Hydrological modeling of the Uruguay River with actionable climate information from statistical and dynamical downscaling

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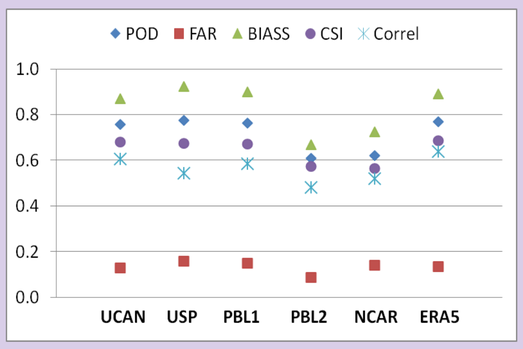
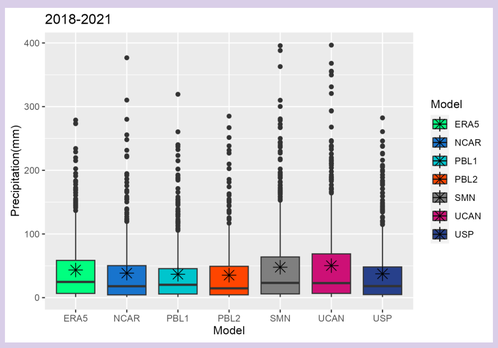
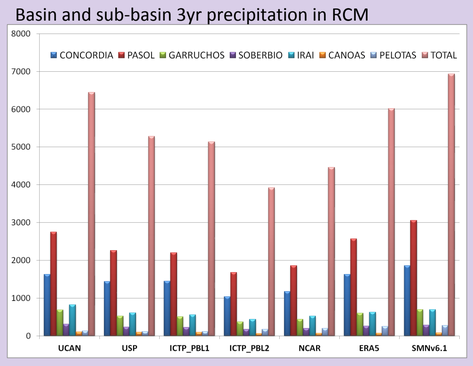
The Flagship Pilot Study in Southeastern South America (FPS-SESA) designed new RCM and ESD simulations for planned impact studies of streamflow modeling of the Uruguay river. A 3-year time period, June 2018 to May 2021, was selected to study the ability of convection-permitting (CP) RCM and deep learning-based ESD simulations outputs to reproduce the Uruguay River streamflows when used to feed the Variable Infiltration Capacity (VIC) hydrological model. During these 3 years extremely dry conditions developed and persisted over the basin with high impact on water resources in the region including very low streamflows. Nonetheless, extreme precipitation events were also observed during warm months, which makes this period particularly interesting to study extreme discharges through hydrological modeling. Results from dynamic downscaling will only be presented

Simulated Precipitation in Uruguay River Basin





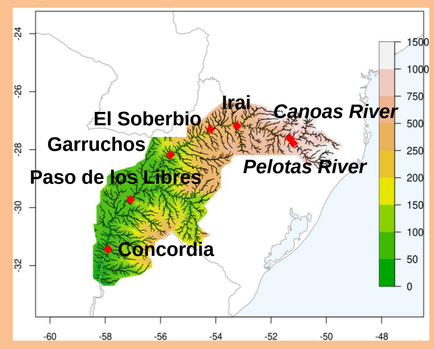
Basin and sub-basin 3yr precipitation in RCM



Results show that models have a high probability of detection (**POD**), with a low false alarm ratio (**FAR**) and in general a higher number of misses with respect to false alarms **(BIASS).** In general, the occurrence of precipitation events within the basin are well captured. However some models underestimate mean and median values, have lower extremes and less variability. Models differ in the amount of precipitation though sub-basin distribution is similar. Hence spread in simulated discharges should be expected

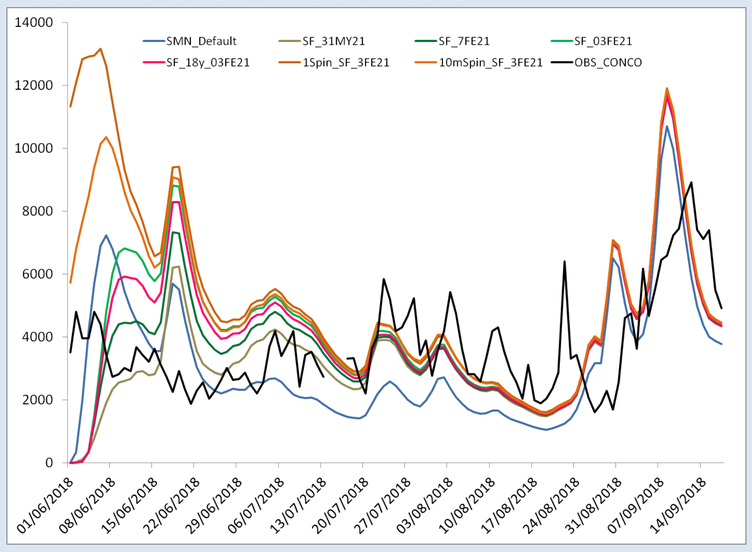
Uruguay River Basin

- Length= 1800 km Area= 365.000 km^2
- Runs through Brazil, Argentina, Uruguay
- Discharges at 7 gauge stations
- Average discharge 5299 m^{3}s^{-1} at Concordia



Deciding VIC Model Initial conditions

Results for Concordia Station using meteorological observations from weather stations

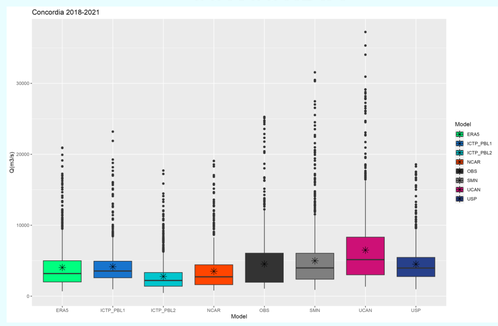


Test runs were made to define the initial soil moisture state file, however spin up is necessary to create initial baseflow. Convergence is faster than with default values.
10mon spin up and a moist state are used to initiate VIC

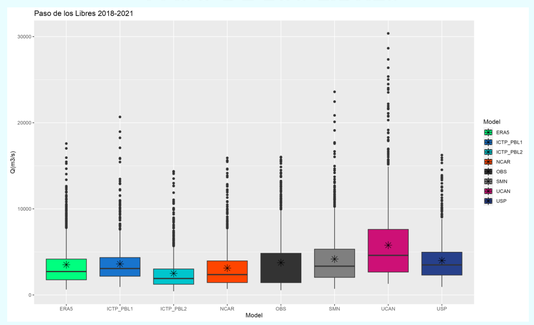
Simulated River Flows

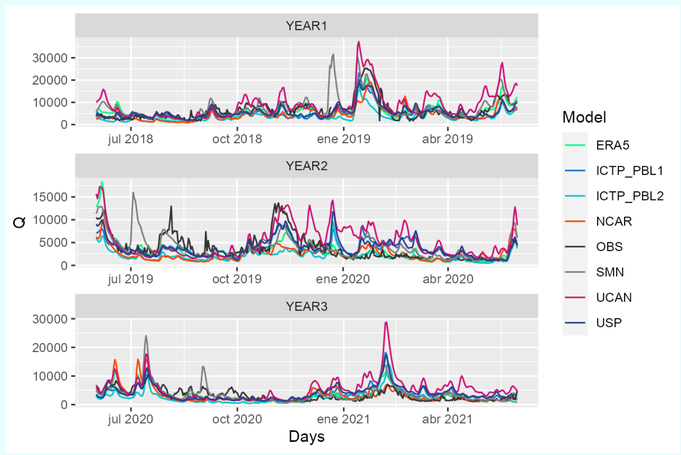
VIC was forced with daily precipitation, maximum and minimum temperature (June 2018-May 2021) from 5 convection permitting RCM (2 WRF and 3 RegCM), ERA5 and weather station observations

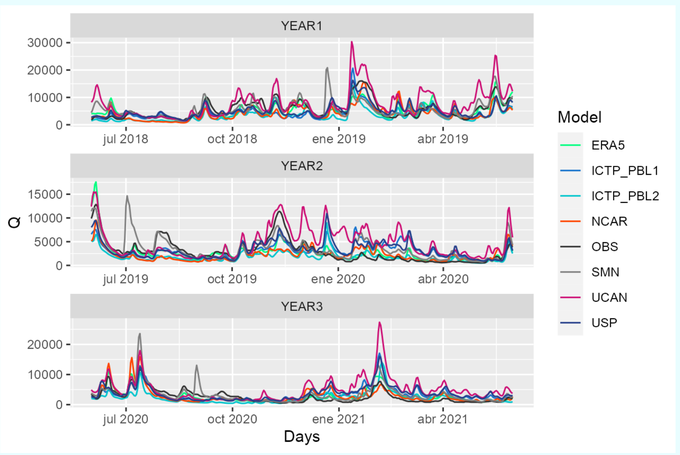
CONCORDIA



PASO DE LOS LIBRES







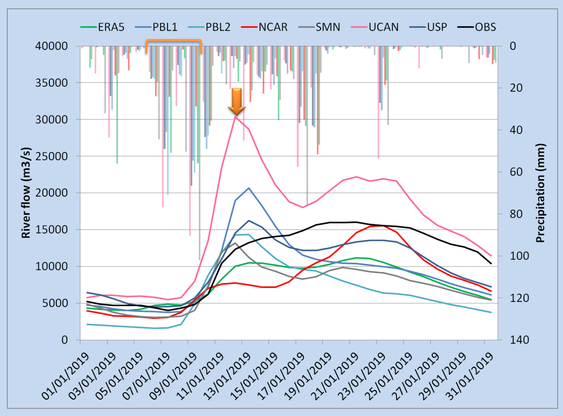
VIC adequately represents mean and variability discharges at Concordia and Paso de los Libres, stations which integrate the basin flow. However low and high extremes are sometimes over/underestimated

EXTREME RIVER FLOW EVENTS

JANUARY 2019

PASO DE LOS LIBRES

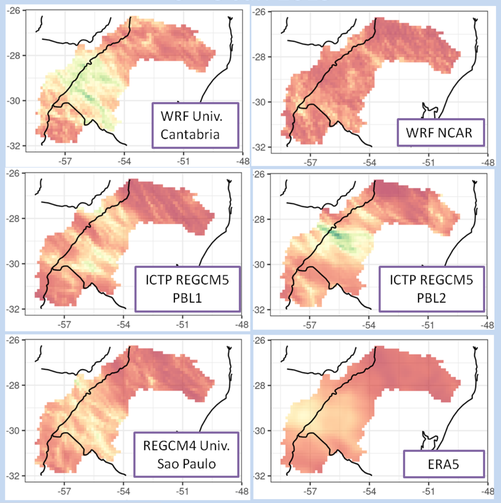
Observed Max: 16018 m^3/s Jan 21st



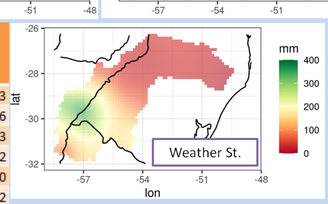
Bars represent total basin precip/basin area

Total Precipitation

6 – 9 Jan 2019



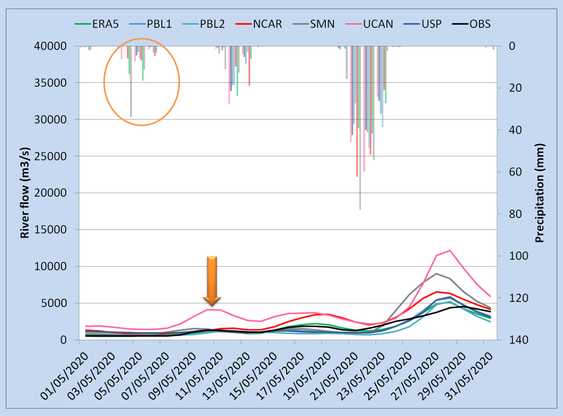
FORCING	06/01/2019	07/01/2019	08/01/2019	09/01/2019	Total	3 day % in Upper Basin	3 day % in Middle Basin	3 day % in Lower Basin
WRF_UCAN	16418	68333	28768	66048	179567	17	60	23
REGCM_USP	14824	40078	15783	48305	118990	15	58	26
ICTP_PBL1	14813	34720	21147	42231	112911	13	64	23
ICTP_PBL2	27895	54971	18355	44619	145840	16	62	22
WRF_NCAR	22486	26507	4264	23716	76973	23	48	30
ERA5	13858	42310	9486	40846	106500	13	55	32
Weather St.	35005	13809	38188	77177	164179	8	47	45



MAY 2020

PASO DE LOS LIBRES

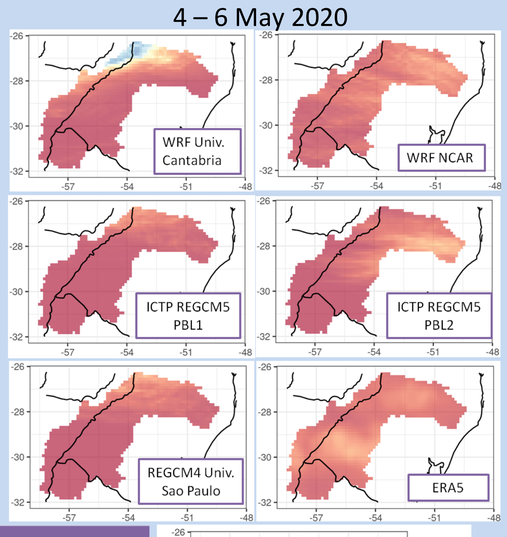
Observed Min: 553m^3/s May 2nd



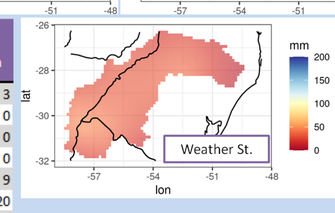
Bars represent total basin precip/basin area

Total Precipitation

4 – 6 May 2020



FORCING	Precipitation 04/05/2020	Precipitation 05/05/2020	Precipitation 06/05/2020	Total 3 day Precipitation	3 day % in Upper Basin	3 day % in Middle Basin	3 day % in Lower Basin
WRF_UCAN	11121	13763	4248	29132	68	29	3
REGCM_USP	755	8298	1210	10263	79	21	0
ICTP_PBL1	190	5588	1013	6791	89	11	0
ICTP_PBL2	81	10703	6898	17682	74	26	0
WRF_NCAR	4589	9649	9798	24036	53	38	9
ERA5	10153	15099	5870	31122	31	49	20
Weather St.	29452	12071	42	41565	26	44	30



In general WRF_UCAN presents the highest rainfall thus the basin is in general wetter creating higher baseflow conditions, as seen by the higher flows during wet and dry conditions. Observed precipitations between 6-9 Jan 2019 were high, only surpassed by WRF_UCAN , while for the 4-6 May 2020 event they were higher than simulated. Differences between the location and magnitude of rainfall lead to differences in discharge peak magnitude and timing in gauge stations.