PROGRAM B6.3

HighFire Risk: Violent Pyro-Convection – an international study

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Introduction

In order to understand the drivers of very large fire events, we must understand violent pyro-convection.

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 pump particulates into the lower troposphere / upper stratosphere (UTLS). They can affect the atmosphere on a hemispheric scale.

Methods

An international collaborative network is in place to monitor (a) weather forecasts, (b) fire activity, (c) explosive fire growth, (d) 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.

Useful data sources 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

We now know that these events are driven by release of latent heat at the saturation level in the fire's plume. This acts like an extraction fan above a fire, and changes the forces driving the fire.

It is now known 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 saturation level.

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, as the more events are measured, the better will be our understanding.

In Australia, few violent pyro-convection events were noted before 2002, but since then there has been a significant number recorded. Research is under way into 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 and is confirming a number of observation-driven ideas.

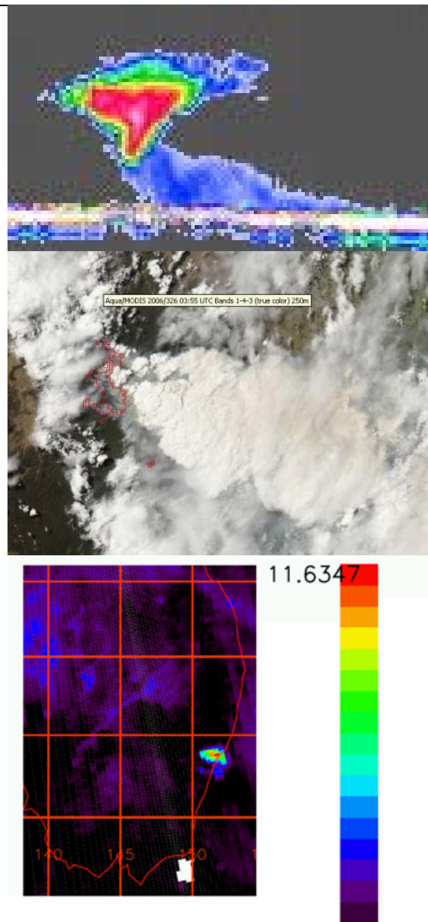

Figure 2. The Wollemi pyro-Cb event, 22 November 2006.
(a) CloudSat cross-section of pyro-Cb, peaking at c. 12km ASL (colours indicate water content, clearly showing triangular thunderstorm)
(b) AQUA-MODIS satellite image of the same (the AQUA satellite orbits 1 minute ahead of CloudSat in the "A-train")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

***Figure 1**. Violent pyro-convective events.*

Left = Binga, British Columbia, 27th June 2004; from 10km ASL [Noriyuki Todo, Japan Airlines]

Right = above Canberra, 18th January 2003, from 7km ASL [Robert Norman, Target Air Services]. This is one of the most intense events ever measured.

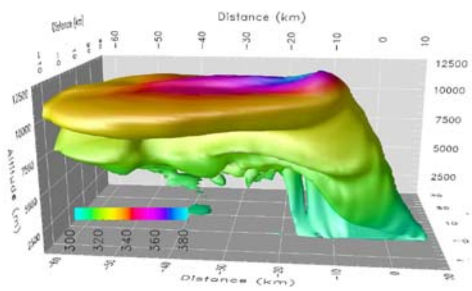

***Figure 3**. Reconstruction of the Chisholm Fire's plume (Trentmann et al. 2006: Atmos. Chem. Phys. Discuss., 6, 6041-6080)*

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