JPL Publication 90-39

Bio-Optical Profile Data Report

Coastal Transition Zone Program
R/V Point Sur
June 15–28, 1987

Curtiss O. Davis
W. Joseph Rhea

December 1, 1990

Prepared for

Office of Naval Research

Through an agreement with

National Aeronautics and
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Jet Propulsion Laboratory
California Institute of Technology
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ABSTRACT

Twenty vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Point Sur, June 15–28, 1987, as part of the Coastal Transition Zone Program off Point Arena, California. Extracted chlorophyll values were also measured at some stations to provide calibration data for the in situ fluorometer. This report is a summary to provide investigators with an overview of the data collected. The entire data set is available in digital form for interested researchers, and requests for the data should be addressed to W. Joe Rhea, (818) 393-6095.

ACKNOWLEDGMENTS

The assistance of the Captain and crew of the R/V Point Sur and Chief Scientist Steve Ramp is gratefully acknowledged.

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2. File: j870616b 10
3. File: j870616c 12
4. File: j870616d 14
5. File: j870617a 16
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INTRODUCTION

The Coastal Transition Zone (CTZ) Program, sponsored by the Office of Naval Research, is an interdisciplinary study of the physical causes and the physical, biological, and optical characteristics of the filaments of cold, salty water that extend over 300 km off the West Coast of North America. The cruise of the R/V Point Sur, June 15–28, 1987, was designed to study a representative filament off Point Arena, California. Guided by satellite sea-surface temperature maps, two surveys of the filament and adjacent waters were conducted. Additionally, a cluster of drifters was placed in the root of the filament and tracked by satellite for several months. One of the drifters was instrumented with a fluorometer, transmissometer, spectroradiometer, water sampler, and a thermistor chain. At the end of eight days, the instrumented drifter was recovered approximately 300 km to the southwest of the launch site. This report describes bio-optical profile data that were collected at 20 stations representative of the filament, freshly upwelled water near the coast, and the offshore water surrounding the filament.

DATA DESCRIPTION

Optical data were collected with a Bio-Optical Profiling System (BOPS), an updated version of the BOPS originally developed by Smith et al. (1984). The heart of the BOPS was a Biospherical Instruments MER-1048 spectroradiometer, which measures up- and downwelling spectral irradiance and upwelling spectral radiance. The MER-1048 also has sensors for Photosynthetically Available Radiation (PAR), depth, tilt, and roll. In addition, temperature and conductivity were measured with a Sea-Bird CTD, chlorophyll fluorescence was measured with a Sea Tech fluorometer, and beam transmission was measured with a Sea Tech 25-cm transmissometer. The MER-1048 acquired all the data 16 times a second, averaged it to four records a second, and sent it up the cable to a deck box and a Compaq-286 computer, which stored the data on the hard disk. The BOPS data (Table I) were filtered to remove obvious data spikes and a depth aberration, which occurred at 95 m, and then binned into one-meter averages and stored as ASCII comma-separated files.

At selected stations, extracted chlorophyll and phaeopigments were measured on water samples taken with the CTD rosette sampler immediately before or after the optical profile. Water samples (100 ml) were filtered on Whatman GF/F filters. Samples were extracted in 10 ml of acetone in the dark in a freezer for 24 h and then measured in a Turner Designs Model 10-005 Fluorometer calibrated with pure chlorophyll (Sigma Chemical Co.). Samples were remeasured after acidification with one drop of 5% HCl, and chlorophyll and phaeopigments were calculated according to Strickland and Parsons (1972).

INDIVIDUAL STATION DATA PROFILES

For each station (Table II), eight profiles are presented to give a graphical overview of the data (Figures 1–20). Data files are identified by a filename of the format:

Nyymmddc.MER

where N = j for JETZ cruise of the R/V Point Sur, June 15–28, 1987
yy = Year
mm = Month
dd = Day

c = Cast order for each day.
i.e. 'a' = first cast of day
'b' = second cast of day, etc.

Temperature and salinity data were from the Sea-Bird CTD. Salinity was calculated from the temperature and conductivity measurements using the standard equations for practical salinity units (Millero et al., 1980). Occasional spikes in salinity were observed at the surface and at the thermocline. This is an artifact caused by the fact that the response time of the conductivity sensor does not exactly match that of the temperature sensor.

Data from the Sea Tech fluorometer are presented in fluorescence units. The fluorometer data were calibrated using extracted chlorophyll and phaeopigment values from water samples taken immediately before or after a number of optical profiles (Table III). Average chlorophyll plus phaeopigment values for the entire cruise give the following equation for calibrating the Sea Tech fluorometer data: chl + phaeo = 0.236 + 0.127 fluor, where r^2 = 0.77 and n = 27.

Beam transmissometer (25-cm path length, 660-nm wavelength) data were recorded in percent transmission (%T; value in pure water = 91.3%). The attenuation of a beam of light is defined by Jerlov (1976):

$$c = a + b$$

and

$$T = e^{-cr}$$

where

c is the beam attenuation coefficient in m^{-1}
a is the absorption coefficient
b is the total scattering coefficient
T is the fraction of light transmitted over path length r.

Then, for this data set, c can be calculated from the following equation (r = 0.25 m):

$$c = -4 \ln(\%T/100)$$

The radiance, irradiance, and PAR data are presented in calibrated units based on a laboratory calibration conducted by Biospherical Instruments on June 11, 1987. A second calibration after the cruise showed no significant deviation from these values. The spectral light data are presented as a plot of spectra near the surface (dashed line) and then at every five meters (5 m, 10 m, 15 m, etc.). Typically, the surface reading is for 2 m; however, during rough weather, the first usable readings are from greater depth, as indicated on the figures. This is calibrated radiance data, but no corrections for ship shadow or other artifacts have been made to the data. We have developed routines for correcting such artifacts, calculating K, etc., following the guidelines of Smith and Baker (1984, 1986) and Gordon (1985), and the reader is referred to those references for a discussion of these problems.

The data are available in digital format for researchers who wish to work with the actual data. Individuals who are interested in working with the data should request it in digital form from Joe Rhea ((818) 393-6095). The data can be provided in a number of formats compatible with most standard computing environments.

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Strickland, J. D. H., and T. R. Parsons, *A Practical Handbook of Seawater Analysis,* Fish. Res. Board Canada, Bulletin 167, 1972.

TABLE I.

Data Channels

0. Number of data points averaged into bin
1. 410-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
2. 441-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
3. 488-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
4. 520-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
5. 550-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
6. 560-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
7. 589-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
8. 633-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
9. 656-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
10. 671-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
11. 683-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
12. 694-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
13. 710-nm Downwelling Irradiance ($\mu W/cm^2/nm$)
14. Depth of averaged bin (m)
15. Tilt (angles in degrees (-45 to +45))
16. Roll (angles in degrees (-45 to +45))
17. 410-nm Radiance ($\mu W/cm^2/nm/sr$)
18. 441-nm Radiance ($\mu W/cm^2/nm/sr$)
19. 488-nm Radiance ($\mu W/cm^2/nm/sr$)
20. 520-nm Radiance ($\mu W/cm^2/nm/sr$)
21. 550-nm Radiance ($\mu W/cm^2/nm/sr$)
22. 633-nm Radiance ($\mu W/cm^2/nm/sr$)
23. 656-nm Radiance ($\mu W/cm^2/nm/sr$)
24. 683-nm Radiance ($\mu W/cm^2/nm/sr$)
25. 410-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
26. 441-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
27. 488-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
28. 520-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
29. 550-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
30. 589-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
31. 671-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
32. 694-nm Upwelling Irradiance ($\mu W/cm^2/nm$)
33. Transmissometer - 25 cm (% transmission)
34. Fluorometer (fluorescence units)
35. PAR (10^{17}quanta/cm^2/s)
36. Temperature (deg C)
37. Conductivity (mmho/cm)
38. Salinity (PSU)
39. Density (g/cm^3)
41. 520-nm Surface Irradiance (ship mounted)
40. 410-nm Surface Irradiance (ship mounted)
42. 589-nm Surface Irradiance (ship mounted)
43. 683-nm Surface Irradiance (ship mounted)

TABLE II.

1987 R/V Point Sur CTZ Cruise–Station Summary

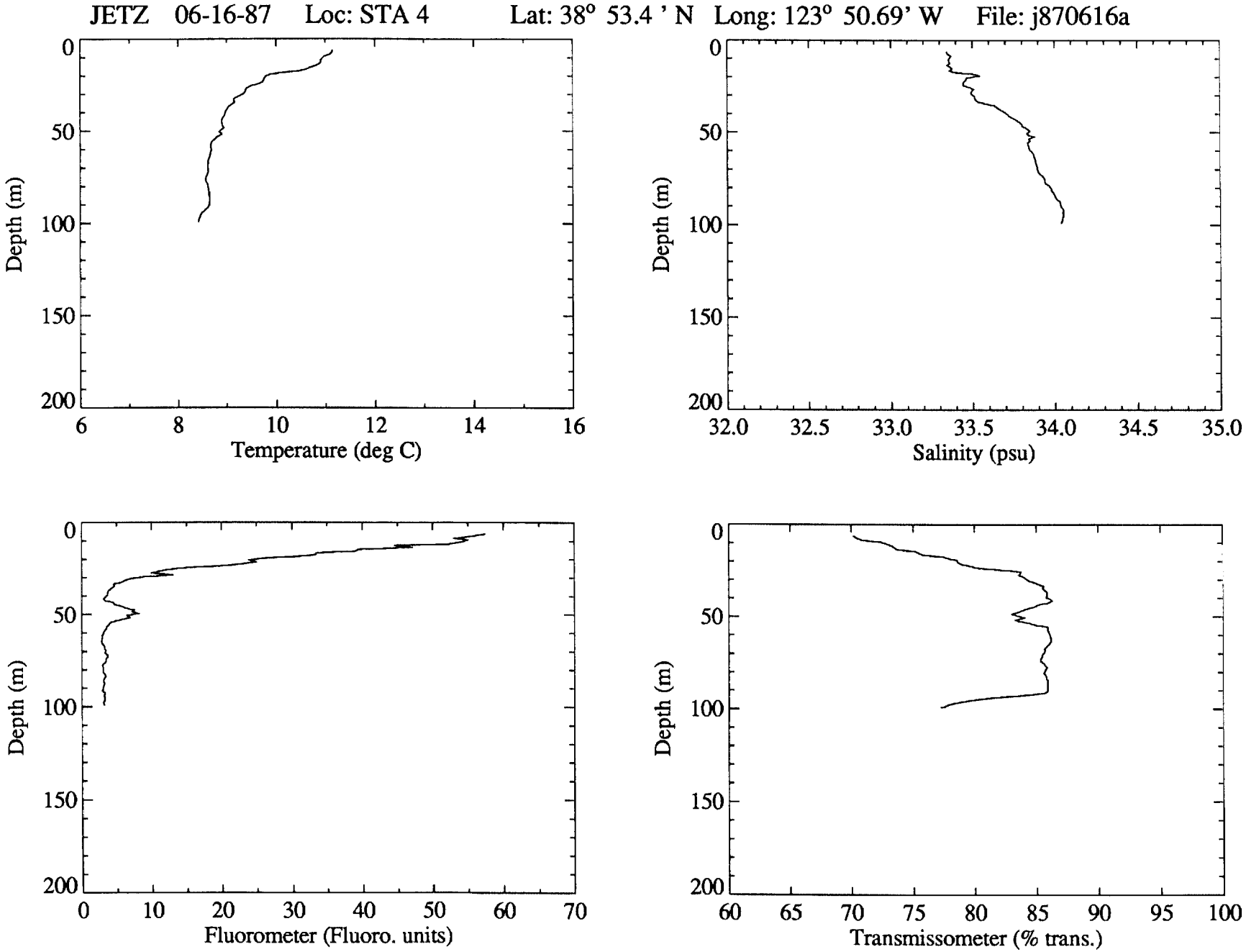
FILENAME yymmdd	Sta (Cast)	Time (Ship)	Latitude Deg	Min	Longitude Deg	Min	Comments
j870616a	004	0736	N38	53.4	W123	50.69	
j870616b	006	1010	N39	06.7	W123	51.82	
j870616c	011	1550	N39	13.2	W124	19.03	
j870616d	012	1702	N39	07.3	W124	12.42	
j870617a	CD	1150	N38	33.9	W124	02.91	Drifter launch
j870617b	D5	1516	N38	34.8	W123	56.45	AOCI overflight
j870618a	031	1158	N39	08.3	W125	07.59	
j870619a	046	1030	N37	46.9	W125	22.04	Blue water station
j870619b	051	1750	N38	35.1	W125	35.08	Evening/overcast
j870620b	055	1120	N38	31.3	W123	20.67	Upwelling center/clear
j870620c	056	1340	N38	31.3	W123	35.68	Clear/calm
j870620d	059	1830	N39	06.8	W123	51.83	Overcast/calm
j870621a	070	1135	N38	11.4	W123	46.38	
j870621b	073	1600	N38	32.2	W124	00.00	
j870625a	079	1122	N37	43.3	W124	37.01	Drifter pickup
j870626a	090	0915	N38	26.8	W124	17.16	Fog/calm
j870626b	905	1050	N38	23.9	W124	15.13	Fog/calm
j870626c	091	1228	N38	20.2	W124	12.64	Bad wire angle
j870626d	091	1240	N38	20.2	W124	12.64	Recast/overcast
j870626e	092	1430	N38	12.4	W124	09.35	

TABLE III.

Extracted Chlorophyll and Phaeopigment Values
(Note: 3-m Depth = sample from underway system)

Date	Sta	Depth (m)	mg/l Chl.	Phaeo-pigments	Total	Comments
6/16/87	6	10	8.23	1.06	9.29	
		20	8.23	1.35	9.58	
		40	2.95	0.59	3.54	
		60	0.22	0.32	0.54	
		80	0.17	0.36	0.53	
		100	0.12	0.35	0.47	
6/17	CD	3	0.92	0.35	1.27	Drifter launch
	D5	3	4.29	1.03	5.32	AOCI overflight
6/18	31	3	0.15	0.038	0.188	
	38	20	0.86	0.22	1.08	
6/19	46	20	0.071	0.035	0.106	
	51	20	0.209	0.115	0.324	
		40	0.356	0.218	0.574	
		60	0.160	0.120	0.28	
		80	0.086	0.061	0.147	
		100	0.037	0.081	0.118	
6/20	55	20	1.04	0.39	1.43	
	56	20	2.70	0.39	3.09	
	58	3	0.71	0.098	0.808	
6/21	70	3	0.29	0.093	0.383	
	73	20	2.15	1.09	3.24	
		40	1.89	1.17	3.06	
		60	0.43	0.47	0.90	
		80	0.38	0.39	0.77	
		100	0.26	0.45	0.71	
6/25	79	10	0.288	0.14	0.428	Drifter pickup
	pre 83	20	1.50	0.56	2.06	
	83	20	1.10	0.34	1.44	
		40	1.63	0.50	2.13	
		60	2.22	0.72	2.94	
		80	1.83	0.97	2.80	
		100	0.23	0.31	0.54	
6/26	90	3	0.36	0.20	0.56	
	905	20	0.60	0.33	0.93	
	91	3	0.27	0.14	0.41	
	92	3	0.26	0.12	0.38	

STATION PROFILES



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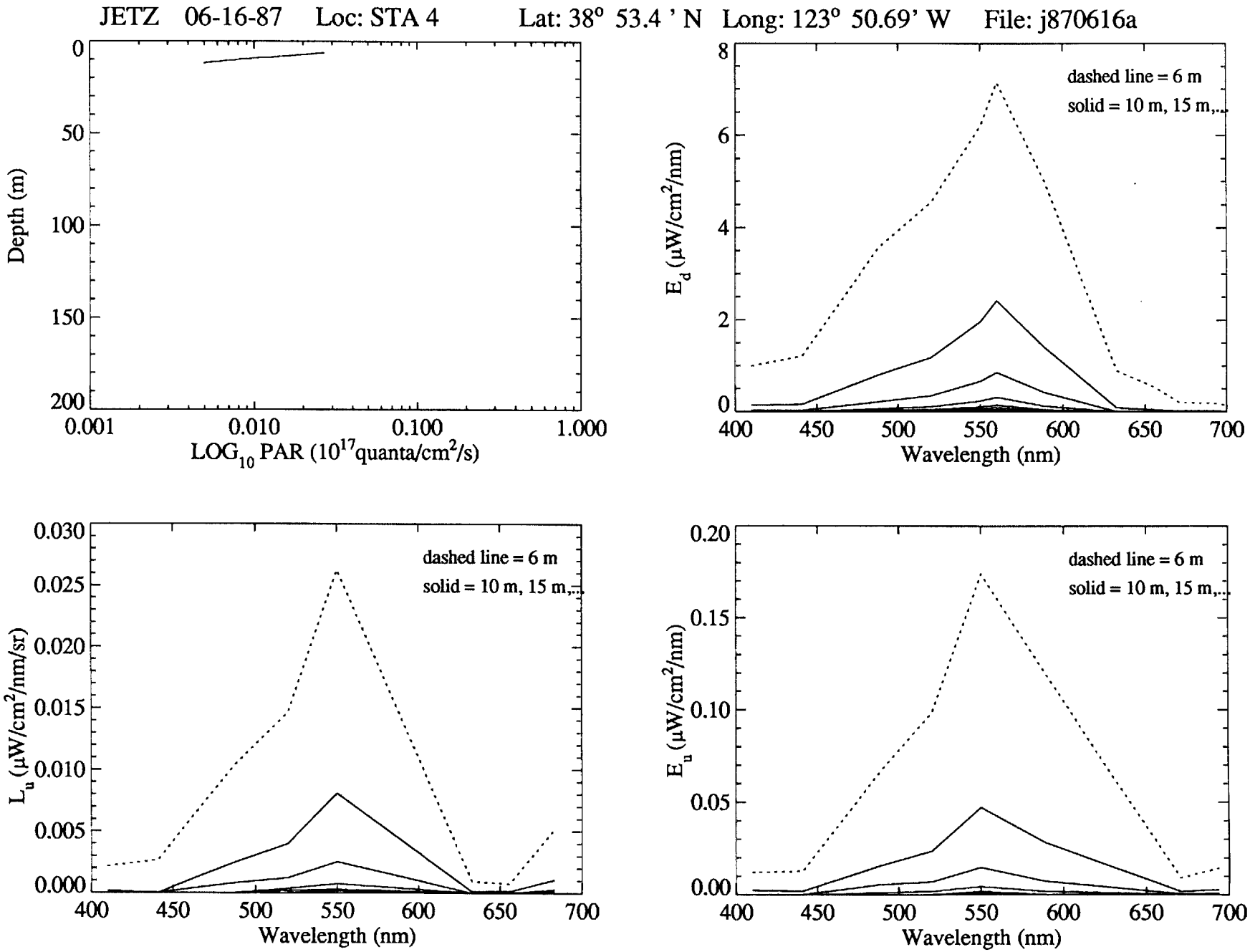

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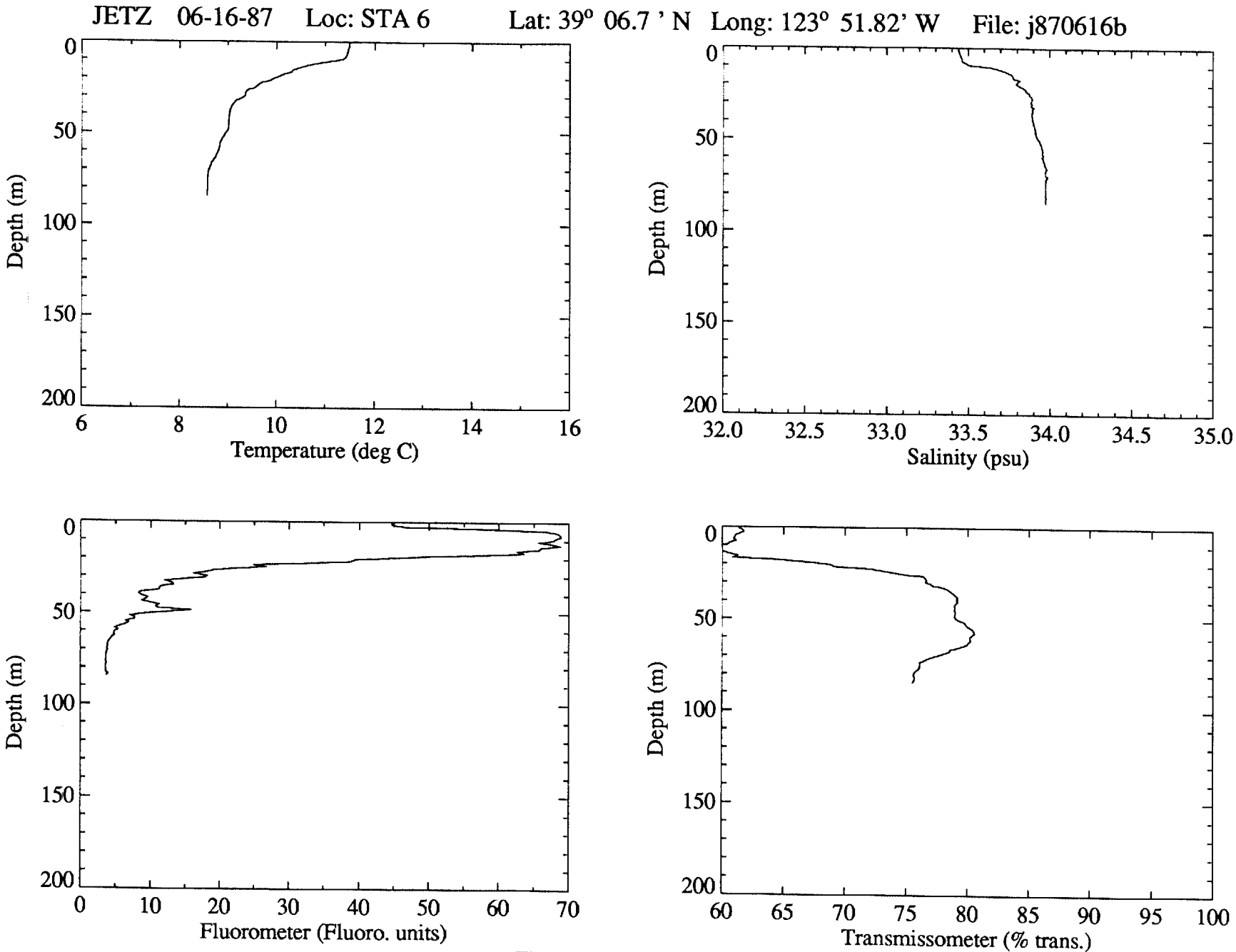

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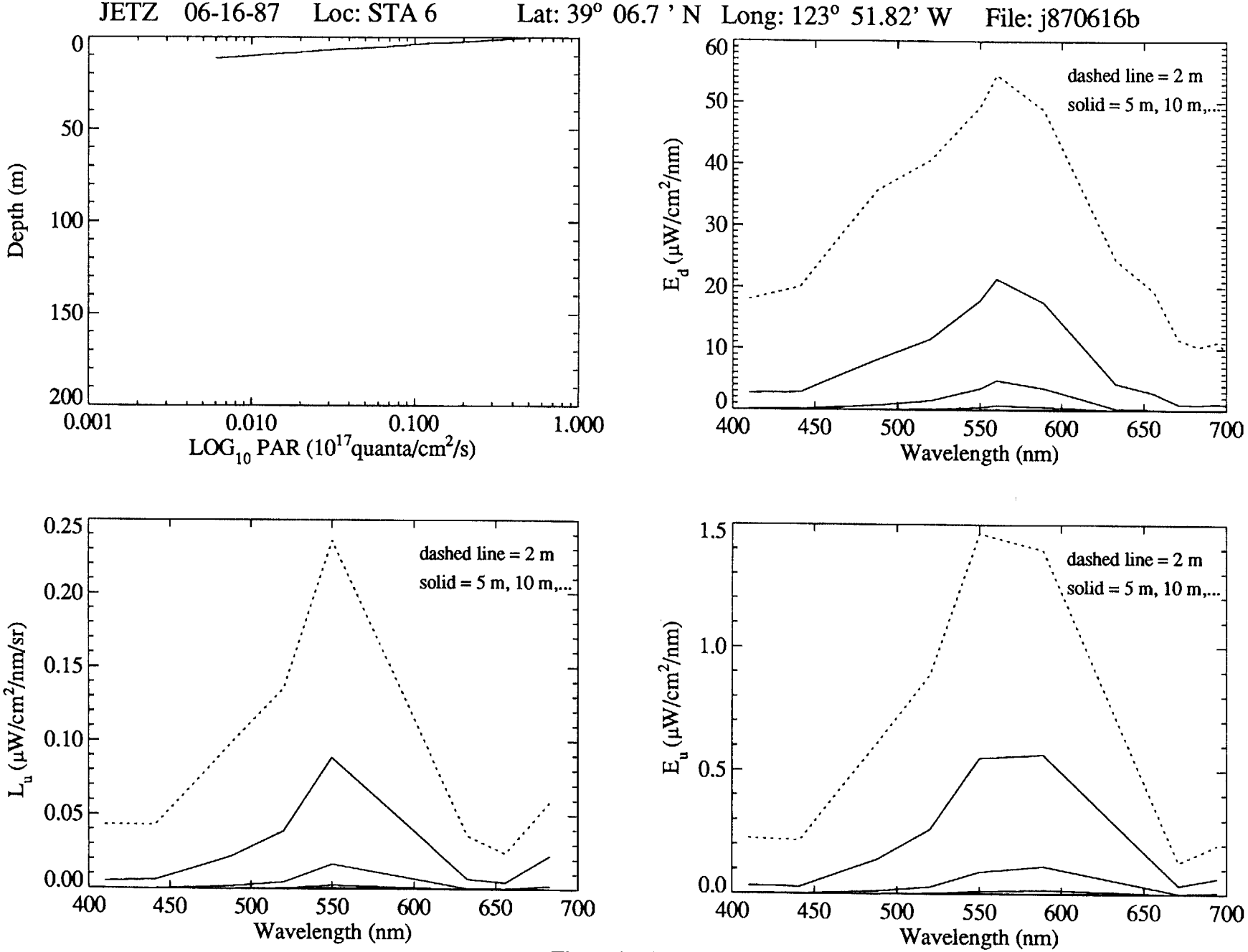

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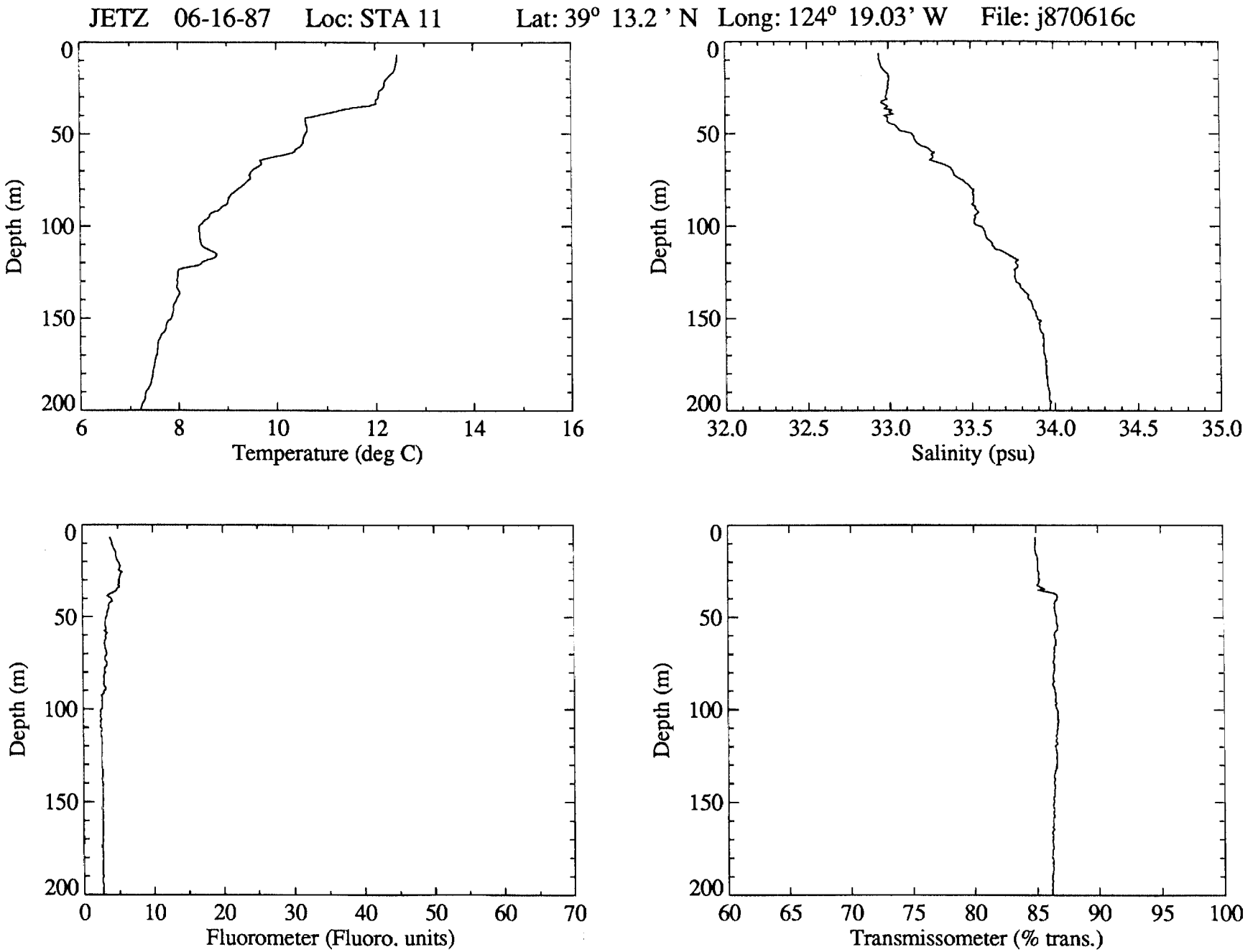

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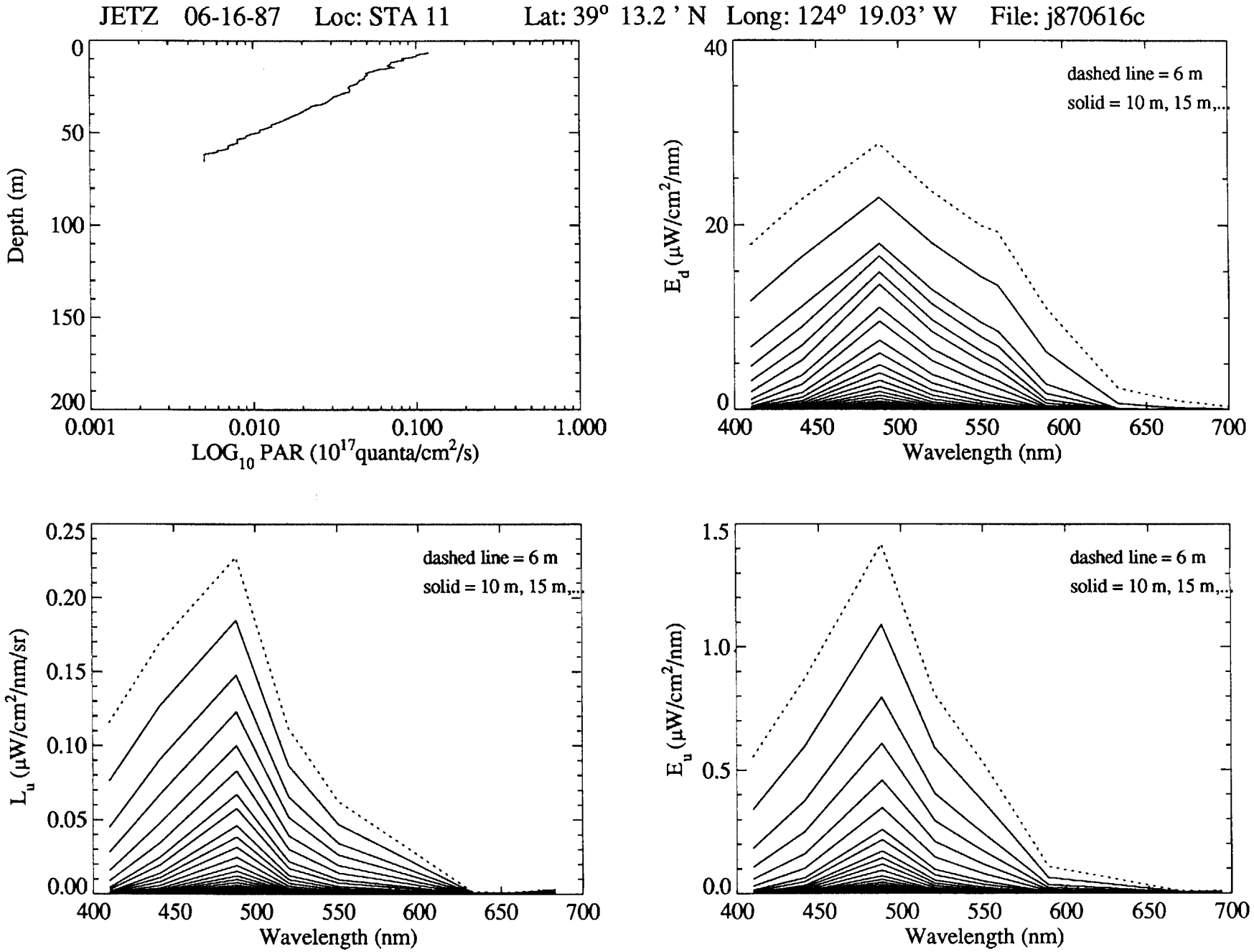

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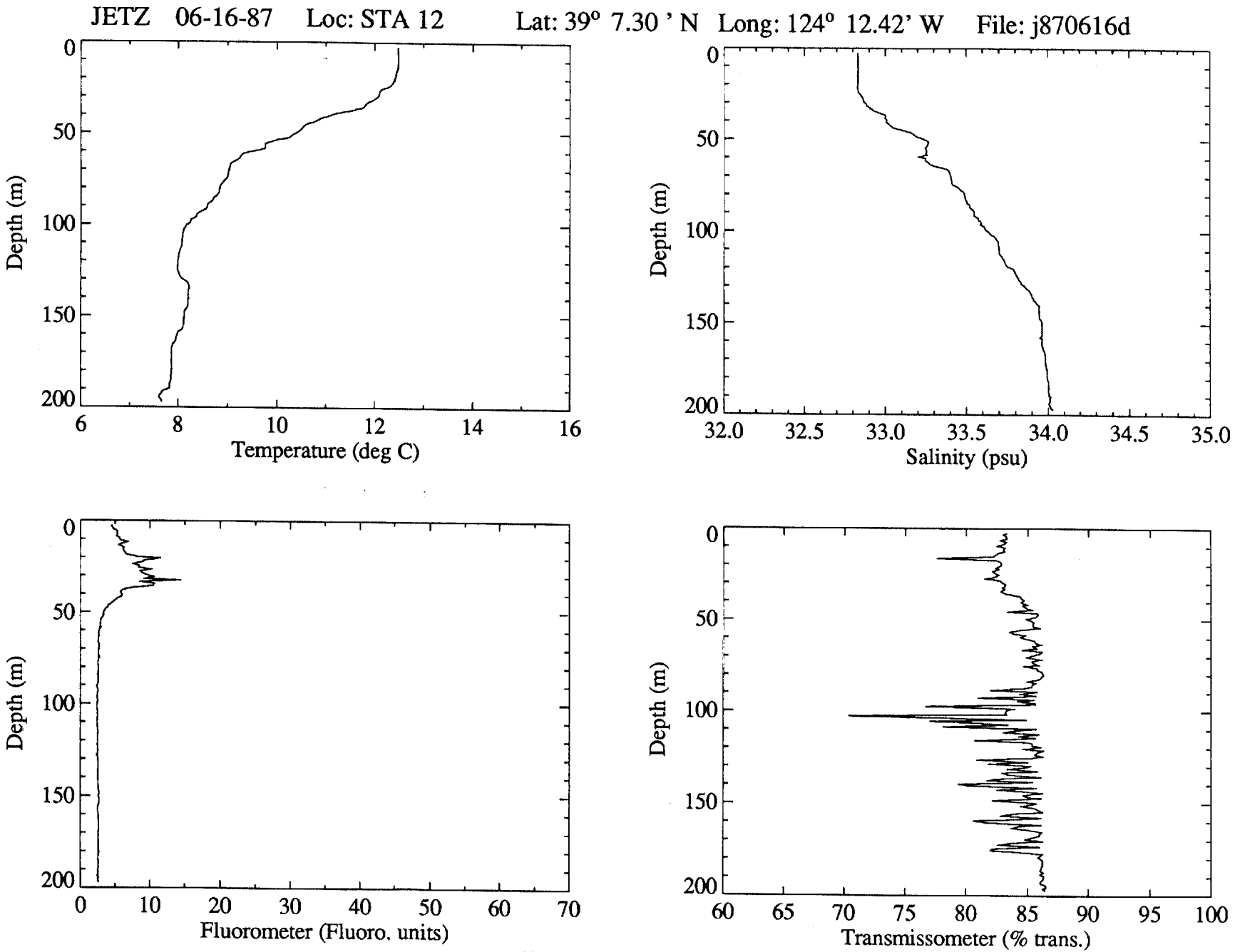

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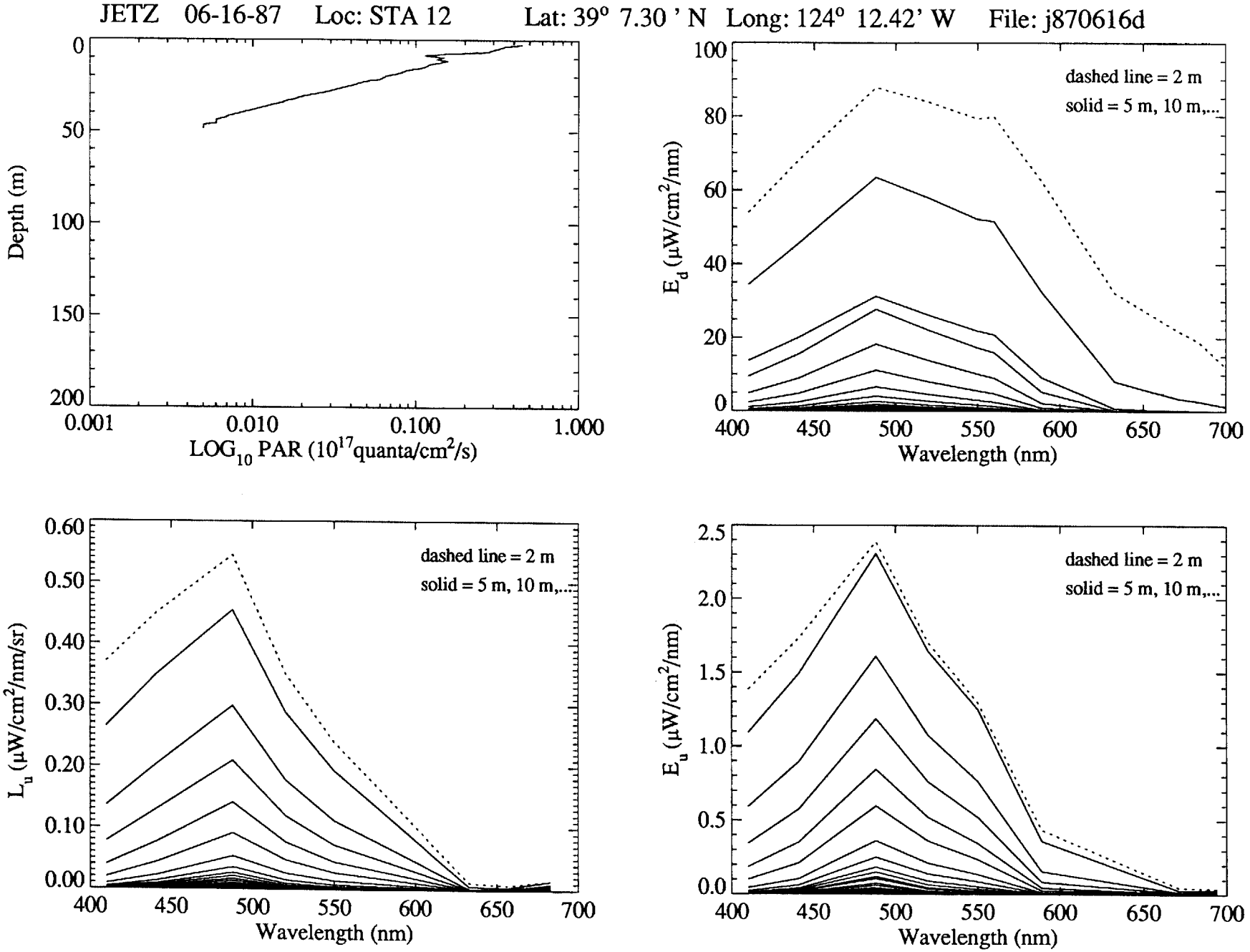

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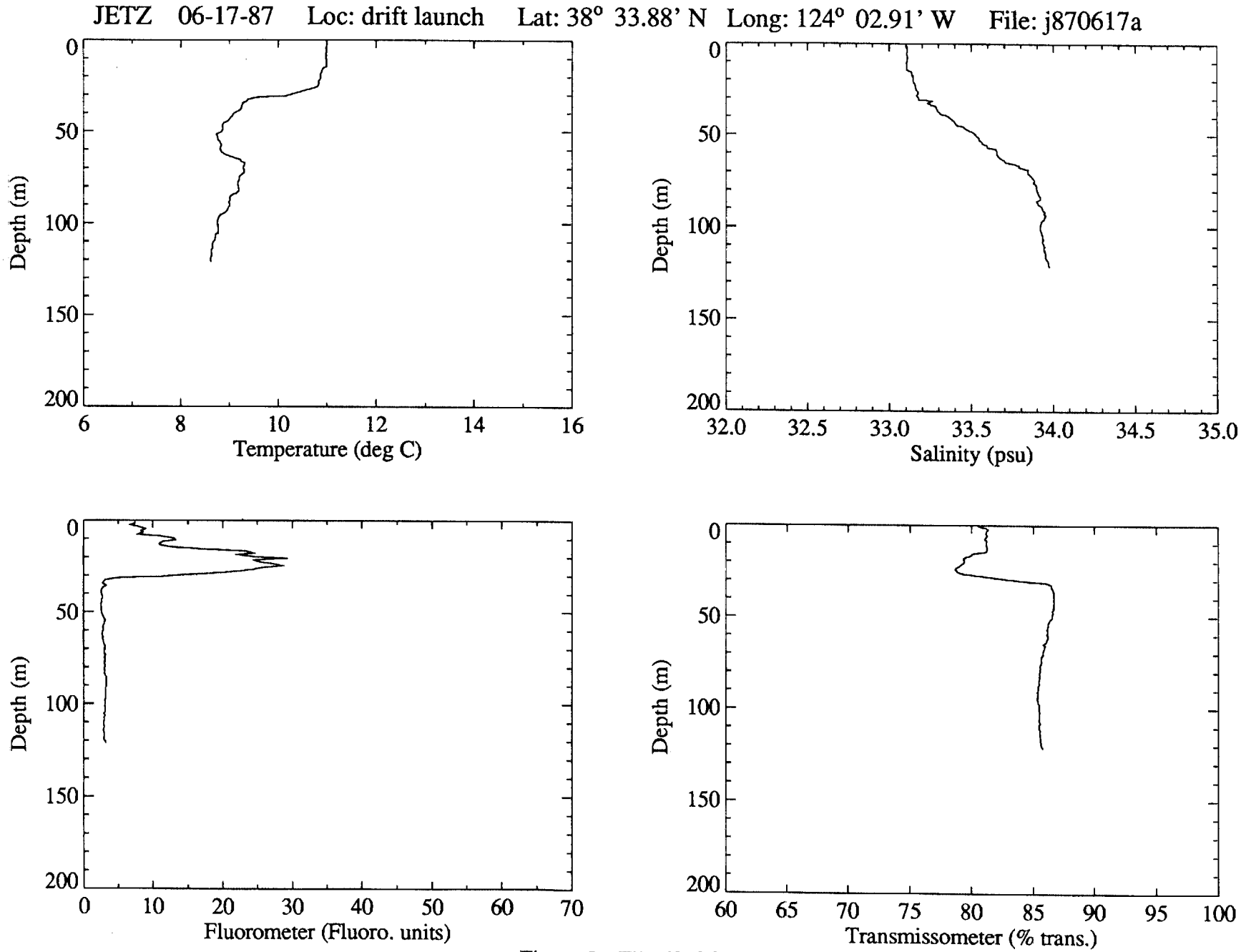

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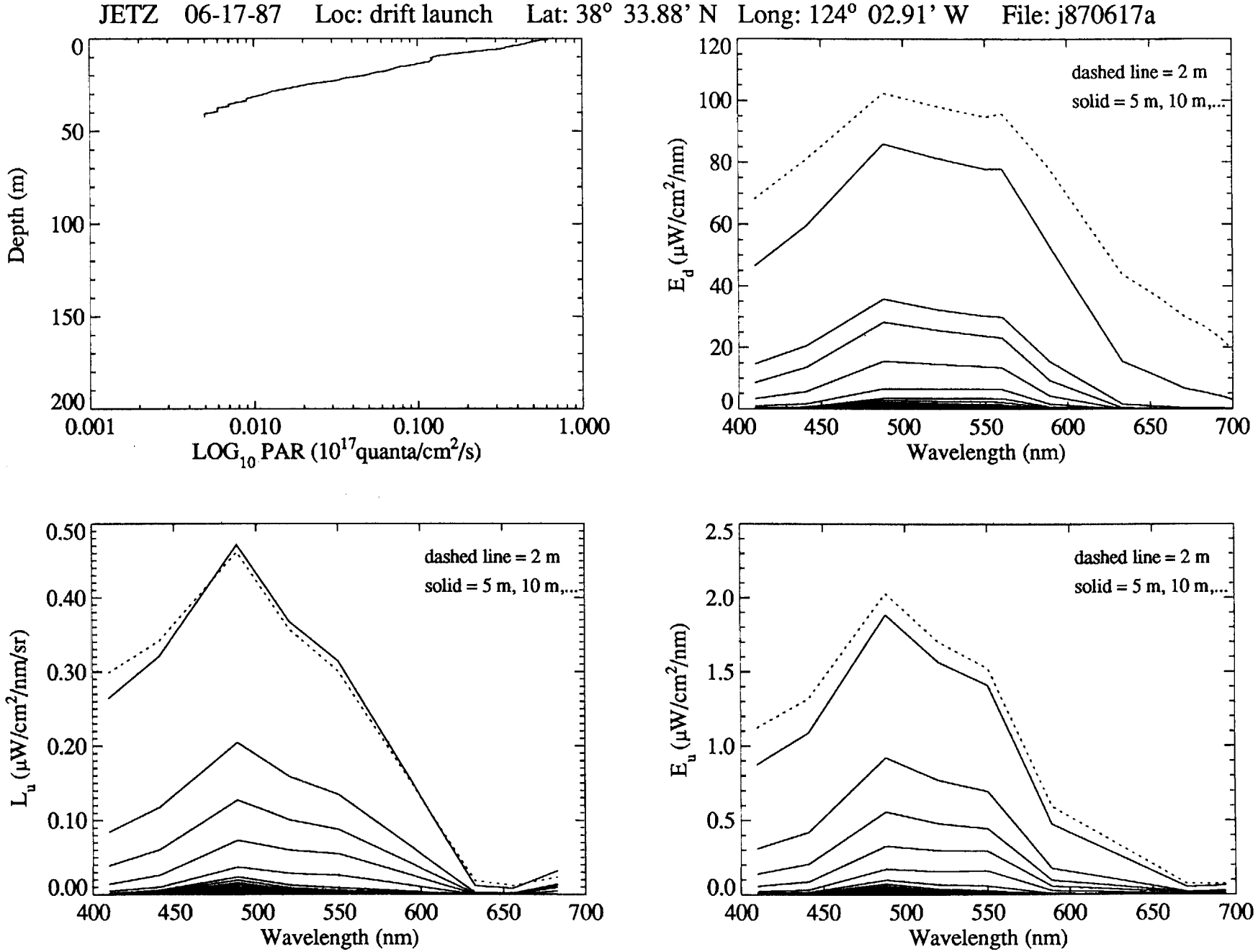

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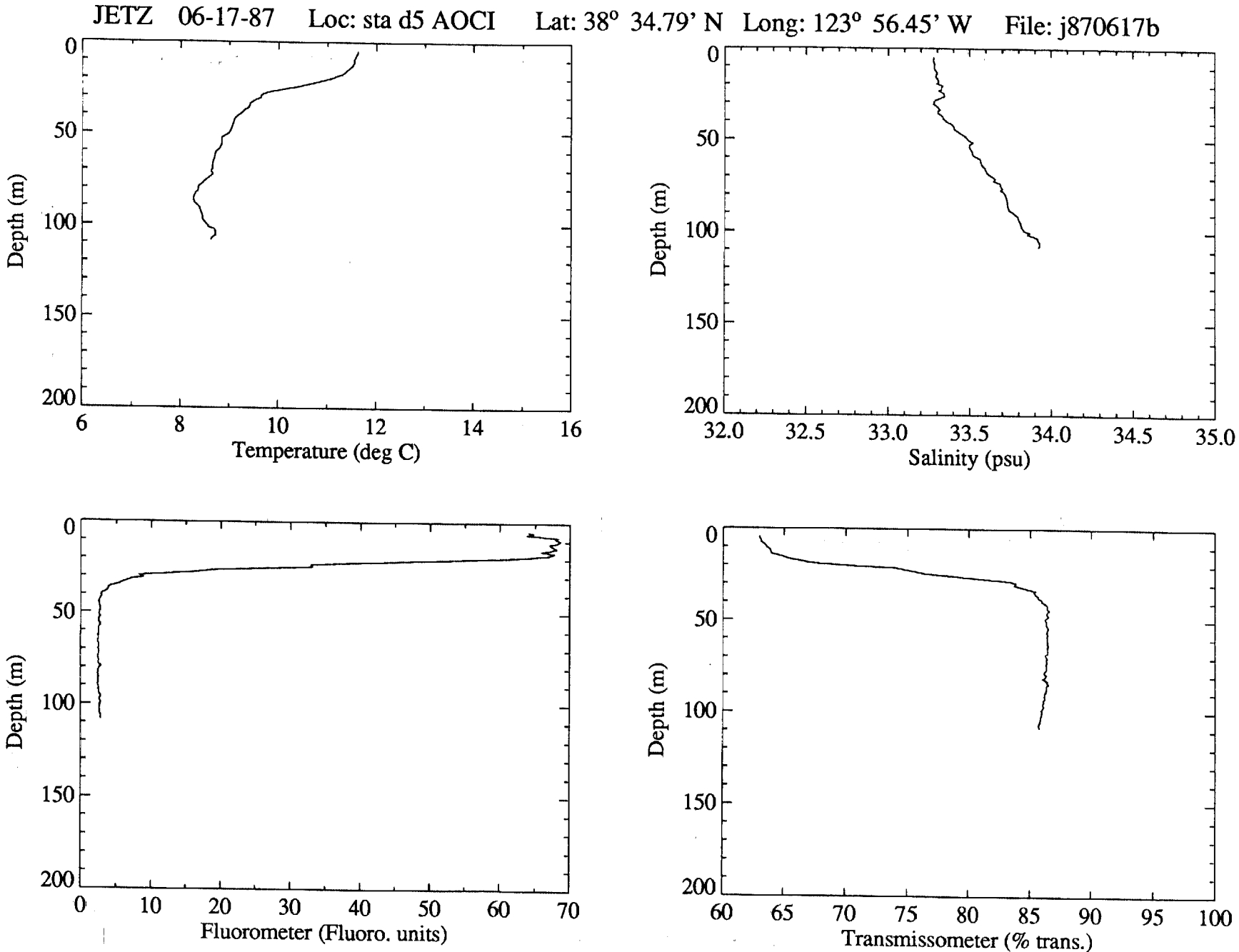

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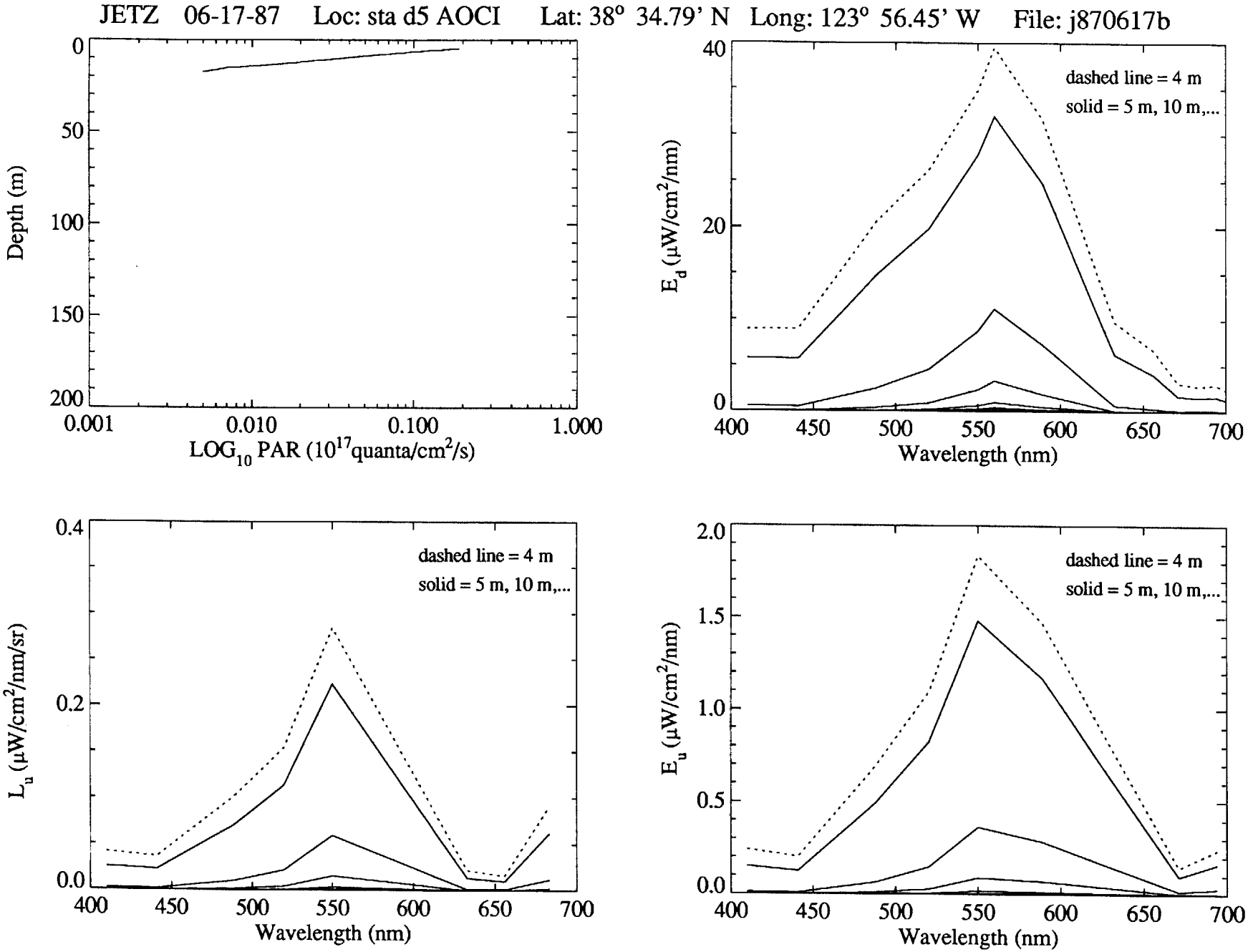

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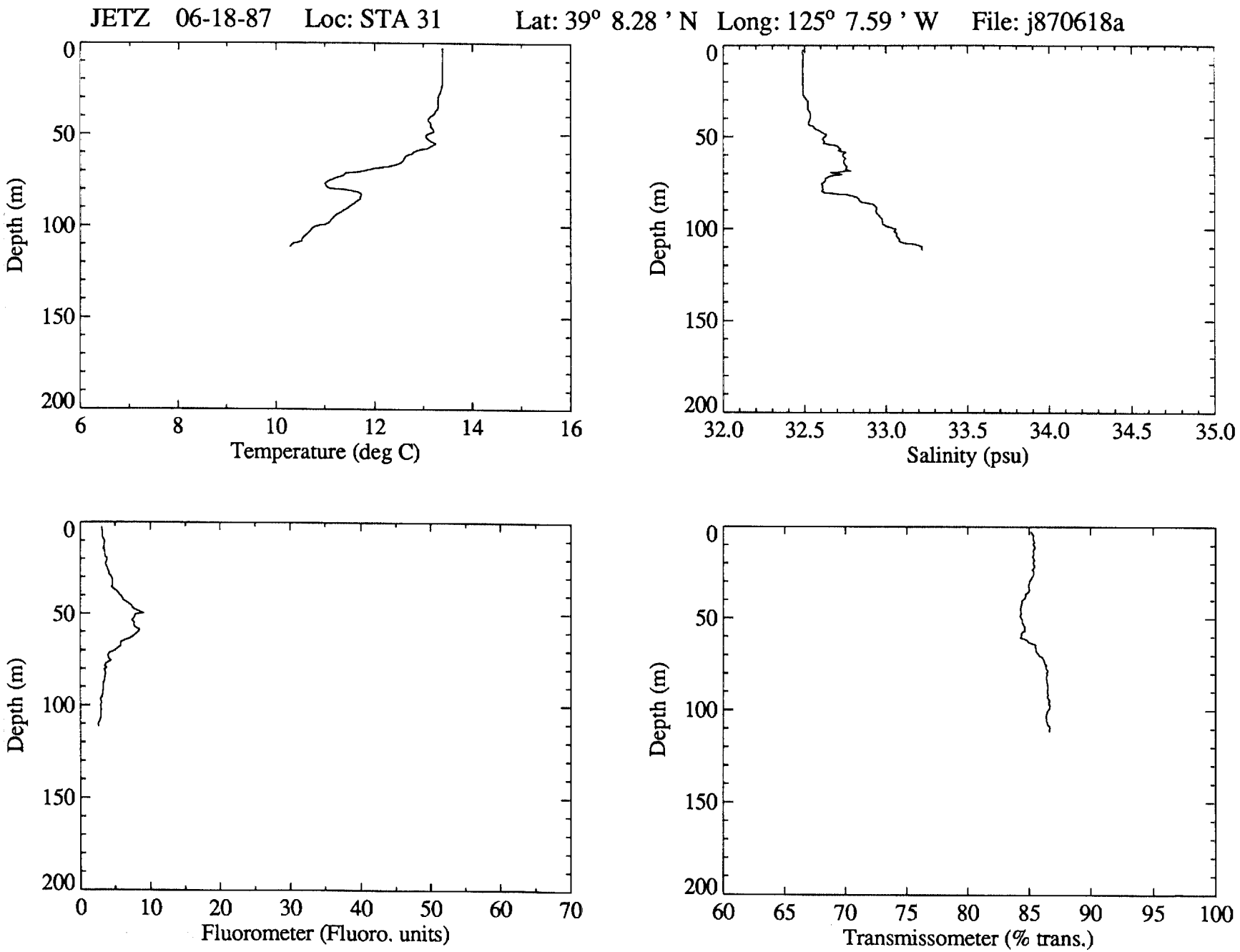

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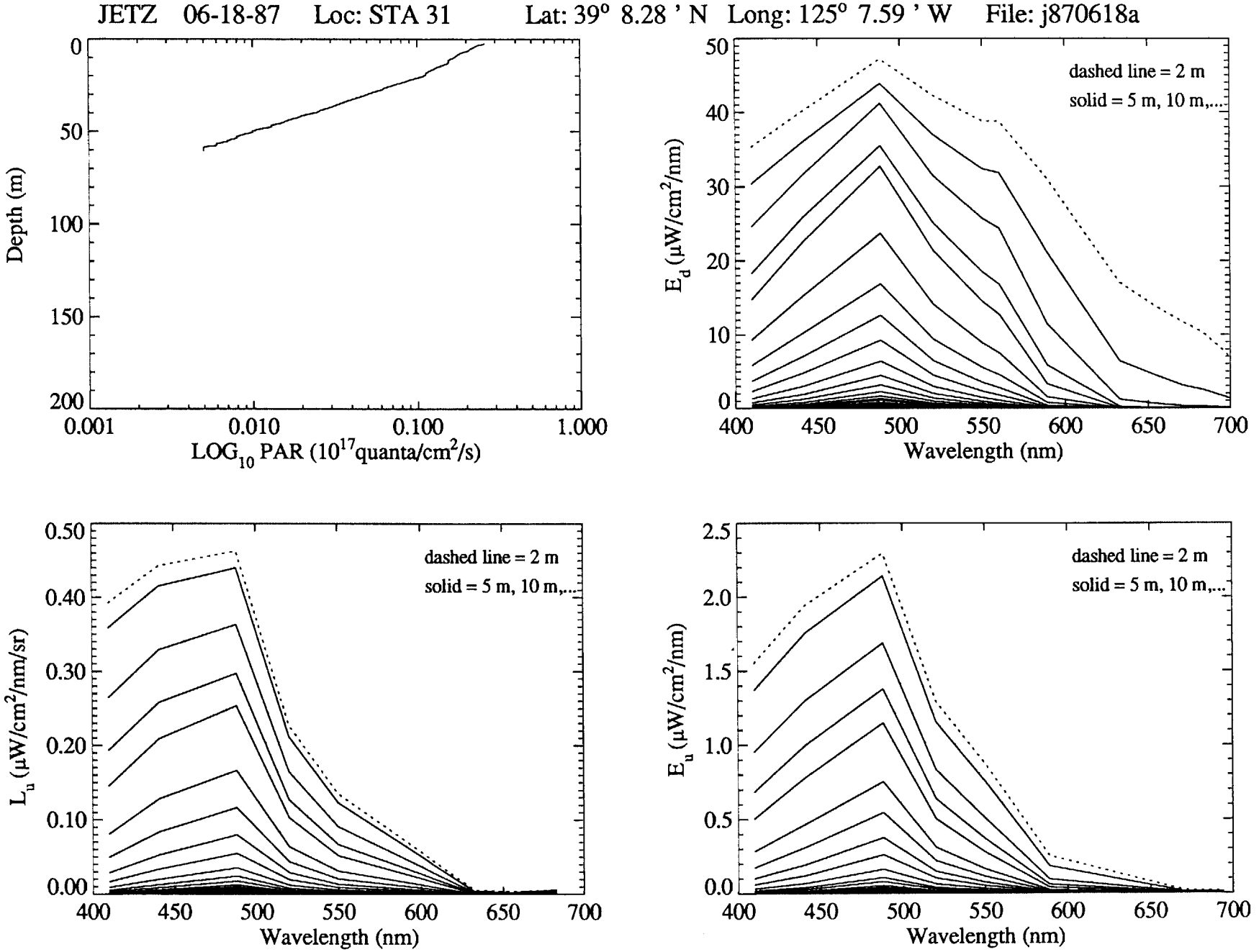

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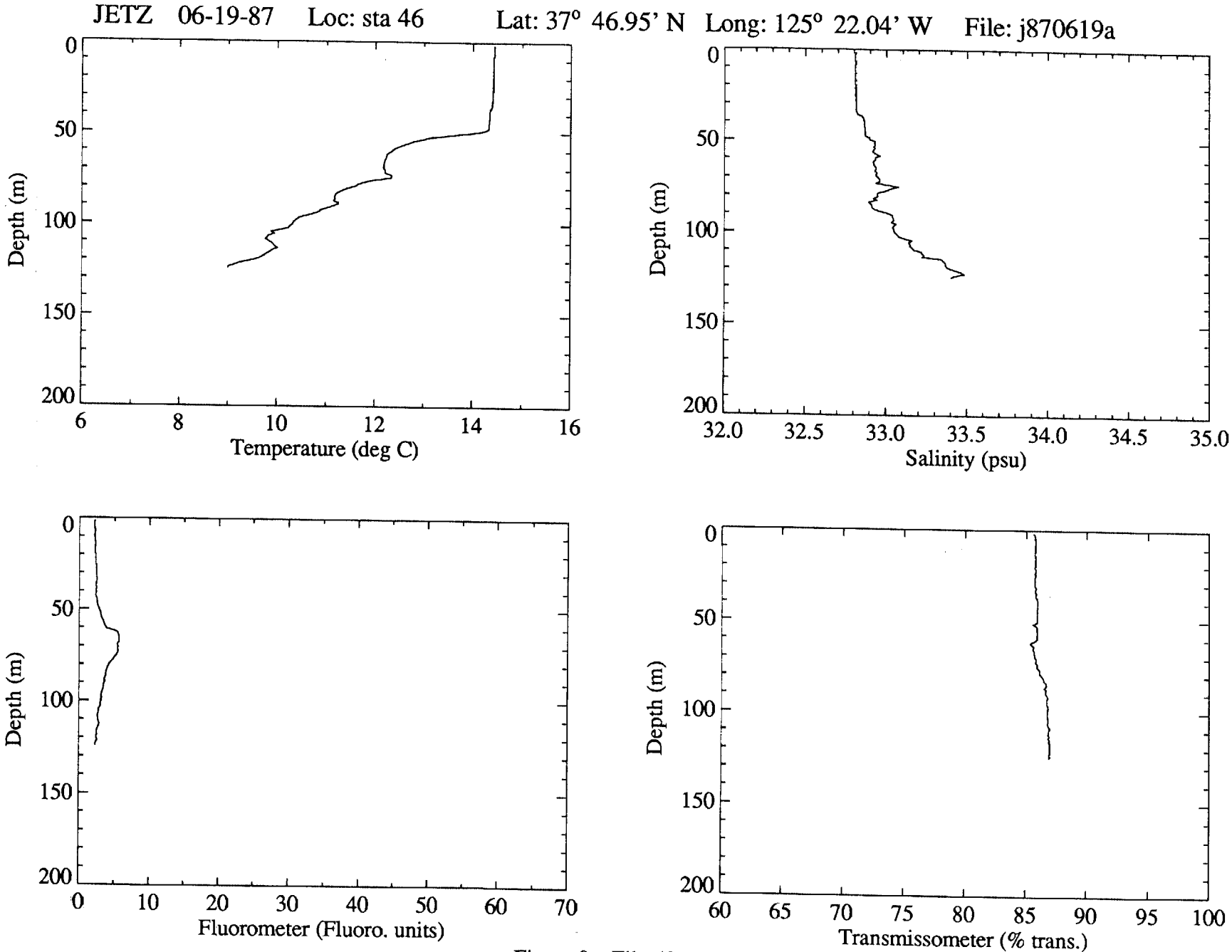

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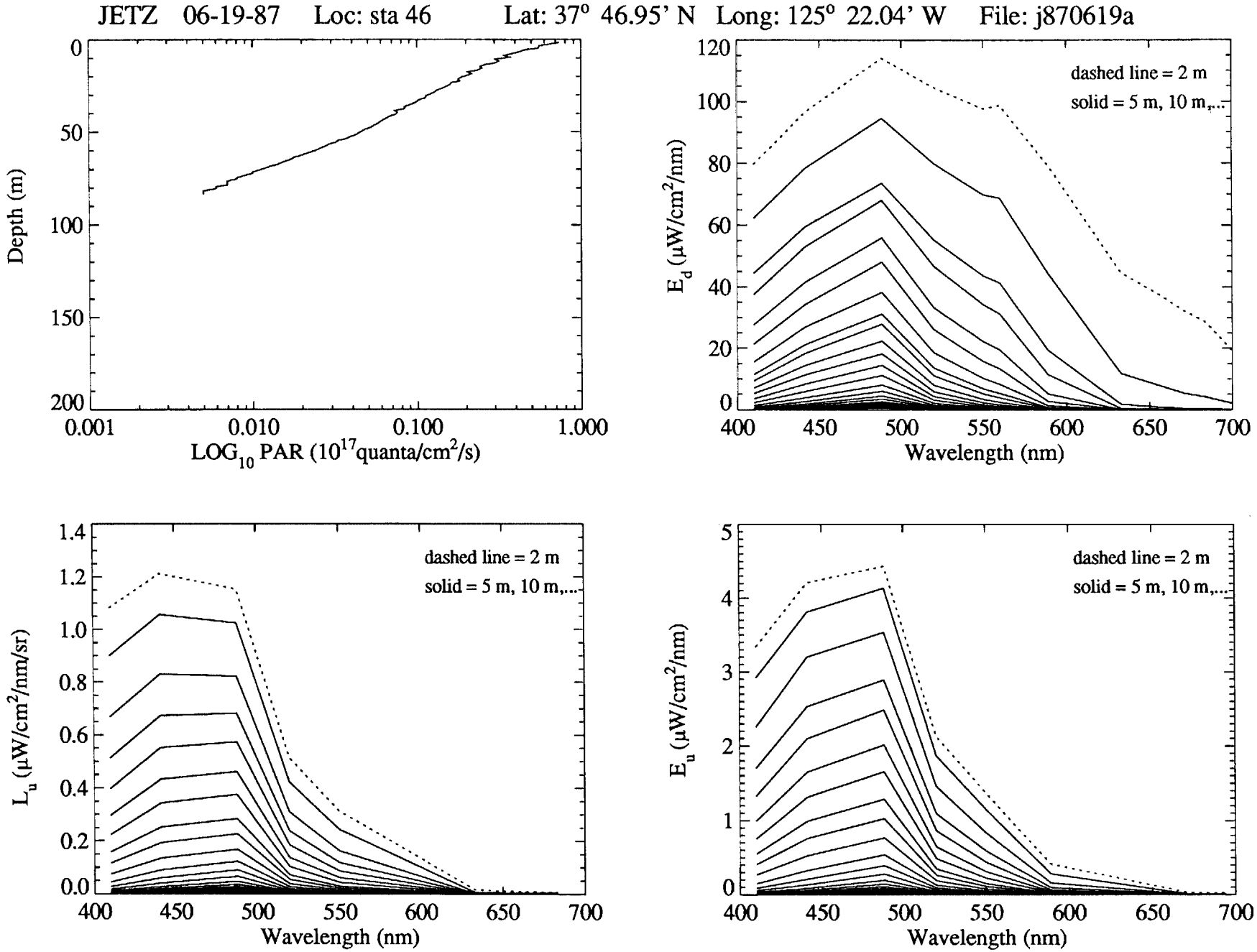

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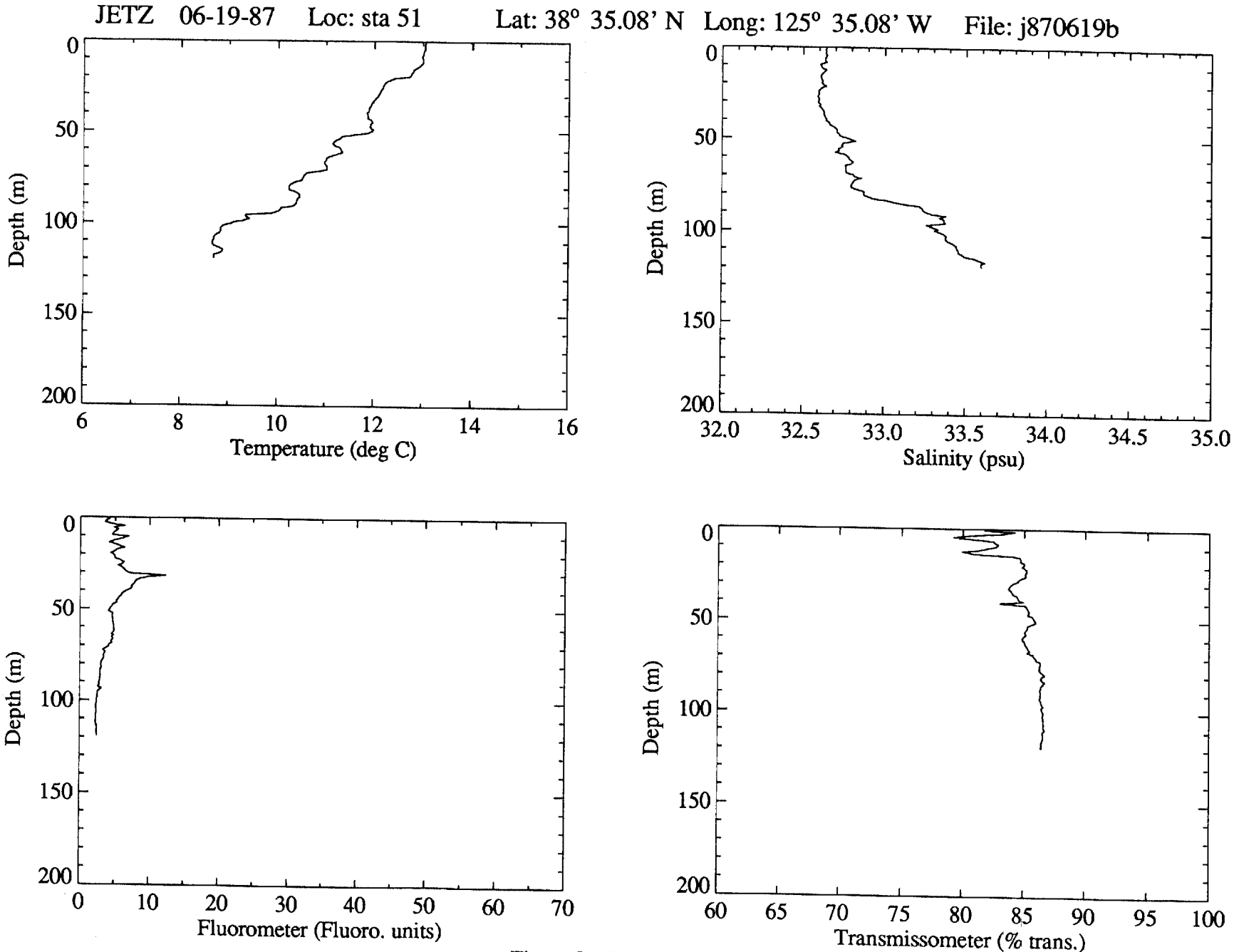

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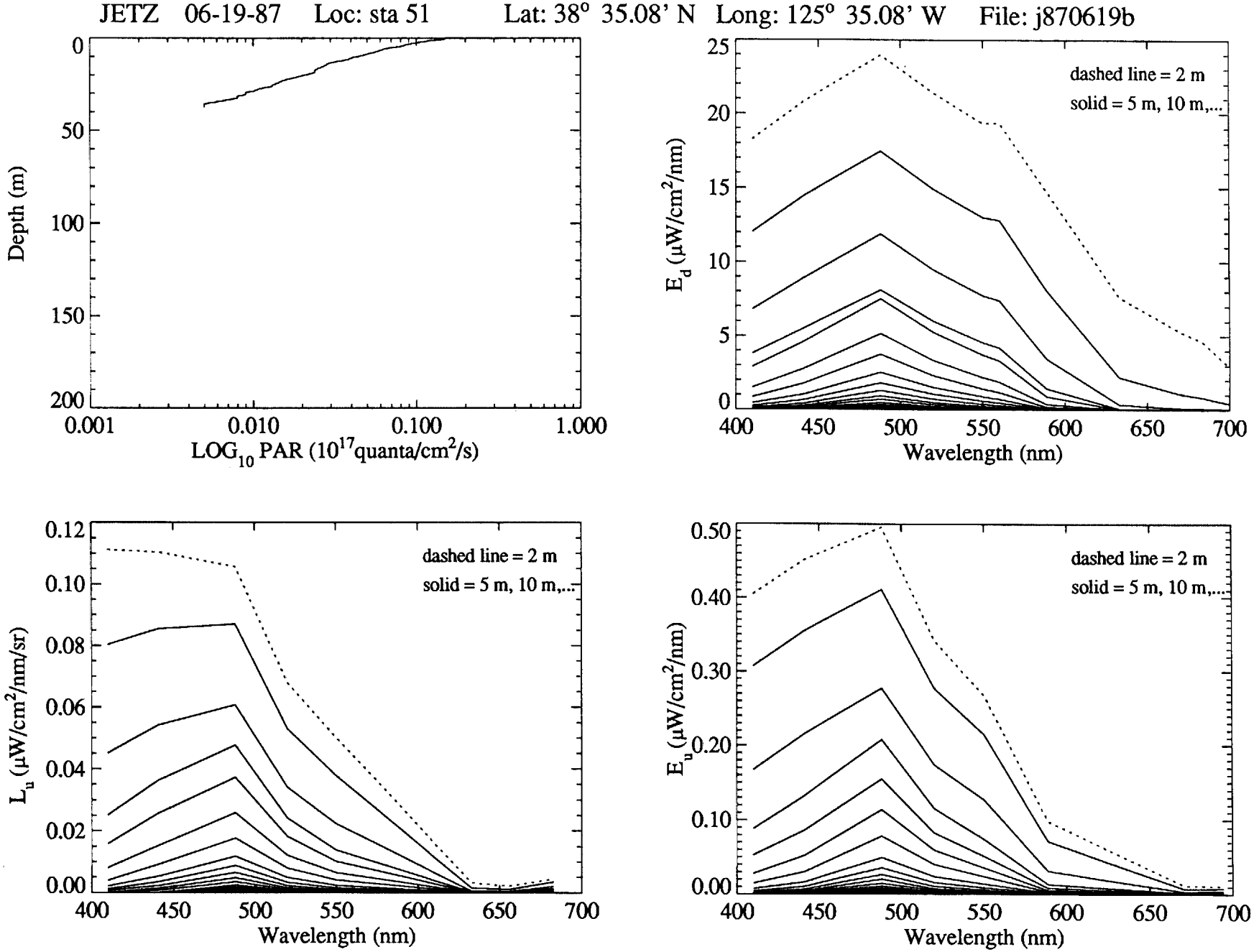

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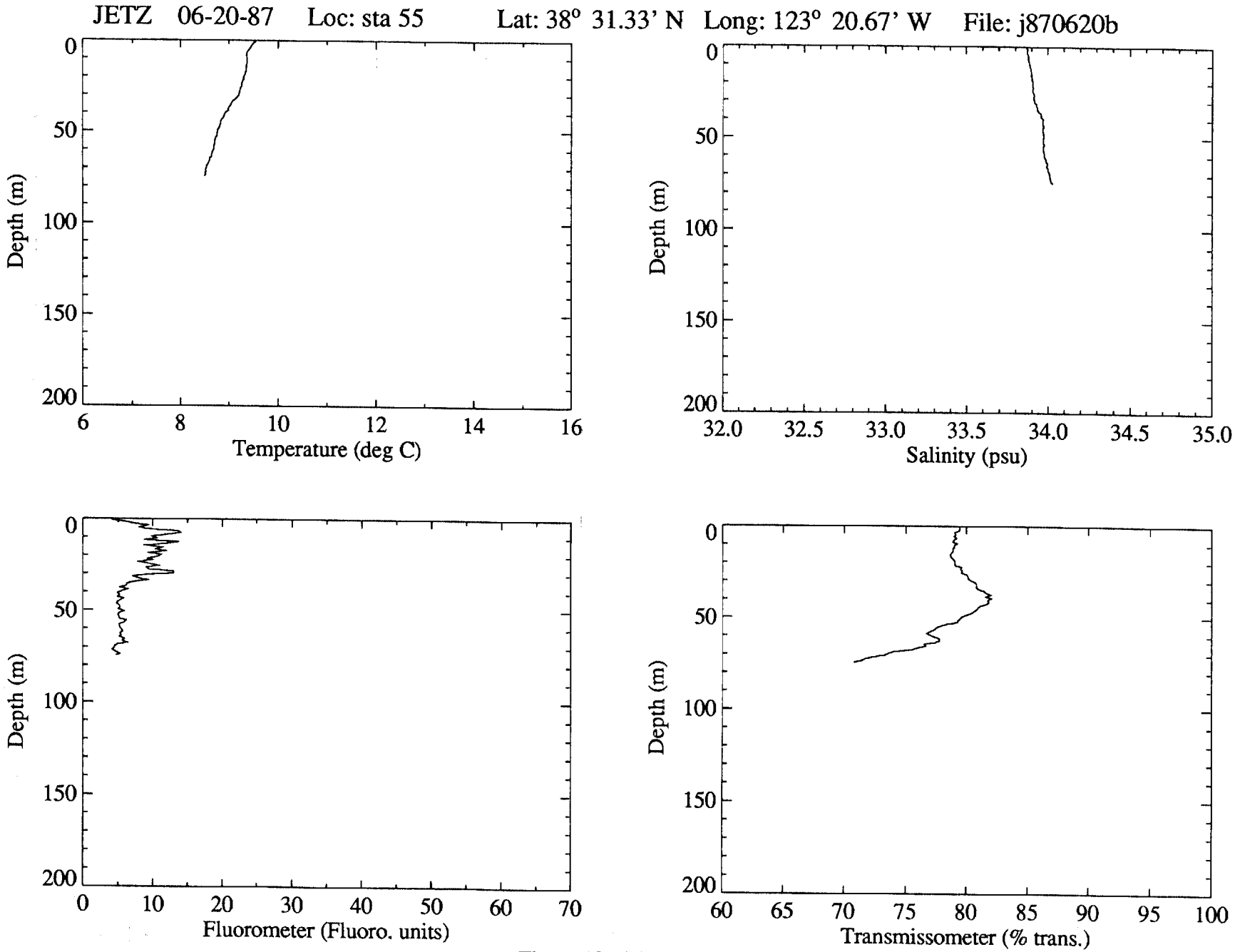

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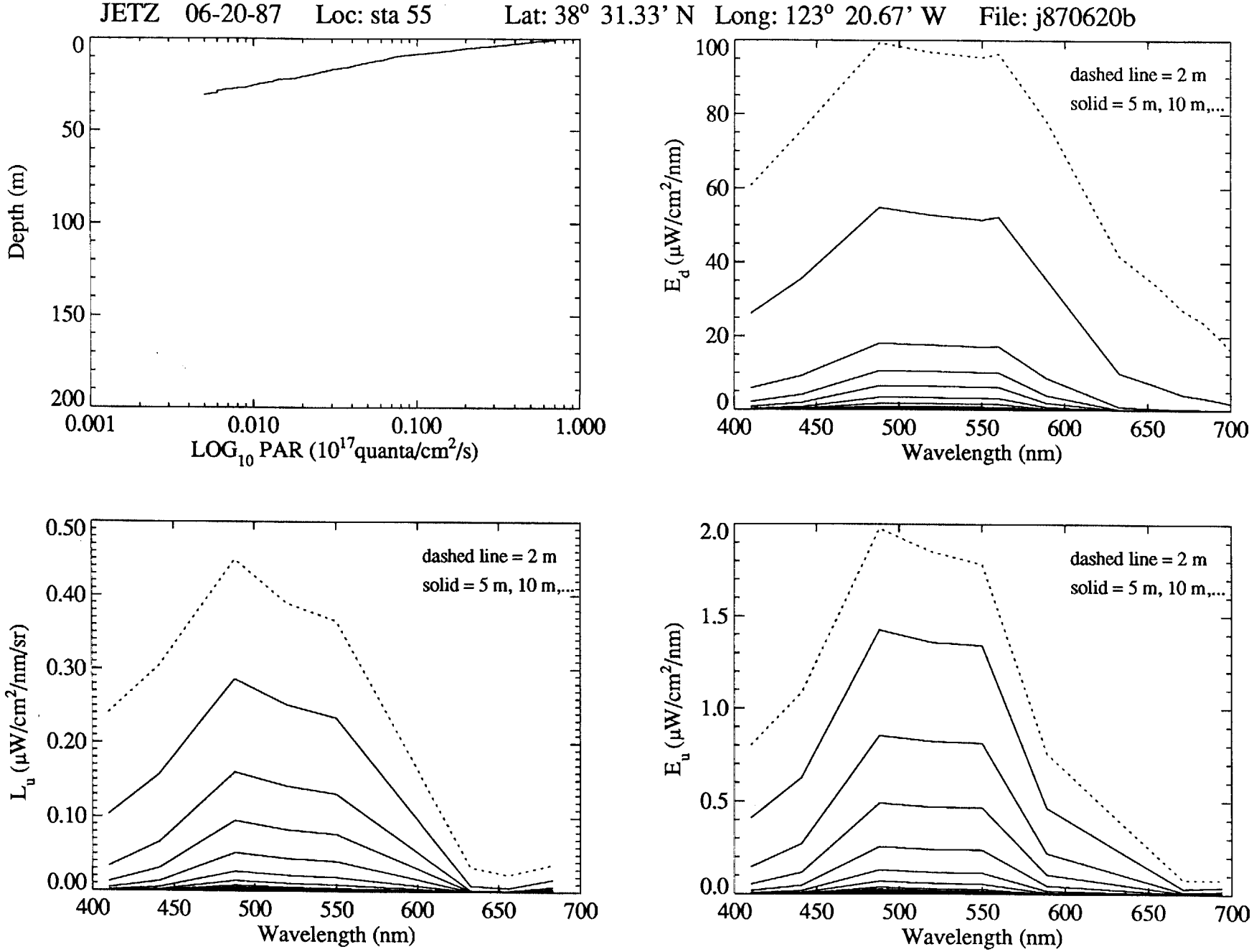

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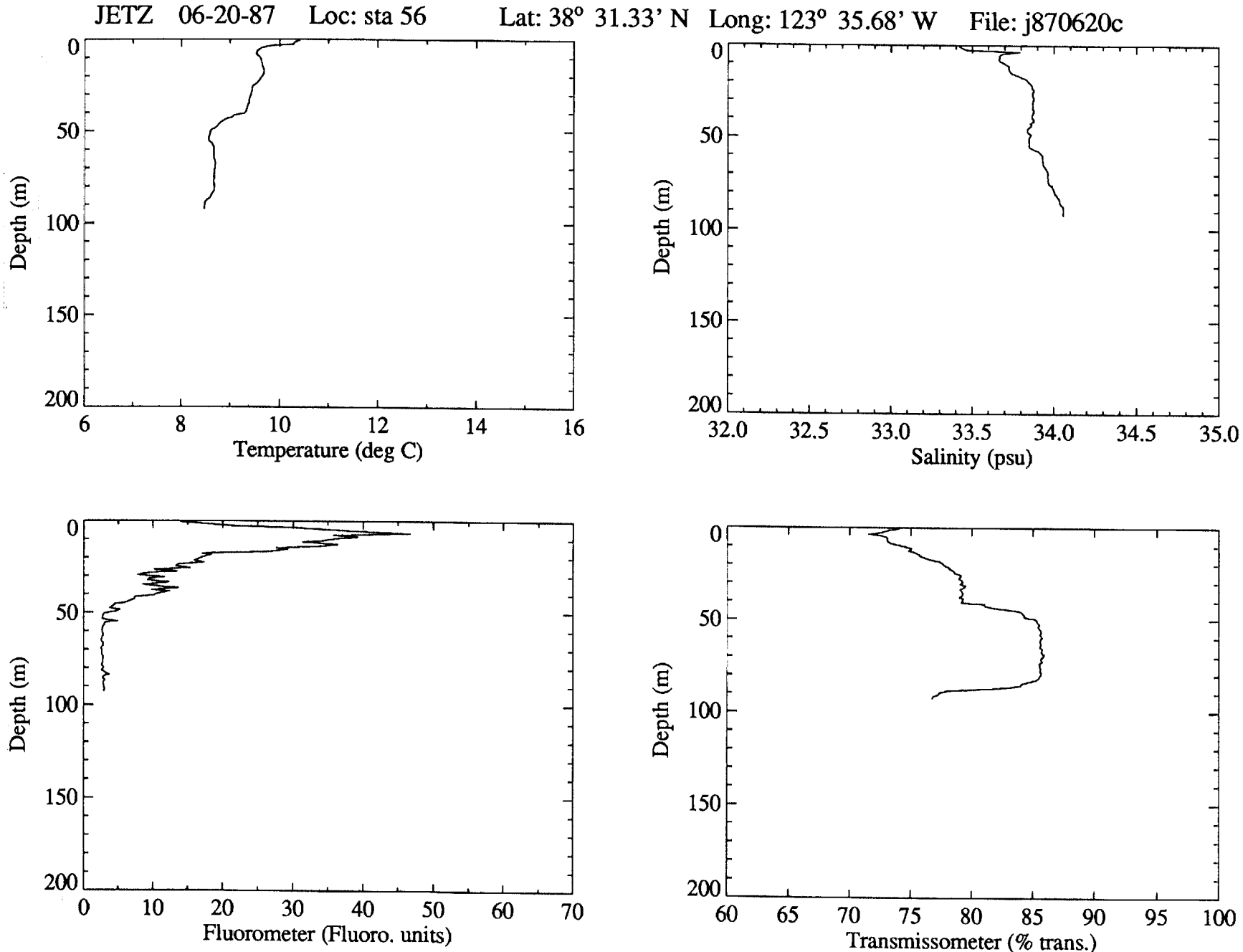

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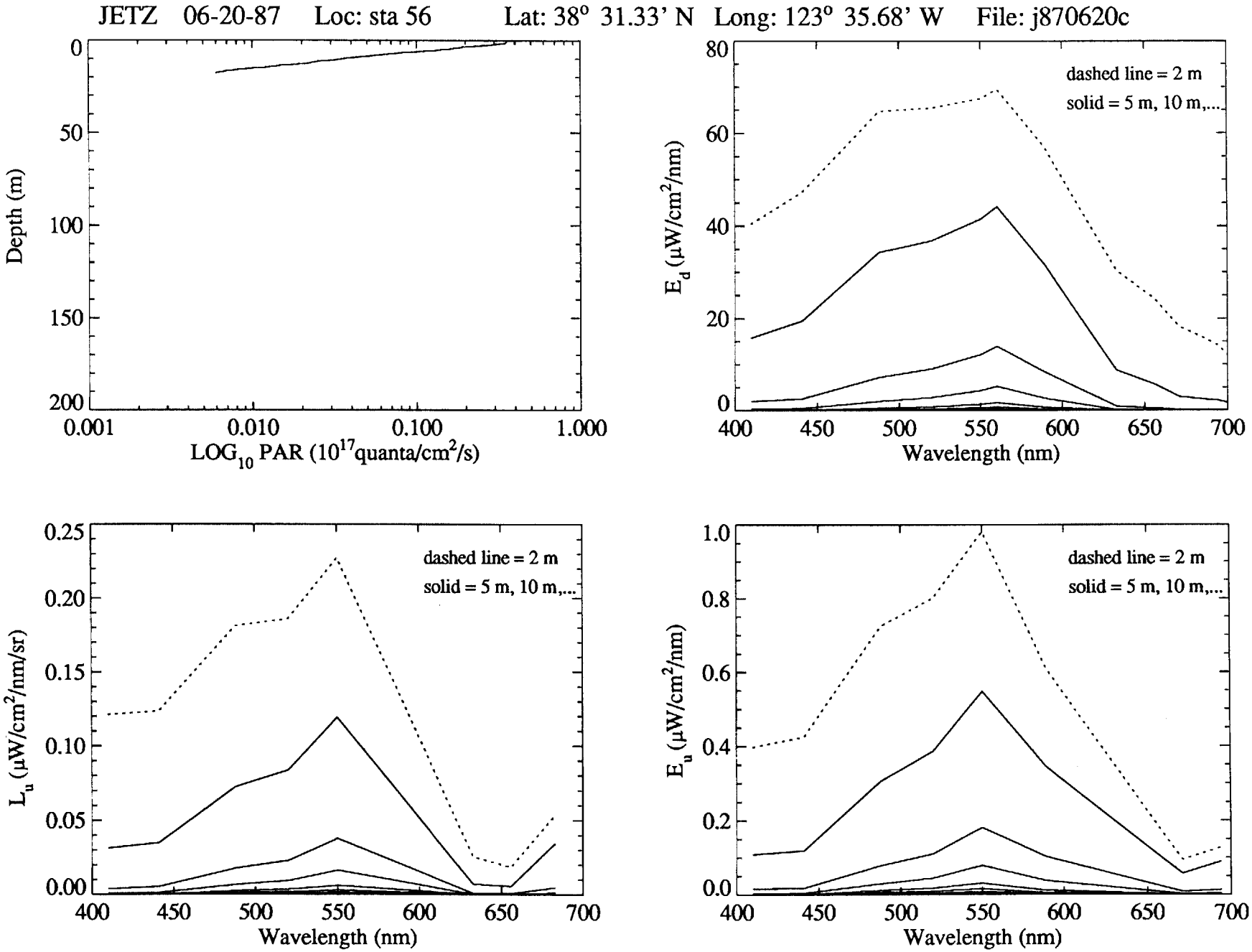

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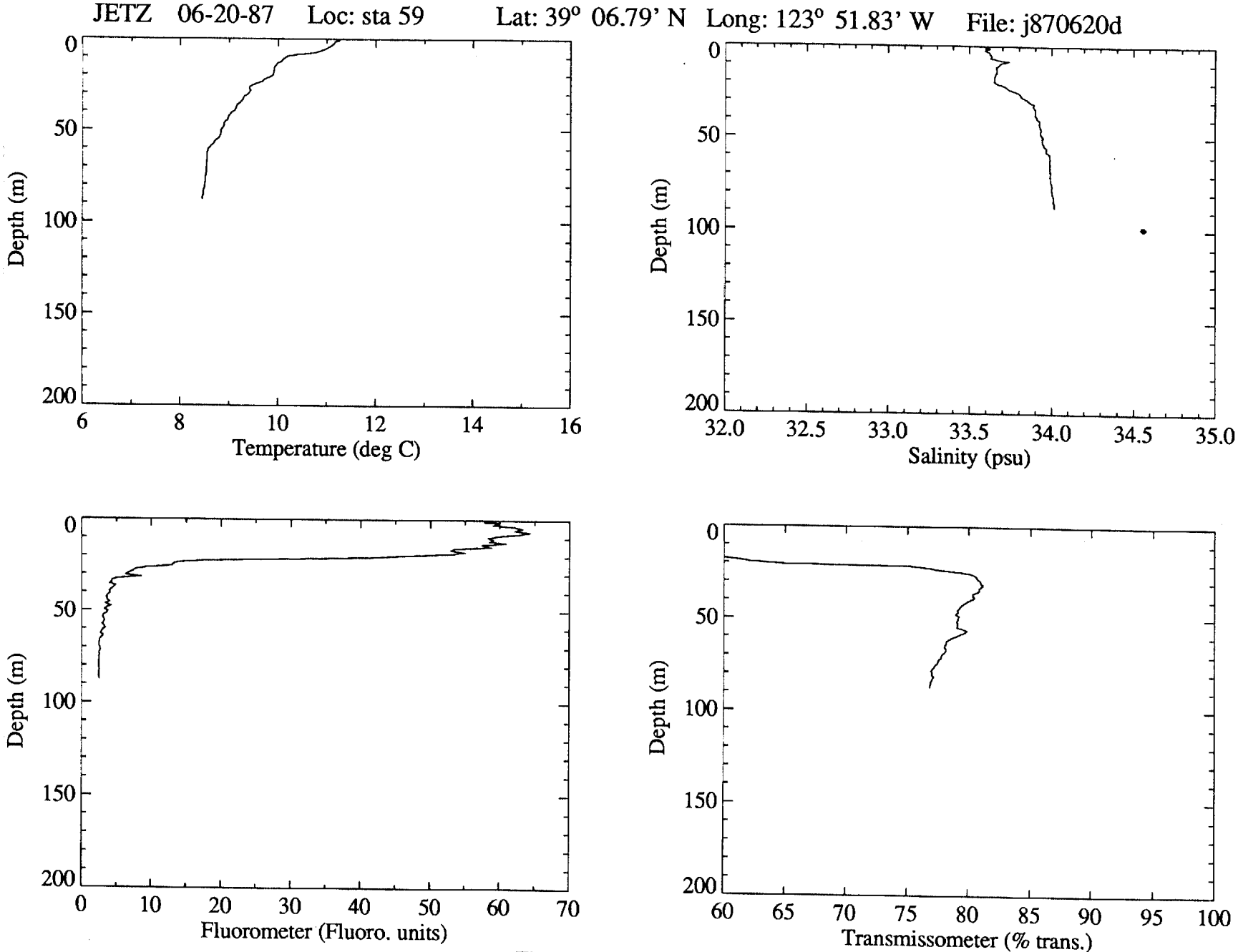

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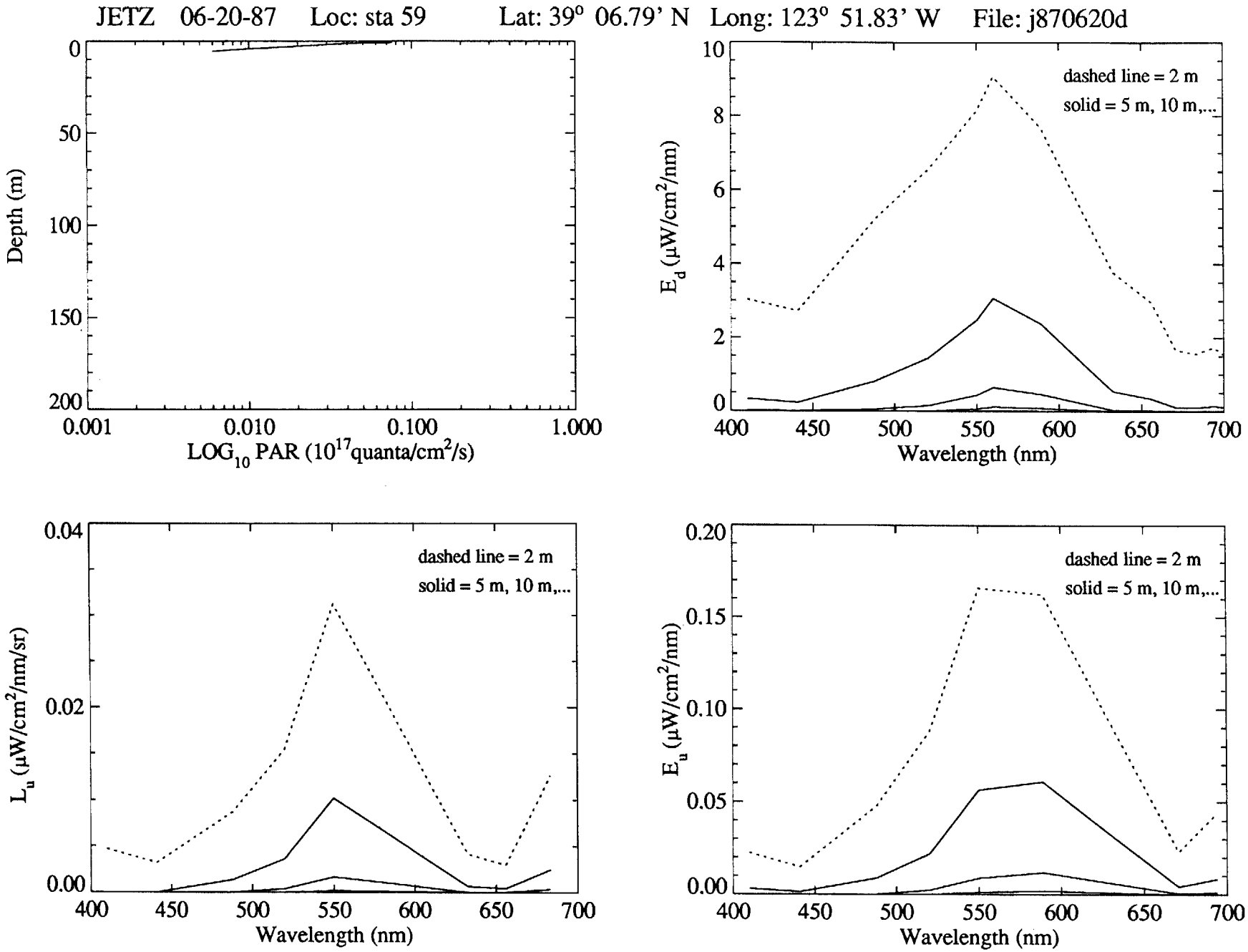

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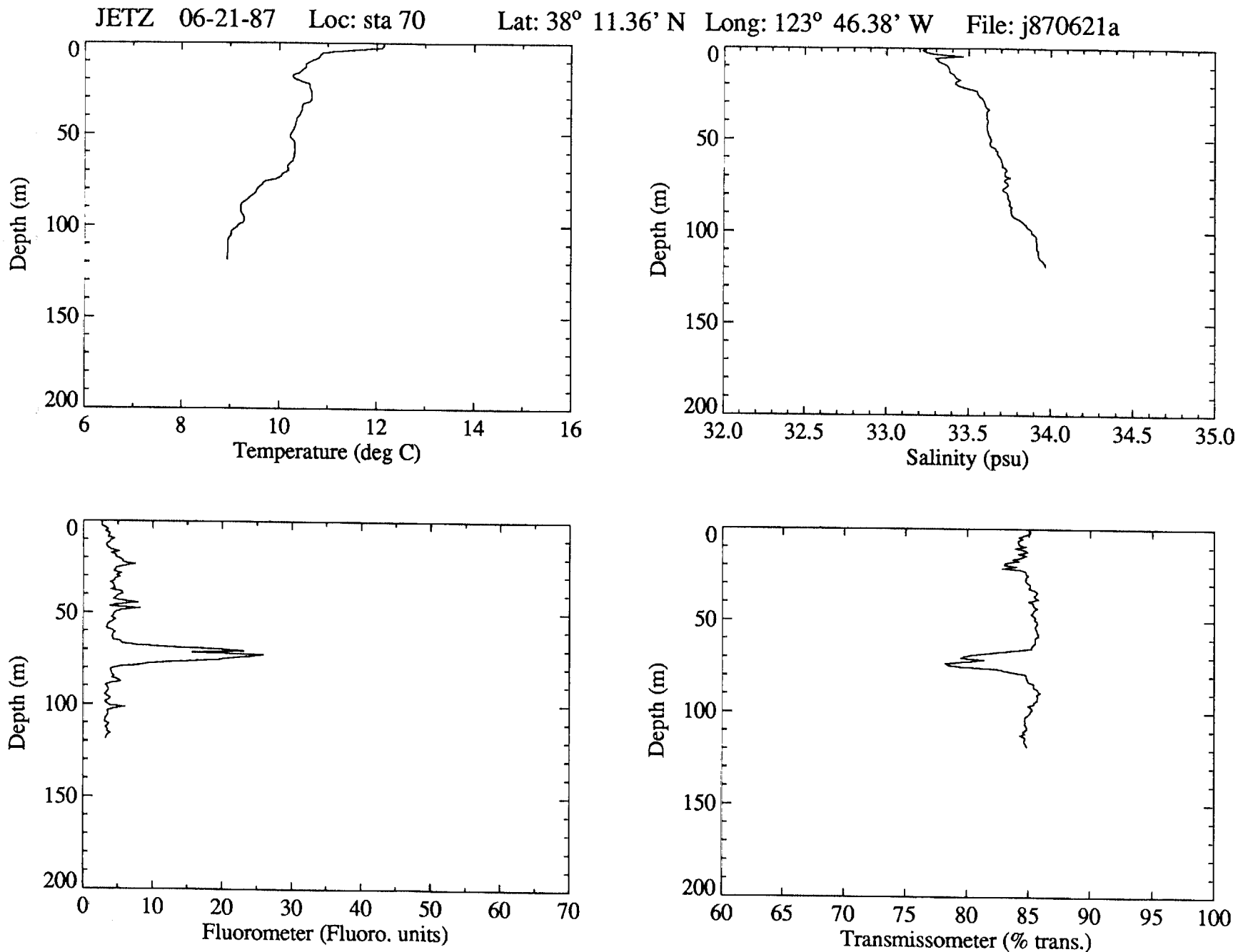

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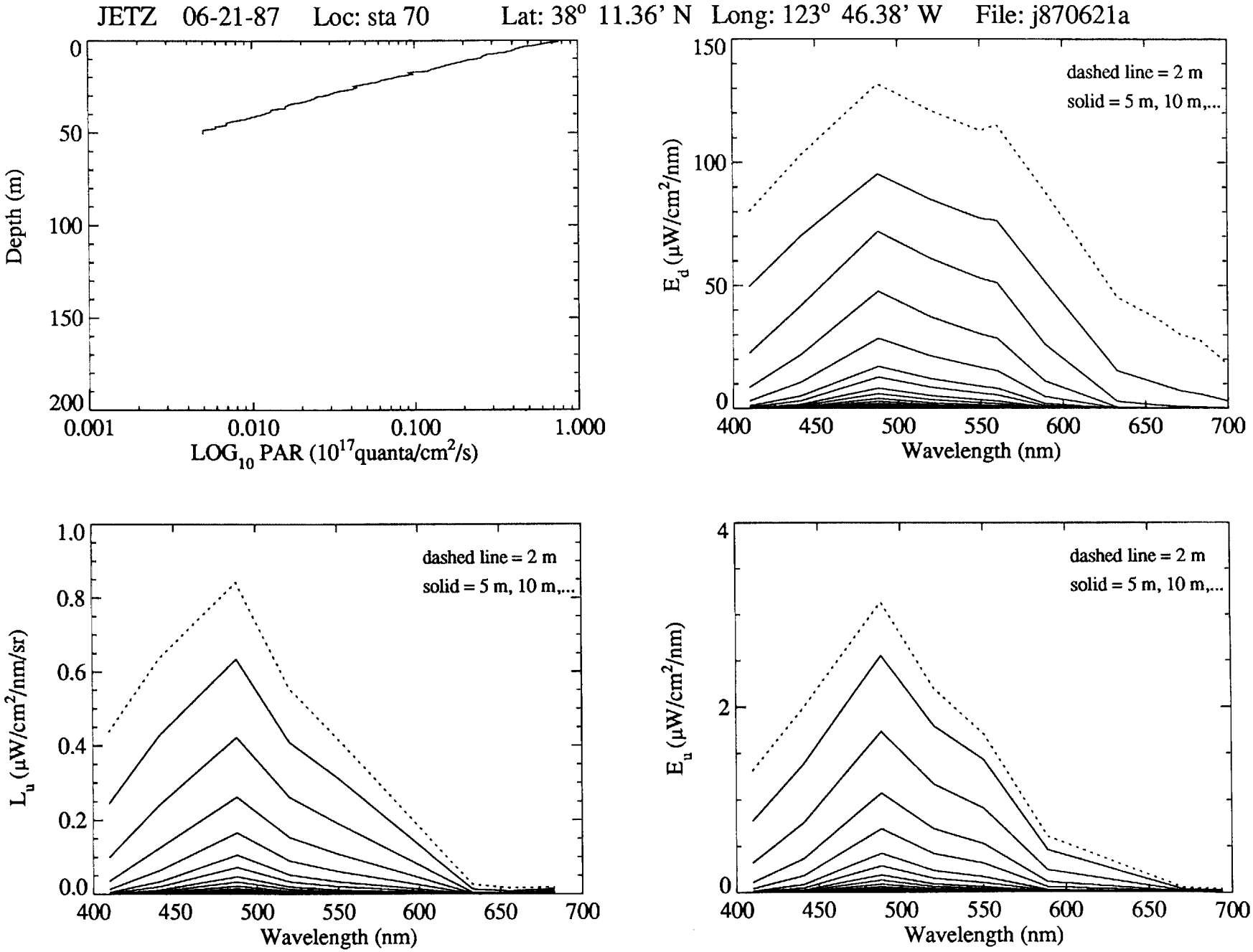

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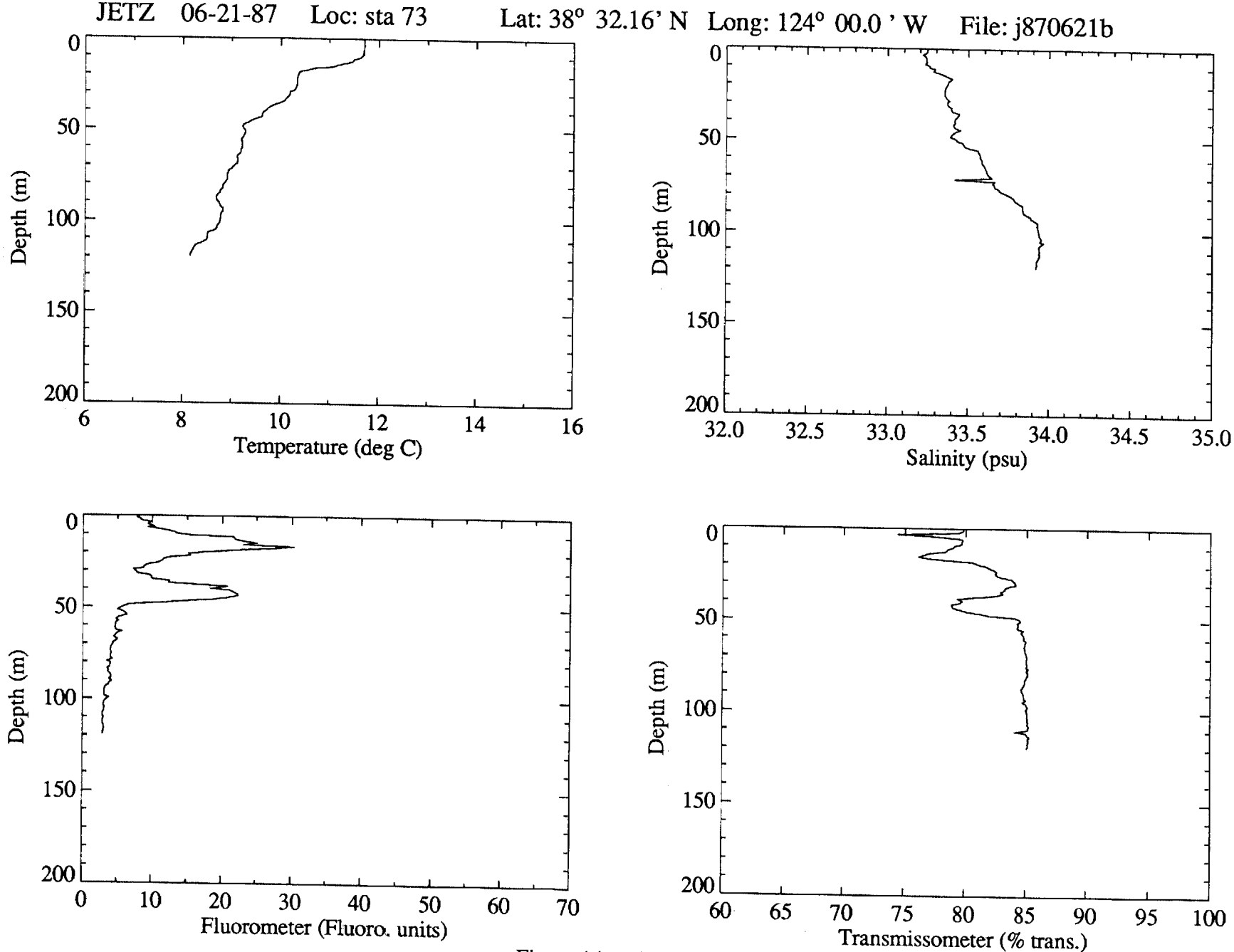

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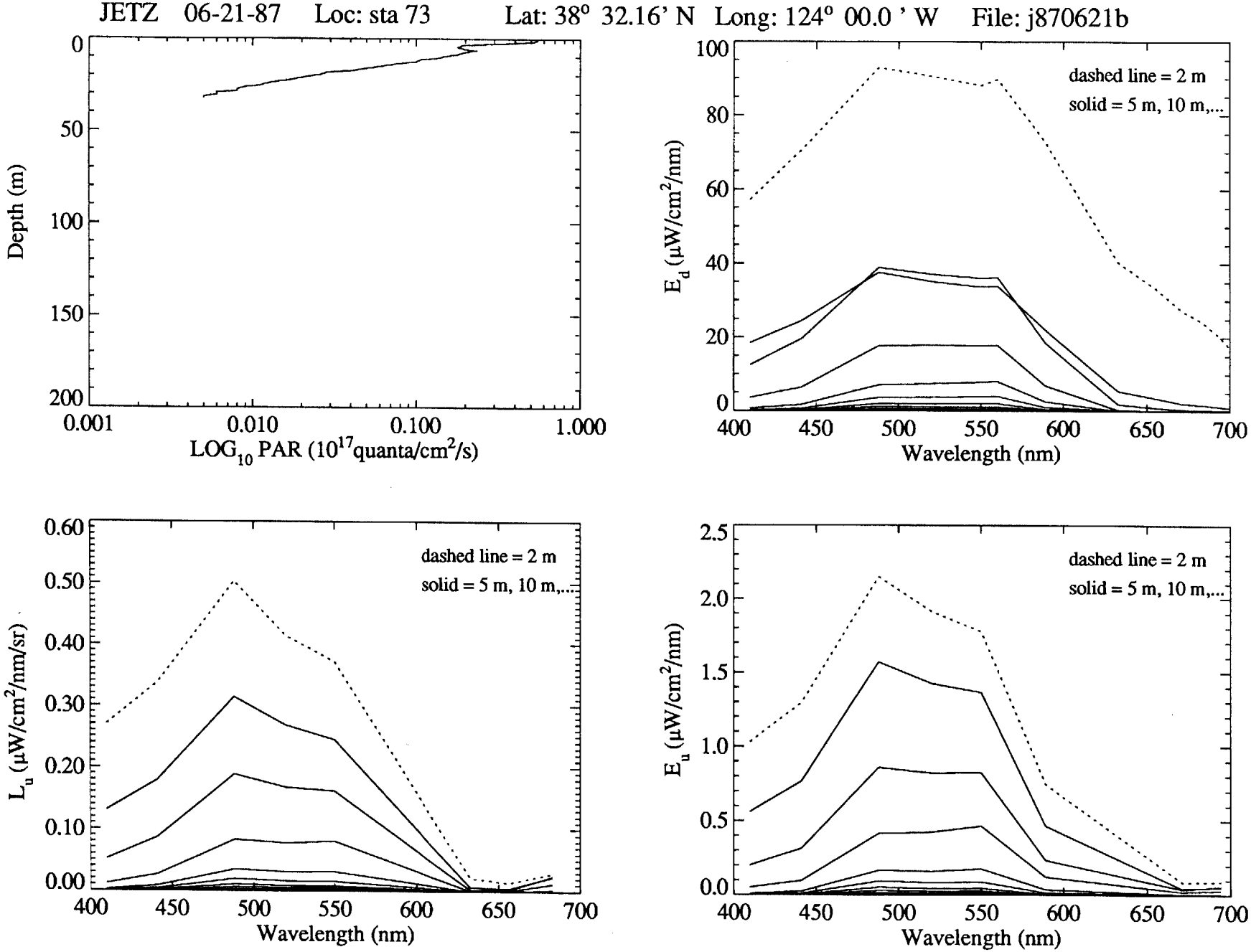

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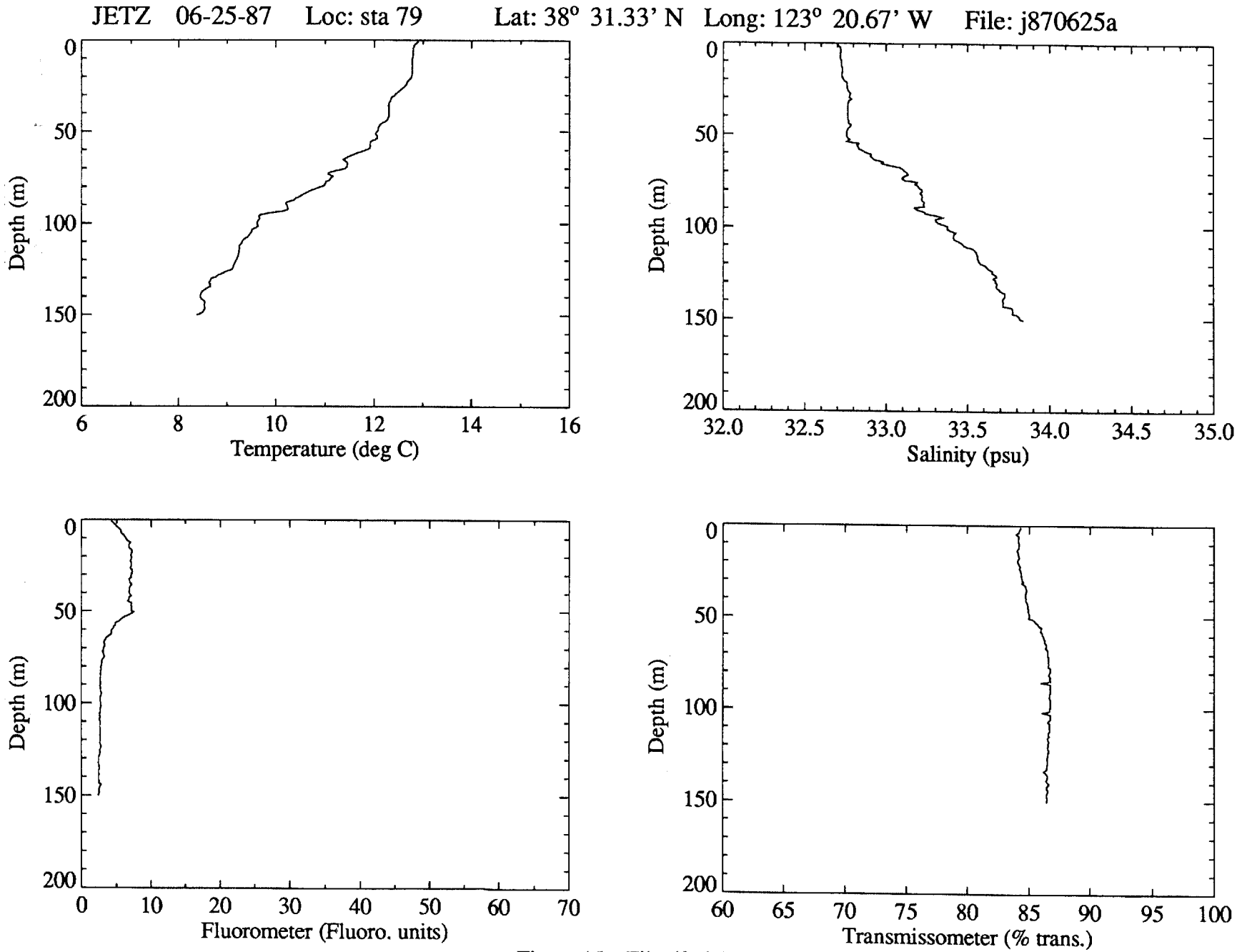

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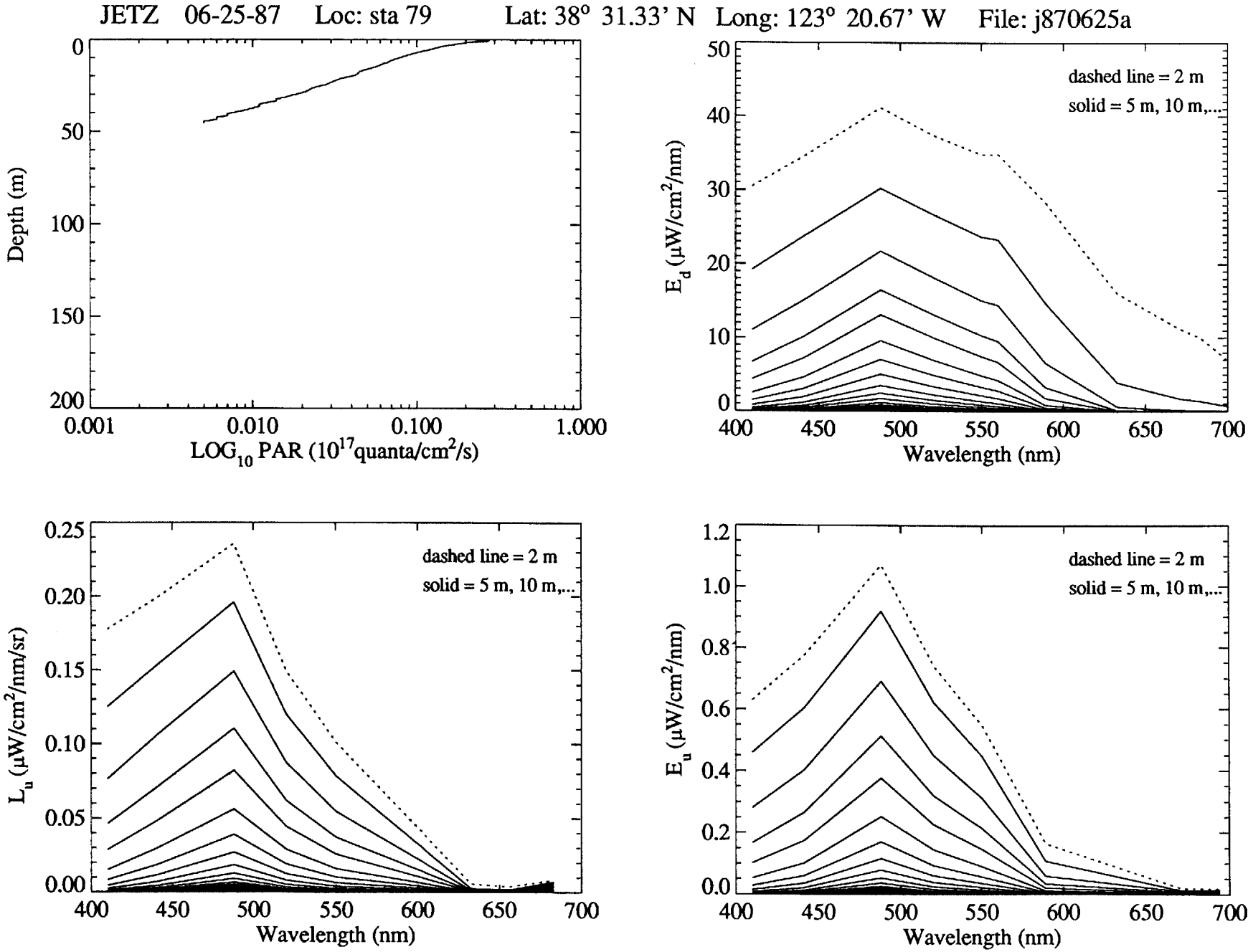

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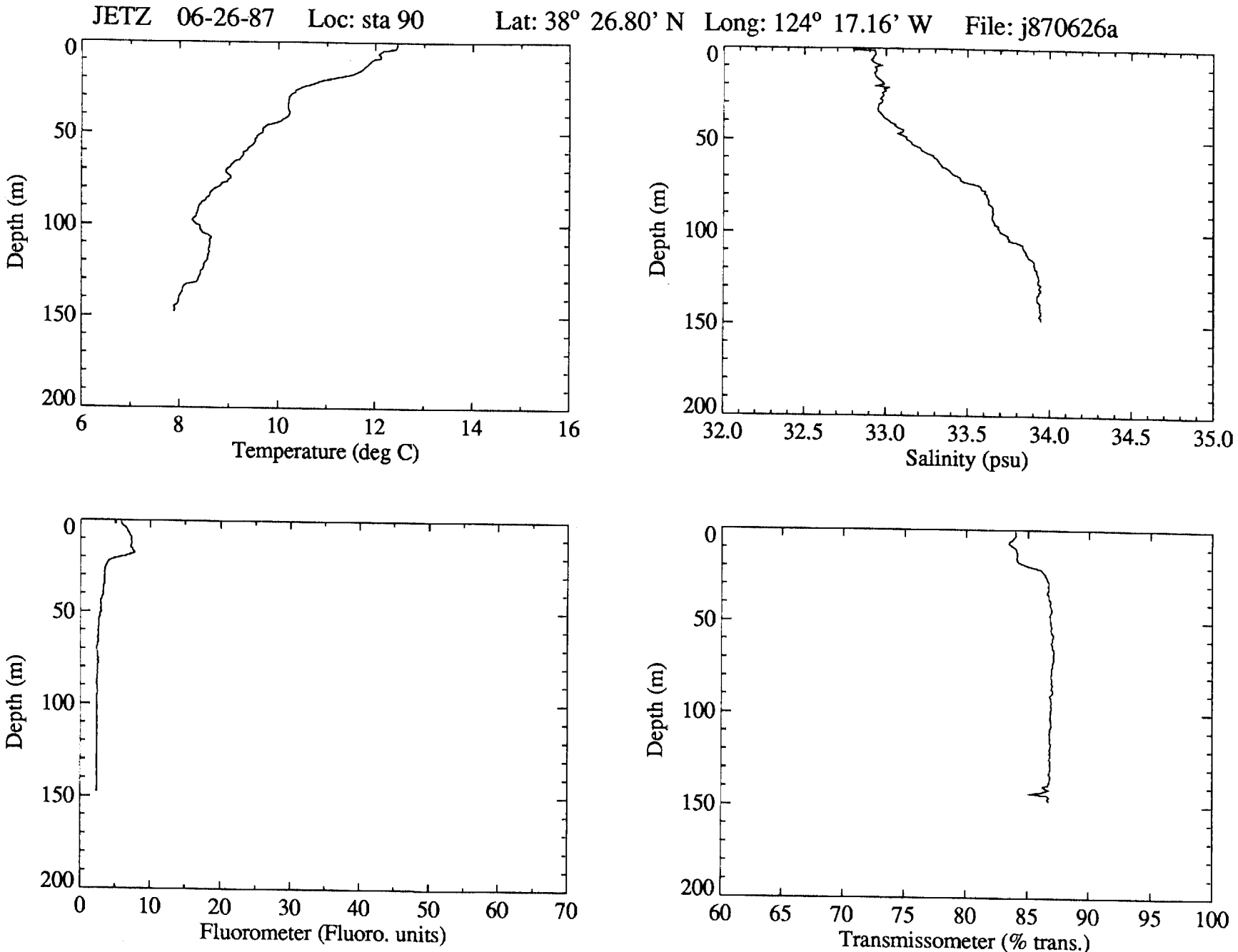

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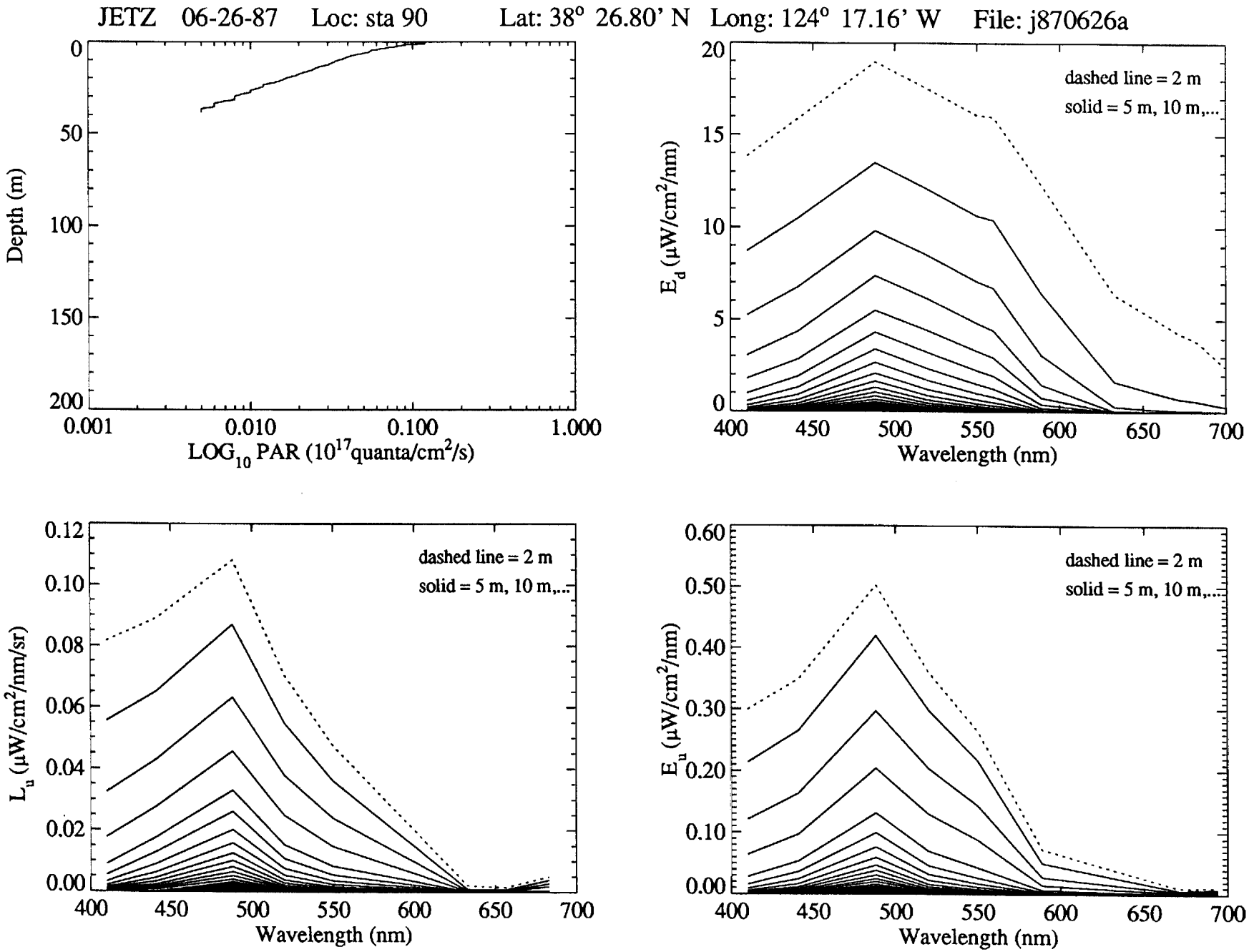

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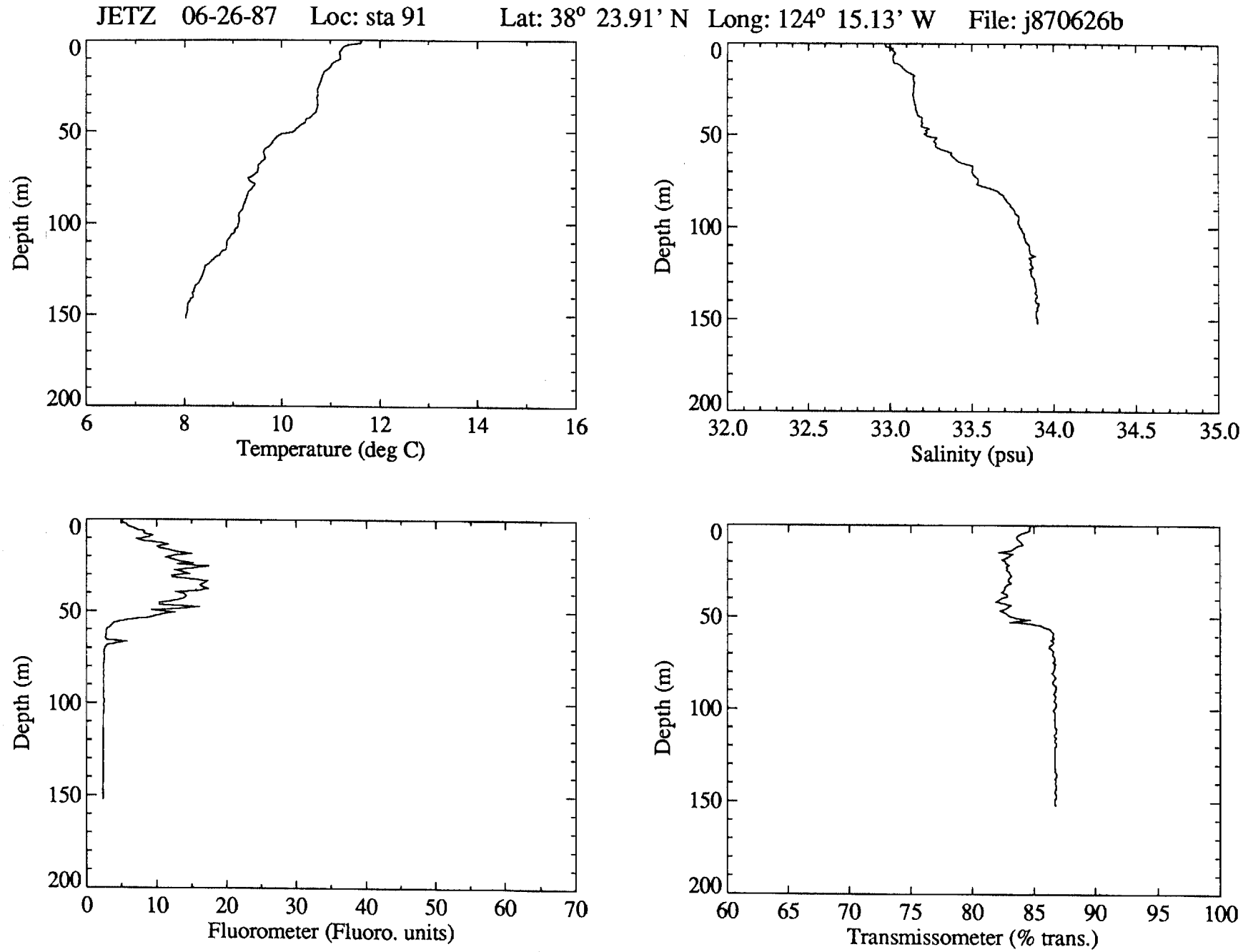

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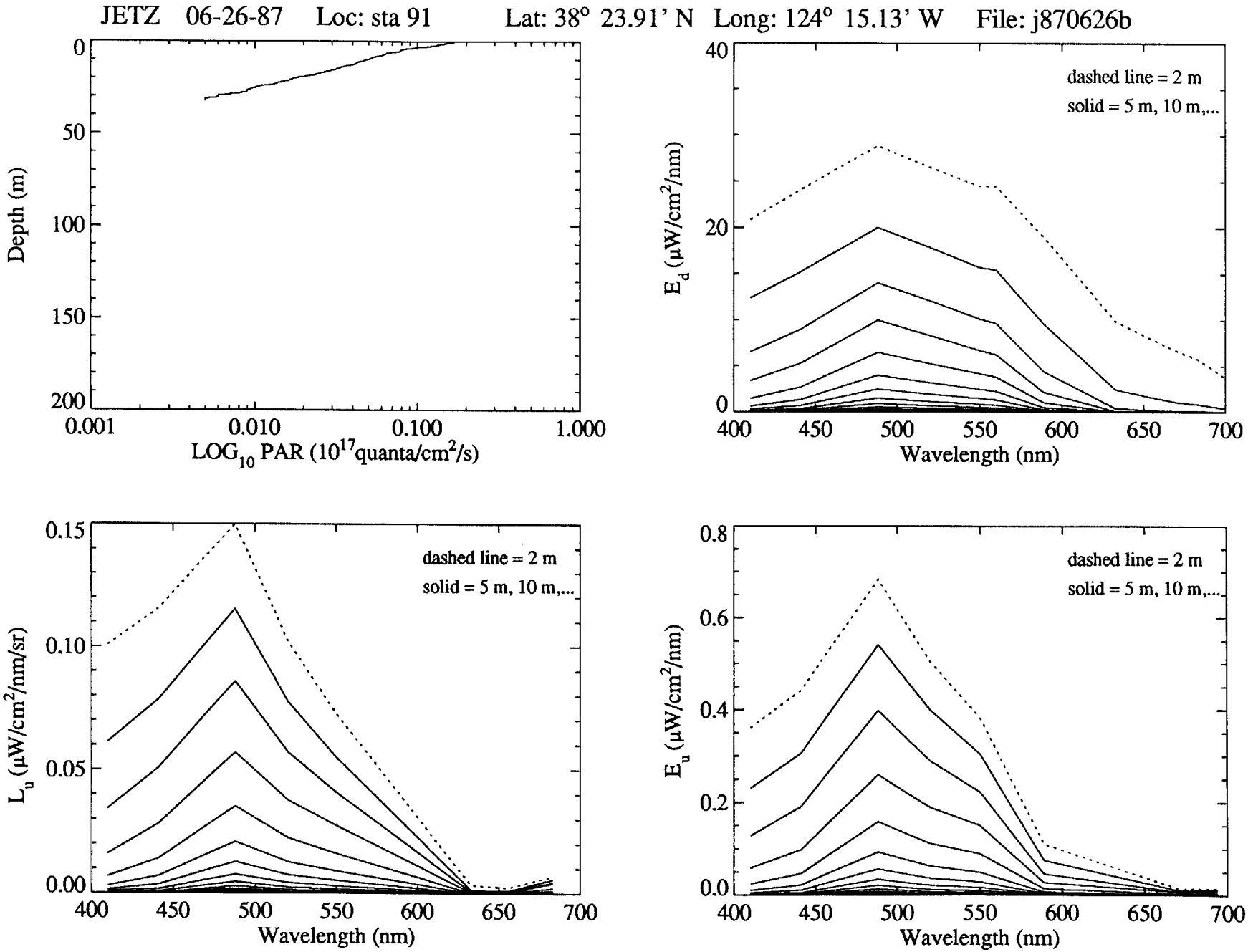

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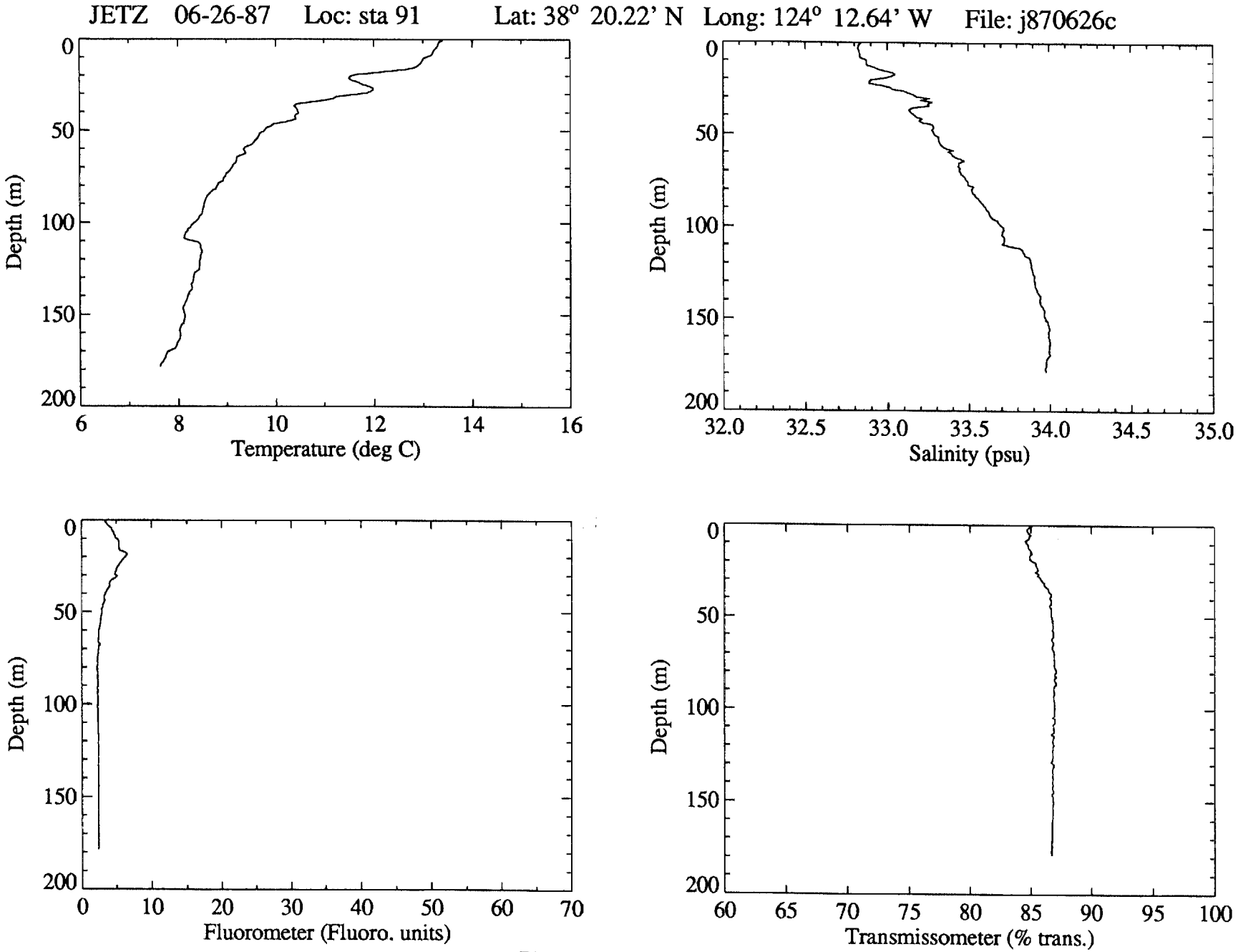

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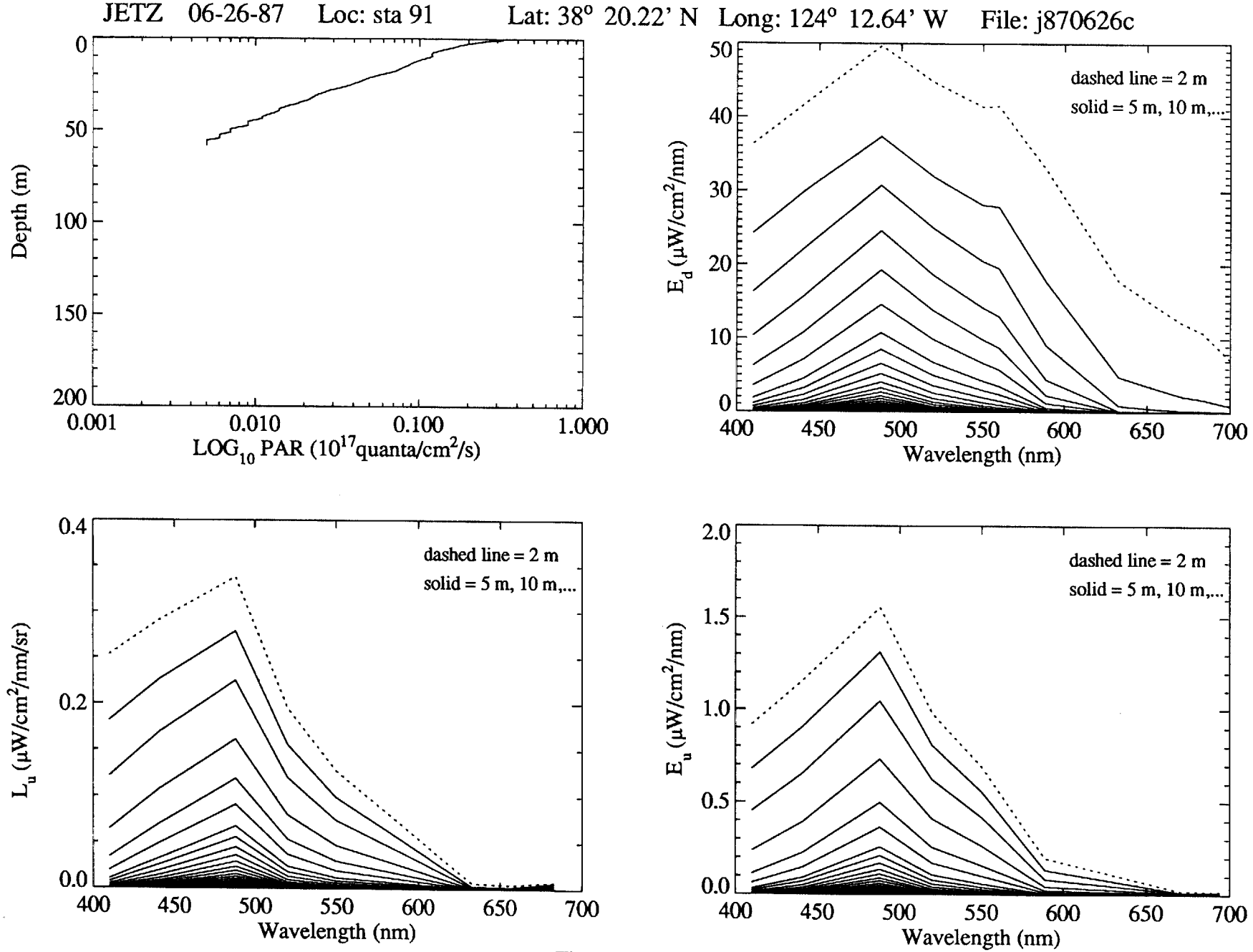

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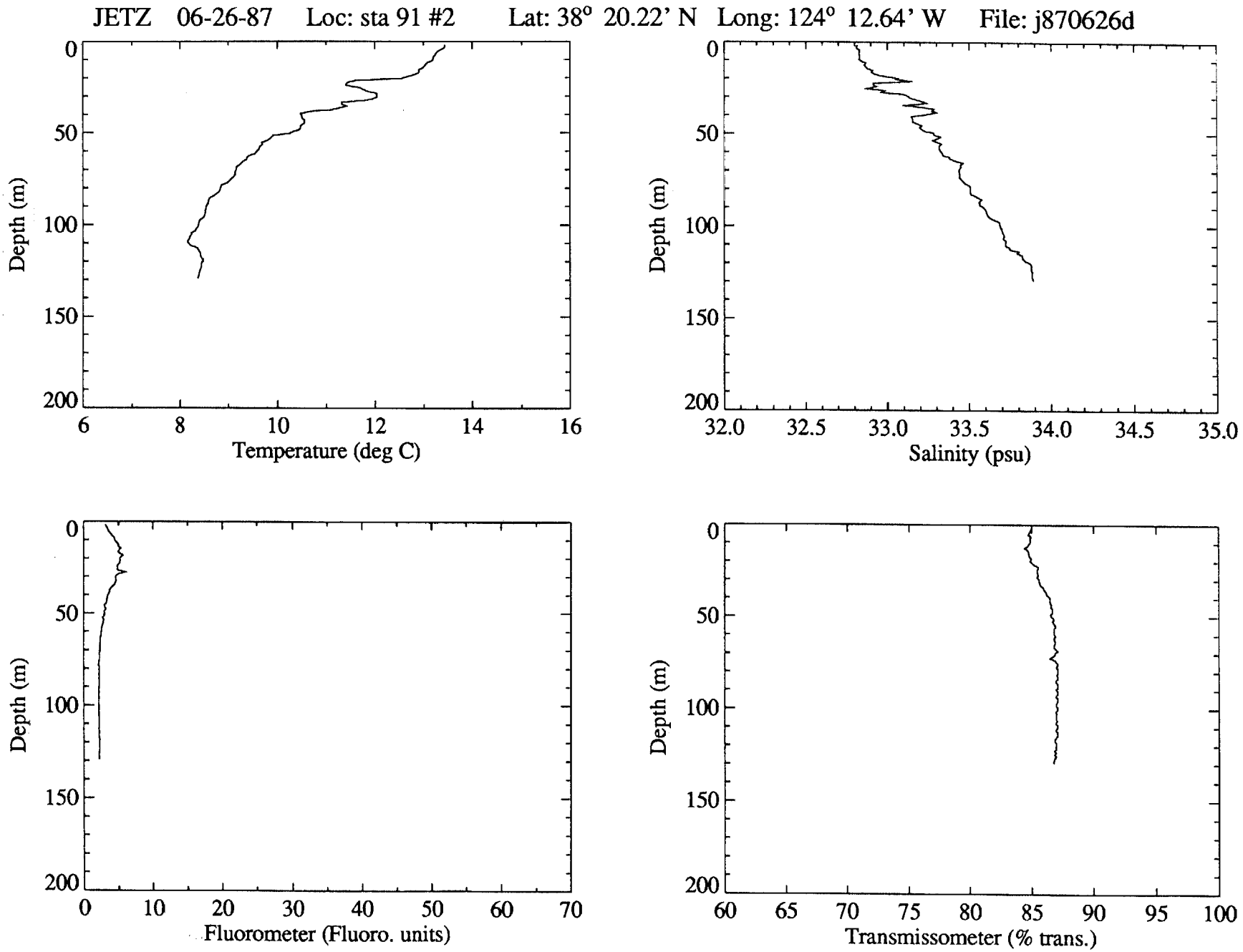

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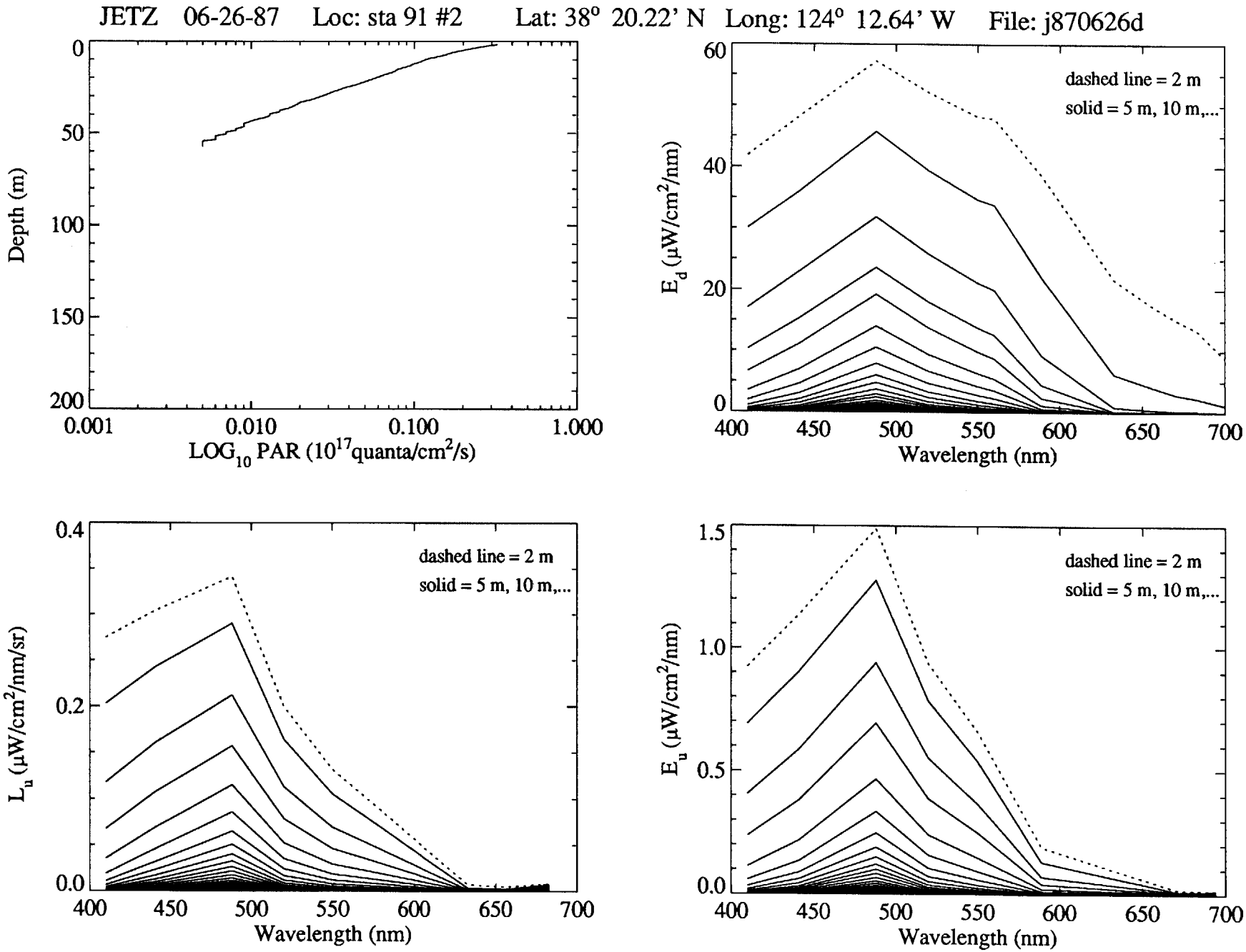

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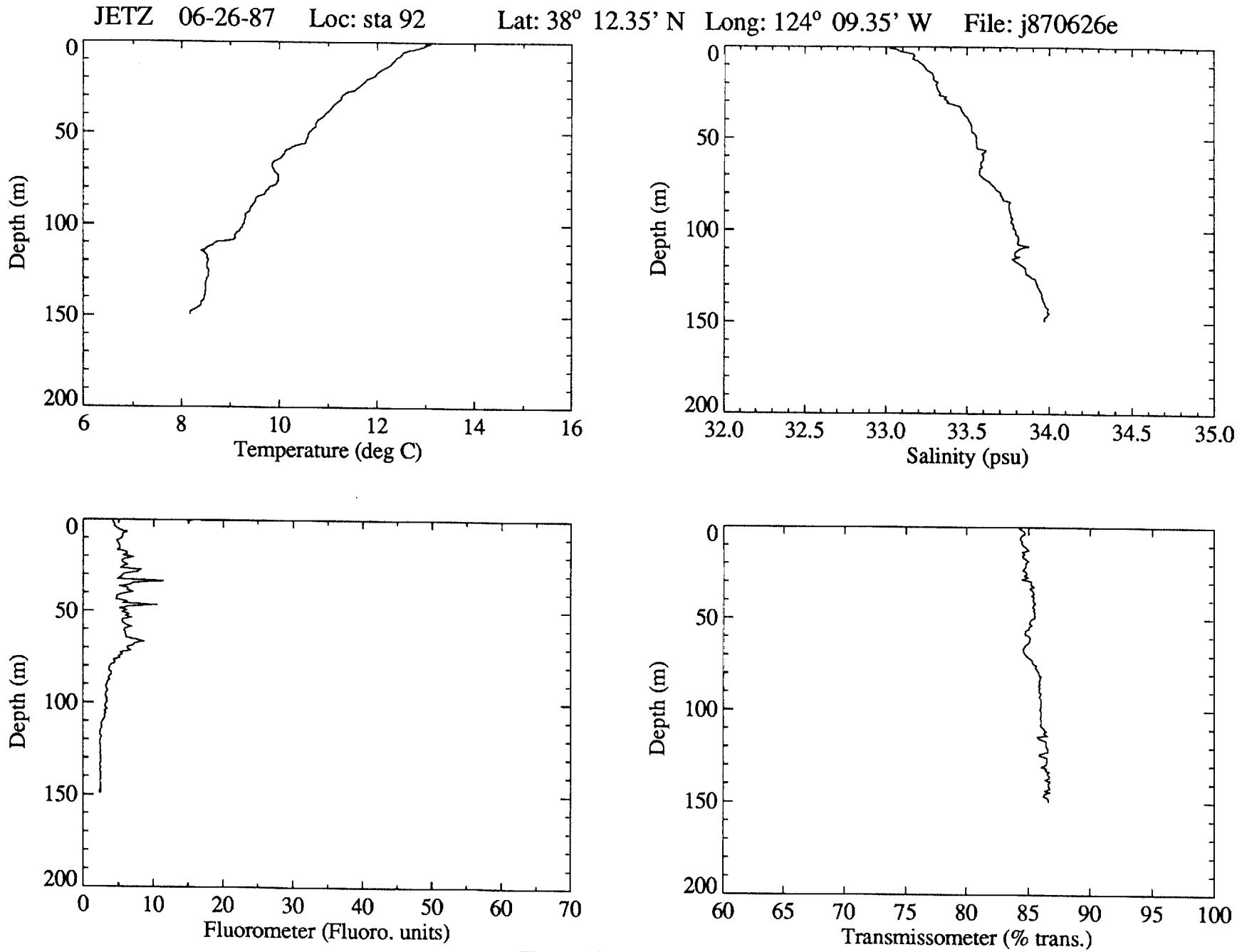

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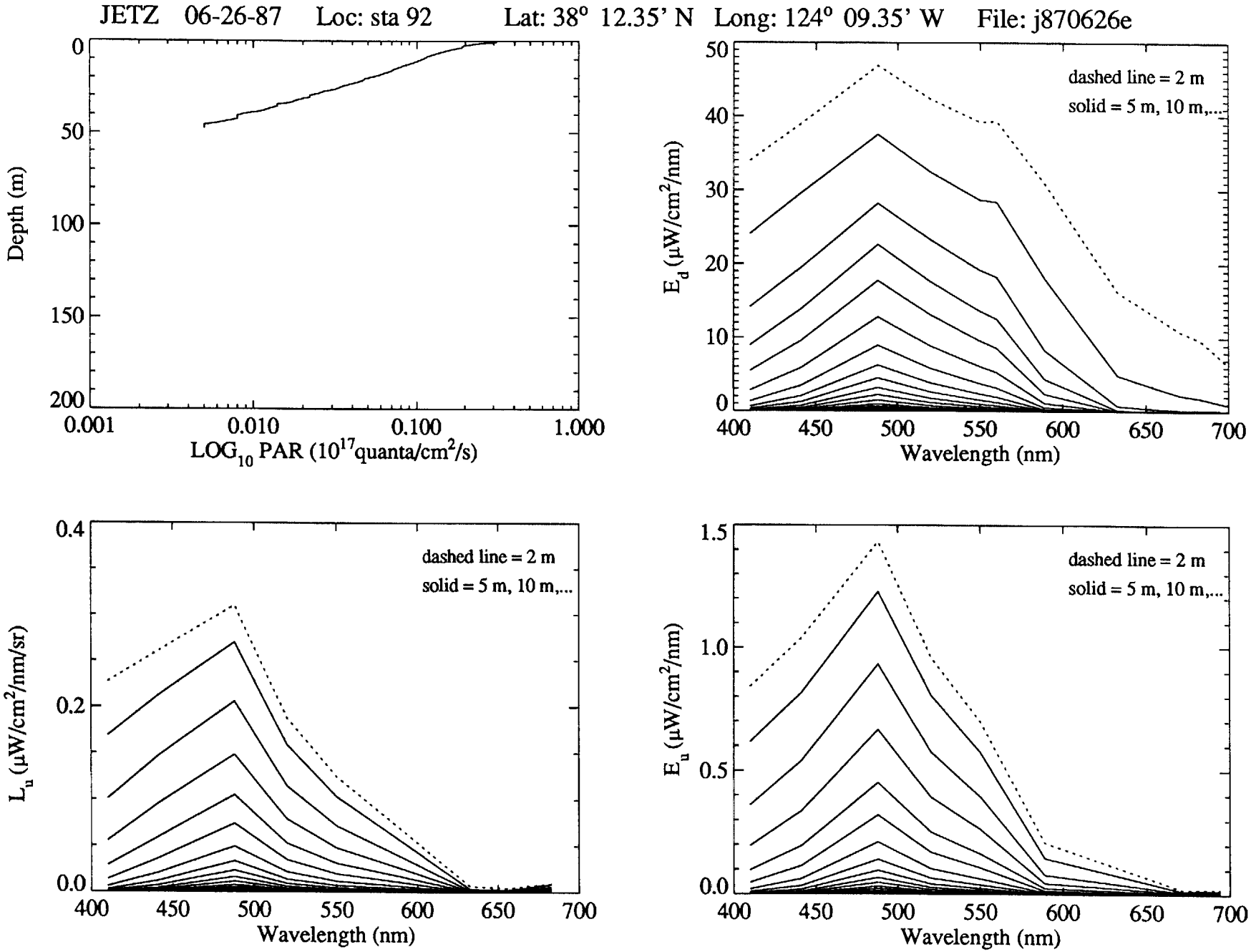

Figure 20. Continued

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15. Supplementary Notes

16. Abstract

Twenty vertical profiles of the bio-optical properties of the ocean were made during a research cruise on the R/V Point Sur, June 15-28, 1987, as part of the Coastal Transition Zone Program off Point Arena, California. Extracted chlorophyll values were also measured at some stations to provide calibration data for the in situ fluorometer. This report is a summary to provide investigators with an overview of the data collected. The entire data set is available in digital form for interested researchers, and requests for the data should be addressed to W. Joe Rhea, (818) 393-6095

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