Application of the Dvorak technique at JTWC for estimating tropical cyclone intensity

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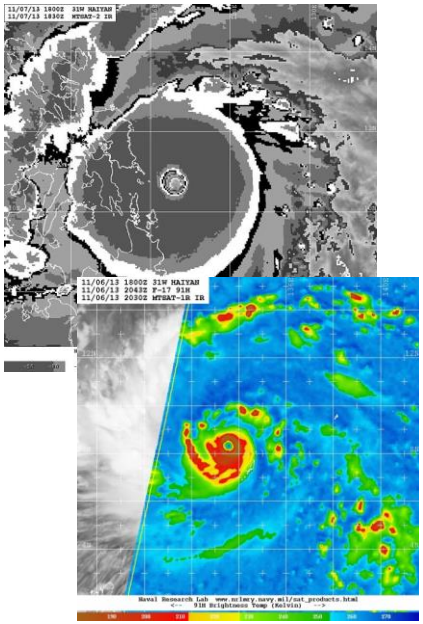
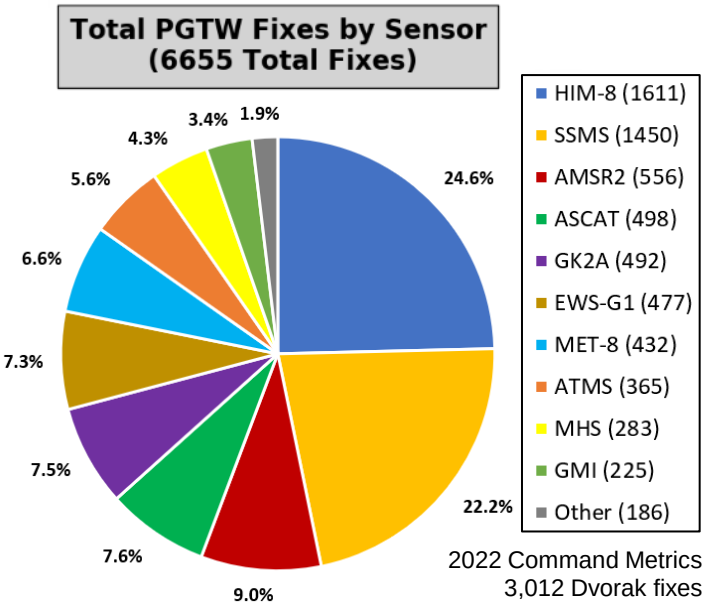
Satellite Analysis of Tropical Cyclones

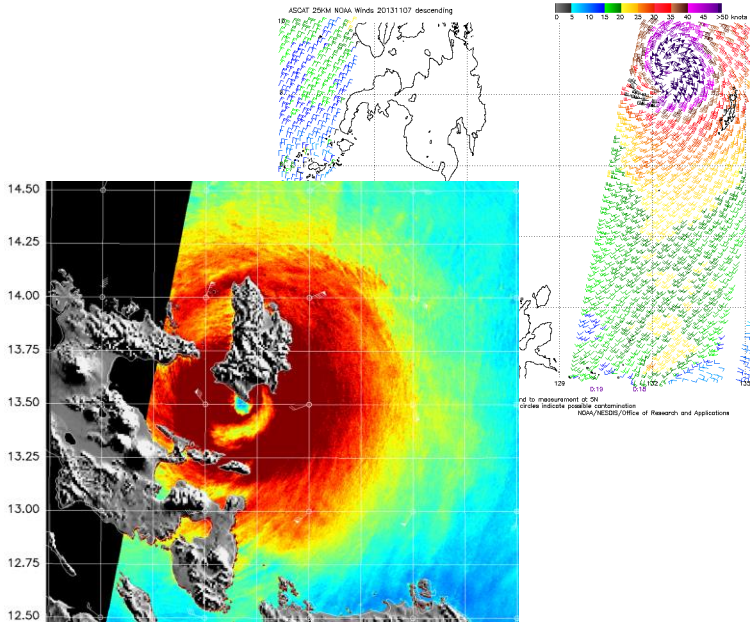
- USAF Satellite Operation Flight embedded at JTWC performs ~10,000 fixes per year
- Relies almost exclusively on space-based sensing since routine aerial recon ended in 1987
- 3 primary satellite data types to fully characterize storm position, intensity, and structure:
  - Geostationary IR/visible
  - 37/89-91 GHz Microwave Imagery
  - Ocean surface winds/vectors
- Utilizes USAF Mark IV-B, USN FMQ, and NWS AWIPS satellite display platforms
- Rapid TC evolution requires tight Satellite Analyst – Forecaster integration on the watch floor

Accurate TC analysis is foundational to the forecast process



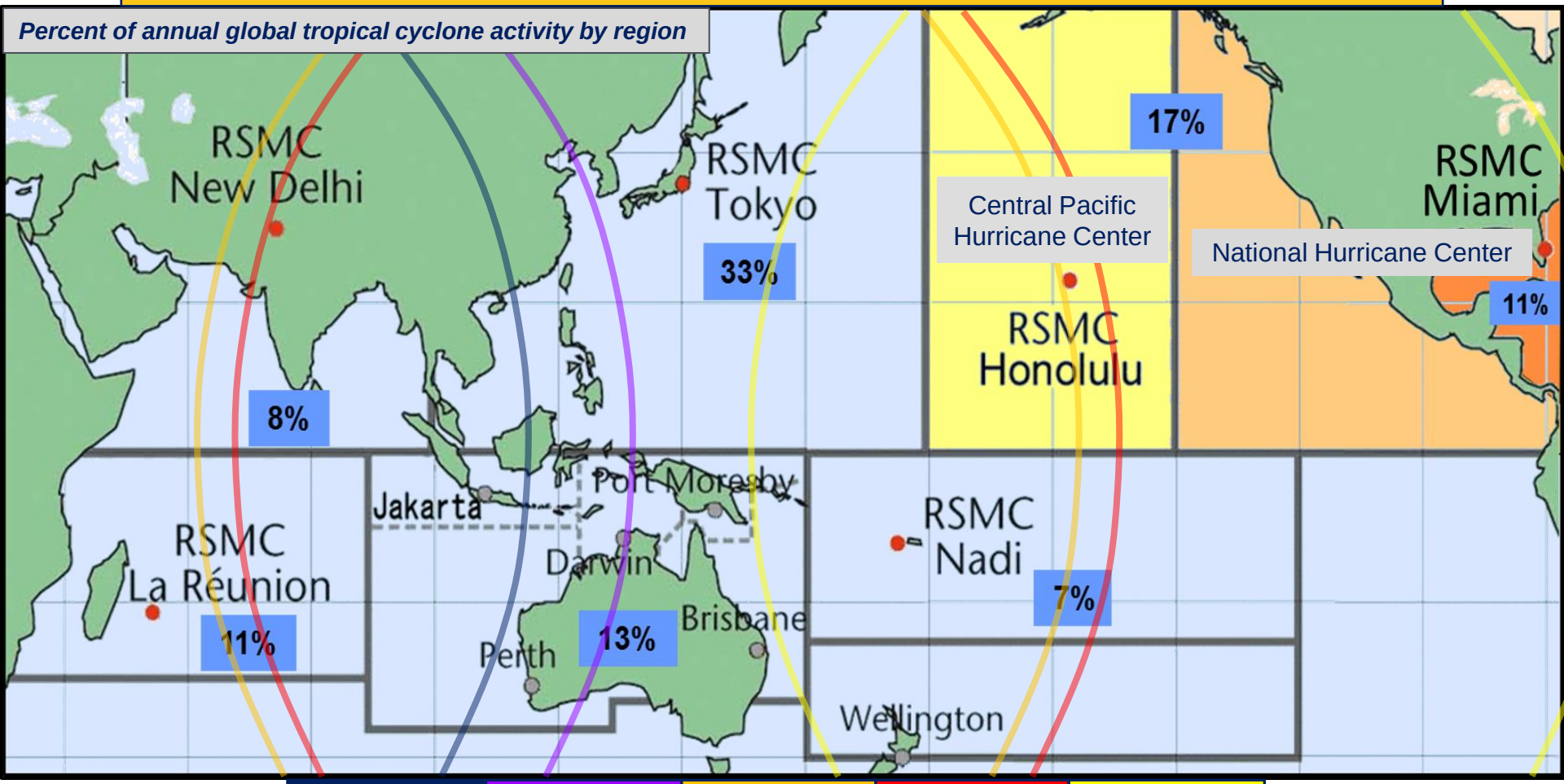


2022 Command Metrics
3,012 Dvorak fixes



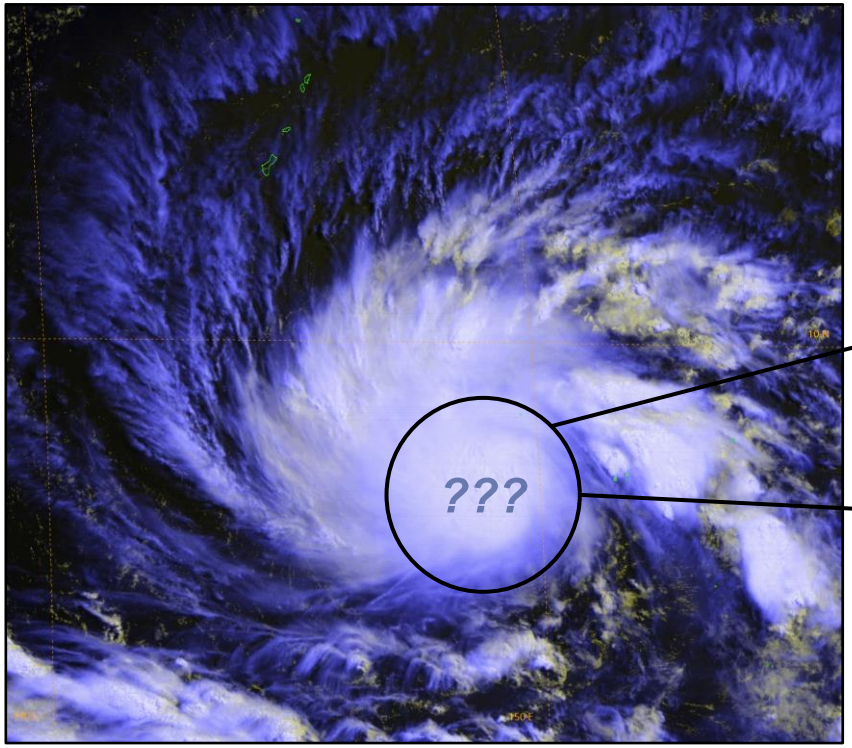
Geostationary Satellite Coverage

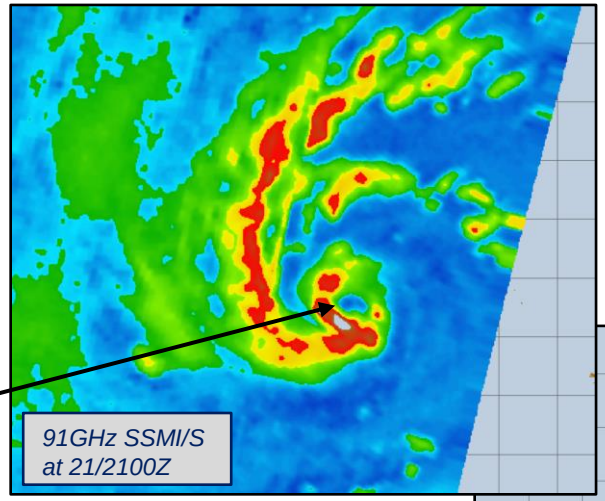
Perform tropical cyclone analysis according to the Dvorak technique

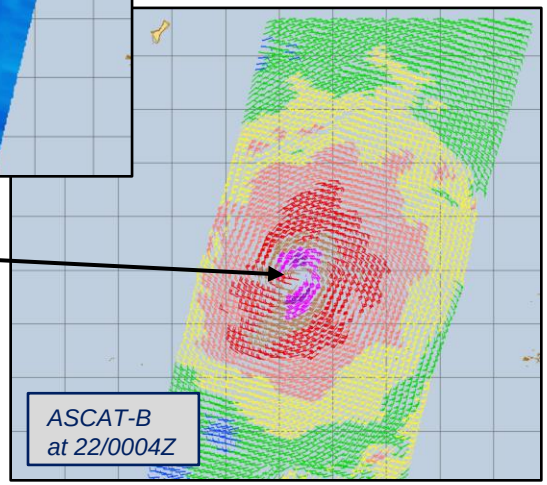


Finding the Center

- The Dvorak technique revolves around visible and IR satellite still images. New satellite technologies have become available since the inception of the Dvorak technique.
- JTWC satellite analysts use all available data to find the lower-level circulation center. Sources include animated geostationary visible, IR, and multispectral imagery, radar loops, and still images from microwave instruments, scatterometers, and other ocean surface wind sensors.



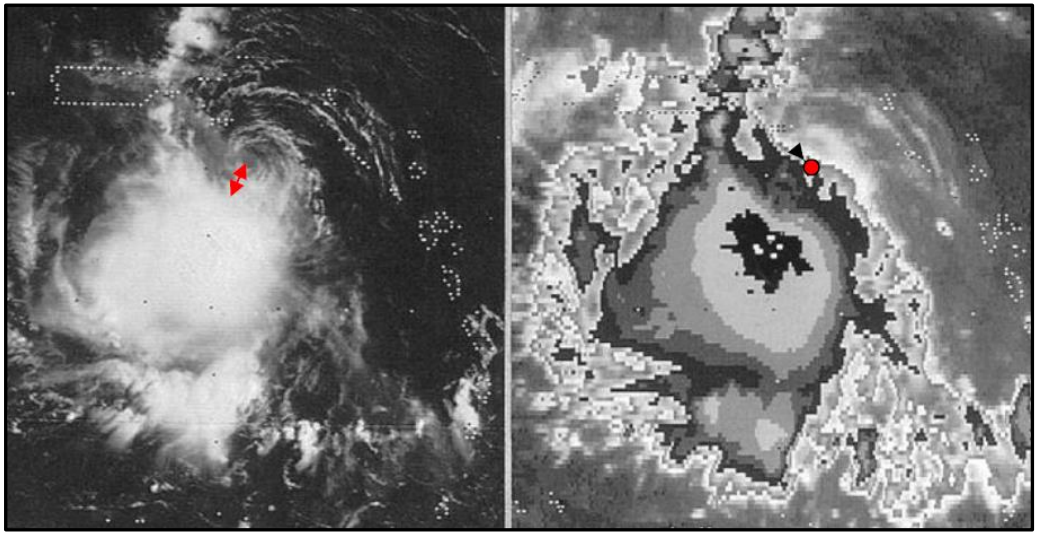




Application of the Shear Method

- The shear method is used to estimate intensity for systems of tropical storm intensity or weaker that exhibit subjectively observable signs of shear.
- JTWC has adopted a modified version of the shear method from NESDIS for systems of T1.0-2.5 intensity.
- Dvorak's original shear method is applied to tropical cyclones of T2.5 or higher intensity.

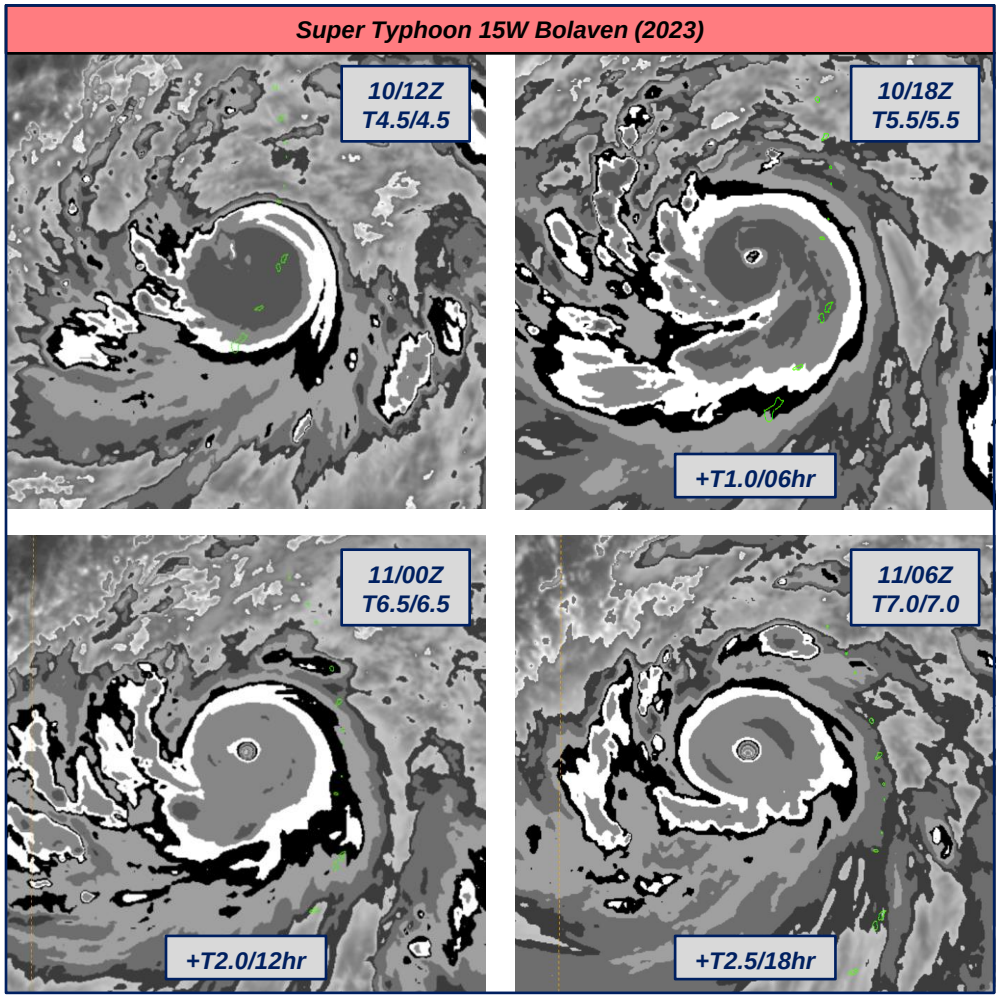
	Modified Shear Method	Original Shear Method
How it works:	Gives multiple intensity estimates after accounting for: • The definition of the low-level cloud lines. • The distance of the cold overcast from the system center. • The size of the cold overcast.	The distance of the system center to the edge of the cold overcast determines the system intensity.
Why we use it:	Tends to give a more accurate intensity estimate for very weak systems.	Tends to be more accurate for moderate to strong tropical storms.



Breaking Constraints

- Dvorak: A typical rate of intensification is +1.0T per day.
- The rate of change in FT is limited by constraints that smooth out short term fluctuations in intensity.
- Satellite analysts are permitted to break constraints when a system is undergoing very rapid intensification or weakening.
- Observation: Constraints are broken more often due to rapid intensification than rapid weakening.

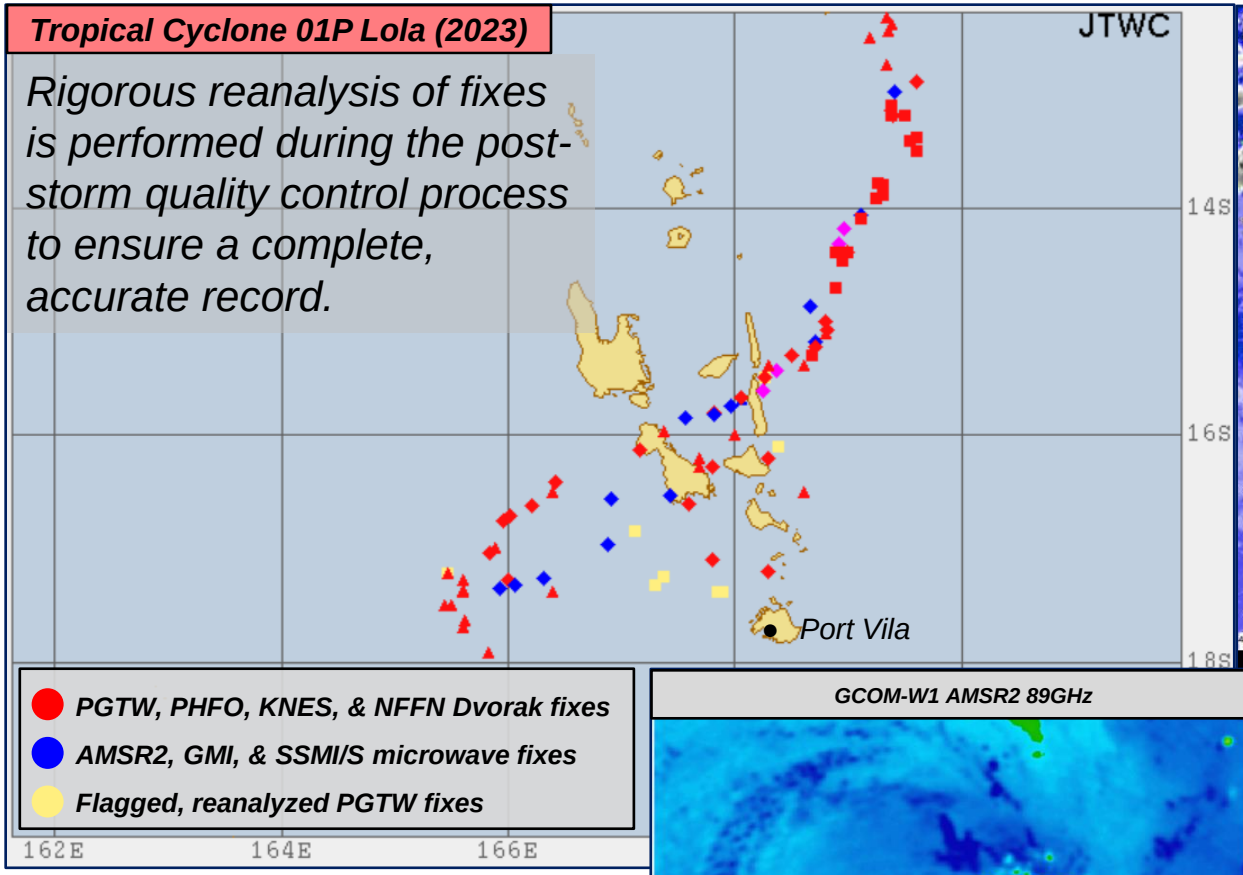
Maximum allowable rate of change in FT	
T-number < 4.0	0.5 over 6 hours
T-number ≥ 4.0	1.0 over 6 hours
	1.5 over 12 hours
	2.0 over 18 hours
	2.5 over 24 hours

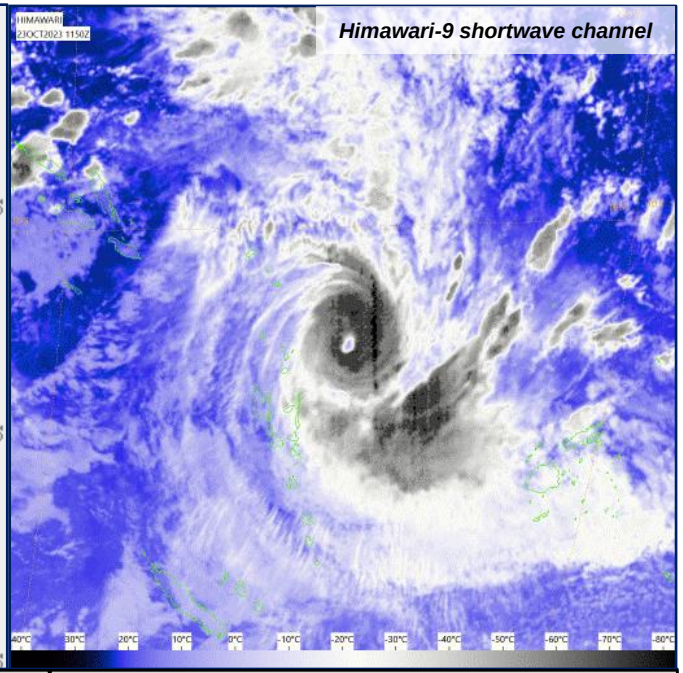


Post-Storm Reanalysis of Fixes

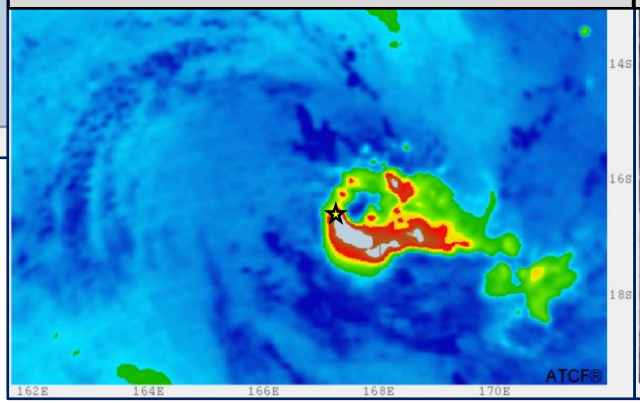
Tropical Cyclone 01P Lola (2023)

Rigorous reanalysis of fixes is performed during the post-storm quality control process to ensure a complete, accurate record.

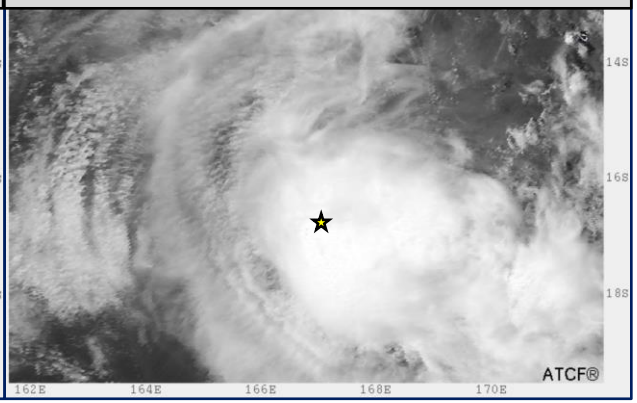




GCOM-W1 AMSR2 89GHz

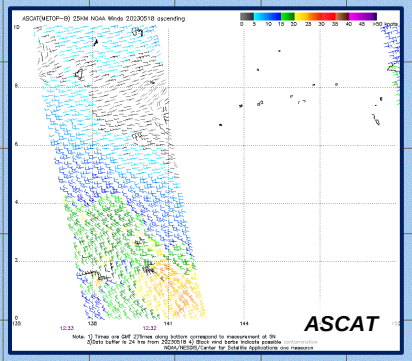


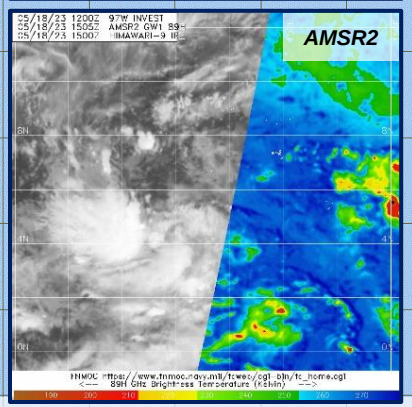
Himawari-9 visible channel



Criticality of Space-Based Sensing

Early NWP Consensus forecast tracks for STY Mawar compared to the actual track





Mawar's southern eyewall grazed the northern tip of Guam.

- A lack of timely microwave imagery coverage over the system during critical formation stage led to high uncertainty in storm positioning prior to TC genesis.
  - Degraded position fed to numerical data assimilation, resulting in poor model track forecasts (black lines).

When available, microwave data enhances JTWC's ability to assess TC position, intensity and structure. Goal: More satellites & aerial recon

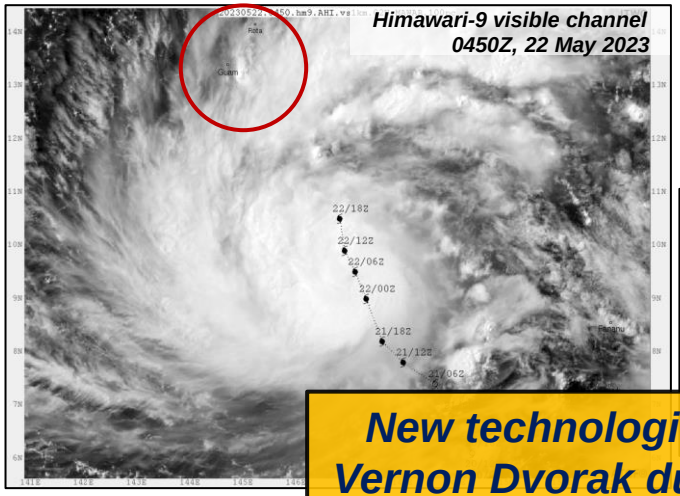
Working best track

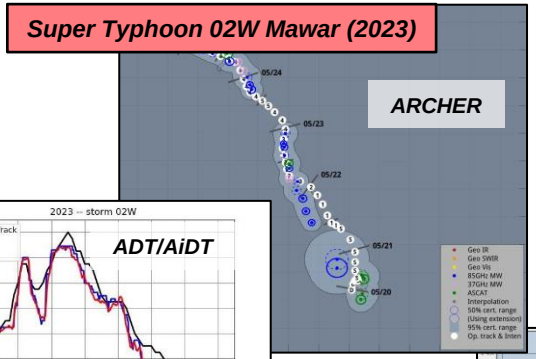
Post-analyzed track

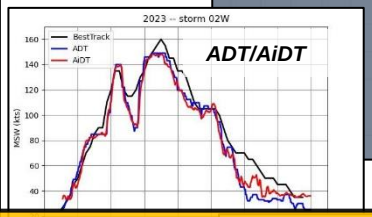
NWP Consensus Tracks

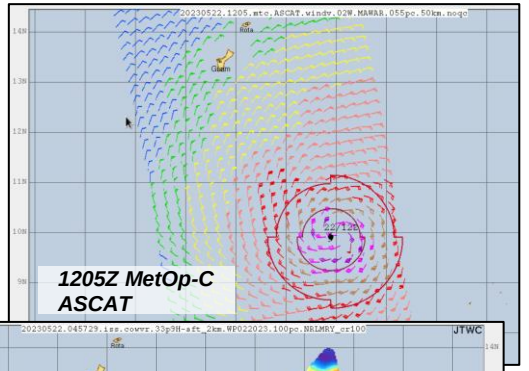
Higher analysis errors → NWP error → Forecast error

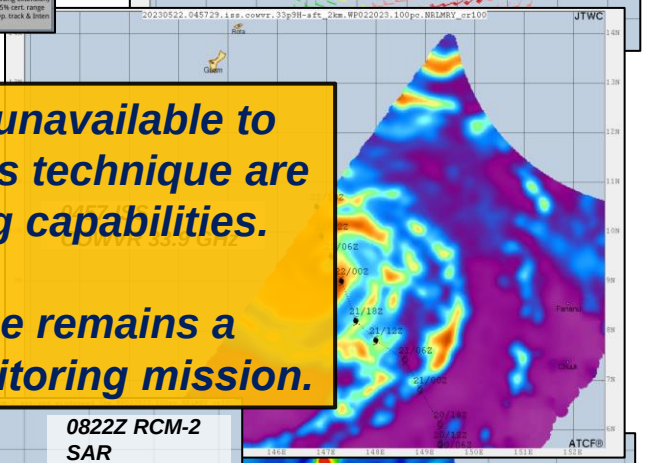
Dvorak Stands the Test of Time











New technologies and sensors previously unavailable to Vernon Dvorak during the development of his technique are contributing to ever improving JTWC fixing capabilities.

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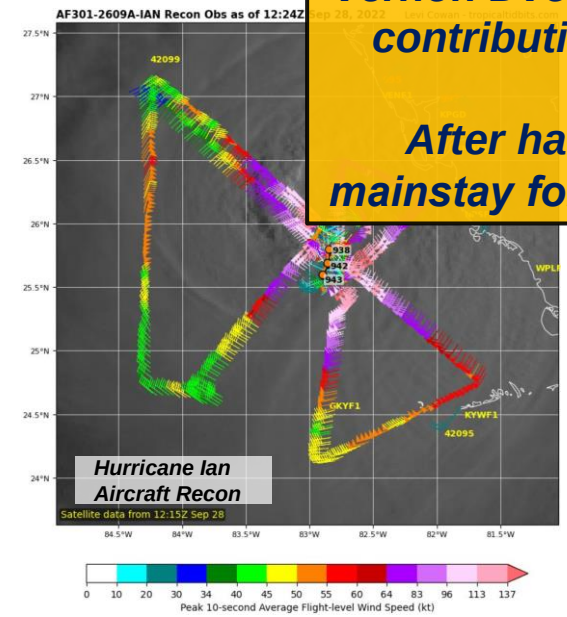
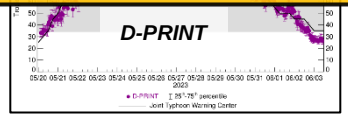
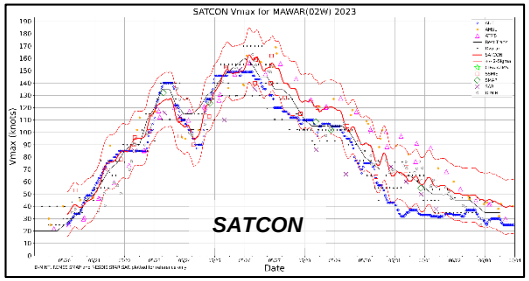
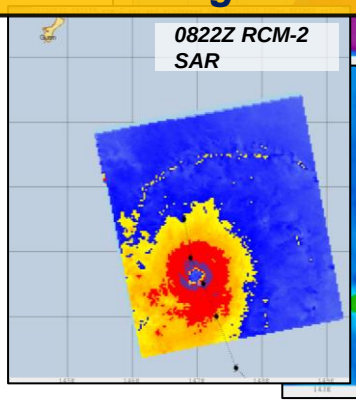
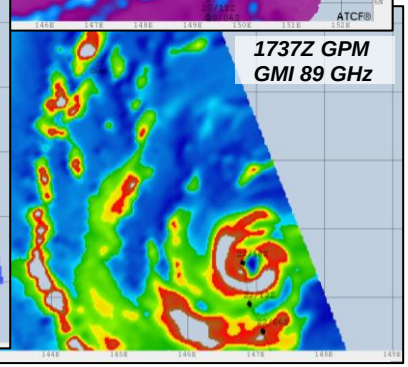
After half a century, the Dvorak Technique remains a mainstay for the DoD's tropical cyclone monitoring mission.











Thank You
Questions? Comments?