Sounding report, leg 1: Ecuador-Peru coastal section

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Global positioning system (GPS) rawinsondes were deployed on the Stratus 2007 cruise starting October 19, 18:00 UTC, and at 0, 6, 12, 18 UTC thereafter until reaching station at the DART/SHOA buoy. During this time the ship steamed south along the coastline of Ecuador and Peru, from 1° to 20° S. Owing to the spatial homogeneity of the stratus cloud deck in this region, the soundings show small and gradual variations in vertical structure of temperature, humidity, and winds with time and latitude.

Overview of the 1°-20° S coastal section

Figure S1 is a contoured latitude-pressure section composed of the 19 soundings between 1° and 20° S. The top panel shows potential temperature, the second shows specific humidity, the third shows zonal wind, and the bottom panel shows meridional wind. The ticks and at the top of each panel mark the times when the sondes were released, 4 times a day; the numbers mark the beginning of the yearday. (Yearday 292 is October 19)

There is a weak indication of descending plumes in the specific humidity (Figure S1, panel 2). The stratification in the free troposphere is considerably stronger at 18S than at 2S. That is to be expected—as the ship progressed farther to the south, the soundings were sampling the atmosphere farther away from convection. Early in the cruise, there was a lot of convection south of the usual seasonal position of the ITCZ.

A southeasterly jet is at 8° S, 700 hPa, with a northwesterly jet above the boundary layer and below 800 hPa at 16° S. These winds were not noticeably affected by the diurnal cycle. Winds in the free troposphere could be quite variable in time, so we don't know how representative these observations are in general. Models have a lot of trouble with simulating winds so close to the Andes, which might be expected to affect reanalyses.

Thermodynamic structure and relation to clouds

Figure S2 shows a typical sounding of cloudy conditions observed on the morning of October 19, 10:00 local time, located at 5.4W, 83S. At this latitude, patchy upper level clouds were observed, and there are tongues of high relative humidity (~50%) especially at 3 and 4.5 km altitude. These tongues of high relative humidity above the boundary layer were associated with plumes of moisture detrained from convection taking place unusually far south for this season. The inversion is 8°, with an additional layer of stability above the cloud. Disturbed by convection, the stratus deck was not as uniform here as it would become as we travelled farther south. The cloud layer is about 75 m thick, centered at 600 m.

Figure S3 is an example from October 21, 2 local, of a sounding observed farther south, where the relative humidity above the boundary layer is considerably drier and the stratus clouds are more solid. This sounding of a thin (150 m) stratus cloud, which nevertheless

covers a wide area, is characteristic of the soundings observed on this coastal section. The cloud base is at about 750 m and the top at 900 m, with a subsaturated layer below the inversion. The inversion strength is 10° C distributed over 925-1025 m height.

Slight thinning and clearing of the stratus cloud deck was observed in the afternoons. On October 22, a pocket of open-cellular convection (POC) was identified from a mid-day (14:25 UTC) visual radiance image from the NOAA-17 polar-orbiting satellite (Figure S4). The ship was under clear skies in the influence of the POC by early afternoon (13:00 local). For about 2 hours, clearing was observed on the ship (passing during this time through 75W, 19S), and vertically-oriented cumuliform clouds were observed to the west. A later satellite image showed that a much wider region became organized into open-cellular mesoscale structures. The sounding (Figure S5) from October 22 noon exhibits a decoupled boundary layer structure, with relative humidity below saturation. Two maxima in relative humidity (minima in dew point depression) are seen at 500 and 800 m height, indicating a poorly mixed scattered-cloud layer in the upper half of the marine atmospheric boundary layer. The thermodynamics are under the influence of nearby decoupled boundary layer convection, likely cumulus rising into stratocumulus. The afternoon of October 22 the ceilometer observed cloud base as low as 550 m.

On October 23, 12:12 local, a rawinsonde was launched at 74.8W, 19.6S (Figure S6). The temperature and relative humidity show that the free troposphere was very dry. The inversion was 10° C, with an additional 5° stability in the 100 m layer above the inversion. The water vapor was near saturation in a very thin layer at the boundary layer top. Clearing was observed the afternoon of October 23.

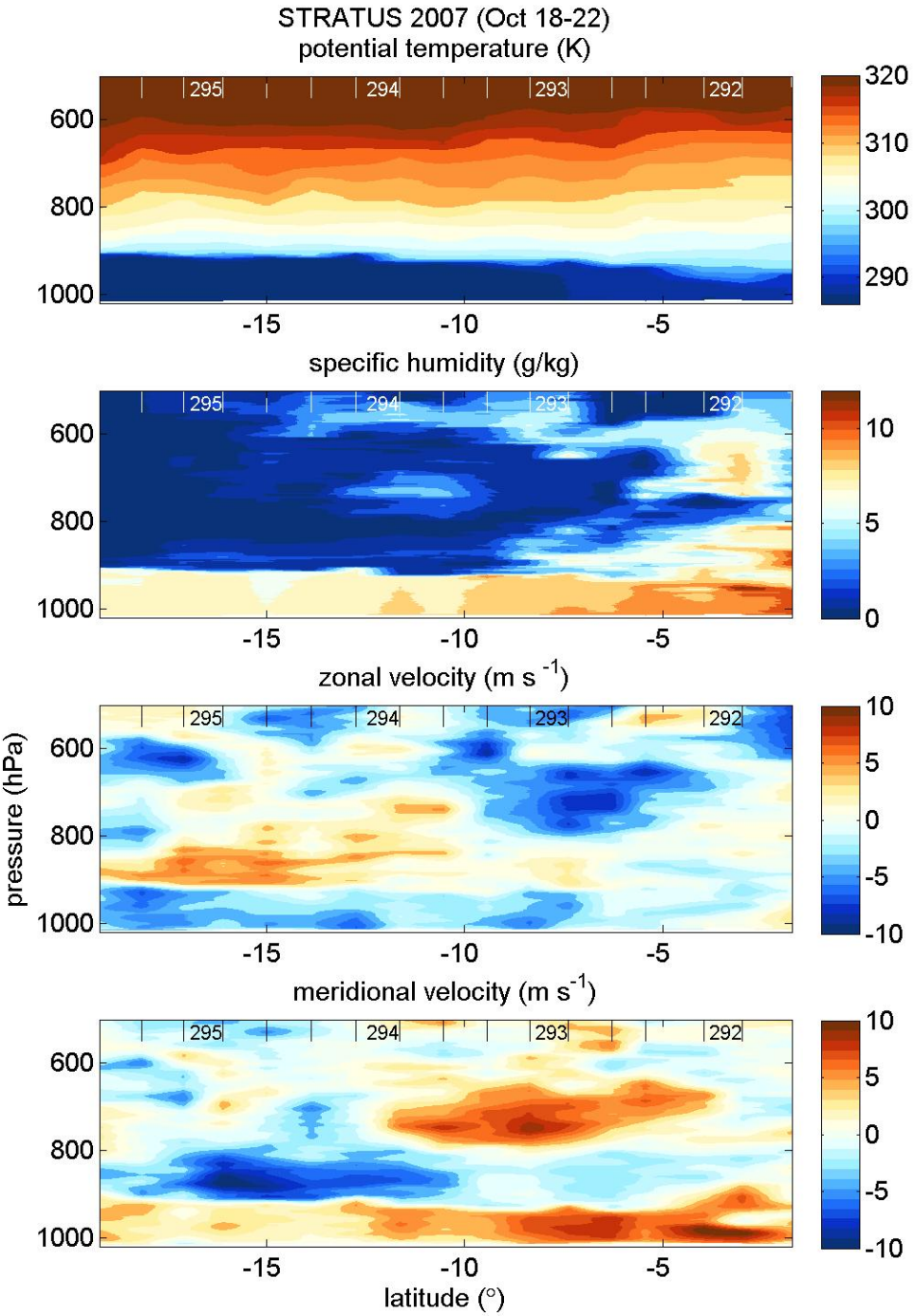

Figure S1. Cross section of observations from rawinsondes. Top panel shows potential temperature (° C), second panel shows specific humidity (g kg^{-1}), third panel shows zonal wind (m s^{-1}), and bottom panel shows meridional wind (m s^{-1})

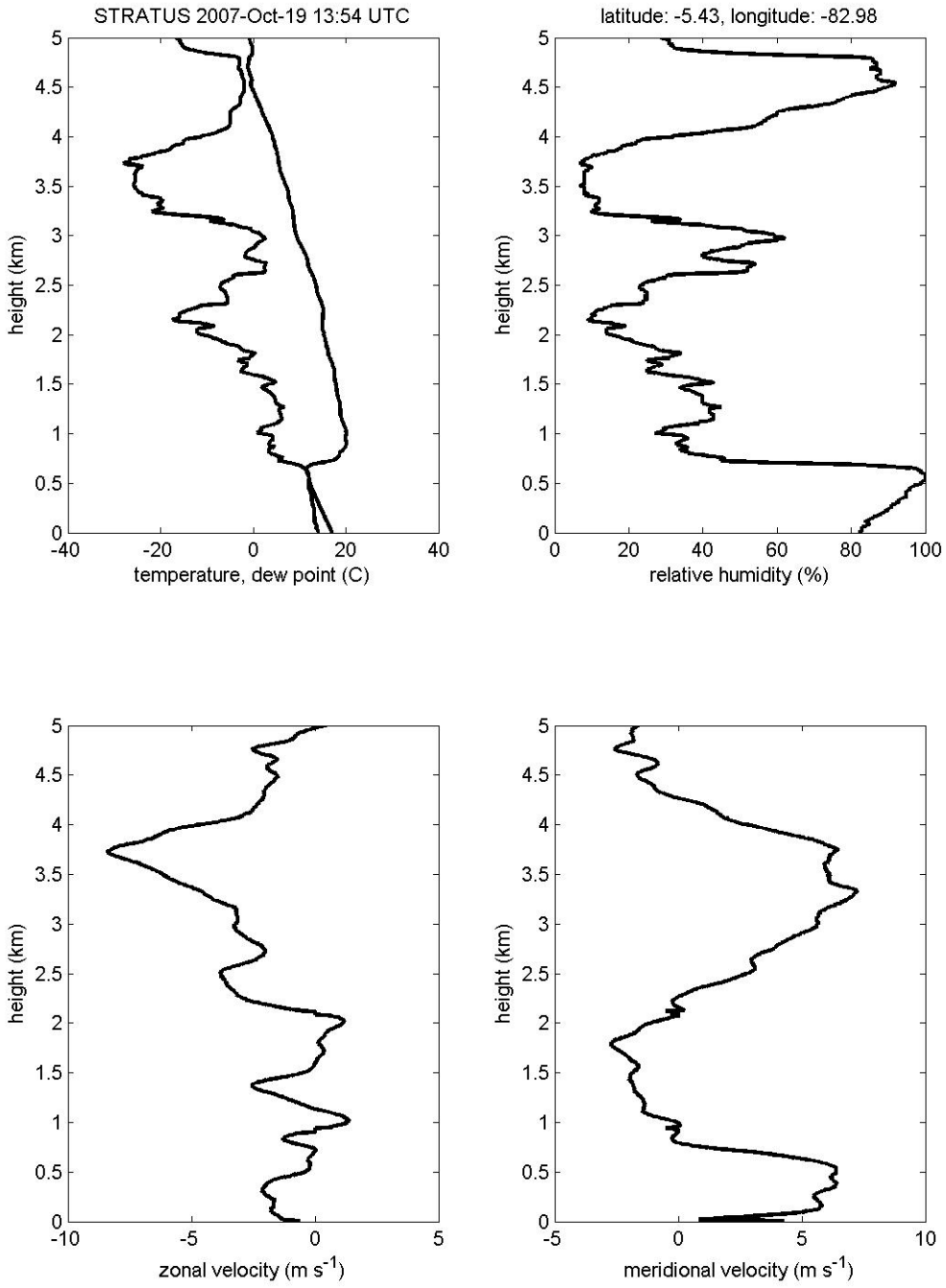

Figure S2. Sounding with stratus cloud in the convectively disturbed region at 83° W, 5.4° S. The top left panel shows temperature and dew point temperature (° C), the top right panel shows relative humidity (%), the bottom left panel shows zonal wind (m s^{-1}), and the bottom right panel shows meridional wind (m s^{-1}).

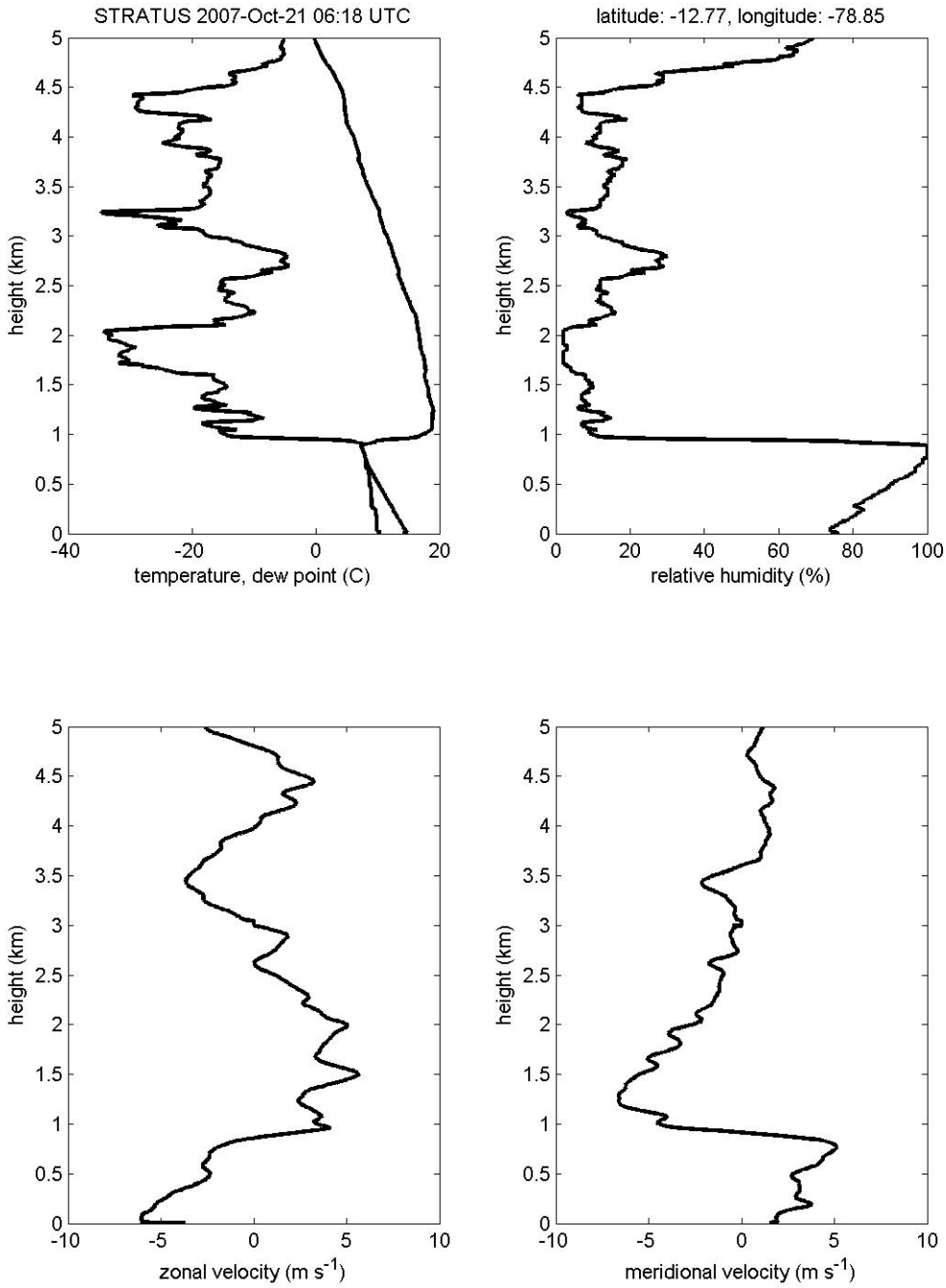

Figure S3. Sounding at 78.9° W, 12.8° S shows a typical thin stratocumulus cloud layer beneath a dry free troposphere.

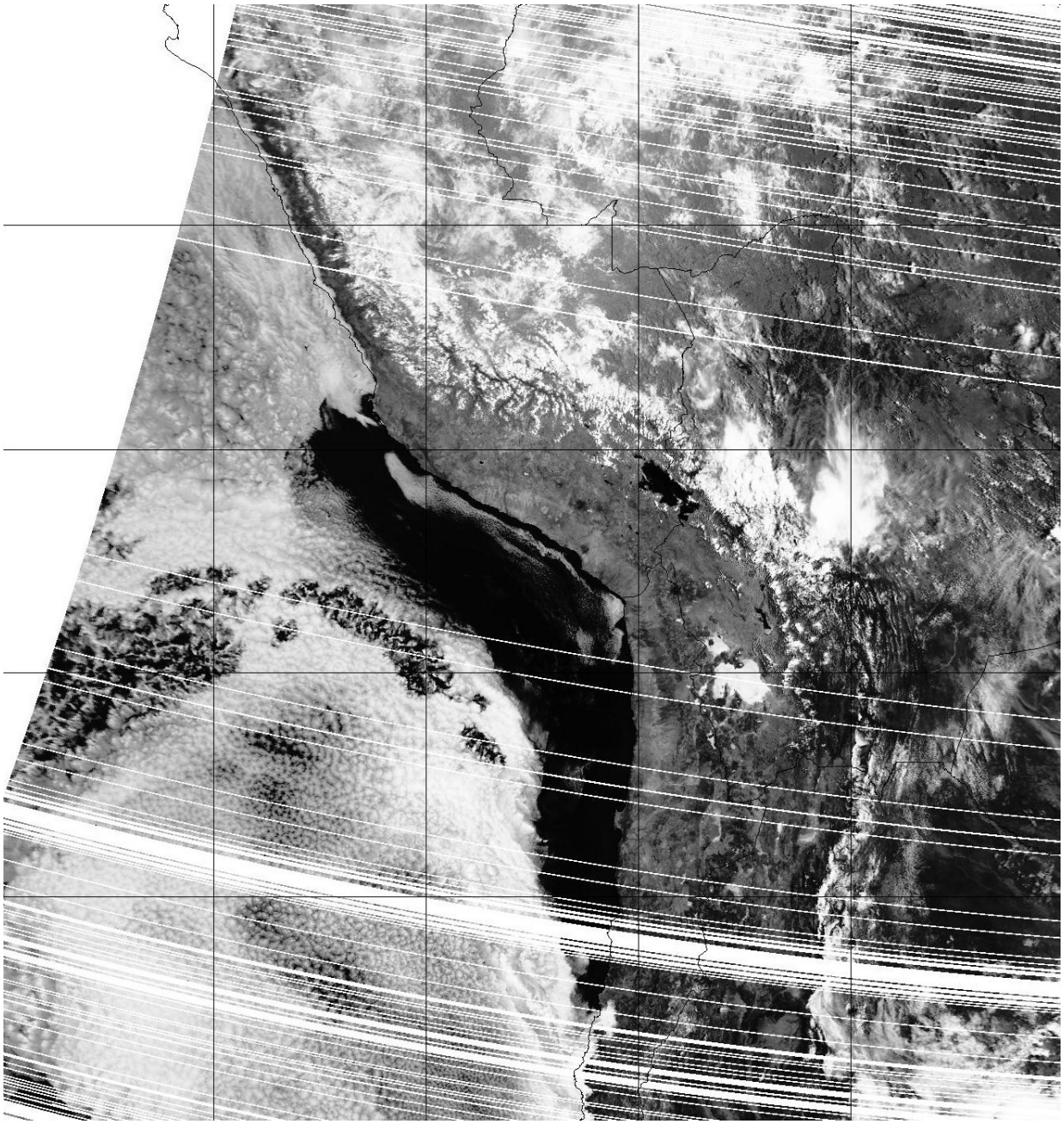

Figure S4. Visible radiance from NOAA-17 polar-orbiting satellite on October 22 at 14:25 UTC. The ship traveled south along 75° W from the strip of clouds between the pocket of open-cellular convection (POC) and the coastal clear region, into the POC.

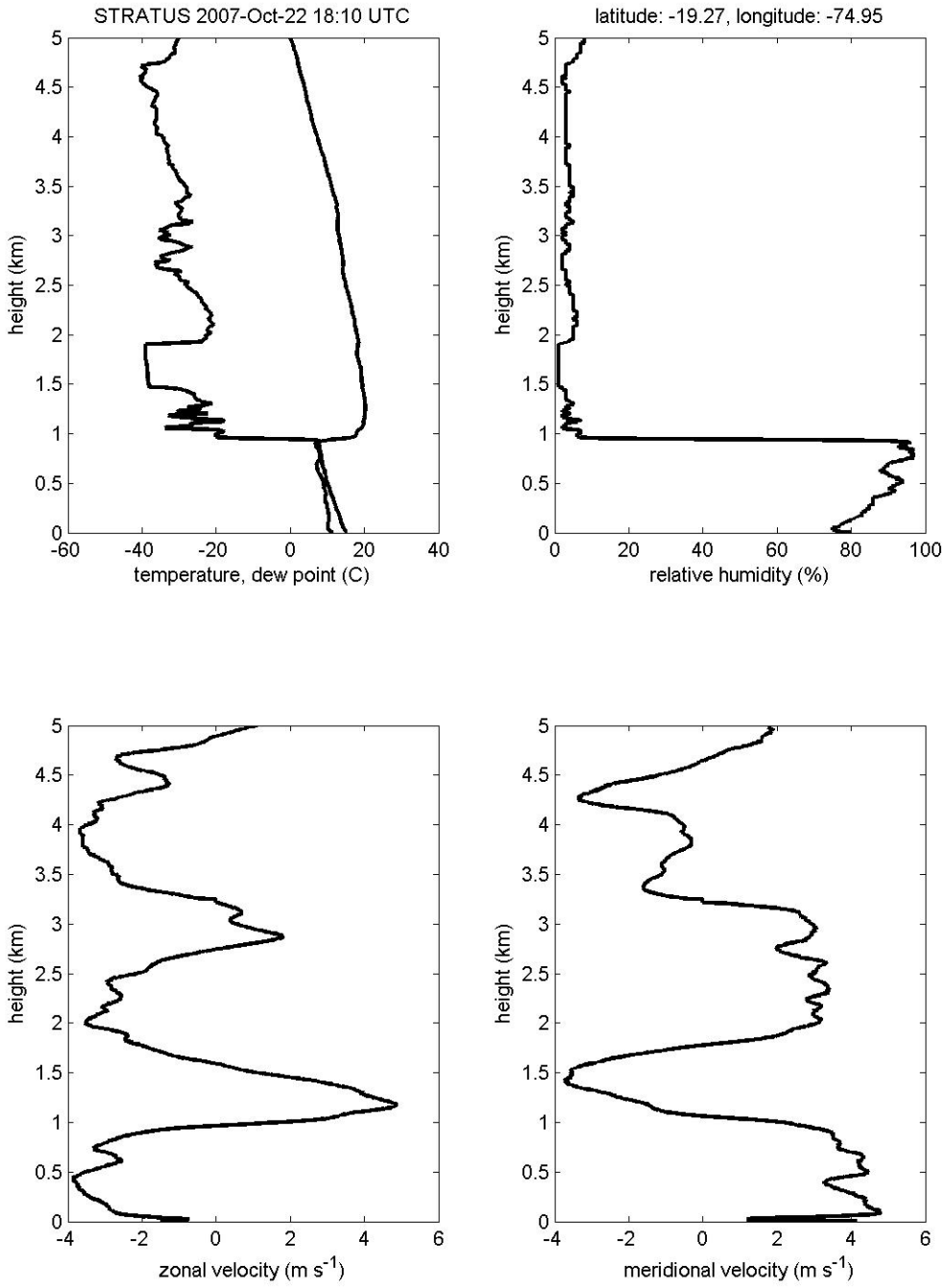

Figure S5. Radiosonde sounding of thermodynamic structure of the atmosphere in the POC, October 22, 18:10 UTC. A decoupled marine atmospheric boundary layer (MABL) is observed, with two subsaturated moist layers at the MABL top.

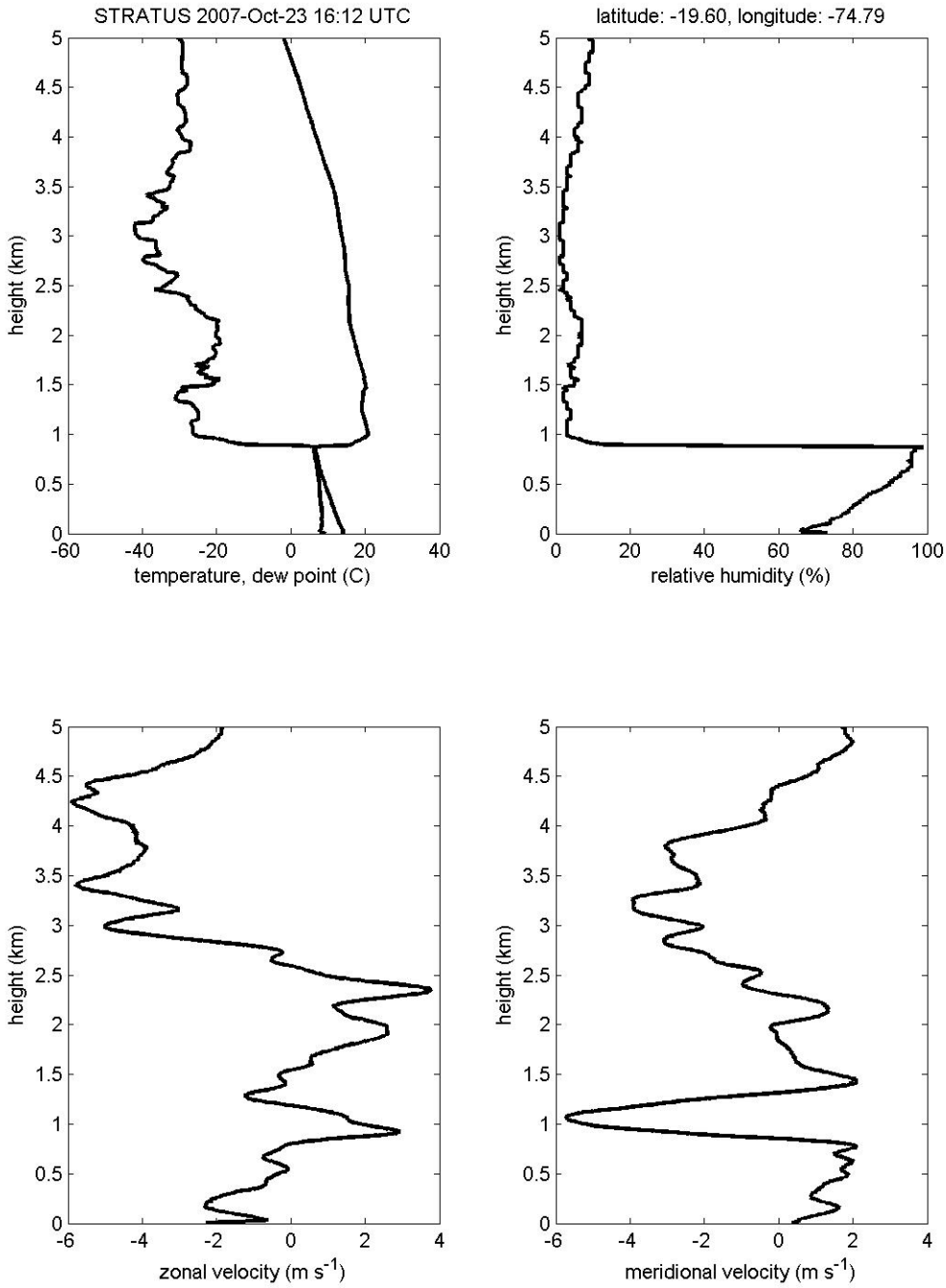

Figure S6. Rawinsonde of afternoon clearing conditions on October 23, 16:12 UTC.