Implementation of AIRS, IASI, and CrIS based stratospheric intrusion forecasting capability into IDEA-International

(Brad Pierce, NOAA/NESDIS)

With significant support from the CIMSS IMAPP/CSPP team (James Davies, Kathy Strabala, Nadia Smith, Elisabeth Weisz, Rebecca Cintineo)
Objective: Provide satellite based support to state and local air quality management for stratospheric intrusion (SI) related exceptional event analysis. (Gail Tonnesen and Pat Reddy POCs)

Tasks:

• Development of a RAQMS public website with products adapted for SI forecasting in Western US. Gail Tonnesen and Pat Reddy will provide guidance during the development of this website and evaluate its effectiveness during Spring 2013 SI events.

• Add capabilities to IDEA-I (http://cimss.ssec.wisc.edu/imapp/ideai_v1.0.shtml) within the International AIRS/MODIS Processing Package (IMAPP) to produce trajectory based SI forecasts initialized with real-time AIRS ozone retrievals.

• Conduct retrospective nested high resolution RAQMS/WRF-CHEM SI forecasts for May 2010 and 2012 and provide an assessment of the influence of mesoscale circulations on SI to the EPA SI Working Group. (This task complements AQAST SI studies by Arlene Fiore using the AM3 model)
The Infusing Satellite Data Into Environmental Applications - International (IDEA-I) SI forecast is being developed under the Community Satellite Processing Package (CSPP)

- CSPP supports the Direct Broadcast (DB) satellite community through the packaging and distribution of open source science software.

- Funded by NOAA JPSS

IDEA-I AIRS, CrIS, and IASI SI forecast capability is currently being beta tested at CIMSS using the UW-Madison Dual Regression retrieval

- Refining initialization criteria

- Extensive testing for June 6, 2012 Wyoming SI Exceptional Event Analysis

http://sunset.ssec.wisc.edu/idea-test2/
Atmospheric Profile and Cloud Parameter Retrievals from Hyperspectral Infrared Radiances

- UW HS retrieval package V1.0
- For AIRS, IASI and CrIS L1 to L2 Processing
- Released under CSPP on 28 November 2012

The UW hyper-spectral retrieval package, based on the Dual-Regression (DR) retrieval algorithm, is the only publicly available retrieval software package to convert hyper-spectral radiance measurements (Level 1) to retrieval (Level 2) products.
Dual-Regression Retrieval Parameters

- atmospheric temperature [K] at 101 pressure levels
- atmospheric humidity [g/kg] at 101 pressure levels
- atmospheric ozone [ppmv] at 101 pressure levels
- atmospheric relative humidity [%] at 101 pressure levels
- atmospheric dew point temperature [K] at 101 pressure levels
- surface skin temperature [K]
- surface emissivity at instrument spectral resolution
- total precipitable water (vertically integrated from 100 hPa to surface) [cm]
- precipitable water 1, 2, 3 (vertically integrated from 900 hPa to surface, 700 to 900, 300 to 700 hPa) [cm]
- total ozone amount (vertically integrated) [dobson units]
- lifted index [°C]
- convective available potential energy [J/kg]
- CO₂ concentration [ppmv]
- cloud top pressure [hPa]
- cloud top temperature [K]
- cloud optical thickness
- effective cloud emissivity
- cloud mask (values: 0 clear, 1 cloud)

Output Format: hdf5

http://cimss.ssec.wisc.edu/cspp/uwhsrtv_edr_v1.1.shtml
Basis for initialization point selection criteria

Upper left quadrant is stratospheric air; dry air with high ozone

14 May, 2012

Plevs threshold: >500mb
O3VMR threshold: >0.08 to 0.10 (80-100ppbv)
Dewpnt-Tair threshold: <-15K

Following the public comment period, this document will be submitted to the US Environmental Protection Agency (US EPA) to demonstrate that the surface ozone exceedances were due to an exceptional event associated with a stratospheric intrusion (SI).

“The Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD) has determined that a stratospheric intrusion created elevated ozone readings resulting in an 8-hour ozone standard exceedance at the Thunder Basin, Wyoming ozone monitor located in northeastern Wyoming on June 6, 2012” (Executive Summary)
Two day’s prior to Wyoming SI exceptional Event
(6 initialization opportunities each day!)

Dual-Regression Retrieval Ozone June 4, 2012

AIRS  IASI  CrIS

June 4

Night

Day

516 hPa ozone (ppbv)
AIRS trajectory forecast showing descent into WY

Starting June 4
(two days before)
AIRS trajectory forecast showing descent into WY

Starting June 4 (two days before)

Each “worm” is 6 hours of air parcel history

500 hPa GFS winds

Initialization points
IASI 516 hPa ozone (ppmv) and 500mb stream lines, June 4, 2012

 Archived gridded data netCDF file includes ozone retrieval swaths and GFS data fields
Ozone from IASI, AIRS, and CrIS can be viewed and compared in McIDAS-V
Future Plans

- Release IDEA-I SI forecast package to CSPP Beta users for testing in July, 2013
- Maintain IDEA-I SI forecast capability at CIMSS for use by State and local AQ forecasters
- Conduct retrospective case studies during 2013 SI events for evaluation by EPA SI Working Group
Las Vegas Ozone Study (LVOS)

Where: Angel Peak, Nevada

When: May - June 2013

NOAA ESRL CSD Tunable Optical Profiler for Aerosol and Ozon (TOPAZ) lidar.

TOPAZ data provided by Andrew Langford (NOAA/ESRL)

http://www.esrl.noaa.gov/csd/projects/lvos.html
Extra Slides
Dual-Regression Retrieval

**Radiances**
- AIRS L1B,
- IASI L1C, CrIS SDR

Training Set
- Simulated Radiances

Regression Coefficients

Retrieval

Temperature, Moisture and Ozone profiles,
Surface and cloud parameters ....

Dual-Regression Training Set

- Global Clear Soundings
  - Radiances (calculated with clear FM)
  - Clear trained EOF regression results
- Global Cloudy Soundings
  - Radiances (calculated with cloudy FM)
  - Cloud trained EOF regression results
- Cloud Top Altitude
  - Level where $T_{cloudy} > T_{clear}$ for $p > p_{cloud}$
- Final Profile
  - clear-trained above cloud level
  - cloud-trained below cloud level