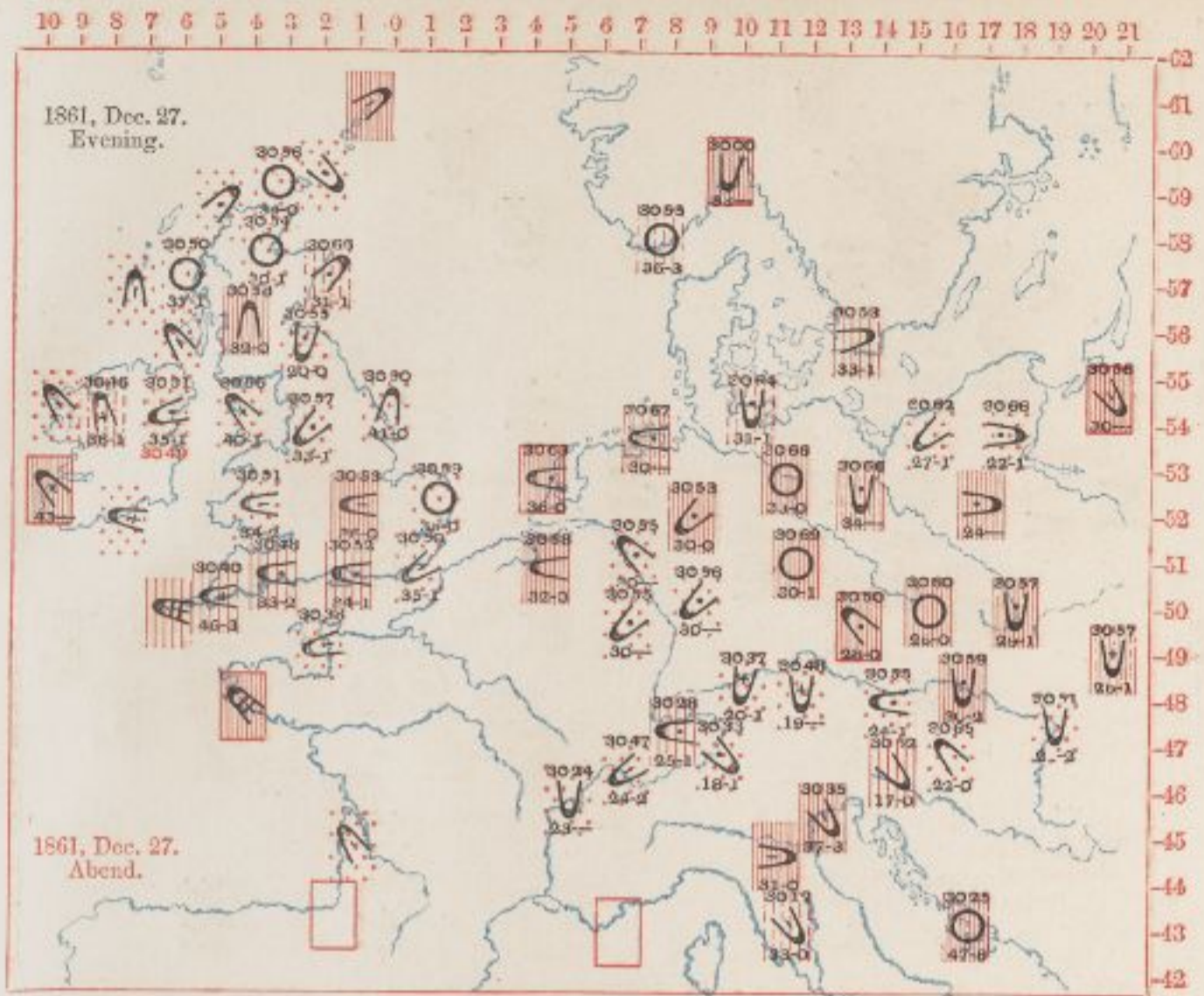


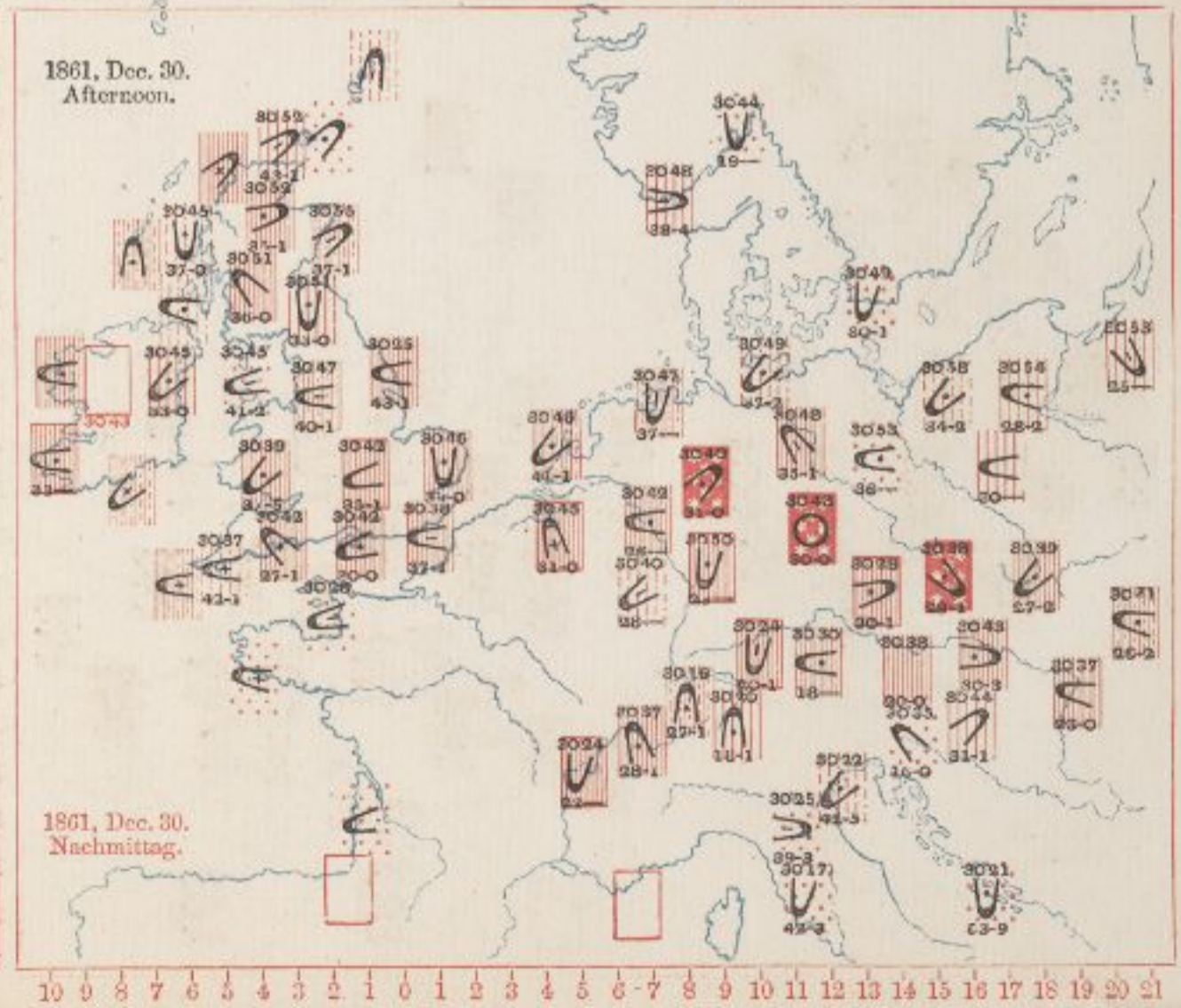
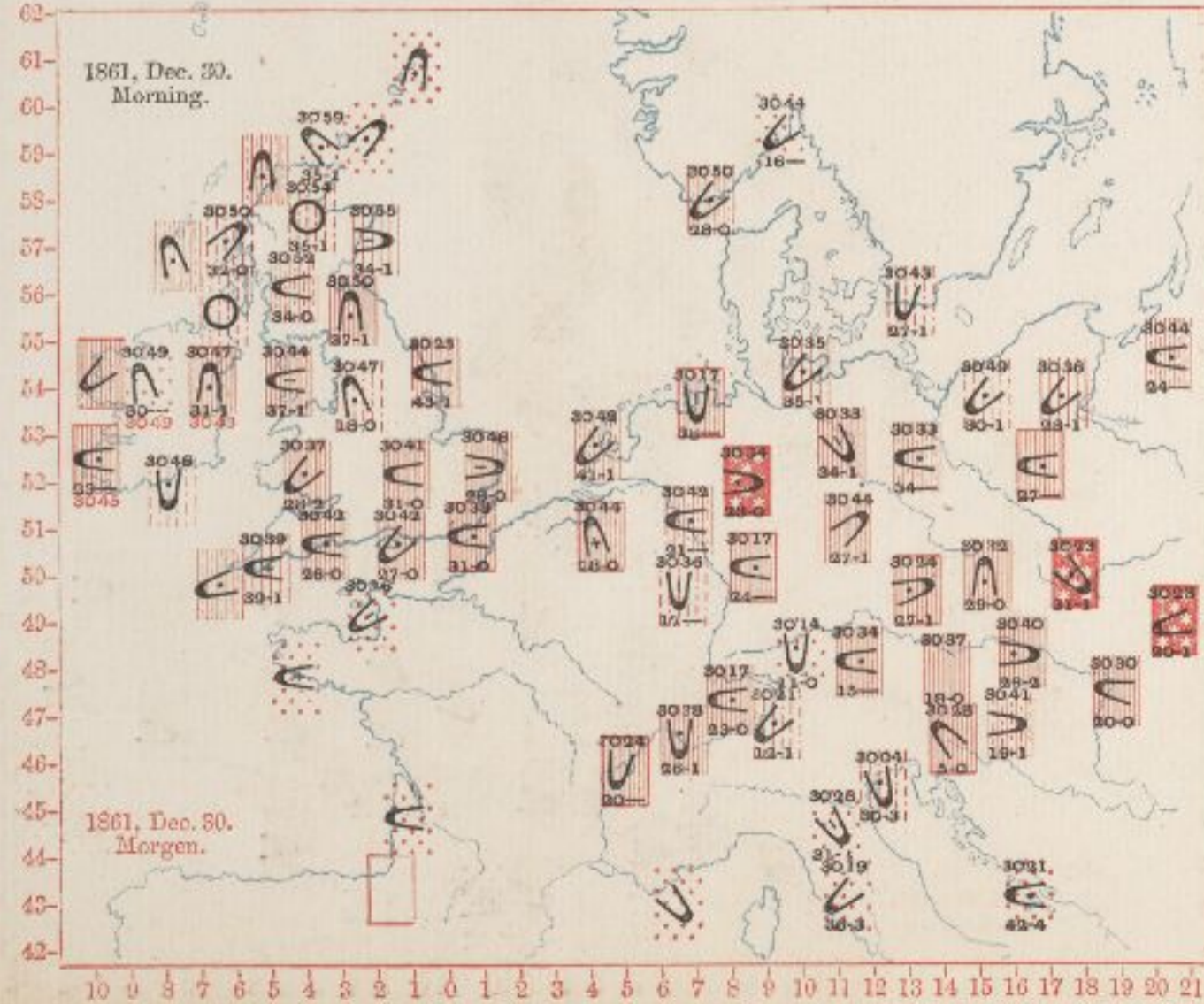
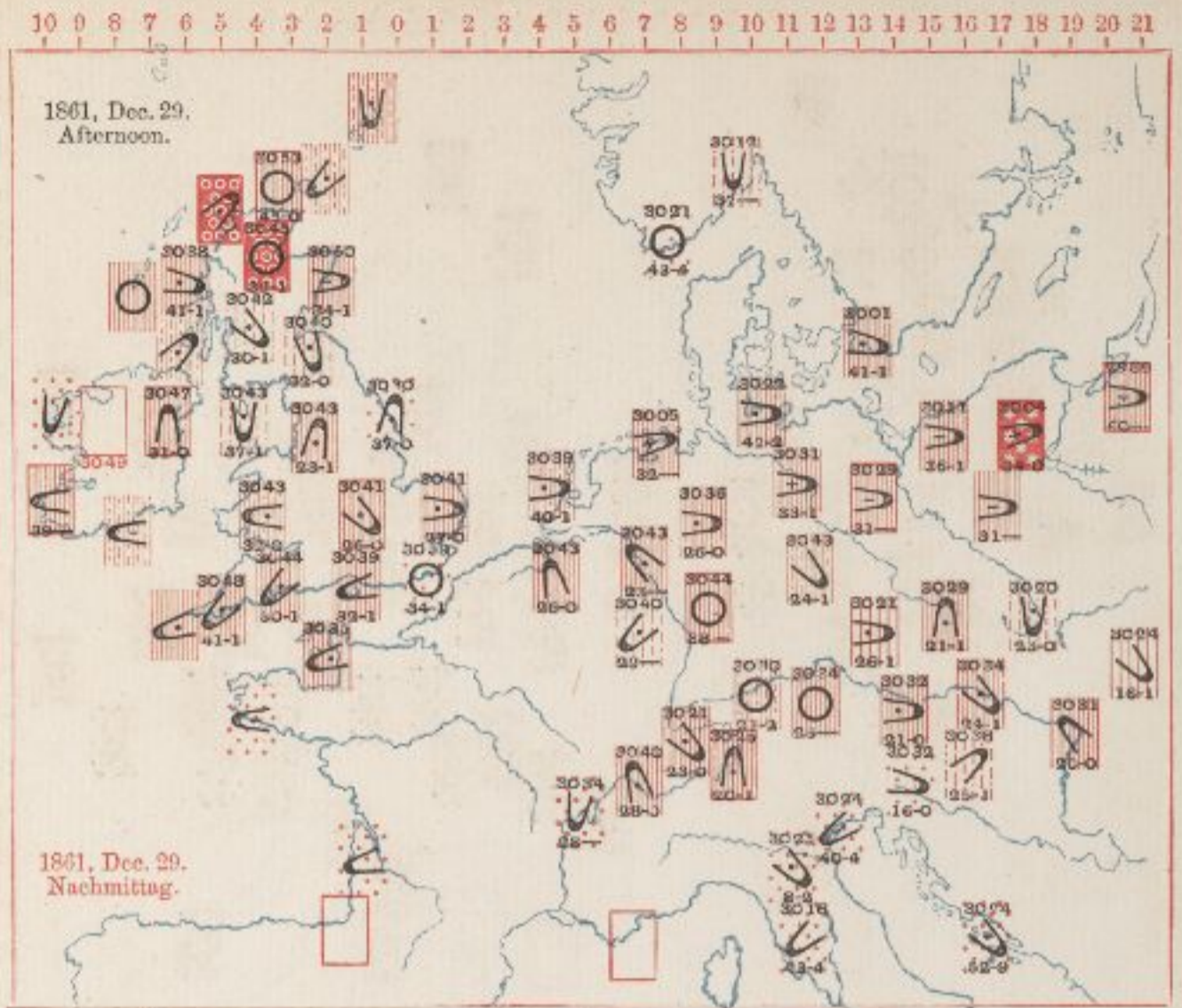
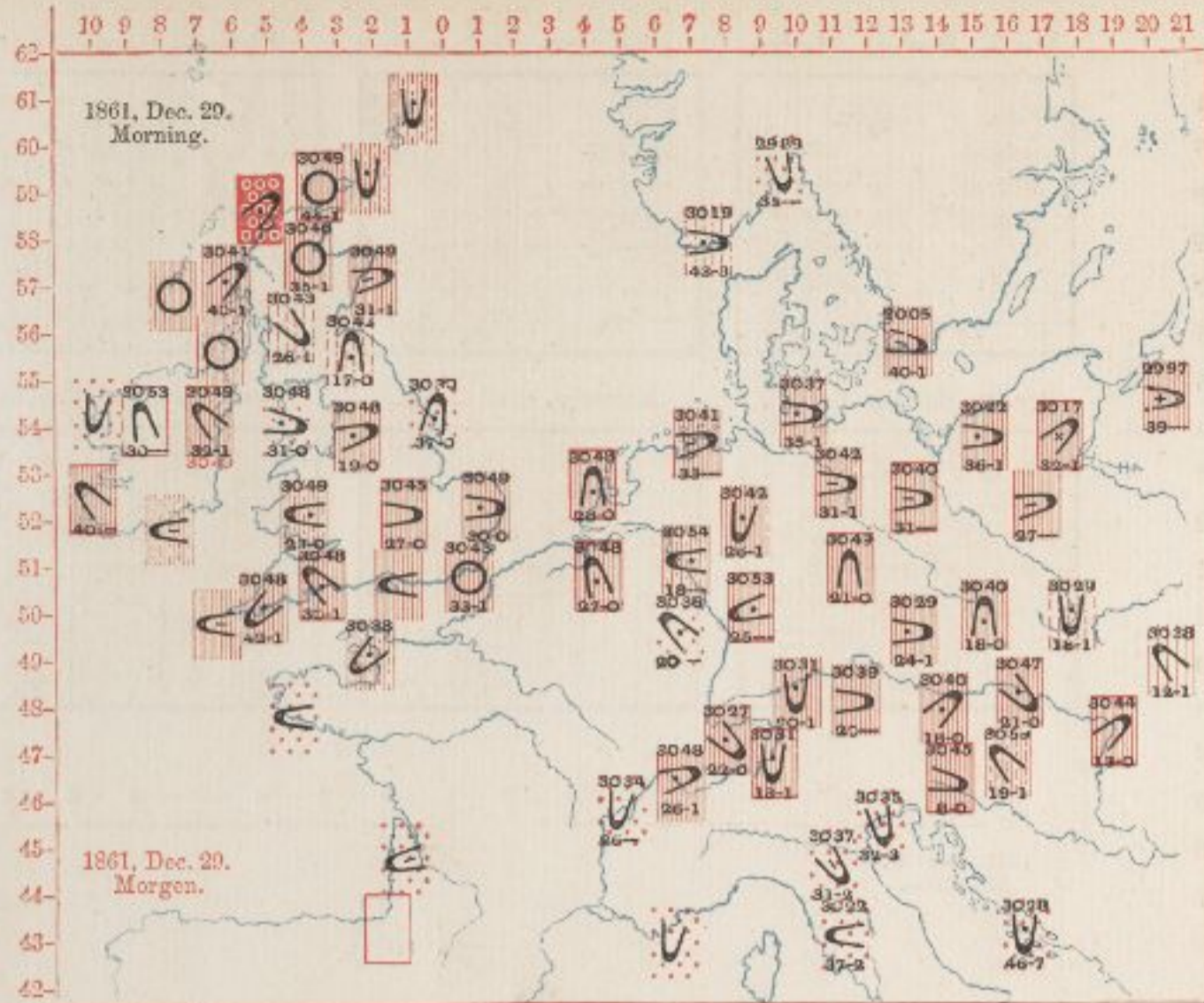


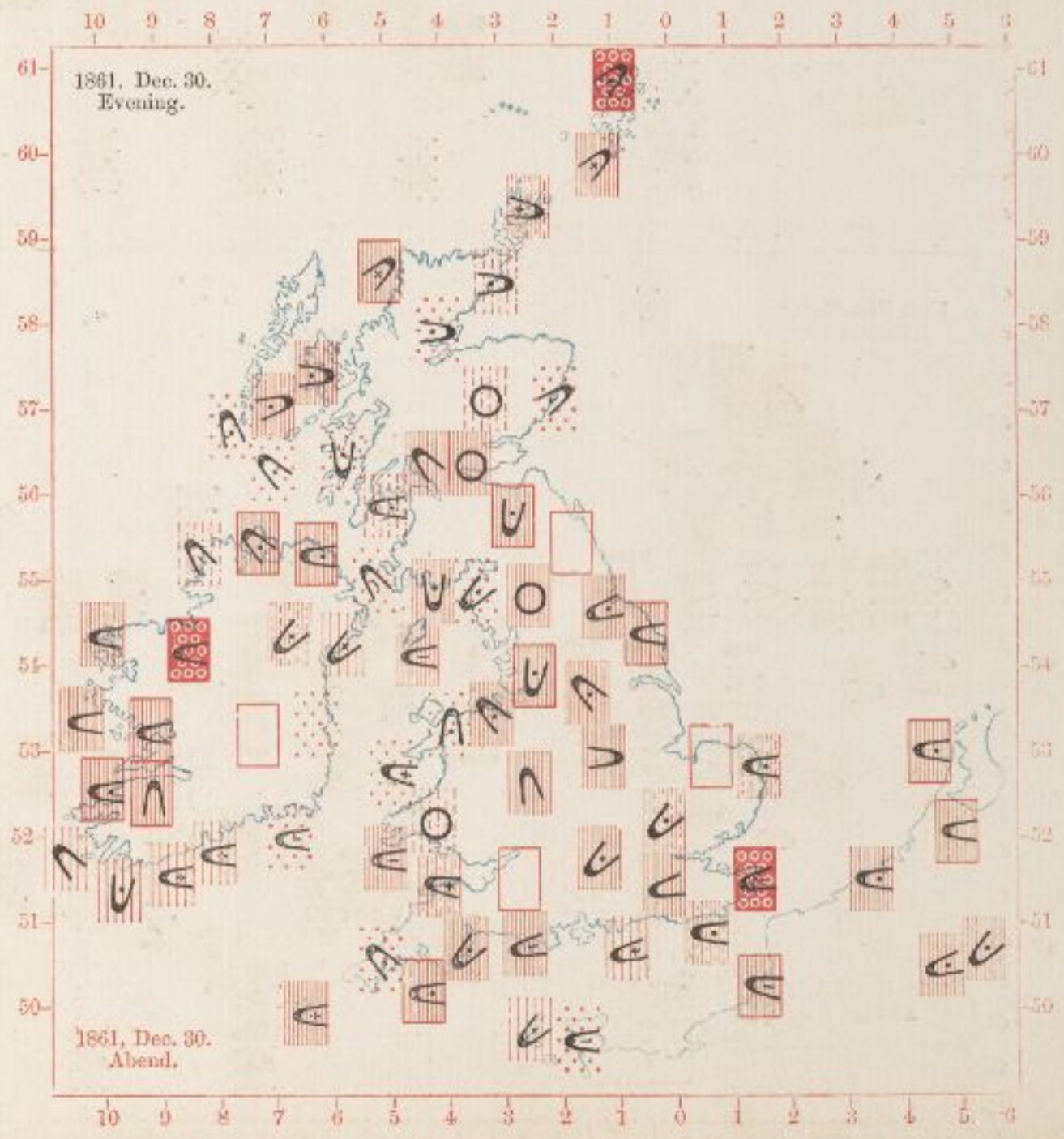
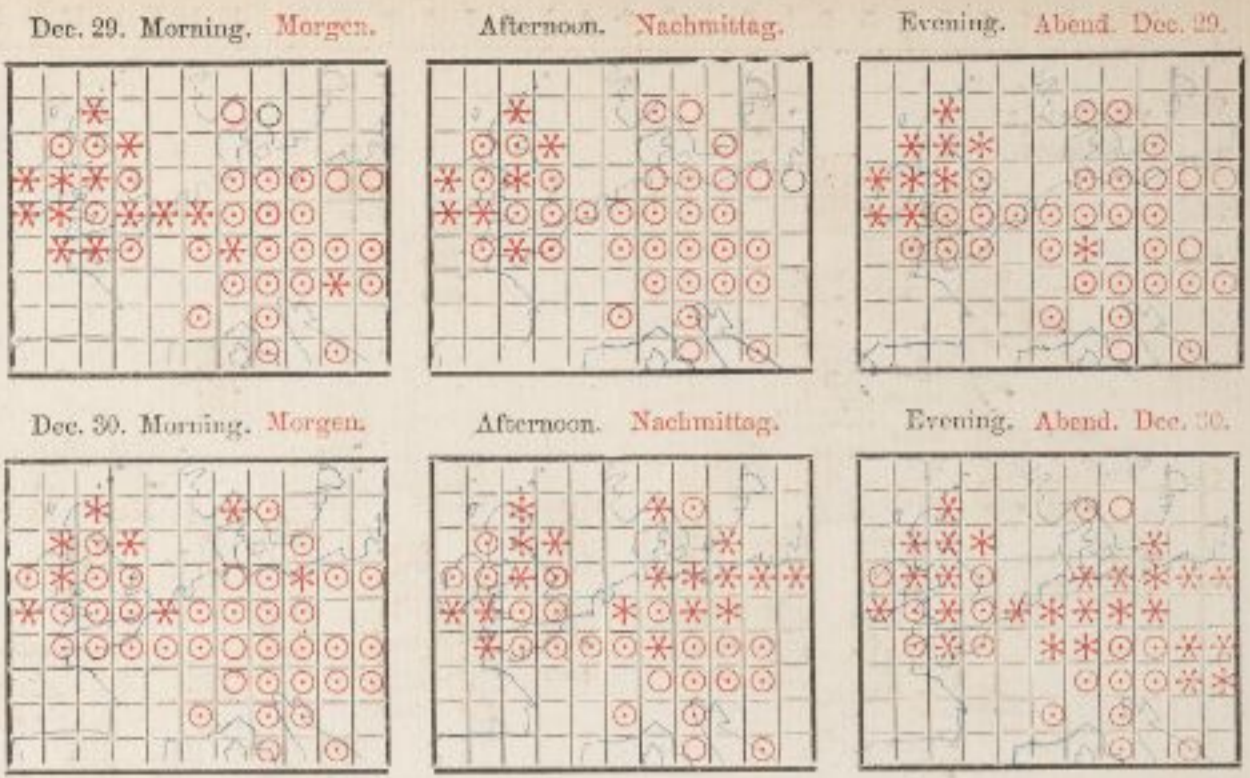
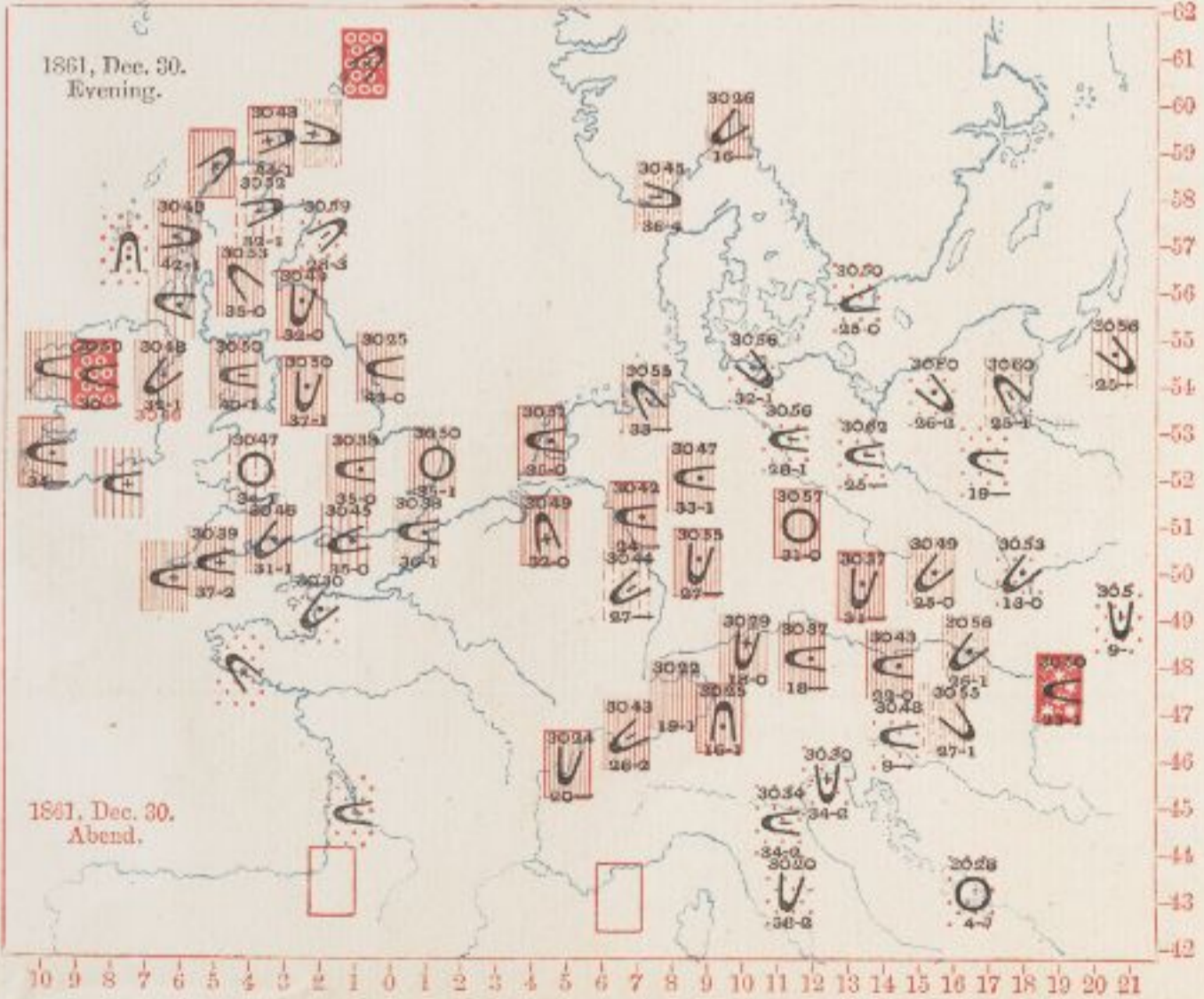
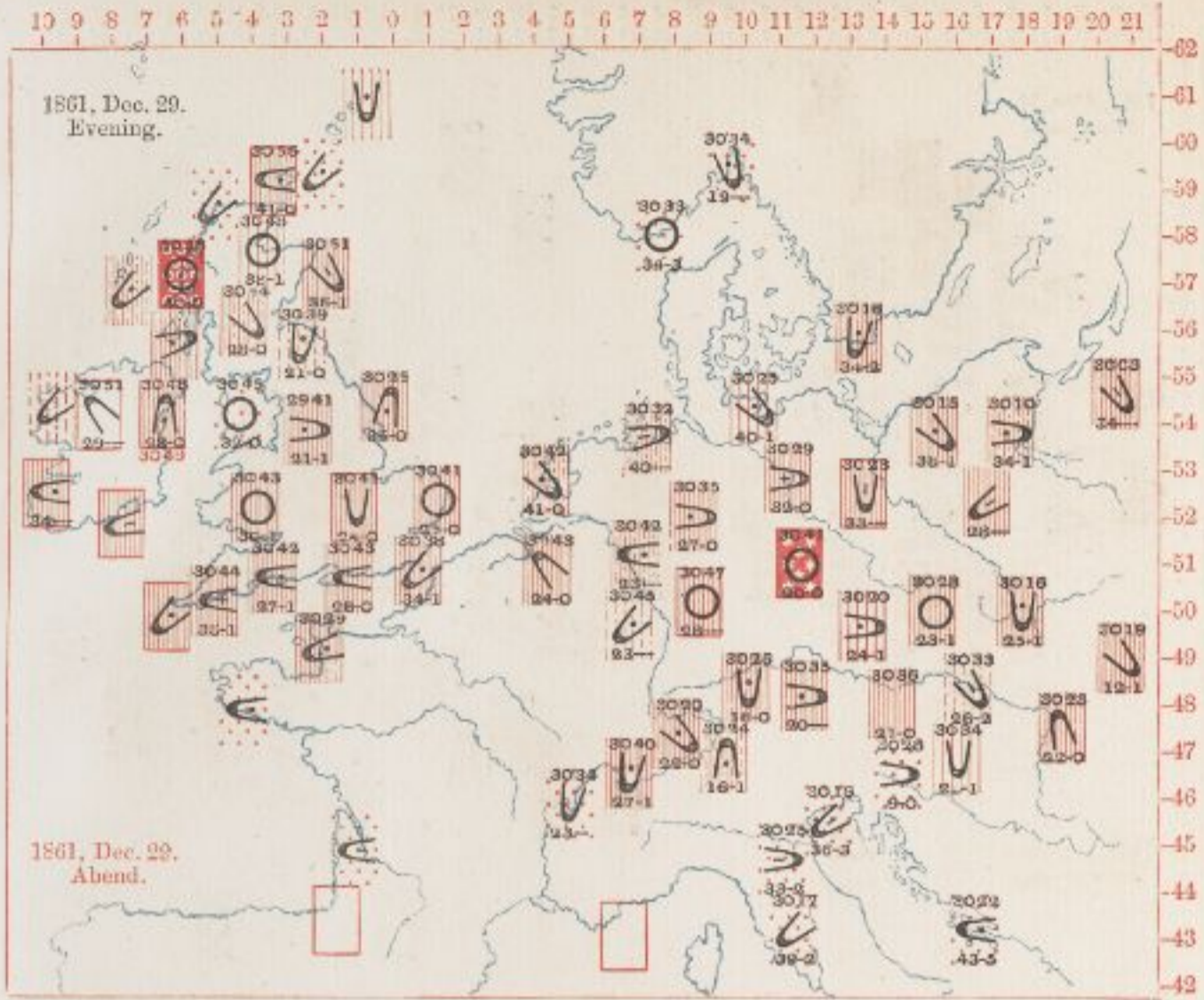


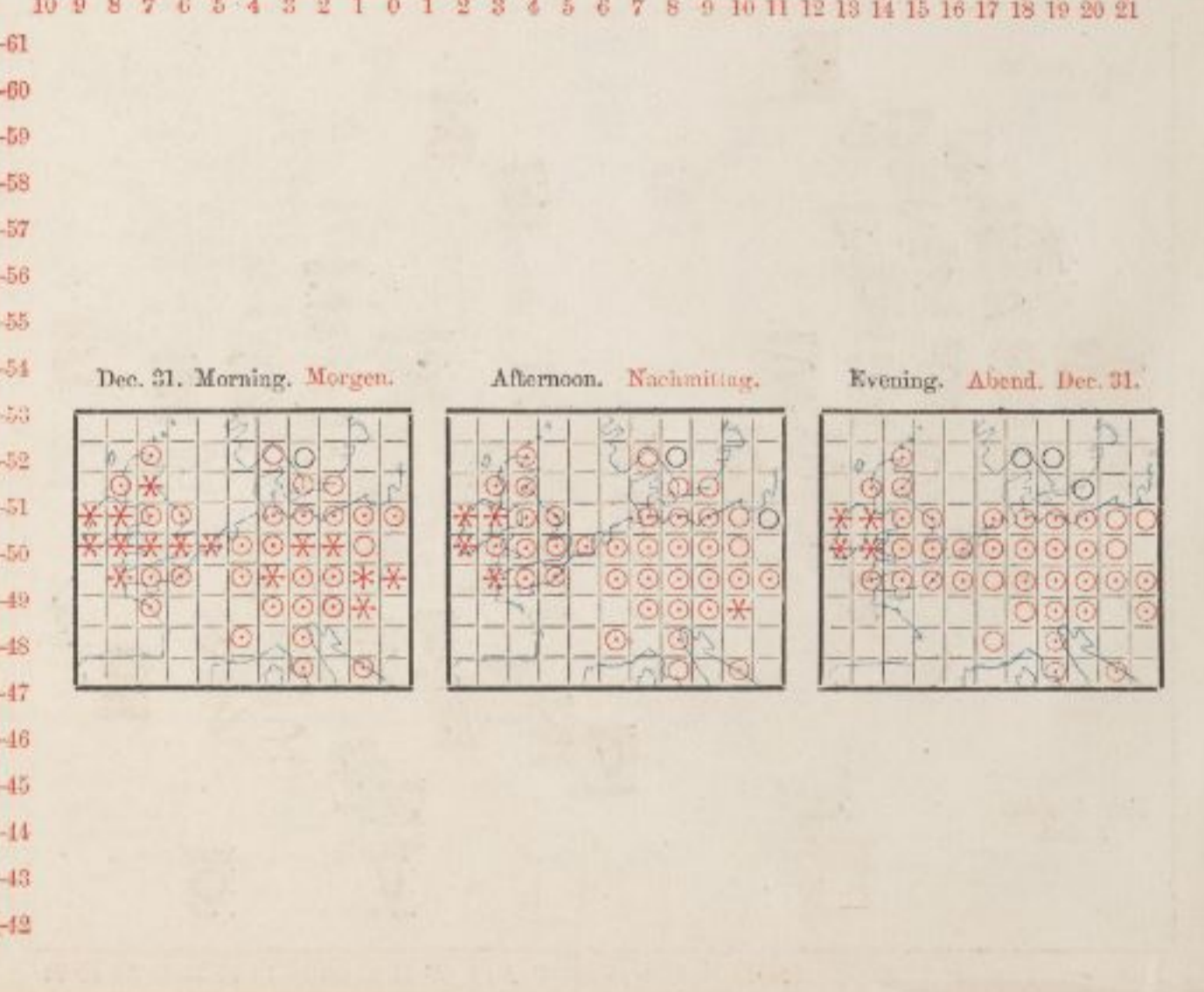
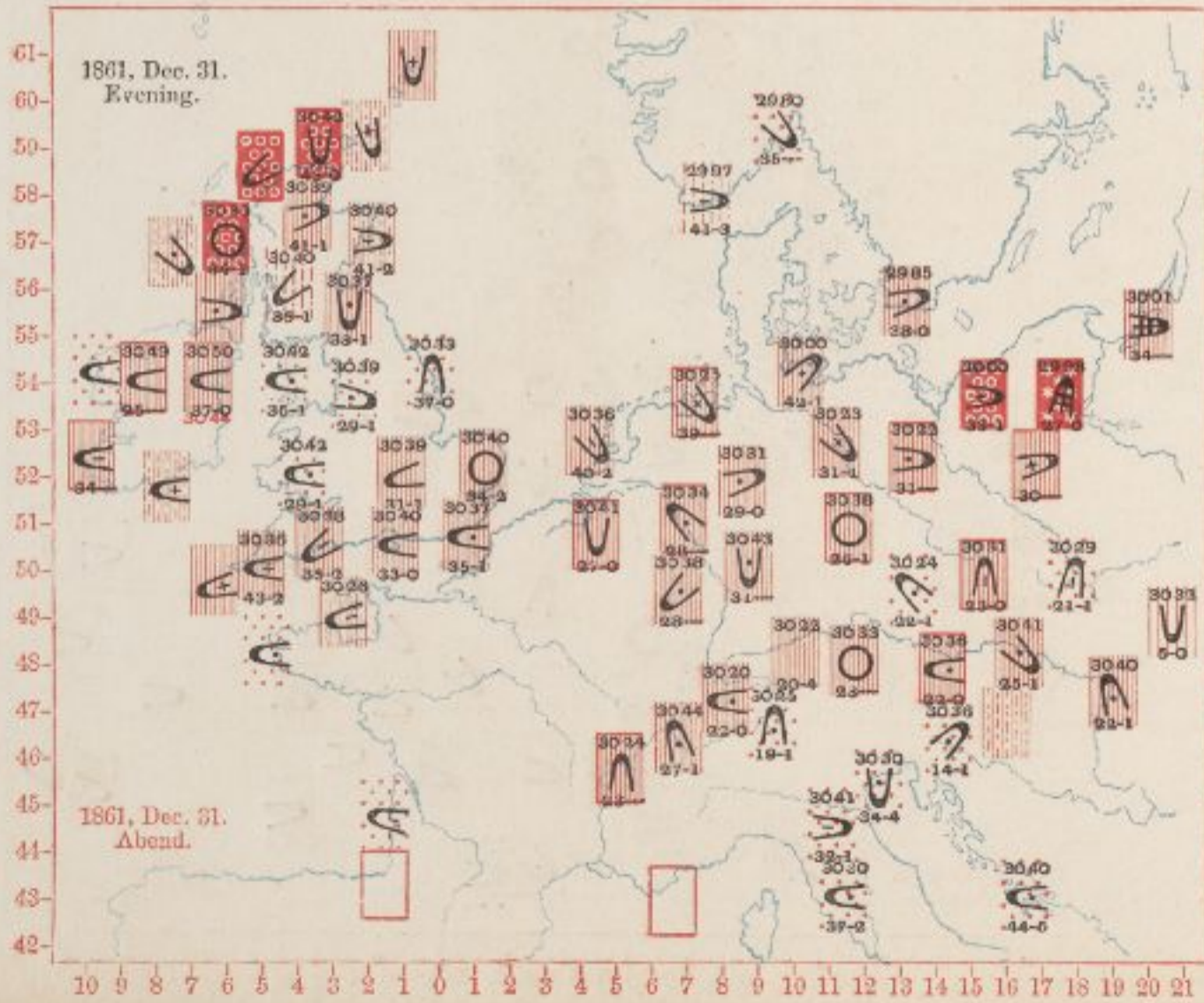
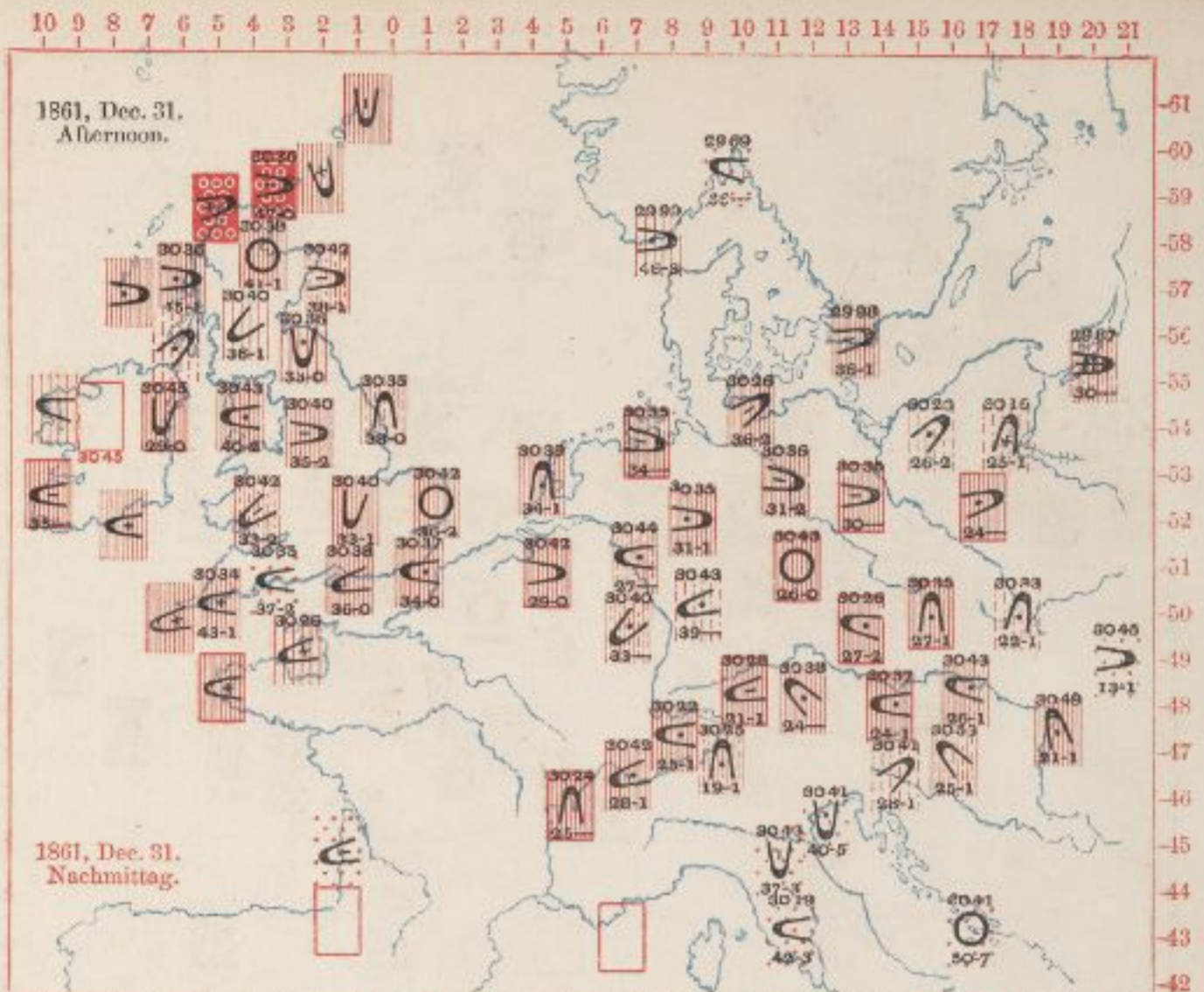
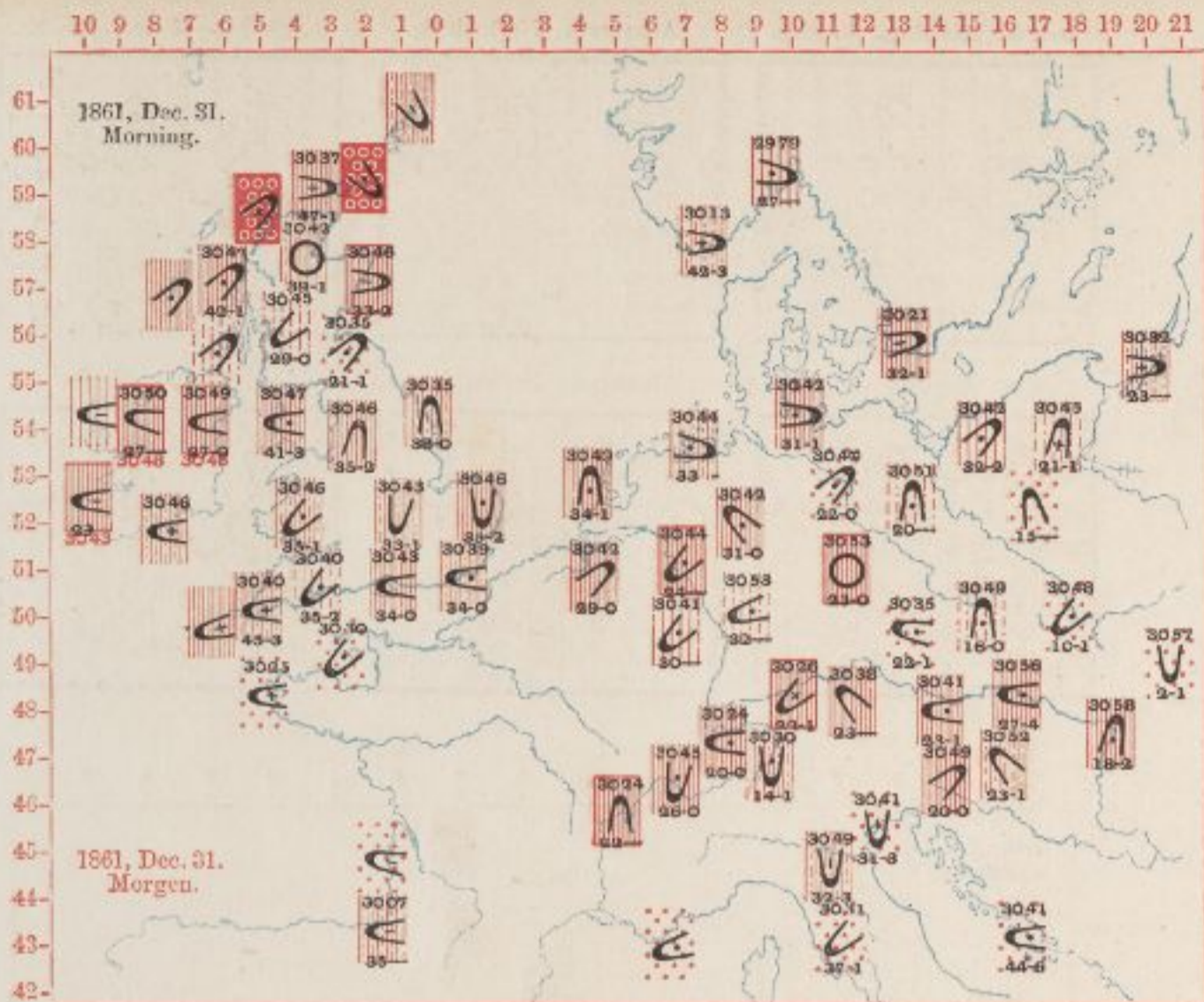












TABLES FOR CONVERSION OF ENGLISH TO FOREIGN SCALES.

$x^{\circ}$ Fahrenheit = $\frac{5}{9}(x^{\circ} - 32^{\circ})$ Centigrade = $\frac{9}{5}(x^{\circ} - 32^{\circ})$ Reaumur.						1 Inch = 25.3995 Millimètres = 11.2595 Paris Lines = 20 Russian Half Lines.			
Fahrenheit.	Centigrade.	Reaumur.	Fahrenheit.	Centigrade.	Reaumur.	Inches and Tenths.	Milli-mètres.	Paris Lines.	Russian Half Lines.
100	37.8	30.2	44	6.7	5.3	28.0	711	315	560
99	37.2	29.8	43	6.1	4.9	1	714	316	562
98	36.7	29.3	42	5.6	4.4	2	716	318	564
97	36.1	28.9	41	5.0	4.0	3	719	319	566
96	35.6	28.4	40	4.4	3.6	4	721	320	568
95	35.0	28.0	39	3.9	3.1	5	724	321	570
94	34.4	27.6	38	3.3	2.7	6	726	322	572
93	33.9	27.1	37	2.8	2.2	7	729	323	574
92	33.3	26.7	36	2.2	1.8	8	732	324	576
91	32.8	26.2	35	1.7	1.3	9	734	325	578
90	32.2	25.8	34	1.1	0.9	29.0	737	327	580
89	31.7	25.3	33	0.6	0.4	1	739	328	582
88	31.1	24.9	32	0.0	0.0	2	742	329	584
87	30.6	24.4	31	-0.6	-0.4	3	744	330	586
86	30.0	24.0	30	-1.1	-0.9	4	747	331	588
85	29.4	23.6	29	-1.7	-1.3	5	749	332	590
84	28.9	23.1	28	-2.2	-1.8	6	752	333	592
83	28.3	22.7	27	-2.8	-2.2	7	754	334	594
82	27.8	22.2	26	-3.3	-2.7	8	757	336	596
81	27.2	21.8	25	-3.9	-3.1	9	759	337	598
80	26.7	21.3	24	-4.4	-3.6	30.0	762	338	600
79	26.1	20.9	23	-5.0	-4.0	1	765	339	602
78	25.6	20.4	22	-5.6	-4.4	2	767	340	604
77	25.0	20.0	21	-6.1	-4.9	3	770	341	606
76	24.4	19.6	20	-6.7	-5.3	4	772	342	608
75	23.9	19.1	19	-7.2	-5.8	5	775	343	610
74	23.3	18.7	18	-7.8	-6.2	6	777	345	612
73	22.8	18.2	17	-8.3	-6.7	7	780	346	614
72	22.2	17.8	16	-8.9	-7.1	8	782	347	616
71	21.7	17.3	15	-9.4	-7.6		785	348	618
70	21.1	16.9	14	-10.0	-8.0				
69	20.6	16.4	13	-10.6	-8.4				
68	20.0	16.0	12	-11.1	-8.9				
67	19.4	15.6	11	-11.7	-9.3				
66	18.9	15.1	10	-12.2	-9.8				
65	18.3	14.7	9	-12.8	-10.2				
64	17.8	14.2	8	-13.3	-10.7				
63	17.2	13.8	7	-13.9	-11.1				
62	16.7	13.3	6	-14.4	-11.6				
61	16.1	12.9	5	-15.0	-12.0				
60	15.6	12.4	4	-15.6	-12.4				
59	15.0	12.0	3	-16.1	-12.9				
58	14.4	11.6	2	-16.7	-13.3				
57	13.9	11.1	1	-17.2	-13.8				
56	13.3	10.7	0	-17.8	-14.2				
55	12.8	10.2	-1	-18.3	-14.7				
54	12.2	9.8	-2	-18.9	-15.1				
53	11.7	9.3	-3	-19.4	-15.6				
52	11.1	8.9	-4	-20.0	-16.0				
51	10.6	8.4	-5	-20.6	-16.0				
50	10.0	8.0	-6	-21.1	-16.9				
49	9.4	7.6	-7	-21.7	-17.3				
48	8.9	7.1	-8	-22.2	-17.8				
47	8.3	6.7	-9	-22.8	-18.2				
46	7.8	6.2	-10	-23.3	-18.7				
45	7.2	5.8							

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Printed by GEORGE E. EYRE and WILLIAM SPOTTISWOODE,  
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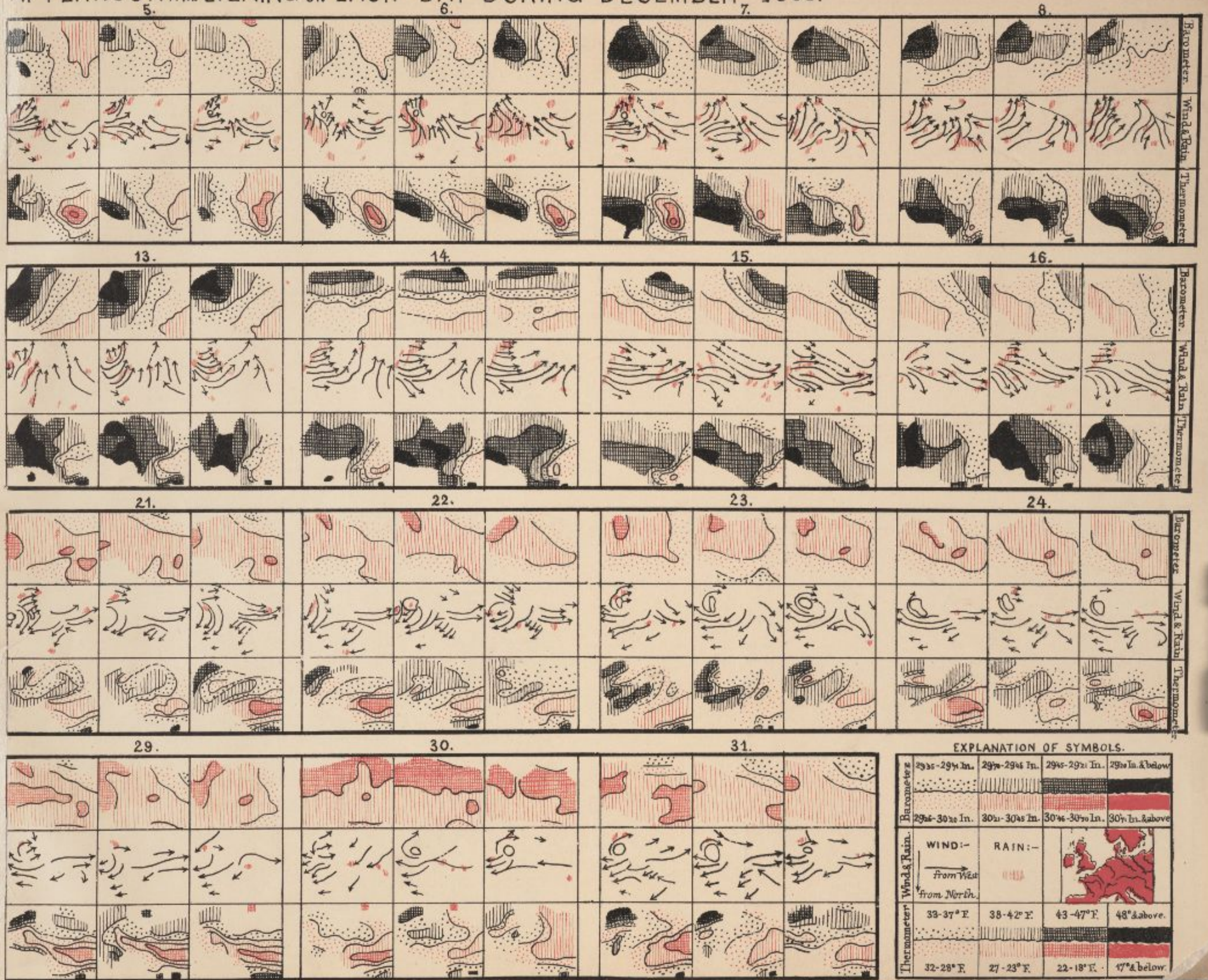




# CHARTS OF THE THERMOMETER, WIND, RAIN AND BAROMETER ON THE MORNING

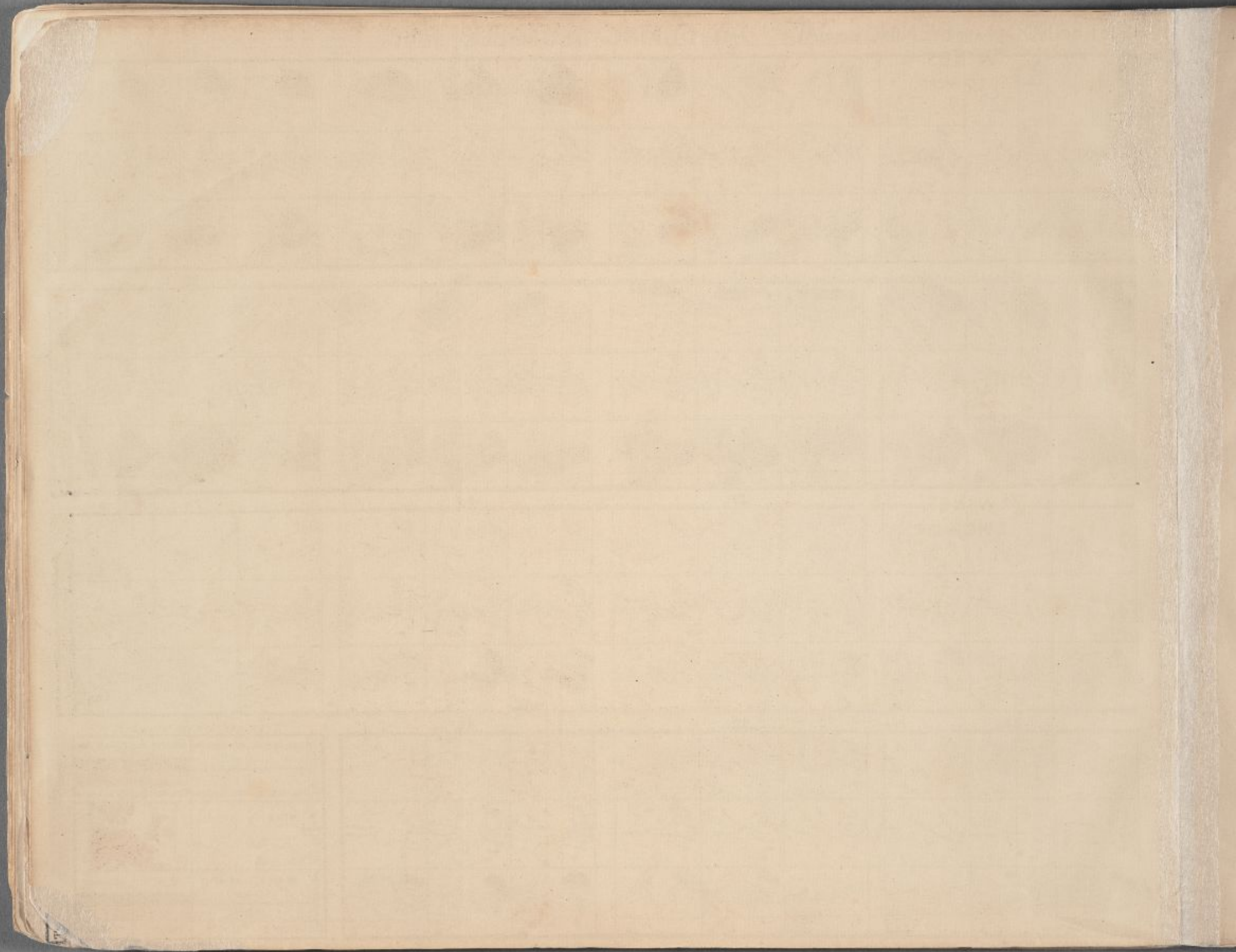


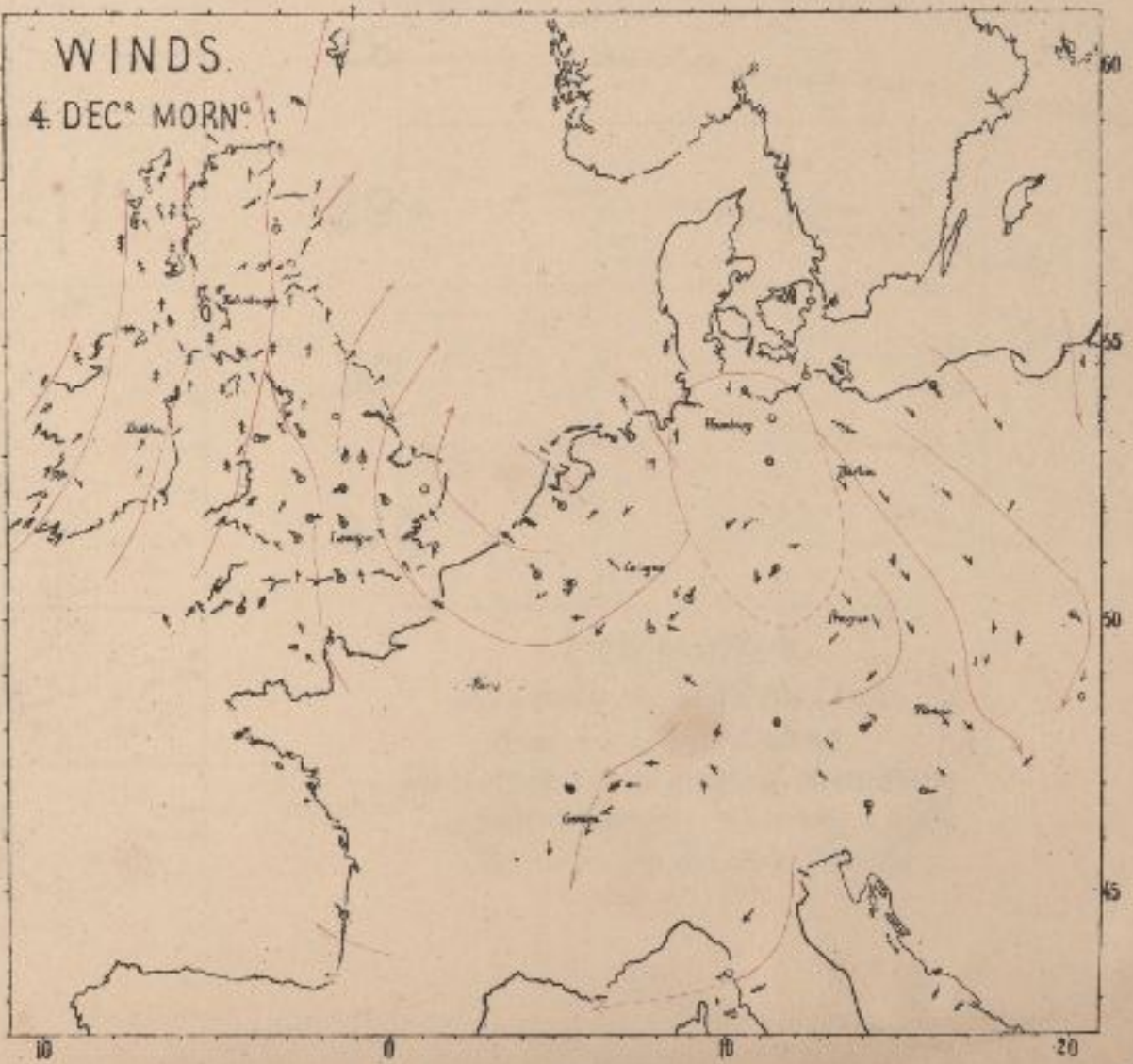
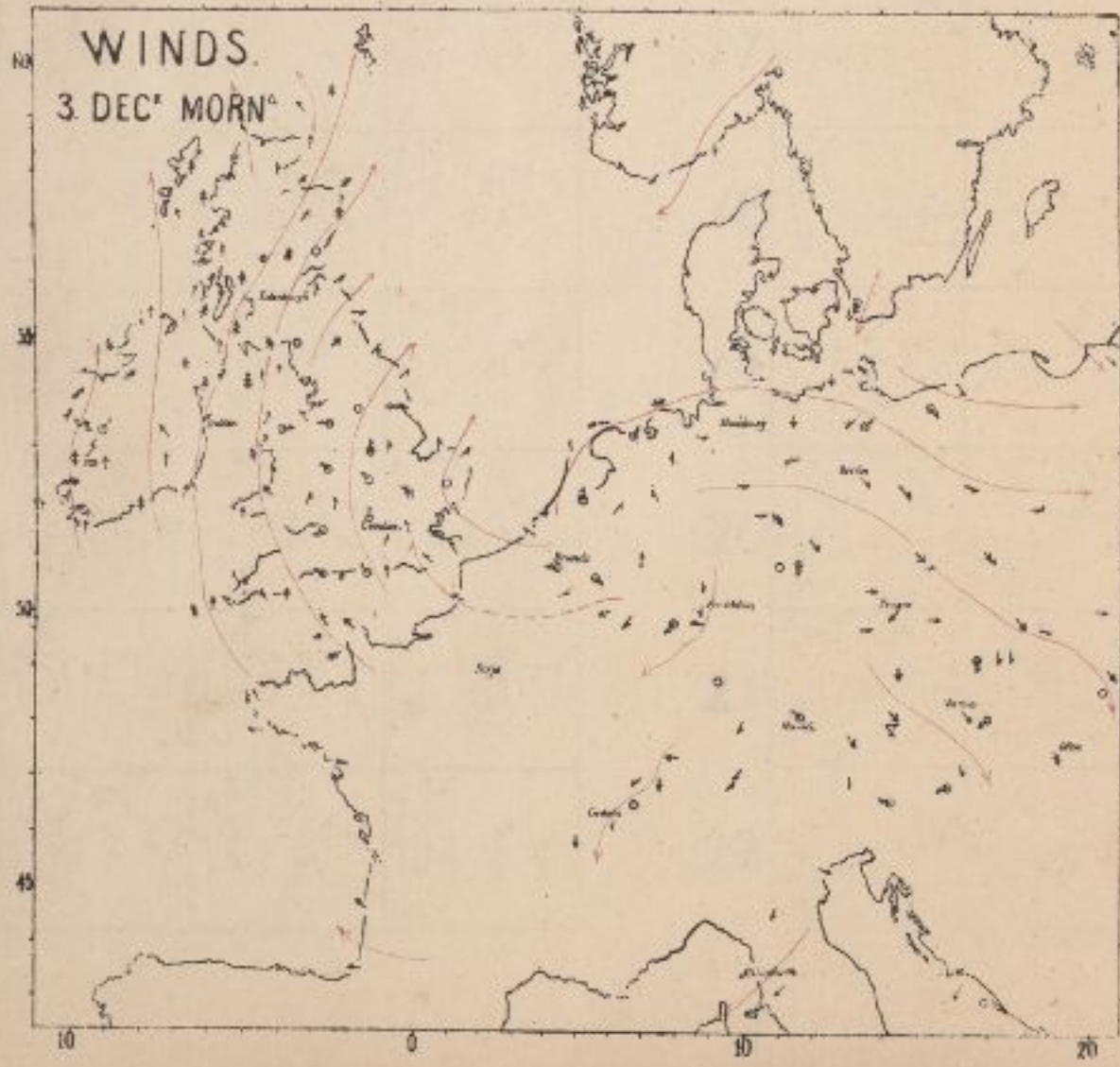
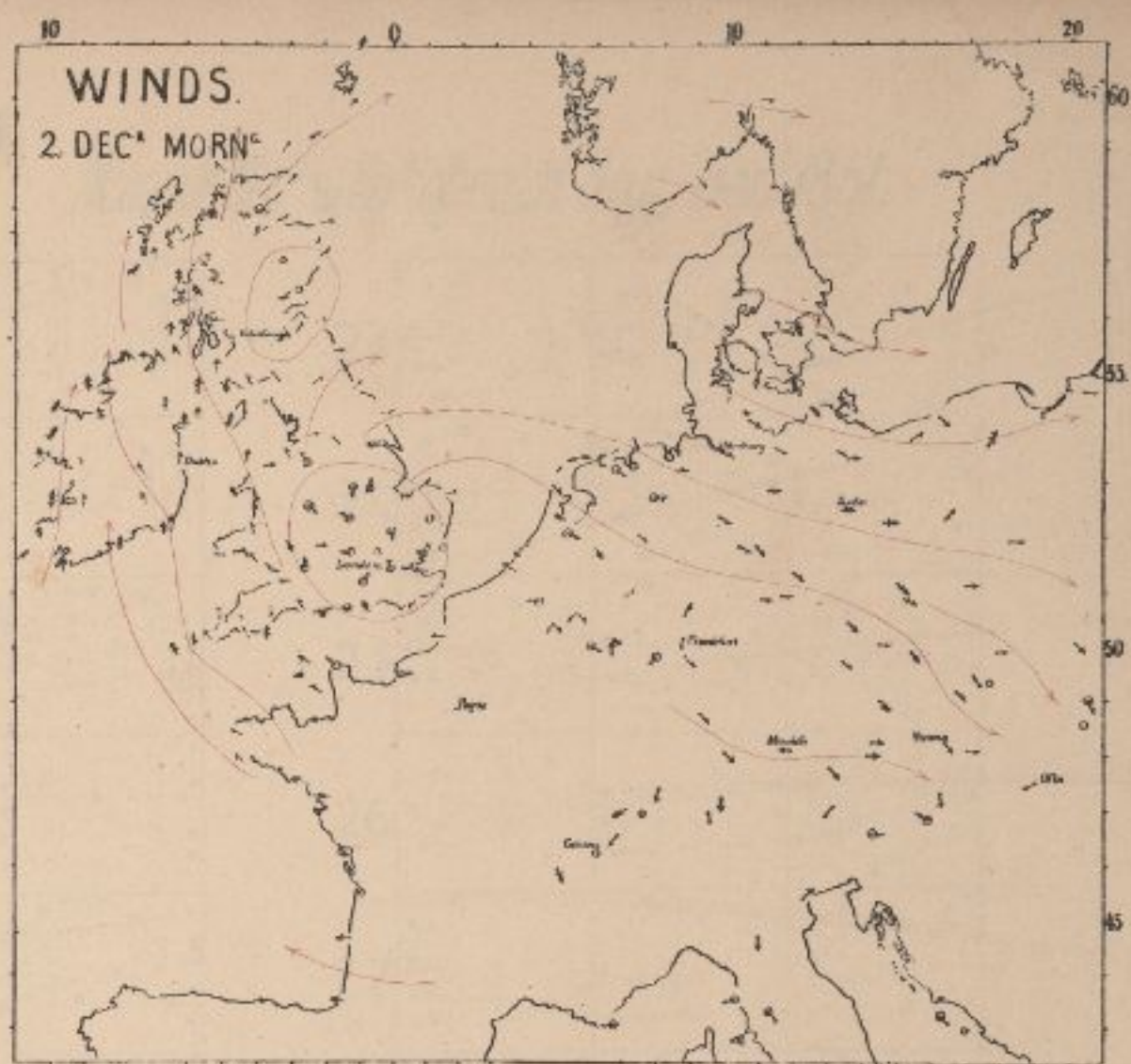
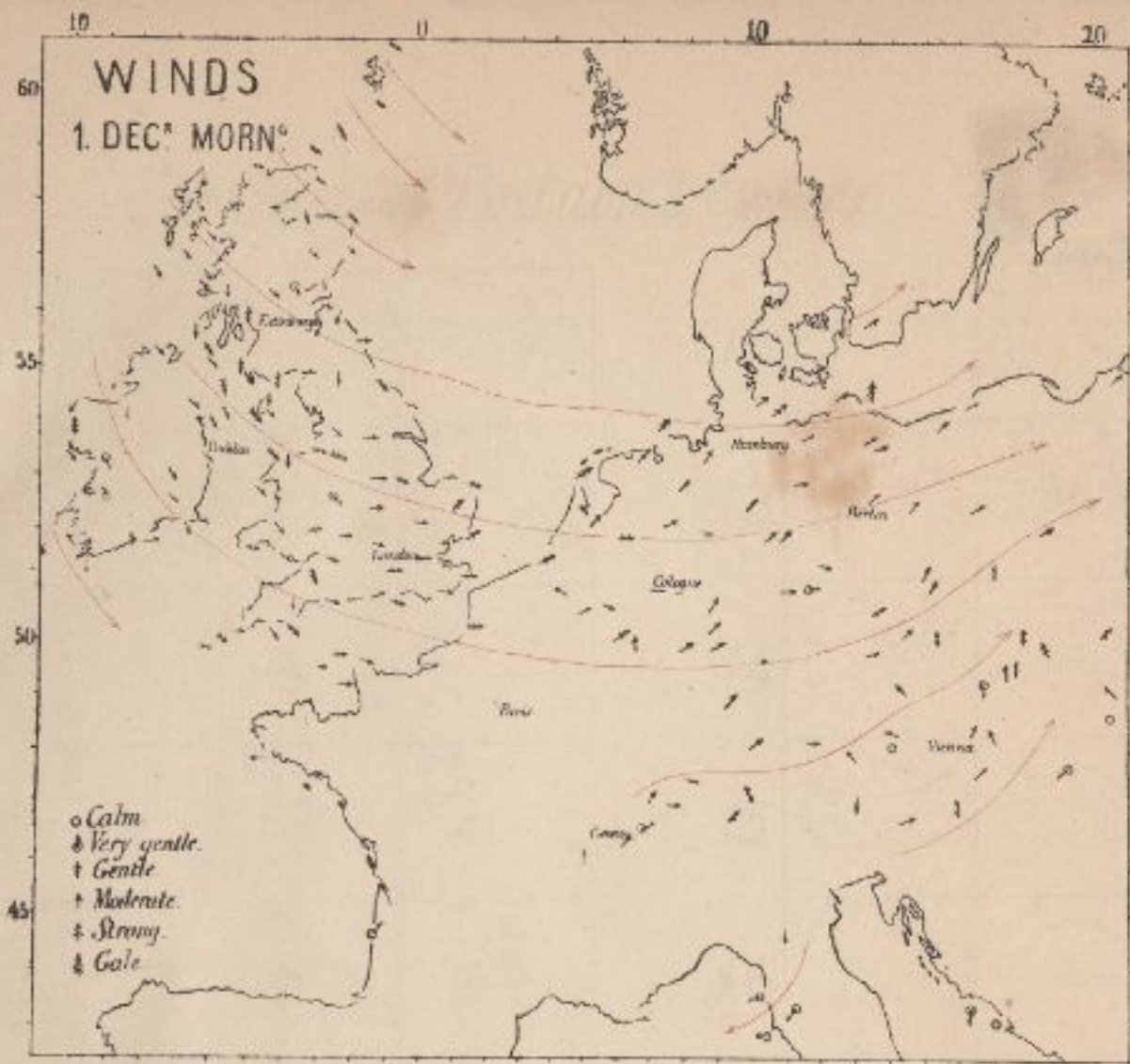
AFTERNOON AND EVENING ON EACH DAY DURING DECEMBER, 1861.

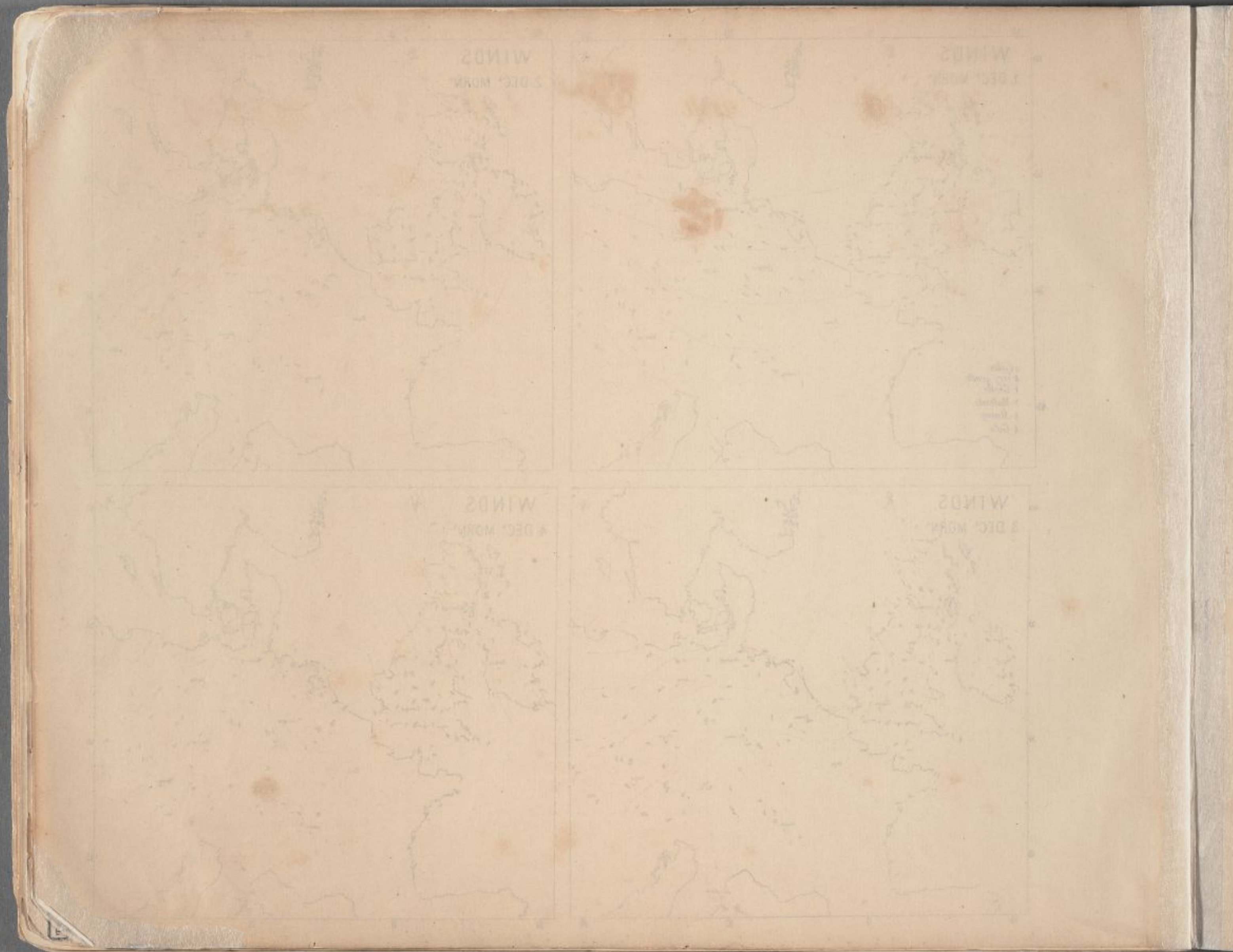


EXPLANATION OF SYMBOLS.

Barometer	29 $\frac{35}{100}$ - 29 $\frac{94}{100}$ In.	29 $\frac{78}{100}$ - 29 $\frac{96}{100}$ In.	29 $\frac{45}{100}$ - 29 $\frac{72}{100}$ In.	29 $\frac{00}{100}$ In. & below
Barometer	30 $\frac{00}{100}$ - 30 $\frac{20}{100}$ In.	30 $\frac{21}{100}$ - 30 $\frac{45}{100}$ In.	30 $\frac{46}{100}$ - 30 $\frac{70}{100}$ In.	30 $\frac{71}{100}$ In. & above
Wind & Rain	WIND:- from West from North.	RAIN:-		
Thermometer	33 - 37° F.	38 - 42° F.	43 - 47° F.	48° & above.
Thermometer	32 - 28° F.	27 - 23° F.	22 - 18° F.	17° & below.







The Winds of Britain & Europe,



Morn<sup>g</sup>, Aft<sup>n</sup> & Ev<sup>g</sup> of each day Dec<sup>r</sup> 1861.

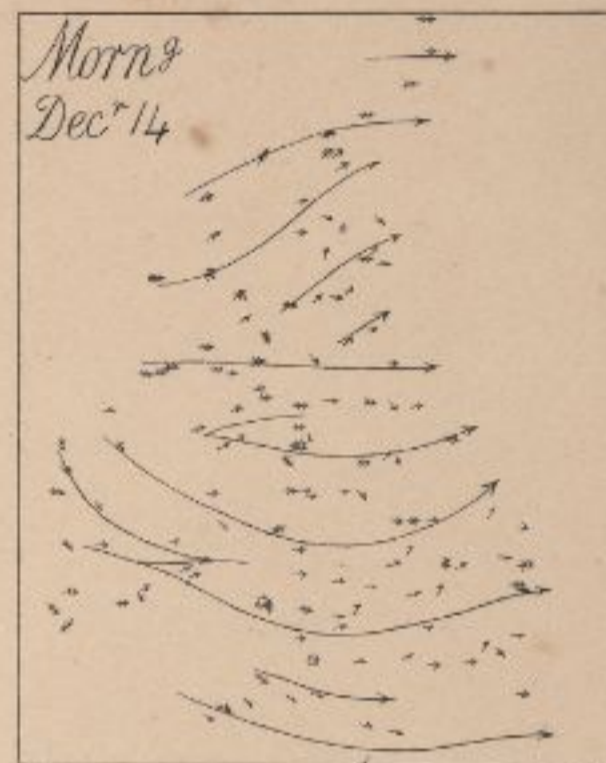
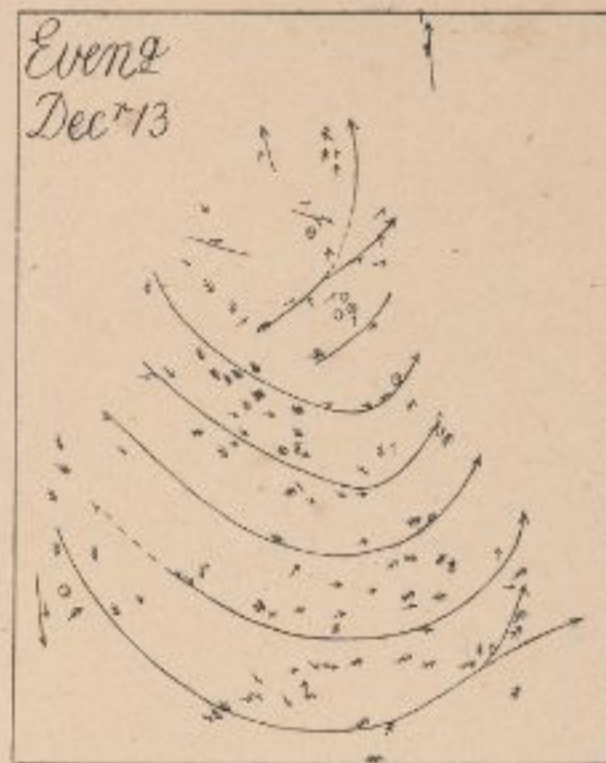
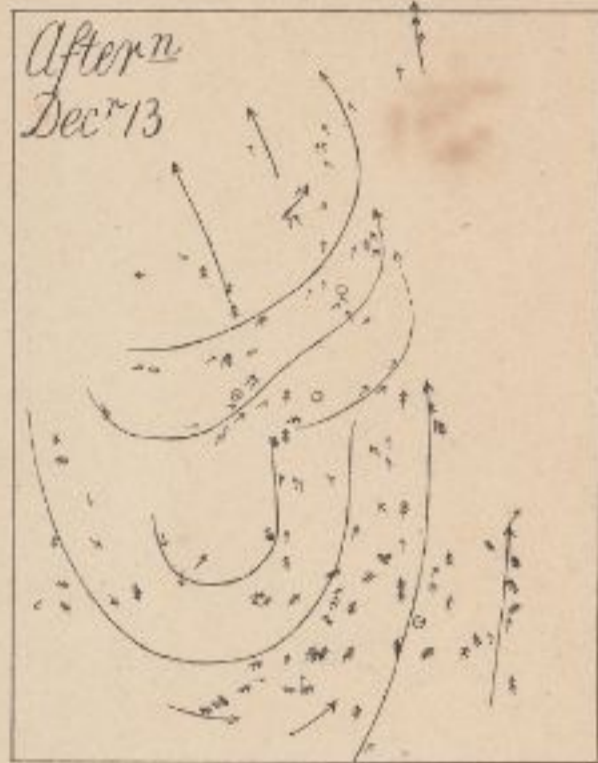
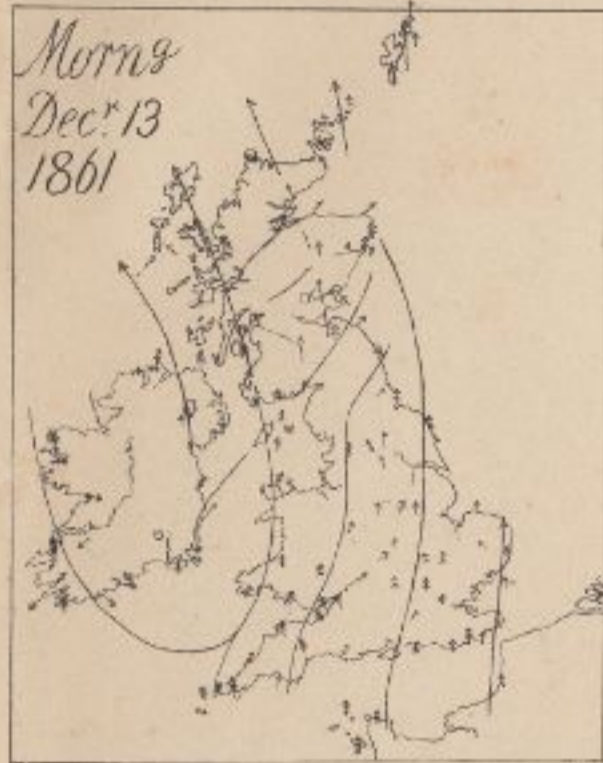


*Explanation.*  
 The arrows fly WITH the Wind.  
 thus → is a West Wind.  
 The expresses selected groups of observations.  
 is gentle or moderate, is strong or a gale.  
 The are deductions from the .

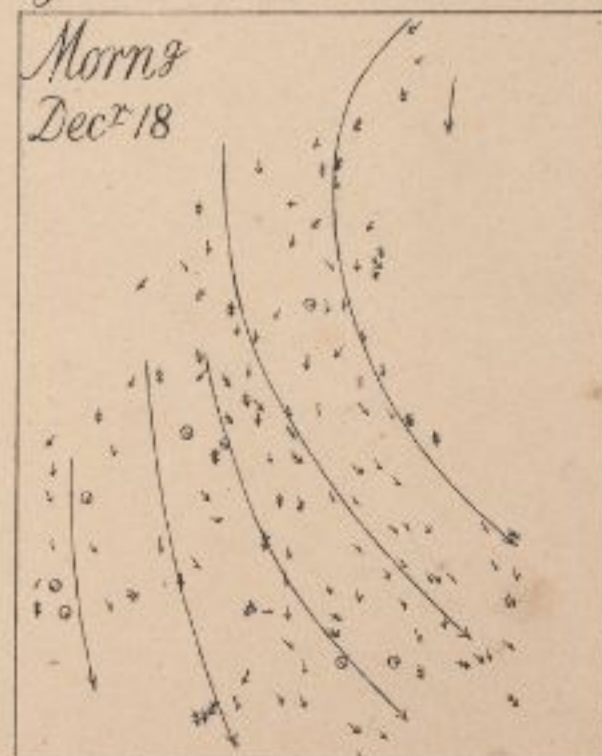
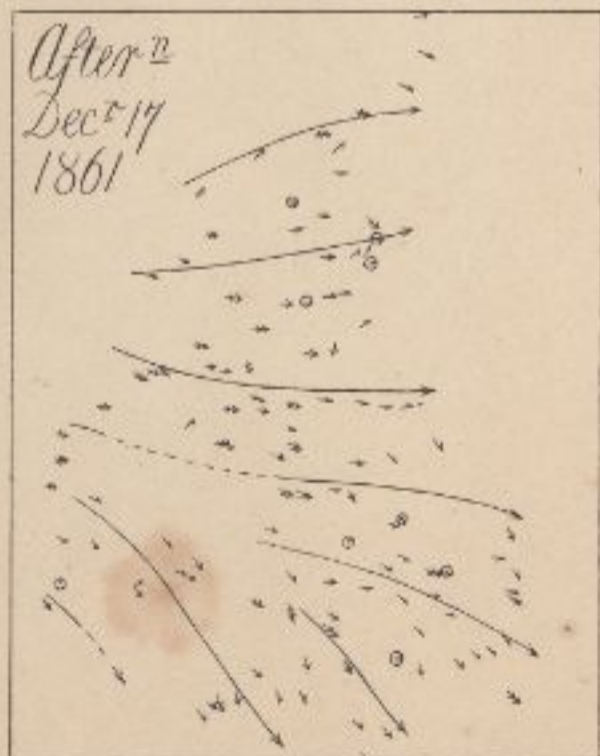




Change from a South to a West Gale.

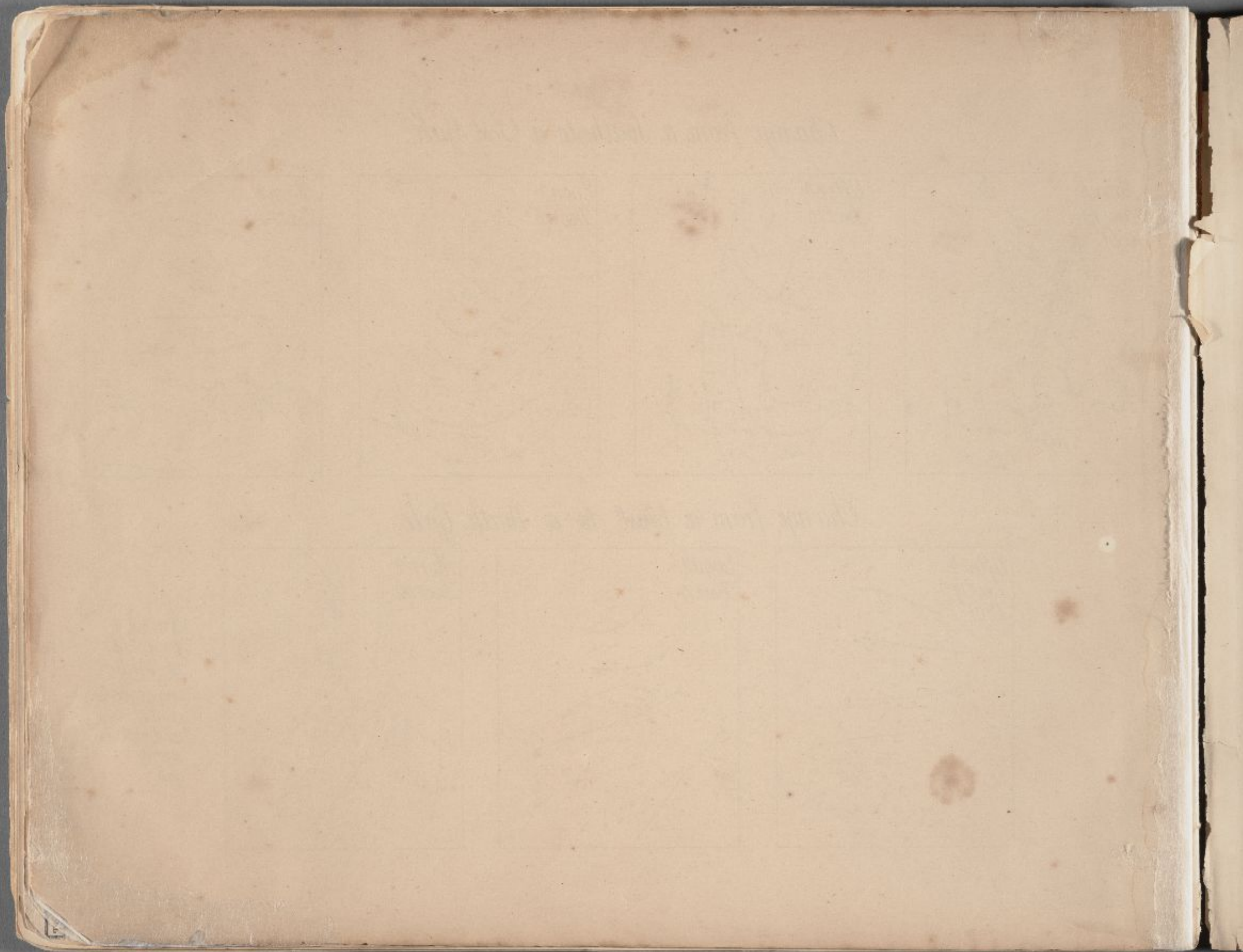


Change from a West to a North Gale

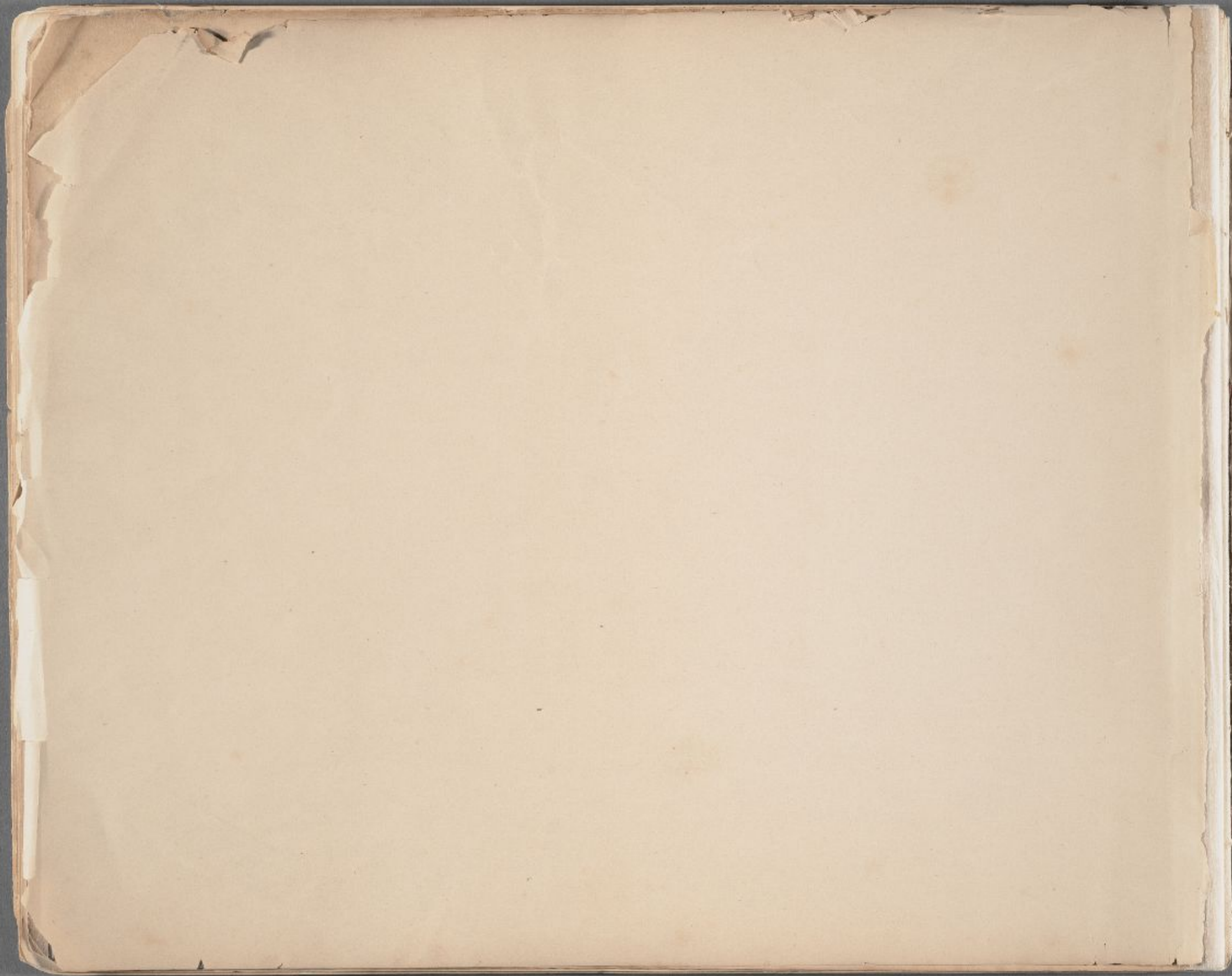


SYMBOLS  
FOR FORCE  
OF WIND

very gentle	○
gentle	↓
moderate	↓
strong	↓
gale	↓







MAR 3 1899  
MAY 0 8 1998  
CANCELLER

