Environment Canada Environnement Canada

Canada

FRAM Workshop Statistical, Climatological, and Post-processing Working Group

FRAM Workshop

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Integration

- Regarding data integration and consistency (e.g., for SCRIBE/PUBTOOLS): Consistency and strategy to use depend on weather element in question: precipitation (occurrence and type), thunderstorm, fog, temperature, etc., E.g., one technique says T-TD spread too high for fog, other says there is fog (perhaps observed), so say FG; guidance says +3°C other guidance says snow, so say rain
- We are often forced to compromise between accuracy and consistency.
- Probabilistic forecasts are forced / rendered into a deterministic products. The forecasters has to decide how to translate / interpret.
- Bayesian networks are highly effective at resolving apparently conflicting guidance (Zazzaro).

Probabilistic forecasts (1)

- KNMI is succeeding in getting users to use probabilistic forecasts, but it takes time and effort. KLM and Amsterdam Air Traffic Control and airport authority and KLM use SKV, a probabilistic +3h to +30h forecast with one-hour timescale. KNMI wonders if SKV is used in a "proper way," as decisions are made by hand, inconsistently, KNMI has had to keep advising users how to use a probabilistic forecast, and about the benefits.
- SKV forecast starts at +3 h, because in the first hours advisors make a trend and generally speak in terms of yes/no. They do not want to contradict the SKV in this short range.
- KLM has a capacity prognosis system which inputs SKV (hourly prob. forecast of vis, cig, wind, snow), if probabilities are high, they might cancel some “less important” flights to Amsterdam, so passengers passing through hub do not appear on TV sleeping in cots, then other airlines pick up the slack).
- Have to show reliability of probabilities if presenting prob fcsts to users (e.g., 30% means so and so), vs. vaguer “prob. fcst” (actually yes/no/maybe, not greater precision possible).

Probabilistic forecasts (2)

- KNMI SKV probabilistic forecast.
- Resolution is 1 hour for range 3-9 h, and 3 hours for the range 9-30 h.

Saturday 15 January 03 UTC till Sunday 16 January 06 UTC

utc:	03	04	05	06	07	08	09	12	15	18	21	24	03	06
Visibility < 5 km and/or ceiling < 1000 ft (%)	60	70	80	90	90	80	40	20	5	5	5	10	30	50
RVR < 1500 m and/or ceiling < 300 ft (%)	30	40	50	50	50	40	10	5	0	0	0	0	0	10
RVR < 550 m and/or ceiling < 200 ft (%)	15	20	25	30	30	20	5	0	0	0	0	0	0	0
RVR < 350 m (%)	5	10	15	20	20	10	0	0	0	0	0	0	0	0
Wind direction (deg)	160	160	160	160	160	160	160	170	180	190	230	240	240	240
Wind speed (kt)	5	4	5	5	5	6	7	9	9	9	10	12	12	13
Gusts (kt)											15	17	18	19
Standard deviation wind direction (deg)	30	30	30	30	30	25	25	20	20	20	20	15	15	15
Standard deviation wind speed (kt)	2	2	2	2	2	2	2	2	2	2	2	3	3	3
Temperature (°C)	1	0	-1	-1	-1	-1	0	2	5			5	4	4
Dewpoint (°C)	1	0	-1	-1	-1	-1	0	0					2	2
Snow (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Moderate or heavy snow (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Freezing rain (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

KNMI

Remarks	Short term	Long term
Visibility and ceiling		
Wind		
Temperature/dewpoint		
Precipitation		

Last update: short term 00.10 utc, long term 22.50 utc

Probabilistic forecasts (3)

- We talk about deterministic and probabilistic forecasts with precision, but often a forecaster's best educated guess of probability of fog, even for now, given available data and models, can only be as precise as five categories: yes, probably, unknown, probably no, and no.
- How to use probabilistic / ensemble data in ops, how will people have time to use all this.
- What is use of all ensemble members?
- Real-time tracking of one member closest to obs might not be the best way to "pick a winner." It is the mean of the subset which is tracking best which verifies best. Refer to work of Steve Tracton, Jun Du, and Draft Recommendations of 2nd Ensemble User Workshop, May 18-20 2004, NCEP, June 1 2004, http://www.emc.ncep.noaa.gov/gmb/ens/ensuser_recommendations.pdf

Probabilistic forecasts (4)

- Best hurricane forecast now is “poor mans ensemble” (NHC’s top 5 better than manned fcst)
- Ensemble systems could be tuned for fog.
- Bayesian Model Averaging with verification feedback on member weighting is promising.
- At United Airlines, a certified meteorologist has the prerogative to overrule NWS TAF.
- Air Canada cancelled CYHZ flights for evening of hurricane Noel, because airport was at the edge of the fanning probabilistic track ("cone of death"). As it turned out, winds in the evening would have been manageable, but winds after midnight reached 80 kts.

Users, particularly air traffic management (ATM) (1)

- KNMI advises in detail ATM about weather that impacts on traffic and airport capacities, e.g., wind shifts, and airlines are lining up traffic and runways,
- In the US there is a national TELCON every 2 hours hosted by the command center (ATCSCC) (includes other FAA centers and airline dispatchers) to discuss traffic management initiatives such as a GDP for fog at SFO
- Philosophy is: save money but do not compromise safety (e.g., wing scraped on runway 23 in Germany in gusty 70 crosswind, recent in news, not a bad forecast, pilot was warned, ATC agreed)
- The cost-loss will be wrong (sometimes), it is good statistically averaged over a year, but on some specific events (plane crashes make headlines).
- DOT webpage reports percentage of flight delays due to weather. Assignment of causes of delays can be complicated (bad weather at a hub airport can have "ripple effects" through network, to places where weather is fine). See: Airline On-Time Statistics and Delay Causes, .S. Department of Transportation's (DOT) Bureau of Transportation Statistics (BTS), http://www.transtats.bts.gov/OT_Delay/ot_delaycause1.asp

Users, particularly air traffic management (ATM) (2)

- Air Traffic Control System Command Center (ATCSCC) use a “playbook,” e.g., line of thunderstorms in this sector, so divert fleet this way. The analogy is to a football huddle. *[P.S. A suggestion is that for fog forecast products to be most useful, they should address identified important scenarios.]*
- The National Operations Manager (NOM) who hosts the 2-hourly TELCONS must constantly refer back and forth between his weather and air traffic management (ATM) tools, e.g., the Collaborative Convective Forecast Product (CCFP) and the playbook). *[P.S. A suggestion is to integrate weather information systems and ATM systems, to increase efficiency.]*
  - National Playbook: The National Playbook is a traffic management tool developed to give the ATCSCC [Air Traffic Control Systems Command Center], field facilities, and system users a common product for various route scenarios. The purpose of the playbook is to aid in expediting route coordination during periods of constraint in the National Airspace System (NAS), that occur en route or at the destination airport. The playbook contains the most common scenarios that occur each severe weather season. The "play" includes the resource or flow impacted, facilities included, and specific routes for each facility involved. Each scenario in the playbook includes a graphical presentation and has been validated by the individual facilities involved in that scenario. The playbook is available on the ATCSCC web site and is updated every 56 days, concurrent with the chart cycle. -- Air Traffic Bulletin, Issue 00-4 *SPECIAL* JULY 2000, http://www.faa.gov/airports_airtraffic/air_traffic/publications/atpubs/atbarc/00-4.htm

Limitations of models

- In one recent instance, increased model resolution gave poorer results in terms of fog. If resolutions gains are hard to achieve, ensembles might be better
- Big models do not focus on fog, they are tuned for other elements (temperature, etc.)
- Fog is very site specific, terrain influenced, local, discontinuous, sub grid scale, so a model alone cannot (might never?) model it well, so we must combine model output with GIS and local conditional climatology (if such observations and data are available). Oceans are data poor.
- Feed model with relevant factors (soil moisture, boundary layer).

Balancing need for "meteorologist in the loop" with drive for automation (1)

- Decades ago in operations, forecaster had a checklist (reasons used for and against forecast alternatives) and would later track outcomes, so could use feedback to learn, refine and weight methods.
- Heading towards 20 TAFs per forecaster (?), so we need more automation, but *how*…?
- There is a post-processing issue, not just supplying forecast information to users, but feeding it straight from meteorological models and computers to air navigation computers and decision support systems. FAA / Joint Planning and Development Office (JPDO) 20-year vision is to have direct probabilistic weather guidance input to an air navigation / air traffic management (ATM) “playbook” algorithm system, and minimize handling by humans as much as possible, ATM.
- Katrina is one (high impact) case that weighs heavily, system needs flexibility to be on auto-pilot much of time to ramp up to labour-intensive forecast operations when needed.
- We need monitoring tools, e.g., CMC ops looks at data flow from analysis to production with global perspective
- In some cases, a human forecaster is invaluable. E.g. Peter Stow (SAR) described a scenario. A boat is in distress far offshore. Sometimes a converging rendezvous is tried. However, there is fog between shore and boat. Forecaster can advise SAR, who can advise sailor to sit tight in clear air, rather than approach and get lost enroute in fog. An automated system for such guidance is hard to imagine.

Balancing need for "meteorologist in the loop" with drive for automation (2)

- What is the (future) role of operational meteorologist? In Canada in 2005 in Canada, The Future Role Of The Operational Meteorologist Committee wrote a report entitled: Roles of Operational Meteorologists in Weather and Environmental Prediction Centres of the Future – A Vision. Selected excerpts follow.
  - EXECUTIVE SUMMARY
  - In 2015, the Canadian weather service will […] be led by a group of expert professionals. They will work with critical partners to provide integrated environmental monitoring, prediction and response to weather and environmental hazards. To ensure that this effort is effective, the latest science and technology will be readily incorporated into the operational environment and decision-making.
    […]
  - ROLE OF THE OPERATIONAL METEOROLOGIST
  - In 2015, operational meteorologists will be more specialized and more highly trained. Their roles will be divided between providing information to critical decision-makers, and assisting in the research and the development of new techniques and tools.
    […]

Balancing need for "meteorologist in the loop" with drive for automation (3)

- What is the (future) role of operational meteorologist? In Canada in 2005 in Canada, The Future Role Of The Operational Meteorologist Committee wrote a report entitled: Roles of Operational Meteorologists in Weather and Environmental Prediction Centres of the Future – A Vision. Selected excerpts follow.
  - The growing Earth Observation System is designed to collect vast amounts of data from surface, airborne and space-based observation platforms. This system will also provide new opportunities to integrate data from many disciplines such as meteorology, oceanography, hydrology, cryogenics, geology, biology, air chemistry, medicine, etc. This information will be integrated to improve the output of numerical prediction models and decision-support systems. The result will be timely, high quality, and long term global information that will become the basis for sound decision making.
    […]
  - Both technology and people have their strengths and weaknesses. Technology is best suited for routine and repetitive tasks, identifying potentially critical components within a complex mass of data, offering an objective assessment, etc. In the weather service, for example, technology is therefore best suited to basic weather monitoring and alerting, producing objective analyses, numerical weather prediction, decision-support systems, automation of routine forecasts, basic dissemination, etc.

Balancing need for "meteorologist in the loop" with drive for automation (4)

- What is the (future) role of operational meteorologist? In Canada in 2005 in Canada, The Future Role Of The Operational Meteorologist Committee wrote a report entitled: Roles of Operational Meteorologists in Weather and Environmental Prediction Centres of the Future – A Vision. Selected excerpts follow.
  - The forecaster is better suited for adapting to the minute-by-minute dynamic of the shift, addressing the deficiencies of the technology and science “on-the-fly” and recommending solutions, effectively utilizing shift resources to ensure the problems of the day are addressed, training new staff, dealing with clients and to adapt their concerns to the forecast output, identifying and addressing gaps in the science and tools, etc.
  - As was noted earlier with the Earth Observation System, humans and technology working together can accomplish more than when working alone. If the technology is suited to the needs of the forecaster, and the forecaster is highly trained in the use of that technology, the output of that partnership is enhanced even further. Development efforts will be designed to foster the ideal “machine-person mix.”
    […]

Balancing need for "meteorologist in the loop" with drive for automation (5)

- What is the (future) role of operational meteorologist? In Canada in 2005 in Canada, The Future Role Of The Operational Meteorologist Committee wrote a report entitled: Roles of Operational Meteorologists in Weather and Environmental Prediction Centres of the Future – A Vision. Selected excerpts follow.
  - APPENDIX B - Drivers of Change
  - There are many drivers of change to which the MSC and Environment Canada must respond. The resulting evolution of the organization will play a part in shaping the future role of the Operational Meteorologist.
  - To envision the operational meteorologists' future roles, the Committee tried to capture one of the likely directions the organization will take in response to these drivers. The primary drivers of change are as follows, including the likely responses:
  - Society is becoming increasingly vulnerable to hazards […]
  - Convergence – society is demanding quick and efficient responses to its needs. To achieve the efficiency needed, the concept of "convergence" has emerged. Convergence, such as integration, "one-stop-shopping", "all-in-one tools", etc., has become an important requirement for organizations to remain effective in our rapidly evolving society.

Balancing need for "meteorologist in the loop" with drive for automation (6)

- What is the (future) role of operational meteorologist? In Canada in 2005 in Canada, The Future Role Of The Operational Meteorologist Committee wrote a report entitled: Roles of Operational Meteorologists in Weather and Environmental Prediction Centres of the Future – A Vision. Selected excerpts follow.
  - Ensembles will become important – The use of numerical weather prediction (NWP) ensembles will increase rapidly in the coming years. As noted during the recent announcement of the new joint Canada-U.S. ensemble system, the greatest improvements to forecasts will occur beyond 24 hours. […]
  - There will be more automation of production – The integration of data, the growing use of ensembles, and the use of digital databases will create a revolution in the availability of weather forecast information. Much of this information will be produced completely by automated systems, while some products will be automatically generated from databases manually adjusted by operational meteorologists. Over time, operational meteorologists will produce only a small number of critical products manually. In addition to their significant analysis, diagnosis, and prognosis duties, operational meteorologists will spend more time monitoring and assessing “live” data to track or detect high-impact events. Still, operational meteorologists will likely have some input into the NWP system in the shorter time frame so that the output will be further refined.
  - There will be increasing amounts of data […]

Miscellaneous (1)

- We should try to get more end-user feedback (we are a room full of meteorologists, and it was interesting to hear from SAR.
- All agreed establishment of a wiki for sharing (data, thoughts, joint project and funding ideas) would be a good idea.
- One remarked fog is a short-term concern, a few hours. However, another remarked it can be a concern in forecasts of day 2, to day 10, especially if there is skill in such forecasts.
- Regarding future work of researchers present: refer to their presentations.

Miscellaneous (2)

- One remarked as there is some argument about definitions of “nowcasting” and “forecasting,” we should recognize that different techniques (e.g., persistence, conditional climatology, model, MOS, rules) may work better at different time projections and in different weather scenarios.
- Satellite data + radar + extrapolation technique could be helpful for first few hours at least, with high-resolution winds.
- DWD has point forecast and point forecast editor.
- NinJo will have set of weather elements on a grid.

Miscellaneous (3)

- Marine fog forecasting (10000 km^2), is different from TAF / site forecasting.
- How can we distinguish between stratus and fog.
- Fog does not advect in same way as rain and snow (e.g., see Gurka's image showed discontinuous evolution off Long Island, NY)
- EC has collected information relating to Air Quality Health Index (AQHI) in a webpage: http://aqhi.cmc.ec.gc.ca, a good reference tool for AQ forecasters, which we might emulate for fog.
- Marine fog is an issue, we need a good model, could make an argument (save lives and $) to do R&D to insert better techniques in systems (Scribe), work on it.
- We need a better sea surface temperature analysis.