Corso di Dottorato di Ricerca in Scienze della Vita e dell'Ambiente - Ciclo XXXVIII

Analysis of Climate Change Impact on the Aviation and Safety Strategies in the European Airports

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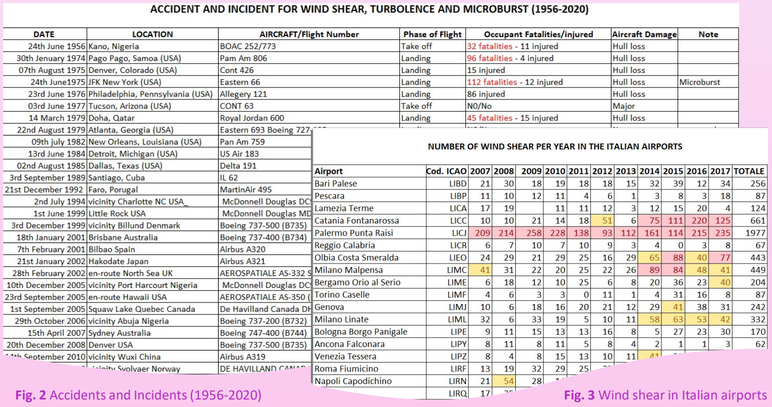
INTRODUCTION

Have you ever experienced turbulence during a flight? Have you ever encountered rough landings or extended takeoffs? Perhaps you thought the pilot wasn't very skilled, but it was probably due to moderate **wind shear.** The International Civil Aviation Organization (**ICAO**) defines wind shear as "a change in wind speed and/or direction in space, including updrafts and downdrafts", specifying its significance to aviation lies in its effects on **aircraft performance** and hence its potentially adverse effects on **flight safety**. Its occurrence in the lowest level 500 m (1 600 ft) is of particular importance to aircraft landing and taking off. In this regard, the US Federal Aviation Administration (FAA) and NASA have established an integrated program to reduce the wind shear hazard to aircraft (*S.S. Mulgund et al. 1993).* However, it is important to note that these strategies are **not universally applied or applicable**, as evidenced by the **tragic crash** of a Boeing 737 at Rostov-on-Don Airport (the European part of Russia) in 2016, resulting in the loss of all **62 lives** on board (*A. O'Connor et al., 2019*).

Fig. 1 Airplane in "go around" during the Ciara winter storm North Europe 2020.

AIM OF THE STUDY

***The research aims to analyze data on significant atmospheric phenomena that have impacted air traffic in Europe, and to consider potential strategies to mitigate the risk of aviation disasters*.**



ACCIDENT AND INCIDENT FOR WIND SHEAR, TURBOLENCE AND MICROBURST (1956-2020)

DATE	LOCATION	AIRCRAFT/Flight Number	Phase of Flight	Occupant Fatalities/injured	Aircraft Damage	Note
24th June 1956	Kano, Nigeria	BOAC 252/773	Take off	32 fatalities - 11 injured	Hull loss	
30th Jenuary 1974	Pago Pago, Samoa (USA)	Pam Am 806	Landing	96 fatalities - 4 injured	Hull loss	
07th August 1975	Denver, Colorado (USA)	Cont 426	Landing	15 injured	Hull loss	
24th June1975	JFK New York (USA)	Eastern 66	Landing	112 fatalities - 12 injured	Hull loss	Microburst
23rd June 1976	Philadelphia, Pennsylvania (USA)	Allegery 121	Landing	86 injured	Hull loss	
03rd June 1977	Tucson, Arizona (USA)	CONT 63	Take off	N0/No	Major	
14 March 1979	Doha, Qatar	Royal Jordan 600	Landing	45 fatalities - 15 injured	Hull loss	
22nd August 1979	Atlanta, Georgia (USA)	Eastern 693 Boeing 727-				
09th july 1982	New Orleans, Louisiana (USA)	Pan Am 759				
13rd June 1984	Detroit, Michigan (USA)	US Air 183				
02nd August 1985	Dallas, Texas (USA)	Delta 191				
3rd September 1989	Santiago, Cuba	IL 62				
21st December 1992	Faro, Porugal	MartinAir 495				
2nd July 1994	vicinity Charlotte NC USA_	McDonnell Douglas DC				
1st June 1999	Little Rock USA	McDonnell Douglas MD				
3rd December 1999	vicinity Billund Denmark	Boeing 737-500 (B735)				
18th January 2001	Brisbane Australia	Boeing 737-400 (B734)				
7th February 2001	Bilbao Spain	Airbus A320				
21st January 2002	Hakodate Japan	Airbus A321				
28th February 2002	en-route North Sea UK	AEROSPATIALE AS-332 S				
10th December 2005	vicinity Port Harcourt Nigeria	McDonnell Douglas DC				
23rd September 2005	en-route Hawaii USA	AEROSPATIALE AS-350 (				
1st September 2005	Squaw Lake Quebec Canada	De Havilland Canada DH				
29th October 2006	vicinity Abuja Nigeria	Boeing 737-200 (B732)				
15th April 2007	Sydney Australia	Boeing 747-400 (B744)				
20th December 2008	Denver USA	Boeing 737-500 (B735)				
14th September 2010	vicinity Wuxi China	Airbus A319				
	vicinity Svolvaer Norway	DE HAVILLAND CANAD				

Fig. 2 Accidents and Incidents (1956-2020)

NUMBER OF WIND SHEAR PER YEAR IN THE ITALIAN AIRPORTS

Airport	Cod. ICAO	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	TOTALE
Bari Palese	LIBD	21	30	18	19	18	18	15	32	39	12	34	256
Pescara	LIBP	11	10	12	11	4	6	1	3	8	3	18	87
Lamezia Terme	LICA	17	19		11	11	12	3	12	15	20	4	124
Catania Fontanarossa	LICC	10	10	21	14	18	51	6	75	111	220	125	661
Palermo Punta Raisi	LICJ	209	214	258	228	138	93	112	161	114	215	235	1977
Reggio Calabria	LICR	6	7	10	7	10	9	3	4	0	3	8	67
Olbia Costa Smeralda	LIEO	24	29	21	29	25	16	29	65	88	40	77	443
Milano Malpensa	LIMC	41	31	22	20	25	22	26	89	84	48	41	449
Bergamo Orio al Serio	LIME	6	18	12	10	25	6	8	20	36	23	40	204
Torino Caselle	LIMF	4	6	3	3	0	11	1	4	31	16	8	87
Genova	LIMJ	10	6	18	16	20	21	12	29	41	38	31	242
Milano Linate	LIML	32	6	33	19	5	10	11	58	63	53	42	332
Bologna Borgo Panigale	LIPE	9	11	15	13	13	16	8	5	27	23	30	170
Ancona Falconara	LIPY	8	11	8	11	5	8	4	2	1	1	3	62
Venezia Tessera	LIPZ	8	4	8	15	13	10	11					
Roma Fiumicino	LIRF	13	19	32	29	25							
Napoli Capodichino	LIRN	21	54	28									
	LIRQ	17											

Fig. 3 Wind shear in Italian airports

METHODOLOGY

The methodology regarding this first year of Ph.D. research involves collecting literature material related to **flight accidents** and to those severe **meteorological phenomena** at their origin. It was decided to investigate air accidents due to **wind shear,** focusing on the impact of its severe forms, such as **microbursts** or **downbursts**, on aviation.

Considering the ongoing climate changes, it is crucial to acknowledge the potential impact on intensifying both the **frequency and intensity** of such weather phenomena, thus, the following phases have been planned for data collection: **(A) Analysis of wind shear accidents and incidents** occurred in air transport over the last couple of decades (Fig.2). **(B) Analysis of data** regarding the **increase in severe meteorological phenomena** in Italy and in the EU airports (Fig.3-6); **(C) Evaluation** of the low-level wind shear **forecasting technologies** available in airports; **(D) Detection of geographical features** increasing airports vulnerability to climate change-induced phenomena.

The overall objective is to increase awareness of these potential risks and help design emergency protocols for those airports lacking the technology to detect the presence of wind shear thus increasing their disaster prevention capacity and overall aviation safety. The solution to this type of problem cannot only be technological in nature but requires policy adaptation.

NEXT PHASES

Over the next months, I will be investigating different aspects of aviation safety, from both the technological and procedural perspectives. For example, I will deepen my understanding of the **FORECASTING TECHNOLOGY,** for which I am in the process of defining an internship period with **LEONARDO Germany GmbH** (by Leonardo S.p.A.) to better understand what is available in terms of technological solutions to reduce fatal accidents due to wind shears.

I will keep analyzing and comparing the **STATISTICS** of the outcomes of the US approach (Fig. 5) in reference to the EU data to better define future strategy suitable for European countries. I am planning to also develop **MAPS** showing the location of the vulnerable airports that will likely be increasingly exposed to wind shear hazard. I will also acquire opinions on flight safety directly from airline pilots by performing **SURVEYS** with both open questions and multiple choices answers.

The interpretation of these results will help understanding the perception of risk in the aviation industry thus direct strategic planning to face extreme meteorological events.

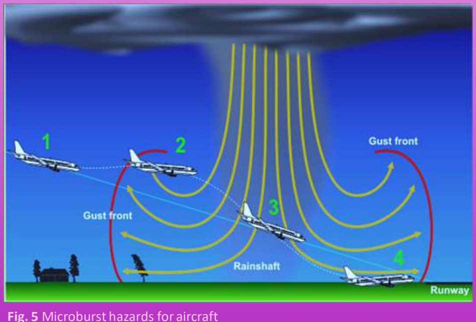
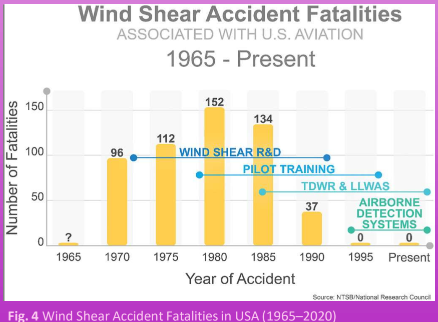


Fig. 5 Microburst hazards for aircraft



Source: NTSB/National Research Council

Fig. 4 Wind Shear Accident Fatalities in USA (1965–2020)

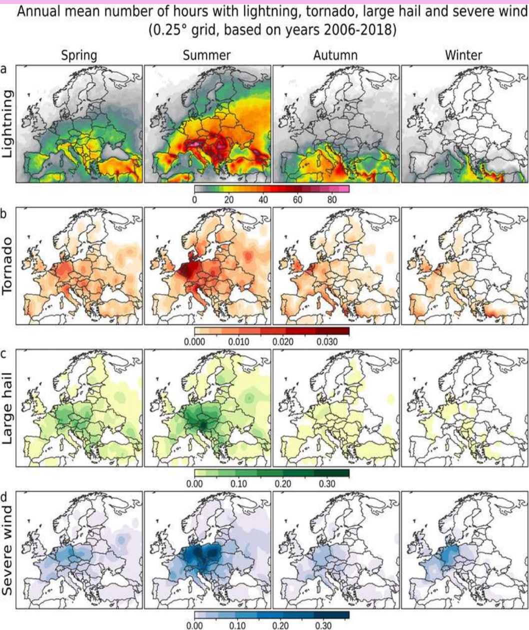


Fig. 6 Severe weather reports in Europe

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