Access to and dissemination of mapping data over the internet empowers the user of the maps. Discuss.

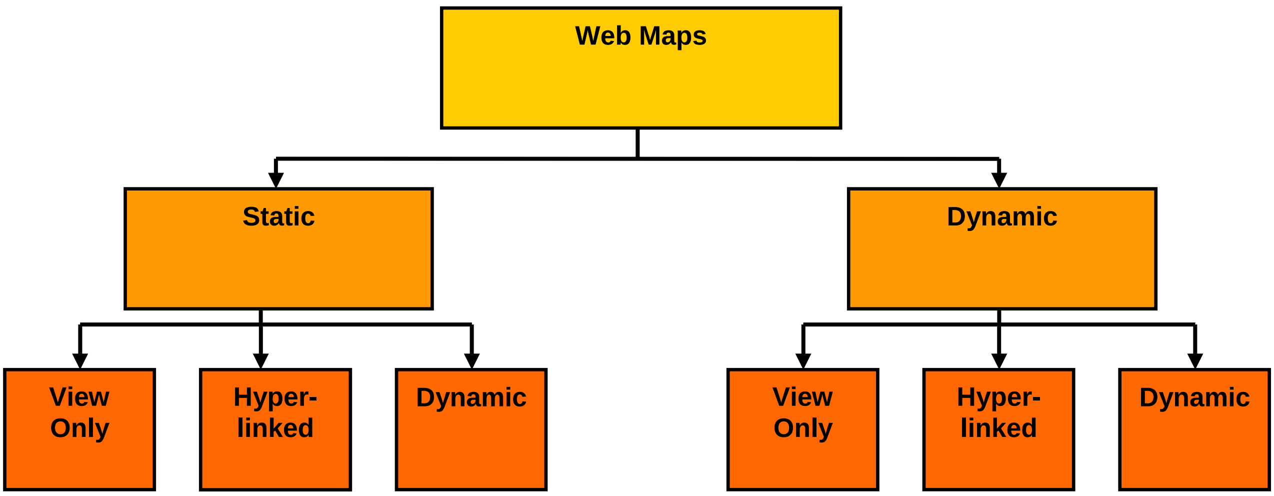
For ease of reference, URLs referred to in this text have been compiled online at http://www.khrm.net/webmaps

Due to the continued development of the World Wide Web (WWW), software and communications networks, it is now possible to efficiently serve electronic pictures and maps on the internet. Weather maps, the chosen focus of this essay, are ideally suited to this method of distribution due to their continually dynamic nature and the time-sensitivity of this data. Kraak *et al*. (2003) cite the greatest advantage of the WWW being it's data dissemination properties, and reinforce the empowering nature this presents the internet user.

Historically, progress in communication through printing presses, newspaper, telegraph, telephone, facsimile systems and later computing networks, television and radio have enabled meteorologists and cartographers to communicate between themselves, and with the public with increasing efficiency (Monmonier, 1999. For more information refer to appendix A). The internet advances this exchange of information and ideas even further and provides a number of other advantages in terms of accessibility and content related possibilities. An online map represents an ideal medium to represent this geographically sensitive weather data.

As an introduction, figure 1 shows how weather maps online can be categorised into several hierarchical levels of interactivity, which shall be examined in turn.

Figure 1: Classification of web maps (heavily modified from Kraak *et al*., 2001:3)



Static maps on the internet are not updated at regular spatial intervals. For this reason the majority of static maps are used for the display or archive of historic weather data (possibly for forecast/projection purposes).

Dynamic weather maps are those which are updated periodically. These imply a supply of data and method of generating maps for viewing online: sometimes this is entirely automated. Being able to view weather forecast maps as soon as they have been produced increases their longevity, relevance and therefore usefulness. This is an empowering nature of the medium for the user.

Three levels of interactivity exist between the map and the user: view only, hyperlinked and dynamic. In a 'view only' situation the map would be used in a similar manner to paper maps or atlases, the web simply being a method of their dissemination. The map may be of various qualities and file sizes according to it's file type and a variety of different technical specifications discussed later.

View only maps might also be animated; shrinking time as well as space on screen (Monmonier, 1999). Static versions of these maps often describe particular events of geographic significance, such as freak weather occurrences. The atmospheric dynamics data and resources site[1] exhibits an example of such a website, detailing a Monsoon in 1996. The site represents a significant resource for the user, providing 2D and 3D Quicktime animations of the event, showing moments of winds, currents and isolines. The animations are provided in various different qualities. This type of online weather map is a useful visual aid for this historical event, but at present it would take a large amount of time and resources to provide this type of map for everyday purposes – and would people be interested in downloading over 7Mb of animation on a daily basis? The public interest (particularly in the USA) in such events creates a demand for the producers work.

Hyperlinked or 'Gateway' maps begin to exploit the multimedia and hyperlinked nature of the web[2]. In these cases the map is used as an interface or index to link to photographs, text, webpages, or multimedia such as sound and video. The concept of the 'hypermap' was introduced by Laurini and Milleret-Raffort in 1990, although it was possible to hyperlink maps before this date. Image mapping[3] allows the web cartographer to specify different areas of a map

[1] See http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/atmospheric_dynamics/ad_images_dao_animations.html
For other examples see http://www.atm.ch.cam.ac.uk/tour/part2.html and
http://www.geovista.psu.edu/grants/VisEarth/climate32.html
[2] 'Hyper' here refers to the non-linear movement of the user through a number of web pages and images (See also the dated descriptions in Peterson, 1995)
[3] Image Mapping is the identification of several different areas of an image (map) to be hyperlinked to several different locations

image to hyperlink to different objects. The widespread extent of hyperlinking of text and images online has lead users to expect or demand web objects to be clickable (Kraak *et al.*, 2003) and delivered quickly:

> "The WWW is a fast medium used by impatient people" (Kraak *et al.*, 2001: 23)

The vast majority of commercial websites seem to fall into this category, possibly due to the fact that they gather their data from similar sources or syndicate from similar services. Services such as Wunderground[4] use a map of the US and world as a gateway to textual and iconic weather data and forecasts for more specific locations. The maps themselves are static and only act as an index to the underlying data. These 'dumb' maps serve little in terms of meteorological purpose, and are essentially a city by city index to more uninspiring data. These services are nearly always heavily commercial and provide forecasts for up to a week in advance, of use to the general public.

Some hyperlinked maps seem to draw heavily from televisual data, both in their presentation and type of delivery. The UK based BBC provide a unique online weather service[5] that uses images similar to what appears on-screen for a feeling of continuity, making the website more accessible to the user. Weather.com[6] follows a similar formula. In the opinion of the author there are pitfalls to this method. One of the drawbacks of presenting weather data on television is the associated time-lag and lack of interactivity. The web should represent advancement over TV for weather mapping, not a facsimile of it.

Interactive weather maps empower the user further by providing greater functionality to maps with the ability to choose layers, colours or temporal and spatial aspects of the map displayed. Often the increased complexity and resources involved with producing these maps means they suffer from a lack the comprehensive coverage of others. The map may update in real-time (according to the dependant technology used to produce and display the map). Cartwright *et al.* (1999) demonstrate the feedback loop involved with interactive maps and their creation in figure 2 (overleaf).

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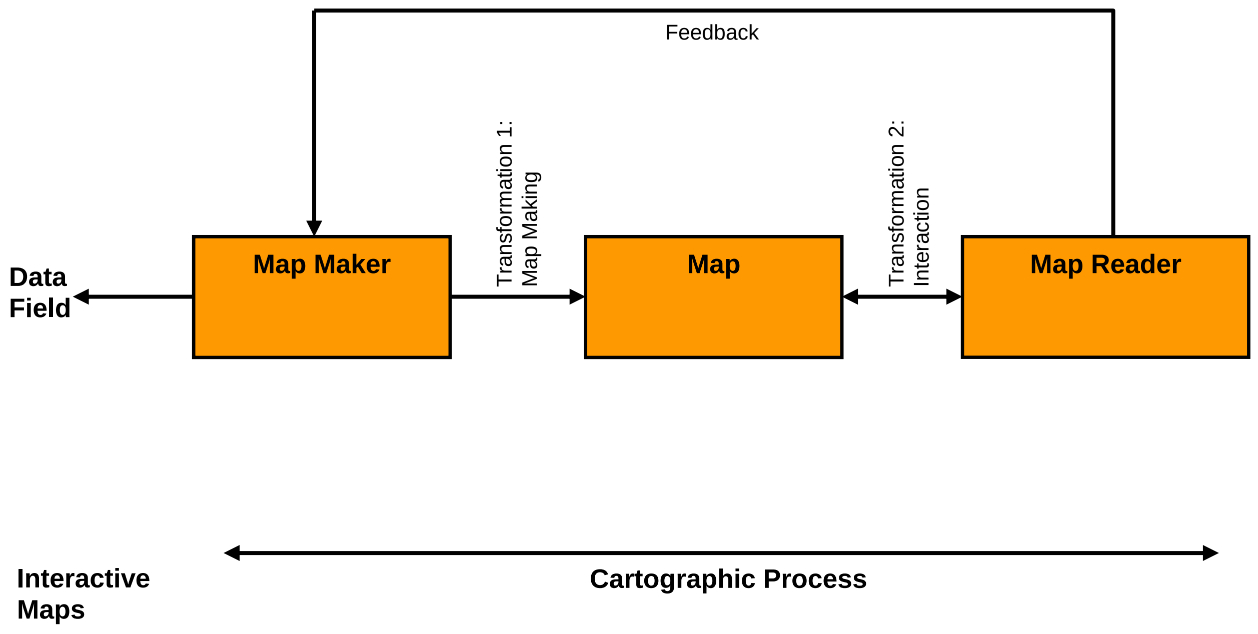
[4] See http://www.wunderground.com For other examples see Yahoo weather at http://weather.yahoo.com/ and CNN weather at http://weather.yahoo.com/
[5] See http://www.bbc.co.uk/weather/ukweather/northwest/
[6] See http://www.weather.com

Figure 2: The interactive cartographic communication process (Cartwright et al, 1999: 157)



Interactive weather maps add a greater level of interactivity to the hyperlinked map by letting the user specify different layers, or allowing interactive manipulation of the viewed scene. WeatherOnline[7] allows the visitor to specify different animated maps showing current (and recent) temperature, humidity and rainfall etc. The NOAA site[8] alternatively grants the user the freedom to display their own area of interest by zooming in from larger scale maps, and uses 'mouseover' data to provide accurate data about an area when the cursor is hovered over it. Such interactive maps increasingly rely on developing technologies such as Flash and Shockwave animations, VRML[9] and GVIS[10], which may limit their accessibility for users of predating technology. These interactive maps empower the user, as they allow them to effectively 'create their own weather map'. Critically, this also leaves the map open to their own interpretation, and not provide as much real information and guidance as a static map. Another website, UIUC Weather[11] allows the user to choose recent satellite images of a particular area and then decide how many days of animation they require.

Maps play a key role in meteorology and are useful to a wide range of end users from the in different socio-economic and ethnic groups. Being able to view current or projected weather conditions allows anyone to shape their daily activities accordingly, and in this respect maps online empower the common end-user. However while many online weather services attempt to

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[7] See http://www.wetteronline.com
[8] See http://www.nws.noaa.gov/forecasts/graphical/
[9] Virtual Reality Modelling Language. A universal set of web code for producing interactive presentations (GeoVRML Working Group, 2003)
[10] Geographic Visual Information Systems, a visual extension to Geographic Information Systems (Blackie, 2000).
[11] See http://www.atmos.uiuc.edu/weather/index.php

provide a one-size-fits all generic weather service for record or projection, a number of sites exist that cater specifically for certain user groups such as tourists or motorists (Peterson, 1995).

One such site is Snocountry[12], which provides weather data for skiers. Links are provided to relevant local maps and web-cams to view skiing conditions at certain resorts. Users can post their own first-hand experiences. These web-based maps are extremely useful for the task they are intended (and therefore empowering to the anticipated user), however the producer holds a large influence over the action of the user. By excluding, for example, a certain ski resort, the producer can influence the decisions of the visitor.

Hazard websites target specific weather features that may be of danger to human life or investment. Typically they provide data on current freak events, and therefore activity on the sites may vary according to these events. The majority of these sites seem to be American in source, embodying the stereotypical dramatic American obsession with such freak weather occurrences[13]. Accuweather's Hurricane Centre[14] provides a good example of this type of site. Here, users can view details of past events and animate or discuss current conditions with a satellite map and risk assessments as reference. The site covers a limited geographical area, and dramatic colours and exclamations detract somewhat from the meteorological data, presumably with the intent of provoking more of a reaction from the reader and directing them towards their paid premium service (providing more detailed commentary and rich media source such as video clips).

Advanced climatologically forecast maps are available from services such as Meteosat[15]. These websites contain high quality satellite images for a number of days in advance. The basic layout and minimal descriptive text suggests that the intended audience is the more informed geographer or climatologist rather than the everyday user. This dense data empowers this anticipated audience, but may bewilder others.

The web contains a number of historical databases of weather conditions and maps. More commonly these are archives of satellite images, filed in a database that can be queried over a WWW interface. One such example is the NCDC (National Climatic Data Centre) website[16], archiving weather satellite images from the early 1990's. Such maps are useful to a number of groups (such as academics and researchers), and empower the user by letting them chose the

[12] See http://www.snocountry.com
[13] American writers such as Monmonier (1999) also devote much time to such events
[14] See http://hurricane.accuweather.com/adcbin/hurricane/index.asp?partner=accuweather
[15] See http://meteonet.nl/aktueel/brackall.htm
[16] See http://cdo.ncdc.noaa.gov/GOESBrowser/goesbrowser For other examples see http://156.42.96.39/wxmaps.html or http://www.metoffice.gov.uk/climate/uk/index.html

exact date/time, thermal band and perspective to display. Climatologists interested in other areas of the globe may be disappointed at the spatial limits of the images. The images are of high quality and contain a useful overlay of a political USA outline map.

There are many advantages of the web as a medium for distributing weather cartography, for both the user and the producer of the map. These can be summarised as the accessibility, choice and interactivity for the end user, and the variety of means available to the producer.

The internet is virtually unrivalled in its ability deliver data to a wide number of people at a global level. Its nature means that it can be accessed from any computer with a data connection worldwide, regardless of platform, and increasingly also by other devices using wireless connectivity. Everybody from professional cartographers to anyone with access to this new medium can view the same online maps (Monmonier, 1999). The cartographer can normally distribute maps online at a much reduced cost to on paper, and the medium presents many more possibilities for display compared to a flat sheet of paper (Peterson, 1995).

Accessibility is compromised, however, in socio-economic circumstances where the user or community do not have the funds to own the hardware or connectivity to access the medium. This is especially common in third-world areas, resulting in an uneven global distribution of internet users: In 2002 the US Census bureau reported approximately 605m people were online, making up only 9.7 percent of the world’s population; thus disempowering the 90.3 percent of people without access (Crampton, 2003).

Mitchell (1986) has previously proposed that map knowledge is a social product. Foucault (1977) talks of this social power, enforcing that the truthfulness of knowledge obtained is empirically linked to the ‘will to power’ of the knowledge-seeker. As the knowledge becomes more readily available surely this shifts the balance of this ‘will to power’?

> Whether a map is produced under the banner of cartographic science – as most maps have been – or whether it is an overt propaganda exercise, it cannot escape involvement in the processes by which power is deployed (Harley, 2001)

In this quote Harley identifies that maps are more than images acting as a means to an end. Instead they are increasingly becoming part of a broader family of value-laden images. No longer embodying a merely passive and descriptive view of the physical features of the coverage area, the maps are socially constructed, reflecting the views and outlook of the author (Harley, 2001). Do maps on the internet act as a catalyst for this movement? Amateur, inexperienced map makers may be more susceptible to replicating social and political imperatives of the time in their maps (Wood, 1993). This is especially true for weather maps, given their complicated and unofficially-standardised symbols (Monmonier, 1996:19). Foucault (1977) talks of this inexperience in terms of the act of 'surveillance'. The relative ease and low cost of producing a map online would certainly imply this is so (Kraak *et al.*, 2003). Accordingly many online weather maps lack recognised features of paper maps such as gridlines and scales.

Multimedia and interactive presentation allows a more dramatic and informative cartographic treatment of weather phenomena. It also promotes integration of maps, graphs, pictures, written text and sound (Monmonier, 1996). The inclusion and presentation of these media however, enables the author of the map (or mapping system) to further influence the view of the user, by using these mediums to convey (consciously or subconsciously) their own political and social views (Monmonier, 1996; Foucault, 1977). However flexible and interactive the system, the user can see only what the data and mapping system allow. Indeed some information can be *more* easily omitted under layers of superfluous data. By seducing viewers into believing that an impressive colourful graphic display or video animation contains accurate and relevant information, geographic information systems can become a powerful tool of deception (Monmonier, 1993, 1996 and 1999).

As well as empowering facets, online weather maps also carry disempowering aspects for the user and/or producer and characteristics which are shifting the process of cartography and the role of the user and producer. These can be defined as the implications of distributed mapping and the selective availability of the medium (geographically, socio-economically, and terms of mental/physical abilities and the technologies available).

Crampton (2003) outlines several implications of online distributed mapping. The first is the transience of these maps, ie their lack of historical legacy[17]. Surprisingly few archives of electronic maps are kept compared to the careful preservation of some historical paper maps. Paradoxically it is very easy to create and keep archives of electronic maps compared to their paper counterparts[18], but perhaps cartographers see their dissemination as sufficient. As Crampton (2003) identifies, many more people have access to electronic maps than their paper counterparts, perhaps indicating a paradigm shift from the paper map (the product) to the serving of the mapping environment (the process) (Crampton, 2003). Is this lack of contemporary legacy a problem or do the infinite map possibilities possible with database-served sites such as

[17] This has been identified as a major criticism of the web as a whole and attempts have been made to remedy this: see http://www.archive.org/web/web.php
[18] Carefully conserved ancient paper maps are now being served electronically over the internet; see http://www.henry-davis.com/MAPS/Ancient%20Web%20Pages/AncientL.html for an example.

Multimap[19] or MapQuest[20] render archiving pointless or a task of too great a magnitude to be worthwhile?

The widespread adoption of online weather mapping is changing the role of the cartographer. With the continuing development of mapping servers to provide maps on demand, the user is increasingly empowered to the role of the cartographer in creating his or her own maps; while the cartographer may begin to be replaced by the web developer using a number of standardised skeletal map elements (Peterson, 1995). Apart from affecting the employment prospects of cartographers, this causes issues for the accuracy and consistency of online maps, and could foreseeably lead to a conceptual widening of the field.

Much of Harley's work (1988, 2001) focuses around finding the empowering and disempowering aspects of different maps for both user and producer. His work centres on unravelling the politics and ideologies of maps to find their true meaning; leading to a repressive view of power, echoing the ideas of Foucault. Since these works there has been limited interest in a move towards a critical politics of cartography, or one that bridges divides between theory and technology (Crampton, 2003).

One of the fascinating aspects of covering weather maps on the internet is the lack of international selectiveness in the range of maps available compared to other web-mapping areas (such as tourist or road maps). Presumably this is due to the fact that a large amount of weather information is remotely sensed from space, and that data for the whole globe is required to make weather projections for any one area of the world. In this way more affluent, developed countries such as the US may pay for remotely sensed weather information benefiting less developed countries.

Perhaps the most considerable problem for the producer of the web map is the online medium itself. The computer represents a completely different way of viewing and interacting with maps compared to traditional formats (Peterson, 1995). There are a number of limitations imposed by the format compared to a paper map, or even a digital map stored locally (for comparison with traditional formats and locally stored media see Appendices B and C).

A problem common to local and remotely served maps is the portrayal of maps on screen. Displaying a map onscreen is inherently different from displaying it in a physical paper form due to several factors. Technically, the computer screen is limited by it's resolution: a finite number of

[19] See http://www.multimap.com
[20] See http://www.mapquest.com

pixels can be displayed at one time, and zooming in on the image will limit it's usefulness as a whole. The numbers of dots-per-inch displayed on screen (normally fixed at 72dpi) is also substantially lower than that of a printed map and the number of colours displayed may be limited in older machines, resulting in a poorer graphic display. Overcoming these problems by using multiple or large screens is expensive and not universally accessible (Monmonier, 1999).

Producing maps for the screen produces the same problems of projection faced by paper mappers (Harley, 2001), however 3D imaging and animation may serve to solve some of these problems of displaying a spherical world on a flat medium.

The layout and display of cartographic data and images may also differ according to the hardware and software used to access the map. For example different web browsers and versions of web browsers will display certain web-page attributes in different ways and offer differing levels of support for display technologies such as Java or Flash. Technical constraints can prevent certain user groups from using an online weather mapping facility, thus disempowering them. The producer will normally ensure the final product represents a compromise between functionality and accessibility. Producers must also attempt to make weather maps accessible to the sensorally impaired.

The speed of internet connection is another technical problem impeding dissemination of high quality mapping online. High quality electronic images, animations, numerical or video files (or those which include the greatest spatial resolution) tend to propagate large file sizes. This is especially true of modern formats such as Flash and Shockwave or streaming media which pose a high strain on bandwidth[21]. Large files take a long time to upload and download using slower connection speeds still used by the majority of internet users, especially those in lower socio-economic groups (Broersma, 2004). If higher bandwidth connections were the norm would maps be served at a greater quality?

Copyright is an awkward problem on the web as many people incorrectly assume anything viewed over the medium to be in the public domain (Kraak *et al.*, 2001). Techniques such as watermarking maps with the producers details or securing the site through access requirements (such as requiring registration) may help solve these problems but this is a major restricting issue for map producers.

Non technical constraints of the WWW format include the physical lack of touch that the user has over the map and it's lack of portability. Portability is an issue that has been addressed lately with

[21] Bandwidth is the amount of data that can be transferred per unit time

the arrival of a number of convenient handheld devices and wireless technologies that allow the serving and/or viewing of cartographic data on agents such as PDAs (Personal Digital Assistants) or mobile phones.

The future holds significant potential for online cartography and from analysing past trends it is possible to make several assumptions about the future of this design medium. Research shows that increasingly the computer is being used to disseminate maps as well as produce them (Kraak *et al.*, 2001). Peterson (1995) notes that far from making the paper map redundant, paper will progressively be used to summarise animations on screen. These web maps increasingly take advantage of advanced presentation technologies and GVIS and VRML (Dorling *et al.*, 1997). Critically, Monmonier (1985) notes that adoption of such technologies must be objective:

> To assume that maps will be better- more accurate, more timely, more accessible, more aesthetic, more tailored to user needs- simply as a result of high technology is unreasonably naïve. New and evolving technologies for handling map information must be adapted carefully and selectively (Monmonier, 1985)

Greater information-integration is also apparent in the online environment, with weather data increasingly being put to more cohesive use in websites serving purposes for particular user groups, such as drivers[22]. Integration and communication between these websites is also increasing, creating a network of information facilitated in part by syndication technologies such as universally compatible RSS and XML feeds.

As technology improves, maps are becoming progressively more detailed, providing increasingly focused data for the user. Developments in technology include the widespread adoption of high bandwidth internet connections which quicken download speed and enable the dissemination of increasingly complex animations, videos and interactive multimedia content. This gives the web cartographer greater flexibility and the option to purvey high quality multimedia content. Monmonier (1999) argues that online maps will supersede the TV channels and programs they currently supplement.

Much of the existing literature covering online weather maps is obsolete due to the fast-changing nature of the subject. However it can be concluded that the maps have an important empowering role both for the user and cartographer yet distribute with ease the social contexts and hidden values that these maps contain. Interactive and dynamic content brings maps into immediate context and provide a plethora of choice. Infinite possibilities presented by interactive maps

[22] For examples see http://www.accuweather.com/adcbin/vacation_trav?nav=travel or http://www.intellicast.com/Local/USNationalStd.asp?loc=usa&seg=DRIVEcast&prodgrp=HighwayConditions&product=BadWeather&prodnav=none&pid=none/

produce a situation where the map producer has little control over the final product, requiring careful design forethought (Kraak *et al.*, 2003). However, limitations of the web as a format, and uneven spatial distribution of the medium and technological barriers means that some groups are excluded from it's reach.

Appendix A: A brief history of meteorological maps and their dissemination

In order to appreciate the impact that mass dissemination of mapping data has on it's interpretation and usage, it is constructive to examine a brief history of their production and distribution, along with the communication networks that convey weather and climatic data to the cartographer.

Monmonier (1999) provides a detailed account of the development of meteorological maps from their very roots. From the advent of the telegraph in the eighteenth century, dissemination of weather maps to the masses has been an important aim for meteorologists and cartographers alike. Henry (1858) recalls large public maps with weather symbols hung by clerks generating substantial public interest, noting that the map was not only of interest to visitors in exhibiting the kind of weather which their friends at a distance were experiencing, but also as a tool for predicting future weather for their own location. Henry also remarks on the entertaining nature of this novel map, a feature of meteorological maps which still promotes them today. In 1857 The Washington Evening Star became one of the first newspapers to publish a telegraphic weather report, bringing weather information to the masses.

Advances in communication between measuring stations, meteorologists, cartographers and publishers encouraged the dissemination of mapped weather data, and when companies like the Daily Weather Map Company Ltd saw commercial value in these maps for predicting weather conditions for other professions, this advancement saw a new injection of funding (Monmonier, 1999).

The requirement of the military national defence for accurate weather forecasting spurred the development of dissemination of weather data and in 1860 Le Verrier helped to set up a system of regular telegraphic weather forecasts for distribution to various ports and military bases (Khrgian, 1970). Telegraphs and later facsimile systems revolutionised weather reporting by allowing pictorial data to be accurately transferred nationwide or even further a field. Further development introduced greater synchronisation in data and dissemination through new media such as colour newsprint, radio and television upon their adoption by consumers.

Increased public interest in weather mapping lead to a shift away from detailed mapping for the meteorologist or professional and towards simplified mapping for the general public. Public interests in final physical outcomes lead to less observed data being displayed in maps and more projected weather conditions with simplified symbols covering larger areas. Monmonier (1999) expresses the advantage of television as a weather map medium; highlighting the ability to have a narrative as a major factor.

The earliest recorded map server existed in an online state in 1993, using Common Gateway Interface (CGI) scripts to create maps on demand according to a number of basic inputs such as attitude and longitude (Putz, 1994), forming the basis of the advanced metrological maps we see online today.

Appendix B: A comparison of the online weather mapping format and more traditional formats

Kraak *et al.* (2001) draw a direct comparison between online maps and television. Table 1, below, critically analyses the merits and disadvantages of the online map for various applications compared to other mediums.

Table 1: Contrasting Characteristics of different mediums for presenting weather data/forecasts (adapted from Kraak *et al.*, 2001; Monmonier, 1999)

Characteristic	**Newspaper**	**Radio**	**Television**	**Internet**
Time-relevance	Inherently 1-2 days old	Up to current, limited by restraints of broadcasting network	Up to current, limited by restraints of broadcasting network	Up to current
Visual element	Static graphics, possibly in colour	None	Moving high quality graphics, video, photos and accompanying data	Colour graphics and photos Moving video and graphics uncommon and of poor quality
Interactivity	None	None	None	High level of interactivity
Access	On demand	On supply	On supply	On demand
Spatial Coverage	Limited to local, depending on scale of newspaper	Limited to local, depending on scale of broadcast	Limited to local, depending on scale of broadcast	Not limited
Narrative	Never	Always	Commonly	Uncommon
Explanation/interpretation	Sometimes	Commonly	Commonly	Possible
Use of Colour	Restricted by print	n/a	Yes	Yes
Depth of information	General	General	General	General to highly specific

Table 1 shows that Kraak *et al.*'s direct comparison with television is perhaps unfair due to the different properties of the medium. It also shows that the internet has many advantages for the dissemination of weather maps, but also a number of limitations which will be explored later.

Kraak *et al.* (2003) point out that maps and data on the internet is inherently different from paper maps because they are neither physically visible nor tangible. In a similar manner, forms of static data storage such as diskettes or CD-ROMs are tangible but not visible.

Appendix C: A comparison between local and remote served mapping data

Cartwright *et al.* (1999) outline advantages and disadvantages of the web as a medium for mapping compared to locally stored data (see table 2, below)[23].

Table 2: Local and internet-served mapping (commented from Cartwright *et al.*, 1999: 156)

	Local Storage	**Internet**	**Added Comment**
Number of Users	Positive Attribute	Positive Attribute	This shows the age of the Cartwright *et al.*, text. The internet now offers an infinitely larger audience than local storage mediums.
Platform Availability	Neutral Attribute	Positive Attribute	
Development	Negative Attribute	Negative Attribute	The increasing ease of publishing material online and development of skills means this gap is shrinking
Data Volume	Positive Attribute	Neutral Attribute	Volume of data is becoming less of a problem online as the cost of physical space falls. Bandwidth (or the amount of data transferred over a connection) is becoming a more valuable commodity.
Transfer Rate	Positive Attribute	Negative Attribute	Although connection speeds are increasing, many people still rely on dial-up connections, limiting the potential practical size of map image files.
Updateable	Negative Attribute	Positive Attribute	

[23] This draws on Cartwright's earlier work (1996) studying sixteen different types of local storage for mapping

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