ICON Ion Velocity Meter (IVM) Data

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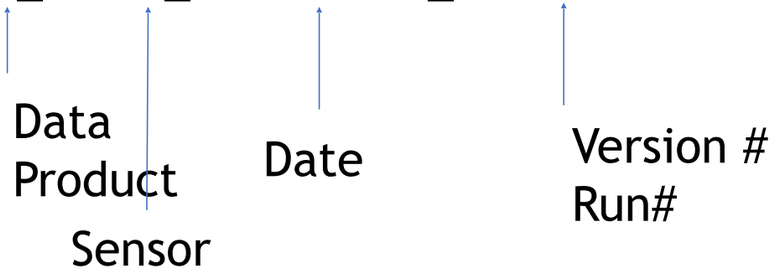
ICON Ion Velocity Meter (IVM) Data

IVM has two sensors Retarding Potential Analyzer and Ion Drift Meter
Together the sensors provide

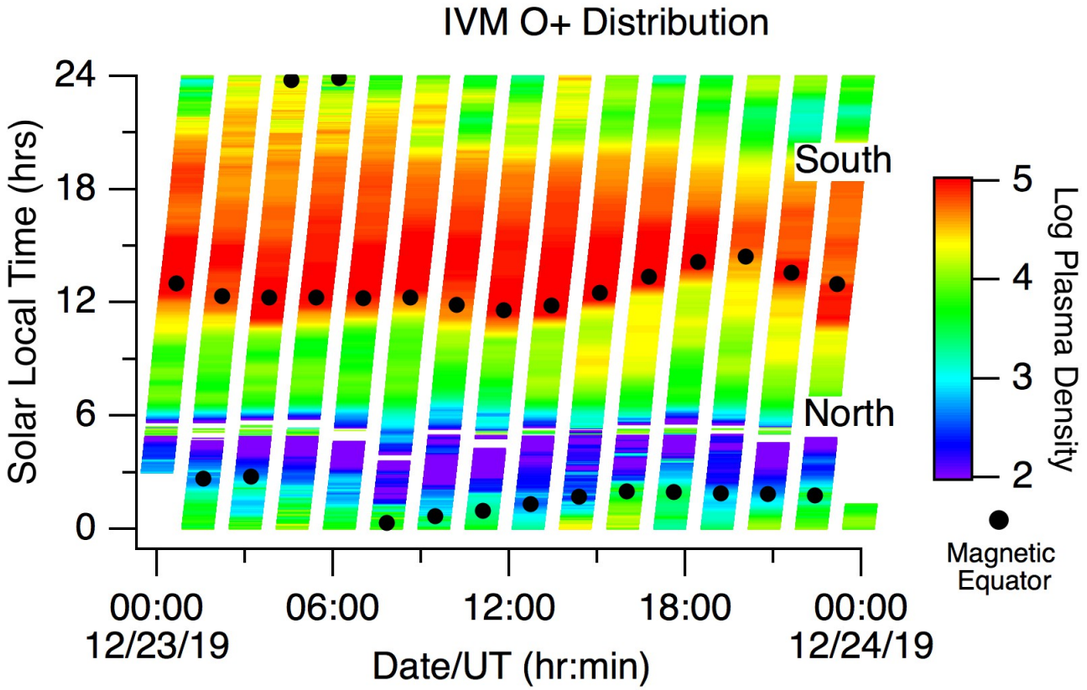
- Major thermal plasma constituent densities
- Thermal plasma temperature
- Thermal plasma drift perpendicular and parallel to magnetic field
- Instrument processing built on open source software
  - Next-Generation core IVM processing built on the Python Satellite Data Analysis Toolkit (pysat)
    - Specifically designed for generalized instrument and science data analysis
    - Files produced using pysat's .to_netcdf4 module
    - pysat manages coupling to unique ICON SDC environment
  - Mission and instrument specific modules couple ICON to core IVM software
  - Expression of locations and vector measurements in geomagnetic basis is traceable
    - Apexpy and OMMBV
  - Similar setup to IVM processing on COSMIC-2 (runs at CDAAC) and SORTIE CubeSat (runs at UTD)
- Data available as a time series in self describing NetCDF files covering one day

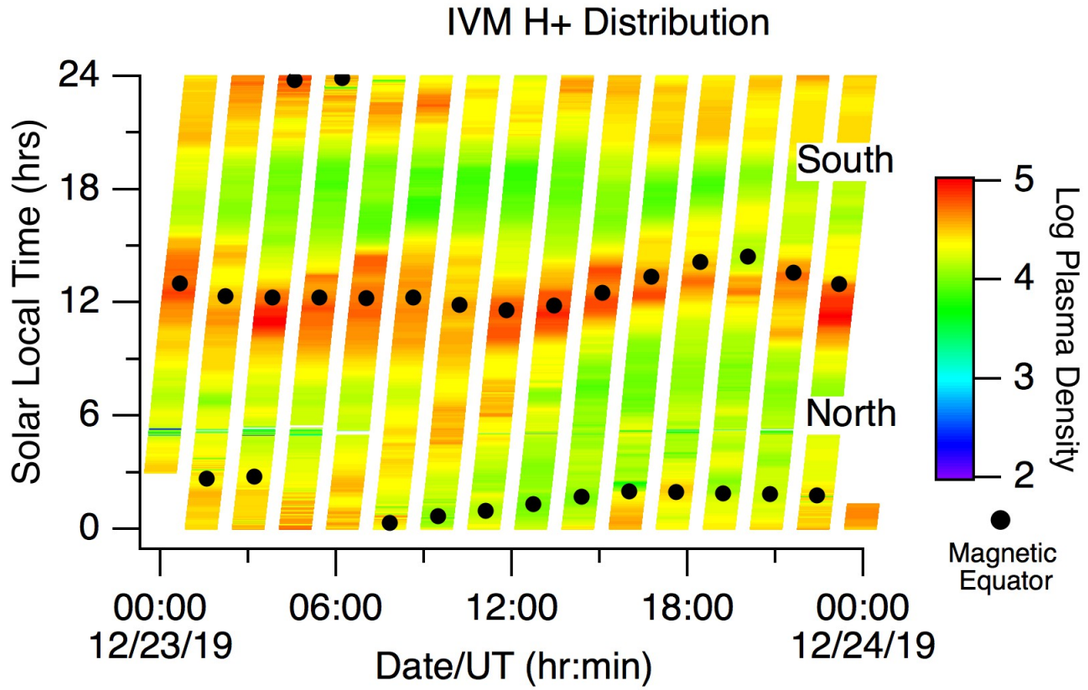
ICON_L2-7_IVM-A_2019-12-23_v02r001.NC



ICON Ion Velocity Meter (IVM) Data Products

Constituent Ion Concentrations Local Time Variations





O+ and H+ comparable

H+ dominates at night ; O+ influenced by interhemispheric transport ; H+ dominated by diffusion from plasmasphere

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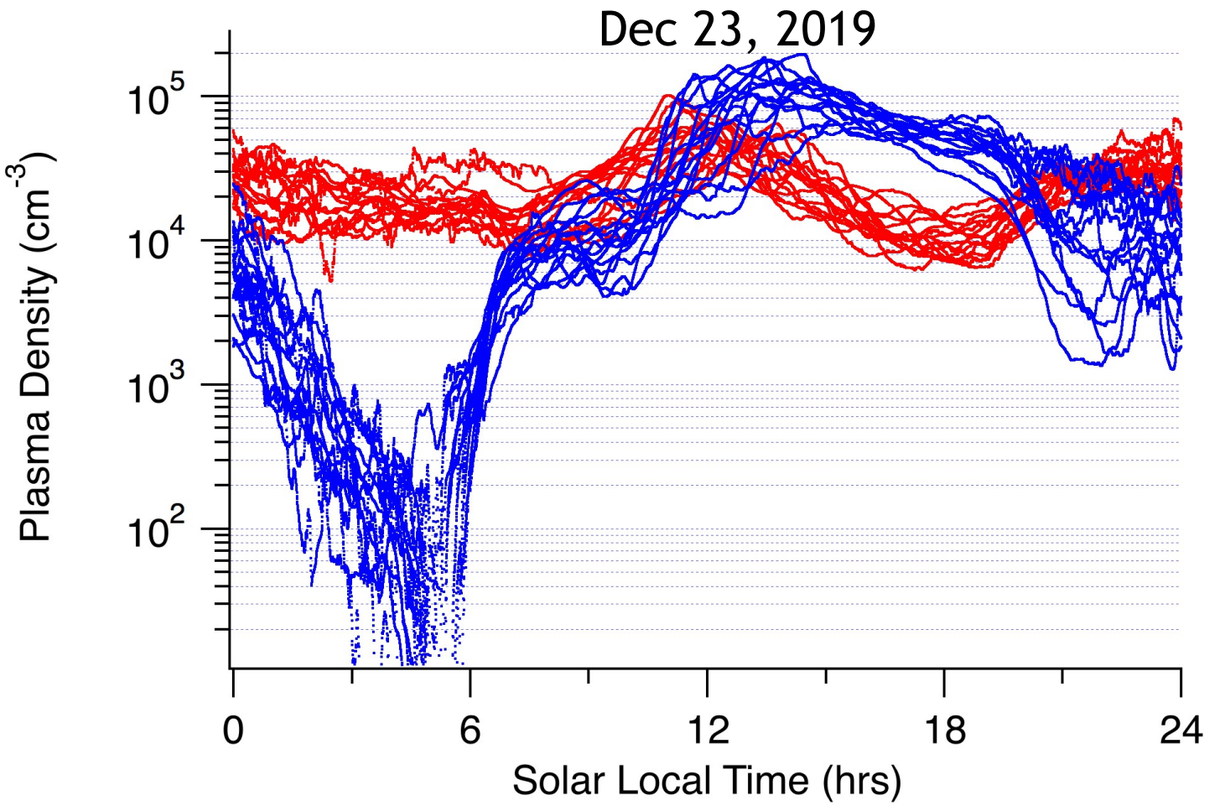
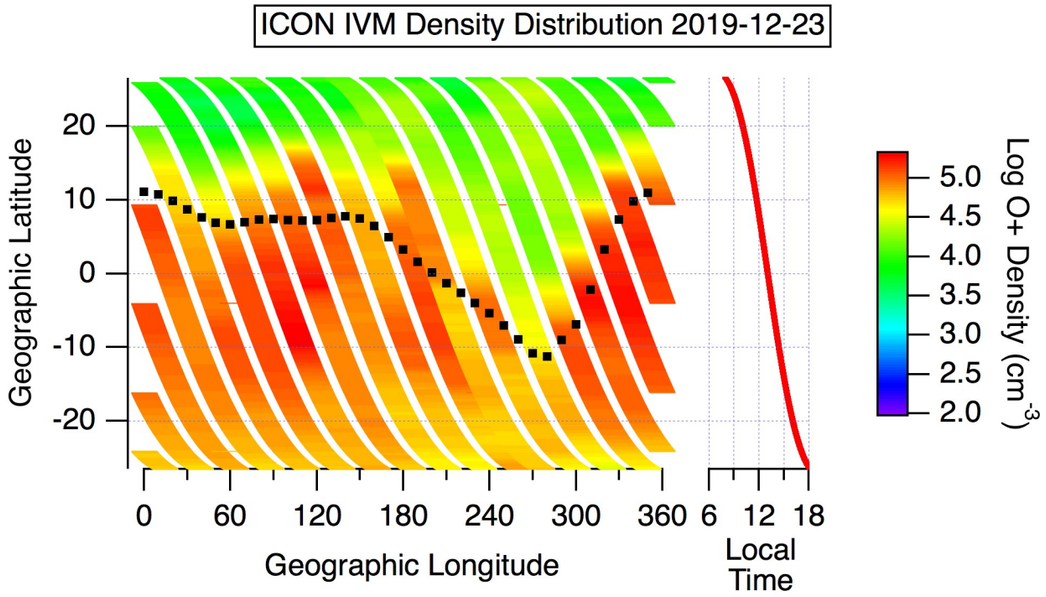
Constituent Ion Concentrations Local Time Variations

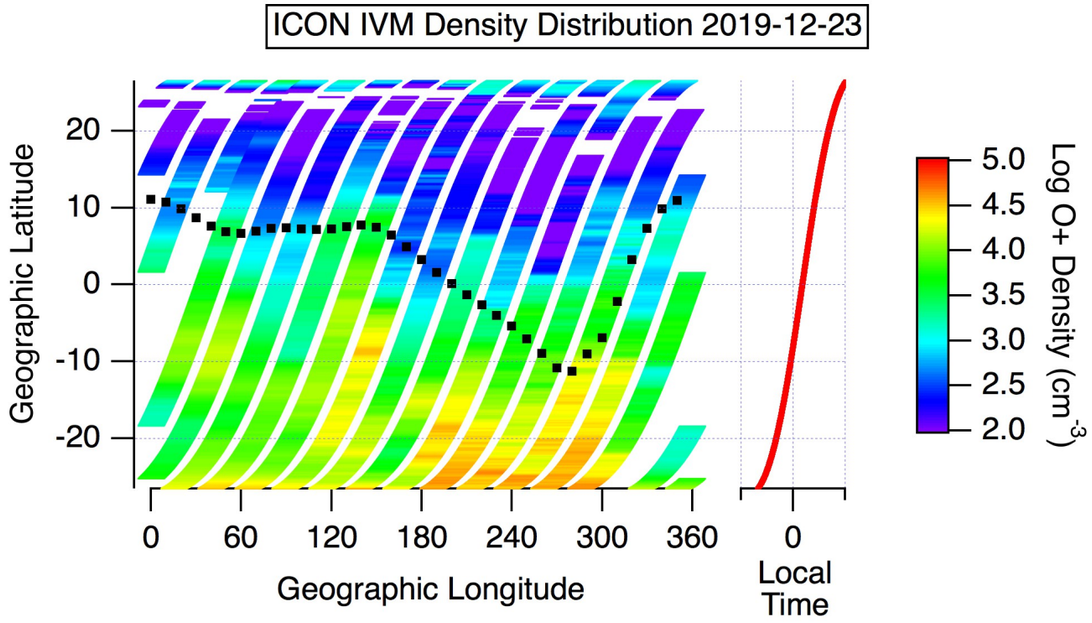


Local Time variation convolves variations in Latitude and Longitude

ICON Ion Velocity Meter (IVM) Data Products

Constituent Ion Concentrations Latitude Longitude Variations

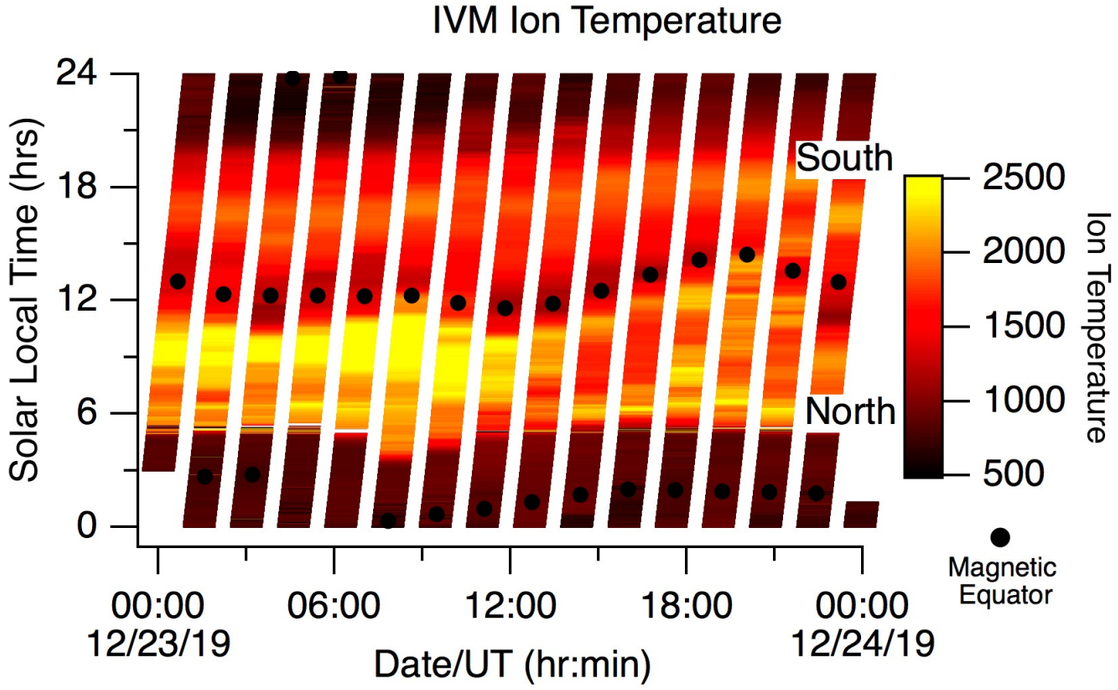


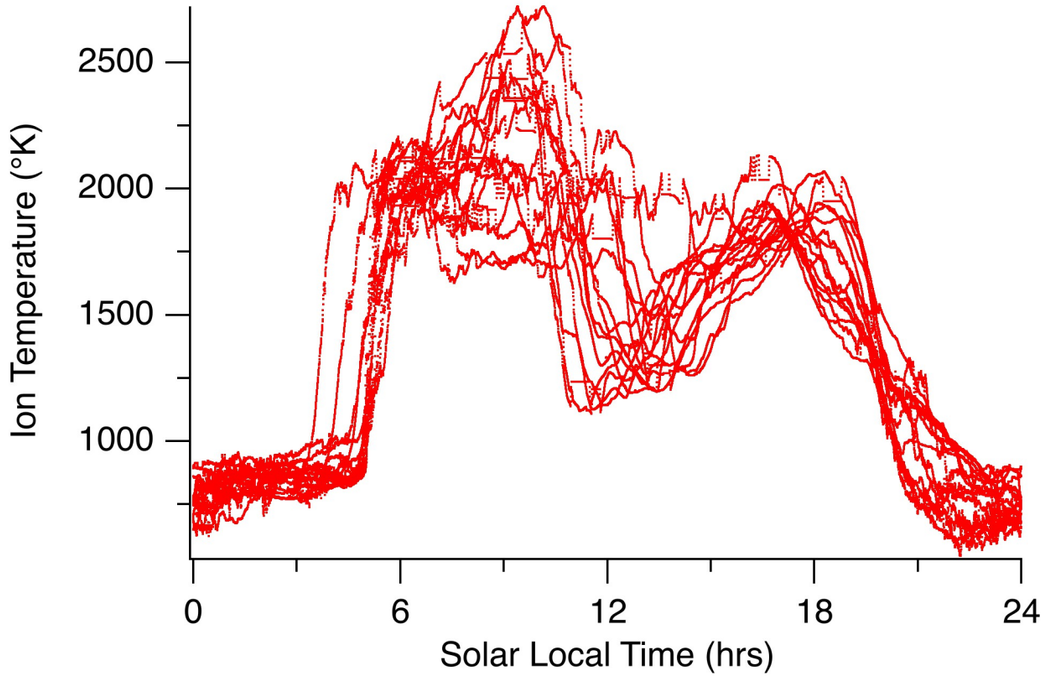


- Summer to winter (south to north) wind raises F-peak in summer and lowers in winter producing latitude asymmetry in plasma density
- Deep minimum in plasma density prior to sunrise appears at higher latitudes in winter where inclined magnetic field allows collapse of the layer at night.

ICON Ion Velocity Meter (IVM) Data Products

Ion Temperature Local Time Variations





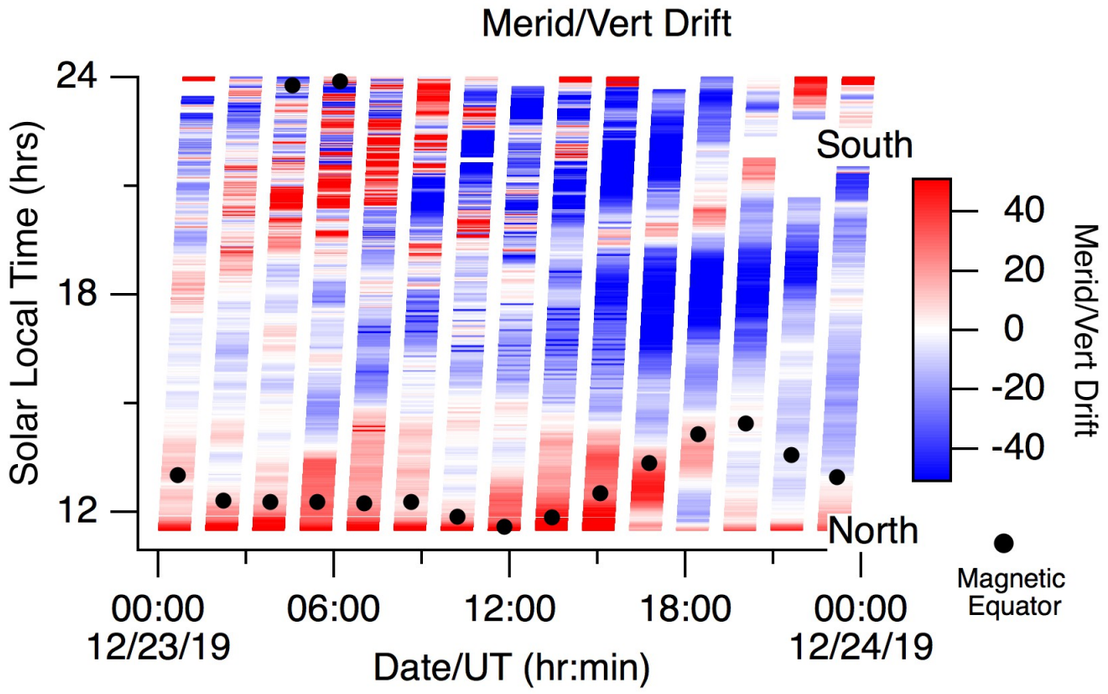
Ions cool to neutral temperature (~800°K) at night

Rapid temperature rise near the equator after sunrise as photoelectron heating takes place in low plasma density

Local minimum in daytime temperature at the equator coincident with plasma density maximum

ICON Ion Velocity Meter (IVM) Data Products

Meridional Vertical Plasma Drift Local Time Variations



Meridional drift derived from three components determined in s/c reference frame.

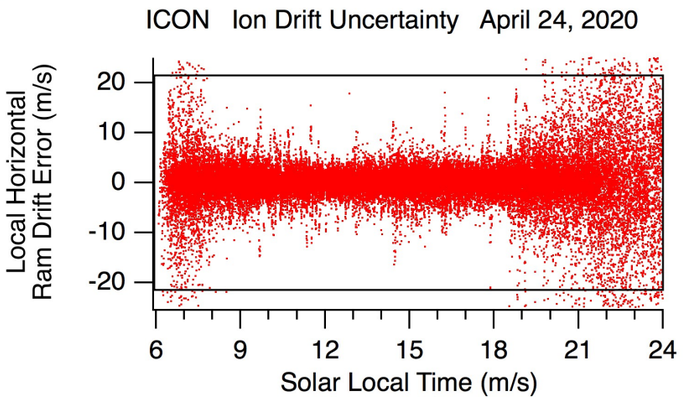
Offsets and photoelectron corrections required to complete vector decomposition.

Measurements compromised when O+ density is less than 10^3 cm^{-3}

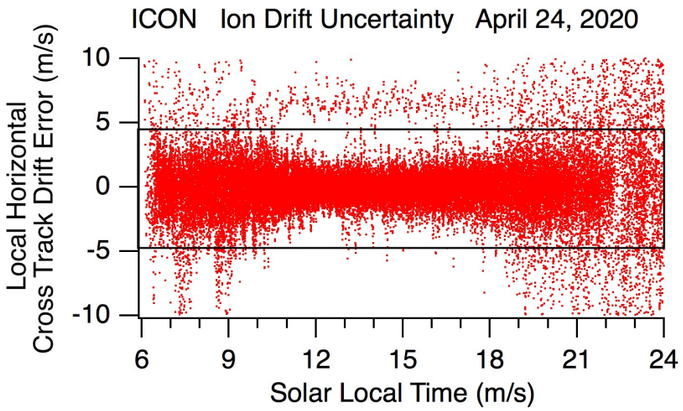
Ion Drifts in Geomagnetic Basis

- Measurement of three dimensional ion drifts in the instrument frame is translated to physical basis defined by the geomagnetic field
- Geomagnetic vectors provided by Orthogonal Multi-pole Magnetic Basis Vectors (OMMBV) software
  - Field-Aligned - directed along field
  - Zonal - perpendicular to field and local magnetic meridional plane
    - Horizontal at magnetic equator (apex)
  - Meridional - perpendicular to field and within local magnetic meridional plane
    - Vertical at magnetic equator (apex)
- OMMBV are the same as apexpy basis vectors for a spherical Earth and dipole magnetic field
  - OMMBV first to retain orthogonality and other properties for a geodetic Earth and a multi-pole magnetic field
  - Maps ion drifts and electric fields along a given geomagnetic field-line
  - Suitable for use in models and may remove a dimension

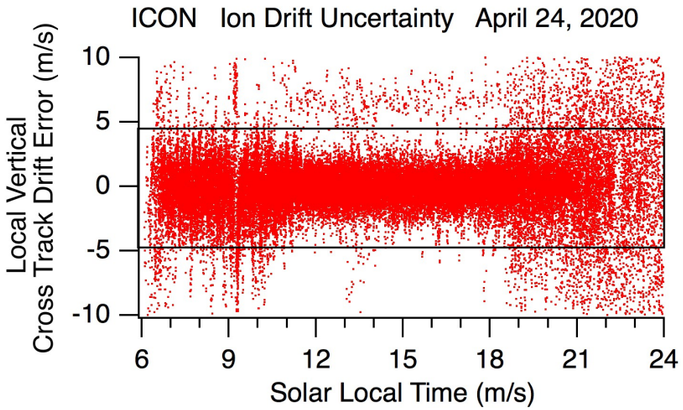
Ion Drifts Initial Performance



RPA Derived Ion Drift
Requirement: 21 m/s



DM Derived Ion Drift
Requirement: 5 m/s



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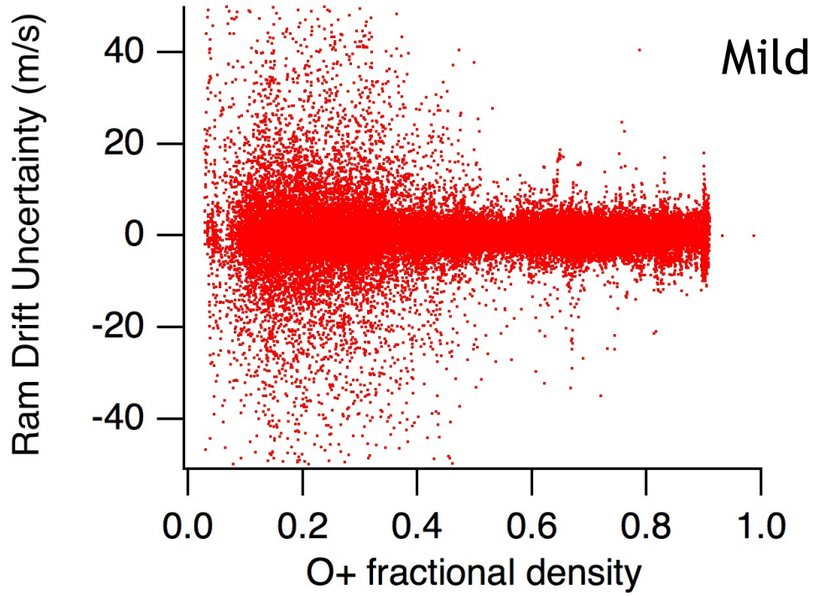
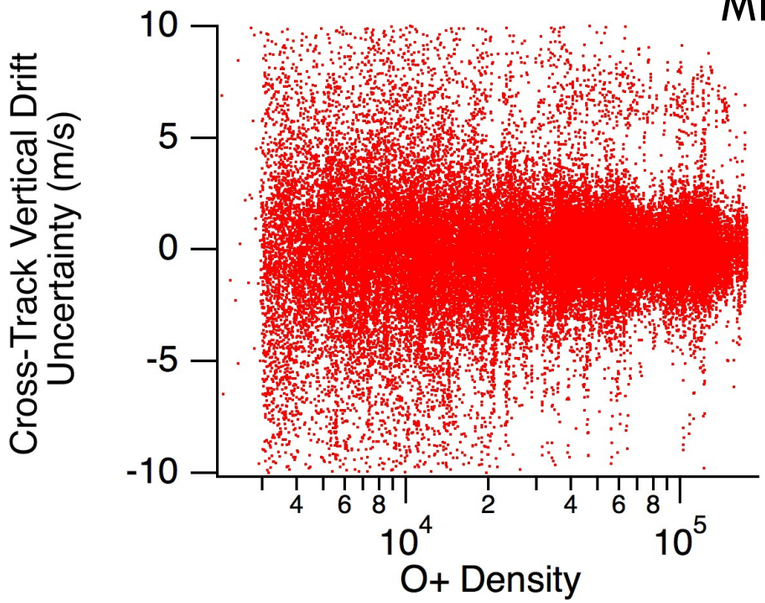
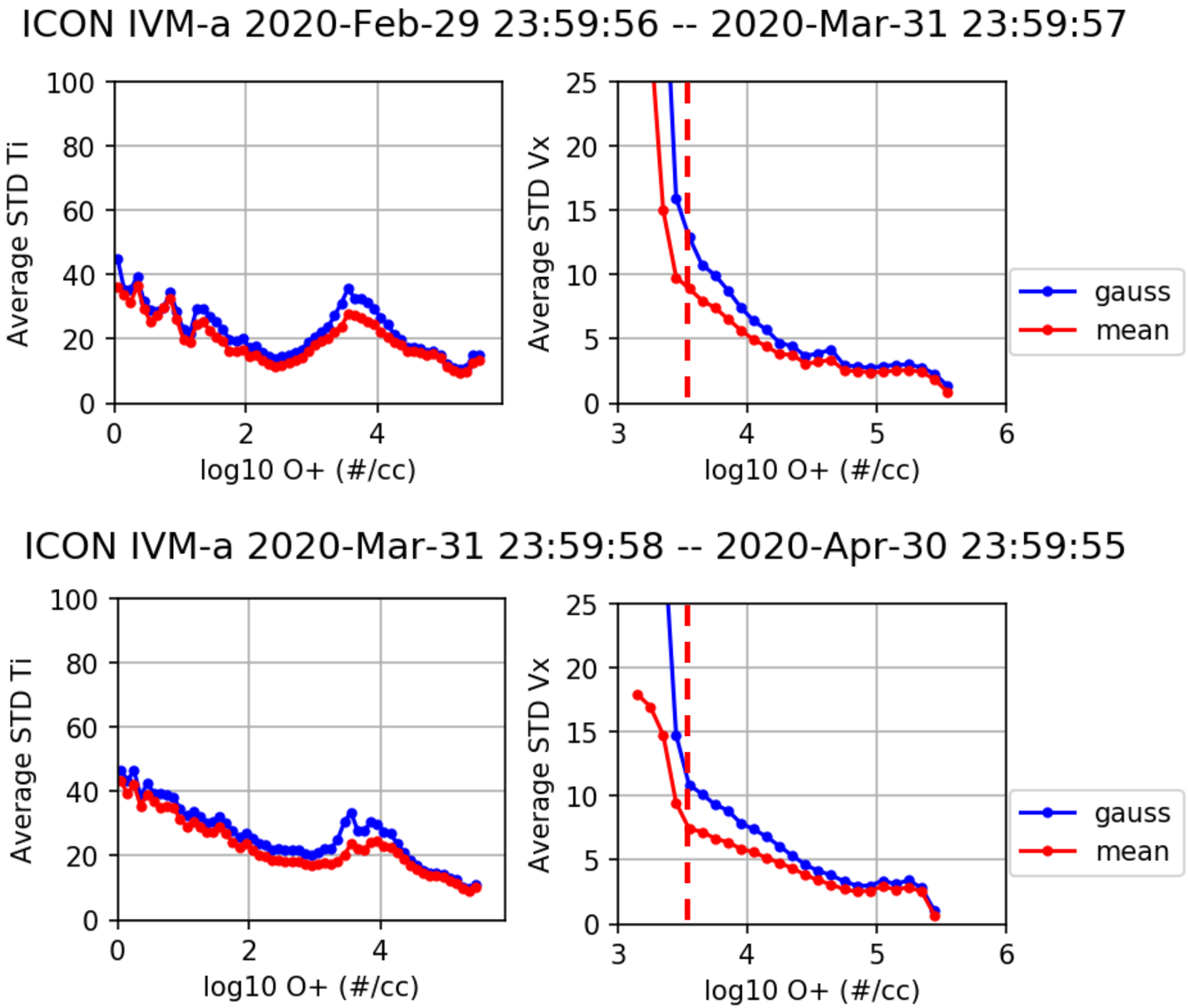


Mild function O+



Mild function O+

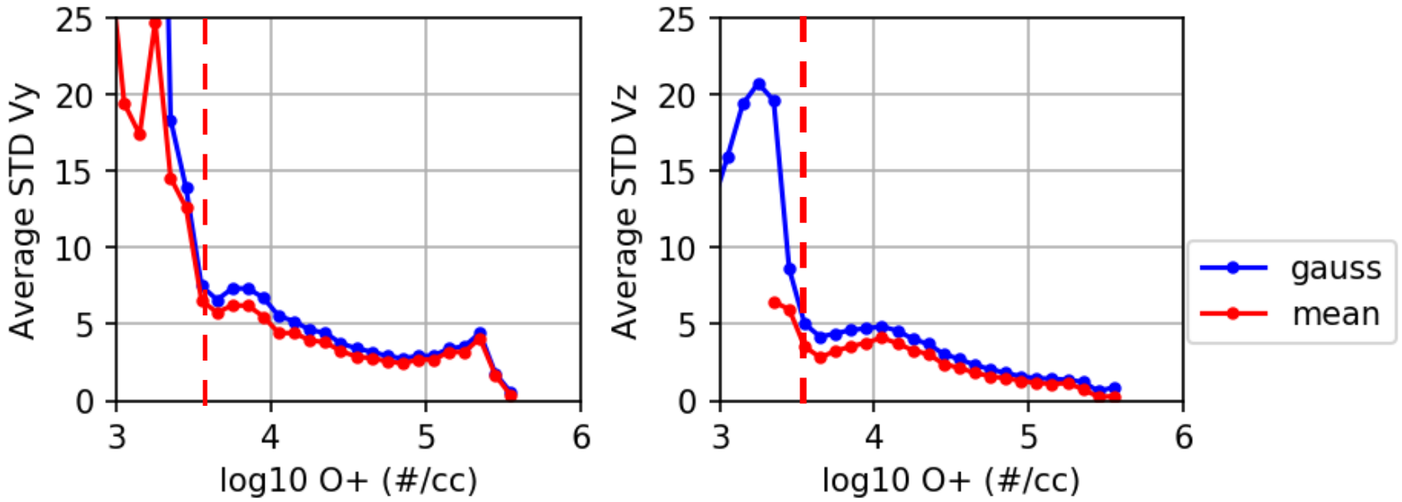
Initial Monthly Performance - Vx and Temps



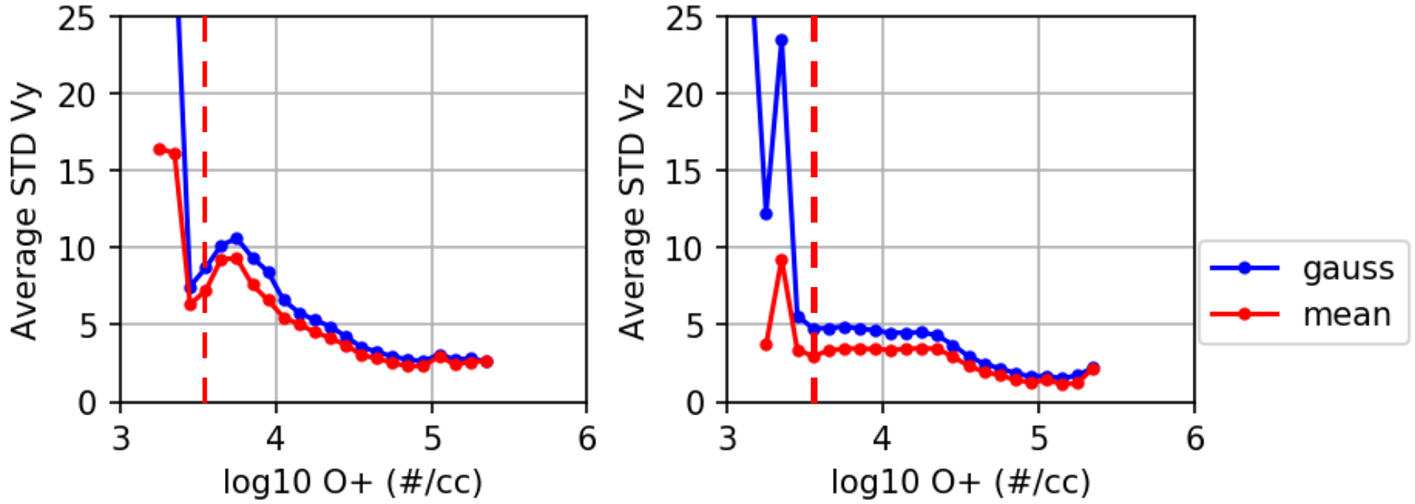
- Deviations computed using 60 points
  - Curve per day by binning over density
  - Average daily curves over month
  - Instrument plus geophysical deviations
- Precision Requirements for Vx are < 21 m/s for O+ > 7E3 N/cc
- Vertical red line at 3E3 N/cc, ~10m/s precision, margin > 2x
- Observed temperature precision < 50 K over all O+ density levels

Initial Performance for Cross-Track

ICON IVM-a 2020-Feb-29 23:59:56 -- 2020-Mar-31 23:59:57



ICON IVM-a 2020-Mar-31 23:59:58 -- 2020-Apr-30 23:59:55



- Deviations computed using 60 points
  - Curve per day by binning over density
  - Average of daily curves over month
  - Instrument plus geophysical deviations
  - All local times
- Precision Requirements for Vy and Vz are < 5 m/s for O+ > 3E3 N/cc
- Vertical red line at 3E3 N/cc
- Vy and Vz measured via the same circuit
- Irregularities present at night with lowest O+ densities

Summary

- Current estimate for data quality is high - release is initial and preliminary
  - Data should be filtered to remove flyers that are not trapped out
    - See Text_Supplement in IVM files for notes on initial quality flags
  - No significant changes to ion density, composition, and temperature are expected
  - Outputs from the instruments related to ion drifts are robust
    - Validation of the translation of ion drifts to an absolute basis is underway
      - Offset determination process developed for C/NOFS will be applied here
      - Offsets in plasma drifts may need user removal using de-trending in the interim
      - Not a ‘known’ issue with data - drifts may not require offset

- Software changes are planned that may further improve geophysical outputs for subsequent releases
  - Refinements to IVM error model may improve performance near boundaries
  - Development of second-generation photoemission correction underway
  - Include observed statistical deviations in files based upon ambient conditions

- Data available at nominal 1-second cadence

DOIs

- pysat publication (10.1029/2018JA025297) and software (10.5281/zenodo.1199703)
- OMMBV software (10.5281/zenodo.1299374)
- Apexpy publication (10.1029/2010JA015326) and software (10.5281/zenodo.1214206)
- Magnetic Basis Vector Review (10.1007/s11214-016-0275-y)
- OMMBV manuscript pending submission
- C/NOFS IVM offsets and photoemission (10.1029/2012JA017636)