

## 6 Validation Plan

### 6.1 Introduction

It is well known that satellite borne observation is very useful for getting information in global scale. The data products derived from these measurements might have literally the same quality over the globe because they are obtained with one, the same, instrument. But also well known is the importance of continuous validation of the satellite borne instrument for maintaining the quality of data through the mission lifetime.

The validation of JEM/SMILES data products should be strictly controlled following the standardized handling procedures. These procedures will be discussed and determined in their details by scientists in JEM/SMILES validation team, which is not yet officially established, and then will be approved later by the members of science team. Another important point of validation is the responsibility for each data product. A scientist on the science team who knows well of its scientific use and meanings must be responsible for the validation of each data product.

As the standardized procedure is not established, the concepts of JEM/SMILES validation as well as those of the correlative measurements are described in this section.

### 6.2 The Basic Concepts of Validation for JEM/SMILES Data Products

The following items should be included in the standardized procedures:

1. Sensitivity studies including the simulation study to determine the expected precision and accuracy of each data product
2. Inspection of all incoming data, and checking the reasonableness and unexpected phenomena through the examination of routine analyses products
3. Close examination of the characteristics of ‘radiance residuals’ as functions of many parameters for checking the artifacts
4. Comparison of the same parameter measured in more than one spectral region as possible as we can
5. Comparison with other correlative measurements from ground-based, aircraft, and balloon measurements
6. Comparison of JEM/SMILES data with data obtained by other space-borne instruments such as Aura(formerly EOS-Chem)/MLS

Each item is essential to maintain the quality of data product and will need a responsible scientist as well.

### 6.3 Correlative Measurement

#### 6.3.1 The Needs of Correlative Measurements

The correlative measurements are inevitable to validate the JEM/SMILES data products. JEM/SMILES is capable of measuring many atmospheric species, exact identifications of whose species are dependent on a final specification of the instrument, though. At present, standard products for JEM/SMILES are not finally determined. Then the needs of correlative measurement are listed below for only major targeted (probable) data products, respectively.

- $O_3$   
Total and vertical profiles of  $O_3$  are needed. Correlative measurements such as aircraft and balloon measurements of the vertical profile coincident with JEM/SMILES observation are very valuable.
- ClO  
Ground-based measurements of vertical profiles are needed at a various site using the millimeter-wave radiometer. Coincident measurements with JEM/SMILES should be organized. Aircraft measurements, coincident with JEM/SMILES observations are also important. Balloon-borne measurement is very useful to compare the vertical profile. Satellite-borne measurements will be comparable with JEM/SMILES product. at the JEM/SMILES era.
- $HNO_3$ , HCl,  $HO_2$   
Balloon measurements of the vertical profile with IR spectrometers are needed, especially coincident with JEM/SMILES observations.
- BrO  
Ground-based measurements of total column are needed. Aircraft measurements, coincident with JEM/SMILES observations, in situ, and column amount measurements are particularly valuable. Balloon-borne measurement is useful to compare the vertical profile. Satellite instruments will also be usable for validation purpose at the JEM/SMILES era.
- $H_2O_2$   
Any kind of measurement of atmospheric  $H_2O_2$  is valuable.

The followings are not for data products of JEM/SMILES, but these data will also be valuable for improving the quality of data products.

1. More accurate spectral parameters for target species and  $H_2O$  in frequency region of 600 - 700 GHz: Linewidth, center frequency, line strength, air broadening coefficients, etc.
2. Atmospheric water vapor profiles in the upper troposphere and in the stratosphere
3. Temperature and pressure profiles along the JEM/SMILES observation

### 6.3.2 Plan of Correlative Measurements

The use of existing data (measurement network), conducting a field validation campaign, and setting a new ground-based instrument to an observation site should be considered in the planning of validation.

#### 6.3.2.1 The Use of Existing Data

As for  $O_3$ , WMO-GAW ozonesonde stations and ground-based Dobson stations routinely make measurements of vertical profile and total column  $O_3$ . These data are available via WMO. The climatology of ozone distribution field can also be constructed based upon these data.

There is no measurement site (network) that provides the profile of other species than  $O_3$  routinely without any special contract. However, NDSC primary and complementary

sites can provide very accurate data of some species, their total and vertical profiles including ClO. Close collaboration with NDSC sites is very valuable for getting accurate validation data.

### 6.3.2.2 Field Campaign

Even for the O<sub>3</sub>, it will be hard to get coincident data with JEM/SMILES observation from routine observation. Therefore several validation (field) campaigns will be planned during the JEM/SMILES mission.

#### *CAMPAIGN Site*

In order to select the campaign site we must consider the geographical coverage of JEM/SMILES observation and the availability of balloon launching facility. In north polar region one of the candidate site will be Fairbanks in Alaska or Lynn Lake in Canada. In Fairbanks there exist ground-based instruments: Millimeter wave radiometer, FTIR, and lidar at Poker Flat (<http://www.crl.go.jp/team5/index.html>). These instruments are maintained with both CRL and Geophysical Institute of University of Alaska Fairbanks. So ground-based and balloon measurements can both be carried out coincident with JEM/SMILES observation. But the geographical position of Fairbanks, about 65°N, is located nearly the northern limit of observable region by JEM/SMILES. On the other hand Lynn Lake is located at around 52°N, where balloon observations were carried out by NSBF, the balloon launching team of the USA. Anyway collaboration with USA or USA/Canada must be necessary.

In mid-latitude regions several balloon observation sites will be found as a candidate site such as France, Japan, United States of America, and Australia. All of these countries have at least one balloon observation site within their home countries. The validation campaign in tropical region is also important and valuable. Christmas Island, where NASDA operates a tracking station, is one of the candidate site as well as Watukosek, Indonesia, where NASDA and LAPAN of Indonesia are conducting the ozonesonde measurement and some ground-based observations.

#### *Balloon borne Instrument*

The candidate instruments for balloon observations will be a submillimeter radiometer, FTIR, and UV-Visible spectrometer. Measurements by more than one instrument will be valuable for validation purpose. So international collaborations must be made. Daily ozonesonde measurements at campaign site during the campaign period will be the minimum requirement.

#### *Ground-based Instrument*

Millimeter radiometer, FTIR, and UV-Visible spectrometer can provide good validation data, total column amounts and profiles for some species. In Poker Flat, Alaska CRL operates, with GI/UAFA, some ground-based instruments usable for validation purpose. This site is important for supplying validation data continuously. As mentioned before, close collaboration with NDSC will also play a key role to achieve a good validation result. Also important point is that NASDA should operate at least one ground-based instrument by itself for checking the quality of JEM/SMILES data constantly.

#### *Candidate period of field campaign*

In high latitude summer is good season for validation considering the stability of at-

ospheric condition. However the enhancement of ClO occurs in winter to spring season. Ozone depletion event will also be expected in winter season. As for the validation purpose, validation campaign in high latitude will be recommended to be conducted both in winter and summer seasons. In middle and low latitudes, exception of special ozonesonde campaign, one field campaign will be planned at anytime in a year.

### **6.3.3 Activities in JEM/SMILES Team for Validation**

#### **6.3.3.1 Development of a Balloon Borne Submillimeter Spectrometer**

JEM/SMILES is one of the most advanced instrument, whose signal to noise ratio is the best among other submillimeter spectrometers of not only space borne but also ground- or air- borne ones. Therefore JEM/SMILES will show the best performance to measure some species such as ClO and BrO. This means that there is no good instrument at present to provide validation data for these species. CRL team is developing a balloon borne submillimeter spectrometer of using super conductor (SIS mixer) as a detector. This balloon borne spectrometer will demonstrate the same performance as JEM/SMILES and will be used for validation purpose for JEM/SMILES. This project of developing the balloon borne SMILES (BSMILES) will play an important role in conducting correlative measurements, because vertical profiles of ClO and other species can be measured by BSMILES with the same or better accuracy than JEM/SMILES. Key components of the BSMILES system were constructed. Performances of those are checked, and good results have been demonstrated as expected. The BSMILES is in integration phase and will be scheduled to complete its development by the end of 2002. The first balloon borne measurement of BSMILES will be carried out in 2003 from SBC (Sanriku Balloon Center of ISAS, Japan).

#### **6.3.3.2 Laboratory Measurement of Spectroscopic Parameters**

As mentioned above, spectroscopic parameters for many atmospheric species are not accurately determined or measured in the frequency range of around 600GHz. In particular an air pressure broadening parameter is one of key parameters to derive the vertical profiles of atmospheric species from limb sounding. CRL and Ibaraki University are jointly planning the laboratory measurements of spectroscopic parameters for some species. They already measured some parameters as described in section 4.4. This project of laboratory measurement will also be one of key projects in validation plan for the success of deriving good data products from JEM/SMILES observation.

#### **6.3.3.3 Use of Observation Sites in Japan**

Within Japan there exist several good observation sites maintained by University and National Institute. So not only the international collaborations but also the collaborations within Japan are also very important. NIES's group operates microwave radiometer, FTIR, and lidar at Tsukuba, Ibaraki and Rikubetu, Hokkaido. STEL of Nagoya University also maintains FTIR, UV-Visible spectrometer and ozonesonde stations at Rikubetu and Moshiri, Hokkaido. These observation sites are very suitable for validation of JEM/SMILES observation. During the mission lifetime of JEM/SMILES these sites are considered as main sites for steadily providing validation data.

## 6.4 Summary

Validation campaign as well as the use of existing database for  $O_3$  will become the key for validating JEM/SMILES data. In order to get coincident data with JEM/SMILES observation, international collaborations play the key role; for example, close collaboration with NDSC. The use of observation sites in Japan maintained by the National Institute and the University will also be inevitable for getting validation data constantly. Even for getting good validation data of  $O_3$ , a kind of special ozonesonde campaign must be planned.

Ground-based instruments of CRL at Poker Flat, Alaska will provide good validation data constantly. NASDA/EORC will operate at least one ground-based instrument for checking the performance of JEM/SMILES. Balloon observation is also essential to get validation data. Close collaboration with foreign research bodies as well as with Japanese researchers must be key point to succeed the balloon campaign.

Cross validation with other space-borne instrument such as Aura/MLS would be useful.