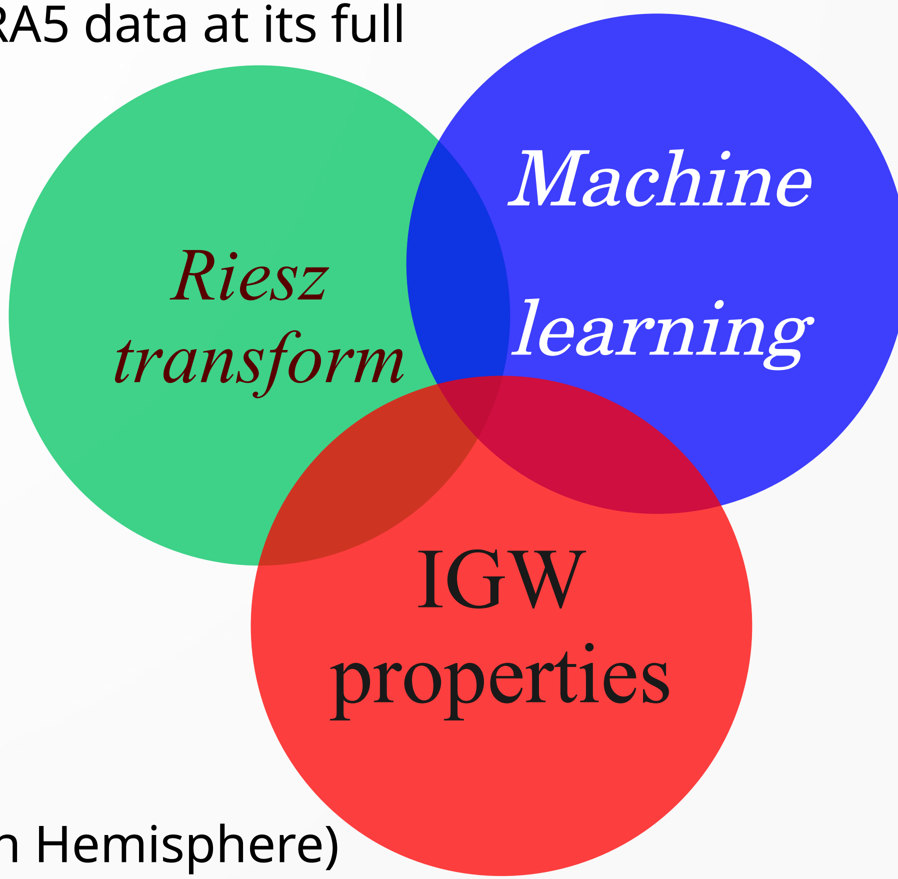
Main idea: *Estimation of wave characteristics at the launch level*

1 . To retrieve the wavenumber using the Riesz Transform from ERA5 data at its full resolution (the generalized form of the Hilbert Transform; Schoon and Zülicke, 2018)

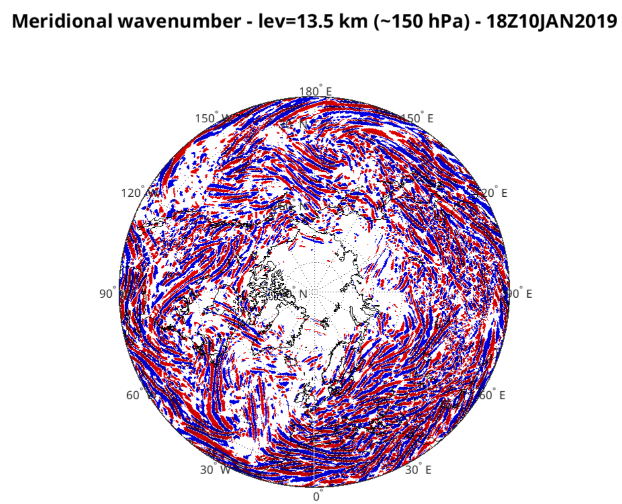
2 . To relate the high-res meso-scale wave properties (Mirzaei et al, 2014) to coarse-grained resolvable variables at the launch level (Amiramjadi et al, 2019)

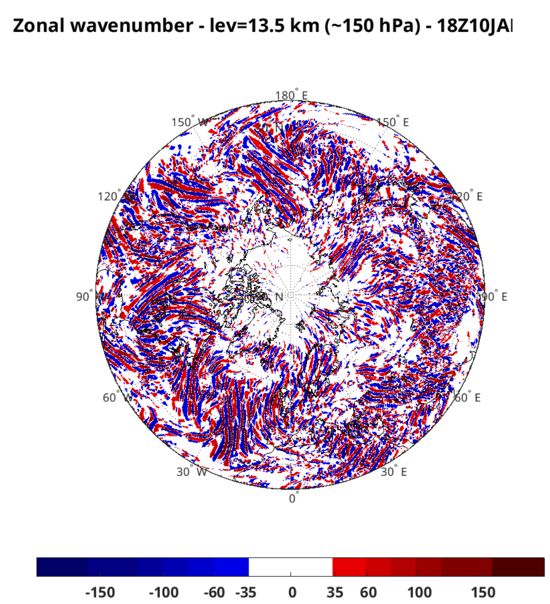
3 . Avoiding mountain waves and focusing on non-orographic

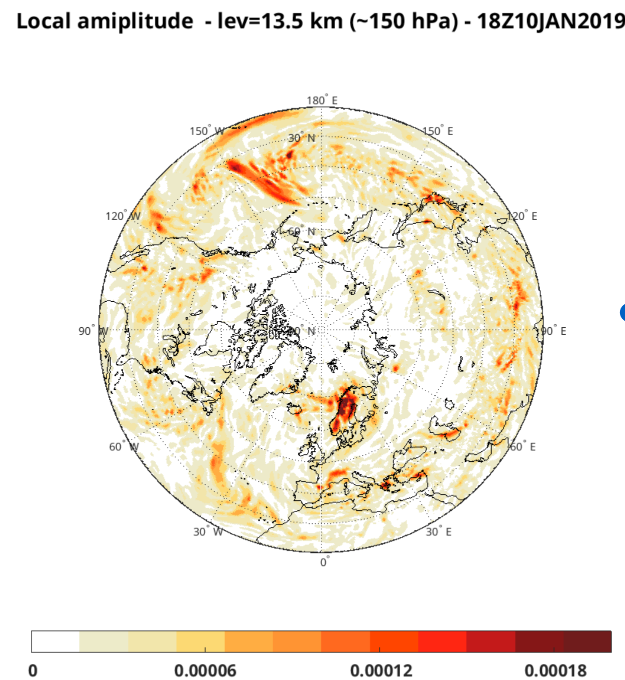
4 .Time: December 2018 to February 2019 (winter time of Northern Hemisphere)
Area: Midlatitude of Northern Atlantic and Pacific Oceans

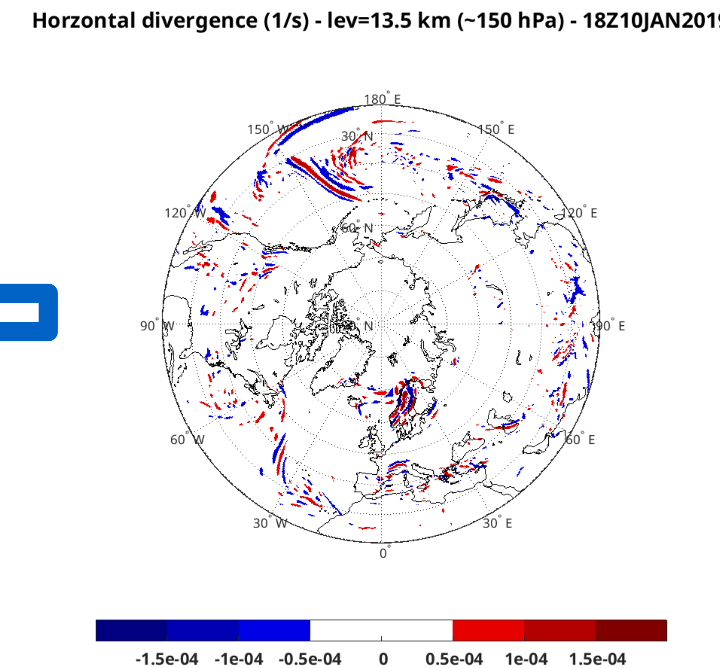


Application of Riesz Transform: Generalized from of Hilbert Transfrom in multi-dimensional analysis







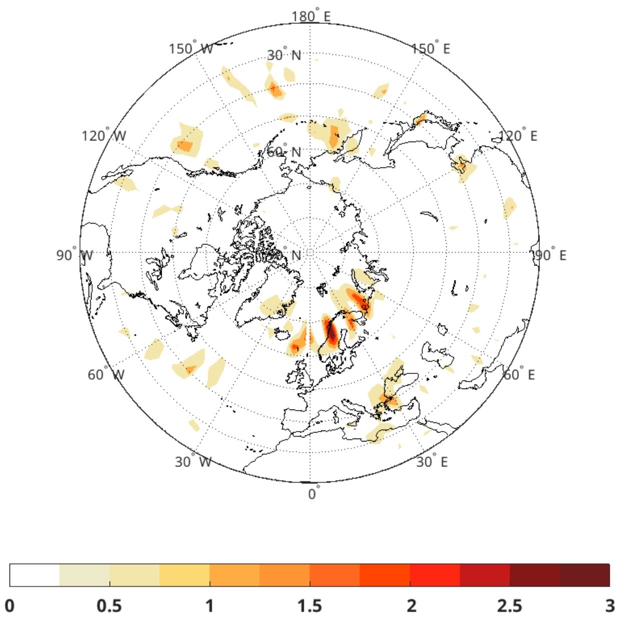


High resolution ERA5:

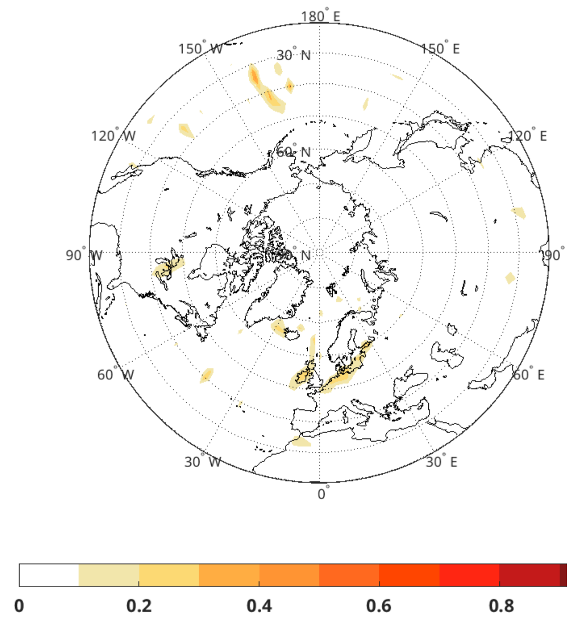
$$Horizontal\ resolution: 0.25^\circ \times 0.25^\circ$$
$$Vertical\ resolution: 500\,m$$

Diagnostics at the lunch level

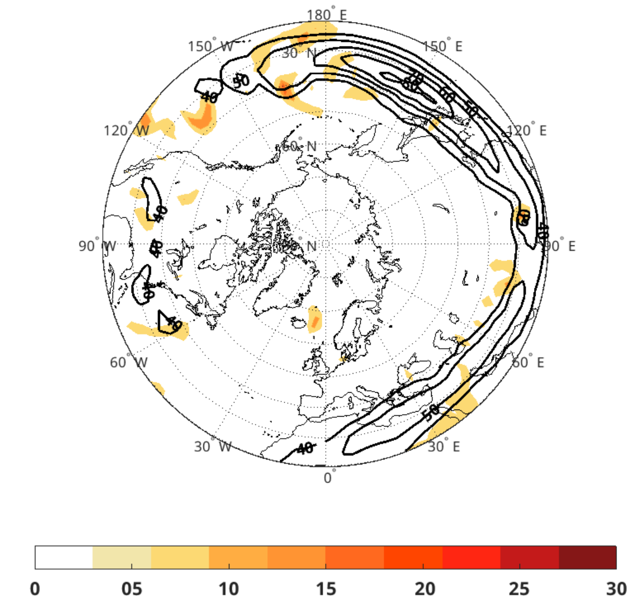
Latent heat released during condensation(K/h)
lev=13.5 km (~150 hPa) - 18Z10JAN2019



frontogenesis function (K/(100 km h))
lev=13.5 km (~150 hPa) - 18Z10JAN2019



Cross-stream ageostrophic wind speed (shaded, m/s) and
horizontal wind speed (contours, wind > 40 m/s)
lev=13.5 km (~150 hPa) - 18Z10JAN2019



Coarse-grained ERA5: $Horizontal\ resolution: 2.5^\circ \times 2.5^\circ$

Machine learning: Data preparation and model setup

Data preparation:

1. To normalize non-normal explanatory variables and target using natural logarithm function

2. To keep the values greater than thresholds:

$$u_a > 1\, m s^{-1}, \quad F_{front} > 0.15\, K\, (100\, km)^{-1} h^{-1}$$

$$q_{conv} > 0.3\, K\, h^{-1}, \quad k_h > 35$$

3. Each set o data must contain at least one diagnostic variable and non-zero target

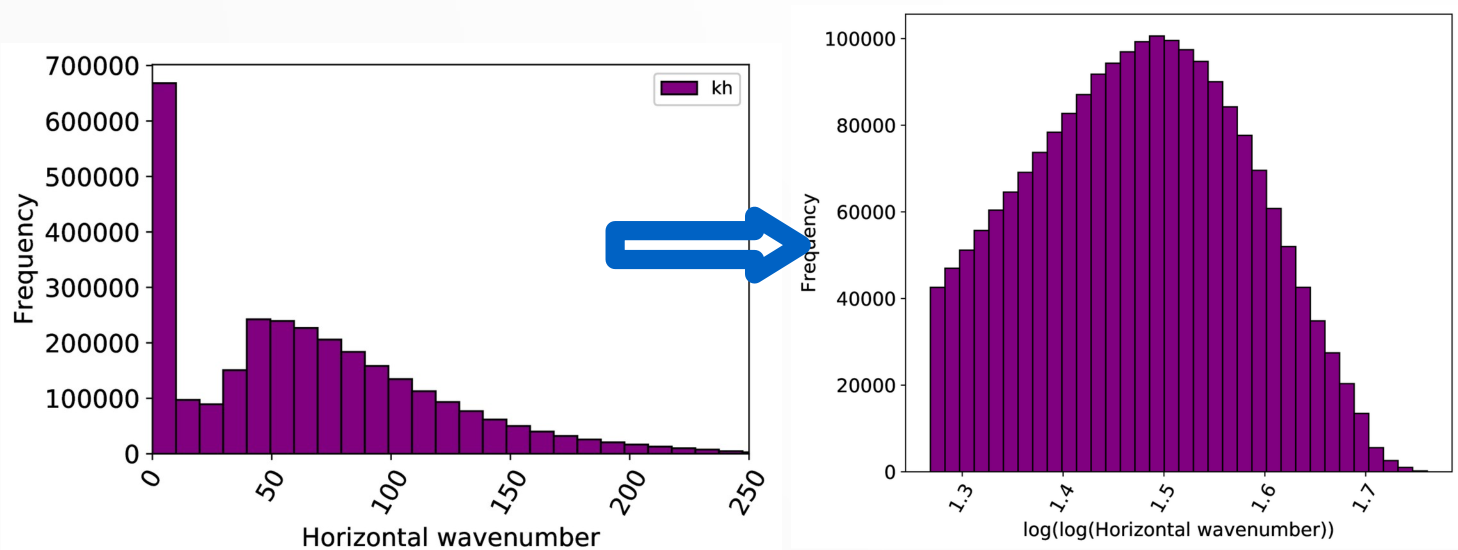
Model setup:

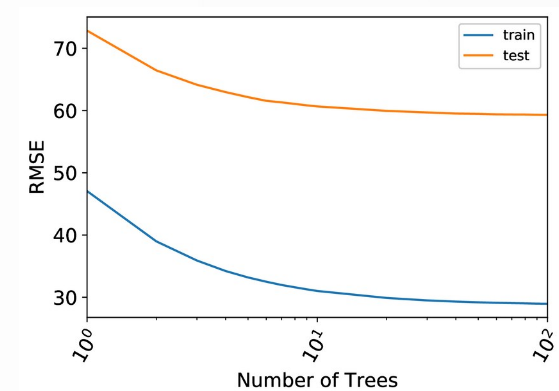
To optimized the model (Random Forest) performance by setting the tunable parameters to minimized the errors (RMSE):

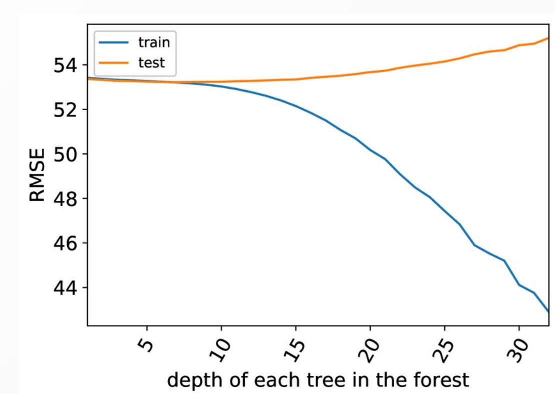
Number of trees in the forest: 30

Depth of each tree in the forest: 7

Other parameters have been set as their defaults.







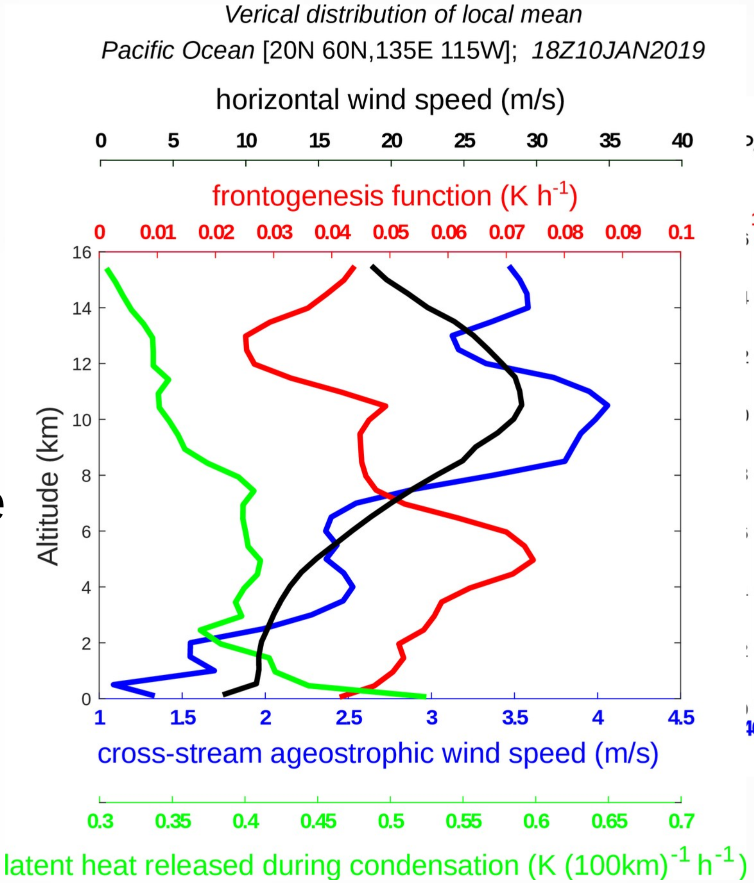
Result and conclusion

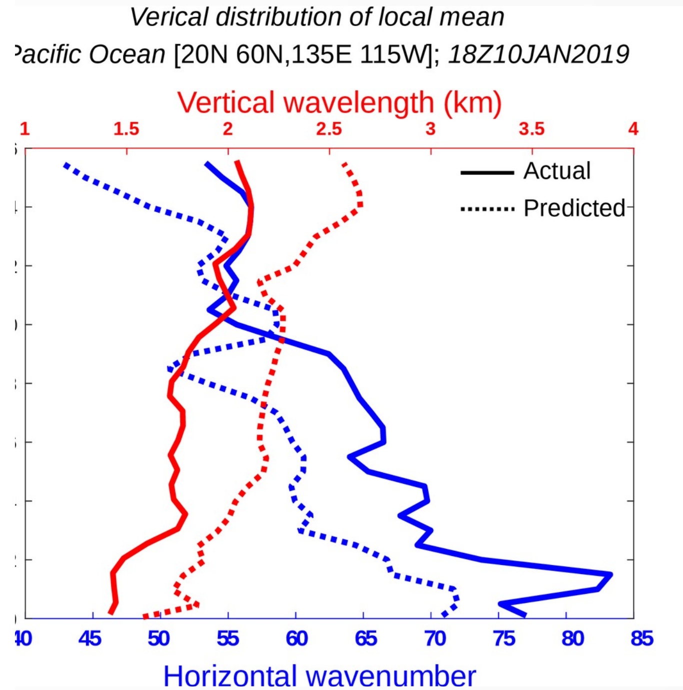
* Results of the application of Riesz Transform are comparable with the results by Schoon and Zülicke (2018).

* Correlation coefficient between the actual and the reconstructed wavenumbers is about 0.6 on the average.

* Geometric mean bias is about 0.86 on the average which means the model somehow underestimates the target.

* Initial results are positive and promising despite the horizontal and vertical wave propagation given that it reconstructs wave properties at the lunch level.





References:

Mirzaei, M., Zülicke, C., Mohebalhojeh, A. R., Ahmadi-Givi, F., & Plougonven, R. (2014). Structure, energy, and parameterization of inertia–gravity waves in dry and moist simulations of a baroclinic wave life cycle. *Journal of the Atmospheric Sciences, 71(7), 2390-2414.*

Schoon, L., & Zülicke, C. (2018). A novel method for the extraction of local gravity wave parameters from gridded three-dimensional data: description, validation, and application. *Atmos. Chem. Phys., 18, 6971–6983.*

Amiramjadi, M., Plougonven, R., Hertzog, A., Mohebalhojeh, A. R., & Mirzaei, M. (2019, January). Using machine learning to estimate Inertia-Gravity Waves properties from a coarse-grained description of the flow. *In Geophysical Research Abstracts (Vol. 21).*