9.14 TAF QUALITY IMPROVEMENT (TQI) EFFORTS IN CANADA

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1. INTRODUCTION

The Meteorological Service of Canada (MSC) produces over 180 TAFs across Canada under contract to NAV CANADA, a private company that's responsible for the air navigation system in Canada. Starting in April 2001, a national TAF quality improvement (TQI) program was created to coordinate and prioritize regional activities, focusing on the TAF segment of the aviation product suite.

In most cases, TAFs are produced by someone dedicated to aviation duties, but covering a large area of responsibility. For example, two forecasters monitor the three prairie provinces of Alberta, Saskatchewan and Manitoba; they generate all aviation related products, including SIGMETS, AIRMETS, the GFA (Graphic Area Forecast) and 30 TAFs. One region handles as many as 35 TAFs with two meteorologists. The GFA depicts all weather, turbulence and icing conditions below flight level 240 at 3 forecast times.

There are several approaches to improving the quality of TAFs, but the question is: "which ones give the biggest bang for the buck?" To help answer it, we decided to view TAF improvement from the perspective of product improvement in general, and chose to examine four aspects:

- increase the accuracy (content)
- reduce syntax errors (cosmetics)
- increase the utility (clarity, ease of use)
- do more client service (contact)

As scientists, forecasters have a tendency to view TAFs in terms of accuracy alone, that is, to focus on the content. But as a passenger on a commercial flight, we know that choosing an air carrier involves considerably more than the product content, that is, getting from A to B. TAFs are no different.

Increasing the accuracy of a TAF is without doubt of high importance. But fundamentally it is also the most challenging, complex, and long term component. We are looking forward to the first operational results from the TAFTools project (Bourgouin et al.). Given the desire to achieve visible improvement in the shorter term, and the limited human resources available (1 person plus 5 part time regional aviation focal points!), our prime focus this past year has necessarily been on the other aspects.

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2. TAF ERROR REDUCTION

Simply said, a product that contains typos and other mistakes looks bad. A user will question the quality of the content if cosmetic flaws are common. Elimination of cosmetic errors leads to improvement as perceived by the users. A positive side effect is a reduction in subsequent amendments.

Bulletin preparation software, "BULLPREP" remains the cornerstone of our TAF production environment. It ensures that our products are properly formatted: grammatically correct and spell-checked.

Still, it is possible to issue a sub-standard TAF that is free of grammatical and spelling errors. Often it will need amending shortly after issue, leaving the user puzzled and frustrated. The November 2001 software upgrade now raises a flag, before trans-mission, for the following classes of "stupid" errors:

- FM0100Z 35015KT 1SM -SN VV007
  TEMPO 0106 OVC015

The forecaster has neglected to add in the P6SM -SN (or NSW) in the TEMPO and in the vast majority of the cases would want to.

- AMD 250107 **0112** 35015KT P6SM -SN OVC015
  TEMPO **0206** 1SM -SN VV007

This slip happens frequently: a weather event starts an hour earlier than expected, but in the amendment the forecaster overlooks the need to advance the hour in the TEMPO block. The raised flag often prevents a second immediate amendment.

- 05015KT 4SM -RA OVC007
  TEMPO 0006 P6SM NSW OVC010

It can easily happen that the rain stops but the visibility remains 4SM BR. Technically this would require an amendment for visibility below 6SM with incorrect obstruction. BULLPREP now suggests that the forecaster could add a BR when the visibility in precipitation is forecast below 6SM.

- VRB20G30KT 2SM -TSRA BKN040

CB is not mentioned in the cloud group with a part period with TS in the forecast.

3. TAF UTILITY/CLARITY/CREDIBILITY

It is surprisingly easy to write a meteorologically perfect TAF that is grammatically correct and free of spelling mistakes, yet is difficult for the client to use! The following real TAF from the spring of 1998 has in no way been modified, and was written by a forecaster with over 15 years experience:

061040Z 061111 12008KT P6SM BKN100 BKN250
FM1400Z 13012KT P6SM BKN100 BKN250
FM1600Z 14012G22KT P6SM SCT100 BKN250
FM1900Z 15015G25KT P6SM SCT100 BKN250
FM2100Z 16020G30KT P6SM SCT100 SCT250
FM0300Z 18012G22KT P6SM SKC
FM0700Z 18010KT P6SM SKC
RMK NXT FCST BY 14Z=

The evolving weather followed the forecast almost to the letter! But does that make it a "good" TAF? Forecasters must recognize that their products are being read out dozens of times over the phone, and sometimes to pilots in transit. The TAF was accurate, but not "user-friendly."

Clarity: A "good" TAF has to be accurate, clear and easy to use:

081719Z 081818 34010KT P6SM FEW040 BKN070
TEMPO 1822 BKN040
FM2200Z 32010KT P6SM BKN040
TEMPO 2204 SCT040
FM0400Z 32010KT P6SM SCT040 BKN100 OVC220

This TAF could have been simplified considerably without losing its essence:

081719Z 081818 33010KT P6SM SCT040 BKN080
TEMPO 1804 BKN040 BKN080

Credibility: TAFs may appear unrealistic. Here are some METARS from a November case on the Canadian prairies:

220900Z 10009KT 5SM BR OVC002 M03/M05
221000Z 11007KT 4SM BR OVC002 M03/M05
221100Z 12005KT 4SM BR OVC002 M03/M05

Official, (but poor) TAF:

1139Z 221224 11005KT 5SM BR BKN008
TEMPO 1219 3/4SM BR OVC002

On occasion the forecaster will want to do this, given conditions at upstream stations or evidence in satellite imagery. However, to the casual eye, whether pilot, briefer, dispatcher, or uninvolved meteorologist, the predominant expected condition is almost certainly not going to be BKN008. How can the user trust the TAFs when a simple extrapolation is considerably more accurate?

Somehow, as a cultural entity, we got into the bad habit of writing TAFs as *Up TEMPO Down*, thanks in part to our generally VFR climate. We need to change our mindset, our habits.

We have begun to encourage the flight dispatchers and aviation weather briefing staff to bring such examples to our attention. As one might expect from experience in the business world, the word of a client appears to carry more weight than that of a supervisor. Additionally, each aviation focal point receives a daily e-mail containing the previous day's TAFs and METARs for the 24-hour sites in their region. When they notice TAFs that lack clarity on a continuing basis, they can approach the individual forecaster and discuss more appropriate TAF writing strategies.

It is important for each forecaster, before hitting the transmit button, to take an extra five minutes to look at their product from a user's point of view. Better yet, pass the list of TAFs on to a colleague for comments.

A simple scan of TAF sites just south of the Canadian border reveals that our US colleagues are not immune to these problems.

4. CLIENT CONTACT

We strongly believe that a better rapport between forecasters and the clients can only serve to increase the quality of the TAFs. First of all, receiving feedback first hand produces a significant impact compared to second or third hand commentary. Secondly, a sustained level of contact in a couple of MSC regions has resulted in a marked drop in the number of complaints (received by NAV CANADA) about our service, proving that product quality is not driven by accuracy alone. There are several ways we have increased client contact:

- **Direct phone calls** from forecaster to briefing staff to discuss the current situation. This is a chance to explain the reasoning behind a forecast, listen to their opinion, and especially give a "heads up" of a significant change to several regional TAFs or to a major hub. Whatever the reason, the calls result in more "buy-on" and teamwork, despite the separate employers and backgrounds.
- **Exchange visits** between forecasters and dispatchers and briefers fosters better mutual understanding. Forecasters can see directly how their TAF "writing style" impacts client workload. Clients gain insight into the limitations of forecasting.
- **Participating at provincial flying council meetings and air shows**. These are wonderful opportunities to talk to general aviation and small business pilots directly. They get a chance to voice their concerns, and forecasters can augment their knowledge of local effects.
- **Joint aviation workshops**. Several successful joint workshops have been held across the country. They provide a chance to get pointed feedback about our TAF writing style (for example on how we deal with scattered thunderstorms, fog formation, LLWS etc.), and forecasters can learn more about how clients use our products.
- **National multi-lateral working group**. This year we hope participate in the creation of a working group (NAV CANADA, MSC, and carriers) whose purpose will be to help direct where and how much to invest in product and forecast development, performance measurement, and related issues.

5. Increasing TAF Accuracy

In this section, a number of tools currently under development are discussed. One can be fairly certain that developing forecast techniques for specific hubs for specific weather scenarios will bring dividends. That said, such activities are resource intensive and typically applicable to only one place (with some spillover benefits for nearby regional airports). MSC's strategy has been to invest in activities that will simultaneously benefit as many of Canada's airports as possible. The proposed joint MSC - NAV CANADA - air carriers working group will determine whether this direction is maintained.

- **TAFTools**: **Objective TAF Guidance for Canada**

For details of this project see Bourgouin et al., 2002. In brief, the Very Short Range Forecast component of this system uses observations and a Multiple Discriminant Analysis (MDA) technique to produce a "persistence modified by diurnal climatology" forecast of category probabilities. Output for 8 prototype stations is now available.

TAFTools holds a lot of promise because it (especially the model-driven component) can be used as a base for producing a first guess auto-TAF. But we are still several years away from this goal, and funding is contingent on positive results for the prototype stations. It is one of the few options that has the potential to increase both the accuracy and the efficiency of TAF production.

- **TAFaid**: **Conditional Climatology for all TAF sites**

Forecasters can improve TAFs by having fast access to site-specific climate data. TAFaid graphs 14 hours of ceiling evolution based on matching historical data: given the current wind direction, ceiling, month and time of day, how did similar cases evolve? Figure 1 depicts the ceiling evolution in terms of probabilities. Currently there are no "smarts" in this prototype system though they could be added. The user has the flexibility to sharpen or blur the search criteria; consequently the graphs must be generated on-the-fly. Data display takes less than 30 seconds, even for a search through 50 years of hourly data. With some development it could provide the basis for a "reality check" for TAFs.

- **TAFaid (part 2): BUFR Profile viewer/Hazard Alert**

Forecasters could spend more time thinking about a TAF if they had an integrated display focussed on aviation needs. Guidance is often found in several distinct places: bulletin form for surface winds, chart form for low level maximum winds, software for vertical profiles, different software for current conditions, and so on. The profile side of TAFaid attempts to corral this information and flag important parameters or potential hazards; a section is depicted in Figure 2. At a glance the forecaster can see the next 12 hours of post-processed surface wind values next to the low level model profile, with non-convective wind shear automatically calculated, for example. Direct model output, such as precipitation amounts and type can also be displayed (not seen here).

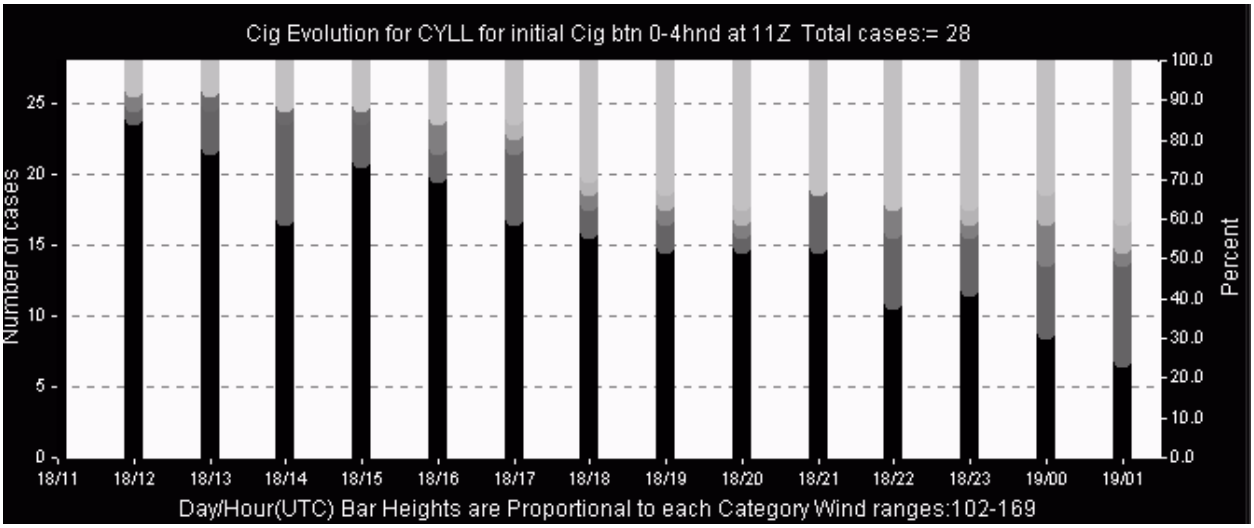

Figure 1. TAFaid conditional climatology output (the color version is easier to interpret). The forecast period extends from left to right, each bar representing one hour. The height of each segment within the bar indicates the probability of that particular ceiling category: IFR at the bottom of each bar, VFR at the top. In this particular case, for starting conditions between 0-4 hundred feet, with a southeast wind at 11Z, historically at least 50% of the cases remained between 0-4 hundred feet for 10 hours (until 21Z). As with most climatological tools, there is a tendency towards normal (VFR) conditions over time.

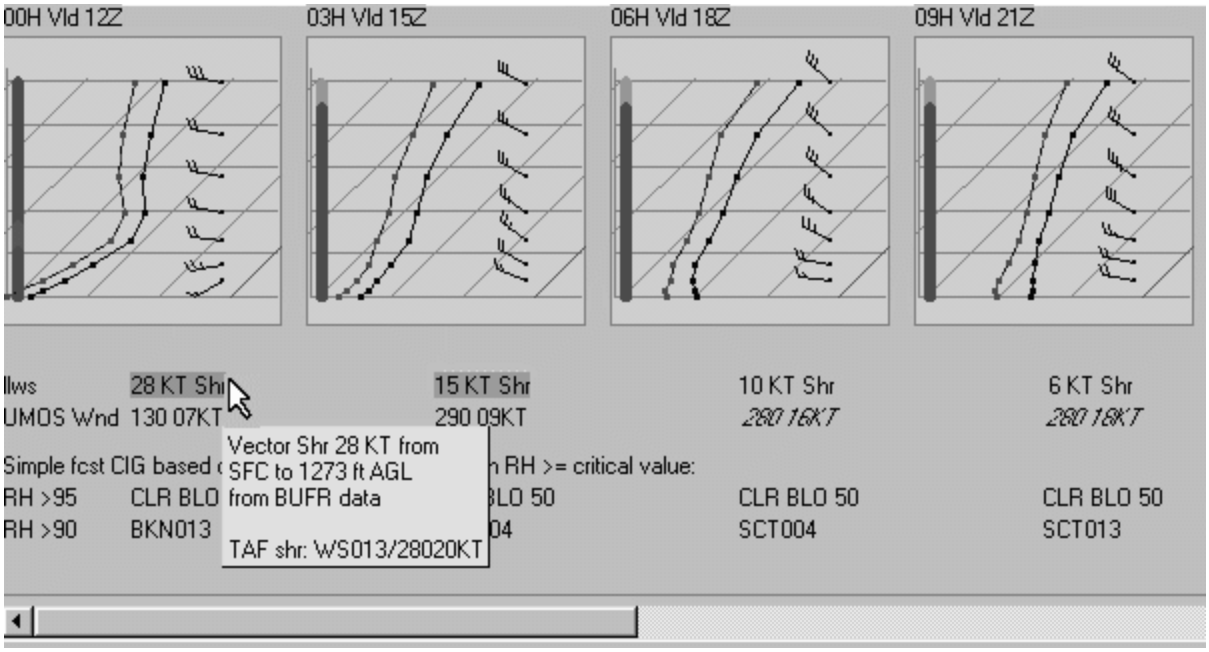

Figure 2: TAFaid Profile viewer: on the same screen as the climatological output of Figure 1, the forecaster can view the low level profiles 12 hours at a time (only a segment of the image is seen here). Elements are color-coded differently when they exceed pre-defined sets of thresholds. Placing the mouse over a flagged wind shear pops up details and a suggested wind shear group for the TAF. It's easy enough to search for and flag important temporal changes too. The pseudo-Skew-T has horizontal lines every thousand feet, while the diagonals are every 5 degrees Celcius. The vertical bar on the left of each block is a color-coded humidity profile. Data farther in time is available with scrolling.

6. Training and Workshops

The TQI manager organizes and participates in the training of staff. During the spin-up of the project, it was recognized that "classic" one-day workshops typically were not successful. They covered too wide a range of issues without the requisite depth. Changing a forecaster's TAF writing style means reinforcing new habits. The lesson to take away from school, music, and golf, is that to create or refine a habit we need to practice, practice, practice.

Our next workshops are designed to include fewer topics, and more lab exercises. Follow-up includes monthly reminders and feedback on the their products in a relatively timely manner. Unfortunately, this will not be a simple low-resource endeavor.

To meet the expectations of increasing accuracy, forecasters will need to deepen their knowledge of meteorological processes at the meso-scale. This will also permit them to properly interpret model output at increasing resolution. Concurrently, there has also been a demand for refresher-type courses on short range forecast techniques!

7. Internal Communication

In order to keep TAF Quality Improvement as a visible goal, it is highlighted in the weekly aviation-related message sent to all staff. Topics include examples of bad and good TAF form, "Tips & Tricks," client feedback, and status reports on initiatives. Staff are encouraged to comment on all activities, including operational software. A web site (internal to MSC) organizes this material.

8. Conclusion

TAFs can be improved in more ways than accuracy alone. Through user feedback, we now recognize that other components, such as error reduction, utility/clarity, and client contact are also important. It turns out that, given limited resources, the best return on investment is to pursue these other aspects. The proposed multi-lateral working group between MSC, NAV CANADA and air carriers should help to drive the direction and funding of projects for increasing TAF accuracy. Appropriate software tools and training strategies will continue to play a fundamental role.

9. References

Bourgouin, P., J. et al 2002: TAFTOOLS: Development of Objective TAF Guidance at CMC, Part one. Preprints, 16th Conf. On Probability and Statistics In the Atmos-pheric Sciences, Orlando, FL, Amer. Meteoror. Soc.