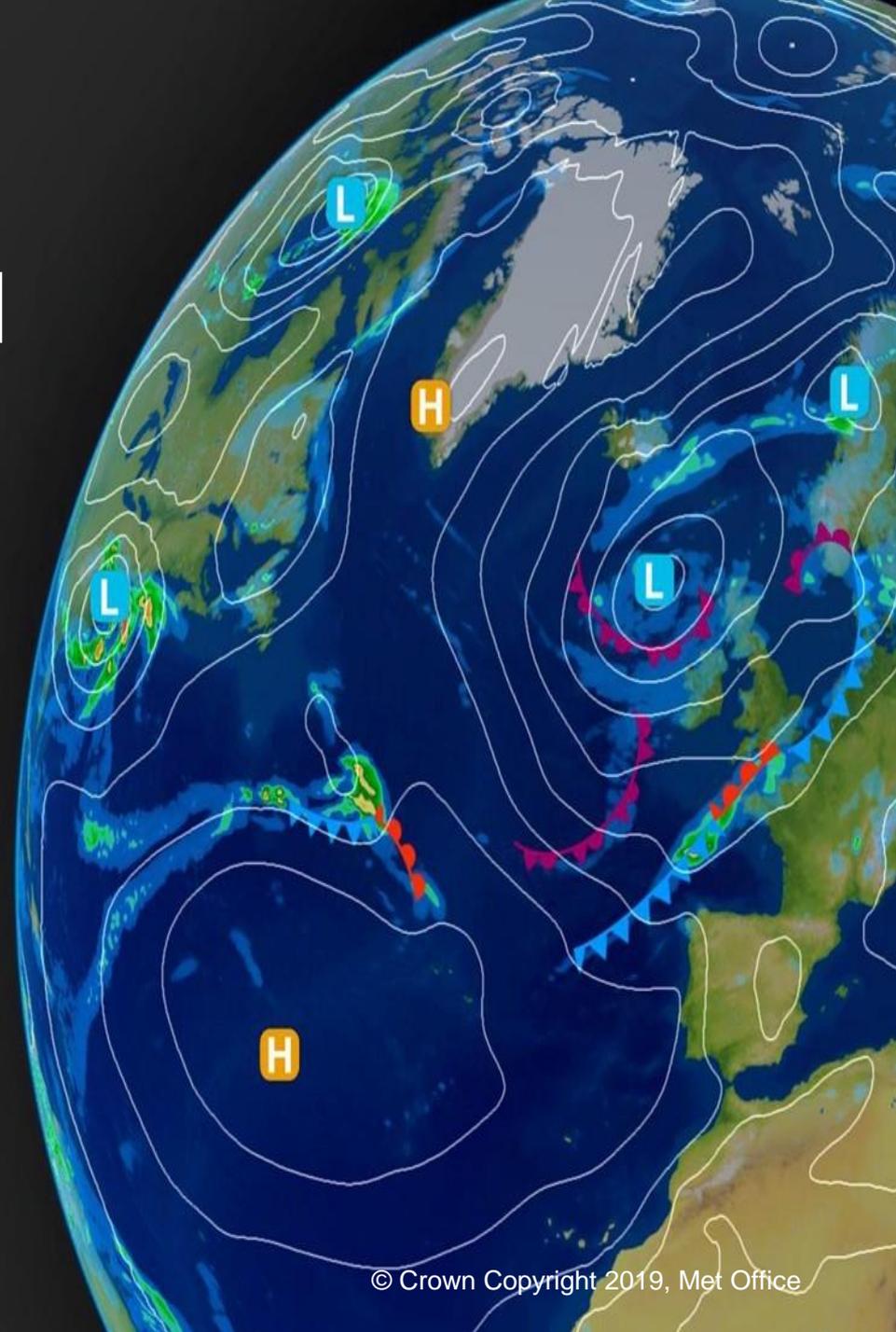


Operational Meteorologists and ABO

ABO Workshop, ECMWF
12th February 2020

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Aviation Operations Manager



Aim of the Presentation

- The importance of meteorology for civil aviation operation planning
- Available ABO sources for the meteorologists
- How meteorologists use the ABO to complement Numerical Weather Prediction
- Case Studies
 - Fog
 - Strong winds
 - Thunderstorms
- Summary
- Future

The importance of meteorology for civil aviation operation planning

- 70% of all delays at Heathrow Airport are weather related.
- Roughly 30% of all delays across Europe are weather related
- Accurate weather forecasts will not stop delays
- Prior planning can support operations on the day. *Better to plan for disruption, than recover from disruption.*



En-route ATC capacity (32.1%), en-route weather (27.1%) and en-route ATC staffing (18.2%) were the main causes of ATFM delays in July 2019.

The importance of meteorology for civil aviation operation planning - Heathrow

- Heathrow Fog – based on risk of forecast fog at D-1.
 - NATS apply flow rates based on the risk
 - High risk – 29-32
 - Moderate risk – 32-36
 - Low risk – 36-40
- Flow rates also applied for snow and strong winds



Heathrow LVP Status Forecast

For VIS < 600M at Heathrow.

Issue time and date: 02:46 (Z), 03/12/19 Meteorologist: Emma Murray

Time:	00-01z	01-02Z	02-03Z	03-04Z	04-05Z	05-06Z	06-07Z	07-08Z	08-09Z	09-10Z	10-11Z	11-12Z	12-13Z	13-14Z	14-15Z	15-16Z	16-17Z	17-18Z	18-19Z	19-20Z	20-21Z	21-22Z	22-23Z	23-24Z
DAY 1 (Tue 03/12/19)	N	N	N	L	ML	ML	ML	ML	ML	ML	L	N	N	N	N	N	N	N	N	N	N	L	ML	ML
DAY 2 (Wed 04/12/19)	MH																							
EXTENDED DAY 2 (Wed 04/12/19)	N/A	L	L																					
DAY 3 (Thu 05/12/19)	ML	L	N																					
DAY 4 (Fri 06/12/19)	N	N	N																					
DAY 5 (Sat 07/12/19)	N	N	N																					

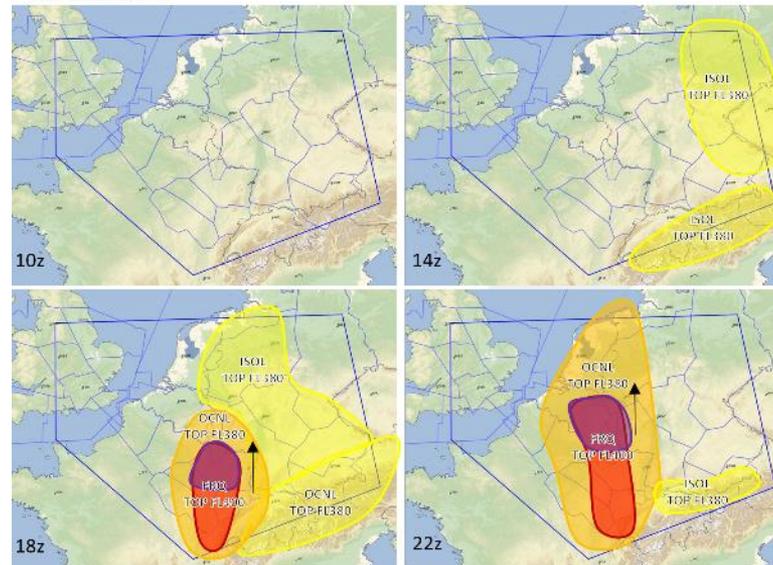
LVP Status	Comments	% Risk
N	Fog/LVP risk considered to be NIL	<5%
L	Fog/LVP risk considered to be 'low' but not NIL, would not normally appear in a TAF	5-29%
ML	Fog/LVP risk considered to be 'moderate', there remains uncertainty in its occurrence and remains less likely than likely	30-39%
MH	Fog/LVP risk considered to be 'moderate', there remains some uncertainty in its occurrence, but is a balance between likely/less likely (50/50)	40-59%
H	Fog/LVP risk considered to be 'high', it is now more likely than not	60-89%
VH	Fog/LVP risk is considered 'very high'. It is likely that this would be used when the airfield is in LVP conditions and the forecast is mainly concerned about clearance.	90% +

Comments: **Tuesday:** There is a Medium-low risk of LVPs/freezing fog developing until 10Z, with a Low risk until 11Z. Visibilities then set to improve during the afternoon ahead of a Low risk of LVPs for the coming night from 21-22Z and a Medium-low risk 22-24Z. **Wednesday:** Wednesday morning then sees a further, Medium-high risk of LVPs/freezing fog until 10Z and a Low risk until 12Z. In the evening there is a risk of fog/freezing fog reforming with a Low risk of LVP from 21Z. **Thursday:** The fog risk increases overnight to a Medium-low risk by Thursday morning, this risk clears faster than previous days as winds increase and cloud spreads in from the north-west. **Friday and Saturday:** Nil LVP risk.

The importance of meteorology for civil aviation operation planning - Europe

- Eurocontrol network managers looking into future pre-tactical decision making in airspace management
- Cross border weather collaboration, expanding across European National Met Services.

Summer Cross Border Weather Co-ordination valid 050619
Issued 04/0900

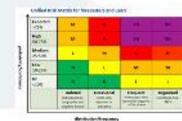


Unsettled conditions continuing across the region.

As daytime temperatures increase, there is a medium probability of ISOL CB developing across Germany.

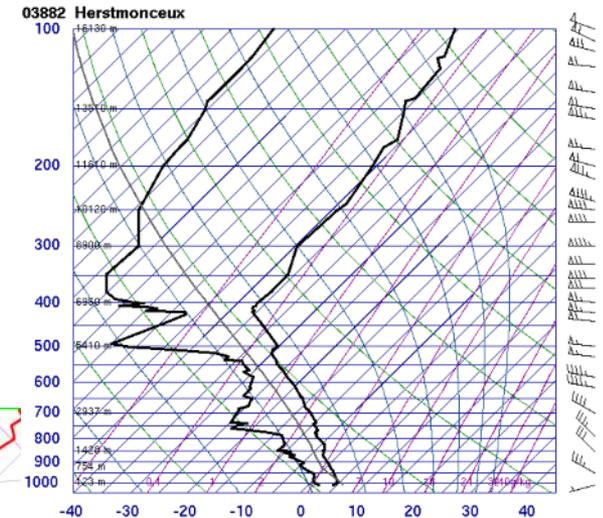
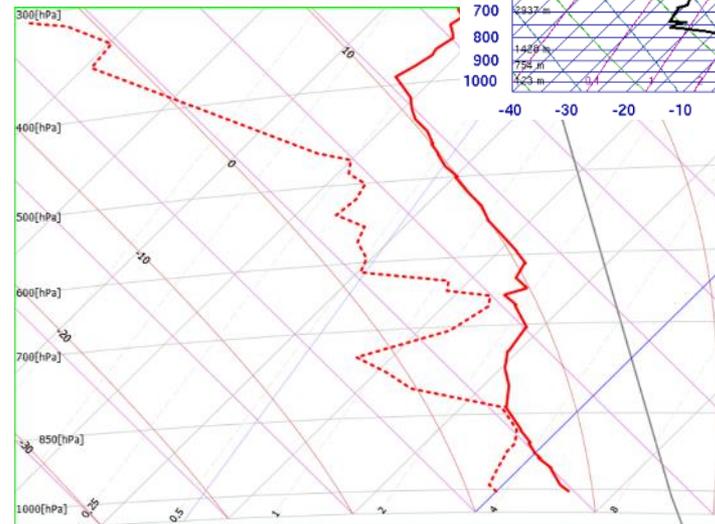
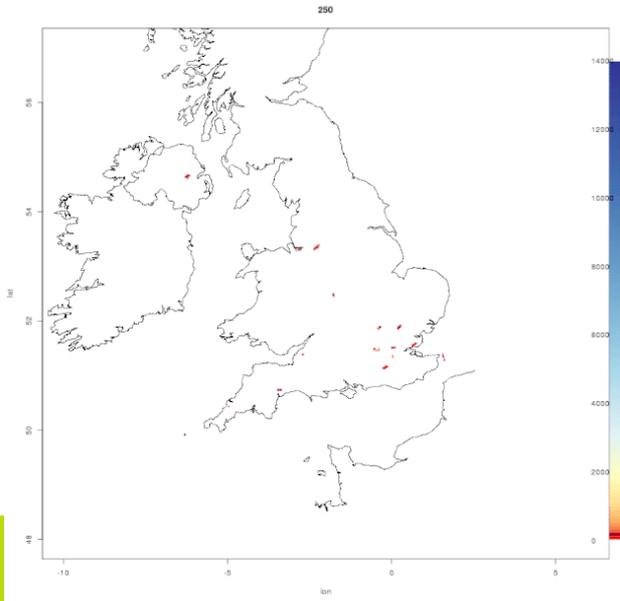
Orographically enhanced showers are likely to develop over the Alps during the afternoon, dissipating overnight.

Towards early evening there is a medium-high probability of FRQ EMBD CB (resulting in a Very High impact area) developing over southern Reims sectors into Brussels sector, moving northwards overnight.



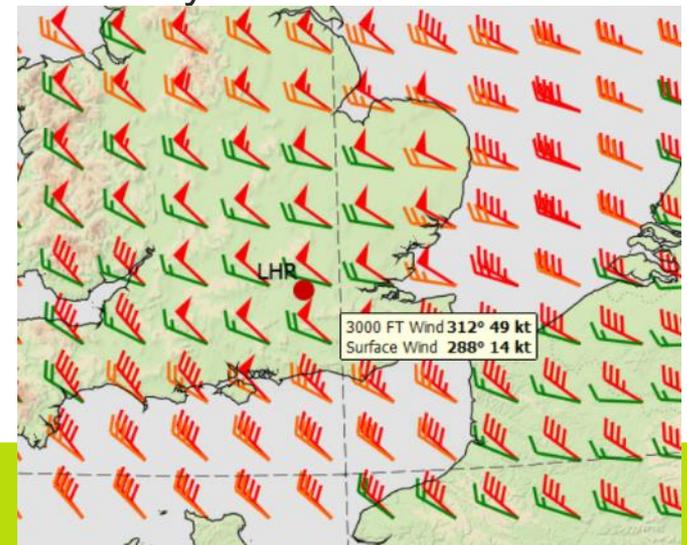
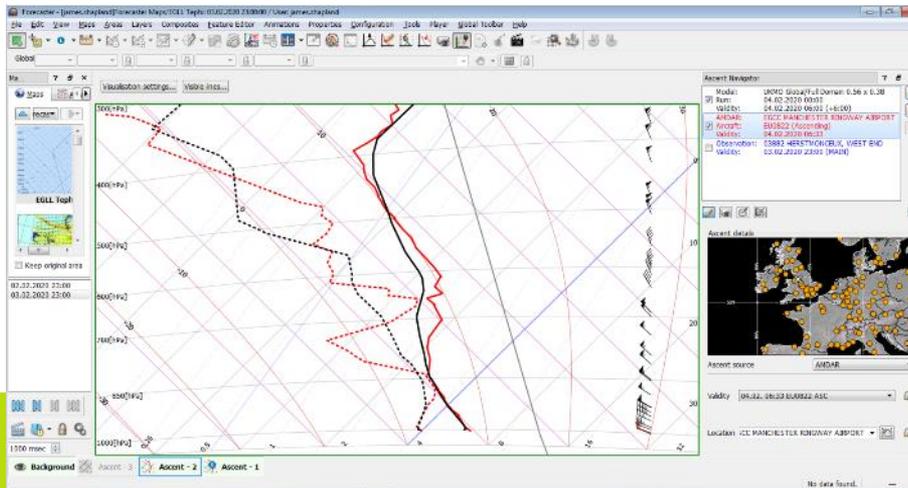
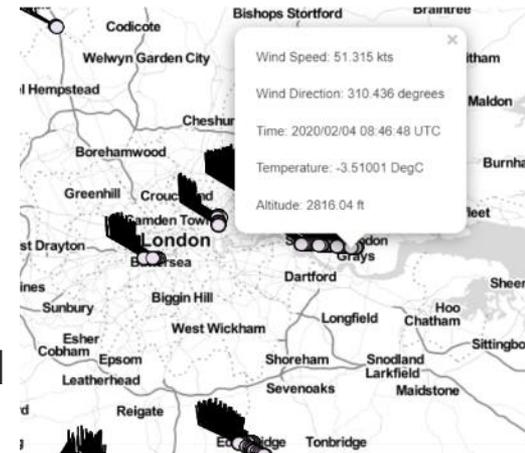
Available ABO sources for the meteorologists

- Radiosondes (via Visual Weather or websites)
- AMDAR (via Visual Weather or websites)
- Humidity enhanced AMDAR (via Visual Weather or websites)
- MODE-S (via website)



How meteorologists use the ABO to complement Numerical Weather Prediction

- NWP is not perfect?!
- Meteorologist still have a role in adjusting NWP to actual observations to enhance guidance to customers.
- Some empirical weather forecasting methods require actual observations (fog forecasting) for improved accuracy.
- Overlaying model fields with observational data is fundamental for forecasters – therefore integration into weather forecast systems is essential.

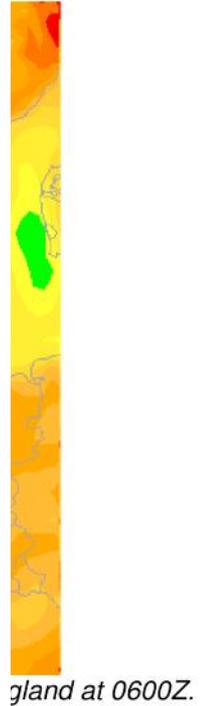
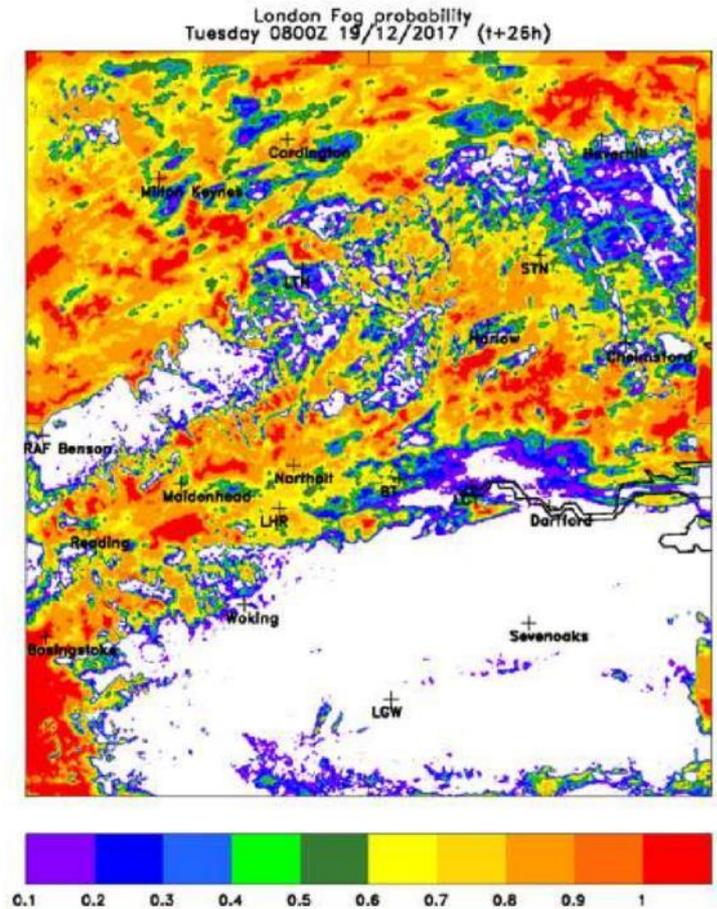
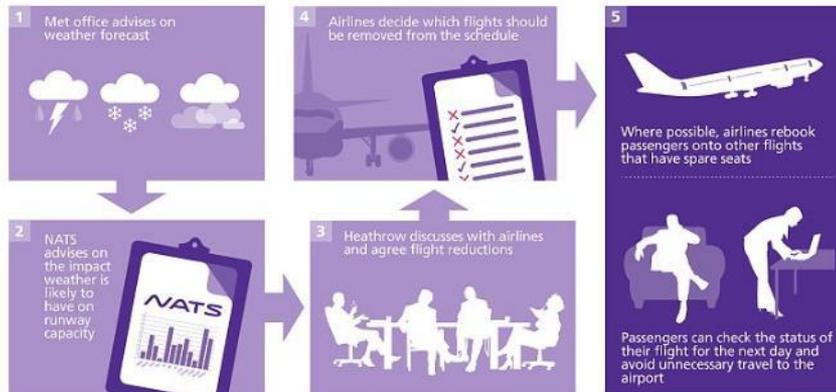


Case Study – 1. Fog (19th Dec 2017)

- Synoptically good setup for fog
- Strong model agreement
- High risk of fog excepted and presented to customers until late AM, possibly PM



THE PROCESS



Case Study – 1. Fog (19th Dec 2017)

- Fog occurred.....
- Fog clear around 0700Z
- **Customer cancelled
117 flights**

Local Obs at 0600Z

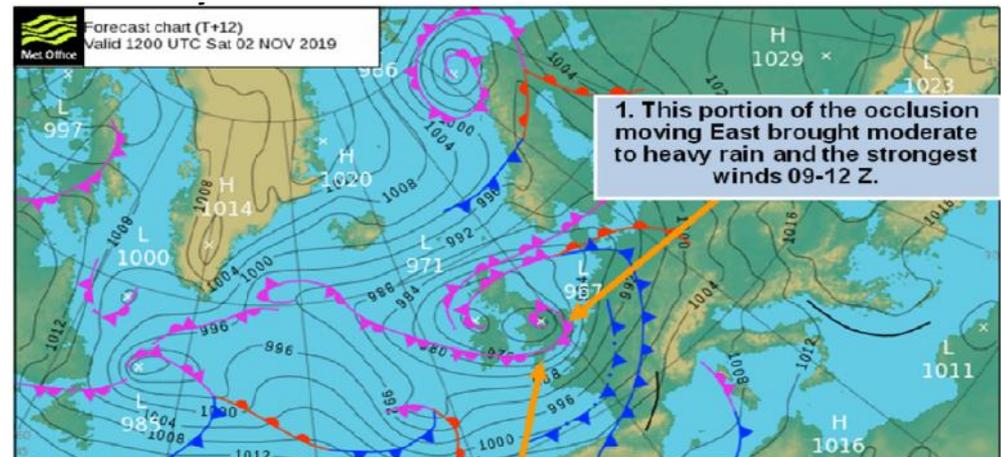


Case Study – 1. Fog (19th Dec 2017)

- Obs data later showed that the inversion was far lower than the models had captured – bringing a very thin, but dense layer of fog over England.
- Hypotheses into the clearance mechanism is that due to the lack of depth of the fog, when the first aircraft started to arrive into Heathrow, the wake vortices caused turbulence, entraining drier air from aloft to disperse the fog.
- *Enhanced ABO would have identified the depth of the inversion, allowing improved clearance times for the forecast – therefore reduce cancellation requirement.*

Case Study – 2. Winds (02nd Nov 2019)

- Low pressure system bringing S winds and CB/TS
- Surface winds expected to reach G45KT and 3000 FT winds 60KT
- Winds expected to bring landing rate down to 34 at times



D-1 Issued Fri 01st Nov

Date	Time (z)	SFC			3000 FT		RWY	COMMENTS	L V P	Mean LRP	Gust LRP	Risk of Reg	Spacing (nm)	Mean X- Wind	Gust X- Wind
		DIR	SPD	Gusts	DIR	SPD									
01/11/19 Fri	0300	130	04		200	22	09	RADZ BR MH risk VIS2, Low risk LVP		44			3.5	3	0
	0600	160	06		210	32	09	RADZ BR MH risk VIS2, Low risk LVP		45			3.5	6	0
	0900	190	10		220	32	27	RADZ BR MH risk VIS2, Low risk LVP		40			3.5	10	0
	1200	200	06		250	18	27	RADZ BR MH risk VIS2, Low risk LVP		40			3.5	6	0
	1500	220	08		250	20	27	PROB30 -RA		40			3.5	6	0
	1800	180	06		230	30	27	PROB40 +SHRA +RA Med risk EMBD CB		40			3.5	6	0
	2100	190	12		230	38	27	PROB40 +SHRA +RA Med risk EMBD CB		38			3.5	12	0
	2400	220	10		250	35	27	Medium risk EMBD CB E LTMA TL 01Z		38			3.5	8	0
02/11/19 Sat	0300	220	12		250	35	27			38			3.5	9	0
	0600	220	15	25	240	38	27	PROB30 SHRA		38	37		3.5	11	19
	0900	210	24	38	220	55	27	RA SHRA		37	36		3.5	21	33
	1200	210	28	45	230	60	27	PROB40 SHRA Low risk ISOL CB S/SE		35	34		3.5	24	39
	1500	210	22	35	230	58	27	PROB40 SHRA Low risk ISOL CB S/SE		36	35		3.5	19	30
	1800	210	18	28	240	52	27	RA SHRA Low risk ISOL CB S/SE		36	36		3.5	16	24
	2100	220	16	26	250	45	27	RA SHRA Low risk ISOL CB S/SE		36	36		3.5	12	20
	2400	220	14	24	250	38	27	RA SHRA Low risk ISOL CB S/SE		37	37		3.5	11	18

Case Study – 2. Winds (02nd Nov 2019)

- Turbulence off the British Airways hangar caused 4 go-arounds, before Heathrow changed runways.
- Forecasters kept track of the NWP and MODE-S 3000 FT winds, to track consistency and trends
- Confidence in the forecast allows Heathrow/NATS to hold firm on their application of flow rates – allowing a consistent and efficient approach
- **12 flights cancelled due flow rates and go arounds.**
- *This could have been worse if it wasn't for the confidence in the forecast from ABO.*

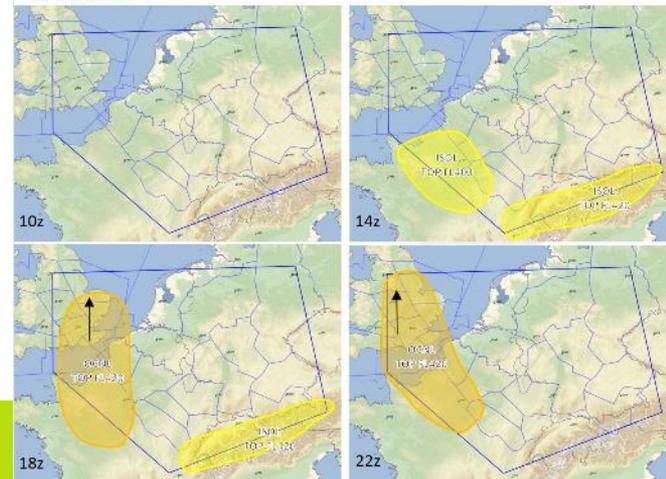
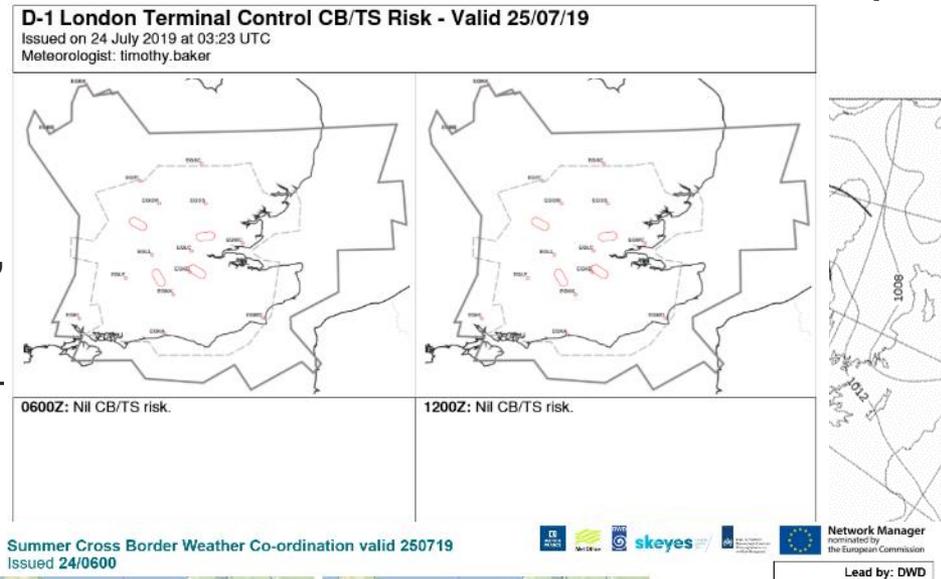
Time	00Z UKV		06Z UKV		Actuals		12Z UKV
	Model Avail 0530Z	Actual Given	Model Avail 1130Z	Actual Given	Amdar A/C Rep	Mode-S	
0500	240 38	230 35					
0600	230 43	230 44					
0700	230 53	230 38					
0800	220 54	230 45					
0900	210 62	228 60	636 641	210 58			
1000	210 66	205 59	637	209			
1100	220 63	218 60					
1200	240 50	230 48	240 48	230 48	240 42		
1300			250 42	240 36			
1400			250 42	240 40			
1500			240 48	245 43			
1600			240 48	245 52			
1700			250 45	240 45			
1800			250 45	240 46			
1900			260 45	230 41			
2000			260 42	240 37			
2100			250 38	240 37			
2200							
2300							

NAE & GM Hybrid 11 = 28
UKV & E4 Hybrid 16 = 29

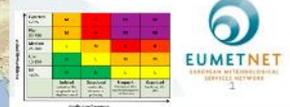
2 GA
de-alternate 10-15z
2 GA - Bird strike

Case Study – 3. Thunderstorms (25th Jul 2019)

- ‘Plume’ style setup across France and the UK.
- Risk of CB/TS developing was a threat, but location confidence was low.
- As confidence in the story was limited – customer took no proactive approach.
- ISOL CB/TS was forecast by meteorologists, with only a low risk of organised cells

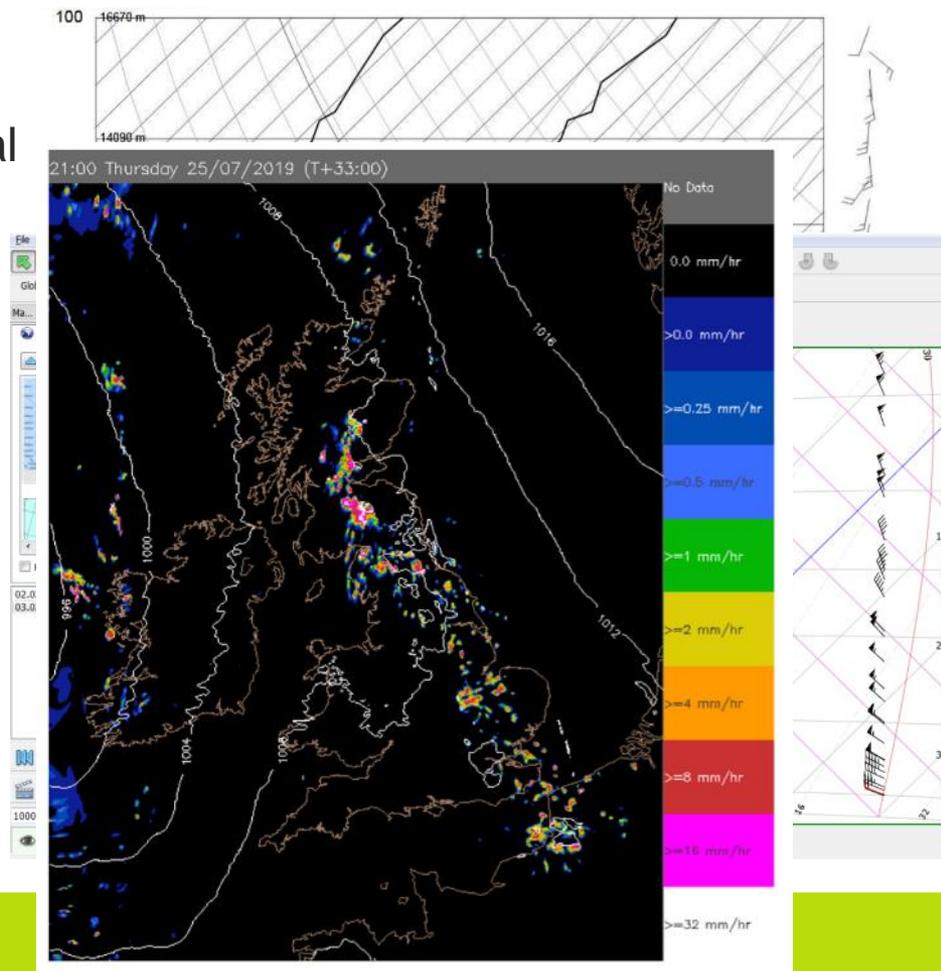


- Initially, settled conditions are expected.
- Due to daytime heating, ISOL CB/TS may develop in the Alps, mainly at the southern rim, dying out by night.
- Caused by dynamic lifting, there is a Medium risk of ISOL EMBD CB/TS in Central and North France in the afternoon. These TS and showers will advance to London TMA and become more organized by evening. A Medium Risk of OCNL CB is also expected during the first half of the night.



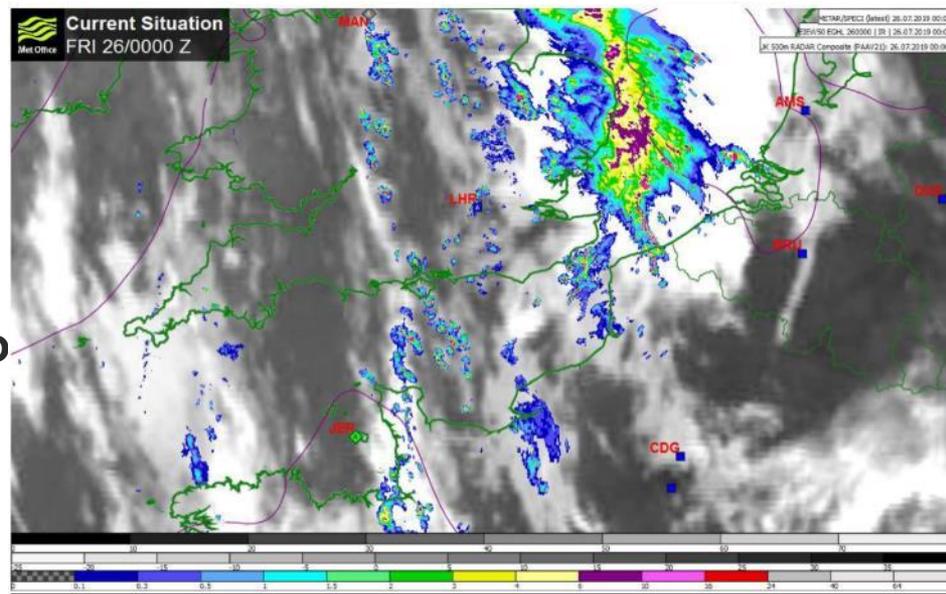
Case Study – 3. Thunderstorms (25th Jul 2019)

- A mixture of radiosondes, AMDARS and Humidity AMDARS were used throughout the day to monitor the actual vertical profile modification throughout the day.
- Assessment of ABO vs NWP allowed meteorologist to give real-time updates of CB development threat
- NWP struggled – especially identifying organised cells
- Forecasters modified output to indicate risk of MSC/plume style event – but confidence was not high in the detail



Case Study – 3. Thunderstorms (25th Jul 2019)

- 40C+ temperatures over Paris enabled surface based convection, and tops to reach FL400
- **154 cancelled flights from Heathrow.**
- **132 flights cancelled from easyJet, with another 180 the following day to recover the schedule.**
- **30,000 minutes of delay reported by NATS**

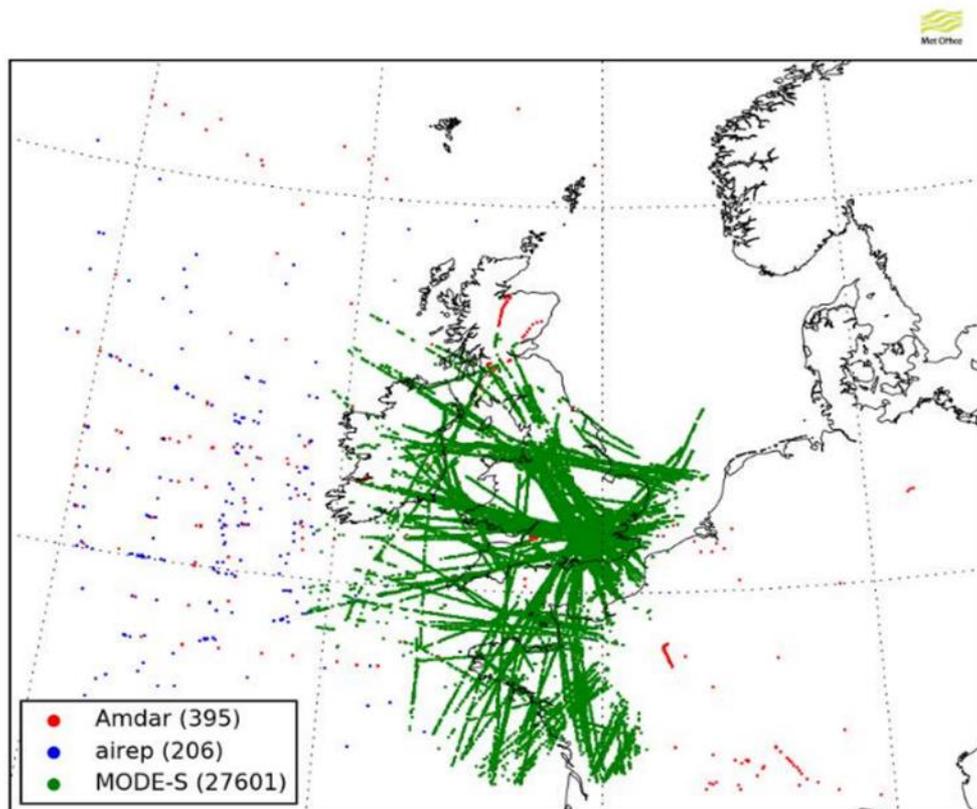


- *ABO allowed forecasters to monitor the constant changing of the vertical profiles of the atmosphere – and identify that NWP was too dry in certain layers, therefore increased the CB threat/extent. Forecaster guidance provided 2-3 hours additional notice of timing/location of CB threat, increasing airborne safety and efficiency.*

Overview

- ABO is assimilated into the NWP
- ABO can be used in realtime (if available on forecaster systems) to enhance NWP, and therefore short and medium term forecasts for wind, snow, CB/TS and fog.
- ABO (MODE-S) data is being used by NATS to optimise aircraft spacing during strong wind events, increasing landing rates by 1-3 per hour.

2020020412 : Aircraft assimilated datacoverage reports =28202



Future?

- Better tracking of the financial, reputational and safety benefits of ABO
- Increase in humidity AMDARS
- Potential use of drones as dedicated Met Observation systems
- Turbulence reporting EDR (Delta, easyJet)
- Future Flight systems – with integrated met equipment / 5G (£300 million investment by UK Gov/industry)

Questions & Answers

For more information please contact



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