Nowcasting in Asia-Pacific: A United States Perspective

Jordan J. Gerth
National Weather Service Office of Observations, Silver Spring, MD

Contributions from:
Rainer Hollmann (DWD) and other WMO members

Joseph K. Zajic and KBR team members
John D. Evans and GST team members
Silver Spring, MD

Twitter: @jjgerth

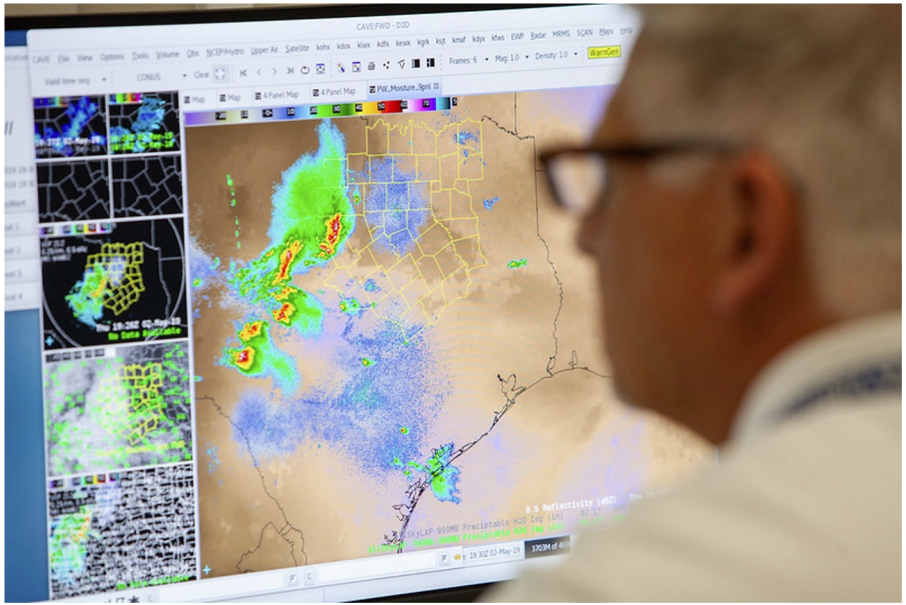
jordan.gerth@noaa.gov

Presentation for Session 9A, Leveraging International Collaboration to Advance the Environmental Satellite Missions, 31 January 2024

It Starts with Observations

How can the U.S. and NOAA achieve service equity?

This presentation will discuss the outcomes of the work in the U.S. to assess and prioritize **observational needs** for **nowcasting** services, focusing specifically on the Asia-Pacific region and the use of **satellites**.

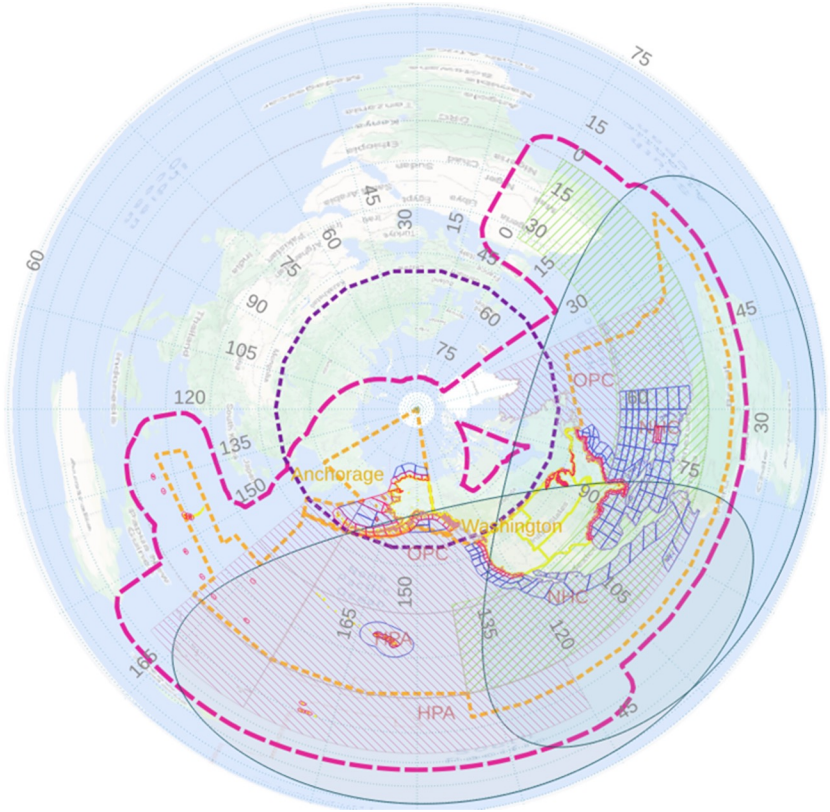


Above: An ever-increasing amount of observational data is reaching meteorologists in native form, derived science products, or through assimilation into numerical models.

Nowcasting is…

- **Local**
- A forecast of minutes ahead out to six hours
- Dependent on observations
- A skill that meteorologists perform as the integrator of numerical model output with multiple sources of observations
- Evolving to incorporate numerical techniques based on observations
- Sometimes specific to an industry, hazard, or phenomenon

Serving All Americans



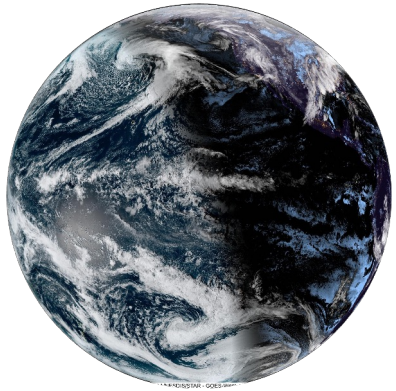
The NWS service area is far more expansive than the contiguous United States.

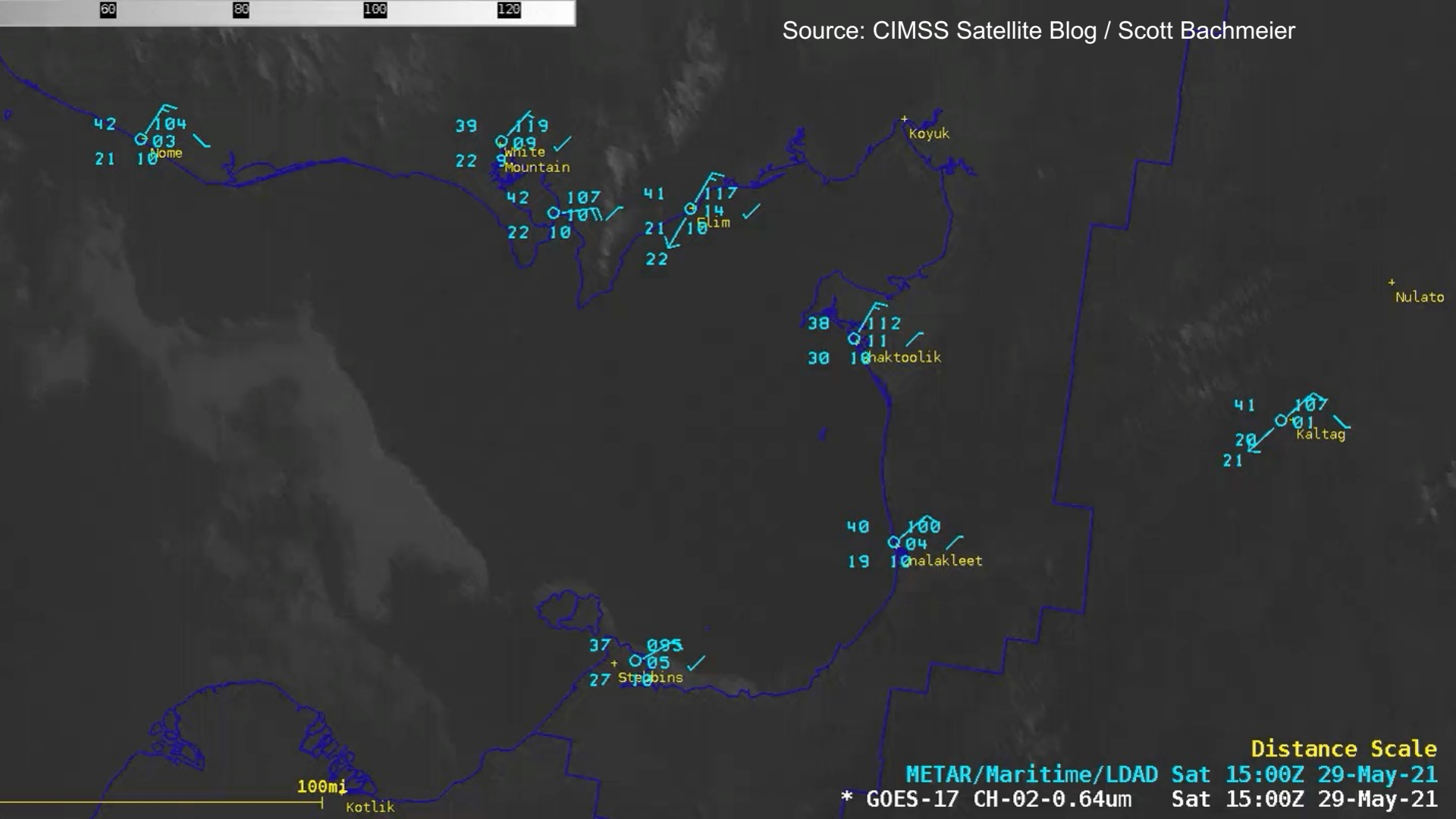
The NWS uses JMA Himawari satellites for the western Pacific Ocean and EUMETSAT Meteosat satellites for the far eastern Atlantic Ocean.

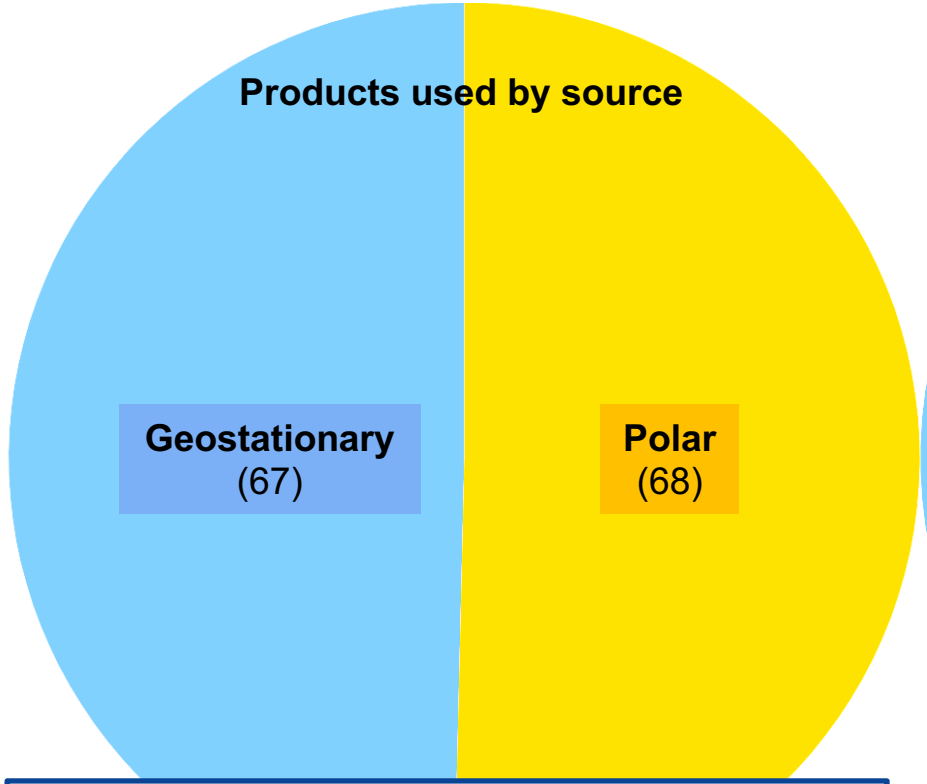
Other American nations use GOES for nowcasting.

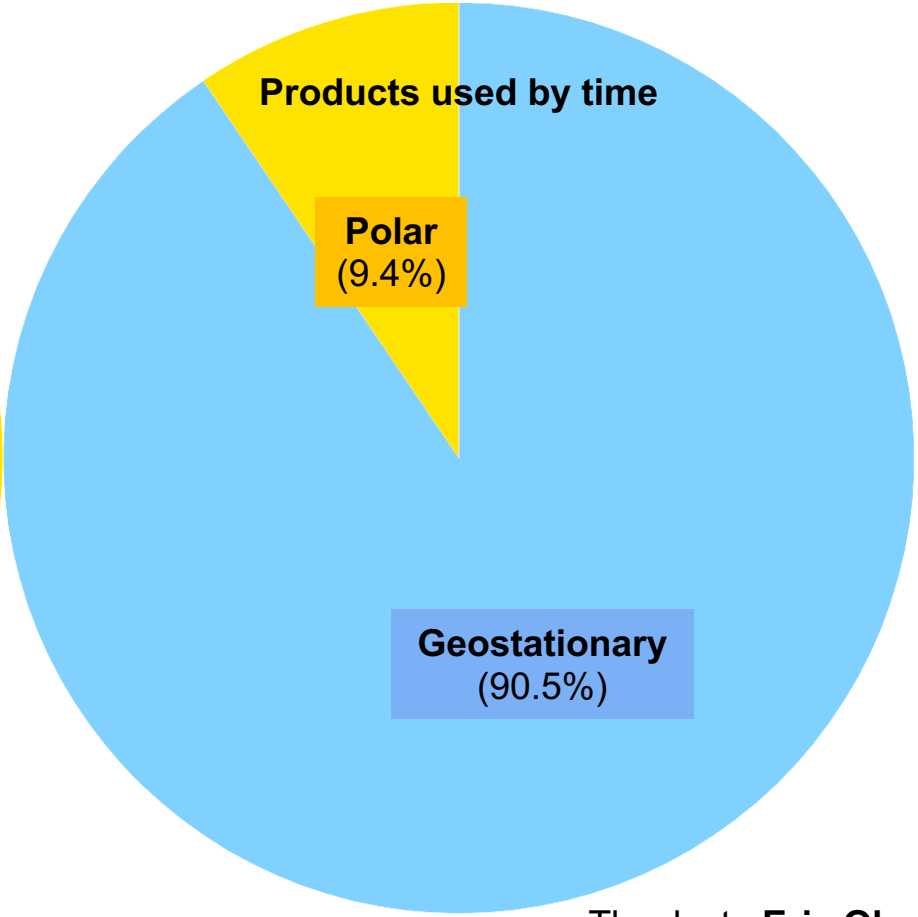
Unique to the Lower 48 – Not OCONUS

- Observations are readily available:
  - Dense surface observations network
  - High volume of regional commercial air traffic
  - Extensive Doppler radar network
- Substantial portions are “landlocked”.
- Tornadoes readily occur over the U.S. Plains and South.
- Meteorologists have access to high resolution regional models.
- No other operators of geostationary satellites cover the Americas.




60
80
100
120
Source: CIMSS Satellite Blog / Scott Bachmeier
Nome
White Mountain
Koyuk
Nulato
Kaltag
Unalakleet
Stebbins
Kotlik
100mi
Distance Scale
METAR/Maritime/LDAD Sat 15:00Z 29-May-21
* GOES-17 CH-02-0.64um Sat 15:00Z 29-May-21





One week: 20 to 28 January 2024 00 UTC

All Alaska Sites (Three WFOs, Headquarters)

Thanks to **Eric Oh**

Offshore Winds and Sea Ice Observational Needs

Requirements Ranges

Geophysical Variable	Units (Accuracy)	Horizontal Resolution (km)	Temporal Refresh (h)	Data Latency (h)
Wind Speed Profile	m/s	[20, 5, 1]	[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Cloud Cover	fraction		[1 h, 5 m, 1 m]	[15 m, 1 m, 0.5 m]
Cloud and Moisture Imagery	unitless			
Sea Ice Age	year		[24 h, 3 h, 1 h]	[6 h, 3 h, 1 h]
Sea Ice Concentration	%		[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Ice Surface Temperature	K	[10, 2, 0.5]		
Sea Ice Motion	m/s	[20, 5, 1]		
Rain Rate	mm/hr	[5, 1, 0.25]	[3 h, 15 m, 2 m]	[1 h, 5 m, 1 m]
Cloud Base Height	km	[20, 5, 1]	[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Sea Surface Temperature	K			
Sea Surface Wind Speed	m/s	[10, 2, 0.5]		
Sea Surface Wind Direction	deg			
Wave Height	m	[20, 5, 1]		

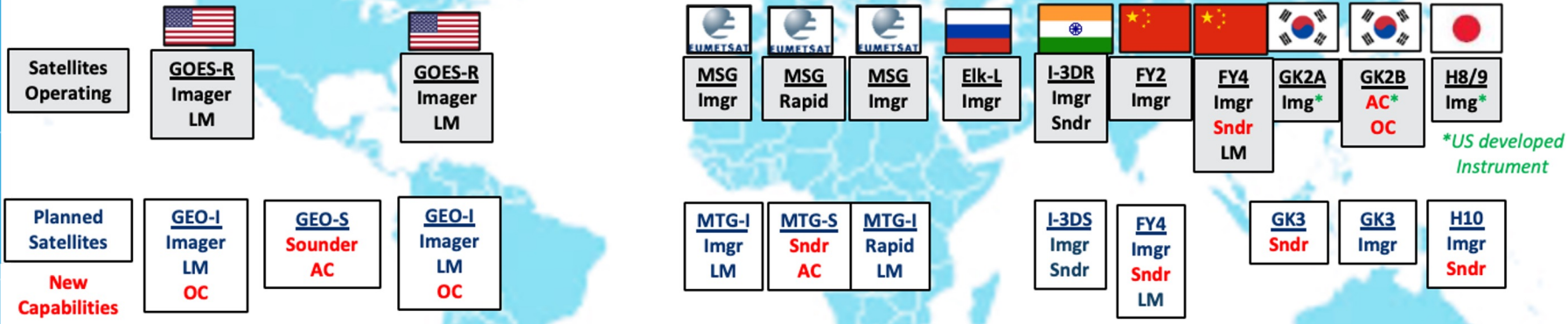
[Minimally useful, Expected (2030), Maximum effective]

Offshore Winds and Sea Ice Observational Needs

Requirements Ranges

Geophysical Variable	Best Observation Platform	Units (Accuracy)	Horizontal Resolution (km)	Temporal Refresh (h)	Data Latency (h)
Wind Speed Profile	**Ground-based or LEO**	m/s	[20, 5, 1]	[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Cloud Cover	**GEO**	fraction		[1 h, 5 m, 1 m]	[15 m, 1 m, 0.5 m]
Cloud and Moisture Imagery	**GEO**	unitless			
Sea Ice Age	**LEO**	year		[24 h, 3 h, 1 h]	[6 h, 3 h, 1 h]
Sea Ice Concentration	**LEO**	%		[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Ice Surface Temperature	**LEO**	K	[10, 2, 0.5]		
Sea Ice Motion	**LEO**	m/s	[20, 5, 1]		
Rain Rate	**LEO**	mm/hr	[5, 1, 0.25]	[3 h, 15 m, 2 m]	[1 h, 5 m, 1 m]
Cloud Base Height	**Ground-based**	km	[20, 5, 1]	[12 h, 1 h, 5 m]	[3 h, 15 m, 2 m]
Sea Surface Temperature	**GEO or LEO**	K			
Sea Surface Wind Speed	**LEO**	m/s	[10, 2, 0.5]		
Sea Surface Wind Direction	**LEO**	deg			
Wave Height	**LEO**	m	[20, 5, 1]		

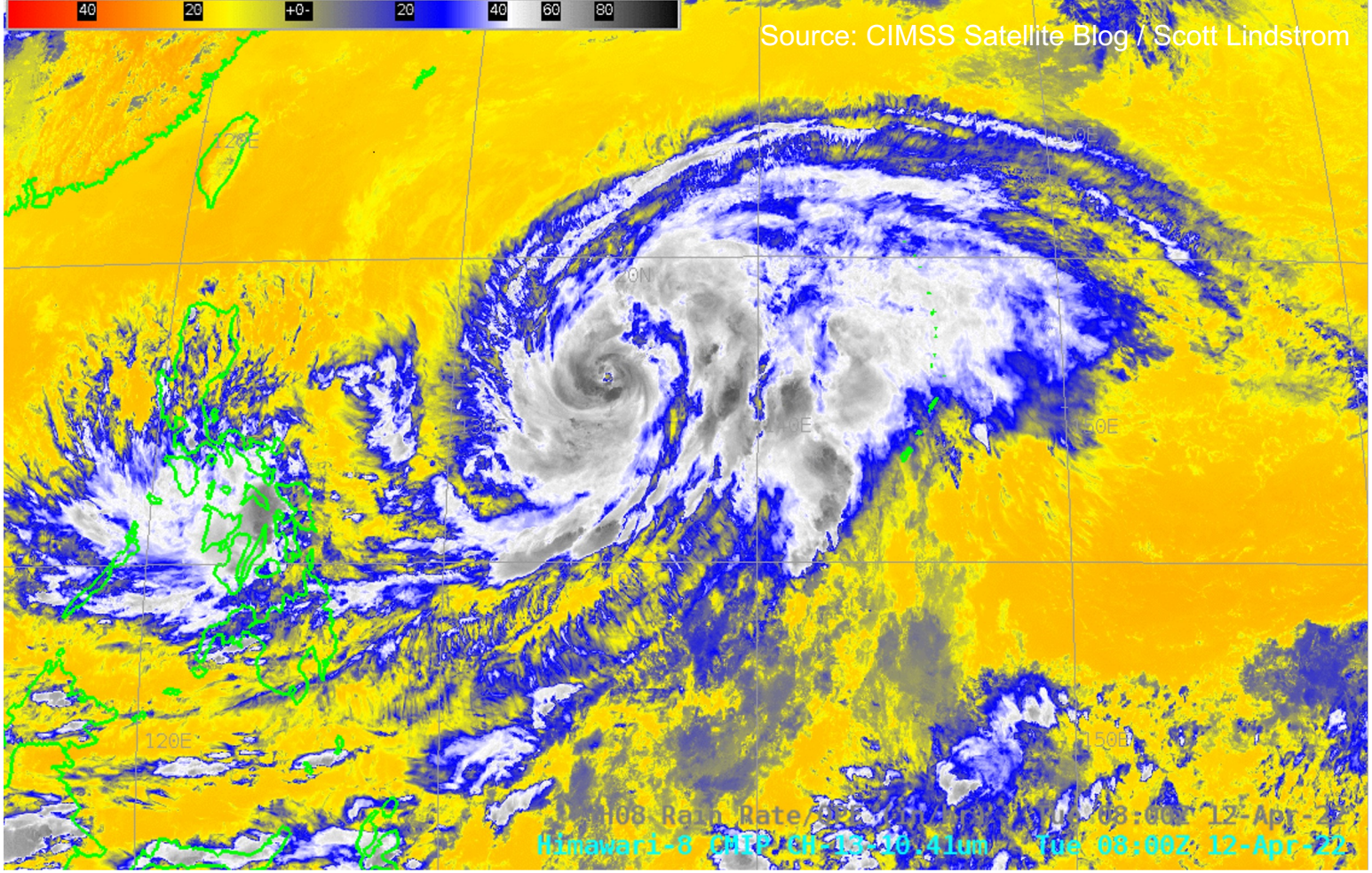
Current or Coming Constellations



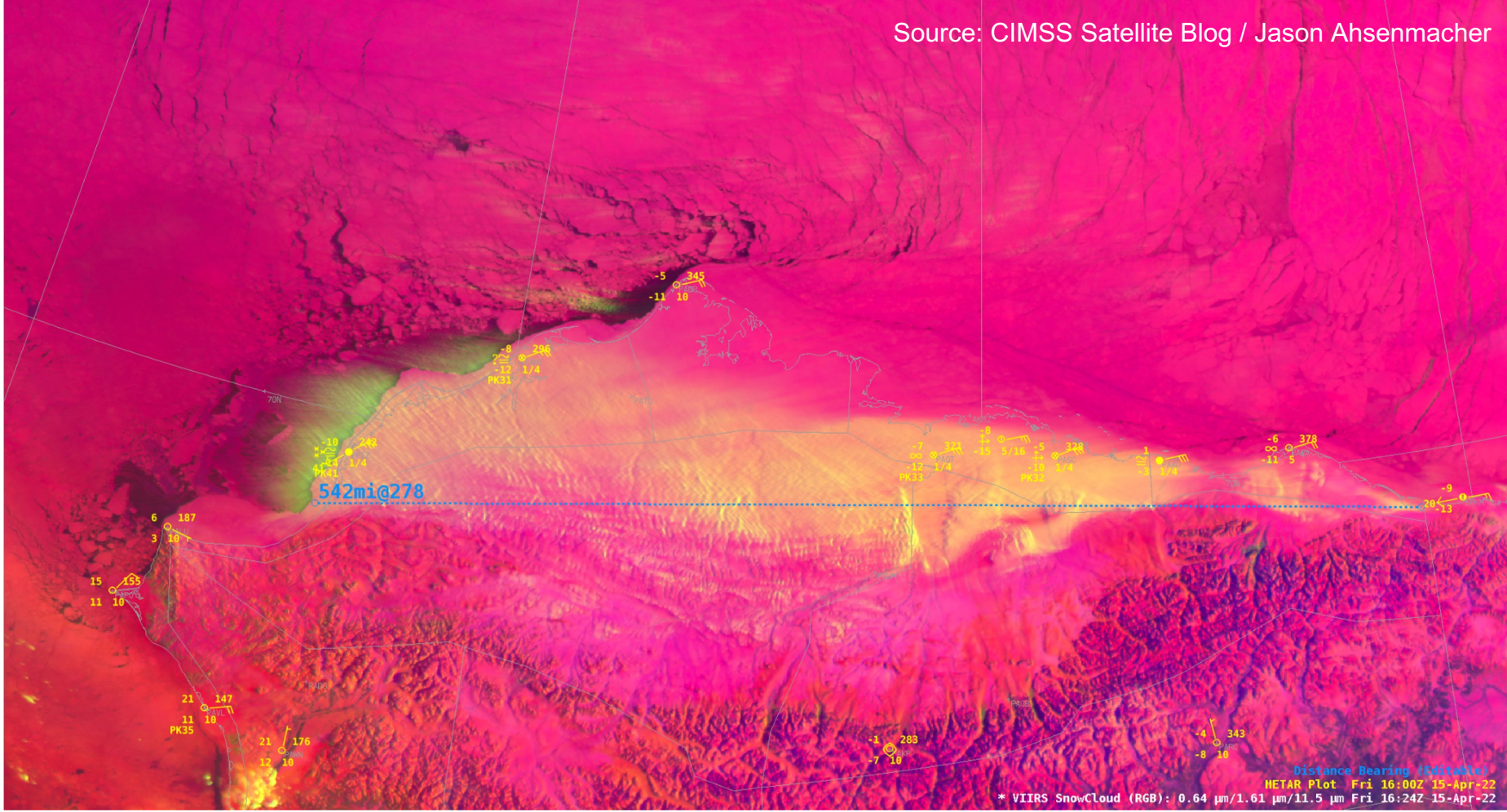
New capabilities for GeoXO allow NOAA to meet World Meteorological Organization objectives; match or exceed European and Chinese capabilities; encourage Japan and Korea to acquire U.S. instruments; and enable global real time sounding observations to be integrated into NWP.

Source: GeoXO program

Core Geostationary Satellite Products for Nowcasting	China / CMA	Japan / JMA	Korea / KMA	U.S. / NOAA
Imagery (Visible / NIR / Infrared / RGBs)	✓	✓	✓	✓
Atmospheric Motion Vectors (AMVs)	✓	✓	✓	✓
Cloud Products (Type, Height, Temperature)	✓		✓	✓
Convective Initiation (Custom)	✓		✓	✓
Precipitation Estimate / Rate	✓		✓	✓
Aerosol Products			✓	✓
Derived Stability Indices			✓	✓
Sea Surface Temperature			✓	✓
Vertical Temperature and Moisture Profiles			✓	✓


40
20
+0-
20
40
60
80
Source: CIMSS Satellite Blog / Scott Lindstrom
120E
Himawari-8 CHIP Ch 13 10.41um
Tue 08:00Z 12-Apr-22

Core LEO Satellite Products for Nowcasting	China / CMA	Japan / JMA	Korea / KMA	U.S. / NOAA
Imagery (Visible / NIR / Infrared / RGBs)		✓		✓
Atmospheric Motion Vectors (AMVs)	✓			
Microwave Imagery (36-37 GHz, 89 GHz)	✓	✓		✓
Microwave Sounder Imagery		✓		✓
Precipitation Rate			✓	✓
Sea Surface Temperature			✓	✓
Sea Surface Wind (Scatterometer)	✓	✓	✓	✓
Vertical Temperature and Moisture Profiles				✓

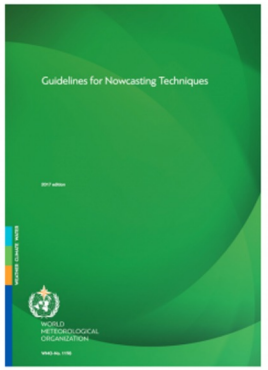

Source: CIMSS Satellite Blog / Jason Ahsenmacher
542mi@278
Distance Bearing (Editable)
METAR Plot Fri 16:00Z 15-Apr-22
* VIIRS SnowCloud (RGB): 0.64 µm/1.61 µm/11.5 µm Fri 16:24Z 15-Apr-22

Core Geostationary Satellite Products for Nowcasting	China / CMA	Japan / JMA	Korea / KMA	U.S. / NOAA
Spatial Resolution Requirements	1-2 km	0.5-18 km	1-6 km	0.5-6 km
Temporal Resolution Requirements	30 min	2.5-30 min	2-10 min	0.5-10 min
Timeliness (Latency) Requirements	NRT	3 min	3-15 min	1 min
Core LEO Satellite Products for Nowcasting	**China / CMA**	**Japan / JMA**	**Korea / KMA**	**U.S. / NOAA**
Spatial Resolution Requirements	15-20 km	3-30 km		<5 km*
Temporal Resolution Requirements	60 min	3-6 hrs		60 min*
Timeliness (Latency) Requirements	30-60 min	60 min		30-60 min

* Not met for all observations/areas

Other Nowcasting Data Considerations

- Observation/Service Equity
- Proximity to Geostationary Satellite Operator
- Data Sharing
- L2+ Product Availability
- Latency of Delivery Mechanism
- Training



Comparing NWP Needs to Nowcasting

- Nowcasting needs are a subset of the NWS requirements for satellite observations, and NWS requirements are different from NOAA requirements.
- WMO established core and recommended satellite observations that contribute to NWP.
- Some observations that are part of the NWP backbone apply to nowcasting (radiances vs. imagery).
- Many data principles for NWP apply to nowcasting.

Summary

NOAA is evaluating observational needs for nowcasting based on NWS meteorologists.

NOAA is working with other satellite operators in Asia-Pacific to establish core and recommended data for the provision of nowcasting services.

This work is informing the next-generation constellation, both domestically and internationally.

Asia-Pacific Application Drivers for GEO

Increased spatial resolution

- Enhance detection of gravity waves and small-scale storm features
- Supports regional and global aviation and wildfire nowcasting
- Improving spatial resolution at nadir supports high latitude applications

Regional hyperspectral infrared soundings

- Monitor pre-storm environments for changing conditional instability
- At a minimum add low-level water vapor bands to GEO ring imagers

Temporal resolution and scan strategies

- Steer rapid observations to areas with evolving weather
- Current advanced GEO imager capabilities are largely meeting needs

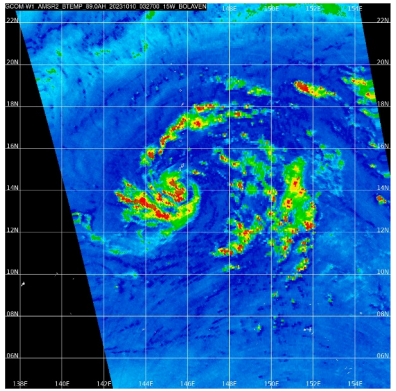
Asia-Pacific Application Drivers for LEO

General constellation considerations

- Maximize return rate
- Must be consistent and reliable throughout day for operational adoption

Microwave imagers

- Maximize spatial resolution for convective systems
- Most valuable in areas without ground-based radar



Microwave and/or infrared sounders

- Atmospheric profiles in absence of any other source

Scatterometers and synthetic aperture radars

- Contribute to nearshore and high seas wind and sea state nowcasting

Nowcasting in Asia-Pacific: A United States Perspective

Jordan J. Gerth
National Weather Service Office of Observations, Silver Spring, MD

Contributions from:
Rainer Hollmann (DWD) and other WMO members

Joseph K. Zajic and KBR team members
John D. Evans and GST team members
Silver Spring, MD

Twitter: @jjgerth

jordan.gerth@noaa.gov

Presentation for Session 9A, Leveraging International Collaboration to Advance the Environmental Satellite Missions, 31 January 2024