Expanding the SSFM dataset for ADM validation

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The Multi-angle Imaging SpectroRadiometer

- 9 view angles at Earth surface with 14-bit pushbroom cameras
- 7 minutes to view each scene from all 9 angles
- 275 m spatial resolution per pixel
- ~400-km swath width
- Calibrated measurements of the intensity of reflected sunlight

- 4 spectral bands at each angle:
  - 446 nm ± 21 nm
  - 558 nm ± 15 nm
  - 672 nm ± 11 nm
  - 866 nm ± 20 nm

Multi-angle Imaging SpectroRadiometer

David J. Diner, JPL, Cal. Tech, Workshop May 22, 2005
• The SSFM dataset co-locates (MISR) narrowband radiances and the CERES footprint.
  
  – Applies the point spread function (PSF)
  
  – Loeb et al 2006

• Allows us to view a CERES footprint from 9 different angles simultaneously.

• We mainly use it to examine the angular consistency of the ADMs
One issue is that the SSFM dataset doesn’t currently account for parallax issues.

- MISR level 1 radiances are projected to a surface ellipsoid
- Means that the surfaces seen are different for different cameras, especially for high clouds
Solution may be to use the level 2 reflectance (BRFs)

- 2.2km area (twice that of the Level 1)
- Projected to the reflecting level of the cloud/surface
- Uses pattern matching to match the scene from different angles

Figure 25. The projection of a RLRA prism on the surface ellipsoid
- Side-leaving BRFs are also included
  - Use a weighted average
• Differences between Level1 and Level2 radiances increase with cloud fraction and camera angle.
• Differences are a function of cloud height
Effect is the strongest at lower solar zenith angles
• Low cloud optical depths have greatest differences
• To evaluate the ADMs we first use a narrow-to-broad band (nbb) conversion.

\[ I_{sw}^j = c_0 + c_1 I_{0.45}^j + c_2 I_{0.67}^j + c_3 I_{0.87}^j \]

• Then apply the ADMs to the 9 MISR radiance measurements to get 9 flux estimates.

  – Use the standard deviation of the 9 as an estimate of the total error.

\[
s = \sqrt{\frac{\sum_{j=1}^{n} (F_{sw}^j - F_{sw})^2}{n - 1}} \quad \rightarrow \quad CV_T = \left( \frac{\sqrt{\frac{1}{M} \sum_{i=1}^{M} s_i^2}}{\frac{1}{M} \sum_{i=1}^{M} F_{sw}^i} \right) \times 100\%
\]

  – ADM error is the difference between the total and the nbb error.

\[
CV_{ADM} = \sqrt{CV_T^2 - CV_{NB}^2}
\]
• Using the level 2 MISR might enable us to get an estimate of the parallax error
  – Total error should include a parallax term
    \[ CV_T^2 = CV_{ADM}^2 + CV_{NB}^2 + CV_{PX}^2 \]
  – Level 2 MISR should have no parallax error
    \[ CV_{T2}^2 = CV_{ADM}^2 + CV_{NB}^2 \]
  – Parallax term is the difference between the level 1 and level 2
    \[ CV_{PX} = \sqrt{CV_T^2 - CV_{T2}^2} \]
• Still a work in progress
  – Some sampling issues
  – The results I show will be for the total error only
Single Layer Clouds: Ocean Both Levels (\// = Level 1)
Multi Layer Clouds: Land Both Levels (// = Level 1)

[Bar charts showing cloud layers at different levels (low, mid, high) for different cloud types (pcl, mcl, ovc)]
Multi Layer Clouds: Snow/Ice Both Levels (// = Level 1)
• Adding MISR clouds and Cloud Heights to the SSFM
  – MISR clouds are stereoscopically derived
  – Do not use spectral information
  – Independent test of CERES cloud mask

• MISR cloud product gives a cloud/surface flag at 1.1km area.
  – Also provides confidence
• Good agreement over land, water and sea ice
  – Just one day in August 2000
• The shape of the BRFs can give us a guide as to what surface we are looking at.
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  – Land:
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  – Land:
• Over ocean
• Over ocean
• Summary:
  – The level 2 MISR BRFs can be used to remove some of the parallax effects present in the SSFM dataset
  – We generally see an improvement in the angular consistency when using the level 2 MISR compared to the level 1 MISR.
  – Needs a bit more work to back out a parallax error term.
  – Cloud fractions between MISR and CERES are comparable (CERES better maybe?)