The SPoRT Center at Marshall Space Flight Center in Huntsville, AL works to improve weather forecasts using unique NASA satellite observations and research capabilities. NASA is using state-of-the-art assimilation techniques for improving atmospheric model initial conditions through use of the Atmospheric Infrared Sounder (AIRS).

Use of AIRS radiances is the most sophisticated method but requires large computational resources; techniques to assimilate profiles are still in their infancy but smaller centers with limited computational resources can still benefit from the data.

Studies of AIRS radiances (e.g. LeMarshall et al. 2005, Garand et al. 2006) and profiles (e.g. Reale et al. 2008) have shown promising results for assimilation of AIRS observations on the global scale.

SPoRT has shown positive impact on short-term forecasts at the regional scale using both AIRS radiances (McCarty et al. 2009 in review) and profiles (Chou et al. 2009 (JP6.11)).

Because AIRS is a heritage instrument to CrIS, lessons learned from AIRS can aid in product development for CrIS, and the data can be used in a similar manner.

Analysis System
- The data assimilation scheme used in this study is the Weather Research and Forecasting 3D-Var (WRF-Var, Barker et al. 2004).
- Background error covariances are determined using the NMC method (Panofsky and Derber 1992) which takes differences between 12 and 24-h control forecasts to determine model error. Background error covariances were created using the “gen bc” program in WRF-Var with forecasts from 17 January to 22 February 2009 in review and profiles (Chou et al. 2009 (JP6.11)).
- Ability to assimilate data above cloud top is important to achieving improved forecasts.

AirS Radiance Assimilation
- The data assimilation scheme used in this study is the Gridpoint Statistical Interpolation (GSI, Wu et al. 2002) 3D-Var scheme used operationally at NOAA/NCEP, NASA/GC, and NOAA/ESRL-GD.
- The system minimizes the cost function
  \[ \chi = \sum_i R_i (O_i - H_i(b)) + \sum_j B_j (b - \hat{b}) \]
  to achieve an analysis increment, \( \Delta b \), which is determined as the combination of the observations, \( O \), and the background state, \( b \), weighted by their error covariance matrices, \( R \) and \( B \), respectively.
- Background error covariances are determined using the methodology of Wu 2005.
- Radiance studies at SPoRT emulated the operational North American Mesoscale (NAM) Model, which is run at 12 km and uses the Weather Research and Forecasting Non-hydrostatic Mesoscale Model (WRF-NMM, Janjić et al. 2001) dynamic core, at NOAA/NCEP.
- All conventional and remotely sensed measurements assimilated operationally during the period of study were utilized.
- The assimilation cycle is performed at every three hours, using a 1.5 hour cutoff for data.
- The independent variable in the study is the AIRS radiances. Launched in 2002, onboard the NASA Aqua EOS satellite, AIRS measures 2378 individual bands (in black) from 3.7 – 15.4 μm, with a 15 km spatial footprint. The major absorption continua are denoted by the red lines.
- 281 bands denoted by the red stars at every footprint are delivered to NCEP for assimilation purposes.
- Radiative transfer calculations necessary for the assimilation of radiances are provided by forward, integrated, and linearized. NCEP has performed using the Community Radiative Transfer Model (Wang et al. 2005).

AIRS Channel Selection
- Only diagonal terms in the observation error matrix are used, but error estimates can be used to fill off-diagonal terms.
- Profiles studies at SPoRT have thus far shown that sensitivity studies to determine the impact of AIRS observations on WRF forecasts.
- Comparisons between forecasts have been made to radiosondes and NCEP Stage IV data (see Poster JP6.11 in this session).
- These QIs are used in preprocessing AIRS profiles for WRF-Var by only including partial soundings where indicated by the QIs.
- AIRS profiles are used over land and water with separate observation errors:
  - Land: From Tobin et al. (2006)
  - Emissivity issues make land soundings less accurate
  - Validation for 500,000 similar environment as SPoRT domain
  - Water: Use AIRS instrument specs (1K in 1 km layer for T; 15% in 4 km layer for RH)
  - Better soundings than land
  - Verified against TRMM sites—different than SPoRT domain

Background
- The SPoRT Center at Marshall Space Flight Center in Huntsville, AL works to improve weather forecasts using unique NASA satellite observations and research capabilities.
- NASA is using state-of-the-art assimilation techniques for improving atmospheric model initial conditions through use of the Atmospheric Infrared Sounder (AIRS).
- Use of AIRS radiances is the most sophisticated method but requires large computational resources; techniques to assimilate profiles are still in their infancy but smaller centers with limited computational resources can still benefit from the data.
- Studies of AIRS radiances (e.g. LeMarshall et al. 2005, Garand et al. 2006) and profiles (e.g. Reale et al. 2008) have shown promising results for assimilation of AIRS observations on the global scale.
- SPoRT has shown positive impact on short-term forecasts at the regional scale using both AIRS radiances (McCarty et al. 2009 in review) and profiles (Chou et al. 2009 (JP6.11)).
- Because AIRS is a heritage instrument to CrIS, lessons learned from AIRS can aid in product development for CrIS, and the data can be used in a similar manner.

AIRS Profile Assimilation
- Background error covariances are determined using the NMC method (Panofsky and Derber 1992) which takes differences between 12 and 24-h control forecasts to determine model error. Background error covariances were created using the “gen bc” program in WRF-Var with forecasts from 17 January to 22 February 2009 in review and profiles (Chou et al. 2009 (JP6.11)).
- Ability to assimilate data above cloud top is important to achieving improved forecasts.

Recommendations for CrIS data for use in Data Assimilation
- It will be necessary to provide near real-time access to radiances and sounding products to the community (e.g. via the NPOESS Data Exploitation (NDE) project, direct broadcast facilities, etc.). These sites will need to maintain the most recent versions of the supporting science algorithms.
- Validation of CrIS soundings with dedicated radiosondes and level-by-level retrieval error estimates are necessary for assigning appropriate observation errors.
- Inclusion of methodology for determining and using uncontaminated channel radiances and corresponding above-cloud levels in profiles is necessary to maximize performance impact within data assimilation systems.