A POTENTIAL BREAKTHROUGH IN WILDFIRE MANAGEMENT

THE CONTINUOUS HAINES INDEX -

A TOOL FOR FORECASTING CATASTROPHIC FIRE ESCALATION

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Forecasting atmospheric stability has long been seen as important. The ACT has used the Pasquill's Index for decades, and Pasquill's also gives guidance on the amount of wind swing.
After Rick Ochoa spoke on the Haines Index at the 1997 Fire Weather Workshop, the ACT and other jurisdictions have used it. John Bally studies HI extensively in Tasmania and found that it predicted days of elevated fire danger as well as did McArthur Forest Fire Danger index. During operatio9nal evaluation on the mainland many found that it "maxed-out" to often to be of value. HI is capped at a vlaue of 6, and most hot dry days in summer were scoring 6, irrespective of the FDR that day.
The onset of frequent violent pyro-convection since 2002 has shown the need for a better index. After the catastrophic 2003 ACT fires, researchers found that there was a growing list of major fire events in which atmospheric stability played an important role. The ability for a vigorous plume to induce mixing down of drier air aloft is a common element. Forecasting of that can be through examination of water vapour satellite imagery or by deriving stability indices from Aerological Diagrams. By analysing the atmosphere above a large set of fire events, Mills and McCaw derived C-Haines.
This new tool wasv developed by the Centre for Australian Weather and Climate Research (BoM & CSIRO) as part of the BushfireCooperative Rresearch Centre. It promises significant improvement in our ability to forecast blow-up days.
Unlike HI, C-Haines gives a significant value if it exceeds a certain percentile in the local climatology. Until we develop those climatologies we can use indicative cut-offs from Mills & McCaw, 2010 (see map below, from the report) or we can simply use a value over a constant – such as 10.
With the switch by BoM to the new graphical forecasting environment there is a need for the fire agencies to carefully monitor the performance of this index, and provide feedback to the forecasters. Any significant fires need careful examination of the fire's stability environment.

The Haines Index

By observing the vertical structure of the atmosphere when "plume driven" fires occurred in the US, Haines was able to note certain conditions that lead to explosive growth of fires, extreme spotting and frequent crowning. These were combined into an index that ranges from 2 to 6, which show the potential for large plume-driven fire growth...

- Index 2 or 3 - very low potential
- Index 4 - low potential
- Index 5 - moderate potential
- Index 6 - high potential

For the technically minded, the index reflects the temperature difference between heights were the air pressure is 850 and 700 hectopascals; and also the dew point depression at the 850 hectopascal height. Each of these are scored from 1 to 3 – as shown below - and the two are added together (thus the range of 2 to 6 for the Haines Index).

STABILITY TERM $T_{850} - T_{700}$ (°C)	
Value	**Score**
5 or less	1
6 to 10	2
11 or more	3
MOISTURE TERM $T_{850} - DP_{850}$ (°C)	
Value	**Score**
5 or less	1
6 to 12	2
13 or more	3

The findings in Tasmania suggest that using Haines as well as McArthur gives a better readiness indicator. In fact 84% of area burnt occured on days with a Haines Index of 5 or 6.

So whenever the Haines Index is a six, or maybe a five, Fire Controllers should be aware of the potential for the fire to grow well beyond what would be expected from the McArthur Indices. A large, vigorous convection column could be dragging down very dry air from aloft to replace the air moving upwards.

If a large cumulus cloud forms in the convection column of a large fire, watch out, as evaporation of moisture from the cloud can generate a sudden downwash of air that can make a fire explode.

REFERENCE

"The Evaluation of Idaho Wildfire Growth using the Haines Index" by Paul Werth & Richard Ochoa 1993.
From *Weather and Forecasting*, Vol. **8** pages 233-234.

CALCULATING CONTINUOUS HAINES INDEX (C-HAINES)

Temperature Depression term: CA = $(T_{850}-T_{700})/2-2$
Dew Point Depression term: CB = $(T_{850}-TD_{850})/3-1$

If(CB > 9) then CB = 9; If(CB > 5) then CB = 5+(CB-5)/2

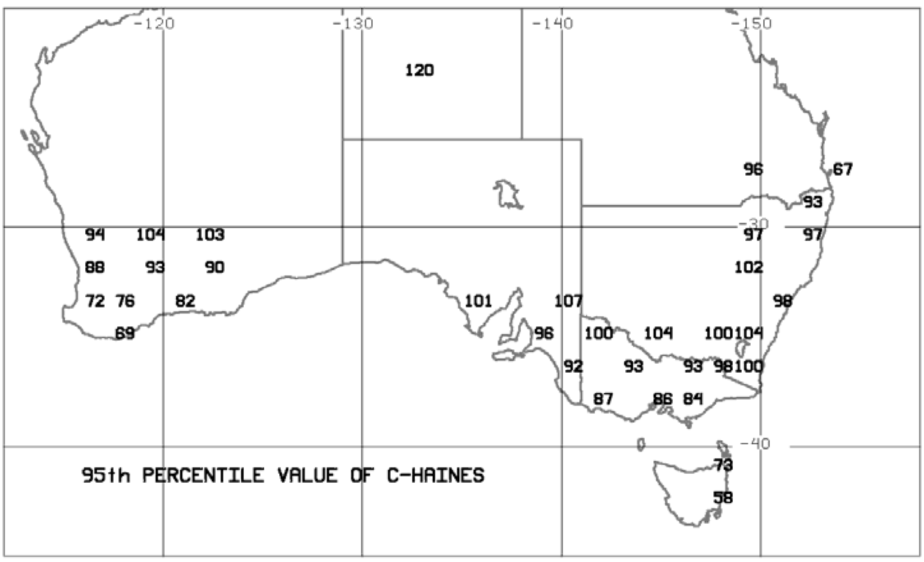
Worked example: T_{850} = 27.5°C, DP_{850}=-1°C, T_{700} = 12°C.
CA = (27.5-12)/2-2 = 5.5
CB = (27.5+1)/3-1 = 6.7
C-Haines = CA+CB
= 12.2
The local 95%ile C-Haines = 8.5, so a value of 12.2 is quite rare anmd significant.

The original work on C-Haines is:
Mills, G.A. & McCaw, L. (2010). Atmospheric Stability Environments and Fire Weather in australia – extending the Haines index. CAWCR Technical Report No. 20.
(Available online at www.cawcr.gov.au)

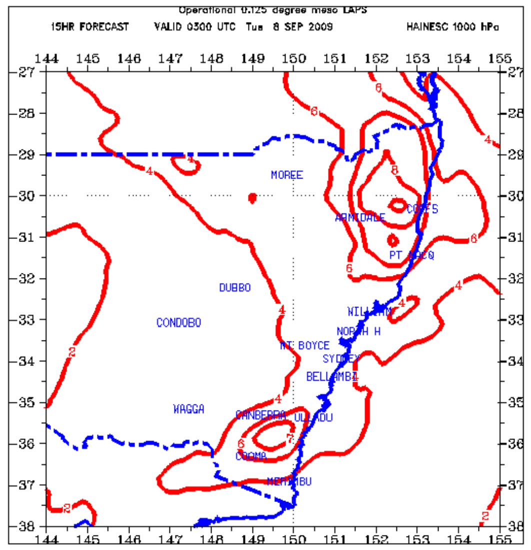
The Abstract of this report is:

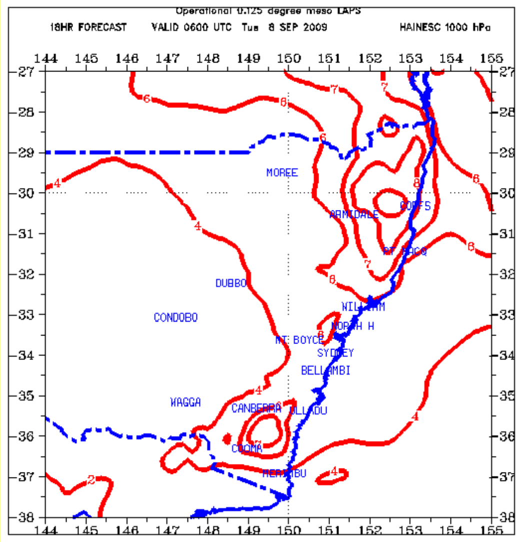
ABSTRACT

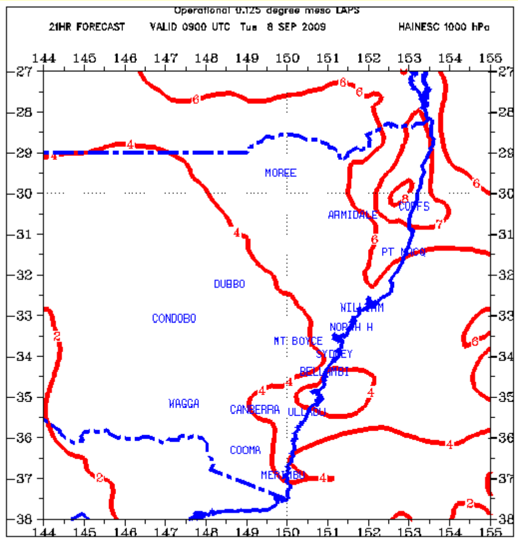
The characteristics of the Haines Index, used to link vertical atmospheric stability and humidity with erratic fire behaviour, are examined for locations covering most of the areas of southern Australia that are subject to bushfires. It is shown that the index, originally developed for conditions in the northwest of the United States, is not configured to identify the most extreme conditions in Australia due to the different temperature lapse and humidity climatology. An alternative extended version of the index is proposed, and along with a number of other measures of atmospheric stability, are compared with the fire danger index on a number of days of extreme or unexpected fire activity, and also for a number of days on which marked pyrocumulus cloud development was noted. While more quantitative comparison with fire behaviour data is required, the results suggest that the use of this new C-HAINES index may provide additional and independent information to that provided by the traditional fire danger indices, particularly in conditions where unexpected night-time flare-ups of going fires have occurred, as well as in a number of prescribed burns, where fire behaviour was unexpectedly active.



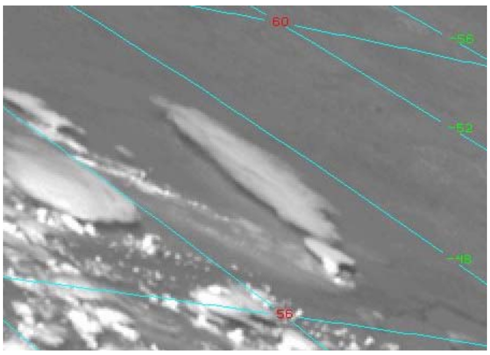
Upper panel – 95th percentile value of C-HAINES (multiplied by 10) at the sampled gridpoints. Data is at 0600 UTC for the months of September to April inclusive, years 2000-2007.







Three C-Haines model charts from Tuesday 8th Sepctember 2009, at 1pm, 4pm & 7pm. These show a C-Haines of 8 to 9 in the Coffs Harbour hinterland. The 95%ile value is 9.7.



Oblique weather satellite (METEOSAT9) view of an extreme fire east of Moscow on 26 July 2010.Note how the plume extends from the ground up to an anvil at the top of the troposphere. This requires a combination of extreme fire behaviour and very unstable air.