Thermodynamic Remote Sensing of the Boundary Layer and Above, A Network Approach

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ABSTRACT

Observations of the boundary layer, from the ground up to about 1,000 m, are critically important to the accuracy of atmospheric forecast and research models. But traditional sensors are typically limited in time and space, and insufficient to support the forecast accuracy desired by the renewables, utilities, aviation, air quality and water management industries. Microwave radiometers provide continuous all-weather boundary layer temperature and humidity profiles with radiosonde-equivalent assimilation accuracy. Radiometers also provide unique liquid profiles to 10 km height. A full suite of traditional forecast tools and indices can be generated if the thermodynamic profiles are combined with wind profiles. In addition, the profiles can be assimilated in numerical weather models.

The Earth Networks Boundary Layer Network (ENBLN) is the first monitoring network for continuous collection of planetary boundary layer data up to around 10 km height. The ENBLN will use radiometers from Radiometrics to provide round-the-clock temperature, humidity and liquid profiles of the boundary layer and above. Earth Networks will combine observations from these instruments with information from its global weather network of more than 8,000 weather stations.

ENBLN PILOT NETWORK BUILDOUT

To build a boundary layer network it was first critical to ensure the venture would be commercially viable. Several potential stakeholders were contacted for feedback on the ENBLN Network concept. Initial targets surveyed were Investor Owned Utilities, Independent System Operators (ISOs), Air Quality Districts, and Private Meteorological Firms. In this investigative stage, several atmospheric issues of concern were identified.

For cost feasibility, a wide scale deployment of the ENBLN was not an option. Too many sensors would be required to cover a large geographic region, and if the density of the sensors was not sufficient, the value of the data could be diminished. The companies settled on an initial network of 10 sensors to be deployed in the State of California, with concentration from the San Francisco Bay area southward.

PROPOSED NETWORK OPERATION

To facilitate easy data distribution to potential customers of the BLN, a centralized data processing approach was devised. Earth Networks is collecting the data from the 10 sensors centrally. This data will be made available from each sensor at an update frequency of 6 minutes. Daily archive files of hourly data will be maintained.

To ensure data quality and robust network operation, each site location will be visited a minimum of twice per year for complete field calibration. All sites will be monitored from a central Networks Operations Center. Here both data availability and data quality will be scrutinized and flagged. Field Technicians located in California will be dispatched to address any problem sites, with the goal of maintaining 99.5% availability during the pilot phase of network build-out.

ATMOSPHERIC TARGETS FOR PILOT

To address the business needs of our target customer base in Electric Utilities, Air Quality, and Federal Government, we focused on placing the radiometers at locations that would yield gains in understanding atmosphere phenomena that plague efficient electric utility operation, impact air quality, or could hinder operations at federal government facilities. The following atmospheric regimes we deemed most critical:

- Marine Layer Inversions
- Boundary Layer Stability near Wind Farms
- Santa Ana and Monsoonal Wind Flow

In all cases, the radiometer is adept at determining both the temperature and humidity profiles that enable forecasters to monitor the data in real-time for their operational purposes, and also allows for the data to be fed into Rapid Update Cycle models for an improved

view of initial boundary layer conditions, and therefore improved forecast output.

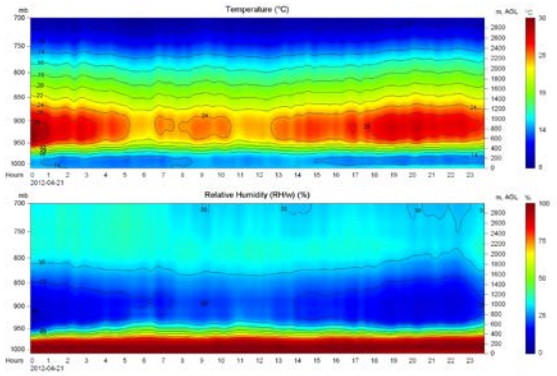

Figure 1. Top profile image shows the sharp temperature contrast over time between the cool surface in the marine cloud layer vs. the warmer air aloft. The bottom profile from the same time period illustrates the vertical extend of the cloud layer moisture, and the drier air aloft. This Data is from a 24 hour period covering 4/21/2012 from a radiometer based at LAX.

NEXT STEPS

The BLN is now moving from concept phase to deployment phase, with a target of late June for 80% network deployment. Once deployed, Earth networks and Radiometrics will be working to bring several customers of this information on-line. Significant efforts will be made to quantify operational usefulness of the data, and model output improvements as a result of better boundary layer initial condition data.

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