Exploiting Satellite Observations of the PBL for Land-Atmosphere Interaction Studies

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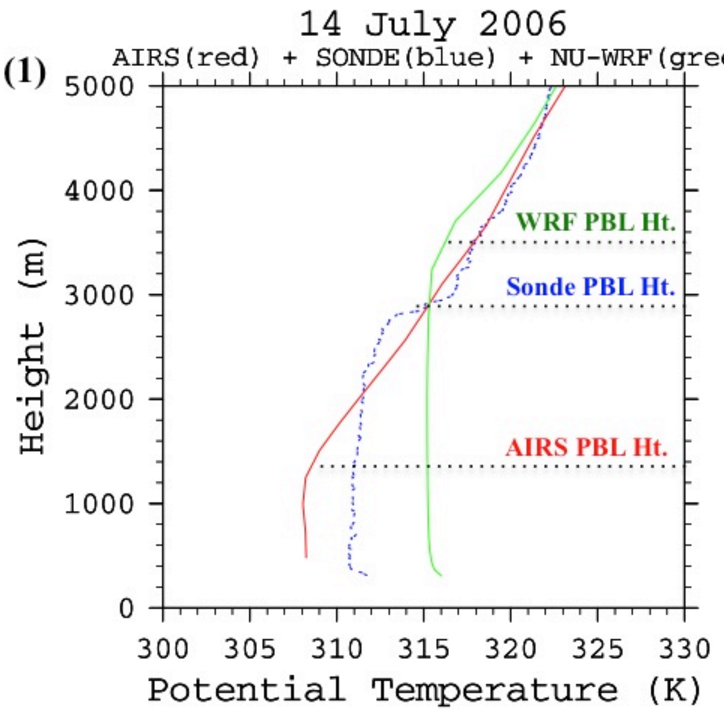

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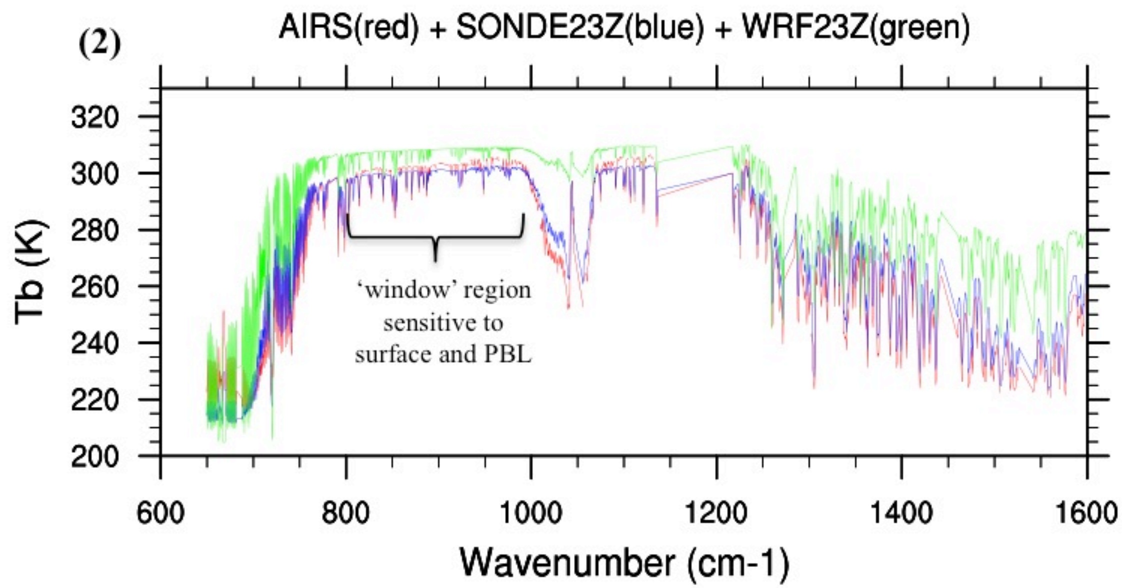

•**The Planetary Boundary Layer** (PBL; <4km above the surface) is a critical reservoir and integrator of land surface process, water and energy cycling, and land-atmosphere (L-A) interactions.

•**Observations of PBL height, temperature, and humidity** are therefore necessary for evaluation and development of L-A coupling in weather and climate models.

•Current **satellite-based *indirect* estimates of PBL structure** (such as from AIRS; **Fig. 1**) are limited by biases in the PBL and/or insufficient spatial, vertical, or temporal coverage.

•By **converting profiles into radiances** (brightness temperature; Tb) measured by the satellite (**Fig. 2**), models and in-situ observations can be ***directly*** compared against the full spectrum of instrument channels sensitive to the land surface and PBL.

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Data Sources:

•**AIRS** measures L1B cloud-cleared radiances across the NIR spectrum, and from this retrieves L2 vertical profiles of temperature and humidity through the troposphere. AIRS (aboard Aqua) is a high resolution sounding instrument that employs 2378 spectral channels with a footprint at nadir of 13km. One profile retrieval is generated for each 3x3 array of AIRS footprints, giving a spatial resolution of 45km and 100 vertical levels and a target accuracy of 1°K/1km for temperature and 15%/2km for humidity.
•Corresponding model output for the same site and time period is from the **NASA Unified WRF (NU-WRF)** model, which is coupled to **NASA's Land Information System (LIS)** to allow for investigations of land-atmosphere coupling and land surface model spinup and calibration. NU-WRF has been run over a large 1km domain over the SGP for this study.
•In-situ observations are from **radiosonde** launches at the **DOE-ARM** facility in Lamont, OK.
•Modeled and observed radiances (Tb) are then generated from the **GSFC Satellite Data Simulator Unit (G-SDSU)** with the addition of the new **Stand Alone Radiative Transfer Algorithm (SARTA)** that exactly replicates the Tb channel resolution of AIRS.

Technical Description of Figures:

Figure 1: Intercomparison of vertical temperature profiles in the lower troposphere from AIRS (red), radiosonde (blue), and NU-WRF (green) on 14 July 2006 over the U.S. SGP region. Limitations of AIRS vertical resolution and accuracy are apparent (PBL height too low; profiles too cold) and limit the ability of AIRS profile retrievals to be used as observations or benchmarks for models.
Figure 2: Brightness temperature spectra for AIRS, sonde, and NU-WRF valid at the same time and location as Fig. 1. By converting the model and sonde profiles into Tb radiance space using G-SDSU/SARTA, direct comparison over 2378 channels can be performed to see where differences, sensitivities, and accuracies lie across the spectrum. The window and PBL-sensitive channels are of primary interest for L-A interaction studies.

Scientific significance, societal relevance, and relationships to future missions: Land-atmosphere interactions remain weak links in our current quantification of the water and energy cycle. This work combines unique NASA satellite and model products to evaluate the ability of current sensors (namely AIRS) to retrieve variability in land-PBL properties and in turn used as a global benchmark to which evaluate models against. To date, profile retrievals from AIRS in lower troposphere over land have shown limited accuracy, but empirical studies suggest that radiances themselves are in fact sensitive to land and PBL variability. Thus, transforming model output profiles into radiance space enables direct comparison across satellite, models, and in-situ observations.
****Improvement in profile retrieval in the lower troposphere should be stressed as a priority for next-generation satellite missions, but is still largely ignored as PBL monitoring at daily and regional scales remains a significant gap in our suite of global observations.***