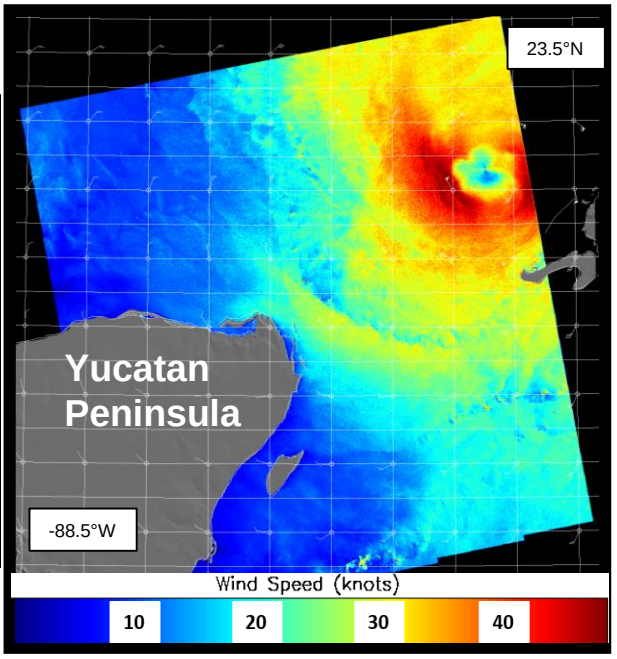
SAR Winds

Quick Guide

Why are SAR Winds Important?

Synthetic Aperture Radar (SAR) Winds (derived from Radarsat-2 and Sentinel satellites) display surface wind speeds over bodies of water, providing forecasters remote wind data for Impact-based Decision Support Services (IDSS). SARs measure high-resolution Normalized Radar Cross Sections (NRCS) that are converted into wind field imagery maps. Rough water surfaces (i.e. high winds over open water, generating waves) result in higher backscattered microwave radar returns, producing bright SAR imagery. After conversion to wind speed, the results are color-coded, with red colors representing higher winds. Calmer water surfaces with less backscatter are displayed as darker, 'cooler' colors: blue and aqua.

SAR Winds from Sentinel-1B observing Hurricane Michael passing through the Gulf of Mexico at 2351 UTC, 8 October 2018. Higher wind speeds (more than 20 knots) are displayed within Michael's inner and outer bands.



SAR Algorithm	Polarization & Frequency	Resolutions	Wind Speed Accuracy
NRCS is a function of wind speed and wind direction. The SAR algorithm incorporates backscattered (active) microwave radar returns from water surfaces and integrates NRCS and GFS model wind direction values to derive wind speed retrievals.	**Dual Polarization:** HH, VV, VH, HV **C-Band:** 4-8 GHz	**Spatial:** Variable, 3-100 m. Imagery displayed at **500 m** via data averaging. **Temporal:** < 1 day at high latitudes, 3 days at equator (asc/desc orbits & overlap)	• For wind speeds less than 29.2 knots: accuracy < 3.9 knots. • Reduced accuracy for winds greater than 29.2 knots.

Impact on Operations

Primary Application

Wind Impacts: Monitor wind observations that may impact IDSS core partners, such as shipping and fishing industries and coastal communities. Observations can identify areas of high wind and atmospheric boundary layer phenomena (e.g. hurricanes, gap winds).

24/7 All-Weather Data: Data produced for both daytime and nighttime applications. Via normal radar frequencies, SARs have ability to detect wind retrievals in the presence of clouds.

Coastlines: High spatial resolution provides wind speed retrievals adjacent to coastlines and in narrow channels or fjords.

Limitations

GFS Wind Direction: Model wind direction values may not be representative of high spatial resolution changes and could result in significant wind speed errors in those locations.

Wind Speeds Only: Note, product only provides derived wind speed retrievals.

Ice or High Wind? Backscattering from microwave radar returns can exhibit differences between sea ice and open water. During winter at higher latitudes, areas of sea ice can be confused for high wind speeds.

Timeliness: Data latency is ~1-4 hours due to model availability and data processing.

Land or Sea? Wind retrievals are only produced over open water and not over land.

Contributors: Jorel Torres, Erin Dagg, and Bernie Connell (CIRA)

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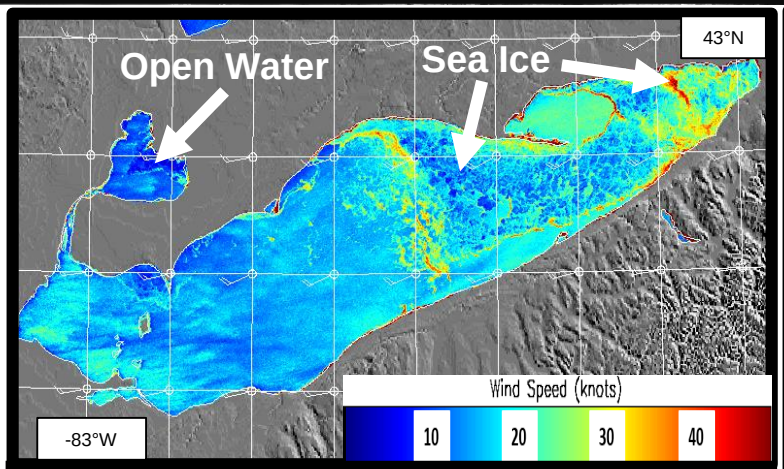
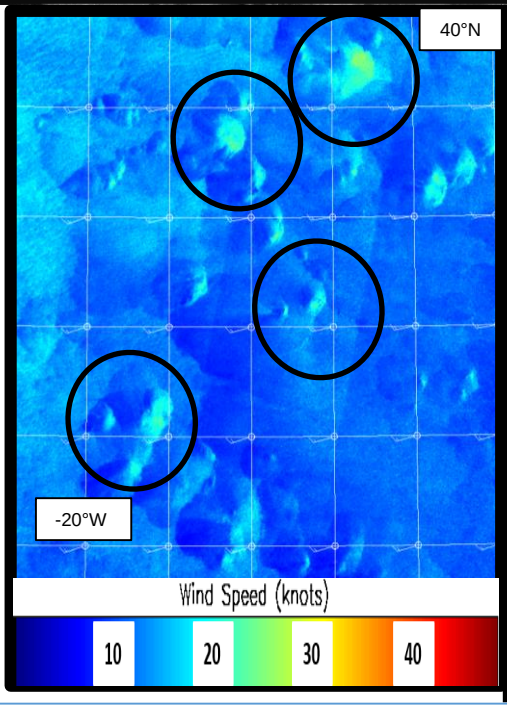


Radarsat-2 SAR Winds (above) show sea ice over Lake Erie on 15 March 2019 at 2318 UTC. Sea ice emulates backscattered microwave radar returns similar to high winds, however the appearance of sea ice in the imagery is conspicuous: sea ice edges and sea ice areal extent are visible. Colors over ice should not be interpreted as a particular wind speed.



Sentinel-1A SAR Winds (left) observing convection in the form of 'mounds'. Features are produced from strong downbursts associated with each convective cell (black ellipses). Wind direction input is westerly, however wind speed values near or around the cells may be prone to error, due to differences between model wind input and actual wind directions from outflow gusts.

Resources: SAR Algorithm Theoretical Basis Document. **European Space Agency (ESA) Sentinel Online:** Sentinel SAR: Revisit and Coverage. **NOAA CoastWatch: SAR Winds. Hyperlinks not available when viewing material in AIR Tool**

Note: SAR imagery in AWIPS will not have isotachs plotted, users will need to upload GFS model surface winds in complement to imagery.

Sentinel-1B SAR and Metop-A Advanced Scatterometer (ASCAT) Winds:

Comparing satellite derived winds from SAR and ASCAT observing Hurricane Rosa located southwest of the Baja Peninsula on 30 September 2018. SAR imagery is ~3 hours earlier than ASCAT, as a result of varying orbits. Due to differing spatial resolutions (SAR = 50 m, ASCAT = 25 km) SAR can provide finer, more detailed wind speed distributions, indicating storm intensity within and around the eye of the hurricane. Notice in the SAR imagery, the 'hourglass' appearance (black ellipse) just north of the eye, indicative of small scale model wind direction error.