Hurricane Force Extratropical Cyclones

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Outline

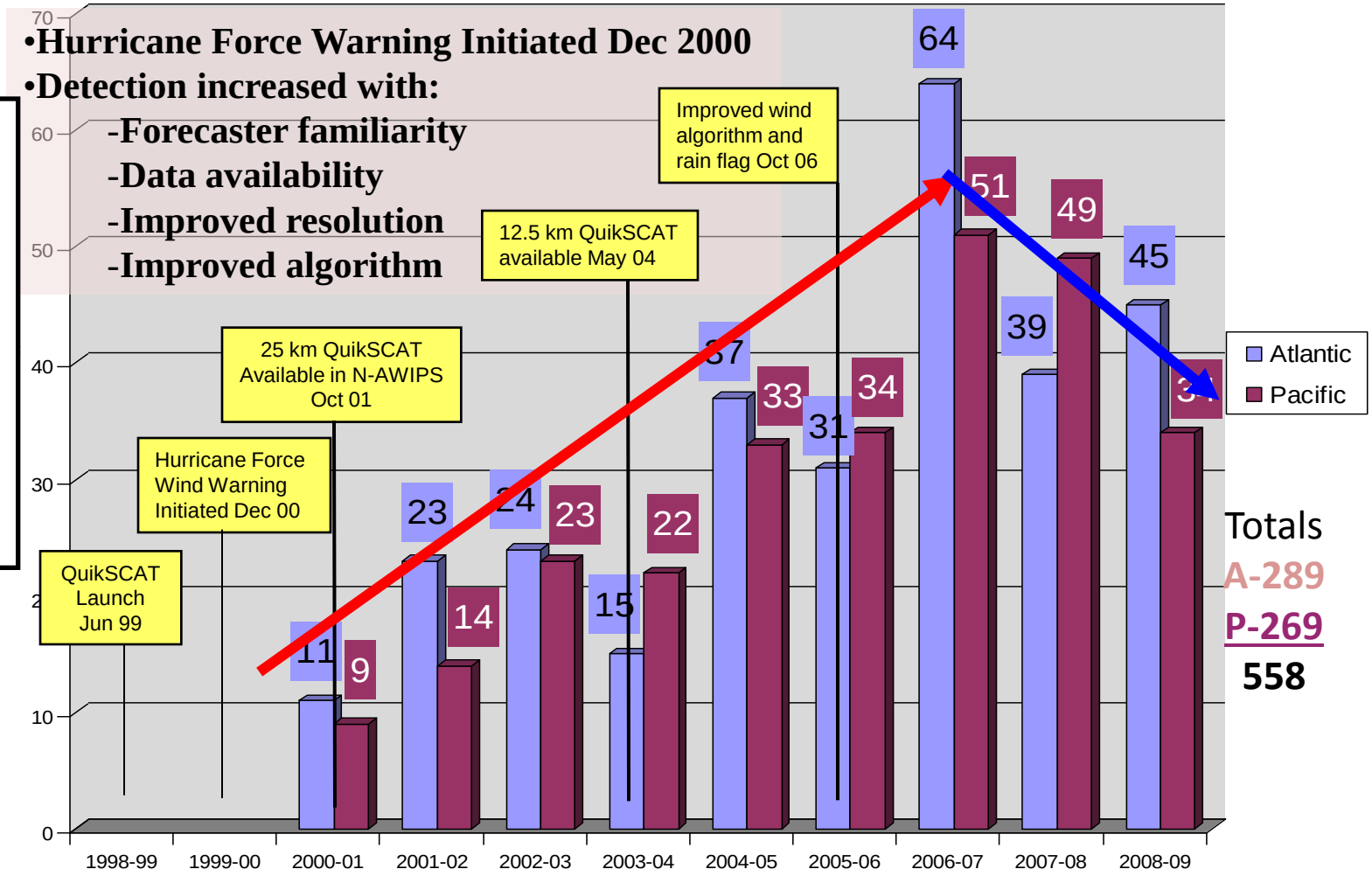
- **Validation of Ocean Prediction Center hurricane force extratropical cyclone best track database**
  - Create HF extratropical best track cyclone database for both NH and SH using NCEP Reanalysis 2. Compare:
    - Seasonal and monthly tracking trends for both NH and SH
    - Monthly event frequencies
    - 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

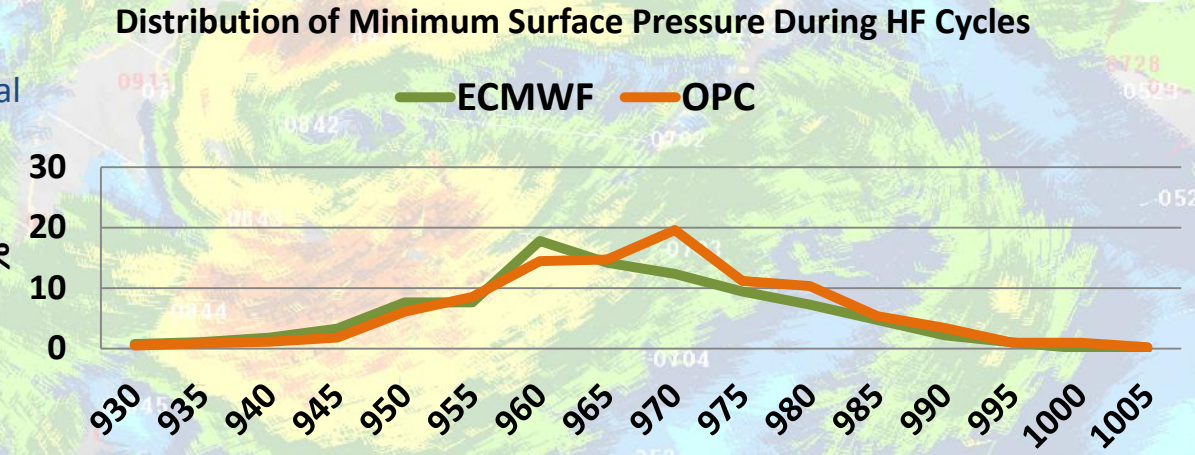
Pre- QSCAT
1. GALE 34-47 kt
2. STORM ≥48

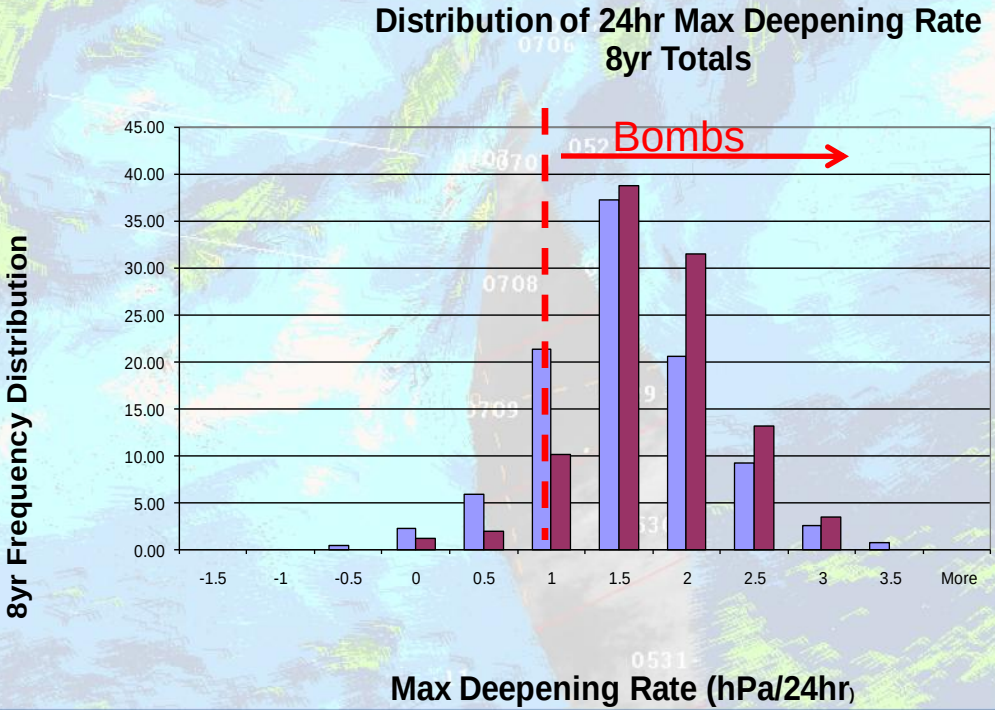
QSCAT ERA
1. GALE 34-47 kt
2. STORM 48 -63 kt
3. HURCN FORCE ≥ 64 kt



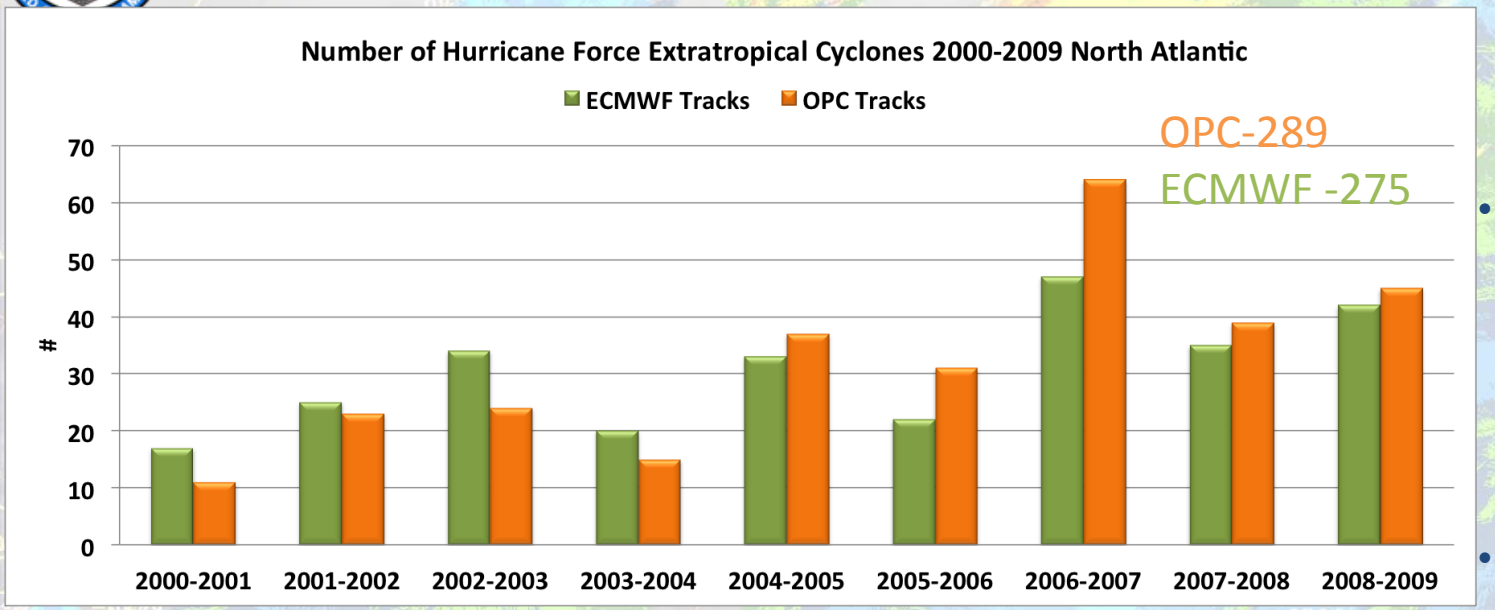
Methodology

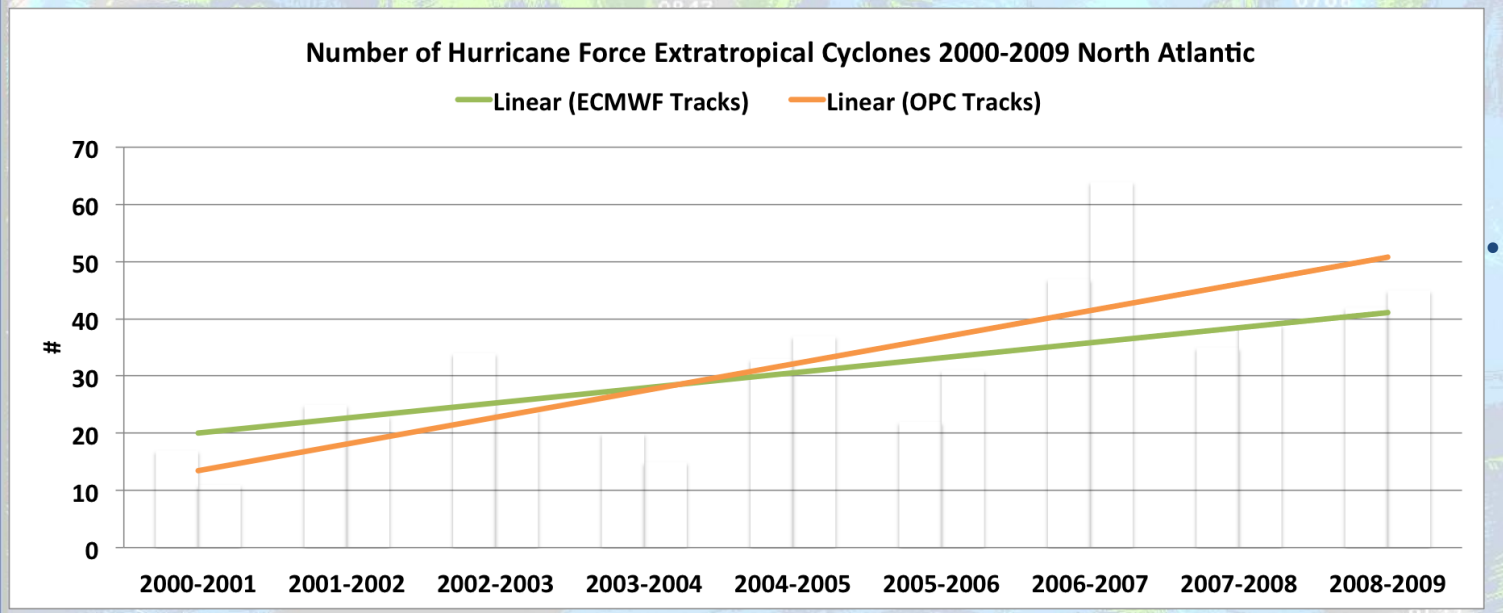
- Datasets
  - OPC Hurricane Force Extratropical Cyclones Database 2000-2010
  - ECMWF 6hourly analysis 2000-2009
  - NCEP Reanalysis-2 2000-2012
- Lin and Simmonds (2002) cyclone tracking scheme adopted by Jerome Patoux (Patoux at al (2009))
  - Tracking algorithm first applied on ECMWF 6hr North Atlantic 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 minimun surface pressure, deepening rate and maximum surface wind within cyclone search radius we developed probability function that ECMWF cyclone reached HF winds





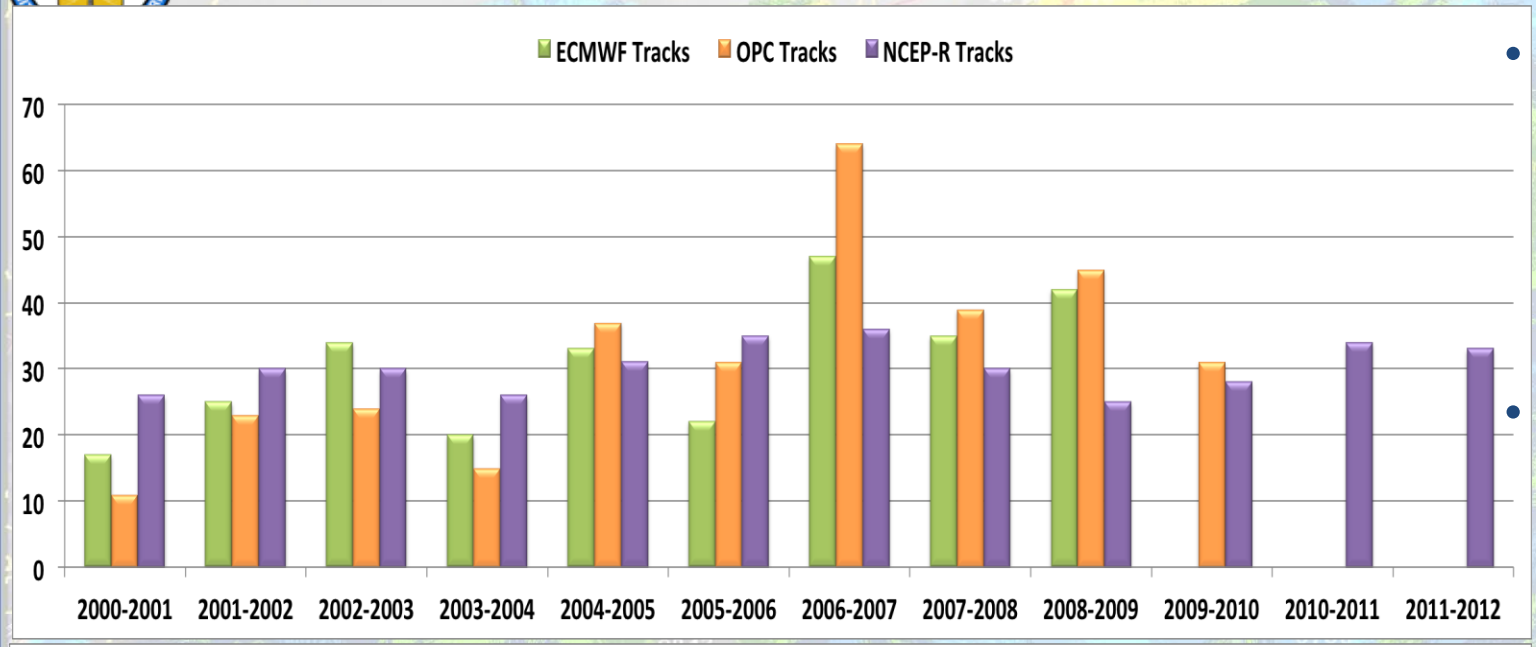
ECMWF vs OPC Hurricane Force ETCs Database 2000-2009

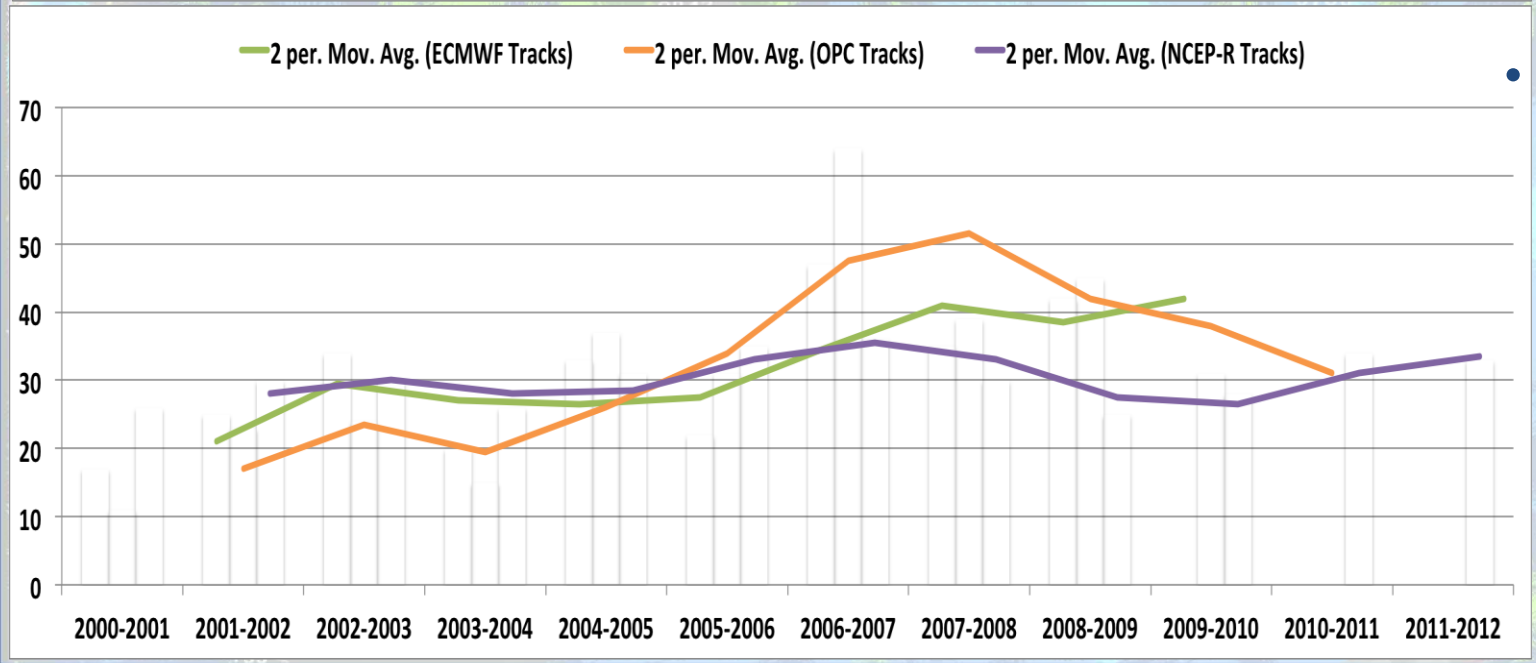




- ECMWF track maximum winds speed need to be multiplied by ~1.25 to match OPC track wind speed categories
- ECMWF track minimal surface pressure during HF stages 10mbar lower than OPC tracks
- Two databases show overall increasing trend in HF cyclones over the 9 year period

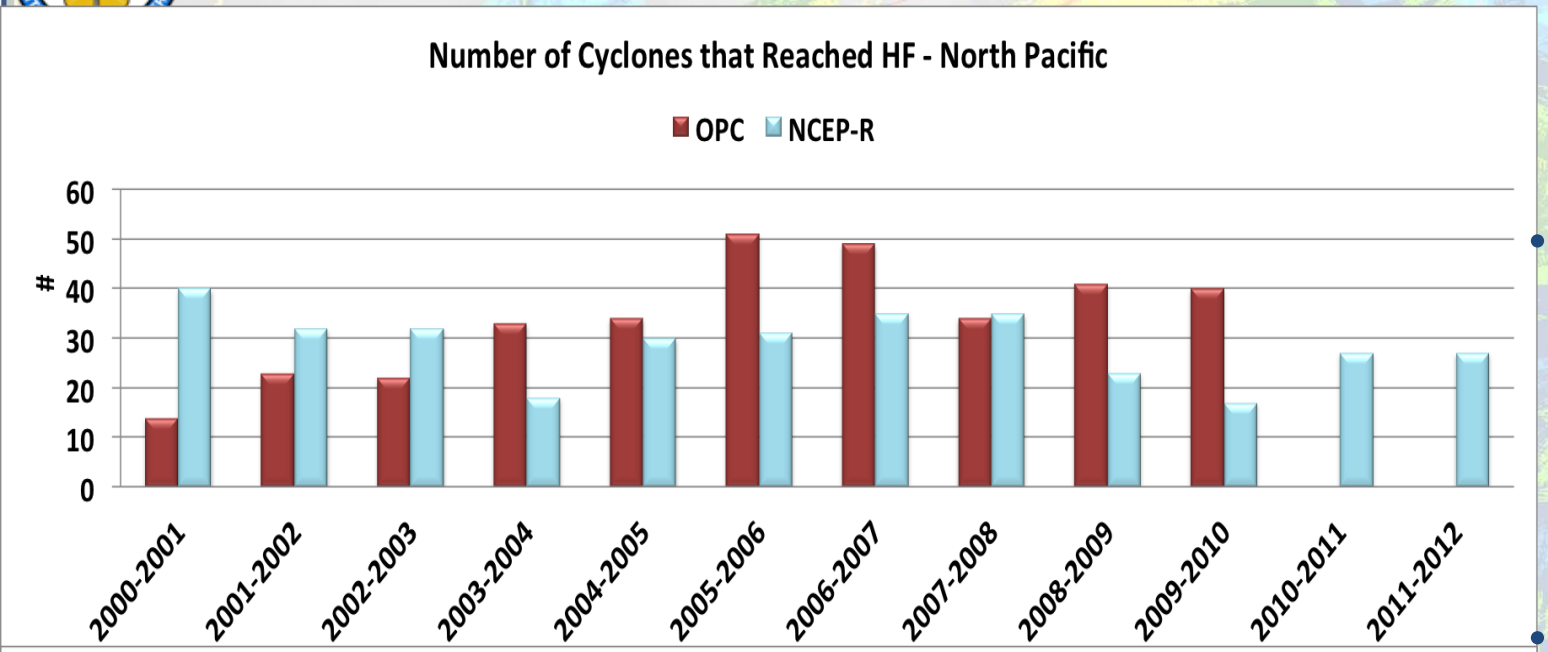
North Atlantic HF ETC 2000-2012 Database

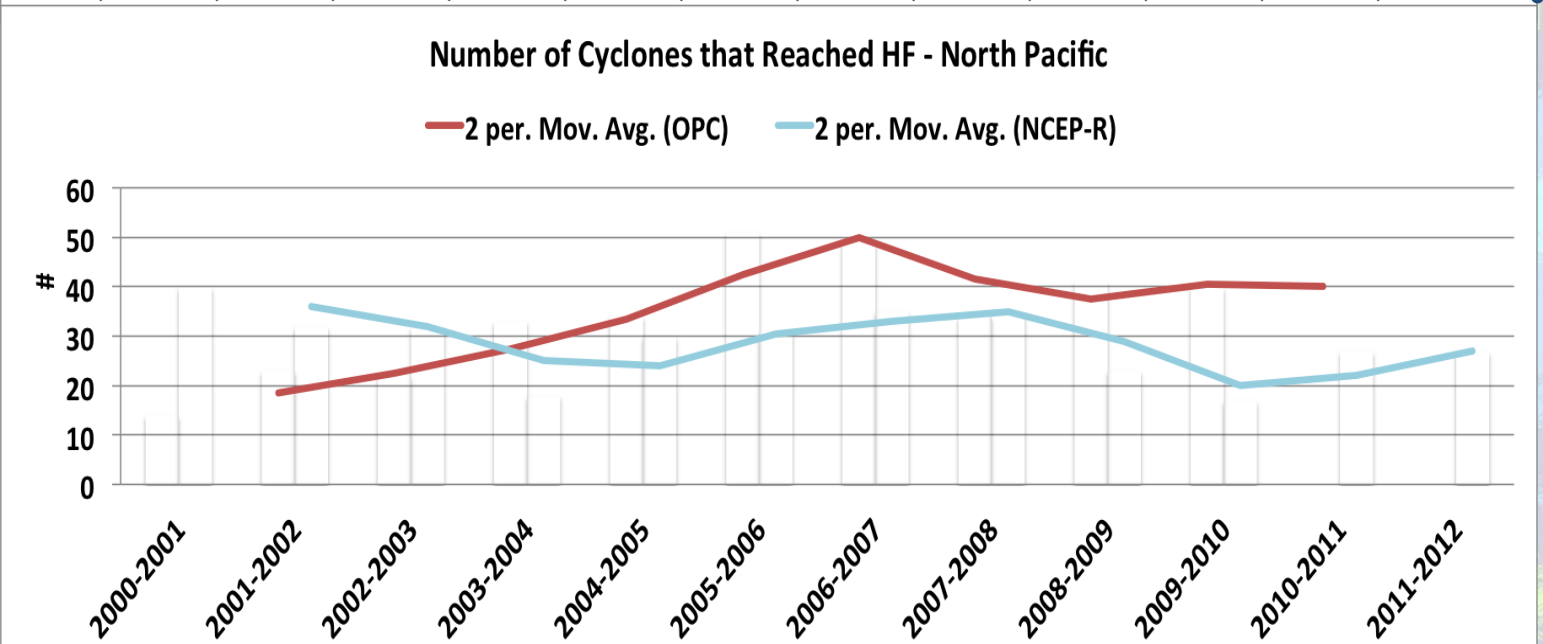




- # of cyclones between 2000-2004 higher in NCEP-R database
- NCEP-R wind speed is ~1.07 factor lower than OPC track speeds
- Average monthly track from NCEP-R shows 5 years cyclical trend in HF ETC

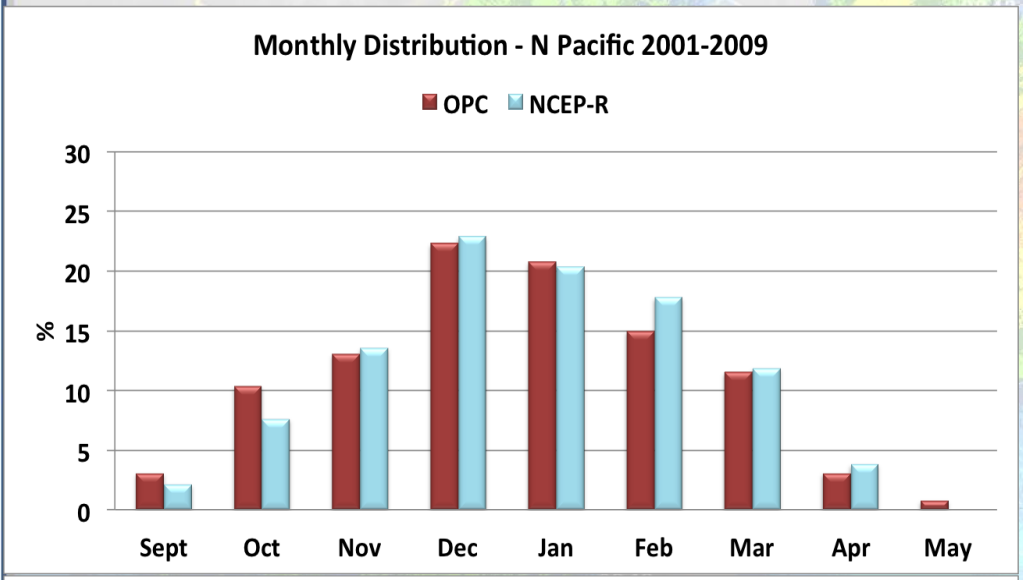
North Pacific ETC 2000-2012

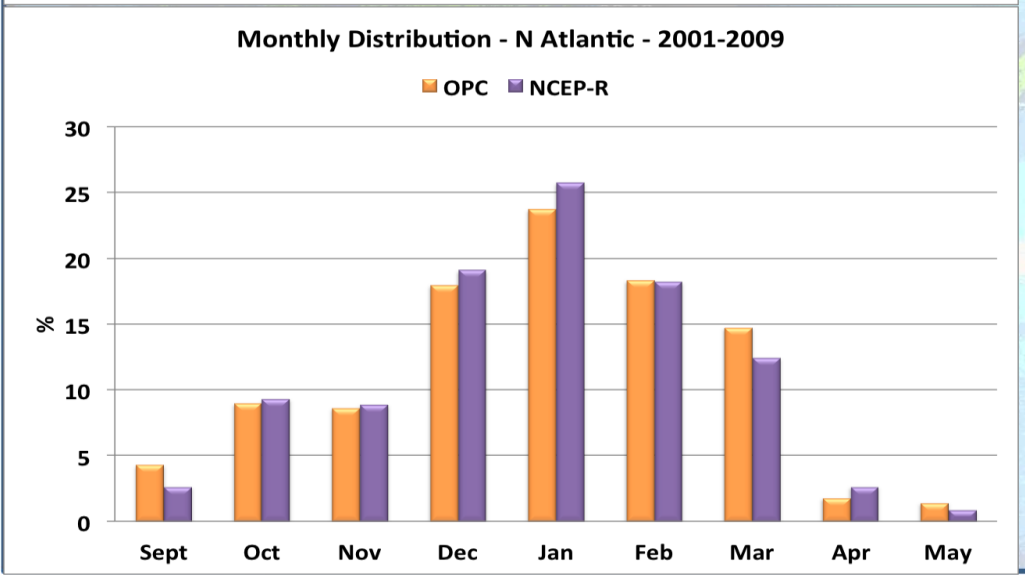




- NCEP-R wind speed is ~1.07 factor lower than OPC track speeds
- Average monthly track from NCEP-R shows 5 years cyclical trend in HF ETC

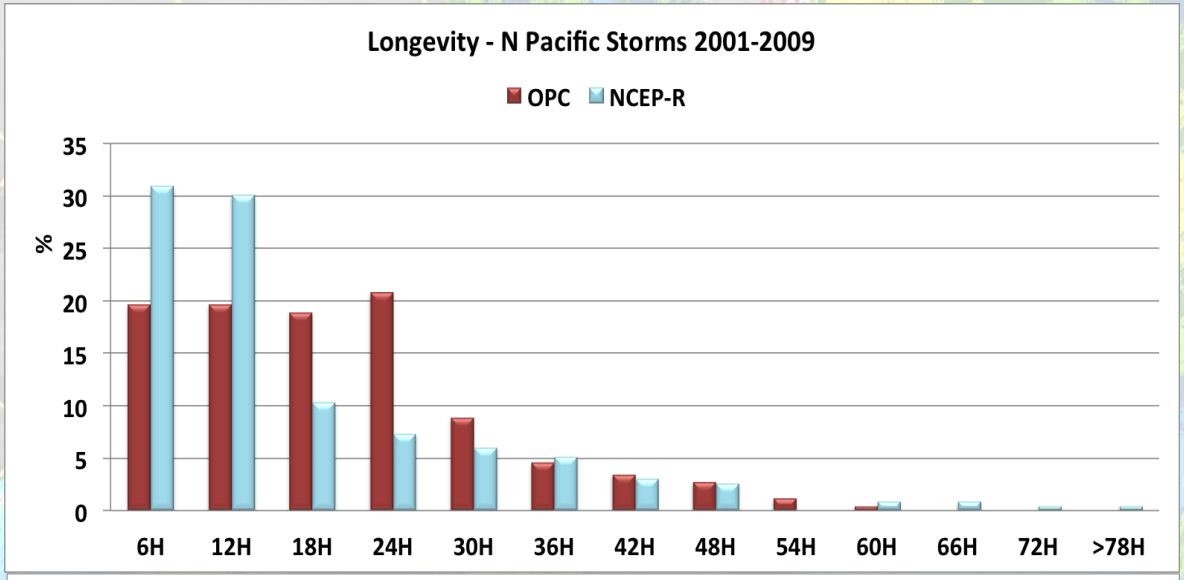
Monthly Distribution 2001-2009

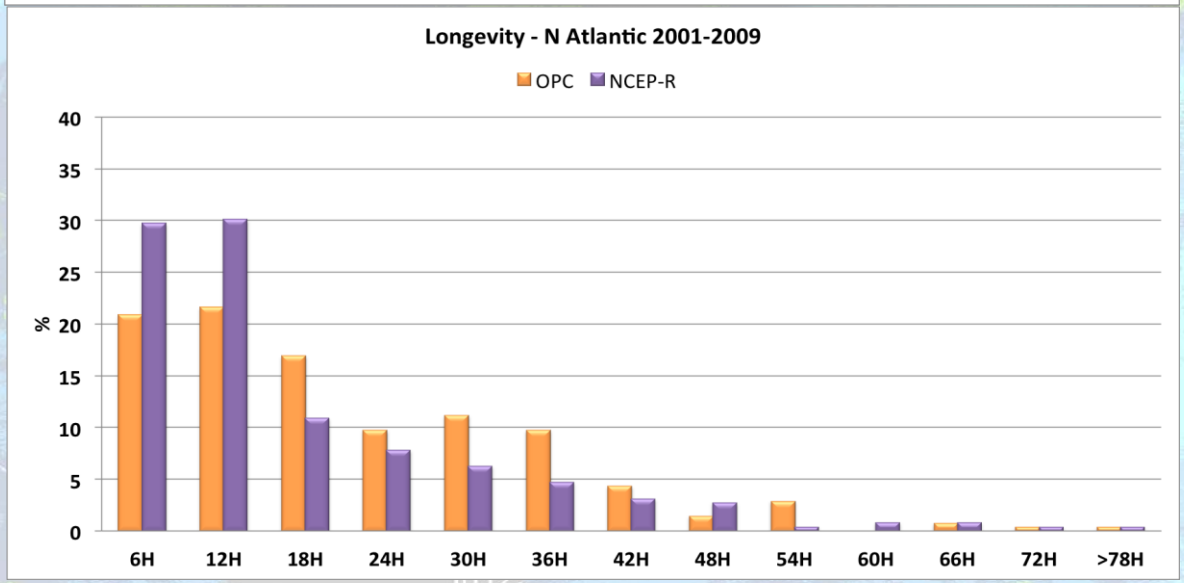




- NCEP-R monthly distribution of ETC's that reached HF status follows OPC detected trends in both N Pacific and N Atlantic ocean
- Peak months are Dec and Jan in N Pacific and Jan in N Atlantic
- NCEP-R shows more cyclones earlier in season in N Atlantic and later in season in N Pacific

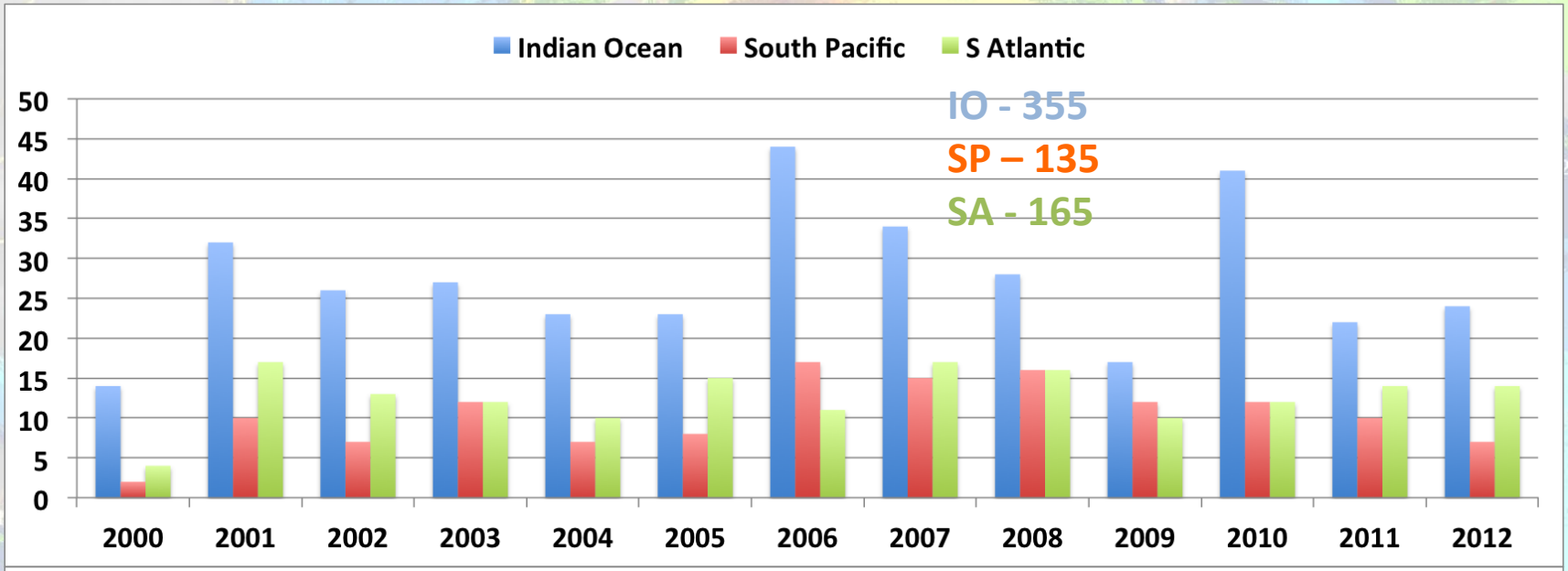
Hurricane Force Cycle Longevity
N Pacific and N Atlantic

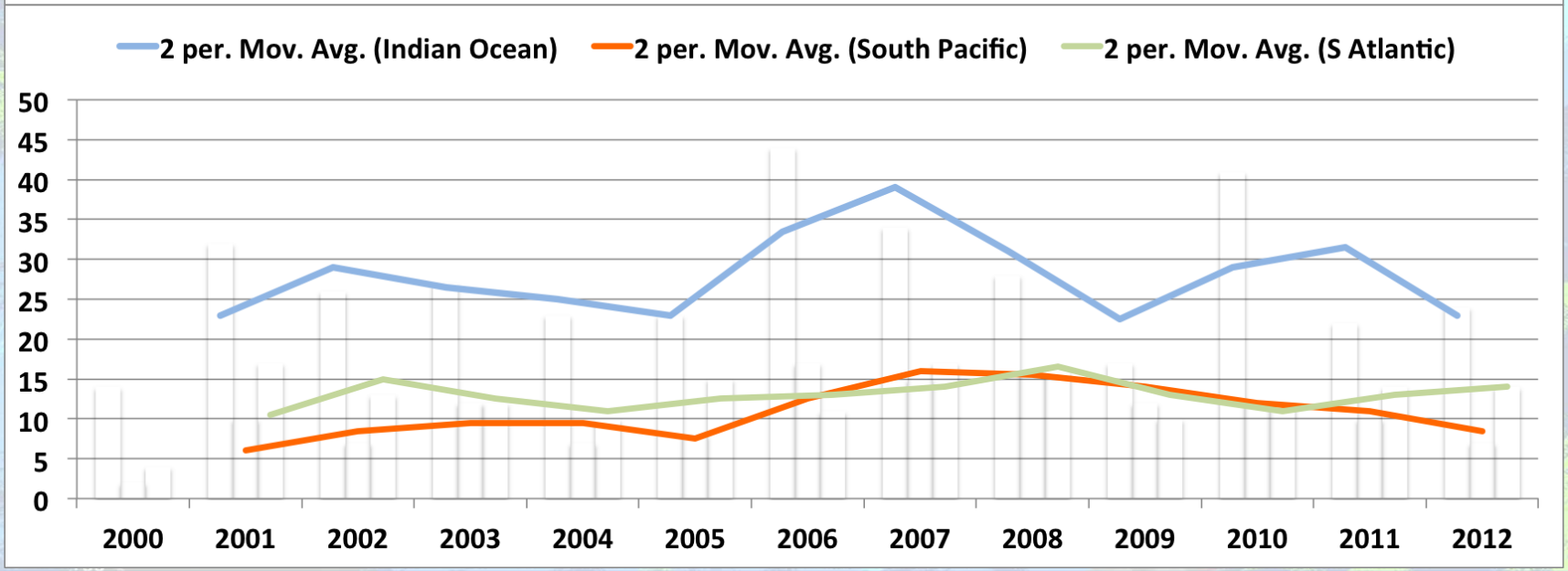




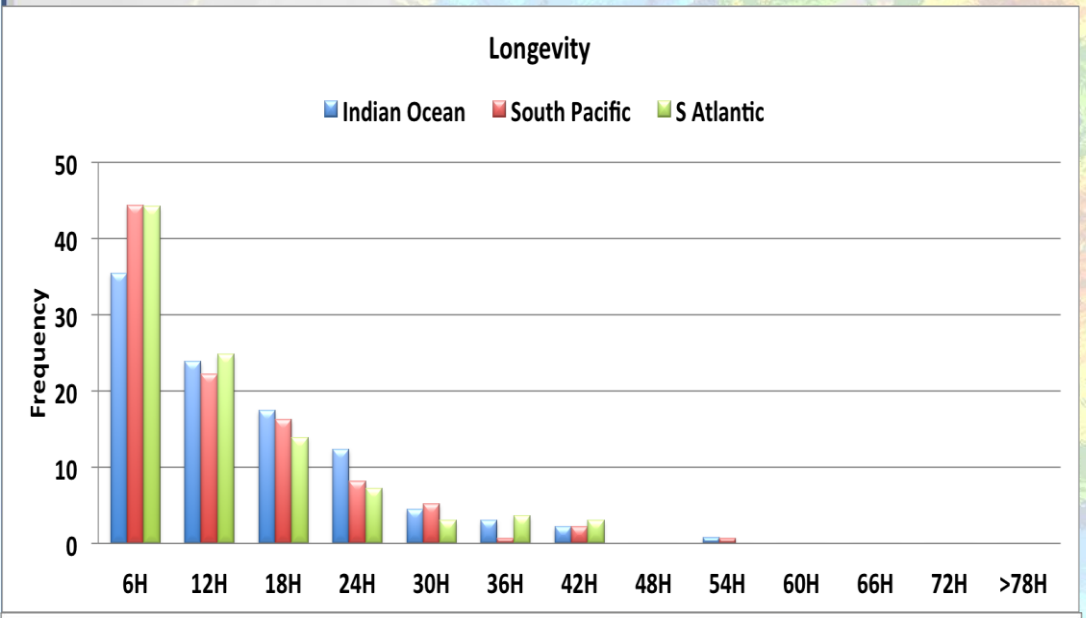
- In NCEP-R database cyclones HF stages are shorter for both N Pacific and N Atlantic
- OPC database observed N Pacific cyclones to have HF stage up to 24h

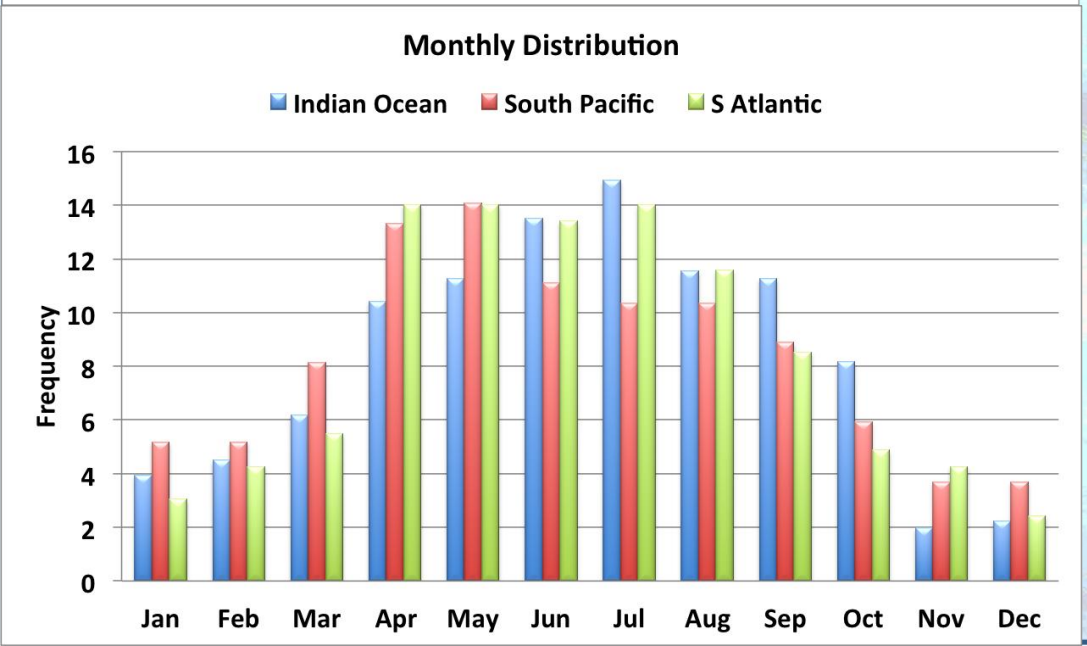
Southern Oceans Cyclone Tracks



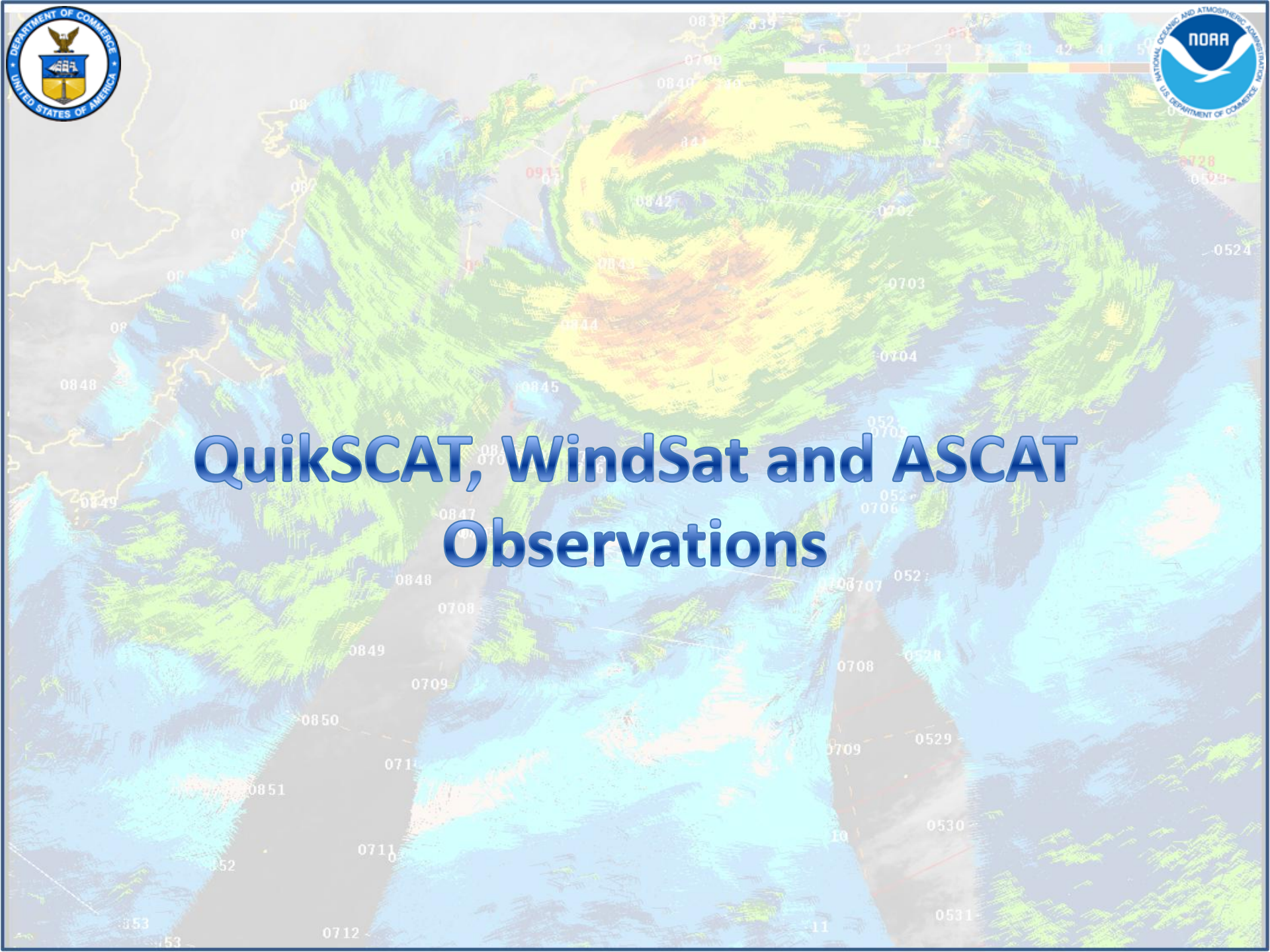


Southern Ocean Cyclone Characteristics



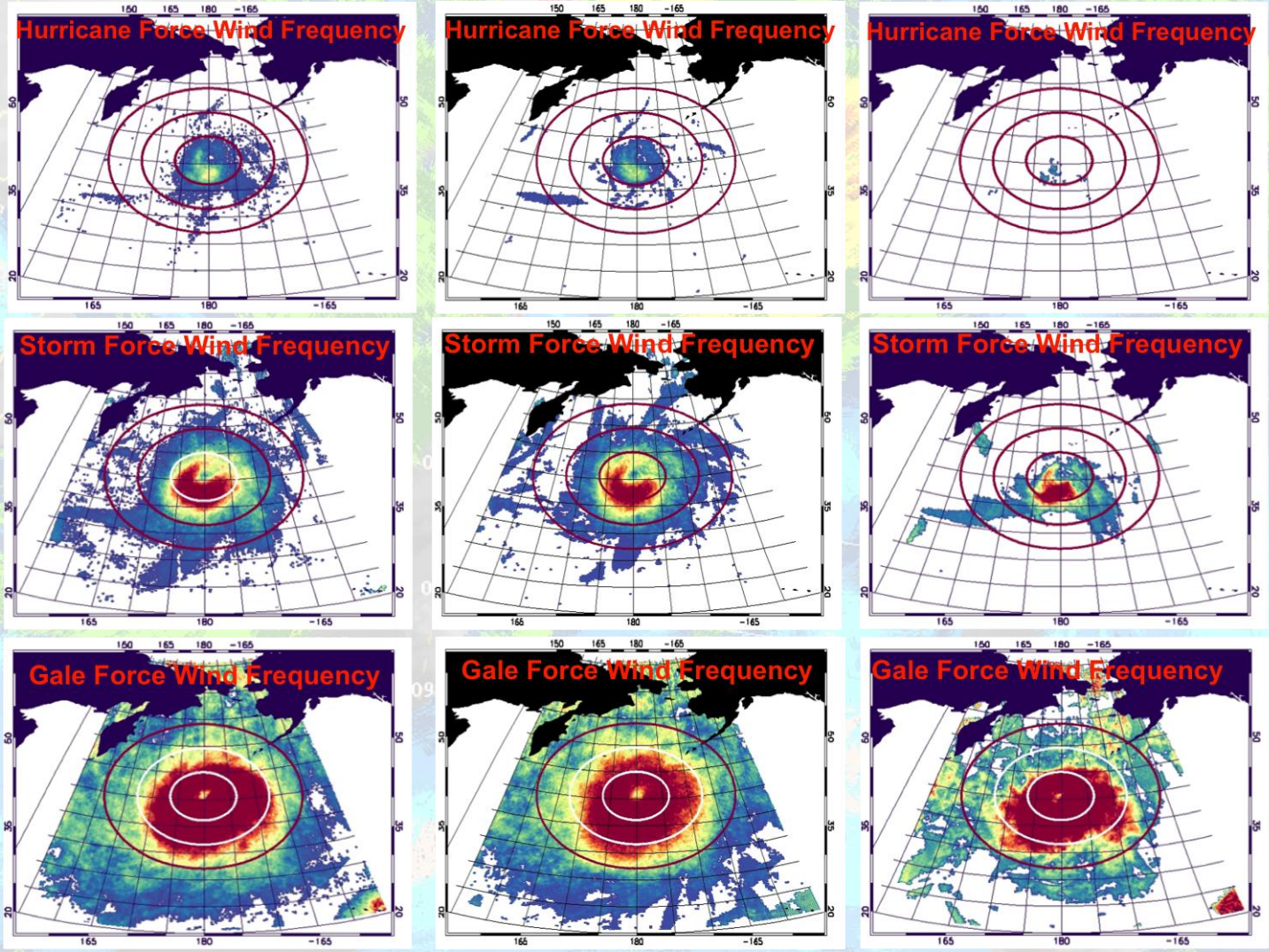


- For almost 50% of ETC that reached HF in S Pacific and S Atlantic ocean HF stages lasted only 6h
- Peak activity reached in July in Indian Ocean
- S Pacific ocean Peak activity months are April and May while S Atlantic peak activity spans over 4 months: Apr-Jul



QuikSCAT, WindSat and ASCAT Observations

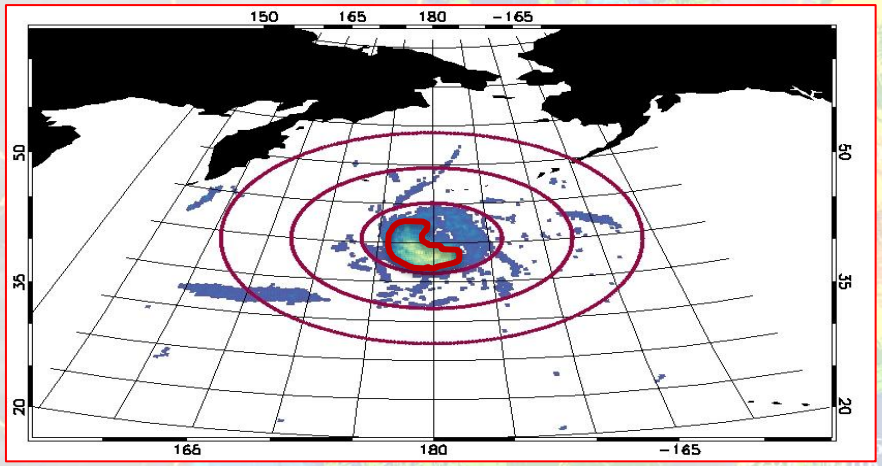
QuikSCAT, WindSat and ASCAT HF Observations within North Pacific ETCs



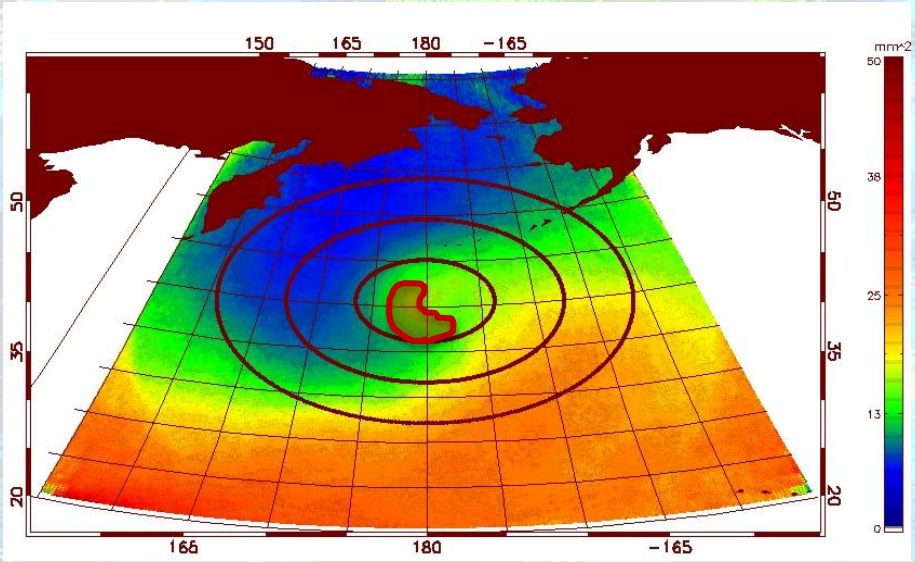
QuikSCAT WindSat (RSS) ASCAT-(cmod5h)

WindSat CLW and TPW Composites

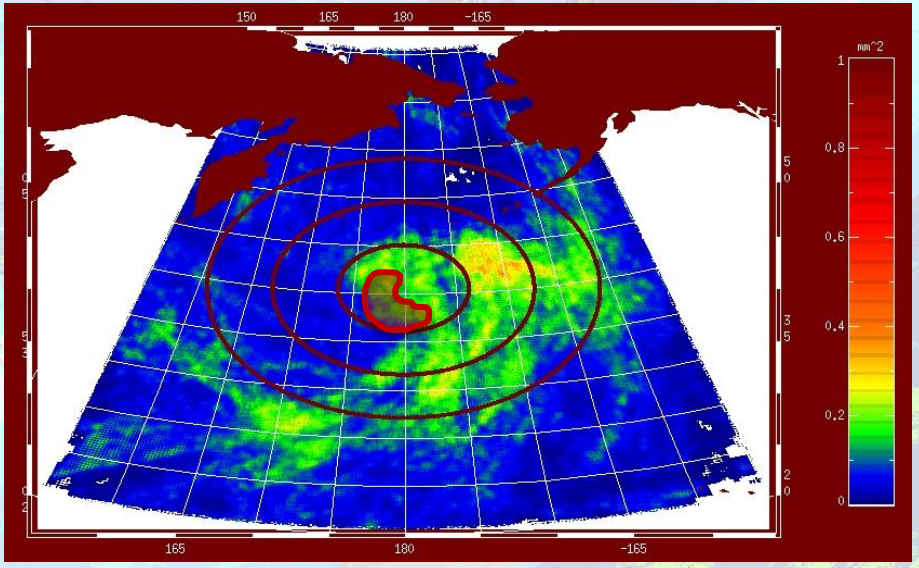
Frequency of HF wind occurrence within 3000km from ETC center



- Highest wind area:
  - CLW levels <0.3mm^2
  - TPW < 15mm^2
- 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.



TPW composites during ETC HF stages



CLW composites during ETC HF stages

NOAA Aircraft Research
Winter Ocean Storms

Key

Flight level

PS dropsonde

Time (UTC)

SFMR WS

Feb 4, 2010

HF drops

HF SFMR

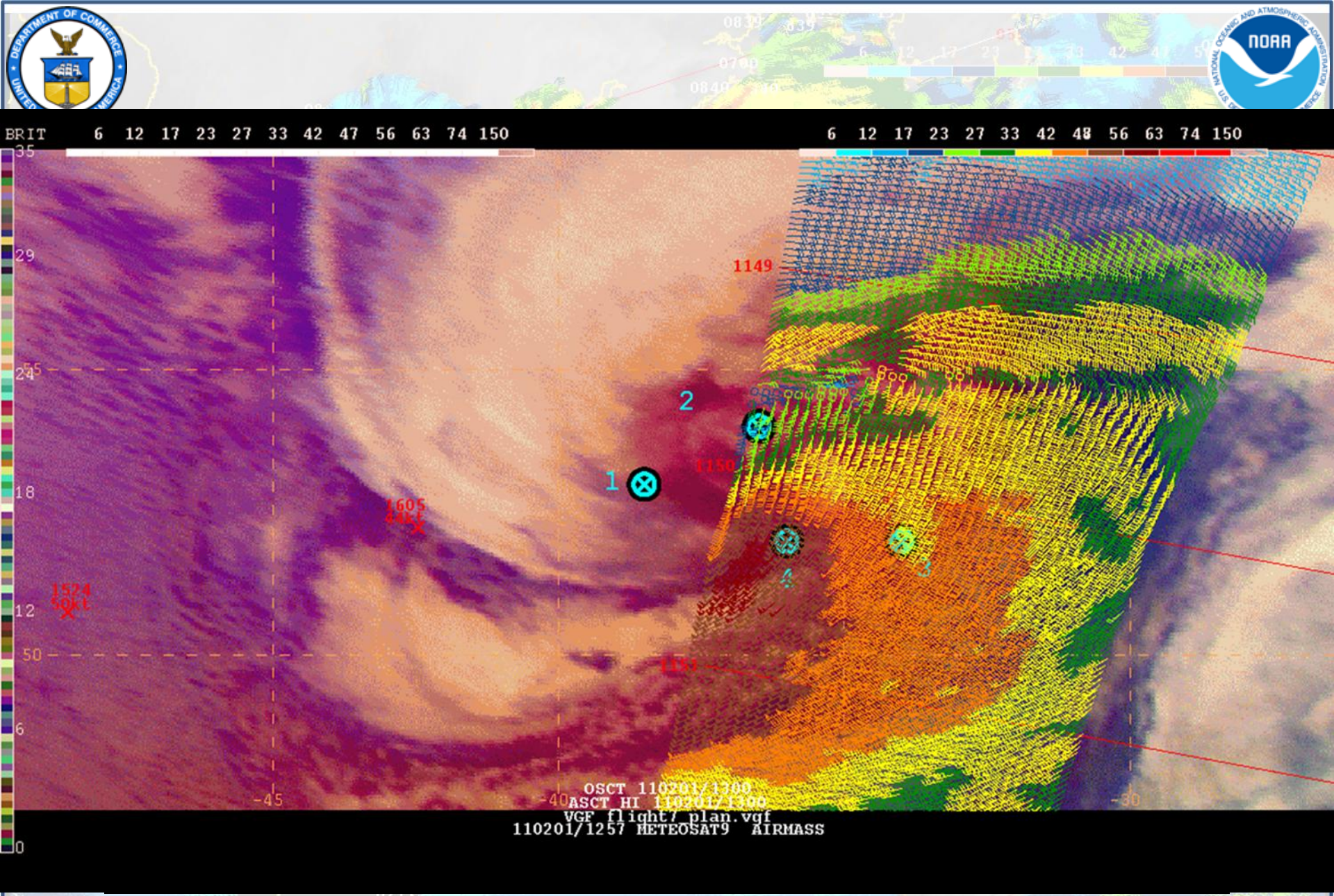
High Winds Research

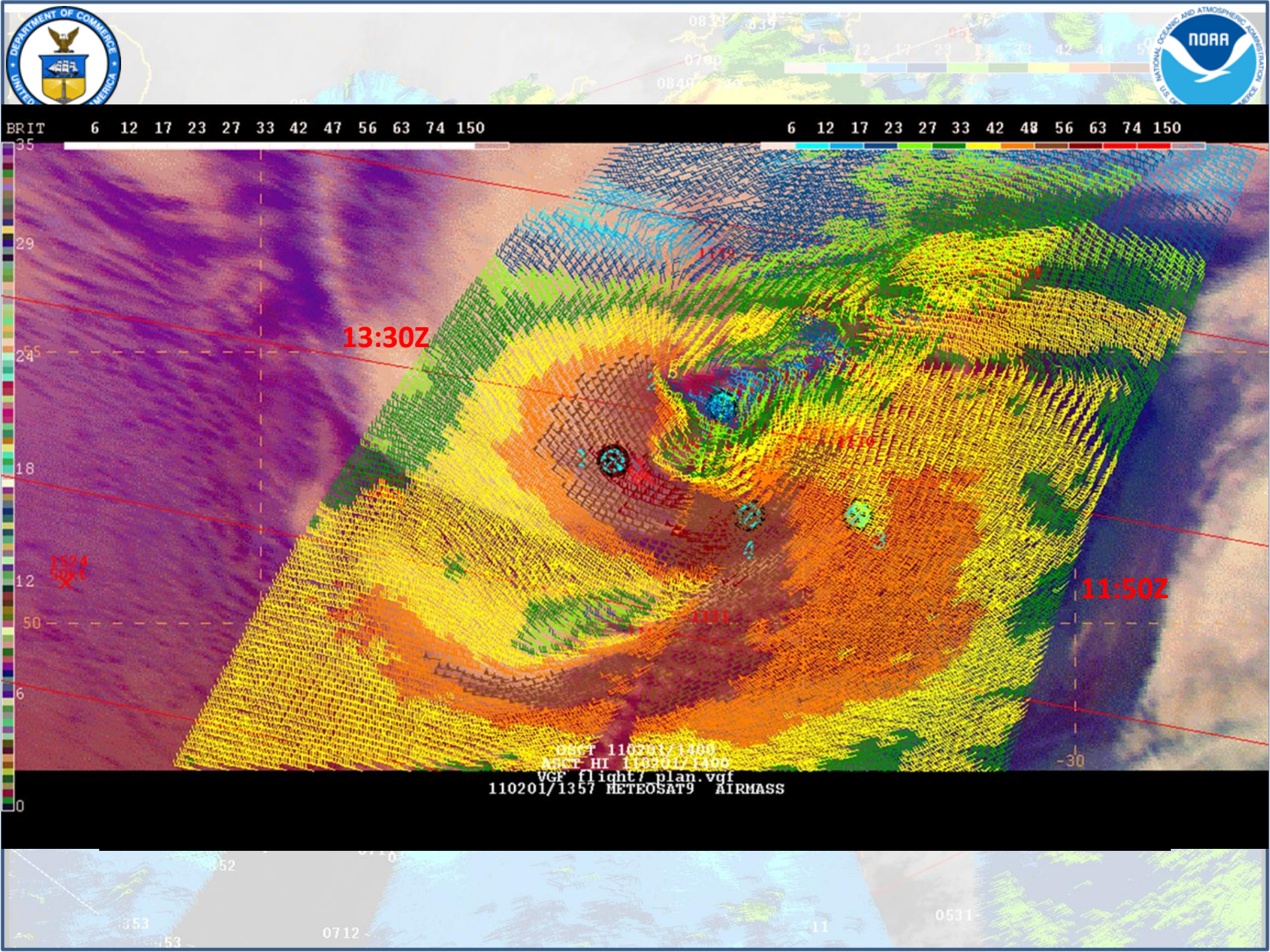
- validation set for remotely sensed winds
  - ASCAT, OceanSat-2, future instruments
  - NWP forecast models
- Instrumentation
  - GPS dropsondes, Step Freq. Mirowave Radiometer
  - UMASS Imaging Wind and Rain Air-borne Profiler (IWRAP)

Year	Number of Missions (31)	Satellite Under Flights (OSCAT-15, ASCAT-6)	HF Winds Measured
2010	Flt1 01/23/2010 Flt2 01/27/2010 Flt3 02/01/2010 Flt4 02/02/2010 Flt5 02/11/2010 Flt6 02/14/2010 Flt7 02/15/2010 Flt8 02/19/2010	Flt1 ASCAT-A 14:57Z 17 m/s Flt3 ASCAT-A 00:13Z 28 m/s; OSCAT 01:49Z 28 m/s Flt4 ASCAT-A 00:44Z 24 m/s Flt6 OSCAT 16:15Z 10 m/s Flt7 OSCAT 15:24Z 27m/s Flt8 OSCAT 16:17Z 14 m/s	Flt4 02/02/2010 39m/s Flt6 02/14/2010 34m/s Flt7 02/15/2010 32m/s
2011	Flt1 01/13/2011 Flt2 01/17/2011 Flt3 01/23/2011 Flt4 01/24/2011 Flt5 01/25/2011 Flt6 01/30/2011 Flt7 02/01/2011 Flt8 02/07/2011 Flt9 02/10/2011	Flt1 OSCAT 17:12Z 22 m/s Flt4 OSCAT 16:21Z 23 m/s Flt8 OSCAT 16:21Z 26 m/s	Flt2 01/17/2011 32m/s Flt5 01/25/2011 40m/s Flt7 02/01/2011 36m/s Flt8 02/07/2011 32m/s
2012	Flt1 01/31/2012 Flt2 02/03/2012 Flt3 02/05/2012 Flt4 02/09/2012 Flt5 02/12/2012 Flt6 02/15/2012	Flt1 OSCAT 16:18Z 27 m/s	Flt2 02/03/2012 33m/s Flt3 02/05/2012 33.5 Flt4 02/09/2012 32m/s
2013	Flt1 01/22/2013 Flt2 01/23/2013 Flt3 01/25/2013 Flt4 02/02/2013 Flt5 02/04/2013 Flt6 02/08/2013 Flt7 02/12/2013 Flt8 02/14/2013	Flt1 OSCAT 17:05Z 18 m/s Flt2 OSCAT 16:14Z 24 m/s Flt4 OSCAT 01:52Z 24 m/s Flt5 ASCAT-A 23:24Z 27 m/s; ASCAT-A 01:14Z 29 m/s; OSCAT 01:50Z 28 m/s Flt6 OSCAT 14:36Z 27 m/s Flt 7 ASCAT-B 15:15Z 9 m/s; OSCAT 16:17Z 12 m/s Flt8 OSCAT 16:20Z 23 m/s; AMSR2 17:00Z 17 m/s	Flt2 01/23/2013 36m/s Flt6 02/08/2013 33m/s

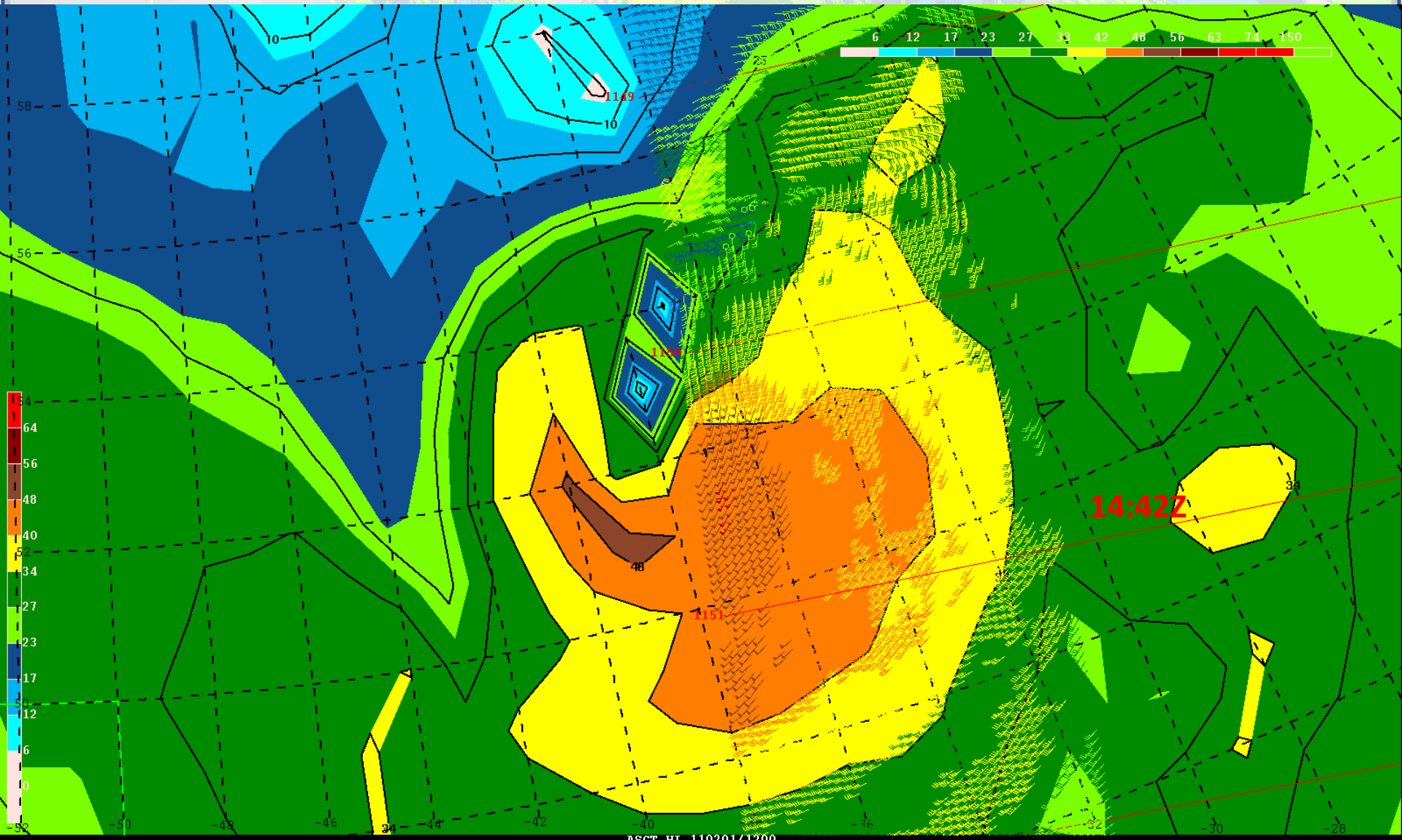
NOAA Aircraft Research
Winter Ocean Storms

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

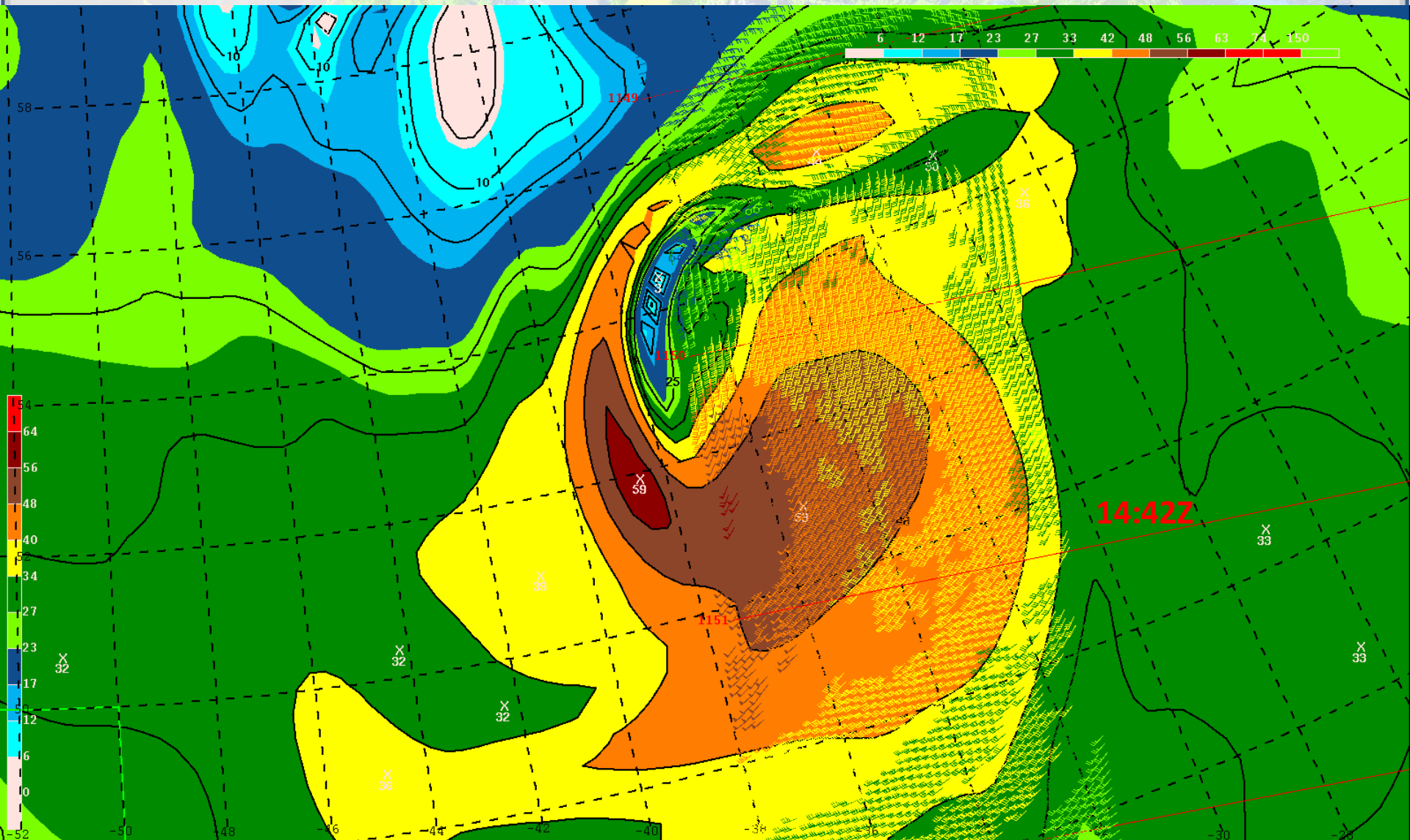

BRIT 6 12 17 23 27 33 42 47 56 63 74 150
6 12 17 23 27 33 42 48 56 63 74 150
35
29
24
18
12
6
0
1149
1150
1151
1605
44kt
1524
50kt
1
2
3
4
-45
-40
-30
OSCT 110201/1300
ASCT HI 110201/1300
VGF flight7 plan.vgf
110201/1257 METEOSAT9 AIRMASS


BRIT 6 12 17 23 27 33 42 47 56 63 74 150
6 12 17 23 27 33 42 48 56 63 74 150
13:30Z
11:50Z
ARCT 110201/1400
ARCT HI 110201/1400
VGF flight7_plan.vgf
110201/1357 METEOSAT9 AIRMASS

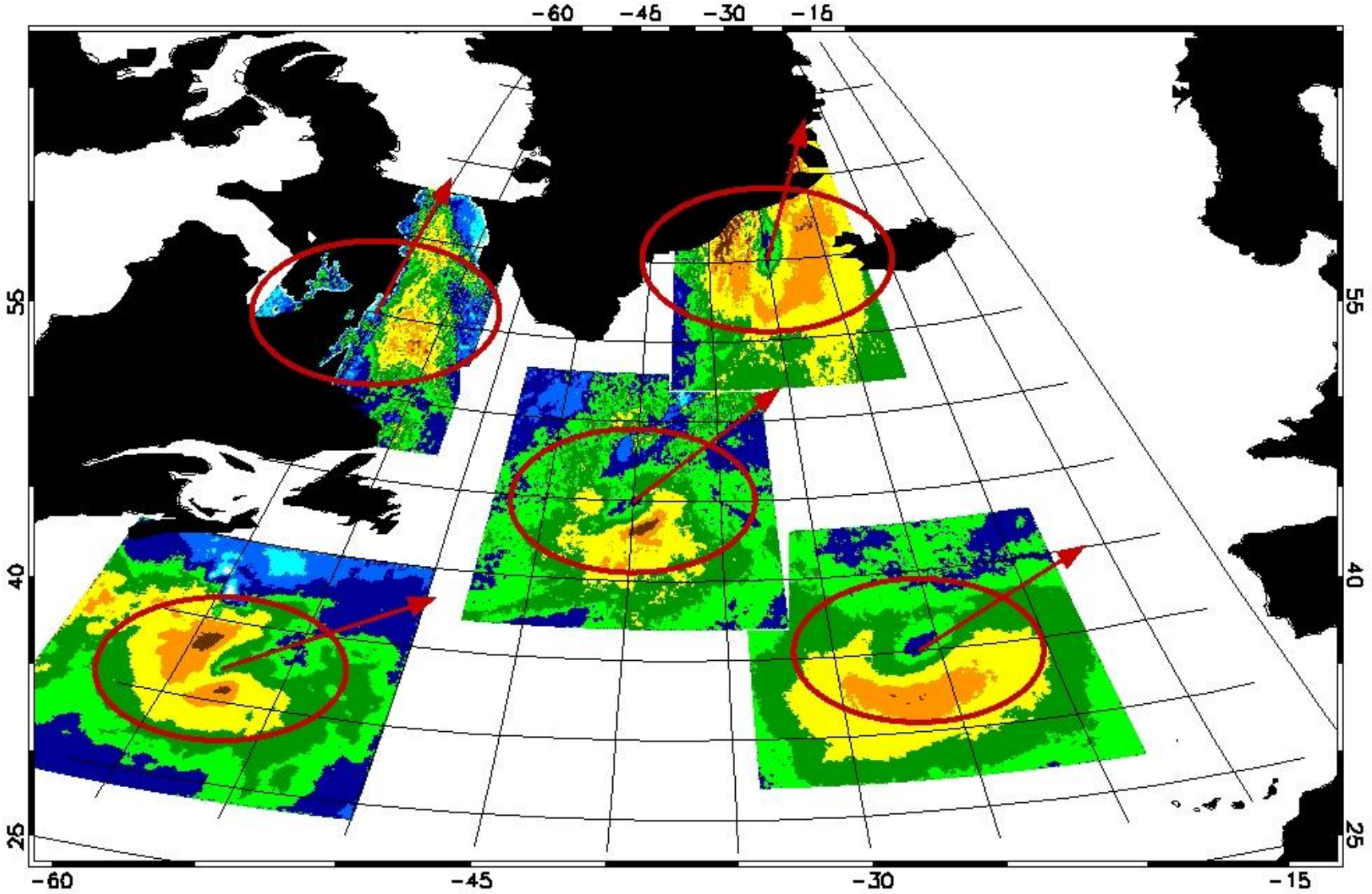
ASCAT vs ECMWF



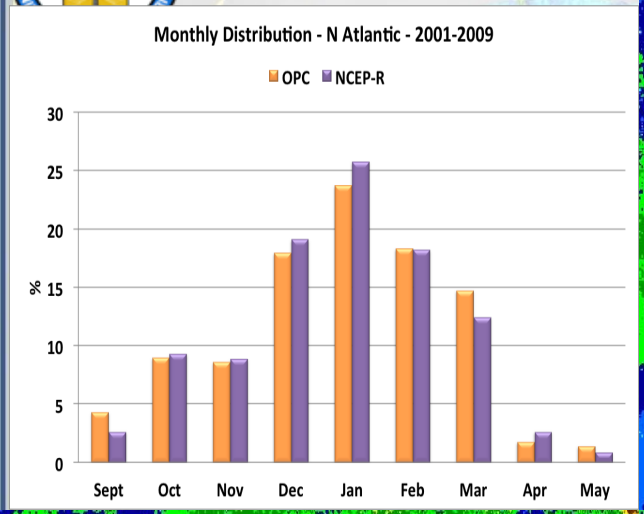
ASCAT vs GFS



>24h



QuikSCAT – N Atlantic



November

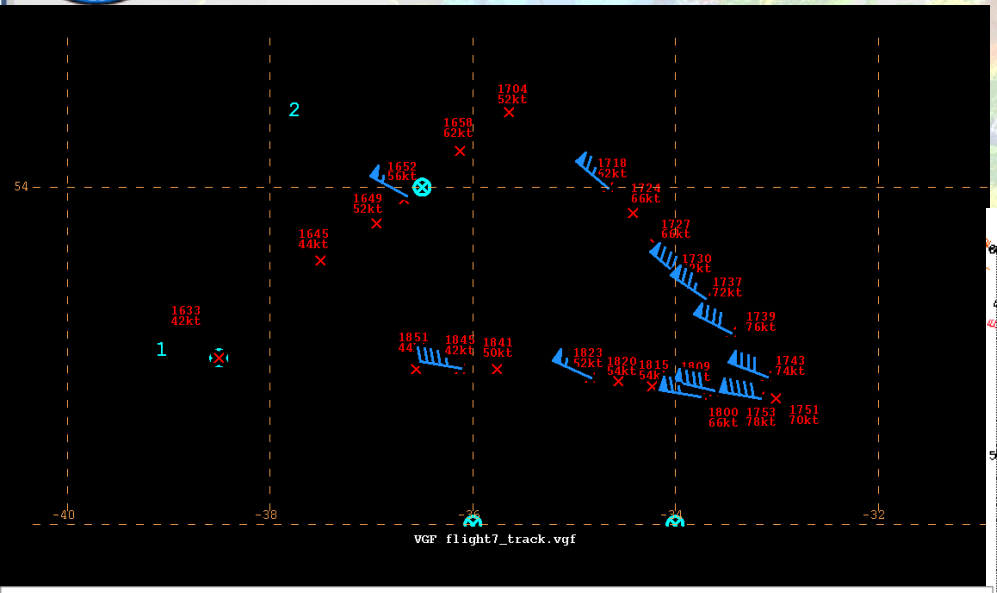
December

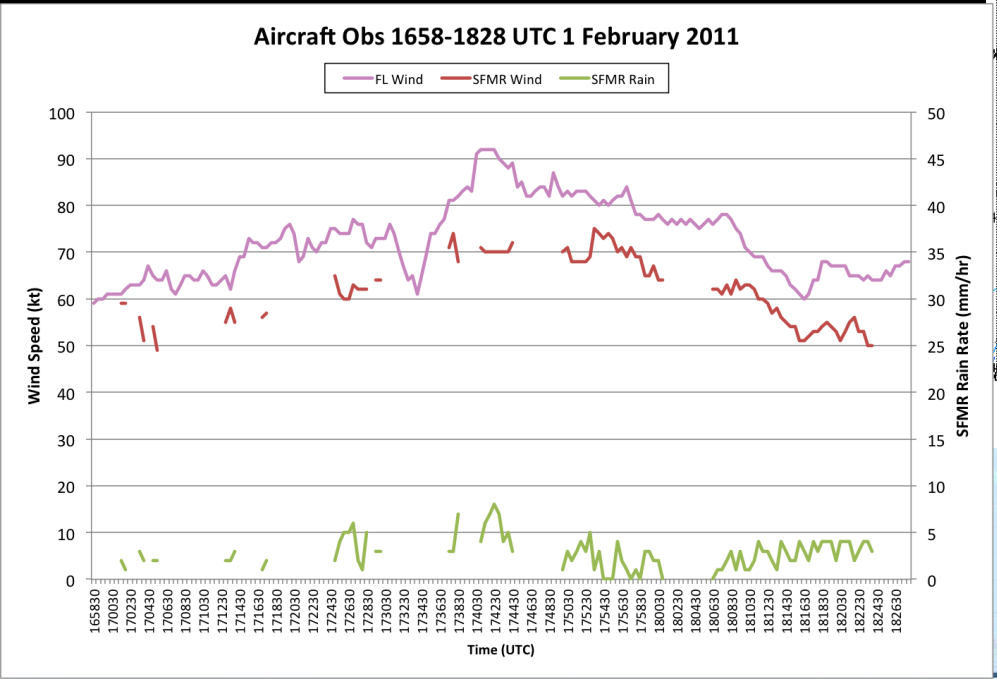
January

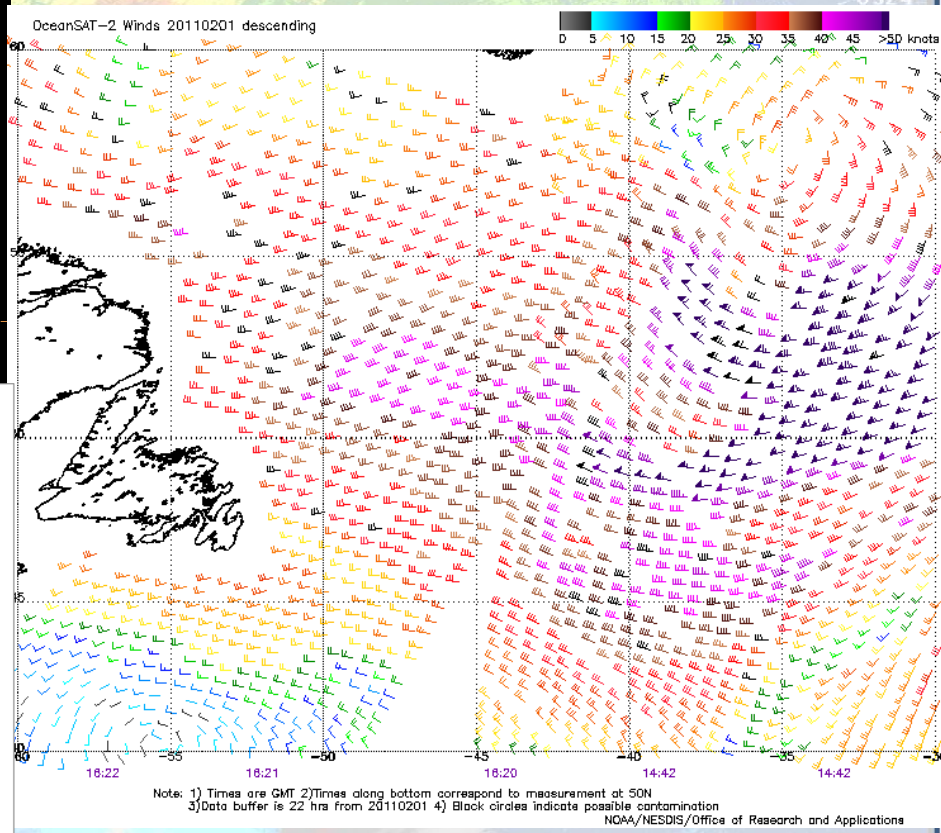
February

March

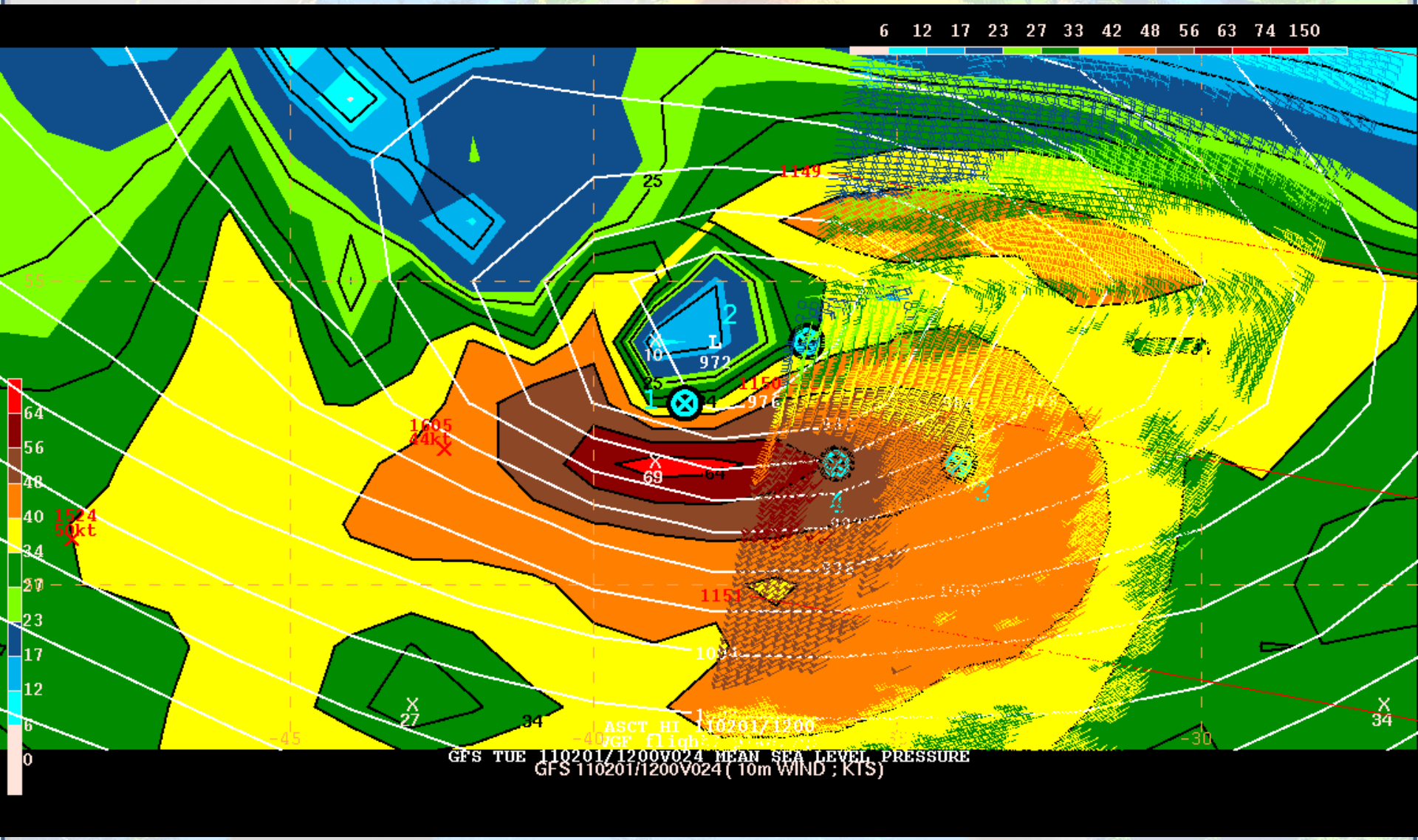
Hurricane Force Winds Observed during Feb 1st 2011 Flight







GDAS & ASCAT winds



Waypoints 1, 2, 3, 4

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 uderflights
  - 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