

MITCHELL INSTITUTE
for Aerospace Studies



Winds of Change: Environmental Monitoring for an Era of Peer Competition

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Why do we even need this?

- **Space-Based Environmental Monitoring (SBEM) impacts all levels of warfare**

- Closing kill chains: right shooter, right place, right time, and right effect
- Directing forces efficiently: anticipating an adversary's decision calculus based on weather information
- Collecting, processing, and exploiting SBEM information better & faster than an adversary is at the core of DOD's CJADC2 strategy

“Weather’s also important when you’re trying to forecast what the adversary’s going to do. War is hard and everything in war is hard and the weather always gets a vote. So it’s important on both sides of the equation.”

**Maj Gen Gregory Gagnon
USSF S-2**

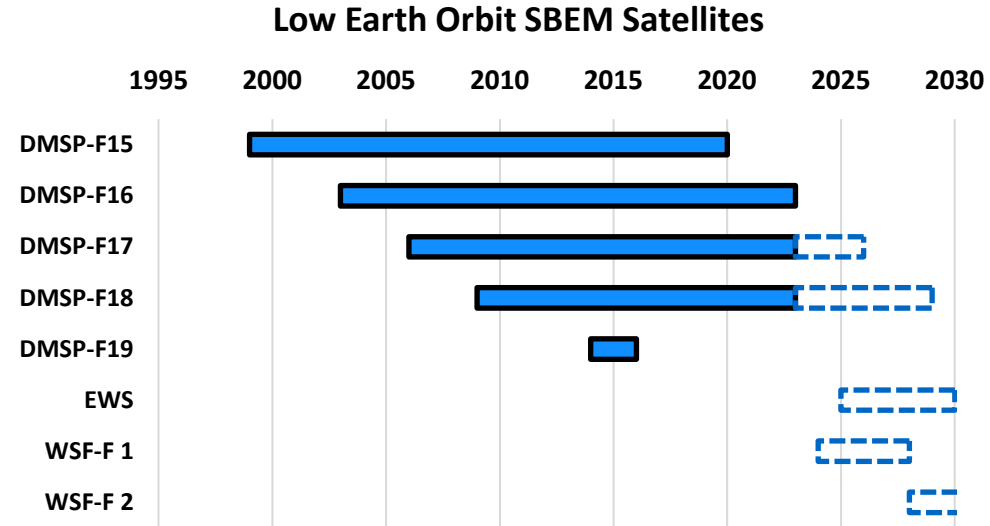
- **SBEM capabilities & capacity have not kept pace with warfighter needs**

- Currently executed by a small number of aging satellites that are well past their design lives—the Defense Meteorological Satellite Program (DMSP)
- Over the last two decades, the Department of Defense has started but never completed programs to replace DMSP



How did we get here?

- Prior efforts to recapitalize the SBEM enterprise were delayed and canceled due to budget concerns and a lack of imminent system failure
- Stop gap measures have since failed
- Current recapitalization plan is based on mission gaps assessed via an Analysis of Alternatives (AOA) executed in the 2010's



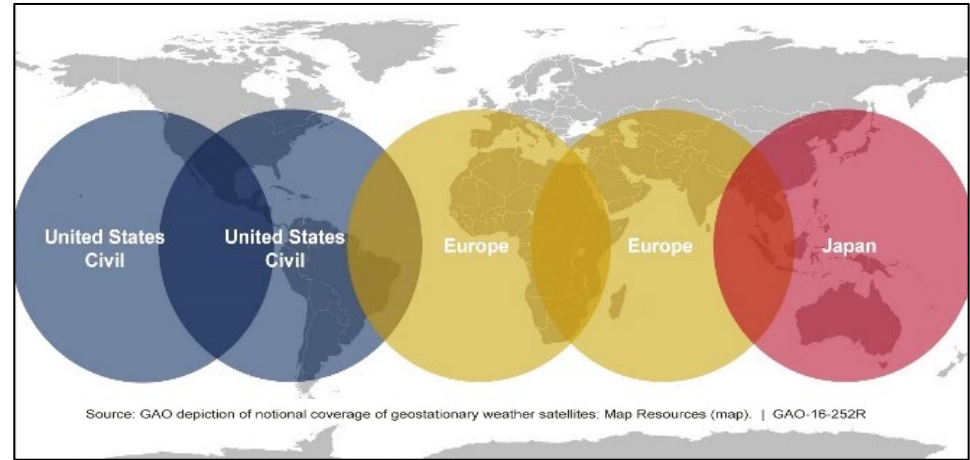
- In 2016, DOD identified these gaps and used the findings of a Joint Requirements Oversight Council (JROC) study to launch SBEM recapitalization
- The Electro-Optical/Infrared Weather Systems (EWS) and Weather Satellite Follow-on Microwave (WSF-M) programs were selected to meet modern space-based environmental sensing requirements

Current plans put the SBEM mission back on the right trajectory, but capabilities and capacity have not kept pace with evolving demands



SBEM challenges

- **DMSP has existed in various forms since the 1960s, and despite the constant demand for its services, there are currently no spares, sensor upgrades, or replenishment satellites**



- **Attempts to refresh or replace DMSP have involved a path of false starts and setbacks over the past 20 years**
- **The warfighter is now depending on a family of systems that rely heavily on civil and foreign sources**

“The thing we have to ask ourselves is do we want to find ourselves where an individual or a business can impact national security by their perception or their political views? And we find ourselves in a situation where now they're impacting our ability to conduct operations around the globe.”

General Glen VanHerck, USNORTHCOM/CC



Forces require information and decision advantage

“Weather operations achieve U.S. decision advantage and impose costs on U.S. adversaries. That’s our goal, that’s what we’re trying to get after.”

Col Patrick Williams, Former 557 Wing/CC

- **CJADC2—“warfighting capability to sense, make sense, and act at all levels and phases of war, across all domains, and with partners, to deliver information advantage at the speed of relevance.”**
- **Empowering decisions in hours and minutes (not days) across an entire theater**
- **New SBEM capabilities can provide data needed to make highly accurate short-term forecasts**
- **SBEM recapitalization is the key to modern combat operations and the migration to CJADC2 concepts**



SBEM future requirements

- **2016: Decision to replace the monolithic DMSP with two separate disaggregated, small satellite constellations to cover 12 mission capability gaps**
 - Improves the architecture's resilience by distributing its functions across multiple satellites
 - Allows more rapid technology updates and progressive constellation modernization
- **However, increasing systems numbers would increase data refresh rates for more dynamic data-driven combat environments**

	Capability Area	System Addressing
1	Cloud Characterization	EWS
2	Theater Weather Imagery	EWS
3	Ocean Surface Vector Winds	WSF-M
4	Ionospheric Density	NOAA
5	Snow Depth	WSF-M
6	Soil Moisture	WSF-M
7	Equatorial Ionospheric Scintillation	Ground Sensors
8	Tropical Cyclone Intensity	WSF-M
9	Sea Ice Characterization	WSF-M
10	Auroral Characterization	Scientific use only
11	Energetic Charged Particle Characterization	WSF-M
12	Electric Field	NOAA

Projected launches in 2024–2025

Considering DMSP end-of-life projections, there is no time to waste



EO/IR Weather System (EWS)

- EWS addresses two major SBEM requirements: Cloud characterization and theater weather imagery
- Characterizing cloud cover is foundational to missile warning timelines and providing timely missile warning
- EWS provides weather imagery critical to warfighters in a specific geographic region, often austere and unsupported by terrestrial weather sensors



“EWS continues to blaze the trail on numerous space acquisition tenants. The program is building smaller satellites while minimizing non-recurring engineering.”

**Col Brian Denaro
Former SSC PEO**



Weather System Follow-on Microwave (WSF-M)

- **WSF-M will use a next-generation passive microwave imager to collect terrestrial weather information and space environment observations**
- **WSF-M will support meteorologists in generating the weather products necessary for daily global mission planning and operations**



- ❑ **A combination of EWS and WSF-M address existing military capability needs**
- ❑ **The USSF must continue to grow and mature architecture requirements for evolving capability, capacity, and resilience requirements**



Modernization of SBEM to meet warfighter needs

- To achieve a U.S. decision advantage and impose costs on adversaries, DOD leadership will rely heavily on assured space-based weather sensing in a constellation sufficiently sized to meet today's warfighter needs

Following a CJADC2 strategy:

- ❑ Collect more near-real-time weather and environmental information
- ❑ Make decisions based on that information to achieve effects before an adversary can, thus achieving a weather decision advantage
- ❑ To deliver this weather decision advantage requires additional consideration about necessary constellation size and orbits

Warfighter demands will be closer to one-hour refresh rates with highly accurate short-term forecasts. This will require a bare minimum of twelve satellites to satisfy the dynamic, high-tempo operations both in the harsh environment of the Northern Tier or in a CJADC2 environment.



Recommendations

1. Congress must protect DMSP replacement efforts

- The NDAA should fence EWS and WSF-M for defense requirements only and avoid repeating the past delays, complexities, and dysfunctions involved with merging many government agency requirements into an interagency program in the name of efficiency

2. The U.S. Space Force must continue to develop a resilient SBEM architecture

- The Space Force must continue to embrace a disaggregated SBEM architecture to provide resiliency with smaller, less expensive platforms to offset the loss of one or two systems

3. The U.S. Space Force must continue to develop SBEM requirements to reflect the current and emerging needs of the warfighter

- The Space Force must continue to update requirements that incorporate combatant commanders' future needs



Recommendations (continued)

Weather decision advantage is wholly dependent upon a new set of space-based environmental monitoring technologies—and the investment required to underwrite this crucial capability

4. The U.S. Space Force needs a stable, long-term program of record for SBEM

- The SBEM enterprise would benefit from a long-term, stable program of record with requisite defined funding to provide a full constellation of satellites

5. Nurturing partnerships is imperative to our nation's weather strategy

- DOD's partnership strategy must prioritize SBEM data assurance through reliable sources and data availability through all phases of conflict

“Every DOD operational mission begins with a weather briefing; either space weather, terrestrial weather, or both. The data required for DOD missions is often unique and necessitates 24/7 global ability to forecast weather in austere and denied environments.”

General David Thompson, VCSO



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