First Insights to Planetary Wave Dynamics in the Project: **Lidar Measurements to Identify Streamers and Analyze Atmospheric Waves (LISA)** (Aeolus+Innovation)

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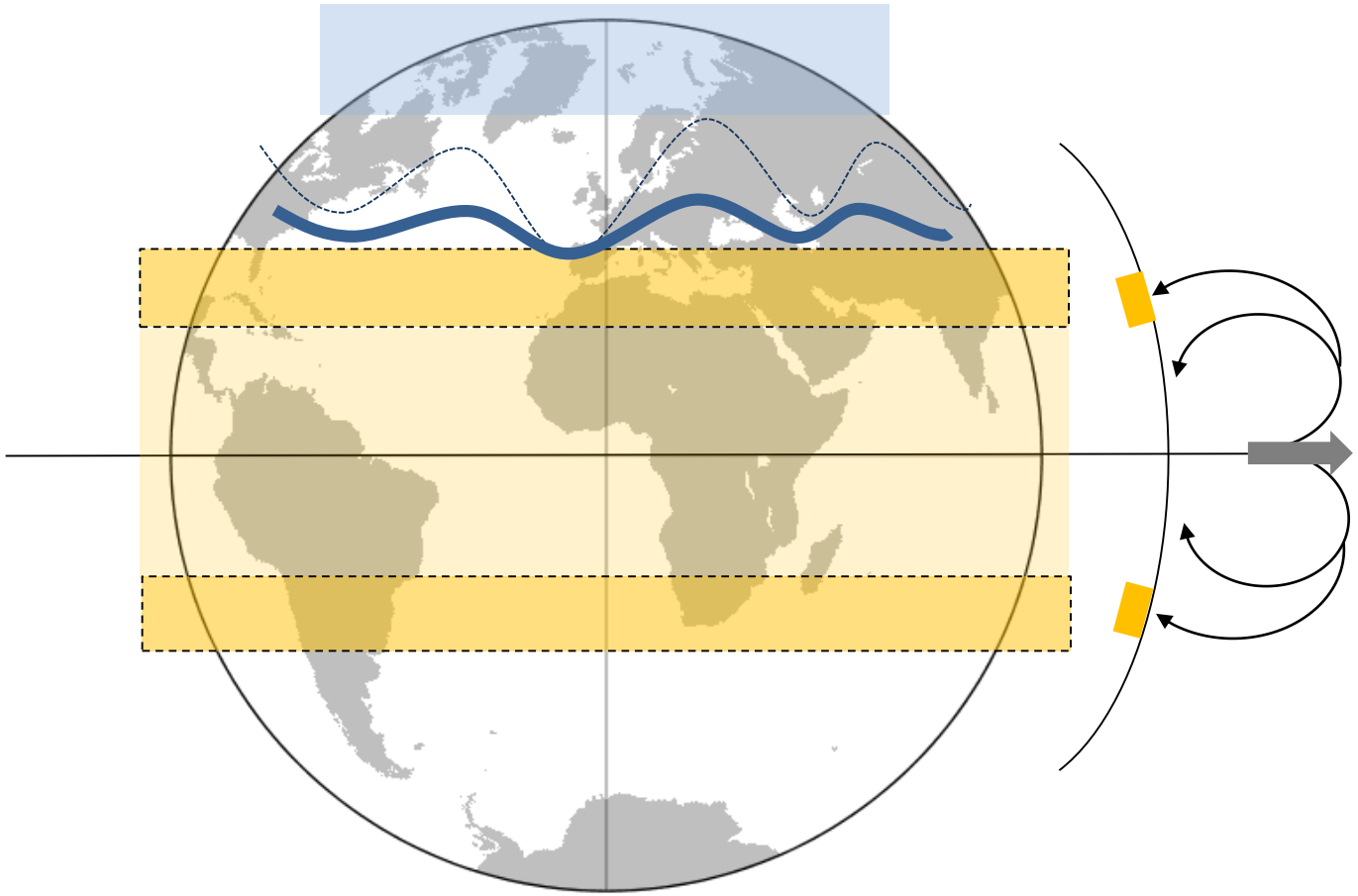
Climate change will affect atmospheric dynamics



Disproportial warming at the North Pole
Serreze et al. 2009, Cohen et al. 2014

Polward shift of storm tracks,
Increase of blocking events, weakening of zonal winds
Francis & Vavrus 2012, Bender et al. 2012, Archer and Caldeira 2008

propagation of dry regions into the subtropics
Sousa et al. 2011; Hoerling et al. 2012

Climate change leads to changes of our circulation system we are not adapted

Wind 200 hPa

PW are the main drivers of the large-scale weather patterns of the mid-latitudes.

Breaking of PW leads to large-scale tongue-like structures (streamer events) and cut-offs of air masses, such as high- or low pressure cells.

Poleward breaking PW lead airmasses into the higher latitudes. Such streamer events are considered in the project.

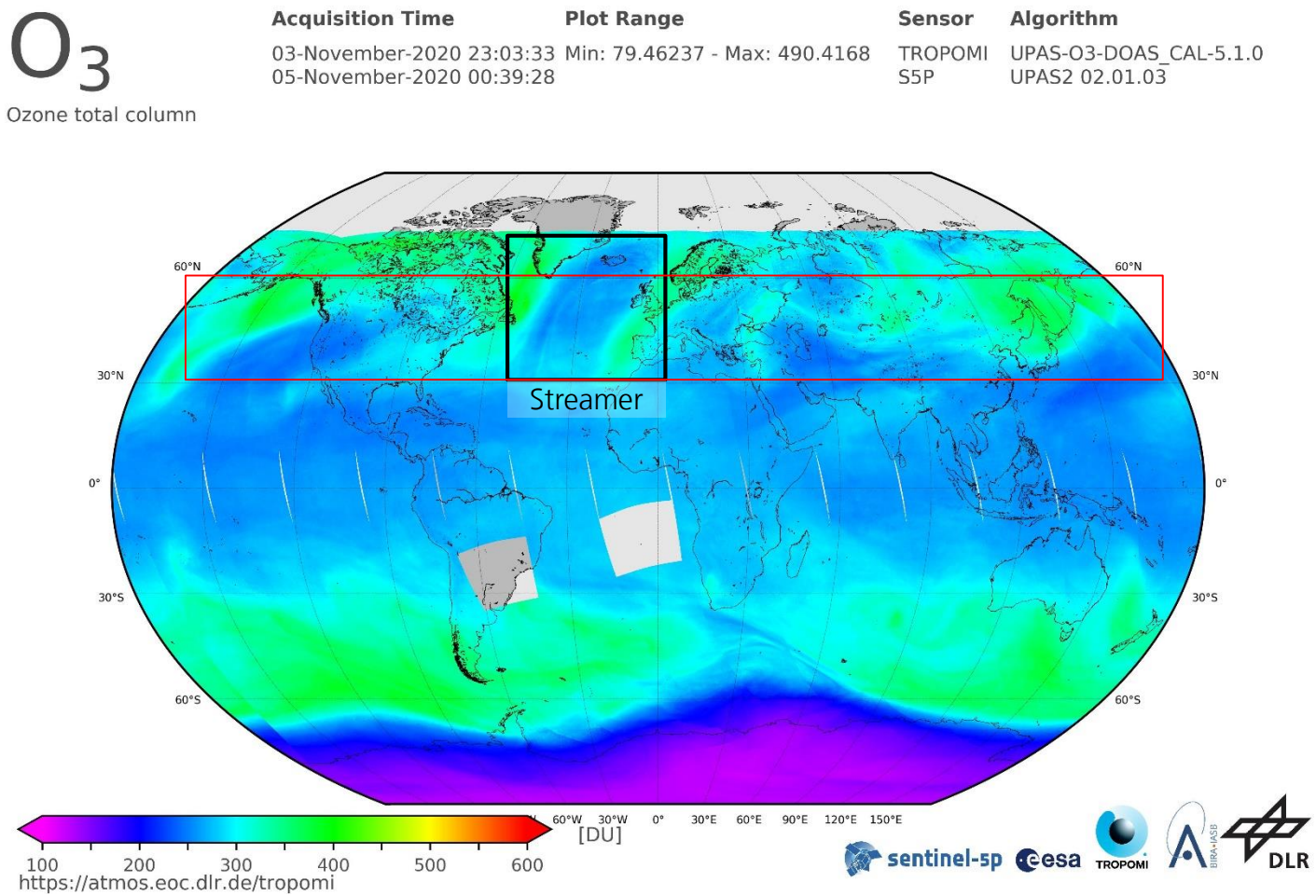
2020-11-01 00:00:00 UTC

Streamer events in TO3

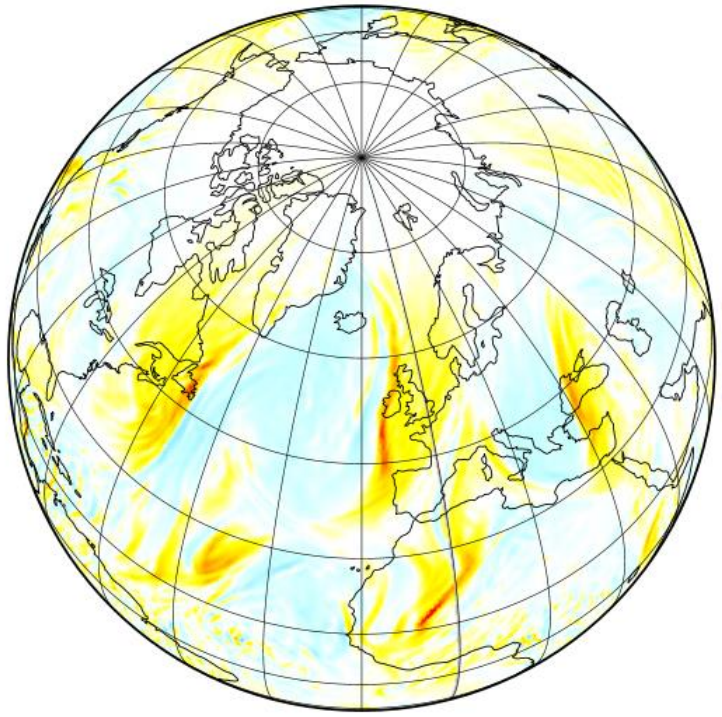
Streamer events

PW dominate the meridional Brewer-Dobson circulation in the stratosphere and thus the large-scale mass transport of ozone.

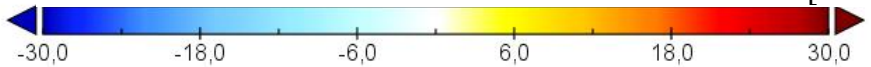
Due to poleward breaking PW air masses with low ozone concentration are mixed into the mid-latitudes.



Gravity waves at the flanks of streamers



First order difference of meridional wind in zonal direction $[ms^{-1}/m]$



- Link between poleward breaking planetary waves exciting gravity waves (Zülicke & Peters 2008)
- Observations of anticyclones which excite GWs (e.g. Kramer et al, 2015, 2016)
- Substantial deviation between the model and observation due to wave links across scales (Hocke et al. 2017)
- Aeolus uniquely enables studies of waves at different scales in detail.

↪ Exact identification of the source regions and quantification of the different wave parameters (period, wavelength, amplitude) required.

Project idea and main goals

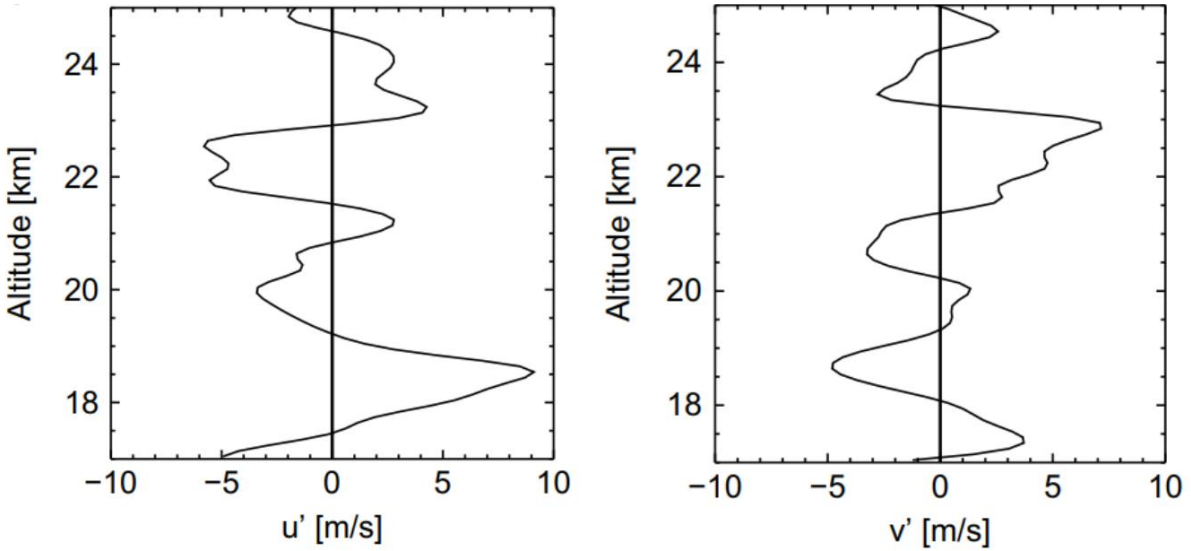
Excitation of gravity waves

Derivation of GW activity by vertical wind profiles
& GW activity at the ground (microbarographs)

Acoustic gravity waves

observations in the troposphere and ionosphere:

- easier than direct observations in the stratosphere.
- allow a cross-check of the temporal evolution of the kinetic wave energy density.



Zonal and meridional wind perturbations from radiosonde measurements derived at Palma de Mallorca, Spain, on 12th December 2011 (Kramer et al. 2015)

Project idea and main goals

Characterization of the dynamical situation of the atmosphere with respect to streamer events by Aeolus measurements

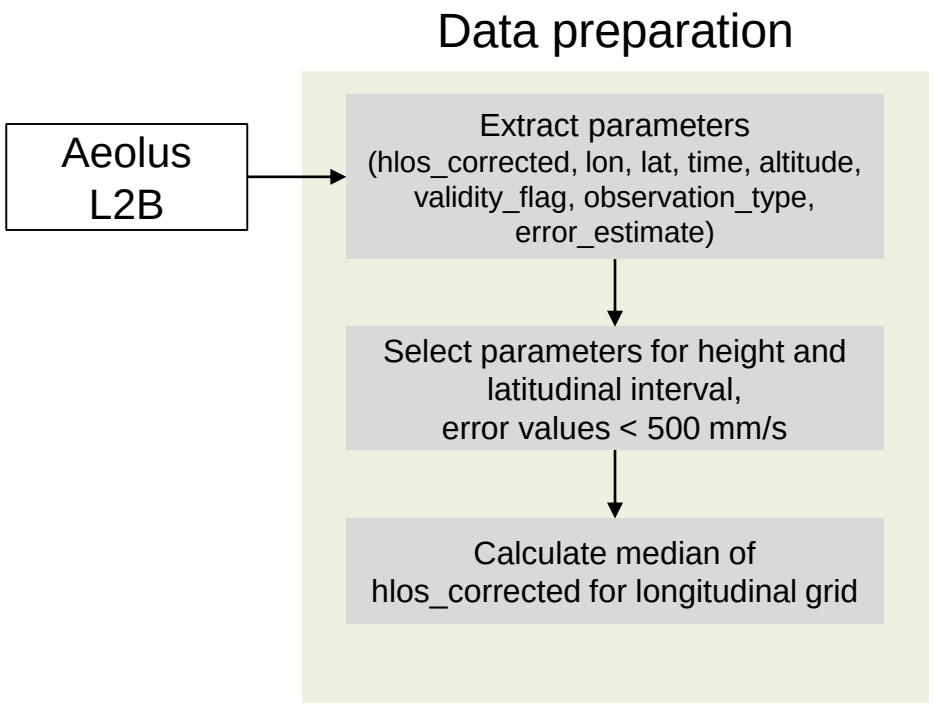
Streamer events

Product I	*Product II*	*Product III*
Lead to strong wind gradients	Planetary wave activity	Kinetic energy density of gravity waves

Demonstration of the prototype products on selected test cases

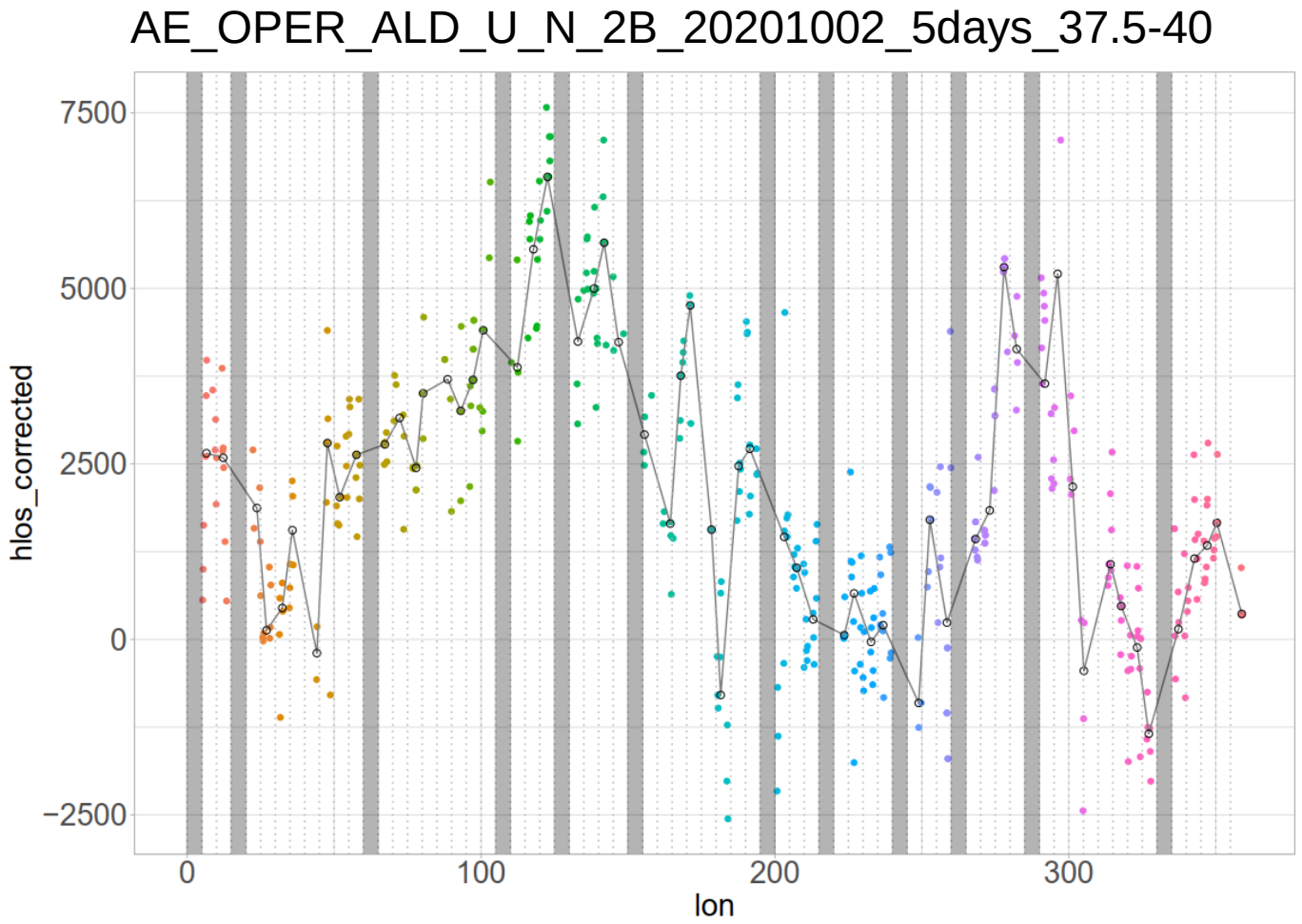
Comparison of Aeolus wind measurements with ERA5 Reanalysis data

Prototype Product II: Calculation of Dynamical Activity Index (DAI)

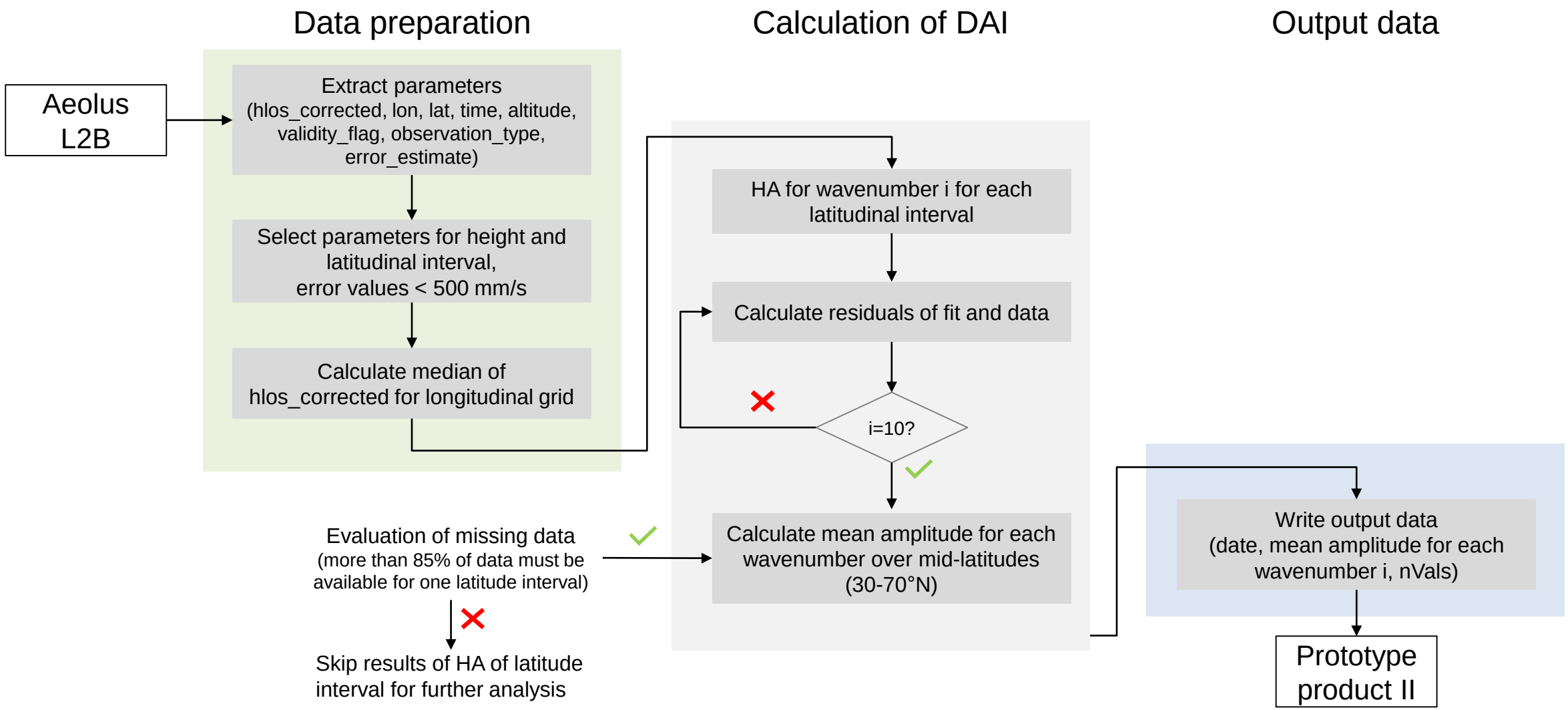


Prototype Product II: Calculation of Dynamical Activity Index (DAI)

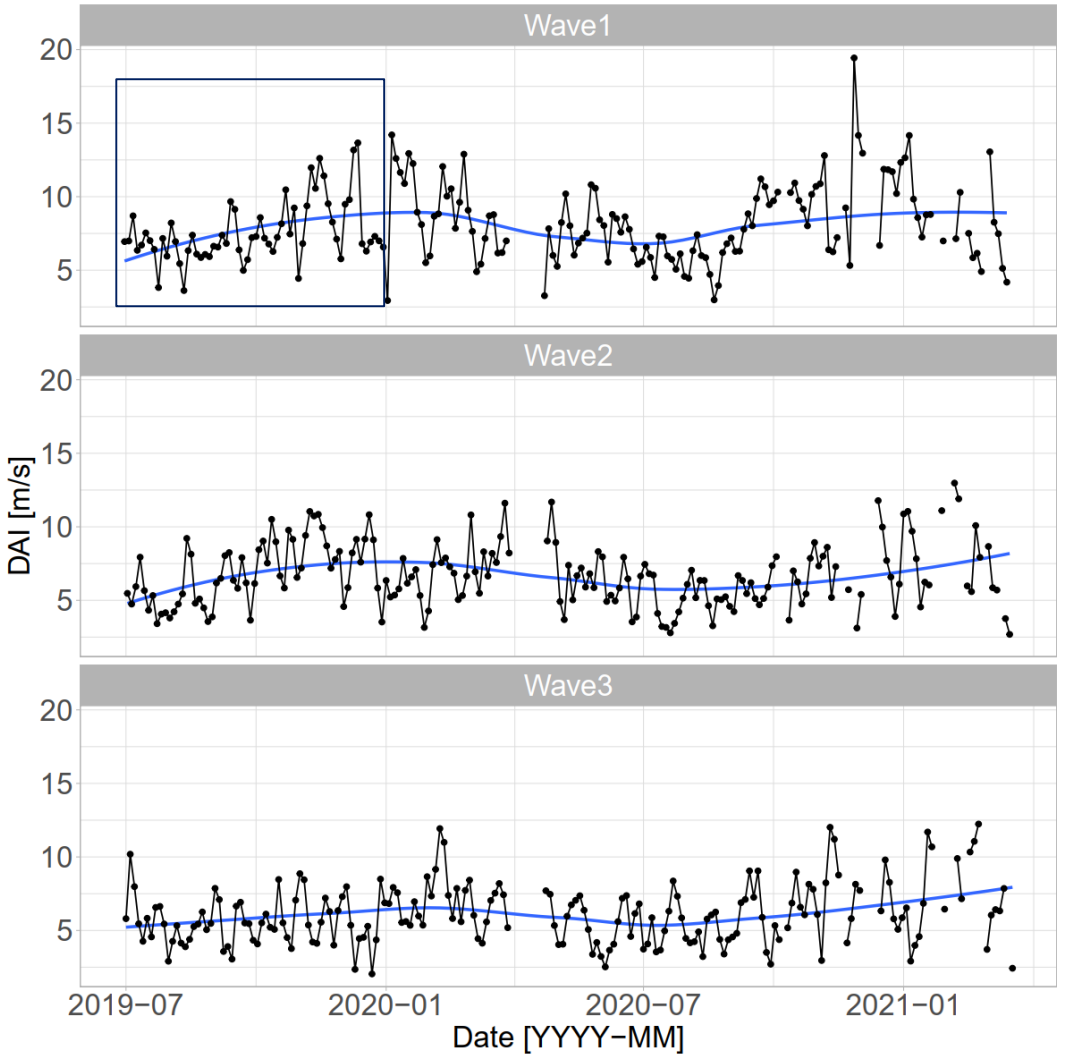
- Aeolus data integrated over **5 days**
- **Median** hlos_corrected is calculated on equidistant lon, lat grid (black circle)
- If no median hlos value is available in grid **NaN values** are created (grey shade)
- If more than 85% of data along longitudes is missing, latitudinal band is skipped
- Residuals of all median hloc_corrected values in HA.



Prototype Product II: Calculation of Dynamical Activity Index (DAI)



Prototype Product II: First preliminary results of DAI
9.5 to 10 km

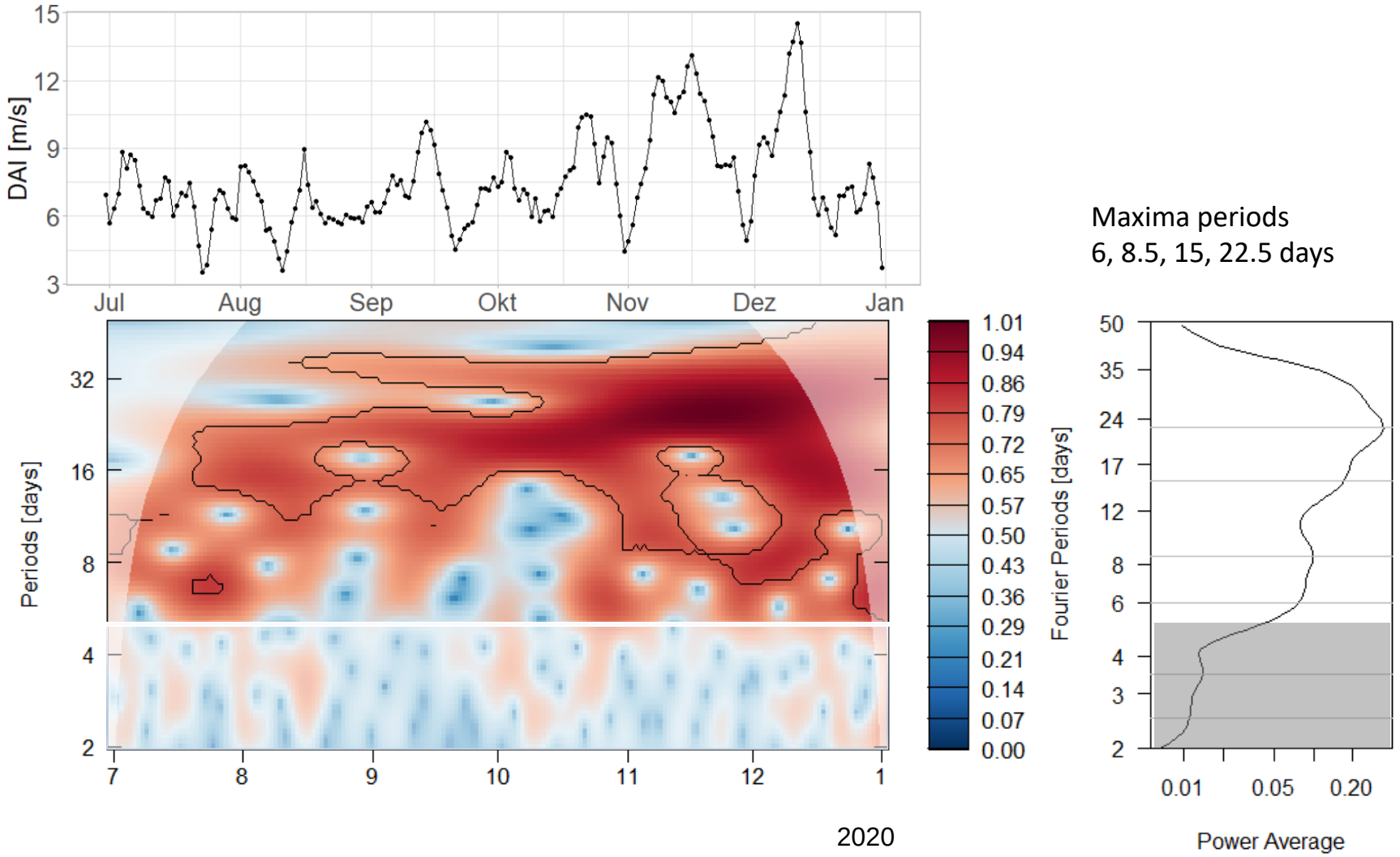


Waveletanalysis of Aeolus-DAI (5 days)

R WaveletComp with significance level 85%

- DAI consists of typical periods of planetary waves (>5 days)

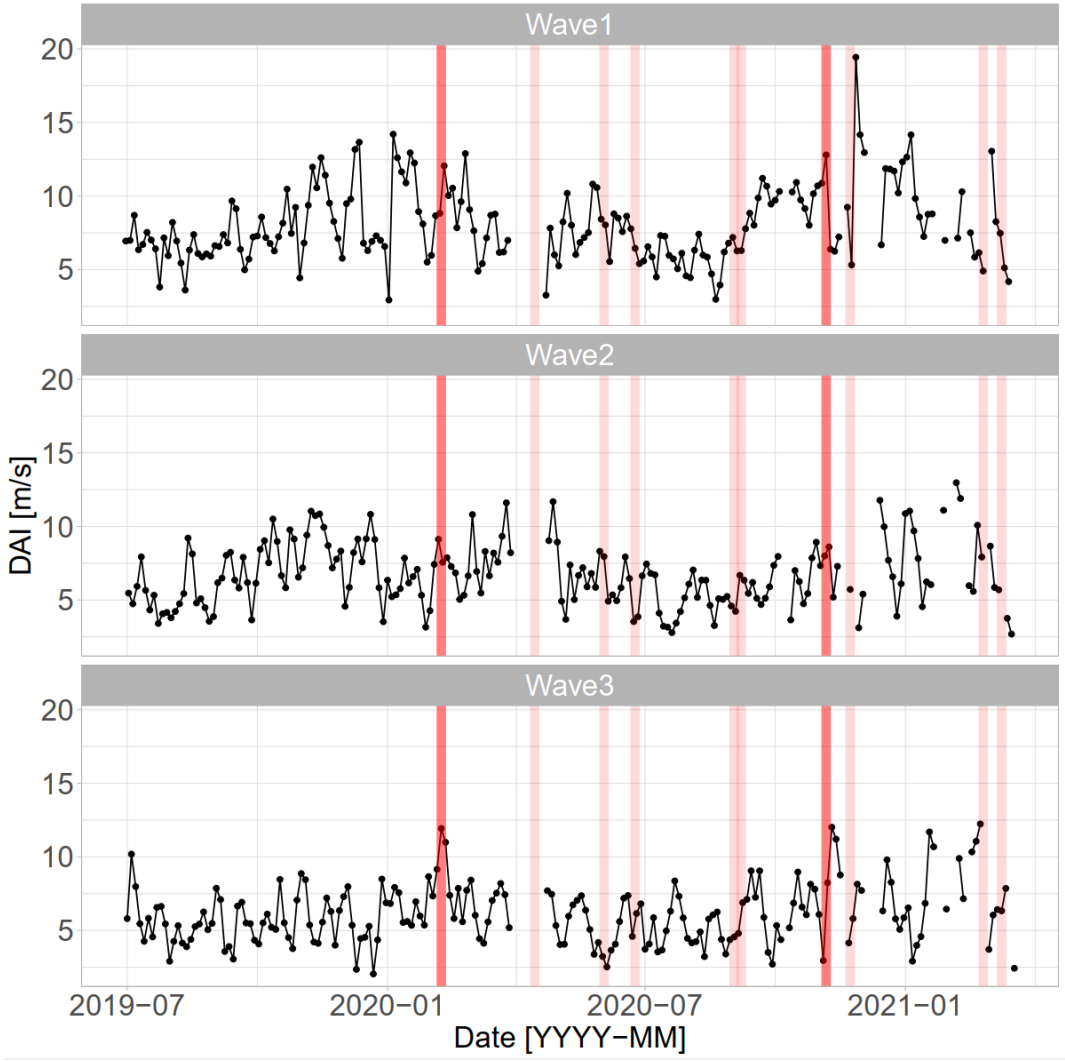
➢ Reasonable measure for planetary waves



Maxima periods
6, 8.5, 15, 22.5 days

Prototype Product II: First preliminary results of DAI
9 to 10 km

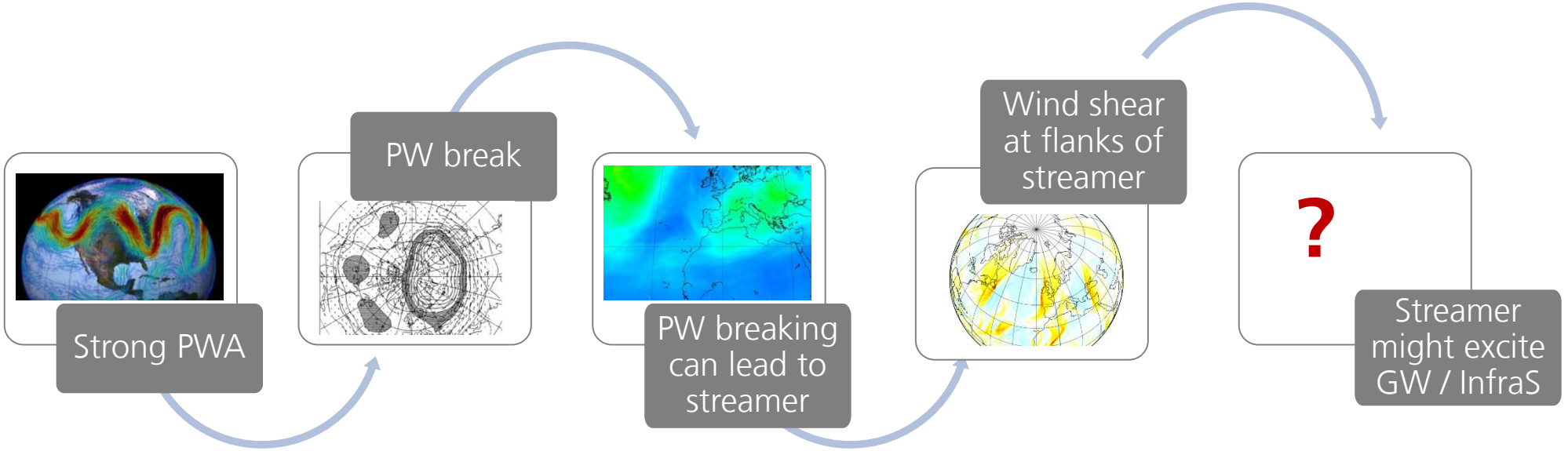
red: streamer events



Summary & Outlook

Characterization of the dynamical situation of the atmosphere with respect to streamer events by Aeolus measurements

Aeolus helps to **characterize PW breaking**



Aeolus helps to **characterize GW** in relation to streamer events

1. Wave excitation over Atlantic, where wind measurements are still sparse
2. Good resolution to study GW