National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

# AIRS Science Processing Software

## Version 5.0 Planning Strategy and Goals

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December 2, 2004

# Improving the Experience

- Version 4 was not as successful as envisioned:
  - Insufficient planning
  - Insufficient time allocated to all phases of effort
  - Schedule creep, schedule slippage, schedule slump
    Schedule landslide ...
  - Down-scaled expectations and release products
- Experience has been unsatisfactory for all involved in the development of the delivery product.
- The Version 5 experience must be better:
  - Customer expectations
  - Sponsor expectations
  - Our expectations

# How do we do it?

- Version 5 needs to be the very best!
- We can produce significantly better product if we start working key issues now.
- We need to:
  - Define Version 5 objectives
  - Define requirements in context of:
    - Validation Timeline
    - Project Office defined goals
  - Understand dependencies
  - Coordinate our efforts
  - Commit to meeting schedules
  - Develop and demonstrate new features before delivery
  - Deliver tested code
  - Allocate more time for integration and validation

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# Standard Product Activation / Validation Timeline

| Version | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 |
|---|---|---|---|---|---|
| Activation Date | 9/15/03 | 2/1/05 rev | 1/1/06 | 1/1/07 | 1/1/08 |
| Radiance Products (L1) | Ocean | Land | Polar | Global | Global |
| AIRS Radiance | Prov | Val2 | Val3 | Val4 | |
| VIS/NIR Radiance | Prov | Val2 | Val3 | Val4 | |
| AMSU Radiance | Beta | Prov | Val2 | Val3 | Val4 |
| HSB Radiance | Beta | N/A | N/A | N/A | N/A |
| Standard Products (L2) | | | | | |
| Cloud-Cleared IR Radiance | Beta | Val2 | Val3 | Val4 | |
| Surface Temperature | Beta | Val1 | Val2 | Val4 | |
| Temperature Profile | Beta | Prov Val2 | Val3 | Val4 | |
| Humidity Products | Beta | Val1 | Val2 | Val3 | Val4 |
| Cloud Cover Products | N/A | Val1 | Val2 | Val3 | Val4 |

Beta = Not suitable for scientific investigations.

Prov = Provisionally validated. Useable for scientific investigations with caution. Validated for non-polar, night, ocean only.

Val1 = non-polar, day/night, ocean.
Val2 = Val1 + land.
Val3 = Val2 + polar
Val4 = Global All Cases

# Version 5 Project Office Objectives

- **Level 1**
  - Improve microwave standard products
- **Level 2**
  - Improved Error Estimation
  - Eliminate (or minimize) IR Tuning
  - IR-only Cloud Clearing
  - Include IR Spectral Emissivity in retrievals
  - Trace Gas Profiles: $CO_2$, CO, $CH_4$, $O_3$, $SO_2$, Aerosols
  - Extend validated retrievals to polar regions
  - Consensus clear flag
- **Level 3**
  - Quantization Product (added to existing set)
  - Formal error propagation

# Methodology

- **Improved Project and Science Team Coordination**
  - Early definition of goals and objectives
  - Defined requirements and responsibilities
  - Coordinated schedules
  - More CCB involvement
- **Fewer software deliveries**
  - Demonstration of new features prior to incorporation into software baseline
  - Earlier integration into baseline
- **Longer validation period**

# Roles

- JPL Role
  - Anticipate and plan for coming changes
  - Implement and/or integrate software
    - Developed at JPL
    - Developed outside JPL by Science Team
  - Manage our coordinated efforts
  - Monitor our schedules
- Science Team Role
  - Develop and suggest new products
  - When developing new or enhancing existing products:
    - Develop and follow a schedule
    - Demonstrate before delivery
    - Ensure code is tested before delivery
    - Deliver on time

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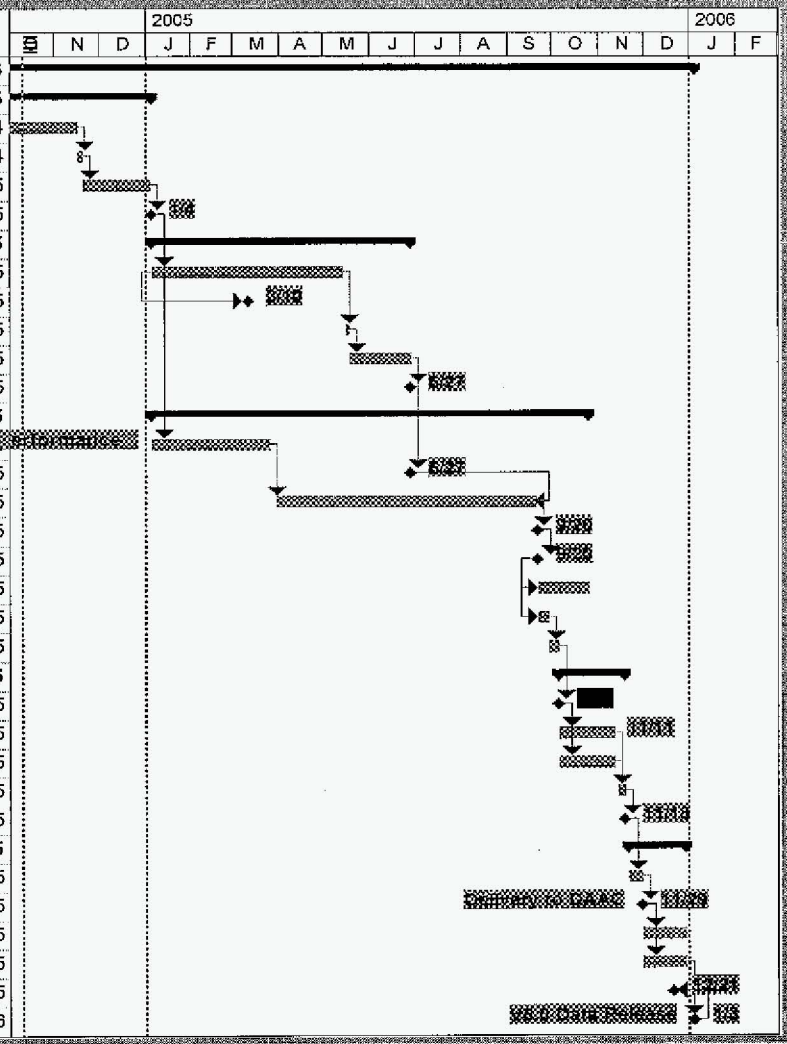
# Schedule

| D | Task Name | Duration | Start | Finish |
|---|---|---|---|---|
| 1 | **V5.0 Development** | **340 days** | **Mon 8/23/04** | **Tue 1/3/06** |
| 2 | **Preliminary Planning** | **92 days** | **Mon 8/23/04** | **Tue 1/4/05** |
| 3 | Concept Development | 60 days | Mon 8/23/04 | Mon 11/15/04 |
| 4 | Science Team Meeting | 3 days | Tue 11/16/04 | Thu 11/18/04 |
| 5 | Solidify Requirements | 28 days | Fri 11/19/04 | Mon 1/3/05 |
| 6 | Finalize contents and tasks | 0 days | Tue 1/4/05 | Tue 1/4/05 |
| 7 | **Prototype and Characterization** | **121 days** | **Wed 1/5/05** | **Mon 6/27/05** |
| 8 | Initial proof of concept | 91 days | Wed 1/5/05 | Fri 5/13/05 |
| 9 | In-Process Status report | 0 days | Thu 3/10/05 | Thu 3/10/05 |
| 10 | Presentation of prelimnary res | 2 days | Mon 5/16/05 | Tue 5/17/05 |
| 11 | Final development | 28 days | Wed 5/18/05 | Mon 6/27/05 |
| 12 | Delivery of code | 0 days | Mon 6/27/05 | Mon 6/27/05 |
| 13 | **Development and Integration** | **203 days** | **Wed 1/5/05** | **Mon 10/24/05** |
| 14 | In-house Improvements | 56 days | Wed 1/5/05 | Fri 3/25/05 |
| 15 | Final Inputs to CCB | 0 days | Mon 6/27/05 | Mon 6/27/05 |
| 16 | Development and Unit Test | 120 days | Wed 3/30/05 | Mon 9/19/05 |
| 17 | CCB Approval to build 5.0 | 0 days | Tue 9/20/05 | Tue 9/20/05 |
| 18 | Initial build and delivery to TDS | 0 days | Tue 9/20/05 | Tue 9/20/05 |
| 19 | Controlled Anomaly Quickfix | 24 days | Wed 9/21/05 | Mon 10/24/05 |
| 20 | TDS SI&T | 5 days | Wed 9/21/05 | Tue 9/27/05 |
| 21 | TDS end-to-end checkout | 5 days | Wed 9/28/05 | Tue 10/4/05 |
| 22 | **Testing** | **33 days** | **Tue 10/4/05** | **Fri 11/18/05** |
| 23 | Operational in TDS | 0 days | Tue 10/4/05 | Tue 10/4/05 |
| 24 | Sustained Testing | 28 days | Wed 10/5/05 | Fri 11/11/05 |
| 25 | Validation Data Processing | 28 days | Wed 10/5/05 | Fri 11/11/05 |
| 26 | Preship Review preparation | 5 days | Mon 11/14/05 | Fri 11/18/05 |
| 27 | Preship Review | 0 days | Fri 11/18/05 | Fri 11/18/05 |
| 28 | **Transfer V5.0 to DAAC** | **25 days** | **Mon 11/21/05** | **Thu 12/29/05** |
| 29 | Packaging and Shipping | 5 days | Mon 11/21/05 | Tue 11/29/05 |
| 30 | Delivery to DAAC and NOAA | 0 days | Tue 11/29/05 | Tue 11/29/05 |
| 31 | JPL Support to DAAC | 20 days | Wed 11/30/05 | Thu 12/29/05 |
| 32 | DAAC I&T | 20 days | Wed 11/30/05 | Thu 12/29/05 |
| 33 | Validation Report Due | 0 days | Wed 12/21/05 | Wed 12/21/05 |
| 34 | Public Data Release V5.0 | 0 days | Tue 1/3/06 | Tue 1/3/06 |



# V5 Key Activities

| Activity | Dates |
|---|---|
| Conceptualization | Through December 2004 |
| Prototype and characterization | Through May 2005 |
| Delivery of code | No later than June 27, 2005 |
| JPL integration and test | June – September 2005 |
| Operational in TDS | October 2005 |
| Validation data processing | Ends mid-November 2005 |
| Delivery to GSFC DAAC | End-of-year 2005 |

# Level 1 Activities

- Overarching Goal:
  - Make this our *last* Level 1 algorithmic delivery
- Microwave
  - Improve microwave standard products
- Infrared
  - No major issues

# Level 1 Activities

- Improved Error Estimation
- Eliminate (or minimize) IR Tuning
- IR-only Cloud Clearing
- Include IR Spectral Emissivity in retrievals
- Trace Gas Profiles: $CO_2$, CO, $CH_4$, $O_3$, $SO_2$, Aerosols
- Extend validated retrievals to polar regions
- Consensus clear flag

# Improved Error Estimation

- **Science Team Component**
  - Recommend error propagation algorithms (Barnet, supported by Susskind)
  - Implement new / improved error propagation algorithms (Susskind)
- **JPL Component**
  - Improve microwave Level 1B error estimates
  - Examine alternative Level 2 error estimation algorithms
  - Verify efficacy through validation
  - JPL to investigate new solution spaces as backup plan
  - Level 3 products based on better error estimation

# Eliminate (or minimize) IR Tuning

- Science Team Component:
  - Modify retrieval to eliminate IR tuning step (GSFC – Susskind)
    - Examine ways to minimize or eliminate tuning
    - Re-evaluate definition of effective noise amplification factor
    - Stability over Time: Tuning, Regression, Biases
    - Develop alternative first guess options
  - Analyze biases in cloud cleared radiances (UMBC – Strow)
  - Develop tuning based on high-quality radiosondes – as a fallback (NOAA – McMillin )
- JPL Component
  - Examine statistics with and without tuning – provide results to Science Team

# IR-Only Cloud Clearing

- Science Team Component
  - Recommend/Develop Algorithms (Barnet)
    - "Dirty" regression
    - MODIS
- JPL Component
  - Develop AVN First Guess for retrieval
    - Implement into PGE
    - Evaluate statistics, biases and trends
  - Investigate alternative algorithmic approaches (several at JPL)
    - Clear FOV - Single footprint retrieval
    - Retrieval above cloud tops
    - Optimal estimation approach
  - Test algorithms within PGE

# Include IR Spectral Emissivity in retrievals

- Science Team Component
  - Implement *surface temperature / emissivity* algorithm (Barnet)
  - Surface regression (Goldberg)
  - Deliver algorithm to JPL for evaluation (Knuteson)

Coordination between various approaches needed

- JPL Component
  - Lead investigation into alternative algorithms (Chahine)
  - Integrate Emissivity Algorithm into PGE
  - Test algorithm on sample clear data sets
  - Improved surface simulation (shortwave)
  - Develop, integrate and test as needed (various at JPL)

# Trace Gases, Aerosols, Cirrus

- **Science Team Component**
  - Develop RTA to model trace gas, aerosol and cirrus contributions (Strow)
  - Develop Aerosol Flag (Strow)
  - Develop software for CO, CO2, CH4 retrievals (Barnet, et al)
- **JPL Component**
  - Investigate alternative approaches for cirrus detection
  - Develop and Test trace gas algorithms (Chahine)
  - Provide input to Barnet (Chahine)
  - Ozone algorithm improvements
  - Integrate new algorithms into PGS

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# Extend validated retrievals to polar regions

- Science Team Component
  - Help improve retrieval algorithm
  - Help identify and overcome problems
- JPL Component
  - Integrate code and algorithms
  - Perform validation

# Phased Experiments

- AVN First Guess
  - JPL to try this on our baseline version 4.0
- Remove IR Tuning
  - Susskind/Strow to settle on approach
- Modify Error Terms
  - Susskind/Barnet to determine best method
- IR Emissivity
  - Barnet/Chahine to define algorithm
- IR Only Cloud Clearing
  - Chahine to develop algorithm. JPL/Barnet to support
- Trace Gas Retrievals
  - Barnet to develop code for PGE