EUROCONTROL Cross Border Convection Advisory - Collaboration in Action

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This year, Operational Meteorologists from 13 national MET Providers [AEMET (Spain), ARSO (Slovenia), AustroControl, Croatia Control (CCL), DWD (Germany), Italian Air Force, KNMI (Netherlands), Met Office UK, Meteo-France, Meteo Swiss, OMSZ (Hungary), SHMU (Slovakia) and Skeyes (Belgium)] have been taking part in the European Cross Border Convective Advisory procedure for EUROCONTROL's Network Manager. The EUMETNET members producing the daily forecast aim to provide clear, and internationally consistent, information regarding the severity and probability of convective weather across the forecast domain.

2018 was a particularly bad year for convective weather in Europe. Weather disruption in general resulted in 5 million minutes of delay equating to around 25% of all air traffic flow management delays[1]. While EUROCONTROL receives weather information on a daily basis, they do not have a clear view regarding the risk of convection occurring. Subsequently they were unaware of how individual air traffic control (ATC) organisations were going to manage traffic in their region of interest and what the knock on impacts could be to air traffic due to the convective disruption. As a result of the disruption EUMETNET was approached to consider if the MET ANSPs (Air Traffic Control Air Navigation Service Providers) in the region of greatest disruption could develop a forecast that would cross the national borders of Europe to give a single view of the convective risk.

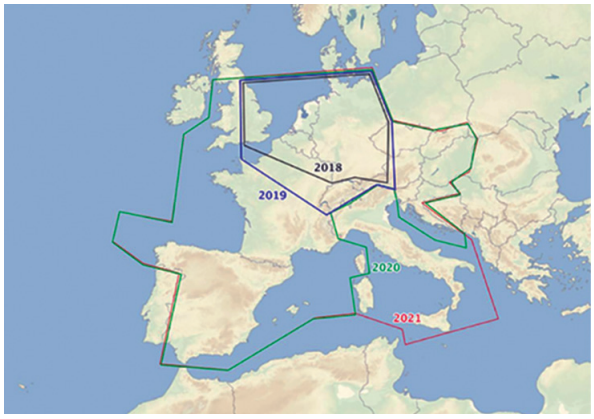
The Cross Border forecast aims to provide information on disruptive convective events across the European airspace, in order to alert EUROCONTROL's Network Manager regarding significant convective weather conditions that could impact air traffic and their capacities. Although Network Manager (NM) has no direct decisive control of individual sectors, constructive coordination with impacted ATCs (Air Traffic Control centers) is sought to implement mitigation measures such as calling in stand-by controllers, postponing military exercises or relaxing routing restrictions.

Since the procedure started in 2018, where only four MET ANSP were involved, the Cross Border Advisory has grown to cover the busiest airspace in Europe and enable NM as well as the ATC's in that area to prepare and plan for disruptive weather.

Who are EUROCONTROL

The European Organisation for the Safety of Air Navigation, commonly known as EUROCONTROL, is an international organisation working to achieve safe and seamless air traffic management across Europe. They have many functions to support airlines, airports, state traffic control as well as implementing the regulations of the EU. Ultimately they coordinate activities between the member states to aid the efficient flow of air traffic and they do this through a service called Network Manager (NM).

While NM does not manage the traffic, they do help all airspace users to manage the airspace



Extension of the Cross Border area from 2018 to 2021

1. https://www.eurocontrol.int/sites/default/files/2019-06/prr-2018.pdf

and keep it open when disruptions such as military activity, strikes, and weather impacts take place. They try to encourage communication and sharing of knowledge and their operations room (NMOC – Network Manager Operations Centre) aids this process.

Traffic has grown year on year and is expected to increase into the future as the recovery after the COVID-19 pandemic continues[2]. The implication of increased aircraft traffic means that there is less space for aircraft to move within the airspace and divert in the event of airspace closing for any reason. If ATC is unaware that airspace near to them, but in another country, is closed they can be taken by surprise when extra aircraft may try to enter their airspace which in turn creates congestion and potential delays as flights have to further divert - the European Network is a complex ecosystem!

Through the relationship that is developing between EUMETNET and EUROCONTROL, the participating MET ANSPs can together help provide advisory forecasts that are consistent within each state but also are effectively communicated through to other airspace users. This information regarding the impacts of convective weather allows users to plan for the disruption that may be caused resulting in fewer delays and happier passengers.

Why is convection significant for aviation?

Cumulonimbus (CB) clouds are the main meteorological phenomena that this forecast focuses on, primarily as CB clouds can be used as a proxy for possible 'weather avoidance'. Weather avoidance is the unplanned movement or deviation from the original flight plan requested at short notice by pilots as a result of 'weather' ahead. The reason that pilots would want to avoid these cloud types is due to the hazardous conditions associated within them (e.g. severe turbulence, downdraughts, icing and lightning). Multiple avoidance requests will lead to additional workload and complexity for air traffic controllers, who are then unable to safely handle the 'normal' amount of traffic, thus capacity of the airspace is affected. This ultimately can lead to the implementation of decisions and measures to help mitigate against this by ANSPs.

2. https://www.eurocontrol.int/covid19

What is the Cross Border Convection Advisory?

The procedure's primary goal aims to increase the stakeholders awareness of potentially significant convection that could disrupt the European Aviation network within the next 12 to 36 hours and support operational decision makers' effective and efficient management of the network. However, this year, the cross-border weather procedure will also play an important role in ensuring that the recovery from COVID-19 is as delay free as possible. A collaborative approach to weather management will be vital to ensure this impact is reduced as much as possible as air traffic begins to increase.

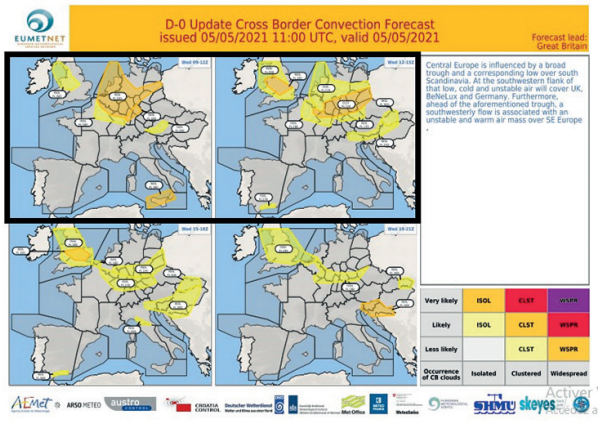
The forecast evolved from a powerpoint map that had hand drawn polygons through to the development of online collaborative tools that all participants could contribute to. The online tools were necessitated by the increased number of contributors considering participating on a daily basis in the advisory.

The forecast product contains a four period chart (09-12Z, 12-15Z, 15-18Z and 18-21Z) and summary text, which is intended to be clear and easily understandable by the Network Manager. A particular focus is given to the areas where the most severe weather conditions are expected or where the busier traffic corridors could be seriously impacted by CBs.

It informs about the CBs extension and their top levels (including the overshooting for deep convection) within harmonized polygons. The following example illustrates the collaboration between northern Europe countries to draw the orange risk level (*Clustered CBs likely*) for 09-12Z and 12-15Z charts (same polygon with a single harmonized top level). A common decision tree for risk level depending on convective ingredients has been created to help forecasters choose the appropriate level. The aim is to limit the number of different polygons in order to facilitate the Network Managers decision making

Risk Matrix

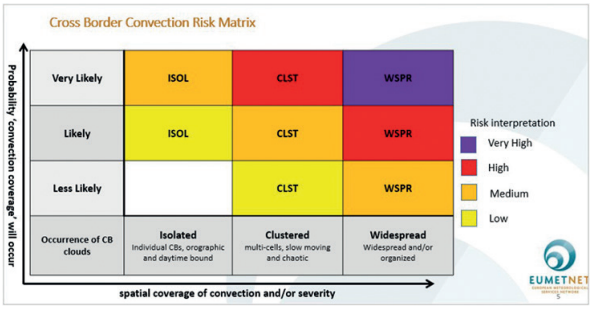
In 2018, the forecasters of the first Cross Border Trial period focused only on indicated informa-



tion on the risk of convection. This view did not consider the actual extent of convective weather, like the area coverage or phenotypic appearance of cumulonimbus clouds. During a workshop for 2019`s forecast preparation, the idea came up to assess both the probability and the extent of a convective scenario to try and better communicate the possible impacts.

This novel approach was well received by the users and helped the involved MET experts to further condense the risk/extent assessment to a 3x3 matrix, excluding low risks for isolated convection being non-significant for network-level weather.

Each operational meteorologist works towards the framework given by the matrix with set definitions for the probabilities and extent of convection. For probabilities 'Very Likely' is covered by a greater than 70% likelihood of convection, 'Likely' by a 40-70% range and 'Less Likely' a 10-40% range. For probabilities of less than 10% are excluded from the product. Extent has been broken down into three elements: isolated, clustered and widespread. Isolated refers to individual CBs which are often associated with diurnal heating and limited convective ingredients. Clustered CBs are supported by greater instability and are more chaotic. They will often change in severity with shear allowing for daughter cells. Widespread is the most severe level designated and covers well organised convective systems. Convection will be deep and spread across large areas without significant gaps.



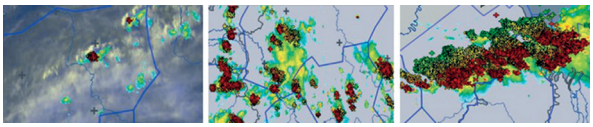
Three defined categories of storm's organization have been chosen to reflect the increasing impact on air traffic:

1. Isolated Cumulonimbus (CBs) (summertime typical convection by diurnal heating) that can be easily avoided by flights and represent a low risk.

2. Clustered CBs may occur with higher instability and when the situation becomes more dynamic with greater shear. Some cells can merge and the en-route avoidance is more difficult, with differing and random requests by pilots to the controller.

3. The highest risk is encountered with widespread convection. That means organized storm systems, such as cold fronts, squall lines or mesoscale convective systems. Thus, the convection spread through a larger area with a high vertical extension, leading to a high impact on the aviation network due to its long lifetime and severity.

Day to day process of preparing the forecast



▲ *Different storm organizations from isolated(left). to clusters (center) and widespread CBs (right).*

Each participant is responsible for the convective forecast in their own FIR(s). To maintain consistency and encourage collaboration six participants took turns to lead the forecast on a D-0 and D-1 basis[3]. This allows regional expertise to drive the product whilst providing a single point of contact to resolve discontinuities in the product.

As part of their forecasting process many meteorologists will use an element of ingredients based forecasting in combination with model output when looking at deep moist convection. This method provides a framework for understanding the potential for deep moist convection, the type of convection and the severity of it. It looks at the combination of instability or potential instability, low level moisture, triggers for release of the energy and wind shear.

3. Markowski P. and Richardson, Y., 2010: Organization of Isolated Convection. Mesoscale Meteorology in the Midlatitudes John Wiley & Sons, LTD, 201-244.

The nature of convection means that specific values do not lead to run on a spectrum which will be different for each participant region.

Whilst all of these parameters are important in the development of deep moist convection vertical wind shear likely exerts the greatest influence on storm type[3]. Commonly the 0-6km wind shear is used as a diagnostic tool with rough guidance thresholds of <20KT for ordinary cells, 20-40KT for multi-cells and >40KT for supercells however some overlap is to be expected. This cannot be used in isolation as supercells will require multi-directional shear, normally seen in a hodograph. Individual cells can, in environments that favour growth, become clustered and multicellular convection can become widespread in such environments.

This fundamental framework combined with model output and observations enables the meteorologist to assess the potential type and probability of convective activity.

As each participant is responsible for their own FIR it is likely that there will be some slight discrepancies between them at times. The lead participant is responsible for coordinating to ensure consistency between the FIRs through collaboration and the merging of polygons. Once the polygons have been created and adjusted the lead will write some accompanying text. This will include an overview of the convective weather situation as well as drawing attention to the key areas of potential disruption. In previous years the lead would write the text alone and other nations would provide comments, however the implementation of the EuFoCs tool has allowed for a more direct collaborative approach. It is important that the text is clear and addresses the key components of the forecast.

If requested by Network Manager, especially when a red and/or violet risk level is forecast, a telephone conference is triggered. The lead forecaster is then the focal point to discuss weather information with the NM and participating ATCs. For the 2021 session, the novelty is that during a specific period, the lead forecaster will be present on site, in the EUROCONTROL operations center, to support the Network Manager's operational staff with the weather forecast. Onsite meteorologists will also have a proactive function as MET information providers (thanks to coordination with the other forecasters) and a higher interaction with the local users.

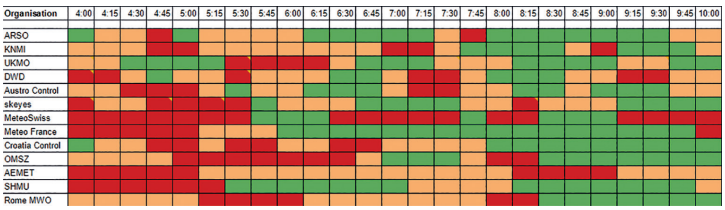
Collaboration! Sharing of knowledge and expertise

One of the key factors in the success of the procedure is the cooperation there has been between all the participant MET ANSPs. While MET organisations are very used to collaborating on research and science, as well as SIGMETs in the aviation world, rarely is there an opportunity for operational meteorologists from different areas to interact on a daily basis.

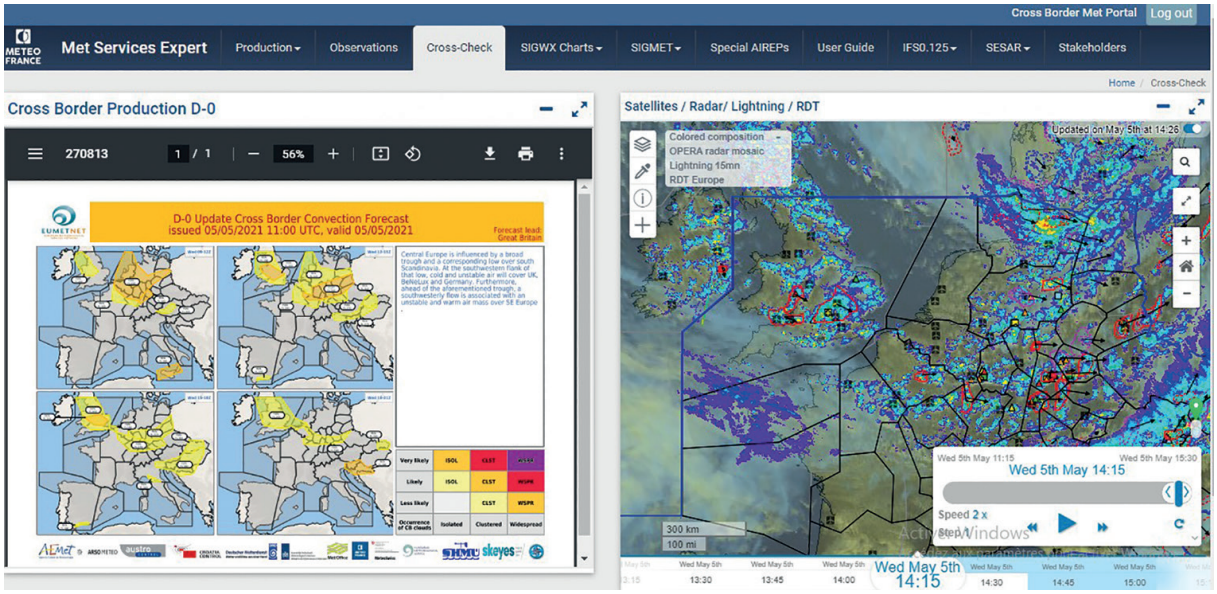
In the process of developing the forecast procedure we discovered many of the challenges faced by meteorologists in one location are similar to challenges faced elsewhere in Europe. These include prioritising forecasting activities, shift handovers, workload peaks and troughs, as well as variations in significance of some weather types. The development of rapport and knowledge base has significantly helped in the production of the forecast but it has also engaged some participants to develop their knowledge e.g. Exposing forecasters to the effects of severe convection over maritime or mountainous areas where they previously had limited experience due to the nature of their usual forecasting regions.

"Our forecasters at Skeyes have been very interested in participating in this product, on the one hand to step out of their comfort zone and work focusing on a larger area than Belgium, on the other hand because the collaboration combines the strength and expertise of the different forecasters (specific for local weather types) in one product. The scale of the collaboration has become much broader in recent years than at the start of the trial, which means that the importance of the input of local expertise has increased even further."

In addition, a Web Portal is provided by Météo-France to gather weather information for both stakeholders and MET participants. Observations (satellite, radar composite and lightning data), nowcasting tools and SESAR products are available via dedicated tabs. The Web Portal also helps as a support during conferences with Eurocontrol participants.



Busy Rosters: Trying to find a time for collaboration is hard when there are other operational tasks to undertake!



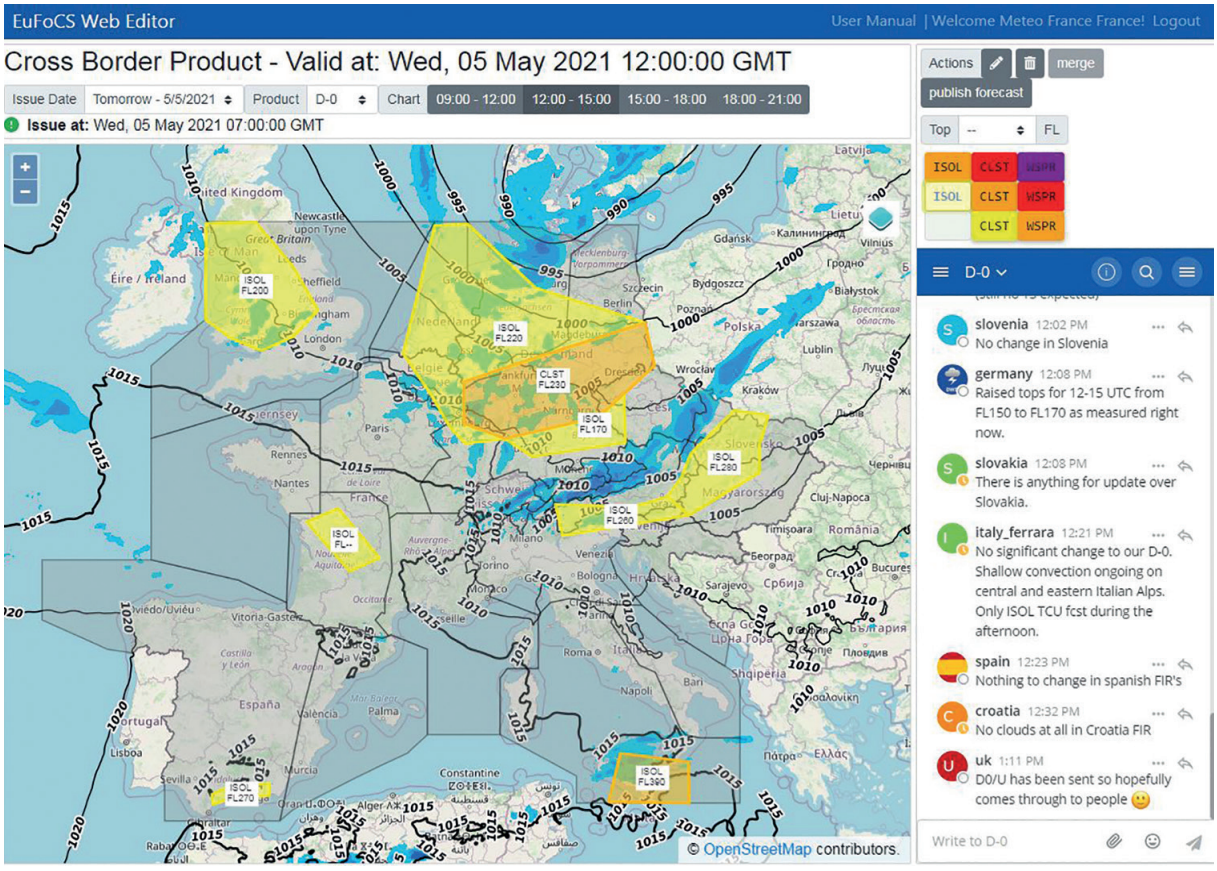
MétéoFrance Web Portal for stakeholders and forecasters

EuFoCS: Collaborative forecasting infrastructure

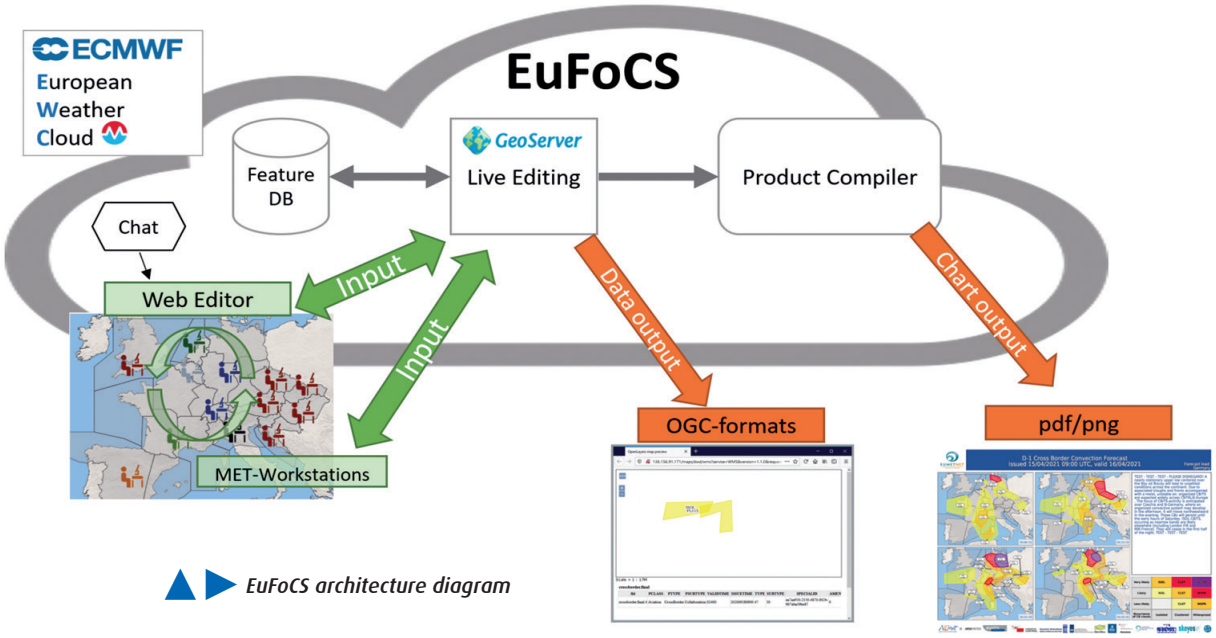
To reinforce the collaborative spirit of this project, a common production infrastructure has been developed by DWD (EuFoCS - *European Forecast Collaboration System*) which includes a commonly available web site with a chat-room section for live exchanges while editing the forecast.

EuFoCS is a system of various components necessary to develop chart forecasts hosted on the European Weather Cloud (EWC). As front end, a common web editor has been provided to enable all participating forecasters the same level of editing capabilities.

EuFoCS makes use of open standards and software libraries. The core element is a data server where all forecast polygons are stored in real time, using the WFS-T functionality (Web Feature Service Transactional). This enables participating forecasters also to use their in-house weather workstations as long as they are capable of using the WFS-T interface. During the forecast, some



EuFoCS Web Editor : forecast editing tool developed by DWD



EuFoCS architecture diagram

participants can assess their local data in their workstation and draw the polygons accordingly which are exchanged in real time to the others who work on the web editor or other linked tools.

The flexibility of EuFoCS as a production infrastructure also extends to the product dissemination: consumers can decide to fetch the forecast polygons directly from the database as OGC-compliant formats or to receive a traditional compiled graphical weather chart, e.g. in the pdf-format.

Using the preoperational EWC for this trial ensures a high level of independency, security and availability. As back up, the developers of DWD have set up a contingency site within EUMETSAT's cloud infrastructure. Further information about EuFoCS can be accessed via eufocs.support@dwd.de.

What the future may hold

The future of MET provision to EUROCONTROL's Network Manager is set to evolve into a longer lasting relationship that enables MET ANSPs to support NM as well as their own local airspace users. The Cross Border Advisory has proven to be an excellent stepping stone for the recognition of what a combined forecast can bring to an operational environment such as the NMOC.

The NMOC has evolved in the scope of its function since first instigated in 1995 and as traffic has increased so too has an awareness of weather impacts. More recently there has been a realisation that MET knowledge can be better utilised. The NMOC is now planning for its new operations centre to open in three years time and there is a drive to include a MET bench within it. How this will be achieved is yet to be seen, but it will involve the dedication of operational meteorologists who will proactively support and build on the first steps of the Cross Border Advisory to advise on the impacts of a wide range of weather phenomena.

Conclusions

Through technical developments and weather forecast skills exchanges, the Cross Border procedure is the result of an efficient European cooperation between meteorological and ATM services. Due to low air traffic during the 2020 session, because of the COVID crisis, there were limited conferences requested by ECTRL/NM despite some high risk forecasts. Nevertheless, feedback from Network Manager and ATCs from the previous Cross Border campaigns shows the Cross Border forecasts are very helpful in the air traffic regulation strategy, and has enabled discussions about the future of pan-European weather services. Furthermore, thanks to the European collaboration where each MET service brings its own local experience, meteorologists enlarge their convective forecast skills and understand the wider impacts of the forecasts they produce.

For further information regarding the whole procedure please contact lauren.donohue@eumetnet.eu.