Answers to Common and Unusual Weather Questions

q. March 2005: What is a "Cut-off Low Pressure System?"

a. A cut-off low pressure system is a low that has become stranded from the normal west to east moving westerly wind flow stream which moves around the mid-latitude areas of the northern and southern hemispheres.

It becomes slow-moving and may even drift back westwards (the opposite to normal movement in the mid-latitudes).

It may become stationary for several days or more, and as it does areas that lie underneath & around the centre of the low may well receive substantial rains for several days or more.

It will eventually be again captured by the normal westerly flow and move away to the east as normal, however it may remain in an area for periods of several days to one or two weeks on occasions.

The cut-off low pressure is essentially a parcel of cold air that has sheared off from the normal cold air belt at higher mid-latitudes and for a time is stranded, surrounded by warmer sub-tropical air. It is therefore unable to move with the normal cool westerly mid-latitudinal flow until contact with the cool westerly flow is again made. It then sweeps away to the east once again as a normal mid-latitude westerly low pressure system.

q. April 2005: What is a "Blocking High/ Blocking Low/ or Blocking High/Low Pair"?

The Earth' atmosphere generally is warmer near the equator and cooler near the poles. In the mid latitudes there is a latitudinal area from around 25 to 50S (Southern Hemisphere) where these two warm and cool areas meet and frontal zones form. Here where these frontal zones form, the warm temperatures to the north and the cooler temperatures to the south (Southern Hemisphere), propel fronts and associated lows eastwards in the well known Westerly Wind Belt.

However, sometimes a warm bubble mass of air will be propelled well southwards, and a cooler bubble mass of air will be propelled well northwards. Usually these two events happen in the same longitudinal zone. When this happens the temperature structure is reversed and cool temperatures are to the north and warm temperatures are to the south (Southern Hemisphere). In this situation the normal westerly flow & eastward movement of lows, highs and fronts cannot be sustained, and easterly movement of systems (retrogression) may even occur.

This blocking high/ blocking low or blocking pair type of situation is hard to break down and may need many strong fronts "hitting" against the block to bring the temperature structure back to normal. And often weaker fronts can move up to the block and on hitting the block shear more cold air north into the blocking low part of the block top. This will intensify the block even further or at least keep it sustained. Thereby, a blocking situation may continue

for weeks at times interrupting the normal west to east movement of systems, and steering fronts well SE around the blocking pair.

If a blocking high is sitting over a site for days or weeks a long dry fine and maybe frosty in winter spell is the result. However, conversely, if you have a blocking low sitting over a site for days or weeks, heavy rains, & even flooding can result.

The answer to this April question is related to the answer to the March question, as a "cut-off low" (as explained in the March 2005 answer) will become the blocking low part of a blocking high/ low pair if enough warm air is forced southwards under it and a blocking high cell forms to the south of the cut-off low pressure system.

Blocks tend to form over favoured sites and the most favoured near Australia is around New Zealand where the N to S hills block the westerly flow and can easily cause such blocking patterns. However, a blocking high/low pair can occur over any part of southern or central Australia at any time of the year.

q. May 2005: What is "Virga & the related 'Dry Downburst' phenomenon?"

Virga is rain that evaporates before it reaches the ground.

Virga is often found in the drier inland regions of Australia, where away from the oceanic water sources, a common lower level very dry atmosphere exists.

Middle level moisture often feeds across Australia from the Indian Ocean area ahead of cold fronts as elongated cloud-bands. These are orientated NW to SE. As the NW cloud-band streams SE across Australia it is uplifted by convergence of the SE'wards moving middle level airflow. This cloud moisture cools & condenses further as the stream is forced to rise. Eventually, rain starts to fall, and as it falls into the lower very dry atmosphere it evaporates before it reaches the surface. The rain can be seen falling from the cloud above as dark rain streaks (they may appear white if sunshine is illuminating them) below the cloud-base and is called "virga".

In such "virga" situations, small to large areas of light radar rain echoes are often shown on the weather radar, and one can think that rain is about to fall. However, it does not, as the radar is only picking up the middle level rain echoes.

At times, only the largest of the raindrops will survive the trip through the very dry lower atmosphere, and just an odd few medium size drops of rain will occasionally fall on the surface. However, if it is widespread enough, the "virga" will eventually slowly moisten up the lower atmosphere through the added water vapour from evaporation of the falling raindrops, & rain will then start to fall on the surface.

The other feature that can occur with "virga" is a "dry downburst". Here, as the virga evaporates, it cools the surrounding airmass, and this cooler dense airmass descends and "hits" the ground spreading out as a "dry downburst". Often it can be seen as a dust ring where the "dry downburst" has hit the ground and spreads out kicking up a ring of dust. These "dry downbursts" can be a very turbulent and are a hazardous phenomenon to low

flying aircraft and to aircraft taking off and landing at an airport. They have been the cause of several aircraft crashes on take-off, and because they are invisible, they are a dangerous Australian aviation weather phenomenon. Also, these "dry downbursts" can cause structural damge to buildings, and may blow down tree branches & the trees themselves.

q. June 2005: Why do High & Low Pressures & Fronts move in a certain direction one day and different direction the next?

The surface High and Low Pressures and fronts shown on weather maps will move in the direction of the 1000hpa to 500hpa (approximate 2,000ft to 18,500ft) general Temperature pattern/wind flow patterns aloft. Generally at these levels in Southern and Central Australian latitudes it is a SE to NE directional movement in the normal mid to upper level NW to SW Westerly wind belt flow.

As Highs, Lows and fronts move along these mid level temperature and flow patterns they change direction following the flow patterns aloft. Occasionally the mid and upper level temperature & flow patterns are aligned in northerly, southerly or even easterly flow patterns. In this case the low or high can move in south, north or even west directions for a period, instead of the usual NE to SE movement.

In light middle and upper level temperature & flow patterns, they will move slowly and conversely in strong middle and upper level temperature & flow patterns, they will move rapidly.

Closer to the equator, in Tropical and Sub-tropical areas, Low pressure systems normally move in a westerly direction, as the general low and middle level temperature and flow patterns are reversed, and the normal low & middle wind flow direction is from NE or SE.

However, if tropical and sub-tropical low pressure systems stray too far south, they get caught in the middle and upper westerly flow, and therefore change to the more normal SE to NE direction of movement of the middle latitude westerly wind belt.

q. July 2005: Sometimes Nocturnal (Night-time) Showers & Thunderstorms start forming in the evening and overnight. As there is no convective heating in the night, what causes them to form?

And why do Autumn to Spring Showery Lines/Bands often form over the South Australian Gulfs and the Lower Murray River at night?

Thunderstorms can occur at night-time if a layer of middle level cloud left-over from the days shower and storm activity remains overnight. This middle level cloud layer is heated from below by radioactive heating from the earths' surface. While above, the top of the cloud layer is cooled by heat being radiated away from its top cloud surface into the upper atmosphere. The cloud layer therefore heats at the bottom and cools at the top, and thereby becomes unstable. Eventually Castellanus unstable cloud turrents start to form, and these then can become high and large enough to glacify (turn to ice) and high-based Cumulonimbus (Thunderstorm) Clouds start to occur.

If there is a strong jet-stream above, and/or an upper level trough approaching, these storms can become widespread and very active often in the period from around 8pm to Midnight, and may well go on until dawn, when the suns' heating starts to warm the cloud-tops and stabilize them. As there storms are often lower precipitation high based storms they make good lightning photography night subjects.

In the tropics, they often form out over the sea at night, as cooler land-breezes push out to sea and warm by contact with the warm oceans, they then rise and form large cumulus. Nocturnal cloud top cooling comes into effect, and then this causes them to build into much storm activity. Converging Land breezes off the Malayan & Indonesian Peninsulas also helps cause the well known nocturnal storm activity at night in that area.

When streams run up the South Australian gulfs, & Lakes-Murray River areas at night, a similar effect can occur in autumn, winter & spring seasons, as converging land-breezes from either sides of the gulfs warm as they move over the warm Gulf water below. These land-breezes then collide and push up long or continuous shower stream lines in the middle of the gulfs/lakes. Nocturnal cloud-top cooling adds to the intensity of these shower lines. These shower lines eventually run up over sites, at, or near, the top of the gulfs/lakes, causing some moderate to high rainfall totals at times. Isolated Thunderstorms can also occur in these Gulf shower lines if the stream is very unstable.

In the Spencers Gulf area, if the air is cold enough, they can form nocturnal snow shower lines in the Orroroo/ Peterborough area as they drift inland from Spencers Gulf on a cold night in a persistent SW to SSW'ly stream.

Whyalla had been known to gain persistent overnight hail showers & showers if the cold stream is from a more southerly direction. Cleve and Cowell areas can gain good rains if the stream is from the SSE, and the Port Germein area can gain some of its heaviest yearly rainfall events in a SSW'ly overnight Gulf convergent/nocturnal cooled showery stream.

In the St Vincents Gulf area, heavy falls can occur in a SSW'ly stream over the Roseworthy/Tarlee/Clare areas. Snow has fallen very occasionally in the Burra Area in cold winter/spring streams. And in a more Southerly stream the Balaklava/Port Wakefield and Hummocks areas can do well for rainfall.

While in the SA Lakes and Lower Murray Rivers areas, a SSW'ly can bring good rainfalls to the Lower Murray River and Near Lower Murray River areas. While in a more southerly to SSE'ly flow, heavy rainfalls can occur as the shower lines are forced to rise up over the eastern Mt Lofty ranges. Feet deep snow falls have been recorded in the Mt Barker/ Nairne/ Gumeracha areas on rare occasions in a cold S to SSE winter/spring showery stream.

q. August 2005: Is the westerly wind belt moving southwards as Global Warming increases? And if this is happening, will rainfall become less in Winter Months in Southern areas of Australia?

There have been suggestions made that the westerly wind belt that rings the Southern hemisphere is becoming stronger and shrinking back southwards towards the Antarctic

continent because of Global Warming. The past ten years appear to show a southward movement of the Winter Westerly Wind Belt in the Australian Region. As a consequence rainfall appears to have lowered in southern areas of Australia during the Winter months. Also, many would have noticed that Dams are no longer are filling from heavy rains during the Winter months.

Is this apparent wind/weather pattern change going to continue or to get worse?

The main points to consider in my opinion are:

a. Continued warming of the global world temperature will cause the mean position of the westerly wind belt to continue to drift erratically further southwards than its' past mean position.

b. Apart from any global world temperature changes, the westerly wind belt latitude will change every year/ season according to sea surface temperature changes around the Australian and Southern Hemisphere areas. And it will be further north than the general mean in some years, and further south of the general mean in other years.

c. Although southern coasts and hills areas may benefit from strong westerly wind type winters, dry westerly wind streams inland can produce drought conditions eg. 1902 and 1957. A quote from John Pringle an Australian Author who wrote once of the dry inland westerly winds, "The Westerly is the Voice of Australia. This is the true aboriginal wind, hard and lean and dry as the bones of a dead sheep".

More general inland rain is actually generally produced in winter years with more meridional flows (N or S flows). In these conditions Tropical Moisture & NW Cloud-bands can move down southwards ahead of fronts, and strong temperature gradient fronts can penetrate well inland bringing good rains.

d. In the general wetter Australian years many inland lows & cut-off lows are also common, little westerly flow occurs, and high pressure systems are often lie well south of the Australian continent for long periods. In many of these general inland wetter years the main westerly flow was broken up & often lay well south of the Australian continent during winter months. eg 1955, 1956 & 1974.

e. Therefore, a movement south of the westerly wind belt will not neccessarily cause a lowering of rainfall in Southern Australia. It will depend on how the sea surface temperatures are structured around the Australian and Southern Hemisphere areas for that particular year/season.

f. However, a general movement southwards of the mean position of the westerly wind belt in winter is likely to continue the erraticly the slow downward trend of lower rainfalls in some southern coastal and hills areas (which gain much of their winter rainfall from coastal westerly winter frontal shower activity).

q. September 2005: Why do we generally get more thunderstorm activity in the Spring and early Summer months?

In Springtime the land temperatures start to warm rapidly as the sun moves southwards (Southern Hemisphere), becomes more overhead, and thereby produces more daytime heating. However, the oceans warm only slowly in Spring time. This creates an unstable situation over the land-masses as the colder air over the water often rushes inland to try to equalise the strong temperature gradient that exists between the air over the warm land and the air over colder water. As these colder unstable frontal airmasses push inland they generate cumulus clouds & thunderstorms as the warm land airmass is rapidly lifted.

Also, over the land at the same time in Spring, the lower layers warm up rapidly, while there is a lag in spreading the heating up into the middle and upper layers, so again unstable air mass cumulus convection clouds and thunderstorms can occur.

In very late Summer and Autumn months, the converse is true, as the land mass is cooling, the sea temps are still quite warm and are only slowly becoming cooler. The land to sea temperature gradients are less, and therefore the frontal passages are less unstable, have less strength, and thereby less storm activity results.

Also, over the land at the same time in Autumn months, the lower layers are cooling faster than the middle and upper layers. More stability is therefore present, as cooler surface air resides below a “warmer" middle and upper airmass, & thereby less air mass storm activity is generally produced.

q. October 2005: What is a "Black Frost" and why does it cause so much damage to plants?

In Springtime the land temperatures start to warm rapidly as the sun moves southwards (Southern Hemisphere), & becomes more overhead, thereby producing more daytime heating. However, the oceans warm only slowly in Spring time. This creates an unstable situation over the land-masses as the colder air over the water often rushes inland to try to equalise the strong temperature gradient that exists between the air over the warm land and the air over colder waters to the south.

As these colder, quite dry, polar frontal airmasses push rapidly northwards over the Australian continent, they arrive as a cold, dry, clear airmass with a few brief showers and small pellet hail embedded showers, mainly around the southern coasts and hills. As these cold & dry airstreams move rapidly inland they dry even further, and in the nocturnal hours become even colder due nocturnal radiational cooling of the near surface air layers in contact with the ground. These cold to very cold airstreams then slow down and temperatures can start to plunge down to the zero mark and below.

However, if they contain little moisture(very low relative humidity and dew points below say minus 3 degrees or less), then they do not form dew or frost on the plant surfaces. This normal dew and frost coating tends to insulate & protect the plant cells from freezing. If the temperature drops below zero and dew and frost do not form, then the plant cells freeze and burst easily. In the morning, a farmer may wake up and see no dew and frost around and feel relieved. But, within a day or less the farmer will start to see "black frost" scald patches start to appear on leaves, and much damage can then become evident.

The actual damage to ears of grain may not even be apparent until harvest , when much of the harvested grain is pinched and of very poor quality, suitable only for stock feed...or in the worst cases the grains may not have even formed in the "black frost" affected head!

Fortunately, in Australia, we have an ocean belt to our south, between us and the Antarctic This tends to warm and moisten any northward moving polar airmass before it reaches the Australian continent. Therefore, “black frosts" are rare events. But, once every few years they do happen in small areas of southern and central Australia and small areas of crops can suffer from the severe damage of a notorious "black frost".

q. November 2005: Medians, Means & Averages...What do they say about rainfall & temperature on your farm or town?

The median (the middle number in a series, with half the obs above and half below), and the mean (the average or mathematical total of all the obs divided by the number of obs), are useful to show the type of expected weather at any site for any month, season or year...BUT, the problem with these type of statistics is that in the fact that Medians and Means rarely occur at any site for any particular month, season or year!

And this is because the Medians and Means for any site are in actuality the Median and Means of many "ABNORMAL" events, ie. The May Mean rainfall for an 12 year period may be 25mm, but the actual rainfall for that 12 year period may be: 2, 8, 15, 15, 18, 25, 25, 32, 35, 36, 49, 50mm. So in actuality, only two May rain totals in 12 are near the mean May rainfall ...all other years are NOT mean or "normal" months for that 12 year period.

And, if we look at the Mean or Average May rainfall for that 12 period... it is the total 285mm of all the obs, divided by 12 years, which equals 25.8mm average rainfall for May for that 12 year period...but again, only two May rain total in the 12 May rain totals were near the mean or average...all other years are NOT "average" May rain years.

A better way of looking at the statistics is to look at the NORMAL SPREAD or STANDARD DEVIATION of May rainfalls:

The STANDARD DEVATION(the difference) from the average of all the 12 May rainfall observations is 12mms (ie. the total of the difference of all 12 rainfall May years from the mean of 25.8mms, is 134mms, divide that by 12 and you get 12mms as the STANDARD DEVIATION).

That means that normally the May rainfall for this particular site is between 13.8 and 37.8mms(ie. within 12mms of the mean). So the only real ABNORMAL or EXTREME type years are the 2, 8, 49 and 50mm May total years. All other years lie within what one would normally expect to occur in May at that particular site.

It is worth noting that most medians or means or Standard deviations of rainfall are calculated over a much longer period than 11 years...30 or 100 year medians, averages or normal spreads are usually calculated.

And it is worth stating once again...Months, seasons and years are rarely near the Median or Mean(Average) rainfall, temperature, etc. They are better looked at as an expected rainfall, temperature, etc range, such as that revealed by the Standard Deviation.

q. December 2005: "When I was younger, say back in the 60's and 70's, the weather Perth was having would come straight east and reach us 3 or 4 days later, why doesn't it do this now?"

The weather patterns do generally move from west to east in the mid-latitudes, and the main weather features often do move east from Perth across to SA/ VIC/ and NSW several days later.

However.....(a) there is also a vast interchange of airmasses from north to south, and south to north, and these can modify and change the weather features as they move across from WA. Low and High Pressure systems can change, weaken or strengthen form or dissipate,

(b) the sea surface temperature patterns, mountain ranges and other topographic features tend to steer weather systems in certain directions for each day, week, month, season and year. This steering may not be west to east, but may be more NW to SE or SW to NE...or even E to W, the opposite to normal,

(c) Blocking weather patterns can form and block all other eastward moving weather systems for day or weeks, and can even send them back westwards for periods,

(d) Moist air masses from the Oceans around Australia can infeed into low pressure systems and change a "dry" low pressure system into an active stronger "wet" low pressure system as it moves eastwards, or conversely dry air from the interiors can infiltrate into a "wet" low pressure system and clear most of the rainfall from the system as it moves eastwards.

The legend of the common belief that "in the 60's and 70's we got Perth's weather a few days later, and now we do not", probably stems from the fact that.....(a) We did not have forecasts that extended out more than 24 to 48 hours, and that they were not as accurate...So people looked westwards to Perth to see what general weather may come across,

(b) We did not have satellite pictures and computers to really see weather systems continually evolve, and,

(c) Some years are more dominated by west to east flow of weather patterns than others, mainly due to sea-surface temperature changes around the hemisphere...the 60's and 70's had a more than the normal share of years that were more dominated by west to east flow.

q. January 2006: "Lake Eyre SA is below sea level. If the State or Federal Australian Government dug a canal from Port Augusta to Lake Eyre and filled it with sea water wouldn't there be more moisture around the inland. And hence wouldn't most fronts and lows drop more rainfall in many areas of Central and Eastern Australia?"

While Lake Eyre can hold a significant area of water surface when full, in comparison to the area of Australia it is quite small. However, having said that, if Lake Eyre were full, there would be more lower level moisture in the atmosphere in the general vicinity of the Lake, and more rainfall would be likely to occur. Also, there would be an increase, to a certain extent, in lower level moisture levels ahead of fronts in NE to NW streams flowing down across Flinders Ranges, Lower and Mid North, Central Districts of SA, Mallee SA, Mallee & Wimmera VIC areas. So the rainfall would likely increase somewhat in those and in some other nearby adjoining areas.

The bigger questions are: (1) How much would the rainfall increase? (2) How much would this project cost a government? (3) And hence, would such a scheme be cost efficient? (4) And would it harm the environment?

The answer to; (1) is probably too hard for even a computer to work out with any real accuracy, (2) is likely to be many millions of dollars, and then an ongoing large maintenance cost would also be incurred, (3) is again very hard to work out, seeing as we cannot answer question (1) satisfactorily. Maybe over a time it would recoup the money with increased agricultural & aquaculture production, a vast increase in tourism and inland tourist resort incomes, and a large increase in the labour market. (4) Again, a hard question to answer. It may increase Spencers Gulf salinity, but, it has other benefits like increasing the migratory bird population, because of the vast areas available for breeding all year around. These issues are complex and would be best answered by an environmental study.

q. February 2006: "It has been observed that showers and storms often follow tree-lined creeks and rivers. Why is this so?"

Over inland areas convective showers and storms develop during the daylight hours. These develop over areas of hotter land. Here more heat energy exists than over the surrounding cooler temperature land areas. However, areas where extra moisture exists also contain higher levels of heat energy in the form of latent heat of condensation. Convective showers and storms tend to develop more easily over these moist areas along tree-lined rivers and creeks, as they can feed on this extra heat energy source viz. latent heat energy.

In fact, areas that gain a storm early in the season tend to gain further storms during the following days, weeks & months, as later storms tend to form and use the latent heat energy of the moisture left from the previous storms and from extra grass growth.

It is also likely, that when most of the forests were cleared for agriculture in the early to mid last century, that we exposed ground areas to greater evaporation rates caused by more sunlight and more wind movement...And that in doing this we have also decreased the moisture present... and hence decreased the latent heat energy available... and hence decreased daily, weekly, monthly, seasonal and annual rainfall in many areas of Australia.

q. March 2006: "When a shower or storm line approaches us the heaviest and darkest part of the shower or storm line almost always seem to pass on either side of our home-site. It seems to almost always split into two heavier areas of rain, one each side of our house,

and we get the lighter looking part of the shower or storm line pass over us. Why does this almost always happen at our site?"

Any line of showers and/or storms passing over a site will appear to have heavier and darker rain areas to each side of the site as the line passes over that site due to an optical illusion effect. If you are looking at the middle of the approaching shower or storm line you are looking through a much shorter distance of rain-band, than if you are looking towards the edges of the line which are passing each side of your site. If you are looking along the rain-band as it is getting closer to you are looking at an angle and therefore through a much greater length of the rain-band and it will appear darker and heavier to your eyesight. Therefore, almost every observer along the shower or storm line will experience that same effect..."The showers always split around us when they approach our house or farm" could be said by almost every weather observer in an area, and often is said because of this optical illusion effect. If you are still not convinced, then view the surrounding rainfall readings each day. Do you really get less rain than all the other sites regularly, or are your readings less some days and more other days. Unless you are in a valley or rain-shadow area, the latter will probably be more correct.

q. April 2006: "What is the MJO Tropical Wave? What is an ER Tropical Wave?"

An MJO (Madden Julian Oscillation) is basically an unstable tropical cloudmass of shower/rain and thunderstorm activity which generally forms in the Tropical Indian Ocean and drifts slowly EASTWARDS during the Mid Spring to Mid Autumn period of each year. It has a periodicity of around 40 to 60 days generally. In between each MJO phase is a suppressed weather drier Anti-MJO phase. The cause of this weather phenomenon is not well understood, but appears to be related to Westerly Mid-latitude airflow and associated Upper Level Troughs further south of the MJO (Southern Hemisphere), and to the Sea Surface temperature structure in the tropical oceans of the Indian and Pacific Oceans. MJOs seem to be more common during the El-Nino phase and less common during the La-Nina Phase. These MJO waves often dissipate in the Middle of the Pacific Ocean as they drift eastwards. If they reach over to the South American Coast, they are said to trigger off an El-Nino surge of some nature.

An ER (Equatorial Rossby Wave) is is basically an unstable tropical cloudmass of shower/rain and thunderstorm activity which generally forms in the Tropical Pacific Ocean and, in contrast to the MJO, drifts slowly WESTWARDS during the Mid Spring to Mid Autumn period of each year. It has a periodicity of around 30 to 45 days generally. In between each ER phase is a suppressed weather dryer Anti-ER phase. The cause of this weather phenomenon is also not well understood, but appears to be related to general Tropical Easterly Flow and to the Sea Surface temperature structure in the tropical oceans of the Indian and Pacific Oceans. ERs, in contrast to the MJO's, seem to be more common during the La-Nina phase and less common during the El-Nino Phase. These ER waves often dissipate in the Middle of the Indian Ocean or near the African continent as they drift westwards.

Often there is a complex mix of MJO & ER Waves present during the active Mid Spring to Mid Autumn period each year, and this makes forecasting Tropical and the associated Mid-

latitude weather & rainfall which may occur from them difficult at times. See current BOM past and forecast chart online here

q. May 2006: "What is a Rossby Wave?"

Across the two hemispheres of the earth the general flow in the upper levels is from west to east. However, the air flow moves across mountain ranges, continents and differing sea surface temperature areas. These cause the west to east flow to change direction to NW to SW flow by various means that are too complex to explain in this short article. In the Southern Hemisphere NW flow starts to drag warmer nearer equatorial air southwards, while SW flow starts to drag SW cooler nearer Polar region air northwards. So an Upper Level Trough develops and moves slowly eastwards with warmer advection air ahead of it and cooler advection air behind it...This feature is called a Rossby Wave after the scientist who discovered them.

Upper Level Troughs or Rossby Waves generally cause unsettled weather as they pass by any area as they direct moist tropical air southwards ahead of them and direct cold fronts to move northwards behind them. This mixture is good for creating rain, storms and showers around the Rossby Wave.

Rossby Waves can also form in the Equatorial Easterly flow of the tropical regions of the world. In this case they move in the opposite direction from east to west and again cause outbreaks of showers, storms and rain in tropical areas. They can also be tropical cyclone (hurricane) generating areas.

q. June 2006: “How can a flat stable layer cloud such as stratocumulus and altocumulus suddenly become unstable and develop unstable castellanus towers? I have often seen occur well ahead of a front or low approaching."

What happens is that as the front or low approaches, the whole atmosphere starts to converge and slowly lift upwards. The stable cloud layer below a stable temperature inversion layer is lifted and cools at the saturated adiabatic lapse rate for moist air, while the warmer clear dry air above the temperature inversion and stable cloud layer cools at the unsaturated adiabatic lapse rate, which is much steeper than the unsaturated adiabatic lapse rate.....

Or, to put it in simpler layman's terms, the stable cloud layer slowly cools on being lifted, while the clear air above cools rapidly upon being lifted. Eventually the clear air above cools down to a lower temperature than the cloud layer below. Then, the now warmer cloud layer becomes unstable and convection cloud turrents shoot upwards into the cooler airmass above, and can even form into middle level thundery showers or thunderstorms.

q. July 2006: "What is Dew Point?"

The Dew Point is the temperature at which a parcel of air at the same pressure would reach 100% humidity and condensation would occur.

Dew point is useful as a tool for estimating overnight temperatures in winter, because the lower the dew point on a clear night, then the lower that the temperature can fall before condensation occurs and latent heat of condensation is released, thereby then slowing the cooling rate substantially. Therefore the lower the dew point on a clear night, then the cooler the minimum temperature will be (unless there is wind to disturb the cooling by mixing the lower layers of the atmosphere).

Dew point is also very useful as a measure of how much humidity is available during the day to fuel any showers and storms that may develop. The higher the dew point, then the better the chance of showers or storms (if instabilty and trigger mechanisms are present).

q. August 2006: "Why does wind often drop overnight, and often pick up again during the morning?"

Overnight cooling near the ground creates a pool of dense cold air near the surface. This cold dense air is harder to set in motion, and the warmer environmental air above tends to "slip" over the top of the colder air below. Thereby, the environmental pressure gradient flow is detached from the near surface layer flow below. And, therefore, the near surface layers overnight tend to just flow slowly and follow topography slopes in a slow downslope-type motion.

In daylight hours, the solar heating causes the near ground layers to warm up. They then connect with the higher environmental pressure gradient flow again and the near surface winds pick up in speed once more.

q. September 2006: " Why is it often clear blue sky in the morning, but cloudy by the afternoon?"

During a clear night period, the air is cool near the ground and no heat (convection) currents occur. Therefore, often no cumulus clouds occur at night, as there are no heat (convection) currents to form them.

However, as the air warms near the ground by the action of sunlight shining on it in the daylight hours, warmer air starts to rise and form heat (convection) currents. These rising heat (convection) currents form cloud as they reach up higher into the atmosphere and cool & condensation takes place within the heat (convection) current. As the ground heats up more and more, further convection currents rise up, they too cool and condense and the sky often fills with these cumulus clouds during the afternoon.

q. October 2006: "The drought this year, 2006, is a bad one, for sure. I have heard that 1914 & 1967 were also bad droughts in SE Australia. How bad were they?"

Various Comments and photos of the 1914 & 1967 droughts

Camels crossing the Murray River, Mildura1914 Drought View Photo

In the 1914 drought, which severely cut average wheat yield, Scaddan set up the Industries Assistance Board; seed-wheat, superphosphate and fodder were distributed to needy

farmers. He was rewarded with a record harvest in 1915-16 (Australian dictionary of biography On-Line Edition) Scaddan, John (1876 - 1934)

WA's drought considered worst since 1914: The drought in Western Australia has been described as the worst since 1914. (Landline News ABC 13/10/2006}

PAUL SIMMONS, COOMANDOOK FARMER: “My father said we've always ripped a crop here but we could be getting close, I understand, to challenging the 1914 drought ...” Stateline ABC 1st September 2006

Another example of very high prices resulted from the 1914 drought that affected most Australian States. This severe drought led to virtually no wheat being available for export from Australia in 1915. The low production and low stocks yet increased demand from Australia and overseas, caused wheat prices to increase sharply. Price Risk Management for Australian Broad acre Farmers: some observations Agribusiness Review - Vol. 8 - 2000 Paper 2 ISSN 1442-6951

"I grew up on a farm and saw the impact of the 1967 drought on my parents. I've been in Mildura since 1975 and have never seen things quite this bad.” Drought Relief Counsellors - a personal touch: National Media Release Tuesday, 24 January 2006

Natimuk. Nearly 3 km north of town is Lake Natimuk which is an ideal spot for fishing, waterskiing and other water sports when it is full. The lake is noted for its plentiful yabbies, redfin and trout. However, it can dry up during a drought. Ironically, the accumulation of dry vegetation on the lake bed in the 1967 drought actually presented a fire risk and prompted a major burnoff which presented the spectacle of a lake aflame. Natimuk Travel: The Age

View Photo: A dust-storm rolls across Mildura, Victoria, at the height of the severe 1967-68 drought in southeastern Australia. (Photo courtesy of the Foto-fella Don Turvey and The Mildura and District Historical Society Inc.)

During the 1967 drought we had our sheep on the road for twelve months. We brought them home in May 1968. FARMER EXPERIENCE - CHEMICAL RESISTANCE IN LIVESTOCK. Hay, Farrer Centre Wagga

In the severe drought of 1967-68, restrictions were introduced relating to the use of fixed sprinklers and hoses, as well as washing cars and filling swimming pools and fountains. People used buckets to water their gardens but even this practice was later restricted, although industry was mostly exempted. Living with drought: A Dry History: Melbourne Water, Historian Jenny Keating, in The Drought Walked Through, commissioned by the Department of Water Resources in 1992, wrote of the 1967/68 drought.... ".....lack of rain in the autumn and early winter of 1967 meant low streamflows and a rapid drawdown. By mid August, Melbourne's water in storage had gone down by more than 50%. In many areas the cumulative rainfall in the first six months of the year was the lowest ever recorded." "The August rainfall was average to above average in all districts except the South Wimmera, but when the September rain partially failed state-wide, drought became a distinct possibility." "...the October and November rains failed completely throughout the state - in only one

district, West Gippsland,was the rainfall average- all the rest were below average, many in the lowest rainfall decile.Taking 1967 as a whole, the rainfall in all 15 meteorological districts was in the lowest decile, eleven of them receiving their lowest ever recorded rainfall up to that time." (pp. 167-8) "Those farmers particularly hard hit by the drought were those reliant on private diversions from unregulated streams and rivers. Most of these streams failed, a number of them completely. In order to conserve water for domestic and stock supplies the (State Rivers and Water Supply) Commission, whose responsibility they are, had to impose restrictions which ranged from severe rationing and rostering to complete bans on the use of water for irrigation from 140 streams. This placed many farmers and growers in a desperate situation." (pp. 199)

q. November 2006: “Is this year 2006 "a one in a thousand year drought", as many people, politicians and the media are claiming?"

The simple answer to the question is that no one really knows. This drought year 2006 is one of the worst since 1900, and since and decent Australian rainfall records began in Australia around 1850. However, no one knows with any surety how bad droughts were before decent Australian rainfall records began, so the statement that this year is a one in a thousand year drought is pure conjecture and certainly cannot be proven.

Looking at this year’s previous 9 months to the end of September 2006, courtesy of the Bureau of Meteorology, it can be seen that some large areas are showing the lowest rainfall on record. However, many other larger areas do not. So, it can only be said that this year is the "lowest rainfall showing on recent records" for the 9 month period in large areas of South Eastern, parts of East & North-Eastern Australia and small areas of West Coast Western Australia.

It appears that comments on the one in 1000 year drought analysis came from the Murray-Darling Basin Commission. The '1 in 1000 year' claim is a statistical analysis (i.e. given that in the data of 114 years of Murray River Inflow Records, the October inflows into the Murray-Darling basin are sufficiently far below the previous record that they would only be expected to occur once per 1000 years on average). This statement would only be (if it is a correct and valid one), applying to the Murray River catchment area. And therefore, should not be used as a basis for claiming that all the remaining areas of Australia are in a "one in one thousand year drought".

q. December 2006: “We are getting a lot of "dry thunderstorms" lately in 2006. What is causing them?

In a drought year, moisture supplies are often very limited in Spring and early Summer. Infeeds of decent ocean or tropical humid airmasses are rare. The land is bone dry. No moisture is available even from some normal green grass ground covering. The temperatures are high and storm production temperatures are easily reached. But, with a low moisture supply, the cloud bases are very high, the rain falls and much of it evaporates on the way down to the ground ,or does not reach the ground at all (this weather phenomenon is called virga).

Result, often much lightning and thunder, but little or no rainfall with each event. Often just a fedw large drops reach the ground in some places. This dry type of thunderstorm often causes bushfires to form on the drought, dry Australian landscape, as it has done in Spring and Summer 2006.

q. January 2007: "The media often talk of "mini-cyclones" and "mini-tornadoes" occurring in Australia. What is the difference between a "cyclone and a mini-cyclone" & a "tornado and a mini-tornado"?

There is NO such weather phenomenon as "mini-cyclone" and a "mini-tornado". It is purely a media term which has crept into the media language, and to which most meteorologists and weather knowledgeable persons find quite irritating!

We either have a "tropical cyclone" or we don't. If we don't and something weaker than a tropical cyclone occurs, then we have a "tropical low". And, in reality, most times that I have seen the media or folk use this term "mini-cyclone" , they are actually referring to a damaging storm wind squall, which has nothing even remotely to do with a "tropical cyclone". It is a damaging thunderstorm downdraft instigated wind squall, i.e. a thunderstorm wind downburst.

Also, we either have a "tornado" or we don't! Sure there are stronger tornados and weaker tornados, but they are still "tornados" . The term "mini-tornado" seems to have come about because Australians feel that only the USA areas experience tornados. Well this is completely incorrect! Australia also has many tornado occurrences each year...some of which are just as strong as your average "USA Tornado Alley" Tornado.

In my opinion, it is time to get rid of this inferior Australian idea. The only reason that not many tornadoes get reported in Australia in the press, is that Australia has a much sparser population than the USA "Tornado Alley" area, and therefore a lot of Australian tornados go unreported in the press.

So in summary, we experience Thunderstorm Downbursts, Tropical Cyclones and Tornados in Australia, but we do NOT experience "mini-cyclones" or "mini-tornadoes".....there is NO such weather phenomenon as these in existence!

q. February 2007: "How can you tell if dew will form overnight"?

The dew will form on the ground when the temperature and dew point temperature are equal or 100% humidity occurs.

To tell if you are likely to get dew at night, look at the late afternoon dew point. Then look at your overnight expected minimum temperature from the nearest town centre. If the overnight temperature is forecast to become within 4 or 5 degrees C of the late afternoon dew point temperature, then dew is is likely to form overnight. If the overnight temperature is forecast to be within 2 degrees C of the late afternoon Dew point temperature, then Dew is highly likely overnight.

Dew is more likely when light winds are expected and little cloud is expected overnight.

q. March 2007: "Can rain fall out of a clear blue sky"?

Yes, I have seen two occurrences of this happening!

The first, was after a shower cloud had formed quickly overhead, it had started raining, then dissipated leaving the shower falling and no cloud above. A brief quite heavy shower fell over my house for a minute or so, yet no cloud was then visible in the sky, just blue everywhere!

The second occasion, and the more common one, is sitting on the lee-side just behind a long ridge, where rain was falling continuously on the windward side. However, as the cloud and rain passed over the ridge it all dissipated in the rain-shadow downdraft on the lee side of the long ridge. However, the wind was so strong that raindrops were being blown over the ridge into the clear blue leeward rain-shadow side and it kept raining for hours out of clear blue skies above my position.

q. April, May & June 2007: "Does Southern Australia do better rainfall-wise during a Growing Season with many westerly frontal passages"?

Growing Seasons with many westerly fronts and many strong westerly wind events tend to favour coastal and southern range areas which are near the Bight and Southern Ocean moisture availability areas. These areas often gain average to above average rainfall in such a "Westerly Weather Growing Season" as just mentioned.

However, many inland areas cannot gain particularly much moisture from these southern coastal moisture sources. Hence, Growing Seasons with many westerly fronts, strong westerly streams, & typical inland dry and mild periods are not very productive. Therefore, Below Average rainfalls are often common in this westerly type of Growing Season in many inland areas.

For inland areas, good NW Cloud-bands from the Indian Ocean moisture sources, and lower level moisture feeding in from the Pacific Ocean & tropical moisture sources, combined together with cut-off low pressure systems, provide much better rainfall mechanisms.

In deference to many folk & researchers, I like to see highs well south of the Australian continent in the Winter Growing Season and cut-off lows tending to form over the Australian continent in the Winter Growing Season.

Many of the dry years have strong NW to SW streams, which is OK for coastal areas, but inland often it leads to windy, dry, mild, strong dust blowing dry years, i.e. 1902, 1957, etc, and even 2002 was a little like that at times.

When we get the highs well south of Australia in winter & blocking, we tend to get slow moving cut-off lows throughout the winter growing season months, popping up in odd spots over the continent as they are this year, and giving everyone a turn at a drenching or decent rainy periods.

You tend to get moisture feeding in from odd directions in these situations from Pacific and tropical and NW cloud-bands aloft in the middle levels, and just feeding in at low levels from in-situ coastal waters areas also, as inland lows are so slow moving. I read an article, which I have since misplaced, which showed that in La-Nina years High pressures (& blocks) were a common feature well south of Australia, well south of their normal winter position. 1955 and 1956 were years of lows over the continent and highs and blocks well south, as was 1974 & 1989 & 1992. All very wet years...as I said I like to see this type of situation, some coastal areas may not, but even they tend to have do quite well in such a year and they tend to be good rainfall years inland. However, having said that, all years are different and some westerly wind years are quite good for all areas also, but every year will depend on how the all the various oceans & parts of them line up and how the El Nino/La Nina and Indian Ocean stack up for the year. Westerlies years are certainly not all good news, and can be very bad news for inland areas in some years and dry the land, crops up and blow half the soil away and prove a heartache for many farmers.

What is a better rain situation, low level dry interior air strong NW'lies flowing from the deserts of WA into Se Australia, or low level moist Pacific and tropical air flowing in from the NE to N area ahead of an inland slow moving cut-off low pressure?!!!

I am not a real westerly wind fan in the Growing Season, I like to see the cut-off low inland and north, & the blocking high well south of Australia.

In fact, I am not at all convinced that the westerlies moving slowly south will have much effect on inland rainfalls, which rely on cut-off lows, NW Cloudbands and Pacific and Tropical Ocean low level moisture infeeds for much of their better rainfalls.

q. July 2007: "Can you tell me some good basic weather links to get me started"?

A list of a few weather links that may help new weather persons with the basics of current weather & weather forecasting.

Cloud picture latest Australian – view here

Current weather analysis – view here

Forecast Australian weather maps-next 8 days – view here

Weatherzone weather map jet stream & basic rainfall forecasts – view here

14 day rainfall forecasts (Cumulative each 7 days – view here

Weatherzone lightning and radar rainfall current – view here

Climate at an Australian Site near You – view here

q. August, September and October 2007: "What is the Indian Ocean Dipole and what does it do to our weather in Australia"?

The Indian Ocean Dipole is a ocean sea surface temperature oscillation similar to the El Nino- La Nina phenomenon that exists in the Pacific Ocean.

(a) If the waters are warmer than normal near West Indonesia and Cooler than normal near East Africa,(Negative IOD) often wet conditions exist in Australia, and dry conditions in Africa.

(b) Conversely, if the waters are Cooler than normal near West Indonesia and warmer than normal near East Africa,(Positive IOD) then often wet conditions exist in Africa and Dry conditions exist in Australia.

In my forecasting I change the signs so that the Positive IOD gives positive Rainfall results for Australia. However, generally the terminology in literature is the reverse.

Winter 2006 to Mid Spring 2007 was a good example of a type (b) event, with many floods in Africa, & bad drought conditions covering much of Australia.