Using Surface Pressure to Produce Scene-Wide, km-Scale Tropical Cyclone Surface Wind Retrievals From SAR

Ralph Foster[1], Jerome Patoux[2], Jochen Hostmann[3], Chris Wackerman[4]
[1] Applied Physics Laboratory, University of Washington; [2] Atmospheric Sciences, University of Washington; [3] NATO Undersea Research Center; [4] General Dynamics

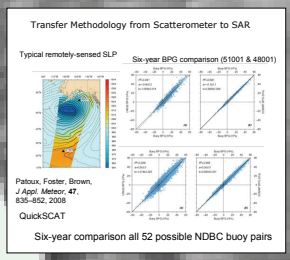
SAR TC Working Group Collaboration
Hans Graber[5], Chris Wackerman; Jochen Horstmann; Ralph Foster; Roland Romeiser[5]; Mike Caruso[5]; [5]CSTARS/RSMAS, U. Miami

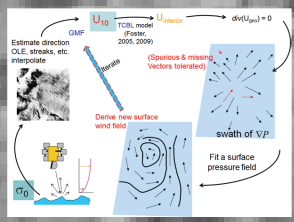
Supported by NASA IOVWST and ONR Physical Oceanography:

Summary

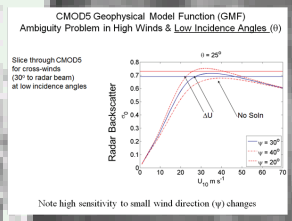
- Surface pressure retrieval methodology successfully transferred to km-scale SAR winds
- Bulk pressure gradient methodology looks promising for improving SAR high wind retrievals.
- SLP technique allows scene-wide surface wind retrievals that improve upon standard GMF methods.

- SAR TC surface winds above 30 m s^{-1} limited by
  - In situ Cal/Val data
  - Geophysical model functions
- Wind directions from rolls/streaks
  - Selection of directions
  - Eye location
- Assume barometers are more reliable than anemometers in TCs
  - Sea-level Pressure (SLP) is an inherently integrated property of surface winds
  - Can we use SLP as an alternate source of surface wind Cal/Val data?
- First step: Use SLP methodology as a scene-wide (vs. pixel-by-pixel) surface wind retrieval

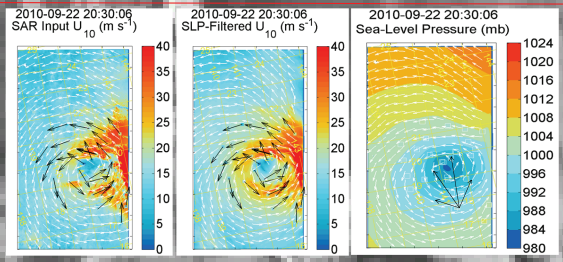


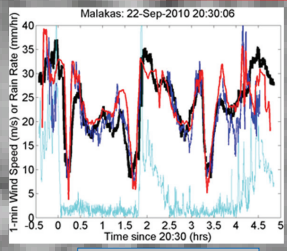


- Impact of Typhoons on the Pacific (ITOP) Experiment (2010)
  - 18 SAR images of eyes and near misses
    - 9 C-band and 9 X-band, various polarizations
    - 7 with near-in-time USAF C-130 under flights (sondes and SFMR)
- Historical Atlantic imagery from Canadian Space Agency Hurricane Watch
- Examples
  - Malakas (22 Sep, 2010, 20:30 UTC) C-130 survey
  - Megi (15 Oct, 2010, 21:00 UTC) C-130 mini-survey
  - Megi (17 Oct, 2010, 21:41 UTC) Super Typhoon, use of high ambiguity winds

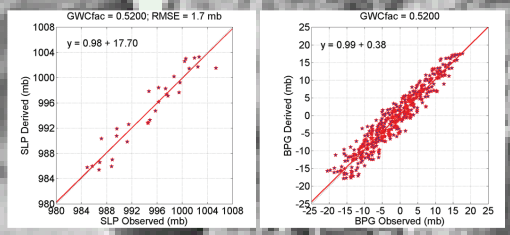


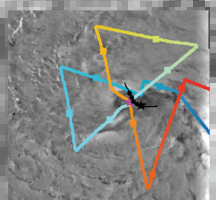
Malakas 22:
- Cleanest example from ITOP
- Close-in-time C-130 survey
- Weak Cat-1 typhoon
- Within range of existing GMFs
- Excellent comparison between SAR and C-130 observations
- Some remaining low incidence angle problems



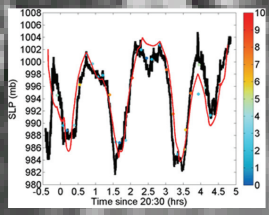


C-130 SFMR winds (black) and rain rate (cyan) compared to CMOD5N SAR winds (blue) and SLP winds (red).

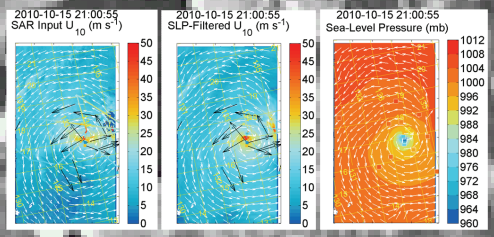




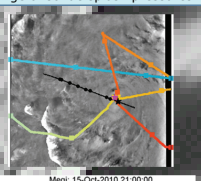
C-130 flight track adjusted to the SAR time HRD/Willoughby method applied to C-130 flight level data. Color coding increases with time (blue to red) Squares mark 30 minute Intervals.90

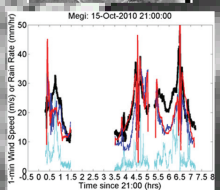


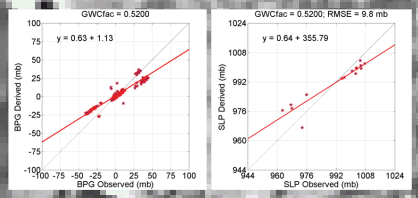
C-130 flight-level estimated surface pressure (black). SAR SLP in red. Sonde splash pressure color-coded by distance from C-130 track.



Megi 15:
- C-130 flight deployed floats, mini-survey on return
- Stronger storm than Malakas 22
- Very compact, trial for PBL model (small errors magnify)
- Limited range of sonde splash pressures

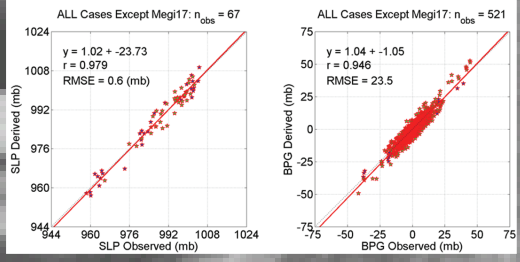


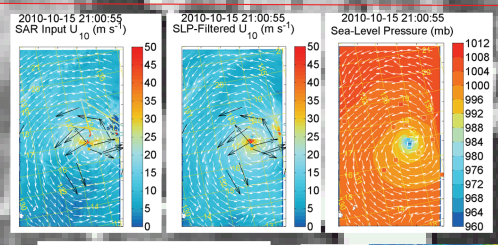




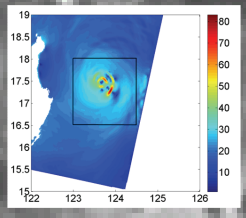
Drop Sonde SLP Summary

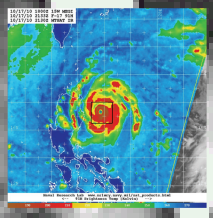
ATL (Blue):	WPAC (Green):
2005-08-27 Katrina	2010-09-22 Malakas
2008-09-13 Ike	2010-09-24 Malakas
2006-09-20 Helene	
2002-09-30 Lili	



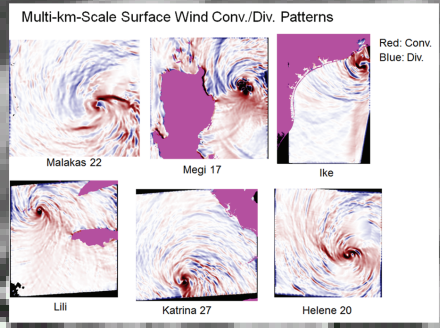


Megi 17:
- Super-Typhoon (record low MSLP, JMA: 885 mb)
- Severe challenge for SAR
- Used small (<200) high ambiguity winds in order to reach reasonable MSLP
- Hint of multiple eye wall (unverified)





Multi-km-Scale Surface Wind Conv./Div. Patterns



The SLP-filtering acts as a low-pass filter
- Smooth enough to calculate convergence
- All images show similar multi-km-scale convergence/divergence patterns
  - ~10 km wavelength coherent motions – looks like PBL roll vortices
  - Hurricane PBL rolls are 1.5 to 2 km wavelength
- Up-scale transfer of low-aspect ratio roll energy into large aspect ratio roll modes
  - Nonlinear wave-wave interactions