Assimilation of passive microwave radiometers has proven useful in Numerical Weather Prediction (NWP), providing Stokes parameters. The COWVR project, with full polarimetric capability, is investigating the ability of fast radiative transfer models to simulate the third and fourth Stokes parameters in NAVDAS-AR, the only microwave sensor which is assimilated using correlated observation error treatment. Key among these developments is the ability to assimilate temperature sounding information, water vapor information, and precipitable water information. The focus of this work is introducing new sensors to NAVDAS-AR and running cases with NAVGEM global model utilizing available system metrics (Forecast Sensitivity Observation Impact, Radiance Fits to Observations, etc.).

Questions:
1. What are the benefits of adding SAPHIR, AMSR2, and GMI?
2. How can we improve the assimilation of TPW retrievals from NAVDAS-AR?
3. What are the impacts of removing TPW retrieval assimilation from NAVDAS-AR?

Methods:
- Add new sensors to NAVDAS-AR and run cases with NAVGEM global model utilizing available system metrics.
- Prepare for COWVR: ECMWF Analysis Fields in combination with RTTOV and CRTM to simulate Windsat, and compare with Windsat observations of 3rd and 4th Stokes parameters.
- Desroziers Method (Desroziers, 2005) to calculate correlated observation error for new sensors.
- Replacing TPW retrievals with direct assimilation of microwave channels.
- Add new sensors to NAVDAS-AR and run cases with NAVGEM global model utilizing available system metrics.

Replacement of TPW retrievals: Effects on forecast

- The replacement of TPW retrievals with direct assimilation resulted in slightly less convective precipitation for light rain events (Figure 11).
- Experiments with TPW retrieval vs no TPW retrieval resulted in a modestly improved score of +6 vs -11 against OPS (Figure 12).

Preparing for COWVR: Polarimetric Observations and Simulations

- We use Windsat’s 18.7 GHz 3rd Stokes parameter measurement as means of validating RTTOV and CRTM in preparation for Windsat.
- We use 0.5 degree ECMWF fields and the Python RTTOV interface.
- Comparing the upper panel and middle panel in Figure 13 there is a clearly phase difference between the observed (top) and simulated (middle) using FASTEM5.
- Chen and Wang, 2016 pointed out this phase shift for FASTEM3, previously.
- When reverting to FASTEM3, this phase difference disappears, see bottom panel in Figure 13.
- We have developed a Python interface along with a modified version of the CRTM 2.2.1, and we observe the same phase difference between observed and simulated using FASTEM5. FASTEM3 is not available in the CRTM.
- RTTOV 12.1 has components which can be used to simulate the 3rd Stokes parameter, while the CRTM requires some modification, and perhaps modifications to update FASTEM or reverting to FASTEM3.

Summary

- Three new microwave sensors (SAPHIR, GMI, and AMSR2) have been added to NAVDAS-ARNAVGEM and show good impact as measured by FSOI, and forecast scores.
- Correlated observation error was recently added to NAVDAS-AR, along with one microwave sensor (AMSR), more microwave sensors will be added in the near future.
- Comparing Windsat observations of the 18.7 GHz 3rd Stokes parameter with simulated from RTTOV12.1 and FASTEM3 are comparable. FASTEM3 appears to have a 90 degree phase shift. Work is needed to update FASTEM 5.0, and CRTM needs modifications to enable 3rd and 4th Stokes parameters individually.

Future Work

- Add Windsat V/H channels to NAVDAS-AR similar to what has been done for GMI, and AMSR2.
- Add Correlated observation error capability for SAPHIR, MHS, and AMSR2, keeping in mind AMSU-A has a slightly different channel selection per platform.
- After Launch, COWVR Calibration and Validation along with adding direct assimilation of V and H channels initially, and perhaps 3rd and 4th Stokes parameters.

References

- Desroziers, G. et al. 2005: Diagnosis of observation, background and analysis-error statistics in observation space, Quarterly Journal of the Royal Meteorological Society, DOI:10.1256/qj.05.108