Litterature review

May 24, 2017

1 Definition

Brightness Temperature : The temperature at which a black body in thermal equilibrium with its surroundings would have to be in order to duplicate the observed specific intensity of an object at a frequency v. Often in radio astronomy brightness temperature (TB) is used as a measure of received intensity.

Anvil cloud : Anvil clouds, which are mostly composed of ice particles, form in the upper parts of thunderstorms. They get their anvil shape from the fact that the rising air in thunderstorms expands and spreads out as the air bumps up against the bottom of the stratosphere. This is because the air in the stratosphere is warmer than the rising air in the anvil, and so prevents the relatively cooler anvil air from rising any farther.

Equivalent reflectivity factor Z and dBZ: Z expresses the volume of reflector per volume area (unit is $mm^6.m^{-3}$). dBZ is defined by $dBZ = 10.log_{10}(\frac{Z}{Z_0})$.

Plan position indicator and Range height indicator : These are the two main types of scans in meteorology. Plan position indicator refers to a scan with a constant elevation and a rotation of the azimuth angle. Range height indicator refers to a constant azimuth angle while the elevation angle varies.

Polarimetric radar/variable:

Standard reflectivity:

Doppler velocity radar parameters:

Energy dissipation rate (EDR) Turbulent flows consist of eddiyes of various size range. The kinetic energy cascades down from large to small eddies by interactionnal forces between the eddies. At very small scale, the energy of the eddies dissipates into heatdue to viscous forces. Energy dissipation rate is the parameter to determine the amount of energy lost by the viscous forces in the turbukent flow.

2 Litterature review

2.1 Articles focused on forests fuel study

Title	**Author**	**Date**	**Keypoints**
The line intersect method in forest fuel sampling	Van Wagner	1968	• Simple and cost efficient method to get the volume or weight per area of woody fuel • Error become small with assumption of random orientation of the wood pieces
Practical aspects of the line intersect method	Van Wagner	1982	• Corretion factor for the ground slope • Importance of total line lenght and number of diameter classes used for the precision.
Development and structure of the Canadian Forest Fire Weather Index System Forestry Technical Report	Van Wagner	1987	• A
Estimating plant biomass : a review of techniques	Catchpole	1992	• A
Heat release rate : the single most important variable in fire hazard	V. Babrauskas	1992	• A

Title	**Author**	**Date**	**Keypoints**
Prescribed burning of thining slash in regrowth stands of farri	Mc Caw	1997	• Consumption of woody fuels slash < 10cm is inversely related to the moisture content of the litter profile • Total amount of fuel consumed varies from 31 to 89 % • Four woody fuel consumption of woody fuel exist. They are tested with an eucalyptus fire. • Gould and Cheney model assumes 50 % will be consumed. Minimum error but doesn't take into account extreme events • CONSUME activity andSouthern woddy models underpredict observation • CONSUME Western woody model has little bias and good prediction • BURNUP model has poor performance with natural fuel, but improves for fuel from clearcut operations.
A new method to estimate fuel surface area-to-volume ration using water immersion	P.M. Fernandes	1998	• A

Title	Author	Date	Keypoints
Loss of carbon during controlled regeneration burns in Eucalyptus obliqua forest	A. Slijepcevic	2001	• Sampling method for fine fuel (diameter < 2.5cm) • Line intercept method with triangles used for sampling of fuel > 2.5cm in diameter. • Getting carbon mass from biomass (50%) • fine fuels negligeable (5 % of the biomass) • Around 70 % of carbon released comes from fuel greater than 7 cm in diameter • Between 44 and 59 % of carbon loss
Testing woody fuel consumption models for application in Australian southern eucalypt forest fires	J.J. Hollis	2001	• Woody fuel consumption varies between 9.1 and 89.9 % : large deviations • Fire Management in Australian Forests states that 50% of the total fuel load is a good figure for wildfires for certain range conditions

2.2 Articles focused on Extreme fire behaviour

Title	Author	Date	Keypoints
Unusual phenomena in an extreme busfire	J. Dold	2005	• A
Firebrands and spotting ignition in large-scale fires	E. Koo	2010	• A
Fire whirls due to surrounding flame sources and the influence of the rotation speed on flame height	R. Zhou	2007	• A
Photographs and analysis of an unusually large and longlived firewhirl	M. Umsheid	2006	• Unusually long lived fire whirl lasted 20 minutes, and towered at 200m. • Firewhirl not associated with strong reflectivity (20, 30 dBZ)
Atmospheric interactions with wildland fire behaviour – I,II	E. Potter	2012	• A

2.3 Articles focused on Pyrocumulonimbus (PyroCb for short)

Title	**Author**	**Date**	**Keypoints**
The Chisholm firestorm : observed microstructure, precipitation and lightning activity	D. Rosenfield	2007	• High convective effect leads to injection of smoke in the stratosphere • Pyro-Cb are formed of very small drops that are slow to coalesce into rain drops due to large concentration of CCN from the fire smoke and/or the updraft velocity. • PyroCb delay rain collaspe and generate updrafts for a longer period, then are favorable to increase fire severity and spotting. • Cloud top temperature can be estimated equal to the thermal brightness temperature under certain conditions (low brightness temp differential between 10. and 12 ym)

Title	Author	Date	Keypoints
Violent pyro-convective storm devastates Australia's capital and pollutes the atmosphere	M.Fromm	2006	• Radar data of the pyroCb • PyroCb generate an anvil (hard to observe with satellite) • The aerosols in the pyro-Cb will asbord/intercept solar radiation once in the stratosphere • Damage consistend with a tornadic event rather than fire whirl for three reasons: – Path dimensions (20km lomg and 450 wide) – Break in the damage path (temporarily lift of the vortex: therefore it wouldn't touche the ground) – Damage extent beyond the burn zone • 1dBZ radar contour allows to see the pyroCb can give a good 3D repreentation • Fire affects the atmosphere : – Disturbs the airflow – Injects smoke/heat/emittants • Atmosphere conditions affect fire: wind/moisture/temperature influence fuel dryness and spotting, control fire behaviour and rate of spread.

Title	Author	Date	Keypoints
Strastospheric impact of the Chisholm pyrocumulonimbus eruption : 1 and 2	M.Fromm	2008	• Use of satellite with views at different slants and sprectral width (MISR) to detect thin clouds, elevated aerosol layers and near surface plume. Wind correction applied. • TOMS Aerosol Index (AI) to detect UV absorbing aerosols located in the UTLS. • Between 0.3 and 2.2 % of the fuel consumed during pyroconvection ended up in the stratosphere • • Sensoring the pyroCb with LIDAR data
The untold Story of Pyrocumulonimbus	M.Fromm	2010	• Average cloud-top altitude and pressure of a pyroCb are 11.6km and 223hPa
Nuclear Winter: global consequences of multiple nuclear explosions	R. Turco	1983	• A •

<table>
<tr><th>Title</th><th>Author</th><th>Date</th><th>Keypoints</th></tr>
<tr><td>The 2013 rim fire: Implications for Predicting Extreme Fire Spread, Pyroconvection, and Smoke Emissions</td><td>D. Peterson</td><td>2015</td><td>Radiant heat can be used as an approximation for the fire intensity
FRP was maximum in late evening and minimum in the morning
Meteorological conditions:
Long and short term drought
Dry fuel
Low relative humidity (<40%)
Dry lower troposhere
Upper-level disturbance near the fire associated with critical FRP
Low atmospheric fire weather are unable to identify the most extreme fire behaviour
Fire spread/intensity and altitude smoke injection are related but not predicted by the same variables
Good precursor for pyro Cb :
Large and intense fire
Ambient mid-level moisture
upper level instability</td></tr>
<tr><td>Severe convective storms initiated by intense wildfires: Numerical simulations of pyro-convection and pyro-tornadogenesis</td><td>P.Cunningham</td><td>2009</td><td>A</td></tr>
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Title	**Author**	**Date**	**Keypoints**
An Australian pyro-tornadogenesis event	R. McRae	2012	• Tornado definition (by Glickman,2000): a violently rotating column of air, in contact with the surface, pendant from a cumuliform cloud, and often (but not always) visible as a funnel cloud. • Path of the tornado shows stronger reflectivity (in this case the radar beam was under the pyroCb) • Movement of the tornado is along the centerline of the fire plume. (support the idea that the tornado was indeed a pyrogenic event)

Title	Author	Date	Keypoints
Smoke-Column Observations from Two Forest Fires Using Doppler Lidar and Doppler Radar	R. Banta	1992	• Use of a 3.2cm-wavelength radar. • Detection of horizontal vortices with vertical motion on the edges of the plume. Cause is strong flow at the edge and weak flow in the center of the plume. • Depolarization ration measurement used to get information on the shape of the object in the plume. • Criterion for wind-driven vs buyoancy-driven fire: ratio between kinetic energy (KE) of the buyoancy and KE of the ambient wind flow. • Rotation contributes to a stronger fire intensity by increasing the updraft. • Turbulent dissipations are limited by helicity.

2.4 Articles focused on Vorticity/Turbulence in plumes

Title	Author	Date	Keypoints
Note of the observation of small-scale amospheric turbulences by Doppler radar techniques	R. Lhermitte	1969	• A
Fire whirls, why, when and where	Countryman	1971	• Fire whirl form from the rising of unstable air, and are linked to the heated surface. • They don't lift off along their path. • Fire whirld wind speeds may reach and exceed 300 miles/h.
Intense atmospheric vortices associated with a 1000 MW fire	C. Church	1980	• A
Radar detection of turbulence in precipitation environments	A. Bohne	1982	• A
Streamwise Vorticity: The Origin of Updraft Rotation in Supercell Storms	R. Davies-Jones	1984	• A

Title	Author	Date	Keypoints
Development of large vortices on prescribed fires	D McRae	1990	• Fire whirl usually associated with low winds speed (< 10 m/s) and therefore nearly vertical smoke column • Production of intense firewirls is believed to be a function of the interation of the rate of energy release and the degree of atmospheric instability in the 1000 to 3000 m layer • Fire whirls need available vorticity close to form • Two types of fire whirl observed: – Type 1: Whirlinds formed in pair in the leeward side of the convective column. Vorticity is tilted to match the vertical motion field of the column – Type 2: Entire column goes in rotation and lead to large whirls. Cause is likely to be stretching of existing vertical vorticity adveted from the surroundings or result of buoyancy.
NEXRAD Detection of Hazardous turbulence	J. Williams	2006	• A
Turbulent Plumes in Nature	A. Woods	2010	• A

Title	Author	Date	Keypoints

Review of vortices in wildland fire	J Forthofer	2011	• Fire whirls characterized by sudden formation, erratic movement, often sudden dissipation. Definition: vertically oriented, intensely rotating column of gas found in or near fires.
			• Contribution to the formation of firewhirls:
			  – Lee slope
			  – Superadiabatic or dry lapse rate in the atmoshere (big decrease of temerature with height)
			  – Vorticity associated with passage of a cold front
			• Range varies between 10m-3km and 10m/s-100m/s for the wind velocity
			• Can be strong enough to move over 1000m away from the fire and lift a house
			• Formation of a firewhirl requires ambient vorticity and a concentrating mechanism (buoyancy flow from the fire)
			• Reduction by one order of magnitude of the tubulent mixing (due to a balance between radial gradient pressure with the low pressure in the core and centrifuge acceleration), increasing flame lenght and burning rate.
			• cyclostrophic flow reached above the ground. Near the ground, drag force cut the cyclostrophic balance, the main flow is then due to the pressure gradient and fuel/gas are draggged toward the core and then lifted.

Title	Author	Date	Keypoints

2.5 Articles focused radar

Title	**Author**	**Date**	**Keypoints**
A real time four dimensional Doppler dealiasing Scheme	C. James	2001	• A
A Mobile Rapid-Scanning X-band Polarimetric (RaXPol) Doppler Radar System	A. Pazmani	2012	• A
Applications in Low-Power Phased Array Weather Radars	R. Palumbo	2016	• A