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J. W. Sandström—a biographical sketch

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ABSTRACT

J. W. Sandström's (1874–1947) activities encompassed meteorological and oceanographic research in Sweden, as well as Norway. As shown in this biographical sketch, his scientific interests ranged over wide fields and were pursued well past his retirement from the Swedish Meteorological Office. In addition to Sandström's well-known results with bearing on the global thermohaline circulation on which much of his present-day reputation rests, he made other highly important theoretical contributions to both oceanography and meteorology, at the same time not neglecting field research. At a very early date, Sandström, inspired by his academic benefactor Otto Pettersson, recognized the importance of the North Atlantic inflow to the Norwegian Sea for the climate of Northwestern Europe and, furthermore, attempted to investigate this process during a number of Nordic-Sea research cruises in the 1930s.

1. Introduction

For a wider international audience, the name of J. W. Sandström (Fig. 1) is most familiar on account of his pioneering contribution to our understanding of the global thermohaline circulation (Sandström, 1908), the centenary of which is being given due recognition in the present issue of Tellus.

However, as is well known among an elder generation of Nordic meteorologists and oceanographers, Sandström was also a highly colourful personality, with a broad range of talents and with numerous, as well as varied, scientific and other accomplishments to his credit. In what follows, an attempt is made to provide a flavour of the man and his times, with particular reference to his work within oceanography.

2. Sandström's childhood and youth

Johan Wilhelm Sandström, born in 1874, was raised in a very poor rural home in the interior region of northern Sweden. Already at a tender age, he was fascinated by the winter and has left us a vivid description of how he, as a toddler, was thrilled to see the patterns created by the hoar-frost, growing on the window-panes of his humble childhood dwelling (Sandström, 1936b). When his father died, Sandström was only 14 years old and had to assume responsibility for the well-being of his mother and younger brother. The family's earthly belongings were loaded on a small sledge, and a 200-km walk to Sundsvall ensued (in fact, as Sandström later commented, his first long-distance winter journey). In this thriving industrial city, the youngster found work as a labourer in a saw-mill, where his exceptional talents were somehow recognized, and in 1893, a group of local benefactors provided the means for Sandström to move to Stockholm for pursuing his education beyond elementary schooling.

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3. Early years in Stockholm

In the Swedish capital, Sandström worked as a mechanic at the state artillery workshop and at the same time engaged in evening studies at the Technical Institute, with the aim of graduating as an engineer. In this educational establishment he caught the eye of the dean, Professor Pontus Henriques, who recommended Sandström for studies at Stockholms Högskola (the predecessor of Stockholm University).

At the time, Stockholms Högskola was a remarkable non-government institution, founded in 1878 by the public-spirited commercial and intellectual citizenry of the capital and financed by private donations and a municipal grant. A noteworthy fact is that the Högskola was established in clear-cut opposition to the venerable Swedish universities in Uppsala and Lund, with their mainly humanistic and theological orientation. Not only was the Högskola primarily dedicated to the natural sciences, it also did not have matriculation from a gymnasium (studentexamen) as a prerequisite for higher studies. This made it possible for Sandström, who only had 6 years of elementary school, to join the body of students in the mid-1890s. Even though the Högskola was of comparatively recent vintage, it already sported a remarkable gallery of distinguished professors, for example, Svante Arrhenius in physics, Ivar Bendixson in mathematics, Vilhelm

Fig. 1. Portrait of Johan Wilhelm Sandström (Courtesy of Alf Olsson).

Bjerknes in mechanics and mathematical physics and Otto Pettersson in chemistry.

Sandström was in close contact with Bendixson, who directed him to Nils Ekholm of the Meteorological Central Institute (Meteorologiska Centralanstalten), where Sandström was hired as a temporary assistant in 1898 even though he did not have a university degree. At the same time, Bendixson recommended Sandström to Bjerknes (Bergeron, 1962). As will be recognized, this proved highly fortuitous, and Bjerknes came to exert a decisive influence on Sandström's scientific interests and, indeed, career.

4. Sandström's scientifically formative years

In 1899, Bjerknes instituted as part-time scholarship for Sandström, and a highly fruitful collaboration developed. Based on his mentor's circulation theorem (Bjerknes, 1898), Sandström carried through a number of theoretical investigations concerning stationary atmospheric motion, as related to the distribution of temperature and pressure aloft. He and Bjerknes also found the time to contribute a chapter on the circulation of the atmosphere to Svante Arrhenius' classical work on cosmic physics (Arrhenius, 1903). Considerable efforts were also devoted to oceanographic problems, as attested to by a study on the use of hydrographic sections for dynamic analysis (Bjerknes and Sandström, 1901), as well as an investigation on the determination of barotropic transports from tidal-gauge data (Sandström, 1903). From a purely oceanographic standpoint, Sandström's most path-breaking research during this period was, however, undertaken in collaboration with Bjørn Helland-Hansen. Their joint efforts resulted in a seminal paper on the dynamic computation of relative currents, that is, the determination of the baroclinic velocity field of the ocean based on hydrographic data (Sandström and Helland-Hansen, 1903). The importance of this study can hardly be overestimated, since applications of this technique not only were essential for the emergence of our modern view of the general ocean circulation, but also formed the basis of a significant part of all oceanographic research during last century.

When the Meteorological Central Institute terminated his employment (Sandström, 1938) and Bjerknes no longer had the means of supporting him, Sandström had the good fortune to enjoy Otto Pettersson's patronage. Although a professor of chemistry at Stockholms Högskola, Pettersson, ever since working up the hydrographic data from the Vega expedition through the Northeast passage in 1878–1880 (Nordenskiöld, 1880), had primarily devoted his research to oceanography. Pettersson had been instrumental (Svansson, 2006) in establishing the International Council for the Exploration of the Sea (ICES), as well as the Swedish Hydrographical-Biological Commission (SHBK)—a scientific body constituted to fulfill Sweden's founding-member obligations towards ICES. Together with his close collaborator Gustaf Ekman, Pettersson erected Bornö research station in the Gullmarsfjord on the west coast of Sweden (Crawford and Svansson, 2003). The station was located on an island owned by Pettersson (in close proximity to his summer residence) and was leased to SHBK for a more-or-less symbolic fee until 1932, when it was transformed into government property.

Pettersson ensured that, in 1903, Sandström was appointed first assistant at SHBK. This position, also known as chief hydrographer, entailed residing at Bornö station and, furthermore, serving as scientific leader on board the temporary SHBK research vessel 'Svensksund' on its regular cruises in the Baltic, Kattegat and Skagerrak. During these 'happy years' (Sandström, 1938), the chief hydrographer acquired a taste for the sea, which was never to desert him. When not at sea he, under the stewardship of Pettersson, undertook numerous and varied tasks, ranging from fjord studies (Sandström, 1905a) to an investigation of the melting of sea-ice (Sandström, 1905b). The latter paper dealt with the results from experiments conducted at the ICES Central Laboratory in Kristiania (present-day Oslo), where Sandström collaborated with Vagn Walfrid Ekman of subsequent boundary-layer fame, who was at the time employed as an assistant to Fritiof Nansen (The experience gained in the course of this laboratory work proved useful a few years later when

Sandström conducted his dynamic experiments with sea-water, cf. Sandström, 1908). Melting sea-ice continued to fascinate him, and it is noteworthy that when Sandström, several decades later, reported field-survey data from the Nordic Seas, he never omitted his most recent observations of ice-melting.

Bjerknes' capacity to support research improved due to a generous grant from the Carnegie Institution in Washington, USA, and in 1906, he could hire Sandström as a personal scientific assistant (Eliassen, 1982). The union between Norway and Sweden had been dissolved in 1905, which, among other repercussions, led to Bjerknes being called to a chair at the university in Kristiania in 1907 (His successor at Stockholms Högskola was Ivar Fredholm—the mathematician who resolved the non-stationary version of V. W. Ekman's boundary-layer problem). Sandström accompanied Bjerknes to Norway, and a highly productive period ensued. One important task was to fulfill their obligations to the Carnegie Institution; this was accomplished by completing their magnum opus on dynamic meteorology and hydrography (Bjerknes and Sandström, 1910). Another significant meteorological contribution was made by Sandström (1910), when he generalized the Guldberg–Mohn principle by permitting the frictional force to act at angle to the counter-direction of the flow. On the basis of his observational experiences as chief hydrographer at Bornö station, Sandström further initiated a series of tank experiments, the results of which were summarized in a classical paper (Sandström, 1908) comprising the thermodynamic result later elevated by Defant (1961) to the rank of a theorem. One minor, although interesting, aspect of this study is that already at this early stage in his career Sandström did not limit his interests to Scandinavian waters, but had turned his sights on 'the Gulf Stream'.

Even though he had been highly successful in his research with Bjerknes, Sandström in 1908 chose to return to Sweden in view of the uncertainties regarding his longer-term prospects in Norway (During these early Kristiania years, neither Sandström nor Bjerknes could have imagined that the Carnegie grant, in fact, would be prolonged until 1941, thereby, making it possible for Bjerknes to maintain a 'nursery' for several generations of eminent Norwegian meteorologists and oceanographers).

This overview of Sandström's youthful research activities abroad may serve as an illustration of how tightly knit the Scandinavian community of meteorologists and oceanographers was in these early days of modern geoscience.

5. Civil-service career

Once back in Stockholm, Sandström was appointed bureau engineer at the Hydrographic Bureau, a subsidiary of the Swedish Ministry of Agriculture, created in the wake of SHBK. This was Sandström's first proper civil-service job, and, lacking a university degree, his application for the position had instead been based on his publications, his knowledge of experimental devices and a number of letters of recommendation attesting to his prowess at calculations. Consonant with the robust interests of its political masters, research at the Hydrographic Bureau tended to be of an applied nature, and during Sandström's time here, he published papers dedicated to such diverse topics as hydrometric experimentation (Sandström, 1912a) and the meteorological constraints affecting log-floating and -rafting, activities of considerable economic importance in the early 1900s (Sandström, 1912b).

In 1913, Sandström returned to the Meteorological Central Institute (where he eventually rose to the position of state meteorologist) but was initially not altogether happy working under Nils Ekholm. The underlying reason appears to be that the 'old guard' at this institute was somewhat hesitant in adopting Bjerknes' meteorological programme, a set of ideas, which not surprisingly, had a strong adherent in Sandström (Carlsson, 2001). In addition to arguing the case for a new approach to weather forecasting, Sandström appears to have consoled himself with oceanographic investigations focusing on more exotic climes than those which generally attracted his attention. He thus completed a study of oceanographic conditions in the doldrums (Sandström, 1914), as well as worked up a hydrographic data set from the Newfoundland–Labrador region, acquired during the 1915 surveys undertaken by the Norwegian scientist Johan Hjort on invitation from the Canadian government in the wake of the Titanic disaster (Sandström, 1918). This latter study made use of the conceptual framework previously developed by Sandström (1908).

With constantly increasing agrarian clamour for better meteorological forecasts as well as the advent of air transport, new societal demands were placed on the weather service. To face these challenges, the Meteorological Central Institute and the Hydrographic Bureau were, in 1919, merged into Statens Meteorologiska-Hydrografiska Anstalt (SMHA, which in 1945 transmogrified into present-day Sveriges Meteorologiska och Hydrologiska Institut, SMHI). Sandström became head (byrådirektör) of this agency's Meteorological Bureau, a post he remained at until his retirement 20 years later.

6. Multi-faceted activities during the 1920s

Sandström's first years at the new agency were a time of high activity since he had to oversee considerable change and innovation. An aeronautical weather service was added to the agency's responsibilities, and, somewhat later, the Meteorological Bureau was augmented by a subunit, dealing with military meteorology. The communication system within the Swedish network of weather-reporting stations was updated, wireless links being introduced where appropriate. Well-established technical systems have, however, a tendency to persist; one of Sandström's first tasks at SMHA was to supervise a modernization of the coastal storm-warning stations. This necessitated boat travel along considerable parts of the Swedish sea-board, an activity he hardly was averse to (Sandström, 1938).

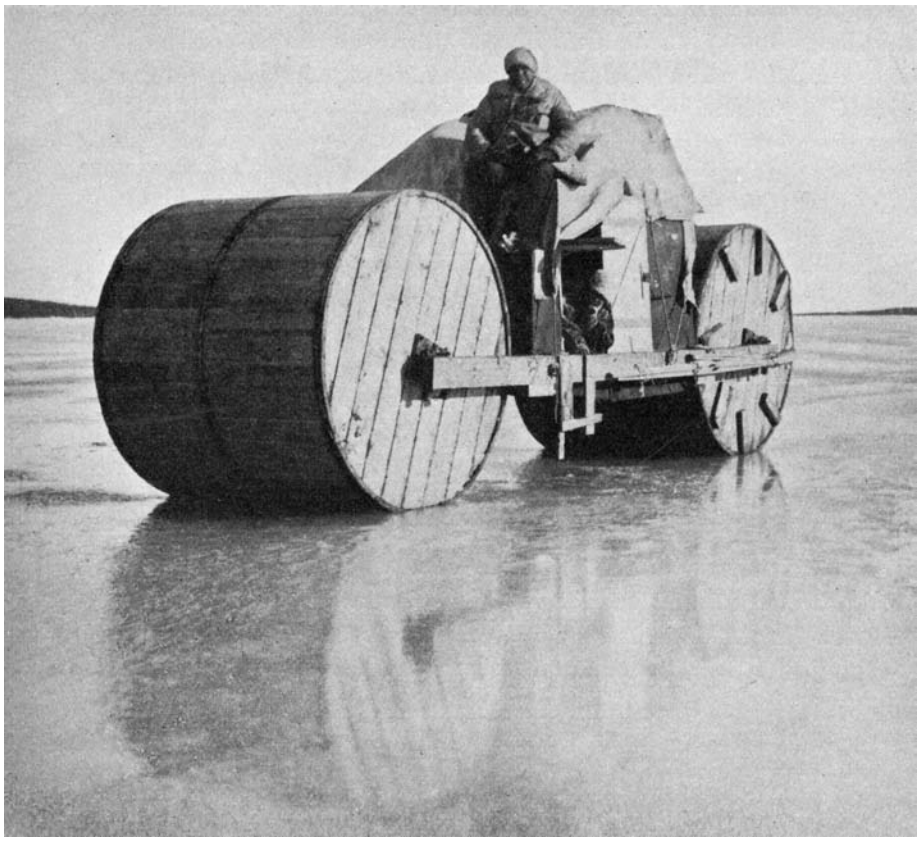

Fig. 2. Amphibian vehicle powered by a 16-horsepower engine constructed and built by J. W. Sandström in the early 1920s.

Day-to-day duties at the Meteorological Bureau did not, however, occupy Sandström's undivided attention. In the early 1920s, he took up the polar challenge and built an amphibian vehicle for travel on ice and water, cf. the photograph in Fig. 2. Almost entirely constructed of timber and powered by a 16-horsepower motorcycle engine, its two barrel-like contraptions of diameter 2 m were used for flotation, as well as propulsion. The crew members had their habitat in the minuscule closed shack, equipped with bunks and a primus stove. Herein, Sandström and his technician spent 47 nights during a pilot expedition on the ices of the Bothnian Sea in the winter 1921–1922 (Sandström's recently wedded bride evidently was of less stern stuff; she called it a day after only 43 honeymoon nights in the hovel). Sandström presented his innovation in the contribution 'Preparations for Polar Expeditions' to a Festschrift, published in 1923 for the 75th birthday of his old benefactor Otto Pettersson, wherein he stressed that the amphibian had attracted favourable attention from local seal-hunters, who, in those days, pursued their trade from skid-equipped open boats, dragged and rowed across the Bothnian ice-fields and polynyas, respectively. The vehicle, however, never came to any practical use in a high-arctic environment but can nevertheless serve as an indication of Sandström's fertile mind and willingness to test new ideas, however bold (Lest any reader should find the amphibian preposterous, it is relevant to point out that the underlying concept was resuscitated towards the end of last century, as nowadays manifested by the vehicles with oversized, low-pressure tires, used for transport in and across the abundant swamps found in the southeastern parts of North America).

Sandström also found the time to conduct fundamental research. Inspired by practical experiences of weather forecasting, he published a paper (Sandström, 1923) querying a fundamental tenet of his teacher Bjerknes and the Bergen school of meteorology (Friedman, 1989), *viz*. that the presence of a frontal zone is a prerequisite for cyclogenesis; Sandström argued that a cyclone may well reinforce a frontal zone (Here it deserves to be emphasized that Sandström was extremely broad-minded as regards scientific divergences of opinion; for example, when Jeffreys (1925) called into question the general validity of Sandström's (1908) results, the latter accepted this criticism with great equanimity). The Norwegian scientists responded in defence of the Bergen-school views, and, not least, due to the stimulus provided by somewhat provocative public statements ascribed to Sandström, news of these, as well as other conflicting views made the headlines of daily papers in Bergen and Stockholm, where the matter inevitably was given a nationalistic slant. (The protagonists themselves took a more relaxed view, as attested to by a contemporary personal letter to Sandström from Bjerknes,

cf. Persson, 1999.) One of Sandström's enemies at SMHA, state hydrographer G. Wersén, seized this opportunity to launch an attack on his antagonist. In a formal letter of complaint to the Swedish government, Wersén castigated Sandström's allegedly cavalier attitude towards his responsibilities as head of SMHA's possibly most important bureau. This, and other intemperate outbursts from a subordinate, led to the director-general of SMHA, in flagrant contravention of Swedish law, imposing a 'gag edict' to be countersigned by his staff. A full-blown feud ensued, including a letter of complaint from Wersén to the government's legal chancellor. Due to Wersén's ignorance concerning the finer points of bureaucratic in-fighting, Sandström, with significant support from his superiors, survived this ordeal comparatively unscathed. It has, however, been speculated (Persson, 1999) that this unsavoury episode contributed to the decision of one of Sandström's SMHA-underlings, namely Carl-Gustaf Rossby, to seek his future in the United States. To conclude the review of these not altogether pleasant events, it is worth emphasizing that Sandström, never media-shy, enjoyed a carefully honed reputation with the general public among which he was known as the 'Weather-God', a sobriquet hinting at the goodwill, Sandström could deploy to full advantage in the well-publicized skirmish with his detractor from the ranks of SMHA.

In 1928, Sandström served as meteorologist during the Swedish Spitzbergen relief expedition for the survivors of Umberto Nobile's ill-fated Zeppelin venture into the Arctic (Liljequist, 1993). His main task was to advise the airmen, who ultimately located and assisted Nobile's stranded party on the ice-floe (Běhounek, 1928). Unfortunately, the rescue came too late for the Swedish oceanographer and noted ice researcher Finn Malmgren, who perished during a gallant attempt to seek aid for his Italian comrades (Lazazzera, 1931). This was doubly tragic in that Malmgren, who in the early 1920s had collaborated with the Norwegian oceanographer Harald Ulrik Sverdrup during the Maud drift through the Arctic ice pack (Sverdrup, 1926), not only was a gifted scientist but also an old acquaintance of Sandström (both of them having served as first assistants at Bornö station). As the dramatic rescue events unfolded, the chief meteorologist attached to the Swedish air-force relief team did not, however, spend all his time issuing forecasts to the flyboys. He also examined the meteorological phenomena, the ocean currents and the ice conditions characterizing the Spitzbergen region, observations which were summarized in an expedition report. Sandström (1928) concluded this paper by advocating the use of ice-strengthened small and medium-sized commercial vessels for scientific work in the sub-Arctic regions.

Towards the end of the 1920s, Sandström's interests, thus, had become more and more orientated towards the Greenland, Iceland and Norwegian Seas (nowadays comprehensively denoted the Nordic Seas). This change of focus was certainly reinforced by his abovementioned Arctic foray, but mainly it was due to his life-long interest regarding the factors controlling the Scandinavian climate, and, not least, the severity of the winters. The conceptual framework underlying Sandström's approach to these matters had its origin in classical studies by Ekholm (1899) and Pettersson (1896; 1898), where the latter, on the basis of 20-year meteorological records and via a two-month time lag, had succeeded in linking February atmospheric conditions at the west coast of Norway to the date when spring tilling commenced in central Sweden (It should be noted that these studies served as direct inspiration for Walker (1928) in his studies of climatological indices based on air-pressure records). These general ideas about oceanic influence on the European weather were expanded upon and given a more rigorous formulation by Meinardus (1898), who pioneered the use of the, nowadays so celebrated, air-pressure difference between Horta in the Azores and Stykkishólmur on Iceland denoted the North Atlantic Oscillation index (Hurrell, 1995).

Sandström initiated his research on these matters by examining meteorological records comprising the winter months of 1900–1910, from which he noted that the Azores-Iceland pressure gradient could not be directly linked to a unique weather type dominating conditions in northern Europe. He came to the conclusion that to find an atmospheric indicator of the heating caused by what he termed 'the Gulf Stream' (in modern parlance, the Atlantic inflow to the Nordic Seas), it was necessary to pursue the investigations at higher latitudes. As a consequence of these insights, Sandström in 1929 undertook his first dedicated research cruise in Arctic waters. This expedition was conducted on the basis of a public subscription managed by Dagens Nyheter (one of the largest Swedish daily newspapers), as well as grants and donations in kind from farsighted and generous businessmen and companies. A measure of government support was obtained from the Swedish Board of Navigation, which agency provided an echo-sounding apparatus and its attendant technician, as well as from the Swedish Navy, which detached a radioman to serve Sandström's needs of transmitting synoptic meteorological observations from the high seas. The aim of the expedition was to investigate the near-surface thermal structure of the Barents as well as Greenland Seas, and to determine how conditions in these ocean regions could exert longer-term effects on the Scandinavian weather. Consonant with the ideas expressed in the report summarizing Sandström's Spitzbergen experiences, the survey took place on board the chartered sealer 'Bjørnøya' from Tromsø. Sandström and the seconded helpers were accompanied by his trusted assistant (and niece) Miss Thea Ahlberg. The two-month cruise ranged from Novaya Zemlya in the east to Greenland in the west, Spitzbergen and Franz Joseph's Land providing the northern delimitations of the zone of operations. The scientific work, in addition to standard meteorological observations, consisted of measurements of the thermal structure of the uppermost 100 m of the ocean, reversing thermometers being employed for this purpose. Sandström (1929) concluded his expedition report by underlining that repeated yearly surveys of the Gulf Stream were necessary to provide the hydrographical

Fig. 3. J. W. Sandström's 36-foot research vessel 'Golfströmmen' moored in an East-Greenland fjord. The female posing on deck is Sandström's niece, Miss Thea Ahlberg (Courtesy of Alf Olsson).

and meteorological insights required for longer-term Scandinavian weather prediction.

The hardships experienced during this first expedition must have whetted Sandström's appetite for the Nordic Seas, since he, the following summer, commanded a similar cruise on board a chartered Norwegian fishing vessel. This time, the investigations were focused on a southerly sector of the Norwegian Sea between Iceland, the Faroes and the Lofoten peninsula in Norway (Sandström, 1930a).

7. The 1930s; focus on the Nordic Seas

Sandström commenced his final decade of SMHA-service by summarizing his ideas concerning the Atlantic inflow to the Nordic Seas and its effects on the atmosphere in two review papers (Sandström, 1930b, 1932), inspired by ideas already proposed in his classical study (Sandström, 1908). These 'tours d'horizon' attracted favourable attention, and in 1931, Sandström found himself the recipient of a generous research grant from the Knut and Alice Wallenberg foundation. He used the funding to build a 36-foot survey vessel, powered by a 20-horsepower Bolinder engine, cf. Fig. 3. Sandström named it 'Golfströmmen' and used it for a series of truly remarkable research cruises in the Nordic Seas during the 1930s. The vessel was generally manned by himself and Miss Thea Ahlberg, supplemented by a young band of enthusiasts and/or adventurers. During several of these expeditions, the vessel and its crew braved the East-Greenland ice-drift and made landfalls on the coast of Greenland. In those unconstrained days predating international conventions on the protection of endangered species, the crew of 'Golfströmmen', on occasion, shot polar bears for 'sporting' purposes, cf. Fig. 4. These daring and spectacular expeditions attracted considerable public attention and gave rise to travelogues in a popular magazine (Sandström, 1934; 1936a), as well as a book, authored by two crew members recruited from Stockholms Högskola and Uppsala University (Odelberg and Olrog, 1936).

After the summer cruise in 1939, 'Golfströmmen' was left to hibernate in the harbour of Narvik, where it was destroyed by British and French troops as they, in late spring 1940, ejected the German invasion force from this strategically important Norwegian port. Coincidentally, Miss Thea Ahlberg was, at the time,

Fig. 4. Polar bear shot by the crew of 'Golfströmmen' during the 1936 summer cruise to East Greenland and Jan Mayen.

serving as a weather observer for SMHA at nearby Riksgränsen and heard about the demise of the vessel from a Narvik refugee crossing into Sweden.

When in Stockholm as head of the Meteorological Bureau at SMHA, Sandström also had to deal with numerous issues of more standard meteorological character. A number of these resulted in scientific papers on topics ranging from the technical aspects of weather analysis to the hydrological properties of snow (Sandström, 1930c; 1936b). Also Sandström's most widely disseminated publication originated during this period, since he, in the mid-1930s, authored a lengthy essay on his cherished Swedish winter (Sandström, 1936c) for the year-book of STF, the Swedish Tourist Society. This study, which reveals Sandström as a masterful stylist, is a charming blend of scientific digressions, boyhood reminiscences and anecdotes from his field investigations of meteorological phenomena in northern Sweden.

8. Last years

Sandström retired from his position at SMHA in 1939. The war years, which led to a cessation of the field-work in the North Atlantic, provided him with an opportunity to summarize his work related to 'the Gulf Stream'. The first paper which resulted (Sandström 1941a), discusses the occurrence of cold and warm winters in Scandinavia, on the basis of long-term (1871–1930) meteorological records from northern Europe and the islands in the North Atlantic. Hereafter, Sandström (1941b) utilized a 1900–1937 data set from ICES in Copenhagen to examine the relationship between the temperature of the sea-surface (SST) and that of the air. The same data set was also used for a pioneering compilation of the monthly mean SSTs of the North Atlantic and the Nordic Seas (Sandström, 1942). Both of these studies, based on the ICES data archive, are interesting from a methodological standpoint since Sandström had to devise more-or-less new techniques to deal with the oceanographic records. The overall results from this suite of papers were summarized in a final study of 'The Gulf Stream and the Weather' (Sandström, 1944).

A striking feature of these investigations is, however, that Sandström did not make any use of the observational records he so laboriously had gathered in the course of his field surveys during the 1930s, but instead took recourse to previously assembled data sets. Sadly enough, but perhaps inevitably, this reflects the limitations of the observational programmes which were possible to carry through during Sandström's strenuous Nordic-Seas field surveys in his puny vessel.

A victim of bilateral pneumonia in the days predating the breakthrough of antibiotic therapy, Sandström passed away in 1947 and was given highly respectful obituaries in the main Swedish dailies, where special attention was paid to his Gulf Stream researches as well as his noteworthy achievements within Swedish meteorology.

9. Concluding remarks

It has been highly rewarding to delve into the life and times of J. W. Sandström, a personality who by no means can be said to conform to modern notions of the 'organization man' (Whyte, 1956). It should, however, be emphasized that the present, and somewhat oceanographically biased, biographical sketch is almost entirely based on secondary material; no primary sources except contemporary newspaper files and Sandström's own publications have been consulted.

10. Acknowledgments

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mother Thea Olsson (née Ahlberg) on board 'Golfströmmen', as well as the portrait of J.W. Sandström. I further wish to thank two reviewers for constructive comments on a preliminary version of the manuscript.

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