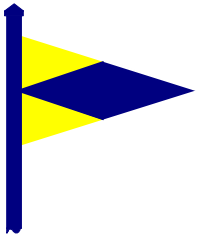
The Sea Breeze

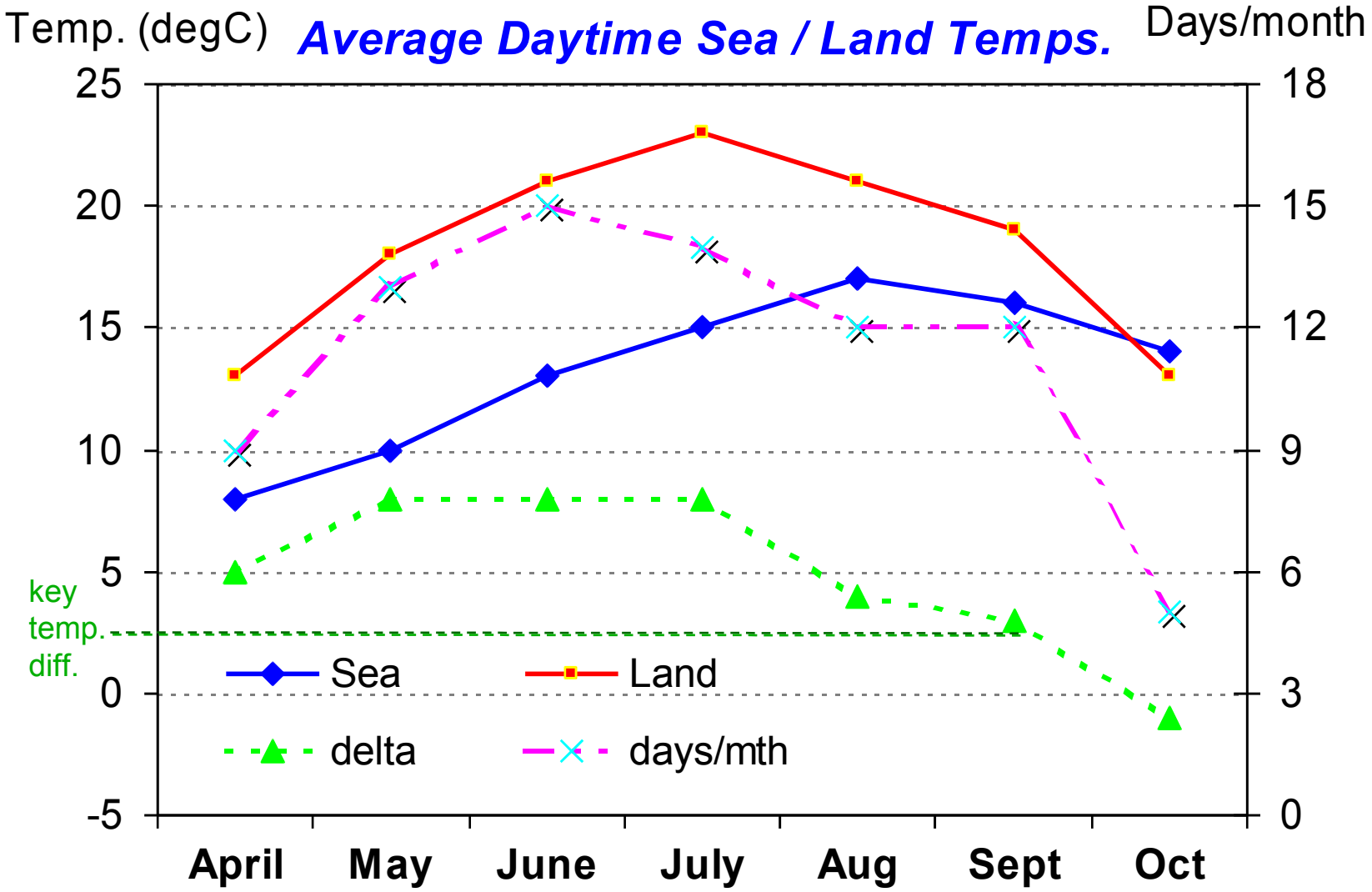


What?

Why?

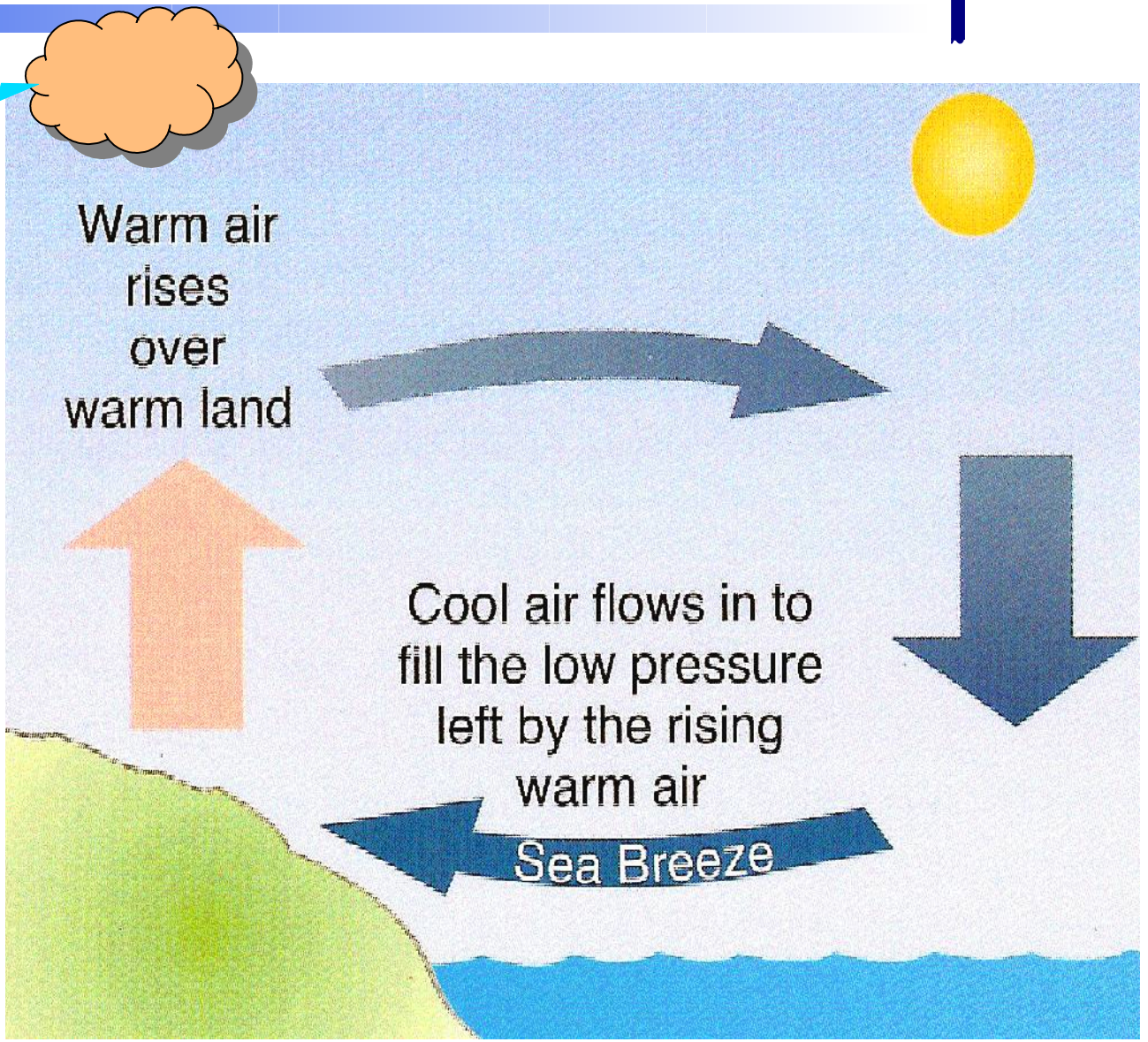
How?

‘thermally driven wind effects local to the coast driven by the temperature difference between the sea and land…..’



‘thermally driven wind effects local to the coast driven by the temperature difference between the sea and land…..’

Note the fluffy clouds



- **Temperature difference**
  - hot air is lighter
  - creates low pressure zone

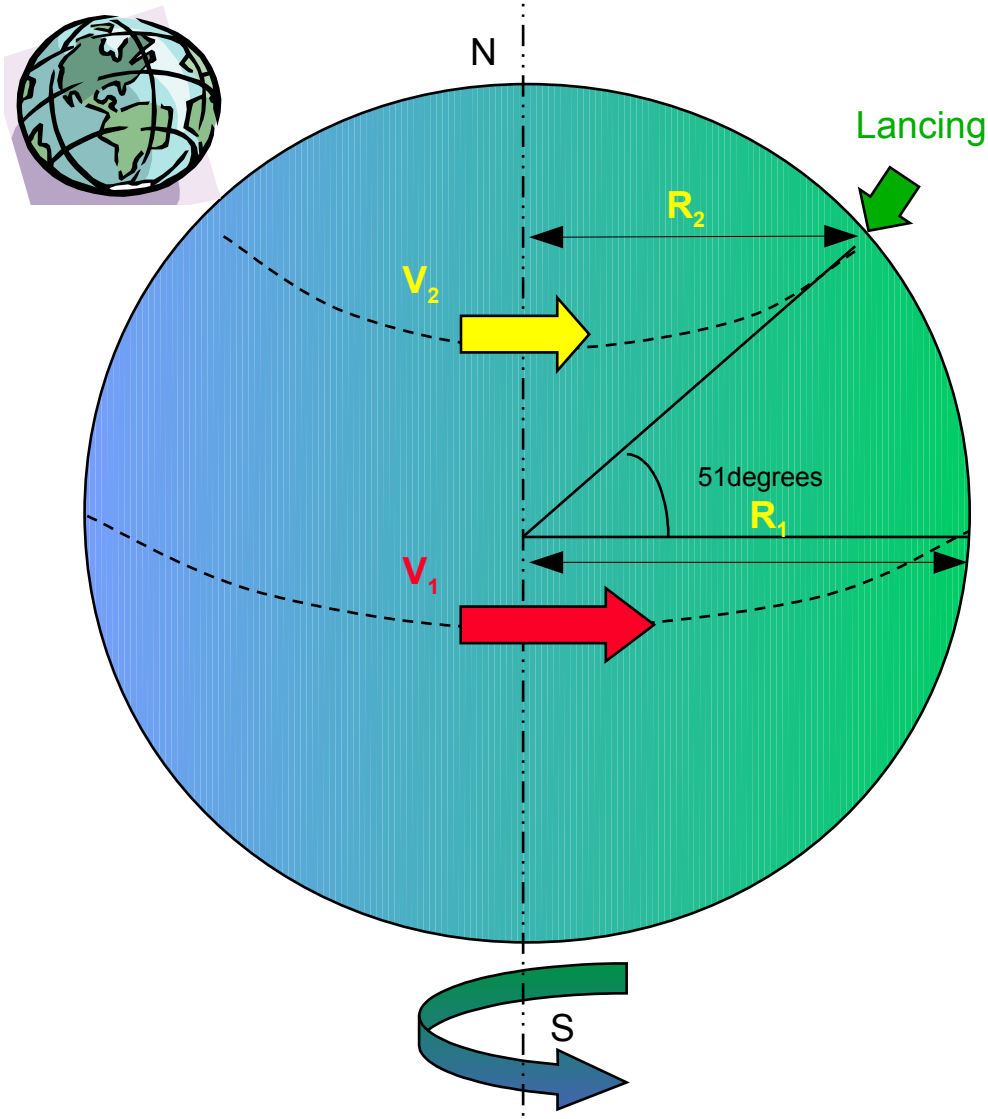
If only it were that simple!

coriolis effect?

gradient wind?

both of these greatly affect the way the sea breeze works!

Coriolis effect?



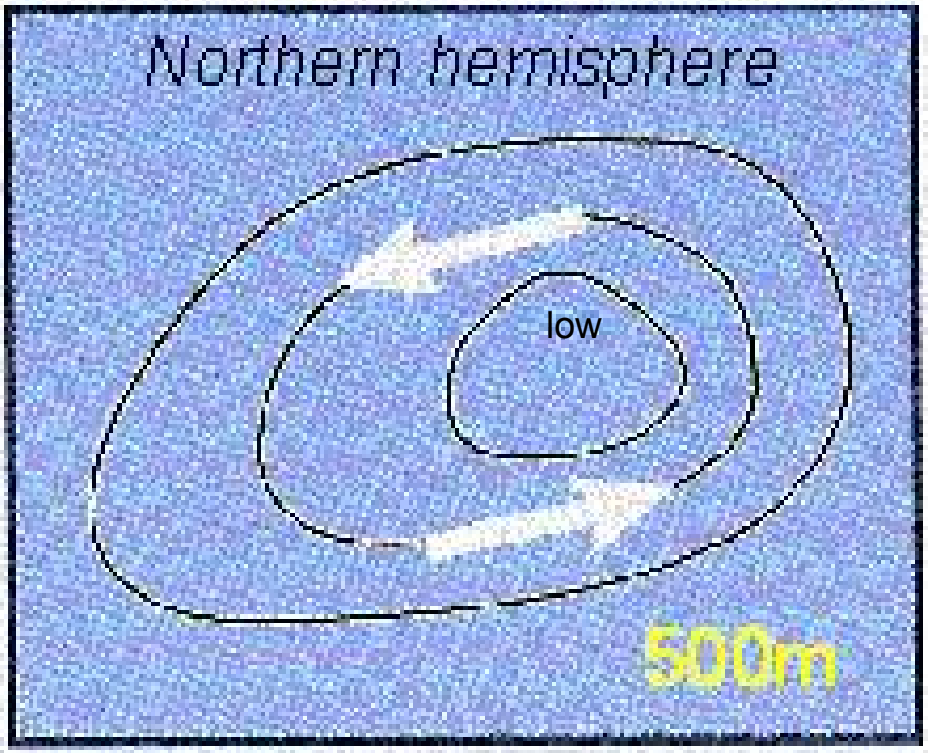
- R_1 = 6400km
- R_2 = 4000km

conversely, air moving south from the north pole 'gains' a westerly velocity relative to the land

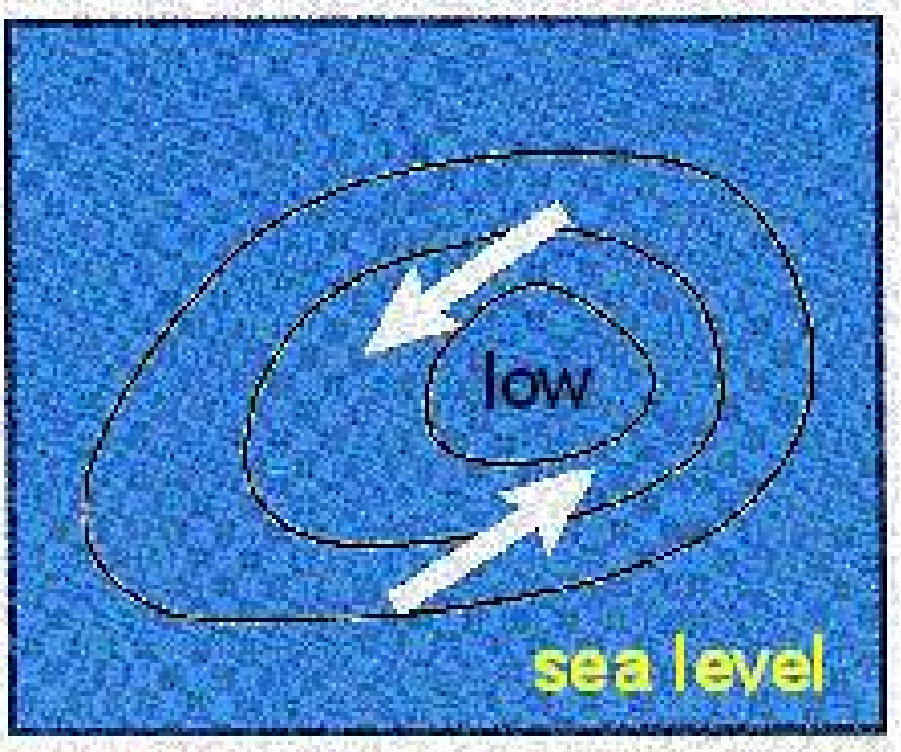
- V_1 = 1670km/hr
- V_2 = 1050km/hr

In the northern hemisphere, if air moves north, it 'gains' an easterly velocity relative to the land underneath it....

Coriolis effect

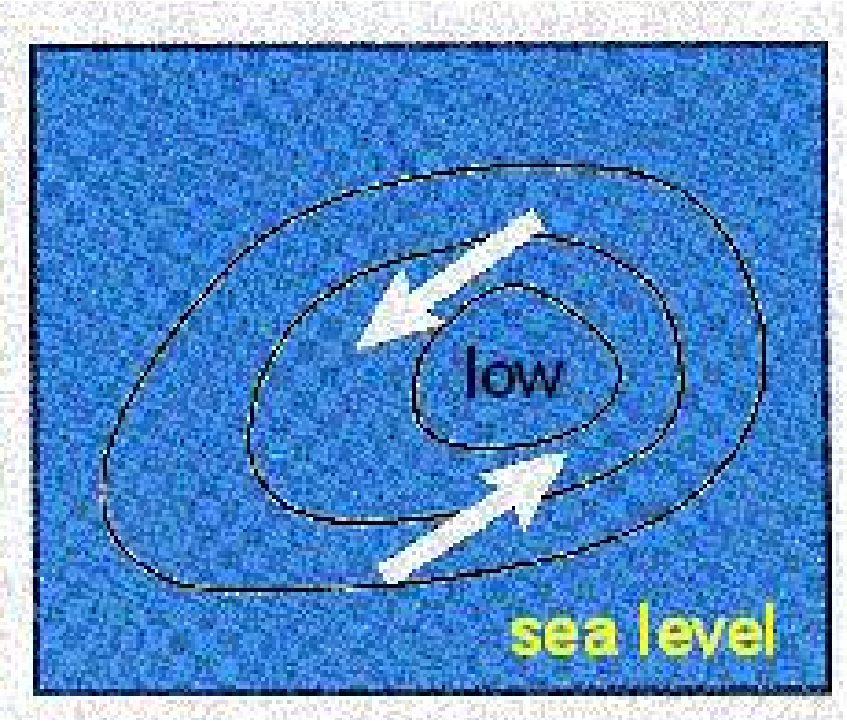


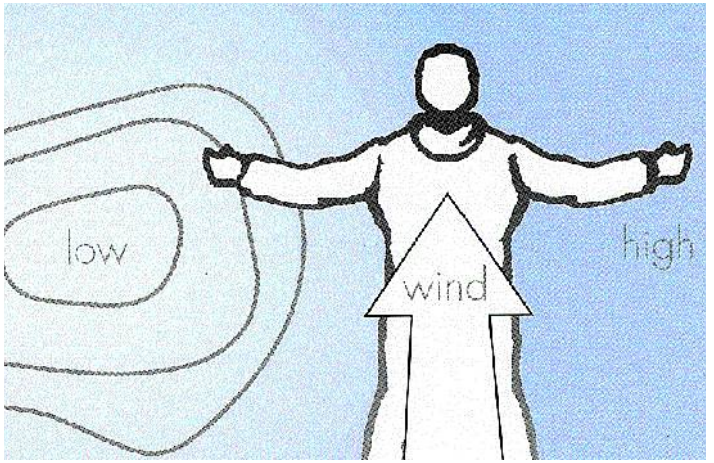
The nett effect is to create a swirling pattern around low, and high, pressure areas



Note that the sea level wind is backed relative to the 500m wind....

Coriolis effect





Buys Ballot's Law:

with your back to the wind

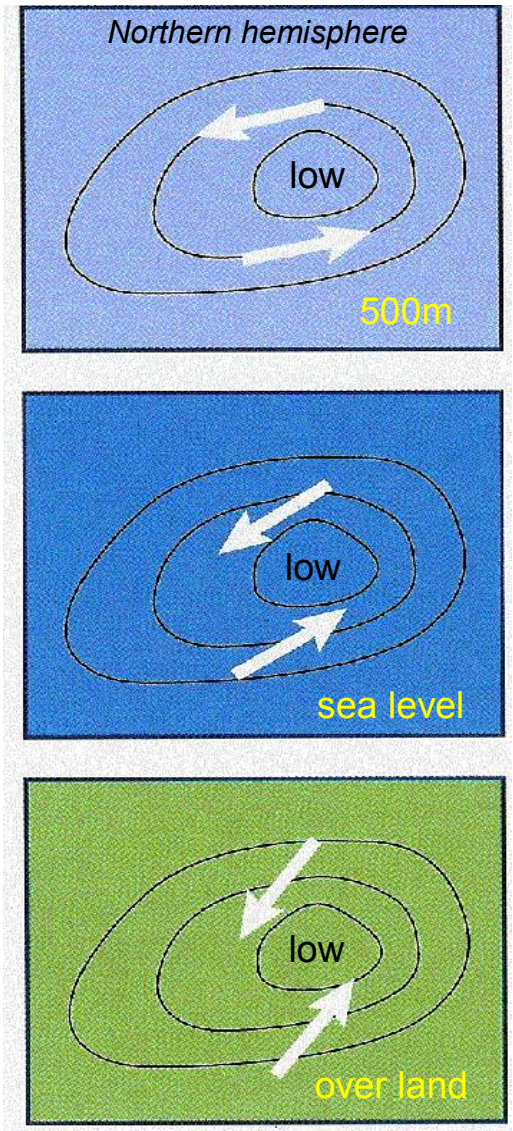
low pressure is on the left

initially the sea breeze will be directly on-shore, but due to coriolis effects as the breeze builds it veers

Simple sea breeze:

- *veers 40deg in first hour*
- *20deg to coast after 3hrs*

Effect of surface roughness on gradient wind?

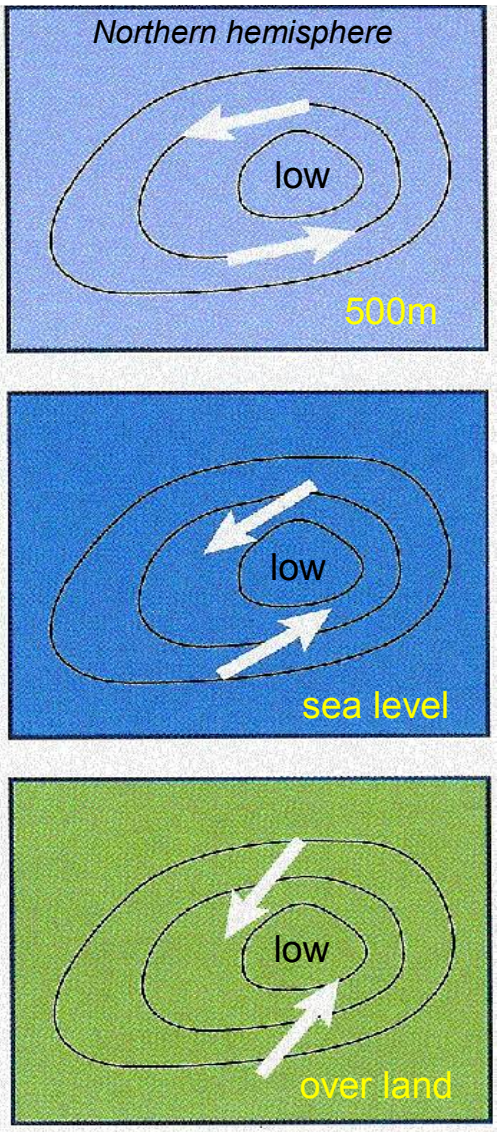


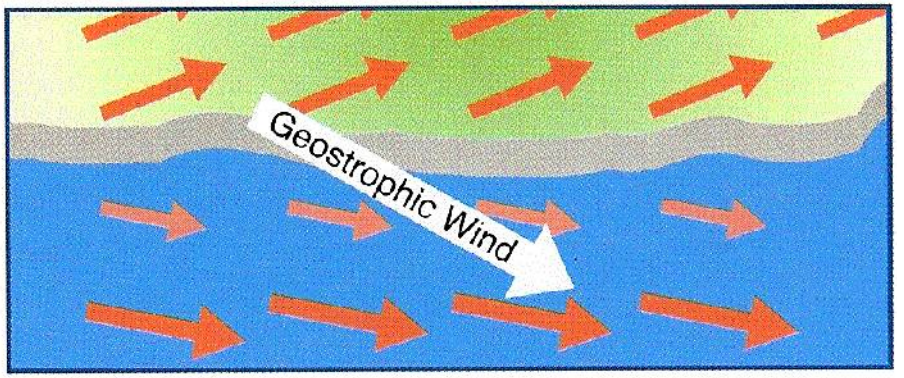
Surface roughness slows down rotational effect:

- *sea level breeze is backed relative to that at 500m*
- *breeze backs as it moves over land*

nothing to do with the sea breeze itself, but this characteristic of the gradient wind affects the sea breeze generation mechanism

Effect of surface roughness on gradient wind



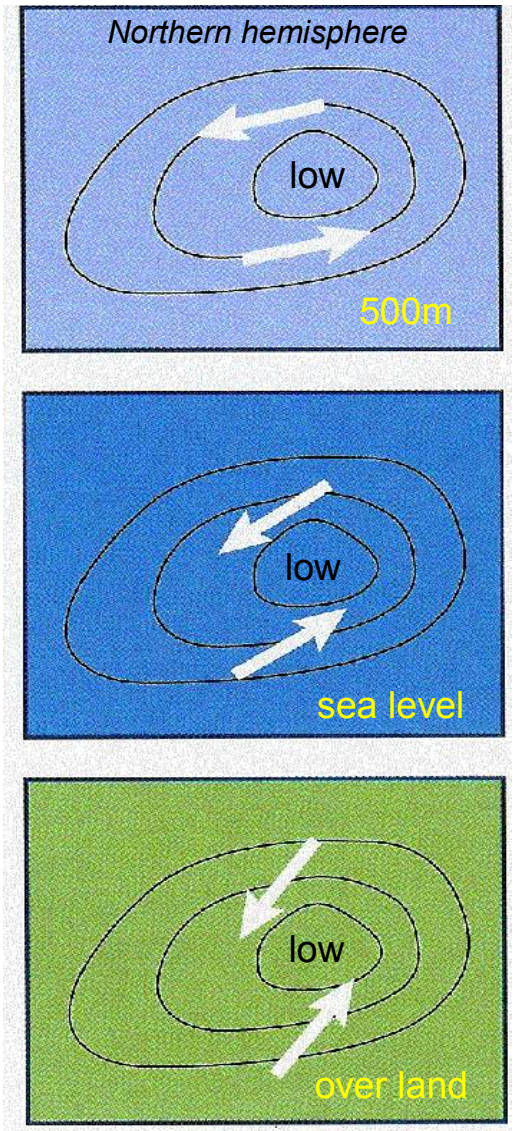


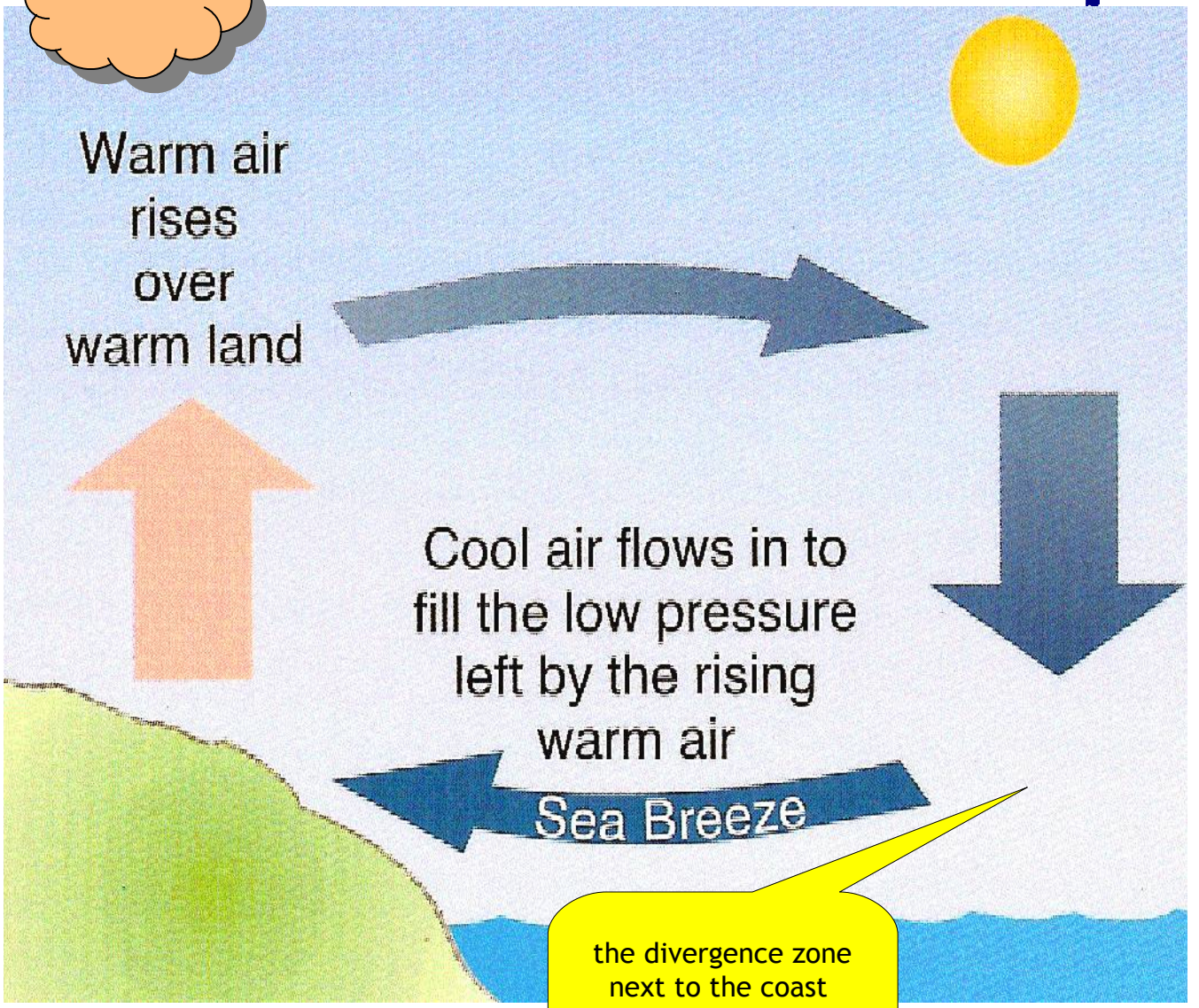
close to shore:

- *lighter winds – 'divergence'*
- *lower pressure - sea breeze is assisted*

the divergence zone next to the coast provides a 'hole' for the outflowing land air to 'fall into'

Effect of surface roughness on gradient wind





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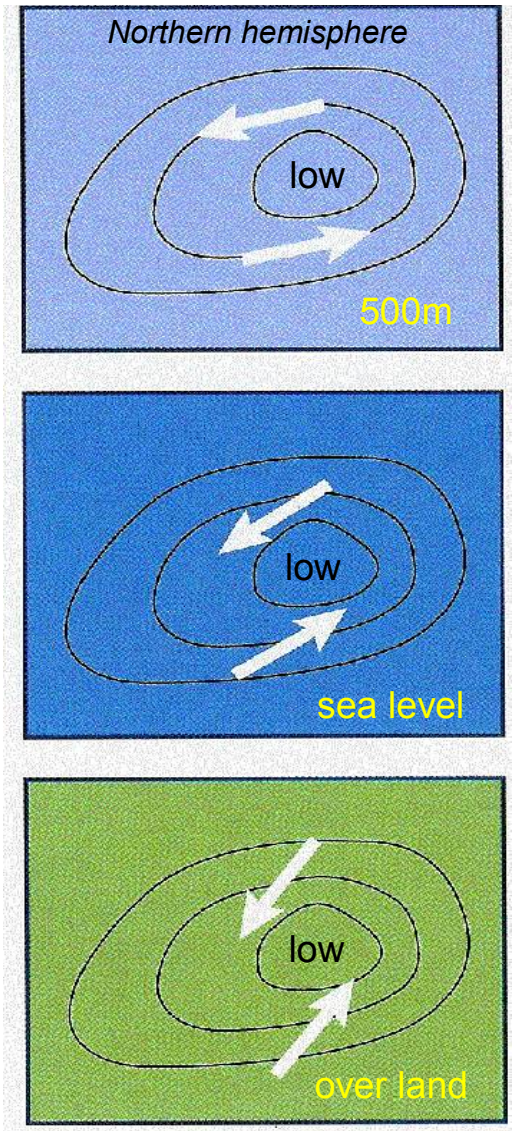
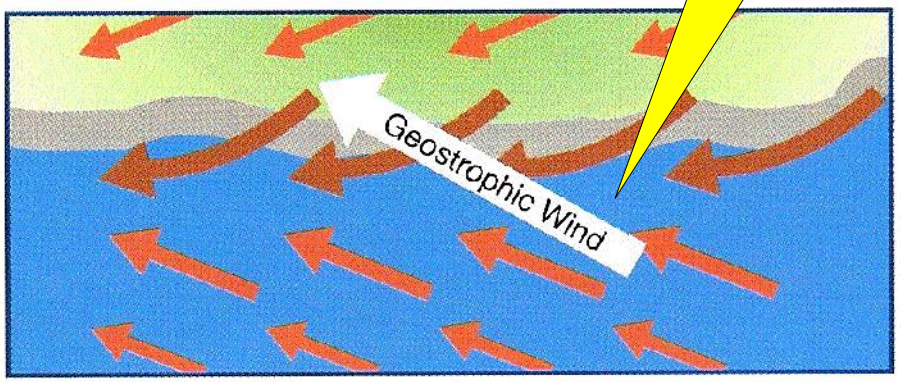
Effect of surface roughness on gradient wind



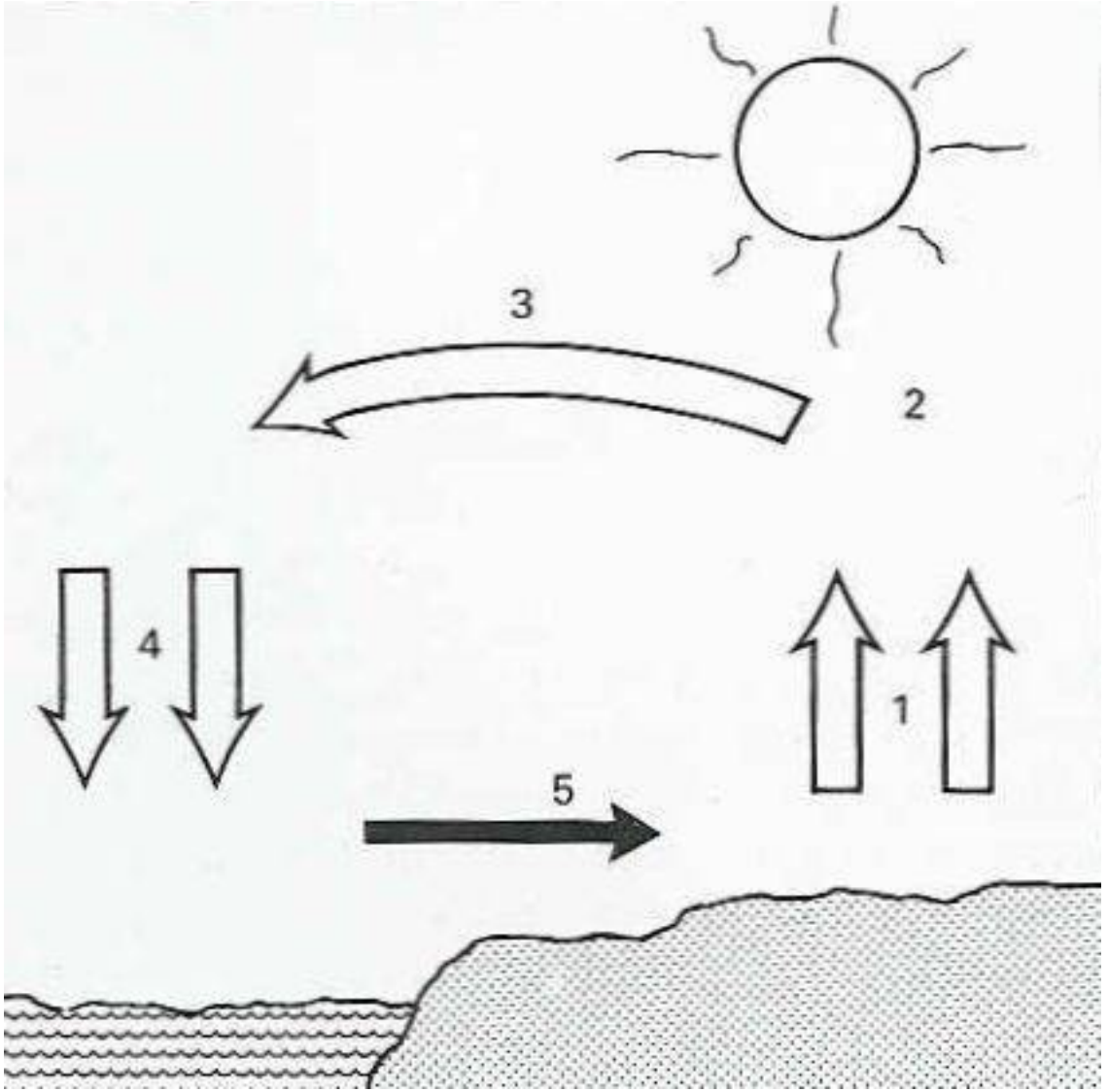
the convergence zone next to the coast acts as a barrier, stopping the outflowing land circulating



close to shore:

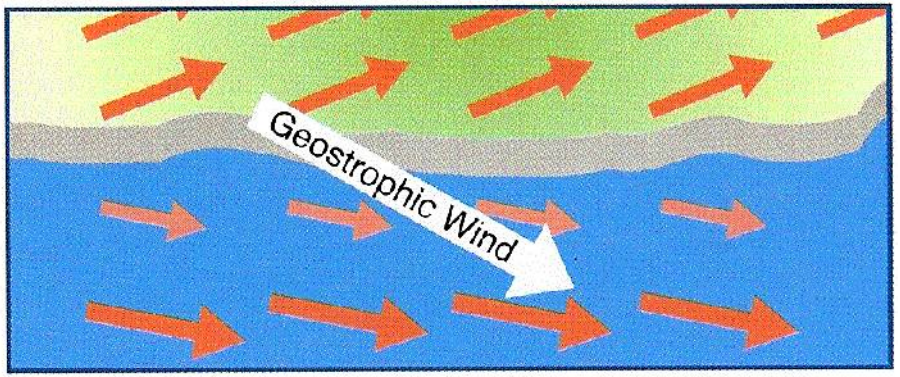
- *stronger winds – 'convergence'*
- *higher pressure - sea breeze is opposed*

Effect of gradient wind – return flow



the return flow (3) is helped if there is an off-shore gradient wind

Effect of gradient wind?



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- *lighter winds*
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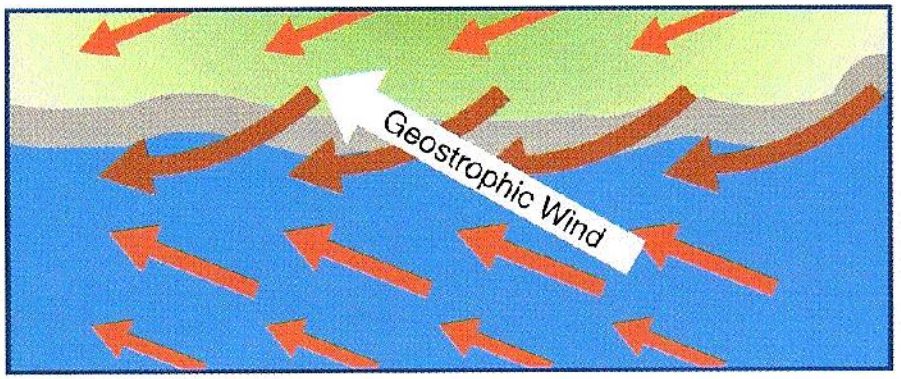

close to shore:

- *stronger winds*
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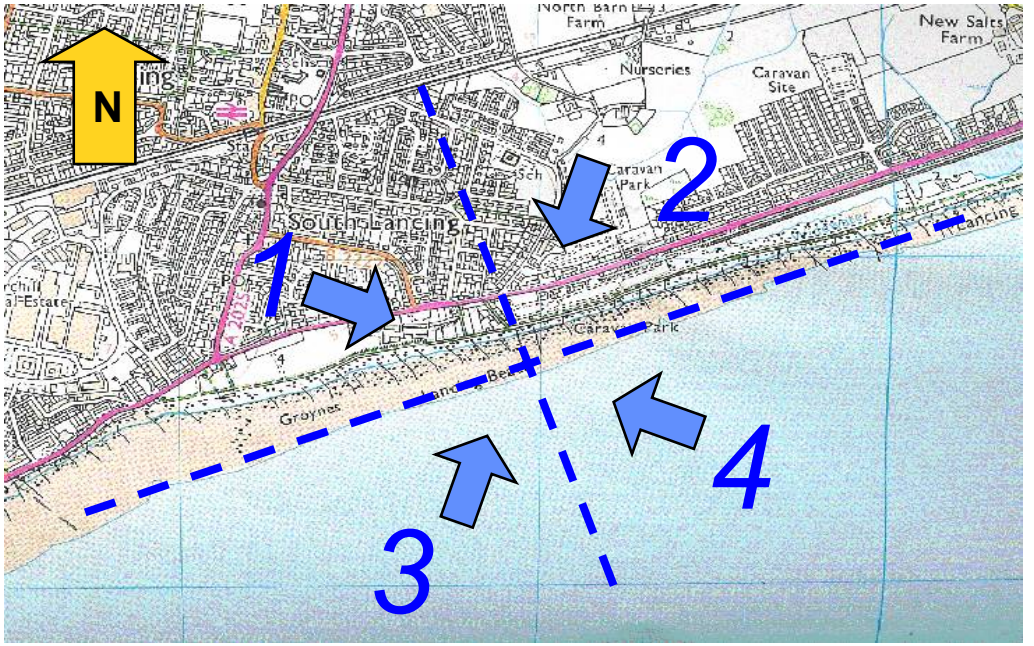
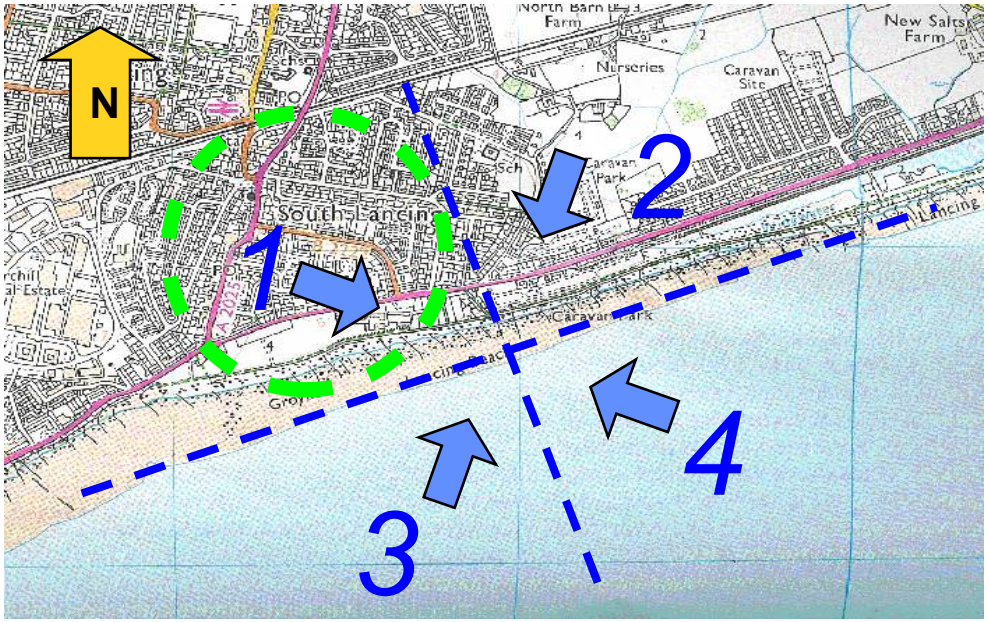


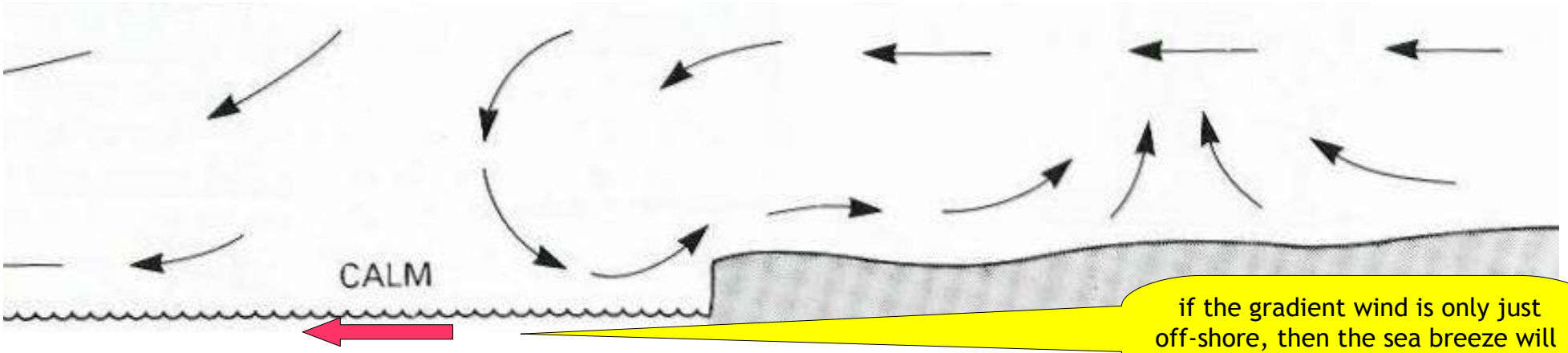
consider 4 quadrants aligned to the shoreline

Effect of gradient wind in quadrant 1



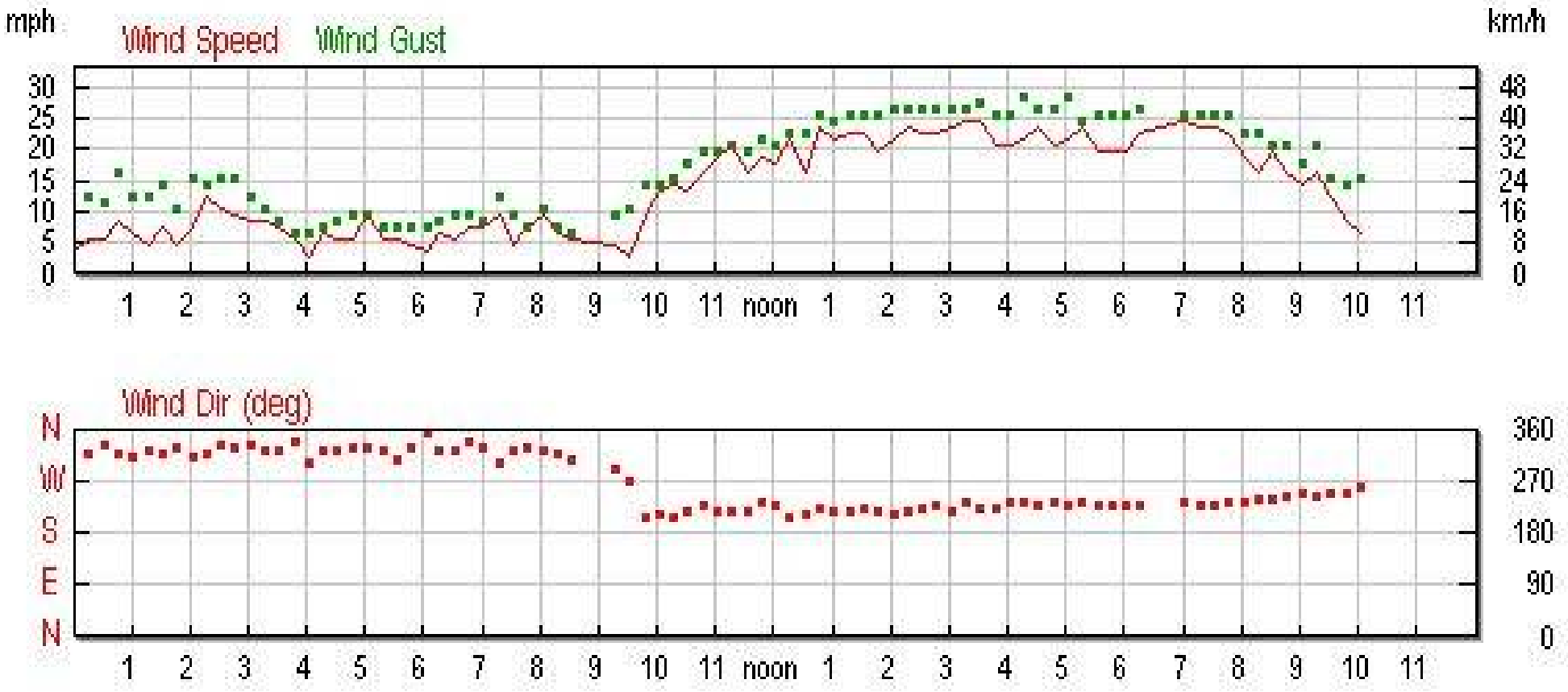
1: pressure gradient ✓ return flow ✓

- **strongest near shore**
  - up to 25kt
- **initially onshore**
  - slowly veers ~70deg
- **unlikely if gradient is > 20kt**
- **calm zone moves off-shore**

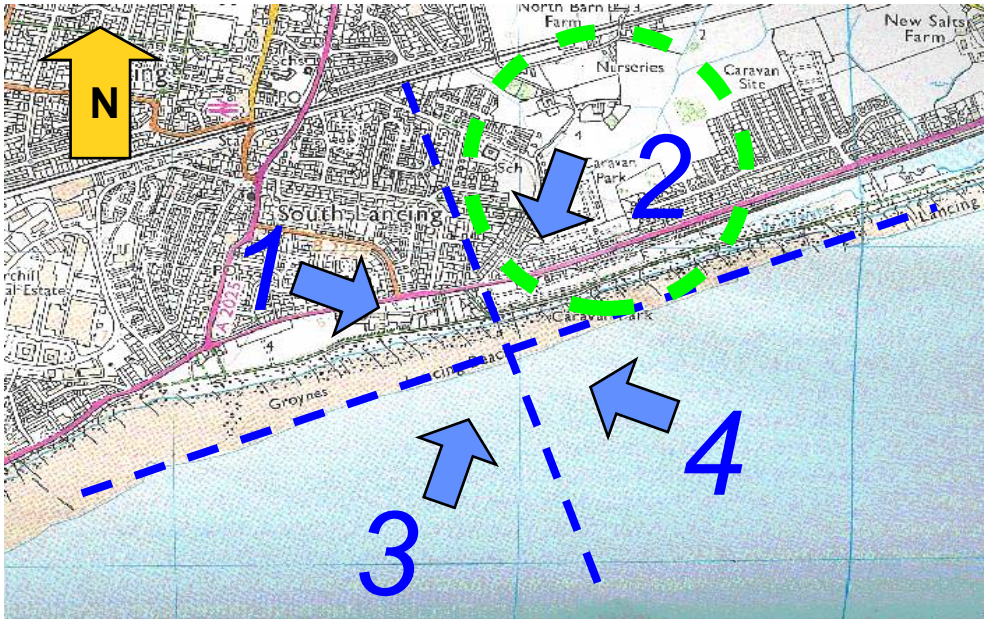


if the gradient wind is only just off-shore, then the sea breeze will initially back the wind to close to directly on-shore
- there will be no calm zone

Quadrant 1 example – Shoreham Beach

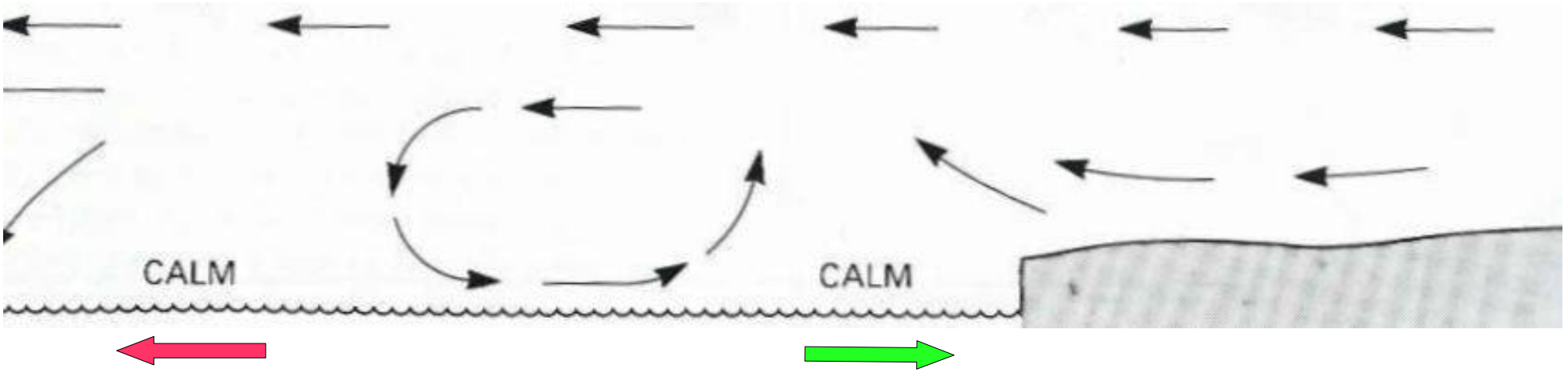


Effect of gradient wind in quadrant 2

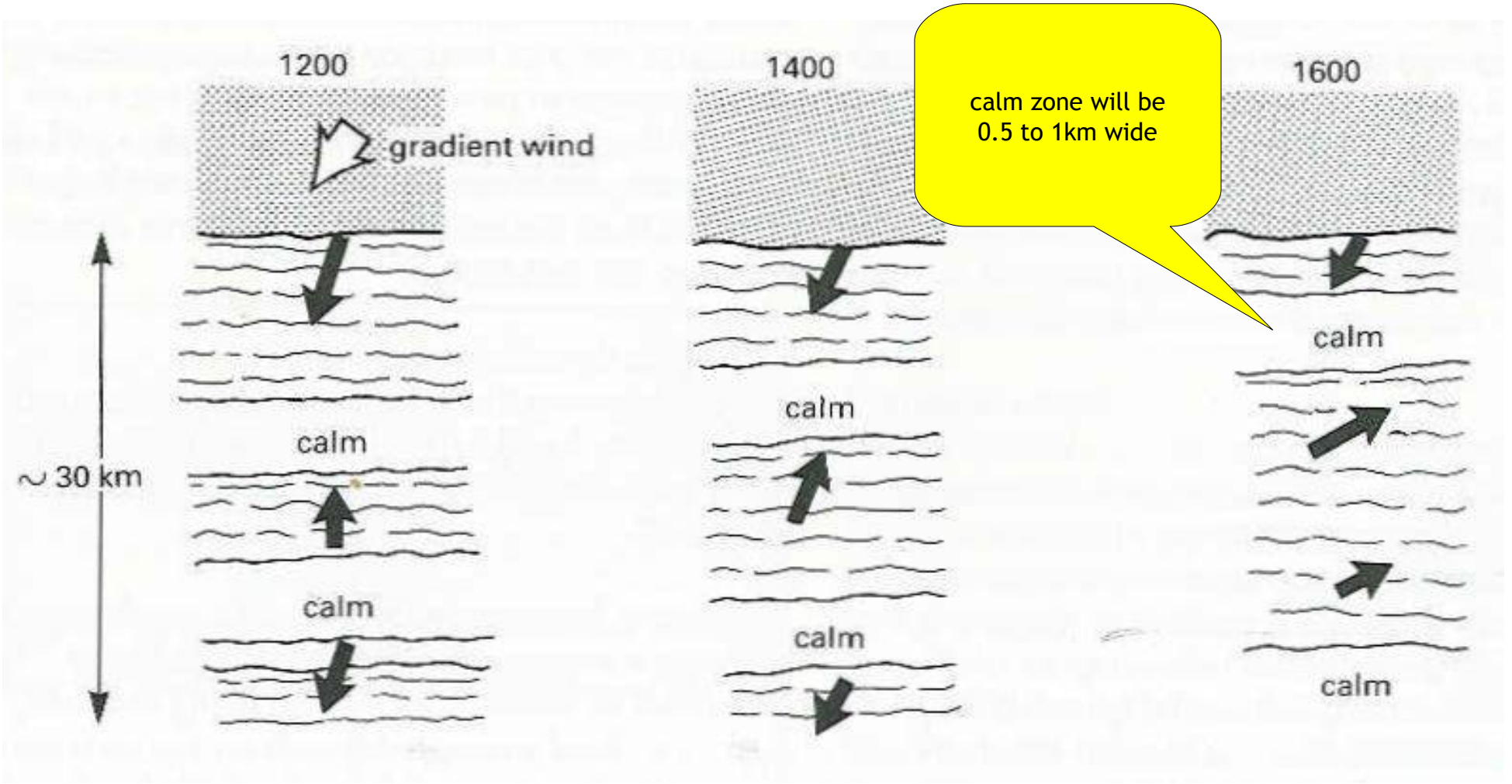


2: pressure gradient X return flow ✓

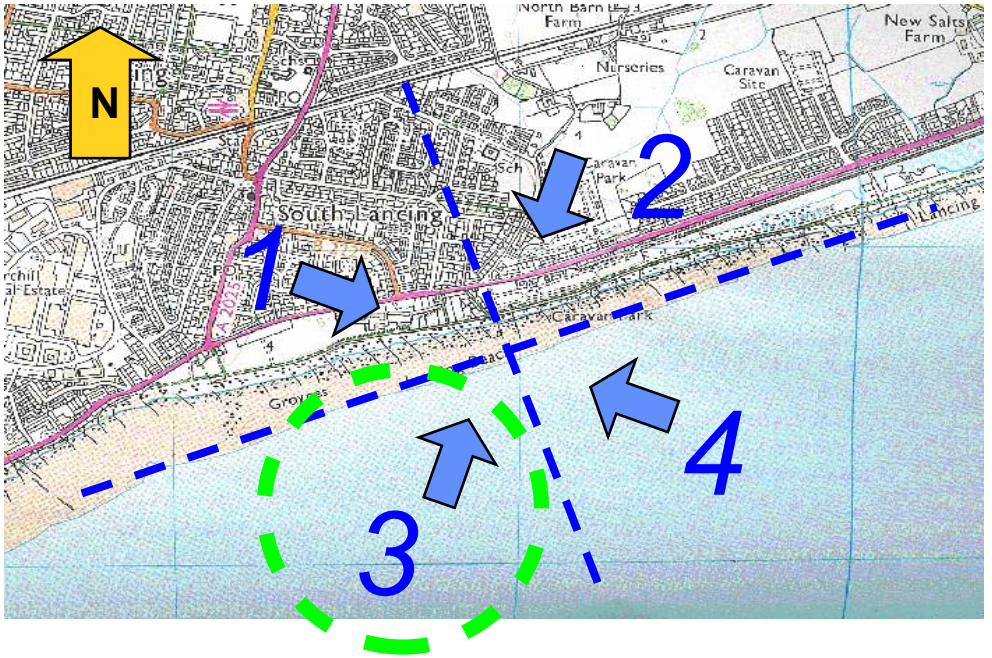
- **breeze starts offshore (!)**
- **inner calm zone will cross the shore and move inland if gradient wind is more than ~40deg to shore**
- **outer calm zone will move slowly out to sea**



Quadrant 2 overview – gradient wind <40deg offshore



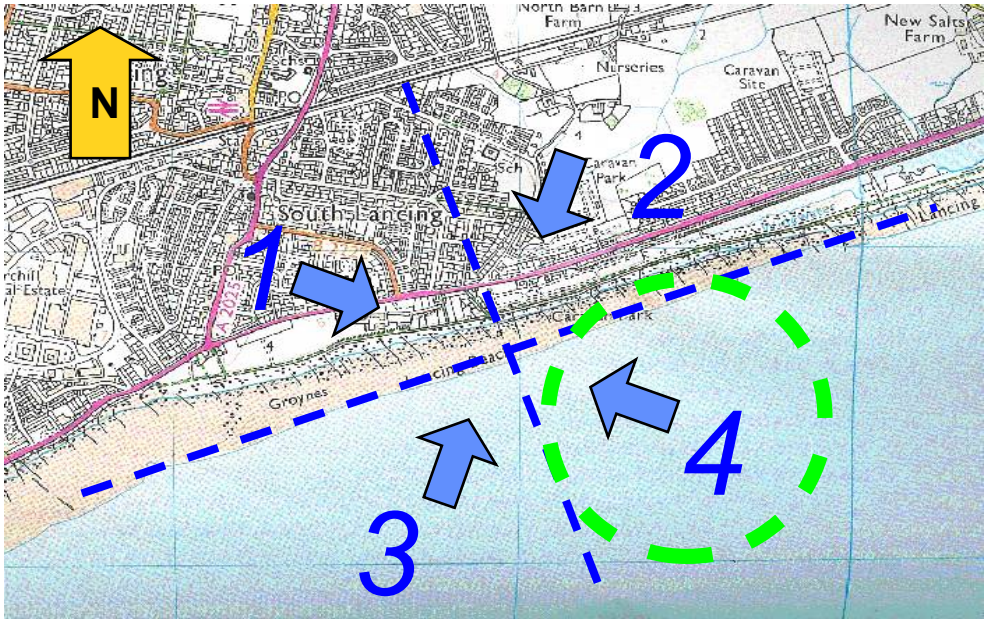
Effect *on* gradient wind in quadrant 3



3: pressure gradient✓ return flow X

- **wind strengthens and veers**
  - less if gradient strong or directly on-shore

Effect *on* gradient wind in quadrant 4

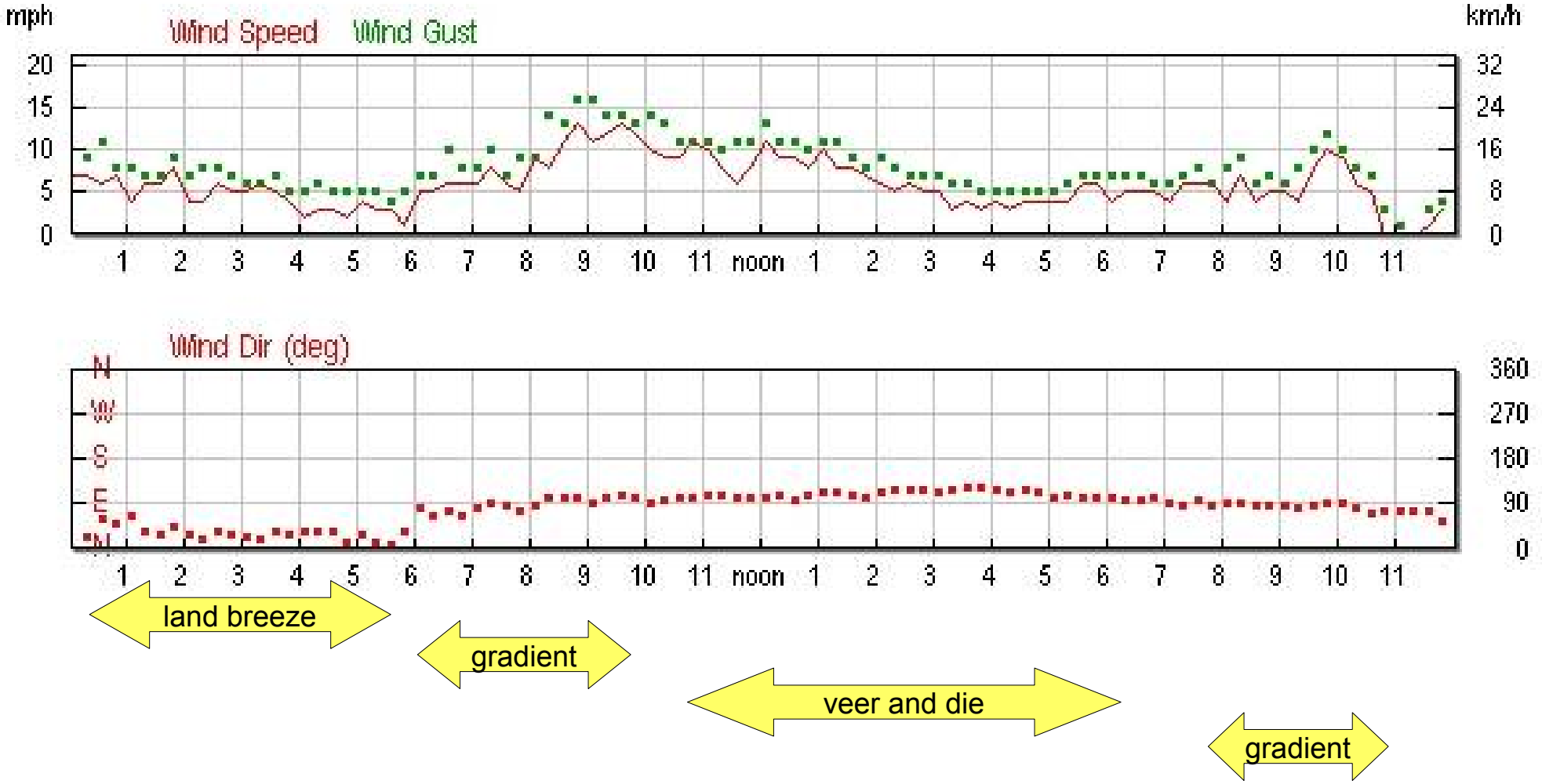


4: pressure gradient X return flow X

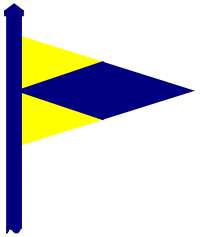
- **pressure is high over the land**
- **heating of land reduces pressure**
- **wind veers and dies**
  - if gradient is light, then wind may veer and die, then a genuine light sea breeze may appear
- **very occasionally, a strong SE 'sea breeze' will develop**
  - why?

search me,
I don't know!

Quadrant 4 example (April '07)



Tactics



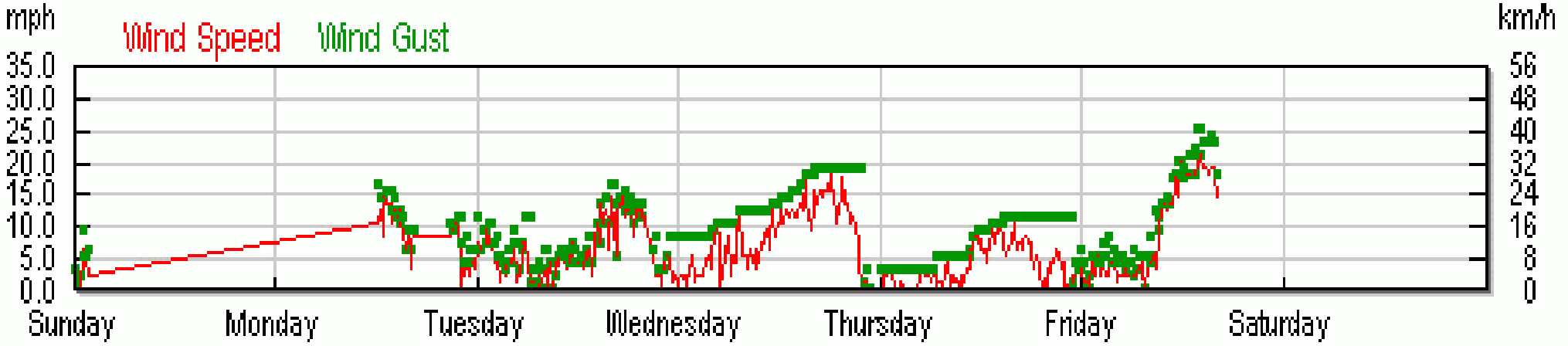
Off-Shore Gradient

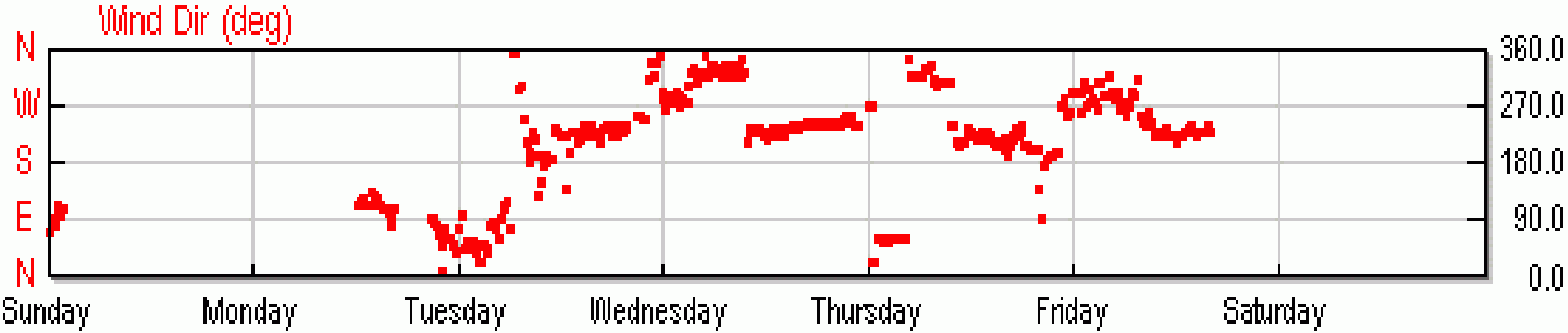
- **Q1**
  - stay close to the shore once the sea breeze has started
    - strongest wind
    - veering wind
- **Q2**
  - avoid the calm zones (!)
  - stay close to the shore, but in the sea breeze zone
    - strongest wind
    - veering wind

On-Shore Gradient

- **Q3**
  - stay close to the shore once the sea breeze has started
    - strongest wind
      - less marked than Q1
      - other factors likely to be more important
- **Q4**
  - go right (veer)
  - don't bother(!) or wait for true sea breeze if gradient is light to start with

A Good Sea Breeze Week
Shoreham Beach July 2004





Q2 **Q1** **Q1?** **Q1**