

Surface Wave Measurements in Space and Time using Coherent Marine Radars

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Utilized Marine Radar Systems

Fino-3



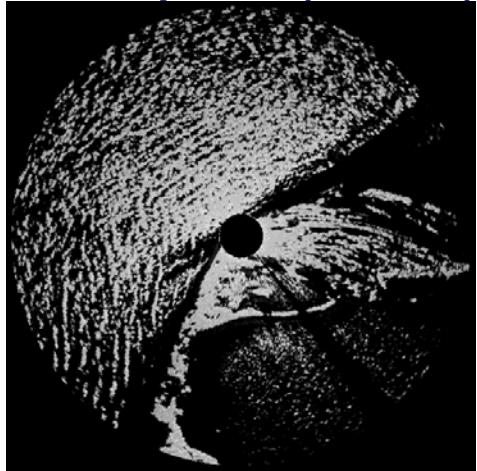
X-band (9.3 GHz)
4 kW & 12 kW
8 foot antenna
HH & VV-polarization
Incoherent and coherent
up to 1 m range resolution
0.8°azimuth resolution



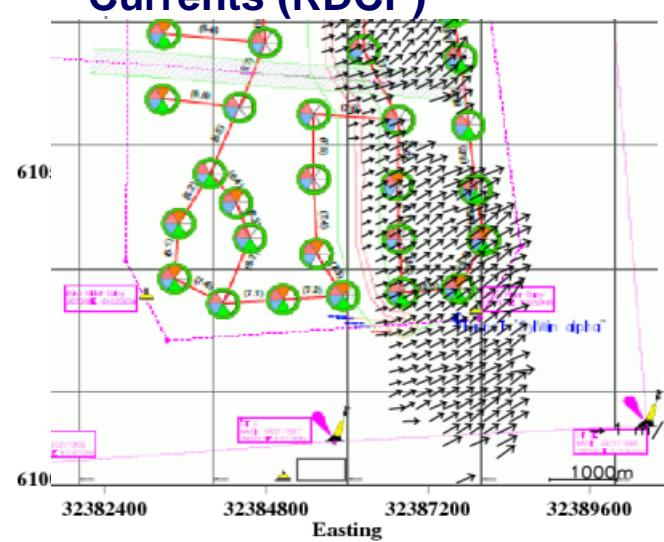
Bunkerhill, Sylt

Hydrographic Parameters Retrieved from Marine Radars

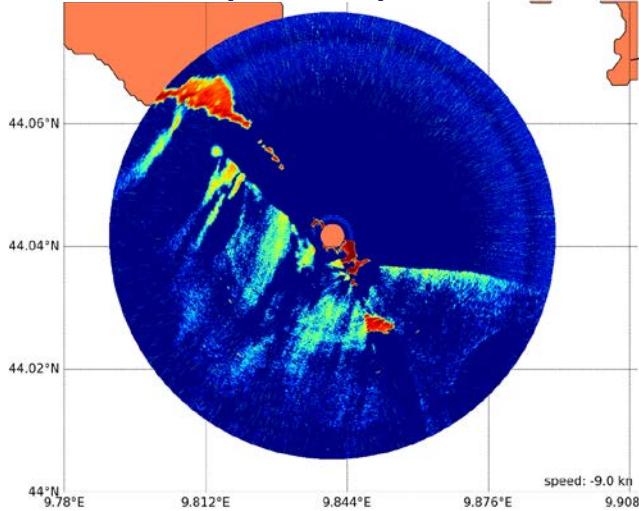
Wave Spectra (WaMoS)



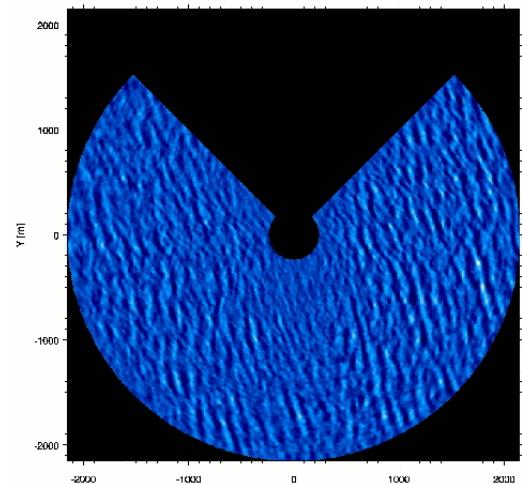
Currents (RDCP)



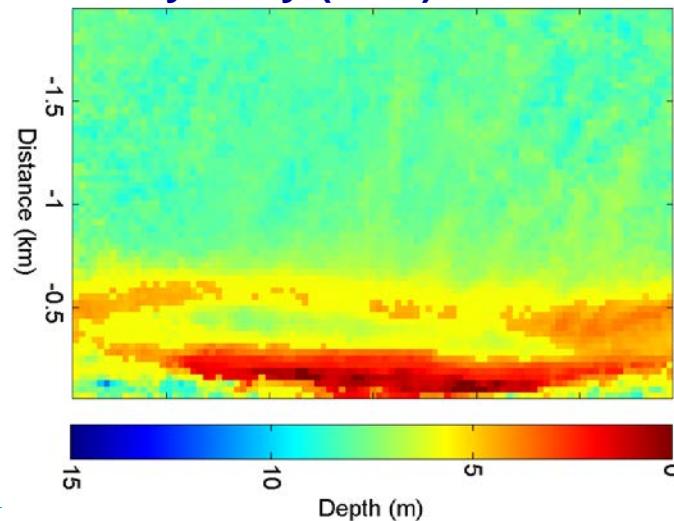
Winds (WiRAR)



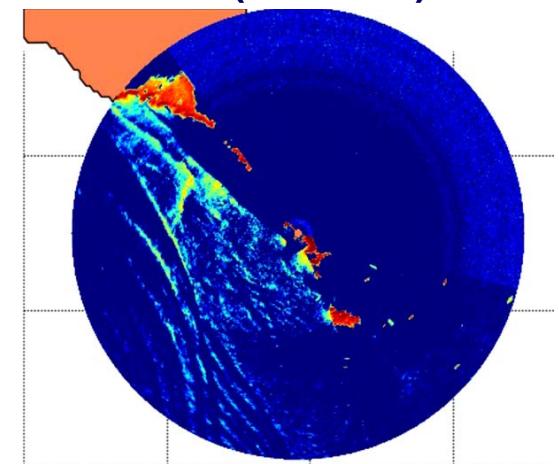
Individual Waves



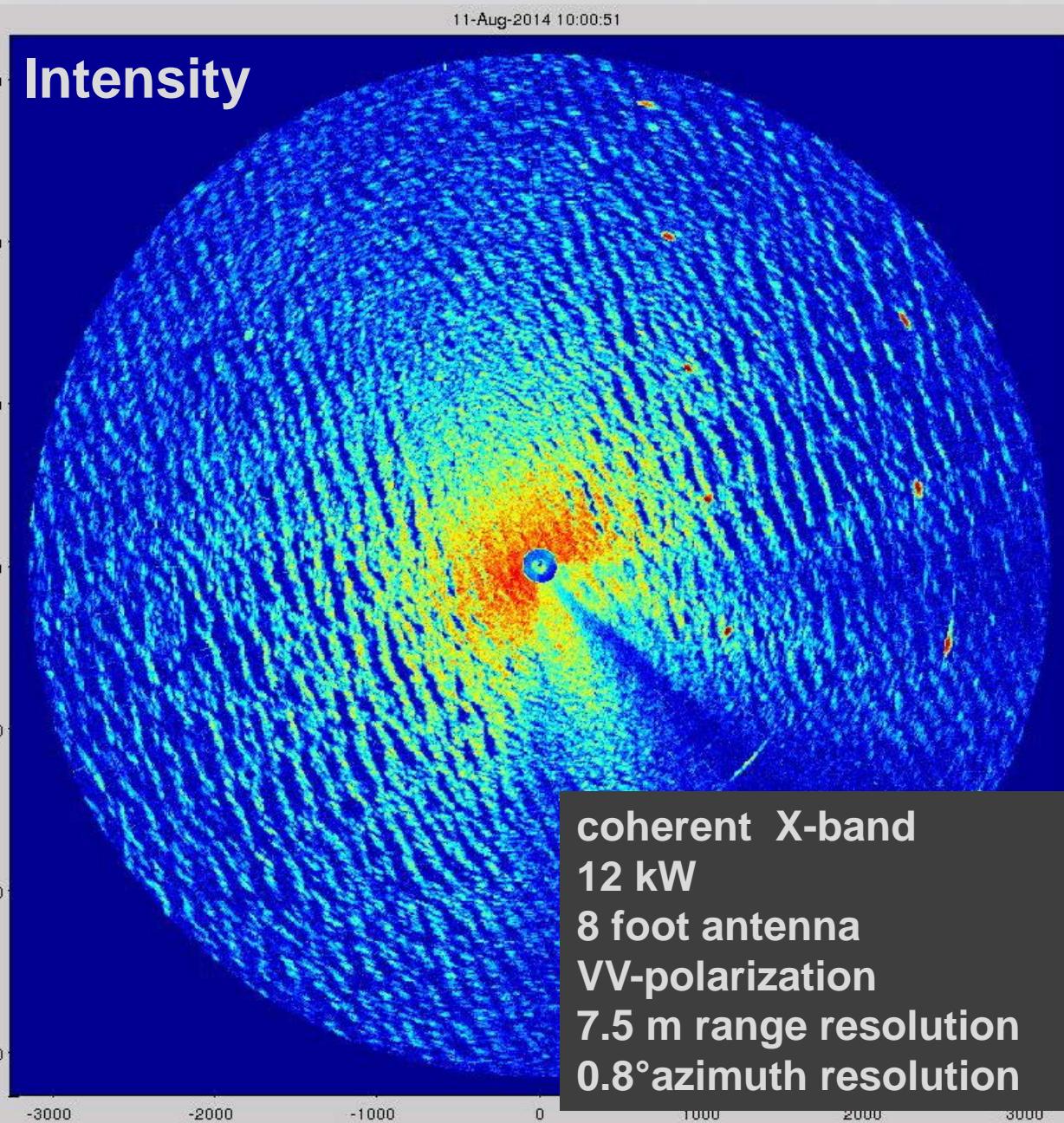
Bathymetry (Disc)



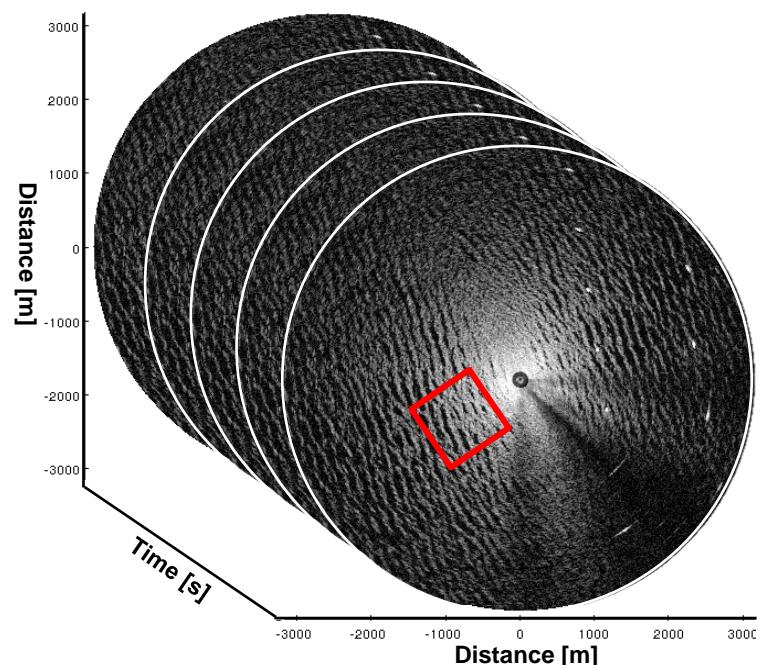
Features (SuFMoS)



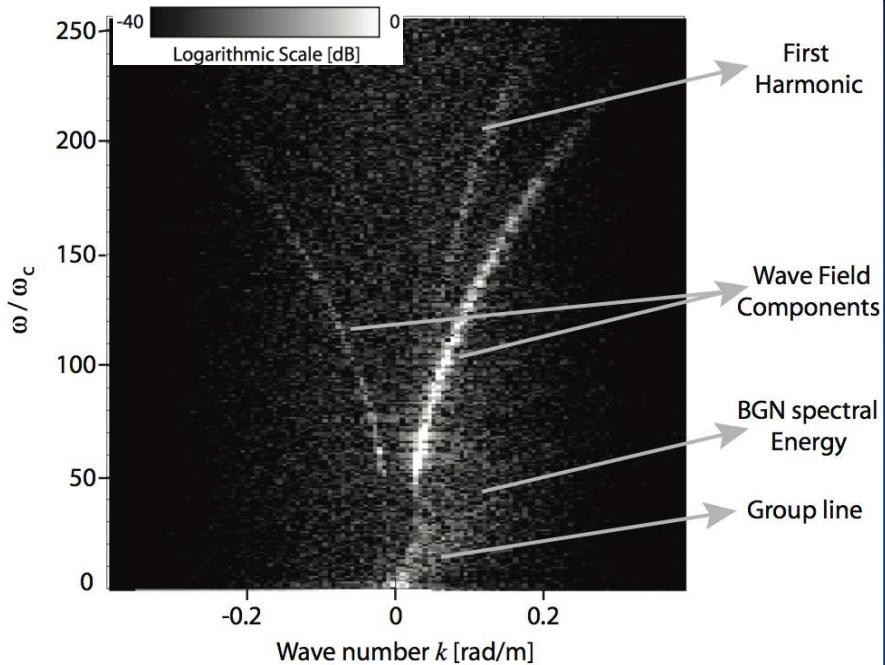
Measurements Acquired at Fino-3



Current Retrieval from Incoherent Marine Radars

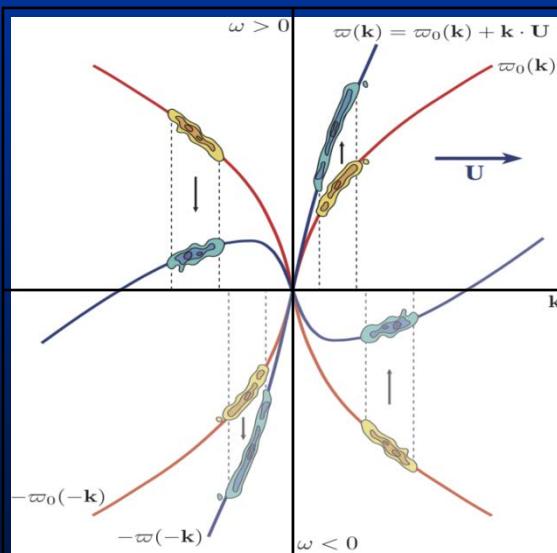


3D FFT

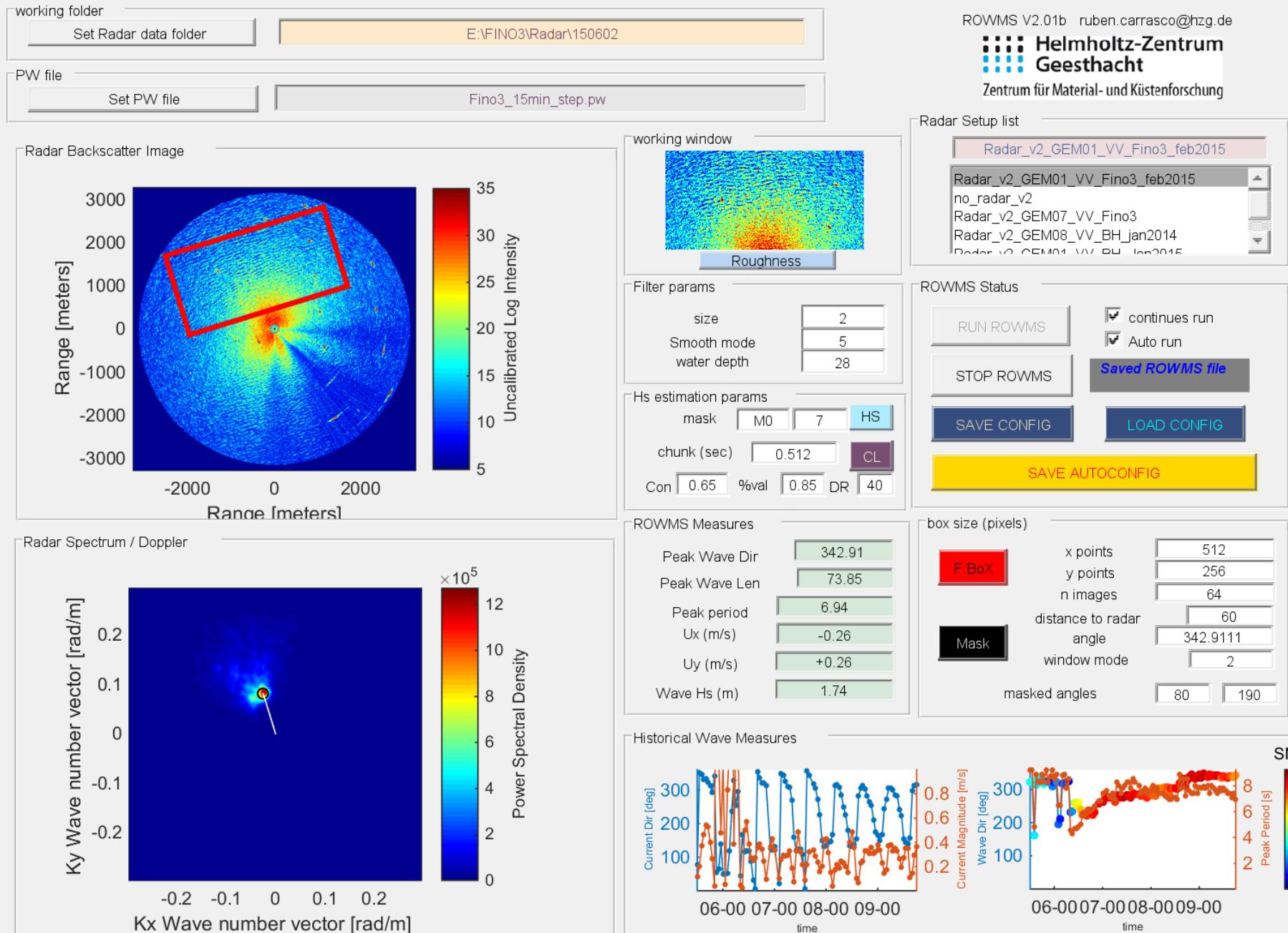


$$\omega = \sqrt{gk \tanh(kd)} + \mathbf{k} \cdot \mathbf{U}$$

Young et al. JGR 1985



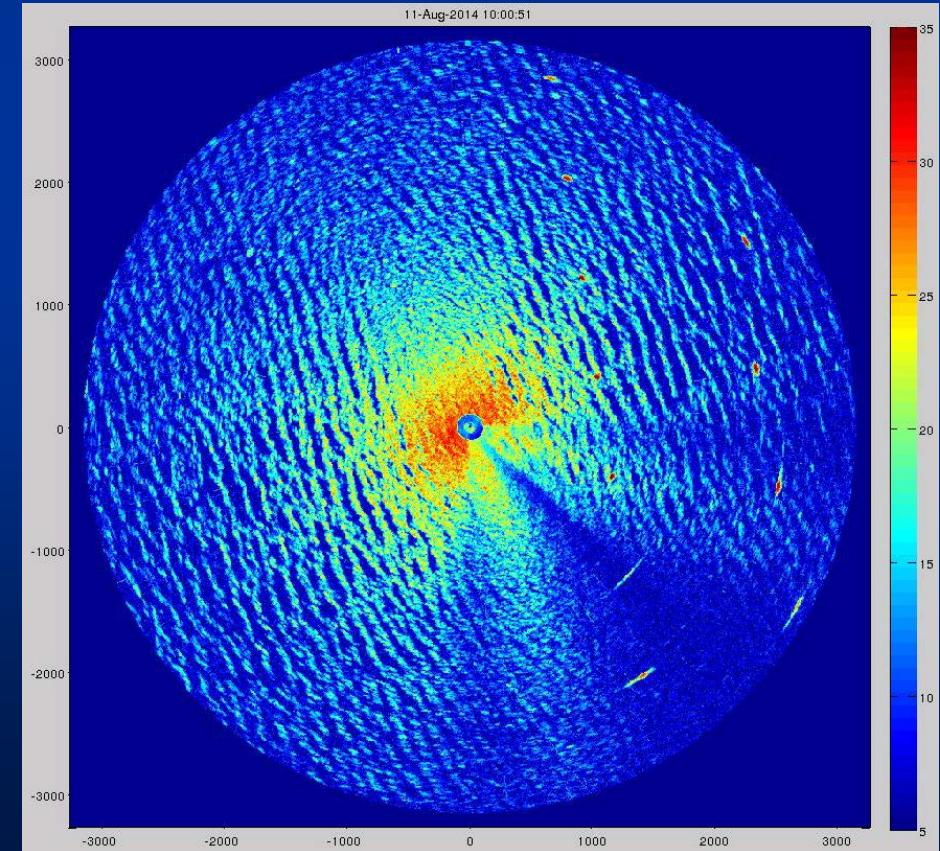
Operational Mode at Fino-3



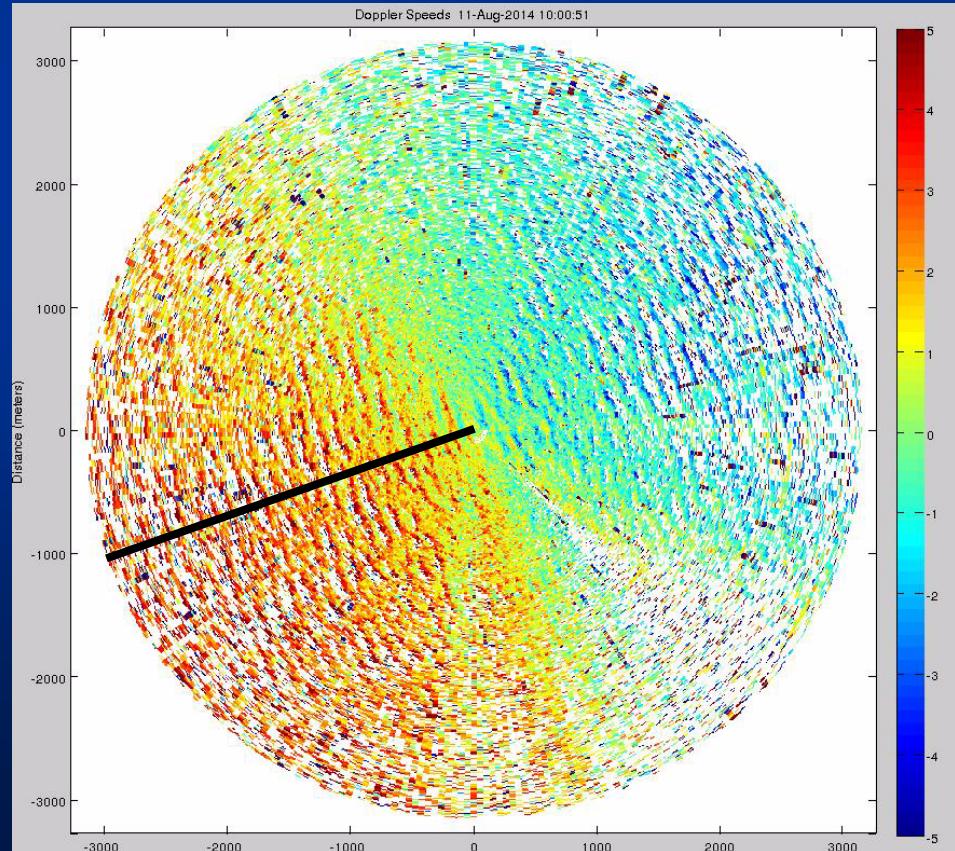
Coherent Radar Image Sequences from FINO-3

$$\mathbf{U}_{\text{tot}} = \mathbf{U}_{\text{wind}} + \mathbf{U}_{\text{cur}} + \mathbf{U}_{\text{orb}} + \mathbf{U}_{\text{break}} + \mathbf{U}_{\text{shad}} + \mathbf{U}_{\text{rest}}$$

Intensity

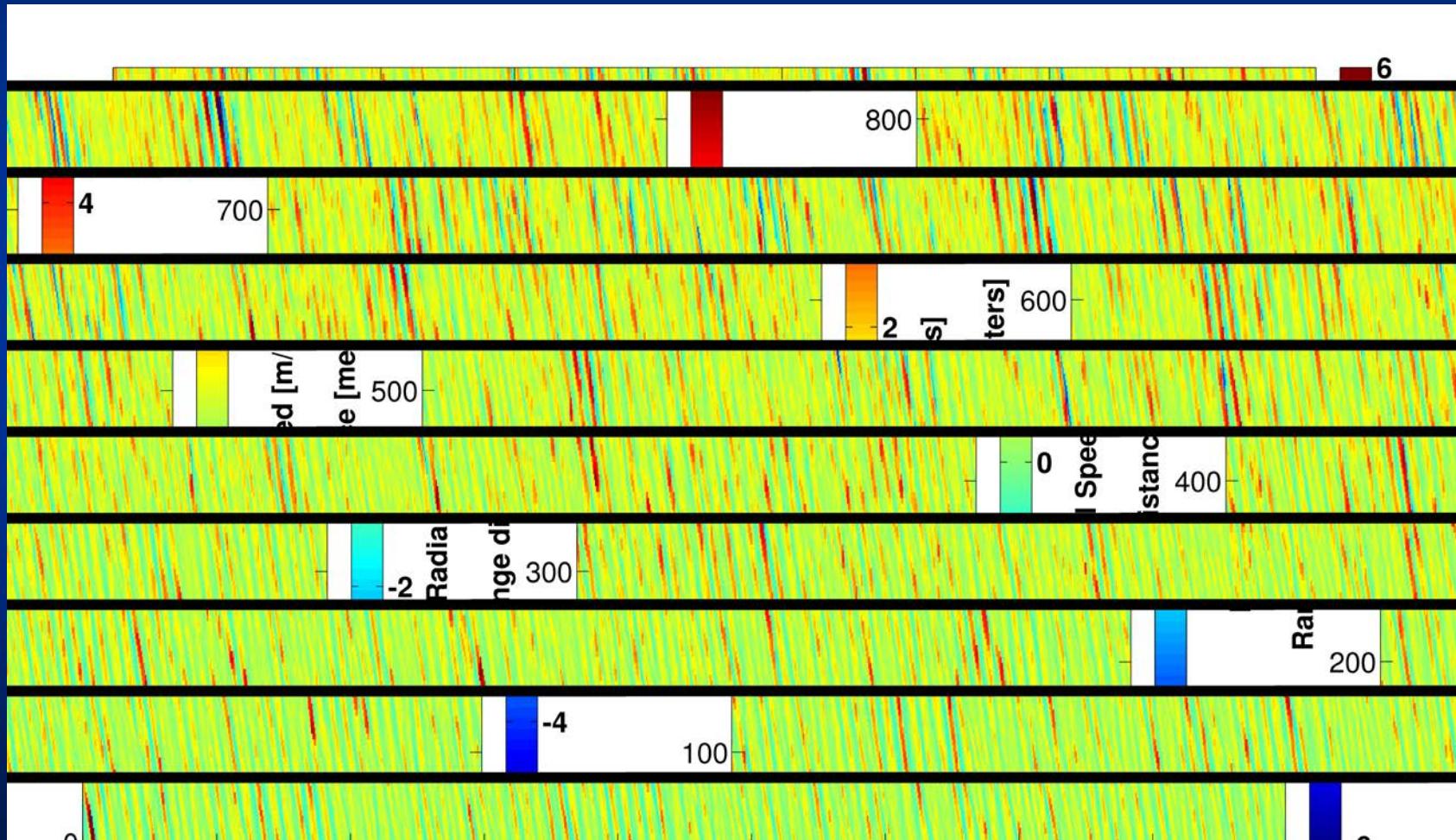


Doppler Speed



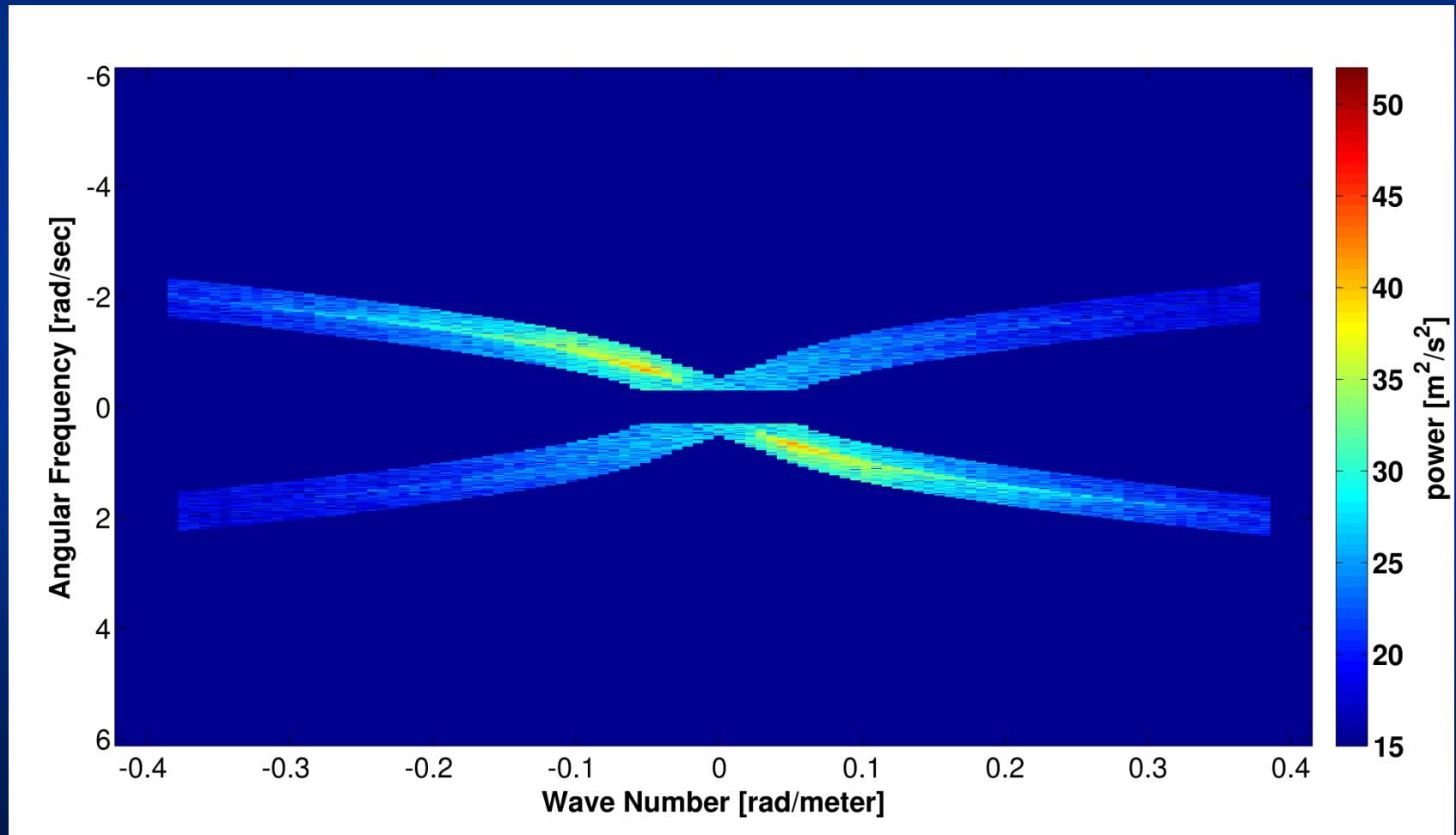
Range Time Information on Doppler Speeds

$$U_{\text{tot}} = U_{\text{wind}} + U_{\text{cur}} + U_{\text{orb}} + U_{\text{break}} + U_{\text{shad}} + U_{\text{rest}}$$



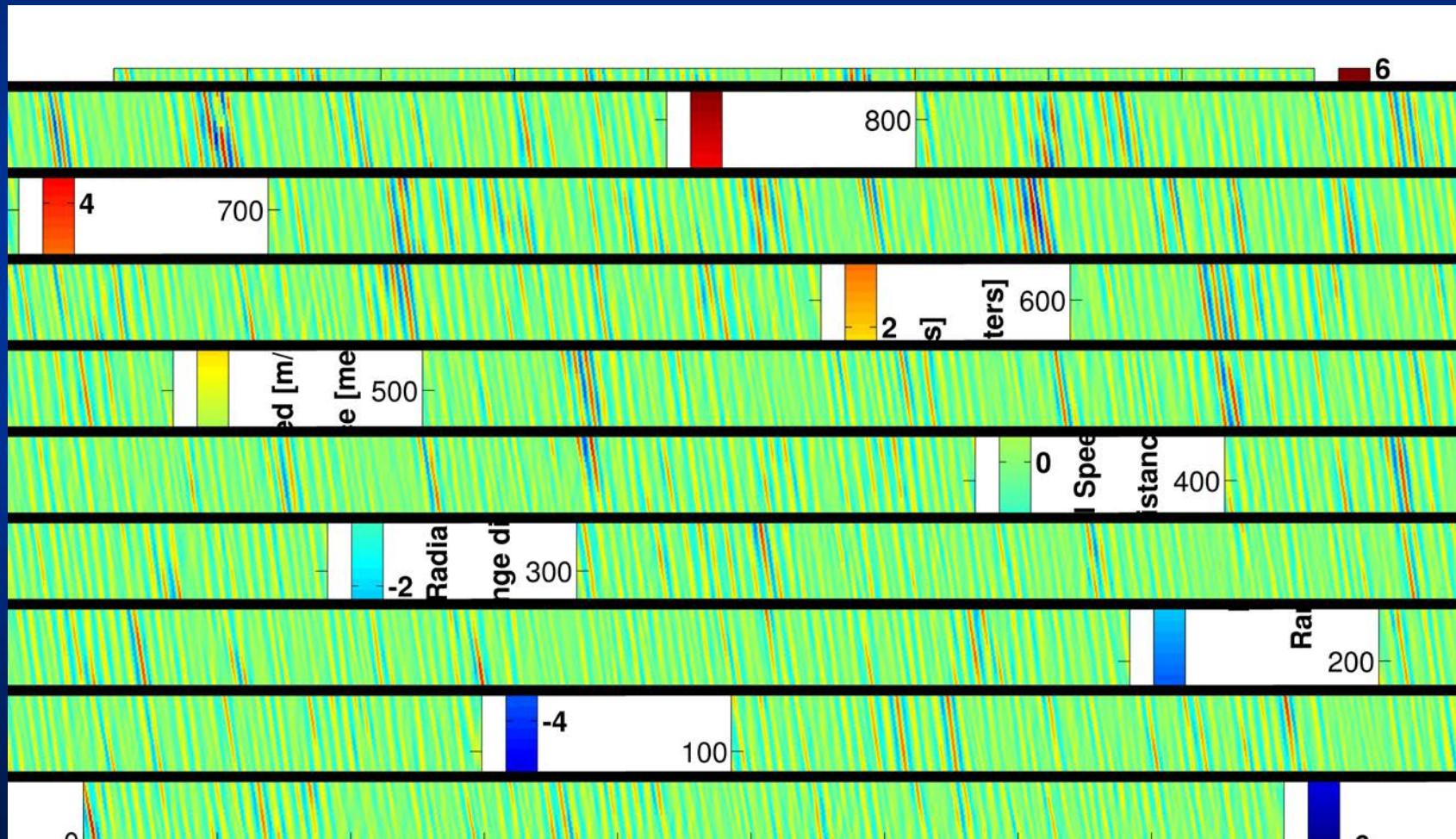
Dispersion Filter

$$U_{\text{tot}} = U_{\text{wind}} + U_{\text{cur}} + U_{\text{orb}} + U_{\text{break}} + U_{\text{shad}} + U_{\text{rest}}$$

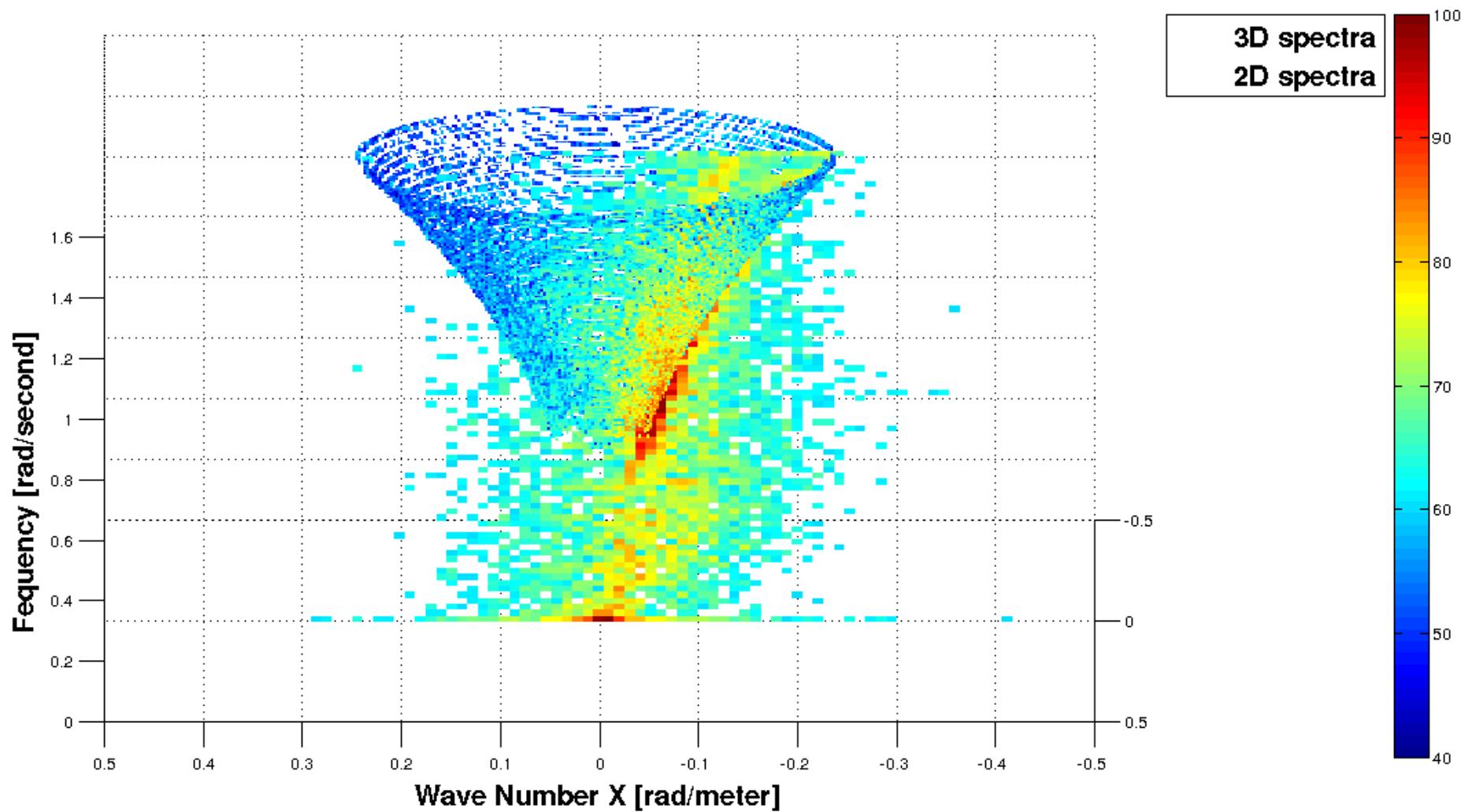


Range Time Information of Waves

Horizontal Orbital Velocities

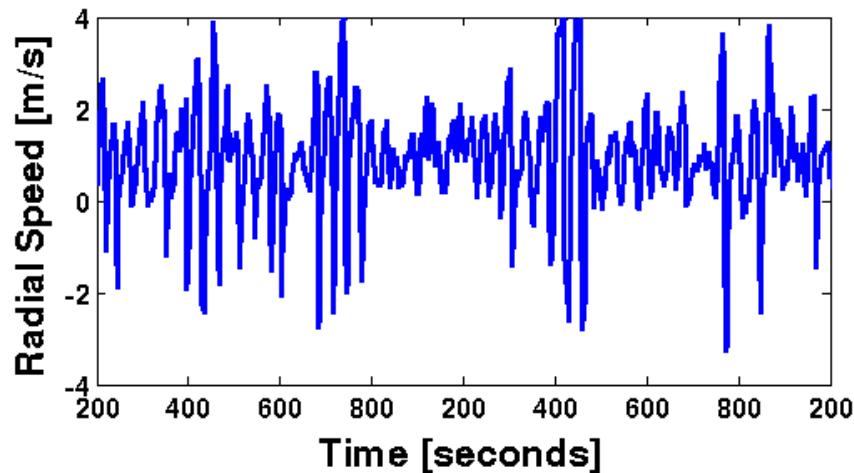
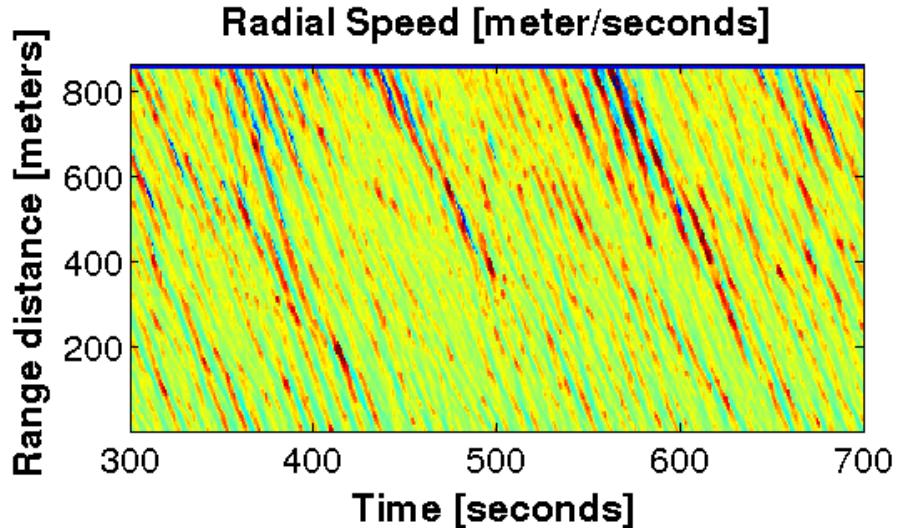


Correction for the Width of Wave Spectra (Ongoing)

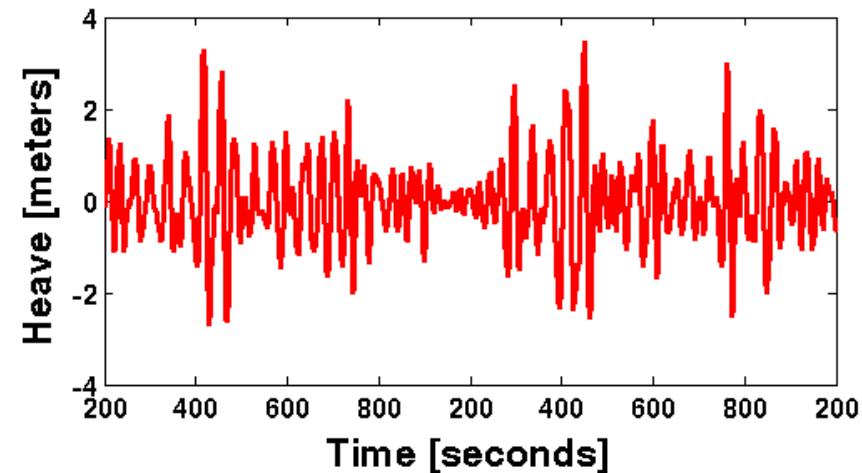
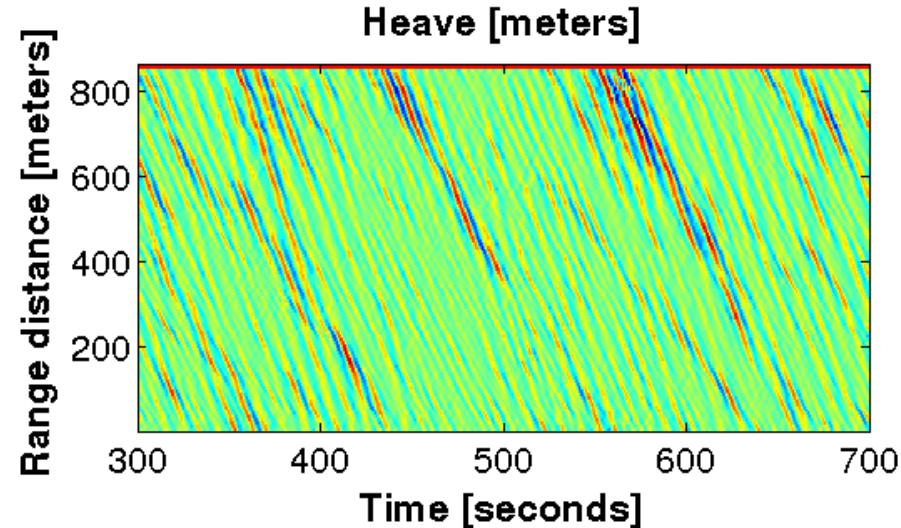


Retrieval of Heave from Horizontal Orbital Velocities

Horizontal Orbital Velocity



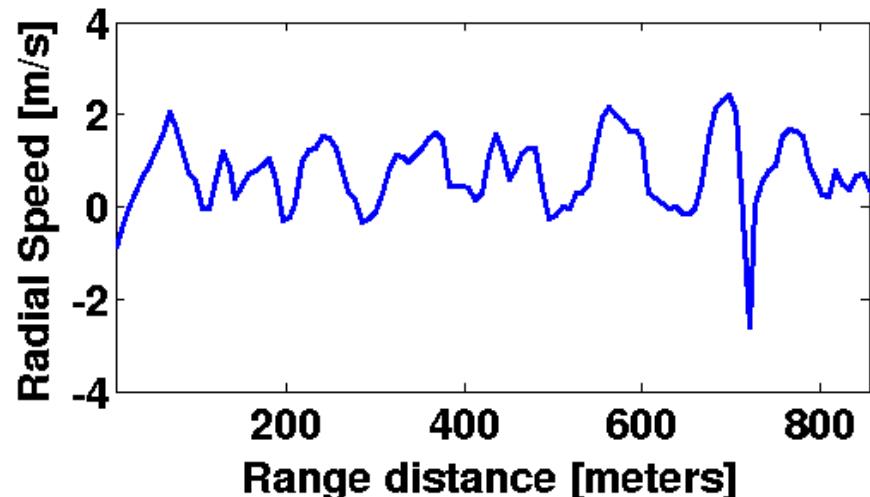
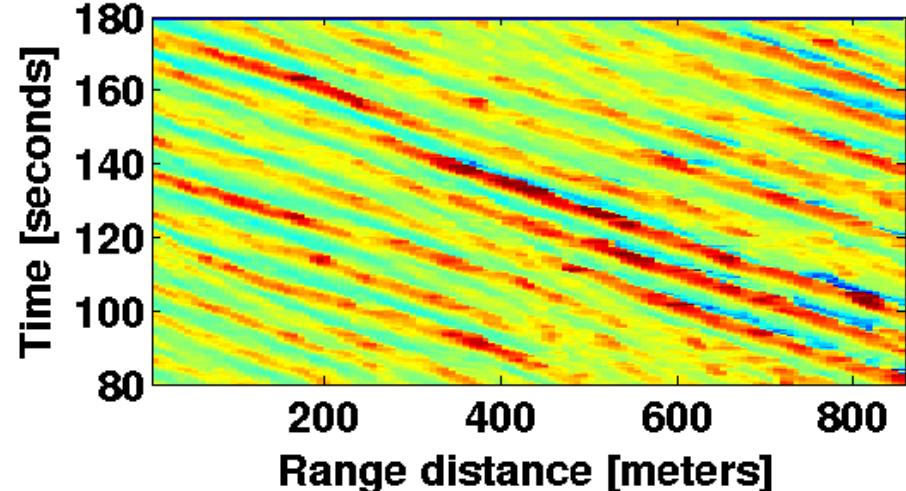
Wave Heave



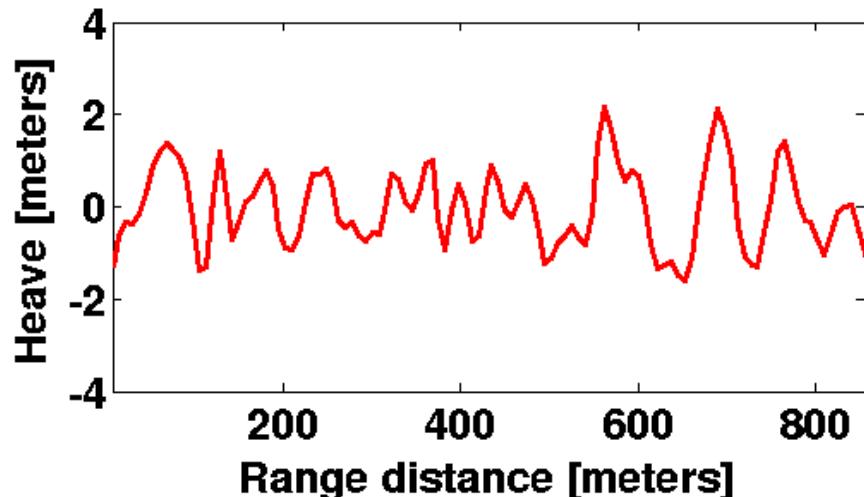
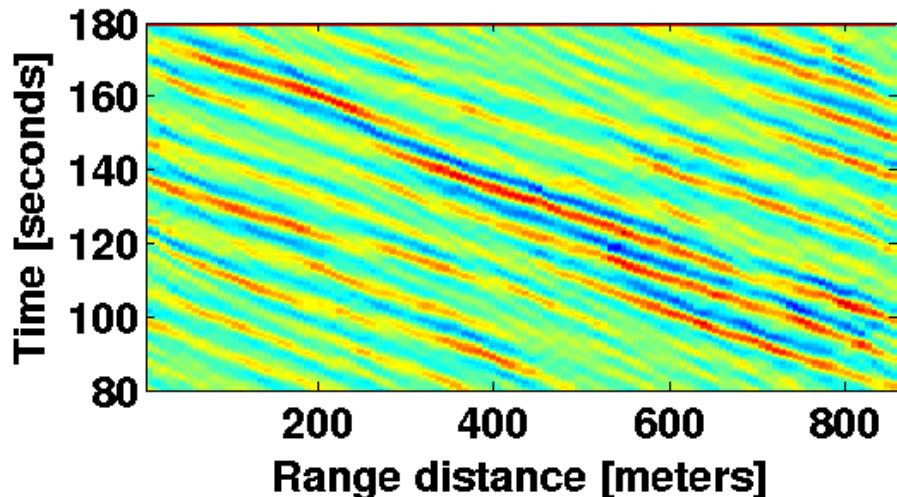
Observation of Waves in Space and Time

Horizontal Orbital Velocity

Significant Wave Height: 3.41 meters

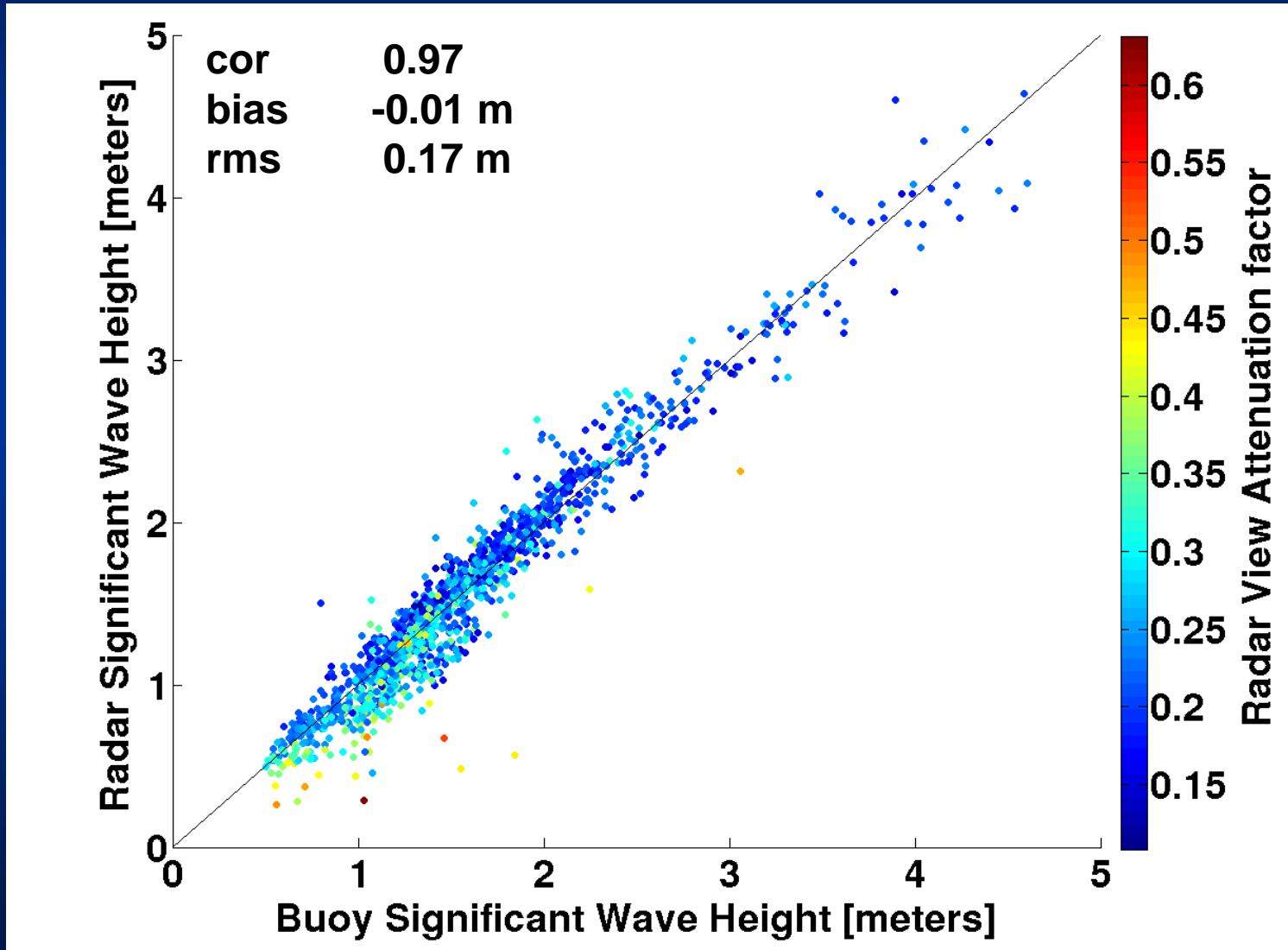


Wave Heave

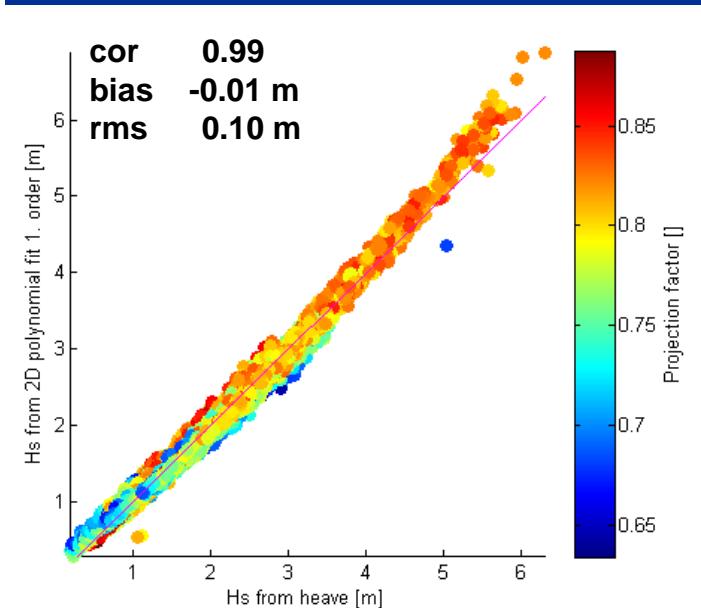
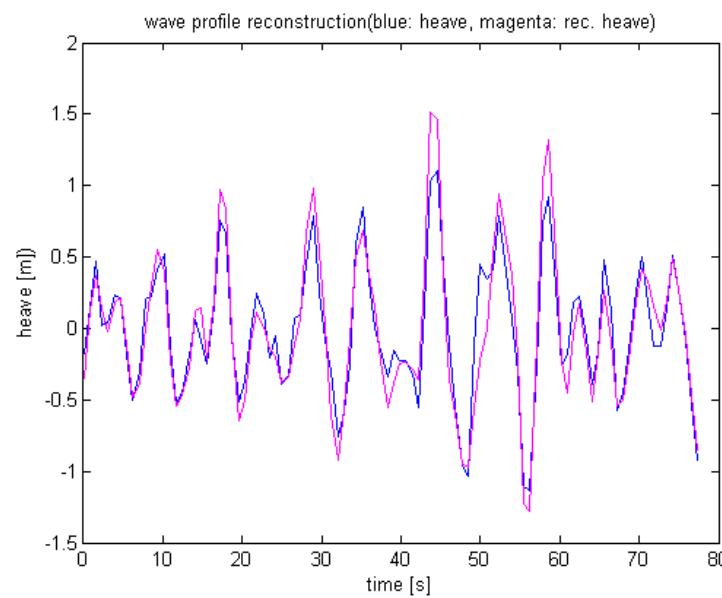
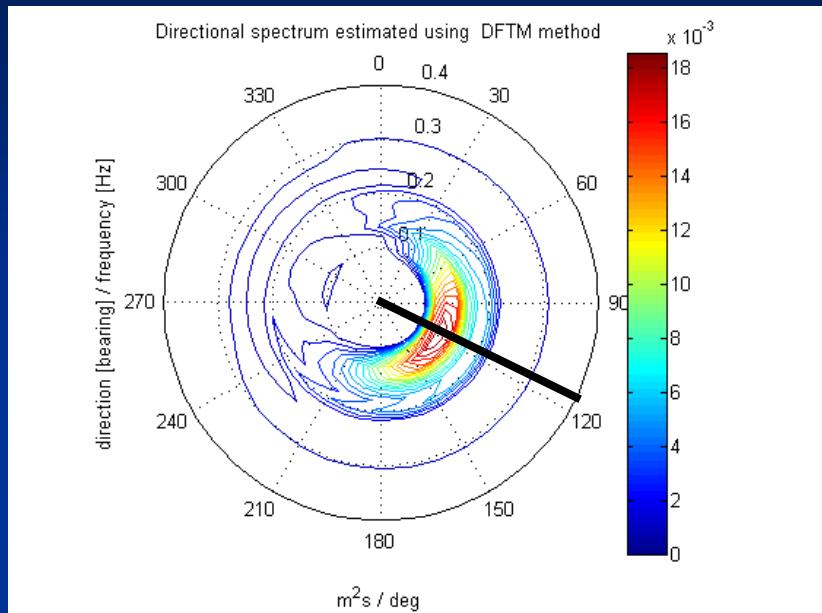


Comparison to Buoy Data

Significant Wave Height

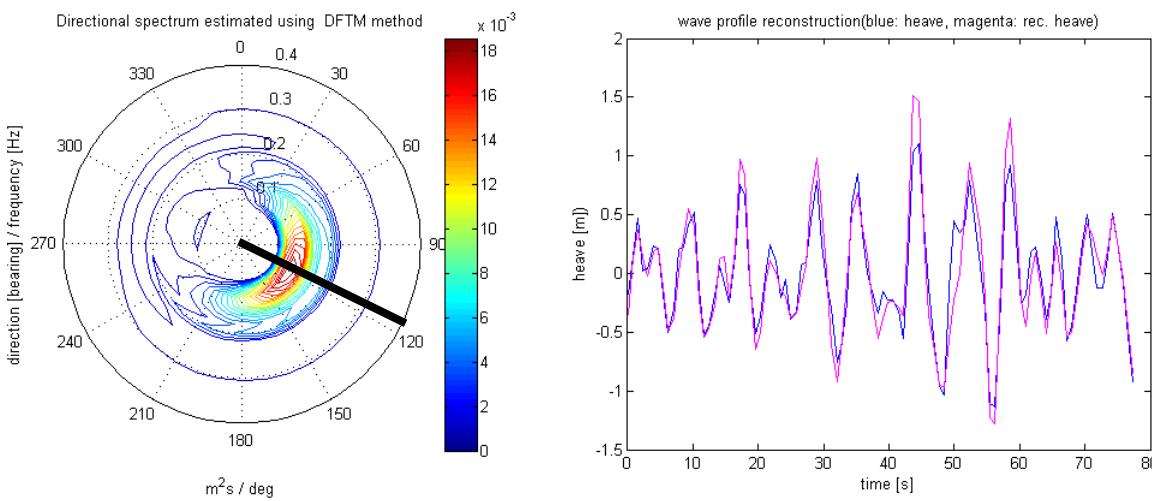


Application of Radar Methodology to Buoy Data (at Fino-3)

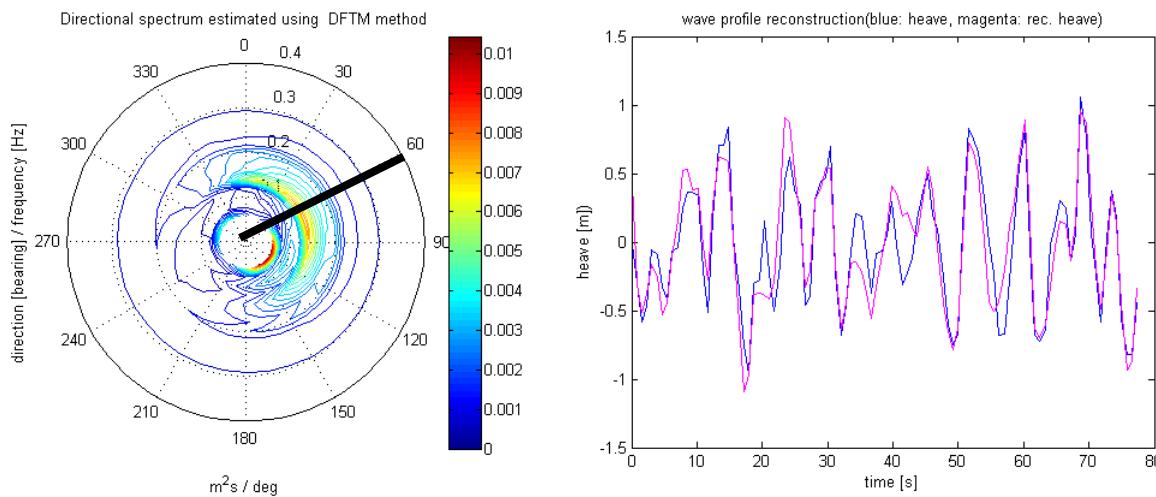


Outlook: Multi-modal Seas

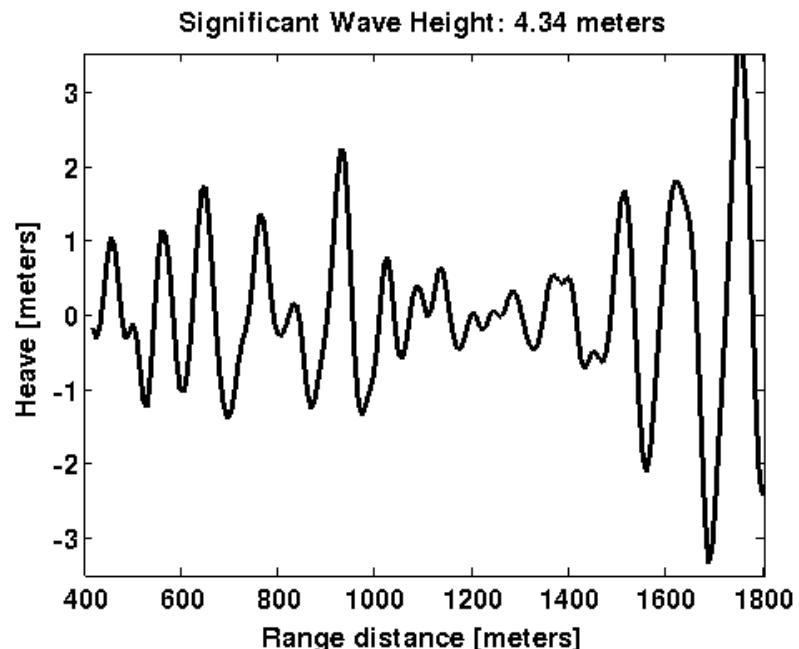
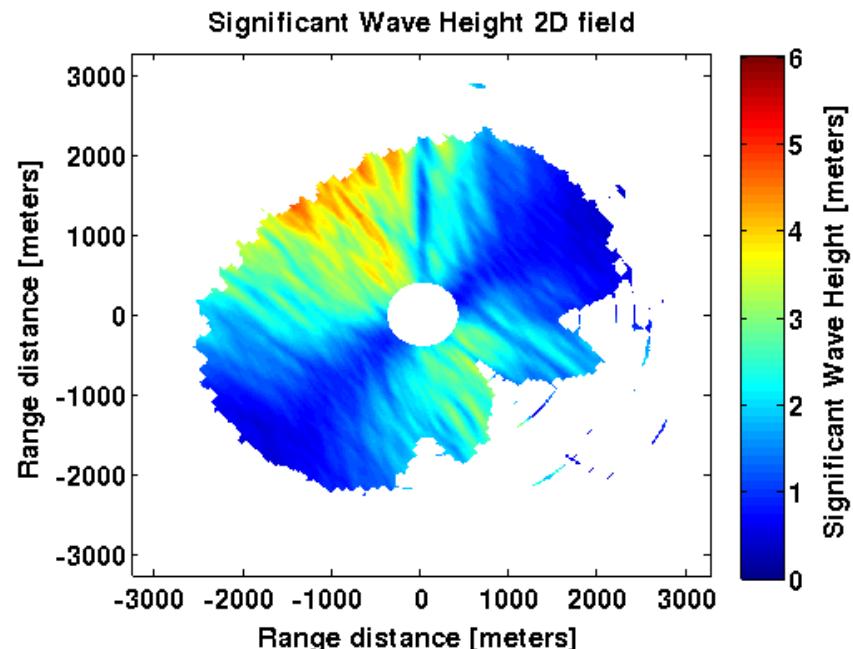
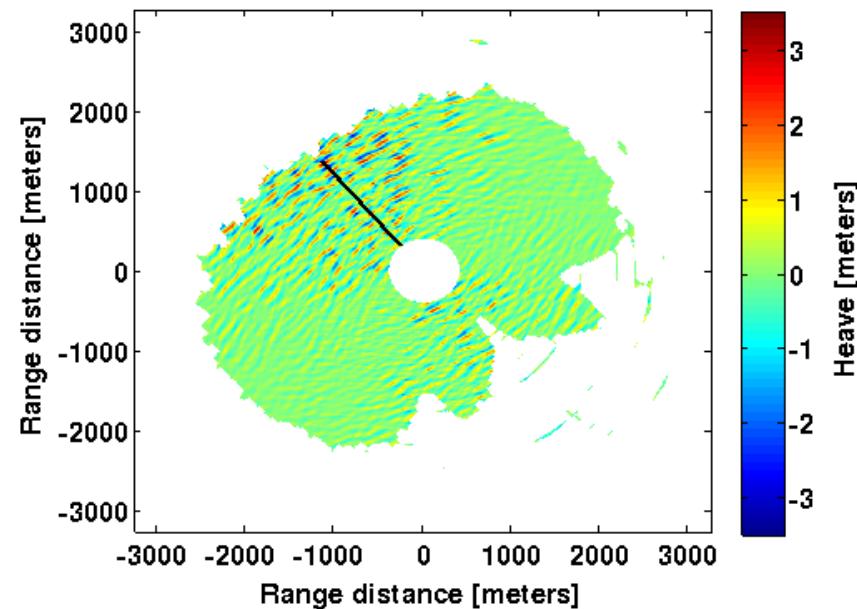
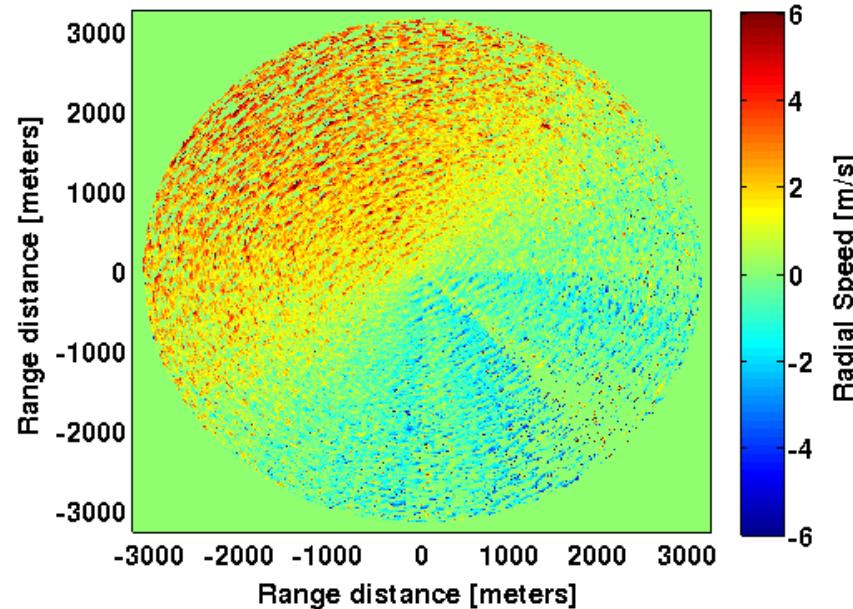
Uni-modal Seas



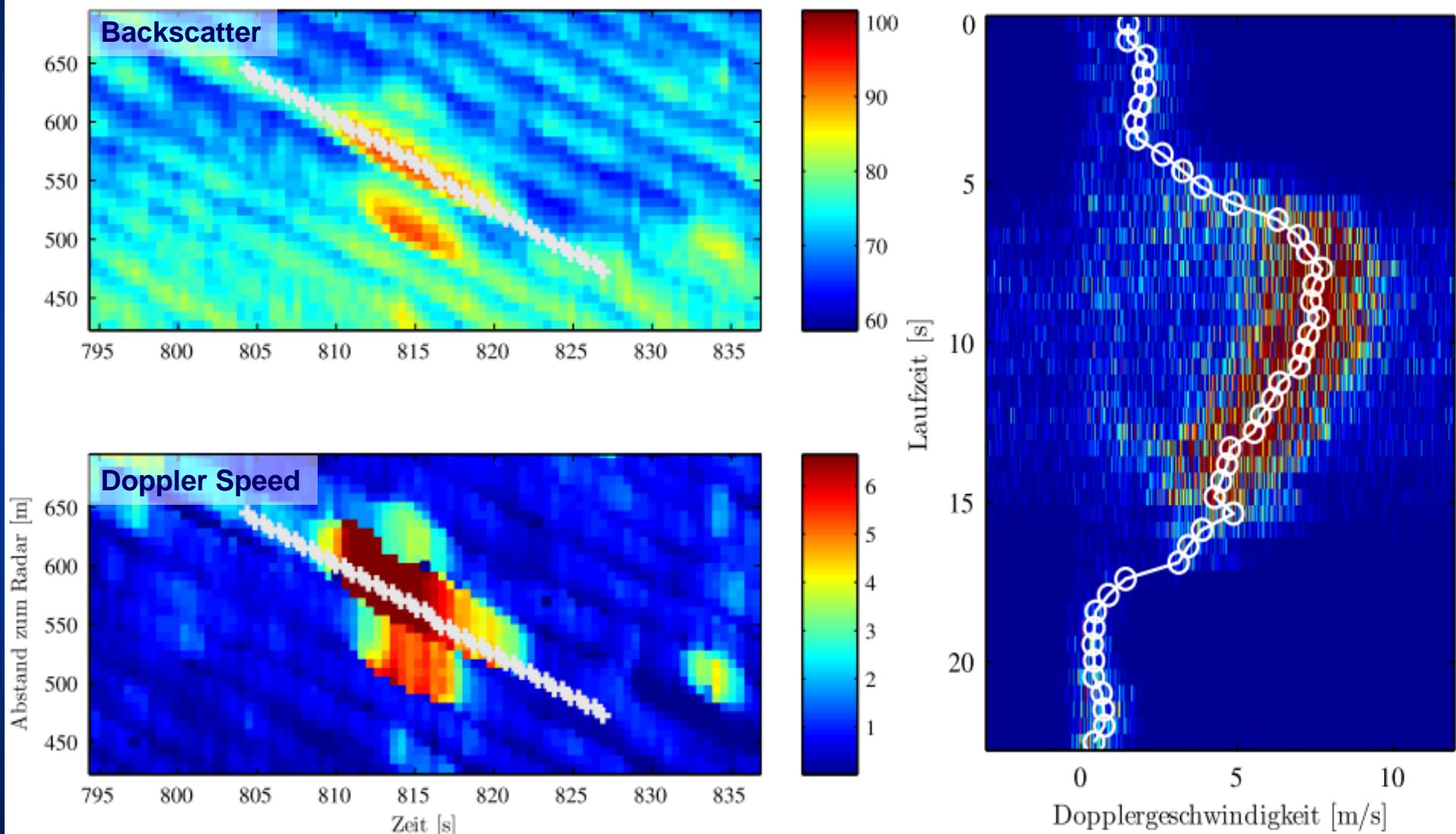
Multi-modal Seas



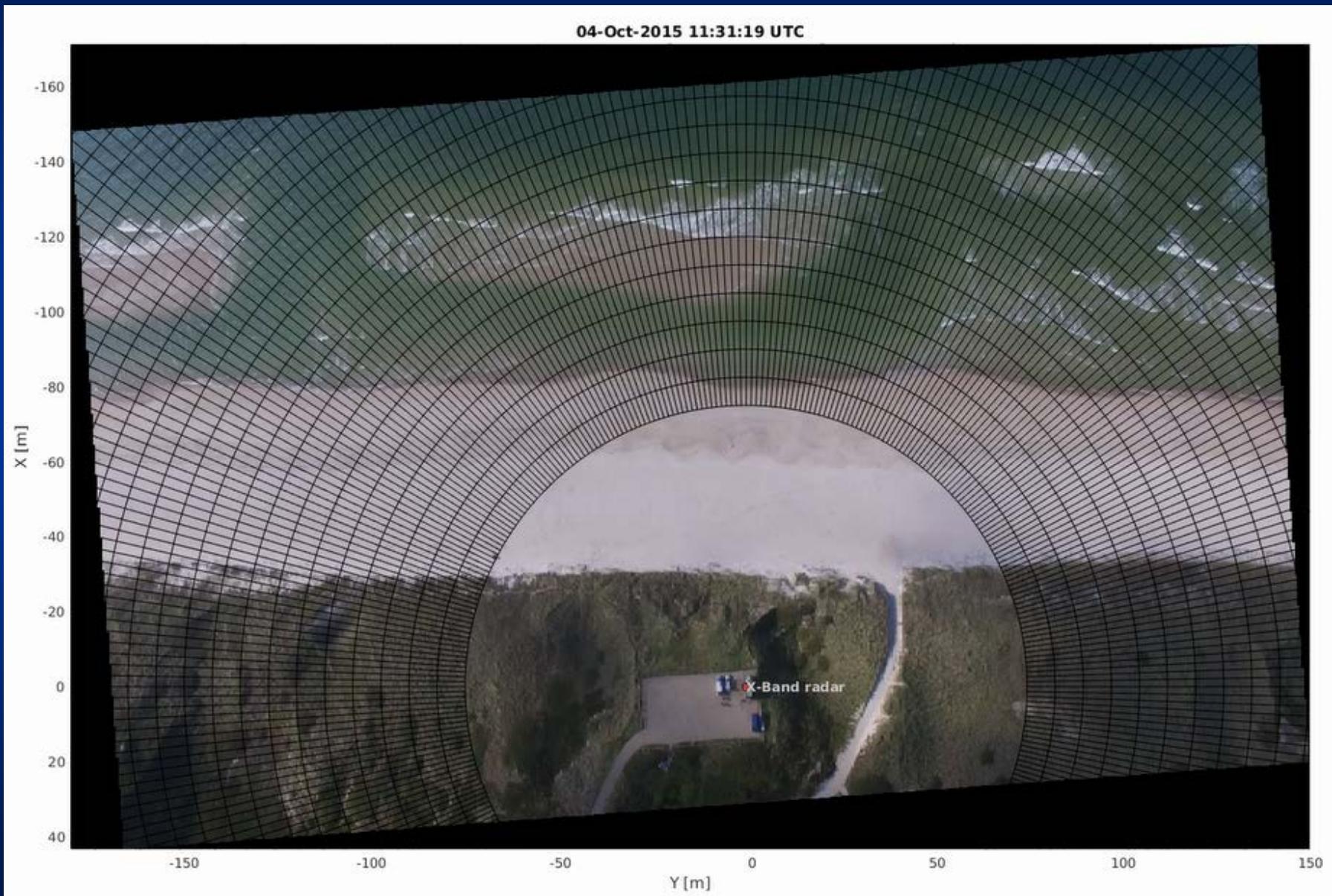
Outlook: 3D Doppler Speeds



Outlook: Wave Breaking and Wave Dissipation

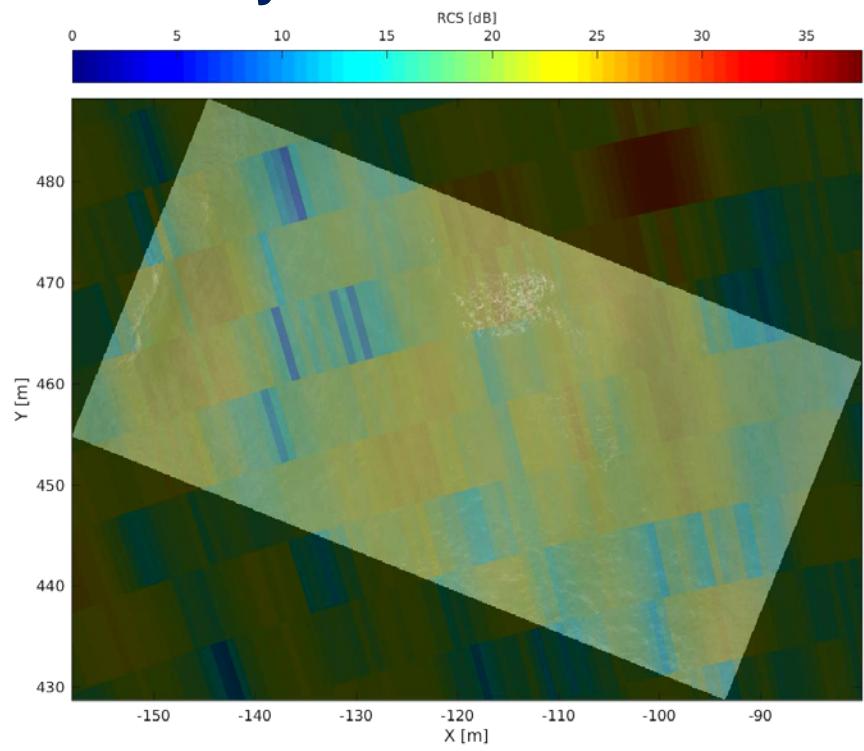


Outlook: Wave Breaking and Wave Dissipation

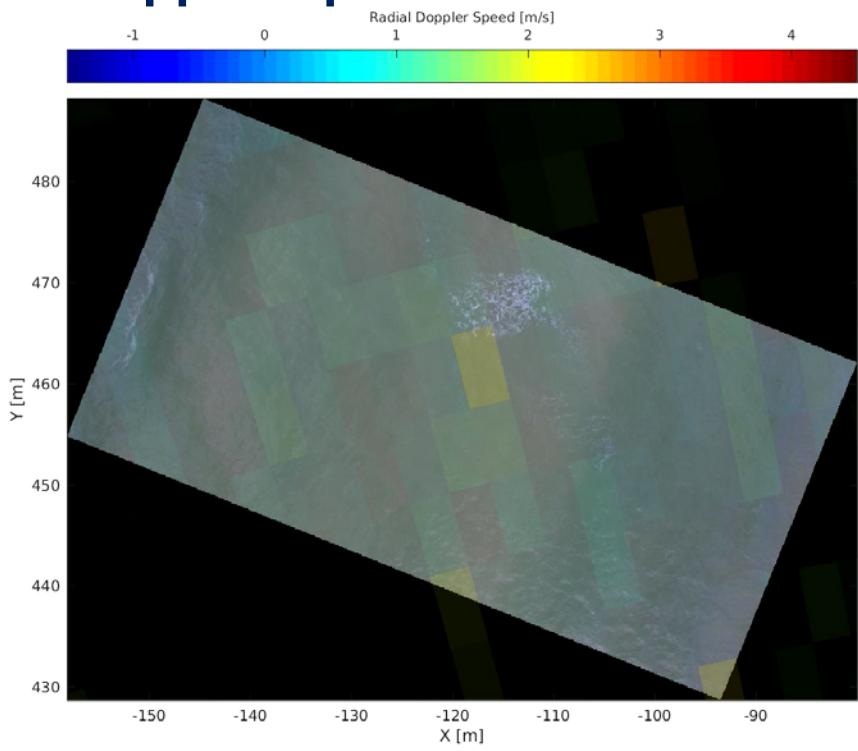


Outlook: Wave Breaking and Wave Dissipation

Intensity



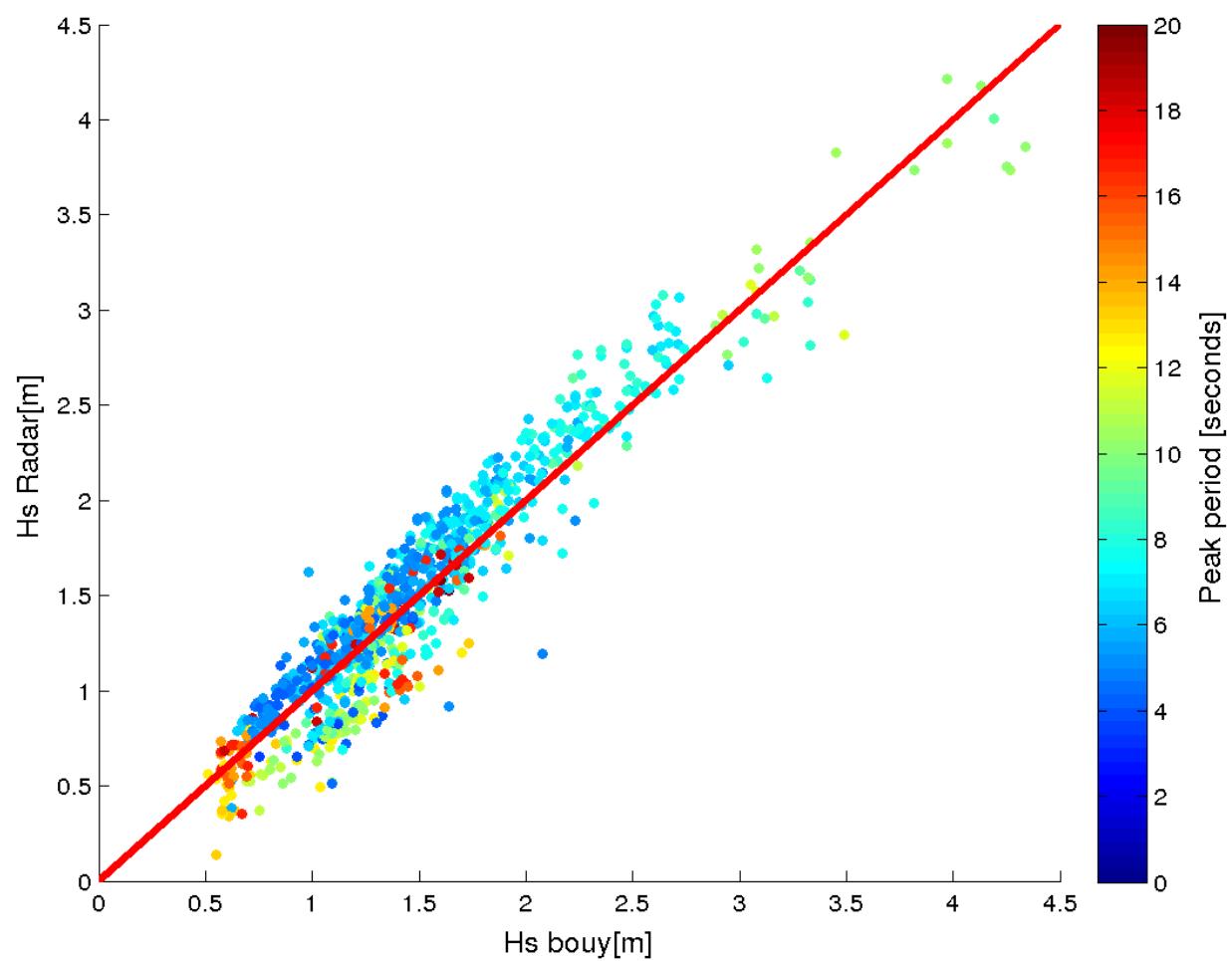
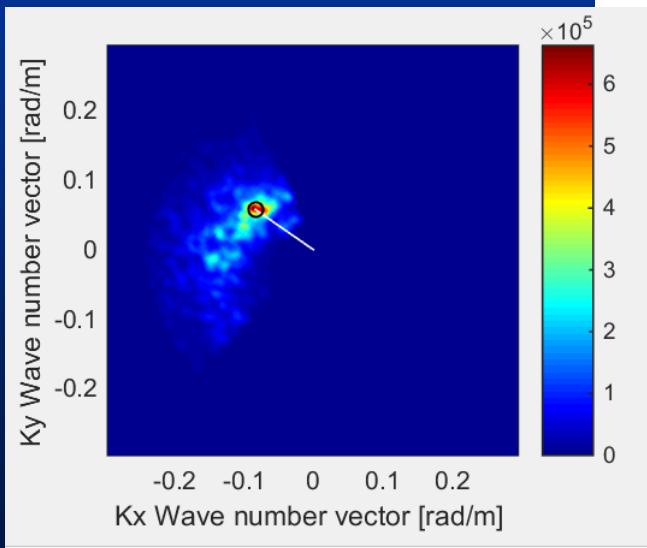
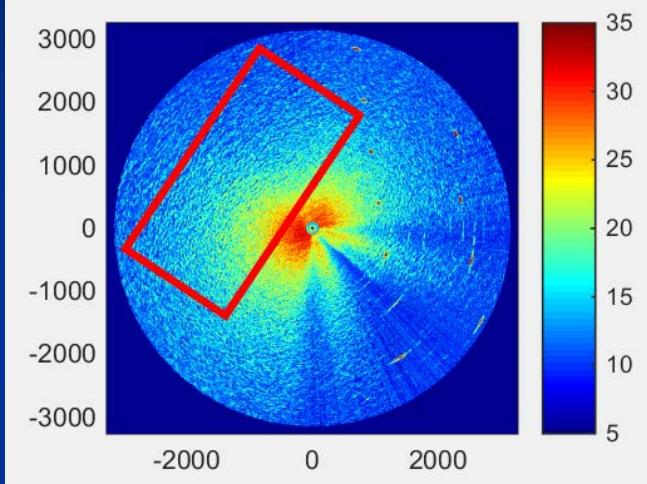
Doppler Speed



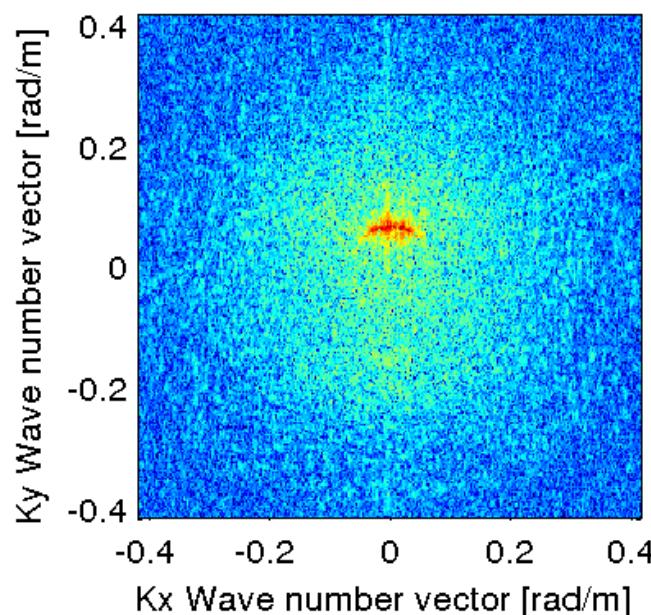
video: 04-Oct-2015 13:23:39 UTC
radar: 04-Oct-2015 13:23:37 UTC



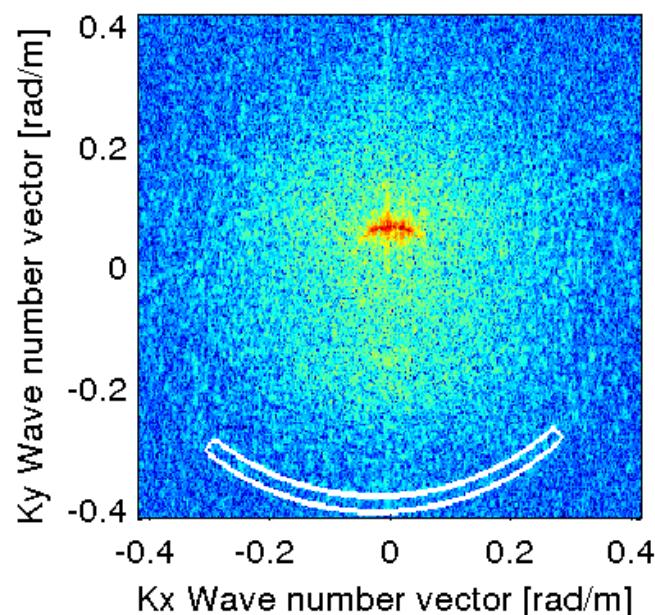
Estimation of Significant Waveheight from the Doppler



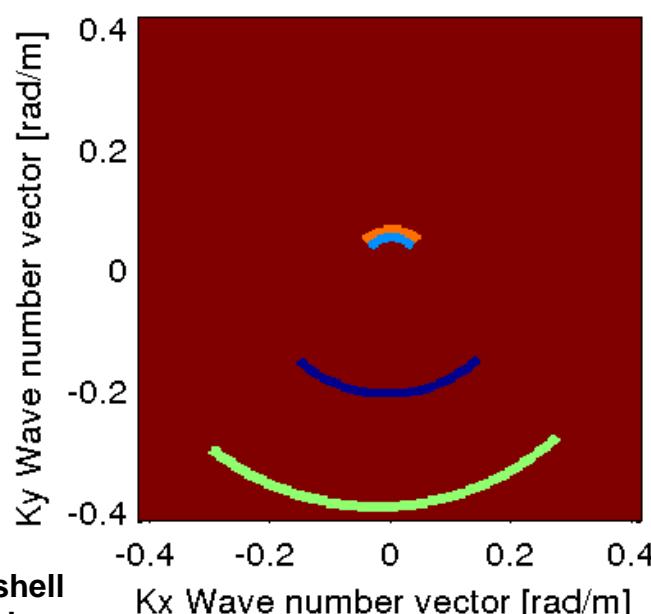
RAW Spectra



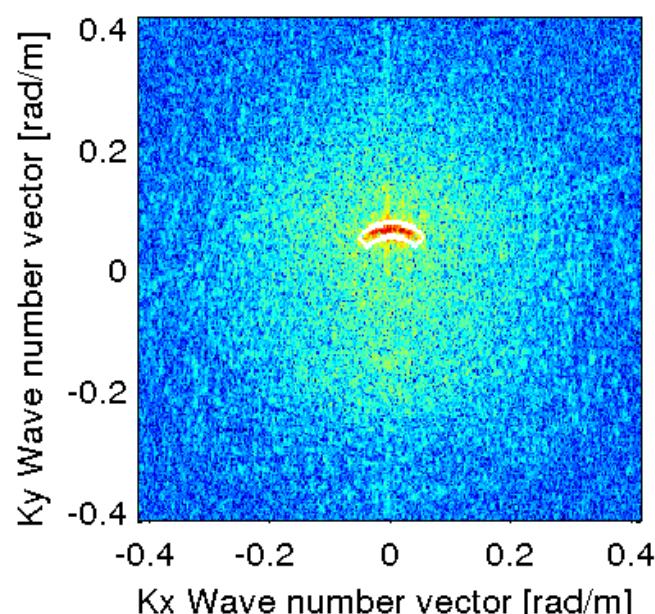
Aliasing



Dispersion Rel. masks

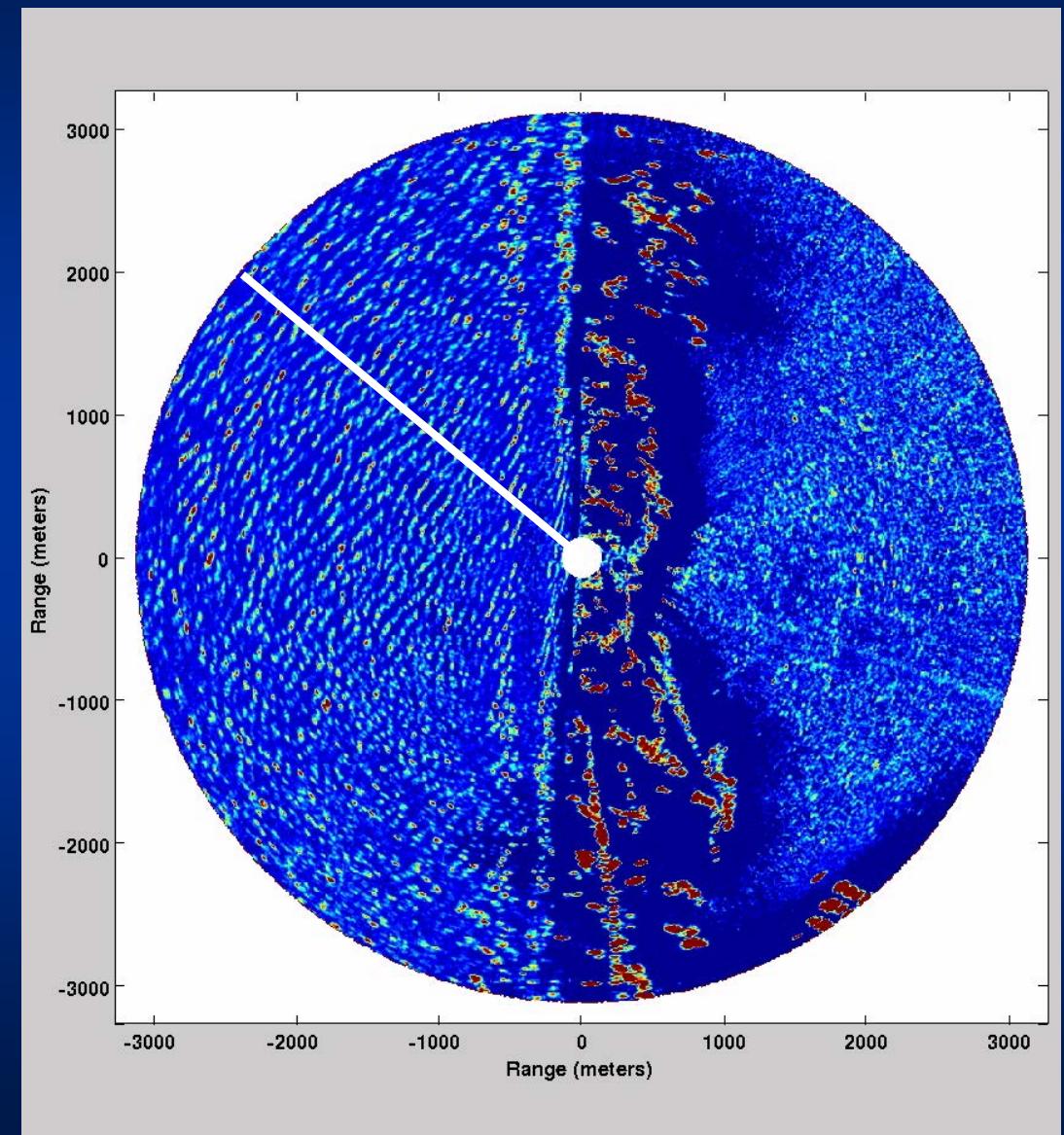


Dispersion Relation



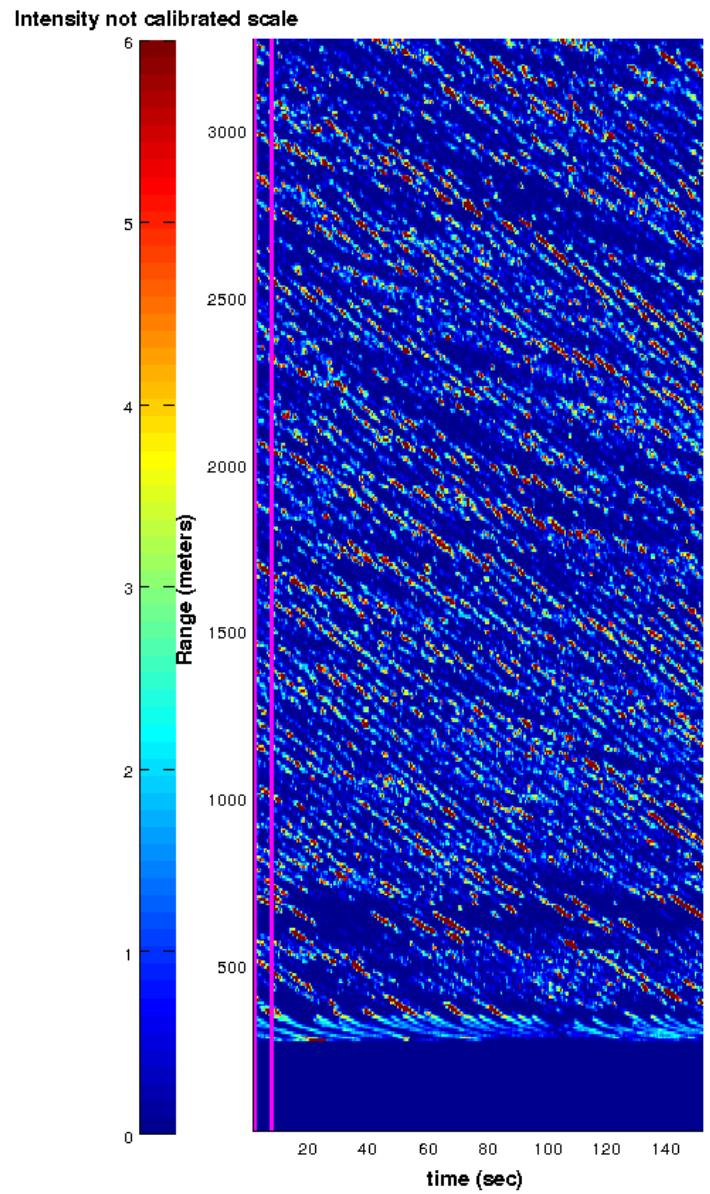
- dispersion shell
- first harmonic
- aliased dispersion shell
- aliased first harmonic

Polarization Measurements Collected at Bunkerhill (HH/VV)

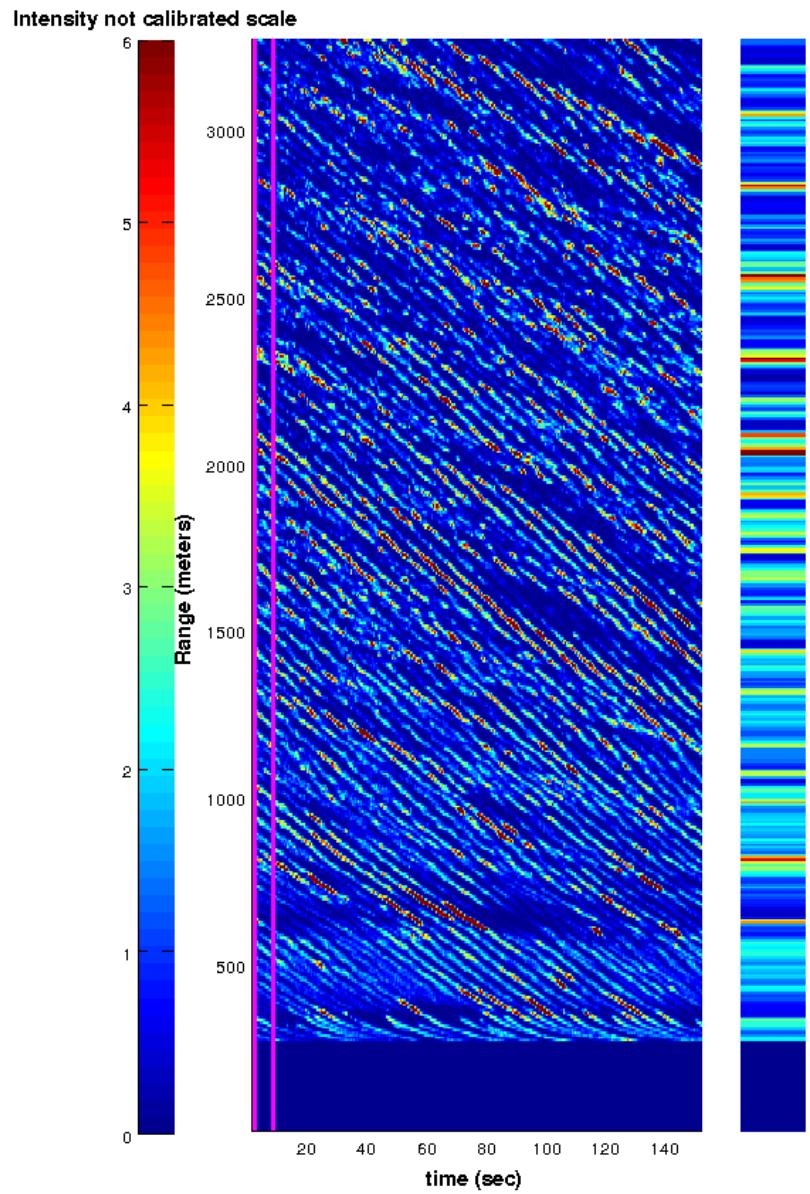


Investigation of Polarization Intensity

HH-polarization at 16 m/s 18:00 UTC

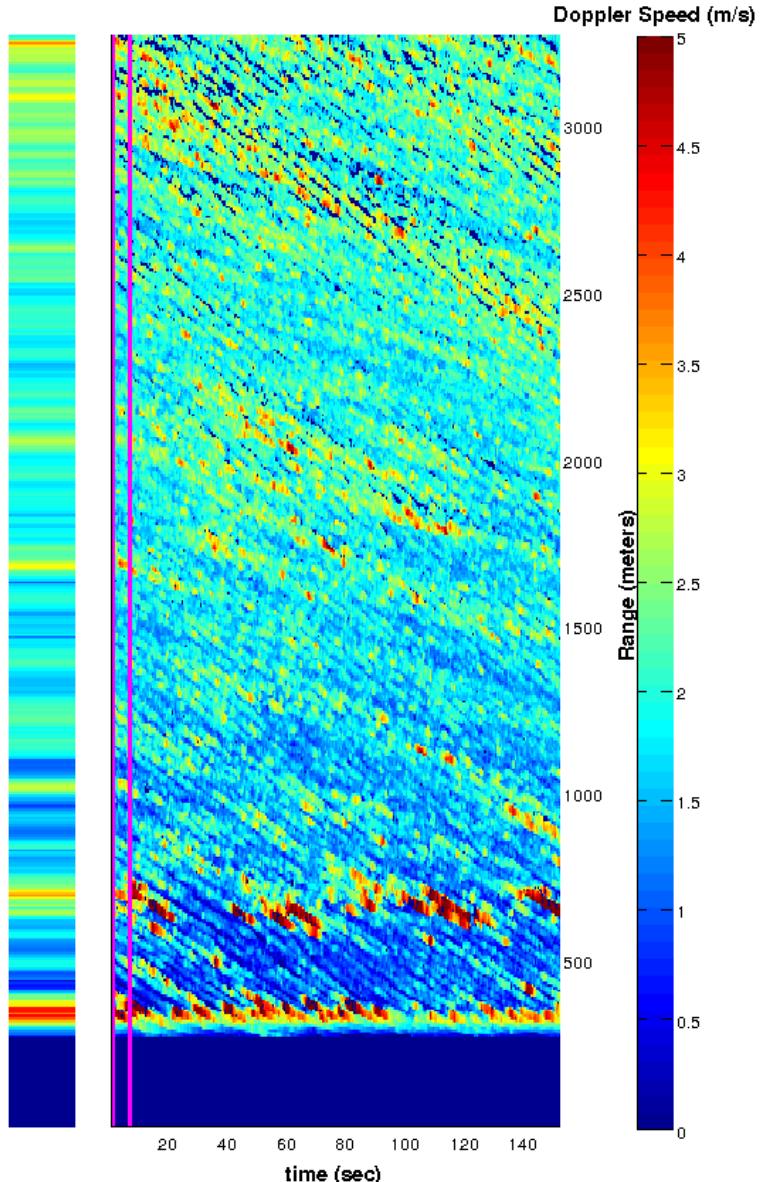


VV-polarization at 16 m/s 19:00 UTC

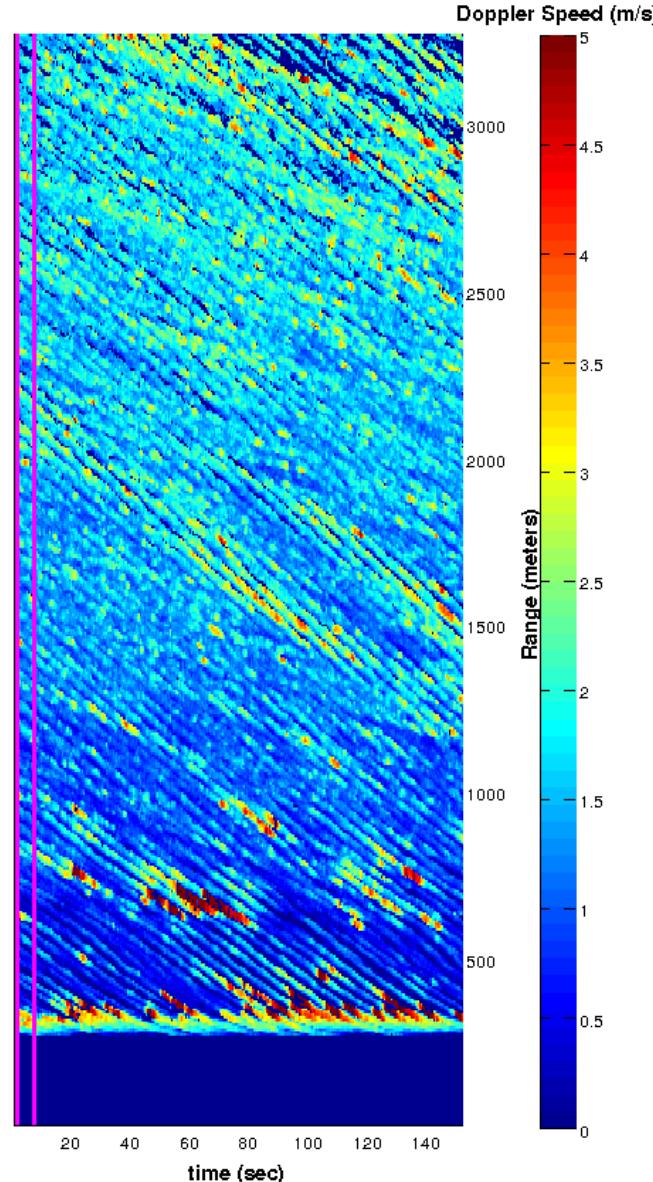


Investigation of Polarization Doppler Speed

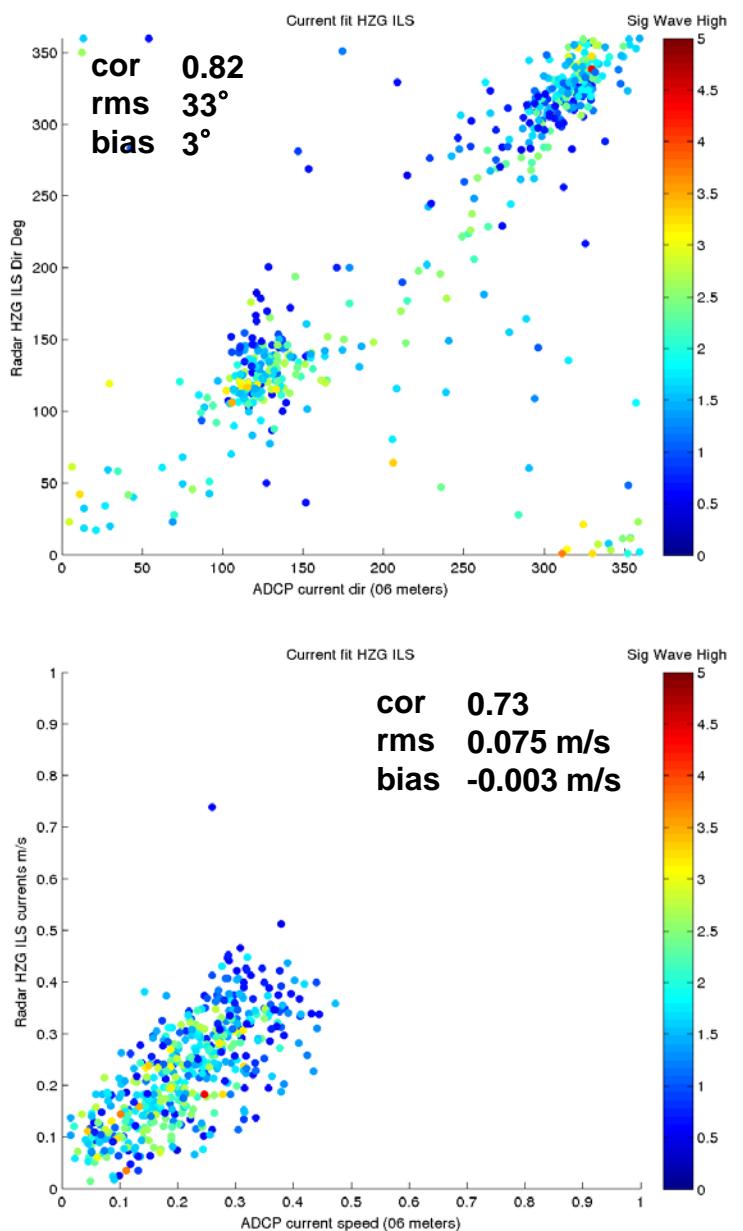
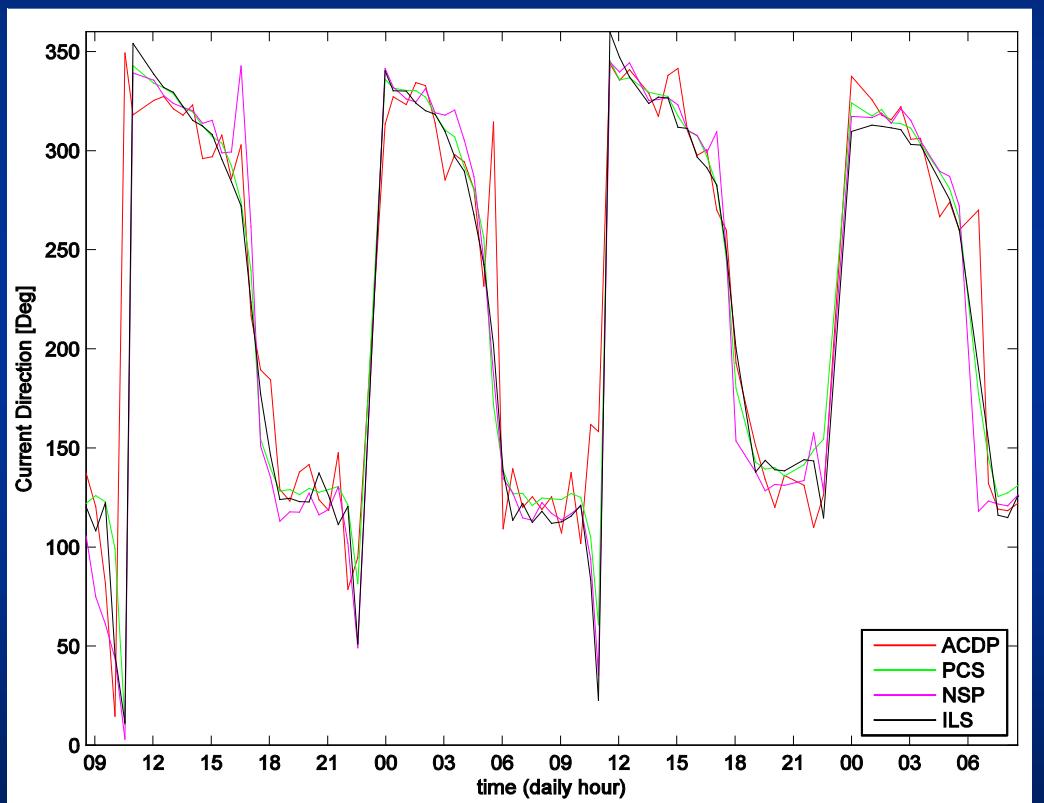
HH-polarization at 16 m/s 18:00 UTC



VV-polarization at 16 m/s 19:00 UTC



Validation of the ILS Current Retrieval Method

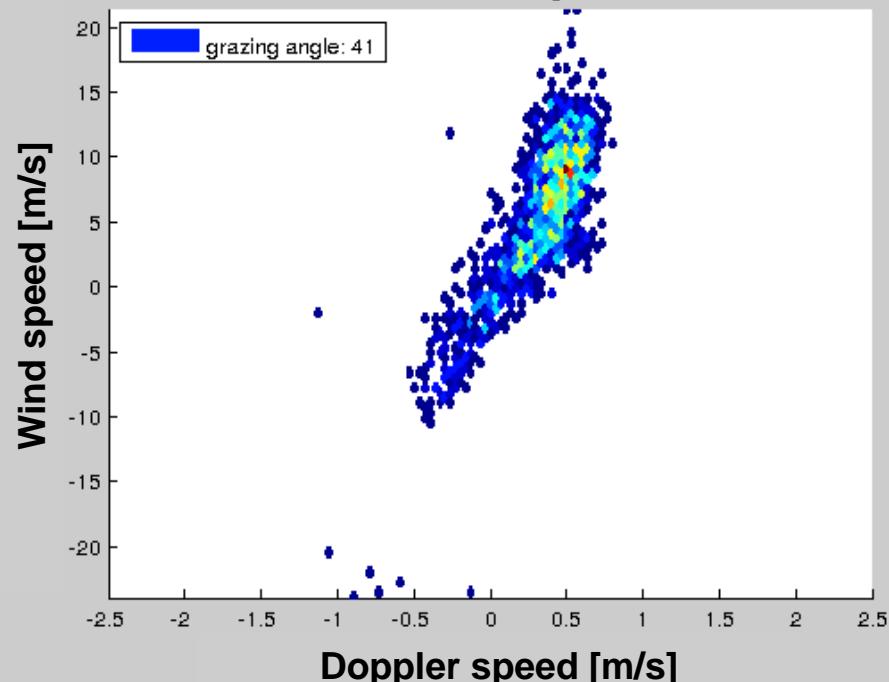
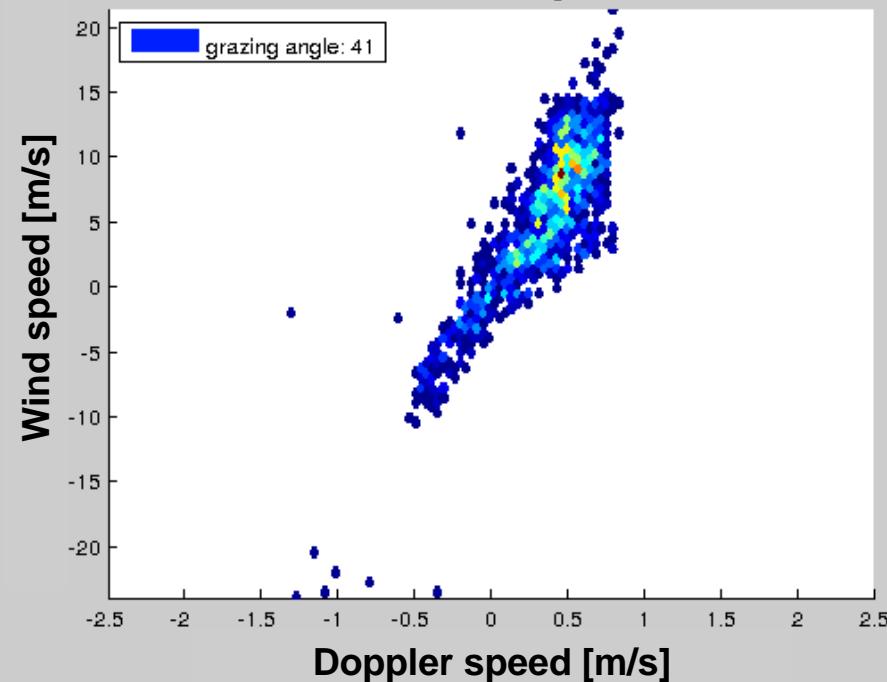


Doppler Speed Dependency on Wind Speed and Incidence Angle

wind speed component in radar look direction

uncorrected

corrected for currents



04-Oct-2015 11:31:19 UTC

