Hurricane Force Extratropical Cyclones as Observed by QuikSCAT

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Outline

1. 7 yr. QuikSCAT climatology
2. Impact / forecast skill
3. 12 km WRF results
4. Summary
QuikSCAT

Increased awareness of the *pervasiveness* of Hurricane Force Winds

Intense, non-tropical cyclone with hurricane force winds Feb 23, 2008, North Pacific
Methodology

• 6 hourly oceanic surface analyses
• Forecaster decision (based on all data - primarily QuikSCAT)
• Catalog events
• Similar to NHC “best track”
  – some post analysis
Hurricane Force Extratropical Cyclones - Detection and Warning Trend using QuikSCAT

**WARNING CATEGORIES**

- **Pre-QuikSCAT**
  1. GALE 34-47 kt
  2. STORM ≥48

- **QuikSCAT 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

- Improved wind algorithm and rain flag Oct 06
- 12.5 km QuikSCAT available May 04
- 25 km QuikSCAT Available in N-AWIPS Oct 01

- Hurricane Force Wind Warning Initiated Dec 00
- QuikSCAT Launch Jun 99

- Atlantic
- Pacific

2001-2008 Climatology

7yr Average Monthly Distribution

average number of HF cyclones 7 yrs

Month

Sept Oct Nov Dec Jan Feb Mar Apr May

Atlantic
Pacific
2001-2008 Climatology

Distribution of Maximum 24 Hour Deepening Rate

1 Bergeron = 1 mb / hour @ 60 deg latitude
2001-2008 Climatology

- Hurricane Force winds in extratropical storms
  - much more frequent than thought
  - Detection linked to algorithm and resolution improvements
  - Onset within 24 hours of cyclone reaching maturity (minimal central pressure)
  - Conditions short lived, average 24 hrs or less
  - Occur on meso to small synoptic scale in limited precipitation and little turning of wind!!! (over unparalleled fetch lengths)
    - Scale appropriate for remote sensing
    - Primarily ocean phenomena...landfall possible (West Coast, AK, Maritimes, Europe, New England)
      - waves do impact shoreline
    - Do not know maximum strength of winds!
      - Category 2, 3, or 4?
Major Shipping Routes
North Atlantic
4,000/yr container transits
1,000/yr bulkers


Geographic distribution of cyclones with winds of HF intensity Sep-May 2000-2007

7 yr annual average number of extratropical cyclones observed (contoured) with hurricane force winds for the years 2001 - 2008
Major Shipping Routes North Pacific
6,000/yr container
1,500/yr bulker


7 yr annual average number of extratropical cyclones observed (contoured) with hurricane force winds for the years 2001 - 2008
Impact on Maritime Commerce

- Present level of warning/forecast services to 48 hours w/QuikSCAT
  - $135 million per year savings in reduced damage / cargo loss for **container** and **bulk** commerce (Kite-Powell, 2008)
  - Potential impact of other instruments (XOVWM and ASCAT) also defined
  - Second study near shore/coastal impacts underway - QuikSCAT vs XOVWM
2 & 4 day cyclone forecast skill

Mean Sea Level Pressure Error (hPa)
(Observed - Forecast)

ATL
PAC

48_ATL_ALL
48_PAC_ALL
96_ATL_ALL
96_PAC_ALL

Mean position error (n mi)

ATL
PAC

48_ATL_ALL
48_PAC_ALL
96_ATL_ALL
96_PAC_ALL

2 & 4 day warning skill

Hurricane Force Warning Skill
Probability of Detection

POD

Hurricane Force Warning Skill
False Alarm Ratio

FAR

2 & 4 day forecast skill

- More skill in Atlantic than Pacific (intensity, track, warning)
- Skill improvement from 92/93 review (Uccellini et al 1999) has been slow
- Intensity forecast skill still underestimates development rates for most intense storms
- Underestimate of intensity translates to warning skill
  - Appreciable skill at 48 hrs
  - Limited at 96 hrs (suggests probabilistic approach)
- In essence for HF cyclones:
  - Can predict cyclone will exist and where
    under predict intensity and associated winds
0000 UTC 9 Feb 2007
Atlantic

12 km WRF

PMSL

Wind Speed

925 mb Theta, Theta gradient

925 mb frontogenesis

WRF results

• Hurricane Force Winds
  – Successfully modeled (7 cases)
  – Onset, rapidly deepening phase
  – Bent-back front, key ingredient to formation of low-level jet, HF winds
  – Onset of winds occurs in area of maxima of frontolysis downstream of area of frontogenesis
  – Scale varies, meso to small synoptic scale

• Science issues
  – Mechanism for development of structure and for momentum transfer
  – Predictability; maximum winds

Using results to tailor ensemble based forecast guidance
Summary

• Hurricane Force conditions exist in non-tropical cyclones (much more frequent than thought)
  – Validation of high winds **NEEDED**

• Loss of QuikSCAT
  – Significant reduction in detection, warning & verification capabilities (lose consistency!!!)
    • Rely on ASCAT, conventional obs, satellite interpretation, **NWP analyses**
    • ASCAT – (Poster – Khalil Ahmad)

• Effort initiated by NOPP and then R2O

• HF Cyclone database available at:
  – Hurcn_Force_Pac_Atl_01_08.xls