# Infrasound arrays and propagation

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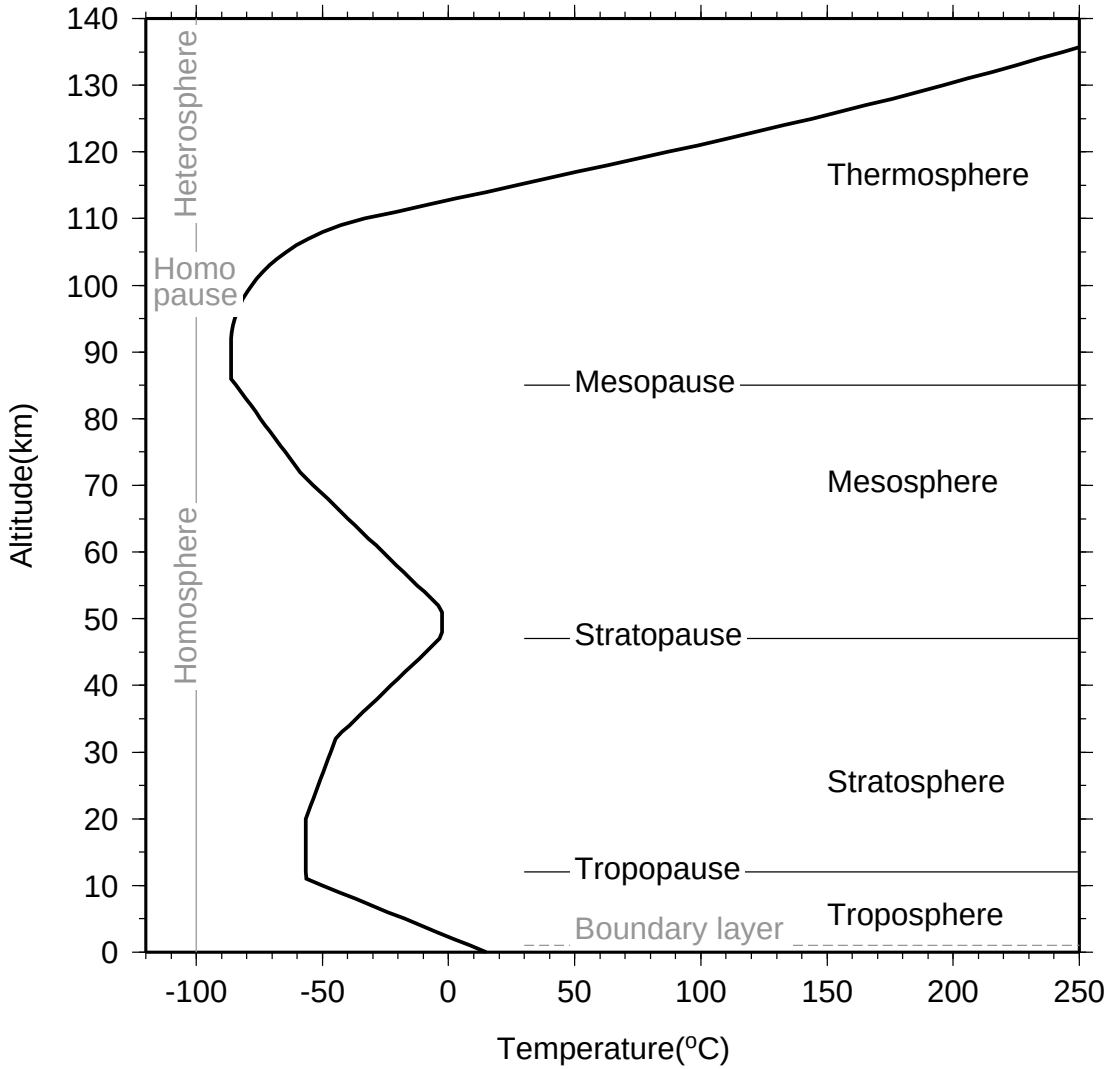
# The Atmosphere as Medium of Propagation

- The atmosphere is highly dynamic medium, variations on all temporal and spatial scales
- Infrasound propagation depends on the wind and temperature structure

$$c_{eff} = c_T + \hat{n} \cdot \vec{u} = \sqrt{\gamma R T} + \hat{n} \cdot \vec{u}$$

- Gradients in the effective sound speed ($c_{eff}$) caused by variations in temperature ($T$) and wind ($\vec{u}$) create waveguides
- Channels for efficient long range sound propagation (like SOFAR channel in the oceans)

# The Temperature Structure of the Atmosphere




- Decreasing temperature in the troposphere
- After the tropopause, an increase due to presence of ozone
- After decrease in the mesosphere, again increase in thermosphere due to direct absorption of solar radiation

Temperature from the US Standard Atmosphere NOAA (1976)

# Infrasound Propagation

- Refraction of sound – think of Snell's law
- Effective sound speed $c_e$: combined effect of temperature $T$ and wind $\mathbf{w}_{u,v}$ in the direction of propagation $\hat{n}$: $c_{eff} \approx 20\sqrt{T} + \mathbf{w}_{u,v} \cdot \hat{n}$
- Upward (downward) refraction: negative (positive) sound speed gradient
- Horizontal refraction: horizontal advection due to wind / temp. gradients

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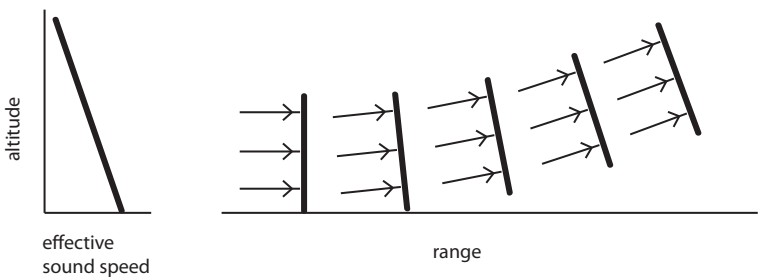

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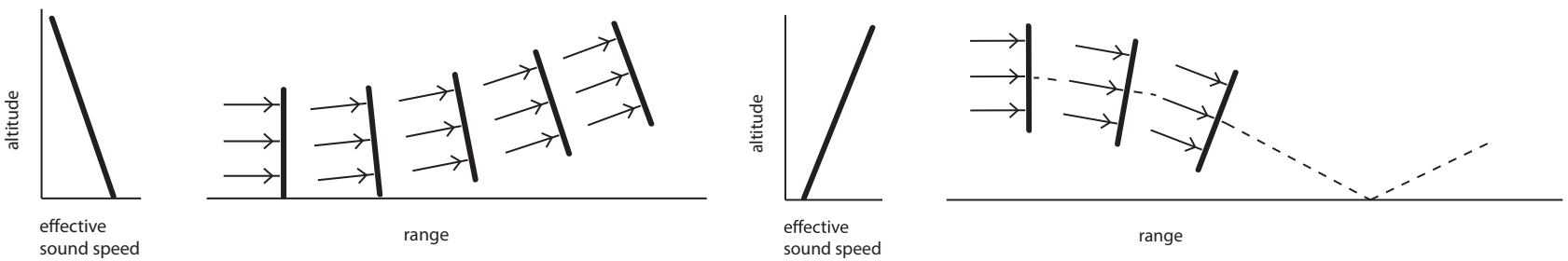

# Infrasound propagation example

Domestic gas explosion at 27 January 2010, Liège, Belgium.

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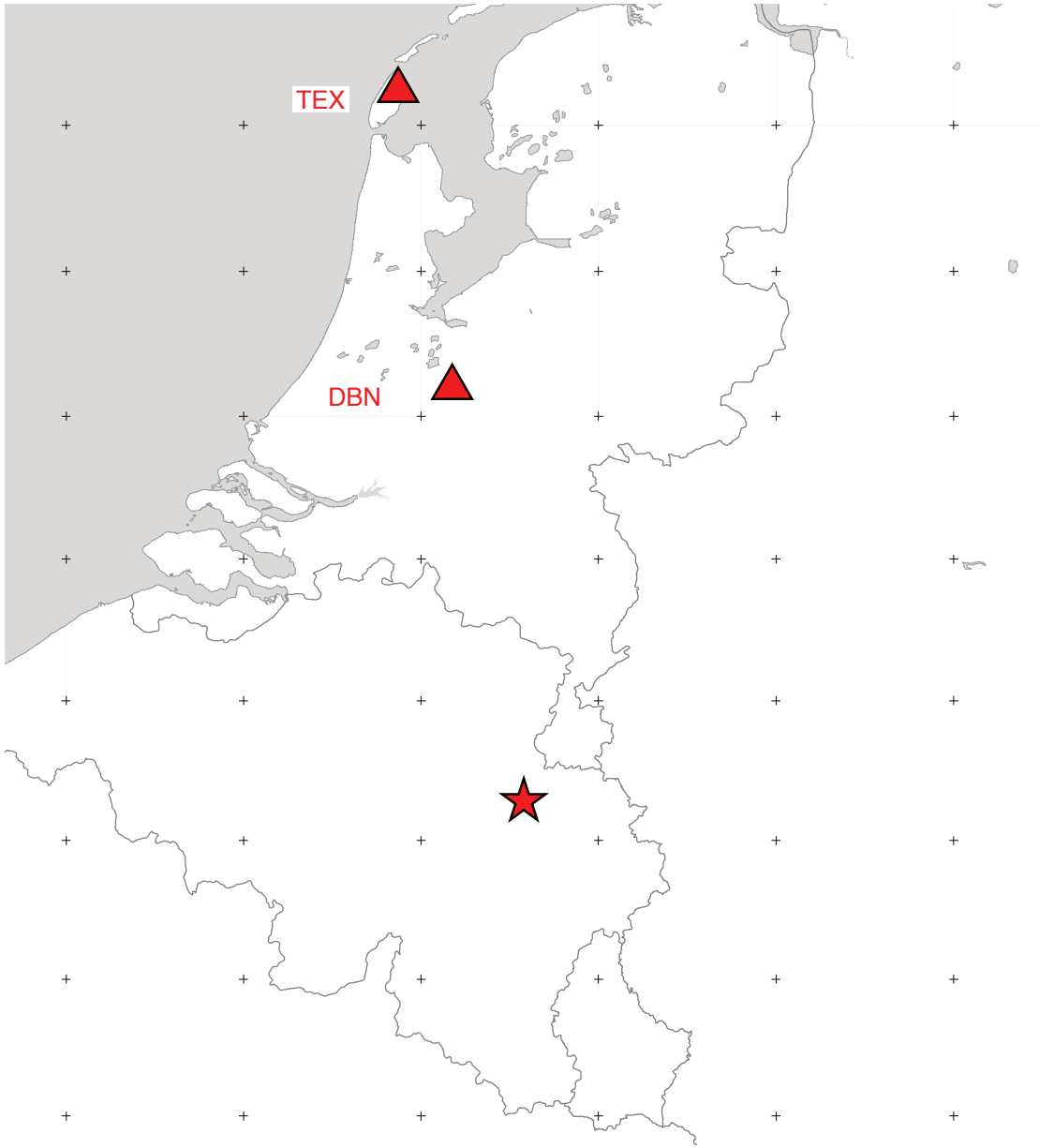

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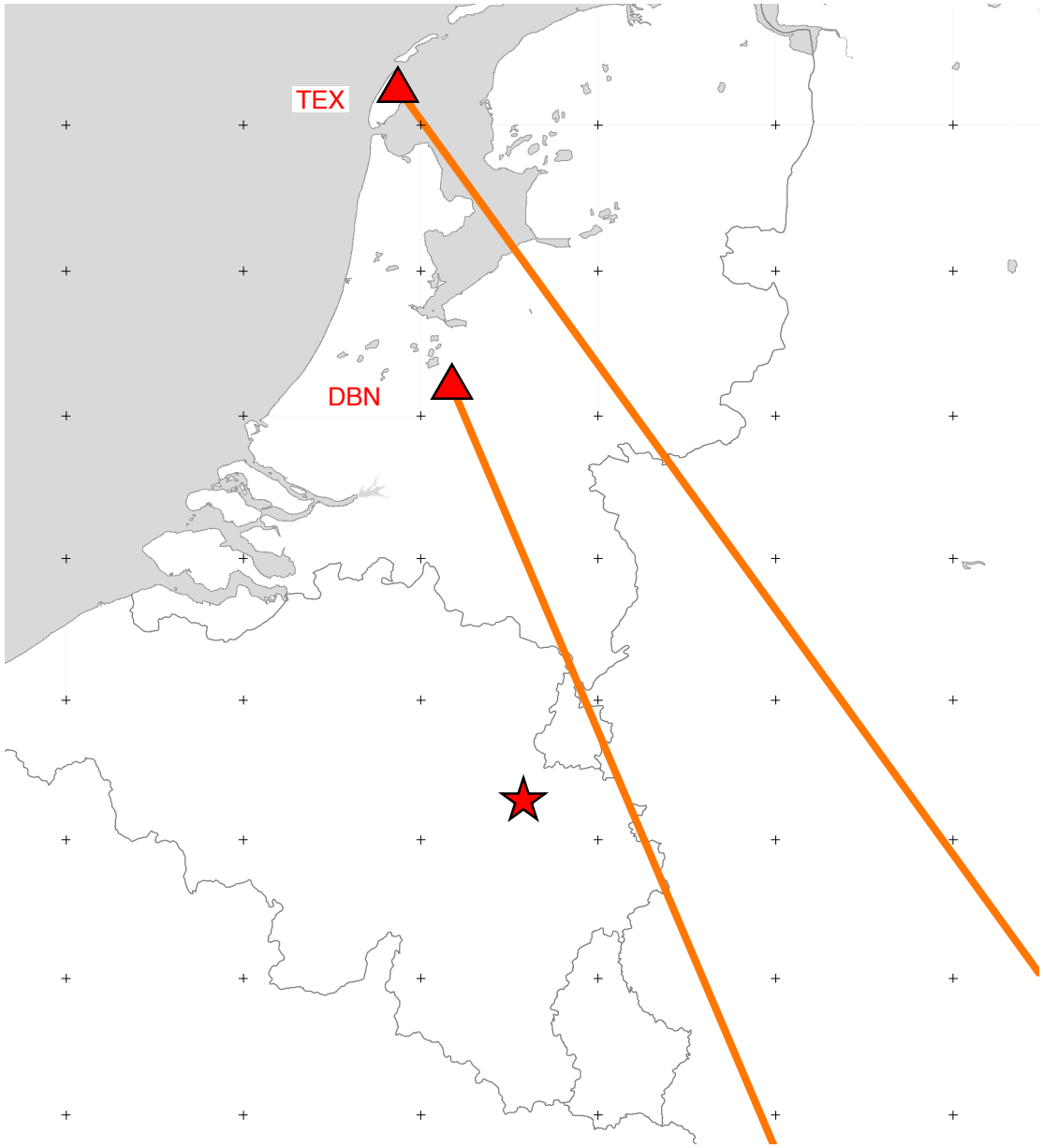

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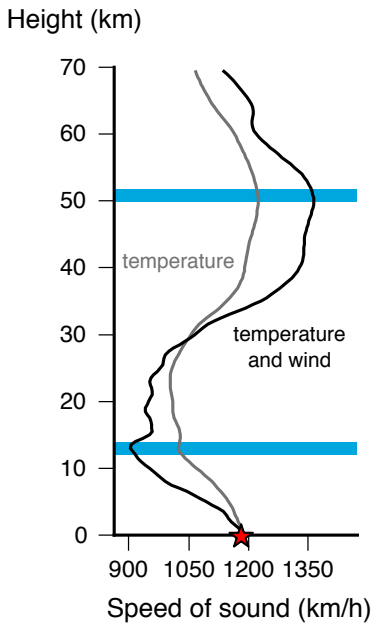

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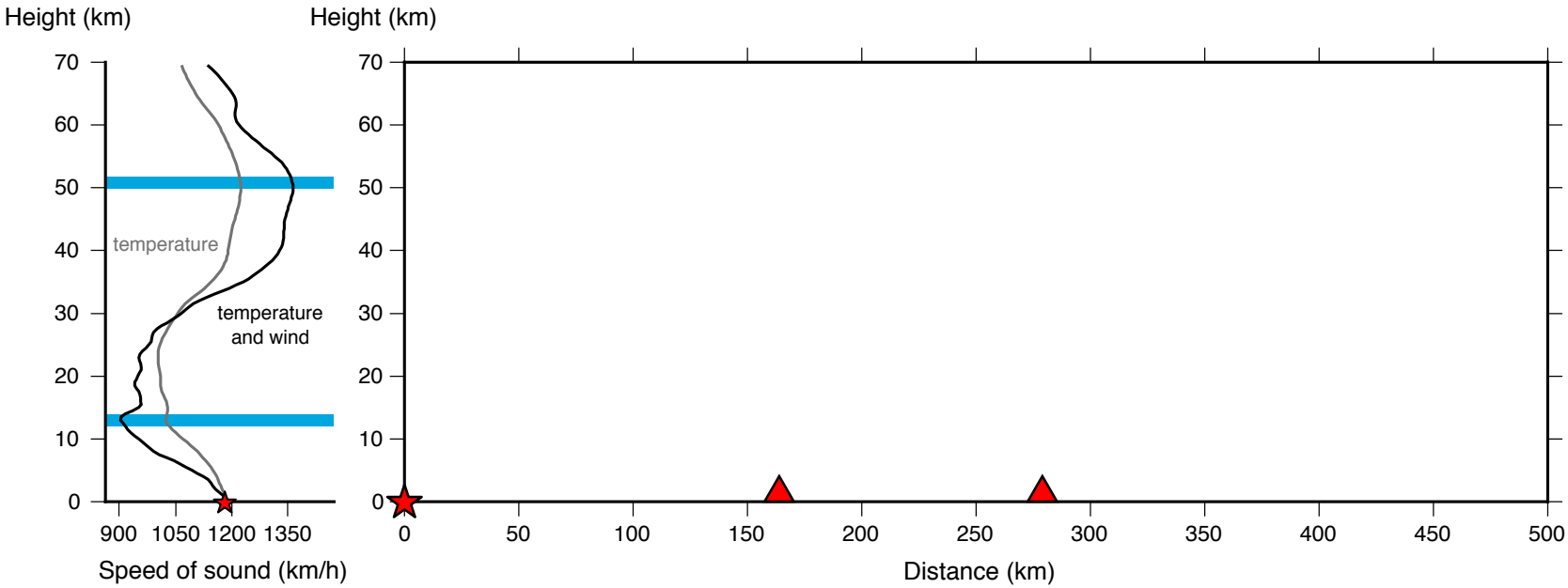

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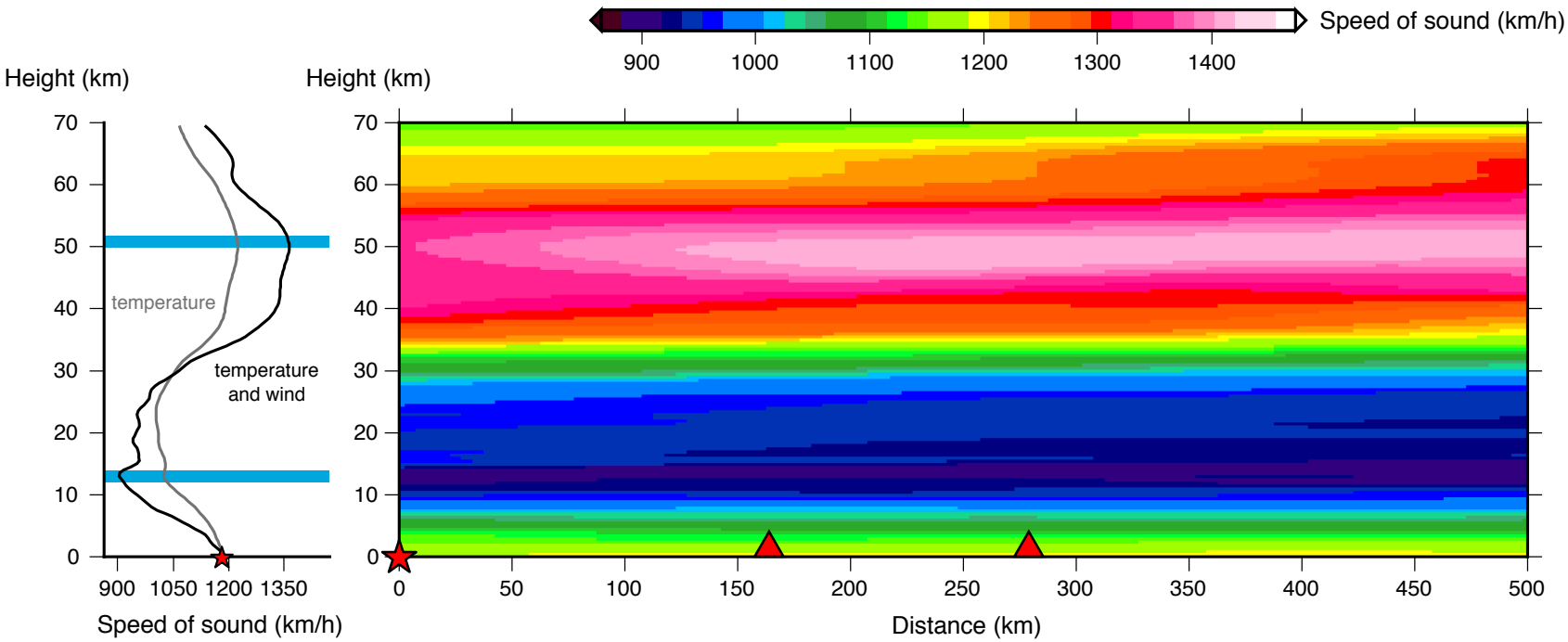

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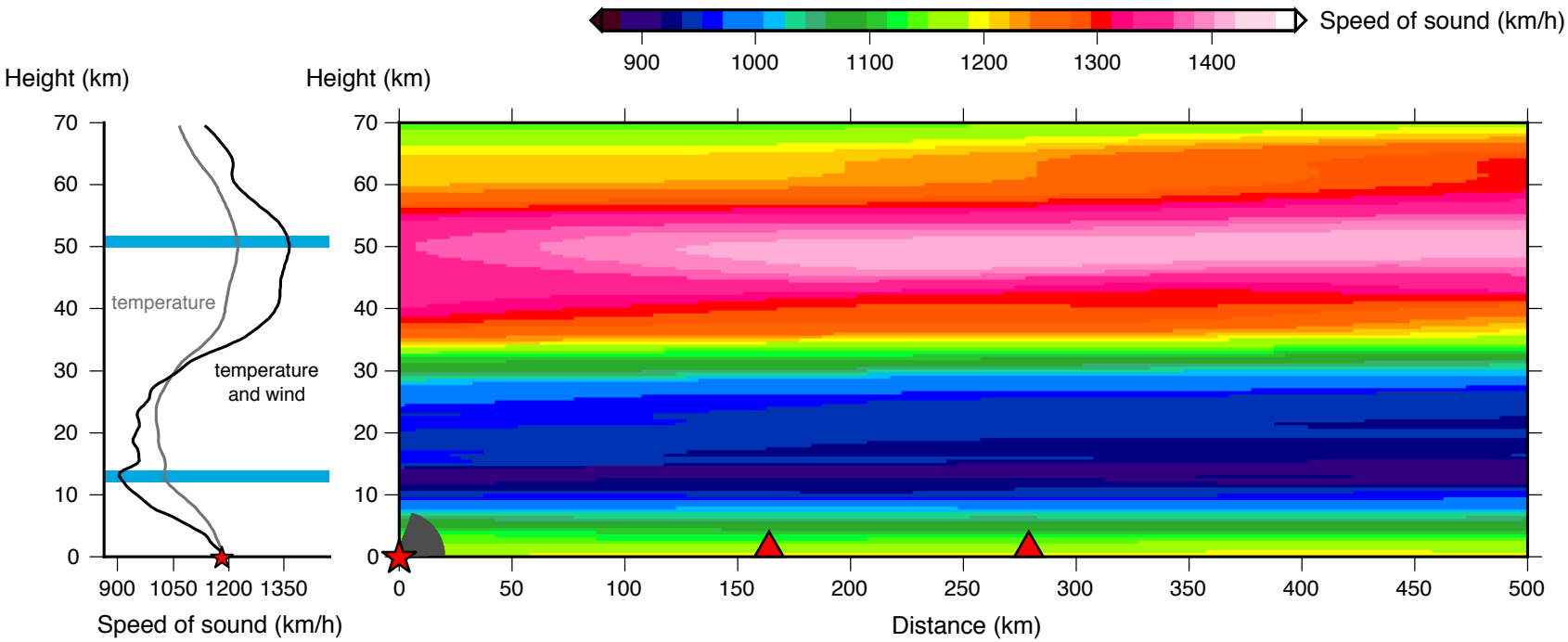

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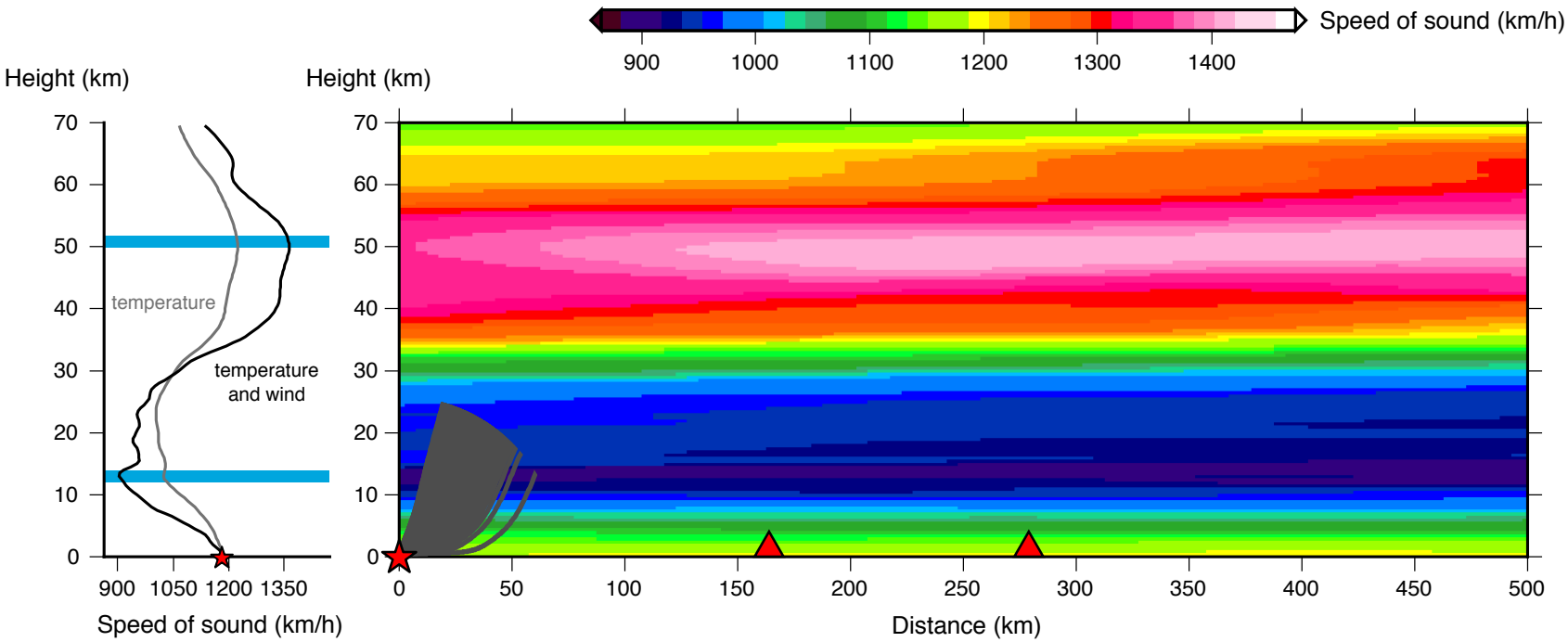

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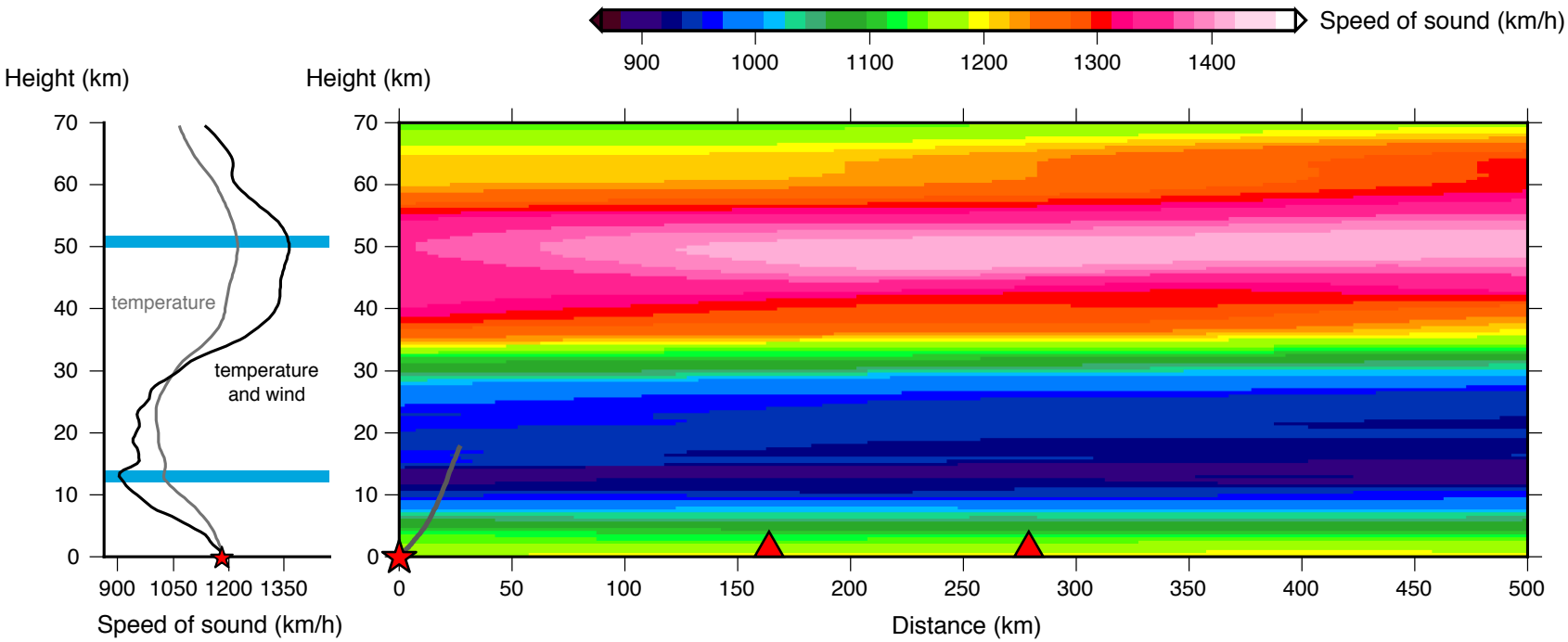

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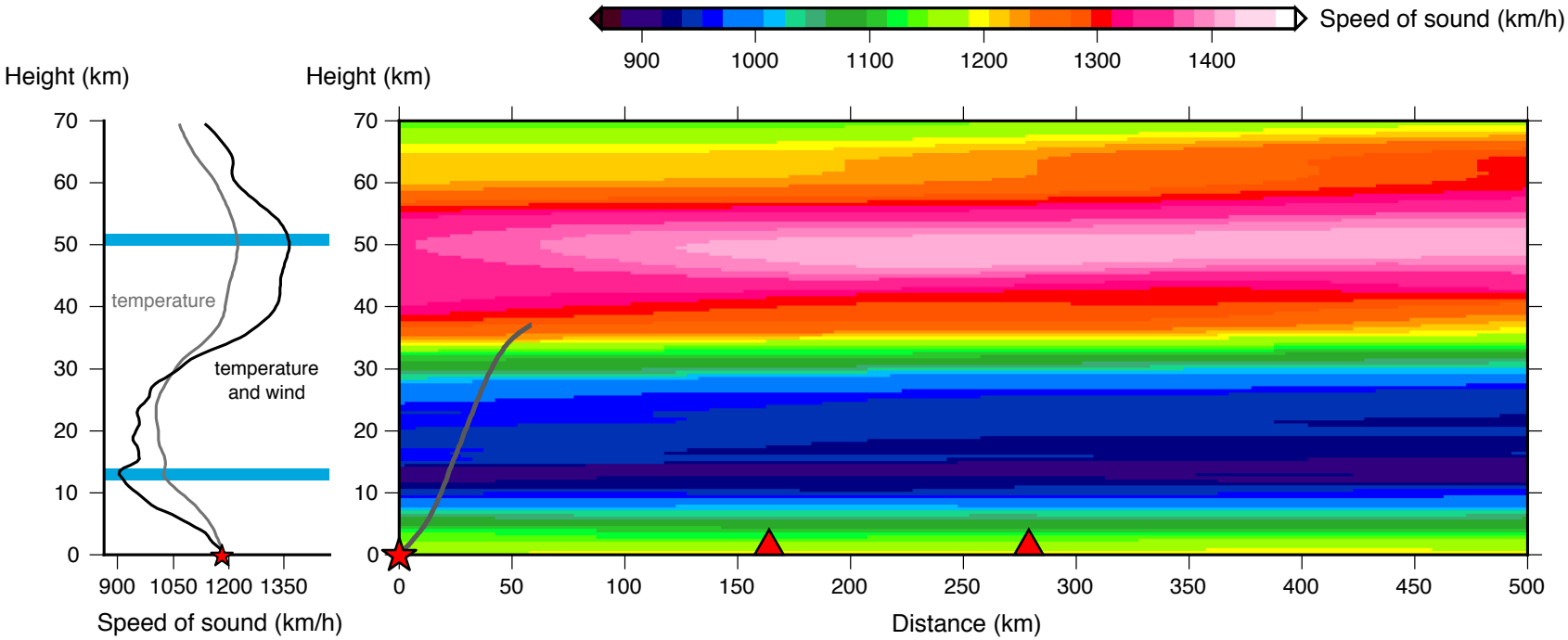

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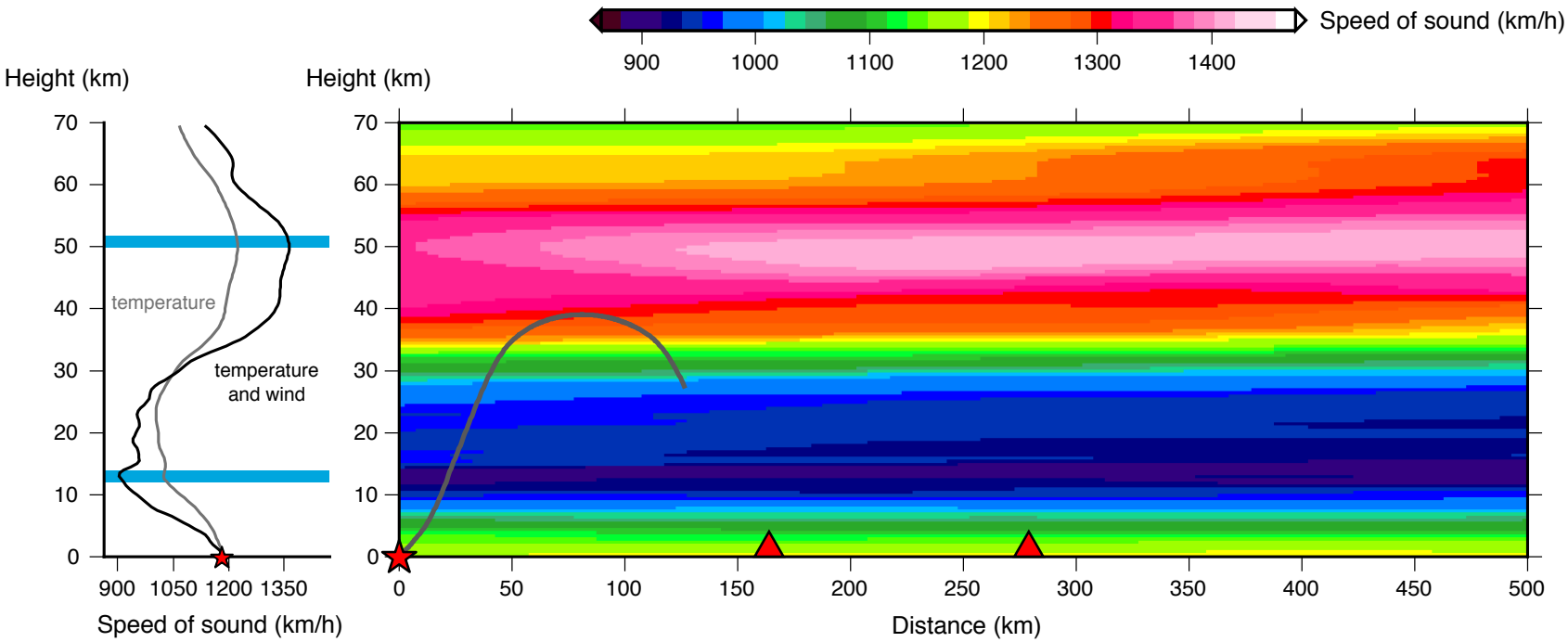

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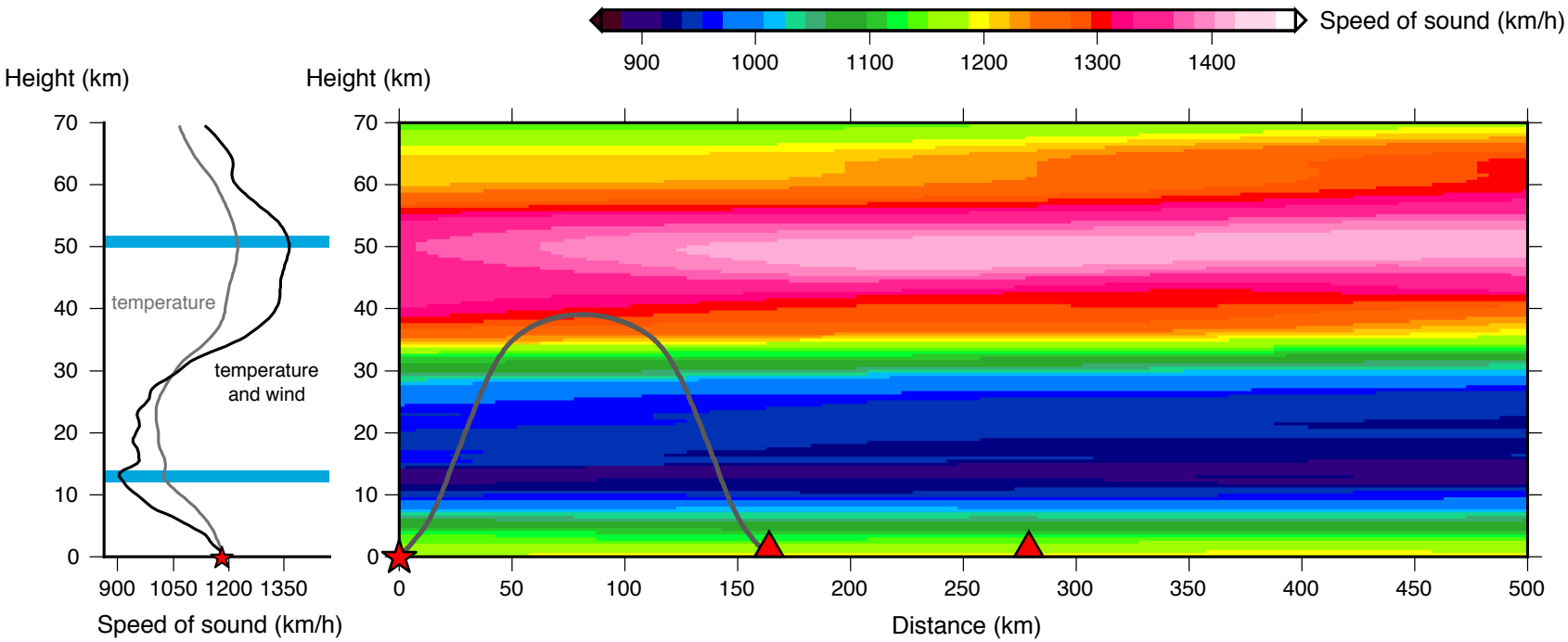

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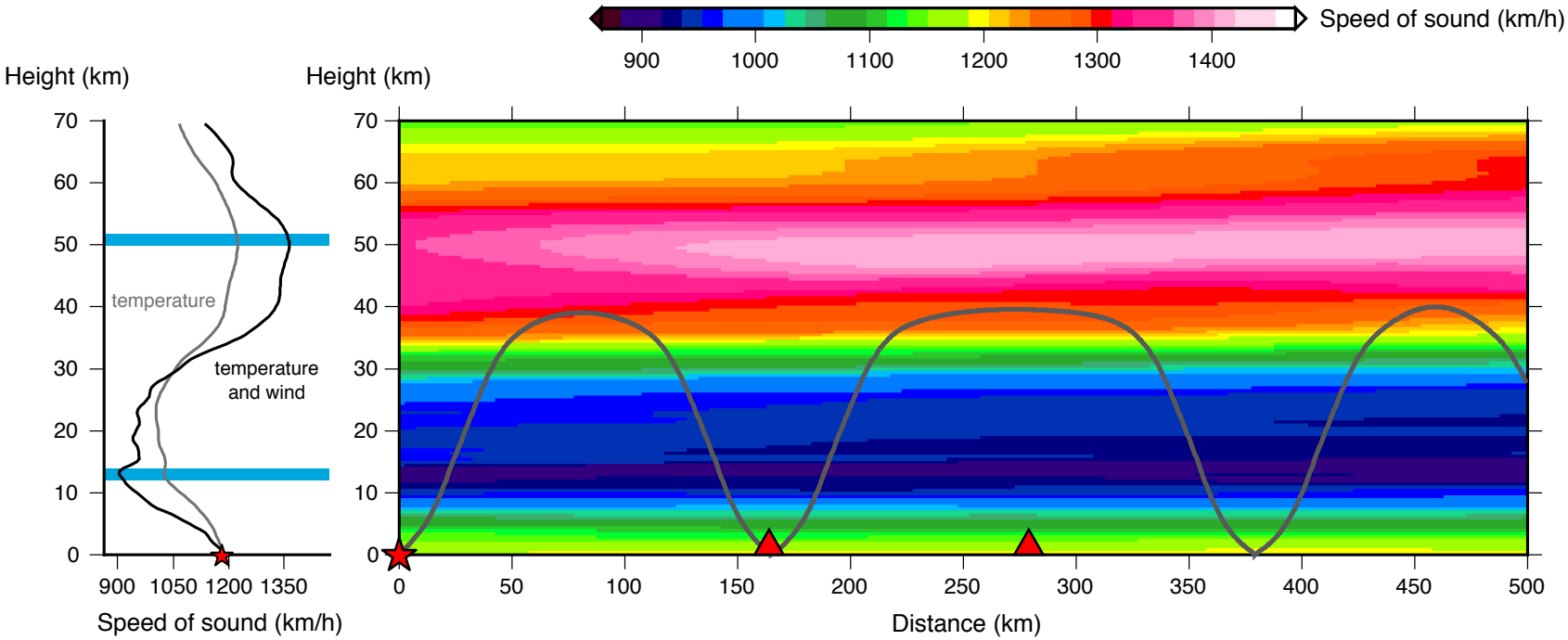

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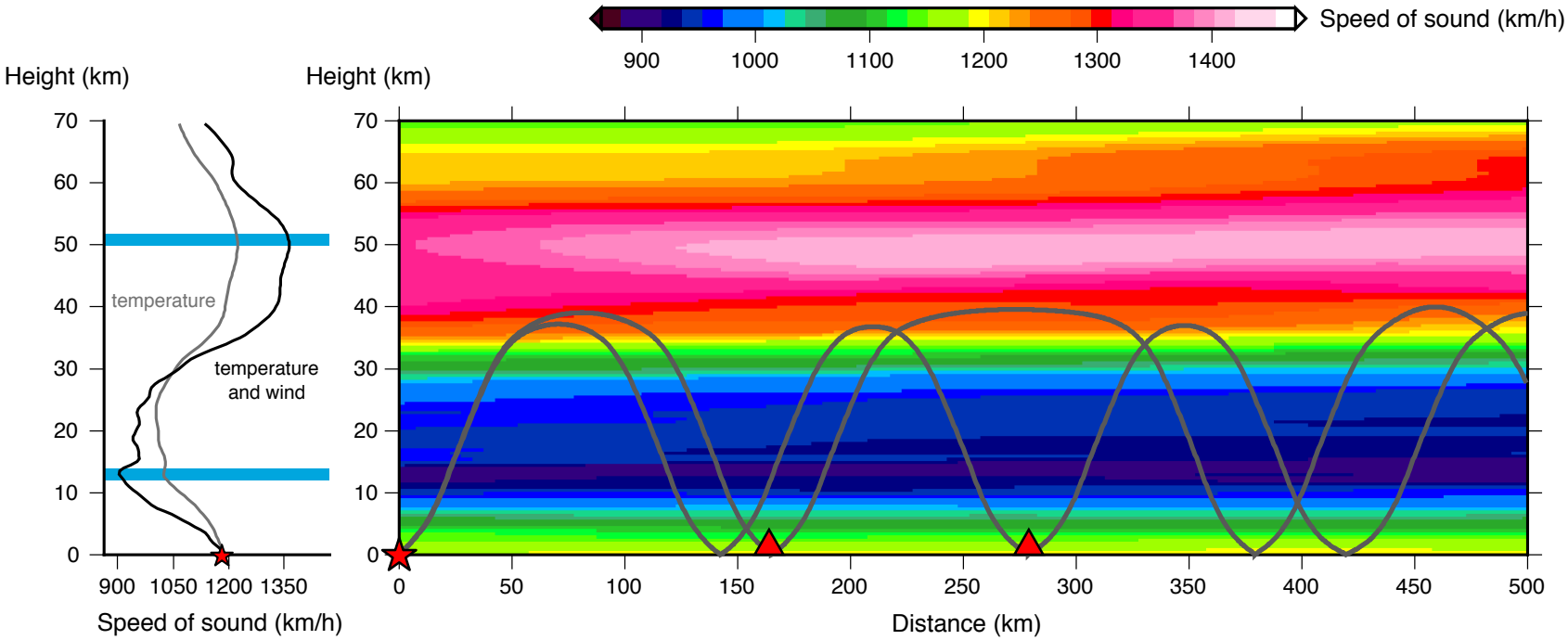

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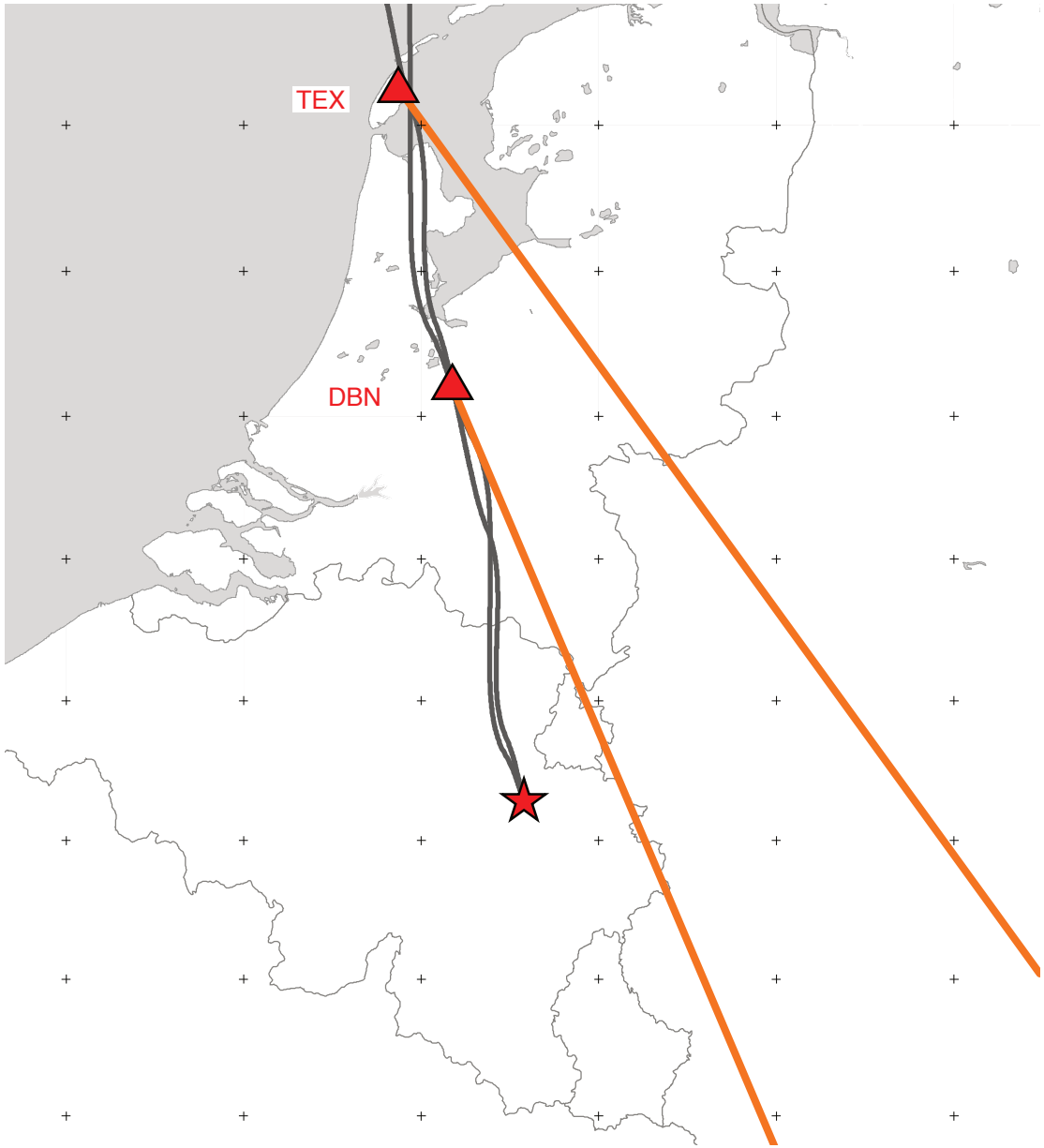

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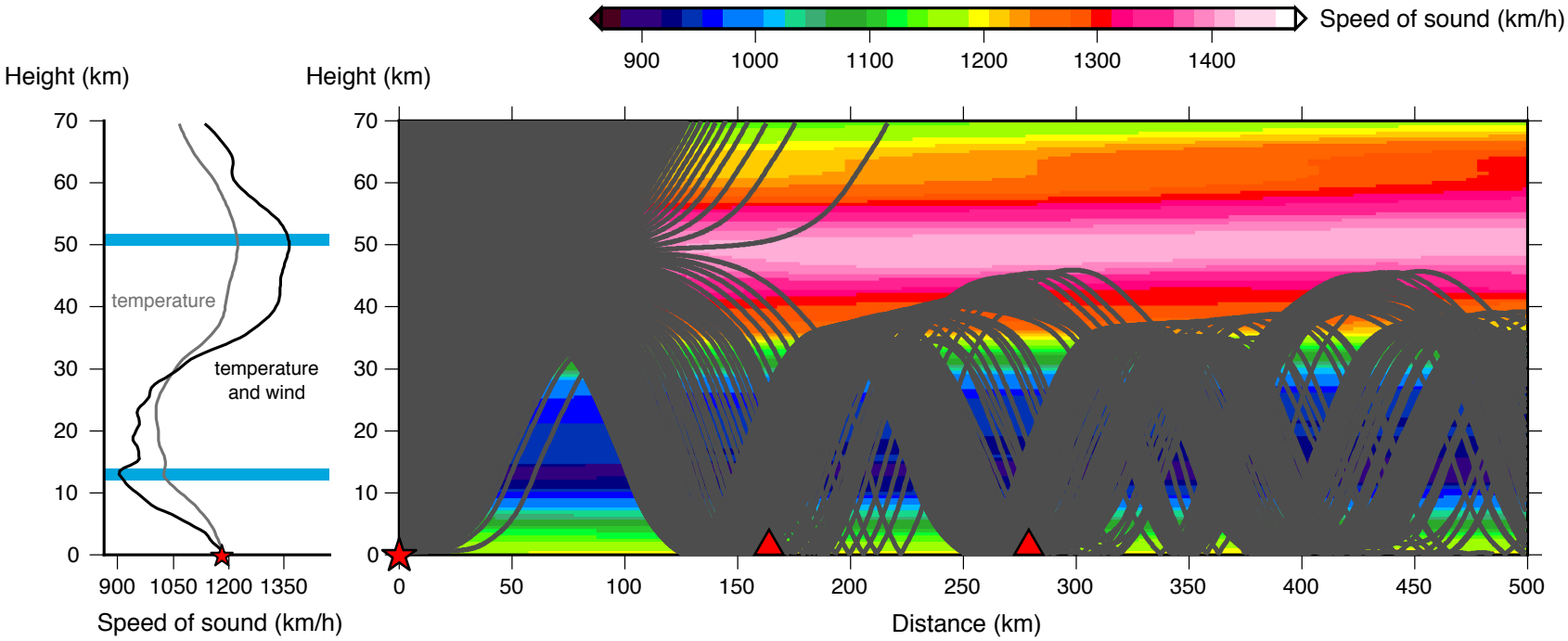

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