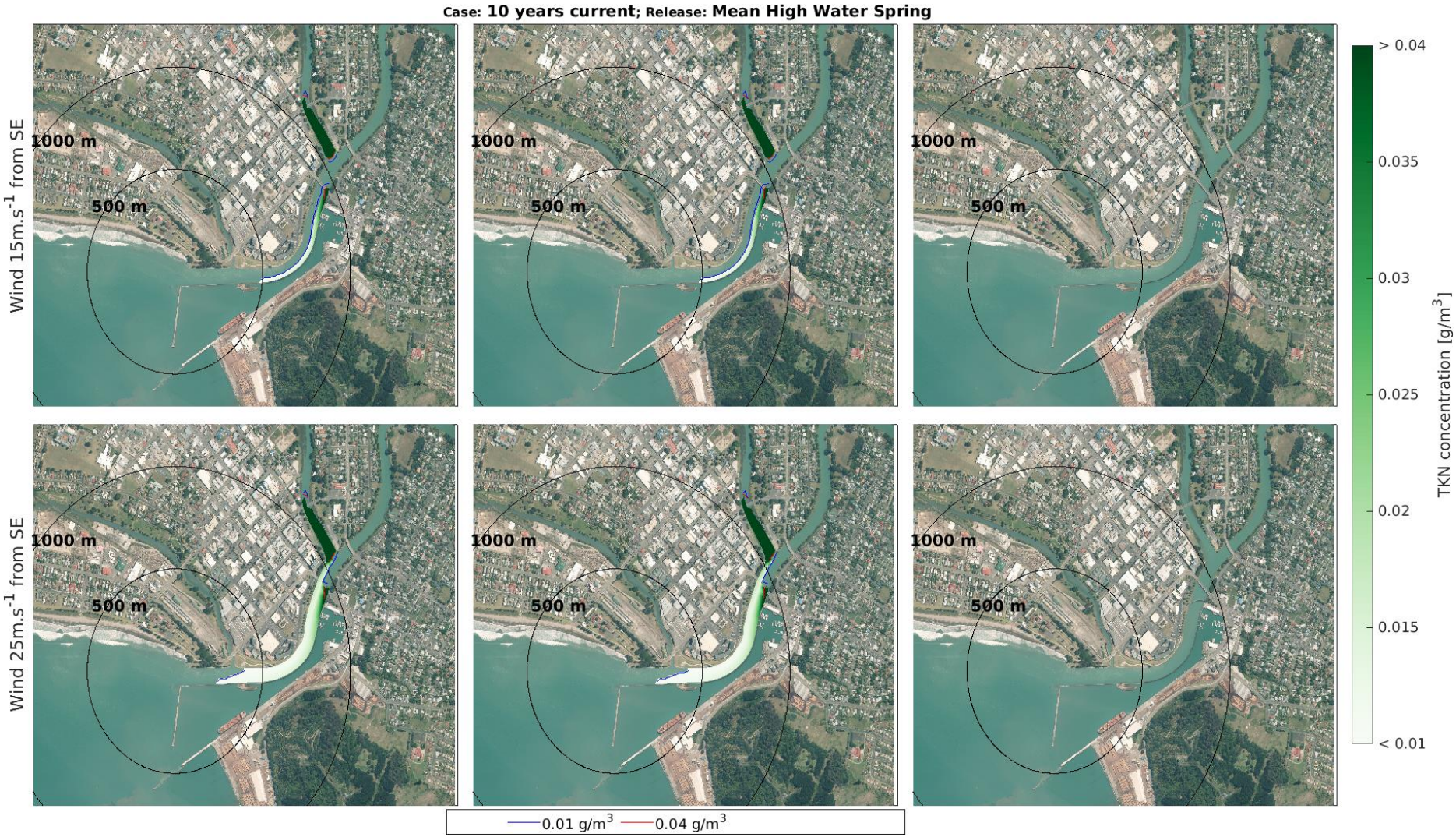


Figure 3.68 Close-up view of the 10 year current scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s^{-1} (bottom) South-Easterly wind.

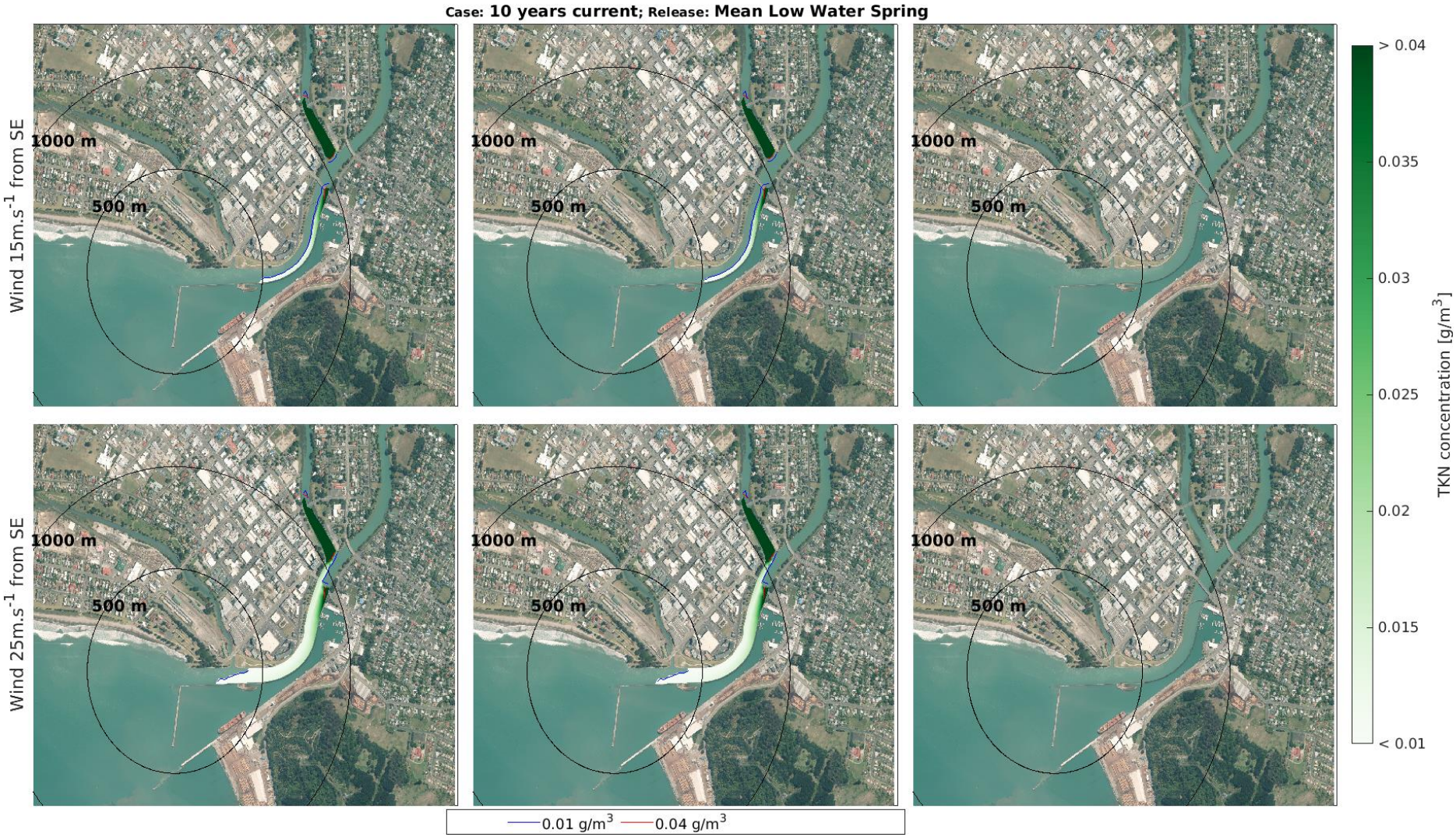


Figure 3.69 Close-up view of the 10 year current scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MLWS release with 15 (top) and 25 m.s^{-1} (bottom) South-Easterly wind.

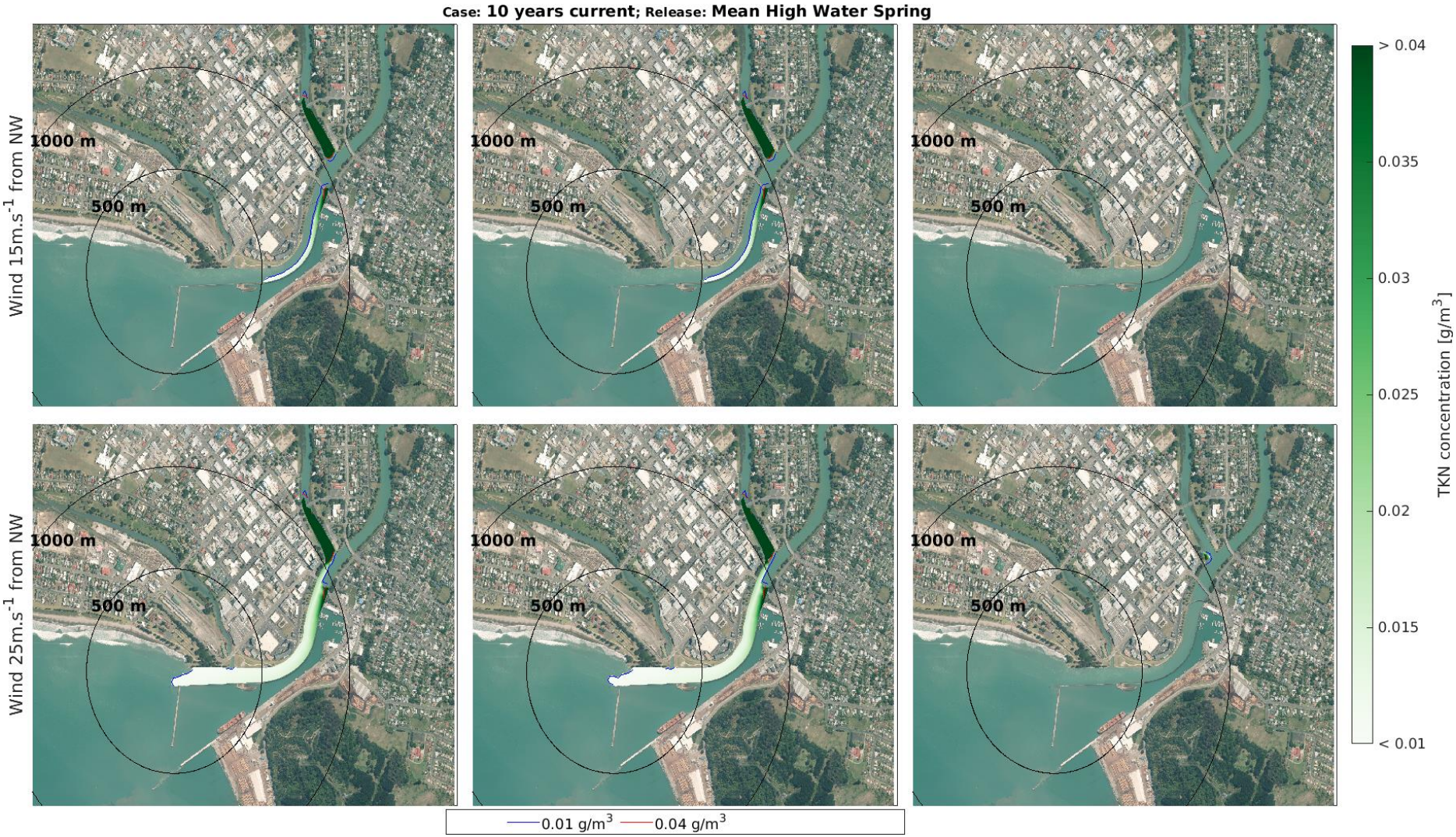


Figure 3.70 Close-up view of the 10 year current scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s^{-1} (bottom) North-Westerly wind.

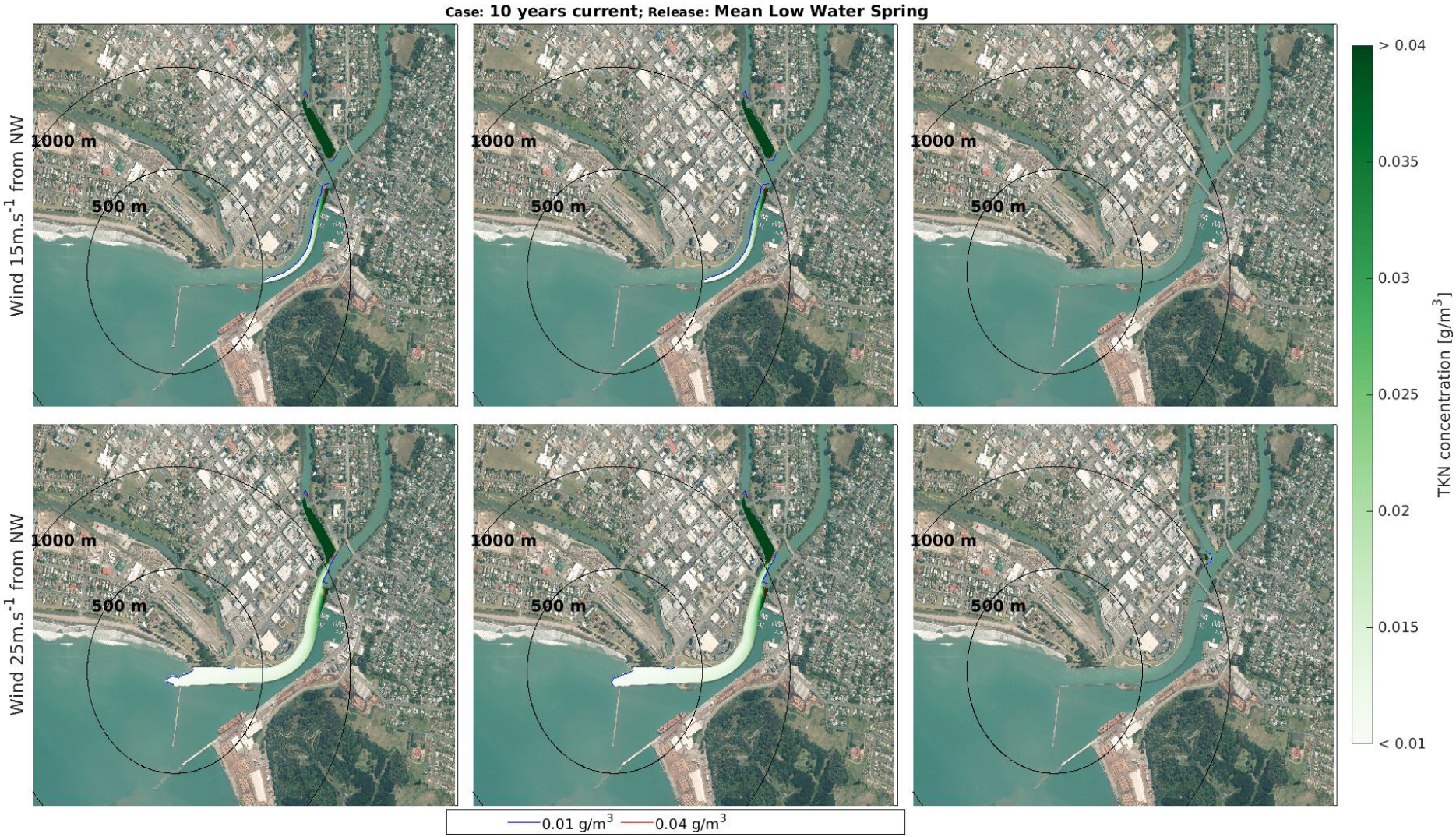


Figure 3.71 Close-up view of the 10 year current scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MLWS release with 15 (top) and 25 m.s^{-1} (bottom) North-Westerly wind.

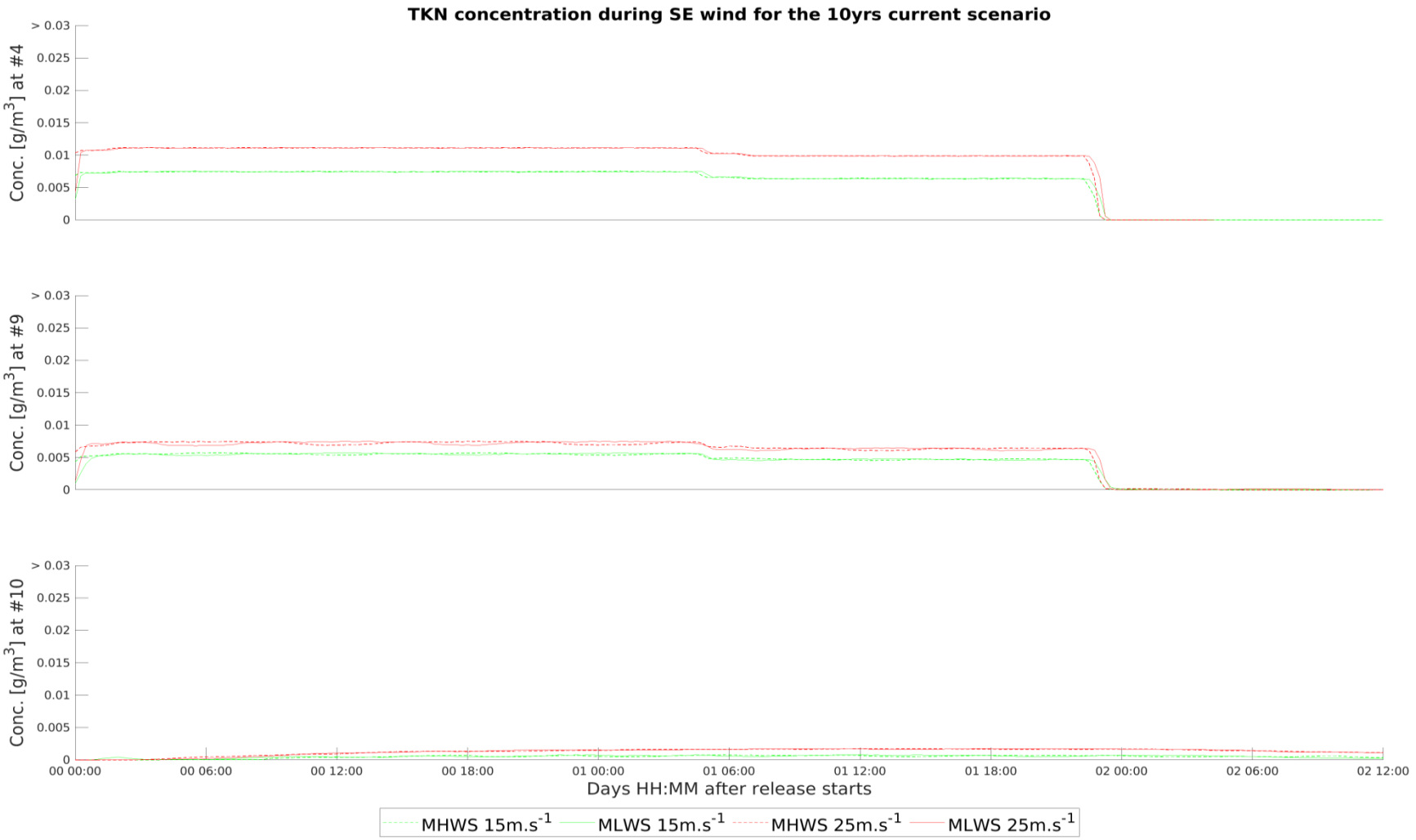


Figure 3.72 *TKN concentration time series in Ent/100mL extracted at the four location for the 10yrs current scenario under South-Easterlies condition. The solid line and the dot line represented the initial tidal state of the release (MHWS and MLWS respectively). The 15 m.s^{-1} wind speed is shown by the green colour and the 25 m.s^{-1} is represented by the red colour.*

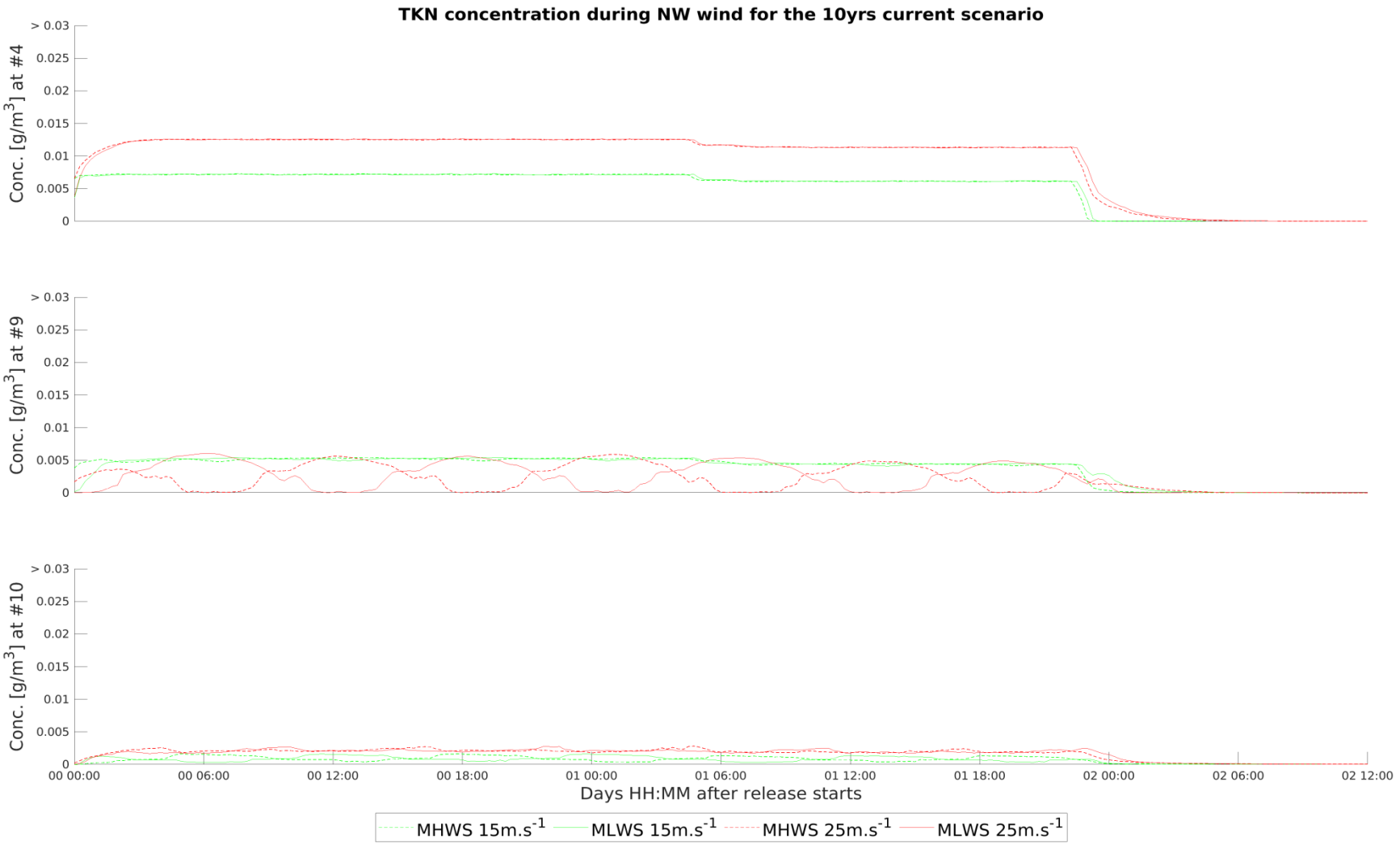


Figure 3.73 *TKN concentration time series in Ent/100mL extracted at the four location for the 10yrs current scenario under North-Westerlies condition. The solid line and the dot line represented the initial tidal state of the release (MHWS and MLWS respectively). The 15 m.s^{-1} wind speed is shown by the green colour and the 25 m.s^{-1} is represented by the red colour.*

3.3.3 10-year ARI future scenarios

TKN concentration plots for S-E wind events (15 and 25 $m.s^{-1}$) are presented in Figure 3.74 and Figure 3.75 for the MHWS and MLWS release respectively. TKN concentration plots for N-W wind events (15 and 25 $m.s^{-1}$) are presented in Figure 3.76 and Figure 3.77 for the MHWS and MLWS release respectively.

Time-series of TKN concentration for each of the events simulated (i.e. varying release conditions and timing) are provided at location #4, #9 and #10 in Figure 3.78 and Figure 3.79.

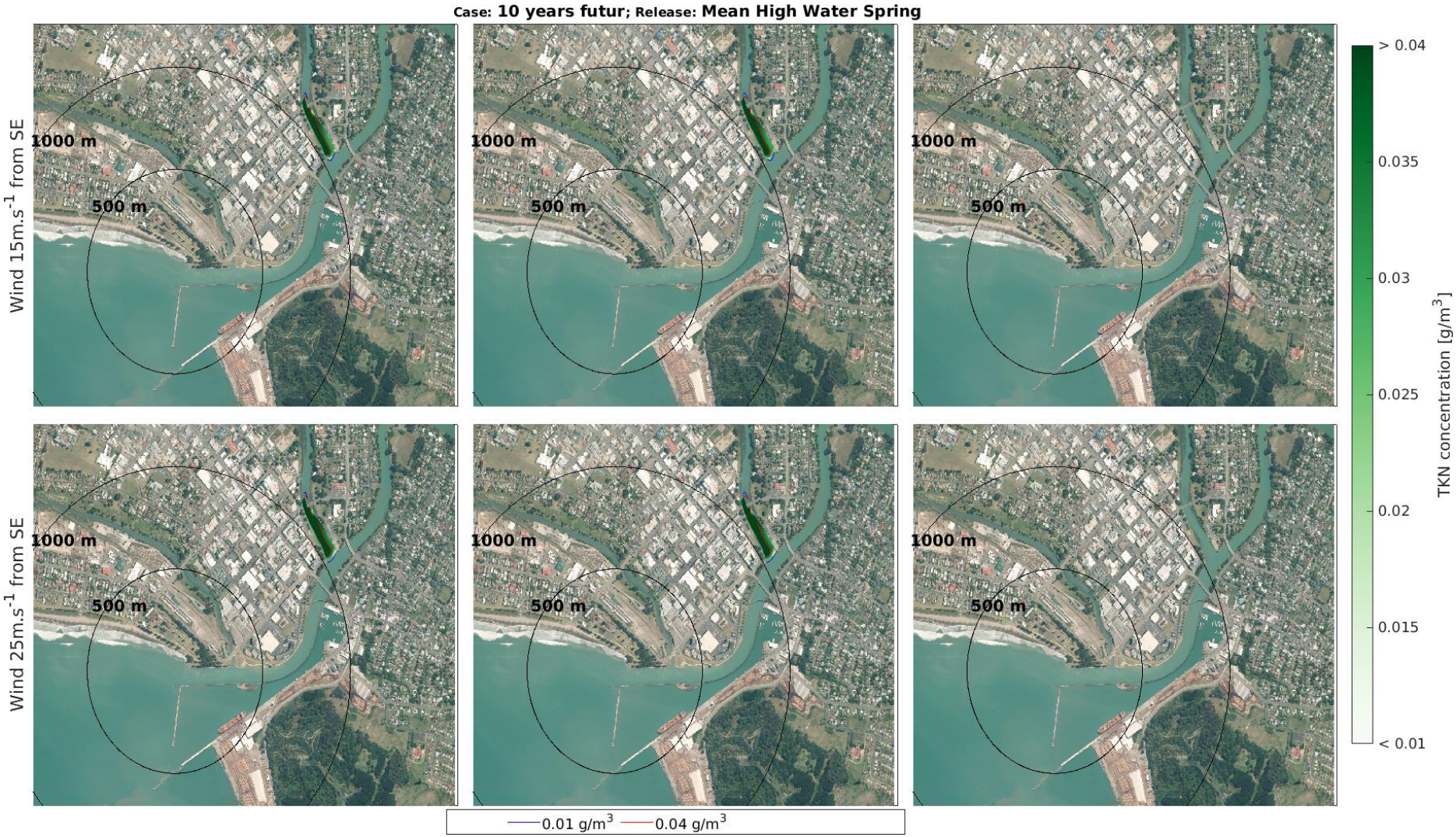


Figure 3.74 Close-up view of the 10 year future scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s^{-1} (bottom) South-Easterly wind.

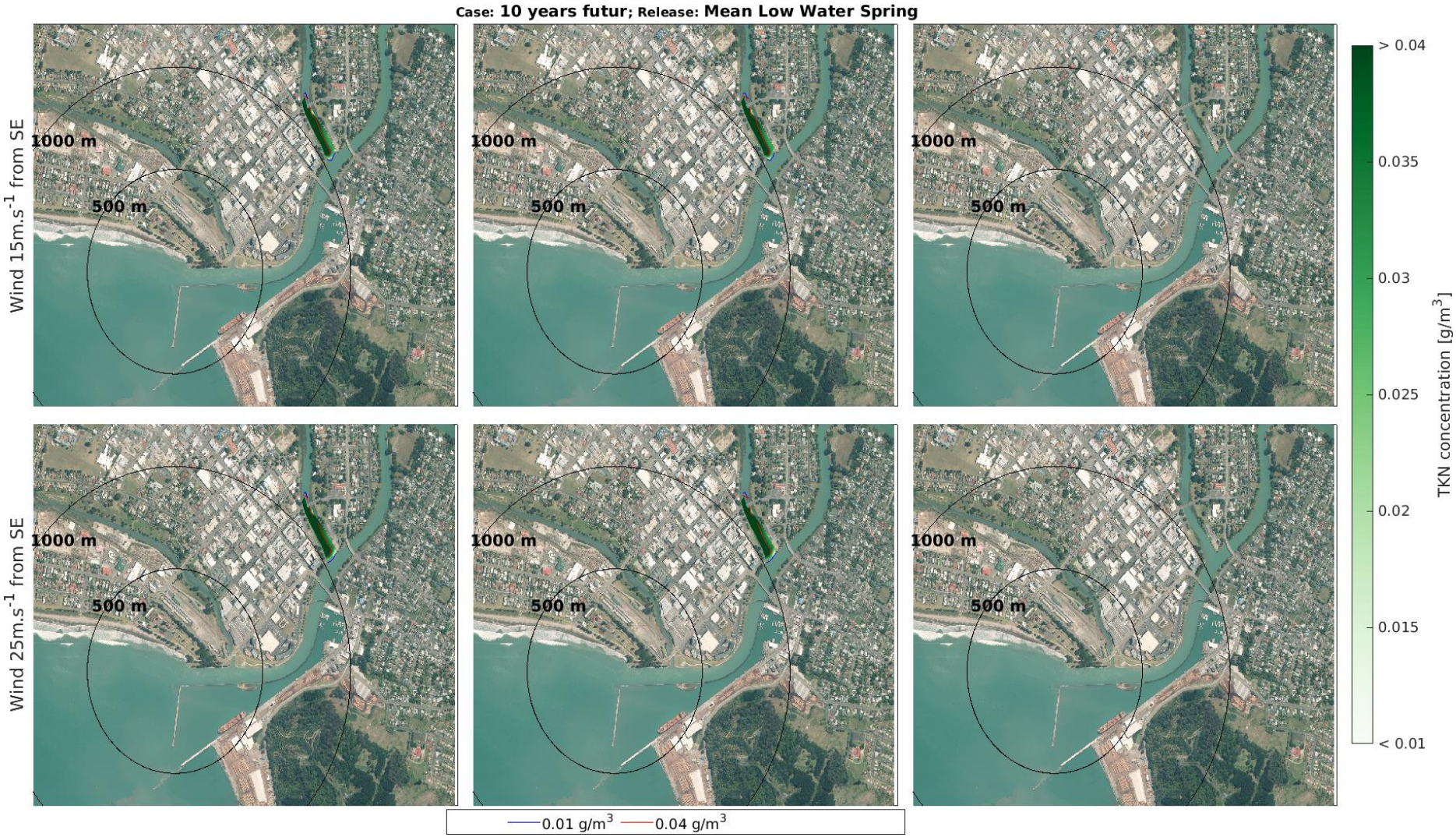


Figure 3.75 Close-up view of the 10 year future scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MLWS release with 15 (top) and 25 m.s^{-1} (bottom) South-Easterly wind.

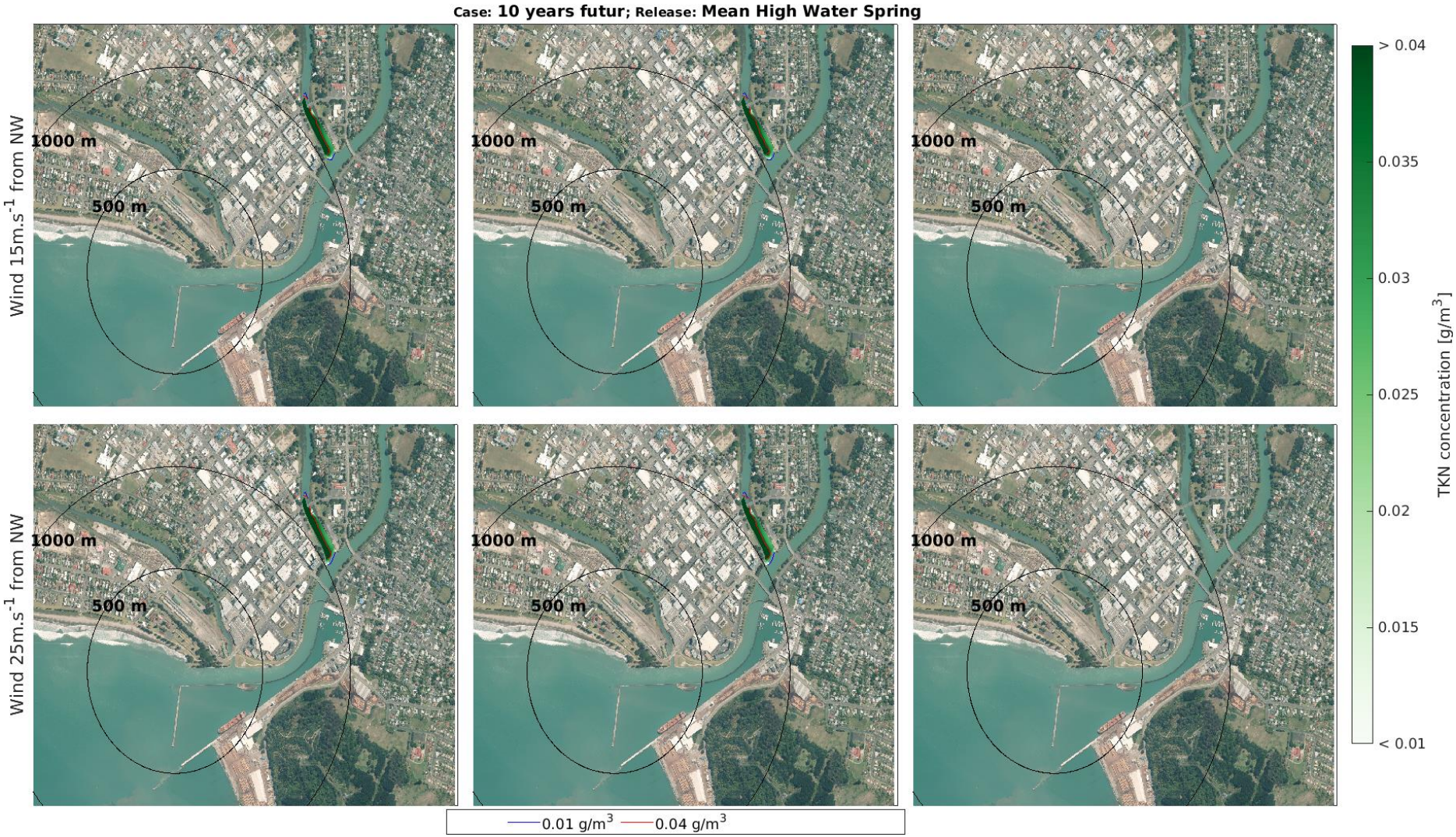


Figure 3.76 Close-up view of the 10 year future scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MHWS release with 15 (top) and 25 m.s^{-1} (bottom) North-Westerly wind.

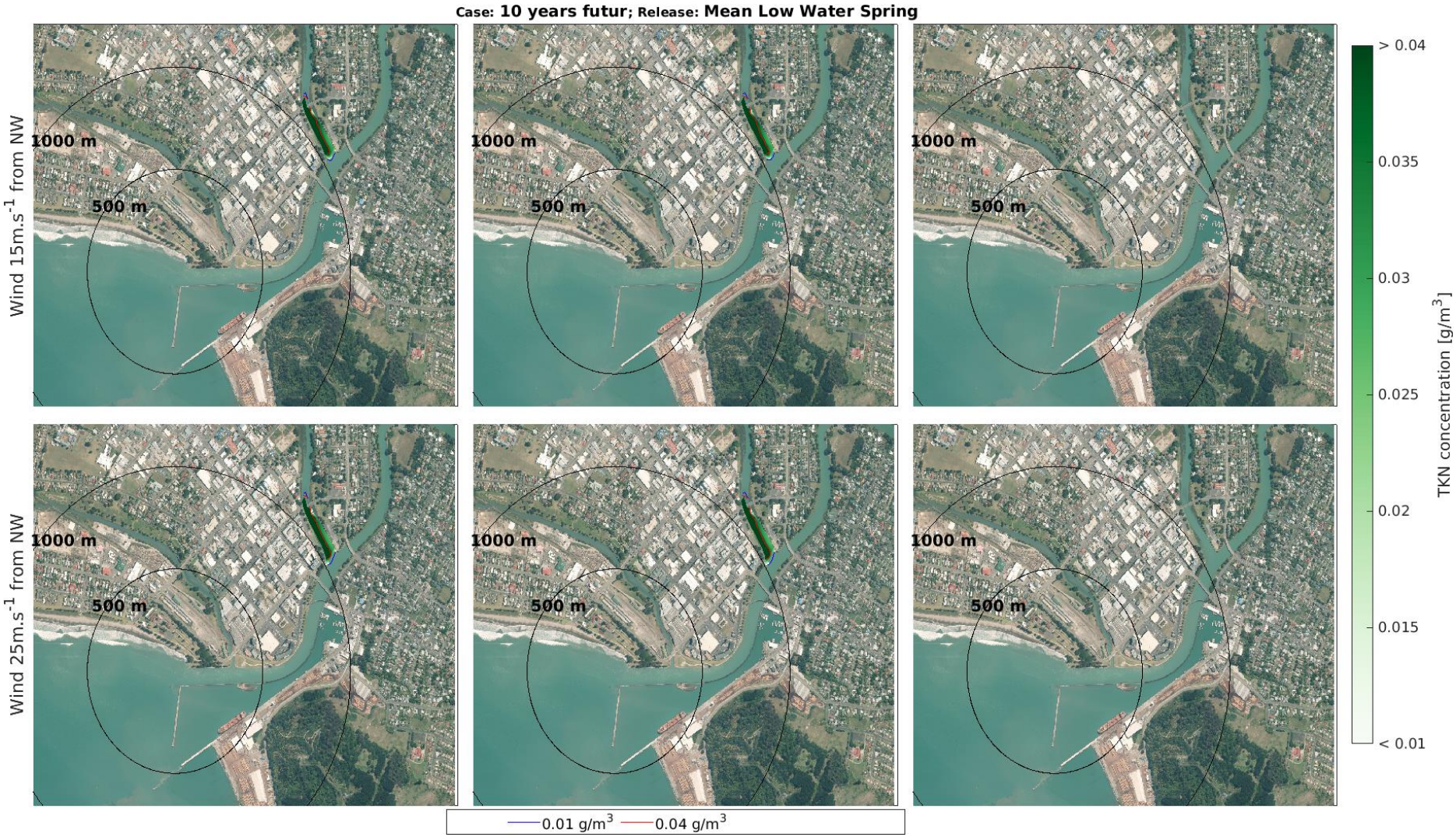


Figure 3.77 Close-up view of the 10 year future scenario of maximum TKN concentration field, after 6 (left), 24 (middle) and 48 (right) hours, from a MLWS release with 15 (top) and 25 m.s^{-1} (bottom) North-Westerly wind.

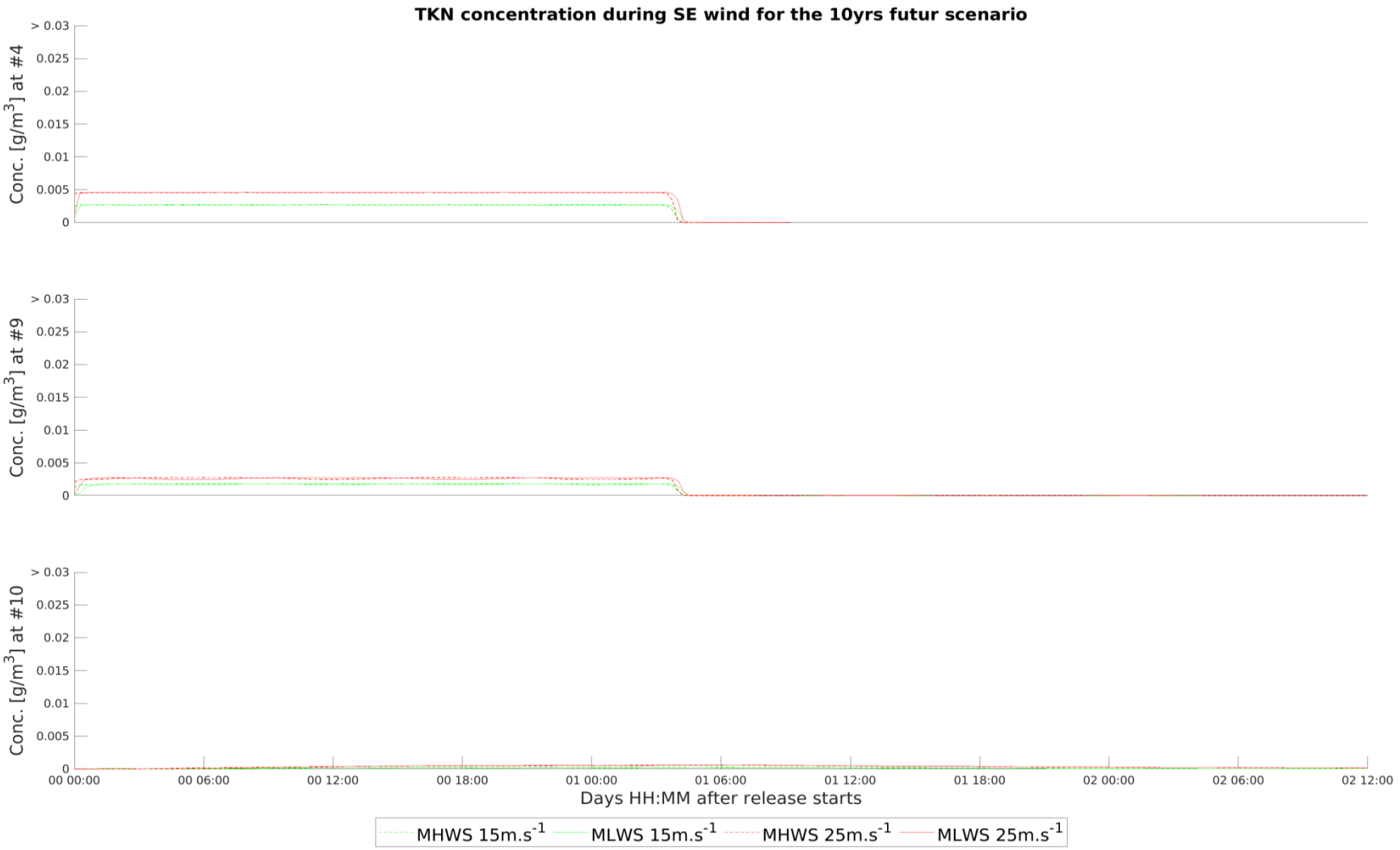


Figure 3.78 *TKN concentration time series in Ent/100mL extracted at the four locations for the 10yrs future scenario under South-Easterlies condition. The solid line and the dot line represented the initial tidal state of the release (MHWS and MLWS respectively). The 15 m.s^{-1} wind speed is shown by the green colour and the 25 m.s^{-1} is represented by the red colour.*

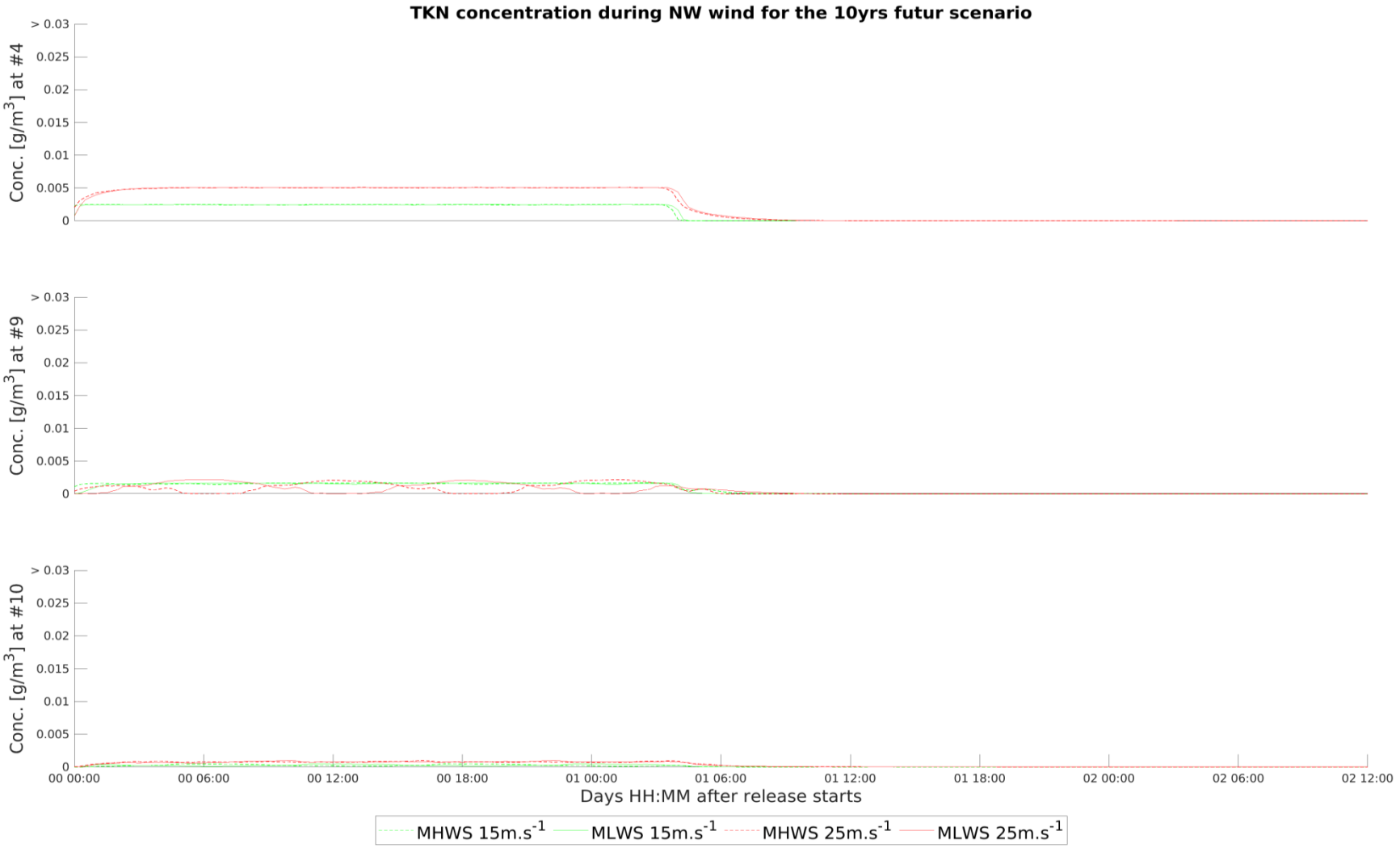


Figure 3.79 *TKN concentration time series in Ent/100mL extracted at the four locations for the 10yrs future scenario under North-Westerlies condition. The solid line and the dot line represented the initial tidal state of the release (MHWS and MLWS respectively). The 15 m.s^{-1} wind speed is shown by the green colour and the 25 m.s^{-1} is represented by the red colour.*

4. Summary

The present study has characterised the spatial distribution of dilution levels associated with wastewater overflow discharges into streams and creeks at four locations within the boundaries of Gisborne City, Poverty Bay, New Zealand (see Figure 1.1).

In order to quantify the hydrodynamics of Poverty Bay, a high-resolution finite-element mode of the environs was established, including salient fluvial inputs at appropriate ARI levels. The dispersion modelling approach consisted of simulating realistic scour discharge rates for both 2 and 10-year ARI events assuming the existing private and public wastewater and stormwater network, and at the 10-year ARI level assuming upgraded wastewater and stormwater networks. To account for the potential impact of tidal stages on the discharge characteristics simulations were modelled beginning at both MHWS and MLWS tidal stages.

For both the exiting 2 and 10-year ARI events, under persistent and relatively strong S-E wind events the plume of contaminated water is held against the shoreline along Waikanea Beach and towards the Waipaoa River mouth. The plume is eventually advected out into Poverty Bay and re-enters the southern end of the bay in the vicinity of Young Nicks Head Conversely, under persistent and relatively strong N-W wind events the plume is forces offshore and out into Poverty Bay away from the Turanganui River mouth and propagates southwards towards Tokomaru, Hawea and Te Moana Rocks and along Kaiti Beach. At the 2-year ARI, dilution levels exceed 1:10,000 at T+48 hours after the initial start of the accidental discharge for all events simulated, while only under strong N-W events (where the plume propagates offshore) are 1:10,000 dilution levels exceeded at T+48 hours. During strong onshore S-E wind events dilution levels of <1:10,000 can be expected along Waikanea Beach at T+48 hours.

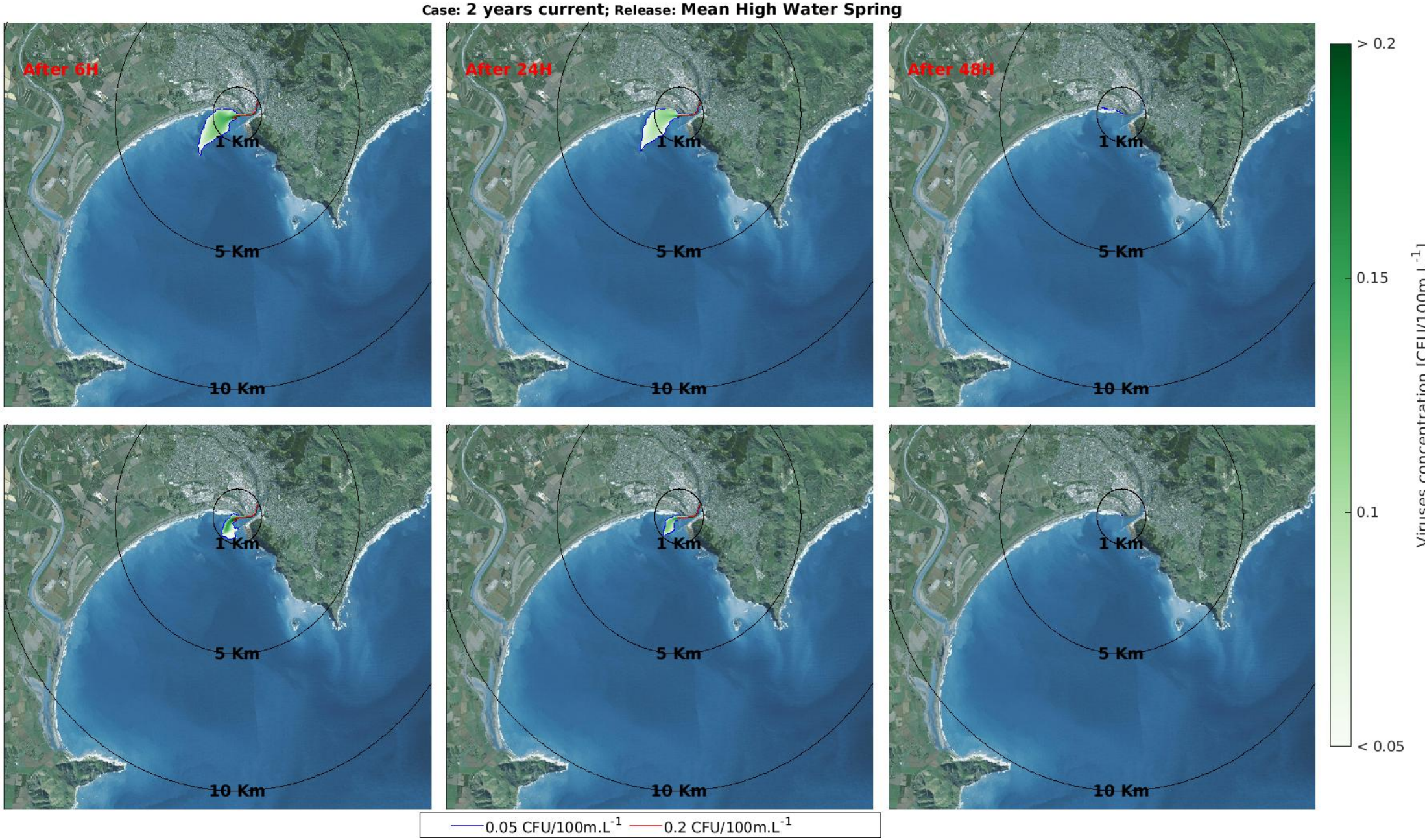
For the improved wastewater/stormwater drainage 10-year ARI events actual discharge volumes are significantly reduced (see Table 2-2), with resulting dilution levels significantly increased (i.e. decreased concentrations) with the plume remaining mostly concentrated near the discharge locations and within the Turanganui River and along Waikanea and Kaiti Beach under S-E and N-W winds respectively.

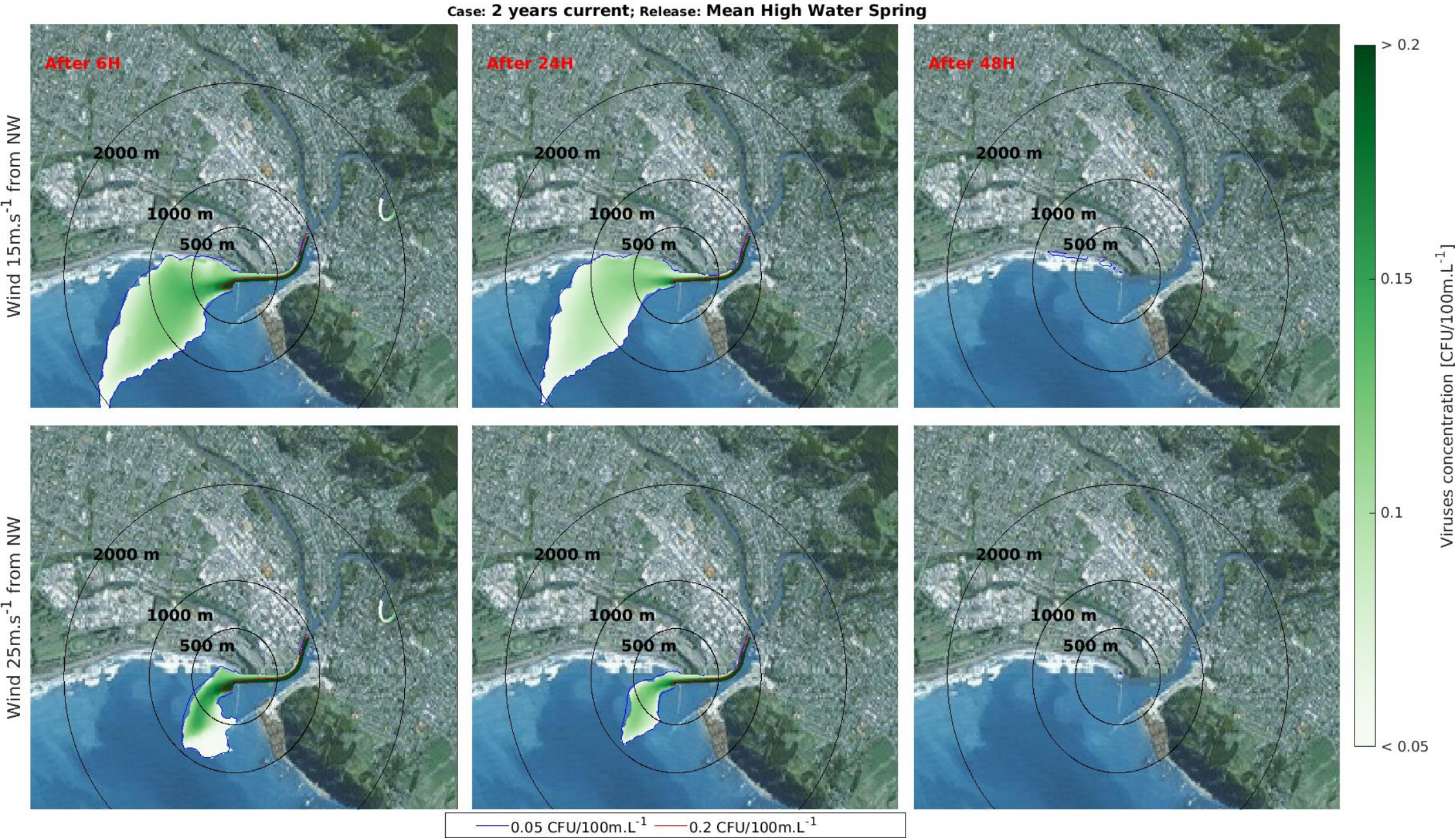
5. References

Zhang, Y. L., and A. M. Baptista. 2008. “A Semi-Implicit Eulerian-Lagrangian Finite Element Model for Cross-Scale Ocean Circulation.” *Ocean Modelling* 21: 71–96.

Appendices

Virus loadings


Case: 2 years current; Release: Mean High Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1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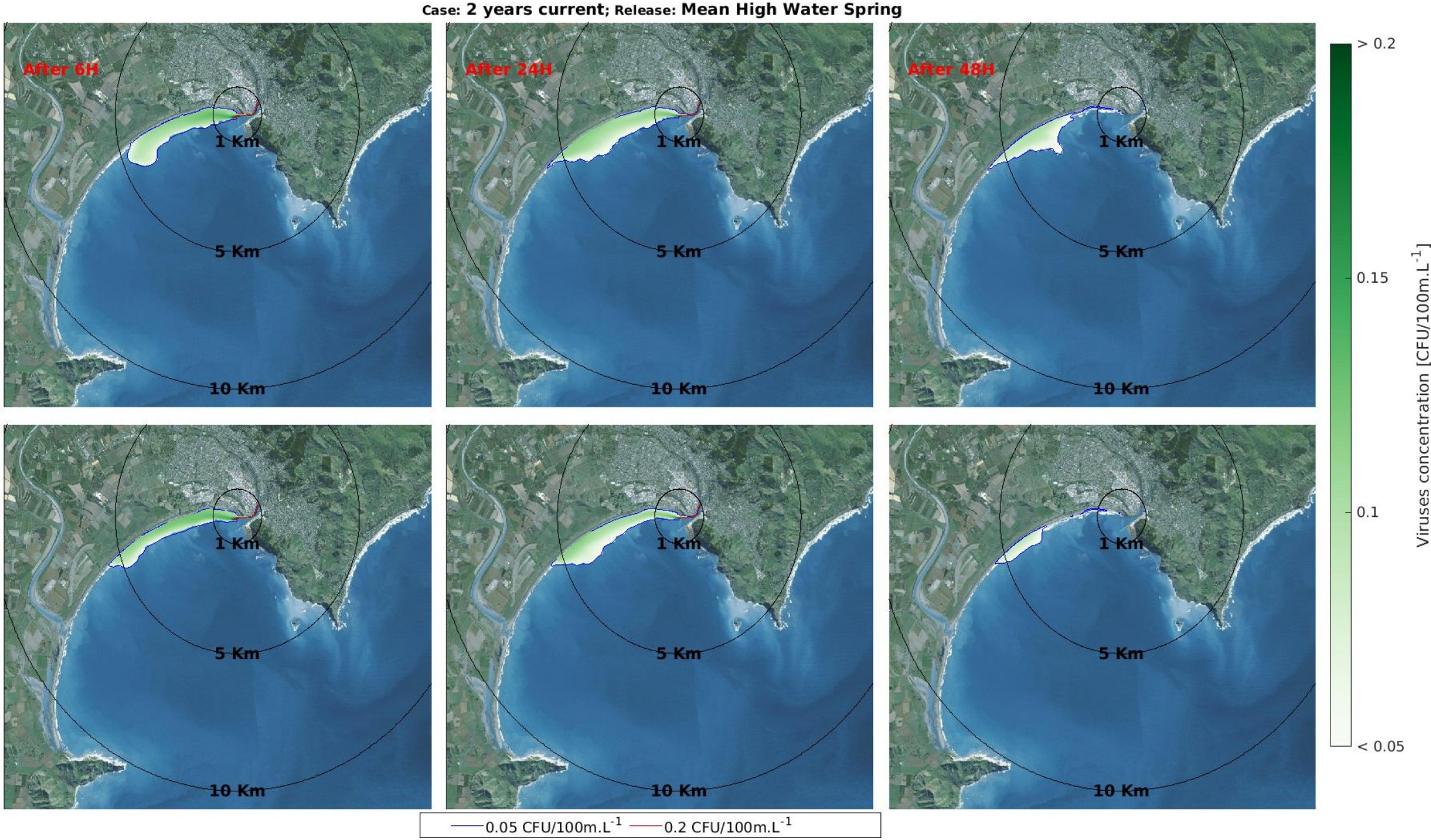
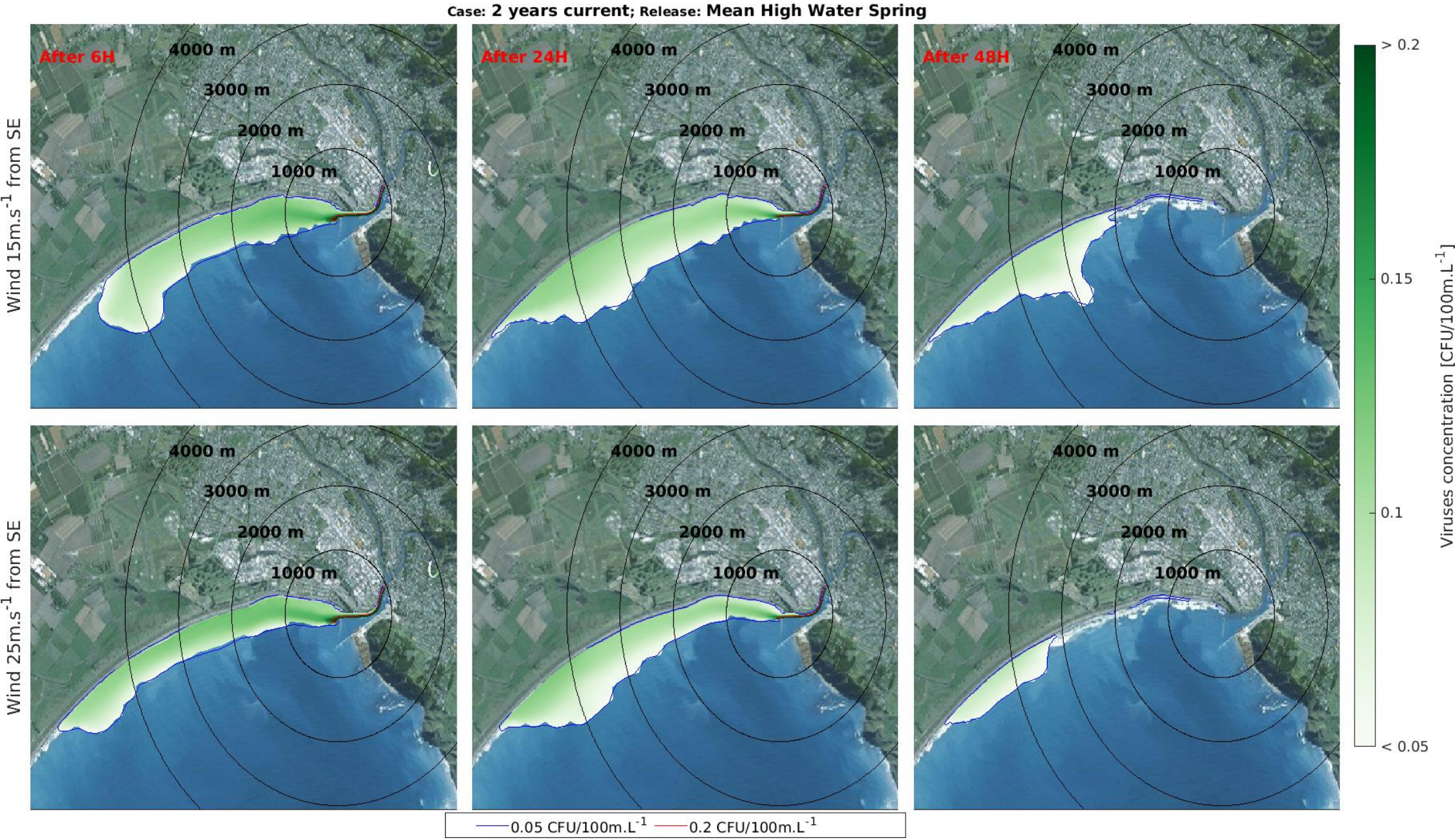
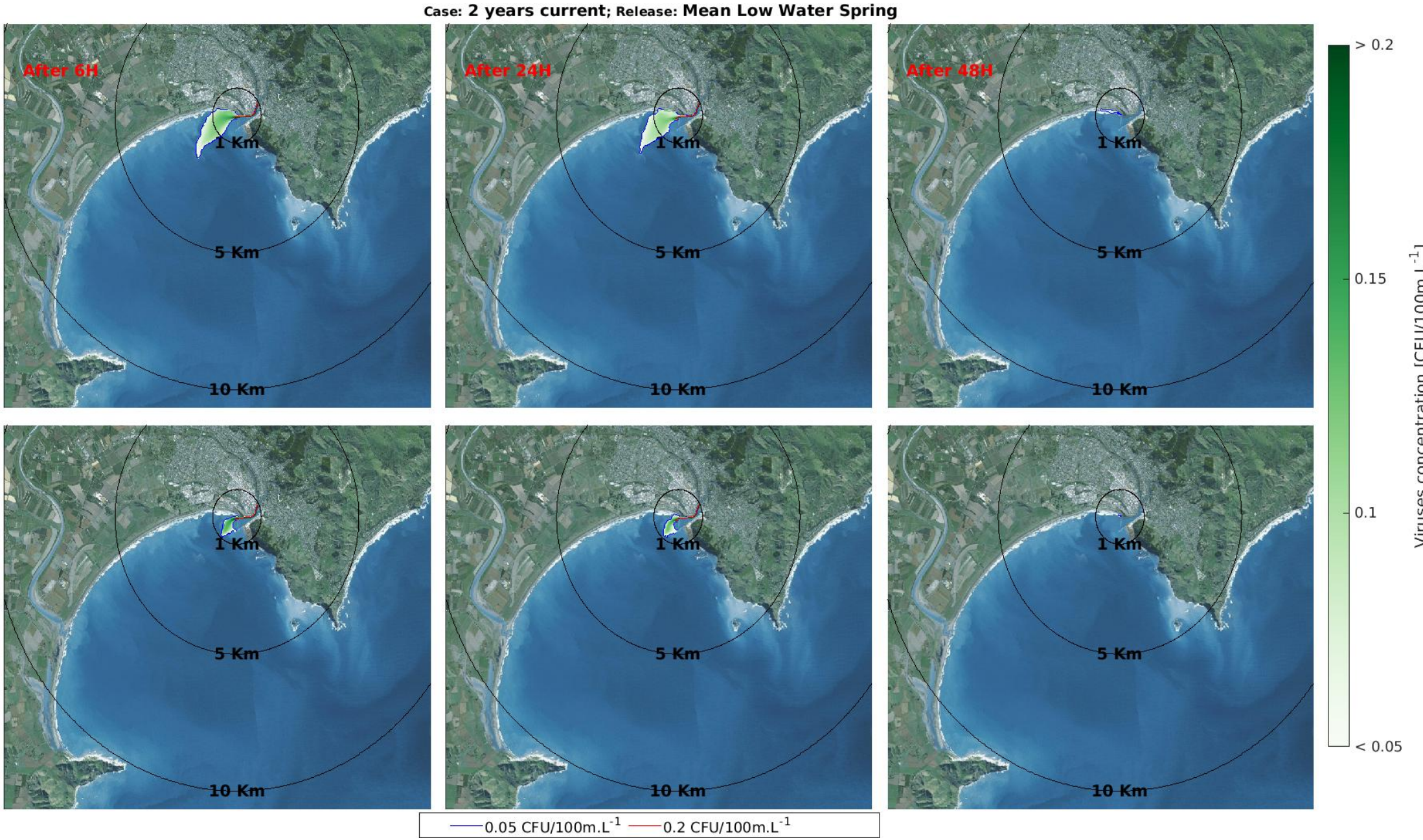
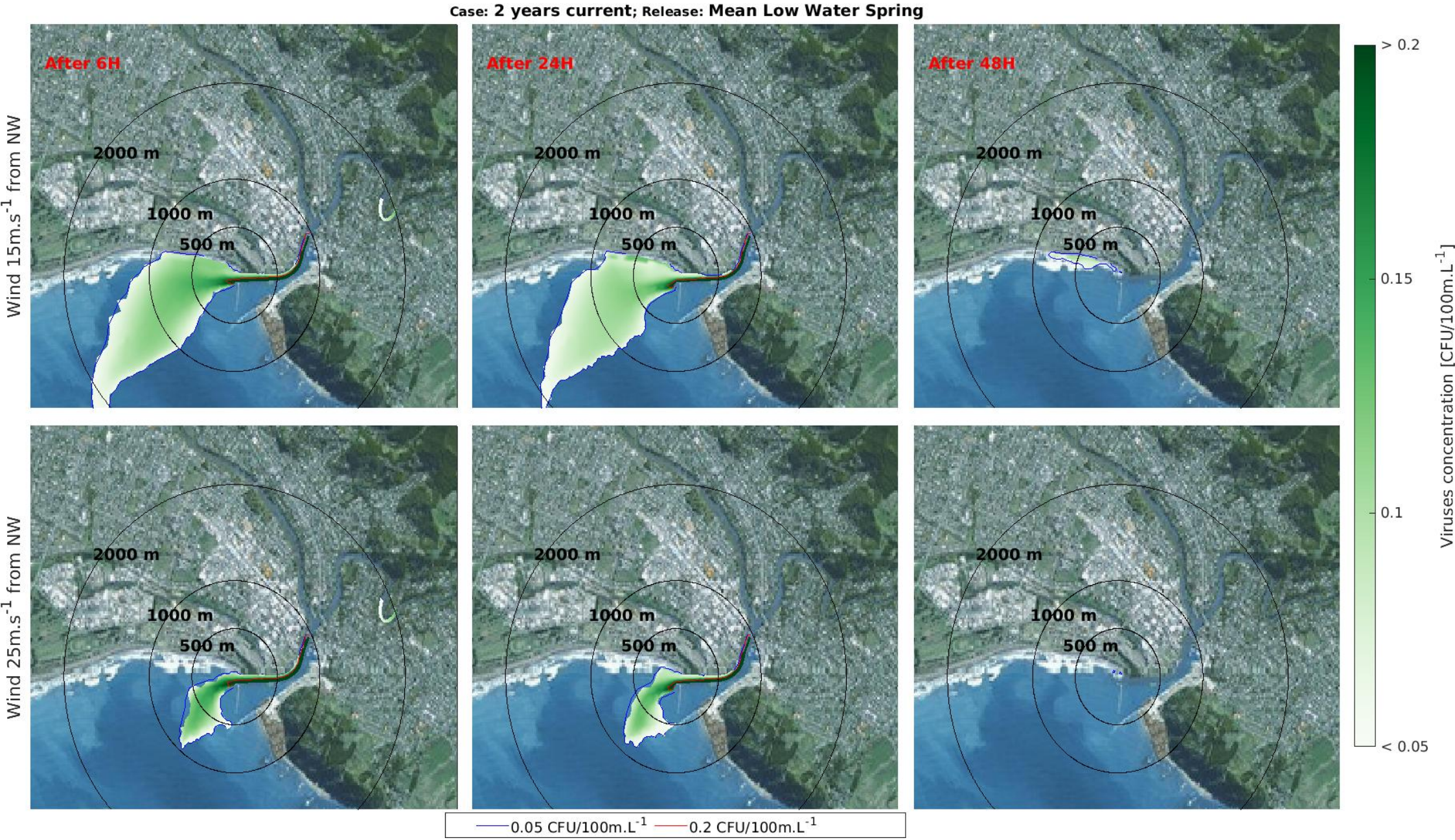
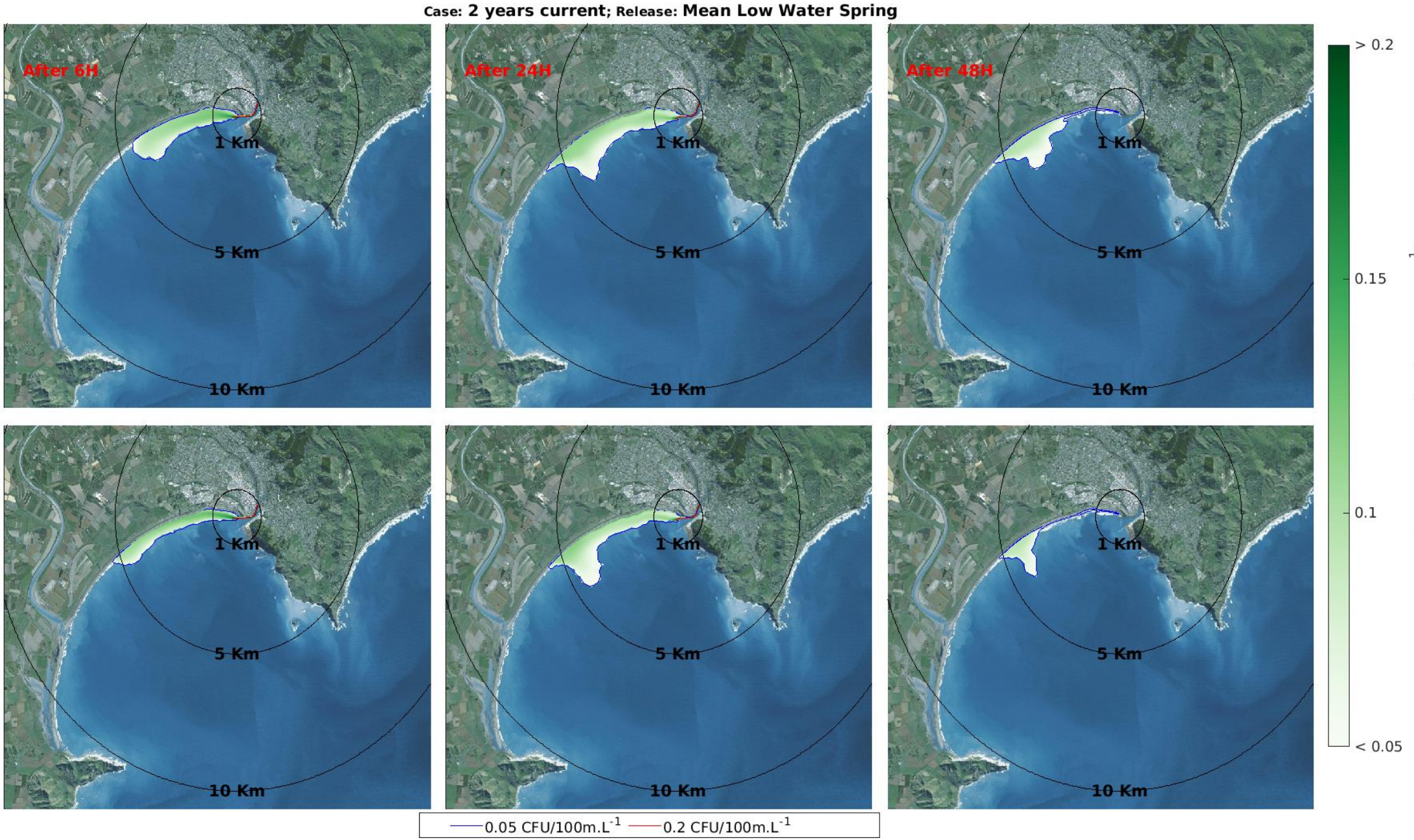
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1

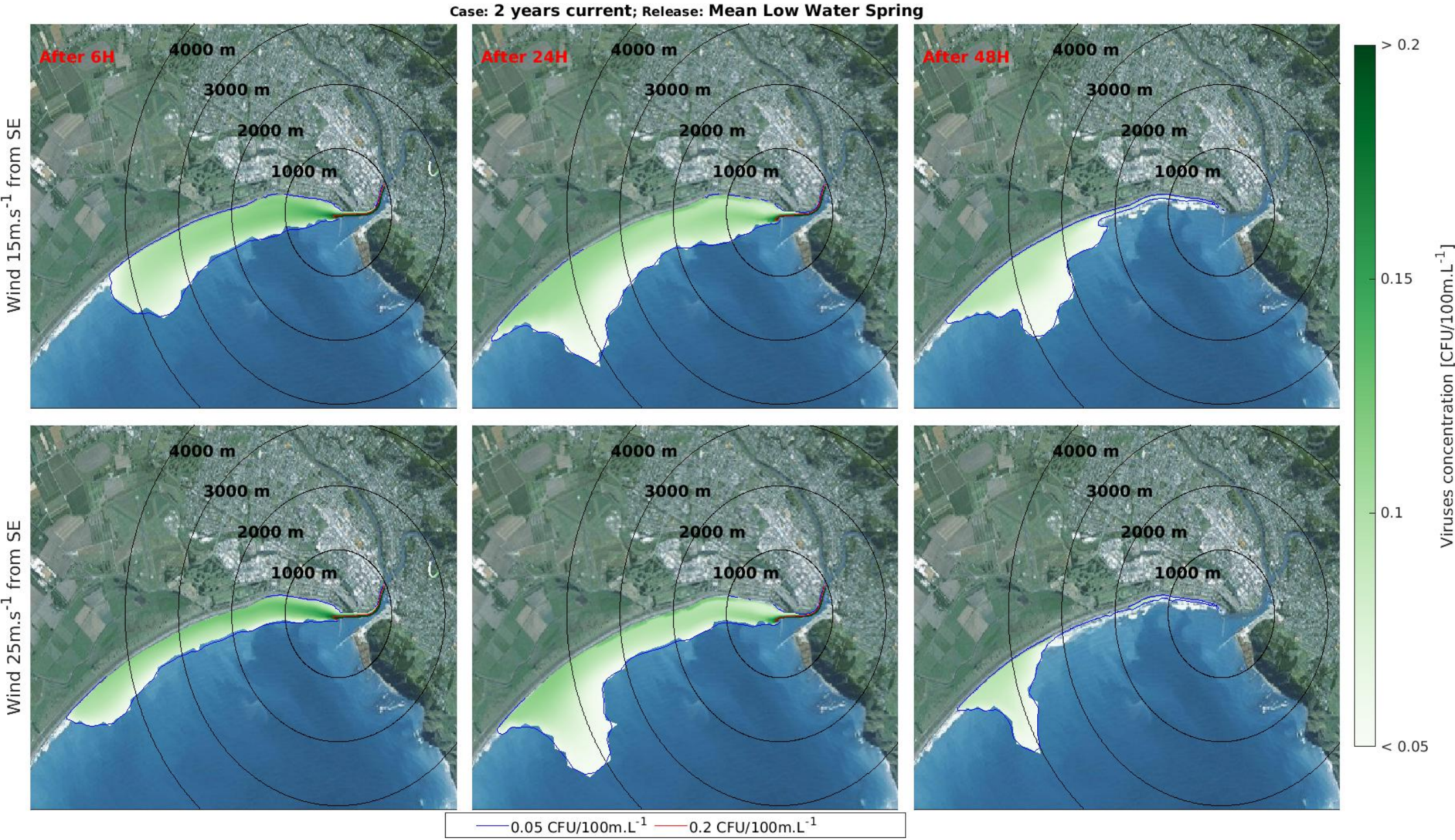

Case: 2 years current; Release: Mean High Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1

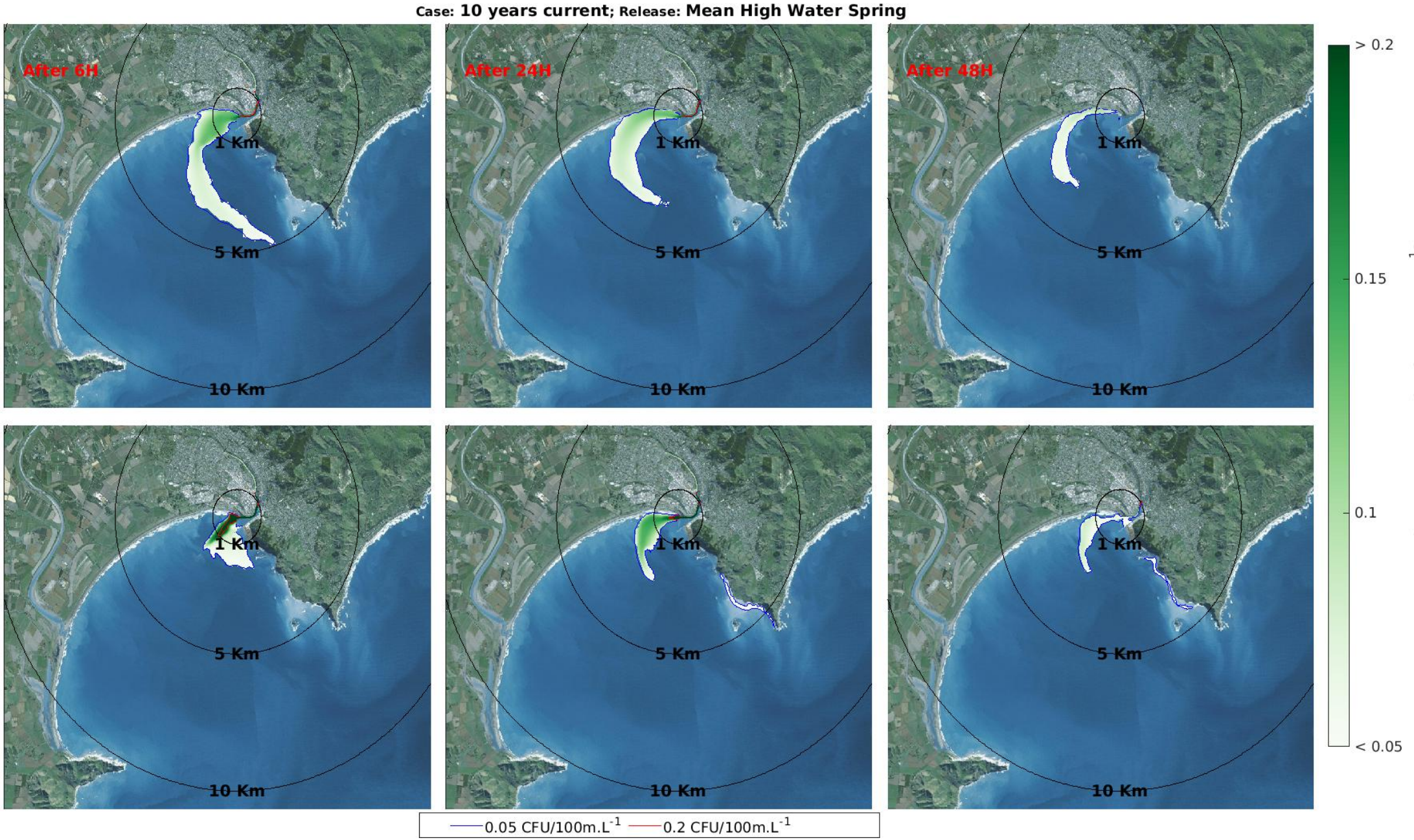

Case: 2 years current; Release: Mean High Water Spring
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 2 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 2 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 2 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 2 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1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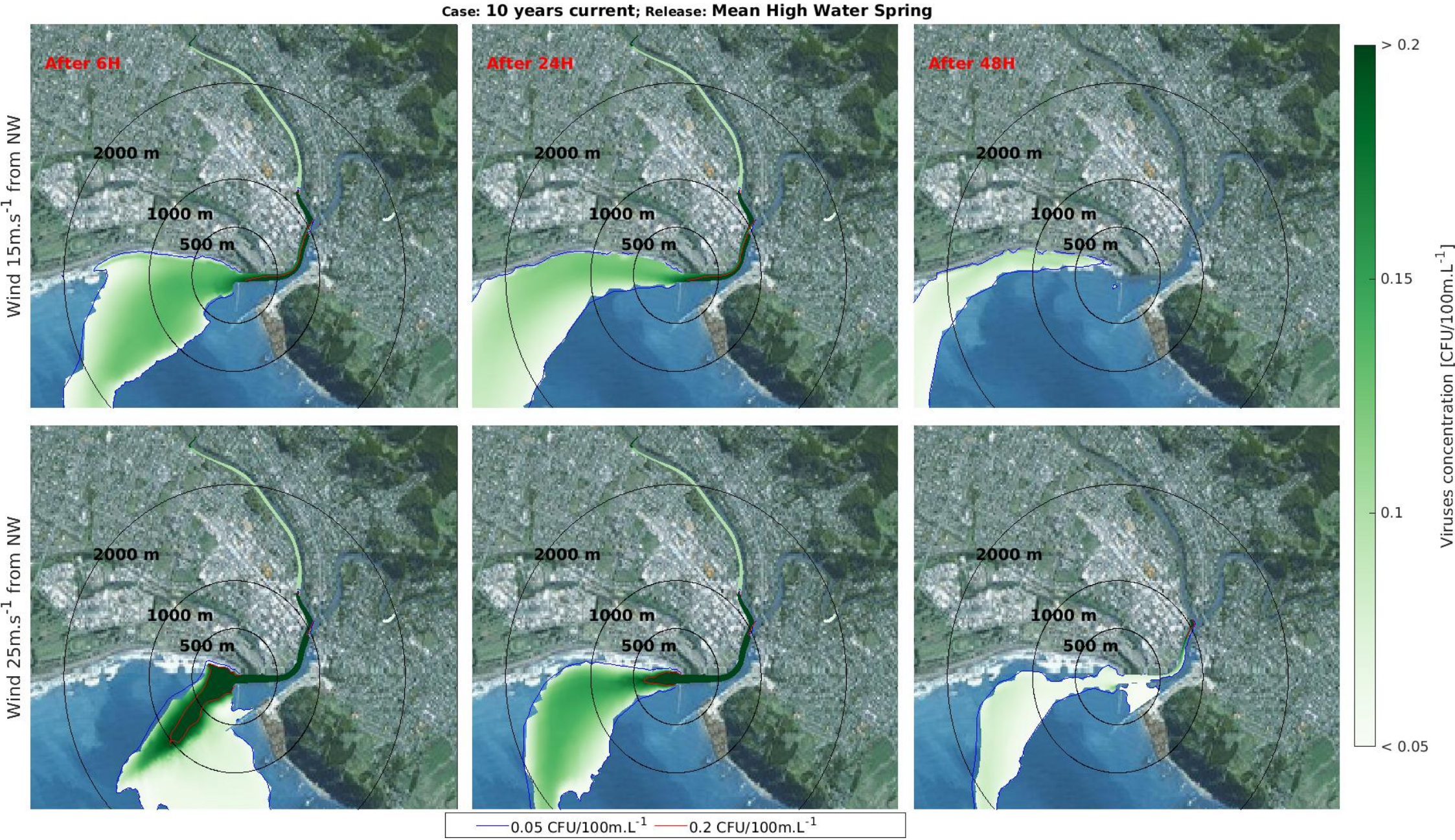
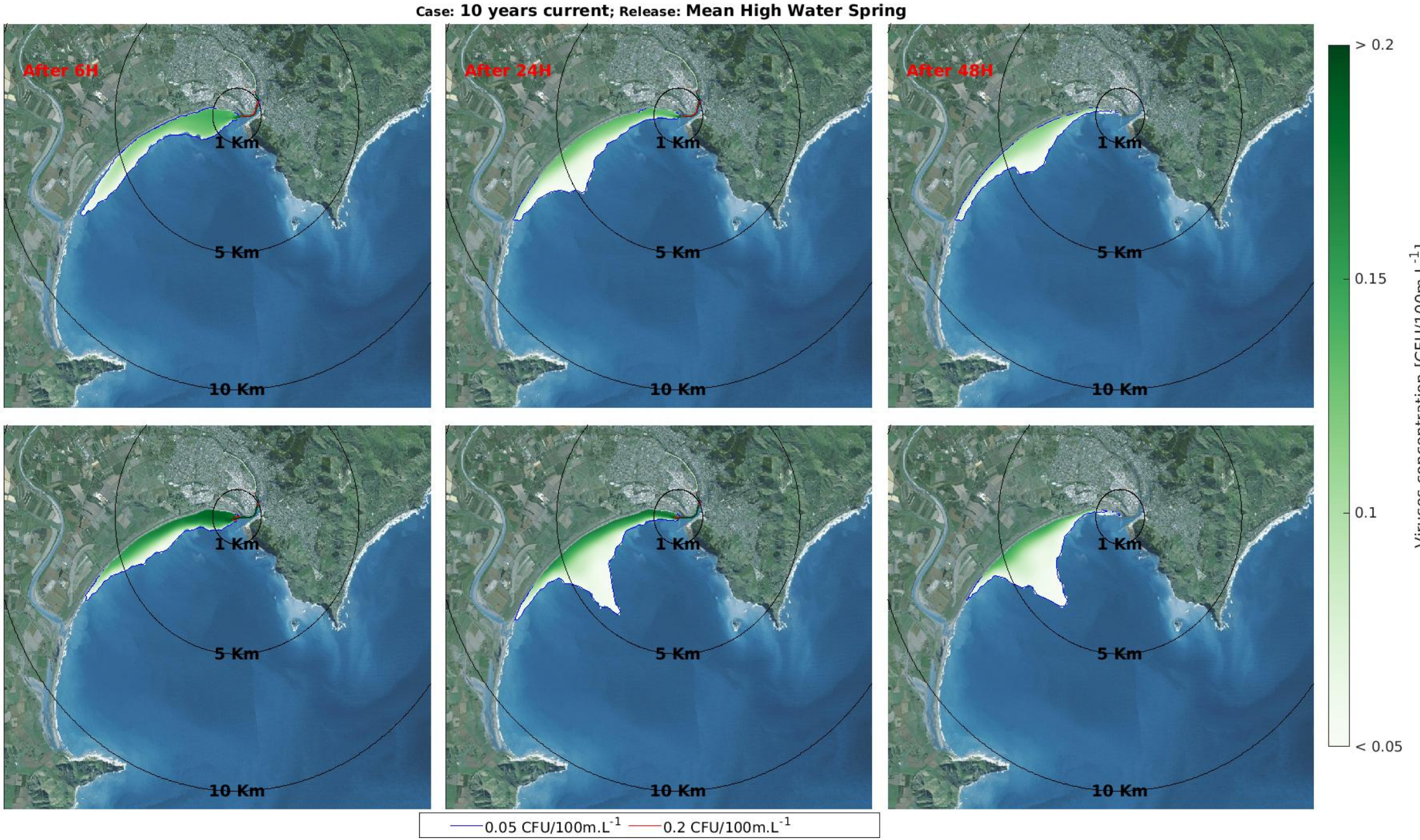
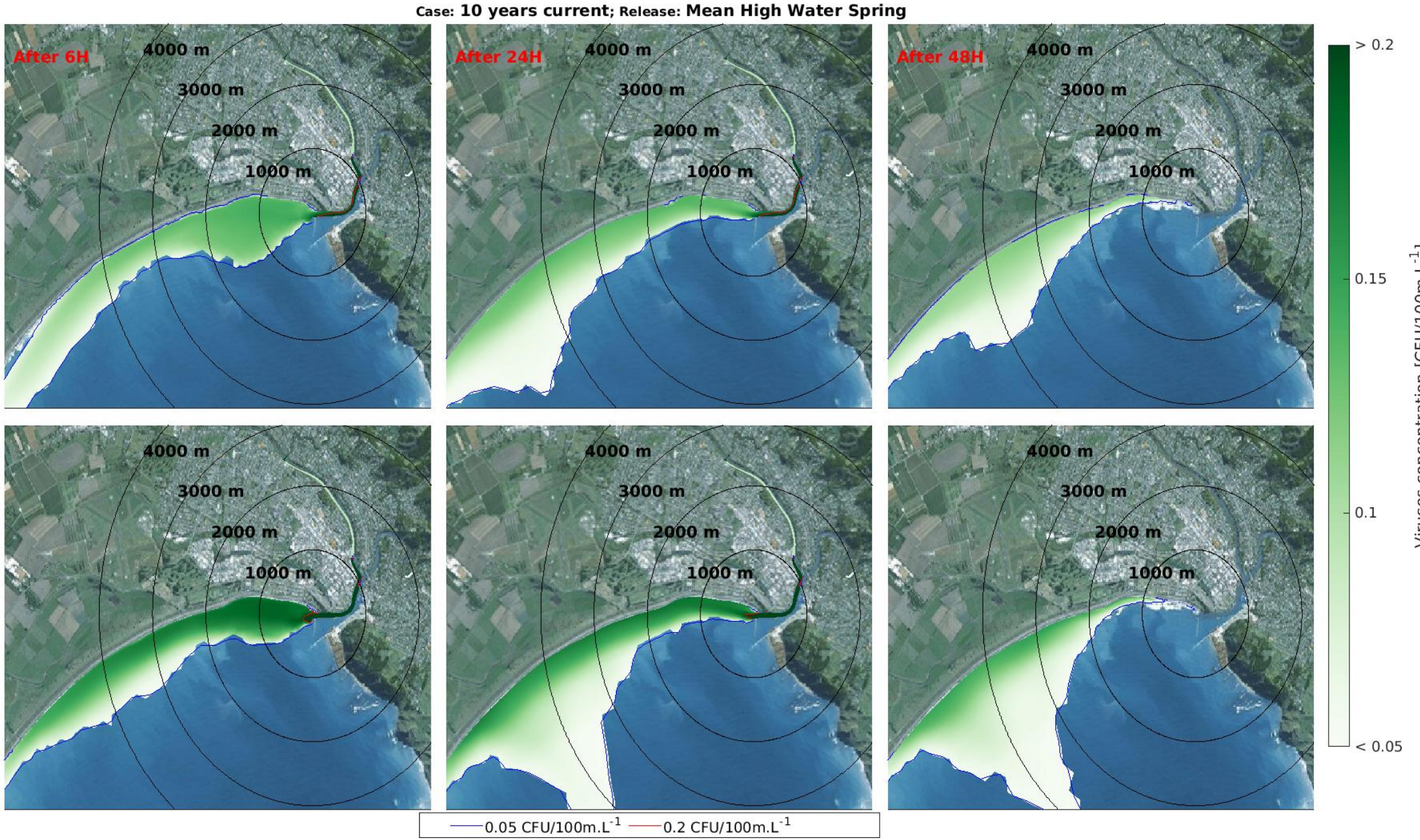
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years current; Release: Mean High Water Spring
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years current; Release: Mean High Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1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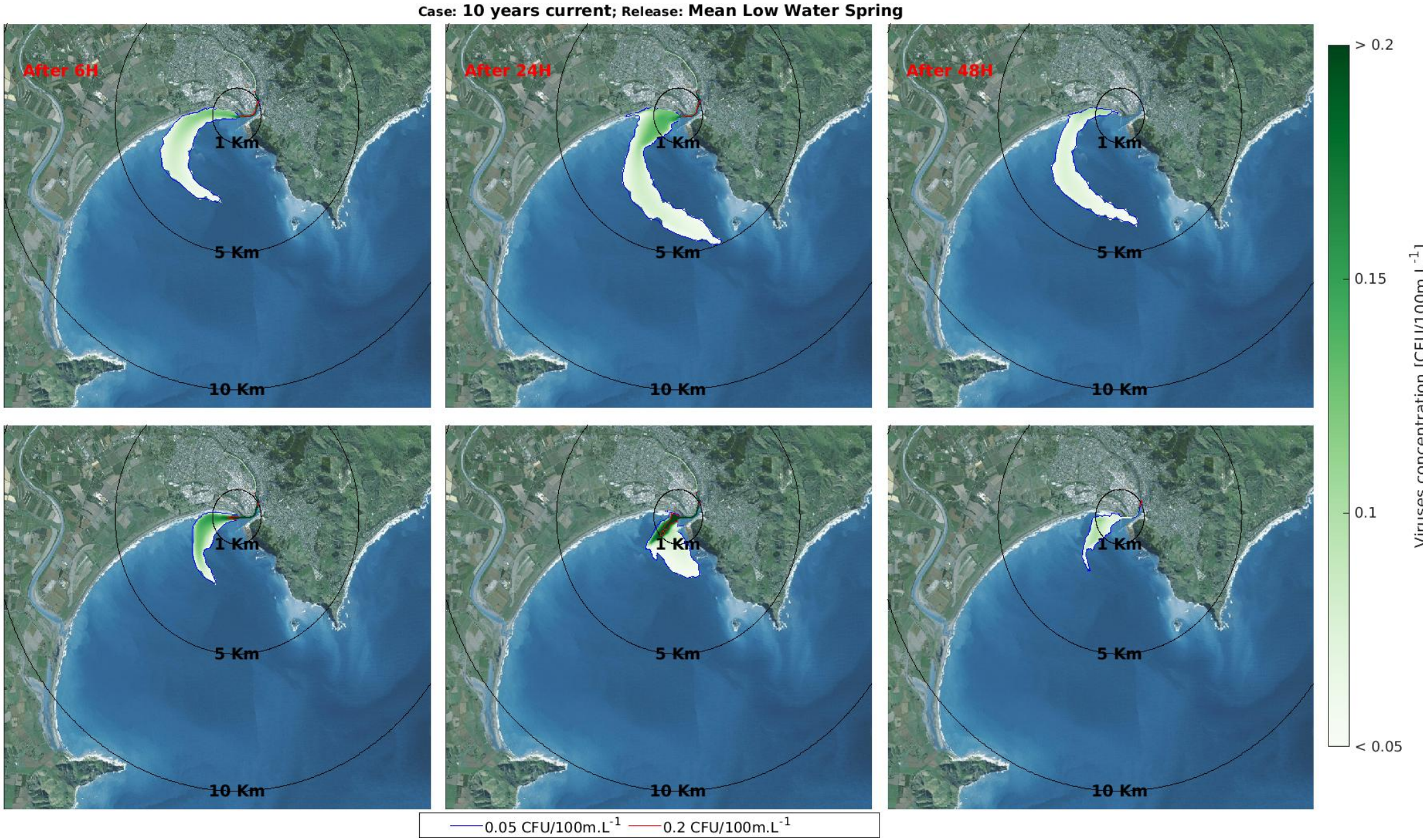
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1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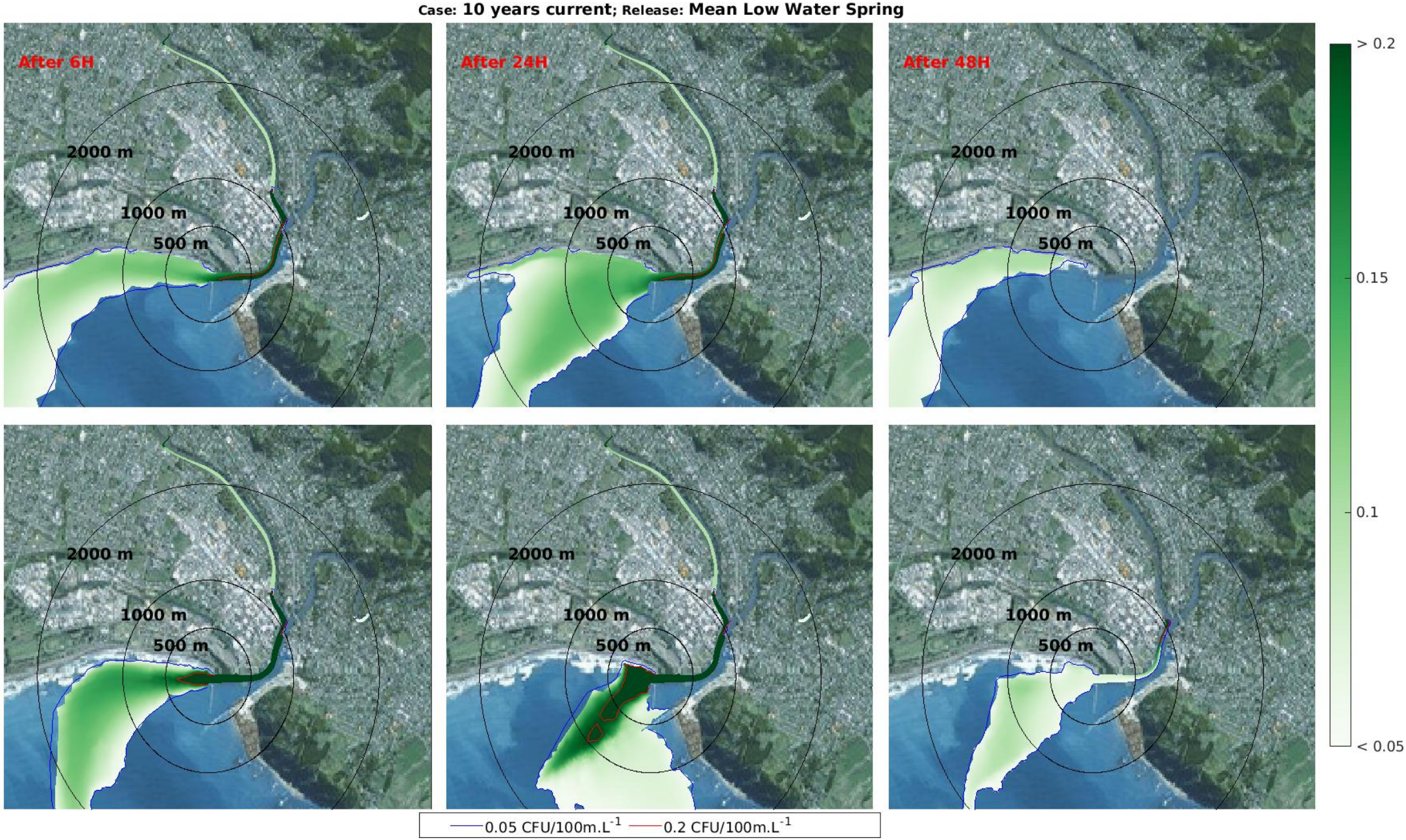
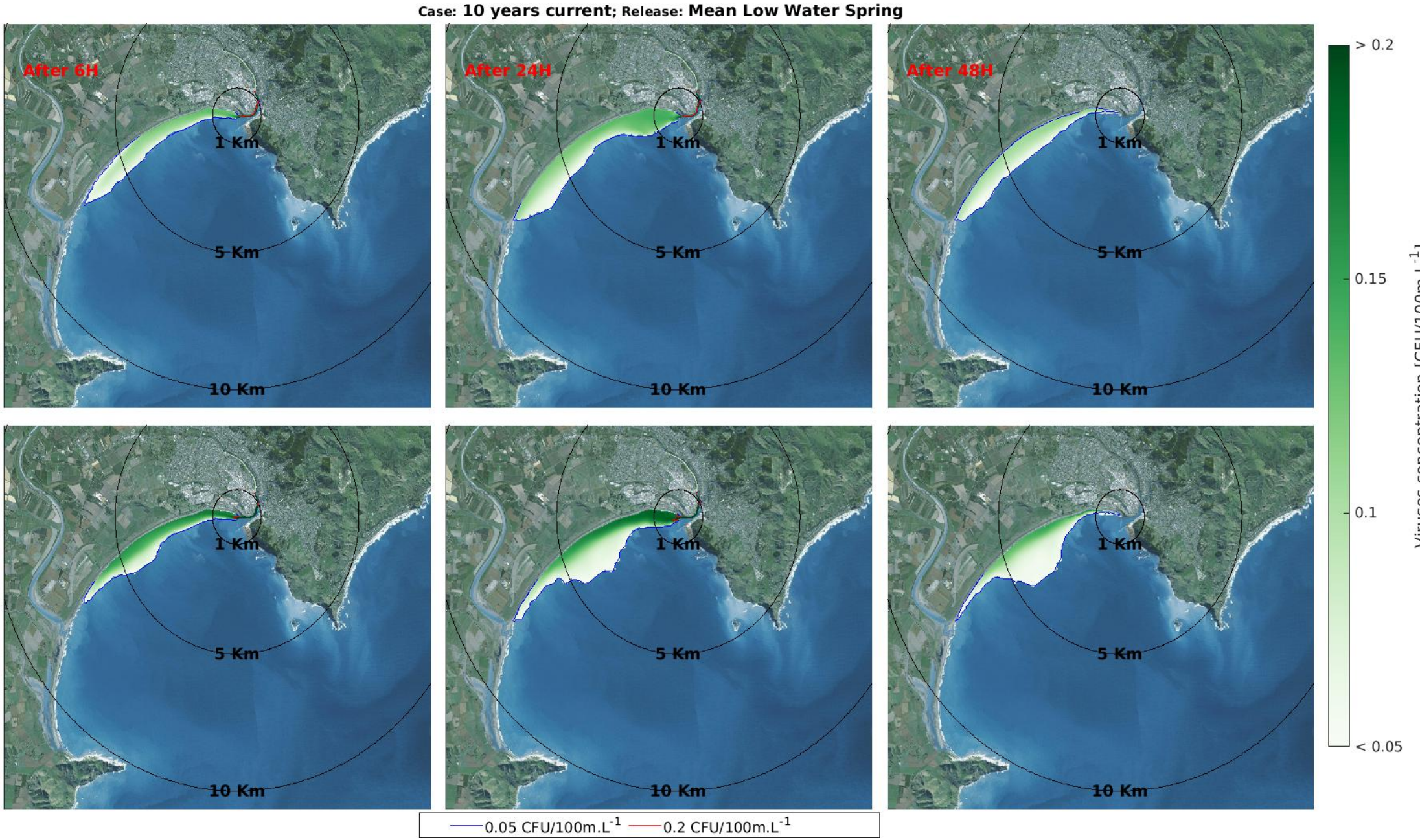
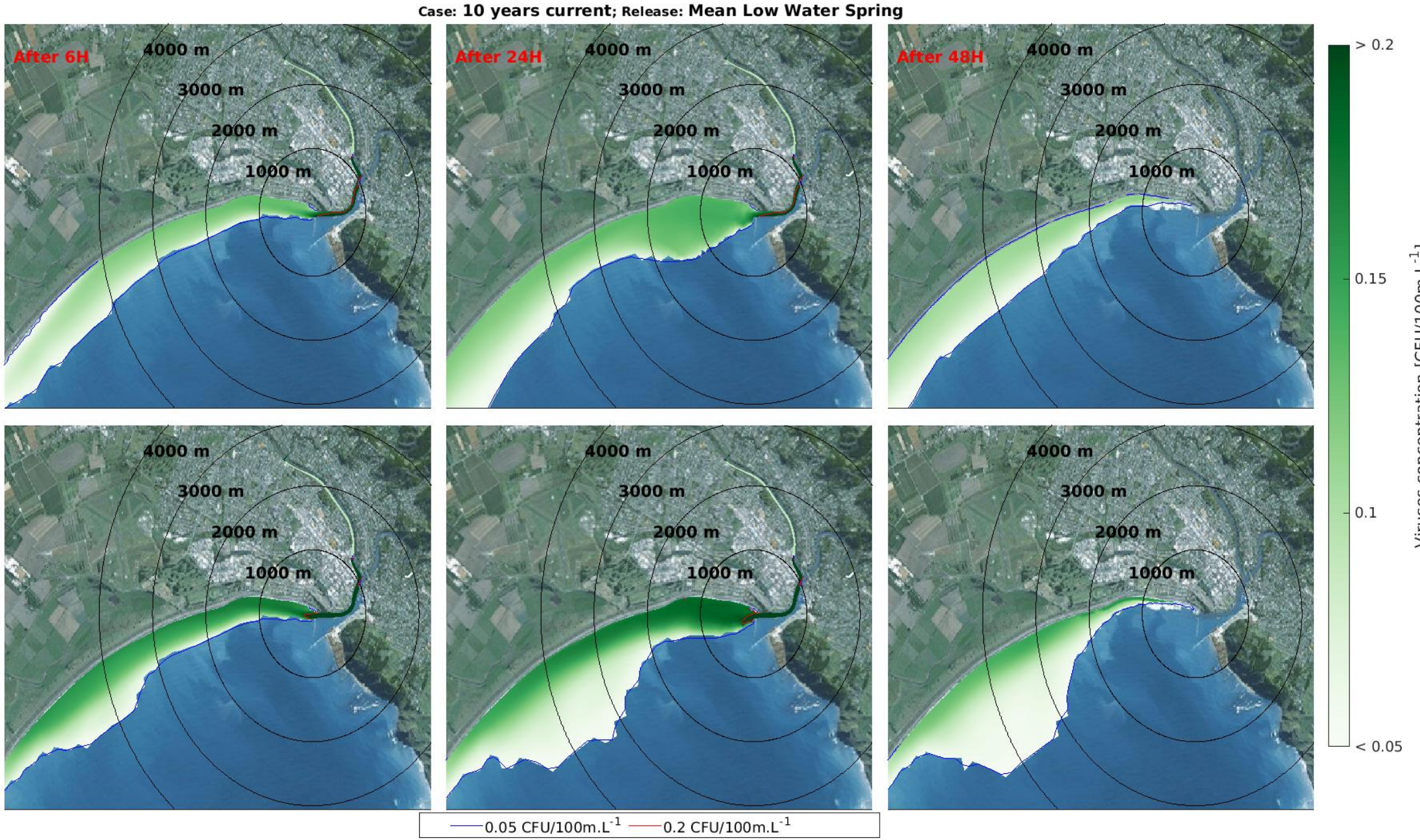
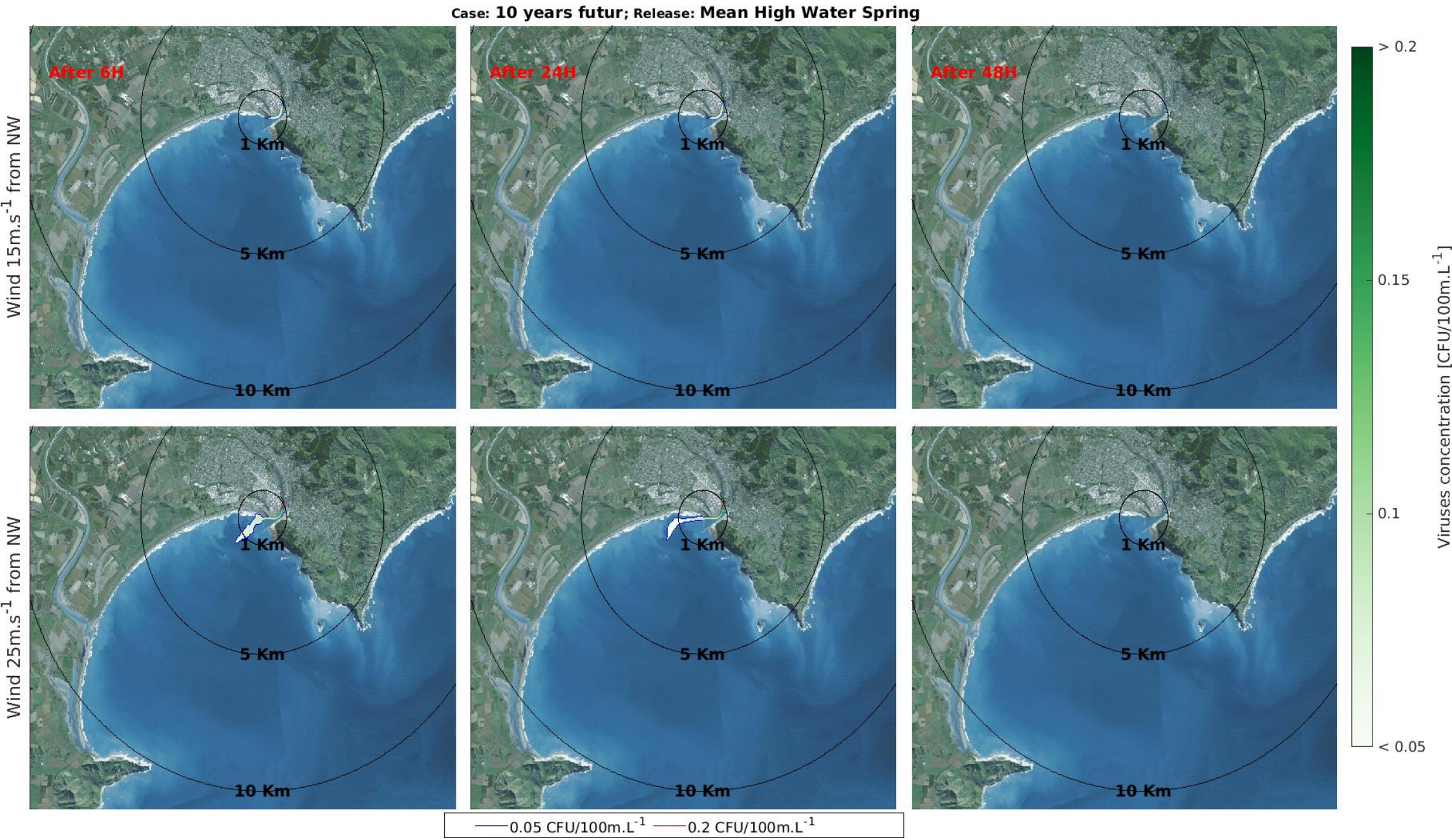
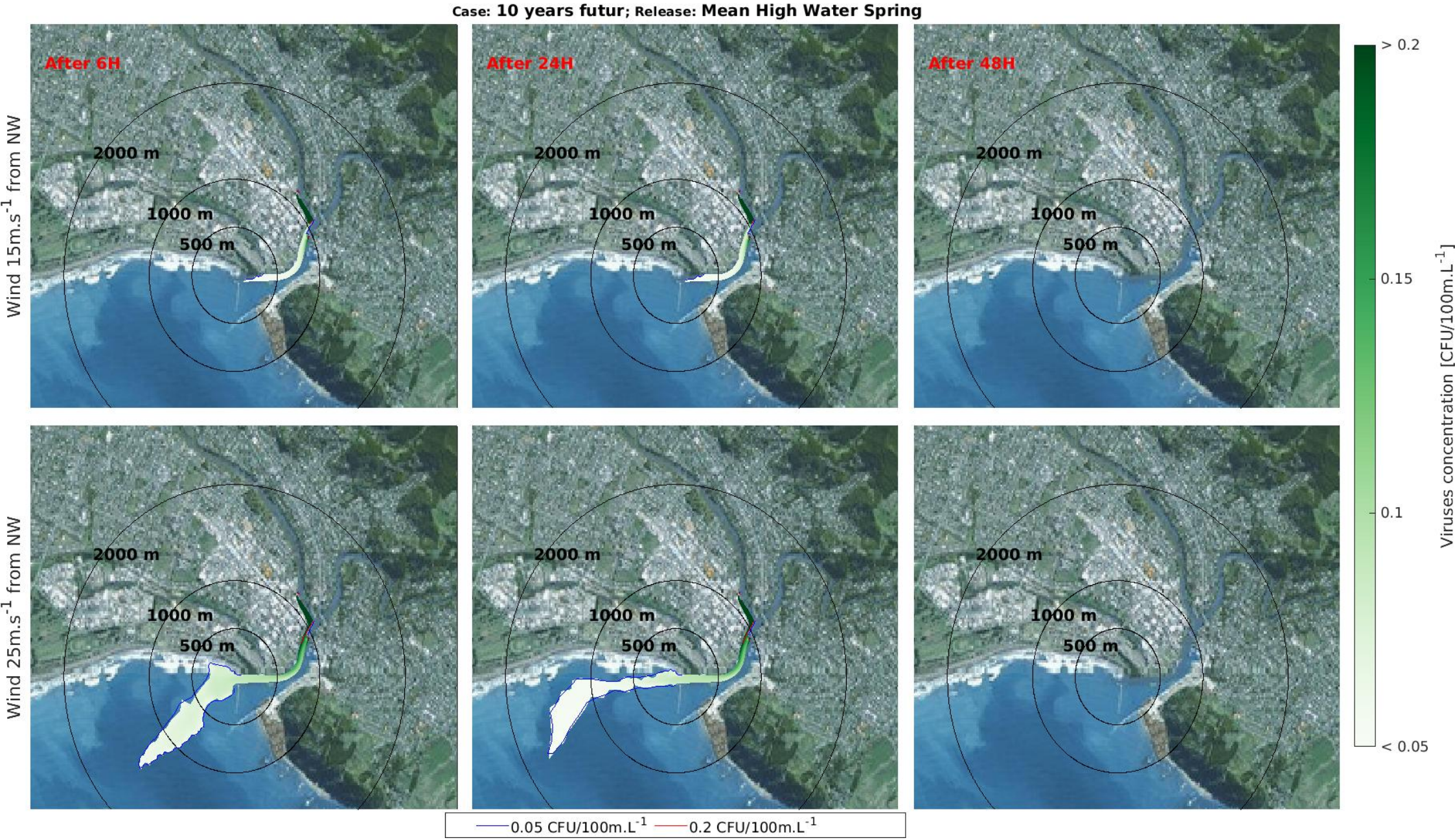
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years current; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean High Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1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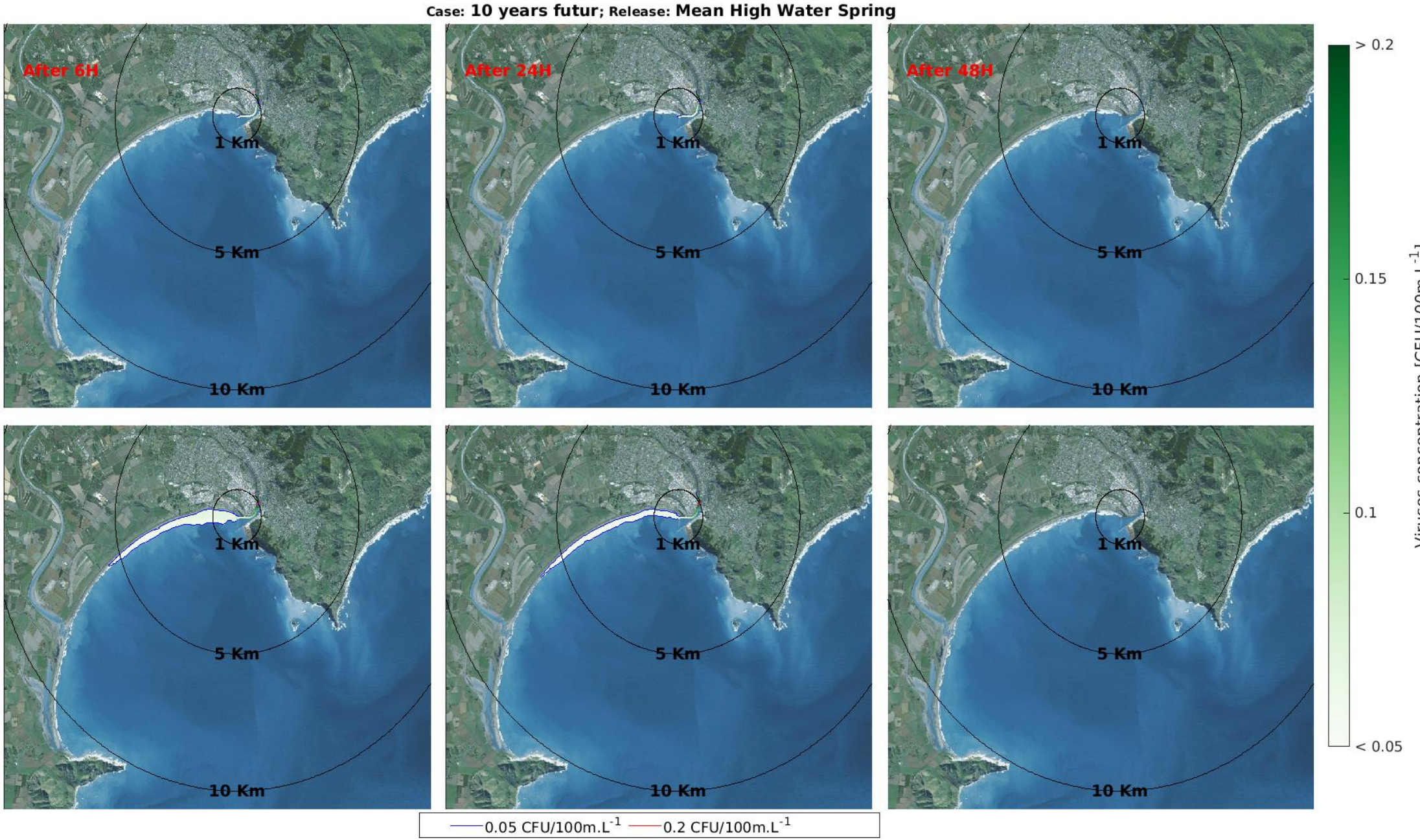
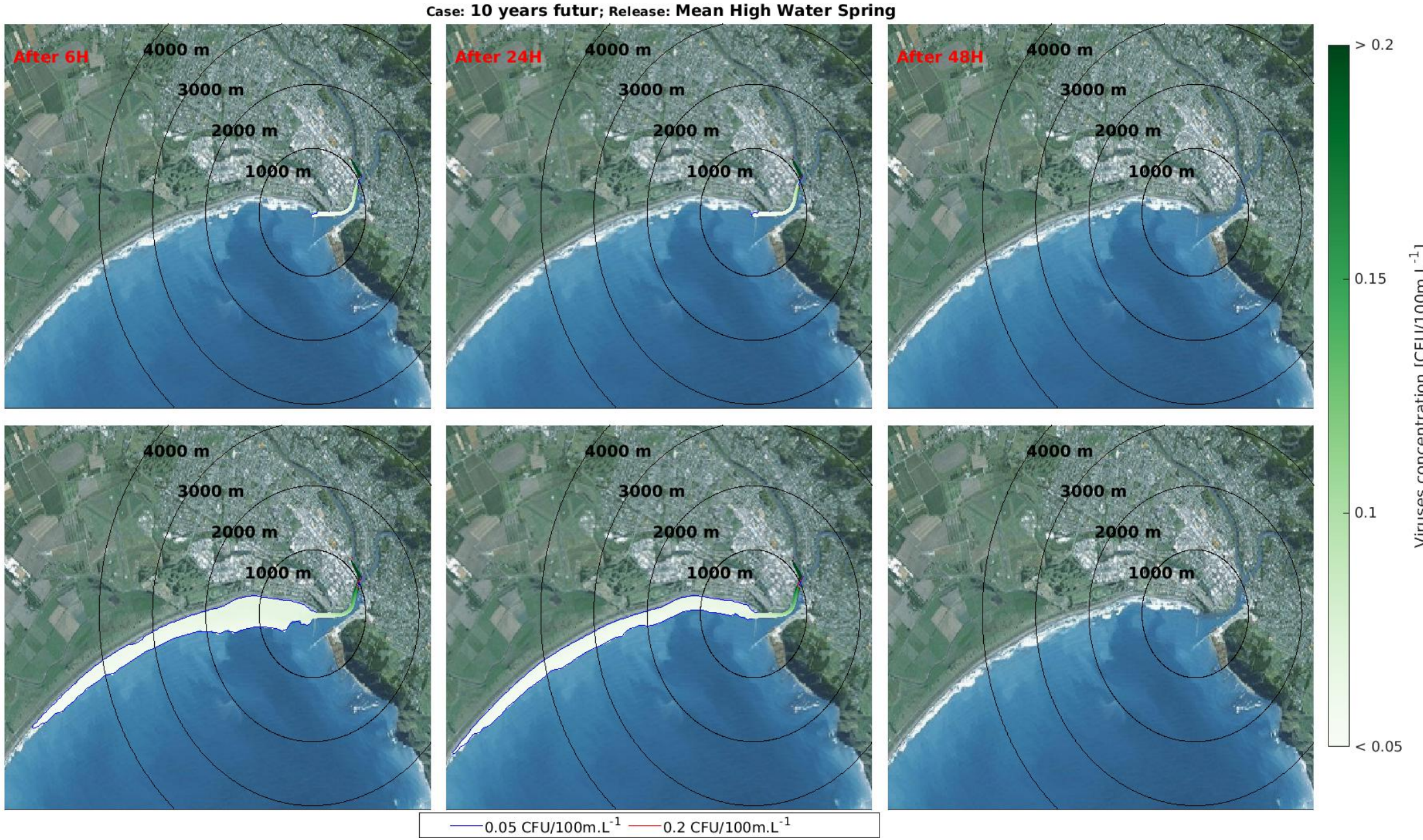
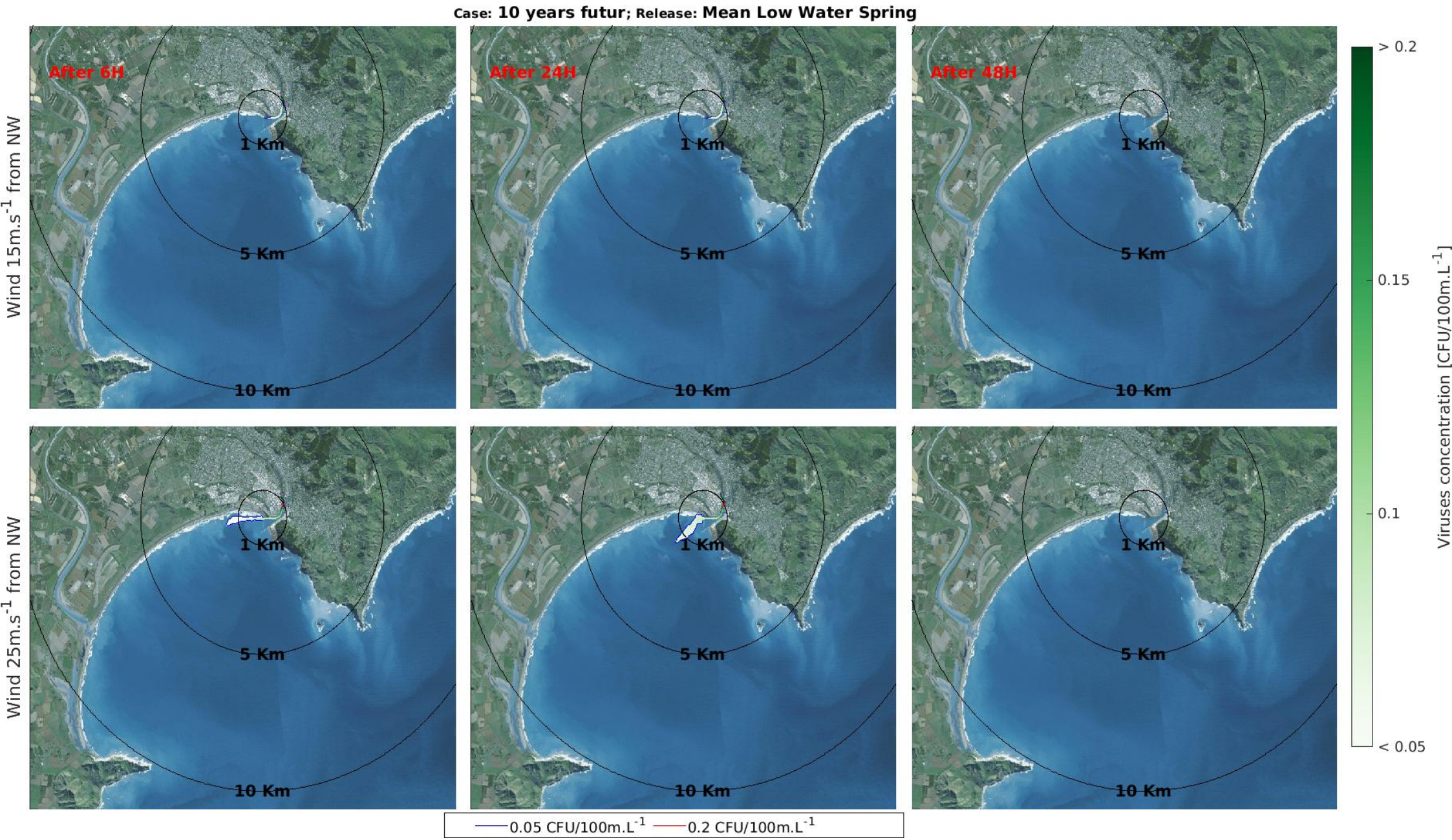
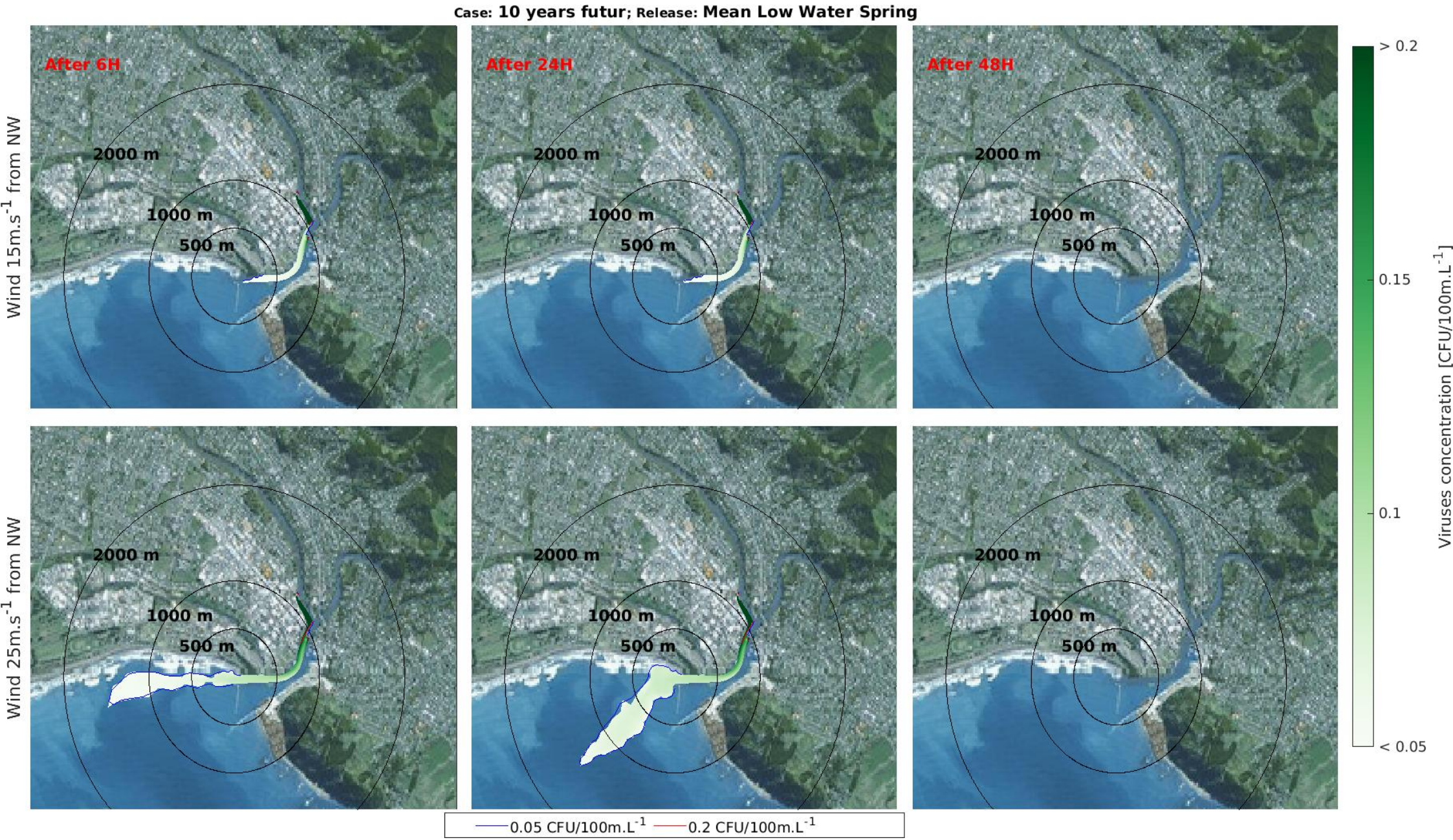
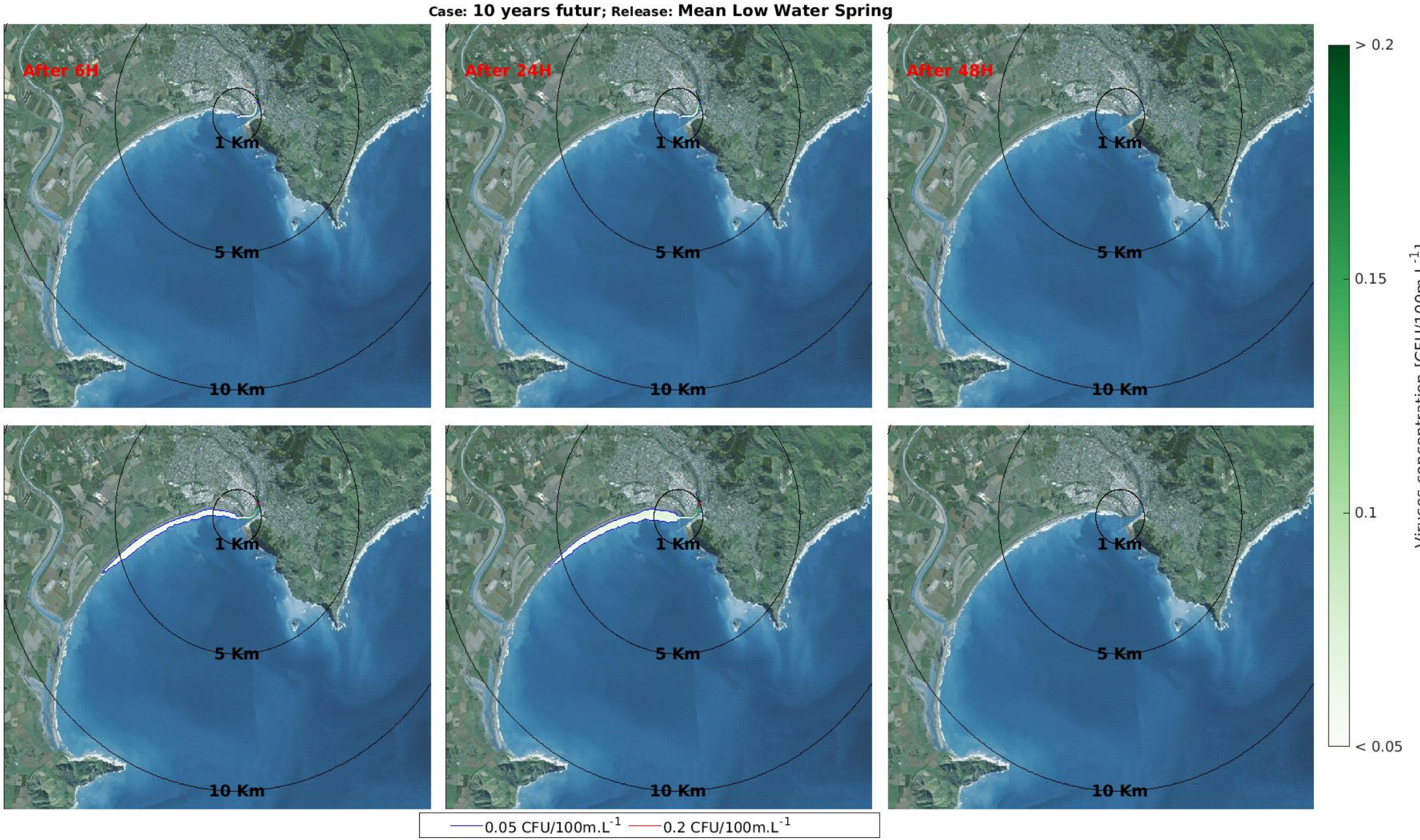
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1

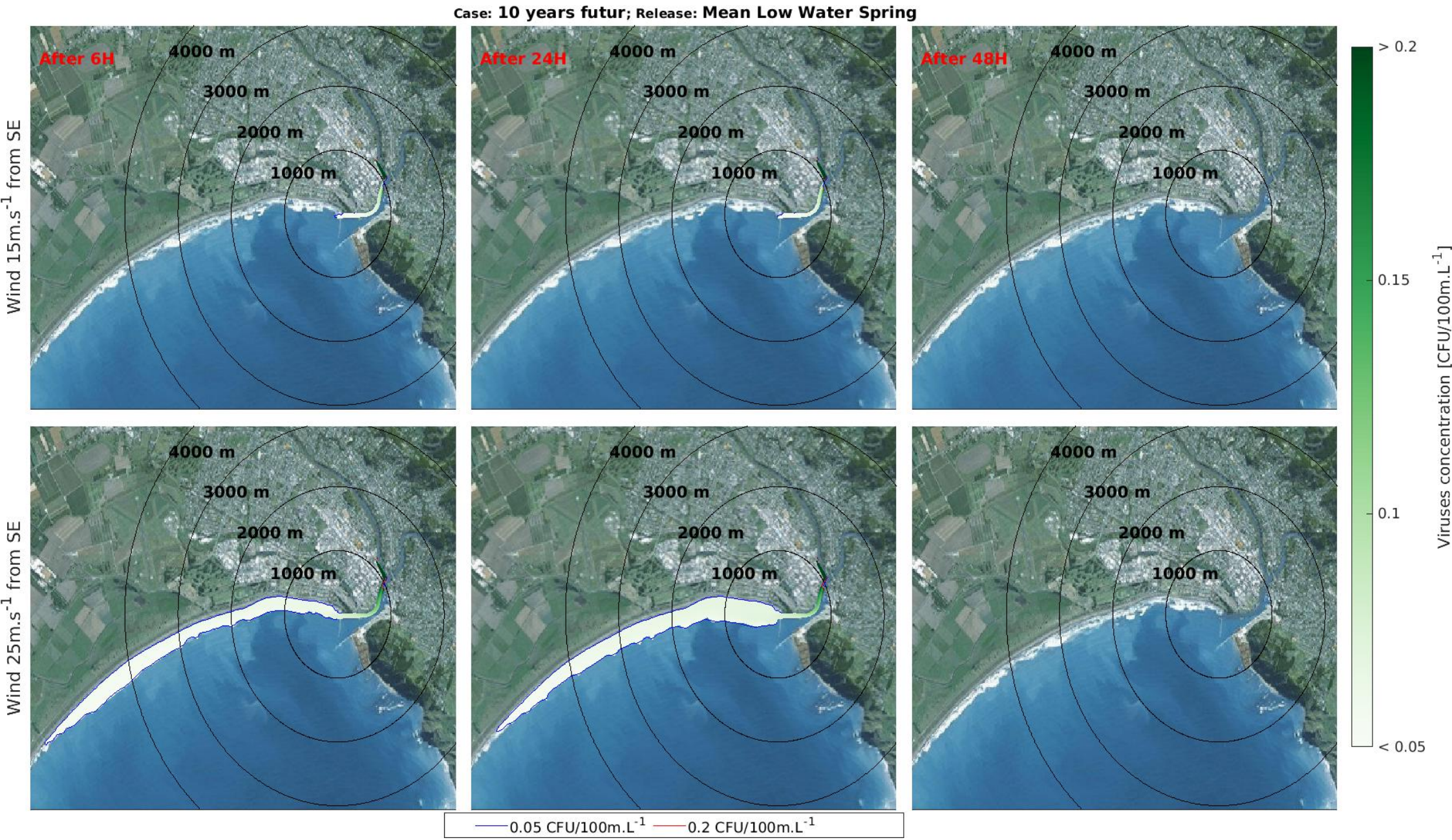

Case: 10 years futur; Release: Mean High Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean High Water Spring
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
2000 m
1000 m
500 m
Wind 15m.s-1 from NW
Wind 25m.s-1 from NW
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
1 Km
5 Km
10 Km
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1


Case: 10 years futur; Release: Mean Low Water Spring
After 6H
After 24H
After 48H
4000 m
3000 m
2000 m
1000 m
Wind 15m.s-1 from SE
Wind 25m.s-1 from SE
> 0.2
0.15
0.1
< 0.05
Viruses concentration [CFU/100m.L-1]
0.05 CFU/100m.L-1
0.2 CFU/100m.L-1