



Investigation of Thunderstorms over Atatürk International Airport (LTBA), Istanbul

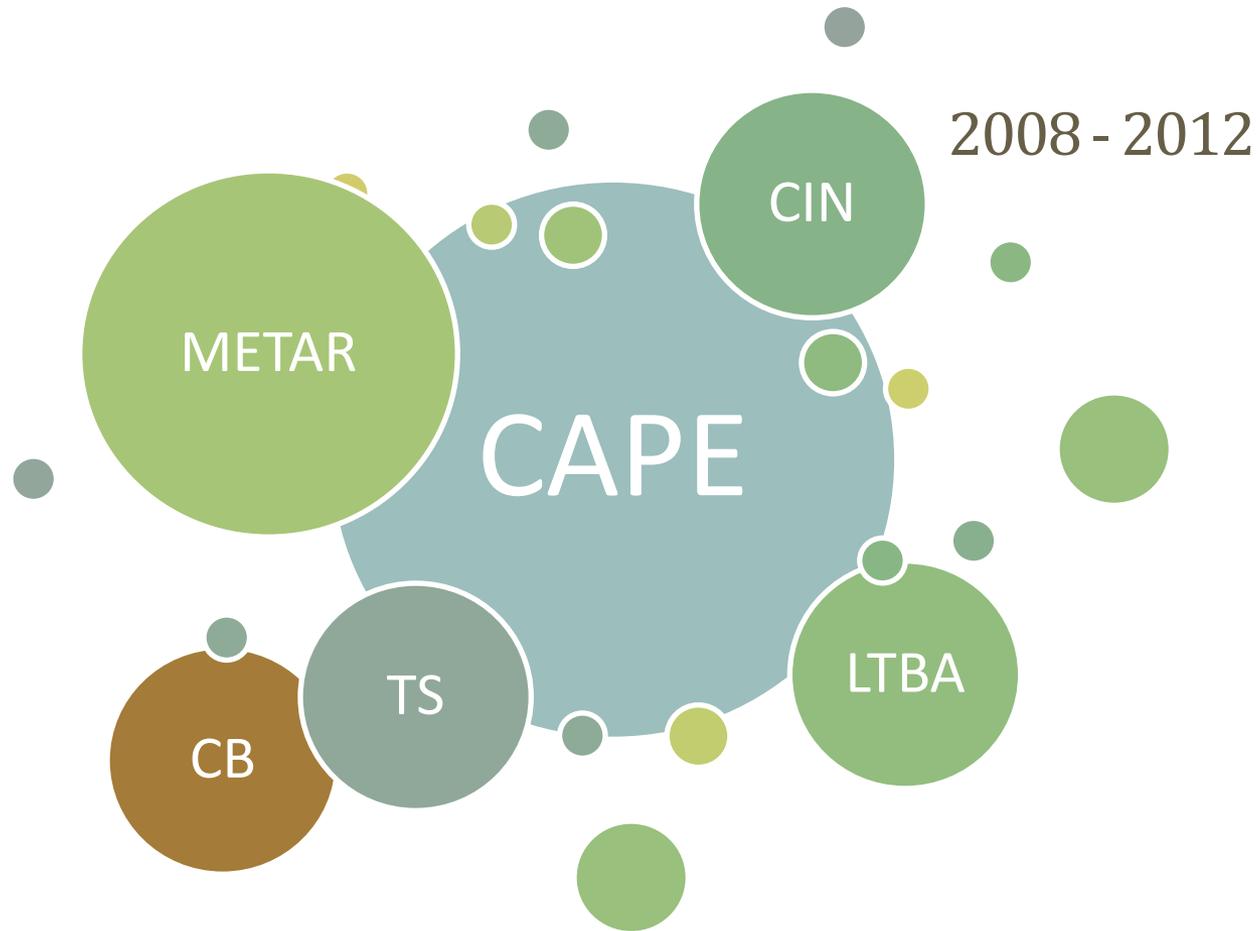
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Main Purpose



TS and CB

A **thunderstorm (TS)**, also known as an electrical storm, is a severe weather phenomena characterized by lightning and its acoustic effect, extreme shower, updraft and downdraft and sometimes severe icing at higher levels produced by cumulonimbus cloud. (NOAA Glossary, 2013).



Previous Studies

A

- **Sasse and Hauf (2003)**, investigated the effects of TS on landing aircrafts.

B

- **Tafferer et al (2010)** compared TS locations measured by ground-based systems.

C

- **Adams and Souza (2009)** investigated CAPE and Convective Events in the Southwest during the North American Monsoon and they found a moderate positive correlation; approaching 0.6 between precipitation and CAPE.

D

- **Riemann-Campe et al., (2010)** are estimated the memory of convective precipitation via the analysis of the convective parameters convective available potential energy (CAPE) and convective inhibition (CIN).

E

- **Kaltenböck et al., (2009)** described the environmental atmospheric characteristics in the vicinity of different types of severe convective storms in Europe during the warm seasons in 2006 and 2007.

LTBA and Kartal Met. Station



Methodology

2008 - 2012





Methodology

A

- **TSSN**, Thunderstorm & Snow

B

- **TSRA** Thunderstorm & Rain

C

- **VCTS** Thunderstorm in the vicinity of aerodrome

Methodology

A

- **Shallow Convection**, less than 100 J/kg

B

- **Deep Convection** between 500 and 4000 J/kg



Data Analysis

- Total 88273 report belong to LTBA are examined in the period of 2008 and 2013.
- 1827 of reports are METAR and 645 of reports are SPECI.
- Unfortunately, 12 in 2008, 1 in 2009, 3 in 2010, 52 in 2012 and totally 68 METAR reports are missing.

Year	Day Number	Metar Number	Speci Number	Total
2008	366	17.556	107	17.663
2009	365	17.519	134	17.653
2010	365	17.517	118	17.635
2011	365	17.520	129	17.649
2012	366	17.516	157	17.673
Total	1.827	87.628	645	88.273



Data Analysis

Distribution of TS days by years

- Autumn has 43 TS days and it is the season that most TS is observed.
- Least TS days are in winter and number of days is 17.

Year/Season	Spring	Summer	Autumn	Winter
2008	5	7	6	2
2009	8	8	14	4
2010	4	14	8	6
2011	1	5	5	0
2012	11	4	10	5
Total	29	38	43	17

Data Analysis

Distribution of TS days by years and months

- Total 127 days are detected
- In monthly basis, September is the month that most TS events are detected with 22 days in the period.
- January is the month that least TS events are exist with 3 days and also this is only in 2010.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot.
2008		2	3		2	3	3	1	3	1	2		20
2009			6	2		2	4	2	8	3	3	4	34
2010	3	2	2	1	1	9	4	1	4	3	1	1	32
2011				1		4	1		2	3			11
2012			1	5	5	1		3	5	4	1	5	30
Total	3	4	12	9	8	19	12	7	22	14	7	10	127



Data Analysis

CAPE and CAPE(max)

- Mean of the closest CAPE values to the TS time is 292.80 J/kg
- Corresponding CIN mean is 50.50 J/kg.
- Mean of maximum CAPE values in 127 days is 359.28 J/kg.
- Corresponding CIN mean is 53.46 J/kg.
- Maximum CAPE is on August 7, 2009 and it's value is 2529.12 J/kg and corresponding CIN value is -0.18 J/kg.

Data Analysis

The mean of CAPE, CAPE(max) and corresponding CIN values according to seasons for the entire period

- Maximum CAPE values are mostly estimated in summer and minimum CAPE values are in winter.
- The summer mean of CAPE values in 2009 is 1018.21 J/kg and the CAPE (max) mean is 1058.91 J/kg. This is maximum value of the 5 years period.

2008	CAPE	CIN	CAPE(Max)	CIN
Spring	62.55	-33.33	109.79	-15.46
Summer	434.00	-36.73	633.22	-24.69
Autumn	112.31	-35.59	378.70	-47.26
Winter	0.00	0.00	6.61	0.00

a)

2009	CAPE	CIN	CAPE(Max)	CIN
Spring	4.14	-6.35	10.21	-11.71
Summer	1018.21	-54.70	1058.91	-52.88
Autumn	245.46	-54.27	279.82	-50.54
Winter	3.13	-21.48	5.92	-75.48

b)

2010	CAPE	CIN	CAPE(Max)	CIN
Spring	28.04	-	28.09	123.71
Summer	540.04	-62.26	659.07	-59.89
Autumn	254.99	-71.39	266.45	-73.06
Winter	30.63	-18.88	44.67	-30.46

c)

2011	CAPE	CIN	CAPE(Max)	CIN
Spring	0.00	0.00	0.08	119.92
Summer	462.73	-15.46	557.89	146.03
Autumn	193.47	-	202.51	110.25
Winter	0.00	0.00	0.00	0.00

d)

Data Analysis

Classification of CAPE values

- The number of days for deep convection (between 500 J/kg and 4000 J/kg) is 30 for CAPE and 36 for CAPE(max). Deep convection is occurred 23.62% of the days in 5 years period.
- Least TS days are in winter and number of days is 17.

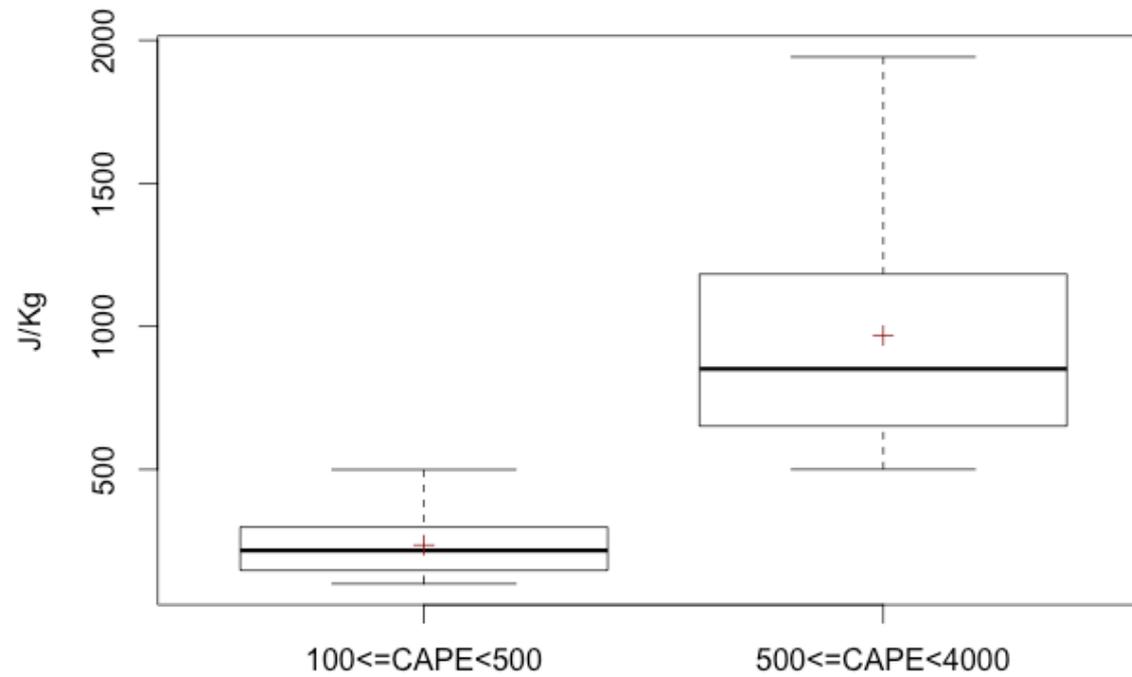
CAPE J/kg	DAYS	Avg. CAPE	Avg. CIN
Less Than 100	70	24,83	-28,38
Between 100-499	27	270,59	-99,25
Between 500-4000	30	938,06	-58,22

CAPE J/kg	DAYS	Avg. CAPE(Max)	Avg. CIN
Less Than 100	57	28,90	-45,39
Between 100-499	34	242,77	-63,75
Between 500-4000	36	992,42	-56,52

Data Analysis

Box plots for the entire CAPE values

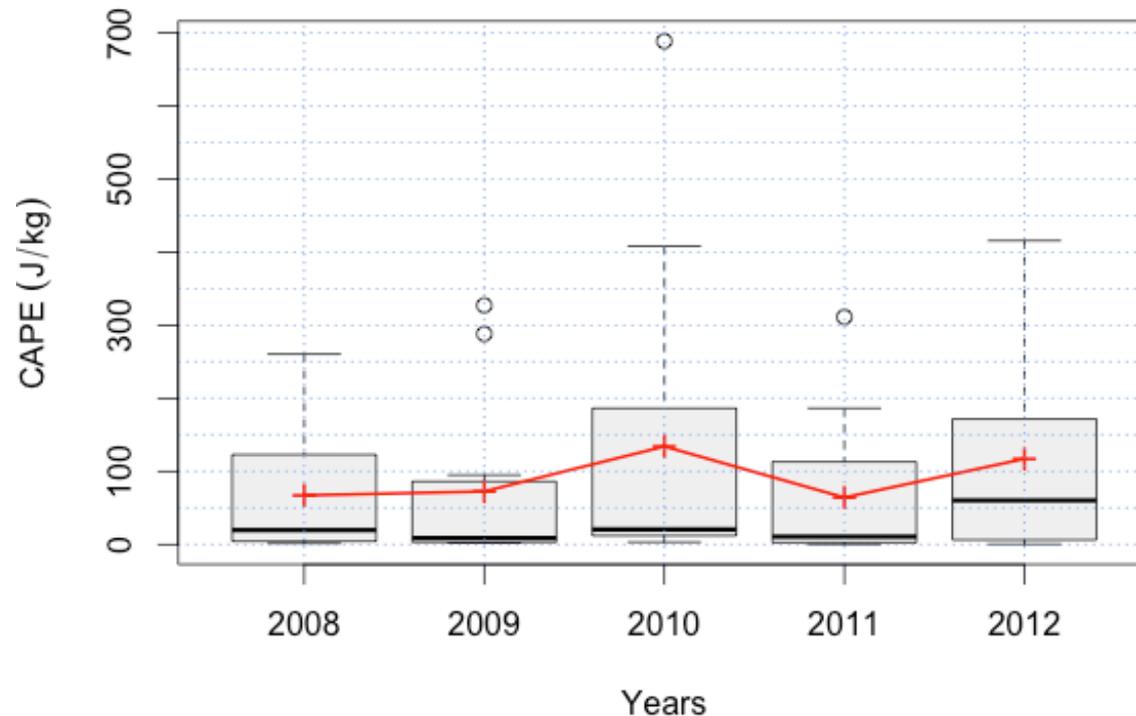
- Total 88273 report belong to LTBA are examined in the period of 2008 and 2013.



Data Analysis

This figure depicts that how the CAPE values are behave according to years

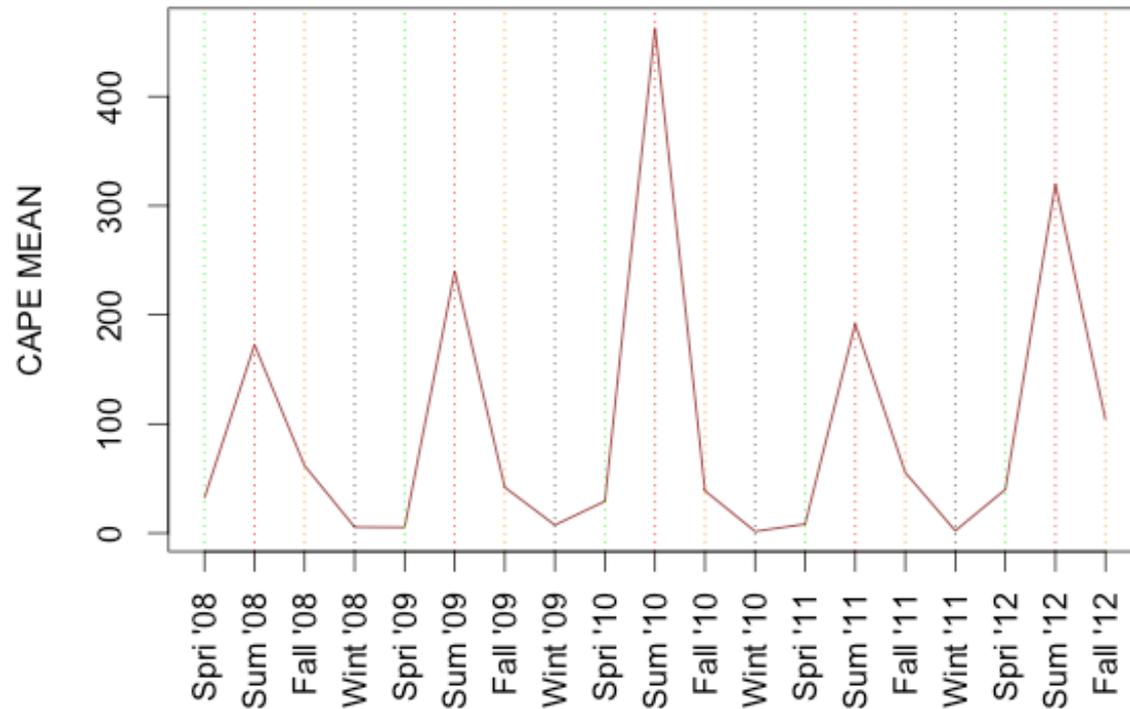
- CAPE values do not have a trend although they are higher in 2010 and 2012 respectively. Red plus signs are mean of CAPE values in the year.



Data Analysis

CAPE means in the years according to seasons

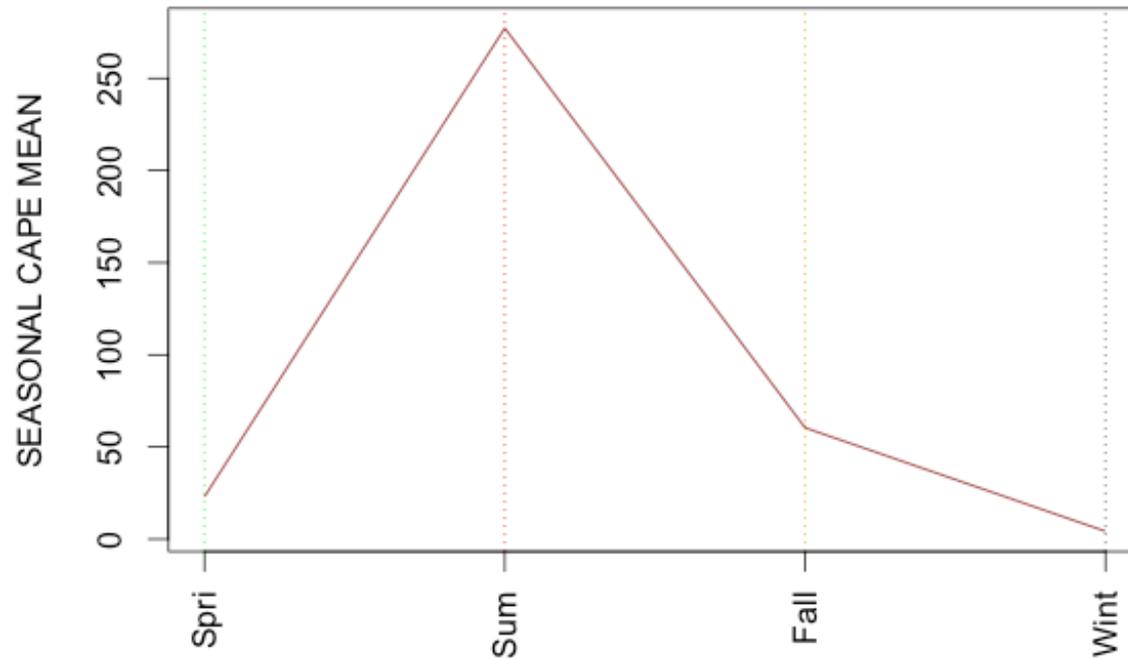
- CAPE values are high in summer season and lower in winter. Mean of CAPE values in Summer 2010 is highest respect to others.



Data Analysis

CAPE means for the seasons

- CAPE values are still high in summer season and low in winter.





Results and Discussions

- TS events in METAR & SPECI reports
- CAPE values are from Wyoming University at Kartal Meteorology Station
- Period is 5 years from 2008 to 2013.
- We studied for TS days and specially for CAPE values on the TS days.
- We also analysed entire CAPE values independently.
- TS probability is **6.95%** in 1827 days in the 5 years period. TS events are mostly detected in Autumn (43 days) in the period but still maximum frequency of TS events differ as per years because atmospheric conditions causing TS show changes according to seasons and years.



Results and Discussions

- The least number of TS is in February (4 days) and January (3 days) while the most TS is in September (22 days) and June (19 days).
- **42.16%** of TS events are **between 17:00 UTC and 24:00 UTC** and **17.48%** are **between 09:00 UTC and 13:00 UTC**.
- The most long lasting TS is at September 8 and 9, 2010 in the 5 years period and its duration is 7 hours 30 minutes. The other long lasting TS is on October 23, 2012 (5 hours 40 minutes), November 22, 2008 and November 23, 2010 (5 hours 30 minutes). These TS events are continued without interval.



Results and Discussions

- The mean of the closest CAPE values to the TS time is 292.80 J/kg and the mean of corresponding CIN values is 50.50 J/kg. The mean of maximum CAPE values in 127 days is 359.28 J/kg and the mean of corresponding CIN values are -53.46 J/kg. The date of maximum CAPE value in the period is August 7, 2009. The maximum CAPE value on August 7, 2009 is 2529.12 J/kg and CIN value is -0.18 J/kg.
- Summer is the maximum CAPE season and winter is the minimum CAPE season.
- The probabilities of deep and shallow convections are 23.62% and 55.12% respectively.

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Thank you

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