

*Institut für Chemie und Dynamik der Geosphäre 2:
Chemie der Belasteten Atmosphäre*

**Ozone Profiles at Jülich, Germany
during 1993/1994
and at Santa Cruz de Tenerife, Spain
in August 1993**

H.G.J. Smit W. Sträter D. Kley E. Cuevas

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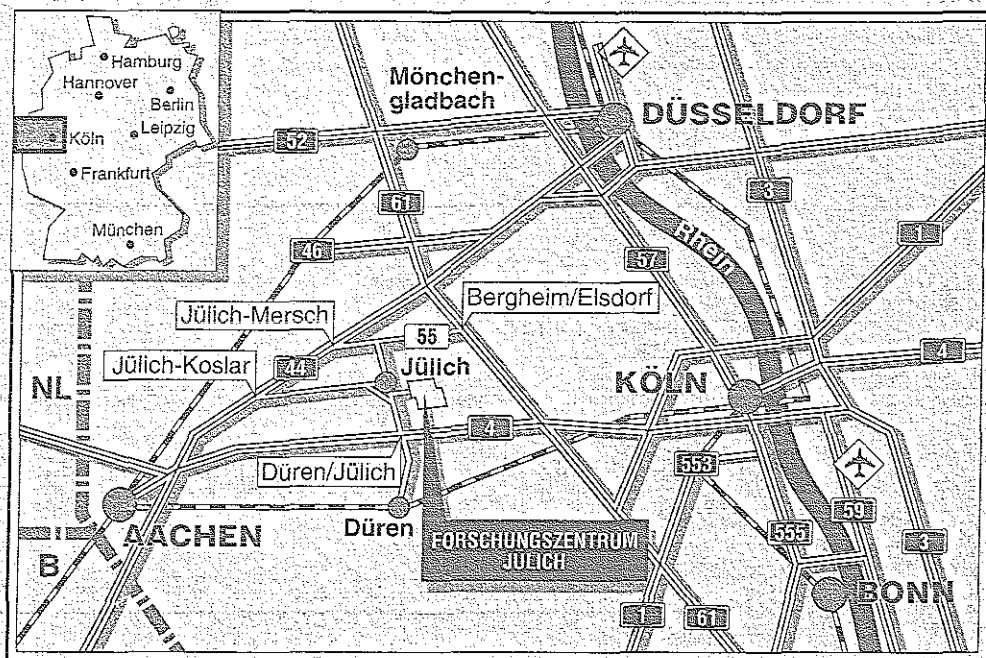
1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods used to collect and analyze data. It includes a detailed description of the sampling process and the statistical techniques employed to interpret the results.

3. The third part of the document presents the findings of the study. It shows that there is a significant correlation between the variables being studied, which supports the hypothesis that was tested.

4. The fourth part of the document discusses the implications of the findings for future research and practice. It suggests that the results of this study could be used to inform policy decisions and to guide the development of new programs and initiatives.

5. The fifth part of the document provides a conclusion and a summary of the key points. It reiterates the importance of the study and the need for further research in this area.



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Ozone Profiles at Jülich, Germany during 1993/1994 and at Santa Cruz de Tenerife, Spain in August 1993

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1. The first part of the paper is devoted to the study of the properties of the function $f(x)$ defined by the equation

$$f(x) = \int_0^x \frac{1}{1+t^2} dt$$

for $x \in \mathbb{R}$. It is shown that $f(x)$ is an odd function and that $f(x) \in C^1(\mathbb{R})$. Moreover, it is proved that $f(x)$ is a strictly increasing function and that $f(x) \in C^2(\mathbb{R})$. Finally, it is shown that $f(x)$ is a concave function.

2. The second part of the paper is devoted to the study of the properties of the function $g(x)$ defined by the equation

$$g(x) = \int_0^x \frac{1}{1+t^4} dt$$

for $x \in \mathbb{R}$. It is shown that $g(x)$ is an even function and that $g(x) \in C^1(\mathbb{R})$. Moreover, it is proved that $g(x)$ is a strictly increasing function and that $g(x) \in C^2(\mathbb{R})$. Finally, it is shown that $g(x)$ is a concave function.

3. The third part of the paper is devoted to the study of the properties of the function $h(x)$ defined by the equation

$$h(x) = \int_0^x \frac{1}{1+t^6} dt$$

for $x \in \mathbb{R}$. It is shown that $h(x)$ is an even function and that $h(x) \in C^1(\mathbb{R})$. Moreover, it is proved that $h(x)$ is a strictly increasing function and that $h(x) \in C^2(\mathbb{R})$. Finally, it is shown that $h(x)$ is a concave function.

4. The fourth part of the paper is devoted to the study of the properties of the function $k(x)$ defined by the equation

$$k(x) = \int_0^x \frac{1}{1+t^8} dt$$

for $x \in \mathbb{R}$. It is shown that $k(x)$ is an even function and that $k(x) \in C^1(\mathbb{R})$. Moreover, it is proved that $k(x)$ is a strictly increasing function and that $k(x) \in C^2(\mathbb{R})$. Finally, it is shown that $k(x)$ is a concave function.

5. The fifth part of the paper is devoted to the study of the properties of the function $l(x)$ defined by the equation

$$l(x) = \int_0^x \frac{1}{1+t^{10}} dt$$

for $x \in \mathbb{R}$. It is shown that $l(x)$ is an even function and that $l(x) \in C^1(\mathbb{R})$. Moreover, it is proved that $l(x)$ is a strictly increasing function and that $l(x) \in C^2(\mathbb{R})$. Finally, it is shown that $l(x)$ is a concave function.

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Summary

This sixth report of a series of ozone profiles contains the individual measured vertical profiles of ozone and the meteorological parameters like pressure, temperature and relative humidity obtained from incidental soundings made at Jülich, Germany ($50^{\circ} 41' \text{ N}$, $6^{\circ} 24' \text{ E}$) during 1993 and 1994. The report also includes vertical profiles measured at Santa Cruz de Tenerife, Canary Islands, Spain ($28^{\circ} 18' \text{ N}$, $16^{\circ} 30' \text{ W}$) during an intensive field campaign in August 1993.

TOR

Tropospheric Ozone Research



1. Introduction

Tropospheric ozone plays a crucial role in tropospheric chemistry as a precursor for reactive radicals. As a significant absorber of infrared radiation it contributes to the greenhouse effect. Ozone is a toxic gas and especially at higher concentrations it will give damage to human-, animal- and plant life. Already at low concentrations it reduces the photochemical activity of green plants. Ozone is thought to play an important role in the syndrom of forest damage.

Measurements of ozone from the last century up to now show that its concentrations near the ground as well as in the free troposphere are increasing at a rate of approximately 1 % per year [Attmanspacher (1984), Feister (1987), Volz (1988)].

The chemistry, transport and budget of tropospheric ozone and other photooxidants is investigated as a major component of the EUROTRAC project TOR (Tropospheric Ozone Research).

Within TOR, a network of stations in Europe performs regular vertical soundings of ozone and meteorological parameters (pressure, temperature and relative humidity) to investigate the seasonal effects in the role of stratosphere/troposphere exchange and transport from the atmospheric boundary layer into the free troposphere. Particularly the relation of ozone and the simultaneously measured water vapor enables us to investigate the influences of both transport and chemistry on the tropospheric ozone budget [Smit et al. (1993)].

The sounding program at Jülich started in July 1988 with incidental flights, while regular flights with a frequency of one per week were started in July 1989. The results up to December 1989 were reported in the first volume of these series [Smit et al. (1989)]. In January 1990 the frequency of soundings was extended to two flights per week and was continued until the end of 1992. In the second volume in these series the results obtained at Jülich during 1990, as well as the results of incidental soundings performed at the Schauinsland (Black Forest, Germany) mainly during an intensive field campaign in August

1990, were reported [Smit et al. (1991-A)]. The third volume reports the results of individual flights made at different latitudes over the Central Atlantic Ocean during two scientific cruises aboard the research vessel "Polarstern" in March/April 1987 and September/October 1988 respectively [Smit et al. (1991-B)]. The fourth and fifth volume reports the results of individual soundings made at Jülich during 1991 and at Jülich and the Schauinsland during 1992 respectively [Smit et al. (1994-C and 1994-D)].

In January 1993 the regular sounding program at Jülich have been stopped and since then only incidentally ozone soundings were made as participation in intensive, dedicated sounding campaigns. In this report, the sixth volume, we present the results of individual flights incidentally made at Jülich during 1993 and 1994, as well as the results of incidental soundings performed in collaboration with the Instituto Nacional de Meteorologia (INM) at Santa Cruz (Tenerife, Canary Islands, Spain) during an intensive field campaign in August 1993.

The ozone sounding system, instrumental set up and data processing, used at the sounding station at Jülich has been described in the first volume of these series [Smit et al. (1989)]. A detailed description of the TOR ozone sounding station at Jülich has been reported by Smit et al. (1994-A). A brief description of the ozone sounding program at Santa Cruz is reported by Cuevas et al. [1993]

2. Vertical ozone profiles

The results of the soundings performed during 1993 and 1994 are presented in the form of individual vertical profiles of ozone and the simultaneously measured meteorological parameters like pressure, temperature and relative humidity. For every flight two plots are presented. The first plot shows the complete profile during ascent up to the burst altitude of the balloon. This plot gives a standard ozonogram with the partial pressure of ozone (mPa), temperature (°C) and relative humidity (%) on the abscissa as a function of pressure (hPa) on

a logarithmic scale. The second plot presents the tropospheric part of the individual soundings in greater detail. Here, we use units of mixing ratio (ppbv) for ozone on the abscissa as a function of geometric altitude (km) where the altitude was computed step by step as the cumulative sum of the height difference between two successive pressure levels using the hydrostatic equation.

Acknowledgement

This work was supported as part of the EUROTRAC subproject TOR by the Bundesminister für Forschung und Technologie.

The authors wish to thank Mrs. C. Fries and Mr. B. Hermanns for assistance during the preparation and launches of the ozone sondes at Jülich and Mr. W. Petrick for modification of the radiosondes. Also we wish to thank Mrs. M. Carretero for the preparation of the ozone sondes and assistance during the launches at Santa Cruz de Tenerife.

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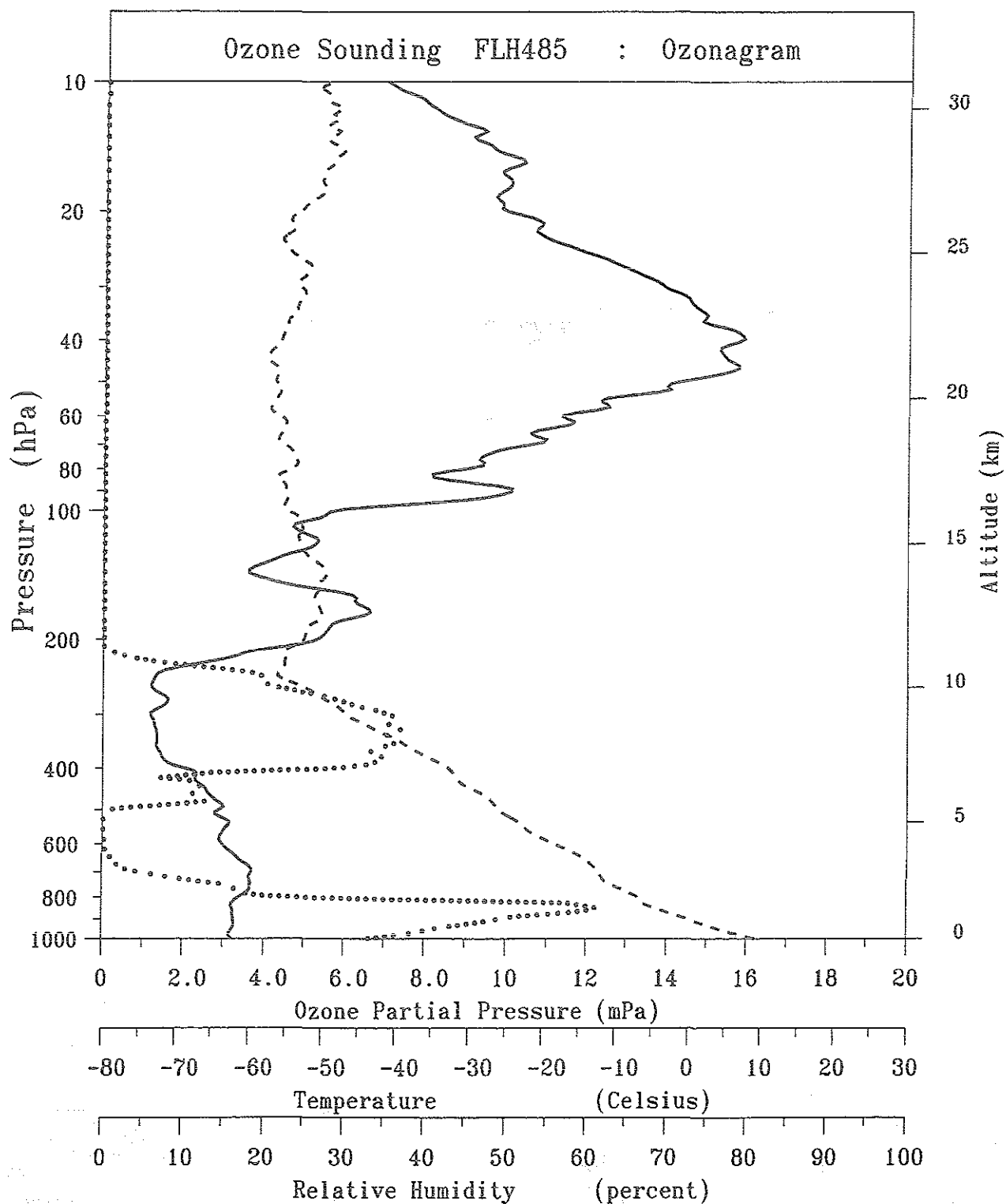
2. Vertical ozone profiles

Ozone Soundings at Jülich			
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FLH486	24- 3-1993	12: 5	12
FLH487	25- 3-1993	12:20	14
FLH488	4- 8-1993	12: 6	16
FLH489	13- 8-1993	11: 7	18
FLH490	17- 8-1993	11: 4	20
FLH491	26- 8-1993	11:44	22
FLH492	28- 8-1993	11:27	24
FLH493	1- 9-1993	12:22	26
FLH494	25- 4-1994	12: 4	28
FLH495	26- 4-1994	12: 5	30

Ozone Soundings at Santa Cruz, Tenerife			
Flight- Number	Date dd-mm- year	Time hh:mm (UTC)	Page
OCT001	15- 8-1993	15:25	34
OCT002	16- 8-1993	10:30	36
OCT003	16- 8-1993	13:30	38
OCT004	16- 8-1993	18:00	40
OCT005	17- 8-1993	13:50	42
OCT006	18- 8-1993	10:25	44
OCT007	18- 8-1993	13:15	46
OCT008	18- 8-1993	18:25	48
OCT009	20- 8-1993	13:25	50
OCT010	21- 8-1993	10:30	52
OCT011	21- 8-1993	13:55	54
OCT012	21- 8-1993	19:30	56
OCT013	22- 8-1993	13:15	58
OCT014	30- 8-1993	10:39	60

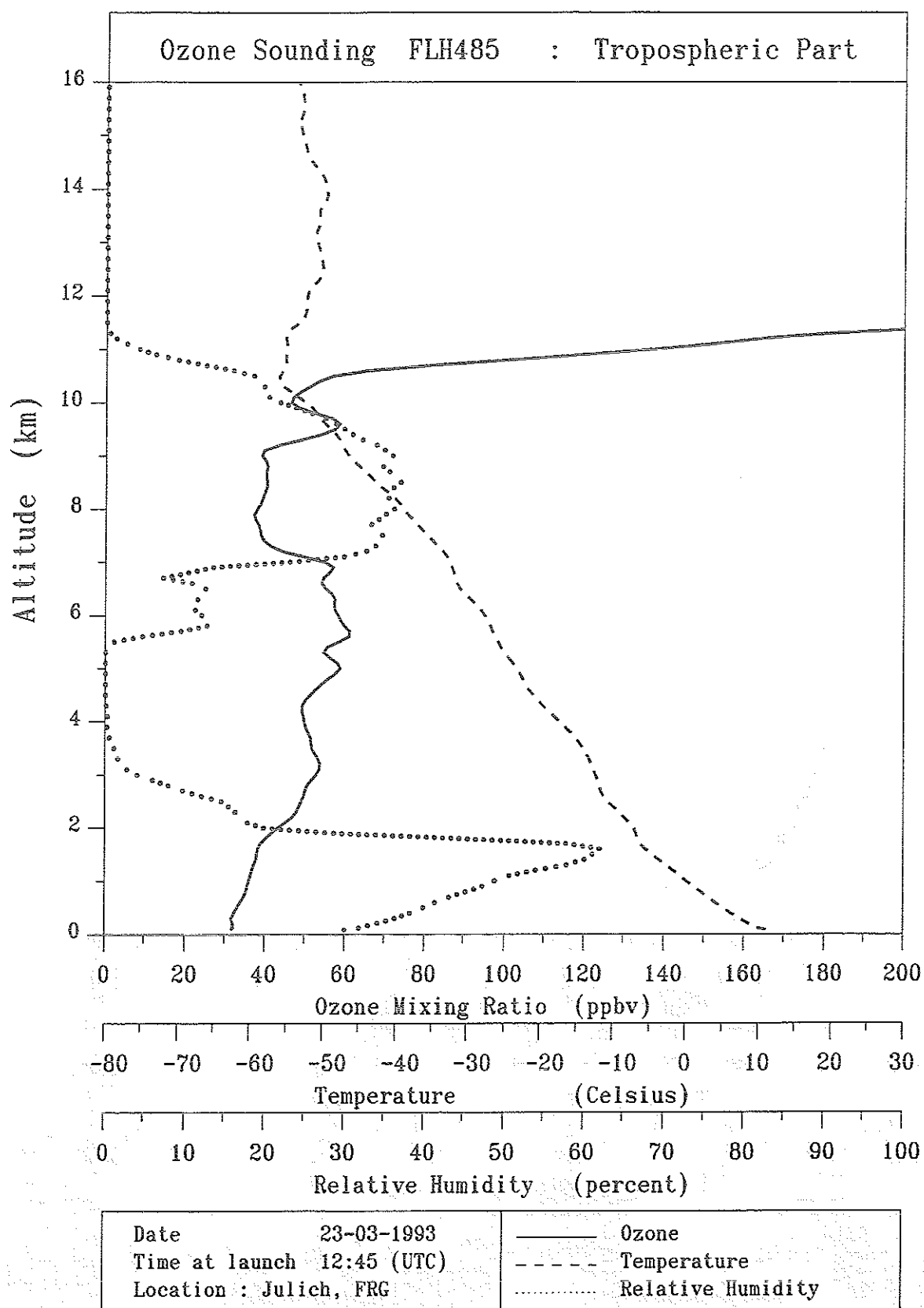


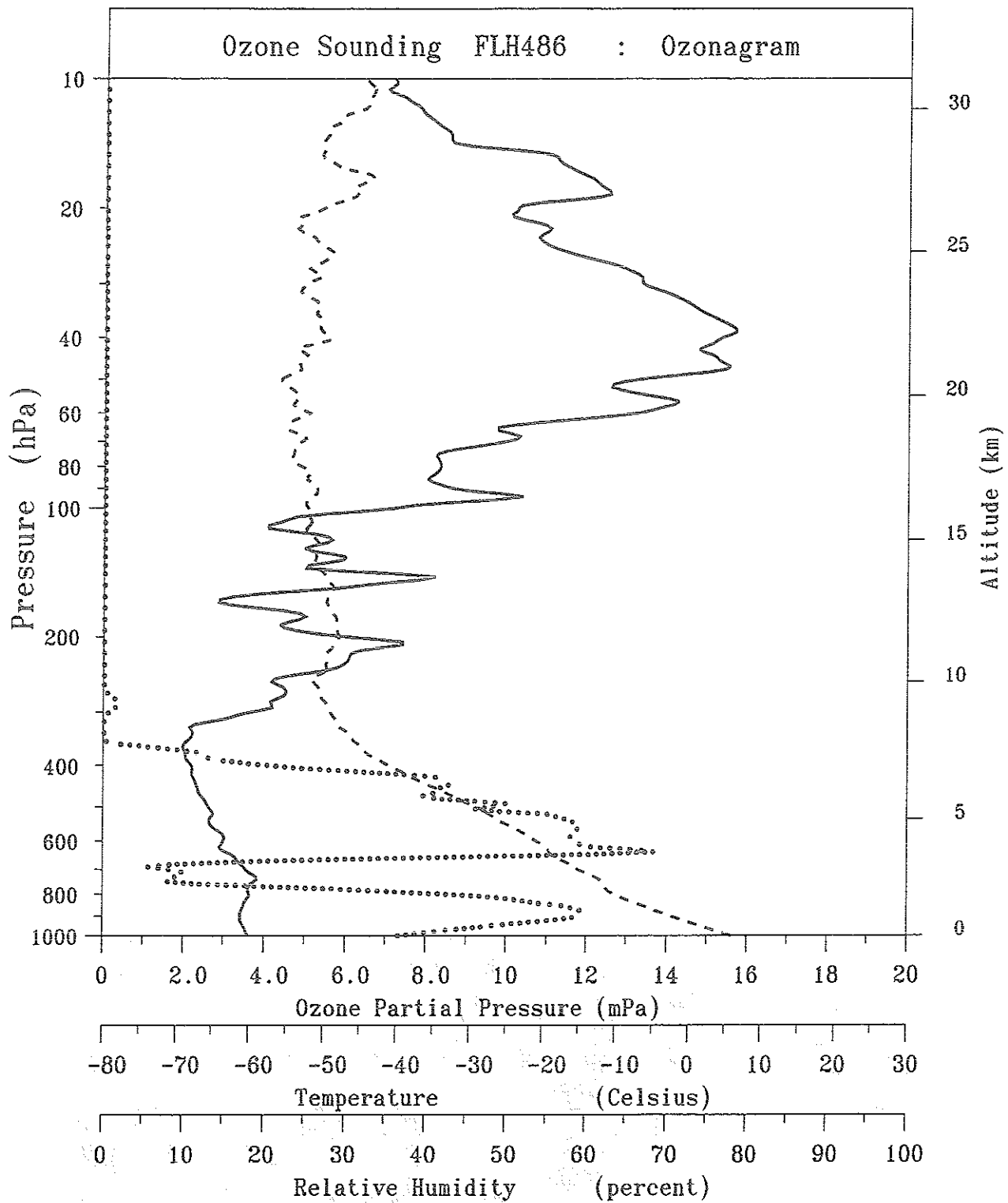
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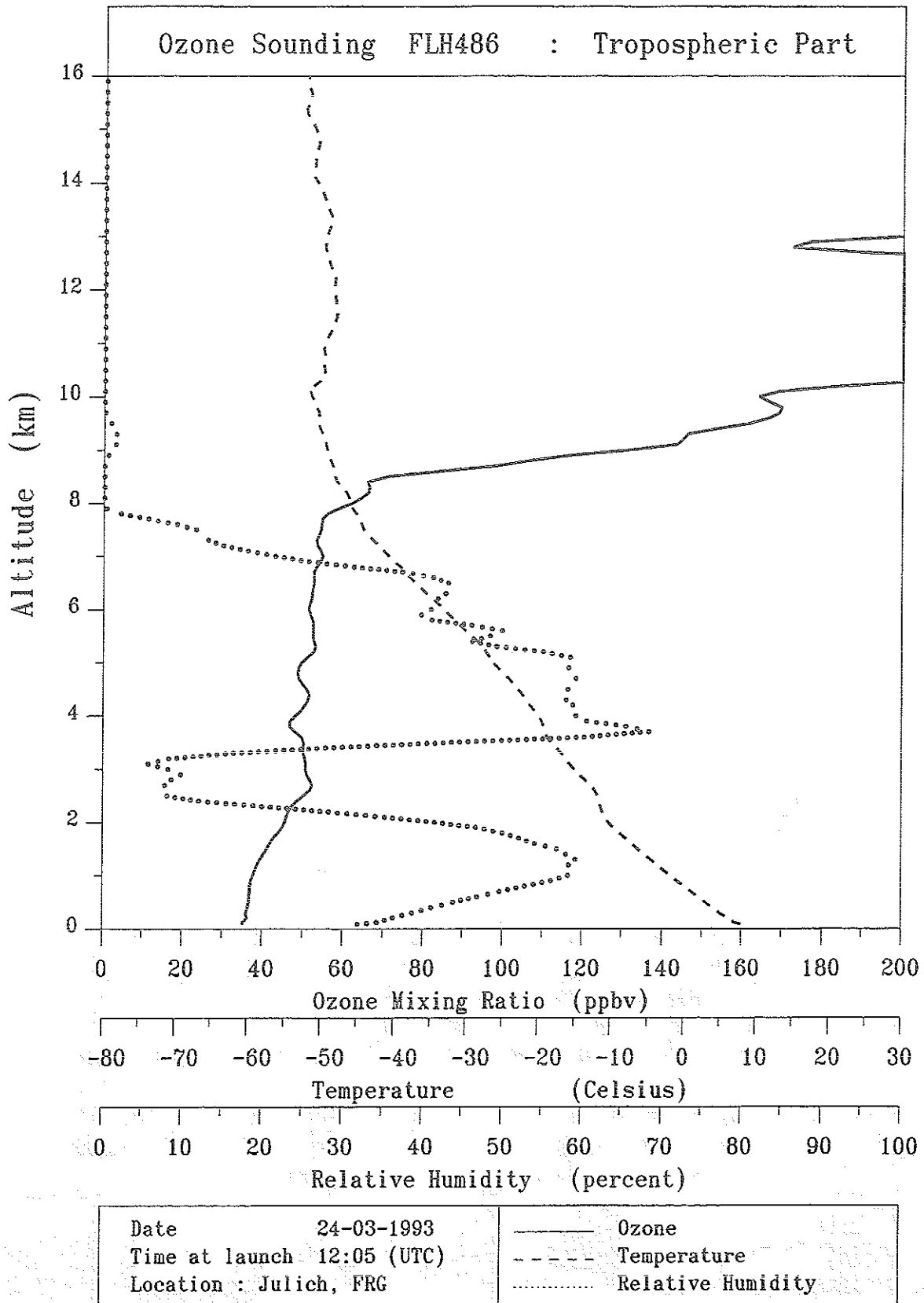
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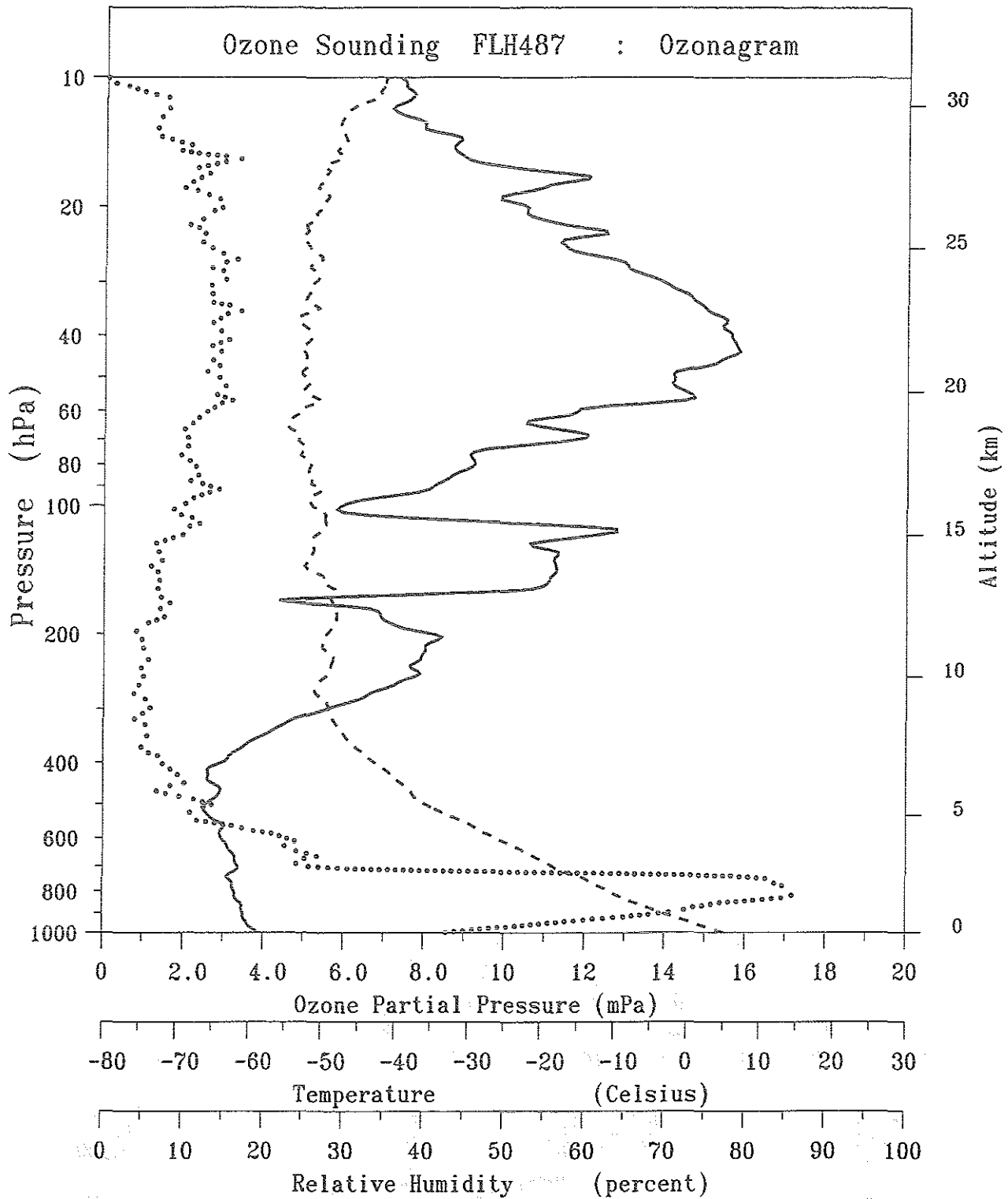




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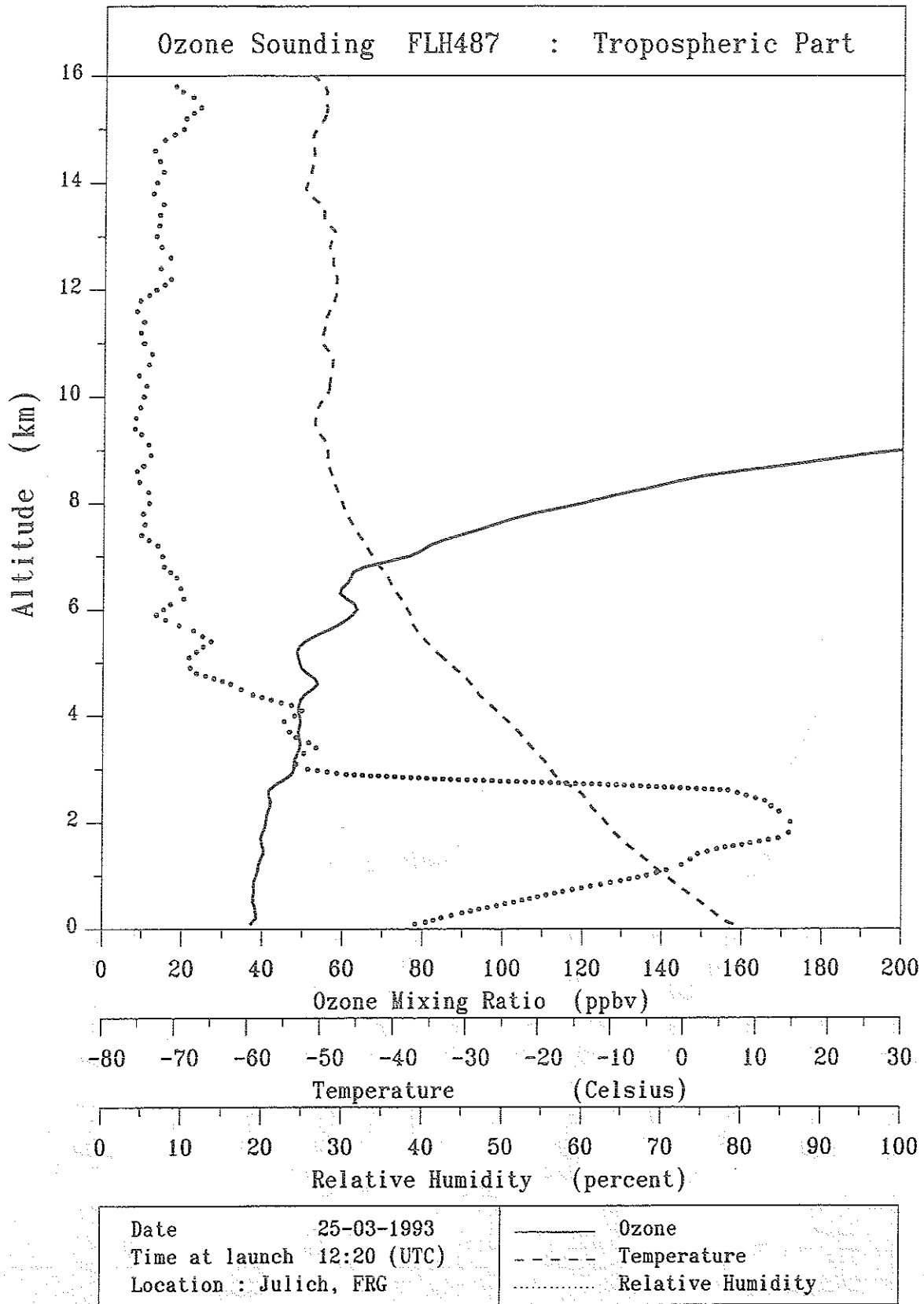
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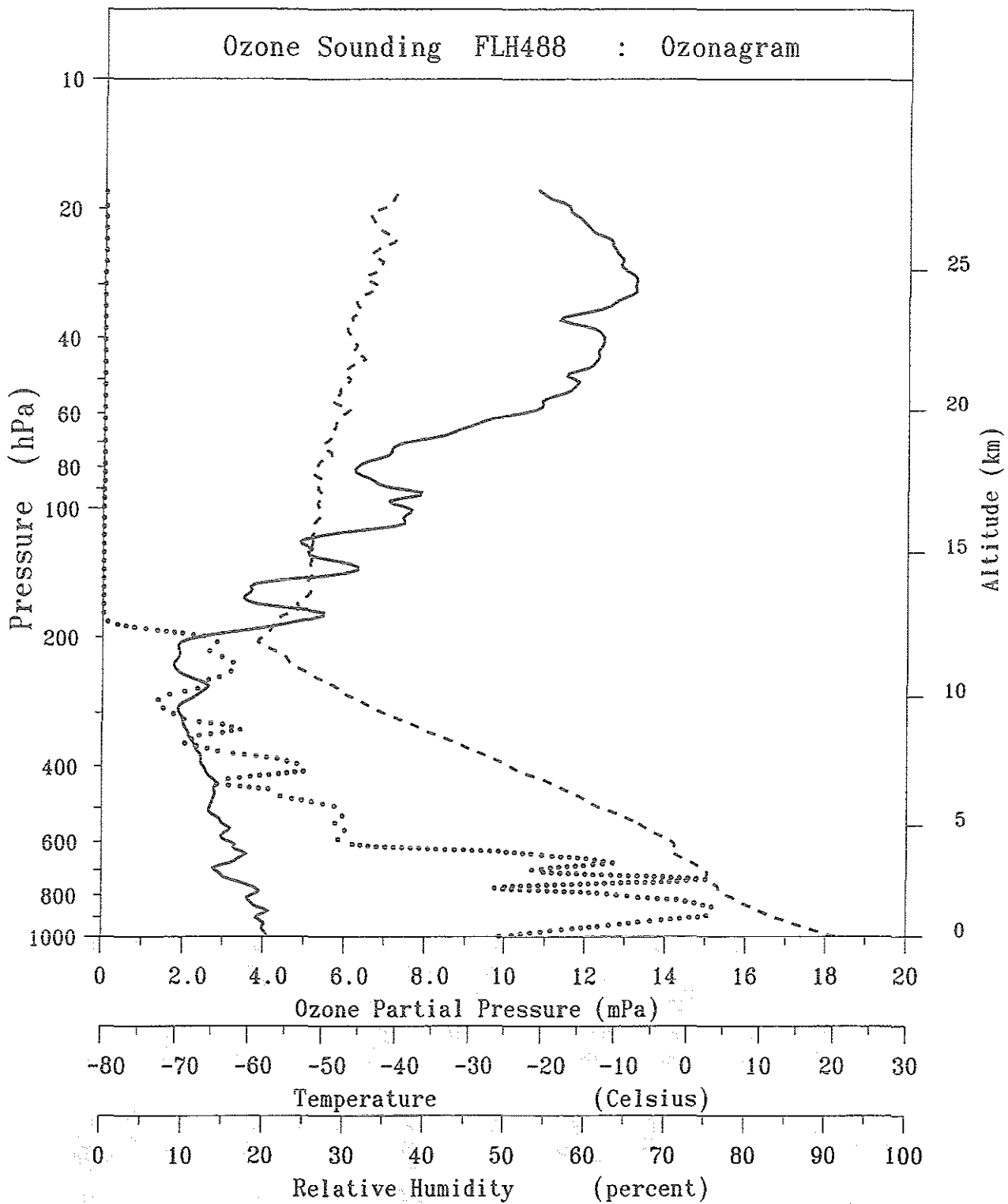




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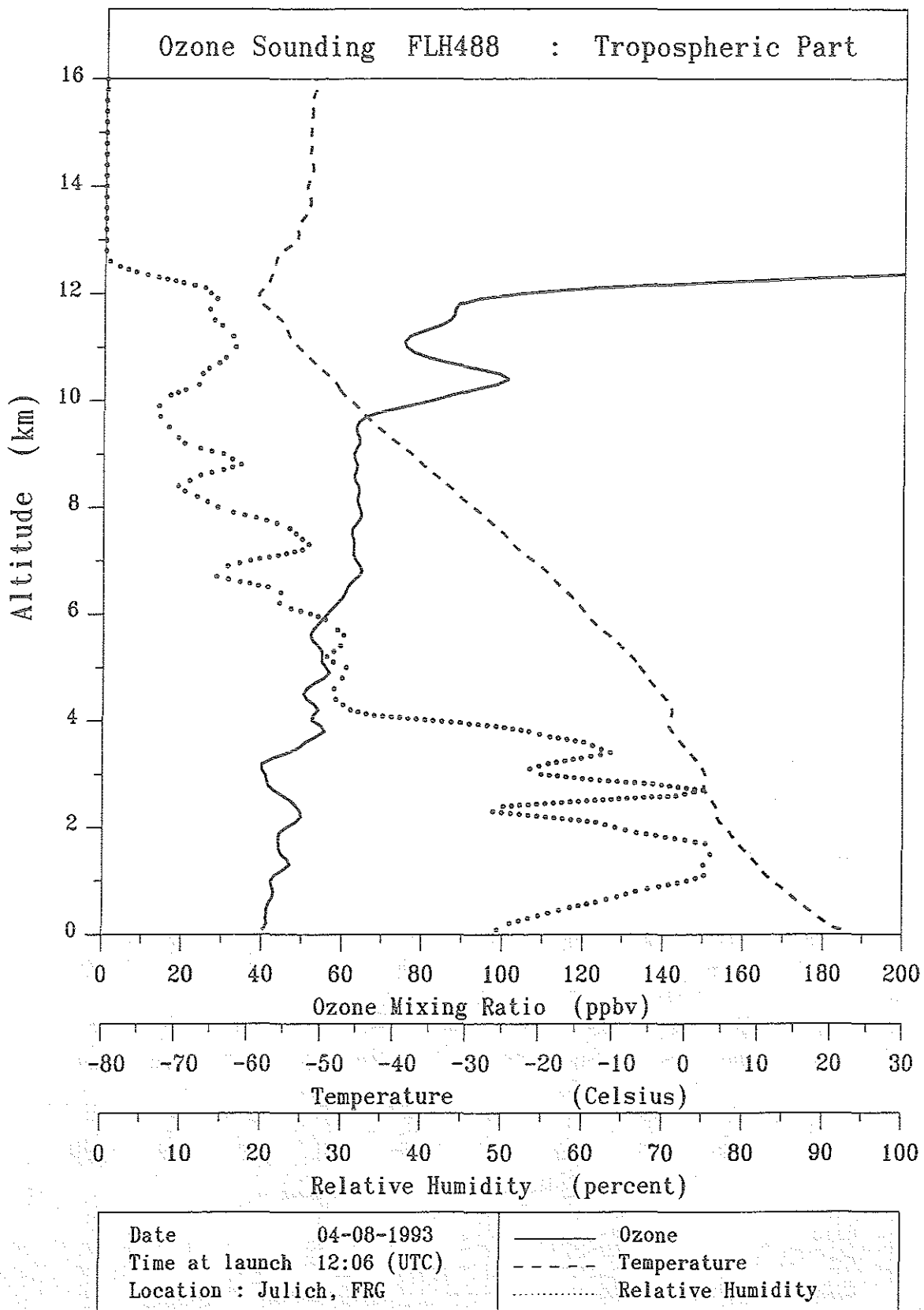
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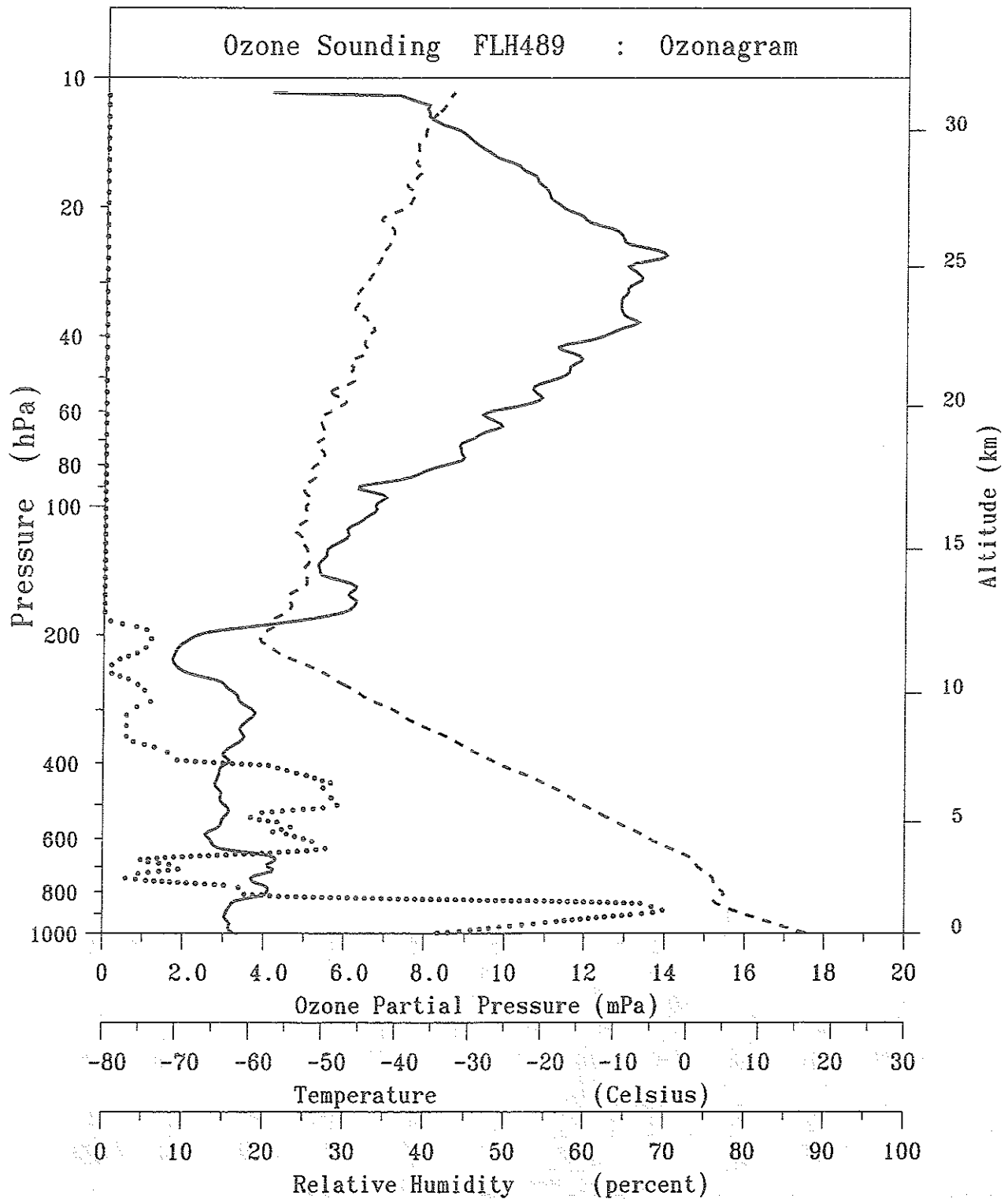




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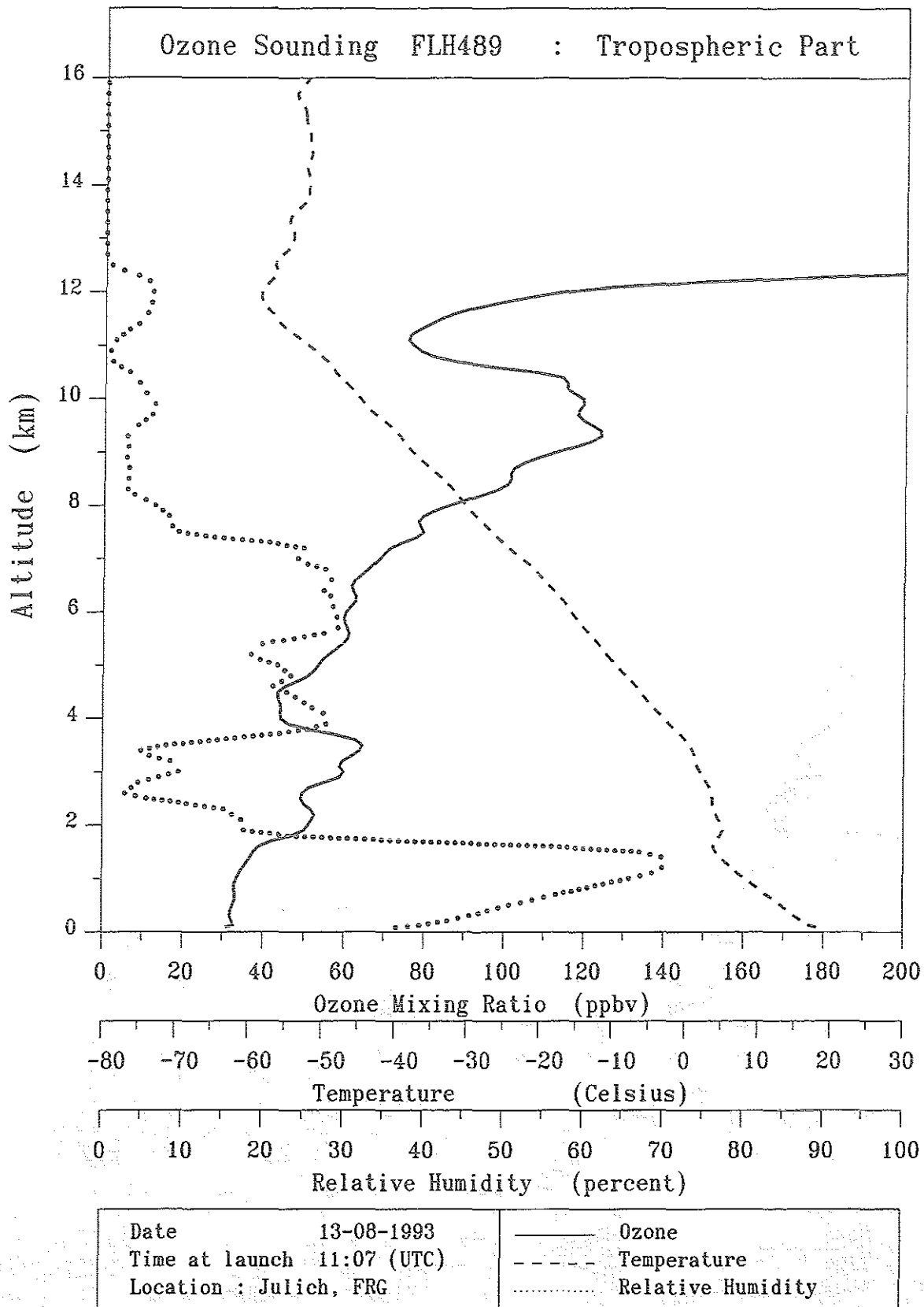
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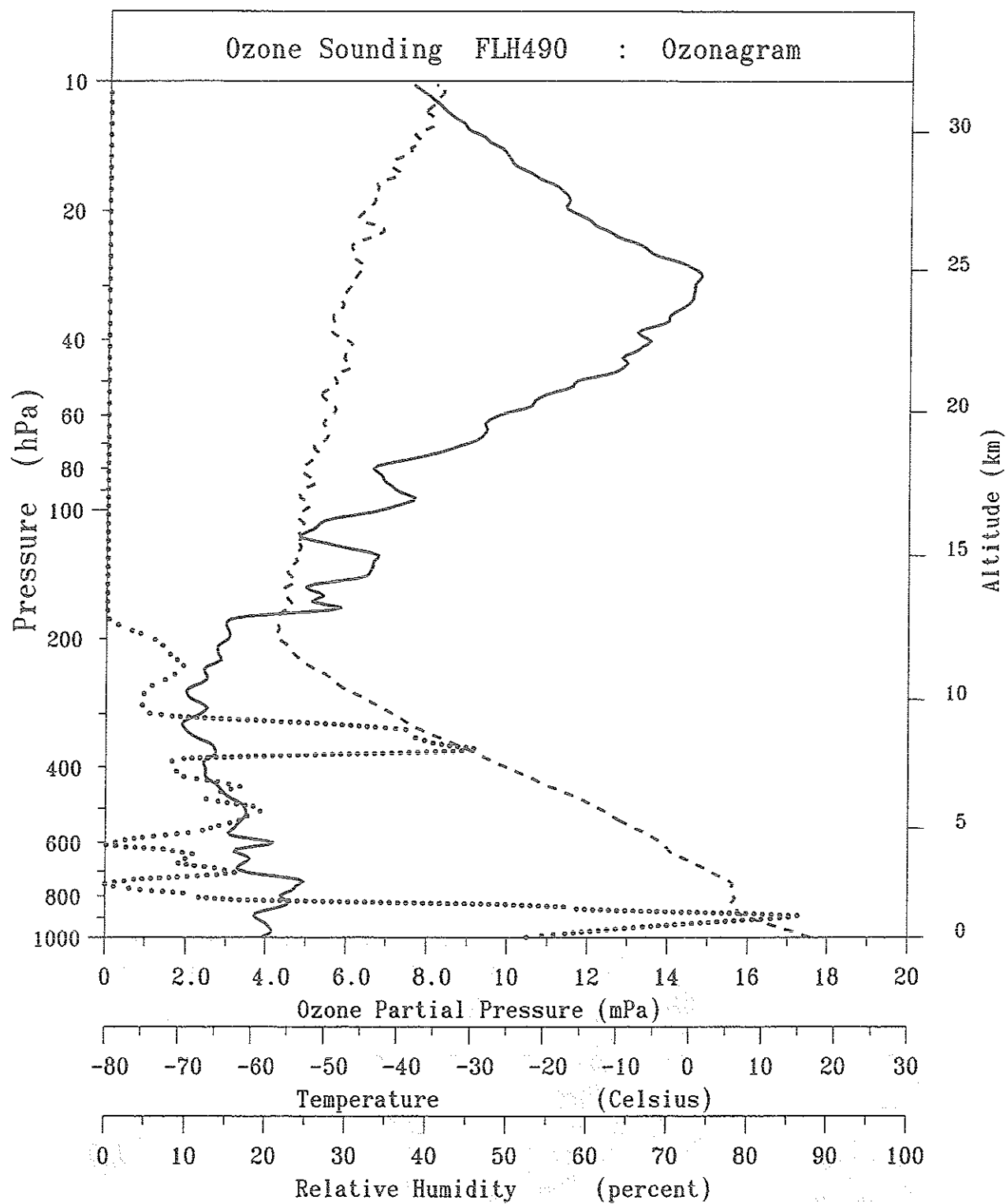




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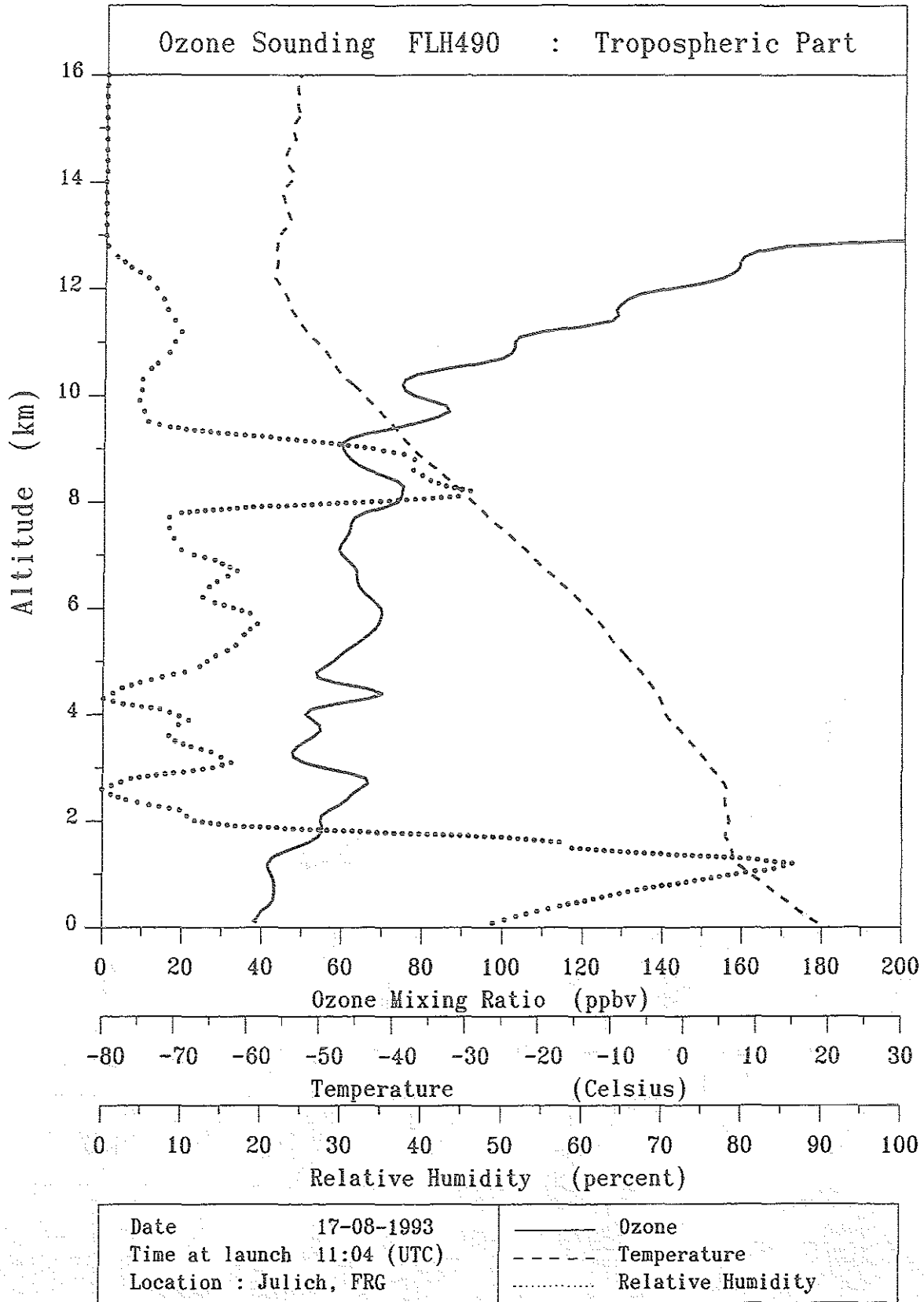
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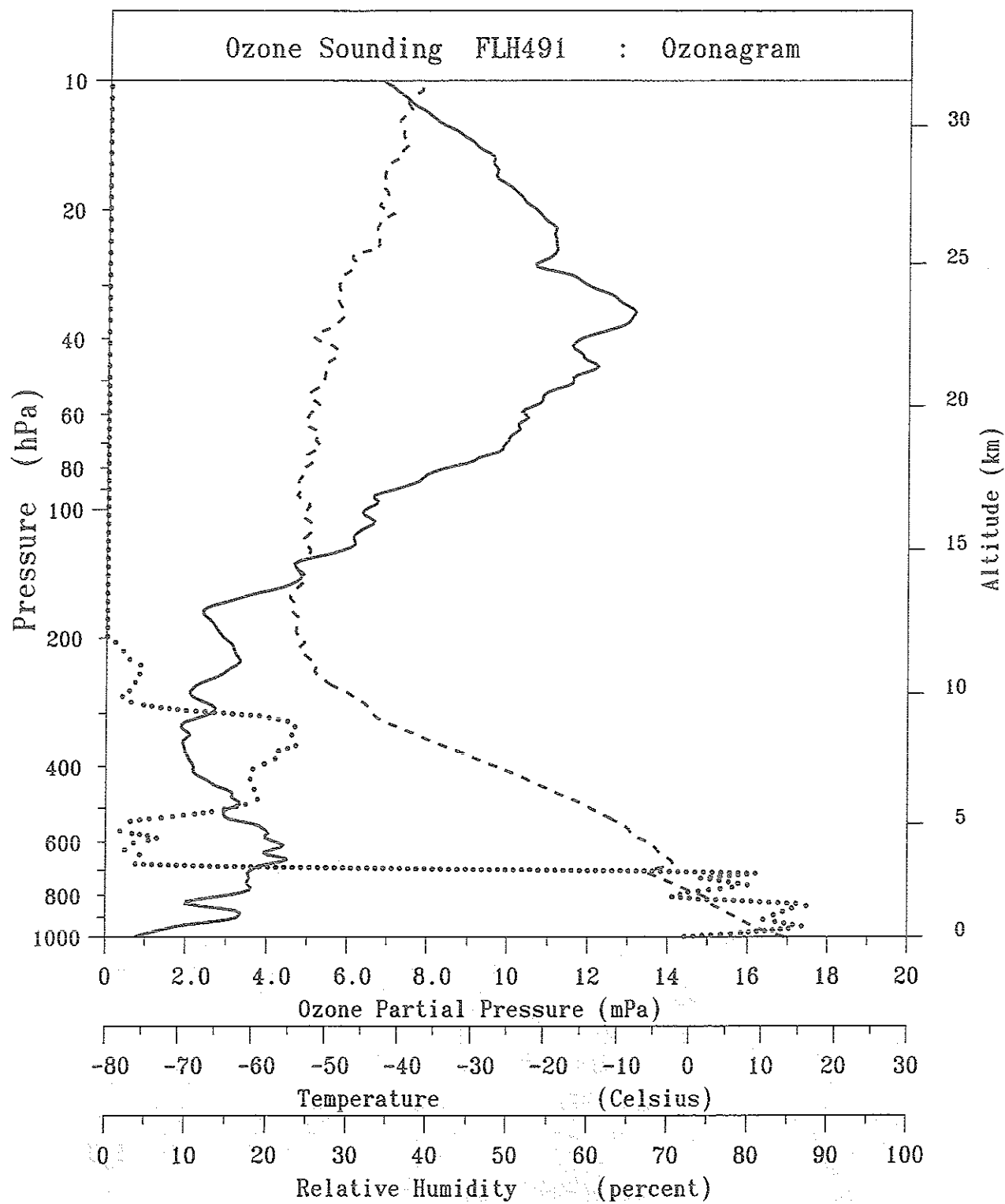




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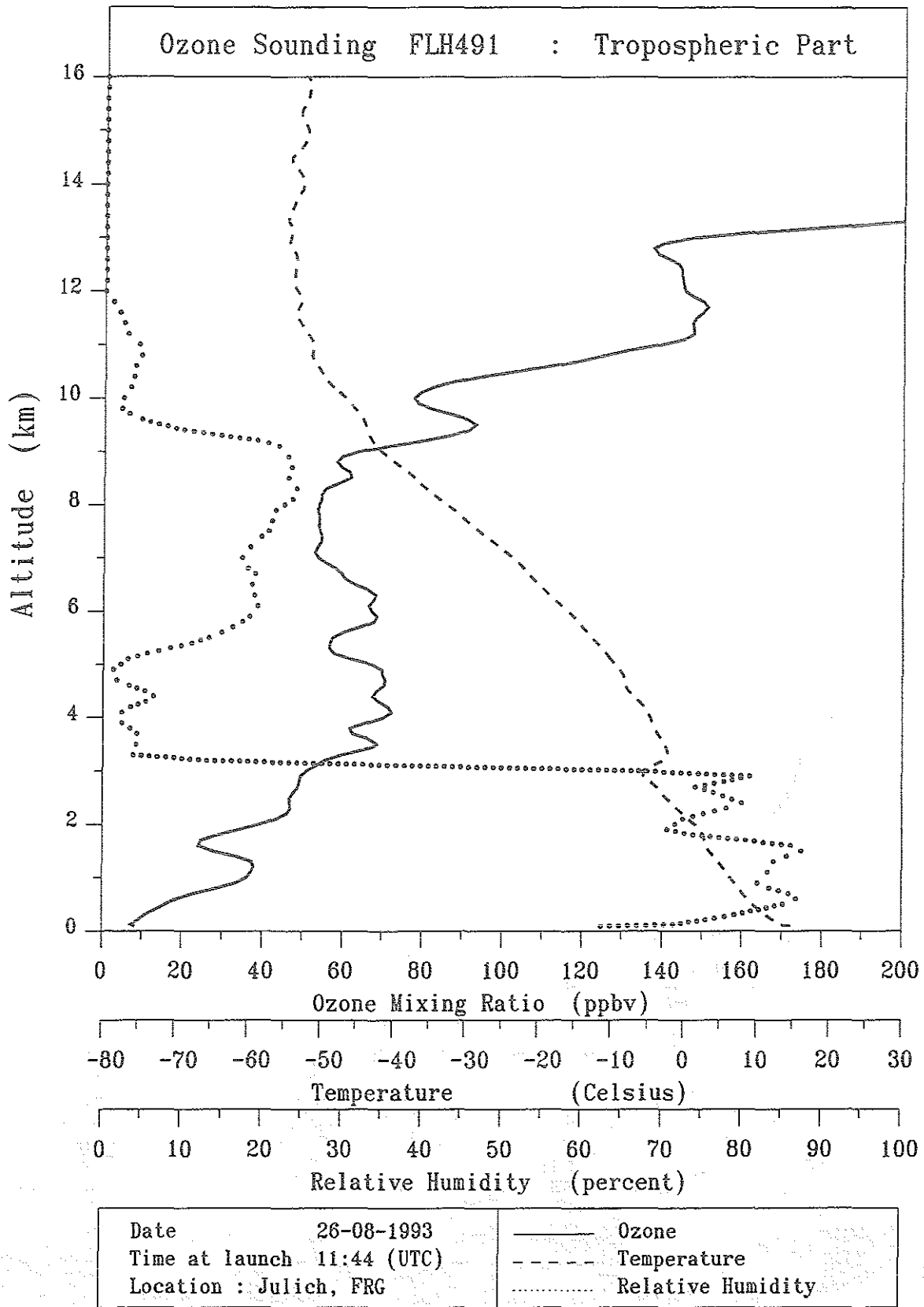
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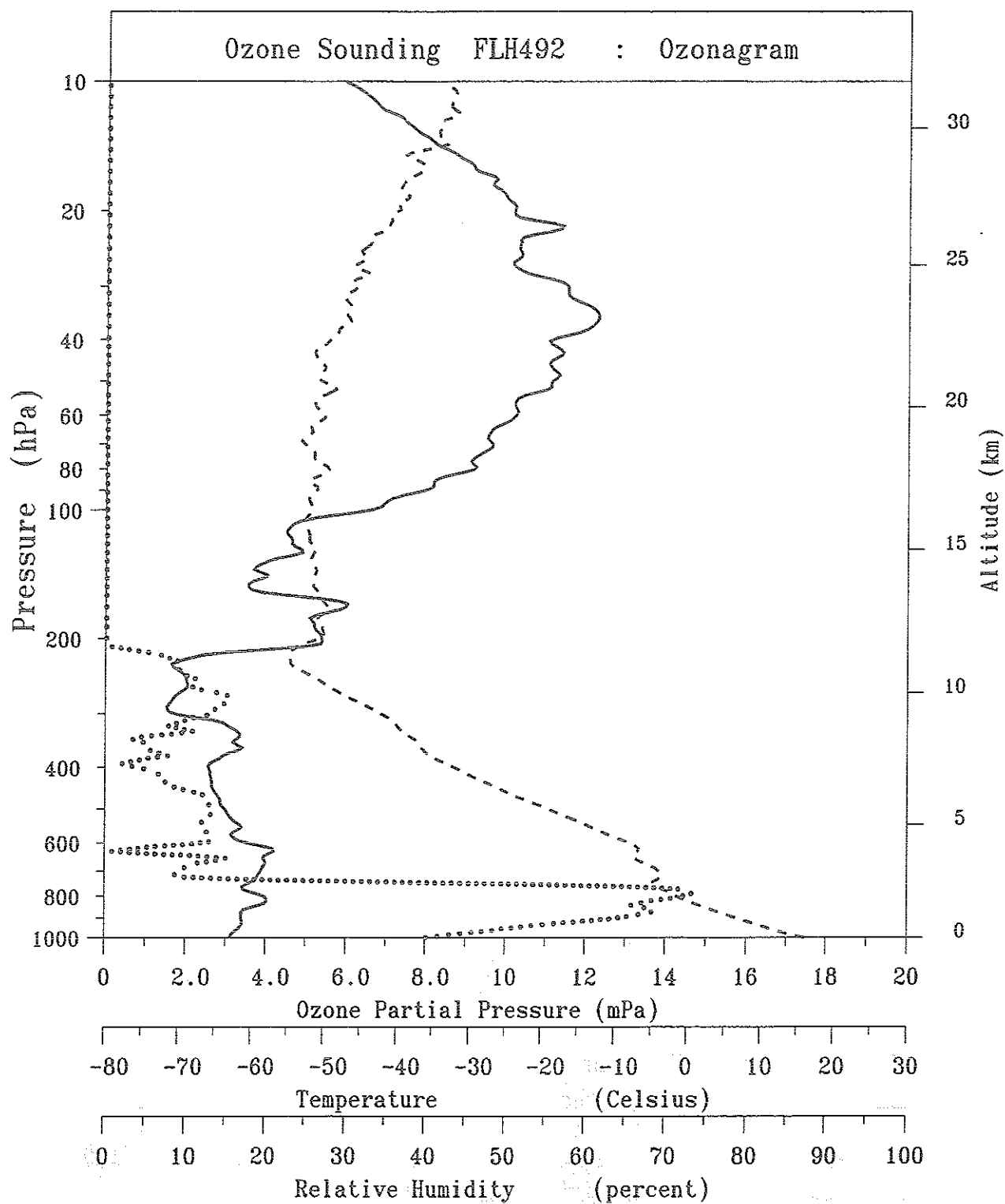




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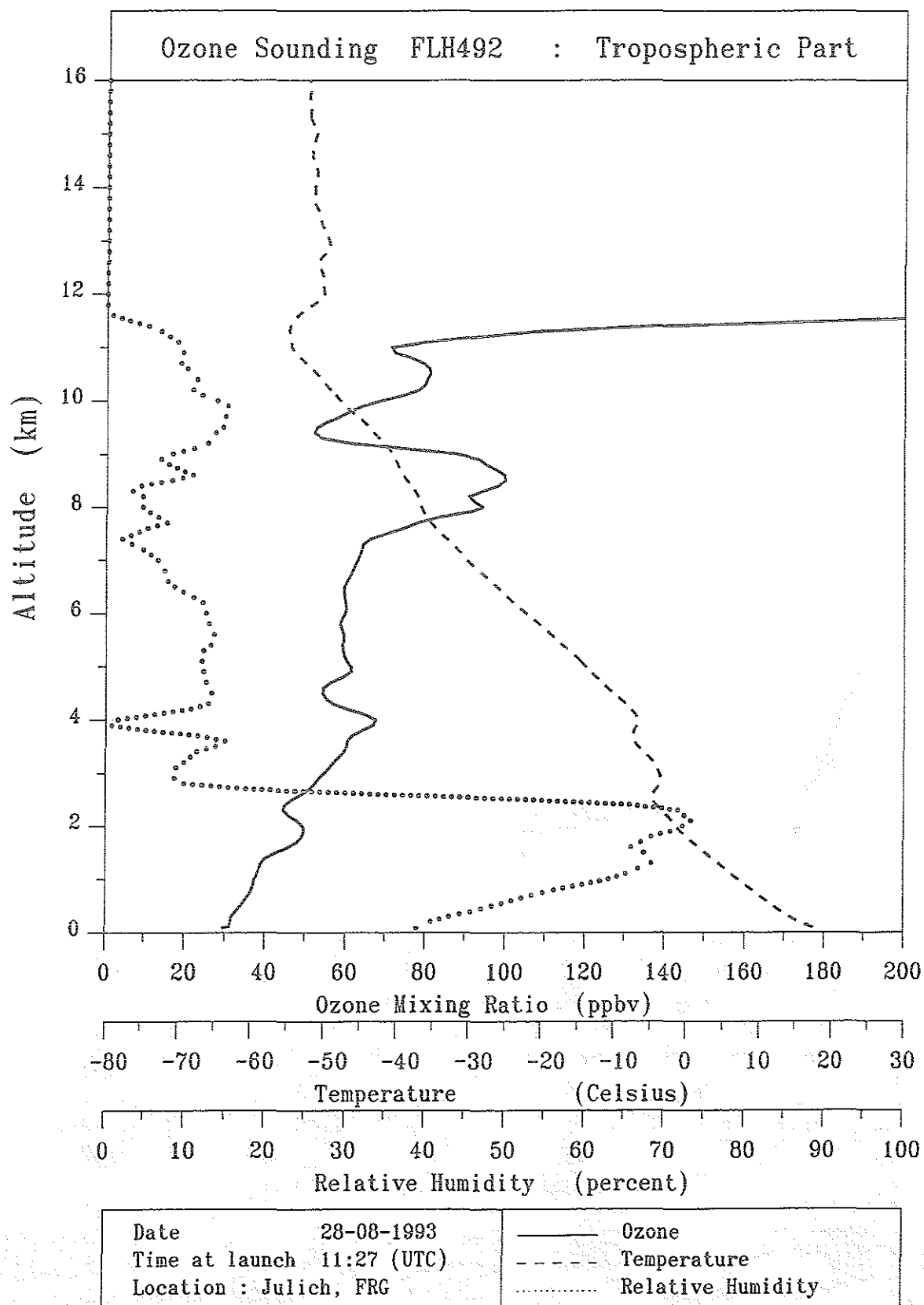
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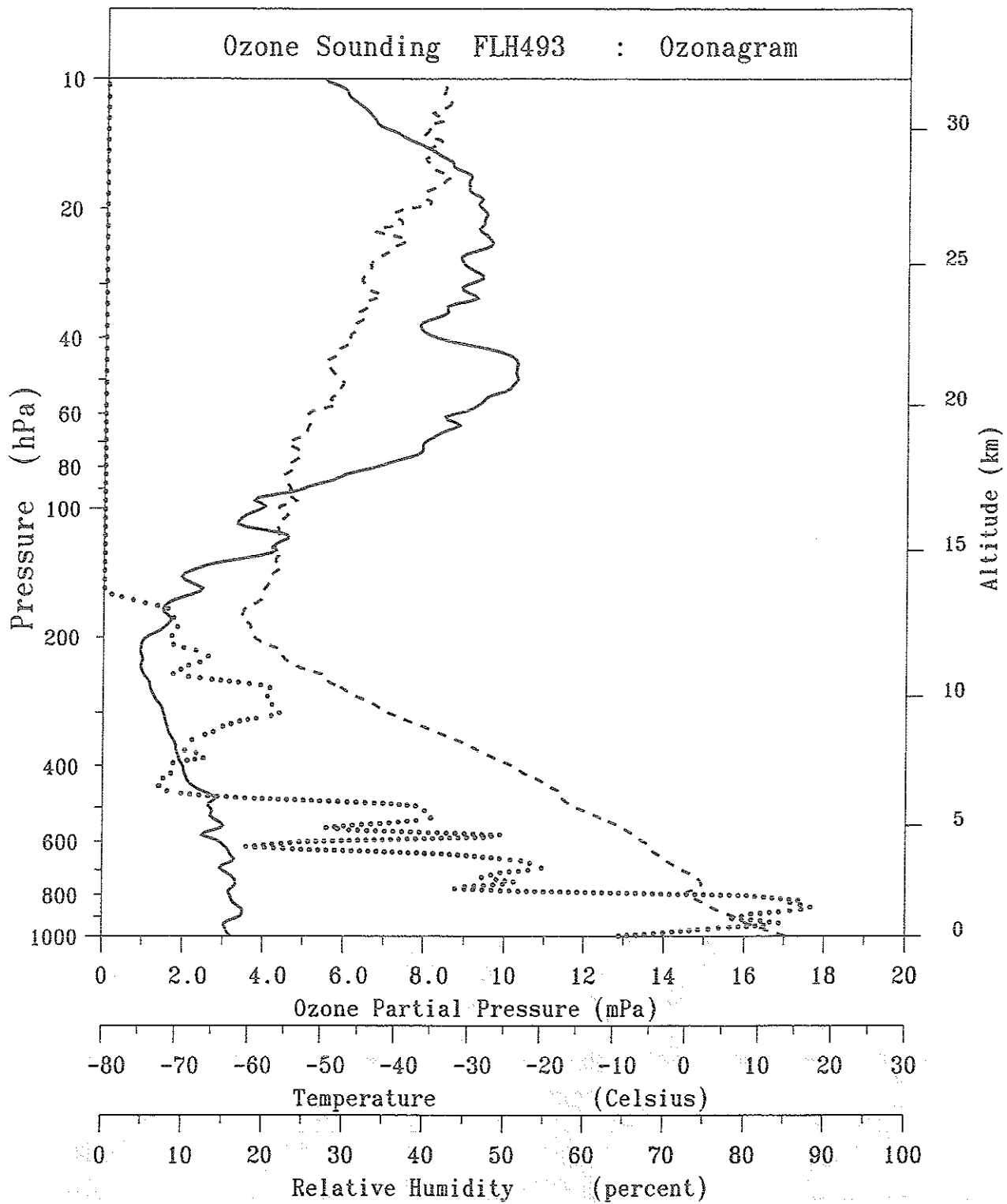




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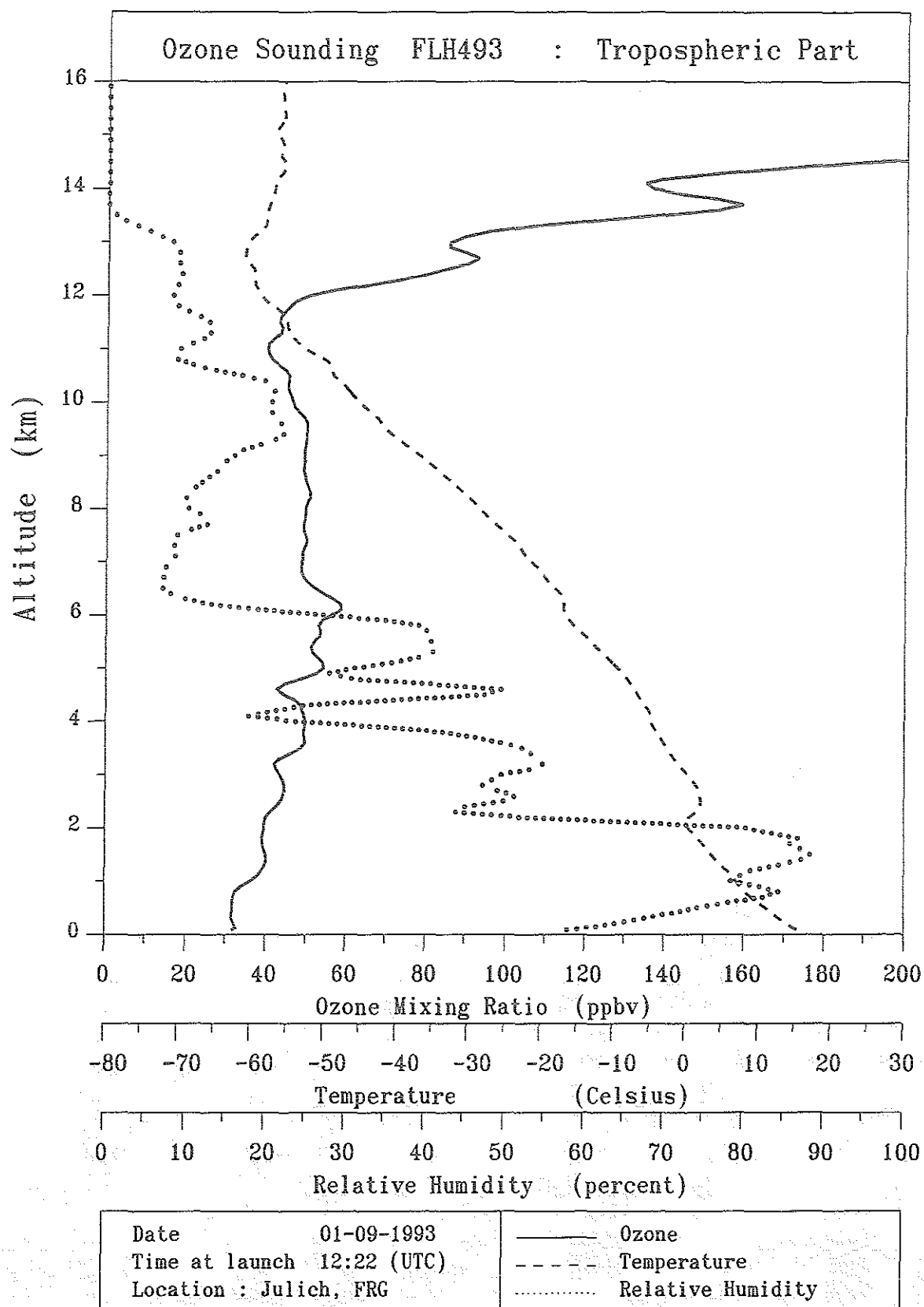
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 Relative Humidity

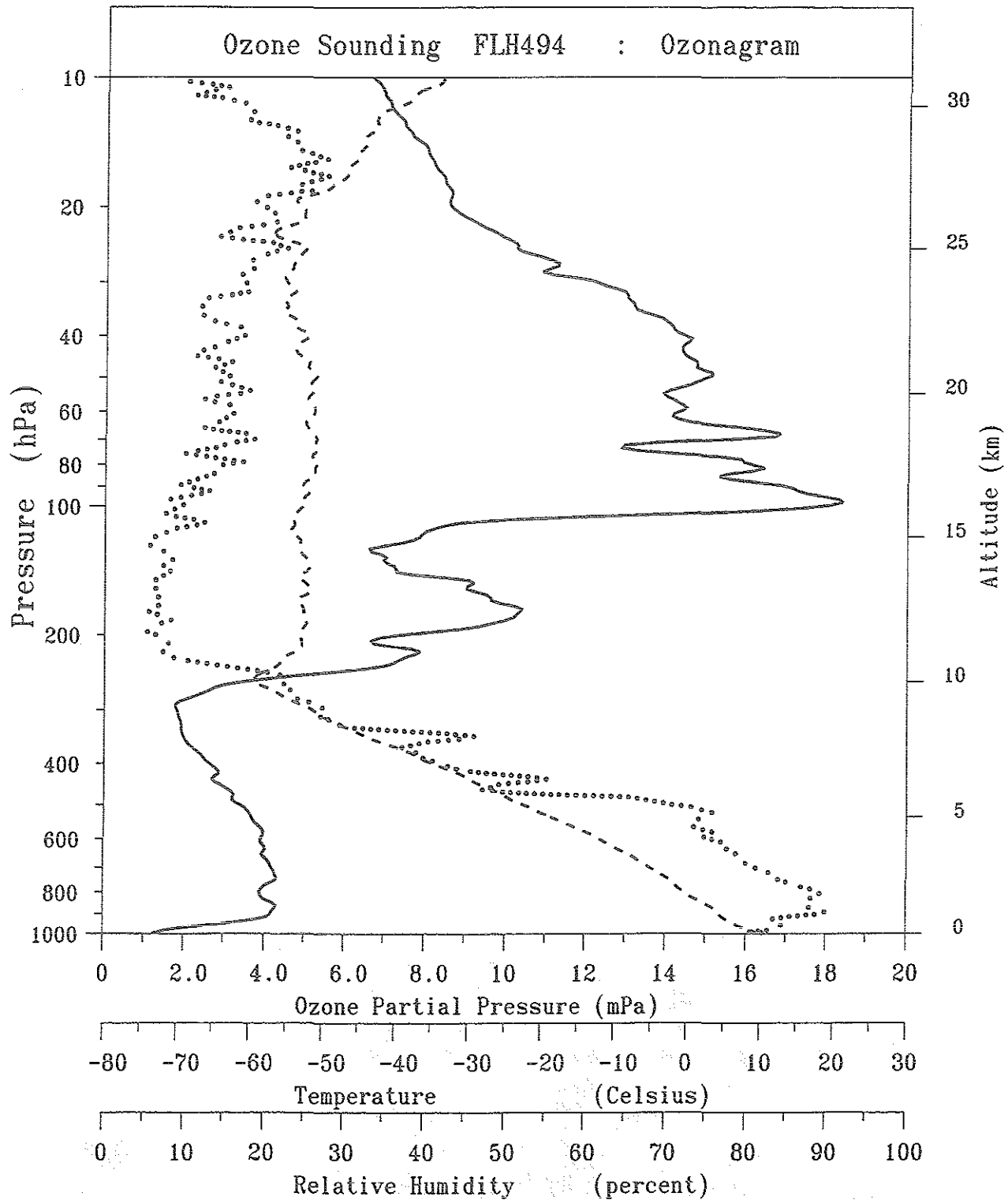




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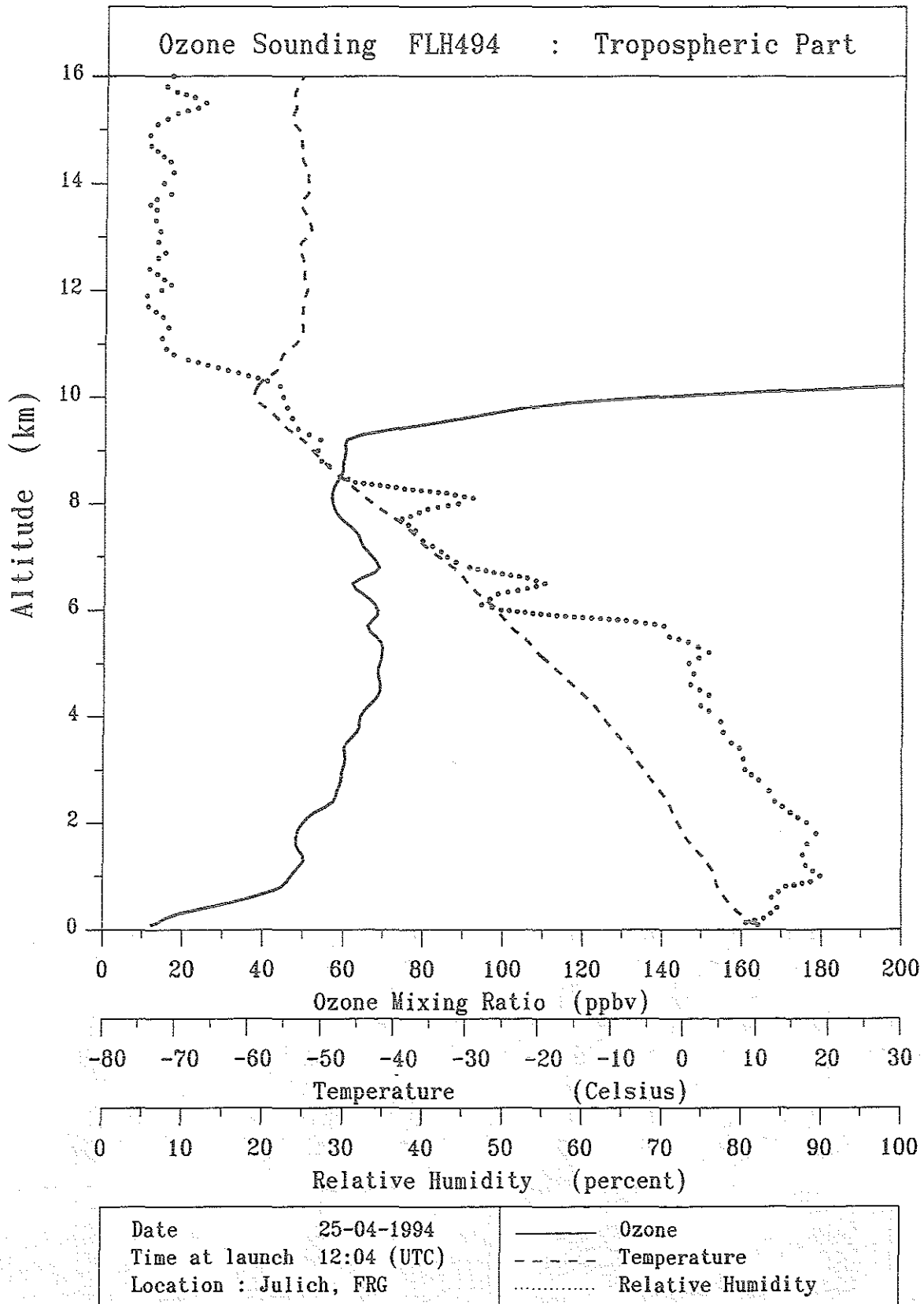
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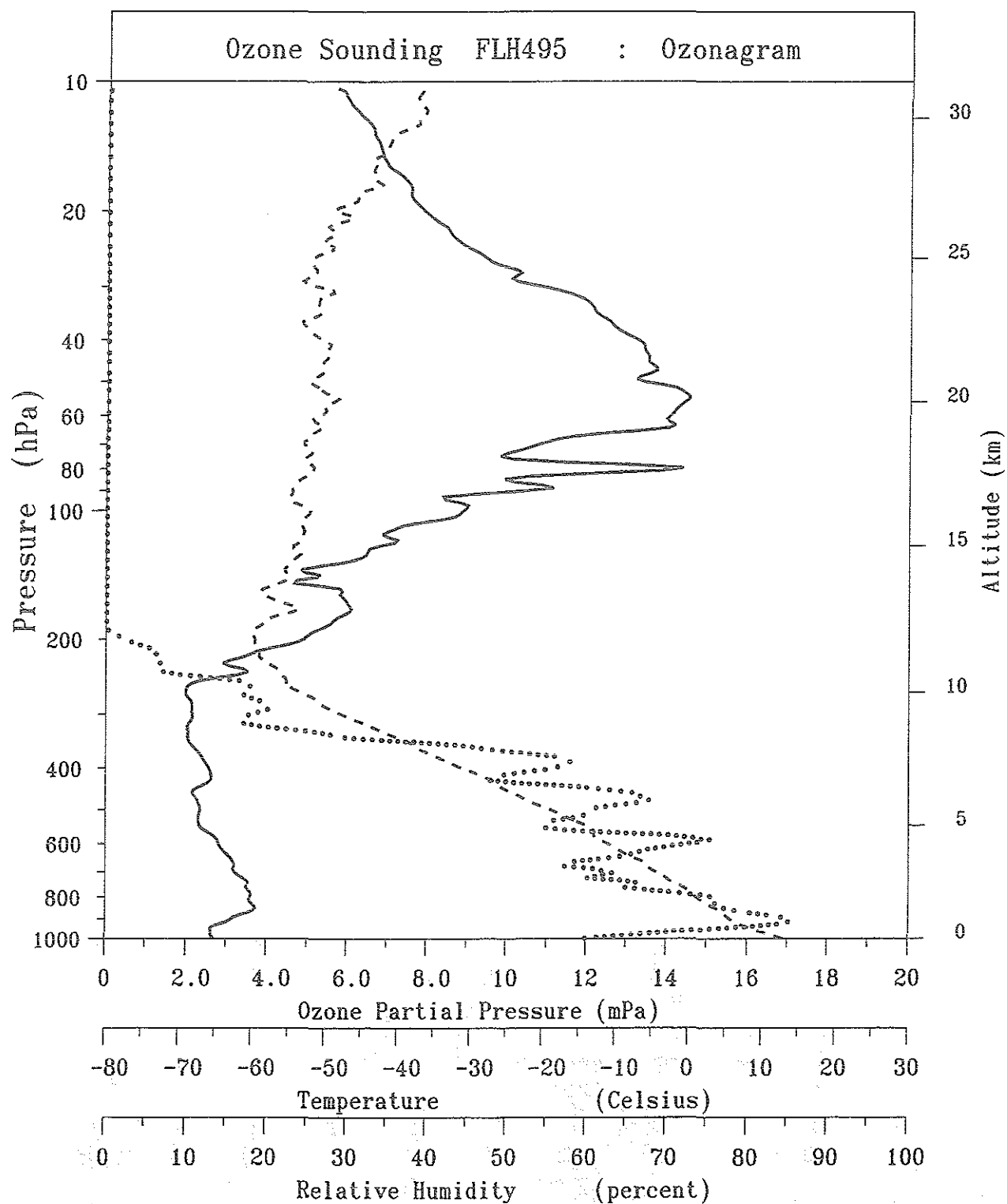




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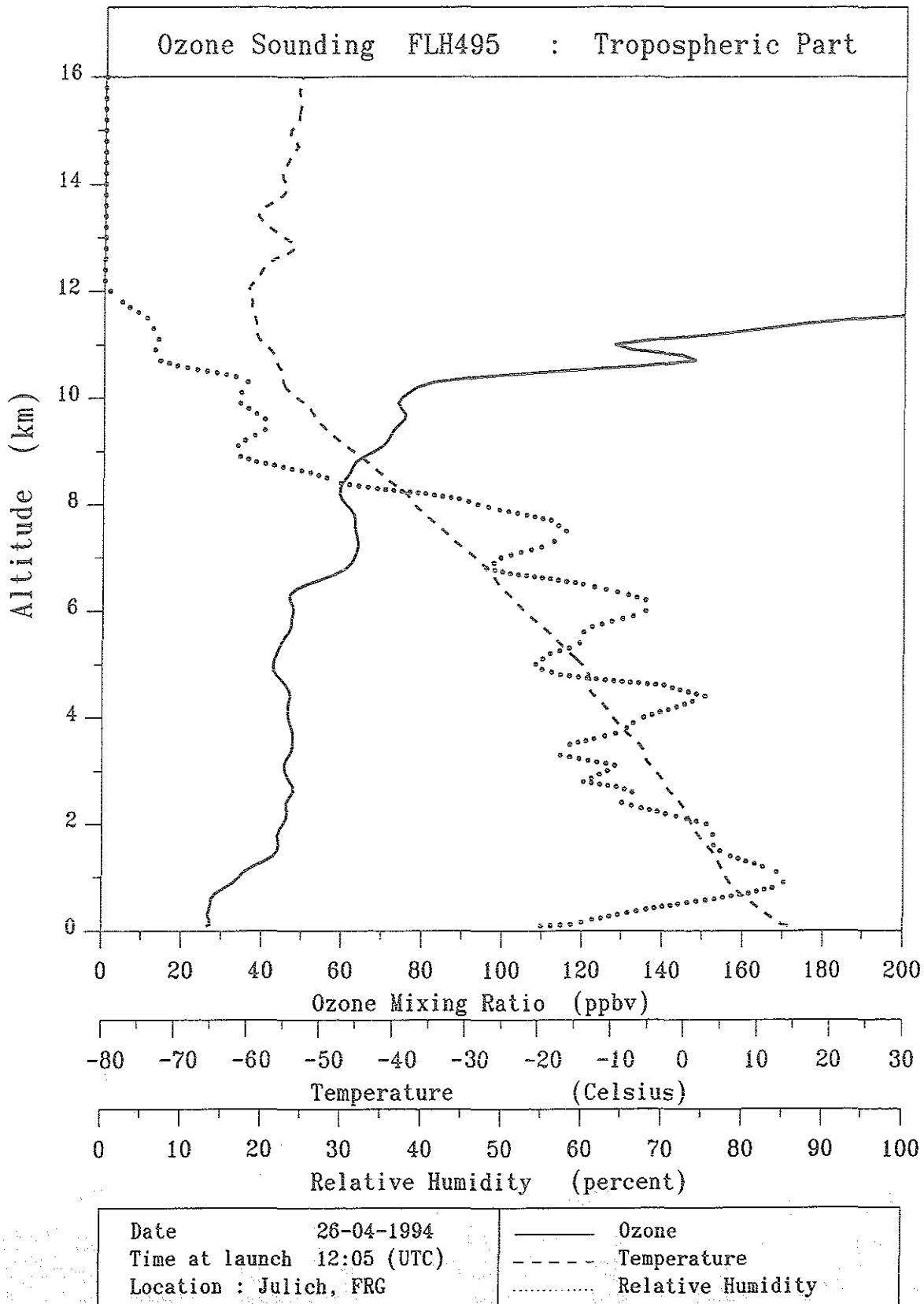
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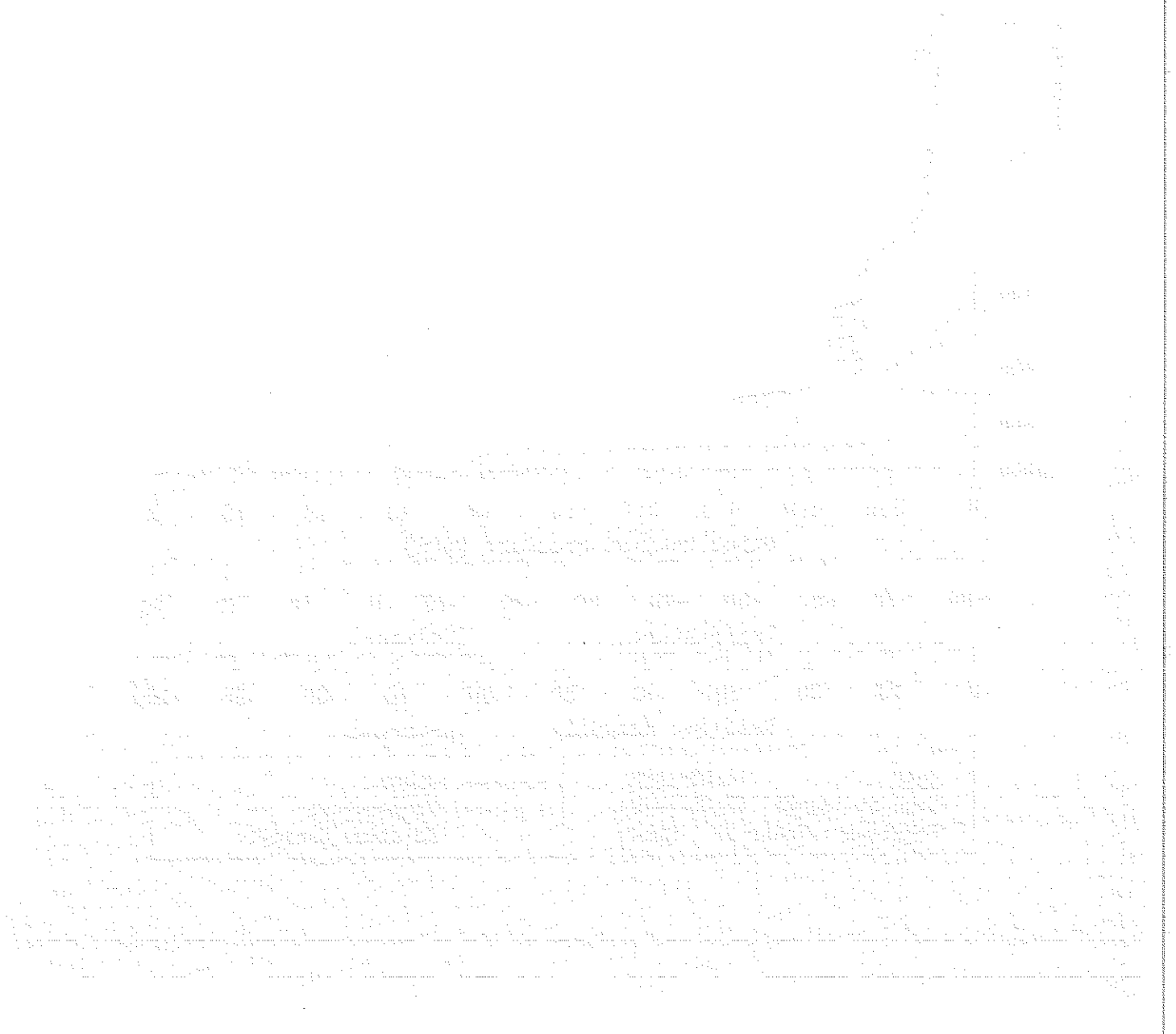


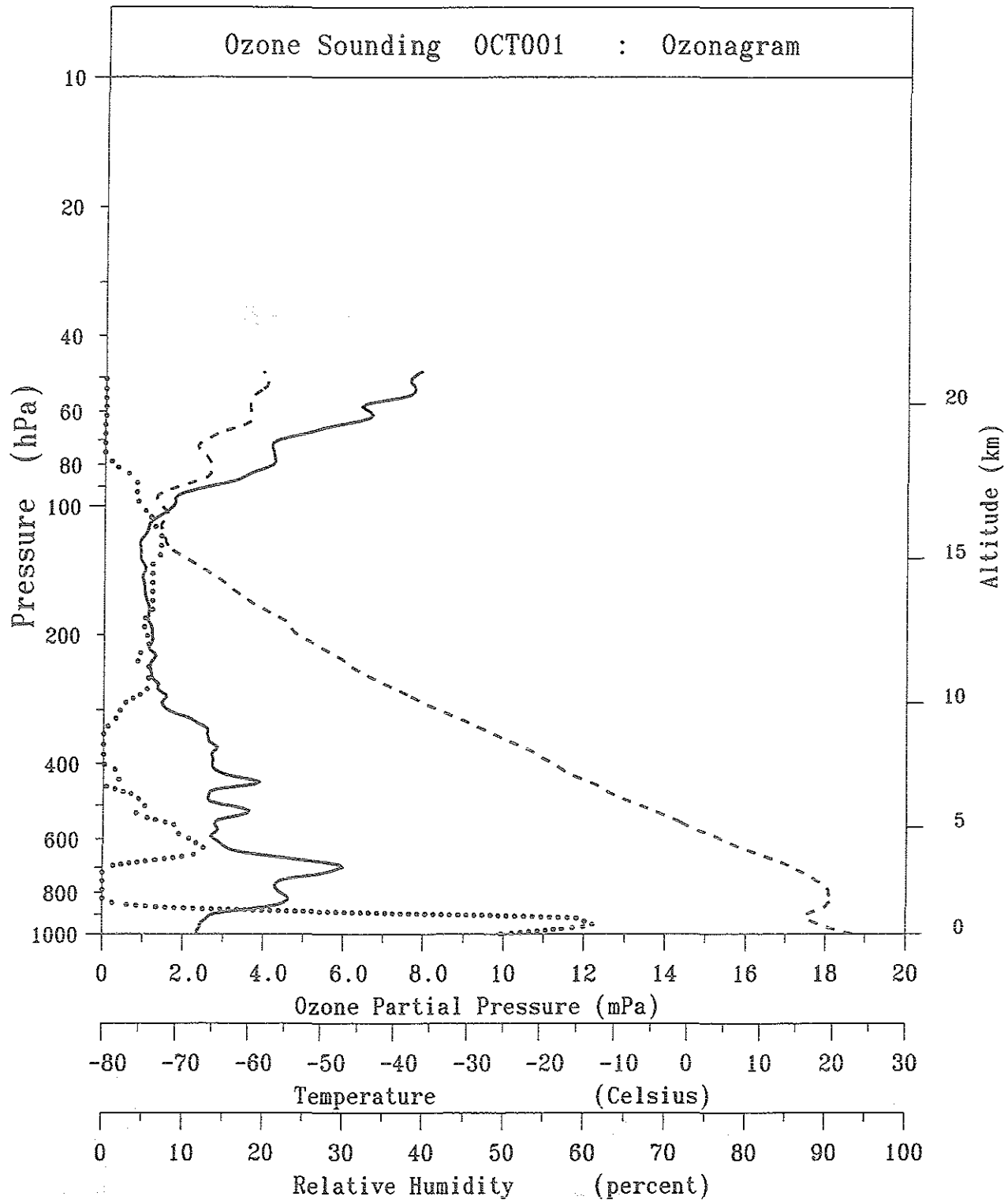
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 - - - Temperature
 Relative Humidity



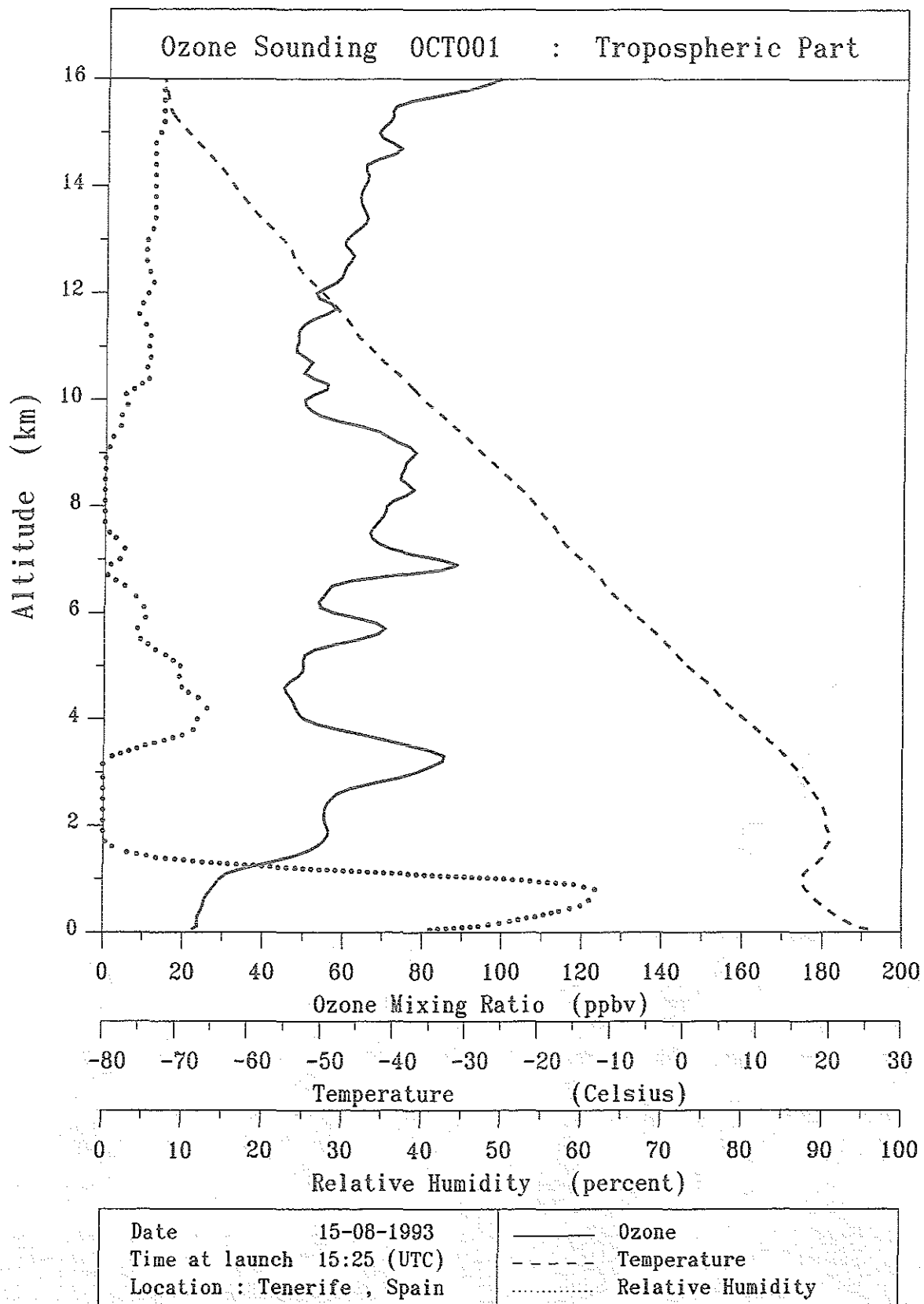
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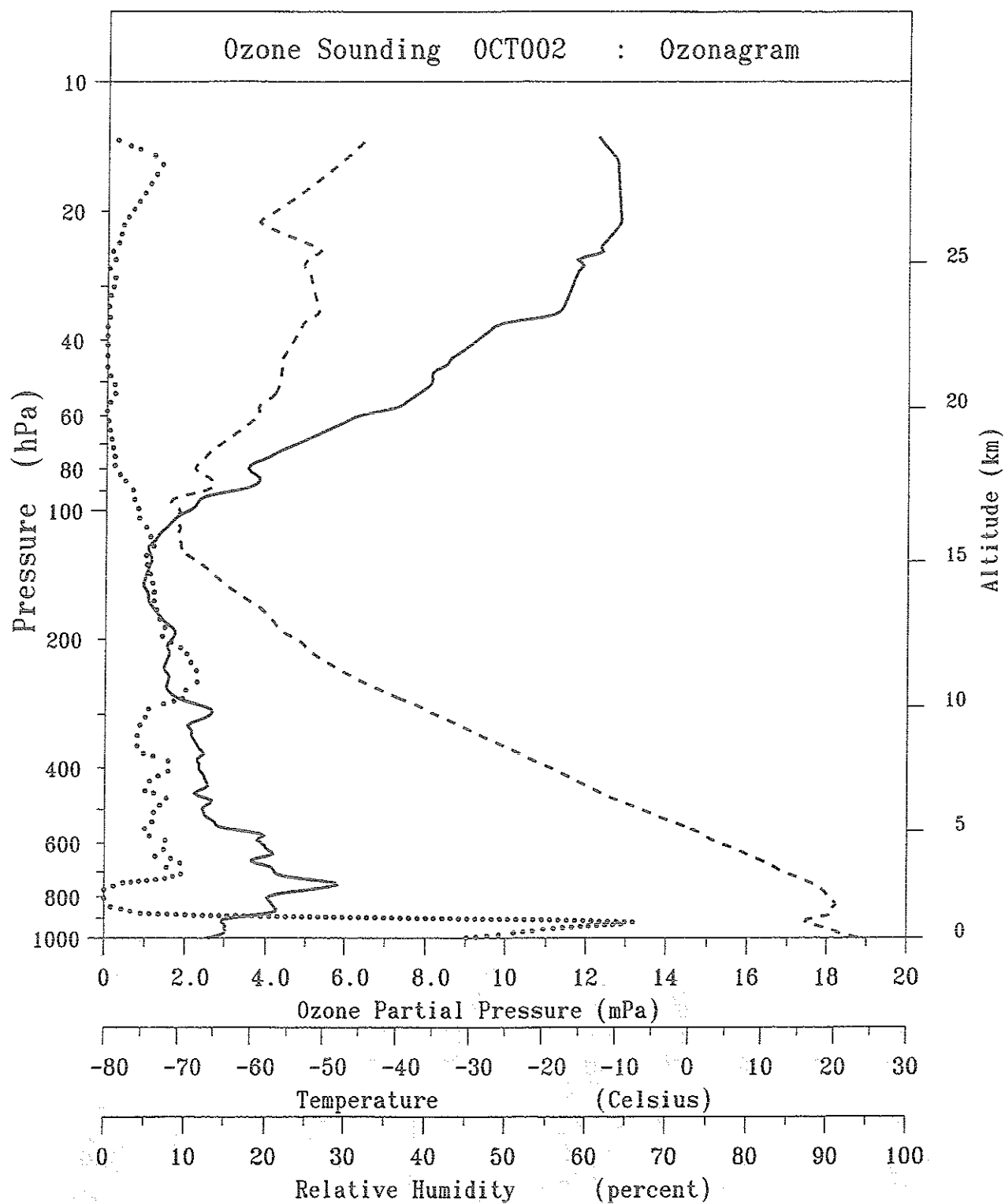




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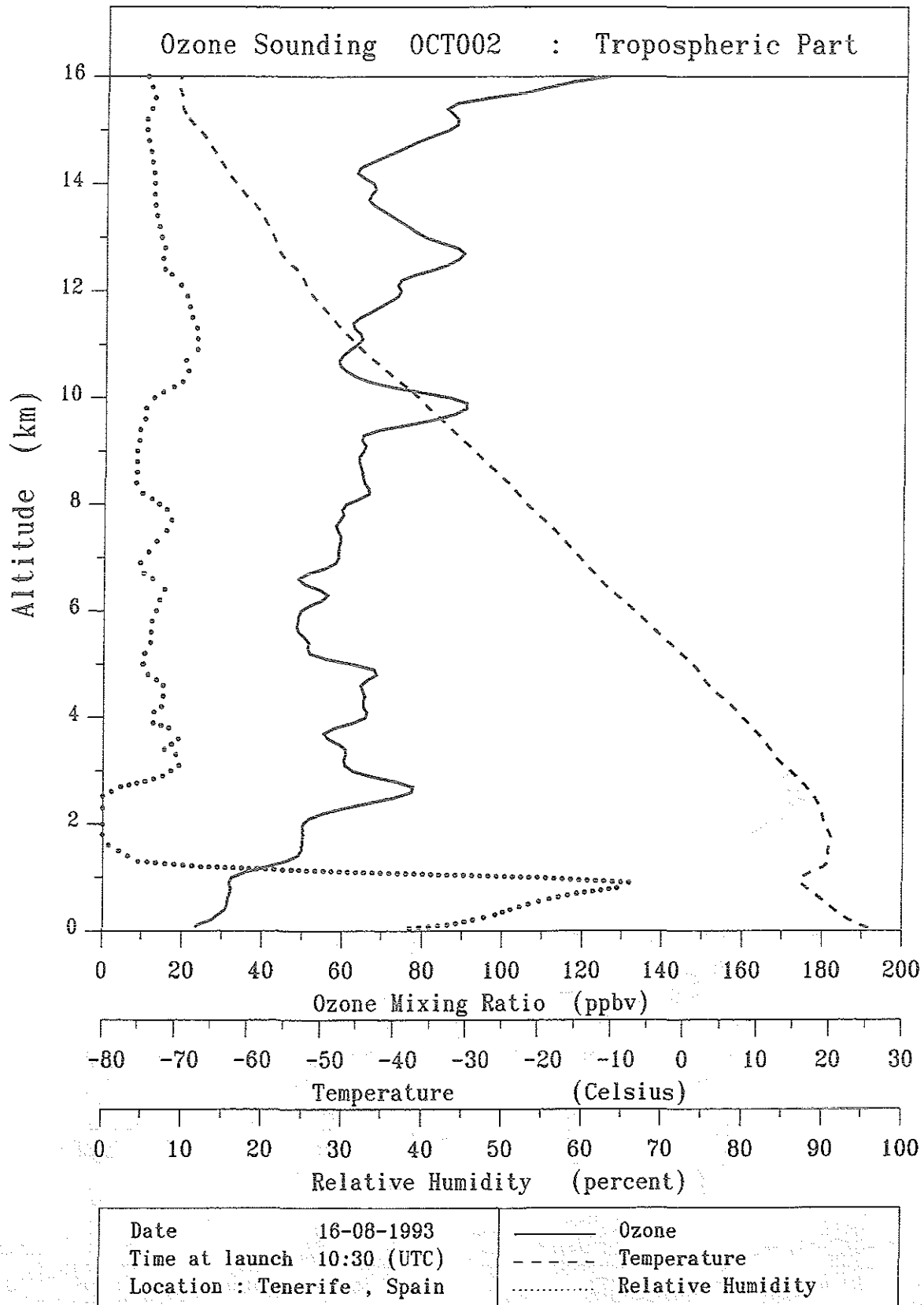
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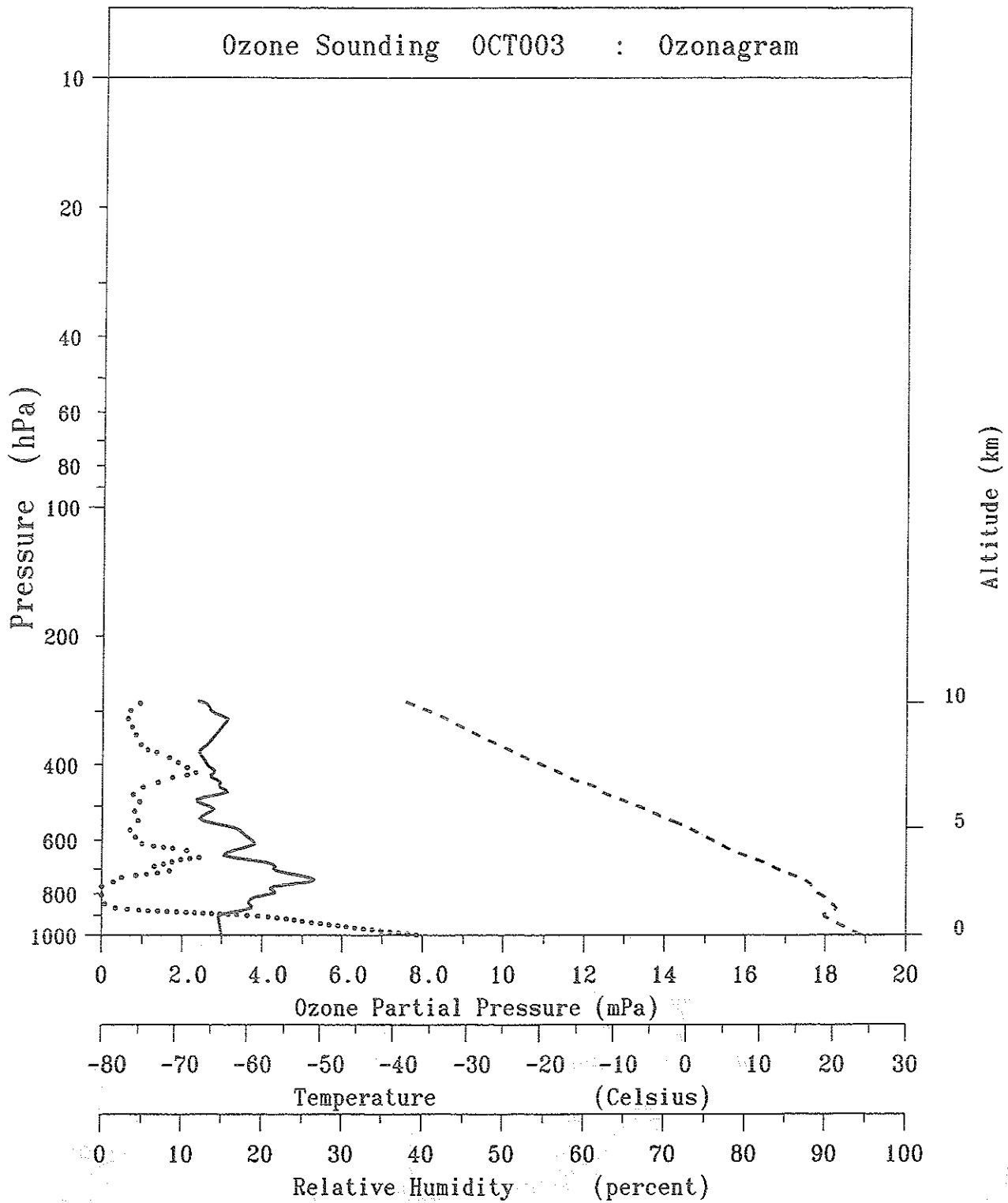




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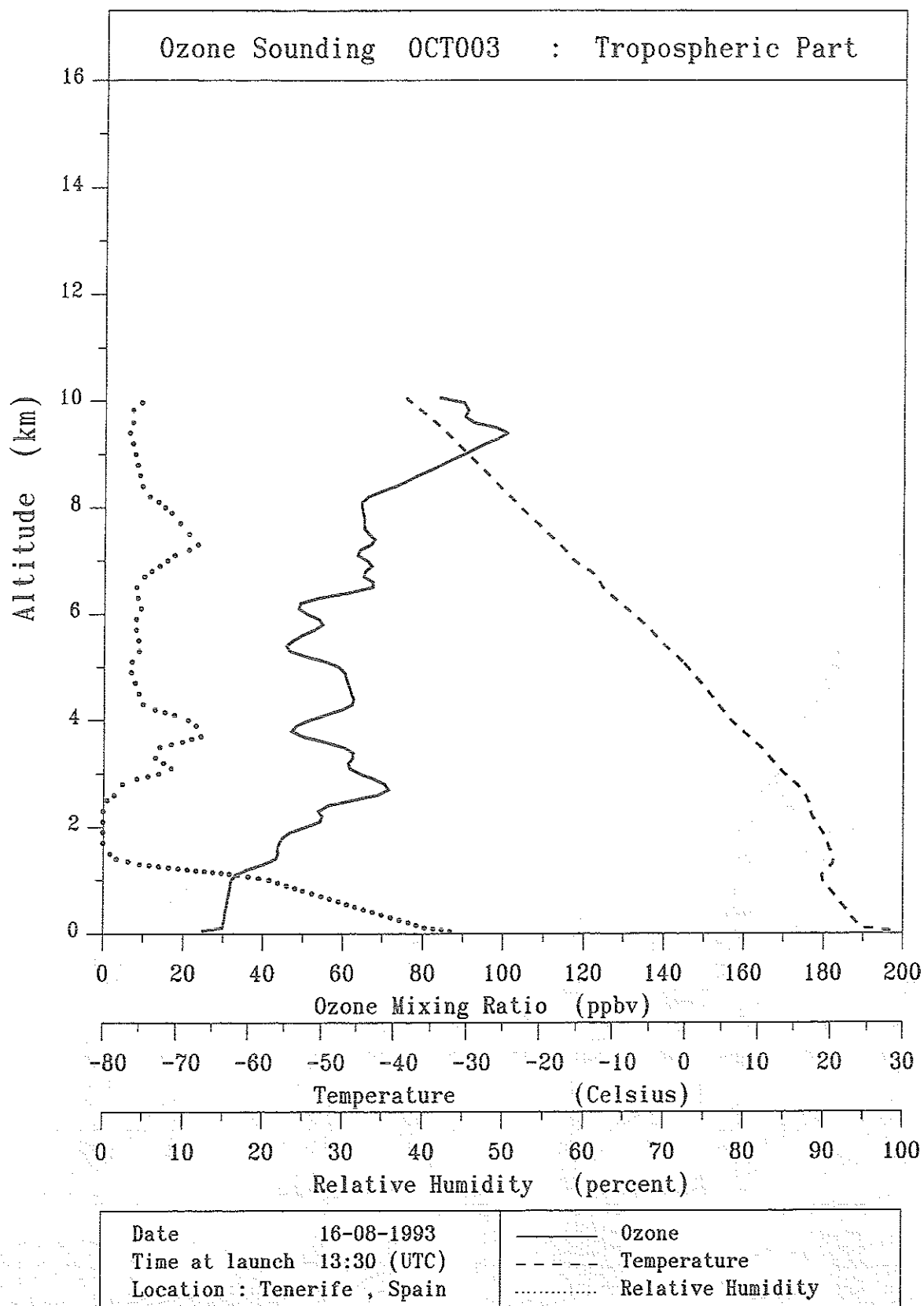
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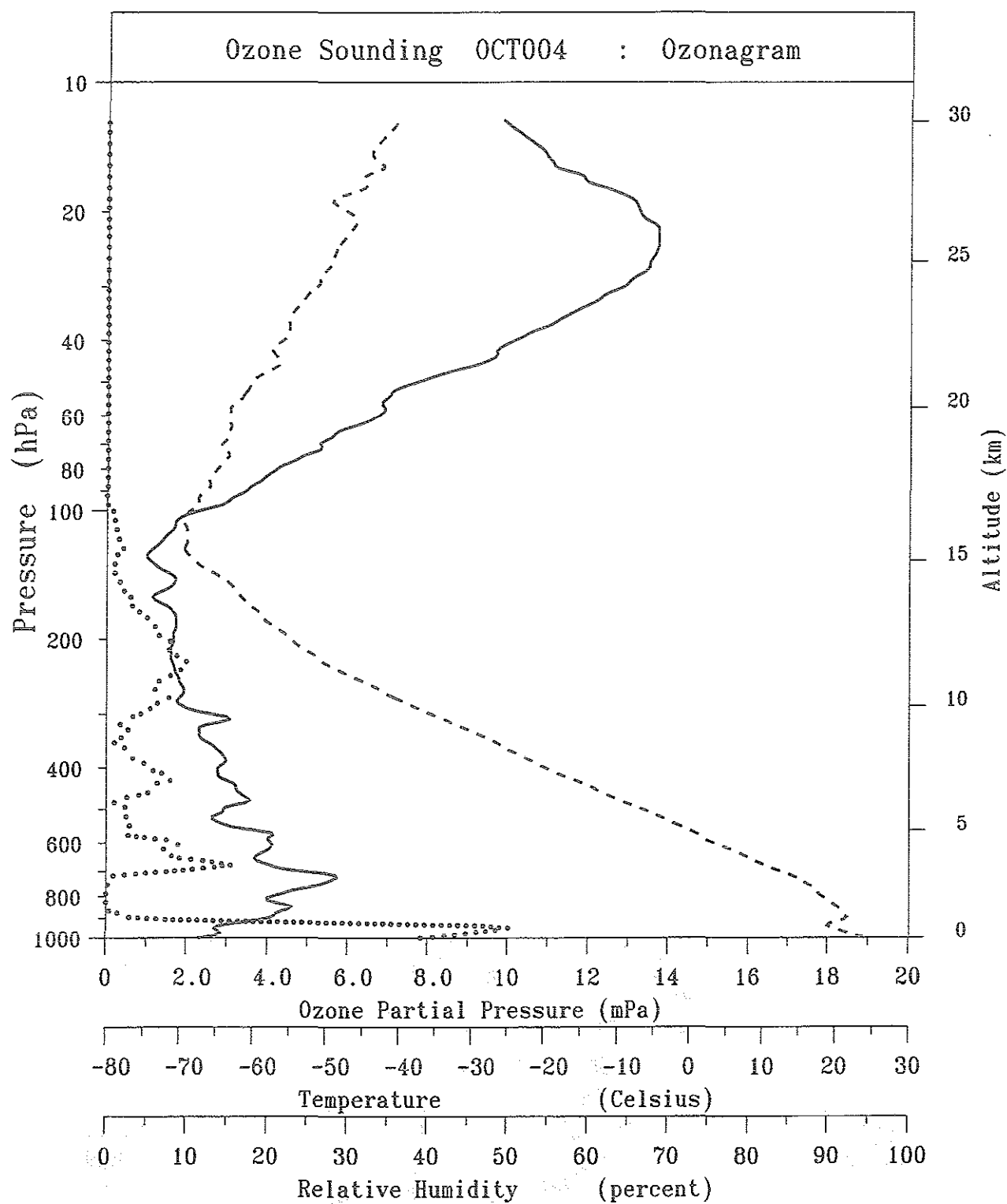




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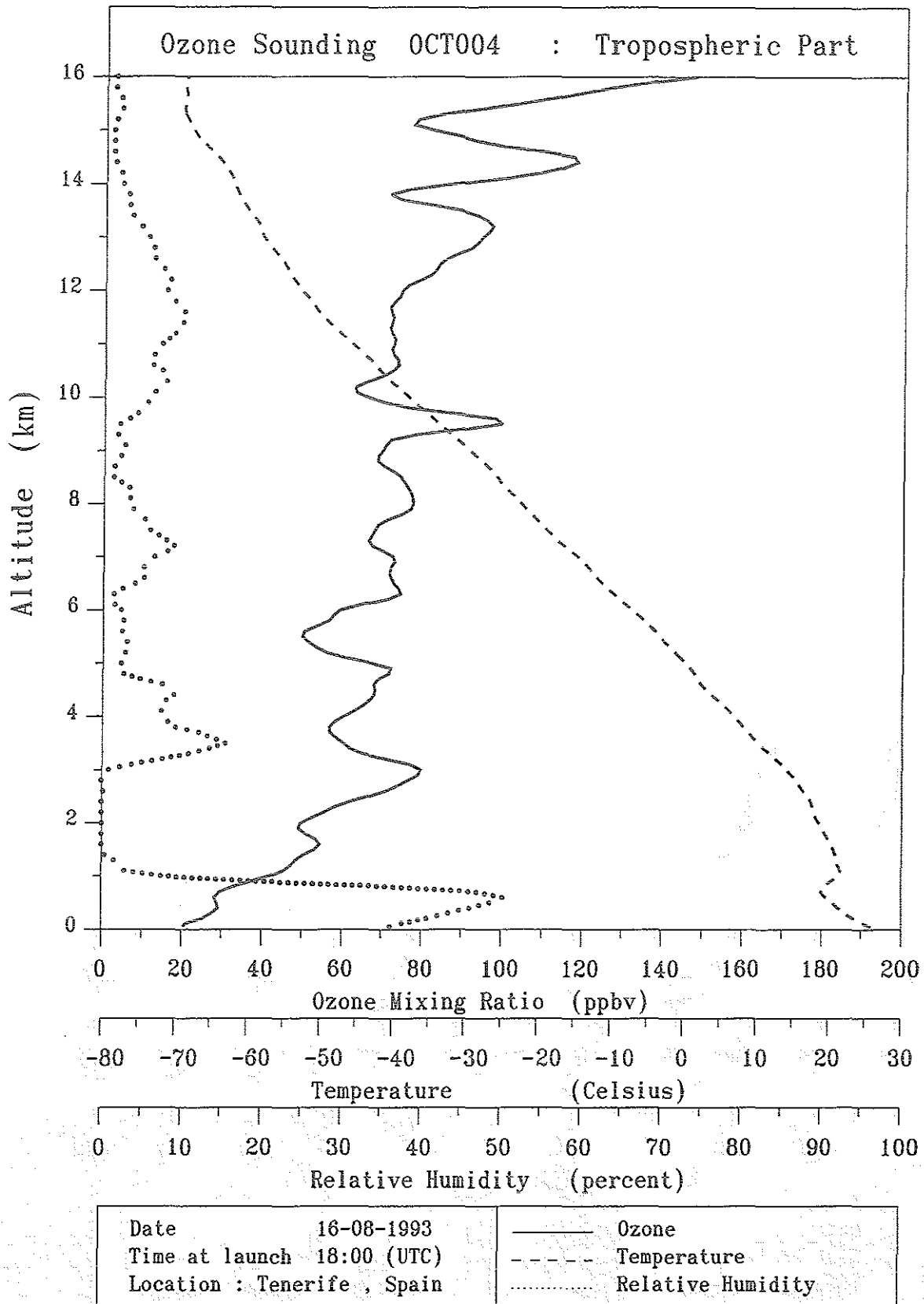
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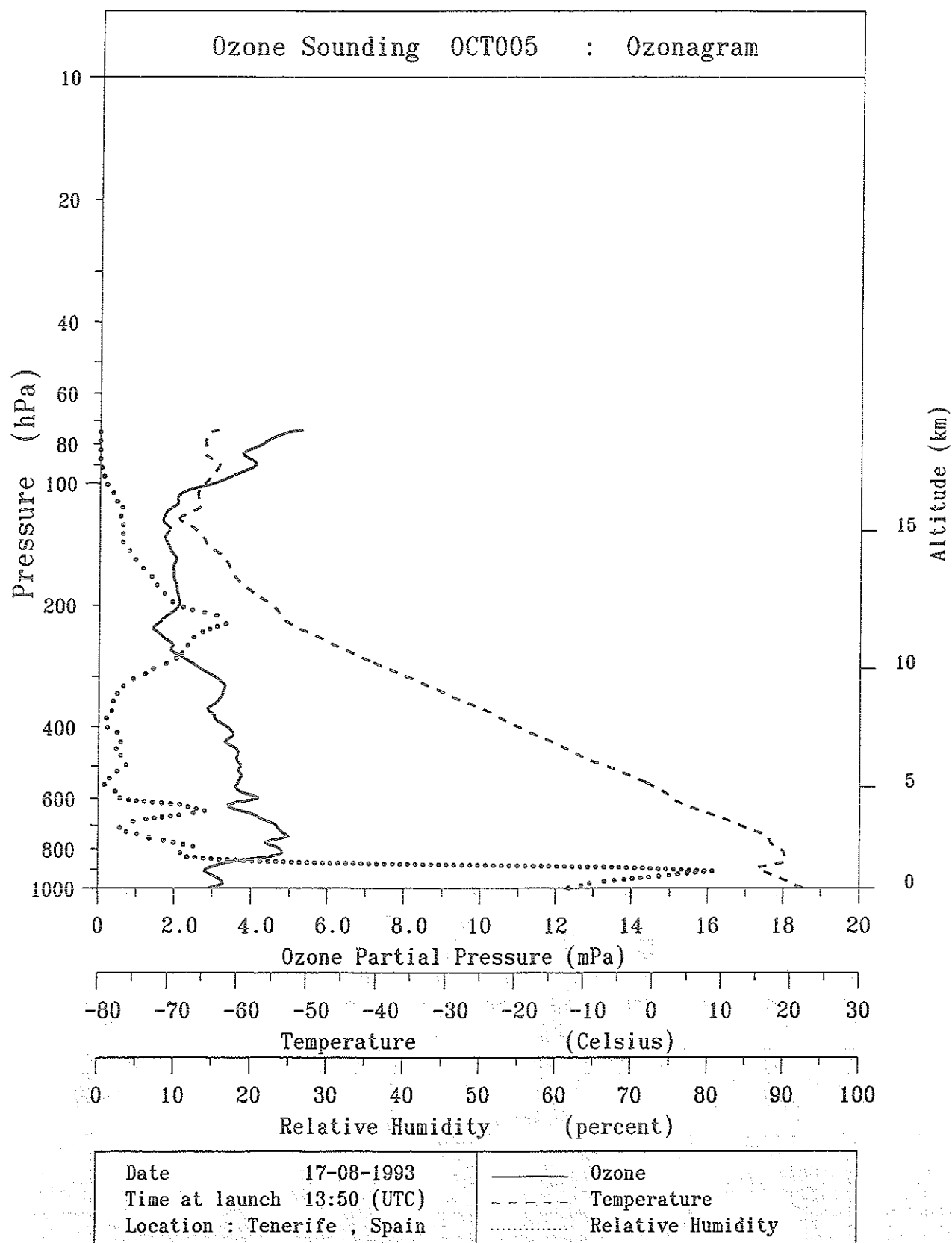


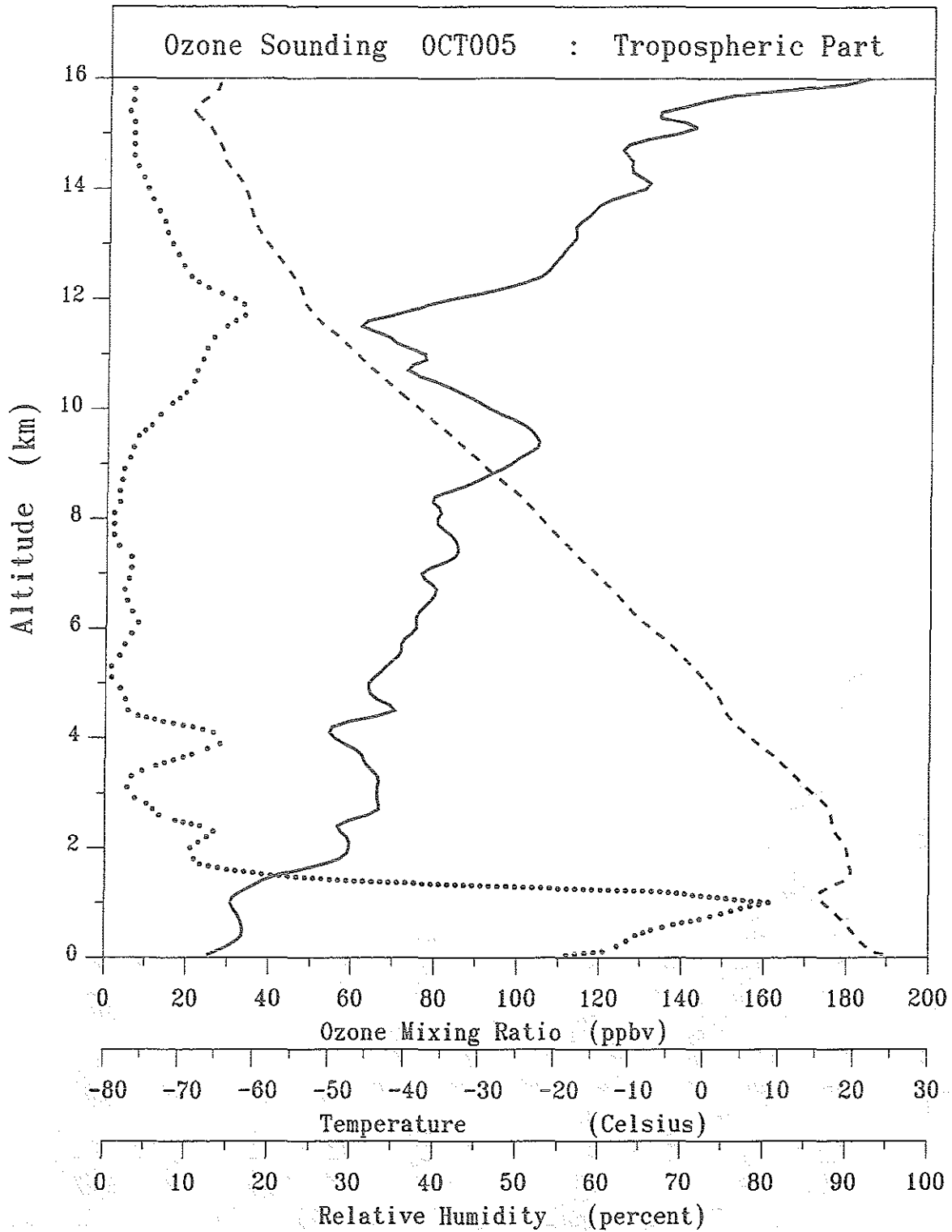


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— Ozone
 - - - Temperature
 Relative Humidity

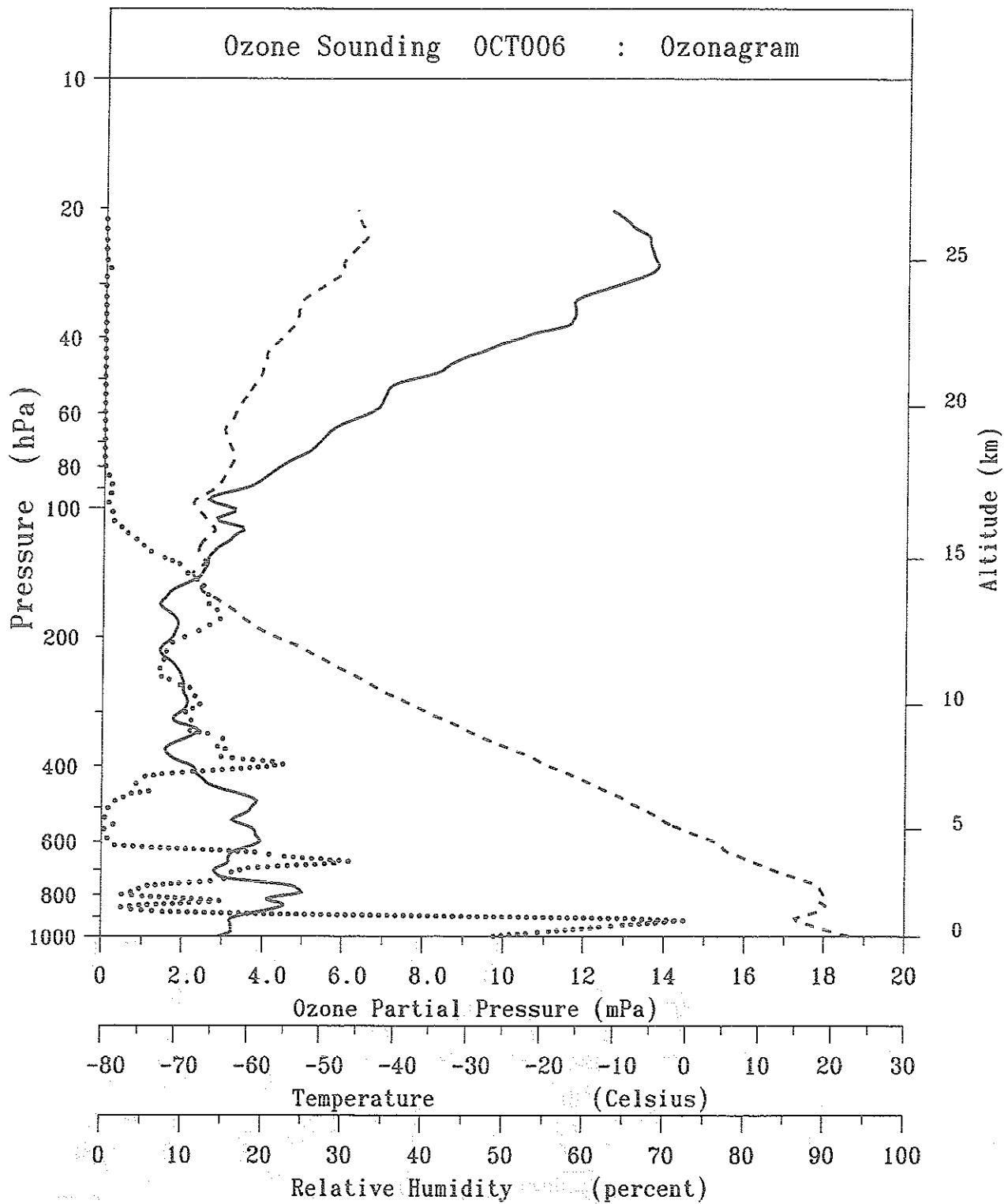




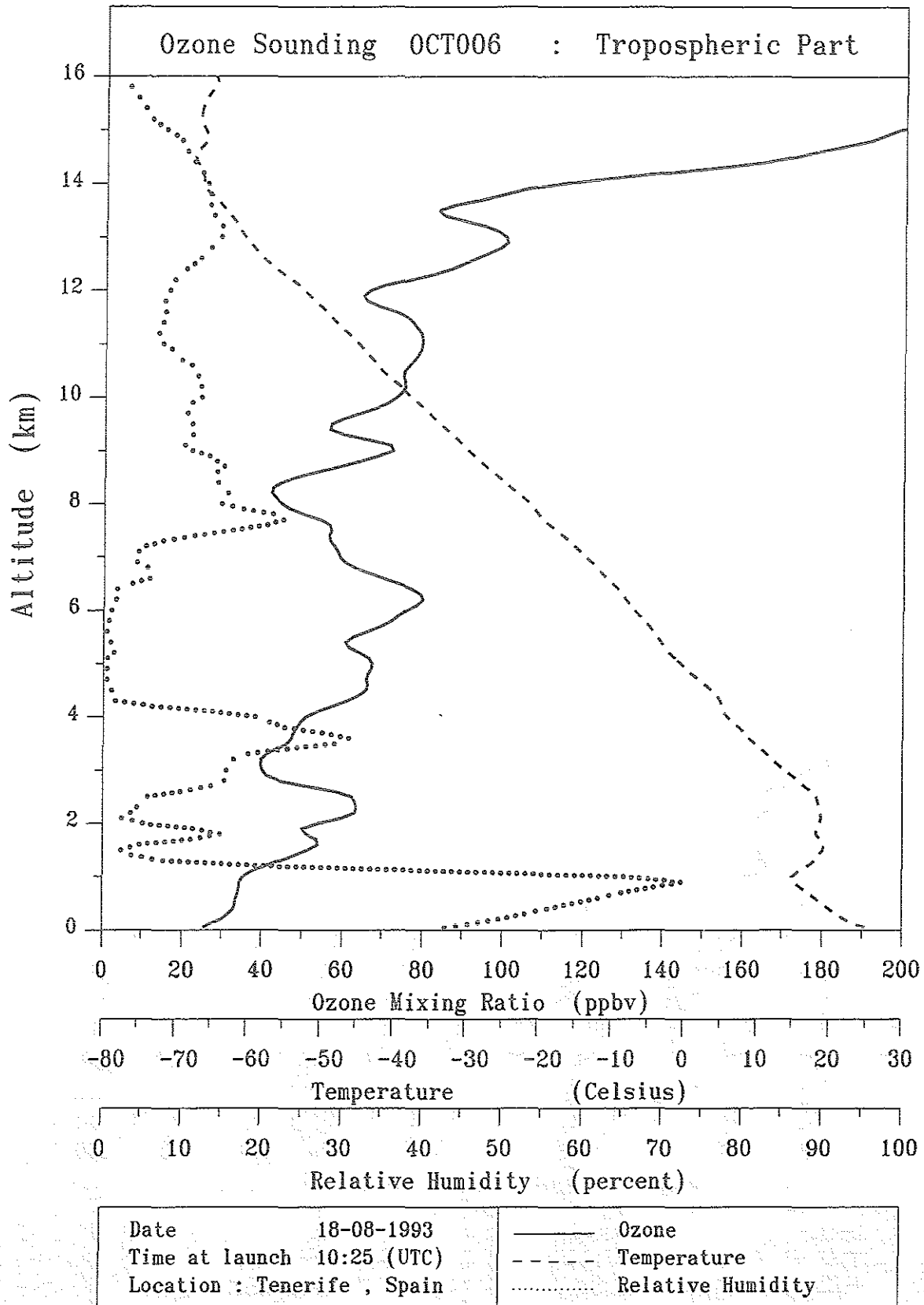


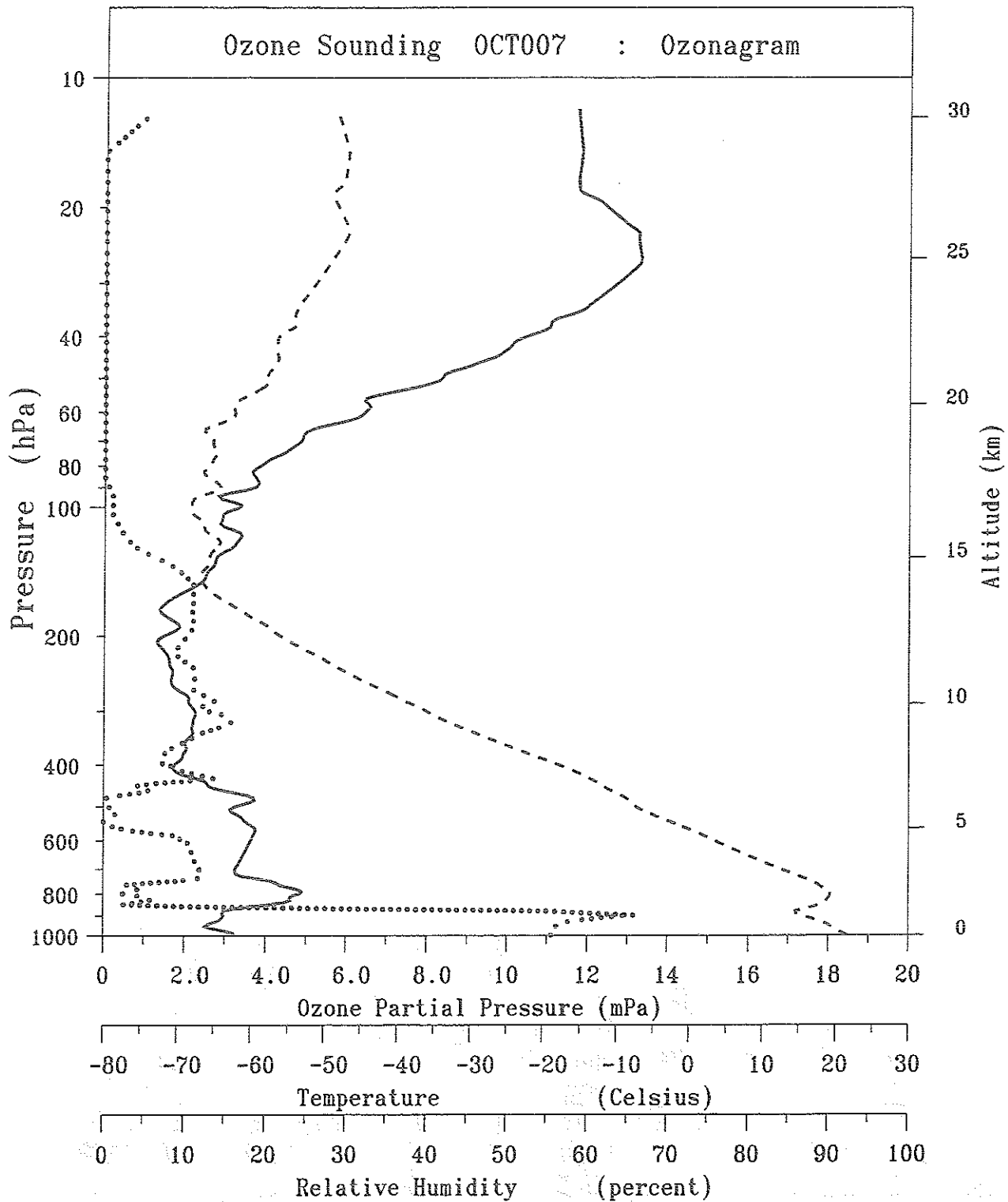
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 Relative Humidity

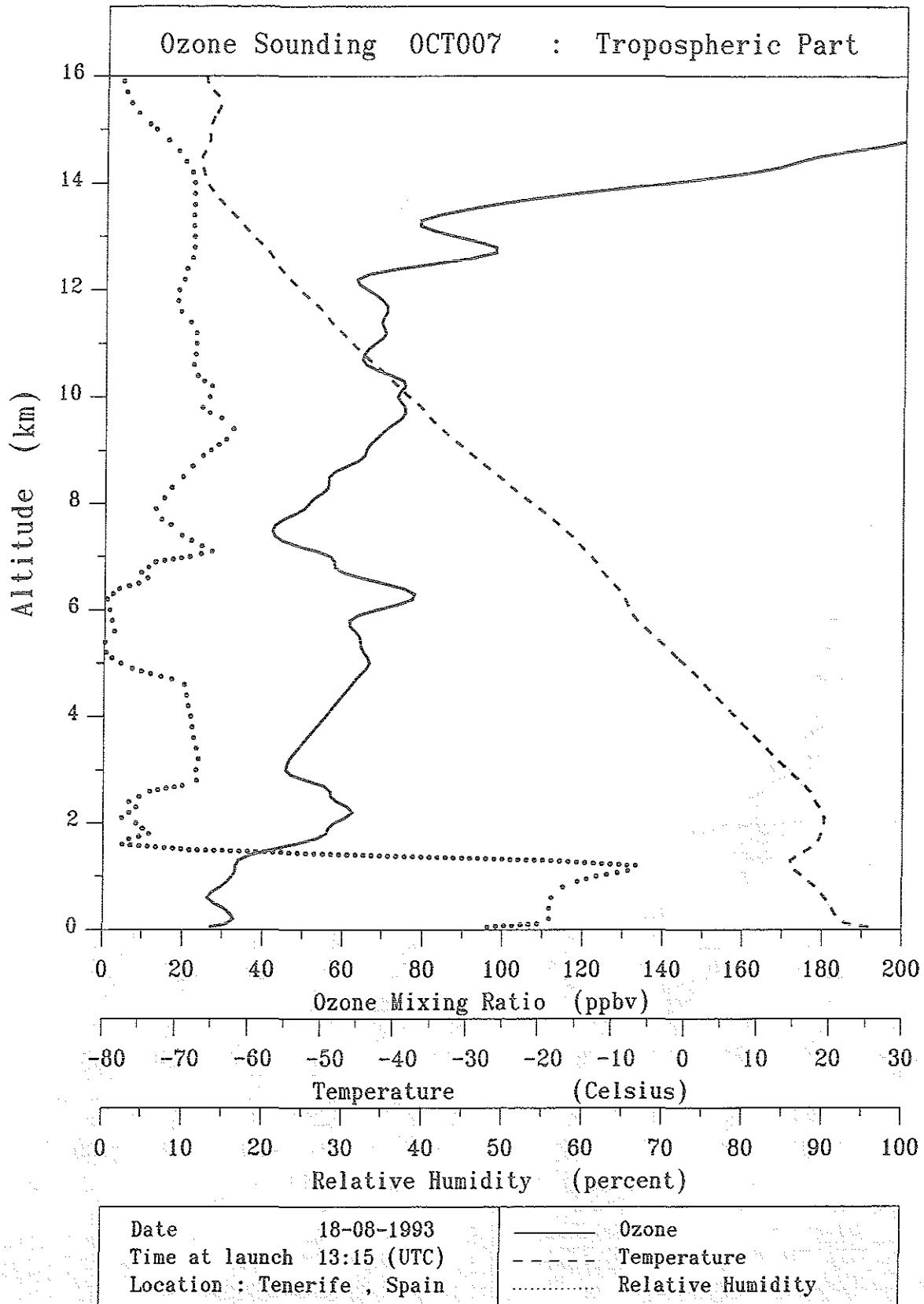


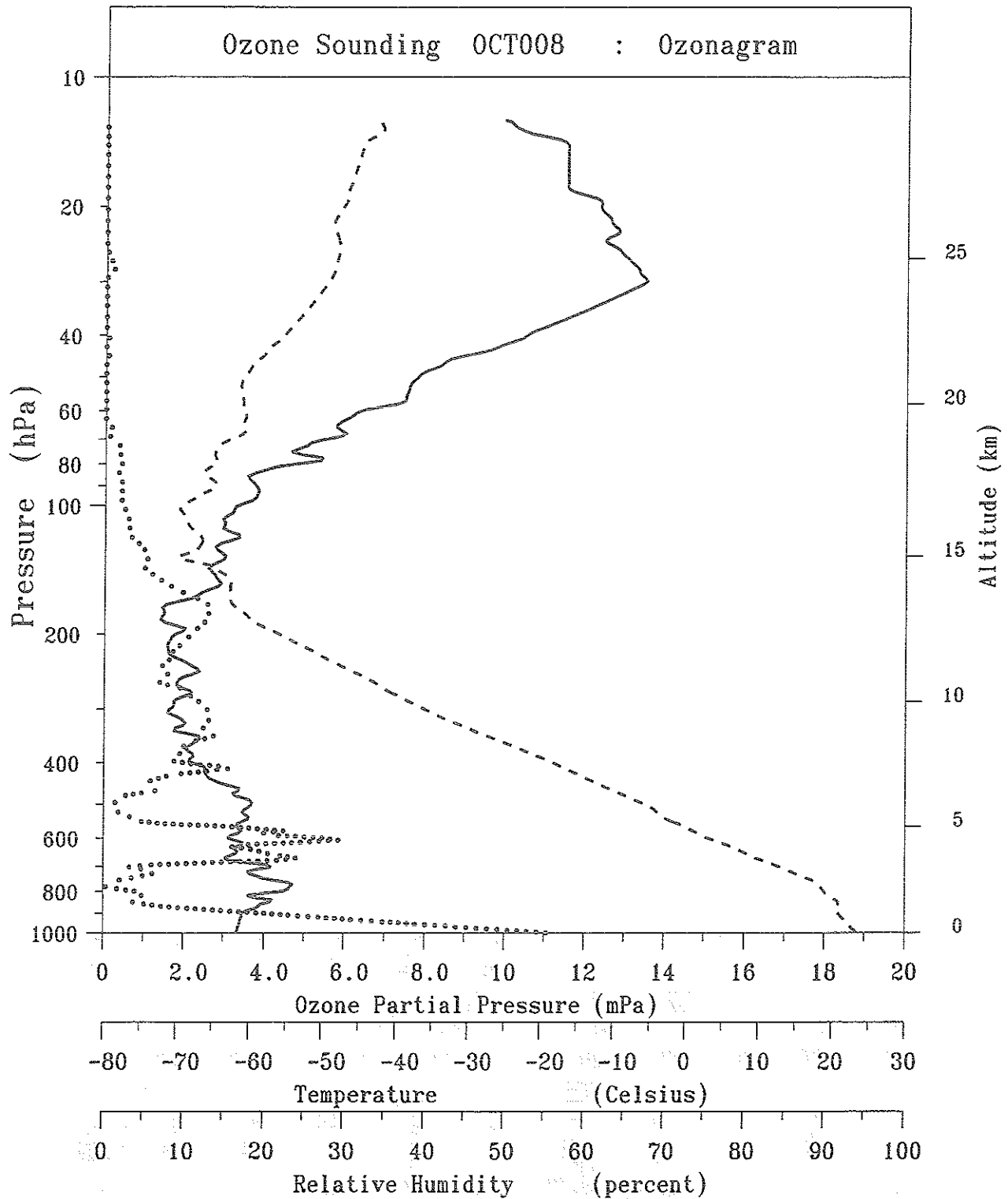
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Location : Tenerife , Spain			Relative Humidity



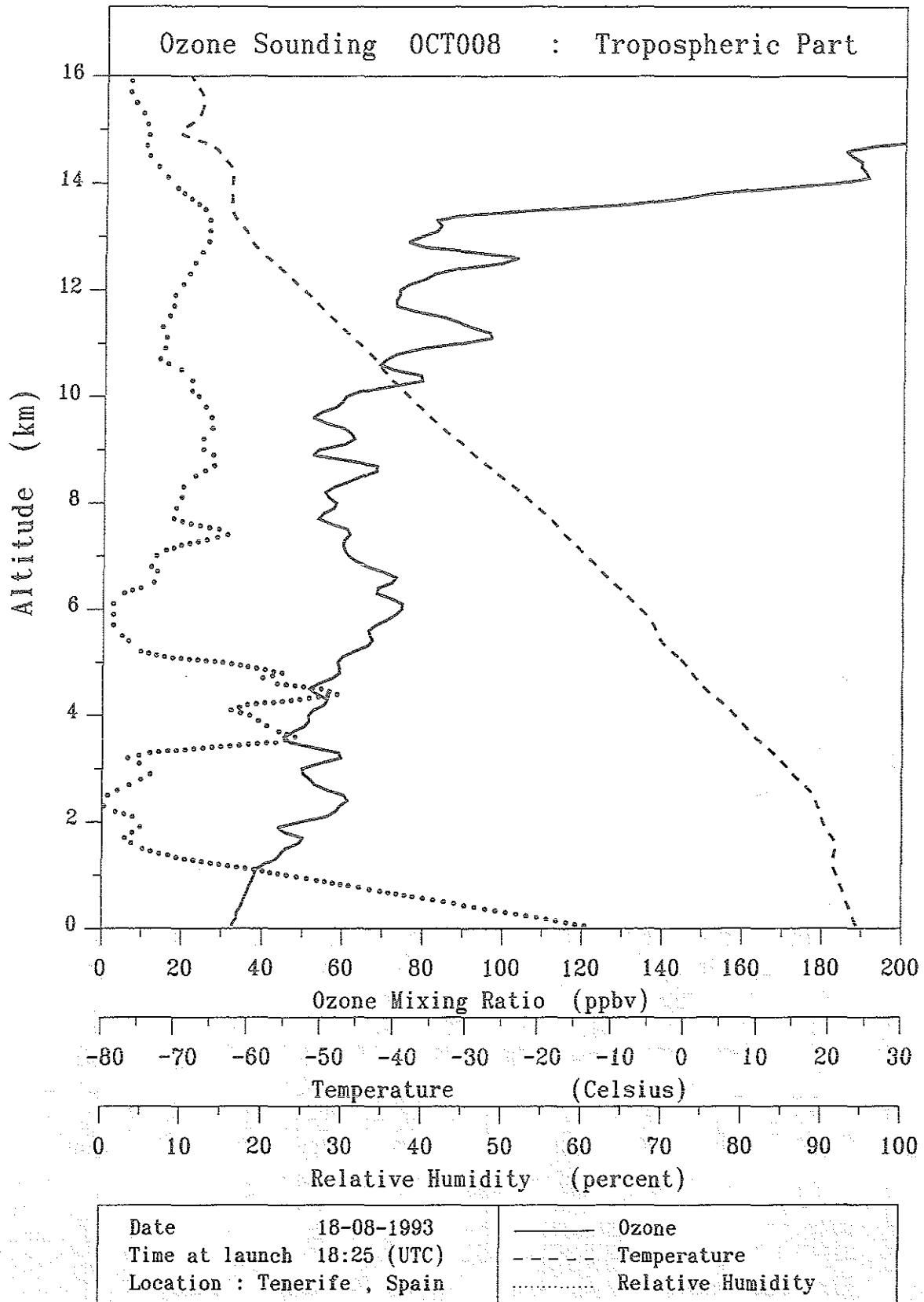


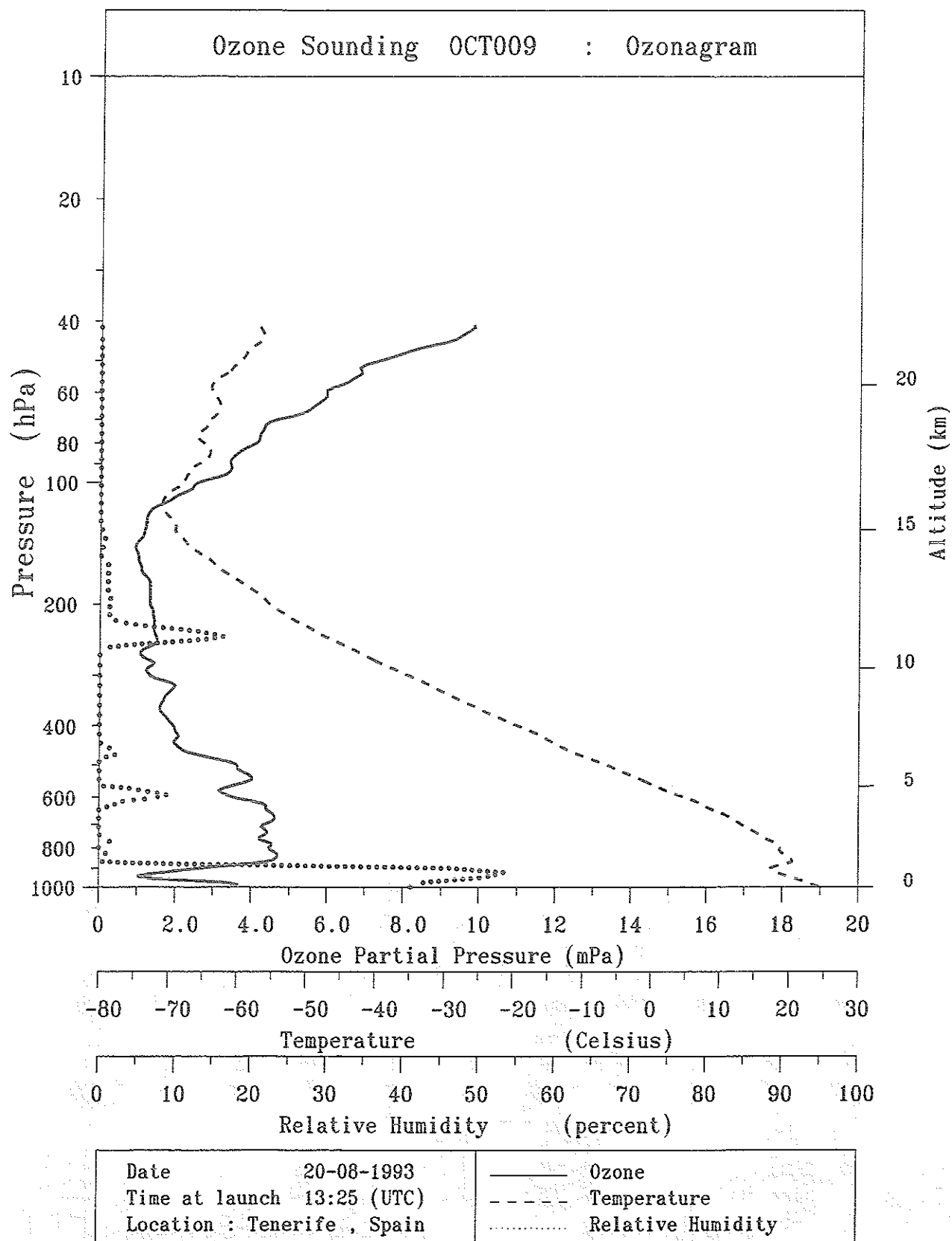
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Time at launch	13:15 (UTC)	- - - -	Temperature
Location : Tenerife , Spain			Relative Humidity

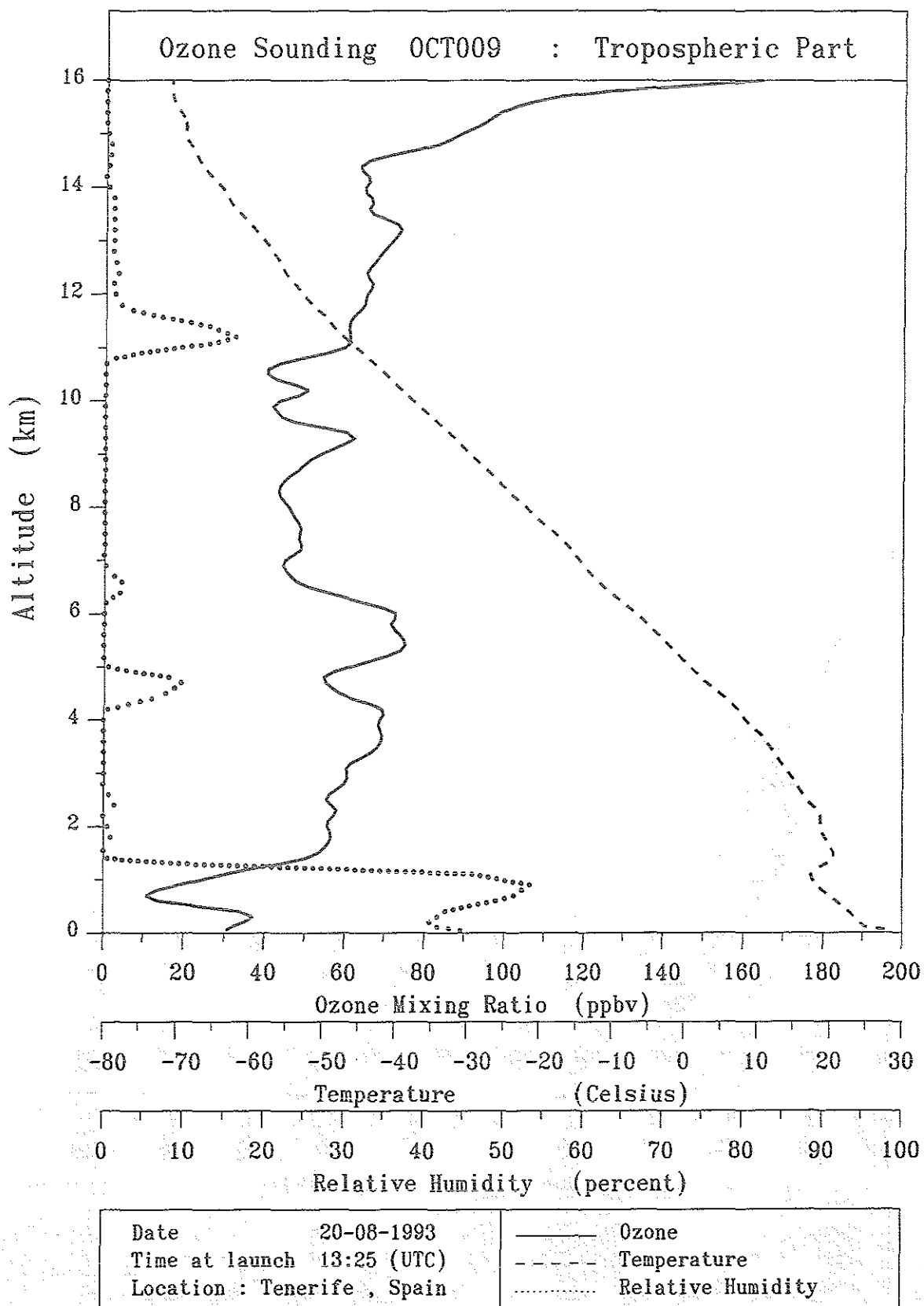


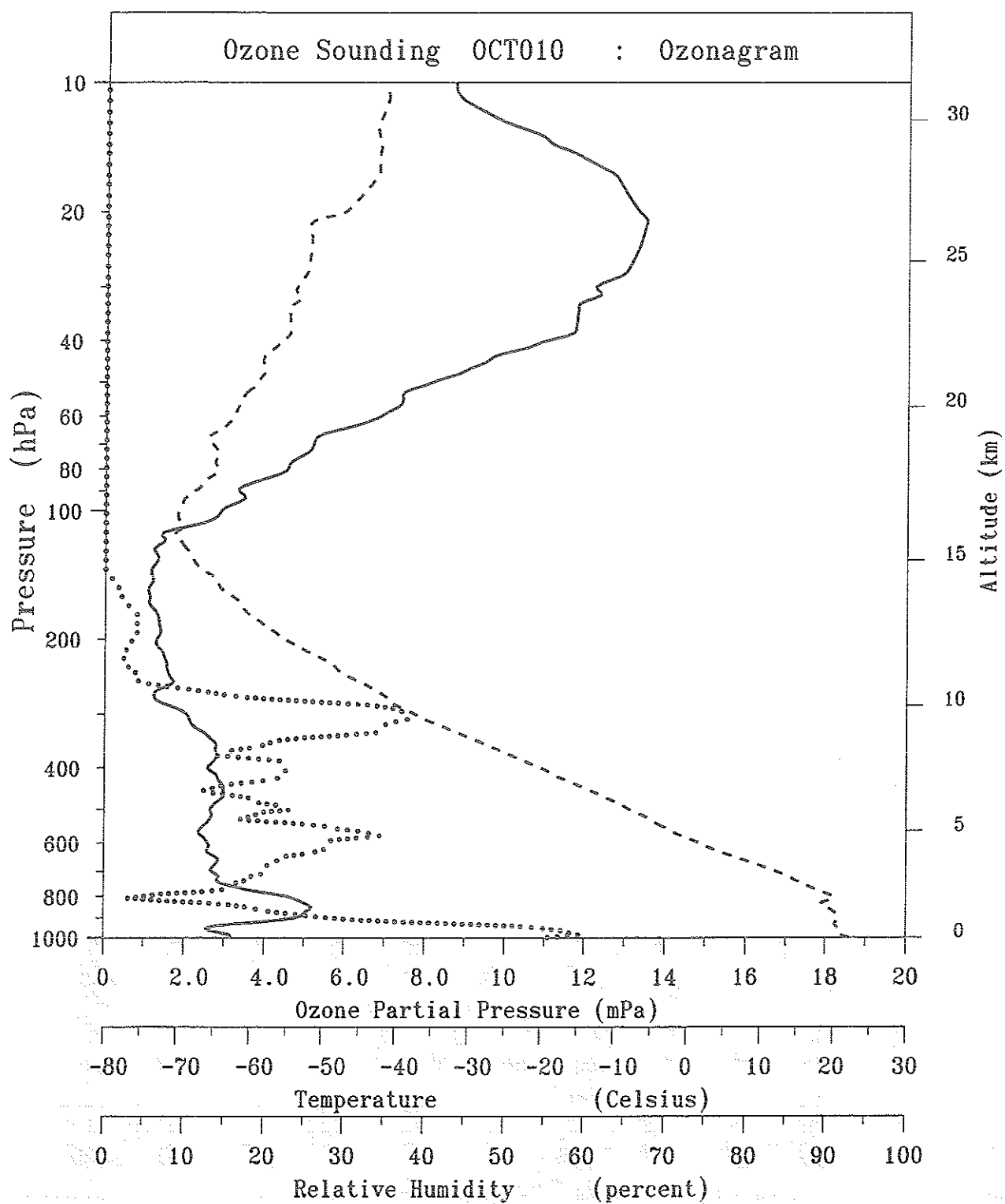


Date	18-08-1993	—	Ozone
Time at launch	18:25 (UTC)	- - - -	Temperature
Location : Tenerife , Spain			Relative Humidity



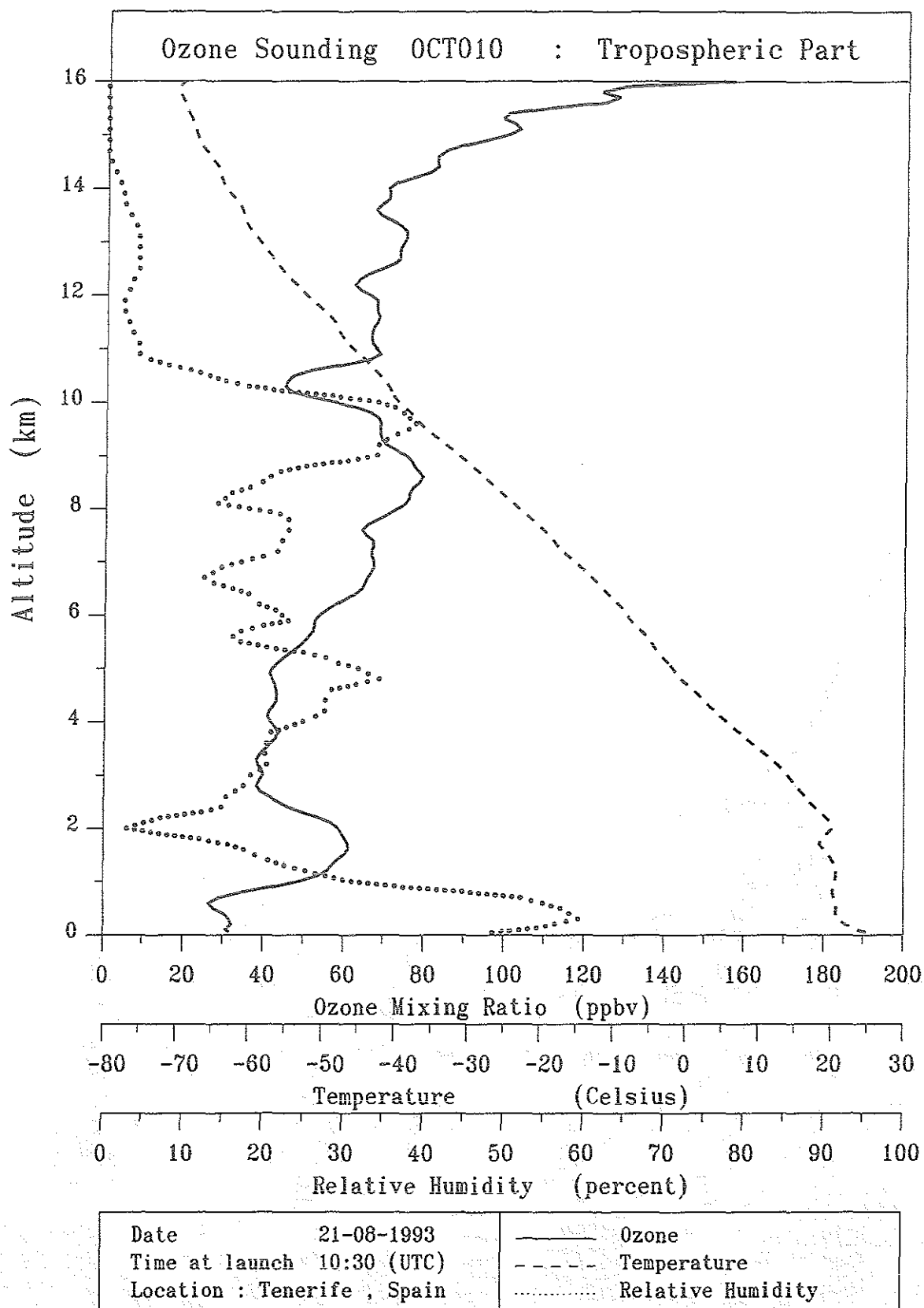


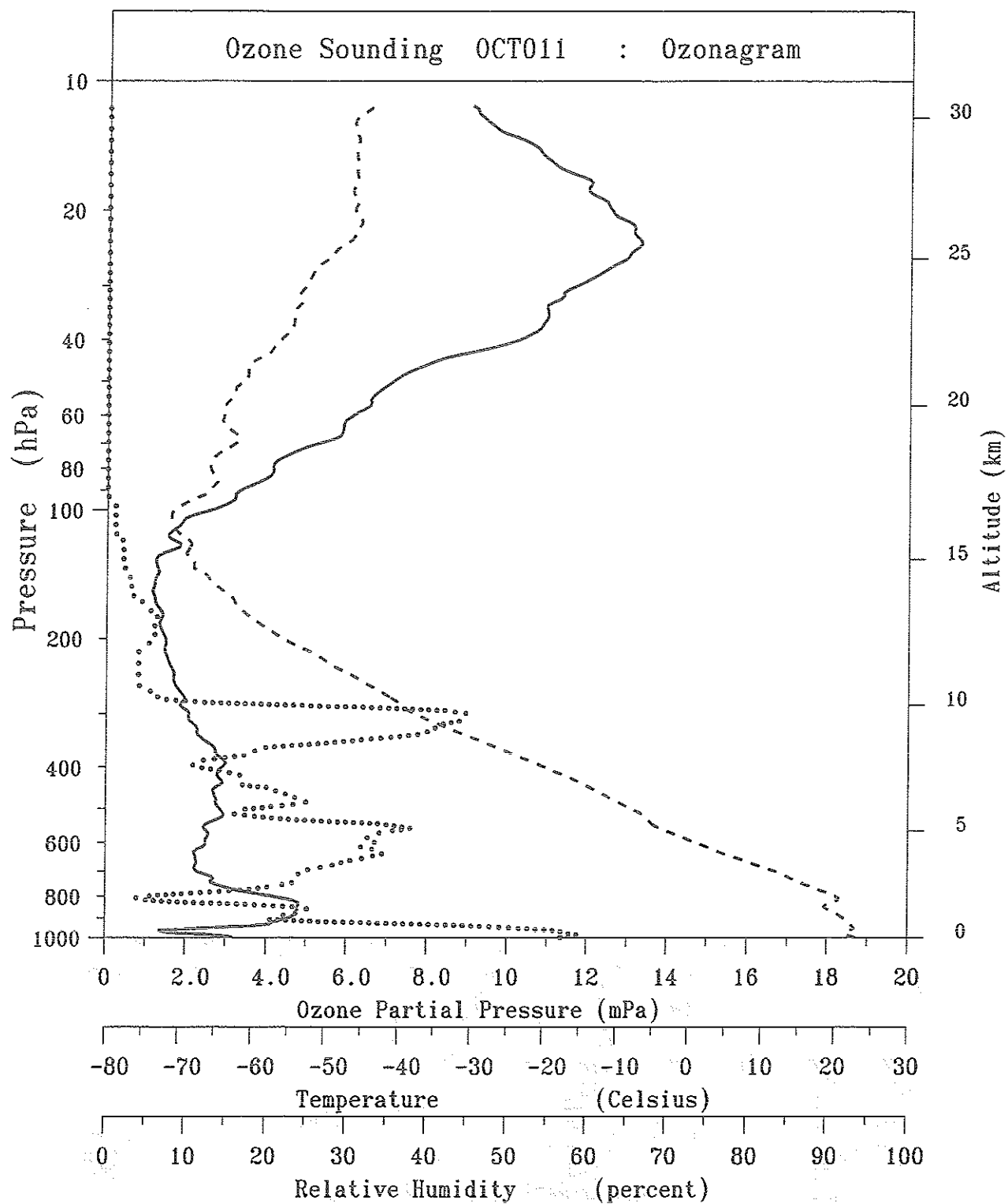




Date 21-08-1993
 Time at launch 10:30 (UTC)
 Location : Tenerife , Spain

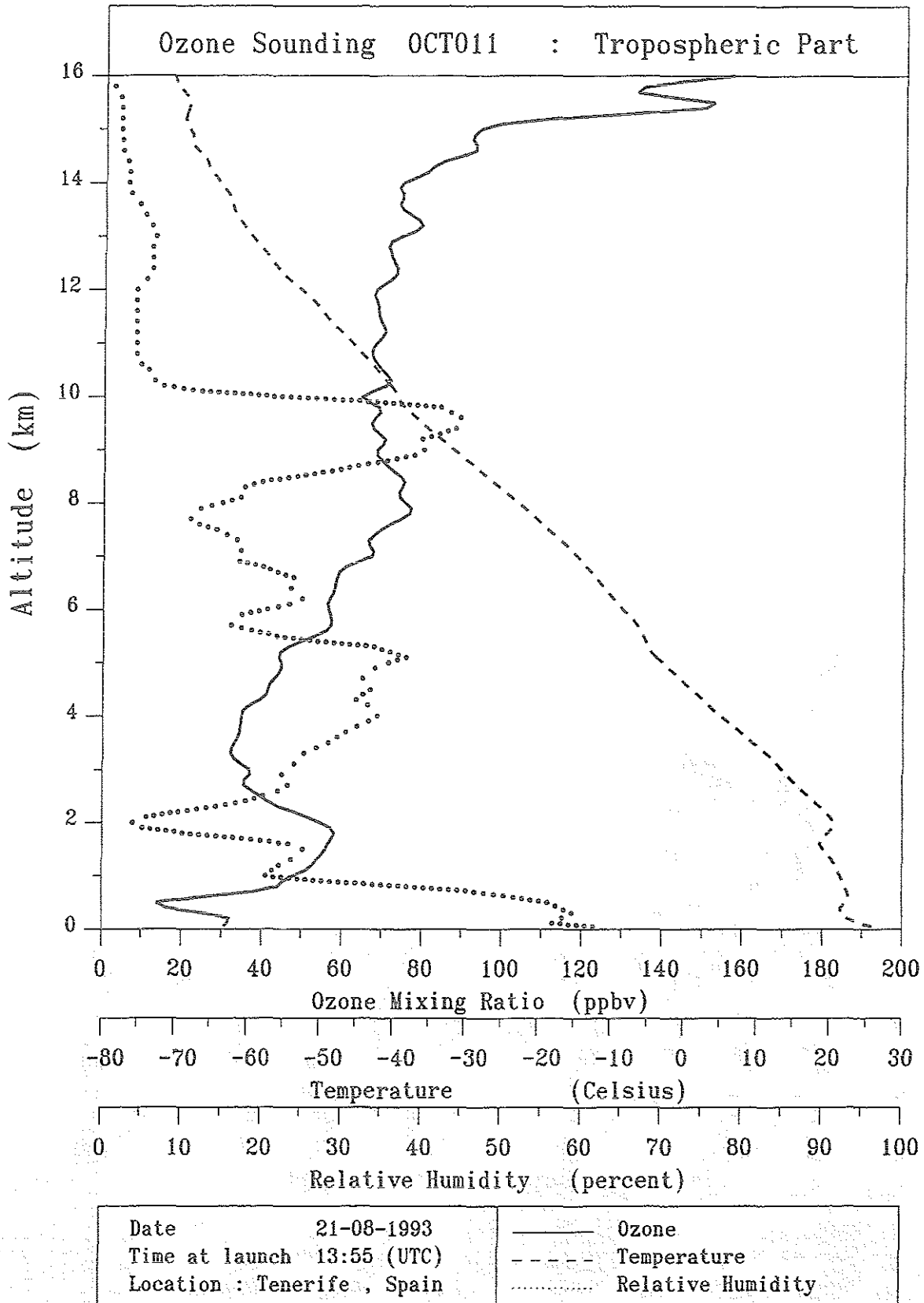
— Ozone
 - - - Temperature
 Relative Humidity

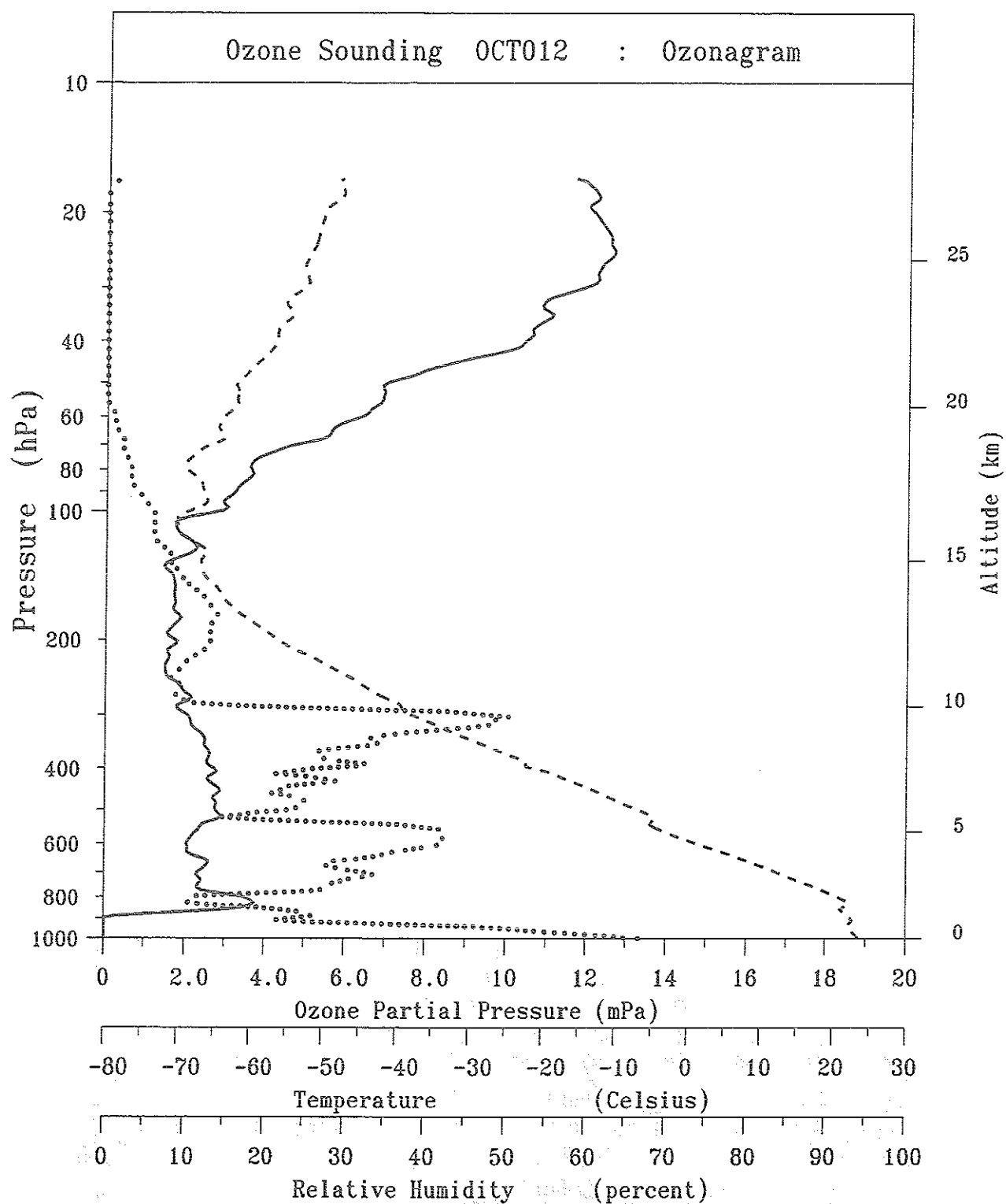




Date 21-08-1993
 Time at launch 13:55 (UTC)
 Location : Tenerife , Spain

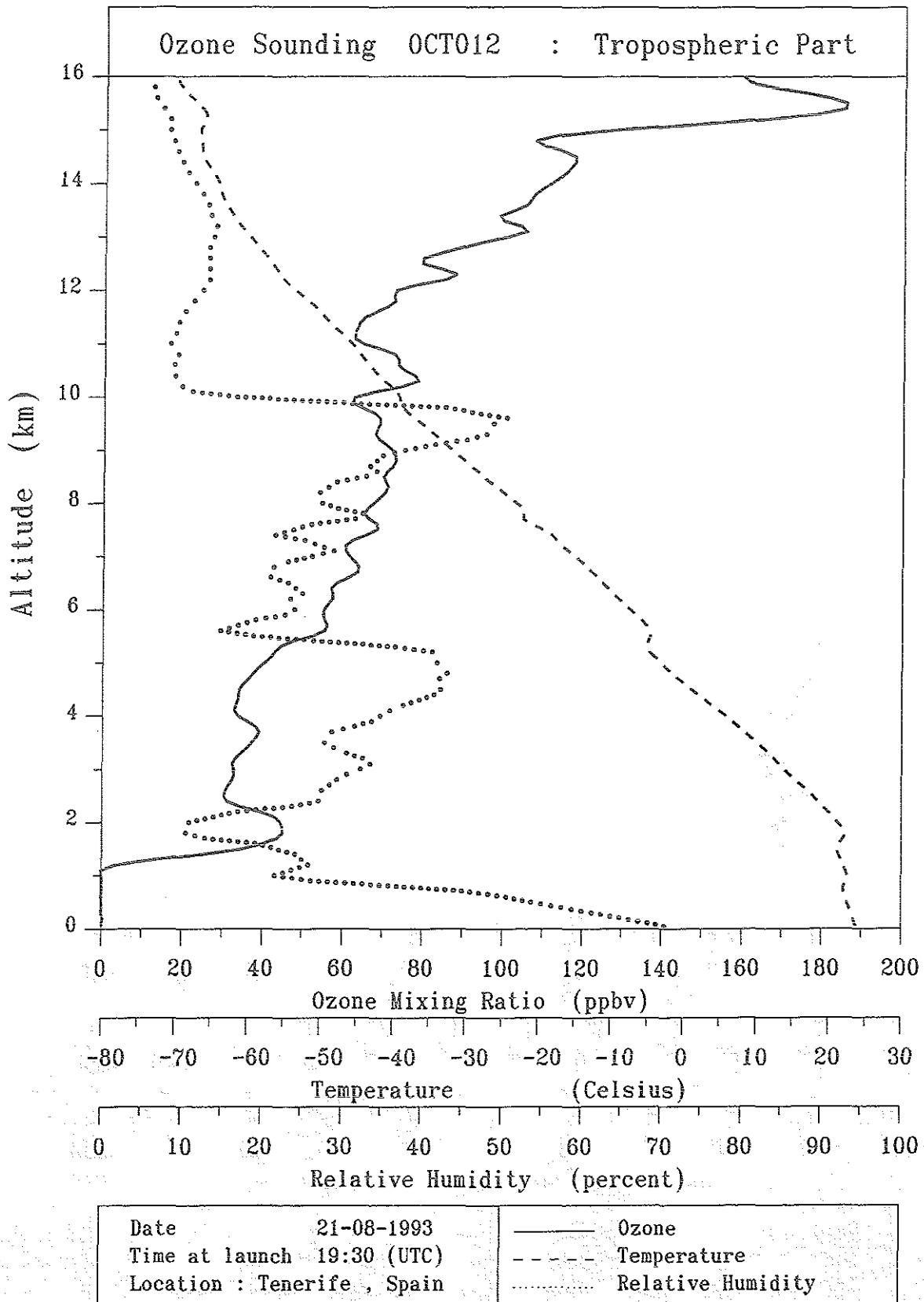
— Ozone
 - - - - - Temperature
 Relative Humidity

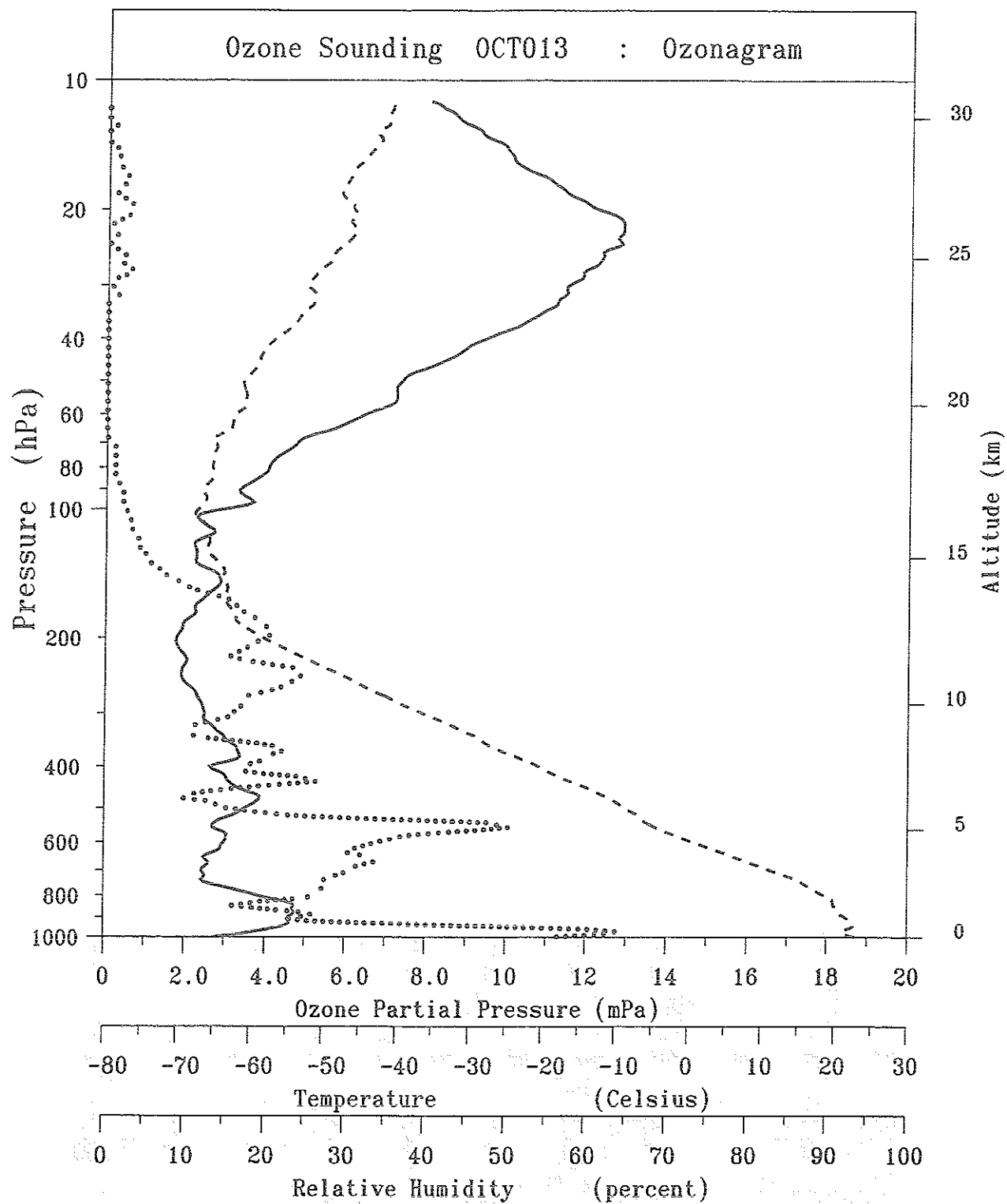




Date 21-08-1993
 Time at launch 19:30 (UTC)
 Location : Tenerife , Spain

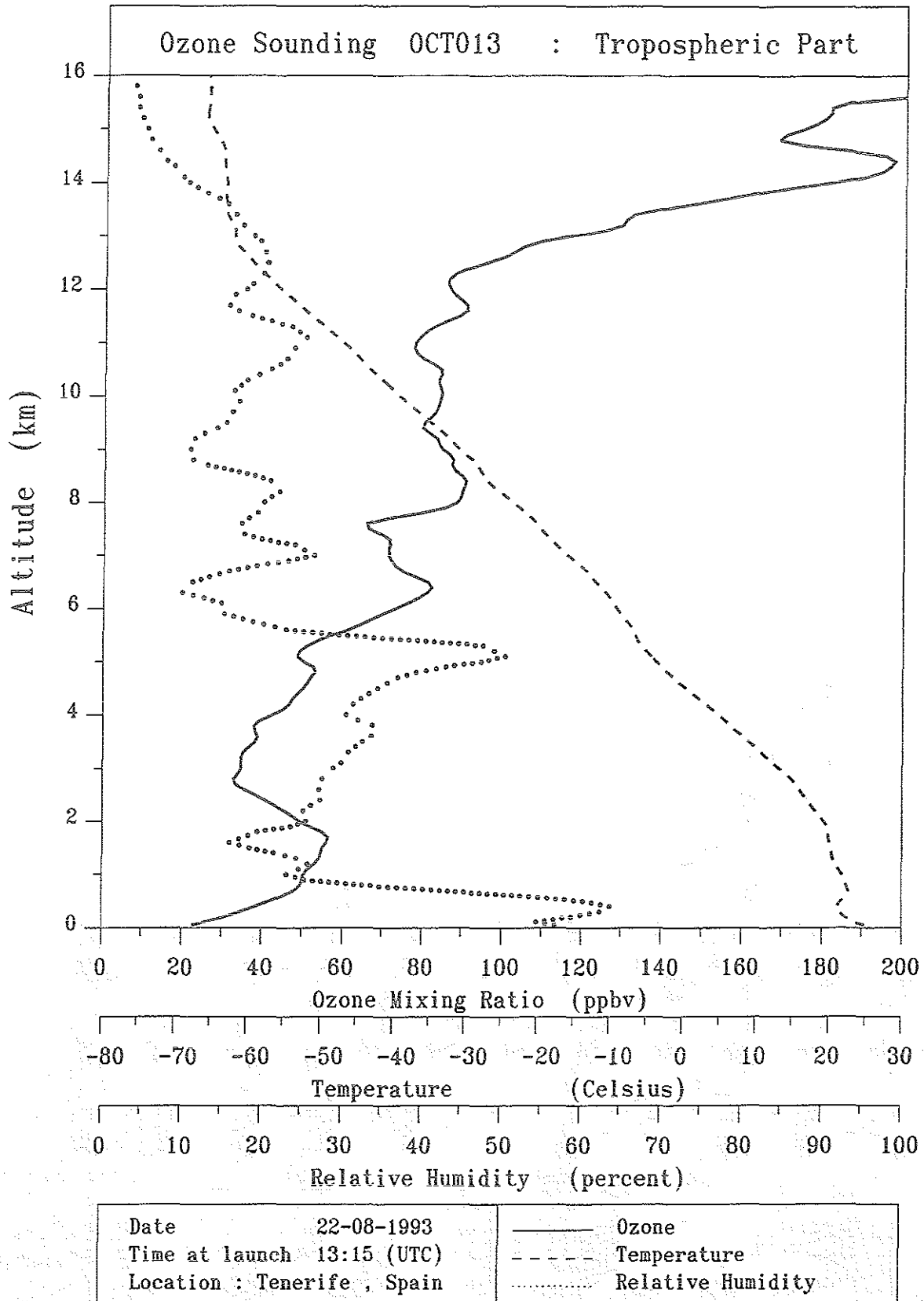
— Ozone
 --- Temperature
 Relative Humidity

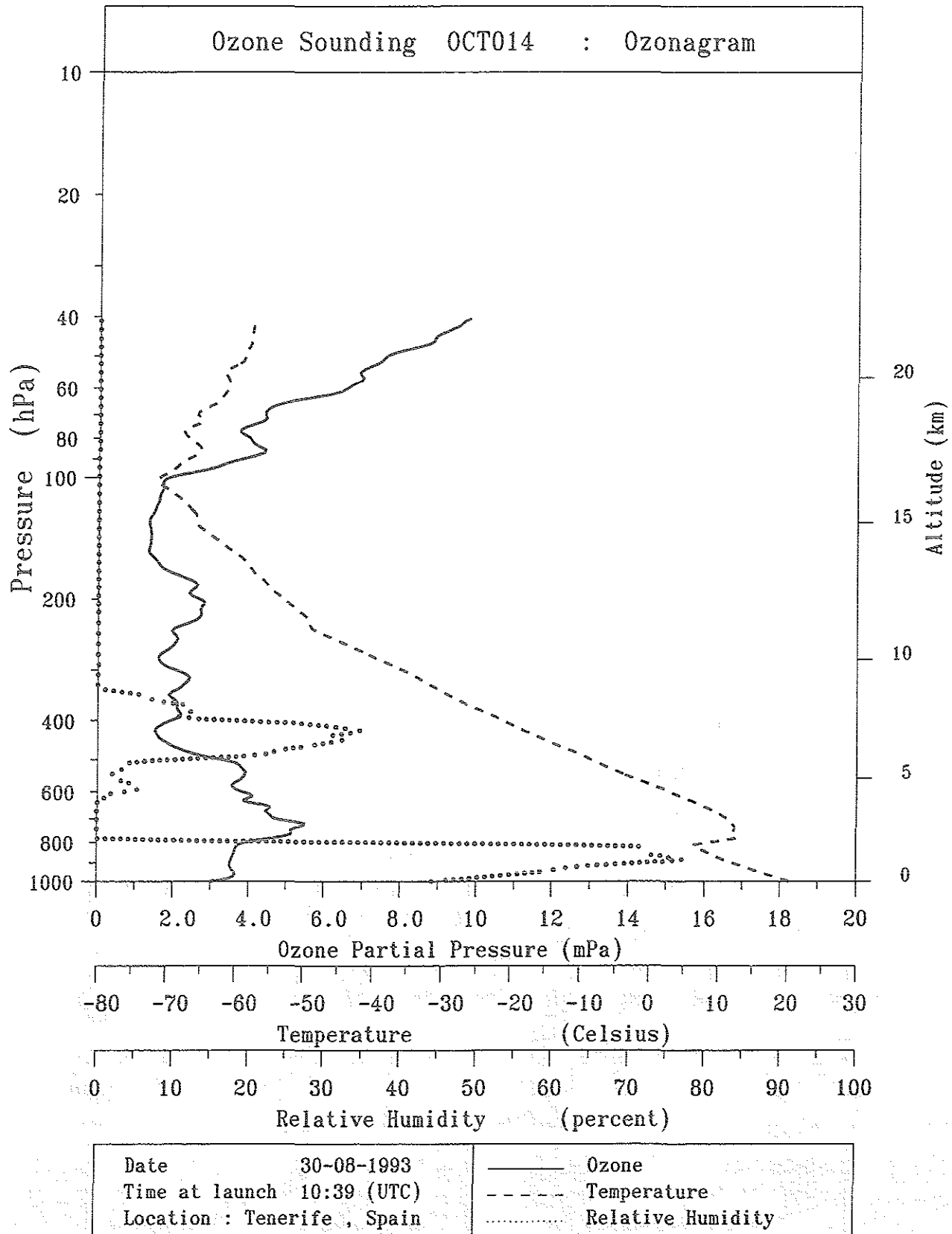




Date 22-08-1993
 Time at launch 13:15 (UTC)
 Location : Tenerife , Spain

— Ozone
 - - - - Temperature
 Relative Humidity





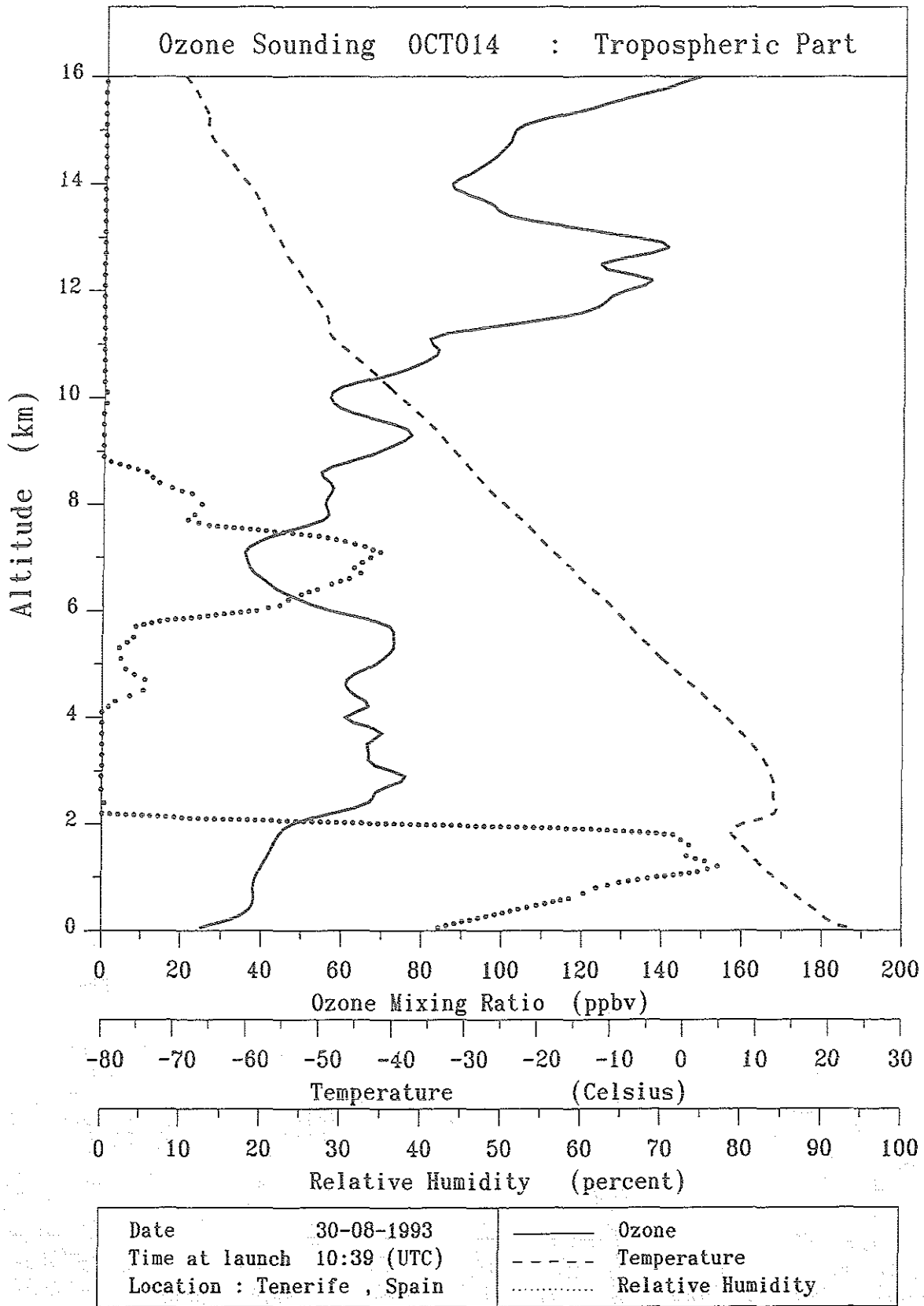


Figure 1. The effect of the concentration of the polymer solution on the apparent viscosity of the polymer solution. The concentration of the polymer solution was 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0, 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 6.0, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 7.0, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.0, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 9.0, 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9, 10.0, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6, 10.7, 10.8, 10.9, 11.0, 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 12.0, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 12.9, 13.0, 13.1, 13.2, 13.3, 13.4, 13.5, 13.6, 13.7, 13.8, 13.9, 14.0, 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 15.0, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7, 15.8, 15.9, 16.0, 16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8, 16.9, 17.0, 17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8, 17.9, 18.0, 18.1, 18.2, 18.3, 18.4, 18.5, 18.6, 18.7, 18.8, 18.9, 19.0, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, 19.9, 20.0, 20.1, 20.2, 20.3, 20.4, 20.5, 20.6, 20.7, 20.8, 20.9, 21.0, 21.1, 21.2, 21.3, 21.4, 21.5, 21.6, 21.7, 21.8, 21.9, 22.0, 22.1, 22.2, 22.3, 22.4, 22.5, 22.6, 22.7, 22.8, 22.9, 23.0, 23.1, 23.2, 23.3, 23.4, 23.5, 23.6, 23.7, 23.8, 23.9, 24.0, 24.1, 24.2, 24.3, 24.4, 24.5, 24.6, 24.7, 24.8, 24.9, 25.0, 25.1, 25.2, 25.3, 25.4, 25.5, 25.6, 25.7, 25.8, 25.9, 26.0, 26.1, 26.2, 26.3, 26.4, 26.5, 26.6, 26.7, 26.8, 26.9, 27.0, 27.1, 27.2, 27.3, 27.4, 27.5, 27.6, 27.7, 27.8, 27.9, 28.0, 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 29.0, 29.1, 29.2, 29.3, 29.4, 29.5, 29.6, 29.7, 29.8, 29.9, 30.0, 30.1, 30.2, 30.3, 30.4, 30.5, 30.6, 30.7, 30.8, 30.9, 31.0, 31.1, 31.2, 31.3, 31.4, 31.5, 31.6, 31.7, 31.8, 31.9, 32.0, 32.1, 32.2, 32.3, 32.4, 32.5, 32.6, 32.7, 32.8, 32.9, 33.0, 33.1, 33.2, 33.3, 33.4, 33.5, 33.6, 33.7, 33.8, 33.9, 34.0, 34.1, 34.2, 34.3, 34.4, 34.5, 34.6, 34.7, 34.8, 34.9, 35.0, 35.1, 35.2, 35.3, 35.4, 35.5, 35.6, 35.7, 35.8, 35.9, 36.0, 36.1, 36.2, 36.3, 36.4, 36.5, 36.6, 36.7, 36.8, 36.9, 37.0, 37.1, 37.2, 37.3, 37.4, 37.5, 37.6, 37.7, 37.8, 37.9, 38.0, 38.1, 38.2, 38.3, 38.4, 38.5, 38.6, 38.7, 38.8, 38.9, 39.0, 39.1, 39.2, 39.3, 39.4, 39.5, 39.6, 39.7, 39.8, 39.9, 40.0, 40.1, 40.2, 40.3, 40.4, 40.5, 40.6, 40.7, 40.8, 40.9, 41.0, 41.1, 41.2, 41.3, 41.4, 41.5, 41.6, 41.7, 41.8, 41.9, 42.0, 42.1, 42.2, 42.3, 42.4, 42.5, 42.6, 42.7, 42.8, 42.9, 43.0, 43.1, 43.2, 43.3, 43.4, 43.5, 43.6, 43.7, 43.8, 43.9, 44.0, 44.1, 44.2, 44.3, 44.4, 44.5, 44.6, 44.7, 44.8, 44.9, 45.0, 45.1, 45.2, 45.3, 45.4, 45.5, 45.6, 45.7, 45.8, 45.9, 46.0, 46.1, 46.2, 46.3, 46.4, 46.5, 46.6, 46.7, 46.8, 46.9, 47.0, 47.1, 47.2, 47.3, 47.4, 47.5, 47.6, 47.7, 47.8, 47.9, 48.0, 48.1, 48.2, 48.3, 48.4, 48.5, 48.6, 48.7, 48.8, 48.9, 49.0, 49.1, 49.2, 49.3, 49.4, 49.5, 49.6, 49.7, 49.8, 49.9, 50.0, 50.1, 50.2, 50.3, 50.4, 50.5, 50.6, 50.7, 50.8, 50.9, 51.0, 51.1, 51.2, 51.3, 51.4, 51.5, 51.6, 51.7, 51.8, 51.9, 52.0, 52.1, 52.2, 52.3, 52.4, 52.5, 52.6, 52.7, 52.8, 52.9, 53.0, 53.1, 53.2, 53.3, 53.4, 53.5, 53.6, 53.7, 53.8, 53.9, 54.0, 54.1, 54.2, 54.3, 54.4, 54.5, 54.6, 54.7, 54.8, 54.9, 55.0, 55.1, 55.2, 55.3, 55.4, 55.5, 55.6, 55.7, 55.8, 55.9, 56.0, 56.1, 56.2, 56.3, 56.4, 56.5, 56.6, 56.7, 56.8, 56.9, 57.0, 57.1, 57.2, 57.3, 57.4, 57.5, 57.6, 57.7, 57.8, 57.9, 58.0, 58.1, 58.2, 58.3, 58.4, 58.5, 58.6, 58.7, 58.8, 58.9, 59.0, 59.1, 59.2, 59.3, 59.4, 59.5, 59.6, 59.7, 59.8, 59.9, 60.0, 60.1, 60.2, 60.3, 60.4, 60.5, 60.6, 60.7, 60.8, 60.9, 61.0, 61.1, 61.2, 61.3, 61.4, 61.5, 61.6, 61.7, 61.8, 61.9, 62.0, 62.1, 62.2, 62.3, 62.4, 62.5, 62.6, 62.7, 62.8, 62.9, 63.0, 63.1, 63.2, 63.3, 63.4, 63.5, 63.6, 63.7, 63.8, 63.9, 64.0, 64.1, 64.2, 64.3, 64.4, 64.5, 64.6, 64.7, 64.8, 64.9, 65.0, 65.1, 65.2, 65.3, 65.4, 65.5, 65.6, 65.7, 65.8, 65.9, 66.0, 66.1, 66.2, 66.3, 66.4, 66.5, 66.6, 66.7, 66.8, 66.9, 67.0, 67.1, 67.2, 67.3, 67.4, 67.5, 67.6, 67.7, 67.8, 67.9, 68.0, 68.1, 68.2, 68.3, 68.4, 68.5, 68.6, 68.7, 68.8, 68.9, 69.0, 69.1, 69.2, 69.3, 69.4,

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