Innovations and New Technology For Improved Public Weather Services

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The emergence of new, innovative and technologically advanced forecast systems and communications systems offers the opportunity to integrate public weather services dissemination and service delivery. Digital database forecasting and next-generation workstations, along with new and emerging information technology systems and applications, can significantly enhance and improve public weather services provided by NMHSs. State-of-the-art Nowcast systems will integrate an array of real-time data and NWP output to provide prognostic information while also helping to rapidly generate and disseminate forecast products. Information technology systems and associated applications, including XML, CAP, and RSS, will allow NHMSs to exploit the latest telecommunication networks, including broadband, wireless, and mobile systems. Coupled with GIS and GPS capabilities, NMHSs can satisfy customer and partner demands forever increasing precision, accuracy, and detailed, location-specific hydrometeorological forecasts and warnings. Together, these efforts will allow NMHSs to cultivate an innovative and effective PWS program which leverages technological advances to create a holistic forecast and warning dissemination, service delivery, and all-hazard decision support process that best serves the user community.

1. Introduction

New communication and forecast system innovations and technology (e.g. the Internet, wireless communication, digital database forecasting, next-generation workstations, Nowcasting systems) have emerged which provide the opportunity to improve public weather services (PWS). These innovations allow World Meteorological Organization (WMO) National Meteorological/ Hydrometeorological Services (NMHSs) to provide hydrometeorological forecasts and warnings in a variety of formats (graphic, digital) beyond the traditional text products. In addition, these innovations can impact NMHS service delivery capabilities. Digital database forecasting and next-generation workstations, along with new and emerging Information Technology (IT) systems and applications offer the opportunity to further enhance and integrate PWS dissemination and service delivery functions.

This paper provides an overview of several key innovations, technological advancements, and IT systems/applications which are, or can, have a substantial impact on improving NMHSs public weather services and their dissemination and service delivery. The paper will focus on digital database forecasting, next-generation forecast workstations, Nowcasting systems, and IT systems and applications.

2. Digital Database Forecasting

The traditional forecast process employed by most NMHSs involved forecasters producing text-based sensible weather element forecast products (e.g., maximum/minimum temperature, cloud cover) using numerical weather prediction output as guidance. The process is typically schedule driven, product oriented, and labor intensive. Over the last decade, technological advances and scientific breakthroughs have allowed NMHS's hydrometeorological forecasts and warnings to become much more specific and accurate. As computer technology and high speed dissemination systems evolved (e.g. the Internet), NWS customers/partners were demanding detailed forecasts in gridded, digital, and graphic formats. Traditional NWS text forecast products limit the amount of additional information that can be conveyed to the user community. The concept of digital database forecasting provides the capability to meet customer/partner demands for more accurate, detailed hydrometeorological forecasts. Digital database forecasting also offers one of the most exciting opportunities to integrate PWS forecast dissemination and service delivery, which most effectively serves the user community. Both the NOAA/National Weather Service and Environment Canada are currently using digital database forecasting technology to produce routine forecasts. The Australian Bureau of Meteorology is in the process of evaluating and developing an

implementation plan for database forecasting using the NOAA/National Weather Service National Digital Forecast Database approach.

2.1 Environment Canada's National Weather Element Database

Environment Canada (EC) has developed the National Weather Element Forecast Database (NWEFD) that is populated with the output from the EC numerical weather prediction models. EC forecasters manipulate the NWEFD making adjustments to forecast fields based on an analysis of the current state of the atmosphere and model output including known model biases and trends. When complete, the forecaster runs software that creates text-based forecasts. To assist in the development and population of the NWEFD, EC has developed an expert system called SCRIBE.

SCRIBE is an expert system capable of automatically or interactively generating a wide array of weather products for a region or a specific locality[1]. The system uses data from a set of matrices which are generated after the 00Z and 12Z numerical weather prediction model runs. These matrices contain different types of weather elements including numerical weather prediction (NWP) output, statistical guidance model output (Perfect Prog – PP and Updateable Model Output Statistics – UMOS models), and climatological data. SCRIBE's temporal resolution is 3 hours. SCRIBE produces forecasts twice daily for 1,145 Canadian station locations. When ready, the matrices are sent to each regional SCRIBE system. Upon arrival, the data is processed by the Concept Generator and is synthesized and downsized to a set of well defined weather elements called "*concepts*". These concepts are output in a digitally-coded format called METEOCODE and can be displayed on a graphic interface. Forecasters can modify the concept output to incorporate the latest observations as well as the evolving weather scenario/event. The concepts are used by the regional offices to generate local forecast products. The concepts will also be sent to the NWEFD where a suite of national forecast products are generated. Figure 1 shows the main steps in the SCRIBE data processing.

2.2 NOAA/NWS National Digital Forecast Database

In the 1990s, the NOAA/National Weather Service (NWS) recognized that it had to evolve its hydrometeorological products and services beyond text-based forecasts to meet growing customer/partner demands. In 2003, the NWS launched the National Digital Forecast Database (NDFD). The NDFD is an event driven, information oriented, interactive, and collaborative 7-day hydrometeorological forecast database. The NDFD consists of a 7-day forecast for a set of sensible weather elements on a 5-km domain which covers the contiguous United States, Alaska, Guam, Hawaii, and Puerto Rico – see Table 1. Each of the 122 NWS Weather Forecast Offices (WFO) produces and maintains the database for its area of responsibility. Figure 2 shows examples of NDFD output graphics. Using the latest observations, radar and satellite data, guidance products from the National Centers for Environmental Prediction (NCEP), and numerical weather prediction model output, forecasters interactively modify the database using the Gridded Forecast Editor[2]. Several NCEP centers also contribute forecast information into the NDFD. NWS forecast text, tabular, and graphic products are generated directly from the database using product formatters and other output-defined software. Also, the database itself is provided as an NWS product to customers and partners. This allows users to access the database for their own applications, manipulate the database, and extract forecast information tailored to their specific needs. In the years ahead, the NWS will continue to work toward evolving the NDFD into a complete four-dimensional environmental database. Future NDFD expansion will include observations, analyses, uncertainty/ probabilistic information, outlooks, watches, and warnings.

3. Next-Generation Forecast Workstations

Continuing advances in information technology and communication capabilities suggest that the rapid increase in the volume of hydrometeorological data during the last three decades will continue and may even accelerate in the years ahead. The proliferation of automated observing systems and mesonetworks, coupled with improvements and/or replacements of existing remote sensing observing systems portend at least an order of magnitude increase in data. The next generation forecast workstations will need more bandwidth, storage capacity, and processing power to handle the expected rapid increase of data. This, coupled with increased temporal and spatial resolution NWP model output, will make it imperative that the next generation forecast workstations are equipped with new, state-of-the-art visualization and information processing techniques, including three-dimensional techniques, to assist forecasters with data analysis and interpretation. Sophisticated diagnostic tools will also be required to examine the data and highlight meteorological processes. In addition, the large volume of data will require an increased reliance on advanced algorithms and processing techniques to monitor both current and forecast conditions, extract and portray the most relevant information, and assist with hydrometeorological decision support. The next generation forecast workstations will assist in the preparation of forecasts, warnings, and their dissemination through a host of communication channels. These workstations will also

have the capability to support digital database forecast preparation.

Some next generation workstations may also look to incorporate an Internet-based instant messenger chat (IMChat) capability to allow NMHSs to communicate with key customers and partners during significant hydrometeorological events and all-hazards incidents. The NWS is currently experimenting with the IMChat concept in significant hydrometeorological operations. IMChat allows key customers and partners to get critical information in real-time for an unfolding time-sensitive event or incident. In turn, NMHSs would receive site-specific reports or other information which can assist with forecast and warning operations.

3.1 Nowcasting Systems

A number of NMHSs have been developing innovative, next generation Nowcast systems. Nowcast systems range in complexity with some that rack radar echoes and use extrapolation to produce 0-1 hour nowcasts, while more complex systems utilize a combination of NWP output and probabilistic/uncertainty forecast techniques to extend the Nowcasting time horizon out to 3-6 hours. Some of these systems also incorporate other remote sensing platforms including satellite and lightning data. Many of these systems are still challenged to optimize the role of the forecaster in the Nowcast process. One of the other key focus areas is incorporating real-time verification and feedback to forecasters. An important strength of a Nowcast system is it's ability to rapidly generate hydrometeorological forecast products and disseminate them in a variety of formats. This capability will have significant implications for timely and effective PWS service delivery. Several Forecast Demonstration Projects have been organized through the WMO to test Nowcasting systems and applications. The first Demonstration Project was successfully carried out in 2000 at the Summer Olympic Games in Sydney. Another demonstration project is scheduled to be conducted during the 2008 Summer Olympics in Beijing.

4. Information Technology Systems and Applications

Since its inception, NMHSs have exploited the Internet to varying degrees. While almost all NMHSs have an Internet web page, the dissemination and services provided vary considerably. The Internet allows NMHSs to present hydrometeorological forecasts and warnings, and climate information to its customers, partners, and the public in graphic and digital formats that would otherwise be unavailable. It also provides opportunities to enhance and expand service delivery. For example, EC has developed an Internet web site exclusively for the media that allows them to tailor EC data to their specific needs. In another example, the NWS implemented an aviation-focused initiative called the Collaborative Convective Forecast Product (CCFP) in partnership with its aviation community. Weather-related delays due to convective activity are the single most disruptive force within the U.S. National Airspace System.

The expansion of the Internet in the 1990s, coupled with new computer and telecommunications technologies, has led to a proliferation of Information Technology (IT) systems and applications. The evolution of PWS dissemination/service delivery integration is directly linked to the emergence of new computer and telecommunication technologies and information systems (e.g. the Internet, wireless communication technologies, GIS, GPS, mobile communication networks). Namely, these innovations allow NMHSs to provide weather forecasts and warnings in a variety of new formats (digital, XML, CAP) to meet customer demands for more precise and accurate environmental information. In addition, these new and emerging technologies offer the opportunity to further integrate PWS dissemination and service delivery functions. Other evolving capabilities (PodCasts/VodCasts) can further enhance PWS service delivery.

4.1 Geographic Information Systems and the Global Positioning System

Geographic Information Systems (GIS) are designed for capturing, storing, analyzing and managing data and associated attributes which are spatially referenced to the Earth. The Global Positioning System (GPS), originally developed in the 1970s by the U.S. for military applications and transitioned for civilian use in the 1980s, is comprised of 24 earth-orbiting satellites which provided location specific information as precise as tens of meters. Together, GIS and GPS provide a powerful technological tool for NMHSs to enhance their PWS service delivery. Utilizing GIS and GPS with mobile communications networks and devices (cell phones, PDAs), NMHSs can effectively deliver user and location specific warnings and forecasts.

The NWS is utilizing GIS technology in its short-fused hydrometeorological warning program through the implementation of storm-based warnings (also referred to as polygon warnings). Currently, four types of short-fused warnings (Tornado, Severe Thunderstorm, Flash Flood, and Special Marine) include polygon information which takes the form of latitude and longitude pairs which highlight the threat area. – See Figure 3. Data from these warnings are collected and databased into a real-time set of GIS shapefiles. These files can be downloaded from the NWS website in real-time and used by customers and partners in other GIS applications.

Figure 4 is an example of a graphic display of a NWS severe thunderstorm warning in northern Florida by Media Weather Innovations, a private weather provider. GIS and GPS users include emergency managers/planners and media partners. Emergency managers and the media can quickly access and download GIS shapefiles via the Internet, add them to their existing GIS fields, and incorporate them into other GIS applications.

4.2 EXtensive Markup Language – XML

E**X**tensible **M**arkup **L**anguage (XML) is an Internet-based language format for documents containing structured information or data. An Internet markup language is a mechanism to identify structures in a document. The XML specification defines a standard way to add markup to documents. Structured information contains both content (words, pictures, etc.) and some indication of what role that content plays (for example, content in a section heading has a different meaning from content in a footnote, which means something different than content in a figure caption or content in a database table, etc.). XML is designed to describe data/information and the document tags are user-defined. XML is a cross-platform, software and hardware-independent tool for transmitting data and information. It is important to emphasize that XML complements **H**yper**T**ext **M**arkup **L**anguage (HTML) and is not a replacement for HTML. XML is designed to describe data/information while HTML is designed to format and display data/information.

Another benefit of XML is its ability to exchange data between incompatible systems. In many instances, computer systems and databases contain data in incompatible formats. One of the most time-consuming challenges has been the exchange of data between such systems over the Internet. Converting data to XML format can greatly reduce this complexity and create data that can be read by a wide array of applications.

4.3 Common Alerting Protocol – CAP

The Common Alerting Protocol (CAP) is an open, non-proprietary standard data interchange format that can be used to collect all-hazard warnings and reports locally, regionally and nationally, for input into a wide range of information-management and warning dissemination systems. CAP format uses eXtensible Markup Language (XML) and standardizes the content of alerts and notifications across all-hazards including hazardous material incidents, severe weather, fires, earthquakes, and tsunamis. CAP's origins can be traced back to recommendations of the "Effective Disaster Warnings" report issued in November, 2000 by the United States Working Group on Natural Disaster Information Systems, Subcommittee on Natural Disaster Reduction. Systems using CAP have shown that a single authoritative and secure alert message can quickly launch Internet messages, news feeds, television text captions/scrolls, highway sign messages, and synthesized voice-over automated telephone calls or radio broadcasts to effectively alert the public. CAP is a simple but general format for exchanging all-hazard emergency alerts and public warnings, including hydrometeorological warnings, over a wide variety of communication networks. CAP allows a consistent warning message to be disseminated simultaneously over many different warning systems, thus increasing warning effectiveness while simplifying the warning dissemination task. CAP provides a template for effective warning messages based on best practices identified in academic research and real-world experience. Growing segments of the emergency management community are embracing CAP as a comprehensive, all-in-one approach to provide critical all-hazard information to the public. In turn, the NWS is working towards adopting the CAP standard. Figure 5 shows both the raw CAP code and an example of how CAP is used in real-time from the California office of Emergency Services.

4.4 Real Simple Syndication – RSS

XML is driving a host of new, innovative communication capabilities that can enhance PWS service delivery. This includes Real Simple Syndication (RSS). RSS is a family of web formats used to publish frequently updated digital content. RSS is commonly used to update news articles and other content that changes quickly. Typically, RSS feeds deliver text and graphic content; however, RSS feeds may also include audio files (PodCasts) or even video files (VodCasts).

RSS is a pull-focused approach to receiving environmental information. Rather than the traditional approach of NMHSs "pushing" hydrometeorological products to its user community, users install RSS feed readers which allows them to select and tailor the environmental information they need to meet their specific needs. Users subscribe to a feed by entering the link of the RSS feed into their RSS feed reader; the RSS feed reader then checks the subscribed feeds for new content since on a recurring basis. If new content is detected, the reader retrieves the new content and provides it to the user. Most standard Internet web browsers (e.g. Firefox, Internet Explorer 7, Mozilla, Safari) can read RSS feeds automatically. Alternatively, users can install a stand-alone RSS feed reader or news aggregator. Thus, RSS gives the user the ability to maintain environmental situational awareness and quickly obtain the latest hydrometeorological information from their NMHS as needed. This approach

also has the added benefit of reducing the load on web servers during significant high impact hydrometeorological events and other high-traffic periods. Figure 6 shows the United Kingdom Met Office RSS instruction web page describing how users can access RSS feeds for their products and the NOAA/NWS.Internet site with links to available RSS feeds.

4.5 Keyhole Markup Language – KML

Keyhole Markup Language (KML) is a recent XML-based offshoot designed for geospatial data applications. More specifically, KML is an XML-based language and file format for describing three-dimensional geospatial data and its display in application programs. KML has a tag-based structure similar to HTML with names and attributes used for specific display purposes. XML can be used to store geographic features such as points, lines, images, polygons, and models for display in Google Earth and Google Maps. A KML file is processed by Google Earth and Google Maps in a similar way that HTML and XML files are processed by web browsers. NMHSs may be able to exploit features of KML to add another dimension to delivering user and location specific warnings and forecasts.

5. Future Technology – Dual Polarization Radar and Phased Array Radar

One of the most exciting, innovative future technology enhancements for PWS is in the radar remote sensing arena. Next generation radar systems (Dual-polarization Radar, Phased Array Radar) provide the opportunity to improve severe weather detection, rainfall estimates, winter weather warning, and increase the lead time for severe weather hazards including tornadoes and heavy rain/flash flood events.

Dual-polarization radars transmit radio wave pulses that have both horizontal and vertical orientations. The additional information from vertical pulses will greatly improve forecasts and warning for a variety of hazardous weather including severe weather, heavy rainfall, and winter weather events. Unlike current WSR-88D radars, which transmit one beam of energy at a time, listen for the returned energy, then mechanically tilt in elevation and sample another small section of the atmosphere, a phased array radar system uses multiple beams, sent out at one time, so the antennas never need to tilt. This results in a complete scan of the entire atmosphere in about 30 seconds compared to 6 to 7 minutes for the WSR-88D radar. In addition, the phased array radar system incorporates the dual-polarization radar capabilities.

The benefits of phased array radars on PWS are broad and significant. They will allow NMHSs to issue more timely and improved warnings of severe weather hazards including the potential to issue graphic formatted tornado warnings up to 45 minutes in advance, improve the lead time for flash flood warnings and icing forecasts for aviation interests.

6. Summary

The emergence of new, innovative and technologically advanced forecast systems and communications systems provide a host of exciting possibilities for NMHSs to improve PWS and effectively integrate dissemination and service delivery. Moreover, NMHS PWS dissemination and service delivery integration will be dictated in large part by the development and application of new, innovative computer and telecommunication technologies and information systems. Digital database forecasting offers one of the most fascinating opportunities to integrate PWS forecast dissemination and service delivery most effectively to NMHS customers, partners and the general public. While it's recognized that digital forecasting is in its formative stages, and new telecommunication technologies are still emerging, NMHSs should keep abreast of this evolving forecasting approach.

Next-generation forecast workstations bring the promise of new methods to assimilate vast amounts of observational data and NWP output, including new visualization and information processing techniques, to assist forecasters with data analysis and interpretation. These workstations will assist with forecast preparation and significant event, high-impact hydrometeorological decision support. In addition, these workstations will likely incorporate sophisticated Nowcast systems which will integrate an array of real-time data and NWP output to provide prognostic information out 6 hours while also helping to rapidly generate and disseminate forecast products.

IT systems and associated applications, including XML, CAP, and RSS, will allow NHMSs to exploit the latest telecommunication networks, including broadband, wireless, and mobile systems, to improve PWS. Coupled with GIS and GPS capabilities, NMHSs can satisfy customer and partner demands forever increasing precision, accuracy, and detailed, location-specific hydrometeorological forecasts and warnings. Together, these efforts will allow NMHSs to cultivate an innovative and effective PWS program which leverages technological advances to create a holistic forecast and warning dissemination, service delivery, and all-hazard decision support process that best serves the user community.

Element	CONUS	Puerto Rico	Hawaii	Guam	Alaska
Maximum Temperature	Operational since 12/1/04	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Experimental since 9/6/06 Comments closed 4/6/07
Minimum Temperature	Operational since 12/1/04	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Experimental since 9/6/06 Comments closed 4/6/07
12-hour Probability of Precipitation	Operational since 12/1/04	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Experimental since 9/6/06 Comments closed 4/6/07
Temperature	Operational since 3/15/05	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Not available
Dewpoint	Operational since 3/15/05	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Not available
Weather	Operational since 3/15/05	Operational since 6/21/05	Operational since 6/21/05	Operational since 9/20/05	Not available
Quantitative Precipitation Forecast (QPF)	Experimental since 6/16/03 Comments closed 9/15/05	Experimental since 6/16/03 Comments closed 9/15/05	Experimental since 11/1/06 Comments closed 1/1/07	Not available	Not available
Snow Amount	Experimental since 6/16/03 Comments closed 9/15/05	Not required	Experimental since 9/14/04 Comments closed 9/15/05	Not required	Not available
Wind Direction and Speed	Operational since 12/14/05	Operational since 12/14/05	Operational since 12/14/05	Operational since 12/14/05	Experimental since 9/6/06 Comments closed 4/6/07
Significant Wave Height	Operational since 5/31/07	Operational since 5/31/07	Operational since 5/31/07	Operational since 5/31/07	Experimental since 9/6/06 Comments closed 4/6/07

Element	CONUS	Puerto Rico	Hawaii	Guam	Alaska
Sky Cover	Experimental since 6/16/03 Comments closed 9/15/05	Experimental since 6/16/03 Comments closed 9/15/05	Experimental since 9/14/04 Comments closed 9/15/05	Experimental since 9/14/04 Comments closed 9/15/05	Not available
Apparent Temperature	Operational since 3/15/06	Operational since 3/15/06	Operational since 3/15/06	Operational since 3/15/06	Not available
Relative Humidity	Operational since 3/15/06	Operational since 3/15/06	Operational since 3/15/06	Operational since 3/15/06	Not available
Probabilistic Tropical Cyclone Surface Wind Speeds 6 separate elements: >34kts (incremental) >34kts (cumulative) >50kts (incremental) >50kts (cumulative) >64kts (incremental) >64kts (cumulative)	Operational since 5/31/07	Not available	Not available	Not available	Not available
Wind Gust	Operational since 9/20/07	Operational since 9/20/07	Operational since 9/20/07	Operational since 9/20/07	Not available
Convective Outlook Hazard Probabilities 9 separate elements: Convective Hazard Outlook Probability of: ▪ Tornadoes ▪ Hail ▪ Damaging Thunderstorm Winds ▪ Extreme Tornadoes ▪ Extreme Hail ▪ Extreme Thunderstorm Winds Total Probability of: ▪ Severe Thunderstorms ▪ Extreme Severe Thunderstorms	Experimental since 2/27/07 Comments accepted until 6/29/07	Not available	Not available	Not available	Not available
Climate Outlooks 12 separate elements: Days 8-14, 30, and 90 Days ▪ Temperature Above/ Below Normal ▪ Precipitation Above/ Below Normal	Experimental since 10/18/07 Comments accepted until 2/18/08	Not available	Not available	Not available	Experimental since 10/18/07 Comments accepted until 2/18/08

Table 1. Status of NWS NDFD Elements as of October 2007

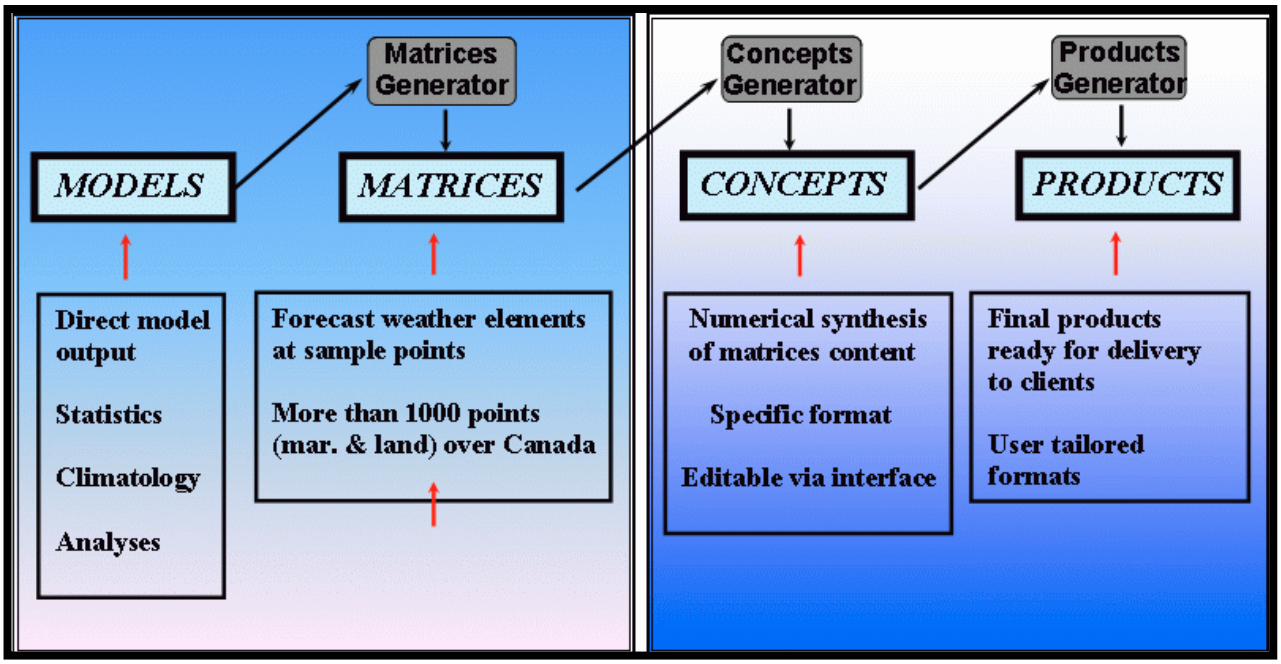
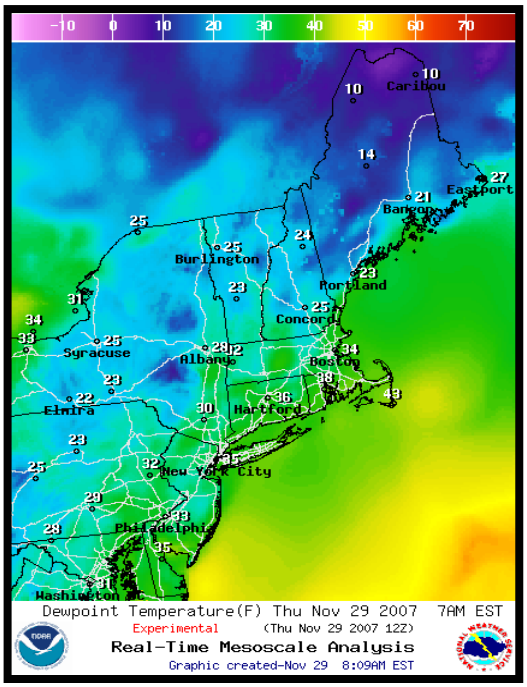
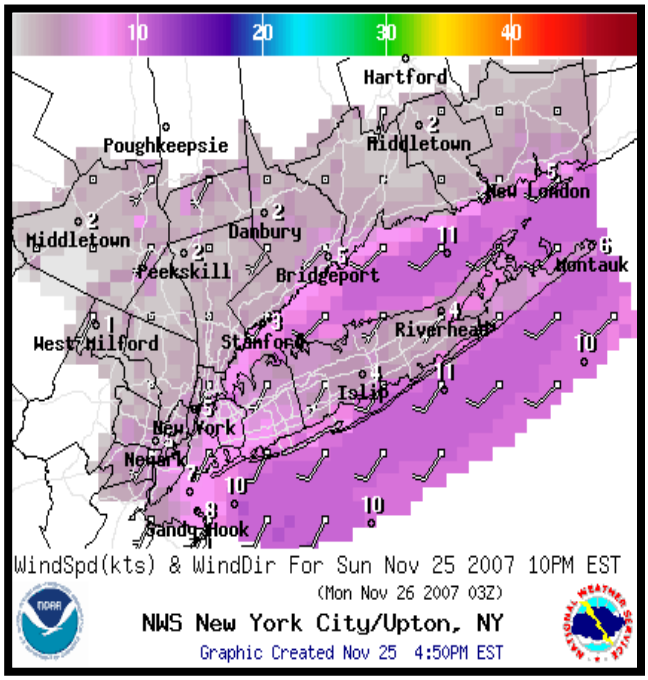


Figure 1. Flow chart depicting the primary steps in the SCRIBE data processing (Landry, C. et. al. 2005)



(a)



(b)

Figure 2. Examples of NDFD output graphics: (a) regional dewpoint graphic (b) local wind speed and direction graphic.

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WUUS52 KTAE 261332
SVRTAE
FLC063-133-261400-
/O.NEW.KTAE.SV.W.0173.071126T1331Z-071126T1400Z/
BULLETIN - EAS ACTIVATION REQUESTED
SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE TALLAHASSEE FL
731 AM CST MON NOV 26 2007

THE NATIONAL WEATHER SERVICE IN TALLAHASSEE HAS ISSUED A
* SEVERE THUNDERSTORM WARNING FOR...
NORTHWESTERN JACKSON COUNTY IN THE PANHANDLE OF FLORIDA...
NORTHEASTERN WASHINGTON COUNTY IN THE PANHANDLE OF FLORIDA...
THIS INCLUDES THE CITY OF CHIPLEY...

     •   UNTIL 800 AM CST

* AT 726 AM CST...NATIONAL WEATHER SERVICE DOPPLER RADAR INDICATED A
LINE OF SEVERE THUNDERSTORMS CAPABLE OF PRODUCING DAMAGING WINDS IN
EXCESS OF 60 MPH.  THESE STORMS WERE LOCATED ALONG A LINE EXTENDING
FROM CHIPLEY TO 18 MILES SOUTHWEST OF CHIPLEY...OR ALONG A LINE
EXTENDING FROM BONIFAY TO VERNON...AND MOVING NORTHEAST AT 55 MPH.

     • SEVERE THUNDERSTORMS WILL BE NEAR...

     • CHIPLEY BY 740 AM CST...

DOPPLER RADAR HAS INDICATED SOME WEAK ROTATION WITHIN THESE STORMS.
WHILE NOT IMMEDIATELY LIKELY...A TORNADO MAY STILL DEVELOP. IF A
TORNADO IS SPOTTED...ACT QUICKLY AND MOVE TO A PLACE OF SAFETY IN A
STURDY STRUCTURE...SUCH AS A BASEMENT OR SMALL INTERIOR ROOM.

RELAY REPORTS OF SEVERE WEATHER TO THE NATIONAL WEATHER SERVICE IN
TALLAHASSEE AT (8 5 0) 9 4 2 8 8 3 3. OR...YOU MAY CONTACT THE
NEAREST LAW ENFORCEMENT AGENCY OR YOUR COUNTY EMERGENCY MANAGEMENT.
THEY WILL RELAY YOUR REPORT TO THE NATIONAL WEATHER SERVICE.

LAT...LON 3064 8546 3073 8566 3075 8565 3075 8561
3078 8562 3080 8559 3082 8560 3098 8550 3098 8518
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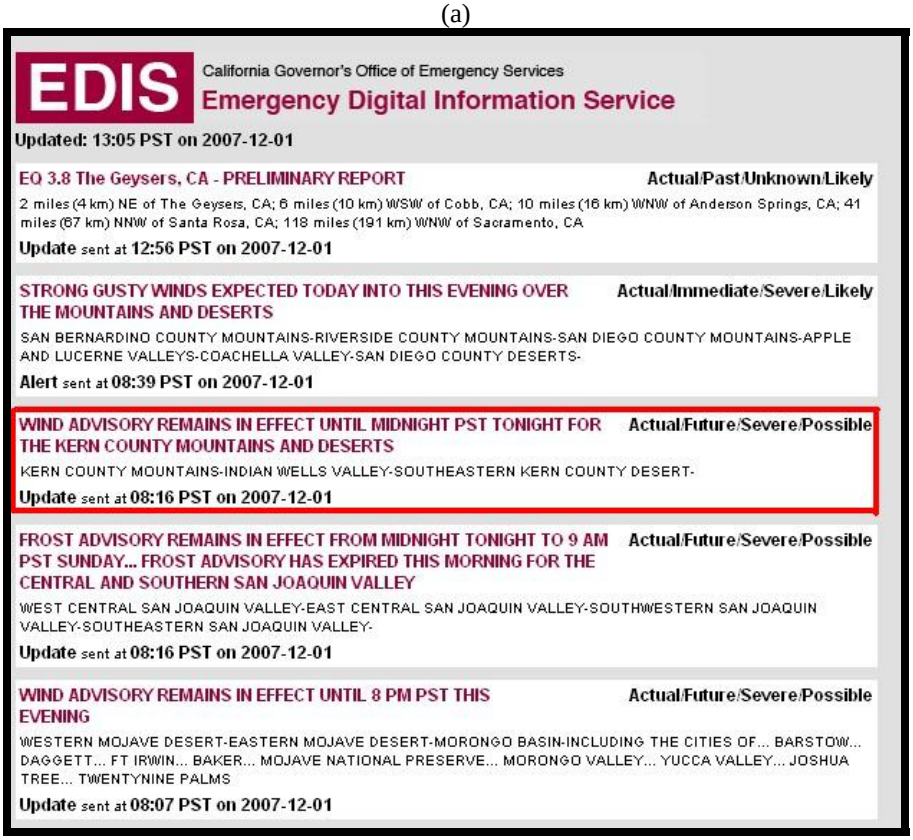
Figure 3. Sample severe weather warning with latitude and longitude pairs (highlighted at the end of the warning) which can be utilized by GIS applications.

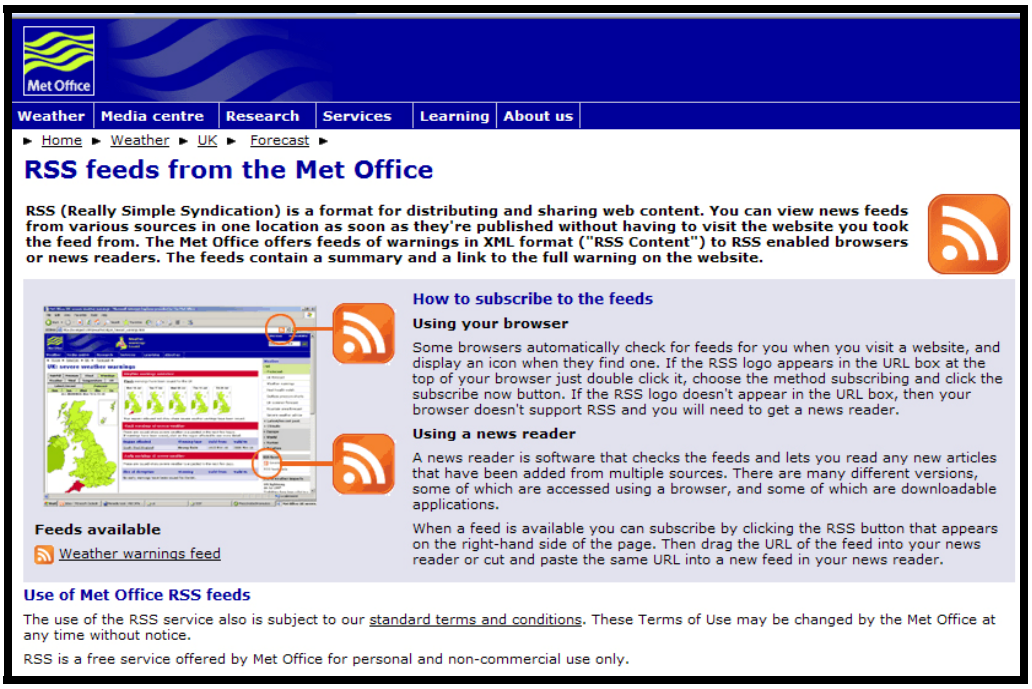
Figure 4. Graphic display of a NWS severe thunderstorm warning in northern Florida (Image courtesy of Media Weather Innovations, LLC.)

(a)

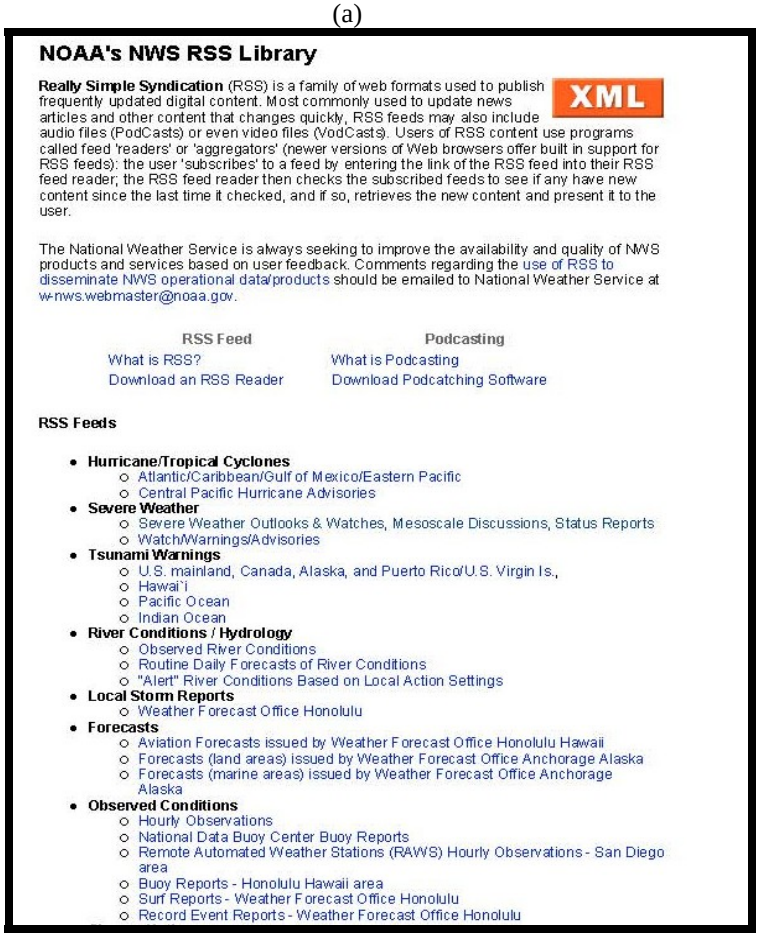


(b)

Figure 5. NWS raw CAP code (a) and real-time application from the California Office of Emergency Services (b). Highlighted text in (a) corresponds to text in red outlined box in (b).



(a)



(b)

Figure 6. Information on hydrometeorological RSS feeds from (a) the United Kingdom Met Office describing how users can access RSS feeds for Met Office products (b) NOAA/NWS.Internet site with links to available RSS feeds.

References

[1] Landry, C. et. al. 2005: Operational Scribe Nowcasting sub-system: Objective Verification Results. *21st International Conference on Interactive Information Processing Systems (IIPS) for Meteorology, Oceanography, and Hydrology*, San Diego, CA 8-14 January, 2005, pp 1-4.

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