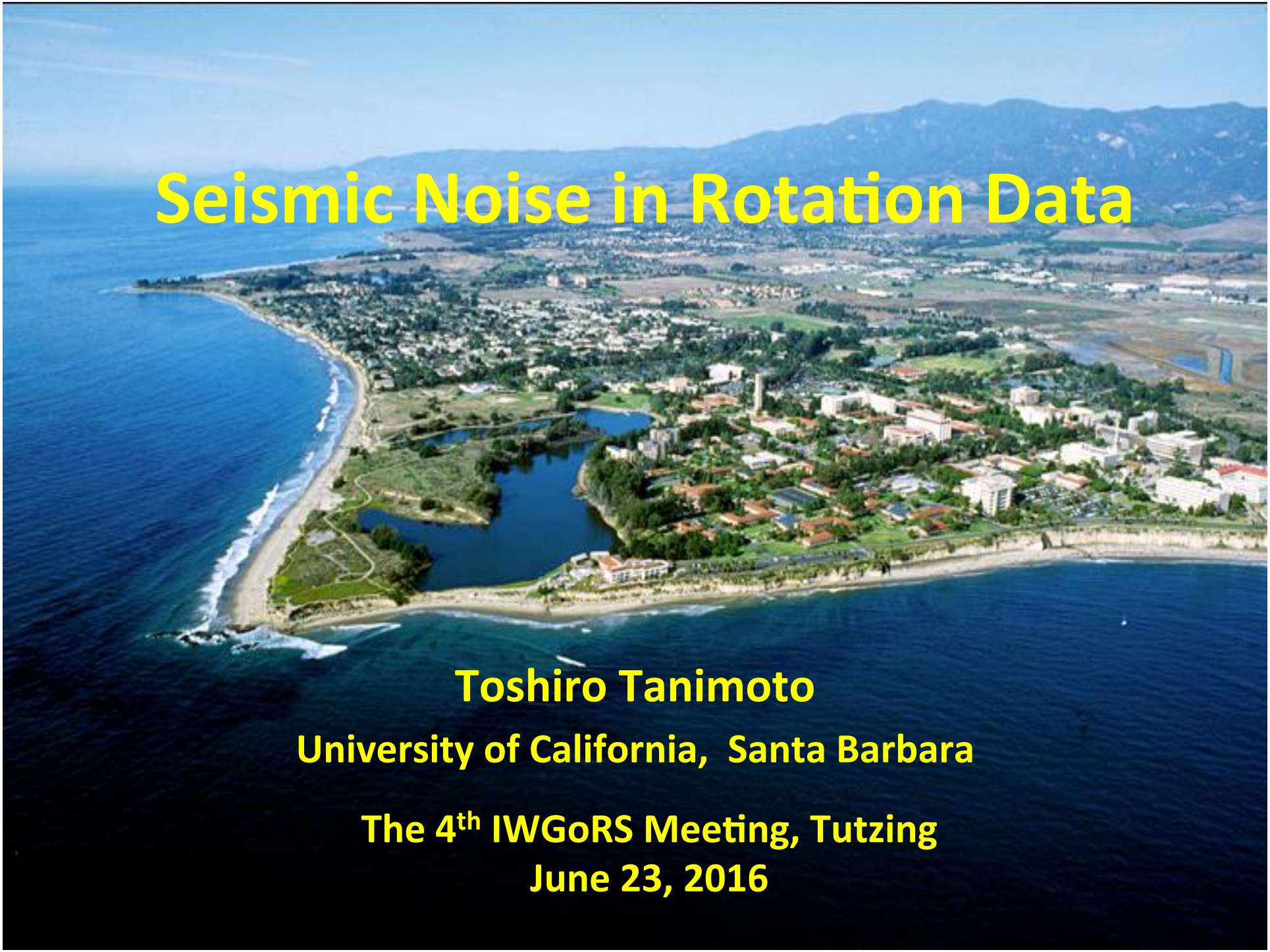
Seismic Noise in Rotation Data



Toshiro Tanimoto

University of California, Santa Barbara

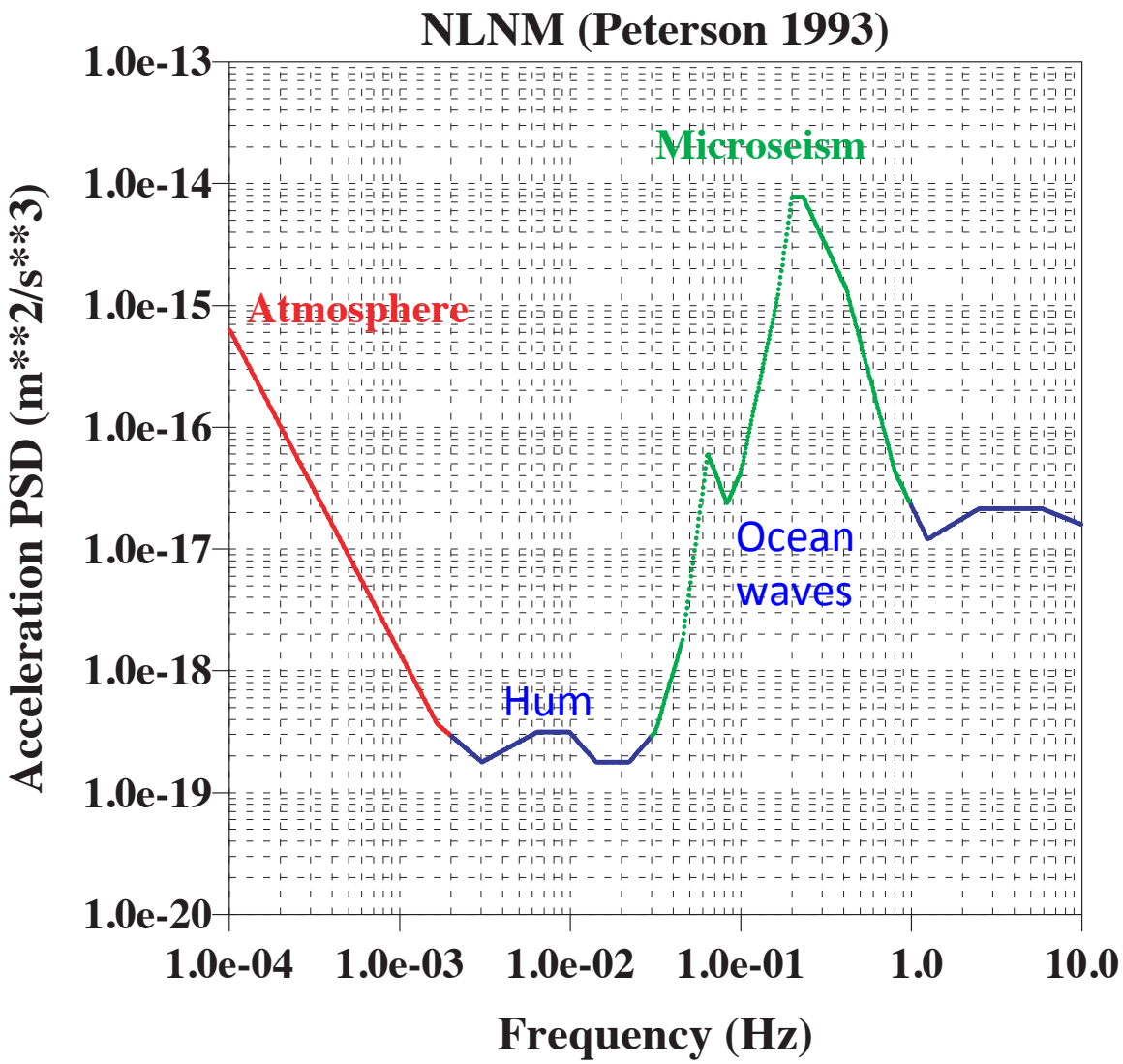
The 4th IWGoRS Meeting, Tutzing

June 23, 2016

Two Topics on Seismic Noise

1. G-ring data (Wettzell) and Microseisms

2. Tilt



Microseisms

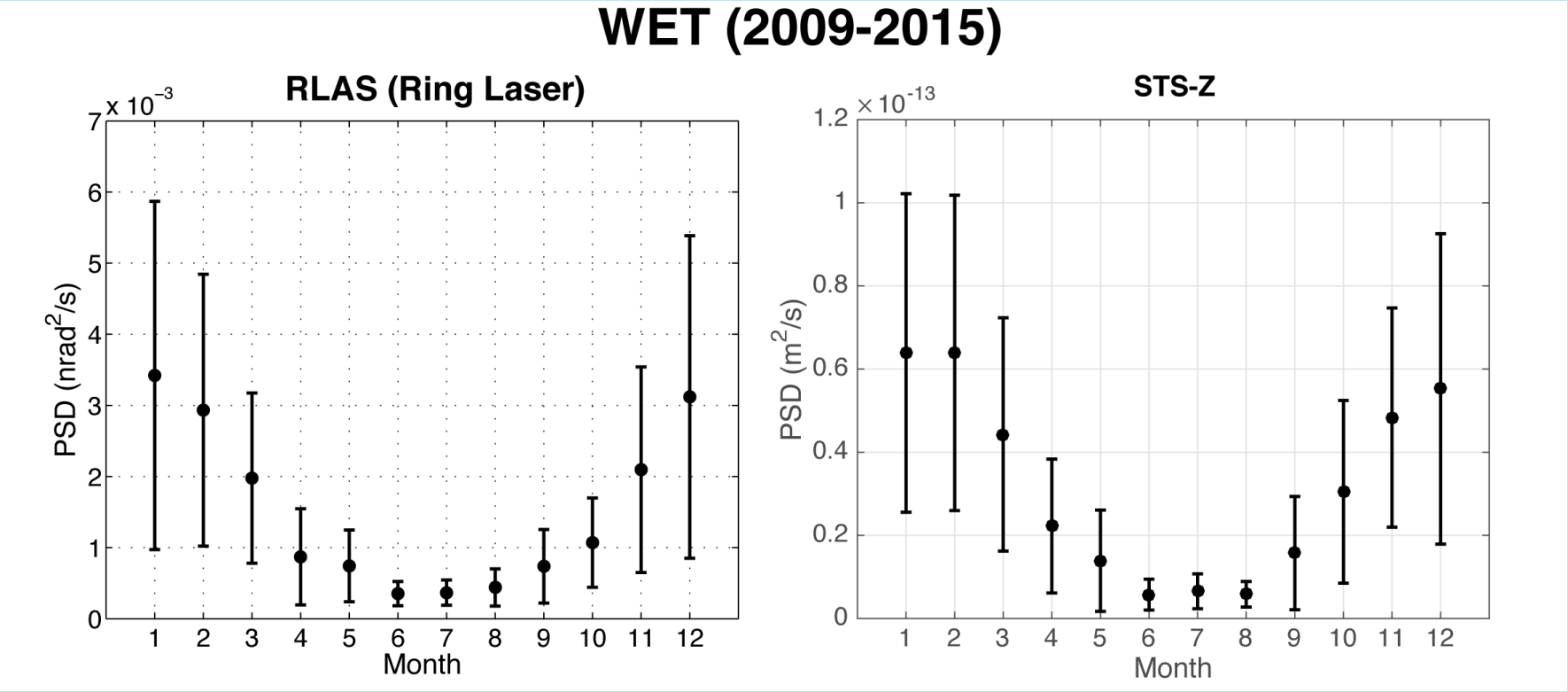
1. Double peaks
2. Longuet-Higgins (1950) explains it.
   But **only Rayleigh waves.**

G-ring and STS2 (WET)

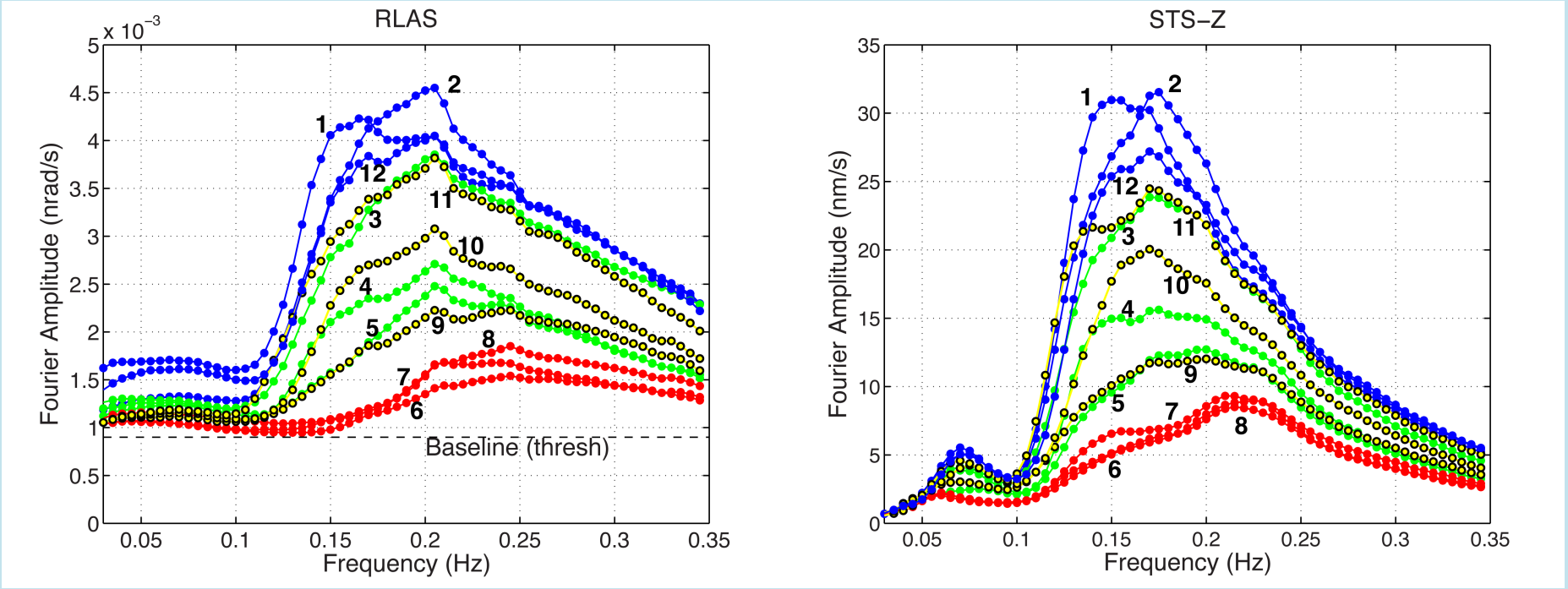
G-ring pure SH (Love waves)

STS2 Vertical (Rayleigh waves)

Monthly Averages : Raw Data (Integrated PSD for 0.1-0.4Hz)

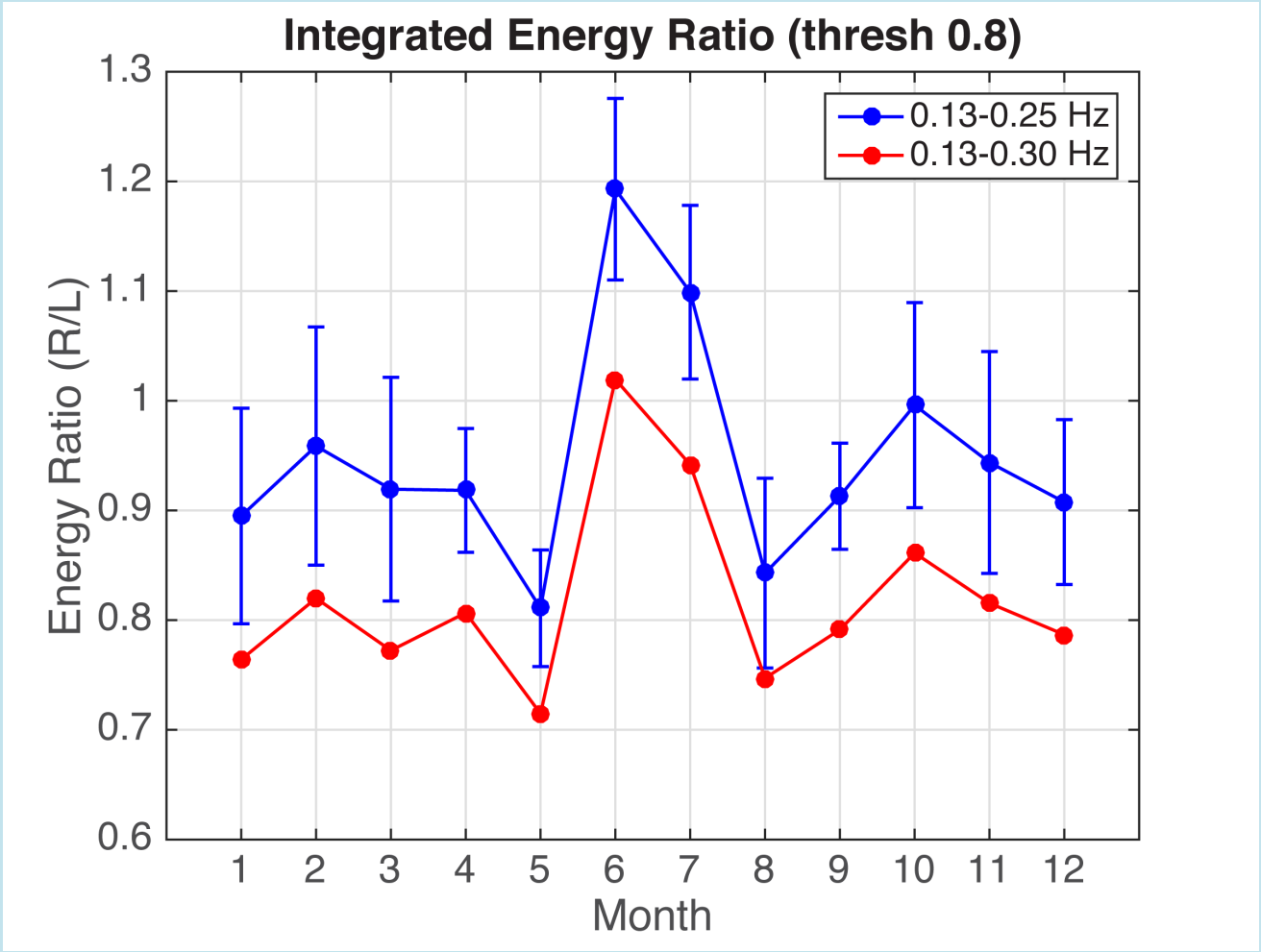


Monthly Spectra : Raw Spectra



Love Waves

Rayleigh Waves



1. More Love wave energy ~ 10-20 %

2. Seasonal change in summer

AGU PUBLICATIONS

JGR

Journal of Geophysical Research: Solid Earth

RESEARCH ARTICLE

10.1002/2016JB012885

Key Points:
- Colocated ring laser and STS2 to estimate Rayleigh and Love wave energy in microseism
- More Love wave energy in secondary microseism than Rayleigh wave energy
- Seasonal variations in Rayleigh-to-Love wave energy ratio

Correspondence to:
T. Tanimoto,
toshiro@geol.ucsb.edu

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Seasonal variations in the Rayleigh-to-Love wave ratio in the secondary microseism from colocated ring laser and seismograph

Toshiro Tanimoto[1], Céline Hadziioannou[2], Heiner Igel[2], Joachim Wassermann[2], Ulrich Schreiber[3], André Gebauer[3], and Bryant Chow[2]

[1]Department of Earth Science and Earth Research Institute, University of California, Santa Barbara, California, USA, [2]Department of Earth and Environmental Sciences, Ludwig-Maximilians-University, Munich, Germany, [3]Forschungseinrichtung Satellitengeodaesie, Technische Universitaet Muenchen, Koetzting, Germany

Abstract Monthly variations in the ratio of Rayleigh-to-Love waves in the secondary microseism are obtained from a colocated ring laser and an STS-2 seismograph at Wettzell, Germany. Two main conclusions are derived for the Rayleigh-to-Love wave kinetic energy ratios in the secondary microseism; first, the energy ratio is in the range 0.8–0.9 (<1.0) throughout a year except for June and July. It means that Love wave energy is larger than Rayleigh wave energy most of the year by about 10–20%. Second, this ratio suddenly increases to 1.0–1.2 in June and July, indicating a larger fraction of Rayleigh wave energy. This change suggests that the locations and behaviors of excitation sources are different in these months.

1. Introduction

It has generally been assumed that there is more Rayleigh wave energy than Love wave energy in seismic noise within the microseismic frequency band (0.05–0.4 Hz). This is because the mechanism for exciting

ROMY and Tilt measurement

1. With ROMY, we will get a lot of data on tilt.

2. Tilt is the main source of noise in horizontal components.
   (tilt – local effects, many signals – global)
   Example : Tilt-free toroidal mode data

There is an opportunity to understand tilt better and figure out a way to remove it (reduce noise).

Nature of tilt

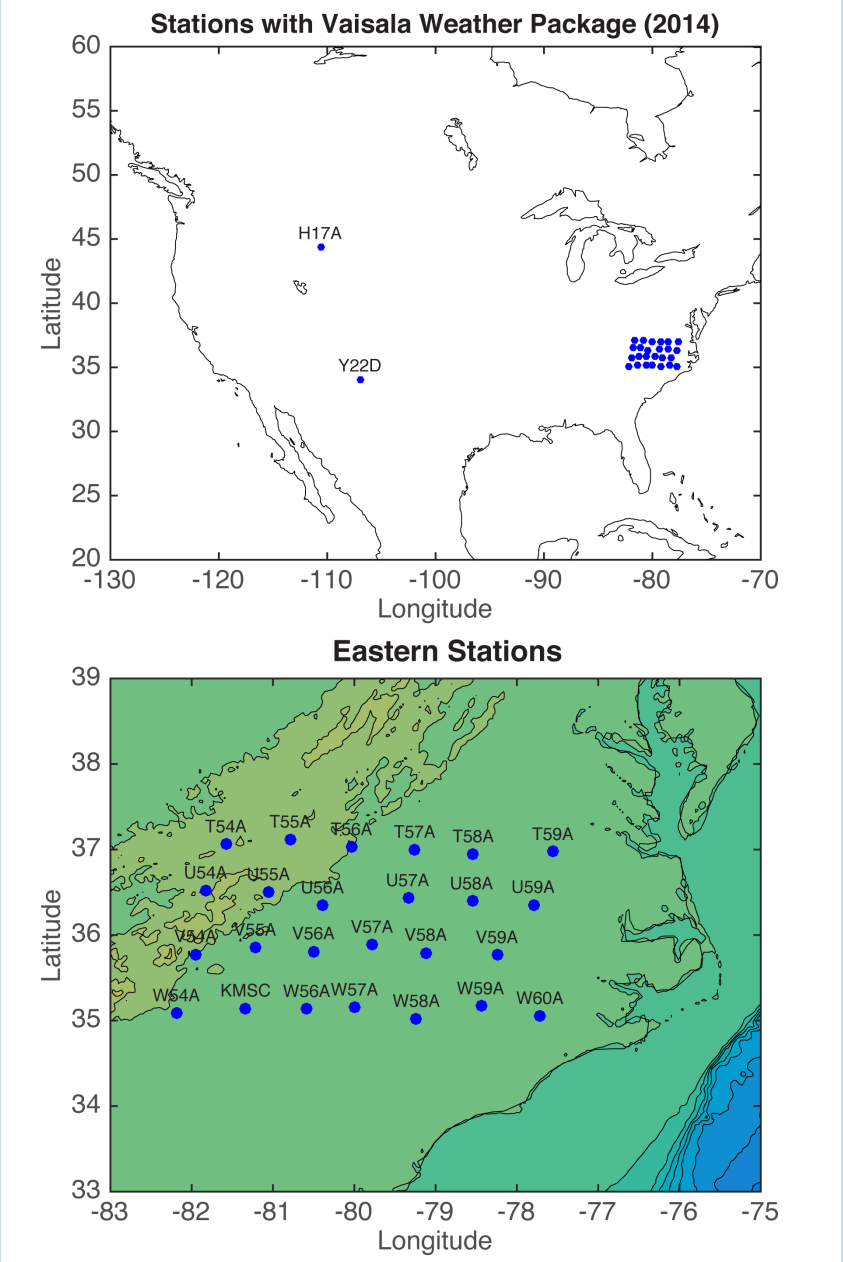
Weather Data : A subset of Earthscope TA

Barometers and 3-comp Seismometers

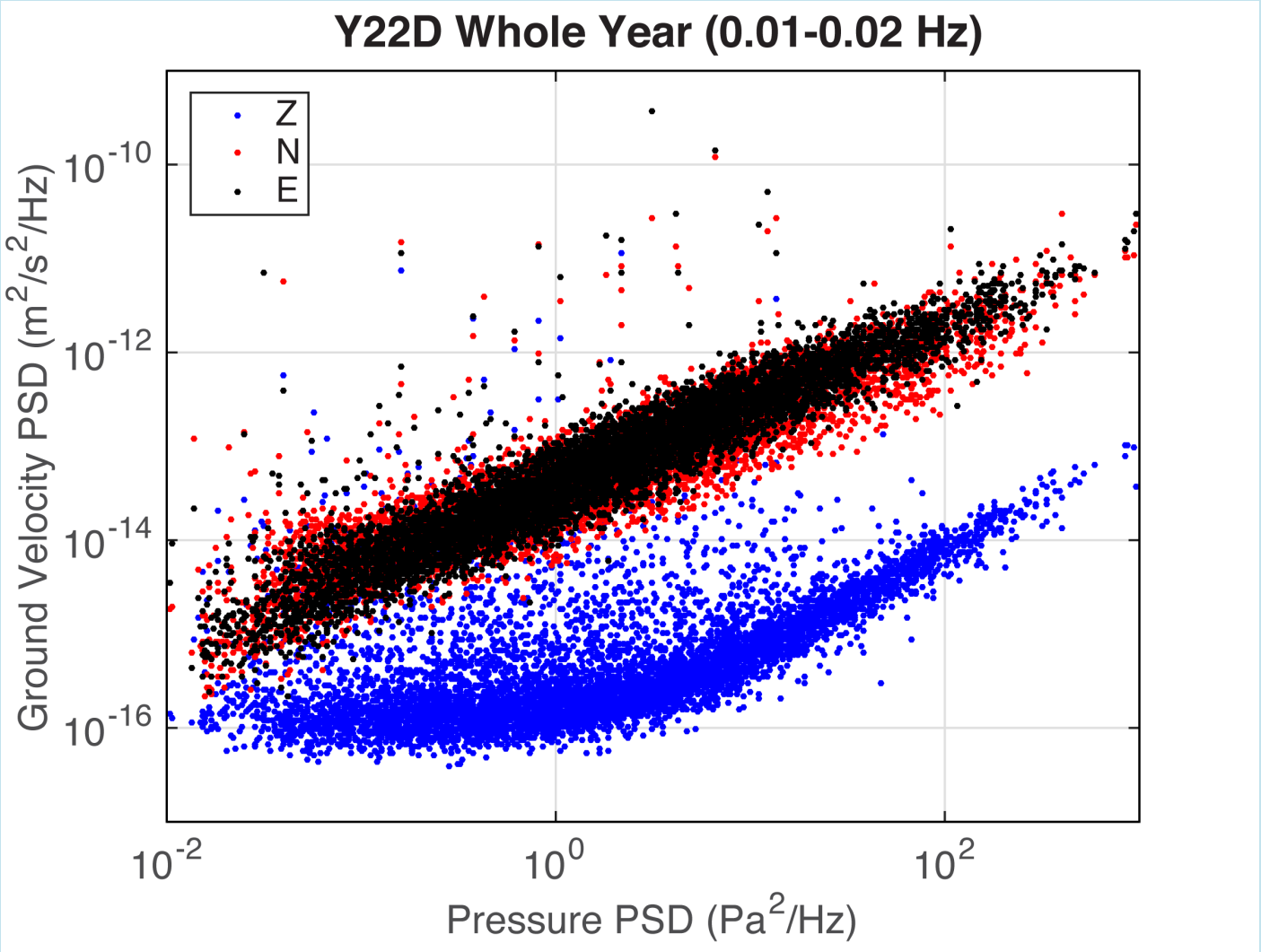
Wind data, Temp. data, Humidity, Rain, etc.

Weather Station Data (wind, temperature, humidity, rain, hail,…)

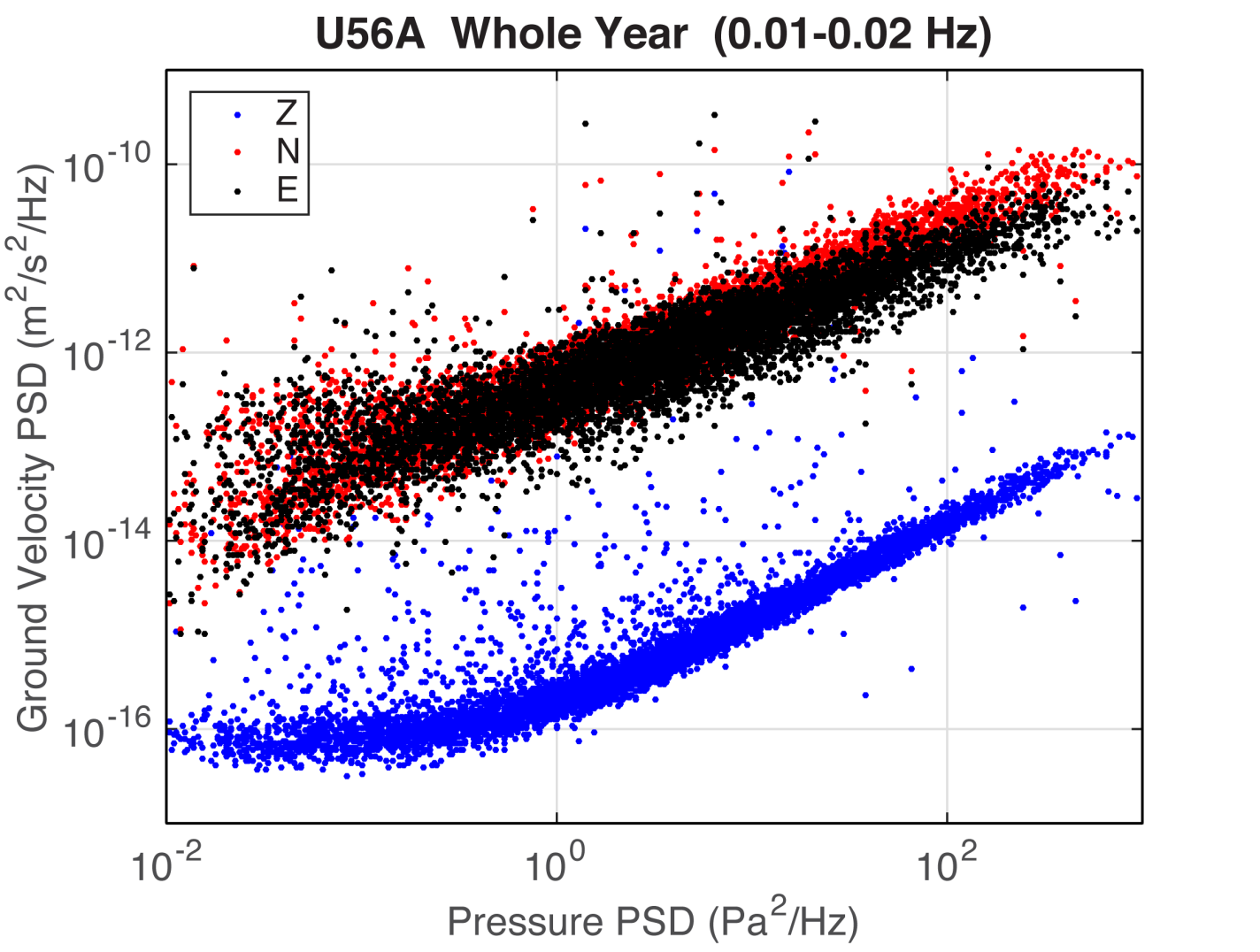
This array is mostly in North Carolina (A subset of TA)



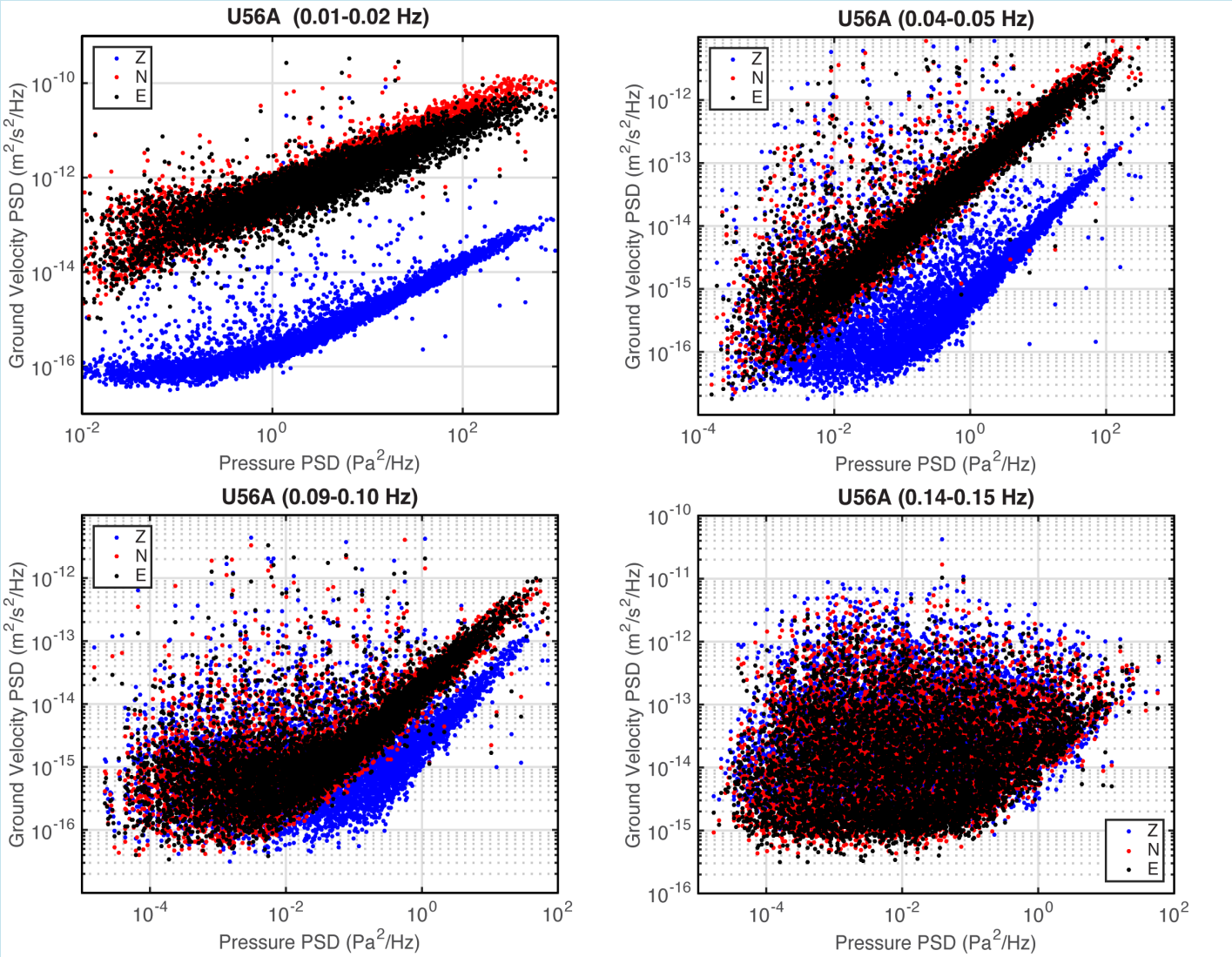
Pressure PSD vs. Seismic PSD
Station Y22D for the year 2014



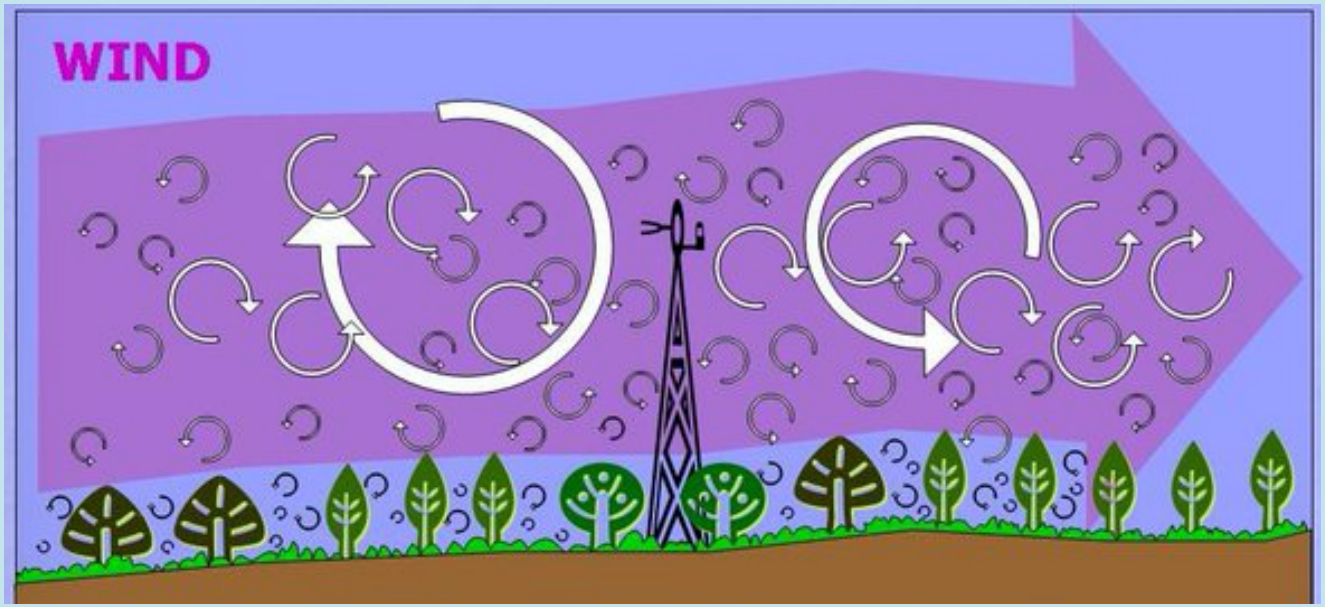
Pressure PSD vs. Seismic PSD
Station U56A for the year 2014



Pressure PSD vs. Seismic PSD (four frequency ranges) Station U56A for the year 2014



Tilt generation

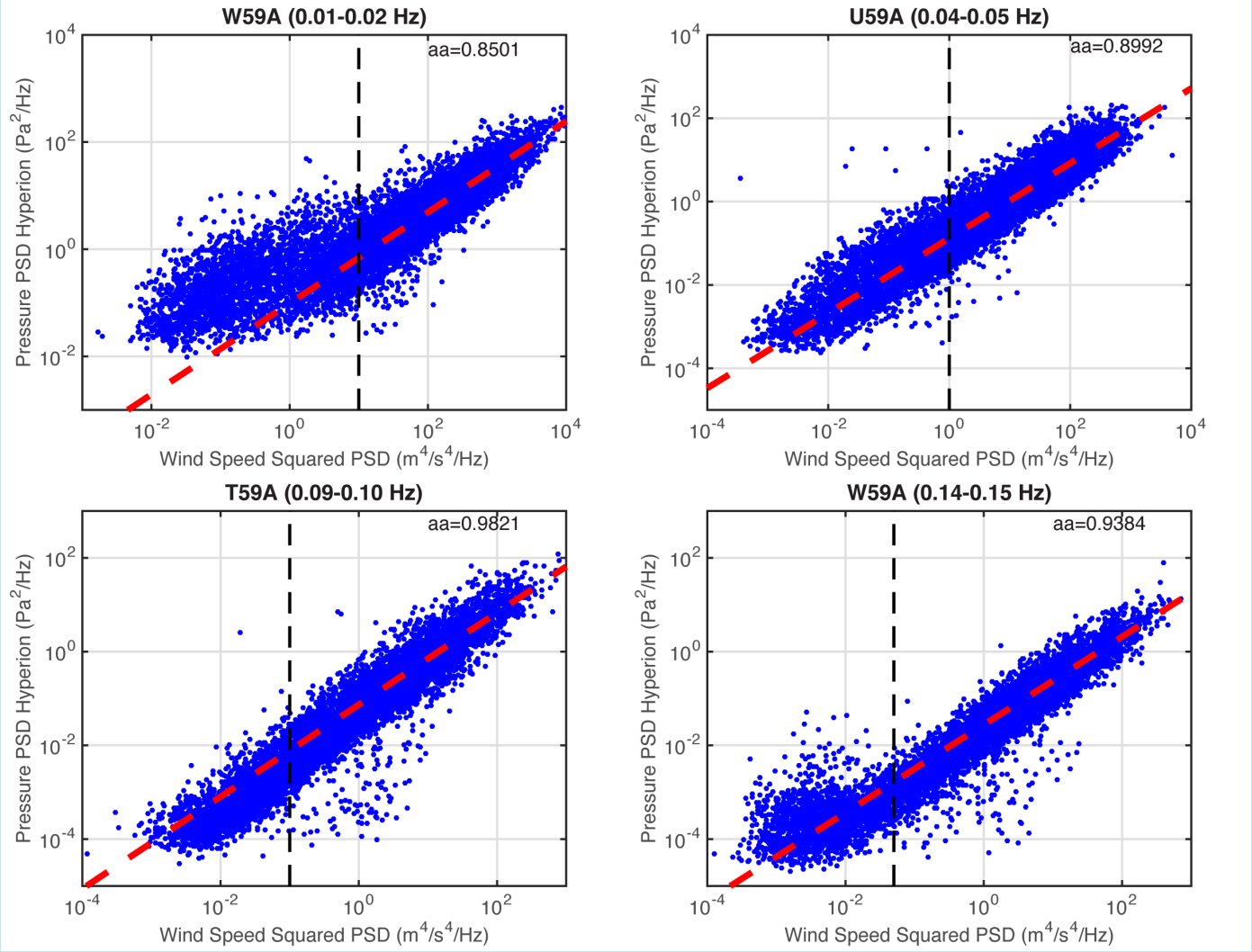


Turbulence : Eddies create pressure variations

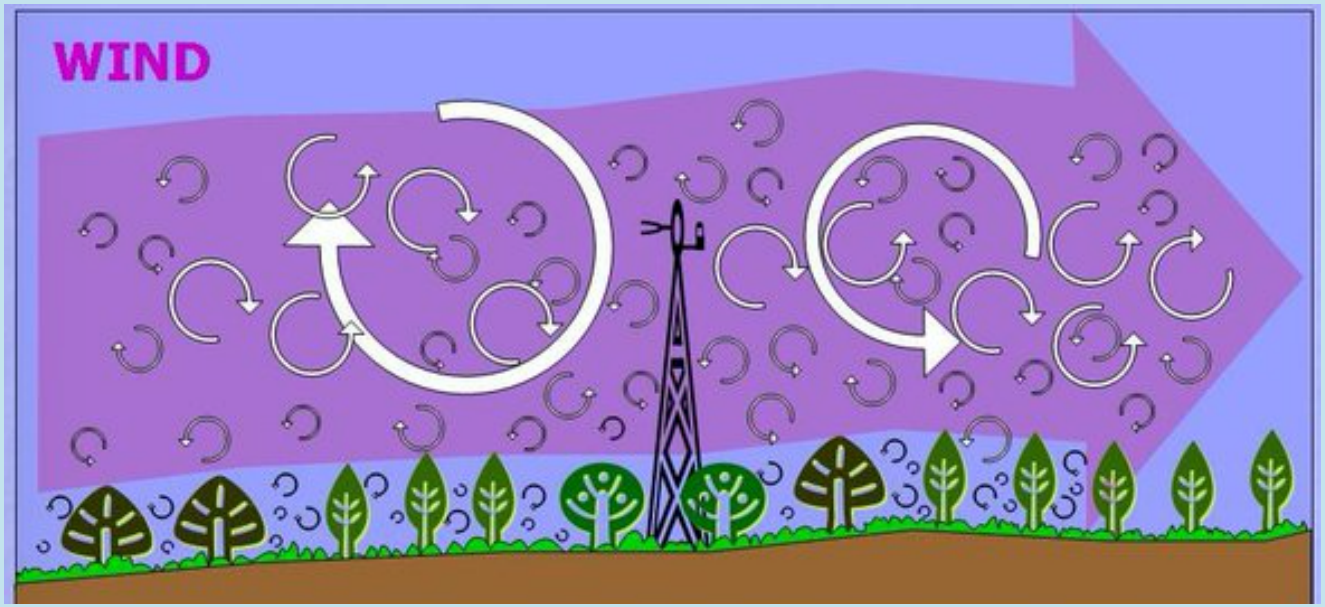
Swaying of trees and buildings by winds

Wind velocity (v^2) vs. Pressure

$$\Delta p \propto (\mathbf{v}^2)^{aa}$$

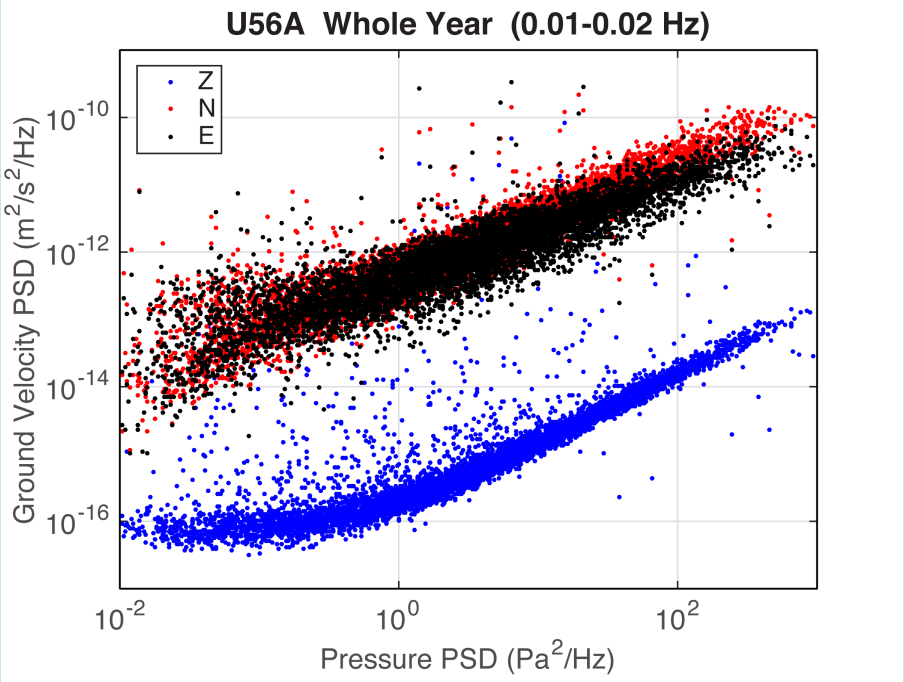


Tilt



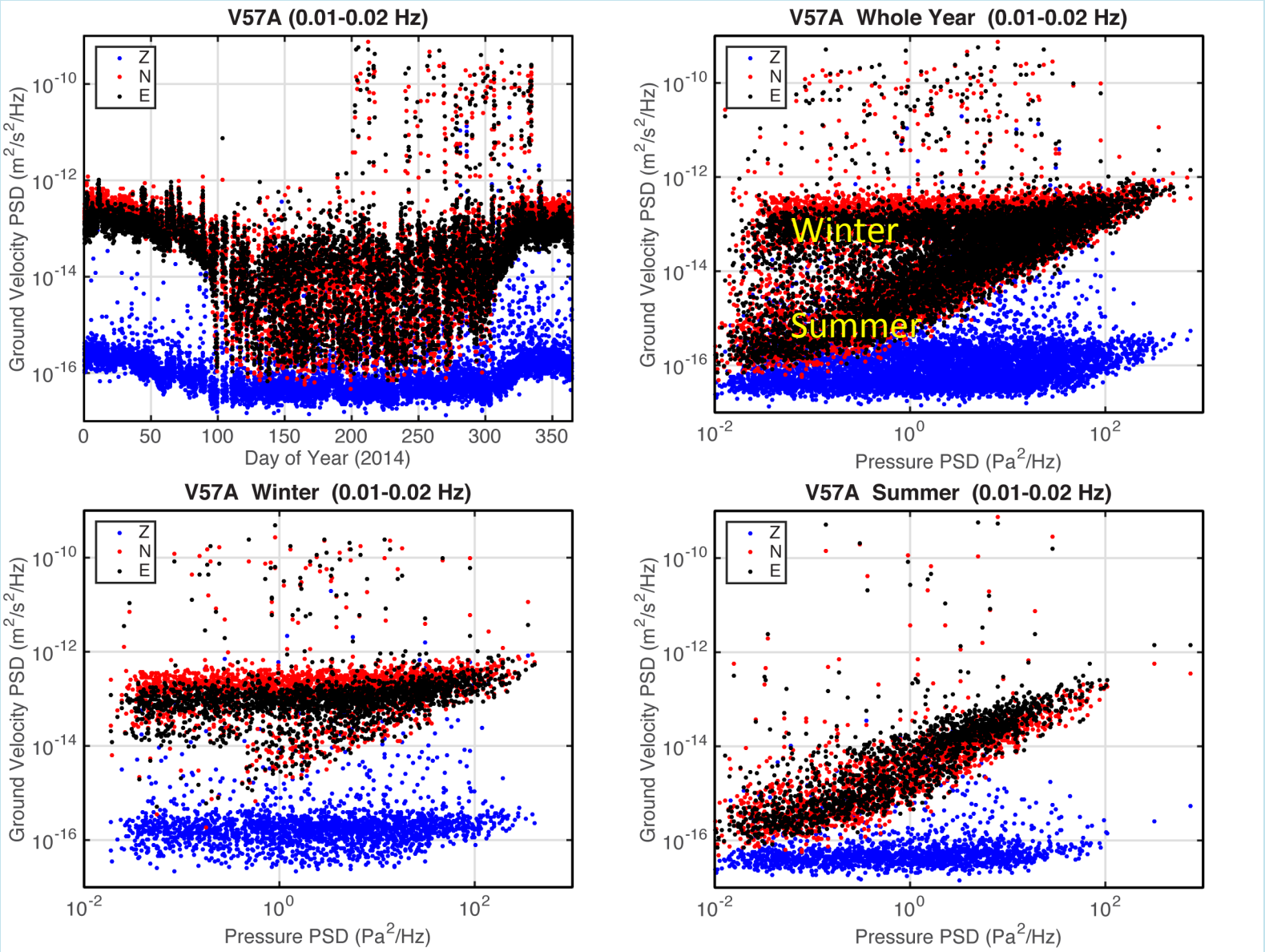
Wind → Pressure lateral gradient → Tilt
→ Large horizontal noise

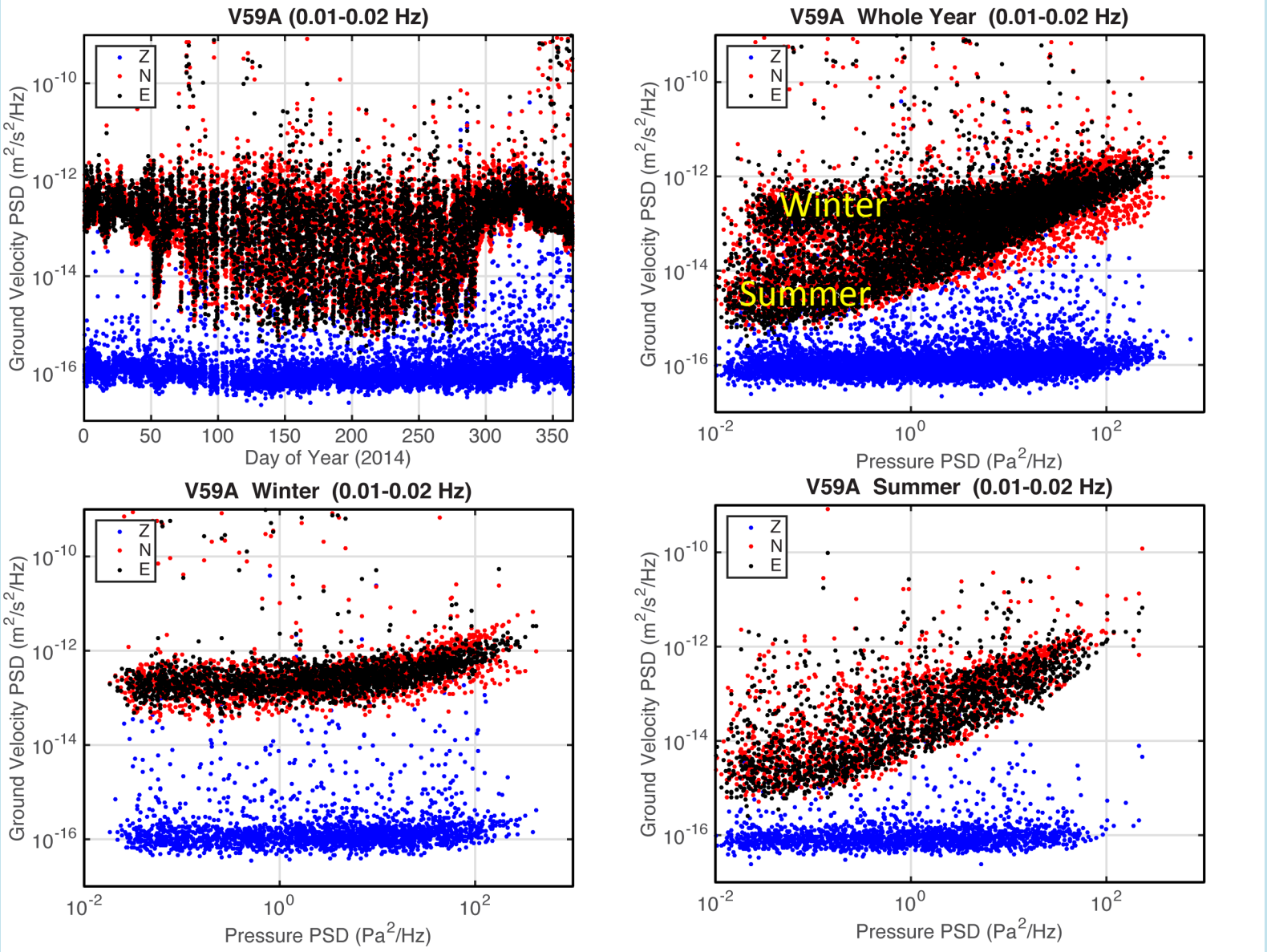
We can reduce noise in horizontal components by regression.



My wish list for ROMY

1. Pressure data (1 sps, Setra 278 or Infrasound sensor)
2. Weather data (Wind, Temp etc).


V57A (0.01-0.02 Hz)
Z
N
E
Ground Velocity PSD (m²/s²/Hz)
Day of Year (2014)
V57A Whole Year (0.01-0.02 Hz)
Winter
Summer
Pressure PSD (Pa²/Hz)
V57A Winter (0.01-0.02 Hz)
V57A Summer (0.01-0.02 Hz)


V59A (0.01-0.02 Hz)
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Winter
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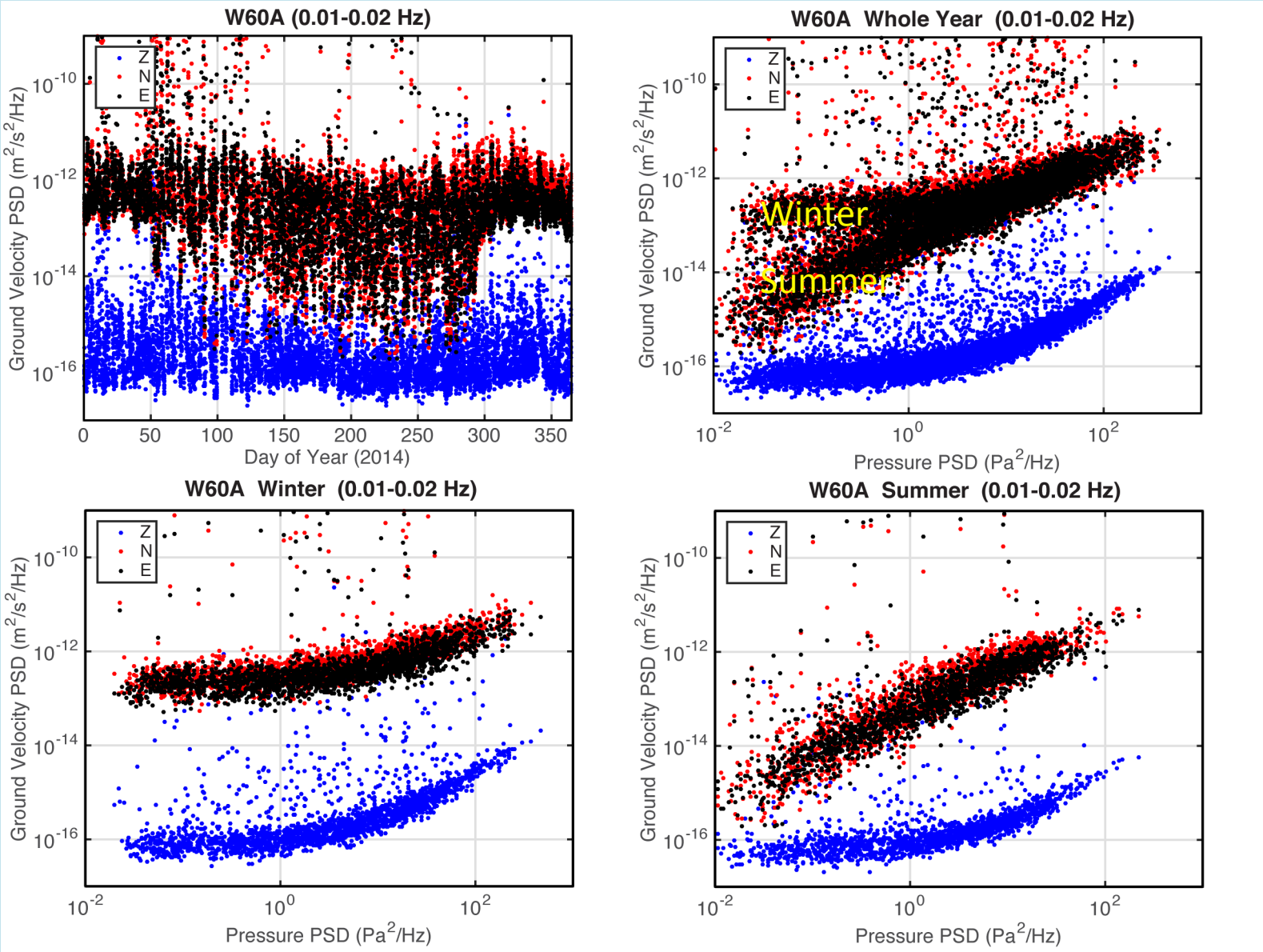
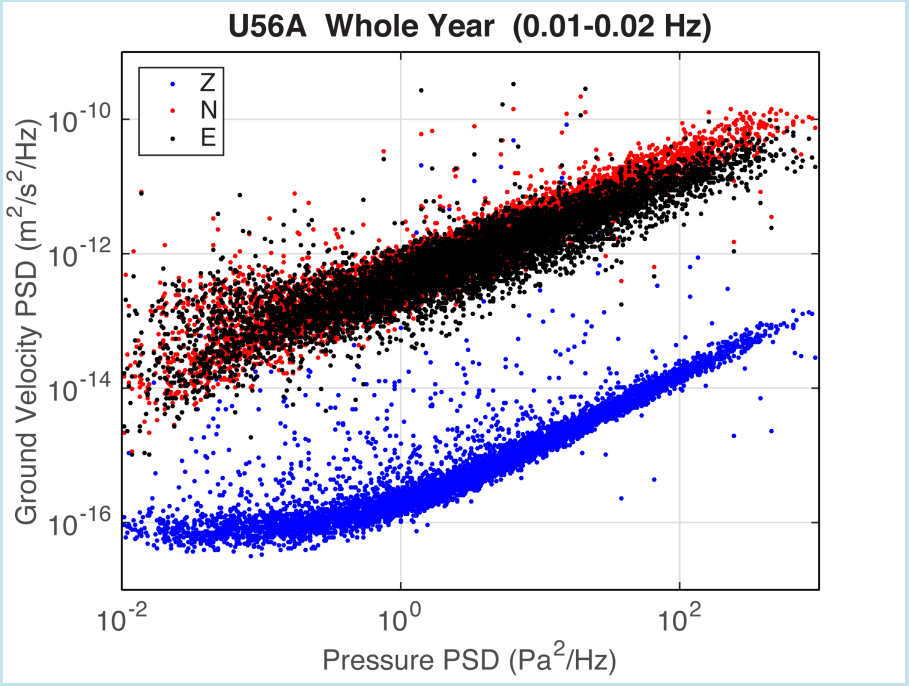
Pressure PSD (Pa²/Hz)
V59A Winter (0.01-0.02 Hz)
V59A Summer (0.01-0.02 Hz)


W60A (0.01-0.02 Hz)
Ground Velocity PSD (m²/s²/Hz)
Day of Year (2014)
Z
N
E
W60A Whole Year (0.01-0.02 Hz)
Winter
Summer
Pressure PSD (Pa²/Hz)
W60A Winter (0.01-0.02 Hz)
W60A Summer (0.01-0.02 Hz)

With ROMY, we can understand tilt much better.



Thank you for your attention.