



Tracking jetstream winds through gravity waves arriving on surface based pressure sensors

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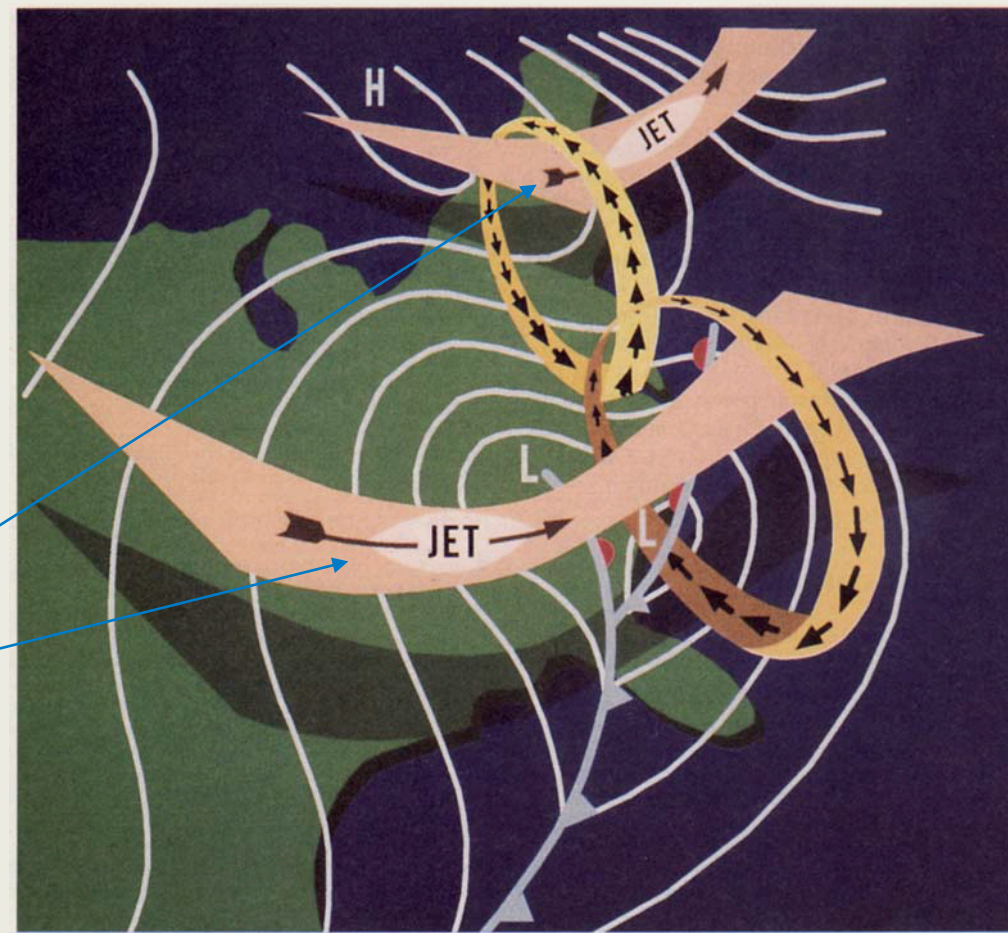
Motivation to study the jet stream:

Severe weather events can be linked to specific jetstream configurations:

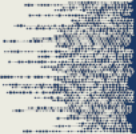
- > cold snaps
- > snowstorms
- > heatwaves
- > droughts
- > floods
- > ...

Example of a configuration with two jet streaks that enhance surface weather.

In this configuration up to **50 cm of snow** fell in 2 days!



[Fig 16 of Uccellini & Kocin 1987]



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It is challenging to measure at 10 km altitude! (*problem*)

Current observational techniques:

Airplanes; Mode-S

Radiosonde **balloons**

Satellites; e.g. **LiDAR** (ALADIN), ...

Research funding (*solution*):

Surface pressure perturbations

[Tracking Jetstream Winds](#)

WP1: Gravity Waves

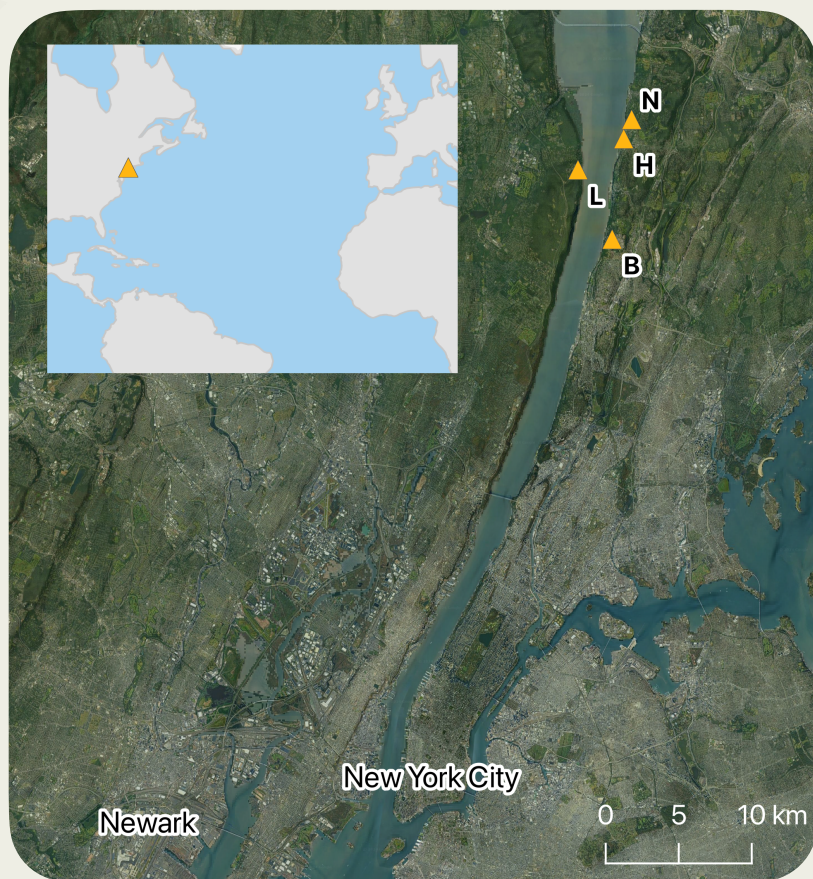


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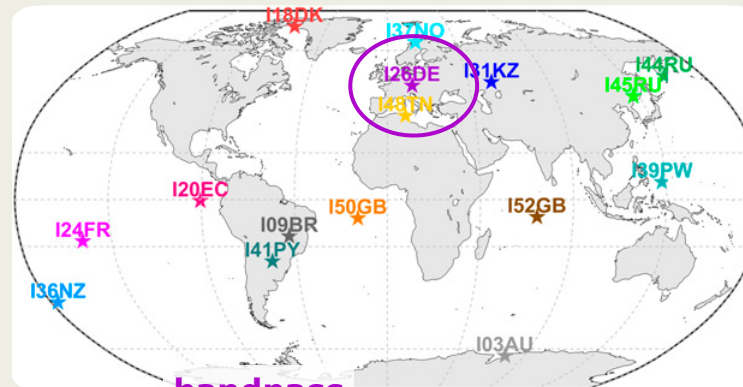
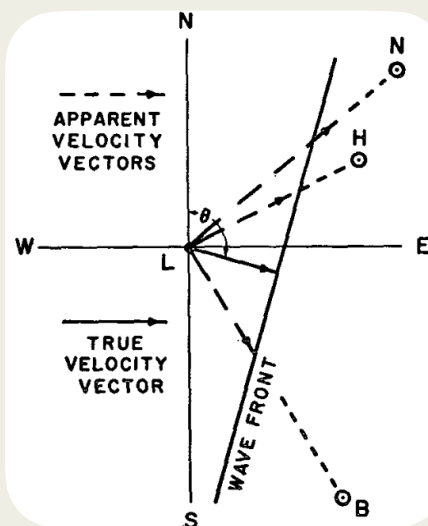
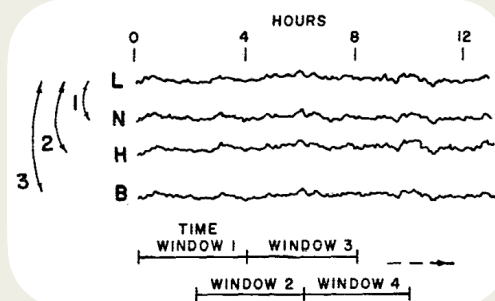
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History

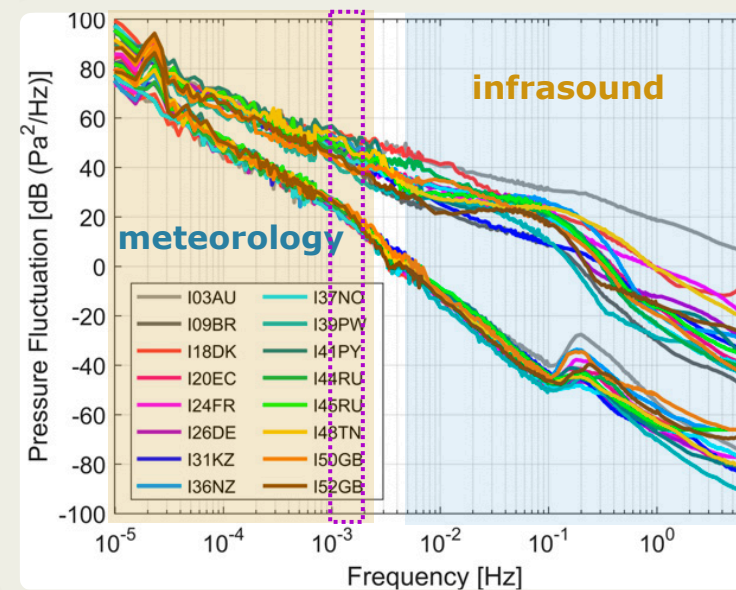
Tracking Jet Stream Winds from Ground Level Pressure Signals¹



[Herron & Tolstoy, 1969]



bandpass

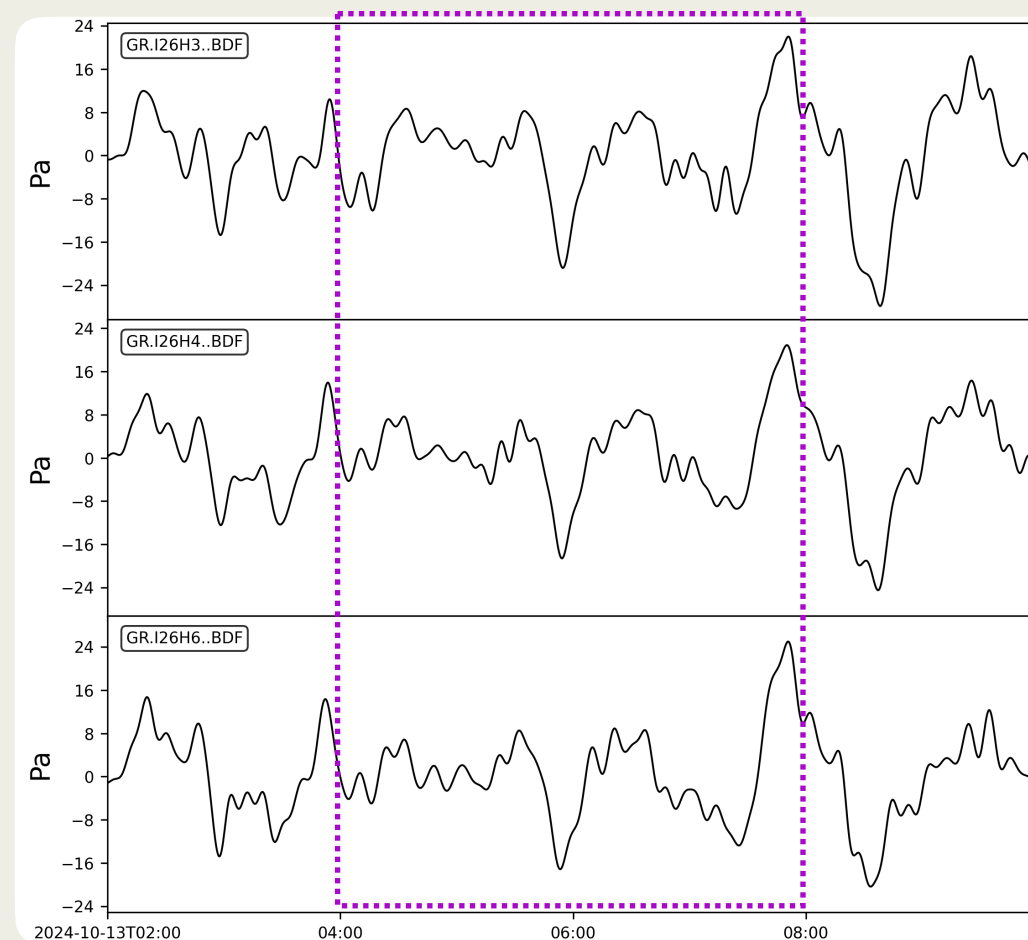
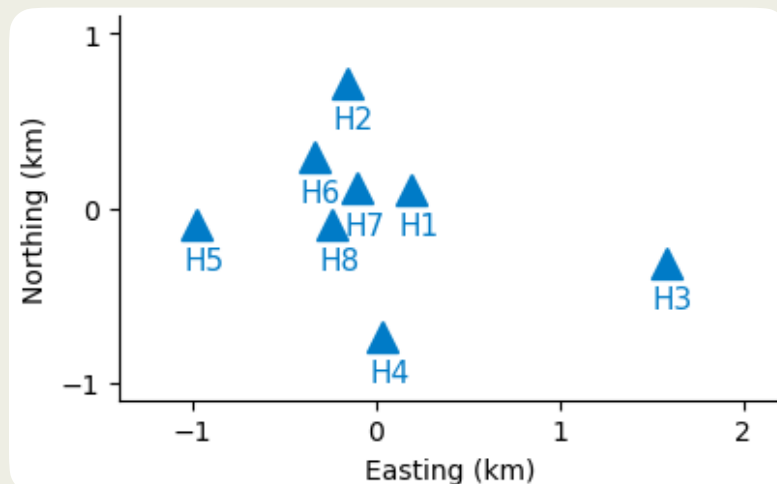


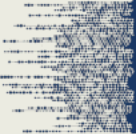
[Marty et al., 2021]

Gravity wave detections at IS26

BEAMFORMING METHOD:

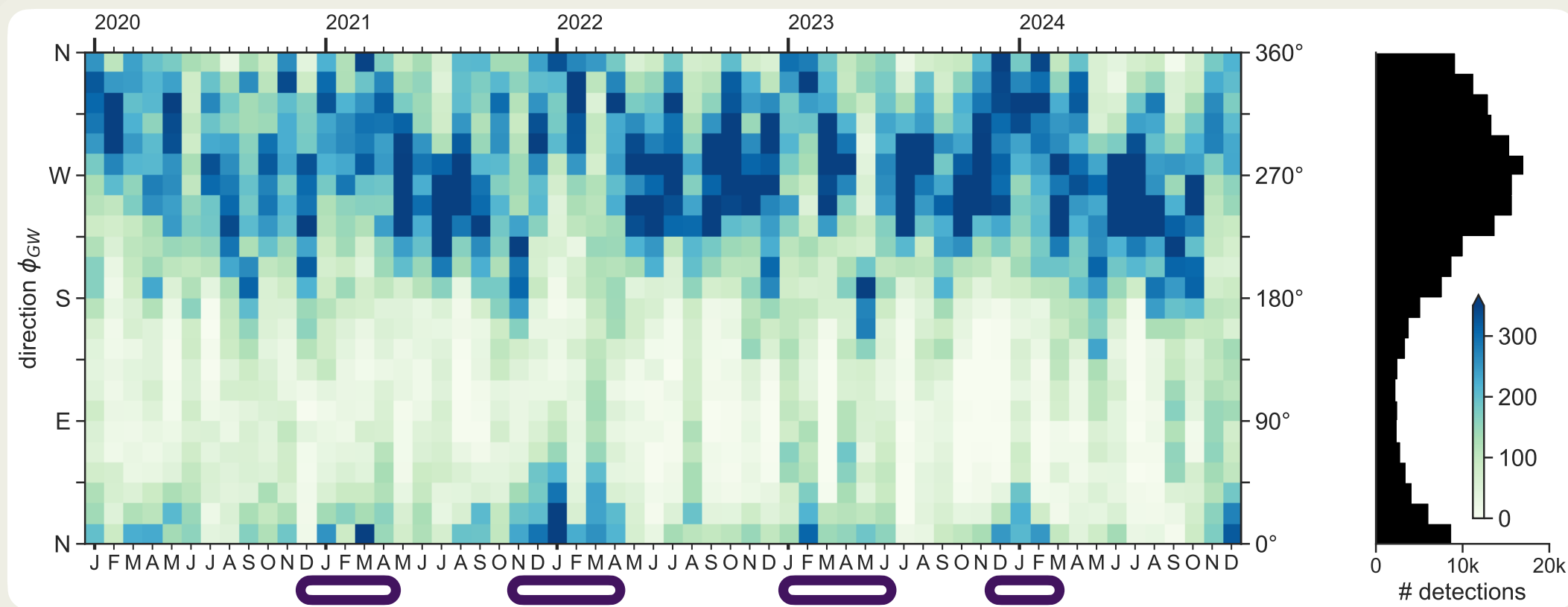
- > On **4 hour windows** of filtered pressure signals,
- > to find directions ϕ_{GW} and apparent velocities c_{app} of gravity waves.
- > We relate these to overpassing winds.





Seasonal dynamics

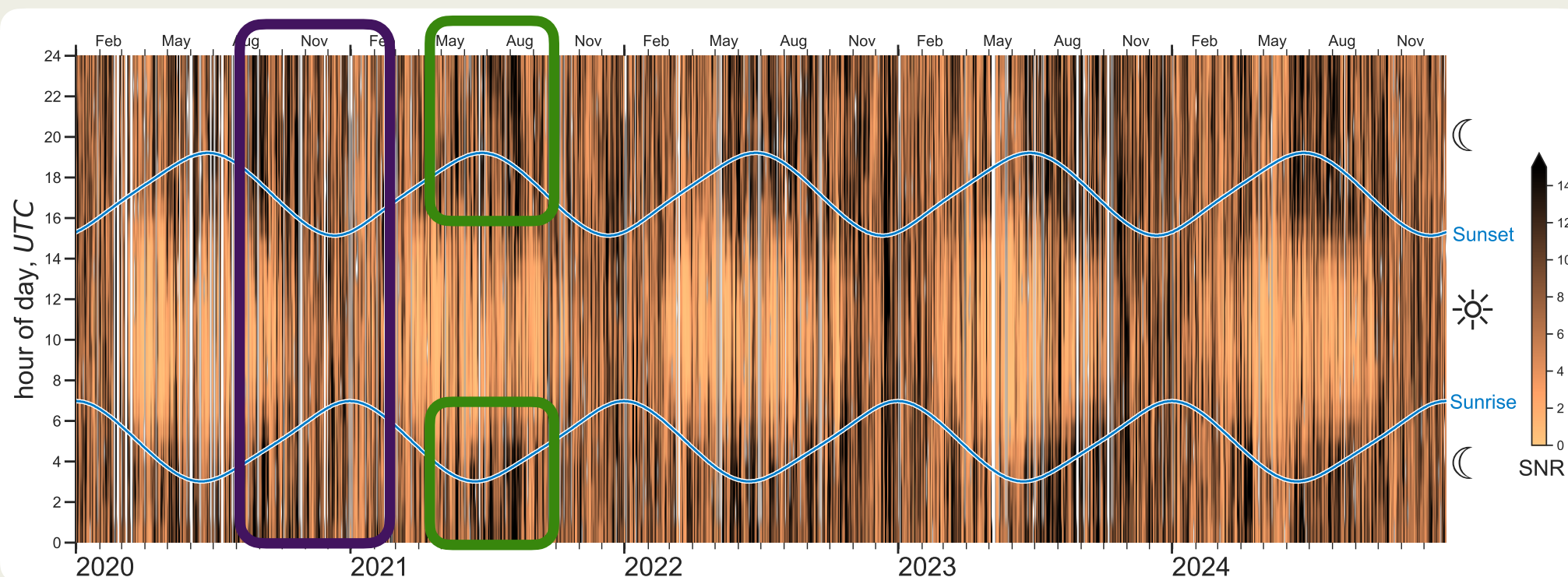
Detections are mostly from westerly sectors, with a seasonal cycle, shifting to more **northerly in winter**.



Temporal dynamics

Detections have high **Signal-to-Noise-Ratio** SNR;

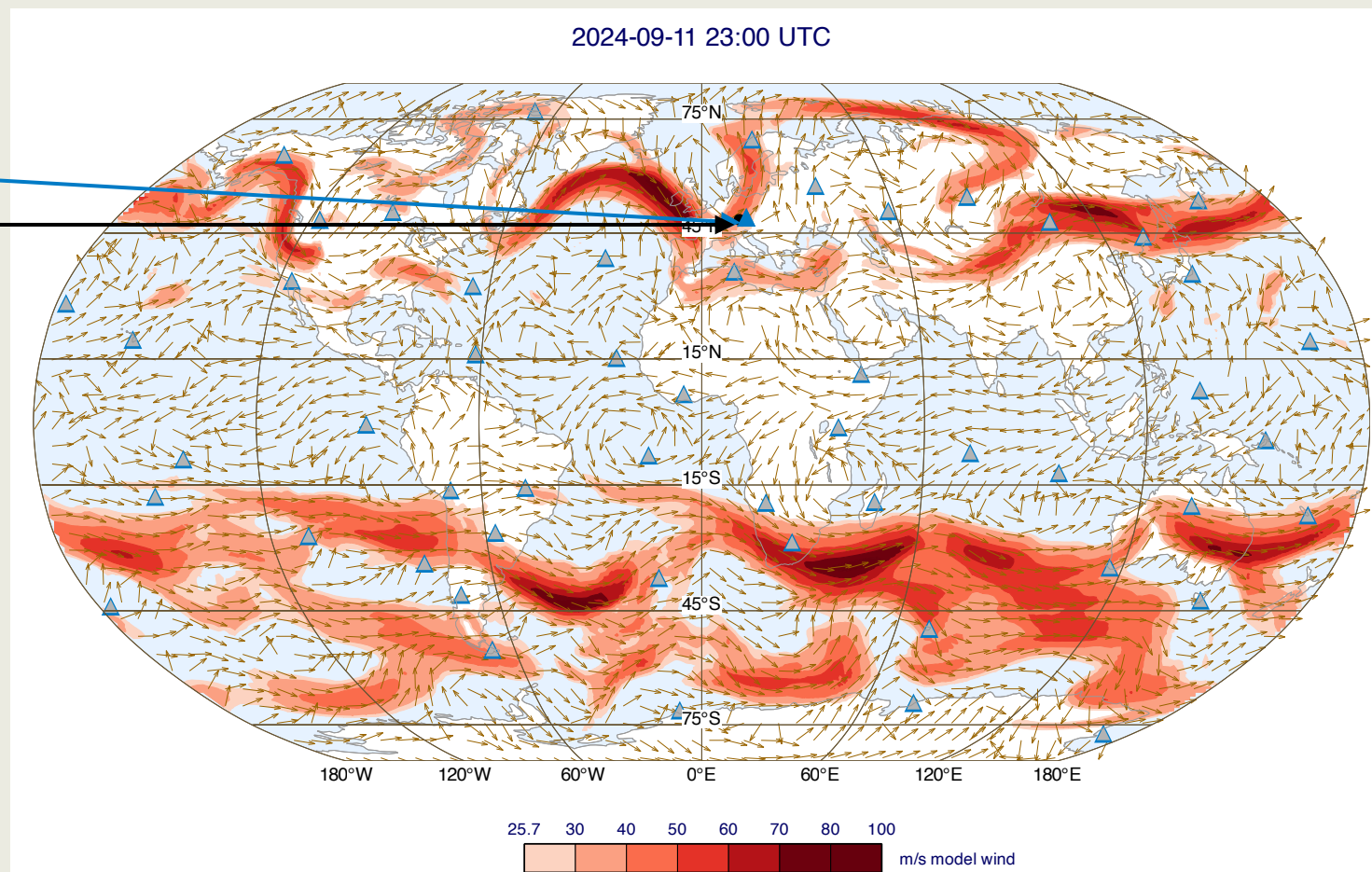
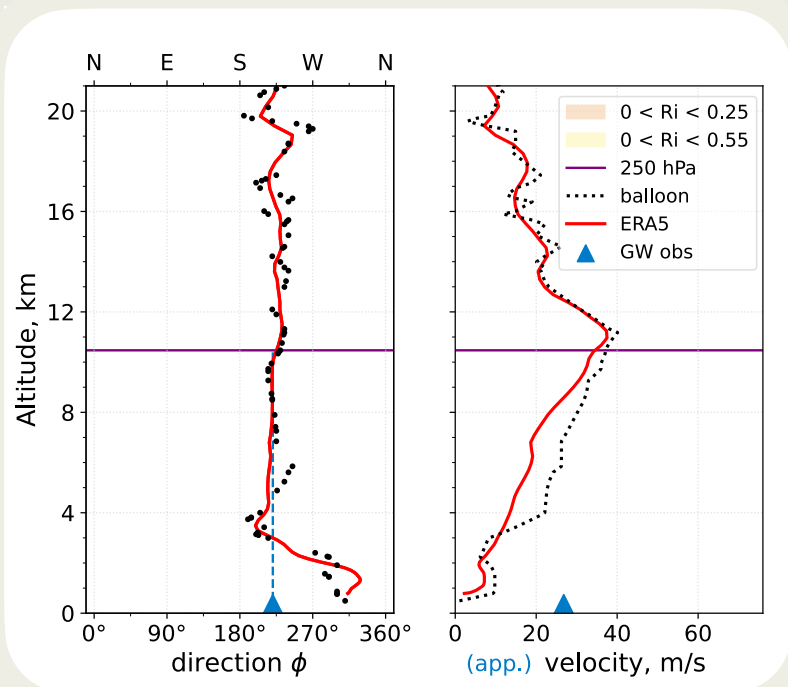
- > In the **winter** period during **day and night** (more baroclinicity)
- > In the **summer** period during **night** (night is stable in lower troposphere)



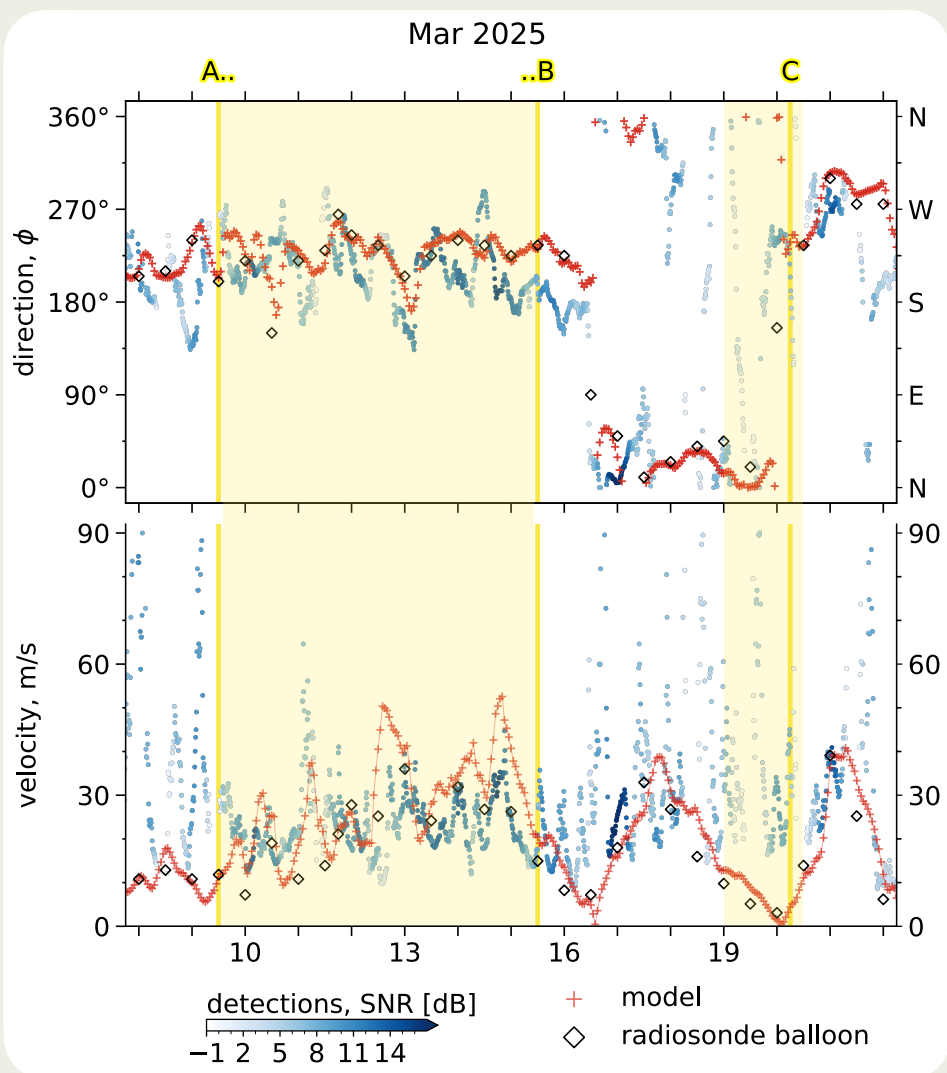
Model and radiosonde balloons

WE COMPARE DETECTIONS;

- > with ERA5 winds in the column directly above IS26.
- > with radiosonde soundings launched 170 km west of IS26



Comparison to model and radiosonde balloons at 250 hPa (~10 km)



A.. - ..B:

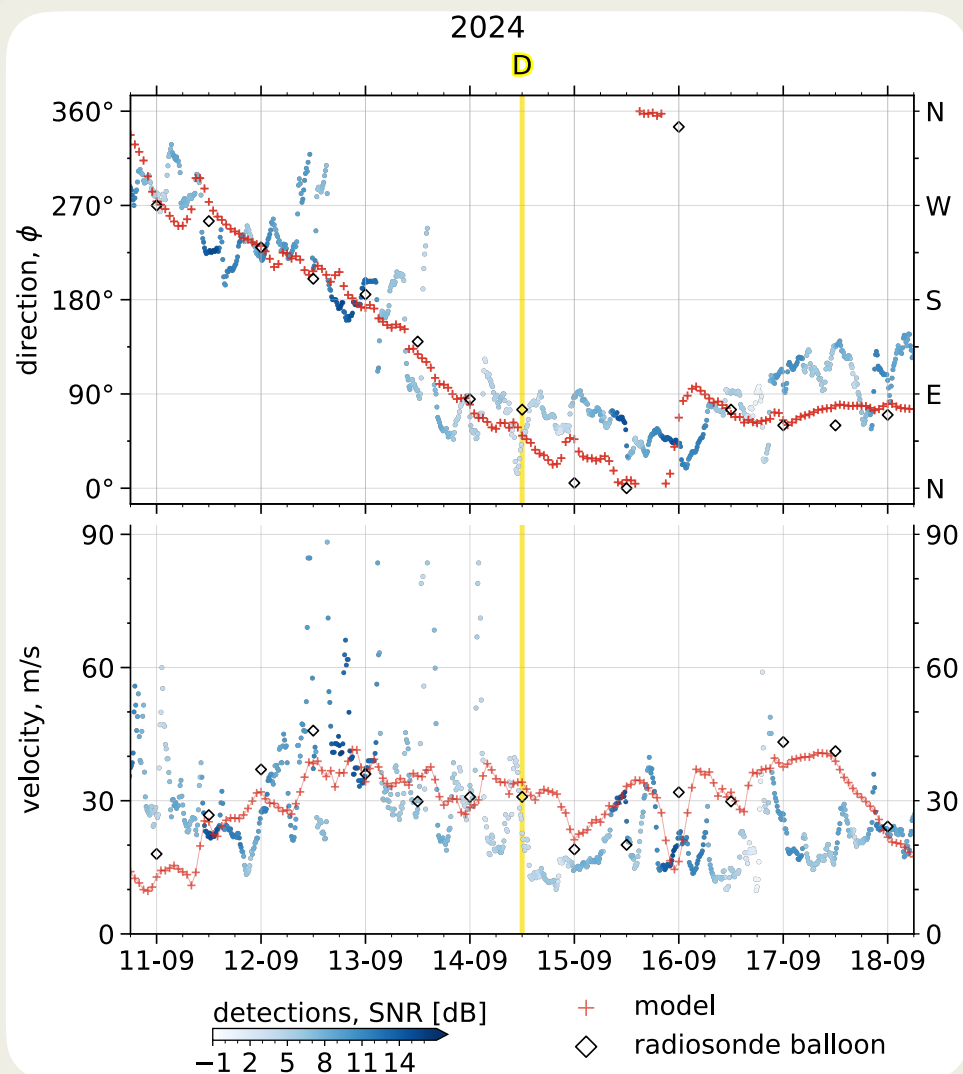
In periods of **more wind at jet height**, the **direction** of the detected gravity waves **corresponds** to the model and balloon measured winds.

C:

When **wind speeds are low**, there is barely any relation between observations and ERA5 model / balloons.

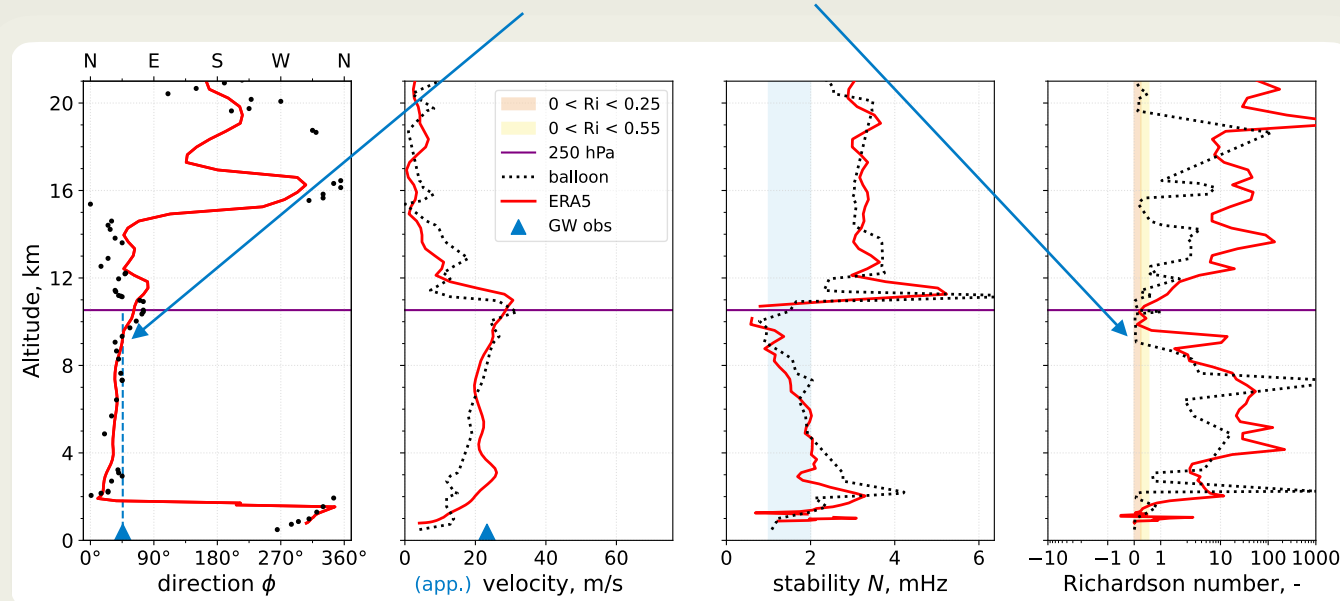
We do not correct for incidence angle here, therefore overestimation of velocity by detections is expected.

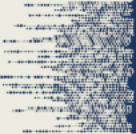
Gravity wave source mechanism: shear instability



This can happen when the **Richardson number** is in the critical range of 0 - 0.25.

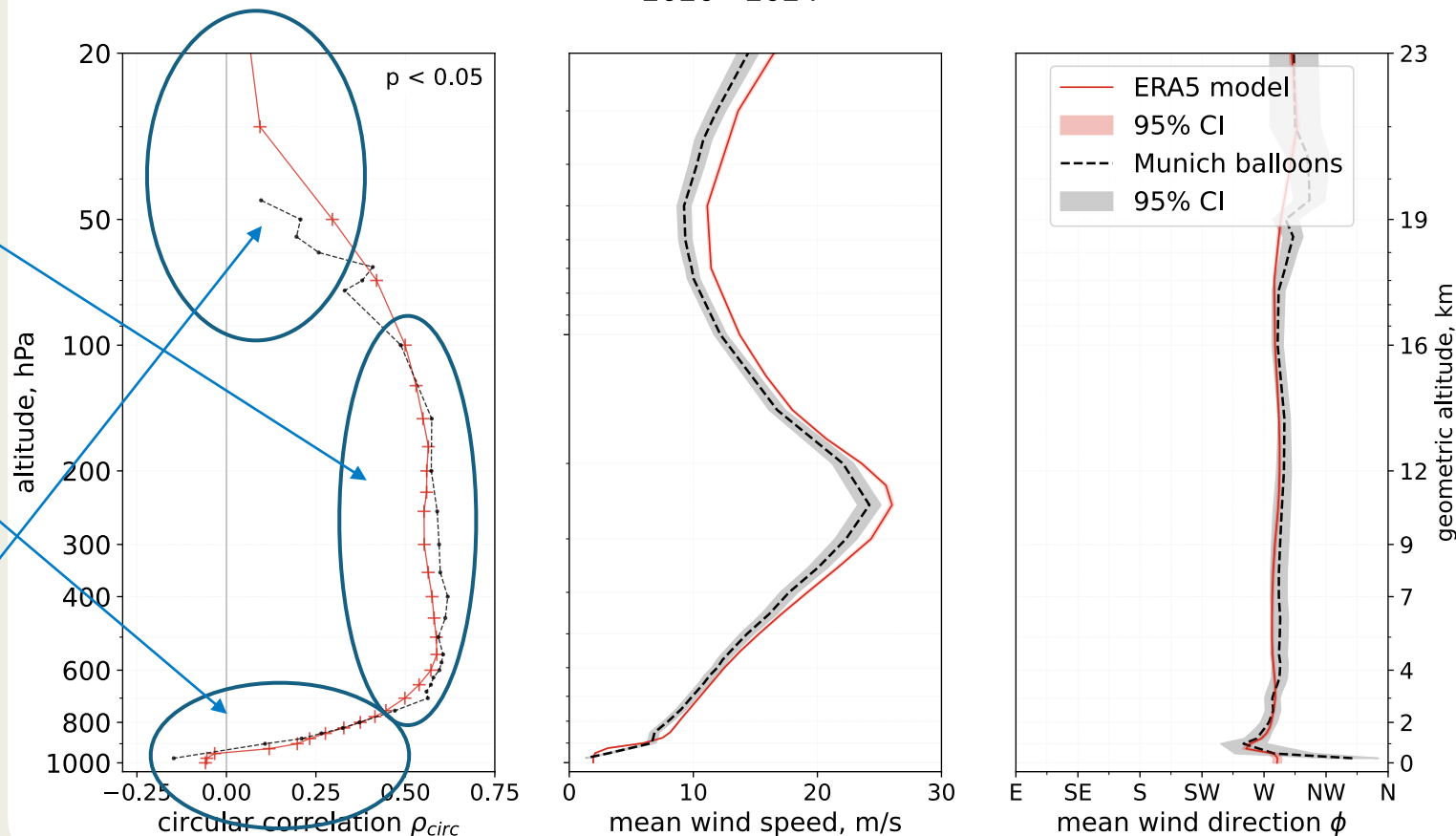
D: a layer of critical Richardson number is present in the vertical profile between 9 and 11 km altitude.





Vertical profile climatology

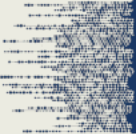
2020 - 2024



We find significant correlations between the **model/balloon** and the **detections** of gravity waves on the microbarometer array.

On the altitudes near the surface, there is no/weak directional relation between the surface based detections and the model.

Above ± 16 km, correlations decrease as well.



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Take home message

- > There is information on jetstream winds in **mesoscale gravity waves**.
- > Gravity waves at IS26 come mostly from the **westerly** sectors, with a **seasonal cycle**, shifting to more northerly directions in winter.
- > Throughout the upper troposphere, we find **significant correlations** between the **directions** of model/balloons winds and the surface based detections of mesoscale gravity waves.

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