

Small-scale temperature perturbations in the middle atmosphere

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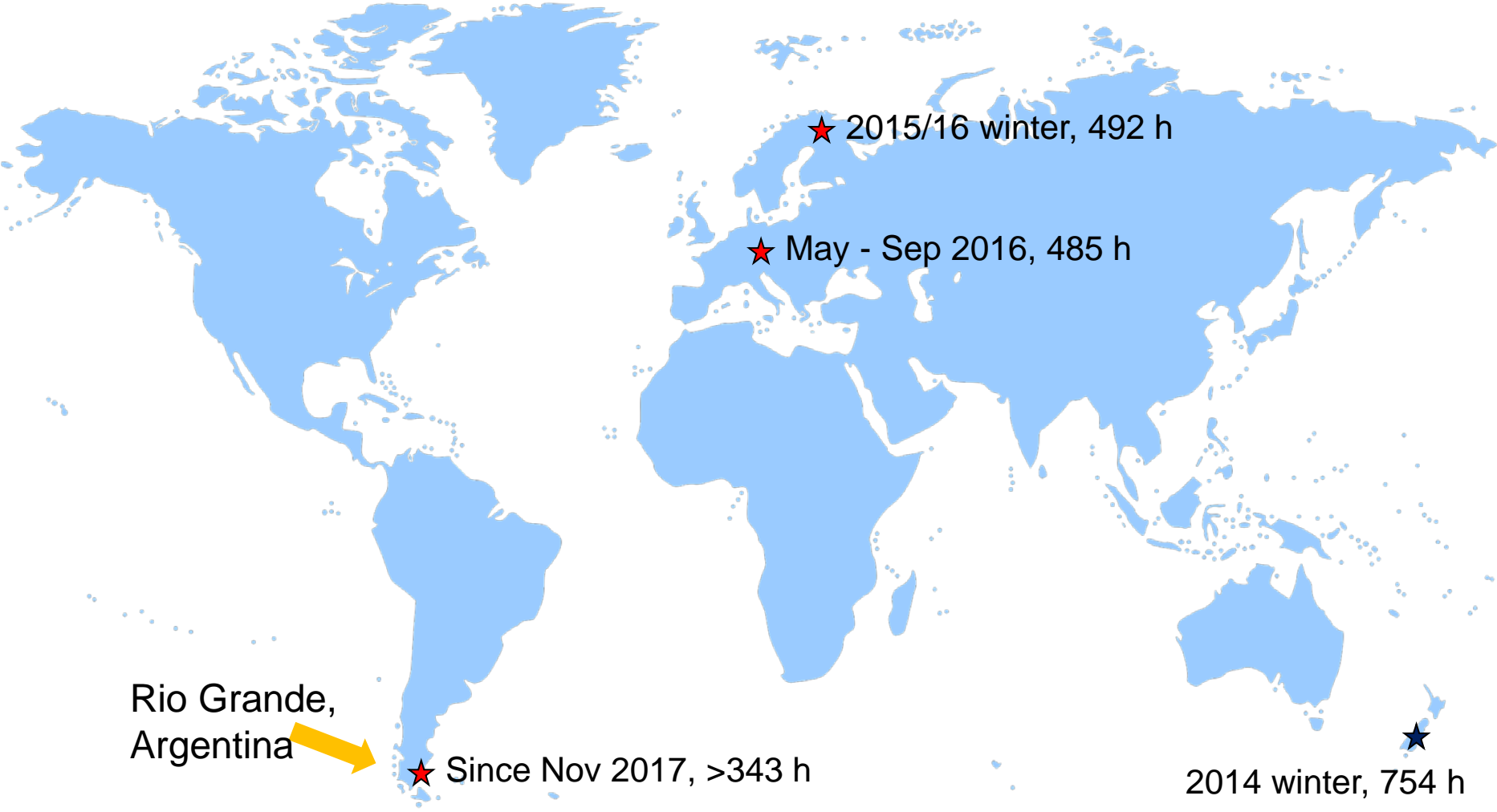
Institute of Atmospheric Physics
German Aerospace Center, Oberpfaffenhofen

ARISE-Workshop
Hamburg
15 May 2018

Knowledge for Tomorrow

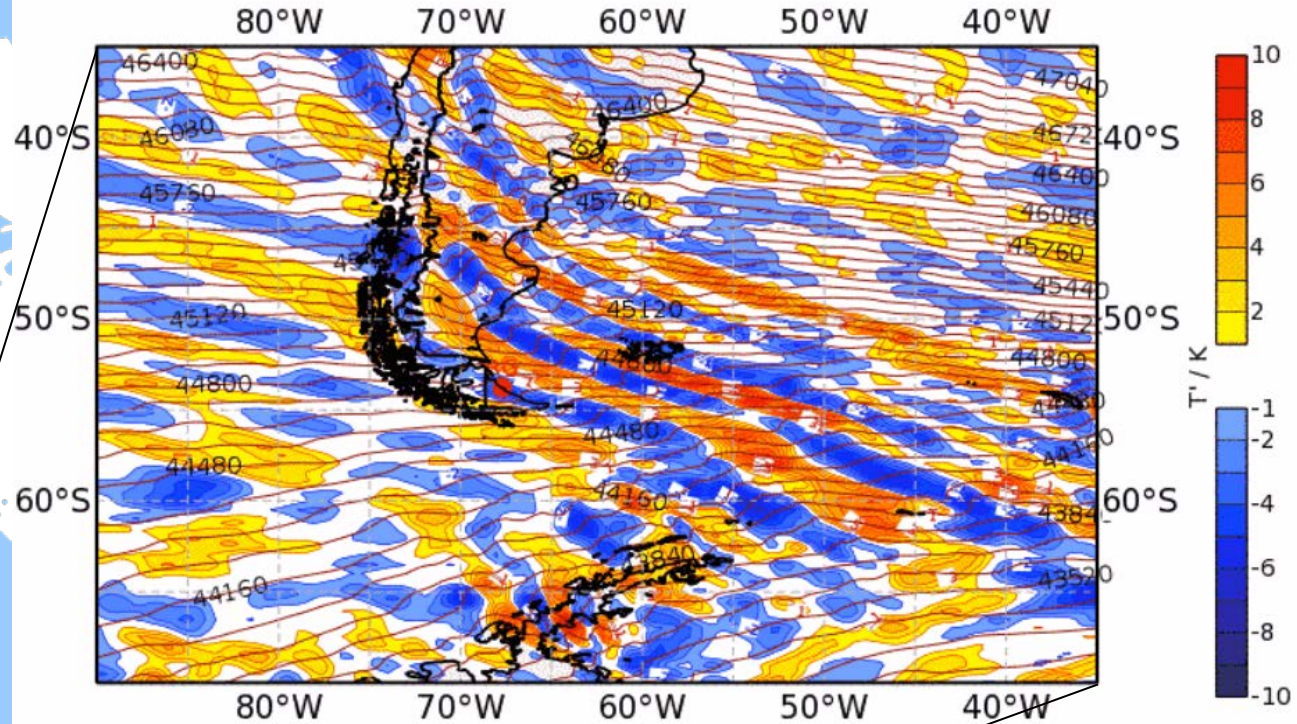


CORAL stations



Gravity wave (GW) hot spot

Temperature Perturbations (K) & Z (m) at 1 hPa
Valid: Fri, 11 May 2018, 00 UTC (step 072 h from Tue, 08 May 2018, 00 UTC)



★ Since Nov 2017, >343 h

CORAL lidar

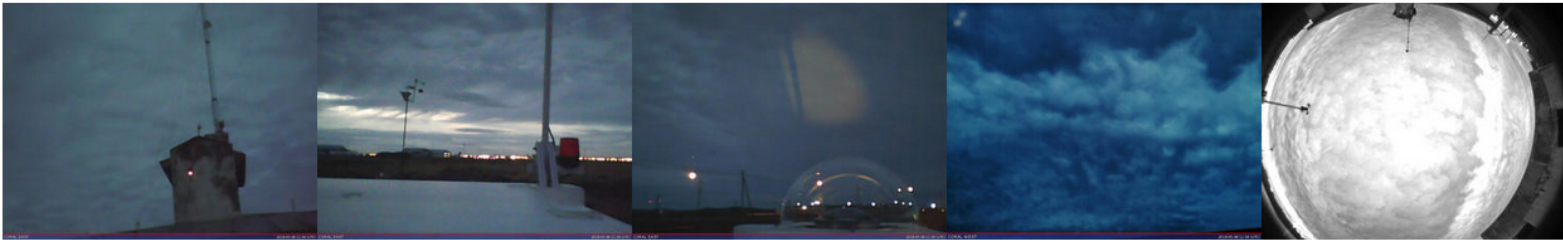
- Rayleigh lidar @ 532 nm
- 12 W power, 63 cm telescope
- 8 foot container, 1500 kg
- 2 kW power consumption



- **Since Feb 2018: Fully autonomous**
- Start/stop/operating conditions:
 - Darkness, rain, wind
 - Cloud and precipitation forecast
 - Stars
 - Lidar signal

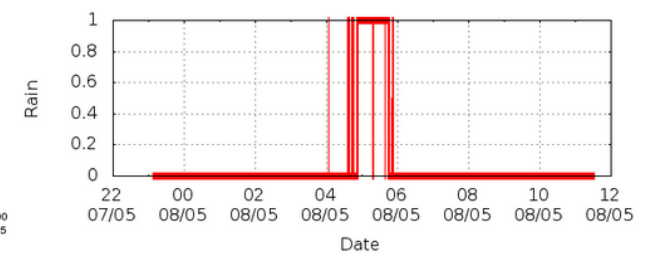
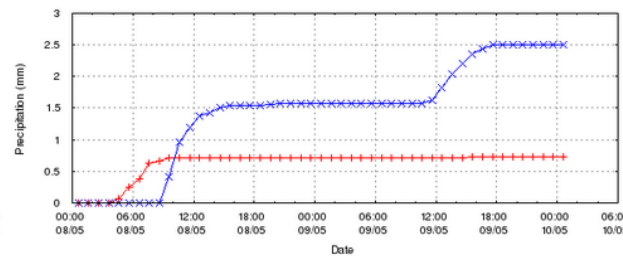
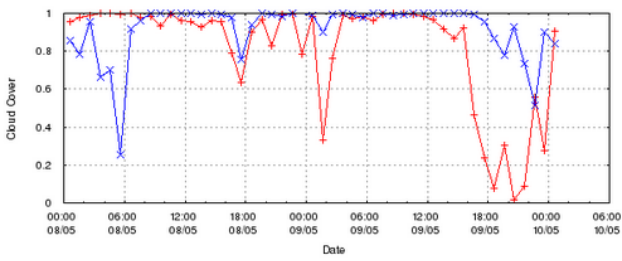


Cloud Cameras

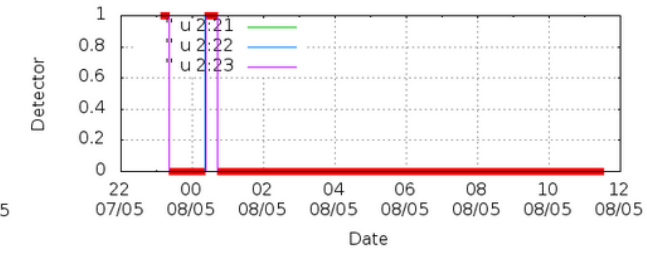
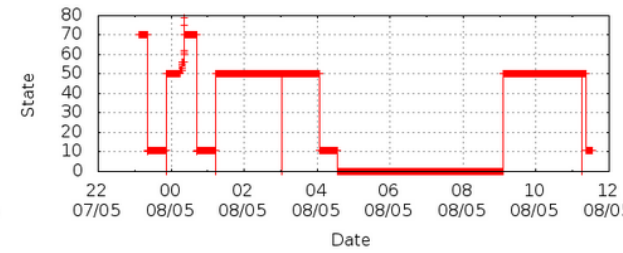
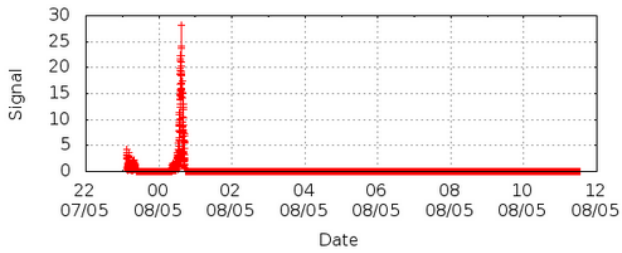
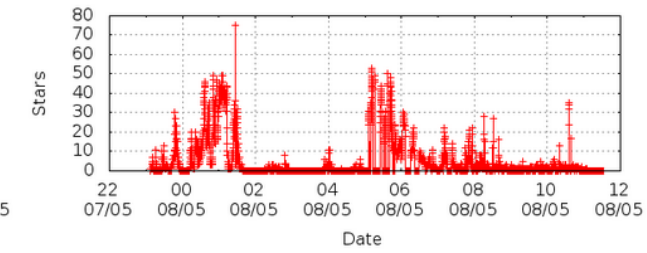
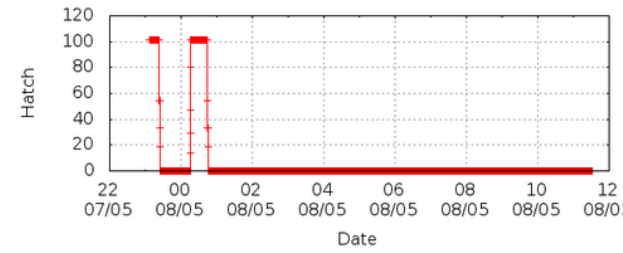
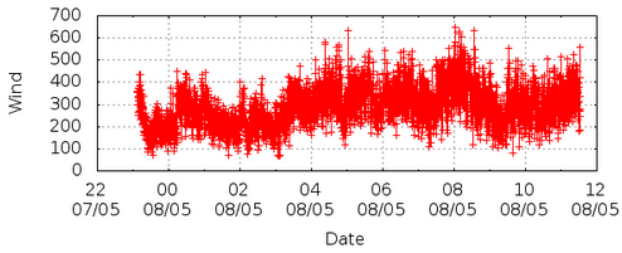


ECMWF Forecast

Rio Grande (red) and Rio Gallegos (blue)



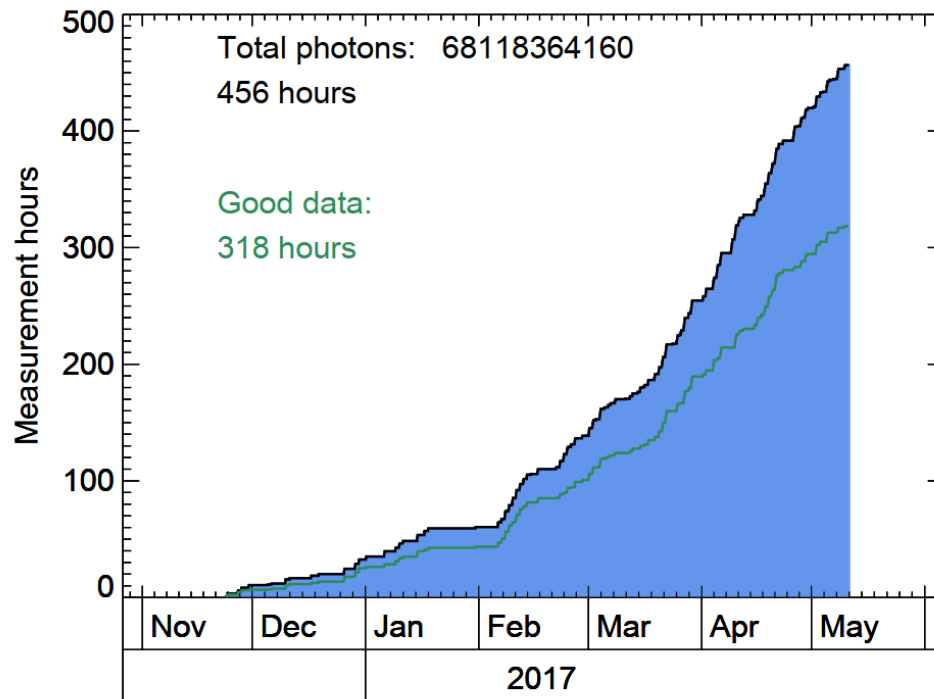
Lidar



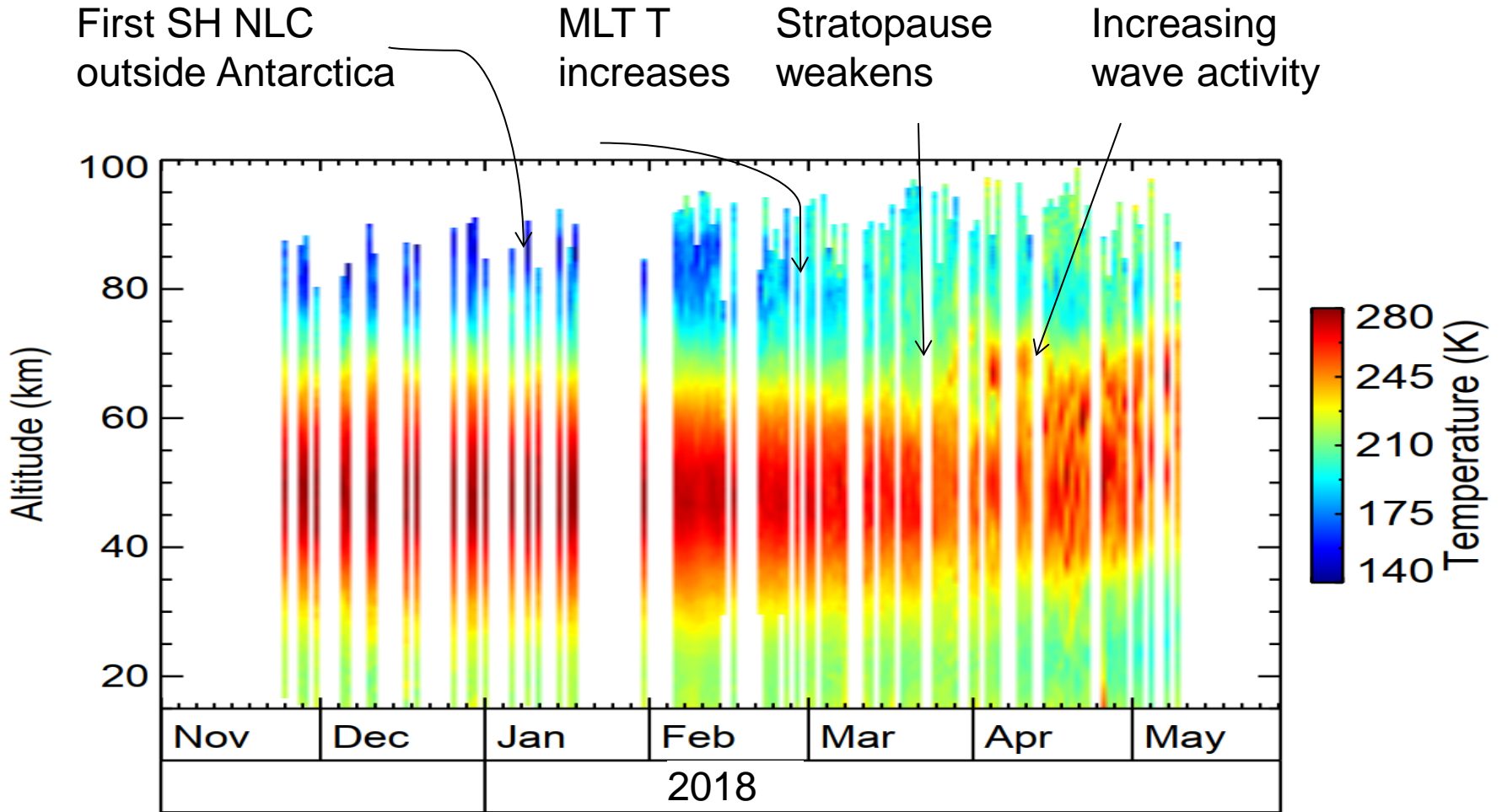
CORAL @ Rio Grande



DLR Lidar at Rio Grande

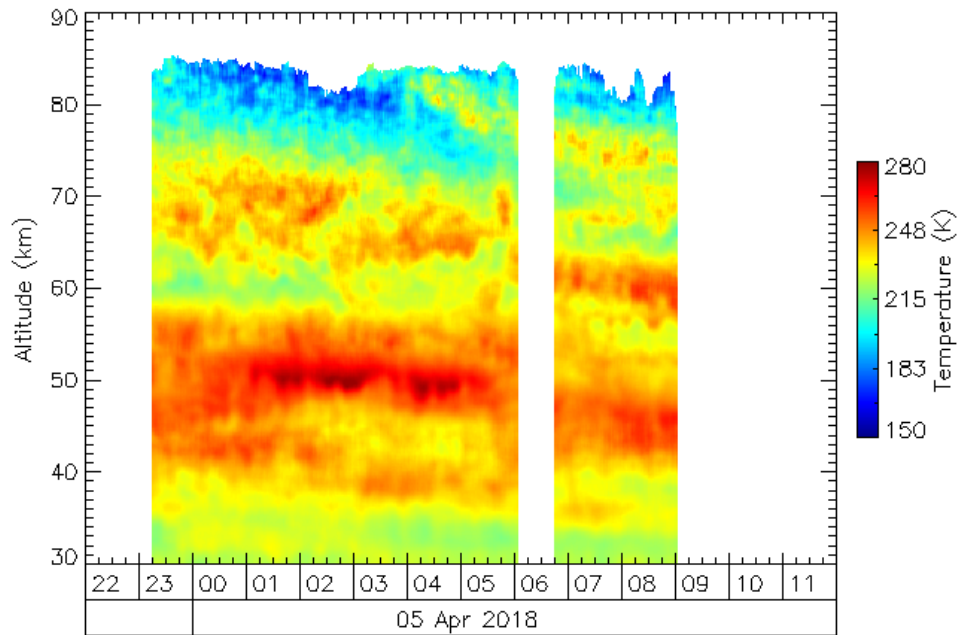


Nightly mean temperatures

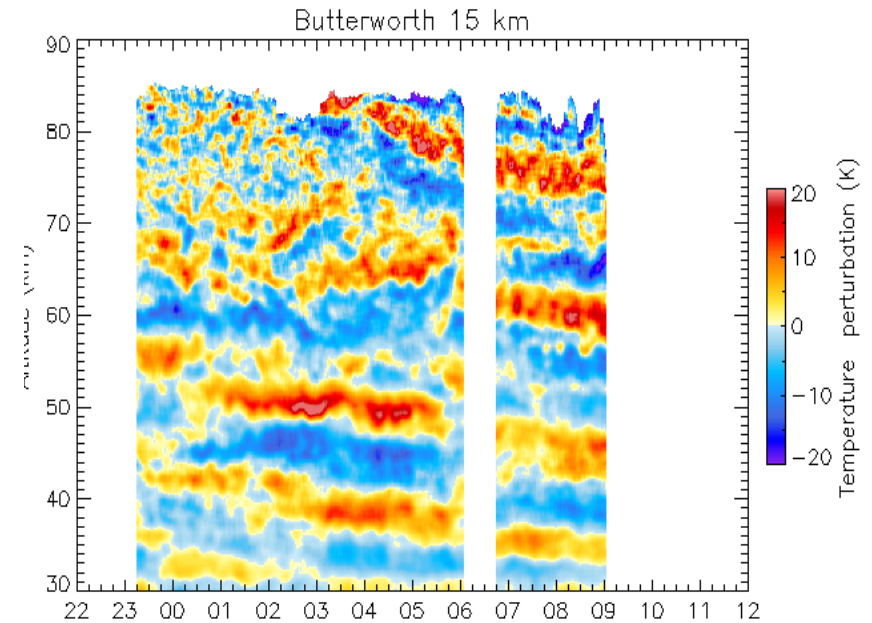


High resolution T, T' (5/6 April 2018)

- Temperature



- Temperature perturbation = GW

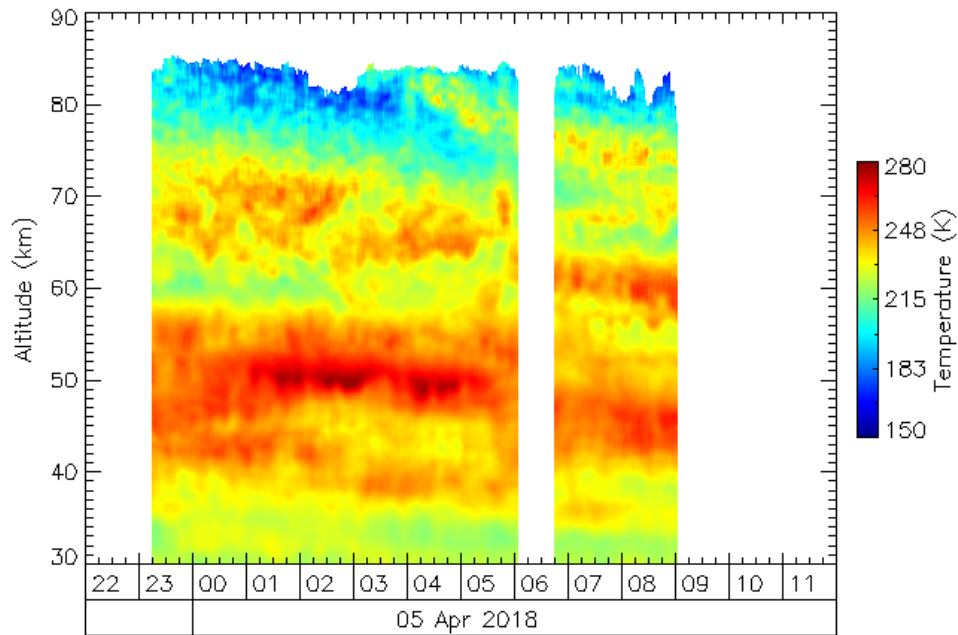


Spectral filter with 15 km cutoff

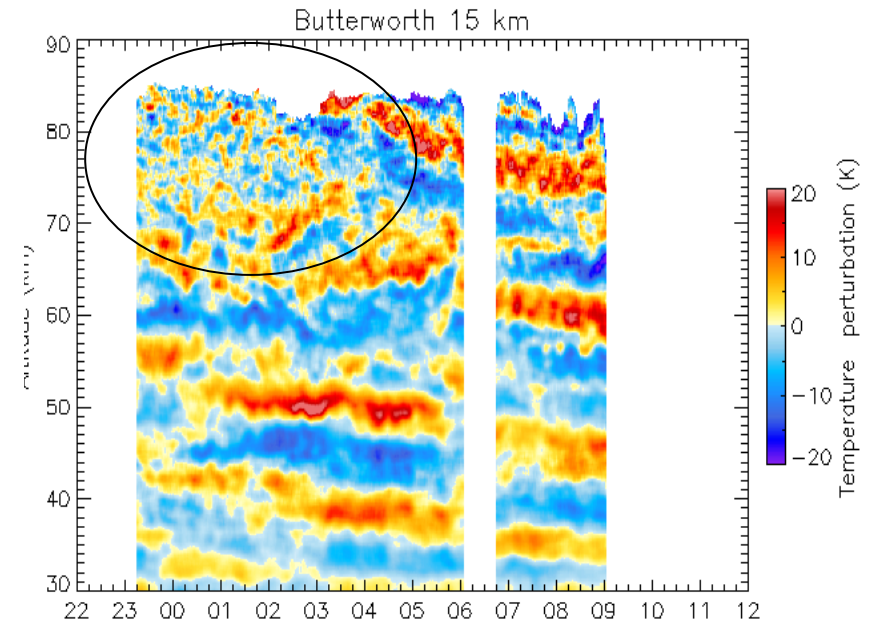


High resolution T, T' (5/6 April 2018)

- Temperature



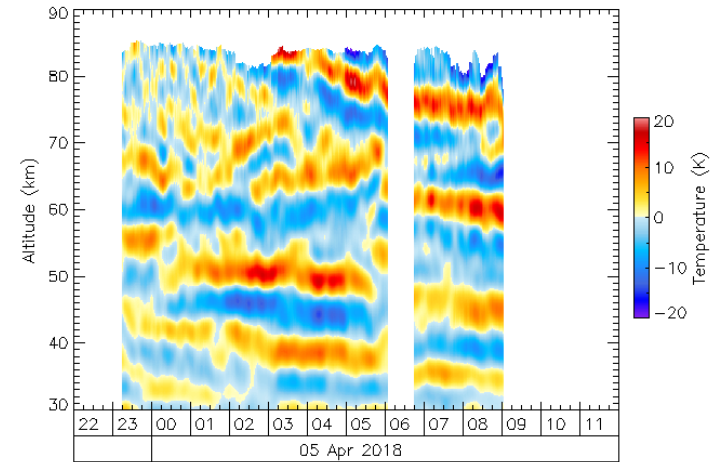
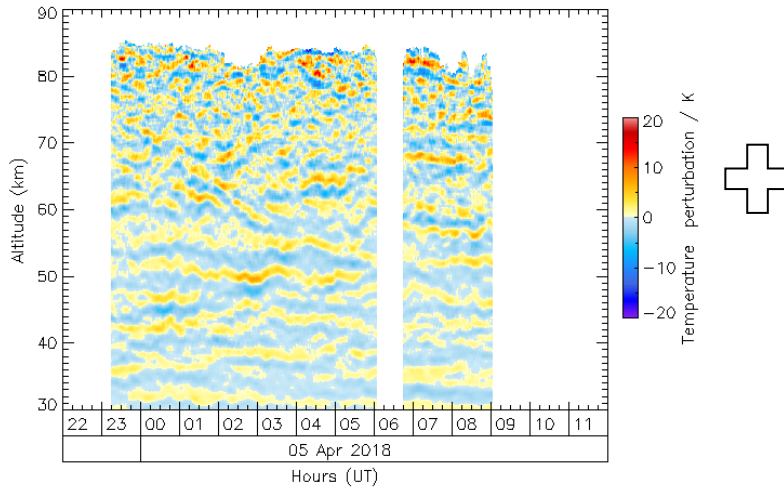
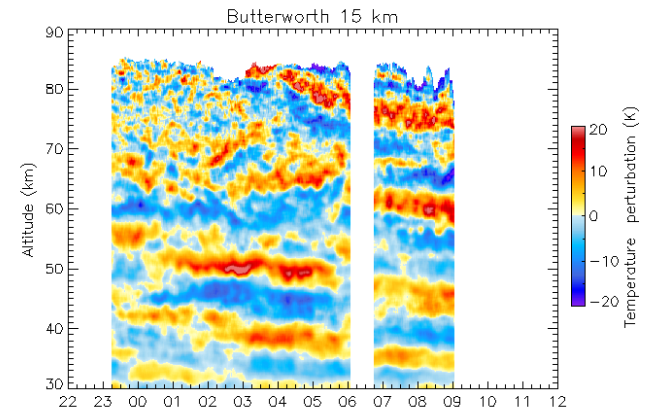
- Temperature perturbation = GW



➤ Different scales?



Wave filtering for short and large scales



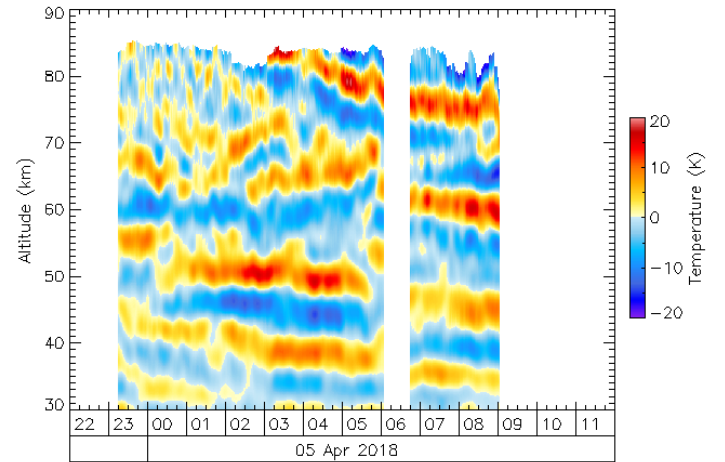
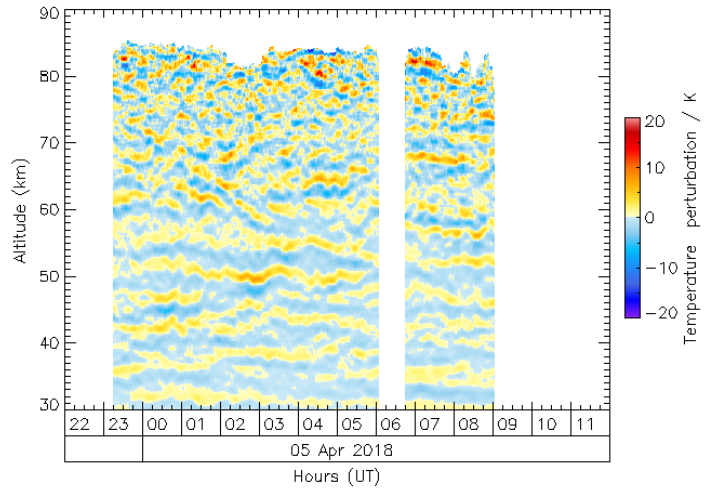
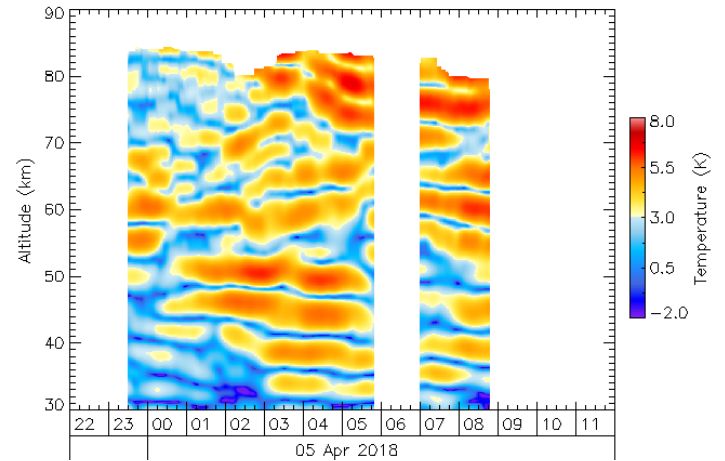
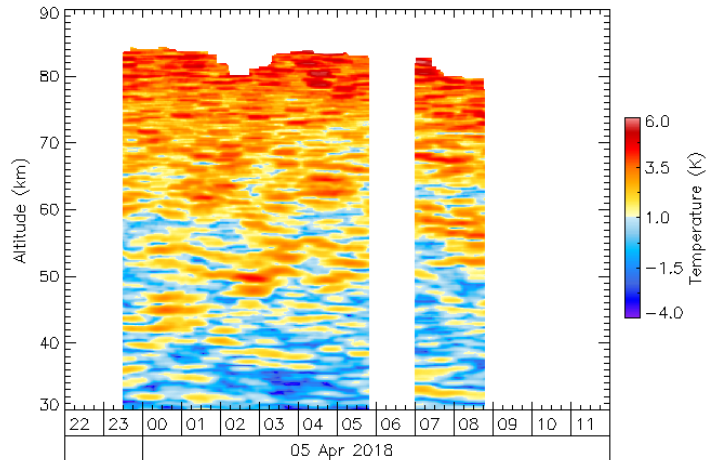
- GW < 5 km vertical wavelength

- GW > 5 km vertical wavelength



GW potential energy density

$$E_p(z) = \frac{1}{2} \frac{g^2}{N^2(z)} \overline{\left(\frac{T'(z, t)}{T_0(z, t)} \right)^2}$$



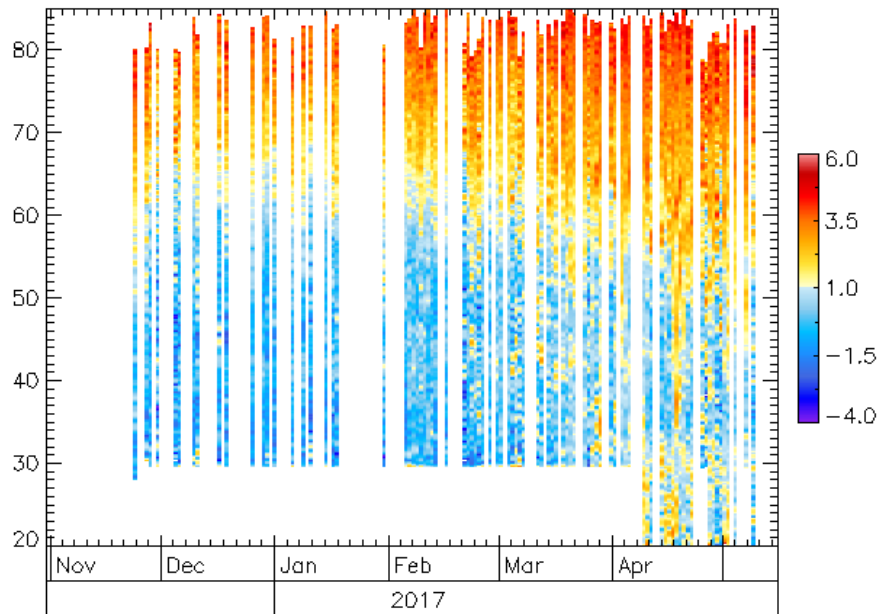
- GW < 5 km vertical wavelength

- GW > 5 km vertical wavelength

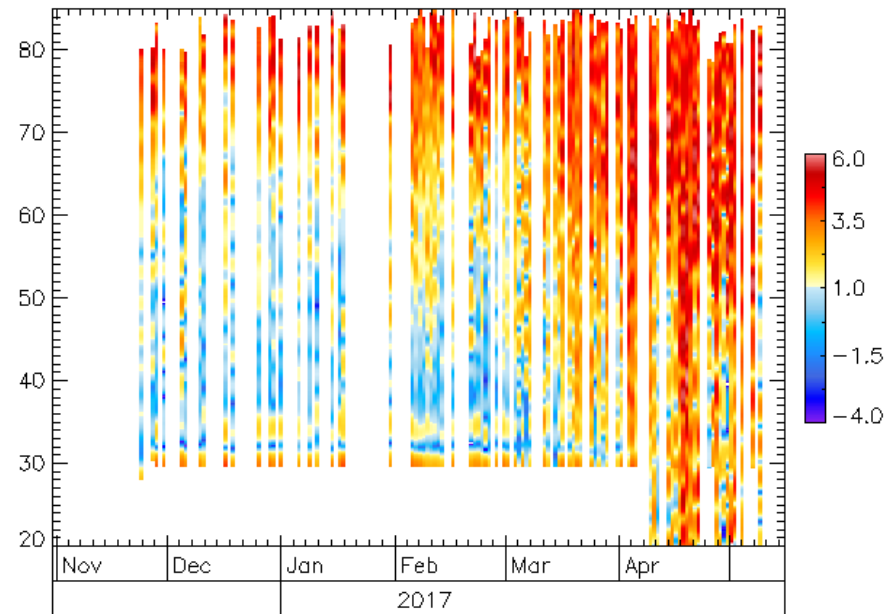


Nightly mean GW E_p

- GW < 5 km vertical wavelength



- GW > 5 km vertical wavelength

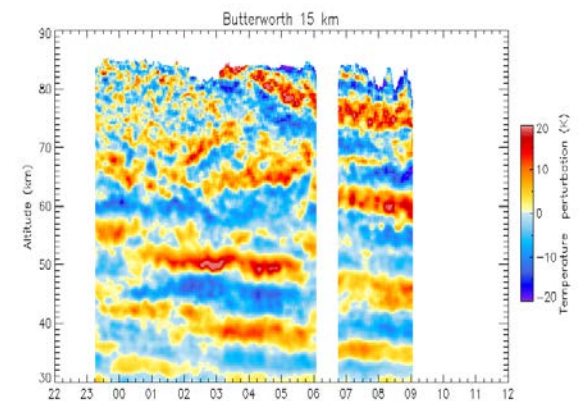
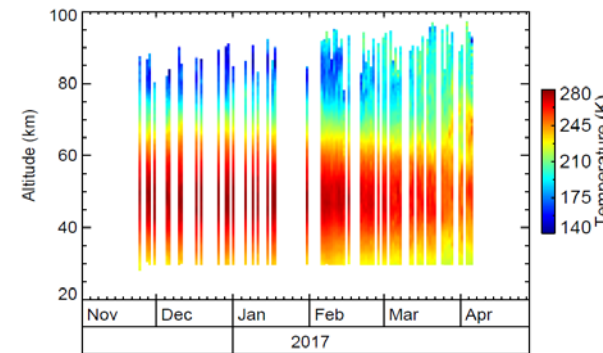


- Always high GW activity in the MLT region
- Small scales strongest in the MLT region
- In winter not as much increase as large-scale E_p



Summary

- CORAL middle atmosphere lidar at Rio Grande, Tierra del Fuego, Argentina
 - Autonomous operation
 - Large, high quality dataset
 - Strong gravity wave signatures
 - Spectral filtering to analyze energy at different scales
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- Upcoming:
 - SOUTHTRAC airplane campaign in 2019
 - NASA PMC-Turbo in June 2018 Kiruna-Canada



First SH noctilucent cloud outside Antarctica

