a multidisciplinary remote sensing research group. The CrIS-VIIRS collocation and evaluation in the report include the collocated radiance validation, problems and algorithms adjustment.

**CrIS-VIIRS Integration, Product and Evaluation**

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**SUMMARY:***
An operational processing system has been developed in NESDIS to collocate and integrate observation and product from The Visible/Infrared Imager/Radiometer Suite (VIIRS) to Cross-track Infrared Sounder (CrIS) observation dataset. The collocated VIIRS observation and product provide the CrIS retrieval processing with extended spectral coverage and sub-pixel spatial resolution information. The collocation algorithm based on look-up table (LUT) is selected to satisfy the processing speed requirement for operational processing. The LUT is defined by the instrument optical characteristic, sampling pattern and the feature of satellite orbit. The CrIS instrument spatial response function is also applied in integration processing to obtain the physical consistency between the observations from two different satellite sensors. A brief review the integration algorithms, the LUT algorithms and the problems existing in operation processing will be given. The product detail, the parameters selection and the product evaluation result are presented.

**CrIS-VIIRS integration product:**

The present CrIS-VIIRS integration processing system is designed to integrate VIIRS observation and cloud product to CrIS observation FCD/ED dataset. The collocated VIIRS observation and cloud product provide CrIS processing with sub-pixel level information, cloud cover, cloud height and cloud phase information. Those data are required in cloud clearance radiance algorithms and related product development. The collocated VIIRS radiance products include total radiance, radiance over cloudy area and radiance over clear area within the CrIS FOV. The collocated VIIRS radiance provided the CrIS with extra visible/near infrared information. The collocated VIIRS cloud fraction is generated from Cloud Mask Intermediate Product. If a cloud is detected, the VIIRS Cloud Mask (VCM) indicates whether its phase is water, ice, or mixed. Cloud Mask IP is produced on the CrIS Moderate Resolution Geo-location (non-Terrain Corrected) and contains cloud mask data for each pixel (750 m pixel), scan, and granule. Collocated VIIRS height is generated from the Cloud Base Height EDR. The cloud base height is defined as the height above sea level where cloud bases occur. The cloud base heights are horizontal spatial averages over a cell (Cloud Aggregated 6 km x 6 km cell), a square region of the earth’s surface. If a cloud layer does not extend over an entire cell, the spatial average is limited to the portion of the cell that is covered by the layer.

**CrIS-FOV Spatial Characteristic:**

- **CrIS FOV Spatial Characteristic**
- **Band**
- **Spatial Range**
- **Bandwidth**
- **Resolution**
- **MPD**

<table>
<thead>
<tr>
<th>Band</th>
<th>Spatial Range (km)</th>
<th>Bandwidth (μm)</th>
<th>Resolution (μm)</th>
<th>MPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW</td>
<td>650 - 1050</td>
<td>15.4 - 9.1</td>
<td>0.625</td>
<td>0.8</td>
</tr>
<tr>
<td>SW</td>
<td>2150 - 2550</td>
<td>4.6 - 3.9</td>
<td>0.2</td>
<td></td>
</tr>
</tbody>
</table>

**CrIS Channel Frequency:**

- **Basic Step:** observation collocation and observation regulation.
- **Collocation:** Observation collocation processing is to search VIIRS observations/products that are spatially collocated, temporally concurrent and geometrically aligned to CrIS. The collocation between CrIS and VIIRS is accomplished with observation geo-location information or spatial searching algorithms. The offline pre-calculated Look-Up-Table (LUT) is applied in the collocation processing to satisfy the processing speed requirement.
- **Regulation:** Indentify all collocated VIIRS observations and regulate the collocated VIIRS observations/products to the same CrIS physical representation. The collocated observation point with lower spatial resolution (CrIS) to get the contribution weight of the collocated points. The point with non zero weight will be collocated and averaged with the contribution weight. The Master instrument is the instrument onto whose footprints the slave instruments are to be overlaid.

**Data Flow:**

- **Master Instrument optical/mechanical primitive**
- **Master observation**
- **Master Product CrIS**
- **Collocation**
- **Spatial/Spectral Regulation**
- **Segmented observation product**
- **Offline system**
- **Master observation: EFOV database, auxiliary system**

**CrIS-VIIRS collocation Validation, Problems and algorithms Adjustment:**

In CrIS-VIIRS collocation, the comparison between the spatial collocated VIIRS M13/M15/M16 radiance and the VIIRS M13/M15/M16 radiance generated from convolutional radiance at the same point is required. The collocated VIIRS spectral response function and VIIRS spectral response function, the collocated radiance from VIIRS and convoluted radiance from CrIS have the same spatial and spectral resolution and should equal to each other. This conclusion relies on the accuracy of VIIRS and CrIS geo-location accuracy. The problem of relative position shifting due to the different sensor optical design sampling pattern can be resolved with multiple LUTs. The LUTs for the collocation between VIIRS observation/product and CrIS is trained with the real observation dataset. Multiple tables (At present 16 tables) are obtained with different relative position shifting due to the scan mirror rotate period difference. The LUTs include the most of the influence factors, such as instrument installation parameter. The LUT table keeps the relative scan line index and FOV index of all collocated VIIRS observation. In the LUT training processing, the collocated VIIRS point is identified with the CrIS observation spatial response function (SRF) of effective field of view (EFOV). The observation regulation - Master Observation EFOV SRF.

The instrument observation is contributed by all the points within the effective field of view (EFOV). The EFOV is defined as effective area swept by the sensor observation beam during the integration time. The physical collocation required the collocated observation and physical variables have the same spatial and physical representation. The same spatial representation required the collocated physical variable are from the same coverage area. The same physical representation required the contribution weight of the individual point to the collocated physical variable are same. For the observed radiance, the contribution weight of the individual point within the coverage of the convolution product of the spatial response function (SRF) of instrument instantaneous field of view (EFOV) and the integration time. In the collocation processing, the master instrument EFOV SRF is used to identify all collocated slaver observation within the EFOV and assign a weight for spatial regulation. A physical CrIS SRF model which fits the instrument PSF requirement is applied to obtain the EFOV and EFOV SRF. The model parameters are optimized with spatial collocated M13/M15/M16 radiance from VIIRS and spectral convoluted M13/M15/M16 radiance from CrIS.

**CrIS-VIIRS collocation Validation, Problems and algorithms Adjustment:**

**Bow Tie Effect:**

CrIS Geolocation Algorithm apply three pixel aggregation modes to minimize variation of the horizontal sampling interval (HIS) in the along-scan direction and “bow-tie deletion” method to remove the called the “bow-tie” effect which leads to scan to scan overlap. But scan to scan overlapping still exist in the moderate resolution observations and products. Present VIIRS “Bow-tie Deletion” can’t totally remove the overlap observation. In the collocation algorithms, a equal space grid is used in LUT generation to control the bow tie overlapped VIIRS points.

**CrIS-VIIRS collocation Product:**

- **Product:** The physical collocation algorithms will be used in CrIS-VIIRS observation and product collocation processing. The present observation product includes the CrIS cloud fraction from VIIRS, CrIS cloud height from VIIRS and VIIRS total radiance/radiance over cloudy area/radiance over clear area within the CrIS FOV. The product will provide in real time with operation mode.