Description of the objective analysis of large-scale forcing data for the PECAN experiment

1. Overview

The Plains Elevated Convection at Night (PECAN) Experiment (Greets et al. 2017) was a large field campaign conducted from **1 June to 15 July 2015** supported by the National Science Foundation (NSF) with contributions from the National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA), and U.S. Department of Energy (DOE). PECAN is aimed to improve the understanding and simulation of the processes that initiate and maintain convection and convective precipitation at night over the central portion of the U.S. Great Plains. Nocturnal convection in the Great Plains is most often decoupled from the ground and is thus forced by other phenomena, such as a stable lower boundary layer, propagating bores, and low-level jets (LLJ), which are uniquely nocturnal. The experiment focuses on the processes and conditions leading to pristine nocturnal convective initiation (CI), the initiation, structure, propagation, and evolution of bores, solitons, and other trapped wave disturbances, the structure and evolution of the nocturnal LLJ, as well as the dynamical and microphysical structure of nocturnal meso-scale convective systems (MCSs).

The PECAN experiment was held over a large domain that encompasses most of western and central Kansas, northern Oklahoma, and southern Nebraska. A unique component of the PECAN observational strategy is the concept of the PECAN Integrated Sounding Array (PISA). As shown in Figure 1, there were **six fixed PISA sites (FP)** in the domain and **four mobile PISA sites (MP)**; the latter were relocated for each Intensive Operational Period (IOP) to augment the domain where convection was anticipated to occur. The DOE Atmospheric Radiation Measurement (ARM) Climate Research Facility's Southern Great Plains (SGP) Central Facility (CF) served as one of the fixed PISA sites in the southeastern cornerstone of the PECAN domain **(FP1)**. A large number of instruments from the NSF Lower Atmospheric Observing Facility pool, university investigators, a private company, and from other agencies such as NOAA and NASA were used to instrument the other PISA sites.

2. Data details

The large-scale forcing data are derived from the constrained variational analysis (VARANAL) (Zhang and Lin 1997), which has been widely used in SCM/CRM/LES studies. Multiple large-scale forcing datasets were developed for PECAN experiment to utilize data collected from both the fixed and mobile PISA sites to better capture various convective systems that occurred during

the field campaign. The standard forcing data for PECAN was derived over a fixed analysis domain centered at 38.5˚N, 98.75˚W for the entire PECAN period from 00Z 1 June - 23Z 15 July 2015 by utilizing soundings collected at the six fixed sites. In addition, PECAN scientists performed a number of one-night IOPs focusing on different missions (e.g., LLJ, MCS, CI, bore). The IOP information can be found at http://catalog.eol.ucar.edu/pecan/tools/missions. The forcing data was also developed for each IOP over a moving analysis domain according to the location of mobile radiosondes (Figure 2). All these forcing data are within the domain of 350km in diameter, similar as the continuous forcing data at the ARM SGP domain. The radiosonde measurements are combined with RAP analysis using the analysis scheme of *Cressman* [1957] as the background fields. Surface precipitation comes from the NCEP/EMC 4KM Gridded Stage IV Data. Other surface and TOA constraints are obtained from PECAN surface measurements and data archived by ARM (Figure 3). The time resolution is 1 hour and the vertical resolution is 25 hPa from 1050 hPa to 50 hPa.

Standard PECAN forcing data: continuous from 00Z 1 June - 23Z 15 July 2015 and located centered at 38.5˚N, 98.75˚W. Only the radiosondes from the six fixed stations are used to construct the large-scale forcing data in this domain. Data format:

> *pecan60varanaPECANC1.c1.20150601.000000.cdf*

IOP forcing data: 24-hour large-scale forcing data are generated for each one-night IOP from local noon to noon of the next day. The upper-level fields are constructed based on fixed and mobile radiosonde. The location of the analysis domain was chosen based on the location of the mobile radiosondes, as well as to cover the propagation path of MCSs or regions with CI but no other systems. The location of analysis domain for each IOP is given in a separated document *IOP_information_PECAN_VARANAL.pdf*. Data format:

> *pecan60varanaIOP**C1.c1.20150601.000000.cdf*

3. Note

radiosondes in fixed and mobile stations except FP1 were only launched during night time. For the period when no sounding was available, the RAP analysis data was used.

A separated document, *IOP_information_PECAN_VARANAL.pdf*, provides the location of mobile radiosondes, VARANAL domain, time period and weather summaries (from chief scientist summaries in http://catalog.eol.ucar.edu/pecan/tools/missions) for each IOP.

Forcing data for IOP 28 are not available, due to that the focused system was too far away from the PECAN research area.

4. References

Cressman, G. P., (1959), *An operational objective analysis scheme.* *Mon. Wea. Rev., 87,* 367-374.
Geerts, B., D. Parsons, C. L. Ziegler, T. M. Weckwerth, M. I. Biggerstaff, R. D. Clark, et al. (2017), *The 2015 Plains Elevated Convection at Night Field Project*, Bulletin of the American Meteorological Society, 98(4), 767-786, doi: 10.1175/bams-d-15-00257.1.
Zhang, M. H., and J. L. Lin (1997), *Constrained variational analysis of sounding data bases on column-integrated budgets of mass, heat, moisture, and momentum: Approach and application to ARM measurements.* *J. Atmos. Sci., 54*, 1503-1524.
Zhang, M. H., J. L. Lin, R. T. Cederwall, J. J. Yio, and S. C. Xie (2001), *Objective analysis of ARM IOP Data: Method and sensitivity.* *Mon. Weather Rev., 129,* 295-311.

5. Contacts

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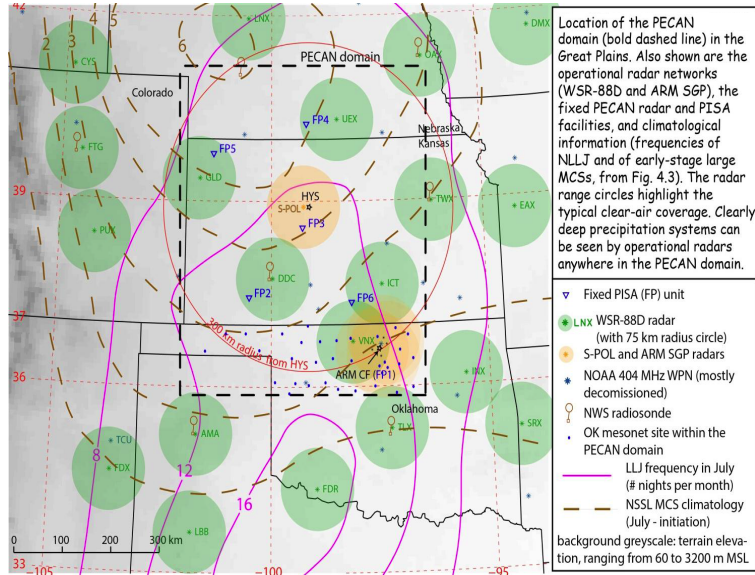*Shaocheng Xie:* *xie2@llnl.gov*

Figure 1: The PECAN experiment domain and the fixed ground observation network
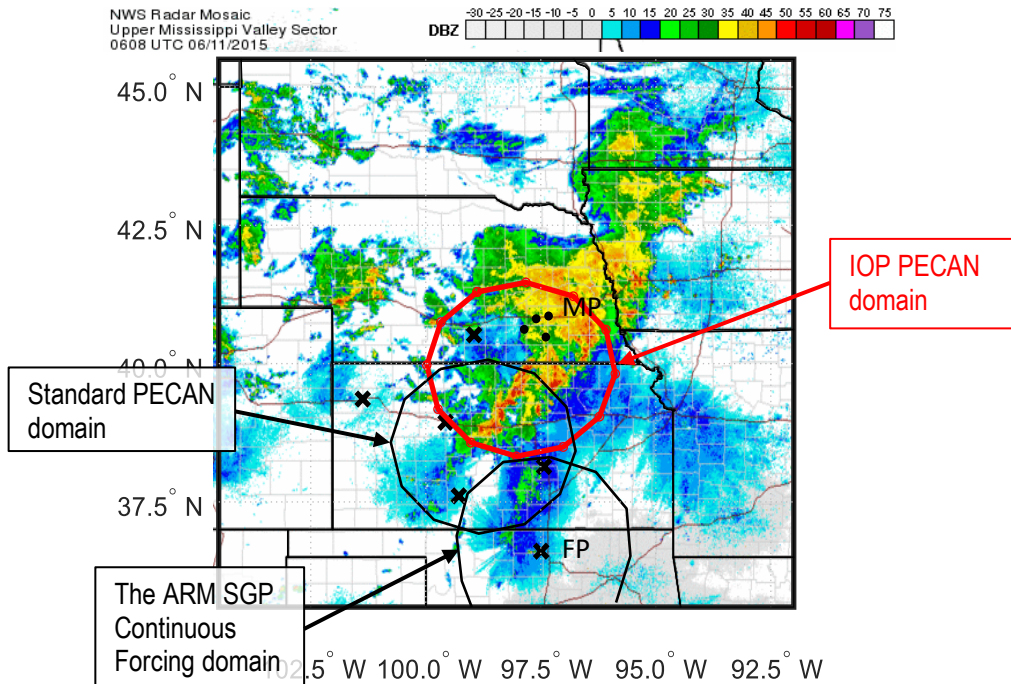
IOP8

Figure 2: An example of standard and IOP PECAN domain. Black crosses are location of fixed PISAs. Black dots are location of mobile PISAs at this IOP.

Surface stations
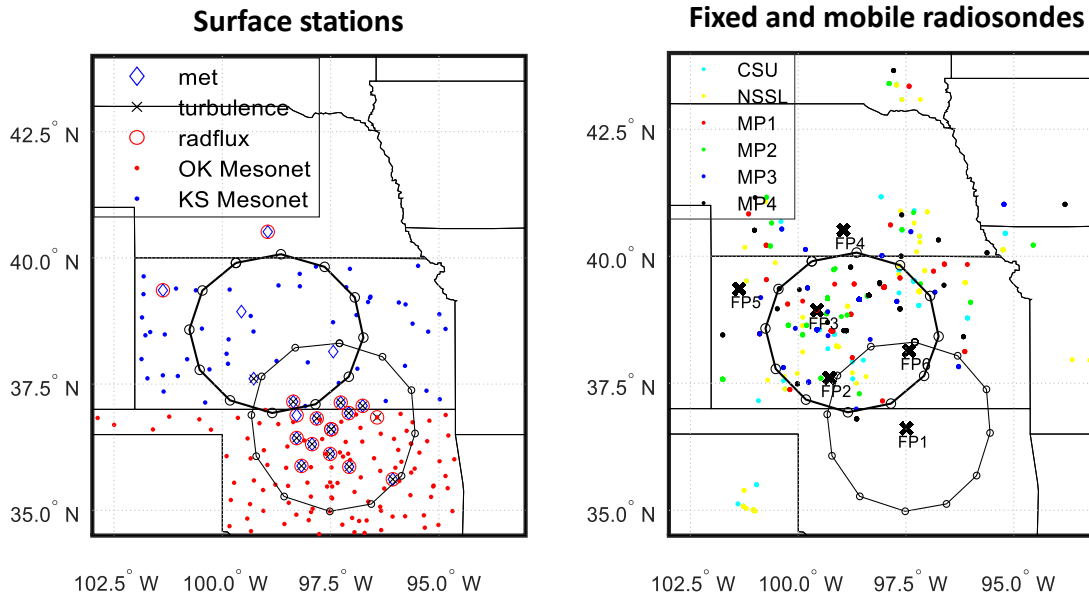

Fixed and mobile radiosondes

Figure 3: location of surface measurements (left) and radiosondes (right) for the PECAN experiment. The bold circle in Kansas represents the fixed PECAN analysis domain. The light circle cross Kansas and Oklahoma represents the analysis domain for the ARM continuous forcing.