UAH
The University of Alabama in Huntsville

SWA

Organized Aerosol Backscatter Features in the Marine Boundary Layer Observed by TODWL and Optical Particle Counters

D.A. Bowdle
University of Alabama in Huntsville

G.D. Emmitt and S.A. Wood
Simpson Weather Associates

Working Group on Space-Based Lidar Winds
Sedona, Arizona, February 1-3, 2005

UAH
The University of Alabama in Huntsville

SWA

CONTENTS

- PURPOSE
- EXPERIMENT
- RESULTS
- SUMMARY

UAH
The University of Alabama in Huntsville

SWA

MOTIVATION

- **Joint research project by ONR and NPOESS IPO**

- **Investigate data processing issues related to future space-based wind lidar operations**

- **Develop calibration/validation procedures for all wind profiling systems (ground-based, airborne, space-based)**

- **Conduct basic research on lower tropospheric winds and aerosols in the marine and continental boundary layers**

UAH
The University of Alabama in Huntsville

SWA

GOALS AND OBJECTIVES

- Characterize backscatter – velocity covariance
- Relate observed covariance to atmospheric processes
- Determine the particle size fraction that dominates backscatter magnitude and variance
- Relate measured and modeled aerosol backscatter

UAH
The University of Alabama in Huntsville

SWA

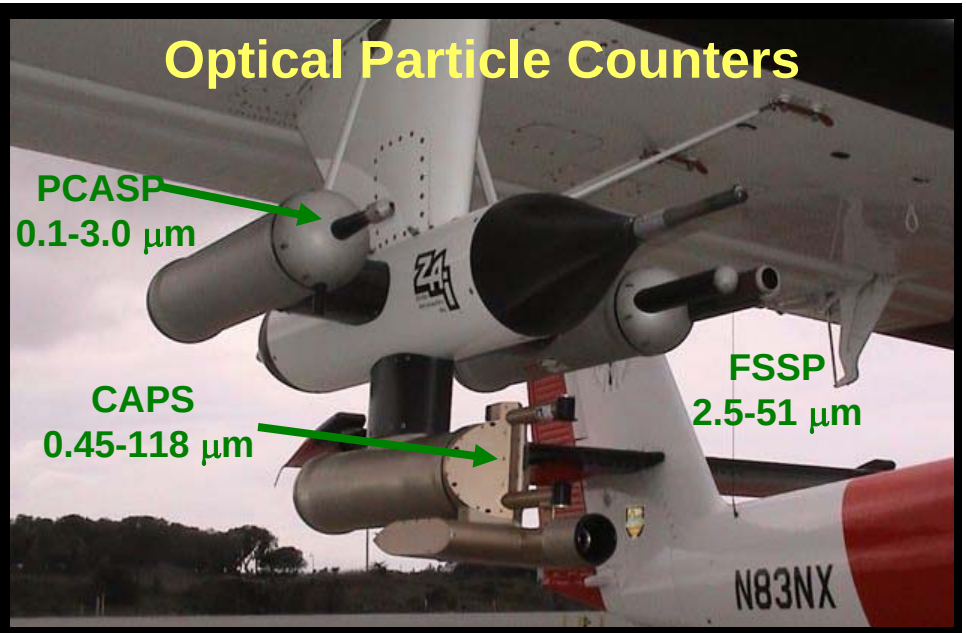
INSTRUMENTS

Aircraft Platform

NPS CIRPAS Twin Otter

Naval Postgraduate School
Center for Interdisciplinary Remotely-piloted Aircraft Studies

Optical Particle Counters



TODWL Transceiver

2.0125 μm, coherent detection

4-6 mJ, 330 nsec (FWHM), 80 Hz

10 cm telescope

two axis scanner, ±30 & ±120 deg, side door mount

digitization rate 100 MHz

~7-10% total system efficiency

TODWL Scanner

UAH
The University of Alabama in Huntsville

SWA

OPERATIONS

Schedule

- Series 1: February 9-15, 2002
- Series 2: March 12-15, 2002
- Series 3: February 8-21, 2003

Location

Series 1:
- Monterey area & San Joaquin River

Series 2:
- Monterey area
- Monterey to Boulder via Las Vegas

Series 3:
- Monterey area, ocean & land

Flight Plans

- Straight and level 50-100 km runs
- Along-wind and cross-wind runs
- Multiple altitudes over same ground track
- Near surface, near and above inversion

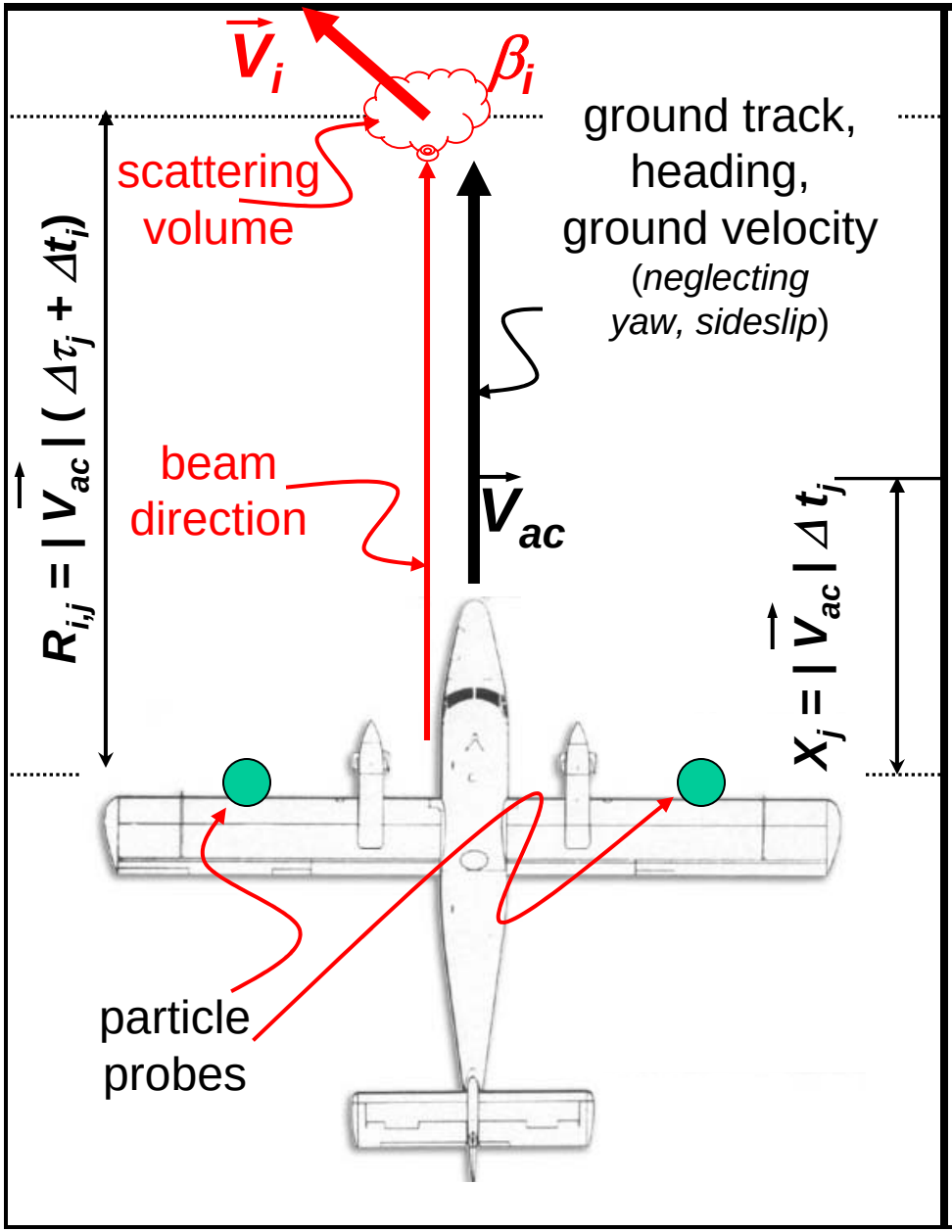
MBL Database

- 8 flights, approx 30 hours
- multiple scanning patterns
- concentrate on February 20, 2003

UAH
The University of Alabama in Huntsville

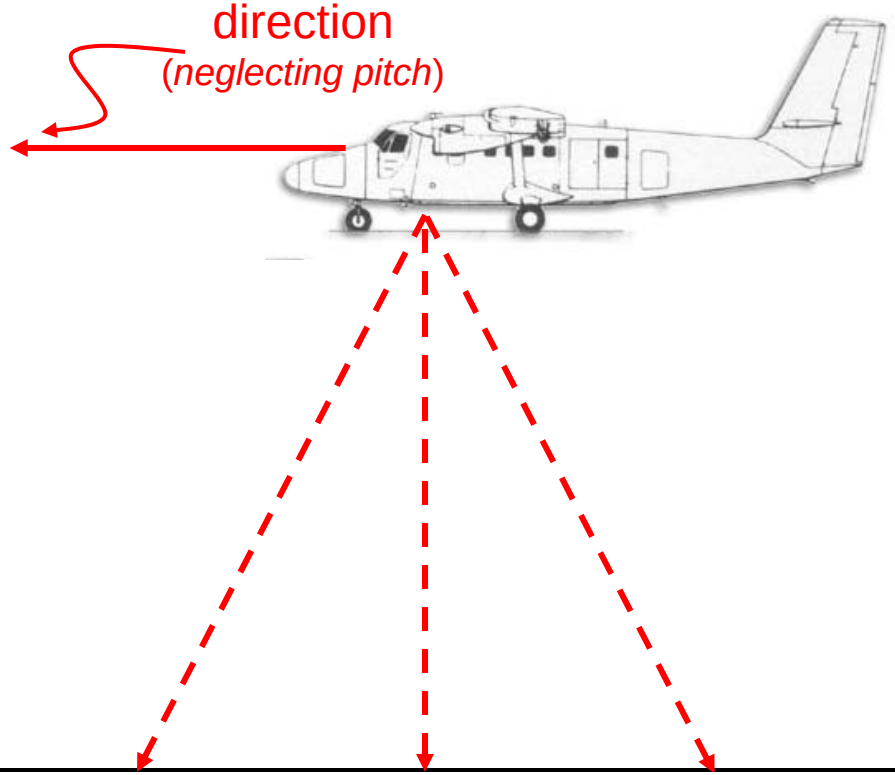
SWA

MEASUREMENTS*



***Backscatter-related scan patterns**

- along-track RHI step-and-stare
- forward stare
- nadir stare

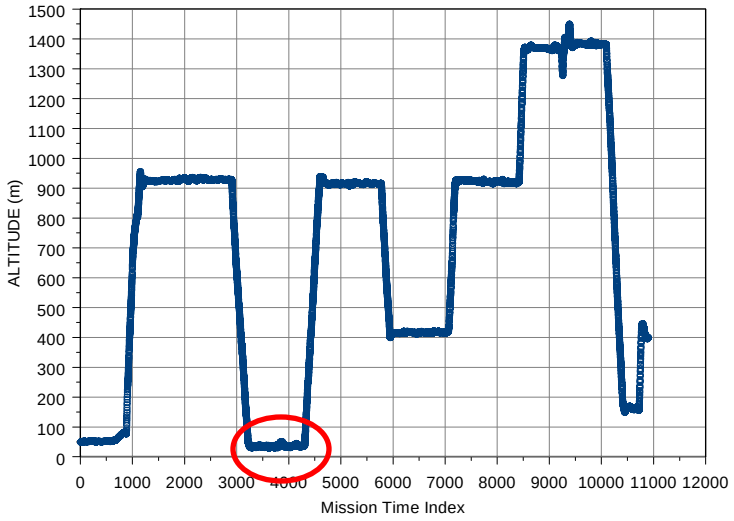


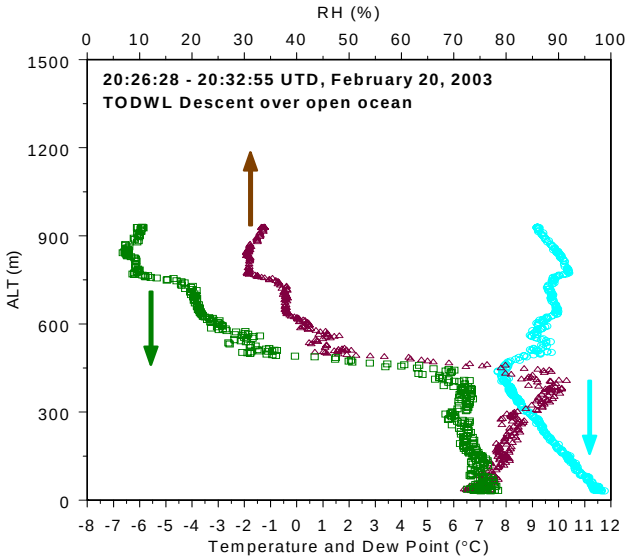
UAH
The University of Alabama in Huntsville

SWA

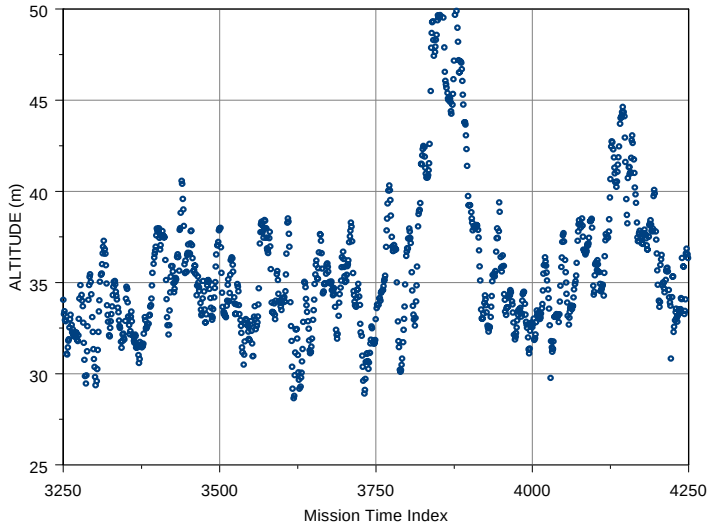
FEBRUARY 20, 2003

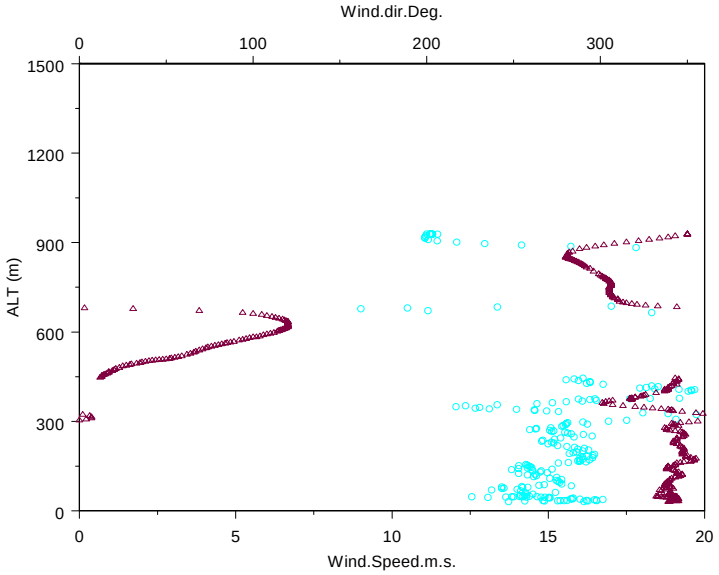
TODWL ALTITUDE, ENTIRE FLIGHT, FEBRUARY 20, 2003





TODWL ALTITUDE, 35-m PASS, FEBRUARY 20, 2003





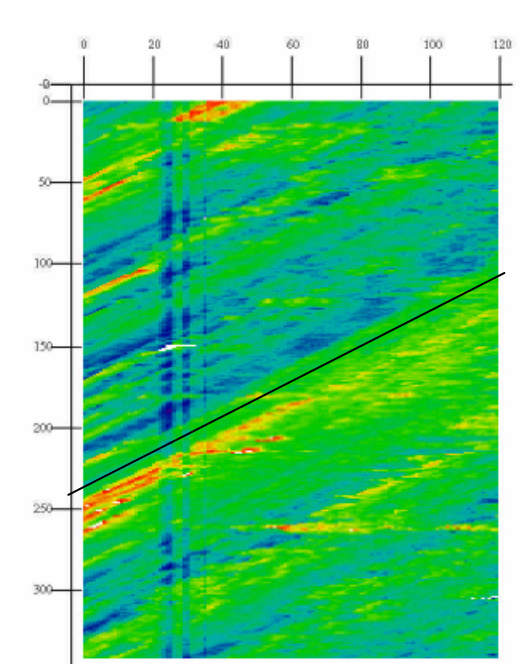
UAH
The University of Alabama in Huntsville

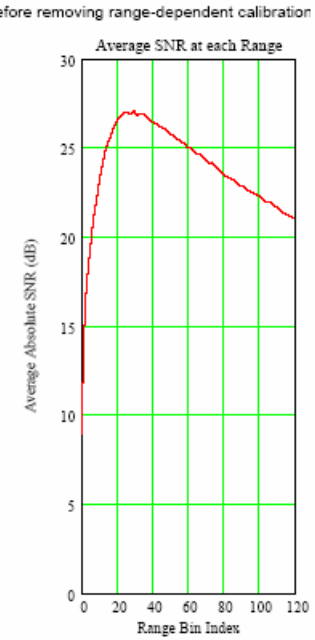
SWA

TURBULENT FIELDS FROM TODWL

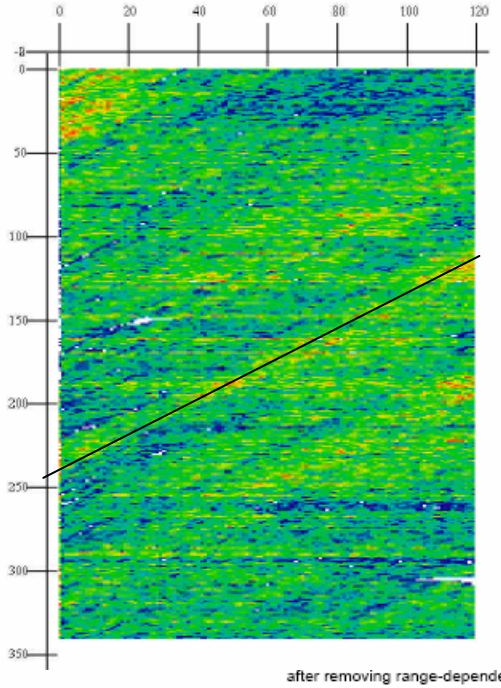
LOS Velocity Hovmuller

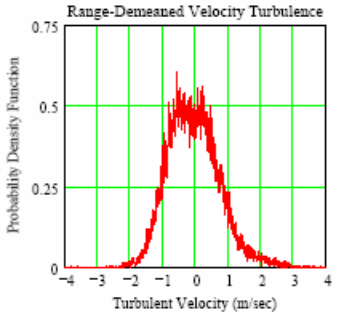
40,920 data points





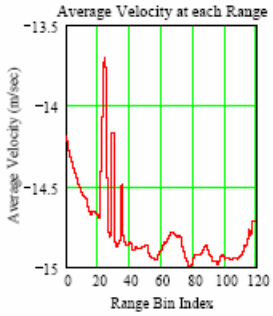
SNR HOVMULLER



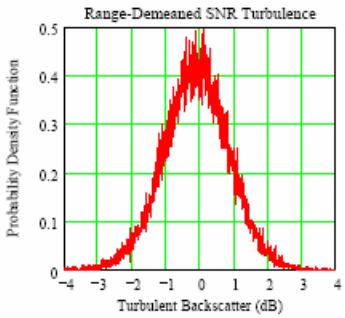


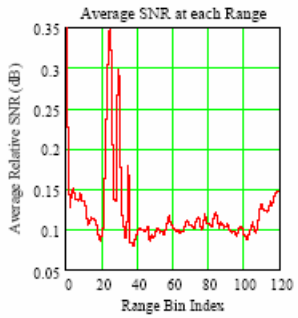
Much less noisy than field-demeaned PDF.

Note weak bimodality



after removing range-dependent calibration



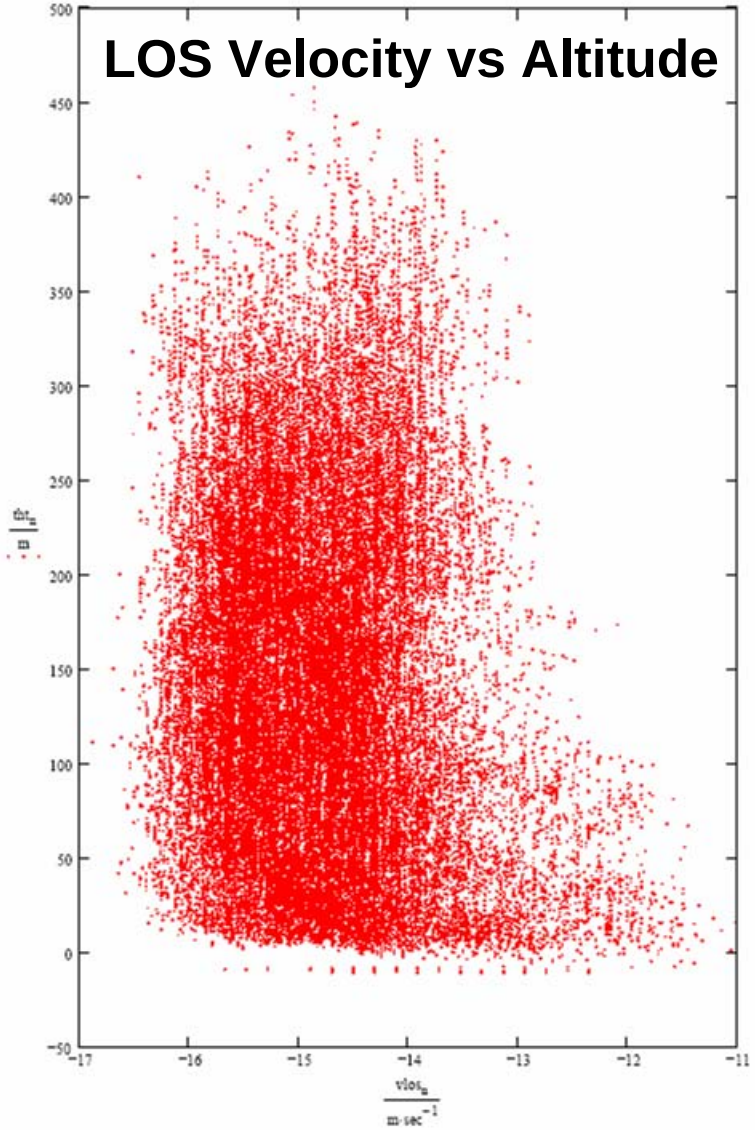


No compensation for anomalous features or pitch fluctuations, except for using range-dependent means

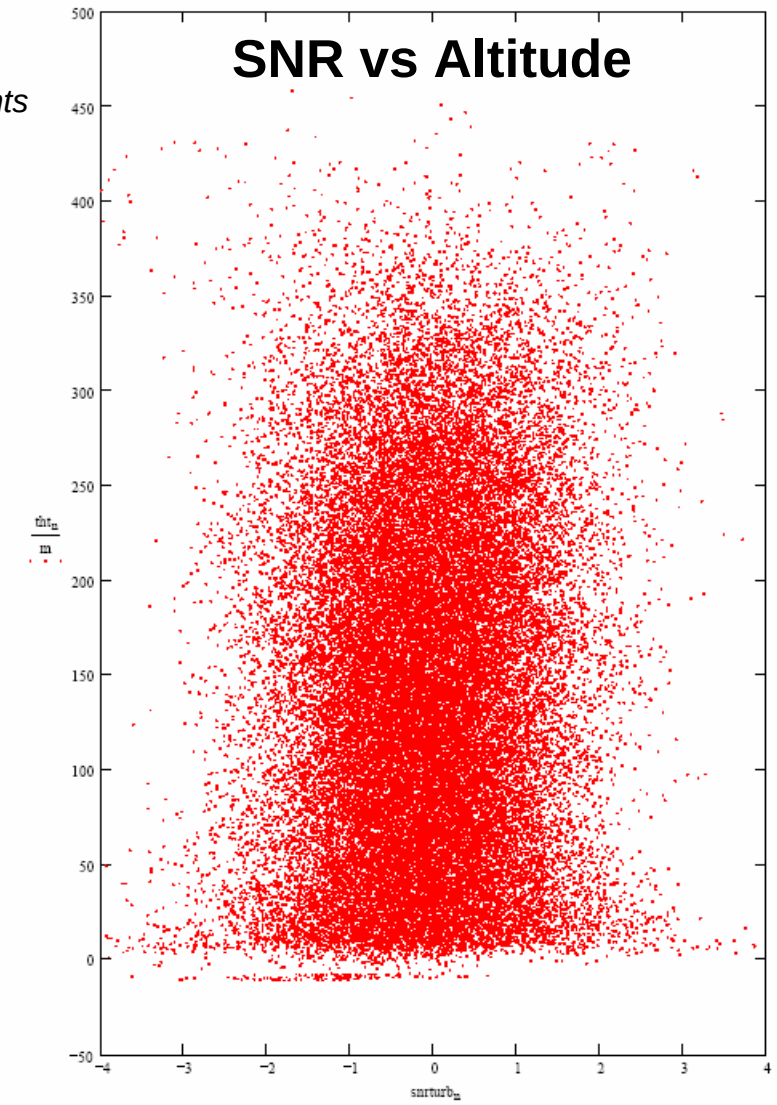
UAH
The University of Alabama in Huntsville

SWA

TURBULENT FIELDS FROM TODWL



40,920 data points

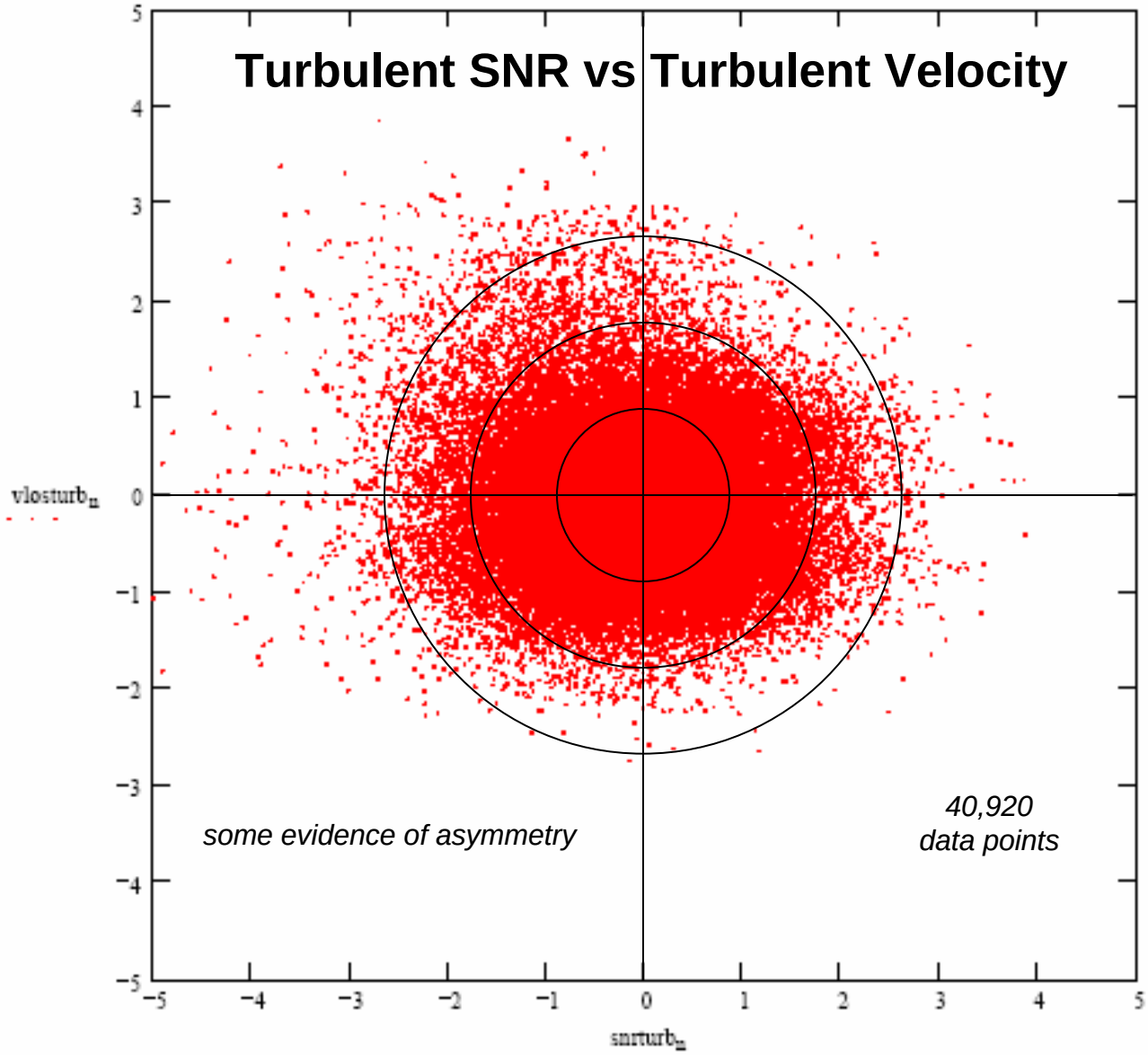


accounts for pitch fluctuations

UAH
The University of Alabama in Huntsville

SWA

TURBULENT FIELDS FROM TODWL

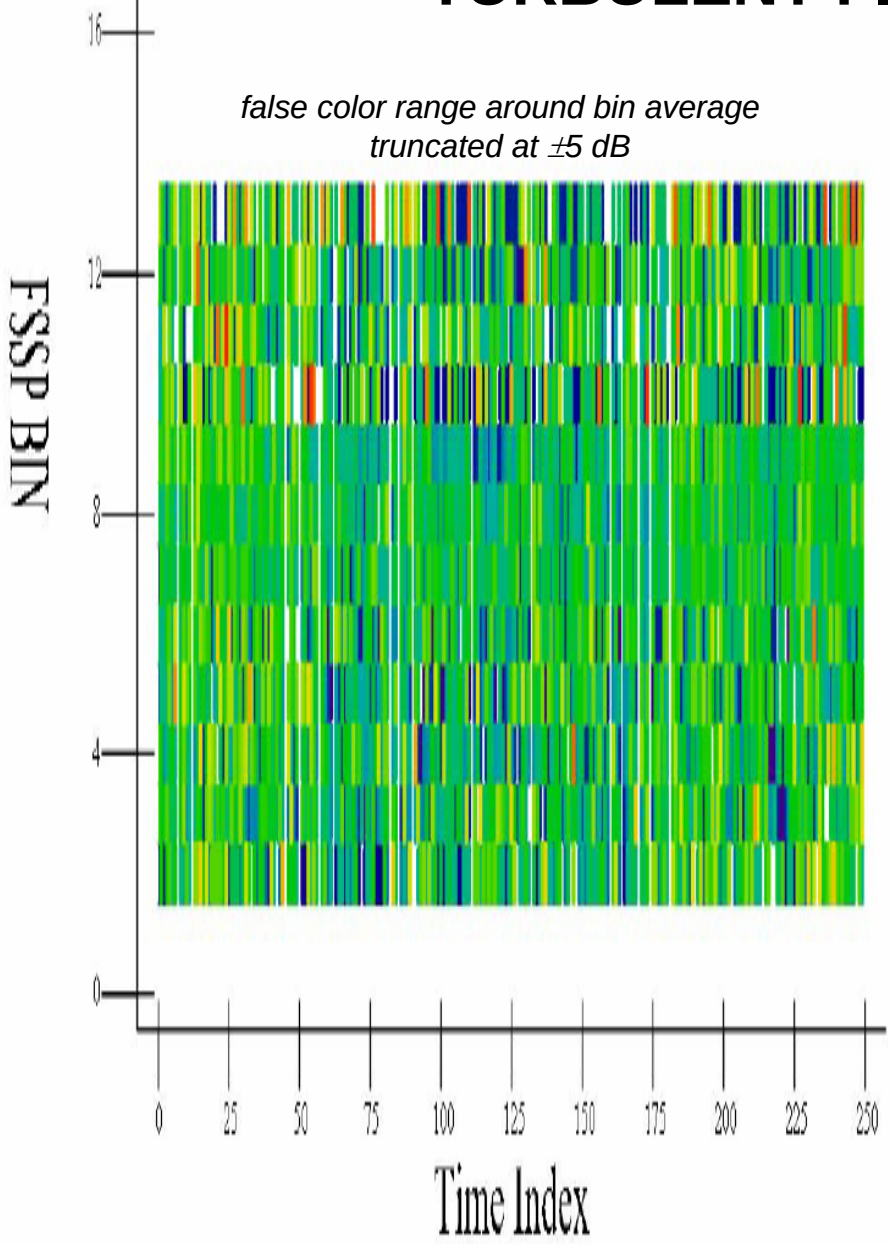


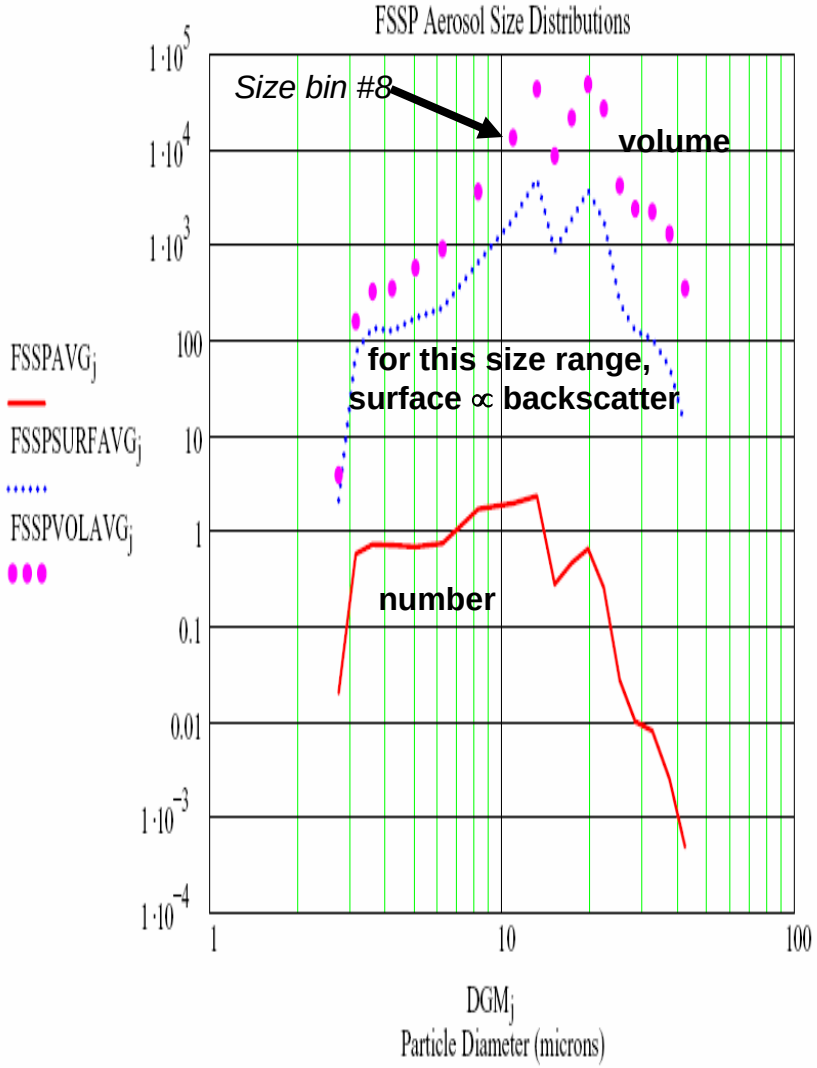
UAH
The University of Alabama in Huntsville

SWA

TURBULENT FIELDS FROM FSSP

false color range around bin average
truncated at ±5 dB





UAH
The University of Alabama in Huntsville

SWA

CONCLUSIONS

- Velocity and SNR have well defined turbulent probability distributions

- Backscatter-velocity correlations would bias shot-integrated velocity estimates from a down-looking Doppler lidar

- Particles of ~10-20 microns diameter dominate average backscatter at 2 microns wavelength at 30-m altitude over Monterey Bay

- Hard to tell what particle size range dominates backscatter variance

UAH
The University of Alabama in Huntsville

SWA

ACKNOWLEDGMENTS

• This work was funded by the Office of Naval Research through the Center for Interdisciplinary Remotely-piloted Aircraft Studies and by the Integrated Program Office of NPOESS

• SPAWAR and ONR 35/SBIR Program provided the lidar and supported its integration into the CIRPAS Twin Otter

• IPO co-funded the lidar adaptation to the Twin Otter.

• IPO solely funded the mission planning, flight hours, data collection, and the post-flight installation of the lidar in a trailer for inter-flight research.