Atmospheric and Oceanic Research at Chesapeake Light

http://cove.larc.nasa.gov

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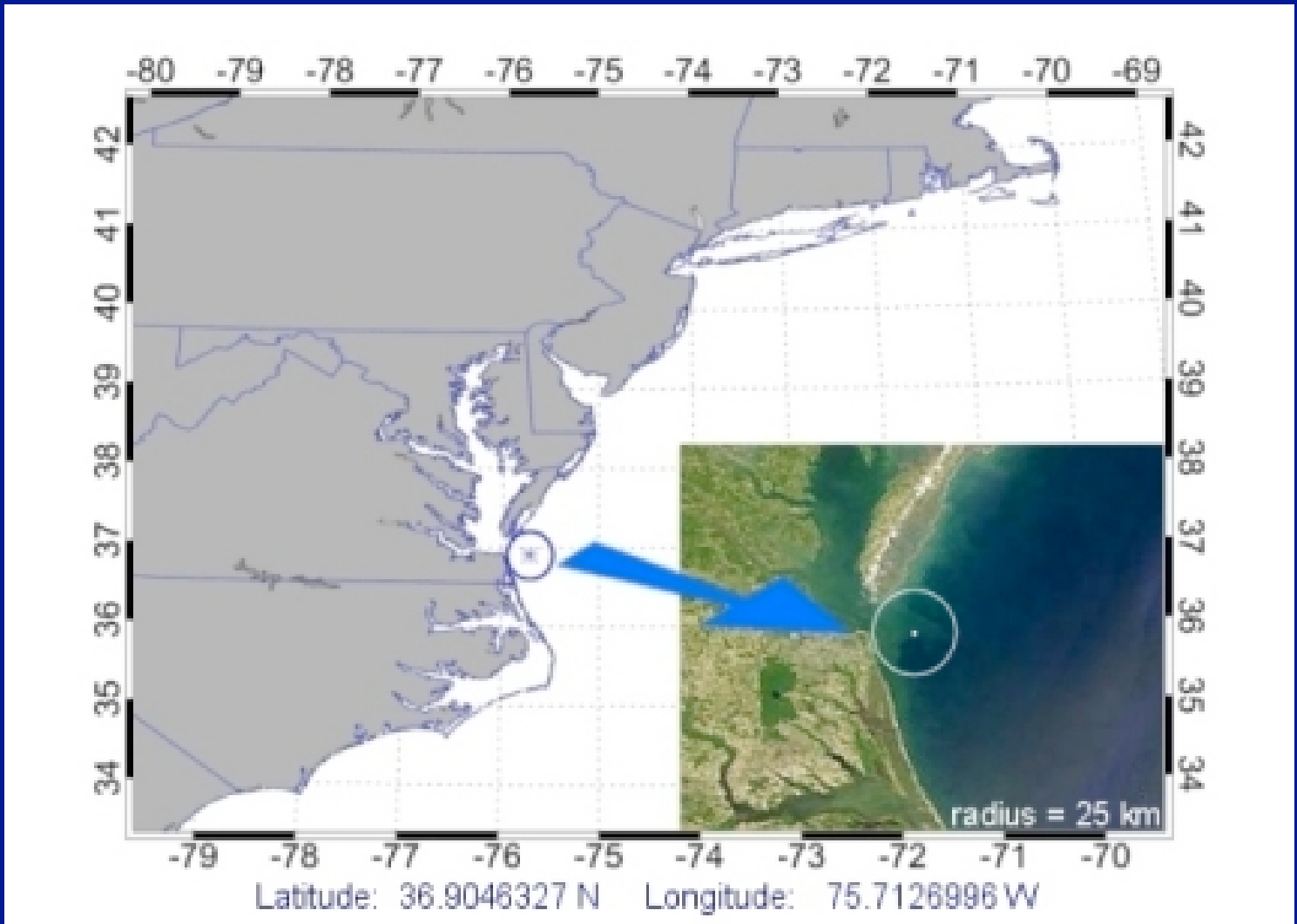
Introduction

- History and logistics of Chesapeake Light
- Analysis of NASA and NOAA wind monitors
- NASA's primary work and analysis
- Recent and future use of Chesapeake Light

Where is Chesapeake Light?

- ~25 kilometers (~16 miles) East of Virginia Beach, Virginia
- Coordinates: 36.90 N , 75.71 W
- Water Depth is shallow. Only ~10 meters (~ 33 feet)



History of Chesapeake Light

- Built in 1965 and stands 36 meters (120 feet) tall
- Built to mark the entrance to the Chesapeake Bay
- Automated in 1980 (U.S.C.G. manned crews no longer needed)
- In 1997, NASA leased Cheslight from the U.S.C.G. for atmospheric and oceanic research
- NOAA wind data available from 1984; NASA's from 2000
- The Department of Energy will acquire Chesapeake Light in late 2012 with a plan to install a wind monitoring tower for wind farm suitability studies

Transportation To Chesapeake Light

Helicopter
(almost every time in 12 years)

Boat
(rare, a few times in 12 years)

Communications at Chesapeake Light

2 Freewave Radios:

- 900 MHz
- 867 Kbps over the air throughput

Freewave at Hotel site

Radio Link - ~25 km

Freewave at Cheslight

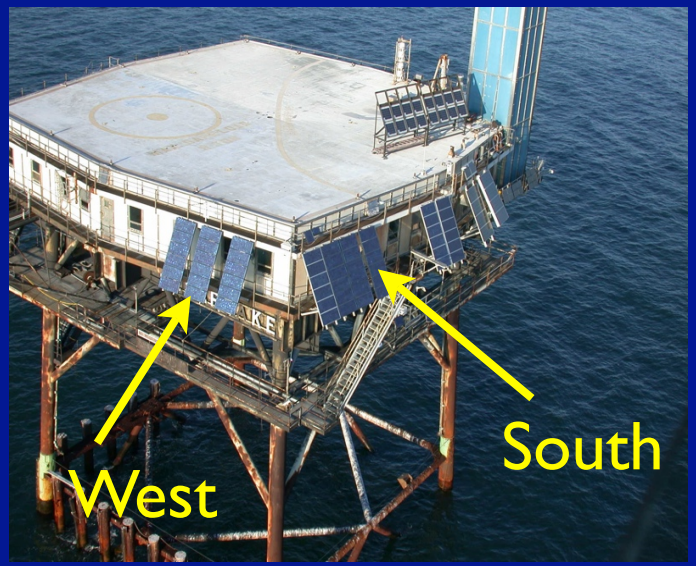
Power at Chesapeake Light

7.5 kW generator

6 - 1000 amp hour batteries
in 12V parallel

Solar Panels:

- 8 banks on South Side
- 3 banks on West Side



Other:

- Inverter for AC power
- 12V to 24V DC to DC converter

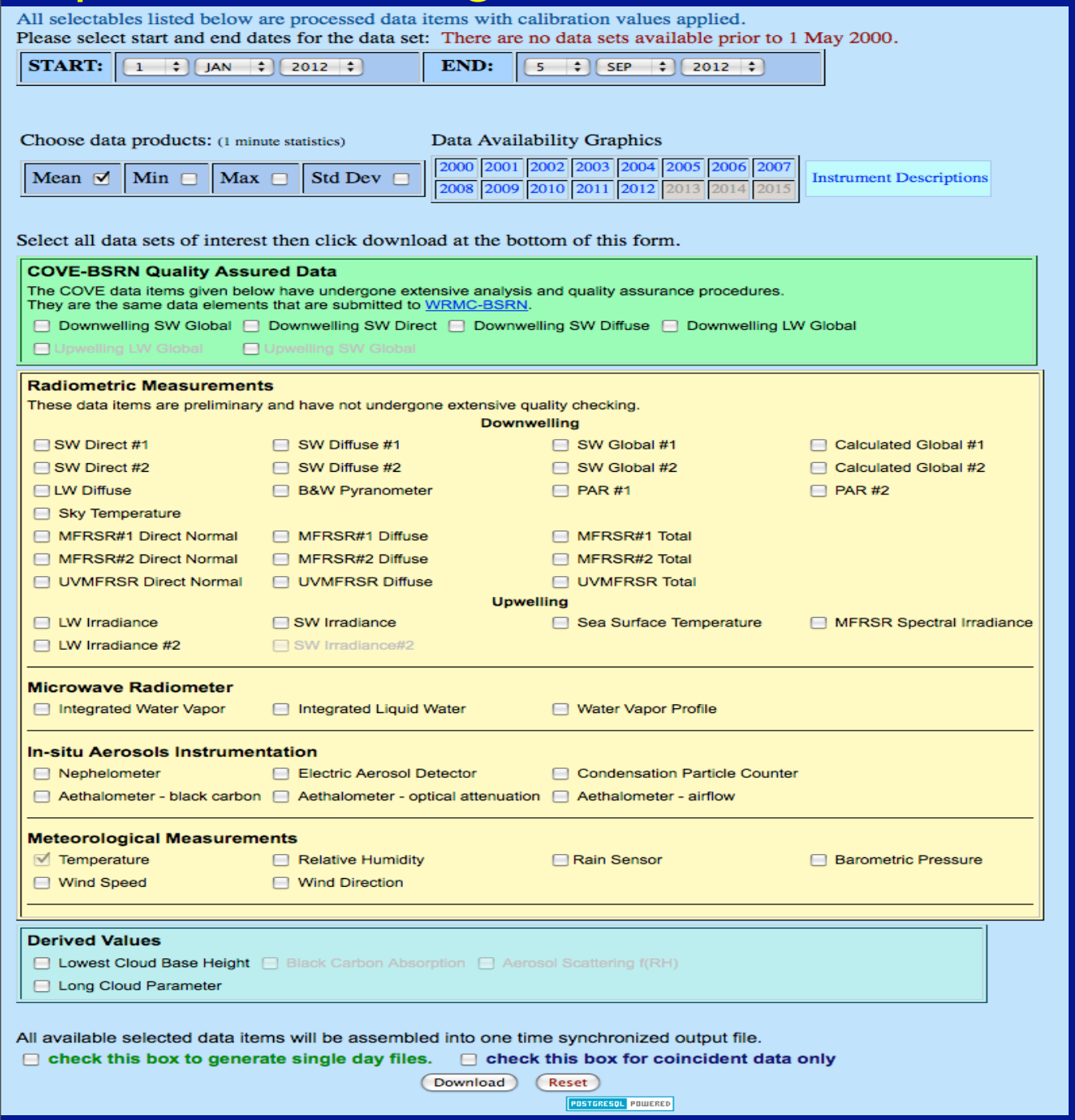
NOAA and NASA wind monitor locations and height above sea level

43 meters (141 feet)

36 meters (118 feet)

Data Website for NASA Wind Measurements

http://cove.larc.nasa.gov/COVE-DataDownloadTool.shtml



- NASA wind speed and direction data is available the next day
- Data resolution is every minute

Data Website for NOAA Wind Measurements

http://www.ndbc.noaa.gov/station_history.php?station=chlv2

Conditions at CHLV2 as of (2:00 pm EDT) 1800 GMT on 09/06/2012:

Unit of Measure: English | Time Zone: Station Local Time | Select

Click on the graph icon in the table below to see a time series plot of the last five days of that observation.

Wind Direction (WDIR):	W (260 deg true)
Wind Speed (WSPD):	10 kts
Wind Gust (GST):	11 kts
Atmospheric Pressure (PRES):	29.90 in
Pressure Tendency (PTDY):	-0.02 in (Falling)
Air Temperature (ATMP):	84.9 °F
Dew Point (DEWP):	73.4 °F
Heat Index (HEAT):	91.9 °F
Wind Speed at 10 meters (WSPD10M):	10 kts
Wind Speed at 20 meters (WSPD20M):	10 kts
Combined plot of Wind Speed, Gust, and Air Pressure	

Continuous Winds

TIME (EDT)	WDIR	WSPD
2:00 pm	WSW (247 deg)	11 kts
1:50 pm	SW (236 deg)	13 kts
1:40 pm	WSW (241 deg)	14 kts
1:30 pm	WSW (245 deg)	15 kts
1:20 pm	WSW (237 deg)	14 kts
1:10 pm	WSW (237 deg)	15 kts

Peak gust during the measurement hour

TIME (EDT)	GDR	GST
1:08 pm	WSW (240 deg)	17 kts

Previous observations

MM	DD	TIME (EDT)	WDIR	WSPD kts	GST kts	WVHT ft	DPD sec	APD sec	MWD	PRES in	PTDY in	ATMP °F	WTMP °F	DEWP °F	SAL psu	VIS nmi	TIDE ft
09	06	1:00 pm	SW	14	16	-	-	-	-	29.91	-0.02	83.7	-	74.5	-	-	-
09	06	12:00 pm	SSW	11	12	-	-	-	-	29.91	+0.00	81.9	-	77.4	-	-	-
09	06	11:00 am	SW	14	14	-	-	-	-	29.92	+0.00	80.6	-	76.3	-	-	-
09	06	10:00 am	SW	15	16	-	-	-	-	29.92	+0.02	79.9	-	75.4	-	-	-

- NOAA wind speed and direction is available in near real time
- Data resolution is every 10 mins. (under continuous winds) and once an hr. (under standard meteorological data)
- For historical data, data is located here:

http://www.ndbc.noaa.gov/station_page.php?station=chlv2

Station CHLV2 - Chesapeake Light, VA

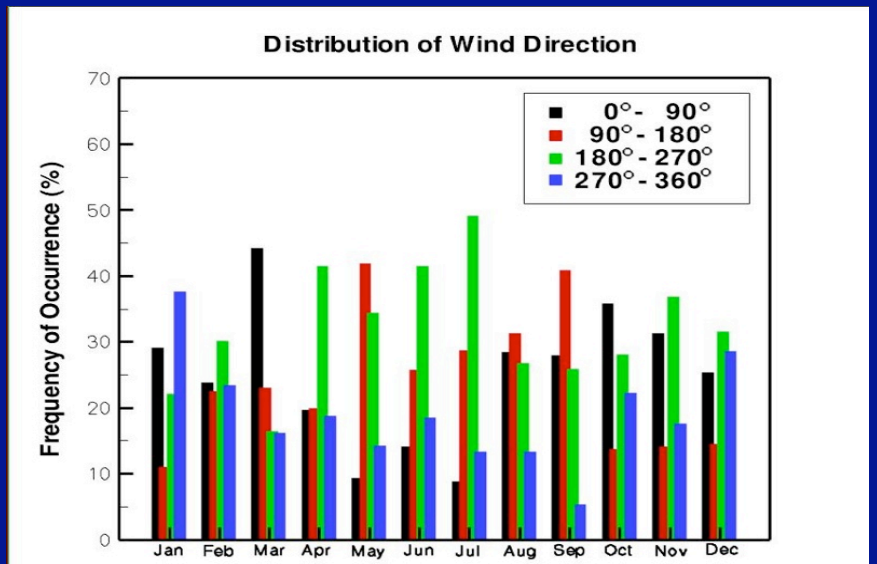
Owned and maintained by National Data Buoy Center
36.910 N 75.710 W (36°54'35" N 75°42'35" W)

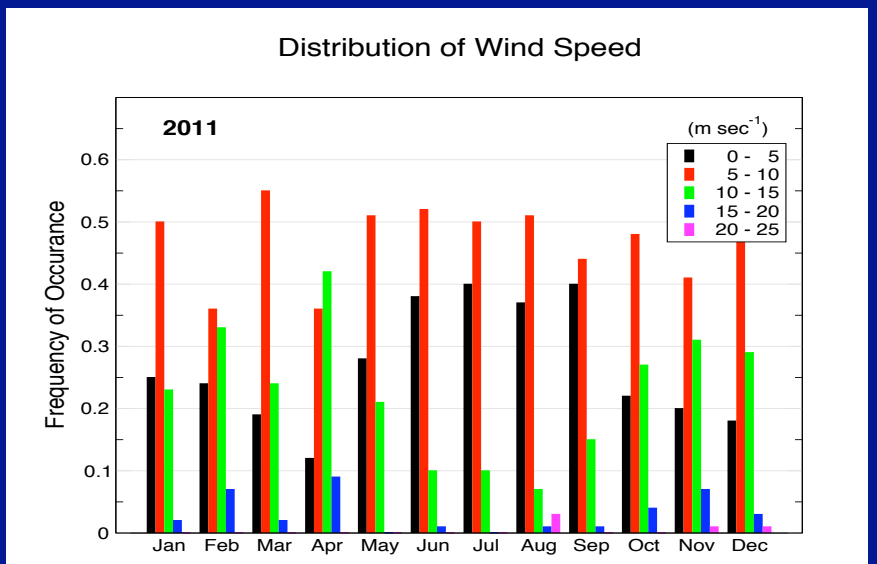
Available historical data for station CHLV2 include:

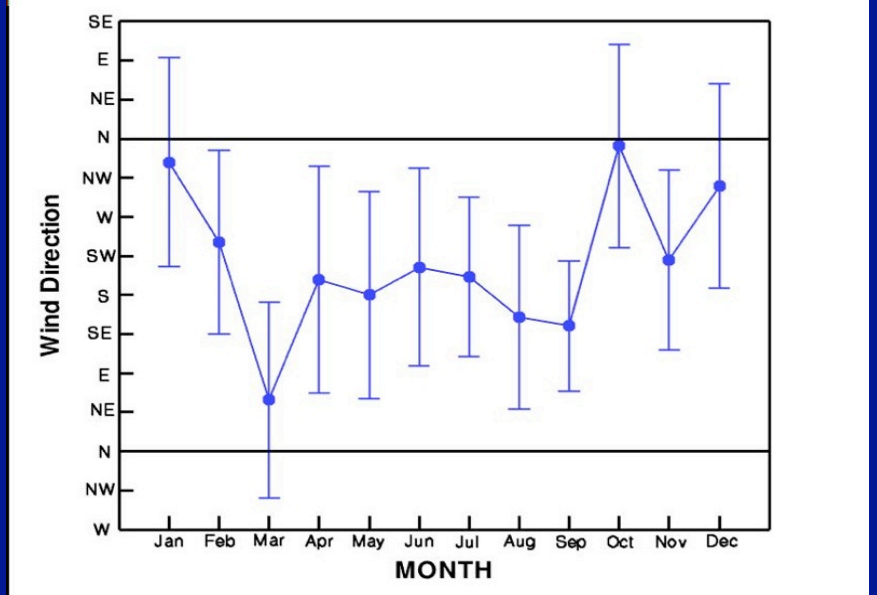
- **Quality controlled data for 2012** (*data descriptions*)
  - **Standard meteorological data:** Jan Feb Mar Apr May Jun Jul
  - **Continuous winds data:** Jan Feb Mar Apr May Jun Jul
- Historical data (*data descriptions*)
  - **Standard meteorological data:** 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
  - **Continuous winds data:** 1990 1991 1992 1993 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

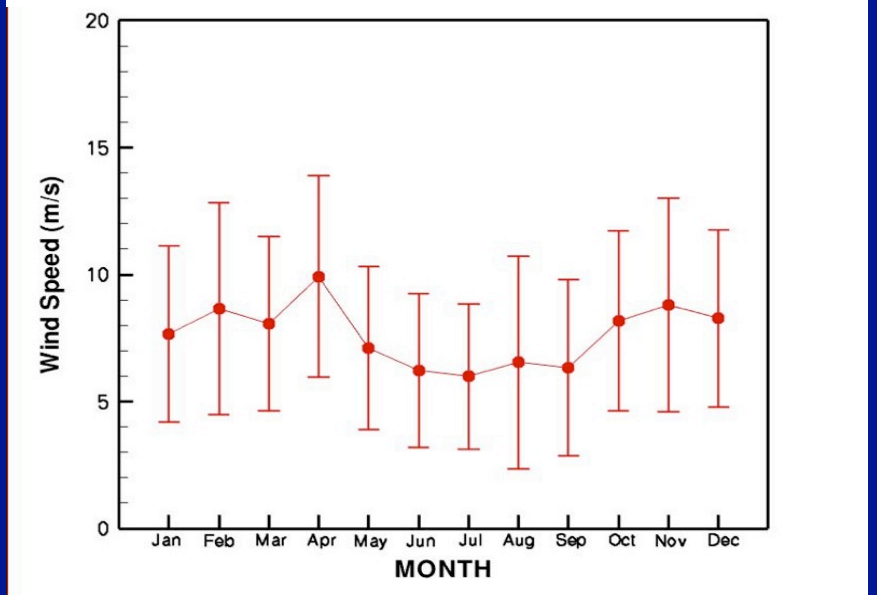
NOAA WIND Climatology by bins (WS and WD) - 2011

- Wind direction is from the South in the spring and summer but tend to be in a more northerly direction in the colder months
- Winds are strongest in April with lightest winds in the summer





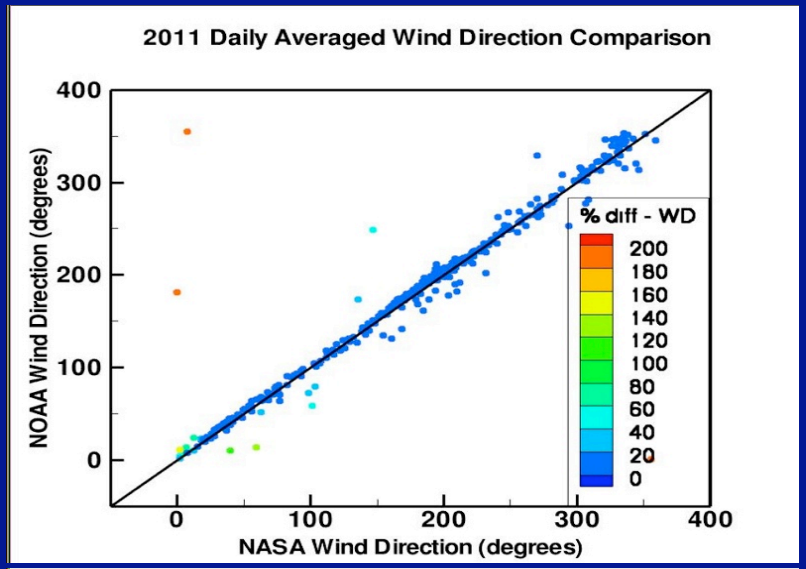


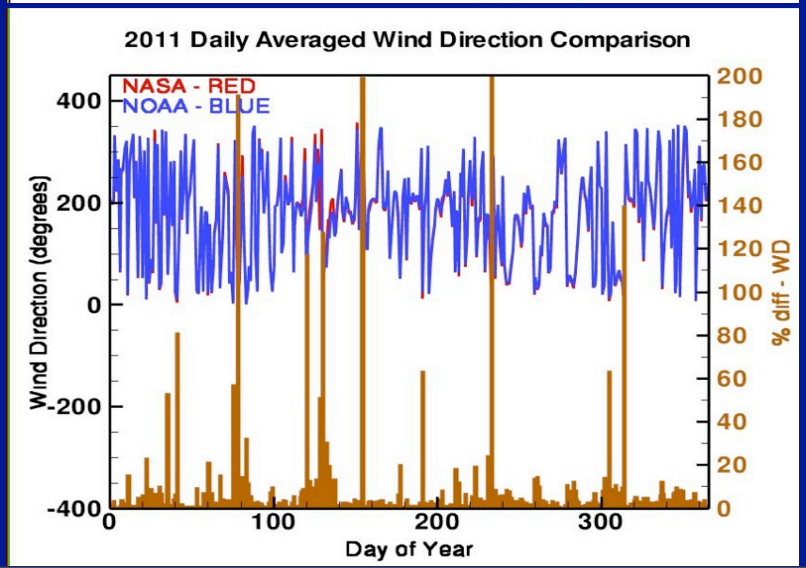


NOAA vs NASA Wind Speed and Direction comparison - 2011 only

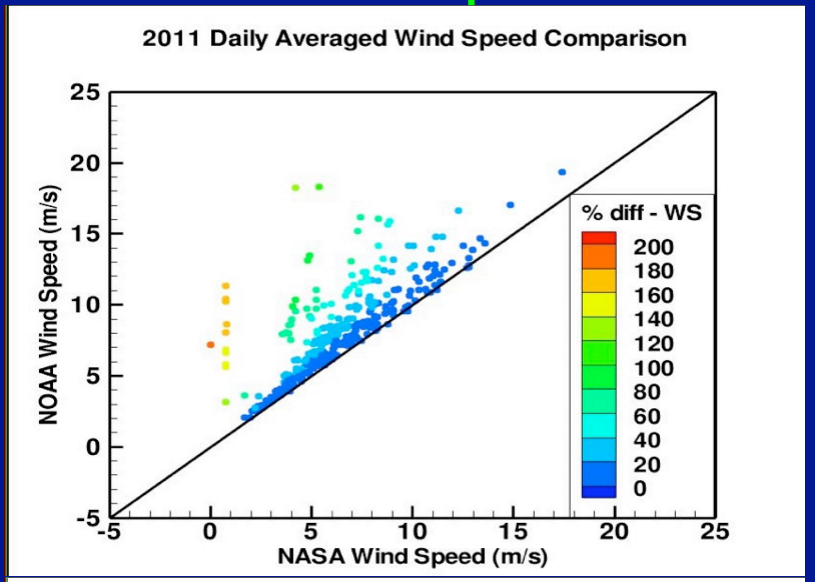
- Wind direction has less percent difference than Wind Speed
- Presume Wind Speed has higher percent difference due to NASA's wind monitor being located at instrument level, thus being obstructed by other instruments

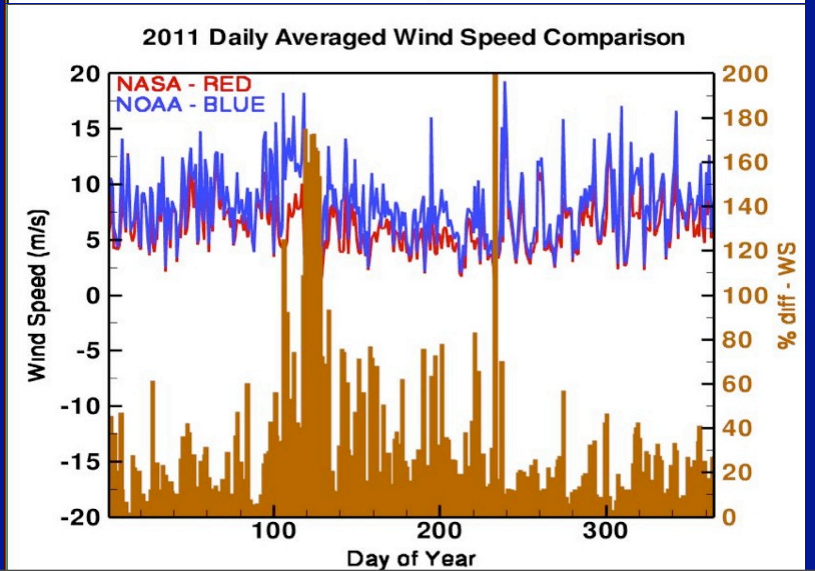
Wind Direction





Wind Speed





Potential site for a new wind monitoring tower at Chesapeake Light

NASA Research at Chesapeake Light:

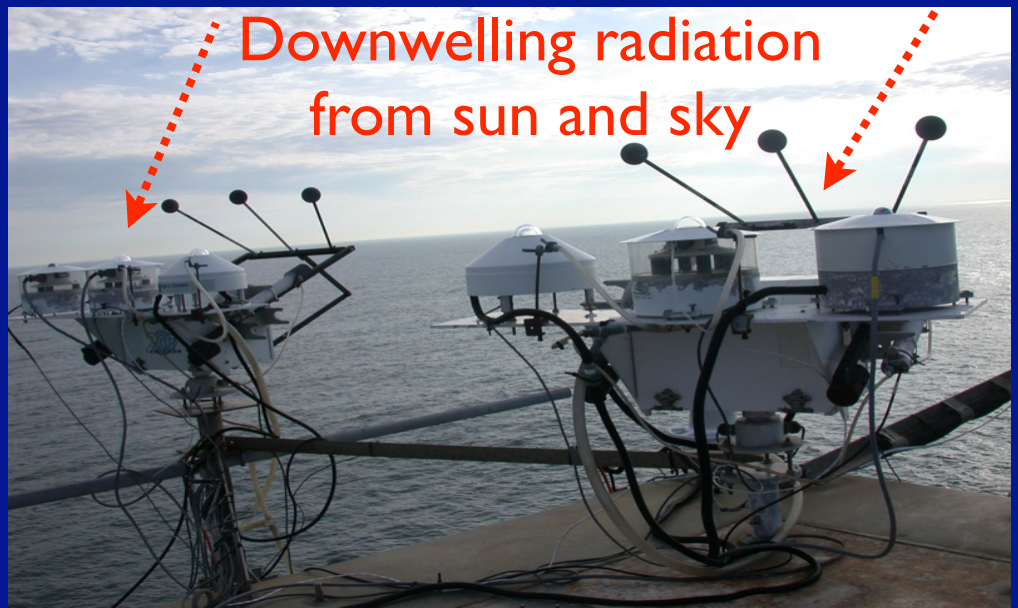
- Chesapeake Light is also known as the Clouds and the Earth's Radiant Energy System (CERES) Ocean Validation Experiment (COVE)
- COVE was established to provide continuous downwelling and upwelling solar radiation measurements for surface validation of CERES and other satellites
- Compare surface measurements under 3 sky conditions (clear, partly cloudy and cloudy sky) to modeled data
- Other parameters measured are aerosols, black carbon, water vapor, cloud and aerosol vertical structure, meteorological and more
- COVE's website is http://cove.larc.nasa.gov

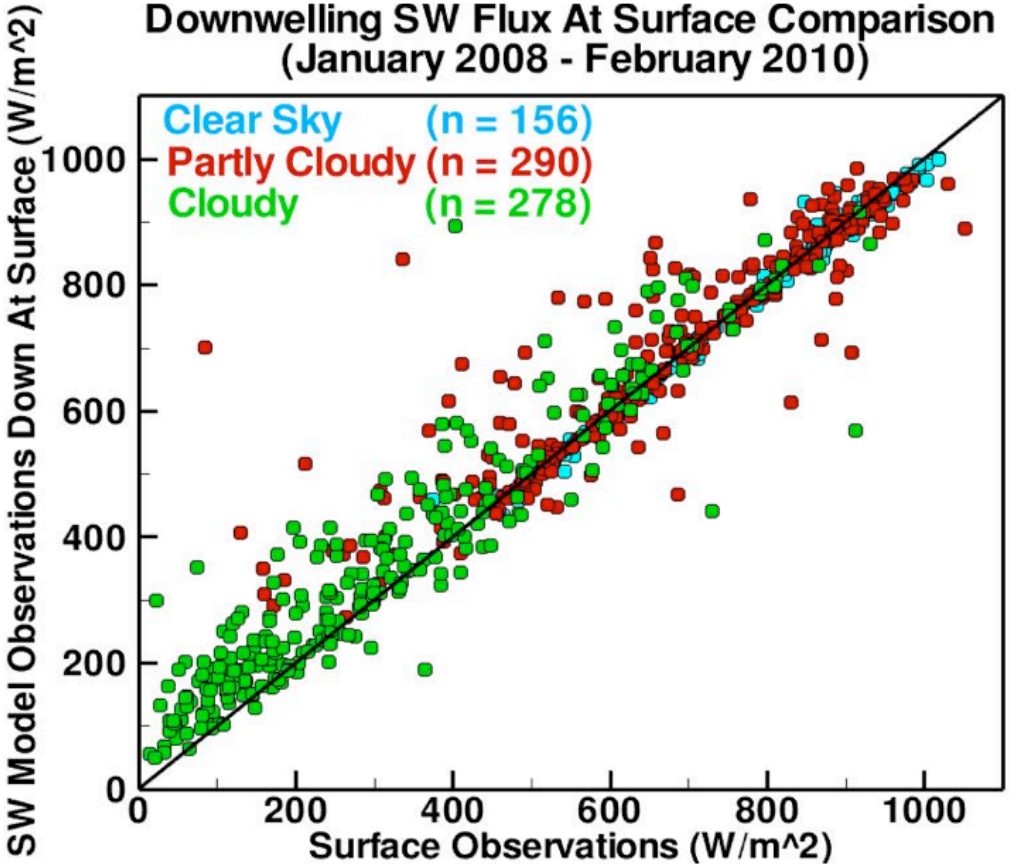
Long view from helicopter

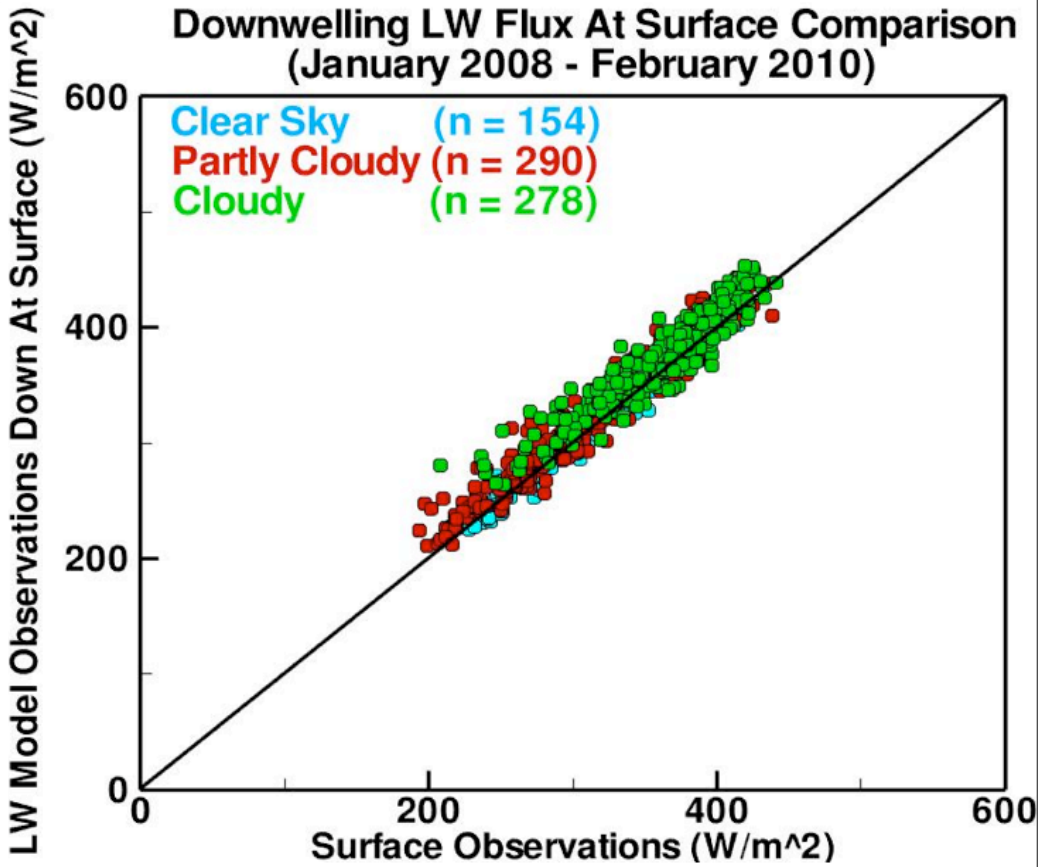
Long view from boat

Downlooking Instruments

Uplooking Instruments







Sky Condition	Y = mx +b	R^2	Standard Deviation
Clear	Y = 0.995x + 0.845	0.991	15.9
Partly Cloudy	Y = 0.802x + 158.506	0.837	82.6
Cloudy	Y = 0.898x + 77.259	0.885	73.2

Sky Condition	Y = mx +b	R^2	Standard Deviation
Clear	Y = 1.015x - 1.915	0.974	9.5
Partly Cloudy	Y = 0.975x + 19.944	0.951	13.5
Cloudy	Y = 0.859x + 63.565	0.876	15.6

Current Measurement Collection at Chesapeake Light

Measurement	Units	Instrument	Wavelength (nm)
Direct Shortwave Irradiance	W/m^2	Kipp and Zonen Pyrheliometer	200-4000
Diffuse Shortwave Irradiance	W/m^2	Kipp and Zonen Pyranometer	200-4000
Global Shortwave Irradiance	W/m^2	Kipp and Zonen Pyranometer	200-4000
Longwave Irradiance	W/m^2	Eppley Pyrgeometer	5000-50000
Photosynthetically Active Radiation (PAR)	mV	Li-Cor PAR	400-700
Global and Diffuse Narrowband Radiance	W/m^2	Yankee Multi-Filter Rotating Shadowband Radiometer	415, 496, 614, 671, 868 and 939
Direct and Diffuse Narrowband Radiance		AERONET sunphotometer	412, 443, 490, 532, 551, 667, 870 and 1020
Normalized Water Leaving Radiance	mW/cm^2 sr um	AERONET sunphotometer	413, 441, 489, 530, 551, 668, 869 and 1020
Aerosol and Cloud Vertical Structure		Micro-Pulse Lidar	523
Total Column Precipitable Water Vapor	cm	Global Positioning System (GPS) Meteorology	
Black Carbon	$\mu g/m^3$	Magee Scientific Aethalometer	370, 430, 470, 520, 565, 700 and 950
Light Scattering Extinction Coefficient	1/m	Radiance Research Nephelometer	530
Sky Temperature	Kelvin	Heitronics Infrared Thermometer	9600-11500
Sea Surface Temperature	Kelvin	Heitronics Infrared Thermometer	9600-11500
Air Temperature	°C	Rotronic Temperature Sensor	
Relative Humidity	Percent	Rotronic Relative Humidity Sensor	
Barometric Pressure	millibar	Vaisala Pressure Sensor	
Wind Speed and Wind Direction	m/s and 0-360°	Young Wind Speed and Direction Anemometer	
Rain Sensor		SKYE rain sensor	

Summary:

- Chesapeake Light is located ~25km (16 miles) East of Virginia Beach, VA
- SSAI/NASA personnel travel to Chesapeake Light an average of twice a month for routine maintenance, installation, data acquisition and calibration
- The Department of Energy will take over Chesapeake Light at the end of 2012 to monitor the wind energy potential offshore
- Wind measurements are collected from both NOAA and NASA anemometers. However, NOAA's is above any obstructions
- NOAA wind data is available every 10 minutes or every hour and in near real time. NASA wind data is available every minute and available the next day
- Our work primarily focuses on continuous radiation measurements at the surface for validating satellite data products and with aerosol studies
- Other unique research at Chesapeake Light include bat monitoring studies

Thank you:
- United States Coast Guard (USCG)
- Airborne Wind Energy Conference

Acknowledgements:
- NOAA/NDBC
- NASA Langley Research Center
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