



RQ-4B Global Hawk

Lessons learned from stratospheric operation

Lt Col Cory Turner

Commander, 348th Reconnaissance Squadron

*Overall Classification: **UNCLASSIFIED***



RQ-4 Block 40



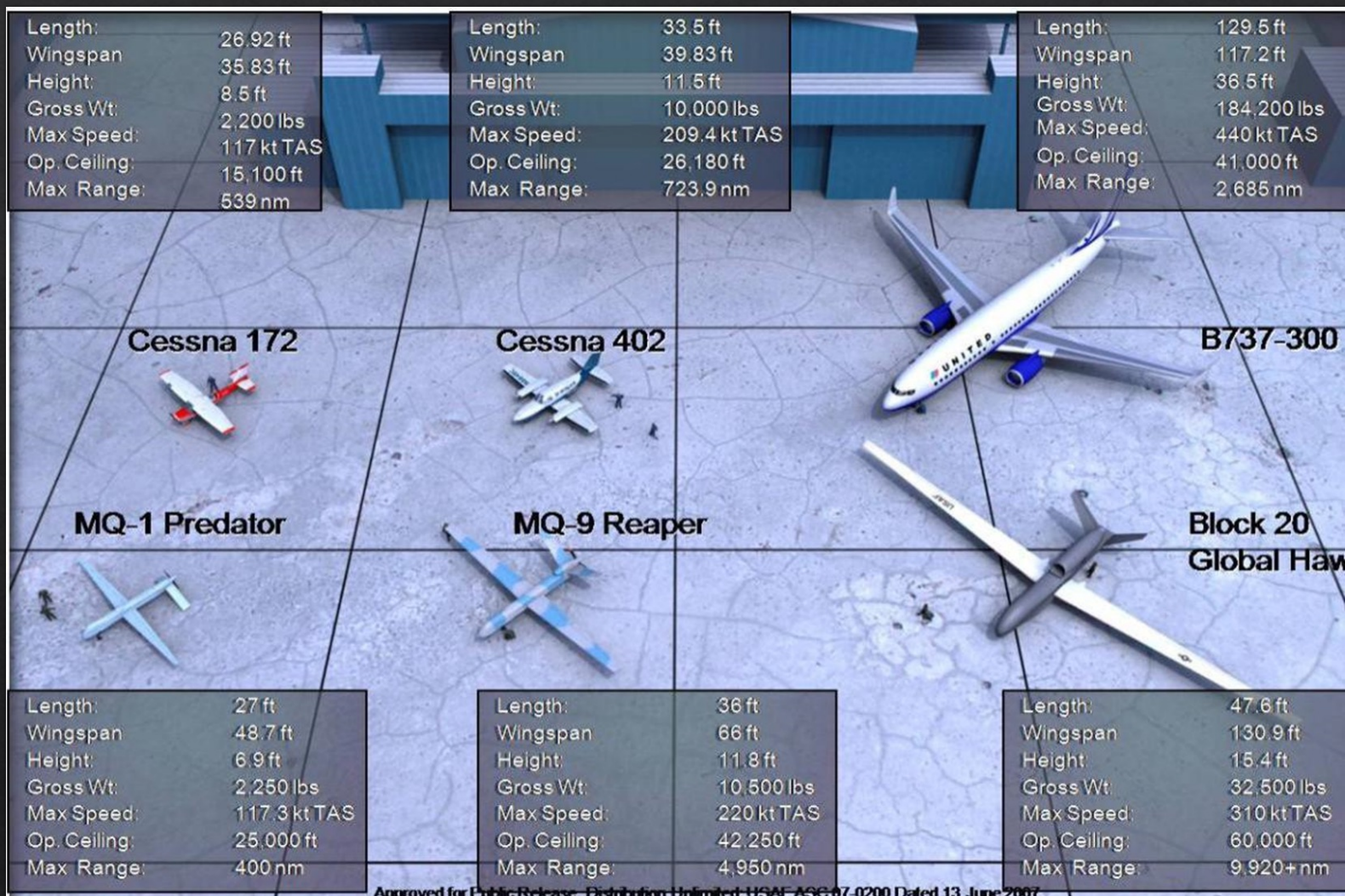
RQ-4B Block 40 is a high-altitude long endurance ISR asset which provides wide area search capabilities using Moving Target Indicator and Synthetic Aperture Radar. This information delivers National Leaders, Combatant Commanders, and Joint partners greater situational awareness across vast operating areas.



Intelligent
Strong
Ready

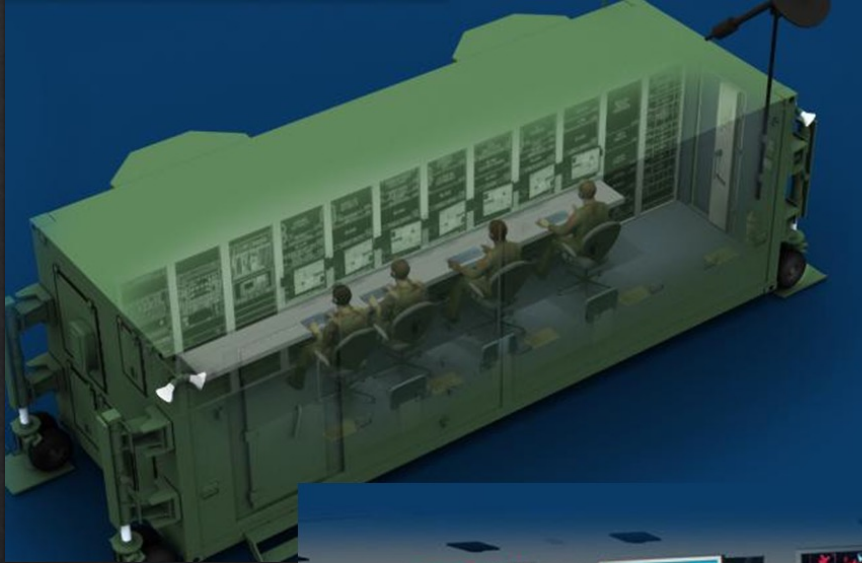


Size Comparison





Common Ground Station





Pilot Interface



Advisory LREE

File Audio

Alerts: **NO ALERTS**

UAV Control

C&C Link Switch

- CDL UHF LOS
- Ku SATCOM UHF SATCOM
- INMARSAT None

Apply Reset Close

File View Options Help

Config... C&C Link... Link Mask... In Ctrl...

C Ku Sat OP / /

C CDL OP / /

C LRE80 LCP1(LOS) OP RDY/RDY M

C LCP2(SAT1) OP/Off ACQ/ /

C NMAR(Auto) OP / /

State Data Meter (sec)

File View Options Help

Config Status Test

Ku Satcom NP /ACQ

CDL (X) /ACQ

UHF SAT 1 /ACQ

UHF SAT 2 /ACQ

UHF SAT 3 /ACQ

UHF LOS RDY/RDY 07-0028

INMARSAT /ACQ

NBIU

GCI OP

DGPS

Normal ATC Advisory Maint Req'd

Flight Control (GH 07-0028 : MSNUV14NA10)

File

Spoiler (deg) 0
ITT (Deg F) 2500
N1 (%) 25
PLA (deg) 20

Gear Up Emergency Gear Down Taxi
Gear Down Gear Rate Slop Taxi
Nav Lts On Gear Brakes Speed Takeoff
Nav Lts Off Strokes On Emerg Fuel Shutoff T/O Abort
Strokes Off Vehicle Shutdown Land
Execute Cancel

File View ATC Presets Options Help

ATC - CALLSIGN

118.050
AM

COMSEC State Guard Channel

Encryption On Off Monitor On

Unencrypted Rx Yes No Monitor Off

COMSEC Key

IFF Transponder State

Normal Emerg On Ident On XPulse On

Stby Emerg Off Ident Off XPulse Off

Mode 1 Mode 2 Mode 3/A & C

On 12 On 1200 On 1200 C On

Off 12 Off 1200 Off 1200 C Off

Mode 4

On Off Reply Caution A B

Mode 5

On All-Call Inhibit On AIS:

Subsystem Status (GH 07-0028 : MSNUV14NA10)

File

Engine	ECS	Man Load	DGPS	Rad Alt	Gr & Brk	Ice Det
IMMC	INS	Air Data	GNC	Omnistar	INMARSAT	FTS
FADEC	Fuel	Actuators	Elec Pwr	Test CDL/Ku	Test SAR	Test EO/IR
ATC	IFF	UHF/LCP1	UHF/LCP2	Ku/SAT	CDL	Test Stair
SAR	EO	IR	Recorder	TWR	SMU	Decoys
LR100	ASIP					

PFED (GH 07-0028 : MSNUV14NA10) CALLSIGN

File View Options

ALT ERR XTRK ERR

SPD 0 TAS NA GS 0
RAD 200 1000
ALT 0 214 0
WVI 0 0 0
BARO 0.00 LEVEL

FCS... AVS... ATC... LINK... PAYLD... GOTOL... IFF MAGVAR

WYPT WP P2
LAT 37:24:18 N
LON 014:55:03 E
RNG 0.05 NM
ETE
ETA
WIND 180/000
NAV KN4074A 18

LINK UHF LOS
CONT None
FUEL 16204 LB
GWIT 31300 LB
RAT +015 C
GPS 214 FT

EXECUTE ONTRACK RESET

QUAL	KN4074A	KN4074B	SAR LN100	EO LN100
HPRE	18	18	17	17
DGPS	9	9	25	25

RAIM Status

RAIM Avail Avail

RAIM Passes Passes

RAIM Alarm

NAV Control

LOS Enable Enable Enable

Map Window

File View Options Threats Planning

20:11z LRE80: FLT: 0X-20XX: Taxi Command Parameters: Start Taxi

20:12z LRE80: FLT: 0X-20XX: Attained waypoint 7

20:12z LRE80: AVN: 0X-20XX: Radar Altimeter Action Point Command Initiated

20:12z LRE80: AVN: 0X-20XX: Strokes Action Point Command Initiated

20:12z LRE80: CMS: 0X-20XX: Action Point Command Initiated Loss Comms Timeout

20:12z LRE80: FLT: 0X-20XX: Turn started, at waypoint 8, Fly through, non-turning

20:12z LRE80: FLT: 0X-20XX: Attained waypoint 8

20:12z LRE80: FLT: 0X-20XX: Turn finished

20:13z LRE80: FLT: 0X-20XX: Attained waypoint 9

20:13z LRE80: AVN: 0X-20XX: Nose Gear Hike change to HIKED

Route Control

Mission ID: ABCD1234

Alt. Routes

Primary: ID:1

Primary

P6
P7
P8
P9
P10
P11
P12
P13
P14
P15
P16
P17
P18
P19
P20
P21
P22
P23
P24
P25
P26

Step Size: 1

Close

1234:)

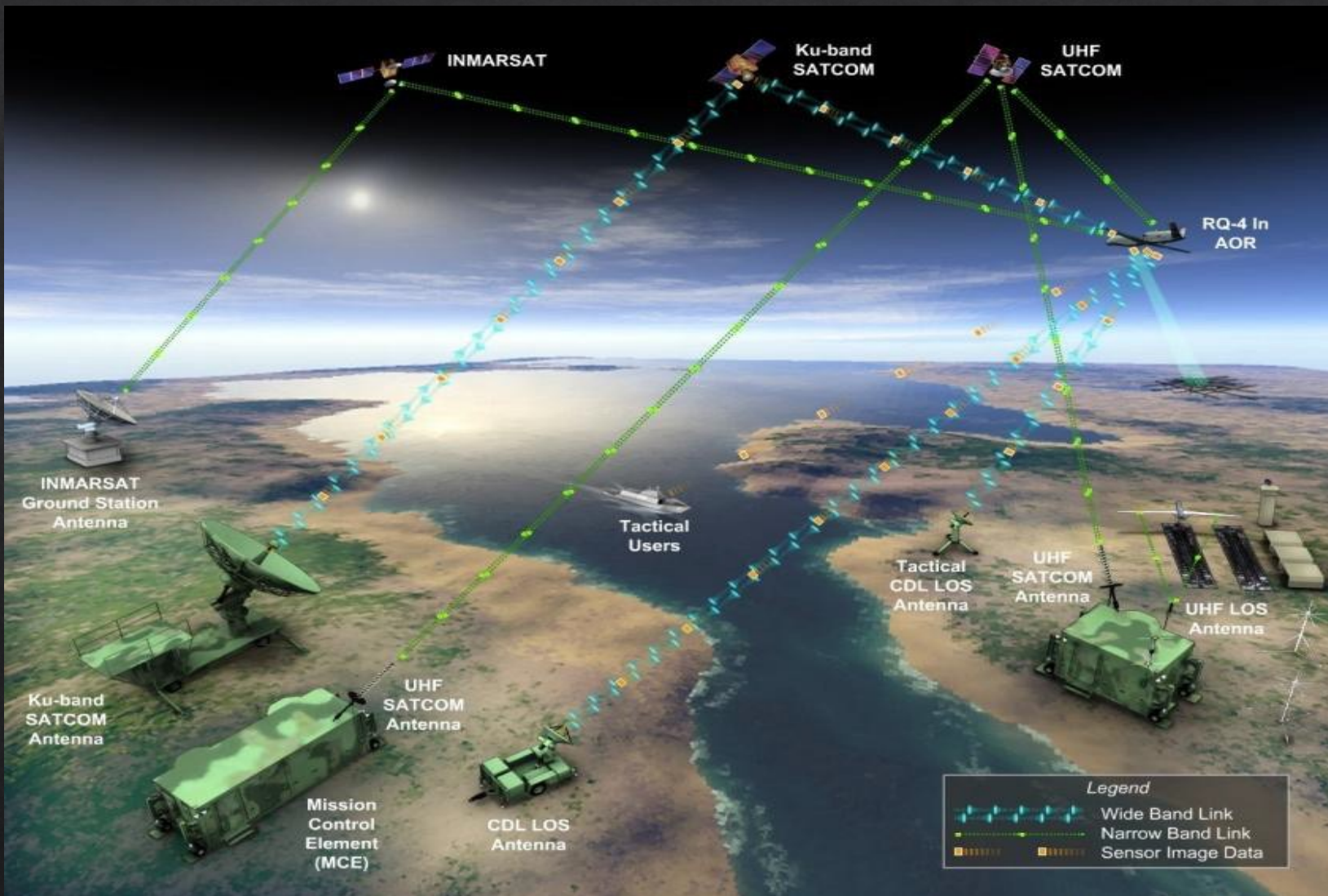
Help

Approach Route: 18 WP: A155
Approach Route: 25 WP: A201
Approach Route: 31 WP: A241
Approach Route: 32 WP: A266
Approach Route: 41 WP: A295
Approach Route: 42 WP: A315

One Two Three Four EXIT



Link Architecture

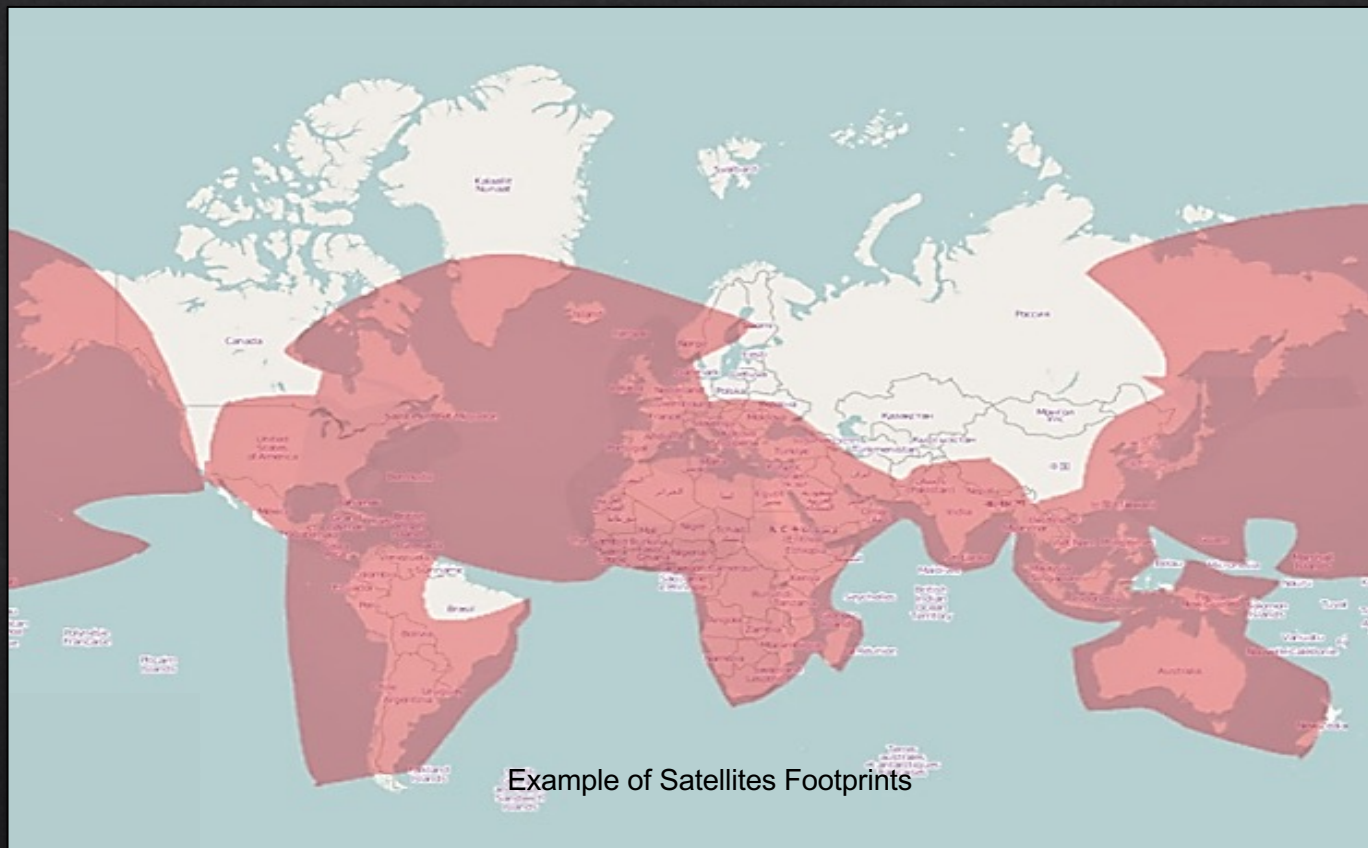




Satellite Footprint



- ◇ Weather?
- ◇ Aircraft Logic?
- ◇ Communication?
- ◇ Altitude and Traffic?





Scope of Mission



Annual Flying Hours 2023: 6,500

- 90%* flying hours supporting 6 COCOM requirements
- 10% Continuation Training / Formal Training Unit/Exercise



RQ-4 Block 40

- Ground Moving Target Indicator (GMTI)
- Synthetic Aperture Radar (SAR)



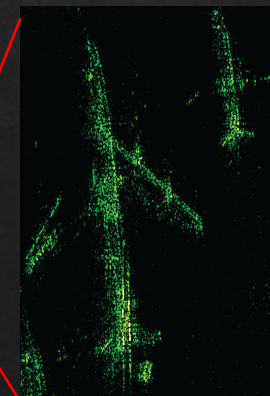
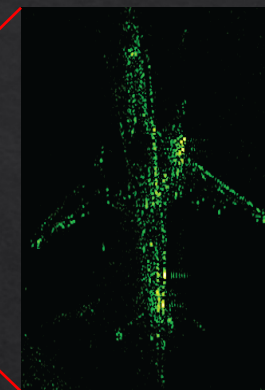
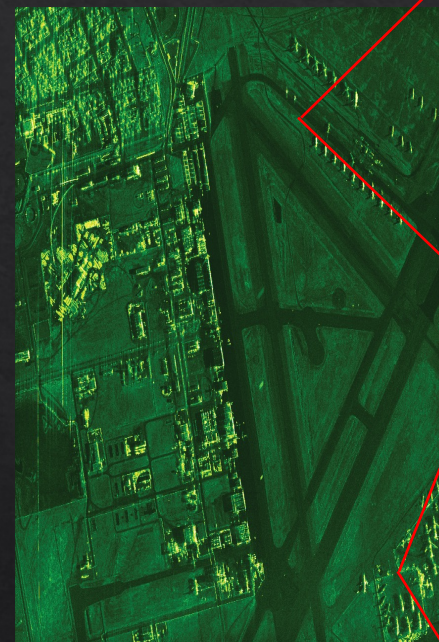
RQ-4B Block 40 SAR and MTI



Ground Moving Target Indicator Collection



Synthetic Aperture Radar (SAR) Imagery - Mojave Airport



- Multiple SAR Modes
- Global reach
- High altitude/Deep look
- Wide-area surveillance
- Persistence (30+ hour sorties)
- World-wide data dissemination

Unmatched global vigilance MTI / Deep Look SAR platform



HALE Operations



- ◇ High Altitude Long Endurance (HALE)
 - ◇ Flight Level 500 to 600
 - ◇ Mission Duration of 24+ Hours
- ◇ Benefits
 - ◇ Persistence
 - ◇ Range
 - ◇ Deep penetrating radar imaging – Standoff
- ◇ Considerations
 - ◇ Weather
 - ◇ Aircraft Performance
 - ◇ Scheduling





Temperature Considerations



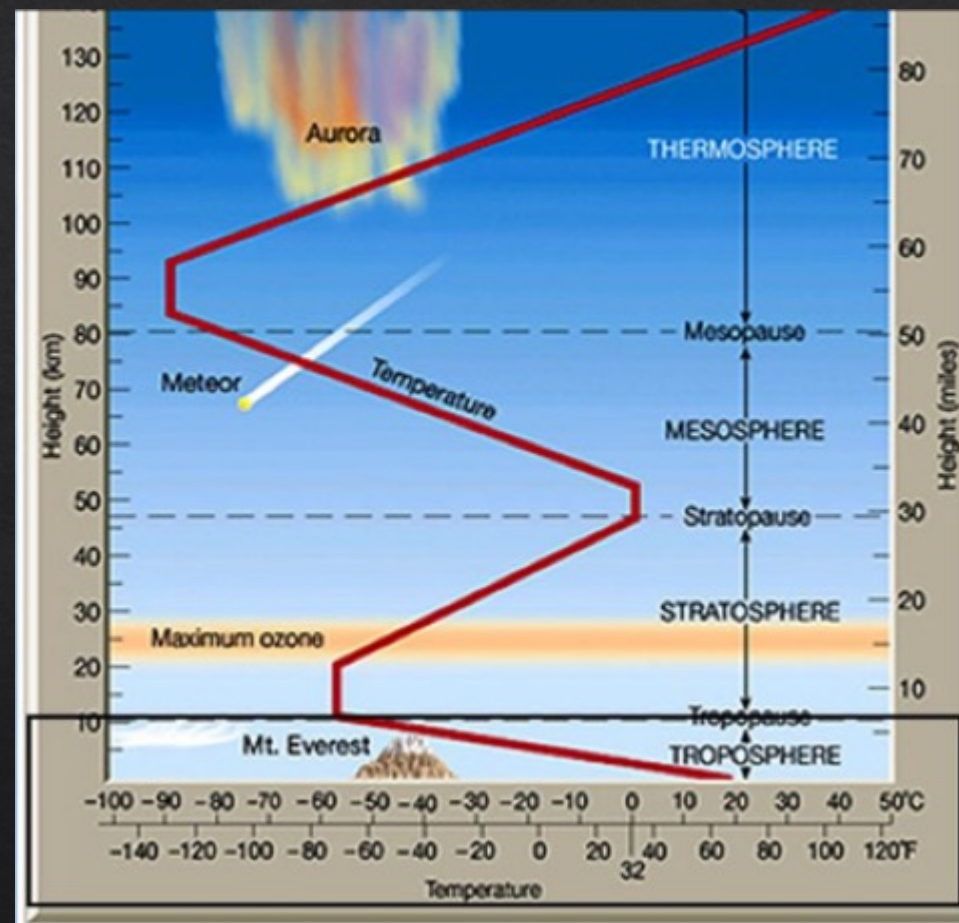
- ◇ Tires/Struts
 - ◇ No colder than □ 70°C (□ 94 °F) in the first 3 hours, after first 3 hours no colder than □ 68 °C (-90°F)
- ◇ Sensor/Payload
 - ◇ When the sensor is in use, it must be cooled. When its off, it cools rapidly at altitude (danger of cold soaking)
- ◇ Temperature increase due to friction
 - ◇ Normally expect 12 degrees increase in temperature on the aircraft compared to ambient temps
- ◇ Inversion Layer
 - ◇ Depending on the location of the inversion layer, aircrew will climb or descend to maintain certain temperatures
- ◇ Mission Planning for temperature
 - ◇ Locations and temperature at altitude are considered for fuel, location, and altitude for flights
- ◇ Nonstandard systems used to manage heating or cooling
 - ◇ Turning on a system to use the warmth from its power supply



Temperature Lapse Rate



- ◇ Temperature Changes with Altitude at a Relatively Constant Rate
- ◇ Rates of Change are Specific to Each Atmospheric Layer
- ◇ Lapse Rates are Based on the Hypothetical ICAO Standard Atmosphere Used to Predict Aircraft Performance
 - ◇ Actual Temperatures/Lapse Rates Can Vary Significantly from Standard Atmosphere
 - ◇ Temperatures at Altitude are Typically Colder Near the Equator

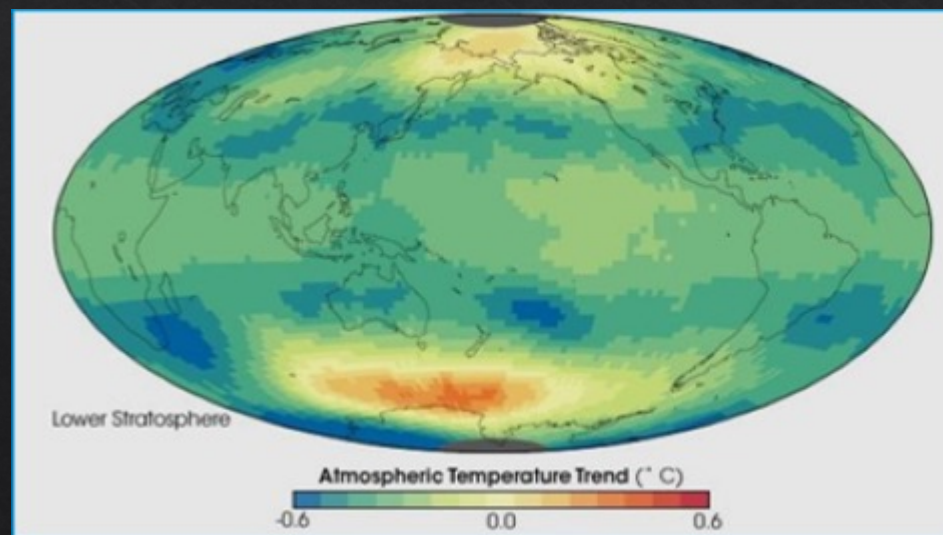
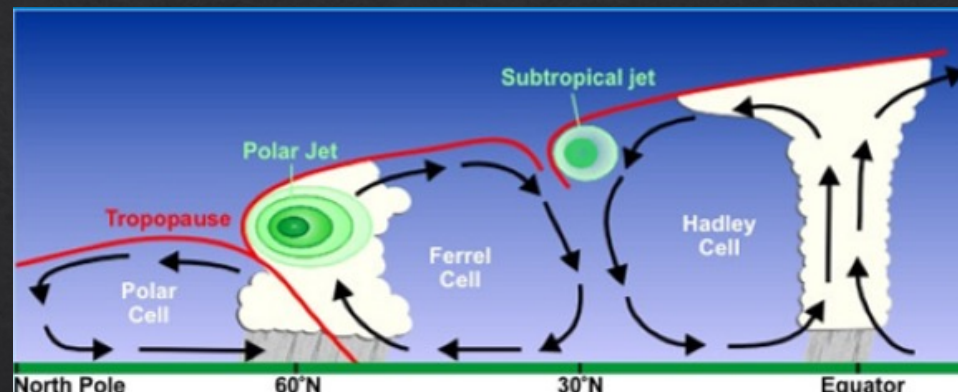




Tropopause and Thunderstorms



- ◇ Boundary Between the Troposphere and the Stratosphere
 - ◇ Band of Dry Air Where Cooling Ceases or Ceases to Less Than 1 °C Degree Per 1000 Ft
 - ◇ Roughly 50,000 ft in Equatorial Regions
- ◇ Acts as a Barrier to Keep MOST Weather in the Troposphere
 - ◇ Not Uncommon to see Thunderstorms in Excess of FL600
 - ◇ Unmanned considerations





Thunderstorm Avoidance



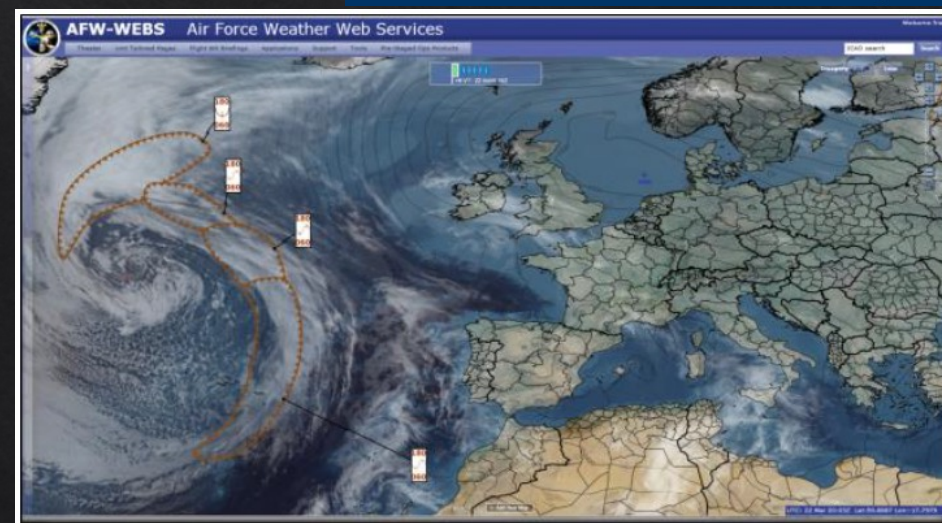
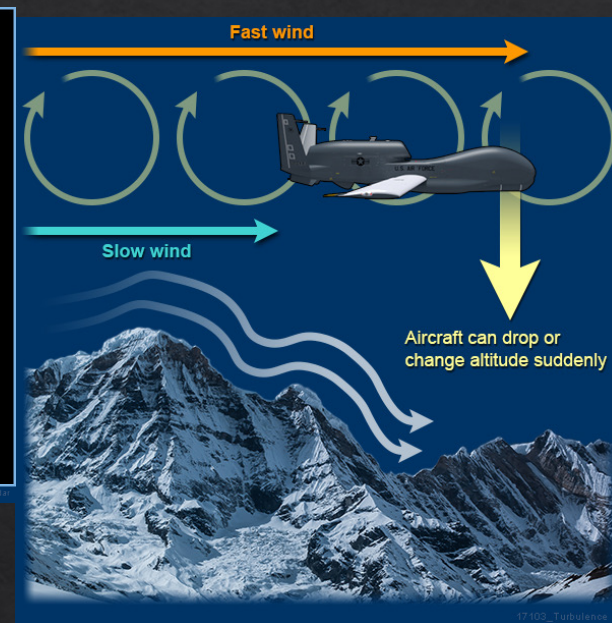
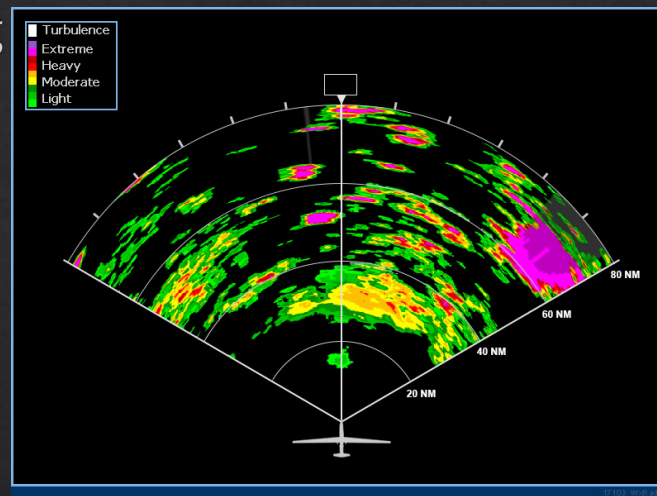
- ◆ Required to Avoid Thunderstorms by 20 Nautical Miles or Fly Over by 10,000 ft if above FL500.
- ◆ Lightning
 - ◆ May Cause Physical Damage to Aircraft and Computer Systems
- ◆ Hail
 - ◆ Can be Encountered up to 45,000 feet and 20 Miles Away from the Storm's Center
 - ◆ Hailstones Larger than 1/2 to 3/4 of an Inch can Cause Significant Aircraft Damage in a Few Seconds



Lessons Learned



- ◆ Having 24/7 Weather Personnel Support During Operations is CRITICAL
- ◆ Onboard Weather Radar vs Satellite Weather is Situational on Most Cases
 - ◆ Global Hawk Crews Prefer Satellite Weather and Weather Personnel
 - ◆ If we Navigate Through Storms, What Happens if We Lose Link?
- ◆ PIREPS are Extremely Useful for Unmanned Systems (We Can't Look Out the Window)
- ◆ Having Alternates Ready and Making a Decision Early is a Requirement





Aircraft Performance



- ◇ Climb Performance Decreases
- ◇ True Airspeed Increases
 - ◇ Turn Radius Increases
- ◇ Stall Margin Decreases
 - ◇ Altitude vs Airspeed
- ◇ Fuel Burn
 - ◇ Decreases up to the Stratosphere
 - ◇ May Increase in Stratosphere With Increasing Temps

Pressure Altitude (1000 Feet)	Rate of Climb (Feet/Minute)	Time to Climb (Minutes)	Distance to Climb (NM)	Fuel to Climb (Pounds)
60	2.34	1605.084	8508.729	13447.842
59	2.34	1340.861	7118.197	11655.141
58	2.34	1063.205	5690.251	9751.213
57	2.34	784.166	4255.195	7687.408
56	2.34	540.172	2939.499	5735.454
55	4.28	313.089	1666.768	3731.149
54	24.14	163.098	830.781	2345.852
53	30.44	116.574	572.275	1889.264
52	50.44	91.051	432.138	1628.076
51	77.59	75.112	345.567	1458.947
50	116.63	64.775	290.135	1345.414
45	310.97	39.729	159.991	1042.358
40	536.73	27.678	102.217	867.76
35	799.51	20.129	69.26	735.856
30	1139.34	14.946	48.381	623.646
25	1531	11.194	24.296	521.231
20	1897.58	8.318	24.217	423.011
15	2267.34	5.915	16.409	323.361
10	2514.62	3.808	10.109	223.07
5	2814.53	1.931	4.933	120.682
Sea Level	6.38	0	0	0



Air Force Operational Imperatives



“The heart of our mission is to deter aggression. We don't want to fight wars -- we want to prevent them -- and the way you prevent conflicts is to convince the other side that you have the will to resist and the capability to defeat aggression.” – Secretary Kendall

- ◆ OI 1- Space Order of Battle
- ◆ OI 2 - Operationally Focused Advanced Battle Management System
- ◆ OI 3 – Moving Target Engagement
- ◆ OI 4 – Tactical Air Dominance
- ◆ OI 5 – Resilient Basing
- ◆ OI 6 – Global Strike
- ◆ OI 7 – Readiness to Deploy and Fight



Readiness



READINESS TO DEPLOY AND FIGHT

OPERATIONAL IMPERATIVE 7



SITUATION

The Department relies upon a wide range of supporting information systems and facilities, in the continental U.S. and overseas, to mobilize, deploy and support our forces in a major conflict. All of these dependencies can be targeted by a wide variety of threats, including cyber and kinetic threats.



CHALLENGE

The Department of the Air Force must analyze the entire mobilization and support chain to ensure the entire system is hardened against the threats we would expect an enemy to present, so we can meet our commitments to combatant commanders.



APPROACH

Deploying Airmen, Guardians, and the systems they employ takes a herculean effort. This imperative will identify priority gaps and vulnerabilities in the Department's ability to transition to and support current and projected operational plans in a contested environment.





Agile Combat Employment



RESILIENT BASING

OPERATIONAL IMPERATIVE 5



SITUATION

One of the dependencies that our competitors have come to understand is the U.S. reliance on forward air bases. We rely on a handful of forward air bases in the Western Pacific and a relatively small number of air bases in Europe



CHALLENGE

We must deny our adversaries an easy targeting opportunity and the perceived vulnerability that a small number of known fixed locations provides.



APPROACH

A mix of investments in resilient forward basing for current and planned tactical aircraft. The concept that the Department of the Air Force is pursuing in this regard, called Agile Combat Employment (ACE), is a strong step in the right direction, but a range and combination of concepts must be considered and resourced.





Moving Target Engagement



MOVING TARGET ENGAGEMENT



SITUATION

This imperative is about being able to identify, track, and engage numerous targets simultaneously, which will take a mix of air- and space-based capabilities.



CHALLENGE

In a hypothetical scenario with a well-resourced adversary, U.S. forces could be faced with numerous ground moving targets and aerial moving targets. We must be capable of engaging those threats simultaneously, in high numbers, and in a time-compressed situation where a few hours are likely to decide the outcome of the conflict. Traditional airborne moving target intelligence, surveillance, and reconnaissance sensors will be threatened.



APPROACH

The joint force must be able to leverage capabilities, such as next-generation sensors and decision support provided by our ABMS investments, to acquire and, if necessary, prosecute targets, prioritizing those that would deny our access to an area of operations.

OPERATIONAL IMPERATIVE 3





Reoptimizing For Great Power Competition



THE CASE FOR CHANGE



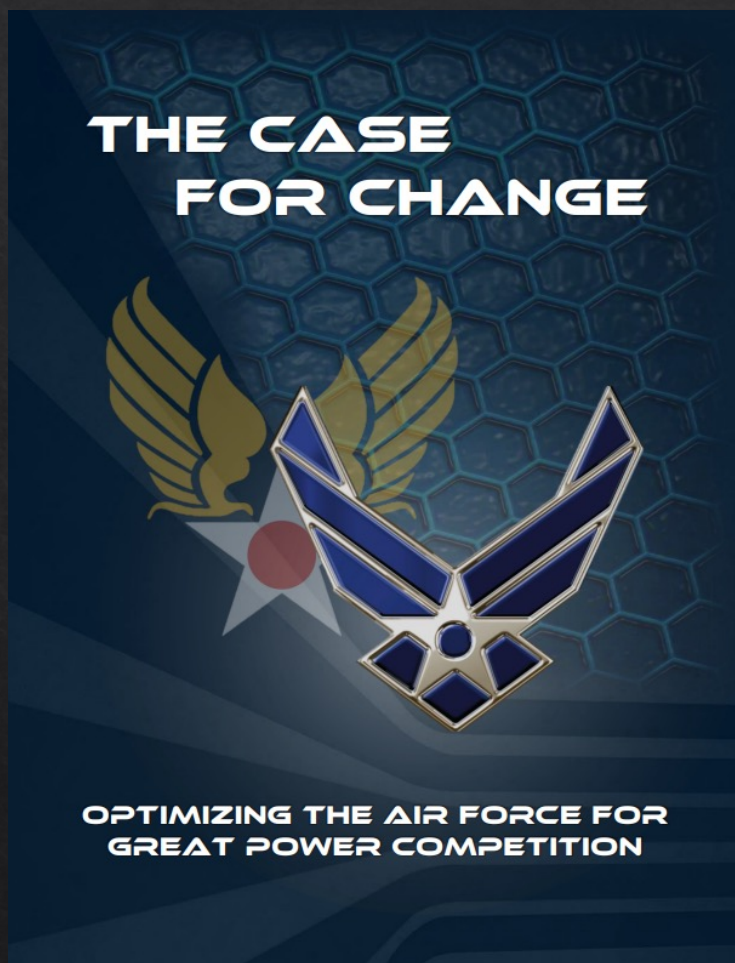
OPTIMIZING THE AIR FORCE FOR
GREAT POWER COMPETITION

- ◇ Develop People - Optimize the force we have by centralizing force development, reinvigorating our warrior ethos to create Mission Ready Airmen, and establishing robust and effective “paths” for technical areas critical to creating competitive advantage.
- ◇ Generate Readiness
- ◇ Project Power
- ◇ Develop Capabilities

“No one wants a great power conflict, and no one can predict when one might occur, but come it may, and we must be as ready as can be – now, tomorrow, and every day. Change is hard, losing is unacceptable”
– Frank Kendall, Secretary of the Air Force



Reoptimizing For Great Power Competition



- ◆ Develop People
- ◆ Generate Readiness - Realign from functional readiness to mission readiness, prioritize mission-focused assessments and inspections, and enhance mission support effectiveness.
- ◆ Project Power
- ◆ Develop Capabilities

“No one wants a great power conflict, and no one can predict when one might occur, but come it may, and we must be as ready as can be – now, tomorrow, and every day. Change is hard, losing is unacceptable”
– Frank Kendall, Secretary of the Air Force



Reoptimizing For Great Power Competition



- ◇ Develop People
- ◇ Generate Readiness
- ◇ Project Power - The Air Force will clearly define and assemble modular "Units of Action," define the relationship between the Combat Wings and the Base Commander, and streamline Service Components aligned directly to Combatant Commands
- ◇ Develop Capabilities

“No one wants a great power conflict, and no one can predict when one might occur, but come it may, and we must be as ready as can be – now, tomorrow, and every day. Change is hard, losing is unacceptable”
– Frank Kendall, Secretary of the Air Force



Reoptimizing For Great Power Competition



THE CASE FOR CHANGE



OPTIMIZING THE AIR FORCE FOR GREAT POWER COMPETITION

- ◇ Develop People
- ◇ Generate Readiness
- ◇ Project Power
- ◇ Develop Capabilities - the Air Force must establish a single authoritative entity focused on identifying and prioritizing future operational capabilities, drive cross-platform mission systems integration and capability development, establish focused acquisition Systems Centers for effective portfolio and life cycle management, and establish relevant Secretariat offices which inform Department of the Air Force senior leaders on enterprise decisions

“No one wants a great power conflict, and no one can predict when one might occur, but come it may, and we must be as ready as can be – now, tomorrow, and every day. Change is hard, losing is unacceptable”
– Frank Kendall, Secretary of the Air Force



Questions?



Cory “RICO” Turner, Lt Col, USAF
Commander, 348th Reconnaissance Squadron
319th Reconnaissance Wing
NIRP: Cory.Turner.2@us.af.mil
SIPR: Cory.R.Turner.mil@mail.smil.mil
JWICS: Cory.Turner@af.ic.gov