



Risks of Space Weather: A Commercial Aviation Perspective

2016 AMS Washington Forum
Leveraging Environmental Intelligence to Enhance Risk Management

12 April 2016, Space Weather Session
 American Association for the Advancement of Science
 1200 New York Ave., Washington, D.C.

Panelist
 Tom Fahey, Mgr. Meteorology, Delta Air Lines
 Tom.Fahey@Delta.com

Solar Events & Aviation

NOAA's solar activity categories:

1. Radio Blackouts (R)
2. Solar Radiation (S) Storm
3. Geomagnetic (G) Storm

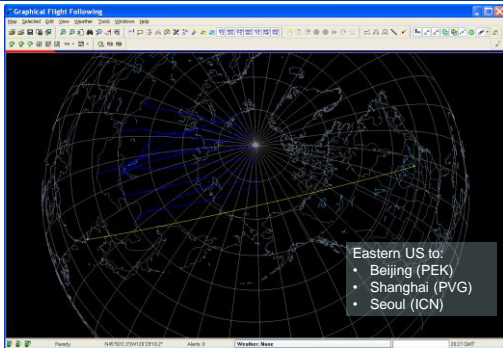
Aviation Impacts:

- Radio Communications
- Health Affects



2

Flight Routes: Asia ↔ U.S. Polar Routes



DELTA Weather Hazard Avoidance Procedures

- Apply to **All** Weather Hazards for both:
 - Preflight Planning
 - En Route Adjustments
- Color Coded for both Pilot & Flight Dispatch Use:
 - **ADVISORY: YELLOW**
No Action required Preflight or en route.
 - **ALERT: ORANGE**
Adjust route preflight & en route provided no other operational limitations
 - **AVOID: RED**
Adjust route preflight & en route

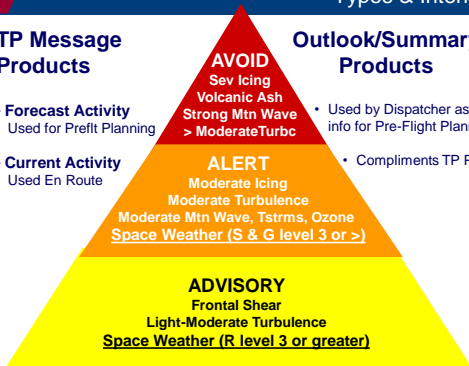
Delta Weather Hazard Products Types & Intensity

TP Message Products

- **Forecast Activity**
Used for Preflight Planning
- **Current Activity**
Used En Route

Outlook/Summary Products

- Used by Dispatcher as initial info for Pre-Flight Planning.
- Compliments TP Products.



Delta's Space Weather Procedures

Each flt must maintain constant communication with ATC & with the company.

Delta's Primary Comms Method: ACARS (using VHF or SATCOM)
 Delta's 2nd Comms Method: Voice Communications (using HF Radio or SATCOM)

Health

No Ops on all Polar Routes During Strong Solar Radiation (S) Storms Due psbl Health affect

Communications

Inmarsat SATCOM is not available North of 82N. ACARS or ~~Voice~~ SATCOM

VHF ACARS is not available in the Polar Region. Voice HF Radio only option

No Ops North of 82N During Strong (G) Geomagnetic Storms Due psbl loss HF

Delta Weather Hazard Products Space Weather Summary/Outlook

- Used as Pre-flight Planning Tool
- Green = Good

Delta Meteorology Space Weather Activity and Forecast					
Issue Time: 0030Z		Sunday, May 15, 2013		*Valid Times See Below	
Next Update: 1100Z		Monday, May 20, 2013			
Fctr: LONGOBARDI					
Previous 24 hour Activity					
Valid: 0600Z		5/18/2013		to 0600Z 5/19/2013	
Scale	Event 1	Event 2 (if needed)	Event 3 (if needed)	Event 4 (if needed)	Event 5 (if needed)
	Valid Time	Scale	Valid Time	Scale	Valid Time
Geomagnetic Storms:	G1	180252z-180900z	NONE	NONE	NONE
Solar Radiation Storms:	S1	180252z-180900z	NONE	NONE	NONE
Radio Blackouts:	NONE	N/A	NONE	NONE	NONE
Current Activity					
Scale	Valid Time				
Geomagnetic Storms:	NONE				63, 64, 65
Solar Radiation Storms:	NONE				53, 54, 55
Radio Blackouts:	NONE				
See latest TPs issued for:					
24 hour Forecast Activity					
Valid thru: 0000Z 5/20/2013		Forecast Description:			
Scale					
Geomagnetic Storms:	G2 Space weather for the next 24 hours is predicted to be moderate. Geomagnetic storms reaching the G2 level are likely.				
Solar Radiation Storms:	S1 Solar radiation storms reaching the S1 level are expected. Radio blackouts reaching the R1 level are expected.				
Radio Blackouts:	R1				

Space Weather Info Storm Scales & Delta TP Product

G or S Storm: Scale > or = 3, requires Delta TP Alert

Storm Scale	TP	Forecasting/Alert Status
G1	No TP Issued	Geomagnetic Storms (G1-G2) Communications: Possible HF radio loss Delta TP Product: No TP
G2	No TP Issued	Geomagnetic Storms (G2-G3) Communications: Possible HF radio loss Delta TP Product: No TP
G3	Alert Issued (Required)	Geomagnetic Storms (G3-G4) Communications: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
G4	Alert Issued (Required)	Geomagnetic Storms (G4-G5) Communications: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
G5	Alert Issued (Required)	Geomagnetic Storms (G5-G6) Communications: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
Storm Scale	TP	Forecasting/Alert Status
S1	No TP Issued	Solar Radiation Storms (S1-S2) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
S2	No TP Issued	Solar Radiation Storms (S2-S3) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
S3	Alert Issued (Required)	Solar Radiation Storms (S3-S4) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
S4	Alert Issued (Required)	Solar Radiation Storms (S4-S5) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
S5	Alert Issued (Required)	Solar Radiation Storms (S5-S6) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
Storm Scale	TP	Forecasting/Alert Status
R1	No TP Issued	Radio Blackouts (R1-R2) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
R2	No TP Issued	Radio Blackouts (R2-R3) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
R3	Advisory Issued (if needed)	Radio Blackouts (R3-R4) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
R4	Advisory Issued (if needed)	Radio Blackouts (R4-R5) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss
R5	Advisory Issued (if needed)	Radio Blackouts (R5-R6) Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss Delta TP Product: Possible HF radio loss

Slide 45 - Fall 2014
1st Released
Corrected &
Clarified TP for
G1-G2, S1-S2

Solar Events & Actions

Solar Storm Activity						
Type of Storm	Sun → Earth	Duration	Maximum Affects			
Abbrv.	Travel Time	Average	Aviation	Earth	Time	
Radio Blackout	R Storm	8 minutes	A few hours	HF Radio	Near Equator	Daylight
Solar Radiation	S Storm	Approx. < 1 hour	< 1 day	HF Radio & Health	Near Poles	Any
Geomagnetic	G Storm	Approx. 18-24hrs	1-2 days	HF Radio	Near Poles	Any

Delta Actions					
Type of Storm	Storm Scale				
Abbrv.	1	2	3	4	5
Radio Blackout	R Storm	None	None	Awareness: HF problem on sun lit side	
Solar Radiation	S Storm	None	Aware	Adjust Route: if btwn 78N & the Pole	
Geomagnetic	G Storm	None	Aware	Adjust Route: if btwn 82N & the Pole	

Edited version of Slide 44 -- from Fall 2014 IRTI Reconnect

Delta Air Lines Conclusions

Delta's Ops Concerns:

- HF Radio Communication disruption
- Improved Space Wx Fcsting for both Airline safety & efficiency

Space Wx Info Needs

- As simple as psbl for Aviation Ops Decision Makers
- "H" (Health) Scale. Implement after details addressed.

Performance Values for Space Weather Forecasting

- A goal not a mandate
 - Re-routes are the responsibility of Operator
 - Fcsting should not over reach accuracy capability