A Selection from

Smithsonian at the Poles

Contributions to International Polar Year Science

Igor Krupnik, Michael A. Lang,
and Scott E. Miller
Editors

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Advancing Polar Research and Communicating Its Wonders: Quests, Questions, and Capabilities of Weather and Climate Studies in International Polar Years

James R. Fleming and Cara Seitchek

ABSTRACT. Since its inception, the Smithsonian Institution has been a leader in advancing science and communicating its wonders. It functioned as a "national center for atmospheric research" in the nineteenth century and served as a model for the founding of the U.S. Weather Bureau. Its archives and collections document Smithsonian support and involvement over the years in many of the early weather and climate science initiatives: in both the first and second International Polar Years; in the founding of the Arctic Institute of North America and the National Academy of Sciences Conference on the Antarctic; and in the International Geophysical Year in 1957–1958. This presentation examines science, technology, and public opinion surrounding weather and climate research at both poles, from the middle of the nineteenth century through the first and second International Polar Years and the International Geophysical Year, up to the current International Polar Year 2007–2008.

INTRODUCTION

During the past two centuries, the scientific study of weather and climate has changed repeatedly and dramatically. In different eras, telegraphy, radio, rocketry, electronic computing, and satellite meteorology have provided new capabilities for measuring, monitoring, modeling, and theorizing about the atmosphere. While the scale and sophistication has changed, what has not changed is the need for cooperative efforts spanning the largest areas possible—including the poles. Over the years, polar science has served as a very positive example of international peaceful cooperation. The first International Polar Year (IPY-1) of 1882–1883 involved 11 nations in a coordinated effort to study atmospheric changes and "electrical weather" as shown by magnetic disturbances and the polar lights. These efforts were confined to surface observations (Heathcote and Armitage, 1959). In IPY-2 of 1932–1933, 40 nations were involved in a global program to study meteorology, magnetism, and radio science as related to the ionosphere, using instrumented balloons to reach altitudes as high as 10 kilometers (Laursen, 1959). The International Geophysical Year (IGY) of 1957–1958 involved 67 nations in what the British astronomer and geophysicist Sydney Chapman (1888–1970) called, "the common study of our planet by all nations for the benefit of all." Using rockets, new earth-orbiting satellites, and a variety of other techniques, scientists studied

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the interaction of the sun and the earth, with a special focus on Antarctica (Chapman, 1959a:102). These international cooperative efforts serve as benchmarks for meteorological efforts in high latitudes and help reveal larger issues concerning the continuity and interconnectedness of the science and technology of weather and climate research. Indeed, each successive IPY was based upon the technological innovations of its era and was informed by cutting-edge scientific theories and hypotheses. The launch of the current IPY of 2007–2008, involving more than 60 nations, provides an occasion to look back and to look beyond for larger messages about weather and climate research, the interrelationships created by international science, and the connection between science, technology, and popular culture.

HISTORICAL PRECEDENTS

Cooperative scientific observations date to the early seventeenth century. In the closing decades of the eighteenth century in Europe, and slightly later in Russia and the United States, serious attempts were made to broaden the geographic coverage of weather observations, standardize their collection, and publish the results. Individual observers in particular locales dutifully tended to their journals, and networks of cooperative observers gradually extended the meteorological frontiers. A century before IPY-1, the Societas Meteorologica Palatina (1781–1795), an international organization whose members represented the chief European scientific institutions, collected observations from a network of 57 stations extending from Siberia to North America and southward to the Mediterranean. The observers, who received instruments, forms, and instructions free of charge, sent their results to Mannheim, Germany, where they were published *in extenso* (Cassidy, 1985:8–25; Societas Meteorologica Palatina, 1783–1795). Many subsequent projects emulated their example.

In the 1830s Sir John Herschel (1791–1872), then in Cape Town, South Africa, initiated the practice of collecting extensive hourly geophysical measurements on "term days"—36-hour periods surrounding the dates of the equinoxes and solstices. The measurements, according to a common plan, were taken simultaneously from widely dispersed stations in order to obtain knowledge of the "correspondence of [the] movements and affections [of the atmosphere] over great regions of the earth's surface, or even over the whole globe" (Herschel, 1836). These efforts were patterned after the Göttingen Magnetic Union, which also used term days and instituted a vast network of magnetic observers operating on a common plan. As with the IPYs, which cited these precedents in instituting its own term days, simultaneous observations were meant to foster both scientific understanding and peaceful international cooperation.

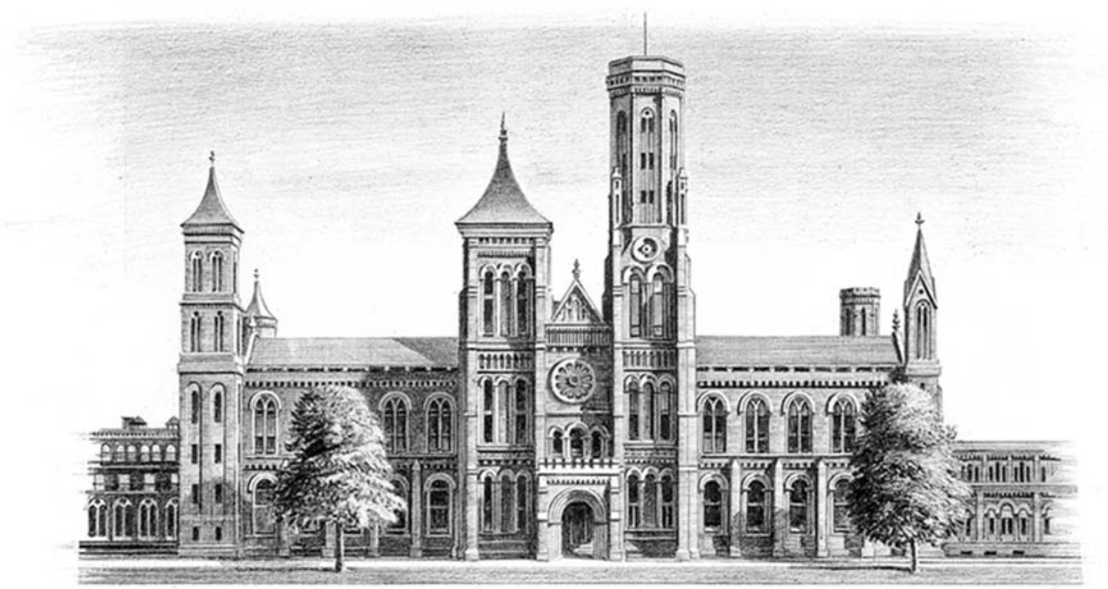

FIGURE 1. Smithsonian Institution ca. 1860, home of the Meteorological Project. Source: Smithsonian Institution.

James P. Espy (1785–1860), the first meteorologist employed by the U.S. government, captured the basic difference between the lone astronomer and the needs of the gregarious meteorologist:

> The astronomer is, in some measure, independent of his fellow astronomer; he can wait in his observatory till the star he wishes to observe comes to his meridian; but the meteorologist has his observations bounded by a very limited horizon, and can do little without the aid of numerous observers furnishing him contemporaneous observations over a wide-extended area. (Espy, 1857:40)

Espy worked closely with Joseph Henry (1797–1878), the first secretary of the Smithsonian Institution, to create a meteorological network of up to 600 volunteer observers, reporting monthly, that spanned the entire United States and extended internationally. Some telegraph stations also cooperated, transmitting daily weather reports to Washington, D.C., where the information was posted on large maps in the Smithsonian Castle (Figure 1) and at the U.S. Capitol. The Smithsonian meteorological project provided standardized instruments, uniform procedures, free publications, and a sense of scientific unity; it formed a "seedbed" for the continued growth of theories rooted in data. To increase knowledge of the atmosphere, it sponsored original research on storms and climate change; to diffuse knowledge, it published and distributed free reports, instructions, and translations. It soon became the U.S. "national center" for atmospheric research in the mid-nineteenth century, as well as a clearinghouse for the international exchange of data (Fleming, 1990:75–94).

Nineteenth-century meteorology benefited from many of the leading technologies and theories available at the time, which, in turn, fueled public expectations about weather prediction. Telegraphy provided instantaneous transmission of information, at least between stations on the grid, and connected scientists and the public in a vast network of information sharing.

Nineteenth-century meteorology, climatology, and other areas of geophysics were undoubtedly stimulated by telegraphic communications that enabled simultaneous observations, data sharing, and timing of phenomena such as auroras, occultations, and eclipses. The vast amounts of gathered data also encouraged scientists to experiment with new ways of portraying the weather and other phenomena on charts and maps (Anderson, 2006). In an effort to enhance both the understanding and prediction of weather phenomena, Yale professor Elias Loomis (1811–1889) searched for "the law of storms" governing storm formation and motion (Figure 2) (Fleming, 1990:77–78, 159). He also mapped the occurrence, intensity, and frequency of auroras from global records, providing a preview of what might be accomplished by observing at high latitudes (Figure 2) (Shea and Smart, 2006).

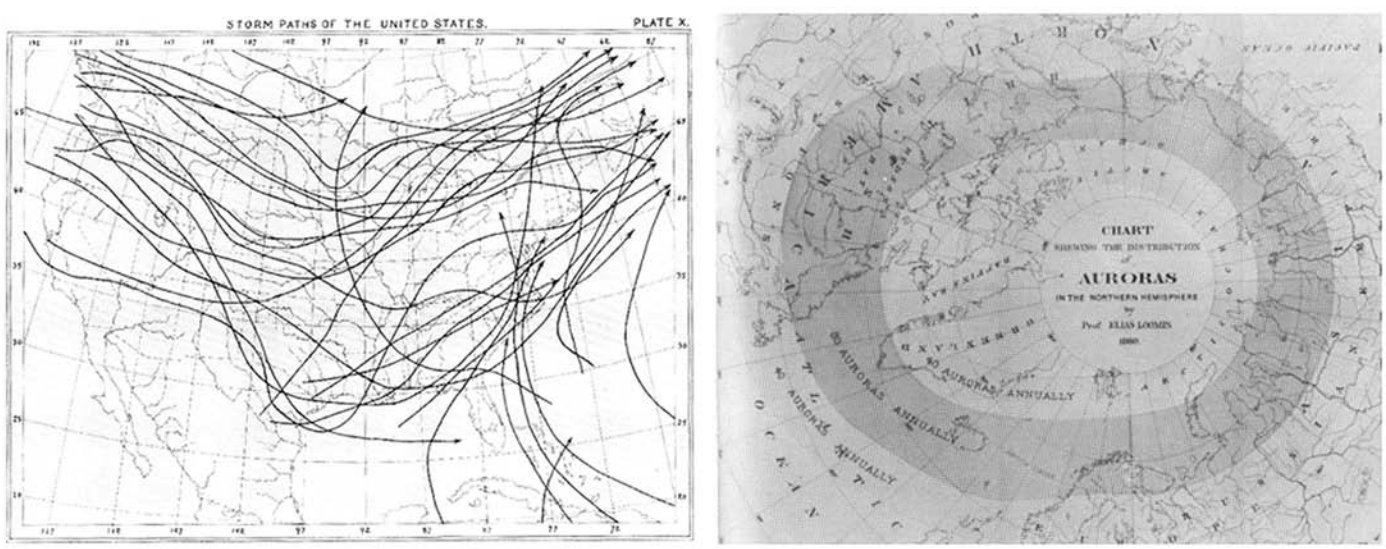

FIGURE 2. Charts by Elias Loomis, ca. 1860. (left) Trajectories of storms entering northeastern USA. Source (Fleming 1990, 159); (right) Frequency of aurora borealis sightings; darker band shows at least 80 auroras annually (http://www.phy6.org/Education/wloomis.html).

Public demand for weather-related information worldwide led to the establishment of many national services by the 1870s. In the United States, the Army Signal Office was assigned this task and soon took the lead in international cooperation. In 1873, the U.S. proposed that all nations prepare an international series of simultaneous observations to aid the study of world climatology and weather patterns. This suggestion led to the *Bulletin of International Simultaneous Observations*, which contained worldwide synoptic charts and summaries of observations recorded at numerous locations around the world (Figure 3) (Myer, 1874:505). Beginning in 1871, the U.S. National Weather Service issued daily forecasts, heightening public expectations that weather could be known—and in some cases, prepared for—in advance. The increasing density and geographic extent of information becoming available in meteo-

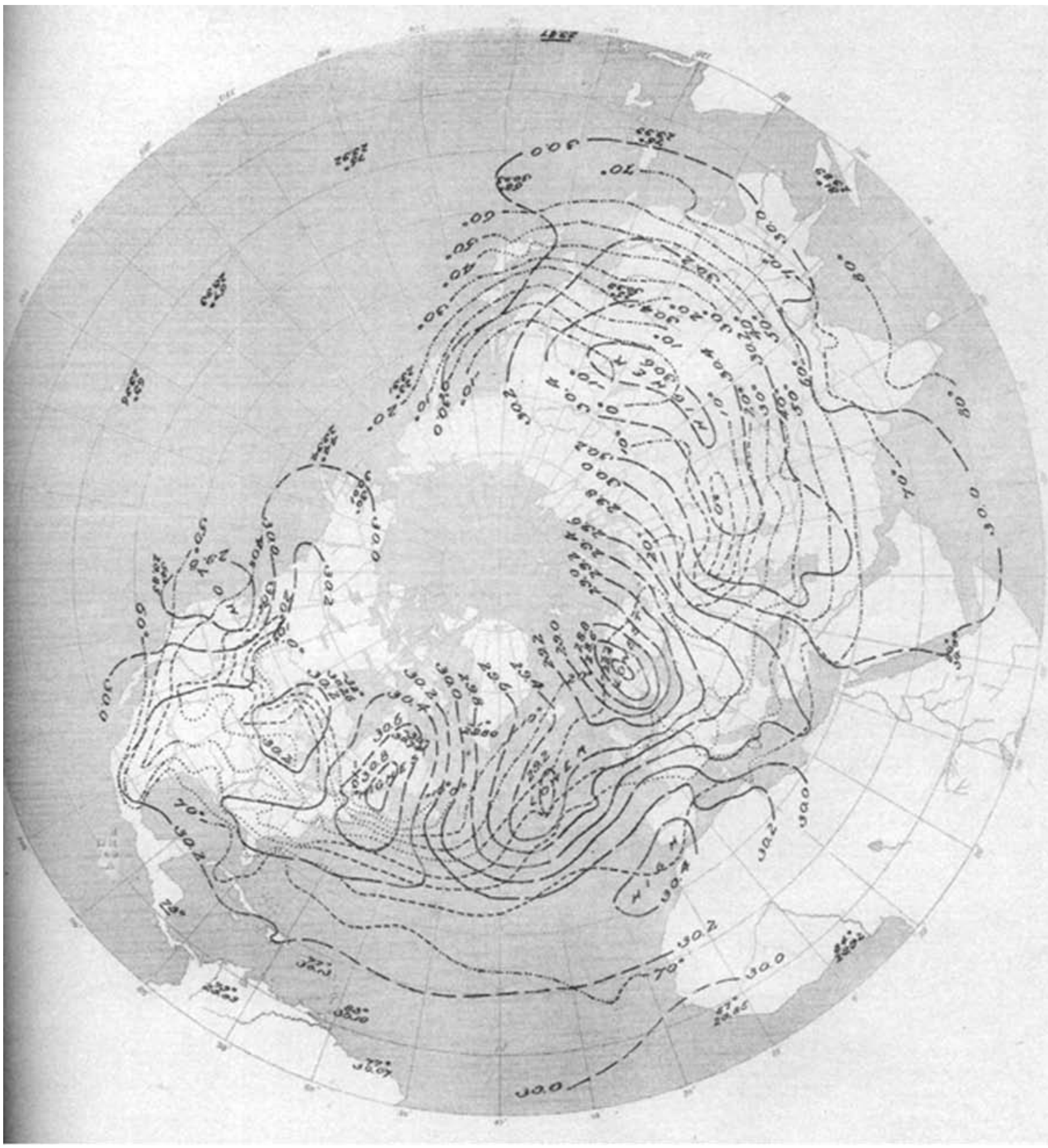

FIGURE 3. International Synoptic Chart: Observations cover the Northern Hemisphere, except for the oceans and polar regions. Dashed lines indicate projected or interpolated data. Source: U.S. Army Signal Office, *Bulletin of International Meteorology*, 28 January 1884.

rology fueled hopes that the scientific enterprise would soon encompass the entire globe, including the polar regions.

THE FIRST INTERNATIONAL POLAR YEAR

The IPY-1 resulted from the ideas of the Austrian naval officer and polar explorer Karl Weyprecht (1838–1881) and the organizational skills of Georg von Neumayer (1826–1909), director of the German Hydrographical Office, along with Heinrich Wild (1833–1902), director of the Central Physical Observatory in St. Petersburg. Weyprecht, who co-directed the unsuccessful 1872 Austro-Hungarian North Pole Expedition, argued that decisive scientific results could only be obtained by research stations distributed over the Arctic regions and charged with the task of obtaining one year's series of reliable meteorological and geophysical observations made with the same methods (Barr, 1983:463–483). Weyprecht wrote in 1875:

> The key to many secrets of Nature . . . is certainly to be sought for near the Poles. But as long as Polar Expeditions are looked upon as merely a sort of international steeple-chase, which is primarily to confer honour upon this flag or the other, and their main objective is to exceed by a few miles the latitude reached by a predecessor, these mysteries will remain unsolved. (Weyprecht, 1875:33)

Weyprecht formulated six principles of Arctic research: (1) Arctic exploration is of greatest importance for a knowledge of the laws of nature; (2) geographical discovery is of serious value only when linked to scientific exploration; (3) detailed Arctic topography is of secondary importance; (4) the geographic pole is of no greater importance for science than other high-latitude locations; (5) favorable locations for stations are near high-intensity phenomena; and (6) isolated series of observations are of limited value (Baker, 1982).

Weyprecht's ideas were institutionalized in 1879 with the establishment of the International Polar Commission at the German Hydrographical Office, chaired by von Neumayer. The IPY-1, launched just one year after Weyprecht's death, brought together a cast of hundreds, eventually resulting in 11 nations placing 12 stations around the North Pole and two near the South Pole (Figure 4) (Anonymous, 1884).

The scientists in IPY-1 practiced a form of coordinated Humboldtean science; that is, they emulated the exhaustive methods of the famed German scientific traveler Alexander von Humboldt (1769–1859), who took precision measurements of natural phenomena. The expeditions set out with an ambitious agenda and tracked data for fields as diverse as meteorology, magnetism, glaciology, oceanography, sea ice studies, geomorphology, phytogeography, exploration, mapping, ethnography, and human geography. They made observations in conditions of hardship, hunger, extreme cold, severe gales, blinding drifting snow, and continuous darkness, with frozen instruments often coated with ice.

Each station established its own identity while retaining its position in the greater network. The station at Point Barrow (Figure 5), established by the U.S. Army Signal Service, also served as a crucial part of the Smithsonian Institution's natural history and ethnographic studies (Burch, this volume; Crowell, this volume; Krupnik, this volume). The Kara Sea observations were conducted on sea ice when the Norwegian steamer *Varna* became beset. The *Varna* and a Danish relief vessel *Dijmphna* gathered data for the entire IPY. The *Varna* eventually sank after being crushed by the moving ice. The signal service station at Fort Conger, Lady Franklin Bay (Figure 5), originally conceived as a base from which a U.S. expedition might reach the North Pole, met with tragedy. The expedition lost 19 of 25 men when resupply efforts failed in 1883–1884. Yet its leader, Lt. Adolphus Greely (1844–1935),

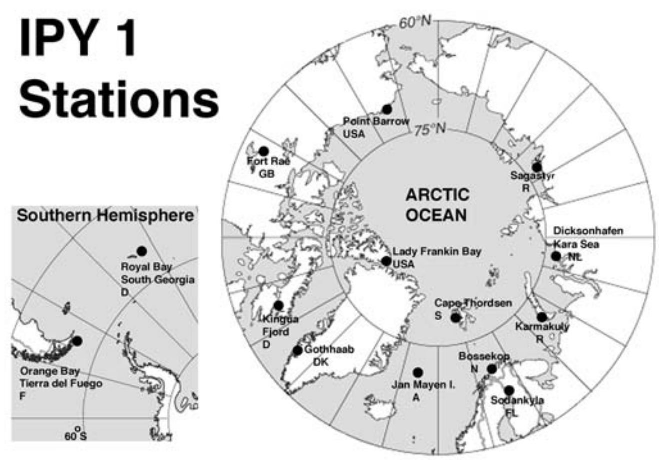

FIGURE 4. The IPY-1 Stations (and their sponsoring countries) during 1881–1884. Arctic (clockwise): Sagastyr (Russia, R), Kara Sea near Dicksonhafen (Netherlands, NL), Karmakuly (Russia), Sodankyla (Finland, FL), Bossekop (Norway, N), Cape Thordsen (Sweden, S), Jan Mayen Island (Austria, A), Godthaab (Denmark, DK), Lady Franklin Bay/Fort Conger (USA), Kingua Fjord (Germany, D), Fort Rae (Great Britain, GB), Point Barrow (USA); Southern Hemisphere: Orange Bay, Tierra del Fuego (France, F) and Royal Bay, South Georgia Island (Germany). Source: original graphic, after Barr, 1985.

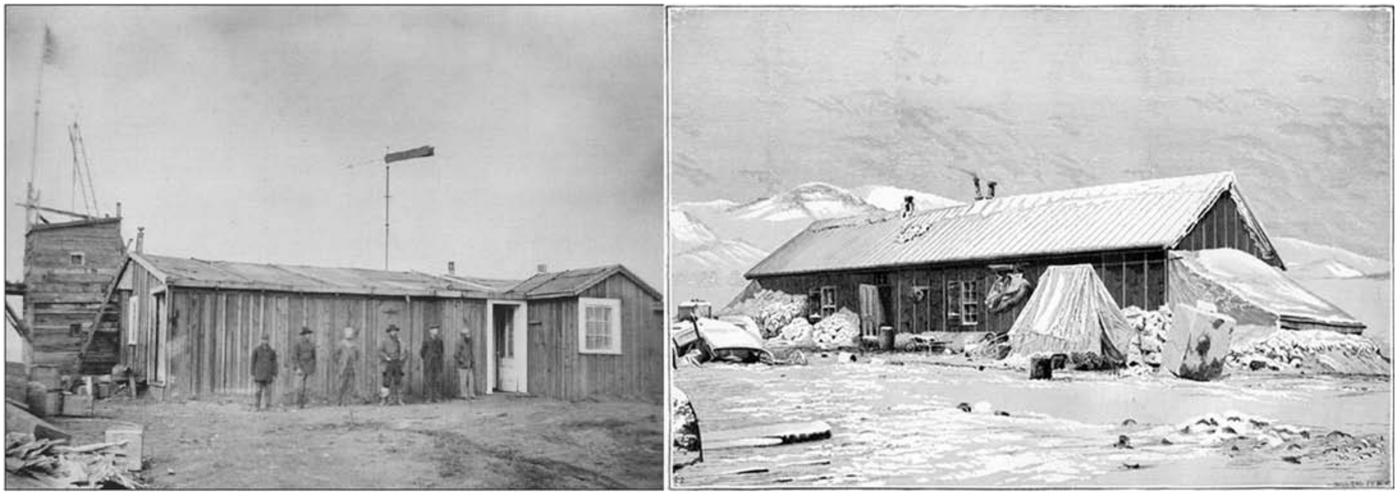

FIGURE 5. U.S. IPY-1 stations at (left) Point Barrow, Alaska, and (right) Fort Conger, Lady Franklin Bay, Canada. Source: Wood and Overland 2007.

who nearly starved to death himself, took steps to protect the instruments and data.

Despite hardships and limitations, each expedition published a final report accompanied by numerous scientific articles and popular accounts. The IPY-1 data were intended to enable the creation of new synoptic charts that could connect polar weather conditions to those in lower latitudes. Yet ultimately, the network of only 12 stations scattered north of 60 degrees latitude was spread too thin (cf. Wood and Overland, 2006). Alfred J. Henry (1858–1931), chief of the meteorological records division of the U.S. Weather Bureau, observed that the "gap between the polar stations and those of the middle latitudes [was] entirely too wide to span by any sort of interpolation and thus the relationship of polar weather to the weather of mid-latitudes failed of discovery." Noted geographer Isaiah Bowman (1878–1950) commented in 1930, "The first polar explorers could go only so far as the state of technology and theory permitted" (Bowman, 1930: 442).

Still there were modest accomplishments, for example, in expanded knowledge of the weather in the Davis Strait between Canada and Greenland and the influence of the Gulf Stream in northern latitudes. IPY-1 data were also used in 1924 to construct circumpolar charts for planning "Aeroarctic," the international airship expedition to the Russian Arctic, conducted in 1931 (Luedecke, 2004). In 2006, a systematic reanalysis and reevaluation of IPY-1 data provided insights on climate processes and points of comparison with subsequent Arctic climate patterns. While the stations showed that sea-level pressures and surface air temperatures were indeed influenced by large-scale hemispheric circulation patterns, in the end, the data lacked sufficient density and the time period was too short to allow for any fundamental discoveries in meteorology or earth magnetism (Wood and Overland, 2006).

TOWARD THE SECOND INTERNATIONAL POLAR YEAR

As the fiftieth anniversary of the IPY approached, the leading edge of 1930s technology, particularly aviation and radio, provided scientists with new capabilities for collecting data and collaborating with colleagues on projects of global scale. New theories and new organizations supported the geosciences, while public expectations for weather and climate services continued to rise. The "disciplinary" period in meteorology began in the second decade of the twentieth century, rather late compared to parallel developments in other sciences, but just in time to inform planning for IPY-2. Meteorologists in World War I were trained to analyze and issue battlefield weather maps; to take hourly measurements conducive to launching and defending against poison gas attacks; and to collect data on upper-air conditions, especially winds, to help calculate the trajectories of long-range artillery shells (Bates and Fuller, 1986:15–19; Fuller, 1990:9–15). By using pilot balloons with theodolite trackers and electrical timers, observers could track the winds and atmospheric conditions aloft.

Meteorologists also provided critical support for aviation and benefited, especially after the war, by data collection from instrumented aircraft, using wing-mounted aerometeorographs that continuously recorded atmospheric data. By 1920, the Bergen school of meteorology in Norway had firmly established the principles of air-mass analysis. Of greatest relevance to polar meteorology are the massive domes of clear cold air called *continental arctic air masses* that sweep across Canada and Siberia, dramatically influencing the weather in lower latitudes. The so-called polar air masses—both continental and maritime—are also significant weather-makers, although they originate below the Arctic Circle. Also, using newly available information on the vertical structure of the atmosphere, Bergen meteorologists identified inclined surfaces of discontinuity separating two distinct air masses, most notably the polar front that spawns many severe winter storms (Figure 6). These conceptual models, combined with objective techniques of weather map analysis and the hope of someday solving the complex equations of atmospheric motion governing storm dynamics, breathed new theoretical life into what had been a largely empirical and applied science (Friedman, 1982).

Radio technology also provided new scientific capabilities. Since magnetic disturbances and auroral displays interfered with radio transmission and telephone wires, radio equipment could be used to detect these phenomena and measure their strength. Radio also provided precise time signals to coordinate simultaneous measurements and communication links that allowed the polar stations to stay in touch with each other and with supporters in lower latitudes (Figure 7, left). Balloon-borne radiosondes used miniature transmitters to send pressure, temperature, and humidity to earth from altitudes as high as 10 kilometers. (Figure 7, right). Special sondes were outfitted to take measurements of cosmic rays, ultraviolet light, ozone, and other data previously gathered with self-registering balloonsondes; this provided a significant advantage since it was almost impossible to recover meteorographs launched in remote polar areas (DuBois et al., 2002).

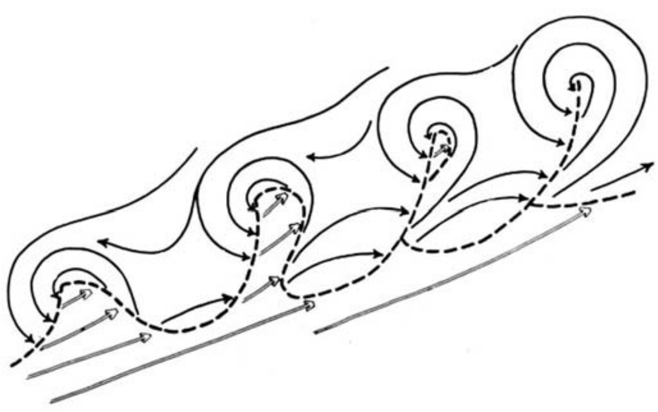

FIGURE 6. Norwegian model of the polar front through a series of cyclones (Bjerknes and Solberg, 1922).

Public expectations about climate and weather broadened as radio broadcasts of weather conditions became commonplace. As weather broadcasts increased, so did the number of people employed in weather reporting. Radio in the mid-1920s created the "weather personality," which became an established role at many stations. One of the first weather personalities was E. B. Rideout at station WEEI that started broadcasting from Boston in 1924 (Leep, 1996).

Early commercial airlines also benefited from the improved weather data. An airways weather service provided valuable information to pilots and dispatchers in support of commercial aviation, which navigated by landmarks and instrument readings.

In 1927, based on significant technological advances, new theories of dynamic meteorology, and rising public expectations, the German meteorologist Johannes Georgi (1888–1972) raised the issue of a possible second International Polar Year. Two years later, the International Conference of Directors of Meteorological Services at Copenhagen approved the following resolution:

> Magnetic, auroral and meteorological observations at a network of stations in the Arctic and Antarctic would materially advance present knowledge and understanding [of these phenomena] not only within polar regions but in general ... this increased knowledge will be of practical application to problems connected with terrestrial magnetism, marine and aerial navigation, wireless telegraphy and weather forecasting. (C. Luedecke, 2006, cited with author's permission)

IPY-2 was held in 1932–1933, the fiftieth anniversary of IPY-1. Although a worldwide economic depression limited participation, some 40 nations sent scientific teams to reoccupy the original stations and open new ones. Research programs were conducted in meteorology, terrestrial magnetism, atmospheric electricity, auroral physics, and aerology using the newest technologies of radio communication. As in previous field programs, certain periods, now called "international days," were designated for intensive, around-the-clock observations. Even in that era, scientists detected signs of Arctic warming.

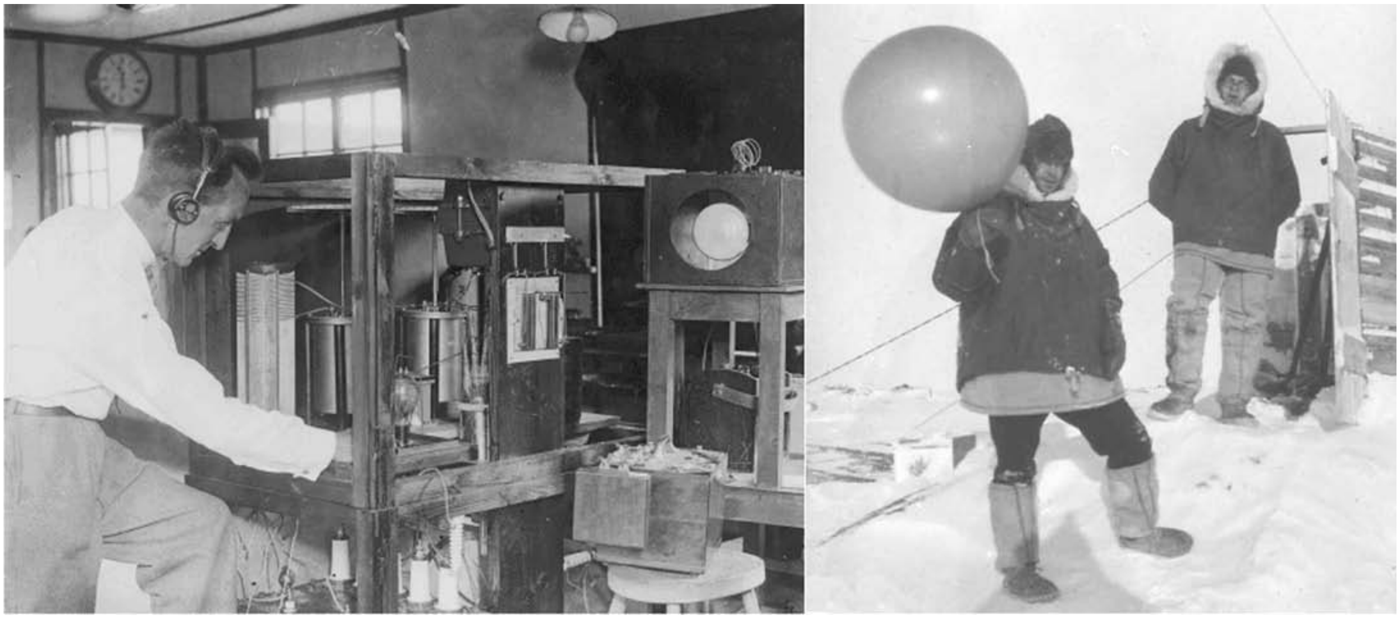

FIGURE 7. (left) W. C. Brown operating radio equipment at Simavik, Norway, during IPY-2 (http://www.wdc.rl.ac.uk/ionosondes/history/IPY.html); (right) John Rea, left, and Stuart McVeigh launching a radiosonde at Chesterfield Inlet, Hudson Bay, Canada, in winter. Source: University of Saskatchewan Archives.

Also, the Second Byrd Antarctic Expedition of 1933–1935—that coincided with, and expanded beyond, IPY-2—brought new focus to Antarctica. It established a year-round meteorological station on the Ross Ice Shelf and captured public attention through live weekly radio broadcasts. Several additional IPY-2 stations in low latitudes added to the worldwide nature of the effort.

The IPY-2 benefited from a sense of interconnectedness stimulated by the International Union of Geodesy and Geophysics (IUGG), a nongovernmental, scientific organization founded in 1919 to promote both disciplinary advances and the ultimate unity of the planetary sciences. The polar front theory also provided focus. As Isaiah Bowman remarked, IPY-2 meteorologists, especially those trained in Norwegian methods, were "inspired by a profound curiosity as to the suspected influence of weather conditions in high latitudes upon (or interaction with) those of the temperate regions as well as the tropics" (Bowman, 1930:442). The IPY-2 accomplishments included simultaneous measurements at multiple stations; higher temporal and spatial resolution, including the vertical; and new instrumentation such as radiosondes, ionosondes, rapid-run magnetometers; and accurate timing of global current patterns for magnetic storms. Reporting included the launch of the *Polar Record* in 1931, an international journal on polar research published in Cambridge, UK, numerous scientific papers, articles, personal accounts, data archives, and a comprehensive IPY-2 bibliography published in 1951, just in time for planning the IGY (Laursen, 1951). However, an expected summary publication for IPY-2 was not produced until 1959 (Laursen, 1959), and a part of the IPY-2 instrumental data was lost at its major international depository in Copenhagen, presumably during World War II.

THE DAWN OF THE INTERNATIONAL GEOPHYSICAL YEAR

World War II swelled the ranks of practicing meteorologists and introduced new technologies originally developed for the military. Rockets provided a new means for accessing upper levels of the atmosphere, broadening the scope of data collection. Not only could instruments be sent high into and even beyond the atmosphere to take measurements, but also cameras could travel to new heights to send back images of the earth. Electronic computers, designed to crack codes, calculate shell trajectories, and estimate bomb yields, were applied to problems of geophysical modeling, while radar enabled scientists to visualize weather patterns remotely. An important aspect of this new technological age was atmospheric nuclear testing, which injected radionuclide "tracers" into the environment. Meteorology, climatology, and aeronomy—"the atmospheric sciences"—benefited intellectually from an influx of new talent from fields such as mathematics, physics, chemistry, and engineering.

The same technology that provided remote-imaging capabilities for scientists was also used in broadcasting to reach the general public. While long-range weather forecasts and even weather control were distinct possibilities, the public was growing apprehensive about the meteorological effects of atmospheric nuclear testing and increasingly visible levels of smoke and smog. Scientists were increasingly interested in the interconnected workings of the global environment, while military planners sought new geophysical capabilities (Fleming, 2000).

American physicist Lloyd Berkner (1905–1967) suggested that IPY-3 take place 25 years after IPY-2. His colleague, Sidney Chapman, who suggested that the event be called the International Geophysical Year, served as president of Comité Spécial de l'Année Géophysique Internationale (CSAGI), which coordinated the effort internationally. In his presidential remarks, Chapman (1959b) emphasized the earth's fluid envelope and the continuing need for widespread simultaneous observations:

> The main aim [of the IGY] is to learn more about the fluid envelope of our planet—the atmosphere and oceans—over all the earth and at all heights and depths. The atmosphere, especially at its upper levels, is much affected by disturbances on the sun; hence this also will be observed more closely and continuously than hitherto. Weather, the ionosphere, the earth's magnetism, the polar lights, cosmic rays, glaciers all over the world, the size and form of the earth, natural and man-made radioactivity in the air and the seas, [and] earthquake waves in remote places will be among the subjects studied. These researches demand widespread simultaneous observation.

The IGY logo emphasized the influence of the sun on the earth, scientific focus on Antarctica, and the hope that geophysical satellites would soon be placed in orbit (Figure 8). The breadth of the program was certainly made possible by new technological developments in transportation, communication, and remote sensing. Teams of observers equipped with the latest scientific instruments were deployed around the globe—some to the ends of the earth in polar regions, on high mountaintops, and at sea—to study earth processes. The effort in Antarctica alone involved hundreds of people in logistically complex

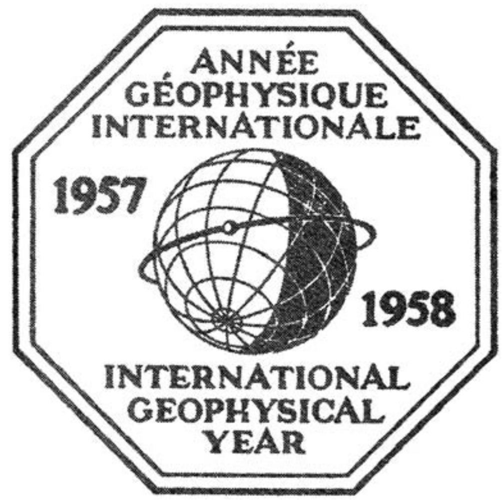

FIGURE 8. The IGY logo adopted in 1955 and used on IGY instruments and publications. Source: U.S. National Academy of Sciences.

and expensive expeditions. While Earth-orbiting satellites were in their infancy, *Explorer 1* and *Explorer 3* brought immediate geophysical results that fundamentally altered our understanding of the planet—the discovery of the Van Allen radiation belts (National Research Council, 2007). The IGY's 18 months of comprehensive global research resulted in other accomplishments as well, including the charting of ocean depths and currents, an in-depth study of Antarctic ice sheets, and, notably, the beginnings of global CO_2 monitoring efforts. The IGY captured scientific center stage at the time and generated many technical and popular publications. Its organizers, recognizing that the international interchange of geophysical data was "the immediate and specific end of its vast scientific program," also made careful provisions for its preservation in the World Data Centers (Odishaw, 1962).

The IGY was actually the twenty-fifth anniversary of IPY-2. Had there been a full fiftieth anniversary, it would have occurred in 1982–1983, well into the era of Earth satellite observations that by then were providing complete coverage of many global atmospheric processes. In the late 1970s, the Global Atmospheric Research Program (GARP) was gearing up for the Global Weather Experiment (GWE)—at the time the largest fully international scientific experiment ever undertaken—linking in situ and satellite data to computer modeling in an attempt to improve operational forecasting, determine the ultimate range of numerical weather prediction, and develop a scientific basis for climate modeling and prediction. In this experiment,

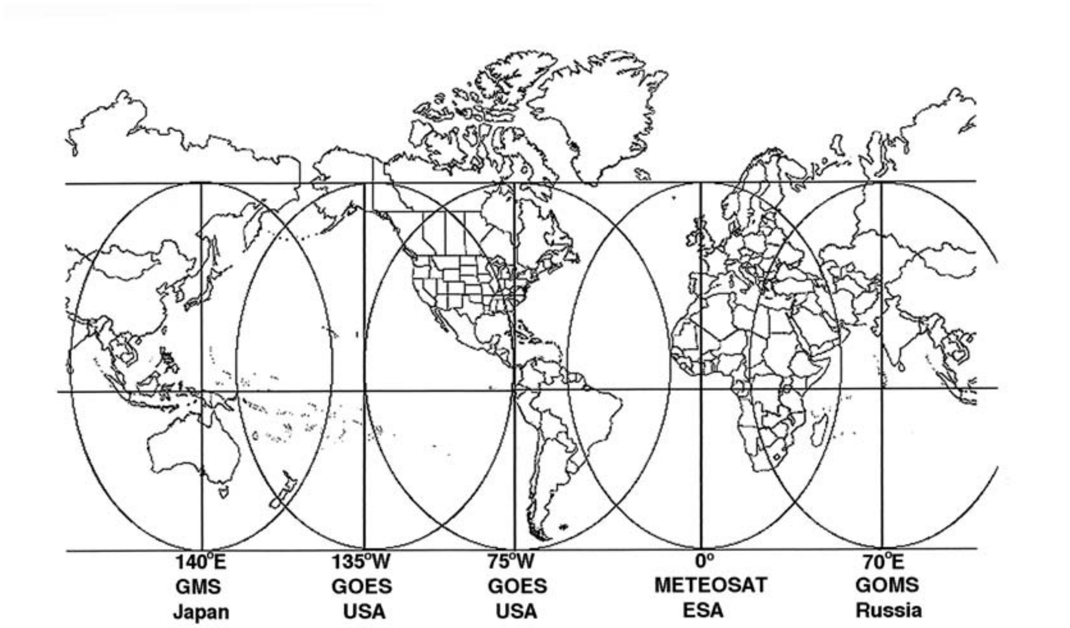

FIGURE 9. During the Global Weather Experiment of 1979, five international geostationary satellites supported global mid-latitude observations of cloud-tracked winds. (GMS = Geostationary Meteorological Satellite; GOES = Goestationary Operational Environmental Satellites; METEOSAT, ESA = a meteorological satellite (European Space Agency); GOMS = Geostationary Operational Meteorological Satellite)

worldwide surface and upper-air observations from satellites, ships, land stations, aircraft, and balloons were combined with global coverage provided by five geostationary satellites operated by the United States, Russia, Japan, and the European Space Agency (ESA) (Figure 9). Polar orbiting satellites covered the rest of the globe. This experiment was followed by the World Climate Research Programme (WCRP), which began in 1980. Today, it can be said that the global observing system provides the equivalent of a GWE of data every day (National Research Council, 2007). The challenge today lies in analyzing, assimilating, and archiving the massive flows of data.

CONCLUSIONS—TOWARD IPY 2007–2008

As we enter the International Polar Year of 2007–2008, today's scientists are heirs to a grand research tradition. With more than 60 nations participating, the current IPY has a broad interdisciplinary focus on environmental change. Six scientific themes provide a framework for IPY 2007–2008 (Allison et al., 2007:13):

1. Status: to determine the present environmental status of the polar regions;
2. Change: to quantify and understand past and present natural environmental and social change in the polar regions and to improve projections of future change;
3. Global linkages: to advance understanding on all scales of the links and interactions between polar regions and the rest of the globe, and of the processes controlling these;
4. New frontiers: to investigate the frontiers of science in the polar regions;
5. Vantage point: to use the unique vantage point of the polar regions to develop and enhance observatories from the interior of the earth to the sun and the cosmos beyond; and
6. The human dimension: to investigate the cultural, historical, and social processes that shape the sustainability of circumpolar human societies and to identify their unique contributions to global cultural diversity and citizenship.

The current IPY is supported by the latest technologies including computer models of ice sheet dynamics, ice cores reaching all the way to bedrock, and advanced surface, airborne, and satellite sensors that measure ice thickness, surface elevation, mass balance, and subsurface conditions. Recently, scientists have discovered rapid changes in ice sheets. The latest collapse of the Larsen B ice shelf in Antarctica in 2002, captured only because of frequent coverage by satellite imagery, illustrated this dynamic on astonishingly short time scales. These new "bits" of knowledge carry weighty implications: The rapid transfer of ice from the continental ice sheets to the sea could result in a significant rise of sea level. Because of the global implications of the changes at the poles for ecosystems and human communities everywhere, IPY 2007–2008 science aims to reach a wide audience, train a new generation of polar researchers, and galvanize public opinion through the associated education, outreach, and communication efforts.

The 125-year history of polar scientific quests, like the much longer history of cooperative observations, involves scientific research questions, technological (including logistic) capabilities, and public perceptions. Since 1882–1883, all IPY ventures have been about science done in extreme conditions, fruitful international cooperation, arctic air masses and polar fronts, melting ice caps, and rising sea levels. That is, the IPY studies are essentially "about us." Each successive IPY has been based upon the technological innovations of its era and the leading scientific theories and hypotheses developed by its time.

In 1881 at the start of IPY-1, the Russian meteorologist Heinrich Wild observed that "the good and favorable idea of Weyprecht . . . has survived the calamities of war, the discords of nations, the obstacles of jealous people, and the death of the author" (Baker, 1982:284). Today, in spite of intervening world wars and numerous discords and obstacles, this statement still rings true. The International Polar Year 2007–2008 is solidly grounded in scientific cooperative efforts for the increase and diffusion of knowledge. Its goal, like those of its predecessors, is to advance research and communicate its wonders. It also aims to preserve the habitability of the planet. Joseph Henry would be pleased.

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