Pyrocumulonimbus Firepower Threshold: A pyroCb prediction tool.

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Pyrocumulonimbus (fire-induced thunderstorms, pyroCb) are associated with unpredictable changes in fire intensity, spread rates and direction, enhanced ember transport and lightning ignitions. Conventional thunderstorm threats such as downbursts, hail, lightning, tornadoes may also be present. PyroCb are difficult to forecast.

PYROCB FIREPOWER THRESHOLD (PFT)

The PFT uses the Briggs plume model to determine a theoretical minimum net heatflux (firepower) for pyroCb formation.

The PFT has three basic ingredients: two thermodynamic and one kinematic.

THERMODYNAMIC INGREDIENTS

In a previous BNHCRC study (Tory et al. 2018) a method for determining how thermodynamically favourable the atmosphere is for pyroCb formation was developed. The method identified two parameters:

- z_{fc}, free-convection height,
- b_{fc}, free-convection buoyancy.

z_{fc} is the minimum height the plume must rise, and b_{fc} is the minimum buoyancy the plume must have at z_{fc}, for pyroCb to develop.

KINEMATIC INGREDIENT

The Briggs plume equations assume a neutral atmosphere with constant wind speed U.

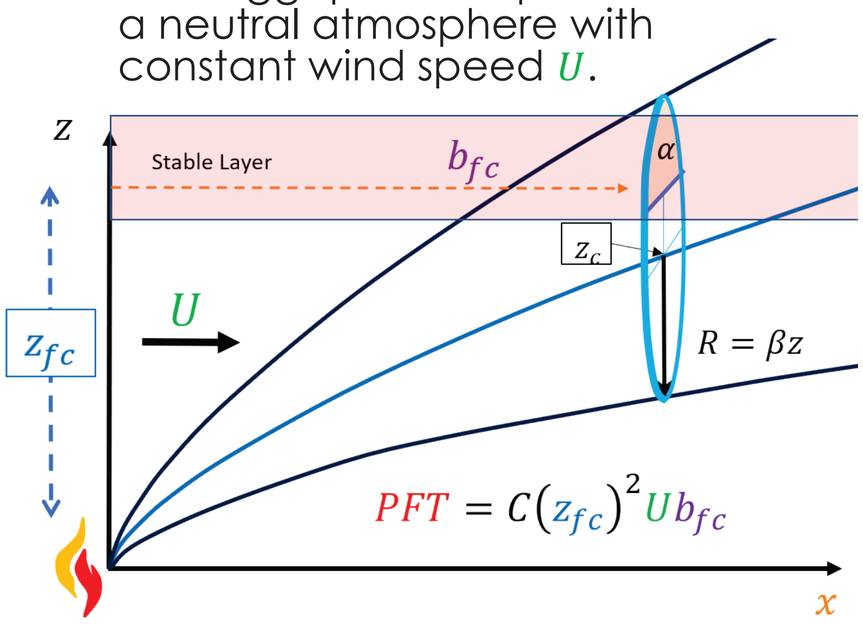

Figure1: Schematic representation of the three variables (z_{fc}, b_{fc} and U) that define the *PFT*. C is approximately constant. The Briggs plume has a vertical, circular cross-sectional area about the plume centerline (z_c, pale blue).

PFT EQUATION

An equation for the buoyancy distribution along the Briggs-plume centreline is inverted to obtain the PFT as a function of z_{fc}, b_{fc} and U (Fig. 1).

PFT FORECASTS

Spatial plots of PFT generated from computer forecast models provide valuable insight into how the pyroCb threat varies in space and time (Fig. 2).

Both cases in Fig. 2 show increased threat near a wind change.

There are substantial differences in PFT values for the two cases, with *pyroCb conditions* much less favourable for the Sir Ivan fire than the Licola fire.

However, Sir Ivan had catastrophic *fire conditions* that would have supported a much hotter fire.

PFT FLAG

Conditions that highly favour pyroCb (light winds, high humidity) <u>do not</u> favour intense fires and vice versa.

Experiments with a PFT flag are underway. The PFT flag identifies when a favourable ratio of pyroCb potential to intense fire potential is present (Fig. 3). A modified fire danger index defines the fire potential.

The PFT flag has been applied to more than 30 case-studies, with very promising results.

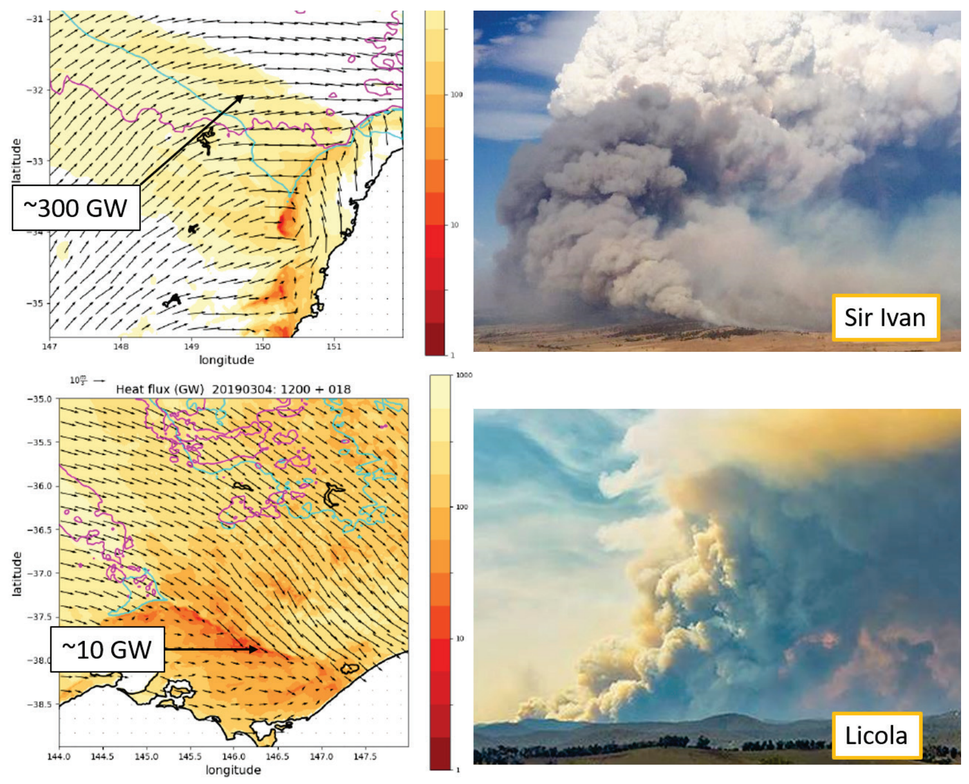

Figure 2: PFT forecasts for two pyroCb events. PFT units are GW, shading scale is logarithmic.

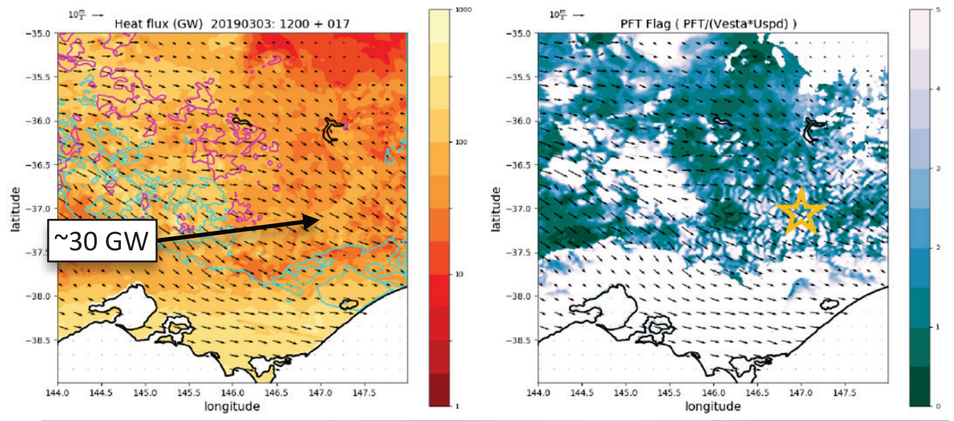

Figure 3: PFT (top left) and PFT-flag (top right) during the Mayford-Tuckalong Track fire pyroCb event, near Mt. Hotham.

REFERENCE

Tory, K.J, W. Thurston and J. D. Kepert, 2018: Thermodynamics of pyrocumulus: a conceptual study. *Mon. Wea. Rev.*, **146**, 2579—2598.

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