An Integrated Approach for Air Force Mission Planning

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Abstract

Weather information for Command and Control (C2) is usually available through separate weather systems, which are not necessarily implemented to satisfy specific C2 requirements for military end users. This paper describes an integrated approach for weather requirements for the Canadian Air Force Command and Control Information System (AFCCIS). Presentations for observations, forecasts, and weather warnings are made based on near real-time data from the Canadian military weather network. Static runway configuration and aircraft performance data are combined with dynamic weather data to obtain limitations for aircraft operations. Pertinent information is presented in graphical form, including the operational status of air bases on a map background. Additionally, Grib data is obtained periodically from another source for the generation of forecast isotachs, jetstreams, isobars, calculation of contrail possibilities, and the detection of fronts. The weather features have been integrated with a prototype candidate component for AFCCIS.

1. Introduction

Defence Research and Development Canada - Valcartier (DRDC – Valcartier) has evolved several functional prototypes for Air Force Command and Control, leading to the current Wing and Squadron Planner (WASP).

The main objective of WASP is to develop a prototype to meet and validate the requirements for mission support primarily at the Air Force Wing and Squadron levels and also for the 1 Canadian Air Division/Canadian NORAD Region Headquarters (1CAD/CANR HQ). Components of WASP are candidates for segments of the Air Force Command and Control Information System (AFCCIS).

WASP proposes an event-driven, seamless approach for treating mission requests from 1CAD headquarters down to the assignment of crew and aircraft at the wing and squadron levels. The WASP functionalities include the capabilities to receive, store, and correlate mission and resource information and weather data. Tools are provided to plan missions, to assign airframes and crews to missions, to monitor missions and to produce mission reports. The prototype promotes interaction among all those involved in or affected by a particular operation and uses an international standard message format (the U.S. Message Text Format or USMFT) Air Tasking Order (ATO) to exchange information with complementary or supporting systems from allied nations. USMTF ATOs from external sources may be

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received and parsed with information populated into a database, or ATOs may be generated and disseminated to appropriate operations centers.

Weather requirements for military Command and Control Information Systems are often simply not addressed, due to the assumption that a "Weather Information System" would provide the necessary information. While it is true that such systems are available with detailed weather information, and are deployed across flying bases in Canada, they do not necessarily address the specific needs of classes of users. Furthermore, weather information in these cases is provided in separate workstations that are not necessarily co-located, with their own user interfaces.

Mission planning for air operations, for example, the Monthly Airlift Plan, is prepared months in advance without regard, obviously, to weather, or rarely even to climatological data. Unforecasted missions, or ATOs, may prepared 24 hours or more in advance, also without regard to weather conditions (which are verified just prior to the mission). However, weather may be a critical factor for all air operations which may effect departures, en route flight segments, arrivals and for example, targeting, where laser spotting and visual confirmation of targets is essential. Therefore means for obtaining information on weather should be an integral feature of any system for mission planning for increased probability of success and to expose to planners the necessity to consider alternatives.

WASP integrates a weather sub-system to provide information on weather factors that may affect current or near-term operations. This sub-system summarizes weather reports from Canadian Forces airfields, using color-coded symbols on a map display, and allows detailed queries on weather reports. An alert module monitors current and forecast conditions to draw attention to particular situations that may effect operations. A graphics package is also included for the production of weather maps and to their incorporation in comprehensive weather briefings for command staff. While the emphasis has been for the Canadian territorial area, WASP supports activities for world wide deployed operations. The philosophy for WASP is to provide only the specific weather features tailored for mission planning and execution.

Interviews were conducted at several wing and squadron operational centers to determine what weather features should be integrated with the mission planning. Missions that were planned more than a few days in advance paid little heed to weather or even climatological data. However several centers, including Rescue Coordination Centres, did express the need for integrating weather in their automated planning processes. In order to obtain up to date weather information, planners must, at several operations centers, call the weather office on the telephone or make personal visits. AFCCIS terminals that are planned to be installed in operations centers should therefore have appropriate integrated weather features.

2. Architecture

Weather data is distributed by the Canadian Forces Weather Services to all Canadian bases with flying operations, on HP workstations that offer comprehensive weather functionalities. The DRDC - Valcartier Command and Control Laboratory is included in this distribution, where a selected class of the data is forwarded from the HP workstation to WASP through a Local Area Network. A daemon on the WASP server controls the weather parser which decodes the data, populates the WASP database, and invokes processes for weather calculations. Several processes provide textual reports and graphical overlays on a map display. The reports include observations, forecasts, aerodrome notices, weather

warnings, and limitation warnings. The graphical map overlays display isotachs, isobars, probability of contrail generation, and other weather phenomenon.

The data flow is outlined in Figure 1 for data that are received from the HP weather workstation.

Once parsed, the data is sent to the Air Environment Data Model (AEDM), a relational data model implemented in Oracle 8i. AEDM has been designed to support all data requirements for WASP, i.e. mission planning and weather. The weather components of the database are contained in the tables of Figure 2. WASP contains several categories of data for the weather features: the dynamic weather data, tables of sites monitored, alert thresholds and criteria, and static data of airfield configurations and of aircraft performance.

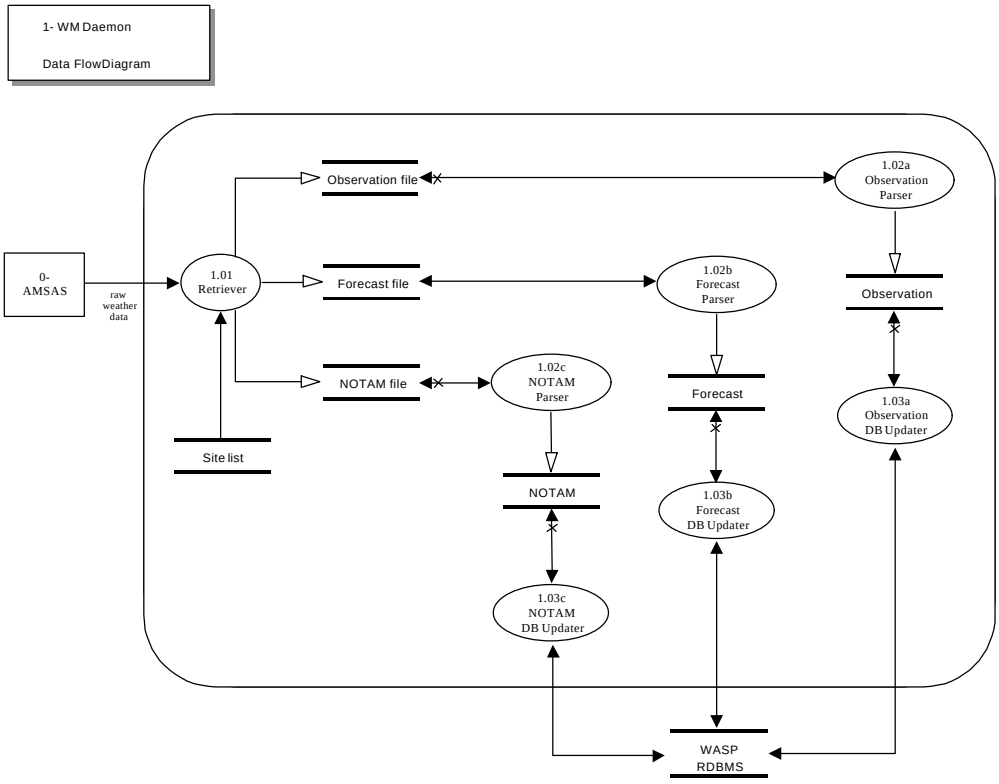

Figure 1 Weather Data Flow

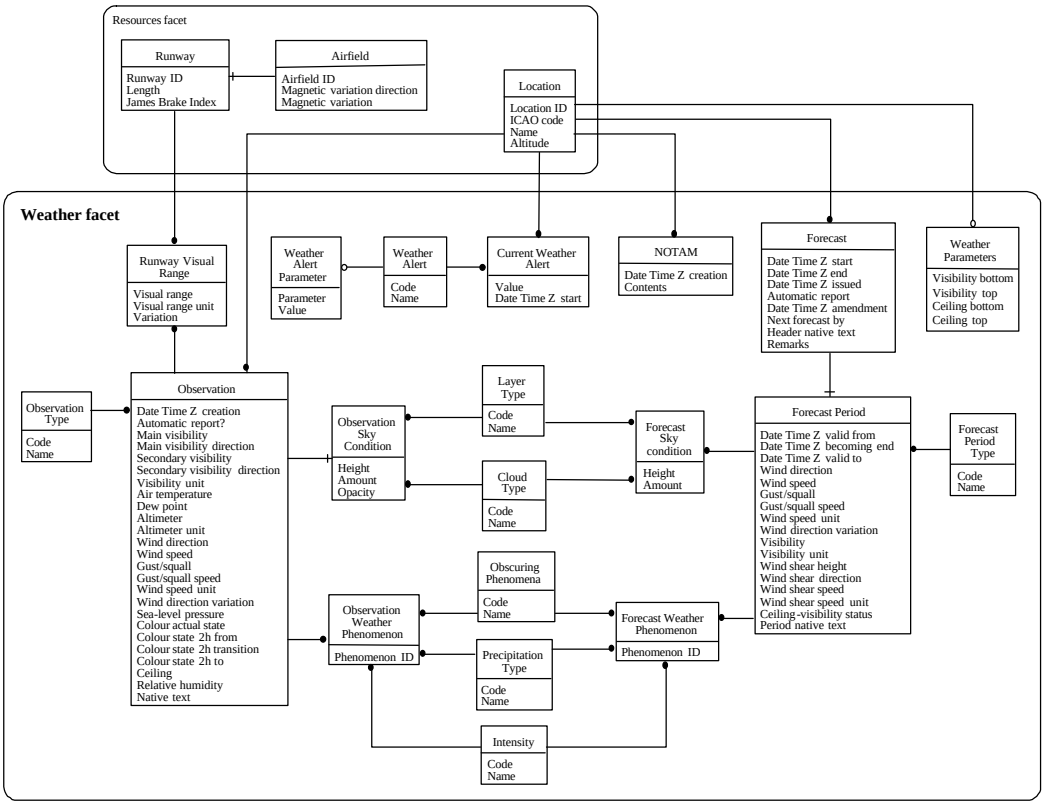

Figure 2 Data Structure

3. Features

A script in the HP weather workstation invokes calls to observation, forecast and other weather products as outlined below. In addition, the WASP prototype obtains GRIB (GRIdded Binary) data from a separate source for the display of graphical map overlays of isotachs, jetstreams, isobars, contrail probabilities, and fronts. GRIB data are a numeric rendition of computer forecast models in a open international standard format that cover a period of three to four and a half days or more in two to three hour intervals.

Figure 3 shows the flight category status of several airfields. The first color in the block indicates the current status (green VFR, yellow IFR, red X-ray closed, grey for no recent data), and the adjacent ones the forecasted status to 24 hours. The display may also show visibility obscuring phenomena, surface isobars, istotachs, jetstreams, areas of precipitation, cloud cover, and fog, and contrail generation. The window also displays point to point missions that are unassigned, assigned, or in progress, filtered according to date.

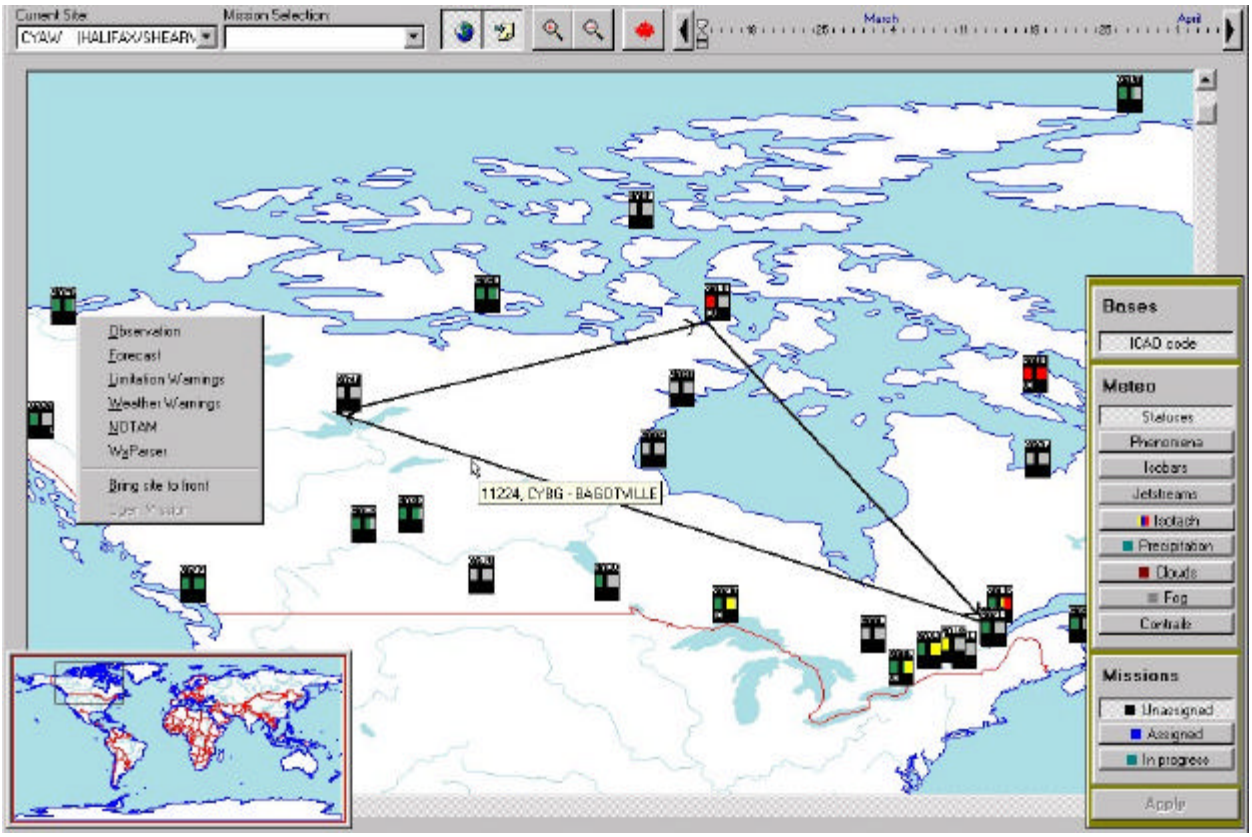

Figure 3 Flight Category Status

3.1 Observations

Canada has adopted the international format for weather reports and terminal forecasts. The METAR (METeorological Aerodrome Report) is normally issued every hour on the hour of current meterological conditions. Should weather conditions change significantly, a SPECI (SPECIal report) is sent. The information includes the ICAO location indicator, time of observation (on the hour), surface winds,visibilities, precipitation, ceiling, clouds, tempertures, altimeter settings. Figure 4 is an example display of a METAR with the native undecoded text in the lower box. Calculuated values are made for snow fall rate, pressure and density altitudes, chill temperature, chill factor, and relative humidity. For temperatures above +10 degrees C, humidex values are displayed instead of chill factors. Previous observations are avaialble for comparison of trends. An observation is considered out of date if it has not been received within 30 minutes past the hour.

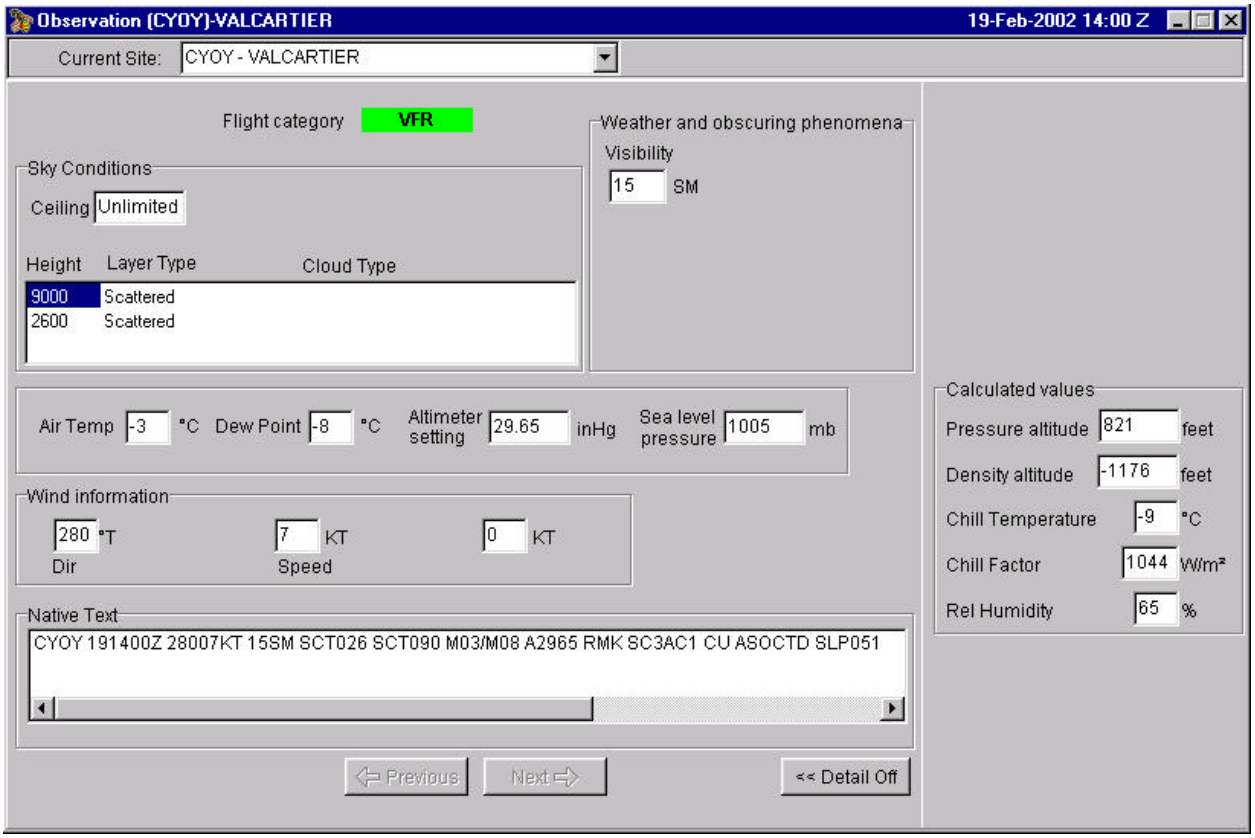

Figure 4 Observation - METAR

3.2 Forecasts

Forecasts of weather conditions and expected changes for are provided by TAF (Terminal Area Forecast) reports, which are issued every normally every 6 hours and are valid for 24 hours. Some variations exist for transcontinental flight planning and for European forecasts. The format is similar to the METAR but Canadian usage does not include expected temperatures, altimeter settings, and ceiling (which may be available in some countries or in military forecasts). An example TAF is illustrated in Figure 5. The time segments are separated and displayed individually once the color-coded buttons in the upper left are depressed. The color coding indicates the expected airbase flight status of VFR, IFR, or X-Ray closed. Temporary and probability fields within the time segment may also be displayed.

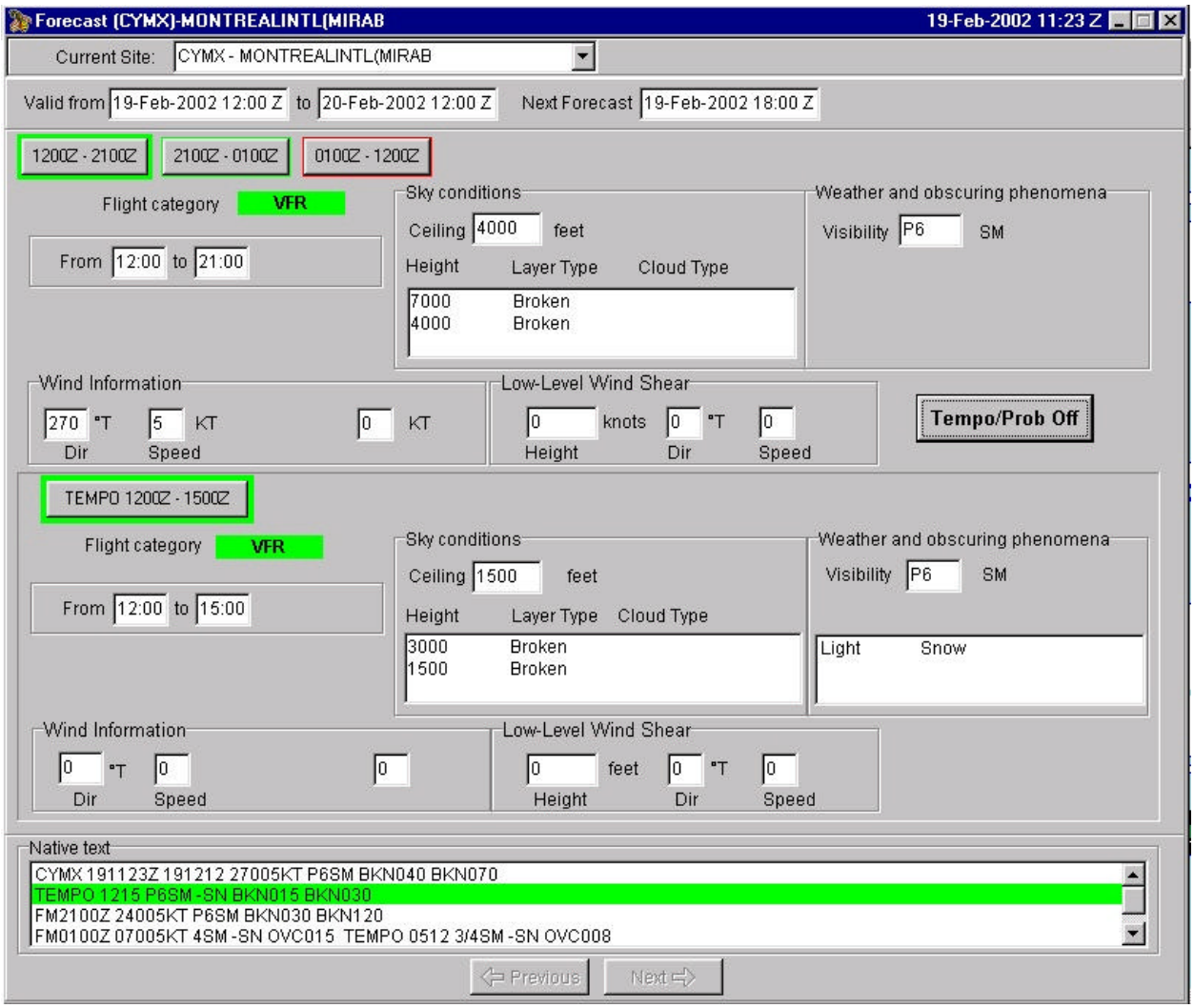

Figure 5 Forecast - TAF

3.3 NOTAMs

Notice to Airmen (NOTAM) describe situations at aerodromes that may effect movement of aircraft on the ground, or approach and takeoff. NOTAMS provide the James Brake Index (JBI) to report the runway coefficient of friction, and is graduated in increments from 0 to 1 (only JBI values 0.4 and below are reported). Small numbers represent low braking coefficients of friction while numbers on the order of 0.8 and above indicate the braking coefficients to be expected on bare and dry runways. The minimum JBI value to avoid directional control difficulties is calculated for current cross-wind conditions and is independent of aircraft type.

3.4 GRIB

GRIB (GRIded Binary) is a World Meteorlogical Organization bit-oriented data exchange format for weather product information. The data as listed in Table 1 provides information for the display of isotachs at 250 mb, jet streams, isobars, thickness lines, low and high pressure centers, and probability

of contrail generation with altitude. The data provides the means for determining presence of warm and cold fronts based on a surface wind shift of 80 degrees or more, and temperature and dew point differences of 7 degrees C or more. A search is performed starting from low pressure centers across geographical areas.

Isobars	Pressure (sea level)
Fronts	Temperature (surface) Dew Point Spread (surface) Wind U (surface) Wind V (surface)
Thickness lines	Altitude (500 mB) Altitude (1000 mB)
Jet Stream	Wind U (250 mB) Wind V (250mB)
Contrails	Specific Humidity (100 mB) Specific Humidity (150 mB) Specific Humidity (200 mB) Specific Humidity (250 mB) Specific Humidity (300 mB) Specific Humidity (400 mB)
Precipitation & Cloud coverage	Relative Humidity (850 mB) Relative Humidity (700 mB) Relative Humidity (500 mB)

Table 1 GRIB Data

3.5 Weather Warnings

Weather conditions that may effect current or near-term flying operations generate warning alerts. These include NORAD Point Weather Warnings which are issued for surface winds of 50 knots or more, snowfall of 15 cm within a 12 hour period, wind chills of greater than 2125 watts per square meter, blizzard conditions, freezing rain, or thunderstorms within 5 miles of the site. The alerts are summarized in Table 2.

Alert Name
Blizzard
Chill factor upper limit exceeded
Presence of freezing rain or drizzle
Presence of thunderstorm
Temperature variation exceeded
Temperature transition through freezing point
Windspeed upper limit exceeded
Windspeed variation exceeded
Visibility lower limit exceeded

Table 2 Alerts

3.6 Limitation Warnings

Conditions that may effect aircraft operations at a given site are reported as limitation warnings (Figure 6). The flight category of the aerodrome is reported as VFR (green), IFR (yellow), X below minimums (red), and Unknown (grey). The minimum landing length according to weather conditions and specific aircraft are calculated. While runway lengths usually are not of concern at most airbases, for deployed operations they may be important. Only aircraft expected to operate at as specific site are considered. Crosswind tolerances are flagged if exceeded, and minimum JBI values for current crosswinds are displayed.

An alert window displays the alert's severity (yellow or red), textual description, threshold and exceeding values if applicable, and date and time of occurrence. Alert criteria have threshold values valid for all sites by default, but can also be site-specific.

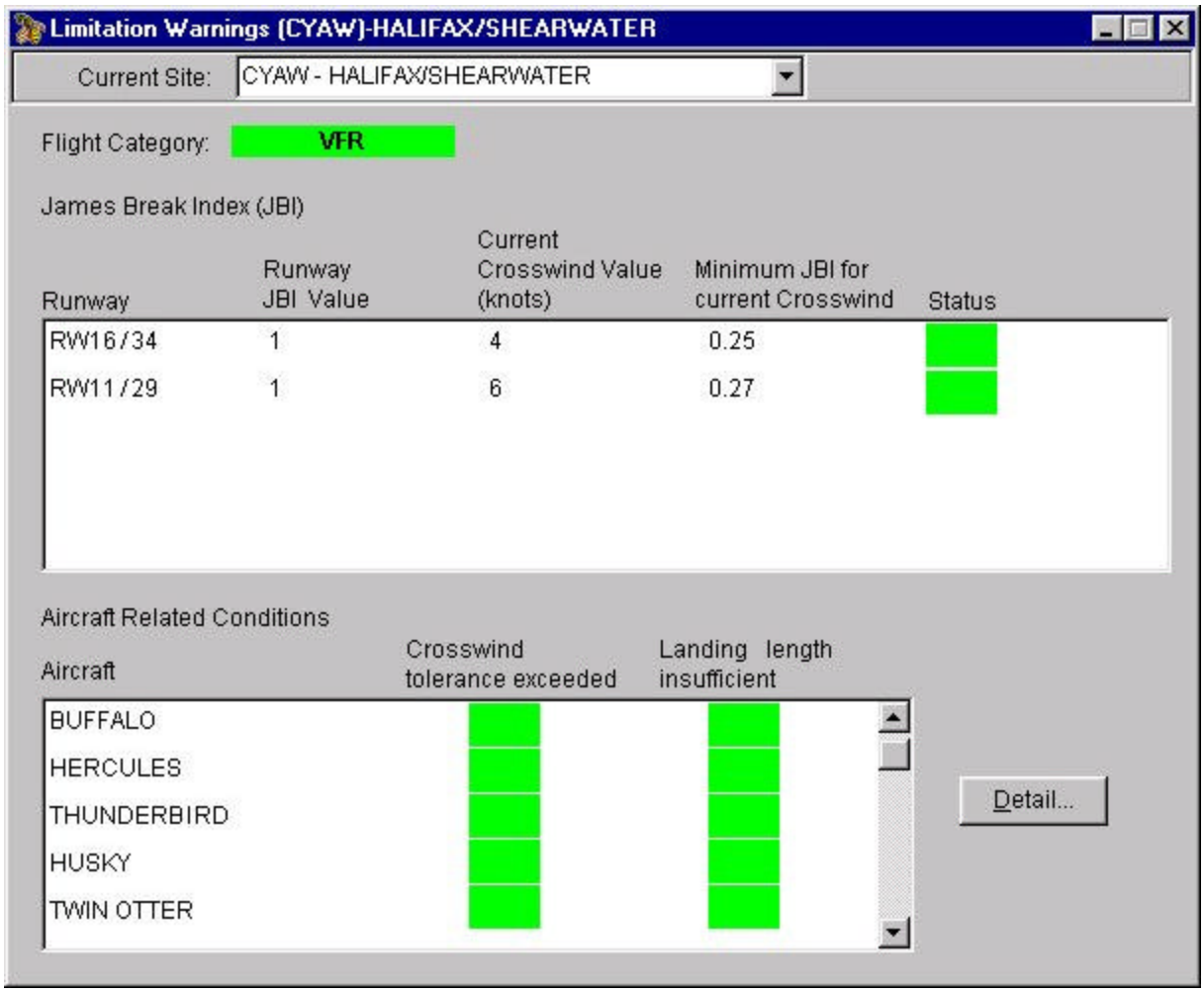

Figure 6 Limitation Warnings

4. Summary

The main objective in this project was to identify weather requirements specifically in conjunction with mission planning, and to propose an integrated approach for the Canadian Air Force Command and Control System. The intention was not to replace the current weather display systems in place at the airbases. Specific automated aids, for example, tools that take en route winds aloft into consideration to calculate elapsed times for flight legs, will also continue to have their role for flight planning. The weather sub-system of WASP supports world-wide deployed operations with updated weather data available through terrestrial or satellite modem links.

During acceptance tests, users had recommended several for additional features, some not necessarily directly weather related but that should be integrated as well:

A) satellite images
B) weather charts – surface analysis, surface forecast
C) user specific definable alerts and criteria on a per site basis
D) anamolous propagation map

E) sunrise, sunset, moon illumination
F) tides
G) user specified map projections and datum.

From an architectural viewpoint, the Canadian Weather Services has offered to provide the specific weather products required by WASP, bypassing the HP workstations and the dependence on its functionalities. GRIB data could also be included in this distribution, thus providing a continuous data flow from one source.

Trials of WASP are being prepared to further validate the identified requirements and the results will be considered for inclusion for future cycles of AFCCIS implementation. A stand-alone version of the weather sub-system of WASP has been extracted for potential inclusion in other Canadian Command and Control Information Systems.