Indian Satellites for Meteorological Observations

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Satellite Meteorology branch of IMD really started in 1982 with the launch of INSAT-1A which was a multipurpose satellite meant for services to Meteorology, Doordarshan and Communication. Before that Indian meteorologists were using analog imageries received from U.S. Polar orbiting satellites series of TIROS-N.

Many satellites for meteorological purposes were launched after the launch of INSAT-1A as given below:

- **INSAT-1A** – 10 April 1982  
- **INSAT-1B** – 30 Aug., 1983  
- **INSAT-1C** – 21 July 1988  
- **INSAT-1D** – 12 June, 1990  
- **INSAT-2A** – 10 July, 1992  
- **INSAT-2B** – 23 July, 1993  
- **INSAT-2E** – 03 April 1999  
- **KALPANA-1** – 12 Sept. 2002  
- **INSAT-3A** – 10 April 2003

<table>
<thead>
<tr>
<th>Two Channel VHRR</th>
<th>Three Channel VHRR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INSAT-1A</strong> – 10 April 1982</td>
<td><strong>KALPANA-1</strong> – 12 Sept. 2002</td>
</tr>
<tr>
<td><strong>INSAT-1B</strong> – 30 Aug., 1983</td>
<td><strong>INSAT-3A</strong> – 10 April 2003</td>
</tr>
</tbody>
</table>
Current Indian Geostationary Meteorological Satellites

Kalpana-1

INSAT-3D:2013

INSAT-3A
The GEO Imaging Satellite (GISAT) will carry a GEO Imager with multi-spectral (visible, near infra-red and thermal), multi-resolution (50m to 1.5 km) imaging instruments.
INSAT - 3D: Main sensors

6 Channel IMAGER

- Spectral Bands (μm)
  
  - Visible: 0.55 - 0.75
  - Short Wave Infra Red: 1.55 - 1.70
  - Mid Wave Infra Red: 3.80 - 4.00
  - Water Vapour: 6.50 - 7.10
  - Thermal Infra Red – 1: 10.30 - 11.30
  - Thermal Infra Red – 2: 11.50 - 12.50

- Resolution
  
  - 1 km for VIS, SWIR
  - 4 km for MIR, TIR
  - 8 km for WV

19 Channel SOUNDER

- Spectral Bands (μm)
  
  - Short Wave Infra Red: Six bands
  - Mid Wave Infra Red: Five Bands
  - Long Wave Infra Red: Seven Bands
  - Visible: One Band

- Resolution (km)
  
  - 10 x 10 all bands

- No of simultaneous sounding per band
  
  - Four

Launch: July-2013

Location: 82° E
NINETEEN CHANNEL ATMOSPHERIC SOUNDER
with a resolution of 10 km at Sub-Satellite

<table>
<thead>
<tr>
<th>Channel No.</th>
<th>Central Wavelength (in μm)</th>
<th>Principal absorbing constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.71</td>
<td>CO₂ – band</td>
</tr>
<tr>
<td>2</td>
<td>14.37</td>
<td>CO₂ – band</td>
</tr>
<tr>
<td>3</td>
<td>14.06</td>
<td>CO₂ – band</td>
</tr>
<tr>
<td>4</td>
<td>13.64</td>
<td>CO₂ – band</td>
</tr>
<tr>
<td>5</td>
<td>13.37</td>
<td>CO₂ – band</td>
</tr>
<tr>
<td>6</td>
<td>12.66</td>
<td>water vapor</td>
</tr>
<tr>
<td>7</td>
<td>12.02</td>
<td>water vapor</td>
</tr>
<tr>
<td>8</td>
<td>11.03</td>
<td>window</td>
</tr>
<tr>
<td>9</td>
<td>9.71</td>
<td>ozone</td>
</tr>
<tr>
<td>10</td>
<td>7.43</td>
<td>water vapor</td>
</tr>
<tr>
<td>11</td>
<td>7.02</td>
<td>water vapor</td>
</tr>
<tr>
<td>12</td>
<td>6.51</td>
<td>water vapor</td>
</tr>
<tr>
<td>13</td>
<td>4.57</td>
<td>N₂O</td>
</tr>
<tr>
<td>14</td>
<td>4.52</td>
<td>N₂O</td>
</tr>
<tr>
<td>15</td>
<td>4.45</td>
<td>CO₂</td>
</tr>
<tr>
<td>16</td>
<td>4.13</td>
<td>CO₂</td>
</tr>
<tr>
<td>17</td>
<td>3.98</td>
<td>window</td>
</tr>
<tr>
<td>18</td>
<td>3.74</td>
<td>window</td>
</tr>
<tr>
<td>19</td>
<td>0.69</td>
<td>vis</td>
</tr>
</tbody>
</table>

Only Sounder in Geostationary orbit, after GOES

- Temperature and humidity profile
- Total Ozone and Ozone profile
- Derived products

Scan time: A: 6 x 5 = 30 Frames x 1.8 min = 54 min
  B: 4 x 7 = 28 Frames x 1.8 min = 51 min

- This sounding repeated every hour over land (A)
- Every 6th hour sounding over Ocean (B)
- Best suited for nowcasting over land and NWP
Oceansat-II

- **Instruments:**
  - Scatterometer Ku band
  - Ocean Color Monitor (8 bands 0.4-0.885 μm)
  - Radio Occultation ROSA
- **Launched**
  - 23 September 2009
- **Applications:**
  - Sea State Forecast: Waves, Circulation and MLD
  - Monsoon and Cyclone Forecast
  - Antarctic Sea Ice
  - Fisheries and Primary productivity estimation
  - Monitoring of Phytoplankton blooms
  - Sediment dynamics

<table>
<thead>
<tr>
<th>Scatterometer Specifications</th>
<th>Inner Beam</th>
<th>Outer Beam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>720 km</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>13.515 GHz</td>
<td></td>
</tr>
<tr>
<td>PRF</td>
<td>200 Hz</td>
<td></td>
</tr>
<tr>
<td>Wind speed range</td>
<td>4 to 24 m/sec</td>
<td></td>
</tr>
<tr>
<td>Wind speed accuracy</td>
<td>Better than 20% (rms)</td>
<td></td>
</tr>
<tr>
<td>Wind direction accuracy</td>
<td>20° (rms)</td>
<td></td>
</tr>
<tr>
<td>Polarization</td>
<td>HH</td>
<td>VV</td>
</tr>
<tr>
<td>Swath</td>
<td>1400 km</td>
<td>1840 km</td>
</tr>
<tr>
<td>Elevation angle</td>
<td>42.62°</td>
<td>49.38°</td>
</tr>
<tr>
<td>Incidence angle</td>
<td>48.90°</td>
<td>57.60°</td>
</tr>
<tr>
<td>Footprint</td>
<td>26 x 46 km</td>
<td>31 x 65 km</td>
</tr>
<tr>
<td>Scanning rate</td>
<td>20.5 rpm</td>
<td></td>
</tr>
</tbody>
</table>

Scatterometer Observational Geometry

Sub-satellite track
Oceansat-2 Scatterometer winds overlaid on KALPANA Image

Altika Mission: Belongs to the global altimetry system for the precise and accurate observations of ocean topography, circulation and sea surface monitoring with same accuracy as ENVISAT and complementary to the JASON-2 mission. Launched in Feb, 2013 by PSLV C-20.

Altika Payload:

- A Ka-band (35.75 GHz, BW 500 MHz) radar altimeter
- A dual-frequency MW radiometer (23.8 and 37 GHz), for tropospheric range correction
- DORIS: For achieving adequate orbitography performances
- LRA: For Orbitography and system calibration

Altika/SARAL central objective:

- Ocean meso-scale variability: Sea state Monitoring & Now Casting
- Data assimilation: Sea state forecasting
- Coastal altimetry: (Bathymetry, coastal upwelling & circulations etc.)

Other Objectives:

- Operational oceanography
- Continental waters
- Inland ice sheet monitoring
- Light rainfall and clouds climatology
- Climate Change: Mean sea level
- Geodetic reference system determination
- Geophysical and geological investigations

**Satellite Description:**
- Sun-synchronous, polar orbiting, inclination: 98.38 Deg.
- Altitude: ~800 km,
- Repeat cycle: 35 days
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Thanks