



# Intercomparisons of RO electron density using Abel inversion and data assimilation

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# Motivation

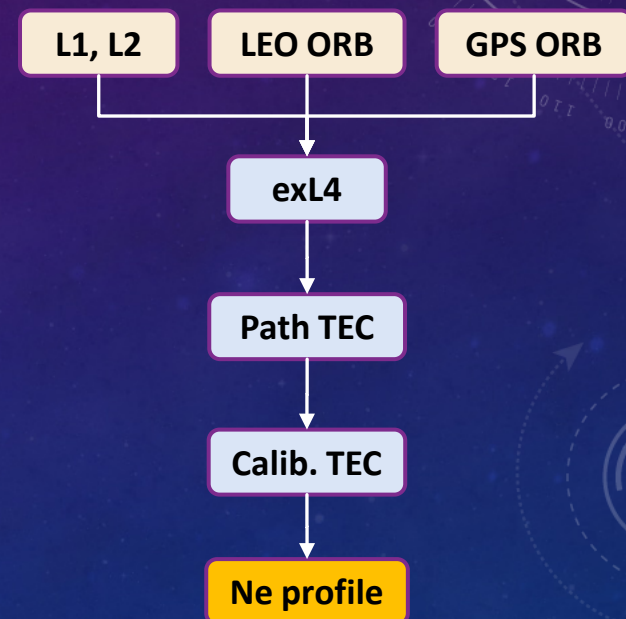
- Develop ionospheric RO data processing for FORMOSAT-7/COSMIC-2
- Evaluate the results from
  - Abel inversion with TEC (dual-frequency combination)
  - Abel inversion with bending angle (single frequency)
  - Data assimilation with the calibrated TEC into IRI model





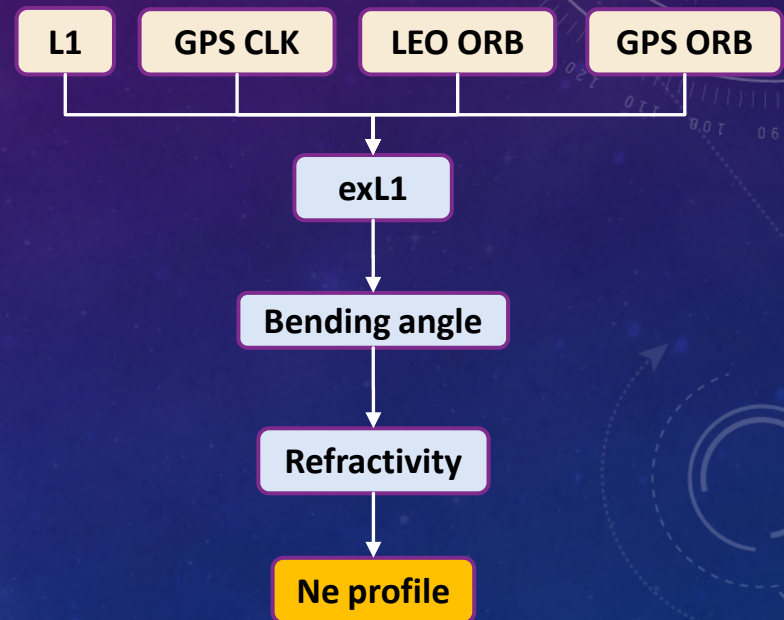
# Dual-frequency data processing

- Based on Schreiner et al. (1999)
- Use FORMOSAT-3/COSMIC L1 and L2 phases as input
- Derive excess phase by dual-frequency difference (assuming no bending)
- Convert to path TEC
- Estimate the calibrated TEC by subtracting non-RO TEC (assuming co-plane)
- Retrieve electron density profile by Abel inversion (assuming spherical symmetry)



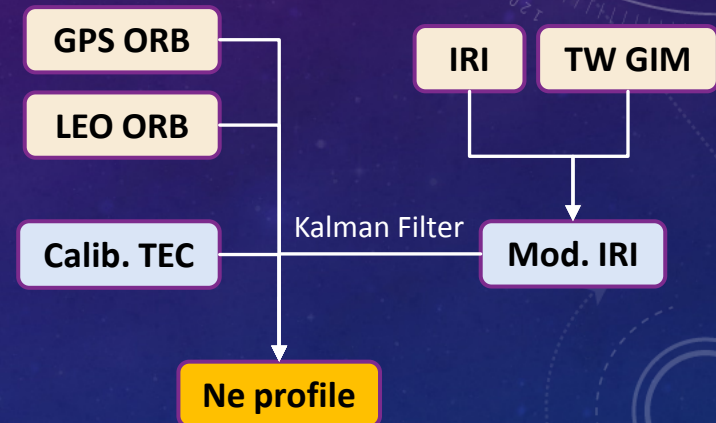
# Single-frequency data processing

- Based on Tsai et al. (2002)
- Use FORMOSAT-3/COSMIC L1 phase as input
- Derive L1 excess phase from single difference
- Estimate bending angle based on GO
- Retrieve refractivity profile by Abel inversion (assuming spherical symmetry)
- Convert to electron density profile (use first-order Taylor expansion of Appleton formula)



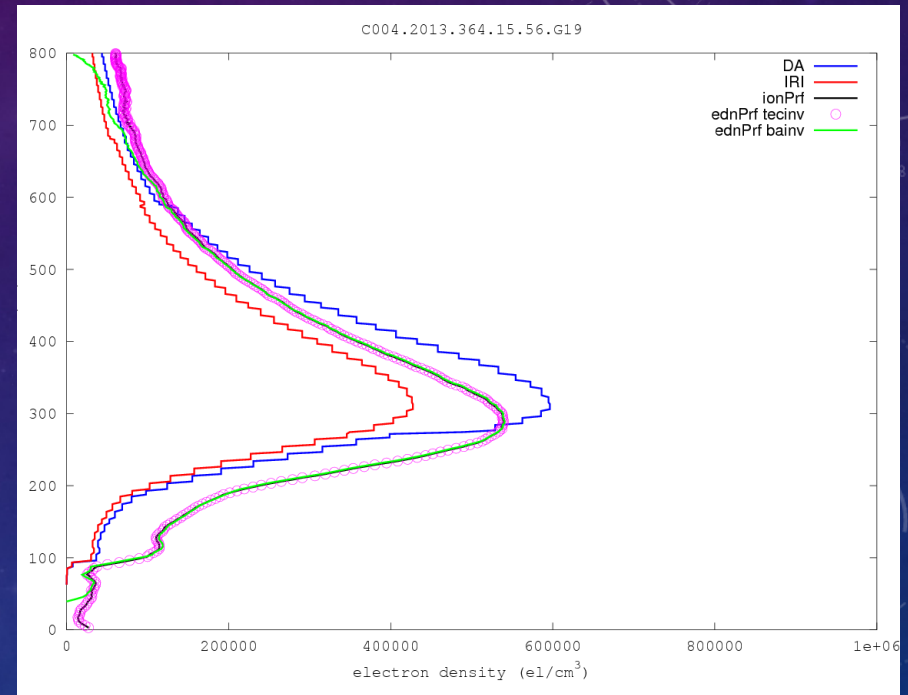
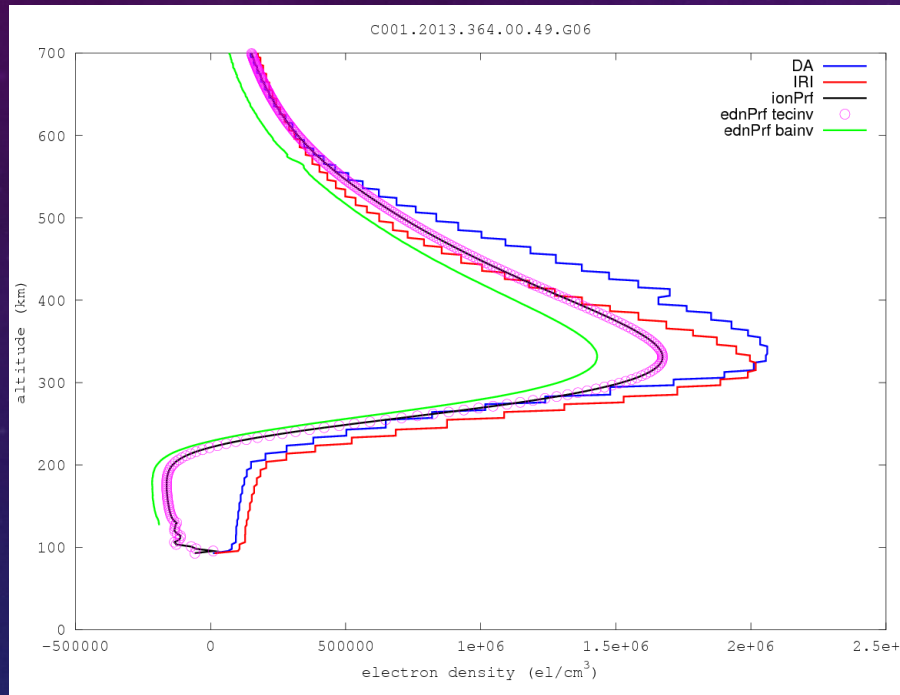
# Data assimilation processing

- Based on Lin et al. (2015)
- Assimilate the calibrated TEC from FORMOSAT-3/COSMIC into IRI model (adjusted with TW GIM) based on Kalman filter (no forecast step; no symmetry assumption)
- Location-dependent model error covariance applied
- Data thinning applied on observation data
- Background error covariance is calculated from 62 IRI samples based on random IG (ionosphere global) index and sunspot number input

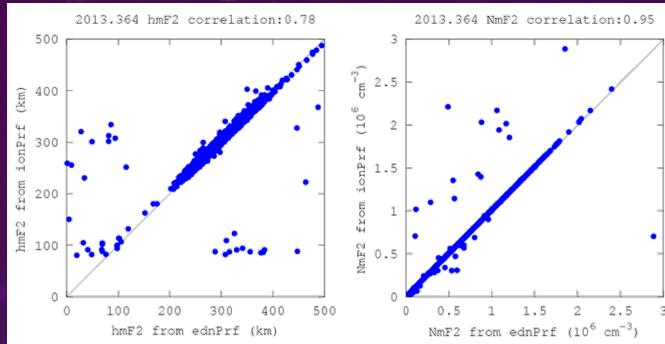




# Electron density profiles from Abel inversion and data assimil.



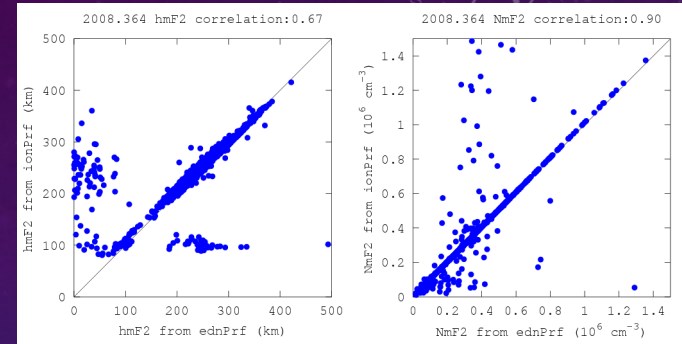
CDAAC  
ionPrf



(dual-freq) hmF2

NmF2

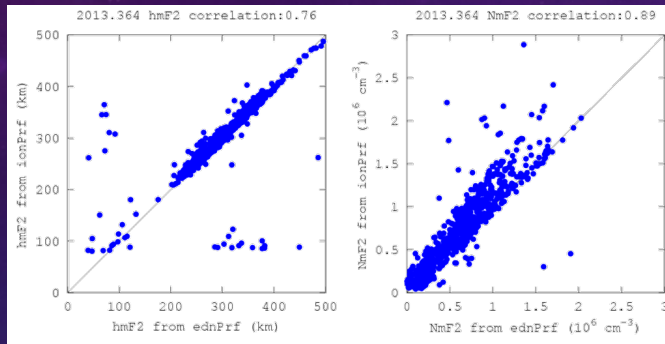
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(dual-freq) hmF2

NmF2

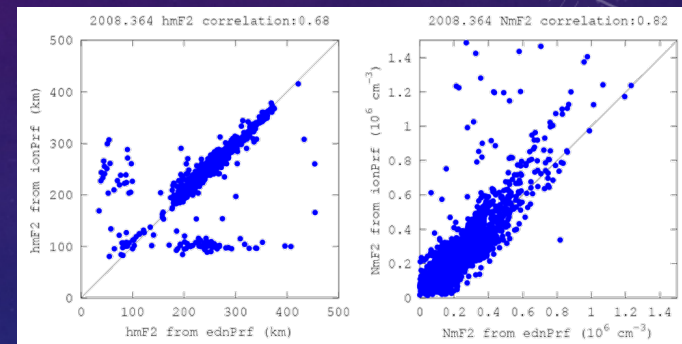
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(single-freq) hmF2

NmF2

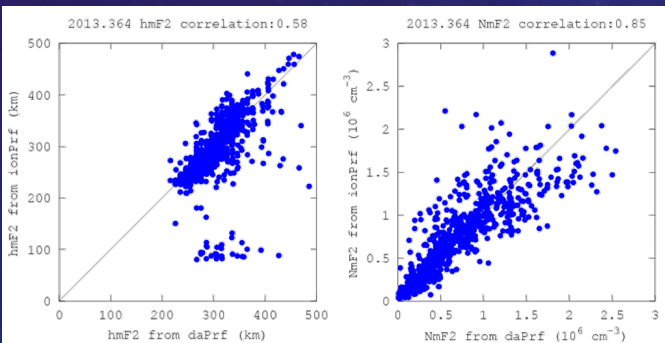
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(single-freq) hmF2

NmF2

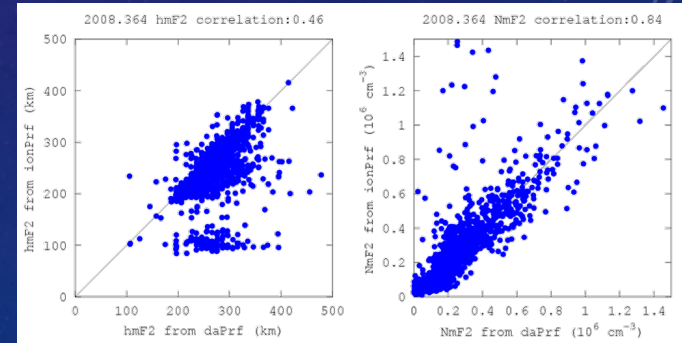
CDAAC  
ionPrf



(data assimil.) hmF2

NmF2

CDAAC  
ionPrf

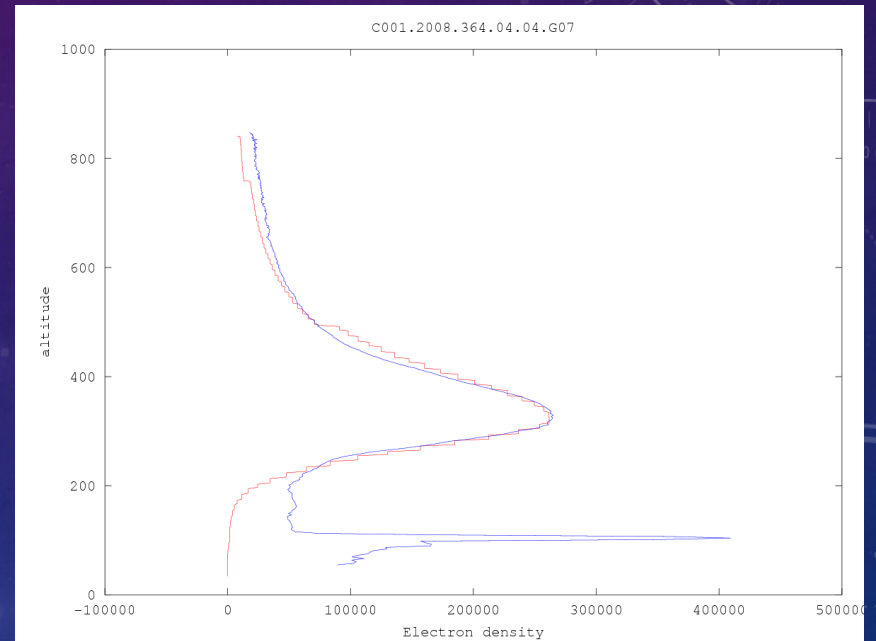
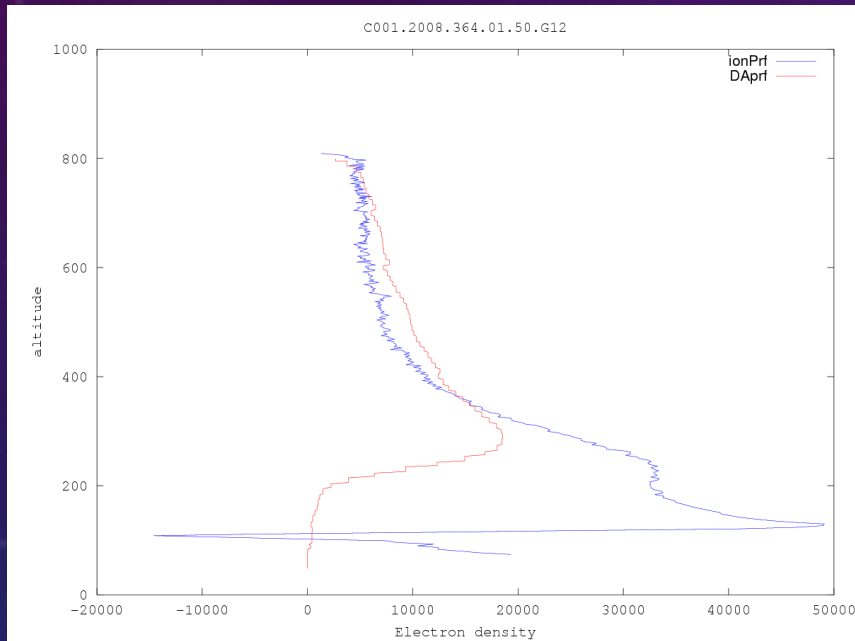


(data assimil.) hmF2

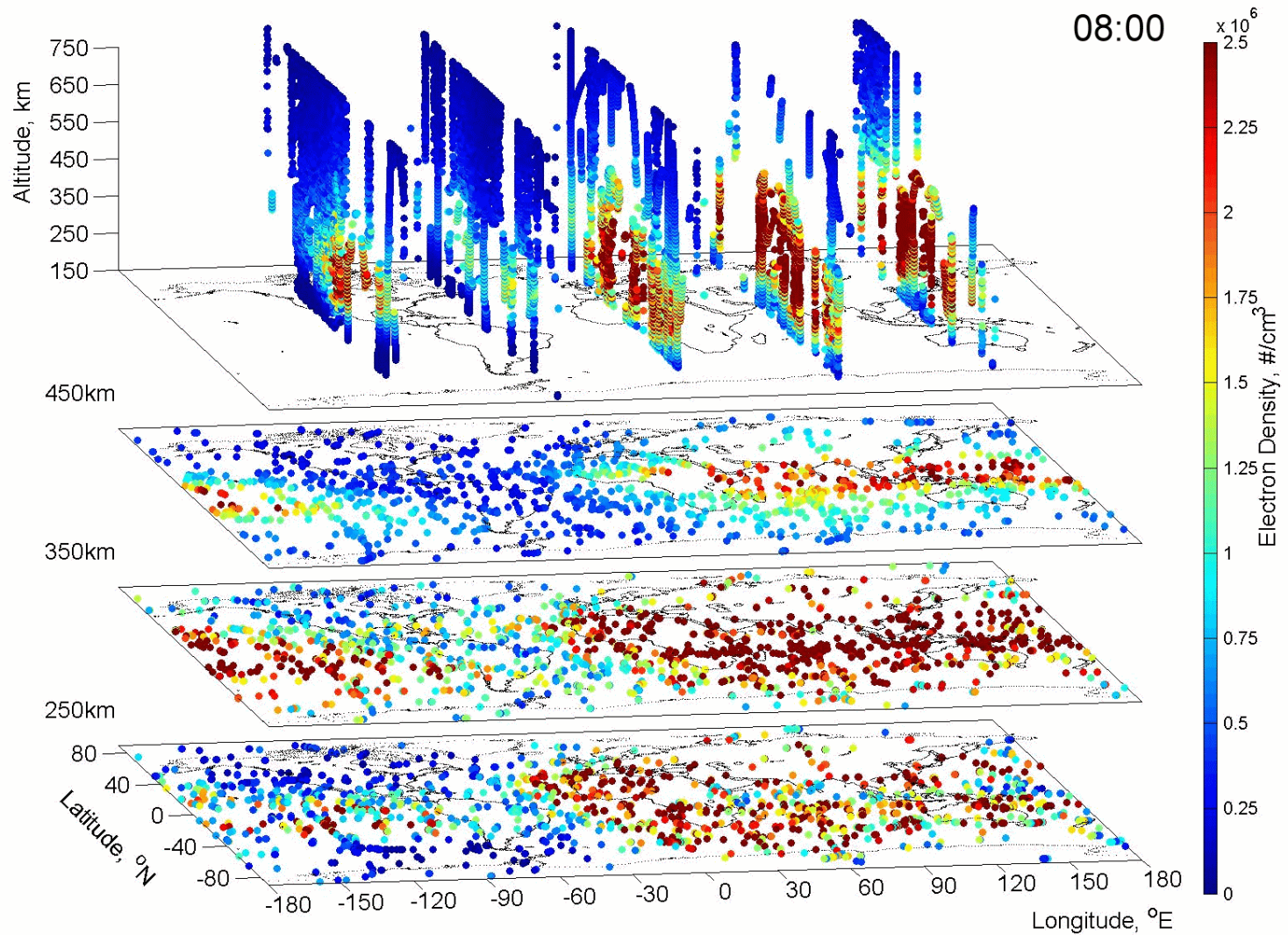
NmF2



# Es layer or not?



# Ionospheric structure based on FORMOSAT-7/COSMIC-2 OSSE



# Summary

- **Electron density profiles retrieved from Abel inversion with dual-frequency and single-frequency observables and from data assimilation are estimated**
- **In general, comparisons between them show high correlation for hmF2 and NmF2, respectively**
- **Es layers revealed in Abel inversion but not in data assimilation need to be further validated**