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Super Auroral Radar Network Expansion and its Influences on the Derived Ionospheric Convection Pattern

Motivation

- SuperDARN* was built to study high latitude ionospheric convection
- Radio signals are backscattered by magnetic field-aligned ionospheric irregularities
- Doppler shift is used to calculate ionospheric convection velocities
- **SuperDARN has changed drastically over the years:** e.g. addition of mid-latitude radars allows us to study the effects of additional data on the high-latitude ionospheric convection pattern
- **What effect do the mid-latitude radars have on e.g. data coverage?**
- **What effect does an updated baseline model have (i.e. a model with mid-latitude radars vs one without)?**

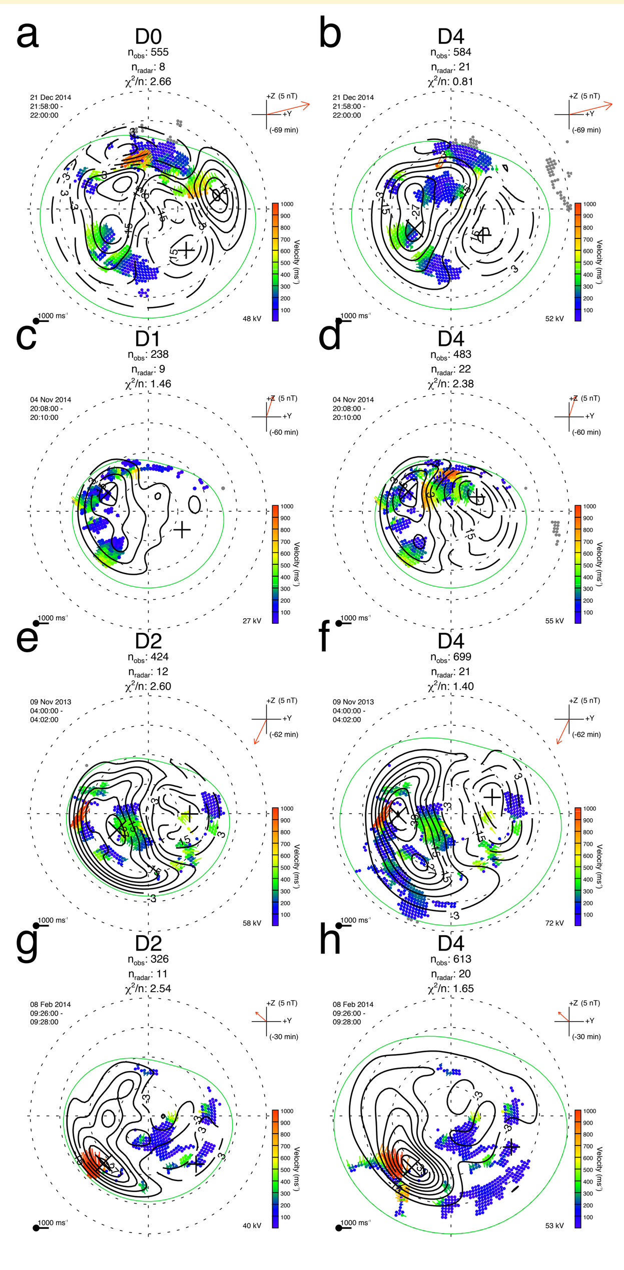
Method

- A large dataset (2 min cadence, 2012-2018) allows us to statistically study the impacts of adding mid-latitude data & changing the background convection model (fitting methods)
- We create 5 versions of the SuperDARN* maps and statistically compare the differences:

D0: **Ruohoniemi & Greenwald (1996)** background model **without mid-latitude data without polar cap data**
D1: Same as D0 but **with a range limit of > 800 km and < 2000 km** (See Thomas and Shepherd, 2018)
D2: Same as D1 but **with polar cap data**
D3: Same as D2 but **with mid-latitude data**
D4: **Thomas & Shepherd (2018)** background model with same data as D3

Results I:

Example maps:



Comparing maps from the same date & time illustrates some of the problems introduced/solved by changing the radar network or data processing: e.g. mid-latitude radars were only built 2005+; RG96 was made using Goose Bay radar data only (see SI) etc.

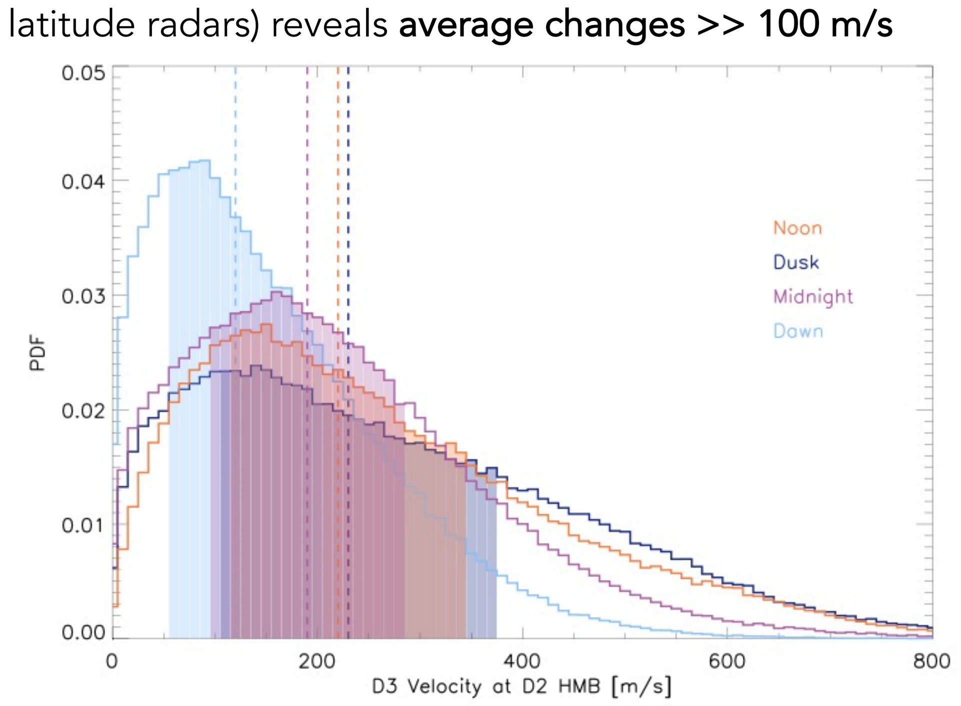
a) Lack of polar cap and mid-latitude data creates extra convection cells in comparison to b)

c) Lack of polar cap data reduces dawn convection cell dramatically in comparison to d)

e) Lack of mid-latitude data sets HMB (Heppner-Maynard boundary in green) at too high latitude and reduces CPCP in comparison to f)

g) Lack of mid-latitude data produces a dawn convection cell in comparison to h)

Probability distribution function of the convection speed for D3 (**with** mid-latitude data) at the HMB latitude location for D2 (**without** mid-latitude radars) reveals **average changes >> 100 m/s**



dashed lines: median

shaded areas: lower (25%) and upper (75%) quartiles

Adding polar cap radars reduces the *CPCP* & adding mid-latitude radars increases the *CPCP*

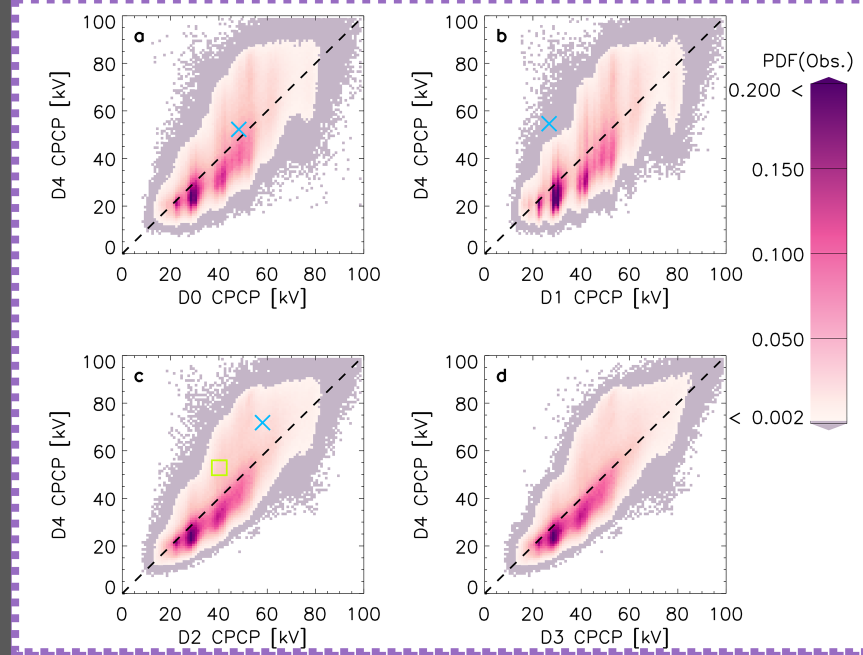
If *n* is high, *CPCP* is less likely to vary

Adding mid-latitude radars routinely increases ionospheric convection by 200s m/s

*Super Dual Auroral Radar Network (SuperDARN)

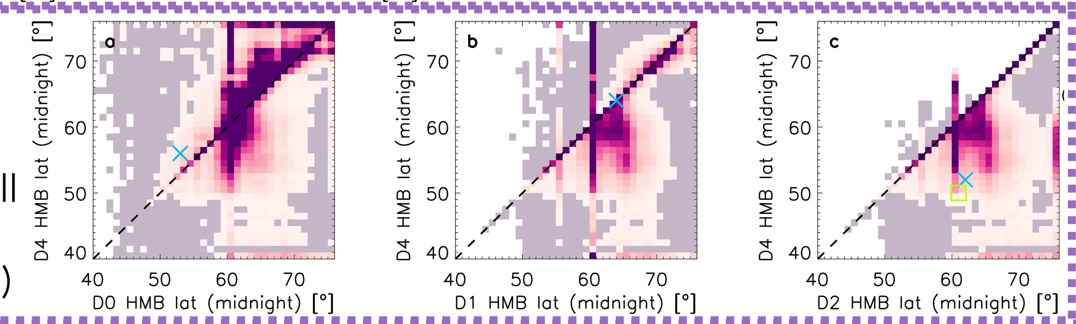
**CPCP* = cross polar cap potential

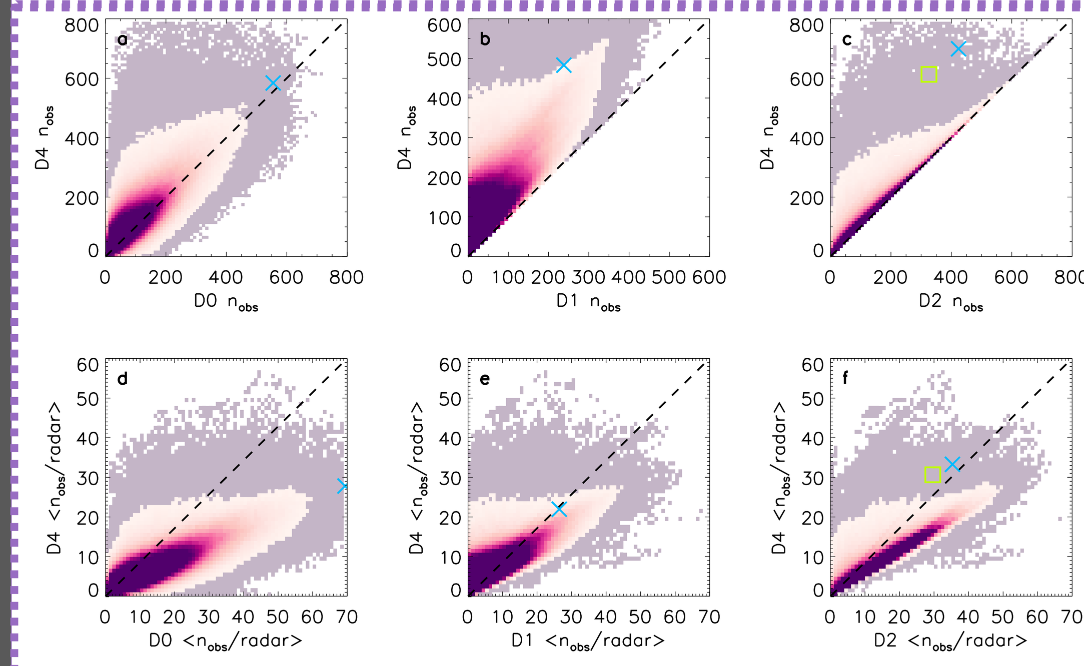
Results II:



- Systematic comparisons of the CPCP show that variations can be > 20 kV
- Striations are due to over-reliance on model and discrete model bins in RG96
- D3 is closest to D4
- Adding polar cap radars reduces CPCP; adding mid-latitude data increases CPCP

HMB changes drastically: velocities will change (see also results I)





Number of datapoints per map (*n*) and average *n/radar* are most likely highest for the most up-to-date dataset (D4), but are not necessarily a function of number of radars.

Supporting Information:

SuperDARN* coverage, Jan. 2018:

High-latitude
Mid-latitude
Polar cap

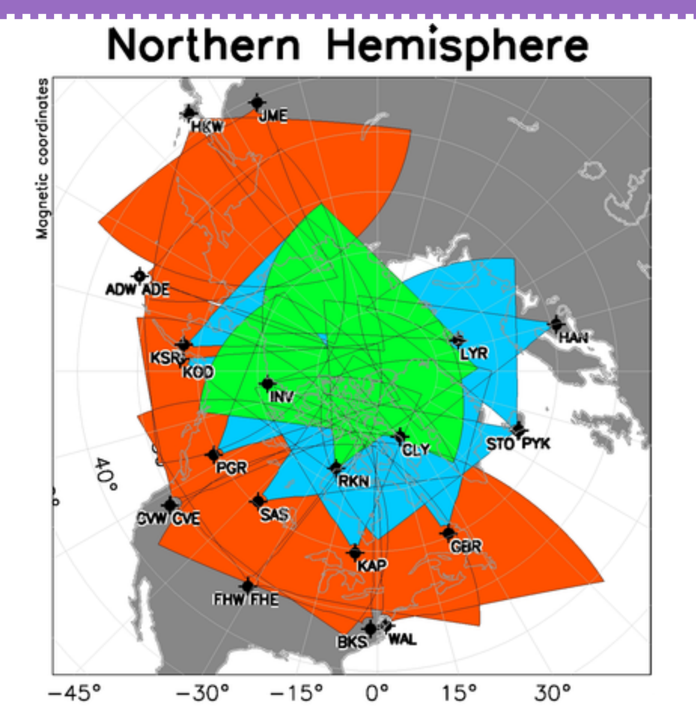


Figure from vt.superdarn.org

Data and background models as a function of solar cycles:

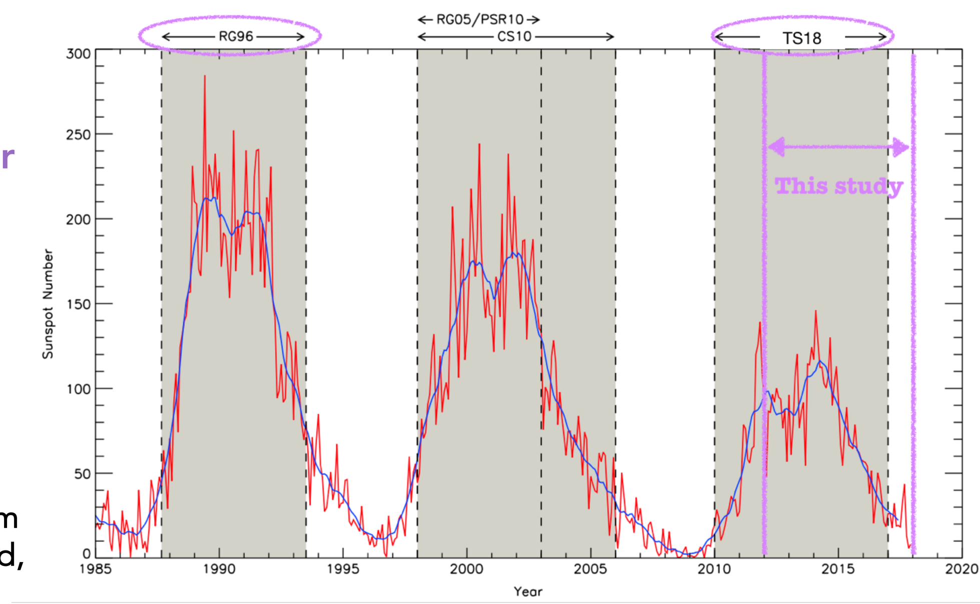


Figure adapted from Thomas & Shepherd, 2018

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