

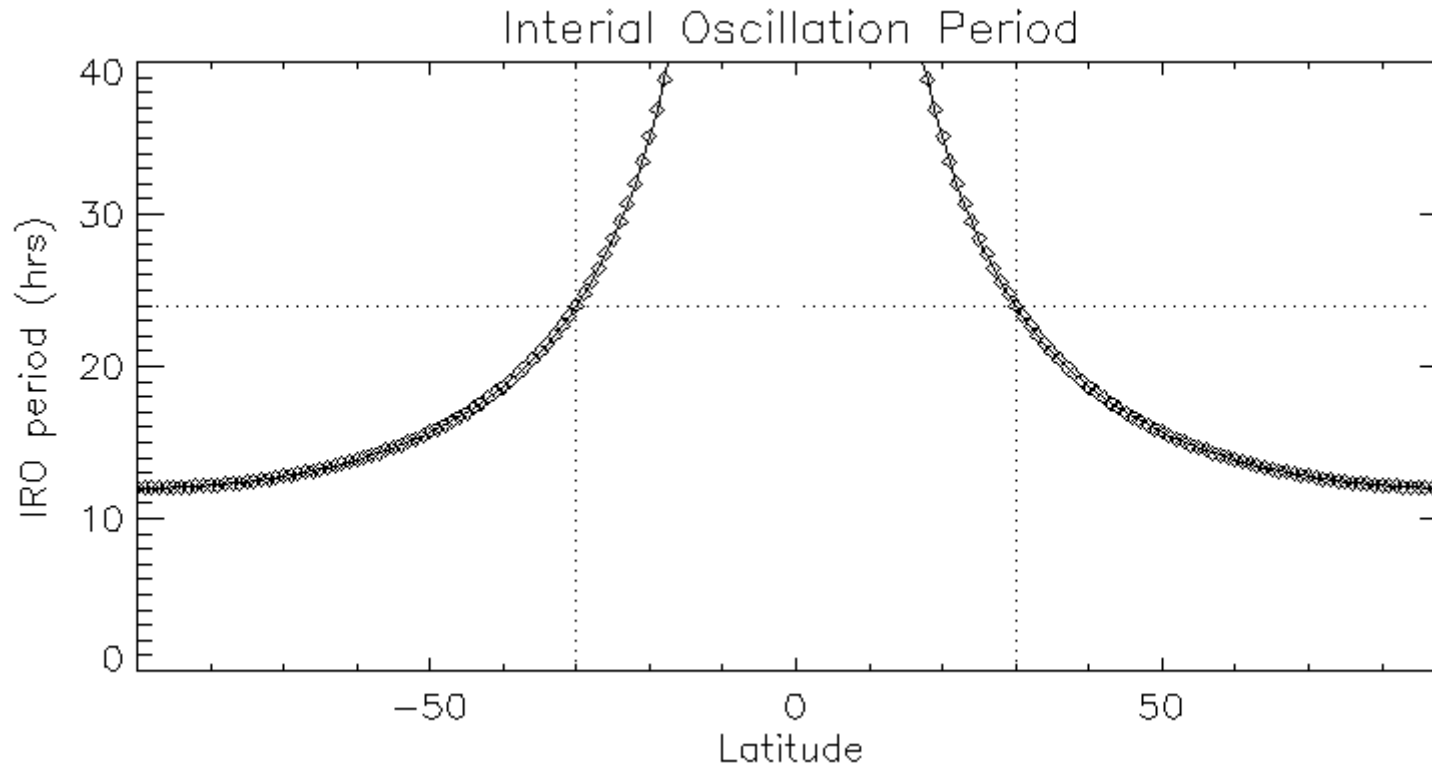
Inertial Range Oscillations in the combined QSCAT-ADEOS-II ocean surface wind data set

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Purpose: to prove that one can see IROs in satellite based measurements.

- 1) Introduction: IROs
- 2) Ground Truthing (what do IROs look like in NBDC data?)
- 3) Can satellites see IROs? (sampling issues)
- 4) Comparison: moored buoys v. satellite
- 5) Global IRO measurements



Anticyclonic oscillations near the local inertial frequency in the upper ocean currents can be forced by the surface wind field. Inertial oscillations can be generated by the sudden onset of a steady wind blowing over an ocean mixed layer and they can play a major role in deepening the layer. Inertial variability in surface winds has been observed at various sites, but due to its transient nature, has been considered to be less dominant.

IROs in the NDBC dataset

The National Data Buoy Center (NDBC) is an agency within the National Weather Service (NWS) of (NOAA).

They provide data for hundreds of moored data buoys that provide high time resolution winds. These are an ideal source in which to search for IROs.

The moored data buoy dataset provides wind data at with sufficient sampling (hourly) to sample inertial range oscillations at all latitudes.

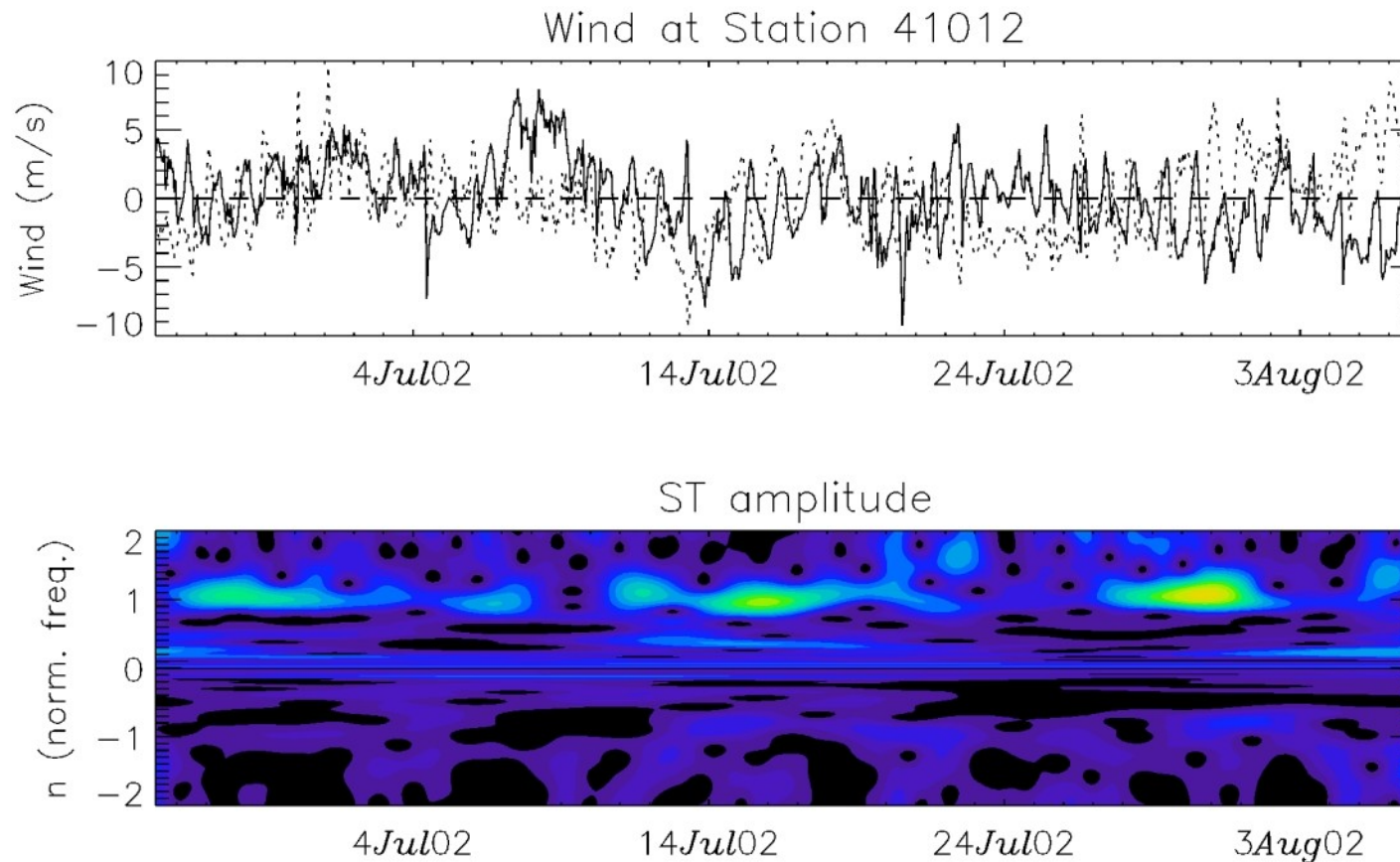
We analyzed data from several hundred moored buoys.



<http://www.ndbc.noaa.gov/>

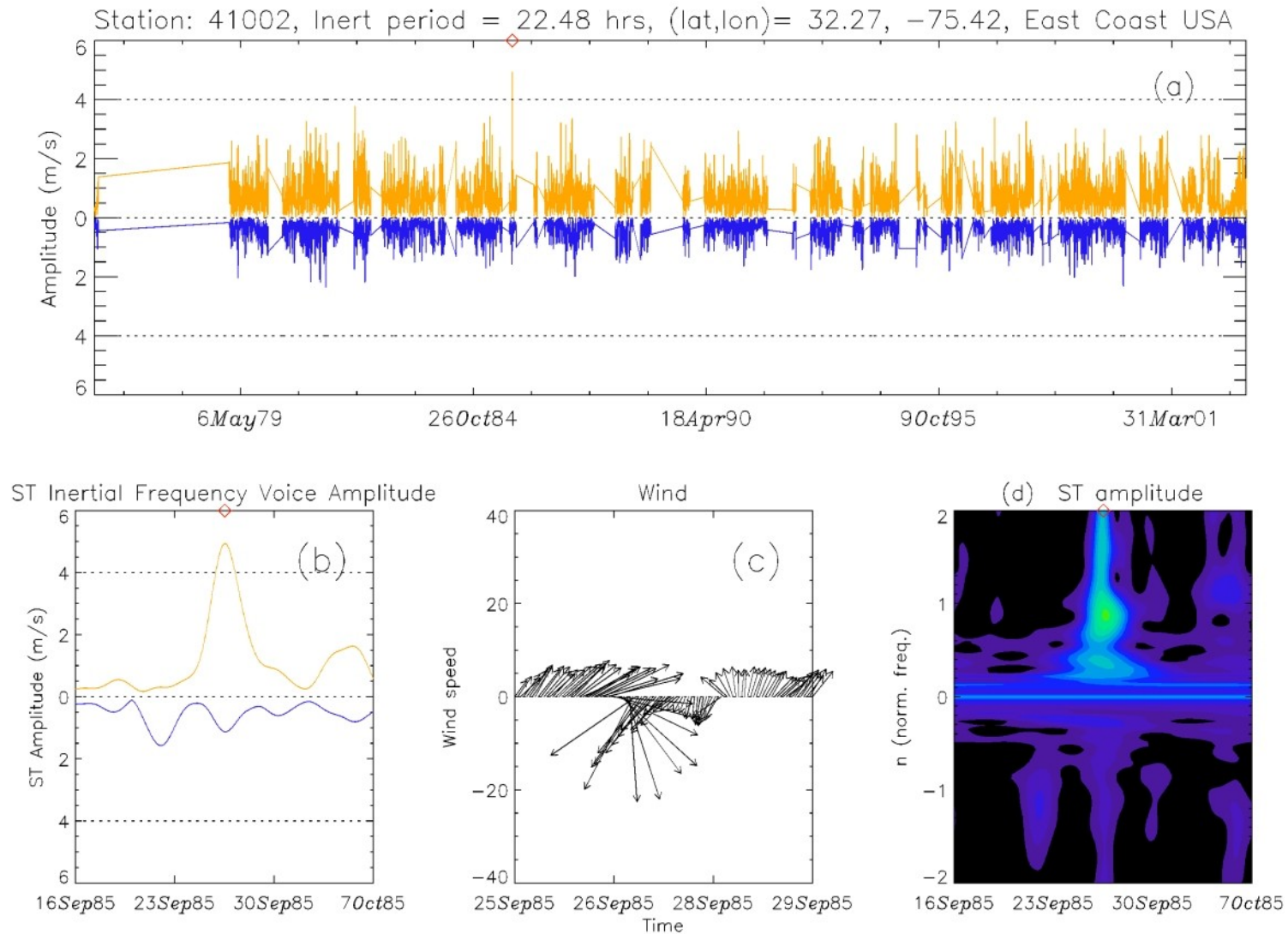
IROs from data buoys

- IROs are strong, transient signals, thus a local spectral analysis (S-Transform) is appropriate.
- Station 41012 at (30.0 N 80.5 W) sampled hourly shows strong IRO signals (IR period = 24 hours)
- ST shows the rotational spectrum of $u + iv$ as a function of time. (anticyclonic, CC in NH is $+n$)



IROs from data buoys

- Closeup of a single IRO event from a 23 year long data record.

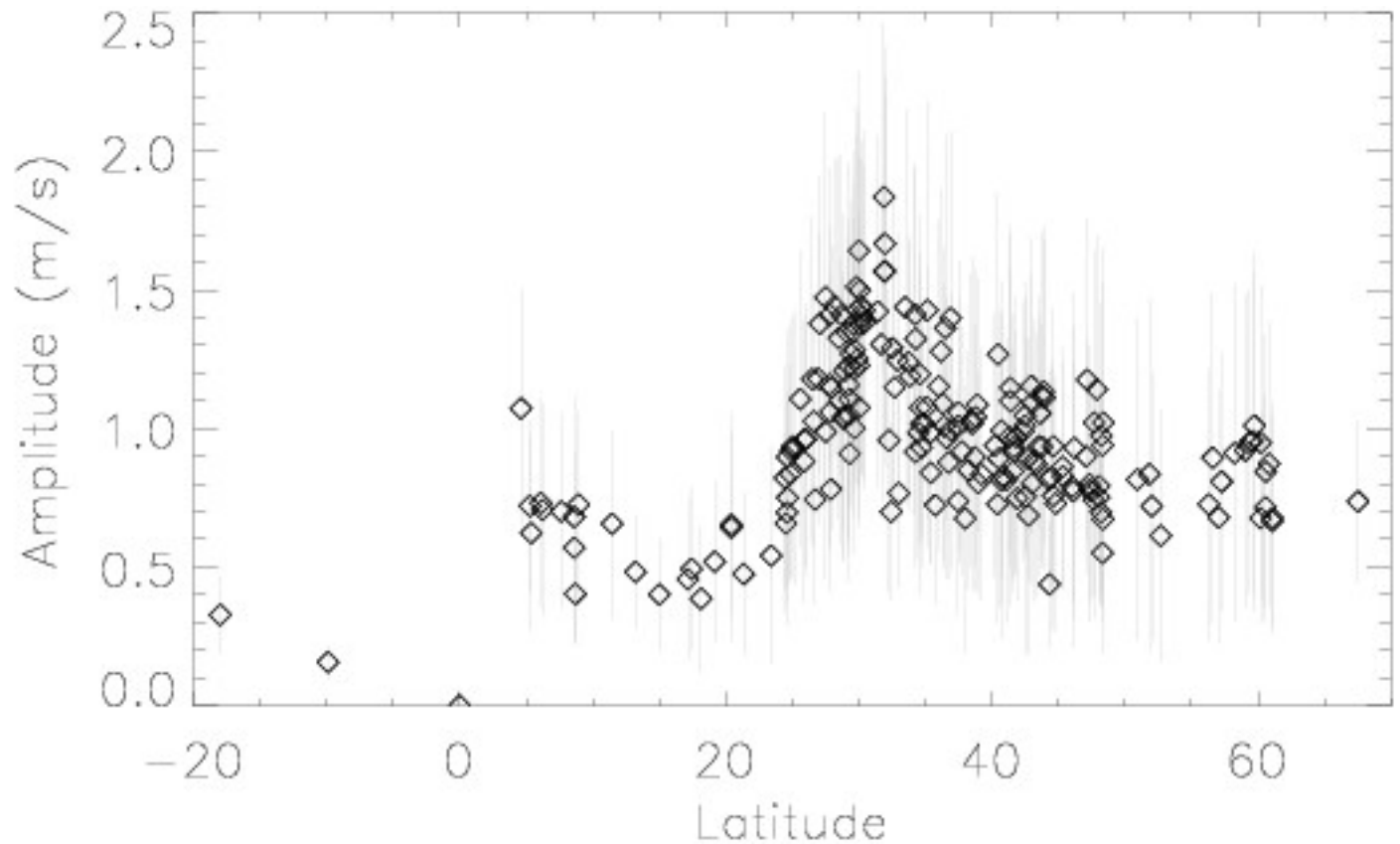


IROs from data buoys: Latitudinal Dist.

This shows the amplitude of the IROs vs latitude.

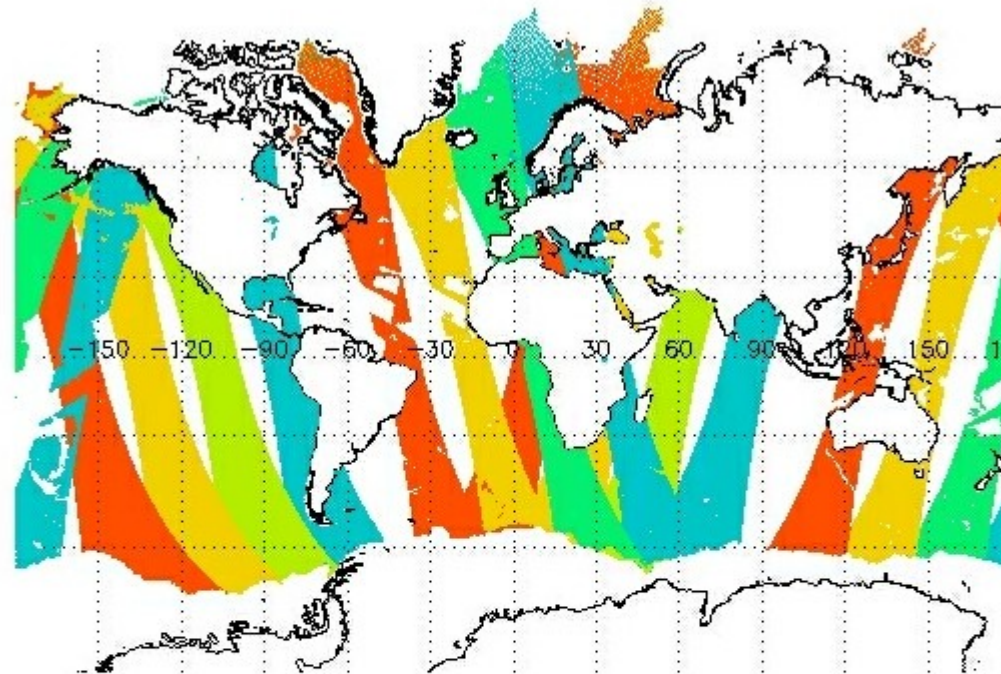
It summarizes the entire Moored Buoy Dataset, and can be used for comparison with satellite results.

Note: There is a geographic bias, most of the buoys are near coastal N.A.



Can satellites see IROs? (sampling)

Global Coverage provided by QSCAT and ADEOS-II over 6 hours.



★ 20030719-03:33

★ 20030719-05:14

★ 20030719-06:55

★ 20030719-08:36

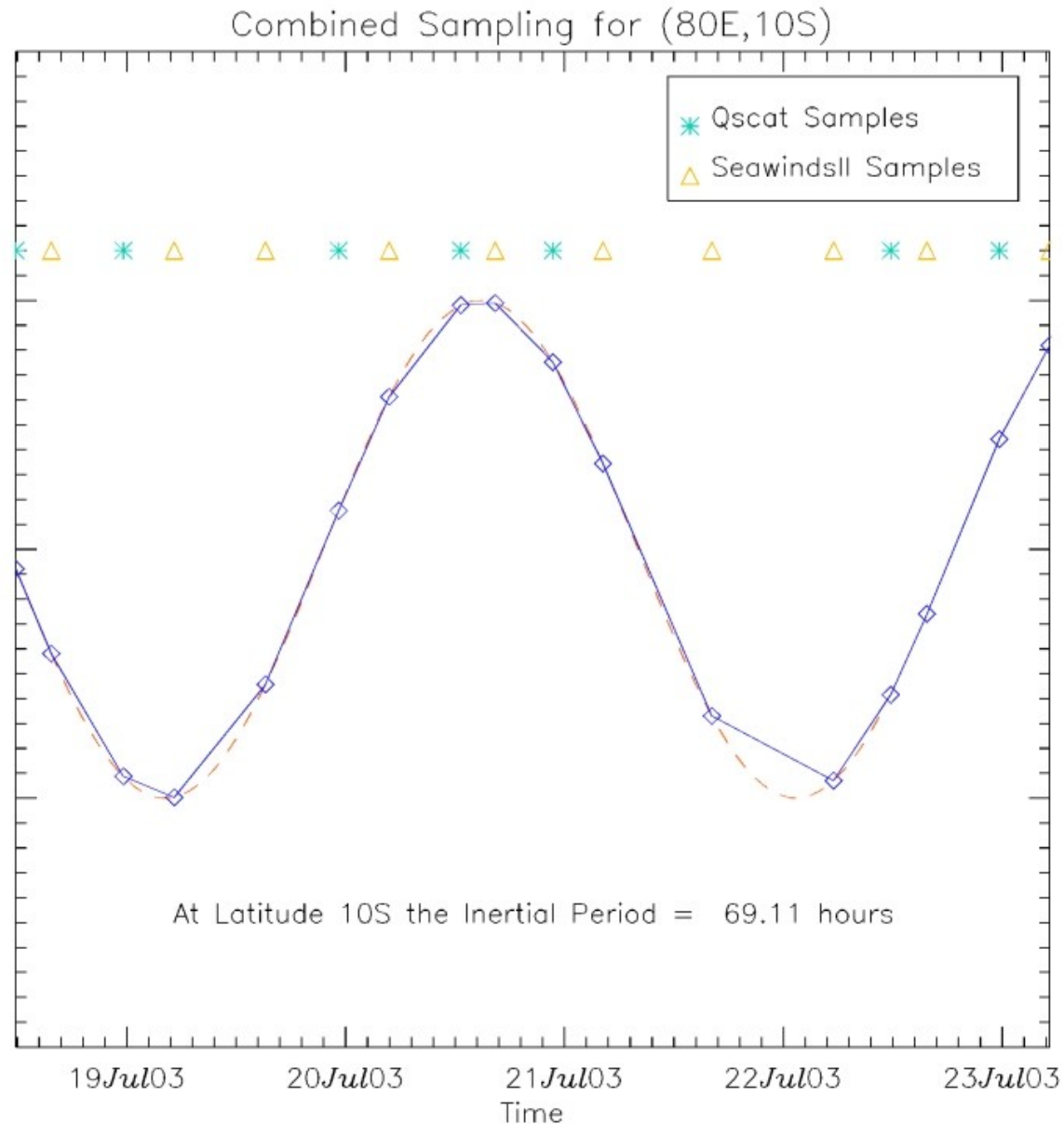
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★ 20030719-04:51

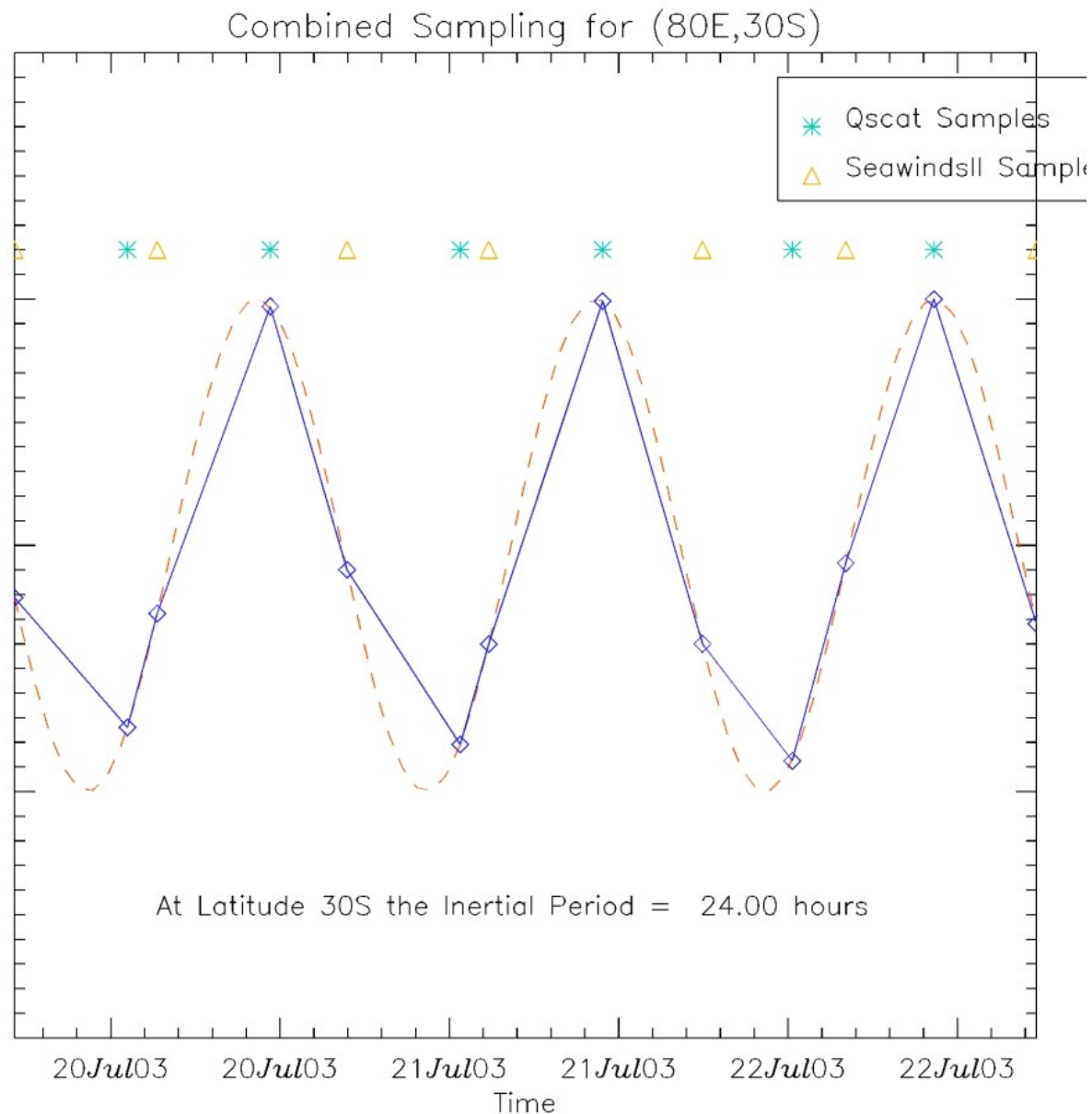
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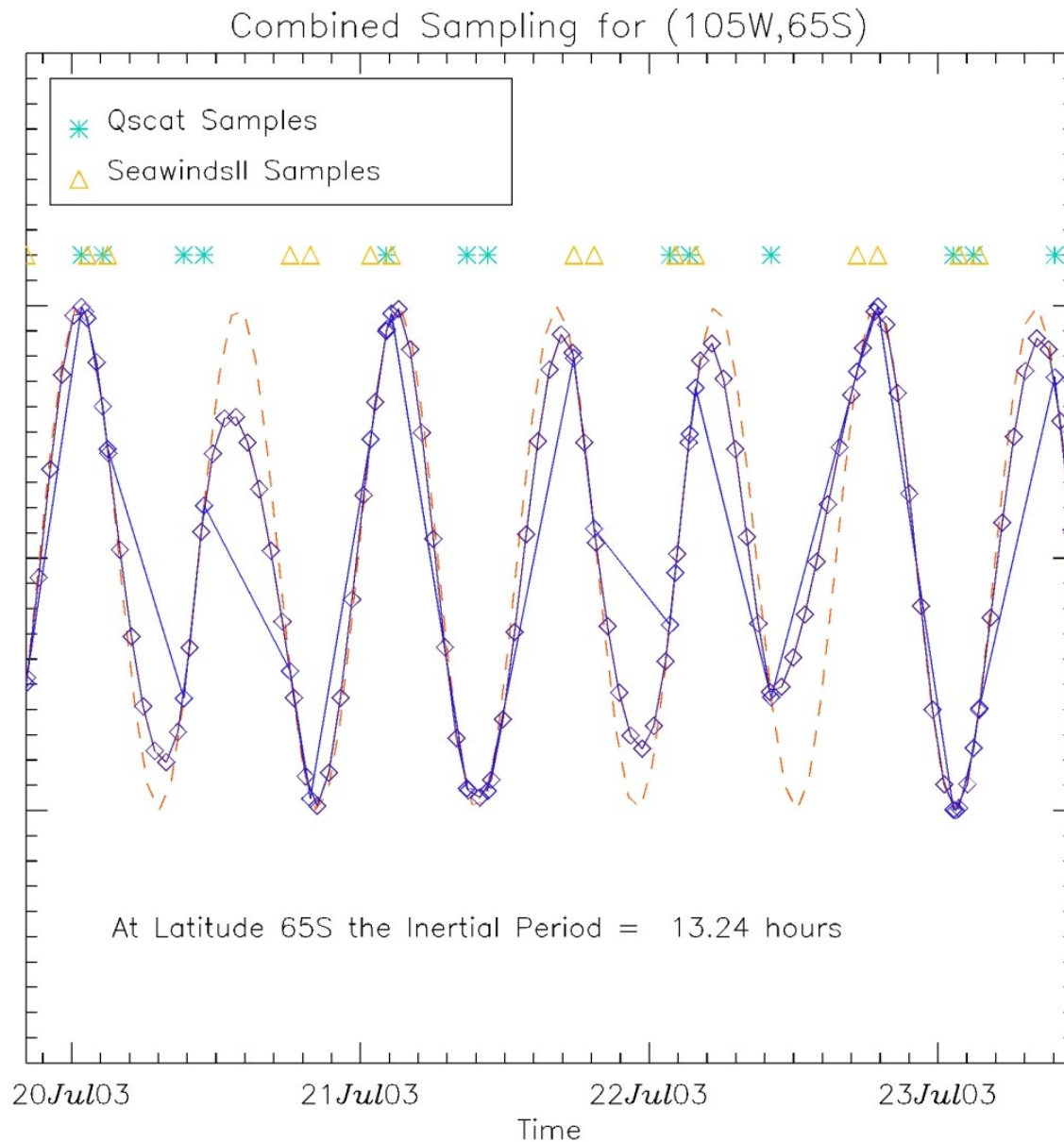
Can satellites see IROs? (sampling)



Can satellites see IROs? (sampling)



Can satellites see IROs? (sampling)



IRO from Satellite measurements

The strategy is to:

- 1) create a very high time resolution (yet non-stationary) regularly gridded wind product, then,
- 2) apply non-stationary analysis using a local spectral analysis.

The gridded wind product is derived by a modified LOESS (local regression) analysis.

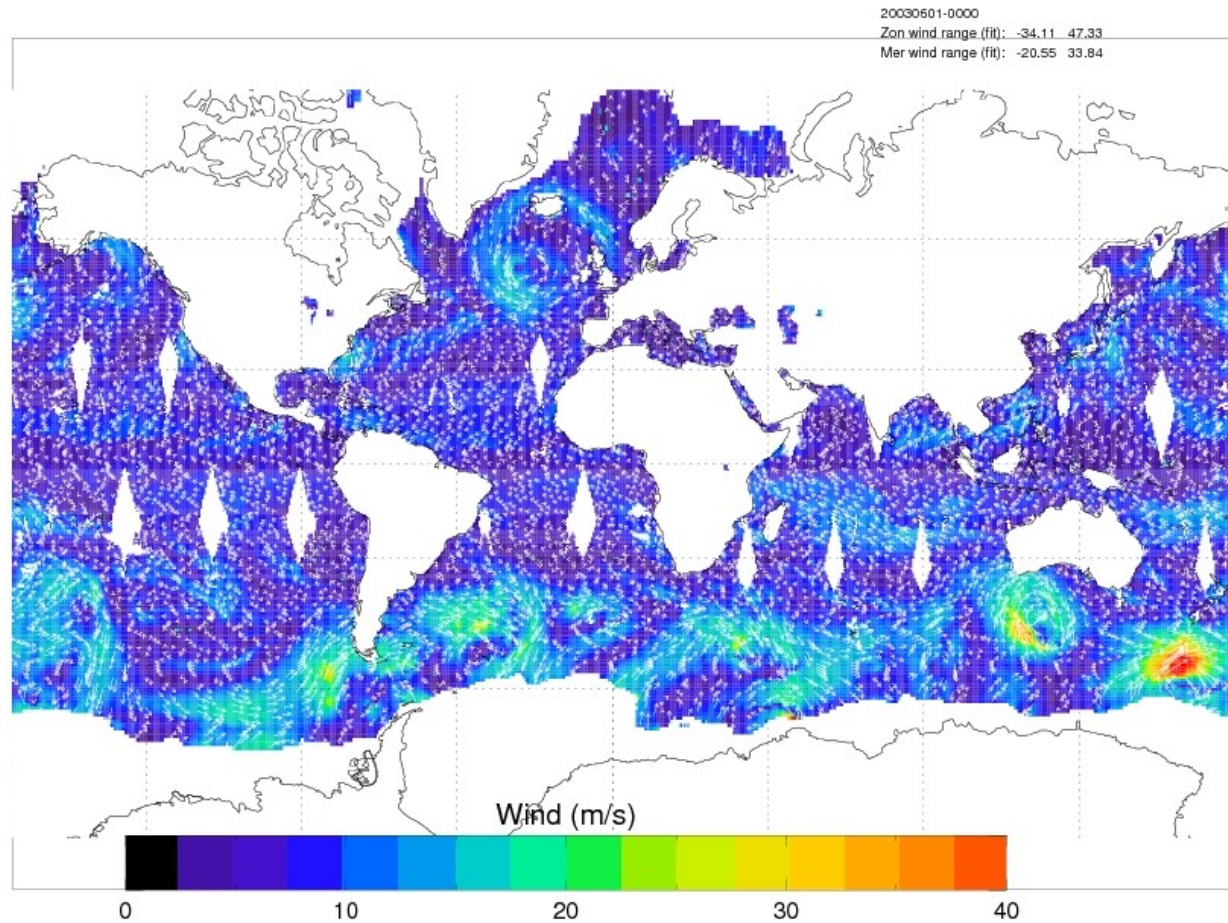
It is a data adaptive process where Singular Value Decompositions were used to solve three dimensional weighted least squares fit over small Regions of Interest (ROI) using a raised Gaussian window. Multiple quality checks are performed on the results (singular values, goodness of fit, 3D data centroid, etc.) and the best solution is found. (LOESS calculates center bin values, i.e. no jitter error).

IMPORTANT: This gridded product does not have uniform statistics. The gridded product is best thought of as a collection of time series.

Gridded Wind Product

Snapshot at 06-01 2003 at 00T.

Wind Magnitude & Dir - 3 Hr. (0.5d x 0.5d) for 20030601-0000



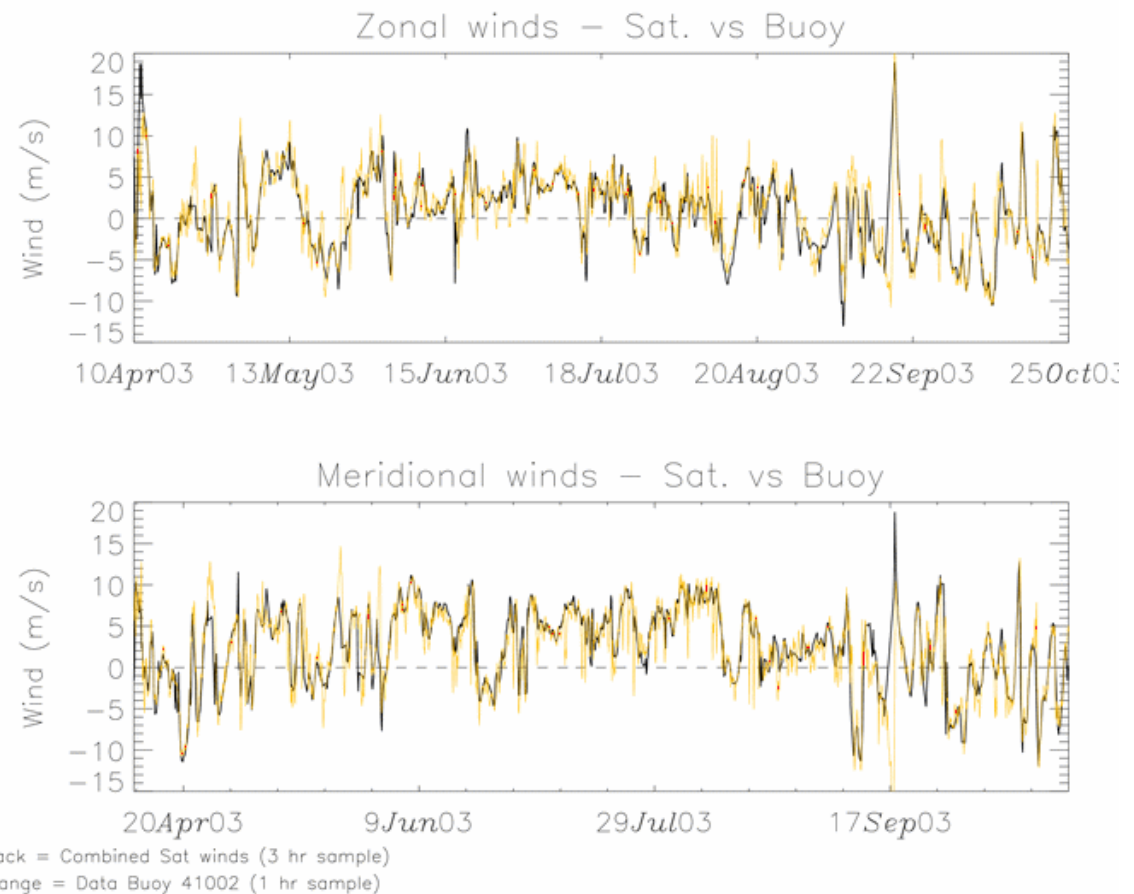
Comparison of the gridded wind with data buoy measurements

Note: a buoy measurement is completely different than a satellite measurement.

A wise man once said "BE CAREFUL WHEN VALIDATING SCATTEROMETER WINDS AGAINST POINT MEASUREMENTS"

That's correct, however, a derived product like the local IRO can be measured in both instruments, and can be directly compared. It may be a more appropriate comparison than a direct wind measurement.

(orange = buoy, black = gridded wind)

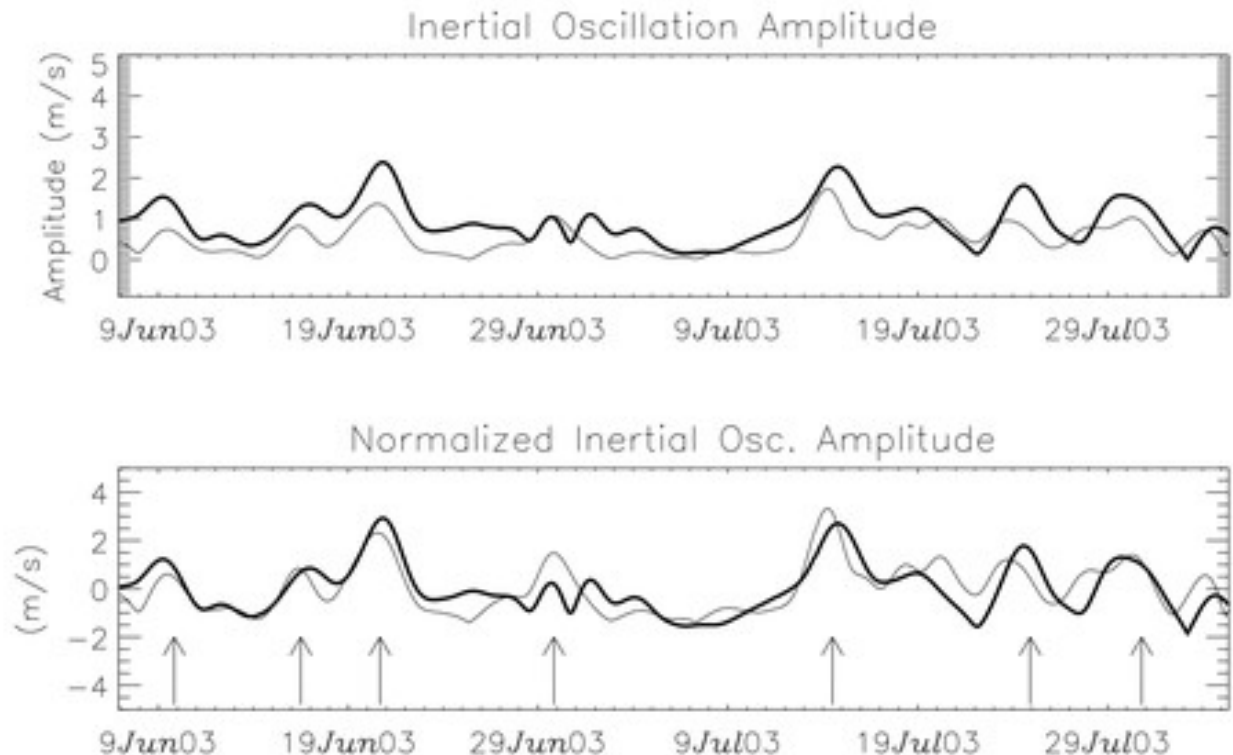


Comparison of the gridded wind with data buoy measurements

The derived Inertial Range Oscillation Amplitude from the gridded winds and from the hourly data buoy measurements for June of 2003.

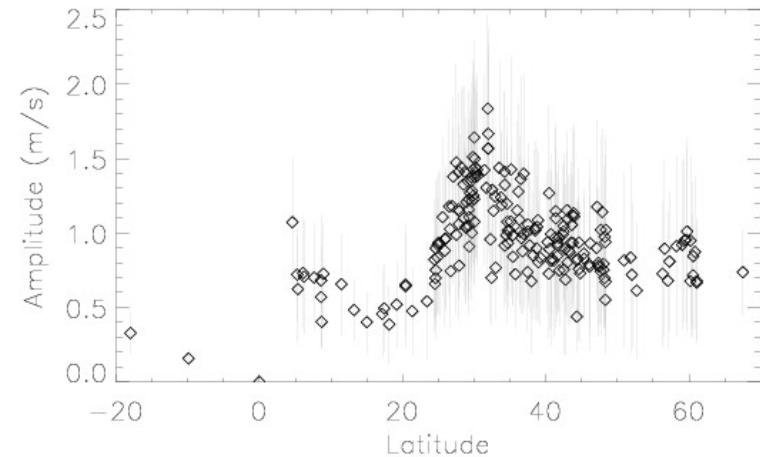
The comparison of these gridded results with all data buoys in the NDBC database is in progress.

(Dark line = buoy, grey line = gridded wind result)

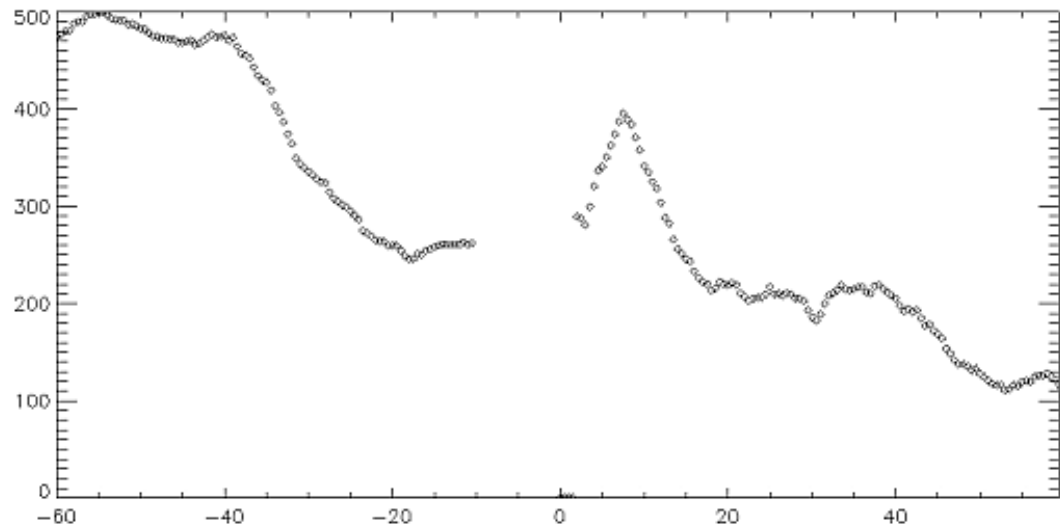


Comparison of the gridded wind with data buoy measurements

Latitudinal distribution of IRO amplitudes from the entire NDBC data base.

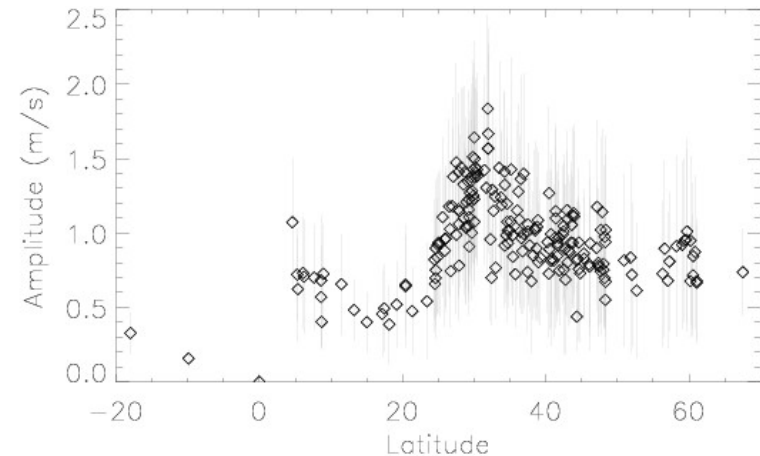


Latitudinal distribution of IRO amplitudes from the gridded winds.

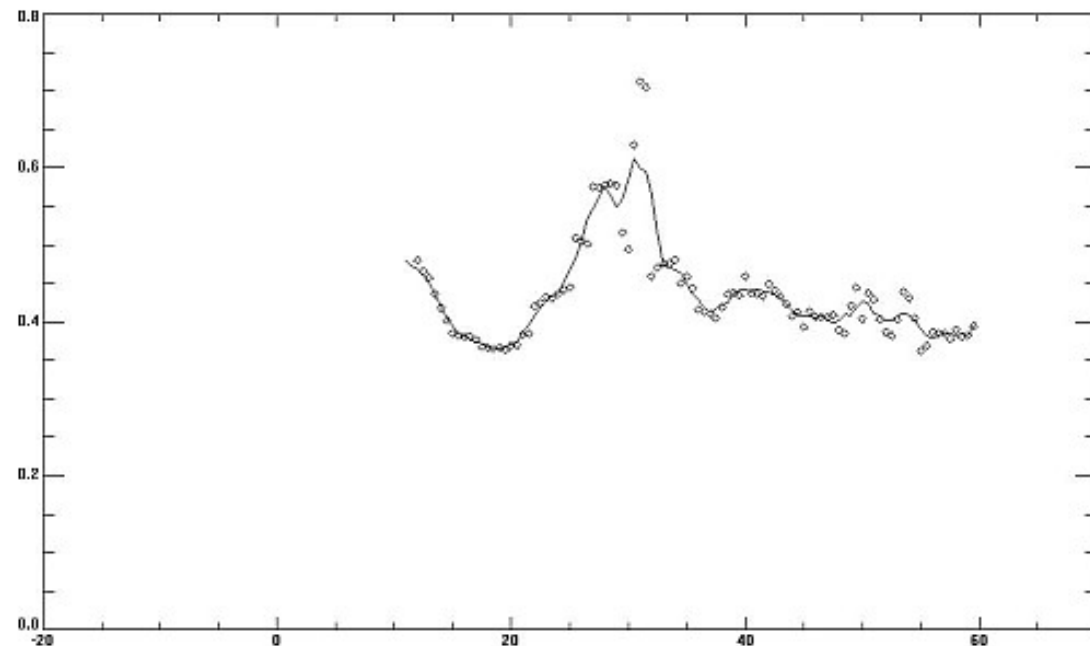


Comparison of the gridded wind with data buoy measurements

Latitudinal distribution of IRO amplitudes from the entire NDBC data base.



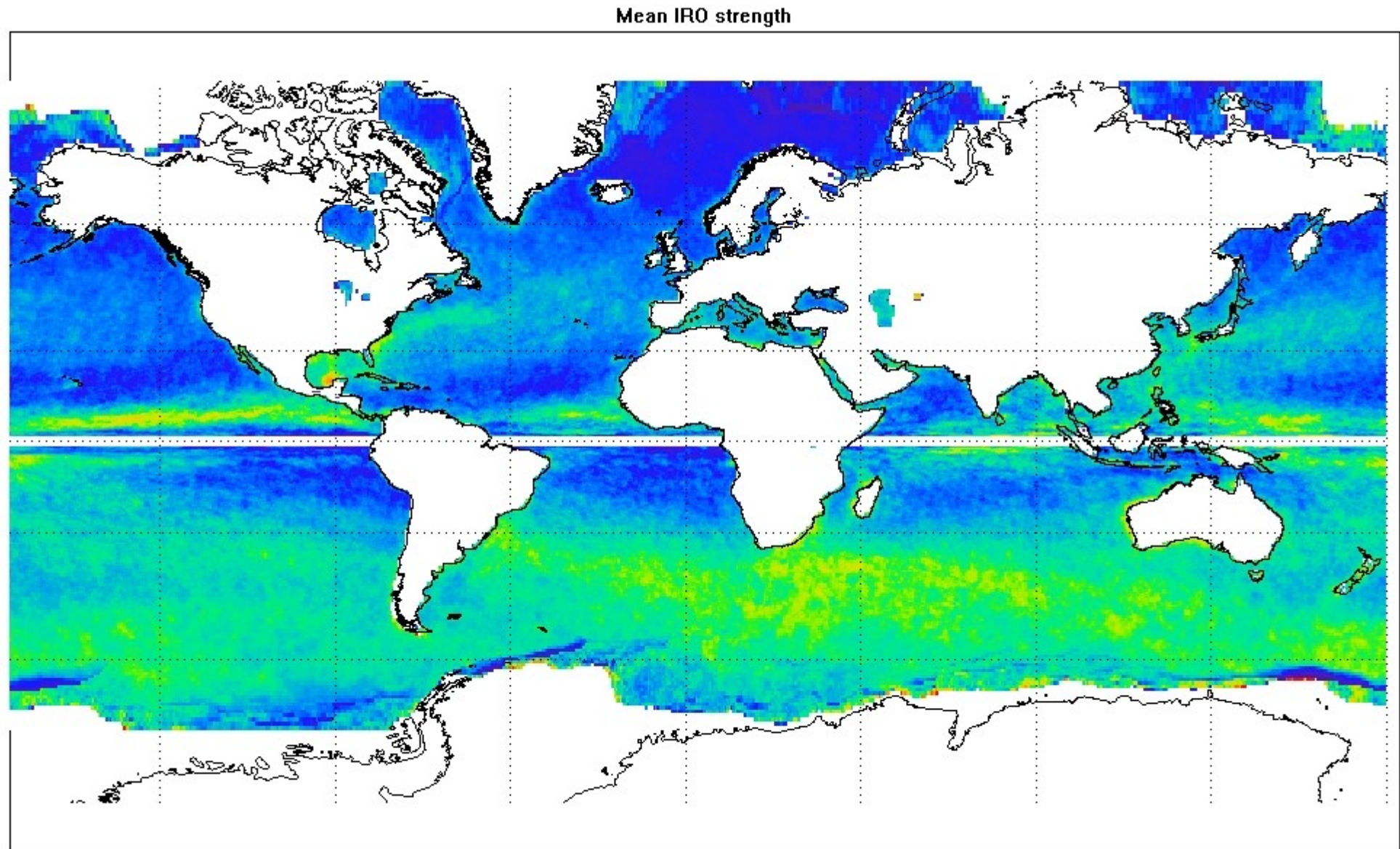
Latitudinal distribution of IRO amplitudes from the gridded winds, now restricted to the spatial regions sampled by the NDBC database (i.e. predominantly the coast of North America)



Therefore the gridded wind IRO results agree in a direct comparison (a single point to the Data Buoy), and they agree well in the aggregate.

Global measurement of IRO amplitudes.

Based on QSCAT – ADEOS-II measurements made April to October, 2003



Conclusion

In spite of the very difficult problems presented by irregularly sampled satellite data, it is possible to measure IRO amplitudes over the whole earth from space with multiple satellites.