Hurricane Force Extratropical Cyclones

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IOVWST Meeting 6-8 May 2013 Kona, Hawaii
• Validation of Ocean Prediction Center hurricane force extratropical cyclone best track database
  – Create HF extratropical best track cyclone database for both NH and SH using NCEP Reanalysis 2. Compare:
    • Seasonal and monthly tracking trends for both NH and SH
    • Monthly event frequencies
    • The length of the lifecycle and specifically the duration of HF stages

• QuikSCAT, WindSat and ASCAT HF Observational capabilities
  – Differences/Similarities in storm characteristics as a result of different measurement techniques or instrument characteristics

• Aircraft observations of HF ETC’s
  – Validate cyclone surface characteristics such as maximum wind and storm radius

• Use study results to train marine forecaster in using scatterometer data
**HF Cyclones Observed During 2000-2009 Winter Seasons**

**WARNING CATEGORIES**
- **Pre-QSCAT**
  1. GALE 34-47 kt
  2. STORM ≥48
- **QSCAT ERA**
  1. GALE 34-47 kt
  2. STORM 48-63 kt
  3. HURCN FORCE ≥ 64 kt

**Hurricane Force Warning Initiated Dec 2000**
- Detection increased with:
  - Forecaster familiarity
  - Data availability
  - Improved resolution
  - Improved algorithm

**Hurricane Force Wind Warning Initiated Dec 00**
- 25 km QuikSCAT Available in N-AWIPS Oct 01
- 12.5 km QuikSCAT available May 04
- Improved wind algorithm and rain flag Oct 06

**Totals**
- **A-289**
- **P-269**
- **558**
• Datasets
  – OPC Hurricane Force Extratropical Cyclones Database 2000-2010
  – ECMWF 6hourly analysis 2000-2009
  – NCEP Reanalysis-2 2000-2012
  – Tracking algorithm first applied on ECMWF 6hr North Atlantic analysis for period of 9 years (2000-2009).
  – During this time period ECMWF model produced only 24 cyclones that reached hurricane force winds (>63kts) based on maximum wind within storm radius tracked with automated scheme.
• ECMWF tracks first matched to OPC tracks.
  – Using minimum surface pressure, deepening rate and maximum surface wind within cyclone search radius we developed probability function that ECMWF cyclone reached HF winds
• ECMWF track maximum winds speed need to be multiplied by ~1.25 to match OPC track wind speed categories

• ECMWF track minimal surface pressure during HF stages 10mbar lower than OPC tracks

• Two databases show overall increasing trend in HF cyclones over the 9 year period
- Number of cyclones between 2000-2004 higher in NCEP-R database
- NCEP-R wind speed is ~1.07 factor lower than OPC track speeds
- Average monthly track from NCEP-R shows 5 years cyclical trend in HF ETC
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NCEP-R monthly distribution of ETC’s that reached HF status follows OPC detected trends in both N Pacific and N Atlantic ocean.

- Peak months are Dec and Jan in N Pacific and Jan in N Atlantic.
- NCEP-R shows more cyclones earlier in season in N Atlantic and later in season in N Pacific.
• In NCEP-R database cyclones HF stages are shorter for both N Pacific and N Atlantic

• OPC database observed N Pacific cyclones to have HF stage up to 24h
Southern Ocean Cyclone Characteristics

• For almost 50% of ETC that reached HF in S Pacific and S Atlantic ocean HF stages lasted only 6h

• Peak activity reached in July in Indian Ocean

• S Pacific ocean Peak activity months are April and May while S Atlantic peak activity spans over 4 months: Apr-Jul
QuikSCAT, WindSat and ASCAT Observations
QuikSCAT, WindSat and ASCAT HF Observations within North Pacific ETCs

- Hurricane Force Wind Frequency
- Storm Force Wind Frequency
- Gale Force Wind Frequency

QuikSCAT  WindSat (RSS)  ASCAT-(cmod5h)
Highest wind area:
- CLW levels <0.3mm²
- TPW < 15mm²

RSS WindSat and JPL QuikSCAT products show very similar performance within all three wind categories (gale 17-24m/s, storm 24-32.5m/s, hurricane force >32.5m/s) and therefore are complementary for this type of study.
High Winds Research
- validation set for remotely sensed winds
  - ASCAT, OceanSat-2, future instruments
  - NWP forecast models
- Instrumentation
  - GPS dropsondes, Step Freq. Microwave Radiometer
  - UMASS Imaging Wind and Rain Airborne Profiler (IWRAP)
<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Missions (31)</th>
<th>Satellite Under Flights (OSCAT-15, ASCAT-6)</th>
<th>HF Winds Measured</th>
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</thead>
<tbody>
<tr>
<td>2010</td>
<td>Flt1 01/23/2010&lt;br&gt;Flt2 01/27/2010&lt;br&gt;Flt3 02/01/2010&lt;br&gt;Flt4 02/02/2010&lt;br&gt;Flt5 02/11/2010&lt;br&gt;Flt6 02/14/2010&lt;br&gt;Flt7 02/15/2010&lt;br&gt;Flt8 02/19/2010</td>
<td>Flt1 <strong>ASCAT-A</strong> 14:57Z 17 m/s&lt;br&gt;Flt3 <strong>ASCAT-A</strong> 00:13Z 28 m/s; <strong>OSCAT</strong> 01:49Z 28 m/s&lt;br&gt;Flt4 <strong>ASCAT-A</strong> 00:44Z 24 m/s&lt;br&gt;Flt6 <strong>OSCAT</strong> 16:15Z 10 m/s&lt;br&gt;Flt7 <strong>OSCAT</strong> 15:24Z 27 m/s&lt;br&gt;Flt8 <strong>OSCAT</strong> 16:17Z 14 m/s</td>
<td>Flt4 02/02/2010 39 m/s&lt;br&gt;Flt6 02/14/2010 34 m/s&lt;br&gt;Flt7 02/15/2010 32 m/s</td>
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<td>2011</td>
<td>Flt1 01/13/2011&lt;br&gt;Flt2 01/17/2011&lt;br&gt;Flt3 01/23/2011&lt;br&gt;Flt4 01/24/2011&lt;br&gt;Flt5 01/25/2011&lt;br&gt;Flt6 01/30/2011&lt;br&gt;Flt7 02/01/2011&lt;br&gt;Flt8 02/07/2011&lt;br&gt;Flt9 02/10/2011</td>
<td>Flt1 <strong>OSCAT</strong> 17:12Z 22 m/s&lt;br&gt;Flt4 <strong>OSCAT</strong> 16:21Z 23 m/s&lt;br&gt;Flt8 <strong>OSCAT</strong> 16:21Z 26 m/s</td>
<td>Flt2 01/17/2011 32 m/s&lt;br&gt;Flt5 01/25/2011 40 m/s&lt;br&gt;Flt7 02/01/2011 36 m/s&lt;br&gt;Flt8 02/07/2011 32 m/s</td>
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<td>2012</td>
<td>Flt1 01/31/2012&lt;br&gt;Flt2 02/03/2012&lt;br&gt;Flt3 02/05/2012&lt;br&gt;Flt4 02/09/2012&lt;br&gt;Flt5 02/12/2012&lt;br&gt;Flt6 02/15/2012</td>
<td>Flt1 <strong>OSCAT</strong> 16:18Z 27 m/s</td>
<td>Flt2 02/03/2012 33 m/s&lt;br&gt;Flt3 02/05/2012 33.5&lt;br&gt;Flt4 02/09/2012 32 m/s</td>
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<td>2013</td>
<td>Flt1 01/22/2013&lt;br&gt;Flt2 01/23/2013&lt;br&gt;Flt3 01/25/2013&lt;br&gt;Flt4 02/02/2013&lt;br&gt;Flt5 02/04/2013&lt;br&gt;Flt6 02/08/2013&lt;br&gt;Flt7 02/12/2013&lt;br&gt;Flt8 02/14/2013</td>
<td>Flt1 <strong>OSCAT</strong> 17:05Z 18 m/s&lt;br&gt;Flt2 <strong>OSCAT</strong> 16:14Z 24 m/s&lt;br&gt;Flt4 <strong>OSCAT</strong> 01:52Z 24 m/s&lt;br&gt;Flt5 <strong>ASCAT-A</strong> 23:24Z 27 m/s; <strong>ASCAT-A</strong> 01:14Z 29 m/s; <strong>OSCAT</strong> 01:50Z 28 m/s&lt;br&gt;Flt6 <strong>OSCAT</strong> 14:36Z 27 m/s&lt;br&gt;Flt7 <strong>ASCAT-B</strong> 15:15Z 9 m/s; <strong>OSCAT</strong> 16:17Z 12 m/s&lt;br&gt;Flt8 <strong>OSCAT</strong> 16:20Z 23 m/s; <strong>AMSR2</strong> 17:00Z 17 m/s</td>
<td>Flt2 01/23/2013 36 m/s&lt;br&gt;Flt6 02/08/2013 33 m/s</td>
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NOAA Aircraft Research
Winter Ocean Storms

Feb 1, 2011 – Depart Halifax, NS Canada  1332 UTC
3 hour ferry flight to developing major ocean cyclone
Mission: SAMPLE HIGHEST WINDS
QuikSCAT – N Atlantic

Monthly Distribution - N Atlantic - 2001-2009

- OPC
- NCEP-R

Wind Speed (knots)

- November
- December
- January
- February
- March

Wind Speed Legend:

- 0
- 5
- 10
- 15
- 20
- 25
- 30

- September
- October
- November
- December
- January
- February
- March
- April
- May

Map of wind speed distribution for different months in the North Atlantic.
Waypoints 1, 2, 3, 4

GDAS & ASCAT winds

GFS TUE 11/20/17 1200UTC 24 HRN SEA LEVEL PRESSURE
GFS 11/20/17 1200 UTC 24 (10m WIND; KTS)
Conclusions

• Hurricane force ETCs 2000-2012 database constructed using NCEP-Reanalysis 2
  – Results reveal cyclical trend in HF ETC in both N Pacific and N Atlantic and Southern Oceans
• Performed comparison of QuikSCAT, WindSat and ASCAT HF ETC observations
  – All three data set reveal similar wind field structures, radius and frequency of hurricane, storm and gale force winds
• 31 flights into N Atlantic ETCs conducted from 2010-2013
  – 15 OSCAT and 6 ASCAT underflights
  – Aircraft measurements validated studies wind field distribution and highest wind radius results
• Results of this study used in scatterometer training for marine forecasters
• The ETC HF OPC and NCEP-R database together with NOAA aircraft ETC N Atlantic flight data will be made available to the community via manati web site within next year