# Atmospheric studies with TRAGALDABAS

Irma Riádigos Sánchez, Ph.D. Student

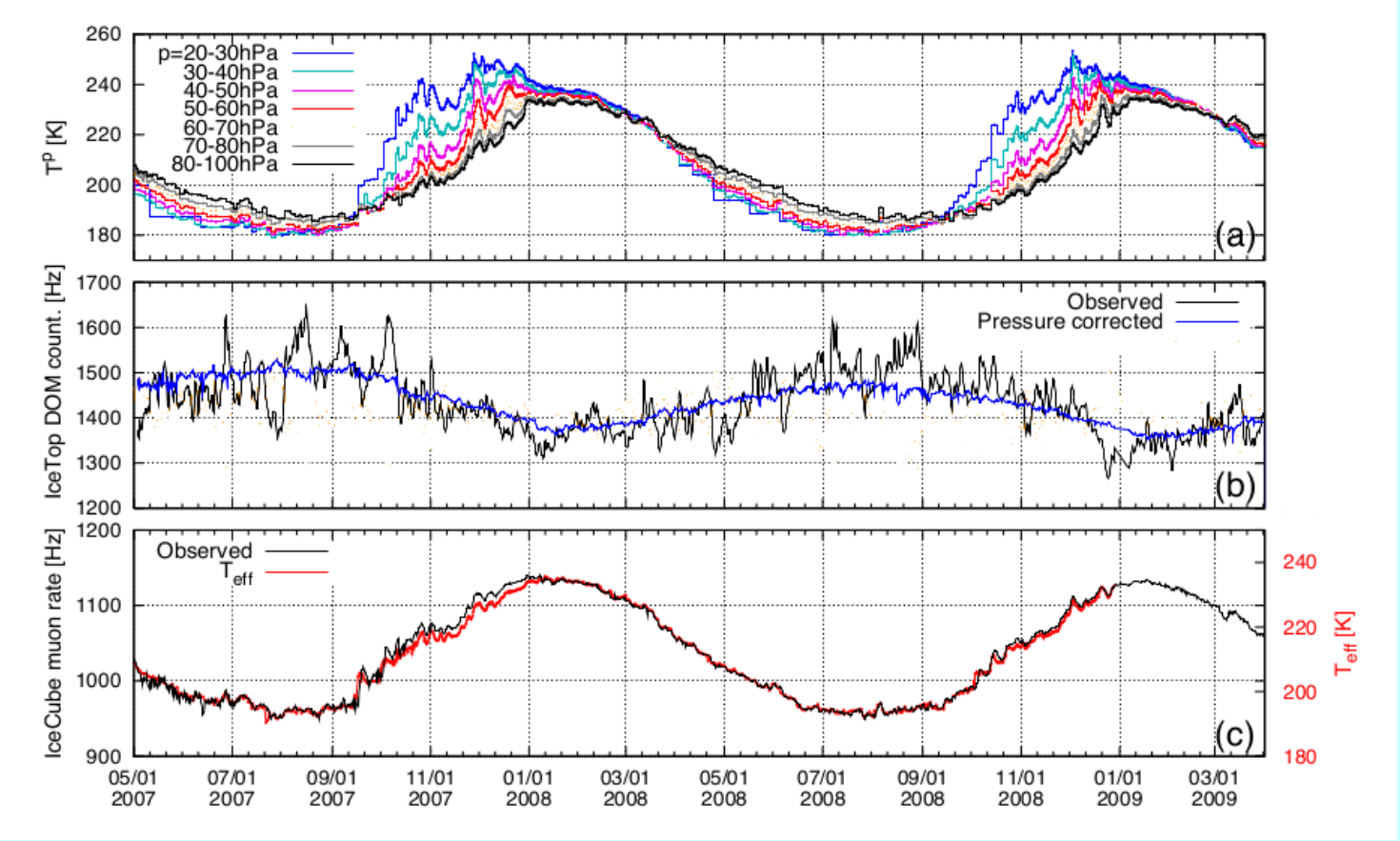
Juan A. Garzón Heydt
Vicente Pérez Muñuzuri

*Univ. Santiago de Compostela*
*June, 2017*

How does temperature affect the measurement of Cosmic Rays?

# 1. Motivations

## IceCube - Results




Stratosphere's Temperature

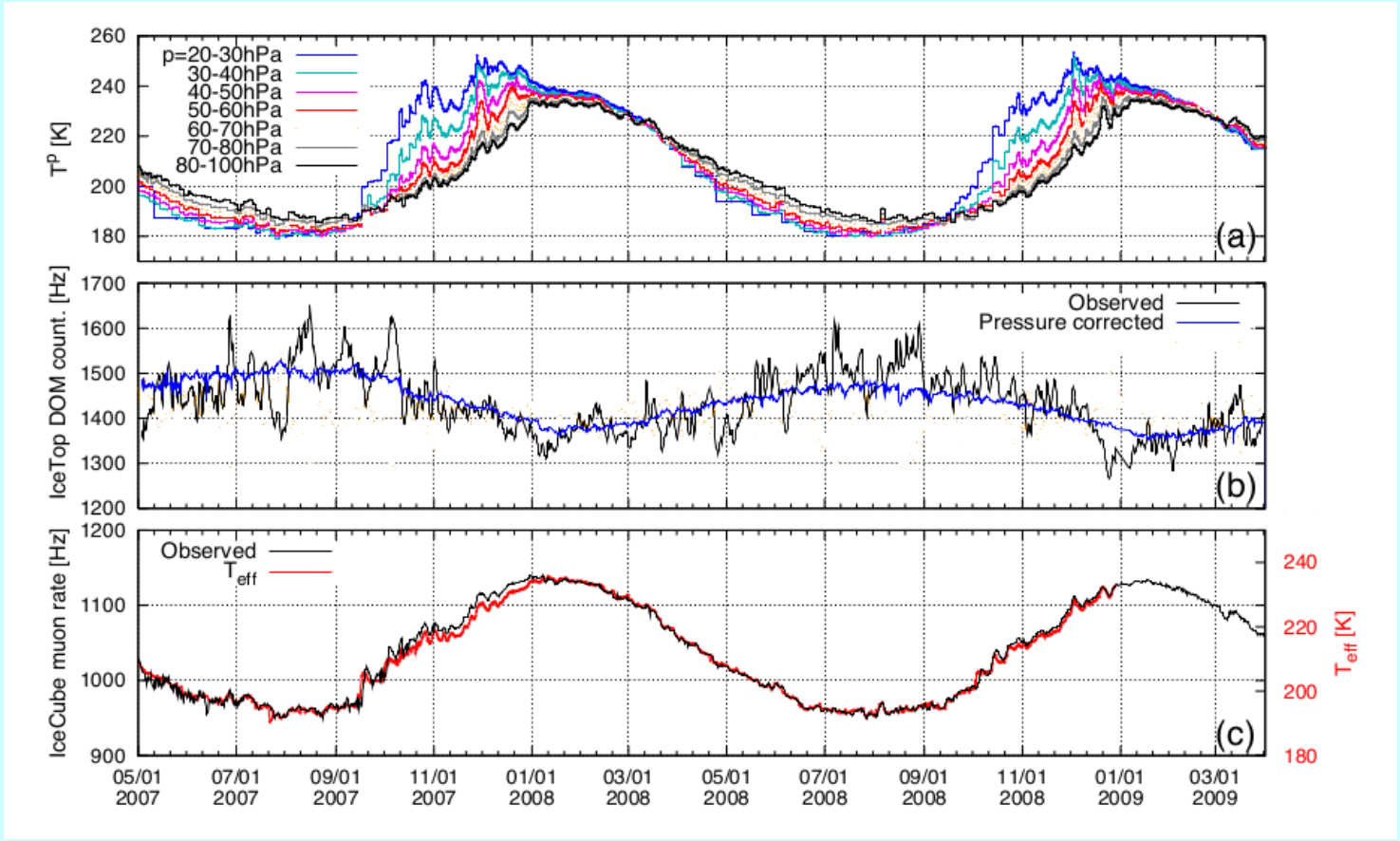
Muon Rate in IceTop (~1GeV)

Muon Rate in IceCube (>400 GeV)

*S. Tilav et al. (2010)*

# 1. Motivations

## IceCube - Results




Stratosphere's Temperature

Muon Rate in IceTop (~1GeV)

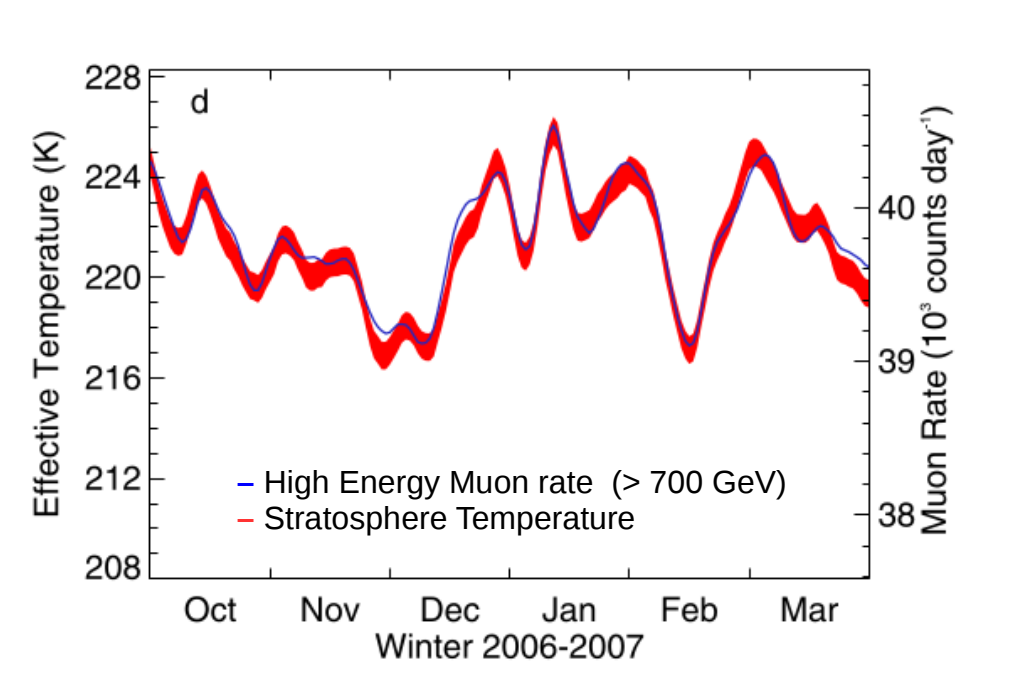
Muon Rate in IceCube (>400 GeV)

*S. Tilav et al. (2010)*

- **Low energy** muon rate **anticorrelated** with low stratosphere (40-80 hPa).
- **High energy** muon rate **correlated** with high stratosphere (30-60 hPa).

# 1. Motivations

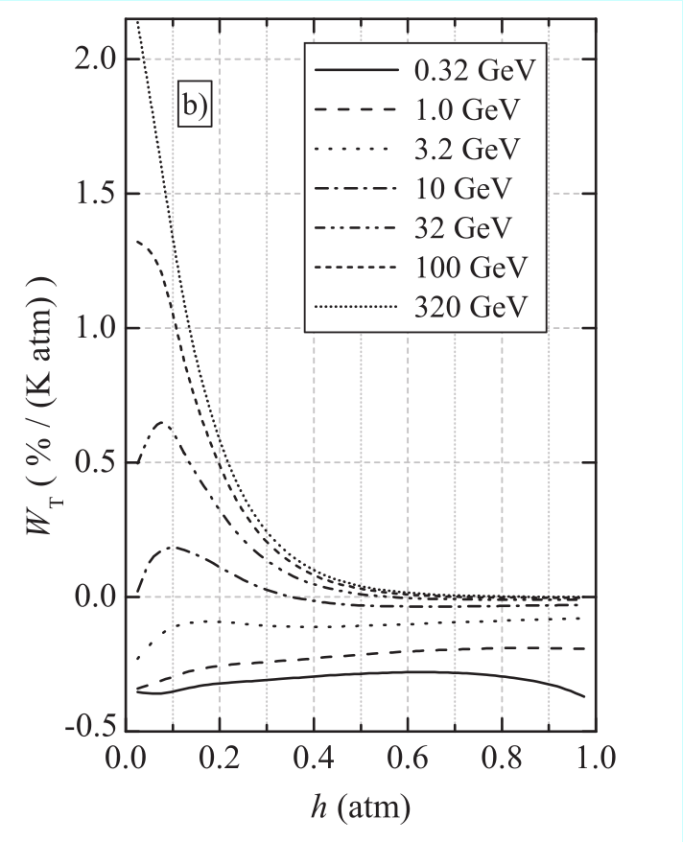
**MINOS - Results**




*S. Osprey et al. (2009)*

# 1. Motivations

**Calculations of the influence of atmospheric temperature**




Dmitrieva et al. (2011)

Diff. Coef. of temperature

$$\frac{\Delta N_T(E_{min}, X, \theta)}{N_0(E_{min}, X, \theta)} \approx \sum_i W_T(E_{min}, X, \theta)\Delta T(h_i)\Delta h_i$$

$E_{min}$ : minimum energy of muon

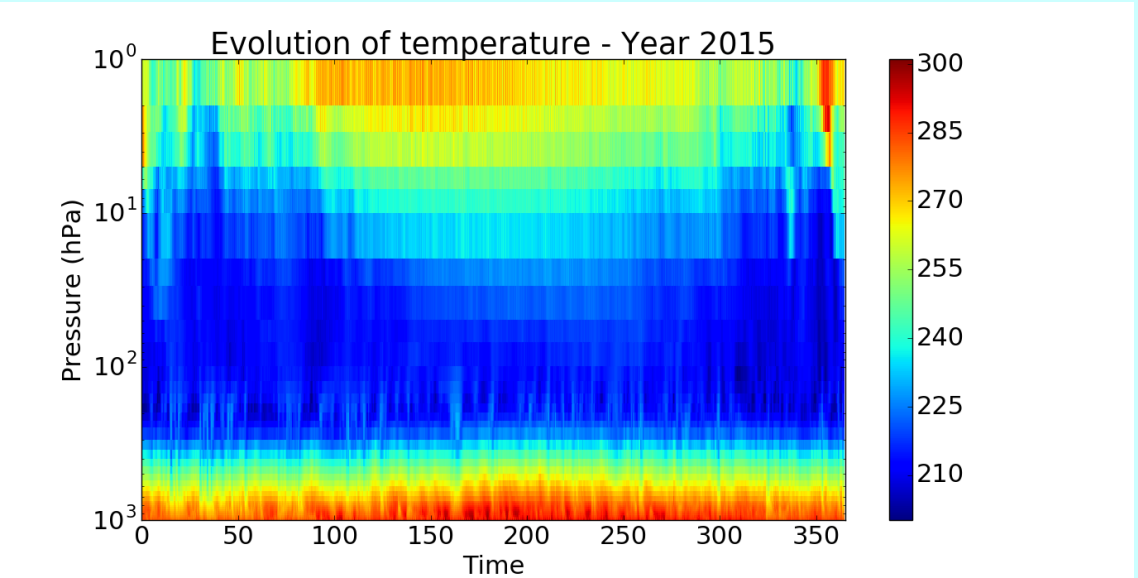
X: level of observation

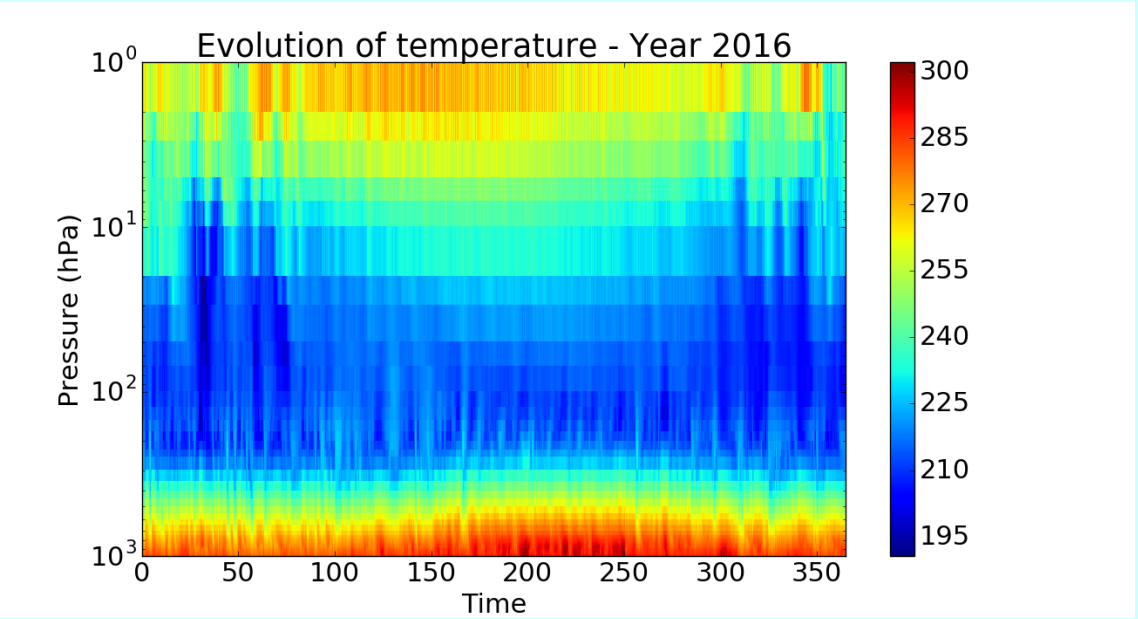
h: atmospheric depth

# 2. Atmosphere: Santiago de Compostela

ERA-Interim

ECMWF

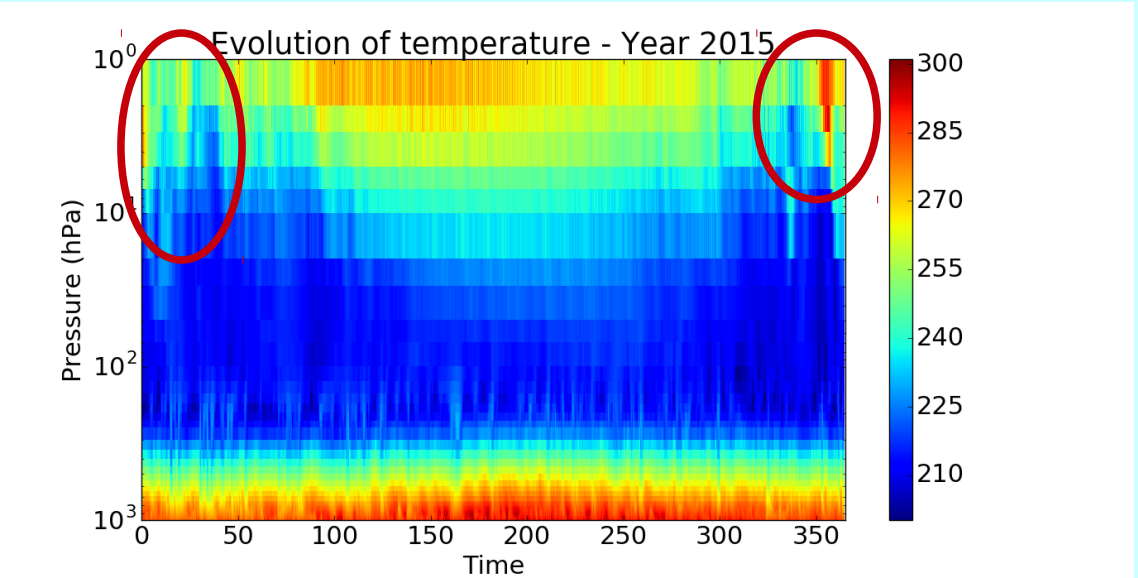


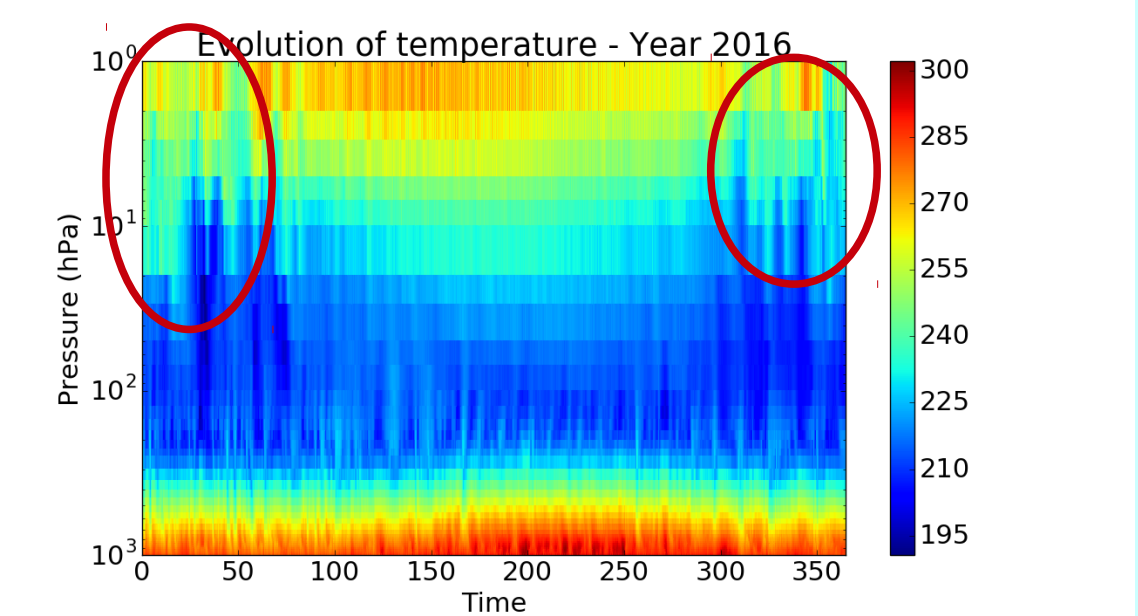



# 2. Atmosphere: Santiago de Compostela

ERA-Interim

ECMWF



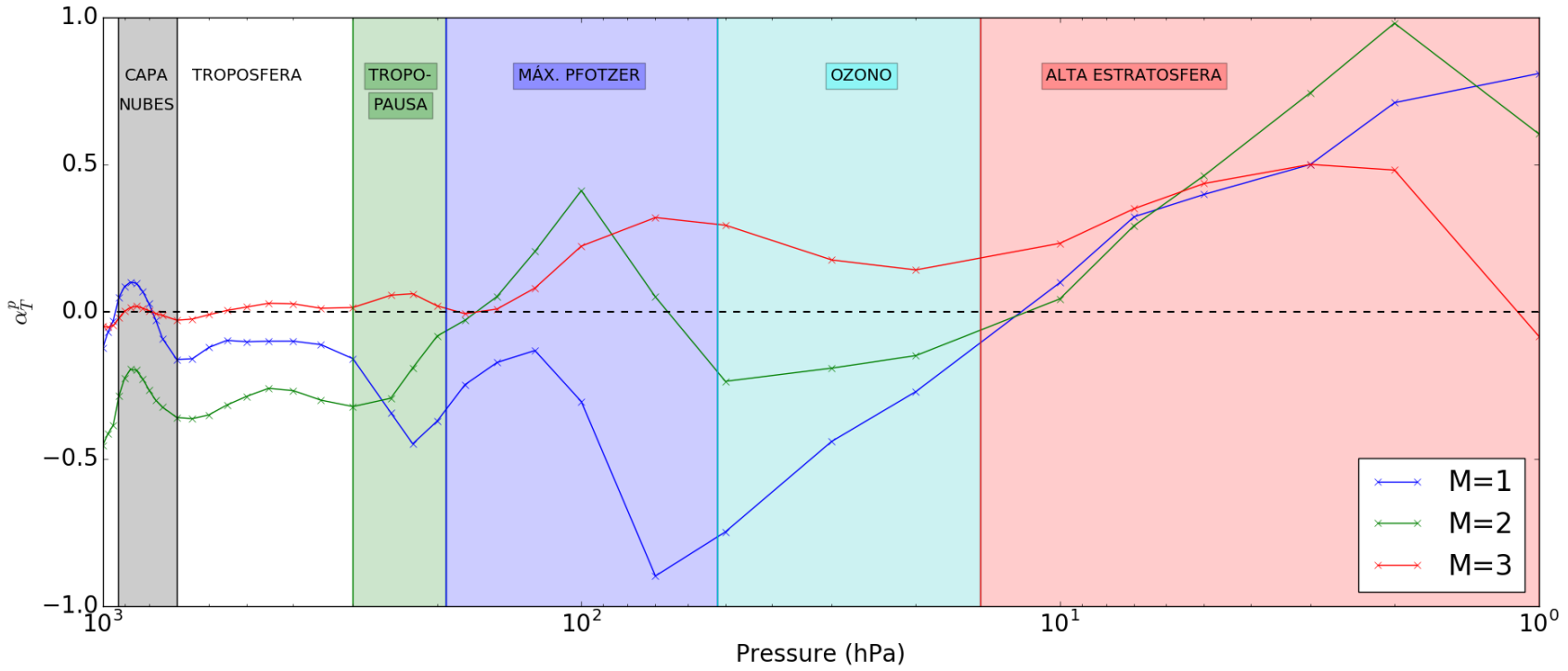




SSW

# 3. TRAGALDABAS Data Analysis: Preliminary

$$\frac{\Delta R}{< R >} = \alpha_T^p \frac{\Delta T^p}{< T^p >}.$$

**April-September 2015**

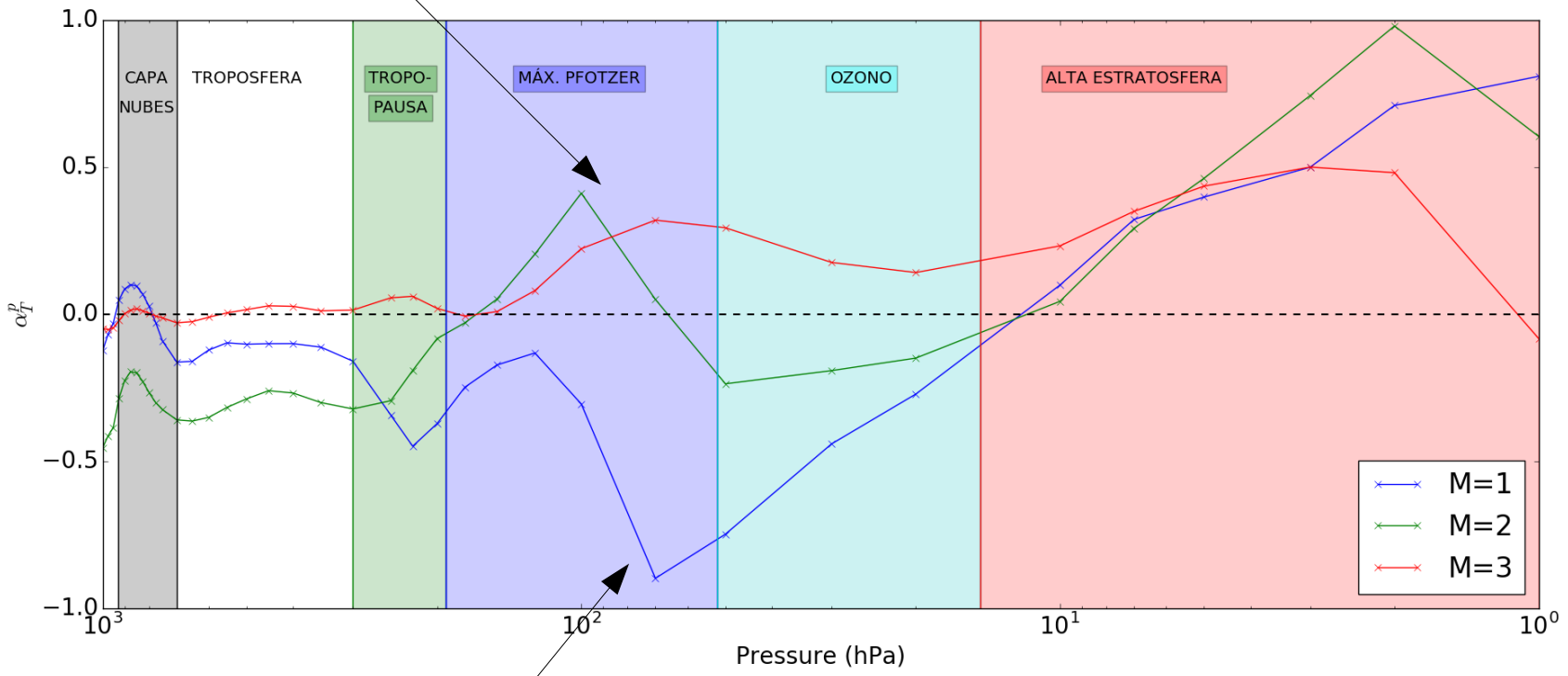


# 3. TRAGALDABAS Data Analysis: Preliminary

$$\frac{\Delta R}{< R >} = \alpha_T^p \frac{\Delta T^p}{< T^p >}.$$

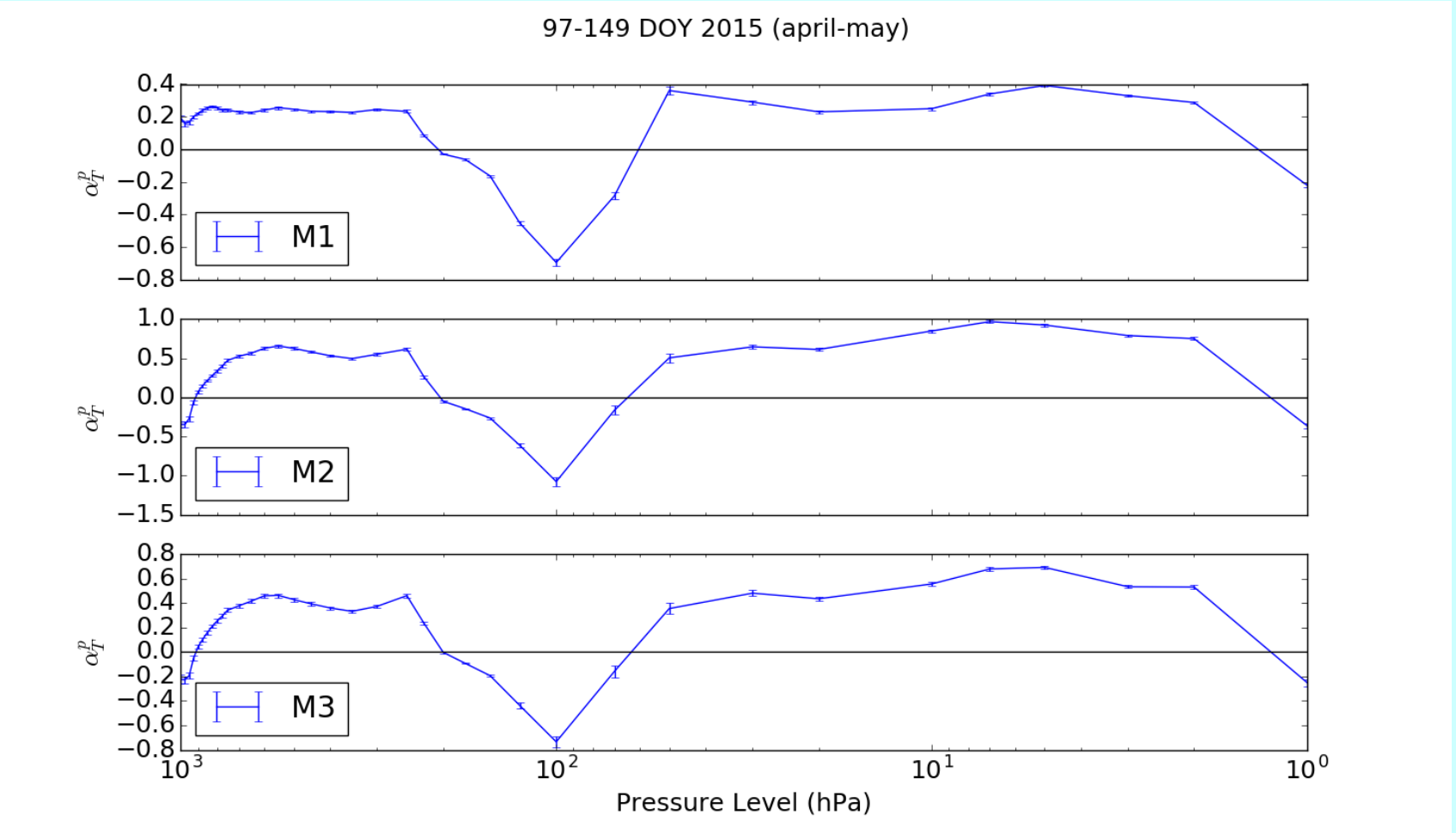
Correlation
High energy
IceCube

**April-September 2015**

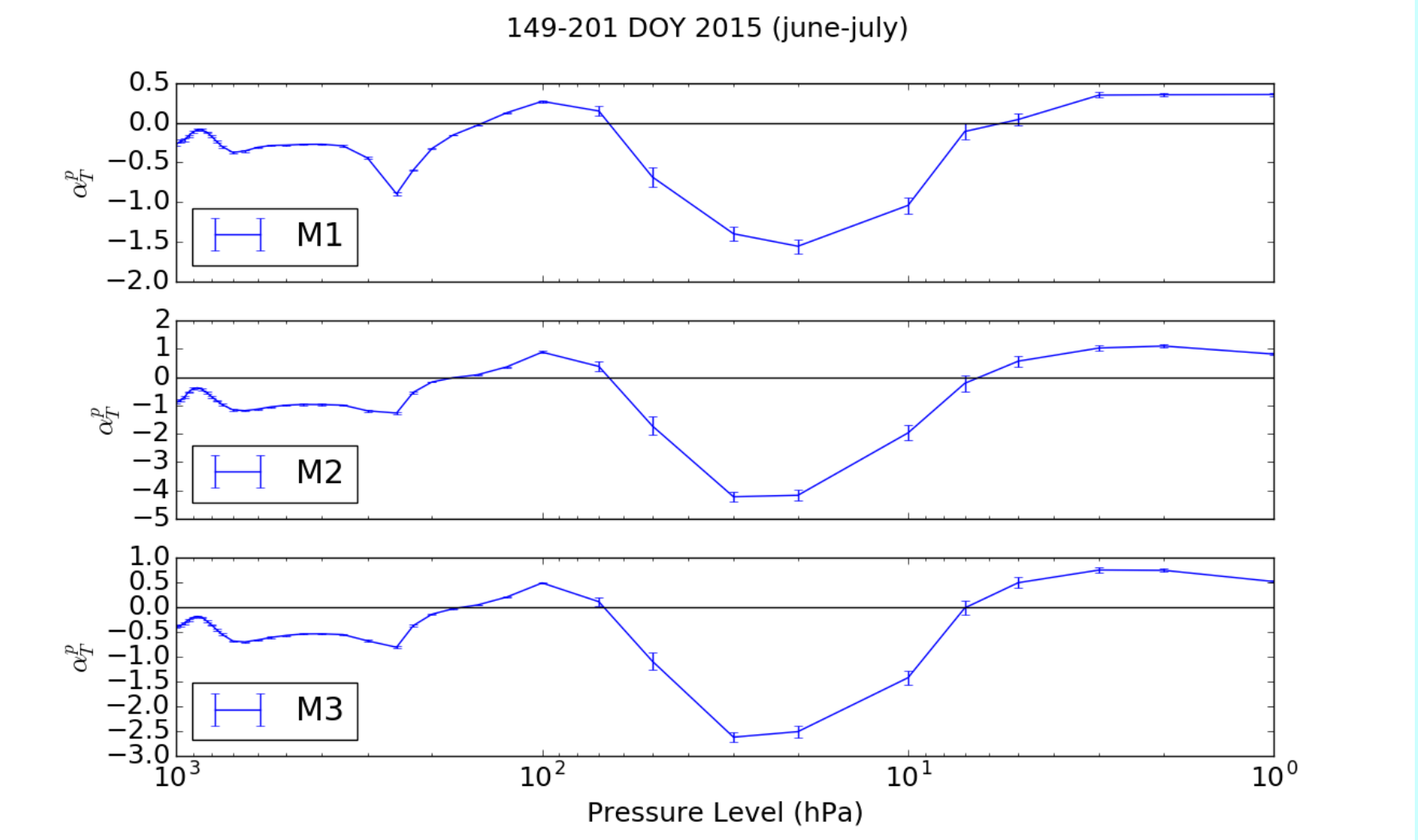



Anticorrelation
low energy -
IceTop

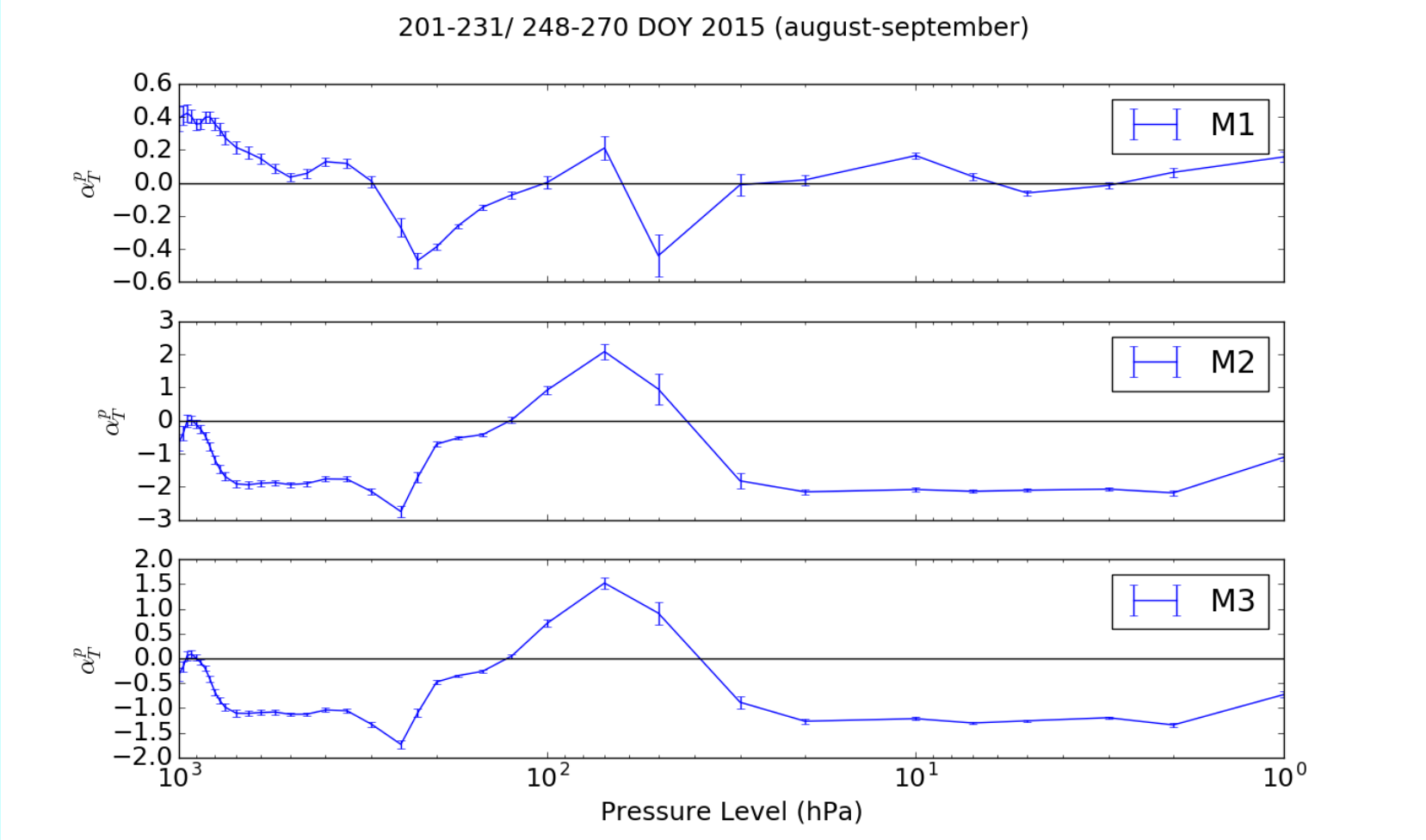
# 3. TRAGALDABAS Data Analysis: Preliminary



# 3. TRAGALDABAS Data Analysis: Preliminary



# 3. TRAGALDABAS Data Analysis: Preliminary



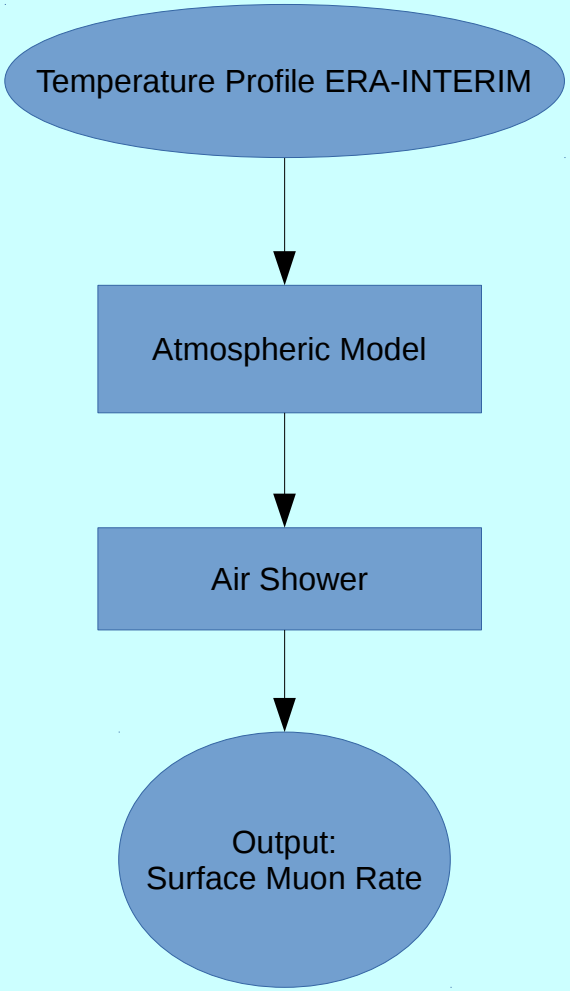
# 4. Numerical simulations

**Main Objectives**

- Impossibility of changing atmosphere in other programs (Aires, Corsika…).

- Understanding real temperature effects on muon rates.

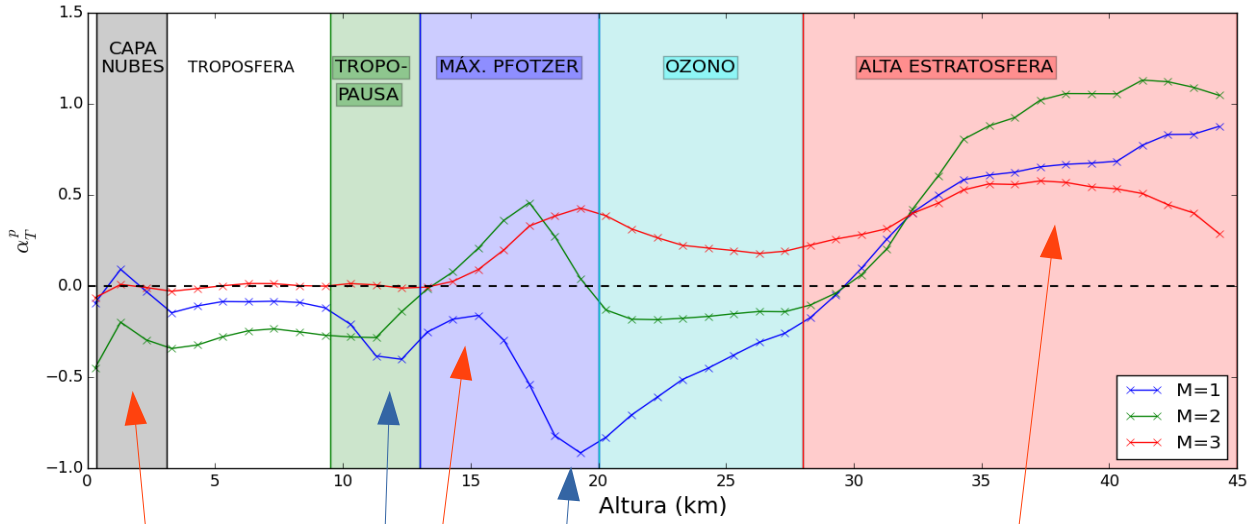
- Checking the validity of TRAGALDABAS data analysis.



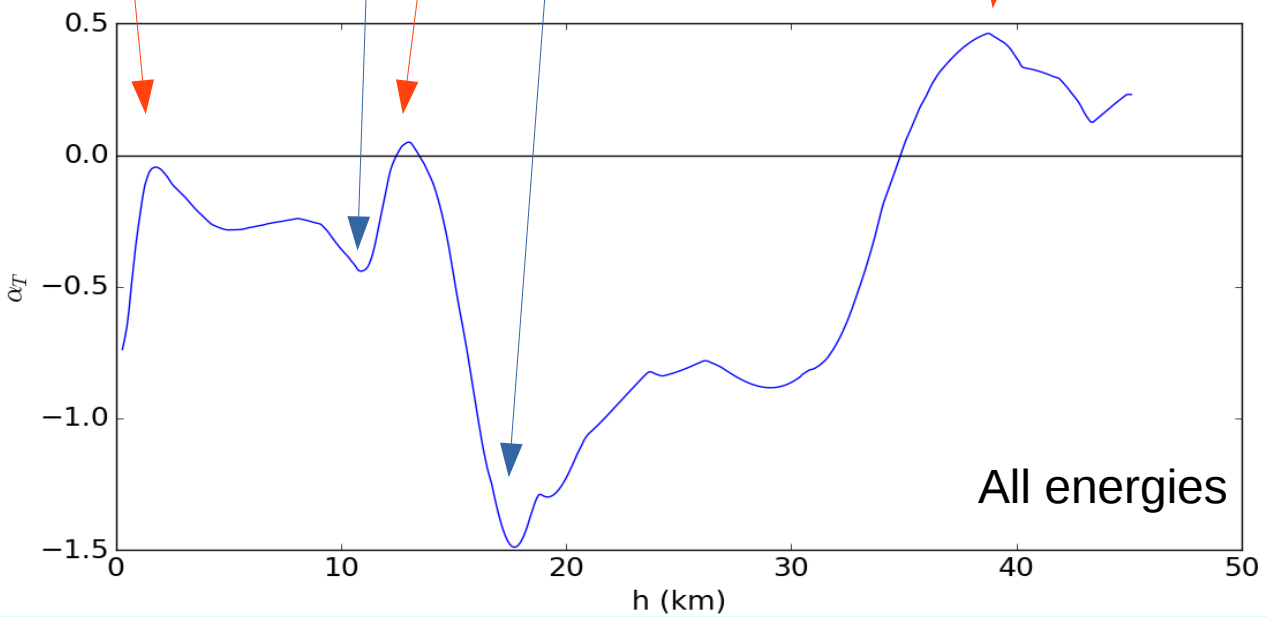
# 4. Numerical simulations

**April-August 2015**

**TRAGAS**



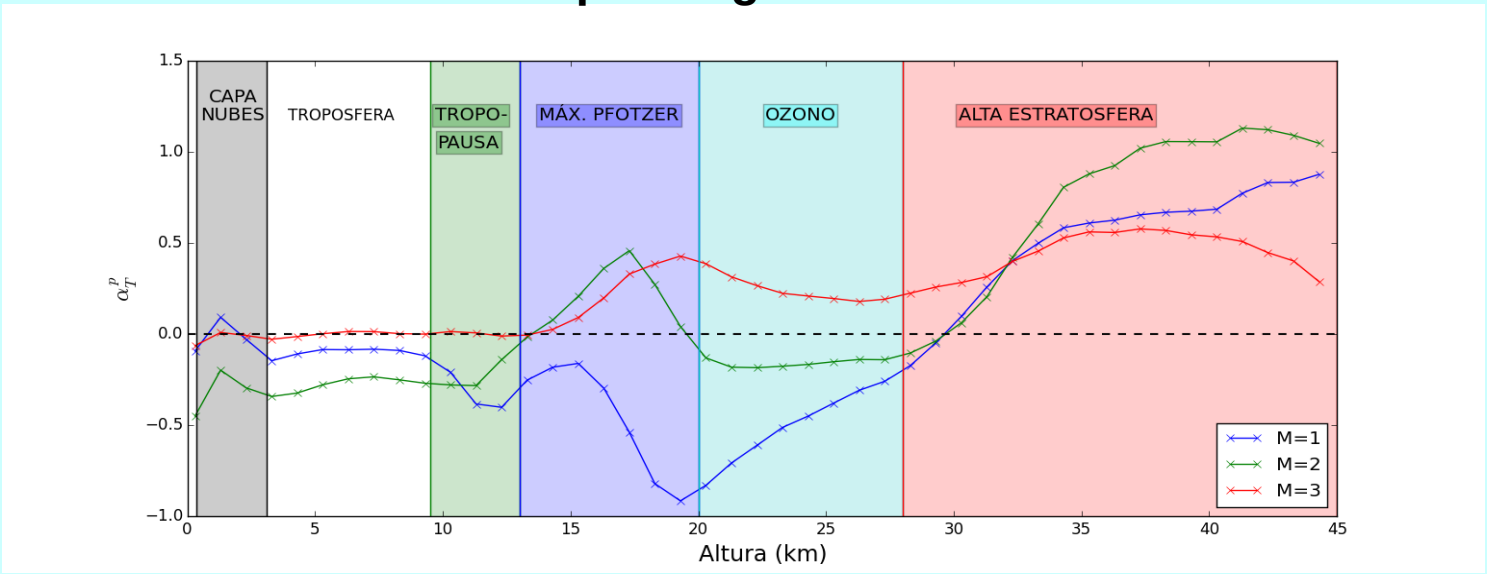

**SIMULATION**



# 4. Numerical simulations

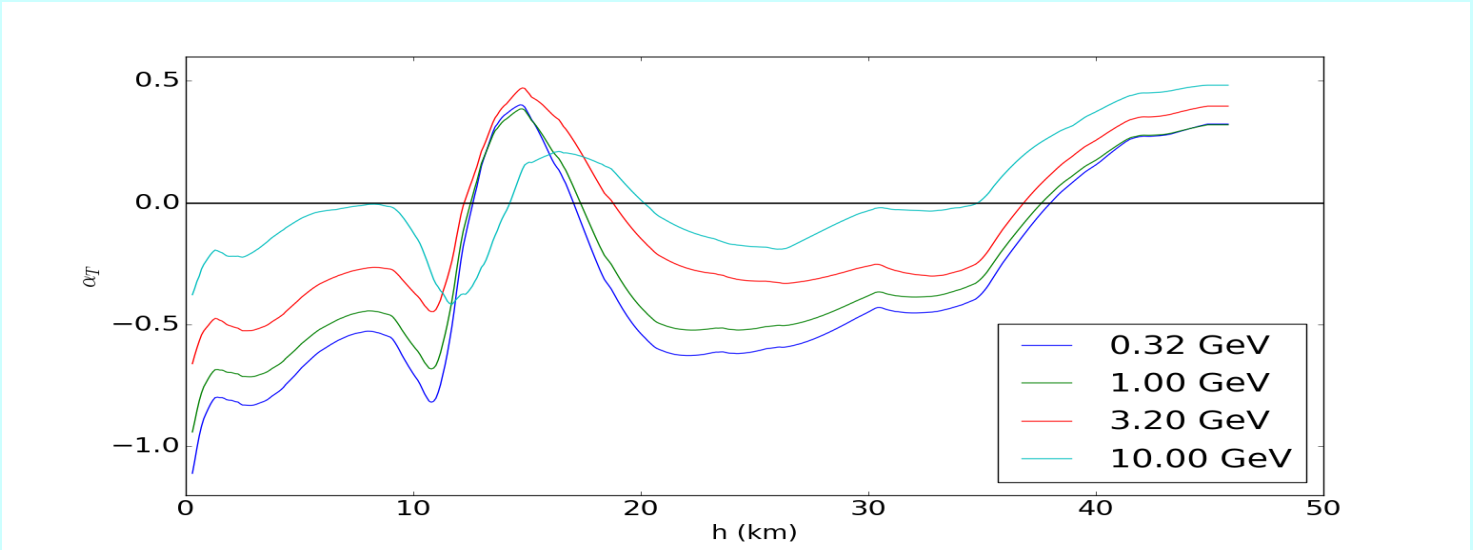
**TRAGAS**

**April-August 2015**




**SIMULATION**

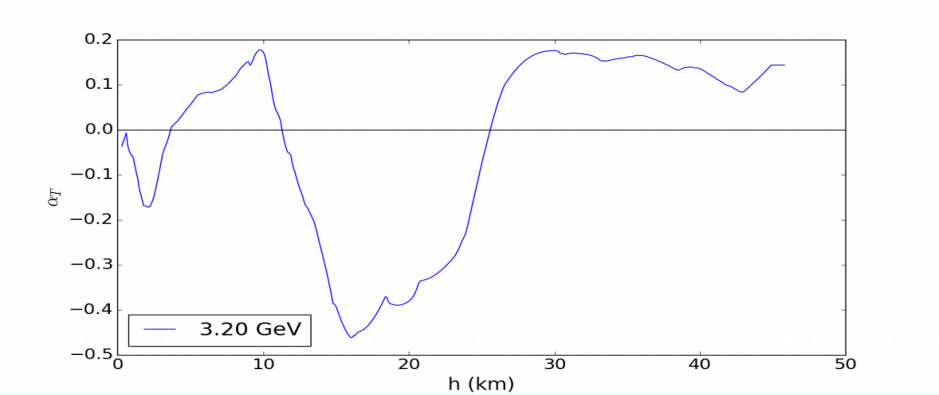
**2014 – 2015 - 2016**



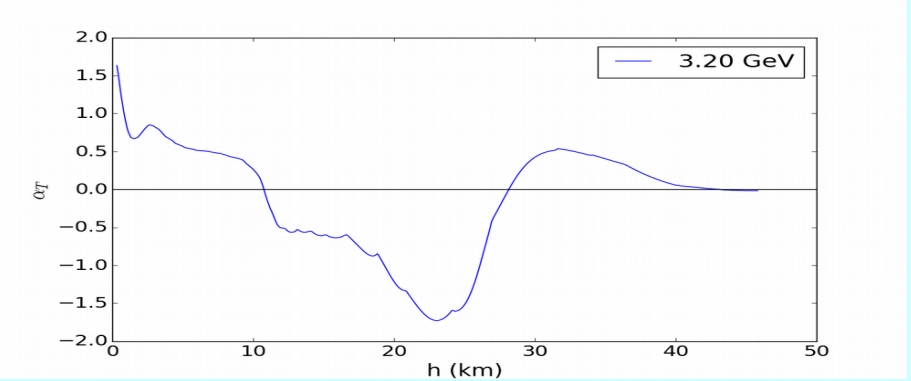
# 4. Numerical simulations

**2014 – 2015 - 2016**

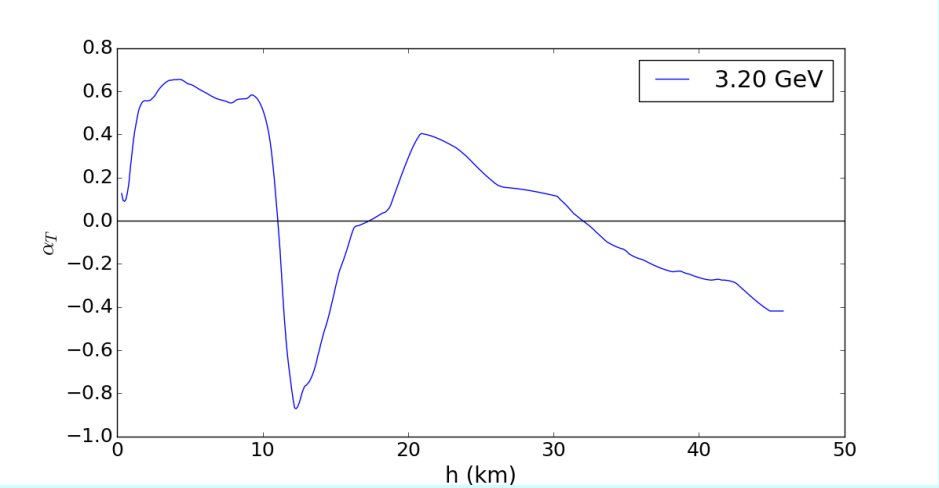
March-April-May



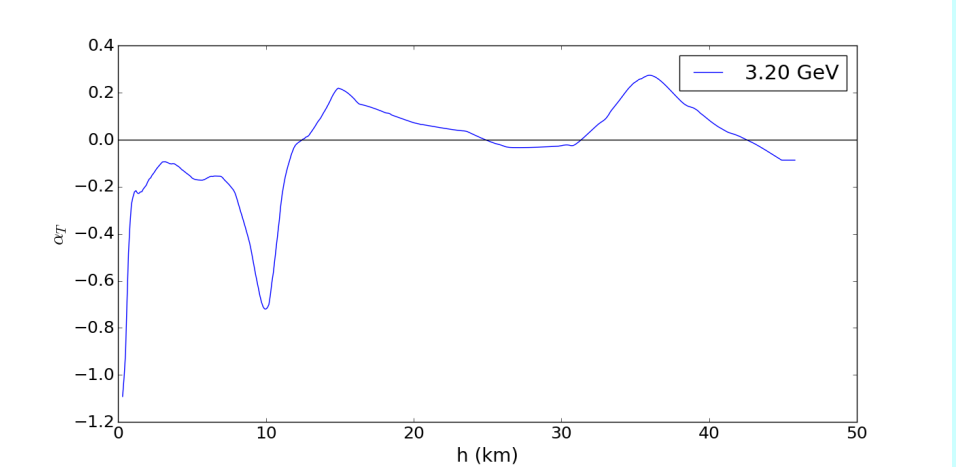

June-July-August




September-October-November




December–January-February



# 6. Conclusions

- Better understanding of the atmosphere.

- Better understanding of the multiplicities.

- Analysis of new data: 2015, 2016, 2017…

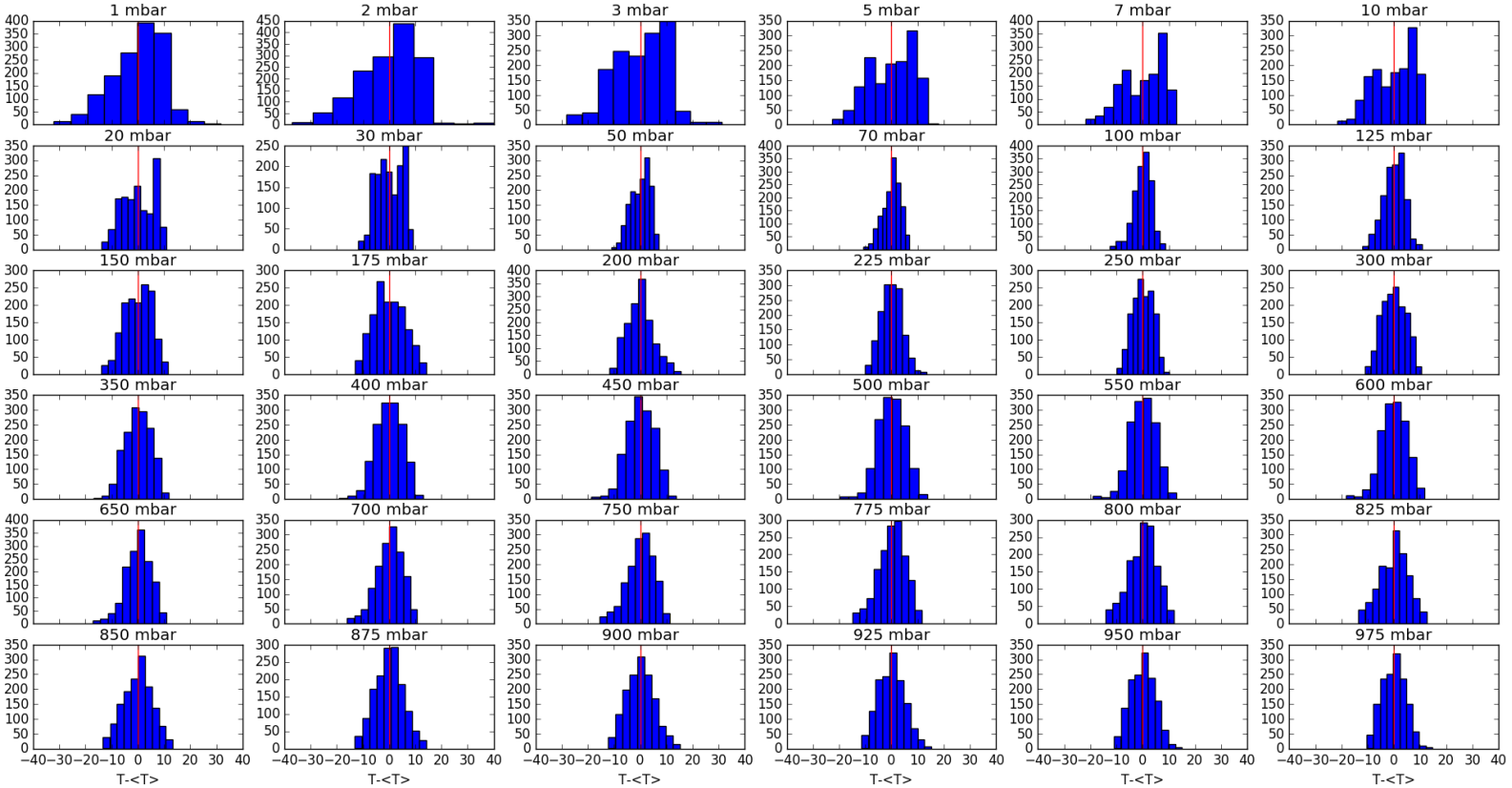
- Improving simulations.

- Etc

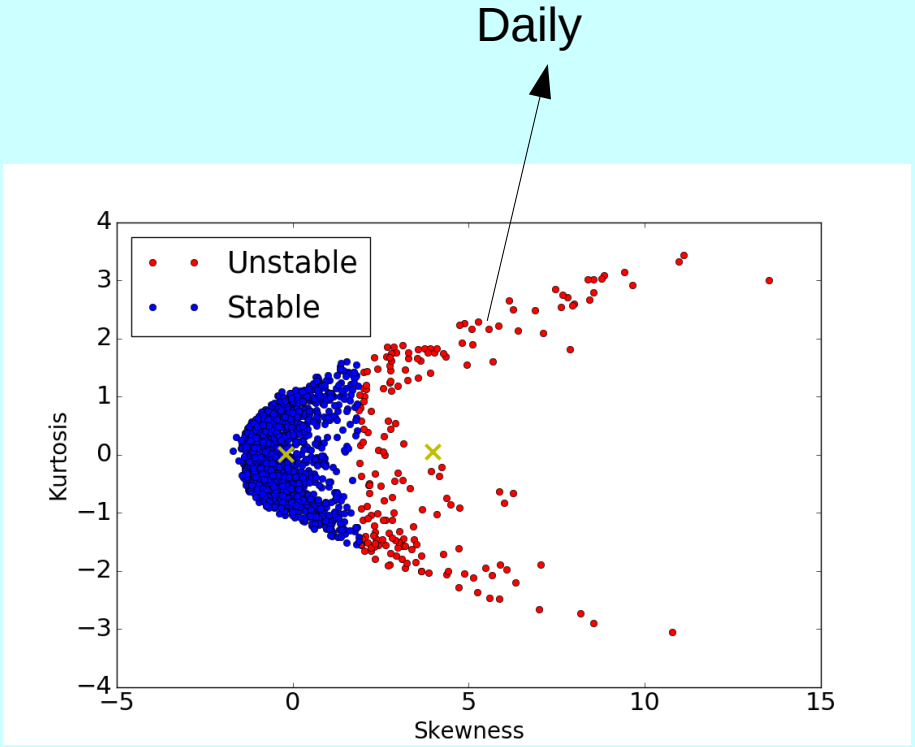
The end...

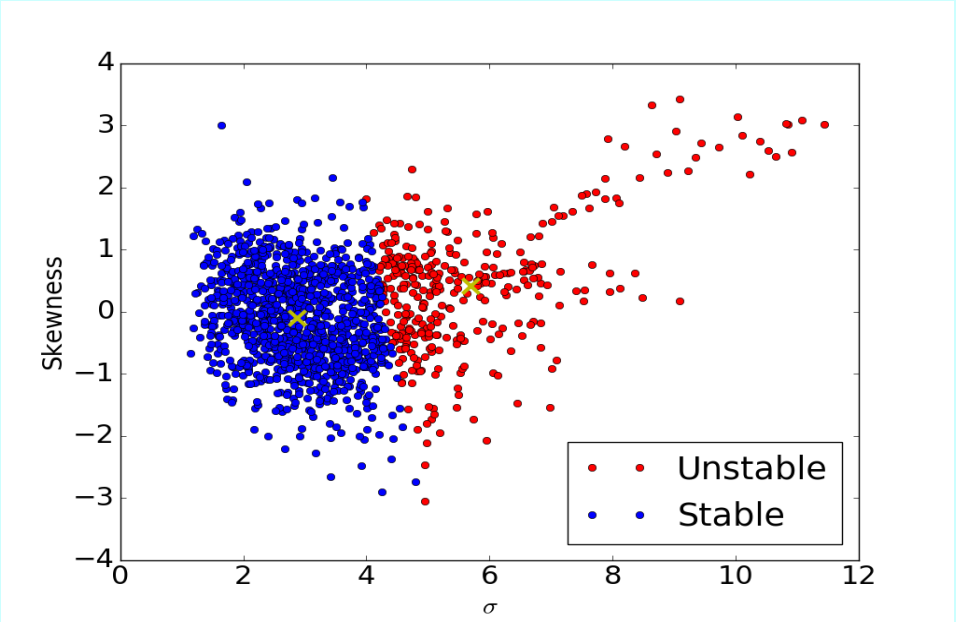
Thanks for your attention

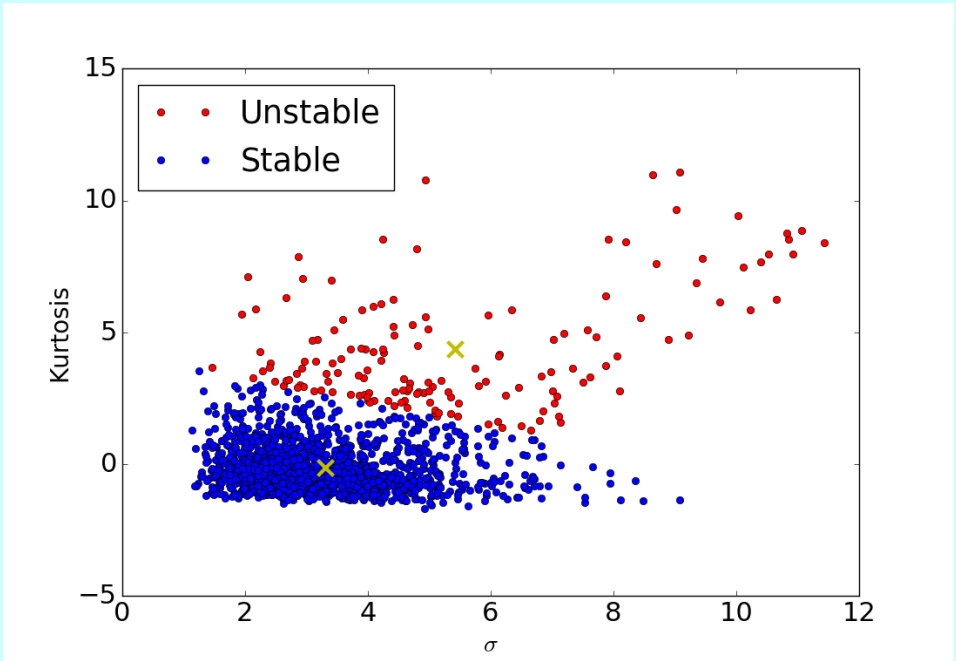
# 2. Atmosphere



# 2. Atmosphere: Sigma, Skewness and Kurtosis



# 2. Atmosphere: Fourier Analysis

**Sigma vs. Press Level**