Evaluations and Applications of GEO-GEO and LEO-GEO Stereo Products

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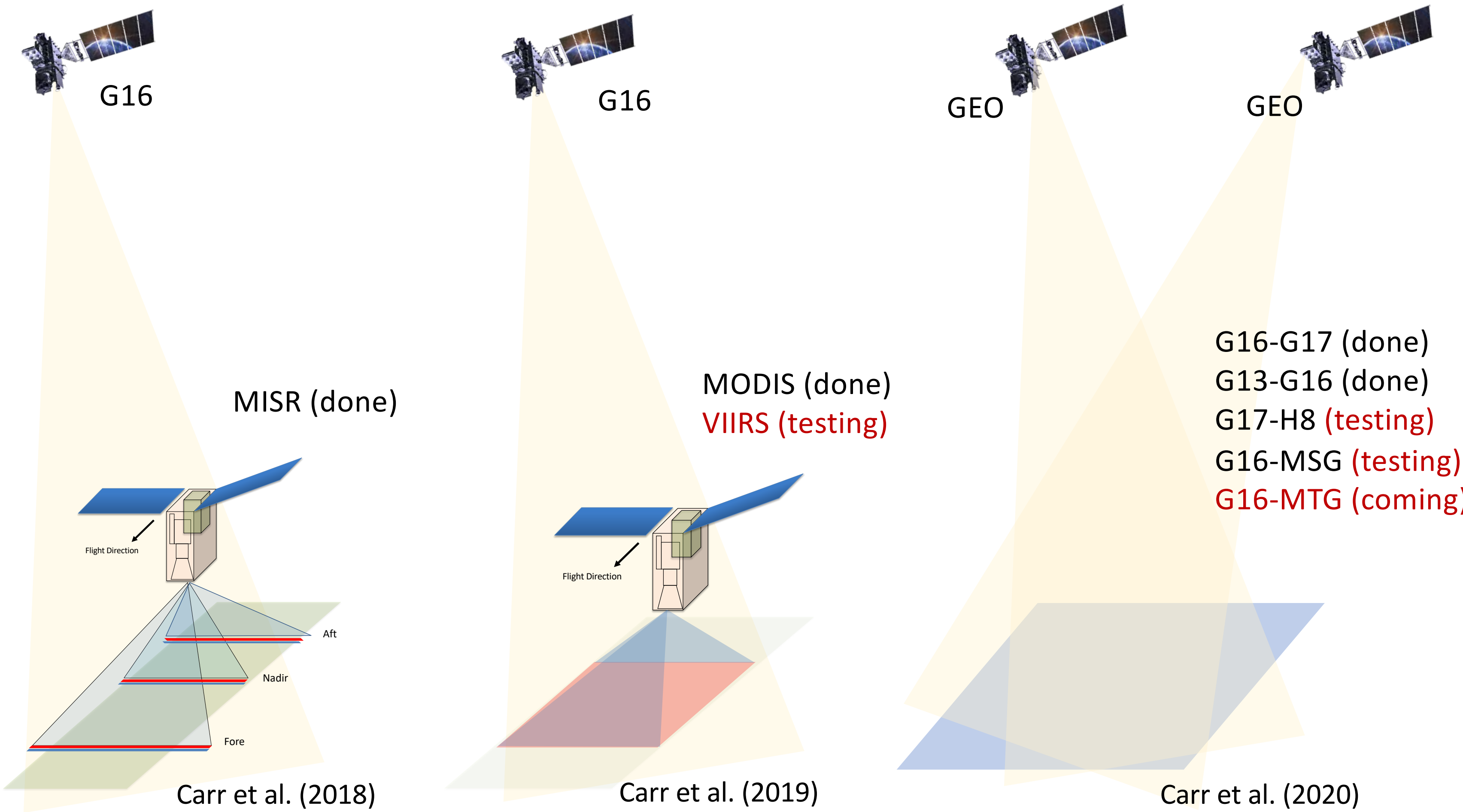
Recent LEO-GEO and GEO-GEO Stereo Wind Development



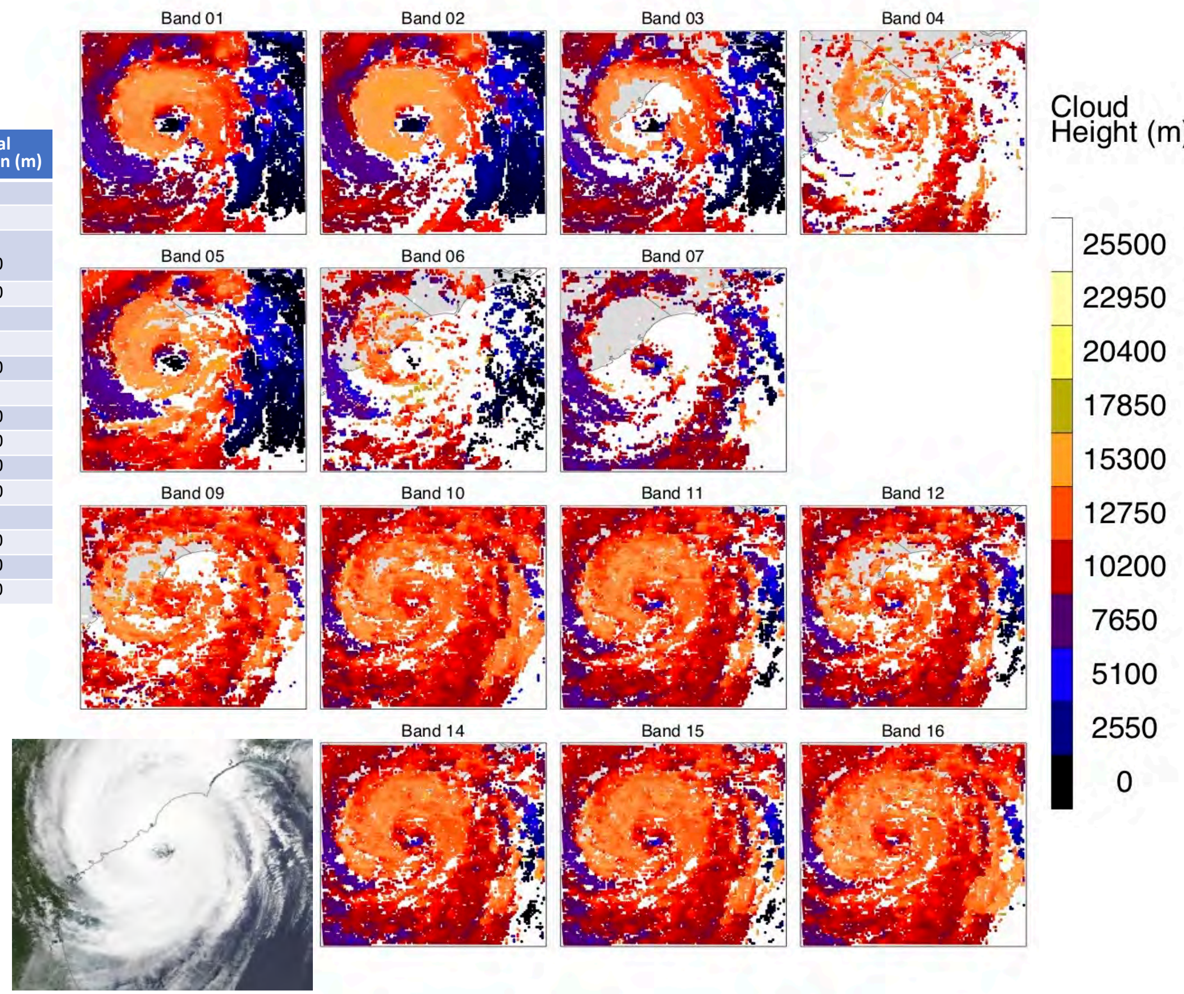
MODIS-GOES Stereo Winds

Carr et al. (2019)

	ABI Band	Wavelength (mm)	Spatial Resolution (m)	MODIS Band	Wavelength (mm)	Spatial Resolution (m)
Visible	1	0.45-0.49	1000	3	0.459-0.479	500
	2	0.59-0.69	500	1	0.620-0.670	250
	3	0.846-0.885	1000	2 16	0.841-0.876 0.862-0.877	250 1000
	4	1.371-1.386	1000	26	1.360-1.390	1000
	5	1.58-1.64	1000	6	1.628-1.652	500
	6	2.225-2.275	2000	7	2.105-2.155	500
MWIR/TIR	7	3.80-4.0	2000	21, 22	3.929-3.989	1000
	8	5.77-6.6	2000	-	-	-
	9	6.75-7.15	2000	27	6.535-6.895	1000
	10	7.24-7.44	2000	28	7.175-7.475	1000
	11	8.3-8.7	2000	29	8.4-8.7	1000
	12	9.42-9.8	2000	30	9.58-9.88	1000
	13	10.1-10.6	2000	-	-	-
	14	10.8-11.6	2000	31	10.780-11.280	1000
	15	11.8-12.8	2000	32	11.770-12.270	1000
	16	13.0-13.6	2000	33	13.185-13.485	1000

- No synchronization required for LEO and GEO images
- Accuracy (except at singularity)
  Height ~200 m
  Wind < 0.5 m/s

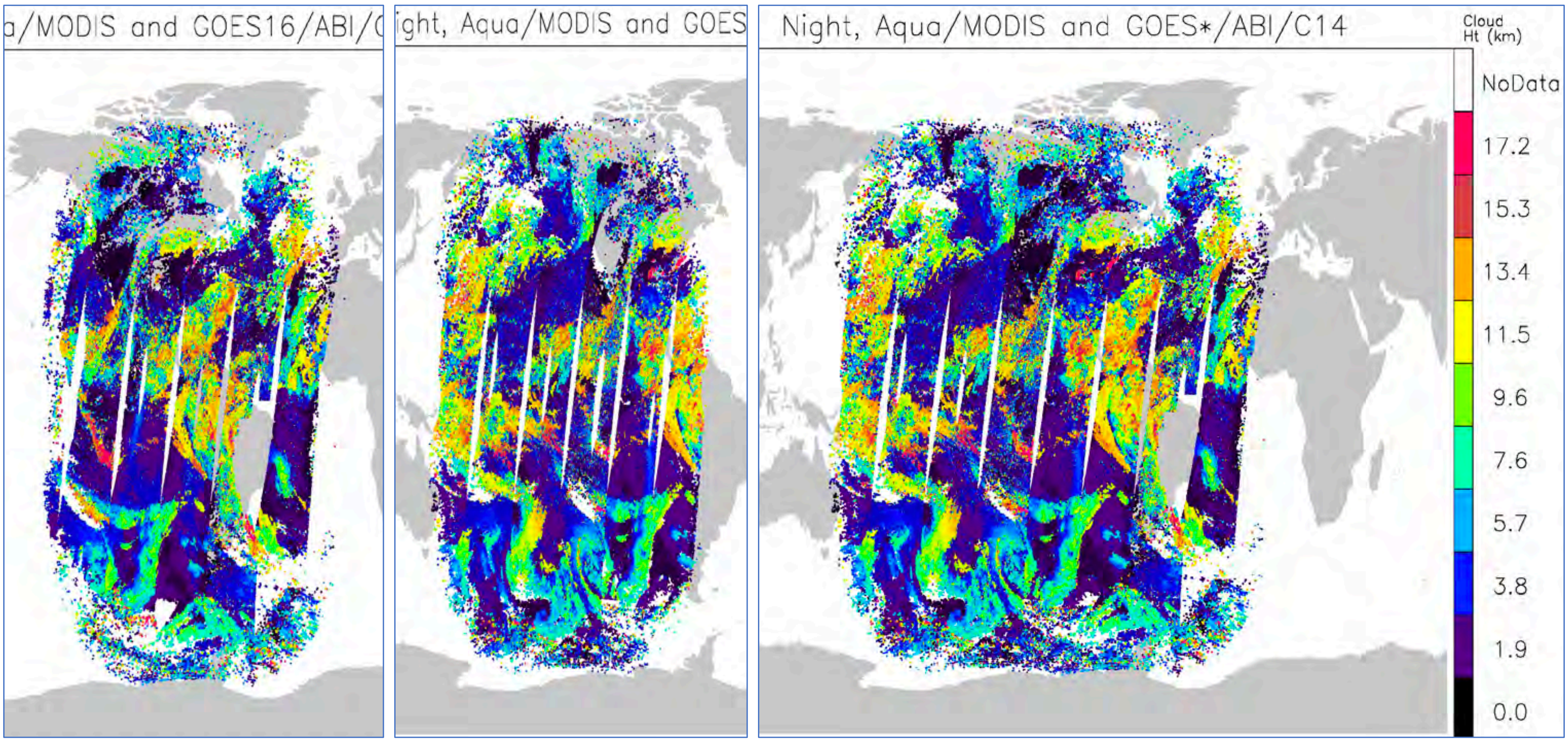
Hurricane Dorian (Sep 5, 2019)



Self-consistent AMV height assignment within each spectral band

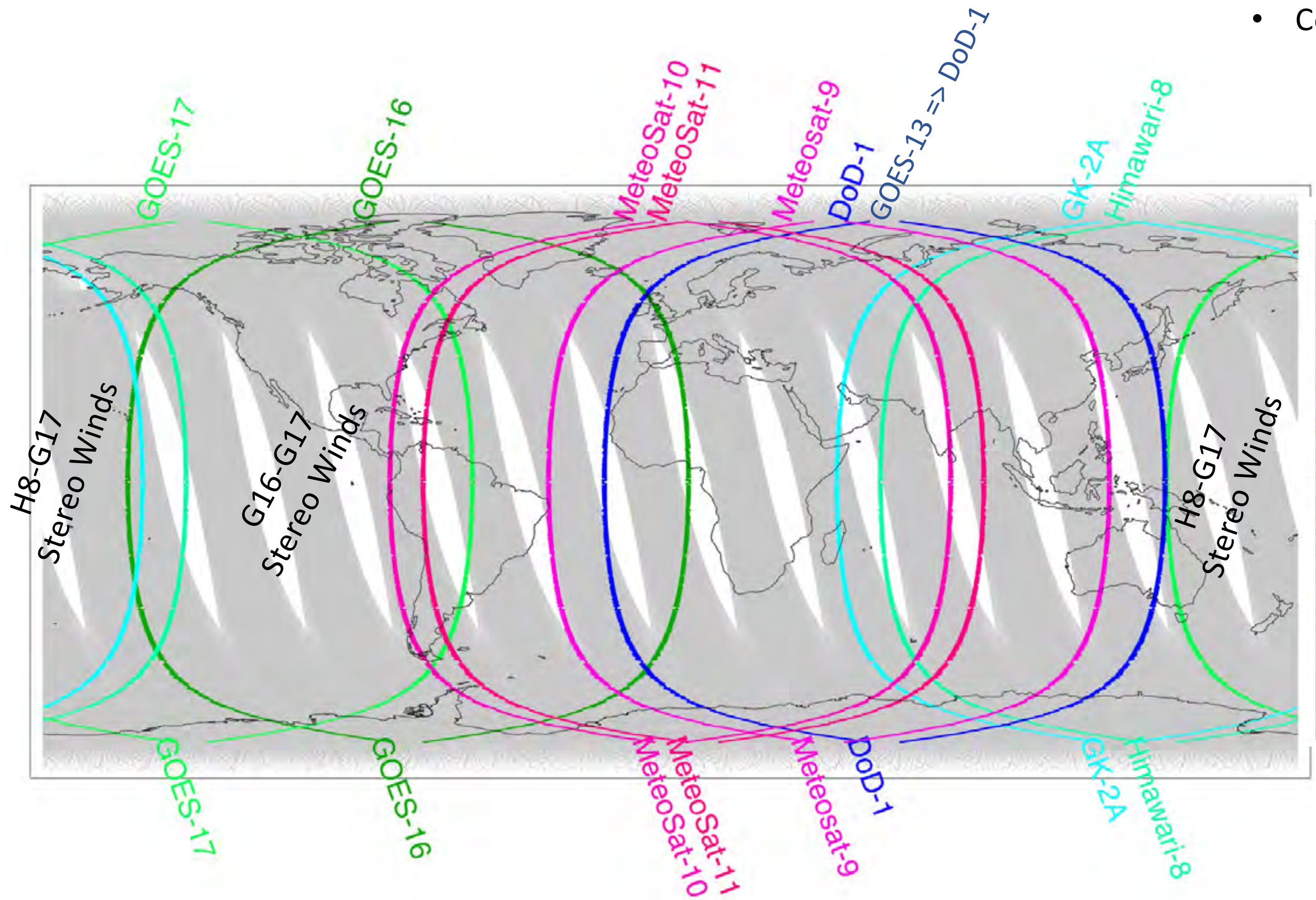
LEO-GEO Stereo-Winds Coverage
from Aqua-G16 (1:30 AM/PM) and Aqua-G17 (10:30 AM/PM)

- Coverage over full disk
- Not all local times
- Stereo blind spots

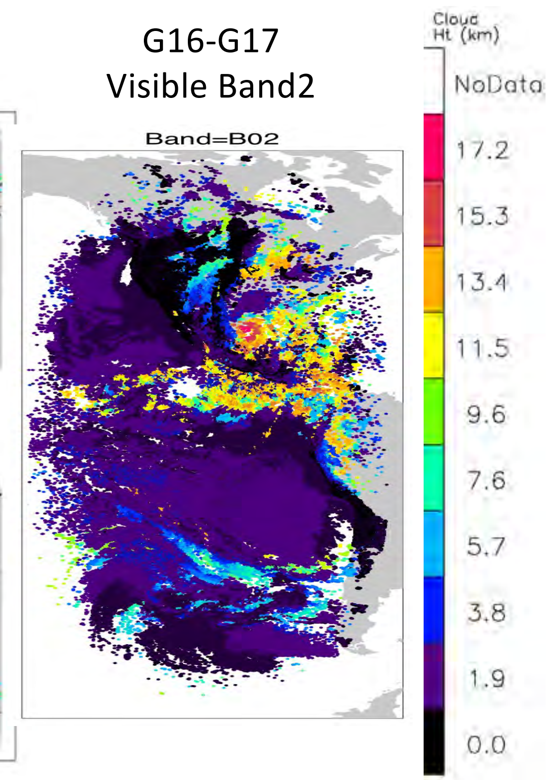


GEO-GEO Stereo-Wind Coverage

- Full diurnal coverage
- Limited to overlapped regions
- Coarser pixel resolution at edges

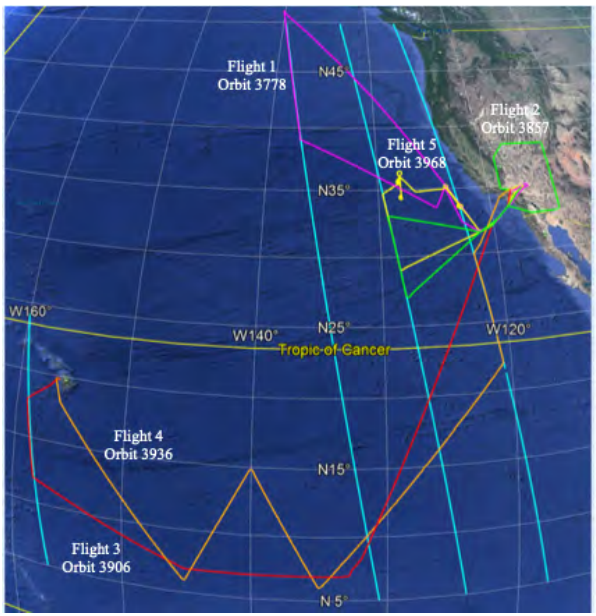


G16-G17
Visible Band2

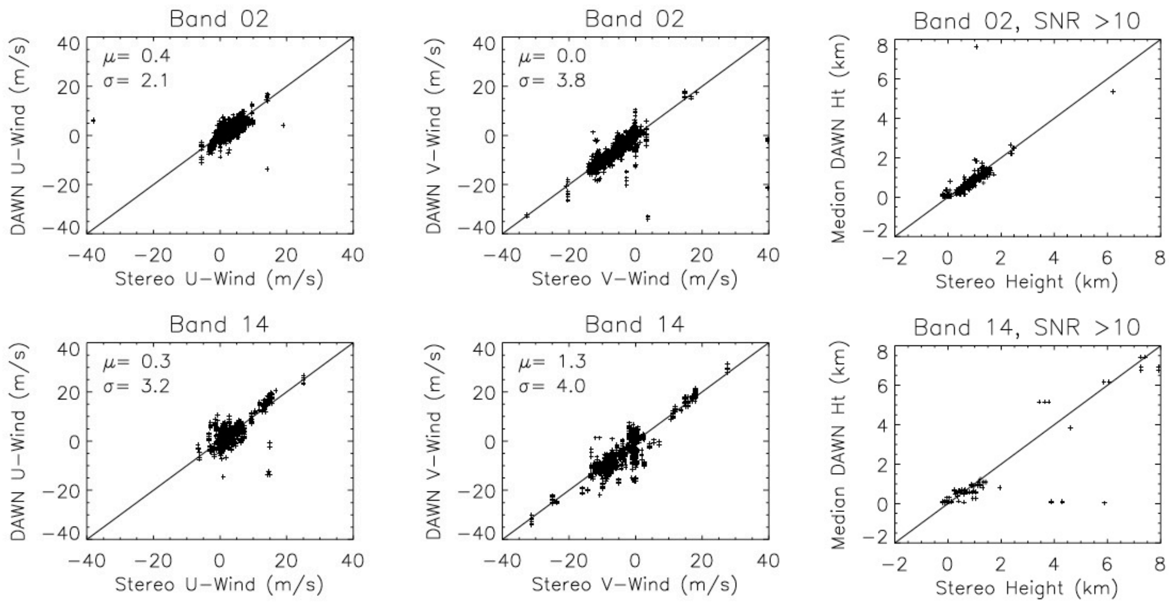


Comparisons with Airborne Wind Lidar (DAWN)

April 17-30, 2019



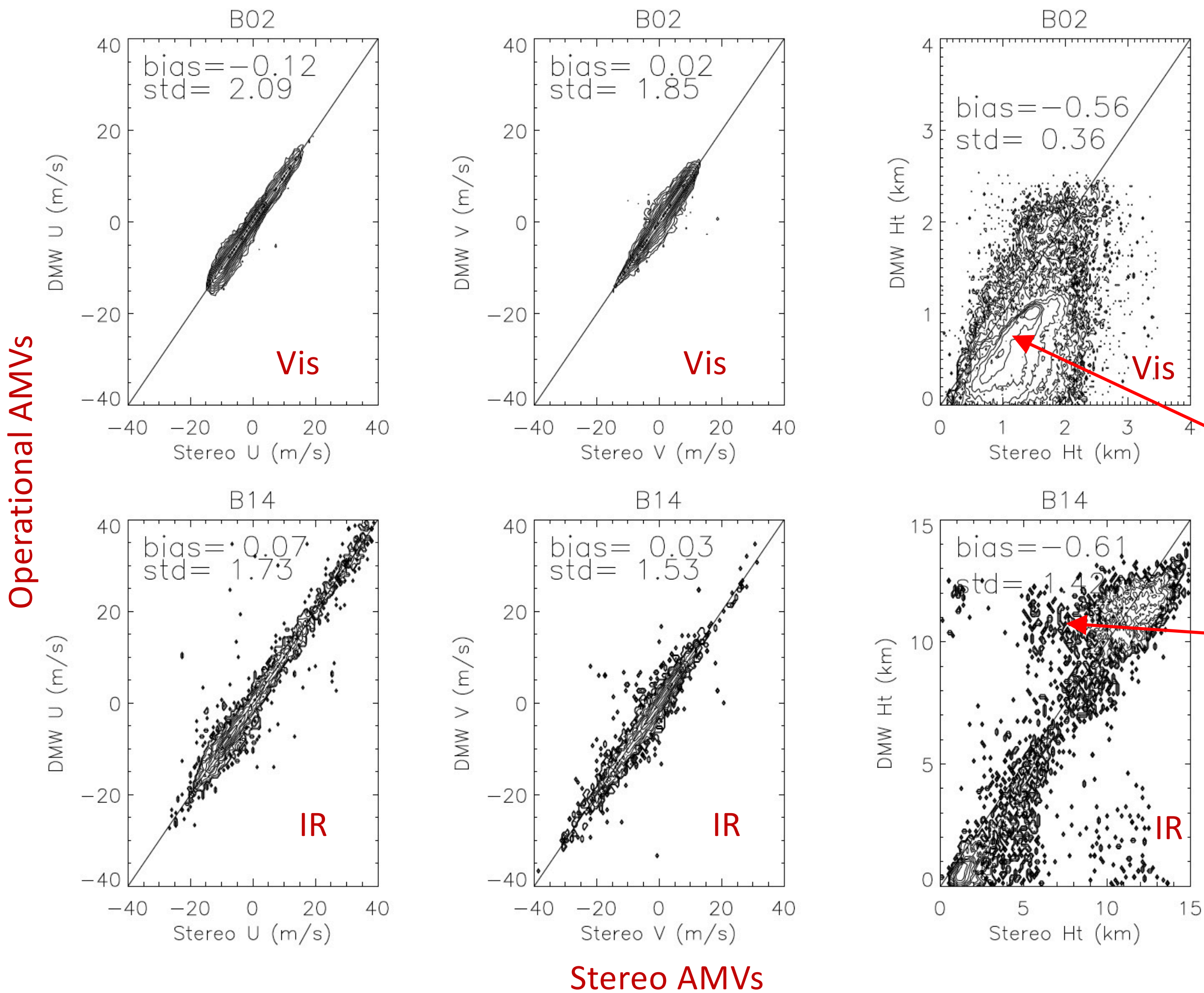
U-Wind | V-Wind | AMV Height



VIS

IR

Why Stereo Wind/Height?

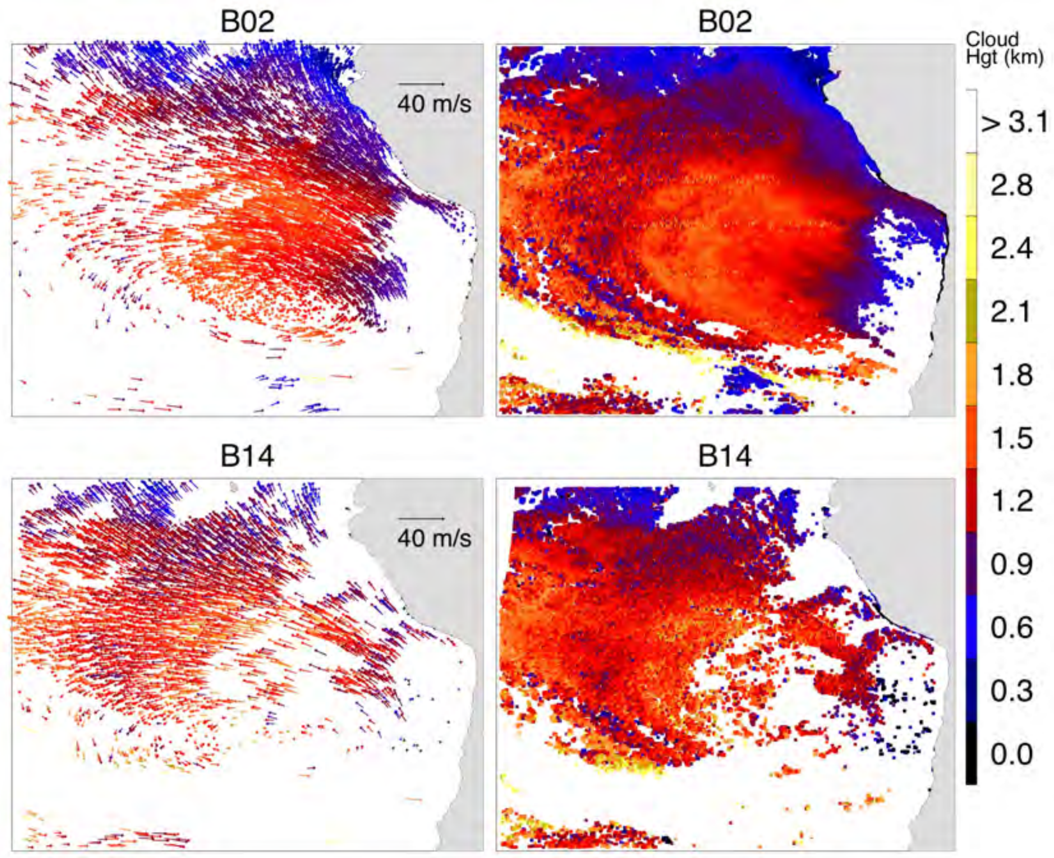


- Good 1:1 correlation between operational and stereo AMVs (U and V)
- Operational AMV errors are largely associated with height registration uncertainty
  - Systematic biases for PBL heights
  - Problems for multi-layer clouds

Applications

- Deep Convective Systems
  - Tropical cyclones
  - Severe weather
- PBL
  - Cold air outbreak
  - Stratocumulus-to-cumulus transition
  - Orographic clouds
- Wildfire plume and Air Quality
  - Pyrocumulonimbus (pyroCb) cloud
  - Plume transport

G16-G17 PBL
Stereo Winds and Height



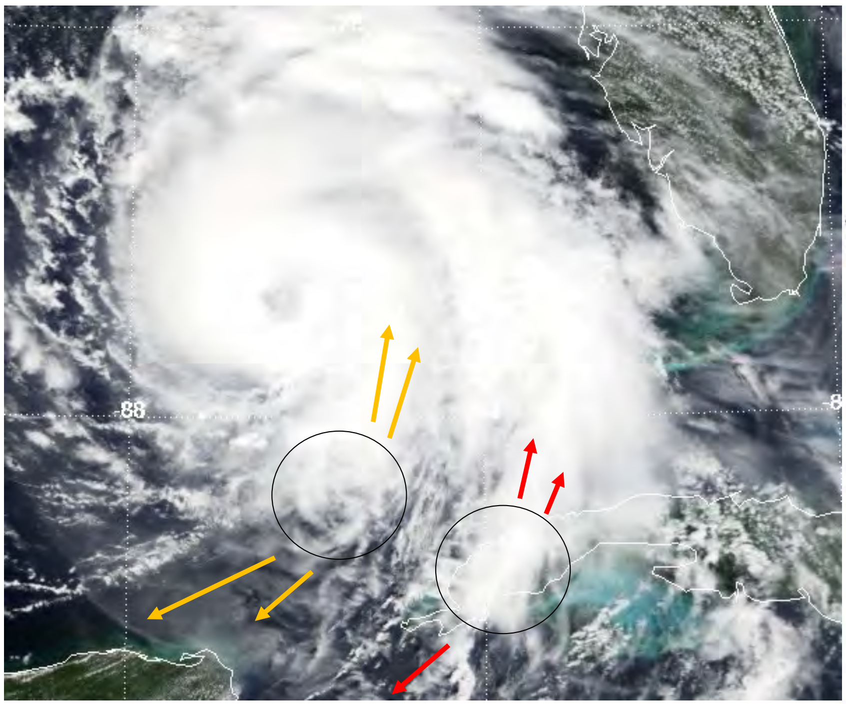
Carr et al. (2020)

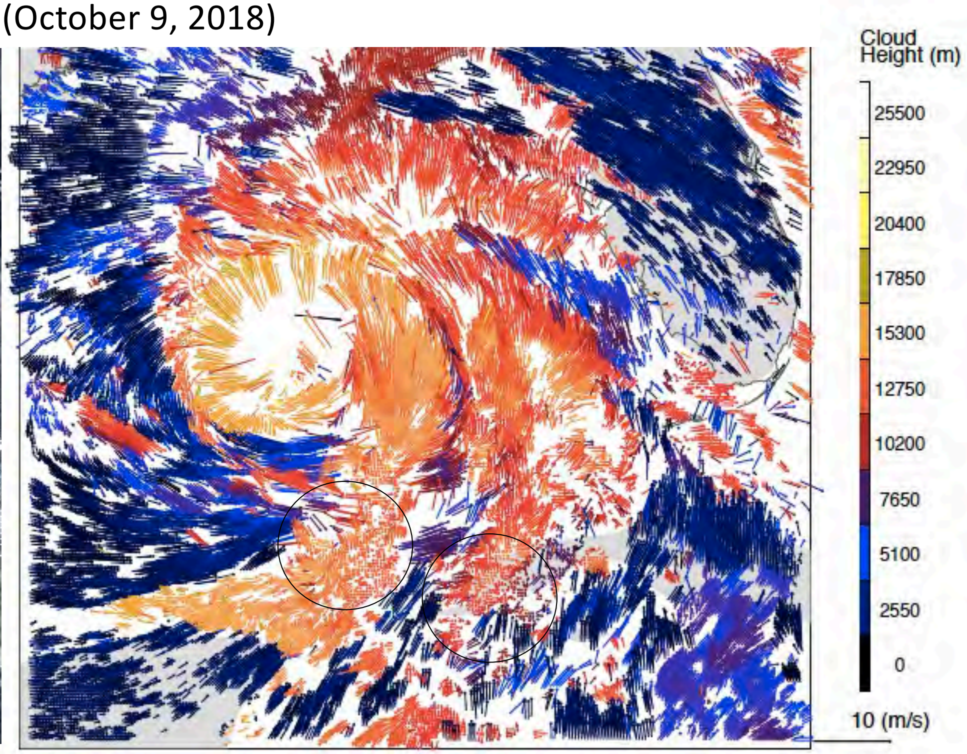
MODIS-GOES Stereo Winds

Carr et al. (2019)

- Good coverage and yield from stereo pattern matching
- Detailed hurricane dynamics from mesoscale stereo winds
- Convective divergence flows indicated in the circled regions

Hurricane Michael (October 9, 2018)



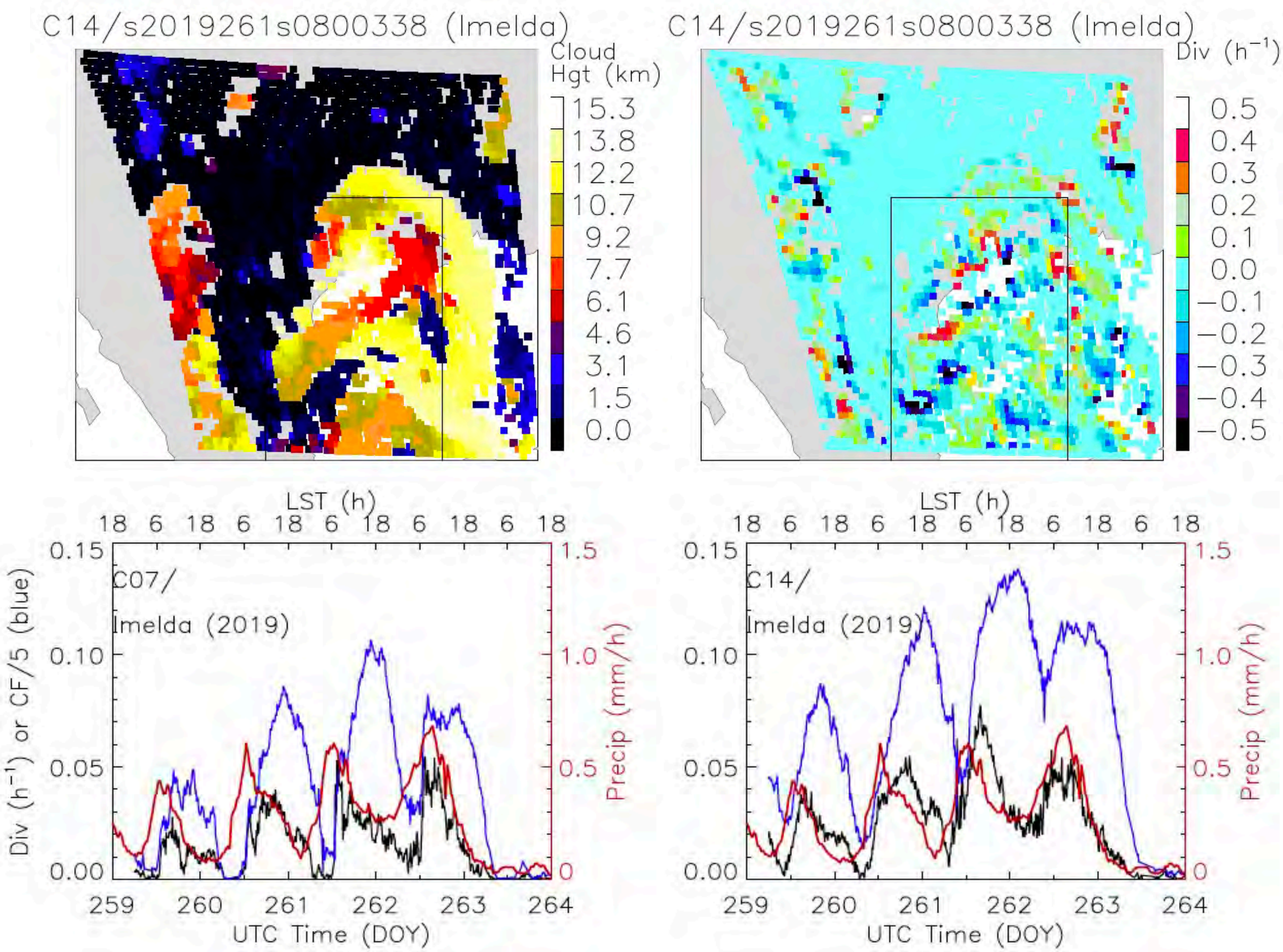


G16-G17 Stereo Winds and Height

Tropical Storm Imelda (2019)

Carr et al. (2020)

- Dense wind measurements to derive cloud top divergence at z >11 km
- Strong diurnal cycles in upper-level cloudiness and divergence, and in precipitation
- Precipitation leads upper-level divergence by ~6 hours



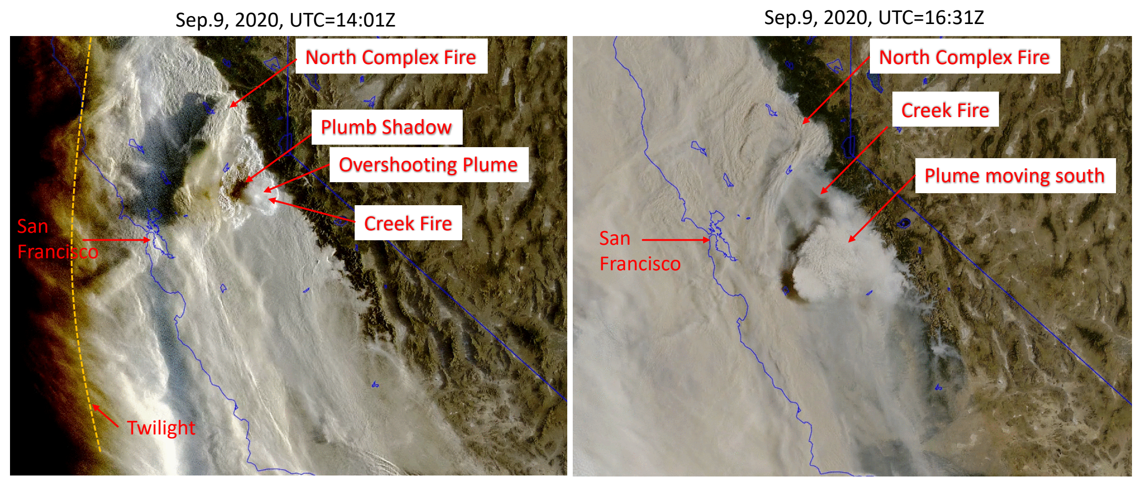
Divergence
Cloud fraction
IMEG Precipitation

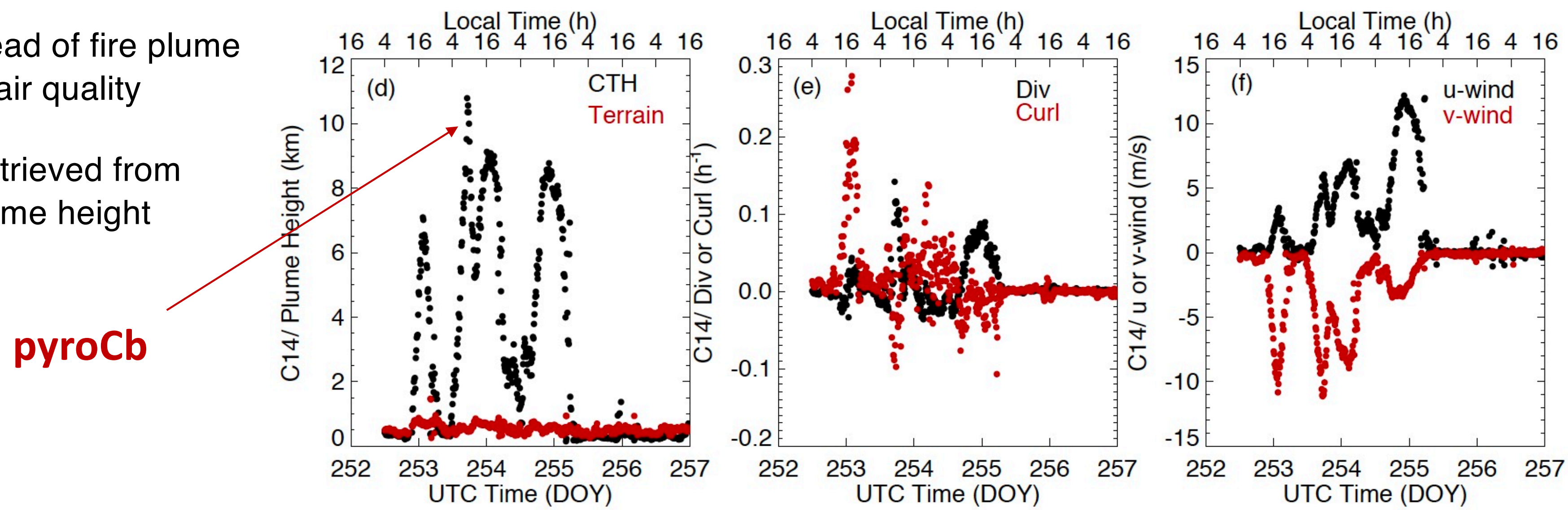
G16-G17 Stereo Plume Height

Carr et al. (2020)

- Intense and deadly wildfire season in the West Coast in 2020
- Strong diurnal cycles in plume height and winds
- Wide spread of fire plume and poor air quality
- pyroCb retrieved from stereo plume height

California Creek Fire (Sep 2020)





Summary

- Stereo methods offer a direct method of height assignment for AMVs, showing improvements in PBL and multi-layer clouds.
- The stereo-winds method solves for AMVs and their heights jointly using the same feature tracking algorithm.
- No radiometric calibration is required between imagers as atmospheric features are identified and tracked by relative intensity.
- No synchronization between observing systems is required as the pixel time is built in the stereo-winds solver.
- Quality stereo winds enable future studies on PBL dynamics, diurnal variations, and aerosol transport.
- Cost-effective LEO constellation with calibration-less compact imagers such as CMIS (Compact Midwave Imaging System) will be able to improve spatiotemporal coverage of LEO-GEO and LEO-LEO stereo winds.