Meteorology – Lecture 6

Robert Fovell

rfovell@albany.edu

Important notes

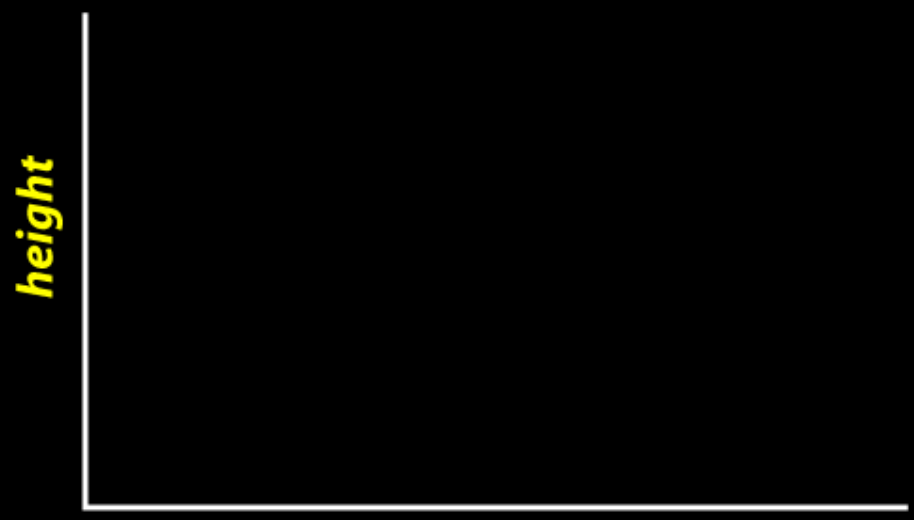
- These slides show some figures and videos prepared by Robert G. Fovell (RGF) for his “Meteorology” course, published by The Great Courses (TGC). Unless otherwise identified, they were created by RGF.
- In some cases, the figures employed in the course video are different from what I present here, but these were the figures I provided to TGC at the time the course was taped.
- These figures are intended to supplement the videos, in order to facilitate understanding of the concepts discussed in the course. *These slide shows cannot, and are not intended to, replace the course itself and are not expected to be understandable in isolation.*
- Accordingly, these presentations do not represent a summary of each lecture, and neither do they contain each lecture’s full content.

Animations linked in the PowerPoint version of these slides may also be found here:

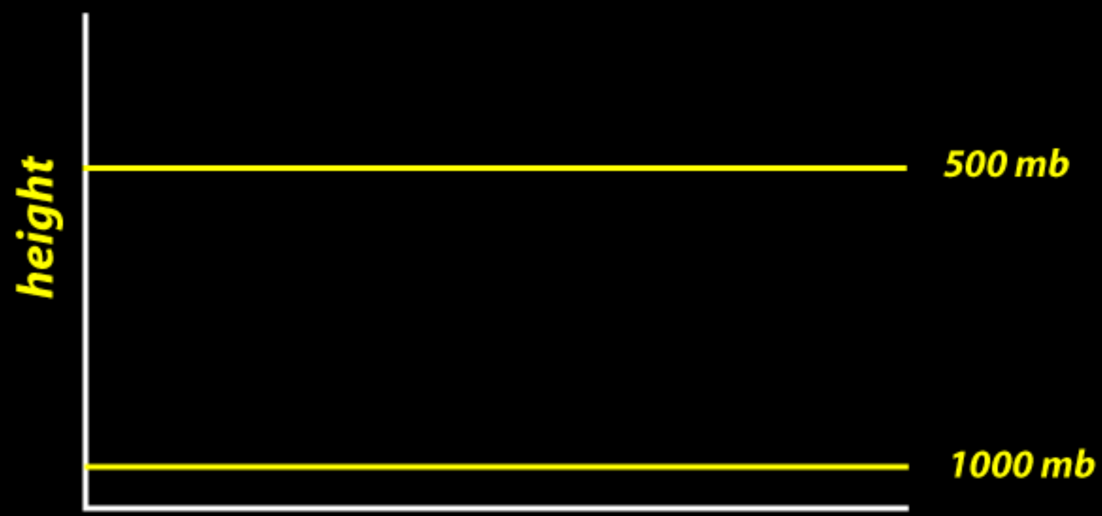
http://people.atmos.ucla.edu/fovell/meteo/

Pressure

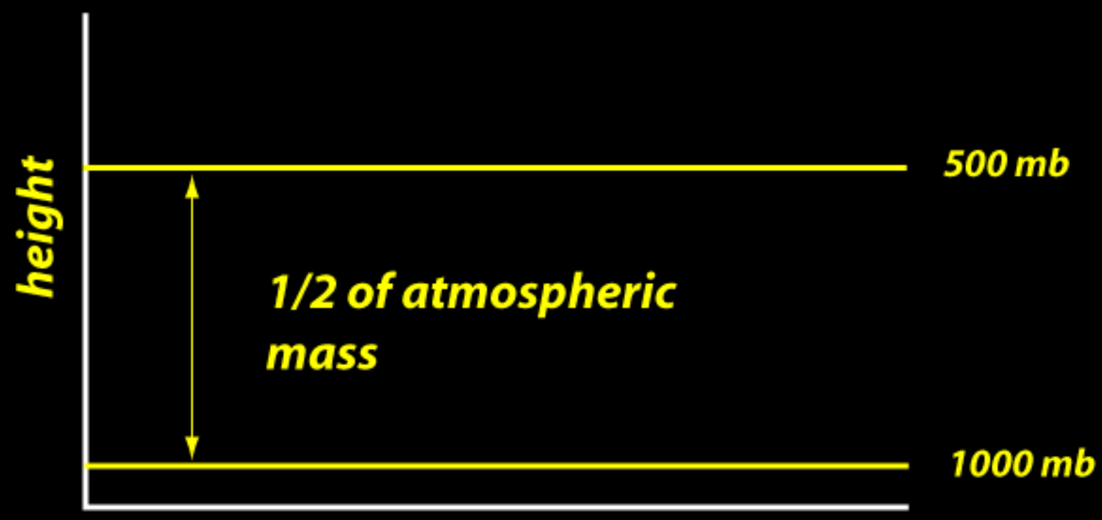
Picture a vertical cross-section



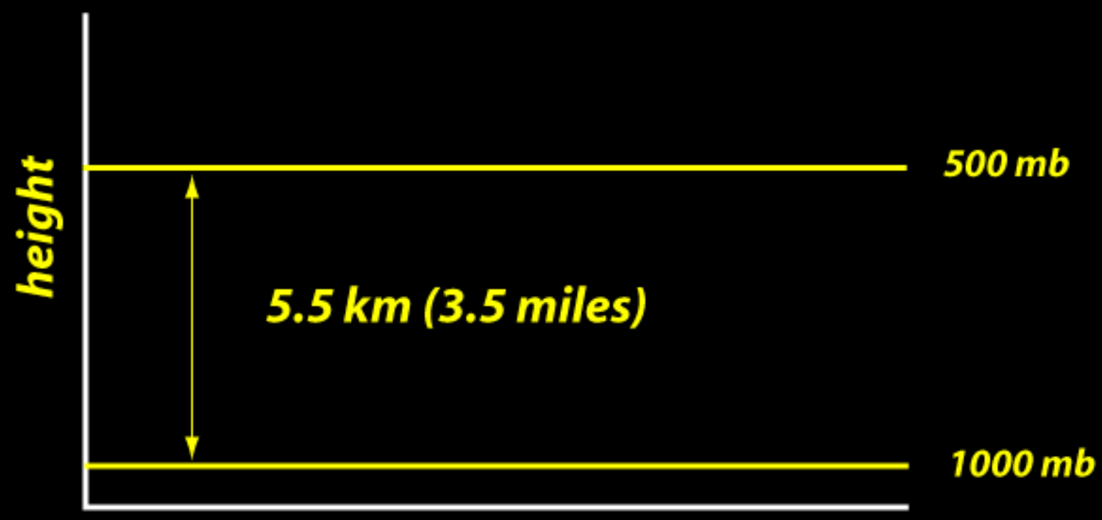
Isobar = line of equal pressure Here are 1000 and 500 mb isobars



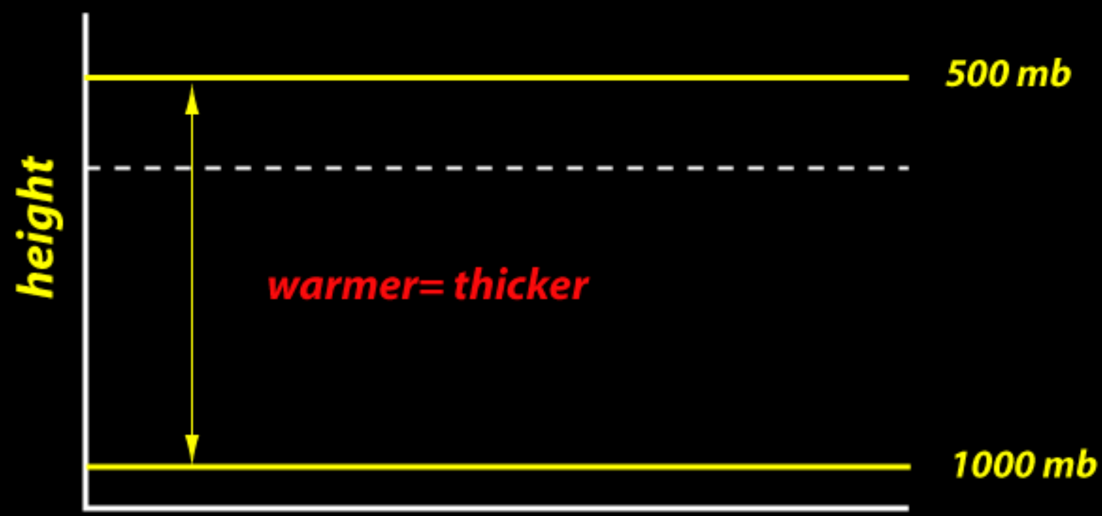
Half of the atmospheric mass is found in between…



Only 5.5 km/3.5 mi thick… *on average*



Temperature affects the thickness of this layer



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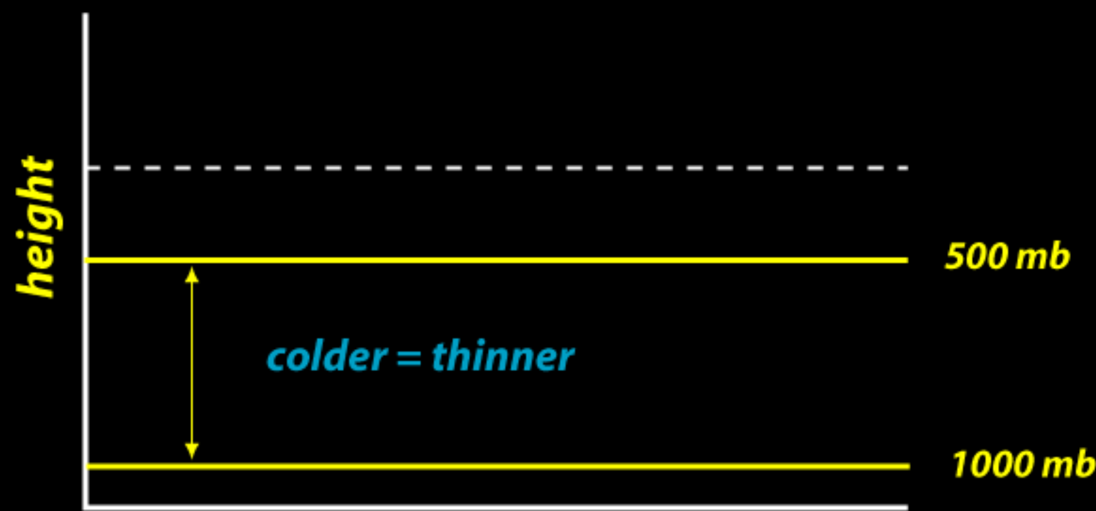
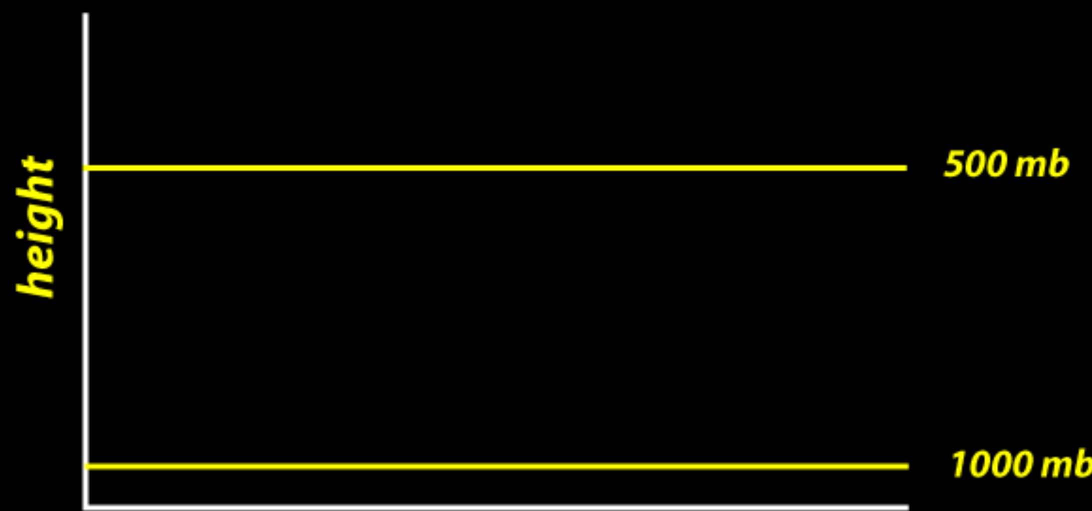


Pressure decreases with height···
faster in colder air

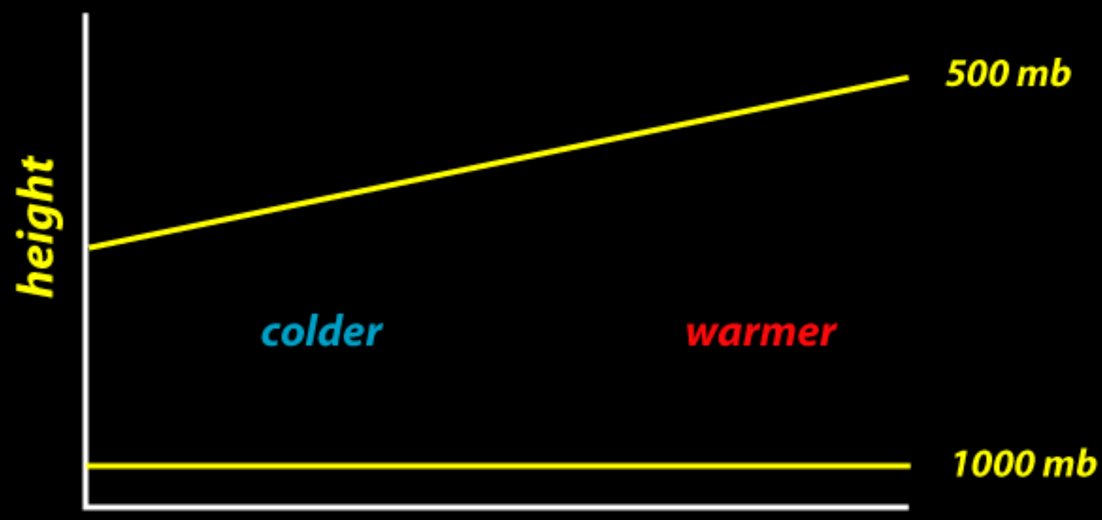
Temperature differences make pressure differences

Start with the same thickness everywhere.

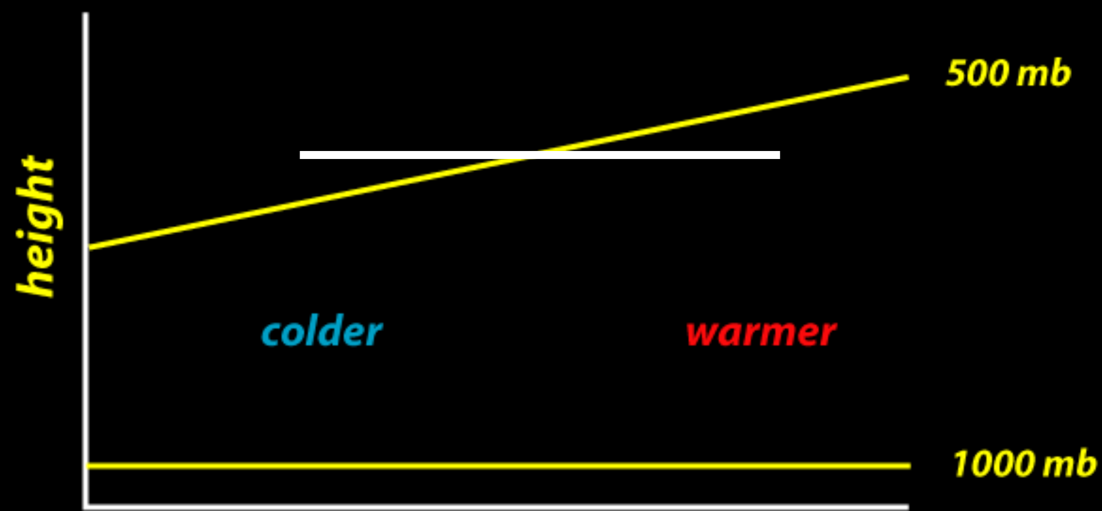
This implies temperature is the same



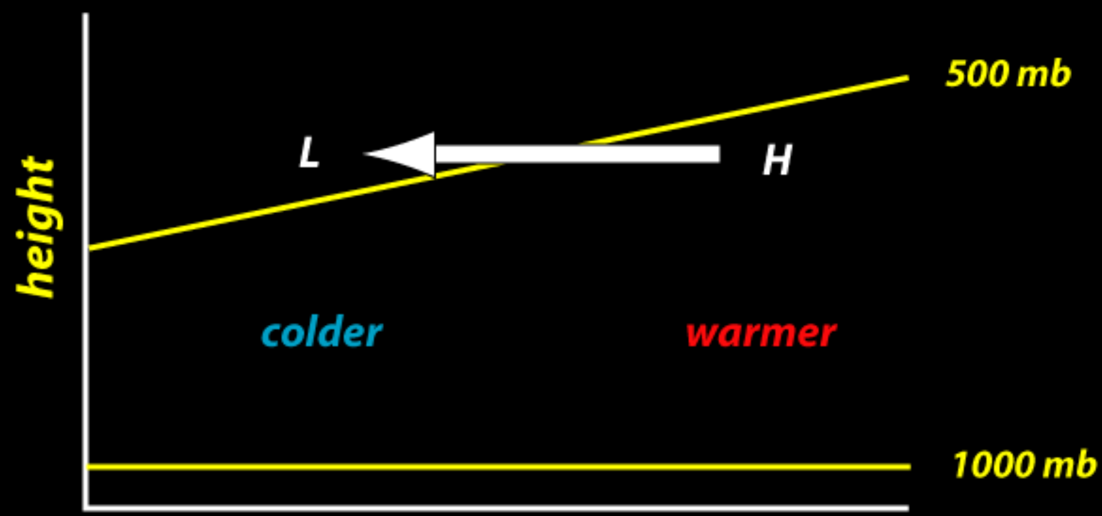
Introduce a T difference.
The 500 mb isobar is now tilted down towards the colder air



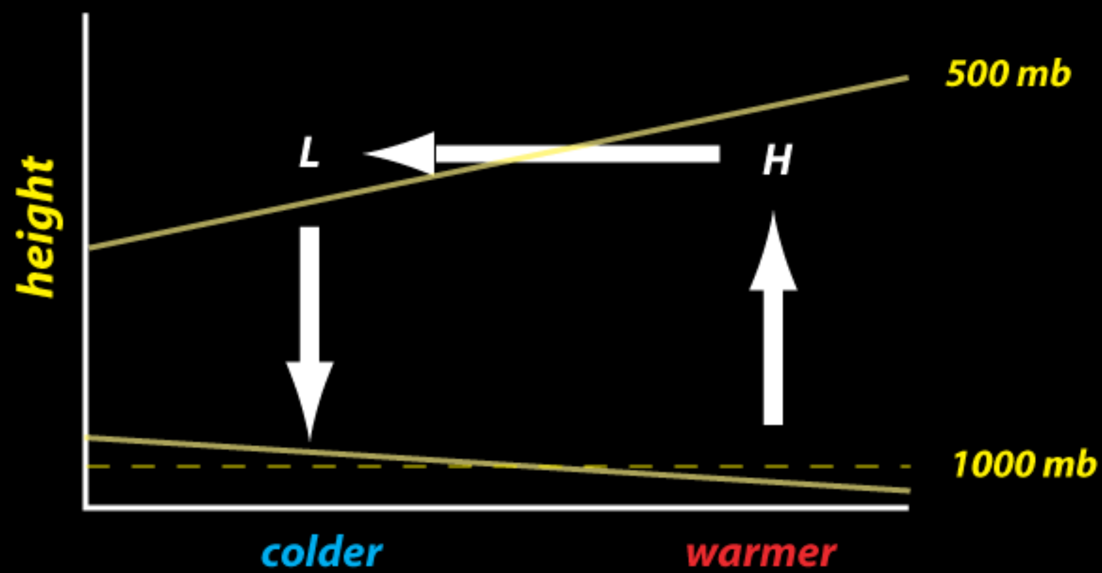
Pick a point along the 500 mb isobar. Do you see a horizontal pressure difference?



Pressure differences make winds. Nature wants to move mass from H to L. Wind! But we're not done…

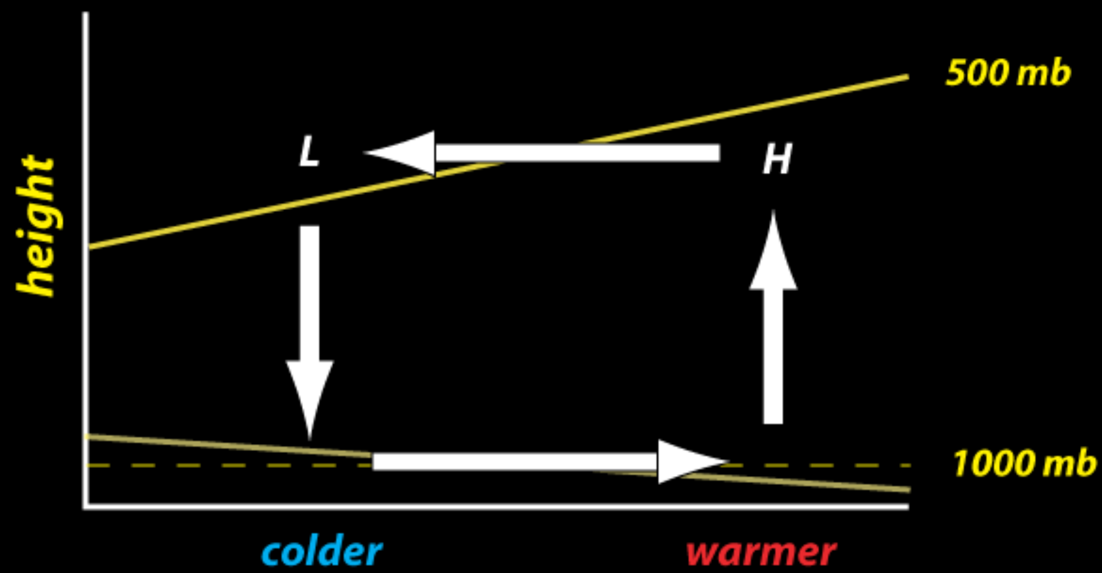


This wind (mass flow) has consequences...



Transport of mass (air) out of the warmer column causes its surface pressure to *drop*. That mass collects in the colder column, making its surface pressure to *rise*.

So the 1000 mb isobar is now tilted as well.

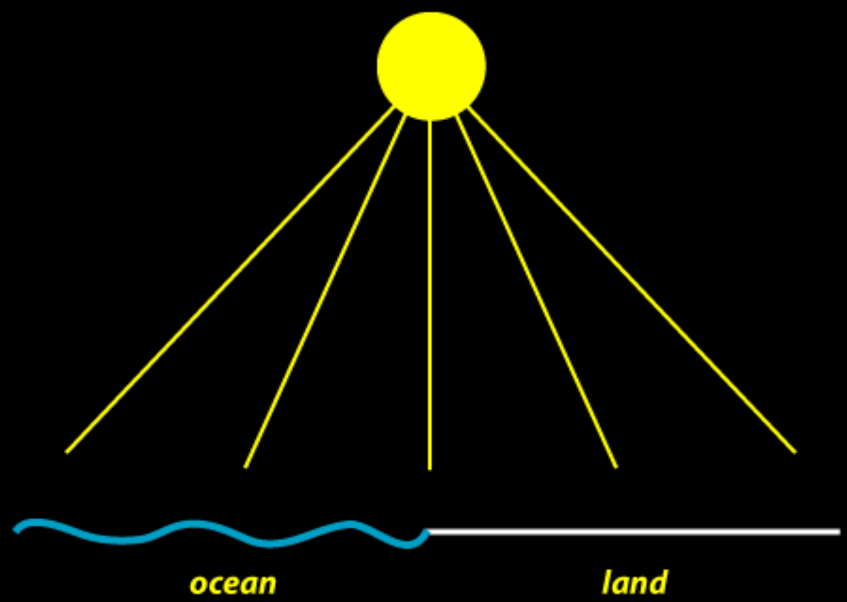


Now we have a *circulation*.
The circulation is called thermally direct.
Notice at the surface the flow is cold towards warm.

Apply to the sea-breeze

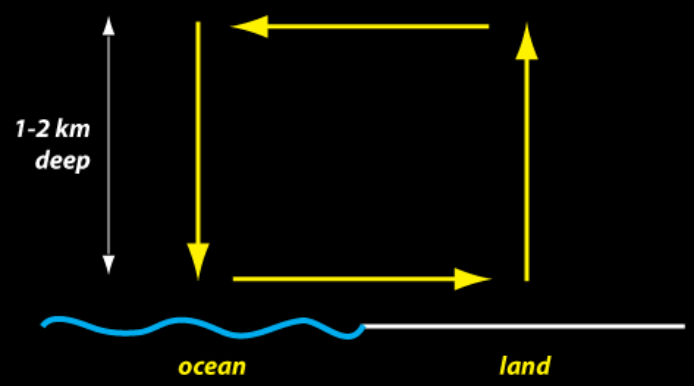
We start with ocean and land

Which surface absorbs more solar radiation during the day?



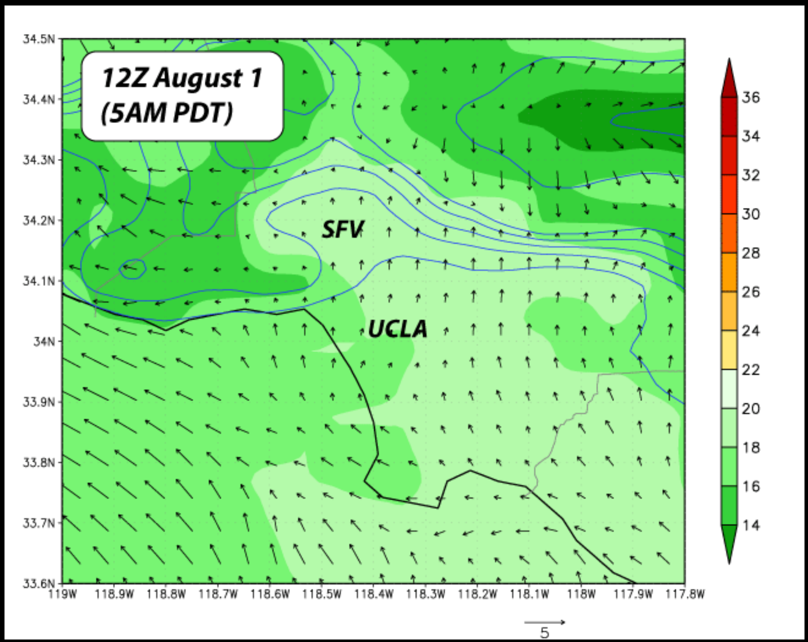
The **ocean** does, because it's darker than land when the sun is high in the sky. But, the ocean doesn't heat up much during the day.

The sea-breeze circulation



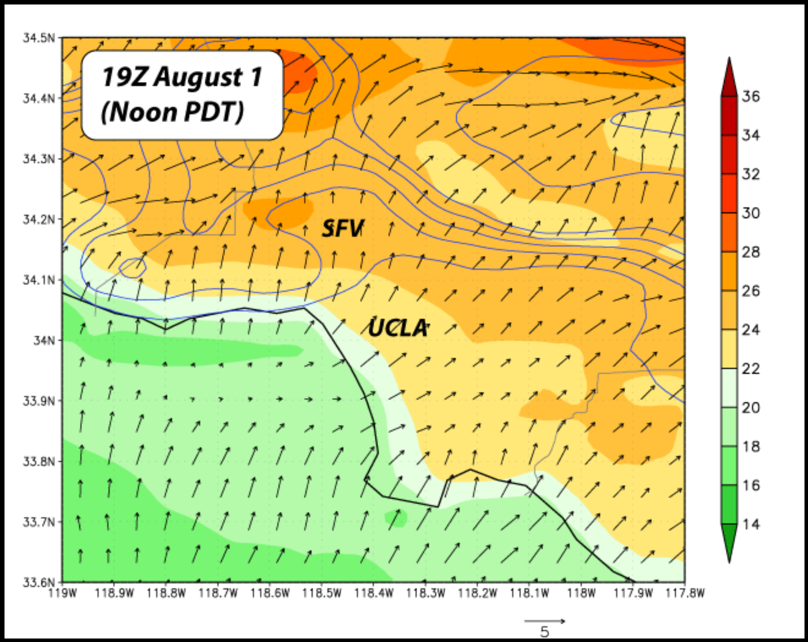
- Warm air rising over the heated land
- Cool air sinking over the cooler ocean
- The surface sea-breeze blowing inland
- It's about 1-2 km deep or so

Example: Los Angeles sea-breeze



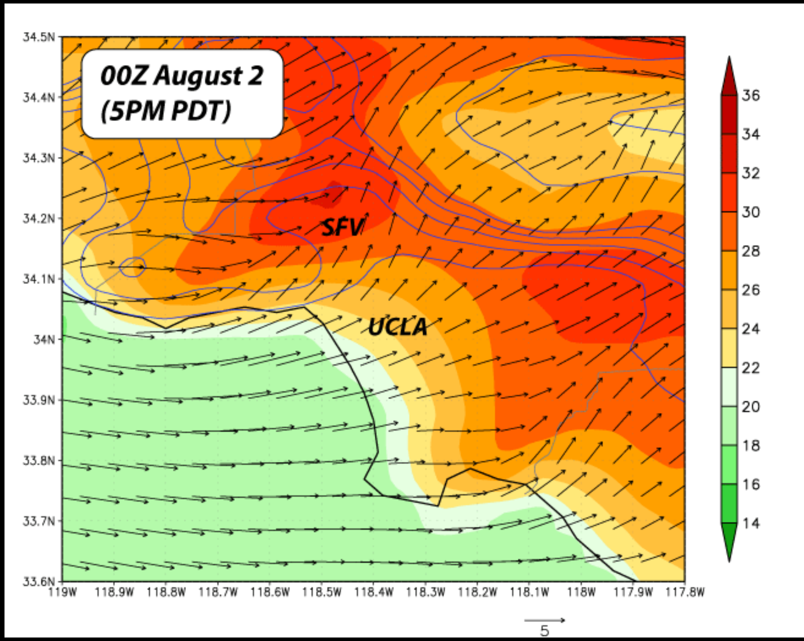
- Colored field is surface temperature (green = cool; red = hot)
- Greens cool… reds will be hot
- Vectors are surface winds
- For 12Z August 1
- NOON in London
- 5AM PDT
- Cool everywhere
- Winds are weak

Example: Los Angeles sea-breeze



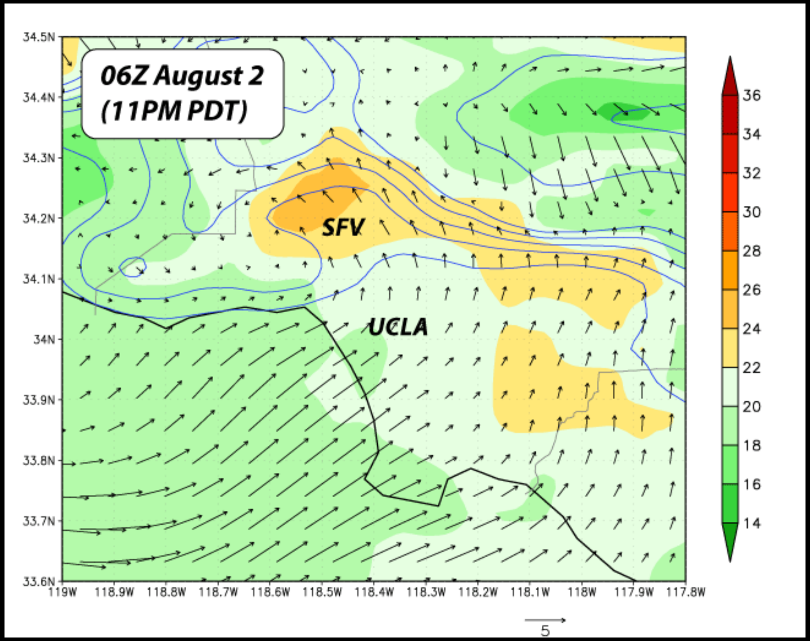
- By 19Z… Noon in LA
- Land's warmed up a lot
- Little temperature rise over the sea… thermal inertia
- Winds have increased
- Blowing sea to land

Example: Los Angeles sea-breeze



- 00Z August 2… midnight in London… 5PM August 1 in LA
- The wind vector LENGTH indicates wind speed
- Winds a lot stronger now
- Very hot inland, especially SFV
- The cool sea air is keeping UCLA a lot cooler

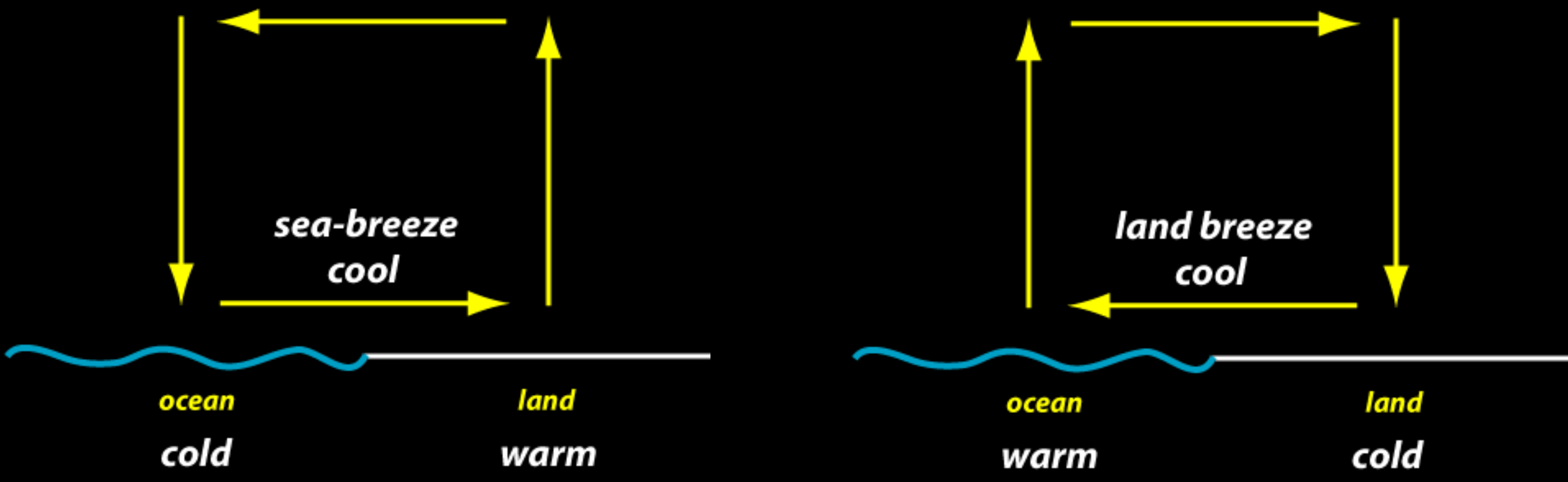
Example: Los Angeles sea-breeze



- After sunset the land cools off quickly (low thermal inertia)
- And as the temperature difference disappears, the winds die down
- Warmest in SFV; sea-breeze reaches there last and is weakest

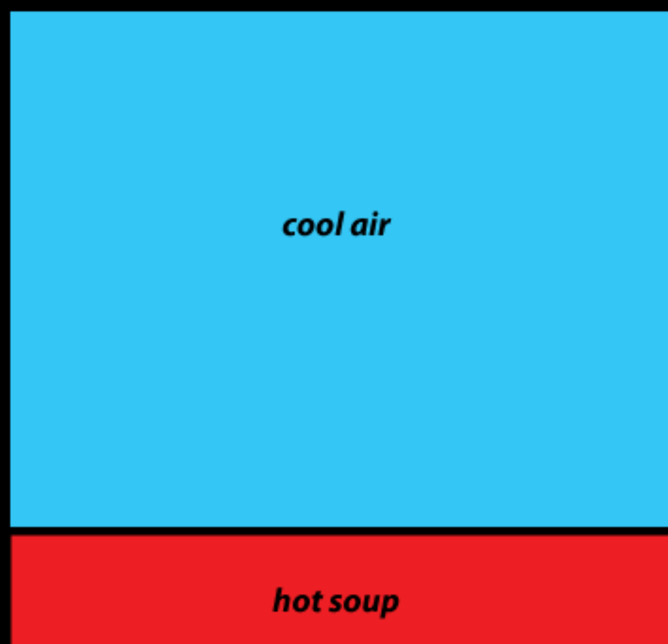
If land becomes colder at night, a **land-breeze** may develop

Sea- and land-breezes

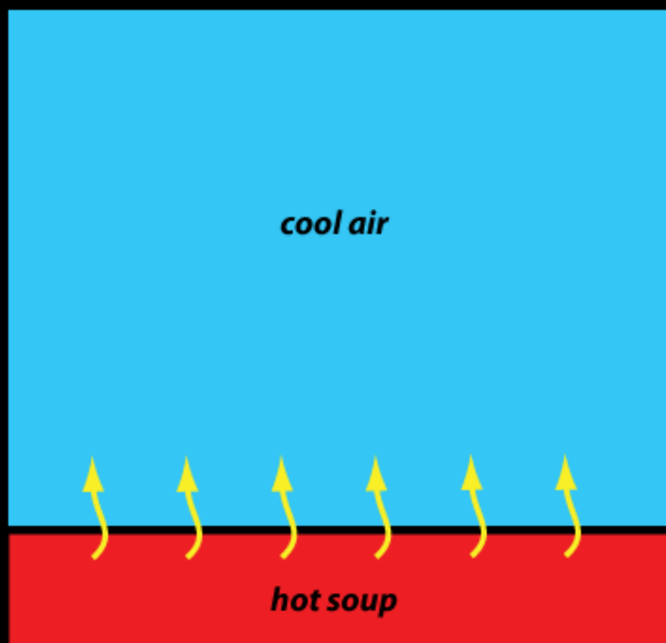


Wind chill

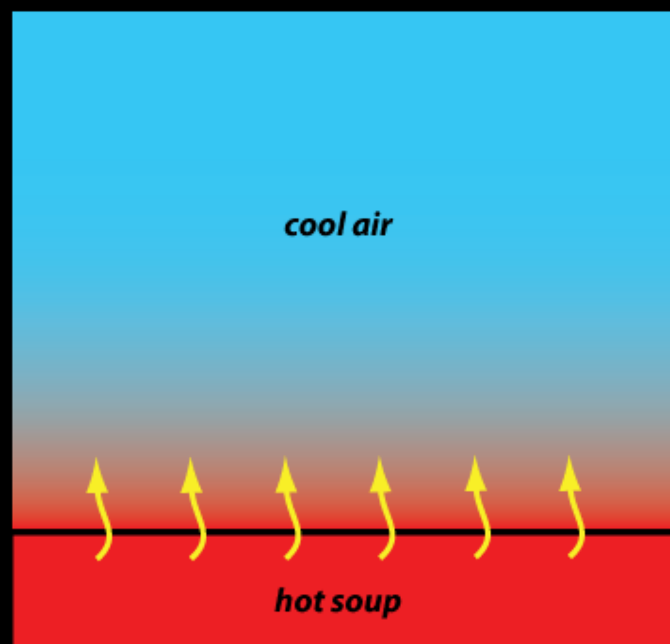
Consider a familiar example: hot soup in a cool room



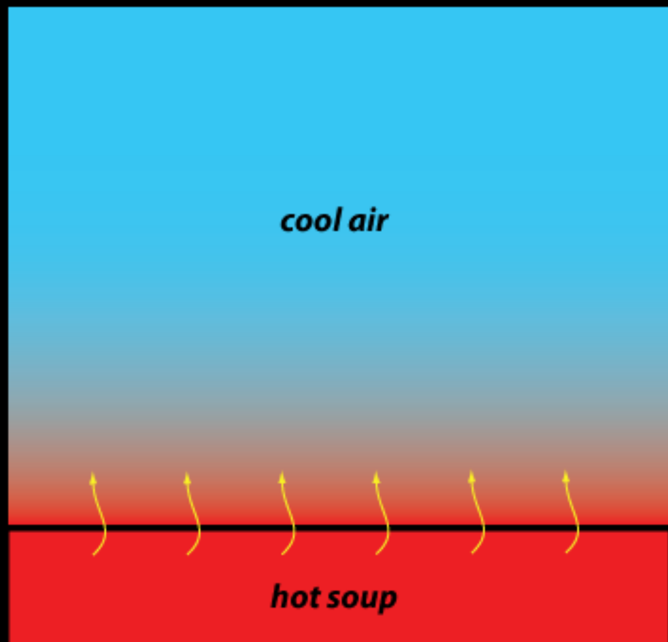
The soup loses heat energy to the room air via conduction



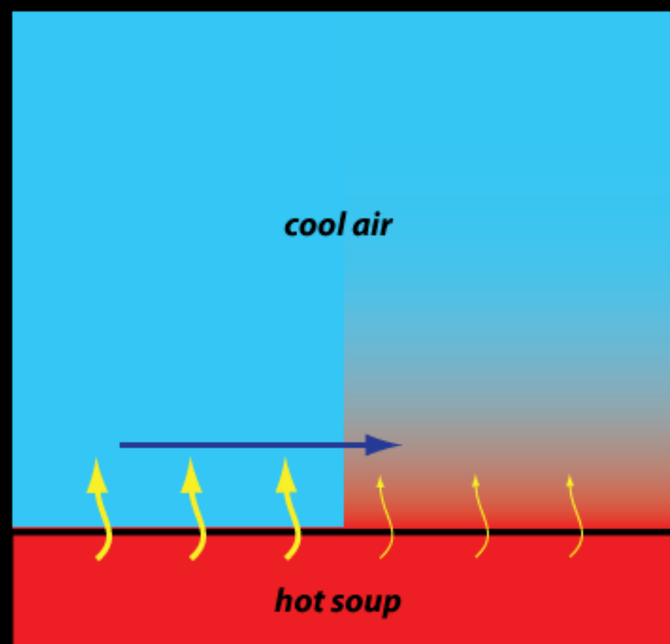
This warms up the air in contact with the soup.
Air, a poor conductor, does not carry
this heat energy vertically away efficiently



As a result, the soup-air T difference DECREASES.
This **decreases** the heat loss.
The air is actually acting as an INSULATING BLANKET helping to keep the soup warm

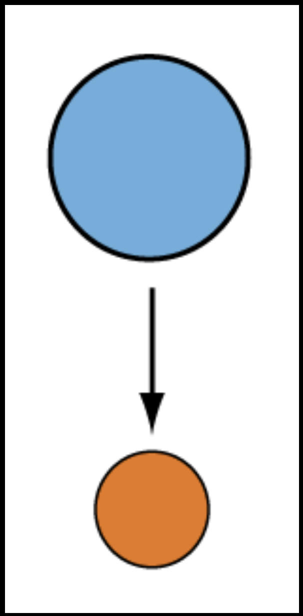


BLOW that insulating blanket away,
replacing it with more cool air.
Temperature difference is again LARGER and the heat loss has increased.
The soup has been subjected to **wind chill**



Descending and ascending air

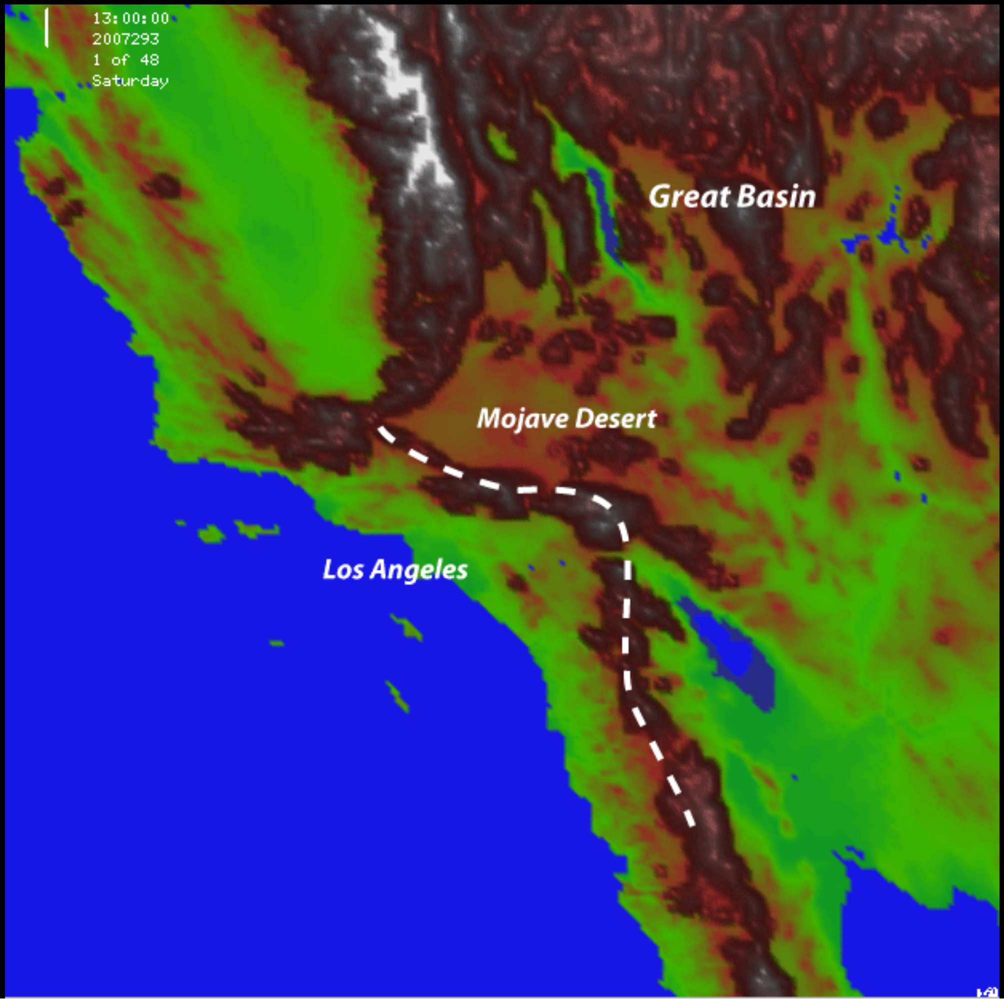
DESCENDING AIR



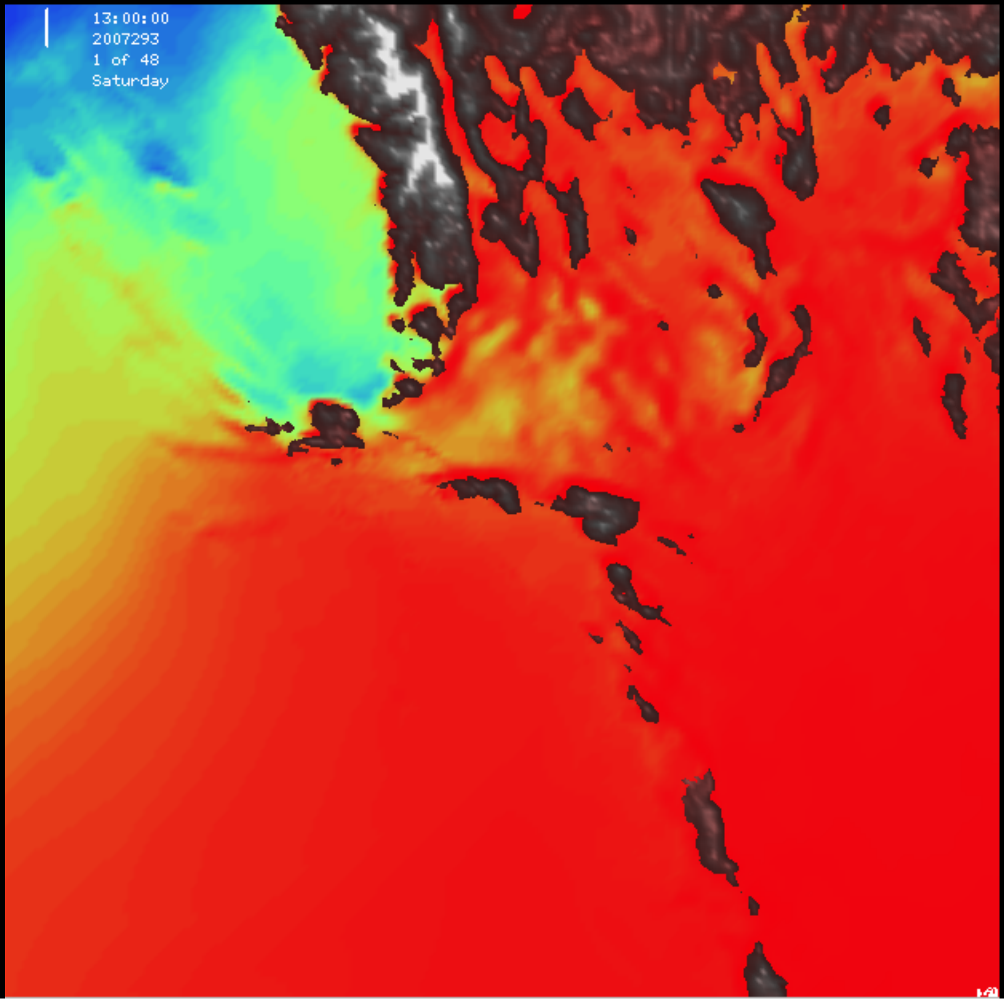
- Descending air warms at a RAPID RATE
- 10C/km ~ 30F/mi
- Temperature change due to VOLUME CHANGE ALONE
- There is NO heat transfer
- **“Dry adiabatic”**
- Ascending air cools at that same rate, at least at first!

“Santa Ana” winds

Topography of Southwestern US

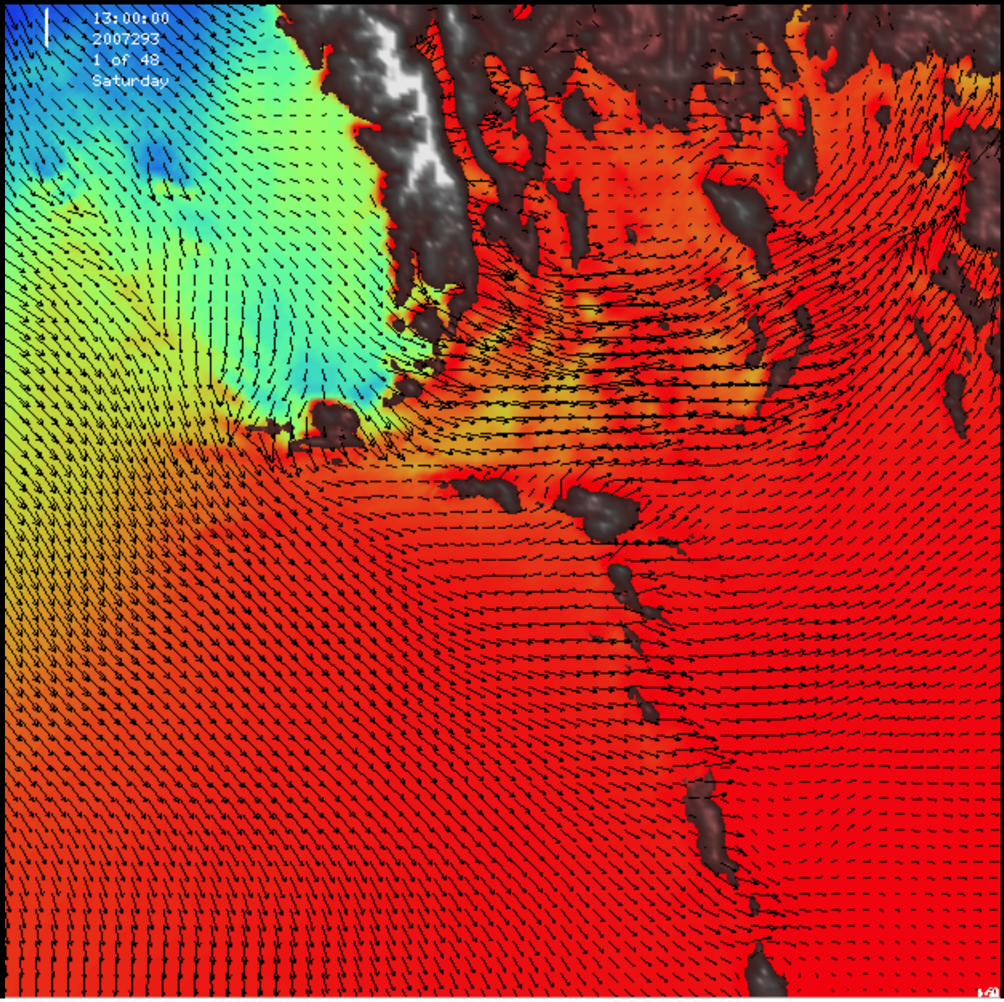


Colored field: density of the air at 850 mb level (about 1.5 km or 1 mi above sea-level.) Red = less dense, blue = more dense

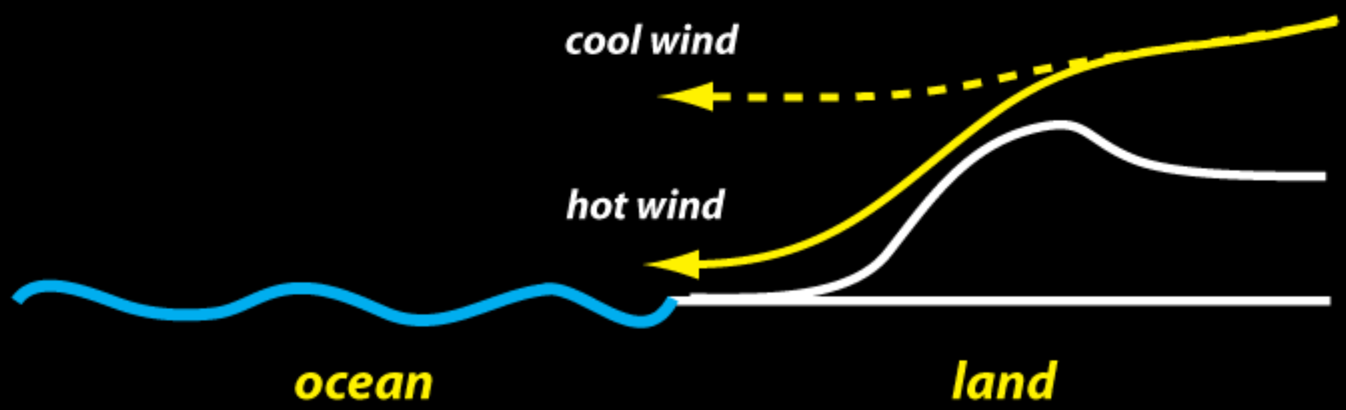


For animation, see http://people.atmos.ucla.edu/fovell/meteo/

Added 850 mb wind vectors.
At this time, the air in Southern California has low density and LA has a seabreeze



“Santa Ana” winds become warm (or hot) owing to elevation change



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