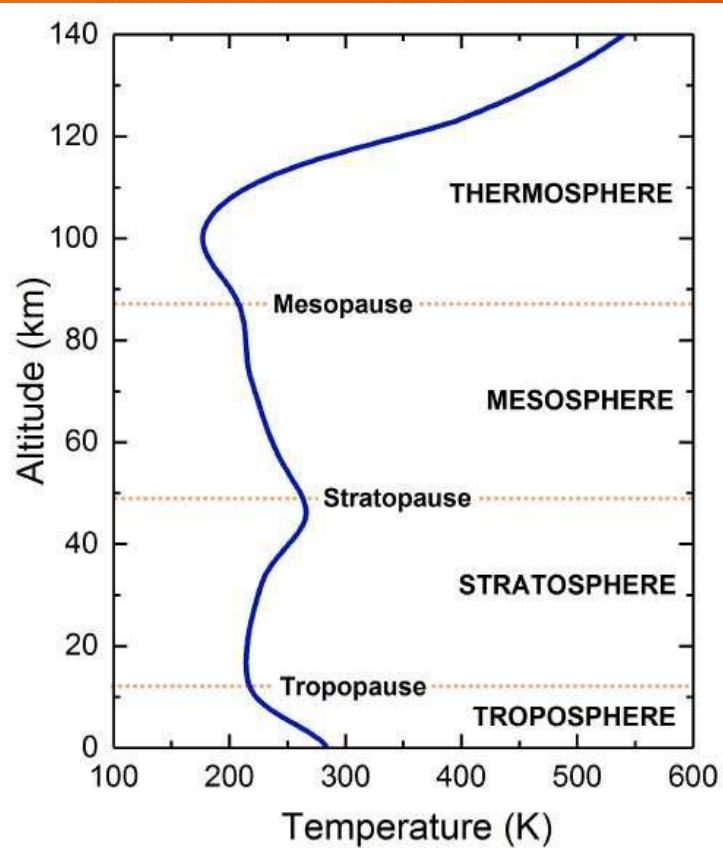


Stratosphere-Troposphere Exchange

Vasura Jayaweera & Luke McFadden

Troposphere and Stratosphere



Troposphere

- 8 - 18 km above surface
- 15 C down to -50
- Contains 85% of atmospheric mass
- Most of the water vapour

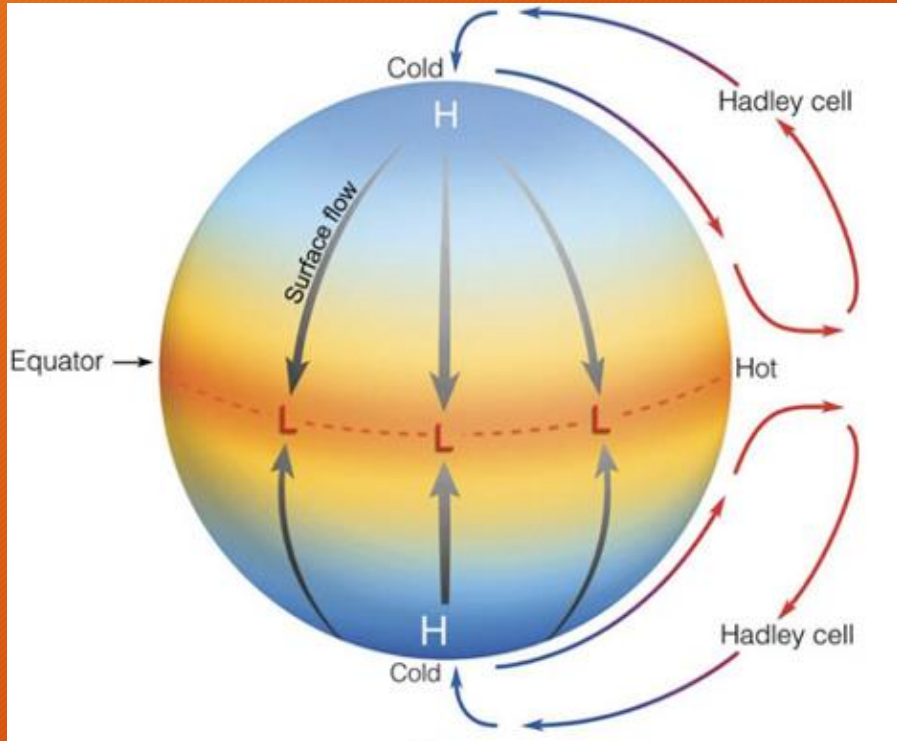
Stratosphere

- Between the tropopause and 50 km
- Presence of ozone

Global Atmospheric Circulation

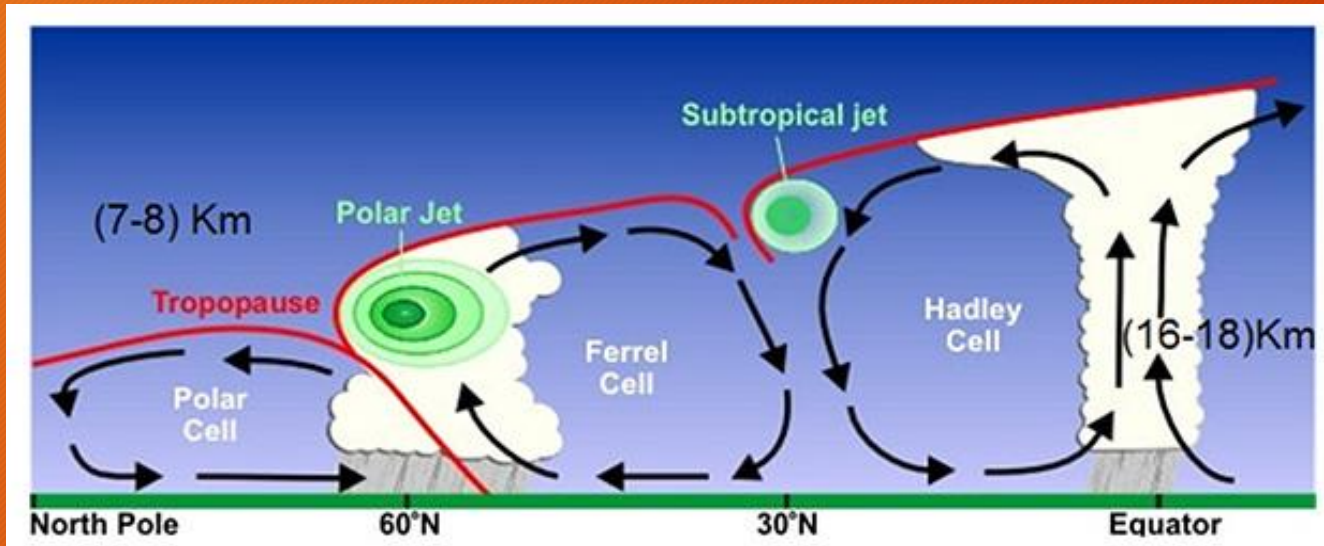
- Differential heating on the surface causes warmer air to rise through convection and reaches the top of the troposphere.
- Accumulated air will eventually cool and descend towards the surface thus reaching the equator as easterlies.
- This type of circulation is referred to as cells.
- The circulation of our planet can be represented by a three-cell model.

Original Hadley Cell



- Hadley proposed wind observations were from a single cycle from the equator to the poles.
- Matched observations but was later found to be inconsistent for the mid latitudes.
- Ignored the Coriolis effect.

Ferrel and Polar Cell

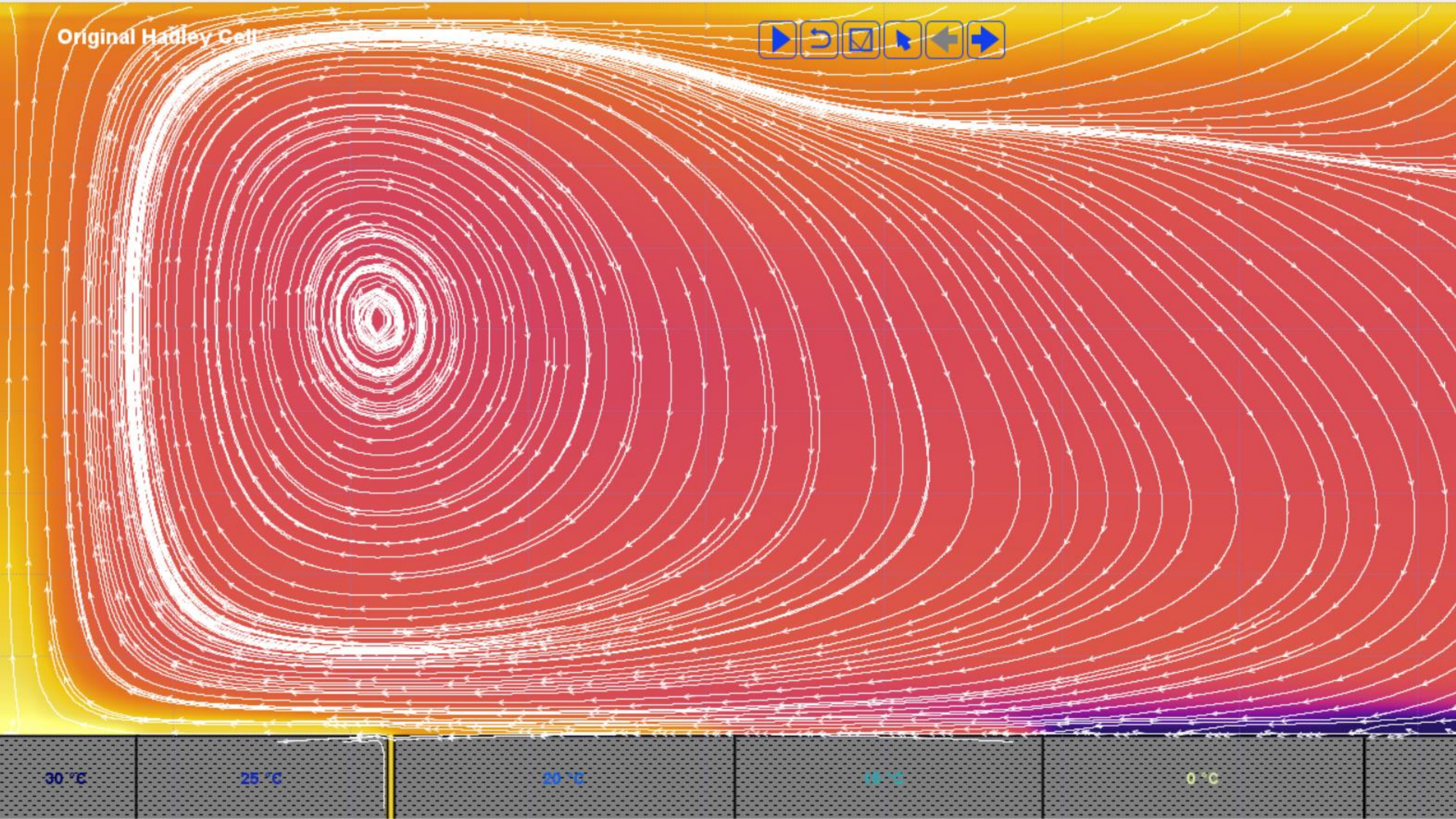


- William Ferrel (1817-1891) - accounted Earth's rotation in wind systems.
- Provide explanations to the reverse circulation that was observed in the midlatitudes.
- Ferrel cells are not driven by temperature.
- Polar Cell - Driven by surface temperatures.
- Smallest and weakest cell extending between 60° and 70° latitude.

Simulations

- We use Energy2D - a two-dimensional heat transfer simulation interface
- We modify the original Hadley cell example project to learn more about cell formation
- We use constant-temperature “blocks” to represent surface temperatures, with higher temperatures at the equator

Original Hadley Cell



30 °C

25 °C

20 °C

15 °C

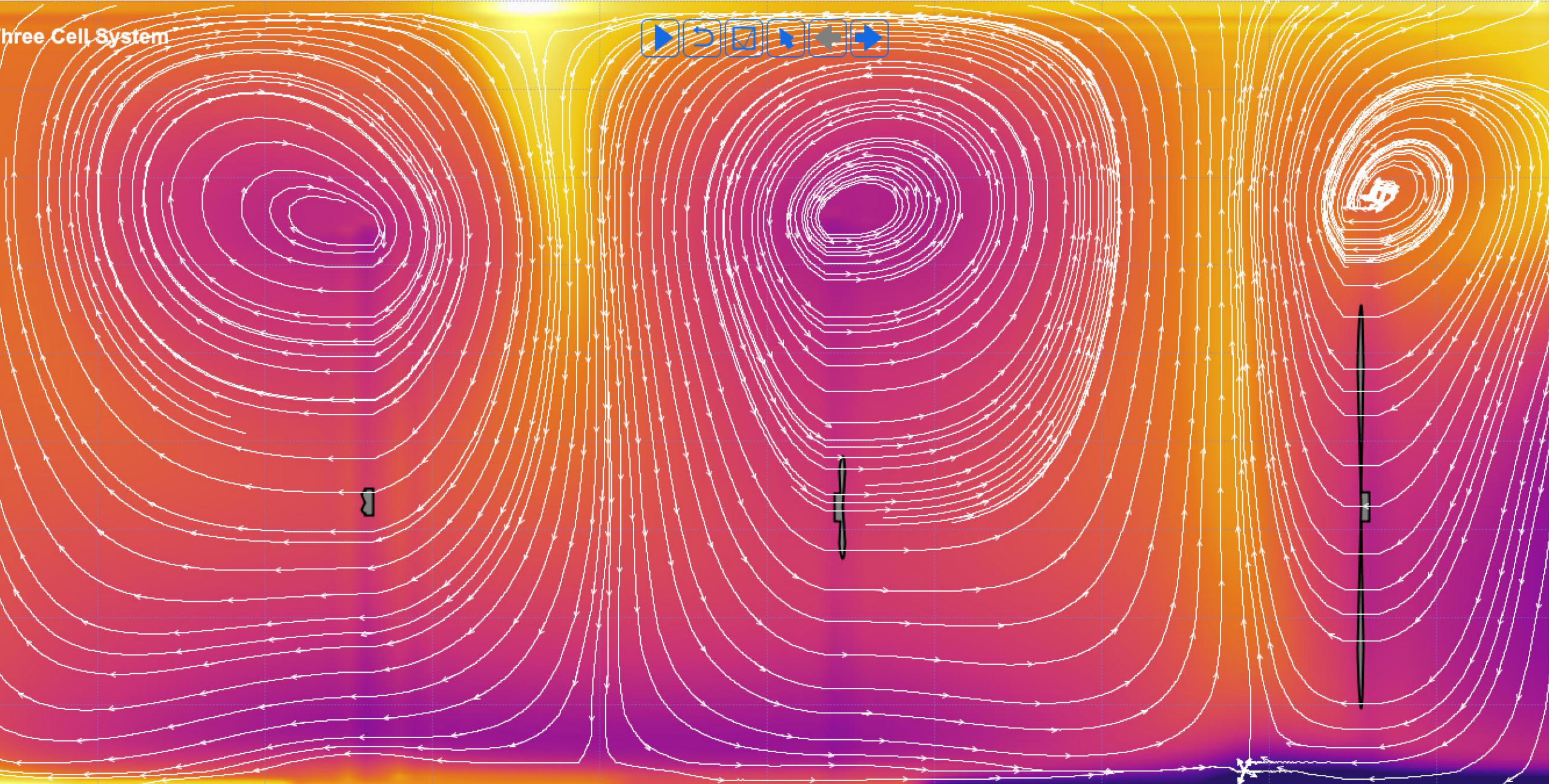
10 °C

0 °C

Three Cell Circulation

- The Coriolis effect adds forces depending on your latitude
- The north-south component of these were simulated by adding winds

Three Cell System



°C

25 °C

20 °C

15 °C

0 °C

-10 °C

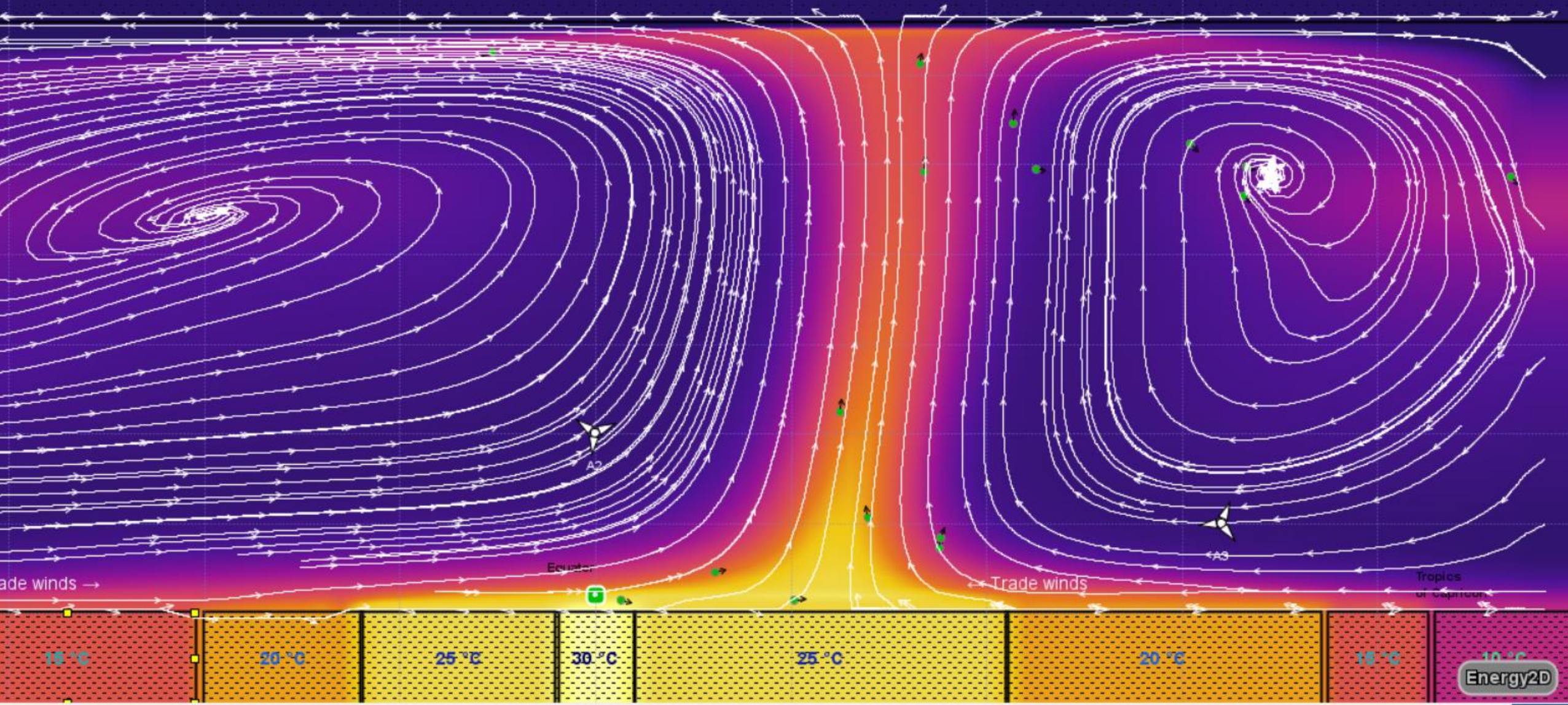
Energ

More Realistic Hadley Cell

- We observe a larger Northern Hadley cell when the Northern Hemisphere is in Winter
- Land/Ocean ratio higher in the North, different surface temperatures



-20 °C



Conclusion

- Circulation is responsible for mass transport between the stratosphere and the troposphere
- A (simple) three-cell structure can be explained by the differential heating and Coriolis forces