Answer to the Reviewer 1

We thank very much for a thorough review of our paper. We revised the paper according to the suggestions.
Below are the answers to the comments supplemented with a detailed list of changes in the text of the manuscript. The following convention is applied:

- standard font: referee comments;
- italics: *reaction to the comments*,

answers – red,
changes in the text - blue.

This manuscript describes the set-up, functionality and characteristics of the improved Ultrafast Thermometer UFT-M. First results from flights penetrating stratocumuls clouds from above demonstrate how well this instrument works. The description and discussion is well quantitative and fulfils all requirements of a journal on atmospheric measurement technology. This manuscript describes an excellent experimental work. It omits any new meteorological insights, but since it is submitted to a more technology-focused journal, this should not be a problem. With this new instrument, that provides an enormously high spatial resolution of air temperature measured during flight, meteorological results will follow soon.

Thank you for a high evaluations of our efforts.
Two papers with of POST results are already submitted, they are listed in the references.

However some minor corrections and some additional information are suggested from my side:

1) In section 1 or in section 4, the flight path and the length of the analysed flight sections should be explained, preferably in a map. Also information on the weather and other experimental boundary conditions should be given.

A new figure explaining flight strategy was added (now Fig.1). The first part of an introduction was changed in order to account for this remark.

Physics of Stratocumulus Top was a research campaign aimed at the airborne investigation of marine stratocumulus clouds and capping inversion. In June and July 2008, a research aircraft, a turbo-prop CIRPAS Twin Otter, equipped with high-resolution instrumentation used to measure thermodynamic, microphysical and dynamic properties of clouds, performed 17 research flights over the Pacific Ocean in the area 125 km west of Monterey Bay, California. This area is well known from persistent presence of marine stratocumulus fields capped by a strong inversion due to large-scale subsidence in high-pressure systems. Many earlier campaigns aimed at airborne measurements of stratocumulus properties were performed in Western Pacific along the California coast (see e.g. overview in Wood 2012). A description of the flight strategy during POST campaign and a summary of the flights can be found in previous studies (Gerber et al., 2010; Carman et al., 2012; Gerber et al., 2013) and in the POST database held by the NCAR's EOL at http://www.eol.ucar.edu/projects/post/. Of key interest was investigating the interactions among turbulence, thermodynamics and microphysics, which were assessed to improve the understanding of the entrainment of free tropospheric air into stratocumulus clouds and the subsequent mixing processes. The scientific importance of these interactions has been underlined in recent reviews (Bodenschatz et al., 2010; Siebert et al., 2010; Devenish et al., 2012). The main part of each flight (so called "pod", see Fig.1) consisted of porpoising manoeuvres at an amplitude of 200 m; these *manoeuvres involved ascents from the cloud top region across the capping inversion to the free troposphere and subsequent descents into the cloud top. Additionally, in each pod three horizontal segments: above the sea surface, at the cloud base and close to the cloud top were taken in order estimate turbulent fluxes. A typical flight consisted of three pods and two vertical soundings.*

2) The UFT-M is an open-wire thermometer. So the systematic measurement errors due to solar radiation, black-body radiation from the environment (the aircraft fuselage where the sensor was mounted on) and dynamic pressure increase should be analysed and discussed.

The following analysis was added in section 2:
A comprehensive description of accuracy, resolution and overall performance of UFT sensors can be found in (Haman et al., 1997). Below we discuss in more detail errors due to radiation and velocity fluctuations. The first is estimated from the comparison of heat fluxes due to solar heating of the sensing wire Qr and heat transfer Q between the air and the sensor at temperature difference ΔT. Q per unit length of the sensing wire can be estimated after chapter 2 of Sandborn (1972) from the formula:

$$Q = N_u \kappa \pi \Delta T \approx \kappa \pi \Delta T (0.318+0.69)(u D \nu^{-1}) \qquad (1)$$

where N_u is the Nusselt number, $\kappa = 0.025\ Wm^{-1}K^{-1}$ is the heat transfer coefficient for air, $u = 60\ ms^{-1}$ is the air velocity, $D = 2.5\cdot10^{-6}$ m is wire diameter, $\nu = 1.5\cdot10^{-5}\ m^2s^{-1}$ is the kinematic viscosity of air. This value compared to the radiative heat flux per unit length of the wire:

$$Qr = S A D \qquad (2)$$

where $S = 1300 Wm^2$ is the maximum solar flux and $A=0.3$ is absorption coefficient for platinum gives the maximum temperature effect of radiation $T = 0.005$ K.
Temperature effects of dynamic pressure - changes of the airflow velocity - also affect temperature measurements (see e.g. section 2.5.1 in Bange et al. 2013). They depend on the recovery factor of the thermometer. Estimates the UFT recovery factor by Haman et al. (1997) give value of 0.6. This, together with the measurement speed of 55 ms^{-1} and fluctuations in the range of ±5 ms^{-1} result in the shift of temperature by $T = 0.2$ K and fluctuations ±0.04 K The value of shift is of secondary importance, since UFT's are designed to measure small-scale temperature fluctuations, not static temperature and are used together with calibrated low frequency temperature probe (see section Calibration and averaging).

3) The slope of the measured temperature power spectra are compared to the Kolmogorov distribution in Fig. 10. Such comparison can better be done using structure functions (in addition to the power spectra that are more suited to identify e.g. sharp resonances)

We agree that structure functions are useful in such analysis. We use structure functions in the new paper (in preparation) in which we discus details of temperature fluctuations in different layers of stratocumulus clouds and atmospheric boundary layer.
In the present paper we decided to keep the power spectra in former Fig. 10 (now Fig. 11) to be consistent with earlier analysis presented in Figs. 7 and 9 (former Figs 6 and 8). We think that introducing structure functions in this place would require additional descriptions behind the scope of the present paper.

4) Although the manuscript focusses on the technology, it would be interesting to know

for what scientific tasks and questions the sensor is useful (i.e. what hypothesis can be check with this sensor in future?)

In the abstract "aimed at in cloud measurements" is added.

In the introduction there is a new paragraph describing possible applications of the UFT-M:
The present study focuses on the description and performance of a specially designed version of the Ultra Fast Thermometer (UFT) (Haman et al., 1997, 2001), which was one of the key instruments used in the POST field campaign and may be used in future campaigns that involve airborne investigations of small-scale features of warm clouds. High resolution temperature measurements are needed to characterize filaments formed in the course of mixing of cloud with the environmental air. They allow to distinguish volumes undergoing active mixing from those mixed earlier, characterize homogeneous and inhomogeneous mixing (see discussion in Devenish et al., 2012 and references therein), investigate a relative importance of radiative vs. evaporative cooling in clouds (see e.g. Wood , 2012), seek for the effects of evaporative cooling at the interfaces between cloudy and clear air (Malinowski et al., 2008) . It can be also used, together with the other airborne data to characterize properties of different cloud layers and regions (see e.g. Haman et al., 2007; Malinowski et al., 2013). Last, not least, high-frequency temperature measurements can be used, together with the appropriate vertical velocity data in sensible heat flux estimates (like in Metzger et al., 2012).

5) Throughout the manuscript, but especially in line 4 to 24: please make correct use of parentheses around citations.
Corrected

6) 2088, line 9: Do you really mean 'from'?
Yes we do. In order to avoid misunderstanding the segment was rewritten:
UFTs high-frequency output signals...

7) 2096, Line 23: Describe flight TO10 (also see remark 1)
We skip this remark since, according to remark 1, we added text in the introduction.

8) 2095, line 5: What do you mean with 'stored by the authors'?
In order to avoid misunderstanding the segment was rewritten:
...can be obtained from the authors.

9) Fig. 4,5,6 and 9 are too small, especially the axis labels and numbers
Figures are replotted according to the suggestions.
The bottom panel in former Fig.6 (now Fig.7) was changed in order to better illustrate effect of noise and to address better remarks of the Reviewer 2.