ALASKA
WIND PROSPECTING
VILLAGE SCALE

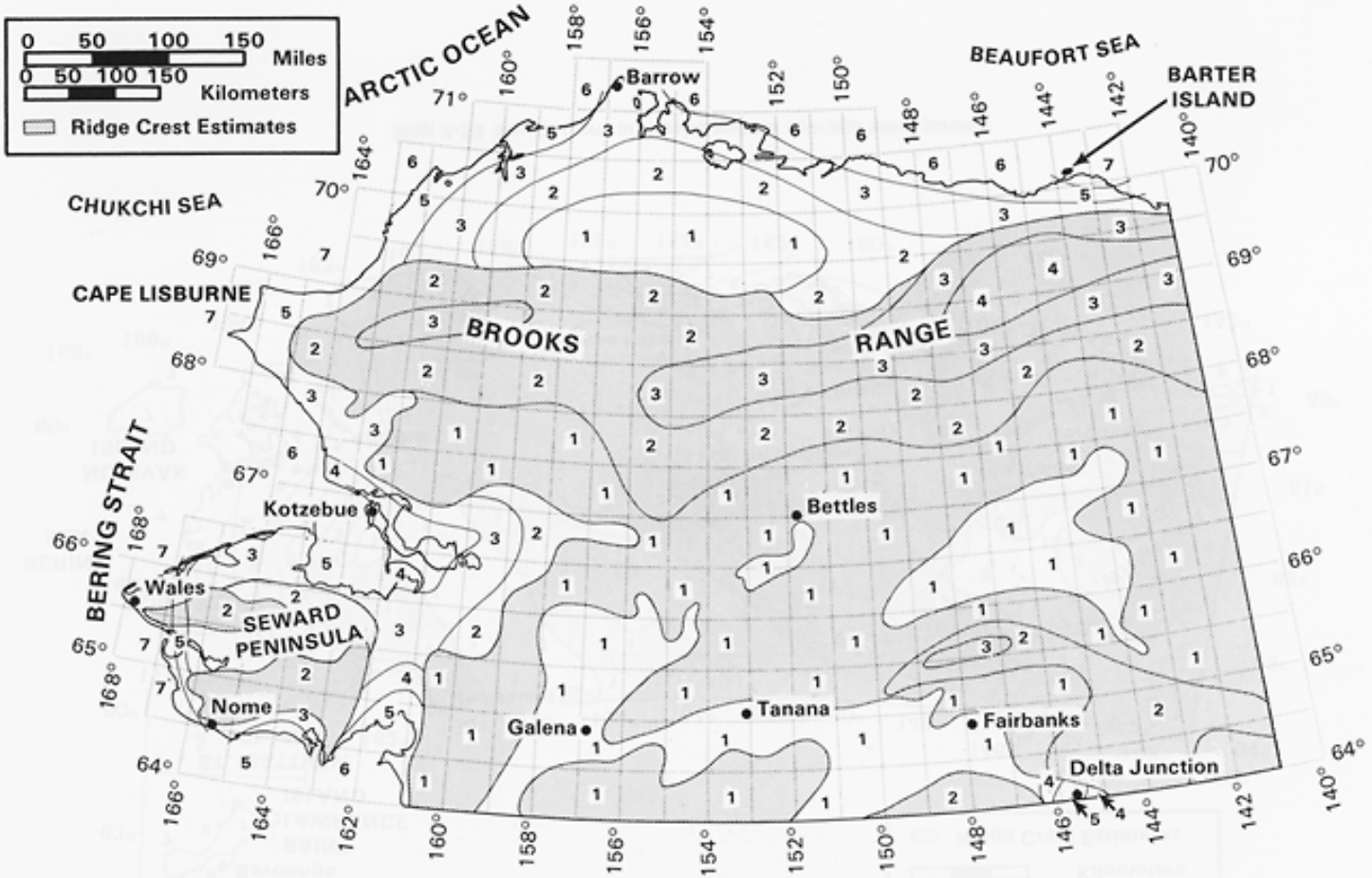
How do you prospect for the wind?

Who has seen the wind?
Neither you nor I
But when the trees bow down their heads
The wind is passing by.
Christina Rosetti

- Climatological Study
- Prospecting Survey
- Measure the Wind
- Assess the Wind Resource

What is Climatology?

- Wind data collected by the National Weather Service, Coast Guard and the FAA
- National Renewable Energy Laboratory (NREL) studies of wind power
- Alaska Wind Map


0 50 100 150 Miles
0 50 100 150 Kilometers
Ridge Crest Estimates
ARCTIC OCEAN
BEAUFORT SEA
BARTER ISLAND
Barrow
CHUKCHI SEA
CAPE LISBURNE
BROOKS RANGE
BERING STRAIT
Kotzebue
Bettles
Wales
SEWARD PENINSULA
Nome
Galena
Tanana
Fairbanks
Delta Junction
71°
70°
69°
68°
67°
66°
65°
64°
164°
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158°
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154°
152°
150°
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146°
144°
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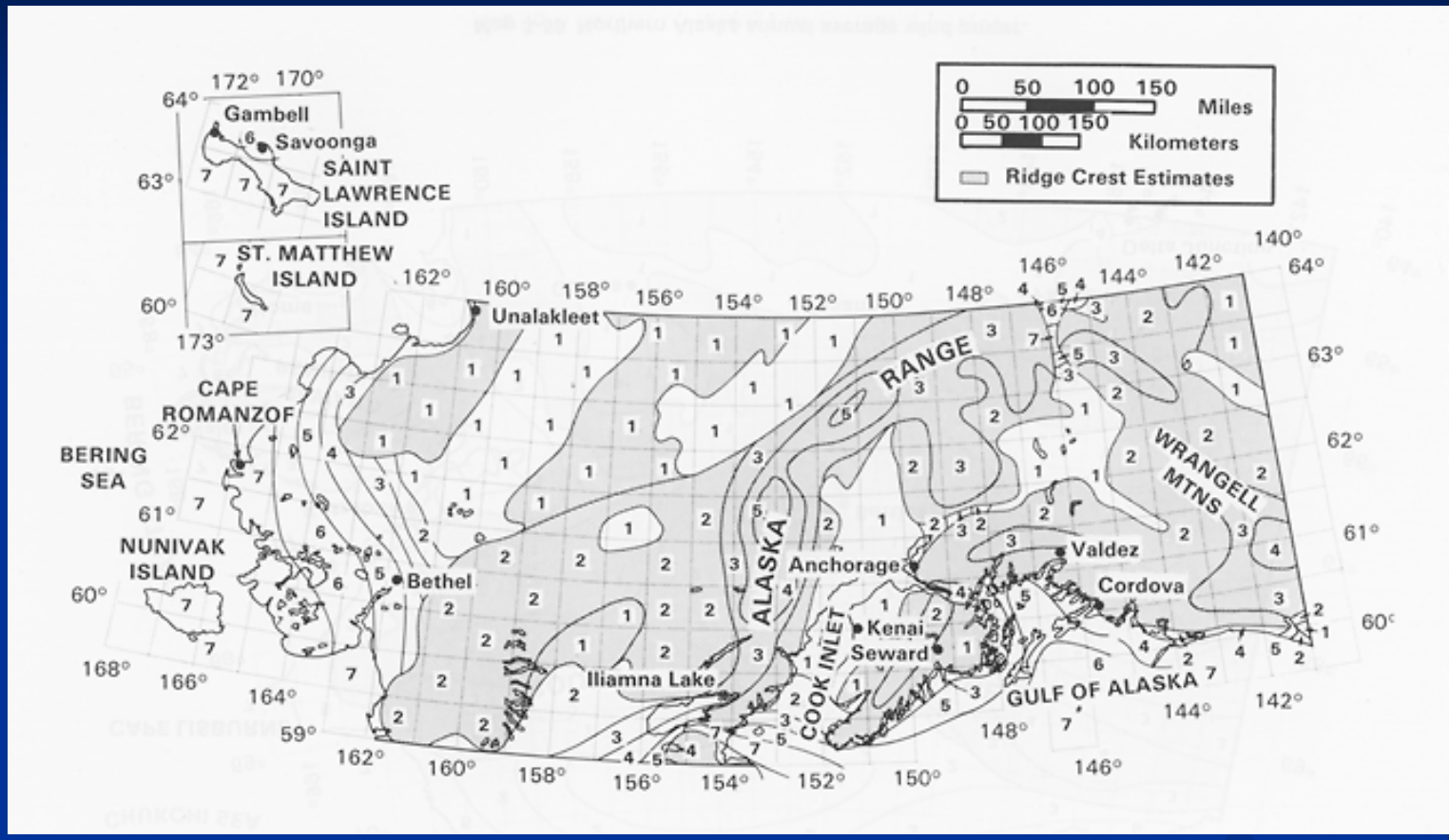
0 50 100 150
Miles
0 50 100 150
Kilometers
Ridge Crest Estimates
Gambell
Savoonga
SAINT LAWRENCE ISLAND
ST. MATTHEW ISLAND
Unalakleet
CAPE ROMANZOF
BERING SEA
NUNIVAK ISLAND
Bethel
Iliamna Lake
ALASKA RANGE
Anchorage
Valdez
Cordova
Kenai
Seward
COOK INLET
GULF OF ALASKA
WRANGELL MTNS
172° 170°
64°
63°
60°
173°
162°
160°
158°
156°
154°
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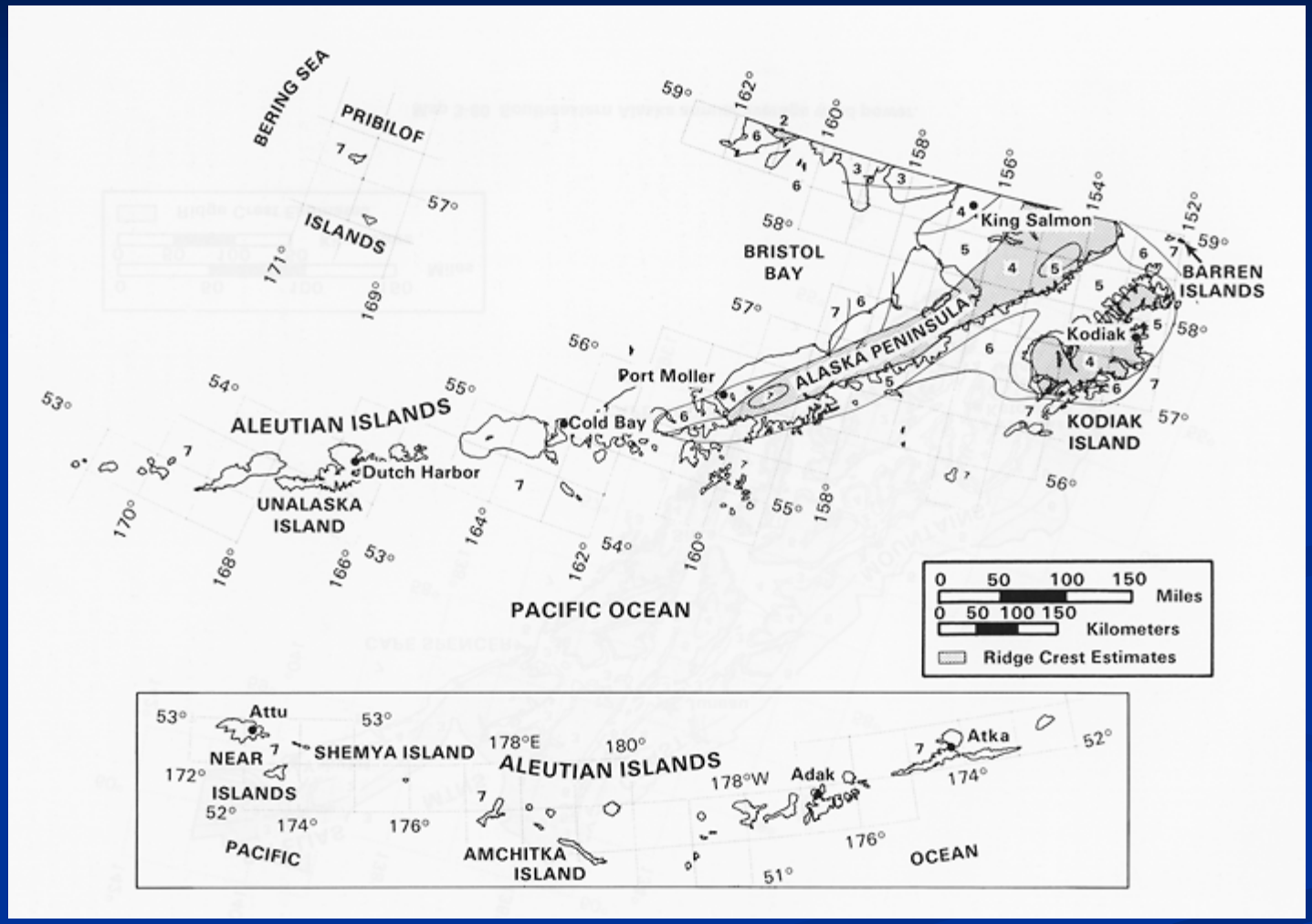
BERING SEA
PRIBILOF ISLANDS
BRISTOL BAY
King Salmon
BARREN ISLANDS
ALASKA PENINSULA
Kodiak
KODIAK ISLAND
Port Moller
Cold Bay
ALEUTIAN ISLANDS
Dutch Harbor
UNALASKA ISLAND
PACIFIC OCEAN
0 50 100 150 Miles
0 50 100 150 Kilometers
Ridge Crest Estimates
Attu
NEAR ISLANDS
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ALEUTIAN ISLANDS
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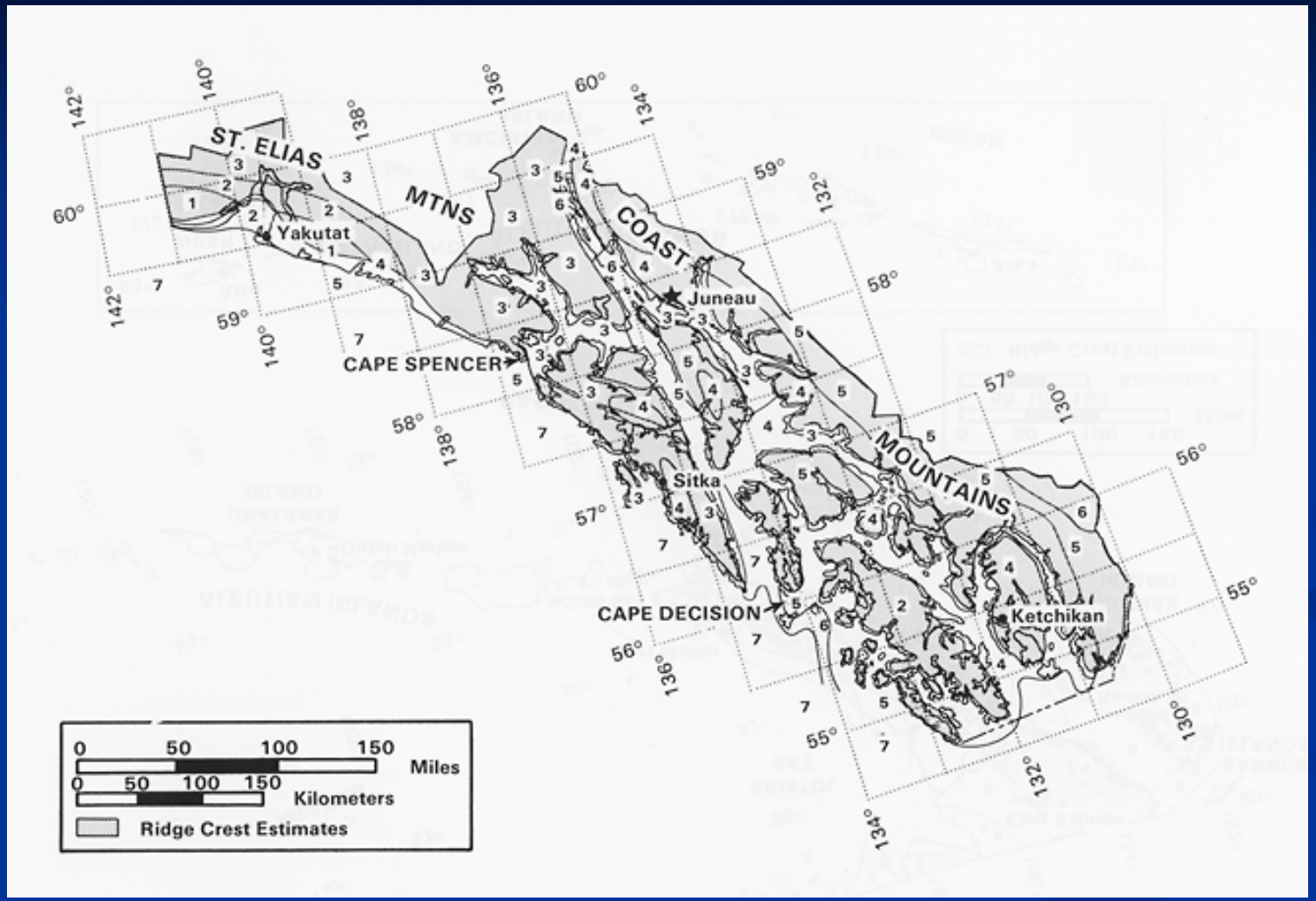
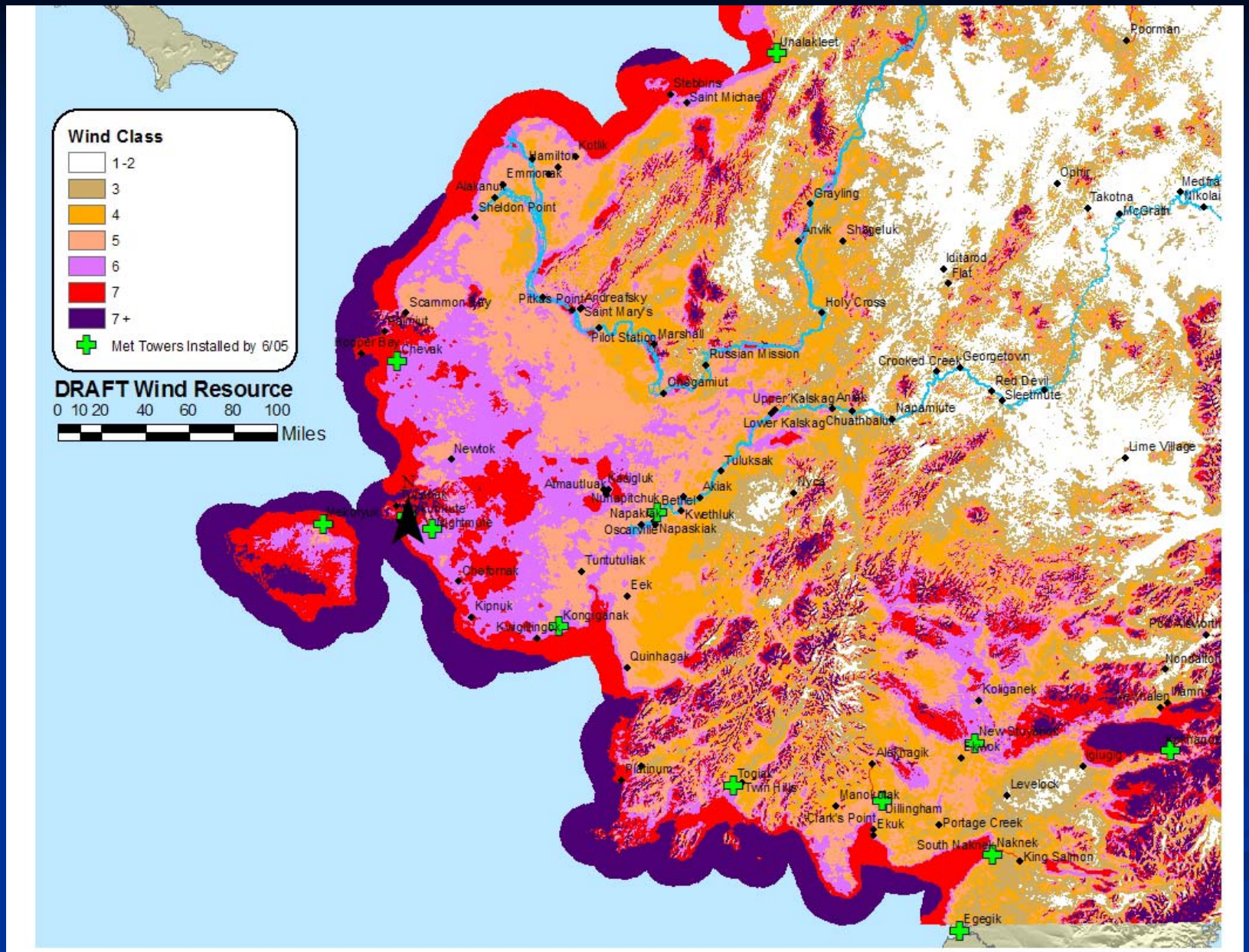
AMCHITKA ISLAND
PACIFIC OCEAN


ST. ELIAS
MTNS
COAST
MOUNTAINS
Yakutat
Juneau
Sitka
Ketchikan
CAPE SPENCER
CAPE DECISION
0 50 100 150
Miles
0 50 100 150
Kilometers
Ridge Crest Estimates


Wind Class
1-2
3
4
5
6
7
7+
Met Towers Installed by 6/05
DRAFT Wind Resource
0 10 20 40 60 80 100
Miles
Unalakleet
Poorman
Stebbins
Saint Michael
Kotlik
Hamilton
Emmonak
Alakanuk
Sheldon Point
Grayling
Ophir
Takotna
McGrath
Medfra
Nikolai
Anvik
Shageluk
Iditarod
Flat
Holy Cross
Scammon Bay
Hooper Bay
Chevak
Pitkas Point
Andreafsky
Saint Mary's
Pilot Station
Marshall
Russian Mission
Crooked Creek
Georgetown
Red Devil
Sleetmute
Napamiute
Upper Kalskag
Lower Kalskag
Aniak
Chuathbaluk
Oscarville
Bethel
Napaskiak
Kwethluk
Akiak
Kasigluk
Nunapitchuk
Atmautluak
Tuluksak
Nyac
Lime Village
Newtok
Tuntutuliak
Eek
Chefornak
Kipnuk
Kongiganak
Quinhagak
Koliganek
New Stuyahok
Ekwok
Togiak
Twin Hills
Manokotak
Dillingham
Ekuk
Clark's Point
Portage Creek
Levelock
South Naknek
Naknek
King Salmon
Egegik

How do you find something that is invisible like wind?

What makes a good wind site?

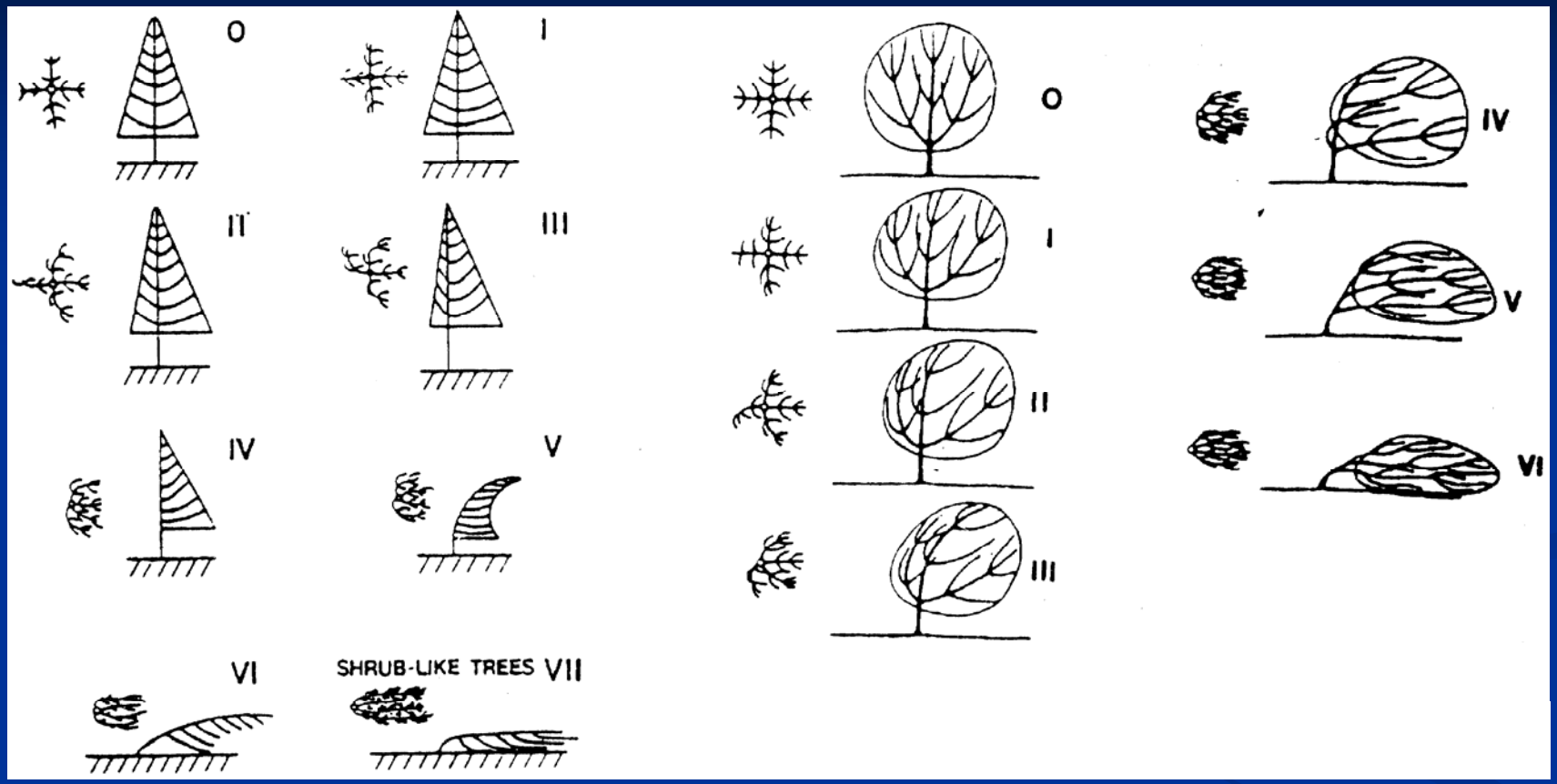
- Strong steady winds
- Good exposure to the wind
- Ridgelines oriented perpendicular to the prevailing wind direction
- Low surface roughness or lack of vegetation

THE WIND PROSPECTOR'S TOOLS AND CLUES

- Wind shaped trees and bushes
- Plants and trees characteristic of wind zones
- Persistent snow sweep
- Topographic features that favor the wind
- Judging wind exposure

THE WIND PROSPECTOR'S TOOLS AND CLUES (continued)

- Talking with local people
- Satellite Imagery
- Aerial surveys
- Ground level Inspection
- Three dimensional Analysis
- Wind Measurement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I
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III
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V
VI
SHRUB-LIKE TREES VII
0
I
II
III
IV
V
VI


Winter Trl
CITY BOUNDARY
Bethel
Hangar Lake
H-Marker Lake
Borrow Pit
Cabin
Radio Tower
Borrow Pits
Airway Beacon
Municipal Airport
Park
Hosp
Prison
Steamboat Slough
Straight Slough
Church Slough
KUSKOKWIM RIVER
Tidal Flat
TUPUKNUK
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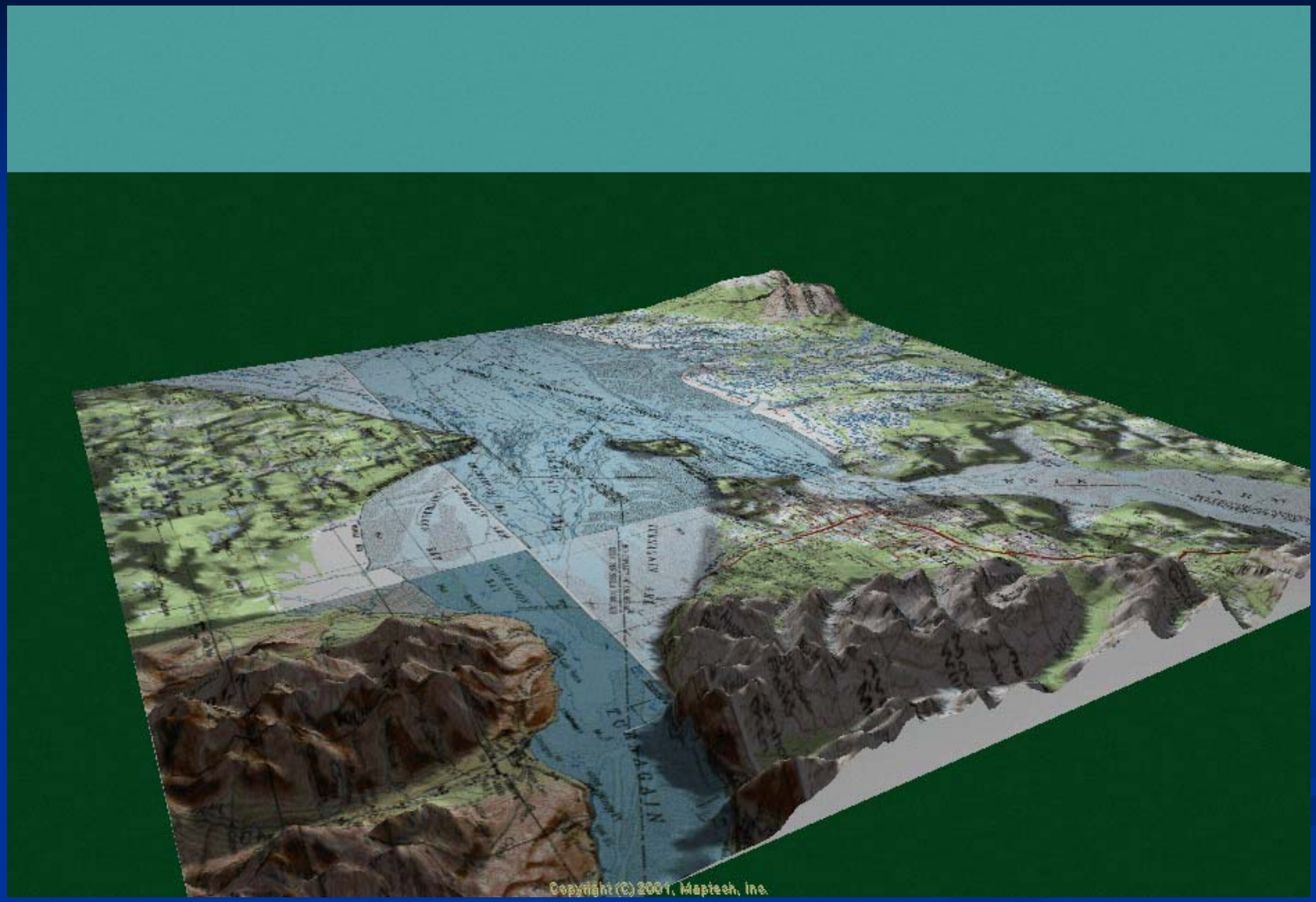
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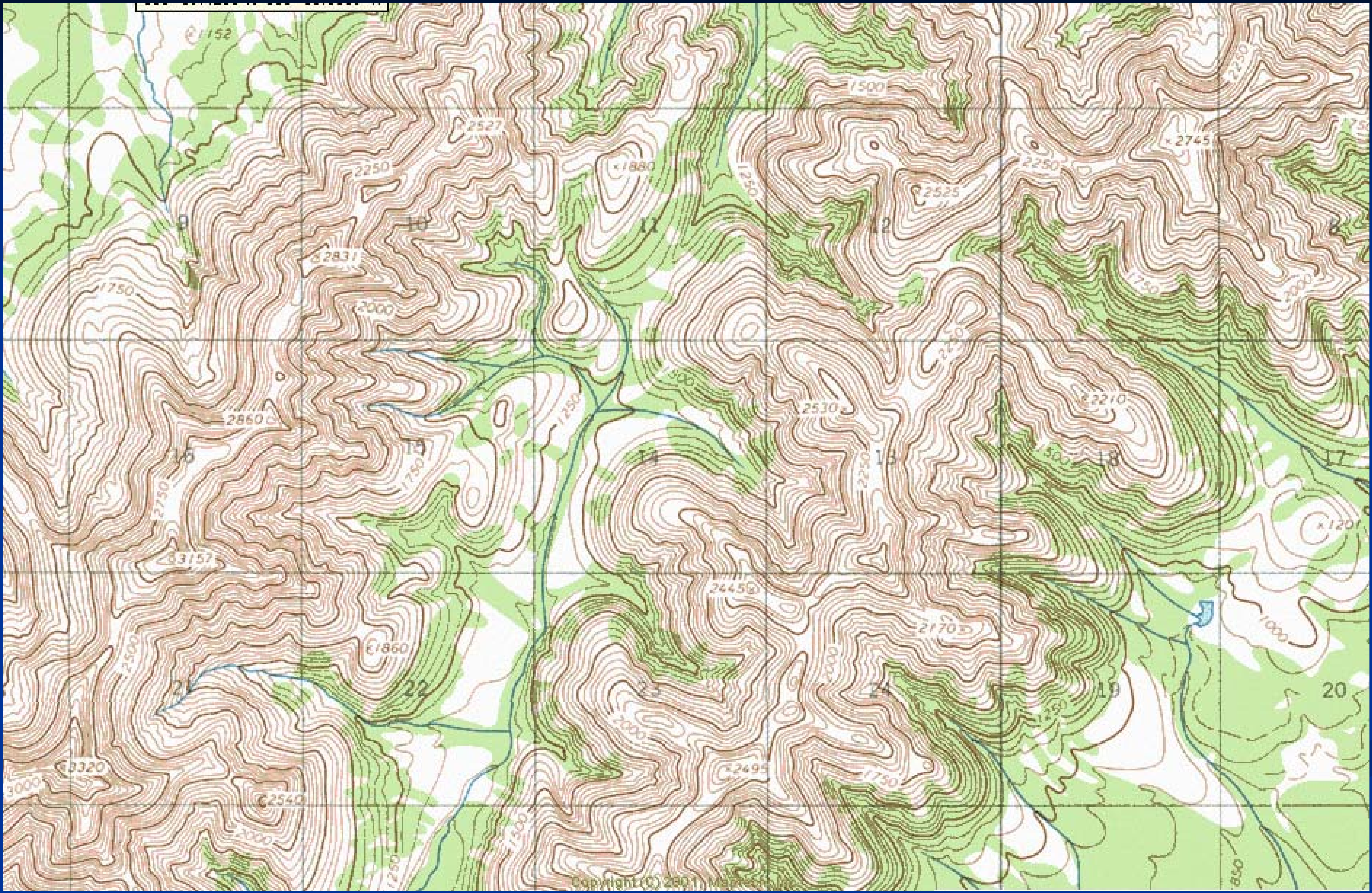

1152
2527
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1201
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2170
1860
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1000
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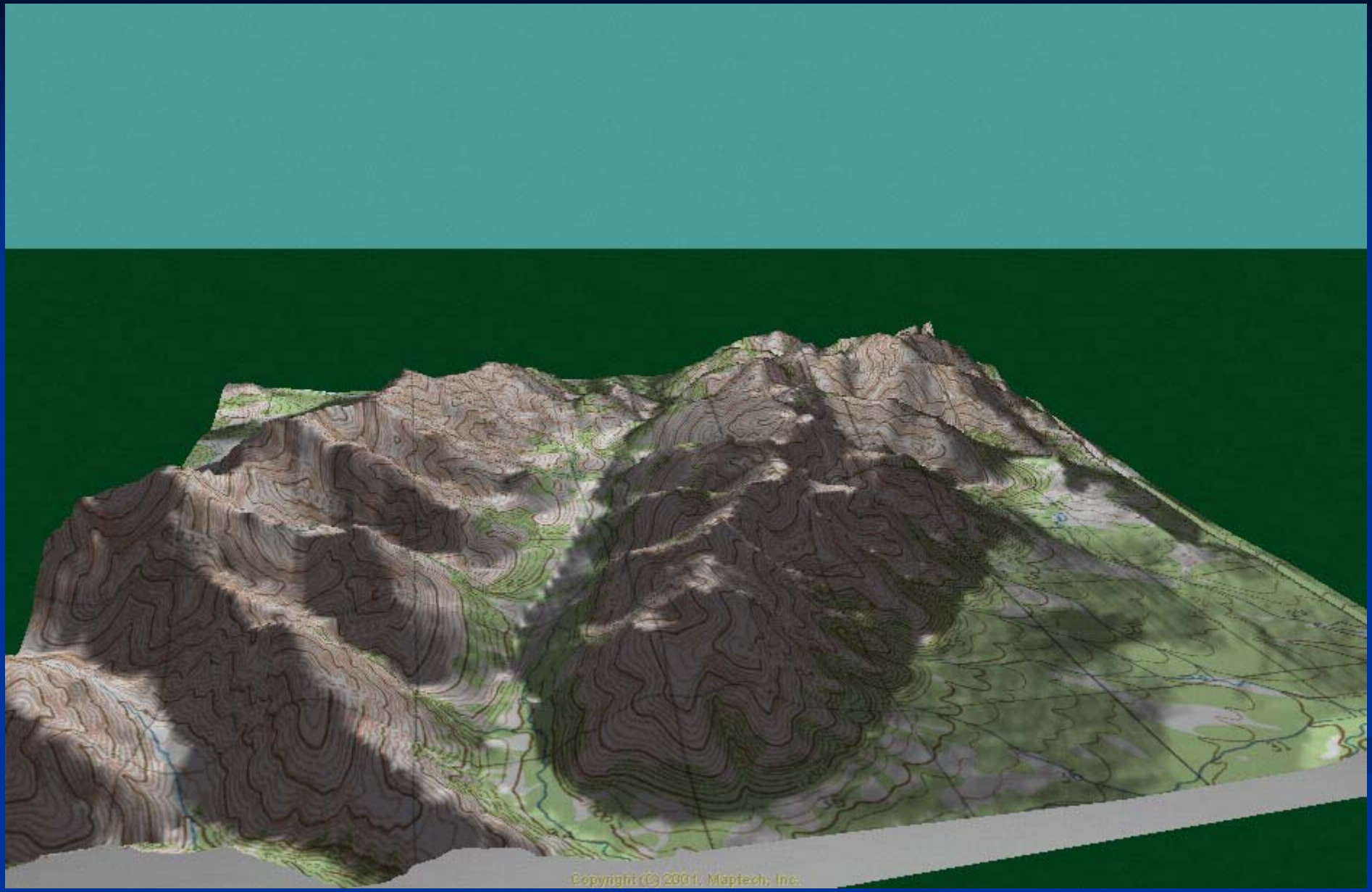
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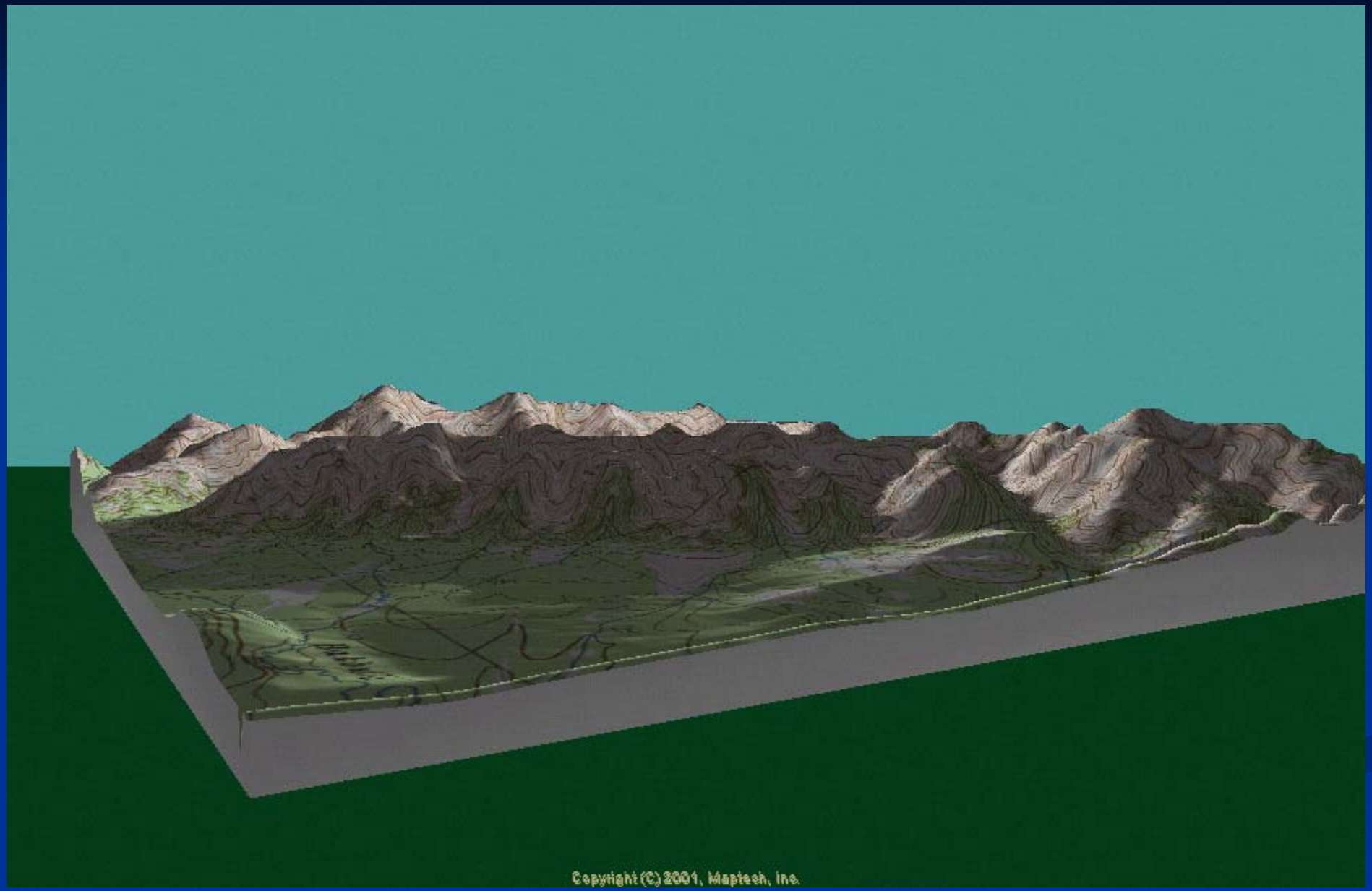
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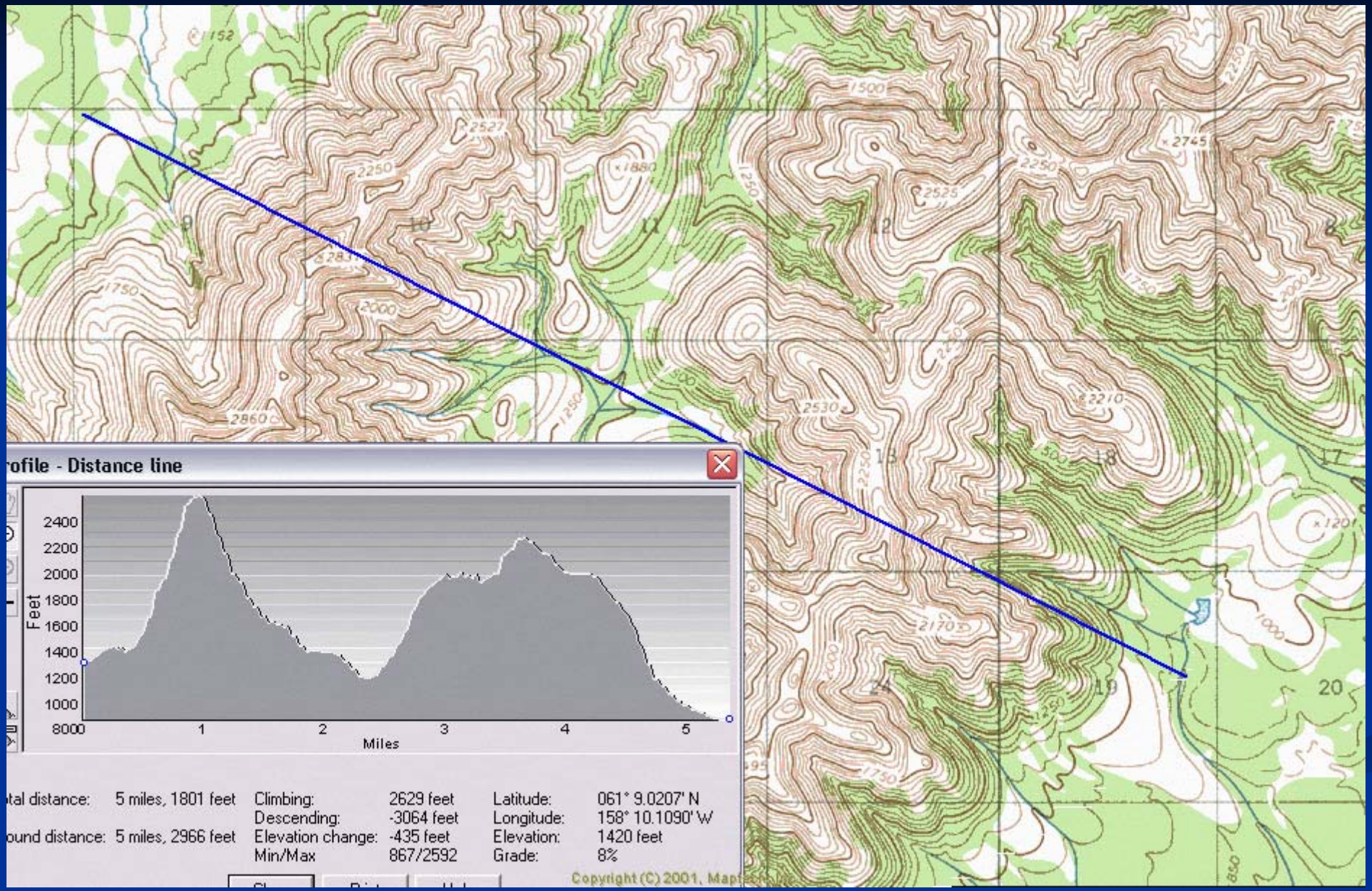
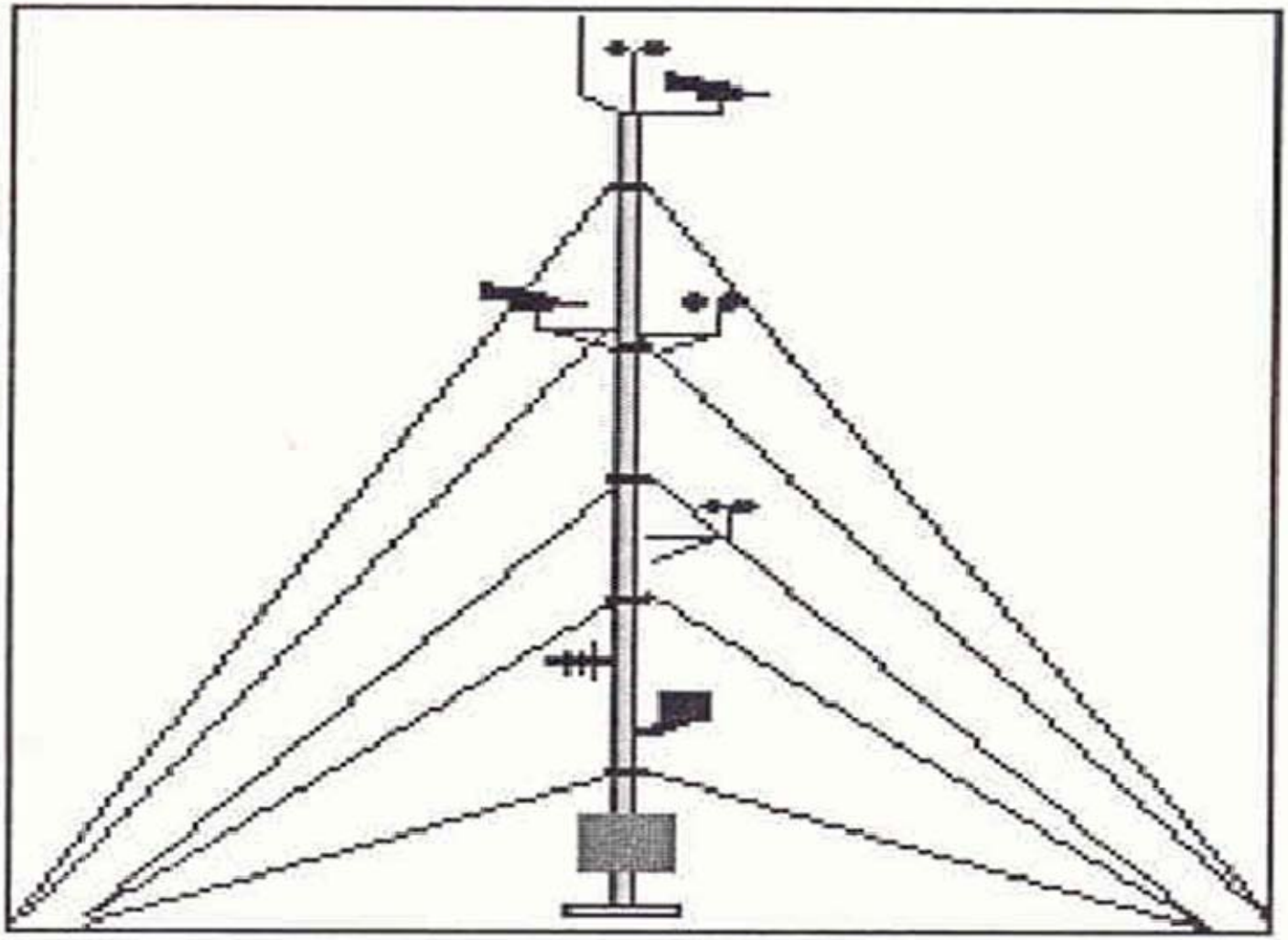
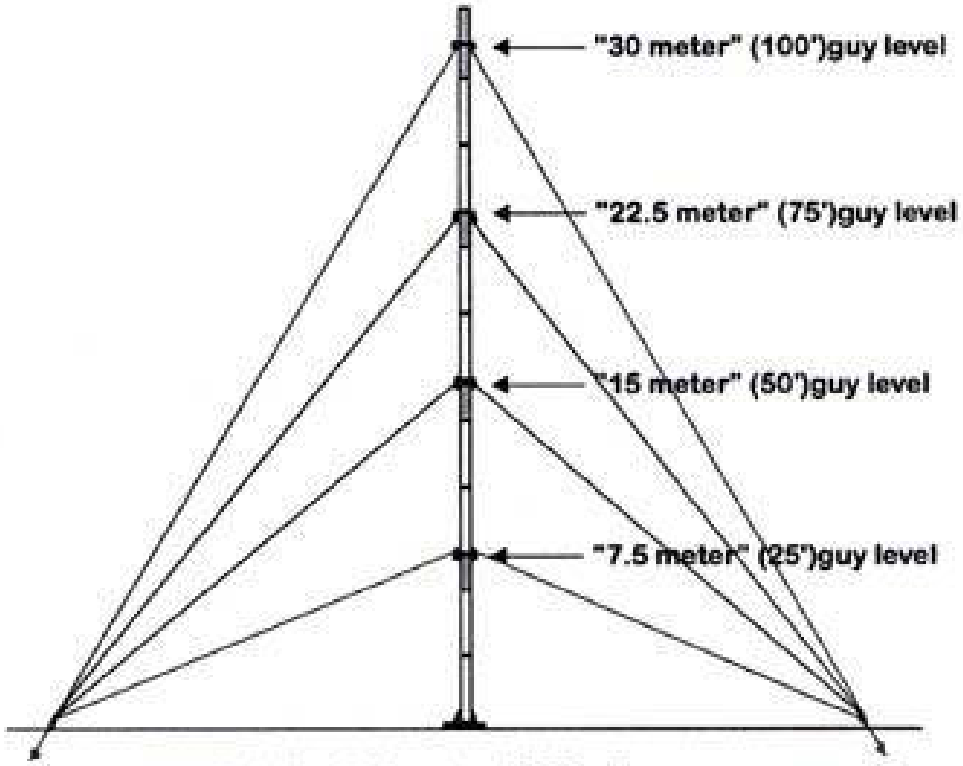

rofile - Distance line
2400
2200
2000
1800
1600
1400
1200
1000
8000
Feet
1
2
3
4
5
Miles
tal distance: 5 miles, 1801 feet
ound distance: 5 miles, 2966 feet
Climbing: 2629 feet
Descending: -3064 feet
Elevation change: -435 feet
Min/Max 867/2592
Latitude: 061° 9.0207' N
Longitude: 158° 10.1090' W
Elevation: 1420 feet
Grade: 8%
Copyright (C) 2001, Map



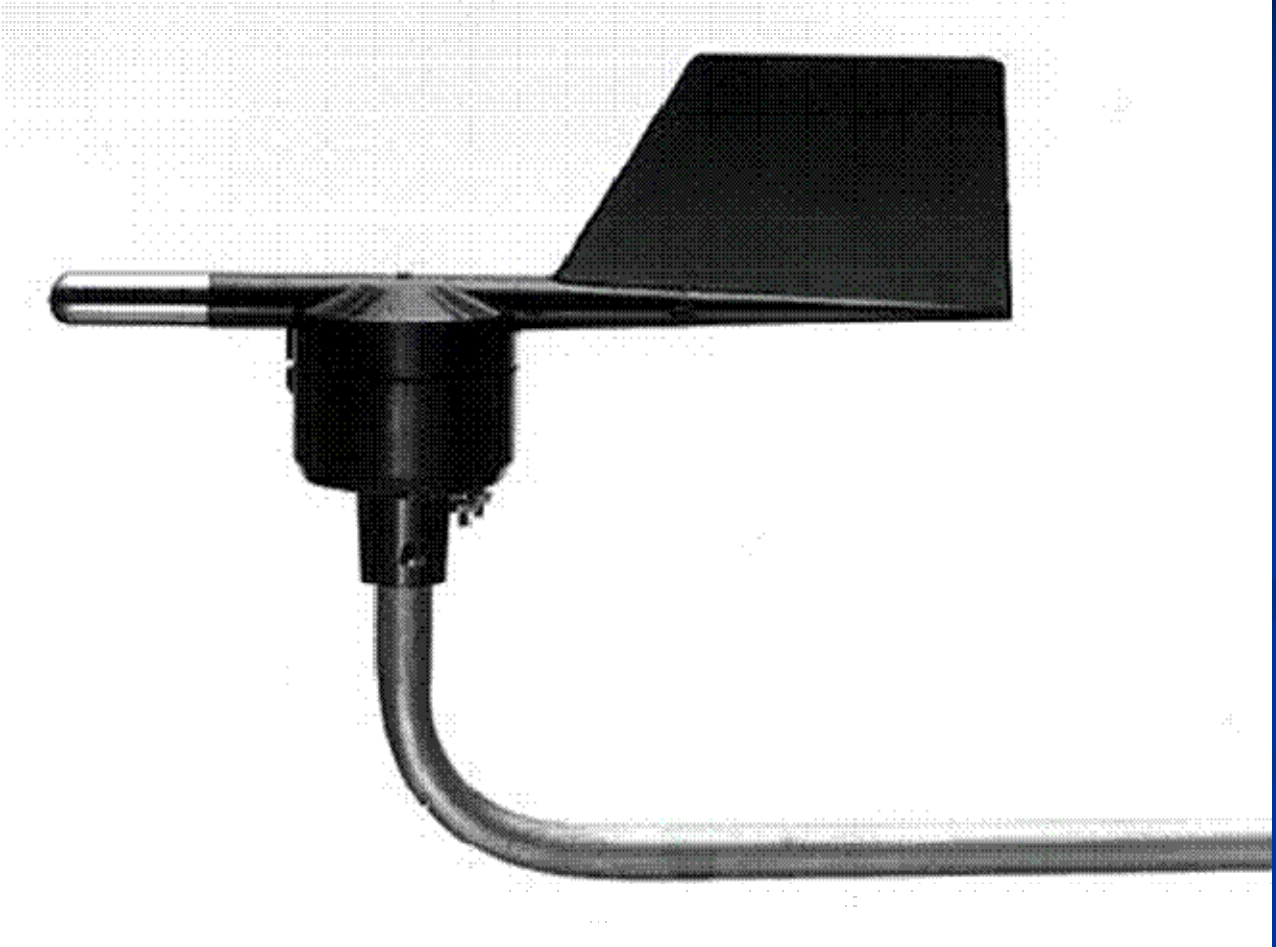
30 m (100 ft.) TallTower



Height: 30.0 meters (100 feet)
Diameter: 114 or 152 millimeters (4.5 or 6.0 inches)
Guy Radius: 18.3 meters (60 feet)

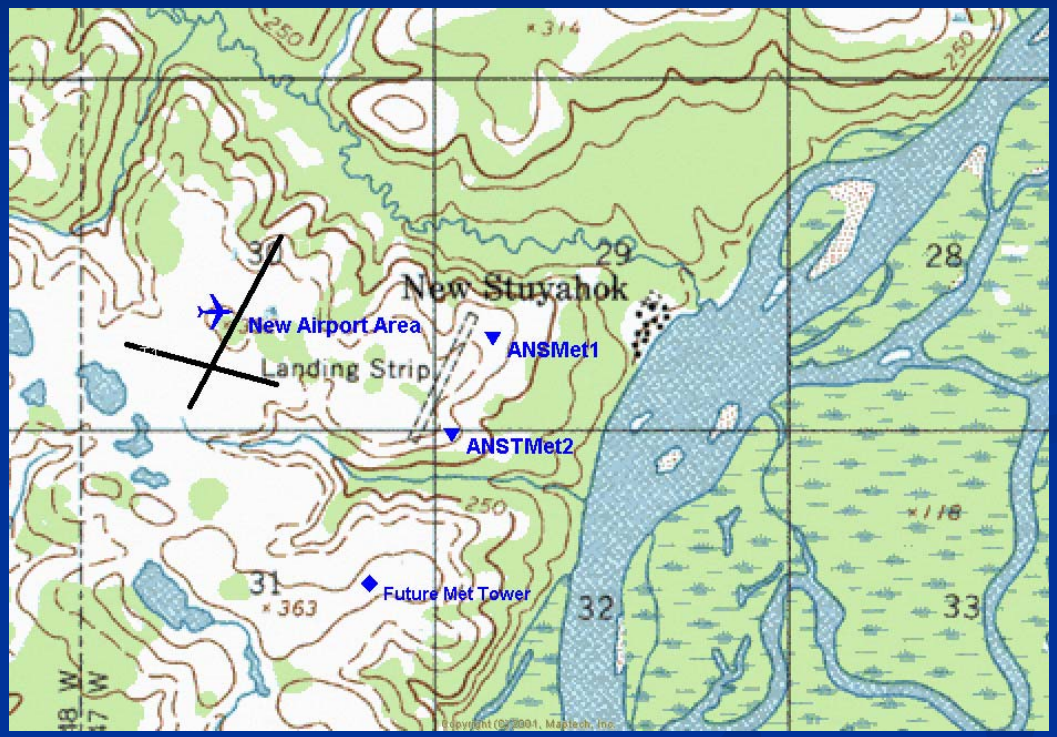
Note: Shaded sections of the tower represent 1.5 meter (5 foot) tubes. Unshaded sections represent 3.0 meter (10 foot) tubes. Guy level heights are nominal. Actual heights are less than the nominal heights when tower tubes are assembled.


NRG
Symphonie
Logger
INTERNET ENABLED
Channel Configuration
Keypad and Display Quick Reference
Routine Site Check and Data Collection
Symphonie
NRG



Field Trip October 2003
Sites Visited

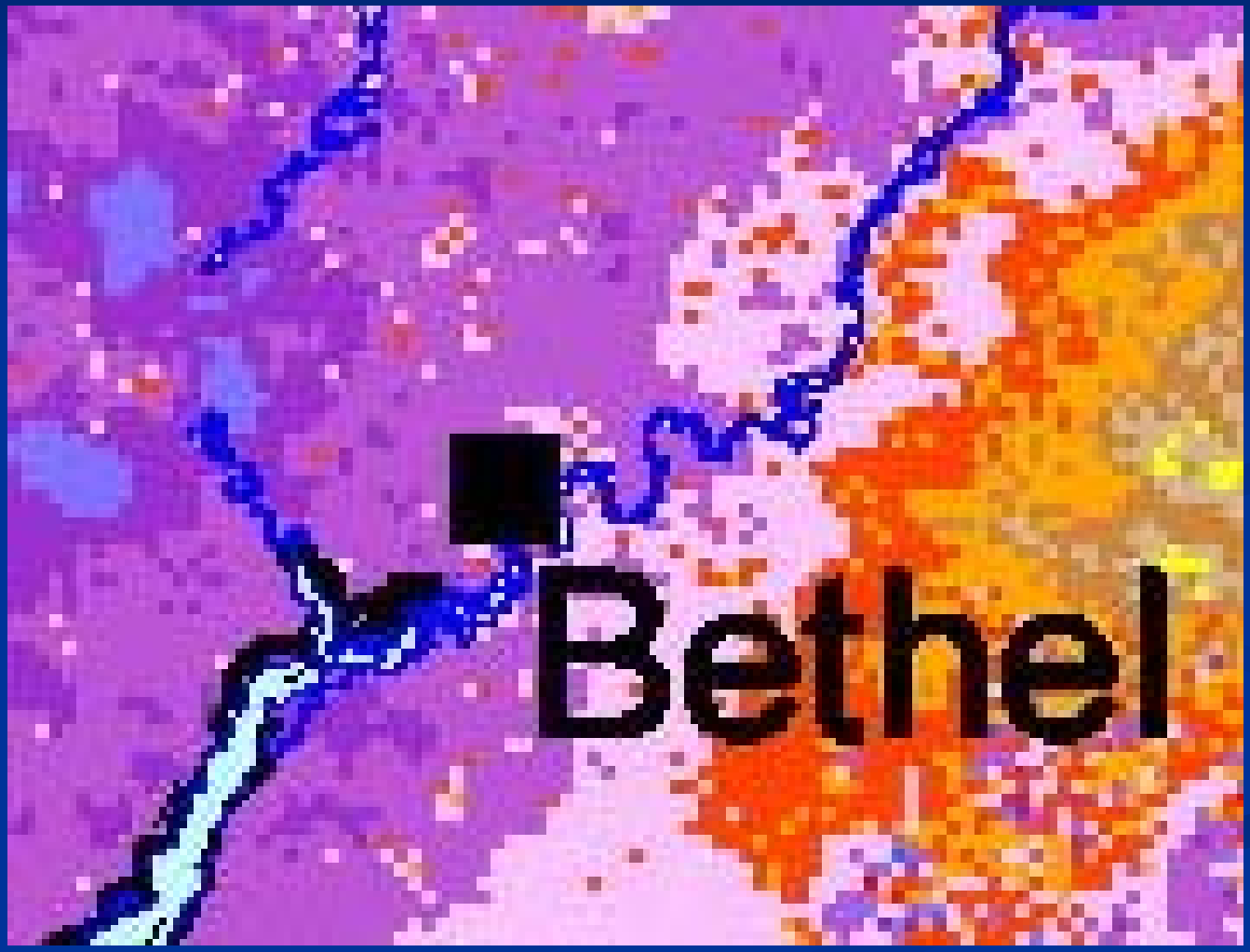
- Dillingham
- Togiak
- New Stuyok
- Naknek
- Kodiak



AUGUST 2-6 2004
SITES VISITED

- Nome
- Teller
- Brevig
- Golovin
- Elim
- Moses Point
- Koyook
- Slaktoolik
- Unakaleet
- Stebbins
- St Michaels
- Bethel
- Kongignak
- Kwigillinok
- Kipnuk
- Port Heiden
- Chignik

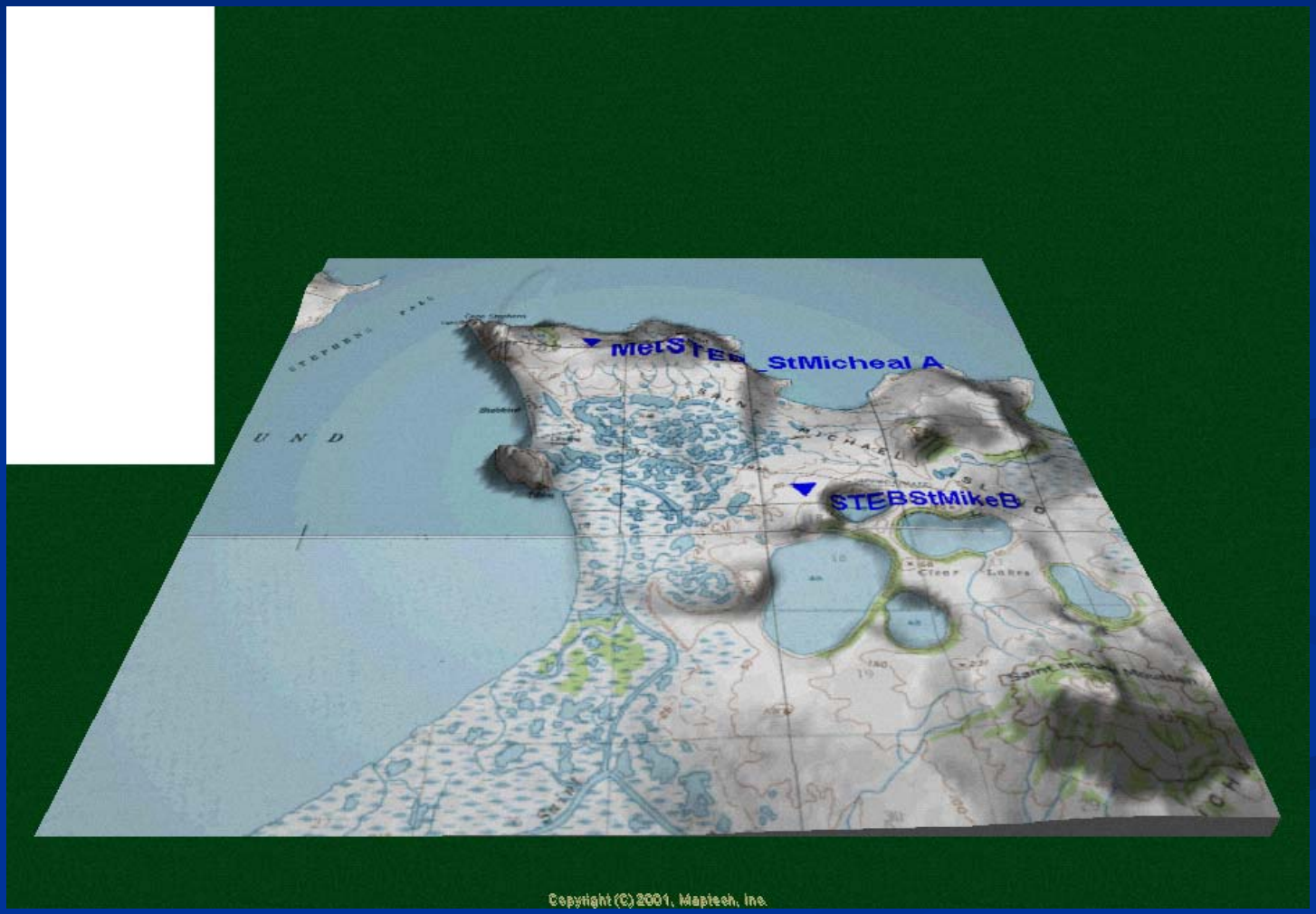
Wind Map estimate for Bethel indicates 7 to 7.5 mps Class 4 and 5 at 50 meters




NATIONAL
WILDLIFE
REFUGE
Bethel 60 meter met tower
Bethel
KUSKOKWIM
RIVER
Graveyard Point
Copyright (C) 2001, Maptech, Inc.

Anvil Mountain near Nome

Stebbins and St. Michaels



Kongiginak

Port Heiden
Wind Deformed Vegetation

Chignik

WHAT IS DIFFERENT ABOUT ALASKAVILLAGE SCALE WIND PROSPECTING

- In utility scale applications wind turbine hub heights are 60 to 90 meters (200 to 300 feet) and the top of the blade at 90 to 135 meters (300 to 500 feet). Village applications might have hub heights of 30 meters (100 feet) and the top of the blade may extend only to 150 feet at most. Therefore it is much easier to measure thee wind and estimate vertical wind variation in village applications.
- In village scale applications the cost of connecting to the grid can not be amortized over as many turbines and thus selecting the best resource needs to be balanced against keeping the installation cost low.
- Alaska village applications present huge technical challenges like foundations in permafrost, cold climate challenges, extreme winds, remote operation, and multimodal wind regimes. These challenges mean turbulence takes on an even more crucial importance here in Alaska.
- Low light conditions in the winter months present new challenges for remote data collection.

THE CHALLENGE FOR ALASKA VILLIAGE WIND DEVELOPMENT

- Wind prospecting efforts need to be resourceful and thrifty when selecting wind locations. An example might be using high school age science students flying kites with ribbon attached to find areas with the smoothest and steadiest wind.
- Use of natural indicators and local knowledge to determine the best wind sites, as described in this presentation, will mean better site selection, but also more participation in the siting process .
- Where the wind resource is known to be good, less expensive wind measuring efforts can be considered (ten-meter towers and a shorter duration measurement program). Other locations with uncertain wind resource should have to prove themselves with industry standard measurement programs.
- More effort to examine performance data and wind measurement data at Alaska's existing wind developments are needed to look for markers that can predict the performance of future Alaska wind plants.