

Marie-France Turcotte*

Meteorological Service of Canada, Dorval, Québec, Canada

1.0 Introduction

Since August 2001 the Aviation Weather Web Site (AWWS) has been made available to the aviation community. NAV CANADA, owner and operator of Canada's civil Air Navigation Service (ANS), provides funding for AWWS development and maintenance. Operational support and development is done at the Canadian Meteorological Center (CMC), the national center for telecommunications, weather modeling and environmental emergency response services of the Meteorological Service of Canada (MSC).

2.0 AWWS current state and products

The current AWWS products available are of two types: alphanumeric bulletins and graphical products. The standard alphanumeric bulletins can be retrieved from the different request types. Last year, NOTAM bulletins were added to the suite of alphanumeric bulletins provided. The graphical products available are the SIGWX, North Atlantic Turbulence charts, Surface and Upper Air analysis, Graphical FA (GFA), Upper winds and temperature, RADAR and Satellite imagery.

3.0 ASEP

The Aviation Supplementary Enroute Prediction (ASEP) products that are to be added are the main component of the Internet service. It allows users to directly query a gridded aviation database generated from the Canadian Global Environmental Multi-scale model (Côté et al., 1998) in the regional configuration (Regional GEM). The current Regional model horizontal resolution is 15 km. ASEP database is derived from the model's operational output at 24 km horizontal resolution at 41 levels (from surface to FL400) interpolated from the 53 eta levels of the model, and a 3 hour time resolution from 0 to 48 hours. The ASEP database generation has been introduced in the CMC meteorological operations in August 2004. It is important to note that all ASEP products are solely based on Numerical Weather prediction (NWP) model outputs and do not include any human intervention.

Most variables, including diagnostic clouds, icing and turbulence, are calculated using algorithms that are adapted from the pre-existing operational ones. The current icing algorithm used is based on supercooled liquid water content forecast by the driving model (Tremblay et al. 1995). The turbulence algorithm is based on the deformation vertical shear index, DVSI

(Ellrod, 1989) weighted by the magnitude of the wind speed.

The remaining variables are already available as standard outputs from the model (mean sea level pressure, air temperature, winds, mechanical turbulence). The database will be updated twice per day (based on 00 and 12 UTC) in real time.

ASEP development was funded by NAV CANADA over the past 6 years and went to a beta testing pilot project between October 1999 and January 2000 (Ouellet, 2000). Prior to its upcoming operational implementation, NAV CANADA will make it available for the Flight Information Center (FIC) personnel training between September and November 2004.

4.0 ASEP Interface

Figures 1 and 2 shows the different interfaces for the Route selection. The geographical coverage of the ASEP database is indicated at Figure 2. It covers all Canada, parts of the United States and portion of the Pacific, Atlantic and Arctic oceans. Note that there are no US alpha numeric bulletins available on AWWS.

To retrieve ASEP products, users have to fill the Route form through 6 steps defining the flight characteristics:

- Departure Point,
- Enroute (if any) and Destination Points,
- Flight Altitude,
- Departure Time,
- Estimated time Enroute and
- Selection of the ASEP products.

Departure, Enroute, Destination can be Aerodrome ID or Lat-Long coordinate. Alternate must be Aerodrome ID. The default departure time is the current date and time which means it is not possible to select a departure time prior to current time. Possible departure time is dynamically driven by the weather database availability. The maximum departure time possible is 42 hours into the future. Estimated time en route varies from 1 to 12 hours.

A Product Identification Number (PIN) quick link (item **a** in Figures 1 and 2) and the PIN entry box (item **f** in Figure 3) allows a previously made request (max 6 hour old) to be retrieved. This feature will allow pilots to make a request and have a FIC personal to have a look at it simultaneously.

*Corresponding author address: Marie-France Turcotte, Canadian Meteorological Center, 2121 route transcanadienne, Dorval, Québec. H9P 1J3; email: marie-france.turcotte@ec.gc.ca

5.0 ASEP Products Output

The interactive system allows retrieving of the meteorological products for a specific flight route based on the flight characteristics entered by the users. The following section describes different product output generated by the system.

Figure 4 illustrates the **mechanical turbulence** forecast (surface momentum flux) for a flight between CYYZ (Toronto) and CYHZ (Halifax) via CYUL (Montréal), CYYY (Mont-Joli) and CYGP (Gaspé). Potential for turbulence is related to the color scale at the right of the picture. In the example shown potential for light mechanical turbulence is likely to occur near Halifax. A line of moderate turbulence is forecast along the Maine and New Brunswick coast.

The model surface momentum flux is used to assess mechanical turbulence intensity. The momentum flux will increase with vertical wind shear, surface roughness and thermodynamic instability. The surface momentum flux is defined as:

$$Fq = \rho C_D F^2,$$

where:

ρ = air density,

C_D = drag coefficient and

F = wind speed.

The mechanical turbulence is applicable to the surface while Clear Air Turbulence (CAT) as defined with the Deformation Vertical Shear Index (DVS) is applicable between 700-400 hPa (middle level) and 400-200 hPa (high level).

Figure 5 illustrates the **clear air turbulence** (CAT) forecasts for the same flight (CYYZ to CYHZ) as in **Figure 4**. Potential for turbulence is related to the color scale at the right of the bottom picture. The forecast tropopause height (using World Meteorological Organization (WMO) definition) is indicated by the black line (showing around CYUL and between CYUL and CYYY). The planned flight level is indicated in magenta (FL150) with arrows heads enhancing the flight direction. The plan view (bottom panel) indicates the forecast potential for CAT at the selected flight level (**FL150**, indicated in the upper left corner).

The clear air turbulence (CAT) algorithm in use for the aviation package is based on the Deformation vertical Shear Index (DVS) (Ellrod 1989). The DVS formulation, currently used is as followed:

$$DSVSI = (DEF) \cdot (VS) \cdot [F/45],$$

with DEF and VS defined as:

$$DEF = \sqrt{\left(\frac{\partial u}{\partial x} - \frac{\partial v}{\partial y}\right)^2 + \left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)^2} \text{ and}$$

$$VS = \sqrt{\left(\frac{\partial u}{\partial z}\right)^2 + \left(\frac{\partial v}{\partial z}\right)^2}.$$

Where:

F: wind speed in m/s,

x: the east-west coordinate,

y: the north-south coordinate,

z: the vertical coordinate,

u: the east-west wind component and

v: the north-south wind component.

The 45 m/s value used is based on an estimation of the wind speed above FL100.

The actual value of the index that is correlated with CAT is model dependent. As the resolution of the model increases, both in the horizontal and vertical, the value of the shear that is forecasts increases. According to past experiments, the correlation of DVS values with occurrences of CAT must then be calibrated for each forecast model.

Figure 6 illustrates the horizontal winds at flight level (FL150) for the same flight as in **Figure 4**. Conventional wind barbs representation is used on this product. The planned route is enhanced in magenta with the Departure, Enroute and Destination ID displayed. In **Figure 6**, a southwest circulation is clearly indicated at the selected flight level.

Figure 7 illustrates the Head and Tail wind components along the planned flight route based on the same flight trajectory as in **Figure 4**. Blue/Green colors indicate Tail components while Yellow/Red indicates Head components. The vectors (small black arrows) and the background color indicate that for most of the trip, a tail wind component can be expected except for the CYGP-CYHZ where a 7 knots head component is forecast. The small boxes on the trajectory in the vertical cross section indicate the average velocity for each segment of the flight.(+ for Tail winds and - for Head winds) The average head wind component at a flight level of 150, between CYUL and CYYY is 28knots. The plan view (bottom panel) indicates the main flow at the selected flight level (FL150).

Figure 8 illustrates the icing forecast for the same planned flight route (enhanced in light blue) as in **Figure 4**. The vertical cross section (top panel) shows the icing forecast along the route with icing forecast over CYUL. The dark blue line indicates the forecast height of the 0 Deg C isotherm along the route. The Plan projection (bottom panel) shows the icing forecast at the selected flight level (FL150).

6.0 Future development

To be made available in a near future are the Internet Flight Planning System (IFS) that will allow users to file flight plans on line and Wx Mail, an automated email delivery system for previously saved weather package.

6. References

Côté, J., S. Gravel, A. Méthot, A. Patoine, M. Roch, and A. Staniforth, 1998: The operational CMC-MRB Global Environmental Multiscale (GEM) model: Part I. Design considerations and formulation. *Mon. Wea. Rev.*, **126**, 1373-1395.

Ellrod, G. P., 1989: An Index for clear turbulence based on horizontal deformation and vertical wind shear. Preprints of the 3rd International Conference on Aviation Weather System, Anaheim, 1989.

Ouellet, Mario, 2000: The AWeD (ASEP) pilot project. *Internal Report*. Meteorological Service of Canada.

Tremblay, A., A. Glazer, W. Szyrmer, G. Isaac, I. Zawadzki, 1995: Forecasting of supercooled clouds. *Monthly Weather Review*, **123**, 2098-2113.

Annexe 1- Figures

NAV CANADA
Login Search Feedback Disclaimer Français Tips
Aviation Weather Web Site
What's New Weather and NOTAM File a Flight Plan Publications Update Profile
My Wx Data Route Data Regional Area Data Local Data Forecasts & Observations

Route Data

[Quick access to PIN entry box.](#) **a**

Route selection: **b** [Map View](#)

	c Aerodrome ID / Lat-Long	d Help: Location Name	
e *Departure	<input type="text"/>	<input type="text"/>	Look Up
Enroute Points	<input type="text"/>	<input type="text"/>	Look Up
*Destination	<input type="text"/>	<input type="text"/>	Look Up
IFR Alternate(s)	<input type="text"/>	<input type="text"/>	Look Up

*mandatory

Figure 1: Text View. Description of the main features: **a**) indicates the Quick link to the PIN entry box. The Map View button (**b**) to change from Text View. Entry boxes for Aerodrome ID / Lat-Long coordinates for the Route definition point's (**c**)(**d**). Location name help tool with Look up (**d**). Entering a location name and clicking Look up will provide the appropriate Aerodrome ID.

Figure 2: Map View. Description of the main features: **a**) indicates the Quick link to the PIN entry box. The Text View button (**b**) to change from Map View. Site ID/Lat-Long display box (**c**). Mode status (**d**). Mode can be: Zoom in (default), Panning, Input Route, Modify Route and Input Alternate. The different status is triggered using the corresponding button on the interface. Route / Alternate selection (**e**). Delete selection (**f**). Zoom Panel (**g**) and Show locations panel (**h**). This allows users to display a variety of Aerodrome ID that are part of the application dictionary : All the Aerodromes or only those with METAR, TAF available.

New Feature !

Automated Supplementary Enroute weather Predictions - ASEP

Disclaimer : The ASEP graphic products are computer generated directly from processed numerical forecast data. There is no human intervention or alteration of the displayed product(s).

Altitude **a**

Departure time **b** UTC

Estimate Time Enroute **c** Hour(s)

- | | |
|---|--|
| <input type="checkbox"/> Clear air turbulence | <input type="checkbox"/> Mechanical turbulence |
| <input type="checkbox"/> Horizontal winds bars d | <input type="checkbox"/> Head/Tail winds |
| <input type="checkbox"/> Moisture Content | <input type="checkbox"/> Mean sea level pressure |
| <input type="checkbox"/> Icing | <input type="checkbox"/> Air Temperature |

Disclaimer : Pilots are advised to obtain an interpretative weather briefing and all pertinent NOTAM from Flight Information Centers / Flight Service Stations (FIC/FSS) prior to flying. The user accepts sole responsibility and all risks associated with use of the information on this web site. The user expressly releases NAV CANADA, its employees, agents and assigns from any liability or obligation in respect thereof.

e

An ASEP product (less than 6 hours old) can be recalled by entering its unique Product Identifier Number (PIN)

Enter PIN

f

Figure 3: ASEP Selection Description of the main feature. The Altitude selector (drop down list **a**). Altitude ranges from 1000 feet to FL400. Departure time (**b**) display is driven by the availability of the meteorological gridded database. Default departure time is set to current date, which means that departure time cannot be prior to current date. Maximum departure time can be of 42 hours in the future. Estimated time Enroute (**c**) ranges from 1 to 12 hours. The default value is set to 1. List of ASEP available products (**d**). ASEP products can be recall from previous requests using the PIN recall button. Maximum of 6 hours old requests can be recall.

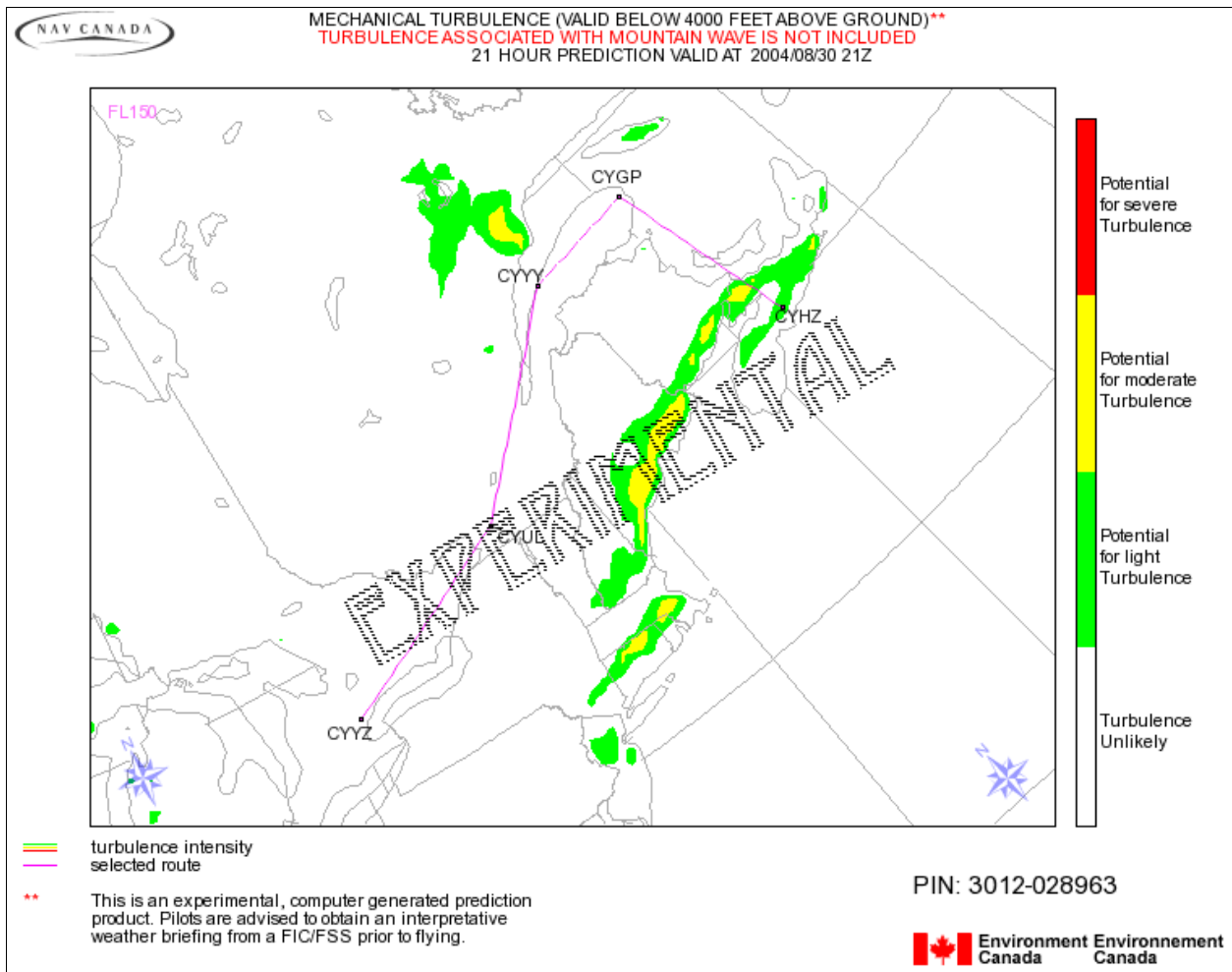


Figure 4: 21-h forecast of mechanical turbulence, valid at 21UTC August 30th 2004. Potential for turbulence is indicated by the color scale at the right. Flight Departure is CYYZ (Toronto) and Destination is CYHZ (Halifax). Magenta line indicates the planned route. Note the Product Identifier Number (PIN) in the lower right corner of the image.

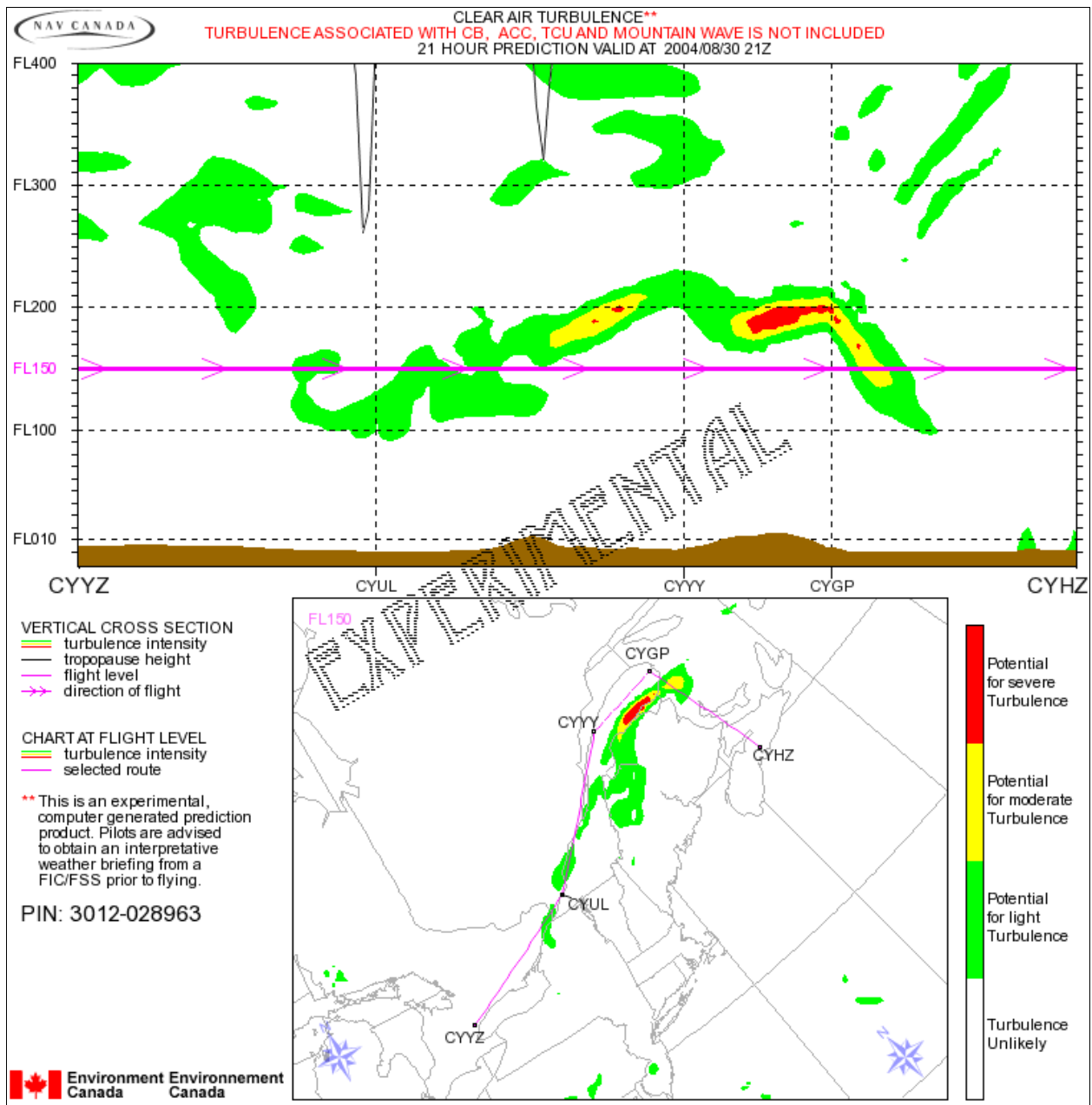


Figure 5: 21-h forecast of clear air turbulence (CAT) valid at 21UTC August 30th 2004. Potential for turbulence is indicated by the color scale. Flight Departure is CYYZ (Toronto) and Destination is CYHZ (Halifax). The vertical cross section (**top panel**) indicates potential for CAT along the route, from surface to FL400. The magenta line shows the planned route with arrow head enhancing flight direction. At the bottom of the vertical cross section, Departure, Enroute and Destination ID/Lat-long coordinate are displayed. Brown color indicates topography. The plan projection (**bottom panel**) shows forecast of CAT at the selected flight level (FL150). Note the Product Identifier Number (PIN) under the image description on the left side of the image.

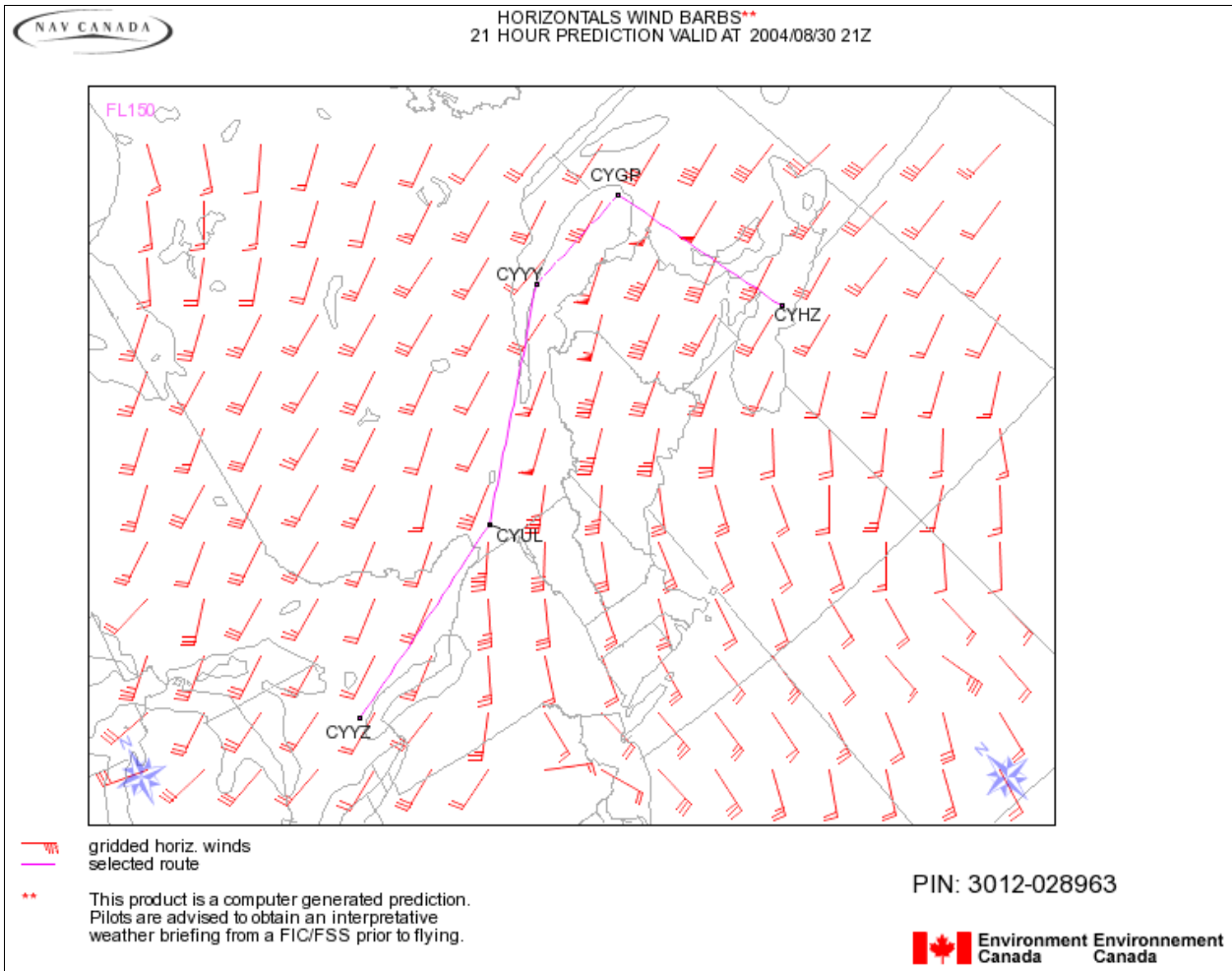


Figure 6: 21-h forecast of the horizontal winds at the flight level valid at 21UTC August 30th 2004. Conventional wind barbs are used for this product. Magenta line enhances the planned flight route (between CYYZ and CYHZ) with Enroute aerodromes indicated. Note the Product Identifier Number (PIN) in the lower right corner of the image.

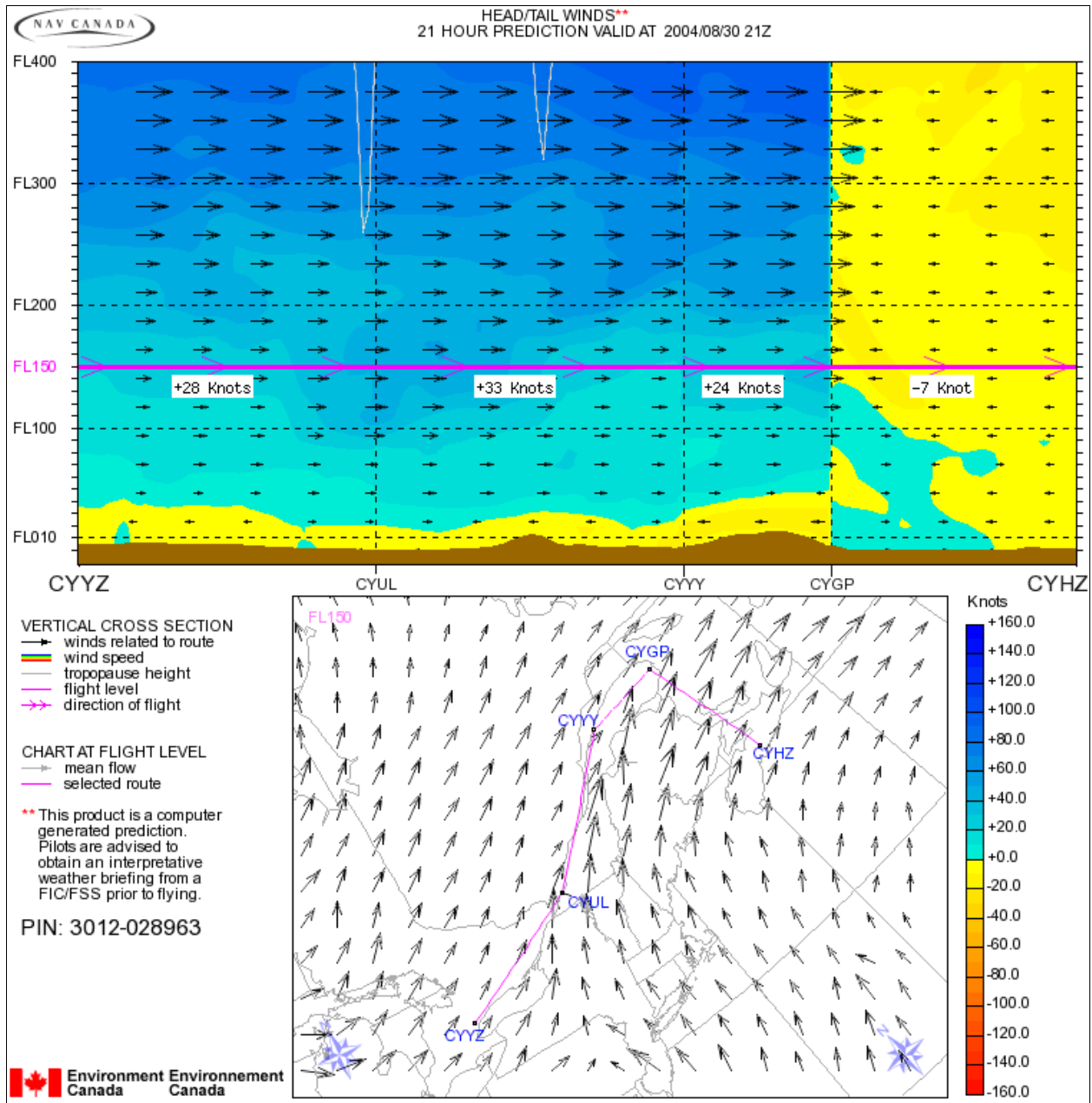


Figure 7: 21-h forecast of Head/Tail winds valid at 21UTC August 30th 2004. The color scale in the Vertical cross section (**top panel**) indicates the strength of the head/tail wind component. Blue/Green colors reflect the Tail component while the Yellow/Red color indicates head component. Average velocity for each flight segment is indicated using a + sign for Tail winds and a - sign for Head winds. The plan view (**bottom panel**) indicates the main flow at the selected flight level with the planned route in magenta. Note the Product Identifier Number (PIN) under the image description on the left side of the image.

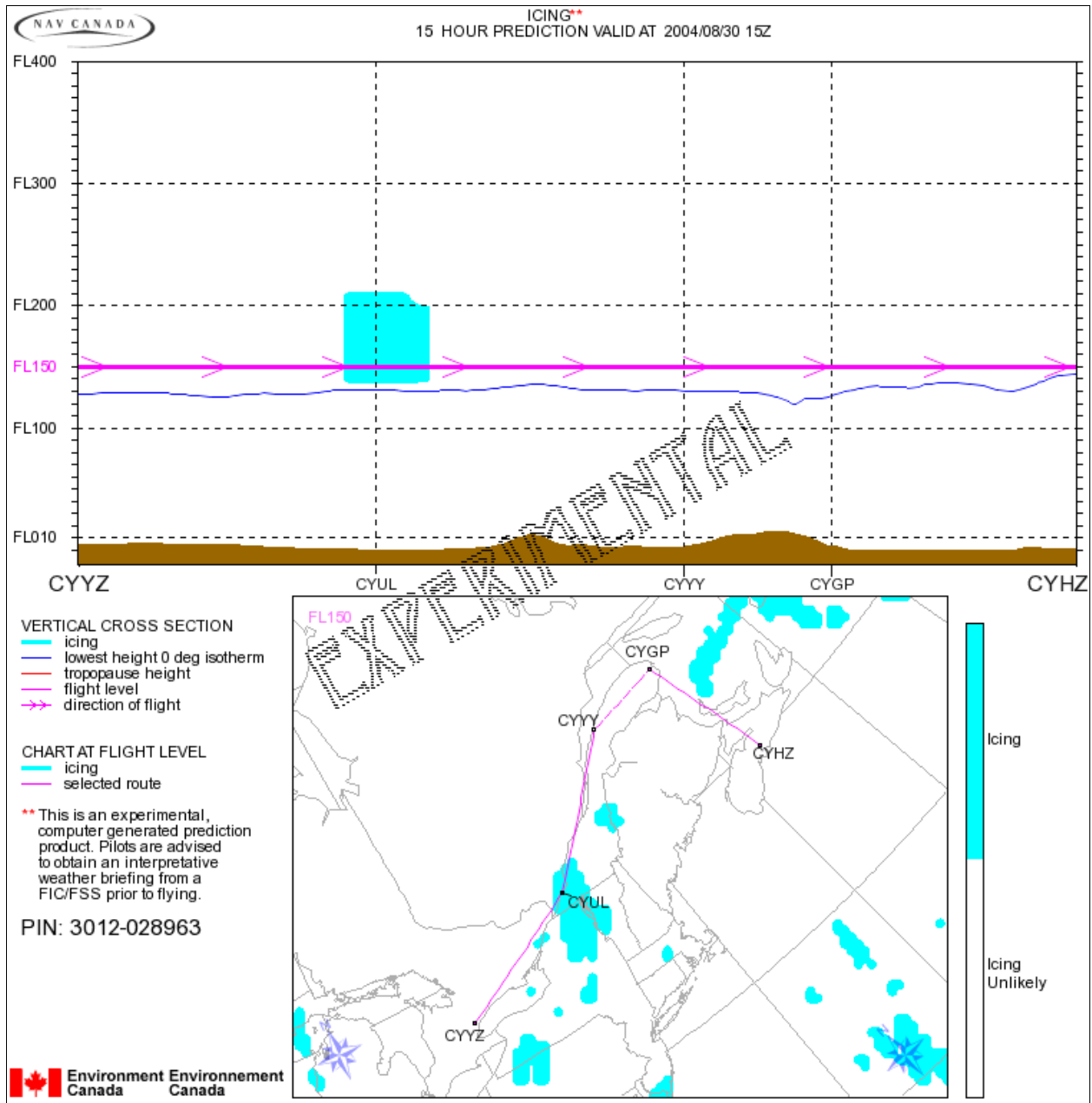


Figure 8: 15-h forecast of icing valid at 15UTC August 30th 2004. The vertical cross section (**top panel**) indicates vertical distribution of forecast icing (light blue) along the planned route. The magenta line enhances the route. The dark blue line is the forecast 0 Deg C isotherm along the route. The plan projection (**bottom panel**) indicates the horizontal distribution of icing at the planned flight level (FL150). Note the Product Identifier Number (PIN) under the image description on the left side of the image.