cooled coastal power plant by using wind direction-dependent wind speed differences of onshore/offshore wind measurements by J. H. Snooks and T. F. O'Hara (Yankee Atomic Electric Co., Westborough, Mass.). The last paper, by S. SethuRamen, C. Nagle, and G. S. Raynor, found a wind directional dependence of the frequency of internal gravity waves generated on the upper portion of a boundary layer cooled by the ocean. The occurrence of the waves was also dependent on distance from the coast and time of day.

10. Session 9: MABLES WC and California inversion

Chairman: D. F. Leipper, Naval Postgraduate School, Monterey, Calif.

MABLES WC stands for Marine Atmospheric Boundary Layer Experiments on the West Coast. The experiment concerned an area extending 220 km west of San Francisco and continued from 31 July to 17 August 1978. It was conceived and initiated by the late Albert Miller. Papers were presented by his associates and former students at San Jose State University with the support of J. Jarrel, J. Ernst, G. Schacher, and K. Davidson from cooperating institutions.

P. Lester (San Jose State University, San Jose, Calif.) outlined the objectives of the experiment and described the facilities and operations involved. The main purpose was to obtain a better understanding of the marine inversion and the boundary layer. The observations were obtained from two ships, three aircraft, the Mt. Sutro tower in San Francisco, an island station, four pibal stations, and six sodar stations, in addition to standard networks. The inversion base was generally below 400 m except from 12 to 14 August.

J. Jarrell (Science Applications, Inc., Monterey, Calif.), J. Ernst (National Environmental Satellite Service/NOAA, Washington, D.C.), and G. Schacher and K. Davidson (Naval Postgraduate School, Monterey, Calif.) reviewed the data collected by *R/V Acania* and the manner in which they were being used as ground truth to calibrate the active spectrometer and the passive radiometer imagery from SEASAT. There were six orbits of high quality data that could be used in such tests. J. Ernest is investigating wind-wave interaction and stability influences.

G. W. Roope (San Jose State University, San Jose, Calif.) analyzed 10 flights of the NCAR research aircraft over the MABLES area to analyze the detailed structure of the marine boundary layer. Cross sections of temperature and wind speed were presented. With the inversion base height at 250–305 m, vertical temperature gradients through it were as large as 4.8°C/100 m. Maximum wind speeds were found within the inversion.

C. W. King (San Jose State University, San Jose, Calif.) described efforts to obtain the temporal and spatial distribution of the height of the inversion base during MABLES by utilizing continuous sodar observations from the two ships and from the Farallon Islands. Convective plumes were observed, with 87% of them occurring when the sea was warmer than the air. In a 32 h data period, ground-based wind shear layers were observed to be approximately 150 m deep. These occurred when the sea was cooler than the air. Waves imbedded within the elevated stable layers were observed to start in coincidence with the initial breaks in the overcast. The height of the inversion had its diurnal minimum at night and its maximum in the late afternoon.

The Mt. Sutro tower is located on a 254 m hill in the center of San Francisco. It is 224.6 m high, two-thirds of the tower being above the average height of the summer inversion base at this location. B. D. Van Patten (San Jose State University, San Jose, Calif.) used data from the tower collected in 1976 to obtain spectra of wind and temperature in summer at 300 m and 390 m mean sea level, one level above and one level below the mean height of the inversion base. Primary peaks in the spectra were found at periods of 10 days, 4 days, and 24 h. The wind variance was primarily in the E-W component. Waves with amplitudes less than 20 m were found at the interface.

In a final paper, H. Y. Holman (San Jose State University, San Jose, Calif.) presented a formulation of the turbulent energy budget in the elevated inversion and included many of the features indicated by the MABLES observations.

11. Session 10: Stratus fog and marine boundary layer structure

Chairman: W. S. Lewellen, Aeronautical Research Associates of Princeton, Princeton, N.J.

Many factors influencing the formation and dissipation of coastal stratus/fog and the marine layer were examined in this session. Acoustical remote sensing of the height of the temperature inversion during fogs was reported by B. A. Kunkel (Air Force Geophysics Lab., Hanscom AFB, Mass.). He found no relationship between surface meteorological parameters and the inversion depth in relation to fog forecasting. Using July 1977 and 1978 GOES data, T. F. Lee, J. Rosenthal, and R. A. Helvey (Pacific Missile Test Center, Point Mugu, Calif.) found the horizontal distribution of stratus clouds over the Southern California Bight to reliably depend on latitude, coastal land topography, and sea-land breeze. Their results demonstrated the value of satellite data in coastal climatological studies. Good estimates of over water vertical diffusion were obtained from measurements during five

[Reprinted from BULLETIN OF THE AMERICAN METEOROLOGICAL SOCIETY, Vol. 61, No. 11, November 1980]
Printed in U. S. A.

Second Conference on Coastal Meteorology AMS, 30 January–1 February 1980, Los Angeles, Calif.

V. Ray Noonkester [1], Christopher N. K. Mooers [2], and Dale F. Leipper [2]

Program Committee

1. Introduction

Increasing societal needs concerning recreation, natural preserves, industry, energy, housing and environmental quality, and the rapid population increase along coasts give geophysical scientists increased responsibilities to provide information to aid present and planned uses of coastal regions. A response of the meteorological community to these rapidly increasing needs was provided through the First Conference on Coastal Meteorology, held at Virginia Beach, Va., 21–23 September 1976. The increasing importance of coastal regions was clearly exhibited when President Carter announced in August 1979 that 1980 was the "Year of the Coast." To better define the state of the art and to identify serious gaps in the knowledge of coastal atmospheric processes, the Committee on Meteorology of the Coastal Zone of the American Meteorological Society sponsored the Second Conference on Coastal Meteorology, held in Los Angeles, Calif., 30 January–1 February 1980. The program for this meeting was published in the October 1979 (**60**, 1261–1279) issue of the BULLETIN.

The triple-point intersection of the air, land, and water creates unique atmospheric and oceanic processes requiring a multidisciplined approach to solving coastal environmental problems. Consequently, the Second Conference on Coastal Meteorology was planned to encourage interaction with highly related scientific meetings. The Second Conference was held simultaneously with the Third Conference on Ocean-Atmosphere Interaction and overlapped with the 60th AMS Annual Meeting. Further interaction was encouraged by scheduling the Second Conference near the Winter Meeting of the American Society of Limnology and Oceanography (31 January–4 February) and the Fifth IDOE (International Decade of Ocean Exploration) International Symposium on Coastal Upwelling (4–8 February) also being held in Los Angeles.

These plans to encourage multidisciplined interactions appeared successful. The number of papers increased from 38 to 66, the number of agencies represented increased, and the number of specialized subjects increased considerably from the First to the Second Conference. There were 109 registered participants at the Second Conference, with six foreign countries represented; and there were 375 registrants for all three meetings, with 11 foreign countries represented.

AMS President Robert M. White (National Academy of Sciences, Washington, D.C.) opened the Conferences by indicating pleasure that the meetings were being held simultaneously and that the subjects, concerning many problems such as those related to fishing, climate stability, oil spills, and storm surges, were of importance to the American Meteorological Society.

The following summary of the technical presentations is divided according to sessions. Papers not presented are included.

The preprint volume of this conference can be obtained from the American Meteorological Society, Boston, Mass.

2. Session 1: Coastal and ocean studies (Joint Session with 60th AMS Annual Meeting and the Third Conference on Ocean-Atmosphere Interaction)

Chairman: Robert M. White, National Academy of Sciences, Washington, D.C.

The first session consisted of two invited speakers concerned with contemporary coastal meteorology and two invited speakers concerned with contemporary ocean-atmosphere interactions. This joint session was planned to encourage registrants to attend subsequent sessions in both conferences. Participants were observed to proceed regularly between the two conferences by having sessions conveniently placed in adjacent rooms.

The session was opened by S. A. Hsu (Louisiana State University, Baton Rouge, La.), who gave a comprehensive review of low-level atmospheric behavior concerning air-sea interaction, sand and salt transport, roughness length, air flow, heat balance, and the relation between mixing height and radon concentrations. Hsu discussed low-level radio propagation and mixing height variation peculiar to coasts. He stressed the need to increase interaction with other geophysicists

[1] Naval Ocean Systems Center, San Diego, Calif. 92152.
[2] Department of Oceanography, Naval Postgraduate School, Monterey, Calif. 93940.

and showed how some coastal problems can be solved using existing knowledge. E. C. Kindle (Old Dominion University, Norfolk, Va.) presented a paper originally scheduled to be presented by the late K. H. Jehn[3] on coastal zone data requirements that had been evaluated in a Workshop on Environmental Data in Coastal Regions (see pp. 1417–1422). Kindle discussed the difficulty of establishing coastal data requirements because optimum data systems are difficult to establish for coordinated collection and dissemination. Any changes in existing data networks would be expensive, particularly if new offshore data platforms are involved. He recommended the use of modeling as a focal point for all users to collectively establish data requirements. Kindle indicated that satellite data systems should be vigorously pursued. He stressed the need for a central agency to establish data requirements and networks and the need to increase cooperation among all users of coastal data. The lively discussion following Kindle's paper verified the complexity of the problem. The papers by P. K. Taylor (Institute of Oceanographic Sciences, Surrey, England) and K. Hasselmann (Max-Planck-Institut für Meteorologie, Hamburg, West Germany) are discussed in the Review of the Third Conference on Ocean-Atmosphere Interaction, pp. 1423–1428.

3. Session 2: Pollution, power plant siting, and societal needs

Chairman: W. T. Sommers, Forest Fire and Atmospheric Sciences, Forest Service /USDA, Washington, D.C.

The emphasis in this session was upon the inadequacy of available data to properly describe transport and diffusion of pollutants in coastal areas. Many of the speakers presented new data to assist in overcoming this inadequacy.

G. S. Raynor presented results of his and J. V. Hayes' (both of Brookhaven National Lab., Upton, N.Y.) work, which included transport and diffusion statistics at 25 selected coastal stations from Portland, Maine, to Brownsville, Tex. Consideration was given to diurnal and seasonal differences and examples were shown. Ratings of the 25 stations on a five-point diffusion scale were tabulated. The authors believe that use of their detailed information may permit preliminary site evaluation on the east and Gulf coasts without diffusion modeling.

For data on diffusion in a lake shore environment, D. Rai (Applied Environmental Research, Inc., Palatine, Ill.), with J. S. Touma (Consumers Power Co., Jackson, Mich.) and K. M. Parker (Wisconsin Power and Light Co., Madison, Wis.), used a network of acoustic sounders operated for two years near Lakes Huron and Michigan. They measured the thickness of the stable layer and, at times, detected stack plumes. They found little diurnal variation close to shore and noted a direct relation between the layer thickness and wind speed. Their inferred stabilities agreed very well with radiosonde data. They concluded that wind shear is very significant in the diffusion of pollutants.

To compare stability at shore and inland sites, R. M. Brown, with S. SethuRaman and C. Nagle (Brookhaven National Lab., Upton, N.Y.), compared wind fluctuation measurements at two representative sites on Long Island, New York. They sorted the observations into the Brookhaven five class gustiness categories and found seasonal trends. They showed that with onshore winds in spring, summer, and early fall there was much more stable gustiness than with offshore winds. An unscheduled paper by E. Juarequi, M. A. Valdovinos, and M. Rodriquez (Direction General De Saneamiento Atmosferico, Mexico City) presented similar observations for a point on the Mexican shore of the Gulf of Mexico.

P. J. Rye (Western Australian Institute of Technology, S. Bentley, Australia) applied a rather classical sea breeze model to observations on 2 March 1978 near Perth in Western Australia. He concluded that the model shows strength in its ability to produce 3-dimensional wind fields and turbulent fluxes. It provides a quantitative expression of the meteorology for a range of sea breeze types.

In the only discussion emphasizing the societal needs of coastal data, H. S. Ram Mohan (University of Cochin, Cochin, India) classified the coastal zones of India with regard to climatological features, including solar radiation, wind power, and coastal upwelling. He discussed the impact of these results upon the economic development of the regions.

J. Goll (Nuclear Regulatory Commission, Washington, D.C.) described the need for an overwater receptor model, discussed the extreme sparsity of data suitable for use in such model development, and presented a simple model for the "near worst" case pollution situation. He strongly urged that more attention be given to transport and diffusion of effluents over water.

In the overall analysis of prediction methods for coastal sites, G. S. Raynor, with P. Michael and S. SethuRaman (Brookhaven National Lab., Upton, N.Y.), also indicated the great shortage of diffusion data over water. The authors described the various general types of conditions occurring at coastal sites and some of the model characteristics that could involve these conditions. They recommended that diffusion parameters be obtained by measurement at each prediction site, that models provide for a lid of fixed or changing height formed by the stable air aloft, and that provision be made for changing the diffusion parameters when the plume crosses a bound-

[3] See Necrology, *Bull. Am. Meteorol. Soc.*, 1980, **16**, 507–508.

ary into different diffusion conditions, such as a coastline.

R. F. Abbey, Jr. (Nuclear Regulatory Commission, Washington, D.C.) described a measurement and modeling program concerning atmospheric diffusion and transportation of radioactive plumes designed to characterize conditions over complex onshore/offshore regions. Results will be compared with theoretical principles.

4. Session 3: Data and forecasting

Chairman: Leonard W. Snellman, National Weather Service/NOAA, Salt Lake City, Utah

Session 3 consisted of presentations by representatives of NOAA. R. C. Landis (Environmental Services Operations, Rockville, Md.), from the administrative offices, described user requirements. G. Hamilton of the Data Buoy Office (NSTL Station, Miss.) told about operations and plans for drifting and anchored data buoys. D. P. Barnes (New Orleans Forecast Office, Slidell, La.) and B. E. Heckman (National Environmental Satellite Service, Kansas City, Mo.) presented a plan to integrate satellite information into short-range forecasts. N. A. Pore (Techniques Development Lab., Silver Spring, Md.) and S. F. Brown (National Weather Service Forecast Office, Silver Spring, Md.) compared wind and wave forecasts produced by the six- and seven-layer primitive equation models.

G. Hamilton's data buoy location map showed six operational buoys in the Gulf of Alaska, four in the Gulf of Mexico, and five off the east coast. On a normally three-hour schedule, these buoys report sea-level pressure, wind speed and direction, air and sea surface temperature, and wave height and period. Design studies are considering vertical profiles of humidity, radiation, precipitation, and visibility in the atmosphere and observations of water quality, salinity, and tsunamis in the ocean. An ocean current measuring system is also being tested.

The paper by R. C. Landis entitled CO-OPS (for Coastal, Offshore, and Oceanic Prediction Services) concerned the integration of data available from the anchored and drifting buoys with automatic weather stations, skywave and groundwave radar, navigational aids, cooperative ships, tide gages, and environmental satellites to better meet user requirements. Key users include those concerned with offshore oil and gas, marine transportation, commercial fisheries, marine recreation, marine construction, and coastal communities. Suggestions were made for improving the observational system.

Whereas the CO-OPS program described by Landis resuires a congressional appropriation for implementation, some of the immediate practical steps suggested by Barnes and Heckman can be undertaken with existing data and facilities. The Gulf Support Unit was established primarily to increase the use of satellite services in support of Gulf of Mexico activities. As to the importance of these activities, Barnes mentioned that there are now 6000 offshore platforms in the Gulf, that there were 2.4 million boats operating in Gulf Coast states in 1978, that Louisiana ports handled $23.8 billion of cargo in 1977, and that many activities are extremely weather-sensitive. The Gulf Support Unit is working to increase the timeliness of government meteorological services and to better meet the required user specificity. For fast-developing situations, a nowcasting program implementation was recommended using high quality satellite data such as that from the Satellite Interpretation Message. An example was given utilizing the 1 km visible GOES imagery. The nowcasts would apply to a coastal band some 240–320 km wide and for developments that occur rapidly, in 1–3 h. It was recommended that a more general marine environment forecast for operations in coastal waters be issued daily in early morning, late morning, and mid-afternoon. The purposes of the three forecasts were described and an example, prepared for a specific date, was presented.

The presentation by Pore of the paper by Pore and Brown concerned the accuracy of wind and wave forecasts over the area off New England extending north of 32°N and west of 35°W. Both the 36 h automated forecasts and the 24 h manually produced hindcasts were regularly improved in 1978 over those of 1973–77. Verification was accomplished by averaging ship observations in given forecast areas. Since all forecasts were based upon the National Meteorological Center's Primitive Equation model and since, in January 1978, a six-layer model had been replaced by a seven-layer one, it was concluded that the improved performance probably resulted from this change.

5. Session 4: CEWCOM–76, 78, and marine aerosols

Chairman: J. H. Richter, Naval Ocean Systems Center, San Diego, Calif.

This session contained 12 papers essentially concerned with data taken within 200 miles of coasts. Several papers considered data taken during two Navy-sponsored experiments, titled Cooperative Experiments in West Coast Oceanography and Meteorology (CEWCOM) (News and Notes, *Bull. Am. Meteorol. Soc.*, 1977, **58**, 1226) that occurred in 1976 and 1978 over the ocean near southern California. These papers focused on modification processes of temperature, humidity, wind, turbulence, and the aerosol type and spectra in the atmospheric layer below about 1 km as the layer moves on- and offshore during the diurnal sea/land breeze, during large-scale synoptic changes, or during mesoscale changes.

D. F. Leipper (Naval Postgraduate School, Monterey, Calif.) demonstrated that the height of the moist marine layer capped by a temperature inversion is generally inversely proportional to the heat content below 1 km when the air is warmer than the sea, using data offshore of southern California during Santa Ana conditions (CEWCOM–76, 78). He showed that fog generally formed when the heat content was unchanging or decreasing (inversion base below 400 m) and that the heat content changed over areas hundreds of square kilometers, demonstrating optimism for predictability. Using mixed layer entrainment models, K. L. Davidson, G. E. Schacher, and C. W. Fairall (Naval Postgraduate School, Monterey, Calif.) showed a case where the inversion base height could be well predicted using an initial radiosonde, an assumption on subsidence, and continuous surface measurements including heat and moisture flux (bulk estimation) taken aboard the *R/V Acania*. A shipboard acoustic echosounder was used to measure continuously the inversion base height to verify predictions, including clear and stratus/fog conditions. The surface wind speed, the friction velocity, and the turbulence structure function measured at an instrumented tower near the water on the northwest tip of San Nicolas Island, California, were compared with identical measurements on the *R/V Acania* upwind (onshore wind) of the tower by C. W. Fairall, G. E. Schacher, K. L. Davidson, and T. M. Houlihan (Naval Postgraduate School, Monterey, Calif.). They showed that the tower measurements could provide data representative of the upwind over-ocean region for climatological purposes, but the modification of the near surface wind and turbulence profile by the surf and escarpment prevents the tower measurements from clearly representing the nearby ocean conditions. T. V. Blanc (Naval Research Lab., Washington, D.C.) described the instrumented tower at San Nicolas Island and its capabilities using seven carefully monitored instruments producing 19 measured and calculated parameters. The effect of the surf and escarpment on the low-level marine layer structure was examined but the significance of the escarpment modification has not been clearly resolved.

Session 4 continued with five papers concerned with the categorization of the offshore air mass during CEWCOM-78 into marine (M), continental (C), or mixed (transitional, T). J. Rosenthal, T. E. Battalino, and H. Hendon (Pacific Missile Test Center, Pt. Mugu, Calif.) and V. R. Noonkester (Naval Ocean Systems Center, San Diego, Calif.) used climatology, synoptic patterns, upper-air charts, satellite imagery data, pressure gradient characterizations, vertical time cross sections, and the temporal changes in single station data for the CEWCOM-78 study off the southern California coast. Using onshore and offshore flow classifications for the data period from 25 April to 1 June 1978, they classified days as M, C, or T and concluded that air masses at San Nicolas Island are ". . . distinctly more maritime than would be encountered on a populated mainland coast . . . ." R. E. Larsen and D. J. Bressan (Naval Research Lab., Washington, D.C.) used surface radon (^{222}Rn) concentrations to classify offshore air near Southern California, near Panama City, and along the coasts of the northeastern United States, Nova Scotia, and Newfoundland into M, C, or T categories. Pure M or C air masses were seldom observed but they found certain synoptic patterns producing repeatable changes in radon concentrations. They stressed that good estimates of the air flow and vertical mixing are required over a period of several days to categorize air as M, C, or T. T. A. Niziol, C. W. Rogers, E. J. Mack, and C. K. Akers (CALSPAN Corporation, Buffalo, N.Y.) showed that Aitken particle concentrations can be used to categorize coastal air into M, C, or T using CEWCOM-78 data taken aboard the *R/V Acania*. These concentrations changed in an expected manner during frontal and offshore/onshore flows and generally agreed with the previously stated results of Rosenthal *et al.* and Larson and Bressen, indicating that air offshore to at least San Nicolas Island is substantially influenced by continental air. E. J. Mack, C. K. Akers, and T. A. Niziol used several instruments to measure the aerosol composition and size distribution at sea during six measurement periods along the eastern and western United States coasts and in the North Atlantic and Mediterranean regions. They concluded that aerosols vary considerably in size and composition over ocean regions, particularly near coasts, and do not consist primarily of sea salt. In the validation of a Navy marine aerosol model specifying the number density spectrum as a function of relative humidity, surface wind speed, and elevation, V. R. Noonkester used aircraft measurements of the aerosol spectra ($0.23\ \mu m \leqslant$ radius $\leqslant 14.7\ \mu m$), humidity, and elevation over the ocean near southern California taken during CEWCOM-78. He showed that the model approximated marine aerosols but often approximated C or T aerosols when measurement errors are considered. M, C, and T air masses were selected according to air flow patterns given by Rosenthal *et al.* and radon concentrations given by Larsen and Bressen.

J. G. Hudson (Desert Research Institute, Reno, Nev.), J. Podzimek (University of Missouri, Rolla, Mo.) and A. K. Goroch (Naval Environmental Prediction Research Facility, Monterey, Calif.) concluded Session 4 by examining the offshore spectral shape. Hudson was concerned with the role activated and unactivated haze particles played in visibility during fog. Using an isothermal haze chamber, a continuous flow diffusion chamber, and a Royco optical particle counter, he deduced that the great variations in fog microstructure (exhibited by visibility) are caused by variations in fog condensation nuclei concentrations. Supersaturation is not critical in fogs with low visibilities, particularly in continental air compared to marine air. From measurements near Padre Island, Texas, Podzimek concluded that a universal aerosol size distribution ($0.01\ \mu m \leqslant$ radius $\leqslant 10\ \mu m$) will not be easily attainable for high humidities and that a multimodal aerosol distribution revealing photochemical, accumulation, and mechanical processes may be required. He indicated that one or more log-normal distributions can describe marine air, particularly at high humidities, except during the onset or dissipation of fog. When concerned with aerosols greater than a few micrometers in radius, Goroch found that the standard gamma function distribution is adequate to describe Woodcock's classical aerosol observations made in 1953. A method of finding the two coefficients of the gamma distribution using the method of maximum likelihood was presented. Marine aerosol distribution changes related to surface wind speed were included by using a volume distribution. This session, containing results from a number of field experiments, showed the complexities of the evolution of the lower atmospheric structure in coastal regions and the great advantage of cooperative experiments.

6. Session 5: Sea and lake breeze

Chairman: E. C. Kindle, Old Dominion University, Norfolk, Va.

The first three of four papers in Session 5 were motivated by the need to know the effects of onshore/offshore flow on pollution dispersion from power plants. M. E. Guski and P. L. Miller (United Engineers and Constructors, Inc., Boston, Mass.) obtained climatological data on the daytime breeze from Lake Ontario near the Town of New Haven, N.Y., using four meteorological monitoring stations placed up to 8 km inland from shore. During a two-year measurement period, a lake breeze was observed on 79 days and only between March and September. The lake breezes required a weak pressure gradient when the water was colder than the air and significantly affected the near shore meteorology. T. W. Fritts, F. J. Starheim, and B. J. Deihl (Equitable Environmental Health, Inc., Woodbury, N.Y.) gave a new predictive method for the temporal development of the thermal internal boundary layer (TIBL) along a vertical plane perpendicular to the shore. Measurements near a proposed power station 12 km NNE of Portland, Maine, during the summer of 1977 were used to develop a model containing simple meteorological variables. The model contains the "classic proportionality of the TIBL height to the square root of the distance inland and relies on hour-to-hour sea-air and overland temperature differentials." Unexplained features of the TIBL may have been caused by ignoring factors like surface roughness. Frontal slopes and vertical velocities were estimated from 55 tetroon positions launched in June 1965 near New York, N.Y., by S. Anderson and R. D. Bornstein (San Jose State University, San Jose, Calif.). Frontal slopes increased over the central urban regions and vertical motion was at a maximum in convective activity over large anthropogenic heat sources. E. A. Brotak (Kean College of New Jersey, Union, N.J.) described four case studies when a sea breeze front significantly modified wildland fires. Wind shifts, convergence, and changes in sea breeze frontal passages alter the character of wildland fires, often endangering lives. Ongoing mesoscale analysis can possibly prevent the loss of lives and aid in fire control by short-term prediction of sea breeze frontal movement.

7. Session 6: Mesoscale circulation

Chairman: J. G. Edinger, University of California, Los Angeles, Calif.

There is substantial interest in the estimation of winds over coastal waters. Papers in this session focused on specific orographic effects, while papers in Session 8 focused on some statistical features of coastal winds.

Warm offshore winds (California Santa Anas) intersecting coastal mountains create conditions conducive to the formation of internal gravity waves, which then produce erratic winds contributing to dangerous forest fire behavior, as presented by W. T. Sommers (Forest Fire and Atmospheric Sciences, Forest Service/USDA, Washington, D.C.). S. Brand and R. P. Chambers (Naval Environmental Prediction Research Facility, Monterey, Calif.), H. J. C. Woo, J. E. Cermak, and J. J. Lou (Colorado State University, Ft. Collins, Colo.), and M. Danard (University of Waterloo, Ontario, Canada) reconstructed wind fields dangerous to ships in Subic Bay in the Philippine Islands for stalled tropical storms using scaled physical models. Surface wind fields in Cook Inlet, Alaska, were found to depend strongly on synoptically imposed pressure gradients along two orthogonal orographic channels by S. A. Macklin, R. W. Lindsay, and R. M. Reynolds (Pacific Marine Environmental Lab., Seattle, Wash.), but some independent wind circulations were also formed. In the last paper of the session, R. M. Reynolds discussed a 1-dimensional vertically integrated model capable of explaining the decay of cold offshore winds (katabatic) within 15–20 km offshore associated with positive heat flux and consequently thickening of the mixed layer.

8. Session 7: Climatology, synoptic-scale circulation, and insolation

Chairman: D. Lust, National Weather Service Forecast Office/NOAA, Los Angeles, Calif.

Session 7 contained 11 papers and focused on some general characteristics of coastal phenomena with little overlap in content. The Thornthwaite evapotranspiration methodology was evaluated for the Texas coast for the 1941–70 period by H. J. Hillaker and K. H. Jehn (University of Texas, Austin, Tex.). Evapotranspiration estimated by 30-year mean data is 6–18% higher than that based on month-by-month data that approximates the actual evapotranspiration. C. N. K. Mooers (Naval Postgraduate School, Monterey, Calif.) and G. R. Halliwell (University of Delaware, Lewes, Del.) determined statistical characteristics of surface data for 20 shore and offshore stations between Cape Hatteras and Nova Scotia using data from 1974 through 1978 to determine the response of shelf waters to atmospheric, storm-time forcing. By using means, cross-spectrum analysis, space-time correlations, and empirical orthogonal functions they found that propagating cyclones and anticyclones dominated the atmospheric forcing variability between periods of two to six days. Using orthogonal spatial eigenvectors of annual cyclone frequencies (1885–1978) along the east coast of the United States, B. P. Hayden (University of Virginia, Charlottesville, Va.) found a maximum variance in cyclone frequency off the U.S. Atlantic coast. The increased storminess off the U.S. east coast since 1940 was found to be part of a secular variation having a long time scale. A. Court (Geoscientific Systems & Consulting, Playa del Rey, Calif.) and L. Meskimen (California State University, Northridge, Calif.) attempted to identify and track tropical storms moving into western North America during the first half of the century from many data sources. About 40 were identified, although numerous years were void of reports on their presence, possibly because of the lack of a proper definition of a tropical storm. They described the history of several tropical storms significantly affecting the western United States. Their statistics fill a gap in the climatology of important weather events. A barotopic primitive equation model on an equatorial beta plane was used by P. R. Bannon (National Center for Atmospheric Research, Boulder, Colo.) to explain characteristics of lows around the Cape of South Africa. These lows were found to have the structure of coastal Kelvin waves and mountain barriers were found to be a primary requirement. Severe winter storms along the coast of the eastern United States often result from offshore frontogenesis and cyclogenesis and were discussed by L. F. Bosart (State University of New York, Albany, N.Y.) These storms involve the modification of a layer about 300–500 m thick, are formed locally, and require a cold anticyclone to the north of the forming storm region. He suggested that experimentation concerning increased lower tropospheric resolution in operational numerical weather predictions and improved boundary layer physics be considered. He also stressed continuity of existing offshore data sources (e.g., Coast Guard) and the acquisition of data from nearby ships to aid in forecasting these significant storms.

In continuation of Session 7, J. Rutllant (University of Chile, Santiago, Chile) described an experiment obtaining the noontime surface energy budget components using 12 measurement sites along the Chile-Peru coast to calibrate climatic models of the daily surface energy budget. Equations for the net long-wave radiation, the sensible heat flux, and other equations were presented. A study on coastal solar radiation differences by season and time of day was described by W. D. Bach (Research Triangle Institute, Research Triangle Park, N.C.) using radiation data at six sites between the coast and 100 km inland in southeastern North Carolina. A maximum deficit of global insolation was found about 50 km inland near 1400 EST during the summer months and a deficit of direct normal insolation was found near the coast during spring and fall, apparently caused by clouds created by the sea breeze. W. D. Bach presented a supporting paper by P. J. Gunthrope and K. R. Knoerr (Duke University, Durham, N.C.) giving results of using satellite visual spectrum data to measure cloud type and amount on sea breeze days in the same study region. The daily global radiation was found to decrease as the delay of the sea breeze frontal passage increased. H. F. Diaz and R. G. Quayle (National Climatic Center/NOAA, Asheville, N.C.) presented a paper on air-sea temperature differences at nine stations along the coasts of the United States for multiple purposes. The time series of the air-sea temperature differences were examined for randomness or trends using statistical randomness tests and the results varied from station to station. One important result is that the bucket and intake temperatures aboard ships have a high correlation and may, with proper adjustment, be independently used in future studies.

9. Session 8: Low-level wind and gravity waves

Chairman: D. A. Haugen, Wave Propagation Lab./NOAA, Boulder, Colo.

The first four papers considered the effect of surface roughness and vertical shear on wind variations. Significant seasonal wind speed variations and onshore/offshore differences found along the Gulf of Mexico by C. E. Myers and N. K. Wagner (University of Texas, Austin, Tex.) are considered important factors in selecting wind power sites. They found the Wiebull distribution adequately characterized the sample means and variances at all locations. Using wind measurements of 10, 45, 50, and 100 m, T. J. Lockhart (Meteorology Research Inc., Altadena, Calif.) demonstrated that the method of averaging winds must be selected according to application. A validated method to predict changes in wind profiles by abrupt surface roughness change was discussed by W. R. Goodin (Dames & Moore, Los Angeles, Calif.) and G. J. McRae (California Institute of Technology, Pasadena, Calif.). Improved estimates of offshore heat transfer coefficients were determined for a proposed water-cooled coastal power plant by using wind direction-dependent wind speed differences of onshore/offshore wind measurements by J. H. Snooks and T. F. O'Hara (Yankee Atomic Electric Co., Westborough, Mass.). The last paper, by S. SethuRamen, C. Nagle, and G. S. Raynor, found a wind directional dependence of the frequency of internal gravity waves generated on the upper portion of a boundary layer cooled by the ocean. The occurrence of the waves was also dependent on distance from the coast and time of day.

10. Session 9: MABLES WC and California inversion

Chairman: D. F. Leipper, Naval Postgraduate School, Monterey, Calif.

MABLES WC stands for Marine Atmospheric Boundary Layer Experiments on the West Coast. The experiment concerned an area extending 220 km west of San Francisco and continued from 31 July to 17 August 1978. It was conceived and initiated by the late Albert Miller. Papers were presented by his associates and former students at San Jose State University with the support of J. Jarrel, J. Ernst, G. Schacher, and K. Davidson from cooperating institutions.

P. Lester (San Jose State University, San Jose, Calif.) outlined the objectives of the experiment and described the facilities and operations involved. The main purpose was to obtain a better understanding of the marine inversion and the boundary layer. The observations were obtained from two ships, three aircraft, the Mt. Sutro tower in San Francisco, an island station, four pibal stations, and six sodar stations, in addition to standard networks. The inversion base was generally below 400 m except from 12 to 14 August.

J. Jarrell (Science Applications, Inc., Monterey, Calif.), J. Ernst (National Environmental Satellite Service/NOAA, Washington, D.C.), and G. Schacher and K. Davidson (Naval Postgraduate School, Monterey, Calif.) reviewed the data collected by *R/V Acania* and the manner in which they were being used as ground truth to calibrate the active spectrometer and the passive radiometer imagery from SEASAT. There were six orbits of high quality data that could be used in such tests. J. Ernest is investigating wind-wave interaction and stability influences.

G. W. Roope (San Jose State University, San Jose, Calif.) analyzed 10 flights of the NCAR research aircraft over the MABLES area to analyze the detailed structure of the marine boundary layer. Cross sections of temperature and wind speed were presented. With the inversion base height at 250–305 m, vertical temperature gradients through it were as large as 4.8°C/100 m. Maximum wind speeds were found within the inversion.

C. W. King (San Jose State University, San Jose, Calif.) described efforts to obtain the temporal and spatial distribution of the height of the inversion base during MABLES by utilizing continuous sodar observations from the two ships and from the Farallon Islands. Convective plumes were observed, with 87% of them occurring when the sea was warmer than the air. In a 32 h data period, ground-based wind shear layers were observed to be approximately 150 m deep. These occurred when the sea was cooler than the air. Waves imbedded within the elevated stable layers were observed to start in coincidence with the initial breaks in the overcast. The height of the inversion had its diurnal minimum at night and its maximum in the late afternoon.

The Mt. Sutro tower is located on a 254 m hill in the center of San Francisco. It is 224.6 m high, two-thirds of the tower being above the average height of the summer inversion base at this location. B. D. Van Patten (San Jose State University, San Jose, Calif.) used data from the tower collected in 1976 to obtain spectra of wind and temperature in summer at 300 m and 390 m mean sea level, one level above and one level below the mean height of the inversion base. Primary peaks in the spectra were found at periods of 10 days, 4 days, and 24 h. The wind variance was primarily in the E-W component. Waves with amplitudes less than 20 m were found at the interface.

In a final paper, H. Y. Holman (San Jose State University, San Jose, Calif.) presented a formulation of the turbulent energy budget in the elevated inversion and included many of the features indicated by the MABLES observations.

11. Session 10: Stratus fog and marine boundary layer structure

Chairman: W. S. Lewellen, Aeronautical Research Associates of Princeton, Princeton, N.J.

Many factors influencing the formation and dissipation of coastal stratus/fog and the marine layer were examined in this session. Acoustical remote sensing of the height of the temperature inversion during fogs was reported by B. A. Kunkel (Air Force Geophysics Lab., Hanscom AFB, Mass.). He found no relationship between surface meteorological parameters and the inversion depth in relation to fog forecasting. Using July 1977 and 1978 GOES data, T. F. Lee, J. Rosenthal, and R. A. Helvey (Pacific Missile Test Center, Point Mugu, Calif.) found the horizontal distribution of stratus clouds over the Southern California Bight to reliably depend on latitude, coastal land topography, and sea-land breeze. Their results demonstrated the value of satellite data in coastal climatological studies. Good estimates of over water vertical diffusion were obtained from measurements during five cruises of the *R/V Acania* by G. E. Schacher, K. L. Davidson, and C. N. Fairall. Vertical diffusion rates varied with distance from the coast and time of day near the coast.

The temporal evolution of the marine layer structure related to convection, fog, stratus, and refractive index were examined in the last four papers. K. L. Davidson and V. R. Noonkester presented data on the rarely observed growth of a convective mixing layer by encroachment over water, which behaved according to theoretical formulations. C. W. Rogers, J. T. Hanely, R. J. Pilie, and E. J. Mack (Calspan Corp., Buffalo, N.Y.) applied a model to simulate the formation of fogs downwind of warm water patches observed near Monterey Bay, Calif. The successful results for two cases suggest that the model, with some modifications, could be useful in predicting some coastal stratus/fog. A 1-dimensional model incorporating turbulent transfer, solar and IR radiative transfer, and heat balance of soil surface and summer stratus data at El Monte, Calif., was used by F. Moeng and M. G. Wurtele (University of California, Los Angeles, Calif.) to demonstrate that the sea breeze and convective heating are critically important in stratus formation and dissipation, respectively. S. D. Burk (Naval Environmental Prediction Research Facility, Monterey, Calif.) described a 2-dimensional model providing vertical profiles of radio and optical properties downwind of sea surface temperature gradients. The model appears capable of predicting important radio/optical properties but has not been tested using data.

12. Session 11: Sea surface and subsurface behavior

Chairman: C. N. K. Mooers, Naval Postgraduate School, Monterey, Calif.

The oceanic analogies to many atmospheric phenomena discussed previously were studied with the Cyclesonde, the underwater equivalent of the rawindsonde, by J. C. Van Leer (University of Miami, Miami, Fla.), who pointed out the great need to model coastal ocean behavior. J. H. Suhayda (Louisiana State University, Baton Rouge, La.) discussed the relationships between simultaneously measured wave spectra and photographically determined drift velocities. W. L. Wood (Purdue University, W. Lafayette, Ind.) discussed a model of a storm-generated sea surface that provides clues to recently recognized long-period variations in long shore currents. Frontal passage over Texas bays was found to create large ($\sim$1 m) rapid variations in the water level by wind stress changes over the Gulf of Mexico by G. H. Ward (Epsey, Huston & Associates Inc., Austin, Tex.).

13. Concluding remarks

This conference successfully provided a forum for needed interdisciplinary discussions on the increasingly important problems in coastal meteorology. Increased interest is expected to be demonstrated at the next Conference on Coastal Meteorology, planned to be an international meeting in 1982, with greater emphasis to be placed on data, remote sensing, modeling, and air-sea interactions. Coastal meteorology has clearly emerged as a major subdiscipline of the broad field of meteorology.

Acknowledgment. The conference was supported in part by Office of Naval Research Grant N0014-80-G-0024. ●