

Space Weather and Delta's Polar Routes



Polar Routes and Fixes





A map of the Arctic region showing flight routes. The map is centered on the North Pole, with latitude and longitude lines. The landmasses of North America, Europe, and Asia are visible. Four city pairs are highlighted with red lines: DTW - PVG, JFK - NRT, and two others. The text 'Current Polar routes' is in the top left, and 'City pairs that will traverse polar region' is at the bottom.

Current Polar routes

DTW - PVG

JFK - NRT

City pairs that will traverse polar region

Polar route statistics

A polar projection map of the Arctic region, centered on the North Pole. The map shows the Arctic Ocean and surrounding landmasses including North America, Europe, and Asia. A network of thin white lines represents flight routes or entry fixes, radiating from the North Pole. Two specific locations are marked with blue dots and labeled: RAMEL and ORVIT. The map also shows the outlines of major landmasses and bodies of water in the Arctic region.

Delta/Northwest polar flights:
564 (Dec 06-Jan 10)

Of the 5 entry fixes, our flights will favor
ORVIT and RAMEL

RAMEL

ORVIT



A map of the North Pacific region, centered on the Arctic Ocean, showing landmasses in green and brown and water in blue. A grid of latitude and longitude lines is overlaid. Two red lines represent proposed polar flight routes. One route starts at a yellow dot in East Asia (near Japan) and ends at a yellow dot in Western Europe (near the UK). The other route starts at a yellow dot in East Asia (near China) and ends at a yellow dot in North America (near Alaska). Both routes pass through the Arctic region. Text labels are overlaid on the map: 'Future North Pacific routes' in the top left, 'DTW - HKG' and 'DTW - ICN' in the center, and 'New city pairs that will likely go polar' in the bottom right.

Future North Pacific routes

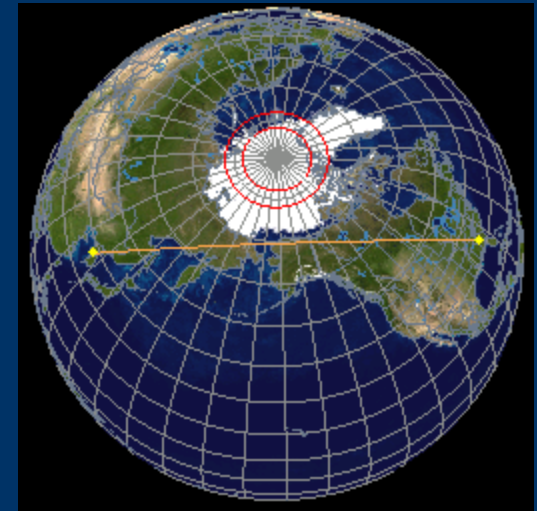
DTW - HKG

DTW - ICN

New city pairs that will
likely go polar

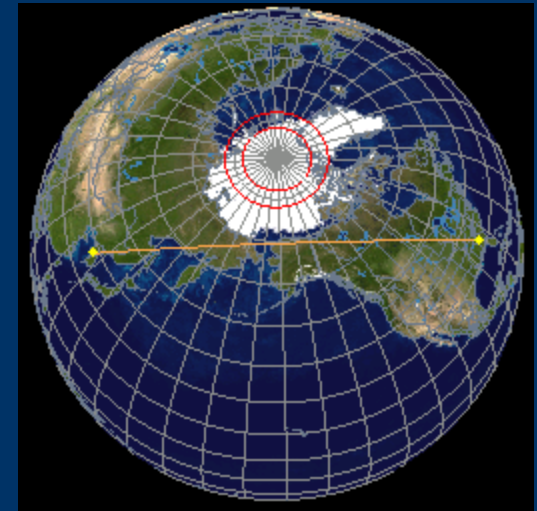
Requirements for Operating in the Polar Area:

- Authorization for operating in areas of magnetic unreliability
- Procedure for fuel freeze
- Effective communication for all portions of the flight route
- The following MELS (Minimum Equipment List):
 - Fuel quantity/temperature indicating system
 - Auto-throttle System
 - Communications system
 - Medical Kit to include AED
 - Include MEL restrictions for 180-min operation
 - APU
- Training
 - QFE/QNH and meter/feet conversion
 - Fuel freeze
 - Area and route-specific weather patterns and aircraft system limitations
 - Special considerations into diversion airports
 - Cold weather anti-exposure suit (2 onboard)
- Suitable alternate airports



Delta Meteorology's Role in Space Weather Planning

- Authorization for operating in areas of magnetic unreliability
- **Procedure for fuel freeze**
- **Effective communication for all portion of the flight route**
- The following MELS:
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- **Suitable alternate airports**



Storm Scales

Storm	Scale	
Geomagnetic	G1, G2	FLY
	G3, G4, G5	NO FLY (ABERI, RAMEL, DEVID)
Solar Radiation	S1, S2	FLY
	S3, S4, S5	NO FLY
Radio Blackout	R1, R2	FLY
	R3, R4, R5	NO FLY

Space Weather Effects on SATCOM/HF Radio

Effective Communications

POLAR REGION

No SATCOM Coverage
HF Radio Only

RAMEL

NIKIN

ORVIT

Delta's Primary Communication Method: ACARS using VHF or SATCOM

Delta's Secondary Communication Method: Voice Communications using HF Radio or SATCOM

SATCOM is not available North of 82N. Any flights entering north of ORVIT must on rely HF Radio as a primary source to communicate with ATC and Delta.

**But Solar Activity can interfere with HF Radio,
which could mean no communication method is available.**



Effective
Communications

No SATCOM Coverage
HF Radio Only

POLAR REGION

RAMEL

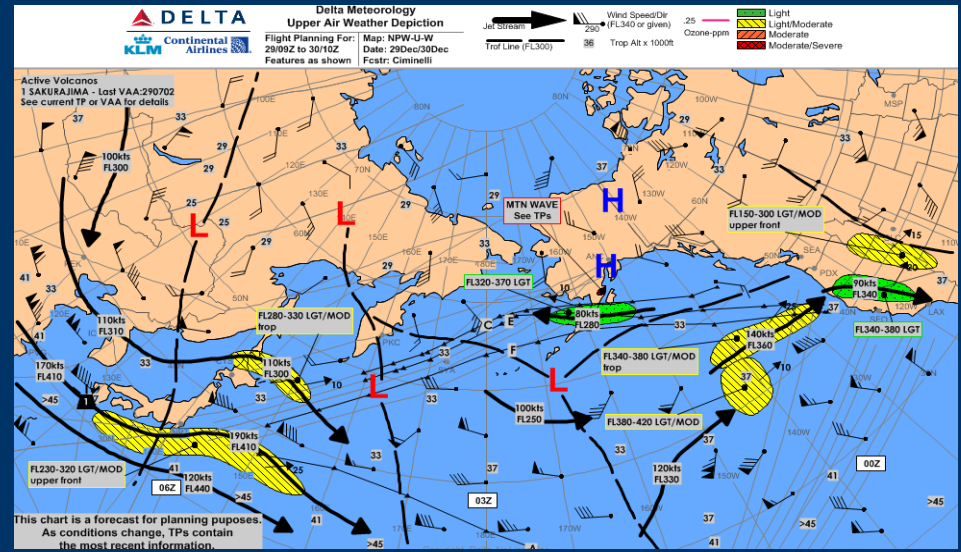
NIKIN

ORVIT

We can enter via ORVIT, during a small Geomagnetic Storm or Radio blackout because it is within SATCOM range. We will not fly any polar routes during a moderate or larger solar radiation storm due to effects on communications and possible radiation exposure.

Planning a Polar Flight

- Run analysis through FPS for each flight to determine best routes and flight levels
- Polar routes will almost always be more economical
- Consider Meteorology department's random routes
- Determine safest route - forecast weather (turbulence, thunderstorms, space weather activity, cold temps)
- Evaluate alternate airports



Delta Flight Planning System

Save WIP

Send

1389 DTW-PVG

Flt/Dt 1389/29 Ship 7105 Orig KDTW Dptr 2030 ETD 2030 Dest ZSPD Arvl 1120 ETA 1158 Arvl Var 0.38 DP 21

Fuel ☐ FOB Block 274000 Hold Tm 5 TGAF 29959 ☐ TNKR Taxi 25 Sar ☐ APU ☐

AltnPrim ZSSS Sec Tkof

Pyld Pax 268 Cargo 35000

Performance VCI MIN FUEL Max FL ☐ CDR ☐ Playbook ☐ NON-EQPD ☐ Use 8575 Rule ICAO

Compute

Lock	Status	Map	ID	Cost	Burn	Brn Diff	Trip Tm	ETA	Arv Df	Init FL	Comments	Status	Scenario
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.TRK.92	12030	269690	28675	16:16	13:16	1:56	280		<input checked="" type="checkbox"/>	Initial
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.TRK.F	14963	296375	55360	17:32	14:32	3:12	280		<input checked="" type="checkbox"/>	Current
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.RAN.PRM.	39847	236100	-4914	14:44	11:44	0:24	300			
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.RAN.	39847	236100	-4914	14:44	11:44	0:24	300			
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.TRK.88	40853	236275	-4739	14:45	11:45	0:25	300			
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	.TRK.87	41000	236622	-4392	14:47	11:47	0:27	300			

Summary

Preview

Route

Weights

Ship

Fuel

Remarks

Driftdown

Notams/Wx

AWABS

ETOPS

Redispach

Constraints

Errors

Fuel

	Req Time	Req Fuel	Plan Time/Fuel
Taxi Out	25		25/1792
Contingency	5		5/1017
Tanker Fuel			0
Block Fuel			274000
TGAF			29959

Payload

	Estimated	Requested	Planned	Source
Pax Count	0	268	268	Disp
Bag Count		348	348	Ratio
Cargo Wt		35000	35000	Disp
Total Payload	0	97700	97700	

Performance Data

NO MATCH - ORIG/DSTN

Weights

	Structural	Limits	Dispatcher	Planned
Zero Fuel	461000			446400
Ramp	768000			720400
Takeoff	766000			718608
Driftdown	<input type="checkbox"/> Payload Optimized			
Landing	492000			476717

Alternates

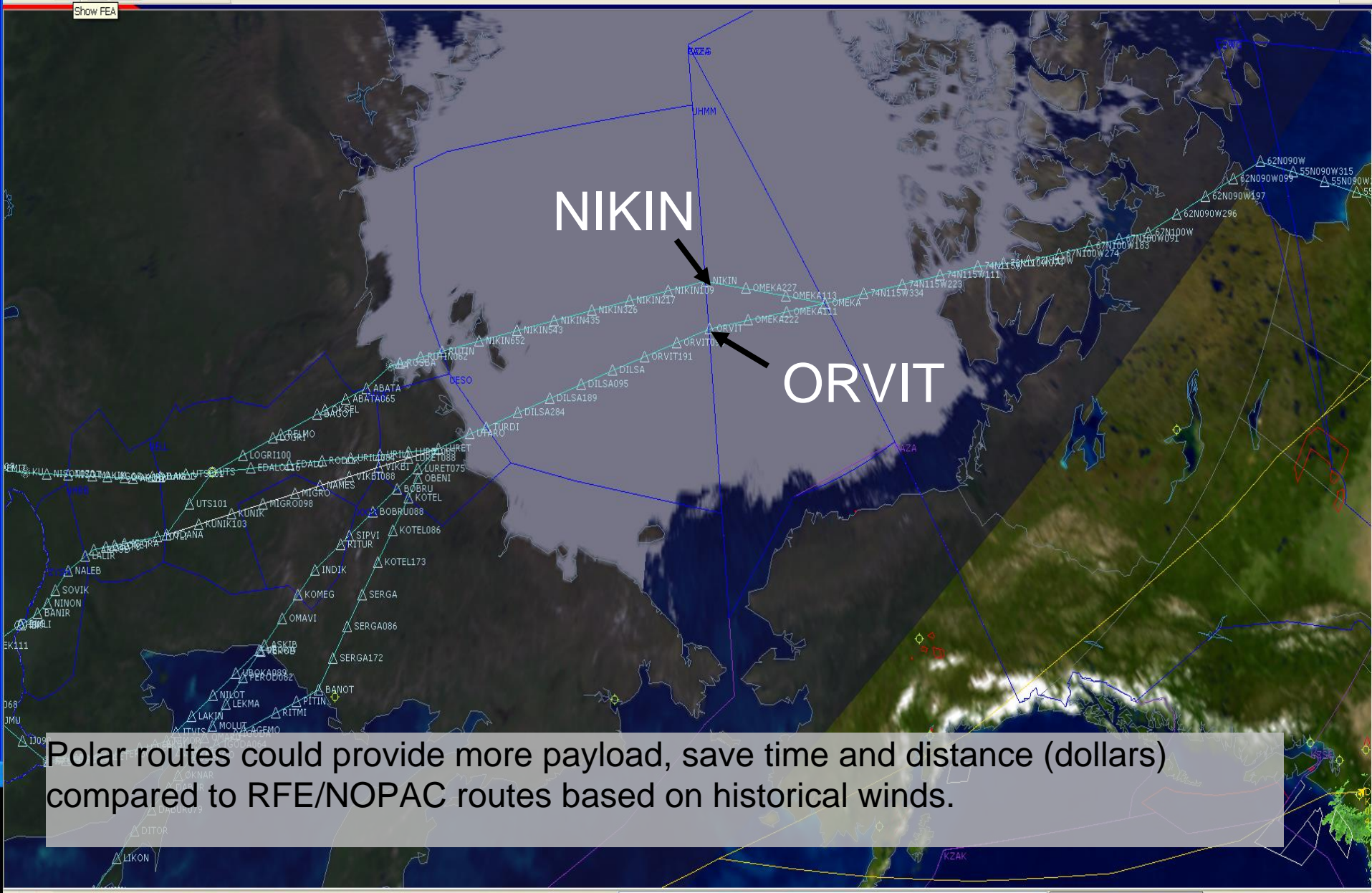
Max FL

Dest Altn 1 ZSSS ... Takeoff Altn ...

Dest Altn 2 ...

Planned Dest Altn 1	Flt Lvl	Time	Fuel
ZSSS	020	11	4087
Planned Dest Altn 2			

Route analysis – Why the polar routes?





Delta Meteorology


Upper Air Weather Depiction

Flight Planning For:
26/09Z to 27/10Z
Features as shown

Map: NPW-U-W
Date: 26Apr10
Fcstr: VAN GERPEN



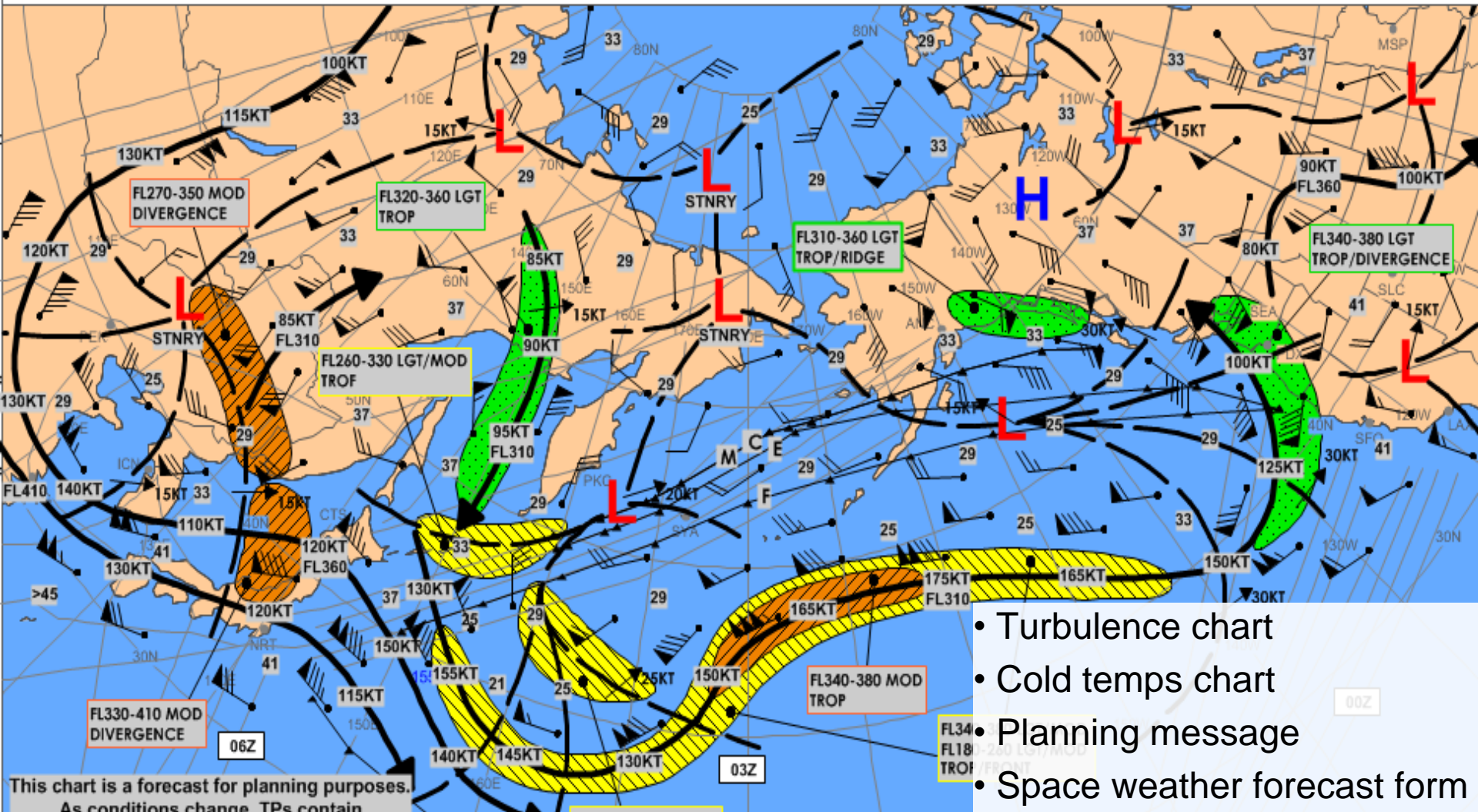
Trof Line (FL300)

 Wind Speed/Dir
(FL340 or given)

Trop Alt x 1000ft

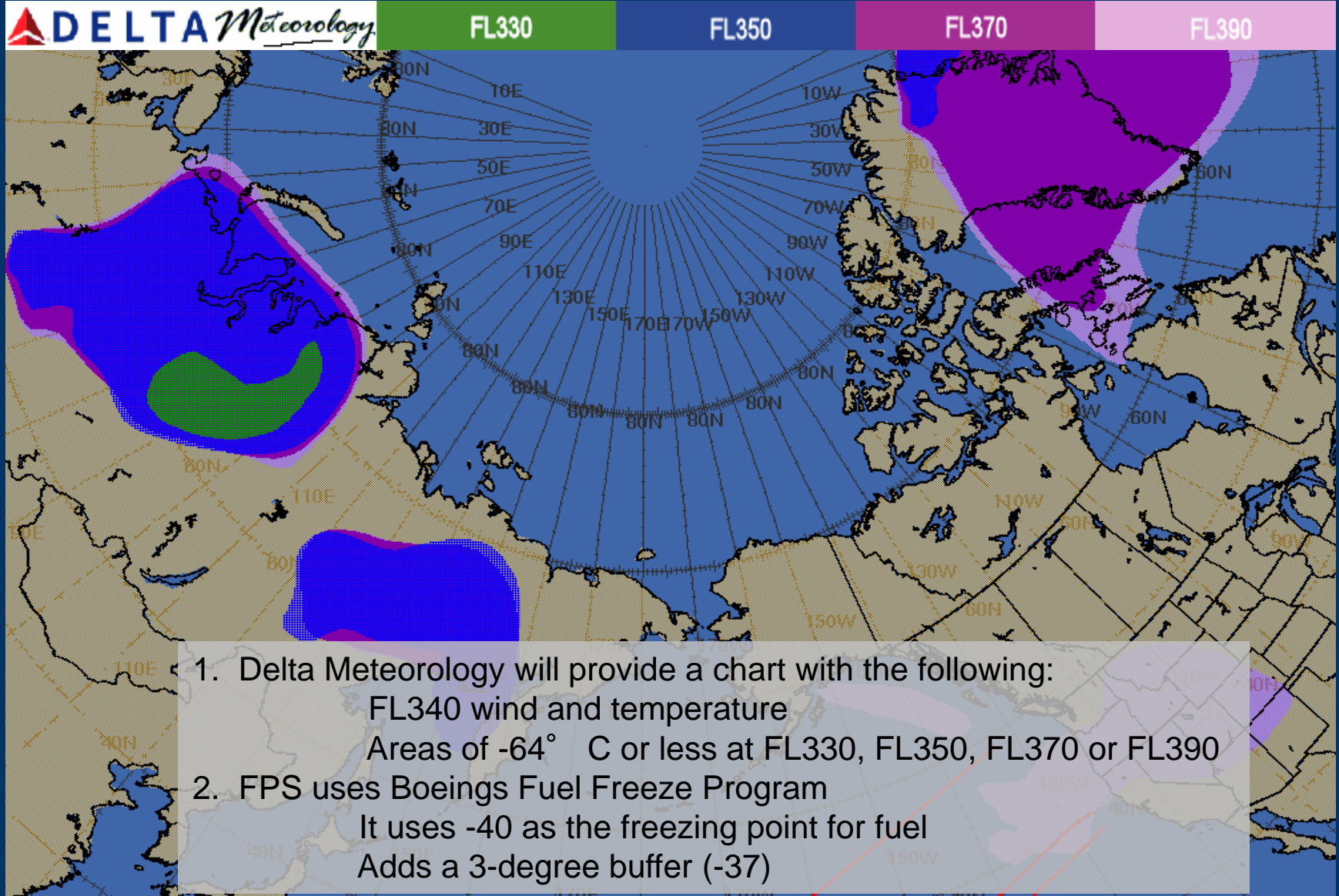
.25 —
Ozone-ppm

 Light
 Light/Moderate
 Moderate
 Moderate/Severe



- Turbulence chart
- Cold temps chart
- Planning message
- Space weather forecast form

Cold temp chart (-64C)



Space Weather Forecast Form – part 1

Delta Meteorology Space Weather Activity and Forecast

Date: Monday, April 26, 2010

Valid: Monday, April 26, 2010 thru Tuesday, April 27, 2010

Fcstr: SEXTON

Current NOAA Scales Activity

Geomagnetic Storms:	NONE
Solar Radiation Storms:	NONE
Radio Blackouts:	NONE

Solar Activity Forecast

Solar activity is expected to remain very low for the next 3 days (Apr 26-28).

Geomagnetic Field Activity Geophysical Activity Forecast: The geomagnetic field is

The geomagnetic field is expected to be mostly quiet on day one (26 April). Quiet to unsettled levels are expected on days 2 and 3 (27-28 April) with isolated active periods possible on day 3 in response to the CME observed on 22 April.

Space Weather Forecast Form – part 2

Avoid Polar Routes N of 82N (over ABERI, DEVID, RAMEL)
**** S3, S4 or S5 Avoid All Polar Routes**

Fly Polar Routes

Geomagnetic Storm Effects

G1	Communications: No Effect Satellite No Effect
G2	Communications: Possible HF radio fade Satellite No Effect
G3	Communications: Possible intermittent HF radio outages Satellite Possible intermittent satellite navigation problems
G4	Communications: Possible sporadic HF radio outages Satellite Possible satellite navigation degraded for hours
G5	Communications: Possible HF radio outages for 1-2 days Satellite Possible satellite navigation degraded for days

Solar Radiation Storm Effects

S1	Communications: Possible minor effects on HF Radio Satellite No Effect Biological: No Effect
S2	Communications: Possible small effects on HF Radio Satellite Possible navigation at polar cap affected Biological: Possible elevated radiation risk
S3**	Communications: Possible HF radio degradation Satellite Possible satellite navigation errors Biological: Possible elevated radiation risk
S4**	Communications: Possible blackout of HF radio for several days Satellite Possible satellite navigation errors for several days Biological: Possible elevated radiation risk
S5**	Communications: Possible complete blackout of HF radio for several days Satellite Possible satellite navigation errors for several days Biological: Possible elevated radiation risk

Solar Flare - Radio Blackout Effects

R1	Communications: Possible minor degradation to HF radio on sunlit side of Earth Satellite No Effect
R2	Communications: Possible blackouts to HF radio for tens of minutes on sunlit side of Earth Satellite No Effect
R3	Communications: Possible blackouts to HF radio for an hour on sunlit side of Earth Satellite No Effect
R4	Communications: Possible blackouts to HF radio for 1-2 hours on sunlit side of Earth 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 Possible satellite navigation errors for several hours on sunlit side of Earth

This section does not change. It is effects of each type of storm on HF Radio, Satellite Navigation and/or Biology

Suitable Airports in Russia

Russian ETP's



Yukutsk – UEEEE/YKS

An ETP airport is considered unsuitable when the surface temperature is colder than **-40F**. The meteorologist will need to make a remark on the flight planning message if one of our ETP airports are this cold.

The greatest threat is YKS, where the average January high is -36F!



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SURFACE WEATHER«  
YKS 060600 METAR 060600Z 00000MPS 0450 R23L/0550N FG BKN200«  
M39/M43 Q1054 NOSIG RMK QFE782 23450150«  
YKS 060700 METAR 060700Z 00000MPS 0450 R23L/0600V0800U FG«  
BKN200 M38/M43 Q1054 NOSIG RMK QFE781 23450150«  
YKS 060800 METAR 060800Z 00000MPS 0600 R23L/1400D FG BKN200«  
M39/M43 Q1054 NOSIG RMK QFE781 23450150«  
YKS 060800 METAR 060830Z 00000MPS 0400 R23L/1100D FG BKN200«  
M39/M43 Q1054 NOSIG RMK QFE781 23450150«  
«
```


Space Weather Activity Procedures

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Valid: Monday, April 26, 2010

thru

Tuesday, April 27, 2010

Fcstr: SEXTON

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Enroute Notification

Meteorology department printer will immediately receive alerts/warnings from SWPC.



The meteorologist will

- Notify Flight Control of any activity that is occurring or forecast to occur
- Issue TP

Enroute Response

For Geomagnetic Storms or Radio blackouts:

- Dispatcher and flight crew amend flight route if needed
- Relay TP information

For Solar Radiation Storms:

- Surface meteorologist will receive the Solar Radiation Alert
- Flight Control/Crew determine best altitude to minimize radiation dose for the remainder of the flight.
- Likely drop to lower flight level or change entire route.
- Relay TP information

Turbulence Plot (TP) System – Space Weather

TP System: Delta Air Lines' primary method for weather hazard avoidance

TP Status TP Edit Mountain Wave Outlook TP WFL Status Procedure Manual

Space Weather AO-Arctic Areas: AO

Hazard: SPACE WX

Source: ☐ Forecast ☒ Observed

Category: Radio: ☐ None ☒ R3 ☐ R4 ☐ R5
Storm: ☒ None ☐ S3 ☐ S4 ☐ S5
Geomagnetic: ☒ None ☐ G3 ☐ G4 ☐ G5

Lat/Lon: 90.0N100.0W

Radius: 480

Time:

Alts: Low: 300 High: 500

Standard Info's

Info (optional): RCMND AVOIDING POLAR
RTES ABERI, DEVID,
RAMEL.

Begin(Optional) End

Default ☐ plus 2 hours ☐ plus 3 hours ☐ plus 4 hours ☐ plus 5 hours ☐ plus 6 hours ☐ plus 12 hours

Cancel: No TPs for the selected region Enter other Region : Region

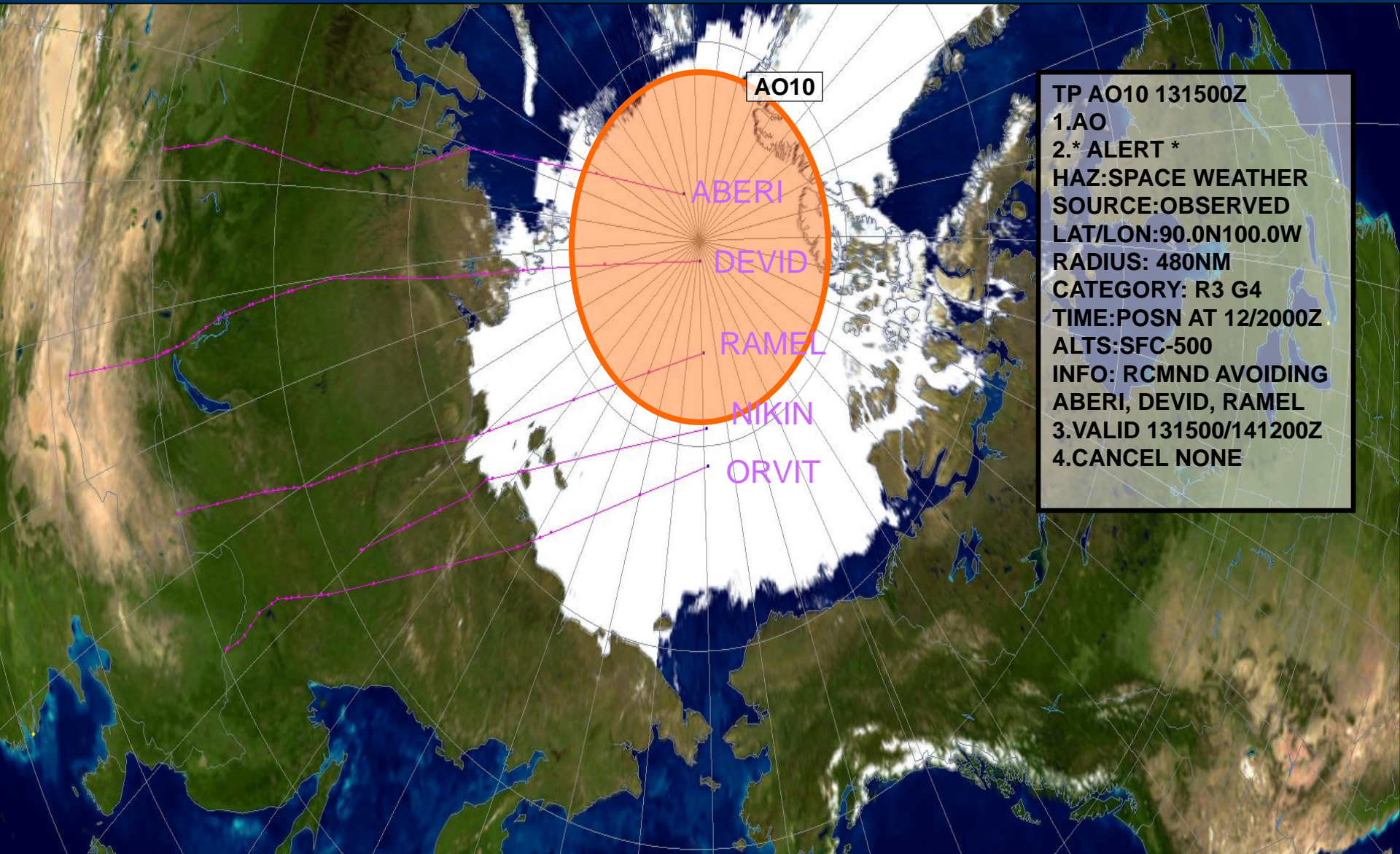
Error Check Clear

Radio and Geomagnetic scales – 480NM
Solar Radiation Storm – 780NM

TP AO10 131500Z
1.AO
2.* ALERT *
HAZ:SPACE WEATHER
SOURCE:OBSERVED
LAT/LON:90.0N100.0W
RADIUS: 780NM
CATEGORY: S3 R3 G3
TIME:POSN AT 12/2000Z
ALTS:FL300-500
INFO: RCMND AVOIDING
ALL POLAR ROUTES
3.VALID 131500/141200Z
4.CANCEL NONE

Space Weather TP Messages

G and R Scale Storms – 480NM Radius

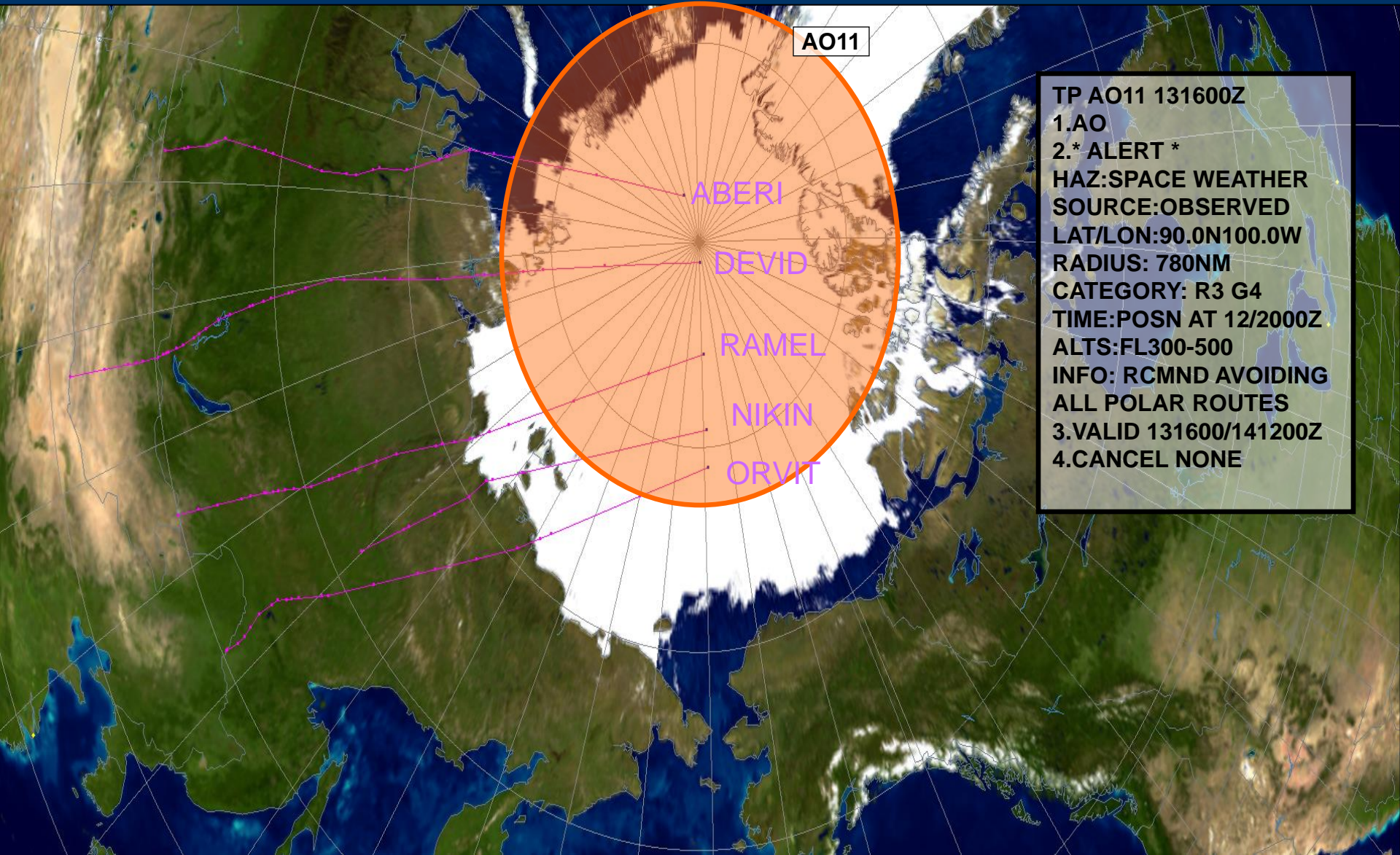


AO10

TP AO10 131500Z
1.AO
2.* ALERT *
HAZ:SPACE WEATHER
SOURCE:OBSERVED
LAT/LON:90.0N100.0W
RADIUS: 480NM
CATEGORY: R3 G4
TIME:POSN AT 12/2000Z
ALTS:SFC-500
INFO: RCMND AVOIDING
ABERI, DEVID, RAMEL
3.VALID 131500/141200Z
4.CANCEL NONE

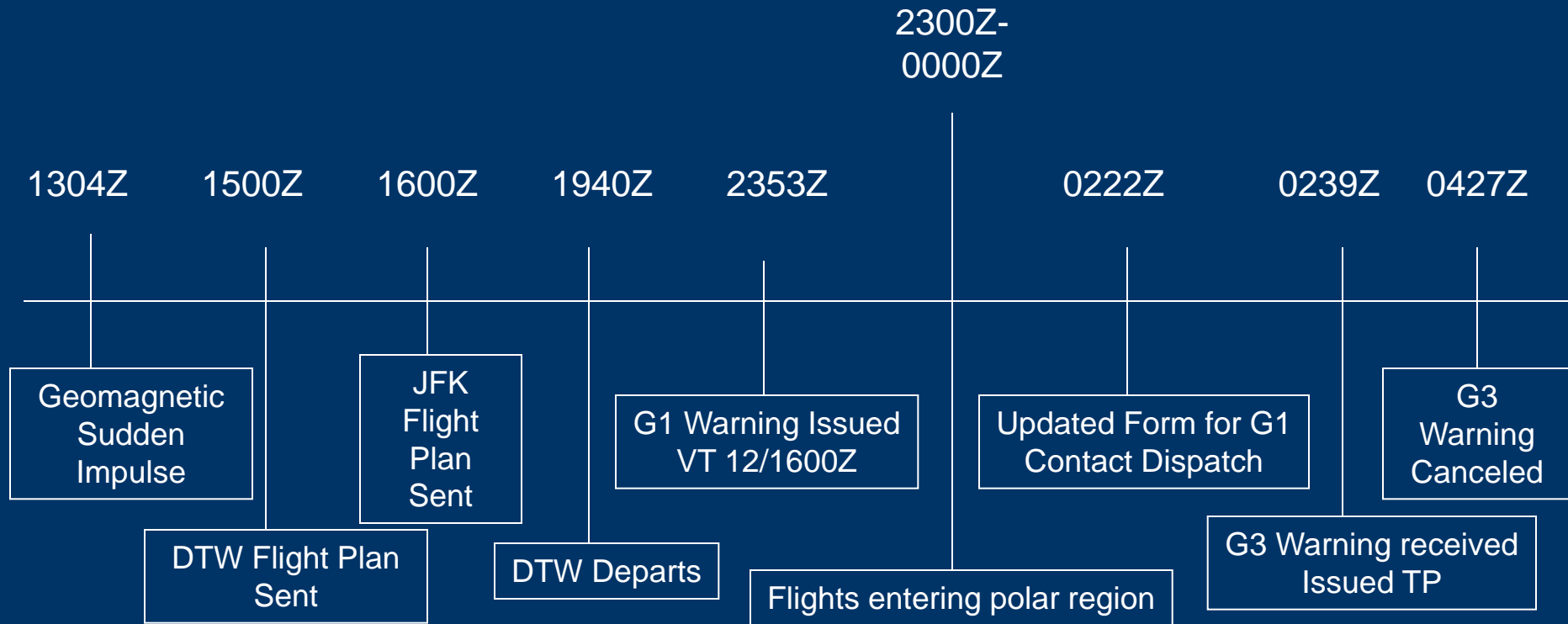
Space Weather TP Messages

S Scale Storms – 780NM Radius



TP AO11 131600Z
1.AO
2.* ALERT *
HAZ:SPACE WEATHER
SOURCE:OBSERVED
LAT/LON:90.0N100.0W
RADIUS: 780NM
CATEGORY: R3 G4
TIME:POSN AT 12/2000Z
ALTS:FL300-500
INFO: RCMND AVOIDING
ALL POLAR ROUTES
3.VALID 131600/141200Z
4.CANCEL NONE

April 11th-12th 2010 Event



What do we need from SWPC?

- Continued communication/education between our groups
- Timely communication of space weather events
- Warnings to include affected geographical areas/flight levels/latitude restrictions
- Duration of conditions