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AIRCRAFT/ISLAND/SHIP/SATELLITE INTERCOMPARISON: PRELIMINARY RESULTS FROM JULY 16, 1987

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1. Introduction

The FIRE objective of validating and improving satellite algorithms for inferring cloud properties from satellite radiances was one of the central motivating factors in the design of the specific field experimental strategies used in the July, 1987 marine stratocumulus IFO. The *in situ* measuring platforms were deployed to take maximum advantage of redundant measurements (for intercomparison of the *in situ* sensors) and to provide optimal coverage within satellite images. One of the most ambitious of these strategies was the attempt to coordinate measurements from San Nicolas Island (NSI), the R/V *Pt. Sur*, the meteorological aircraft, and the satellites. For the most part, this attempt was frustrated by flight restrictions in the vicinity of NSI. The exception was the mission of July 16, 1987, which achieved remarkable success in the coordination of the platforms. This talk concerns operations conducted by the NCAR Electra and how data from the Electra can be integrated with and compared to data from the *Pt. Sur*, NSI and the satellites. The focus will be on the large-scale, integrated picture of the conditions on July 16 from the perspective of the Electra's flight operations.

2. Electra operations

The NCAR Electra departed NASNI at 1600Z on 16 July for a planned 5-hour mission in the vicinity of NSI. The flight plan involved a ferry to NSI, descent to 50 m and a 50 m turbulence leg toward the *Pt. Sur*, located approximately 50 km to the WNW (Fig. 1). This was to have been followed by other legs between NSI and the *Pt. Sur* and then a series of legs (nearly) perpendicular to this track. Because of dense clouds near NSI, and the possibility of a very low ceiling in the vicinity of NSI's

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terrain, the first leg toward the *Pt. Sur* was made at 4600 m for lidar mapping purposes. A descent was made at the *Pt. Sur's* location, the ship was located, and subsequent runs were made according to the original plan. Table I (adapted from the *Summary of Operations and Synoptic Conditions* [FIRE Technical Report No. 1] by Kloesel *et al.*) summarizes the various data legs of the mission; the start and end points refer to those on Fig. 1.

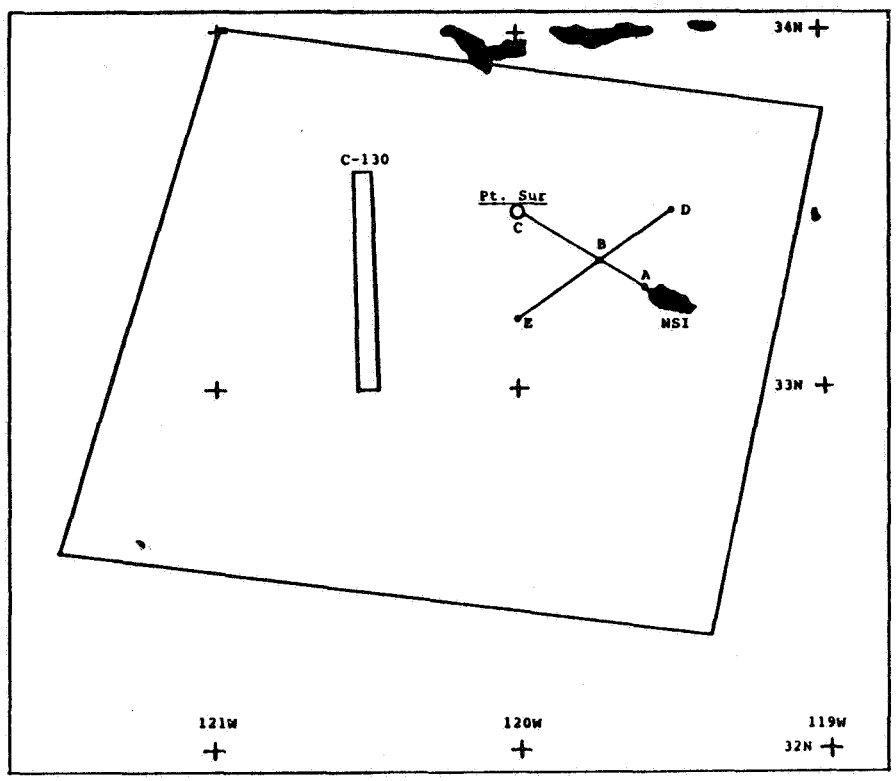

Fig. 1 FIRE-87 IFO, 16 July operations. Shown are the operations areas of the BMO C-130 and the NCAR Electra (among the labeled points). Also shown are the location of the *Pt. Sur* and the area of the LANDSAT scene taken at 1801Z.

The large box in Fig. 1 shows the location of the LANDSAT scene that was taken at 1800Z, when the Electra was in the latter stages of a LIDAR run at 1525 m, near point E. Also shown in Fig. 1 is the location of the operating area of the BMO C-130 during approximately the same time period. In Table 1, the "Porpoise" leg consisted of a sine-wave-like track in the vertical plane with an amplitude of about 150 m, through the cloud top. This was performed for the purpose of obtaining repeated measurements of the inversion strength.

NCAR ELECTRA FLIGHT SUMMARY
16 JULY 1987

Leg Type	Altitude (m)	Start Time (Z)	End Time (Z)	Track (Start-End)
LIDAR	1400	1625	1643	A-C
Sounding	1400-46	1643	1655	C-C
Turbulence	46	1655	1701	C-A
Sounding	Cloud	1704	1717	A-A
Turbulence	640	1717	1724	A-C
Sounding	Cloud	1724	1736	C-C
LIDAR	1370	1736	1741	C-A
LIDAR	1370	1746	1749	A-B
LIDAR	1370	1750	1753	B-D
LIDAR	1525	1756	1804	D-E
Porpoise	Cloud	1804	1817	E-D
Turbulence	610	1819	1829	D-E
Turbulence	490	1831	1840	E-D
Sounding	410-46	1840	1844	D-D
Turbulence	46	1844	1853	D-E
Turbulence	91	1855	1900	E-B
Sounding	91-1615	1900	1911	B-B
LIDAR	1585	1911	1914	B-C
Sounding	1585-46	1914	1922	C-C
Turbulence	91	1930	1940	C-A*
Sounding	91-1525	1943	1951	A-A

* *Pt. Sur* had departed; 8 minutes spent searching, spotting whales and tuna boats.

3. Other data sets

NSI operations

Operations at NSI consisted of two flights of the NRL balloon, five rawinsondes (two of which, at 1600 and 1004Z, are directly relevant to the Electra operations), and the continuous operation of the PSU acoustic and microwave systems, the ERL microwave radiometer, the NPS tower system and the CSU ground station.

Pt. Sur *operations*

The *Pt. Sur* was on station at C until approximately 1900Z. Turbulence measurements were made at the 10-m level, and several radiosondes were released during the time that the Electra was in the vicinity.

Remote sensing

In addition to the LANDSAT image mentioned above (the coverage of which is indicated in Fig. 1), the NASA ER-2 flew over the operations area early in the Electra's mission. GOES data, of course, is available nearly continuously. There was a NOAA-10 overpass at 1648Z.

Synoptic conditions

The ideal scenario for this mission would have been well-established northwesterly flow; in this case, the soundings made from the *Pt. Sur* and NSI would have provided an indication of the advective terms in the thermodynamic and dynamic budgets. However, the winds were relatively light, although generally in the appropriate direction. The cloud structure was quite complex, with multiple layers and breaks during some of the flight legs. Early in the Electra's mision, precipitation was observed.

4. Discussion

The amount of data available for this multiple-platform comparison is daunting, and combining the various data sets into a single coherent picture may not be possible. However, various subsets will lend themselves to valuable intercomparison studies, of relevance both to the FIRE objectives as well as to other scientific issues concerned more with details of stratocumulus convection than satellite validation.

An example of the former includes comparisons of the cloud physics data from the PMS probes obtained during the in-cloud legs with the LIDAR data obtained along the same track (albeit earlier); both of these can be compared to the TMS data from the ER-2 and to the LANDSAT data. The vertical profiles of liquid water obtained by the NRL balloon can be compared to the time series of total integrated liquid water from the ERL microwave radiometer; these, in turn provide the downstream anchor of the Electra's operations area and the Electra data can be used to infer the cloud microphysical properties of the air passingover the Island. Combining the ascents from the *Pt. Sur* and NSI will allow a cross section to be constructed (which the Electra data can fill in) that can be compared to the continuous time series obtained by the acoustic sounder and the profiles on the Island.

Various aspects of these intercomparisons will be discussed in the talk.

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