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Q15

What are aurora australia and aurora borealis? How are these triggered?

UPSC Civil Services Mains 2024 · GS I · 15 marks · World's Physical Geography

Salient features of world's physical geography.

Core demand of the question

- State what aurora australis and aurora borealis are
- Explain how these displays are triggered

Revision summary

Aurora borealis is the northern lights. Aurora australis is the southern lights.

Both are ovals of glowing upper air around the **geomagnetic poles**.

Colours come mainly from excited oxygen and nitrogen at **ionospheric heights**.

The trigger is solar-wind plasma coupling to Earth's magnetosphere, especially after coronal mass ejections.

Precipitating electrons collide with the upper atmosphere and make it emit light.

Strong geomagnetic storms expand the oval toward mid-latitudes.

Introduction

Aurora borealis is the name for the northern lights. **Aurora australis** is the name for the southern lights. Both are coloured glows in the upper air when the Sun's charged wind meets Earth's magnetic field and sends energy into the **ionosphere**. They are the same physical process in the two polar regions. They are not ordinary weather. They are not fire. They are not an astrological sign. They are a visible form of space weather.

Body

What the two auroras are

Both are luminous ovals around the **geomagnetic poles**, typically in a ring offset from the geographic pole. Green is common. It comes from **atomic oxygen**. Reds and rare blues and purples come from oxygen and **nitrogen** at different heights, often tens to a few hundreds of kilometres up. The australis is the southern counterpart over **Antarctica and the Southern Ocean**. Most people never see it. The borealis is famous over **Fennoscandia, Canada, and Alaska**. During strong storms the oval expands toward mid-latitudes. That is when people in unusual places report lights.

They are not rainbows, which are refraction in rain. They are not lightning. They can flicker and form arcs, curtains, and coronas. They are accompanied by magnetic disturbance on the ground.

- **Borealis:** This is the northern oval. It is better observed because more inhabited land sits under it.
- **Australis:** This is the southern oval. It is the same process with fewer witnesses.
- **Colour and height:** Colour depends on the chemistry of oxygen and nitrogen and on the energy of incoming particles.

How they are triggered

The **Sun** emits a **solar wind** of plasma. **Coronal mass ejections** and fast streams from coronal holes add extra energy and a **southward interplanetary magnetic field** that couples efficiently to Earth's **magnetosphere**. Reconnection on the dayside opens the magnetic shield. Energy is stored in the magnetotail and then released along field lines into the polar ionosphere. Electrons and protons precipitate, collide with upper-air atoms, and excite them. Light is released as the atoms relax. The auroral oval is the footprint of that circuit, closed through field-aligned currents.

A **geomagnetic storm**, measured operationally by a high **Kp** index, is the trigger for vivid, expanded displays. The **11-year sunspot cycle** changes how often such storms occur. Earth's dipole tilt and the season affect how well coupling works.

- **Solar source:** Wind, flares, and CMEs supply the trigger on the Sun.
- **Magnetospheric gate:** Only certain field orientations dump energy into the poles.
- **Atmospheric screen:** Collisions in the ionosphere turn particle energy into photons.

Without a magnetic field, the air would be stripped over geological time. With a magnetic field, particle energy appears as polar lights instead of a stripped atmosphere. That is the chain from the photosphere to the polar sky.

Why two names, one mechanism

Borealis and australis are geographic labels. They are not two different kinds of light. Earth's dipole has two polar funnels. The same solar storm can light both ovals, sometimes with a time lag as the magnetosphere responds. The south is mostly ocean, so the australis is photographed less often. It is not weaker. During extreme events the ovals swell. Radio, GPS, and power grids feel the same storm that observers see as coloured light. The GS point is that the trigger is solar and magnetic, and the place is the polar ionosphere in both hemispheres.

Flow diagram

Solar wind and CME -> Magnetosphere reconnection
Magnetosphere reconnection -> Tail energy release
Tail energy release -> Particle precipitation
Particle precipitation -> Aurora borealis north
Particle precipitation -> Aurora australis south

Conclusion

Aurora borealis and aurora australis are polar ionospheric glows produced by the same solar-terrestrial process. They are triggered when the solar wind couples to the magnetosphere and sends electrons into the upper air. A GS answer should treat them as physics, not as folklore. They are space weather made visible as colour.

Facts & figures

Ionospheric heights

Auroral emission typically occurs from tens of kilometres to a few hundred kilometres above the surface, in the upper atmosphere.

Oxygen green line

The common green aurora is associated with excited atomic oxygen; reds involve oxygen at other transitions; blues often involve nitrogen.

Coronal mass ejection

A large expulsion of solar plasma and field that can drive geomagnetic storms and bright, expanded auroras.

Geomagnetic poles

Auroral ovals circle the magnetic poles, which are offset from the geographic poles, so the lights are not centred on the map's north and south.

Solar cycle

Roughly eleven-year sunspot modulation changes how often strong solar storms, and thus vivid auroras, occur.

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