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Modernizing the Danish Network

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Introduction

The Danish seismological network is currently highly heterogeneous with seismometers ranging from WWSSN over S-13 to STS-1 that are connected to a mixture of digital and analog recording systems. In early 1998 extra funds were made available for upgrading the stations in Denmark and Greenland in order to obtain a more homogeneous, fully digital network. The objective of this letter is to outline the process of modernizing an entire, although small, network with the hope to inspire and encourage other network operators planning similar undertakings.

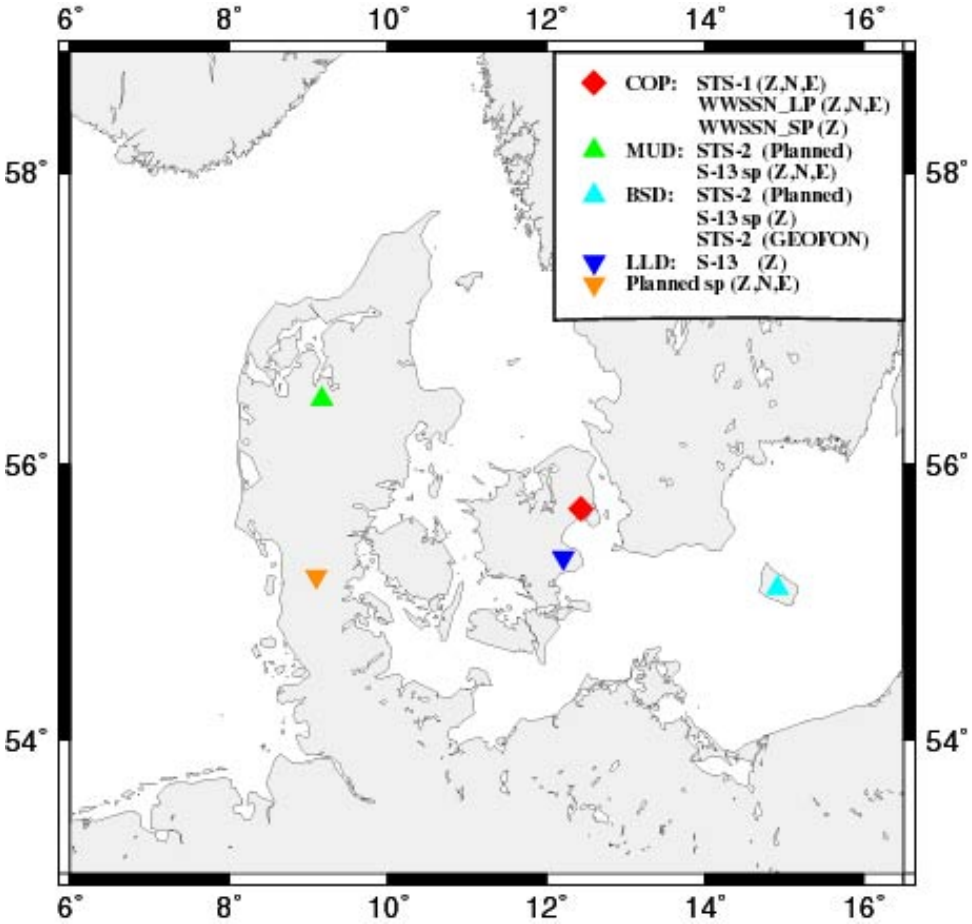

Figure 1. Stations in Denmark

Requirements for the new system

The very first step of the process was to envision the look and feel of the upgraded network. This lead to the formulation of the following list of requirements:

- **Broadband seismographs.** The added possibilities offered by broadband seismographs over short-period instruments, combined with a long Danish tradition for surface wave studies made this an easy choice.
- **Large local ringbuffers.** Data must be saved locally at each station, even if the data is transferred continuously to the main office. Too many times data has been lost due to problems with the phone lines, and the price of large hard disks has become quite manageable.
- **Local time stamping.** In the current system data from several stations are transferred over dedicated phone lines to the KMS office, where the time stamps are added. This procedure is incompatible with local storage of the data.
- **Dial-up access to all stations.** It is not feasible to transfer data from all stations in the network over phone lines on a daily basis, but it should be possible to call up any station and transfer chunks of data whenever desired.
- **Continuous data.** Local Danish earthquakes usually do not stand out significantly from the background noise and could too easily be overlooked by an automatic event picker. It is therefore necessary to save continuous data.
- **Historical link.** A connection should be established between the old data and the data from the new instruments. It is important to know how the new registrations relate to the old ones, otherwise the data will be less useful.
- **Instrument response.** Only companies willing and able to provide complete information about data formats and instrument response ahead of the purchase would be considered.

Based on these requirements, a call for proposals was sent out to a handful of companies. The companies were asked to delineate how their equipment would fit into our upgrade strategy, which made a final purchase decision easier.

Instrumentation and software

The Streckeisen STS-2 seismometer was chosen due to its wide frequency band, good reputation and widespread use among colleagues. To digitize the data the Nanometrics HRD24 was chosen owing to considerations of price, quality and customer support. The HRD24 also has a built-in GPS for timing and it is compatible with the University of Bergen SEISLOG acquisition software, which we decided to use. The SEISLOG system has the advantage that it is free, and it is used by some of our close neighbors, both in Norway and at the British Geological Survey. The SEISLOG and SEISAN packages will be supplemented by some KMS developed PC software.

Data communication

Data transfer between the seismological stations and the KMS is complicated by the fact that the KMS computer systems are protected by a firewall. It is therefore impossible to make direct dial-up connections between the stations and the office computers. Instead we are setting up a system where we can call the stations in Denmark over ISDN lines and transfer the data through a central KMS dial-up point to the main computer system for processing. Two stations, COP and MUD, will keep on sending data continuously to the KMS office over dedicated phone lines, while the remaining stations will be used on a dial-up basis. Continuous data from the dial-up stations will be saved on CD-ROM or DAT and mailed to the KMS on a regular basis.

The situation in Greenland is more complicated. While ISDN is available in Greenland, the fast transfer rates can be obtained only within Greenland and not across the Atlantic to Denmark. Given the high cost of phone calls to Greenland, it is not feasible to transfer data on a regular basis over phone lines. Instead we are working on an Internet solution, where the stations in Greenland would connect locally to the Internet, so that we may ftp the data from Greenland at the cost of a local phone call. The technical details of this solution have not been worked out yet.

Data availability

Data from the Danish network (old system only) is available by autodrm (autodrm@kms.dk), and the weekly bulletins can be found on the KMS seismology web page under Seismic service.

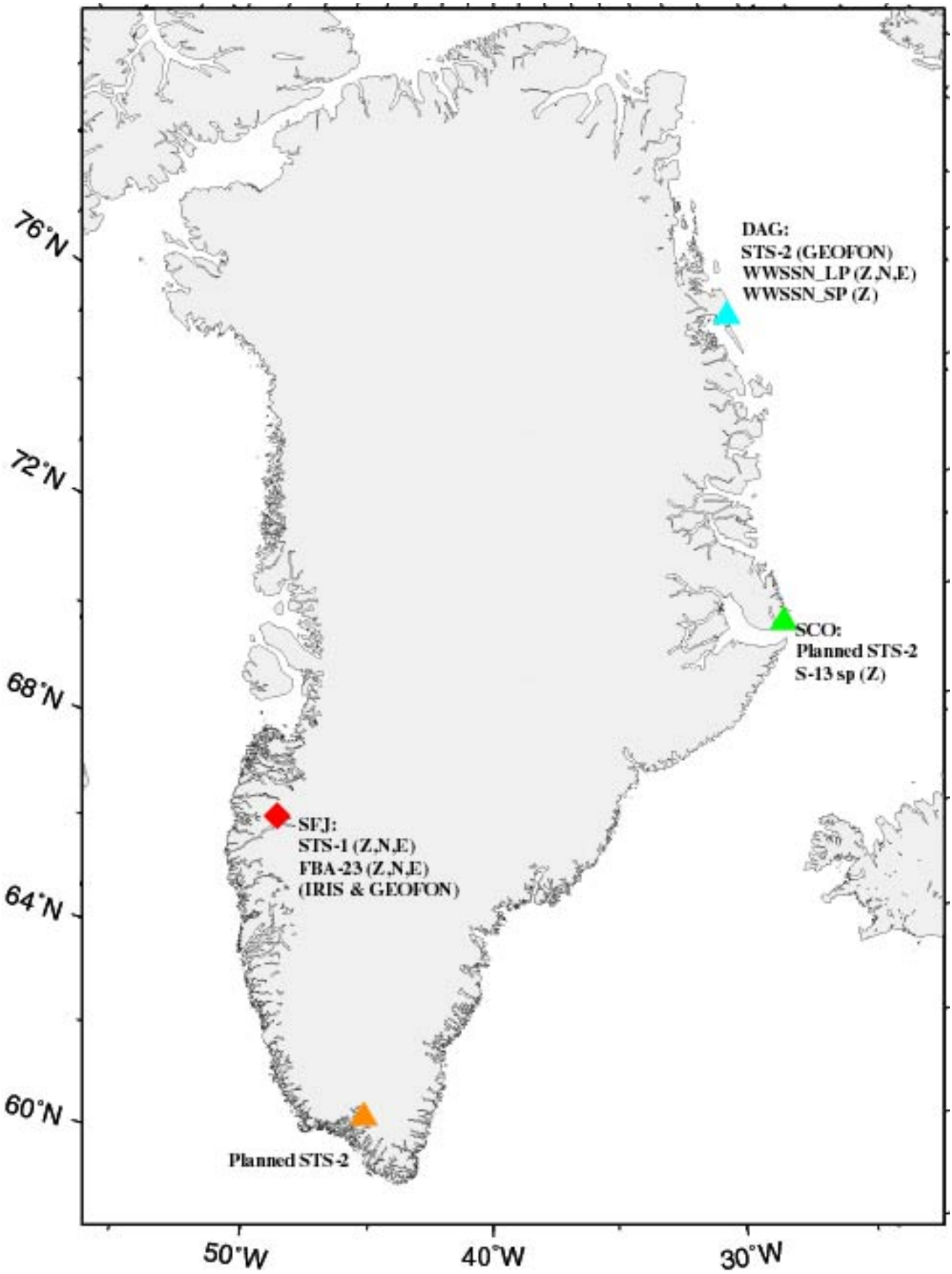

Figure 2. stations in Greenland.

The transition process

Before the Danish seismological network is fully upgraded and the old instruments are phased out, a final calibration will be performed on all the current seismographs. In this way the older data is well-documented and can be used later. The method chosen is developed by Prof. Erhard Wielandt and was presented at the ORFEUS workshop in Prague, November 1998. For our calibration we used his software, CALEX. The method is a relative calibration of each seismic sensor where the calibration signal is compared with a known reference signal. The calibration has been performed on the STS-1 seismometers at the COP station, but not without difficulties, as it turned out that the old Nanometrics RD3 digitizer had been modified with a high-pass filter. This experience emphasizes the importance of calibrating old equipment, when no-one can remember how it was modified.

Looking to the future

Four STS-2 seismometers and four HRD24 digitizers were delivered in December 1998, and the instruments are planned to be in operation at MUD, BSD and SCO by fall 1999. The new station in Narsarsuaq will be slightly delayed due to a field project, but the station is expected to be fully operational sometime in 2000. The old systems will be shut down by the end of 1999.

Acknowledgement

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