Jet Propulsion Laboratory
California Institute of Technology

Validation of COSMIC BLH through MAGIC data

Maria Paola Manzi, Peter Kalmus, Chi Ao

Foreword

- Introduction
- Geographical distribution of Marine ARM GPCI Investigation of Clouds (MAGIC) data and Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) data
- Estimation of Boundary Layer Height (BLH) from MAGIC via:
  - minimum gradient of refractivity
  - minimum gradient of Relative Humidity (RH)
  - determination of temperature inversion
- Seasonal validation of COSMIC via these methods
- Conclusions

Introduction

- The aim of this work is the study of vertical profiles in order to discern the water vapor structure of Earth's boundary layer.
- We use the following methods to estimate of atmospheric Boundary Layer Height (BLH) from radiosondes:
  - minimum gradient of refractivity
  - minimum gradient of Relative Humidity (RH)
  - detection of the base of an elevated Temperature (T) inversion

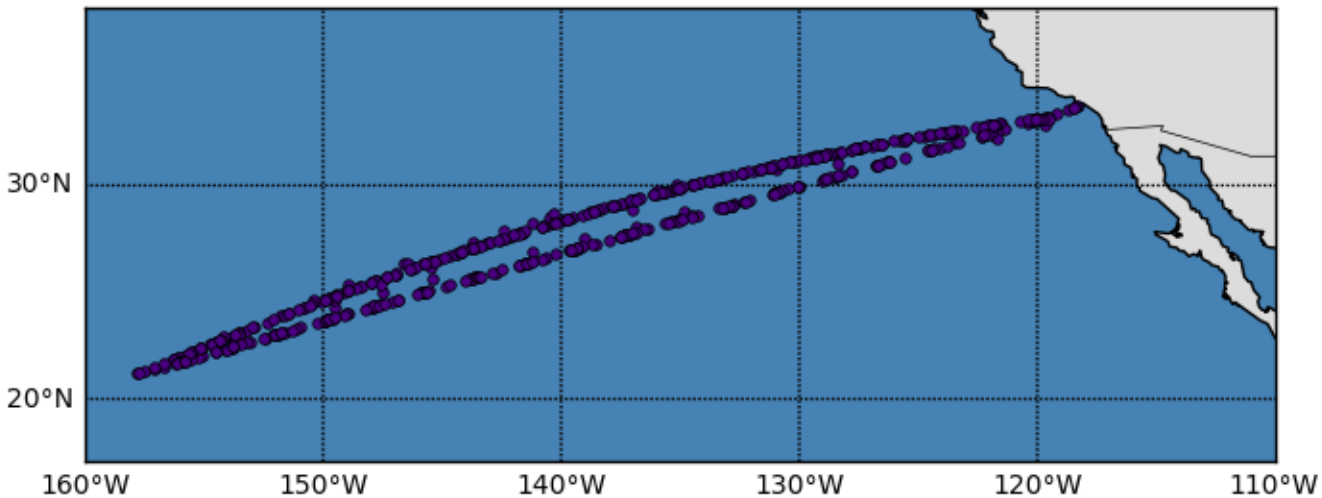
- We use these estimates to validate BLH product from COSCMIC GPS radio occultation.

- Data used to calculate BLH are radiosondes data from the ship-based Marine ARM GPCI Investigation of Clouds (MAGIC) campaign in the northeast Pacific.

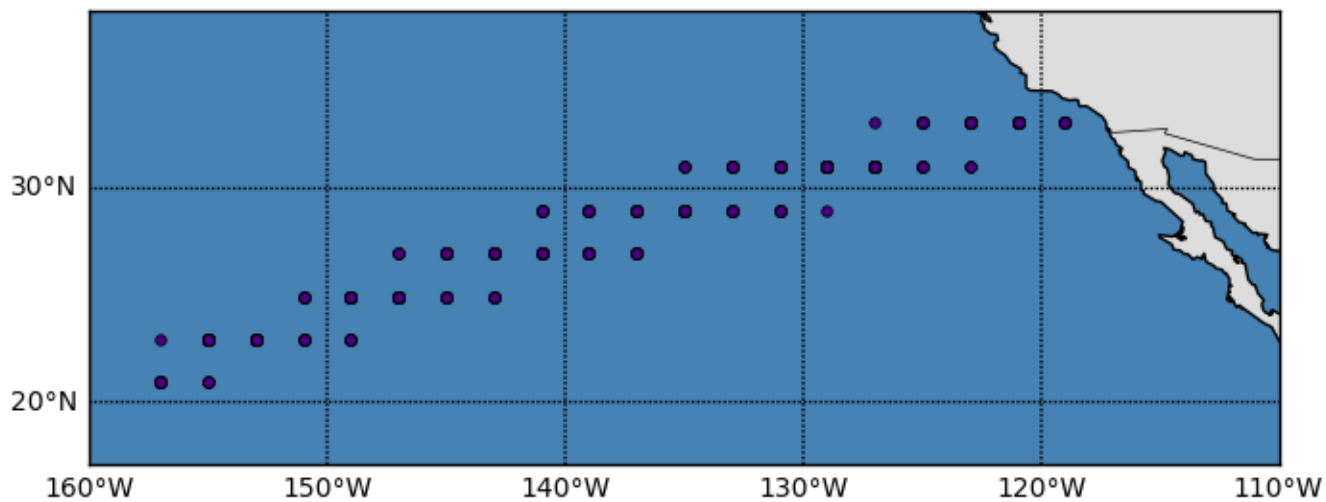
- Data used for the assessment are COSMIC data (GPS radio-occultation measurements – GPS RO) from orbiting receivers.

Geographical distribution of MAGIC and COSMIC

MAGIC data - Positions



Nearest COSMIC points (2-degree gridded climatology, 2006-2015) - Positions



BLH through the minimum vertical gradient of refractivity

To obtain refractivity profiles from radiosondes:

[Smith and Weintraub, 1953]

$$N = 77.6\frac{P}{T} + 3.73 \times 10^5 \frac{P_w}{T^2}, \qquad (1)$$

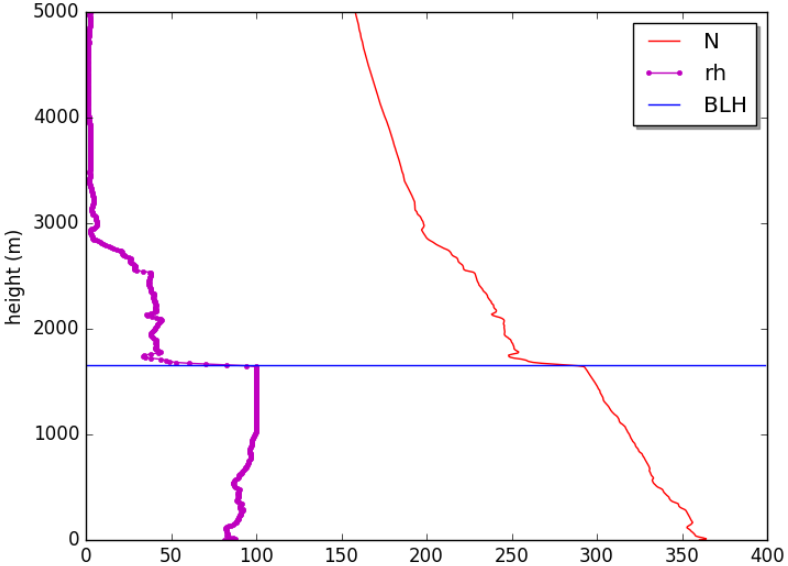
where P is atmospheric pressure (hPa) and P_w atmospheric vapor pressure (hPa), T is in Kelvin, and refractivity N

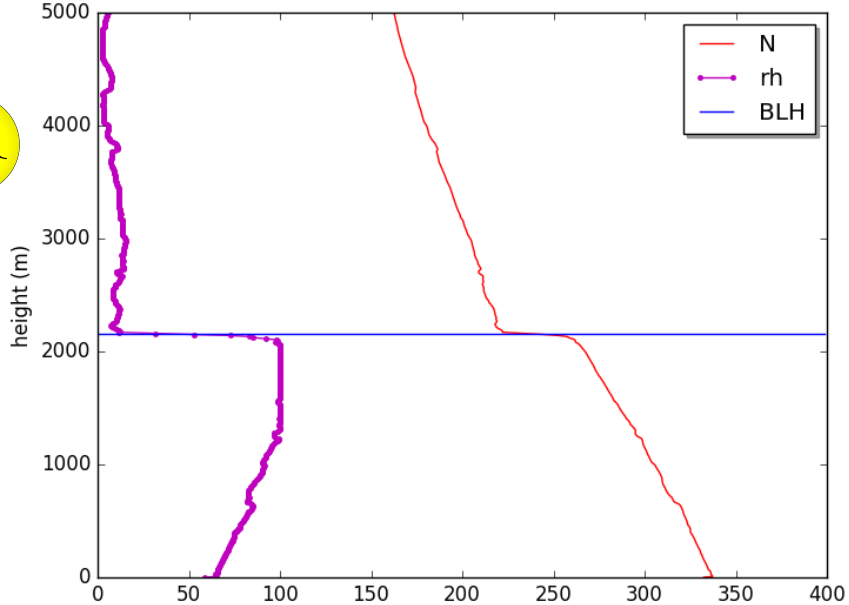
Whatever the atmospheric parameter considered, the BLH is more clearly detected in the presence of strong inversions.

The comparisons have been calculated for each season.

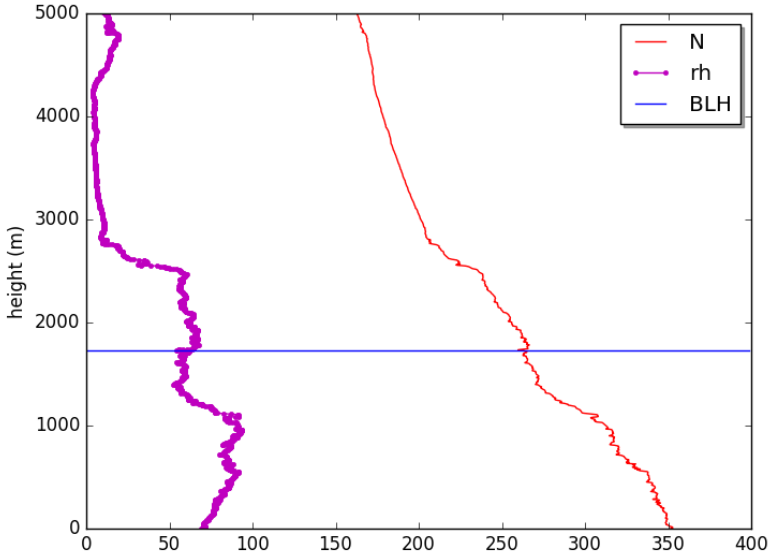
BLH through the minimum vertical gradient of refractivity

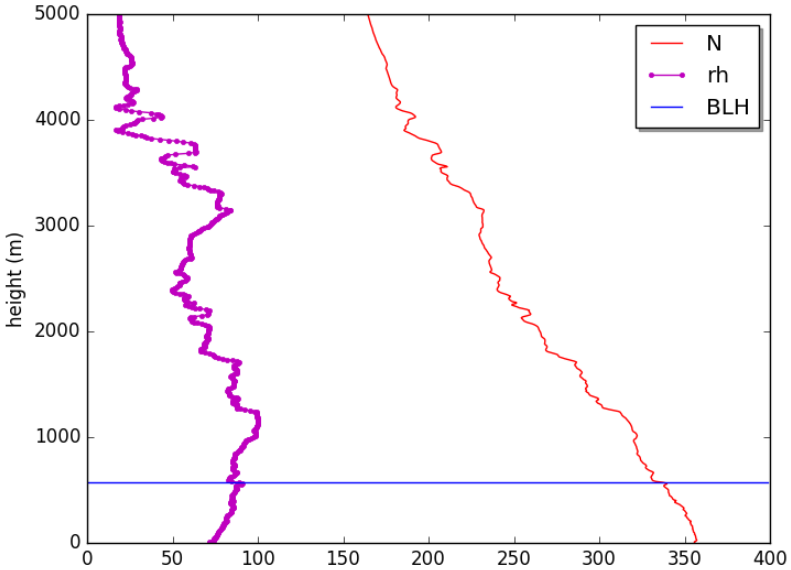
Strong inversions



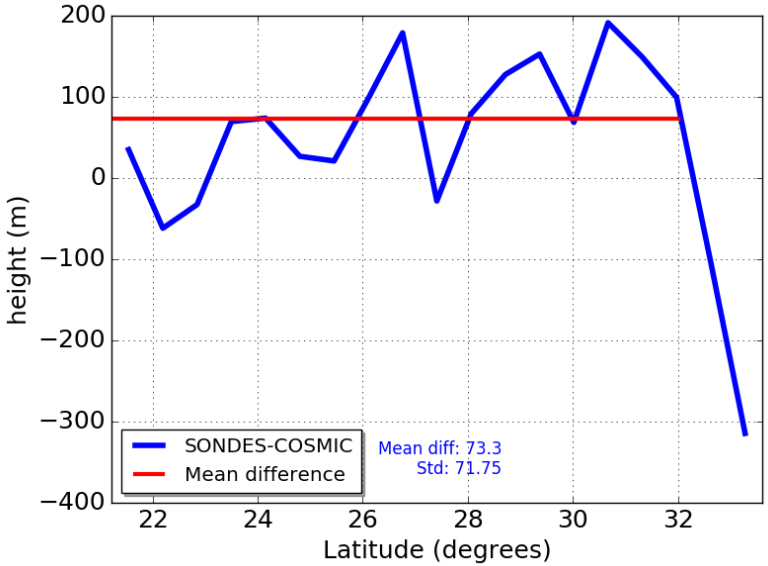


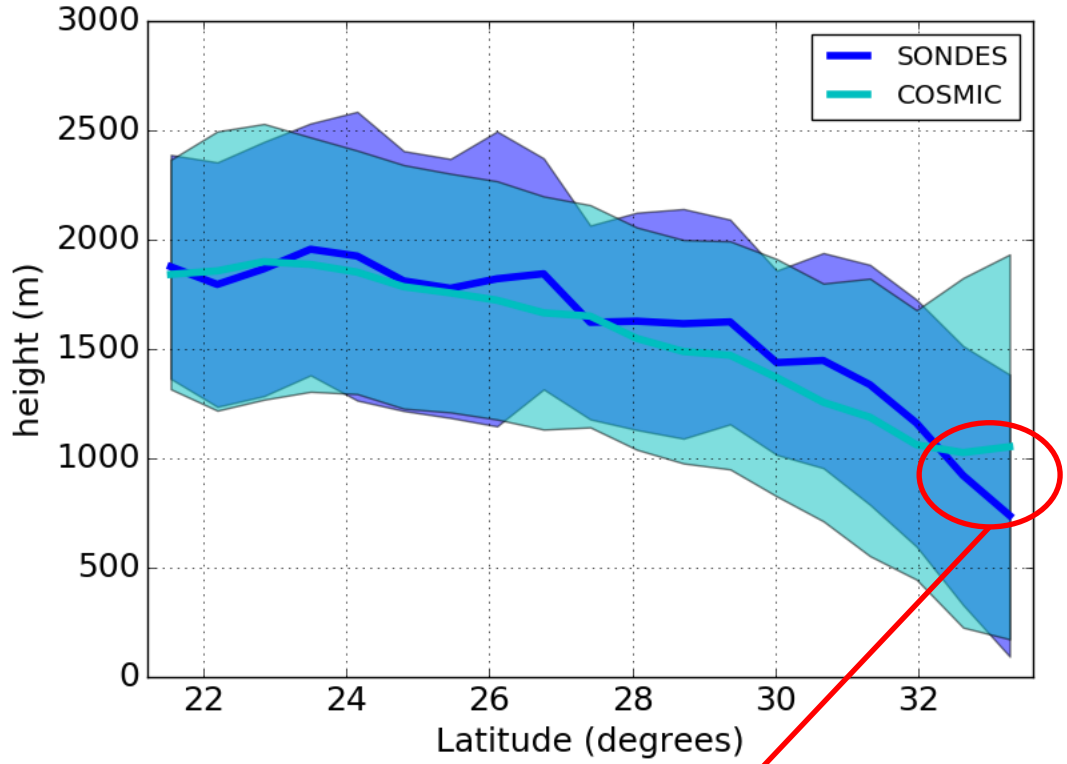
Weak / indeterminate inversions – **more than 60 over 542 samples**





BLH through min. grad. of refractivity – comparison with COSMIC values

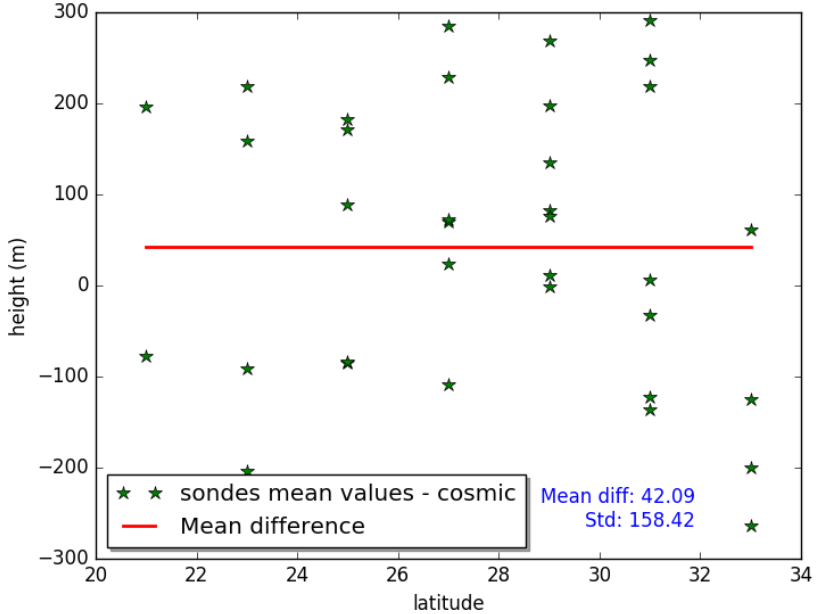


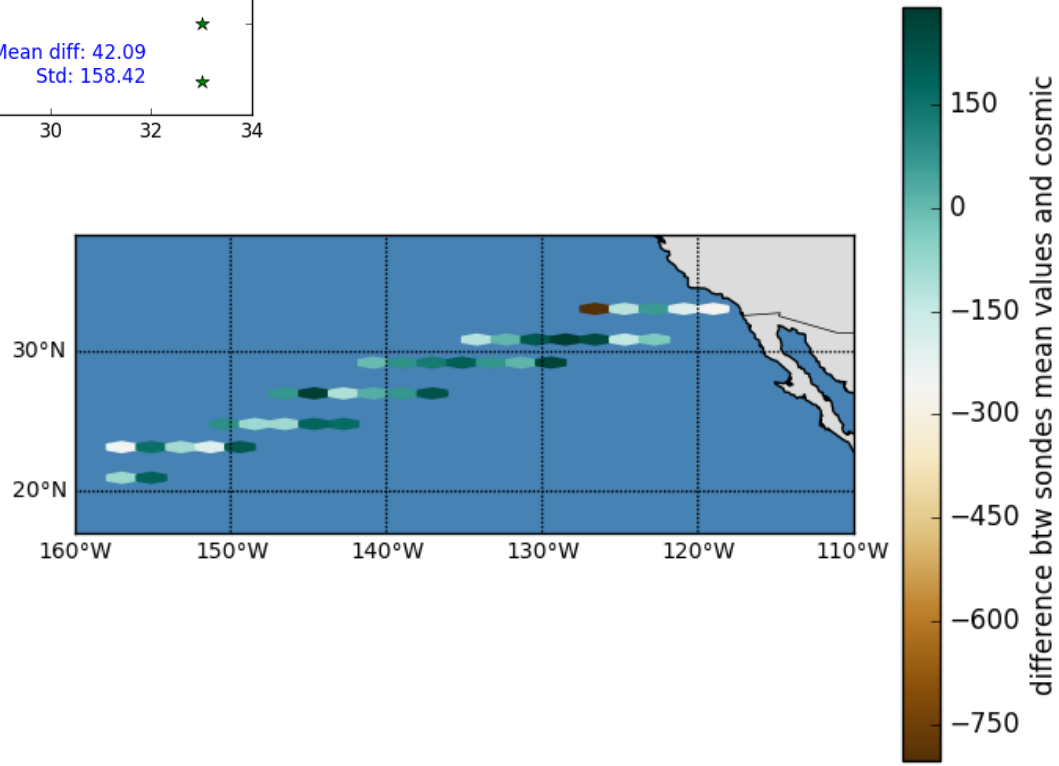


The comparison with COSMIC data has been realized in terms of differences of BLH values, through different latitudes

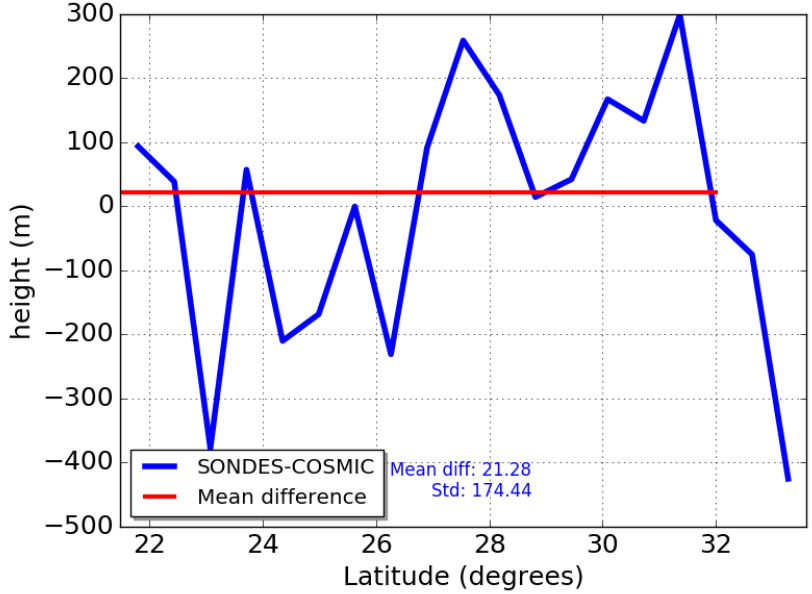
Probable land contamination of the ocean data near Los Angeles.

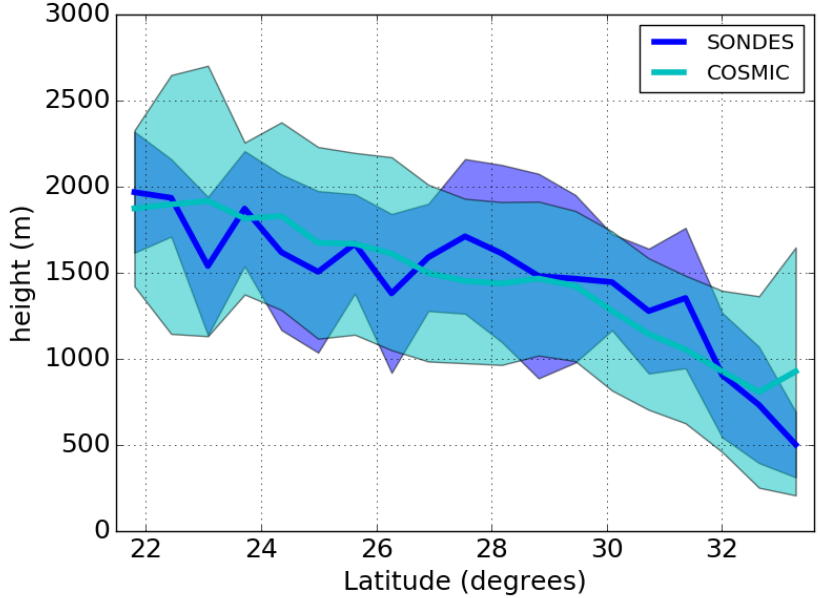
BLH through min. grad. of refractivity – comparison with COSMIC (mean values)

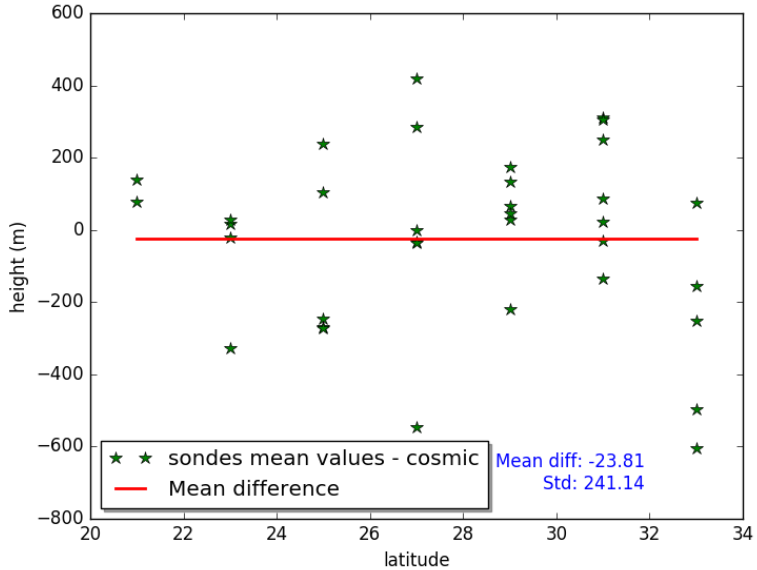


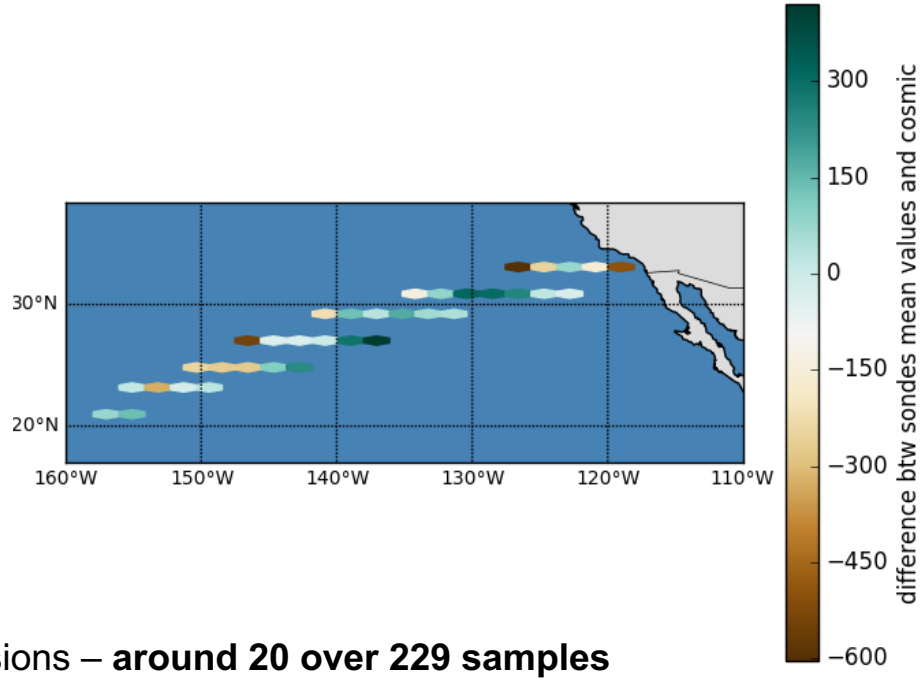


BLH through min. grad. of refract. – comparison with COSMIC values (JJA)



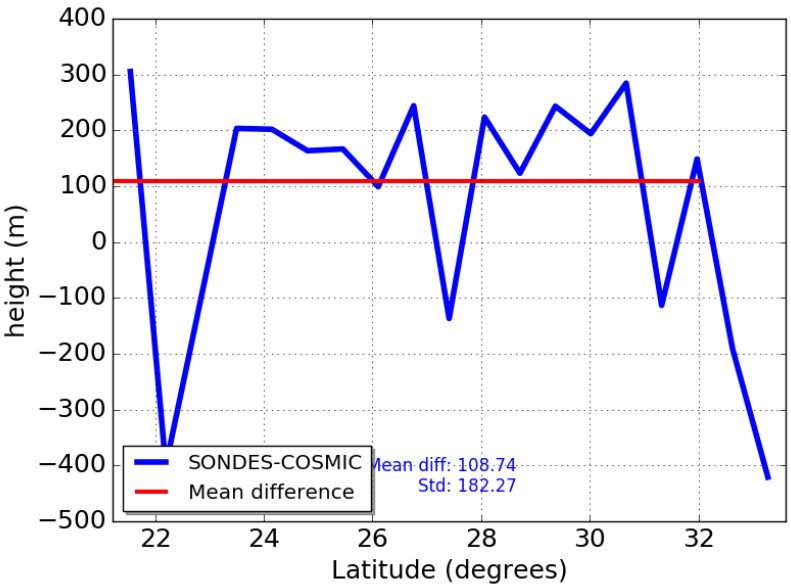


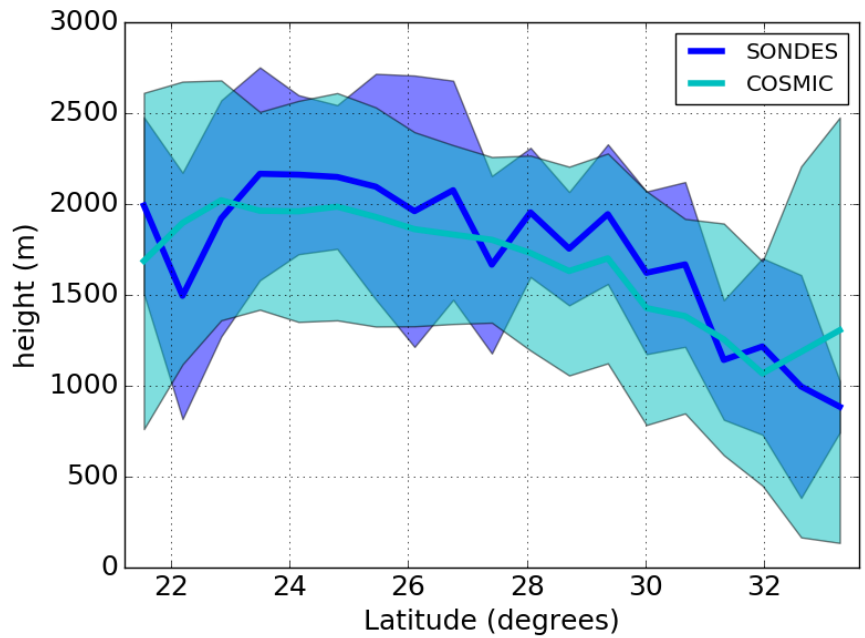


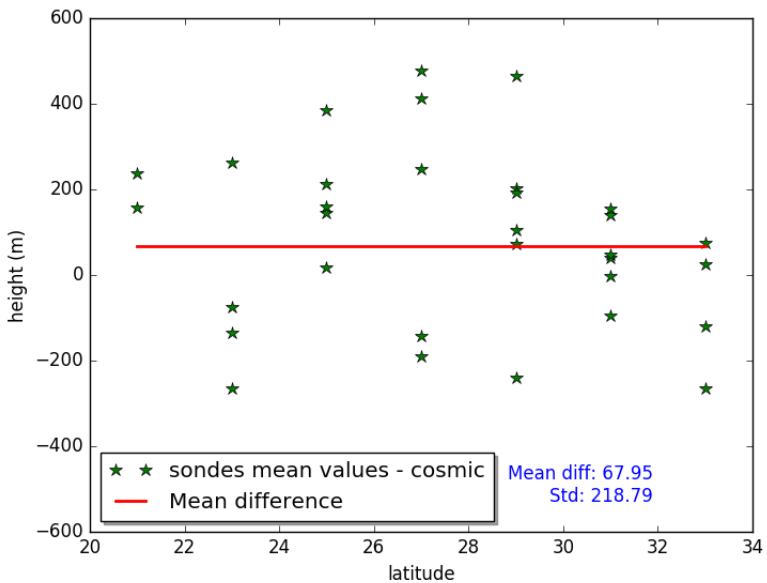


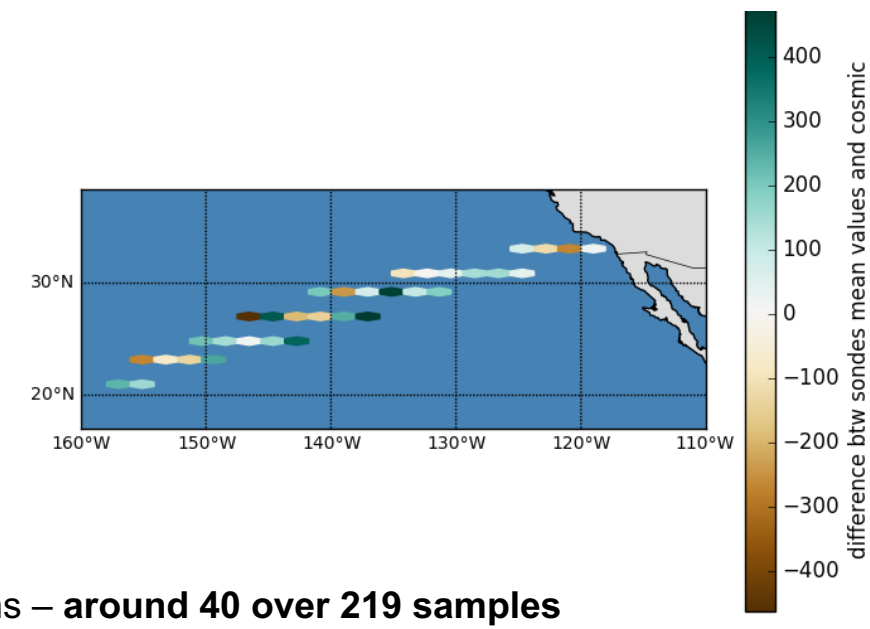
☹ Weak / indeterminate inversions – **around 20 over 229 samples**

BLH through min. grad. of refract. – comparison with COSMIC values (SON)





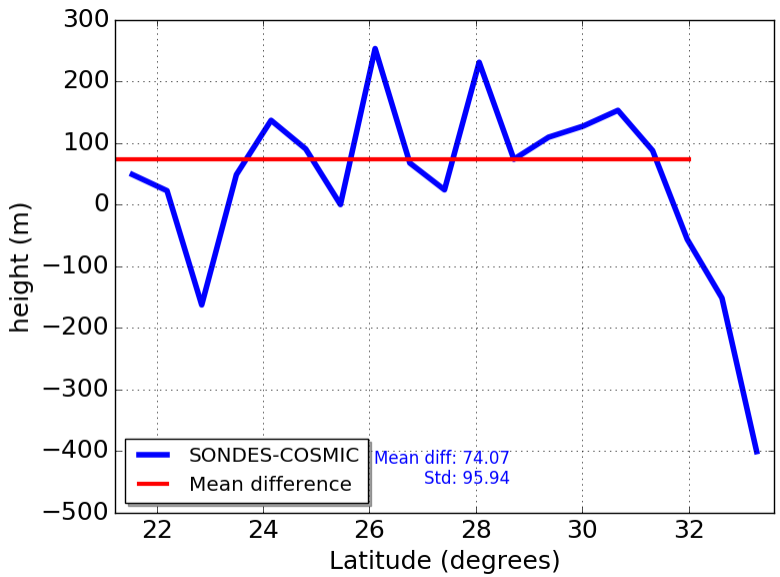


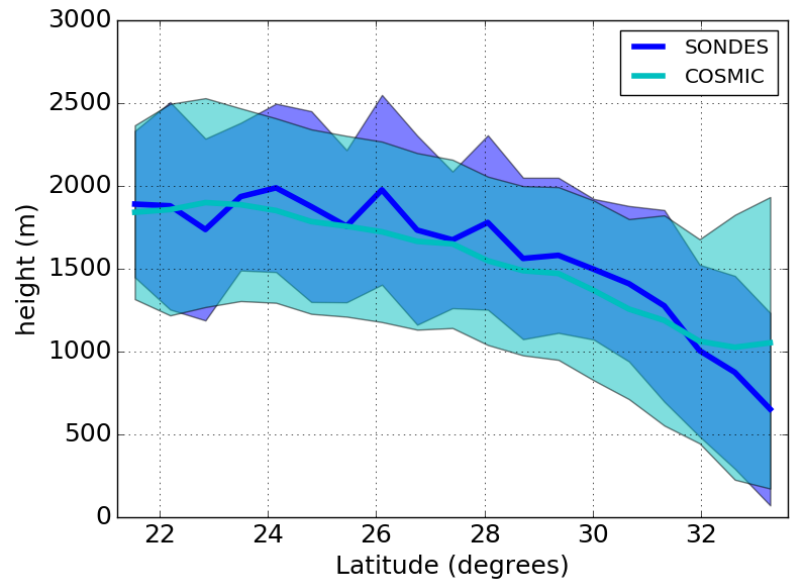


Weak / indeterminate inversions – **around 40 over 219 samples**

BLH through min. grad. of refract. – smoothing (using a moving average at 100m)

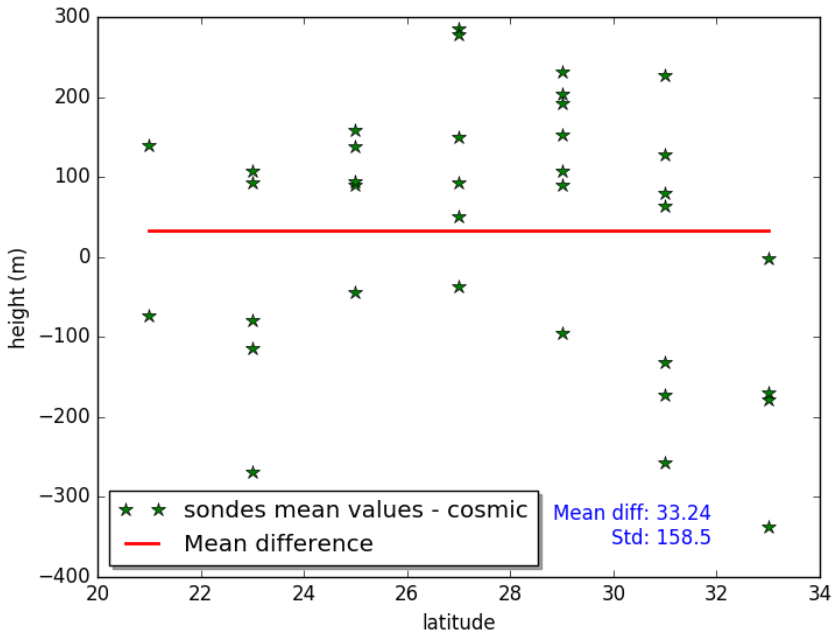
The higher vertical resolution of soundings with respect to that of COSMIC could introduce an error while performing the assessment.
Another approach considered to avoid that error is the smoothing of vertical values of soundings, using a moving avarage at 100 m.

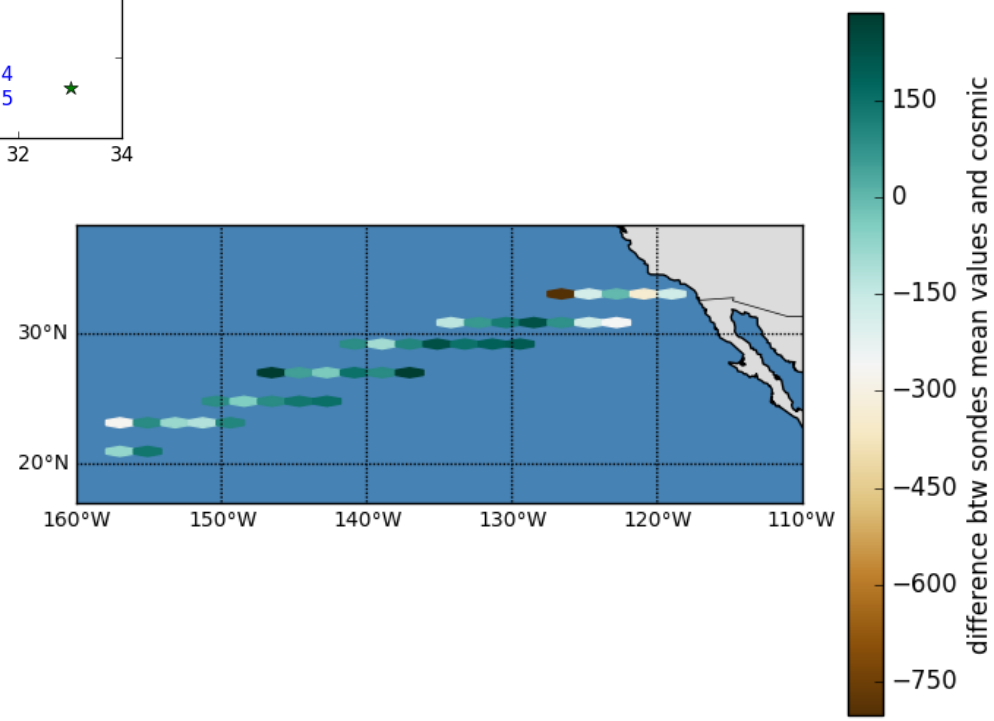




Weak / indeterminate inversions – **more than 50 over 542 samples**

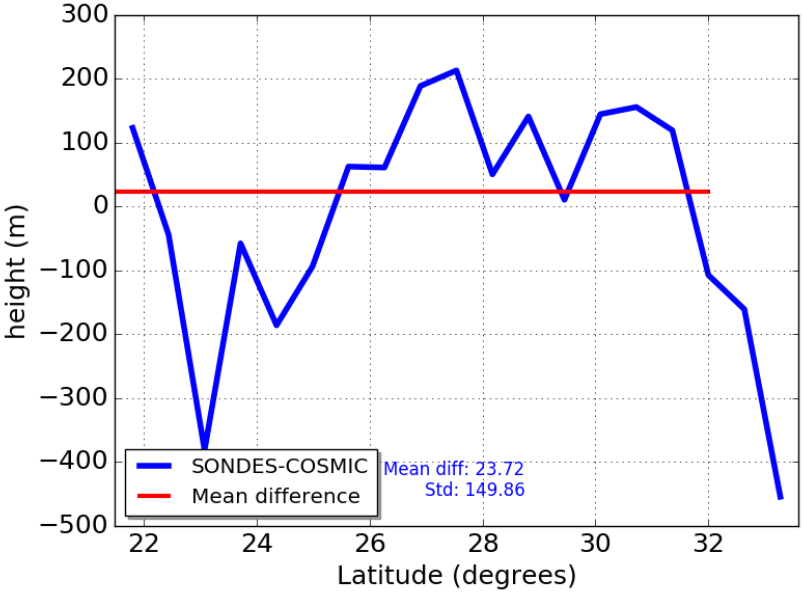
BLH through min. grad. of refract. – smoothing (using a moving average at 100m)

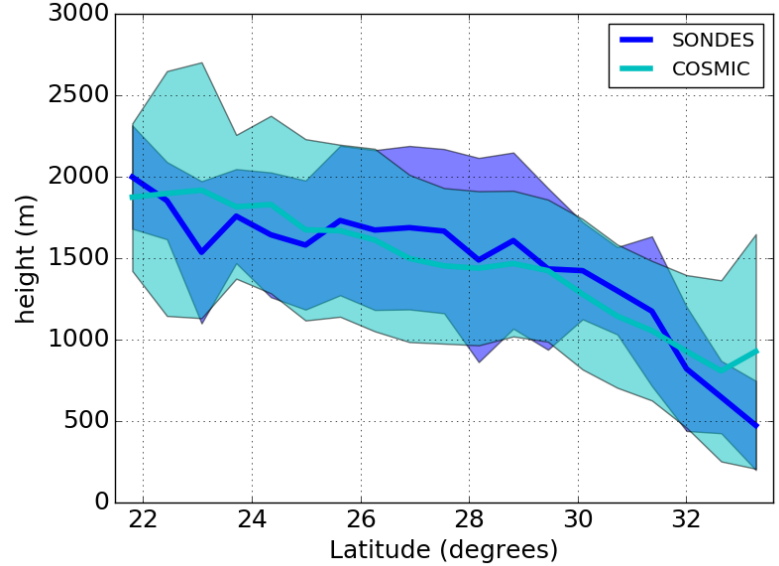


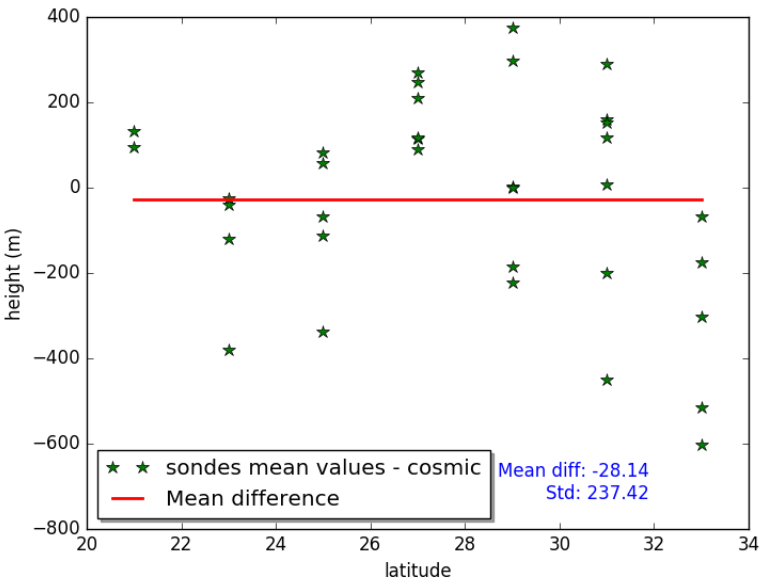


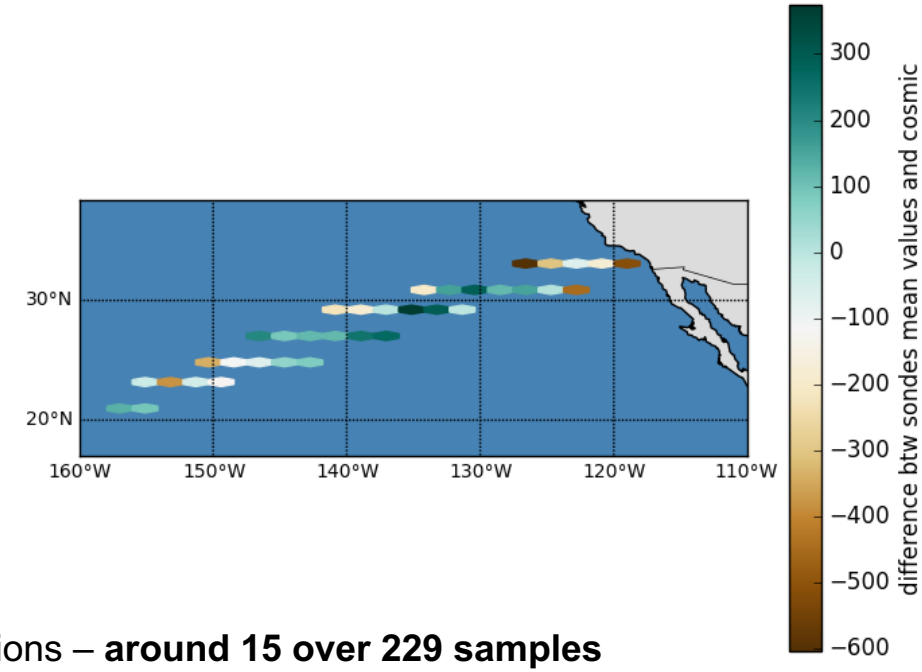
☹ Weak / indeterminate inversions – **more than 50 over 542 samples**

BLH through min. grad. of refractivity – smoothing (JJA)



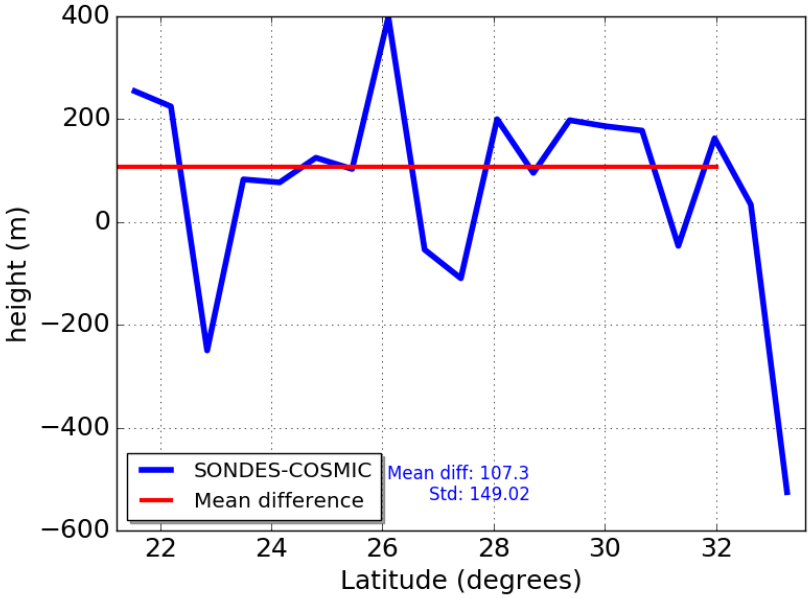


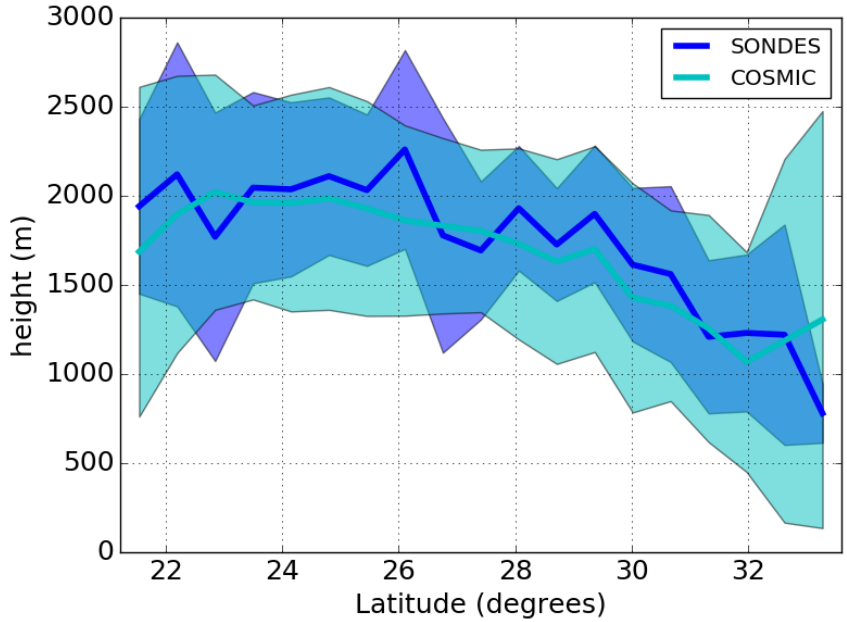


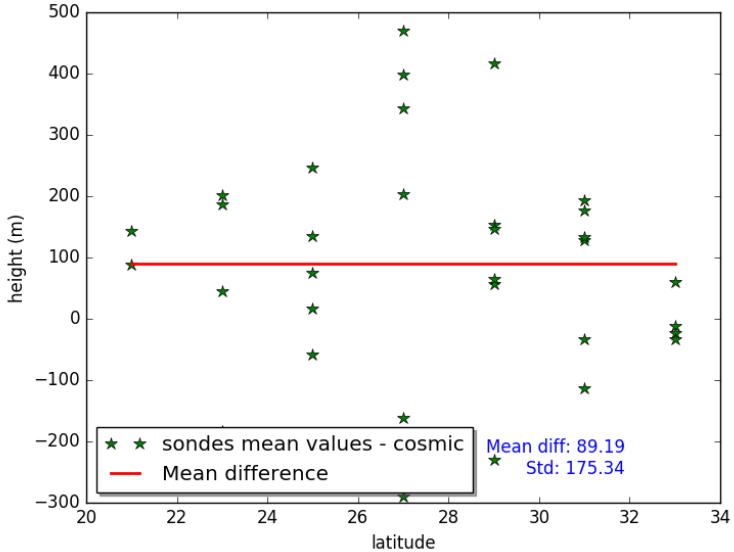


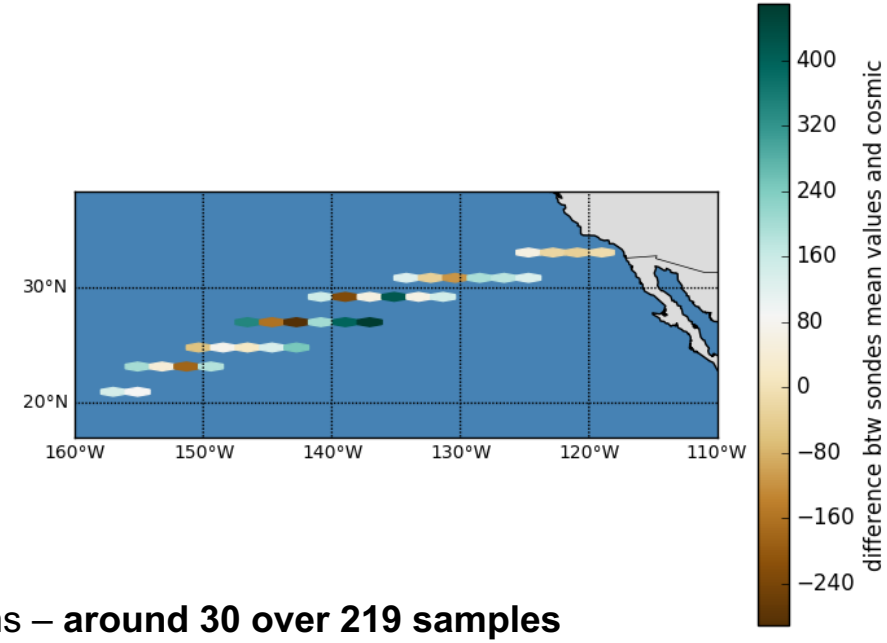
Weak / indeterminate inversions – **around 15 over 229 samples**

BLH through min. grad. of refractivity – smoothing (SON)





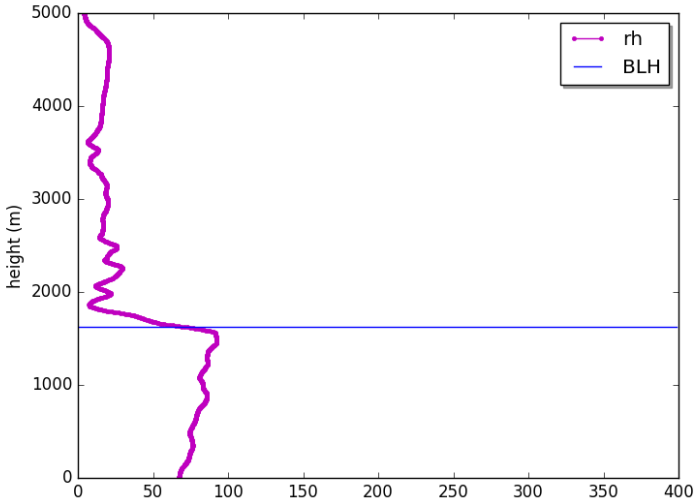


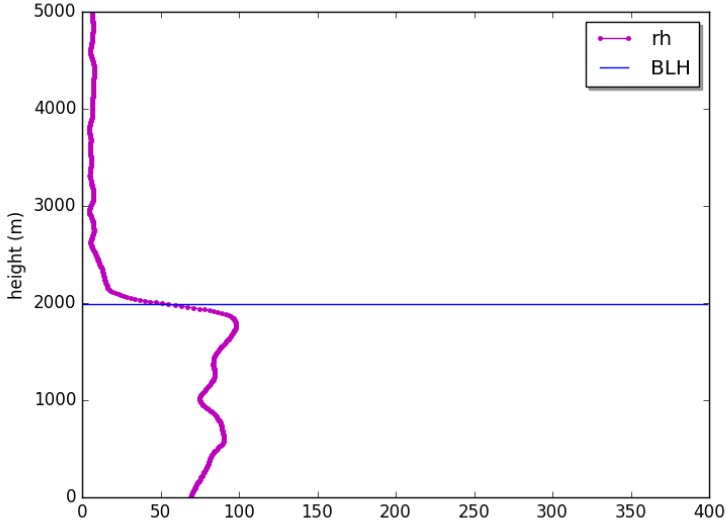


Weak / indeterminate inversions – **around 30 over 219 samples**

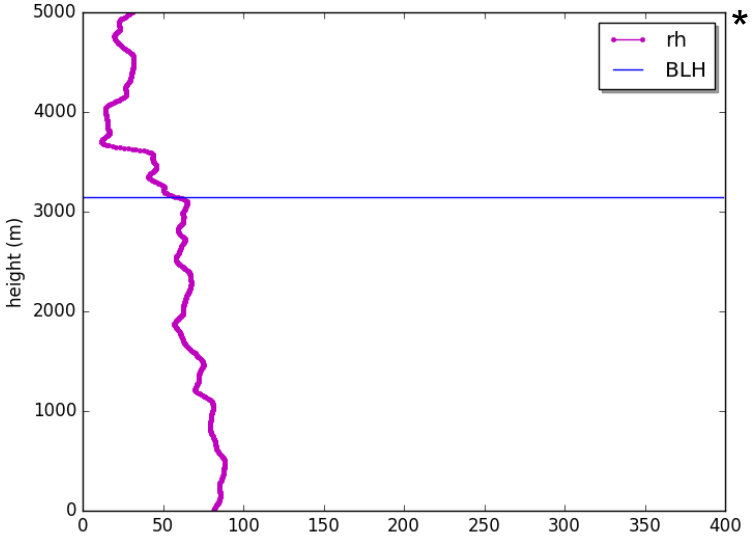
BLH through the minimum vertical gradient of RH

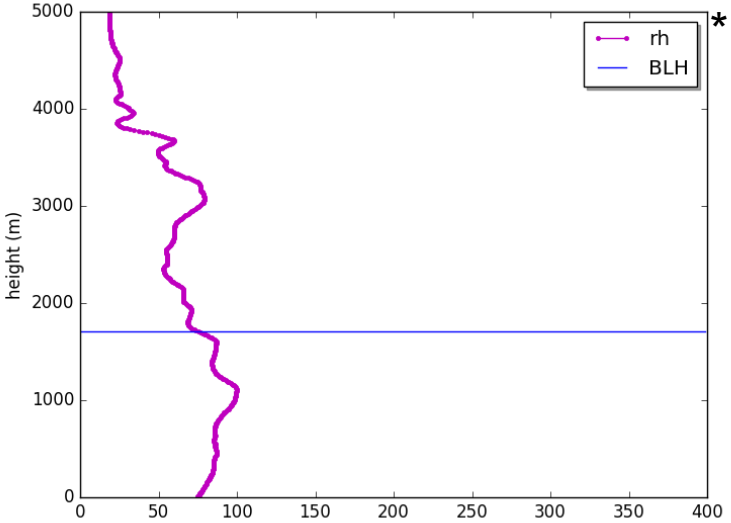
Strong inversions





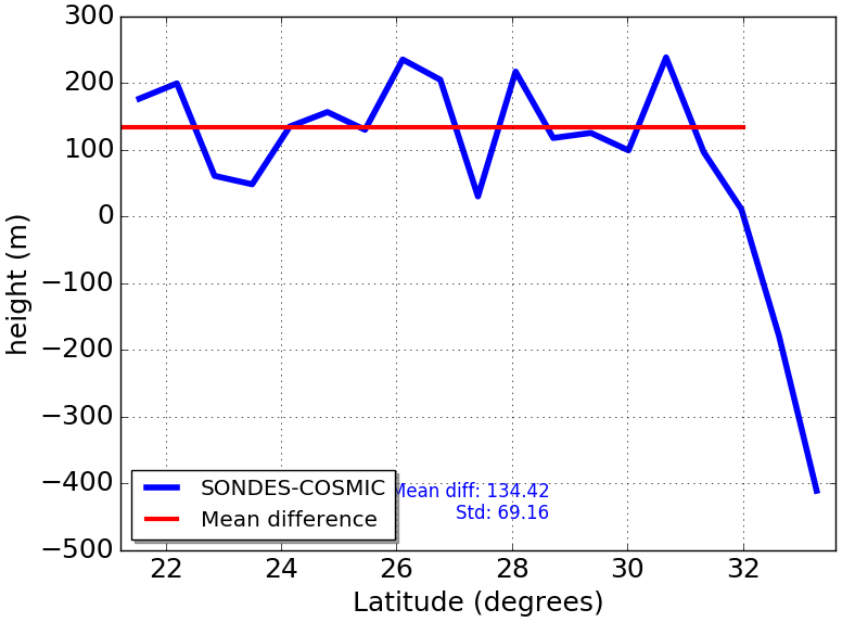
*Near Hawaii Latitude

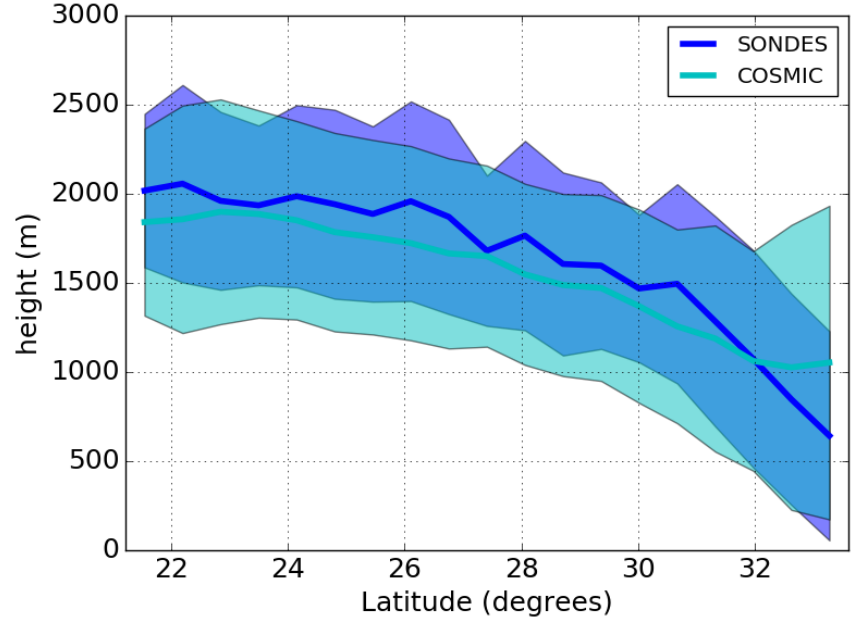


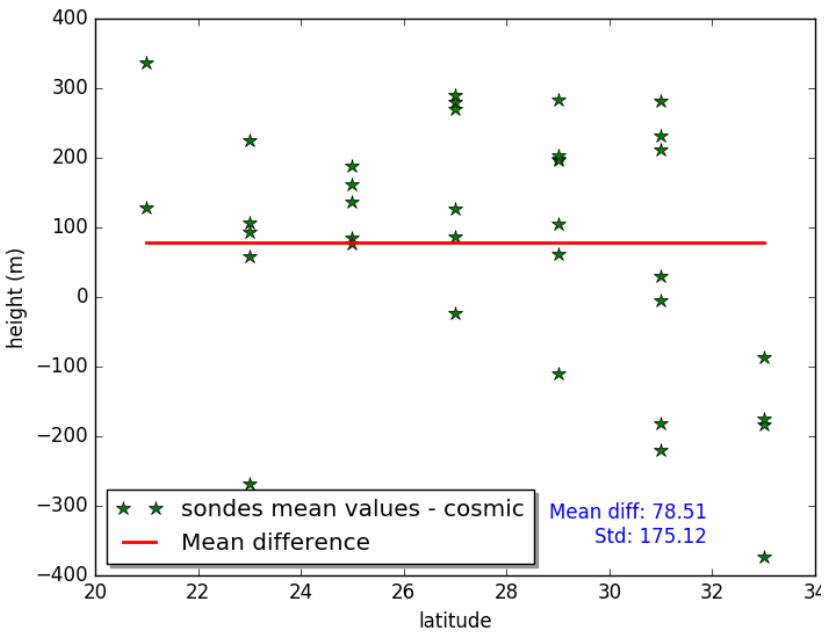


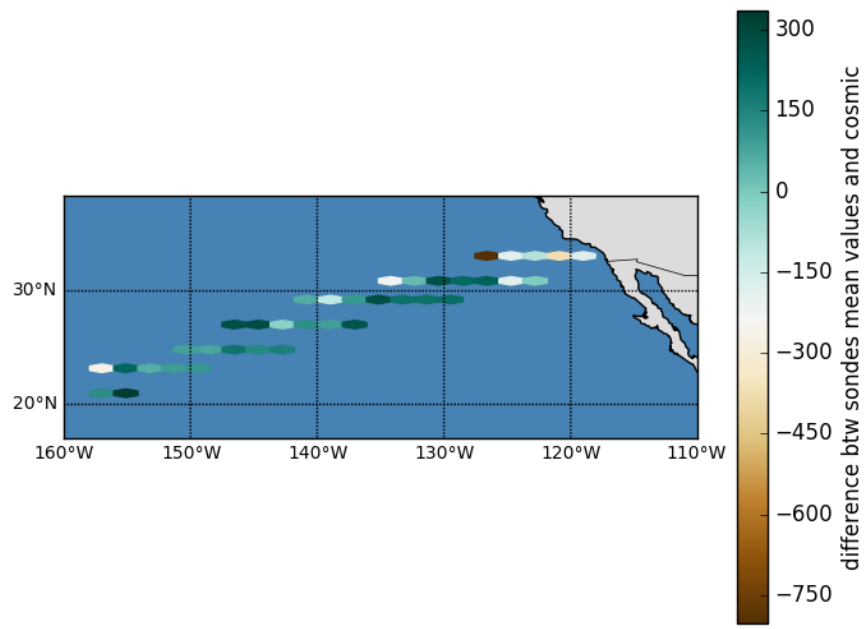
Weak / indeterminate inversions – **around 30 over 542 samples**

BLH through min. grad. of RH – comparison with COSMIC values

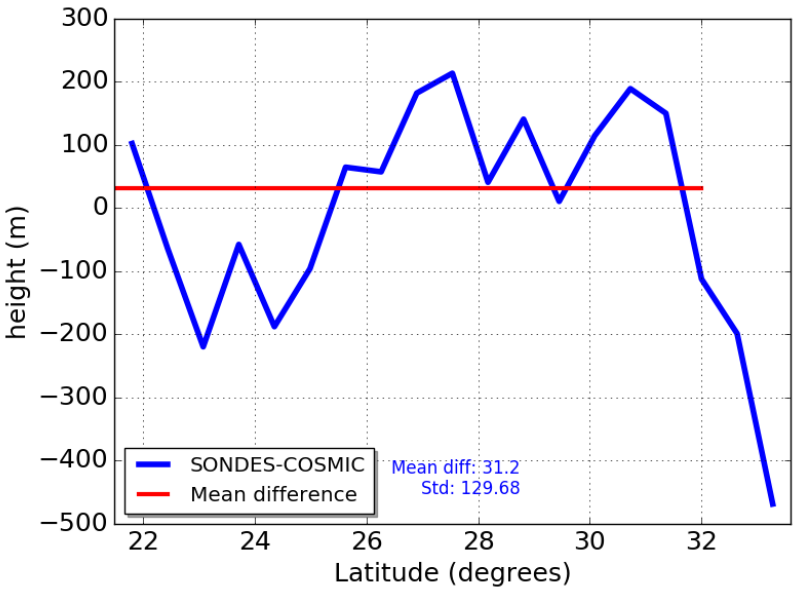


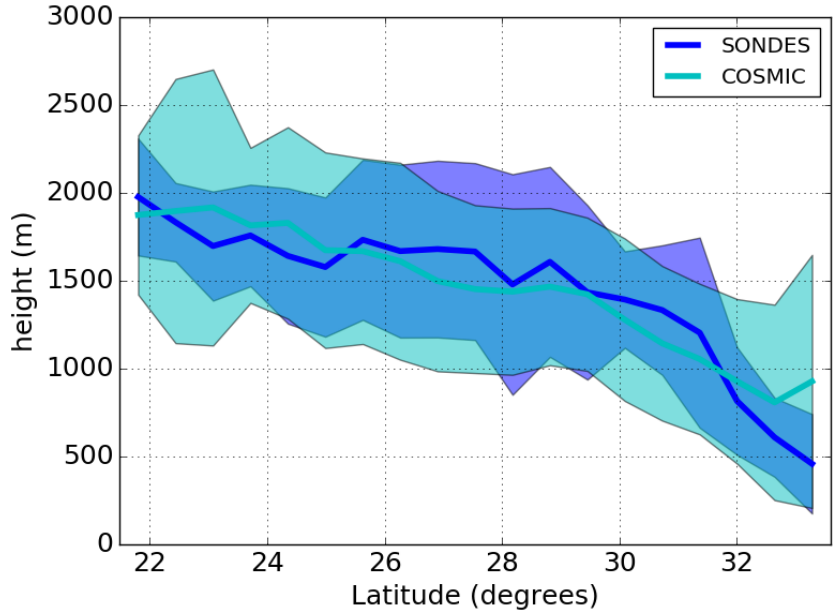


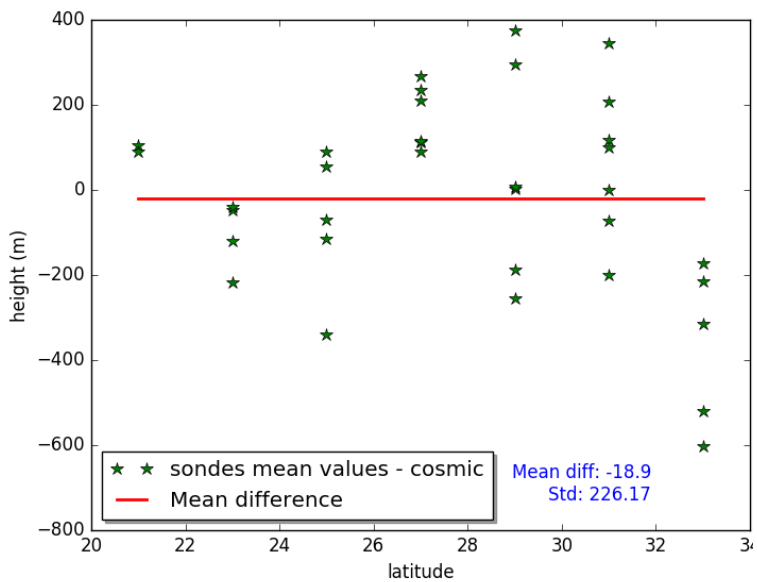


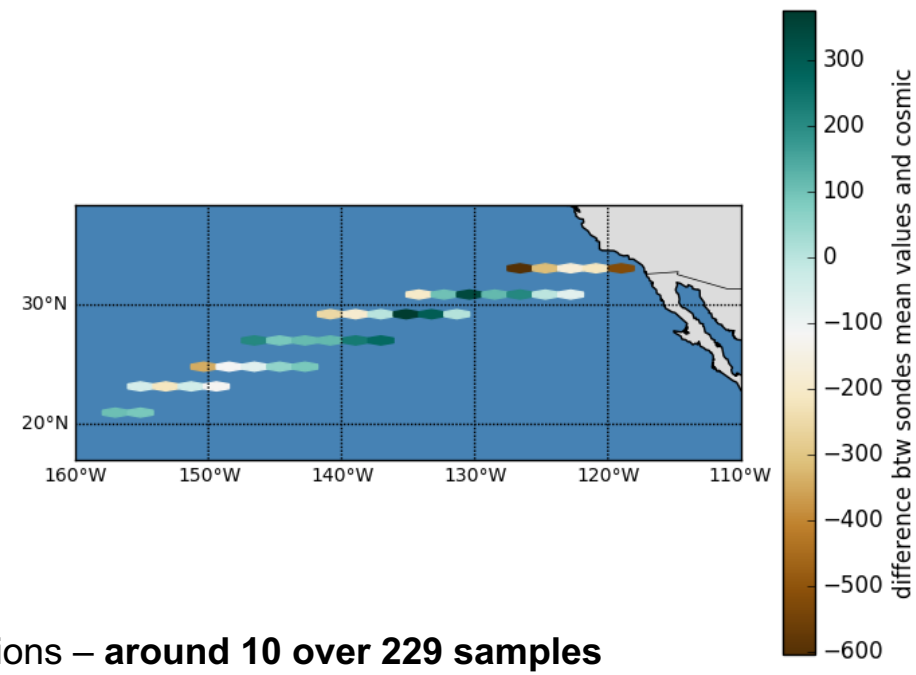


BLH through min. grad. of RH – comparison with COSMIC values (JJA)



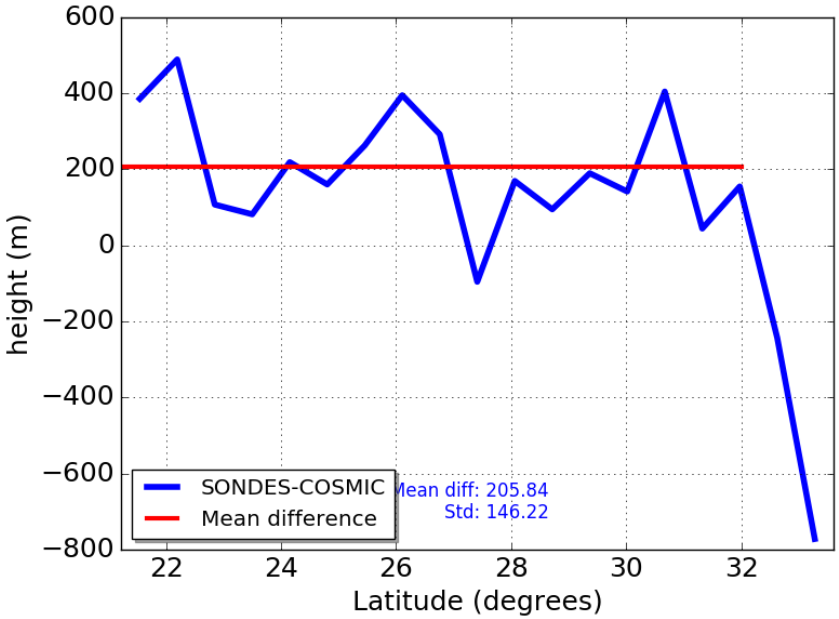


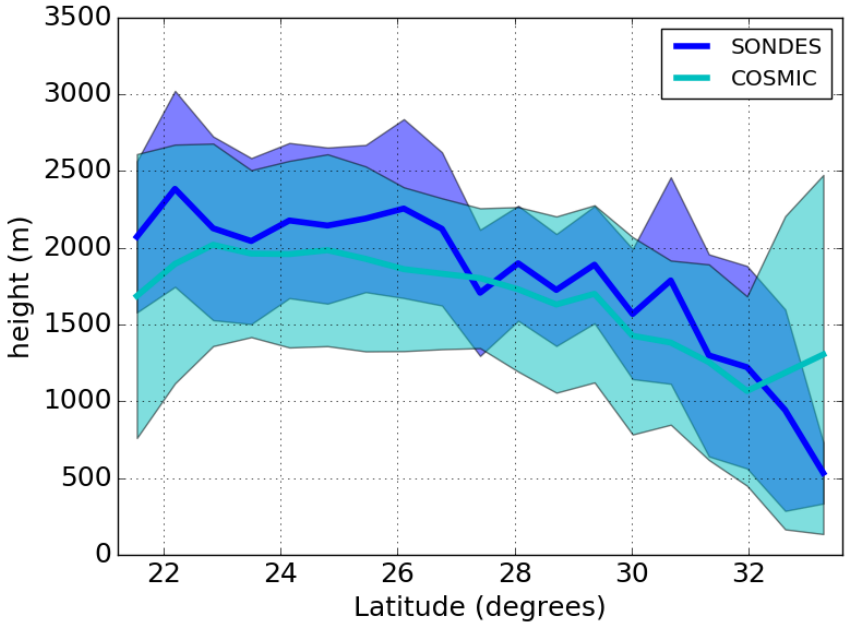


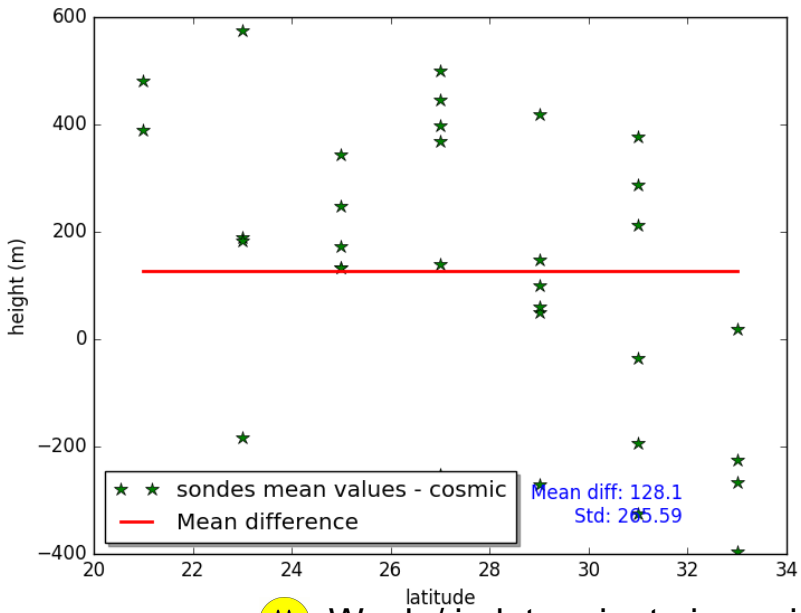


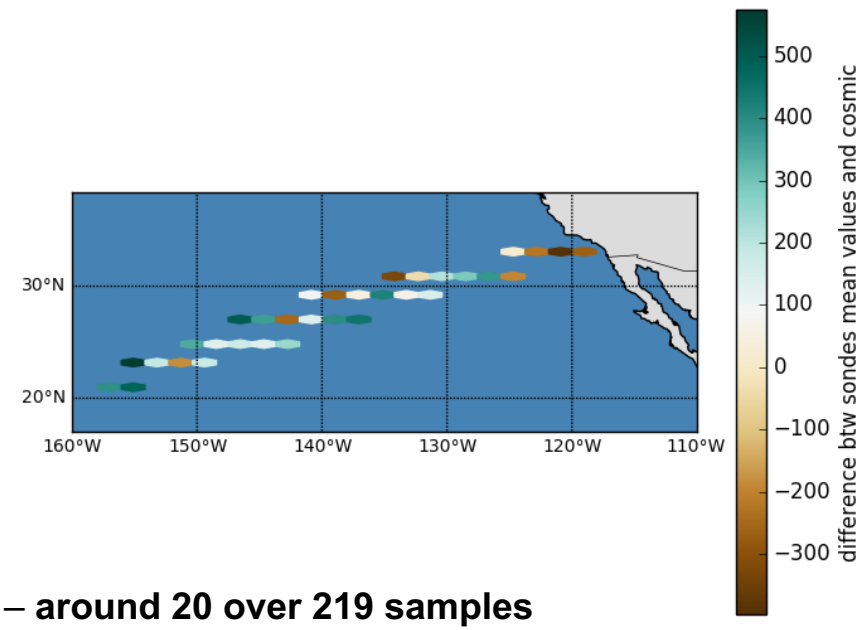
Weak / indeterminate inversions – **around 10 over 229 samples**

BLH through min. grad. of RH – comparison with COSMIC values (SON)





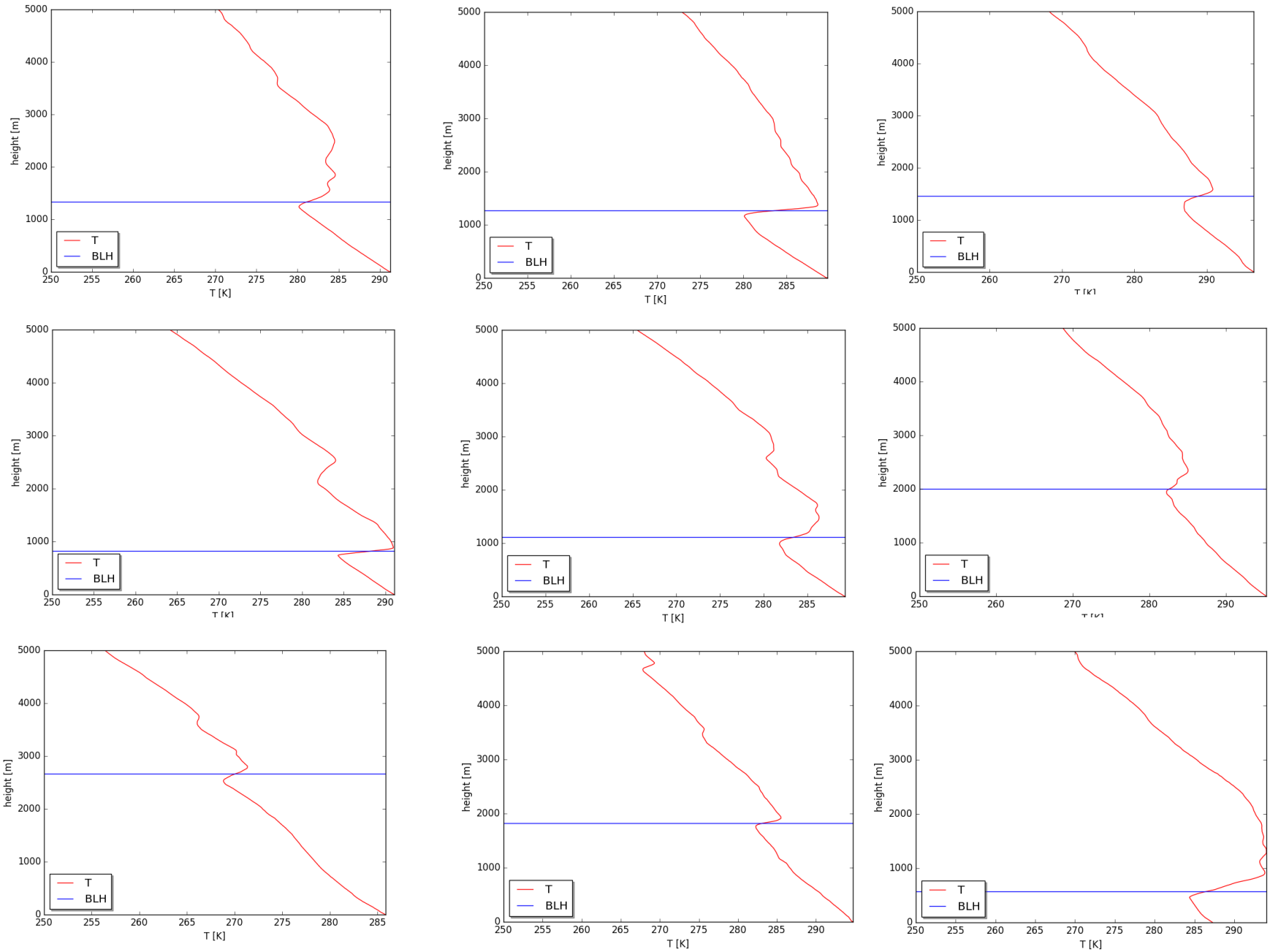




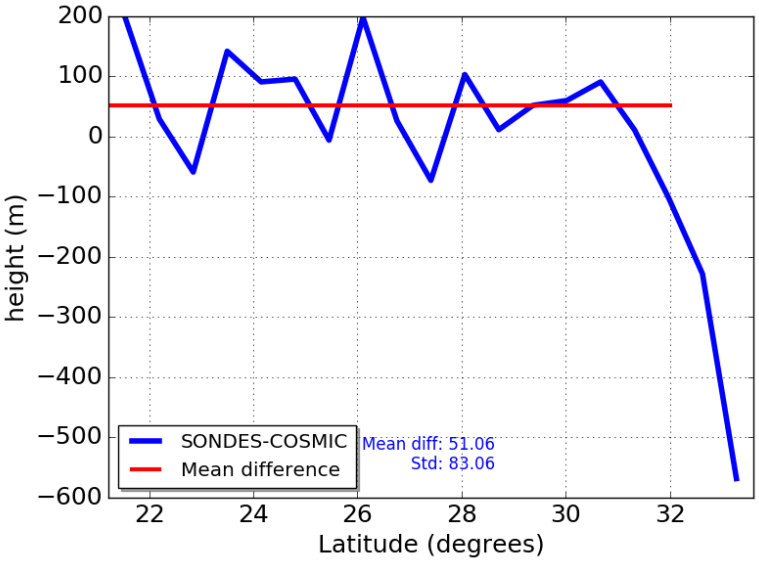
Weak / indeterminate inversions – **around 20 over 219 samples**

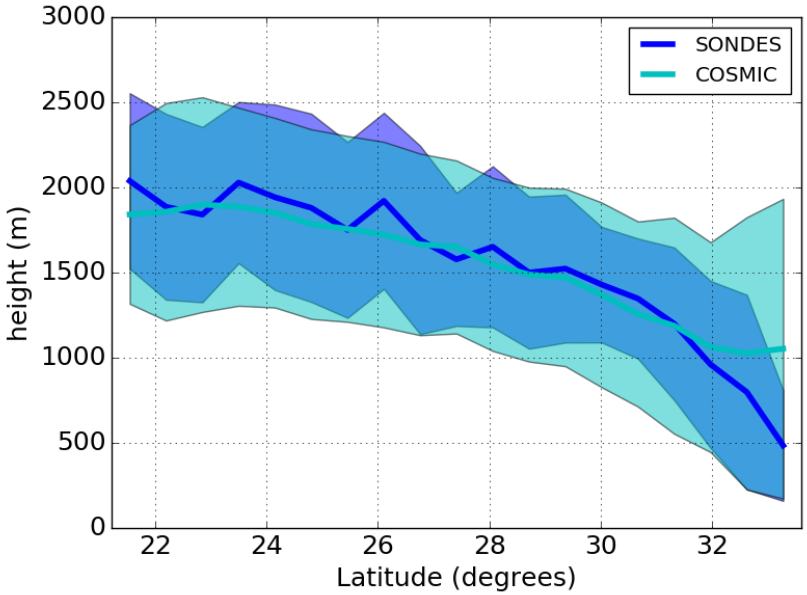
BLH through T

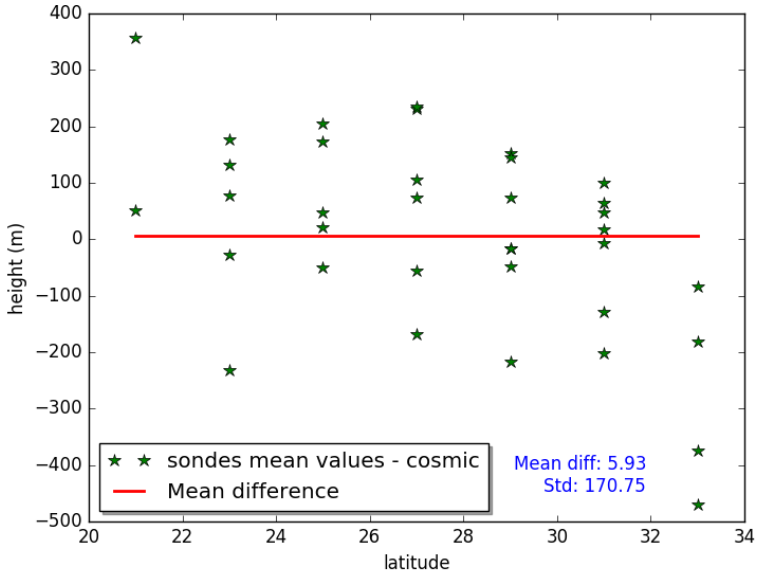
The use of Temperature (T) profiles gives less cases of weak inversion. This leads to a clearer detection of BLH

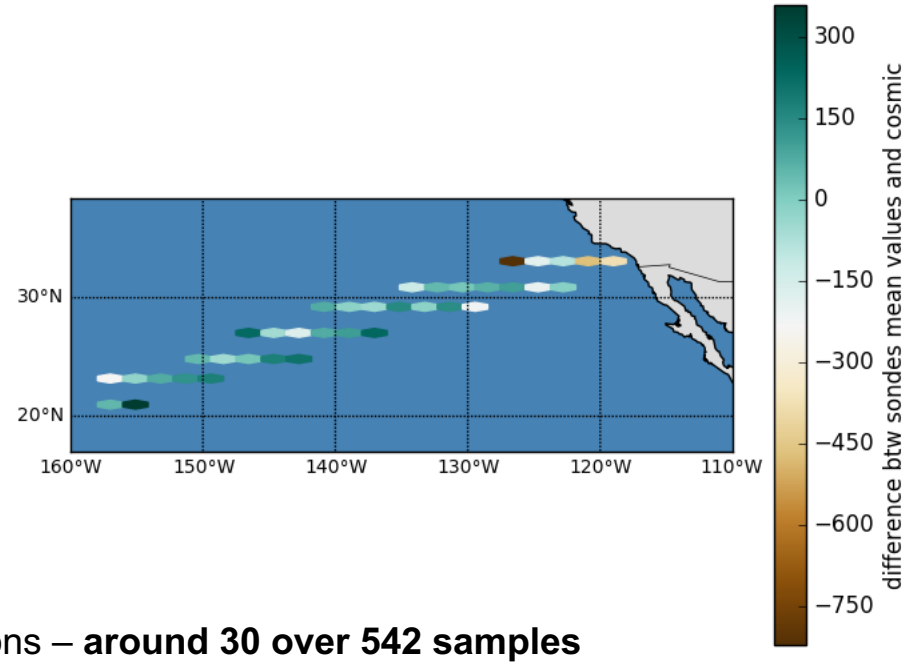


BLH through T – comparison with COSMIC values



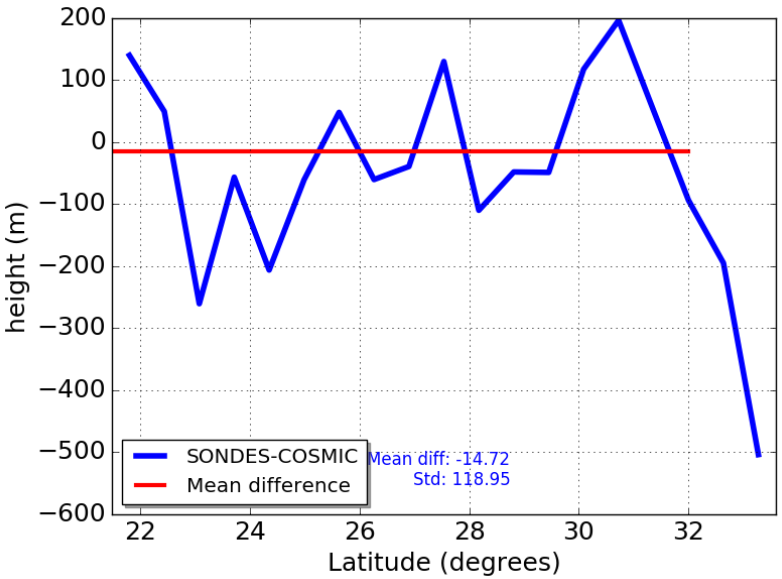


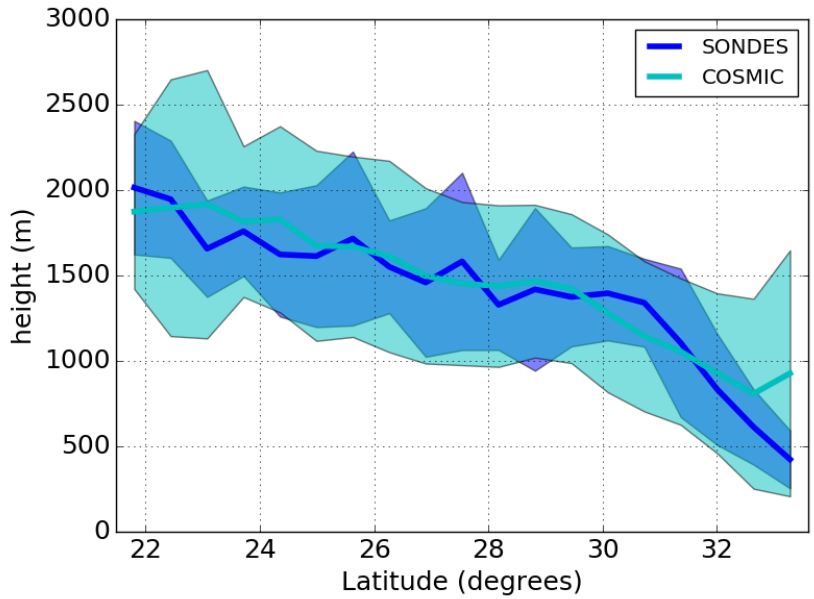


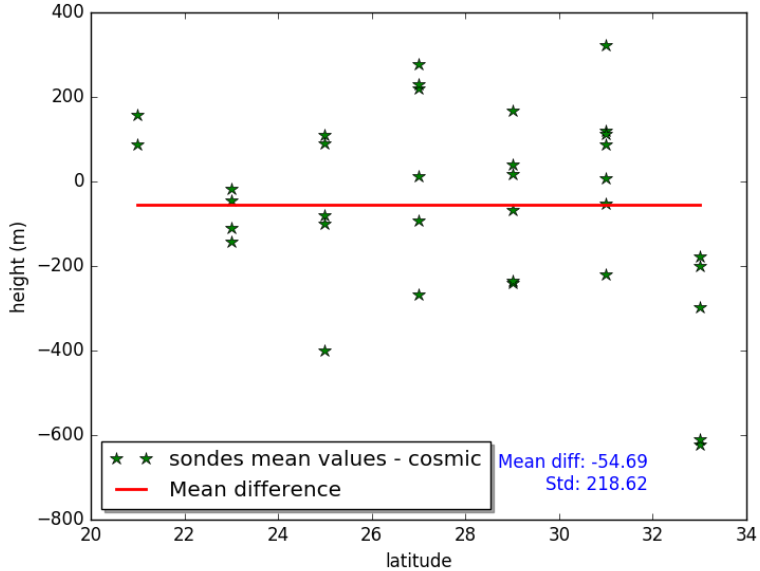


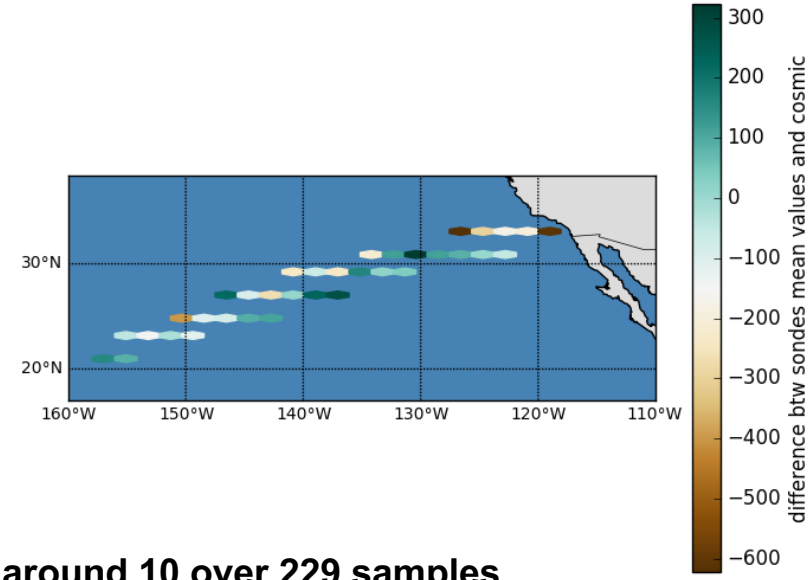
Weak / indeterminate inversions – **around 30 over 542 samples**

BLH through T – comparison with COSMIC values (JJA)



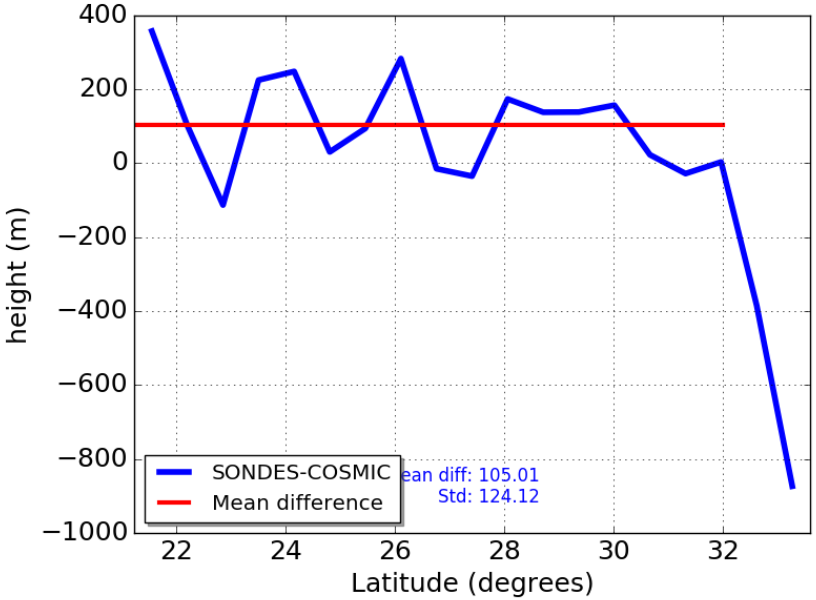


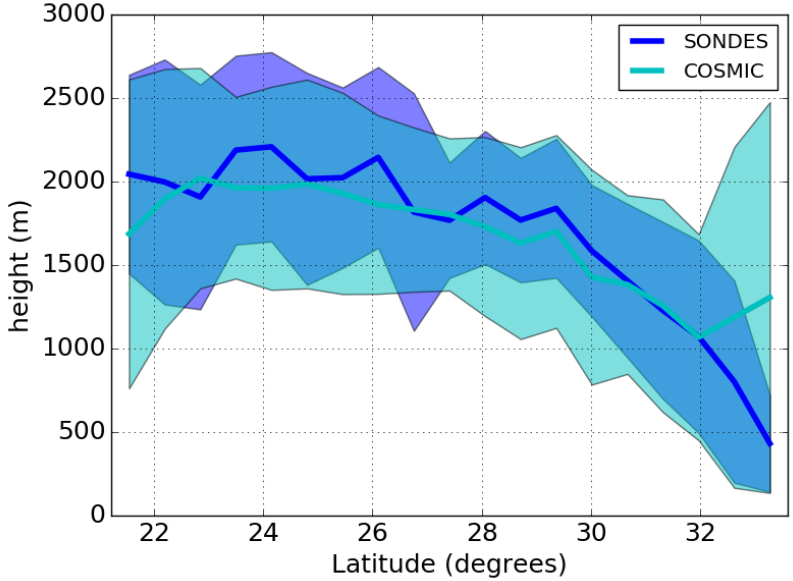


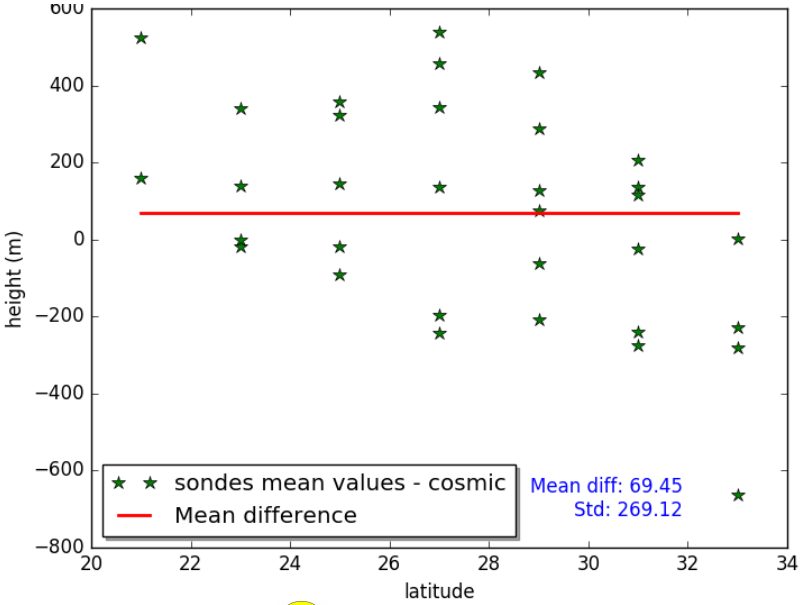


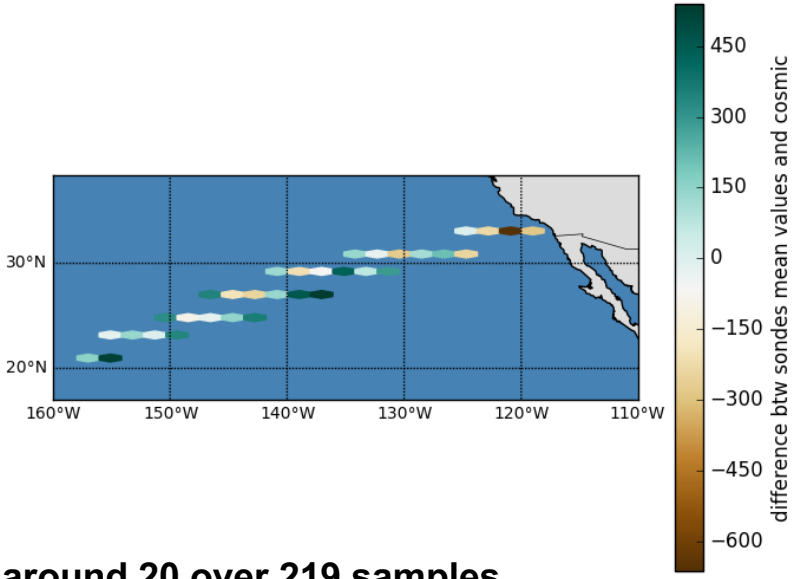
Weak / indeterminate inversions – **around 10 over 229 samples**

BLH through T – comparison with COSMIC values (SON)





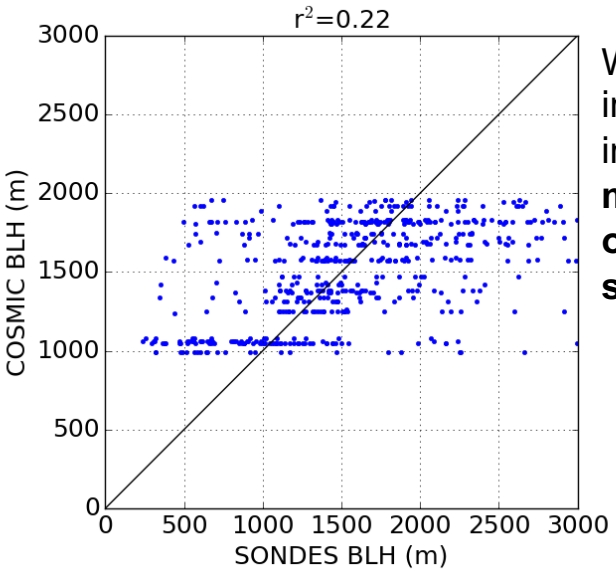




Weak / indeterminate inversions – **around 20 over 219 samples**

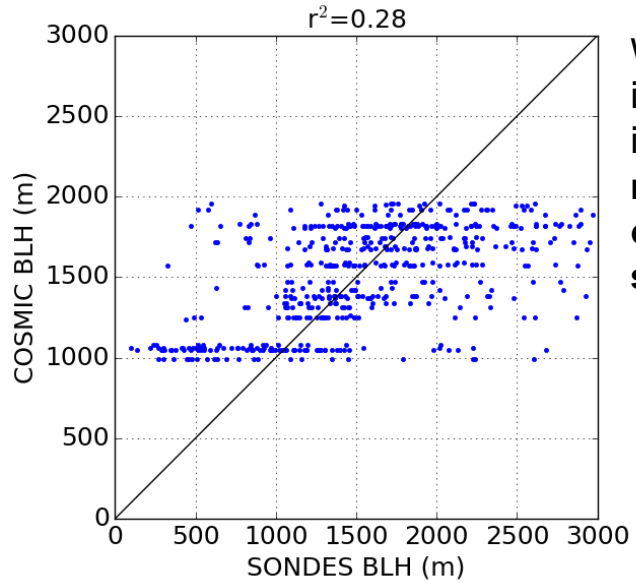
BLH – comparison with COSMIC values

N



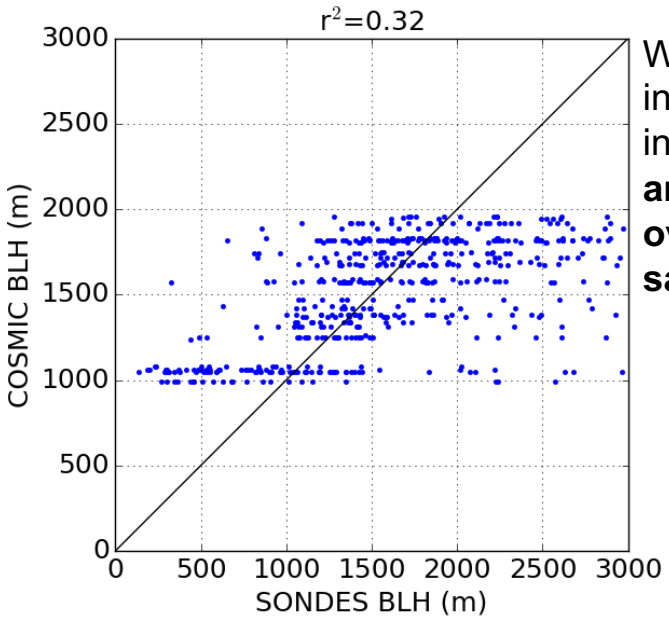
Weak / indeterminate inversions – **more than 60 over 542 samples**

N smoothed



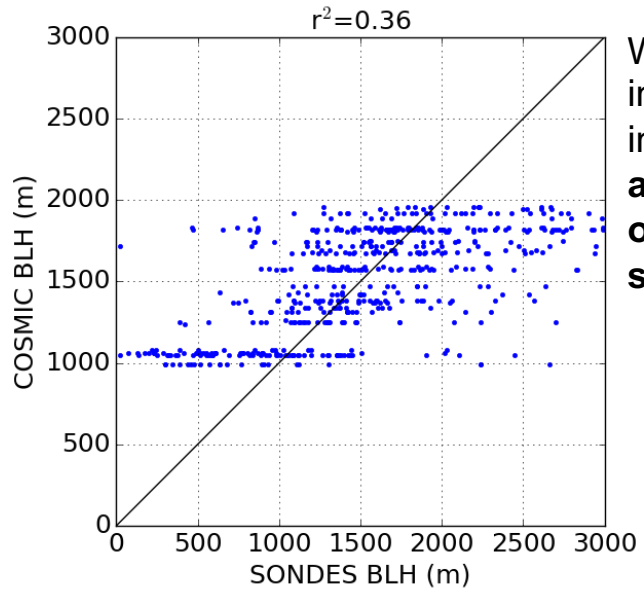
Weak / indeterminate inversions – **more than 50 over 542 samples**

RH



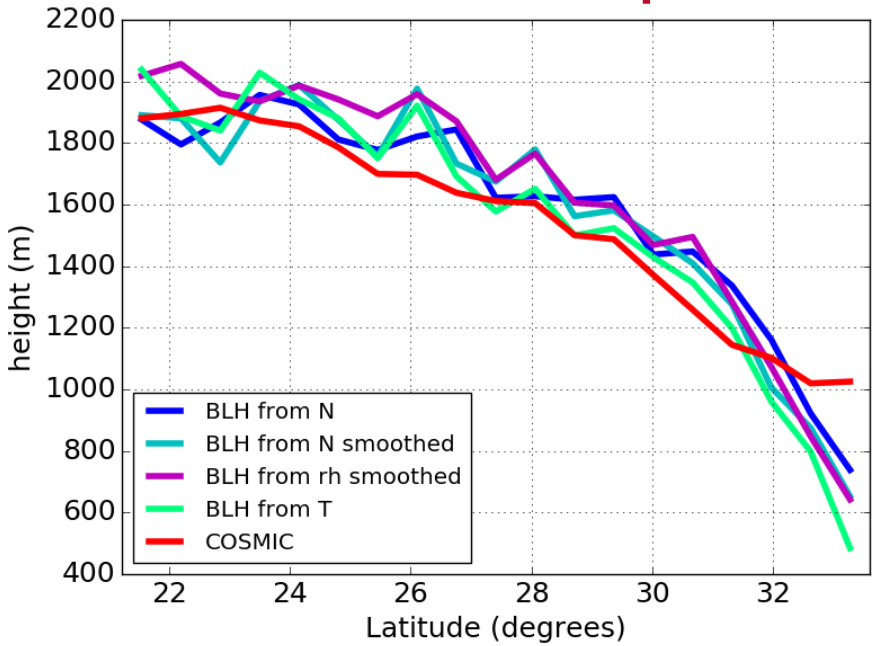
Weak / indeterminate inversions – **around 30 over 542 samples**

T



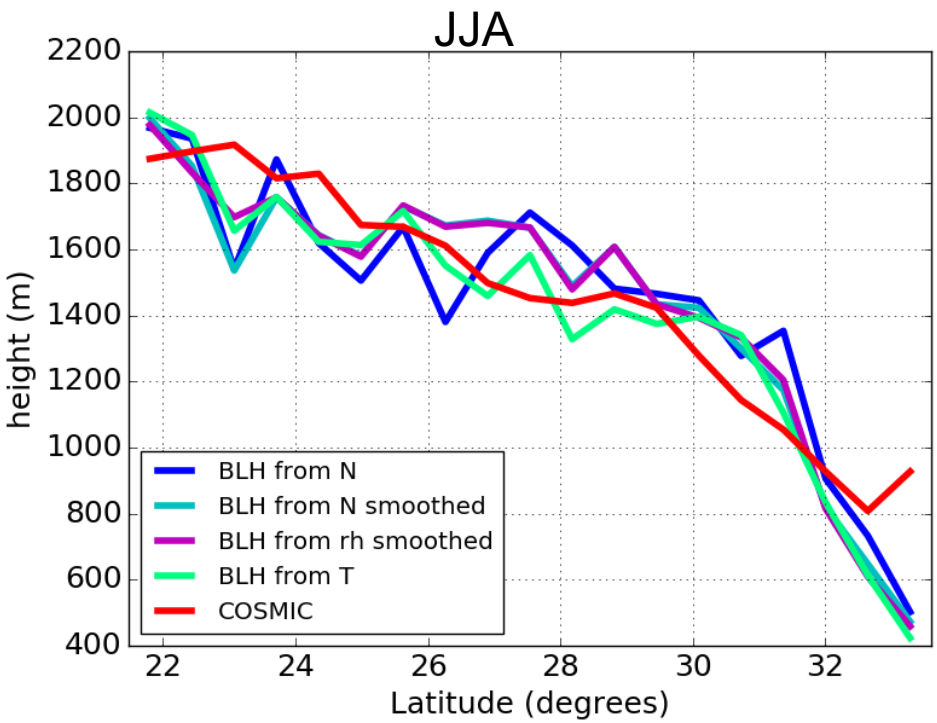
Weak / indeterminate inversions – **around 30 over 542 samples**

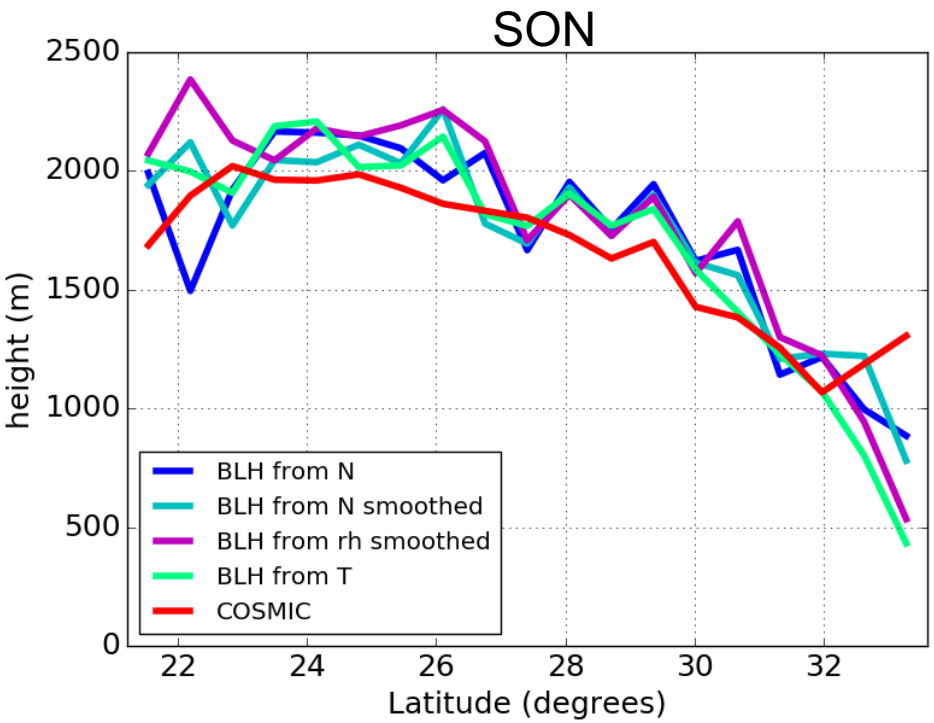
Comparison among all methods



ALL | JJA | SON

METHOD	MEAN DIFF	STD DIFF
N	73.30 | 21.28 | 108.74	71.75 | 174.44 | 182.27
N smooth	74.07 | 23.72 | 107.3	95.94 | 149.86 | 149.02
RH	134.42 | 31.2 | 205.84	69.16 | 129.68 | 146.22
T	51.06 | -14.72 | 105.01	83.06 | 118.95 | 124.12





Conclusions

- The work allowed the study of Earth's boundary layer through several methods used for its estimate

- Whatever was the method used, the BLH was more clearly detected in presence of strong inversions, rather then in presence of weaker ones

- The detection of Temperature inversion to calculate BLH gives better results compared to other methods. This is probably connected to the lower height given using Temperature, which fits well the slight underestimation of BLH of COSMIC data

- Some points in proximity of Los Angeles latitudes seem to be affected by land contamination. The removal of this kind of error could lead to better results for these points