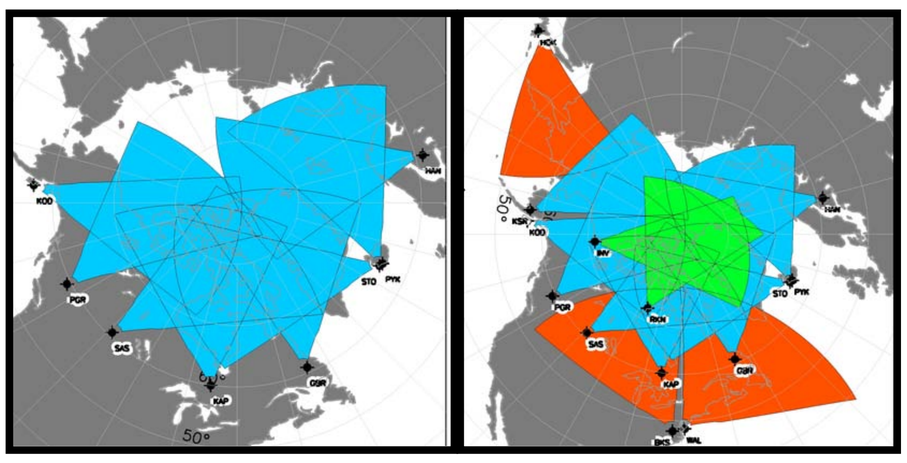
SuperDARN HF radar data coverage for ionospheric electric field measurement

Gareth Chisham, Mervyn Freeman, Andrew Kavanagh

British Antarctic Survey, High Cross, Madingley Road, Cambridge, England, CB3 OET, UK
gchi@bas.ac.uk

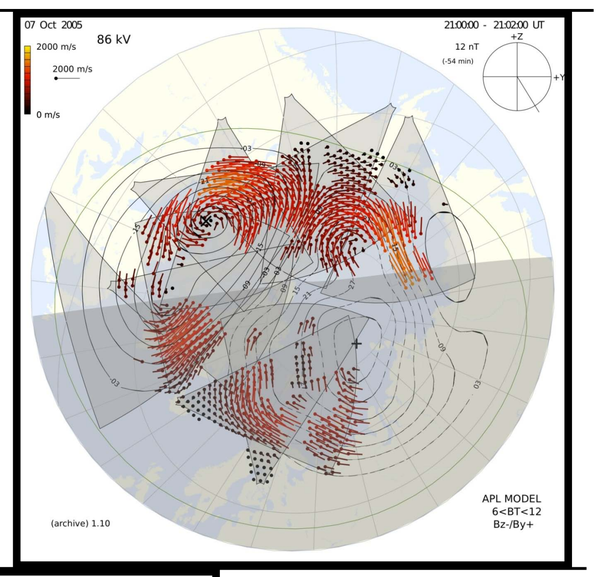


Northern Hemisphere SuperDARN radar fields of view 2001

Northern Hemisphere SuperDARN radar fields of view 2008

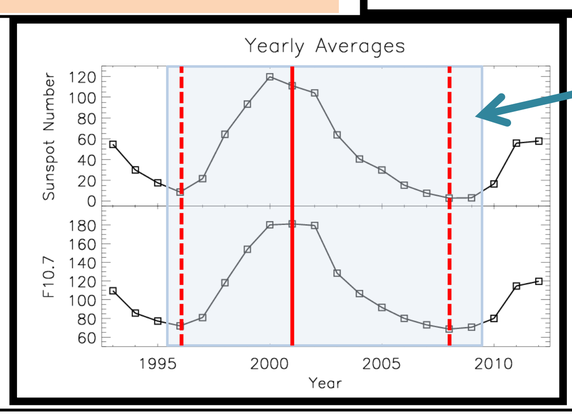
INTRODUCTION

Specification of the ionospheric electric field, and its extension into the magnetosphere, is of fundamental value to many space weather research problems. Consequently, it will be essential to assimilate electric field measurements into whole atmosphere, magnetospheric, and radiation belt models now under development for space weather forecasting. The Super Dual Auroral Radar Network (SuperDARN) currently comprises 33 radars around the world which provide the capability to determine the ionospheric electric field in both hemispheres through measurement of the **ExB** plasma drift velocity (see figure). However, measurements are not made continuously as they require the existence of ionospheric irregularities in the polar ionosphere. Here, we quantify the percentage of time that SuperDARN electric field measurements are likely to be available, and how this varies with the solar cycle.



DATA ANALYSIS OVERVIEW

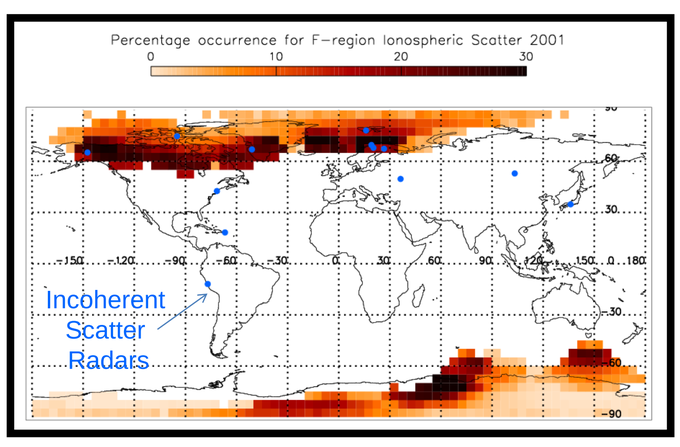
- SuperDARN has data going back over 20 years for some radars.
- Determine coverage of data for over a solar cycle (1996 – 2009).
- Coverage presented as the percentage of 1-min or 2-min scan periods within each year for which one or more data samples exist to provide electric field measurements within each 5^0 latitude by 5^0 longitude grid cell.

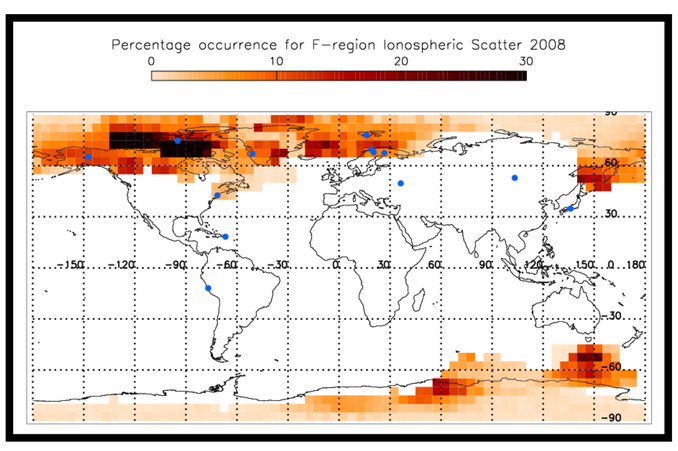


IONOSPHERIC DATA COVERAGE FOR ELECTRIC FIELD MEASUREMENT

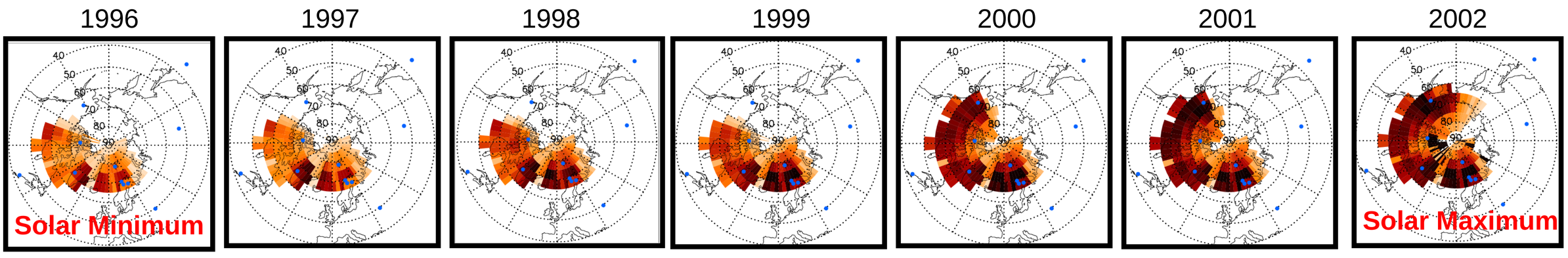
Factors influencing coverage

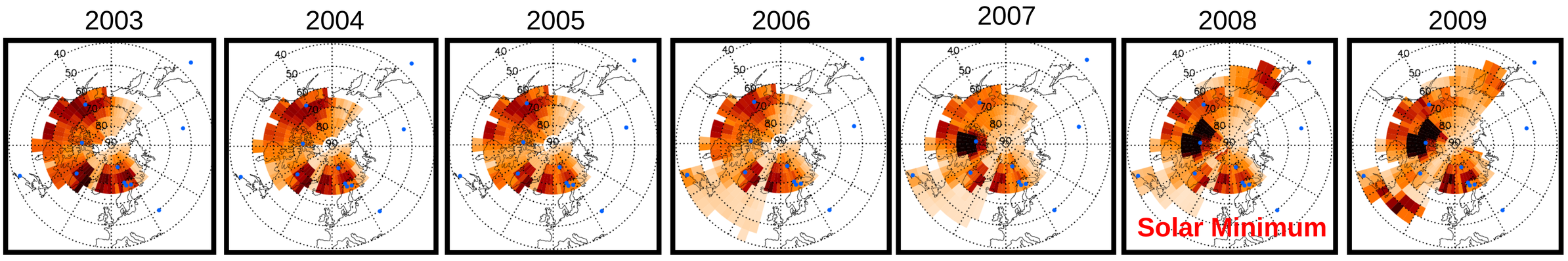
- Number of radars – increasing number of radars has improved spatial coverage and accuracy of electric field maps.
- Locations of radars – addition of mid-latitude and polar radars to the network has similarly improved accuracy of electric field maps.
- Increased solar/F10.7 activity leads to an increase in ionospheric irregularities which results in greater data coverage around solar maximum.





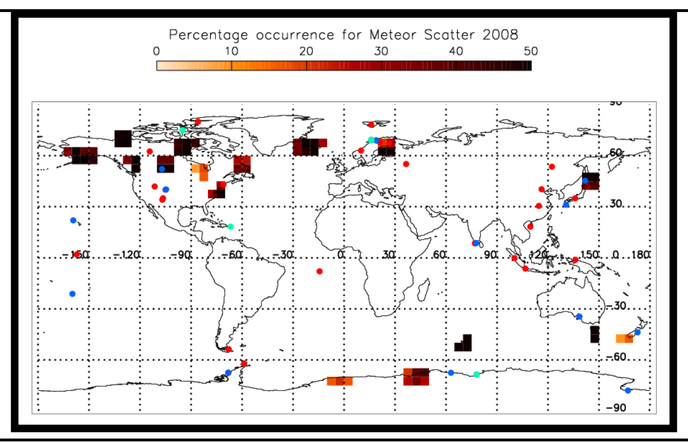
Solar Maximum **Solar Minimum**





SUPERDARN METEOR SCATTER COVERAGE FOR DETERMINATION OF NEUTRAL ATMOSPHERE WINDS, WAVES AND TIDES IN THE UPPER MESOSPHERE AND LOWER THERMOSPHERE (MLT)

MLT wind measurements provide information on the dynamical state of the upper neutral atmosphere. Neutral tides and planetary waves propagate to higher altitudes and influence the ionized atmosphere. Any consideration of how the ionosphere responds to space weather drivers should also take into account the day-to-day variability of the neutral atmosphere.



Other radars providing measurement capability for neutral atmosphere winds

- Meteor Radars
- MF Radars
- MST Radars

SUMMARY/CONCLUSION:

Use of SuperDARN electric field data in current models – SuperDARN electric field maps combine current data and a climatology to provide a more accurate representation of the ionospheric electric field than the climatological model alone. However, well-defined, data-driven maps of the electric field in the polar regions are only likely to be available for between 10 to 30% of the time, depending on the position in the solar cycle.

Comparison with other electric field measurements – EISCAT can provide electric field measurements about 13% of the time, but in only ~2 grid cells. Polar-orbiting spacecraft can only provide electric field measurements for <<1% of the time in each grid cell.

World Meteorological Organisation observing goals – The ionospheric plasma velocity/electric field is one of the space weather observation requirements for the WMO. WMO goals are set at 3 levels with increasing resolution (threshold, breakthrough, and goal). The present SuperDARN maximum horizontal resolution of ~50 km matches that required for ‘breakthrough’, and the maximum temporal resolution of 1 minute matches that required for ‘goal’. However, as presented in this paper, these measurements cannot be made consistently at this resolution throughout the year to presently meet the WMO goals.