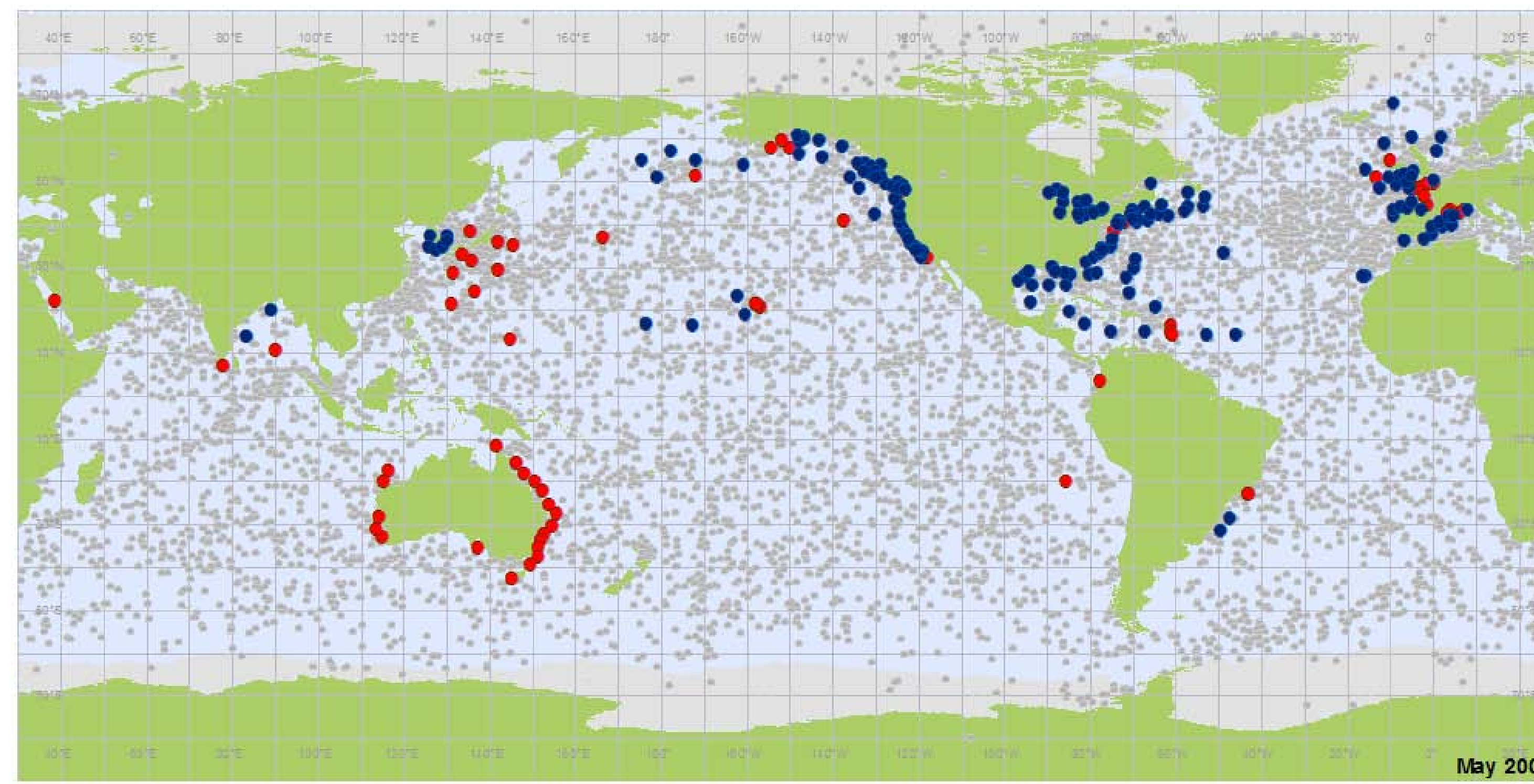


Wave Measurements Needs and Developments for the Next Decade

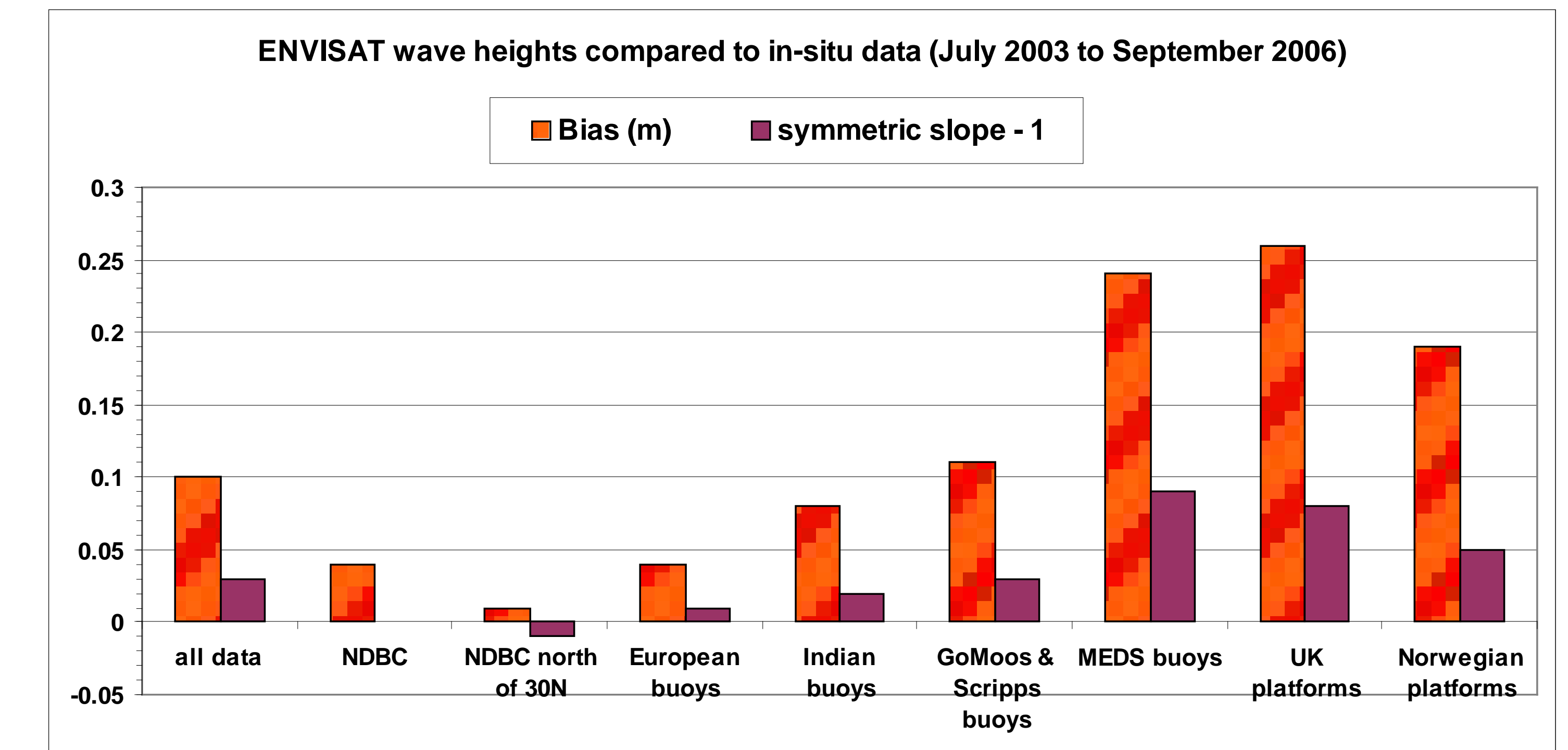
V. Swail, R. Jensen, B. Lee, J. Turton, J. Thomas, S. Gulev, M. Yelland, P. Etala, D. Meldrum W. Birkemeier, W. Burnett, G. Warren

Summary

A recent JCOMM workshop on *in situ* wave measurement technology noted that: geographical coverage of *in-situ* data is still very limited especially wave directionality; most measurements are taken near coasts in the Northern Hemisphere; present *in situ* reports are not standardized resulting in impaired utility; significant differences exist in measured waves from different platforms, sensors, processing and moorings. This paper focuses on the development of components of a global integrated ocean observing plan for waves, including various *in-situ* observation systems and complementary remote sensing systems, both land and space-based, capable of providing the type, quantity, quality and distribution of wave observations necessary for the wide range of direct and indirect wave applications.

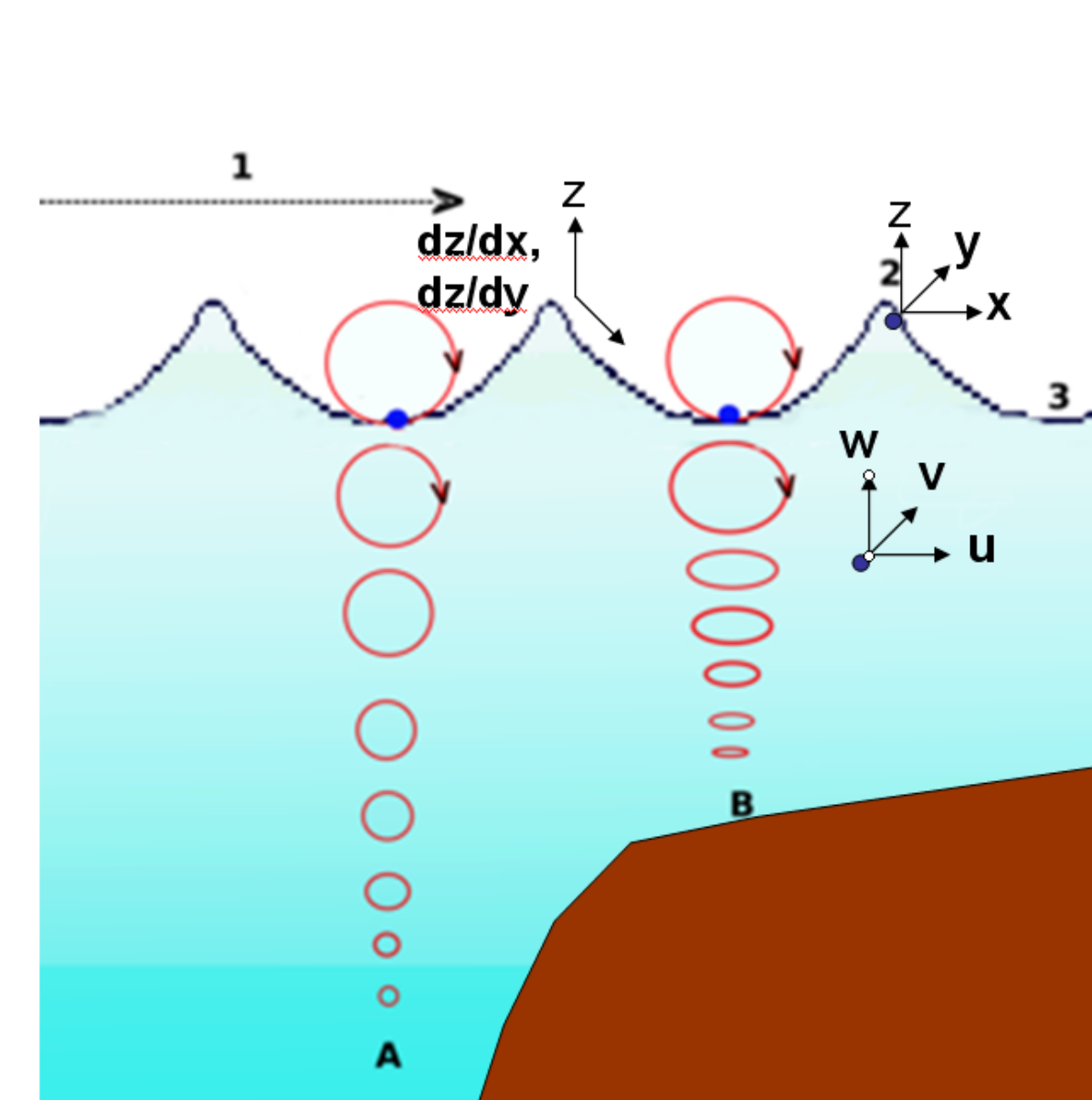


• Wind & Waves (165) • Waves (46) • All ocean data on the GTS
In-situ observations from buoy and platforms



Discrepancies in wave observations (Bias: Altimeter – In-situ
Symmetric slope: ratio of variance Altimeter to In-situ) (courtesy Jean Bidlot)

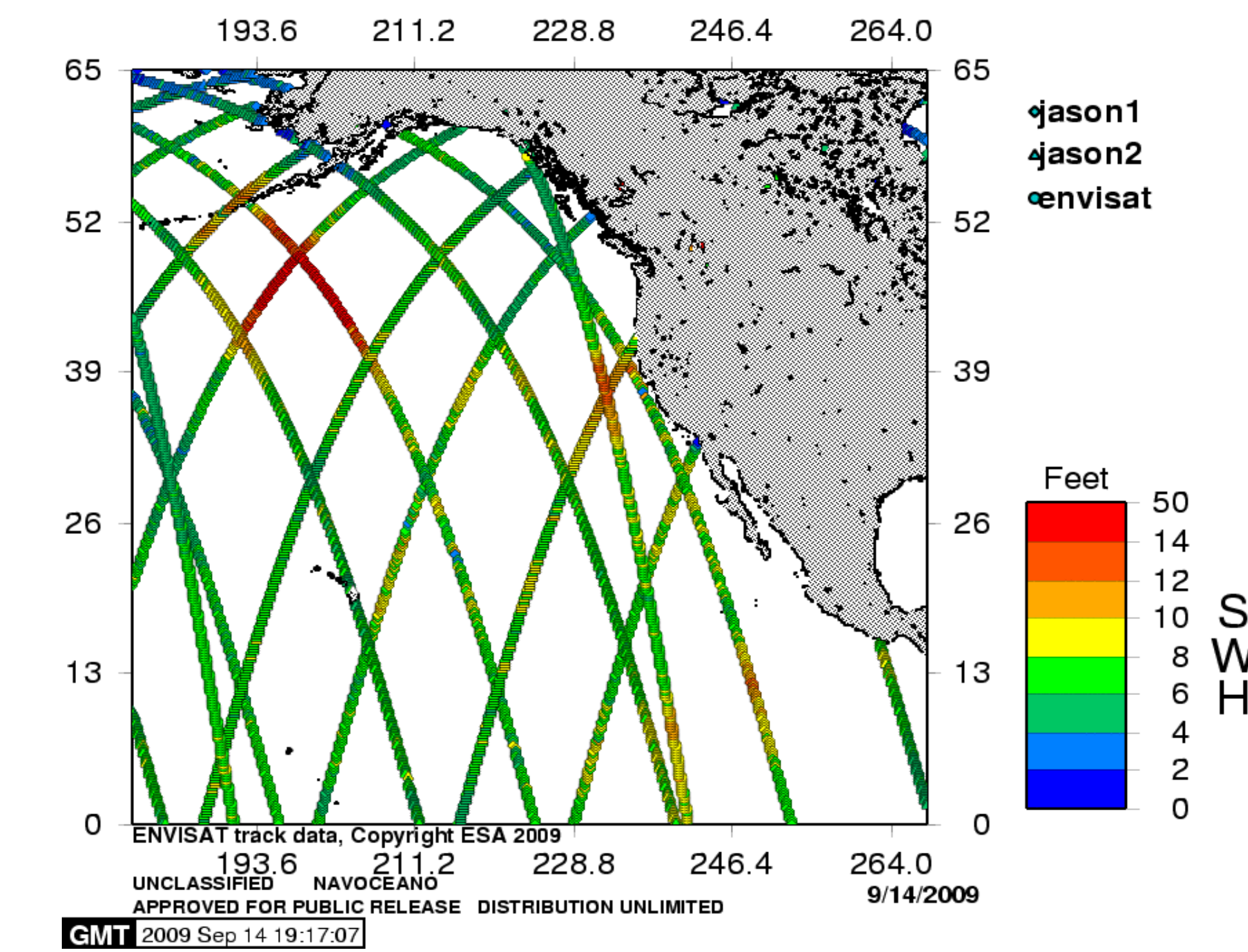
The Basics: Estimating the Motion of a Sea Surface Particle



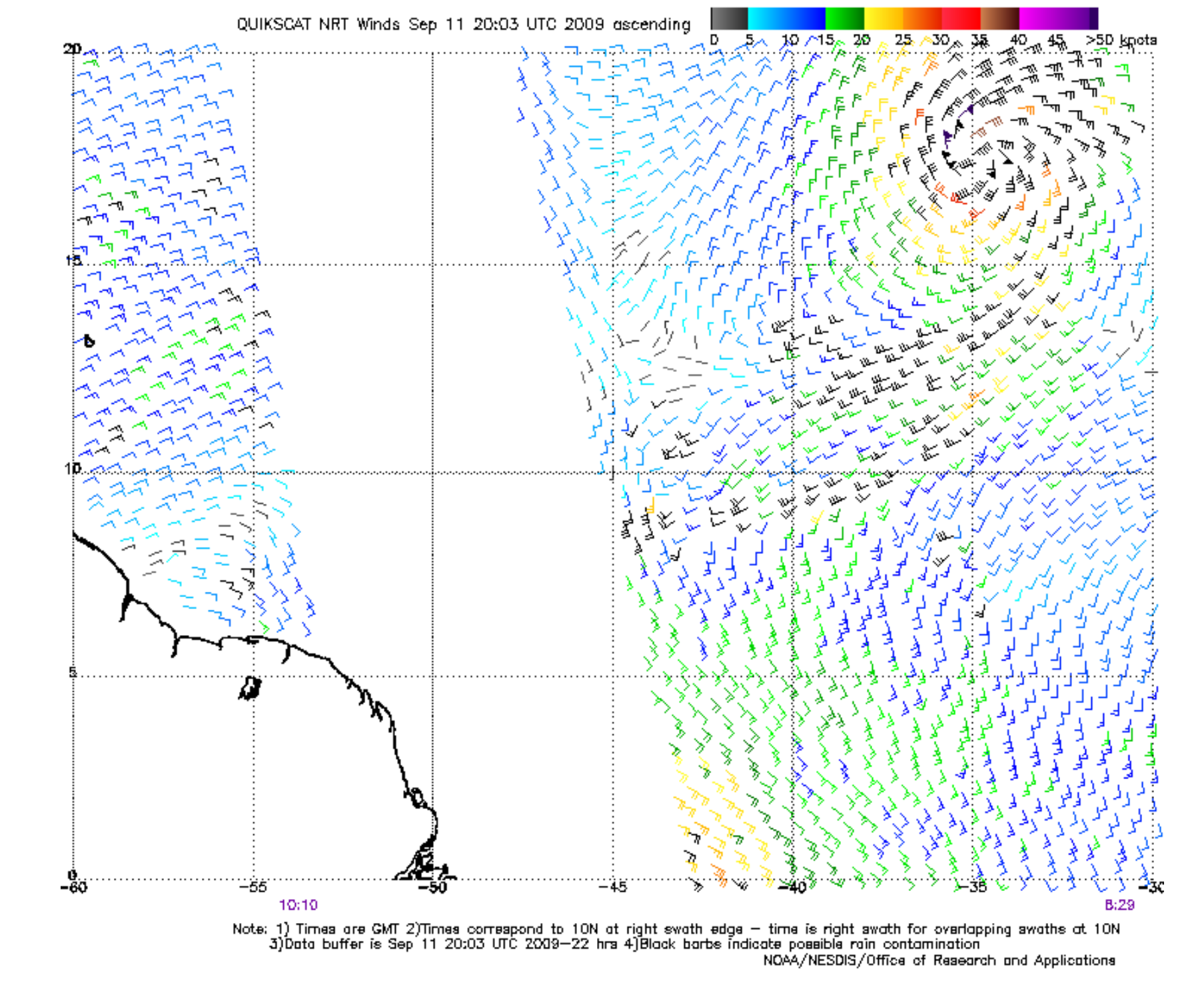
The Big 3

X, Y, Z

- Pressure Sensors
- Accelerometers
- Tilt sensors
- Angular Rate Sensors
- Acoustic Sensors
- GPS

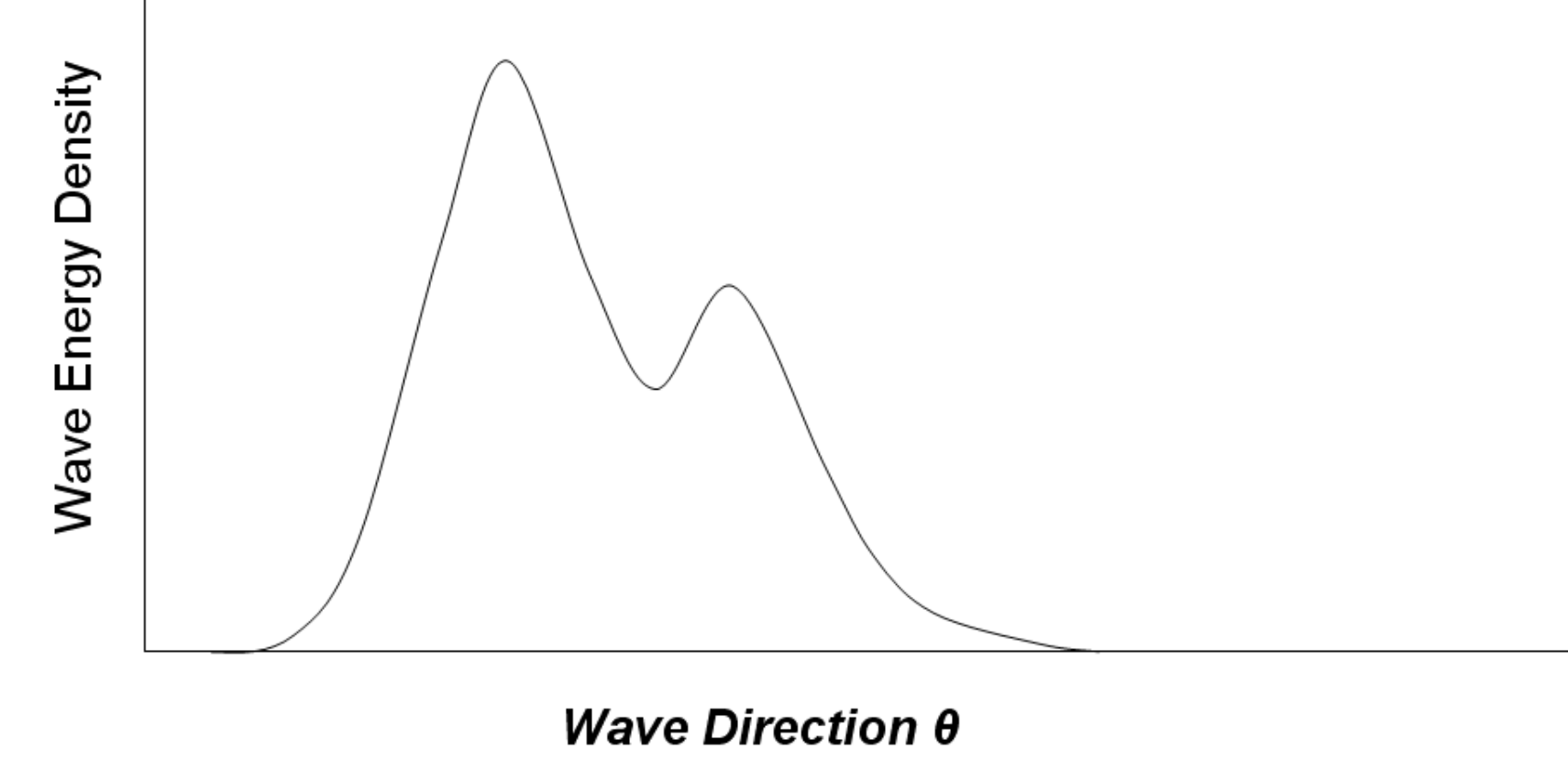


Importance of value added remote sensing altimeter wave height estimates



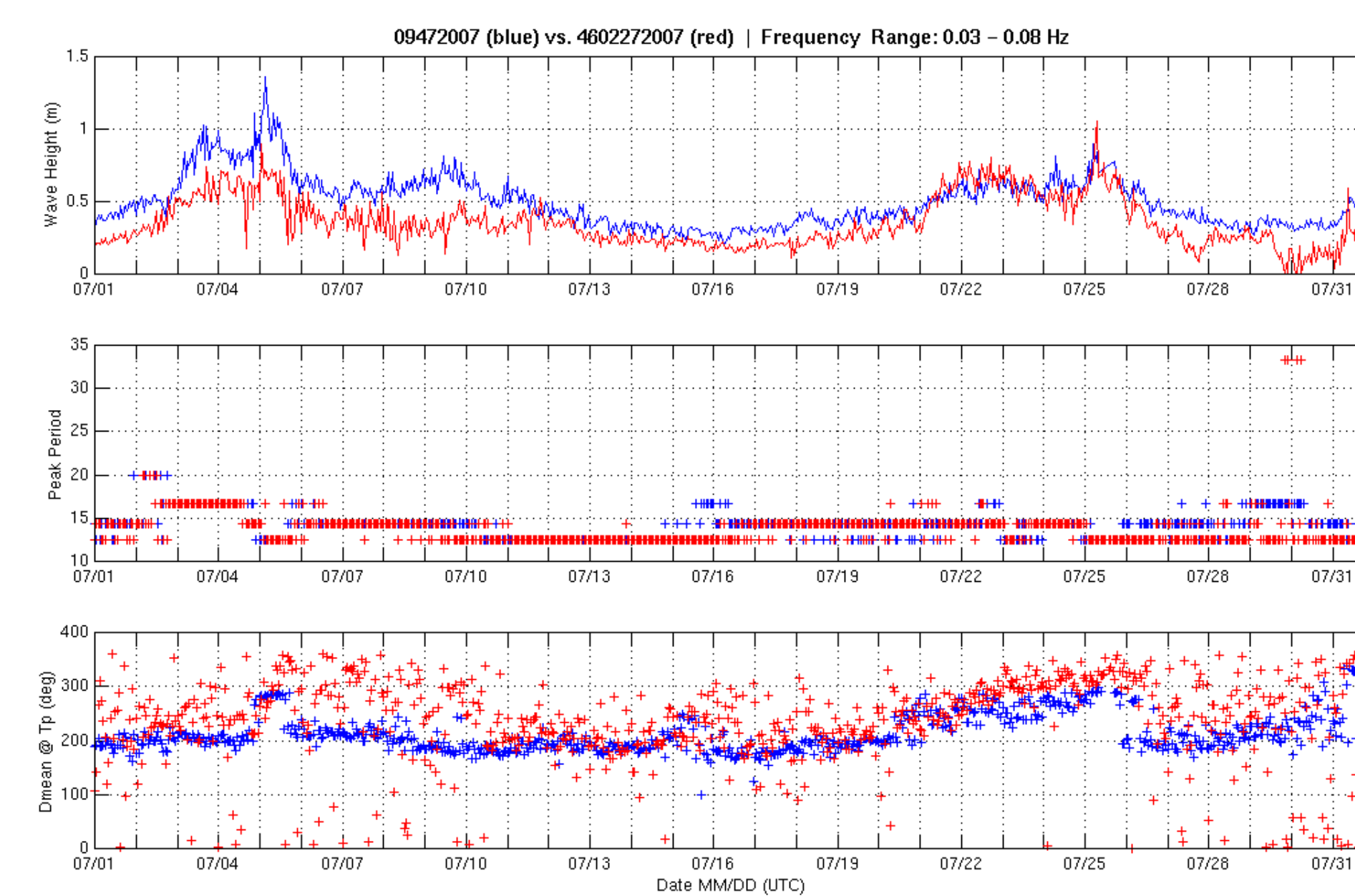
QuikScat provides wind estimates for waves

The Directional Spectrum



$$S(f, \theta) = S(f) [a_1 \cos(\theta) + b_1 \sin(\theta) + a_2 \cos(2\theta) + b_2 \sin(2\theta) + a_3 \cos(3\theta) + b_3 \sin(3\theta) + a_4 \cos(4\theta) + b_4 \sin(4\theta) + \dots \text{infinity and beyond}]$$

First-5 compliance provides higher moments in the directional distribution



Waves are estimates from other physically measured parameters.

Recommendations for Development of Global Wave Observation System:

- Continuity of established buoy networks: (First-5), expansion of directional measurements: (e.g. US National Waves Plan)
- Data sparse areas need to be filled (Southern Ocean)
- VOS wave data should be further validated and incorporated
- Comprehensive metadata records for wave information developed
- DBCP Pilot Projects (Wave Measurement Evaluation Test / Wave Measurements from Drifting Buoys) should be supported
- Research conducted in development of innovative directional wave measurement devices (e.g. on OceanSites moorings)
- Multiple altimeters are required (denser coverage / long-term / stable repeat observations / high temporal resolution)
- SAR wave observations important component / land based radar systems
- Ku-band scatterometer capability for measurement of winds

