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Infrasound monitoring for global climate model calibration: a two-way collaboration

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T1.1-P17

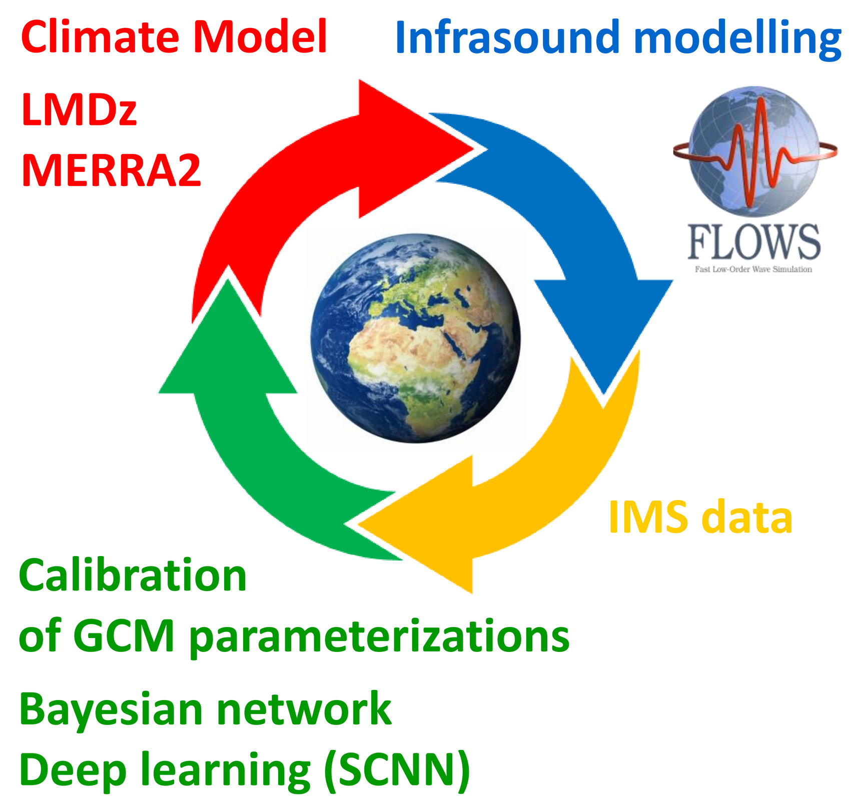
1. GLOBAL CLIMATE MODELS (GCMs), INFRASOUND AND GRAVITY WAVES (GWs)

The parameterization used in LMDz (similarly to most GCMs) assumes that each GW is launched in the troposphere at a fixed altitude. The question that naturally arises is: How the tunable parameters would change the middle climatology?

An answer can be given using the infrasound technology and IMS stations to propose alternative settings:

- LW (Long-Waves), which is the parameterization currently in use in the French Climate Model LMDz [1].
- SW (Short-Waves), which is the parameterization obtained using the FLOWS platform (CEA), and signals recorded at I37NO during the Hukkakero campaigns over five years (see T3.5-P39).
- SW² (vertically Weighted Short-Waves), which is a version of SW with sources specified using MERRA2 data.

Motivation: Use infrasound signals at the IMS stations, a GCM model (LMDZ), full-wave modelling (FLOWS) and SCNN [2] to improve our knowledge of the atmosphere.

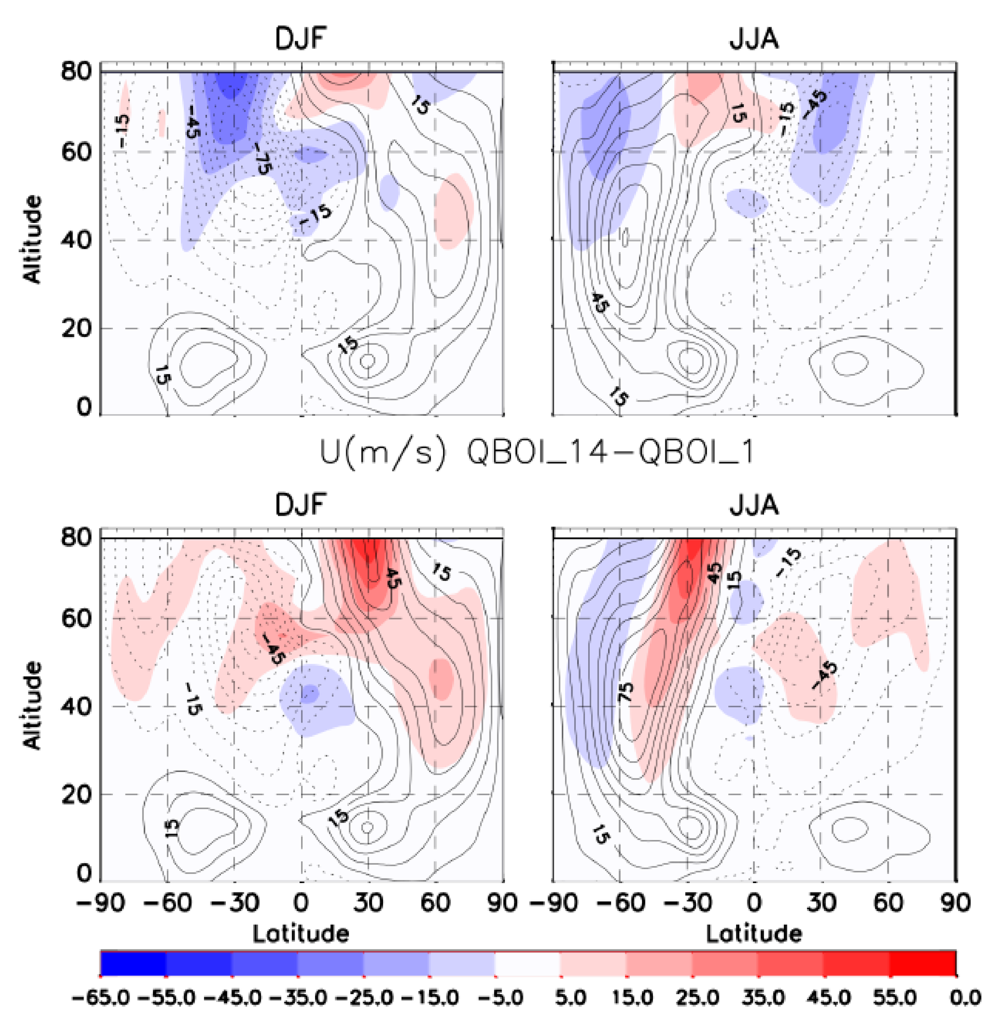


Each new data at IMS improve the climate simulations through supervised convolutional neural network (SCNN).

2. MID-LATITUDE CLIMATOLOGY AND STRATOSPHERIC VARIABILITY

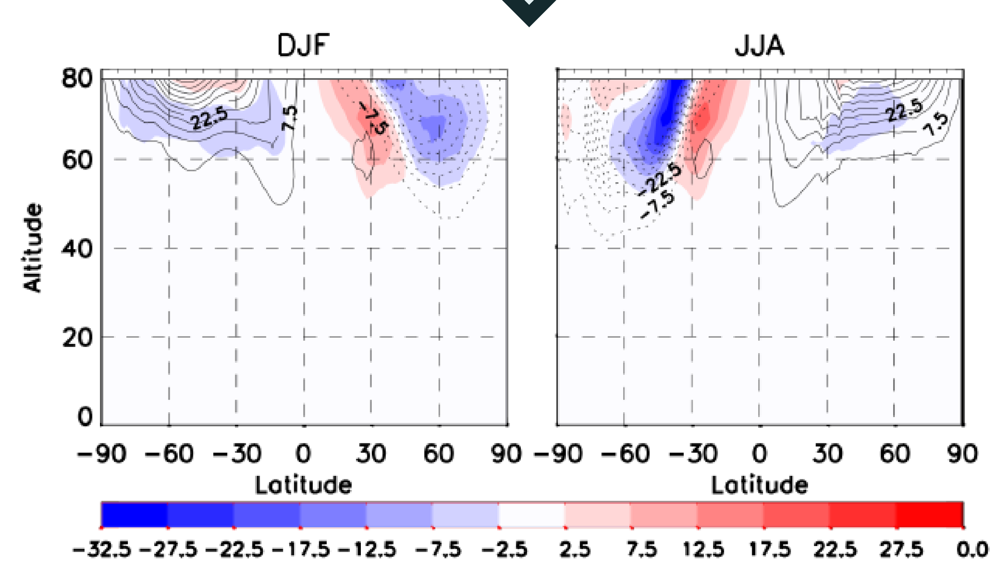
The performance of LW, SW and SW² are assessed using 15-years runs with LMDz. The simulations are forced with the observed mean seasonal cycle of sea surface temperatures. The new GW models produce:

- A displacement toward the poles of the negative drag region in the winter hemispheres.
- A weakening of the positive drag in the summer hemisphere.



Zonal wind profiles for SW-LMDz (top panels) and SW2-LMDz (bottom panels), with the color shading displaying differences with LW-LMDz.

Latitude-pressure cross section of discrepancies between zonal-mean GW drags (m.s^{-1}.day^{-1}).

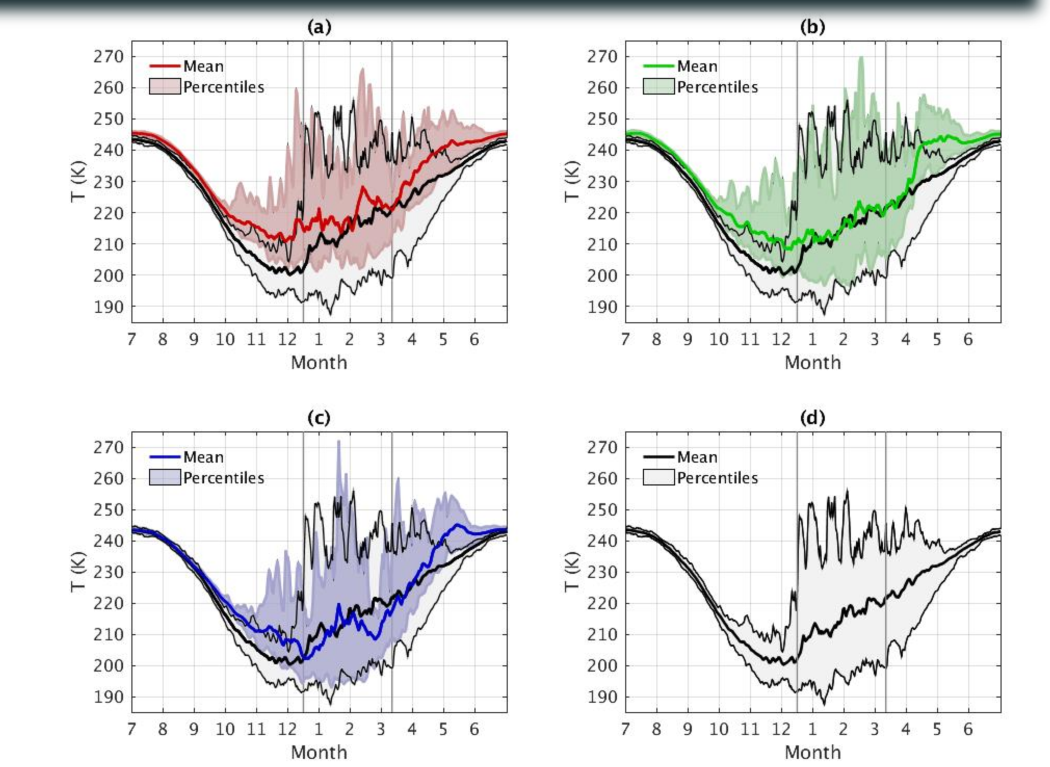


3. SUDDEN STRATOSPHERIC WARMINGS

Annual cycle of the zonal mean temperature at 80N and the variability over the period 1996-2010 quantified through the 5th and 95th percentiles (shading). Starting with the control run LW-LMDz (red line), the model has a clear warm bias at the pressure level 10 hPa as compared to MERRA2 (black line).

This temperature bias is reduced using the alternative GW settings SW (b) and SW² (c), both in the mean cycle and the variability given by the percentiles.

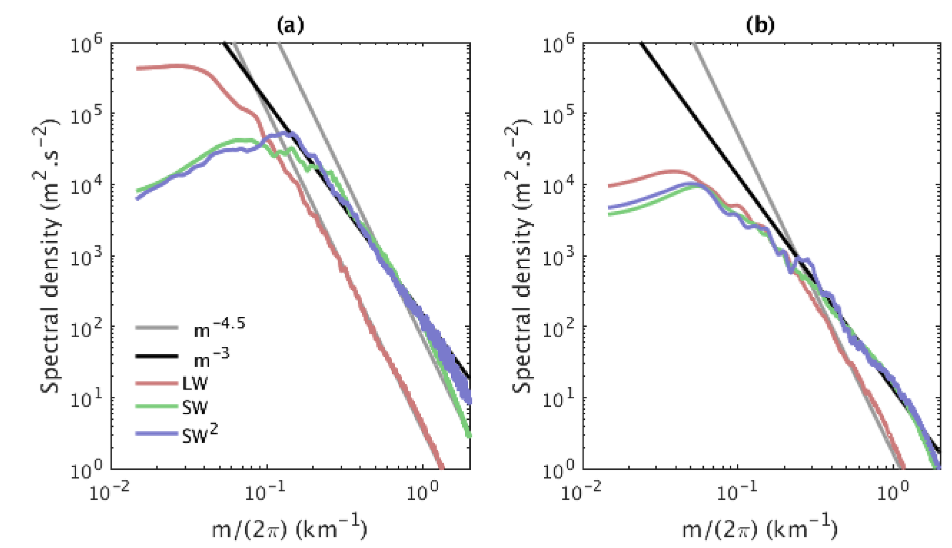
MERRA2: Modern-Era Retrospective Analysis for Research and Applications version 2.



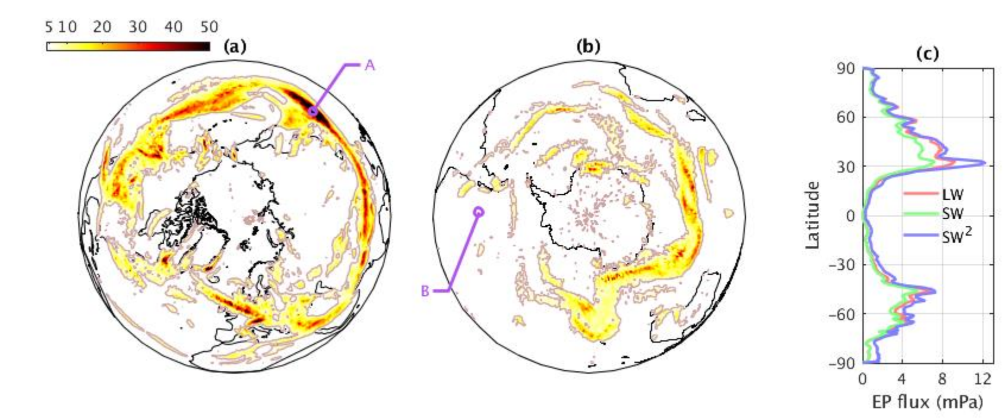
4. FROM GRAVITY WAVE TO TURBULENCE

Average energy spectra of GW fields for locations A and B, and altitude ranges 0-65 km.

While the energy spectra obtained with LW and SW are proportional to $m^{-4.5}$ the shape obtained with SW² is characterized by a m^{-3} tail, which is suggestive of 'saturation' and reproduce the empirical GW energy spectra (mainly derived from radiosonde and satellite data).



The vertical profiles of the wind and temperature GW disturbances are obtained from the parameterized profile of vertical EP flux by applying local polarization relations and the WKB formalism [1]. For infrasound propagation studies.



Can the infrasound technology improve climate simulations?

Specifying GW in GCMs is a major challenge. Overall, the mean middle atmospheric circulation with two new settings of the GW parameterization (SW and SW2) presents specific improvements in the shape of the austral winter jet (polar night jet in the SH in JJA tilts better towards the tropics with altitude) that looks promising to correct long-standing biases.

SW and SW2 are actually implemented in the FLOWS platform as part of the Bayesian network tool. Perspective is to apply SCNN at a larger scale (e.g., use more IMS stations) in order to improve both global climate predictions and IDC's network processing (Global association, see T3.5-P79).