APRS™ and PropNET: Potential Tools for Collaborative Radio Propagation Research

Scott E. Parker, K7LU
Occidental Radio Sciences
K7LU@qsl.net

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PropNET is an APRS network operating on the six meter band whose primary objective is to monitor and study radio propagation. There is interest outside (as well as within) the amateur community in the long distance propagation modes that PropNET has been designed to study. The possibilities for collaborative research and potential benefits of inter-community cooperation are explored.

Introduction

The potential of the Automatic Packet Reporting System as a tool for monitoring and studying radio propagation has been recognized since the early days of APRS. Bruninga [1995] described APRS networks operating at HF as a "poor man's chirp sounder". He further described how the data logging features of the APRS software extend this "sounding" capability beyond a simple snapshot of current band conditions by providing an entire day's overview of HF channel dynamics. Horzepa [1997] has called attention to the ability of APRS to alert users to band openings at VHF.

Recently, Tupis [1998] has proposed PropNET, an APRS network operating at 53 MHz whose express purpose is to monitor and provide a means for investigating propagation on the six meter band. Details of how the PropNET design has been optimized for propagation study are available in this Proceedings and on the web at http://www.greeceny.com/PropNET. In addition to being a real time indicator of band conditions, PropNET will have the ability, once widely implemented, of producing a database for long term propagation study.

DXing for the non-amateur

Amateurs are not the only users of the VHF spectrum interested in using natural (ionospheric, tropospheric) modes of medium and long distance propagation. For example, military users find these modes attractive for a variety of reasons, both strategic and practical [Lott, 1997]. But in order to make good use of long haul VHF, these users must be able to accurately characterize and forecast propagation conditions. The current state of understanding and forecasting ability does not measure up to the requirements of these users in many instances. Their ability to fully exploit these long haul modes in the future will require further research in the area of VHF propagation.

Data collected by a network such as PropNET, designed explicitly to aid in advancing the state of radio propagation science, can potentially make a significant contribution toward increased understanding and improved forecasting abilities at VHF. Herein lies a unique opportunity for amateurs to make a significant contribution to the science of radio propagation and forge a symbiotic relationship with the professional research community.

Six Meters

The six meter band supports a host of interesting propagation modes In fact, almost any mode of 6m propagation beyond line of sight tends to be categorized as "unusual". These range from F2 reflection, mundane at HF but considered unusual at VHF since it signals an MUF well beyond normal bounds, to the exotic and less understood modes such as ionospheric scatter and transequatorial ducting.

Less understood means less predictable. Several modes of long haul propagation, utilized by amateurs and potentially useful to occupants of the adjacent VHF spectrum, are known to be operative on the band, making it fertile ground for long haul propagation research. The goal of such research is an improved ability to forecast band openings, not only when the band will open but to where, for how

long and how reliably. This is a capability that amateurs would love to have and many non-amateurs absolutely require on the VHF bands. Of late, members of the scientific community have emphasized lines of research which will contribute to efforts at improving this forecasting capability.

Space Weather

The use of communications and navigation technologies whose accuracy and effectiveness are subject to conditions in the space environment is on the increase. This implies an ever increasing need to understand, characterize and predict the state of the space environment. The region of interest extends from the sun to near the earth's surface, taking in the ionosphere and its sources of variability [WG/NSWP, 1997].

In order to meet the demand for more effective mitigation of technology's vulnerability to the space environment, research activities in the field of atmospheric and space science have been redirected in recent years to focus on space weather. The goals of space weather research include augmentation of our ability to monitor, characterize and forecast the state of the space environment.

Space weather research has and will continue to provide several elements essential to advancing our ability to better understand and predict VHF ionospheric openings. Data on the state of the ionosphere and other regions of the space environment which affect it are increasing in availability and timeliness. And improvement of our ability to predict the future state of the ionosphere, a fundamental goal of space weather science, is the key to reliable propagation forecasts.

PropNET's potential contributions

How can PropNET contribute to advancing the science of VHF radio propagation forecasting once the network has been deployed on a broad scale9 Two examples come immediately to mind.

First, PropNET data can help point out potential avenues of inquiry. Space weather researchers avail themselves of data from many different sensors which measure different parameters of the space environment: electromagnetic and particle fluxes from the sun, chemical composition, dynamics and temperature structure of the upper atmosphere and electrical currents in the ionosphere and beyond. Any strong correlations between data from these sensors and band openings recorded by the PropNET database can be used as initial clues as to possible cause and effect relationships which should be investigated.

Should the pursuit of one of these initial clues prove fruitful, the end product of the research will take the form of a theory and/or propagation model. Here PropNET can contribute again. This time the network's role is theory and model verification. Are the theoretical predictions borne out in the PropNET data? How good is the model at forecasting what PropNET will see?

These are only two examples of many possible contributions that PropNET can make to collaborative research. The possibilities go beyond the basic science of radio propagation to include engineering issues such as optimization of equipment and communications parameters to better take advantage of different propagation modes.

Return on the investment

The current state of the art in tropospheric weather forecasting is much more advanced than its space weather counterpart. Not only are the relevant theories and models more accurate, but the troposphere is much more accessible to measurement. There is simply a lot more information on the troposphere, both its present state and predictions of its state in the near future, available at any given time. Amateurs have used this information to advantage in predicting tropospheric openings at VHF and above [e.g., Pocock, 1985]. Current capabilities for forecasting ionospheric openings on the VHF bands lag far behind.

The climatology of the VHF ionospheric modes has been known for some time [Jacobs and Cohen, 1982]. This is to say that we know, based on past history, when and where the different types of openings are most likely to occur. But the next generation of predictors will go beyond the seasonal or monthly probabilities that these statistical histories provide. Instead, they will forecast openings in the coming hours based on the current state of the space environment.

The amount of space weather data available to the general public, primarily through the intemet, has increased dramatically in recent years. But in order to use this data in forecasting band openings, reliable physical models of the propagation modes and the ionospheric weather they rely on must be developed and refined. This is the goal of space weather research in the area of radio propagation.

When that goal is attained, enhanced forecasting capability for the ionospheric modes at VHF will be the dividend returned on the amateur community's investment of data into the PropNET database.

Future Directions

PropNET is currently in a formative stage. The current design of the network and of the APRS software allows network nodes to monitor propagation in real time and maintain a short term local database of propagation conditions. However, the construction of a centralized, long term propagation database is a very real possibility whose potential utility and benefits have been outlined above. Now is the time to give serious thought to the details of a central PropNET database so that the relevant issues can be resolved by the time wide scale implementation of the network has been realized. The following are some of the forefront concerns that need to be addressed:

Database Structure. The database should be designed so as to maximize its utility within both the amateur and professional scientific communities. The database should be kept as compact as possible while at the same time maintaining adequate temporal and spatial resolution.

Data Collection and Access. A plan for collecting data from individual PropNET nodes into the centralized database and for making the database accessible to potential users must be implemented.

Data Logging. The most important contributors to the database will be the PropNET hub class nodes, many of which will be unattended. Steps to facilitate automated data collection and submission by unattended sites need to be taken. This will likely involve some software design and development.

Conclusions

The possible contributions of the PropNET network proposed by Tupis [1998] to the science of VHF radio propagation have been explored. A six meter propagation database generated by the network could form the basis for collaboration between the amateur community and radio science professionals. As the PropNET network is presently in a very early stage of realization, measures necessary to facilitate the construction of a centralized propagation database will never be easier to implement. These data recording and archiving features should be integrated into the network as soon as possible.

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