The Tortoise and the Hare, Blending Instrument Outputs

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a passion for discovery

ASP

Office of Science

Core Measurements

CO – VUV Fluorescence

SO_2 – Research-Grade Instrument

O_3 – Research-Grade Instrument

In-flight calibrations/zeros, real-time display

New/Enhanced Measurements

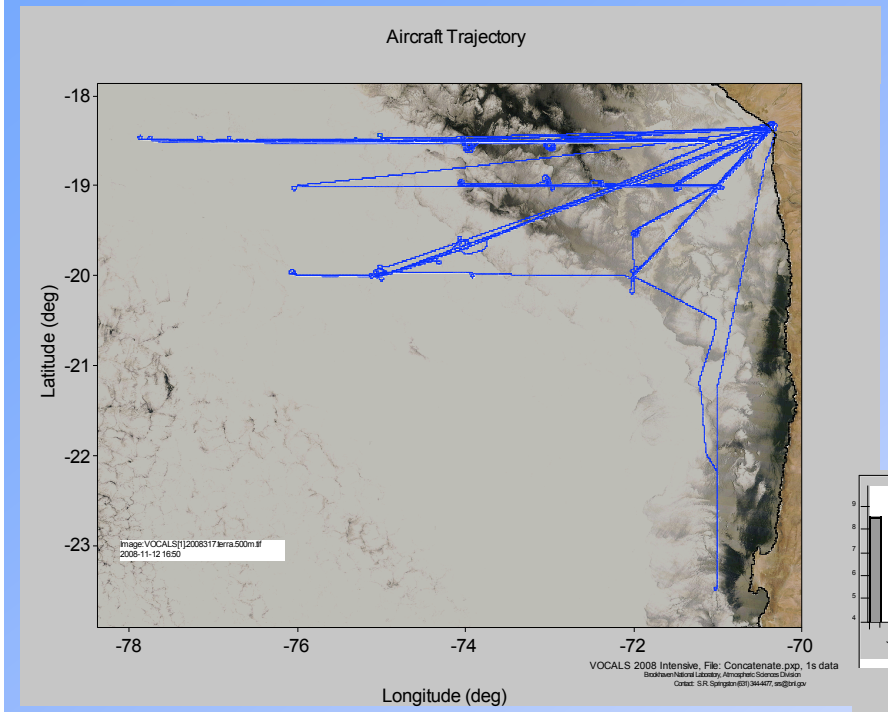
CAPS Particle-by-Particle

Fast O_3

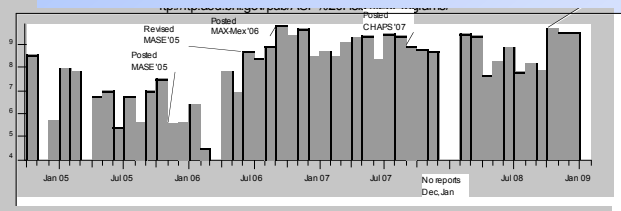
Reverse Flow Temperature Probe

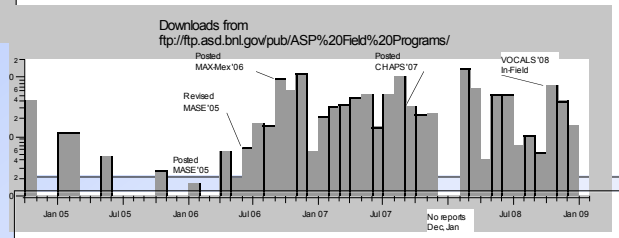
Fast Gerber

Modified Gust Probe Sensors



17 Research Flights
62:52 Flight Time
~22,000 km
~14 GB raw data*





Compare: ~2.5 GB CHAPS 07

WHY SO MUCH?

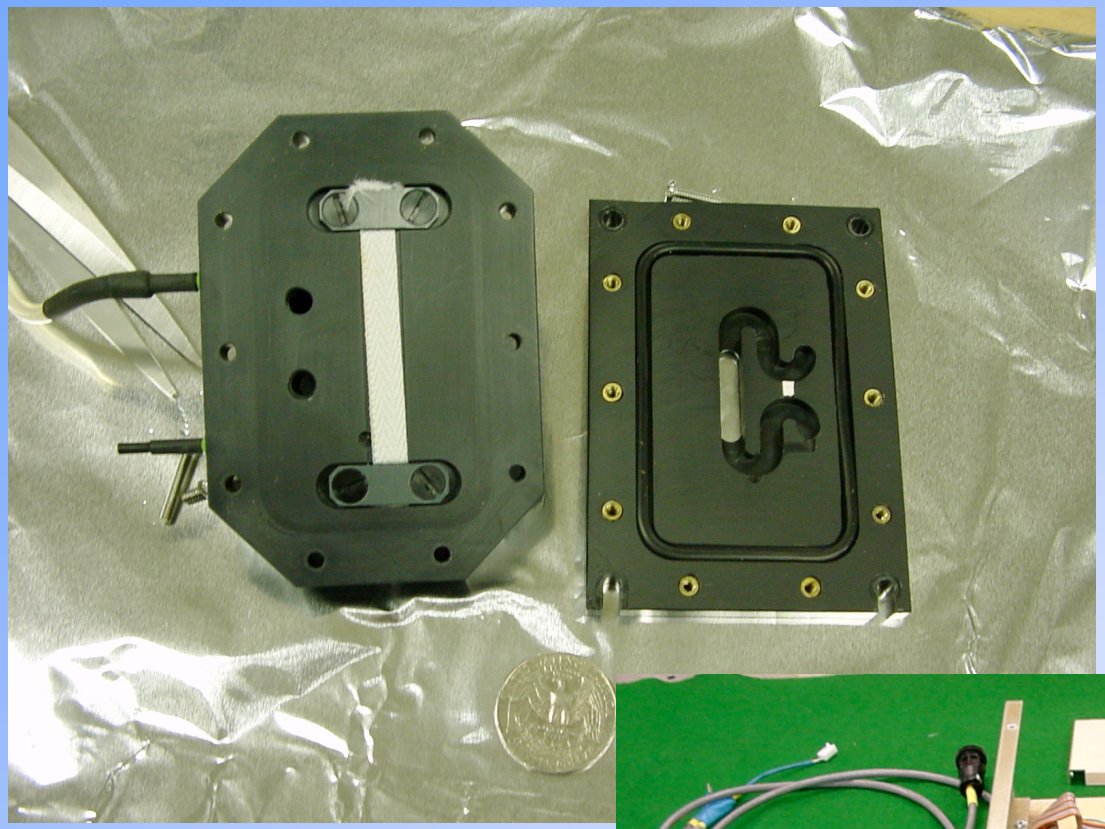
ftp://ftp.asd.bnl.gov/pub/ASP%20Field%20Programs/

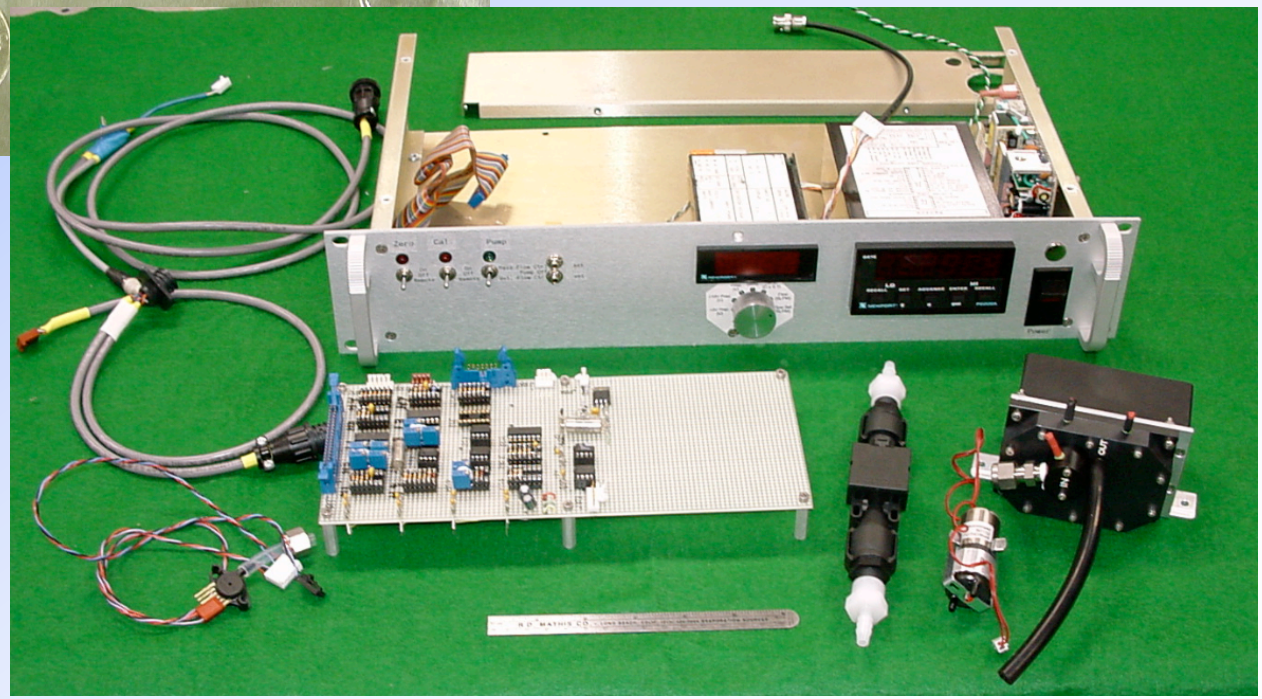
ftp://VOCALS_DOE:Arica123@ftp.asd.bnl.gov/pub/ASP%20Field%20Programs/2008VOCALS

The Need for Speed

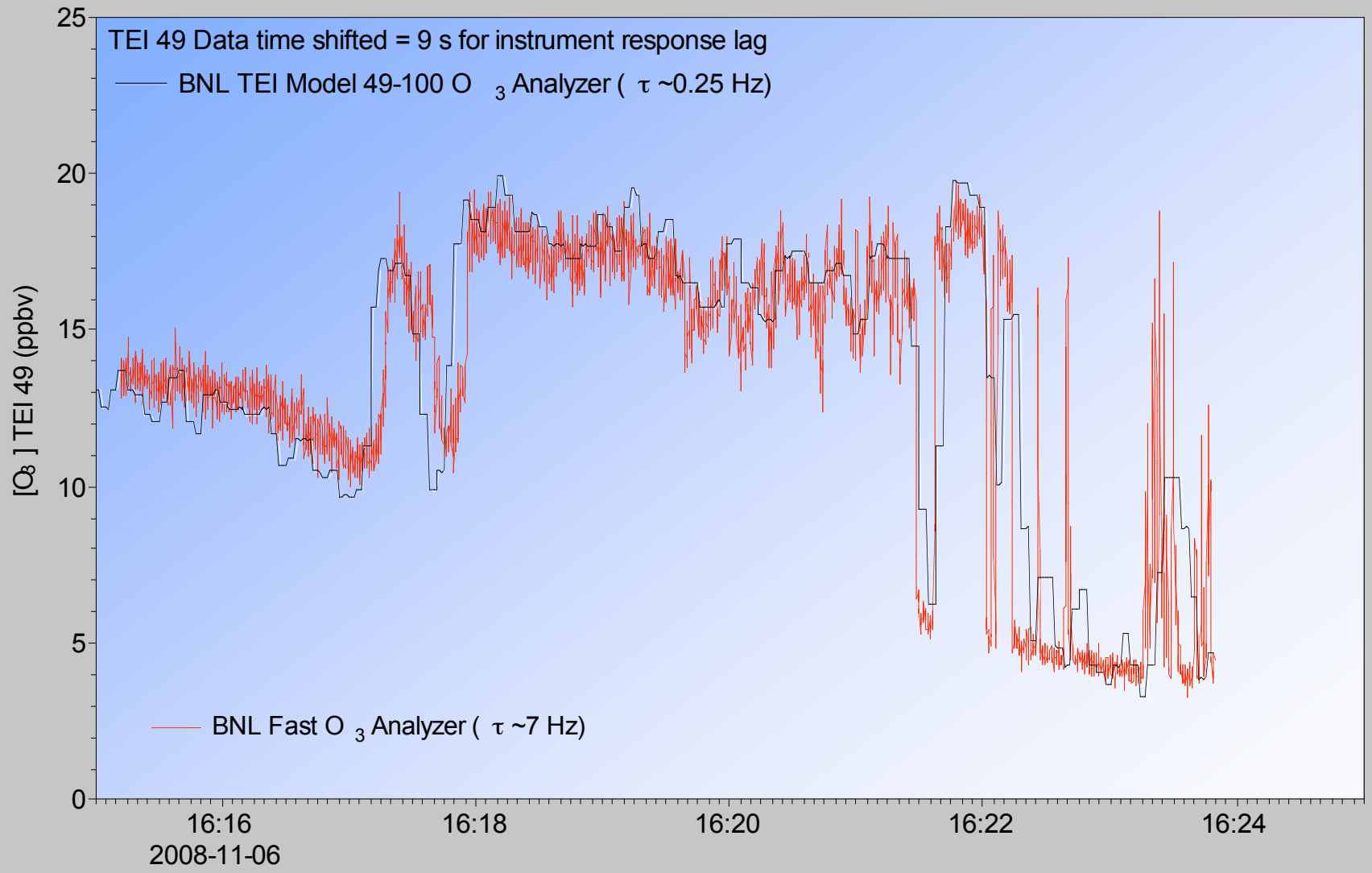
- Particle by particle on CAS probe: resolve up to 8160 individual droplets per second to ~5μm precision in space, **not diameter!**
- Second PCASP (monitoring aerosol inlet)
- Maximum acquisition speed increased from 80 to 200 Hz using new BNL A-to-D
    - Gust probe
    - Liquid water content
    - Temperatures
    - Acceleration
- Additional recorded channels

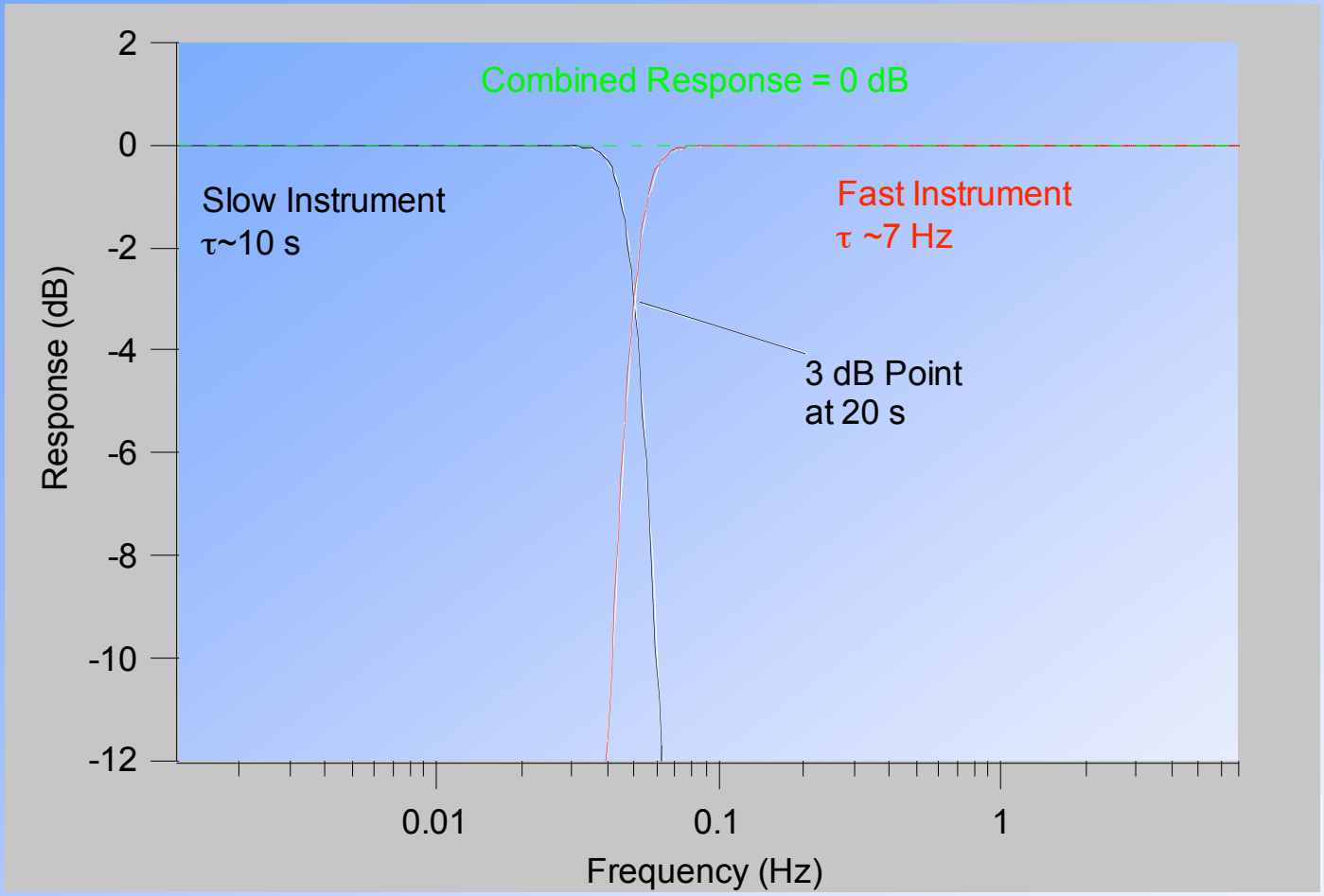
Basic Fast Ozone Monitor





8-lbs
2U height
~25 W

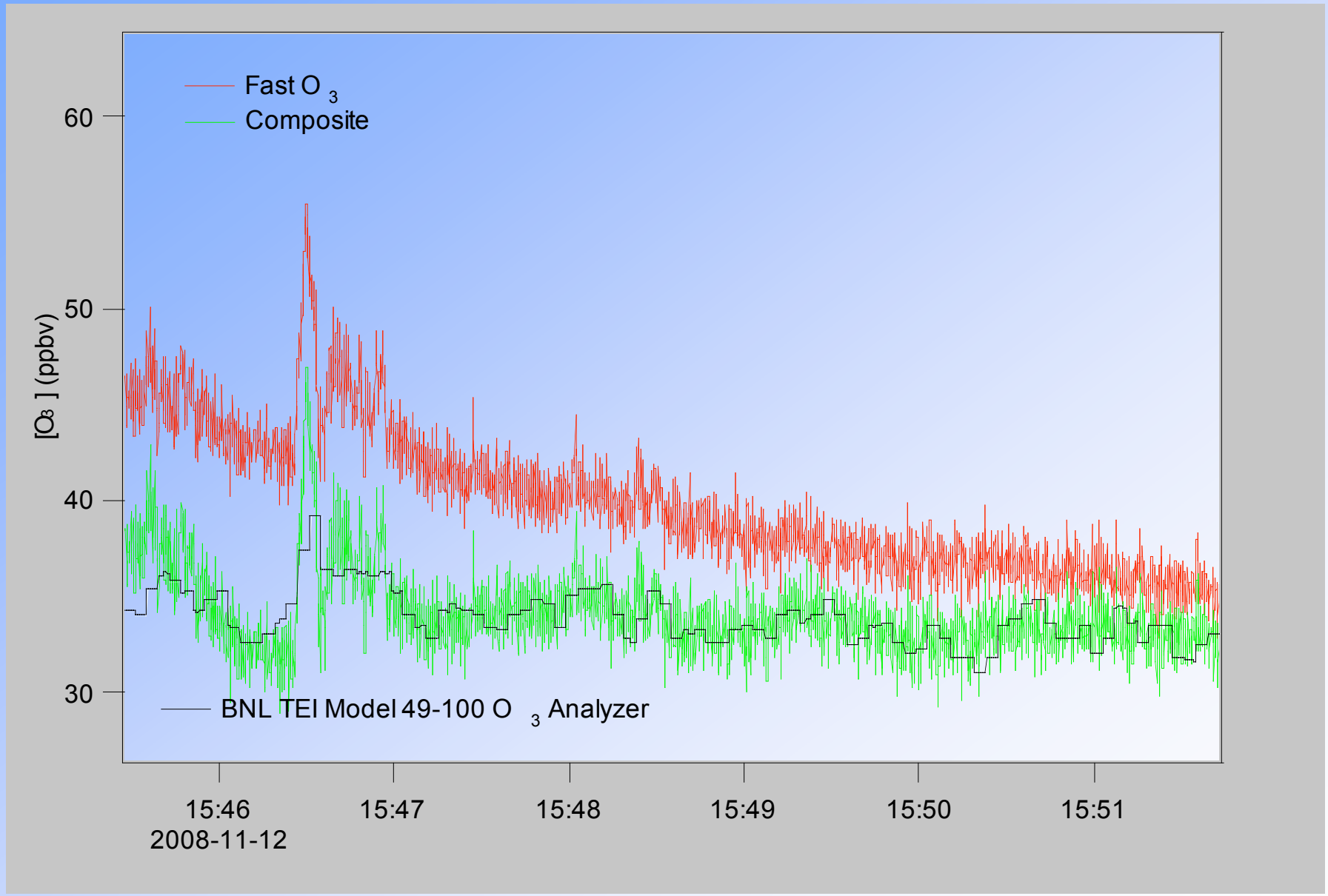

TEI 49 Data time shifted = 9 s for instrument response lag
BNL TEI Model 49-100 O 3 Analyzer (τ ~0.25 Hz)
BNL Fast O 3 Analyzer (τ ~7 Hz)
[O3] TEI 49 (ppbv)
25
20
15
10
5
0
16:16
2008-11-06
16:18
16:20
16:22
16:24



Digitally combine output with TEI 49-100

Calculated in Matlab

Bidirectional to eliminate time shifting


Fast O 3
Composite
BNL TEI Model 49-100 O 3 Analyzer
[O3] (ppbv)
60
50
40
30
15:46
2008-11-12
15:47
15:48
15:49
15:50
15:51

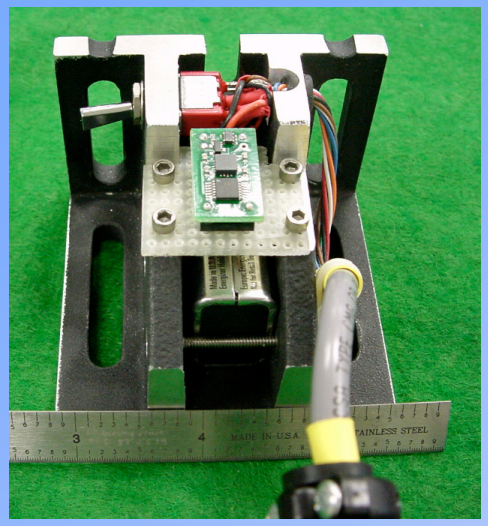
To Do:

Characterize τ (prototype was ~5-10 Hz)

$r = f([H_2O])$

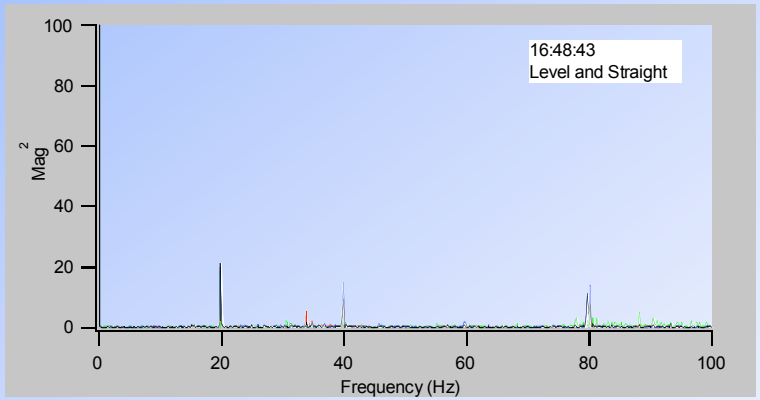
Interferences (literature tested for most)

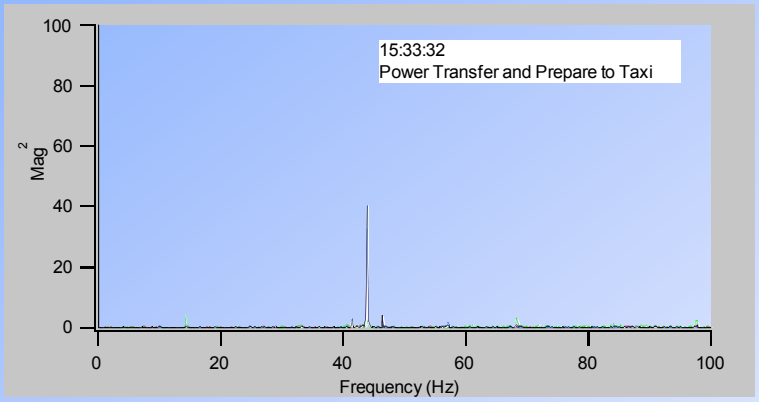
Extend to other species?

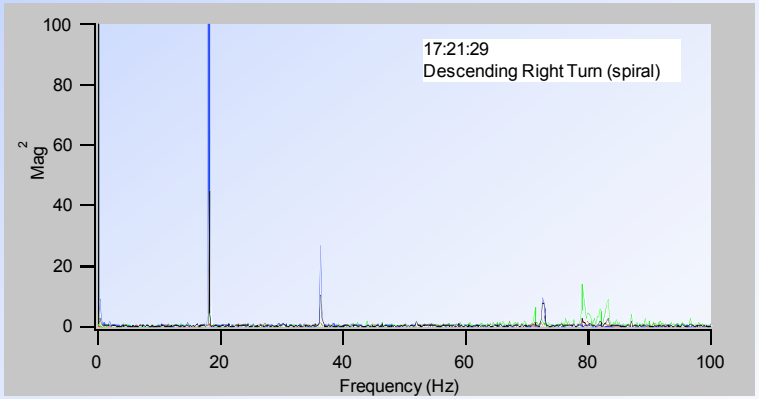


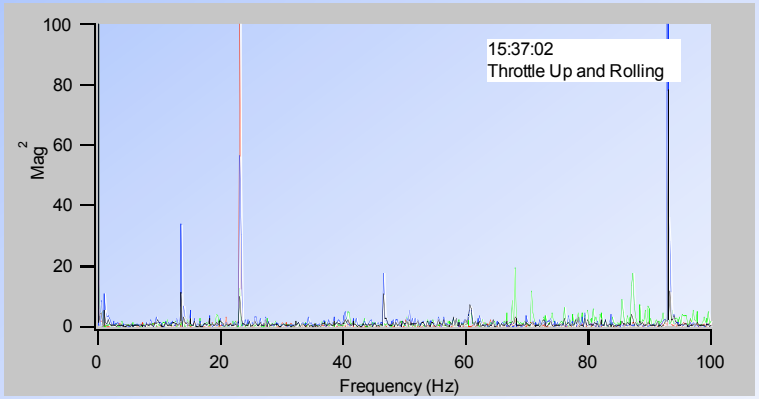
δ ~7.3 mG

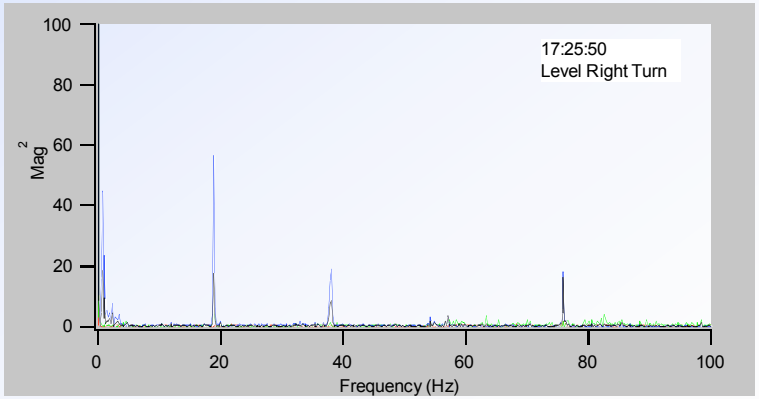
@ 500 Hz


16:48:43
Level and Straight
Mag 2
Frequency (Hz)


15:33:32
Power Transfer and Prepare to Taxi
Mag 2
Frequency (Hz)


17:21:29
Descending Right Turn (spiral)
Mag 2
Frequency (Hz)


15:37:02
Throttle Up and Rolling
Mag 2
Frequency (Hz)


17:25:50
Level Right Turn
Mag 2
Frequency (Hz)

Winds Aloft

$$\vec{V} = \vec{V}_p + \vec{V}_a$$

V_p measured with GPS

V_a measured with pressure transducers

$$U = -U_a * \sin(\Psi + \beta) + U_p$$
$$V = -U_a * \cos(\Psi + \beta) + V_p$$
$$W = -U_a * \sin(\Theta + \alpha) + W_p$$

U – East Wind Velocity
V – North Wind Velocity
W – Upward Wind Velocity
U_p – East Aircraft Velocity
V_p – North Aircraft Velocity
W_p – Upward Aircraft Velocity

U_a – True Air Speed (Pitot Pressure, Temperature, Pressure)

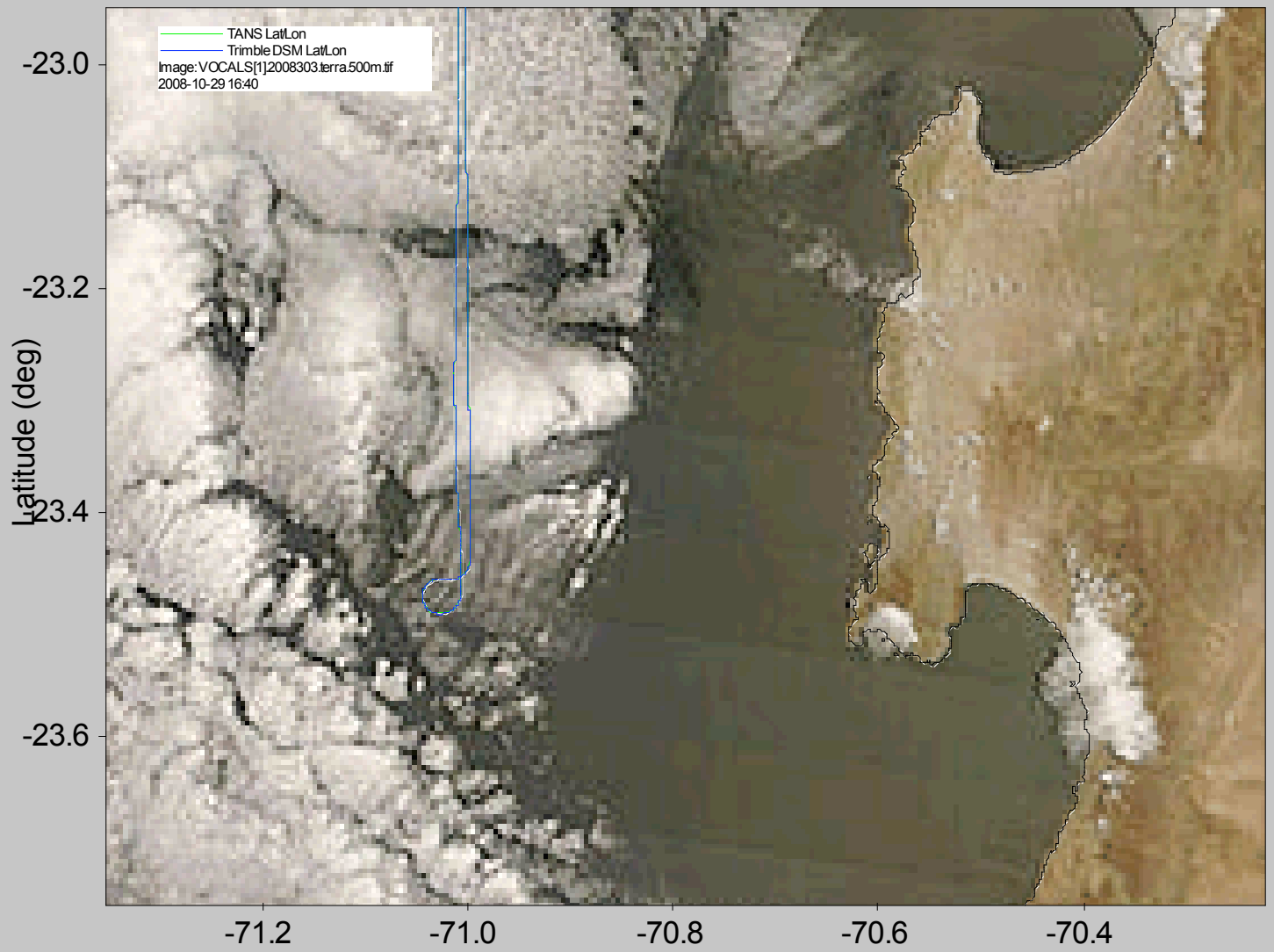
For winds aloft to $\delta_v = 0.1$ m/s

$\delta_H < 0.06^o$, $\delta_{p,a} < 0.07$ m/s

Comment 1: Maps:VOCALS2008.pxp
Comment 2: VOCALS 2008 Intensive
Comment 3: Vector Map
Comment 4: Interpolated and adjusted to Time-Of-Fix
Comment 5:
Comment 6:

Aircraft Trajectory

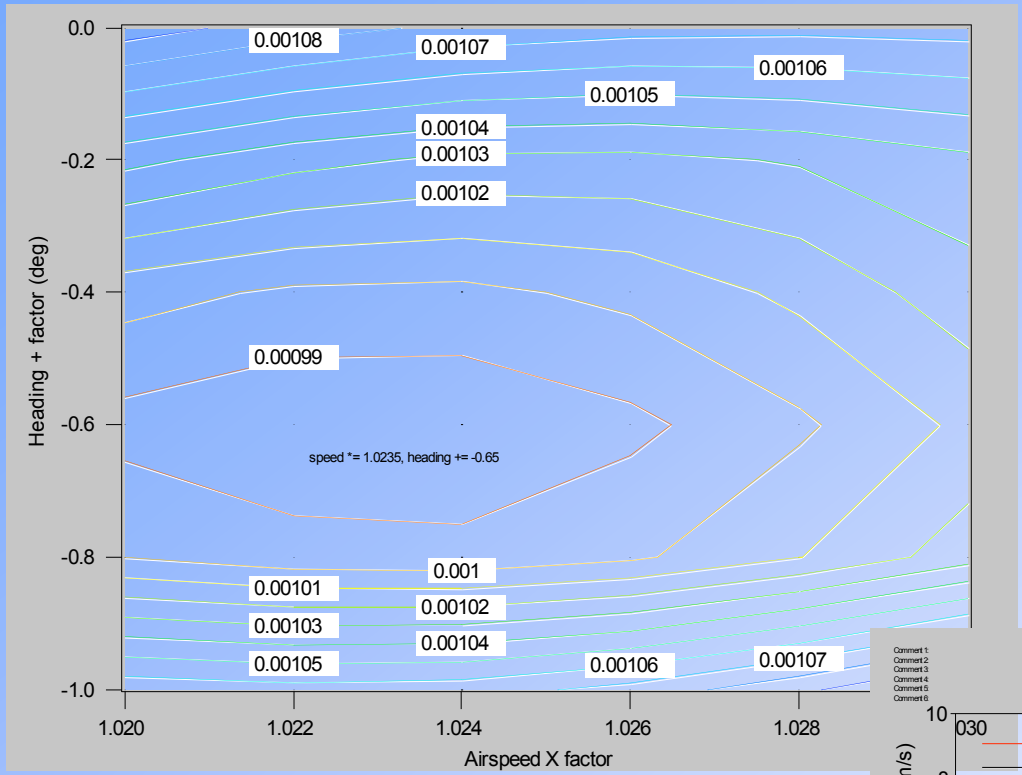
-60 = C1
60 = C2
-20 = C3
-16 = C4

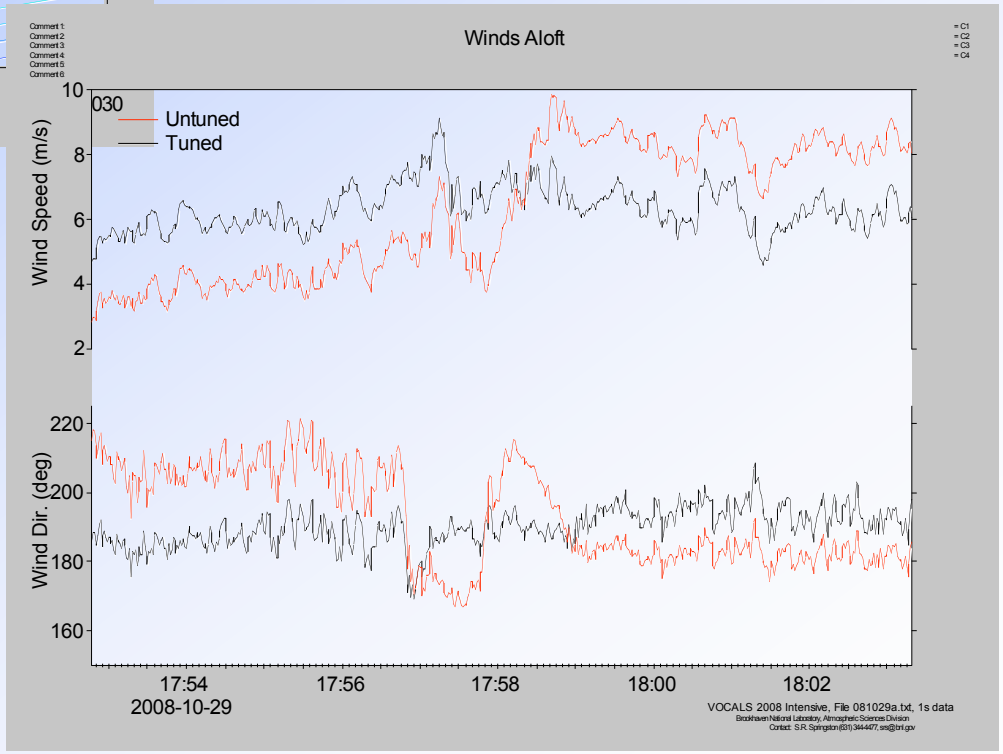


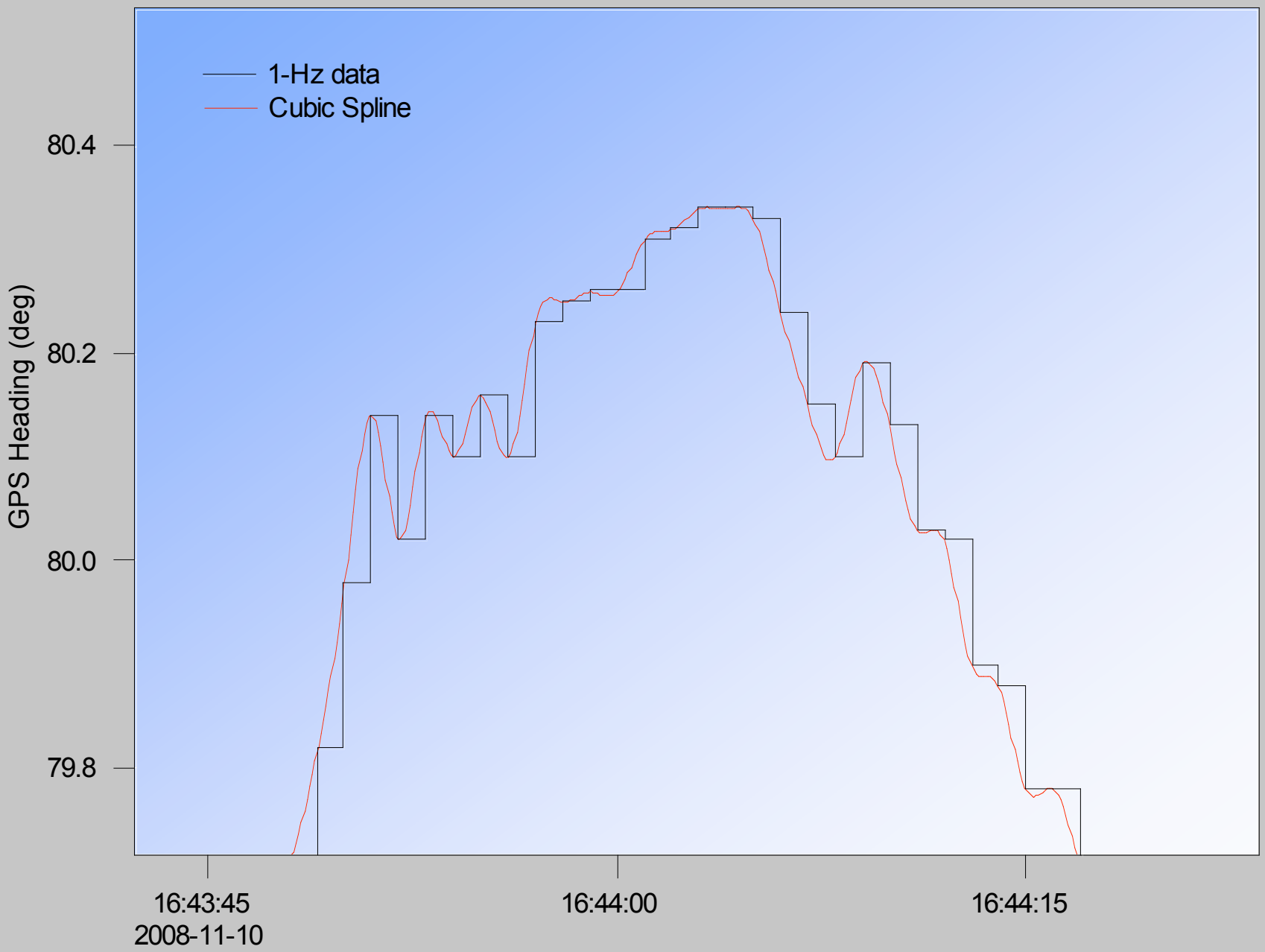
VOCALS 2008 Intensive, File 081029a.txt, 1s data

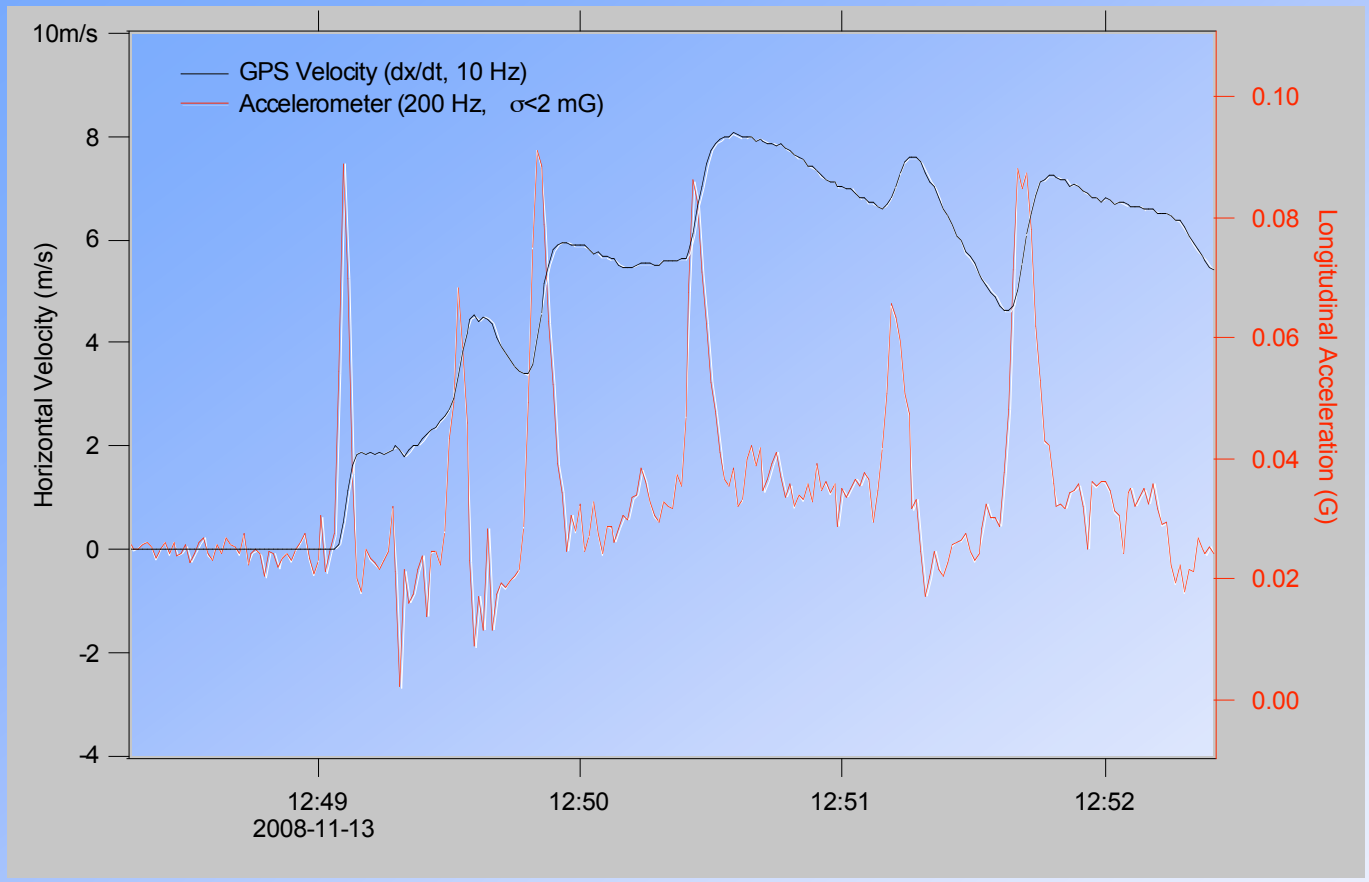
Brookhaven National Laboratory, Atmospheric Sciences Division
Contact: S.R. Springston (631) 344-4477, srs@bnl.gov

Calibration of Winds






1-Hz data
Cubic Spline
GPS Heading (deg)
80.4
80.2
80.0
79.8
16:43:45
2008-11-10
16:44:00
16:44:15



Implementing interpolation between GPS fixes problematic because of platform tilt.

What you really need is 6 DOF (INS)

Future Implementation

Analog 6-DOF INS (50 Hz)

3 accelerometers ($\sigma \sim 100\ \mu G/Hz^{1/2}$)

same as 0.1 cm/s^2

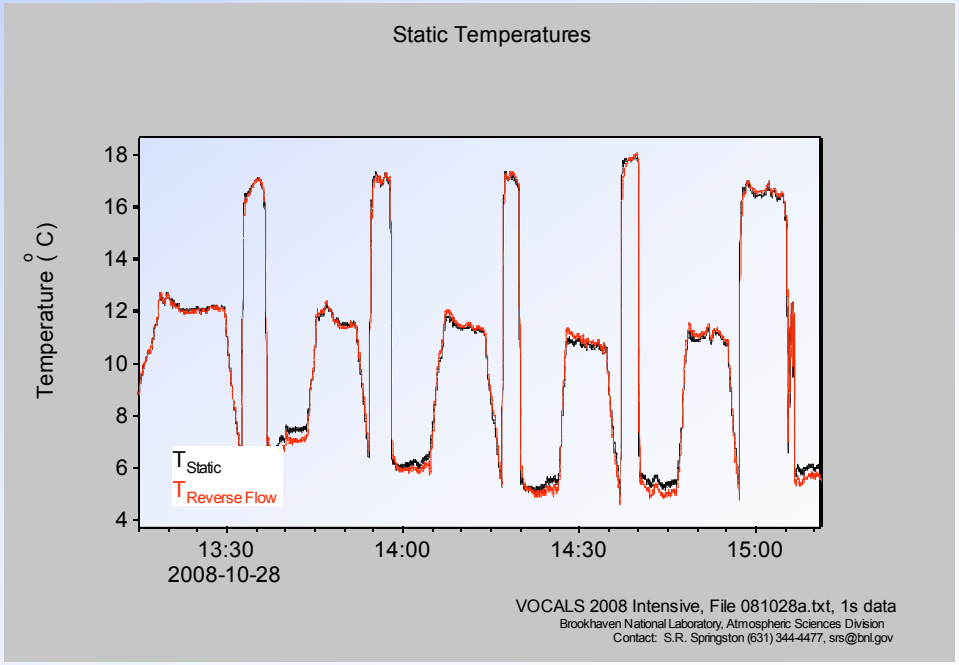
3 gyroscopes ($\sigma \sim 0.1\ ^{o}/s/Hz^{1/2}$)

Temperature

0.2”

0.013”
diam

Pacific Northwest
NATIONAL LABORATORY


Static Temperatures
Temperature (°C)
18
16
14
12
10
8
6
4
T Static
T Reverse Flow
13:30
2008-10-28
14:00
14:30
15:00
VOCALS 2008 Intensive, File 081028a.txt, 1s data
Brookhaven National Laboratory, Atmospheric Sciences Division
Contact: S.R. Springston (631) 344-4477, srs@bnl.gov

Signal Blending Applications

GPS	⟷	MEMS INS
$[O_3]$ by UV abs	⟷	$[O_3]$ by ss C.L.
Temperature	⟷	Microbeads
PILS	⟷	AMS

Data Processing/Analysis: Comparing parameters measured with different temporal resolution

6/3/2008

10/12-
11/16/2008

2/17/2009