NEW TECHNOLOGY REPORT

Radiant Power Measuring Instrument (RPMI)

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FOREWORD

The Radiant Power Measuring Instrument (RPMI) reported here was developed to support an 'Investigation of Techniques for Correcting ERTS Data for Solar and Atmosphere Effects', Bendix ERTS data user Contract NAS 5-21863 (MMC #655). The RPMI is used for ERTS ground truth.

1. Title: Radiant Power Measuring Instrument (RPMI)

2. Brief Description: The Radiant Power Measuring Instrument (RPMI) provides an ERTS investigator with a capability of obtaining radiometric measurements needed to determine solar and atmospheric parameters that affect the ERTS radiance measurements. With these parameters, ERTS data can be transformed into absolute target reflectance signatures, making accurate unambiguous interpretations possible.

3. Detailed Description: The RPMI is a rugged, hand-carried instrument accurately calibrated to measure both downwelling and reflected radiance within each ERTS multispectral scanner (MSS) band. A foldover handle permits a quick change from wide angle global or sky irradiance measurements to narrow angle radiance measurements from sky and ground targets. These measurements yield ground truth site reflectance and permit calculation of additional parameters such as beam transmittance between spacecraft and ground, and path radiance (path reflectance).

Summary of Characteristics

- Spectral Bands: All measurements made in ERTS MSS bands (0.5 to 0.6 micron (μ); 0.6 to 0.7μ; 0.7 to 0.8μ; and 0.8 to 1.1μ). Bands formed by bandpass filter in switched turret followed by silicon detector.

- Field of View: Two modes

  1. 2π steradian field of view through removable diffuser.
  2. Handle permits 6.0° circular field of view for sky and earth measurements.

- Sensitivity (Measurement Ranges):

  10 range scales permit irradiance measurements from 0.01 to 300.0 watts/meter^2 and radiance measurements from 0.01 to 300 watts/(meter^2 · steradian).

- Calibration Accuracy:

  1. An absolute accuracy of ±5% is maintained over the field operating ranges for a period of over 1 year.
  2. Relative (band to band) accuracy is ± 2.0%.
  3. Repeatability ± 0.5%.

- Frequency Response:

  0 to 1.0 Hz on meter.
  0 to 20 Hz at BNC output.

- Controls: Irradiance/Radiance, Range (10 positions), Band Select (6 positions include the 4 ERTS MSS bands, and a closed and an open position), Meter Zero, Battery Test, and ON/OFF Switch.

- Meter: 3 1/2-inch taut band 1.0% hand calibrated, mirrored scale; scaled 0 to 1.0 and 0 to 3.0 with 50 and 60 divisions, respectively.

- Power Source: 9.0-volt batteries; battery life while operating — 50 to 100 hours.

- Environmental Specifications:

  1. Sealed against dust and humidity to 100%.
  2. Shock and vibration expected in field and aircraft environments.
  3. Storage -55°C to +80°C.
  4. Operational -20°C to +70°C.

- Size: 4 x 7 x 8 in. (10 x 18 x 20 cm).

- Weight: 5.8 pounds (2.6 kg) with batteries.

Measurement Modes

Global Irradiance (H) - 2π steradian field of view for measuring downwelling (incident) radiation in bands identical to ERTS MSS.

Sky Irradiance (H_{SKY}) - Global Irradiance minus direct sun component, in every ERTS MSS band. Angle from zenith to sun is also measured in this mode.

Radiance from Narrow Solid Angles of Sky - Handle serving as field stop permits direct measurements through a 6.0° circular field of view. This mode is also used to measure direct beam solar irradiance.

Reflected Radiation - Used with small calibration panels, cards, to obtain direct measurement of truth site reflectance. Same field of view as above.

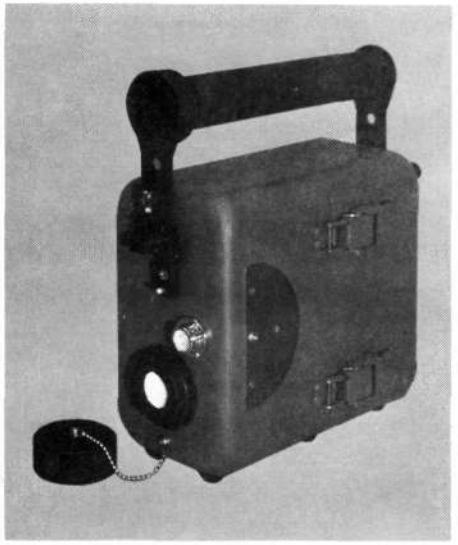
Packaging (See pictures on following page)

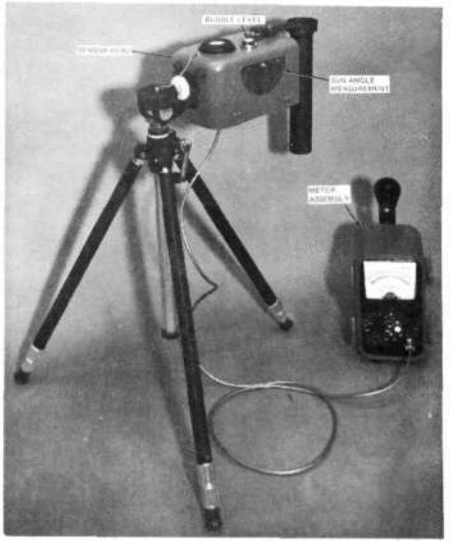
- Handle joins sensor head and meter assembly to form compact unit.
- Sensor head, containing filter wheel and silicon detector, is separated from meter assembly by 6 ft of shielded cable. Sensor head is threaded with standard tripod mounting (1/4-20 tapped hole) to facilitate pointing at sky and ground.
- Bubble level and sun angle measuring device are integral parts of sensor head.
- Foldover handle attached to sensor head permits immediate change from the wide 2π steradian field of view to a narrow one.
- Separate meter assembly facilitates accurate meter reading and permits remote monitoring.

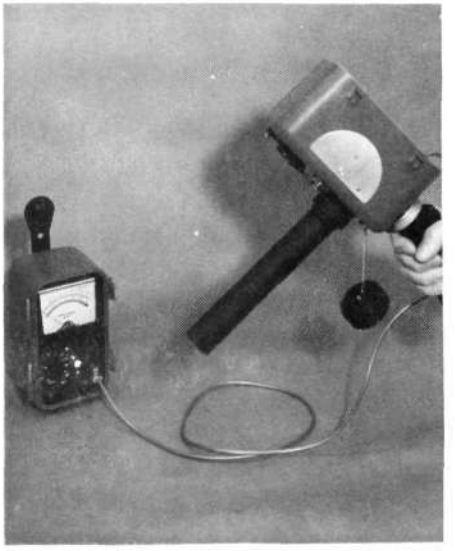
Options

- Filter to match ERTS RBV bands, EREP experiments, etc.
- Circular field of view from 1.0 to 6.0°.

ERTS - Radiant Power Measuring Instrument







4. Applications and Benefits: Measurements made by this instrument permit ERTS MSS data to be transformed into absolute target reflectance signatures, making accurate unambiguous interpretations possible.

   1) Standardization. The measurement and recording of atmospheric parameters with this instrument or ones of equivalent performance are essential if the observations and reports of large numbers of PIs are to be correlated and compared by NASA and other PIs in a meaningful way.

   2) Manual Image Interpretation. Using RPMIs to measure reflectance of test sites directly and/or measuring atmospheric parameters and transforming ERTS data to reflectance units would improve interpretation of ERTS imagery. This instrument will permit the PIs who have knowledge of and have compiled catalogs of spectral reflectance of targets pertinent to their studies to extend the use of this information to ERTS imagery.

   3) Recognization Techniques. RPMI measurements would be used to remove spectral variations due to atmospheric effects from data prior to processing. The benefits in this case includes reduced number of training sites needed and the frequency sites need to be selected to achieve a given level of classification performance by computer procedures.

5. Possible Extensions: The instrument could be modified by changing filters and be used for providing ground truth for ERTS RBV, EREP experiments, etc.

6. Degree of Development: Five instruments were completed during the 1 October through 1 December time period.

7. Technological Significance: In relationship to instruments now being used by most PIs this is a major improvement.

8. Innovator: Robert H. Rogers

9. Publication: The instrument was reported as 'significant results' in Bi-Monthly Progress report for period 1 October to 1 December 1972, for ERTS-Atmospheric Experiment, MMC #655.