Marianna Ridderstad

Orientations of the Medieval Stone Churches in Finland

In 1290–1560 A.D., about one hundred stone churches were built in Finland. About eighty of those have survived to date, some of them in a ruined state. In this study, the orientations of 81 Medieval Finnish stone churches were measured. The obtained results were related to the ecclesiastical calendar used in Medieval Finland and the historical records of the folk beliefs concerning the feast days of saints. The results showed the church orientations to be mainly towards the eastern and north-eastern directions. The orientations of individual churches were, within the given error limits, found to be mainly towards the sunrises of the day of the equinox as given by the various definitions of the equinox. The orientations of some churches may have been intended towards the sunrises of the feast days of saints, although it was observed that, generally, the churches were not oriented towards the sunrises of the feast days of their patron saints. The general form of the orientation distribution can be explained by orientations towards the sunrises of the equinoxes, with contributions from the orientations towards the sunrises of the feast days of some individual saints and the Easter Day.

1. Introduction

Archaeoastronomy is a relatively new, genuinely multidisciplinary field of study combining the practical methods of positional astronomy with archaeology, history, religious studies, and anthropology, among others. One point of view, then, is to see archaeoastronomy as an auxiliary science to each of the aforementioned fields of study. Closely related fields are cultural astronomy, which concentrates on the historical and contemporary meaning of astronomy in culture, and ethnoastronomy, which studies the astronomical lore of contemporary cultures.

Among the most popular objects of archaeoastronomical studies have been the orientations of various megalithic structures, buildings of the ancient Mayan culture, temples from Classical Antiquity – and early Christian churches. The popularity of these research subjects is obviously due

both to the great amount of monuments belonging to those categories and to the central position of religion in past cultures: as architecture provides a medium to express religious symbolism, the studies of the astronomical orientations of sacred structures and spaces of a religion usually provide information on the central beliefs of that particular religious system.

While the early Christian churches belong to historical times, they have been a popular subject of archaeological, architectural, and art historical research, too, due to the scarcity of written sources from the early Medieval times. Archaeoastronomical studies of the orientations of early Christian churches can be used to reveal details of the technological level and astronomical knowledge of the period. Consequently, the subject is rather well researched, although also many open questions and areas where no data exists remain.

To date, Finland has remained as one of the geographical areas where no extensive research on the matter has been conducted. In the present study, the orientations of the Medieval stone churches of Finland are investigated by combining archaeoastronomical methodology with the perspectives of the history of ecclesiastical and folk calendars, archaeology, and studies on the local vernacular religion and folklore.

In a recent study by González-García (2013), orientation data for 1274 early Christian and Medieval churches – including 425 churches with reliable horizon height data, which has been lacking in some studies – were reviewed. The vast majority of the church orientations (95%) turned out to be inside the range of sunrises (i.e., the solar azimuthal range). Most of the churches turned out to be oriented to or close to true east, although, as the author stated, it is not always clear which definition of 'east' was used.

The equinoctial orientation is to be expected, since already the early accounts from the very first centuries of the Christian church stated that the priest and the participants of the mass should face the east during prayer, and that churches should therefore be built to face the east, namely the true east or the equinox (see, e.g., McCluskey 2010, and references therein; González-García 2013, and refs. therein).

In addition to the equinoctial orientation, other possibilities that have been put forward to explain the church orientations are the hypotheses on the orientation towards the sunrise on the feast day of the church's patron saint, orientation to the sunrise on the day of construction, orientation towards the sunrise of Easter or some other important communal church festival, and orientation affected by local pre-Christian religious traditions (e.g., Ruggles 2005, p. 96; González-García 2013, and refs. therein).

Despite the many studies targeted to solve the question of the possible church orientations to the sunrise on the feast day of the church's patron

saint, no definite conclusion has been reached on the matter (González-García 2013). McCluskey (2010), who in his study of 130 Romanesque churches of England included also reliable horizon data, came into the conclusion that the patron saint hypothesis in its general form does not seem to hold, although it may hold in the case of certain saints, e.g., Virgin Mary (see below for another possible explanation for a similar result concerning the churches dedicated to the Virgin in Finland). However, studies carried out in Central Europe, Italy and Germany concluded that some churches were oriented to the sunrise on the day of the patron saint (Guszik 1978; Dietrich and Mertens 1990; Eckstein et al. 1995).

Considering Finland, the subject of our study, perhaps the most interesting comparative data is provided by Nordic churches, especially the Medieval churches of Sweden, since the diocese of Turku was part of the Uppsala archdiocese from ca. 1250 A.D. on. The study by Nilsson (1982) on the early Medieval Swedish churches showed that they are oriented roughly towards the eastern direction, but with deviations towards the northeast (NE) as well as some towards the southeast (SE). Another study by Brunius (1997) argued that the practice of orienting many of the oldest and most important churches in Sweden towards the southeast was connected to the ancient definition of the compass points, which, according to him, defined the eastern direction as the direction of the sunrise on the winter solstice. The orientations of Danish Romanesque churches, which likewise show deviations towards the southeast, had previously been explained by Abrahamsen (1985, 1992) by the use of a magnetic compass and the error due to magnetic declination.

In Finland, there are 75 Medieval stone churches, built in the period from ca. 1270 to 1560, that have been preserved to date (Hiekkanen 2007, p. 20, 24–26).[1] Originally, there were more than 80; a few have been preserved in a ruined state. This study includes 81 churches, six of which are in ruins. Most of the churches are located in Southern Finland and along the coast. The southernmost church is on the Kökar island in Åland, and the northernmost one is in Alatornio. The westernmost church is in Eckerö in Åland and the easternmost one in Hamina; the churches of Viborg in Carelia are not included in the sample of the present study.[2]

1 In Finland, the definition of the Medieval period varies, but is usually considered to have lasted from ca. 1200 A.D. well into the 16th century A.D. (see Hiekkanen 2007, p. 8). It thus begins and ends notably later than the Medieval period in the Central Europe (ca. 450 A.D.–1450 A.D.). In this paper, it should be clear from the context, which one of these definitions is meant. The period from 800 A.D. to ca. 1200 A.D. is the Late Iron Age in Finland; it includes the sub-periods of the Viking Age (800–1050 A.D.) and the Crusade Period (ca. 1050–1200 A.D.), and is preceded by the latter part of the Middle Iron Age, the Merovingian Period (550– 800 A.D.).

2 There were three Medieval churches in Viborg (Finn. *Viipuri*), which was part of Finland until 1944 and now belongs to Russia; see Hiekkanen (2007, p. 544–551).

Most of the Medieval churches preserved to date were made of local granite and other common rock types, which has given them the name 'grey-stone church' (*harmaakivikirkko*) often used in Finland as the synonym of a Medieval church, although it is known that in Medieval times, the churches were covered with white chalk plaster and, hence, were mostly not grey but white in colour; nowadays, only a few of them are chalked. A few churches were made mostly of brick, with a stone base. There were also wooden ones, but none have survived – the oldest wooden churches in Finland are from the 17th century. It is believed that the Medieval stone churches were usually preceded by more than one generation of wooden churches (Hiekkanen 2007, p. 16–19). The stone churches were of the simple so-called longhouse church type, see Figure 1 for a typical example.

To date, the orientations of the earliest churches of Finland have not been studied beyond the observation that they all face the eastern horizon (i.e., the main altar is always at the eastern end of the long axis of a church). Even a superficial look into the matter reveals, however, that many of them are not facing the true east (i.e., the azimuth of 90 degrees and the declination of 0 deg; see Figure 2 for the concepts of azimuth and declination used in positional astronomy) but deviate from that direction as much as 35 degrees. This deviation is often towards the northern direction, which means that it cannot be caused merely by the effect of elevated horizon on the azimuthal values of the sunrise position.

Christianity arrived in Finland relatively late when compared with the rest of Europe. It has been suggested that the very first Christian communities may have been those that used the inhumation cemeteries of Eura and Köyliö in Western Satakunta, where the burials started already in the Merovingian Period around 600 A.D. and continued to the 13th century (Cleve 1943, p. 205–209, 227; Lehtosalo-Hilander 1982a–c; Salo 2005, p. 305–311, and refs. therein). While the Christianity of the earliest Eura-Köyliö burials is uncertain, the many inhumation cemeteries appearing in that region ca. 1000 A.D. and in Finland Proper starting 1000–1100 A.D. have generally been seen as a mark of strong Christian influence in those regions (Purhonen 1998, p. 135–137, 139, 191–92, and refs. therein). Before that, cremation had been the general method of burial in Finland (Purhonen 1998, p. 38, 188). On the other hand, the eastern parts of Satakunta and the core regions of Tavastia may have been only partly Christian until the Swedish conquest ca. 1250 A.D., although also there the inhumation burial practice had started to spread from ca. 1100 A.D. on (Purhonen 1998, p. 136–139). [3] In Savo and Carelia, the situation was probably rather similar to Tavastia, with the

3 As late as 1340 A.D., 25 peasants from Sääksmäki in the heart of Tavastia were excommunicated for refusing to pay their taxes to the church (see, e.g., Purhonen 1998, p. 142, and refs. therein). The first record of a priest in Sääksmäki after this incident is dated 1497 A.D., which may mean that the schism between the locals and the church had continued for some time (Jutikkala 1934, p. 105).

exception that the Eastern Orthodox faith had gained more followers in Eastern Finland and, especially, in Carelia; this has been seen as one of the reasons why the Western Catholic Church and Sweden joined their forces in the conquest of Tavastia, Savo and Carelia in ca. 1250–1300 A.D. Thus, while the building of the Medieval stone churches started at the same time in many parishes within three main constructions periods (see Section 3.2 below), in local communities, Christianity had been accepted at different times. Many of the parishes that built the stone churches studied in this paper had a long history, including many generations of wooden churches, behind them, while others had relatively recently been formed in a largely 'pagan' region.

Despite the official conversion of Finland and Carelia into Christianity by the end of the 13th century, the pre-Christian religion continued to thrive, partly fusing with the new faith, and its rites were still widely practiced until the 17th century in the Western Finland and until the 20th century in some parts of the Eastern Finland (Siikala 1992, p. 288–291). Because of the long survival and popularity of the pre-Christian beliefs and rituals in Finland, it is especially interesting to investigate whether this had any effect on the orientations of some of the earliest Christian churches in the region. The church orientations may also provide information that could help to identify the hitherto unrecognized patron saints of some churches and the relative popularity of the different festivals of the church year. In principle, the orientations could also provide information on the details of the church building process, such as the annual building times, and the practical methods of orienting the church axes.

Figure 1. Church of Hollola. Photo: M. Ridderstad.

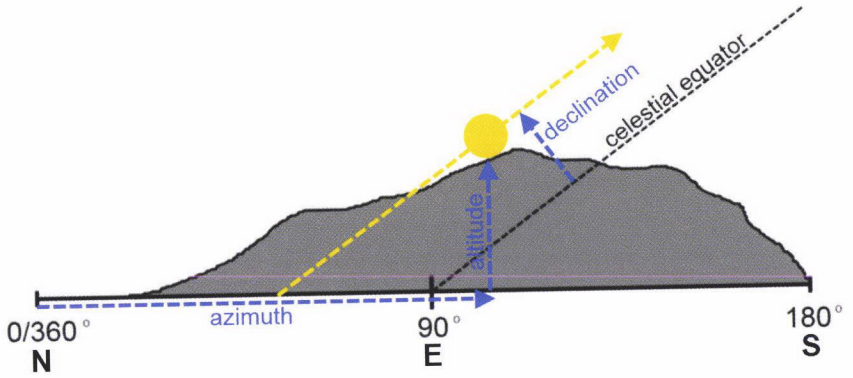

Figure 2. Basic concepts of positional astronomy used in this paper. The view is towards the eastern horizon and sunrise. Azimuth and horizon altitude are used to obtain the declination, which is the distance of an astronomical object from the celestial equator. At the level of zero horizon, positive values of declination are north of true east (E) and negative values are south of it. Declination is independent of the observer's latitude and is therefore often preferred to azimuth. On the equinoxes, the sun has the declination 0 and crosses the celestial equator. On the summer solstice, the sun reaches its maximum declination of +23.5 degrees, and on the winter solstice, the sun is at its minimum declination of –23.5 degrees.

2. Measurements

The orientations of the 81 churches were measured from the aerial orthographic photos provided by the National Land Survey (NLS 2012). Orthographic photos are used in map making and have already been corrected to the 2D orthographic projection, which allows them to be used, e.g., for reliable estimates of surface areas and directions.

Since Finland is located between the northern latitudes of ca. 60–66 degrees, the difference between a map (grid) north and the true (meridian) north can be up to more than 6 degrees due to the cartographic projection used, increasing clockwise from the longitude 27 towards the west, and anticlockwise towards the east. Thus, a correction to compensate for the meridian convergence was made to obtain the true orientations, relative to the direction of the true north, from the values measured from the orthophotos.

To estimate the reliability of the orthophoto measurements, 19 churches (Hattula, Hauho, Hollola, Janakkala, Lammi, Lempäälä, Lieto, Maaria, Masku, Messukylä, Mynämäki, Porvoo, Raisio, Renko, Rusko, Sipoo, Sääksmäki, Tuulos, Vanaja) were also measured on site. The on-site measurements were made with a compass. A long rod was placed along the

church wall to obtain the general direction of the wall and to prevent direct physical contact between the compass and the possibly magnetic wall stones. Possible local magnetic anomalies of the bedrock were eliminated both by measuring the direction relative to solar position and towards two opposite directions along the walls. The walls were measured at every corner of the rectangular main hall of a church, thus resulting into at least eight different measurements. Only the orientation of the original Medieval main hall of the church was measured, all later additional structures were ignored. In addition, the long axis of the church was measured by taking the direction perpendicular to the walls in the middle of the ends of the main hall, i.e., the direction along the main isle. The direction of the axis was, in principle, then to be taken as the mean value of the ten measurements. However, the four walls of Medieval churches rarely form a strict rectangle, and it in fact it turned out that the walls of the main halls of several churches were all oriented to different directions with considerable deviations from parallel and perpendicular relative directions. Therefore, the values measured for the short end walls were left out in the cases where it was clearly observable in the measurement results, as well as in the plans of the churches given in Hiekkanen (1994), that the orientations of the end walls relative to the long side walls deviated considerably from the strictly perpendicular direction, i.e., the angle of 90 degrees. In these cases, the on-site measurement result was taken to be the average of several measurements along the long side walls, as well as, in most cases, the general direction of the long axis.

In Table 1, the results of the on-site and the aerial photographic orientation measurements for the 19 churches measured on-site are shown. The average difference (mean absolute error) between the orientations measured from aerial photos and the on-site measurements made with a compass was ca. 1.2 degrees in azimuth. This error is of the same order as the maximum error of the compass measurements, which was estimated to be 1–2 degrees. In Southern Finland, an error of 2 degrees in azimuth corresponds to 2–3 days (48–72 hours) deviation from the day of the obtained sunrise position around the equinoxes; in late July in Medieval times, when the Julian calendar was used, it corresponded to a deviation of 3 days. These limits correspond to ca. 1 degree in declination. The maximum error caused by the use of orthophotos was 3.2 degrees in azimuth, corresponding to about 2 degrees in declination and 5–6 days in February–April and August–October.

Because of the error limits obtained, the feast days given in Table 1 for a certain church orientation were limited to the closest feasts within 2 days (48 hours) of the calculated exact sunrise days. Because of the maximum error of +/–3.2 deg in azimuth, some churches will in reality not be oriented to the days given in Table 1. One should therefore not put too much emphasis on the individual dates presented except in the cases of the churches that

were measured on site. However, the feast days listed in Table 1 give a good overall look at the feasts that were celebrated in Medieval times in the part of year towards which the majority of the churches had their orientation, and, for the majority of the churches, the results obtained are accurate enough to give rough estimates on the feast days possibly related to the orientations and to trace the accurate form of the orientation distribution.

The horizon heights were calculated from maps, because in most cases the original horizon is no longer visible due to the surrounding buildings and other changes in land use. In the calculation process, it soon became obvious that carefully reconstructing the ancient vegetation cover and horizon line around each of the churches was outside the practical possibilities of this study. Also some archaeological Geographic Information Systems (GIS) modelling studies of the landscapes around prehistoric sites have concluded that, generally, it is very difficult or even impossible to reconstruct the ancient vegetation cover (Boaz and Uleberg 1995, p. 253–254; Pietiläinen 1999). The error caused by the unknown vegetation cover around the church at the time the orientation was made is thus basically unknown. However, it is known that the landscape around the villages and other centres of inhabitation was more open in the early historical times in Finland than it is today. This was due to the larger number of fields that, because of the inefficient cultivation methods, were required to produce the amount of grain needed for subsistence, and to the slash-and-burn cultivation method that effectively left out large parts of the forest cover cleared out at any given time (see, e.g., Taavitsainen et al. 1998).[4]

Because of the open late Iron Age and Medieval landscape, we can thus assume on a reasonable basis that the error caused by the vegetation cover is usually limited to the unknown height of the forest tree line at some distance from the church. A 15 m high tree line at the distance of 1000 m from the church would correspond to the height of about 1 degree. Taking into account that the orientations can be to the upper limb, the lower limb, or the centre of the solar disk (note: the diameter of the solar disk is ca. 0.5 deg), the minimum error caused by the horizon height of 1 deg corresponds to ca. 1 deg in azimuth (from a lower limb orientation to an upper limb orientation), which, in turn, corresponds to less than 1 day. Thus, the error caused by the horizon height uncertainty is, in most cases, not significant compared to the other sources of error. Moreover, it was observed that the lines of sight from many churches towards the direction of orientation are towards an open landscape, such as the open sea, a bay area, a lake, a river, a river delta, or lowlands covered by fields. Naturally, each case should be separately investigated on site to reconstruct and determine the exact hori-

4 The damage caused by the slash-and-burn cultivation to the forests was, in fact, so extensive that the method became prohibited in the 17th century (Taavitsainen et al. 1998, and refs. therein).

zon height at the time of the building of the church. At the time being, this important challenge is left for future investigation.

3. Results and discussion

In the following, the orientations of the 81 Finnish Medieval churches are analysed. First, the orientation distribution for all the churches is analysed along with some of the orientations of individual churches. Then the churches of different ages are compared to reveal possible differences in the orientation based on the building period. Third, the orientations of the churches belonging to six different geographical regions are compared. Finally, the meaning of the church orientations to the Medieval parish members is discussed.

As a prerequisite for the analysis presented in this paper it was necessary to assume that when a stone church was built, its orientation was determined anew, i.e., that the orientation of a possible preceding wooden church was not simply replicated. This seems to be supported by the ruins of Koroinen, where there are two different sets of wall structures oriented to slightly different directions (see Hiekkanen 2007, p. 184–187). However, if the orientation of a previous wooden church on some site had been used to determine the direction of the axis of the new stone church, this would cause a maximum error of 2–3 days in the determination of the original intended calendrical day corresponding to the orientation, since the use of the Julian calendar would have caused the annual dates to move that much relative to the solar year during the couple of hundred years that would have passed since the first wooden church had been built.

For what follows it is also important to note that during the timespan the stone churches were built in Finland, from ca. 1260 A.D. to 1560 A.D., the slow shift of the dates of the Julian calendar relative to the solar year caused the equinoxes to move about 2.3 days backwards, from the 13th–14th of March to the 10th–11th of March, and from the 15th–16th of September to the 13th–14th of September. Thus, whenever an outdated or otherwise erroneous astronomical equinoctial date was used in a calendar, even the day when the astronomical equinox was supposed to happen could be ambiguous. For example, in the early 16th century the 12th of September was marked as the autumn equinox in some calendars (see Vilkuna [1950, p. 263] for the marking of the prayer book of Bishop Mikael Agricola), while the actual equinox happened closer to the 14th of September. Also in the wooden runic staff calendars, which could be copied and used for several centuries, the given date of the astronomical equinox had often become outdated. The feast of the Holy Cross on the 14th of September, which in the early Medieval period coincided with the astronomical autumn equinox,

could be seen as the day of the astronomical equinox for many centuries after.

In addition, there were other ambiguities in the definition of the equinoctial day, causing the possible number of 'equinoxes' to grow rather large. The 'Greek' or 'Nicaean' spring equinox, used in the computation of Easter, was on the 21st of March, in the place where it had been fixed in 325 A.D. by the Nicaean council – causing the true, astronomical equinox to continue to shift relative to Easter so that by 1200 A.D., the true equinox was about one week earlier than the Nicaean equinox. The corresponding calendrical autumn equinox was the 20th or 21st of September, the latter of which was also the feast day of Apostle Matthew, the Finnish *Syys-Matti*, i.e., 'Autumn-Matt'. There were also the (original) equinoxes of the Roman calendar: the 25th of March, which had become the Christian feast of the Annunciation, and the 24th of September. Finally, also the 18th of March, when the sun was supposed to move into the sign of Aries, and the 17th of September, when the sun was to enter Libra, could be considered equinoxes in the early Medieval church calendars, the kind of which were used by the clergy also in Finland (McCluskey 2010).

Because of the many different definitions of the equinox, the azimuthal range of sunrises corresponding to the days when the 'equinox' could be taken to happen was wide: in Southern Finland, the equinoctial azimuths span from ca. 78 deg (the sunrise of the 25th of March) to 98 deg (the sunrise of the 24th of September), i.e., a range of about 20 degrees around the direction of the true east, with most of the 'equinoctial' azimuths on the NE side of the azimuth 90. The corresponding range of declinations was from +5.1 deg to −3.8 deg.[5]

Obviously, also the solstices and other important solar events shifted similarly in the Julian calendar. In the Middle Ages, the solstices were in mid-June and mid-December, while the Roman solstices had been on the 25th of December and the 24th of June (which explains why those dates had subsequently become the birth days of Christ and John the Baptist, respectively). Even today, the effect of the Julian calendar can still be seen in the beliefs and traditions associated with certain feast days that coincided with the Julian solar key dates. For example, in Scandinavia, the traditions of the popular winter festival of light, the feast day of St. Lucia on the 13th of December have obvious roots in the calendrical location of the true winter solstice of Medieval times. In Sweden and Finland, the Gregorian calendrical system was only adopted in the latter part of the 18th century, when the building of the Medieval style stone churches had long ago ceased.

5 The values were calculated for Tampere (61.5 deg N, 23.8 deg E) in 1450 using the Julian calendar.

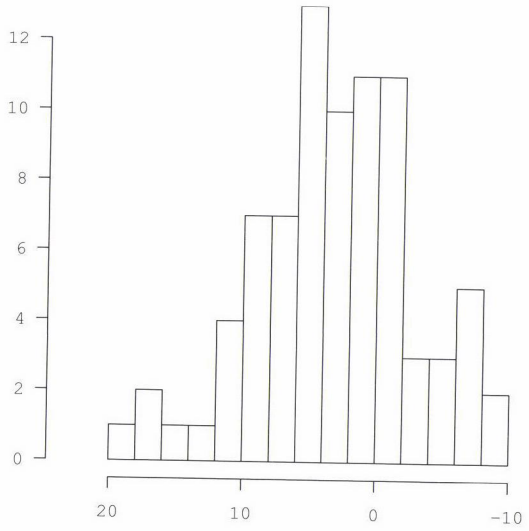

Figure 3. Declination distribution for the orientations of 81 Medieval churches in Finland. The axis has been inverted to place the positive (northern) declinations on the left, to correspond to the view towards the eastern horizon, where the north is on the left side of the observer.

3.1. Declinations of all churches: general distribution and individual peaks

From the data presented in Table 1 and the declination distribution presented in Figure 3 it can be seen that the orientations of all of the churches fall between declinations –9.4 deg and +18.2 deg. This is well within the annual solar range. However, most of the orientations in the distribution are confined between declinations –9.4 deg and +11.8 deg, whereas the declinations close to +18 deg form a peak separate from the bulk of the distribution. While all orientations fall within the range of sunrises from mid-February to the beginning of May and from late July to early October, 95% of the orientations correspond to the period from mid-February to mid-April and mid-August to early October.

The most prominent peaks of the declination distribution can be related to the different definitions of the time of year when the equinoctial sunrise could be taken to occur. Declinations closest to 0 deg correspond to the true east and to the true, astronomical spring and autumn equinoxes, which between 1250 A.D. and 1550 A.D. could occur on the 10th–14th of March and on the 13th–16th of September (in the Julian calendar, which was in use when the churches were built; hereinafter, all dates are given in the Julian calendar, unless otherwise stated). However, as seen above, the dates of the astronomical equinoxes given in the calendars of the period may occasion-

ally have been a few days in error, which widens the possible declination range of the 'true' equinoxes.

In the times of the Julian calendar, the limit of ca. –2 deg seen in the distribution corresponded to the Nicaean autumn equinox (the Finnish 'Autumn-Matt', see below) and the sun's entry to Libra on the 17th of September, both of which could be seen as equinoxes and, consequently, be used to determine the direction of 'true east' as the direction where the equinoctial sun rose. In the spring time, the declinations roughly between –1 deg and –2 deg did not correspond to any important feasts (the feast day of St. Thomas Aquinas was on the 7th of March, but he is not known to have been widely venerated in Finland). The declinations between +1 deg and +2 deg, on the other hand, can be related to the sun's entry into Aries on the 18th of March and possibly to the feast day of St. Gertrud on the 17th of March, although she is not known to have been among the most popular saints in Medieval Finland (Vilkuna 1950, p. 68). In autumn, the declination of +2 deg was close to the Nativity of Mary on the 8th of September, a few days before the astronomical autumn equinox.

At the declination of ca. +5 deg is the peak corresponding to the feast of the Annunciation, the original Roman spring equinox as it was at the start of the Julian calendar.[6] In Medieval Finland, as in many other countries, the feast of the Annunciation had, together with Easter, effectively absorbed all possible pre-Christian beliefs and rites, most importantly, the solar rites connected to the equinox. This can be seen in the sun-related folk beliefs and practices concerning those feasts, e.g., that the rising sun dances on the Easter Day, the burning of Easter bonfires, and the custom of casting omens in the nights both before the Annunciation and the Easter Day (Vilkuna 1950, p. 73, 90–97). On the Finnish runic staff calendars the feast of the Annunciation as well as other feast days of the Virgin are marked with a solar symbol – a practice, which is tell-tale of the original solar connection of those festivals (Ridderstad 2013a, 2013b). In Finland, the deity that had been replaced by the Virgin was the Finnic solar goddess Päivätär (Siikala 2002; 2012, p. 288, 295, 479; Ridderstad 2013a, 2013b).

The orientations from ca. –7 to –9.5 deg at the negative side limit of the declination distribution corresponded to the sunrises of late February and early October. The individual orientations could be to the sunrises of the feast days of St. Sigfrid on the 15th of February, the Cathedra of St. Peter on the 22nd of February, St. Francis of Assisi on the 4th of October, and St. Bridget on the 7th of October. Of these, the feast of St. Bridget most fre-

6 The original Roman spring equinox on the 25th of March according to the Julian calendar seems to have been defined as the day of the sun's entry into Aries, while the sun reached the declination 0 a few days later.

quently appears in the oldest Finnish runic staff calendars, many of which can be traced back to the Medieval period (Pöyhönen 2013). St. Bridget is known to have been a popular saint in Scandinavia and Finland in the late Middle Ages and many churches were dedicated to her (see Table 1).

The declinations from ca. –4 to –5 deg corresponded to the Roman autumnal equinox on the 24th of September. In Medieval Finland, that day fell between two important late autumn feasts: the feast day of Apostle Matthew on the 21st of September (*Syys-Matti*), which coincided the Nicaean autumn equinox, and the feast of St. Michael the Archangel (Finn. *mikkelinpäivä* or *mikkeli*) on the 29th of September. Both of these could be taken as the last day of the 'summer half' of the year (Vilkuna 1950, p. 265–273). After 'Autumn-Matt', many winter tasks were started, and it was, for example, believed that the bear went for his winter sleep. The agricultural year ended by the time of *mikkeli*, and in many regions in Finland as well as in Estonia a special ram or a sheep would be slaughtered and eaten in a festival on that day to ensure good fortune for the next year's agricultural yield – a custom with obvious pre-Christian roots and one that had probably originally belonged to the ancient Finnic new year's festival *kekri* in late October (Vilkuna 1950, p. 268–273). *Mikkeli* was a day off for the household staff and on the following week they could either renew their contracts or make new ones in other households (Vilkuna 1950, p. 271). See Table 1 for the many churches dedicated to St. Archangel Michael.

In late winter, the declination –5 deg was only a few days off from the feast day of Apostle Matthias (the Finnish *Talvi-Matti*, i.e., 'Winter-Matt') on the 24th of February. 'Winter-Matt' marked the start of the last days of winter: the snow had already started to melt (Vilkuna 1950, p. 45–48). The declinations close to –5 deg thus approximately corresponded to the start and end of the winter period in ancient Finland. It was said that Winter-Matt "throws a hot stone into the lake" (Vilkuna 1950, p. 46; a corresponding belief about "a cold stone" was attached to the day of St. Jacob in July, see below). According to folk belief, the bear, who had fallen asleep on the Autumn-Matt, awoke on the Winter-Matt (Hautala 1948, p. 57). The two days of 'St. Matt' thus formed a pair in the Finnish calendrical tradition, similar to many other feasts (e.g., the Christian feast days of the Holy Cross, the feast days of St. Henry, etc., as well as the pre-Christian Winter and Summer Nights). In the Finnish runic staff calendards, the two days of Matt together formed the most popular pair of feasts: they were marked in almost every calendar and had more markings than the feast days of the Nordic kings St. Olaf, St. Eric and St. Cnut combined (Pöyhönen 2013).

In the spring, the declinations between ca. +6 deg and +12 deg corresponded to the sunrises from late March to mid-April. No important feast days of saints are known to have fallen on those dates in Medieval Finland.

The feast day of St. Ambrose was on the 4th of April, but he is not known to have been popular in Medieval Finland and his feast is marked in few Finnish calendar staffs (Pöyhönen 2013). The orientations falling on this period could be related to Easter Day sunrises. The middle point of the possible calendrical positions of Easter falls around the 7th of April, corresponding to the middle point of the declinations between ca. +3 deg (the Nicaean spring equinox) and ca. +16 deg (the last possible day of Easter) in Figure 3.

In autumn, the declinations of +6–12 deg corresponded to the days from mid-August to the end of August. The two most important feast days falling on that range of dates were Mary's feast of Assumption on the 15th of August and the feast day of St. Bartholomew on the 24th of August (Finn. *pärttyli*), which was one of the key days marking the beginning of autumn (Vilkuna 1950, p. 213); the second feast day of St. John on the 29th of August was not as popular.

The declinations of ca. +12–13 deg corresponded to the sunrises of an important Nordic calendrical event: 'Summer Nights' on the 13th–15th of April, which traditionally started the summer half of the year. Correspondingly, there were Winter Nights, which started the winter, on the 13th–15th of October (Vilkuna 1950, p. 283–285). Winter Nights, however, fall outside the observed declination distribution by about one week. As mentioned above, *mikkeli* could be taken as the last day of summer. Winter Nights then occurred about 15 days after that – a difference, which corresponds to one half of the lunar synodic month.[7]

Summer Nights and Winter Nights were part of an ancient four-fold division of the year used by the Finnic peoples probably already in the Iron Age: Summer Nights and Winter Nights divided the year according to the two seasons, and the 'Bear Days', the Heart of Winter on the 14th of January (the Bear's 'Turning Day') and the Midsummer Day on the 13th of July (the Bear's Birth Day) marked the seasonal temperature-based low and high points occuring a few weeks after the solstices. A similar four-fold division, originally based on the lunar calendar, was also at use in late Iron Age and Medieval Scandinavia, but without any known connection to the bear.

One may notice that Summer Nights and Winter Nights occurred a couple of weeks before the solar mid-quarter days in the beginning of May and November. However, in the annual division based on the Bear Days, the two popular Medieval feasts 'Winter-Matt' and the day of St. Bartholomew on the 24th of August corresponded to the calendrical midpoints, the 'mid-quarter days' between Midwinter and Summer Nights, and Midsummer

7 It has been suggested that this calendrical arrangement had its origin in the ancient Fennoscandian lunar calendar: Summer (Winter) Nights would have been the time of the full moon of the first summer (winter) month (see Vilkuna 1950, p. 284–285). This would explain why Summer/Winter Nights last for three days: that corresponds to the brightest phase of the moon. On the other hand, the time of the absence of the moon, the new moon, also lasts about three nights (depending on visibility conditions, as the thin first or last crescent is hard to see).

and Winter Nights, respectively. The Finnish folk beliefs related to these two feasts, as well to the feast days of St. Urban on the 25th of May and St. Catherine on the 25th of November indicate that all of those four feast days probably belonged to some ancient year division system, perhaps to an eight-divided 'Bear year'. [8] The eight-fold division of the solar year by two solstices, two equinoxes, and four mid-quarter days, which was used, e.g., by the Celtic and Baltic peoples, was probably known in some form by the Finnic peoples (or their ancestors) from very early on, since both the Finnic New Year's festival *kekri*, as well as the spring festival *vappu* (the feast day of St. Valborg, the present May Day) seem to be based on this Indo-European custom of dividing the year into eight parts.[9] It is difficult to evaluate, which one of these different types of dividing the year, the solar Indo-European one or the 'Bear year' is more ancient. The significance of these old calendrical systems to the church orientations arises from their contribution to the impact individual feast days belonging to these annual divisions had in the Medieval festival calendar and possibly also in the church orientations in Medieval Finland and Scandinavia, although, by that period, their pre-Christian connections may not have been fully recognized.

Two churches, those of Vihti and Hollola, were oriented towards more northerly declinations than the others. Their orientations corresponded to the sunrises near the beginning of May and the end of July. The declinations of some other churches, e.g., Masku, Rusko, and Sastamala were also relatively large, but those still fell inside the Easter period.

The orientation of the church of Holy Mary in Hollola was towards the sunrise of the feast day of St. Jacob on the 25th of July, or possibly *vappu* on the 1st of May or the Feast of the Cross on the 3rd of May (see Table 1). The orientation of the church of Vihti was towards the sunrise of the feast of the Holy Cross on the 3rd of May or the feast of St. Mary Magdalene on the 22nd of July. Within the error limits of 2 days, also the church of Vihti could be oriented to the St. Jacob's day. Both churches thus had orientations that closely corresponded to two festivals of essentially pre-Christian nature: *vappu* and 'Ukon pyhä', the feast day of Ukko, the Finnic god of heavens, thunder and rain.

The significance of *vappu*, the present May Day, which has traditionally been celebrated especially in Western Finland, arises from the fact that it

8 The feast day of St. Urban, who otherwise was an insignificant saint in Finland, was regarded as the start of summer, which is tell-tale of the ancient calendrical significance of the day or the days nearby. Also, in Finland, St. Catherine became the protector of cattle from beasts, e.g., the bear – a detail, which has been difficult to explain, but is easy to understand in the context of the connection of the calendrical location of her feast day to the bear cult (see Vilkuna 1950, p. 132, 310–314).

9 The latest linguistic research shows that the Samí and the Finnic peoples lived near the Bay of Finland and the Indo-European Baltic peoples at least since the Bronze Age (see Häkkinen 2010a, 2010b; and refs. therein). The IE influence had started even before this in 2000–3000 B.C. in the area of mid-Volga and mid-Urals in Asia (Parpola 2005).

is a Nordic pre-Christian spring festival corresponding to the solar mid-quarter day at the beginning of May, i.e., the Celtic Beltaine. The feast day of Ukko, on the other hand, was celebrated in Eastern Finland well into the 17th century (Vilkuna 1950, p. 192). In Finland, St. Jacob, who was called the 'Pointed-hat' or 'Broad-hat', apparently had many properties that can be connected to an earlier agricultural deity, a protector of grain, in addition to the epithets of a weather god (see Vilkuna 1950, p. 190–194). Those mixed roles are easy to understand on the basis that weather deities always have central roles in agricultural rites, too. Thus, the cult of St. Jacob seems to have replaced some pre-Christian practices.[10]

Hollola is located in Eastern Tavastia and Vihti in Western Uusimaa, close to the southern border of Tavastia, which it had been part of in the early Middle Ages. The parish of Vihti once was a border region of the Lohja parish (Hiekkanen 2003, p. 213). Pre-Christian customs and beliefs could thus have thrived there more openly than in more central areas. However, according to current knowledge, Vihti was largely uninhabited before the Medieval period, and the settlers would thus most probably have been no less Christian than elsewhere near the southern coast of Finland. Hollola, on the other hand, is located deep in the inland and was, in Medieval times, a border region relative to the more central areas of Tavastia. In Hollola, the first church and graveyard were located in Kirkailanmäki, ca. 8 km away from the local Iron Age centre, where the present church was built in 1495–1510 A.D. (Hiekkanen 2003, p. 234–235; 2007, p. 296–297). As Tavastia accepted Christianity somewhat later than Western Finland, moving the centre of the Hollola parish into its present location could reflect the general acceptance of Western Catholic Christianity in the region, including areas that had previously been sheltered from its influences. The peculiar orientation of the Hollola church could thus result from an active attempt to replace the local pre-Christian cult centre with a new Christian one. However, when the stone church was built in the end of the 15th century, the region must already have been largely Christian. A possible explanation for the seeming dilemma is that the first denomination of Christianity accepted by the people of Hollola parish had been Eastern Catholic. The Eastern Orthodox Church is known to have been more tolerant towards the practices of the old vernacular religion (Siikala 1992, p. 288–291). The local pre-Christian worship site at the Iron Age centre could have been preserved intact, which no doubt would have encouraged small-scale vernacular ritual activity to continue there until the present stone church was built in Medieval times. This kind of development could have caused the features of the pre-Christian religion to become visible in the new church building, as the

10 Some of the many weather and temperature-related beliefs connected to St. Jacob may have originally belonged to the cult of the Bear's Birth Day in mid-July, which marks the warmest days of summer.

practices previously embraced by the local Eastern form of Christianity had to be taken into account, when the locals were to become supporters of the Western Catholic Church.

From the declination distribution it can be seen that the late autumn and winter time from mid-October to mid-February was avoided in the church orientations as well as the late spring and summer season from May to the latter part of July. The churches were oriented mainly to the sunrises in the spring time before Summer Nights and *vappu* and in the autumn before Winter Nights and *kekri*, at the same time avoiding both the solstices and the ancient bear-related days the Heart of Winter and the midsummer 'Bear's Birth Day' by at least one lunar month.

Determining the orientation of a church and starting the building work would have been easier when there was no snow cover, which, in principle, could be related to the lack of winter period orientations of the churches. However, during the Middle Ages the annual temperatures varied greatly, being higher than today in 950–1250 A.D. (the so-called Medieval Warm Period) and then approaching the cold temperatures of the Little Ice Age towards the end of the 15th century (see Mann 2001a, 2001b). In some years, there would have been winters with little or no snow, and in some years, the first snow probably fell in late October or early November, as it does today. Nowadays, the snow cover usually starts to melt by the end of February and is largely gone by mid-April in Southern Finland. The snowiest time thus approximately fell between the calendrical dates corresponding to the observed negative limit of the declination distribution. However, this relation does not hold for the earliest centuries of church building in Fennoscandia, as they were warmer. It is also known from more recent history that any local communal building work was preferably done in winter time so that it would not disturb the agricultural tasks.

Indeed, there may be another reason why no churches were oriented to the sunrises of the winter period: that dark time of year had traditionally been the time connected with the dead and the underworld in the pre-Christian religions of Northern Europe. The church builders may therefore have made a conscious decision not to orient any churches to the sunrises of late autumn and midwinter – especially as the practices and beliefs of the old religion still thrived next to the Christian faith in many places during the Middle Ages in Finland.

The traditional Finnish Christmas is essentially a remnant of the late Iron Age Nordic midwinter festival with its many pre-Christian customs and was probably adopted in its present Christianized form from Scandinavia in the late Iron Age or early Medieval period (Vilkuna 1950, p. 335–336). Also avoided was the time of the pre-Christian Finnic agricultural New Year's festival *kekri*, which was celebrated in late autumn around the end of October

and beginning of November. *Kekri* ended or started the lunisolar intercalary period of 12 days (Vilkuna 1950, p. 290–297). During the time of *kekri* and the associated intercalary period, spirits of the ancestors roamed the earth and were to be appeased by offerings. Rites were equally performed to ensure the next year's income (cf. the sacrificial ram of *mikkeli*, see above). *Kekri* thus had many similarities with both the Samhain festival of the Celts, similarly celebrated at the beginning of November, and the Scandinavian New Year, *jul* (related to Germanic *Yule*), which was celebrated at the time of winter solstice (Vilkuna 1950, p. 335; Ruggles 2005, p. 265). Those similarities are not surprising, since already in the Iron Age, the cultural traditions of Finnic peoples must have been strongly influenced by the Scandinavian festival traditions, as well as the traditions of the Balts, who also employed the Indo-European custom of dividing the solar year into eight parts.

The declination distribution also proves that the time of sowing, planting and haying season from early May close to the end of July was avoided in the church orientations as well as the winter period. The intensive agricultural tasks alone do not explain the lack of church orientations towards the sunrises on those dates – the 18th of June, for example, was one of the great feast days of St. Henry, the patron saint of Finland, and the feast of the Visitation on the 2nd of July was equally important (Vilkuna 1950, p. 151, 177).

It is known from historical records that rites were generally performed in connection with the sowing time that was mainly from May to June; at the summer solstice; and at the time of haying and harvest, which was mainly in July—August (see, e.g., Vilkuna 1950, p. 134–257). Similar to the rites performed in the late autumn, the spring and summer rites had their roots in the late Iron Age Finnic vernacular religion, and the main points of the rites of the summer and winter periods were essentially the same: the ensurance of fertility and security. For example, the famous poem of the robbery of *sampo* was still sung during the sowing time in 19th century Carelia (e.g., Vilkuna 1950, p. 185).

Thus, it can be suggested that the strong connection of the sowing time, *kekri*, high summer and high winter with the traditions of pre-Christian practices may have caused avoidance of church orientations towards the sunrises of those periods. There were some counterexamples to the general practice, however, in the regions where Christianity arrived latest, as seen above. Also, for some reason, Summer Nights and Winter Nights do not have as many 'pagan' customs attached to them and were not avoided in the church orientations as much as the clearly pre-Christian Bear Days, the solstices, or the mid-quarter days *vappu* and *kekri*. Perhaps the pre-Christian nature of Summer Nights and Winter Nights had been erased simply by the fact that they fell inside the Easter period.

One more reason for the avoidance of the summer and winter period sunrises in the church orientations could be related to the fact that at the latitudes of Finland, the midsummer and midwinter sun rise close to the cardinal directions, i.e, the north-south (N-S) line. The N-S orientation is often seen in the late Iron Age graves of Finland and also Northern Europe in general, where it has been interpreted as a sign of pre-Christian burial (see, e.g., Cleve 1943, p. 53; Purhonen 1998, p. 218–237; Trotzig 1983, p. 374–375; Watts 1991, p. 196, and refs. therein; Pluskowski and Patrick 2003, p. 35, and refs. therein; Mejsholm 2008, p. 38–40, and refs. therein; Zugaiar 2012). The orientation along the N-S line can be related to some central beliefs of the pre-Christian Finnic vernacular religion. The Finnic runic folk poetry tells us that Päivölä (cf. Finn. *päivä*, the sun), the ever sunny and warm habitat of gods was located in the South, while Pohjola (cf. *pohjoinen*, the north), a dark and gloomy place connected with death, albeit also the location of the world pillar that supported the sky, was in the North (Siikala 2012, p. 168–177; Ridderstad 2013b). This kind of polarization between the north and the south in the belief system of the time could explain why the direction of the meridian line was favoured in the orientations of the late Iron Age burials in Finland while, on the other hand, the strong connection of the pre-Christian Finnic mythology to the meridian direction also provides an explanation for the avoidance of the solsticial directions in the orientations of the Medieval churches of Finland.

In conclusion, in Table 1 it can be seen that, within the error limits of 2 days, most of the individual church orientations (59%; within the larger error limits of 5 days the result is 69%) can be connected to some definition of the equinox and, consequently, a direction relatively close to the true east. Also, a significant portion of the orientations (41%, or 57% within the 5-day limit) can be interpreted to have a connection to some of the feast days of the Virgin. However, these two explanations are not mutually exclusive: the feasts of the Annunciation and the Nativity of Mary can both be connected to some definition of an 'equinoctial' orientation. The connection for the latter arises from the observation that in some years of the 13th century, on the on the Nativity of Mary, the 8th of September, the sun rose at the same position as it did on the day of the Nicaean spring equinox, the 21st of March.

In general, orientations to the sunrise on the day of the patron saint of the church do not play any significant role in the Finnish church orientations. This is the case even as we know that some churches had more than one patron saint and that the original patron saints of some churches may have been changed or forgotten. Already the basic form of the orientation distribution reveals that the orientations are concentrated on the sunrises of a specific part of the ecclesiastical year, while the feast days of the saints cov-

er the course of the whole solar year. For example, the important feast days of St. Henry, the patron saint of Finland, which were the 20th of January and the 18th of June, are left outside of the range of the sunrise declinations seen in the distribution of Figure 3. In Table 1, almost all cases where the day of the patron saint coincides with the actual orientation of the church are days which are close to the equinoxes and/or important calendrical and festival days in any case, e.g, the many feast days of the Virgin. The only case where the orientation of the church may have been determined especially towards the sunrise on the feast day of the patron saint is the church of Pertteli, where the patron was St. Bartholomew (Finn. *Pärttyli*, *Perttyli*, or *Pertteli*). Moreover, further calendric considerations reveal that the feast days of the three Nordic kings, which top the list of most popular feasts in the Finnish calendar staffs (Pöyhönen 2013), are nearly absent in the church orientations. In fact, the failure of the patron saint hypothesis should not be surprising, since, as McCluskey (2010) pointed out, there is no mention in the Medieval texts that a church could be oriented to the sunrise on the feast day of its patron saint.

As seen above, some of the orientations could be to Easter Day sunrises. However, while the range of Easter sunrise orientations (from ca. +3 deg to +16 deg in 1250–1550 A.D.) is inside the observed extremes of the declination distribution, the overall distribution extends beyond the limits of the Easter period orientations, and Easter orientations cannot be singled out from the rest of the distribution as most of the individual orientations have other possible explanations as well. Easter orientations also seem somewhat unlikely considering the Nordic tradition prevailing also in Western and Southern Finland, where Christmas is, in practice, the main church festival of the year, overcoming even Easter in importance. If there were deliberate orientations towards Easter sunrises, those could have been made by the clergy or foreign builders of the church. It is also possible that since, ecclesiastically, Easter is more important a feast than Christmas, the first Christian parishes of Finland would have wanted to stress out its importance and purely Christian nature relative to other annual festivals of the time by orienting many of the first wooden churches of Finland towards the sunrise of the Easter Day a.k.a. the Resurrection Day. The orientation of a stone church may then have simply followed the orientation of the former wooden church on the site.[11]

11 After the submission of this paper, the discovery of the remains of the very first church from the 12th–13th century, located in the Ristimäki of Ravattula in Kaarina near Turku, was announced (University of Turku press release 4.9.2013 [UT 2013]; see also Ruohonen 2012). The church had been a small wooden building of Romanesque style in a surrounding graveyard. Based on the maps in the excavation report by Ruohonen (2012), the azimuthal orientation of the church was measured to be 56 degrees. Estimating the horizon height from the maps of the National Land Survey of Finland, the declination was calculated to be +16.57 degrees, which corresponded to the sunrise of the 1st of May in 1150 A.D. The orientation thus resembles the orientations of the Medieval churches of Hollola and Vihti. The orientation is also towards the Aurajoki river passage between two hills leading to the hillfort of Vanhalinna of Lieto.

The results obtained could not give any clues on the actual methods with which the orientating of the church axes were made. A compass may sometimes have been used, especially with the youngest churches of the sample, but the possible tell-tale deviation would probably have changed sign during the several hundred years in question and in any case cannot be distin-

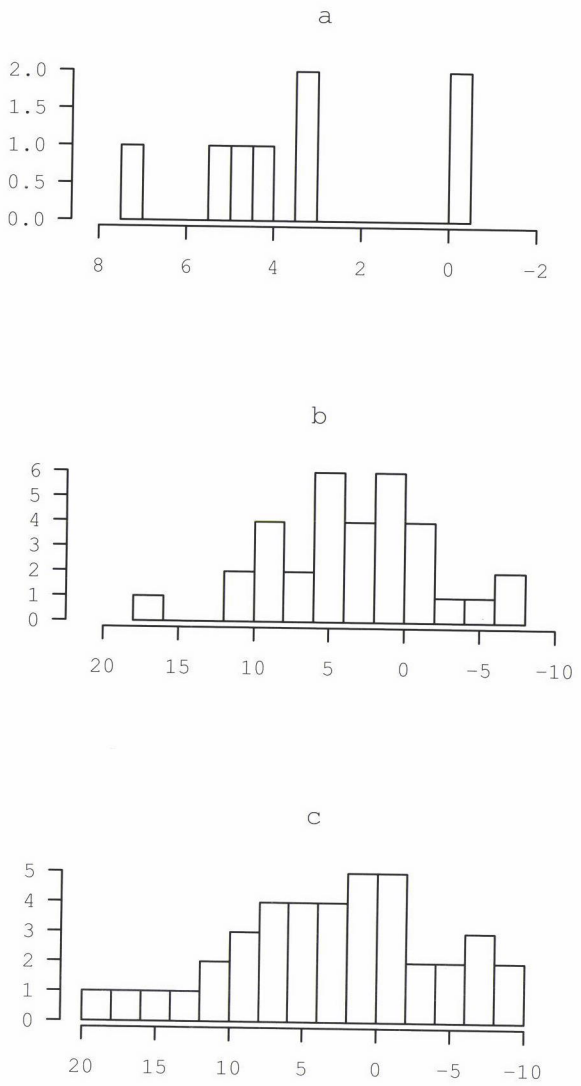

Figure 4. Declination distributions for the churches of the three different building periods defined in Hiekkanen (1994, 2007): Period 1 (a), Period 2 (b), and Period 3 (c). See the text for details. In the figure, the axis showing the declinations has been inverted, i.e., the north is on the left, the south on the right on the axis, to correspond to an observer's view towards the eastern horizon.

guished from the rest of the distribution. The general direction towards the east can of course be roughly estimated also by observing the highest point of the sun's daily course at noon: the eastern direction is perpendicular to the meridian line (the N-S line). Most likely the orientation was made simply by observing the sunrise; the rising point of the sun on the proper day may have been marked well in advance before the construction began.

3.2. Comparison by the period of construction

The churches can be roughly divided into three groups based on the building period as defined by the now generally accepted datings of the Medieval stone churches of Finland by Markus Hiekkanen (1994; see Table 1 for the datings of the individual churches by Hiekkanen [1994, 2007]). The churches of the oldest group were built approximately between years 1270 and 1400 (Period 1). They are located on Åland and in Finland Proper. The second group (Period 2) was built between ca. 1400 and 1480, the most intense phase being in 1440–60. Most of the churches of Period 2 were built in Finland Proper and Uusimaa. The last period of stone church building started ca. 1495 and continued until 1560 (Period 3). The churches of the last period were built mostly in Satakunta, Tavastia and Ostrobothnia.

From Figure 4, one can see that the churches in all three age groups have declination distributions roughly resembling the distribution of all 81 churches shown in Figure 3. The size of Period 1 group is very small, but the same main features can be observed in that one, too. The distributions peak close to the declination 0 deg corresponding to the equinoctial sunrise position, the maximum being slightly on the side the positive declinations, between –2 deg and +6 deg in all three cases. All three distributions are concentrated more on the side of positive declinations corresponding to the sunrises of spring and early autumn. Perhaps surprisingly, the two older age groups have narrower ranges of orientations than the youngest churches. Since the churches of different periods are concentrated on different geographical areas, also the differences between the regions must be analysed to reveal the possible reasons behind the observed differences between the age groups.

3.3. Comparison by region

The declination distributions for the churches of six different regions – Åland, Finland Proper, Uusimaa and Southern Carelia, Satakunta, Tavastia, and Ostrobothnia – are shown in Figure 5. The classification of the churches by region follows that given by Hiekkanen (2007). Although the sample

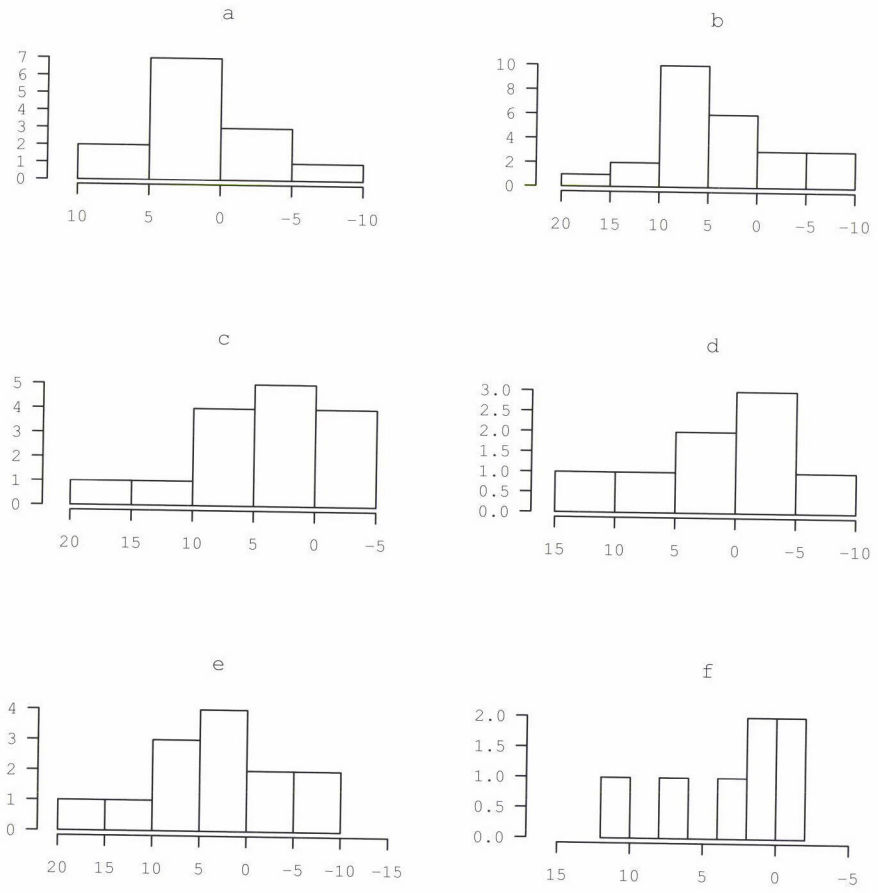

Figure 5. Declination distributions for the churches of six different regions of Finland (as defined in Hiekkanen 2007): Åland (a), Finland Proper (b), Uusimaa and Southern Carelia (c), Satakunta (d), Tavastia (e), and Ostrobothnia (f). See the text for details. In the figure, the axis showing the declinations has been inverted, i.e., the north is on the left, the south on the right on the axis, to correspond to an observer's view towards the eastern horizon.

sizes are small, many of the same main features that can be observed in Figure 3 and in Figures 4a–c are again detectable in Figures 5a–f. In all six cases, the declinations are mostly positive. In all but one case (Figure 5b, Finland Proper, which has its maximum between +5 and +10 deg), the declination maxima are located within the limit of 5 degrees on either side of the declination of 0 deg.

Most of the orientations of the churches of Åland (Figure 5a), many of which are among the oldest, seem to be towards the sunrises of the various equinoxes, with emphasis on the spring equinoxes (see also Table 1). The oldest of all churches in Finland, Jomala, is oriented to the sunrise of the Roman spring equinox, the feast of the Annunciation.

Of the many churches of Finland Proper (Figure 5b), only two are oriented close to the astronomical equinox at the declination of 0 degrees; five orientations are towards the sunrise of the Roman spring equinox. The declinations are scattered between about –8 and +16 deg, peaking farther north than any other distribution in Figure 5, between +5 and +10 deg – a range of declinations corresponding to the sunrises between late March and the first days of April, and the latter half of August. All of the orientations of the churches of Finland Proper are towards sunrises from late February to late April, and from the last days of July to early October. About half of the orientations allow an equinoctial interpretation (see Table 1). Most of the oldest stone churches in mainland Finland are located in Finland Proper and it is generally believed that Christianity arrived there earlier than to other parts of mainland Finland, with the exception of the westernmost parts of Satakunta. The churches of Finland Proper, however, are not very closely oriented towards true east, which could mean, e.g., that many of those were built on former pre-Christian cult places or that they have more orientations towards the sunrises of the Easter period than the churches in other regions. [12]

Like Åland, almost all of the churches of Uusimaa have an equinoctial orientation (within the 5-day limit, see Figure 5c and Table 1). The exceptions are the churches of Kirkkonummi, Pernaja, and Vihti.

With the exception of the church of Sastamala, all the churches of Satakunta (Figure 5d) are oriented towards the sunrises within ca. one month in spring or autumn, March or September, with the declination distribution peaking slightly on the negative side. Although the sample size is small, one may suggest that the observed distribution results from the intention to orient most of the churches approximately towards the equinoctial sunrise, with the emphasis on the autumnal equinoxes. The church with the largest absolute declination value, the church of Sastamala, was built on the site of a late Iron Age and early Medieval inhumation cemetery (Hiekkanen 2007, p. 256, and refs. therein). Similar situations occur in Masku in Finland Proper, where a late Iron Age inhumation cemetery is located right on the north-eastern side of the church, in the same direction towards which the church is oriented (+16.24 deg in declination), and in Janakkala of Tavastia, where the orientation of the church deviates almost 11 degrees in declination from the true east towards the NE (see Table 1; Hiekkanen 2007, p. 304; NBA 2013). While all the churches of Satakunta were built in Period 3, it must be noted that the westernmost Satakunta (the Eura-Köyliö region) is

12 The letter sent in 1229 A.D. from Pope Gregory IX to the bishop of Finland, which contains a permission to confiscate to the church the sacred groves and cult places of the pagans, has widely been seen as evidence that the remaining Finnish pre-Christian cult centres were forcefully taken by the church; the letter can also be seen as part of the development that lead to the conquest of Tavastia in ca. 1250 A.D. (see, e.g., Purhonen 1998, p. 141–142, and refs. therein).

believed to have been one of the first regions in Finland to become Christian, whereas the easternmost Satakunta (including, e.g., Nokia, Messukylä, Lempäälä, and Vesilahti) may have a history of conversion more similar to Tavastia, including the possible strong influence of the Eastern Orthodox denomination of Christianity (discussed above in the case of Hollola).

The declination distribution of Tavastia (Figure 5e) has the southernmost and some of the northernmost orientations. The southernmost one corresponds to the sunrises of mid-February and early October, and the northernmost one to the sunrises of the beginning of May and late July. Also with this region, about half of the orientations have a possible interpretation as equinoctial (see Table 1). A common feature between Tavastia and Uusimaa is that these two regions have the churches with the largest positive declinations of ca. +18 deg: Hollola and Vihti.

The orientations of the churches of Ostrobothnia (Figure 5f), all of which are among the youngest (Period 3) churches, seem to be mostly equinoctial. In this case, they are centred at the astronomical equinox, around the declination 0. One may also notice that the orientations of the Ostrobothnian churches are towards the sunrises within about one month from early March to early April, and from mid-August to mid-September.

It is interesting to compare the churches of Åland and Ostrobothnia, in average the oldest and the youngest set of churches. Both show equinoctial orientations. They can be compared with Uusimaa, which also has majority of its churches oriented to the (various) equinoxes. The reason for the observed feature is probably the same in all three cases: when these churches were built, organized Christianity already had a long history among the locals. In the case of Åland this means that the church builders probably came from some area which had been Christian for some time, e.g., Gotland, mainland Sweden, Denmark, or Germany. Indeed, it is believed that immigrants from Sweden inhabited Åland from ca. 1200 A.D. on (Hiekkanen 2003, p. 13). Of the occupants of coastal Uusimaa it is known that the region was inhabited by Swedish immigrants in 1100–1300 A.D. (Hiekkanen 2003, p. 13). The same is true for most of Ostrobothnia: Kokkola, Mustasaari, Närpiö, Pedersöre, and Vöyri (Hiekkanen 2007, p. 504, 512, 516, 520, 526, and refs. therein). In Isokyrö, the settlers were Finnish-speaking and probably already Christian (Hiekkanen 2007, p. 498). [13] In Keminmaa, on the other hand, the late start of constructing the stone church may have been affected by the late arrival of Christianity in the area.

13 In Åland and probably also in Southern Ostrobothnia, the settlers came to inhabit almost empty areas: even if lacunae in research are taken into account, the local pre-existing population must have been small based on the existing archaeological finds. The reason why so much of the outer coastal region had been practically abandoned in the late Viking Age is not known, but the time coincides with the datings of many hillforts in the inland and Finland Proper (see Taavitsainen 1990, p. 128, Table 17).

It can be seen in Figure 5 that the declination distributions of all regions, except that of Finland Proper, peak within 5 degrees of the true east. The simplest explanation would be that in most regions, an orientation as closely towards true east as possible was intended. However, an explanation is lacking for the fact that the distributions of all regions are clearly skewed towards the NE direction. This feature may be related to the different definitions of equinox, to Easter sunrise orientations, to pre-Christian influences, or to some unknown factor. The first of these possibilities was already shown above to be valid: especially the many orientations to the feast of the Annunciation create a peak on the side of positive declinations. However, the equinoctial orientations only span a relatively short range compared to the total widths of the distributions. The Easter orientations, on the other hand, are feasible but difficult to separate from other orientations.

If one specifically looks for large 'outliers' and, thus, possible pre-Christian influences in the orientations, those can be found in the churches of Vihti in Uusimaa, Hollola in Tavastia, Masku in Finland Proper, Sastamala in Satakunta, and possibly also in some other churches oriented more than ca. one month away from the sunrise of the astronomical equinox. Some of these churches were built on late Iron Age burial grounds (Sastamala, Janakkala). However, there are also those that were built on late Iron Age burial grounds but do not show such large deviations from the direction of the true east (Kaarina, Mynämäki, Tyrvää), and those that show large deviations from the true east but are not known to be situated on or near a former burial site (Lemu, Rusko, Pedersöre, Pernaja, Vihti). Sometimes there is a nearby burial ground that can contain pre-Christian as well as early Christian graves (e.g., in Hauho, Laitila, Masku, Sääksmäki, Tammela, Tuulos, Vanaja), often on the other side of a waterway (e.g., in Maaria, Nousiainen, Lempäälä). Some of the churches are close to a late Iron Age hillfort (e.g., Hollola, Lammi, Porvoo, Sääksmäki, Vanaja), which indicates that those churches were built right in the hearts of the former pre-Christian centres of those regions. The churches of Janakkala and Hämeenkoski are located next to a possible pre-Christian sacrificial natural well.[14]

The concentration of Iron Age monuments and archaeological sites in the vicinity of the churches indicates that many of the Medieval churches were built in the middle of the formerly 'pagan' late Iron Age local centres. A typical example is Janakkala, where there are several burial grounds, cup stones, a sacrificial well, and a hillfort near to the church location. A similar situation is in Sääksmäki, where the church is next to the former location of a sacred tree, more than one Iron Age cremation cemetery, several cup-holed stones, and a hillfort. Of these two churches, Janakkala points towards NE, Sääksmäki has an equinoctial orientation.

14 The information on the ancient monuments and archaeological sites near the churches has been obtained from the register of the National Board of Antiquities (NBA 2013).

It thus cannot be deduced with certainty whether the orientation of a church had been affected by its location on a pre-Christian sacred ground. Most probable that possibility seems for those churches, where the orientation can be connected with some important feast day, one far from the equinoxes, that has an apparent pre-Christian connection (like the St. Jacob's day in July).

The hypothesis on the connection of the 'anomalous' church orientations to the influences of the vernacular religion requires that the actual orientations of the churches were determined by the locals. Indeed, the construction work was a relatively long and most expensive project, and much of the actual building work was done by local workmen. However, the leaders of the construction project, the architects and master masons are believed to have been usually foreign at least in the Period 1 and 2 church projects (see Hiekkanen 2007, p. 26). Many of the early Nordic churches were constructed by professionals from the southern side of the Baltic – for example, the master builder of the cathedral of Lund was from Germany and the master of the Uppsala cathedral from Central Europe (Rydbeck 1936, p. 98, 114–127; Lovén 2010, p. 300). Had they also oriented the churches, the orientations would probably have reflected the practices of their home region. Currently, no studies on the matter exist.

In Finland, the master masons probably often came from the shores of the Baltic – Gotland, Sweden, the Baltic countries, Northern Poland, and Northern Germany – where the churches and other large buildings of the period show features similar to the Finnish stone churches (Gardberg and Welin 1993; Drake 1997; Gardberg et al. 2000; Hiekkanen 2007, p. 182). The so-called 'Master of Pernaja', an unidentified master builder, who constructed the churches of Eastern Uusimaa (Pernaja, Porvoo, Pyhtää, Sipoo, Vantaa) and also that of Vehkalahti, probably came from Northern Germany (Hiekkanen 2007, p. 451, 460, 465, 473, 485, and refs. therein). Another master was Petrus of Kemiö, who constructed the vaults in the Cathedral of Turku and also in the churches of Kemiö, Perniö, Sauvo, and Tenhola in the mid-15th century (Hiekkanen 2007, p. 21, 65, 133, 171, 201, 205, 481, and refs. therein). He may have come from the State of the Teutonic Order (Gardberg et al. 2000, p. 87–88). Other master builders that we know of were the 'Master of Huittinen', who supervised the building of the churches of Huittinen, Messukylä, Rauma (the Franciscan Church of the Holy Cross), Sastamala, and Tyrvää; and the 'Master of Karjaa', whose work can be seen in the churches of Karjaa, Halikko, and Pohja (Hiekkanen 2007, p. 55, 221, 249, 263, 437, and refs. therein).

The Finnish churches constructed by a single master – the Master of Pernaja, Master of Huittinen, Master or Karjaa, or Petrus of Kemiö – do not show orientations similar to each other (see Table 1). This feature alone

indicates that the orientation of the church was not a concern of the foreign architect, but was determined by the locals – the local headsmen, craftsmen, or the clergy – who also decided on the exact location where the church was to be built on. That kind of arrangement explains why the orientational practises, including the various definitions of the day of the equinox, were so varied and also how the local religious beliefs could have influenced the choice of orientation.

There is also no obvious relationship between the orientational preference of the Finnish churches towards the NE direction and the church orientations of the home countries of the master builders, although some interesting observations can be made. As mentioned above, it is assumed that many master masons came to Finland from the Nordic countries, e.g., from Stockholm. Similar to the Finnish church orientations, the orientations of early Medieval Swedish churches show a slight concentration towards the NE direction and most of them are concentrated between the azimuths of ca. 70 deg and 110 deg (Nilsson 1982). However, most of these churches are a few hundred years older than the Finnish churches, and many of them show much larger orientational deviations towards the southeast than the Finnish churches (Brunius 1997, and refs. therein).

In Germany, where many of the master masons working in Medieval Finland are believed to have originated, the early Medieval church orientations show large deviations from the true east towards both the NE and SE directions. Dietrich and Mertens (1990) and Eckstein et al. (1995) concluded that many of the early Christian churches of Germany were oriented towards the sunrise on the feast day of the patron saint of the church (although one should notice that in those studies, the horizon altitude was not taken into account). As seen above, for the Finnish churches the patron saint hypothesis could not be verified.

In addition to Sweden, orientational preference towards the NE direction can be found, e.g., in England, where McCluskey (2010) conducted a study on 130 Romanesque churches, which had belonged to the Medieval diocese of Lincoln and were dedicated to Virgin Mary, St. John the Baptist, All Saints, and Apostle Andrew. 95% of the churches were found to be oriented inside the range of sunrises from mid-February to mid-April, and early August to early October, and all orientations fell inside a three-month period centred around the (spring or autumn) equinox (McCluskey 2010). The range of the declination distribution of the Lincoln churches is thus almost exactly the same as the range of the distribution obtained for the Finnish Medieval stone churches, which is interesting especially considering the tradition that the first bishop of Finland, St. Henry was an Englishman, who arrived to Finland via Sweden.[15] The underlying reasons for the apparent

15 For the legend of St. Henry, the patron saint of Finland, see Heikkilä (2005).

similarity of the distributions may be various, starting from Scandinavian influence in both regions and ending to the influence of a similar Indo-European pre-Christian solar ritual calendar.

Other studies made in the United Kingdom did not show a similar range of orientations, although their orientation distributions were also concentrated on the NE side of the azimuth of 90 deg (Hoare and Sweet 2000; Ali and Cunich 2001; Hinton 2006). Orientations concentrated towards the NE direction were also found by Iwaniszewski (1998) in the rotundas of Poland. This could, in principle, have some connection to the Finnish orientations, as some of the master masons of Finland had probably come from Northern Poland (see above). Other church orientation distributions skewed towards the NE direction can be found in, e.g., the Czech Republic, Austria, Italy and Spain (González-García 2013, and refs. therein).

Slight deviations towards the NE can be explained by the orientations to the feast of the Annunciation (the Roman spring equinox), as seen above. However, in Britain and in Central Europe the NE orientations have also been connected to the practice of building Christian churches upon the former worship sites of the indigenous pre-Christian religions (Ministr 1997; Iwaniszewski 1998; Garcia Quintela et al. 2013; González-García 2013). As seen above, this explanation is feasible for some individual Finnish churches that show notable deviations towards the NE but, in the light of the general avoidance of the 'pagan' times of year, seen in the Finnish church orientations, it is unlikely to explain the form of the whole distribution. Other possibilities, as mentioned above, include the concentration of the orientations towards Easter sunrises, or some unknown factor that could be perhaps be revealed by studying the early church history of Finland or the orientations of the earliest wooden churches. Currently, very little is known about the early Christian wooden churches in Finland, and the early ecclesiastical history of Finland is likewise a difficult and extensive subject to investigate. Both are therefore outside the practical scope of this study.

The possibility of Easter orientations is supported by the fact that they are most likely seen in the church orientations of Finland Proper, which was one of the first areas to become Christian in Finland. It is easy to see how the emphasis on the Easter Day a.k.a. the Resurrection Day church orientations among the first Christians would have resulted from the need and will to stress out the one central element of the Christian faith that was so different compared to the pre-Christian religion: the prospect of resurrection.[16] The possible Easter orientations thus would be an interesting subject for further investigation. Effectively, however, the question of the confirmation of the

16 One example of the central position of Easter among the early Christians was that baptism, which can be seen as a form of resurrection of a convert into her or his life as a newborn Christian, could originally occur only during Easter Vigil lasting from the Easter Saturday sunset to the Easter Day sunrise (e.g., Hiekkanen 2003, p. 122).

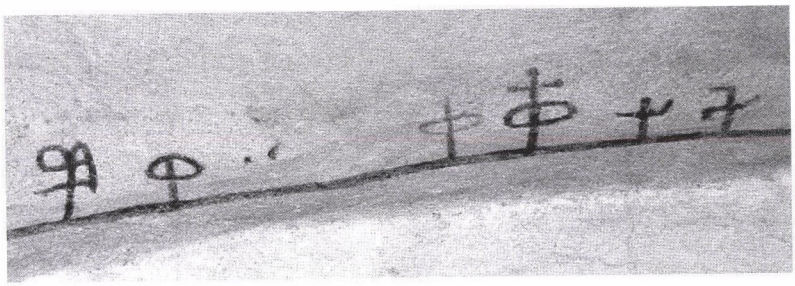

Figure 6. Calendrical markings, similar to those found on Finnish and Swedish runic staff calendars, painted on the walls of Maaria church. Photo: M. Ridderstad.

Easter orientations returns to the absence of data concerning the orientations of the earliest wooden churches and literary sources in early Christian Finland.

3.4. Meaning of the church orientation to the parish members

Not much is known about the practice of astronomy in Medieval Finland. The rites of the pre-Christian religion, which required a certain amount of astronomical knowledge based on observation and calendars, must still have been practiced by many, but very little research on the subject exists to date. Church calendars were used by the clergy, and at least the priests who had been educated in the universities of Central Europe probably had some basic scientific astronomical knowledge. For their everyday practical calendrical needs, individuals in all social orders used wooden calendar staffs, the calendrical system of which was based on the Julian (and later the Gregorian) calendar and the 19-year lunar cycle (Vilkuna 1950, p. 366–368).

In the times before the electric light and mechanical clocks, the movements of the celestial bodies, especially the sun and the moon, were much more closely followed. It seems reasonable to assume that a keen user of the runic staff calendar would easily have been aware of the differences between the three spring equinoxes, each of which could be used to orientate a church: the astronomical one based on solar movements, the one used for the calculation of Easter, and the day of the Annunciation. For the autumn equinox, the following 'equinoxes' were marked in the wooden runic calendars: the true equinox; the feast of the Holy Cross on the 14th of September, which in the early Medieval times in Finland coincided the true astronomical equinox; and the feast of Apostle Matthew on the 21st of September corresponding to the 'Nicaean' equinox in autumn. The Roman autumn equinox is not known to have been important for the Finnish layman of

the period. Indeed, it can be argued that most persons with the calendrical information carved on the common runic calendar and observing the solar rising positions in the landscape, where the church was located, could have made the connection between the local church orientation and the sunrise of an equinox or any other feast day.

Everywhere in the area around the Baltic Sea, the earliest churches often had calendrical markings and even actual calendars painted on their walls (see Figure 6; Stigell 1974; Ridderstad 2013a, 2013b). It is not known for certain how the onlookers interpreted those calendars. The markings on the runic staff calendars, however, sufficiently resemble those seen in Figure 6 to indicate that the church visitors were probably able to 'read' the calendrical imagery inside the church and thus make the connection between the calendrical markings, the feast days celebrated in the church, and the orientation of the church itself. In this way, a Medieval church formed a sacred focal point in its landscape, where it stood surrounded by the human habitats, the wilderness, and the sky manifesting the cosmic cycles followed by the ecclesiastical calendar.

4. Conclusions

The study of the orientations of the Medieval stone churches of Finland presented in this paper has led to the following conclusions:

1) All of the church orientations fall between the declinations of –9.4 deg and +18.2 deg corresponding to the range of sunrises from mid-February to the beginning of May and from late July to early October. However, 95% of the orientations correspond to the period from mid-February to mid-April and mid-August to early October.

2) The general declination distribution of all of the church orientations peaks close to the declination 0, but clearly on the side of positive declinations, i.e., slightly towards the NE direction. Most of the individual church orientations are close to the true east or the sunrises on the day of the equinox as given by various different calendrical definitions of the equinox.

3) No general practice of orienting the Finnish churches towards the sunrises of the feast days of their patron saints could be proven to exist. The few examples detected can also be explained by other means, e.g., the general importance of the day as a calendrical marker, like those feast days of the Virgin, which are close to equinoxes, as well as the feast days of St. Bartholomew and Apostles Matthew and Matthias, which in folk belief were considered as the starting or ending days of autumn and winter.

4) No churches were oriented towards the sunrises of late autumn, winter or most of the summer period. This could be partly due to the deliberate

avoidance of the sunrises of the annual times of the most important pre-Christian festivals and rites (the solstices, the sowing time, time of *kekri*), as well as avoidance of the N-S direction, which had played an important part in the pre-Christian Finnic mythology.

5) The church of Hollola located close to the eastern border of Tavastia, which probably accepted Western Catholic Christianity later than the SW Finland, has an anomalous orientation that could be related to the deliberate Christianization of a former pre-Christian festival.

6) Slight deviations of the orientations towards the NE can be explained by the orientations towards the Nicaean and Roman (the feast of the Annunciation) spring equinoxes. Larger deviations towards the NE direction could be explained by Easter Day orientations or by pre-Christian influence. The latter explanation is possible for some individual stone churches of Finland (see §5 above). In the light of the general avoidance of the 'pagan' times of year (§4 above), however, it is unlikely to explain the form of the whole distribution.

7) A feasible explanation for the overall shape of the observed church orientation distribution is preference towards equinoctial orientations, combined with orientations to Easter Day sunrises and some orientations to the feast days of saints. However, at the present state of research, the Easter orientations could not be distinguished from the rest of the distribution with certainty.

Finally, it is suggested that in the future, to confirm or reject the orientation of each individual church towards the sunrise of a certain feast day, the orientation of each church measured from maps must be measured on-site and the local horizon at the time of the construction of the church must be carefully measured and/or modelled. It is also suggested that in future excavation studies, special attention should be paid to the possible varying orientations of the different construction phases of a church.

Acknowledgements

I wish to thank the anonymous referee for many useful suggestions.

References

Abrahamsen, Niels (1985). *Romanske kirkers orienteering og den magnetike misvisning i 1100-tallet i Danmark.* GeoSkrifter 23. Geologisk institut, Aarhus universitet, Aarhus, Denmark.

Abrahamsen, Niels (1992). Evidence for church orientation by magnetic compass in twelfth-century Denmark. *Archaeometry* 34: 293–303.

Ali, Jason R. and Cunich, Peter (2001). The orientation of churches: some new evidence. *The Antiquaries Journal* 81: 155–93.

Boaz, J. S. and Uleberg, E. (1995). The Potential of GIS-Based Studies of Iron Age Cultural Landscapes in Eastern Norway. In Lock, G. and Stancic, Z. (eds.), *Archaeology and Geographical Information Systems: A European Perspective*, pp. 249–59. Taylor and Francis, London.

Brunius, Teddy (1997). Old Nordic churches and the points of compass. *Konsthistorisk tidskrift/Journal of Art History* 66(4): 211–217.

Cleve, Nils (1943). *Skelettgravfälten på Kjuloholm i Kjulo I–II.* Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreninges Tidskrift XLIV. The Finnish Antiquarian Society, Helsinki.

Dietrich, Conrad and Mertens, Klaus (1990). *Kirchenbau im Mittelalter: Bauplanung und Bauausführung.* Edition Leipzig, Leipzig.

Drake, Knut (1997). *Hinrich Brunsberg und Finnland.* Armin Tuulse-Kolloquium, Dorpat.

Eckstein, Rudolf, Büll, Franziskus and Hörnig, Dieter (1995). Die Ostung mittelalterlicher Klosterkirchen des Benediktiner- und Zisterzienserordens und seiner Zweige. *Studien und Mitteilungen zur Geschichte des Benediktinerordens und seiner Zweige* 106: 7–78. Bayerische Benediktinerakademie, Salzburg.

García Quintela, Marco V., González-García, A. César and Seoane-Veiga, Yolanda (2013). From hillforts to saints: sun tropoi and patterns of Christianization in NW Spain. In Pimenta, F., Ribeiro, N., Silva, F., Campion, N., Joaquinito, A. and Tirapicos, L. (eds.), *Stars and Stones: Voyages in Archaeoastronomy and Cultural Astronomy*, Proceedings of SEAC 2011, British Archaeological Reports, in press.

Gardberg, C. J., Heininen, Simo and Welin, P. O. (2000). *Kansallispyhäkkö: Turun tuomiokirkko 1300–2000.* Tammi, Helsinki.

Gardberg, C. J. and Welin, P. O. (1993). *Suomen keskiaikaiset linnat.* Otava, Helsinki.

González-García, A. César (2013). A Voyage of Christian Medieval Astronomy: Symbolic, Ritual and Political Orientations of Churches. In Pimenta, F., Ribeiro, N., Silva, F., Campion, N., Joaquinito, A. and Tirapicos, L. (eds.), *Stars and Stones: Voyages in Archaeoastronomy and Cultural Astronomy*, Proceedings of SEAC 2011, British Archaeological Reports, in press.

Guszik, T. (1978). Sol Aequinoctialis – Zur Frage der Äquinoktialen Ostung im Mittelalter. *Periodica Polytechnica: Architecture* 22(3–4): 430–435.

Hautala, Jouko (ed.) (2000). *Vanhat merkkipäivät.* Suomalaisen Kirjallisuuden Seura. 7th edition, 2000 (1948). Gummerus, Jyväskylä.

Heikkilä, Tuomas (2005). *Pyhän Henrikin Legenda.* Suomalaisen Kirjallisuuden Seuran toimituksia 1039. SKS, Helsinki.

Hiekkanen, Markus (1994). *The Stone Churches of the Medieval Diocese of Turku. Systematic Classification and Chronology.* Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreninges Tidskrift 101. The Finnish Antiquarian Society, Helsinki.

Hiekkanen, Markus (2003). *Suomen kivikirkot keskiajalla*. Otava, Helsinki.
Hiekkanen, Markus (2007). *Suomen keskiajan kivikirkot*. Suomalaisen Kirjallisuuden Seuran toimituksia 1117. SKS, Helsinki.
Hinton, Ian (2006). Church alignment and patronal saint's days. *The Antiquaries Journal* 86: 206–26.
Hoare, Peter G. and Sweet, Caroline S. (2000). The orientation of early medieval churches in England. *Journal of Historical Geography* 26(2): 162–73.
Häkkinen, Jaakko-Pekka (2010a). Jatkuvuusperustelut ja saamelaisen kielen leviäminen 1. *Muinaistutkija* 2010(1): 19–36.
Häkkinen, Jaakko-Pekka (2010b). Jatkuvuusperustelut ja saamelaisen kielen leviäminen 2. *Muinaistutkija* 2010(2): 51–64.
Iwaniszewski, Stanislaw (1998). The development of a regional archaeoastronomy: the case of Central-Eastern Europe. In *Convegno Internazionale Archeoastronomia, credenze e religioni nel mondo antico: Roma 14–15 Maggio 1997*, Atti dei convegni Lincei 141, pp. 177. Accademia nazionale dei Lincei, Roma.
Jutikkala, Eino (1934). *Sääksmäen pitäjän historia*. Gummerus, Jyväskylä.
Lehtosalo-Hilander, Pirkko-Liisa (1982a). *Luistari I – The Graves*. Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreninges tidskrift 82(1). The Finnish Antiquarian Society, Helsinki.
Lehtosalo-Hilander, Pirkko-Liisa (1982b). *Luistari II – The Artefacts*. Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreninges Tidskrift 82(2). The Finnish Antiquarian Society, Helsinki.
Lehtosalo-Hilander, Pirkko-Liisa (1982c). *Luistari III – A Burial-Ground Reflecting the Finnish Viking Age Society*. Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreninges Tidskrift 82(3). The Finnish Antiquarian Society, Helsinki.
Lovén, Christian (2010). *Uppsala domkyrka. Konsthistoriskt inventarium 3: Byggnadsbeskrivning, Byggnadshistoria, Domkyrkans konsthistoriska ställning*. Sveriges kyrkor 229. Upplandsmuseet, Uppsala.
Mann, Michael (2001a). Little Ice Age. In MacCracken, M. C. and Perry, J. S. (eds.), *Encyclopedia of Global Environmental Change Vol. 1, The Earth System: Physical and Chemical Dimensions of Global Environmental Change*, pp. 504–509. John Wiley & Sons, London.
Mann, Michael (2001b). Medieval Climatic Optimum. In MacCracken, M. C. and Perry, J. S. (eds.), *Encyclopedia of Global Environmental Change Vol. 1, The Earth System: Physical and Chemical Dimensions of Global Environmental Change*, pp. 514–516. John Wiley & Sons, London.
McCluskey, Stephen C. (1998). *Astronomies and Cultures in Early Medieval Europe*. Cambridge University Press, New York.
McCluskey, Stephen C. (2010). Calendric cycles, the eighth day of the world and the orientation of English churches. In Ruggles, C. and Urton, G. (eds.), *Skywatching in the Ancient World: New Perspectives in Cultural Astronomy*, pp. 331–353. University Press of Colorado, Boulder.
Mejsholm, Lotta (2008). Constructions of early childhood at the syncretic cemetery of Fjälkinge – a case study. In Lewis-Simpson, S. (ed.), *Youth and Age in the Medieval North*, pp. 37–56. Brill, Leiden.
Ministr, Z. (1997). Christian rotundas in Bohemia with pagan orientation to the sun. In Jaschek, C. and Atrio Barandela, F. (eds.), *Actas del IV congreso de la SEAC 'Astronomía en la Cultura'*, pp. 277–280. Universidad de Salamanca, Salamanca.

NBA (2013). Register of the National Board of Antiquities of Finland. http://www.nba.fi. Accessed 14.2.2013.

Nilsson, B. (1982). De äldsta svenska kyrkornas orientering. *Kyrkohistorisk årsskrift* 1982(12): 55–67. Svenska kyrkohistoriska föreningen, Uppsala.

NLS (2012). Kansalaisen karttapaikka web service. National Land Survey of Finland. http://kansalaisen.karttapaikka.fi. Accessed 31.12.2012.

Parpola, Asko (2005). The Nâsatyas, the chariot and Proto-Aryan religion. *Journal of Indological Studies* 16–17: 1–63. Association for the Study of Indian Thought, Kyoto.

Pietiläinen, Petteri (1999). GIS-analyysi keskiaikaisen Etelä-Karjalan jatulintarhoista. *Muinaistutkija* 1999(4): 3–17.

Pluskowski, Alexander, and Patrick, Philippa (2003). 'How do you pray to God?' Fragmentation and Variety in Early Medieval Christianity. In Carver, M. (ed.), *The Cross Goes North: Processes of Conversion in Northern Europe AD 300–1300*, pp. 29–57. York Medieval Press, York.

Purhonen, Paula (1998). *Kristinuskon saapumisesta Suomeen.* Suomen Muinaismuistoyhdistyksen Aikakauskirja/Finska Fornminnesföreningens Tidskrift 106. The Finnish Antiquarian Society, Helsinki.

Pöyhönen, Anne (2013). *Riimusauva – vanha suomalainen kalenteri.* Yläkuu kustannus, in press.

Ridderstad, Marianna (2013a). Astronomy, religion and the structure of society in prehistoric Finland. In Rappenglück, M. A., Rappenglück, B. and Campion, N. (eds.), *Astronomy and power – How worlds are structured*, Proceedings of SEAC 2010, British Archaeological Reports, in press.

Ridderstad, Marianna (2013b). Solar and calendrical symbolism in the Early Medieval Finnish church murals. In Pimenta, F., Ribeiro, N., Silva, F., Campion, N., Joaquinito, A. and Tirapicos, L. (eds.), *Stars and Stones: Voyages in Archaeoastronomy and Cultural Astronomy*, Proceedings of SEAC 2011, British Archaeological Reports, in press.

Ruohonen, Juha (2012). Kaarina Ravattula Ristimäki. Arkeologiset tutkimukset 2012. Excavation report, University of Turku, Archaeology.

Ruggles, Clive L. N. (2005). *Ancient Astronomy: An Encyclopedia of Cosmologies and Myth.* ABC-CLIO, London.

Rydbeck, Monica (1936). *Skånes stenmästare före 1200.* Gleerup, Lund.

Salo, Unto (2005). *Risti ja rauta.* Emil Cedercreutzin säätiö, Vammala.

Siikala, Anna-Leena (1992). *Suomalainen šamanismi.* Suomalaisen Kirjallisuuden Seuran toimituksia 565. SKS, Helsinki.

Siikala, Anna-Leena (2002). What Myths Tell about Past Finno-Ugric Modes of Thinking. In Siikala A.-L. (ed.), *Myth and Mentality, Studies in Folklore and Popular Thought*, pp. 15–32. Studia Fennica Folkloristica 8. SKS, Helsinki.

Siikala, Anna-Leena (2012). *Itämerensuomalaisten mytologia.* Suomalaisen Kirjallisuuden Seuran toimituksia 1388. SKS, Helsinki.

Stigell, Anna-Liisa (1974). *Kyrkans tecken och årets gång: tideräkningen och Finlands primitiva medeltidsmålningar.* Suomen Muinaismuistoyhdistyksen Aikakauskirja /Finska Fornminnesföreningens Tidskrift 77. The Finnish Antiquarian Society, Helsinki.

Taavitsainen, Jussi-Pekka (1990). *Ancient Hill-forts of Finland, with special reference to the hill-fort of Kuhmoinen.* Suomen Muinaismuistoyhdistyksen Aikakauskirja 94. The Finnish Antiquarian Society, Helsinki.

Taavitsainen, Jussi-Pekka, Simola, H. and Grönlund, E. (1998). Cultivation History Beyond the Periphery: Early Agriculture in the North European Boreal Forest. *Journal of World Prehistory* 12(2): 199–253.

Trotzig, Gustaf (1983). Den gamla och den nya religionen. In Jansson, I. (ed), *Gutar och vikingar*, pp. 357–394. Statens Historiska Museum, Stockholm.

UT (2013). University of Turku press release 4.9.2013. http://www.utu.fi/fi/Ajankohtaista/mediatiedotteet/Sivut/aurajoen-varrelta-paljastui-arkeologinen-suurloyto-suomen-vanhin-kirkko.aspx. Accessed 27.10.2013.

Vilkuna, Kustaa (1950). *Vuotuinen ajantieto*. 3rd edition, 1973. Otava, Helsinki.

Watts, Dorothy (1991). *Christians and Pagans in Roman Britain*. Routledge, London.

Zugaiar, Adriana (2012). *The orientation of pagan graves in Viking Age Iceland*. MA thesis, Faculty of History and Philisophy, University of Iceland, Reykjavík.

Table 1 (next four pages). Orientations of the Medieval stone churches of Finland. The regional and periodical divisions, as well as the building periods given are according to Hiekkanen (1994, 2007). The Julian dates corresponding to a declination have been calculated for the middle year of the construction period given. Question marks indicate nearby feast days that are not exact matches to the dates given. An asterisk after the name of a church indicates that it has been preserved in a ruined state.

Region, church	Building time	Period	Az, map	on-site	Declination	Patron saint	Date of ori.	Closest feast day (within 2 days)
Åland								
Eckerö	1380–1420	1	85,6		3,04	St. Lawrence	20.3./7.9.	Nicaean spring eqx.?/Nativity of Mary?
Finström	1445–1460	2	88,9		4,3	Holy Cross	23.3./3.9.	Nicaean; Roman spring eqx.?/?
Föglö	1500–20	3	87,3		5,02	St. Mary Magdalene?	24.3./1.9.	Roman spring eqx.?/?
Geta	1510–40	3	86,8		2,46	St. George?	17.3./7.9.	St. Gertrud/Nativity?
Hammarland	1300–50	1	75,7		7,2	St. Catherine of Alexandria	31.3./27.8.	?/Beheading of St. John?
Jomala	1275–85	1	80,9		4,54	St. Olaf	24.3./4.9.	Roman spring eqx.?/?
Kumlinge	1500–10	3	101,6		-4,53	St. Anne	28.2./25.9.	?/Roman autumn eqx.?
Kökar	1500–20	3	104,7		-7,01	unknown	21.2./2.10.	St. Peter's Cathedra?/St. Francis?
Lemböte chapel	1500–30	3	89,9		0,44	St. Olaf	13.3./13.9.	astr. spring eqx.?/astr. autumn eqx.?
Lemland	1290s	1	85,0		3,06	unknown and St. Bridget?	21.3./8.9.	Nicaean spring eqx./Nativity
Saltvik	1370s	1	85,0		4,41	Virgin Mary	24.3./4.9.	Roman spring eqx.?/?
Sund	ca. 1300	1	96,0		-0,25	St. John the Baptist	12.3./16.9.	astr. spring eqx./astr. autumn eqx.?;sun to Libra?
Vårdö	1520–60	3	97,2		-2,57	Apostle Matthias	4.3./20.9.	?/Nicaean autumn eqx.

table continues

Region, church	Building time	Period	Az, map	on-site	Declination	Patron saint	Date of ori.	Closest feast day (within 2 days)
Finland Proper								
Halikko	1460–75	2	71,6		9,81	St. Bridget?	6.4./19.8.	St. Ambrose?/?
St. Catherine's Ch., Turku	1440–60	2	85,9		2,59	St. Catherine of Alexandria	18.3./8.9.	sun to Aries/Nativity
Kalanti	1430–50	2	93,3		0,5	Virgin Mary and St. Olaf	13.3./13.9.	astr. spring eqx.?/astr. autumn eqx.?
Kemiö	1460s	2	72,3		8,97	Virgin Mary and St. Andrew	4.4./21.8.	St. Ambrose/?
Koroinen*	1266–1286?	1	81,9		5,43	Virgin Mary	27.3./1.9.	Roman spring eqx.?/?
Korppoo	1430–50	2	101,3		-1,59	St. Michael the Archangel	7.3./18.9.	Thomas Aquinas/sun to Libra?
Laitila	1460–83	2	79,4		5,37	St. Michael the Archangel	25.3./31.8.	Roman spring eqx./Beheading of St. John?
Lemu	1460–80	2	68,6		10,59	St. Olaf	9.4./17.8.	?/Assumption of Mary?
Lieto	1470–90	2	79,0	78,7	6,28	St. Peter?	27.3./28.8.	Roman spring eqx.?/Beheading of St. John?
Maaria	1440–50	2	87,9	87	1,9	Virgin Mary and St. Dionysius	16.3./9.9.	St. Gertrud?/Nativity?
Masku	1490–1510	2	66,7	63,5	16,24	St. John the Baptist	26.4./30.7.	St. Mark?/St. Olaf?
Mynämäki	1425–1440	2	81,6	80	5,62	St. Lawrence and St. Eric	26.3./31.8.	Roman spring eqx.?/Beheading of St. John?
Naantali	1480s	2	105,7		-7,15	Most Holy Saviour?, Virgin Mary, St. John the Baptist, St. Anne, St. Bridget	22.2./2.10.	St. Peter's Cathedra/St. Francis?
Nauvo	1430–50	2	106,6		-7,67	St. Olaf?	21.2./4.10.	St. Peter's Cathedra?/St. Francis
Nousiainen	1420s	2	95,8		-1,26	Virgin Mary and St. Henry	8.3./17.9.	Thomas Aquinas?/sun to Libra
Parainen	1440–60	2	88,9		1,99	unknown	17.3./9.9.	St. Gertrud/Nativity?
Perniö	1460–80	2	82,6		8,36	St. Lawrence	2.4./23.8.	St. Ambrose?/St. Bartholomew?
Pertteli	1500–20	3	72,7		8,79	St. Bartholomew	3.4./22.8.	St. Ambrose?/St. Bartholomew?
Raisio	1500–20	3	82,8	82,9	4,7	St. Martin	23.3./2.9.	Roman spring eqx.?/?
Rusko	1510–30	3	63,8	61,6	14,2	St. Mary Magdalene	19.4./5.8.	?/Transfiguration of Jesus?
Rymättylä	1510s	3	110,6		-7,62	St. Jacob the Elder	20.2./4.10.	St. Peter's Cathedra?/St. Francis
Sauvo	ca. 1470	2	78,3		6,67	P. Clementius	29.3./28.8.	?/Beheading of St. John the Baptist?
Taivassalo	1425–40	2	91,3		1,63	Holy Cross	16.3./10.9.	St. Gertrud?/Nativity?
Turku Cathedral	1290s?/ca. 1450	1	92,9		-0,45	Virgin Mary and St. Henry	11.3./16.9.	astr. spring eqx.?/astr. autumn eqx.?;sun to Libra?
Vehmaa	1425–40	2	70,4		9,55	St. Margaret	6.4./20.8.	St. Ambrose?/?

table continues

Region, church	Building time	Period	Az, map	on-site	Declination	Patron saint	Date of ori.	Closest feast day (within 2 days)
Satakunta								
Huittinen	ca. 1500	3	87,2		1,7	St. Catherine of Alexandria	15.3./9.9.	St. Gertrud?/Nativity?
Lempäälä	1500–10	3	105,2	105,1	-6,71	St. Mary Magdalene and St. Bridget	22.2./1.10.	St. Peter's Cathedra/St. Michael the Archangel?
Messukylä	1510–30	3	104,2	104,2	-3,78	St. Michael the Archangel	1.3./23.9.	?/Roman autumn eqx.?
Rauma Franciscan Ch.	1515–20	3	99,2		-4,12	Holy Cross	1.3./24.9.	?/Roman autumn eqx.
Rauma City Ch.*	1495–1505	3	82,2		3,92	unknown	21.3./3.9.	Nicaean spring eqx./?
Sastamala	1497–1510	3	62,5		13,86	Virgin Mary	18.4./7.8.	?/Transfiguration of Jesus?
Tyrvää	1506–16	3	78,5		6,08	St. Olaf	27.3./29.8.	Roman spring eqx.?/Beheading of St. John
Ulvila	1495–1510	3	95,5		-1,97	St. Olaf	7.3./19.9.	Thomas Aquinas/Nicaean autumn eqx.?
Tavastia								
Hattula	1472–90	2	88,7	87,8	1,41	Holy Cross and St. Anne	15.3./10.9.	St. Gertrud?/Nativity?
Hauho	1500–20	3	78,9	77,1	7,32	unknown	30.3./26.8.	?/St. Bartholomew?
Hollola	1495–1510	3	51,6	51,5	17,76	Virgin Mary	2.5./25.7.	St. Valborg?; Holy Cross?/St. Jacob
Hämeenkoski*	1510–60	3	94,4		-1,48	St. Lawrence?	8.3./18.9.	Thomas Aquinas?/sun to Libra
Janakkala	1510–20	3	70,9	72	10,54	St. Lawrence	8.4./17.8.	?/Assumption?
Lammi	1510s	3	87,3	86,6	2,26	St. Catherine of Alexandria?	17.3./8.9.	St. Gertrud/Nativity
Pälkäne*	1495–1505	3	78,6		5,54	Virgin Mary?, St. Michael the Archangel?	25.3./30.8.	Roman spring eqx./Beheading of St. John?
Renko	1510–60	3	108,6	110,3	-9,41	St. Jacob the Elder	15.2./8.10.	St. Sigfrid/St. Bridget?
Sysmä	1510–20	3	89,8		0,57	St. Olaf	13.3./13.9.	astr. spring eqx.?/astr. autumn eqx.?
Sääksmäki	ca. 1500	3	84,4	82,3	4,49	unknown	22.3./2.9.	Nicaean spring eqx.?/?
Tammela	1535–50	3	107,2		-8,11	St. Michael the Archangel	18.2./5.10.	?/St. Francis?
Tuulos	1510–40	3	74,1	73	9,88	St. Bridget?	6.4./18.8.	St. Ambrose?/?
Vanaja	ca. 1500	3	94,3	96,8	-0,71	unknown	18.3./6.9.	sun to Aries/Nativity?

table continues

Region, church	Building time	Period	Az, map	on-site	Declination	Patron saint	Date of ori.	Closest feast day (within 2 days)
Uusimaa								
Espoo	1485–90	2	88,0		2,66	unknown	18.3./7.9.	sun to Aries/Nativity?
Inkoo	1510s	3	78,4		6,28	St. Nicholas	28.3./29.8.	?/Beheading of St. John the Baptist
Karjaa	1460–70	2	88,1		2,58	unknown	18.3./7.9.	sun to Aries/Nativity?
Kirkkonummi	ca. 1500	3	74,8		8,74	St. Michael the Archangel?	3.4./22.8.	St. Ambrose?/St. Bartholomew?
Lohja	1470–90	2	102,5		-4,92	St. Lawrence	28.2./26.9.	?/Roman autumn eqx.?
Pernaja	1435–45	2	72,2		11,83	St. Michael the Archangel and St. Eric	12.4./13.8.	Summer Nights/Assumption?
Pohja	1475–80	2	98,0		-3,2	Virgin Mary	3.3./22.9.	?/Nicaean autumn eqx.?
Porvoo	1440–50	2	80,8	82,7	5,66	Virgin Mary? and/or St. Enevald?	26.3./31.8.	Roman spring eqx.?/Beheading of St. John?
Pyhtää	ca. 1460	2	86,6		4,44	St. Henry	23.3./2.9.	Nicaean, Roman spring eqx.?/?
Sipoo	1450–55	2	93,5	94	-1,33	St. Sigfrid?	8.3./17.9.	Thomas Aquinas?/sun to Libra
Siuntio	1460–89	2	85,6		3	St. Peter	20.3./7.9.	Nicaean spring eqx.?/Nativity?
Tenhola	1460–80	2	89,8		1,21	unknown	15.3./11.9.	St. Gertrud?/?
Vantaa	1450–60	2	80,3		5,07	St. Lawrence	25.3./2.9.	Roman spring eqx./?
Vihti*	1500–20	3	62,7		18,2	St. Bartholomew?	3.5./23.7.	Holy Cross/St. Mary Magdalene?
Southern Carelia								
Vehkalahti (Hamina)	1430–70	2	93,2		-1,39	Virgin Mary?	8.3./18.9.	Thomas Aquinas?/sun to Libra?
Ostrobothnia								
Alatornio	1496–1550	3	89,4		0,33	St. John the Baptist	12.3./13.9.	astr. spring eqx./astr. autumn eqx.?
Isokyrö	1513–33	3	91,8		-0,73	St. Lawrence?	10.3./16.9.	astr. spring eqx.?/sun to Libra?
Kaarlela (Kokkola)	1500–30	3	93,5		-1,56	St. Michael the Archangel? St. Catherine?	8.3./18.9.	Thomas Aquinas?/sun to Libra?
Keminmaa	1551–1553	3	90,8		0,01	St. Michael the Archangel	11.3./13.9.	astr. spring eqx./astr. autumn eqx.
Korsholma (Mustasaari)*	1500–20	3	85,3		2,37	Virgin Mary	17.3./8.9.	St. Gertrud/Nativity
Närpiö	1550–55	3	74,0		7,46	Holy Cross, Virgin Mary and St. Olaf	30.3./25.8.	?/St. Bartholomew?
Pedersöre	1510–30	3	64,2		11,2	St. Peter?	10.4./15.8.	Summer Nights?/Assumption

End of Table 1.