WAVEMILL PROOF-OF-CONCEPT

DATA ANALYSIS NEAR MERSEY BAR LIGHT

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NATURAL ENVIRONMENT RESEARCH COUNCIL

SATOC

AIRBUS DEFENCE & SPACE

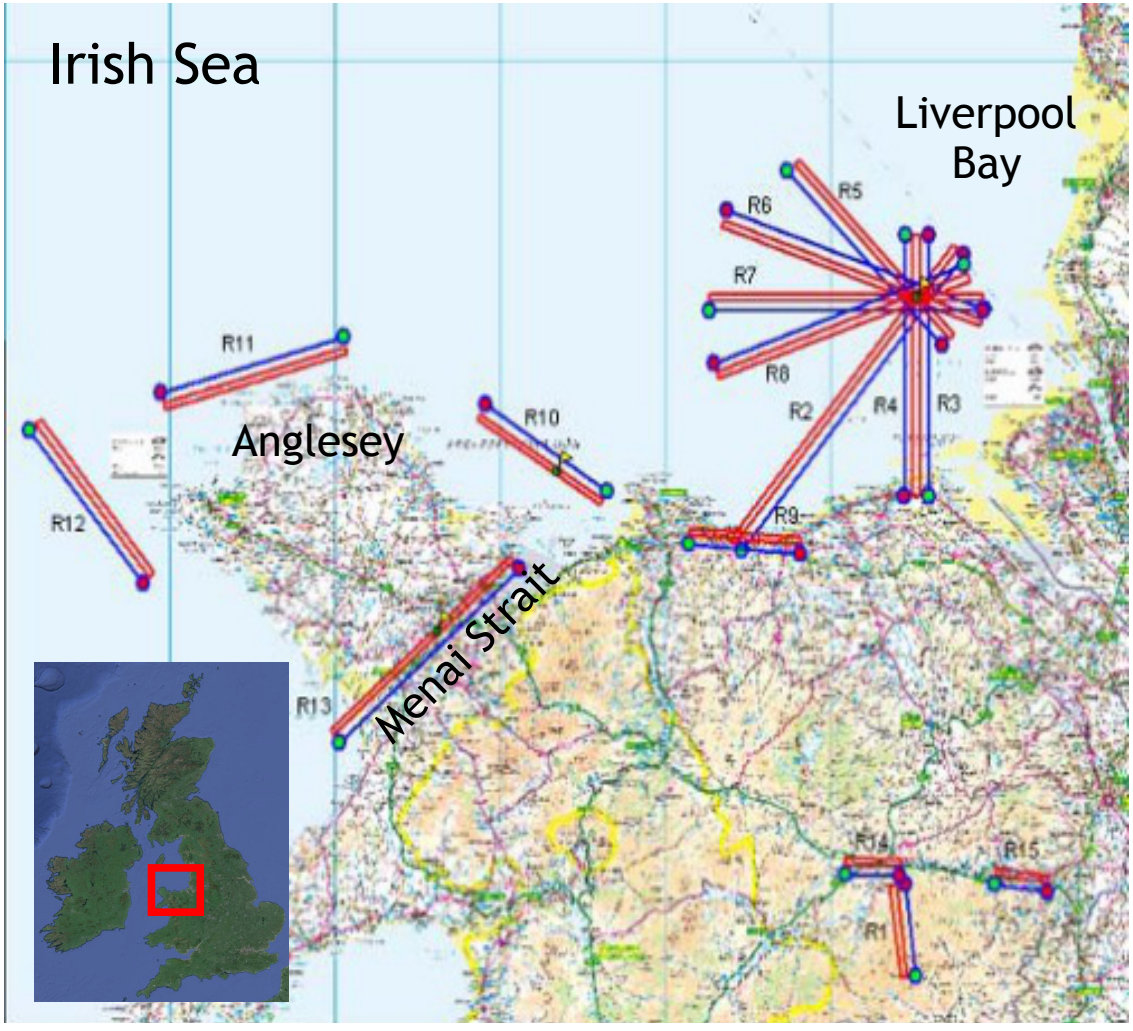
Ifremer

Starlab®
Living Science

Outlines

Outline

Area & Configuration



- October 26th, 2011
- Javelin Configuration

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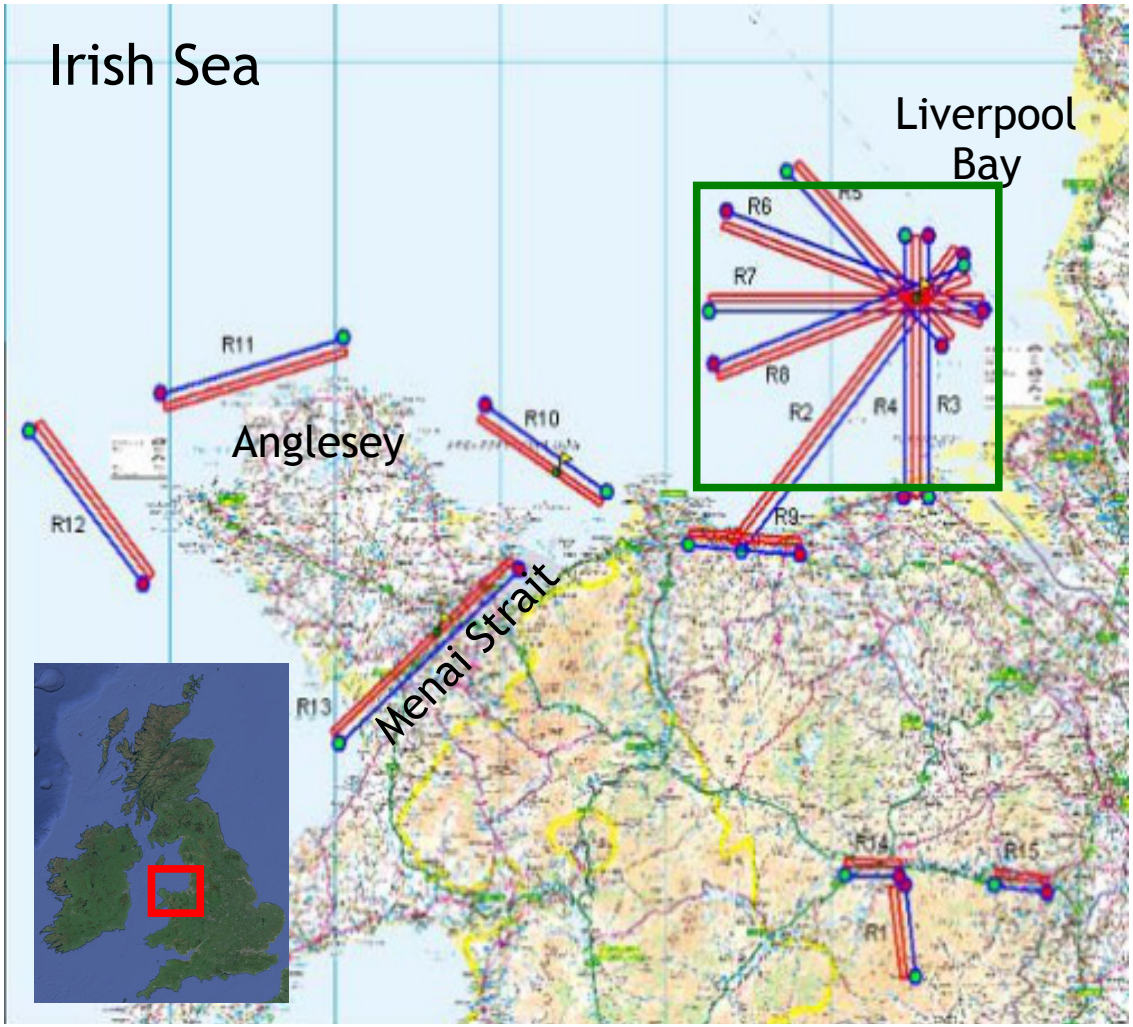

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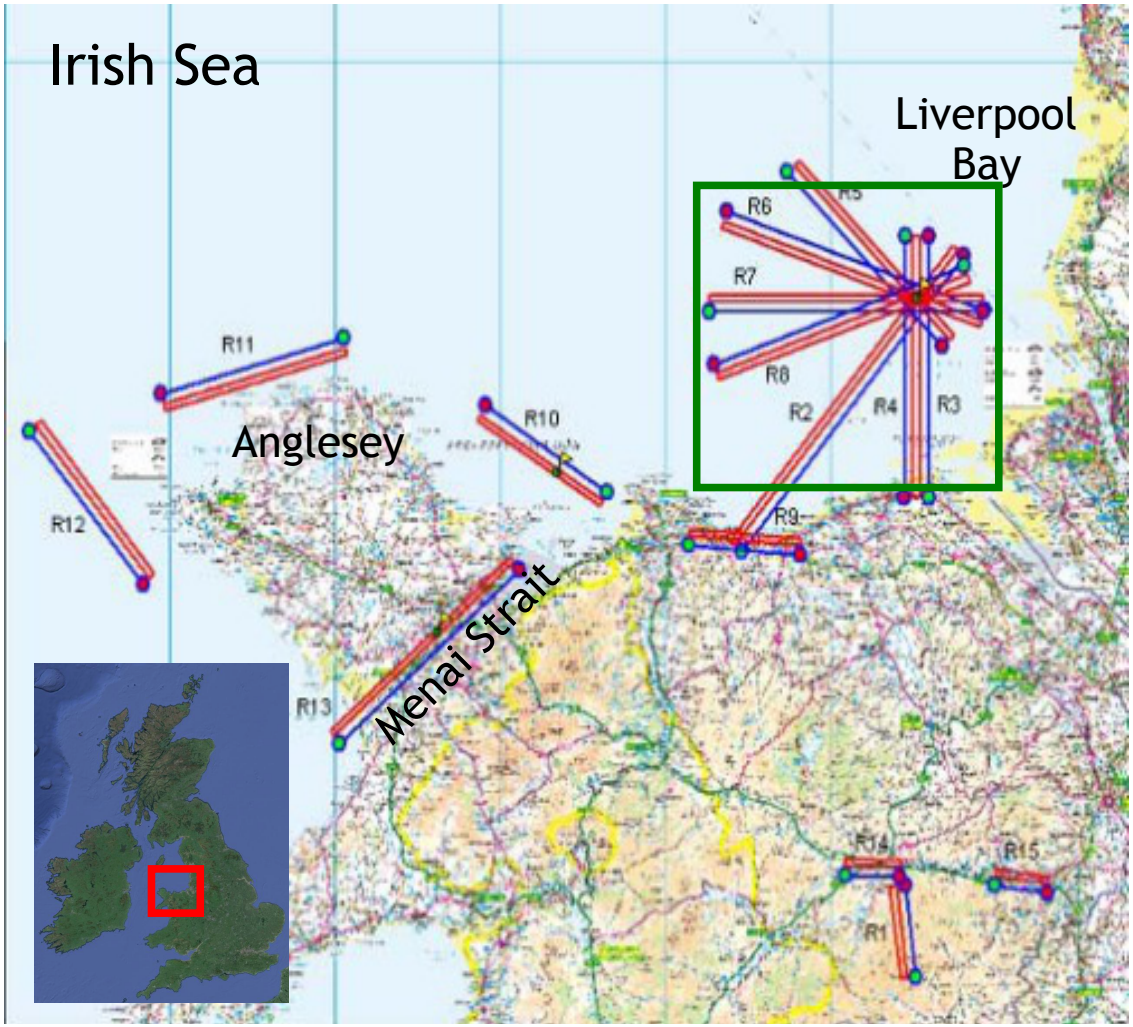
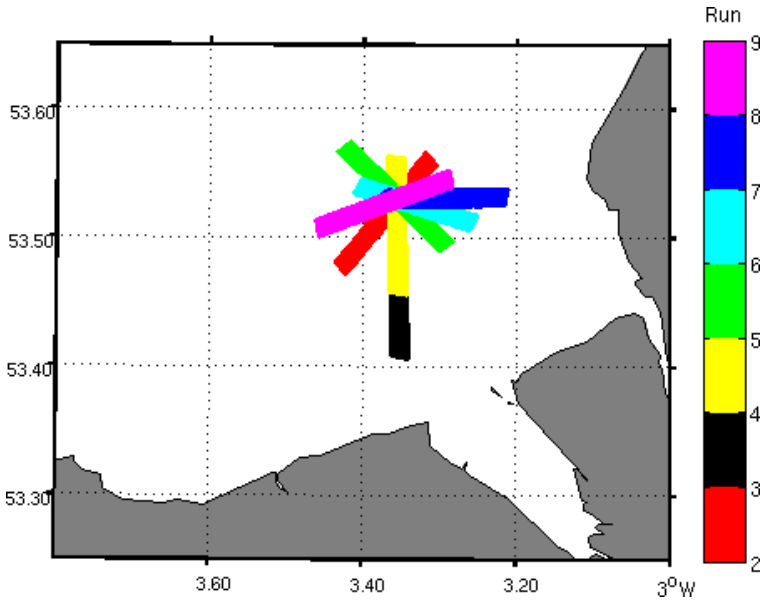
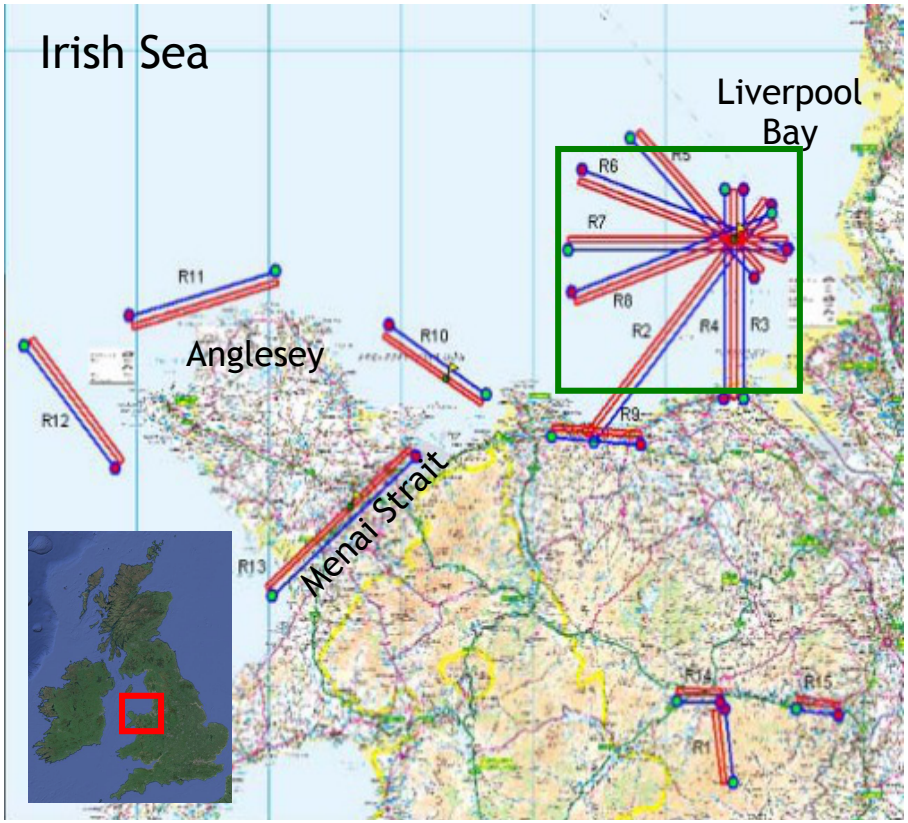




Geophysics Conditions

Geophysics Data

- ADCP at 2-4m
- HF radar (current & wind direction)
- Wave Spectrum up to 5m wavelength
- MetOffice Wind @1.5km;1h



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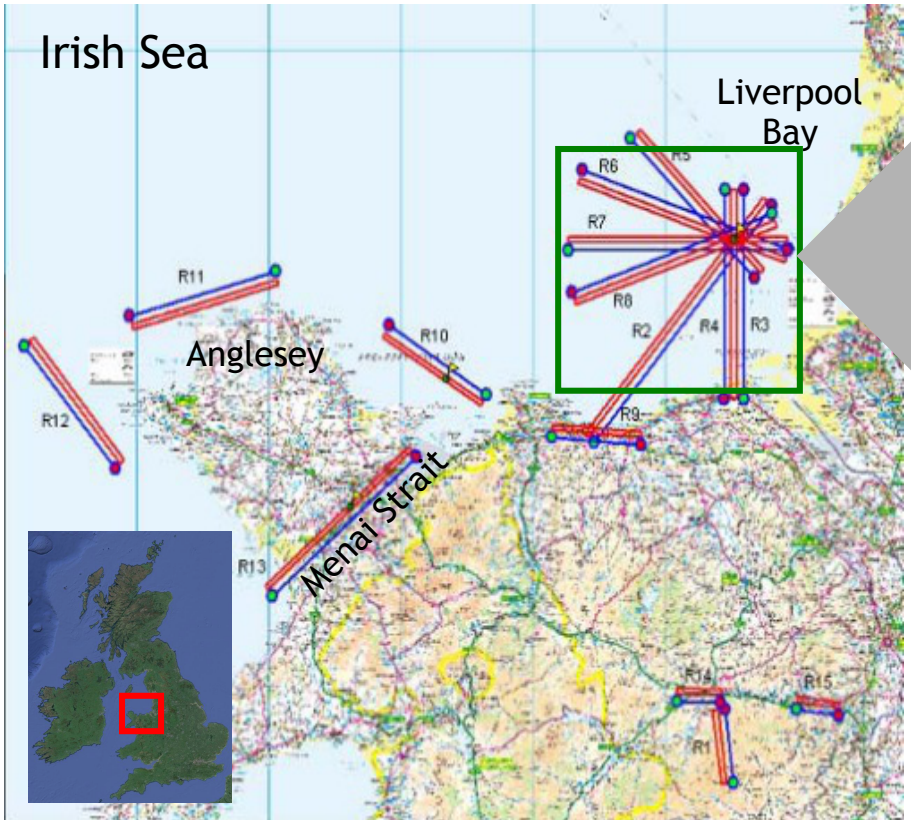

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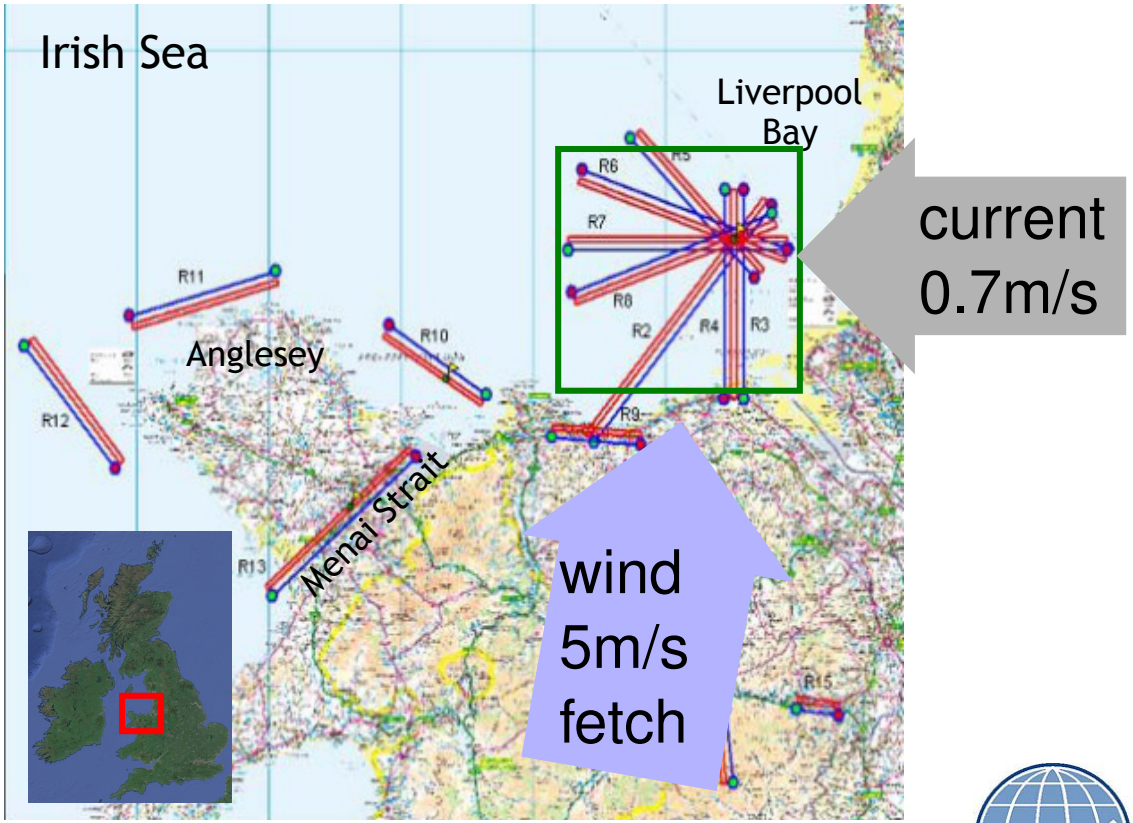

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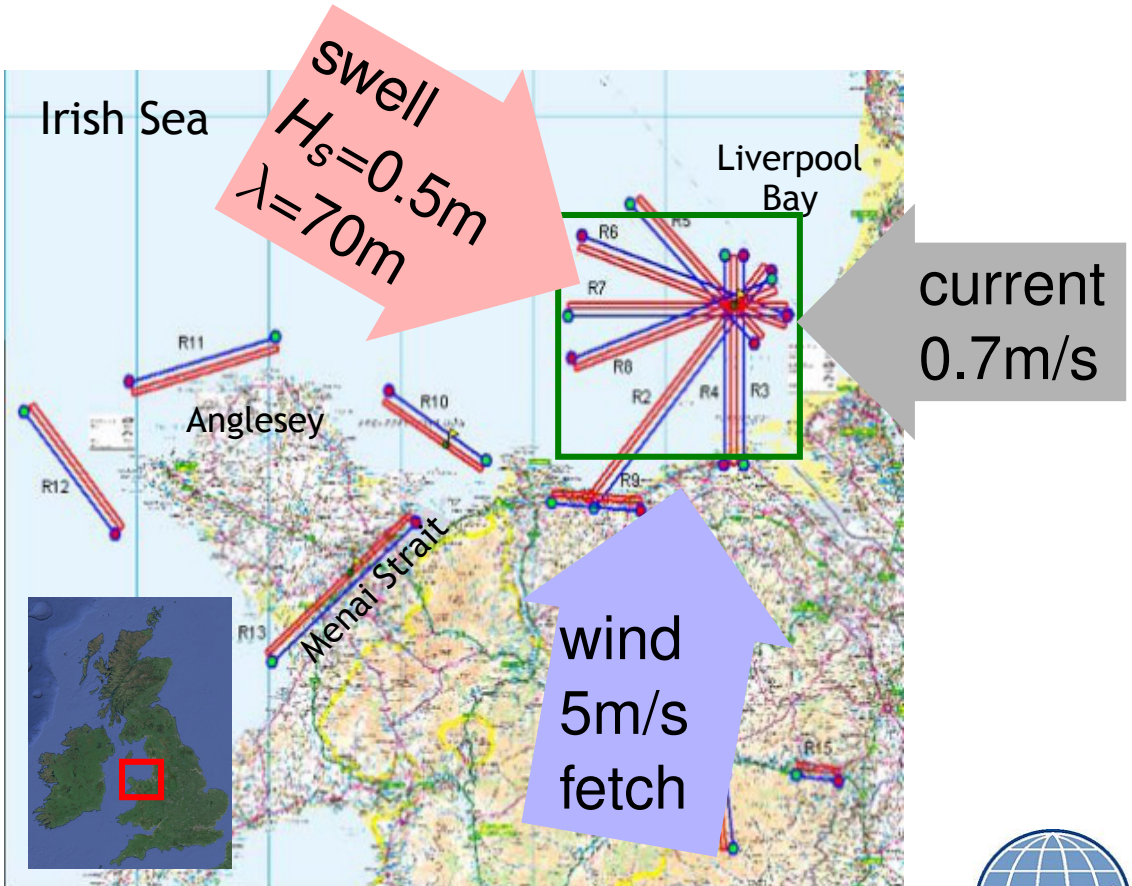
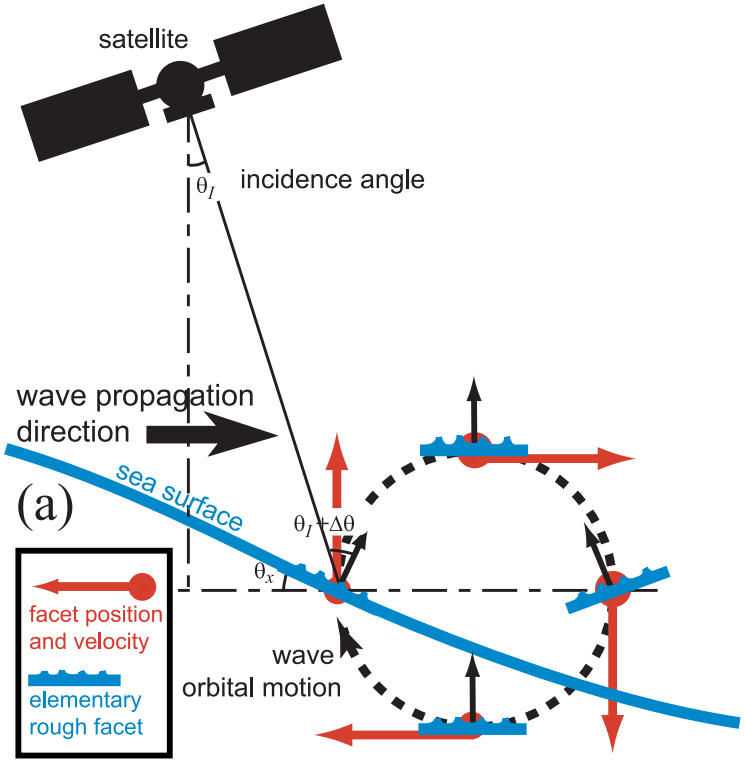


Outline

Wave Artefact Velocity



Chapron et al., 2005

$$T(\varphi,\theta) = \frac{G(\varphi,\theta)}{\tan\theta}\int_k k\omega S(\vec{k})d\vec{k}$$

Model input:

- G: Gain factor derieved from Geophysical Model Function of NRCS interpolated between CMOD5 and NSCAT for X-band
- S: Directional wave spectrum (buoy + KHCC)

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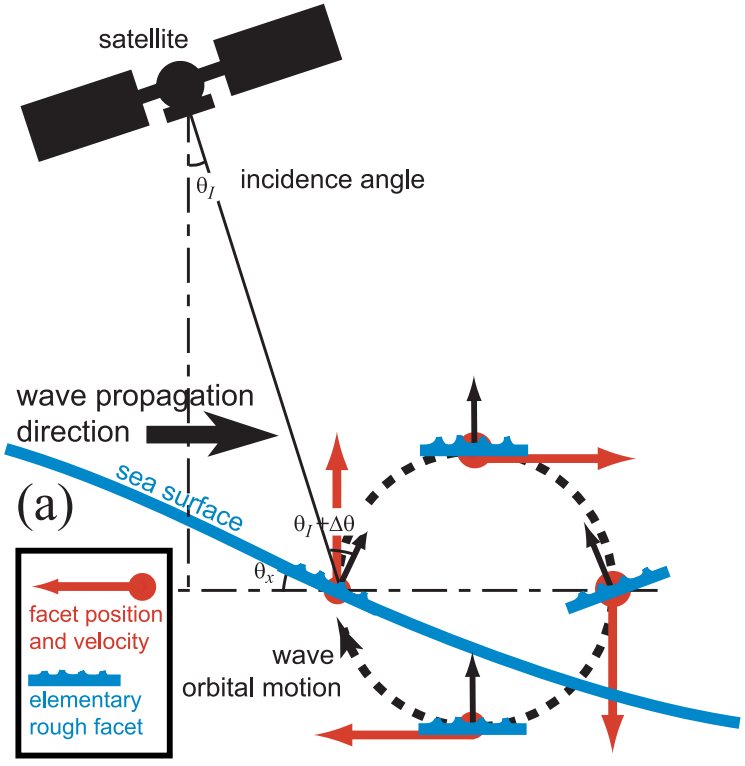

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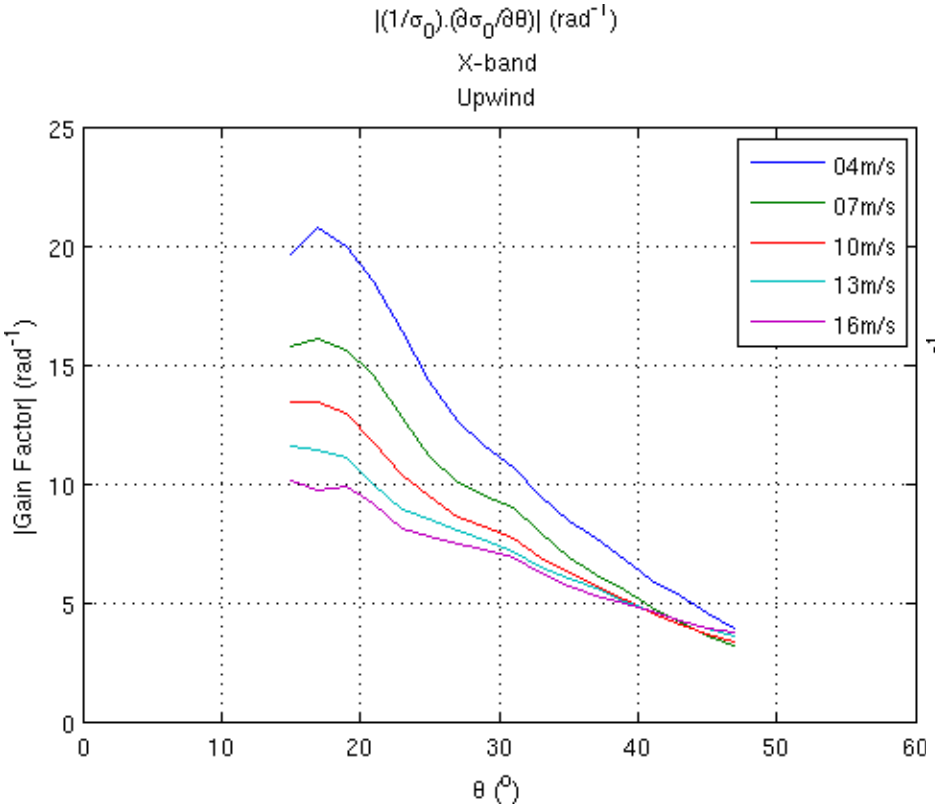
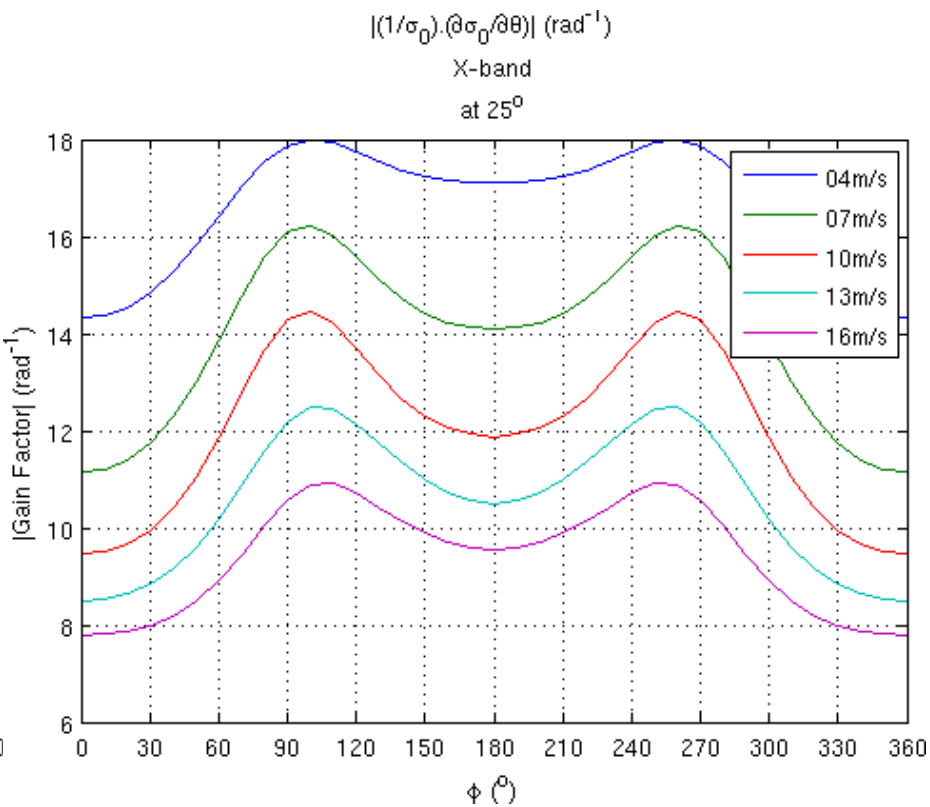
Wave Artefact Velocity — Gain Factor



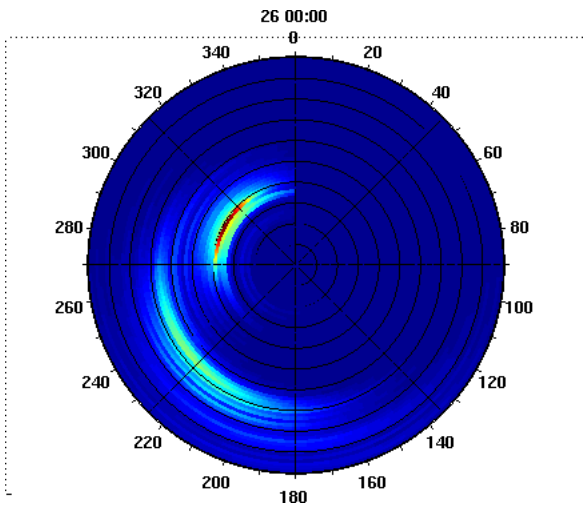


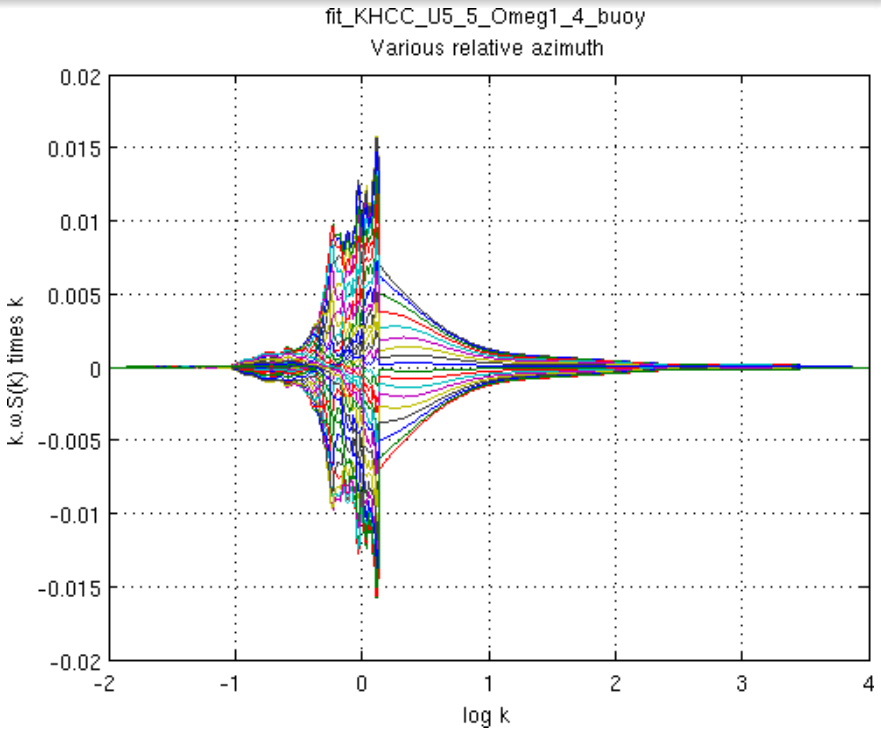
- $|G|$ decrease with incidence angle
- $|G|$ decrease with wind speed
- $|G|$ downwind $>$ upwind

Wave Artefact Velocity — Wave Spectrum

$$T(\varphi,\theta) = \frac{G(\varphi,\theta)}{\tan\theta}\int_k k\omega S(\vec{k})d\vec{k}$$

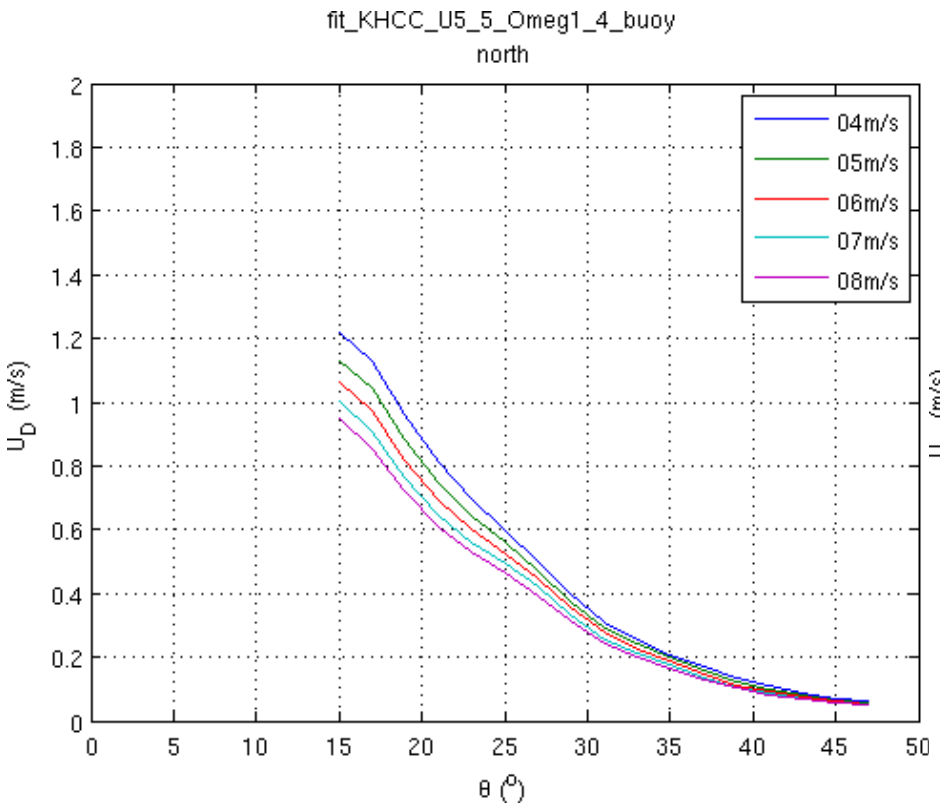
$$S(\vec{k}) = S(k,\varphi) - S(k,\varphi-\pi)$$

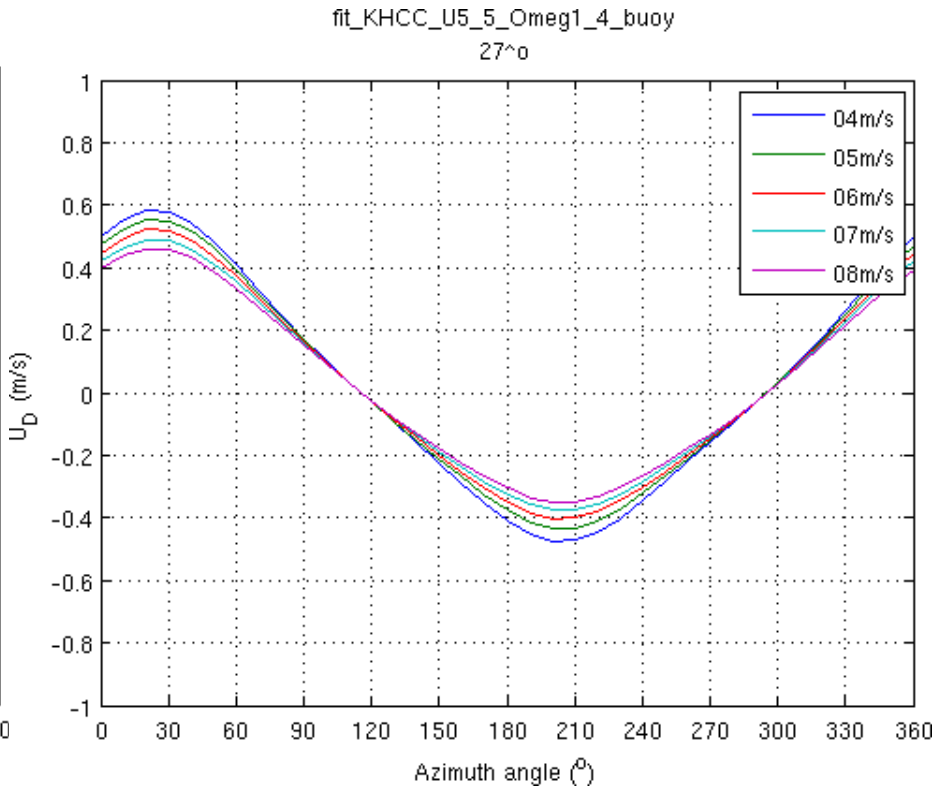




- Sensitivity maximum to wave around 10m of wavelength
- perfect symmetry of 180° of wave component

Wave Artefact Velocity — Model using Buoy



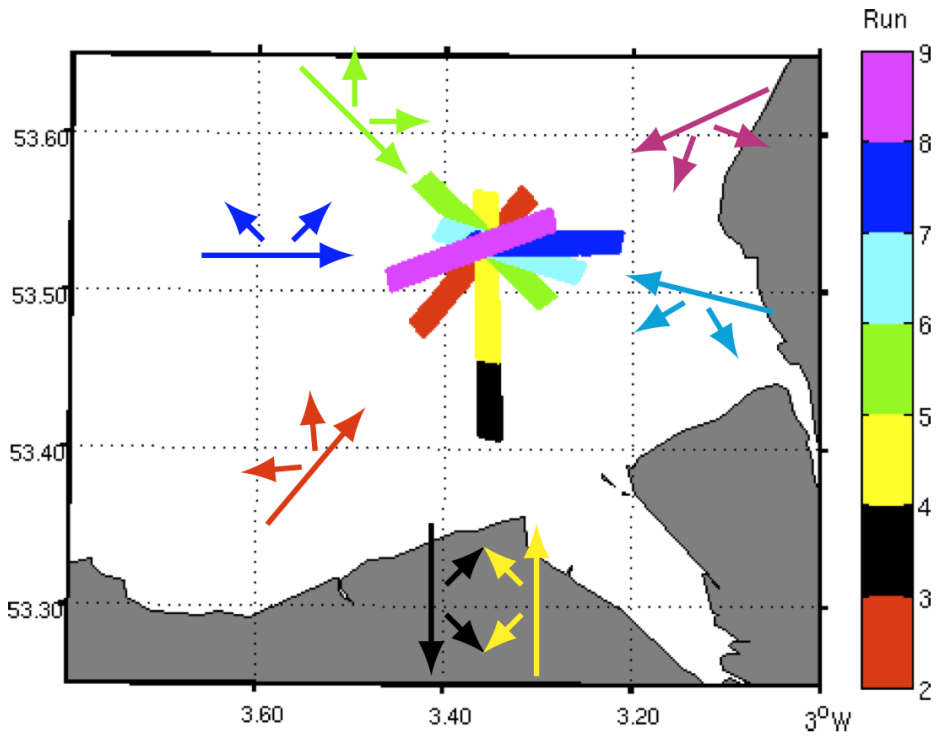


- Amplitude decrease with incidence angle
- Amplitude decrease slightly when wind speed increase
- Azimuthal signal dominated by up/downwind variation
- Downwind $>$ upwind magnitude opposite to observations
  - derived from Gain factor

Outline

Outline

Methods

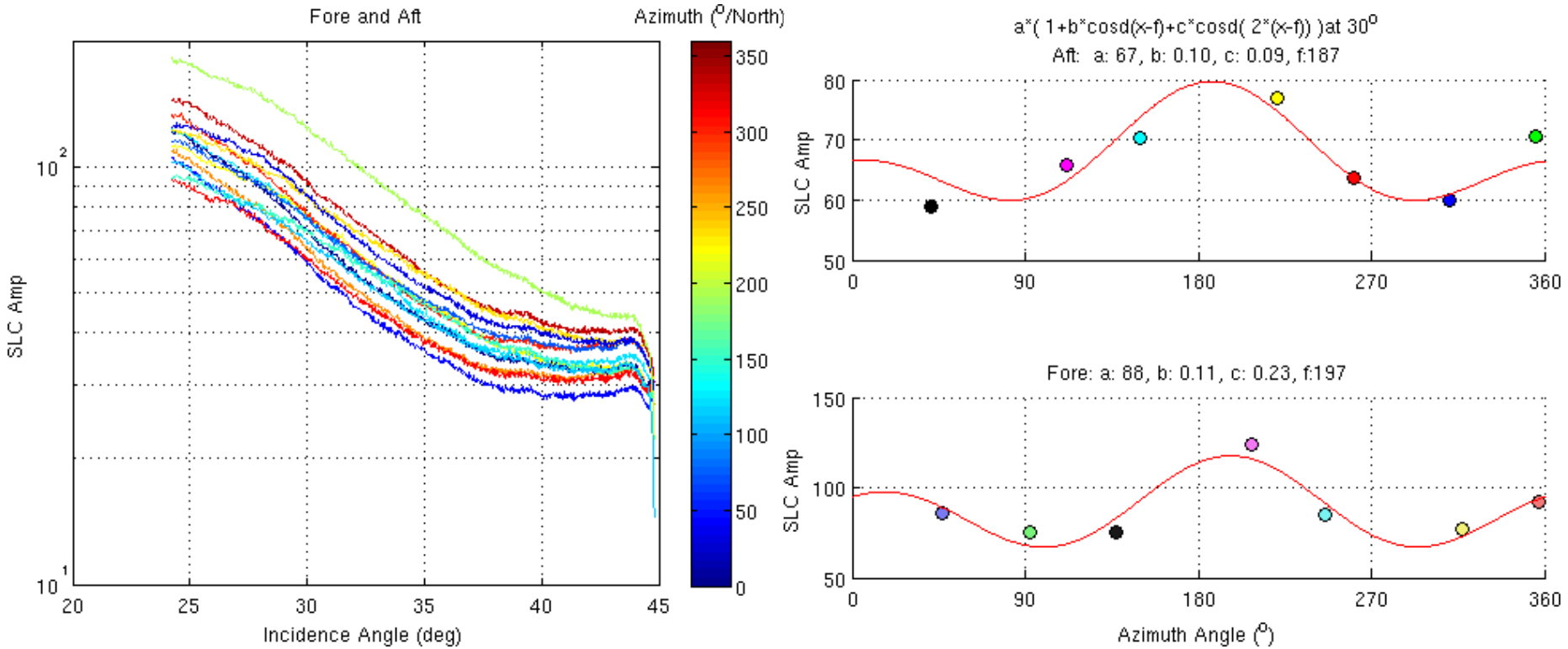


Hypothesis

- Homogeneous geophysic conditions
- No XT baseline component or topography effect

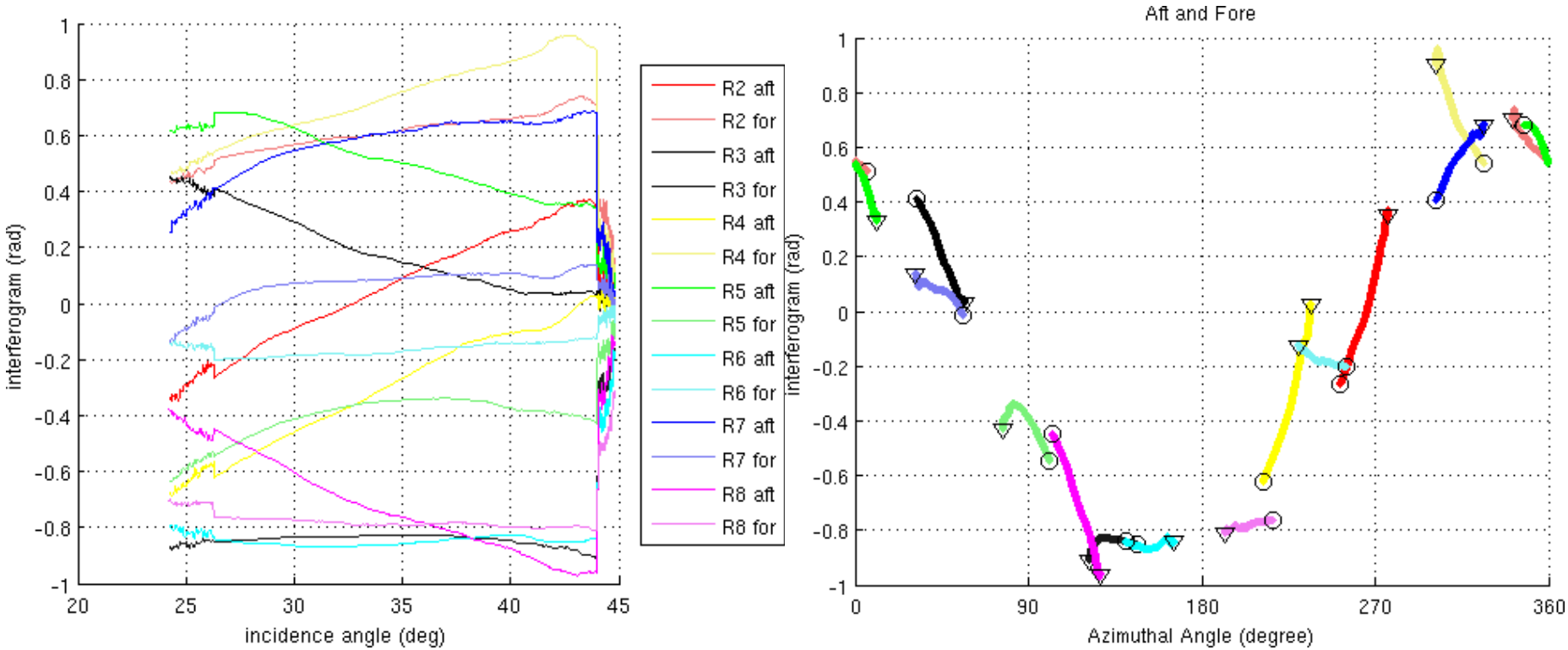
- Median along track of the run's portion for:
  - SLC amplitude
  - Interferogram

SLC Amplitude



- SLC amplitude azimuthal variation in accordance with a southerly wind (for each incidence angle)
- Amplitude discrepancies between Fore and Aft antennae
- Post calibration of antennae using the omnidirectional component ('a' factor) does not improve agreement between antennae (not shown).

INTERFEROGRAMS

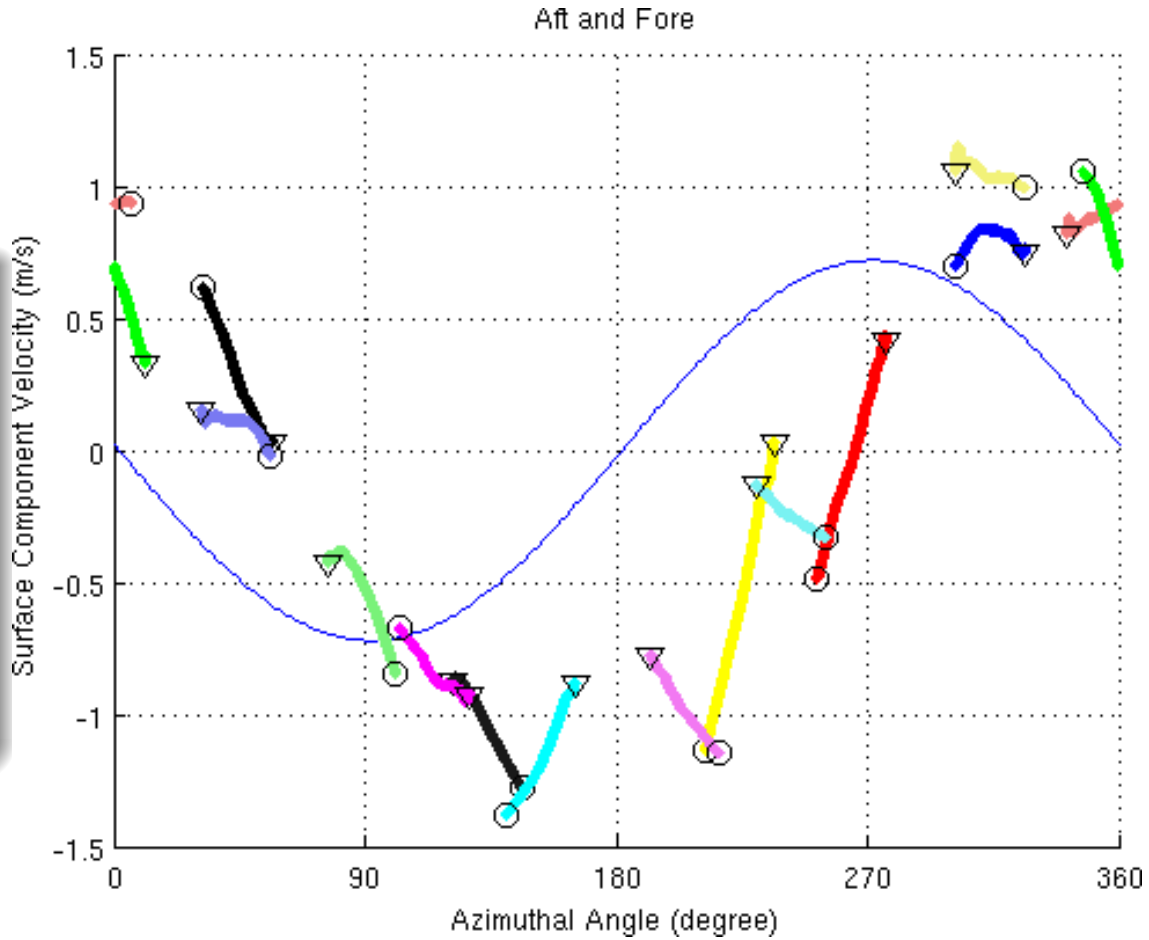


- Azimuth and incidence angle vary together, difficult interpretation
- For similar range (circle or triangle) and azimuth => good agreement between antennae

Interferograms to Surface Component Velocity

$$U_{surf} = \Delta\Phi \frac{\lambda_e V}{2\pi B_{eff} \sin\theta}$$
$$\approx 0.7 \frac{\Delta\Phi}{\sin\theta}$$

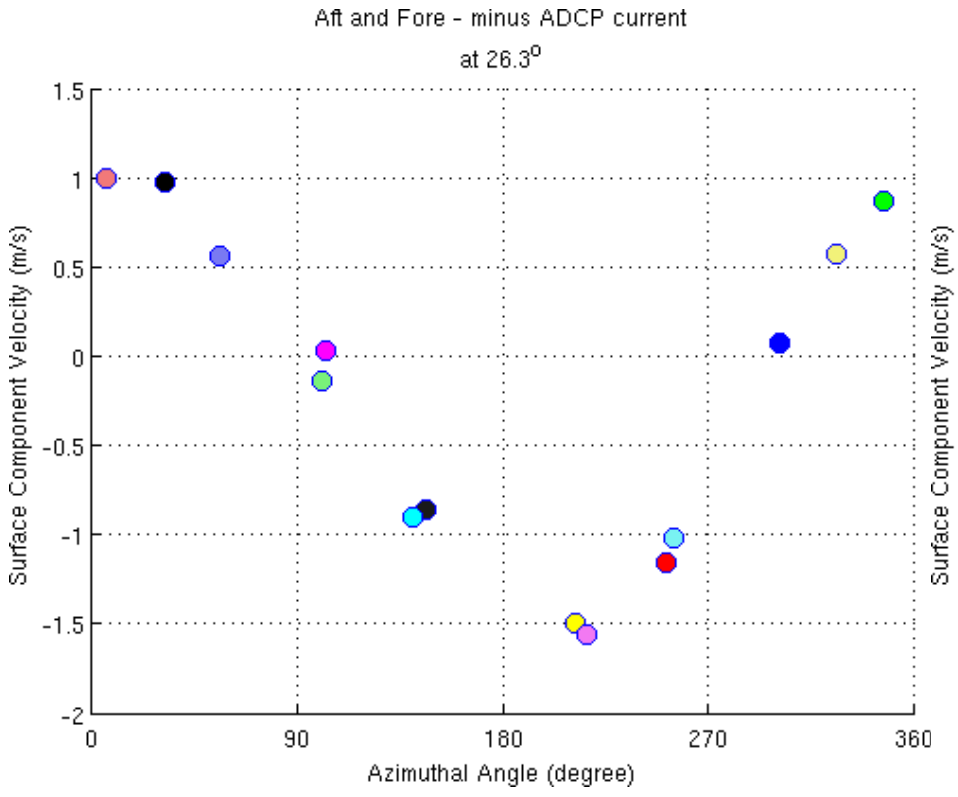
with $B_{eff} \approx Cste$,
V = 76 m/s ($\pm$10%)

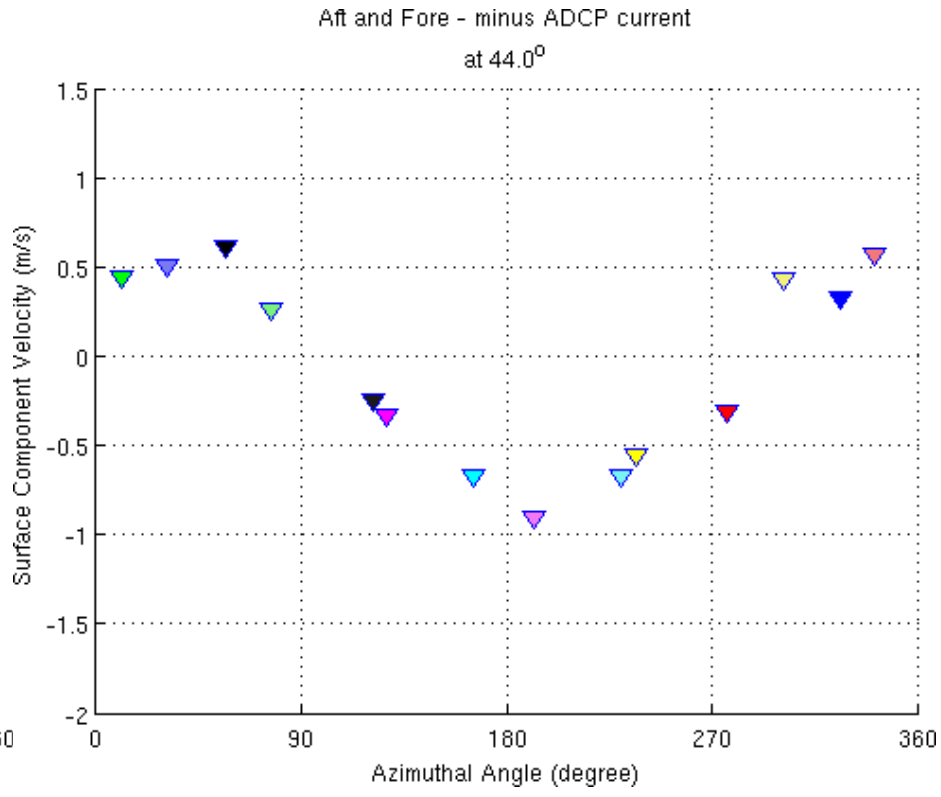


- Figure combine surface current velocity, wave artefact velocity, azimuth and incidence angle variation

=> remove surface current velocity from ADCP

Wave Artefact Velocity — from Data



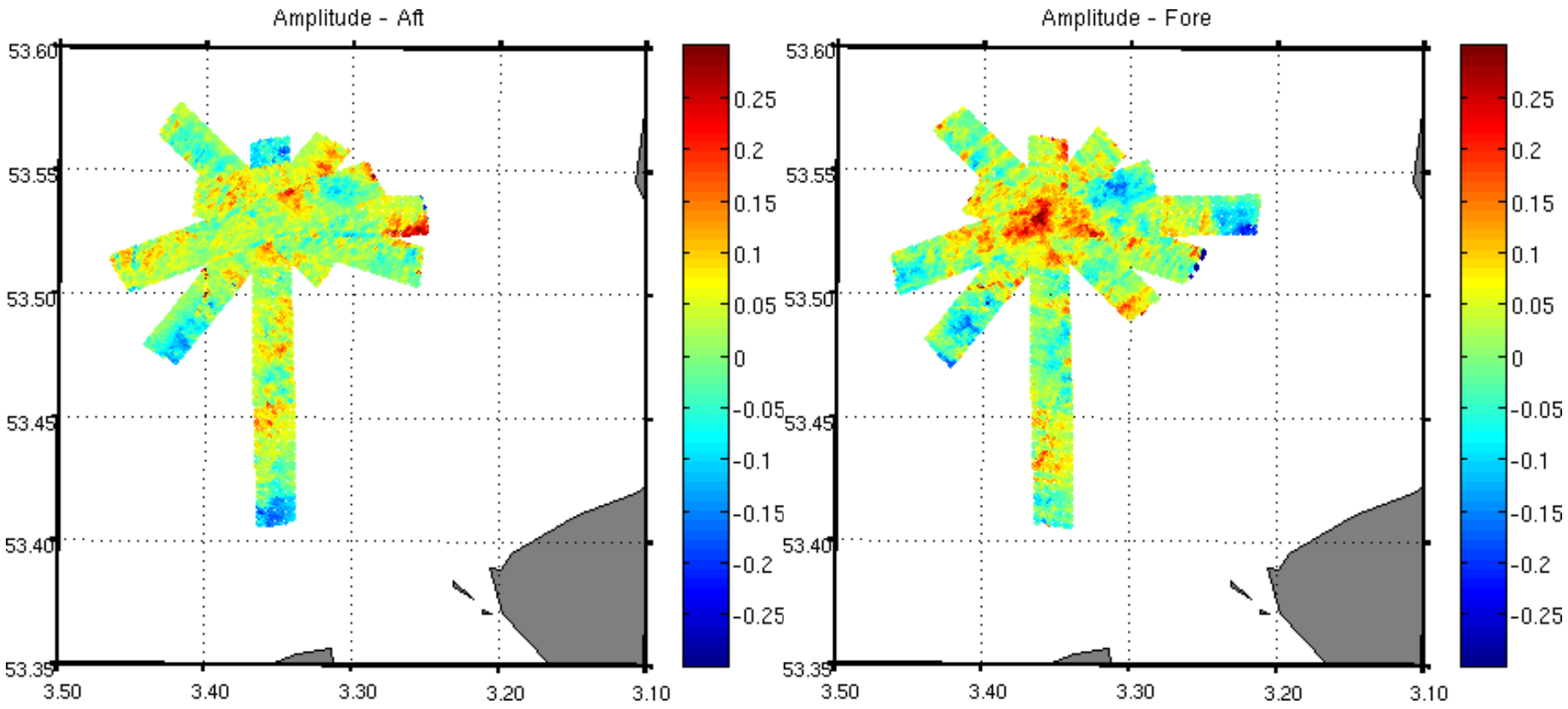


- Amplitude decrease with incidence angle
- Amplitude maxima in up/downwind direction (agreement with model)
- Upwind amplitude $>$ downwind (opposite with model but agreement with ASAR data [Mouche et al., 2012])

Outline

Intra-run Variability — SLC Amplitude

Amplitude corrected for incidence angle dependency — averaging to 100m

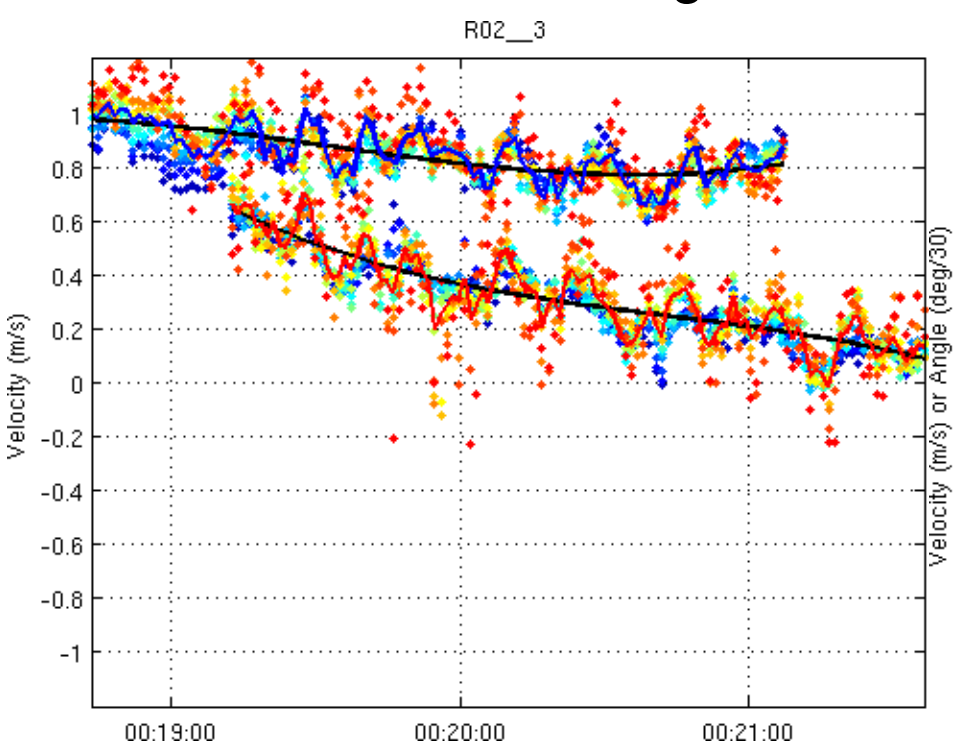


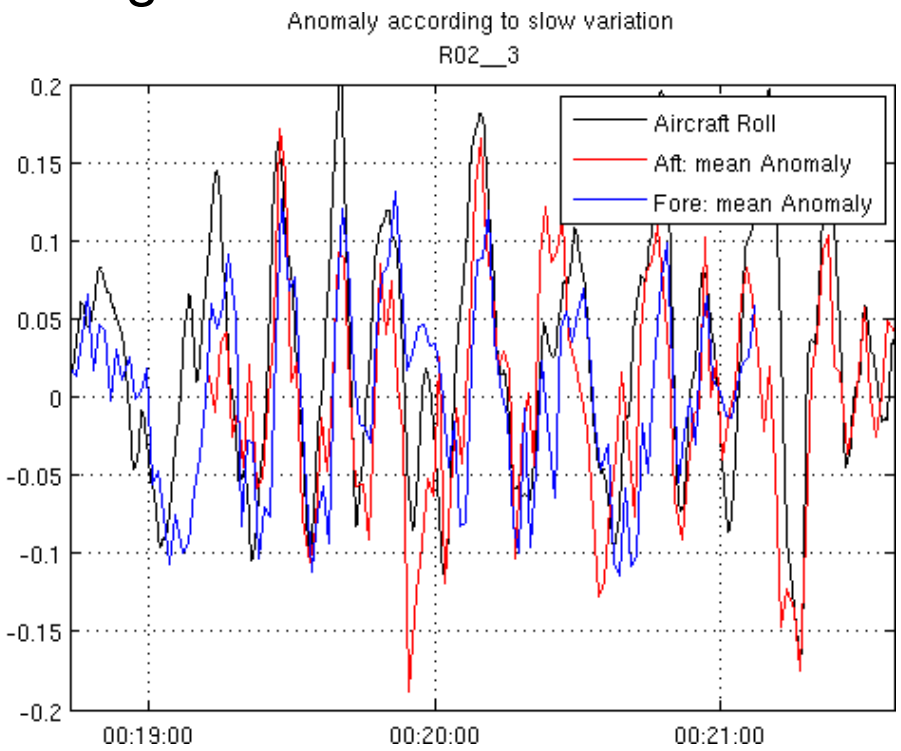
- No obvious consistent features

Intra-run Variability

Starlab-Derived Velocity

Run 2 — SW -> NE — high aircraft rolling effect



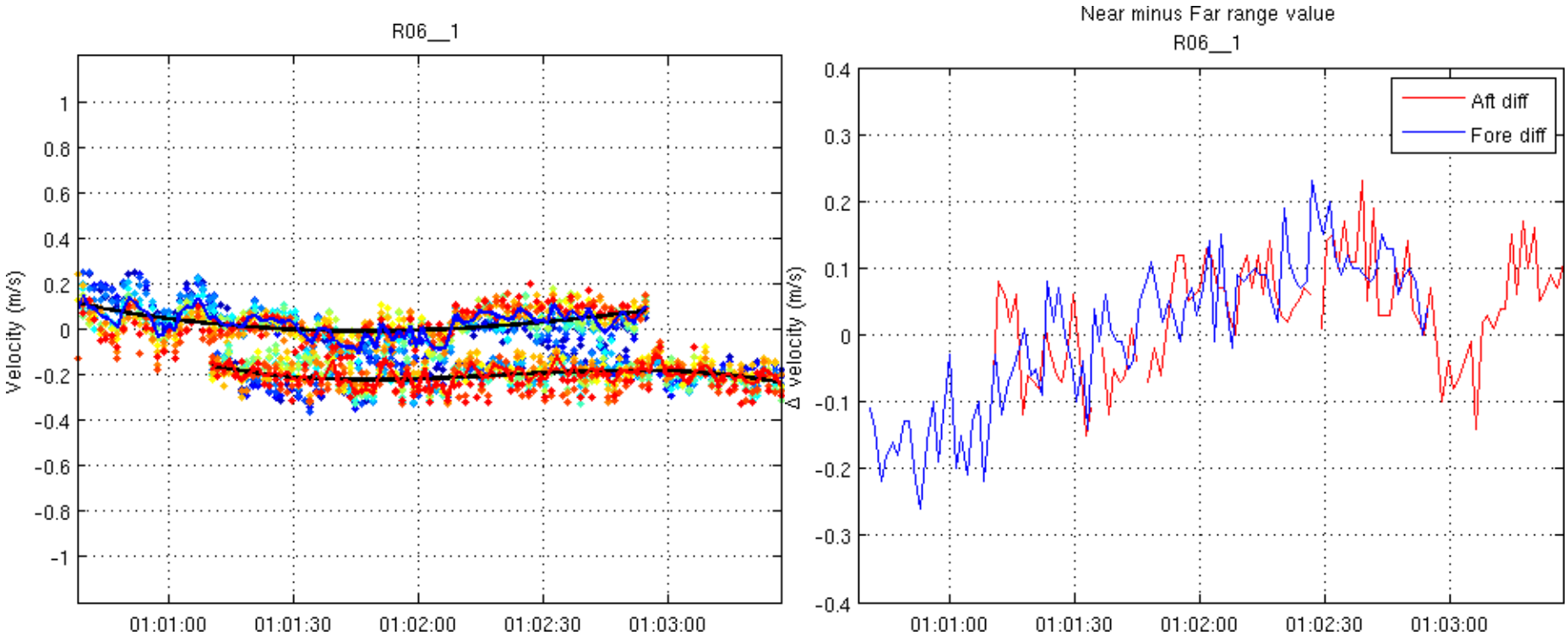


- Trend for the aft antenna derived-velocity, probably due to wind-wave fetch effect (not seen on other run)
- Velocity anomaly of both antennae highly correlated with aircraft rolling angle (0.03 m/s per ° of roll angle)
  - Surprisingly as SAR is installed on a gimbal (corrects aircraft roll)

Intra-run Variability

Starlab-derived velocity

Run 6 — NW -> SE — high aircraft drift variation



- High correlation of near minus far range difference between fore and aft antennae
  - seems to be linked to aircraft drift variation (gimbal corrects yaw)

Outline

Conclusions & Perspectives

Conclusions

- Wind-wave artefact (X-band) in very good agreement with ENVISAT empirical data (C-band)
  - despite very specific condition during Irish Sea experiment (fetch, crossing sea)
- Variation with incidence angle and phase with wave in agreement with a simple theoretical model [Chapron et al., 2005]

Future Work

- More airborne flights with various geophysical conditions (open ocean)
- Inversion of both wind and current
  - need for calibrated sigma0
  - need for VV + HH polarisation
  - difference between X and Ku-band probably small. Need to be confirmed