



AXYS TECHNOLOGIES INC.



A Wind Profiling Platform for Offshore Wind Measurements and Assessment

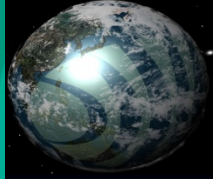
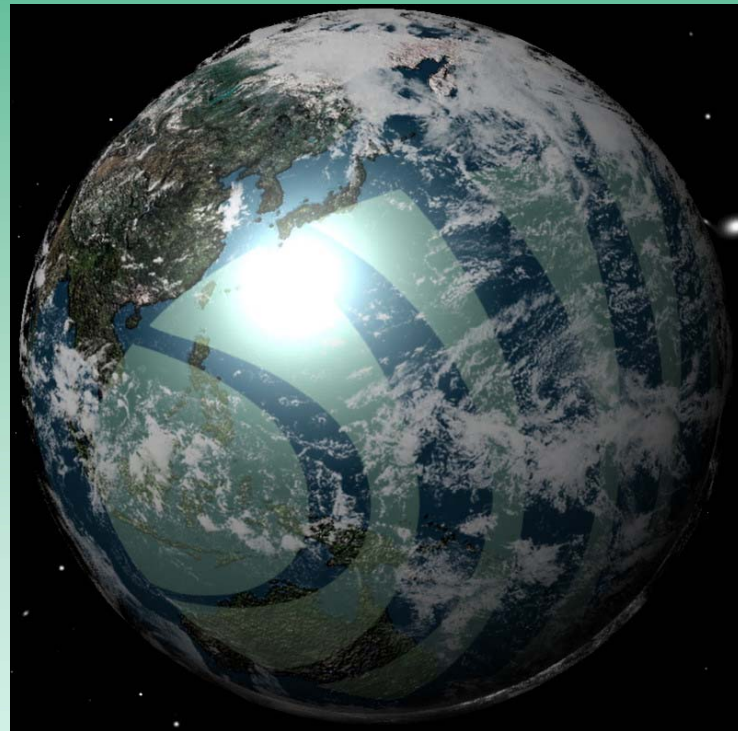
***Presenter: Mark Blaseckie
AXYS Technologies Inc.***





AXYS TECHNOLOGIES INC.

Any Sensor, Any Telemetry, Any Environment

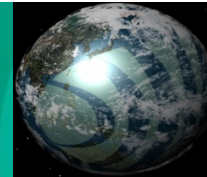




AXYS History

- Founded in 1974
- Part of the AXYS Group
- Marine consulting contracts with EC for wave studies
- Design of marine technology devices - 1980s
- Data buoys for EC Weather Buoy Network - 1986
- 1990s collaboration with NRC – TRIAXYS and WM500
- Over 300 buoys in more than 30 countries
- Leveraged into hydrological and aviation products in 2002; offshore wind assessment in 2008
- ISO 9001:2008 Certified





Focus

Environmental monitoring solutions provider focused on specific market niches:

Marine

- Met Ocean
- Physical Oceanography
- Water Quality

Hydrology

- Greenhouse Gas
- Water Quality
- Hydrometeorology

Wind Resource Assessment

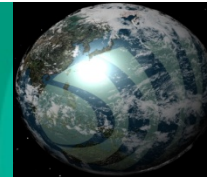
- Offshore met/wind profiling structures
- Offshore met/wind profiling buoys
- Onshore met/wind profiling

Aviation

Services

- Field Service
- Consulting
- Leasing





Waves, Currents, Water-level Monitoring

- TRIAXYS Directional Wave Buoy
- TRIAXYS with Currents Buoy
- TRIAXYS Mini Directional Wave Buoy
- HydroLevel Buoy
- Motion Sensor



Data

- Advanced motion & directional wave analysis
- Near real-time directional wave and current data
- Water elevation for hydrographic surveys





AXYS TECHNOLOGIES INC.

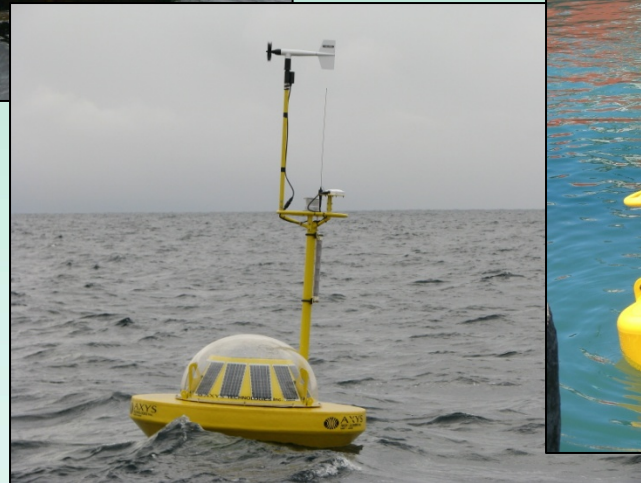
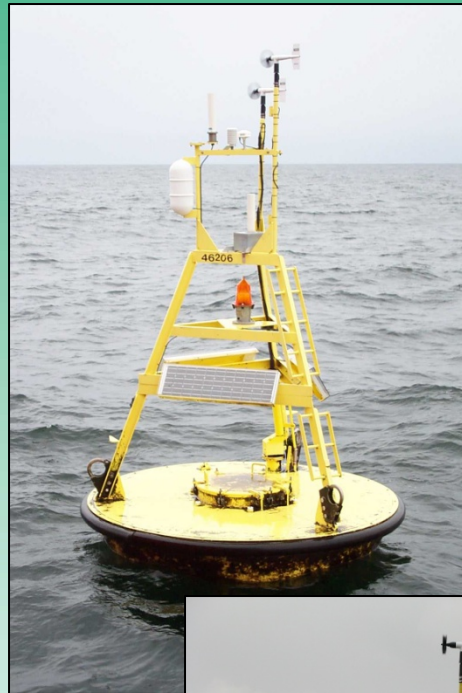


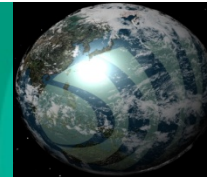
Met Ocean Weather & Observing Platforms

- 3 Metre Buoy
- NOMAD Buoy
- WatchKeeper Buoy
- WatchMate Buoy

Data

- Weather
- Air & Water Quality
- Directional waves & currents





Fixed Stations

Meteorological and oceanographic data collection and transmission system for vessel traffic management



- Port Sentinel
- RigSentinel



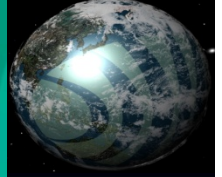
Data

- Real-time wind speed, wind direction, current speed, current direction, and water level information

Application

- Cruise Ship Safety - Victoria Port Authority

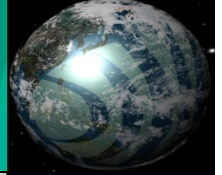




Services

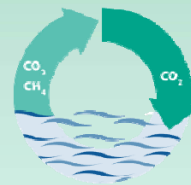
- Field Service:
 - Deployment/Installation
 - Repair/maintenance
- Training
- Mooring Design
- Consulting
- Leasing



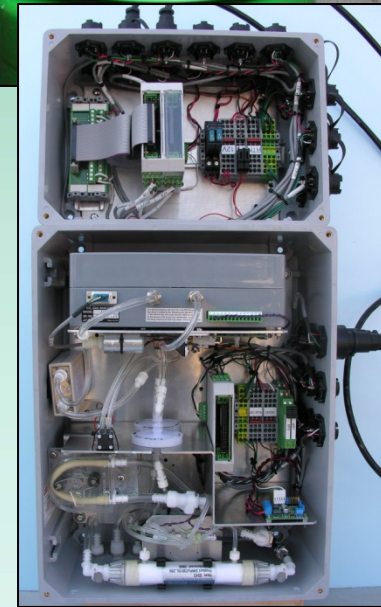


Hydrology

- **Hydrometeorology** – remote hydrological monitoring networks
 - flood forecasting
 - river & stream habitat monitoring
 - reservoir management
- **Water Quality** – continuous fresh water monitoring
 - environmental assessments for natural resource industries,
 - source drinking water protection
- **Greenhouse Gas** – automated GHG concentration monitoring system



GHG Sentinel™
AUTOMATED GHG SYSTEM

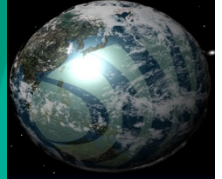




Why Offshore Wind?

- **Growth in the wind energy industry has come from the urgent need to combat climate change.**
- **While wind can be harnessed both on land and offshore, more frequently, developers are looking offshore where the wind blows stronger and more consistently.**
- **Offshore winds tend to flow at higher speeds than onshore winds, thus allowing turbines to produce more electricity.**
- **Since the potential energy produced from the wind is proportional to the cube of the wind speed, increased wind speeds of only a few miles per hour can produce a significantly larger amount of electricity.**
- **Therefore, offshore wind turbines have a higher capacity factor and generate energy more efficiently.**
- **Much of this potential energy is near major population centers where energy costs are high and land-based wind development opportunities are limited.**

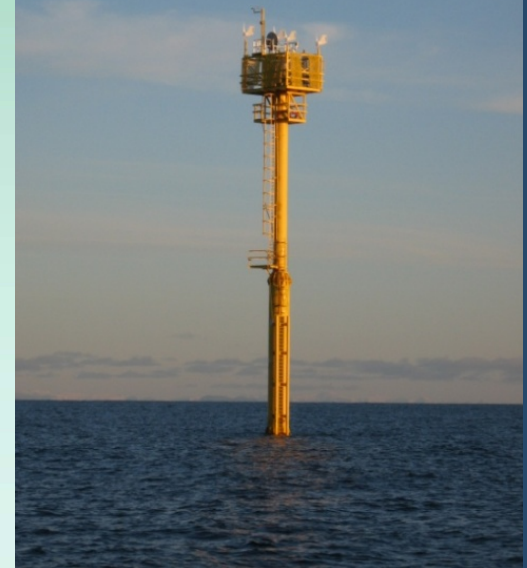




Wind Assessment Industry Overview

- Wind resource assessment is the process by which wind power developers estimate the future energy production of a wind farm.
- Accurate wind resource assessments are crucial to the successful development of wind farms.
- Regional wind maps are valuable tools for site finding, but are not accurate enough to justify the financing of the development.
- The single most important characteristic of a site is its wind speed and the performance of a wind farm is very sensitive to uncertainties and errors in the basic wind speed estimate.
- This means that initial wind resource assessment must be extremely accurate in order to procure funding, as well as for the economic development of a wind farm.
- Currently wind resource assessments are completed by remote meteorological observation masts secured to the sea bed in waters that can be as deep as 80 meters.
- These masts take as long as a year to gain construction permissions and to complete environmental assessments and a further year to build.

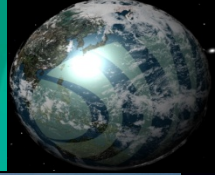
**AXYS Instrumented
Naikun Wind Platform**





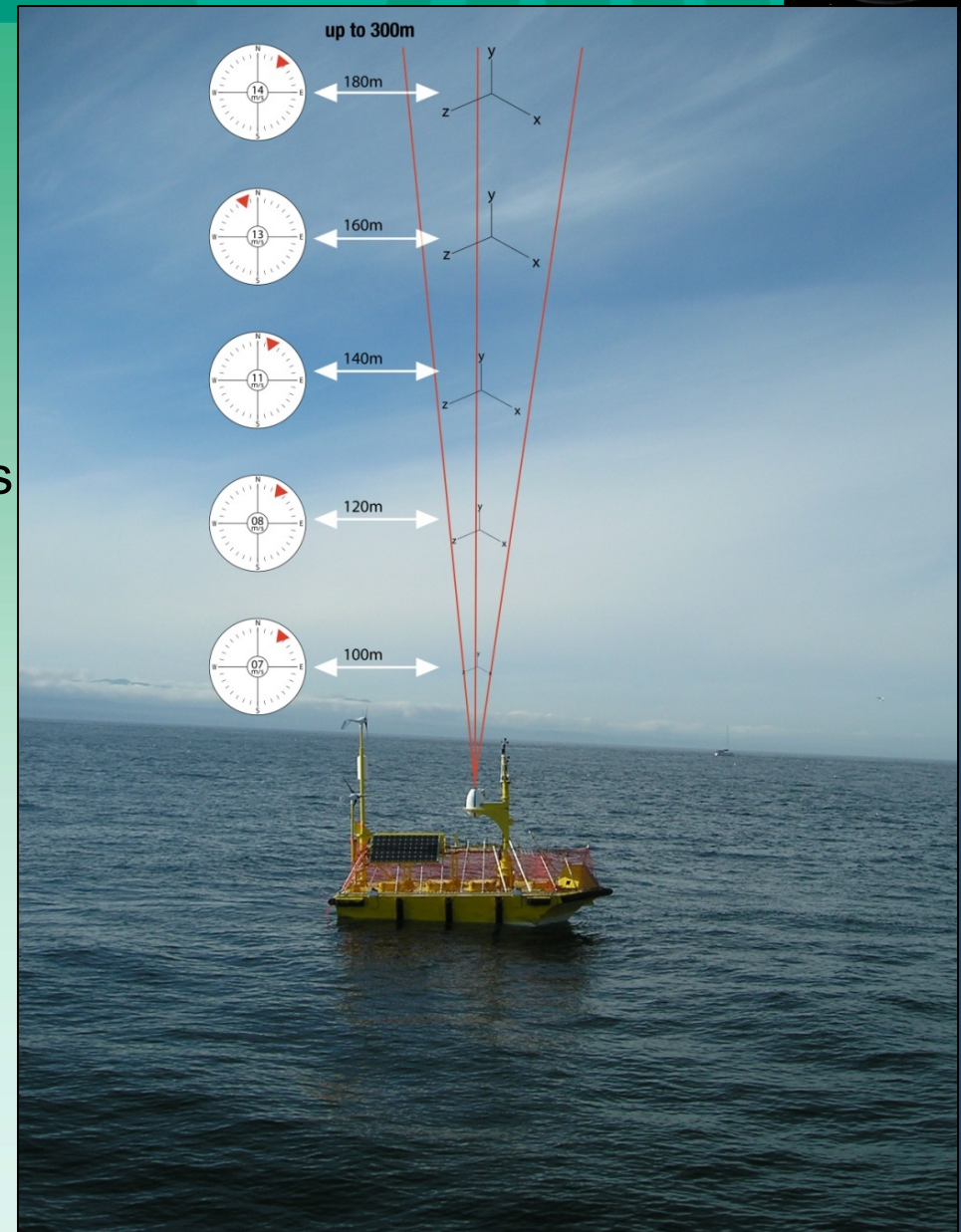
WindSentinel™ Solution

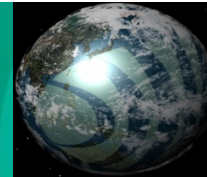
- **Meteorological masts are very costly to build (\$5m to \$10m) and non-mobile as well as non reusable.**
- **Meteorological masts typically measure wind at heights below the blade span and hub height of typical offshore wind turbines.**
- **Construction delays resulting from permitting and environmental assessment periods create wind resource assessment delays of up to two years .**
- **AXYS Technologies was tasked with developing an alternative solution:**
 - **WindSentinel™ is a very cost effective, mobile and reusable wind assessment tool.**
 - **It should allow the developer to gather more, better and more relevant data as either a stand alone met mast replacement or in conjunction with a met mast wind resource campaign (where it reduces the uncertainties applied to WRA data)**
 - **Minimal deployment delays can significantly reduce wind assessment periods**
 - **WindSentinel™ is mobile for quick deployment at multiple wind assessment locations**



The WindSentinel™

- Designed to be the world's first wind resource assessment buoy capable of accurately gathering wind data at turbine hub-height and across the blade span.
- Uses a Laser Wind Sensor
- Replacement for met towers
- Prospecting and siting
- Can reduce applied assessment uncertainty





The WindSentinel™

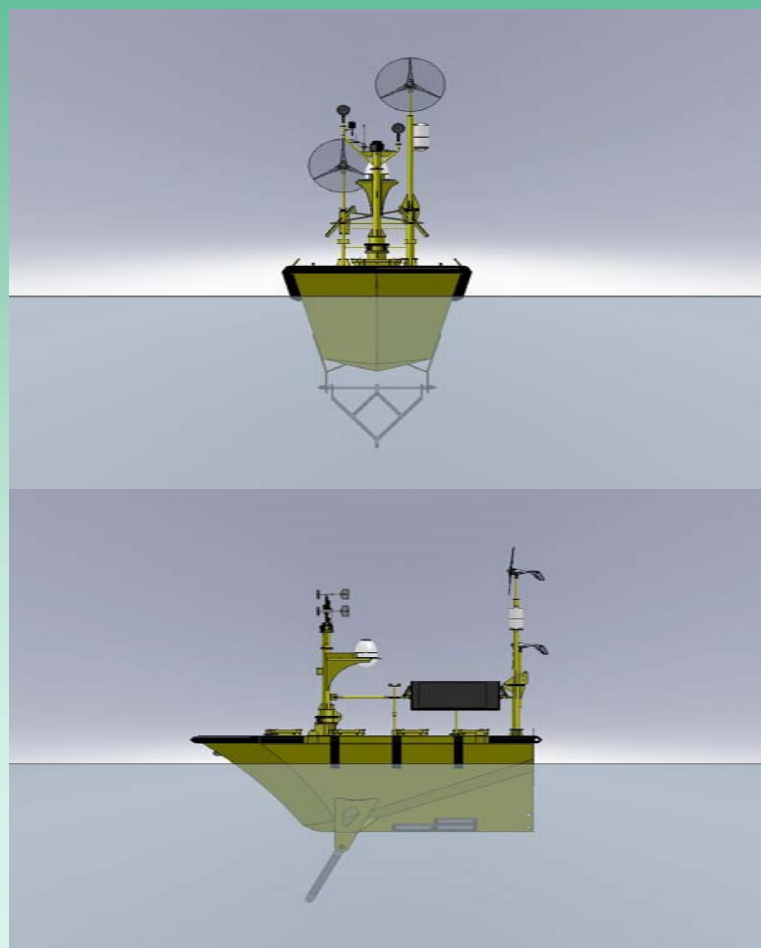
Hull

Wind Sentinel™ Physical Specs

Length:	6.10m
Beam:	2.92 m
Water Line (from Deck):	0.61m
Weight (Fully Assembled):	8700 kg

Forward Mast Sensor Specs

Laser Wind Sensor Lens to Deck:	2.50 m
Laser Wind Sensor Profiling Height	up to 300m
Port Anemometer to Deck:	3.00 m
Starboard Anemometer to Deck:	3.50 m



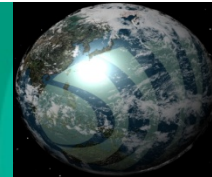


The WindSentinel™

Power System

- 2 x 210W Solar Panels
- 2 x 400W Turbines
- Many Lead Acid Batteries



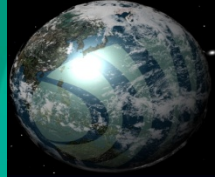


The WindSentinel™

WatchMan500™

- Remote configuration and diagnostics capabilities
- Diverse data collection, and communication capabilities.
- Expandable, Low Power

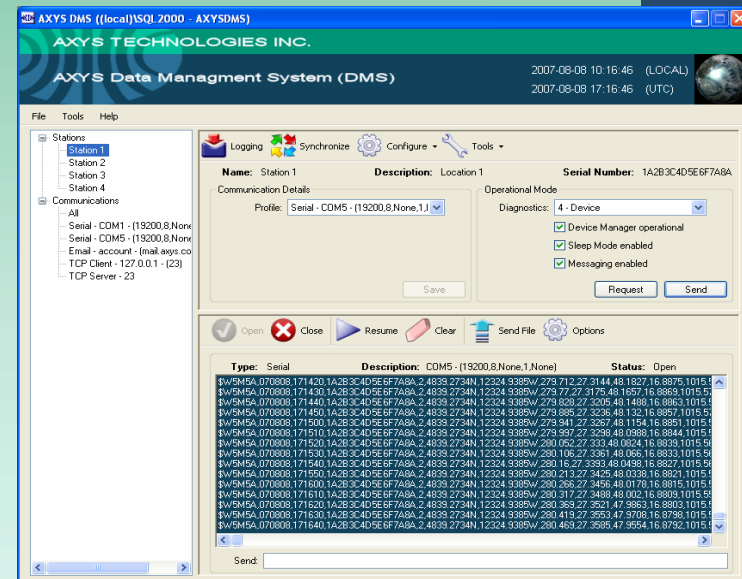


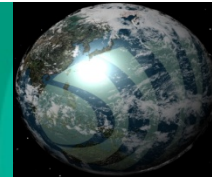


The WindSentinel™

Data Management System (DMS)

- Provides complete control of the WatchMan500™ systems.
- Real-time and scheduled control of system operation and configuration.
- Data storage to MS SQL Database.
- Data can be pushed or polled from a station to the DMS.



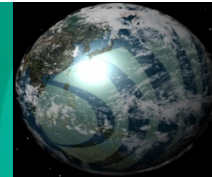


The WindSentinel™

Communications – A small list of the many supported options

- Cellular Modems
- Inmarsat D+, Inmarsat C
- Iridium
- GlobalStar
- AIS
- ARGOS, GOES
- VHF Radio

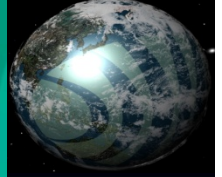




The WindSentinel™

Laser Wind Sensor (Pulsed Doppler Velocimeter)

- Solid state sensor
- Measures real-time horizontal and vertical wind speed and direction corrected for instantaneous motion
- Wind measurements taken at various bins up to 300m.



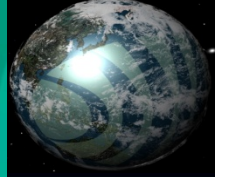
The WindSentinel™

Met Sensors

- Barometer
- Dual RM Young Wind Sensors
- Air Temperature and Relative Humidity

Additional Sensors

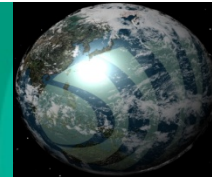
- TRIAXYS Wave Sensor
- 3-axis compass
- Sea Surface Temperature
- Current Profiler
- Depth Sensor
- Power monitoring on all major power sinks and sources



The Trial

- Comparison of wind data between a stationary and moving platform
- Proof of platform suitability for this application
- Performance evaluation



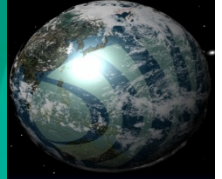


Trial Information

- Trial Date
 - October 20, 2009 to November 20, 2009
- Parameters measured
 - Wave Motion
 - Water Depth
 - Basic MET (ie. Air Temp, Humidity, Surface Winds, Barometric Pressure)
 - Wind Speeds and Directions at 100m, 150m and 200m bin heights

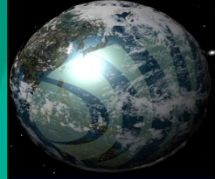


AXYS TECHNOLOGIES INC.

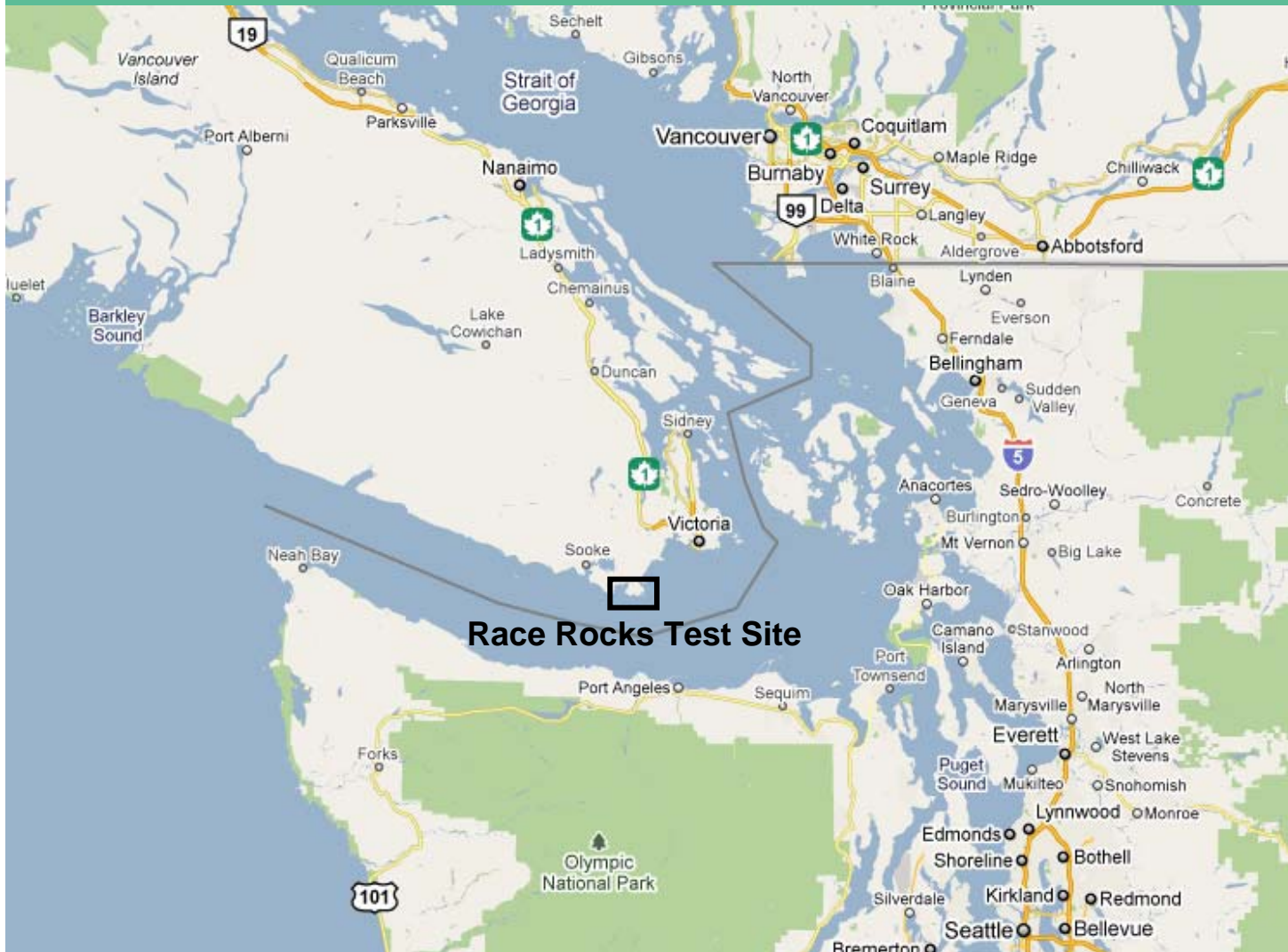


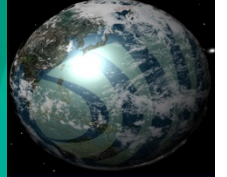
Land Station





Location



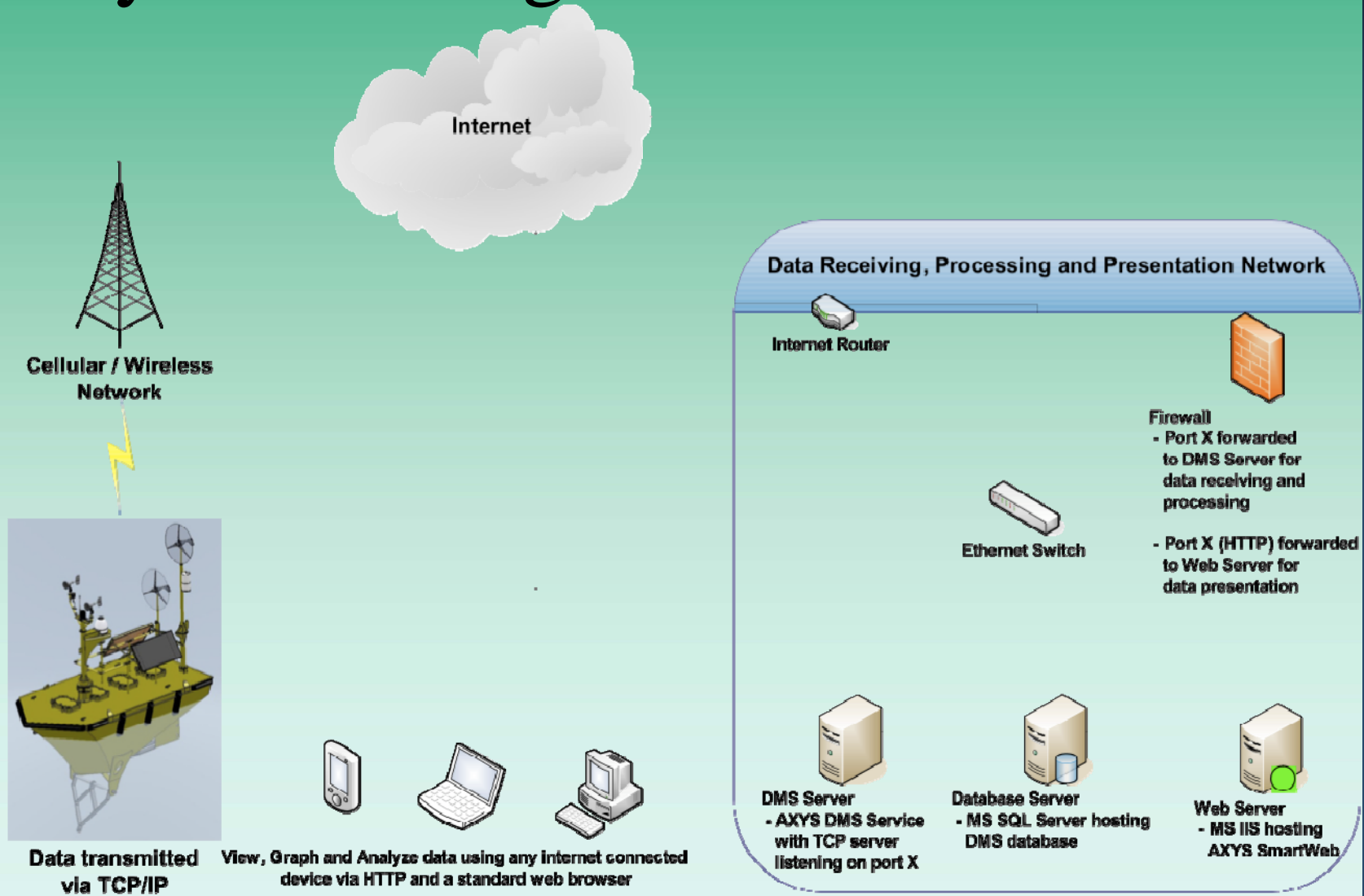


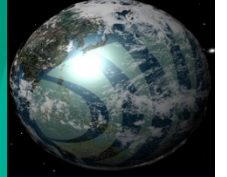
Anticipated Issues

- The effects that obstructions or land mass may have on wind.
- Separation between the two sites (approximately 700m).
- Laser wind sensor performance.
- Impact of buoy motion
- Profiling height difference



System configuration and data links



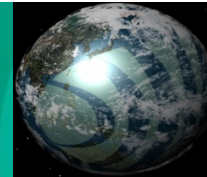


DMS and Data Storage Over the Trial

Number of messages logged by the W500: > 7.8 million (1.8GB)

Messages transmitted in real time: > 23000

Data managed by the DMS: ~10GB



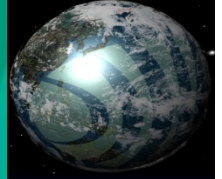
Summary Wind Data

Wind Sentinel™ Wind Data Summary Statistics

Description	Mean	Min	Max
VIN 100m Wind Speed [m/s]	6.41	0.28	22.41
VIN 150m Wind Speed [m/s]	6.40	0.30	22.67
VIN 200m Wind Speed [m/s]	6.63	0.28	22.78
AN1 Wind Speed [m/s]	5.24	0.10	17.10
AN2 Wind Speed [m/s]	5.07	0.10	16.50

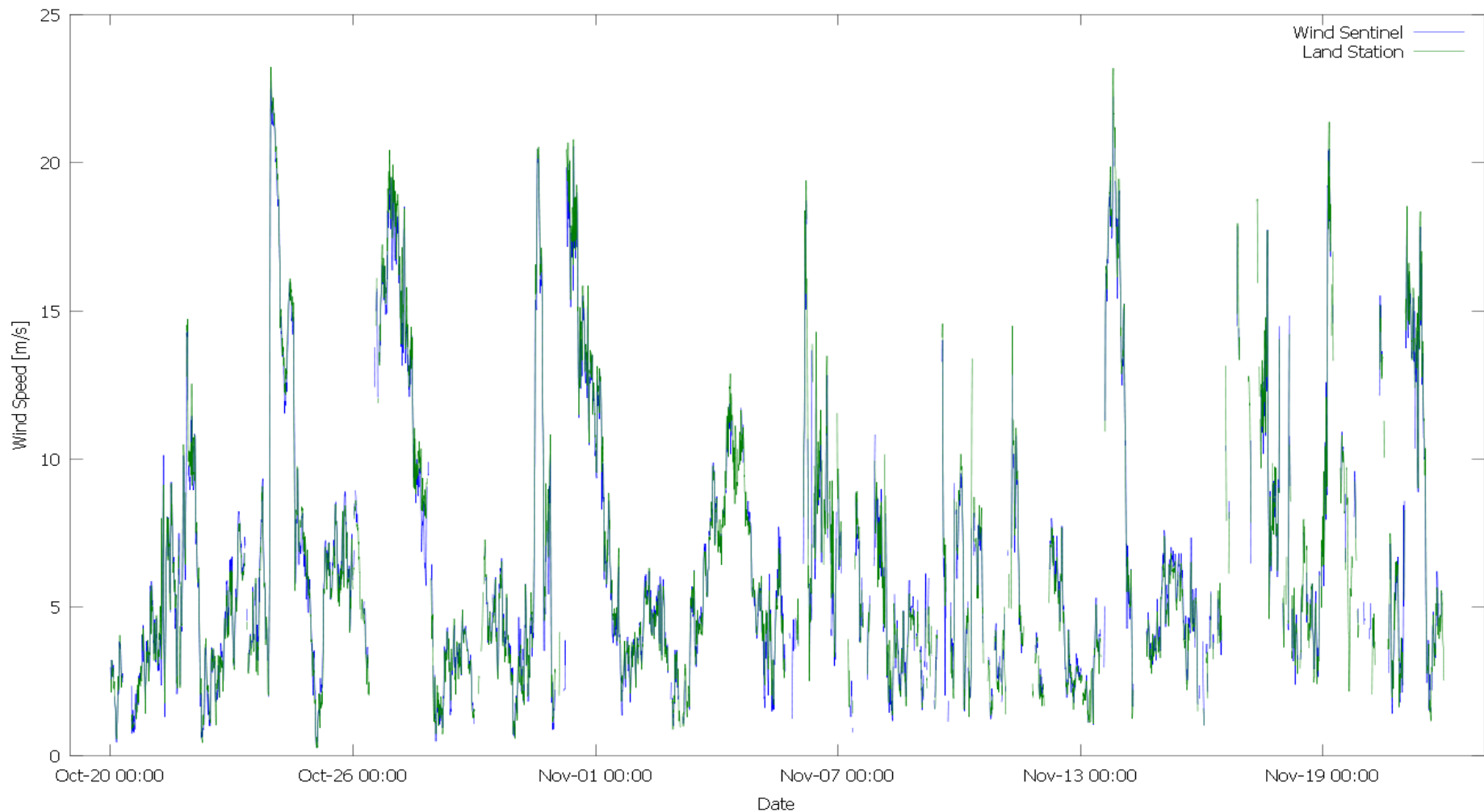
Land Station Wind Data Summary Statistics

Description	Mean	Min	Max
VIN 100m Wind Speed [m/s]	6.45	0.37	23.00
VIN 150m Wind Speed [m/s]	6.55	0.34	23.15
VIN 200m Wind Speed [m/s]	6.69	0.27	23.23
AN1 Wind Speed [m/s]	4.40	0.00	17.70



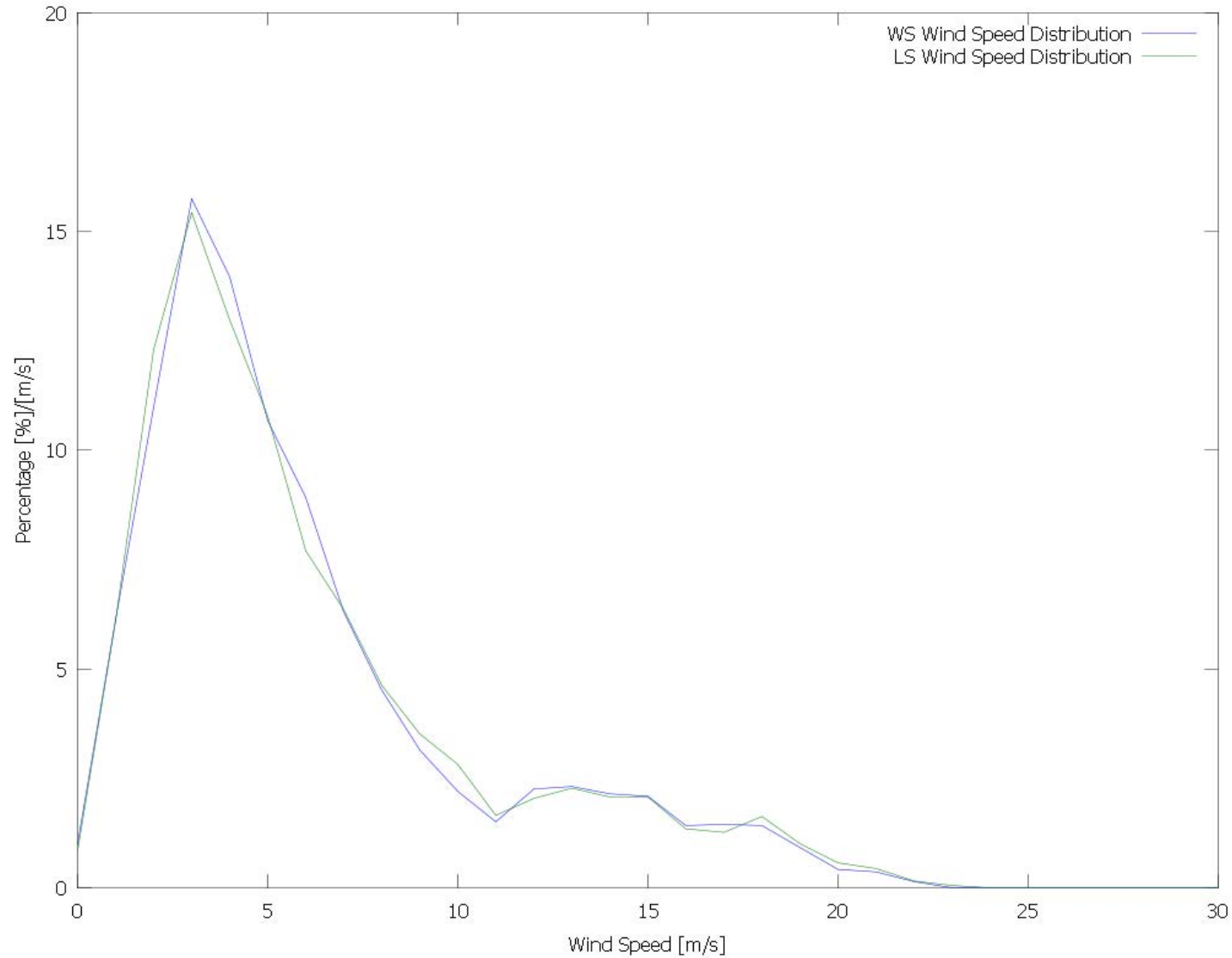
Summary Wind Data

AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - Wind Speed 200m Daily 10min Average vs. Time





AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - 200m Wind Speed Frequency Distribution

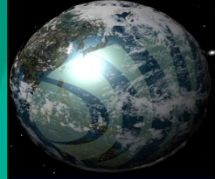




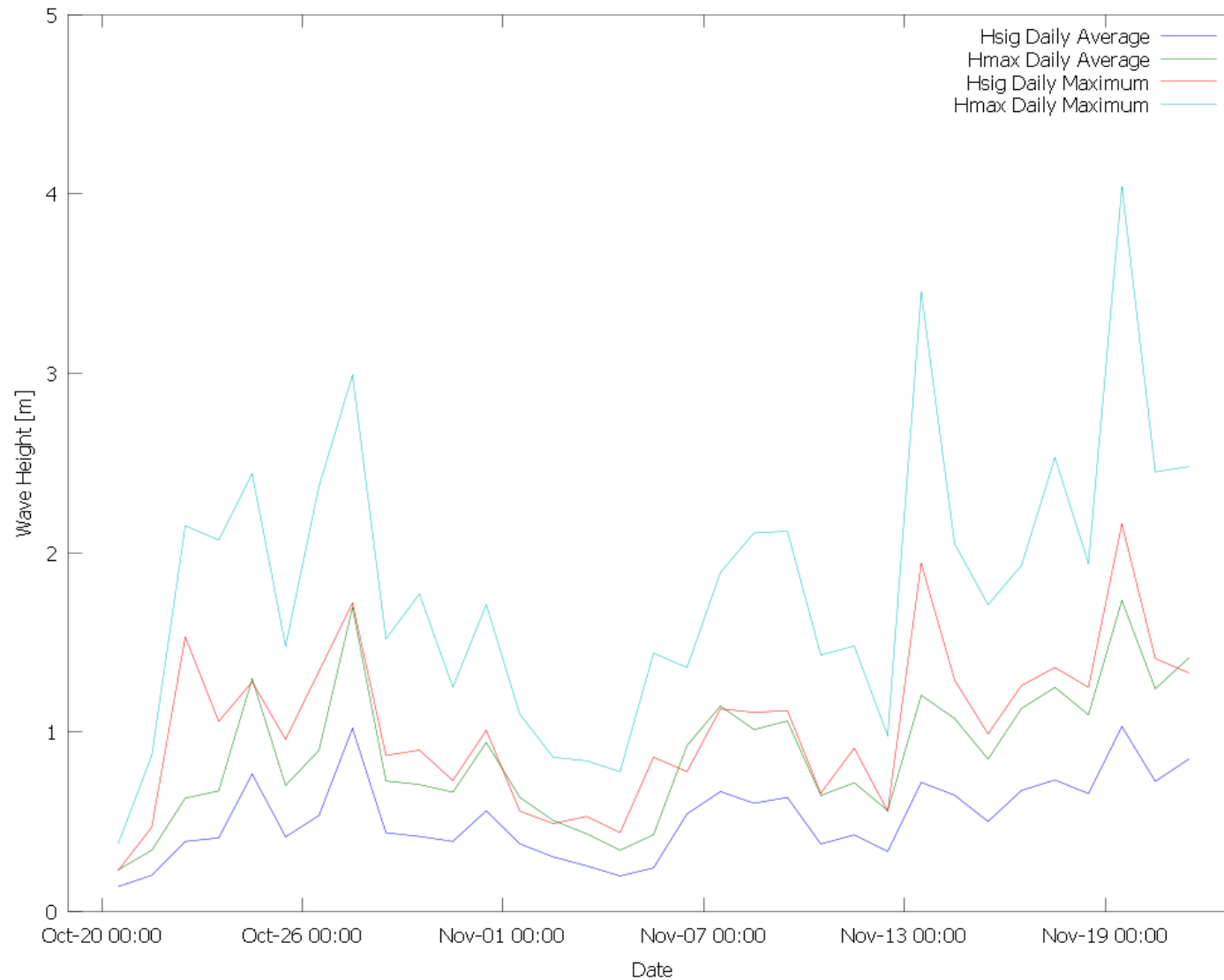
Summary Wave Data

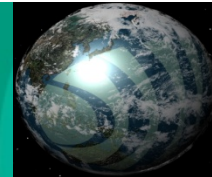
Wind Sentinel™ TRIAXYS Wave Sensor Summary Statistics

Description	Mean	Min	Max
Hmax	0.88	0.07	4.04
Hsig	0.52	0.04	2.16
TP	9.39	2.20	25.00



AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - Daily Wave Height Statistics vs. Time





Summary Conditions

Wind Sentinel™ Meteorological Summary Statistics

Description	Mean	Min	Max
Temp [°C]	8.59	4.10	13.70
Humidity [%]	86.08	59.80	99.40
Dewpoint [°C]	6.33	-1.70	11.80
Pressure[mb]	1014.05	992.68	1032.01

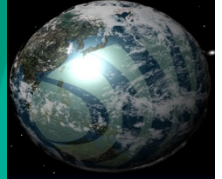
Land Station Meteorological Summary Statistics

Description	Mean	Min	Max
Temp [°C]	8.65	3.90	13.80
Humidity [%]	86.13	59.10	99.40
Dewpoint [°C]	6.40	-2.10	11.60
Pressure[mb]	1013.35	990.77	1030.56

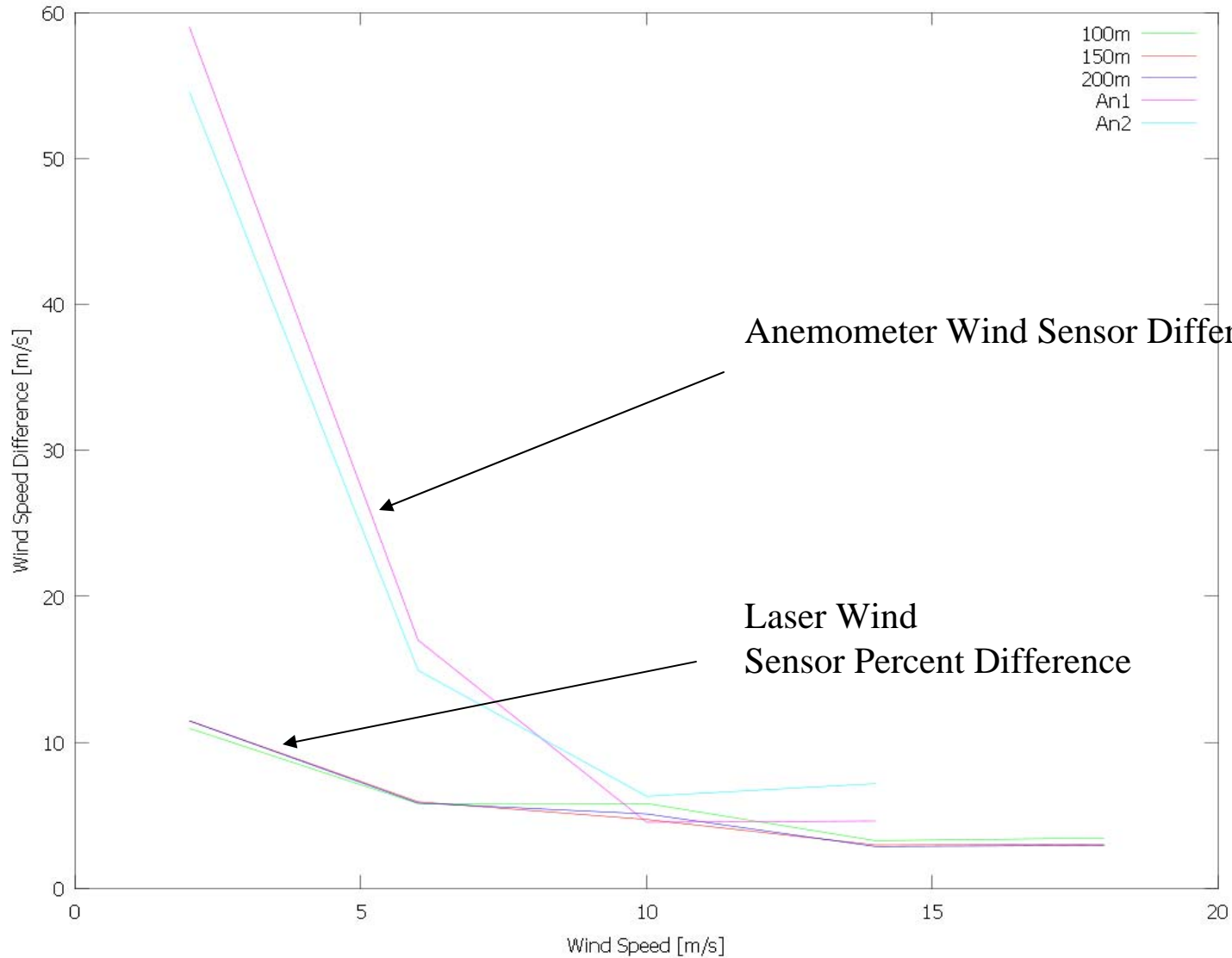


Comparison Statistics

Description	0-4m/s			4-8m/s			8-12m/s			12-16m/s			16-20m/s		
	Mean	Max	Std	Mean	Max	Std	Mean	Max	Std	Mean	Max	Std	Mean	Max	Std
Wind Speed 200m	0.28	2.29	0.23	0.32	4.13	0.29	0.49	2.47	0.45	0.40	2.72	0.36	0.53	3.04	0.45
Wind Speed AN2	1.07	4.30	0.68	0.75	4.20	0.74	0.62	1.90	0.40	0.97	2.30	0.46	-	-	-
Wind Direction 200m ϕ	36.30	154.46	13.50	33.36	57.88	6.51	29.77	45.97	5.84	27.23	47.47	4.69	25.20	38.99	3.63



AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - Speed Binned Wind Speed Absolute Percentage Difference

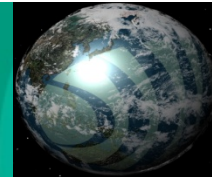


Anemometer Wind Sensor Difference

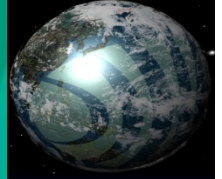
Laser Wind Sensor Percent Difference



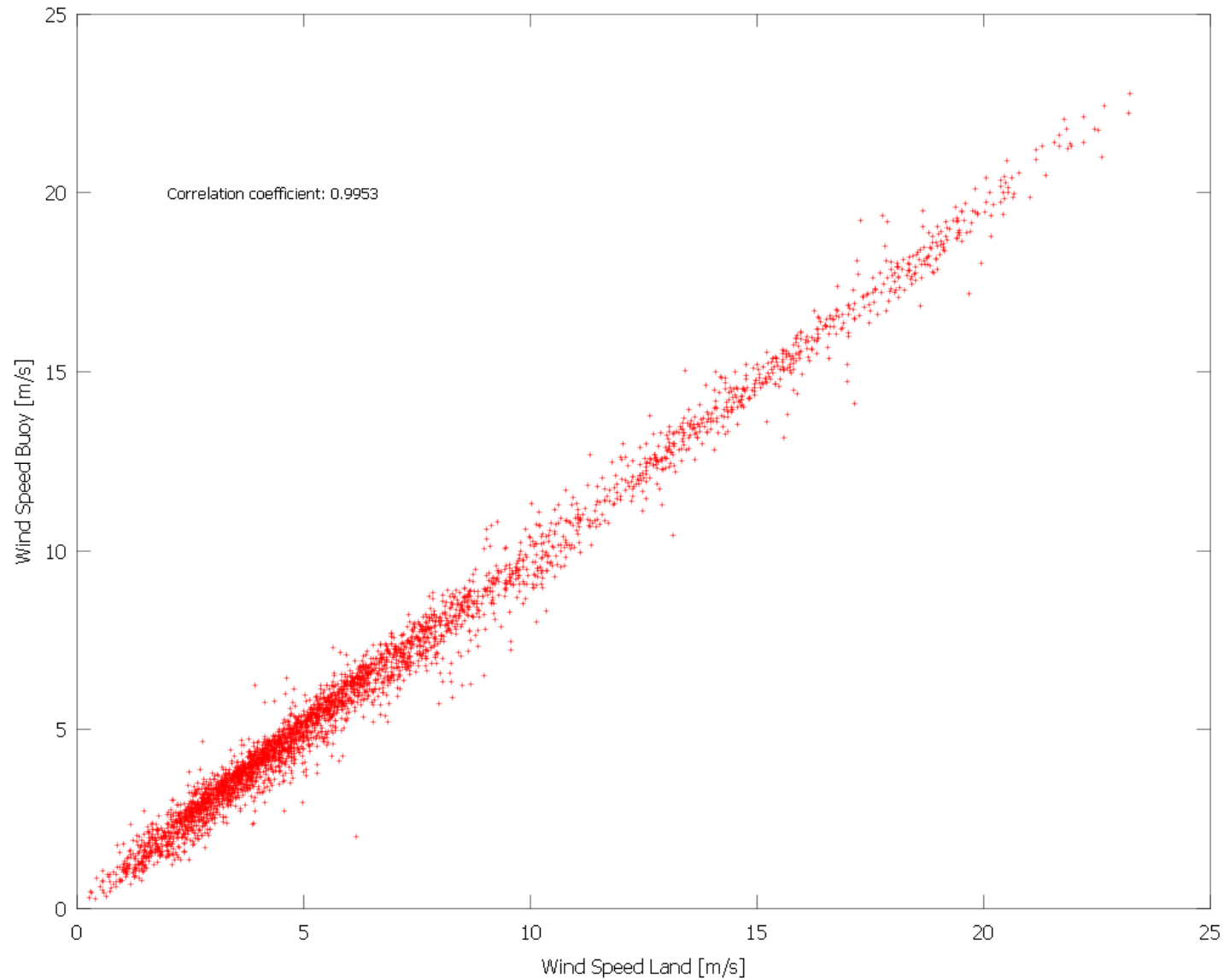
AXYS TECHNOLOGIES INC.

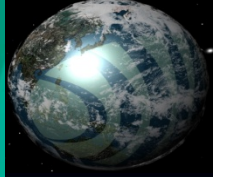


Correlation Sensor to Sensor



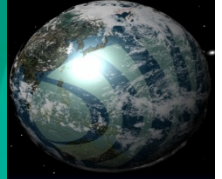
AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - 200m Wind Speed Correlation



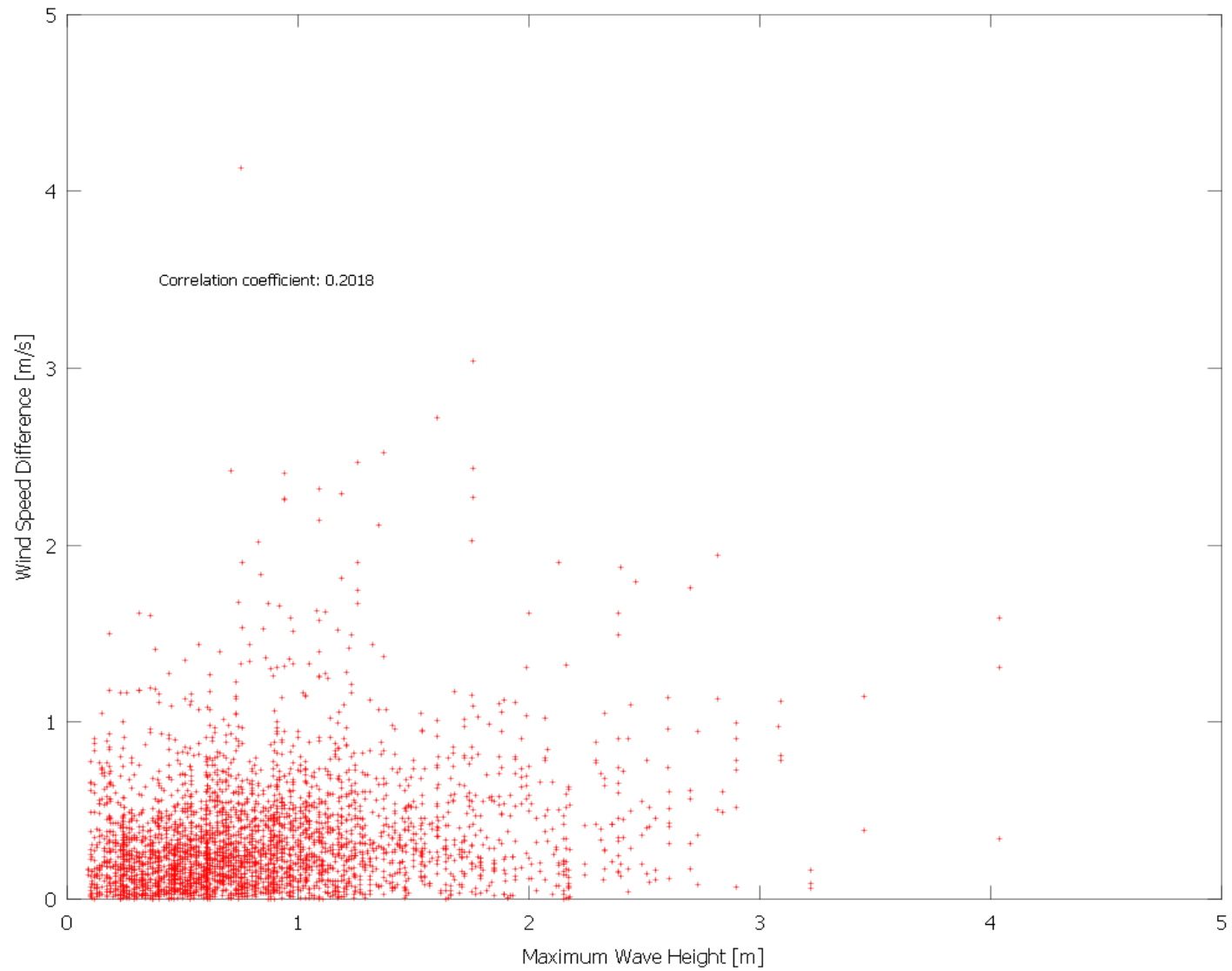


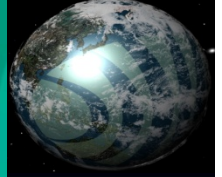
Correlation

Wind difference to wave height



AXYS Wind Sentinel Oct 20 00:00UTC - Nov 22 00:00UTC - 200m Wind Speed to Wave Correlation





The WindSentinel™ - Outcome

- Shows good feasibility for a Laser Wind Sensor mounted on a buoy for use in a wind resource assessment
- We have shown that, if done correctly, wind measured from a Laser Wind Sensor on a moving platform is not significantly different than wind measured from a stationary Laser Wind Sensor



Issues Encountered and Solutions.

➤ **System Issues**

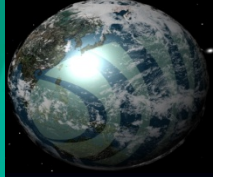
- Compass heading
- Wind turbine failure (12 m/s shutdown)
- Power requirements

➤ **Deployment Issues**

- Working within a Marine Protected Area
- Complex to deploy from a 35ft tug
- Land Station deployment location accessible only by air
-



AXYS TECHNOLOGIES INC.



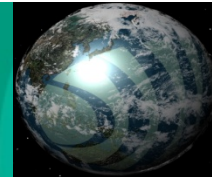


AXYS TECHNOLOGIES INC.



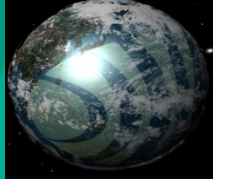


AXYS TECHNOLOGIES INC.



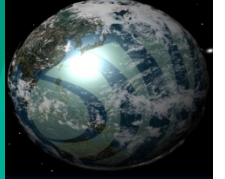


AXYS TECHNOLOGIES INC.





AXYS TECHNOLOGIES INC.



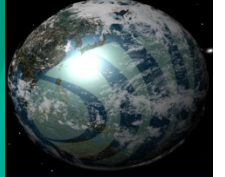


AXYS TECHNOLOGIES INC.





AXYS TECHNOLOGIES INC.



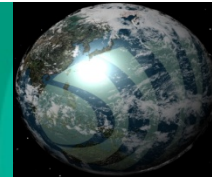


AXYS TECHNOLOGIES INC.





AXYS TECHNOLOGIES INC.



Thank you.

Questions will be taken at
the end of the session.

www.axystechnologies.com