# TAP II™ 1.1

**trajectory analysis planner**

## San Diego Technical Documentation

*January 2000*

PCCI, Inc
U.S. Navy

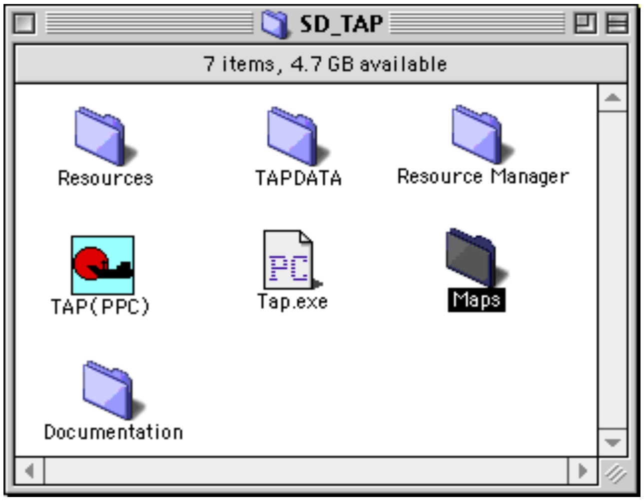
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service

# TABLE OF CONTENTS

# 1. INSTALLING

TAP II files are on two CDs. One CD (Region CD) contains the TAP II application and data for your region and the other CD (Tutorial) contains a tutorial and manual for TAP II. It is recommended that you go through the manual and the corresponding tutorial so that you can fully understand the capabilities and limitations of this application.

1. Copy TAP II's files from the **Region** CD to a folder on your hard drive. You should have at least 1 GB of memory available on your hard drive to accommodate TAP II and it's corresponding folders and files.
2. Keep the TAP II application and the TAPDATA folder in the same.




3. Do not place the application file in the TAPDATA folder or place the application or TAPDATA folder in different locations.
4. Do not retitle any file or folder name, or modify any data files in anyway.

The folder on your hard drive should contain the following files and folders (Figure 1):
• Maps (folder): This folder contains one or more maps of the TAP II region including the receptor sites and their corresponding numbers. These files are in .pdf file format so you can open them on either a Macintosh or PC.

• Resources (folder):

ESI_bio_data.SD.MHR
ESI_shore_data.SD.MHR

This data was extracted from the Environmental Sensitivity Index. Bio and shore stand for biology data and shoreline data, respectively. SD is the abbreviation for San Diego Bay. This could be SF for San Francisco or KB for Kaneohe Bay, for example. The .MHR is the format for all resource files.

You can create other .MHR files using the Resource Manager (these files could contain booming strategies, number of skimmers, number of people, etc.)

• Strategy Solution Folder (folder): This folder contains a stand-alone copy of a FileMaker Pro 4.0, Resource Manager (there are both the Macintosh and PC version in this folder). This application allows you to create or modify existing strategies for a particular TAP II region.

• TAP(PPC) (Macintosh Application)
• Tap.exe (PC Application)

• TAPDATA (folder): This folder contains season folders, text files and a base map file that support the operation of TAP II in a particular region. The following are a description of these folders and files:

• DAGINFO.TXT (text file): This file is used for the shoreline interpolation scheme used in TAP II and for the interpolation between the various start sites throughout a region.

• SD.BNA (text file): This is the base map file in .bna format that is used for a specific region. In this case, it is SD for San Diego Bay.

• SITE.TXT (text file): This file contains the global defaults used for each specific region. This file also contains the receptor site and start site information.

• SUMMER (folder):

• WINTER (folder): Depending on the statistical correlation of the wind data, a TAP II region could have 1,2,3,4 or more “seasons”. In our San Diego Bay example, there is only two statistically correlated seasons.

The TAP II User’s Manual is a portable document format (PDF) file that allows you to print the manual yourself.

**How to Use PDF Files**

To use PDF files, you first must download and install Adobe Acrobat Reader, a free application you can use to view or print PDF files.

Download a copy of Acrobat Reader for your computer system (Macintosh, UNIX, or Windows) using any Internet browser. You will see step-by-step instructions for installing the program. Here is the URL for you to obtain a free copy of Adobe Acrobat Reader:

http://www.adobe.com/products/acrobat/readstep.html

When you click on the TAP II User’s Manual (a PDF file), Acrobat Reader will automatically open and display the first page of the file. Use the scroll bar or hand tool to view other pages in the file. To print the file, choose Print from Acrobat Reader's File menu.

**Why PDF files?**

It can be difficult to share documents created in a particular software application on a particular kind of computer with people who don't have copies of that software or who are using another kind of computer. But when a document is made into a PDF (Portable Document Format) file, people using Macintosh, UNIX, Windows PC, or other computers can view or print that document, whether or not they have the software used to create it. Because PDF files are so portable, they are quickly becoming popular with Internet users.

# 2 BACKGROUND

NOAA’s Office of Response and Restoration has developed the Trajectory Analysis Planner (TAP II v.1.1), a computer-based tool designed to help create and review oil spill contingency plans by answering the following questions:

What is the probability of oil impacting specific areas?
How long will it take oil to impact specific areas?
How much oil can you expect to impact specific areas?
What is the cost of having an oil spill?
Where can an oil spill come from?

This report documents a version of the model developed for San Diego Bay in conjunction with PCCI, Inc. and the U.S. Navy. The purpose of the model was to help the navy port in San Diego Bay to improve their oil spill readiness effort.

# 3. METHODOLOGY OF TAP II

NOAA's On-Scene Spill Model (OSSM) was used to provide statistics of oil spill movement in and around San Diego Bay. TAP II utilizes data from 183,000 modeled trajectories generated in the following way:

Number of different spill sites in and around the San Diego: 183
Number of seasons: 2
Number of model runs per start site, per season: 500
Number of particles used to represent the oil for each run: 1,000

Each trajectory was a function of the physical processes of oil movement, including the dynamics of wind, ocean currents, and turbulent diffusion. Each trajectory is calculated using a unique set of data of hydrologic, oceanographic, and meteorological conditions.

## 3.1. Dynamics of wind:

For San Diego Bay, historical wind records from the Army Air Field Station were examined to determine the wind field for 16 years of continuous records (1980 to 1996). A statistical analysis of the data resulted in two seasons, one from October to March and another from April to September, with winds and ocean patterns specific to each season.
Attached are the statistical tables in Appendix 1.

## 3.2. Ocean Currents:

Data on historical tidal currents and wind driven current patterns were also computed by season to complete the geophysical dataset that defines the physical processes that move the oil. Pictures of the current patterns are included in Appendix 2.

### 3.2.1. Inside the Bay:

Tidal currents and wind driven currents were modeled inside the bay. For most of the bay, the tidal currents are the dominant currents. The wind driven currents were a factor in the south bay region where the tidal currents are small.

The tidal current pattern was created using NOAA's inhouse model (WAC) based on the Shallow Water Wave Equations. This pattern was then driven by a 16-year tide record from the NOAA Tidal Current Tables.

A second wind driven, current pattern was also generated and used for inside of the Bay. This too was generated by using NOAA's WAC model forced by a wind from the NNW down the main axis of the lower Bay. This pattern was scaled and driven by the NNW (from 338°T) component of the wind.

### 3.2.2. Outside the Bay:

Based on a study by T. Hendricks, the currents outside of the harbor, on the inner shelf, were modeled as a combination of two separate barotropic patterns. Both patterns were generated from NOAA's inhouse, shallow water wave equation model, WAC.

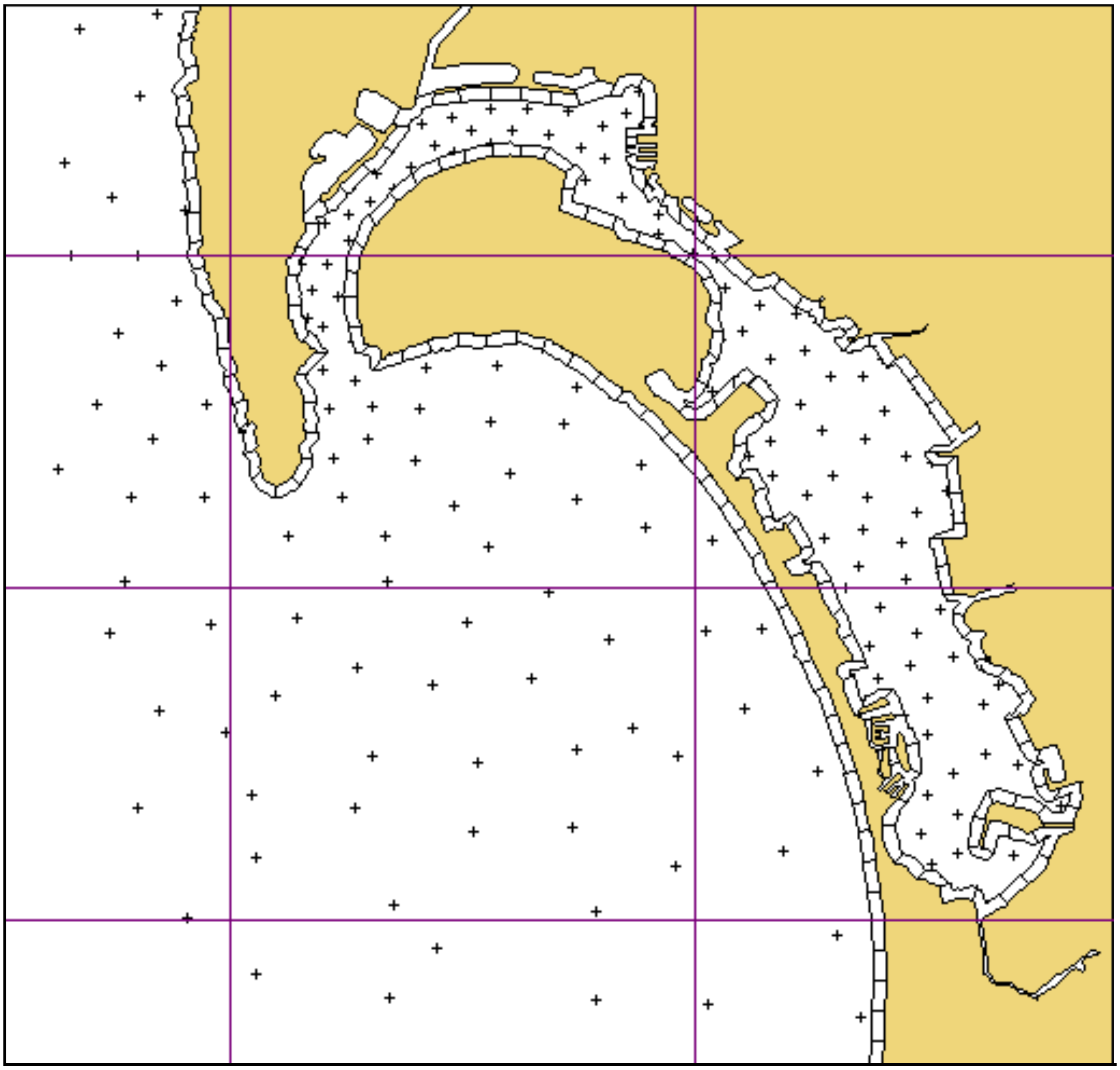
The first pattern simulated a geostrophic flow parallel to the coast and was driven by the along shore component (from 128°T) of the time dependent winds.

A second flow was added to this and was generated by the component of the wind perpendicular to the coast (from 281°T). This second flow resulted in an eddy in the Bight south of Point Loma, as reported by Hendricks.

Except for the inflow and outflow through the entrance of the Bay, no tidal currents were used for the outer coast. Over the time scales of the study we assumed that the net movement of oil from the tides outside of San Diego Bay would be small compared to the wind driven coastal currents and the wind forced movement of the oil.

## 3.3. Spill Sites:

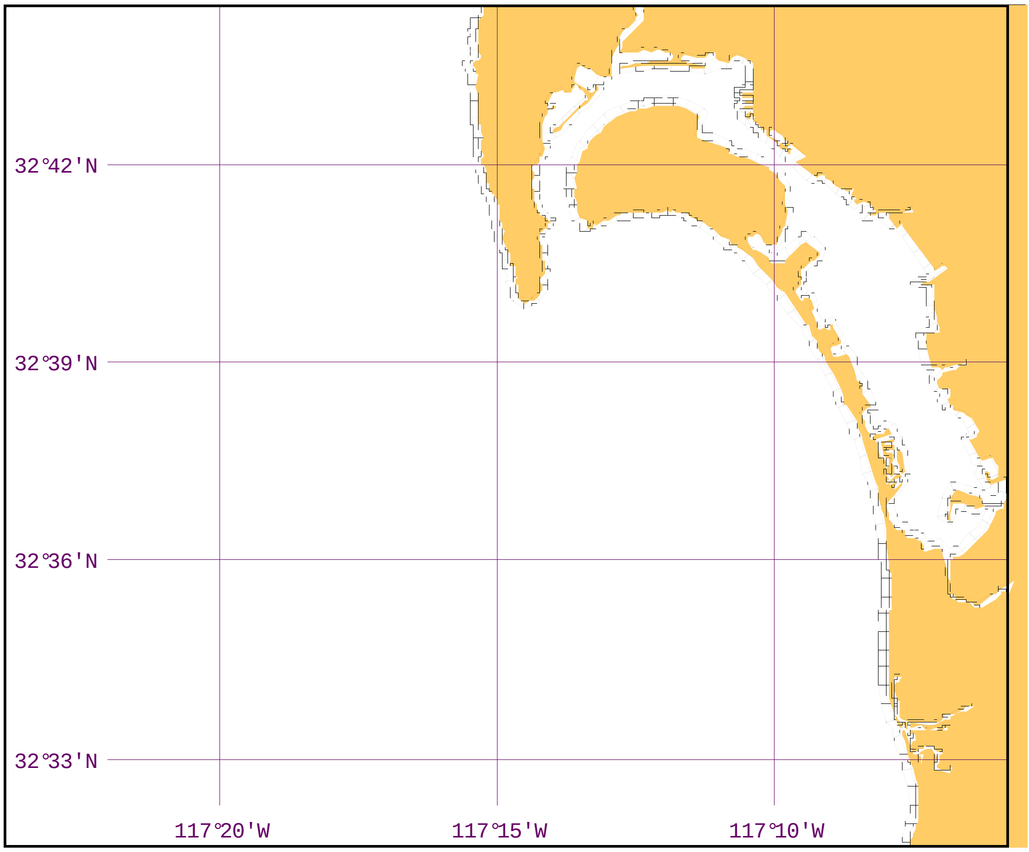
For the San Diego study, 183 spill locations were used. For each spill site, and each season, 500 independent model runs were done. TAP interpolates and extrapolates between these start sites when the user chooses for a spill location. The spill sites are represented by the tiny plus signs “+” in the water regions.



183 San Diego spill sites that were modeled.

## 3.4. Receptor Sites:

The shoreline of the study area was divided into 190 separate segments of approximately 0.5 km in length. This represents the shoreline resolution used by this TAP run. In Appendix 2 detailed maps with the receptor sites are provided.




190 shoreline receptor segments used.

# 4. ON-SCENE SPILL MODEL:

NOAA's On-Scene Spill Model (OSSM) was used in the simulations that generated the TAP statistics. The model was used in a batch mode to automatically loop through 500 independent runs for each start site.

## 4.1. Details of the run:

### 4.1.1. Random Start Times:

The hourly, 16-year wind record was scanned for potential start times. An acceptable start time was defined as any 72-hour record within the 16 years of data that had no gaps larger than 6 hours. The actual start hours were randomly selected from the list of acceptable start times.

### 4.1.2. The Runs:

For each of the 183 spill locations, 500 runs were done for each of two seasons for a total of 1,000 runs. Each run was initialized with 1,000 Lagrangian Elements. When an element path intersected a receptor site, the time of the hit was recorded. The runs resulted in one data file per run for each season. Each data file contains information about how many elements impacted each receptor site by specified times.

### 4.1.3. The Run Parameters:

Each model run went for 5 days with a computational time step of 0.1 hours. A random walk diffusion that allowed each particle to move in a random direction of .3 km every .25 hours was used. 973 bathymetry points and a finite element triangular mesh with 1652 triangles were used to generate the current fields. The average grid size inside the bay was about 250 meters, increasing to about 500 meters on the inner shelf, and increasing to about 800 meters on the mid- to outer shelf areas. To get a feel for the grid, see the current patterns in Appendix 2. The tail of each arrow starts at the centroid of a triangle.

### 4.1.4. Model Shoreline:

The model shoreline used for beaching and refloating was made up of rectangular boxes. Each box was assigned one of eight shoreline types that defined how quickly oil could refloat from the beach. The shoreline inside the bay was mapped into rectangles that average about 100 meters a side. On the outside the shoreline rectangles increased to about 200 meters to a side.

# 5. *LIMITATIONS*

This is not an oil spill response model but a **planning** tool. TAP II will not tell you how a particular oil spill in the future will move. What it will do is estimate the probability of where oil will go based on 1,000 modeled spills from each of 183 different start sites that incorporate 16 years of geophysical data.

The data used for the model runs come with certain assumptions, and built in time and length scales. These limit the accuracy of the results. The following section discusses how accurate the answers are in probability, time, and space. For San Diego, the accuracy of what went into the model can be divided into two sections, **inside the bay**, and **outside the bay**.

For **inside the bay**, we feel confident that the model winds and currents are representative of the dominating physics. The bay is small enough that our use of a constant wind over space should not introduce large errors. The tidal currents and wind-generated currents we used for inside the bay should reflect the major physics that goes on inside the bay.

The wind data is resolved to the hour and the tides come from the NOS tide tables. This being the case, the answers can not be resolved to better than an hour in time. This means that, if TAP II says oil would come ashore by hour 3, it may get there by hour 2 or hour 4, and if the oil moves at an average velocity of 1/3 of a knot, the answers will be resolved to about 1/3 of a mile in distance.

For **outside the bay**, long-term statistics of currents are unavailable and more assumptions had to be made. As a result, the answers outside of the bay are not as accurate as they are inside of the bay. The shelf off San Diego is broad and fairly flat so it was assumed that wind generated barotropic currents dominated the flow. Further assumptions were made concerning the response of the coastal currents to the local winds.

The wind station used for the offshore analysis is also a potential source of error. The Army Air Field Station used for wind data is located on the east side of the Bay. This station may not always be representative of the winds offshore. It is also known that occasionally a large scale eddy in the wind field off Southern California called the Catalina Eddy results in winds from the south nearshore and from the north offshore. This was not taken into account for the analysis.

The farther offshore you go, the greater the potential for error.

**Computational limitations** required that a finite number of spill scenarios be modeled, and that a finite number of Lagrangian Elements (LEs) to be used in each simulation. These limitations introduce uncertainties in the statistics shown in TAP II. A previous study conducted by NOAA/HAZMAT showed that for a few test sites, the statistics became stable to about 1% with 1000 Lagrangian Elements and 500 simulations. This is the reason for the magic numbers of 500 runs and 1,000 elements. However, the statistical errors could vary for different locations depending upon the variability of the winds and currents.

The oil fate model TAP uses is a simplification of NOAA's ADIOS™ oil fate model. The oil fate is not taken into account during the trajectory model runs. Instead it is done as a post processor step after the trajectory runs are finished. The assumption here is that the spread of the oil is not determined by the type or amount of oil spilled. This is a reasonable assumption for the 3 hr to 5 day time scales of the study.

Each spill is modeled as an instantaneous release. This means that the time it takes for the oil to spill should be short compared to the analysis time.

The amount of oil predicted to come ashore is largely dependent upon the evaporation/dispersion rate of the oil and the beaching and refloating estimates used in the model. The beaching and refloating of the oil was based upon beach refloating half-life parameters for eight different shoreline types. These parameters determine how much oil refloats over time from a given shoreline, and are based on past experience with numerous oil spills. The interactions of spilled substance with sediment and biota were ignored. The increase in the volume of pollutant with emulsification is ignored.

# *6. BIBLIOGRAPHY*

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# *APPENDICES*

# Appendix 1: Statistical Wind Tables

ANNUAL MONTHLY CORRELATION USED TO DETERMINE SEASONALITY

For San Diego Army AirField (1/1/80 - 12/31/96)
Located at 32° 44' N, 117° 10' W

| Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JAN | 1.00 | 1.00 | .97 | .94 | .89 | .91 | .92 | .91 | .95 | .97 | .99 | .99 |
| FEB | 1.00 | 1.00 | .97 | .95 | .91 | .93 | .93 | .91 | .95 | .97 | .98 | .98 |
| MAR | .97 | .97 | 1.00 | .99 | .97 | .97 | .98 | .96 | .97 | .98 | .97 | .95 |
| APR | .94 | .95 | .99 | 1.00 | .98 | .99 | .99 | .97 | .97 | .97 | .95 | .92 |
| MAY | .89 | .91 | .97 | .98 | 1.00 | .99 | .97 | .94 | .93 | .93 | .91 | .86 |
| JUN | .91 | .93 | .97 | .99 | .99 | 1.00 | .99 | .96 | .96 | .95 | .93 | .88 |
| JUL | .92 | .93 | .98 | .99 | .97 | .99 | 1.00 | .99 | .98 | .97 | .94 | .90 |
| AUG | .91 | .91 | .96 | .97 | .94 | .96 | .99 | 1.00 | .99 | .97 | .95 | .90 |
| SEP | .95 | .95 | .97 | .97 | .93 | .96 | .98 | .99 | 1.00 | .99 | .97 | .94 |
| OCT | .97 | .97 | .98 | .97 | .93 | .95 | .97 | .97 | .99 | 1.00 | .99 | .97 |
| NOV | .99 | .98 | .97 | .95 | .91 | .93 | .94 | .95 | .97 | .99 | 1.00 | .99 |
| DEC | .99 | .98 | .95 | .92 | .86 | .88 | .90 | .90 | .94 | .97 | .99 | 1.00 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10889
WIND DIRECTION vs SPEED from raw station data

JAN

| 16 PT. DIR. | SPEED (KNOTS) 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 1.5 | 6.0 | 1.4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.0 | 5.2 |
| NNE | .4 | 1.4 | .6 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 5.8 |
| NE | .4 | 1.3 | .6 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 5.9 |
| ENE | .5 | 1.8 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.9 | 5.3 |
| E | .8 | 2.6 | .6 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.0 | 4.9 |
| ESE | .6 | 2.4 | 1.0 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.3 | 5.7 |
| SE | .5 | 1.7 | .8 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.4 | 6.4 |
| SSE | .3 | 1.6 | 1.3 | .6 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | 4.0 | 7.9 |
| S | .5 | 3.1 | 2.3 | 1.5 | .3 | .1 | 0.0 | .0 | .0 | .0 | .0 | 7.9 | 8.0 |
| SSW | .2 | 1.5 | 1.1 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.0 | 6.8 |
| SW | .3 | 1.4 | 1.5 | .2 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 3.4 | 6.8 |
| WSW | .3 | 1.1 | 1.0 | .3 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 2.8 | 7.2 |
| W | .7 | 1.8 | 1.6 | .9 | .1 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | 5.0 | 7.4 |
| WNW | .8 | 3.7 | 4.9 | 2.3 | .2 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | 12.0 | 8.0 |
| NW | 1.4 | 5.0 | 4.4 | 1.5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.4 | 6.9 |
| NNW | 1.2 | 4.4 | 1.6 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.4 | 5.4 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13.3 | 0 |
| ALL | 10.5 | 40.9 | 25.1 | 8.9 | 1.1 | .2 | 0.0 | .0 | .0 | .0 | .0 | 100.0 | 5.7 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 9936
WIND DIRECTION vs SPEED from raw station data

FEB

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | 1.4 | 5.2 | 1.4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.1 | 5.2 |
| NNE | .3 | 1.4 | .6 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.3 | 5.7 |
| NE | .4 | 1.3 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.2 | 5.5 |
| ENE | .4 | 1.6 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 5.4 |
| E | .8 | 2.5 | .7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.0 | 5.1 |
| ESE | .7 | 2.5 | 1.5 | .3 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 5.0 | 6.3 |
| SE | .5 | 1.4 | 1.2 | .6 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.6 | 7.0 |
| SSE | .3 | 1.4 | 1.1 | .8 | .1 | .1 | .0 | .0 | .0 | .0 | .0 | 3.8 | 8.3 |
| S | .4 | 3.3 | 2.8 | 1.7 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | 8.8 | 8.6 |
| SSW | .2 | 1.5 | 1.8 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.0 | 7.1 |
| SW | .2 | 1.2 | 1.8 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 3.7 | 7.7 |
| WSW | .3 | 1.3 | 1.4 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.4 | 7.2 |
| W | .4 | 1.7 | 2.1 | 1.0 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 5.2 | 7.8 |
| WNW | .6 | 3.4 | 5.8 | 3.0 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.8 | 8.2 |
| NW | 1.0 | 4.5 | 4.8 | 2.0 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.4 | 7.4 |
| NNW | 1.0 | 3.9 | 1.7 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.0 | 5.8 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11.2 | 0 |
| ALL | 8.7 | 37.7 | 29.5 | 11.5 | 1.1 | .2 | .0 | .0 | .0 | .0 | .0 | 100.0 | 6.2 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10911
WIND DIRECTION vs SPEED from raw station data

MAR

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | 1.1 | 5.0 | 1.4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.6 | 5.3 |
| NNE | .4 | 1.4 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.2 | 5.0 |
| NE | .3 | 1.1 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.8 | 5.3 |
| ENE | .3 | 1.5 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.2 | 5.3 |
| E | .6 | 2.2 | .7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.6 | 5.2 |
| ESE | .3 | 1.8 | 1.2 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.5 | 6.1 |
| SE | .3 | 1.0 | .7 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 2.4 | 7.3 |
| SSE | .2 | 1.1 | 1.0 | .6 | .2 | .1 | 0.0 | .0 | .0 | .0 | .0 | 3.1 | 8.7 |
| S | .3 | 2.8 | 3.3 | 1.3 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | 8.3 | 8.5 |
| SSW | .1 | 1.7 | 2.1 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 4.5 | 7.6 |
| SW | .1 | 1.7 | 2.3 | 1.0 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 5.1 | 8.0 |
| WSW | .2 | 1.4 | 2.2 | .9 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 4.8 | 8.1 |
| W | .2 | 1.8 | 3.4 | 2.5 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | 8.3 | 9.3 |
| WNW | .5 | 3.6 | 6.8 | 5.2 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | 16.5 | 9.0 |
| NW | .8 | 4.1 | 5.0 | 2.8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.7 | 7.9 |
| NNW | .9 | 3.0 | 1.6 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.7 | 5.7 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.6 | 0 |
| ALL | 6.7 | 35.1 | 33.0 | 15.7 | 1.7 | .2 | 0.0 | .0 | .0 | .0 | .0 | 100.0 | 7.0 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10559
WIND DIRECTION vs SPEED from raw station data

APR

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | 1.2 | 4.7 | 1.0 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.0 | 5.1 |
| NNE | .4 | 1.5 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.3 | 5.1 |
| NE | .3 | 1.2 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.7 | 4.8 |
| ENE | .4 | 1.1 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.6 | 4.7 |
| E | .5 | 1.5 | .6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 5.0 |
| ESE | .2 | 1.4 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 5.9 |
| SE | .2 | .8 | .6 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.8 | 6.4 |
| SSE | .1 | 1.1 | 1.1 | .3 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 2.6 | 7.3 |
| S | .3 | 2.9 | 4.8 | 1.1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.0 | 7.6 |
| SSW | .2 | 1.9 | 3.0 | .8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 6.0 | 7.7 |
| SW | .1 | 2.1 | 3.4 | .9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 6.5 | 7.8 |
| WSW | .1 | 1.4 | 2.8 | .6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.0 | 7.7 |
| W | .4 | 2.5 | 5.0 | 2.7 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 10.5 | 8.6 |
| WNW | .4 | 4.1 | 8.7 | 5.3 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | 18.7 | 8.8 |
| NW | .5 | 4.1 | 5.2 | 2.6 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 12.3 | 8.0 |
| NNW | .6 | 2.9 | 1.7 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.5 | 6.1 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4.5 | 0 |
| ALL | 5.7 | 35.1 | 39.4 | 15.0 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 7.1 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10912
WIND DIRECTION vs SPEED from raw station data

MAY

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | .5 | 3.4 | 1.0 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.0 | 5.4 |
| NNE | .3 | 1.7 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.3 | 5.0 |
| NE | .2 | .8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.0 | 4.6 |
| ENE | .2 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.1 | 4.8 |
| E | .2 | 1.0 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.5 | 5.1 |
| ESE | .1 | .9 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.3 | 5.4 |
| SE | .1 | .5 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .9 | 5.7 |
| SSE | .1 | 1.0 | .7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.9 | 6.6 |
| S | .3 | 4.0 | 5.3 | .8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 10.4 | 7.3 |
| SSW | .1 | 3.1 | 4.1 | .6 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.0 | 7.4 |
| SW | .1 | 3.3 | 5.3 | 1.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.6 | 7.6 |
| WSW | .2 | 3.0 | 4.4 | 1.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.6 | 7.6 |
| W | .2 | 3.2 | 5.9 | 2.7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.2 | 8.4 |
| WNW | .3 | 4.9 | 8.3 | 4.7 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 18.3 | 8.5 |
| NW | .4 | 3.8 | 5.2 | 2.6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 12.1 | 8.1 |
| NNW | .3 | 2.2 | 1.3 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.0 | 6.2 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 | 0 |
| ALL | 3.6 | 37.6 | 42.8 | 13.9 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 7.4 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10560
WIND DIRECTION vs SPEED from raw station data

JUN

| 16 PT. DIR. | SPEED (KNOTS) 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | .4 | 3.9 | 1.5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.8 | 5.6 |
| NNE | .2 | 1.5 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.0 | 5.3 |
| NE | .2 | .6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .9 | 4.7 |
| ENE | .1 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .7 | 5.1 |
| E | .2 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .7 | 4.5 |
| ESE | .1 | .4 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .7 | 5.4 |
| SE | .1 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .7 | 5.2 |
| SSE | .1 | .9 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.8 | 6.5 |
| S | .1 | 4.3 | 5.6 | 1.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 11.0 | 7.3 |
| SSW | .1 | 2.9 | 4.4 | .8 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.2 | 7.5 |
| SW | .1 | 3.5 | 5.4 | .9 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.9 | 7.5 |
| WSW | .1 | 2.9 | 3.8 | .5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.4 | 7.3 |
| W | .3 | 3.6 | 4.6 | 1.6 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 10.2 | 7.7 |
| WNW | .3 | 5.9 | 9.6 | 4.5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 20.2 | 8.3 |
| NW | .4 | 4.9 | 5.8 | 2.3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 13.5 | 7.7 |
| NNW | .3 | 3.0 | 1.7 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.1 | 6.2 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.3 | 0 |
| ALL | 3.0 | 39.9 | 44.0 | 11.8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 7.2 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 10912
WIND DIRECTION vs SPEED from raw station data

JUL

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | .5 | 5.3 | 1.7 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.6 | 5.5 |
| NNE | .2 | 1.7 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.4 | 5.2 |
| NE | .1 | .6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .8 | 4.8 |
| ENE | .1 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .6 | 4.7 |
| E | .1 | .2 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .4 | 4.4 |
| ESE | .1 | .2 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .4 | 4.9 |
| SE | 0.0 | .3 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .5 | 5.7 |
| SSE | .1 | .6 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.2 | 6.1 |
| S | .2 | 4.1 | 5.3 | .8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 10.4 | 7.2 |
| SSW | .1 | 3.1 | 4.0 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.7 | 7.1 |
| SW | .1 | 3.1 | 5.0 | .5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.7 | 7.4 |
| WSW | .1 | 2.2 | 2.9 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.5 | 7.0 |
| W | .3 | 3.1 | 4.9 | 1.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.3 | 7.4 |
| WNW | .3 | 6.4 | 10.6 | 5.3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 22.7 | 8.3 |
| NW | .4 | 5.4 | 6.7 | 2.3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 14.8 | 7.6 |
| NNW | .4 | 3.4 | 2.0 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.9 | 6.2 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.2 | 0 |
| ALL | 3.3 | 40.3 | 44.3 | 10.9 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 7.1 |

San Diego Army Air Field(1/1/80 - 12/31/96)

LAT 32 44.0 LONG 117 10.0 : Total number of data points = 11406
WIND DIRECTION vs SPEED from raw station data

AUG

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | .8 | 6.2 | 1.8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.8 | 5.4 |
| NNE | .4 | 2.4 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.3 | 5.2 |
| NE | .1 | .9 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.1 | 4.9 |
| ENE | .1 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .5 | 5.0 |
| E | .1 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .6 | 5.1 |
| ESE | 0.0 | .2 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .4 | 5.3 |
| SE | .1 | .3 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .4 | 5.1 |
| SSE | 0.0 | .7 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.1 | 6.0 |
| S | .2 | 3.3 | 3.4 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.3 | 6.8 |
| SSW | .2 | 2.5 | 3.0 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.9 | 7.0 |
| SW | .2 | 2.4 | 3.2 | .5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 6.3 | 7.1 |
| WSW | .2 | 2.0 | 2.0 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.5 | 6.7 |
| W | .3 | 3.5 | 4.4 | 1.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.1 | 7.3 |
| WNW | .4 | 7.5 | 11.9 | 5.6 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 25.4 | 8.3 |
| NW | .5 | 6.3 | 7.2 | 2.8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 16.9 | 7.6 |
| NNW | .6 | 3.8 | 2.2 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 6.8 | 6.0 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.6 | 0 |
| ALL | 4.2 | 42.8 | 40.4 | 11.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 7.0 |

SPEED (KNOTS)

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 11036
WIND DIRECTION vs SPEED from raw station data

SEP

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | .9 | 7.0 | 1.7 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.7 | 5.3 |
| NNE | .4 | 2.6 | .5 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.5 | 5.1 |
| NE | .2 | 1.0 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.4 | 4.9 |
| ENE | .4 | .6 | .1 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.1 | 4.7 |
| E | .3 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.2 | 4.6 |
| ESE | .1 | .6 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .9 | 5.3 |
| SE | .1 | .4 | .1 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | .7 | 5.8 |
| SSE | .1 | .9 | .6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.7 | 6.4 |
| S | .3 | 3.7 | 3.5 | .9 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.4 | 7.1 |
| SSW | .2 | 1.9 | 2.2 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.7 | 7.0 |
| SW | .1 | 2.1 | 2.6 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.3 | 7.0 |
| WSW | .1 | 1.4 | 1.8 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.6 | 7.0 |
| W | .2 | 2.7 | 3.6 | 1.2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.7 | 7.6 |
| WNW | .5 | 6.2 | 9.7 | 4.9 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 21.2 | 8.2 |
| NW | .8 | 6.7 | 7.1 | 3.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 17.6 | 7.5 |
| NNW | .6 | 4.5 | 2.6 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 8.1 | 6.0 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.2 | 0 |
| ALL | 5.3 | 43.3 | 36.7 | 11.4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 6.8 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 11408
WIND DIRECTION vs SPEED from raw station data

OCT

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N | 1.7 | 6.8 | 1.2 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.9 | 5.0 |
| NNE | .5 | 2.3 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.4 | 5.1 |
| NE | .4 | 1.4 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.1 | 5.0 |
| ENE | .4 | 1.4 | .3 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.2 | 5.1 |
| E | .5 | 1.7 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 4.8 |
| ESE | .3 | 1.4 | .8 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.6 | 5.6 |
| SE | .2 | 1.0 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 1.7 | 5.7 |
| SSE | .1 | 1.5 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 6.3 |
| S | .4 | 3.6 | 3.4 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.8 | 6.6 |
| SSW | .2 | 1.9 | 2.0 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.4 | 6.7 |
| SW | .3 | 2.0 | 2.4 | .4 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.0 | 6.9 |
| WSW | .2 | 1.7 | 1.5 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.8 | 6.8 |
| W | .2 | 2.4 | 2.4 | .8 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 5.9 | 7.4 |
| WNW | .5 | 4.4 | 7.4 | 3.5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 15.9 | 8.2 |
| NW | 1.1 | 5.5 | 5.7 | 2.6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 14.9 | 7.4 |
| NNW | 1.2 | 4.4 | 1.8 | .3 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 7.6 | 5.5 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7.9 | 0 |
| ALL | 8.4 | 43.5 | 31.0 | 9.0 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 100.0 | 6.1 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 11040
WIND DIRECTION vs SPEED from raw station data

NOV

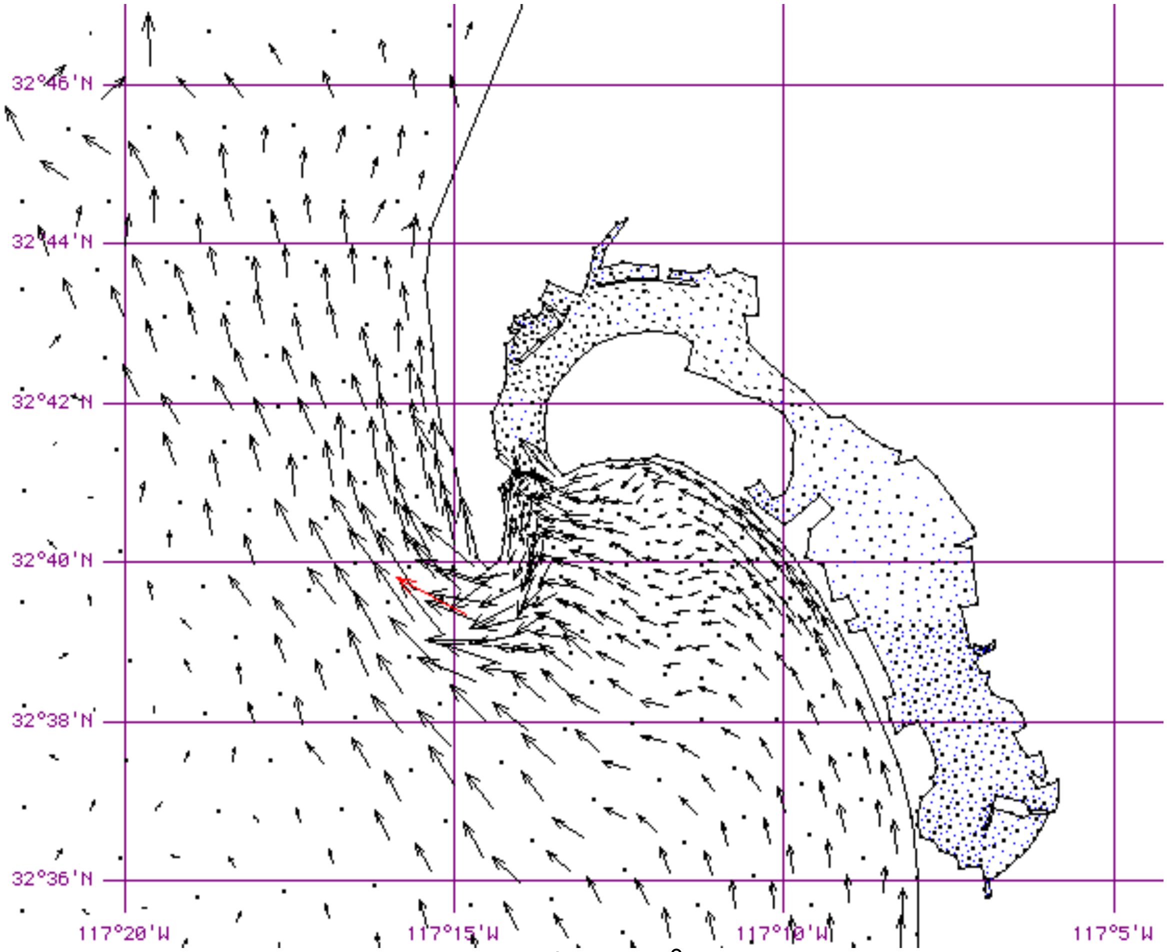
| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | 2.3 | 6.3 | 1.1 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.8 | 4.8 |
| NNE | .6 | 2.0 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.0 | 4.9 |
| NE | .5 | 1.9 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.8 | 5.2 |
| ENE | .6 | 1.9 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.9 | 4.8 |
| E | 1.0 | 2.7 | .5 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.2 | 4.7 |
| ESE | .6 | 2.6 | 1.0 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.4 | 5.5 |
| SE | .4 | 1.4 | .7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.6 | 5.6 |
| SSE | .3 | 1.2 | .9 | .3 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.7 | 6.7 |
| S | .4 | 3.3 | 2.0 | .7 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 6.5 | 6.9 |
| SSW | .2 | 1.9 | 1.0 | .2 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 3.3 | 6.4 |
| SW | .2 | 1.6 | 1.5 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.5 | 6.8 |
| WSW | .3 | 1.6 | 1.4 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.4 | 6.5 |
| W | .4 | 2.1 | 2.1 | .8 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 5.6 | 7.6 |
| WNW | .6 | 3.7 | 6.1 | 2.5 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | 13.1 | 8.1 |
| NW | 1.0 | 5.0 | 5.0 | 1.9 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 13.0 | 7.2 |
| NNW | 1.3 | 4.2 | 1.7 | .3 | 0.0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 7.6 | 5.5 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11.7 | 0 |
| ALL | 10.8 | 43.5 | 25.9 | 7.6 | .5 | .1 | .0 | .0 | .0 | .0 | .0 | 100.0 | 5.6 |

San Diego Army Air Field(1/1/80 - 12/31/96)
LAT 32 44.0 LONG 117 10.0 : Total number of data points = 11408
WIND DIRECTION vs SPEED from raw station data

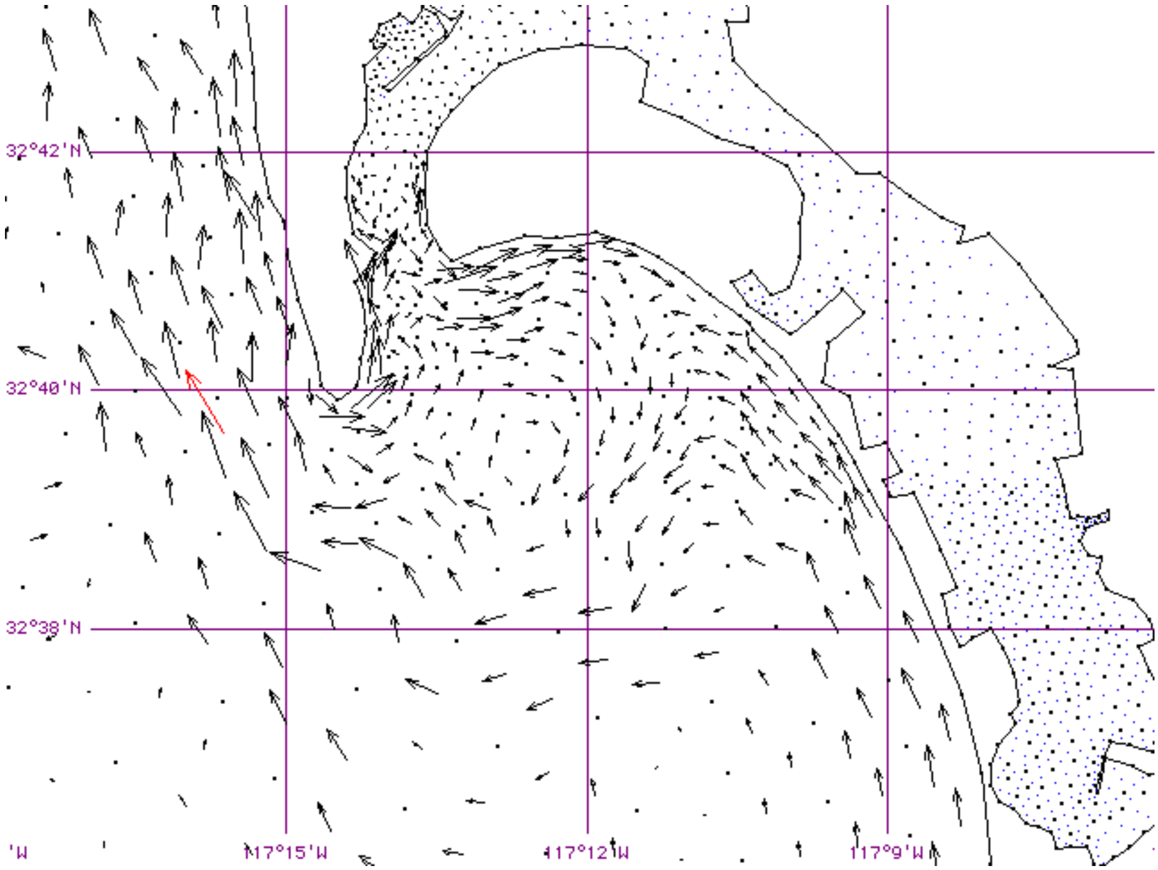
DEC

| 16 PT. DIR. | 1 - 3 | 4 - 6 | 7-10 | 11-16 | 17-21 | 22-27 | 28-33 | 34-40 | 41-47 | 48-55 | >=56 | TOTAL PERCNT | MEAN WIND SPEED |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SPEED (KNOTS) | | | | | | | | | | | | |
| N | 2.0 | 6.1 | 1.1 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 9.4 | 5.0 |
| NNE | .6 | 1.4 | .4 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.6 | 5.1 |
| NE | .4 | 1.5 | .6 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.7 | 5.9 |
| ENE | .6 | 1.8 | .5 | .1 | .0 | 0.0 | .0 | .0 | .0 | .0 | .0 | 2.9 | 5.2 |
| E | 1.0 | 2.9 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.8 | 5.0 |
| ESE | .8 | 2.4 | 1.3 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 4.7 | 5.7 |
| SE | .5 | 1.6 | .8 | .4 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.3 | 6.2 |
| SSE | .3 | 1.3 | 1.2 | .6 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | 3.5 | 7.5 |
| S | .6 | 3.0 | 2.1 | .7 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 6.6 | 6.8 |
| SSW | .2 | 1.5 | 1.2 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | .0 | 3.1 | 6.5 |
| SW | .2 | 1.1 | 1.2 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.7 | 6.5 |
| WSW | .3 | 1.3 | .8 | .1 | .0 | .0 | .0 | .0 | .0 | .0 | .0 | 2.5 | 6.0 |
| W | .5 | 1.8 | 1.5 | .5 | .1 | 0.0 | .0 | .0 | .0 | .0 | .0 | 4.5 | 7.1 |
| WNW | 1.0 | 3.9 | 4.4 | 1.8 | .2 | 0.0 | .0 | .0 | .0 | .0 | .0 | 11.3 | 7.6 |
| NW | 1.2 | 4.7 | 4.3 | 1.3 | .2 | .1 | .0 | .0 | .0 | .0 | .0 | 11.7 | 7.0 |
| NNW | 1.4 | 4.6 | 1.3 | .3 | .2 | .0 | .0 | .0 | .0 | .0 | .0 | 7.8 | 5.6 |
| VAR | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CLM | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16.0 | 0 |
| ALL | 11.6 | 41.1 | 23.6 | 6.7 | .9 | .1 | .0 | .0 | .0 | .0 | .0 | 100.0 | 5.3 |

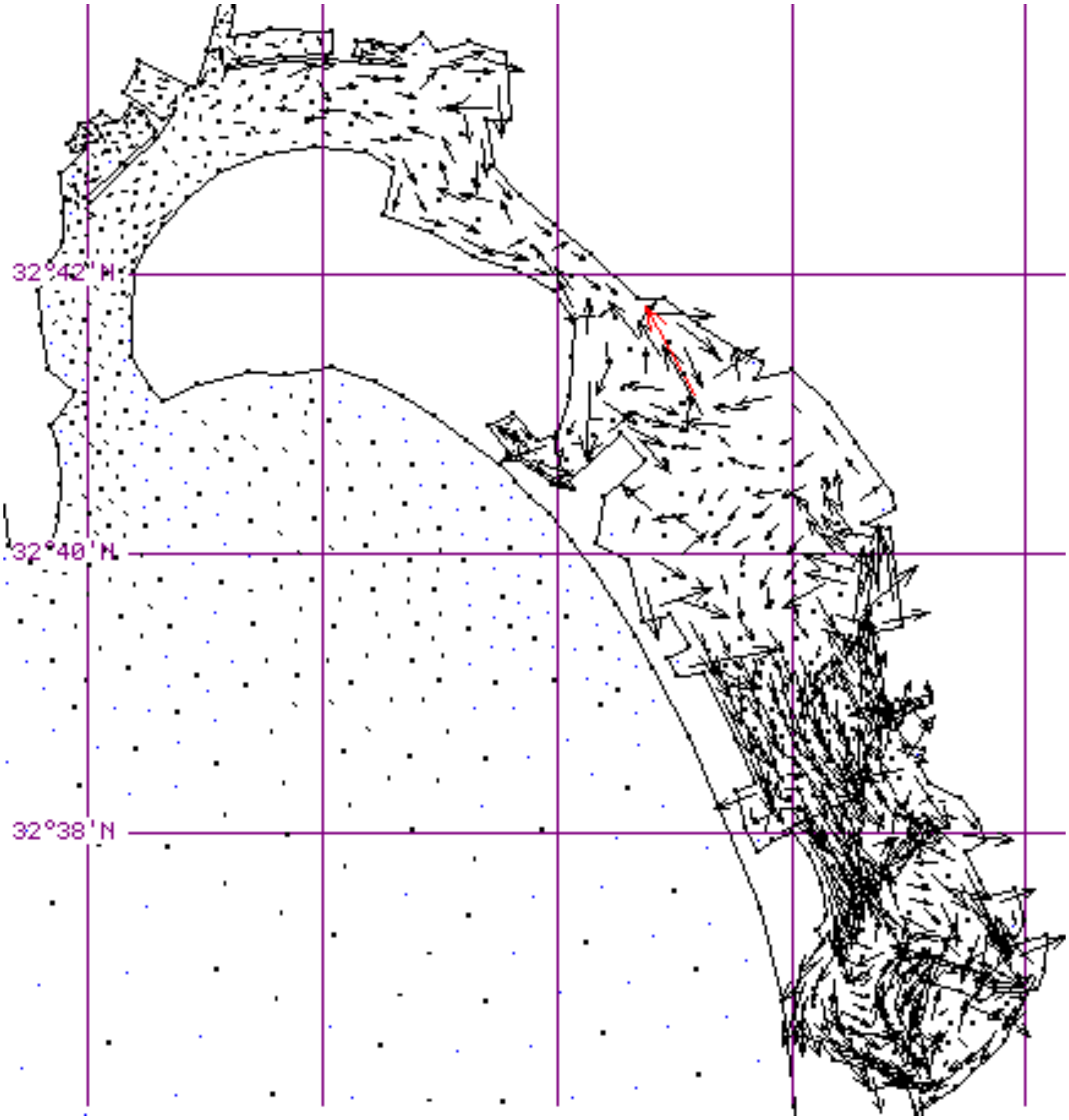
# Appendix 2: Current Patterns



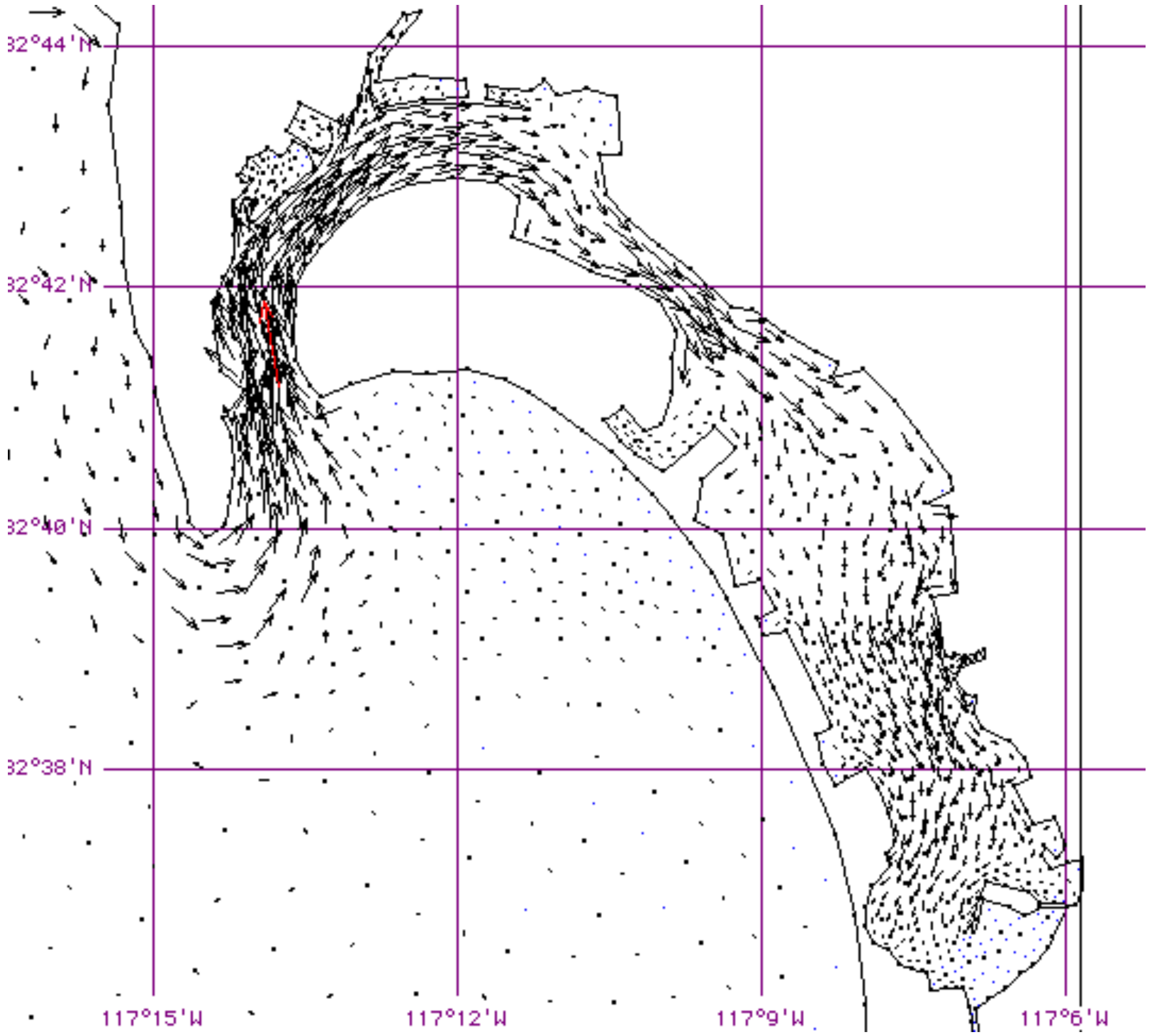
Current pattern driven by along shore wind from 128°T




Current pattern driven by wind perpendicular to shore from 218° T. Note gyre outside of the bay.




Wind driven current pattern inside of the bay. Wind was from 338 ° T for pattern.




Flood tide current pattern for San Diego Bay.

# Appendix 3: Receptor Sites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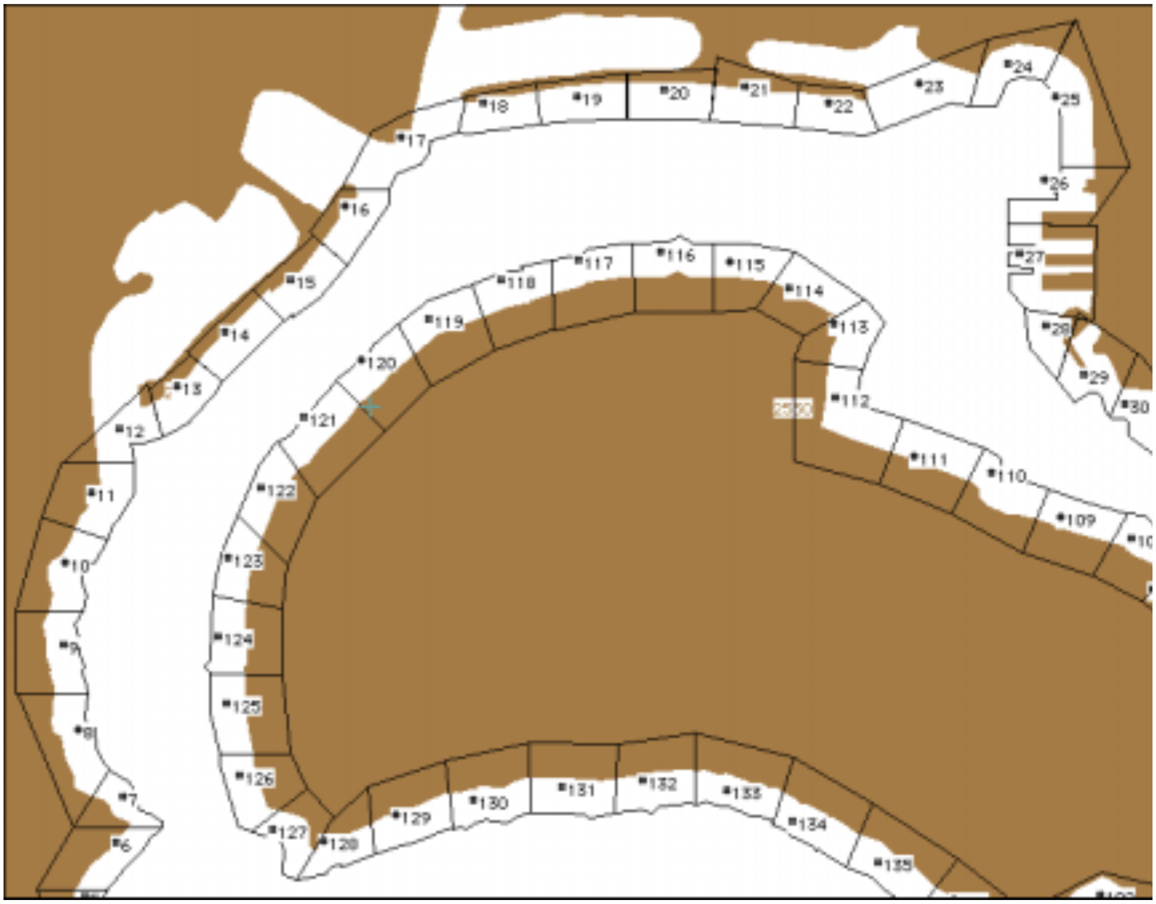
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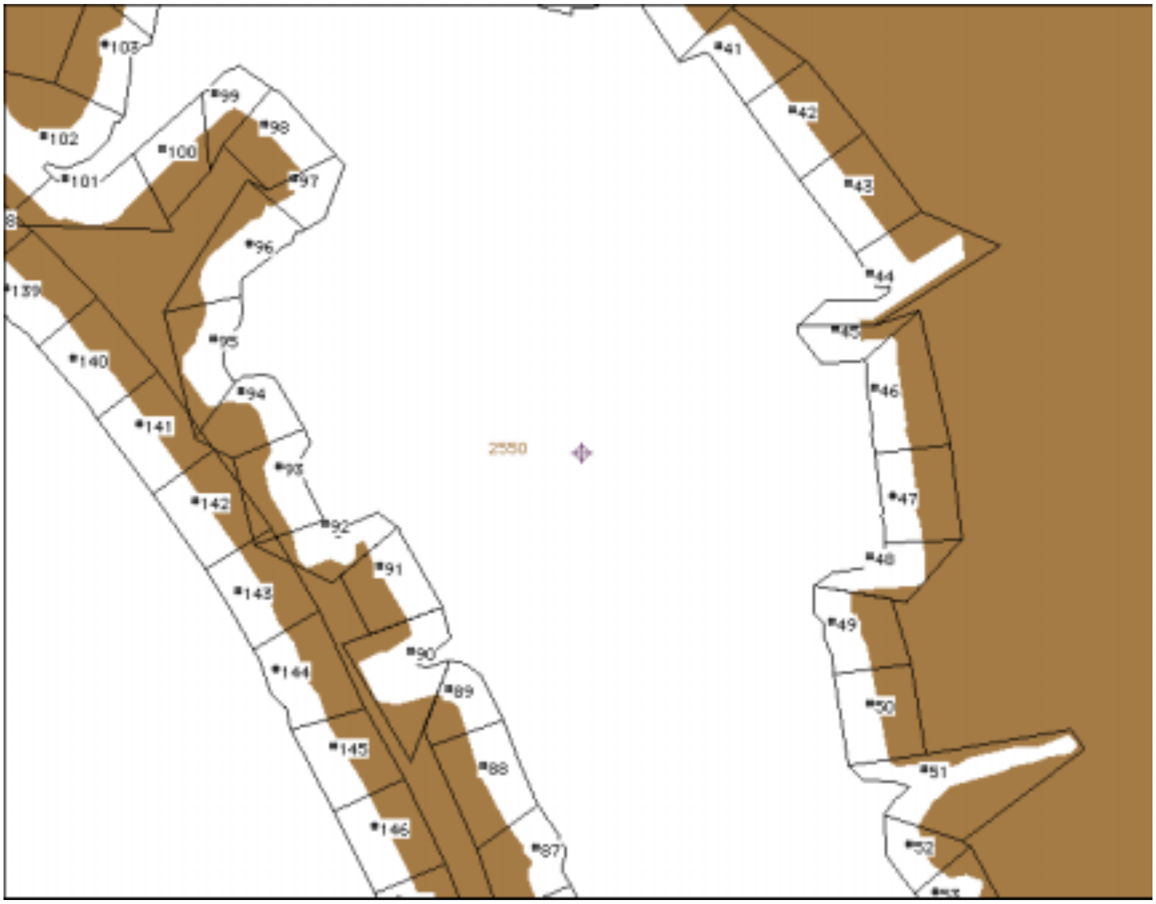
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