ATMOSPHERIC DENSITY CURRENTS: IMPACTS ON AVIATION OVER NSW AND ACT

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Statement of Original Authorship

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Shuang Wang declare that this thesis, is submitted in fulfilment of the requirements for the award of PhD, in the School of Mathematical and Physical Sciences at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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Abstract

Three main types of density currents (DCs) which have significant impacts for aviation are investigated in detail over New South Wales (NSW) state of Australia and Australian capital Territory (ACT) in the research. The three types of density currents are southerly busters (SBs) along the coastal NSW, thunderstorm downbursts over north-western NSW and easterly DCs over Canberra.

The research take advantage of the recently available Himawari-8 high temporal- and spatial-resolution satellite data, Sydney wind profiler data, Doppler radar data, radiosonde data, half hourly METAR and SPECI aviation from observation data Bureau of Meteorology Climate zone, synoptic weather charts and other observational data. In addition, simply model for density currents, global data assimilation system (GDAS) meteorological model outputs, and the Australian Community Climate and Earth-System Simulator (ACCESS) operational model products are employed in the research.

Based on the impacts on aviation, for SBs and strong SBs (SSBs), when wind directions are between 160 degrees to 210 degrees, SBs are the average winds or gusty wind is >= 14.9 m/s (29 knots or 54 km/h), SSBs are the average winds or gusty winds more than 20.5 m/s (40 knots or 74 km/h). For easterly DCs, when wind directions are between 070 degrees to 150 degrees, the average winds or gusty wind is >= 7 m/s (13 knots or 23 km/h). For thunderstorms downbursts, damaging winds are the average winds or gusty winds more than 20.5 m/s (40 knots or 74 km/h) in any direction.

The results of this research show that the data analyses support the widespread view that the SB is a DC, coastally trapped by the Great Dividing Range. In addition, solitary waves develop ahead of SB in a shallow and stable prefrontal boundary layer.

A simplified density current model is applied to SBs, SSBs and easterly DCs. The model results have been verified by the observations. The results that are solely model based also suggest that the solitary waves travel at speeds about 20% faster than the DCs which is consistent with the high-resolution satellite data and shows the solitary waves moving increasingly ahead of the leading edge of the DCs.

The damaging winds caused by thunderstorm downbursts are DCs. The characteristics are presented, and forecast parameters and indices are discussed.

Finally, the climatological trends for SBs and SSBs at Sydney airport are examined statistically by using permutation testing and wavelet analysis. The results show that there is significant increase in SBs over last 49 years, however, the SSBs show no significant trend over the same period.

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List of Abbreviations

ACCESS	Australian Community Climate and Earth-System Simulator
AEDT	Australian Eastern Daylight Time
AP	Airport
ATC	Air Traffic Control
AWS	Automatic Weather Station
CAPE	Convective Available Potential Energy
CAVOK	Sky and visibility OK
CDT	Coastal Trapped Disturbance
DC	Density Current
DMAPE	Downdraught Maximum Available Potential Energy (DMAPE)
GDR	Great Dividing Range
GDAS	Global Data Assimilation System
GPATS	Global Position and Tracking Systems
HAM	Highest Alternate Minina
ICAO	International Civil Aviation Organization.
MCS	Mesoscale Convective System
METAR	Routine weather report issued at hourly or half-hourly intervals.
NSW	New South Wales
NWP	Numerical Weather Prediction systems
QNH	A Q code indicating the atmospheric pressure adjusted to mean sea level. It is a pressure setting used by pilots, air traffic control (ATC).
SB	Southerly Buster
SC	Southerly Change
SIGMET	Significant Meteorological Information AIM 7-1-6
SPECI	Special weather report issued when there is significant deterioration or improvement in airport weather conditions
SSB	Strong Southerly Buster
TAF	Terminal Aerodrome Forecast
TTF	The Trend Forecast
UTC	Coordinated Universal Time

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