THE NATIONAL WEATHER SERVICE SUPPORT FOR THE SAILING VENUE DURING THE 1996 CENTENNIAL OLYMPIC GAMES

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Introduction

This paper will describe the specific responsibilities and duties of a team of meteorologists assembled to provide weather support for the Sailing Venue of the Centennial Olympic Games offshore Savannah, Georgia. After a summary of the venue schedule and related weather requirements, the discussion will concentrate on the types of advanced technology available to the forecasters. The paper will recount significant weather conditions which occurred during the event and relate how they impacted the competition, from the aspect of both race managers and athletes.

Olympic Sailing Event

Four hundred fifty-eight athletes from 79 countries participated in the 1996 Olympic Sailing Venue, making it the largest ever. Sailors used eight one-design (that is, identical) boats to compete for medals in ten Olympic events. Classes ranged from the 34-pound, 12-ft long "Mistral" (single athlete) to the 2280-pound, 27-ft long "Soling" (three athletes) sailboats.

Unofficial practice sailing began during the second week of July, with official competition lasting from July 21 through August 2. Eleven races were scheduled for each class, allowing for the lowest two finishes for each entry to be dropped. If unfavorable weather forced less than 11 races, medals could still be awarded; however, the number of dropped races would be reduced. Based upon climatology, races were scheduled to begin at 1300 LST each day, but could be delayed or postponed for individual classes if sustained winds below 8 kt or above 25 kt occurred. The first medal qualifiers were determined on July 28, with the last medals awarded on the final day of racing. Since all boats were identical and the competition took place over many days under varying conditions, the Olympic event proved to be a true test of sailing skill. A list of the boat classes and final medal standings is shown in Appendix A.

Forecast Support Operations

From June 26 through August 3, seven National Oceanic and Atmospheric Administration (NOAA) meteorologists provided weather support for the Sailing Venue. The start of operations well before the actual competitions enabled the forecast team to tune their forecast and warning program in response to the needs of the venue and the competition. Assisting the NOAA personnel were meteorologists from the Canadian Atmospheric Environment Service (AES) and the Australian Bureau Of Meteorology (BOM). In addition to working forecast shifts, the team member from Canada attended daily weather briefings to translate questions to/from French, an official Olympic language, while the Australian representative began to develop a weather support strategy for the sailing portion of the 2000 Olympic Games to be held in Sydney, Australia.

The Olympic Marine Weather Support Office (OMWSO) was located in a 12- by 40-ft trailer positioned within the "Olympic Marina" on Wilmington Island, 11 mi east of Savannah (Fig. 1). The degree of advanced planning materialized as the OMWSO was transferred from an empty trailer to a fully functioning office in about a week and operated with minimal downtime throughout the Olympics. The office location within the Olympic Marina was chosen to enable face-to-face interactions and briefings between venue officials, team managers, and the forecast staff.

The OMWSO team (shown on next page) consisted of a Meteorologist-In-Charge (MIC), a Systems Administrator (SA) and assistant SA, and seven forecasters. In addition to being responsible for overall office operations, the MIC provided several scheduled daily weather briefings to Olympic management personnel and directly to the sailing teams. The SAs maintained all office equipment and ensured proper data flow from the Olympic Weather Support Office (OWSO) at NWSFO Atlanta. All forecasters rotated through several specific duty positions. Each day, two forecasters worked an early shift (0500-1300 LST), and one forecaster worked an afternoon shift (1100-1900 LST). Available personnel assisted as needed during the day, especially during the critical afternoon competition hours. Additionally, one forecaster staffed a dedicated weather boat to monitor conditions within the "Fields-Of-Play" (FOP), and another forecaster was paired with the venue manager at the "Day Marina" near Williamson Island (Fig. 1) to be available to facilitate the transfer of real-time weather information into the decision- making process. The forecasters aboard the weather boat and at the Day Marina (pictured on next page) typically worked a 0930-1730 LST shift and maintained contact with the OMWSO via cellular telephone.

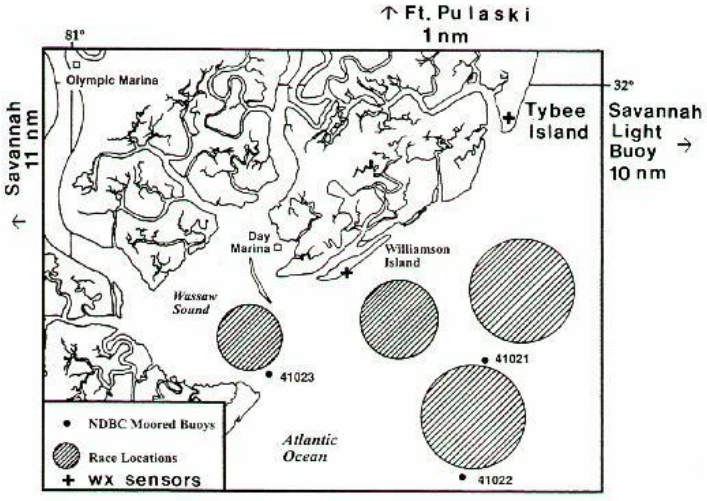

Figure 1. Site of Olympic Regatta

TEAM MEMBER	POSITION	HOME OFFICE
Wally Barnes	Forecaster	TPC/TSAF Miami, FL
Bruce Marshak	Assistant SA	SRH Ft. Worth, TX
Gerard Neault	Forecaster	AES Vancouver, BC
Tom Niziol	Forecaster	NWSFO Buffalo, NY
Mark Powell	Forecaster	AOML/HRD Miami, FL
Steve Rinard	MIC	SRH Ft. Worth, TX
Elly Spark	Forecaster	BOM Sydney, NSW
Scott Spratt	Forecaster	NWSO Melbourne, FL
John Townsend	Forecaster	NWSO Charleston, SC
Mario Valverde	Sys Admin (SA)	SRH Ft. Worth, TX

Appendix B: The members, duties, and home offices of Olympic Marine Weather Support Office (OMWSO) team.

The forecast team determined that enough skill existed to provide forecasts for four specific areas within the venue. The areas were defined as: the Olympic Marina, the Day Marina, Wassaw Sound, and the offshore Field of Play (FOP) Fig. 1. The OMWSO had three primary responsibilities:

- To ensure the safety of the Olympic Sailing Venue (Olympic officials, sailors, and spectators) through the issuance of warnings and forecasts of weather-related problems such as lightning, high winds, seas, and heat indices.

- To provide Olympic managers with a detailed 12-hour forecast of wind direction/speed, seas, and lightning potential each morning so that a decision could be made whether or not to proceed with scheduled races, and to facilitate a discussion of the proper race course setup.

- To provide sailors with a synopsis and forecast of hour-by-hour wind conditions at Wassaw Sound and the offshore race areas, and several meteorological data fields (surface and 500 mb charts, wind profiler time/height cross section).

National Weather Service - Olympic Marine Weather Support Office

1996 Olympic Yachting Venue - Savannah, Georgia

9am Weather Briefing

Friday, July 19, 1996

Synopsis: A high pressure ridge across Florida will result in a moderate W/SW gradient flow across the venue today. The sea breeze will initially develop across the offshore fields of play during the early afternoon, then reach Wassaw Sound by mid afternoon. Warm temperatures aloft and a decrease of the depth of moisture will preclude convective development. Heat Index values will reach dangerous levels of 105 F (40.5 C) or greater during the afternoon at the Olympic and Day Marinas.

HEAT INDEX WARNING 1300-1800 hrs

Forecast for Wassaw Sound/Day Marina/Offshore fields of play: Sunny skies will prevail. Maximum temperatures will reach about 95 F (35 C) at the Olympic Marina, 92 F (33.5 C) at the Day Marina, and the mid 802 F (29 C) offshore. Relative humidity of 85% at 0830 hrs will reach about 55% during maximum heating. Heat index values will rise to dangerous levels of 105-108 F (40.5-42.0 C) at the Olympic Marina between 1400 and 1700 hrs and to 103-105 F (39.5-40.5 C) at the Day Marina between 1300 and 1600 hrs.

Winds: SW gradient flow will give way to sea breeze formation during the early-mid afternoon, initially across the offshore field of play around 1300 hrs, then in Wassaw Sound between 1400 and 1500 hrs. The sea breeze is expected to increase to near 12 kts (6 m/s) and shift to 160-170 degrees across the offshore fields of play and to near 180 degrees within the Sound by late afternoon. A period of lighter winds (near 6 kts, 3 m/s) will occur during a one hour period prior to sea breeze formation.

*******There is a slight chance the gradient flow will remain strong enough to limit sea breeze development. If this occurs, winds will not shift as much as forecast, and will reach only 190-200 degrees, especially within the Sound.

Waves: 1 ft (0.3 m) in Wassaw Sound and 2.5 ft (0.8 m) within the offshore field of play.

Thunderstorms: Not expected.

Heat Index: 105-108 F (40.5-42.0 C) at the Olympic Marina and 103-105 F (39.5-40.5 C) at the Day Marina.

Outlook for Saturday/Saturday night: Little change is expected in the pattern Saturday as winds remain west and a sea breeze develops during the early-mid afternoon offshore and within the Sound. Heat index values will again reach 105 F (40.5 C). An isolated shower or thunderstorm is possible Saturday evening within the City of Savannah.

Tropical Storm Outlook: Negative.

GENERAL FORECAST

Heat Index Warning 1300-1800 hrs as apparent temperatures reach the 105-108 F (40.5-42.0 C) at the Olympic Marina to 103-105 F (39.5-405 C) at the Day Marina between 1300 and 1800 hrs. The sea breeze will develop later than recent days and there is a slight chance that the gradient flow will even limit the sea breeze influence even further than forecast. Convection is not expected.

Day Marina/Wassaw Sound

Time	WD (deg)	WS (knots)	Gust (knots)	Wave Ht (feet)
1000	240	12	14	1
1100	220	10	12	1
1200	210	8	10	1
1300	200	7	9	1
1400	185	10	12	1
1500	180	12	14	1
1600	180	13	15	1
1700	190	12	14	1
1800	195	12	14	1

Offshore Venues

Time	WD (deg)	WS (knots)	Gust (knots)	Wave Ht (feet)
1000	240	12	14	2.5
1100	210	12	14	2.5
1200	200	8	10	2.5
1300	180	10	12	2.5
1400	170	12	14	2.5
1500	165	13	15	2.5
1600	165	13	15	3
1700	175	13	15	3
1800	175	12	14	3

Conditions at 0820 hrs

Winds:	Wassaw Sound:	235	deg;	15	kts; Gust	19	kts
	Offshore:	230	deg;	17	kts; Gust	20	kts
Waves:	Wassaw Sound:	1	ft;	4	sec		
	Offshore:	2.7	ft;	4	sec		
Air temp:	Wassaw Sound:	25.8	deg C;	78	deg F		
	Offshore:	26.5	deg C;	80	deg F		
Sea temp:	Wassaw Sound:	28.7	deg C;	84	deg F		
	Offshore:	28.5	deg C	83	deg F		

By providing this information, all teams were ensured an equal level of weather guidance prior to racing. Each evening, the OMWSO provided each team with a text and graphical debriefing package listing conditions observed at the weather buoys located within the FOPs.

Modern Technology

The multitude of data sets available at the OMWSO was truly impressive. The density of the observational network and frequency of reports, combined with forecaster and model skill, allowed accurate, highly detailed short-term mesoscale forecasts, watches, and warnings.

OMWSO operational hardware consisted mainly of three HP-715 workstations. A high-volume data link between Savannah and Peachtree City (Atlanta) provided a majority of the data fields. Dedicated PCs were used to display RAMSDIS (RAMM Advanced Meteorological Satellite Demonstration and Interpretation System) satellite products and Olympic buoy observations. The individual data platforms and software packages used are described briefly below. Additional details are provided by McLaughlin and Rothfusz (1996).

a. Observations

Real-time observations were provided from three National Data Buoy Center (NDBC) buoys (Fig. 1) deployed specifically for the Olympics. The three "Olympic buoys" provided wind, pressure, temperature, sea state, and ocean current data every ten minutes directly to the OMWSO via a unique line-of-sight antenna and an Olympic Buoy Display System (OBDS). Additionally, the Savannah Light C-MAN just north of the FOP and automated weather sensors located on Williamson and Tybee Islands were some of the approximately 60 such units across Georgia and the southeast U.S. within the Olympic mesonet. Time/height cross sections were obtained from an Environmental Research Lab (ERL) 915 MHz wind profiler located at Ft. Pulaski (Fig. 1). These observations were frequently collected and displayed to the forecasters in addition to being input into local forecast models.

b. Model data

The Forecast System Laboratory (FSL), Boulder, Colorado, Local Analysis and Prediction System (LAPS) was used to display variables on the mesoscale every 30 minutes, and to initialize a high-resolution mesoscale model, the Regional Atmospheric Modeling System (RAMS). RAMS provided, on average, 12-hour forecasts beginning at 0200 and 0500 LST of 8 km and 2 km resolution, respectively. This guidance proved especially useful in timing of seabreeze wind direction/speed changes and, to a lesser extent, with convective forecasts the two major forecasting problems of the OMWSO.

Output from two meso-Eta models (29 and 10 km resolution) were run at the NWS National Center for Environmental Prediction (NCEP) were also examined and compared with RAMS to determine seabreeze wind shifts and the likelihood of convection and its intensity. The NCEP Nested Grid Model (NGM; 90 km) and 48-km Eta model were used primarily to diagnose the synoptic-scale pattern, as was the Aviation (AVN) model, which was used exclusively for the extended forecast package (through Day 5).

Several local studies/models were also highly useful for determining seabreeze wind shifts. A "pattern recognition" technique, using several years of local buoy and sounding data, was developed by Dr. Mark Powell (OMWSO). The data were stratified into five commonly observed synoptic regimes, allowing forecasters to quickly examine hourly wind shifts which occurred during previous day's possessing similar patterns. John Townsend (OMWSO) developed a seabreeze model specifically for the Savannah area, which provided hour-by-hour grid point forecasts of wind speed and direction brought about by adding a heating-induced onshore component to the gradient wind flow. Additional information related to the expected onset time of the seabreeze was available from a modeling study conducted by Tunney, 1996.

Output from an experimental NCEP model based on the meso-Eta provided wind and sea forecasts, which on occasion, helped improve subjectively forecast wave and swell heights. In addition, a model from the Skidaway Institute of Oceanography provided local ocean current and tidal information.

All model output were sent to the OMWSO via Peachtree City and were displayed on the National Centers Advanced Weather Interactive Processing System (N-AWIPS/NTRANS), with the exception of the experimental wave forecasts, the ocean current/tidal information, and the profiler time/height cross-sections, which were obtained via the Internet and displayed on Netscape.

c. Radar data

A dedicated 128-kb data line provided continuous radar data from the NWSO Charleston, South Carolina, WSR-88D, located 64 km (40 mi) north of Savannah. The radar products were run through the Warning Decision Support System (WDSS) and displayed on the Radar and Algorithms Display System (RADS). Typically, one-hour reflectivity and lightning loops were run, zoomed to a 48-km (30-mi) radius of the Sailing Venue. The lightning data, incorporated from the National Lightning Detection Network, displayed 6-minute plots (equivalent to the WSR- 88D refresh rate) of cloud-to-ground strikes, and was updated every minute. An additional lightning sensor, able to detect in-cloud lightning, was provided by a private company to further expand lightning detection capabilities. Suspect cells were individually interrogated for severe signatures through analyses of base and derived products. The WDSS cell table and trend sets were essential for determining convective development and intensification, and for issuing watches/warnings and tracking lightning-producing cells.

d. Satellite data

Satellite data were available from two sources, RAMSDIS and N-AWIPS/NSAT. Both sources allowed quick, user-friendly access to frequent, high resolution imagery. Data were available to 1-km resolution and at 15-minute intervals. By combining the high spatial and temporal resolution of the mesonet, radar, and satellite data, small scale boundaries were continuously monitored for signs of convective initiation.

e. Product issuance

Forecast and warning products were written for venue managers, athletes, and the media on the HP workstations using WordPerfect 6.0 for UNIX. All products were immediately queued for facsimile transmission to local appropriate users. Additionally, all forecast products were placed on several Internet web pages for public access, and they were broadcast on NOAA Weather Radio and across the entire venue on the Olympic venue public address system.

Three forecast packages were also produced each day using Interactive Computer Worded Forecast (ICWF) software. These products were transmitted to the AFOS circuit and "Info 96," the official Olympic data network. Display units for Info 96 consisted of interactive monitors which were placed throughout the Olympic venues and villages around Atlanta and Savannah. These monitors were accessible to athletes and their families, spectators, and the media.

Summary of Olympic Weather Operations

a. Pre-venue operations

All forecasters participated in an initial five-day familiarization exercise in 1995. For the Centennial games, the staff arrived at the OMWSO three weeks prior to the Olympic opening ceremonies to reacclimate themselves with the numerous pieces of technology and to learn how to operate several new systems which were not available in 1995. Preparation of practice forecasts began on June 29, and official operations with full forecast product distribution started on July 5.

Full operations began with a bang, literally, as thunderstorms erupted at 0400 LST from Savannah to the coast, along a northward moving warm front. Ironically a lightning flash climatology constructed for the Olympics (Livingston, et al. 1996) indicated that early morning thunderstorms in the Savannah vicinity were extremely rare during the July 1986-1993 period. Thunderstorms remained in the vicinity of the venue throughout the morning, then increased further in coverage during the early afternoon as an inland-moving marine boundary collided with a seaward-moving line of storms over Savannah. The event climaxed with a localized flash flood within the city of Savannah, where over 7 inches of rain fell in less than two hours.

The next several days were generally uneventful as a typical seabreeze pattern ensued and most thunderstorms remained inland, just west of the venue. At the same time, however, Hurricane Bertha attracted interest as she traveled west-northwest through the Caribbean. OMWSO forecasters began to issue special hurricane updates on July 8; and as Bertha reached just east of the Bahamas late on July 9, the Tropical Prediction Center (TPC) issued a Hurricane Watch for the Georgia coast, including

Savannah. Full attention turned to Bertha and the OMWSO forecasters by midday on the 10th, as the Hurricane Watch for Savannah was upgraded to a Hurricane Warning.

Given TPC forecasts of Bertha's closest point of approach to the venue of 100-180 mi (160-288 km), OMWSO forecasts indicated the possibility of wind gusts to 50 kt at the Day and Olympic Marinas (higher over the outer race area waters and much lower just inland), along with scattered showers for the following afternoon and evening. Based on this guidance, Olympic management officials decided to close the venue by 1800 LST July 10 and keep it closed on the 11th. Numerous tents were dismantled, and all loose objects across the venue were secured. Overnight, Bertha slowed slightly and became less organized, with the center passing nearly 100 mi (160 km) east of Savannah during the morning of the 12th. Peak wind gusts at the FOP buoys reached nearly 40 kt from late morning through late afternoon of the 11th, then diminished below 30 kt by the following morning. A weak outer rainband rotated through the venue producing a few showers and squalls, but only a brief period of light rain occurred within the city of Savannah.

On July 13, the weather boat became available, along with an extremely knowledgeable skipper, John McIntosh, Sr. From July 13 through August 2, marine shifts were filled daily by two meteorologists. Typically, one person would spend four hours either aboard the weather boat or at the Day Marina, then switch locations with the other forecaster. The Day Marina consisted of a huge E-shaped floating structure designed specifically for the Sailing Venue, constructed of 28 river barges. The marina was built within Wassaw Sound, just offshore of Williamson Island (Fig. 1), and contained a wind resistant tent for each team, along with electrical power and running water. Most boats were housed and launched from the Day Marina during the competition.

Isolated thunderstorms affected or threatened the venue during most days between July 14 and 21. On several days, convection fired just inland of the western portion of the venue and moved farther away with time. Although lightning warnings were issued for the Olympic Marina during these occasions, warnings were not necessary for the FOPs, and practice races continued uninter- rupted. On July 21, however, light winds followed by a period of persistent thunderstorms affected the courses, causing all but one race to be abandoned. As accurate site-specific lightning and wind warnings were issued during the practice racing period, Olympic officials became increasingly confident of the OMWSO's capability. For example, when warnings were issued for the Olympic Marina, Day Marina, and/or Wassaw Sound, officials allowed offshore races to continue safely, even though the weather was visually threatening.

b. Olympic Venue operations

The first day of official races (July 22) promised to be convectively active as storms developed early, well inland of the venue. With a southwest steering flow, scattered thunderstorms were forecast to move offshore and reach the venue during the afternoon. To further complicate race scheduling, the forecast of a lull in wind speed during the early afternoon verified and delayed all race starts by at least one hour. By mid-afternoon, lightning warnings were issued for the offshore FOP as scattered storms were expected to reach the area in an hour. Olympic committee officials shortened several race courses in hopes of finishing prior to the storms. Only three of the eight scheduled races were completed, as several storms merged and intensified over the FOP.

Since it was often impossible for all the boats to return to the Day Marina before the onset of rapidly developing thunderstorms, storm plans called for all sailboats to be "corralled" together so as not to become separated from each other, then wait for the storm to pass. The weather boat joined the corralling process and remained in place as the core of several cells passed overhead during the next two hours. The boat crew experienced heavy rain which reduced visibility to well below mi, wind gusts to near 30 kt, 3-ft confused seas, and several nearby cloud-to-water lightning strikes. Once the storms finally moved east, winds weakened to near calm; and it became necessary for the weather boat to tow 3 yachts several miles back to the Day Marina.

The weather during the second day of racing was in sharp contrast to the first day. The seabreeze was forecast to develop early and become strong, pushing the boundary inland and limiting thunderstorm chances until evening. The forecast verified well as winds shifted to an onshore component at 12 kt by race time, and increased to 18 kt, with gusts above 20 kt, by late in the day. The near perfect sailing conditions allowed for completion of all scheduled races.

Unfortunately, the dry weather pattern was short-lived as thunderstorms were again expected to impact the FOPs during the next two days. Storms initiated inland similar to the first day of racing, with the southwest steering flow moving the activity toward the venue. By early afternoon, lightning and wind watches were issued, and they were upgraded to warnings for the offshore FOP about an hour later. Subsequently, strong cells passed over the race courses and produced frequent cloud to water lightning and strong wind gusts. Gusts to 30 kt occurred at the Olympic and Day Marinas and at the offshore buoys on July 24, with peak gusts near 40 kt on July 25. Nearly half of the races were canceled each day.

Due to the mid-afternoon thunderstorms of recent days, race officials decided to change the start time from 1300 LST to 1200 LST beginning July 26. This change proved untimely, as an extensive deck of mid-level clouds persisted during much of the next three days and restricted surface heating, which in turn inhibited seabreeze formation. Initial races were postponed on all three days as wind speeds remained below the critical 8-kt threshold until approximately 1500 LST, generally as forecast. Late afternoon races were completed as winds finally strengthened to 8-12 kt.

Many of the races which were canceled during the previous week were made up on July 30 and 31. Sunshine returned during these days, and the seabreeze developed fully by early afternoon, leading to excellent racing conditions.

The excellent conditions lasted into the early afternoon of August 1, before thunderstorms again pushed offshore across the venue. Races were interrupted due to significant wind shifts from outflow boundaries. After the storms passed, winds weakened to near calm across the offshore FOP, and Olympic officials decided to wait to see if the races could be restarted. However, after learning from the OMWSO that it was unlikely the winds would return to 8 kt during the next hour, the remaining races were canceled.

The final day of racing continued to prove challenging to Olympic officials as light offshore winds lasted into the early afternoon, and the forecast indicated late afternoon storms were probable. The final race was completed just as the OMWSO forecasters issued their last lightning and wind warning.

Conclusions

The Olympic forecast experience provided an exciting insight into capabilities for future NWS forecast operations. Once initial data management, integration, and communication complexities were resolved, the modernized (Olympic) weather office provided forecasters with the ability to diagnose and account

for many mesoscale influences not currently achievable. Integration of the numerous data sets, combined with high resolution numerical models and subjective pattern recognition and climatology techniques, allowed forecasters to provide accurate, site-specific forecasts and warnings. A preliminary study by one of the OMWSO members indicates that forecast hourly wind velocity errors were significantly less than both climatology and persistence (Dr. Mark Powell, personal communication).

Informal feedback from many users of the OMWSO products indicated that the effort was a success. In fact, the meteorologist on the French team stated that the OMWSO team "won the gold medal of the forecasters" as a result of its overall service and accurate warnings and forecasts.

The atypical weather which occurred throughout much of the venue proved challenging to forecasters, athletes, and Olympic management officials alike. The "unusual weather" was a frequently discussed topic around the venue as Hurricane Bertha, frequent thunderstorms, and persistent light winds impacted all operations and participants. Under these conditions, it did not take long for venue personnel to learn to value the benefit of having a weather office located on- site.

Acknowledgments

The efforts of hundreds of individuals from numerous government and non-government agencies enabled the Olympic forecast effort to succeed. Space unfortunately restricts listing of all individuals, offices, or agencies who were essential to the operation. The National Weather Service Southern Region Headquarters in Fort Worth, Texas, was responsible for planning and organizing the overall endeavor.

References

McLaughlin, M. R., and L. P. Rothfusz, 1996: Providing weather support for the 1996 Summer Olympic Games. *NOAA Technical Memorandum NWS SR-179*. NWS Southern Region Headquarters, Fort Worth, TX. 40 pp.

Livingston, E. S., J. W. Nielsen-Gammon, and R. E. Orville, 1996: A climatology, synoptic assessment, and thermodynamic evaluation for cloud-to-ground lightning in Georgia: A study for the 1996 Summer Olympics. *Bull. Amer. Meteor. Soc.*, 77, 1483-1495.

Tunney, D. A., 1996: Numerical studies of the Georgia coast sea breeze. Master's Thesis, Dept. of Meteorology, Florida State University, Tallahassee, FL, 166 pp.

Appendix A

Class	Gold	Silver	Bronze	
470 (men)	Ukraine	Great Britain	Poland	8. USA
470 (women)	Spain	Japan	Ukraine	4. USA
Europe	Denmark	Netherlands	*USA*	
Finn	Poland	Belarus	Netherlands	23. USA
Laser	Brazil	Great Britain	Norway	21. USA
Mistral (men)	Greece	Argentina	Israel	6. USA
Mistral (women)	Hong Kong	New Zealand	Italy	11. USA
Soling	Germany	Russia	*USA*	
Star	Brazil	Sweden	Australia	8. USA
Tornado	Spain	Australia	Brazil	8. USA

Appendix A: List of counties which won medals and results of team USA.