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Auroras Now! Final Report, Volume I

ANSSI MÄLKKI, KIRSTI KAURISTIE, ARI VILJANEN

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Auroras Now! Final Report, Volume I

Anssi Mälkki, Kirsti Kauristie, Ari Viljanen

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Auroras Now!

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Abstract

Auroras Now! was proposed to ESA as a Space Weather Pilot Project for generating a suite of services with several target groups as customers. The services are based on data from the ground-based observational network maintained by the Finnish Meteorological Institute (FMI) for scientific research in Scandinavia. By combining on-line images from auroral all-sky-cameras with magnetometer data, modelling, and weather forecasts, a nowcasting and observation service for hotel customers in Finnish Lapland has been developed. The same data are also used for providing a tailored auroral alert service for the URSA astronomical association: from the magnetometer data messages yielding three-level characterization for probability for observing auroras are generated. The alerts are sent to a commercial operator via e-mail, and further distributed to the end customers as SMS messages over the mobile phone network. In addition to these active nowcasting services, WWW pages for general information about aurora were developed. This service is called the public service.

In parallel to the auroral nowcasting and public www services, a tailored service was developed for the Gasum natural gas pipeline company. This service consists of real-time monitoring of geomagnetically induced current (GIC) in the Finnish pipeline network, combined with a nowcasting system, which calculates the modelled GIC current on the network. The calculation is based on measurements of variations of the geomagnetic field, which are used as input to a model developed at FMI. The data are made available to Gasum over a restricted internet connection. Information about GIC activity is also available on the public WWW pages. The public part of this GIC service is sometimes referred as GIC Now! and the private service to Gasum as Gasum Now!

This document is Volume I of the Final Report of the two-year project, co-funded by ESA and the FMI.

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Issue	Date	Comments
1	17.3.2005	First Issue of document
1 rev 1	22.7.2005	Revised according to comments from ESTEC, divided into two volumes: non-confidential and confidential part
1 rev 2	31.10.2005	Improved based on comments from ESTEC, added Appendices.

Table of Contents

1 Introduction

Auroras Now! was proposed to ESA as a Space Weather Pilot Project for generating a suite of services with several target groups as customers. The services are based on data from the ground-based observational network maintained by the Finnish Meteorological Institute (FMI) for scientific research in Scandinavia. By combining on-line images from auroral all-sky-cameras with magnetometer data, modelling, and weather forecasts, a nowcasting and observation service for hotel customers in Finnish Lapland has been developed. The images, predicted auroral activity for the coming night, and cloudiness prediction are made available to the hotels over the internet, and further displayed at the hotels internal TV system. The occurrence probability for aurora is predicted with a model that is developed using results from FMI's research on the occurrence of aurora in different geomagnetic conditions. This service is the Auroras Now! hotel service.

The same data are also used for providing a tailored auroral alert service for the URSA astronomical association: from the magnetometer data messages yielding three-level characterization for probability for observing auroras are generated. The alerts are sent to a commercial operator via e-mail, and further distributed to the end customers as SMS messages over the mobile phone network.

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This document is Volume I of the Final Report of the two-year project, co-funded by ESA and the FMI. The structure of the document is as follows. In section 2 we describe the project from the development phase to the operational and evaluation phases. Detailed description and discussion of the project is included in the subsequent sections: Section 3 describes the management of the project, and Sections 4 the development phase of the Auroras Now! and Gasum/GIC Now! services, respectively. The operational phase with immediate feedback, maintainability and lessons learned are included in section 5. Service assessment and customer feedback is presented and discussed in section 6, and conclusions and future plans are discussed in the closing section 7.

Cost-Benefit analysis and Business Plan, containing commercially confidential information, are included in a separate confidential part (Volume II of the Final Report).

1.1 Definitions, acronyms and abbreviations

ASC	all-sky camera
ESTEC	European Space Research and Technology Centre
FMI	Finnish Meteorological Institute
GIC	geomagnetically induced current

HTML	HyperText Markup Language
NaN	Not a Number (e.g. indicating a missing value)
NUR	Nurmijärvi Geophysical Observatory
Octave	GNU Octave is a high-level language, primarily intended for numerical computation (http://www.octave.org/).
PSV	pipe-to-soil voltage (voltage between the pipe and the surrounding earth)
SDA	service development activity
SOD	Sodankylä Geophysical Observatory
TeLa	Tensor Language (http://www.ava.fmi.fi/prog/tela.html)
WP	work package
WWW	World Wide Web
B_x,B_y	geographic north (x) and east (y) components of the geomagnetic field
E_x,E_y	geographic north and east components of the geoelectric field
t	time
Z	surface impedance
μ_0	vacuum permeability
ω	angular frequency

1.2 References

[RP-023] Auroras Now! Cost-Benefit Analysis, RP-AUR-023-FMI/05, Issue Draft 2.

[RS-002] Auroral Nowcasting User Requirements Specification, RS-AUR-200-FMI-002, issue 1.1

[RS-003] GIC service User Requirements Specification, RS-AUR-300-FMI-003, issue 1.2

[TN-002] WP 320: GIC Now! WWW service development, TN-AUR-002-FMI/03, Issue 1.3

[TN-003] WP 240: Auroral alerts development, TN-AUR-003-FMI/03, Issue 1.2

[TN-004] WP 410: Technical requirements definition, TN-AUR-004-FMI/04, Issue 1.2

[TR-003] Auroras Now! Test Report and Technical Description, TR-AUR-420-SSF-003, issue 1.2

[UM-002] Auroras Now! User Manual, UM-AUR-420-SSF-002, issue 1.2

[Pulkkinen et al. 2001a] Pulkkinen, A., R. Pirjola, D. Boteler, A. Viljanen, and I. Yegorov, Modelling of space weather effects on pipelines, J. Appl. Geophys., 48, 233–256, 2001.

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[Viljanen et al. 2004] Viljanen, A., A. Pulkkinen, O. Amm, R. Pirjola, T. Korja and BEAR Working Group, Fast computation of the geoelectric field using the method of elementary current systems and planar Earth models. Ann. Geophys., 22, 101–113, 2004.

1.3 Acknowledgements

Gasum Oy has contributed to studies on geomagnetically induced currents in the Finnish natural gas pipeline for more than 20 years. Especially, we would like to thank Mr. Juha Vainikka and Mr. Matti Pitkänen for a continuous interest in our work.

Many colleagues at the Finnish Meteorological Institute have also contributed to this work: Mr. Lasse Häkkinen, Dr. Pekka Janhunen, Ms. Liisa Juusola, Ms. Anneli Ketola, Mr. Mikko Kuitunen, Dr. Risto Pirjola, Dr. Antti Pulkkinen, Mrs. Terttu Sallinen and Mr. Ville Tulkki. Staff at the Nurmijärvi Geophysical Observatory takes care of GIC measurements at Mäntsälä and of data validation. Mrs. Anja Koistinen, Dr. Kari Pajunpää and Mr. Pentti Posio are gratefully acknowledged.

Our subcontractors Space Systems Finland and CDQ Solutions as well as collaborators at Sodankylä Geophysical Observatory and FMI Regional Weather Service in Rovaniemi have had an important contribution to the development of the infrastructure of Auroras Now. Our customers in Lapland, Hotel Hullu Poro and Hotel Luostotunturi have provided valuable viewpoints to guide the development work.

We are also grateful of the valuable and constructive comments provided by the ESA people, especially the SDA technical manager, Dr. Alexi Glover.

2 Description of the project

2.1 Starting point: MIRACLE network

The starting point of the project was the existing ground-based observation network, MIRACLE, which the FMI is leading in Northern Scandinavia. The network consists of magnetometers and all-sky-cameras. A map of the network is shown in Figure 2-1.

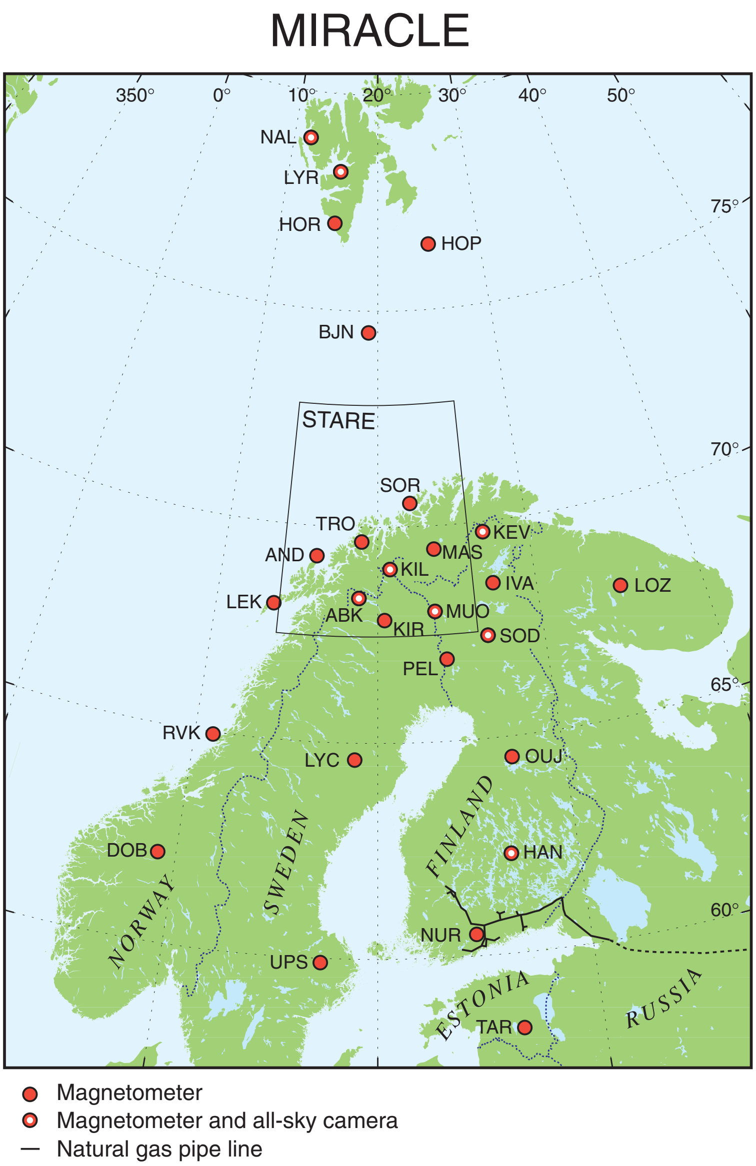

Figure 2-1 The MIRACLE network. Abbreviations for stations where data has been collected for Auroras Now: NUR = Nurmijärvi, SOD = Sodankylä. The Mäntsälä GIC recording station is so close to Nurmijärvi (NUR) that it cannot be shown with the resolution of this figure. The natural gas pipeline is shown with a black line, crossing the Finnish-Russian border in southeast of Finland. Details of the network in Russia are not shown (indicated with dashed line).

For scientific studies, FMI has collected data on auroral occurrence by analysing ASC images over the winter season. By combining those data with magnetic activity data, a statistical model of auroral occurrence during different levels of magnetic activity has been developed. This forms the basis of an auroral prediction service (or nowcasting service, since the prediction time would be only approximately 6 hours). There is also scientific interest to the correlation between activity and auroral occurrence, so this work very nicely supports the scientific work, and vice versa.

During the dark hours, on-line images from the all-sky-cameras can be shown. A technical limitation to the on-line images is that the ASC should be located at a station, which is directly connected to the internet through a fast line, in order to avoid extensive costs from the data transfers.

Correlations between geomagnetic variations and geomagnetically induced currents (GIC) have been studied at FMI since 1980's. The work has been performed in close collaboration with the power transmission companies (former IVO, currently Fingrid Oyj) and the natural gas pipeline company (Gasum Oy). As a result of these studies, very reliable models of GIC occurrence in given networks have been developed. The theory is well understood and documented in refereed publications, and when the network is known, a reliable estimation for the GIC can be given in any part of the network.

2.2 Value-added products

2.2.1 Aurora Nowcasting Service

The value-added products of the Auroras Now! service are a prediction and nowcasting service, provided for two hotels in Finnish Lapland (Hotel Hullu Poro in Levi and Hotel Luostotunturi in Sodankylä). The prediction is based on an algorithm developed at FMI (see section 2.1), and real-time images from the all-sky cameras. The activity prediction is also provided as SMS messages over the mobile phone network. The predictions are based on the same algorithms and data, but the distribution to the customers was different.

The added value from this project, compared to original data, is the analysis algorithm that derives occurrence probability from magnetic field measurements, based on statistical occurrence of aurora during different levels of magnetic activity. The model has been validated against local all-sky camera observations, and the prediction shows very good agreement with real auroral activity. In addition, the prediction, near-real-time auroral images, and local cloudiness predictions were combined to a simple, user-friendly display for the Hotel guests.

2.2.2 GIC nowcasting service

For the Finnish power transmission grid, the conclusion of the GIC studies and real events is that the technology used in Finland is very robust, and no failures due to extreme space weather activity have occurred. Thus the power transmission company was not interested in participating in the project. For the natural gas pipeline company, information of GIC is valuable in order to estimate corrosion in the pipeline, as well as monitoring the activity during maintenance operations – extreme GIC may result in malfunctions or erroneous readings in the maintenance equipment. The GIC service uses on-line measurements of the magnetic activity from the Nurmijärvi (NUR) station of the MIRACLE network, and combines that with readings of actual GIC current measured in Mäntsälä (see map above). Those data are shown at Gasum over a restricted connection on the internet.

The added value compared to the situation before the project is the implementation of the GIC calculation as a nowcasting service. Previous GIC studies for Gasum, as well as for power companies, have dealt with post analysis of geomagnetic data to estimate the occurrence of GIC statistically. An on-line presentation of the near-real-time GIC activity is now available for Gasum around the clock.

2.2.3 Public Service

In addition to the tailored services, WWW pages describing aurora and GIC were developed for the general public. As pilot customer for those pages, we made an agreement with the science centre Arktikum in Rovaniemi and Hotel Revontuli in Hankasalmi, Central Finland. Arktikum has placed dedicated workstations in their display area and/or library, provided assistance for customers, and collected feedback. Hotel Revontuli has shown the public service in a computer terminal at the reception desk and advertised the service in their meeting facilities with a dedicated slideshow.

Auroras Now! public pages include several upgradings when compared with the auroral pages of FMI before the pilot project: The magnetic activity monitor (the bar plots) now cover the whole country and the magnetic data and auroral data are shown together in one location. The supply of general background information has also improved in several ways, e.g. as weekly space weather reports and as records of previous activity and auroral animations.

2.3 Development needs

For the project needs, tailored algorithms for the prediction of aurora would be needed. Also the dedicated GIC nowcasting for the Gasum natural gas pipeline network need to be updated and validated.

For the customer products, data from MIRACLE cannot be used as it is used in scientific studies. Thus for the development phase separate activities were planned and performed for generating the value-added products, maintaining the services on a dedicated server at FMI, and designing an attractive layout for the public WWW pages and the hotel service. For these activities, contractors from a software company (SSF Oy) and a multimedia company (CD Quality Oy) were hired. Model development and maintenance were done at FMI.

3 Project Management

The project management was organised in accordance with the statement of work into work packages, providing a clear structure and basis for schedule planning and control. The highest level work packages were Project Management (WP1XX), Auroral nowcasting service (WP2XX), GIC service (WP3XX) and Service infrastructure (WP4XX). Within each top-level work package, specific work was organised into units that formed a well-defined work package, with clear start and end dates as well as input and output requirements.

Already in the preparation of the proposal it was noticed that the duration of the project – with kick-off in the spring – was almost optimal for our project. The operational season for the auroral all-sky cameras is the dark season, starting usually at the beginning of September, and continuing until late March. For the hotels, on the other hand, the tourist season starts in late December with Christmas-time visitors (mostly foreigners), and with somewhat lower activity in January, continues to the peak skiing season in late March and early April. Thus assuming a kick-off in April, development work could be performed during the summer months, and the system would be operational for the coming winter season. Although not restricted by the dark months, this same schedule was agreed for the GIC service as well.

The resulting project schedule with all levels of work packages is shown as a bar chart in Figure 3-1.

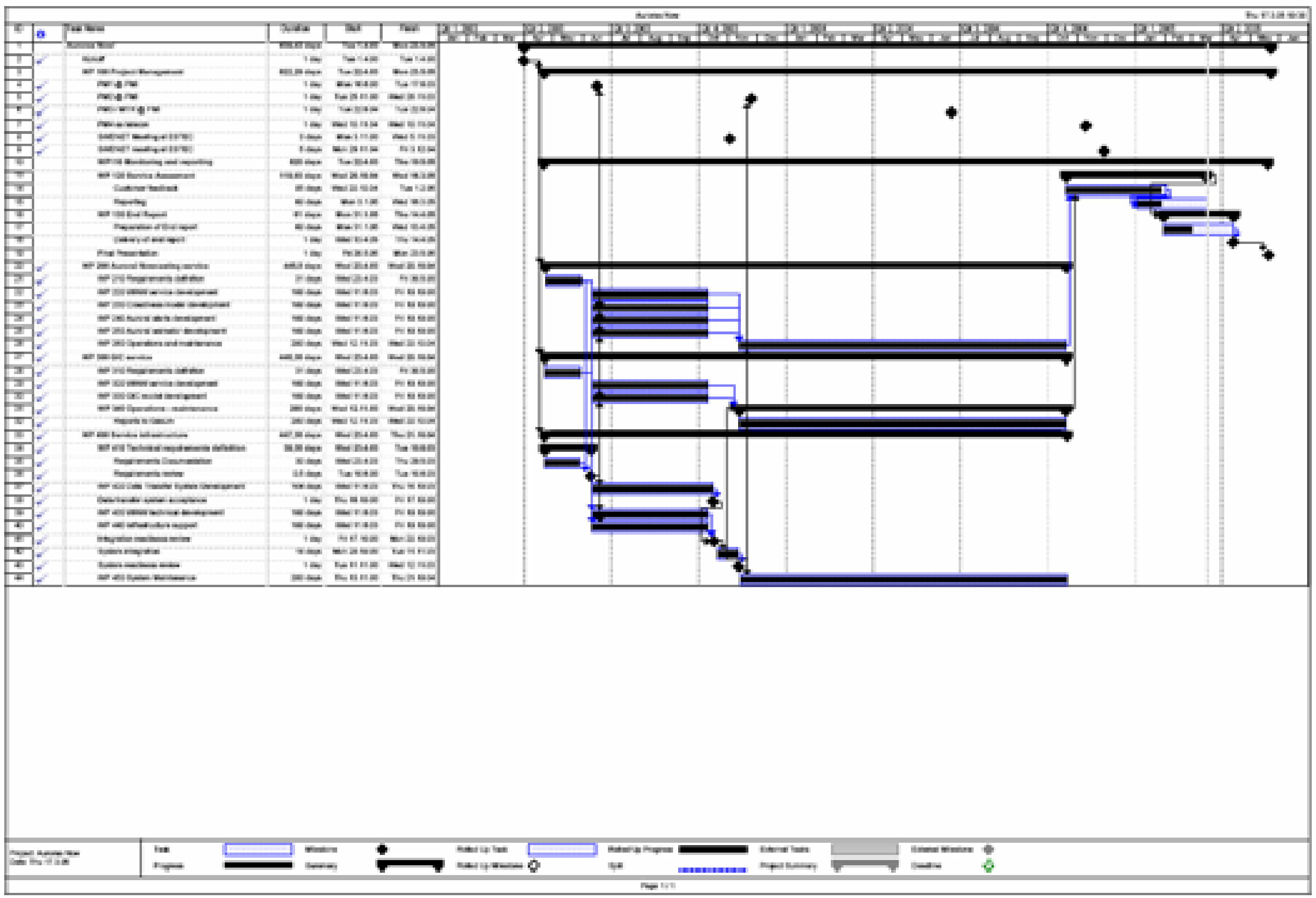

Figure 3-1 Auroras Now project bar chart. The dates have been updated to reflect actual situation in March 2005.

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4 Development Phase

The development phase started with collecting, discussing and documenting the User Requirements for the project. Even though the goal of the project was well documented in the Proposal, a well-prepared User Requirements Document was seen as a necessary step to make the acceptance criteria for the project clear. Specific work packages within the Auroras Now and Gasum Now services were devoted to this work, and the end result was discussed with ESA before final approval. In practice some of the development work was started already before formal approval of the URD, on agreement between ESA and FMI that the testing would be done against the final URD version.

4.1 Auroras Now

4.1.1 General

Auroral activity is associated with variations in the geomagnetic field. During strong geomagnetic storms the amplitude of the variations can be even 4-5 % (2000 nT) of the strength of the main field in the Fennoscandian area (roughly 50000 nT). Typical time scales of the disturbances vary from days (duration of a storm) to a few seconds (magnetic pulsations). The magnetic variations have a direct connection with the visible auroras: The same electron precipitation which causes the auroral emissions carry electric currents and enhance the conductivity in the ionosphere. The ionospheric current system - according to the Biot-Savart law - generates magnetic variations which are measurable with ground-based magnetometers.

Ground-based magnetometers are basic instruments for monitoring space weather phenomena since their maintenance and operation is relatively straightforward. Different magnetic indices provide an easy way to quantify the strength of the space weather events. *Kp* is one of the most widely used index is this area. This global index is determined once per three hours from the variations of the horizontal magnetic field as recorded at 13 sub-auroral stations. Local *K* indices can be determined similarly from the data of individual measurement stations. The values of *K* vary from 0 to 9 according to a latitude-specific logarithmic scale.

While *Kp* describes nicely the overall strength and evolution of a space weather storm, especially geomagnetic induction studies have shown that often the most dramatic consequences of the activity are related with periods of fast temporal variations. Observations of the magnetic field time derivative with high time resolution have thus appeared to be useful when monitoring space weather conditions.

Since the last sunspot maximum year 2000 FMI has operated in routine manner a public web-based alarm system (Nurmijärvi system) for spotting low-latitude auroras in Southern Finland. The system fetches regularly magnetic field data from the Nurmijärvi geophysical observatory (NUR in Figure 2-1 and Figure 4-1, magnetic latitude ~57 degrees) at the end of each UT-hour. From the data of 1-min resolution the time derivative of the horizontal magnetic field is computed and if its maximum is found to exceed a certain threshold value an alarm is issued.

Interested customers have had the possibility to register to the mailing list of the system to get automatically generated messages. Today the list includes roughly 490 names. Also the FMI meteorologist in shift receives these messages. If more than one message are received during the afternoon hours and if the coming night is predicted to be clear the information of enhanced activity is passed to the TV-meteorologist. He or she then encourages in the weather report of the main evening news people also in Southern Finland to watch out for auroras.

The reliability of the Nurmijärvi alarm system has been tested by comparing statistically the magnetic alarm records with the data of a nearby auroral camera station. The analysis revealed that in 77% of the alarm cases which took before or during clear nights the alarm was associated with significant auroral activity. On the other hand, 79% of the auroral nights (auroras in the clear sky for more than two hours) were associated with simultaneous or preceding alarms. The comparisons of the alarm records with the simultaneous Nurmijärvi K-values showed that 73% of the alarms were followed by a K-index higher or equal to 5 and 74% of the *K* indices equal 5 or more were preceded by an auroral alarm.

The auroral activity in the Fennoscandian sector is systematically recorded with the all-sky cameras (ASCs) of the MIRACLE instrument network. These cameras acquire several images per minute and their fields of views are circles with the radius of about 300 km at auroral altitudes (i.e., about 100 km altitude). The spatial resolution of the images varies between less than km distances per pixel to a few km per pixel. As cameras have been designed for accurate scientific measurements they can easily meet the demands of auroral monitoring for tourist purposes as well. However, for near-real time service we can use only cameras with cheap and fast enough data transmission lines available e.g. via a local observatory network.

4.1.2 Public Auroras Now pages

FMI has long traditions in making ground-based auroral observations. As outcome of these activities the institute has an extensive archive of software for data transmission, archiving and analysis. The pre-existing codes were used always when possible in the development of Auroras Now public web-pages. The Nurmijärvi alarm system and the software generating auroral animations are examples of recycled material. The auroral animator utilizes modern machine vision methods (Syrjäsuo et al. 2001) that have been recently developed at FMI for mining the massive all-sky camera data base. The routine can be run every morning for omitting dark images and this way providing relevant input data for a set of auroral animations. The system operator makes the final choice of the best animations to be shown in the publicity.

The main effort demanding new programming work was upgrading the Nurmijärvi alarm system to accomplish the geomagnetic conditions in Northern Finland, i.e. below the auroral zone (for detailed description of the development see TN-003). The alarm system for Northern Finland is based on the magnetic field time derivative recordings of the Sodankylä geophysical observatory (SOD in Figure 2-1 and Figure 4-1, magnetic latitude ~ 64). The previously recorded long series of *K*-values of Nurmijärvi and Sodankylä were used to adjust the threshold of the Sodankylä alarm to be statistically comparable with the threshold of Nurmijärvi. The distributions of the *K*-values after the alarm are supposed to be similar at both observatories. The analysis revealed that typically the next two *K* values after the alarm are equal or larger than 4 and thus correspond to higher auroral occurrence probability. Thus in the best case the alarm system can yield forecasts with the time span of 6 hours.

The hourly maximum values of the magnetic field time derivatives at Nurmijärvi and Sodankylä are shown as bar plots in the public Auroras Now web-pages. The heights of the bars tell the time derivative in units 0.01 nT/s. In these units the alarm threshold at Nurmijärvi is 30 and in Sodankylä 50. Example plots are shown in Figure 4-1.

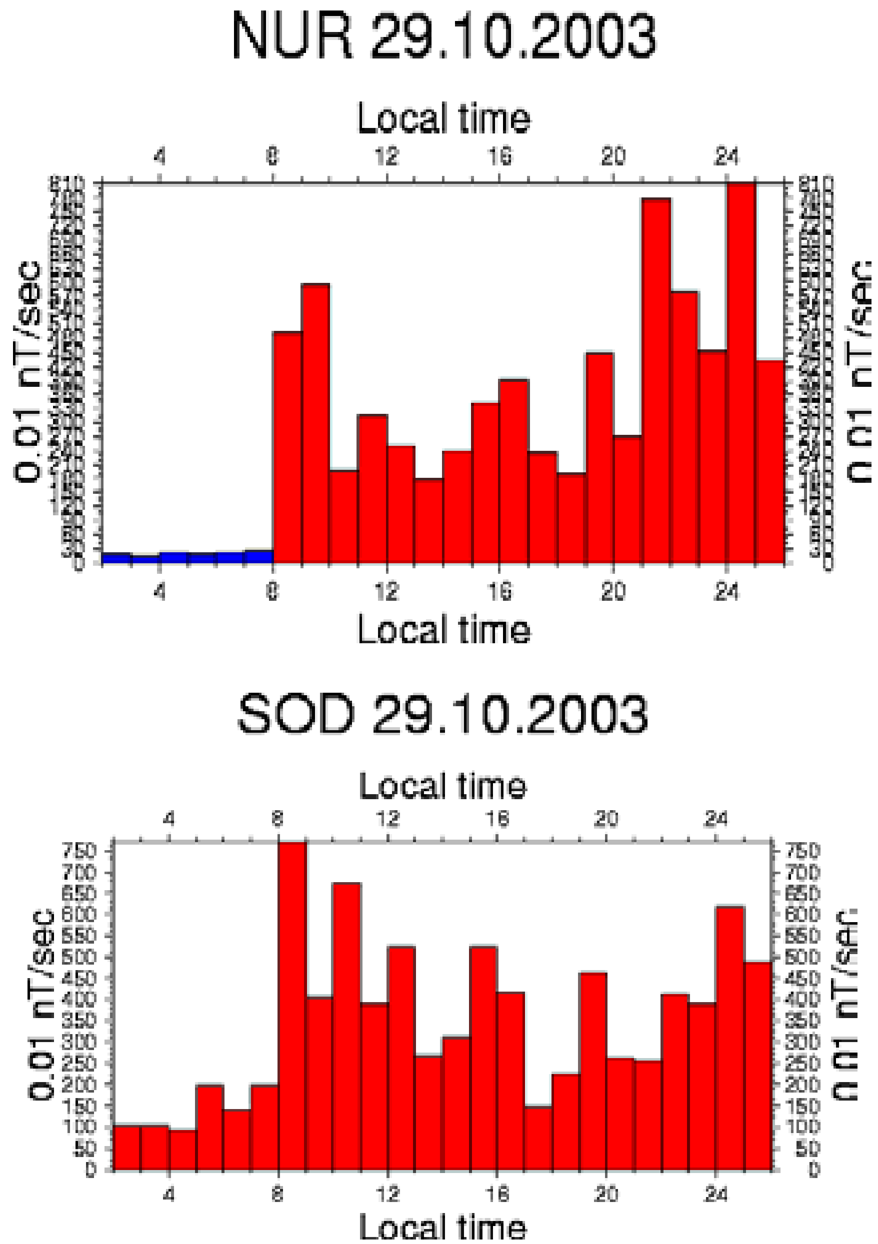


Figure 4-1 Bar plots showing the hourly maximum values of the horizontal geomagnetic field at the Nurmijärvi and Sodankylä geophysical observatories. Auroras Now public web-pages show this kind of plots from the previous and on going day. The bars with the height exceeding the threshold values are highlighted with red while the other bars are blue.

4.1.3 Hotel service

The bar-plots of the public Auroras Now pages are not directly applicable in the hotel service where the customers need to get a view of the activity conditions just by one glance. Thus an interface converting the time derivative indices to a more simple four level characterization of the activity was developed (for further details see TN-003). The four magnetic disturbance levels used in the hotel service are 0=quiet, 1=slightly enhanced activity, 2= clearly enhanced activity and 3= continuous strong activity. When determining the disturbance levels activity events are analysed instead of individual time derivative values. During an event the hourly time derivative maxima stay mainly above the alarm threshold value (one hour drops to lower values are allowed). The hourly updated disturbance level value is determined according to the duration and the peak time derivative value of the on-going event. The disturbance level values are shown in the hotel service with a thermometer-type display (c.f. Figure 4-2).

Figure 4-2 Images used in the hotel service to visualize the magnetic disturbance level. Images from top to bottom correspond to the disturbance levels 0, 1, 2, and 3

Near real-time ASC images from the Sodankylä Observatory are shown during dark hours both in the public Auroras Now web-pages and in the private hotel service. The hotel service shows also the map projection of the raw images. A customized plot is created for every hotel showing the hotel location and some other widely known landmarks. The mapping procedure has been copied from a larger scientific software package that has been developed at FMI for facilitating the analysis of MIRACLE observations together with satellite data. Naturally the outlooks of the mapped images had to be re-designed to get attractive outlooks: the auroral intensities are shown with a palette of green tones and on a black back ground to imitate the impression of real auroras in the night sky. Examples of a raw ASC image and its map-projection are shown in Figure 4-3.

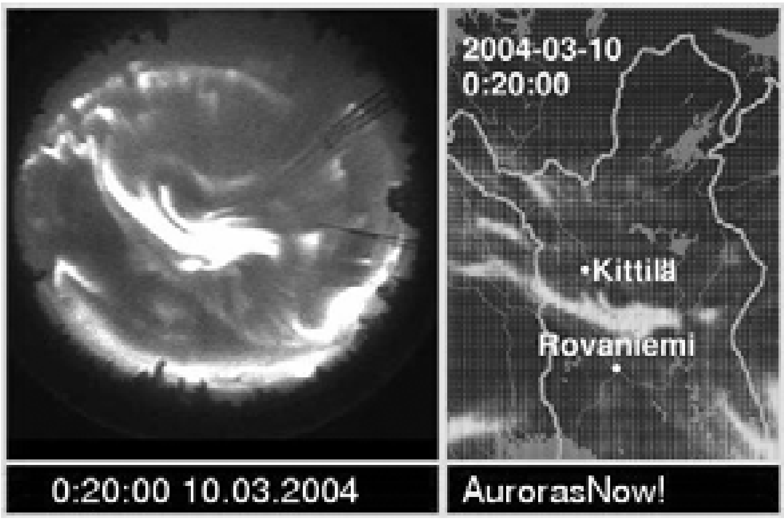


Figure 4-3 (left) An all-sky auroral image acquired by the camera at the Sodankylä Observatory and (right) its map projection as customized to Auroras Now display shown at the Hullu Poro hotel in Kittilä.

Cloudiness predictions for the coming night are an important surplus value of the hotel service when compared with the public Auroras Now service. The predictions have been realized together with the FMI regional weather service in Northern Finland. The weather service has long experience in making tailored weather forecasts for the large skiing resorts in Lapland which facilitated the establishment of the cloudiness service for Auroras Now. This service provides separate forecasts for pre and post-midnight hours and for six different regions in Lapland.

4.1.4 SMS service

The SMS service was designed according to the needs of the URSA association of amateur astronomers. The association has a standardized system for distributing information about rare optical sky phenomena among the association members. Services of a private company (Santa Margarita Ltd) are used for disseminating the messages and for providing the members the opportunity to adjust the number of received messages. In addition to the location information the messages tell the timeliness of the observation and characterize the intensity of the phenomenon. The intensity is described with a three level index (1 = moderate, 2 = clearly visible and 3 = exceptionally spectacular).

The magnetic disturbance level routine that was developed for the hotel service has been utilized also in the Auroras Now SMS service. Magnetic data of Nurmijärvi and Sodankylä observatories are used to generate disturbance level values for Northern and Southern Finland separately. Auroras Now sends hourly e-mails to the Santa Margarita server always when the disturbance level is larger than zero. The e-mails with disturbance values exceeding the previous values of the on-going night are denoted with the flag “first alarm” while the other e-mails are “updating alarms”. The clients of Santa Margarita use the company’s web-interface to describe the profile of their orders. For example, an economical sky-watcher living in the Helsinki area can order from the service only level 3 first alarms for Southern Finland.

4.2 GIC nowcasting in the pipeline

4.2.1 General

The starting point in the GIC modelling of buried pipeline systems is the same as for power networks: the geoelectric field is needed in a grid covering the system. However, calculation of GIC is remarkably more difficult than in a discretely grounded system. Pulkkinen et al. (2001a) present a useful solution based on the distributed source transmission line theory. Within the Gasum Now! SDA, a nowcasting system was developed for the Finnish natural gas pipeline system (Figure 4-4). The input is the real-time geomagnetic field recorded at the Nurmijärvi Geophysical Observatory, and a model of the earth’s conductivity. The geoelectric field is calculated from this data, and then GIC and pipe-to-soil voltages (PSV) at specified points at the pipeline are determined. The owner of the pipeline system, Gasum Oy, is provided with real-time WWW pages indicating the nowcasted GIC levels. The public part of the server also describes the space weather activity level from the GIC viewpoint. As post-analysis, nowcasted values are compared to the recorded values at Mäntsälä.

Figure 4-4 Finnish natural gas pipeline network. GIC measurements with a magnetometer are performed at Mäntsälä (Pulkkinen et al., 2001b). The Nurmijärvi Geophysical Observatory is located about 30 km to the southwest from Mäntsälä.

4.2.2 Calculation of the geoelectric field

Viljanen et al. (2004) presented a practical approach to determine the geoelectric field for GIC purposes, and we have followed that method here too. Because the pipeline system is located at quite a small region, a reasonable approximation is to assume a spatially uniform electric field, which implicitly requires that the earth's conductivity depends only on depth. Then the electric field is related to the geomagnetic field by the surface impedance $Z(\omega)$:

$$E_x(\omega) = Z(\omega)B_y(\omega)/\mu_0, E_y(\omega) = -Z(\omega)B_x(\omega)/\mu_0 \qquad (4\text{-}1)$$

where ω is the angular frequency. The time-domain values are obtained by the Fourier transform.

The surface impedance depends on the local 1-D conductivity structure of the earth. We assume that the same model can be used in the whole pipeline region. However, it is also possible to refine the method by selecting different 1-D models for different sites. As discussed by Pulkkinen et al. (2001b), the active corrosion protection system affects GIC values, so this will be implicitly taken into account in the selected conductivity model. So we should call the model as ”effective” rather the real one.

The use of Equation (4-1) requires some care in nowcasting. The magnetic field is recorded in the time domain, and its Fourier transform in the frequency domain is needed. When using the real time field, the values are only known until the present. This raises a question of how to deal with the unknown future values. One solution is to calculate the inverse transform of $Z(\omega)$ to get the time domain impulse response function, to be convoluted with the time domain magnetic field. Another approach adopted here is to continue the field towards the future in a suitable way.

In the practical computation, we take a sample of the latest magnetic field. It contains real values and then continuations by constant values both before and after the event.

We apply a window function to the data to force the first and last values of the sample to be equal. We have used the Parzen window:

$$W = 1 - \left[\frac{2(n - N/2)}{N}\right]^8 \quad (4\text{-}2)$$

for n = 1, ...,N and W = 0 otherwise.

We illustrate the accuracy of the nowcasting method in Figure 4-5. As a comparison, we have calculated the electric field using the complete time series of the magnetic field. We considered the whole day by using a sliding window of width 60 minutes. Then we compared the electric field values at the end of each sample, which corresponds to the nowcasted value. The result is clearly satisfactory.

4.2.3 Validation of the plane wave method

Presently, the only feasible way is to use real-time data from Nurmijärvi to calculate the electric field in the area of the whole pipeline. The electric field is generally not spatially constant at such a large region, so a single-point magnetic field measurement may not sound sufficient. However, Viljanen et al. (2004) showed that in southern Finland the geoelectric field is spatially quite uniform in the east-west direction in an area of a 100-200 km length scale. So the electric field calculated at Nurmijärvi provides a reasonable proxy. With a spatially uniform electric field GIC at a given site is

$$GIC(t) = \alpha E_x(t) + \beta E_y(t) \quad (4\text{-}3)$$

The coefficients α and β depend only on the topology and resistances of the pipeline system. So for a fixed network, these coefficients must be determined only once, which makes computations very fast. After some experiments, we ended up to a simple two-layer model with the upper layer of thickness 150 km and resistivity 38.5 Ωm, and the lower layer of resistivity 0.385 Ωm. We compared the measured GIC at Mäntsälä in the pipeline with the modelled value in Figure 4-6. Because large GIC are interesting, we considered only time steps with the measured GIC exceeding 1 A, using one-minute values. The relatively large number of errors over 100 % is partly due to occasional data quality problems, but there are obviously time steps with a complicated spatial variation of the electric field (for a more detailed discussion, see Pulkkinen et al., 2001b).

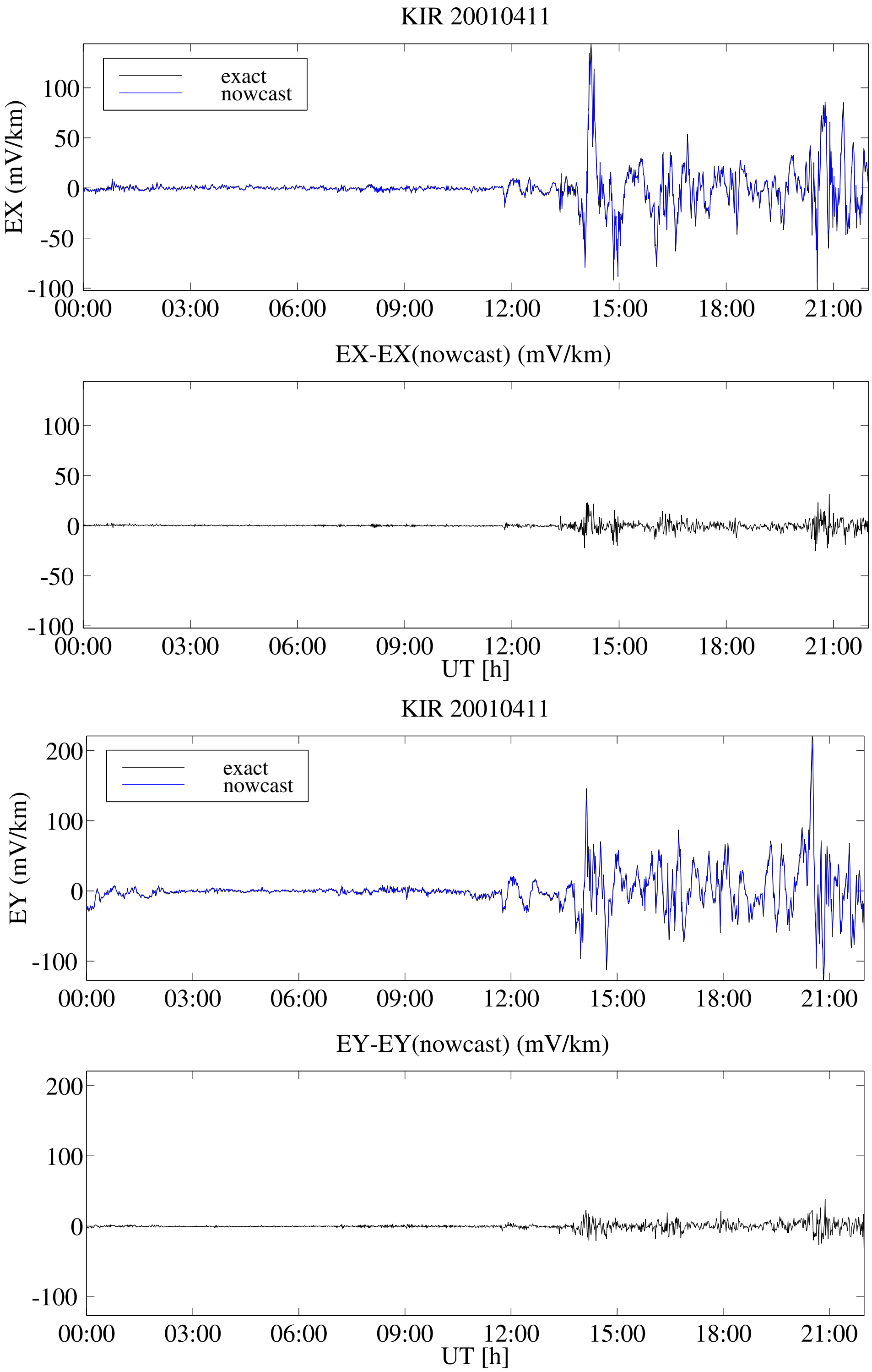


Figure 4-5 Comparison of the nowcasted electric field values (blue) to the measured values (black) obtained using magnetic field data of the whole day.

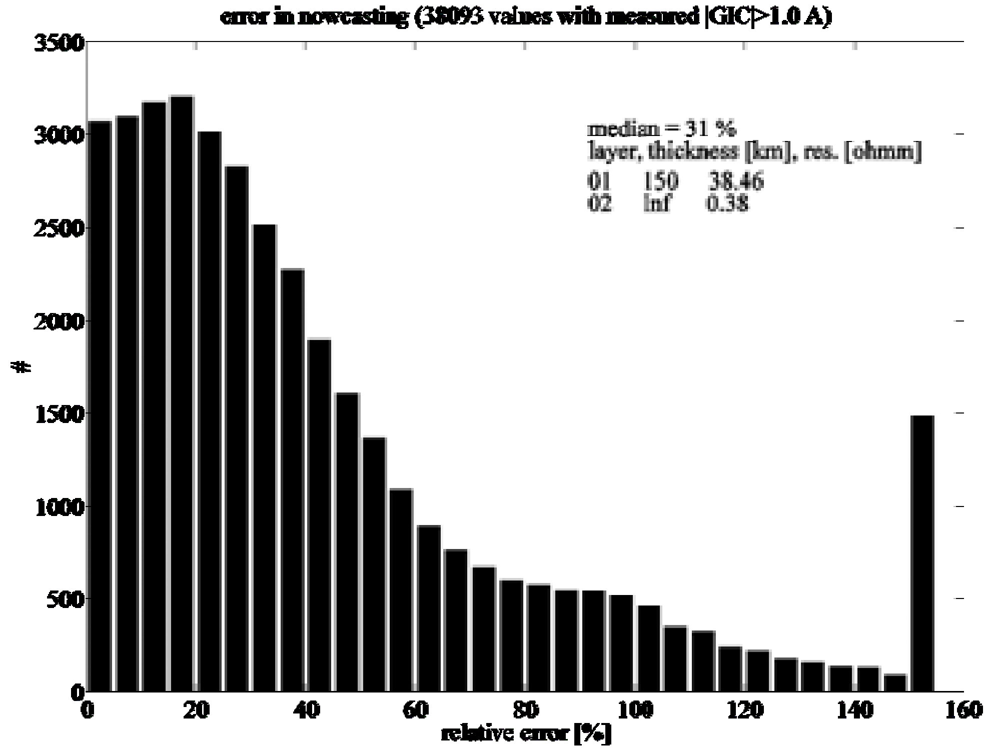


Figure 4-6 Nowcast validation by comparing nowcasted and measured one minute values at Mäntsälä in November 1998 to December 2004. The histogram shows the distribution of the relative model errors. A two-layer earth model was used. The last bar contains all relative errors exceeding 150 %.

4.2.4 Operational description

The nowcasting procedure consists of the following steps:

1. Transfer magnetic data from Nurmijärvi of the present day at a regular interval (10 minutes, easily changed). The file of the previous day is also necessary, and it is transferred once shortly after midnight.
2. Make some automatic error checking of the data file. Try to fix format errors, remove clear error spikes and interpolate missing values.
3. Calculate the geoelectric field.
4. Calculate GIC and PSV.
5. Prepare plots.
6. Update the log file and the error status message.

4.2.5 Pipeline software

Due to a continuous ground contact of a buried pipeline system, determination of GIC from a given geoelectric field is much more complicated than for a discretely grounded power grid. The method is based on the distributed source transmission line (DSTL) model given in a general form by Pulkkinen et al. (2001a). The software is written in MatLab by Antti Pulkkinen (FMI).

The software for nowcasting is mainly written in TeLa. TeLa (Tensor Language) is a computational software package developed at FMI by Dr. Pekka Janhunen (http://www.ava.fmi.fi/prog/tela.html). There are two benefits in using TeLa compared to MatLab: it is faster and it has no license restrictions. The functionality of TeLa routines has been checked by a direct comparison with the corresponding MatLab routines when available.

Plots are prepared by SPPC (Simple Panel Plot Composer), a software package also written by Pekka Janhunen. To get the software, see http://packages.debian.org/stable/math/sppc.html. Examples of SPPC plots are in Figure 5-1 to Figure 5-5.

4.2.6 Measured GIC

Post-analysis of the nowcasting system is based on the recorded GIC at the Mäntsälä compressor station. The measurement system consists of two magnetometers, one just above the pipe and another at the Nurmijärvi observatory (Pulkkinen et al., 2001b). The instrument above the pipe records both the natural geomagnetic variation and the disturbance due to GIC flowing along the pipe. The reference magnetometer at Nurmijärvi measures only the natural variation. Since Mäntsälä and Nurmijärvi are quite close, the natural variation fields are approximately identical. So the difference between Mäntsälä and Nurmijärvi yields GIC with a simple application of the Biot and Savart law.

Because the reference magnetometer is not at the immediate location, the spatial variation of the geomagnetic field causes some error. Instrumental problems (due to electromagnetic noise, hard weather conditions and permafrost movement) are at times seen in the magnetometer above the pipe. As discussed by Pulkkinen et al. (2001b), the active cathode protection system also causes some current, which cannot be distinguished from GIC. However, this ”extra“ current is effectively taken into account in the earth’s conductivity model. As an overall estimate, the noise of the measurement is around 0.1 A, and the inaccuracy due to the various reasons discussed here is around 10-15 %. For the later scientific use, recordings are also visually inspected.

4.3 Technical Infrastructure

4.3.1 Data Transfer System

The Data Transfer System is the project-specific development of software performing data transfer, analysis, and formatting for the WWW-based service. The development work started with analysis of the URD and the existing software system. Working meetings between the contractor (Space Systems Finland, SSF) and FMI were held, as well as regular e-mail and telephone discussions on implementation principles and practical issues.

Originally the aim was to derive a separate Technical Requirements Document from the User Requirements Document (URD). However, in practice this was not considered necessary at the time of the development, and after software approval, it was agreed with ESA that this document would be replaced with a technical description and another technical note describing the system rather than writing a requirements specification afterwards. The resulting output from the work package thus includes these two documents (TN-004 and TR-003).

The basic task for the system is to control the timely data transfers and the processing steps in between. The approach taken for the system was to use the UNIX *cron* function, with timing of the processes implemented in system level timed commands.

The actual transfer and processing chains were then implemented as *cgi* programs and *perl* scripts, and individual processing steps with appropriate codes (MatLab, TeLa, fortran,…) documented elsewhere. The final system runs smoothly on a Linux server described below.

A specific task included in the system is the system maintenance www pages. This approach was selected to improve system safety: only for very specific needs any configurations files in the system need to be directly accessed.

At the end of the development phase, an acceptance review was held, where the results from the tests were reviewed with the contractor. The results of the review were also presented to ESA at a progress meeting, and the system was accepted for operational use, fulfilling all User requirements.

Project documentation may easily become a major cost driver, especially in small software projects, and thus it was agreed that detailed design documentation would be included as comments in the actual code. Other documentation include the technical note referred to above (TN-004), test documents (TR-003) and a User Manual (UM-002).

The system was developed on an FMI computer (with the contractor having remote access to the system), and thus no separate installation was needed.

The system was accepted in the original schedule, and was operational before starting of the peak tourist season in November 2003.

4.3.2 WWW Pages

In order to improve the market value of the service, the design of the WWW pages was contracted out to CD-Quality Oy, specialised in web-based applications and layout design. The functionality of the WWW pages was included in the URD, and layout-specific questions were discussed between the contractor, FMI, and the FMI customers.

For the hotel service, the pages were designed for the TV screen (PAL layout), which does not look that impressive on a computer terminal, but gives the best result when displayed on TV. For the public service and Gasum Now pages, there was no such limitation, and layout was designed taking into account functionality and graphical design. The final content and layout for the public service was also iterated with ESA, with helpful comments improving functionality. Unfortunately, not all comments could be implemented due to technical constraints. All such issues were also agreed with ESA.

4.3.3 Hardware Infrastructure

The Auroras Now! server has Tyan Thunder S2469 Dual AMD motherboard with two AMD Athlon MP 2400+ processors and 1024 Mb DDR memory, six Maxtor 80 GB IDE hard drives controlled by 3ware 7500-8 ATA RAID Controller, and it is running on Debian GNU Linux. The computer resources so far have proven to be adequate. The server is connected to the internet, with WWW services operated on Apache software. Additional software packages include TeLa (TeLa = Tensor Language; http://www.geo.fmi.fi/prog/tela.html), GNU Octave (http://www.octave.org/) and Generic Mapping Tools (GMT, http://gmt.solst.hawaii.edu/).

5 Operational Phase

5.1 Auroras Now

Auroras Now started operation at the beginning of November 2003. Maintenance of the new system was integrated efficiently with the pre-existing FMI data acquisition and forecasting routines. The person in the main charge of Auroras Now operation is a FMI programmer who also monitors the operation of the MIRACLE ASCs and archives their data. Auroras Now requires roughly 10-15% of the programmers working time. Routine work includes publishing the best auroral animations and weekly space weather reports in the public Auroras Now web-pages, preparing the geographically mapped auroral animations for the hotel service, and evaluation of performance of the magnetic alarm system (more details below). The space weather reports give an overview of the previous week solar, geomagnetic, and auroral activity and they are written by FMI researchers. Writing the report can take time from a few tens of minutes to a couple of hours depending on the level of activity and on the enthusiasm of the writer. The daily cloudiness forecasts for the hotel service are made around noon in the FMI weather service unit at Rovaniemi airport and fed via a web-interface to the Auroras Now server.

Occasionally appearing special situations (e.g. the change from the local winter time to summer time and firewall reconfigurations) have caused some error situations and thus some extra work but fortunately only a few times per season. Some parts of the system, e.g. the SMS-routines, have still needed some debugging and special monitoring during the operational phase. The conversion routines from the time derivative values to the disturbance levels were readjusted for a couple of times during the year 2004 in order to get more even distribution for the disturbance level values at both observatories.

The online performance of the auroral alarm system for Northern Finland is evaluated weekly with the following coding (for more details, see TN-003):

3	The alarm threshold was exceeded and auroras were observed. The level of the alarm is consistent with the intensity of the auroras;
2	The alarm threshold was exceeded and auroras were observed;
1	The alarm threshold was exceeded, but only barely visible auroras;
0	No alarm and no auroras;
-1	The alarm threshold was exceeded, but no auroras in the sky;
-2	Clear auroras in the sky, but the alarm threshold was not exceeded.

The conditions not favourable for the evaluation are characterised with the following codes:

A	The camera did not operate;
B	Due to failure in the Internet connections or in the magnetometer recordings no timely alarm level was available;
C	It was cloudy.

The evaluation is performed by comparing the hourly disturbance level indices with the keograms of the ASC that operated in the close vicinity of the Sodankylä observatory. A keogram is a summary plot that shows as a function of time the latitude distribution of the auroral luminosity along the middle meridian line of the ASC image. The time resolution of the evaluation is limited to two values, one for the pre-midnight and one for the post-midnight hours. This resolution is the same as available for the cloudiness predictions of the hotel service and thus considered adequate for tourist purposes. Since making the distinction between dark nights without auroras and cloudy nights is in many cases impossible from keograms alone, the results of the evaluation are re-checked with full scale white light ASC images after every season.

Evaluation results of the first season reveal that Auroras Now can be assumed to be usable (i.e. comparable with the number codes) during ~70 % of the time. Cloudy sky is the most common reason for the lack of near-real time auroral images and problems in the data transmission cause breaks in the near-real time magnetic data flow. The latter problem is not very harmful since it typically appears around the UT-midnight when the service is not used widely and the error gets automatically corrected during the next updates. During the first season the system yielded wrong alarms (i.e. evaluation codes -1 or -2) only in ~15% of the cases, otherwise the magnetic disturbance level values were consistent with the on-going or forth coming auroral activity.

For post-analysis purposes the Auroras Now! Server stores continuously raw data and data products to its archives. The raw magnetic field data from both observatories get stored as well as the hourly time derivative maxima, the disturbance level values, and the weekly space weather reports. The server archives also images - ASC pictures and bar-plots - and animations. Both numerical data (hourly maxima of magnetic field time derivatives) and images (bar-plots as png-files) are pushed via a ftp-site to the ESA space weather server SWENET (http://www.esa-spaceweather.net) to provide the professional service users the possibility to compare Auroras Now products together with other geophysical data and with the products of the other Service Development Activities of the ESA Pilot Project.

5.2 GIC Now

5.2.1 Structure of the WWW server

The WWW server consists of a public and a restricted part. Nearly everything is publicly accessible. All pages are available both in Finnish and English.

The main contents of the public part are:

- General information of GIC
- Near-real-time magnetic data of Nurmijärvi and the calculated geoelectric field
- General description of GIC nowcasting
- Measured GIC at Mäntsälä
- Comparison of measured and modelled GIC at Mäntsälä (as post analysis)

Additional information given in the restricted part is GIC and PSV at selected sites of the pipeline. Results are presented graphically and numerically. URL of the main page is http://aurora.fmi.fi/gic_service/.

5.2.2 Visualisation of nowcasted values

Data are illustrated in several ways. The starting point is the measured magnetic field at Nurmijärvi (Figure 5-1). Because GIC is closely related to the time derivative of the field, it is also shown (Figure 5-2). The calculated electric field resembles more the time derivative than the field variation (Figure 5-3).

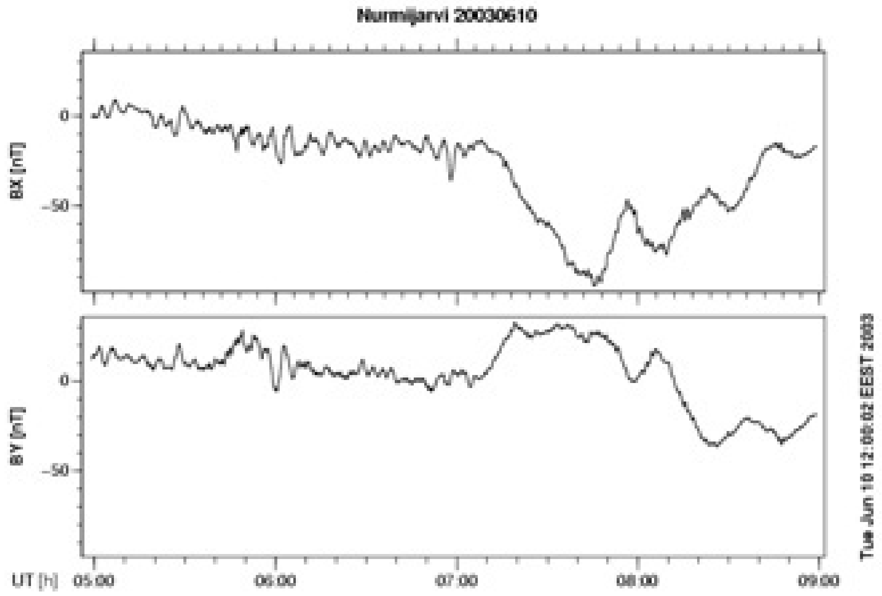


Figure 5-1: Real-time magnetic field at Nurmijärvi.

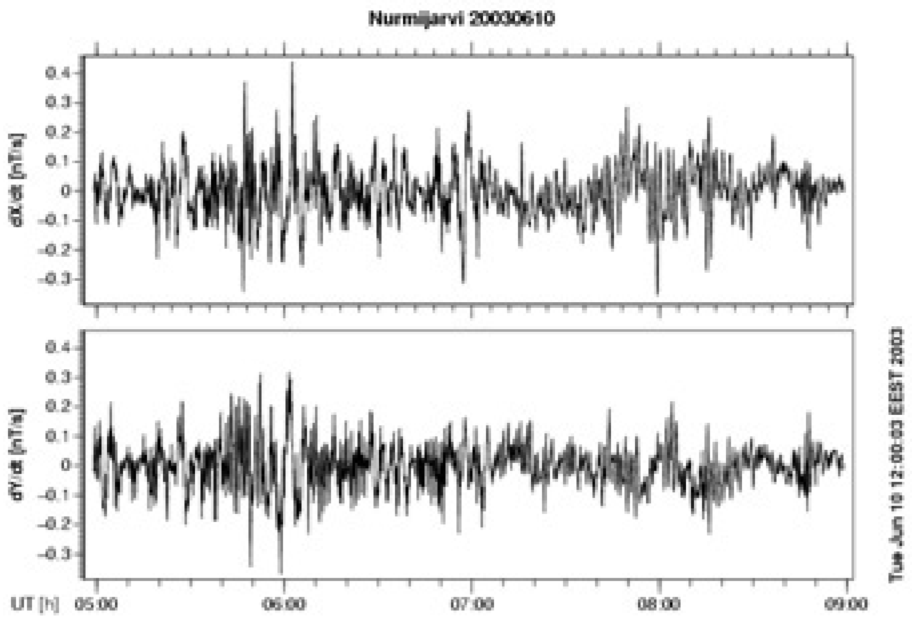


Figure 5-2: Real-time time derivative of the magnetic field at Nurmijärvi.

For the developer's purposes, a combined plot of the fields and GIC is useful (Figure 5-4). For the user, it is more convenient to select a specific GIC site. This is possible by using a simple menu. It is easy to add any new sites just by determining the coefficients in Eq. (4-3).

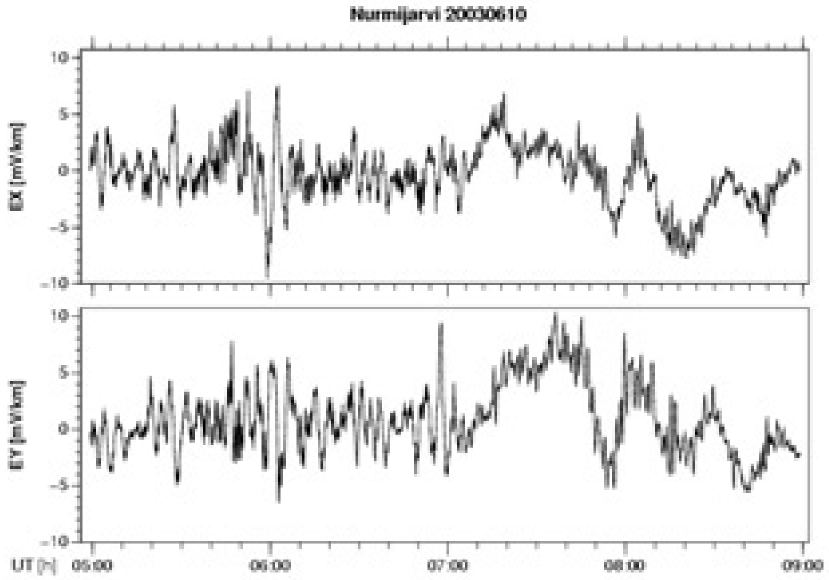


Figure 5-3: Real-time electric field calculated from the magnetic recordings at Nurmijärvi.

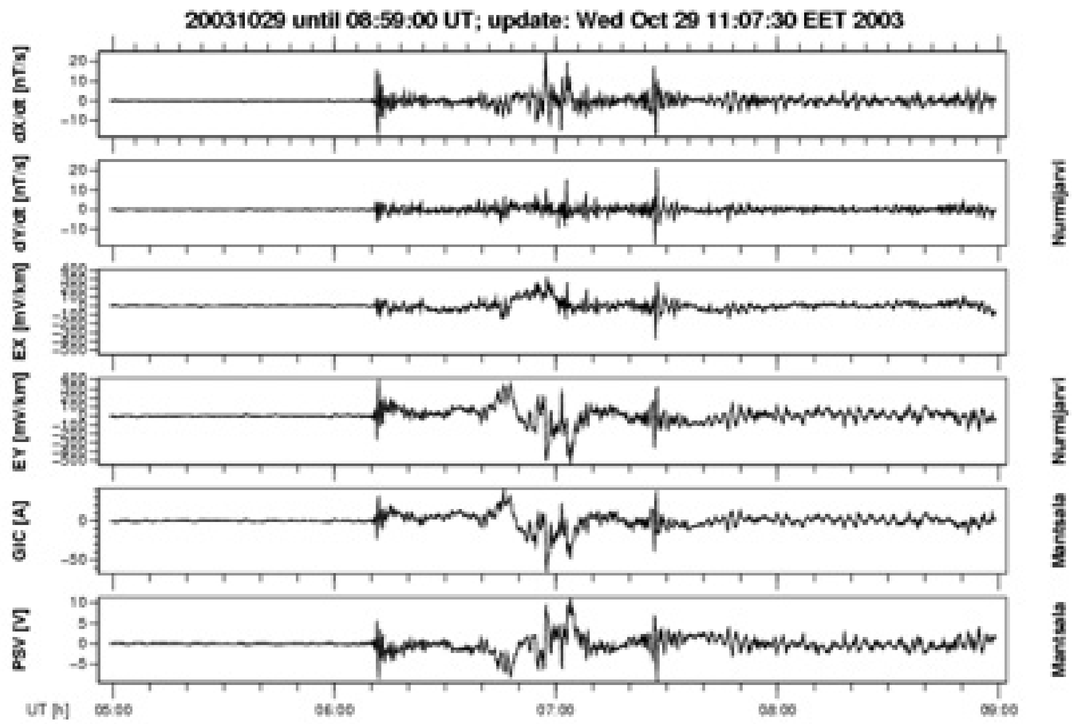


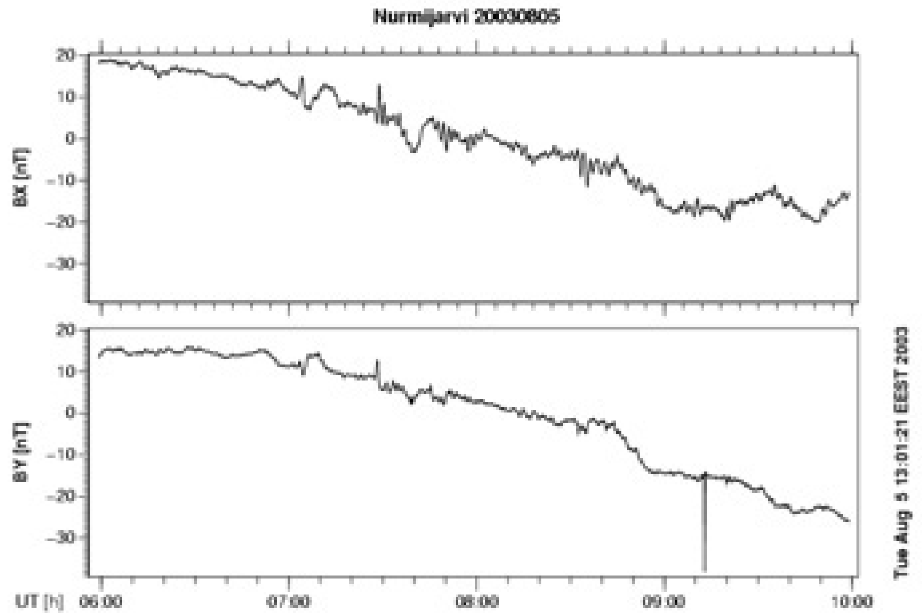
Figure 5-4 Gasum Now!: example of the developer's WWW page with the nowcasted GIC and PSV at Mäntsälä. The event is the huge storm of October 29, 2003. The measured maximum GIC at Mäntsälä was 57 A just before 07:00 UT, so nowcasting was excellent in this case. This storm is still the largest one during the GIC recording period since November 1998.

Other information available is a columnar ASCII file of latest data, and an automatically created error information page.

Plots are regularly updated at a rate to be freely defined by the administrator. The only limit is that the previous calculation should be ready before starting the next one. In the prototype, the computation and figure format conversions usually take about 15 seconds. WWW pages are automatically updated with the refresh command in HTML. The refresh interval is recommended to be about half of the calculation update.

5.2.3 Error checking in GIC nowcasting

Since a human verification is not possible in near real-time operation, several automatic checking routines are performed when the nowcasted GIC is calculated. If there are unnaturally large time derivatives of the magnetic field then the corresponding field values are marked missing and linearly interpolated. This does not break the program, but information is written on the error page. It should be noted that if a long sequence of data is interpolated then output may not be very reasonable. If there are no automatically detected errors this is also reported on the error page. There are also data errors which are very difficult to remove automatically, as shown in Figure 5-5. A small spike in the variation field may cause a relatively large time derivative, which further causes a spike in the electric field and GIC.



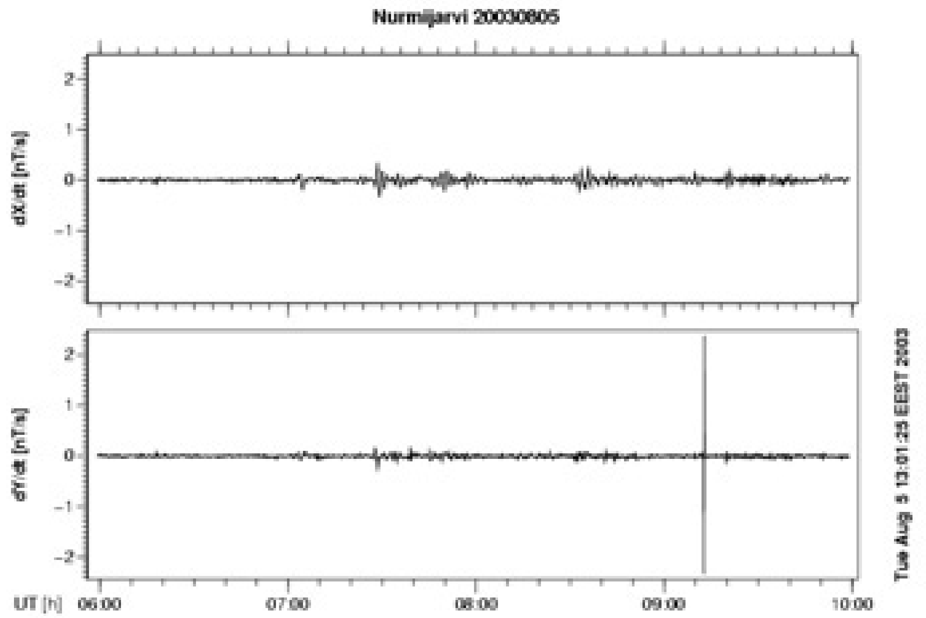


Figure 5-5 Data error in the real-time magnetic field at Nurmijärvi.

5.3 Technical Infrastructure

Apart from the error cases, the daily maintenance of the Auroras Now! service requires human input for the cloudiness prediction and selection of the aurora animations. The cloudiness predictions are twelve digits entered daily by the weather service and the work with animations is a routine check of the automatically generated auroral animations. If these animations include spectacular events, the operator selects the best one for the public animation. This can be done from the admin web pages.

Additionally, the public web pages show weekly written space weather reports and an on-going survey on the reliability of the geomagnetic alarms in predicting auroras. These actions are performed through the admin web pages.

As errors result in detailed notification email to administrator, active monitoring is not needed.

5.3.1 Error cases during early operations phase

The errors encountered during the first months of operation were either result of human errors (trainee setting a subsystem to the test mode and forgetting doing that, etc) or because of problems in remote servers causing failures in data transmissions.

The system has one reoccurring error difficult to avoid: At UT-midnight, the remote servers compiling geomagnetic field data files do not update immediately their deliverables (current day’s file is not available and previous day’s file not yet zipped). It seems that there is a random delay of more than five minutes relative to the server clock in the creation of these files. This results in a failure in the retrieval of the data files at midnight, usually at one server but at some occasions both at Nurmijärvi and Sodankylä servers.

There also have been a few times problems due to the remote server’s firewall configuration, which has caused the program to crash before sending the error warning email. These errors have been easy to spot from the log files and the state of the system (plots not updating etc), but this demands that the system is periodically checked. It seems that there is a bug in the perl ftp package installed in Auroras Now! server which crashes the calling program should the remote firewall deny the connection. If the server is down this crash does not occur, as it doesn't occur at some access denial cases either. Such error cases are hard to reproduce, but easily identifiable from the log files.

All the errors discussed in this subsection occurred during the beginning of the operational phase, and have been corrected. Thus they are not a concern for operations.

6 Service Assessment and Customer Feedback

In this section we will discuss the performance of the service, both in technical and model-dependent terms, as well as how well the customers found the service to fulfil their expectations. We will first discuss the technical aspects, and then the customer feedback. Cost-benefit analysis is included separately in Volume II of the Final report.

6.1 Assessment of auroral forecasting service

FMI has operated for several years an auroral alarm system based on magnetic field observations of a Southern Finland geophysical observatory (at Nurmijärvi). The system checks once in hour the time derivative values of the north and east components of the geomagnetic variation field. If the maximum exceeds a certain threshold the system sends an alarm as an email to the customers. As a part of Auroras Now! (WP240, TN-AUR-003-FMI.03) a new version of the Nurmijärvi system was developed for Northern Finland geomagnetic conditions where auroras appear also during non-storm periods. The alarm system was also upgraded so that instead of hourly time derivative values it distributes hourly disturbance level indices, which take into account also the previous activity. The magnetic disturbance level is characterized with a four level scale (0=quiet, 1=slightly enhanced activity, 2=clearly enhanced activity, 3=continuous strong activity) which facilitates the integration of the system to user-friendly applications, like the hotel service and SMS-services for interested parties (e.g. the Finnish association of amateur astronomers Ursa).

During the pilot period of Auroras Now! the online performance of the new auroral alarm system was evaluated weekly with the following coding:

3= The alarm threshold was exceeded and auroras were observed. The level of the alarm is consistent with the intensity of the auroras;

2= The alarm threshold was exceeded and auroras were observed;

1= The alarm threshold was exceeded, but only barely visible auroras;

0=No alarm and no auroras;

-1=The alarm threshold was exceeded, but no auroras in the sky;

-2=Clear auroras in the sky, but the alarm threshold was not exceeded.

The conditions not favourable for the evaluation are characterised with the following codes:

A: The camera did not operate;

B: due to failure in the Internet connections or in the magnetometer recordings no timely alarm level was available;

C: It was cloudy.

In the following we describe how the evaluation was performed in practice and report about the results

6.1.1 Evaluation of the online performance

The performance of the auroral alarm system was evaluated weekly during the Auroras Now! pilot period from November 1 2003 to March 31 2004. The evaluation was done only for the Northern Finland alarm system because it has the key role in the hotel service and the reliability of the Southern Finland alarms has been investigated earlier. The Northern Finland alarm system is based on the magnetic field data recorded at the Sodankylä Geophysical Observatory. The evaluation was performed by comparing the hourly disturbance level indices with the keograms of the all-sky camera (ASC) that operated in the close vicinity of the Observatory. A keogram is a summary plot that shows as a function of time the latitude distribution of the auroral luminosity along the middle meridional line of the ASC. An example is shown in Figure 1.

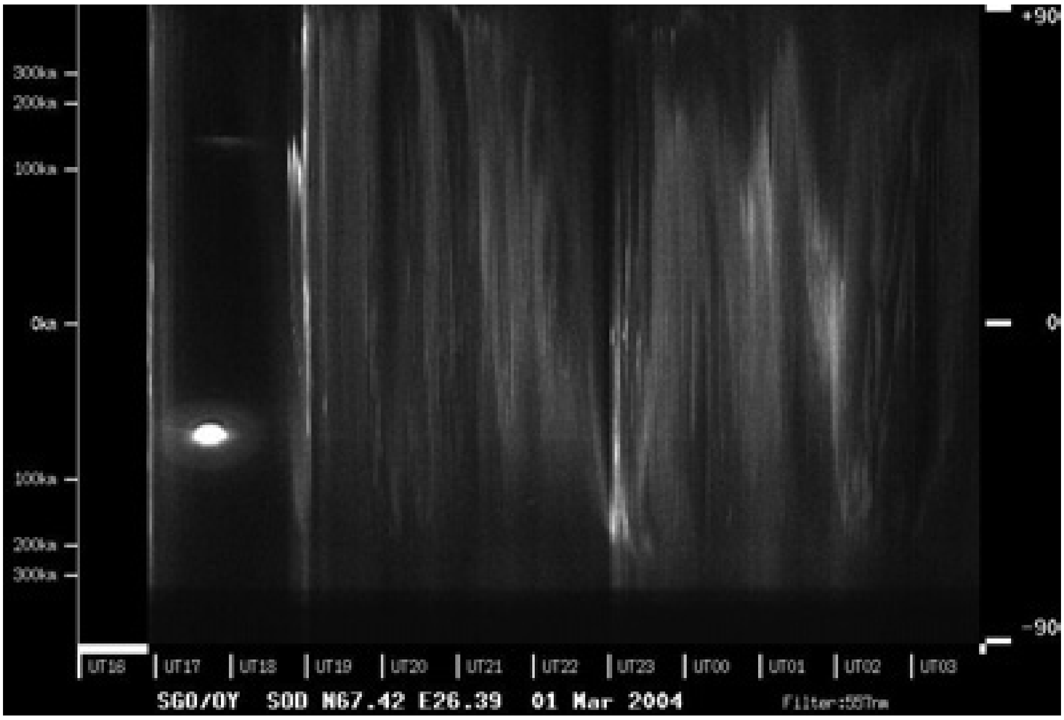


Figure 1: A keogram describing the auroral activity that the ASC at Sodankylä recorded during the night of March 1 – March 2, 2004. The horizontal scale shows the UT-hours and the vertical scale the distance (at 100 km altitude) from the zenith of the camera. The bright spot at UT 17-18 shows the Moon that traversed the ASC middle meridian during these hours. Bright auroras were recorded especially after 19 and 23 UT.

The time resolution of the evaluation was limited to two values, one for the pre-midnight and one for the post-midnight hours. This resolution is the same as available for the cloudiness predictions of the hotel service and thus considered adequate for tourist purposes. Defining the overall scores for the pre- and post-midnight situations from several hourly values and the corresponding keograms is not a straightforward task and may include some subjective biasing. However, it is important to note that the amount of the manual work of the evaluation must be adjusted to give reasonable cost-benefit balance and thus the procedure cannot meet the standards of a scientific investigation. Performing the evaluation with a higher time resolution would be an interesting exercise, but unfortunately without any wider benefits since the results cannot be directly applied to other observation sites.

The times of the evaluation codes 2 (auroras when alarm) and -2 (auroras when no alarm) are much easier to determine than the other codes (excluding the letter codes). Giving the score 3 (auroras when alarm and the brightness of the auroras consistent with the disturbance level) or 1 (only barely visible auroras when alarm) is a more subjective task but includes still less ambiguity than the evaluation the dark times of the keograms (corresponding to the codes 0 and -1). From the basis of a keogram alone even an experienced investigator cannot determine exactly whether the dark period is due to clouds or to real absence of auroras unless the Moon is visible. In many cases studying the full resolution white light images helps in detecting those 0 and -1 values that should be in the category C (cloudy sky). However, for a routine type quick-look evaluation this method is not suitable.

Part of the periods evaluated with the code C may include cases where the dome of the camera was covered with snow. Distinguishing the snowy dome from the cloudy sky even from the basis of full resolution images is often impossible. The snowy dome cases are exceptionally embarrassing for the system because the camera misses auroras that are otherwise clearly visible. The ASC huts are equipped with heaters and fans to keep the temperature high enough and consequently the dome clear. Thus the snow problem is likely to appear only in exceptionally harsh conditions.

The code A (the camera broken) was never used in the weekly evaluation during the pilot period. This does not mean that there would not have been transient blackouts in the near-real time auroral monitor of the hotel service. The error-logs of the Auroras Now! server show that there indeed were periods when the system was able to deliver the magnetic information but not ASC-images. Longer than one hour breaks in the delivery of the ASC-images took place on the following dates: December 9, 12, 26, 2003, and February 27 and March 28-30, 2004. The problems at the beginning of December were due to the firewall reconfiguration at the Sodankylä Observatory. These failures did not hamper the use of keograms in the posterior evaluation.

6.1.2 Results of the evaluation

The summarising analysis of the evaluations codes achieved during the pilot period was performed in three phases. In the first phase the outcome of the weekly quick-look evaluation was analysed. In the second phase part of the original code values were corrected after using the full resolution white light images to verify the reliability of C, especially in the cases of increased magnetic activity (disturbance levels 2 and 3). In the third phase the re-checking with full scale images was widened to include also the periods of the evaluation code 0 (no auroras, no magnetic activity). Furthermore, the sequence of the disturbance level values was cross-checked with the lists of auroral times as defined by the automated auroral search engine run in the Auroras Now! server. If the engine detected auroras for more than 1 hour during the pre- or post-midnight period and the corresponding disturbance level values were zero it was considered as total failure of the system (evaluation code -2).

The questions answered in the summarising analysis are the following:

1. How many of the evaluation codes are either A or B? (Technical problem)
2. How many are C? (Cloudiness problem)
3. How many are number codes? (The system was usable)
4. How many are equal or larger than 0? (Successful hits of variable degree)
5. How many are below 0? (Failures)
6. How many equal 0? (No alarm, no auroras)
7. How many equal 3? (The best hits)
8. How many equal -2? (The system missed clear auroras)

The period from November 1 2003 to March 31 2004 corresponds to 304 evaluation code values. The distribution of the codes to the categories specified above is summarised in Table 1 below.

Question	***Phase 1***	***Phase 2***	***Phase 3***
1. Either A or B?	19 (6%)	18 (6%)	15 (5%)
2. C?	66 (22%)	51 (17%)	61 (20%)
3. Number codes?	219 (72%)	235 (77%)	227 (75%)
4. >=0?	205 (94%)	221 (94%)	196 (86%)
5. <0?	14 (6%)	14 (6%)	31 (14%)
6. 0?	118 (54%)	139 (59%)	105 (46%)
7. 3?	33 (15%)	33 (14%)	34 (15%)
8. -2?	11 (5%)	12 (5%)	29 (13%)

Table 1: Distribution of the evaluation codes to different groups (c.f. the questions above). The percentage values of the first three rows have been achieved by normalising with 304 (total amount of the evaluation codes) while the percentage values of the other rows are due to the normalisation with the values of the 3rd row.

The decrease of the values in the first row (technical problems) is a consequence of the updating of the data bases. The gaps that existed in the near real-time data have been fixed in the post-processing of the data base. The value of the first column is the most relevant to describe the real-time reliability of the system.

The values in the second row (cloudiness) vary quite much (20% relative change). The second phase analysis with full resolution images showed that the C evaluation had been given in the quick-look analysis erroneously for several periods of 2 and 3 magnetic disturbance levels. Fortunately this did not mean that the errors of the service would have been hidden behind the C-label, since there is no significant difference in the 5th row values (failures) of the first and second phase analyses. The increase of C occurrence in the third phase is the correction which the investigation of the 0-events (no alarm no aurora) with full resolution images yield: part of the dark periods were re-identified as cloudy periods. The variability in the values of the 3rd row (usability of the system) is directly linked with the changes of the 2nd row (cloudiness).

The values of the 4th row show highest hit rates in the second phase. Many of the C events of the first phase have been shifted to the group of successful hits, but unfortunately mainly to the somewhat uncertain group of 0 events (c.f. the significant increase in the 6th row values in the transition from the first to the second phase). The increase of the number of >=0 events is 16, but the increase of the 0 events is 21, which means that in the second evaluation part of the >0 events also have been shifted to the 0 group. This implies changes also in the magnetic activity level characterisations. Human errors in the quick-look analysis are the most likely explanation for this phenomenon.

The cross-checking with the auroral times as detected by the auroral search engine decreases clearly the score of the service (c.f. the decrease in the values of the 4th row and increase of the failures in the 8th row in the transition to the third phase). The previously known tendency of the engine to overestimate the auroral occurrence explains mainly the decrease of the score. From the viewpoint of scientific applications the over-sensitivity of the engine is not harmful since also dim (even sub-visual) auroral displays must be included to the analyses, but for tourist purposes many of the periods spotted by the program are useless. The engine found auroras (with integrated duration more than one hour) during 197 (59%) pre- or post-midnight periods of the pilot season. In 39 of these cases the auroral periods are from times with evaluation codes 0 or -1 (no auroras in the sky) and in 2 cases the evaluation codes were either >0 or -2 (auroras in the sky) but the engine did not detect long enough auroral periods.

To summarise, the values of the4th and 5th rows of Table 1 are the clearest measures to describe the reliability of the system. In is difficult to say which of the values should be considered as the “final truth”, but their range can be considered to cover also the real reliability estimate. Giving exact values is difficult because of the subjectivity of the evaluation procedure and due to the cloud detection problems described above. The higher values in the 6th row (0 cases) imply increased uncertainty in the values of the 4th row (successful hits). In order to decrease this uncertainty in the third phase the occurrence of the Moon and stars in the full resolution images was checked. This procedure helped to eliminate the option of cloudy sky in 25 cases (24% of 105).

6.1.3 Evaluation results of the season 2004-2005

During the season 2004-2005 the weekly online evaluation was performed with the help of full resolution white light images and thus there was no need for re-checking after the season. Table 2 presents the evaluation results of phase 3 from 2003-2004 together with the results of 2004-2005. The system got a bit lower scores for the latter season most probably because the evaluator was more experienced and consequently more critical then. The differences between the two columns of Table 2 are larger than those between the columns of Table 1, but in general both seasons yield roughly the same information about the performance of the service.

Question	2003-2004	2004-2005
A or B?	15 (5%)	60 (14%)
C?	61 (20%)	75 (17%)
Number codes?	227 (75%)	299 (69%)
>=0?	196 (86%)	245 (82%)
<0?	31 (14%)	54 (18%)
=0?	105 (46%)	139 (46%)
3	34 (15%)	44 (15%)
-2	29 (13%)	54 (18%)

Table 2: Same as Table 1, but both the seasons 2003-2004 (3rd column from Table 1) and 2004-2005. The total number of evaluation codes of season 2004-2005 was 434.

6.1.4 Conclusions

Analysis of the magnetic disturbance level values of Auroras Now! and simultaneous ASC-data from two seasons (2003-2004 and 2004-2005) has shown that the service is usable about 70% of the time and during 80% of that time it manages to give feasible characterization of the on-going or forthcoming auroral activity

6.2 Auroras Now customer feedback

In order to evaluate the added value of the services FMI made feedback forms available to the hotels. This feedback form was available in Finnish, English and German (the English version of the form is attached as Appendix A). The hotel personnel were interviewed, and additional questions were sent on a questionnaire made available by the ESA contractor (SEA). This questionnaire is also attached (Appendix B) and filled-in questionnaire forms from all customers have been sent to ESA/SEA. At FMI, separate questionnaires were also prepared for URSA (SMS service) and Gasum (Gasum Now). For URSA, the questionnaire was placed on the association's WWW pages. To estimate the customer base of the hotels, statistics of visitors during the operational season was requested and received. Those data are attached as Appendix to Volume II.

For the public WWW, questionnaires were prepared and sent to Arktikum arctic science centre in Rovaniemi and Hankasalmi Revontuli hotel in Central Finland. However, no feedback forms were ever received, and also otherwise the contacts to Arktikum and Hankasalmi Revontuli have been very rare. For Arktikum this may be due to change of some of the key personnel during the project. For the public service, only WWW statistics is used. Samples of those data are included as Appendix C.

In the following, we present a brief analysis of the data, ordered by service.

6.2.1 Questionnaires to Hotel customers and SMS service users

During the project FMI made two questionnaires, one for the hotels and one for the URSA association. Hotels distributed the questionnaires at their reception desk. To further motivate people to fill the forms small prizes (CD-ROMs introducing the space weather concept) were allotted. URSA distributed the questionnaire among its members via internet and e-mails. Despite of the encouragement and repeated requests the amount of feedback that finally reached the service designers was limited: 17 forms were received from the hotel Luostotunturi and six from URSA. In the following we summarize the main points of this feedback. A summary of the feedback is also attached as Appendix D.

In addition to the FMI feedback forms and interviews of hotel personnel, the User Survey Form of Consultant for Systems Engineering & Assessment Ltd (SEA) was filled by PR-personnel of the Luostotunturi and Hullu Poro hotels and by the URSA representative who participated to the definition of user requirements at the beginning of the project.

Roughly half of the hotel customer feedback forms were submitted by Finnish hotel customers. The foreign feedback came from UK, France and Russia. All these people visited the hotel with their families and during their holidays. The durations of their visit varied from 2-7 days. Almost half of the visits, mainly those of foreigners, had been booked via a travel agency. Men were slightly more active than women in giving the response and the reported ages varied from 21 to more than 70 years.

The URSA representative reported that the members have in general been happy with the new service and thus he believes that Auroras Now! has strengthened the image of URSA as an association with versatile interests. With the SMS-system sky watchers get alarmed also when not nearby e-mail connections. He had heard that some subscribers have had problems in fixing the number of warnings economically suitable with the Santa Margarita web-interface (customers pay to Santa Margarita for the service, per incoming message). He also expressed the wish of a higher time resolution for the magnetic activity monitor. The currently used one-hour resolution may in some cases be too low to spot the auroras at the very beginning of a space weather storm.

6.2.2 Visibility, usability, and reliability of the Hotel and SMS service

Most of the hotel customers got familiar with the service only at the hotel. However, they felt they had extremely well learned to use all the different aspects of the service: The activity monitor had been followed roughly as often in the hotel rooms as at the terminal in the entrance lobby, and the service had been used both for real-time monitoring and for predicting the auroral occurrence for the coming night. Only in a few special occasions the service had convinced people so much that they had gone out to see the real auroras.

Adopting Auroras Now! had been easy for the URSA members since many of these people have used the magnetic activity monitor which FMI maintains on its web-pages for several years. One purpose of the questionnaire for URSA was to collect feedback of the usability of the web-interface of Santa Margarita Ltd., which distributes the auroral alarms according to the URSA standard template. Most of the URSA members are interested about low-latitude auroras (the association is based in Helsinki), and many of them are willing to use the SMS service also in future. On the other hand, distributing the information only as SMS messages is not favoured: there was a wish of a more easily loadable format for the magnetic activity bar-plots was also expressed in the feedback. The web-interface of the SMS-messages was not found more difficult than the filters for the other Santa Margarita alarms but on the other hand many of the clients avoided complications by using the default settings.

The service was found to be usually reliable both by the URSA members and the hotel customers, although the evaluation of the latter group should be interpreted with care as the alarms did note lead to anyone to leave building to actually watch the aurora outdoors (at least according to the feedback received). The availability of background information was acknowledged to be adequate.

General information about auroras and the service are distributed in the hotel with several different media: in the display with the activity information, in brochures available in the hotel room folders, and in sheets of Frequently Asked Questions available from the staff upon request.

6.2.3 Customer estimates about effect on Hotel demand

The replies collected from hotel customers suggests that Auroras Now!-type service alone probably does not increase the demand of a hotel significantly. Half of the responders assumed the large audience to favour hotels with auroral monitoring while in less than 20% of the replies the service was reported to have a positive impact on the responder's own hotel choice.

6.2.4 Replies from the Hotel personnel

The hotel personnel representatives found Auroras Now! useful especially when dealing with foreign customers. Also hotel personnel had learned more about auroras with the help of the service. The public part of Auroras Now! had been used in hotels as well. Occasional failures of the system maintaining the connection between Internet and the hotel-TV has caused most of the extra work that had been needed, but the amount of problems had not been disturbing.

As response to the question of actual benefit to the Hotel, evaluating the financial benefit was found to be difficult, but the strategic benefit is obvious. Auroras Now! is seen as one important and easily adoptable ingredient when concreting the exotic PR-image of Finnish Lapland.

6.2.5 Other comments

Our colleague Frank Jansen from Germany travelled to Luosto in Finnish Lapland in December 2004. At Hotel "Luostotunturi" he studied the FMI/ESA "Aurora Now" system for tourists. According to Frank Jansen, the system can be characterized as follows:

- it is a very good monitoring system for auroras for national and international tourists staying in the hotel,

- "Auroras Now "is based on international standards for space weather storm monitoring,

- "Auroras Now" is fully using FMI weather forecast information,

- "Auroras Now" system is fully operational

- "Auroras Now" is fully used by the hotel on the TV monitor in the main building of the hotel, and information about "Aurora Now" is possible to be obtained from the hotel staff, and questionnaires about this service are a part of the hotel information brochure in the rooms.

However, in Dr. Jansen's opinion the public/guest awareness and promotion aspects about this unique service are less sufficient, for instance

a) some guests did not know this service, because the service is displayed on the hotel TV on channel 11 only. It would be very good if the service will be advertised just behind the welcome channel of the hotel (for instance on channel 2)

b) the information about "Auroras Now" on the TV was only available in the main building, not in the apartments outside the main building.

c) it would be very good if the hotel will be able to have a screen in the foyer to display the "Aurora Now" status there, no hints about this special service were available there.

d) the layout of the web service may be a little too complicated for unaware and less educated guests and it might also be shown in a more modern (flash) promotion art.

As FMI comments to the suggested improvements (items a to d above), the first three concern the layout and presentation at the hotel, and cannot much be affected by FMI actions. As for item d (layout of web service), the layout is a compromise between amount of information and easy access. It would be useful to have some more input from users of the Public Service, since these aspects can be improved at any time (see below). At the moment there are no plans to change the layout of the www service.

6.3 Public Service

A WWW-based feedback form has been available on the Public Service web pages. For the relatively large number of visitors to the pages (during the auroral season on average around 160 visits per day; see statistics in Appendix C), very little feedback has been submitted. Until today, ten (10) answers have been received, with mostly very positive comments about the service. Most suggestions for improvements have concerned the layout and accessibility to individual figures such as activity bar charts.

Having a closer look on the WWW hit statistics, there seems to be a correlation between magnetic activity and number of visitors. Comparing the Nurmijärvi activity with WWW hits, one can see a peak around 10-12 February 2004 and 10-12 March 2004. During those periods, the magnetic activity in Nurmijärvi stayed above alarm threshold for an extended time, and possibility to see aurora all over Finland was increased. Apparently seeing aurora makes people find out more about them.

Further the hit rates (with Hotel Service automatic data transfers cleaned out from the statistics) show an average of 140 to 220 visits per day for the winter season (with a peak of 477 visits per day 11 March 2004). This is considered quite good, taking into account the very little active marketing that was done for the service (including only few links from other pages, as far as we are aware).

6.4 GIC Now

GIC Now! was originally a work package of Auroras Now! Gasum Now! is the restricted part of GIC Now! Since the GIC services mostly overlap, we discuss them as an entity. The motivation for this SDA was to convert our long-term expertise on GIC to a continuously operating real-time on-line service. GIC along pipelines and related pipe-to-soil voltages (PSV) were already recognized in the end of 1970's. Previous co-operation between Gasum and FMI has included theoretical modelling since 1980's, and since 1998 also GIC recording performed by FMI at one site.

PSV fluctuations occur frequently disturbing the corrosion protection system. Information about GIC is one of the elements that may affect decision making regarding preventive maintenance. Identifying GIC as a source of disturbances saves time, since then other reasons for fluctuations can be excluded. Real-time observation of an increased magnetic activity is used to inform the control/maintenance personnel about the identified reason of PSV fluctuations. Possible GIC damages in pipelines have a cumulative nature, which will be detected during the regular control checks in a few years period. A large GIC risk at some parts of the pipeline system may lead to a need to shorten the control period there. In a wider context, a special knowledge of space weather phenomena is also beneficial to Gasum concerning international relations within the community of pipeline companies

A specific user requirement of GIC Now! was to prepare a nowcasting service indicating the level of geomagnetic and GIC activity. This was considered sufficient, since space weather does not cause any immediate damages to the pipeline system. The SDA consists of a service calculating GIC at a few points of the Finnish natural gas pipeline in near-real-time. We also show the real-time measured magnetic field at the Nurmijärvi geophysical observatory close to the pipeline network, and a simple real-time activity indicator based on magnetic data.

The main user of the service is Gasum, but there are other visitors at the public WWW site as well. The WWW daily hit rates include visits both to the general Aurora service and GIC service. Although detailed analysis on WWW page level has not been performed, it can be estimated that a relatively constant percentage of visitors to the public service also visit the GIC pages, and interest on all related phenomena increase during high solar activity. For the Gasum restricted pages, number of visits is of course much more constant, as the system is mostly on-line.

Gasum uses the service as one element of their pipeline control system, and they have found the system useful. Occasional problems in the transfer of magnetic field data are not considered harmful. There seems to be no specific needs for major modifications for Gasum. A further development of a GIC indicator based on magnetic data might be useful also from the scientific viewpoint. A (far) future challenge is to provide reliable forecasts, which would require at least real-time solar wind data.

6.5 Service vs. User Requirements

The services (Auroras Now and GIC/Gasum Now) were assessed against the User Requirements (RS-002 and RS-003, respectively for Auroras Now and GIC Now; jointly referred to as URD hereinafter) at the System Readiness Review in November 2003, and the technical development phase was concluded to meet all requirements. After two seasons of operations, we can conclude that this is still the case.

In the URD, there are actually no requirements that needed verification during the operational phase. This may look like there is an omission in the URD, but it can be justified as follows.

Concerning availability of the service, technical aspects at the provider end (FMI) were covered in the System Readiness Review. In practice, the availability of the service depends much more critically on the availability of network connection to the hotels (which FMI does not have any means of affecting) and the availability and correct operation of the system at the hotel (which FMI has no control either) and thus putting requirements at FMI end would not be justified. During the operations, some problems in both of these aspects were detected, and the error cases were traced to the source. Those cases have not been too many, and despite some drop-out periods, the users have generally been satisfied with the system, as discussed above. Thus we conclude that the availability has met the customers' expectations, and the service also meets the needs in that aspect.

Concerning merit of prediction, there are no requirements in the URD either. The system uses the best model available, and improvements have been implemented during the course of the work. Before this project, a correlation of a properly selected activity level with following night's aurora was demonstrated statistically to be of approximately 75 % for a more southerly station. We did set a goal of exceeding that number for the conditions in Lapland, even if activity levels are generally higher, and finding an appropriate trigger level might turn out to be challenging. In practice, the current prediction is exceeding this goal. This working "target requirement" was however not formally documented in the URD, and we still think that this is quite appropriate: With an analogy to meteorological weather forecasting, improvements to the model are implemented step by step as knowledge improves. The current model not only gives a warning of increased probability to see aurora, but also characterises the activity level quite well. It represents our best understanding of the physics, gives in our opinion a very good prediction for visible aurora, and thus meets what can be required from this kind of service.

7 Requirements for implementing services for other locations

The basic requirements for this kind of service are derived from the observations that are needed, and the network to transfer the data both from the observational sites to the processing center, and from the processing center to the customers. The latter requires quite fast, essentially fixed, connection in order to operate smoothly. The requirements listed in the User Requirements Documents for our system are mostly derived for the processing center, and environmental requirements for the whole system are not very well covered. In this section we briefly summarise what would be needed in order to start similar services in another location. Some cost estimates are given in Volume II.

7.1 Hotel Service

Establishing an Auroras Now! type auroral monitoring system would require both magnetometers and auroral cameras. The auroral cameras should be equipped with lenses of wide viewing angles (at least 150 degrees, preferentially the fish-eye lens of 180 degrees) in order to have good enough spatial coverage. Filters for discriminating different wavelengths (i.e. colours) are not necessary which means that the amount of luminosity guided to the CCD-chip can be larger than in the MIRACLE cameras. Consequently the sensitivity requirements (and also price) for the necessary camera unit is lower than for scientific purposes. The human eye starts to see auroras when their brightness exceeds 0.5 kR, so the system should have at least this sensitivity. It is worthwhile to note that the sensitivity of the system cannot be improved very much by making the exposure times longer since then the bright Moon light may cause saturation and damage the image also elsewhere than its actual location (overspilling of the CCD-wells). The time resolution of the auroral images can not be much lower than one minute in order to avoid annoying disappointments in the cases of rapidly changing auroral displays.

The magnetometer should meet the same specifications as in the GIC Now application (see below), i.e. the dynamic range should be +/- 5000 nT and sampling rate 10 seconds in order to have reliable performance also during storm periods. For auroral monitoring purposes it would be enough to monitor only the horizontal component of the magnetic field (without discrimination to the X and Y components), but then re-adjusting of the alarm trigger values would be necessary. Re-calibration of these thresholds would be required also otherwise especially if the magnetic latitudes of the new stations differ significantly from those of Nurmijärvi and Sodankylä observatories.

In Auroras Now! the magnetometer and all-sky camera operate at the same station. Also separate stations can be used if the distance between the measurement points is less than 100 km at auroral latitudes and less than 150-200 km at sub-auroral latitudes. From statistical point view it is better to have the magnetometer station to the east and north from the auroral camera station, because pre-midnight auroras propagate typically from east to west and during magnetic storms the auroral oval expands from high to low latitudes.

7.1.1 Extending the Observations

One way to extend Auroras Now! would be to add some short-term predictions based on solar observations to the service. Collaboration with the SDA of Solar Influensis Data Center (SIDC, at the Royal Observatory of Belgium) would be the most reasonable starting point for this upgrade. The SIDC is maintaining an automated fast warning system (PRESTO) for solar events like coronal mass ejections and recurrent coronal holes. In the simplest solution Auroras Now! could include an additional notice when SIDC has released a recent warning. As the propagation time and path of the solar disturbances are not known accurately, an explanation about the uncertainties should of course be attached to this kind of notice.

A more advanced system would follow the solar wind variations at the Lagrange L1 point. Based on variations of the solar wind magnetic field and velocity a notice could be issued when the conditions are considered favourable for intense auroral activity to start within a few hours. Trigger values for the confirmation notice could be found by consultancy with other SWENET services as many of them use L1 solar wind data in their applications.

During periods when recurrent high speed streams dominate in the solar wind activity (activity decay phases in the 11 year sun spot cycle) one could also try to put up an alarm system which uses the periodicity of the solar rotation period (27 days) as a prediction time. Again, the starting point would be the PRESTO alerts, but only those issued about coronal holes.

If this kind of prediction capabilies were added to Auroras Now!, the big challenges would be in making a clear distinction between the nowcasted and forecasted conditions and in explaining the caveats of the predictions in the limited space available. Especially the users of the hotel service can not be anticipated to read long explanations, these customers have very different backgrounds in terms of space physics, and their tolerance for failed predictions is low. These facts have been the main reason for keeping Auroras Now! as a nowcasting system in the first place, and not include prediction capability beyond a few hours.

7.2 GIC service

To start up a similar service to GIC Now! somewhere else would require ground-based magnetometers whose data are used to calculate the geoelectric field and GIC. The number of them depends on the size (and the shape) of the conductor system under study. If the length scale is at most a couple of hundred kilometres then one magnetometer close to the centre of the system seems sufficient, as in GIC Now!

For possible GIC recordings, additional equipment is needed. In the case of a pipeline a magnetometer above the pipe is a suitable tool (like in Mäntsälä). A reference magnetometer is also needed, and it can be one of those mentioned in the previous paragraph (like in Nurmijärvi). In a power system, there are two possibilities: a measurement of a transmission line current with a magnetometer, or a measurement of the current at a transformer neutral wire with a shunt resistor, for example.

The magnetometers and the related equipment should satisfy the following conditions:

- dynamic range +/- 5000 nT to cover the most extreme magnetic storms
- resolution 0.1 nT
- sampling rate 1 s, to be averaged to 10 s in practice
- remote control allowing for an unmanned site
- real-time data connection

Magnetometers used in long-period magnetotelluric studies have a sufficiently high quality for this purpose.

For the GIC/Gasum service, being more local in nature, the satellite data discussed for Auroras Now! in Section 7.1.1 above is not considered of added value.

8 Conclusions and Future Prospects

The outcome Auroras Now! Service Development Activity is positive. During the development phase, two systems based on observations for scientific research have been developed to customer-oriented nowcasting and information services, which have then been operated basically without problems for two full seasons[1]. The only problems encountered have been related to data transfers, and this kind of minor glitches in the client-network-server system can never be fully avoided. According to the customers, these have not seriously affected the usability of the service either. More improvements to visibility and availability could be gained at the user end (i.e., the hotels) as pointed out in our expert comments (see section 6.2). The hotel aurora nowcasting service is taken as a marketing asset, and there is a clear signal from the users that this service be continued also in the future.

At the same time, with the ESA funding for the maintenance of the system ending and FMI requiring all resources to its core activities, discussions on how to support the service in the future are continued. This is discussed in Volume II.

Tourism as a branch is a complicated one, especially in areas which are remote. The season for Finnish Lapland is short, and the challenge is to make it longer, in the winter filling the gaps between the December (Christmas) and February - early April (skiing) peaks. At the moment it seems that there are a few big hotels/areas in Lapland that attract a lot of tourists, and this also means more investments and services (including spas, restaurants, more ski pistes…) being developed. At the same time there are smaller resorts and hotels that are much more hesitant on investments. From the feedback it can be concluded that we have developed an attractive product. However, how to find the right market and right price for the product so that the customers would pay for it is a question that still needs some work. Ways forward are discussed in the business plan Volume II.

The Gasum Now! server has worked without major problems since June 2003. The service is easily transferable to other pipeline systems and also to power systems. Calculation methods of the geoelectric field and GIC are strictly validated through the scientific review process on previous papers by the service developers. The successful transfer of models to an operative service has been demonstrated during the ESA Space Weather Pilot Programme.

The service concept of GIC Now! would work elsewhere in the world, and after some modifications also for power systems. Some potential markets have been identified, and are discussed in Volume II.

[1] The second season of operation is formally outside the Auroras Now! Project, but experience and feedback from this season have been included in the analysis.

Appendix A: Customer feedback form

Auroras Now
Customer feedback

In this hotel there is a service promoting and helping observation of Aurora Borealis. This service, called Auroras Now! is maintained by the Finnish Meteorological Institute, with support from the European Space Agency. Auroras Now! is a pilot project, testing the system, the correctness of the predictions, and collecting customer feedback in order to improve the service further. By spending a few minutes and answering the questions in this form, you can provide us valuable information and hints of how to make the service better. We draw each week a Space Weather CD-ROM among those who return the filled from to the front desk.

Visibility of the service

1. When and how did you learn about the service?
   a. I knew already before my trip. Where did you get the information? (marketing material / www pages / ....)
   ____
   b. Noticed at the hotel.
   c. Did no notice at all.

2. Did you use the service ?
   a. Yes
   b. No

If you answered No here -> go to question 12.

How the service performed

3. Where did you use the service? (you can pick several options)
   a. In my hotel room (using the internal TV system)
   b. In the lobby (the public computer terminal)
   c. I studied the Auroras Now! public WWW pages before my trip
   d. I did not notice there was a display in the TV system.

4. How did you use the service? (you can pick both)
   a. I looked at the prediction during daytime (auroral alarm and cloudiness)
   b. I used the real-time service (images of the all-sky camera)

5. Did you go out to see aurora based on the prediction or the real-time images?
   a. Yes
   b. No

6. Were there aurora in the sky during your visit ?
   a. Yes (if during several nights, how many: ___________)
   b. No
   c. I do not know, I did not check myself

7. Was the prediction given by Auroras Now correct ?
    a. Yes (If there were several nights with aurora, could you estimate: correct / not correct / clouds cover the full sky: ______/_____/______)
    b. No
    c. I do not know

8. Did the pages on the TV, with the material in your room, give enough information to use the service?
    a. Yes
    b. No, I would improve: ____________________________________
    ____

9. Did you have questions to or did you need support from the hotel personnel?
    a. Yes
    b. No

10. If you answered Yes to the previous question, were you happy with the answers and support you got?
    a. Yes
    b. No, I would have learned more about_______________________
    ____

11. Were you generally satisfied with the service?
    a. Yes
    b. No, If no, what should we specifically improve?______________
    ____

Where to stay during your trip

12. Did the availability of an auroral observation service affect your selection of where to stay during your trip ?
    a. Yes
    b. No
    c. Did not know about the service.

13. Do you think this service might affect some other travellers' selection of hotel or holiday target?
    a. Yes
    b. No

Any other comments:

____
____
____
____
____
____

Background information

Date:_____________________________________

Country of origin _________________ Age: _____yrs. Sex: Male / Female

I am travelling alone / with family / with a group

Purpose of trip: holiday / work / meeting / other: ___________________________

Duration of stay ___________ days

Reservation was made by. myself / travel agent / other: _________________

Thank You!

Appendix B: Service provider feedback form by SEA

(Note: this is the version without SEA-provided guidance)

Introduction

This survey is part of an assessment of the Service Development Activities (SDAs) in order to contribute to a cost benefit analysis of the provision of different levels of space weather service.

We will be contacting both service providers and users in each SDA.

A1) Please confirm your contact details.

A2) Please confirm which SDAs you are involved in.

Background

B1) What is the organisation's interest in space weather?

The rest of the questions relate to the TBD SDA.

Motivation for the SDA

C1) What were your original objectives in Developing the Services or products?

C2) What user needs have you considered to drive the service development?

C3) What specific user requirements did you capture? e.g. Timeliness, accuracy, location? Can you meet them?

Development

D1) What services have you developed? e.g. Forecasts, Nowcasts, Postcasts?

D2) What data sources are used for each service/product?

D3) How often would each product be generated? periodically? on demand?

Quality

E1) Have you undertaken technical evaluations of products and services?

E2) What is the accuracy of the product?

Service provision/update

F1) How are the products/services disseminated?

F2) Which users have taken up products or services (if known)?

F3) How will the users make use of the product?

F4) What feedback have you had from users?

F5) Have you encountered any problems with providing the services?

F6) How could you improve your service? e.g. increase the accuracy, or extend the range of a forecast

F7) Would this require more data? if so what?

F9) Are you interested in turning the pilot project into an operation service?

F10) If so do you have an idea of the business model?

Financial

G1) What is your estimate for the non-recurring costs of setting up an operational service?

G2) What is your estimate for the annual operating costs of an operational service?

G3) What sources of funding would you pursue?

G4) What is your estimate for the total market for your product?

G5) What is your estimate for the initial take up for your product?

G6) What is your estimate for the market value of your product?

Other Comments

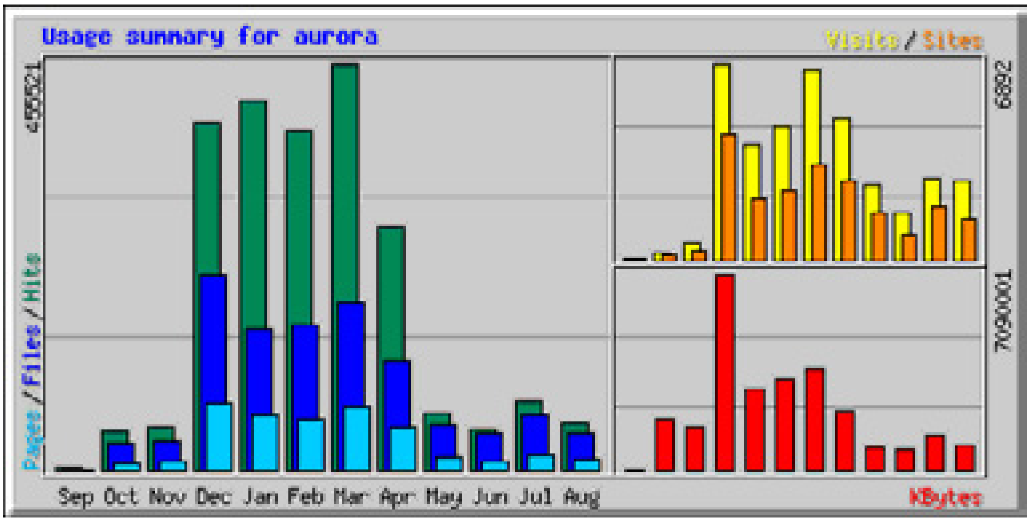
H1) Are there any other comments you would like to make about the SDA?

H2) Are there any other comments you would like to make about Space weather effects?

Appendix C: WWW statistics data

Usage Statistics for Auroras Now! Sep 2003-Aug 2004

Summary Period: Last 12 Months
Generated 21-Oct-2004 16:49 EEST



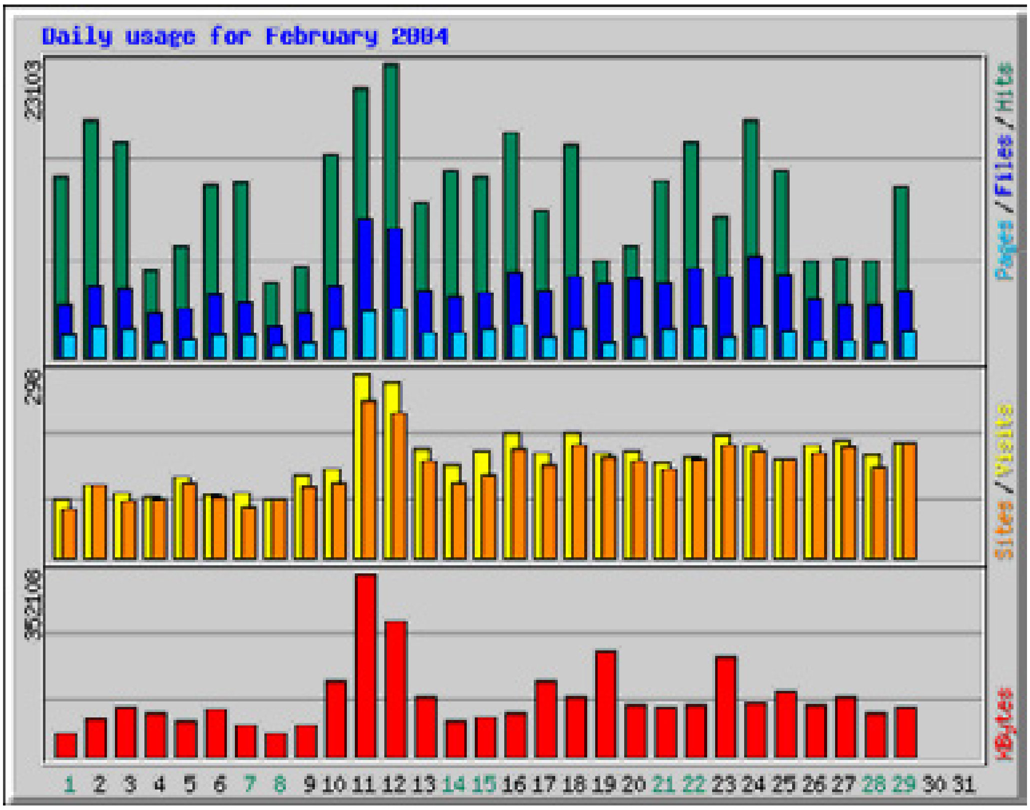
Summary by Month

Month	Daily Avg				Monthly Totals					
	Hits	Files	Pages	Visits	Sites	KBytes	Visits	Pages	Files	Hits
Aug 2004	1712	1329	410	90	1441	935441	2801	12738	41206	53078
Jul 2004	2468	1962	549	92	1840	1289837	2866	17024	60827	76518
Jun 2004	1527	1389	360	53	912	725543	1618	10815	41673	45834
May 2004	2074	1647	469	86	1675	863018	2670	14557	51068	64297
Apr 2004	9054	4056	1573	165	2743	2134214	4964	47191	121680	271636
Mar 2004	14694	6013	2303	215	3324	3661284	6672	71394	186414	455521
Feb 2004	13137	5577	1970	160	2447	3273781	4668	57156	161751	380991
Jan 2004	13329	5107	1964	130	2111	2914146	4040	60900	158340	413223
Dec 2003	12534	7070	2391	222	4412	7090001	6892	74144	219170	388566
Nov 2003	1639	1055	355	20	332	1535049	629	10654	31652	49193
Oct 2003	1425	999	257	7	170	1879144	227	7989	30974	44196
Sep 2003	161	81	44	2	13	11436	36	704	1310	2588
Totals						**26312894**	**38083**	**385266**	**1106065**	**2245641**

Usage Statistics for Auroras Now! February 2004

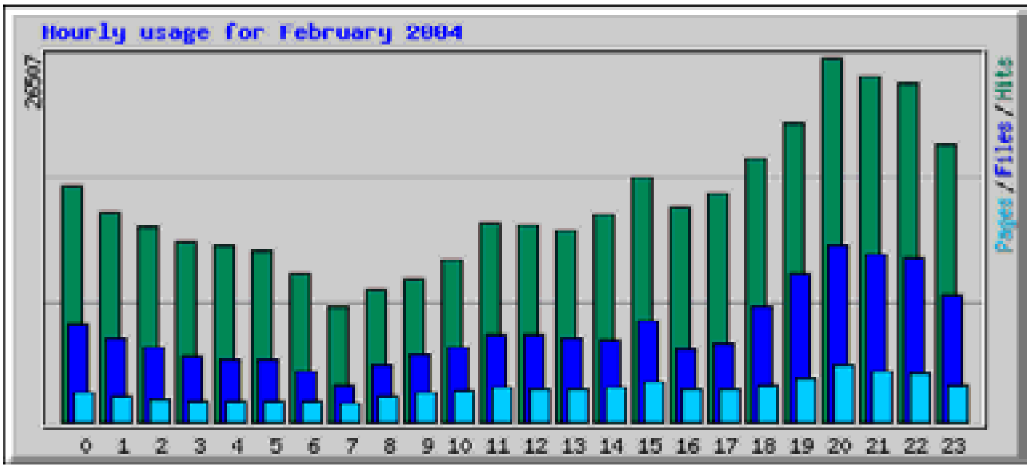
Summary Period: February 2004
Generated 21-Oct-2004 16:49 EEST

Monthly Statistics for February 2004		
Total Hits		**380991**
Total Files		**161751**
Total Pages		**57156**
Total Visits		**4668**
Total KBytes		**3273781**
Total Unique Sites		**2447**
Total Unique URLs		**418**
Total Unique Referrers		**314**
Total Unique User Agents		**61**
	Avg	**Max**
Hits per Hour	**547**	**4161**
Hits per Day	**13137**	**23103**
Files per Day	**5577**	**10969**
Pages per Day	**1970**	**3838**
Visits per Day	**160**	**298**
KBytes per Day	**112889**	**352108**
Hits by Response Code		
Code 200 - OK		**161751**
Code 206 - Partial Content		**706**
Code 301 - Moved Permanently		**62**
Code 302 - Found		**23522**
Code 304 - Not Modified		**194019**
Code 400 - Bad Request		**7**
Code 403 - Forbidden		**57**
Code 404 - Not Found		**781**
Code 405 - Method Not Allowed		**5**
Code 408 - Request Timeout		**21**
Code 500 - Internal Server Error		**53**
Code 501 - Not Implemented		**7**



Daily Statistics for February 2004												
Day	Hits		Files		Pages		Visits		Sites		KBytes	
1	14301	3.75%	4155	2.57%	1805	3.16%	94	2.01%	78	3.19%	44786	1.37%
2	18664	4.90%	5597	3.46%	2429	4.25%	117	2.51%	119	4.86%	69876	2.13%
3	16884	4.43%	5427	3.36%	2342	4.10%	104	2.23%	91	3.72%	94327	2.88%
4	6907	1.81%	3483	2.15%	1126	1.97%	100	2.14%	97	3.96%	81767	2.50%
5	8702	2.28%	3910	2.42%	1482	2.59%	130	2.78%	121	4.94%	69171	2.11%
6	13645	3.58%	4951	3.06%	1820	3.18%	101	2.16%	99	4.05%	91916	2.81%
7	13758	3.61%	4287	2.65%	1828	3.20%	104	2.23%	84	3.43%	58218	1.78%
8	5948	1.56%	2475	1.53%	1022	1.79%	94	2.01%	95	3.88%	44711	1.37%
9	7137	1.87%	3560	2.20%	1165	2.04%	134	2.87%	115	4.70%	60955	1.86%
10	15948	4.19%	5579	3.45%	2345	4.10%	143	3.06%	120	4.90%	145089	4.43%
11	21149	5.55%	10969	6.78%	3764	6.59%	298	6.38%	253	10.34%	352108	10.76%
12	23103	6.06%	10083	6.23%	3838	6.71%	283	6.06%	234	9.56%	260022	7.94%
13	12185	3.20%	5218	3.23%	1924	3.37%	177	3.79%	156	6.38%	115153	3.52%
14	14627	3.84%	4726	2.92%	1928	3.37%	151	3.23%	121	4.94%	66274	2.02%
15	14201	3.73%	5174	3.20%	2202	3.85%	174	3.73%	136	5.56%	74628	2.28%
16	17628	4.63%	6634	4.10%	2594	4.54%	202	4.33%	176	7.19%	83712	2.56%
17	11541	3.03%	5246	3.24%	1695	2.97%	169	3.62%	152	6.21%	144620	4.42%

18	**16764**	4.40%	**6377**	3.94%	**2281**	3.99%	**202**	4.33%	**182**	7.44%	**115622**	3.53%
19	**7689**	2.02%	**5896**	3.65%	**1223**	2.14%	**171**	3.66%	**163**	6.66%	**204984**	6.26%
20	**8745**	2.30%	**6134**	3.79%	**1621**	2.84%	**174**	3.73%	**158**	6.46%	**97208**	2.97%
21	**13850**	3.64%	**5925**	3.66%	**2301**	4.03%	**155**	3.32%	**144**	5.88%	**95263**	2.91%
22	**16877**	4.43%	**6951**	4.30%	**2363**	4.13%	**163**	3.49%	**159**	6.50%	**96844**	2.96%
23	**11125**	2.92%	**6314**	3.90%	**1608**	2.81%	**200**	4.28%	**182**	7.44%	**190552**	5.82%
24	**18595**	4.88%	**7903**	4.89%	**2419**	4.23%	**183**	3.92%	**172**	7.03%	**104420**	3.19%
25	**14620**	3.84%	**6579**	4.07%	**2135**	3.74%	**160**	3.43%	**161**	6.58%	**124884**	3.81%
26	**7619**	2.00%	**4621**	2.86%	**1353**	2.37%	**183**	3.92%	**170**	6.95%	**96764**	2.96%
27	**7723**	2.03%	**4154**	2.57%	**1260**	2.20%	**188**	4.03%	**181**	7.40%	**114820**	3.51%
28	**7669**	2.01%	**4088**	2.53%	**1188**	2.08%	**167**	3.58%	**146**	5.97%	**81948**	2.50%
29	**13387**	3.51%	**5335**	3.30%	**2095**	3.67%	**187**	4.01%	**185**	7.56%	**93141**	2.85%



Hourly Statistics for February 2004												
Hour	Hits			Files			Pages			KBytes		
	Avg	Total		Avg	Total		Avg	Total		Avg	Total	
0	590	17138	4.50%	245	7118	4.40%	72	2113	3.70%	3609	104672	3.20%
1	523	15188	3.99%	207	6023	3.72%	64	1874	3.28%	2508	72726	2.22%
2	487	14135	3.71%	188	5473	3.38%	57	1678	2.94%	2105	61047	1.86%
3	452	13127	3.45%	164	4774	2.95%	52	1524	2.67%	1575	45677	1.40%
4	443	12855	3.37%	157	4560	2.82%	52	1508	2.64%	1554	45053	1.38%
5	431	12499	3.28%	153	4443	2.75%	53	1541	2.70%	1435	41613	1.27%
6	371	10762	2.82%	126	3658	2.26%	52	1508	2.64%	1107	32099	0.98%
7	290	8415	2.21%	90	2616	1.62%	47	1378	2.41%	890	25797	0.79%
8	328	9535	2.50%	143	4173	2.58%	64	1864	3.26%	3055	88583	2.71%
9	359	10429	2.74%	170	4944	3.06%	74	2151	3.76%	3270	94833	2.90%
10	408	11853	3.11%	188	5459	3.37%	80	2320	4.06%	3803	110278	3.37%
11	496	14406	3.78%	217	6321	3.91%	88	2573	4.50%	5579	161777	4.94%
12	491	14267	3.74%	218	6345	3.92%	84	2436	4.26%	10040	291147	8.89%
13	480	13931	3.66%	211	6130	3.79%	84	2440	4.27%	5946	172433	5.27%
14	518	15041	3.95%	205	5950	3.68%	85	2491	4.36%	6602	191452	5.85%
15	615	17853	4.69%	252	7329	4.53%	101	2930	5.13%	8397	243502	7.44%
16	539	15638	4.10%	182	5305	3.28%	82	2389	4.18%	4363	126528	3.86%
17	575	16683	4.38%	196	5705	3.53%	83	2435	4.26%	3481	100946	3.08%
18	659	19129	5.02%	289	8408	5.20%	94	2728	4.77%	5365	155572	4.75%
19	750	21765	5.71%	372	10811	6.68%	109	3177	5.56%	7039	204143	6.24%
20	914	26507	6.96%	442	12827	7.93%	141	4117	7.20%	10098	292845	8.95%
21	865	25104	6.59%	419	12153	7.51%	127	3686	6.45%	7663	222223	6.79%
22	848	24609	6.46%	412	11965	7.40%	123	3573	6.25%	7905	229249	7.00%
23	693	20122	5.28%	319	9261	5.73%	93	2722	4.76%	5503	159588	4.87%

Top 30 of 418 Total URLs					
#	Hits		KBytes		URL
1	185567	48.71%	661322	20.20%	/hotel_service/*
2	156793	41.15%	2162438	66.05%	/public_service/*
3	15338	4.03%	8486	0.26%	/public_service/stylesheet/auroras_style.css
4	11231	2.95%	441143	13.48%	/gic_service/*
5	8546	2.24%	20114	0.61%	/public_service/suomi/latest_asc_image.html
6	6428	1.69%	19389	0.59%	/hotel_service/index_online_fin.shtml
7	6276	1.65%	18414	0.56%	/hotel_service/index_online.shtml
8	3994	1.05%	12132	0.37%	/public_service/suomi/top_frame.html
9	3953	1.04%	54367	1.66%	/public_service/images/SOD_latest.png
10	3861	1.01%	10974	0.34%	/hotel_service/index_warmup.shtml
11	3830	1.01%	11395	0.35%	/hotel_service/index_warmup_fin.shtml
12	3657	0.96%	1035	0.03%	/public_service/
13	3529	0.93%	19610	0.60%	/public_service/suomi/start_page.html
14	3179	0.83%	49559	1.51%	/public_service/images/NUR_latest.png
15	3135	0.82%	9098	0.28%	/public_service/suomi/latest_nur_sod.html
16	2966	0.78%	48556	1.48%	/public_service/images/NUR_edvrk.png
17	2955	0.78%	52297	1.60%	/public_service/images/SOD_edvrk.png
18	2588	0.68%	6626	0.20%	/public_service/suomi/nur_now.html
19	2352	0.62%	3693	0.11%	/hotel_service/index_general.shtml
20	2351	0.62%	3965	0.12%	/hotel_service/index_general_fin.shtml
21	1280	0.34%	77646	2.37%	/gic_service/gasum/images/test.png
22	1280	0.34%	563	0.02%	/gic_service/gasum/suomi/gasum.html
23	796	0.21%	264	0.01%	/
24	652	0.17%	1452	0.04%	/public_service/suomi/earlier_auroras_material.html
25	640	0.17%	687	0.02%	/gic_service/stylesheet/GIC_style.css
26	476	0.12%	1442	0.04%	/public_service/suomi/last_night_activity.html
27	380	0.10%	2171	0.07%	/public_service/suomi/auroras_predicting.html
28	360	0.09%	946	0.03%	/gic_service/suomi/top_frame.html
29	354	0.09%	161	0.00%	/gic_service/
30	313	0.08%	703	0.02%	/gic_service/suomi/front_page_product_descr.html

Top 10 of 418 Total URLs By KBytes					
#	Hits		KBytes		URL
1	156793	41.15%	2162438	66.05%	/public_service/*
2	185567	48.71%	661322	20.20%	/hotel_service/*
3	11231	2.95%	441143	13.48%	/gic_service/*
4	28	0.01%	200744	6.13%	/gic_service/images/IonoGICanim.avi
5	1280	0.34%	77646	2.37%	/gic_service/gasum/images/test.png
6	3953	1.04%	54367	1.66%	/public_service/images/SOD_latest.png
7	2955	0.78%	52297	1.60%	/public_service/images/SOD_edvrk.png
8	3179	0.83%	49559	1.51%	/public_service/images/NUR_latest.png
9	2966	0.78%	48556	1.48%	/public_service/images/NUR_edvrk.png
10	6	0.00%	27348	0.84%	/gic_service/images/aurora_pipe.mov

Top 10 of 56 Total Entry Pages					
#	Hits		Visits		URL
1	3657	0.96%	2462	54.55%	/public_service/
2	796	0.21%	602	13.34%	/
3	3135	0.82%	553	12.25%	/public_service/suomi/latest_nur_sod.html
4	2588	0.68%	210	4.65%	/public_service/suomi/nur_now.html
5	3994	1.05%	199	4.41%	/public_service/suomi/top_frame.html
6	3529	0.93%	132	2.92%	/public_service/suomi/start_page.html
7	476	0.12%	90	1.99%	/public_service/suomi/last_night_activity.html
8	8546	2.24%	26	0.58%	/public_service/suomi/latest_asc_image.html
9	652	0.17%	23	0.51%	/public_service/suomi/earlier_auroras_material.html
10	68	0.02%	22	0.49%	/gic_service/english/

Top 10 of 72 Total Exit Pages					
#	Hits		Visits		URL
1	3135	0.82%	1680	37.02%	/public_service/suomi/latest_nur_sod.html
2	3529	0.93%	602	13.27%	/public_service/suomi/start_page.html
3	8546	2.24%	464	10.22%	/public_service/suomi/latest_asc_image.html
4	796	0.21%	407	8.97%	/
5	2588	0.68%	215	4.74%	/public_service/suomi/nur_now.html
6	476	0.12%	163	3.59%	/public_service/suomi/last_night_activity.html

7	3994	1.05%	108	2.38%	/public_service/suomi/top_frame.html
8	3657	0.96%	93	2.05%	/public_service/
9	380	0.10%	90	1.98%	/public_service/suomi/auroras_predicting.html
10	652	0.17%	84	1.85%	/public_service/suomi/earlier_auroras_material.html

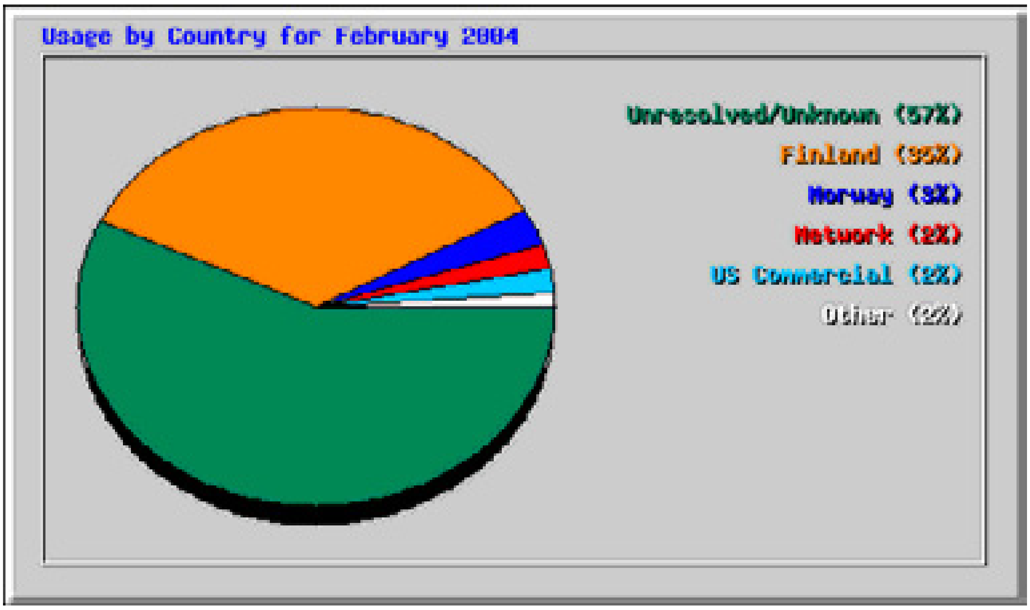
Top 30 of 2447 Total Sites									
#	Hits		Files		KBytes		Visits		Hostname
1	173197	45.46%	40547	25.07%	308133	9.41%	22	0.47%	194.89.115.161
2	19629	5.15%	5577	3.45%	33308	1.02%	33	0.71%	roi-7e2.cable.inet.fi
3	19000	4.99%	4473	2.77%	33389	1.02%	4	0.09%	213.28.157.210
4	15241	4.00%	4771	2.95%	63234	1.93%	51	1.09%	194.89.115.170
5	6494	1.70%	6267	3.87%	114016	3.48%	15	0.32%	ua31d14hel.dial.kolumbus.fi
6	4751	1.25%	1173	0.73%	6312	0.19%	1	0.02%	jumbo143.adsl.netsonic.fi
7	4223	1.11%	1181	0.73%	8275	0.25%	4	0.09%	roi-44e.cable.inet.fi
8	4096	1.08%	3432	2.12%	239190	7.31%	55	1.18%	193.166.209.251
9	4053	1.06%	1052	0.65%	11727	0.36%	36	0.77%	ua137d91.elisa.omakaista.fi
10	3899	1.02%	3884	2.40%	62391	1.91%	1	0.02%	olivaw.eiscat.uit.no
11	3271	0.86%	1952	1.21%	49487	1.51%	1	0.02%	eddie.tky.hut.fi
12	3056	0.80%	3047	1.88%	130131	3.97%	26	0.56%	gic.fmi.fi
13	2994	0.79%	2525	1.56%	146604	4.48%	32	0.69%	kbws253.kolumbus.net
14	2584	0.68%	2579	1.59%	42531	1.30%	0	0.00%	visitor6.eiscat.uit.no
15	1775	0.47%	430	0.27%	7640	0.23%	15	0.32%	dsl-olugw5oc5.dial.inet.fi
16	1747	0.46%	1016	0.63%	16974	0.52%	31	0.66%	dsl-olugw5pa1.dial.inet.fi
17	1691	0.44%	1682	1.04%	15091	0.46%	1	0.02%	212-246-50-126.adsl.tpo.fi
18	1621	0.43%	833	0.51%	8497	0.26%	60	1.29%	dsl-roigw2ad7.dial.inet.fi
19	1496	0.39%	449	0.28%	7039	0.21%	21	0.45%	wl100-91.netplaza.fi
20	1413	0.37%	985	0.61%	8090	0.25%	21	0.45%	axion.fmi.fi
21	1340	0.35%	640	0.40%	10555	0.32%	50	1.07%	esprx02x.nokia.com
22	1190	0.31%	528	0.33%	11741	0.36%	9	0.19%	roi-419.cable.inet.fi
23	1180	0.31%	1123	0.69%	20814	0.64%	6	0.13%	visitor3.eiscat.uit.no
24	1167	0.31%	875	0.54%	12565	0.38%	27	0.58%	helium.fmi.fi
25	1159	0.30%	405	0.25%	12981	0.40%	7	0.15%	dsl-hkigw3a4b.dial.inet.fi
26	1049	0.28%	1022	0.63%	105173	3.21%	2	0.04%	dsl-kpogw5a2b.dial.inet.fi
27	931	0.24%	316	0.20%	4457	0.14%	2	0.04%	gate.siemens.fi
28	925	0.24%	396	0.24%	7402	0.23%	7	0.15%	dsl-kpogw5q96.dial.inet.fi
29	915	0.24%	418	0.26%	12548	0.38%	13	0.28%	dsl-lprgw4qac.dial.inet.fi
30	851	0.22%	347	0.21%	7212	0.22%	16	0.34%	hki2-4-1-e4.hoasnet.inet.fi

Top 10 of 2447 Total Sites By KBytes									
#	Hits		Files		KBytes		Visits		Hostname
1	173197	45.46%	40547	25.07%	308133	9.41%	22	0.47%	194.89.115.161
2	4096	1.08%	3432	2.12%	239190	7.31%	55	1.18%	193.166.209.251
3	2994	0.79%	2525	1.56%	146604	4.48%	32	0.69%	kbws253.kolumbus.net
4	3056	0.80%	3047	1.88%	130131	3.97%	26	0.56%	gic.fmi.fi
5	6494	1.70%	6267	3.87%	114016	3.48%	15	0.32%	ua31d14hel.dial.kolumbus.fi
6	1049	0.28%	1022	0.63%	105173	3.21%	2	0.04%	dsl-kpogw5a2b.dial.inet.fi
7	260	0.07%	257	0.16%	70317	2.15%	2	0.04%	d57687ab.kabel.telenet.be
8	15241	4.00%	4771	2.95%	63234	1.93%	51	1.09%	194.89.115.170
9	3899	1.02%	3884	2.40%	62391	1.91%	1	0.02%	olivaw.eiscat.uit.no
10	3271	0.86%	1952	1.21%	49487	1.51%	1	0.02%	eddie.tky.hut.fi

Top 30 of 314 Total Referrers			
#	Hits		Referrer
1	43416	11.40%	http://aurora.fmi.fi/hotel_service/index_online_fin.shtml
2	42324	11.11%	http://aurora.fmi.fi/hotel_service/index_online.shtml
3	38357	10.07%	http://aurora.fmi.fi/public_service/suomi/latest_asc_image.html
4	22450	5.89%	http://aurora.fmi.fi/hotel_service/index_warmup.shtml
5	22433	5.89%	http://aurora.fmi.fi/hotel_service/index_warmup_fin.shtml
6	19502	5.12%	http://aurora.fmi.fi/public_service/suomi/start_page.html
7	13903	3.65%	http://aurora.fmi.fi/public_service/suomi/top_frame.html
8	12417	3.26%	http://aurora.fmi.fi/public_service/suomi/latest_nur_sod.html
9	11605	3.05%	http://aurora.fmi.fi/public_service/
10	8148	2.14%	http://aurora.fmi.fi/hotel_service/index_general_fin.shtml
11	8141	2.14%	http://aurora.fmi.fi/hotel_service/index_general.shtml
12	8012	2.10%	http://aurora.fmi.fi/public_service/suomi/nur_now.html
13	7986	2.10%	http://cc.oulu.fi/~thu/Aurora/Monitor.html
14	4261	1.12%	http://aurorasnow.fmi.fi/hotel_service/index_online.shtml
15	4244	1.11%	http://aurorasnow.fmi.fi/hotel_service/index_online_fin.shtml
16	2780	0.73%	http://aurorasnow.fmi.fi/public_service/suomi/start_page.html
17	2525	0.66%	http://aurora.fmi.fi/gic_service/gasum/suomi/gasum.html
18	2242	0.59%	http://aurorasnow.fmi.fi/hotel_service/index_warmup.shtml
19	2152	0.56%	http://aurorasnow.fmi.fi/public_service/suomi/top_frame.html
20	2077	0.55%	http://aurorasnow.fmi.fi/hotel_service/index_warmup_fin.shtml

21	1740	0.46%	http://aurorasnow.fmi.fi/public_service/suomi/latest_asc_image.html
22	1463	0.38%	http://aurorasnow.fmi.fi/public_service/suomi/latest_nur_sod.html
23	1452	0.38%	http://aurora.fmi.fi/gic_service/suomi/top_frame.html
24	1400	0.37%	http://aurora.fmi.fi/public_service/suomi/auroras_predicting.html
25	1160	0.30%	http://aurorasnow.fmi.fi/public_service/
26	1147	0.30%	http://aurorasnow.fmi.fi/hotel_service/index_general.shtml
27	1145	0.30%	http://aurorasnow.fmi.fi/hotel_service/index_general_fin.shtml
28	985	0.26%	http://aurora.fmi.fi/public_service/suomi/last_night_activity.html
29	935	0.25%	http://aurora.fmi.fi/public_service/suomi/earlier_auroras_material.html
30	883	0.23%	http://aurora.fmi.fi/public_service/english/start_page.html

Top 15 of 15 Total Search Strings			
#	Hits		Search String
1	84	79.25%	auroras
2	6	5.66%	ground effects
3	2	1.89%	auroras now
4	2	1.89%	sähkökenttä
5	2	1.89%	what are auroras
6	1	0.94%	aurora 1892 telegraph
7	1	0.94%	earth current telegraphy
8	1	0.94%	gic in toronto
9	1	0.94%	katodisuojaus
10	1	0.94%	magnetic disturbances
11	1	0.94%	revontulihotelli
12	1	0.94%	revontulikamera
13	1	0.94%	telluric current canada
14	1	0.94%	the auroras
15	1	0.94%	using derivatives for gic



Top 30 of 41 Total Countries							
#	Hits		Files		KBytes		Country
1	218324	57.30%	58659	36.26%	784508	23.96%	Unresolved/Unknown
2	134084	35.19%	79531	49.17%	1851040	56.54%	Finland
3	9578	2.51%	9455	5.85%	156200	4.77%	Norway
4	8137	2.14%	6570	4.06%	222424	6.79%	Network
5	7289	1.91%	5177	3.20%	110392	3.37%	US Commercial
6	750	0.20%	506	0.31%	27338	0.84%	Sweden
7	494	0.13%	450	0.28%	27388	0.84%	Germany
8	489	0.13%	475	0.29%	73817	2.25%	Belgium
9	423	0.11%	365	0.23%	4764	0.15%	Netherlands
10	282	0.07%	252	0.16%	2286	0.07%	Japan
11	178	0.05%	175	0.11%	1938	0.06%	Estonia
12	131	0.03%	118	0.07%	1216	0.04%	Italy
13	110	0.03%	110	0.07%	1763	0.05%	France
14	88	0.02%	62	0.04%	1394	0.04%	Spain
15	87	0.02%	73	0.05%	1391	0.04%	Switzerland
16	76	0.02%	49	0.03%	1132	0.03%	Israel
17	65	0.02%	65	0.04%	1296	0.04%	Australia
18	54	0.01%	54	0.03%	586	0.02%	United Kingdom
19	49	0.01%	49	0.03%	484	0.01%	United States

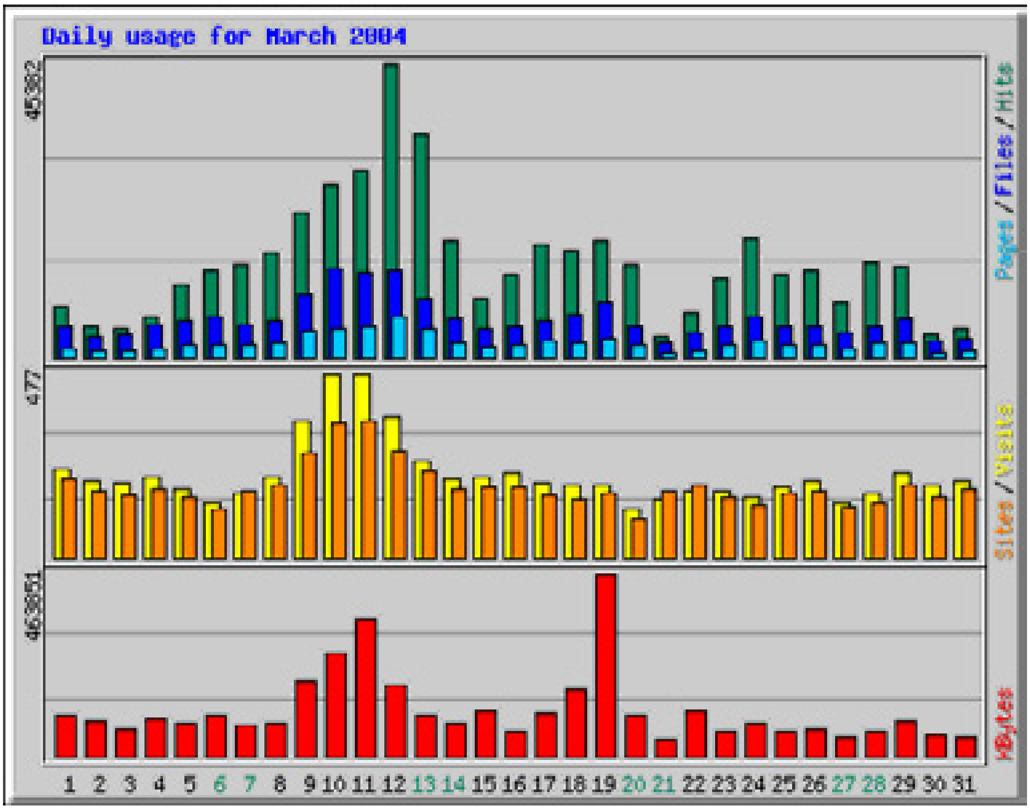
20	**47**	0.01%	**34**	0.02%	**284**	0.01%	Singapore
21	**42**	0.01%	**41**	0.03%	**383**	0.01%	Non-Profit Organization
22	**41**	0.01%	**35**	0.02%	**278**	0.01%	US Educational
23	**38**	0.01%	**37**	0.02%	**343**	0.01%	Canada
24	**23**	0.01%	**20**	0.01%	**210**	0.01%	Greece
25	**22**	0.01%	**21**	0.01%	**174**	0.01%	Taiwan
26	**20**	0.01%	**19**	0.01%	**209**	0.01%	US Government
27	**18**	0.00%	**14**	0.01%	**133**	0.00%	US Military
28	**17**	0.00%	**17**	0.01%	**188**	0.01%	Slovak Republic
29	**15**	0.00%	**15**	0.01%	**137**	0.00%	Colombia
30	**7**	0.00%	**7**	0.00%	**82**	0.00%	International (int)

Generated by **Webalizer Version 2.01**

Usage Statistics for Auroras Now! March 2004

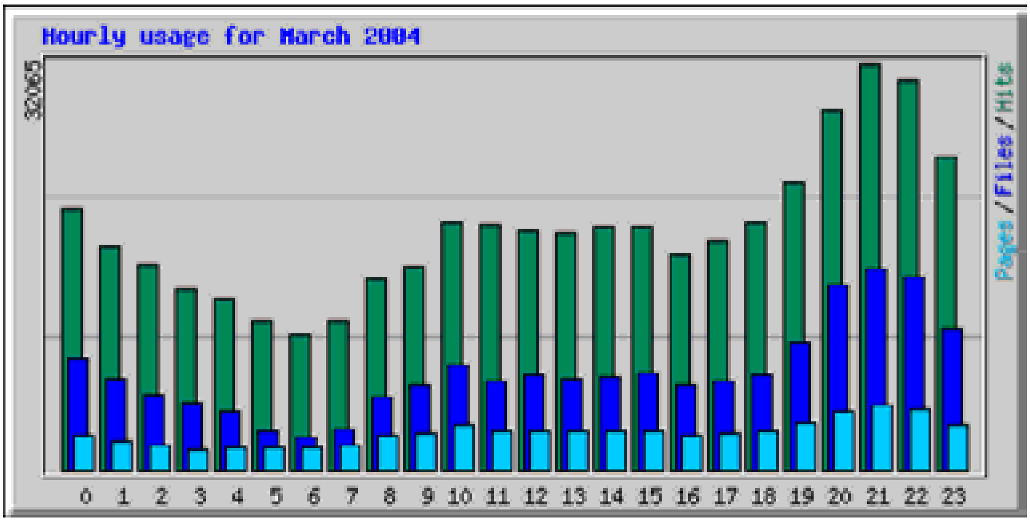
Summary Period: March 2004
Generated 21-Oct-2004 16:49 EEST

Monthly Statistics for March 2004		
Total Hits		**455521**
Total Files		**186414**
Total Pages		**71394**
Total Visits		**6672**
Total KBytes		**3661284**
Total Unique Sites		**3324**
Total Unique URLs		**360**
Total Unique Referrers		**296**
Total Unique User Agents		**63**
	Avg	**Max**
Hits per Hour	**612**	**4545**
Hits per Day	**14694**	**45382**
Files per Day	**6013**	**13696**
Pages per Day	**2303**	**6401**
Visits per Day	**215**	**477**
KBytes per Day	**118106**	**463851**
Hits by Response Code		
Code 200 – OK		**186414**
Code 206 - Partial Content		**693**
Code 301 - Moved Permanently		**84**
Code 302 - Found		**30463**
Code 304 - Not Modified		**237058**
Code 400 - Bad Request		**3**
Code 403 - Forbidden		**59**
Code 404 - Not Found		**708**
Code 405 - Method Not Allowed		**1**
Code 408 - Request Timeout		**29**
Code 500 - Internal Server Error		**4**
Code 501 - Not Implemented		**5**



Daily Statistics for March 2004												
Day	Hits		Files		Pages		Visits		Sites		KBytes	
1	7785	1.71%	4905	2.63%	1495	2.09%	229	3.43%	203	6.11%	102349	2.80%
2	4632	1.02%	3267	1.75%	948	1.33%	200	3.00%	174	5.23%	89092	2.43%
3	4364	0.96%	3426	1.84%	959	1.34%	194	2.91%	165	4.96%	67366	1.84%
4	6460	1.42%	5187	2.78%	1347	1.89%	212	3.18%	179	5.39%	95539	2.61%
5	11287	2.48%	5678	3.05%	1900	2.66%	177	2.65%	157	4.72%	83364	2.28%
6	13567	2.98%	6187	3.32%	2153	3.02%	140	2.10%	128	3.85%	104856	2.86%
7	14505	3.18%	5124	2.75%	2071	2.90%	167	2.50%	173	5.20%	80429	2.20%
8	16218	3.56%	5755	3.09%	2383	3.34%	211	3.16%	189	5.69%	83009	2.27%
9	22453	4.93%	9625	5.16%	4059	5.69%	354	5.31%	273	8.21%	192503	5.26%
10	26690	5.86%	13696	7.35%	4484	6.28%	477	7.15%	351	10.56%	260671	7.12%
11	28990	6.36%	13246	7.11%	4660	6.53%	473	7.09%	354	10.65%	350780	9.58%
12	45382	9.96%	13451	7.22%	6401	8.97%	368	5.52%	278	8.36%	180757	4.94%
13	34475	7.57%	9054	4.86%	4624	6.48%	254	3.81%	227	6.83%	105990	2.89%
14	17913	3.93%	5998	3.22%	2389	3.35%	204	3.06%	177	5.32%	85504	2.34%
15	9008	1.98%	4334	2.32%	1619	2.27%	208	3.12%	184	5.54%	114412	3.12%
16	12879	2.83%	4684	2.51%	2047	2.87%	219	3.28%	182	5.48%	63039	1.72%
17	17551	3.85%	5751	3.09%	2596	3.64%	197	2.95%	164	4.93%	112124	3.06%

18	16513	3.63%	6489	3.48%	2467	3.46%	187	2.80%	155	4.66%	172467	4.71%
19	18210	4.00%	8594	4.61%	2801	3.92%	189	2.83%	170	5.11%	463851	12.67%
20	14485	3.18%	4849	2.60%	2065	2.89%	126	1.89%	102	3.07%	103388	2.82%
21	3237	0.71%	2419	1.30%	664	0.93%	152	2.28%	173	5.20%	44656	1.22%
22	6940	1.52%	3921	2.10%	1220	1.71%	174	2.61%	190	5.72%	116800	3.19%
23	12246	2.69%	4717	2.53%	1891	2.65%	174	2.61%	160	4.81%	64099	1.75%
24	18430	4.05%	6360	3.41%	2649	3.71%	158	2.37%	137	4.12%	81984	2.24%
25	12688	2.79%	4744	2.54%	1953	2.74%	183	2.74%	169	5.08%	64332	1.76%
26	13276	2.91%	4768	2.56%	1965	2.75%	201	3.01%	174	5.23%	70898	1.94%
27	8456	1.86%	3782	2.03%	1282	1.80%	145	2.17%	130	3.91%	50922	1.39%
28	14751	3.24%	4881	2.62%	2184	3.06%	167	2.50%	143	4.30%	65168	1.78%
29	14195	3.12%	5958	3.20%	2333	3.27%	221	3.31%	191	5.75%	89567	2.45%
30	3479	0.76%	2681	1.44%	832	1.17%	188	2.82%	160	4.81%	52110	1.42%
31	4456	0.98%	2883	1.55%	953	1.33%	199	2.98%	180	5.42%	49258	1.35%



Hourly Statistics for March 2004												
Hour	Hits			Files			Pages			KBytes		
	Avg	Total		Avg	Total		Avg	Total		Avg	Total	
0	663	20574	4.52%	283	8773	4.71%	90	2798	3.92%	4545	140904	3.85%
1	570	17671	3.88%	233	7238	3.88%	74	2296	3.22%	3490	108200	2.96%
2	523	16235	3.56%	192	5982	3.21%	63	1970	2.76%	2105	65245	1.78%
3	460	14290	3.14%	171	5312	2.85%	54	1691	2.37%	1716	53187	1.45%
4	437	13568	2.98%	147	4581	2.46%	57	1788	2.50%	1320	40928	1.12%
5	378	11726	2.57%	97	3024	1.62%	60	1876	2.63%	665	20617	0.56%
6	345	10712	2.35%	84	2620	1.41%	58	1822	2.55%	675	20927	0.57%

7	381	11816	2.59%	105	3282	1.76%	65	2023	2.83%	1237	38337	1.05%
8	484	15021	3.30%	187	5811	3.12%	91	2831	3.97%	4343	134632	3.68%
9	516	16018	3.52%	215	6681	3.58%	96	2998	4.20%	6696	207584	5.67%
10	629	19514	4.28%	267	8305	4.46%	113	3521	4.93%	7634	236646	6.46%
11	623	19316	4.24%	226	7033	3.77%	101	3156	4.42%	6433	199411	5.45%
12	607	18826	4.13%	242	7505	4.03%	100	3117	4.37%	6026	186812	5.10%
13	603	18717	4.11%	231	7163	3.84%	96	3005	4.21%	5475	169732	4.64%
14	619	19190	4.21%	236	7345	3.94%	100	3107	4.35%	5419	167980	4.59%
15	617	19154	4.20%	249	7736	4.15%	97	3009	4.21%	5857	181569	4.96%
16	547	16971	3.73%	216	6704	3.60%	87	2710	3.80%	3667	113679	3.10%
17	581	18033	3.96%	226	7026	3.77%	92	2881	4.04%	3621	112247	3.07%
18	626	19435	4.27%	241	7485	4.02%	98	3065	4.29%	3412	105779	2.89%
19	733	22741	4.99%	323	10043	5.39%	118	3680	5.15%	5951	184479	5.04%
20	916	28422	6.24%	468	14537	7.80%	147	4586	6.42%	8854	274469	7.50%
21	1034	32065	7.04%	510	15814	8.48%	165	5123	7.18%	10326	320120	8.74%
22	992	30752	6.75%	491	15222	8.17%	155	4812	6.74%	11594	359420	9.82%
23	798	24754	5.43%	361	11192	6.00%	113	3529	4.94%	7045	218381	5.96%

Top 30 of 360 Total URLs

#	Hits		KBytes		URL
1	216537	47.54%	411967	11.25%	/hotel_service/*
2	194713	42.75%	3067314	83.78%	/public_service/*
3	19932	4.38%	15372	0.42%	/public_service/stylesheet/auroras_style.css
4	10120	2.22%	68160	1.86%	/public_service/images/NUR_latest.png
5	9425	2.07%	173840	4.75%	/gic_service/*
6	7829	1.72%	23038	0.63%	/public_service/suomi/nur_now.html
7	5880	1.29%	16807	0.46%	/hotel_service/index_warmup.shtml
8	5863	1.29%	17539	0.48%	/hotel_service/index_warmup_fin.shtml
9	5441	1.19%	16526	0.45%	/hotel_service/index_online_fin.shtml
10	5329	1.17%	15752	0.43%	/hotel_service/index_online.shtml
11	5213	1.14%	12272	0.34%	/public_service/suomi/latest_asc_image.html
12	4843	1.06%	75648	2.07%	/public_service/images/SOD_latest.png
13	4751	1.04%	1088	0.03%	/public_service/
14	4638	1.02%	7853	0.21%	/hotel_service/index_general_fin.shtml
15	4629	1.02%	7300	0.20%	/hotel_service/index_general.shtml
16	4521	0.99%	61855	1.69%	/public_service/images/NUR_edvrk.png
17	4500	0.99%	71780	1.96%	/public_service/images/SOD_edvrk.png
18	4420	0.97%	13435	0.37%	/public_service/suomi/top_frame.html

19	3941	0.87%	22217	0.61%	/public_service/suomi/start_page.html
20	3739	0.82%	12174	0.33%	/public_service/suomi/latest_nur_sod.html
21	1156	0.25%	417	0.01%	/
22	1083	0.24%	478	0.01%	/gic_service/gasum/suomi/gasum.html
23	1081	0.24%	65454	1.79%	/gic_service/gasum/images/test.png
24	1046	0.23%	2908	0.08%	/public_service/english/top_frame.html
25	936	0.21%	2835	0.08%	/public_service/suomi/last_night_activity.html
26	927	0.20%	3057	0.08%	/public_service/english/latest_nur_sod.html
27	747	0.16%	1663	0.05%	/public_service/suomi/earlier_auroras_material.html
28	559	0.12%	457	0.01%	/public_service/english/latest_asc_image.html
29	527	0.12%	531	0.01%	/gic_service/stylesheet/GIC_style.css
30	408	0.09%	2424	0.07%	/public_service/suomi/auroras_predicting.html

Top 10 of 360 Total URLs By KBytes					
#	Hits		KBytes		URL
1	194713	42.75%	3067314	83.78%	/public_service/*
2	216537	47.54%	411967	11.25%	/hotel_service/*
3	9425	2.07%	173840	4.75%	/gic_service/*
4	4843	1.06%	75648	2.07%	/public_service/images/SOD_latest.png
5	4500	0.99%	71780	1.96%	/public_service/images/SOD_edvrk.png
6	10120	2.22%	68160	1.86%	/public_service/images/NUR_latest.png
7	1081	0.24%	65454	1.79%	/gic_service/gasum/images/test.png
8	4521	0.99%	61855	1.69%	/public_service/images/NUR_edvrk.png
9	15	0.00%	51269	1.40%	/gic_service/images/IonoGICanim.avi
10	7829	1.72%	23038	0.63%	/public_service/suomi/nur_now.html

Top 10 of 64 Total Entry Pages					
#	Hits		Visits		URL
1	4751	1.04%	2754	42.26%	/public_service/
2	1156	0.25%	963	14.78%	/
3	3739	0.82%	777	11.92%	/public_service/suomi/latest_nur_sod.html
4	7829	1.72%	715	10.97%	/public_service/suomi/nur_now.html
5	936	0.21%	377	5.78%	/public_service/suomi/last_night_activity.html
6	4420	0.97%	308	4.73%	/public_service/suomi/top_frame.html
7	3941	0.87%	138	2.12%	/public_service/suomi/start_page.html
8	94	0.02%	45	0.69%	/public_service/english/last_night_activity.html
9	368	0.08%	39	0.60%	/gic_service/
10	747	0.16%	30	0.46%	/public_service/suomi/earlier_auroras_material.html

Top 10 of 66 Total Exit Pages					
#	Hits		Visits		URL
1	**3739**	0.82%	**2158**	32.96%	/public_service/suomi/latest_nur_sod.html
2	**1156**	0.25%	**814**	12.43%	/
3	**7829**	1.72%	**753**	11.50%	/public_service/suomi/nur_now.html
4	**3941**	0.87%	**617**	9.42%	/public_service/suomi/start_page.html
5	**936**	0.21%	**508**	7.76%	/public_service/suomi/last_night_activity.html
6	**5213**	1.14%	**493**	7.53%	/public_service/suomi/latest_asc_image.html
7	**4420**	0.97%	**144**	2.20%	/public_service/suomi/top_frame.html
8	**408**	0.09%	**101**	1.54%	/public_service/suomi/auroras_predicting.html
9	**4751**	1.04%	**91**	1.39%	/public_service/
10	**747**	0.16%	**70**	1.07%	/public_service/suomi/earlier_auroras_material.html

Top 30 of 3324 Total Sites									
#	Hits		Files		KBytes		Visits		Hostname
1	**143276**	31.45%	**29365**	15.75%	**184470**	5.04%	**13**	0.19%	213.28.157.210
2	**98256**	21.57%	**21612**	11.59%	**150111**	4.10%	**13**	0.19%	194.89.115.161
3	**25808**	5.67%	**3915**	2.10%	**29121**	0.80%	**5**	0.07%	b102c.mtalo.ton.tut.fi
4	**12766**	2.80%	**12754**	6.84%	**209273**	5.72%	**23**	0.34%	ua26d43hel.dial.kolumbus.fi
5	**7499**	1.65%	**7483**	4.01%	**125843**	3.44%	**17**	0.25%	ua31d14hel.dial.kolumbus.fi
6	**6351**	1.39%	**1879**	1.01%	**40734**	1.11%	**39**	0.58%	194.89.115.170
7	**5733**	1.26%	**5725**	3.07%	**53027**	1.45%	**12**	0.18%	212-246-50-126.adsl.tpo.fi
8	**4905**	1.08%	**4558**	2.45%	**602081**	16.44%	**37**	0.55%	193.166.209.251
9	**3129**	0.69%	**847**	0.45%	**5380**	0.15%	**1**	0.01%	ua79d121.elisa.omakaista.fi
10	**2881**	0.63%	**602**	0.32%	**9534**	0.26%	**10**	0.15%	dsl-lprgw4rd4.dial.inet.fi
11	**2481**	0.54%	**2478**	1.33%	**69649**	1.90%	**25**	0.37%	gic.fmi.fi
12	**2327**	0.51%	**682**	0.37%	**11327**	0.31%	**11**	0.16%	213214142254.edelkey.net
13	**2300**	0.50%	**410**	0.22%	**3417**	0.09%	**2**	0.03%	firewall.konecranes.com
14	**2151**	0.47%	**2149**	1.15%	**36090**	0.99%	**14**	0.21%	1081.dsl.mtv3.fi
15	**1857**	0.41%	**1587**	0.85%	**28934**	0.79%	**33**	0.49%	kbws253.kolumbus.net
16	**1687**	0.37%	**1667**	0.89%	**27774**	0.76%	**1**	0.01%	tero.sgo.fi
17	**1491**	0.33%	**539**	0.29%	**10461**	0.29%	**46**	0.69%	qn-hvk-5c0.cable.inet.fi
18	**1462**	0.32%	**620**	0.33%	**11508**	0.31%	**10**	0.15%	ua65d216.elisa.omakaista.fi
19	**1332**	0.29%	**552**	0.30%	**11489**	0.31%	**19**	0.28%	cache.ratol.fi
20	**1273**	0.28%	**635**	0.34%	**10348**	0.28%	**31**	0.46%	line-3375.dsl.kpo.dnainternet.fi
21	**1257**	0.28%	**369**	0.20%	**4458**	0.12%	**6**	0.09%	192.194.20.194
22	**1240**	0.27%	**651**	0.35%	**8228**	0.22%	**56**	0.84%	dsl-roigw2ad7.dial.inet.fi
23	**1197**	0.26%	**1176**	0.63%	**21647**	0.59%	**0**	0.00%	titan.sgo.fi

24	1179	0.26%	442	0.24%	6531	0.18%	9	0.13%	kanetti4086.kanetti.com
25	1175	0.26%	591	0.32%	18941	0.52%	0	0.00%	eddie.tky.hut.fi
26	1113	0.24%	396	0.21%	5144	0.14%	4	0.06%	dsl-jklgw1bed.dial.inet.fi
27	1110	0.24%	848	0.45%	32100	0.88%	55	0.82%	62.237.237.3
28	1104	0.24%	311	0.17%	2298	0.06%	1	0.01%	ag71.netikka.fi
29	1096	0.24%	509	0.27%	7161	0.20%	42	0.63%	ua137d91.elisa.omakaista.fi
30	996	0.22%	987	0.53%	16121	0.44%	1	0.01%	jt3-162.tky.hut.fi

Top 10 of 3324 Total Sites By KBytes

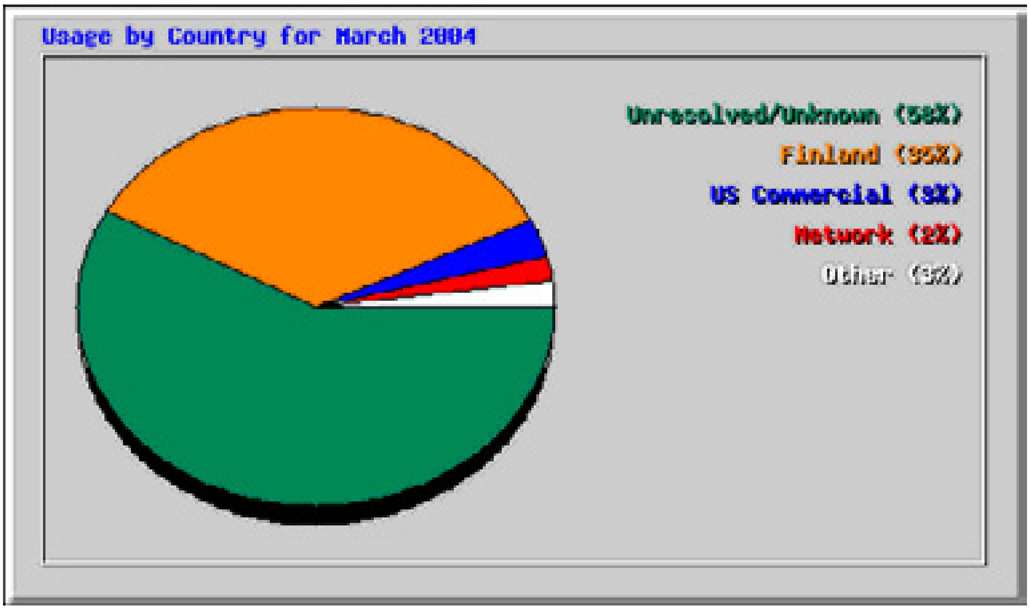
#	Hits		Files		KBytes		Visits		Hostname
1	4905	1.08%	4558	2.45%	602081	16.44%	37	0.55%	193.166.209.251
2	12766	2.80%	12754	6.84%	209273	5.72%	23	0.34%	ua26d43hel.dial.kolumbus.fi
3	143276	31.45%	29365	15.75%	184470	5.04%	13	0.19%	213.28.157.210
4	98256	21.57%	21612	11.59%	150111	4.10%	13	0.19%	194.89.115.161
5	7499	1.65%	7483	4.01%	125843	3.44%	17	0.25%	ua31d14hel.dial.kolumbus.fi
6	903	0.20%	886	0.48%	114794	3.14%	1	0.01%	c168a.mtalo.ton.tut.fi
7	2481	0.54%	2478	1.33%	69649	1.90%	25	0.37%	gic.fmi.fi
8	678	0.15%	620	0.33%	54756	1.50%	11	0.16%	dsl-olugw5jdc.dial.inet.fi
9	5733	1.26%	5725	3.07%	53027	1.45%	12	0.18%	212-246-50-126.adsl.tpo.fi
10	6351	1.39%	1879	1.01%	40734	1.11%	39	0.58%	194.89.115.170

Top 30 of 296 Total Referrers

#	Hits		Referrer
1	27966	6.14%	http://aurora.fmi.fi/public_service/suomi/nur_now.html
2	22068	4.84%	http://aurorasnow.fmi.fi/hotel_service/index_warmup.shtml
3	21956	4.82%	http://aurorasnow.fmi.fi/hotel_service/index_warmup_fin.shtml
4	20840	4.57%	http://aurora.fmi.fi/public_service/suomi/latest_asc_image.html
5	20168	4.43%	http://aurorasnow.fmi.fi/hotel_service/index_online_fin.shtml
6	20151	4.42%	http://aurorasnow.fmi.fi/hotel_service/index_online.shtml
7	20078	4.41%	http://aurora.fmi.fi/public_service/suomi/start_page.html
8	18852	4.14%	http://aurora.fmi.fi/hotel_service/index_online_fin.shtml
9	17990	3.95%	http://aurora.fmi.fi/hotel_service/index_online.shtml
10	15005	3.29%	http://aurora.fmi.fi/public_service/suomi/top_frame.html
11	14623	3.21%	http://aurora.fmi.fi/public_service/suomi/latest_nur_sod.html
12	13925	3.06%	http://aurora.fmi.fi/hotel_service/index_warmup_fin.shtml
13	13897	3.05%	http://aurora.fmi.fi/hotel_service/index_warmup.shtml
14	11343	2.49%	http://aurorasnow.fmi.fi/hotel_service/index_general_fin.shtml
15	11318	2.48%	http://aurorasnow.fmi.fi/hotel_service/index_general.shtml
16	9164	2.01%	http://aurora.fmi.fi/public_service/

17	**7197**	1.58%	http://aurora.fmi.fi/hotel_service/index_general_fin.shtml
18	**7192**	1.58%	http://aurora.fmi.fi/hotel_service/index_general.shtml
19	**6332**	1.39%	http://aurora.fmi.fi/public_service/english/latest_nur_sod.html
20	**4631**	1.02%	http://aurora.fmi.fi/public_service/english/top_frame.html
21	**4131**	0.91%	http://aurorasnow.fmi.fi/public_service/suomi/latest_asc_image.html
22	**2962**	0.65%	http://aurorasnow.fmi.fi/public_service/suomi/start_page.html
23	**2496**	0.55%	http://aurora.fmi.fi/public_service/english/latest_asc_image.html
24	**2474**	0.54%	http://aurorasnow.fmi.fi/public_service/suomi/last_night_activity.html
25	**2220**	0.49%	http://aurorasnow.fmi.fi/public_service/suomi/top_frame.html
26	**2142**	0.47%	http://aurora.fmi.fi/gic_service/gasum/suomi/gasum.html
27	**1901**	0.42%	http://aurora.fmi.fi/public_service/english/start_page.html
28	**1838**	0.40%	http://aurorasnow.fmi.fi/public_service/suomi/latest_nur_sod.html
29	**1592**	0.35%	http://aurorasnow.fmi.fi/public_service/
30	**1519**	0.33%	http://aurora.fmi.fi/gic_service/suomi/top_frame.html

Top 20 of 26 Total Search Strings			
#	**Hits**		**Search String**
1	**28**	40.58%	auroras
2	**6**	8.70%	auroras now
3	**4**	5.80%	aurora ground effects
4	**4**	5.80%	the auroras
5	**4**	5.80%	what are auroras
6	**3**	4.35%	ground effects
7	**1**	1.45%	as auroras
8	**1**	1.45%	aurora borealis 1866
9	**1**	1.45%	aurora fmi
10	**1**	1.45%	aurora.fmi.fi
11	**1**	1.45%	auroras -com
12	**1**	1.45%	auroras\
13	**1**	1.45%	aurorasnow
14	**1**	1.45%	determine the median probability
15	**1**	1.45%	electromotive force england
16	**1**	1.45%	indeksit
17	**1**	1.45%	list of sweden banks on line
18	**1**	1.45%	magnetic disturbances
19	**1**	1.45%	putken geometria
20	**1**	1.45%	revontulikamera



Top 30 of 47 Total Countries							
#	Hits		Files		KBytes		Country
1	**265142**	58.21%	**66580**	35.72%	**1158065**	31.63%	Unresolved/Unknown
2	**161706**	35.50%	**102498**	54.98%	**2105972**	57.52%	Finland
3	**14094**	3.09%	**8119**	4.36%	**184500**	5.04%	US Commercial
4	**9434**	2.07%	**6181**	3.32%	**135331**	3.70%	Network
5	**772**	0.17%	**384**	0.21%	**10849**	0.30%	International (int)
6	**573**	0.13%	**352**	0.19%	**4975**	0.14%	Sweden
7	**530**	0.12%	**346**	0.19%	**10768**	0.29%	Netherlands
8	**434**	0.10%	**426**	0.23%	**15826**	0.43%	Belgium
9	**382**	0.08%	**357**	0.19%	**2982**	0.08%	Japan
10	**262**	0.06%	**228**	0.12%	**7100**	0.19%	Germany
11	**242**	0.05%	**165**	0.09%	**3001**	0.08%	Estonia
12	**233**	0.05%	**140**	0.08%	**1048**	0.03%	US Educational
13	**220**	0.05%	**172**	0.09%	**1995**	0.05%	United Kingdom
14	**156**	0.03%	**96**	0.05%	**2112**	0.06%	United States
15	**149**	0.03%	**138**	0.07%	**1199**	0.03%	France
16	**144**	0.03%	**92**	0.05%	**1349**	0.04%	Russian Federation
17	**139**	0.03%	**74**	0.04%	**1989**	0.05%	Norway
18	**135**	0.03%	**97**	0.05%	**3311**	0.09%	Portugal
19	**89**	0.02%	**71**	0.04%	**653**	0.02%	Poland
20	**84**	0.02%	**56**	0.03%	**1217**	0.03%	Mexico
21	**83**	0.02%	**69**	0.04%	**1245**	0.03%	Switzerland
22	**75**	0.02%	**71**	0.04%	**612**	0.02%	Canada

23	**69**	0.02%	**69**	0.04%	**1477**	0.04%	Australia
24	**67**	0.01%	**53**	0.03%	**559**	0.02%	Denmark
25	**59**	0.01%	**35**	0.02%	**253**	0.01%	Italy
26	**54**	0.01%	**54**	0.03%	**508**	0.01%	Spain
27	**49**	0.01%	**49**	0.03%	**1315**	0.04%	Singapore
28	**27**	0.01%	**26**	0.01%	**253**	0.01%	US Government
29	**27**	0.01%	**26**	0.01%	**231**	0.01%	Non-Profit Organization
30	**25**	0.01%	**25**	0.01%	**208**	0.01%	Turkey

Generated by **Webalizer Version 2.01**

Appendix D: Summary of customer feedback (Hotel Service)

Feedback from

- Hotel customers (17.5 replies)
- Hotel staff (1 person)

Hotel questionary

The feedback from the hotel visitors was collected with a paper form. Eighteen forms were received from Hotel Luostotunturi, with one form only one page out of two filled. The form consisted of thirteenquestions and a field for freeform feedback. The questions and feedback are listed below.

1. When and how did you learn about the service?
a) I knew already before the trip (3)
Where did you get the information? (web pages, radio show, Space2003 event)
b) Noticed at the hotel (10)
c) Did not notice at all (4)

2. Did you use the service?
a) Yes (10)
b) No (7)

3. Where did you use the service? (you can pick several options)
a) In my hotel room (using the internal TV system) (7)
b) In the lobby (using the public computer terminal) (9)
c) I studied the Auroras Now! public WWW pages before my trip (1)
d) I didn't notice there was a display in the TV system (0)

4. How did you use the service? (you can pick both)
a) I looked at the prediction during daytime (auroral alarm and cloudiness) (5)
b) I used the real-time service (images of the all-sky camera) (6)

5. Did you go out to see aurora based on the prediction or the
real-time images?
a) Yes (3)
b) No (5)

6. Were there auroras in the sky during your visit?
a) Yes (2) if during several nights, how many? (no answers)
b) No (6)
c) I don't know, I did not check myself (2)

7. Was the prediction given by Auroras Now correct?
a) Yes (4)

b) No (0)

c) I do not know (6)

8. Did the pages on the TV, with the material in your room, give enough information to use the service?

a) Yes (9)

b) No (0)

9. Did you have questions to or did you need support from the hotel personnel?

a) Yes (2)

b) No (7)

10. If you answered Yes to the previous question, were you happy with the answers and support you got?

a) Yes (4) (including 2 answers who had marked No on previous question)

b) No (0)

11. Were you generally satisfied with the service?

a) Yes (9)

b) No (0)

12. Did the availability of auroral observation service affect your selection of where to stay during your trip?

a) Yes (3)

b) No (6) (Several entries who didn't know of the service beforehand)

c) Did not know about the service (8)

13. Do you think this service might affect some other travellers' selection of hotel or holiday target?

a) Yes (9)

b) No (8)

Additional comments:

"Excellent" "Real nice, easy to use and so on" "Good added value service" and a note about some box blocking the view on the TV screen some of the time (probably from the computer-TV interface at the hotel).

The feedback was received both from Finnish and foreign tourists.

Comments from staff

- Questionaries in the hotel rooms and at the reception (fancy box)
- The staff actively guided people to use the service
- The terminal at the lobby was mainly used by non-customer (people who had rent cottages nearby)
- FAQ info and CDs not used very much
- Stability problems in the internal TV-system

- Mainly positive feedback, no angry, dissappointed customers
- Example: A group of UK tourists rushed out from the dinner table to spot auroras as ANow! showed that they should exist.
- Not very much feedback from Japanese tourists
- Informal advertising in travel exhibitions: Clear potential for this kind of service exists!
- Printed PR-material for the next season should be available by the end of November.

RAPORTTEJA — RAPPORTER — REPORTS

1986: 1. Savolainen, Anna Liisa et al., 1986. Radioaktiivisten aineiden kulkeutuminen Tshernobylin ydinvoimalaonnettomuuden aikana. Väliaikainen raportti. 39 s.

2. Savolainen, Anna Liisa et al., 1986. Dispersion of radioactive release following the Chernobyl nuclear power plant accident. Interim report. 44 p.

3. Ahti, Kari, 1986. Rakennussääpalvelukokeilu 1985-1986. Väliraportti Helsingin ympäristön talvikokeilusta 18.11.-13.3.1986. 26 s.

4. Korhonen, Ossi, 1986. Pintatuulen vertailumittauksia lentoasemilla. 38 s.

1987: 1. Karppinen, Ari et al., 1987. Description and application of a system for calculating radiation doses due to long range transport of radioactive releases. 50 p.

2. Venäläinen, Ari, 1987. Ilmastohavaintoihin perustuva arvio jyrsinturpeen tuotantoedellytyksistä Suomessa. 35 s.

3. Kukkonen, Jaakko ja Savolainen, Anna Liisa, 1987. Myrkyllisten kaasujen päästöt ja leviäminen onnettomuustilanteissa. 172 s.

4. Nordlund, Göran ja Rantakrans, Erkki, 1987. Matemaattisfysikaalisten ilmanlaadun arviointimallien luotettavuus. 29 s.

5. Ahti, Kari, 1987. Rakennussäätutkimuksen loppuraportti. 45 s.

6. Hakola, Hannele et al., 1987. Otsonin vaihteluista Suomessa yhden vuoden havaintoaineiston valossa. 64 s.

7. Tammelin, Bengt ja Erkiö, Eero, 1987. Energialaskennan säätiedot – suomalainen testivuosi. 108 s.

1988: 1. Eerola, Kalle, 1988. Havaintojen merkityksestä numeerisessa säänennustuksessa. 36 s.

2. Fredrikson, Liisa, 1988. Tunturisääprojekti 1986-1987. Loppuraportti. 31 s.

3. Salmi, Timo and Joffre, Sylvain, 1988. Airborne pollutant measurements over the Baltic Sea: meteorological interpretation. 55 p.

4. Hongisto, Marke, Wallin, Markku ja Kaila, Juhani, 1988. Rikkipäästöjen vähentämistoimenpiteiden taloudellisesti tehokas valinta. 80 s.

5. Elomaa, Esko et al., 1988. Ilmatieteen laitoksen automaattisten merisääasemien käyttövarmuuden parantaminen. 55 s.

6. Venäläinen, Ari ja Nordlund, Anneli, 1988. Kasvukauden ilmastotiedotteen sisältö ja käyttö. 63 s.

7. Nieminen, Rauno, 1988. Numeeristen paine- ja ja korkeuskenttäennusteiden objektiivinen verifiointisysteemi sekä sen antamia tuloksia vuosilta 1985 ja 1986. 35 s.

1989: 1. Ilvessalo, Pekko, 1989. Yksittäisestä piipusta ilmaan pääsevien epäpuhtauksien suurimpien tuntipitoisuuksien arviointimenetelmä. 21 s.

1992: 1. Mhita, M.S. and Venäläinen, Ari, 1991. The variability of rainfall in Tanzania. 32 p.

2. Anttila, Pia (toim.), 1992. Rikki- ja typpilaskeuman kehitys Suomessa 1980-1990. 28 s.

1993: 1. Hongisto, Marke ja Valtanen Kalevi, 1993. Rikin ja typen yhdisteiden kaukokulkeutumismallin kehittäminen HIRLAM-sääennustemallin yhteyteen. 49 s.

2. Karlsson, Vuokko, 1993. Kansalliset rikkidioksidin analyysivertailut 1979 - 1991. 27 s.

1994: 1. Komulainen, Marja-Leena, 1995. Myrsky Itämerellä 28.9.1994. Säätilan kehitys Pohjois-Itämerellä M/S Estonian onnettomuusyönä. 42 s.

2. Komulainen, Marja-Leena, 1995. The Baltic Sea Storm on 28.9.1994. An investigation into the weather situation which developed in the northern Baltic at the time of the accident to m/s Estonia. 42 p.

1995: 1. Aurela, Mika, 1995. Mikrometeorologiset vuomittausmenetelmät - sovelluksena otsonin mittaaminen suoralla menetelmällä. 88 s.

2. Valkonen, Esko, Mäkelä, Kari ja Rantakrans, Erkki, 1995. Liikenteen päästöjen leviäminen katukuilussa - AIG-mallin soveltuvuus maamme oloihin. 25 s.

3. Virkkula, Aki, Lättilä, Heikki ja Koskinen, Timo, 1995. Otsonin maanpintapitoisuuden mittaaminen UV-säteilyn absorbtiolla: DOAS-menetelmän vertailu suljettua näytteenottotilaa käyttävään menetelmään. 29 s.

4. Bremer, Pia, Ilvessalo, Pekko, Pohjola, Veijo, Saari, Helena ja Valtanen, Kalevi, 1995. Ilmanlaatuennusteiden ja -indeksin kehittäminen Helsingin Käpylässä suoritettujen mittausten perusteella. 81 s.

1996: 1. Saari, Helena, Salmi, Timo ja Kartastenpää, Raimo, 1996. Taajamien ilmanlaatu suhteessa uusiin ohjearvoihin. 98 s.

1997: 1. Solantie, Reijo, 1997. Keväthallojen alueellisista piirteistä ja vähän talvipakkastenkin. 28 s.

1998: 1 Paatero, Jussi, Hatakka, Juha and Viisanen, Yrjö, 1998. Concurrent measurements of airborne radon-222, lead-210 and beryllium-7 at the Pallas-Sodankylä GAW station, Northern Finland. 26 p.

2 Venäläinen, Ari ja Helminen, Jaakko, 1998. Maanteiden talvikunnossapidon sääindeksi. 47 s.

3 Kallio, Esa, Koskinen, Hannu ja Mälkki, Anssi, 1998.
VII Suomen avaruustutkijoiden COSPAR-kokous,
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