



MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS



Aerial river passage over a forested Indian reservation in the Amazon explains increased grain harvest downwind

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*8 th EGU Leonardo Conference: From evaporation to precipitation:
The atmospheric moisture transport
October 25– 27, 2016, Ourense - Spain*

GeoClimate

Channelled Fluxes of Moisture, Climate Change,
Adaptation and Environmental Services

*Participants: INPE, INPA,
FURB, UNIFEI e Rede CLIMA
Collaboration with Ephyslab Univ. Vigo*

*Funding CNPq CT-HIDRO
CNPq - FAPESP Rede Clima
WindRose Project - Fundação BemTeVi*

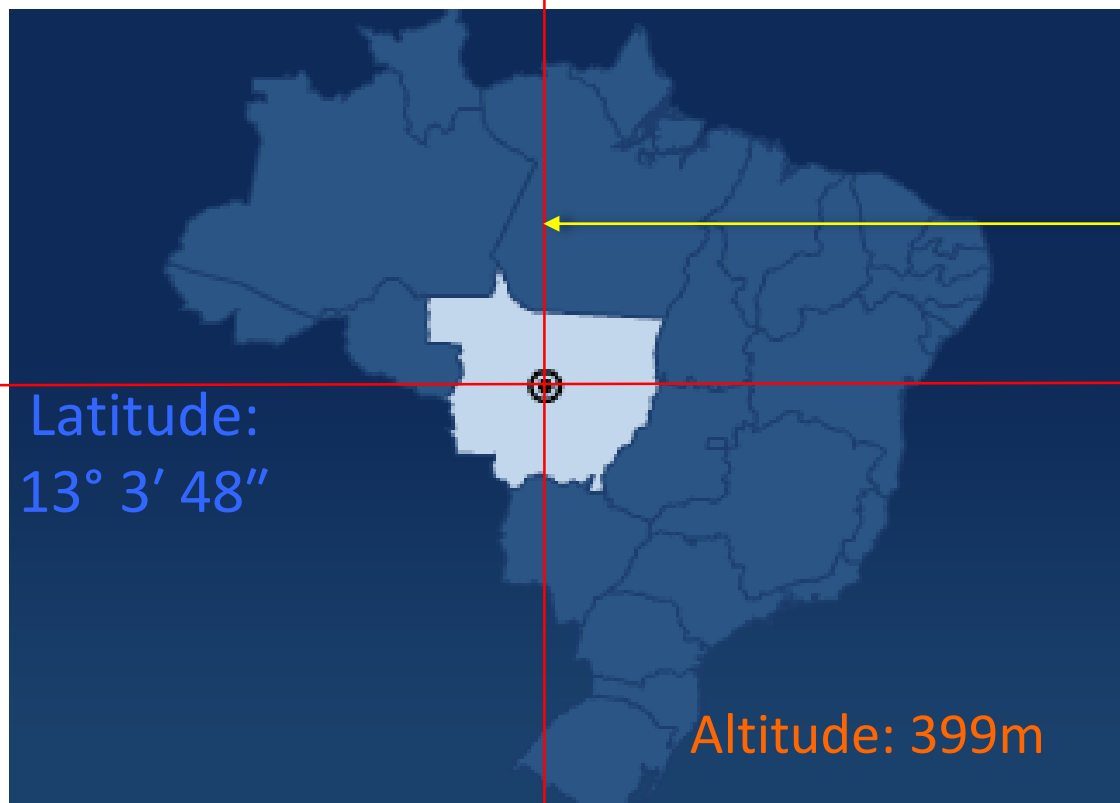
South American grain belt





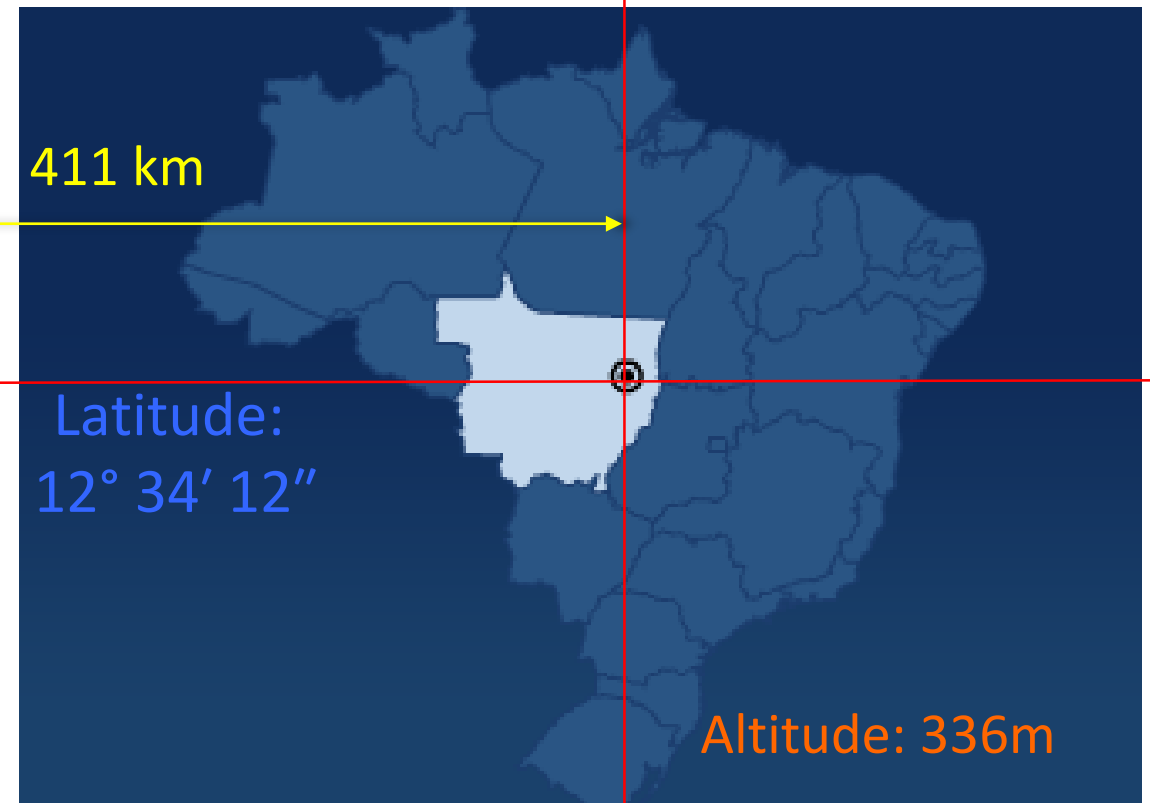
Comparing two grain producing localities in Pre-Amazon

Lucas do Rio Verde



Longitude: $55^{\circ} 55' 16''$

Querência



Longitude: $52^{\circ} 12' 48''$

anecdotal climate evidence

1ª harvest

SOY 2011	planted area ha	production t	productivity Kg/ha
<i>LUCAS do Rio Verde</i>	<i>226200</i>	<i>757800</i>	<i>3350</i>
<i>Querência</i>	<i>242626</i>	<i>841427</i>	<i>3468</i>

2ª harvest

Corn 2011	planted area ha	production t	productivity Kg/ha
<i>LUCAS do Rio Verde</i>	<i>135330</i>	<i>601839</i>	<i>4447</i>
<i>Querência</i>	<i>29039</i>	<i>121964</i>	<i>4200</i>

Lucas do Rio Verde
2 harvests / year

Querência
1 harvest / year

difference of almost 400 thousand tons

water accounting available in the soil

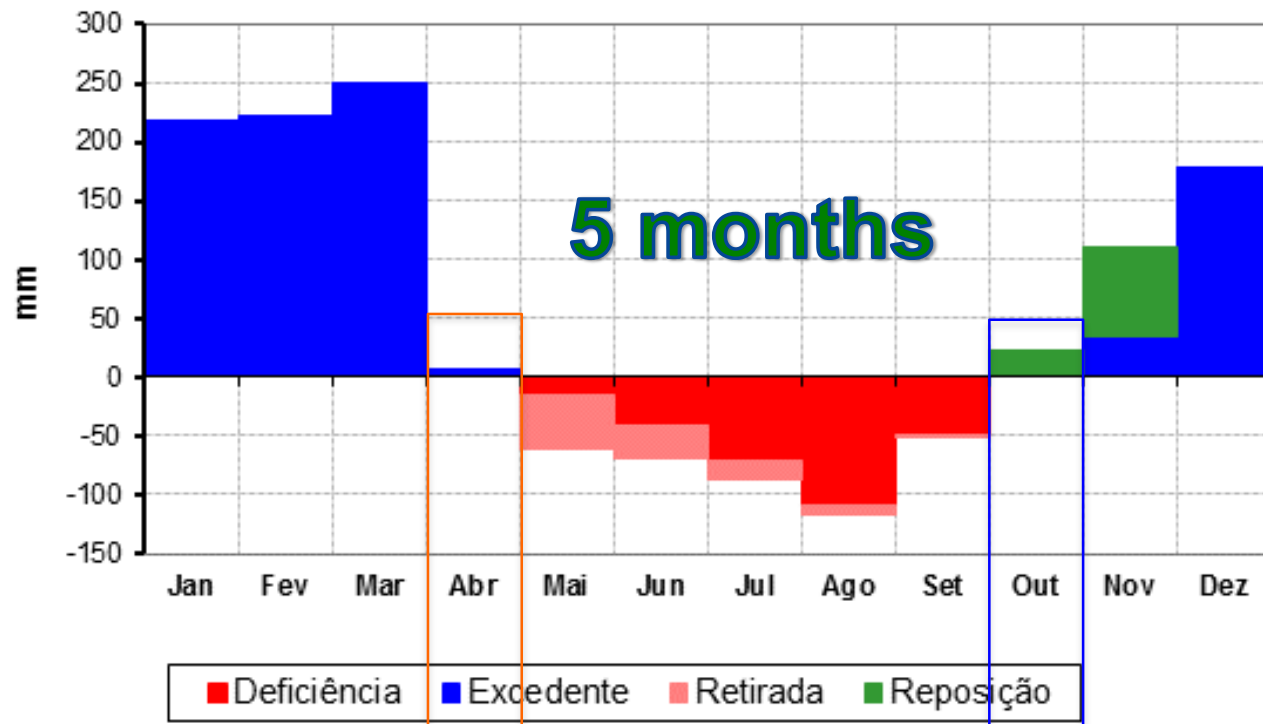
beginning of dry season

beginning of wet season

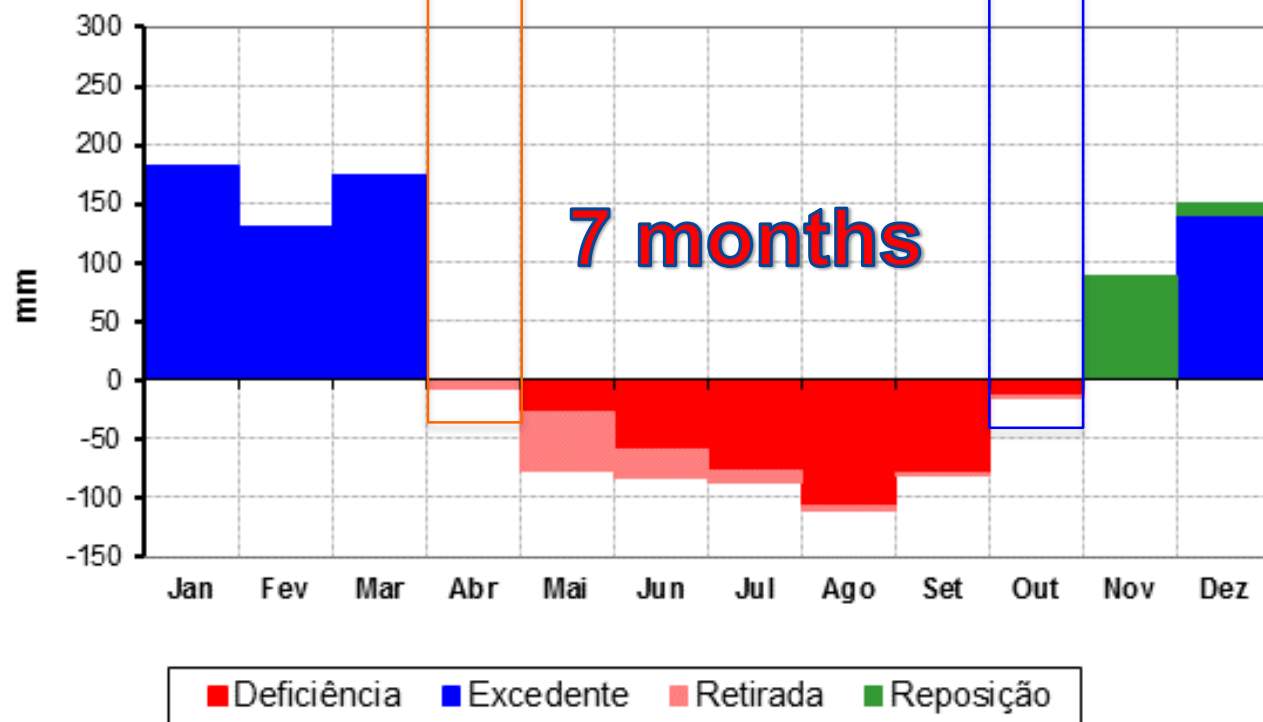
*critical differences
between sites*

Water Deficit, Surplus, Withdraws and Replenishment along the year

Lucas do Rio Verde



Querência





Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Xingu reservation

Caatinga

Querência

Lucas do Rio Verde

Novembro

Média para o mês

Créditos Projeto Rios Voadores
Computação Demerval Soares Moreira

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google earth

Eye alt 3541.83 km

Serra Geral Mountains
14°10'37.47" S 46°37'08.67" W elev 602 m

Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Dezembro

Média para o mês

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Computação Demerval Soares Moreira

Google earth

Eye alt 3541.83 km

Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Xingu reservation

Caatinga

Querência

Lucas do Rio Verde

Fevereiro

Média para o mês

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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Google earth

Serra Geral Mountains 14°10'37.47" S 46°37'08.67" W elev 602 m

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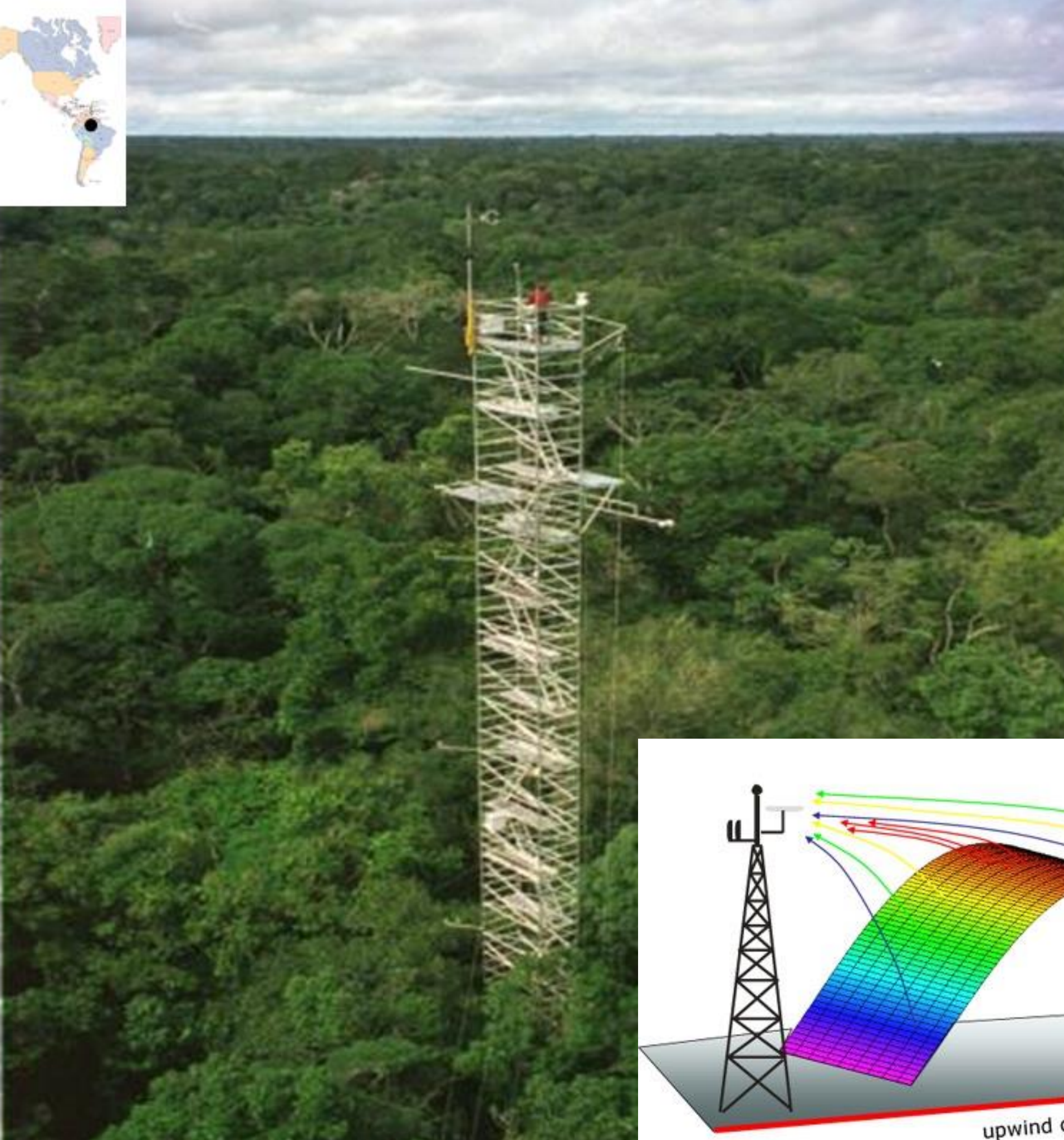


Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis



Créditos Projeto Rios Voadores
Computação Demerval Soares Moreira

Aerial rivers (traj BRAMS) 10 days back trajectories monthly average of daily mean trajectories 2008/2009/2010 ERA Interim reanalysis

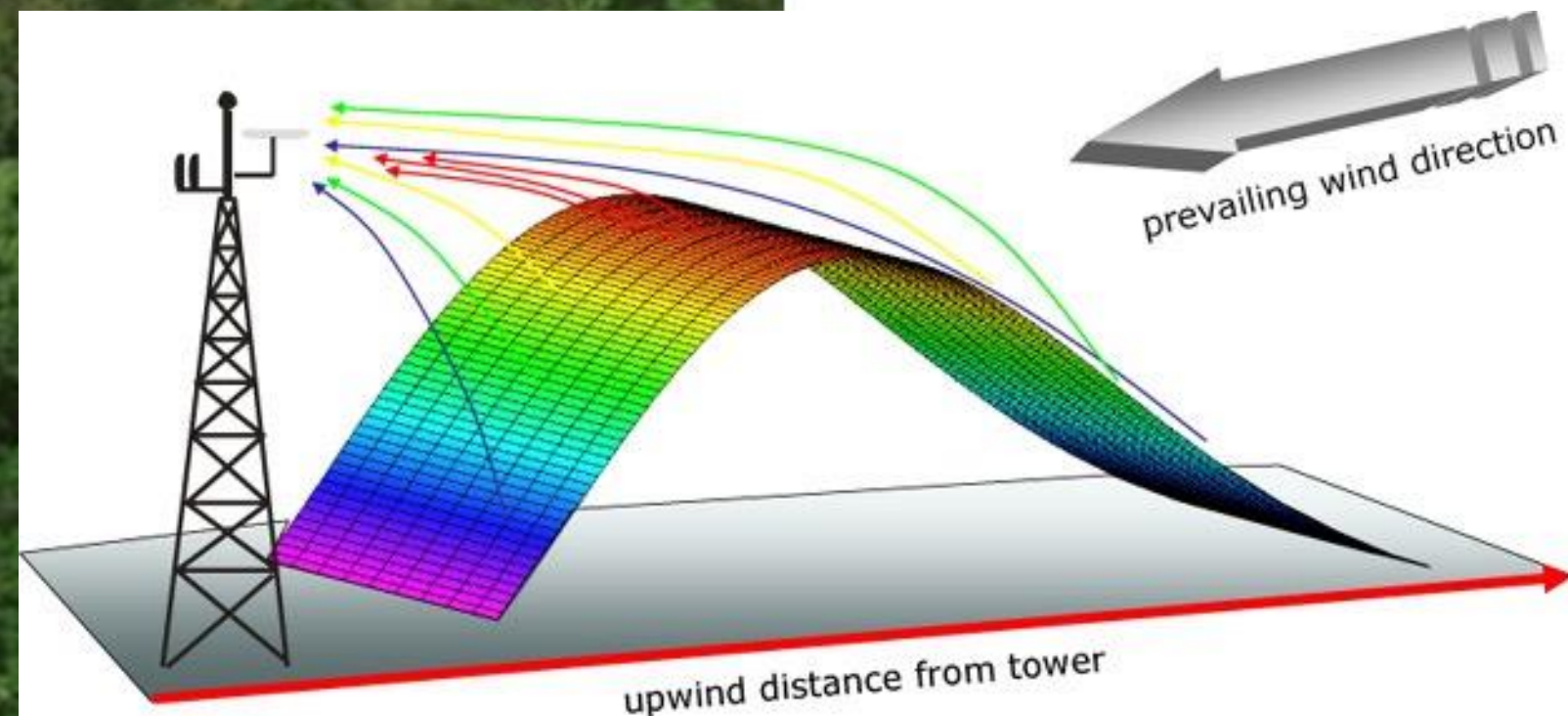


**background:
eddy flux
covariance**

**high frequency
turbulent
exchange**

**short-range
wind footprint**

vertical resolution



concept: flying rivers



**low frequency
net transport**

long range wind footprint

horizontal resolution

www.riosvoadores.com.br



method:
precipitationshed

technique:
Lagrangian flows

735

P. W. Keys et al.: Analyzing precipitationsheds

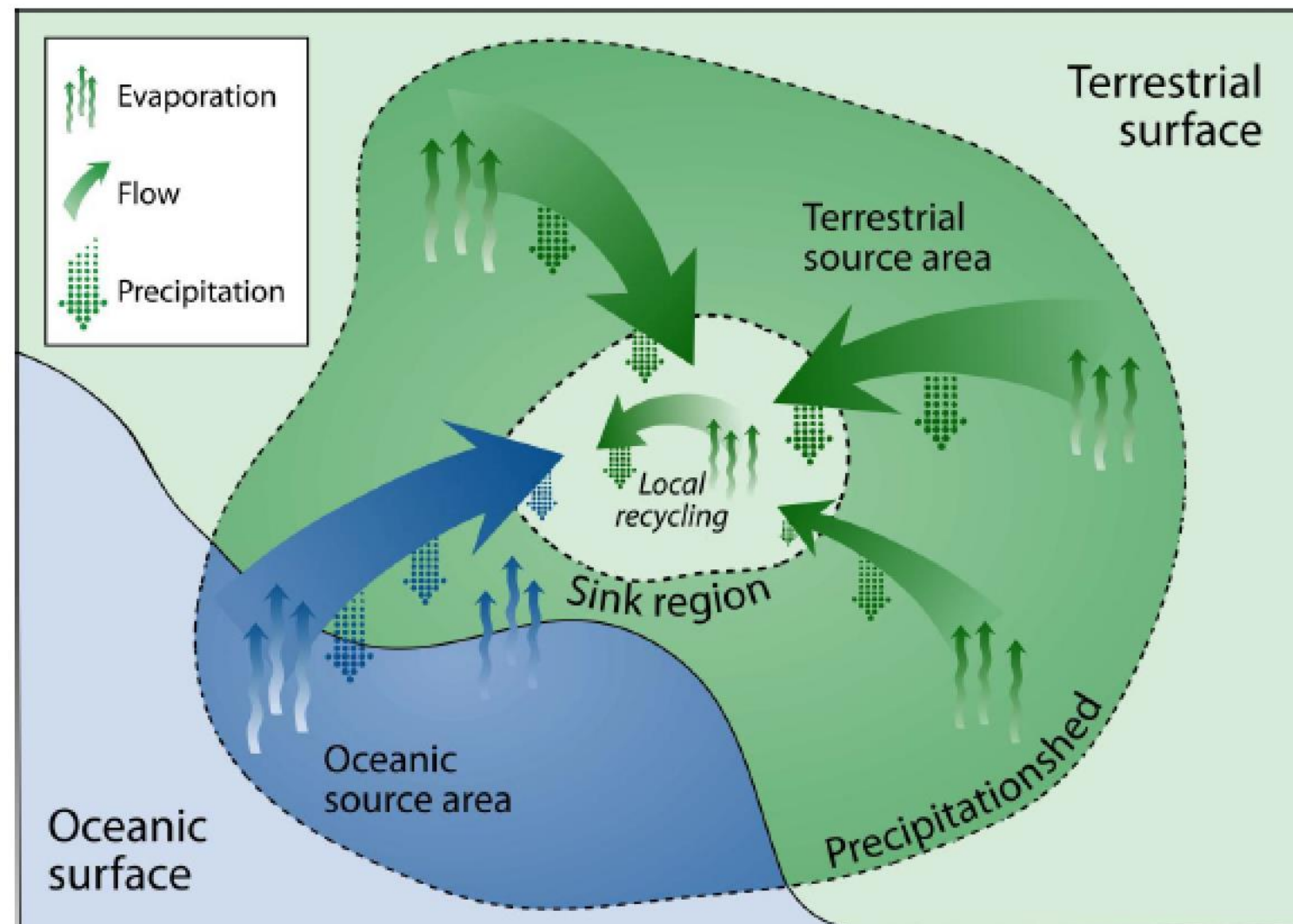


Fig. 1. Conceptual image of a precipitationshed, with precipitation in the sink region originating from both terrestrial and oceanic sources of evaporation.

Inverted learning curve

- FLEXPART **Complex**: lagrangian particle dispersion (tracers) with stochastic component (**Special Thanks to Ephyslab!!**)

subgrid

- TRAJ **Simpler**: Trajectory model developed by CPTEC INPE, three-dimensional kinematic model coupled to the RAMS adapted to the tropics (BRAMS)

grid - work reported

- **WindTrek Simplest**: Trajectory model to read directly from ERA INTERIM

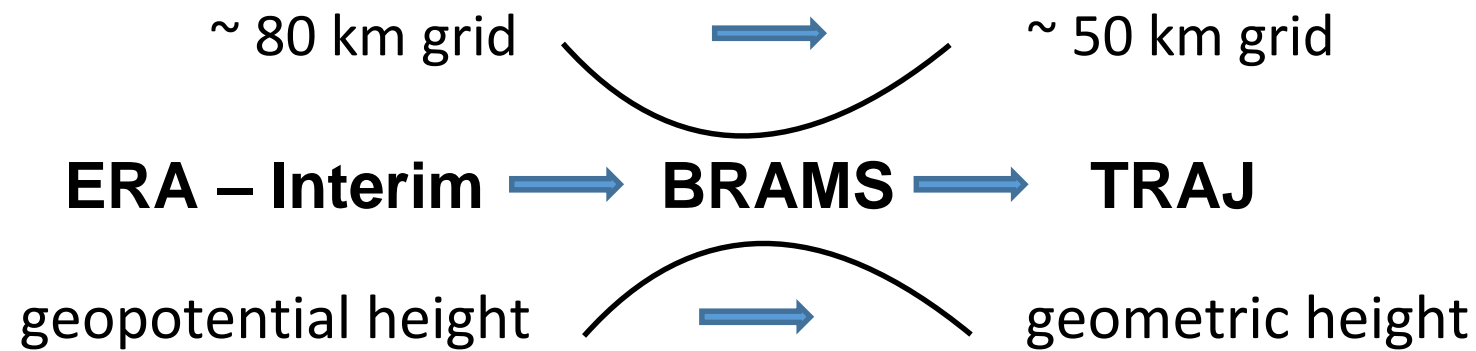
grid - no interest in chemistry, only vapour transport



(Stohl and James 2004)

- in identical repeated runs it changed particle ID and its attributes (altitude, position, humidity)
- Our main interest is connecting atmospheric-rivers climatological-footprints to land cover. Stochastic component compromised its use for our application

TRAJ (Freitas et al. 1996)



BRAMS output - Wind

- ✓ 41 pressure levels
- ✓ Variables: u , v , w (m/s), specific humidity (g/kg)
- ✓ Spatial domain.
 - Lons: -86.61, -21.738
 - Lats: -49,142, 13,758
- ✓ Espatial resolution 50km x 50km ($0.477^\circ \times 0.425^\circ$)
- ✓ Spatial resolution 6 hours

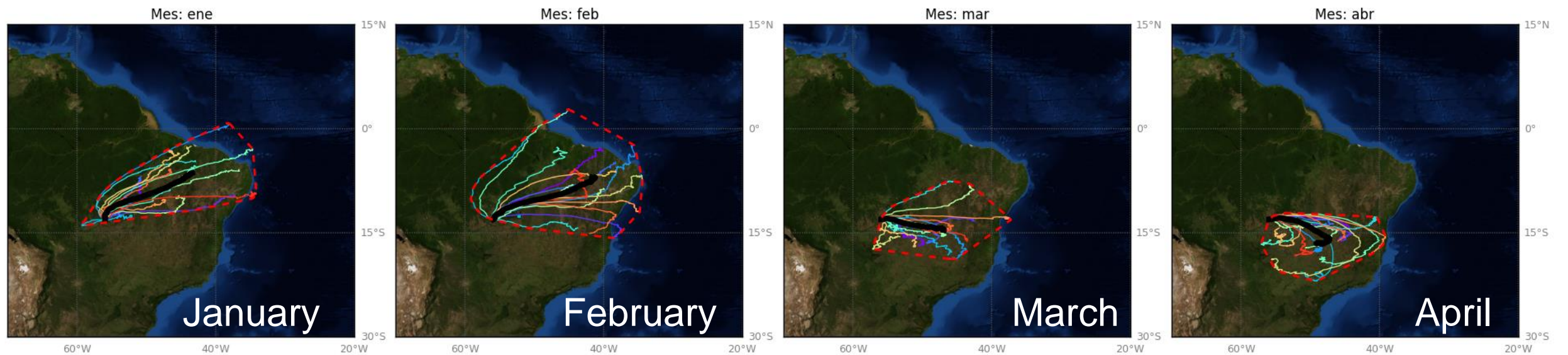


Aerial River Climatology

➤ ConvexHull:

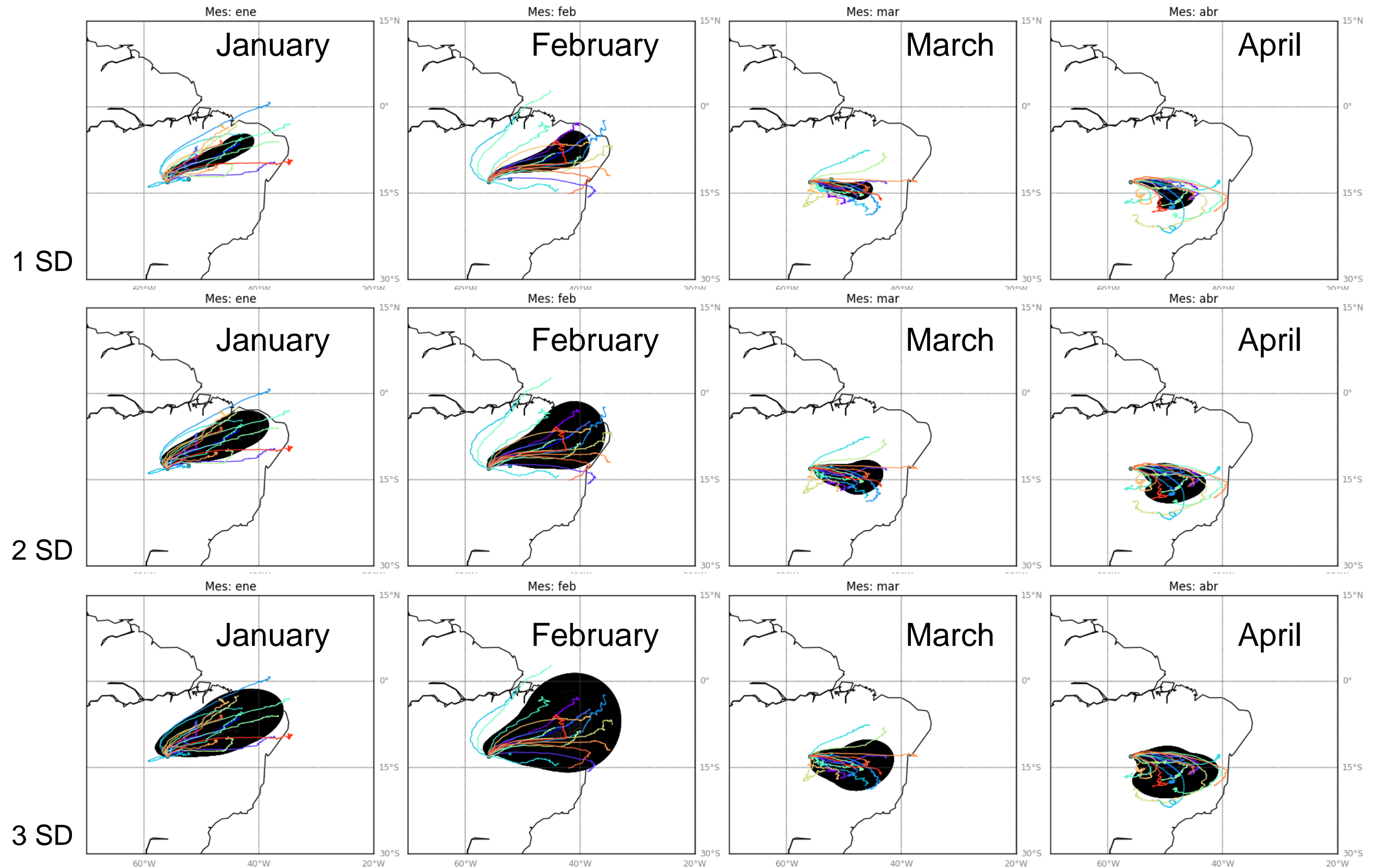
convex polygon of minimum area that covers all points of the paths chosen

CONVEX HULL - Lucas (Todos_los_dias)



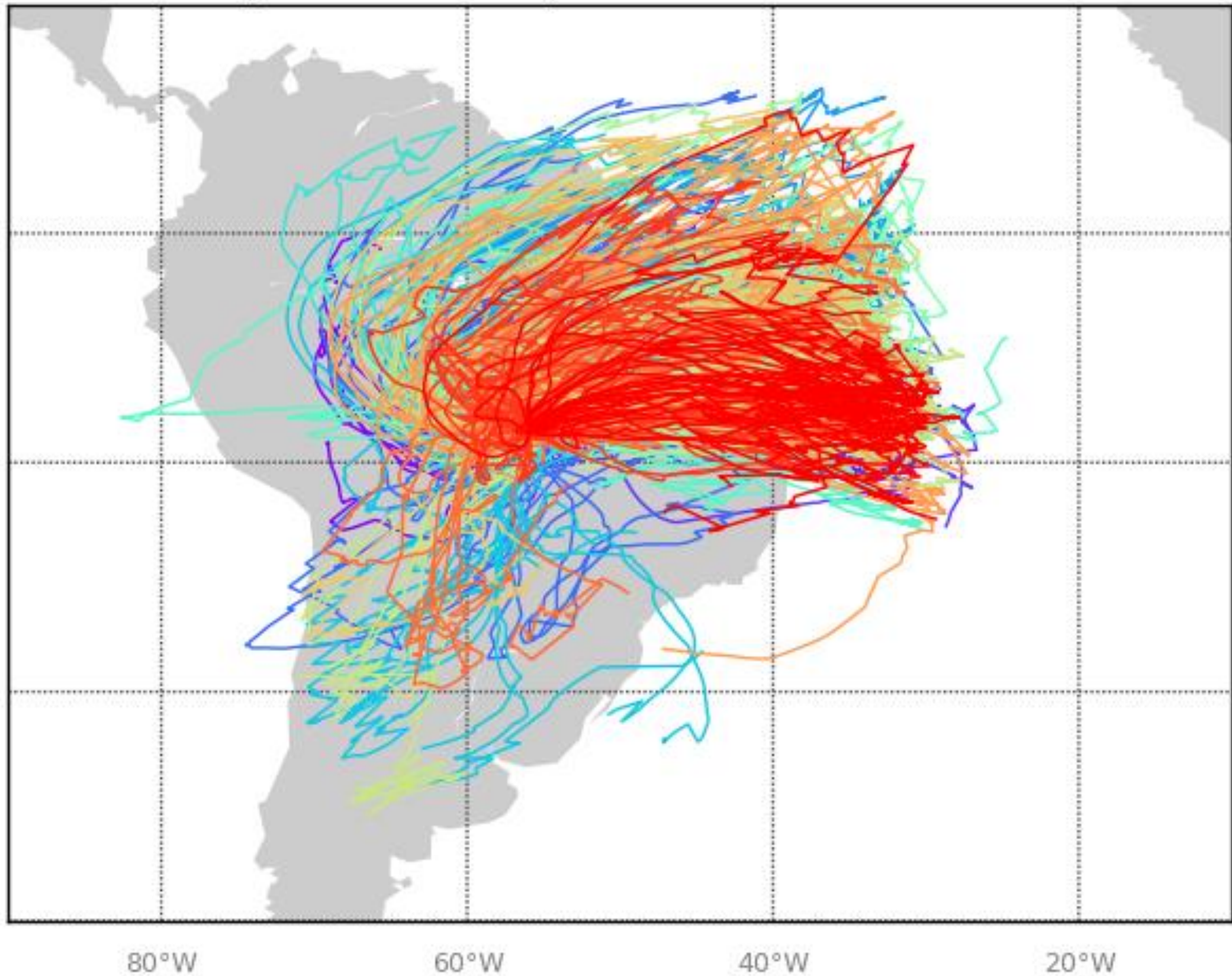
➤ Directional distribution: (standard deviation ellipses)

It is calculated on the paths for each time step, showing representative spatial variability on a set of trajectories



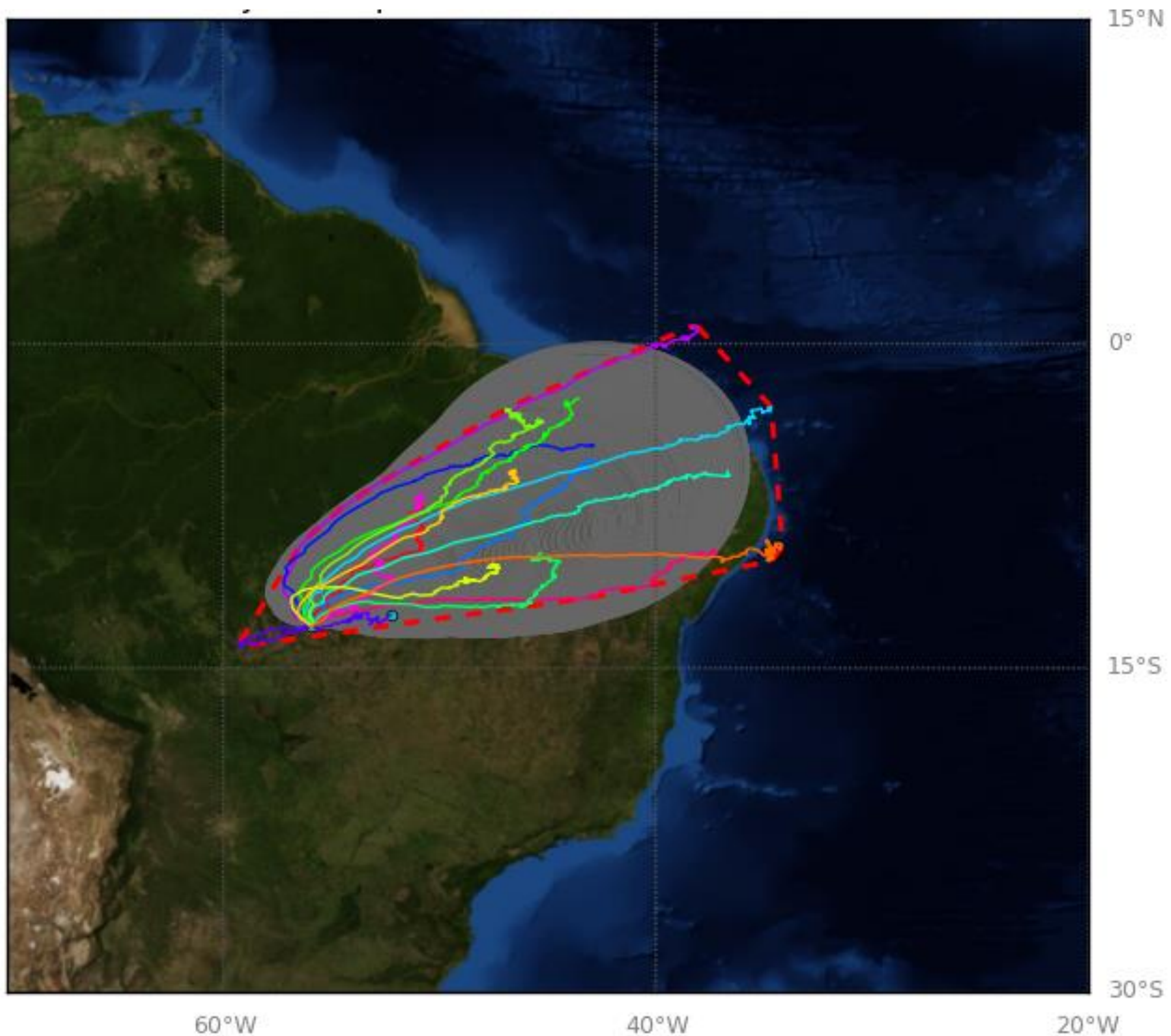
➤ **TRAJ**

January mean-daily 10d BackTraj, 2000-2014



➤ **TRAJ**

January mean-monthly 10d BackTraj, 2000-2014
convex hull and standard deviation ellipses



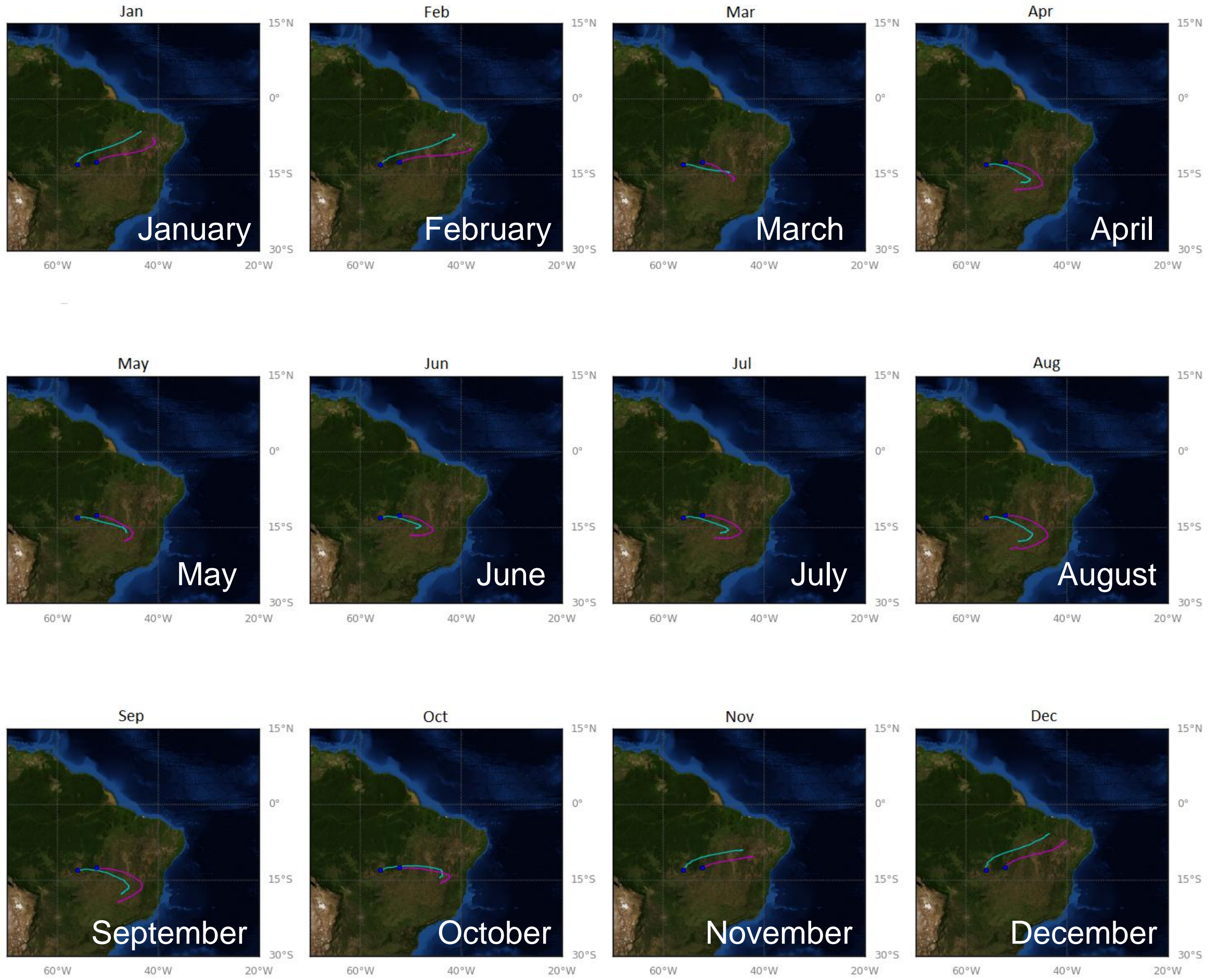
➤ **TRAJ**

January mean 10d BackTraj, 2000-2014

Lucas - blue Querencia - magenta

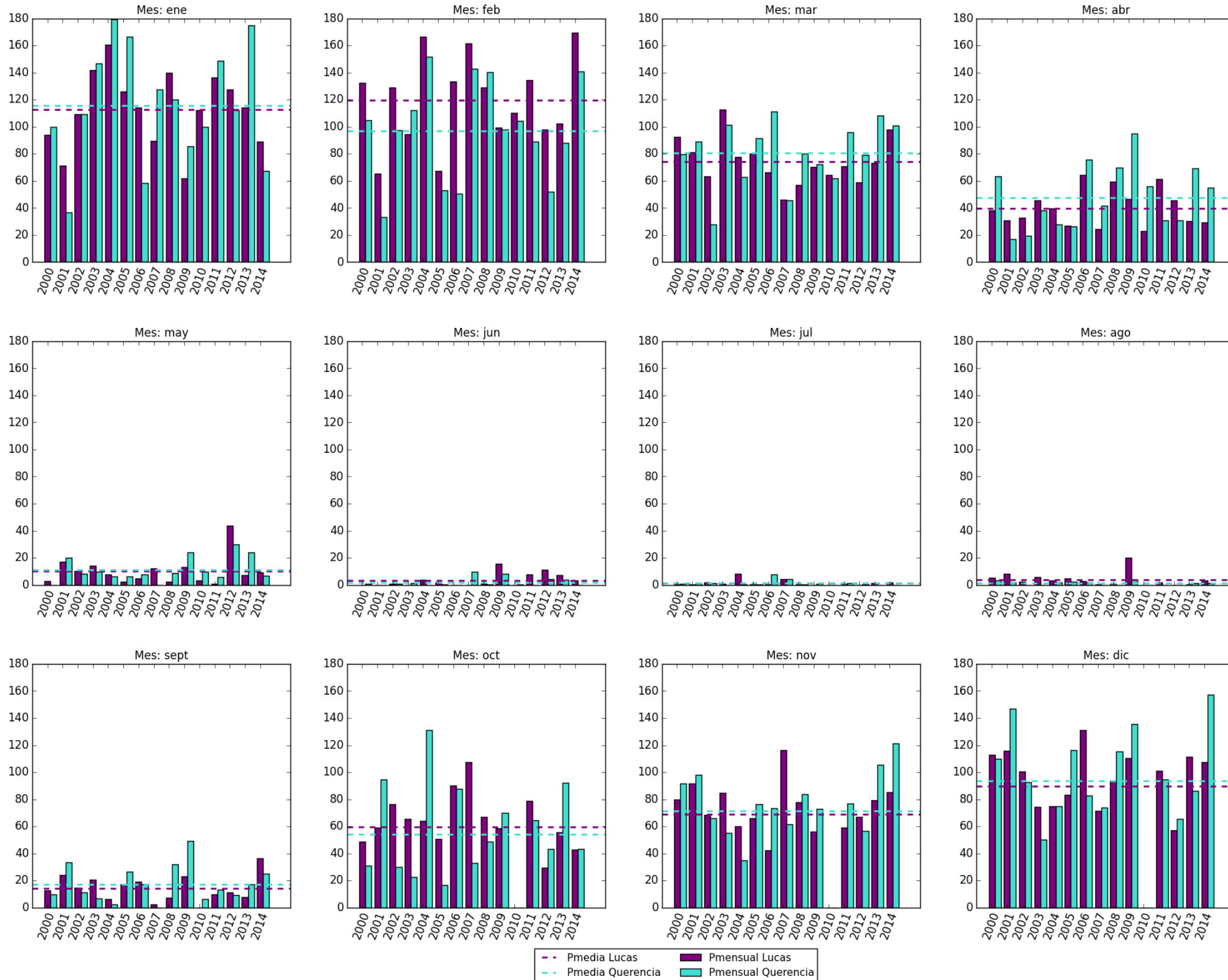


Monthly mean 10 days BackTraj, 2000-2014



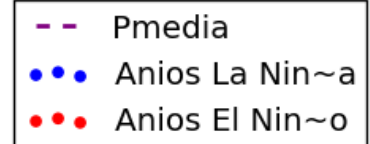
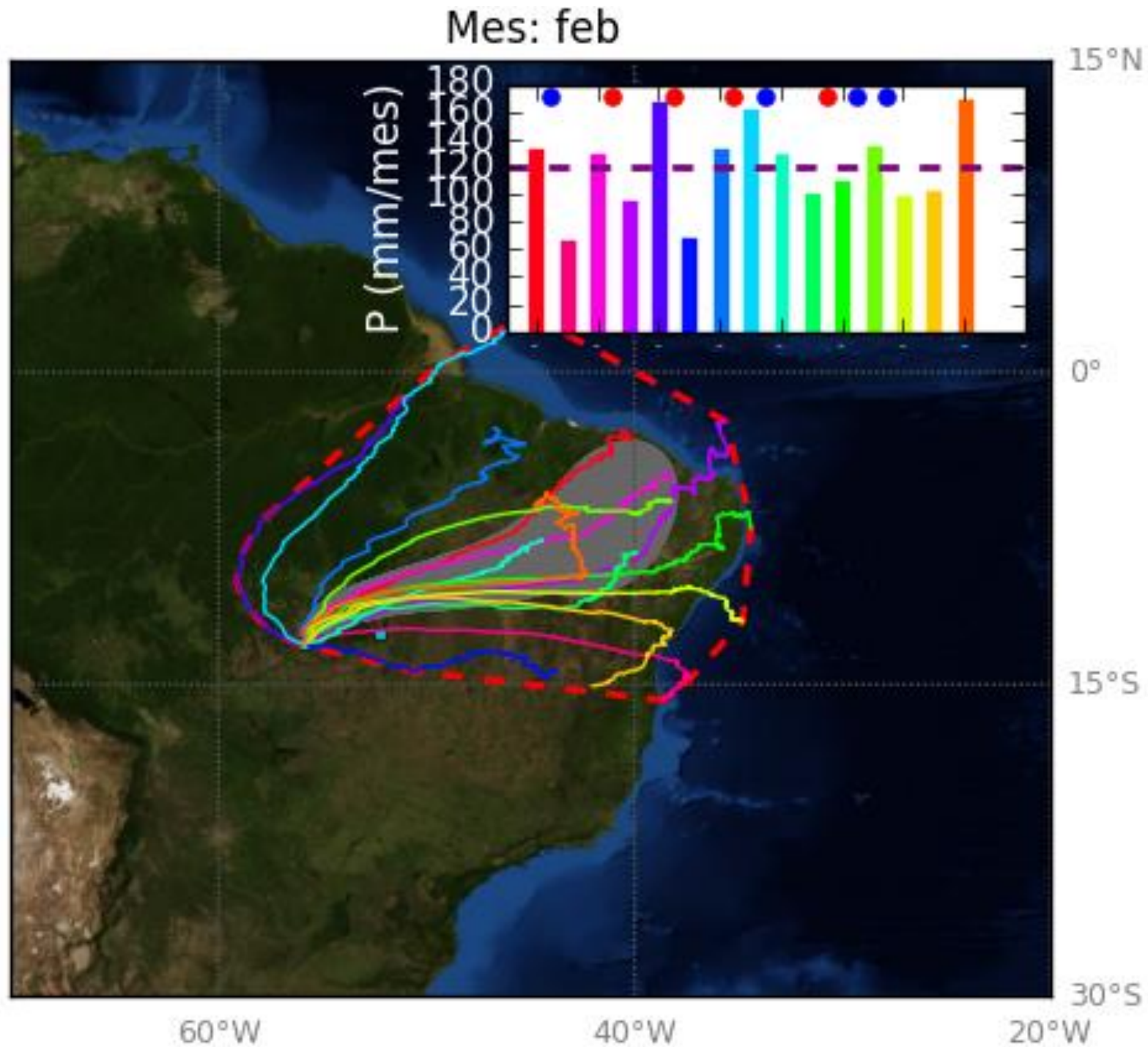
➤ Annual cycle of precipitation: TRMM – 3b42

Precipitación mensual para cada año - Lucas do rio Verde y Querencia

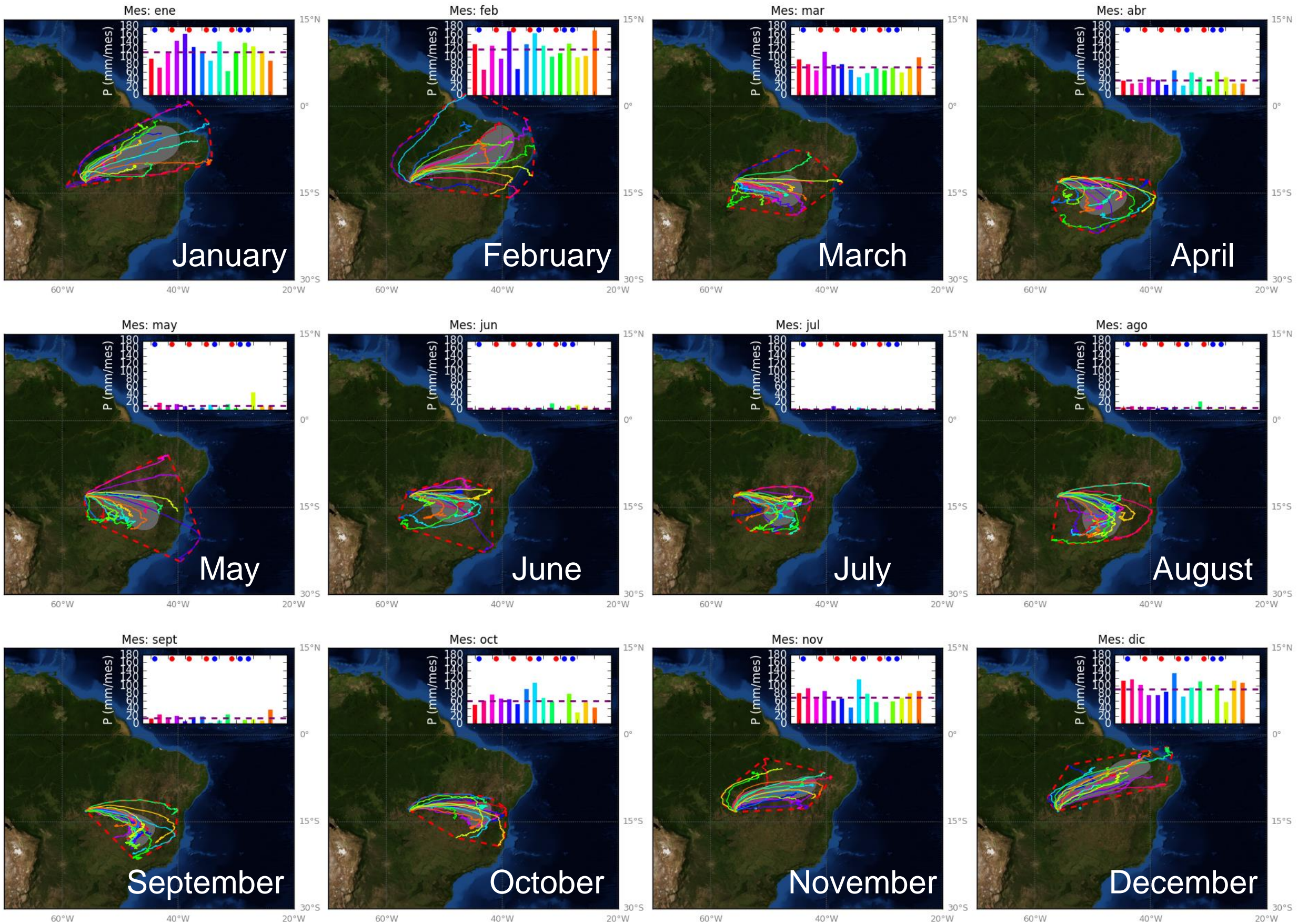


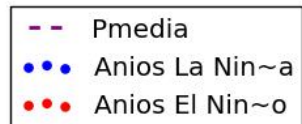
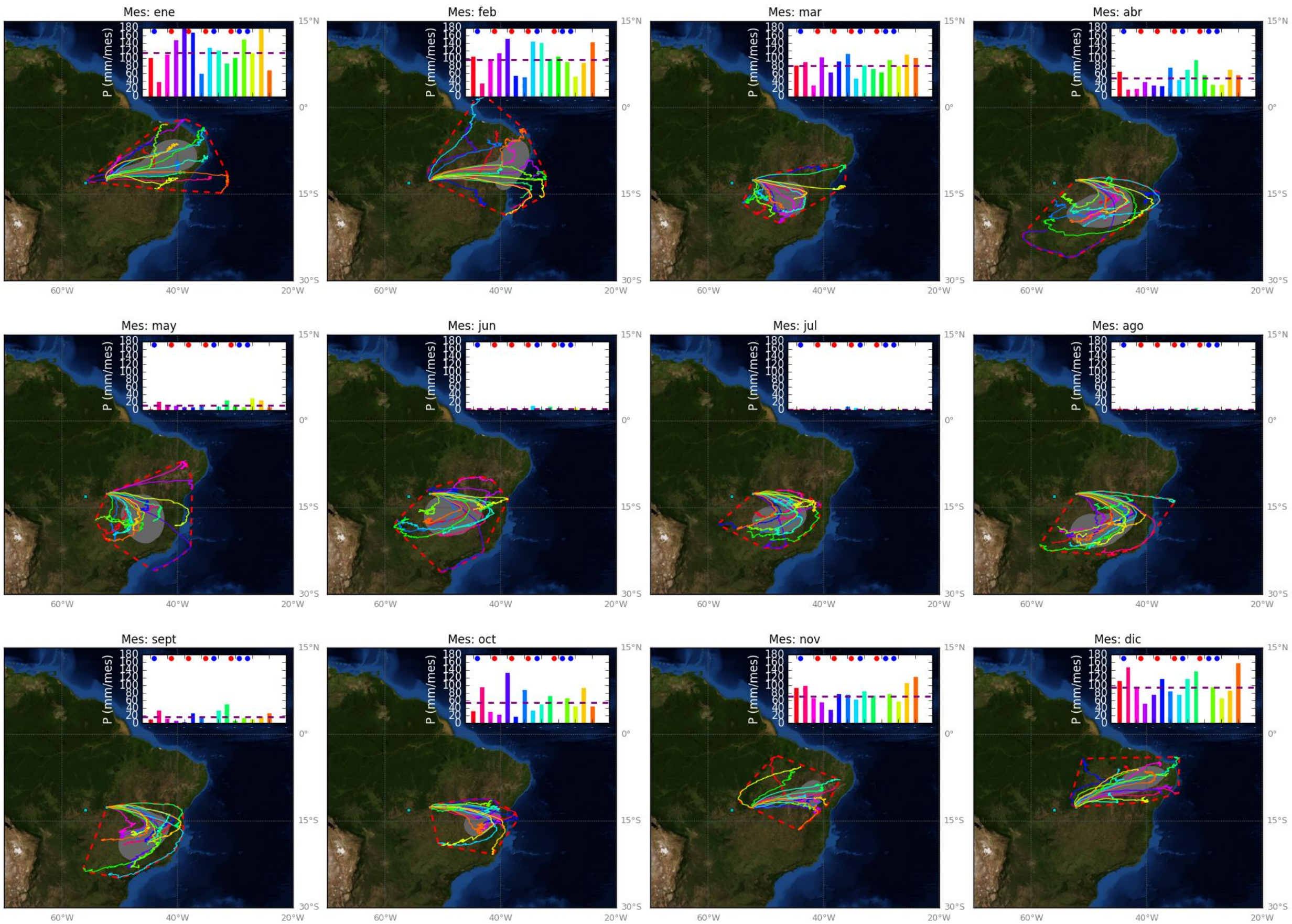
➤ AR Climatology: monthly means for each locality

Vertical integración up to 5500 m (95% of humidity)

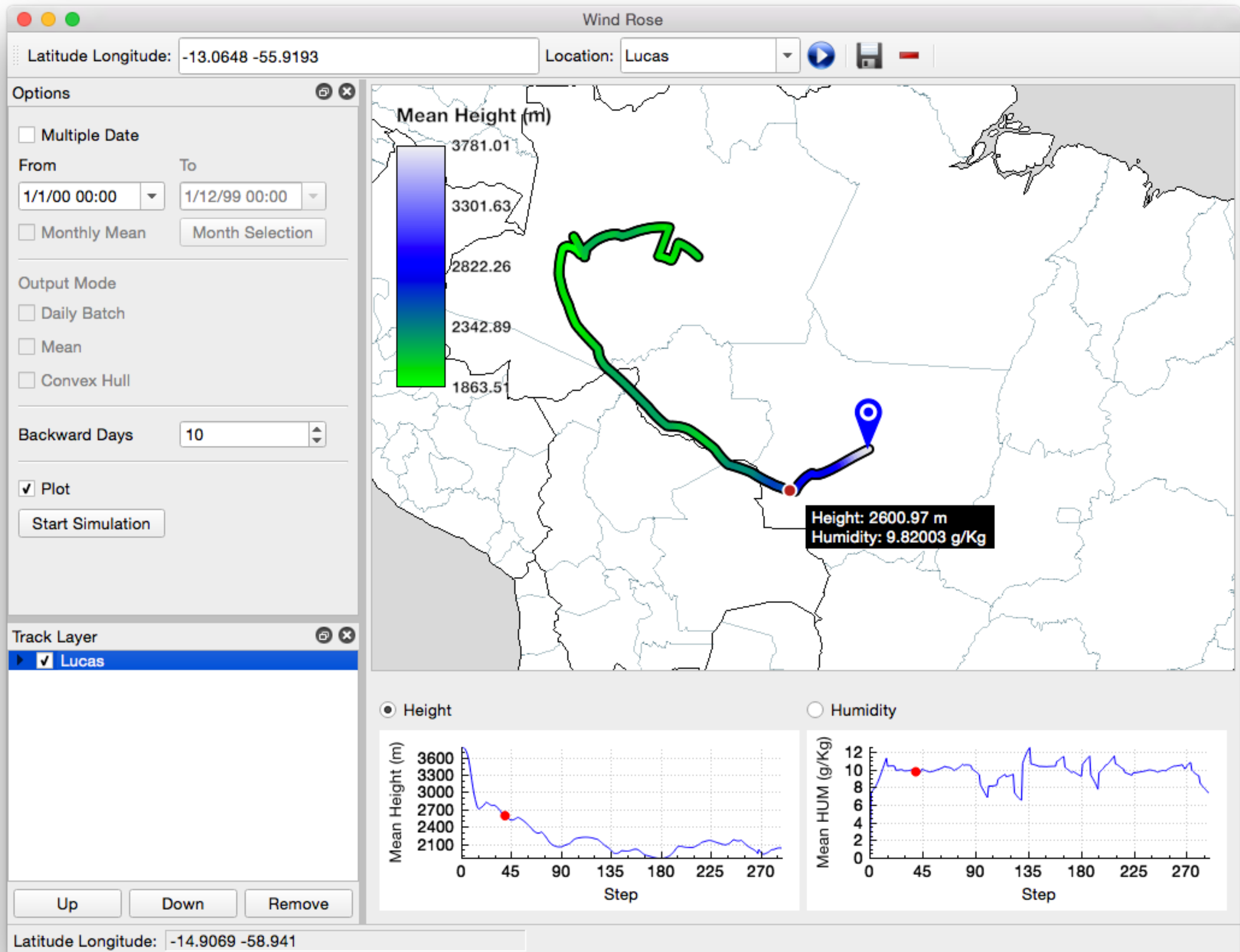


Lucas do Rio Verde



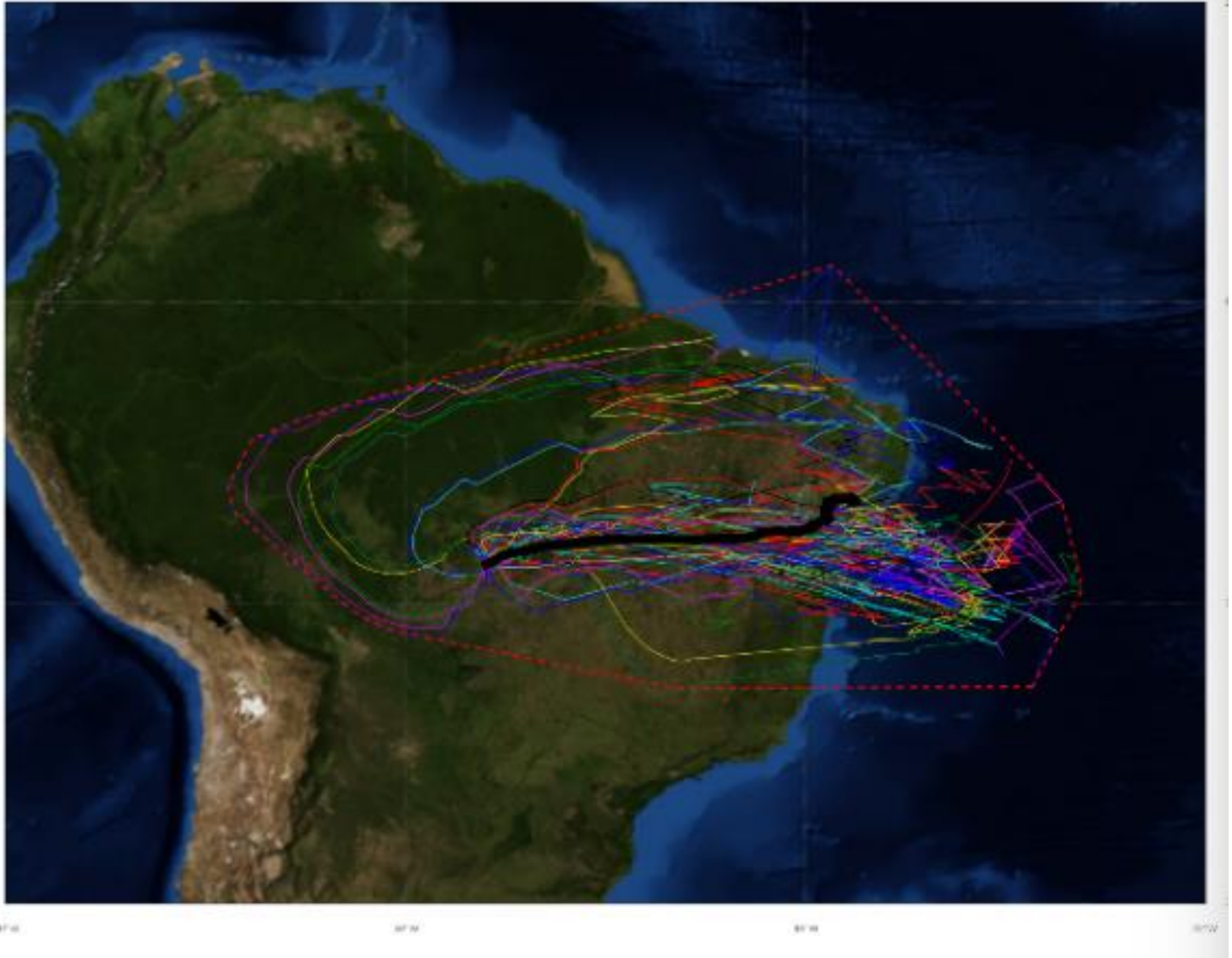


WindTrek Lagrangian rainfall upwind vapor sourcing

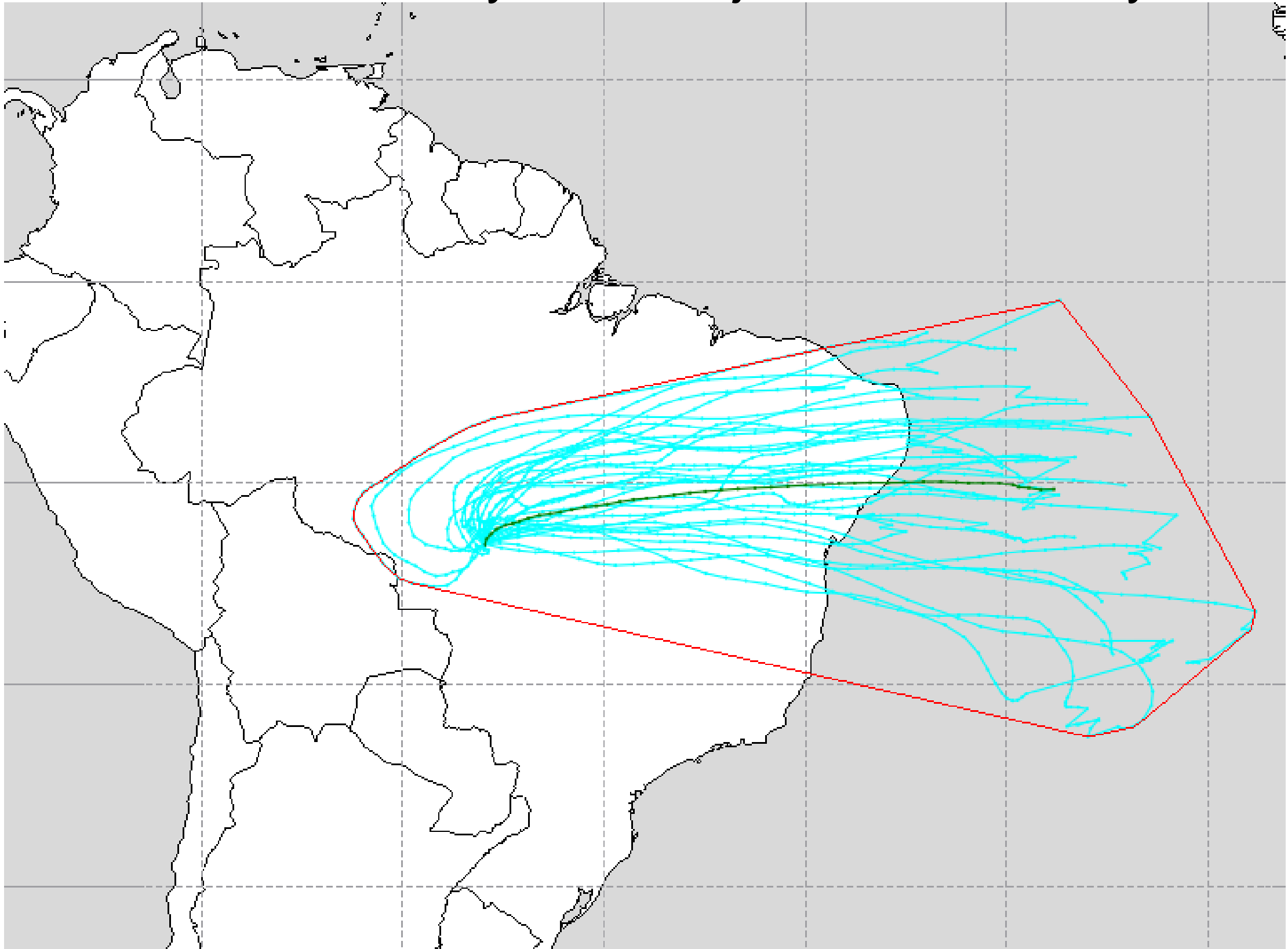


➤ TRAJ

convex hull all 10 days BckTrajectories January 2001



convex hull all 10 days BckTrajectories January 2001



Thank You!



And do not Miss!

Screen "Where have all the swallows gone?"

Thursday Amazon session 10:30 11:00 h

flammable forest reservations no longer protect



fire scars – Xingu indian Reservation

High Xingu Indian Land



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Fire Scars 2010-2012: 30% burned

