Delta Hazard Avoidance Procedures & Use of Space Weather Information

Space Weather Enterprise Forum

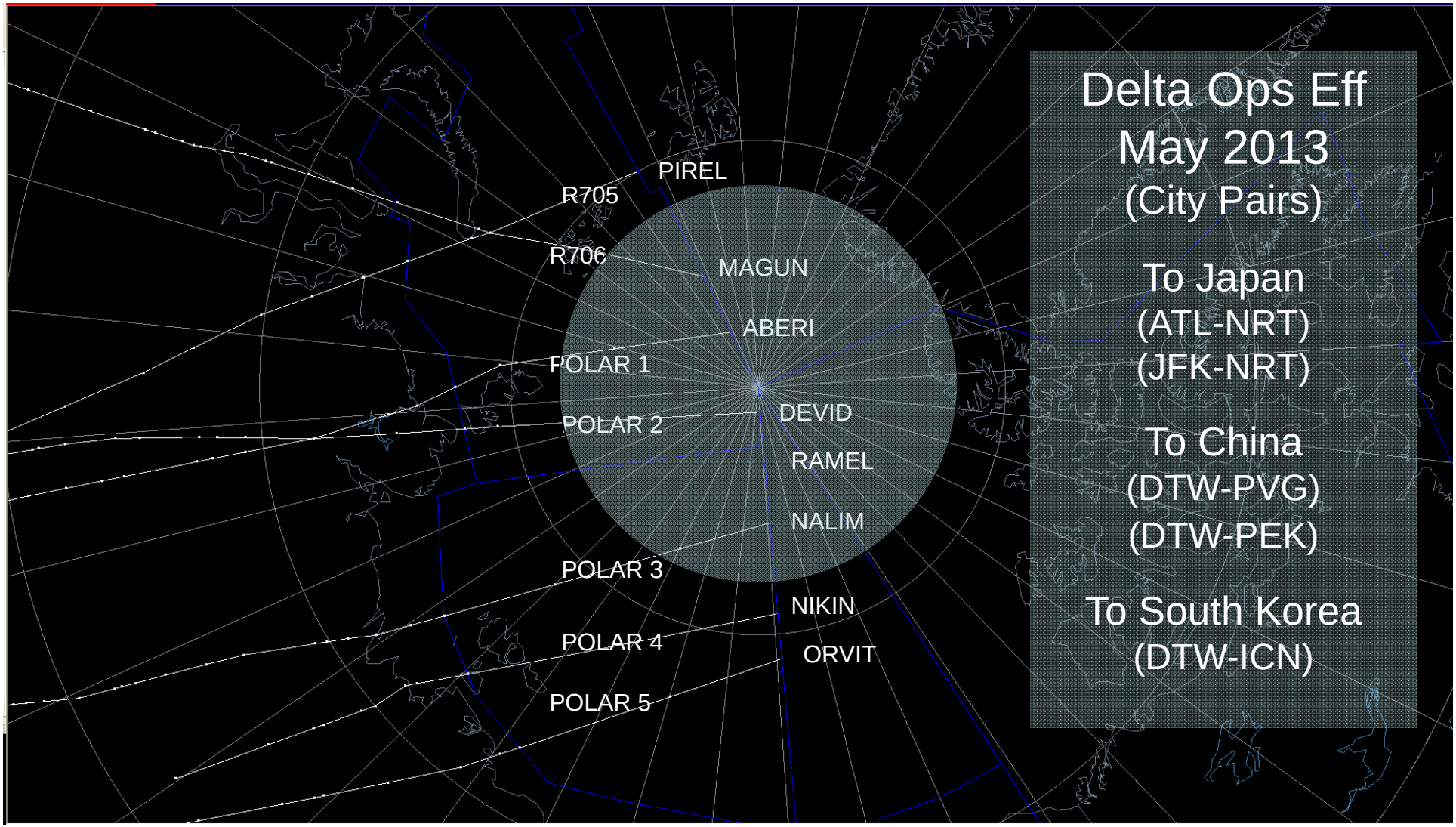
Session 3: Understanding the Day-To-Day Impacts of Space Weather.

04 June 2013

Silver Spring, MD

Tom Fahey & Gregg Scott, Delta Air Lines

Polar Routes/Fixes & Delta Ops



Delta Ops Eff
May 2013
(City Pairs)

To Japan
(ATL-NRT)
(JFK-NRT)

To China
(DTW-PVG)
(DTW-PEK)

To South Korea
(DTW-ICN)

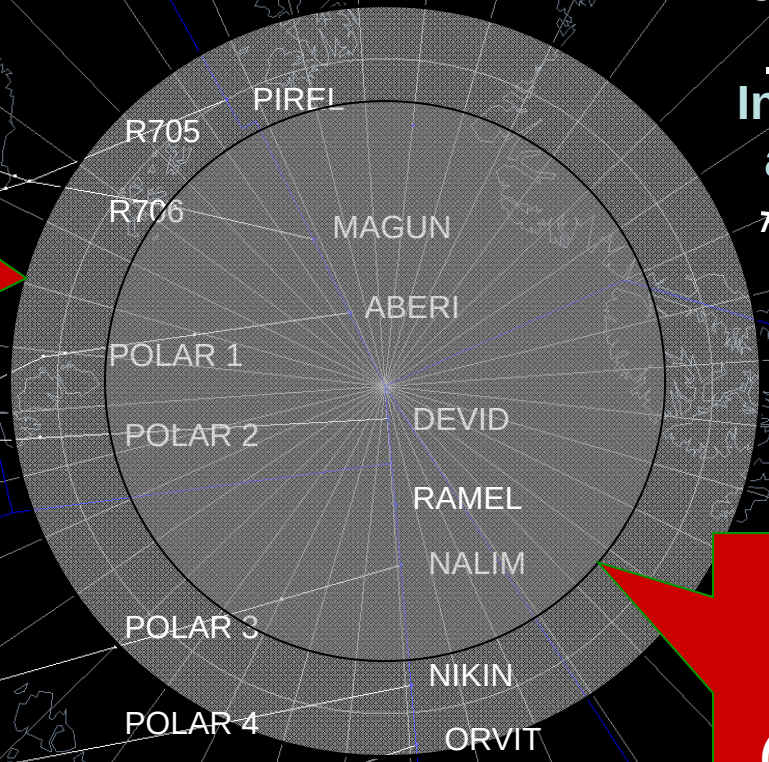
Delta Avoidance
HF Comms & Health Related

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

Delta's Primary Comms Method: ACARS using VHF or SATCOM
Delta's Secondary Comm 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

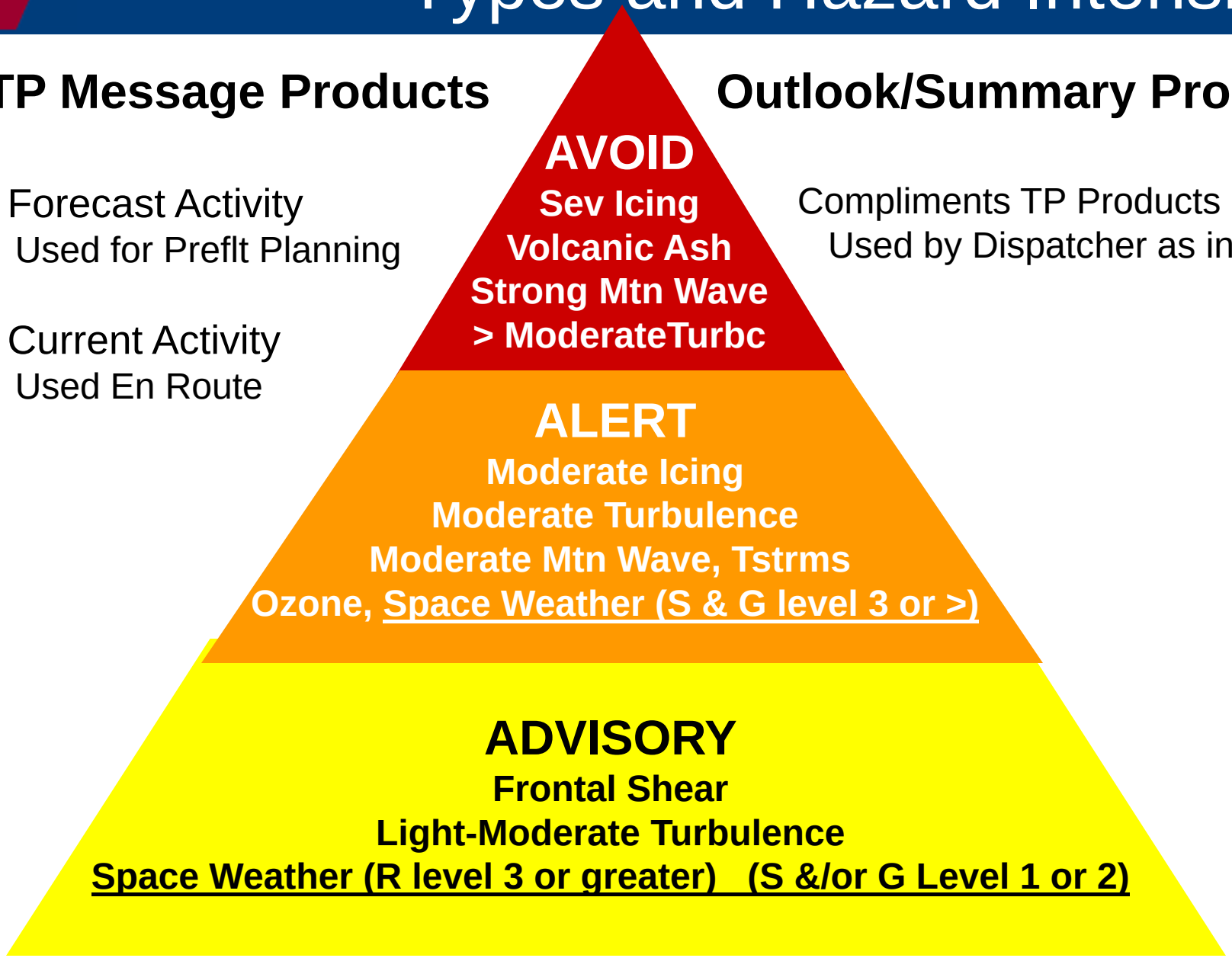
DELTA
Weather Hazard Avoidance Philosophy

- Procedures apply to **all** Weather Hazards both:
  - **Preflight Planning**
  - **En Route Adjustments**
- For Both Pilot & Flight Dispatch Procedures
  - **Advisory**: No Action required Preflight or en route
    YELLOW
  - **Alert**: Adjust route preflight & en route provided no other operational limitations
    ORANGE
  - **Avoid**: Adjust route preflight & en route
    RED

SAFETY
Types and Hazard Intensity

TP Message Products

- Forecast Activity
  Used for Preflt Planning
- Current Activity
  Used En Route



Outlook/Summary Products

Compliments TP Products
Used by Dispatcher as initial info

Space Weather Info
Delta Summary/Outlook Product

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

(issued daily at 10z-12z for westbound planning & if needed at 00z-04z for eastbound)

Delta Meteorology Space Weather Activity and Forecast

Issue Time: 0030Z Sunday, May 19, 2013
Next Update: 1100Z Monday, May 20, 2013
Fcstr: LONGOBARDI
*Valid Times See Below

Previous 24 hour Activity

Valid: 0600Z 5/18/2013 to 0600Z 5/19/2013

	Event 1		Event 2 (if needed)		Event 3 (if needed)	
	Scale	Valid Time	Scale	Valid Time	Scale	Valid Time
Geomagnetic Storms:	G1	18/0252z-18/0900z	NONE		NONE	
Solar Radiation Storms:	S1	18/0252z-18/0900z	NONE		NONE	
Radio Blackouts:	NONE	N/A	NONE		NONE	

Current Activity

	Scale	Valid Time		
Geomagnetic Storms:	NONE		See latest TPs issued for:	G3, G4, G5
Solar Radiation Storms:	NONE			S3, S4, S5
Radio Blackouts:	NONE			

24 hour Forecast Activity Valid thru: 0000Z 5/20/2013

	Scale	Forecast Description:
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 reaching the S1 level are expected. Radio blackouts reaching the R1 level are expected.
Solar Radiation Storms:	S1	
Radio Blackouts:	R1	

Space Weather Info
Storm Scales & Delta TP Product

G or S Storm Scale of 3 or higher requires Delta TP Alert

Advisory TP Messages are normally not issued, but an option.

Storm Scale	TP	Geomagnetic Storm Effects
G1	Advisory Issued (if needed)	Communications: No Effect Satellite Navigation: No Effect
G2		Communications: Possible HF radio fade Satellite Navigation: No Effect
G3	Alert Issued	Communications: Possible intermittent HF radio outages Satellite Navigation: Possible intermittent satellite navigation problems
G4		Communications: Possible sporadic HF radio outages Satellite Navigation: Possible satellite navigation degraded for hours
G5		Communications: Possible HF radio outages for 1-2 days Satellite Navigation: Possible satellite navigation degraded for days
Storm Scale	**TP**	**Solar Radiation Storm Effects**
S1	Advisory Issued (if needed)	Communications: Possible minor effects on HF Radio Satellite Navigation: No Effect Biological: No Effect
S2		Communications: Possible small effects on HF Radio Satellite Navigation: Possible navigation at polar cap affected Biological: Possible elevated radiation risk
S3**	Alert Issued	Communications: Possible HF radio degradation Satellite Navigation: Possible satellite navigation errors Biological: Possible elevated radiation risk
S4**		Communications: Possible blackout of HF radio for several days Satellite Navigation: Possible satellite navigation errors for several days Biological: Possible elevated radiation risk
S5**		Communications: Possible complete blackout of HF radio for several days Satellite Navigation: Possible satellite navigation erros for several days Biological: Possible elevated radiation risk
Storm Scale	**TP**	**Solar Flare - Radio Blackout Effects**
R1		Communications: Possible minor degradation to HF radio on sunlit side of Earth Satellite Navigation: No Effect
R2		Communications: Possible blackouts to HF radio for tens of minutes on sunlit side of Earth Satellite Navigation: No Effect
R3	Advisory Issued (if needed)	Communications: Possible blackouts to HF radio for an hour on sunlit side of Earth Satellite Navigation: No Effect
R4		Communications: Possible blackouts to HF radio for 1-2 hours on sunlit side of Earch Navigation: Possible minor disruptions to satellite navigation on sunlit side of Earth
R5		Communications: Possible complete blackout to HF radio for several hours on sunlit side of Earth Satellite Navigation: Possible satellite navigation errors for several hours on sunlit side of Earth
		***** Radio Blackouts impact the entire sunlit side of the earth. They also serve as a warning for potential Geomagnetic storms or Solar Radiation storms (1/2hr-1 day from Sun to Earth). *****

Space Weather Info
Delta TP Product Examples

To Support Pre-flight Planning & En Route Decision Making:

Meteorology will issue TP Messages for R3 or greater as “Advisory”

S & G scale 3 or greater are “Alerts” (action may be needed)

```
TP AO26 241604Z
1.AO
2.* ADVISORY *
HAZ:SPACE WX
SOURCE:OBSERVED
CATEGORY:R3
LAT/LON:90.0N100.0W
RADIUS:480NM
TIME:POSN AT 24/1600Z
ALTS:FL300-500
INFO:SOLAR FLARE WITH
  NO IMPACT TO
  POLAR RTES KNOWN OR
FCST AT THIS TIME.
3.VALID 241604/241804Z
4.CANCEL  NONE
```

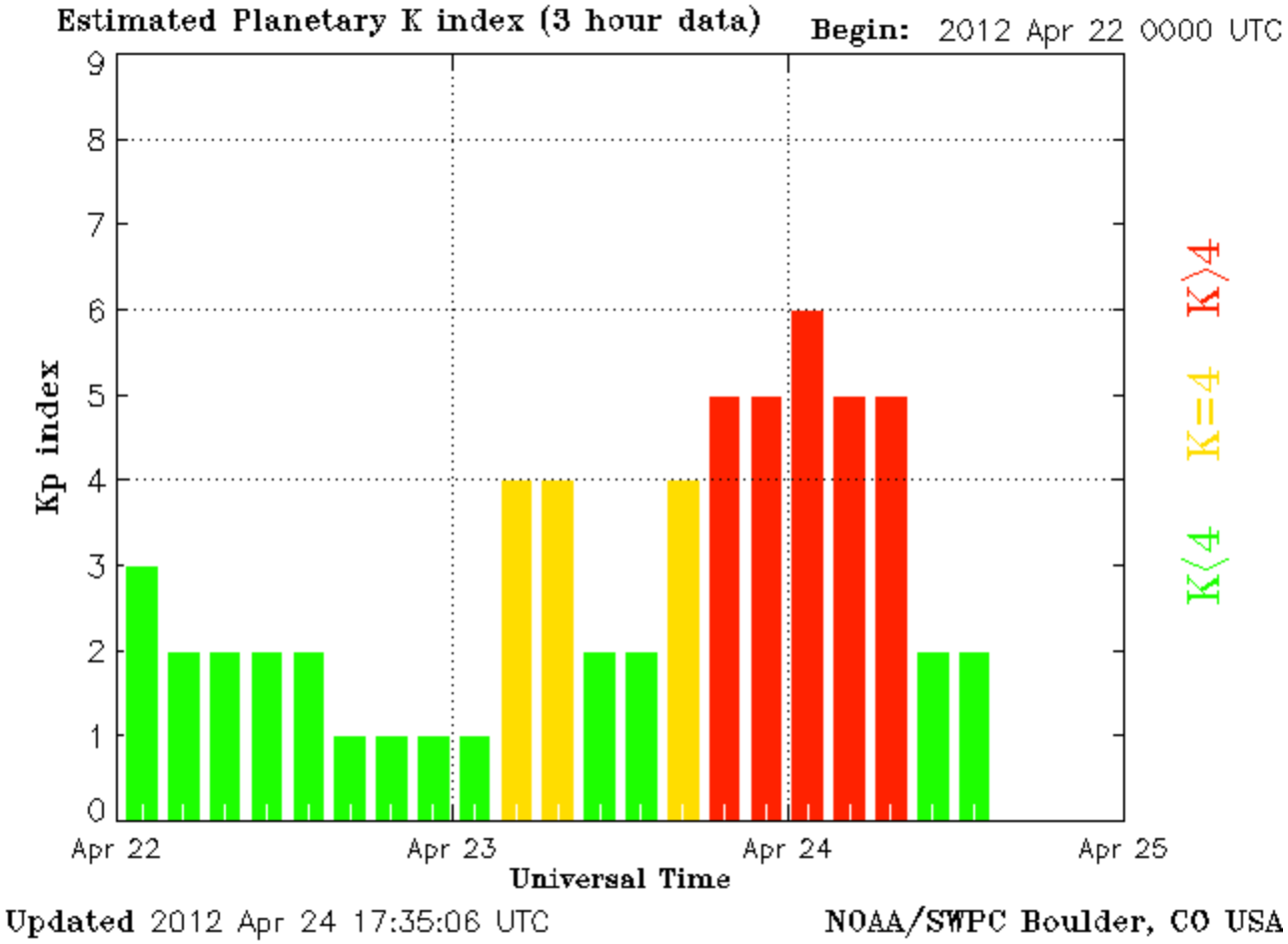
```
TP AO30 241608Z
1.AO
2.* ALERT *
HAZ:SPACE WX
SOURCE:FORECAST
CATEGORY:S3
LAT/LON:90.0N100.0W
RADIUS:780NM
TIME:POSN AT 24/1600Z
ALTS:FL300-500
INFO:RCMND AVOIDING
  ALL POLAR RTES.
3.VALID 241800/250400Z
4.CANCEL  NONE
```

```
TP AO31 241609Z
1.AO
2.* ALERT *
HAZ:SPACE WX
SOURCE:FORECAST
CATEGORY:G3
LAT/LON:90.0N100.0W
RADIUS:480NM
TIME:POSN AT 24/1600Z
ALTS:FL300-500
INFO:RCMND AVOIDING
  POLAR RTES N OF 82N.
3.VALID 241800/250400Z
4.CANCEL  NONE
```

Space Weather Info
Summary of Delta's Actions

- R Scale (Level 3, 4 or 5),
  - Advisory TP Issued: Only as an "Observed"
  - Action Required: None (Issued as an FYI only: No restrictions.)
- S Scale (Level 3, 4 or 5)
  - Alert TP Issued: As "Forecast" or "Observed"
  - Action Preflight: No Polar Routes (78N to Pole).
  - Action if En Route: Reroute or reducing altitude to FL310.
- G Scale (Level 3, 4 or 5)
  - Alert TP Issued: As "Forecast" or "Observed"
  - Action Preflight: No Routes between 82N to Pole.
  - Action if En Route & HF Problems: Try other HF freqs, use SATCOM, &/or reroute. Last resort, land short.
- S or G Scale (Level 1 or 2) – Recently Added
  - Advisory TP Issued: As "Forecast" or "Observed"
  - Action Preflight & En Route: Flight Superintendent/Pilot discretion

Current Solar Cycle Geomagnetic Kp Estimate 22-24Apr12



Kp-index	NOAA Space Wx Scale Geomagnetic Storm Level
Kp=5	G1
Kp=6	G2
Kp=7	G3
Kp=8	G4
Kp=9	G5

Current Solar Cycle Product & Flight Routing Response

- **Product: G-event TP Issued 0229z 24 Apr'12**

TP NP49 240229Z
1. AO
2.* ALERT *
HAZ:SPACE WX
SOURCE:FORECAST
CATEGORY:G3
LAT/LON:90.0N100.0W
RADIUS:480NM
TIME:POSN AT 24/0230Z
ALTS:FL300-500
INFO:RCMND AVOIDING POLAR RTES N OF 82N
3.VALID 240229/240600Z
4.CANCEL NONE

- **Delta Re-route Response**

DTW-PEK Flt 189 rerouted South of 82N (RAMEL to ORVIT)

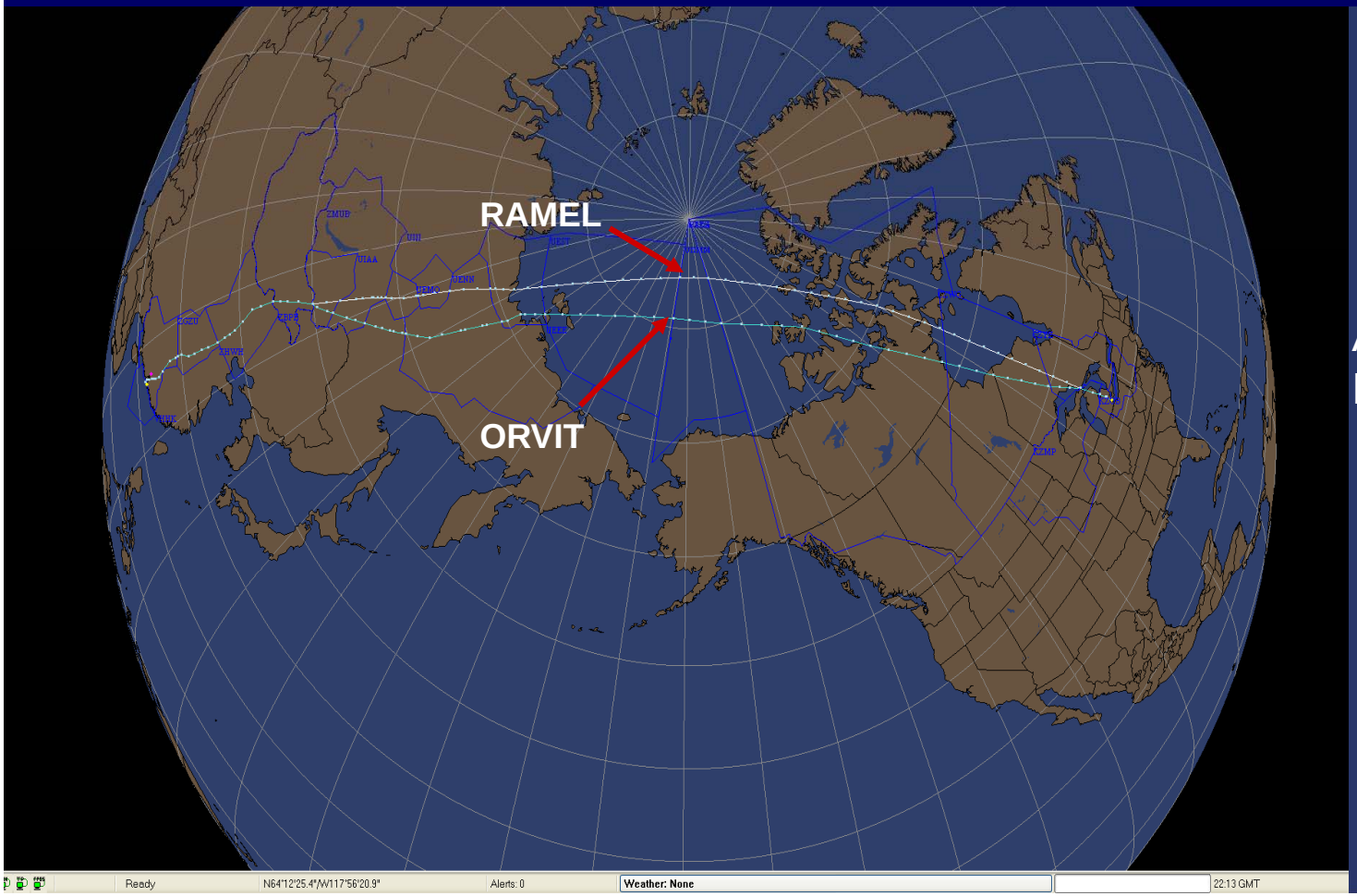
Delta Air Lines

DTW-HKG B777LR: RAMEL is econ track and ORVIT is south of 82N

RAMEL 15:23 en route time, Burn 250.1, block fuel: 274.6, Track distance: 6961nm

ORVIT 15:32 en route time, Burn 253.3, block fuel: 278.0, Track distance: 7019nm

Cost $1350



G scale
Scenario
Alert from Metro

AVOID Polar route
North of 82 North

Current Solar Cycle Product & Flight Routing Response

- **Product: If S3 or greater Event**

TP NP49 240229Z
1. AO
2.* ALERT *
HAZ:SPACE WX
SOURCE:FORECAST
CATEGORY:S3
LAT/LON:90.0N100.0W
RADIUS:780NM
TIME:POSN AT 24/0230Z
ALTS:FL300-500
INFO:RCMND AVOIDING ALL POLAR RTES
3.VALID 240229/240600Z
4.CANCEL NONE

- **Delta Re-route Response**

Avoid All Polar Routes

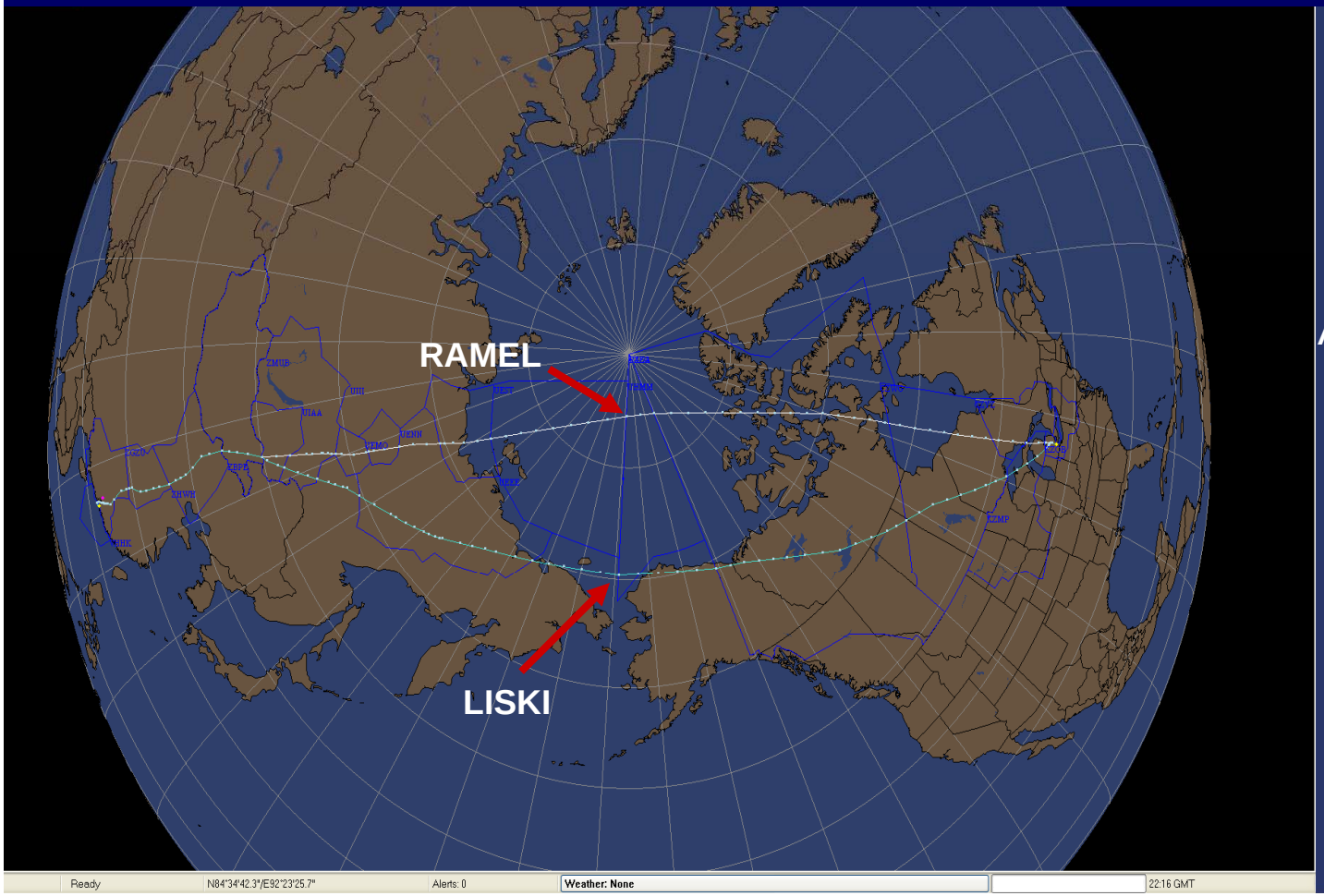
Delta Air Lines

DTW-HKG 77LR RAMEL econ and first “non-Polar” route is LISKI

RAMEL 15:23 en route time, Burn 250.1 block fuel: 274.6, Track distance: 6961nm

LISKI 15:46 en route time, Burn 259.7 block fuel: 284.7, Track distance: 7101nm

Cost $4507



S scale
Scenario
Alert from Metro

AVOID All Polar routes

Current Solar Cycle
Product & Flight Routing Response

- **Product: Issued 18 & 19 May 2013 (Due to reported comm issues)**

TP NP21 192208Z
1. NP AO
2.* ADVISORY *
HAZ:SPACE WX
SOURCE:FORECAST
CATEGORY:S1
LAT/LON:90.0N100.0W
RADIUS:480NM
TIME:POSN AT 20/0000Z
ALTS:FL300-500
INFO: FOR B777 ONLY
RCMND AVOIDING
POLAR RTES N OF 82N
DUE TO PAST HF
DEGRADATION
3.VALID 192208/201400Z
4.CANCEL NP08

This is the Recently Added Option
It was added due to fact that
HF communication problems
were being reported, even though
the level 3 threshold for
Solar Radiation (S) Storms
&
Geomagnetic (G) Storms
Was not being reached.

- **Delta Re-route Response: Operated at or South 82N**

Delta Air Lines

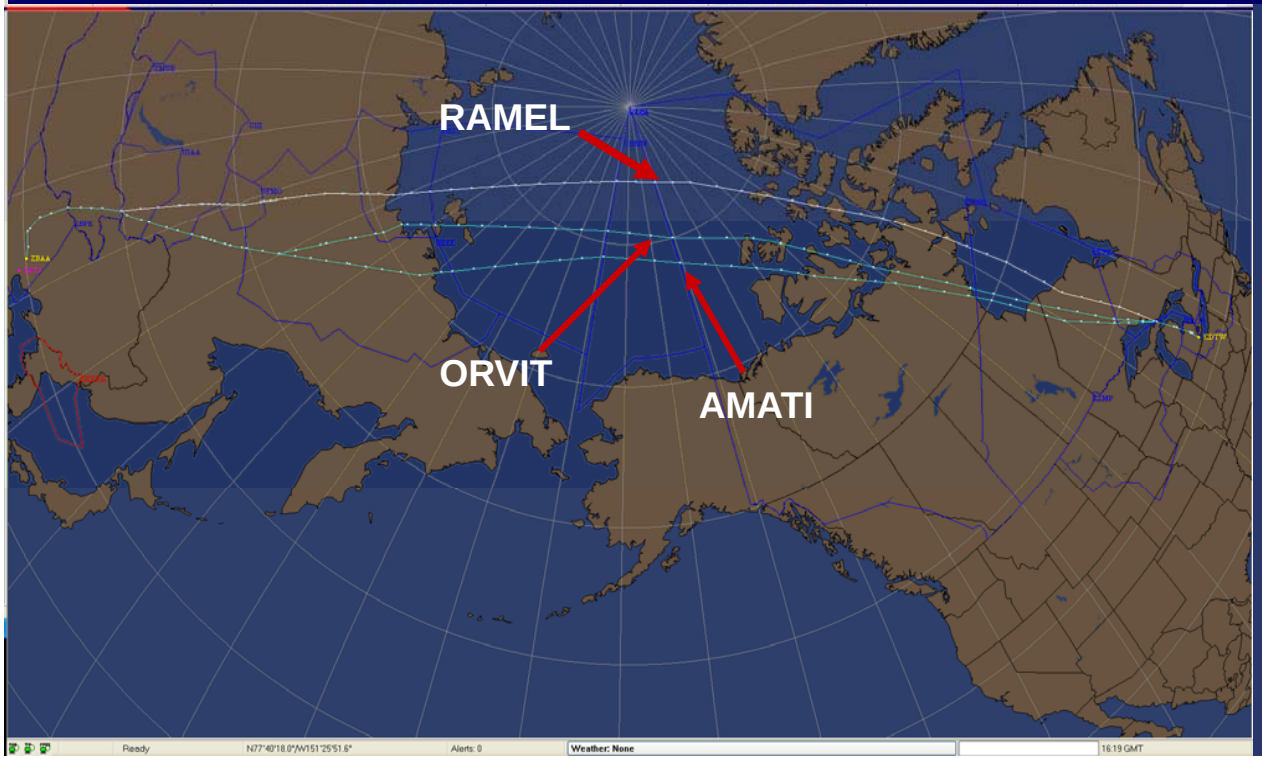
DTW-PEK 77ER RAMEL is econ track and NIKIN is south of 82N

RAMEL 12:42 en route time, Burn 201.9, Block fuel 232.1, Track distance: 5928nm

NIKIN 12:54 en route time, Burn 206.6, Block fuel 236.6, Track distance: 5951nm
Cost $2022, 4700lbs additional fuel, & CO2 emissions: 14,731lbs

ORVIT 12:56 en route time, Burn 206.8, Block fuel 236.9, Track distance: 5947nm
Cost $2071, 5000lbs additional fuel, & CO2 emissions: 15,672lbs

Non-Polar 13:05 en route time, Burn 207.5, Block fuel 237.5, Track distance: 6014nm
Cost $2992, 6750lbs additional fuel, & CO2 emissions: 21,157lbs



S1 scale
Scenario
Advisory from Metro

Normally no action required, however due to known Comm issues
AVOIDED Polar routes North of 82 North

Delta Air Lines

Impact first event January 24 and 28, 2012 approximately 8 flights pushed to non-Polar routes

Impact second event March 08-09, 2012 8 plus flights pushed to non-Polar routes or southerly Polar tracks

Overall impact DTW-HKG south of 82N
On a per flight basis

- $1,350
- 3,550lbs of fuel
- 07 minutes longer flight time
- 58nm additional mileage

Overall impact DTW-HKG Avoid Polar

- $4507
- 9,950lbs of fuel
- 21minutes longer flight time
- 140nm additional mileage

Delta Air Lines

- Impact first event January 24 and 28, 2012
  - Approx 8 flights pushed to non-Polar routes

- Impact second event March 08-09, 2012
  - 8+ flts pushed to non-Polar routes or southerly Polar tracks

Other unintended consequences

- Payload reduction
- Time (crew duty day)
- Additional green house gases
- Airframe costs

Delta Air Lines

Impact to Delta Polar Operations 18-19 May 2013 “S1” events

- 2 days we planned south of 82N
- Approximately 6 flights planned on non-optimal routes

Impact to one city pair DTW-PEK south of 82N on a per flight basis

- $2022
- 4,700lbs of fuel
- 12 minutes longer flight time
- 23nm additional mileage

Delta Air Lines
Conclusions

Delta' Ops Concerns:

- HF Radio Communication disruption is a concern
- Improved Space Wx Fcsting needed for both safety & efficiency

Space Wx Info Needs

- As High level & simplified as psbl for Aviation Ops Decisions
- Support "H" (Health Scale), but not implement until details addressed

Performance Values for Space Weather Forecasting

- Realize there has been a lot of work on Performance Values
- Request:
  - Clear labeling that Perf Values are a goal not a mandate
    - Re-routes remain responsibility of Operator, not ANSP
  - Fcsting efforts should not over reach capabilities
    - A 30hr fcst accurate only 20% of the time is a disservice