System design and operation of GFZ's Satellite Receiving Station at Ny-Ålesund, Spitsbergen

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The GFZ German Research Centre for Geosciences operates an unmanned satellite receiving station at Ny-Ålesund, Spitsbergen in order to receive data from research satellites in polar orbits. The station (Fig. 1) is located about 1 km outside the village, between the local airport and the Kings Bay. Ny-Ålesund is the northernmost location (ca. 1200 km to the North Pole) with regular travel connections (aircraft, ship). The village has between 30 and 180 inhabitants (depending on season, most of them scientists). The local infrastructure (harbor, road system, energy) is provided and operated by the Kings Bay Company on a commercial basis.

Figure 1: The satellite receiving station Ny-Ålesund with two antennas and a hut with further receiving equipment

Many scientific satellites for the observation of the Earth and the near Earth space are in low, polar orbits (e.g., 400 – 500 km) with orbital periods of about 93 minutes. Due to the rotation of the Earth, satellites in polar orbits can be received in Germany not more often than 3 to 4 times per day. The same satellites appear over the poles during each orbit, about 15 times per day, allowing more data download contacts and thus a fast data provision. The fast availability of the data is an important precondition for many applications with tight time constraints. An example is the satellite-based GNSS Atmosphere Sounding, an innovative method to determine temperature and water vapor profiles, which supports the improvement of weather forecasts and climate-related research. Another example is the operational provision of precise satellite orbit predictions for the ILRS (International Laser Ranging Service), on basis of GNSS data, recorded onboard the satellites. This allows the globally distributed laser ranging stations an accurate direction of their instruments to the satellites, which supports a high coverage with laser measurements. The frequent contacts to the satellites allow, beside the scientific benefit, also a quasi-continuous technical monitoring of the satellites. Technical problems on satellites can be detected early and critical situations might be avoided. This can have a positive effect on the lifetime of the satellites being monitored (e.g., CHAMP and GRACE).

The antenna systems of the station are sheltered against the rough climate conditions on Spitsbergen by heatable radomes. The receiver and steering devices are installed in a small hut. Most of the devices are available at least two times and operated in parallel. Thus the failure of one system does not necessarily cause an interruption or complete failure of reception. The first antenna has an “elevation over azimuth” axes positioning system and is in operation since 2001, initially to receive data from the satellite CHAMP only. The station was continuously modernized and extended since 2002, e.g., with high-performance receivers (2004, 2006 and 2007) which replaced older receivers and allow the reception of more satellites. In 2005 the receiving hut was extended and a second antenna with a “X over Y” axes positioning system was installed. Since then either two satellites can be received at the same time or one satellite can be received by two antennas simultaneously (redundant). New antenna operation software was developed by GFZ, to operate both antennas fully automatically according to the needs of a remotely scheduled, unmanned and mostly unattended operation. The antenna operation software provides unique interfaces for users and operation processes, despite the different technical layout of the both antenna systems. Other software was developed by GFZ to support autonomous local system functions (e.g., temperature control of radomes) and a comfortable monitoring of the scheduling process and station performance.

All satellite contacts are scheduled by GFZ, in cooperation with other agencies being responsible for the satellites operations. Tracking schedules (so called “jobfiles”) are prepared for each of the two receiving antennas (Fig. 2). It is taken care that the satellite’s data transmitting schedules are in agreement with the receiving schedules. The schedules are usually valid for one week and prepared three days before getting due. Data received at the station is automatically sent to GFZ at Potsdam, where it is processed and distributed to other users. The station is operated unmanned all-the-year. It is controlled and monitored remotely by GFZ using special remote control devices and cameras. The German-French AWIPEV research station at Ny-Ålesund as well as the Kings Bay Company give support in case of problems which cannot be solved from remote. Generally once per year GFZ works on the extension, maintenance and repair of the station. Until now the satellites CHAMP, BIRD, GRACE-A, GRACE-B, SAC-C, Terrasar-X and Tandem-X were received at the station. The station is also foreseen to receive the two satellites of the upcoming GRACE-FO mission (scheduled for launch in 2017).

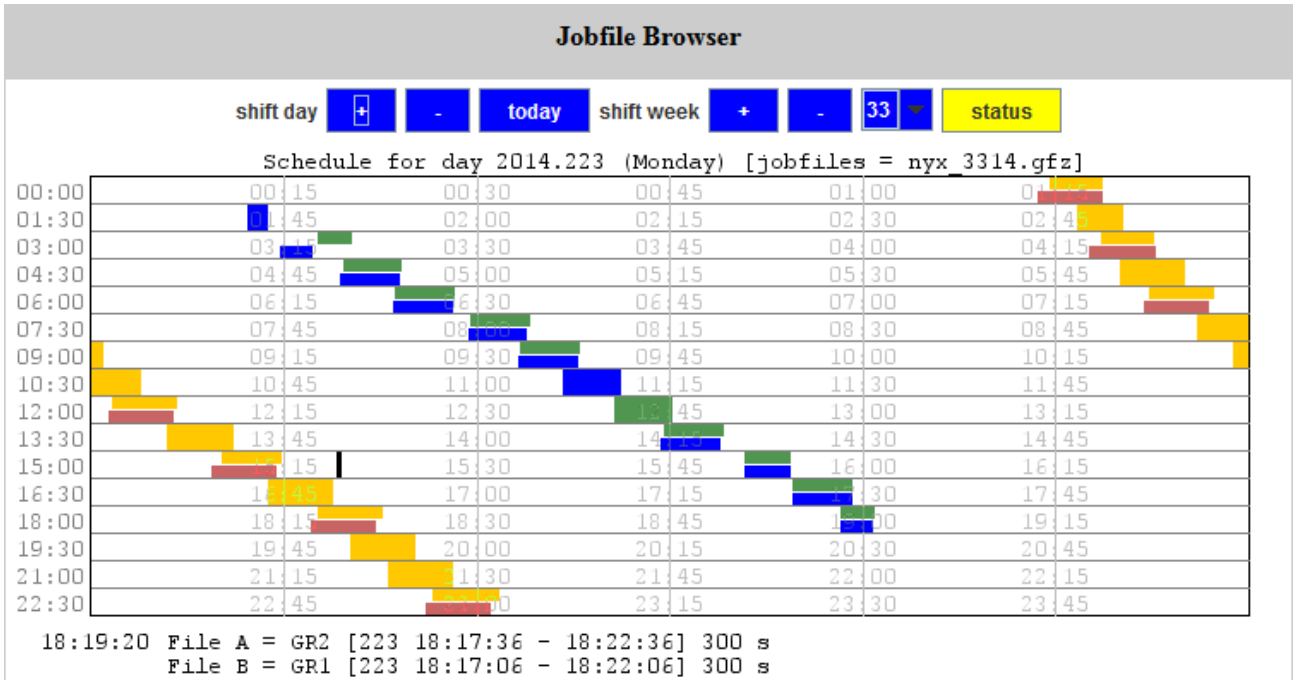

Figure 2: Graphical display of scheduled satellite contacts (jobfiles) to be tracked by the Satellite Station Ny-Ålesund on one day (red = GRACE 1, orange = GRACE 2, blue = Terrasar-X, green = Tandem-X). Some satellite contacts are tracked by both antennas.