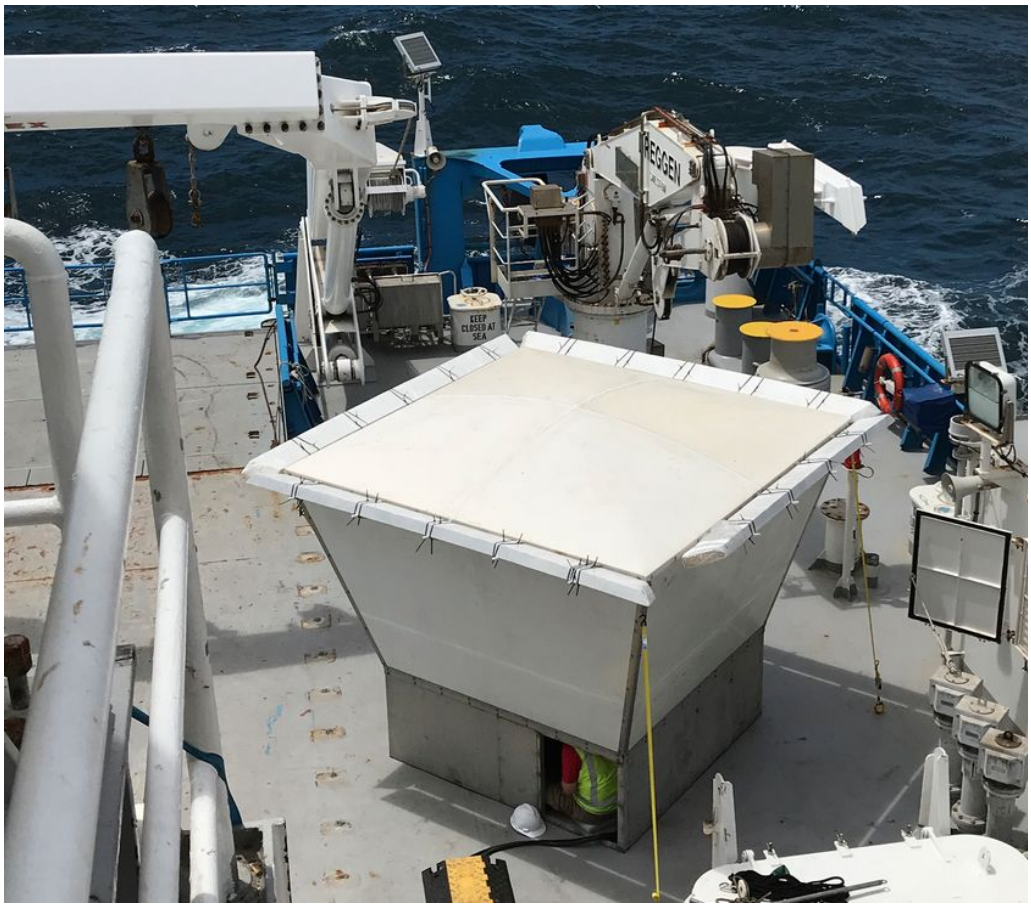
SOCRATES

ISS Radar Wind Profiler

Preliminary Data Report (April 12, 2018)



SOCRATES main EOL webpage: https://www.eol.ucar.edu/field_projects/socrates
SOCRATES ISS webpage: https://www.eol.ucar.edu/content/socrates-iss-0

NCAR/EOL operated a radar wind profiler on board the CSIRO RV Investigator as part of a deployment of an Integrated Sounding System (ISS) for the SOCRATES / CAPRICORN field campaign. The primary voyage (CSIRO designation: IN2018_V01) for this deployment set sail from Hobart, TAS, Australia on 11 Jan 2018 into the Southern Ocean and concluded back in Hobart on 22 Feb 2018. A shakedown, test and training cruise (IN2017_E04) took place off the east coast of Tasmania Dec 7 - 11, 2017.

Instrument	915 MHz radar wind profiler LAP3000	
Data Collection Software	LapXM (version 2.6.1)	Produces raw files in various formats
Data Processing Software	lapxm_ship_prelim.pro	Produces wind data files corrected for ship motion (*.nc) and plots (*.png)

The ISS profiler is a Vaisala LAP3000 915 MHz DBS (Doppler Beam Swinging) radar wind profiler using LapXM hardware and software. This class of wind profiler was originally developed at the NOAA Aeronomy Lab (Ecklund et al, 1990) and has undergone a series of improvements as they were developed into the commercial product (the LAP3000), initially by Radian Inc, then by Vaisala (and now Scintec).

For ship-borne deployments the profiler is mounted on a gyroscopically stabilized platform that keeps the antenna level (Carter et. al. 1992). Integration of these profilers into the ISS for both land and ship-borne applications is described by Parsons et.al. 1994. On the Investigator, the profiler was on the main deck approx 10 meters from the stern and 3.5 m from the port side.

RAW DATA:

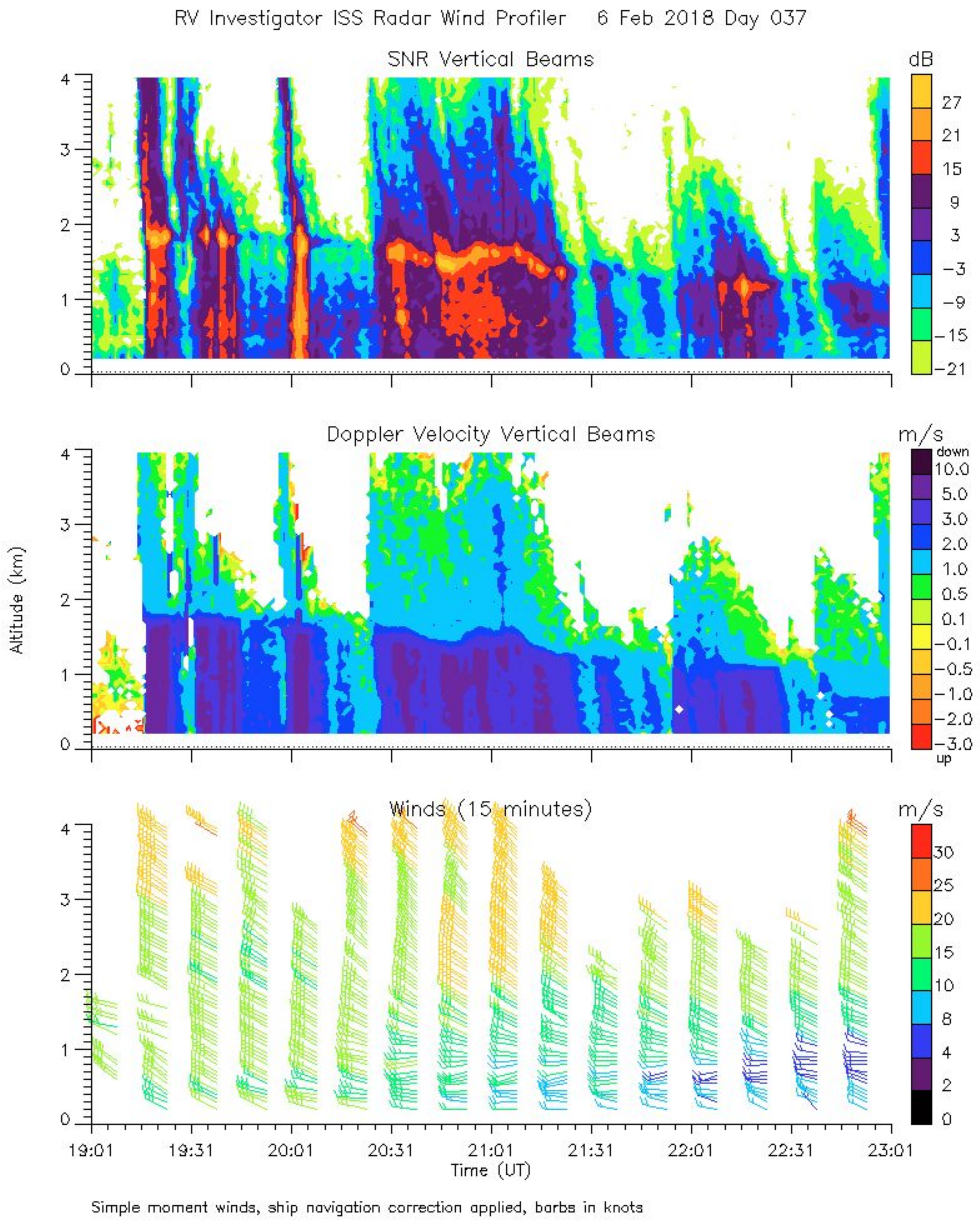
The radar is controlled and raw data is recorded using Vaisala software known Lap-XM. This produces a range of files including raw spectral files in a binary format, as well as processed data such as wind profiles and Doppler moments in netcdf and ascii formats. For SOCRATES data were collected as profiles from around the 200 meter level up to 4.6 km in approx 60 m steps (although as discussed below the useable data range is less).

Note that LapXM (unlike the older POP software used in earlier generation LAP3000 profilers) does not have the capability to correct for ship motion, course and heading; the wind products are relative to the frame of the ship.

PROCESSED DATA:

The LapXM moment data were processed by EOL software (IDL lapxm_ship_prelim.pro) to generate wind estimates corrected for ship motion, course and heading, partly based on the methods of Johnston (2014). This analysis generated plots and the netCDF files that form the preliminary data set. The netCDF files files include 24 hours of 30 minute consensus mean SNR, wind speed and direction, and vertical winds at ~60 meter height steps. An example of the file name is `ship_prof_20180203.winds.nc` for Feb 3, 2018 data. The height and times are at the mid-point of the height and time averaging steps.

DATA EXAMPLE:

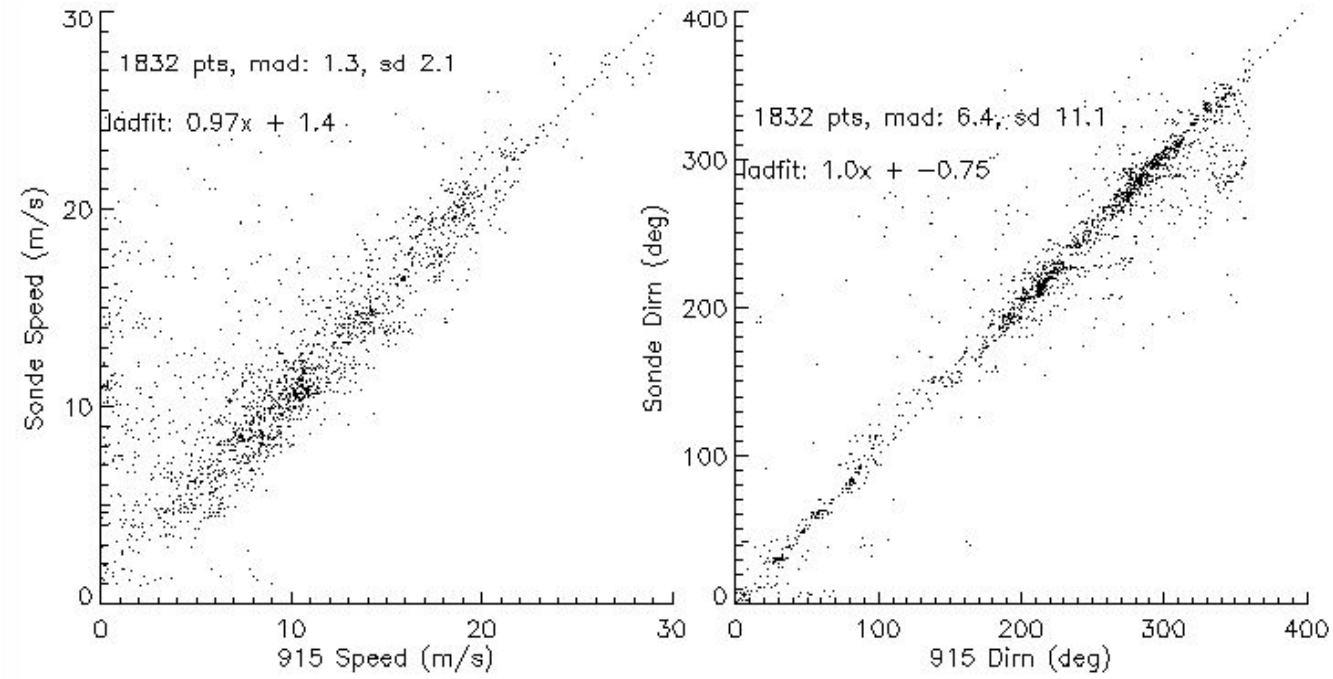


An example of measurements during a squall on Feb 6. The top panel shows SNR (Signal to Noise Ratio), which is an indicator of reflect signal strength. The middle panel shows vertical velocity, (blues are downward and reds upward motion). The light blue regions indicating falling snow and the dark blue is rain. The melting layer starts at about 1.8 km at 19 UTC and lowers to under a 1 km by 23 UTC. The melting layer produces the strongly reflective layer (or “bright-band”) in the SNR plot. Wind barbs are shown in the bottom panel. These 4-hour plots were produced every hour and are available on the SOCRATES ISS web site and the field catalog.

KNOWN DATA ISSUES:

The main issue affecting the profiler was sea clutter, which are unwanted reflections from ocean waves dominating scattering from the atmosphere. The degree of sea clutter was considerably less than expected, stemming in part from the ideal location on the main deck and improvements in the clutter screen and signal processing with the recent upgrade of the profilers to LapXM. A preliminary analysis suggests that data below about 500m was affected by sea clutter. Reprocessing with software known as NIMA (NCAR Improved Moments Algorithm) is expected to improve reject of sea clutter and this analysis will be applied to the data as part of the QC process.

During precipitation, the profiler typically made wind measurements through the full depth of the sampling range (approximately 4.6 km). At other times, the altitude coverage depended on the reflectivity of the clear-air (a complicated function of temperature, humidity and turbulence). During active and humid periods, measurement were made up to around 2km, however during cold dry stable conditions the maximum coverage was frequently as low as 1km. Overall the altitude coverage was from about 400m to about 1200m 75% of the time. It is expected that reprocessing with NIMA will improve the coverage both upwards and downwards during the QC analysis.



The winds from the preliminary processing were compared with radiosonde sounding winds. A sample comparison plot showing wind speed and direction at about the 1 km level is shown above. It was found the the median deviation in speed and direction was 1.3 m/s and 6.4 degrees respectively, and the standard deviations were 2.1 m/s and 11.1 deg respectively. This

performance is very good given the ship-borne operation and strong winds encountered during the voyage, and is comparable to land based operations. There were periods when the wind speeds were lower than on the soundings (note the cluster of points to the right of the fitted line in the speed scatter plot). This effect will be investigated further during the QC analysis. In addition comparisons will be made with the wind lidar also deployed with the ISS during the voyage.

References:

Carter, D., W. Ecklund, K. Gage, M. Spowart, H. Cole, W. Dabberdt, and J. Wilson, 1992: “First Test of a Shipboard Wind Profiler”. Bull. Amer. Meteor. Soc., **73**, 1587–1592, doi: 10.1175/1520-0477

Ecklund W.L., et al., 1990: "Field tests of a lower tropospheric wind profiler," Radio Science, **25** (5), 899-906. doi: 10.1029/RS025i005p00899

Johnston, Paul E, 2014: “Oden Wind Processing”, internal NOAA ESRL report (pers comm.)

Parsons, D. B., et.al., 1994: “The Integrated Sounding System – Description and preliminary observations from Toga-COARE”, Bull. Amer. Meteor. Soc., 75, 553-567. 10.1175/1520-0477(1994)075<0553:TISSDA>2.0.CO;2

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UCAR/NCAR - Earth Observing Laboratory. (1997). NCAR Integrated Sounding System (ISS). https://doi.org/10.5065/D6348HF9
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