

# Evaluating microbarom source models using infrasound recorded on a stratospheric balloon

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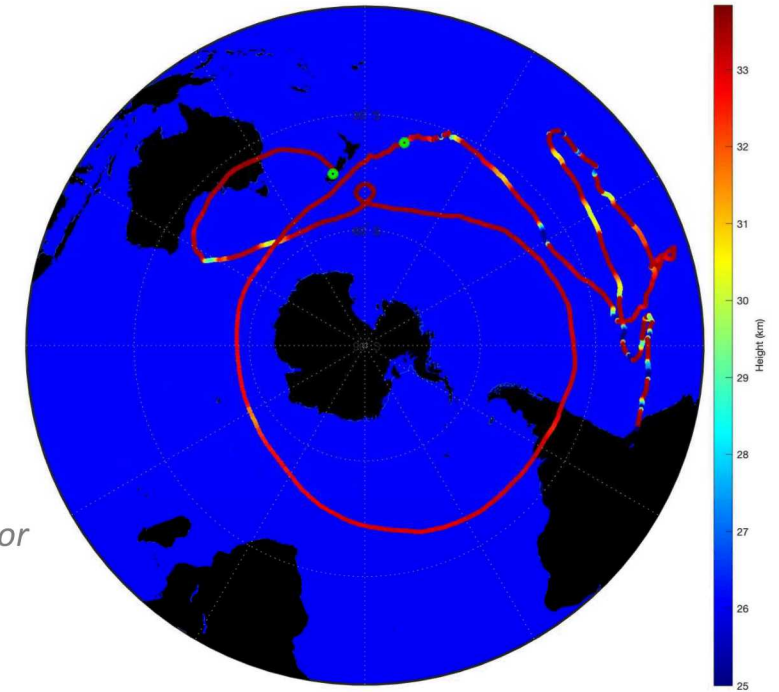
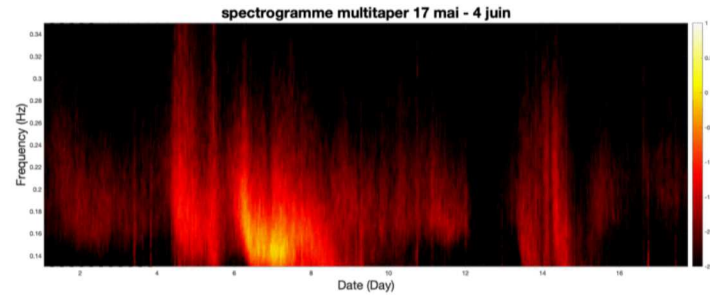
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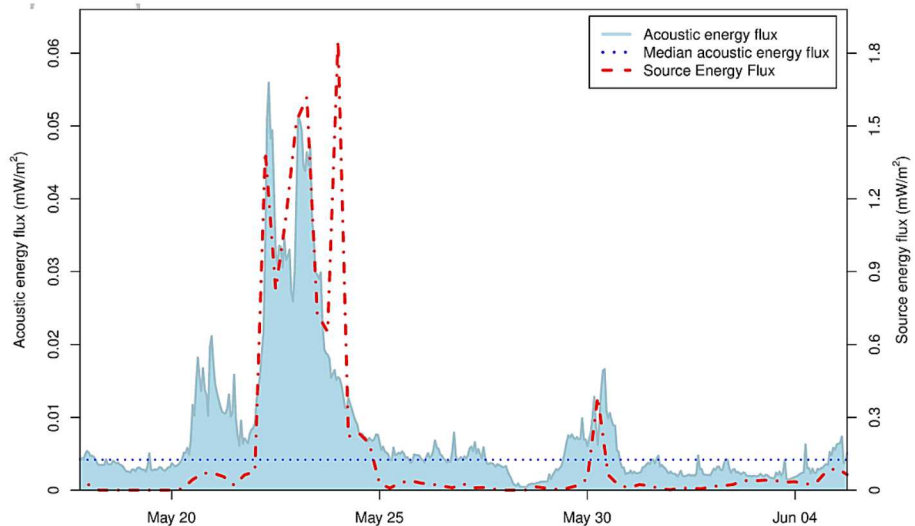


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- ❑ Microbaroms continuously generated by ocean wave interactions around 0.2 Hz
- ❑ NASA Ultra Long Duration Balloon (ULDB)
  - Data recorded: from May 16<sup>th</sup> to June 5<sup>th</sup> 2016
  - Around the peri-antarctic belt
- ❑ Bowman and Lees 2018
  - Comparison between observations and model
  - Wave model: ECMWF
  - Source model: Waxler et al. 2007



ULDB trajectory  
(with altitude color coded)



### Motivations for the study:

- New source model (*De Carlo et al, 2020*) depending on the elevation angle : high bathymetry dependency for elevation angle up to 13° from the vertical
- Looking for enhancement in the modeling with this new source
- Evaluate the influence of different parameters

From Bowman & Lees, 2018 : Upper atmosphere heating from ocean-generated acoustic wave energy, *Geophys. Res. Lett.*, doi:10.1029/2018GL077737

## How to model the acoustic flux energy at the balloon?

Wave Model

+

Source Model

+

Propagation Model

=

Energy modelled

$$E_b = \sum_{i \in N} \int_f \underbrace{\int_{\theta_i} C(\theta_i, f) d\theta_i}_{\text{Source model}} \times \underbrace{H_i(f)}_{\text{Wave Model}} df \times att_i$$

$N$  : Number of sources,  $C(\theta_i, f)$  : Coefficient of the bathymetry impact,  
 $H_i(f)$  : Hasselman integral,  $att_i$  : Attenuation for the cell  $i$ .

(Bowman & Lees, 2018)

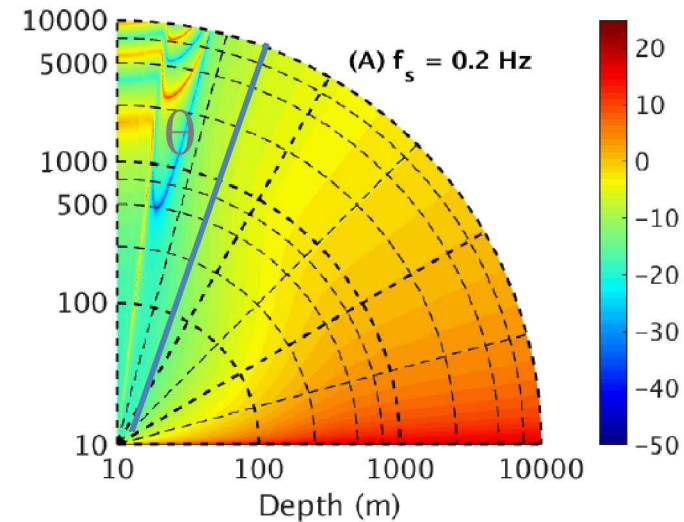
Model 0 : ECMWF Wave Model + Source model =  $C(f)$  + No Propa

Model 1 : WW3 Wave Model + Source model =  $C(f)$  + No Propa

Model 2 : WW3 Wave Model + Source model =  $\int_0^{90} C(\theta, f) d\theta$  + No Propa

Model 3 : WW3 Wave Model + Source model =  $\int_{\theta_{i,1}}^{\theta_{i,2}} C(\theta_i, f) d\theta_i$  + No Propa

Model 4 : WW3 Wave Model + Source model =  $\int_{\theta_{i,1}}^{\theta_{i,2}} C(\theta_i, f) d\theta_i$  +  $1/R$  attenuation

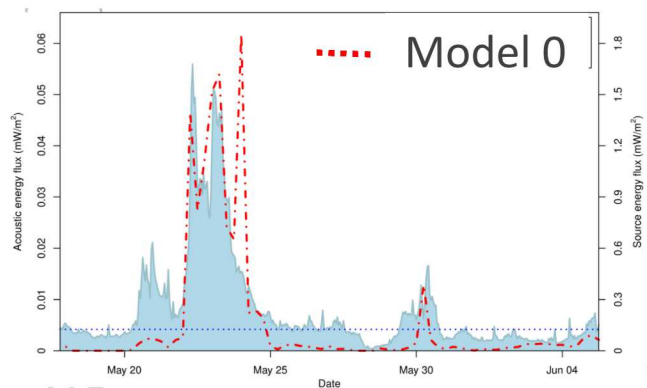
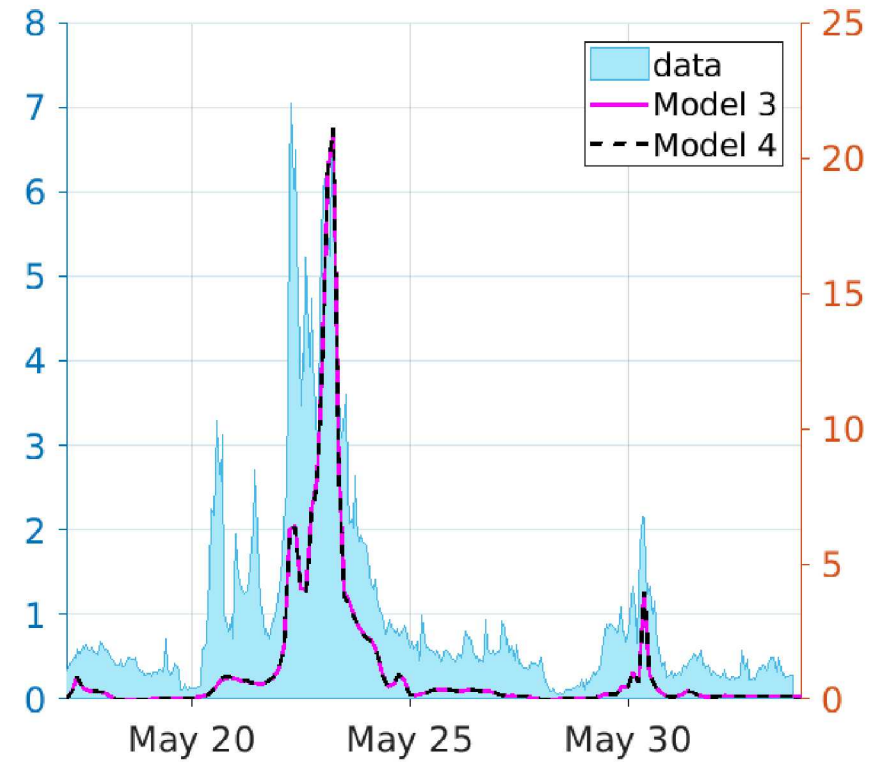
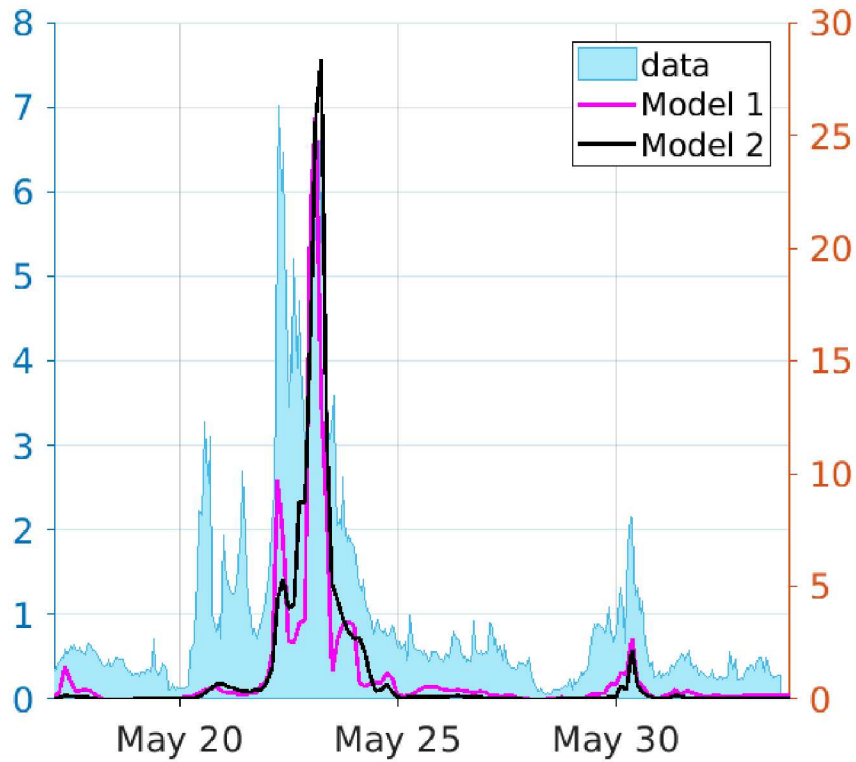


Radiation pattern at 0.2 Hz. Polar representation against the angle  $\theta$  and the depth (according to Eq. 41 from De Carlo et al., Geophys. J. Int., 2020, <https://doi.org/10.1093/gji/ggaa015>)

### Key numbers for calculation:

- frequencies : **0.13 - 0.35 Hz**
- sources in a **100 km** radius circle above the balloon
- wave model: **3 hours**

Acoustic energy flux  
(mW/m<sup>2</sup>,  
relative  
amplitude)



- **Model 1 vs Model 0:** 1<sup>st</sup> and 3<sup>rd</sup> peaks in Model 0 driven by wave action model
- **Model 2 vs Model 1:** 1<sup>st</sup> and 3<sup>rd</sup> peaks smoothed, partly driven by high bathy impact
- **Model 2 vs Model 3:** almost no differences. Relative amplitude of 3<sup>rd</sup> peak decreases
- **Model 3 vs Model 4:** almost no differences

*From Bowman & Lees, 2018*

## Overview

- The ocean microbarom is a global phenomenon, involving multiple source regions at any time
- multiple source regions active at any given time Analyzing infrasound data from balloon-borne observation campaigns offers unique opportunities to evaluate ocean wave models and
- The main difference between Bowman & Lees 2018 and these results is the 3<sup>rd</sup> peak around May 23<sup>rd</sup> which decreases according to the data when the Wave Model WW3 is used
- The comparison between source models reveals that the 1<sup>st</sup> and 3<sup>rd</sup> peaks are partly generated by bathymetry effect (the difference between Model 1 and 2 is explain the bathymetry effect: Model 1 shows measurable effect)
- Accounting for the elevation angle has no significant impact on the modelled relative amplitude: except for the 2<sup>nd</sup> peak where the main source of microbaroms is located strictly under the balloon
- This work is still on-going so we are open to any suggestions !