Paper presented at the 7th International Airship Convention, DGLR, Friedrichshafen, Germany, October 2008

THE INFLUENCE OF GLOBAL ATMOSPHERIC WARMING ON AIRSHIP OPERATIONS

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Abstract

The accelerated global atmospheric warming reported in the Fourth Assessment Report of the IPCC (2007) is endorsed by both the WMO and UNEP. The probability that global warming will continue, and may accelerate further, is no longer disputed, but its impact on airship operations in the next decades will depend on the responses of the airship industry to the new risks, opportunities and technical options.

The projected increases in global mean air temperature will have few direct impacts on airship operations, although the general warming of the Arctic in summer does already offer more opportunities for using airships as the icing risk in flight decreases. The increase in the rate of energy transfer in the atmosphere, the increased thermal activity and storm strengths at all scales, and the increased frequency of extreme events, has rather more impact on airships, and is subject to regional variations.

The increased frequency of damaging winds in sub-tropical and temperate regions will require the construction of more storm-proof hangars, and the intelligent use of medium-range weather forecasting to enable airships with long-range capabilities to avoid advancing storms.

Many commercial airship operations are currently based in cities, on coasts and estuaries, and specialised local scenarios for airship operations will be required in future, to maintain safety standards while global warming produces specific changes in local weather patterns.

Above all, some radical updating of the training in Meteorology for airship pilots, ground crew chiefs and operations planners will be required, to enable them to optimise their use of weather forecasts and raw meteorological information in new situations.

Introduction

The accelerated global atmospheric warming reported in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climatic Change (IPCC, 2007), is endorsed by both the World Meteorological Organisation and United Nations Environment Programme. The very high probability that global warming will continue, and may accelerate further unless the global emissions of the major greenhouse gases are drastically reduced, is no longer disputed. Its impact on airship operations in the next few decades will depend on the responses of the airship industry in identifying the new risks, the new opportunities for viable commercial airship operations, and the range of technical options and operational scenarios which are appropriate to exploit these opportunities safely. In this short paper, there will be insufficient space to discuss the technical content, and full implications of the IPCC AR4 document for airship operations in all the diverse regions of the world where airships may need to be operated, and so, in order to illustrate the diversity and practical significance of the undisputed findings of the IPCC, a short series of examples of the more obvious impacts of global warming on airship operations will be discussed at regional and local scales.

1. Future airship operations in the Arctic.

Amongst the geographical regions most affected by the accelerated global atmospheric warming recorded during the past 30 years has been the Arctic region, where the projected rate of increase in mean annual surface air temperature by 2100 is very approximately 4 times the rate to be experienced, for example, in the UK. In reality, this projection is likely to be a serious underestimate of the rate of warming, partly because the exchange of energy between the Arctic Ocean and the Arctic atmosphere will increase exponentially whenever, and wherever, the final thinnest layers of seasonal sea ice melt away, bringing the two fluid media together in direct contact for a very much more efficient energy exchange. Another physical reason to justify the assumption that the regional warming in the Arctic will be faster than some global models currently predict, is the observed tendency for the thinnest layers of sea ice to very rapidly loose their high reflectivity in respect to incoming solar radiation, and this is caused partly by the growth of marine plants on the underside of the ice sheet, in what is in effect an underwater greenhouse. The visible evidence for this process is the vastly increased area of bright green ice offshore of the Russian Arctic coast since 1995. A very conservative estimate of the increase in mean annual surface air temperatures at 70 degrees north in the 100-year period to 2100 might be about 10 degrees Celsius. The summer temperatures on land areas will be very much higher, and the period of sub-zero sea temperatures in winter will be much shorter. For example, mid-summer daytime maximum surface air temperatures in the Taimyr Peninsula, well north of the Arctic Circle, now regularly exceed 25 degrees Celsius. This projected increase in mean air temperature at low altitude will have fewer more direct impacts on airship flying than in the rapid expansion of the geographical area in which airships can be operated without a risk of engine or envelope icing in the longer summer season, and the shortening of the winter season, in which such icing risks significant for airships do still exist.

Assuming that more extensive airship operations are more feasible in the Arctic and North Polar regions, what could be the commercial or strategic reasons for operators sending them there? Recent airship conventions have publicised the important role which airship transportation could play in supporting the economy of settlements in northern Canada, where very profitable mining activities depend vitally upon the volume of freight which can be driven in trucks along the ‘ice roads’ created across frozen lakes every winter. As the climate warms, the duration of the winter season for using the ice roads is currently subject to an annual reduction from the nominal 60-day ‘window of opportunity’ available to use them safely, when the ice has a critical thickness sufficient to carry the weight of a standard truck. However, the economic development of these regions continues to expand in the longer summer season, with increasingly challenging volume requirements for the re-supply of essential items throughout the whole year. Large airships or hybrid lifting vehicles could meet the requirements for carrying personnel, especially key seasonal workers and their vital supplies, into distant Arctic regions, but the supply of very heavy engineering equipment would more probably be achieved more easily by sea transport or by large hovercraft.

In northern Russia, particularly along the Arctic Ocean coast of Siberia, there have been few major settlements established, partly because of the extreme severity of the winter climate, and the long duration of the winter weather, until the recent accelerated global warming of the past 30 years has rendered this dark period slightly more bearable for humans. The progressive melting away of the edges of the Arctic’s multi-year sea ice, and the progressive thinning of the seasonal sea ice in the longer summer seasons, has been charted efficiently by polar orbiting weather satellites for more than 40 years, and the process has continued to accelerate as the extent of the summer sea ice is further reduced. Because of accelerated global warming, the historical difficulties of the 20th century in reaching this ice-bound coast with any supply ships, except when following in the ephemeral shipping lanes temporarily opened by the three Russian Arctic-based nuclear-powered icebreakers, are now diminished, and the use of ice-breakers along the coast is now unnecessary for several summer months of the year.

The presence of exploitable oil, gas and other high value mineral deposits in areas accessible from the Russian Arctic coast, including the sub-sea deposits of the Lomonosov Ridge, has long been known, but their actual exploitation has been hampered in the past by the severe winter climate, the isolation of the region by the extent and thickness of the coastal sea ice, and the unavailability of both investment capital and the appropriate technology. The situation has now changed in the Russian Federation, and detailed exploration for minerals is currently underway, in the sure knowledge that the climate is warming, the sea coast is becoming accessible, and both the capital investment and the necessary technology is now available. This investment includes investment in airship technology, and there now exist three distinct operational requirements in this region of Russia, and similarly in Arctic Canada, which airships can fill more effectively than other means of transport:

i. Precise airborne surveying is required for mineral deposits, in the way that Zeppelin Luftschifftechnik has already demonstrated with its NT-07 successfully flying an airborne magnetometer and a gravimeter for the DeBeers diamond mining company in Botswana. In this context, an advanced airship such as the NT-07, has been proved to be a more efficient environmental remote sensing platform than any other type of aircraft, and its superior performance over all other types of airships is increased when airborne high-resolution side-scanning equipment is used to detect other kinds of geophysical anomalies as the diagnostic indicators of the deep geological structures, which may contain valuable mineral deposits. The advantage of this type of airship for this work lies in its great directional and altitudinal stability along a survey line, its long flight endurance, and its slow forward speed, and especially its very low altitude operating capability, at about 80 metres a.g.l., without any reduction in safety.

ii. Highly trained personnel, essential for mineral exploitation in the Arctic, will be seasonal workers, and while the warmer and longer summers will extend the season for outside work, the melting of the ice roads, and the melting of the permafrost and the tundra, will prohibit these workers from arriving and departing by surface transport. The airship is an attractive option because the distances involved are too long for the economic use of helicopters, and whereas an airship can operate safely at low altitude in the Arctic in IFR conditions and in periods of darkness, this is significantly more dangerous for a helicopter. Similarly, airships will provide an effective means for delivering vital supplies and high value items of technical equipment to the developing Arctic settlements based on mineral exploitation, because the use helicopters is too risky in the zero-visibility conditions of coastal fog, which is very common in summer, and in the darkness and freezing conditions which affect this high latitude region in winter.

iii. At some future time, the assets of each nation state with claims on the rights to extract mineral deposits from the Arctic will need some regular airborne surveillance, not only to provide frontier intelligence to help to defend national sovereignty, but also to survey at low altitude, and at low speed, such installations as long-distance supply pipelines, and the status of the surface geology on which they rest, in this rapidly changing physical environment.

To operate a regular airship service safely in the Arctic, a very efficient satellite-based weather forecasting service will need to be linked to a network of automatic weather stations, linked by telemetry to the most remote airship operating bases. Very comprehensive personal survival equipment and training will also be required for the airship crews, in a physical environment where even a minor system malfunction or misjudgement of the weather can be fatal. However, above all, there will need to be serious programme of airship hangar building along the proposed airship operating routes, with the development of operating criteria for safe operations at various distances away from these hangars, based upon the airship's performance, the prevailing and forecast wind speed and direction along the route, the forecast surface wind speed and direction at the hangar, and the minimum weather criteria for bringing the airship into the hangar safely. The possibilities exist for developing a wider range of safe weather avoidance scenarios for airships if they are equipped with long-range fuel tanks, and can either carry extra fuel, or have the capability to upload additional fuel along the route, but there will always be commercial considerations to weigh against carrying unnecessary payloads. The operation of a regular airship shuttle service into and out of an Arctic region exposes the airship to much more of the new variability, and unpredictability, of the weather than a single expeditionary flight, and this variability of the weather in the Arctic, even in summer, is now a major area for study.

The reason for the variability of Arctic weather, and for its long-term unpredictability, is the unprecedented deep injection into the Arctic atmosphere of larger flows of water vapour from the exposed ice-free ocean surface, and the potential energy which these flows deliver inland, far away from the coasts. Thermally-driven sea breeze fronts have recently been observed in the Arctic, and even local thunderstorms are now reported from relatively shallow clouds, both of which challenge the accepted models for these processes in the standard aviation meteorology textbooks. Intense polar lows have always been known to be capable of producing storm force winds at the surface in the Arctic. With global warming, there is now also an increasing pole-ward penetration by active frontal low pressure systems, which introduce sequences of weather conditions which are unsuitable for airship operations. The occasional severity of weather conditions in a rapidly changing Arctic environment, means that the only way to organise safe airship operations along regular "shuttle" routes, will be to build strong hangars at intervals of only several hours flying time along these routes, and at any convenient operating bases where the airships may serviced, and may be held safely in readiness for the seasonal operations to start.

Several polar-orbiting weather satellites fly over the Arctic every hour, so there is no shortage of frequently updated raw data about the characteristics of any major weather systems which are characterised by cloud patterns. However, in the absence of an established Arctic aviation weather forecasting service, all airship pilots will need to learn how to monitor, interpret and respond to the weather satellite data, and to facilitate this, direct weather satellite picture receivers and display units, and satellite telephones with data modems and Internet access, must become standard equipment in the cockpits of airships used in the Arctic. A great opportunity now exists in this region for developing airship operations to carry out specialised tasks which are impossible for other vehicles, and with the investment and the technology now available to address the challenging unpredictability of the changing regional weather and climate, the exploitation of this opportunity is imminent.

2. The need for airships to avoid severe storms in tropical and mid-latitude operations.

The increase in the rate of energy transfer in the global atmosphere as a direct result of global warming, the increased thermal activity and storm strengths at all scales, and the increased frequency of extreme events, has a very significant impact on airship operations, and is subject to regional variations.

i. The maximum size of thunderstorm clusters over such tropical regions as West Africa has increased, so that multi-cell thunderstorm clusters 200 kilometres wide can now often be identified in Meteosat weather satellite images, but it is difficult to quantify the long-term trend for larger storms since this source of imagery has been available only since 1977. While it may be acknowledged that only those driven by the search for diamonds might be tempted to accept the risks and operate an airship for survey work in central West Africa during seasonal storms, the gust fronts originating from such large storms may be experienced as far away as 150 kilometres from the edge of any storm, and may interact with tropical sea breeze systems within 150 kilometres of the Atlantic coast. A similar increase in the size and intensity of convective storms in central Africa, with a consequently larger geographical area experiencing the risk of gust fronts capable of ripping an airship from its mast, complicates future airship operations there. The accident to the Zeppelin NT-07 while moored on a mast in Botswana was unavoidable, given that this airship had no hangar and was moored to a temporary mast, and had no long-range capability to fly away from the weather, and given that this region was not routinely supplied with appropriate aviation weather forecasts specific for airships. Unless weather-proof hangars are used to support airship operations in tropical Africa, future airship operations will be exposed to similar risks from gust fronts associated with large thunderstorms. Knowledge about the occurrence of very violent gusts fronts travelling great distances away from large thunderstorms in tropical Africa is not new information, as it was reported in great detail by Hamilton and Archbold as long ago as 1945. What is new is that one highly respected airship operator has unfortunately recently lost a very expensive airship due to its exposure to the risk of such weather phenomena, and while this important practical operational experience has now been gained, it was at an avoidable and very great cost.

Although there exists a legacy of valuable practical experience of tropical weather, gained from operating gas airships is such locations as Florida, Singapore, Hong Kong, and Japan, the weather in such coastal locations is also now subject to global climatic change. Since 1970 a significant increase in the sea surface area in the tropics which reaches the critical sea surface temperature of 27 degrees Celsius, as one of the pre-requisites for the development of tropical cyclones, already has some impact on airship operations in tropical regions which are subject to these storms. The frequency of very severe tropical cyclones coming onshore before re-curvature has increased, the storm season for tropical cyclones has lengthened, and there are more short sequences of tropical rotating storms, of a severity below the hurricane or typhoon category, all of which reduces the length of the seasonal 'windows of opportunity' for airship operations between periods of stormy weather.

ii. In mid-latitudes, accelerated global warming is already having some profound effects on the dynamics of the weather systems, which are of direct significance for airship operations. The increased frequency of more active mid-latitude frontal low pressure systems in all seasons of the year in Western Europe is one such effect, so that, for example, it is no longer possible in the UK to regard the traditional summer season as a season entirely free of potentially damaging surface winds, and the frequency of storm force winds, which could destroy an airship moored on the traditional 'Goodyear' type of temporary mast, has increased.

As a result of global warming there is an expectation that western European winters will be milder and wetter as a result of increased penetration into the continent by Atlantic frontal depressions. Aviation weather forecasting technology has improved greatly in both the UK and in Germany since the unpredicted severe winter storm of 15-16 October 1987, which was well observed by the weather satellites as it approached the English Channel, but was not recognised soon enough by the numerical prediction models, or by the expert forecasters interacting with the observed fields, to update those existing forecasting models. The equivalent severe storm damage resulting from the storms identified as "Lothar" on 24 December 1999, and the "Paris Storm" on 28 December 1999, further intensified scientific efforts in Europe to develop the efficient forecasting tools which we have available today to provide warning when such diverse types of severe winter storms cross from the Atlantic coasts to heavily populated regions inland at very high speed in only 6-12 hours. A lead time of 6-12 hours would be sufficient for an airship operator to abandon operations in any region likely to be affected by the winds from such storms in excess of the 75 knots, which is optimistically regarded as a maximum windspeed tolerable by an airship moored on a 'Goodyear' type of mast. However, if a large hangar is unavailable locally, and the deflation of the envelope is not an option, the realistic range of options for evasive action, will depend on the type of airship, and its performance in terms of speed and endurance, to outrun an approaching storm to reach and safely enter a more distant hangar. Many different scenarios for storm avoidance could be considered, to take account of the specific geography of locations where airships currently operate, but the essential advice is that in Europe, just as in the Arctic, there is now an operational requirement to have strong hangars available within a few hours flying time of any airship operation, with this distance being adjustable based upon the lead time expected in any aviation weather forecast of the arrival of a storm.

For additional safety, it is strongly recommended that airship pilots, ground crew chiefs, and strategic airship operations planners should all become specially trained to interpret routine aviation weather forecast data for the accurate identification of weather hazards to any airship operation which may be approaching fast from beyond the visible horizon. The Deutscher Wetterdienst (DWD) provides a very comprehensive service for general aviation pilots in its truly excellent pilot self-briefing 'pc_met' meteorological data service, and Oxford Scientific Services Ltd. provides short training courses specifically to meet the needs of airship pilots and ground crew chiefs, who will need to access raw weather information via 'pc_met' and other weather information systems in Europe, and in other many more remote geographical regions of the world.

3. Examples of the need for an accurate understanding of local and regional weather processes of great significance to current airship operations, which are affected by global atmospheric warming.

In every region of the world where airships currently operate, there will be a need for an assessment of the weather risks to ensure continued safe operations, which will take some account of the effect of accelerated global atmospheric warming on local and regional weather processes, and the ability of the pilots, ground crew chiefs and strategic operations planners to access and correctly interpret the appropriate weather information and forecast data, and to do so with an appropriate lead time to preserve the widest range of operational options to avoid weather hazards. Many current airship operations are in populous areas, and involve flying in cities, near coasts, or in valleys, and some of the weather processes which pilots of airships need to understand for safe operations there have already been reported by this author elsewhere, (M. J. Harris, 2000, 2001, 2002, 2004, 2006), and will not be repeated here in this short paper.

However, a few selected examples of the observed effects of accelerated global atmospheric warming, in a range of situations relevant for airship operations, will hopefully illustrate how advanced this process is, and how it is already seriously affecting airship operations.

Many commercial airship operations involve flying over large cities. Overflights by passenger-carrying airships of the London metropolitan area are always popular and commercially successful, but the local weather characteristics of this city region are changing, partly as a result of global warming, and partly as a result of increased building development. The aerodynamic surface roughness of this city area is increasing with an increasing density of high-rise buildings near the city centre. The elimination of a significant percentage of open green space in the suburbs, to reduce the reflectivity of the surface in respect to solar radiation, as more gardens are converted into plots for domestic building extensions and for motorcar parking, and the increased energy consumption, and energy release to the atmosphere by air conditioning systems operating throughout the city in mid-summer, are all local factors contributing to the intensification of the London 'heat island' effect, which has now been studied for more than 40 years.

In addition, a significant effect of accelerated global atmospheric warming on the regional-scale weather dynamics has been to increase the probability of more intense high pressure systems, associated with more days of strong sunshine affecting the southern part of the UK in some summers, so that all these geographical factors listed above, which make the city climate hotter, will have longer periods of time to operate and build up a large excess of hot air in the lower atmospheric boundary layer over the city. The effect on airship operations will be a significant increase in thermal turbulence, which will affect passenger comfort, even at higher altitudes, and at progressively earlier times in the day as any summer 'heat wave' endures for more than a few days. There will also be an intensification of the low altitude diurnal 'tidal' flow of air between the largest London parks and the urban 'hot spots', and the similar low-altitude flow of cooler and more stable 'estuary air' from the Thames Estuary, along the sinuous axis of the River Thames, and into the central areas. Just as the thermal plumes from above the new high-rise towers should be avoided, passenger comfort in an airship can be further enhanced by flying above the cooler air which enters the city along the axis of the River Thames.

Similar local weather situations can be experienced in many other large cities throughout the world where airships are used for passenger flying, with the additional complication of the intensification of the other local weather phenomena, for example, those associated with sea-breeze front phenomena in such popular airship operating regions as the San Francisco Bay Area, where there is also a very complex interaction with katabatic and anabatic winds near the San Gabriel Mountains, which rise steeply just inland of the Bay. Experienced local general aviation meteorologists will usually know how such local weather phenomena will affect fixed wing and helicopter operations, but may seldom understand the specific weather requirements for planning airship operations in the same region. For a detailed local weather briefing, it normally requires some special contractual arrangement for an airship pilot to be able to discuss the weather directly with a professionally qualified meteorologist, rather than simply to receive the legally required pre-flight weather briefing from an official ‘weather briefer’. The automated pilot self-briefing weather services intended for general and commercial aviation route flying, are not sufficiently specific to be adequate for planning airship operations, and the official ‘flight briefers’ employed by national weather services and federal aviation authorities have a strict legal remit to convey only the officially approved actual and forecast data, using the nationally approved aviation weather terminology, rather than to enter into the world of speculation in a telephone conversation about what kind of weather might be significant for the safety of an airship. The risks of incurring public liability by indulging in such speculation are well understood by weather forecasting agencies, and that is the prime reason why they may sometimes seem less than helpful in tailoring any forecast for the needs of airship pilots. Even in the most aviation-aware developed countries, the specific weather forecasting requirements for specific airship operations are not covered by the official weather forecasting agencies, so the airship pilot is obliged to search the raw meteorological information data bases in order to retrieve and interpret the information which is specific to his or her operational needs and pre-flight risk assessment. Most airship pilots and ground crew chiefs, who have received some training by Oxford Scientific Services Ltd. in how to establish their own weather checklists for their own specific operational requirements, are usually very enthusiastic to learn more, so a distance learning programme has been designed to allow those airship pilots, who have attended short courses delivered by the author, to retain the capability for further follow-up tutorials by e-mail dialogue, according to the operational needs. This facility has been used most frequently by airship pilots who move from their established operations bases to fly in new geographical regions, with a different range of weather phenomena to understand, monitor and assess.

Psychology is as important as Meteorology in the processes used by airship pilots to make pre-flight risk assessments of the weather. Much of a pilot’s assessment of the weather is qualitative and calibrated relative to his or her own experience of flying in different weather conditions. Therefore an autumn morning in Friedrichshafen with a total cover of low cloud, fog patches, and occasional light rain will not have quite the same appeal for an airship pilot who has flown airships only in dry sunny weather in another continent, and would not be accustomed to waiting for the local weather window for safe airship flying to open after a few hours. Similarly, a European pilot, who has not seen just how large the mature cumulo-nimbus clouds are, which regularly approach Florida from the tropical Atlantic, may be greatly over-awed by such a sight dominating the western horizon, until he or she can realise that such clouds are very much higher than the thunderstorms normally experienced in Europe, and that they are, in reality, several hours away in terms of their local arrival time. In such circumstances, it is absolutely essential for airship pilots to learn how to access the best available weather satellite pictures, and to learn how to interpret them accurately as an essential part of their routine pre-flight assessment of the weather. While teaching pilots Meteorology during the past four decades, the author has also discovered that psychology is also a very important ingredient in the process of interpreting the weather graphics and satellite pictures, but that most pilots become very enthusiastic interpreters of this data after some expert tuition.

In a further development of the discussion of this same topic - the processes involved in the assessment of the risks from cumulo-nimbus clouds and active thunderstorms prior to flying airships - it is important to re-emphasise the need for airship pilots to be able to access and interpret radar images, thermal infra-red satellite images and maps of lightning discharges in their pre-flight weather assessments. In Europe, the DWD's 'pc_met' service provides all the meteorological data which a pilot might reasonably need to assess the risks from thunderstorms, but this information can only play a realistic part in a pre-flight risk assessment if the airship pilot also has a knowledge base of the local and regional effects of the topography, and has some viable concept of how the patterns of regional airflow develop around a thunderstorm in a specific locality.

As a specific example of this, airline pilots approaching Geneva Airport from the east over Lake Geneva, when there are convective rain clouds or thunderstorms over the Alps, often receive ATC warnings about low-level windshear on the approach over the Lake. MeteoSuisse and Geneva ATC are very well-informed about the phenomena which occur when precipitation downbursts from thunderstorms over the mountains, as far away as the Monte Rosa massif, and near the Matterhorn above Zermatt in Mattertal, are first channelled along the Rhone Valley, and then later spread out into a progressively thinner layer of wind shear over the surface of the lake, which delivers a strong tailwind component critically just before landing. The local airflow in the vicinity of Geneva Airport can also be further complicated by other windshears, Venturi effects, foehn winds, lake breezes, katabatic and anabatic winds, glacier winds, and the local 'Juran' wind, and it is interesting to note that one airship operating company often chooses a temporary masting site which can be affected by all these types of local airflow, which ensures that every take-off and landing is a truly educational experience for the pilots! Just as the airline pilots need to know very accurately about the complexity of the local airflow near such airports as Geneva, so do airship plots need to develop a knowledge of similar physical concepts, so that they can look intelligently into the meteorological data sets available to them via the Internet during their pre-flight self-briefing on the weather and make the appropriate risk assessment, and plan the flying accordingly.

In Friedrichshafen, in a location where nearly a century of practical airship flying experience has been acquired over and around Lake Constance (Bodensee), global warming will introduce some significant changes in the local weather in so far as it affects airship operations. For example, reverting to the discussion of the thunderstorm risk, there will be an increased frequency of exposure to low-level windshear in Friedrichshafen due to microbursts arriving from thunderstorms located 20-50 kilometres away, far to the south across the other side of the lake, and this will complicate the operation of the local lake breeze system, depending on the time of day. The maximum size of European summer thunderstorms seems to be becoming larger during the last 30 years, and along with this increased size comes the increased risk of windshear from microbursts, which can travel very fast over the smooth aerodynamic surface of a lake, and from lightning strikes, which have been reported on aircraft as far as 30 kilometres away from thunderstorms. Fortunately for the airship pilots based in Friedrichshafen and their passengers, there is no shortage of accurate and relevant weather information available via the approved Internet sources to maintain flight safety. However, the impact of global warming is producing similar changes to local weather processes elsewhere, which are equally significant for airship operations, in areas which may only be explored by airships on rare expeditionary flights or transit flights, and in preparation for these flights to be accomplished safely, there is a very strong logical case for commissioning some preliminary weather research, and for some more focussed airship pilot training in the relevant Meteorology.

Summary and Conclusion

The recent conclusions of the IPPC expressed in the AR4 document make it very clear that global atmospheric warming is a fact, that it has accelerated in the past 30 years, and that it is likely to increase for decades, even if some significant immediate remedial action is taken to reduce the emission of greenhouse gases within the next few years. Global warming has diverse regional consequences on the regional and local weather processes which will determine the safety and commercial efficiency of airship operations in new and existing locations. The introduction of new weather risks for airships, and the intensification of some existing risks to their safety, is to some extent counterbalanced by the opening up of new operational prospects, for example in the Arctic, and in the tropics, over the extensive corridors of clear air offshore of many very warm tropical land masses when enhanced sea breeze systems operate. The evaluation of risk and the daily assessment of the weather for airship flying will need to be done by the pilots and ground crew chiefs, because airship operations are too specialised for major aviation weather forecast agencies to provide ready-made weather forecasts for airship operations. When airship operations move into new geographical environments, there may be insufficient time to collect enough weather data to evaluate all the weather risks for their climatological significance, so if there is any doubt, a major programme of airship hangar building is required in remote areas.

Finally, above all, an updating of the training curricula and syllabuses in Meteorology for airship pilots and operators will be required, to enable them to optimise their use of weather forecasts in the new situations.

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