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Exhibit R-2, RDT&E Budget Item Justification: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 4: Advanced Component Development & Prototypes (ACD&P)</i>	R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>
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COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
Total Program Element	497.869	195.495	0.000	0.000	0.000	0.000	-	-	-	-	-	-
644289: <i>Weather System Follow-On</i>	497.869	195.495	0.000	0.000	0.000	0.000	-	-	-	-	-	-

Program MDAP/MAIS Code: 488

A. Mission Description and Budget Item Justification

In FY2021, PE 1206422F, Weather System Follow-On efforts were transferred to Appropriation 3620, Research, Development, Test & Evaluation, Space Force, PE 1206422SF Weather System Follow-On from Appropriation 3600, Budget Activity 04 due to the creation of a new Appropriation for Space Force.

In FY2021, PE 1206422F, Military Application of the Space Environment efforts were transferred to PE 1206427F, Appropriation 3620, Research, Development, Test & Evaluation, Space Force, Budget Activity 04 due to the creation of a new Appropriation for Space Force.

Based on completion of the Space-Based Environmental Monitoring (SBEM) Joint Requirements Oversight Council (JROC) Memo 092-14, capabilities will be developed to satisfy weather gaps for which no known mitigation exists. Weather System Follow-on (WSF) is a component of SBEM efforts to develop capabilities to satisfy weather Gap 3 Ocean Surface Vector Winds (OSVW), Gap 8 Tropical Cyclone Intensity (TCI), and Gap 11 Low Earth Orbit (LEO) Energetic Charged Particles (LEO ECP). Gap 3 OSVW and Gap 8 TCI require a space-based microwave sensor to provide polarimetric ocean surface wind direction and speed required for naval sea operations, as well as fighter sortie generations and marine amphibious operations. Gap 11 LEO ECP requires in situ ECP sensor for space situational awareness. The earliest possible launch options are being integrated in the design for critical gaps.

DoD established WSF as a Pre-Major Defense Acquisition Program (MDAP) with the Air force as the lead component. Based on the SBEM AoA results, the WSF initial thrusts will be to enable:

- 1) DoD use of data collected by civil, international and other DoD space systems;
- 2) Timely weather collection over broad oceans in support of maneuvering forces;
- 3) Space weather capabilities to characterize operational orbits, space situational awareness, and the ionosphere.

Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC.

The Military Application of the Space Environment (MASE) is a program to demonstrate mature space environment technology to improve combat operations. MASE will enhance regional ionospheric specification (nowcasts) and predictions (forecasts) affecting signal propagation paths. MASE uses traditional and non-traditional ionospheric measurements in advanced space environment models to forecast and predict impacts to weapon systems. Contributes to satisfying Gaps 4 and 7 of the SBEM AoA results as supplemented by the AFRDM 02-17-02 (SBEM JDCR). MASE was a new start in FY 2019.

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Appropriation/Budget Activity 3600: <i>Research, Development, Test & Evaluation, Air Force I BA 4: Advanced Component Development & Prototypes (ACD&P)</i>	R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>
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Space acquisition must respond with speed and agility to emerging adversary threats. Space & Missile Systems Center (SMC) has transformed the organization and implementation of space acquisition to an enterprise approach, maximizing innovation and resiliency, leveraging international, commercial, and mission partnerships, and managing program/project priorities according to an integrated unclassified/classified enterprise space architecture. Expanding the appropriate acquisition authorities and contract mechanisms to deliver capability sooner, SMC will strategically execute experimentation, prototyping, risk reduction, and other efforts to develop new or repurpose capabilities.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver WSF weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 1206392F and 1206398F.

This effort is in Budget Activity 4, Advanced Component Development and Prototypes (ACD&P), because efforts are necessary to evaluate integrated technologies, representative modes or prototype systems in a high fidelity and realistic operating environment.

B. Program Change Summary (\$ in Millions)	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022 Base</u>	<u>FY 2022 OCO</u>	<u>FY 2022 Total</u>
Previous President's Budget	205.660	0.000	0.000	0.000	0.000
Current President's Budget	195.495	0.000	0.000	0.000	0.000
Total Adjustments	-10.165	0.000	0.000	0.000	0.000
• Congressional General Reductions	0.000	0.000			
• Congressional Directed Reductions	0.000	0.000			
• Congressional Rescissions	0.000	0.000			
• Congressional Adds	0.000	0.000			
• Congressional Directed Transfers	0.000	0.000			
• Reprogrammings	-3.013	0.000			
• SBIR/STTR Transfer	-7.152	0.000			
• Other Adjustments	0.000	0.000	0.000	0.000	0.000

Change Summary Explanation

FY2020: -\$3.013M transferred for higher AF priorities.

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Exhibit R-2A, RDT&E Project Justification: PB 2022 Air Force										Date: May 2021		
Appropriation/Budget Activity 3600 / 4					R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>				Project (Number/Name) 644289 / <i>Weather System Follow-On</i>			
COST (\$ in Millions)	Prior Years	FY 2020	FY 2021	FY 2022 Base	FY 2022 OCO	FY 2022 Total	FY 2023	FY 2024	FY 2025	FY 2026	Cost To Complete	Total Cost
644289: <i>Weather System Follow-On</i>	497.869	195.495	0.000	0.000	0.000	0.000	-	-	-	-	-	-
Quantity of RDT&E Articles	-	-	-	-	-	-	-	-	-	-	-	-

A. Mission Description and Budget Item Justification

Based on completion of the Space-Based Environmental Monitoring (SBEM) Joint Requirements Oversight Council (JROC) Memo 092-14, capabilities will be developed to satisfy weather gaps for which no known mitigation exists. Weather System Follow-on (WSF) is a component of SBEM efforts to develop capabilities to satisfy weather Gap 3 Ocean Surface Vector Winds (OSVW), Gap 8 Tropical Cyclone Intensity (TCI), and Gap 11 Low Earth Orbit (LEO) Energetic Charged Particles (LEO ECP). Gap 3 OSVW and Gap 8 TCI require a space-based microwave sensor to provide polarimetric ocean surface wind direction and speed required for naval sea operations, as well as fighter sortie generations and marine amphibious operations. Gap 11 LEO ECP requires in situ ECP sensor for space situational awareness. The earliest possible launch options are being integrated in the design for critical gaps.

DoD established WSF as a Pre-Major Defense Acquisition Program (MDAP) with the Air force as the lead component. Based on the SBEM AoA results, the WSF initial thrusts will be to enable:

- 1) DoD use of data collected by civil, international and other DoD space systems;
- 2) Timely weather collection over broad oceans in support of maneuvering forces;
- 3) Space weather capabilities to characterize operational orbits, space situational awareness, and the ionosphere.

Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC.

The Military Application of the Space Environment (MASE) is a program to demonstrate mature space environment technology to improve combat operations. MASE will enhance regional ionospheric specification (nowcasts) and predictions (forecasts) affecting signal propagation paths. MASE uses traditional and non-traditional ionospheric measurements in advanced space environment models to forecast and predict impacts to weapon systems. Contributes to satisfying Gaps 4 and 7 of the SBEM AoA results as supplemented by the AFRDM 02-17-02 (SBEM JDCR). MASE was a new start in FY 2019.

Space acquisition must respond with speed and agility to emerging adversary threats. Space & Missile Systems Center (SMC) has transformed the organization and implementation of space acquisition to an enterprise approach, maximizing innovation and resiliency, leveraging international, commercial, and mission partnerships, and managing program/project priorities according to an integrated unclassified/classified enterprise space architecture. Expanding the appropriate acquisition authorities and contract mechanisms to deliver capability sooner, SMC will strategically execute experimentation, prototyping, risk reduction, and other efforts to develop new or repurpose capabilities.

This program element may include necessary civilian pay expenses required to manage, execute, and deliver WSF weapon system capability. The use of such program funds would be in addition to the civilian pay expenses budgeted in program elements 1206392F and 1206398F.

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Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>	Project (Number/Name) 644289 / <i>Weather System Follow-On</i>		
B. Accomplishments/Planned Programs (\$ in Millions)		FY 2020	FY 2021	FY 2022
<p>Title: WSF Microwave Satellite (SV1-2)</p> <p>Description: WSF Microwave Satellite (SV1-2): The Space Force (SF) awarded a contract to Ball Aerospace and Technologies Corp. to develop the WSF - Microwave (WSF-M) Space Vehicle (SV) to meet all three capability gaps. WSF-M SV-2 will be an option to exercise, should SF wish to replenish WSF constellation post-SV-1. SV-2 will be functionally equivalent to SV-1. The WSF-M SV-1 projected Initial Launch Capability (ILC) is FY 2024. Secondary investments may be supported to address weather gaps identified in the SBEM AoA and validated by the JROC.</p> <p>FY 2021 Plans: N/A</p> <p>FY 2022 Plans: N/A.</p>		171.091	0.000	0.000
<p>Title: COWVR Tech Demo</p> <p>Description: The Compact Ocean Surface Wind Vector Radiometer (COWVR) launch objective supports Category A Weather Requirements, as codified in JROC Memo 092-014, providing on-orbit technology demonstration of the new COWVR technology to deliver Weather Gap #3, Ocean Surface Vector Winds (OSVW) and Gap #8, Tropical Cyclone Intensity (TCI). This will be a cooperative mission with NASA for integrating the sensor onto the International Space Station (ISS) as a weather technology demonstration project. The new mission designation for the COWVR launch will be Space Test Program Houston Mission #8 (STP-H8). Demonstrating COWVR technology in the space environment remains an important milestone for the microwave data weather mission in lieu of the ORS-6 cancellation. Unlike ORS-6, COVWR will fly on the ISS and the residual operational capability is not guaranteed as a result. Due to this restructure, the projected COWVR launch will be delayed from FY 2019 to FY 2021.</p> <p>FY 2021 Plans: N/A.</p> <p>FY 2022 Plans: N/A.</p>		14.870	0.000	0.000
<p>Title: ECP</p> <p>Description: Energetic Charged Particles (ECP) will fulfill the Space-based Environmental Monitoring (SBEM) Weather Gap 11 and address the Secretary of the Air Force (SECAF) policy which directs each USAF Satellite Office to plan for and integrate ECP sensors on all pre-Milestone B new satellite acquisitions. To accomplish this requirement, the ECP sensor will be integrated on the WSF-M satellite.</p>		0.534	0.000	0.000

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B. Accomplishments/Planned Programs (\$ in Millions)	FY 2020	FY 2021	FY 2022
<p>Energetic Charged Particle (ECP) Hazard Assessment System (HAS) will be a component of space attack assessment. A commercial sources for Aerospace's ECP-Lite sensor and AFRL's CEASE3 has been established. The ECP sensors will be hosted on international and commercial missions to gain additional flight opportunities, orbital regimes, relationships, and constellation architectures to augment the ECP HAS system with supplemental data.</p> <p>FY 2021 Plans: N/A.</p> <p>FY 2022 Plans: N/A.</p>			
<p>Title: Military Application of the Space Environment (MASE)</p> <p>Description: MASE demonstrates a sensor-to-shooter solution to improve mission effectiveness by providing commanders an operational risk assessment tool. MASE will deliver a capability comprised of weapon system tailored visualizations/decision aids to allow warfighter integration into operational plans and tactics, techniques, and procedures. MASE products and services will be evaluated using quantitative standard measures of performance, effectiveness, and outcome against theater operational requirements.</p> <p>In FY2021, PE 1206422F, MASE efforts were transferred to PE 1206427F, Appropriation 3620, Research, Development, Test & Evaluation, Space Force, Budget Activity 04 due to the creation of a new Appropriation for Space Force.</p> <p>FY 2021 Plans: N/A</p> <p>FY 2022 Plans: N/A.</p>	9.000	0.000	0.000
Accomplishments/Planned Programs Subtotals	195.495	0.000	0.000

C. Other Program Funding Summary (\$ in Millions)
N/A

Remarks

D. Acquisition Strategy
DoD established WSF as a pre-MDAP. The acquisition strategy for WSF is based on validated SBEM AoA results from FY2014 and subsequent acquisition strategy development activities that were conducted in FY 2015. The WSF acquisition strategy focuses on streamlined acquisition process for providing materiel solutions

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<p>to OSVW, TCI & LEO ECP, as validated by the JROC; deliver microwave sensing solution to address DoD needs for OSVW and TCI capabilities and deliver space environment sensing solution to address LEO ECP capabilities for on-orbit attributions and anomaly resolutions.</p> <p>The Air Force is conducting a technology demonstration of the Compact Ocean Surface Wind Vector Radiometer (COWVR) sensor in partnership with NASA Space Test Program (STP) to launch and integrate with International Space Station (ISS), utilizing their unique technology demonstration capabilities for on-orbit demonstration of COWVR technology. SMC's STP is the leading AF organization spearheading the NASA partnership, while SMC/DCIF is responsible for the COWVR project and funding and providing programmatic support to enable COWVR sensor to ISS integration/technology demonstration.</p> <p>The program awarded a contract for WSF satellite, capable of meeting all three weather capability gaps, in a full and open competition environment, in order to reduce overall program cost. The Air Force is procuring one WSF-M satellite with an option for a second satellite. WSF-M first satellite (SV-1) ILC is FY 2024 to mitigate any potential weather coverage gaps. WSF-M SV-2 ILC is currently projected for FY 2028. The WSF SV-2 will be functionally equivalent to SV-1. Naval Research Lab Blossom Point Tracking Facility (BPTF) will be used as a viable unclassified EGS-compatible SOC for WSF-M. BPTF consists of a satellite mission operations center, multiple ground antennas including via AFSCN, and an existing infrastructure capable of providing space system command, control, and communications (C3).</p> <p>The WSF ECP sensor development will leverage current AFRL sensor and hazard assessment technology to accelerate availability of ECP sensor for integration on WSF-M and other planned AF satellite acquisitions. The AF intends to transition AFRL's technology to industry for production via competitive award. Two Tech Demo ECP sensors are projected to be delivered and ready for satellite integration by FY 2022. Post-Tech Demo ECP phase, each respective program offices will be responsible for the procurement/integration and sustainment of the sensors required to meet the SecAF's Space Situational Awareness (SSA) policy.</p> <p>The program intends to continue research and development at AFRL to support the MASE baseline. Features to enhance and improve MASE related prototypes/models will be added through capability drops while maintaining Risk Management Framework compliance. Award contracts to conduct studies and perform technical analysis for external data sources and optimal sensor laydown, system development and external system integration. Conduct field campaigns to validate scientific algorithms. Provision cloud services, deploy ionospheric ground sensors and provide program office support.</p>		

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Exhibit R-3, RDT&E Project Cost Analysis: PB 2022 Air Force **Date:** May 2021

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Product Development (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
COWVR Technology Demonstration	Various	Various : Various	59.132	14.870	Oct 2019	-		-		-		-	-	-	-
WSF Microwave System (SV1-2)	C/FFP	Ball Aerospace : Boulder, CO	182.103	146.058	Nov 2019	-		-		-		-	-	-	-
ECP	Various	Various : Various, NM	6.194	0.534	Mar 2020	-		-		-		-	-	-	-
ECP Prototyping	Various	Various : El Segundo, CA	9.100	0.000		-		-		-		-	-	-	-
MASE	Various	Various : Various, CO	16.242	9.000	Apr 2020	-		-		-		-	-	-	-
Enterprise Systems Engineering & Integration	C/CPIF	Engility Corp. : Andover, MA	8.857	3.970	Dec 2019	-		-		-		-	-	-	-
Technical Mission Analysis	RO	Aerospace Corp : El Segundo, CA	16.483	3.359	Oct 2019	-		-		-		-	-	-	-
Weather Studies (Formerly BAA)	Various	Various : Various, CA	6.489	0.000		-		-		-		-	-	-	-
Ground	MIPR	NRL : Welcome, MD	5.684	6.275	Dec 2019	-		-		-		-	-	-	-
Pre-Acquisition Activities	Various	Various : Various	121.704	0.000		-		-		-		-	-	-	-
Subtotal			431.988	184.066		-		-		-		-	-	-	N/A

Support (\$ in Millions)				FY 2020		FY 2021		FY 2022 Base		FY 2022 OCO		FY 2022 Total	Cost To Complete	Total Cost	Target Value of Contract
Cost Category Item	Contract Method & Type	Performing Activity & Location	Prior Years	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost	Award Date	Cost			
Requirements/Engineering Analysis Support	RO	Defense Information Technical Center : El Segundo, CA	1.543	-		-		-		-		-	-	-	-
Engineering Risk Reduction Studies	Various	Various : Various	1.711	-		-		-		-		-	-	-	-
Subtotal			3.254	-		-		-		-		-	-	-	N/A

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Exhibit R-4, RDT&E Schedule Profile: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>	Project (Number/Name) 644289 / <i>Weather System Follow-On</i>
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	FY 2020				FY 2021				FY 2022				FY 2023				FY 2024				FY 2025				FY 2026			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4

<i>Weather System Follow-On</i>	
COWVR Technology Demonstration I&T	██████████
WSF Microwave Ground CDR	██
WSF Microwave System Milestone B	██
WSF SV-1 Production	██████████
WSF Microwave System CDR	██
WSF ECP Delta CDR	██
WSF Microwave Imaging Integration and Test	██████████
WSF Microwave Ground Segment Development	████
<i>Military Application of Space Environment</i>	
MASE Capability Drops	██████████

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Exhibit R-4A, RDT&E Schedule Details: PB 2022 Air Force **Date:** May 2021

Appropriation/Budget Activity 3600 / 4	R-1 Program Element (Number/Name) PE 1206422F / <i>Weather System Follow-on</i>	Project (Number/Name) 644289 / <i>Weather System Follow-On</i>
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Schedule Details

Events by Sub Project	Start		End	
	Quarter	Year	Quarter	Year
<i>Weather System Follow-On</i>				
COWVR Technology Demonstration I&T	2	2020	4	2020
WSF Microwave Ground CDR	1	2020	1	2020
WSF Microwave System Milestone B	2	2020	2	2020
WSF SV-1 Production	2	2020	4	2020
WSF Microwave System CDR	2	2020	2	2020
WSF ECP Delta CDR	2	2020	2	2020
WSF Microwave Imaging Integration and Test	3	2020	4	2020
WSF Microwave Ground Segment Development	4	2020	4	2020
<i>Military Application of Space Environment</i>				
MASE Capability Drops	3	2020	4	2020