Laboratory for Atmospheric and Space Physics
University of Colorado **Boulder**

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An Autonomous Chemical Measurement Network in the Ross Island Region of Antarctica – The First Year of Operation

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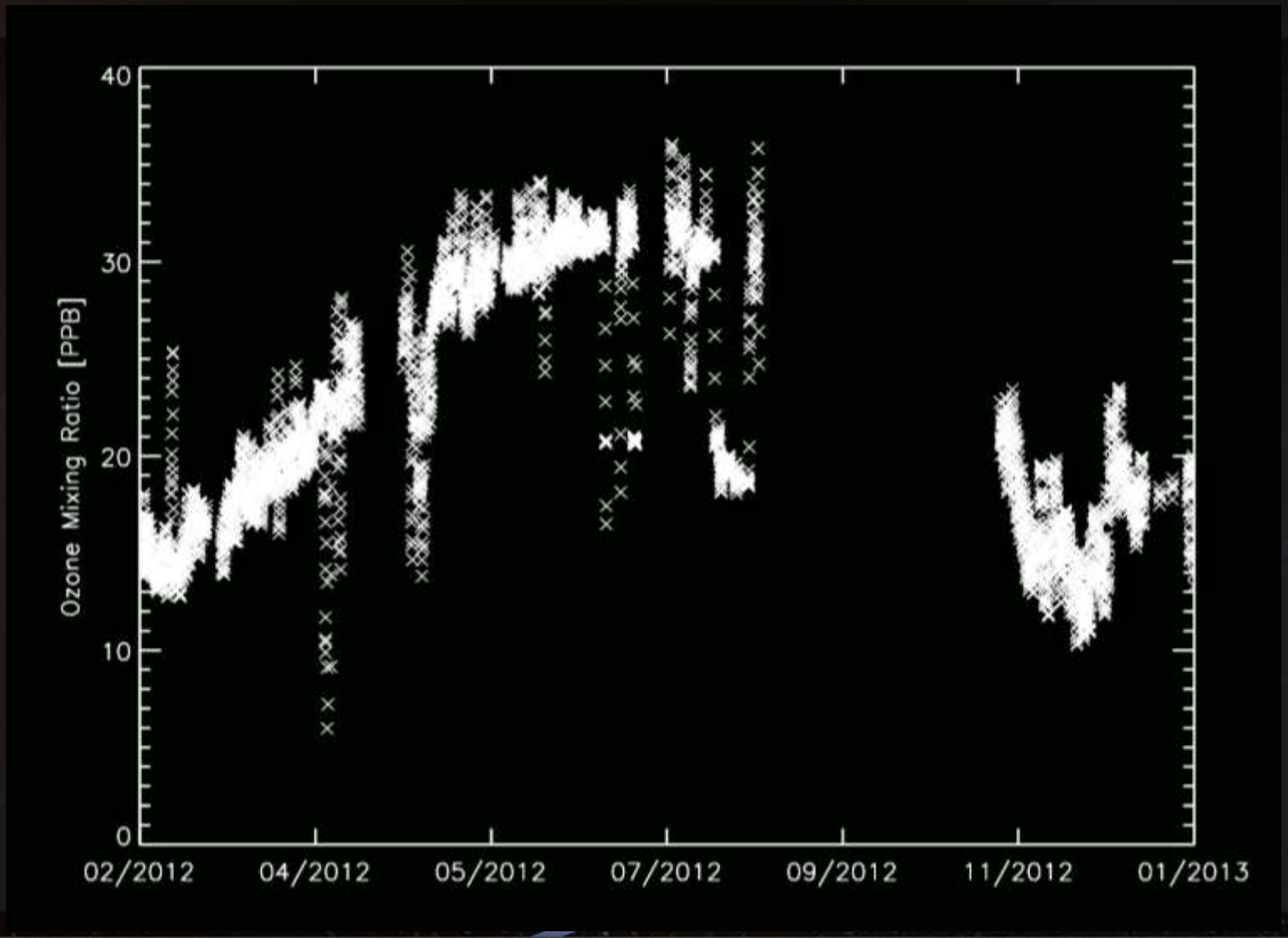
The AWS-Ozone Network

The AWS-Ozone Network

- Scientific Goals:
  - To establish a pollution free ozone climatology for coastal Antarctica
  - To observe spring time ozone depletion events
  - To measure the horizontal extent and transport of ozone depleted air masses
  - To measure the rate of ozone depletion from a given air mass

The AWS-Cape Bird



Network Details

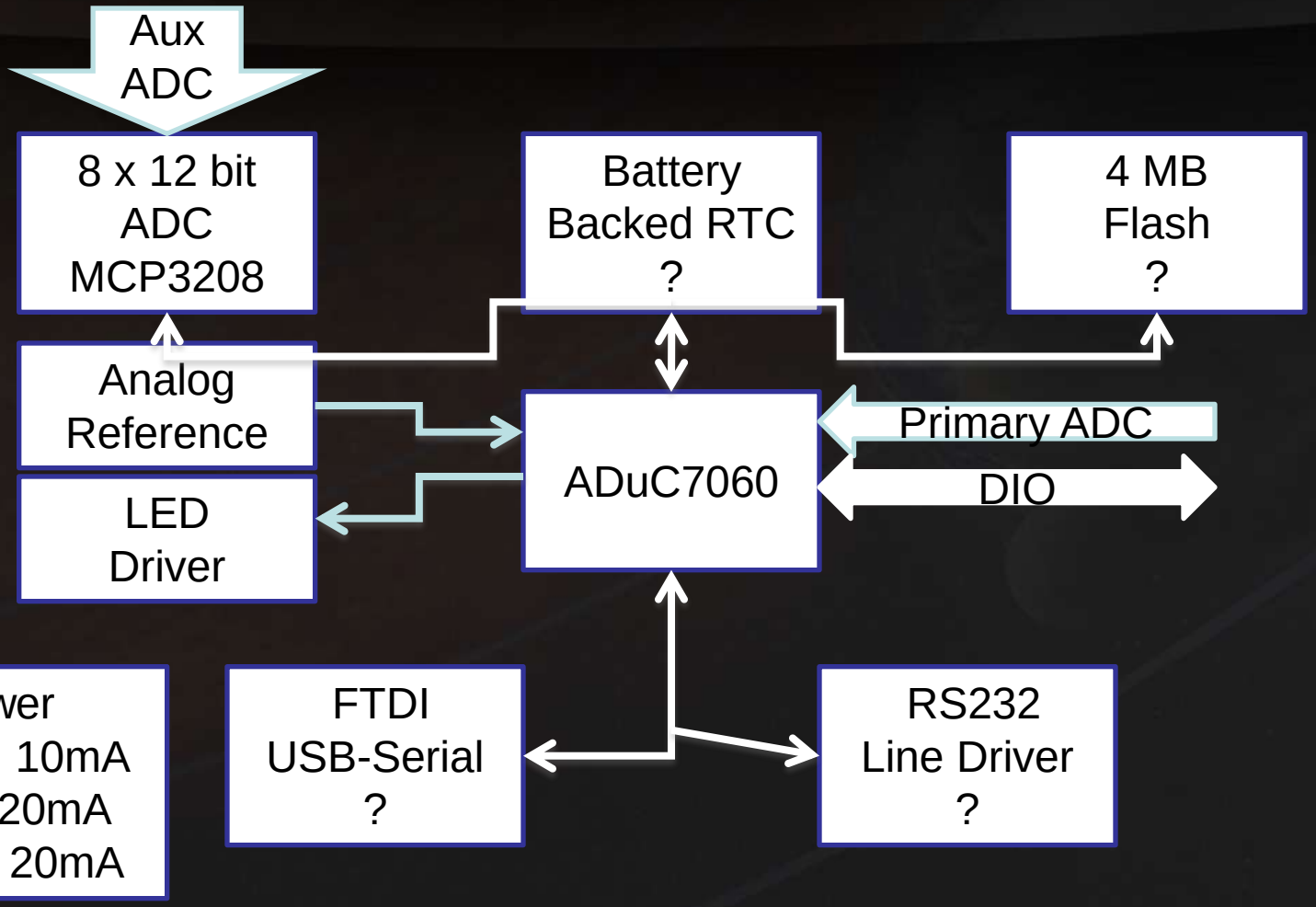
- Five Stations:

Station	Power System	Communication	Instrument
Cape Bird	UW-Madison	FreeWave LOS	2W Ozone
Marble Point	UNAVCO	FreeWave LOS	2W Ozone
Windless Bight	Li-Ion / $LiSOCl_2$	Iridium SBD	1W Ozone
Minna Bluff	UW-Madison	FreeWave LOS	2W Ozone
Lorne	UW-Madison	Iridium SBD	2W Ozone

Ozone Instrument Detail

- In-house designed and built ozone instruments
- UV absorption technique, based on a custom UV-LED source
- Power consumption ~ 4W for continuous measurements / 1 – 2W for reduced 1 – 2 measurements per hour
- Operates down to -55C, measurements down to -38C

Ozone Instrument Detail



Instrument thermal limits

- Data acquisition/control by ADuC7061 ARM7 microcontroller with integrated 24 bit ADC.
- 20mW full bore, <1mW idle @ 2.5V
- Digital core works down to -55C
- Analog systems down to -45C
- Discrete, low overhead 12V -> 2.5V and 12V -> 5V DC-DC switchers. Efficiency > 90% down to 1mA.

Mechanical Systems

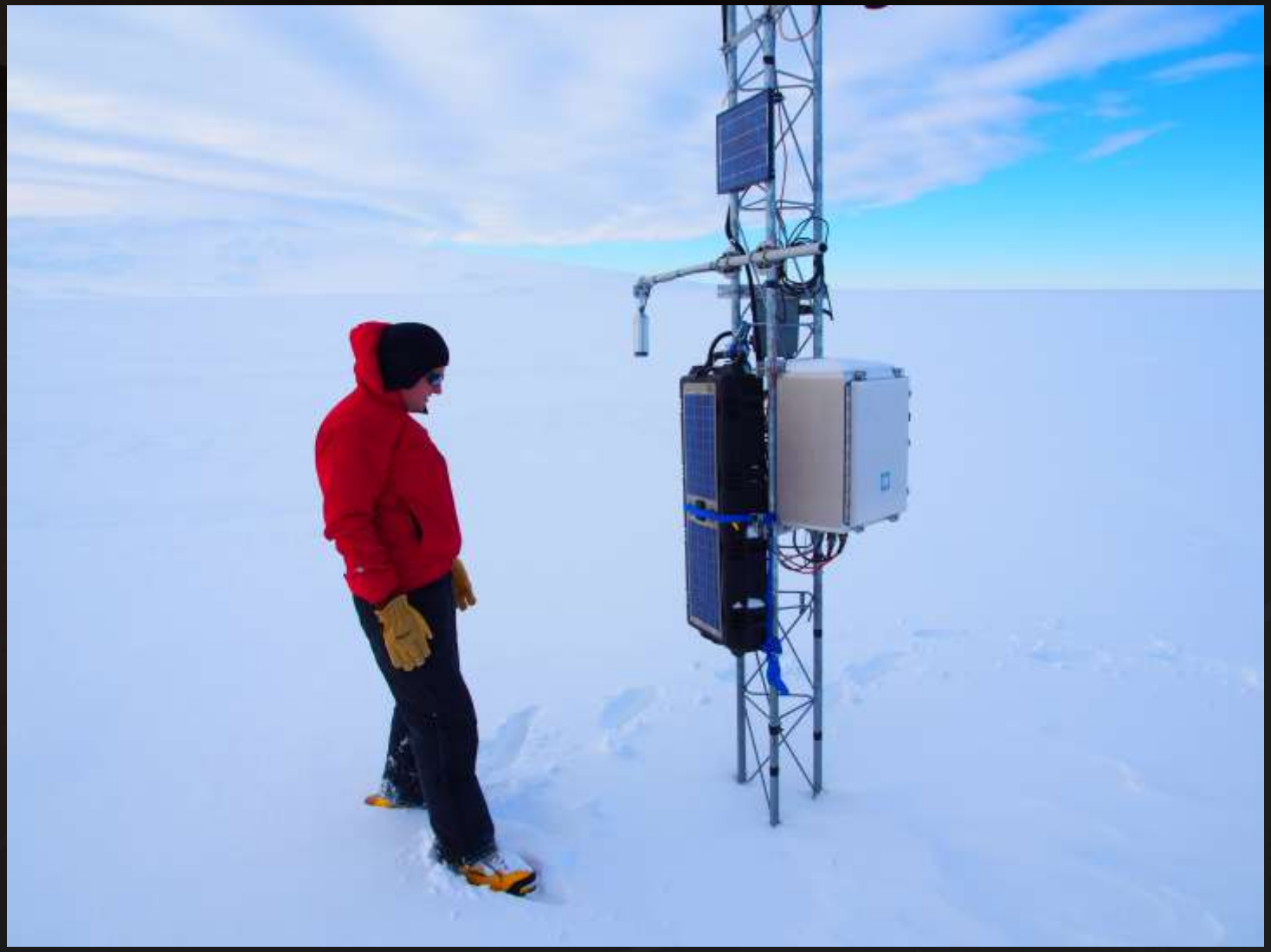
Moving parts are the biggest liability!

- Of 10 version 1 pumps, 6 failed in 1 year – suspect blowing snow and grit
- Blowing snow can be fatal if internal temperatures > 0C
- New pumps – graphite rotary vane pumps – no elastomers, no lubricant
- Pumps are super insulated – retain operational heat for next cycle
- Latching solenoid valves – 1 failure out of 10.
- So far so good on V2 pumps with filters

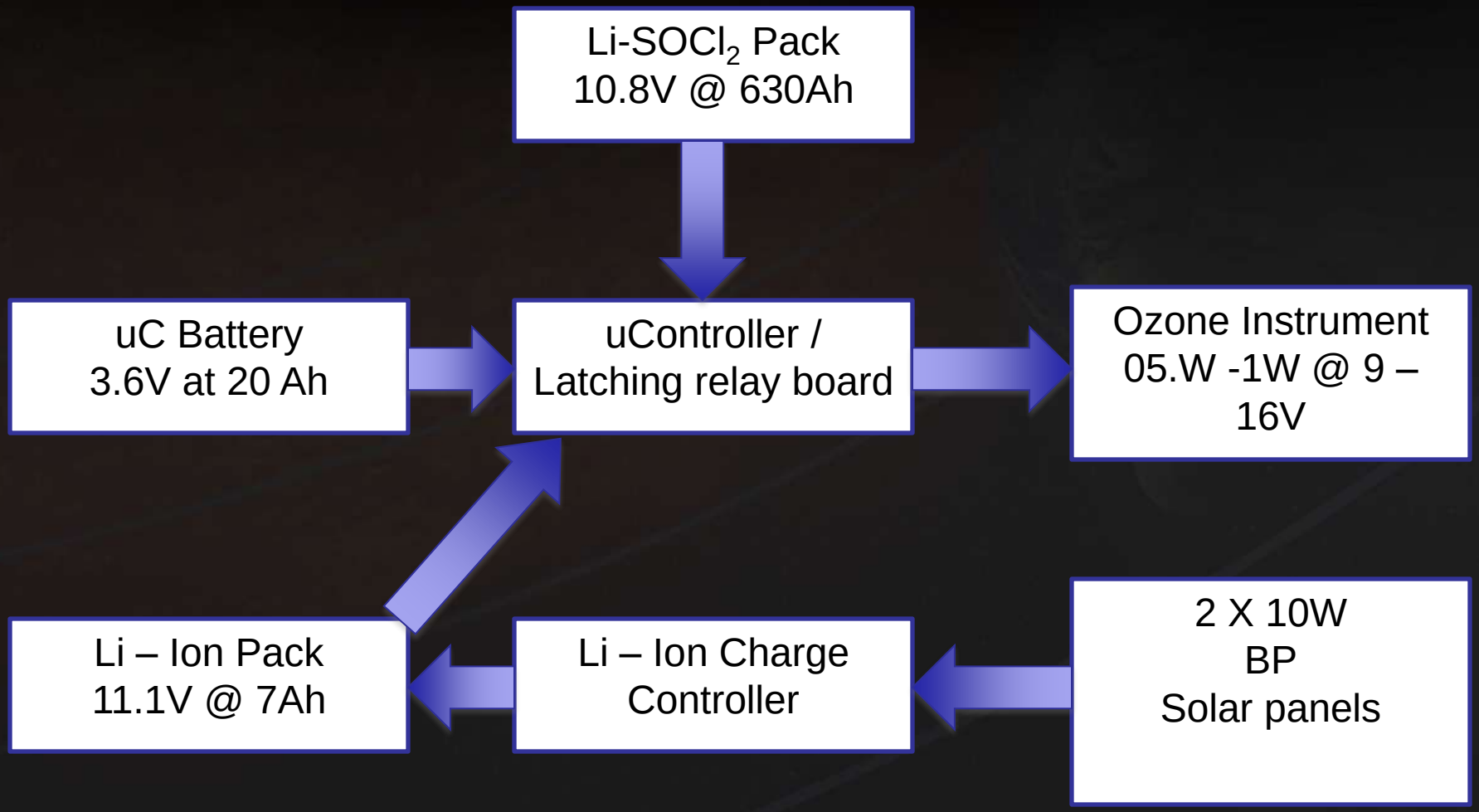
Power Systems - UNAVCO

Power Systems – Wisconsin

Power Systems – Li-Ion / Li-$SOCl_2$



Power Systems – Li-Ion / Li-$SOCl_2$



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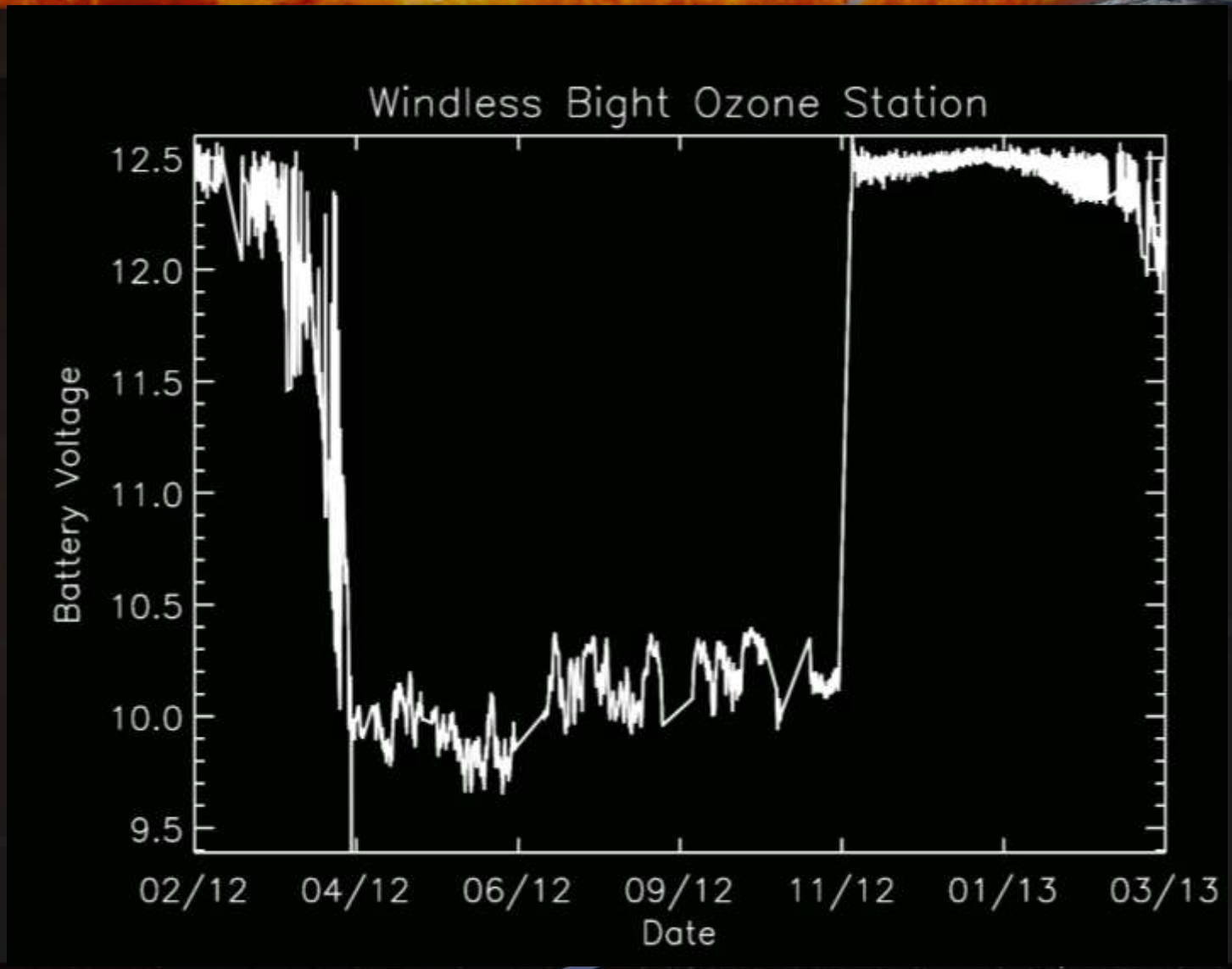
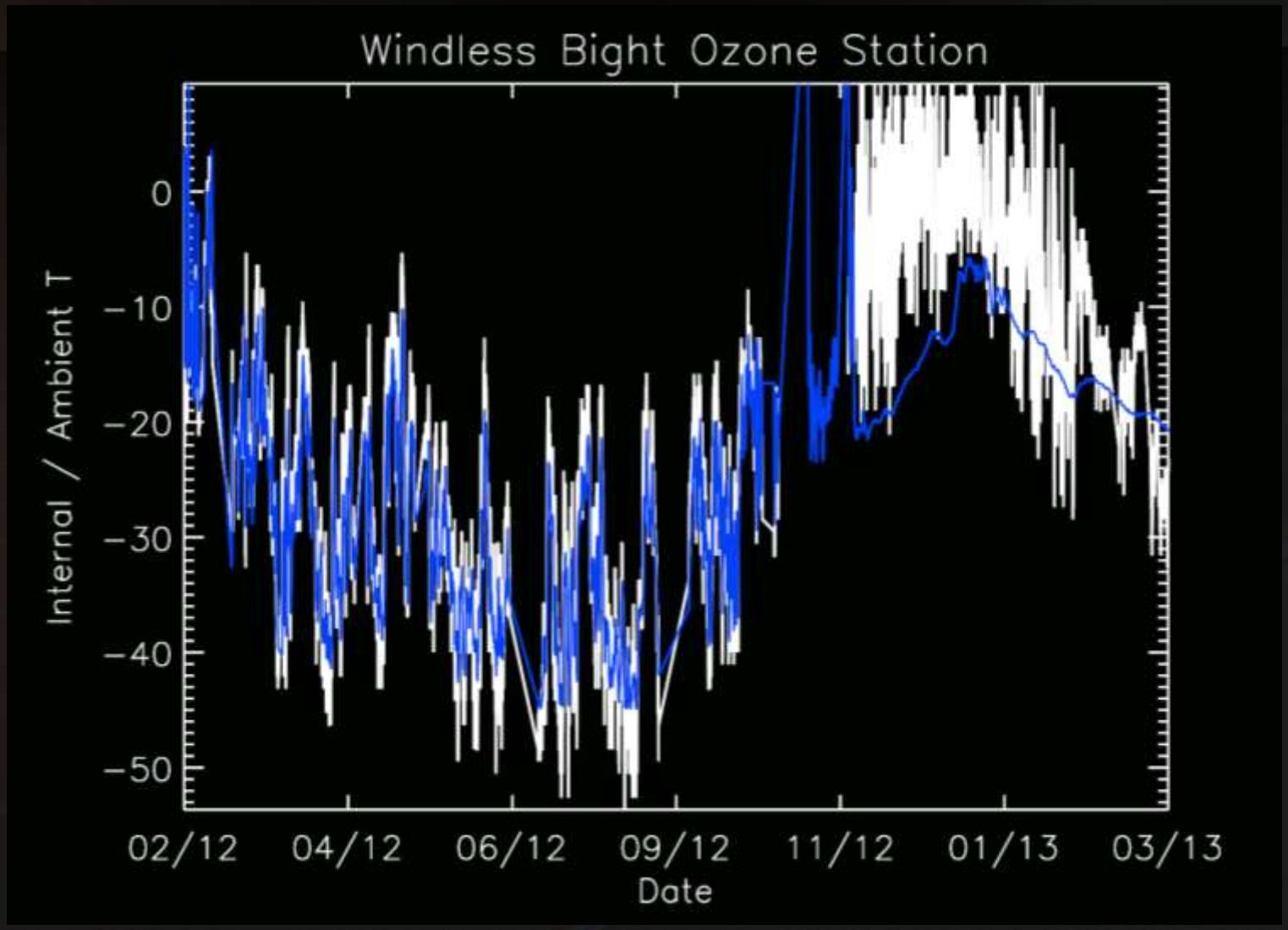


Power Systems – Li-Ion / Li-$SOCl_2$



Power Systems – Li-Ion / Li-$SOCl_2$

- Total weight (instrument + power system) ~ 30Kg
- Dimensions 120cm x 25cm x 10cm (pelican case)
- Power system cost ~ $300 for renewable + $1000 per year for Li-$SOCl_2$ cells (100 @ $10)
- uController – Arduino (ATMega328) based with magnetic latching relay – 2 mA @ 3.6V - $25

	UNAVCO/U. WISC	Li – $SOCl_2$
Weight	600Kg	30Kg
Dimensions (packed)	200 * 150 * 100cm	120*25*10cm
Cost	~$6000 for 10 years	$300 + $1000/year
Power	5W average	1W average

Communications - FreeWave

- 3 Stations on FreeWave line of site radio modems
- Cape Bird -> Marble Point -> McMurdo
- Base station at McMurdo, IP based data transport
- FreeWave modem – 1W idle, ~1.3W active
- Radio link has high reliability, backend software less reliable.
- No hardware failures.
- Link lengths up to 80km

Communications - Iridium

- 2 stations use Iridium short burst data
- NAL 9602-N modems
- Data frames are bit packed to fit in 270 Byte SBD Message
- Bi-directional messaging
- NO packets lost over 1 year!
- NO hardware failures.
- Operating in temperatures down to -53C
- DISA servers offer reliability and data buffer in case of local server failure

Summary

- Collected 1+ years of science data from 5 stations
- Every failure has been due to mechanical issues with pumps – hopefully fixed!
- Micro-controller based systems has been power efficient and highly reliable
- Hybrid Li-Ion/ Li primary battery system is a cost and logistically efficient option for low power stations

Summary

- FreeWave works well when available, however server side software is complex
- Iridium SBD with 9602 modems is extremely reliable
- 9602 modem works reliably down to -53C (at least)
- DISA direct IP message delivery is simple and provides a backup in case of server side failures
- Direct IP clients easily implemented in python

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