Floods in the Pampas: Insights from over a decade of satellite observations

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Introduction

The Argentine Pampas form a wide subhumid eolian plain that experiences episodic flood events covering a significant fraction of the landscape for months or even years (Fig. 1), notably affecting the economy of this highly cultivated region (Aragón et al., 2010). We explore the relative importance of possible hydrological pathways and the associated type of flood dynamics, from slow groundwater-driven ones to faster surface-water-driven flood episodes, by analyzing the spatio-temporal pattern of the Pampas floods together with other datasets of the water cycle during the 2000–2013 period.

Main findings

The Pampas display sporadic flood cycles, 2 major episodes in the last 14 years:
- 4 years (2000–2004), up to 30% cover (~ −515-mm PPT anomaly (20 months))
- 13 months (2012–2013), up to 15%-cover (~330-mm PPT anomaly (8 months))

Flood modes

Large water excess, > several months
Lagged water table rise
Long-sustained flood (several years, up to 15% cover)

Flood-prone Pampas in general

Extreme water excess (weeks to months)
Surface water accumulation
"Flood pulse" (weeks to months, up to 30% cover)

Outlook

- Flood risk anticipation and monitoring in the Pampas can benefit from remote sensing tools, together with a more extensive network of phreatic wells.
- Corresponding annual precipitation excesses were either unprecedented or exceptional (two occurrences) over the last century – is it only the rain?
- Where floods highly connect to groundwater dynamics (e.g. Western Pampa): potentially large impact of land-use/management?
- Climate feedbacks of flood episodes? (e.g. Jobbágy et al., poster H41C-0810)

Data sets & methods

Surface water cover
Threshold criterion applied to MODIS BRDF/albedo product MCD43A (500x500 m², 8-daily), if albedo < 0.09 → water-covered pixel. Spatially aggregated to give an area percentage and preliminary evaluated against LANDSAT-derived estimates (30x30 m², few scenes a year).

Terrestrial water storage
Liquid water equivalent from the Gravity Recovery and Climate Experiment (GRACE, 1°x1°, monthly), averaged between the release products (RL05) from CSR, JPL and GFZ.

Evapotranspiration
8-daily estimate at 1x1 km² resolution: empirical function using MODIS NDVI (from MOD09Q1) and surface temperature (MOD11A2) (Di Bella et al., 2010), restricted to non-flooded pixels.

Precipitation
Daily estimates from the Tropical Rainfall Measurements Mission (TRMM) Multisatellite Precipitation Analysis (TMPA) at 0.25°x0.25° resolution (3B42V7).

Groundwater depth (GWD)
Regional monthly estimate using the averaged in situ GWD variation rates from 6 sites with long-term records, propagated from a reference GWD value.

Results

Flood levels for April 2002 to December 2013 in the focus regions (Aragón et al., 2010).

Surface water cover and terrestrial water storage. The recorded chronological sequence is shown during the main flood events (FE1 & FE2, Fig. 3).

Recurrence of surface water cover and terrestrial water storage. The recorded chronological sequence is shown during the main flood events (FE1 & FE2, Fig. 3).

Relation between the monthly-averaged surface water cover and terrestrial water storage. The recorded chronological sequence is shown during the main flood events (FE1 & FE2, Fig. 3).

Relation between the monthly-averaged terrestrial water storage and surface water cover. The recorded chronological sequence is shown during the main flood events (FE1 & FE2, Fig. 3).

Figure 1. Flooded landscape in the Pampas.

Figure 2. Study region. (A) Recurrence of surface water (500m x 500m resolution), as the relative time span under flooded conditions throughout the period Mar. 2000 – Dec. 2013. (B) Maximum surface water cover at 1x1 resolution during the same time period. The focus regions are delimited by the dashed red (Western Pampa) and blue (Lower Pampa) lines.

Figure 3. Time series of (A) surface water cover from March 6, 2000 to December 27, 2013 in the focus regions (Fig. 2), (B) terrestrial water storage (Apr. 2002 – Dec. 2013) and (C) 6-month-accumulated precipitation anomaly (current month + 5 preceding ones, Mar. 2000 – Feb. 2014 as reference period).

Figure 4. Relation between the monthly-averaged surface water cover and terrestrial water storage. The recorded chronological sequence is shown during the main flood events (FE1 & FE2, Fig. 3).

Figure 5. Relation between the groundwater level in the Western Pampa and (A) terrestrial water storage and (B) monthly surface water cover.

Literature cited