LONG-RANGE RAINFALL FORECASTING IN SOUTHERN AUSTRALIA:

Use of Indian Ocean data and upper level flow patterns

Australia is a continent surrounded by large ocean areas. The origin of all weather is the differential heating of the earth's surface via solar radiation. The warmer sub-tropical and tropical oceans store vast quantities of this heat energy as they are warmed by direct sunlight.

The Indian Ocean to the west of Australia encompasses some of the warmest ocean areas in the world. These areas evaporate large quantities of water into the surrounding lower and middle atmosphere in the form of water vapour. This water vapour is a major source of potential heat energy ready to fuel the southern Australian weather systems.

This large area of warm and moist air forms during the summer months. A broad band of eastward flowing air, the westerly wind-belt, lies to the south of the continent of Australia. This broad belt of westerly wind increases in strength with height due to the thermal contrast between polar and tropical areas of the earth. They reach speeds of up to 100 to 250 Knots (185 to 480 km/hr) at high altitudes and form the strong westerly wind jet stream belts of the earth. As these winds attempt to balance the earth's temperature differences, the jet streams bend, making a northwest to southwest curving westerly wind belt around the globe. These curves are called Rossby Waves. A curve northward towards the tropics is called a long-wave low pressure trough; while a curve towards the poles is called a long-wave high pressure ridge.

As Autumn approaches, this westerly wind-belt moves northward and starts to react with the moisture to the west of the Australian continent. If a seasonal long wave trough is just to the west of Western Australia, the north-westerly wind ahead of the trough will feed this moisture south-eastwards, ahead of short-wave frontal features. This south-eastward moving cloud band (called a northwest cloud band) will rise ahead of the front. The cloud band will then thicken and often produce good rains to the cropping and grazing areas of southern Australia.

The generation of these cloud-bands is dependent on sea-surface temperatures and gradients in the general north-east Indian Ocean area. The effect of these cloud bands is dependent on the presence and strength of a long-wave low pressure trough in the middle and upper atmosphere, over or just west of the Australian continent.

To prepare forecasting models I use surface and upper level measurements over the Indian Ocean and northern/western Australia as input variables. I also use sea-surface temperature measurements over similar ocean areas.

These input variables cover a large range of climatic factors. The models I use are shown to be quite accurate for forecasting growing season rainfall in southern Australia. Correlations of 0.7 to 0.9 (on a scale of 0 to 1) were commonly found on test growing season rainfall data samples in southern Australia (Holton, 1999).

Some southern farmers say that 'we receive good rains from northwest cloud bands, but also we receive a large proportion of our rainfall from post-frontal shower activity'. This is quite true. However, it should be noted that this post-frontal shower activity is also dependant on the same upper level wind-flow patterns. And this shower activity is often strengthened by inflows of potential energy from north-west cloud-bands. The surface pressure systems of the southern Australian growing season are in fact formed and steered by the upper level wave patterns, and by the orientation and strength of the upper jet-streams.

I also use similar upper level Rossby wave patterns and sea surface temperature fields, combined with long years of meteorological experience to complete ten-day to eighteen day weather forecasting for farmers in southern Australia.

The motto for weather forecasting in southern Australia is simple: 'Look up and west'.

REFERENCES: Holton. I. September 1999. "Prediction of growing season rainfall and crop yields in southern Australia". Aust. Met. Magazine.

Examples of the north-west cloud band situation.

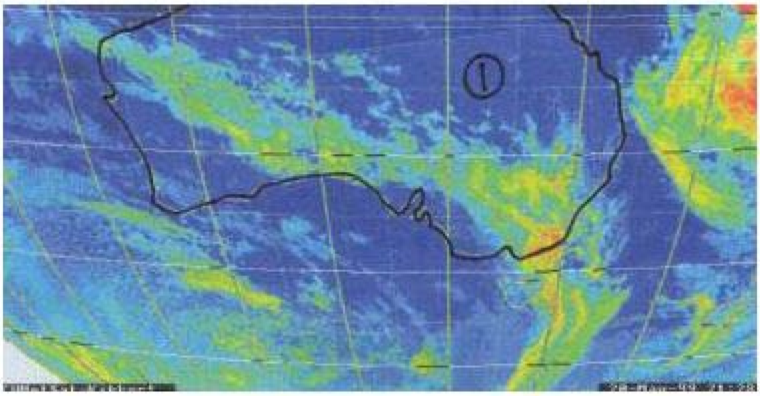

IMAGE 1: 8am CST 21st May 1999

(i) North-west cloud band runs from north-east Indian Ocean Onslow Area to Cold Front over Eastern NSW & VIC.

(ii) Another Cold front can be seen approaching the south-west tip of WA.

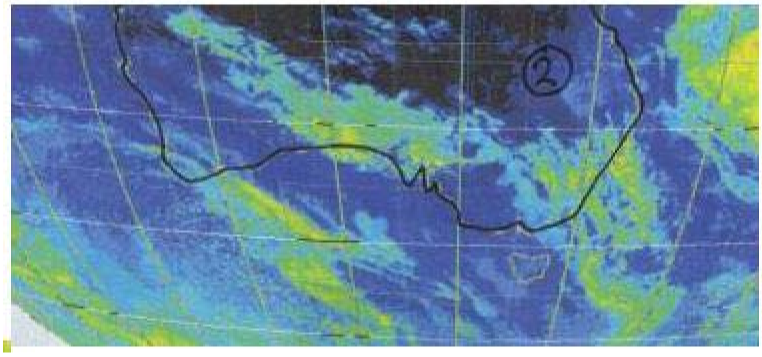

IMAGE 2: 4pm CST 21st May 1999

(iii) North-west cloud band breaks into two as new front over south-west of WA drags the moisture towards the frontal zone.

(iv) Rain starts in western SA.

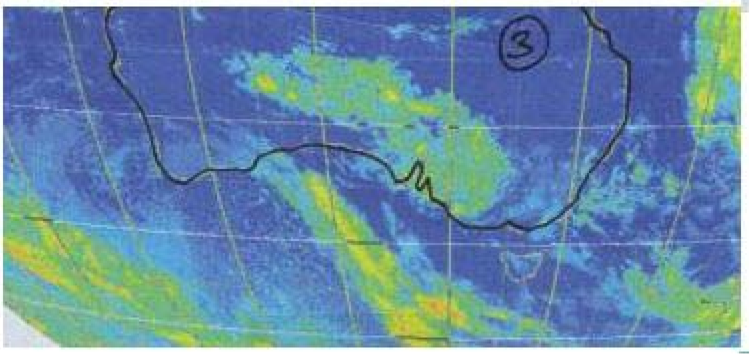

IMAGE 3: 4am CST 22nd May 1999

(v) Rain becomes general over most of SA as north-west cloud-band moisture is lifted by the approaching cold front, now over the Great Australian Bight area.

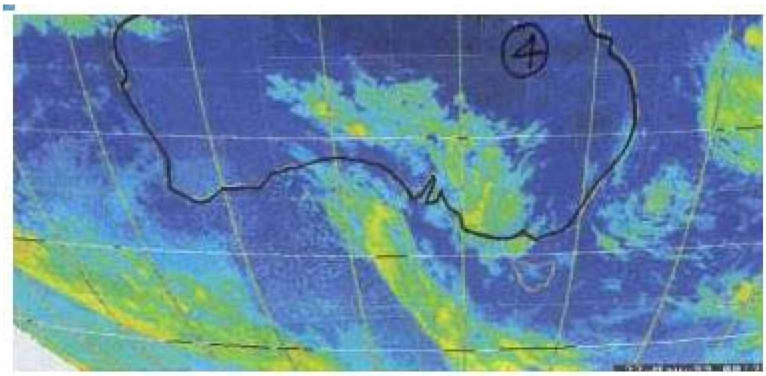

IMAGE 4: 10am CST 22nd May 1999

(vi) The cold front intensifies as the cold frontal air-mass reacts with the warm moist north-west cloud-band air mass.

(vii) Potential energy is released by condensation and glaciation as the warm and moist Indian Ocean air mass is uplifted by the approaching frontal zone.

(viii) This helps cause an intense low pressure area to form on the frontal zone just south of SA.

(iv) Good rains and some thunderstorms result.

(v) These rain and thunderstorms move slowly across VIC, southern NSW and TAS in the following few days.

Images courtesy of James Cook University

For more information on Holton Long-Range Weather Forecasting services for your area contact Ian Holton holton7@bigpond.com or phone 0883886700 and/or view web-site htttp://www.holtonweather.com