# The Relationship between Thermospheric Winds and Equatorial Spread F (ESF)

Patrick Dandenault, JHU/APL
John Noto, Bob Kerr (CPI)
Joe Huba, APL
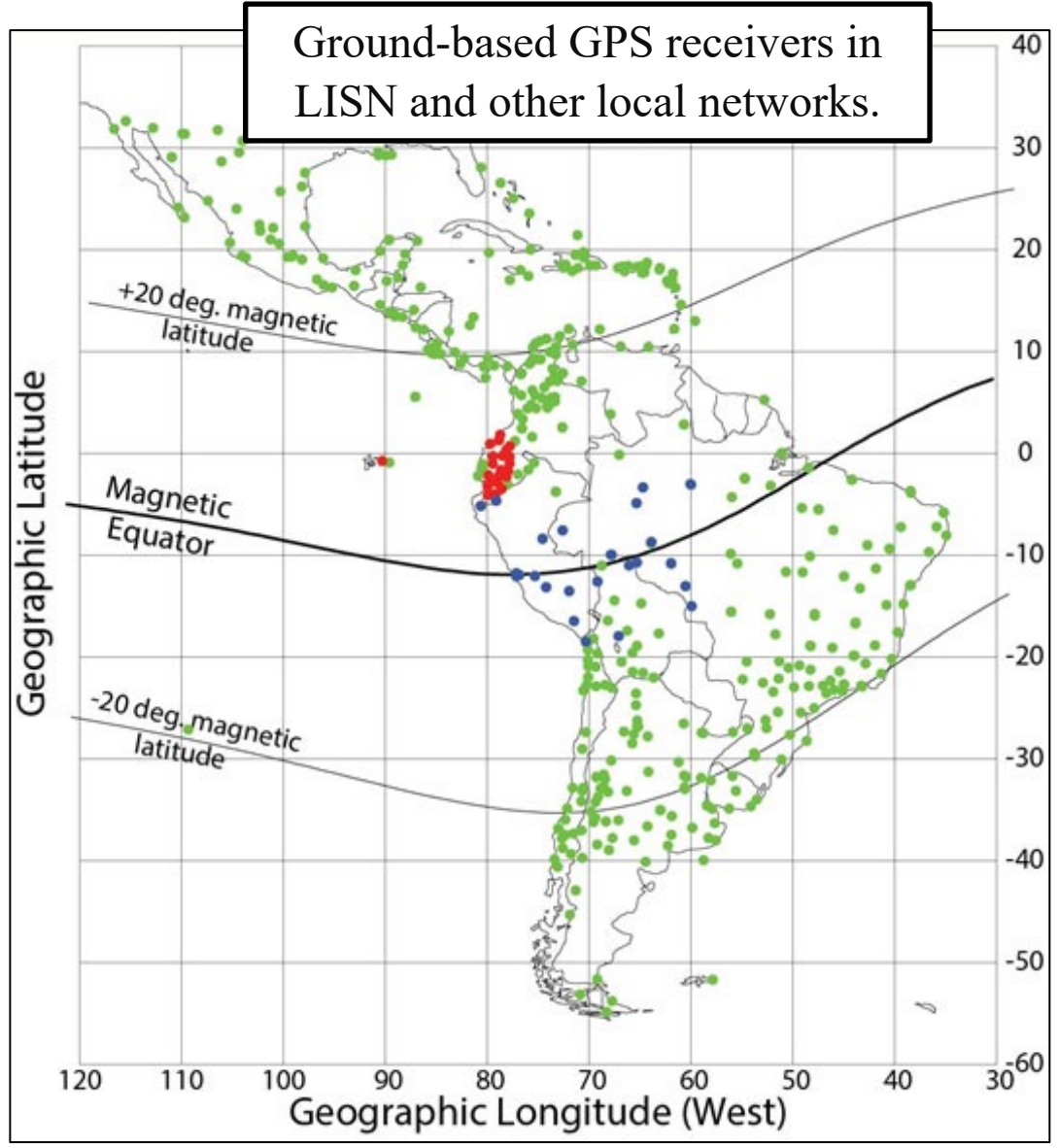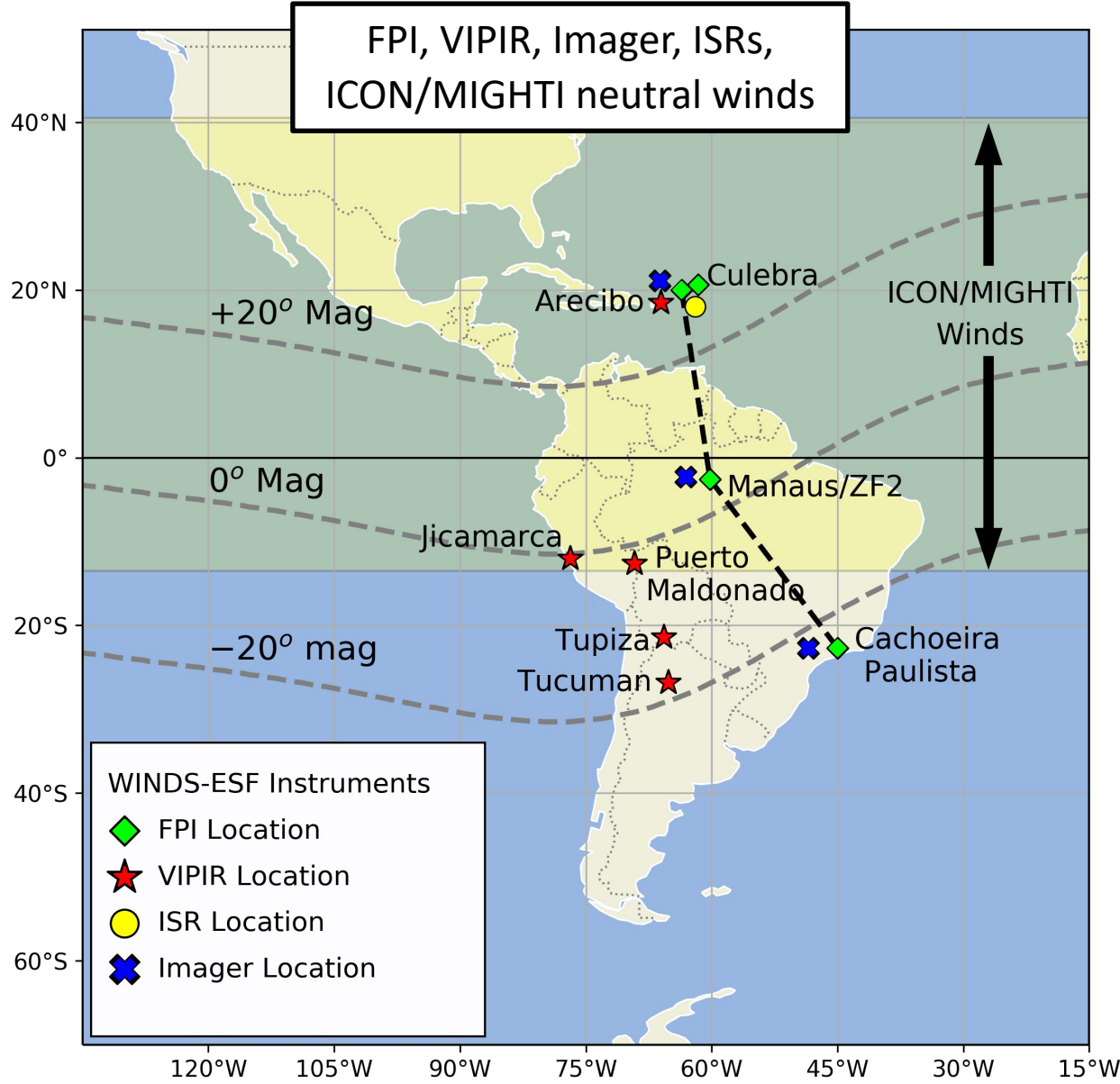Qian Wu, UCAR

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## Background:

- There has been limited research on the relationship between neutral winds and ESF.
  - None has included extended, simultaneous observations of regional neutral winds and the onset/evolution of ionospheric bubbles and ESF.

- Krall et al., [2009] used SAMI3 to simulate the effect of meridional neutral winds on the growth and suppression of ESF.  Conclusions:
  - Moderate meridional wind speeds of least 60 m/s may have a stabilizing effect on ESF.

- Huba and Krall [2013] simulated the problem again. Conclusions:
  - Under different conditions, meridional winds could have a destabilizing effect on ESF.
  - If northward wind is positive, and $\theta$ increases in the northward direction.
    - A wind profile with a positive gradient ($\partial V_m / \partial \theta \geq 0$)  has a ==stabilizing== influence on the generalized Rayleigh-Taylor instability.
    - A wind profile with a negative gradient ($\partial V_m / \partial \theta \leq 0$) has a ==destabilizing== influence on generalized R-T instability.
  - Meridional wind profiles may account for, in part, the longitudinal and day-today variability of ESF.

Proposed New Research

Part #1/2: A New Observational Database

- Develop an observational database in a region surrounding the magnetic equator

  - South American Sector

  - Observe neutral wind dynamics and the local ionosphere

    - Before/During/After bubbles originate and ESF occurs

  - Include: FPIs, Imagers, VIPIRS, ISRs, ground based GPS receivers, ICON observations

# Observational database



FPI, VIPIR, Imager, ISRs, ICON/MIGHTI neutral winds

+20° Mag

ICON/MIGHTI Winds

Culebra

Arecibo

0° Mag

Manaus/ZF2

Jicamarca

Puerto Maldonado

−20° mag

Tupiza

Tucuman

Cachoeira Paulista

**WINDS-ESF Instruments**
- ◆ FPI Location
- ★ VIPIR Location
- ● ISR Location
- ✕ Imager Location

Ground-based GPS receivers in LISN and other local networks.

+20 deg. magnetic latitude

Magnetic Equator

−20 deg. magnetic latitude

Geographic Latitude

Geographic Longitude (West)

# Bubbles/ESF Database

- Include plasma bubble and ESF observations from the LISN network and other local networks & instruments



Location of Ground-based GPS receivers in LISN and other local networks.
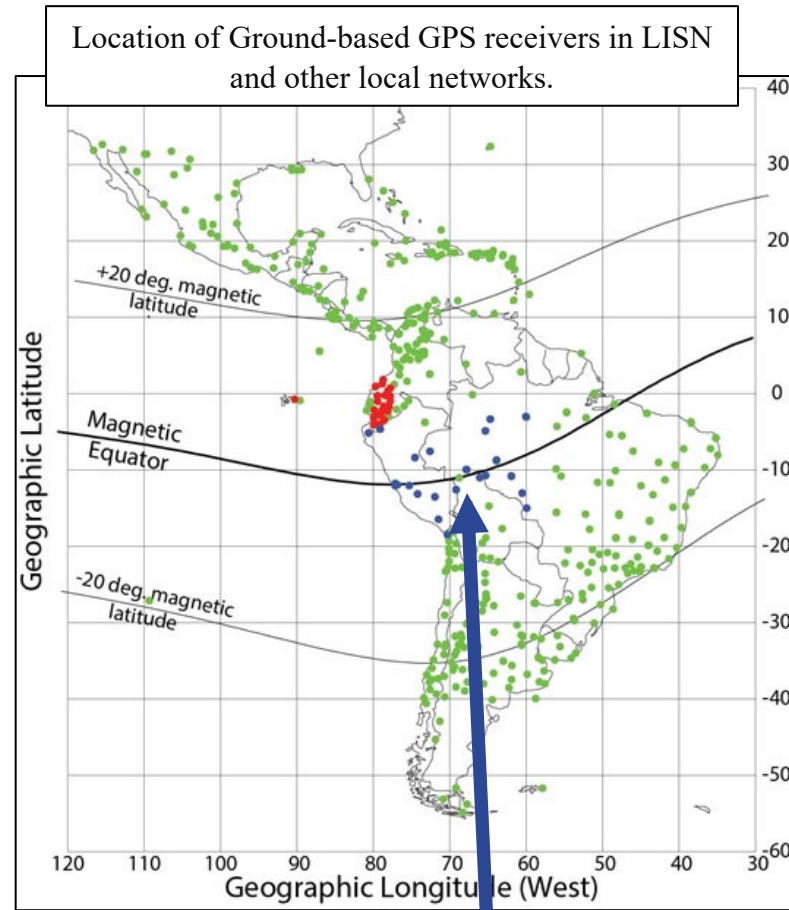
TEC variability due to an Equatorial Plasma Bubble, as observed by ground-based GPS receivers in the LISN network.
Courtesy of Cesar Valladares.
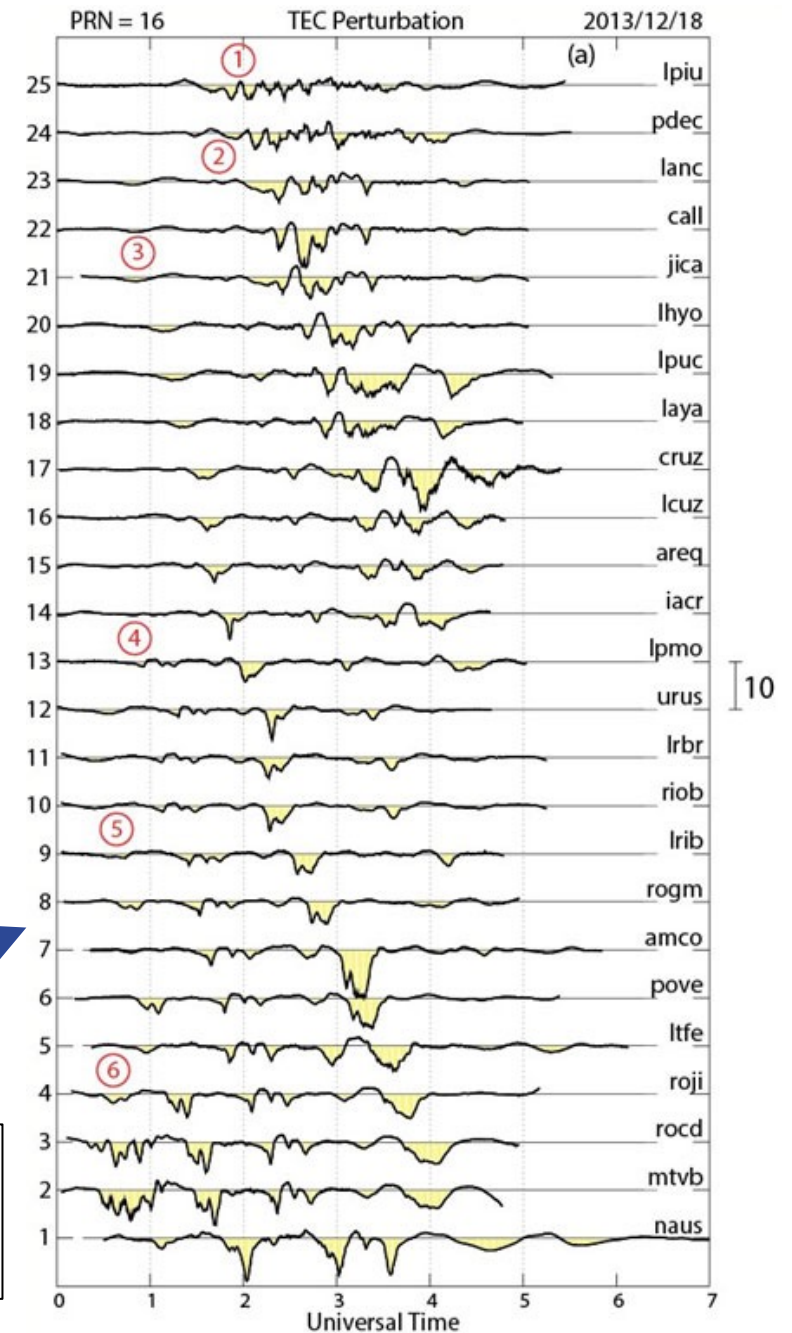
## Proposed New Research

Part #2/2:  New Modeling

- Use SAMI3 to develop a better understanding of the underlying physics

  - Simulate and validate scenarios

  - Use wind data and wind models to drive thermospheric dynamics of SAMI3

    - Use wind observations; use models to fill in missing observations (dayside, etc.)

    - Wind models: HWM14, MENTAT

  - Understand the physics

    - Use FPIs to develop an ESF characterization/forecasting capability(?)

# Thank you. Questions?