TES Level 2 Production Software Design: An Object Oriented Approach

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Design Goals

• Maximize Data Throughput
• Clearly Represent Atmospheric Retrieval Algorithms
• Maximize Flexibility for Updates in a Post-Launch Environment
The TES Level 2 Design Team working in coordination with the TES Science Team is currently designing the production software to encapsulate the retrieval algorithm and retrieval strategy in an object oriented style. OO approaches have been shown to be efficient for projects that are large and require a high degree maintainability and robustness. This paper will present our current status and discuss the issues driving the L2 design: data organization, algorithm, multi-processing, and performance.
Overview of TES Level 2 Subsystem
TES L2 Subsystem
Architectural Overview
An Object Oriented Approach Benefits
  • Larger Implementations of Science Algorithms
  • User Interfaces
  • Maintainability/Reuse

Level 2 Software Development Architecture
  • Target Scene Binning
  • Retrieval Strategy Builder
  • Retrieval
  • L2 Processing Control

Impacts on Physical Architecture
  • Object Duration
  • Object Memory
  • Parallelization
Binning and Data Selection:

- L1B data is categorized hierarchically according to:
  1. Relevance to L2 – e.g. retrievable or not retrievable
  2. Viewing mode – Limb or Nadir
  3. Self similarity criteria – e.g. geolocation, temporal proximity

- Iterator objects pass through the L1B data index
  - Act only on relevant subset of the data
  - Inherit fundamental operations
  - Specialize categorization functions
    - flexibility of algorithm updates or additions
    - reflection of a physics or analysis defined data partition

- Binning organizes data for maximum information reuse.
Class Structure for L1B Data and Associated Iterators
Retrieval Strategy Builder:

- "Fills" an instruction table of retrieval inversion steps
  - rows are specified by a sequence supplier
  - columns are specified by data: Surface Parameters, Retrieval Levels, *A Priori*, Microwindows
- Suppliers implement overall Retrieval Strategy for a Target Scene
- Science Team rules encapsulated in different suppliers
- Based on relevant data and prior knowledge obtained.
- Implements data reuse for Binned Target Scenes
Retrieval Sequence Overview
TES L2 Subsystem
Retrieval Sequence Overview
Retrieval Object Dependencies
StrategyBuilder looks at control tables or Strategy Database and creates the RetrievalStrategy.

```
run_retrieval_sequence()
{
    loop
    {
        if (nadir)
            // create the retrievalInput for one step based on chosen strategy
            NadirRetrievalInput retrievalInput;
        // create Retrieval object to start the single step retrieval and pass the retrievalInput
        NadirRetrieval retrieval()
        retrieval.Run(retrievalInput)
        ....
    }
}
```

Creates the RetrievalInput to do a single step retrieval, it can be either single species or list of species that we want to retrieve at the same time. The method run_retrieval_sequence contains the sequence loop that goes through the sequence steps and performs full retrieval.
Example Retrieval Strategy

Retrieval Strategy II for Nadir retrieval parameters
Case of applicable previous retrieved data set in time/space bin

<table>
<thead>
<tr>
<th>Step Index No.</th>
<th>Retrieval Sequence Step</th>
<th>Retrieval Elements</th>
<th>IFSV Source</th>
<th>Retrieval Levels</th>
<th>A priori Source</th>
<th>μwindows List</th>
<th>Retrieval Type</th>
<th>Additional FM Species</th>
<th>Max No. of Iterations</th>
<th>Convergence criteria</th>
<th>Inversion Method</th>
<th>Continuation Flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T, H2O, O3, Tsurf</td>
<td></td>
<td>Previous Retrieval</td>
<td>L1, ...</td>
<td></td>
<td>1300-1400, 1000-1100, 700-850</td>
<td>Normal</td>
<td>CO2, CFCs, E ...</td>
<td>2</td>
<td>V2</td>
<td>MAP/GN</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>Other species (NO, NO2, CO, CH4, N2O, CFC, ...)</td>
<td>CO, CH4, N2O, CFC</td>
<td>Climatology</td>
<td>L1, ...</td>
<td></td>
<td>Normal</td>
<td>T, H2O, ...</td>
<td>2</td>
<td>V2</td>
<td>MAP/GN</td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Full Spectrum FM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>All L1B spectra For the TGT scene</td>
<td>FM only</td>
<td>All atmospheric species</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>F</td>
</tr>
</tbody>
</table>
Retrieval:
- Encapsulates “kernel” of Forward Model/Inversion process
- Objects represent key physics or analysis information
  - Atmosphere, Atmospheric Layers
  - Rays
  - Instrument (FOV, viewing angle, etc.)
  - Jacobians
  - Modeled Spectrum
  - Retrieval Vector, etc.
- Object and class structure permits data partitioning and algorithm partitioning
  - promotes parallelization
  - numeric processing optimization
Retrieval Object Model
Main Object Model (major classes only)

- **FullStateVector** (from Retrieval Input)
  - **MeasuredSpectrum** (from L1B Access Tool)
  - **RetrievalInput** (from Retrieval Input)

- **Atmosphere** (from Retrieval)
  - **Layer** (from Retrieval)
  - **ABSCoeff** (from Retrieval)

- **Retrieval** (from Retrieval)
  - **ModeledSpectrum** (from Forward Model)

- **ForwardModel** (from Forward Model)
  - **Radiance** (from Forward Model)
  - **Instrument** (from Forward Model)
  - **RayPath** (from Forward Model)

- **Inversion** (from Inversion & Convergence)
  - **Jacobian** (from Forward Model)
  - **Convergence** (from Inversion & Convergence)

- Retrieval object holds the result of the single species retrieval. It initiates the retrieval process and when retrieval is done it gets the retrieval results.