The Effect of Magnetic Anomalies on the Detection of Moon Originating Ions

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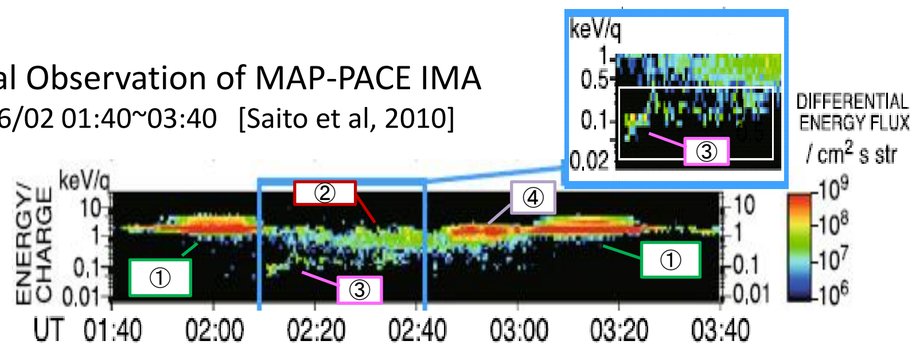
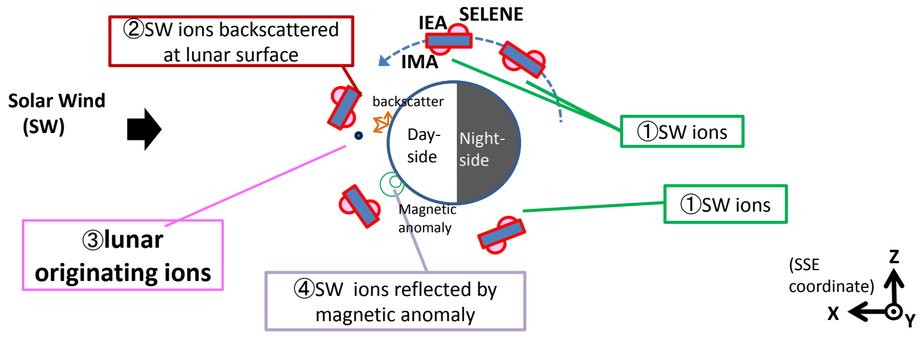
Introduction

The Moon has.. ・Surface Boundary Exosphere
・Magnetic anomalies

Typical Observation of MAP-PACE IMA
2008/06/02 01:40~03:40 [Saito et al, 2010]



Ions detected by IMA



What is **Moon Originating Ion**??

・origin :
lunar surface / lunar SBE (Surface Boundary Exosphere)
・energy :
~several hundreds eV/q (at 100km)
・species :
C+, O+, Na+, K+, Ar+ etc.
・generation process :
・photon-stimulated desorption
・SW sputtering
・thermal desorption …etc.
・transportation processes :
・convection electric field ($E=-V_{SW} \times B_{IMF}$)
・potential field by the electrification of lunar surface
[Yokota et al, 2009], [Stern 1999]

These are not sufficiently understood yet.

Objective

How are these ions affected by

- **Convection electric field** ($E=-V_{SW} \times B_{IMF}$) ?
- **Magnetic anomalies** ?

Analysis

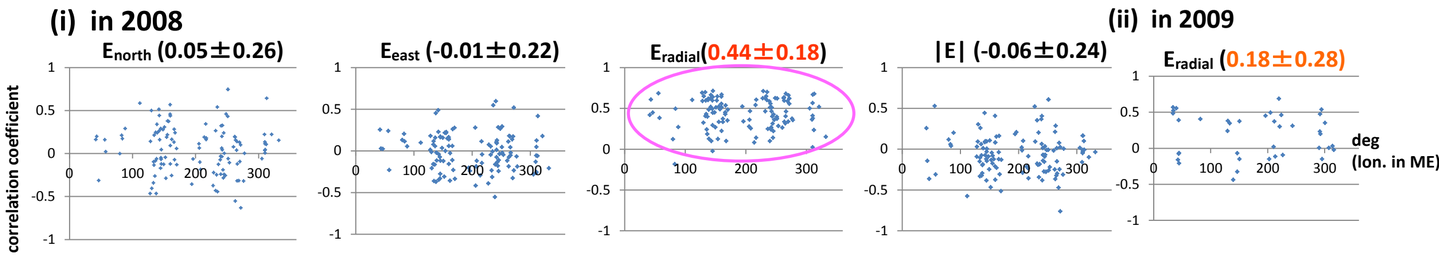
・sum up counts of low-energy heavy ions detected by IMA
- heavy : TOF is longer than that of SW ions (H+, He+, He++)
- low-energy : energy < ~250eV
・$E=-V_{SW} \times B_{IMF}$: V_{SW} (energy data of IEA), B_{IMF} (MAP-LMAG)
・"above magnetic anomaly" :
magnetic anomaly |B| at 10km > 20nT

Result

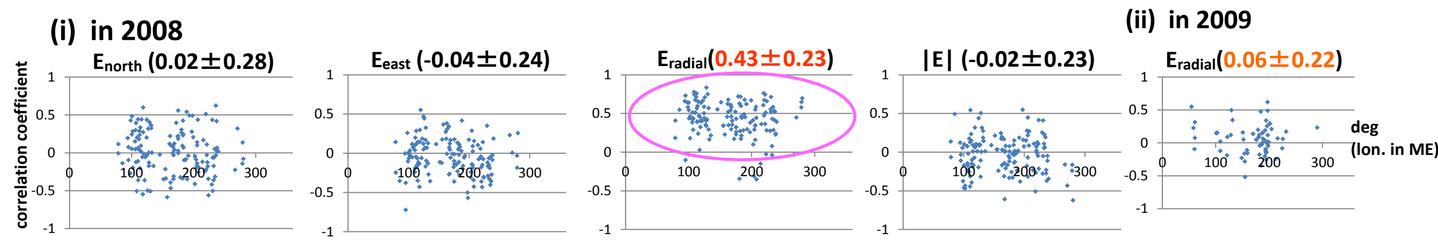
1. Correlation with the electric field

The correlation coefficients with each component of electric field (*average ±s. d.*)

(a) Not above magnetic anomaly



(b) Above magnetic anomaly

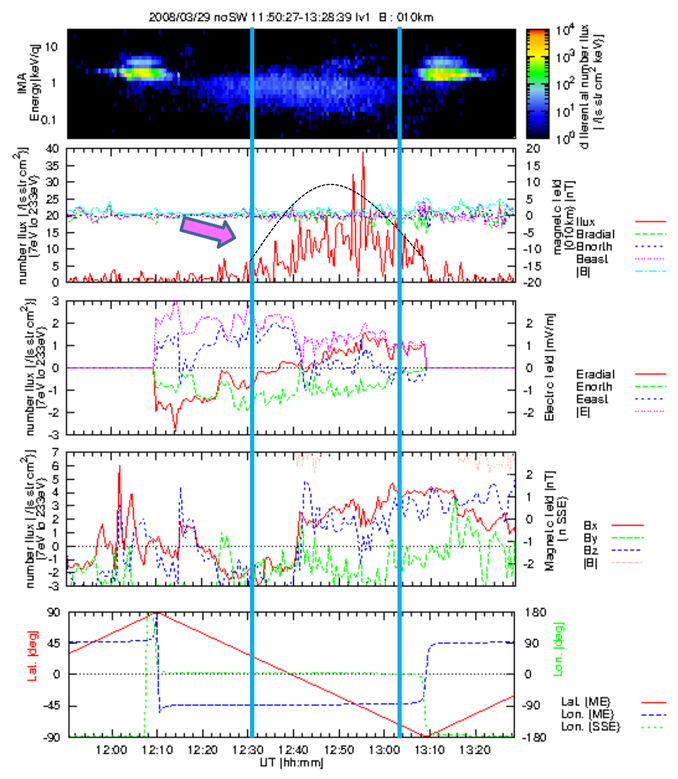


Correlation coefficients with E_{radial} is positive in 2008.
➡ the convection electric field is dominant transportation processes.

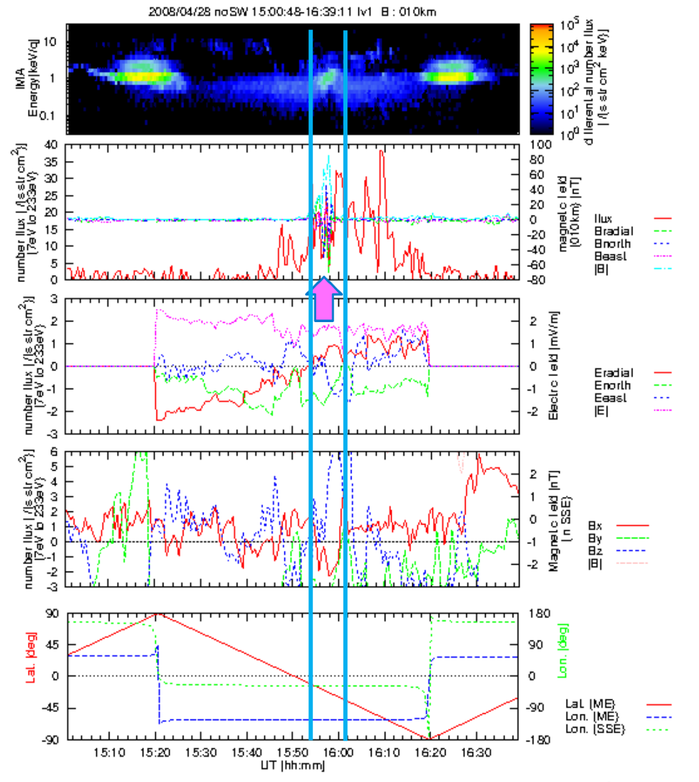
E_{radial} in 2009 < E_{radial} in 2008
・higher altitude (the longer distance) → larger effects of electric field ?
・other factors such as potential field ?

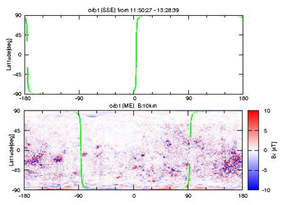
2. The Effect of Magnetic Anomaly

(a)Not above magnetic anomaly

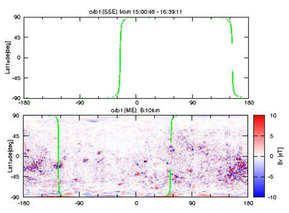


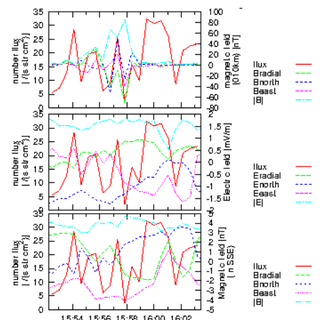
(b)Above magnetic anomaly





In general,
detected flux variations are explained by electric fields





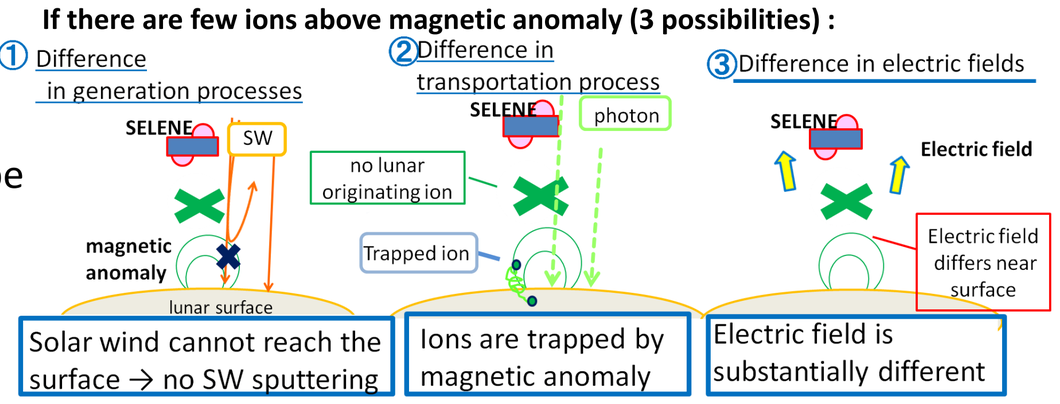
Above magnetic anomalies,
IMA detected less low energy heavy ion fluxes, which could not be explained by electric field.
→ there are less Moon originating ions / Moon originating ions are accelerated

Summary /Conclusion

•**Electric field** ($E=-V_{SW} \times B_{IMF}$) **is dominant transportation process** for Moon originating ions. Since the amounts of detected ions had good correlation, electric field should be taken into account for quantitative analysis.

•IMA detected less Moon originating ion fluxes whose energies are < 250eV.
This indicates three possibilities described in right figures.

If there are few ions above magnetic anomaly (3 possibilities) :



Reference :

Saito et al, Space Science Reviews, July 2010, In flight Performance and Initial Results of Plasma Energy Angle and Composition Experiment (PACE) on SELENE (Kaguya)

Yokota et al, GRL , June 2009, First direct detection of ions originating from the Moon by MAP-PACE IMA onboard SELENE (KAGUYA)

S. Alan Stern, Reviews of Geophysics, January 1999, The Lunar Atmosphere: History, Status, Current Problems, and Context

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