

Supplement to: Evaluation of hydrological models on small mountainous catchments: impact of the meteorological forcings

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1 Percentage of karst

Figure S1 shows the percentage of area characterised as karstic or supplying karstic sources, for each catchment of this study (Brugeron et al., 2018).

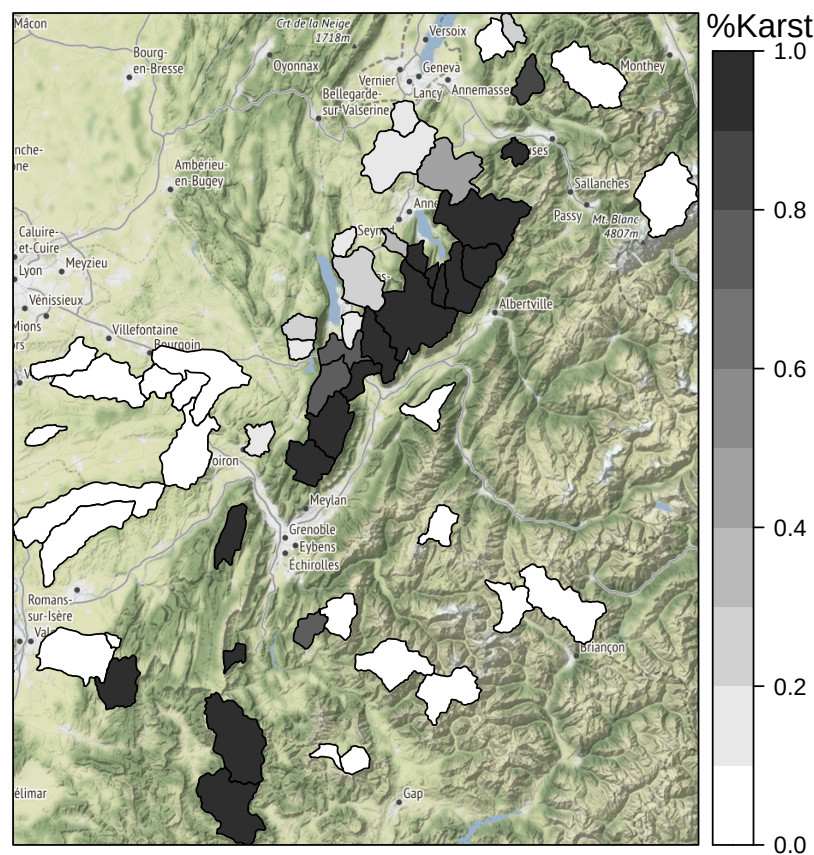


Figure S1. Percentage of karst obtained for each catchment. Map tiles by Stamen Design, under CC BY 3.0. Data by © OpenStreetMap, under ODbL.

2 Illustration of large floods

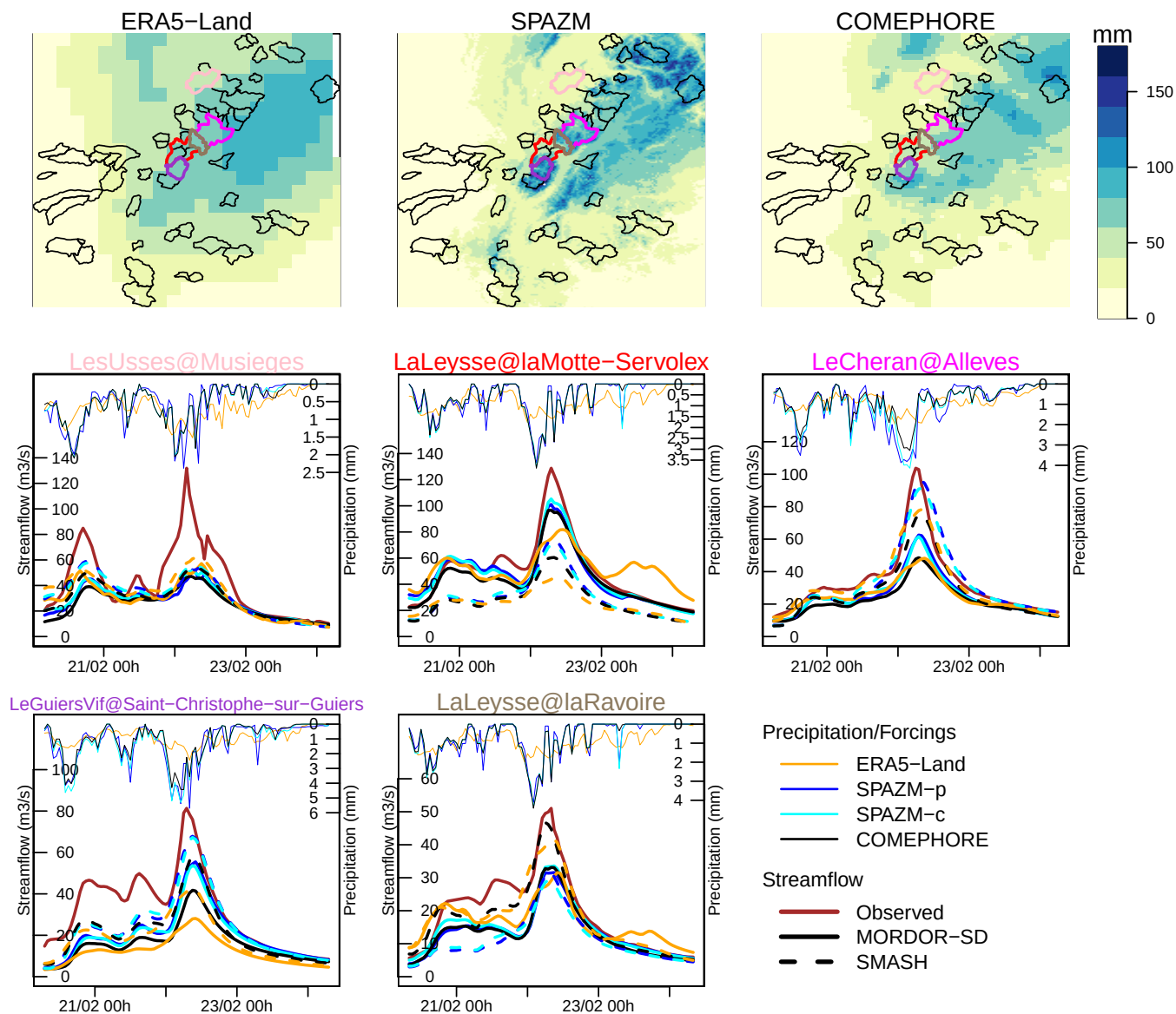


Figure S2. Cumulative amount of precipitation 24 hours before and after 1999-02-22 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

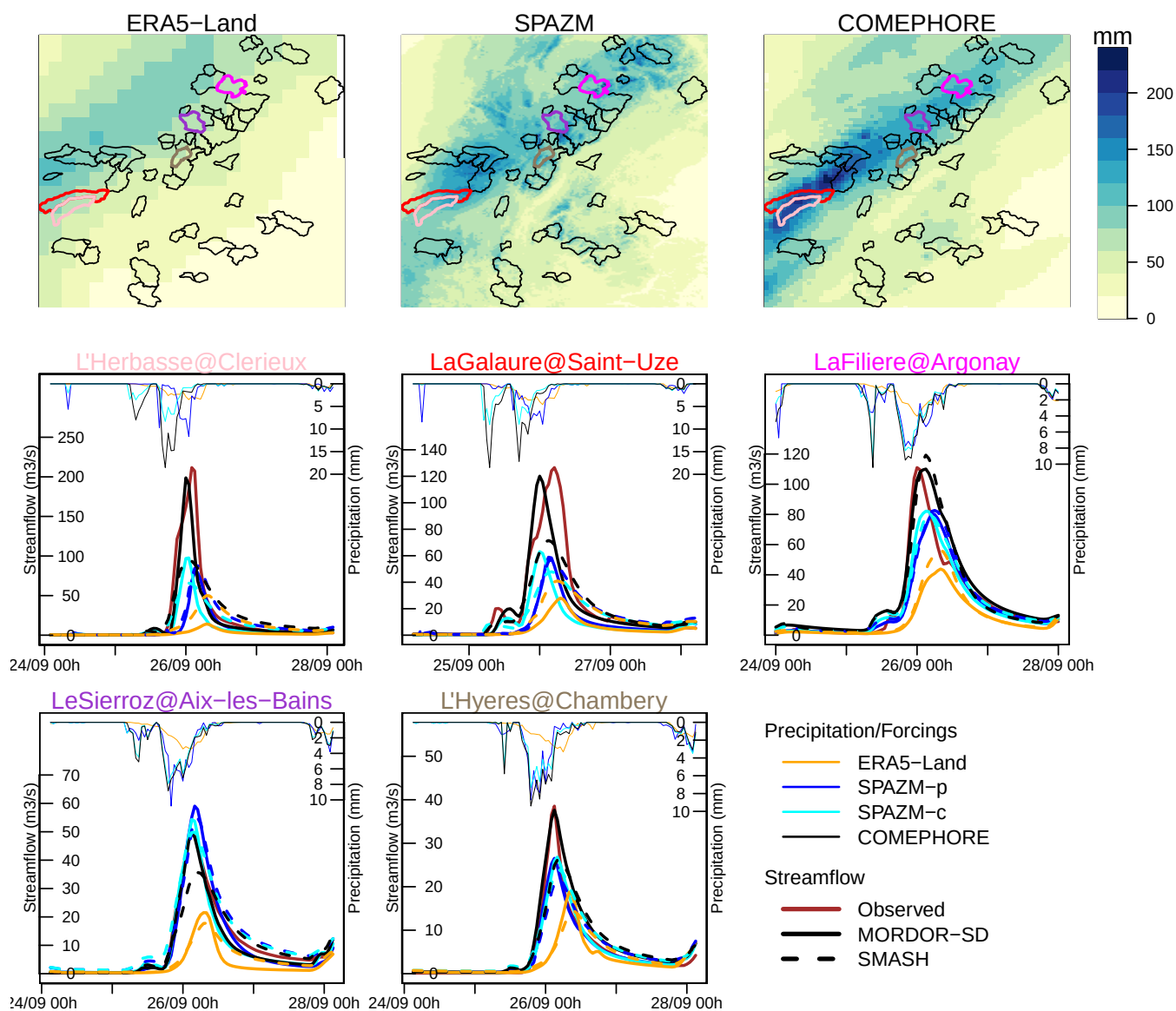


Figure S3. Cumulative amount of precipitation 24 hours before and after 1999-09-26 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

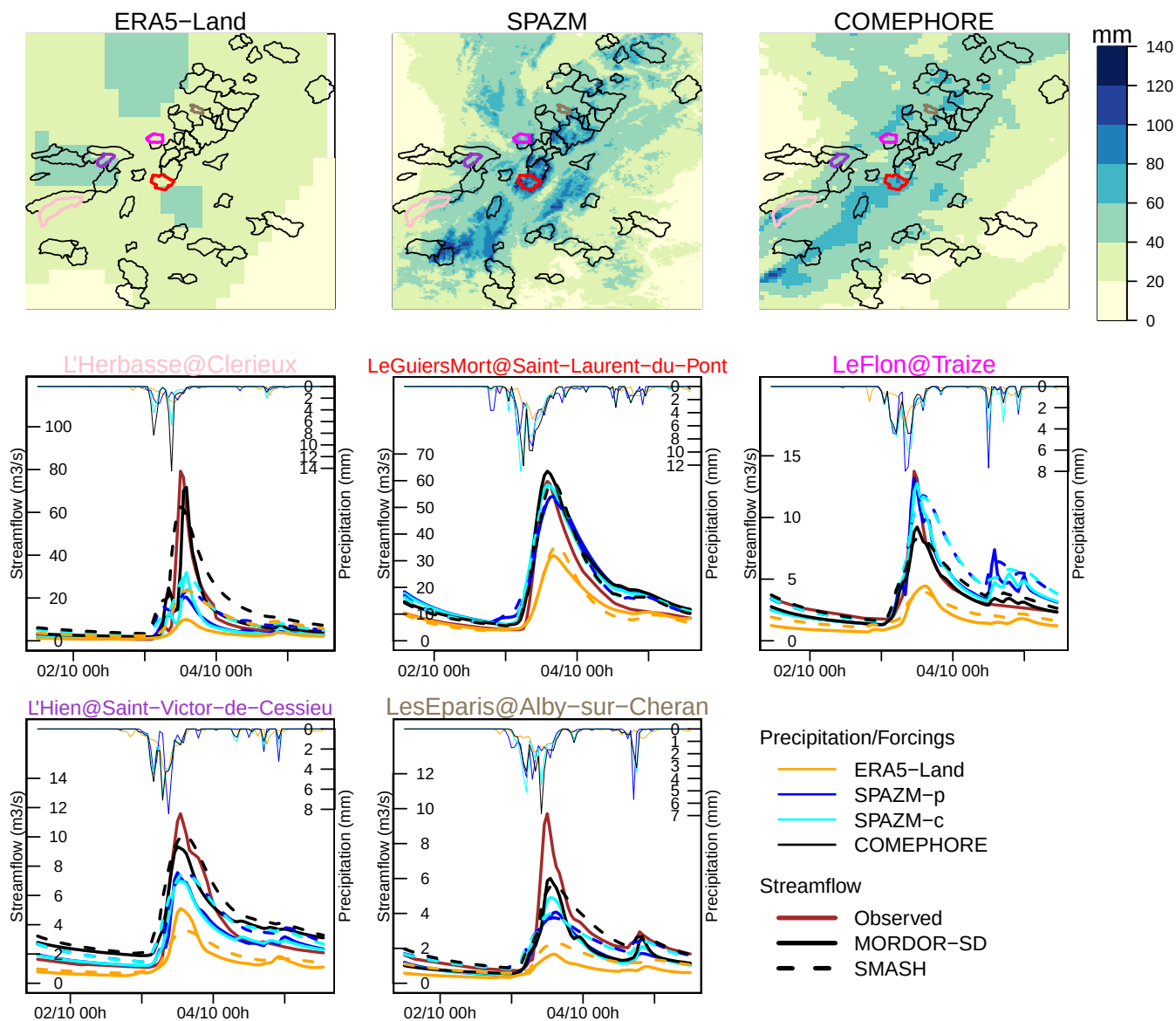


Figure S4. Cumulative amount of precipitation 24 hours before and after 1999-10-03 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

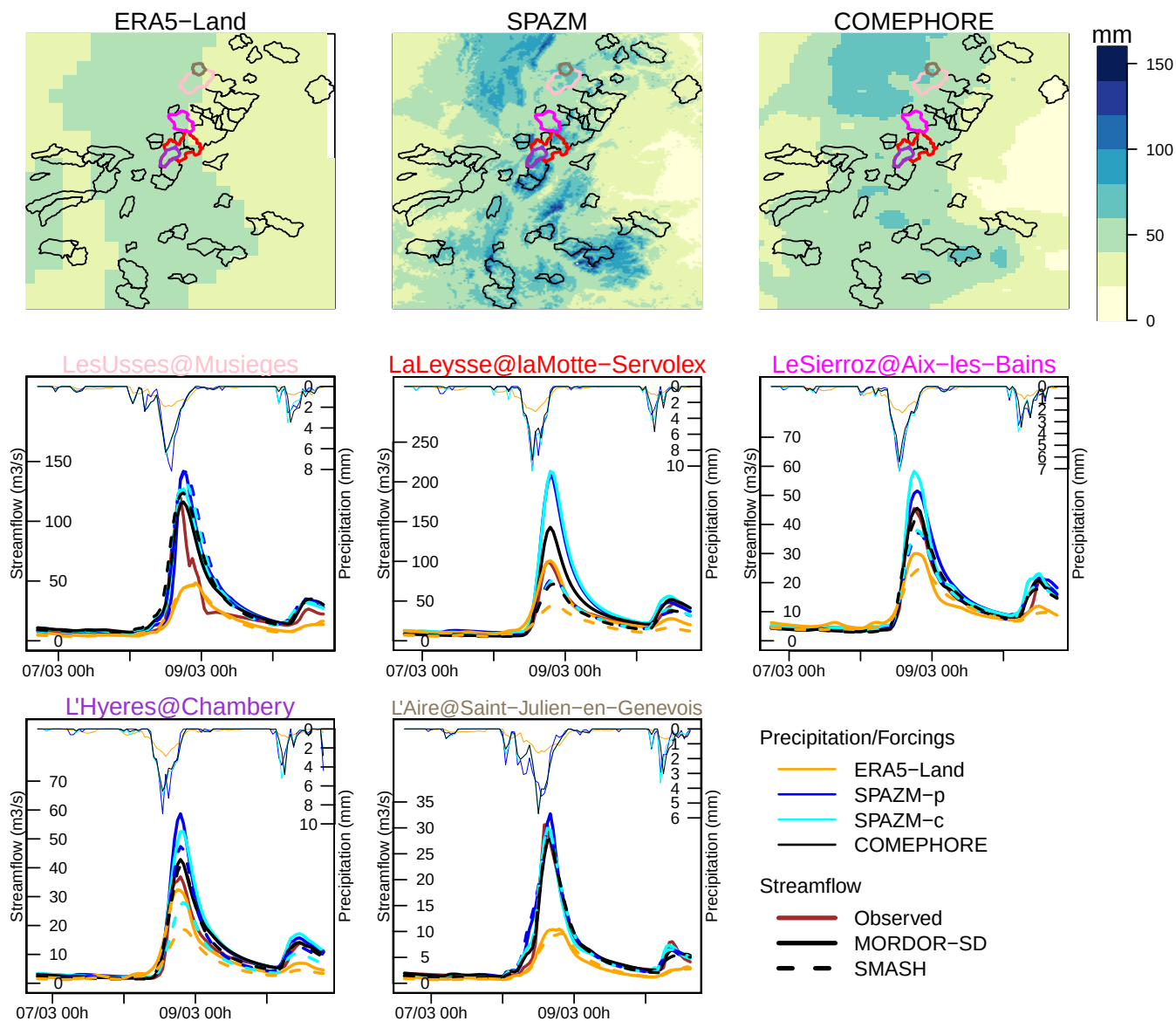


Figure S5. Cumulative amount of precipitation 24 hours before and after 2001-03-08 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

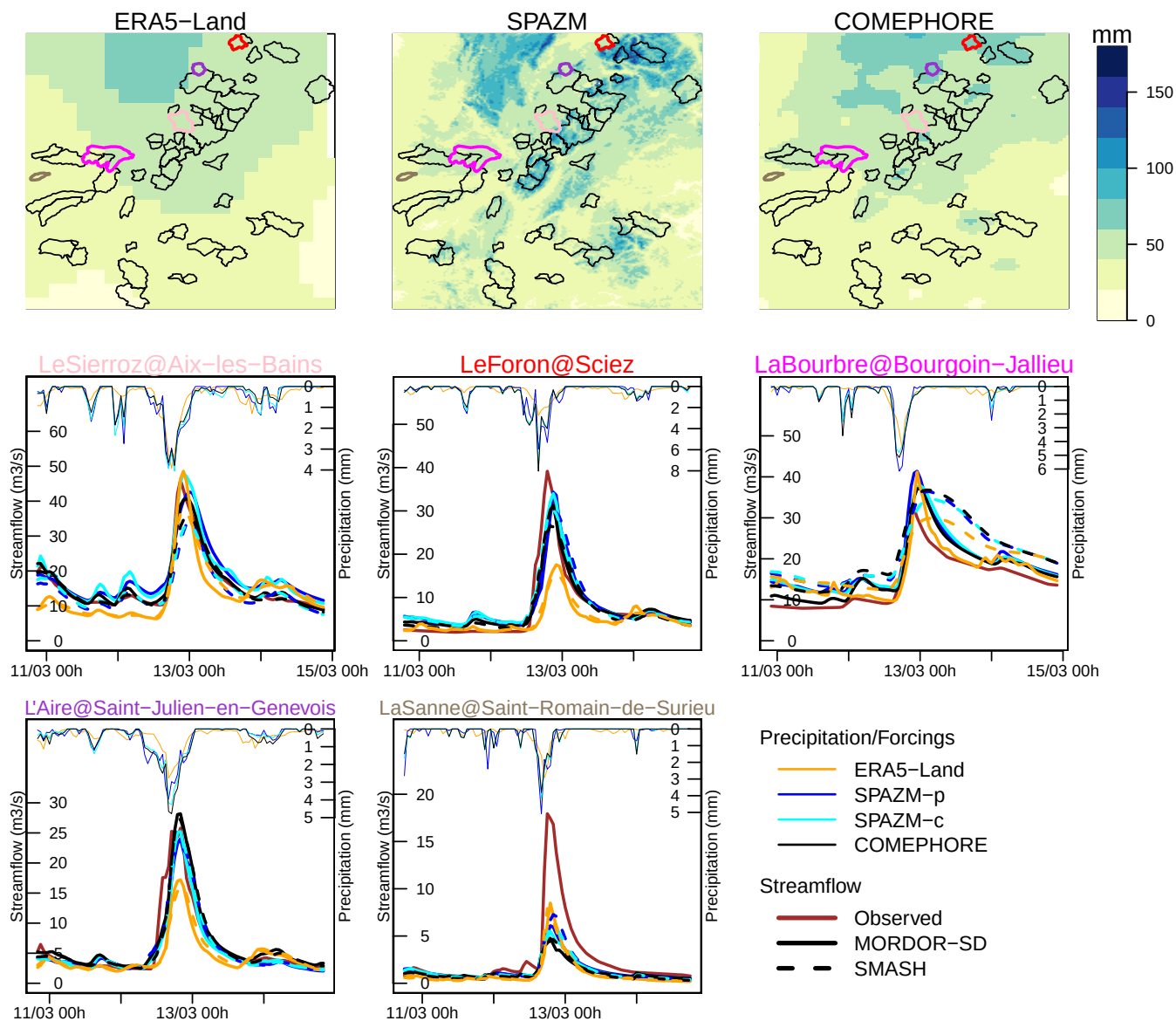


Figure S6. Cumulative amount of precipitation 24 hours before and after 2001-03-12 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

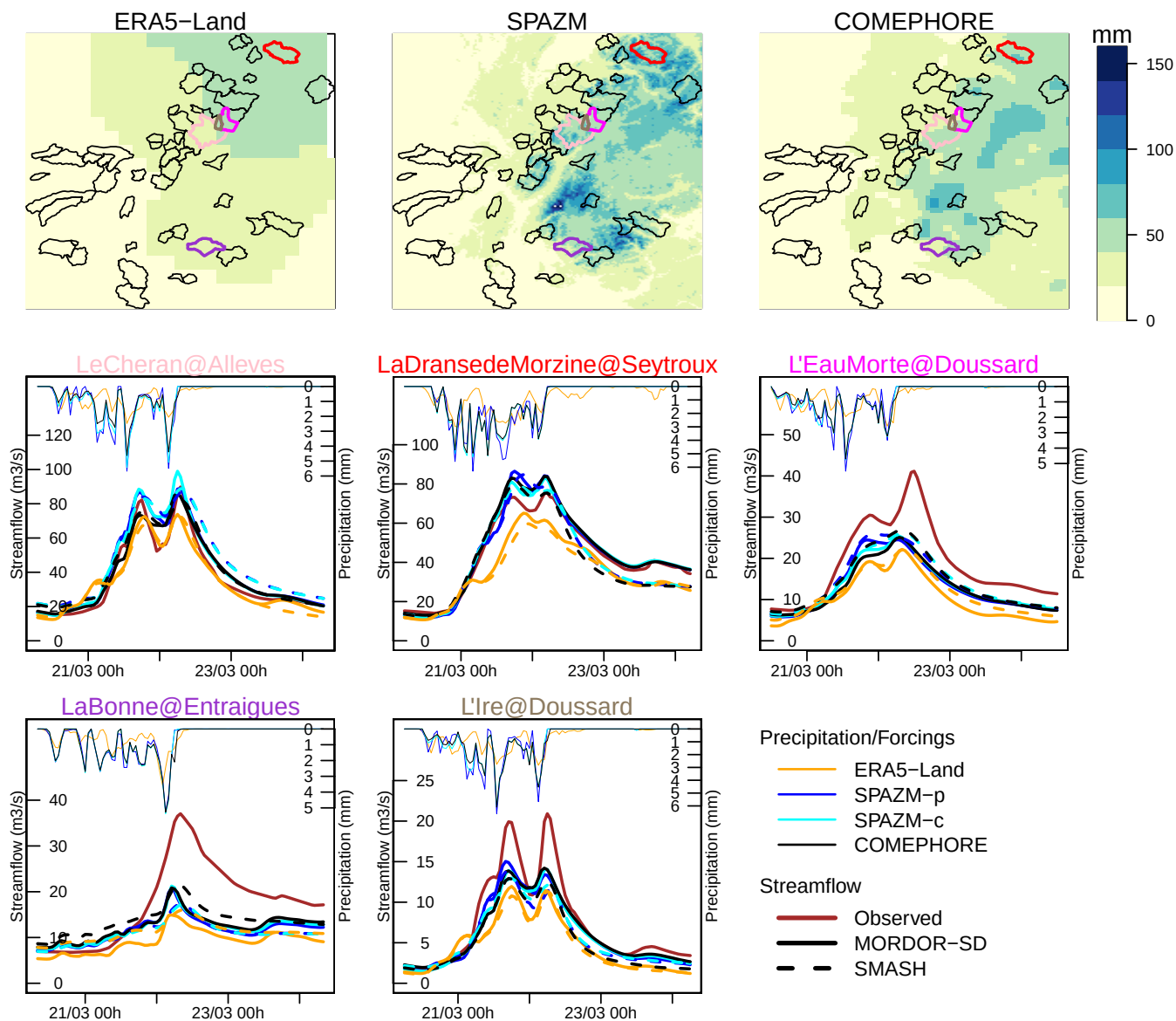


Figure S7. Cumulative amount of precipitation 24 hours before and after 2001-03-22 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

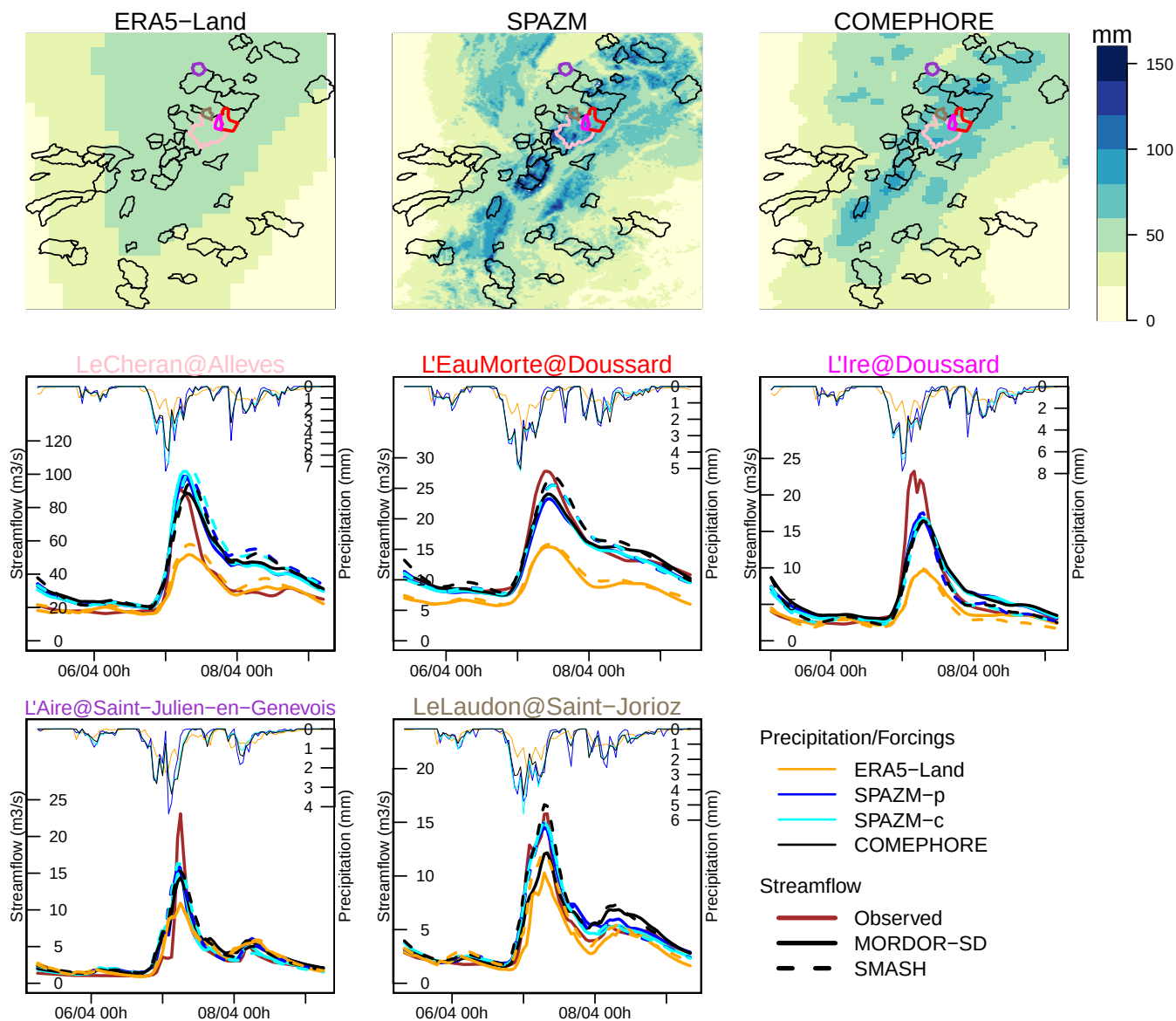


Figure S8. Cumulative amount of precipitation 24 hours before and after 2001-04-07 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

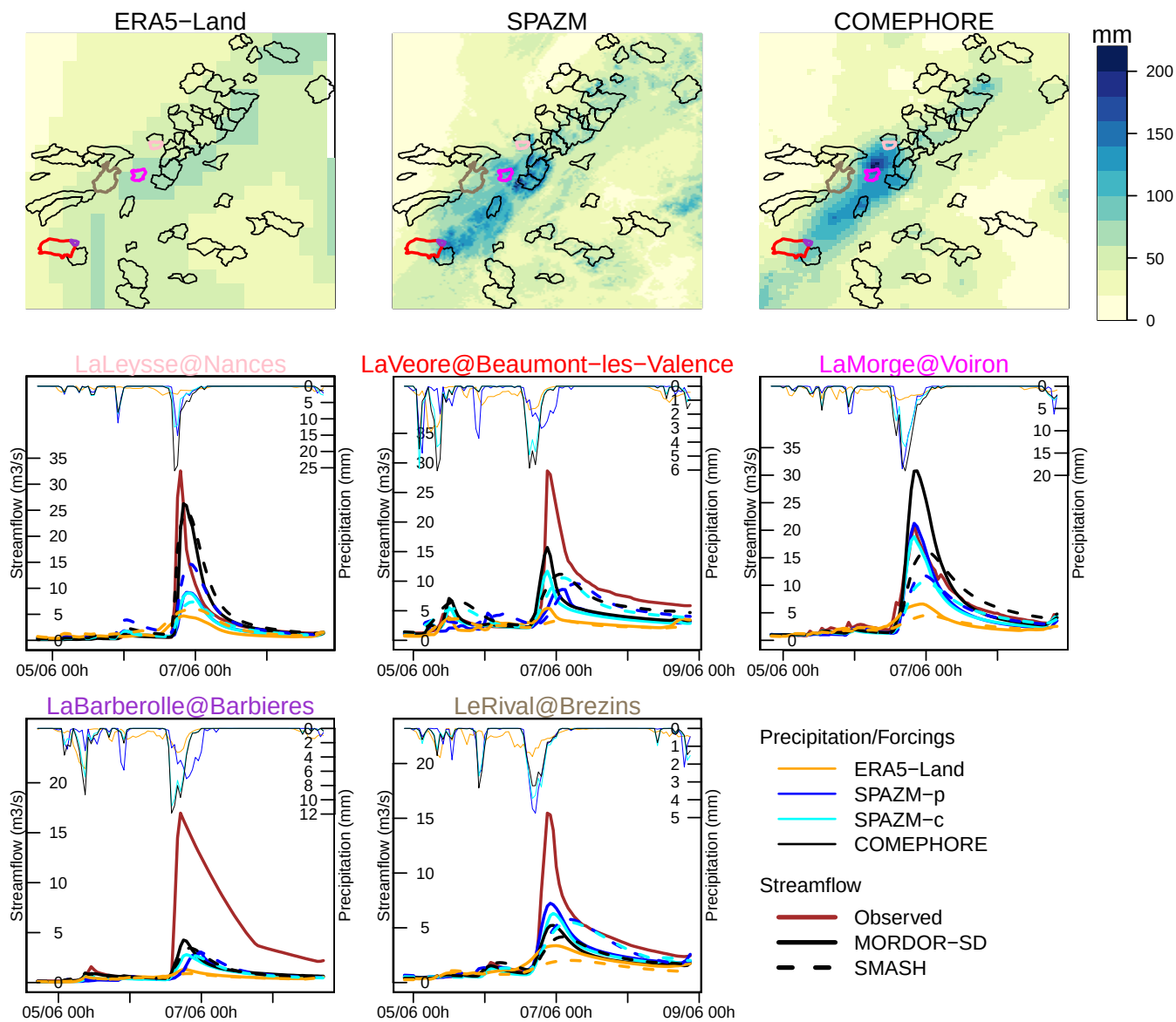


Figure S9. Cumulative amount of precipitation 24 hours before and after 2002-06-06 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

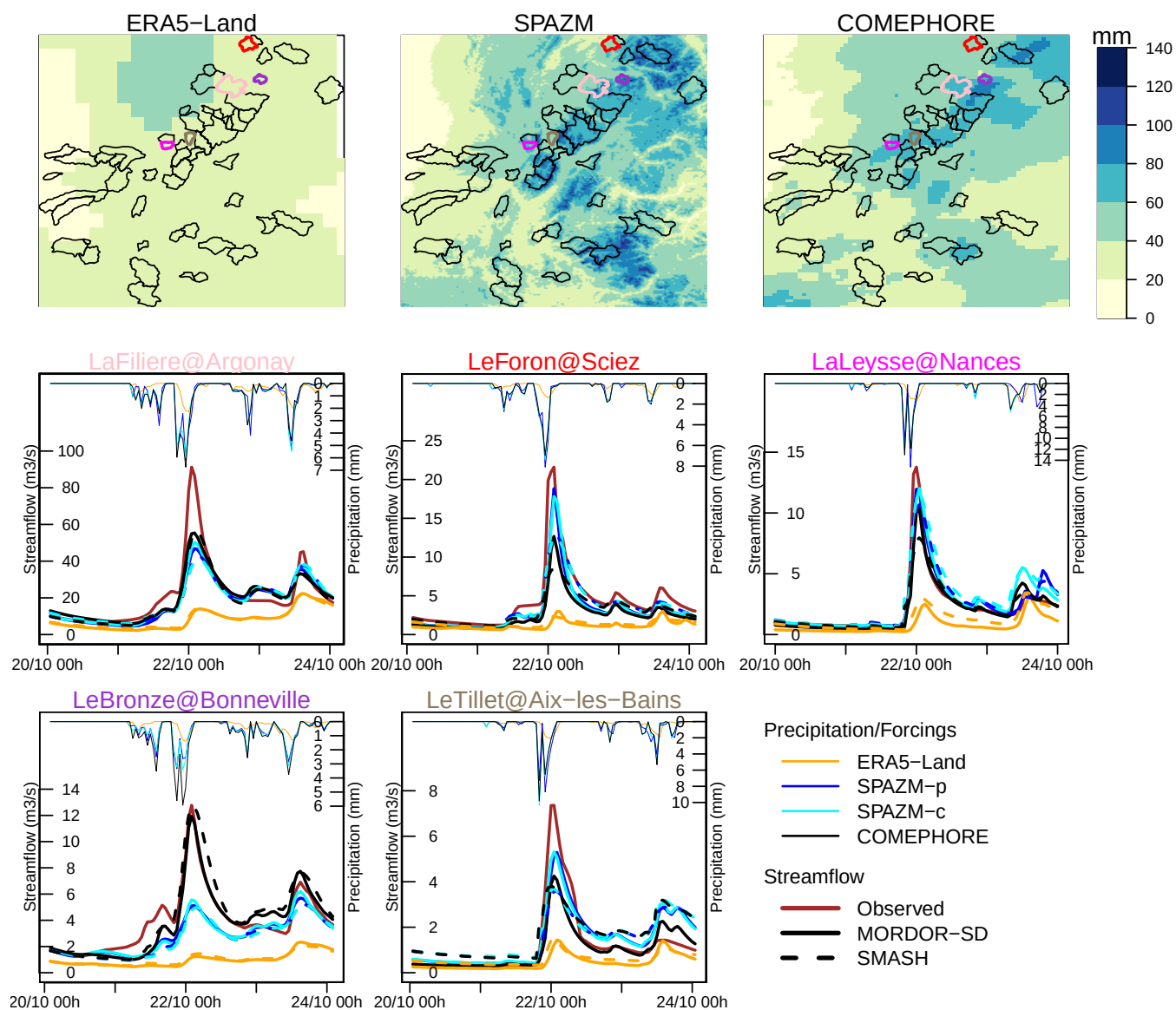


Figure S10. Cumulative amount of precipitation 24 hours before and after 2002-10-22 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

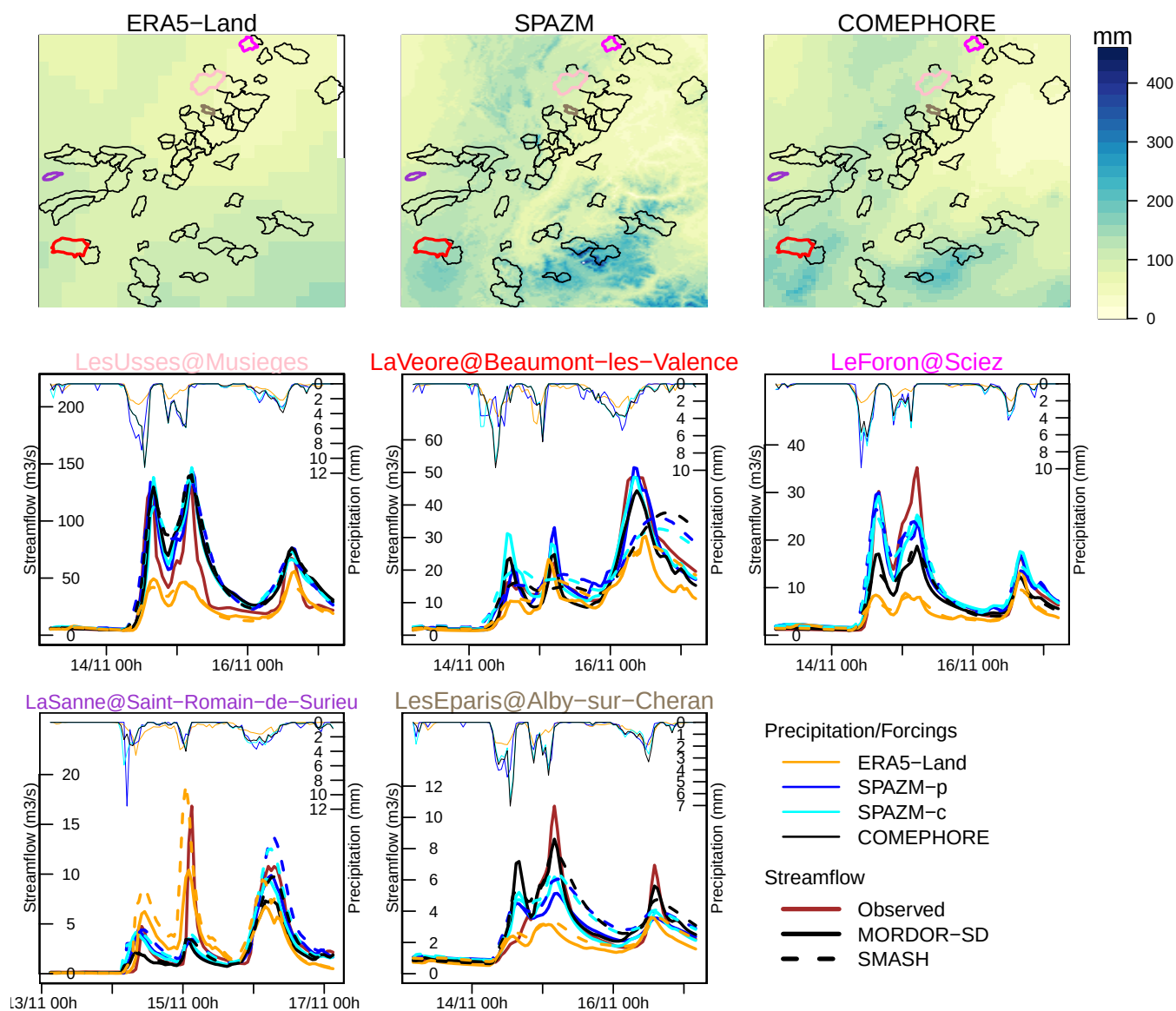


Figure S11. Cumulative amount of precipitation 24 hours before and after 2002-11-15 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

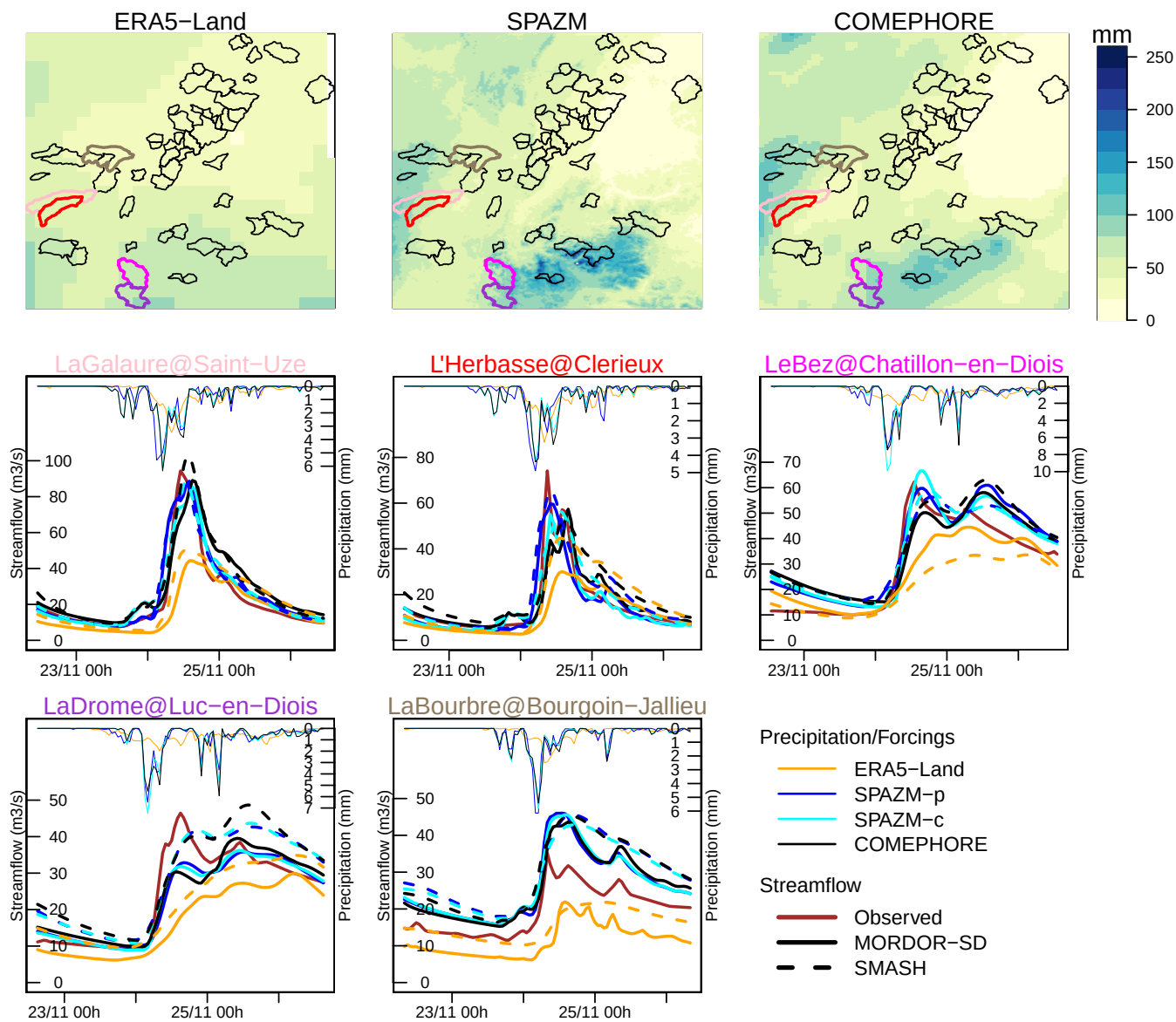


Figure S12. Cumulative amount of precipitation 24 hours before and after 2002-11-24 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

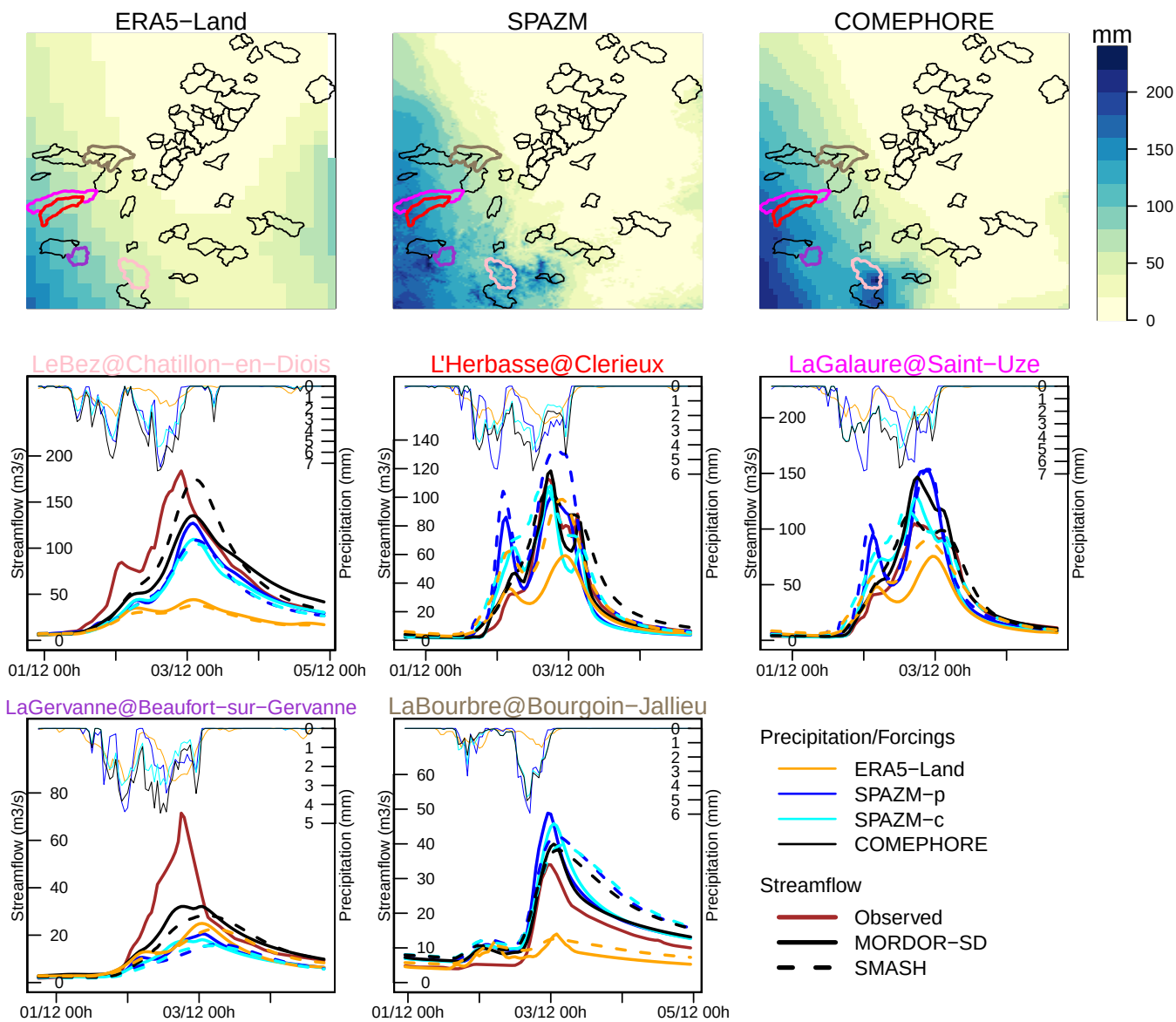


Figure S13. Cumulative amount of precipitation 24 hours before and after 2003-12-02 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

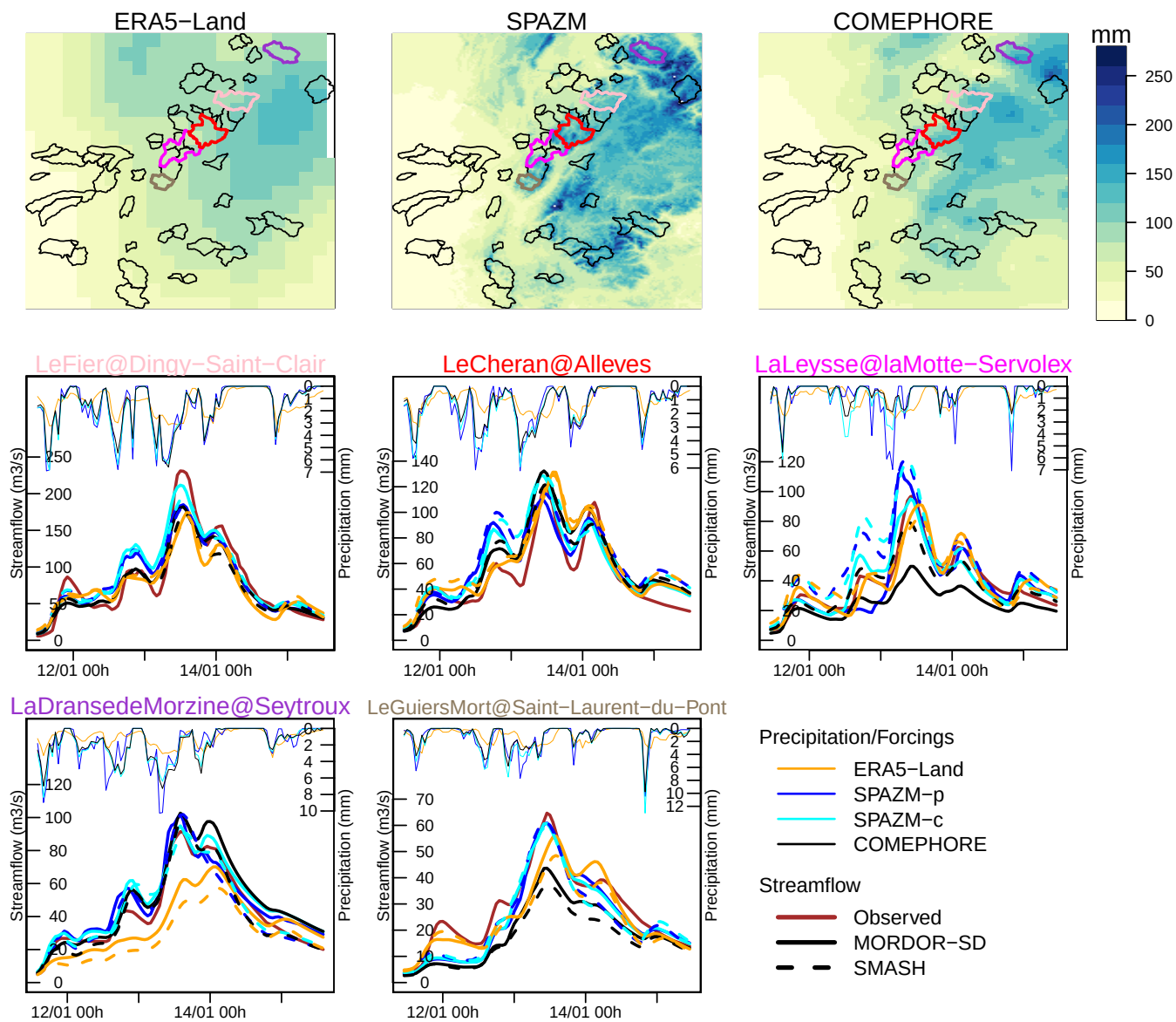


Figure S14. Cumulative amount of precipitation 24 hours before and after 2004-01-13 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

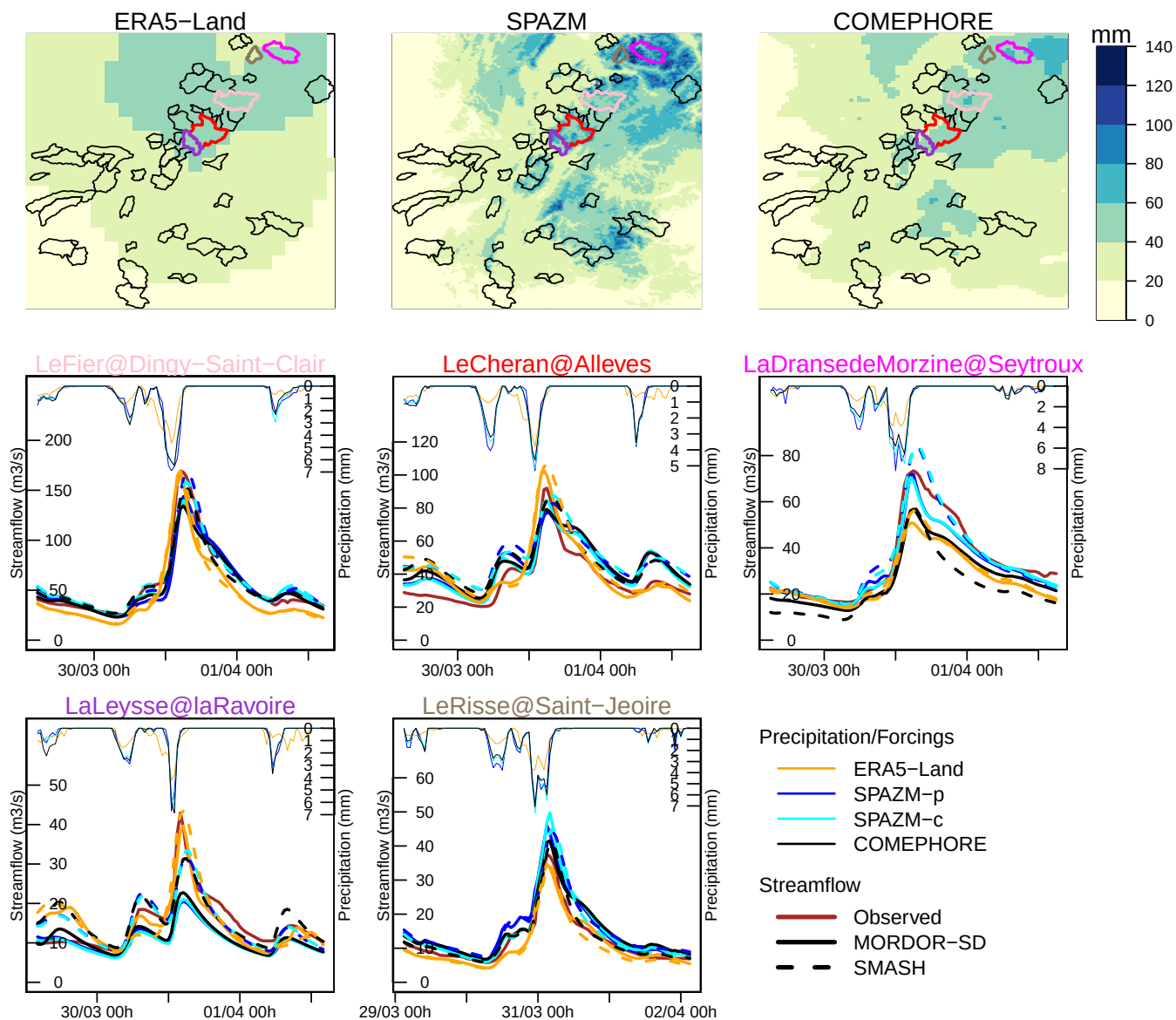


Figure S15. Cumulative amount of precipitation 24 hours before and after 2006-03-31 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

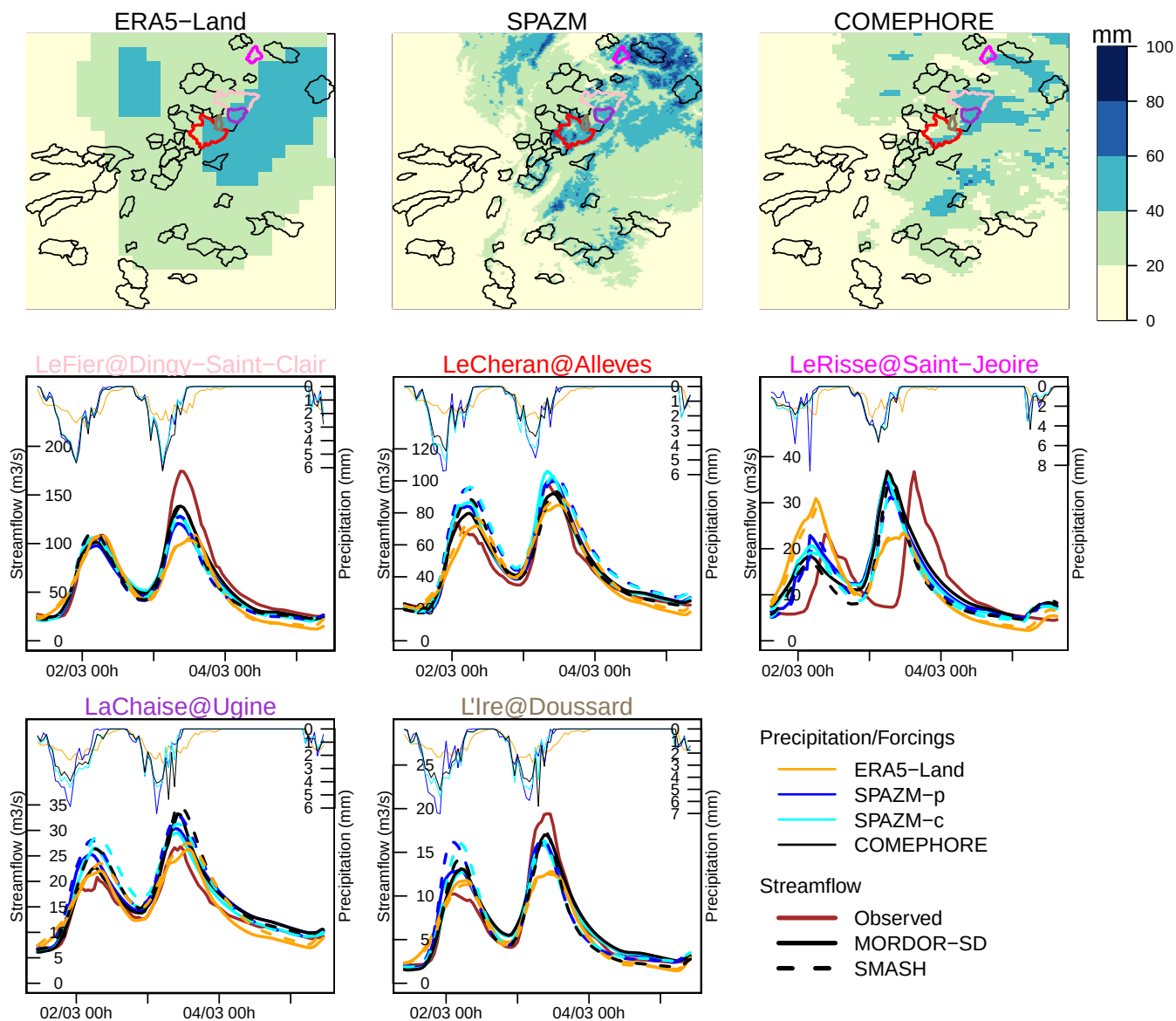


Figure S16. Cumulative amount of precipitation 24 hours before and after 2007-03-03 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

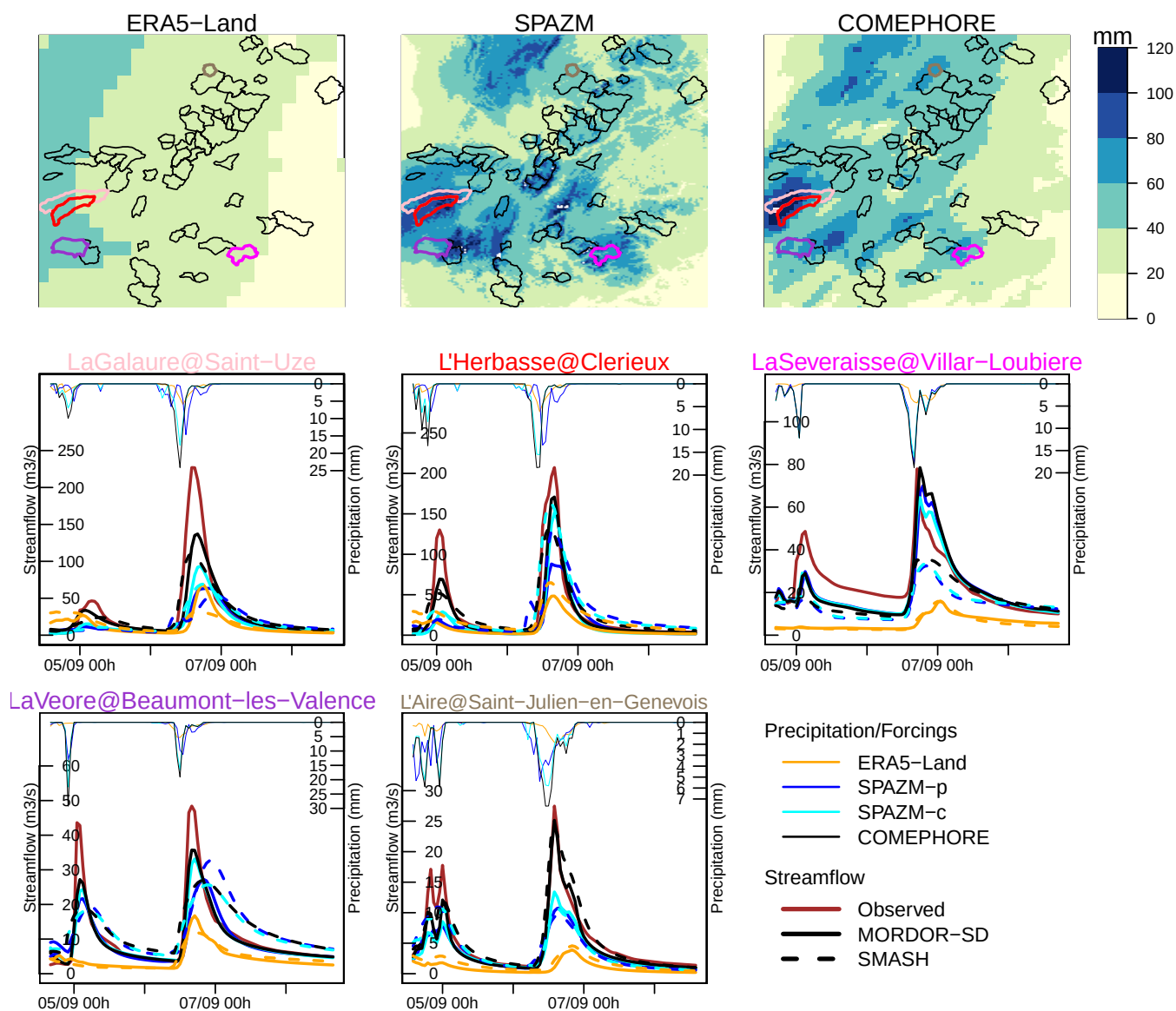


Figure S17. Cumulative amount of precipitation 24 hours before and after 2008-09-06 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

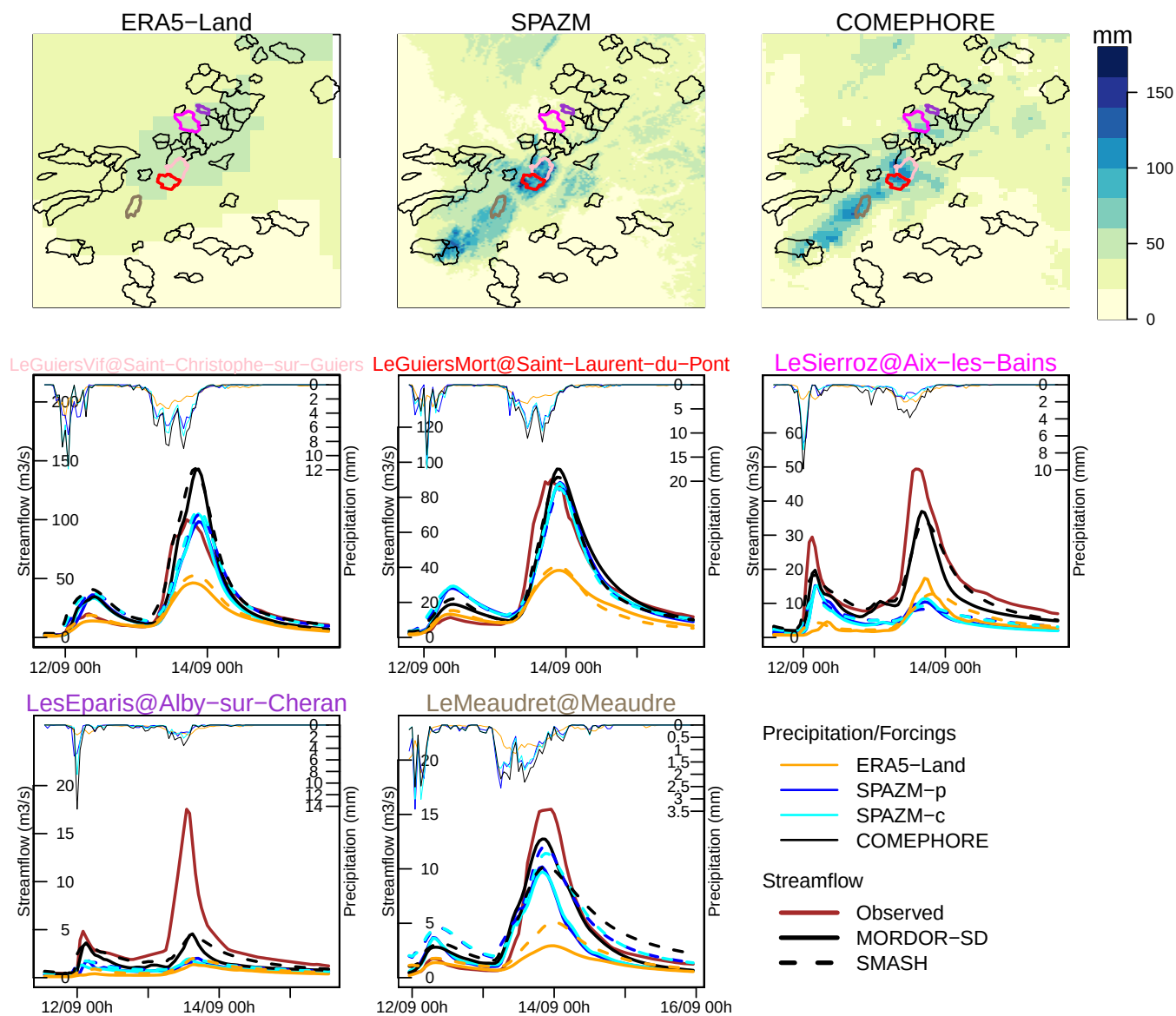


Figure S18. Cumulative amount of precipitation 24 hours before and after 2008-09-13 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

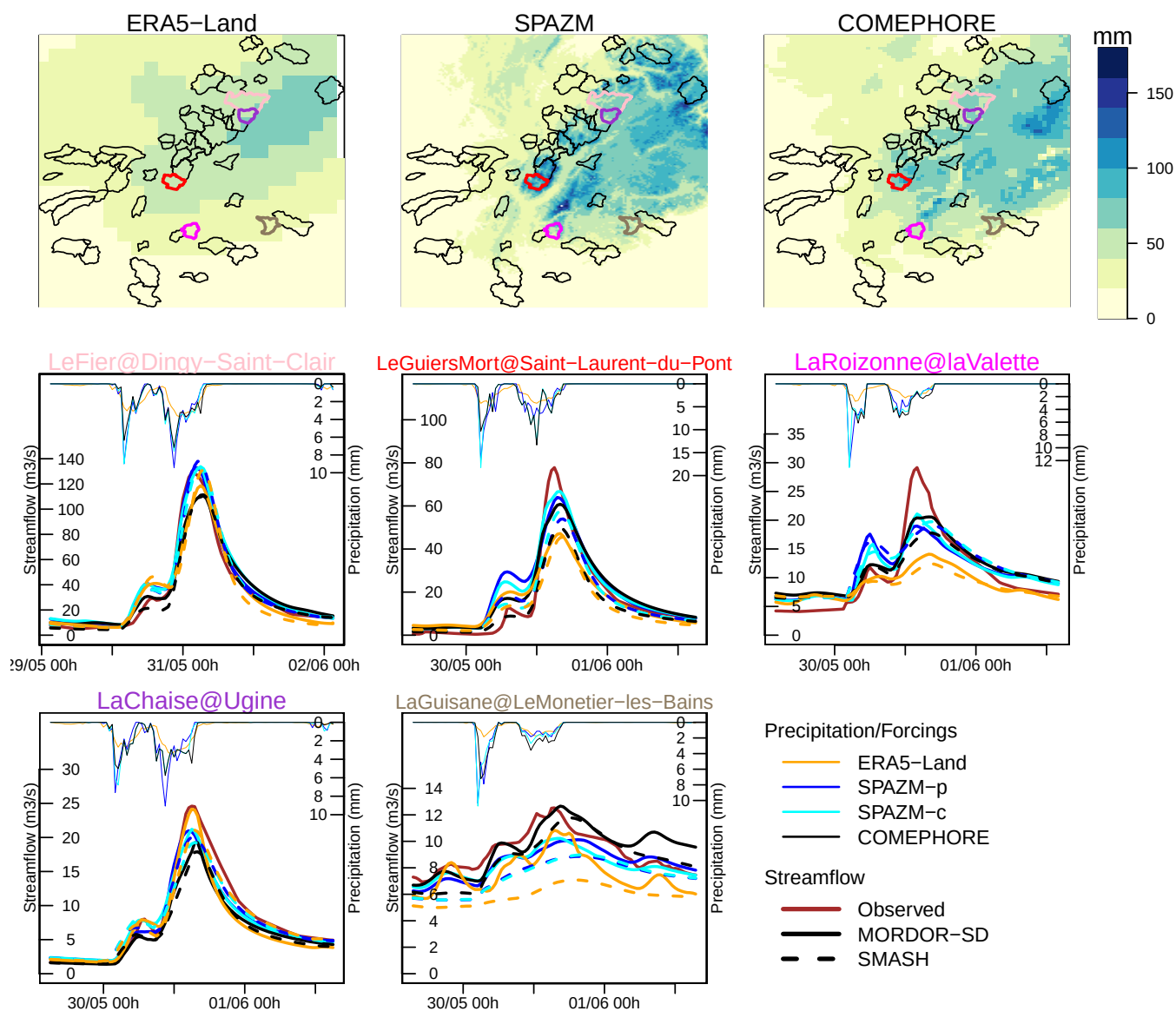


Figure S19. Cumulative amount of precipitation 24 hours before and after 2010-05-31 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

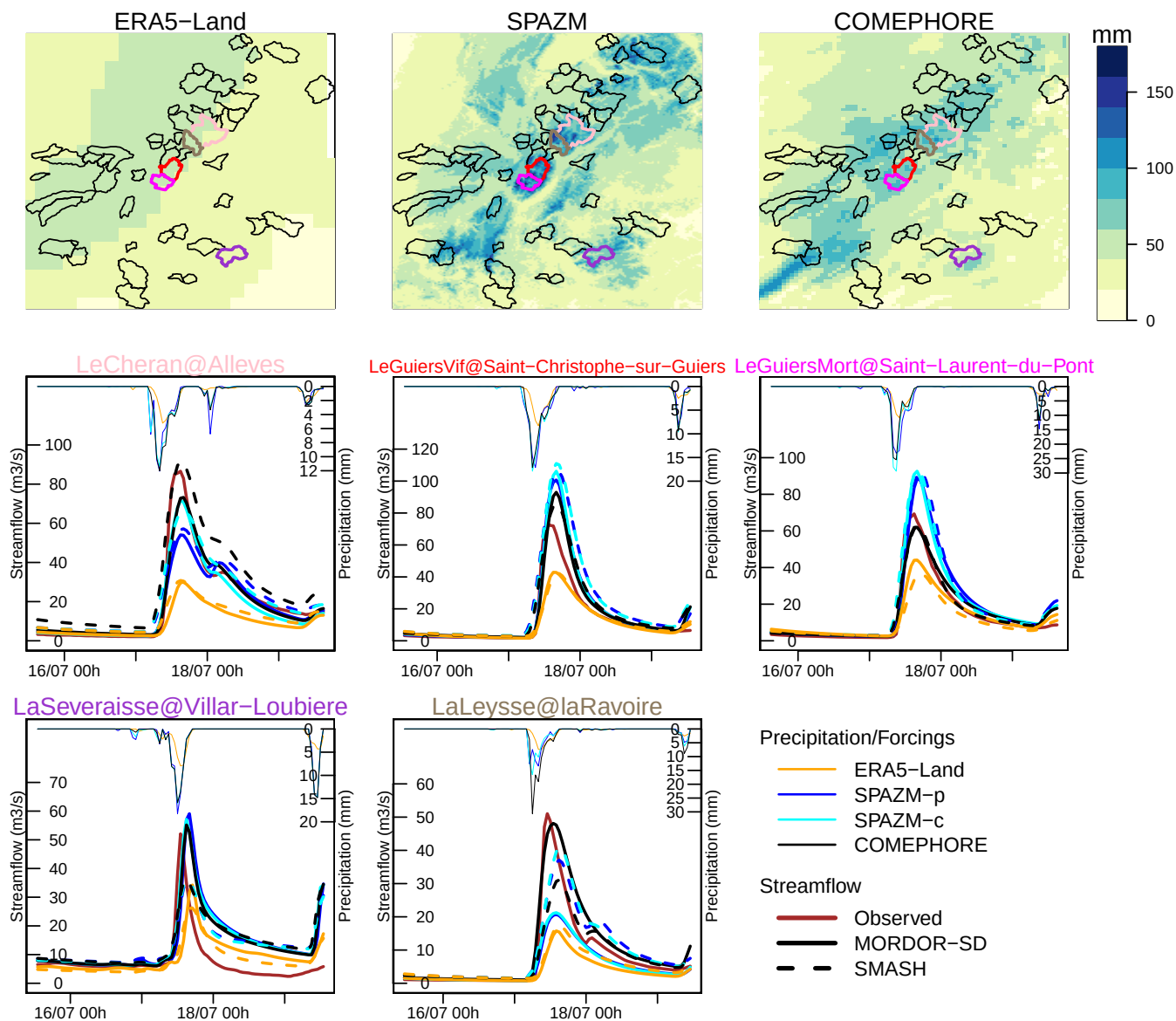


Figure S20. Cumulative amount of precipitation 24 hours before and after 2011-07-17 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

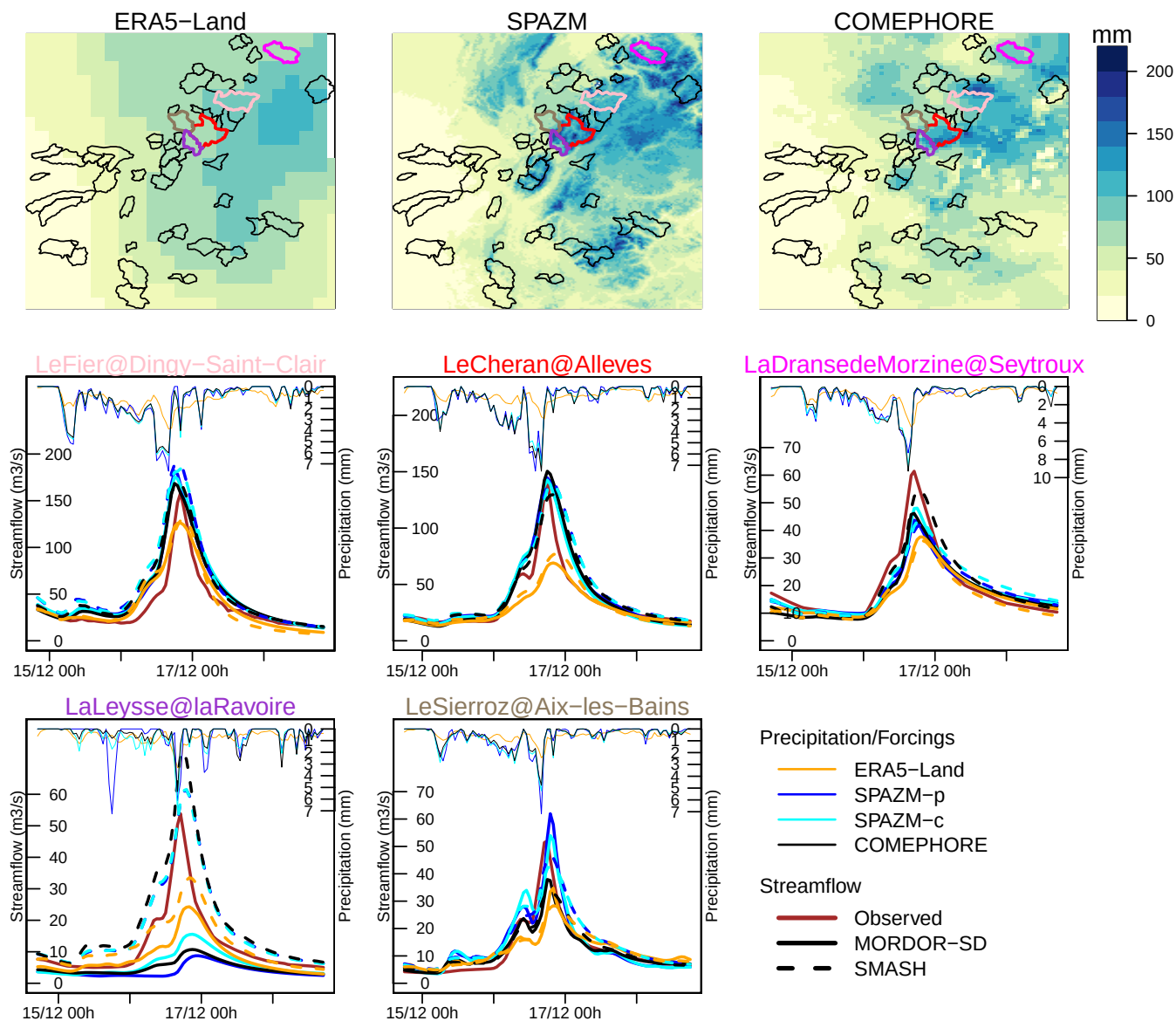


Figure S21. Cumulative amount of precipitation 24 hours before and after 2011-12-16 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

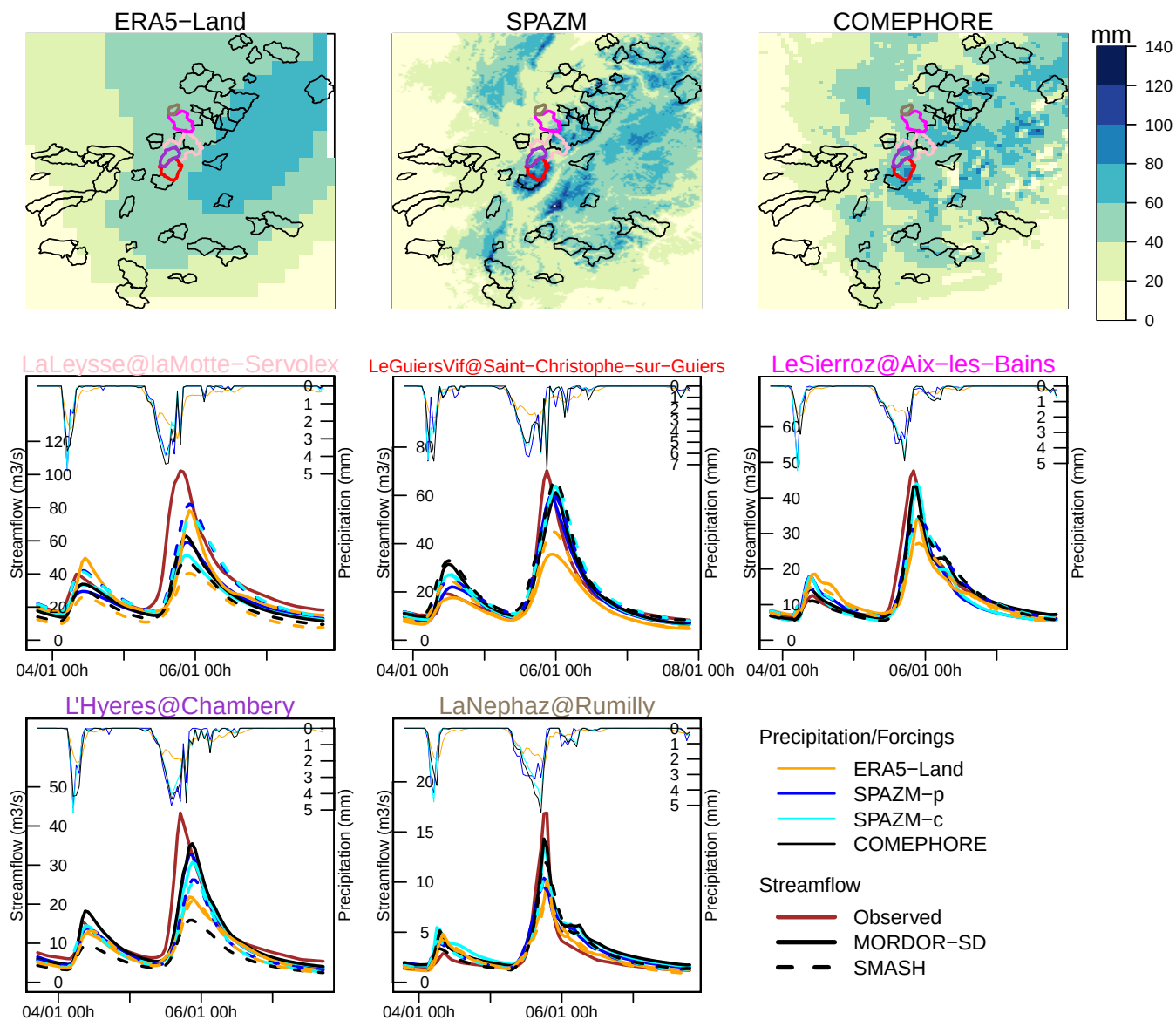


Figure S22. Cumulative amount of precipitation 24 hours before and after 2012-01-05 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

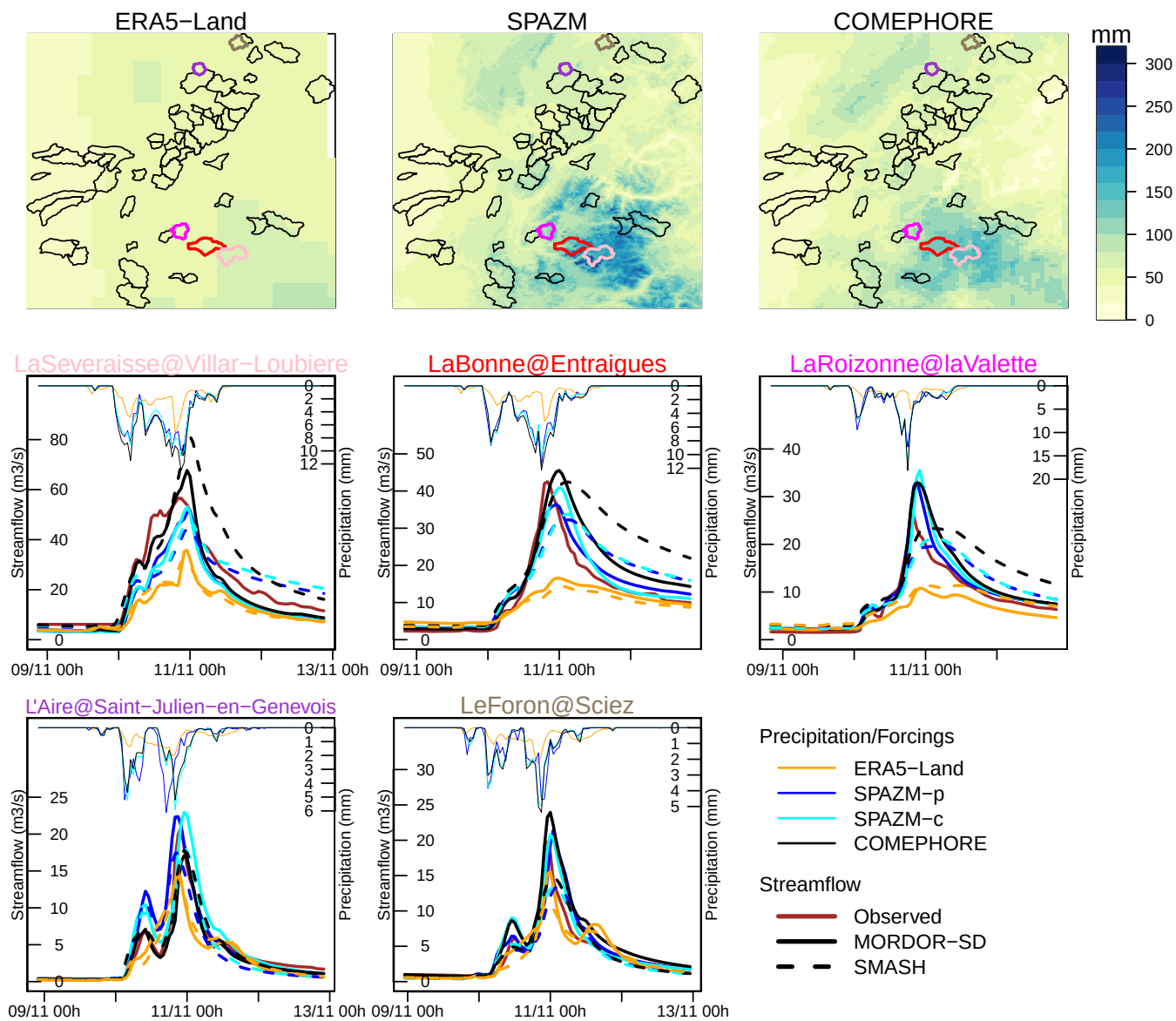


Figure S23. Cumulative amount of precipitation 24 hours before and after 2012-11-10 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

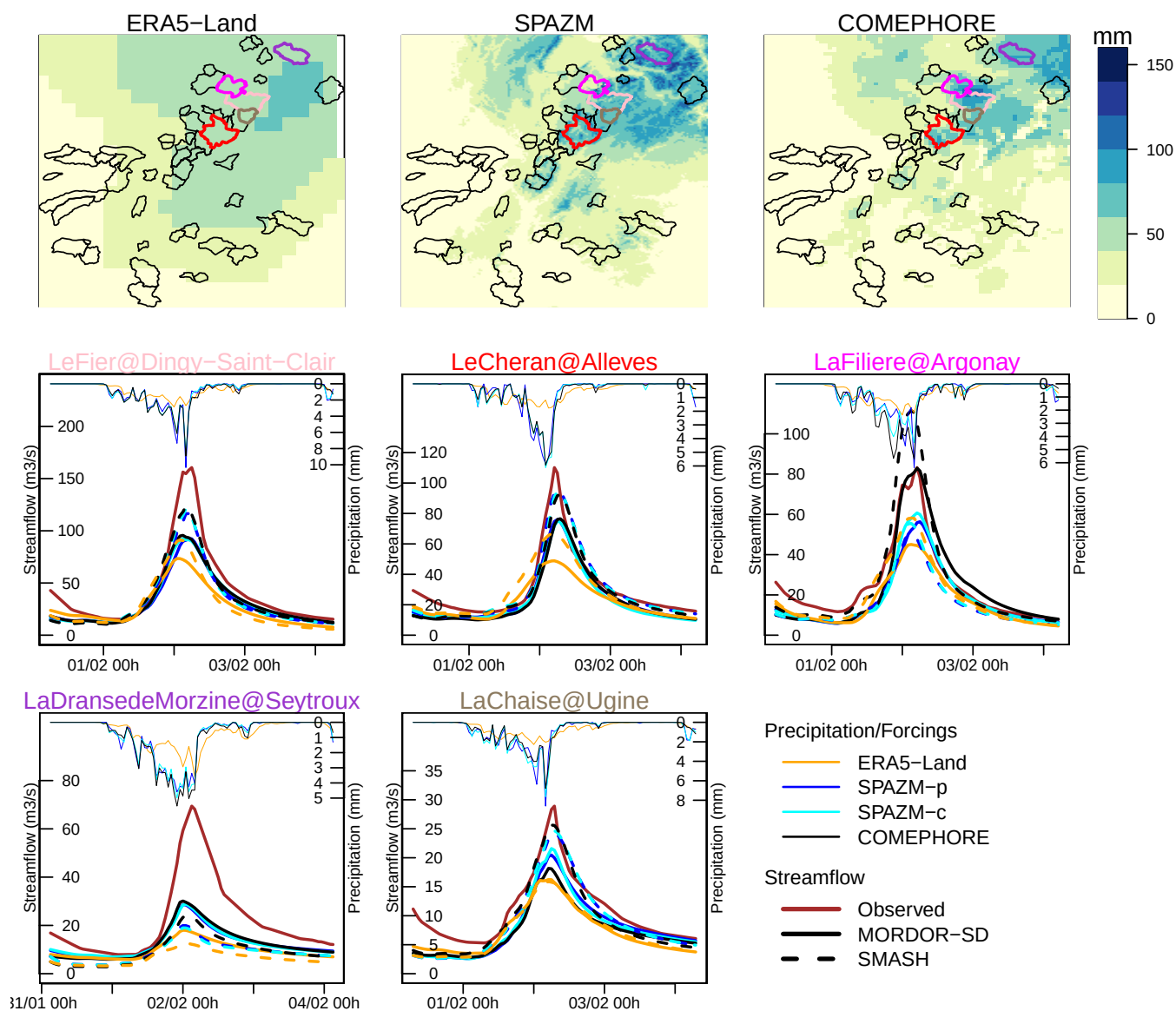


Figure S24. Cumulative amount of precipitation 24 hours before and after 2013-02-02 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

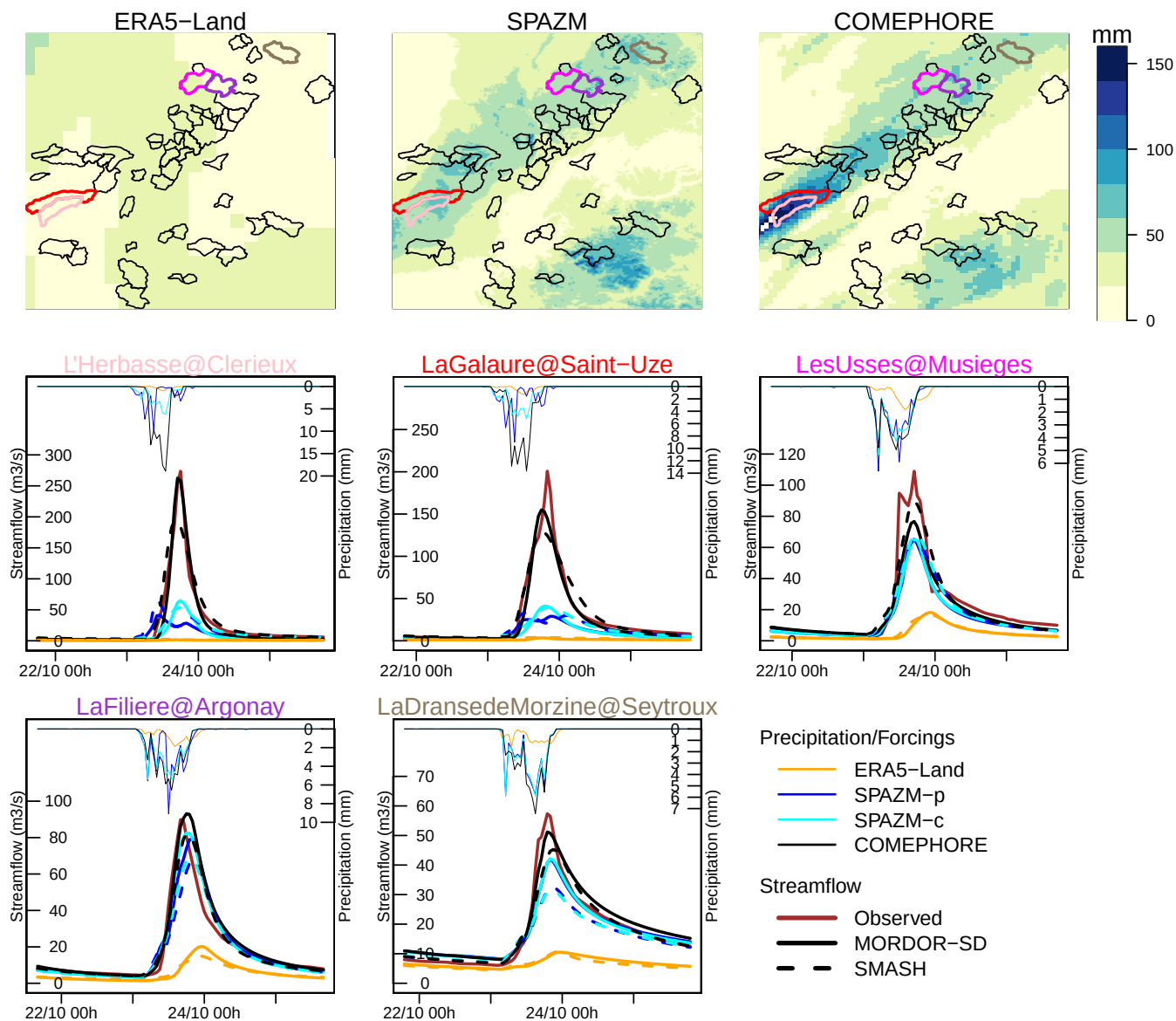


Figure S25. Cumulative amount of precipitation 24 hours before and after 2013-10-23 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

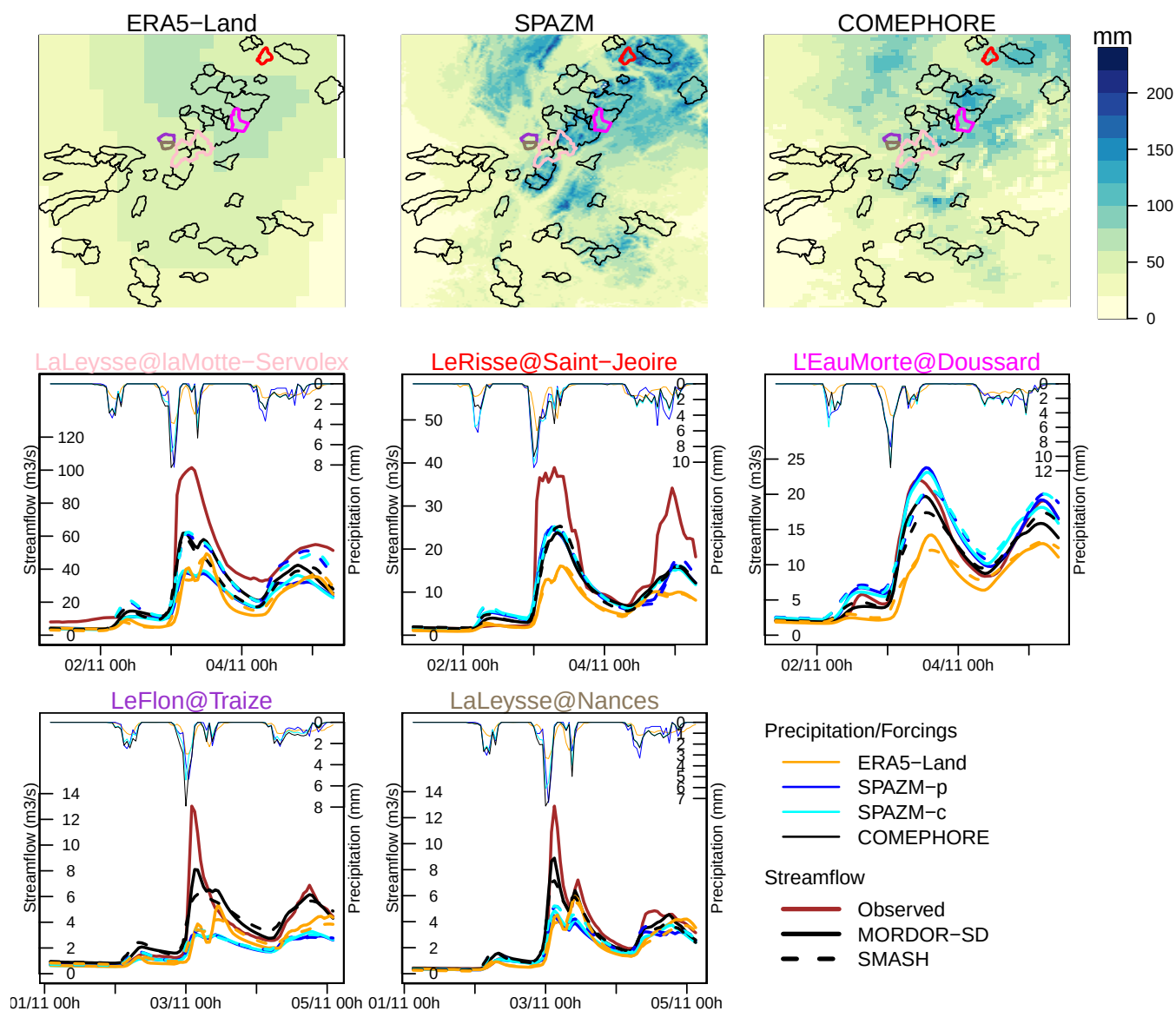


Figure S26. Cumulative amount of precipitation 24 hours before and after 2013-11-03 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

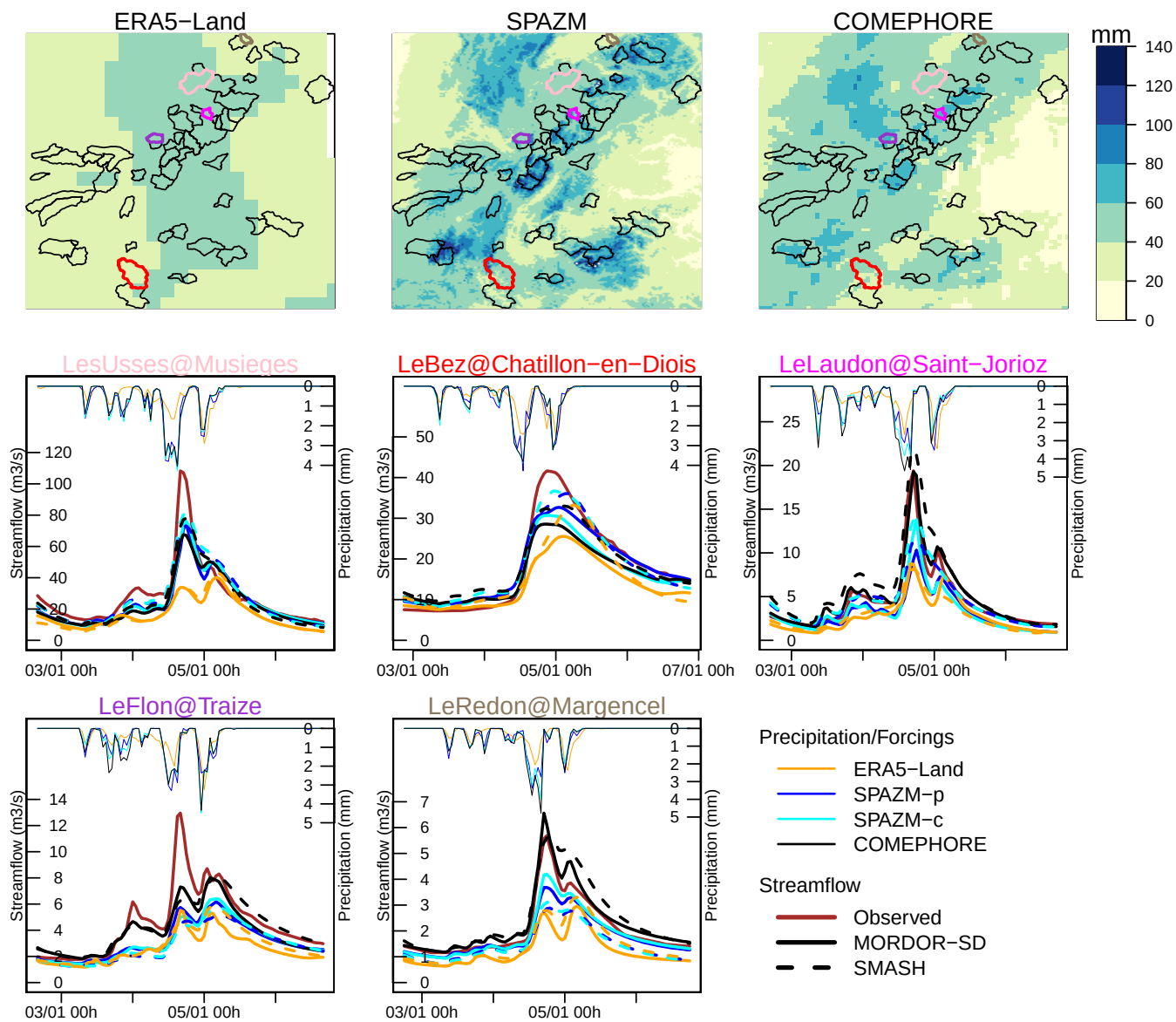


Figure S27. Cumulative amount of precipitation 24 hours before and after 2014-01-04 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

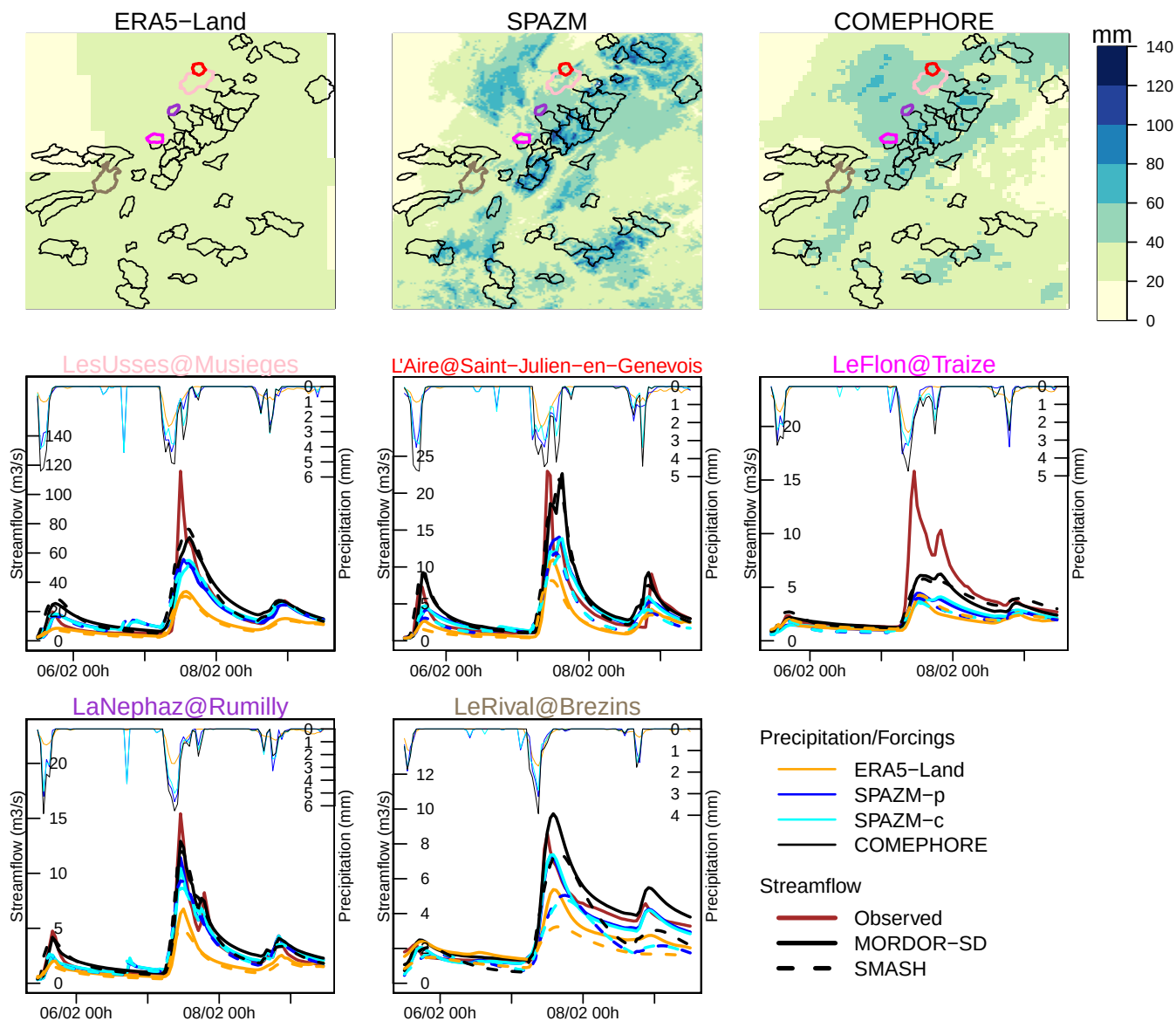


Figure S28. Cumulative amount of precipitation 24 hours before and after 2014-02-07 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

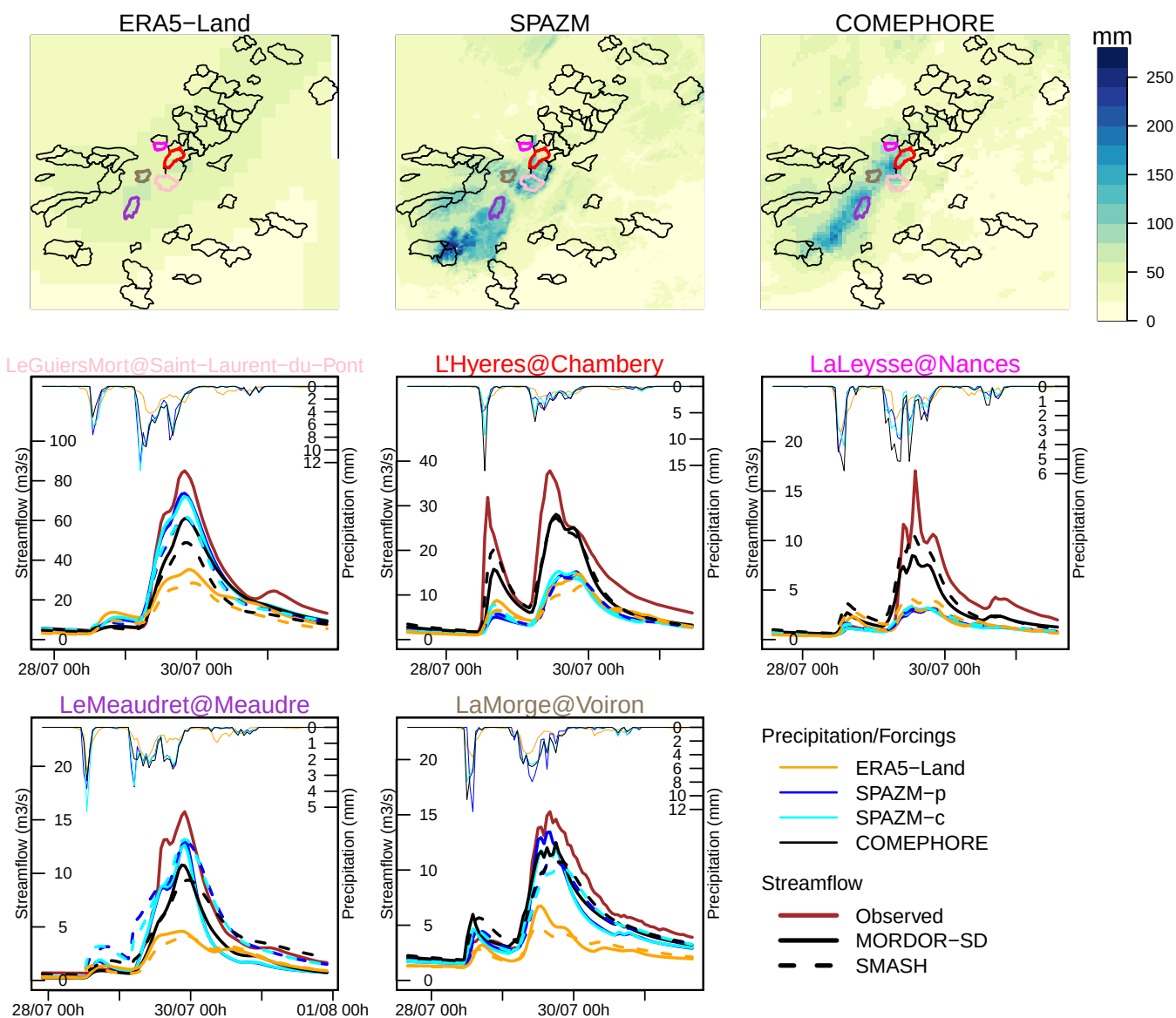


Figure S29. Cumulative amount of precipitation 24 hours before and after 2014-07-29 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

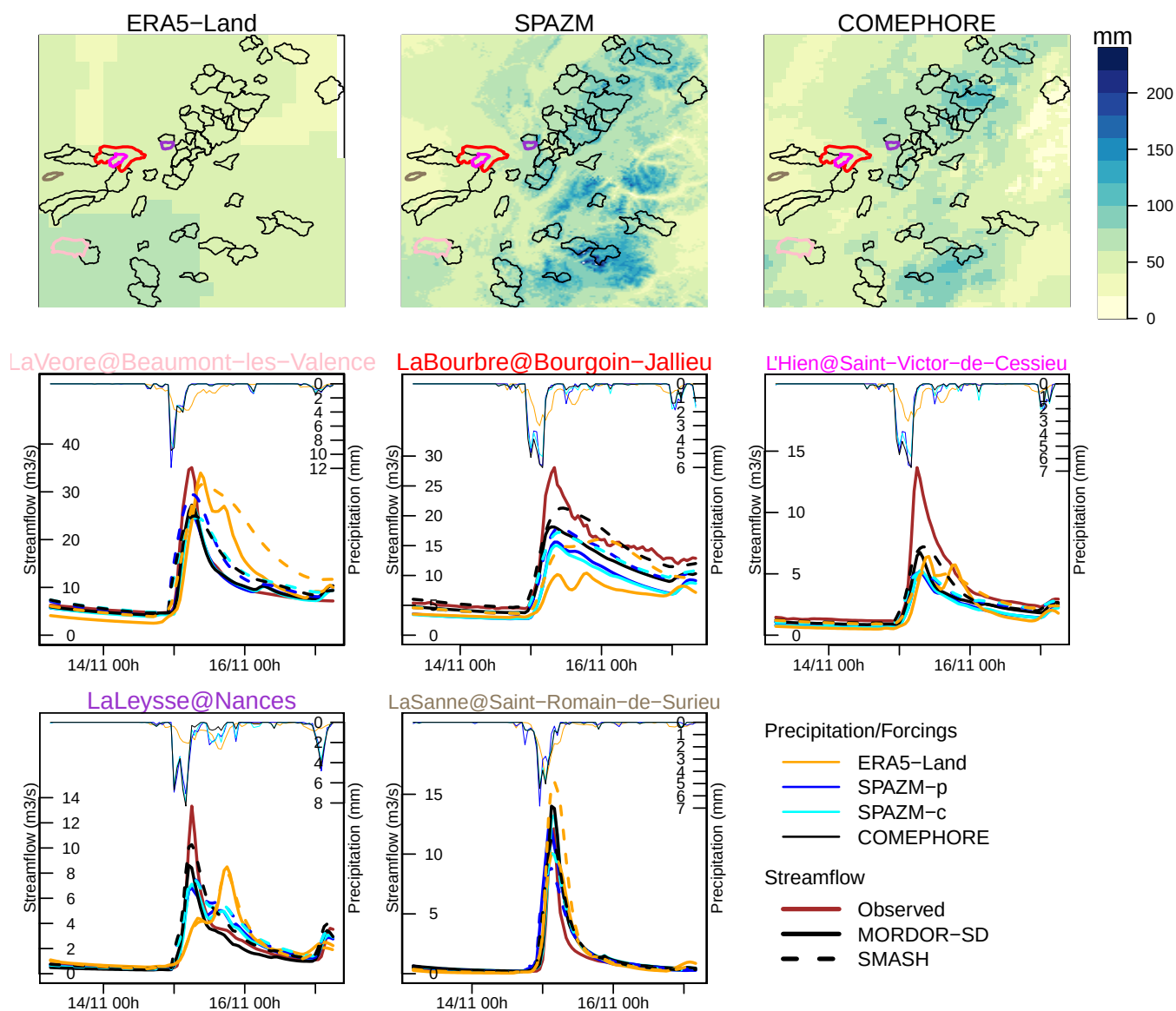


Figure S30. Cumulative amount of precipitation 24 hours before and after 2014-11-15 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

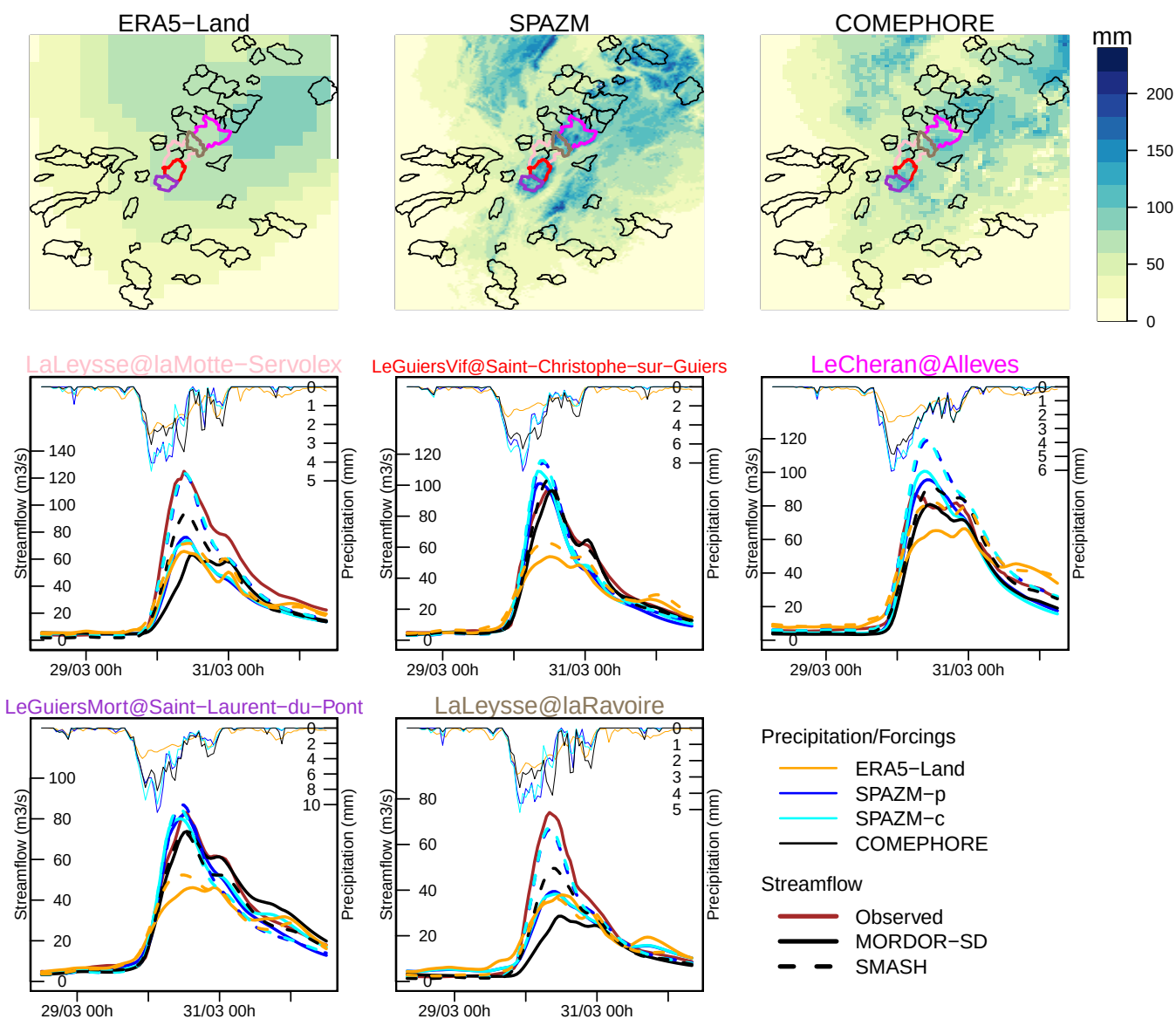


Figure S31. Cumulative amount of precipitation 24 hours before and after 2015-03-30 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

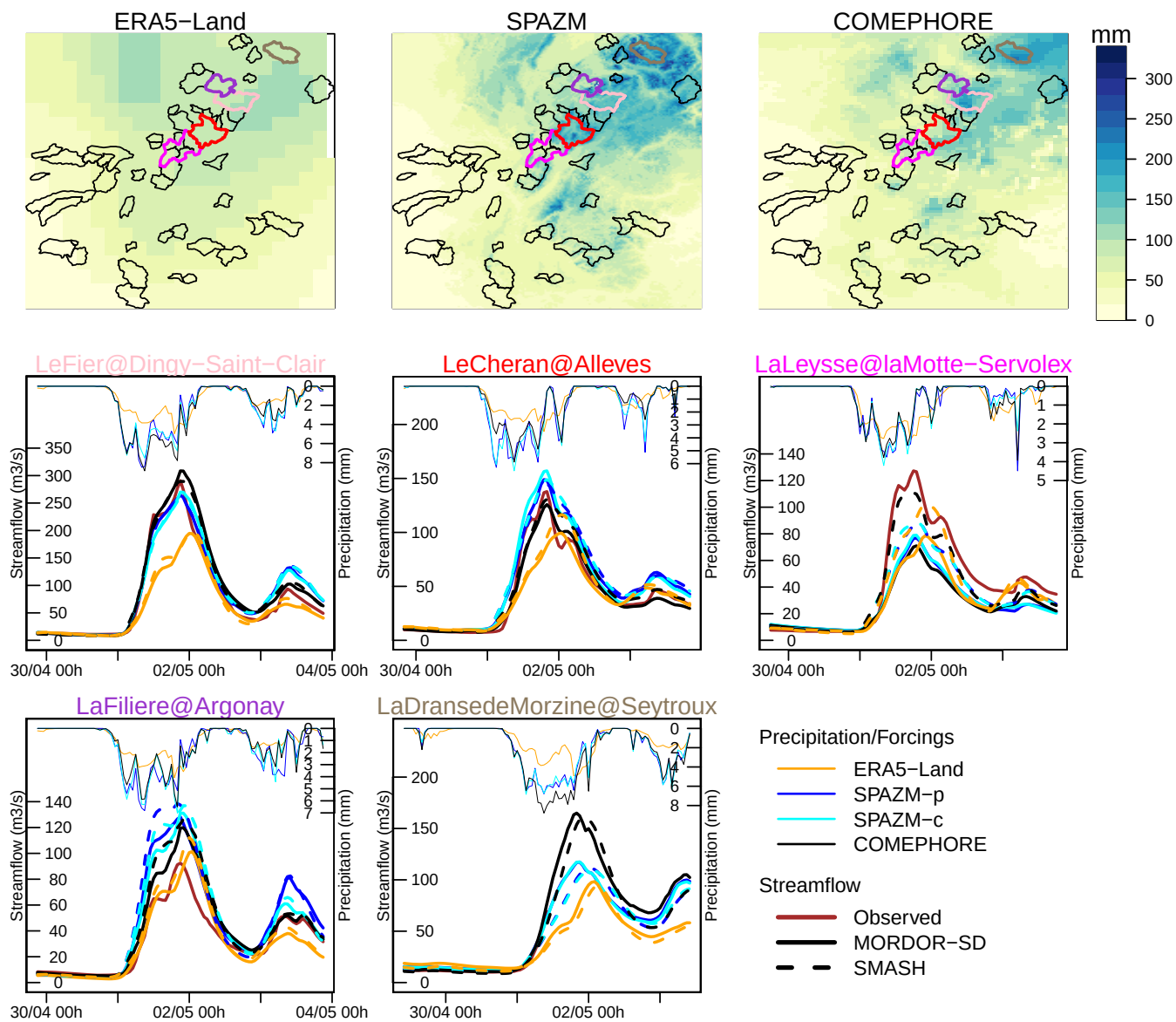


Figure S32. Cumulative amount of precipitation 24 hours before and after 2015-05-01 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

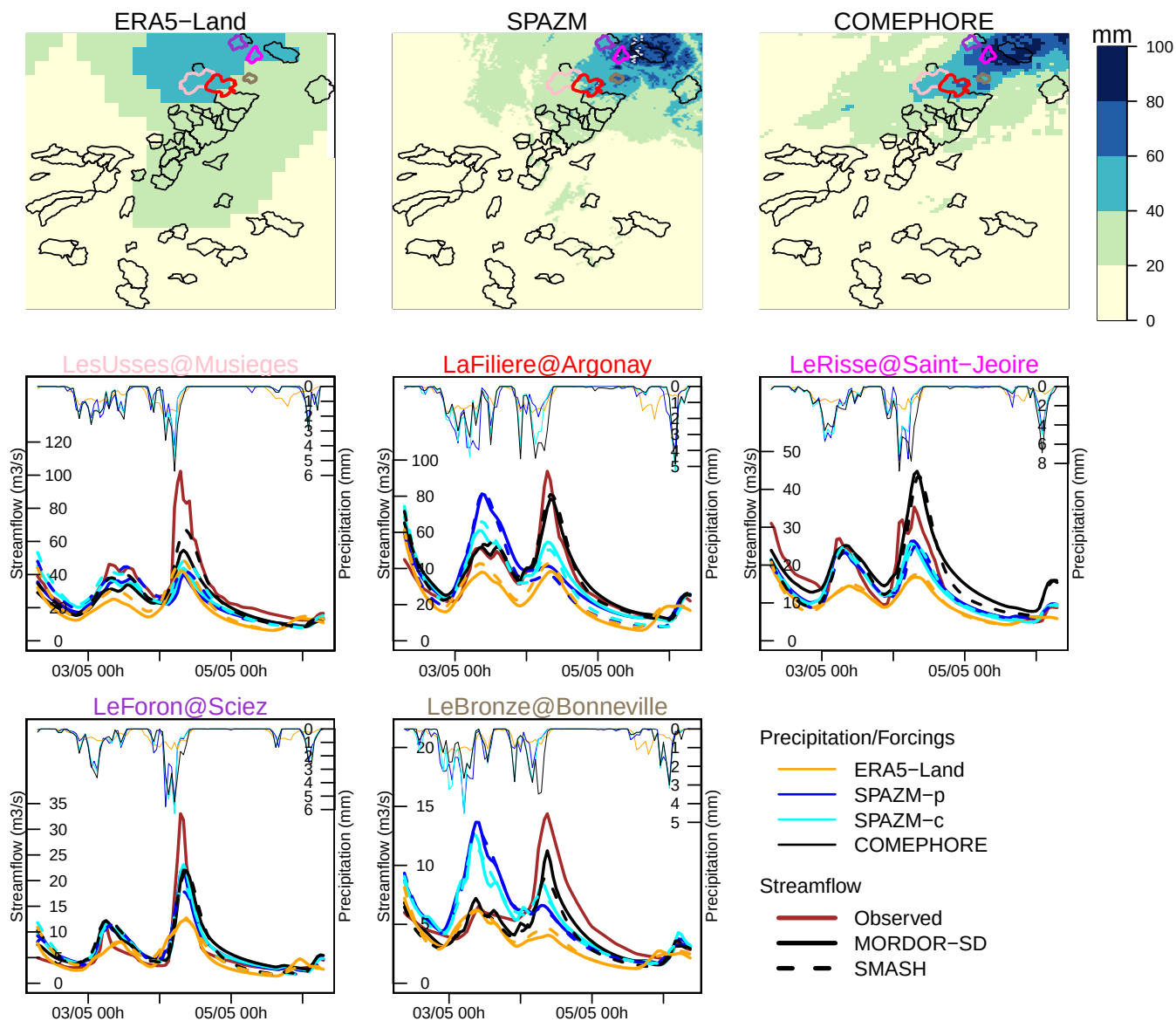


Figure S33. Cumulative amount of precipitation 24 hours before and after 2015-05-04 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

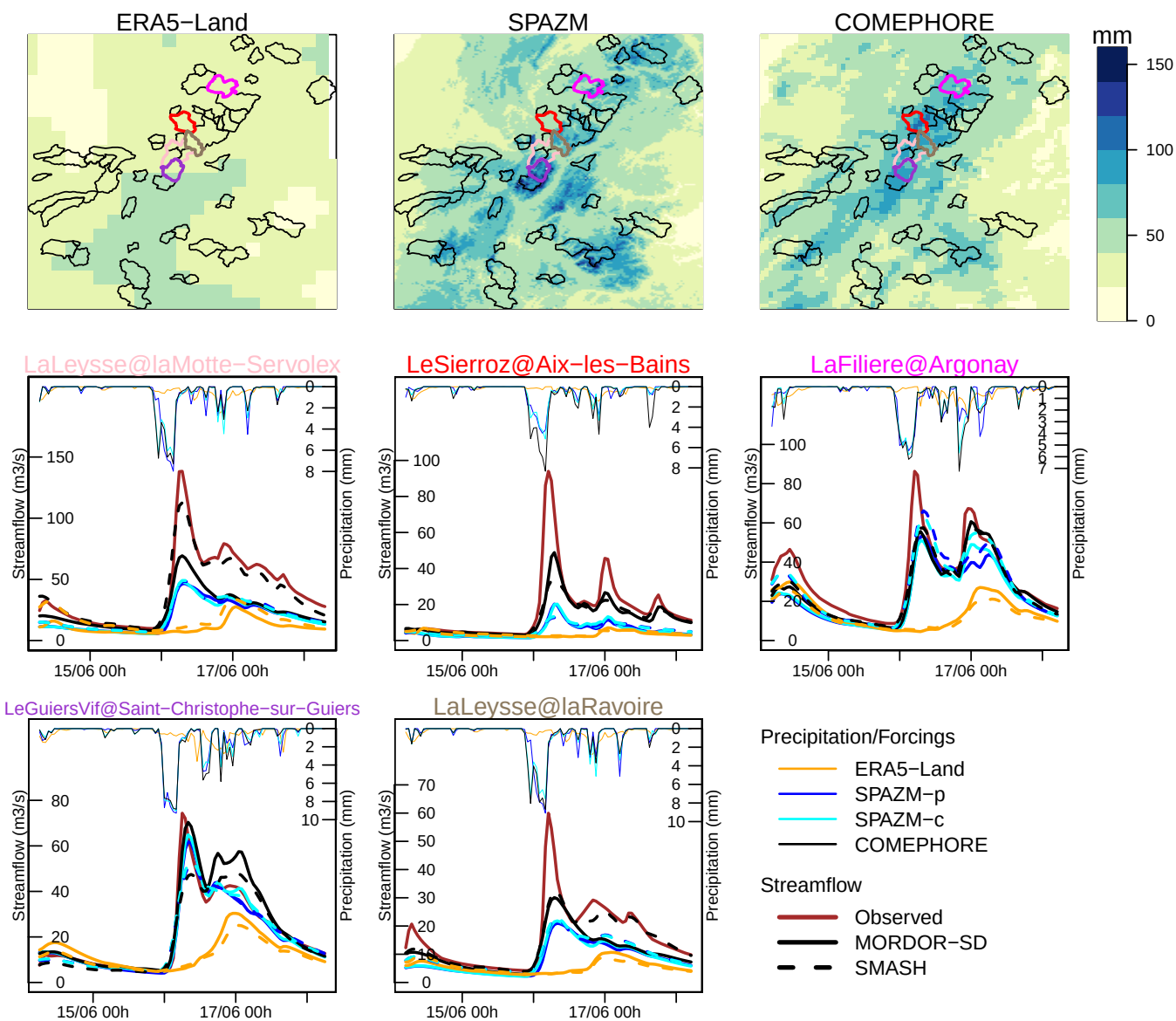


Figure S34. Cumulative amount of precipitation 24 hours before and after 2016-06-16 06:00 for ERA5-Land, SPAZM and COMEPHORE (top row) and time series of precipitation (thin lines) and streamflow (thick lines) for five catchments which have reached the highest observed peak flows for this event (middle and bottom rows).

5 3 Maps of the $mNSE(Q)$ in summer and autumn (JJASON)

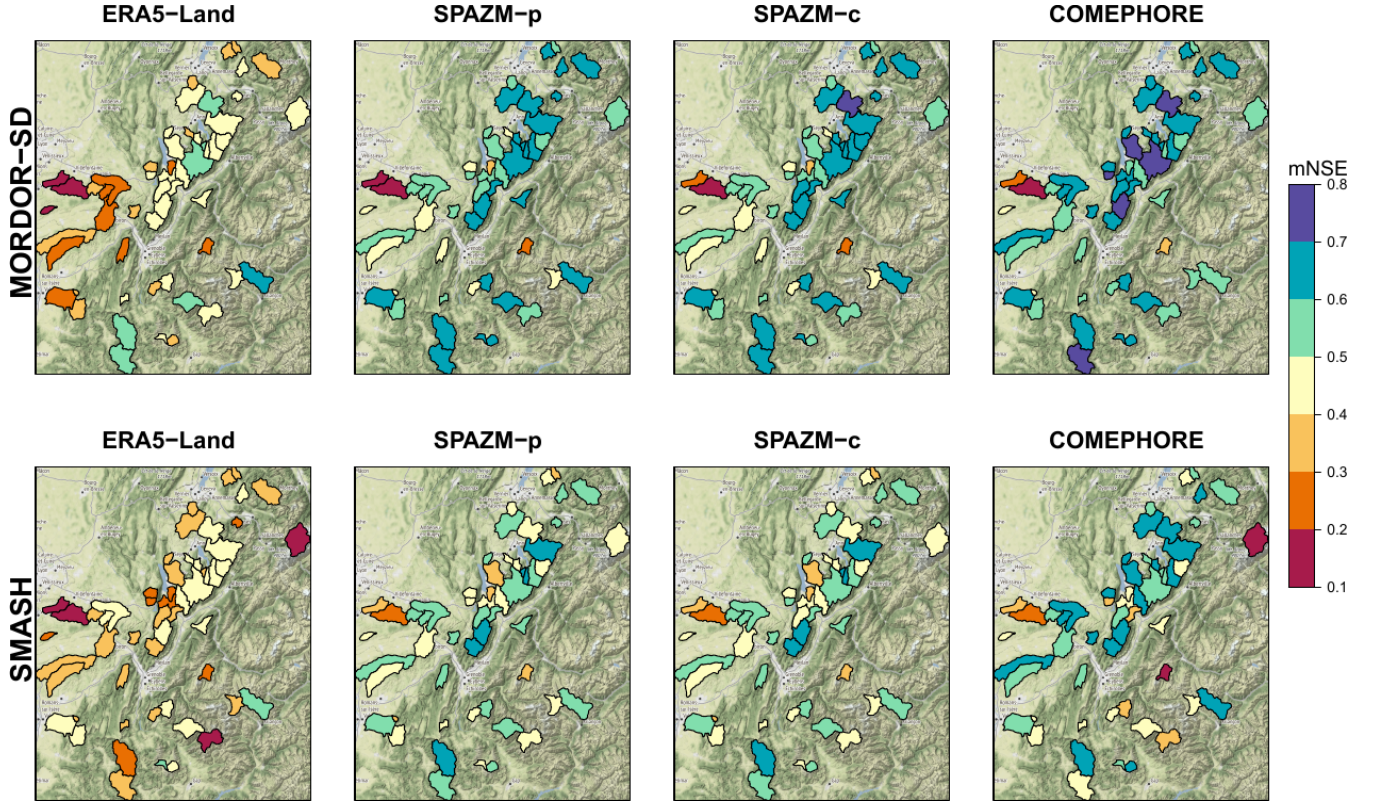


Figure S35. Maps of the $mNSE(Q)$ in summer and autumn (JJASON) obtained with MORDOR-SD (top row) and SMASH (bottom row) and the four types of precipitation forcings. Map tiles by Stamen Design, under CC BY 3.0. Data by © OpenStreetMap, under ODbL.

4 Comparison of performances between periods 1997-2007 and 2008-2017 with COMEPHORE

Figures S36 and S37 shows the differences of performances between periods 1997-2007 and 2008-2017 when COMEPHORE is used as inputs of MORDOR-SD and SMASH, respectively, for different criteria. With MORDOR-SD, a slight improvement of the performances can be noted for the $mNSE$ criteria during winter and spring, with larger values of this criteria in about half of the catchments by 0.05-0.1. With SMASH, these differences are more contrasted, and there is no clear improvement/degradation of the performances between the two periods, over all the catchments.

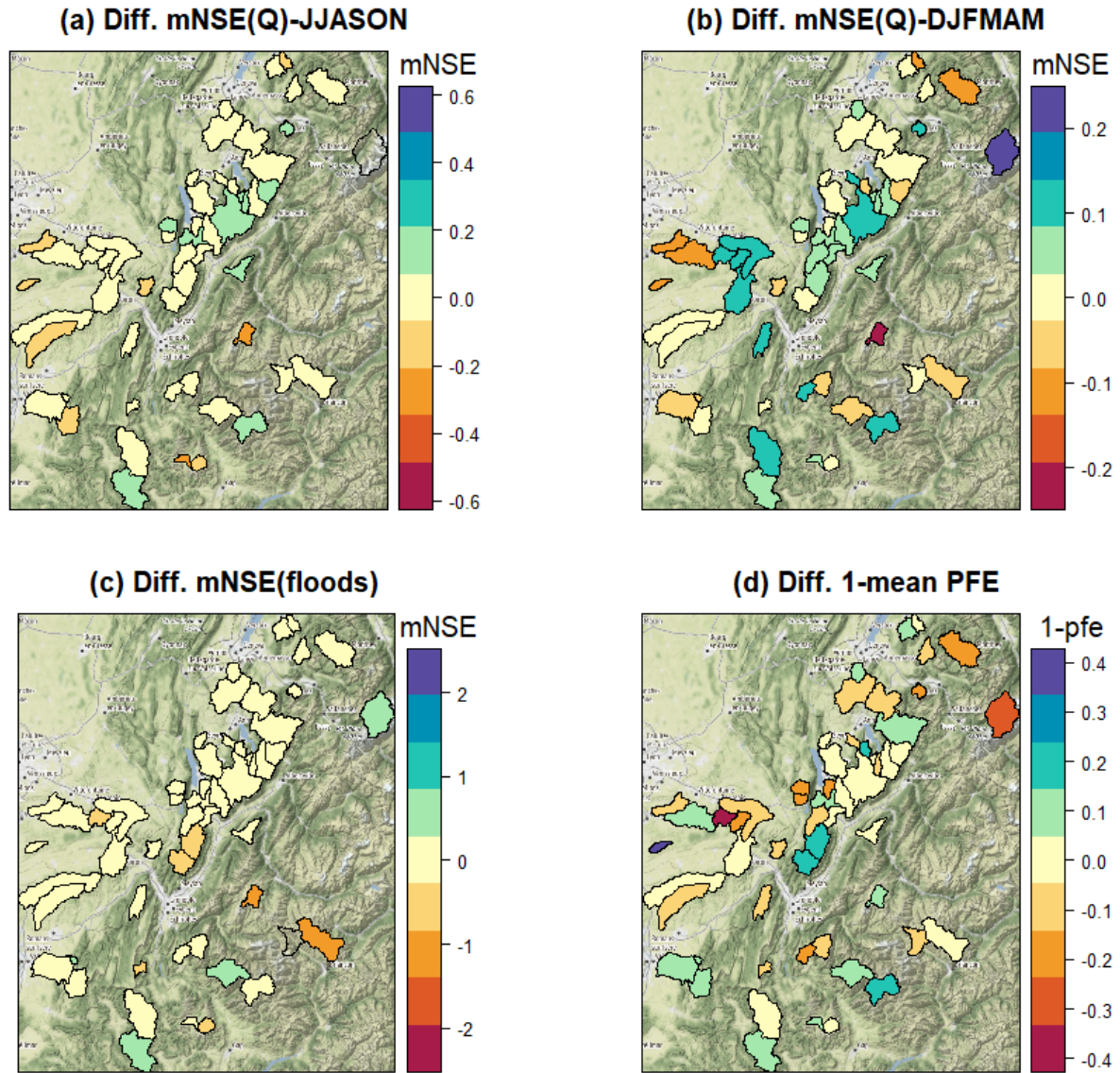


Figure S36. Difference of performances between periods 2008-2017 and 1997-2007 when COMEPHORE is used as inputs of MORDOR-SD. These criteria are positively oriented, which means that positive differences indicate a better performance for the period 2008-2017 than for the period 1997-2007. (a-b) Difference of $mNSE$ criteria for the streamflows Q in DJFMAM and JJASON. (c-d) Difference of $mNSE$ for the 10 largest floods and peak flows error ($1 - \overline{PFE}$). Map tiles by Stamen Design, under CC BY 3.0. Data by © OpenStreetMap, under ODbL.

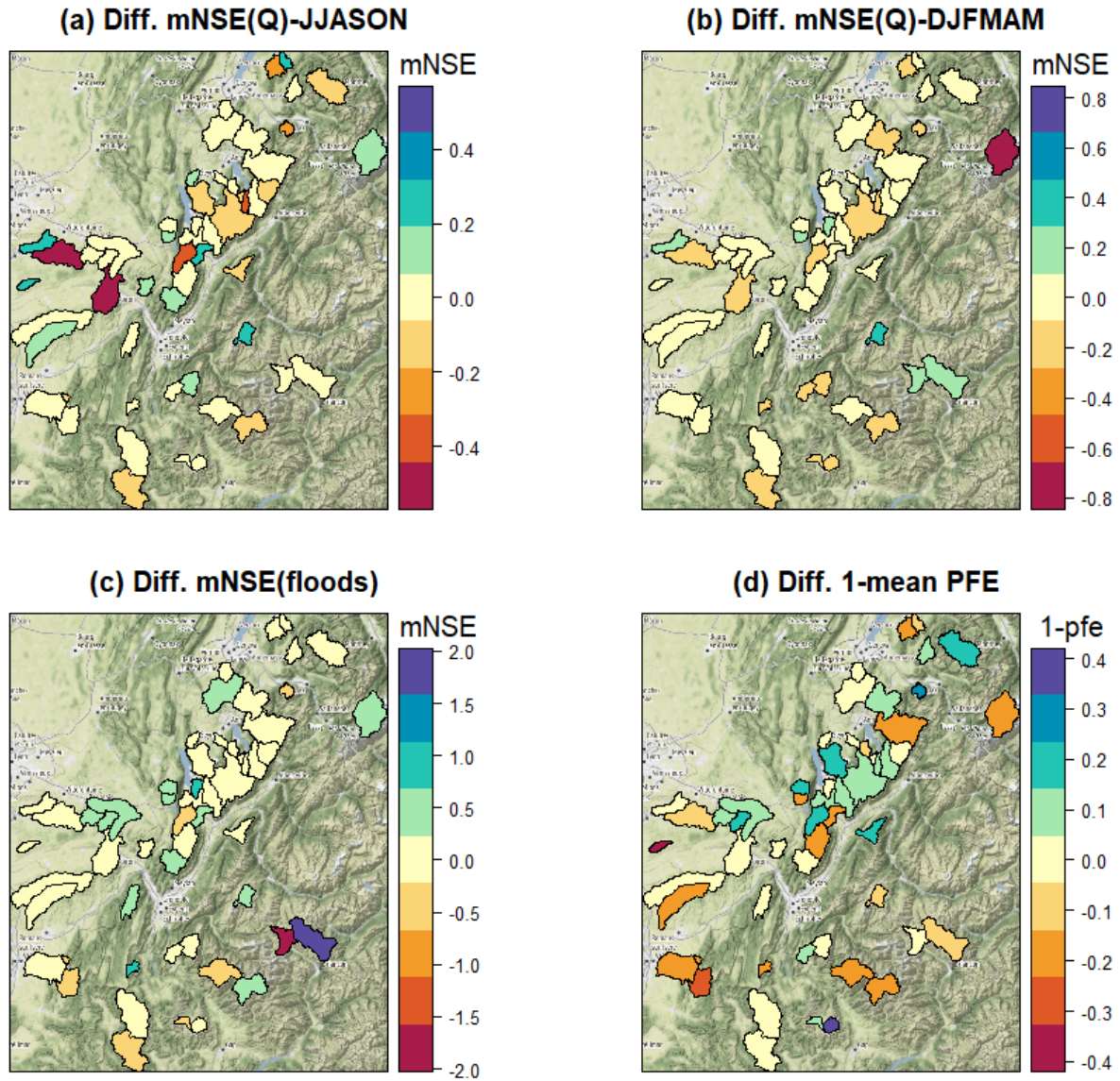


Figure S37. Difference of performances between periods 2008-2017 and 1997-2007 when COMEPHORE is used as inputs of SMASH. These criteria are positively oriented, which means that positive differences indicate a better performance for the period 2008-2017 than for the period 1997-2007. (a-b) Difference of $mNSE$ criteria for the streamflows Q in DJFMAM and JJASON. (c-d) Difference of $mNSE$ for the 10 largest floods and peak flows error ($1 - \overline{PFE}$). Map tiles by Stamen Design, under CC BY 3.0. Data by © OpenStreetMap, under ODbL.

5 Absolute differences between observed and simulated runoff values

Figure S38 shows the differences of mean daily observed and simulated runoff values, expressed in mm/day, obtained with the different reanalysis, and the two hydrological models, in winter and spring (DJFMAM) and summer and autumn (JJASON). For both hydrological models, slight underestimations are obtained in DJFMAM with SPAZM and COMEPHORE, and overestimations in JJASON. These differences are more important with SMASH than with COMEPHORE.

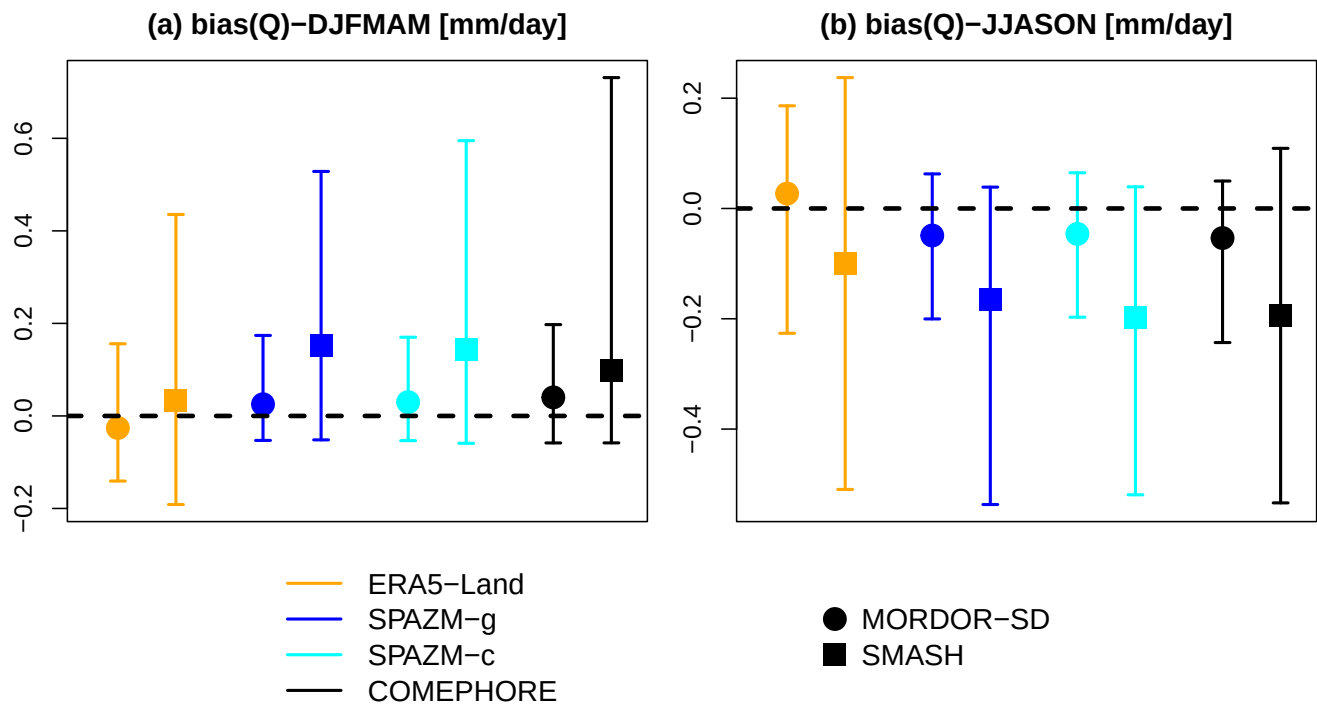


Figure S38. Difference of mean daily observed and simulated runoff, in mm / day, for the different reanalysis and the two hydrological models. (a) Winter and spring (DJFMAM). (b) Summer and autumn (JJASON).

6 Time series of precipitation and streamflow for the ten largest floods

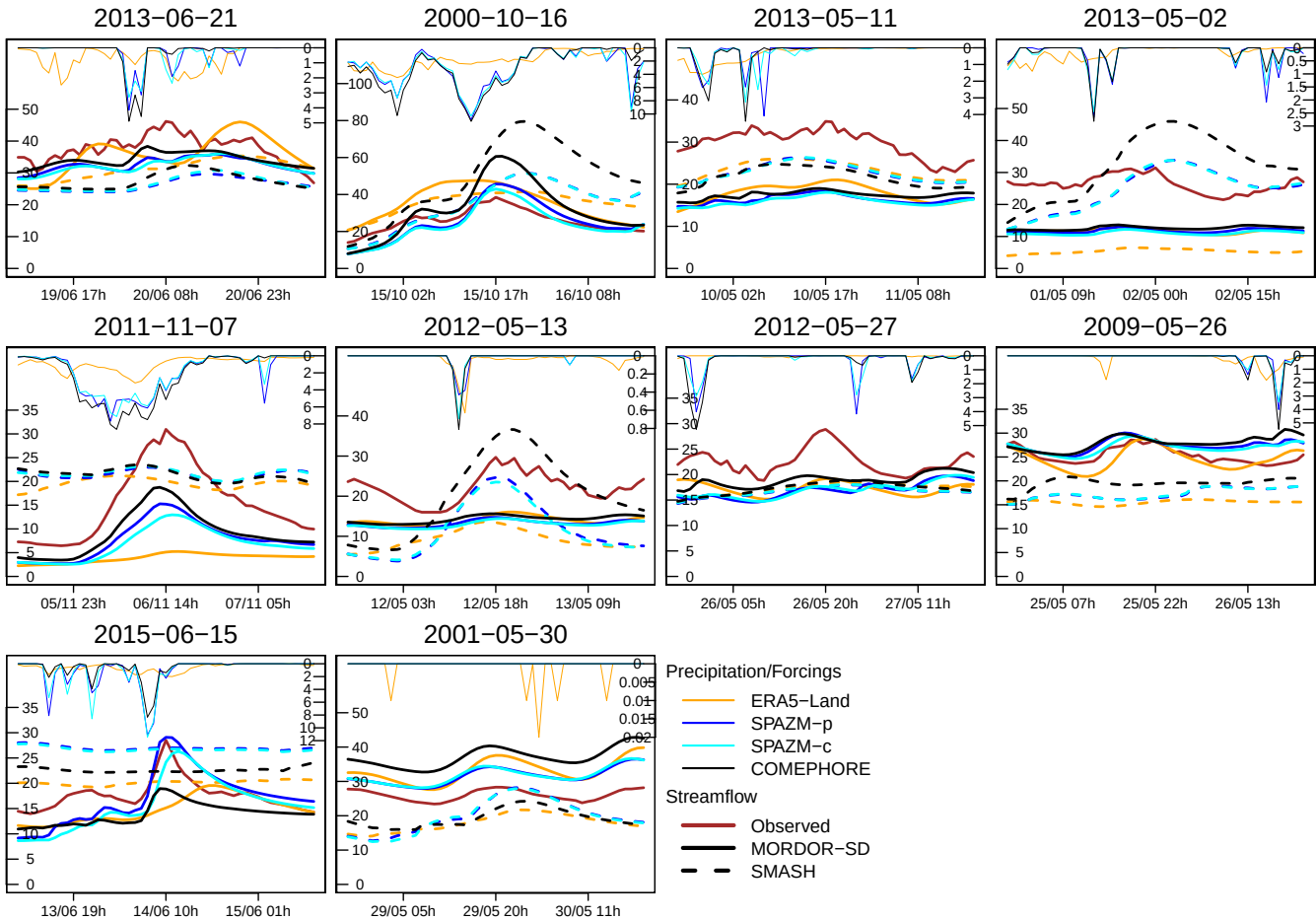


Figure S39. Precipitation and streamflow of the ten largest floods (highest observed peak flows) at LaDurance@Val-des-Pres. Time series of precipitation (thin lines) and streamflow (thick lines) for the different reanalysis.

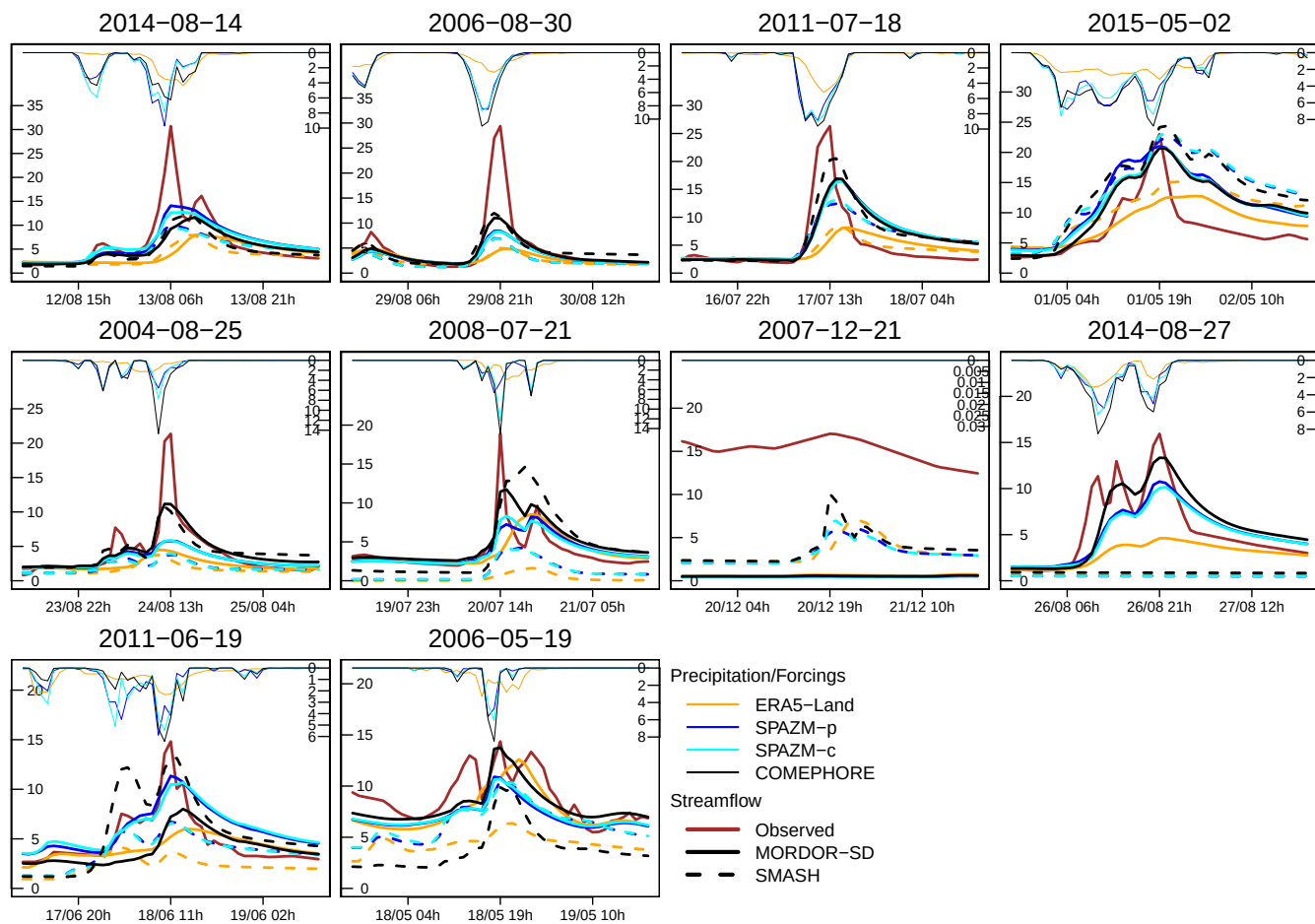


Figure S40. Precipitation and streamflow of the ten largest floods (highest observed peak flows) at L'Arvan@Saint-Jean-d'Arves. Time series of precipitation (thin lines) and streamflow (thick lines) for the different reanalysis.

References

Brugeron, A., Paroissien, J., and Tillier, L. (2018). Référentiel hydrogéologique BDLISA version 2 : Principes de construction et évolutions. Technical Report BRGM/RP-67489-FR, BRGM/OFB.