HighFire Risk: Violent pyro-convection – an international study

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Introduction

To properly understand the drivers of very large fire events, it is important to understand the processes involved in violent pyro-convective events, such as can be seen in figure 1a and 1b. This is the focus of an international research effort, that has evolved from monitoring volcanic plumes to protect commercial airliners. It is now accepted that major fires can distribute particulates into the upper troposphere / lower stratosphere (UTLS) and can affect the atmosphere on a hemispheric scale.

Methods

An international collaborative network is in place to monitor weather forecasts, fire activity, explosive fire growth and the appearance of particulate plumes in satellite data. Any predictions or observations of events are emailed around the group, and a range of data sources are interrogated to allow verification of ideas. Data sources utilised in the study include:

- Direct observations of fires.
- BoM AWS and weather radar.
- Visual, IR and water vapour satellite imagery.
- Airborne remote sensing, including linescans.
- Post analysis of fire behaviour.
- Post analysis of weather, especially in the vertical plane.

Results

Violent pyro-convective events are driven by the release of latent heat at the condensation level in the fire's plume. This acts like an extraction fan above a fire, increasing the coupling between the fire and the atmosphere and thereby changing the processes driving the fire. Research has shown that there are at least three different scenarios behind violent pyro-convection. All require deep flaming depth to provide a vigorous convection column that can reach the condensation level.

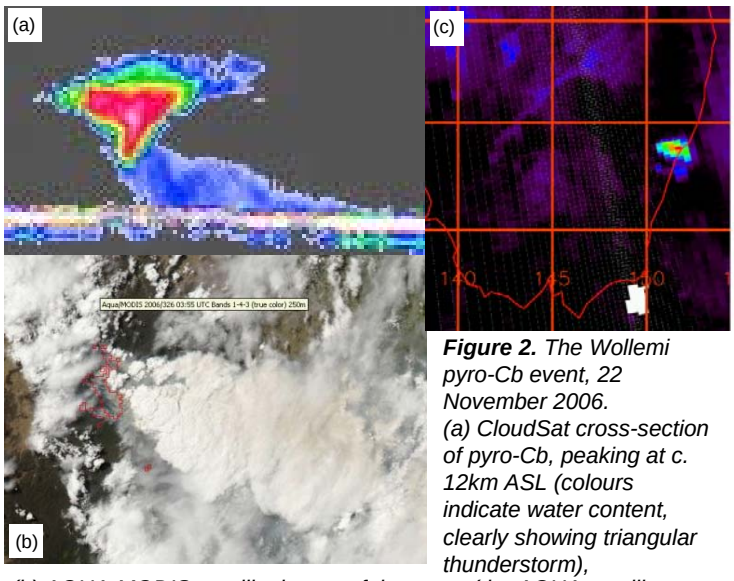

Figure 2. *The Wollemi pyro-Cb event, 22 November 2006. (a) CloudSat cross-section of pyro-Cb, peaking at c. 12km ASL (colours indicate water content, clearly showing triangular thunderstorm), (b) AQUA-MODIS satellite image of the same (the AQUA satellite orbits 1 minute ahead of CloudSat in the "A-train"), (c) AURA-OMI Aerosol Index for the fire (AURA orbits 7 minutes behind CloudSat in the "A-train").*

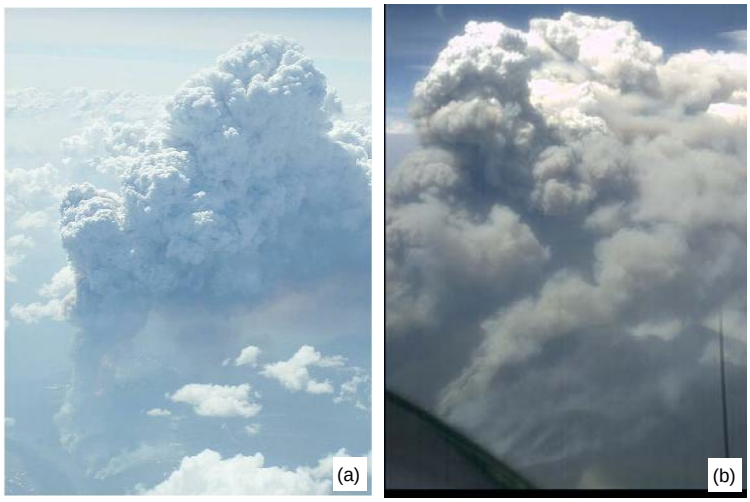

Figure 1*. Violent pyro-convective events. (a) Binga, British Columbia, 27th June 2004; from 10km ASL [Noriyuki Todo, Japan Airlines], (b) Canberra, 18th January 2003, from 7km ASL [Robert Norman, Target Air Services]. This is one of the most intense events ever measured.*

Discussion

This research is providing vital insights into the drivers of the most extreme fire activity globally. NASA's ARCTAS programme currently has aircraft seeking pyro-convection over boreal forests. Improved monitoring of these events will lead to improved understanding of them.

In Australia, only a few violent pyro-convective events were noted before 2002, but since then there has been a significant number recorded. Current research is aimed at determining whether this is due to climate change or better detection.

The biggest event yet detected (Chisholm, Alberta in 2001) has been reconstructed in 3D numerical models, which have confirmed a number of observation-driven ideas (see figure 3).

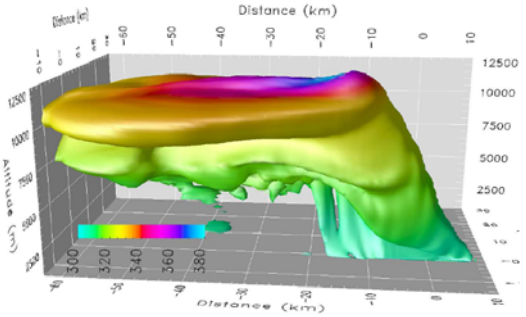

Figure 3*. Reconstruction of the Chisholm Fire's plume (Trentmann et al. 2006: Atmos. Chem. Phys. Discuss., 6, 6041-6080)*

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