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RECENT ADVANCES AT THE JOINT CENTER FOR SATELLITE DATA ASSIMILATION

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1. INTRODUCTION

The Joint Center for Satellite Data Assimilation (JCSDA) was established by NASA and NOAA in 2001, with the DoD becoming a partner in 2002. The goal of the JCSDA is to accelerate the use of observations from earth-orbiting satellites in operational numerical analysis and prediction models for the purpose of improving weather forecasts, improving seasonal to interannual climate forecasts, and increasing the accuracy of climate data sets. Advanced instruments of the current and planned satellite missions, do and will increasingly provide large volumes of data related to atmospheric, oceanic, and land surface state. These data will exhibit accuracies and spatial, spectral and temporal resolutions never before achieved. The JCSDA will ensure that the maximum benefit from investment in space is realised from the advanced global observing system. It will also help accelerate the use of satellite data from both operational and experimental spacecraft for weather and climate related activities. To this end the advancement of data assimilation science by JCSDA has included the establishment of the JCSDA Community Radiative Transfer Model (CRTM) and continual upgrades including, the incorporation of AIRS and snow and ice emissivity models for improving the use of microwave sounding data over high latitudes, preparation for use of METOP IASI/AMSU/HSB, DMSP SSMIS and CHAMP GPS data, real-time delivery of EOS-Aqua AMSR-E to NWP centers, and improved physically based SST analyses. Eighteen other research projects are also being supported by the JCSDA (e.g. use of cloudy radiances from advanced satellite instruments) to develop a state of-the-art satellite data assimilation system. The work undertaken by the JCSDA represents a key component of GEOSS. In particular data assimilation, data impact studies, OSSEs, THORPEX and network design studies are key activities of GEOSS. Recent advances at the JCSDA including the demonstration of the benefits in the Northern and Southern Hemisphere of AIRS radiance assimilation on NCEP GFS forecasts, demonstration of the benefits of MODIS Polar atmospheric motion vector assimilation on NCEP GFS forecasts and the beneficial impact of the CRTM's modeling of sea ice and snow emissivity are recorded below.

2. BACKGROUND

An indication of the impact of satellite data on improving operational numerical weather forecasts is given in Fig. 1, which shows the anomaly correlation coefficient (ACC) for 500mb height calculated for the NCEP 5-day forecast as a function of time. The correlation is between the observed and predicted deviations from the climatological 500mb height field. Neglecting interannual variability, a steady improvement in the ACC is evident, with a larger rate of improvement for the Southern Hemisphere. The noticeable improvements in the late nineties are due, to a significant degree to direct radiance assimilation and instruments such as the Advanced Microwave Sounding Unit (AMSU).

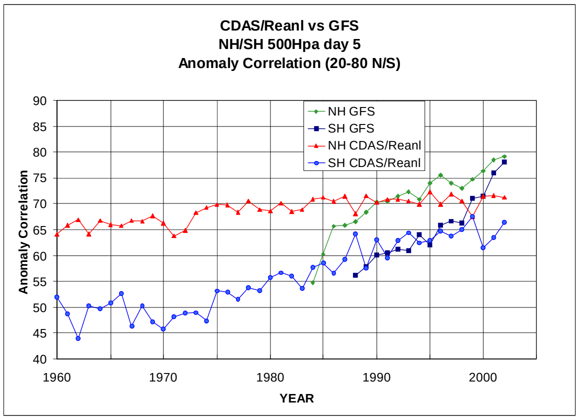

Figure 1. Anomaly correlation coefficient (ACC) for 500mb Z for NCEP 5-day forecast as a function of time. Red and blue (green and black) lines refer to fixed (evolving) model and assimilation system. Red and green (blue and black) lines refer to the Northern (Southern) Hemisphere.

Despite recent improvements in forecast skills however, there is remains room for substantial improvement, in particular toward decreasing the frequency of larger than normal forecast errors, or "busts". It is very clear that assimilation of satellite observations will make a key contribution to that improvement, given the future growth (five orders of magnitude increase in satellite data over ten years) and improvement of the global observing system expected in the area of space-borne

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observing systems. As a result there is a need for increasing the emphasis on satellite data usage in the data assimilation community, both in terms of introducing new and additional satellite data, and refining the assimilation methodologies for both current observations and those from future platforms. This is a complex challenge, whose solution will provide considerable return on investment made in the satellite observing network. Over the coming years, operational instruments, with the capabilities of the current experimental Atmospheric Infrared Sounder (AIRS) will be launched. These instruments will provide data at spatial, spectral and temporal resolutions vastly exceeding those of earlier instruments. This provides the NWP and data assimilation communities with new possibilities and new challenges. New possibilities arise, for example, because of the unprecedented vertical resolution provided by these instruments. New challenges because of the sheer volumes of data they will provide and because of many scientific questions that need to be answered in order to make optimal use of these observations.

3. THE JOINT CENTER FOR SATELLITE DATA ASSIMILATION

In April 2000, a small team of senior NASA and NOAA science managers released a white paper containing plans to improve and increase the use of satellite data for NWP and climate purposes. The white paper provided a specific recommendation to establish a Joint Center for Satellite Data Assimilation (JCSDA). This white paper came in response to a growing urgency for more accurate and improved weather and climate analyses and forecasts. These improvements could only be made possible by the development of improved models and data assimilation techniques, which allow models to utilize more and better quality data. In 2001 the Joint Center was established and in 2002, the JCSDA expanded its partnerships to include U.S. Navy and Air Force.

The cooperative agreement allows the Center partners to take advantage of the science and technology resources of NOAA, NASA and the Department of Defense (DoD) in order to accelerate the use of existing and new satellite data. The JCSDA also provides a focal point for the development of common models and infrastructure among the DoD, NOAA, and NASA partners. This shared approach to research and development activities will eliminate the need for redundant resources and will reduce the need for duplicated efforts within the various government agencies. NOAA has provided a centralized location for JCSDA administrative and information technology (IT) resources. Geographically distributed JCSDA components will be located in various JCSDA member organizations. Projects may be located at universities and other facilities.

The JCSDA consists of an Oversight Board, Director, Deputy Directors, Scientific Staff and Technical Liaisons who represent participating members of the distributed JCSDA. An Advisory Board and the Science Steering Committee provide external advice and review.

All planning efforts have been a collaborative effort among NASA, NOAA and DoD, defining a process that ensures teamwork is a continuing attribute of the JCSDA. Initial efforts have focused on defining a life-cycle approach to data assimilation projects. Several critical elements have been defined: Firstly an end-to-end process that begins with defining an instrument, then moves to characterizing that instrument's in-flight performance, to developing algorithms and testing forward models for data assimilation, to testing the impact of synthetic data, integrating the data into operational systems, and finally to assessing the data's impact on analyses and forecasts. Secondly, a scientific review process by JCSDA personnel and the JCSDA Science Steering Committee, which provides feedback on each scientific project and determines if new systems are ready for implementation into operations. Thirdly, a transition-to-operations plan to ensure that new systems developed at the JCSDA are transitioned smoothly and JCSDA scientists participate in the overall implementation process to the extent needed.

The prime benefit from the JCSDA will be improved weather and climate analyses, forecasts and warnings and an extension of the time range of weather and climate forecasts, resulting in reduced losses of life and property. There will also be considerable productivity increases by reducing the average time for operational implementation of data from new satellite technology from two years to one year. With average satellite lifetimes of five years, this represents a 20 percent productivity increase per satellite. Enhancements to the current satellite data assimilation process are also being developed.

4. JCSDA MISSION, GOALS AND SCIENCE PRIORITIES

The mission of the Joint Center for Satellite Data Assimilation is to accelerate and improve the quantitative use of research and operational satellite data in weather and climate analysis and prediction models.

Three goals support this mission. The first is to reduce from two years to one year the average time for operational implementation of new satellite technology. The second is to increase the use of current satellite data in NWP models and the third is to assess the impacts of data from advanced satellite sensors on weather and climate predictions. The first goal will result in an increase of 20% in productivity. In the second goal we emphasize the uses of current satellite data because for example fundamental information from satellites associated with clouds and precipitation has not yet been optimally assimilated and the benefits of the current sensors to weather and climate predictions have not been maximized.

To achieve its goals, the JCSDA has *initially* set the *five scientific priorities* discussed below:

4.1 Improve Radiative Transfer Models

4.1.1 Atmospheric Radiative Transfer Modeling – The Community Radiative Transfer Model (CRTM)

Satellite radiances are not components of atmospheric state vectors predicted by NWP models. For radiances to be assimilated by NWP models, a relationship between the model state vectors and the observed radiances is required. This is provided by forward radiative transfer models with the state vectors as input (see Fig. 2). In addition, the Jacobian vectors (or the derivative of radiance relative to the state vectors) are also needed for satellite data assimilation systems. Radiative transfer modeling uses atmospheric transmittance as the key input. The transmittance varies with the atmospheric conditions in a complicated way and is often computed through the line-by-line (LBL) models. Although LBL models are accurate, they take considerable time to calculate transmittances for just a few atmospheres. To provide accurate transmittances in a timely fashion, the JCSDA has generated and uses fast approximations commonly known as fast forward models for specific channels. Current fast models are discussed in Kleespies et al., 2004.

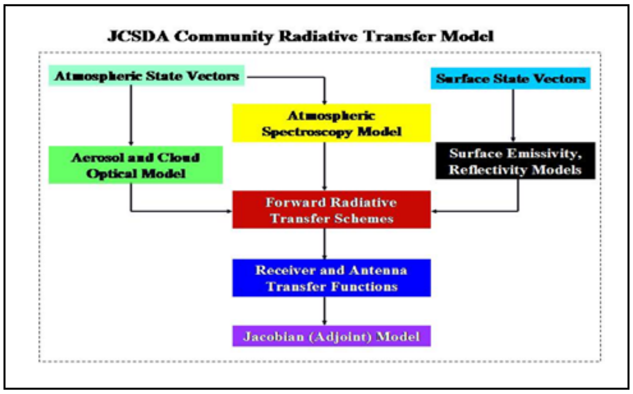

Figure 2. Components of the JCSDA community radiative transfer model (CRTM).

Transmittance models now need consider more minor gases such as carbon dioxide, methane, and carbon monoxide because the forecast models are making more use of satellite measurements that are sensitive to them. Presently, transmittance models usually only include a number of “fixed” gases, water vapor, and ozone. Assimilating these measurements into forecasting models and predicting their distributions require transmittance models that include variations in these gases. As the transmittance models become more accurate, the variations in retrieved temperature due to changes in minor gases become significant when they are ignored. For these reasons, future fast models must include the effects of these minor gases. In the short wavelength regions near four microns, aerosols begin to have a minor but significant effect. Volcanic gases and aerosols can also affect the radiation at other wavelengths as well, and must be included in transmittance calculations.

To fully utilize the information of satellite measurements under all weather conditions for NWP, forward modeling capability needs to be enhanced to include both scattering and polarization processes (Fig. 2). Cloud affected satellite radiances have not generally been assimilated into operational forecasting models although the measurements contain considerable information pertinent to the atmospheric hydrological cycle. In the next decade, many advanced infrared and microwave sensors will be deployed in space and their sensitivity to various atmospheric and surface parameters is significant. *The uses of cloudy radiances in NWP models will ultimately enhance the impacts that have been demonstrated presently through clear radiance assimilation and add to our knowledge of clouds, the surface and the hydrological cycle*.

4.1.2 Surface Emissivity Modeling

Satellite observations in and around window regions of absorption spectra are affected by surface emissivity. Without a surface emissivity model, measurements from advanced sounders for example may not be effectively assimilated into NWP models. As a critical part of a radiative transfer model (see Fig.2), surface emissivity modeling should explain the variability of both emissivity and reflectivity. The JCSDA is supporting theoretical and technology advances in quantifying the emissivity spectrum for various sensors covering the global environment.

4.2 Prepare for Advanced Operational Instruments

A key activity of the JCSDA is the development of the methodologies and associated software and hardware tools for assimilating data from the next generation of advanced satellite instruments. These instruments will be flying on NOAA, NASA and DoD satellites, as well as other international spacecraft. The large number of advanced sensors will provide environmental data at spatial, temporal, and spectral resolutions never before achieved. A key performance measure for the JCSDA will be a decrease in the time required to develop and transfer assimilation systems to NOAA, NASA and the DoD for operational use, for each new instrument. The development process will have pre-launch and post-launch phases.

4.3 Assimilating of Observations of Clouds and Precipitation

4.3.1 Assimilation of Precipitation

Satellite precipitation estimates have two key strengths for data assimilation. Firstly, they have a wide area of coverage, especially over the data sparse oceans. Secondly, they provide a means for adjusting the vertical profile of latent heating in the atmosphere, which is a quantity that typically cannot be obtained using current in situ coverage. This adjustment is usually accomplished by inverting the convective parameterization scheme of the model and adjusting the vertical profiles of latent heating and, consequently, of temperature and moisture (Krishnamurti et al., 1983; Hou et al., 2000). This process will increase the consistency between the model precipitation and the observed precipitation during a dynamic assimilation period. Similar adjustments can be made to vertical profiles of moisture for grid-scale precipitation.

A number of issues remain to be resolved, however, in order to make optimal use of precipitation data in NWP models, including, the current accuracy of precipitation estimates from satellite data; the lack of error characterization of satellite precipitation estimates at model scales in a form that can be used to develop appropriate weighting for assimilating the data; convective schemes still do not accurately depict the relationship between latent heating and precipitation; and a single value (precipitation rate) cannot by itself adequately constrain and adjust vertical profiles of latent heating (and thus temperature and moisture).

4.3.2 *Direct Assimilation of Radiances in Cloudy and Precipitation Conditions*

Direct radiance assimilation under cloudy and precipitating conditions may be improved by detailed information on the profiles of cloud microphysical variables that can be explicitly simulated by the NWP models. Cloud schemes based on Zhao and Carr (1997) and Ferrier et al. (2002) for example have been implemented into NCEP global and regional (Eta) forecast models, respectively. These schemes run slightly different physical packages but predict water mixing ratios associated with various condensates within the model grids. In principle, these cloud schemes can resolve all cloud condensates only when the model resolution is increased to less than a few kilometers. At larger resolutions, the forecast model must use the cumulus parameterization scheme to determine the clouds and precipitation associated with convective motion.

To estimate the quality of the model predicted cloud condensates, observational data sets are required to characterize the errors of the forecast model cloud water/ice content. Retrievals from satellite passive sensors may be used for assessments of model errors in the column-integrated water (Weng et al., 1997), however, it remains difficult to characterize the errors in the profiles of cloud condensates predicted by forecasting models before the data from satellite active sensors such as Cloudsat (Stephens et al., 2002) become available.

The errors of forward radiative transfer models in cloudy conditions also need to be characterized. At microwave frequencies less than 60 GHz, the cloud optical parameters are not sensitive to the particle size and the errors of the forward model may be characterized. However, in microwave window channels, the simulations of cloudy radiances are complicated by the variability in surface emissivity. Understanding the error characteristics at higher microwave frequencies, and visible/infrared wavelengths remains a challenge since the radiative transfer processes are more sensitive to particle size distribution, shape, bulk volume density and phase (Evans and Stephens, 1995; Weng and Grody, 2000). The simulations are also affected by the vertical structure of clouds in various phases. It is necessary that detailed observational data of cloud microphysical parameters be available in order to quantify the forward model errors.

4.4 Assimilation of Land Surface Observations from Satellites

NWP models can use satellite based operations to provide model lower boundary conditions in two ways: In the specification of surface boundary conditions and as forcing in uncoupled model surface physics schemes. Lower boundary conditions for NWP models over land surfaces include most of the properties of vegetation, soil, and snow/ice cover. Quantities such as green vegetation fraction, leaf area index, vegetation class, soil albedo, surface emissivity, and snow cover and snowpack parameters (snow water content, snow depth) can be estimated from satellite measurements. Because some of these characteristics change on time scales of hours to days, real-time estimates from satellite observations are required. Satellite estimates of components of the surface radiative fluxes and precipitation may be used to force uncoupled land data assimilation systems (e.g. LDAS). Near real-time estimates of insulation, downward longwave and surface temperatures (the latter for surface physics validation, and later for assimilation into the surface model) are required.

Land surface states are also critical to the initialization of seasonal climate forecasts, especially the memory in the system associated with soil moisture and snow. Global retrievals of snow mass, snow cover and soil moisture are available from various research satellite sensors, including AMSR-E and MODIS on the Aqua satellite. NASA GMAO has developed a system to assimilate these data into the GMAO catchment land surface model using an Ensemble Kalman Filter and are in the early stages of incorporating the system into the GMAO coupled seasonal forecast system. As with other data types, an issue to be addressed is the observational error characterization and biases between different data sources and models (e.g., Reichle et al., 2004; Reichle and Koster, 2004).

4.5 Assimilation of Satellite Oceanic Observations

Satellite-derived ocean observations/products are increasingly being used in data assimilation systems. The wind vectors over oceans are retrieved directly from QuikSCAT data and are being operationally assimilated into the GDAS. Oceanic wind speeds derived from DMSP SSM/I and are also assimilated into the GDAS. Outstanding issues still remain. Satellite observations are currently being utilized at a degraded resolution. For QuikSCAT, NCEP has completed a study using the data at near half-degree resolution and have shown forecasting skills are improved at this increased resolution. Further efforts will focus on utilizing the data in higher resolution models such as the future WRF models.

Recently at JCSDA, Derber and Li (private communication) have developed an assimilation methodology for deriving accurate SSTs from clear radiances. In the longer term this will allow sea surface temperatures to be consistent with atmospheric and skin temperatures derived from multispectral radiance observation. Several other oceanic data assimilation projects are underway and may be viewed on the JCSDA website (www.jcsda.noaa.gov). In particular, NCEP and NASA GMAO have developed ocean data assimilation systems to initialize the ocean as part of their coupled seasonal forecast systems. Although the TAO/TRITON mooring array has had a substantial impact on the forecast skill of equatorial Pacific sea surface temperature, the array is sparse and even with other in situ data provide inadequate coverage outside the equatorial Pacific. Hence the near-global information provided by satellite surface altimetry, along with the ocean surface winds, is a critical source of information on ocean variability. Even so, the use of this surface information to infer the subsurface ocean variability that contains the memory of the climate system is not without difficulty, particularly with inadequate information of the geoid. The developments at NCEP and NASA and in the external contributions to the JCSDA are focused on how to make best use of this data source and how to characterize the observational errors in sea surface height in terms of representativeness for the climate system (e.g., Kaplan et al., 2004). The NCEP Global Ocean Data Assimilation System (GODAS) is a three-dimensional variational (3DVAR) method that is an extension of the work of Derber and Rosati (1989) (e.g, Behringer et al., 1998). At NASA GMAO, multivariate forecast error statistics are derived from an Ensemble Kalman Filter to project the information from the surface data to the subsurface ocean (e.g., Keppenne and Rienecker, 2002, 2003). Related developments are focused on improvement of assimilation systems to take into account systematic errors in the forecast models, using techniques following Dee and Da Silva (1998).

5. RECENT ADVANCES

5.1 The Community Radiative Transfer Model (CRTM)

The JCSDA has made significant advances in formulating a Community Radiative Transfer Model (CRTM). For atmospheric transmittance calculations, the gas absorption coefficients are predicted with the atmospheric parameters and the polynomial expansions of the absorber amount (Kleepies et al., 2004). This approach significantly reduces the coefficients which reside in computer memory and preserves the accuracy. Now, only 70 coefficients instead of 1800 are needed to compute the transmittance at each channel. The transmittance is calculated with a correction term to account for the average strengths of gaseous absorption within the instrument band width. In addition, new predictors are added to improve the ozone absorption. Figure 3 displays the performance of a recent fast transmittance model (OPTRAN-V7) and compares it with the recent operational model for 20 HIRS channels.

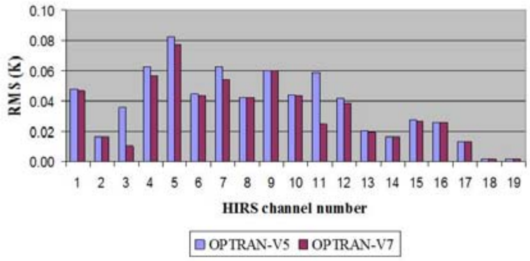

Figure 3. Latest optical path of gaseous transmittance model performed at 19 HIRS channels

Studies have also been completed to develop a fast microwave radiative transfer model which includes scattering and polarization of clouds, precipitation and aerosols (Liu and Weng, 2002) and (Weng and Liou, 2003). Recent work has also addressed the modeling of ice and snow emissivity, and trials have shown improvement in high latitude forecasts from NCEP's Global Forecast System(GFS). Fig.4 shows the improved anomaly correlation at 850hPa for the GFS with the new emissivity model, compared to the control (Operations).

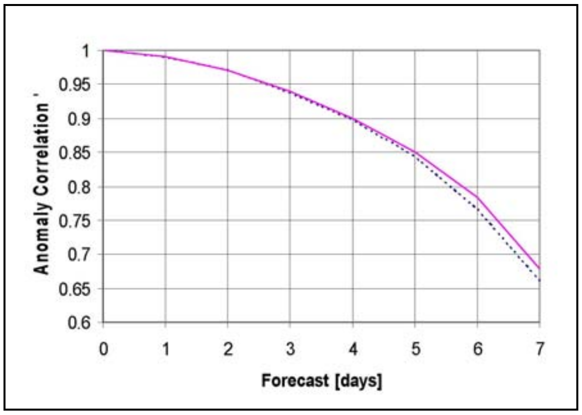

Figure 4. Impact of sea ice and snow emissivity models on the GFS 24 hr. fcst. at 850hPa. (1 Jan. – 15 Feb. 2004); the pink curve shows theACC with new snow and sea ice emissivity models).

5.2 AQUA Applications: AIRS Data Thinning, Distribution and Impact/MODIS Winds

The JCSDA has successfully distributed AIRS data to the world's major NWP centers. An initial constraint in providing AIRS radiances in near real-time to the main NWP centers is data volume size. AIRS/AMSU/HSB level 1b data is about 2.5 Gigabytes for a 100 minute orbit in comparison to the approximately 14 megabytes per orbit from ATOVS (HIRS ~4.5 megabytes, AMSU-A ~2 megabytes, AMSU-B ~7.5 megabytes). Each six-minute granule consists of 90 AIRS and HSB field of views (fov) per scanline and 30 AMSU-A fovs per scanline. There are 135 AIRS and HSB scanlines per granule, and 45 AMSU-A scanlines per granule (Goldberg et al., 2003; Aumann et al., 2003). A simple solution to the relatively high volume of AIRS/AMSU/HSB is to increase available communication bandwidth. But that option is costly and at present most NWP centers cannot assimilate all the data due to computational costs and limitations in storing the data. As a result the AIRS/AMSU/HSB data are thinned into several sub-datasets Visually, each AMSU-A fov, which has a spatial resolution of approximately 42 km on the Earth near the nadir view position, contains a 3 x 3 array of AIRS and HSB fovs, each with a spatial resolution of approximately 14 km. The AIRS and HSB fovs are spatially coincident. The data are thinned by sub-sampling fovs and channels. A subset of about 324 channels (see Figure 5) is extracted from the center AIRS fov of the 3 x 3 array, as well as all 15 AMSU-A channels and the 4 HSB channels from the center HSB fov. Each granule has two files, each containing data from alternate center fovs. The size of each file is about.5 megabyte. An orbit of data is about 16 megabytes which is only about 15% greater than the full ATOVS data. The method of channel selection is described in (Suskind et al., 2003). The single fov thinned radiance dataset is the core data that is used by most NWP centers assimilating AIRS radiances. The files are available in BUFR and HDF formats.

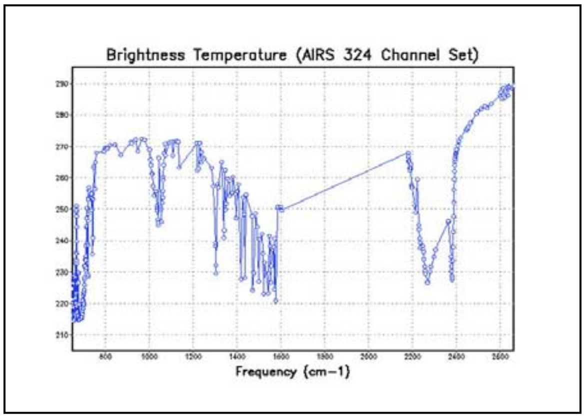

Figure 5.Spectral locations for 324 AIRS thinned channel data distributed to NWP centers.

The result of this distribution is that several key Centers have documented their utility for NWP, and included the radiances in their operational data stream. Evidence of the positive impact of AIRS data on global forecasts has been recorded in trials at the JCSDA, where each fov has been considered, and can be seen in Fig. 6 (a) and (b) (Le Marshall et al., 2004a,b). The improvement in forecast skill at 6 days is equivalent to gaining an extension of forecast capability of several hours.

This is quite significant when compared to the rate of general forecast improvement over the last decade. A several hour increase in forecast range at 5 or 6 days normally takes several years to achieve at operational weather centers.
Operational use of these AIRS data will be enabled by the enhanced computing resources associated with the next operational upgrade at NCEP.

A number of studies have also been completed in relation to the use of data from the MODIS instrument on AQUA. Winds generated using sequential MODIS images over polar regions (Daniels et al., 2004) have been used in a series of impact studies using NCEPs operational global forecast model (Le Marshal et al., 2004). Impacts in both northern and southern high latitudes were positive (see for example Fig. 7) even though winds were only assimilated up to the second last analysis, to simulate existing operational data availability. These data will also become part of the operational suite at NCEP after the next system upgrade.

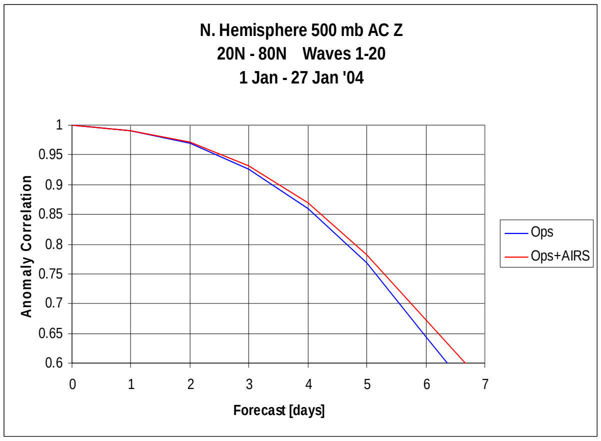

Figure 6(a) Impact of AIRS on GFS forecasts at 500hPa (1 – 27 Jan. 2004); pink (blue) curve shows ACC with (without) AIRS data. (20-80°N)

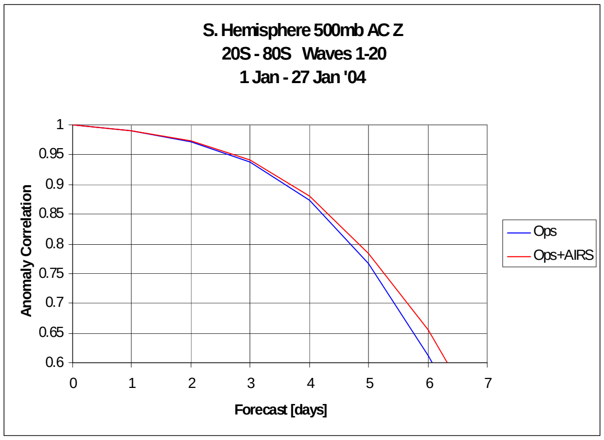

Figure 6(b) Impact of AIRS data on GFS forecasts at 500hPa (1 – 27 January 2004; pink (blue) curve shows ACC with (without) AIRS data. (20-80°S)

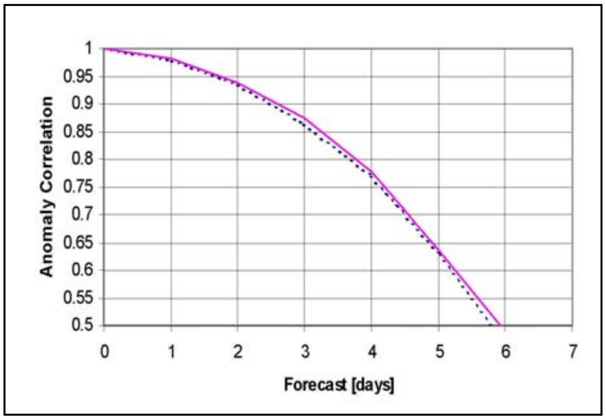

Figure 7. Impact of MODIS AMVs on the operational GFS forecast at 500hPa (60°S - 90°S). (1 Jan. – 15 Feb. 2004); the pink (dashed) curve shows the ACC with (without) MODIS AMVs

5.3 Precipitation and Cloud Data Assimilation

Satellite precipitation products are assimilated at JCSDA member institutes. At EMC, the global data assimilation system (GDAS) makes use of instantaneous rain rates derived from SSM/I and TMI brightness temperatures. The Eta model data assimilation system (EDAS) uses these observations as available over its North American domain plus total column water vapor (TCWV) from GOES (over land) and SSM/I (over water). Overall, the greatest effect of rain rate assimilation is the reduction of excessive precipitation. Increases in the simulated rain rates are less pronounced.

At NASA GMAO, Hou et al. (2000) has also assimilated the TMI derived surface rainfall and total precipitable water (TPW) into the Goddard Earth Observing System (GEOS) global analysis. A unique feature of the GEOS data assimilation system is that it uses the incremental analysis update (IAU) developed by Bloom et al. (1996), which virtually eliminates the spinup problem. The control variables are analysis increments of moisture and temperature, within the IAU framework. The procedure minimizes the least squares differences between the TMI observations and the corresponding values generated by the column model averaged over the 6-h analysis window. The minimization procedure is one-dimensional, but the evaluation of the cost function involves a 6-h time integration of the time-averaged rainfall and TPW.

6. THE FUTURE

JCSDA activities are divided into directed R&D/infrastructure activities and proposal-driven projects. Initially, infrastructure activity will maintain focus on the development and maintenance of a scientific backbone for the JCSDA community fast radiative transfer model, a community emissivity model, and an infrastructure for performing assimilation experiments with real and simulated observations from new and future instruments. Proposal-driven scientific projects will be an important mechanism used to accelerate the transition of research and technological advances in satellite data assimilation by planned incorporation of new code into the NASA/NOAA/DoD operational data assimilation systems and by performance of preliminary testing with these systems. Initial JCSDA projects in the past few years have solidified NOAA, NASA and DoD collaborations on AIRS, QuikSCAT, TRMM, and the NPOESS Preparatory missions. Furthermore, the JCSDA will facilitate further collaborations in areas deemed potentially important for improving climate and weather prediction, such as in the utilization of IASI, CrIS/ATMS, GIFTS and GPS radio-occultation data and will support an examination of the utility of geostationary microwave observations.

A primary goal of the JCSDA in next few years will be to lay the groundwork for and to establish a common data assimilation infrastructure for assessing new satellite data and optimizing the utilization of these data in operational models. An important step is to establish, and make accessible to the community, parallel versions of the EMC, GMAO and DoD partners global/regional data assimilation systems on JCSDA computer systems. This will include establishment of real-time communications to JCSDA computers and real-time data bases and observation handling algorithms for continued assessment of new instruments.

A most important activity for the Center is planning in relation to the form of the next generation assimilation system to be used by the partners. Strategic planning activity is already underway detailing the optimal form of the infrastructure, for the next model and assimilation system. Planning involves the use of the 4DVar and Ensemble Kalman Filter Approaches.

In summary JCSDA deliverables by 2007 will include the development of a community forecast and data assimilation system for both global and regional scale applications. The system will be linked to the research community through the USWRP and will serve as the primary mechanism for infusing research and operational satellite data into NCEP, GMAO and DoD operations.

In conclusion, a strong start has been made by the JCSDA. This has been vital, as the strength of satellite data assimilation in the Center is central to the quality of future operational climate and weather analysis and forecasting in the US. As a result every effort is being made by the partner organizations to work effectively together for the common good.

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