Figure S1. PT2 concentration after 25 minutes in reference simulation.

The plot above shows the concentration of passive tracer PT2 after 25 minutes of simulation in the reference simulation (in x-z cross section, averaged along the squall line). It was initially installed in the region where 0 < x < 30 km at levels of 1600-2400 m. We can see that it is mostly still present in this region, while the easterly winds have advected it slightly westward. This lead to upward transport by the updrafts, which are approximately in the region -3 < x < 3 km. Concentrations are particularly high at the inflow of the updraft near x = 0 km and z = 3 km. We can also see some undulations between 0 < x < 10 km or so, which can be caused by gravity waves, moving layers vertically by a few hundred meters.

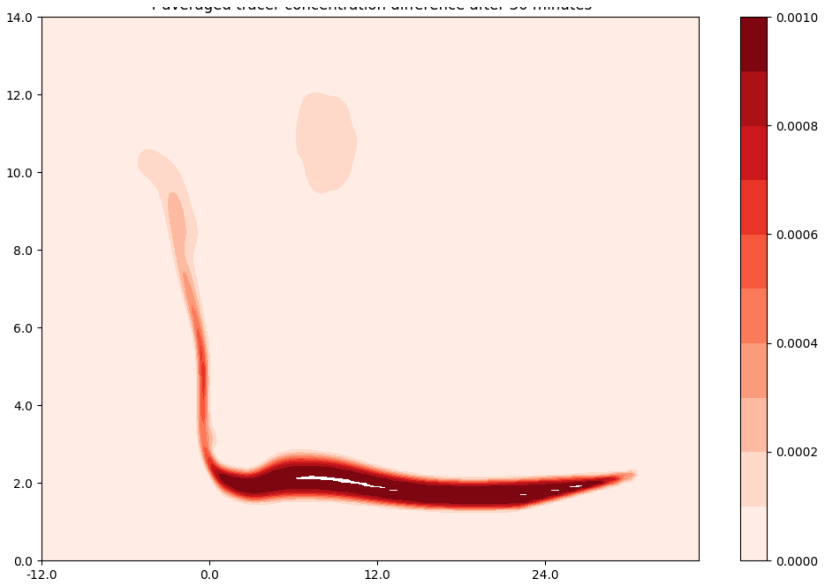

Figure S2. PT2 concentration after 30 minutes in reference simulation.

The next plot, Figure S2, represents the same as the previous plot (Figure S1), but then for 5 minutes later. The updraft seems to be more upright vertically and enhanced concentrations reach higher regions. Furthermore, the undulating pattern has moved by a few kilometers. On the next page we add one ensemble member's PT2 concentration on top of these plots.

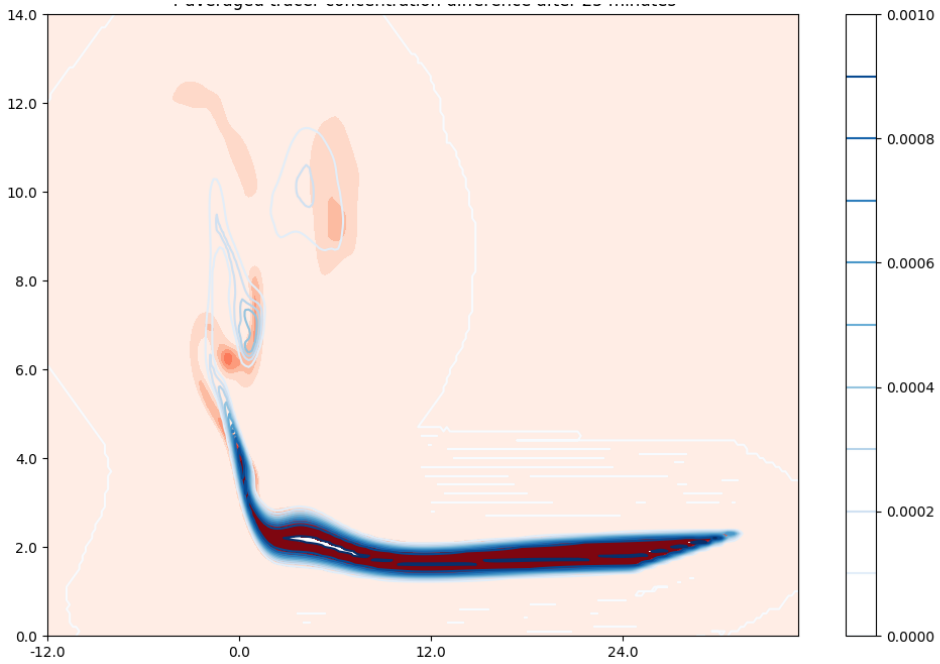

Figure S3. Same as Figure S1, but now blue isolines are superposed at concentrations given in the colorbar.

In Figure S3 the blue isolines and red fill overlap very strongly at low levels. However, at midlevels and in the upper troposphere slight differences occur: in the reference simulation, PT2 occurs slightly westward compared to ENS_03 at midlevels (4-7 km). This is very likely associated with a slight difference in updraft location. Differences are also visible in the upper troposphere, due to differences in location of tracer outflow. These differences are essentially nothing else than dislocation of PT2 in the two simulations, as shown in Figures 4a, 4b, 4c and 5a and 5b in the main text.

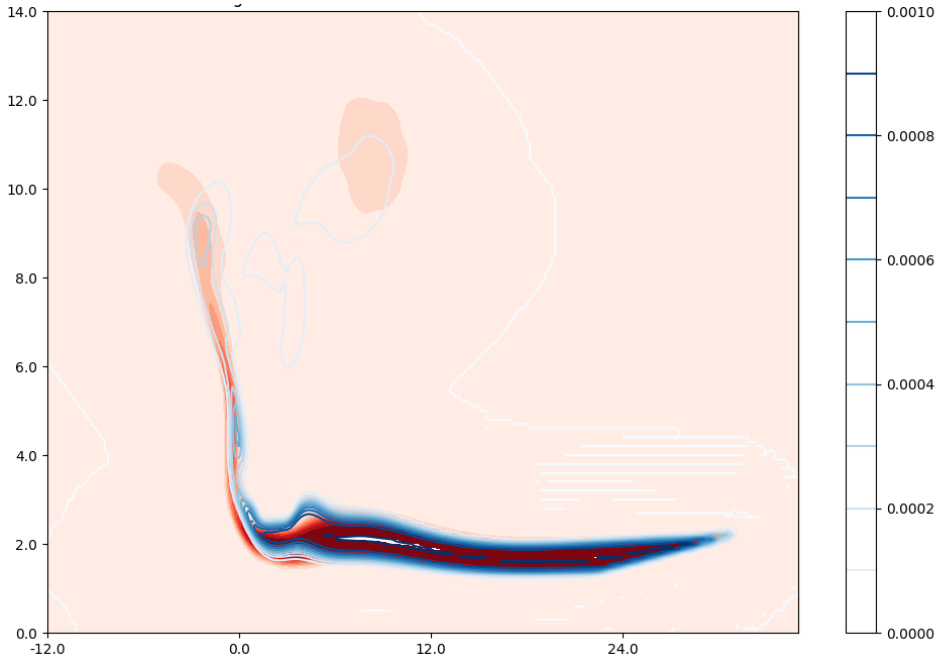

Figure S4. Same as Figure S3, but now for 30 minutes

Figure S4 represents the PT2 distribution in the reference simulation and ENS_03. What can be seen is that there is a strong overlap: the undulating signal at low levels, z = 1600 to z = 2400 m and $0 < x < 30$ km. The nearly upright updraft also occurs in both at about x = 0 km. However, when one focusses on the gradients of concentration one can also see that there are slight shifts between the two simulations: the updraft is very slightly shifted to the west in ENS_03 (blue isolines) than in the reference (red filled). Furthermore, whereas there is near perfect overlap in the region $5 < x < 30$ km at low levels, this is not the case directly east of the updraft at $0 < x < 5$ km. There is the pattern tracer PT2 has moved upward in the form of a crest-like pattern in ENS_03 and not in the reference simulation. This pattern is emphasized with the difference concentration plots, as given in Figures 4a, 4b, 4c, 5a and 5b.

Hovmöller diagrams of cold pool intensity

See the next page!

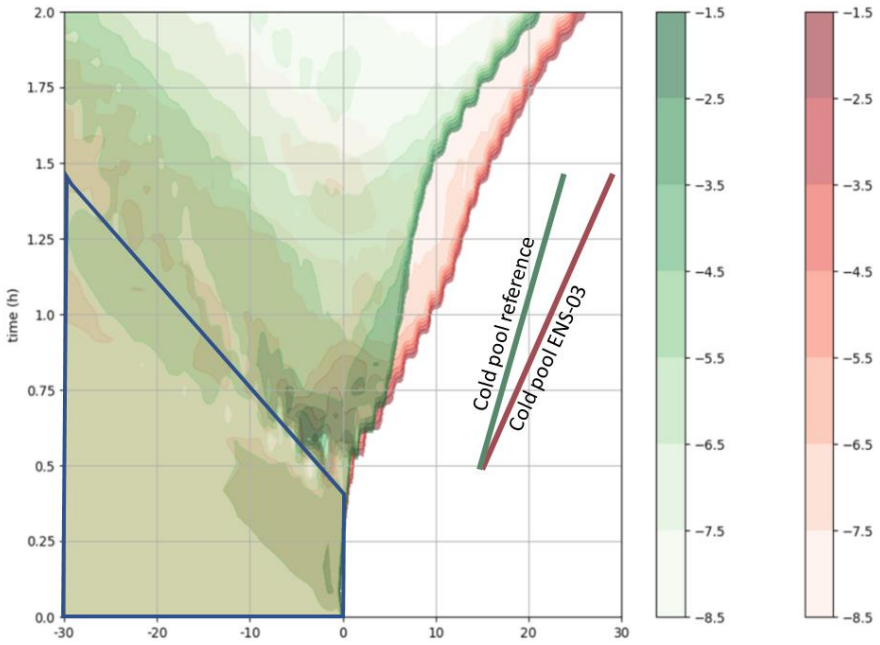

Figure S5a. Mean cold pool intensity at the surface as a function of x and t along a subsection of 10 km of the squall lines along the y-axis in the reference simulation and ENS-03.

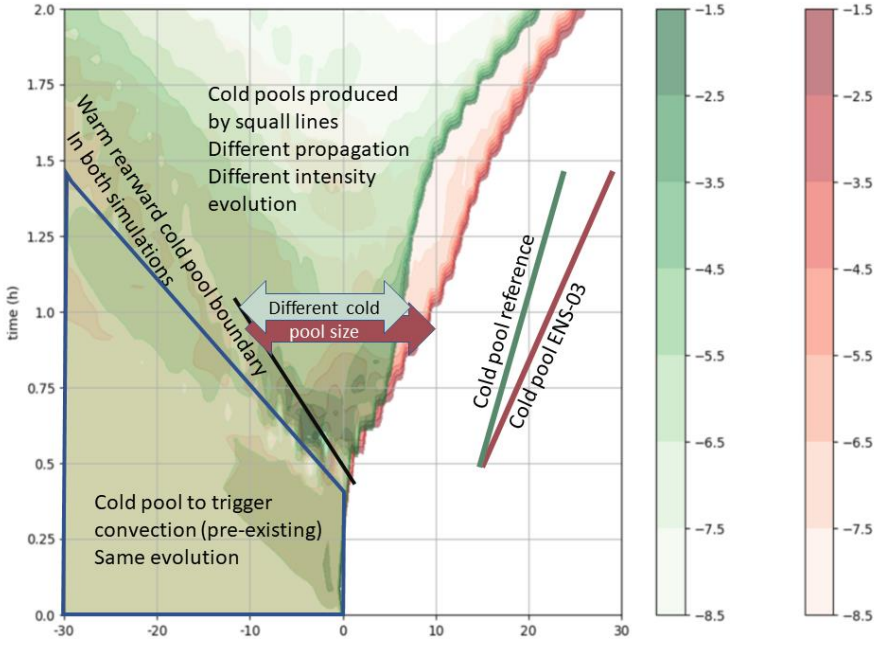

Figure S5b. Same, as Figure S5a, with additional annotations.

In Figure 5 one can see the area growth in the cold pools of squall lines ENS-03 and the reference. One can see that the cold pool in ENS-03 accelerates faster after 30 minutes, while the back side or rear flank of the newly generated cold pool (black line) coincides for both simulations. This means that the cold pool area of the newly generated cold pool grows faster in ENS-03 than in the reference case (light green; reference and dark red arrow; ENS-03). Note that the amplitude of the cold pools also evolves with time, as a response to precipitation intensities, evaporation and other tendencies.

However, one can see that the cold pool area increase coincides with an increase in the available space for cooling downdrafts in the figure.

Time series ensemble sensitivity analysis – correlations and circulation anomalies

On the next pages the full time series of the ensemble sensitivity analysis is available (see Figures 7 and 8 of the main text). First the time series complementing Figure 7 is shown (correlation structure), followed by that complementing Figure 8 (u-amplitude). Then Figure 7 is repeated, but masked regions that are not significant at α = 0,05 and restricted to the interval between 20 and 100 minutes of simulation time, which is the most relevant time interval.

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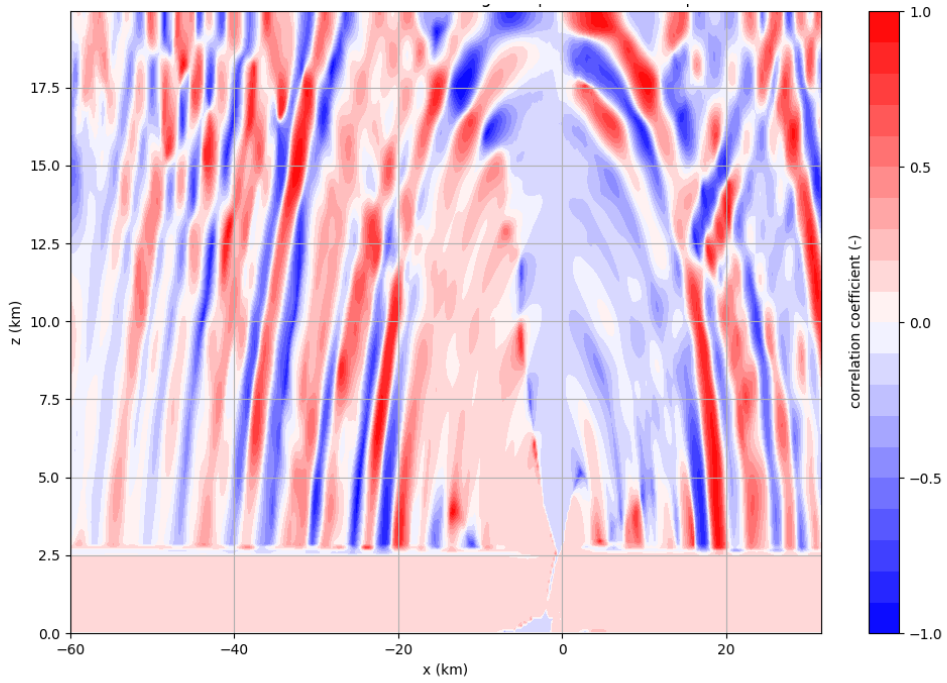

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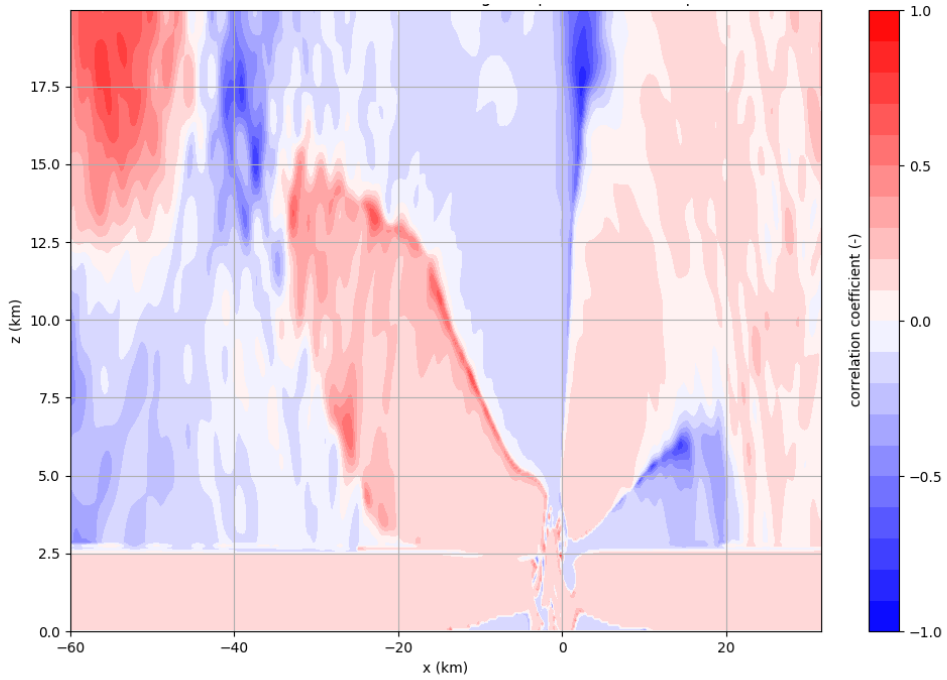
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12.5
10.0
7.5
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20
1.0
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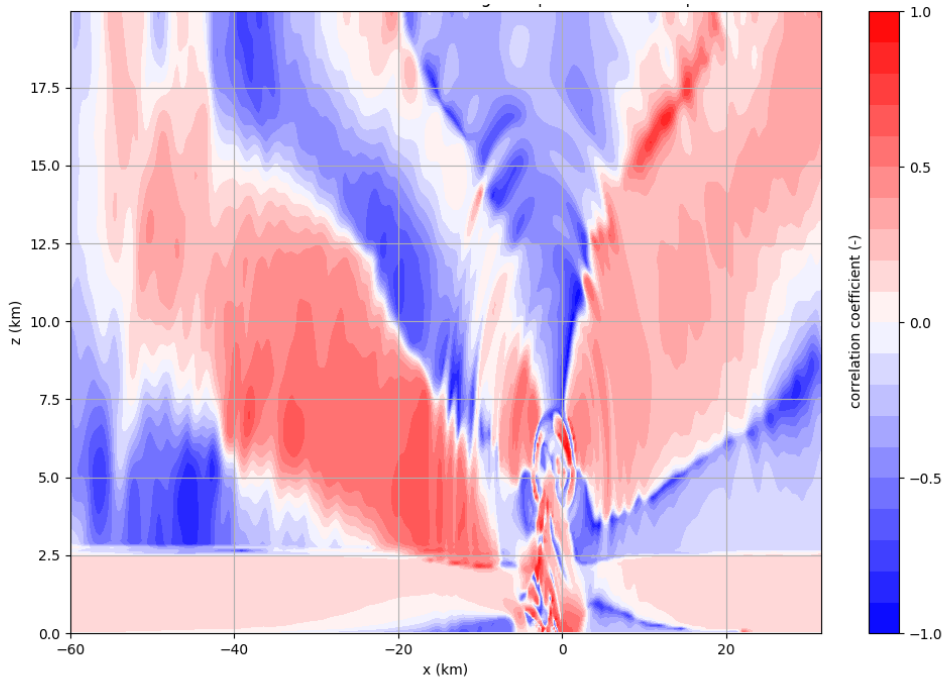
−0.5
−1.0

15 min: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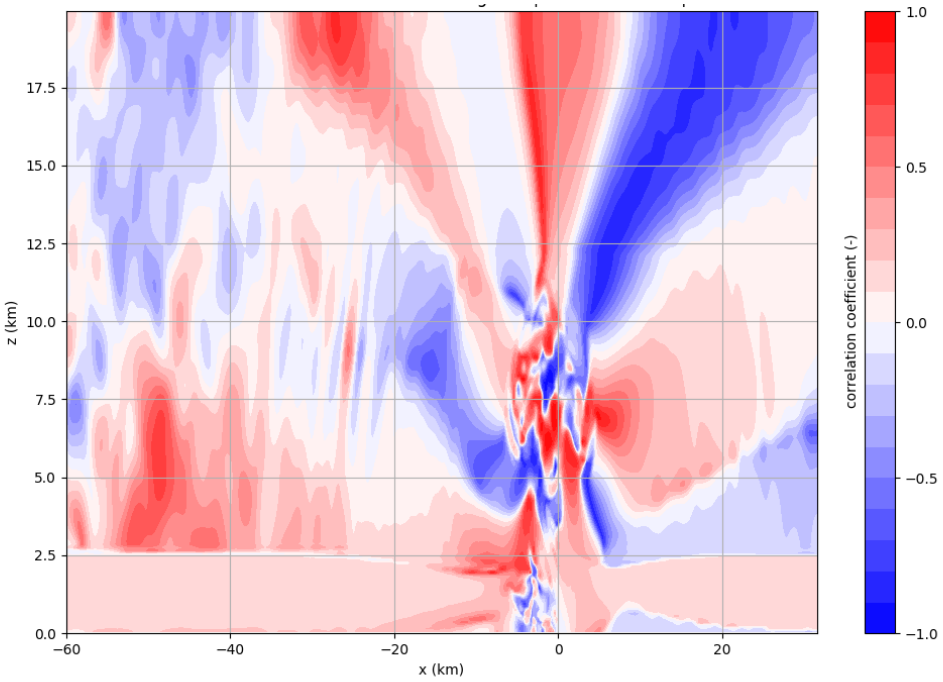
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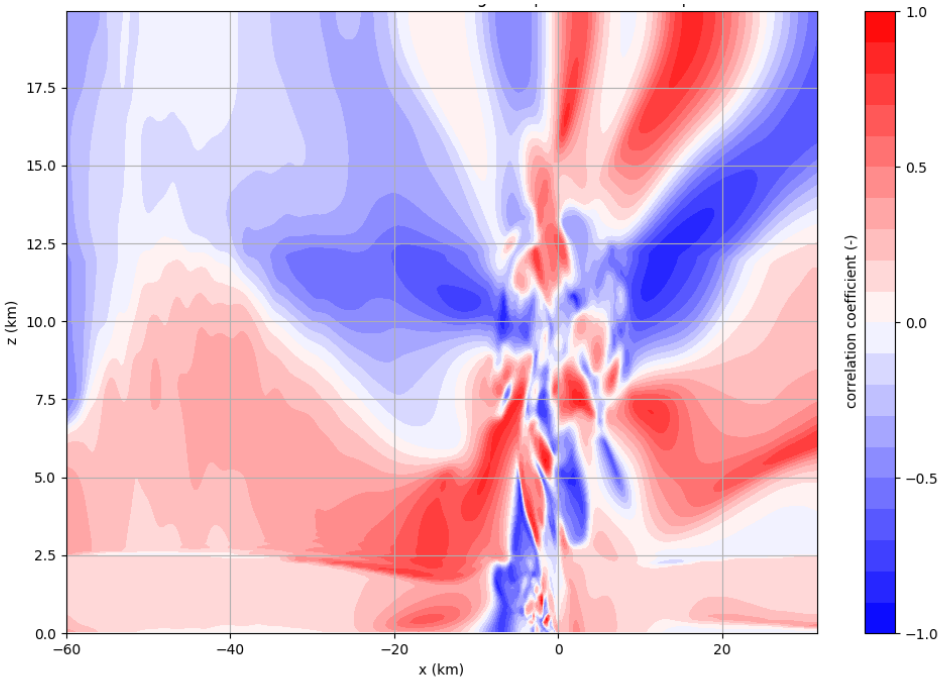
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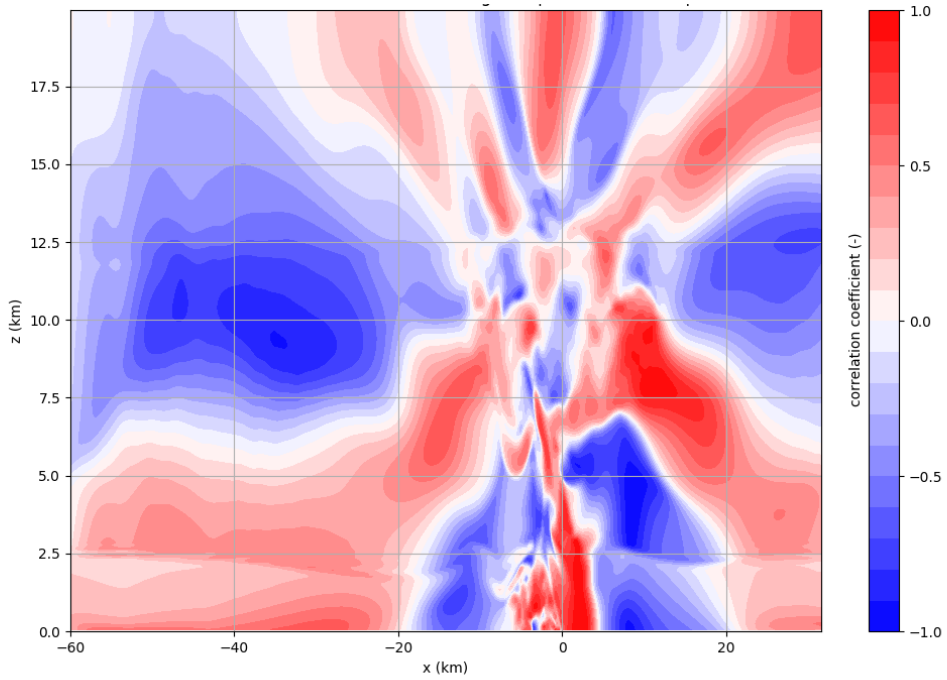
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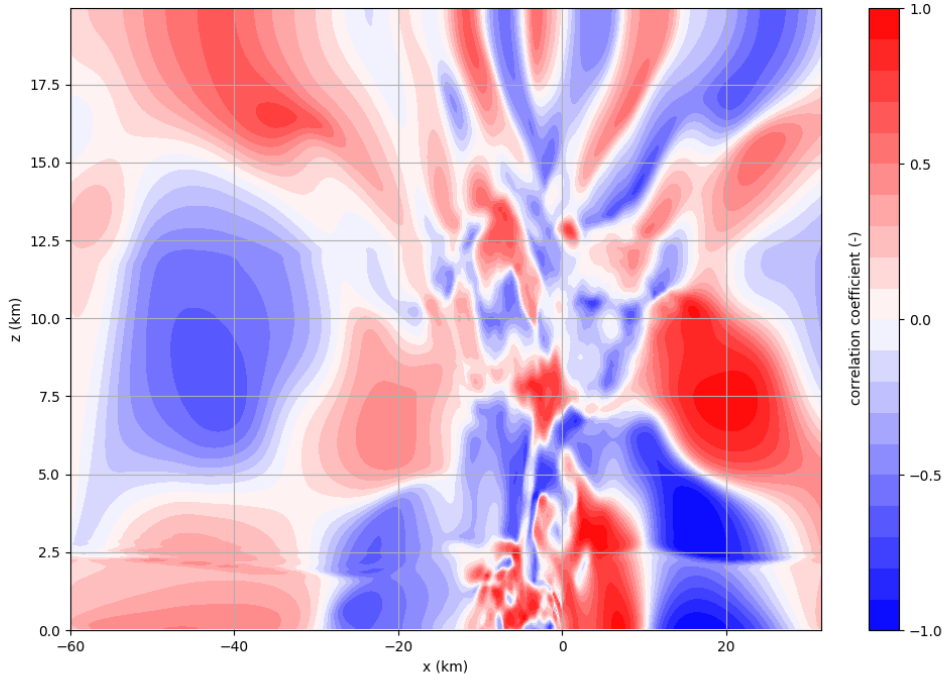
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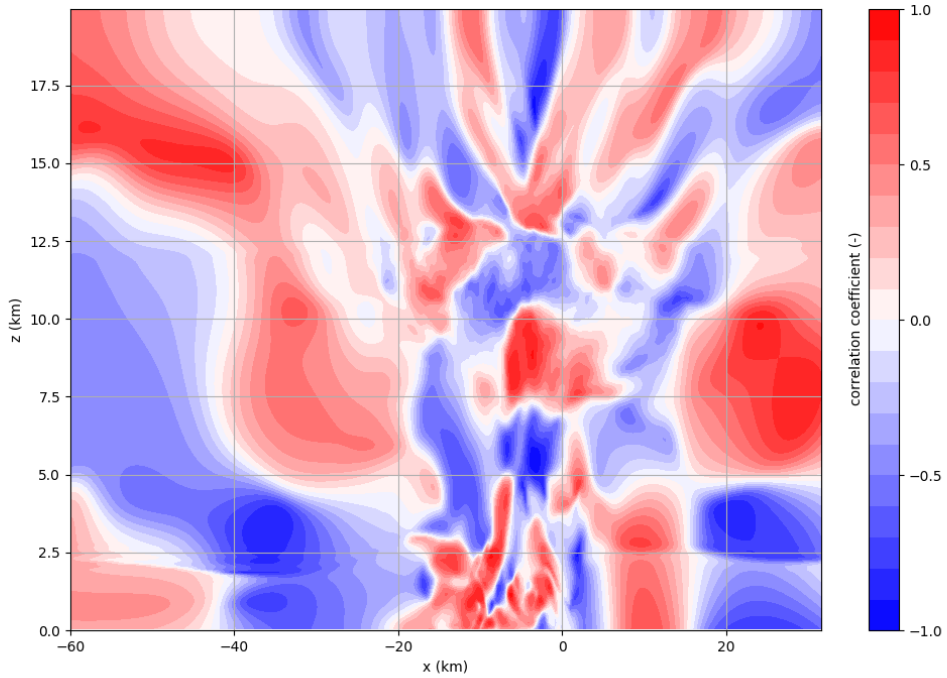
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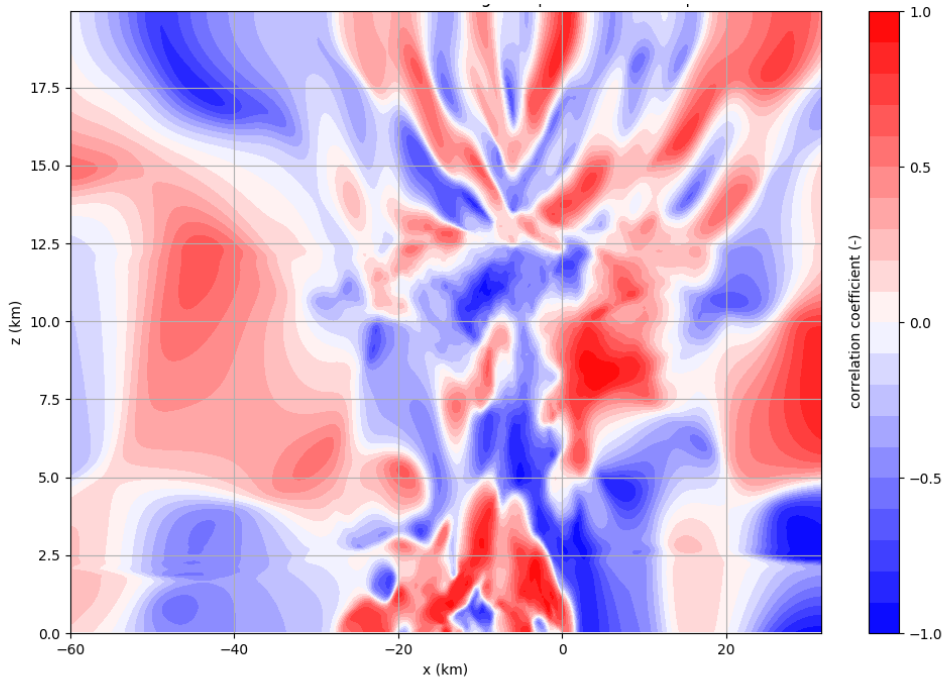
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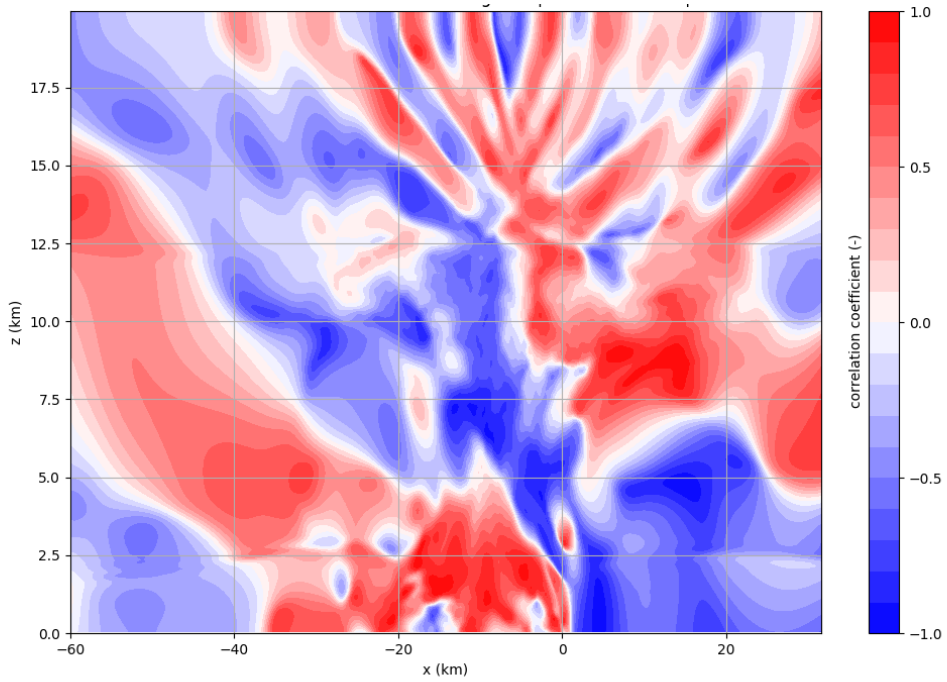
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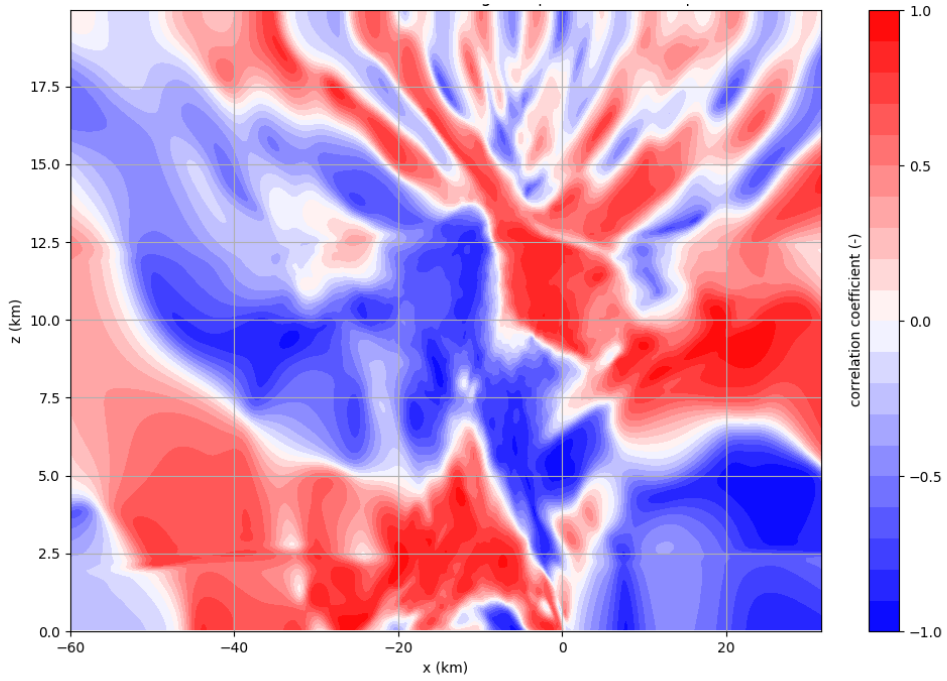
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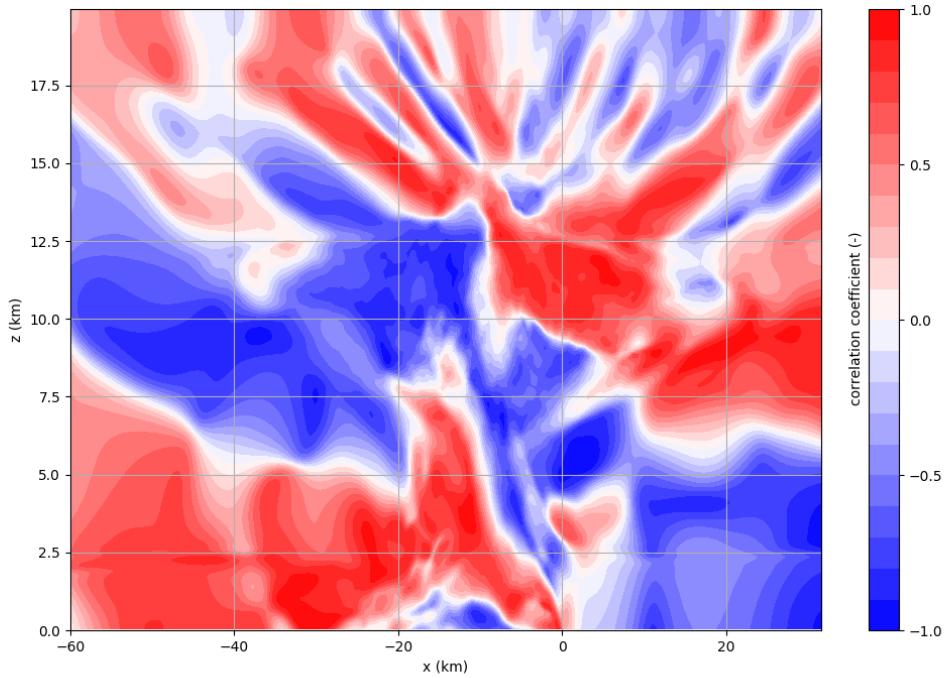
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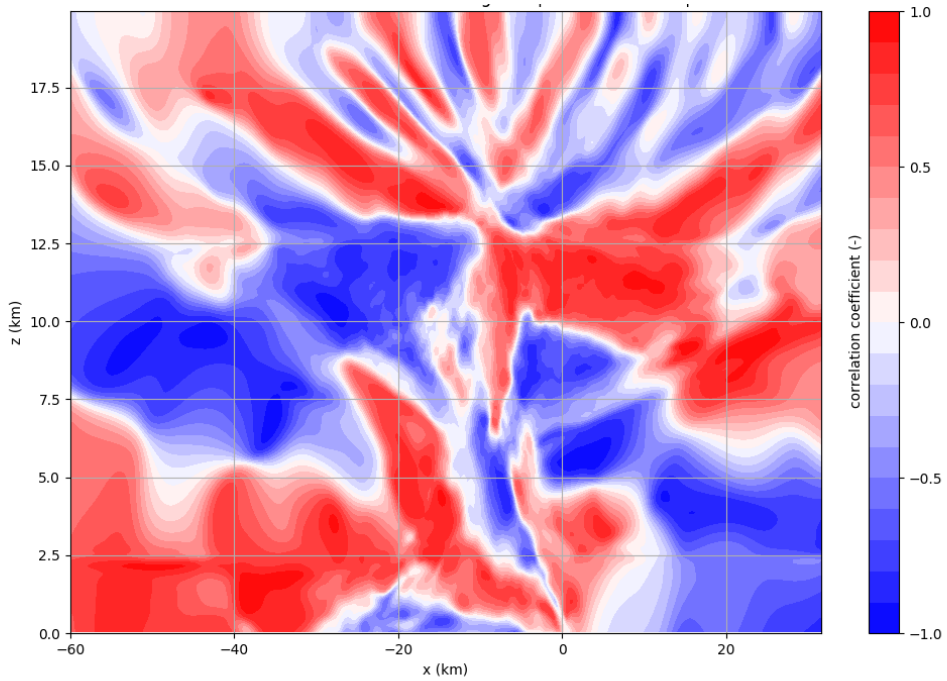
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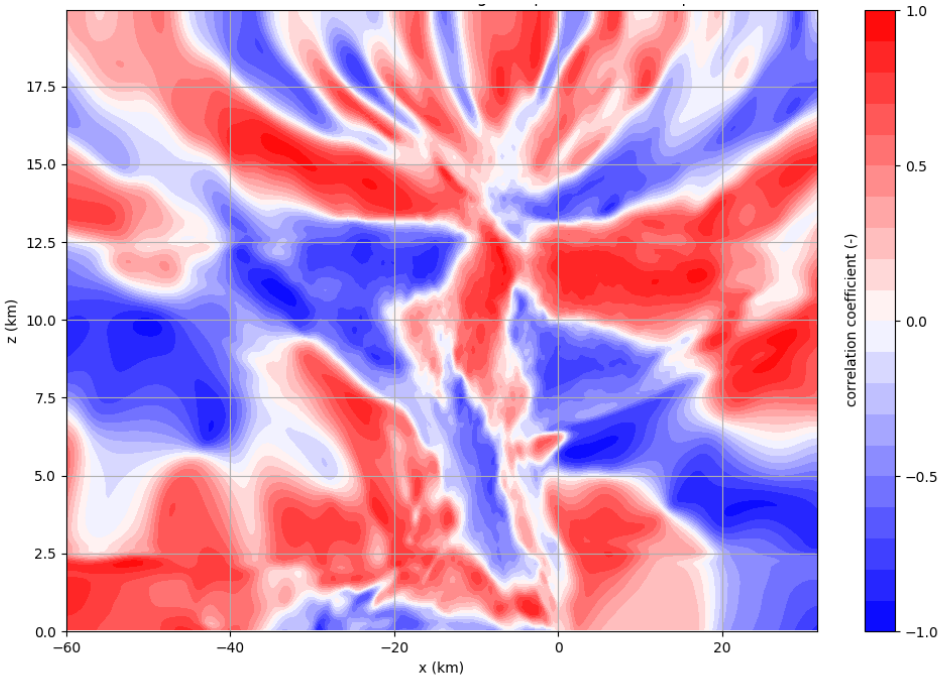
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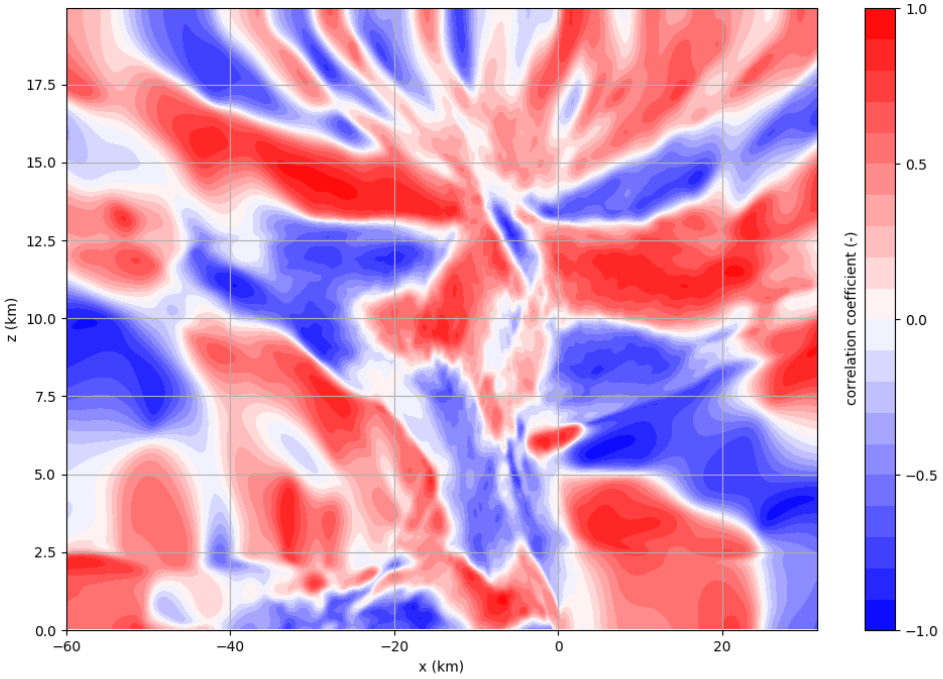
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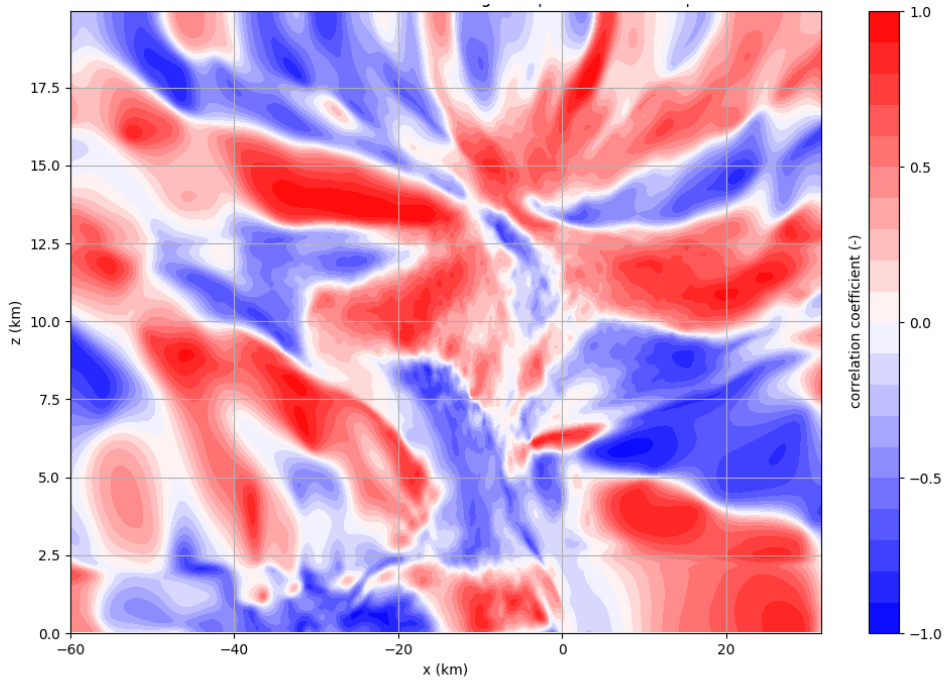
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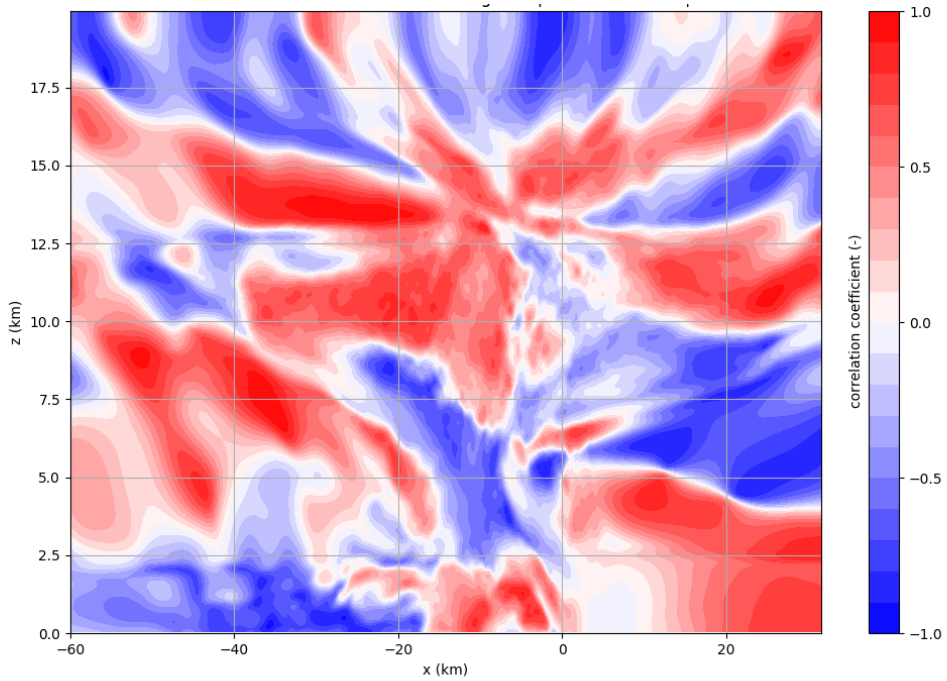
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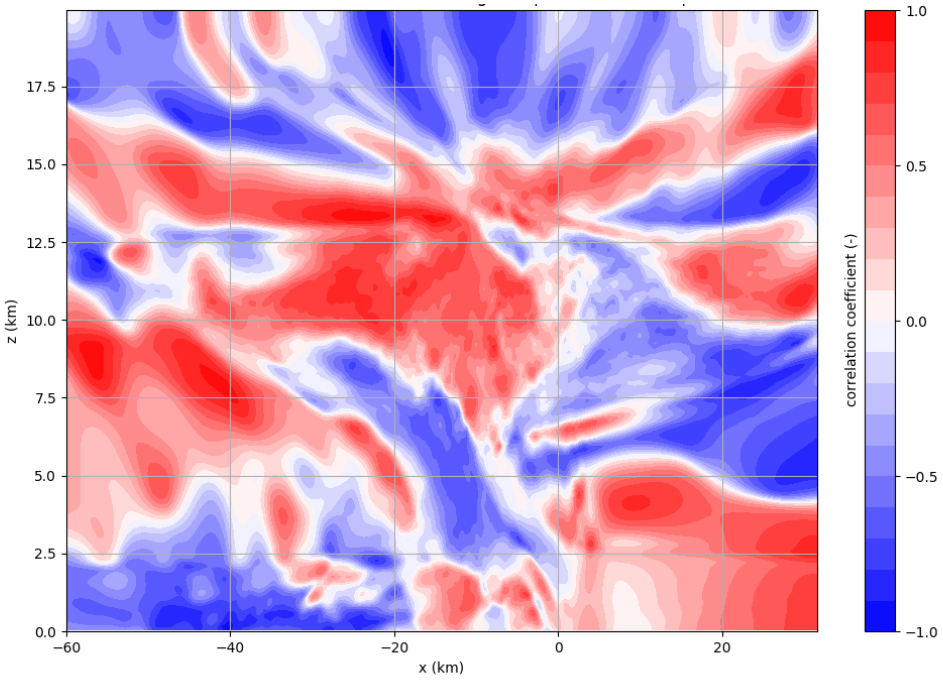

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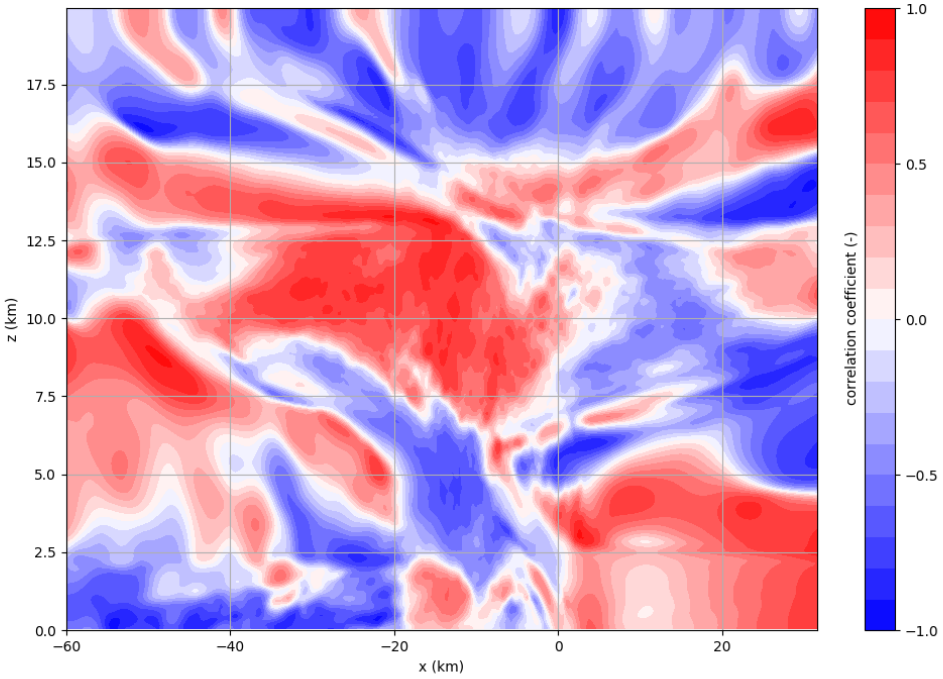

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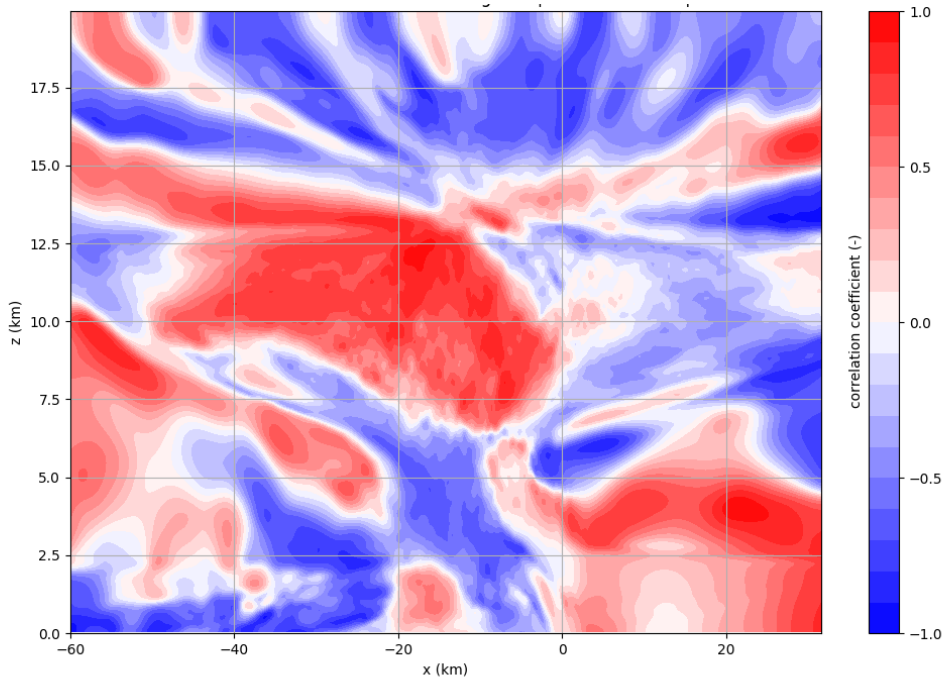

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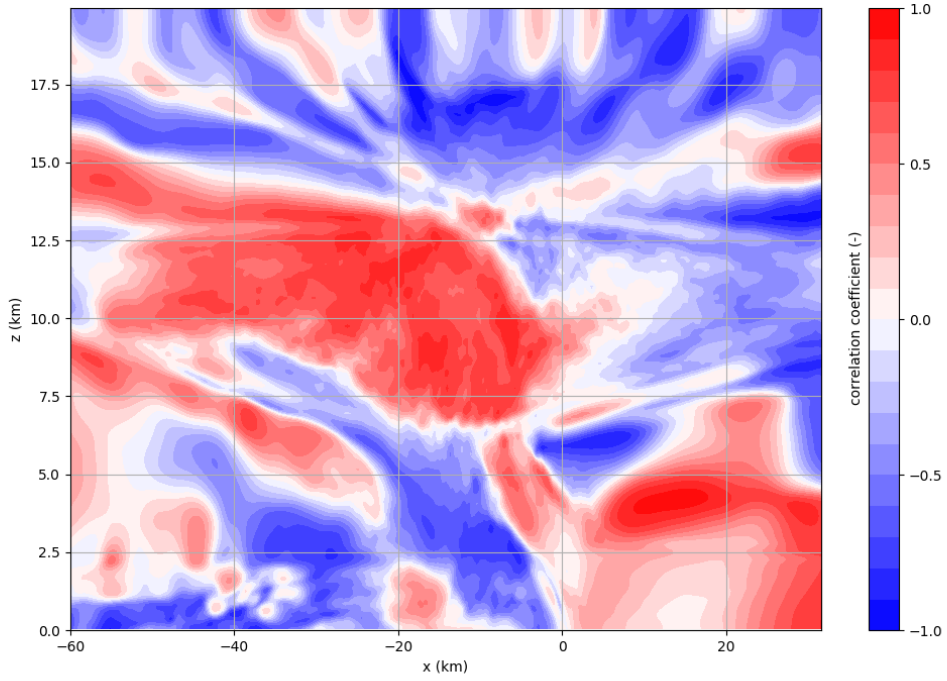

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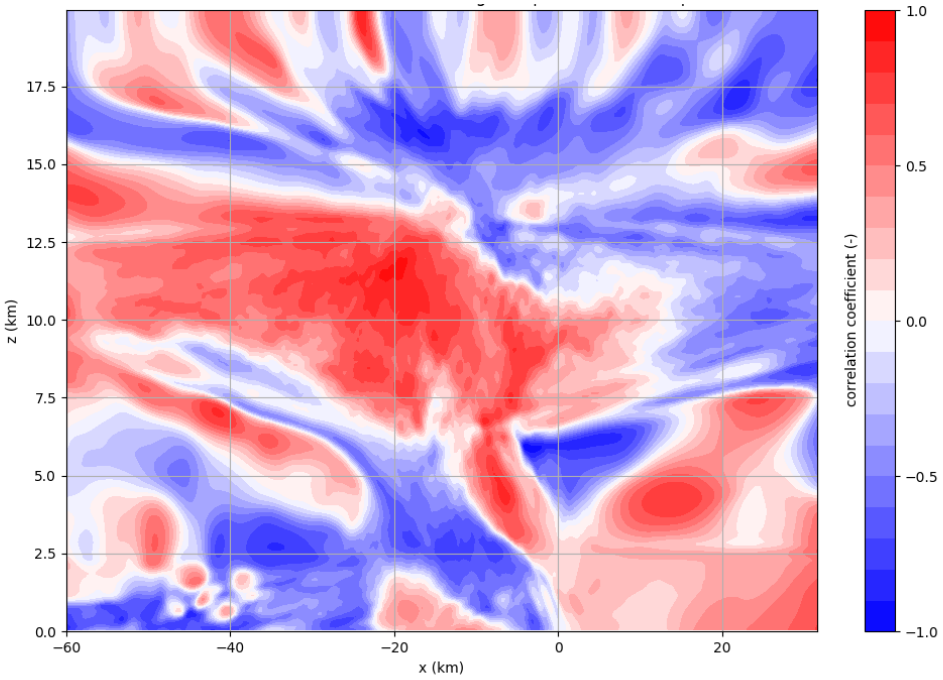

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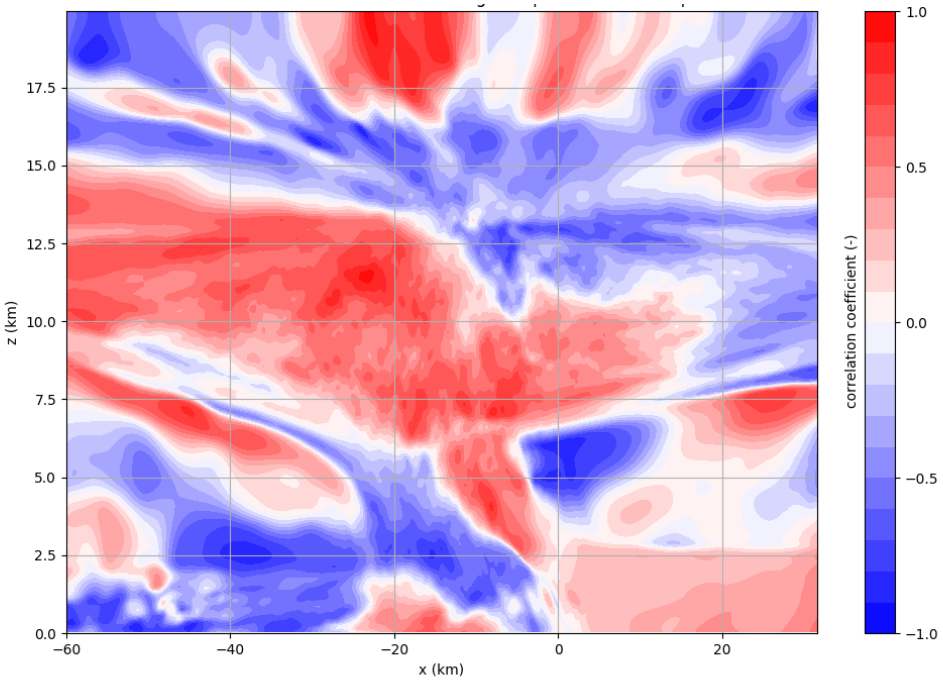

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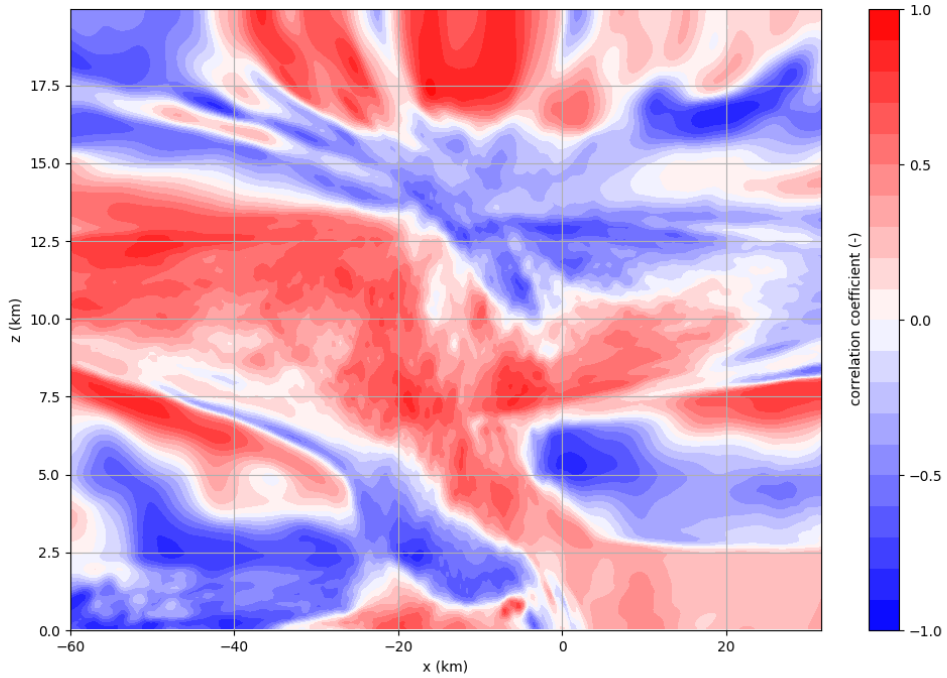

U-amplitude/anomaly

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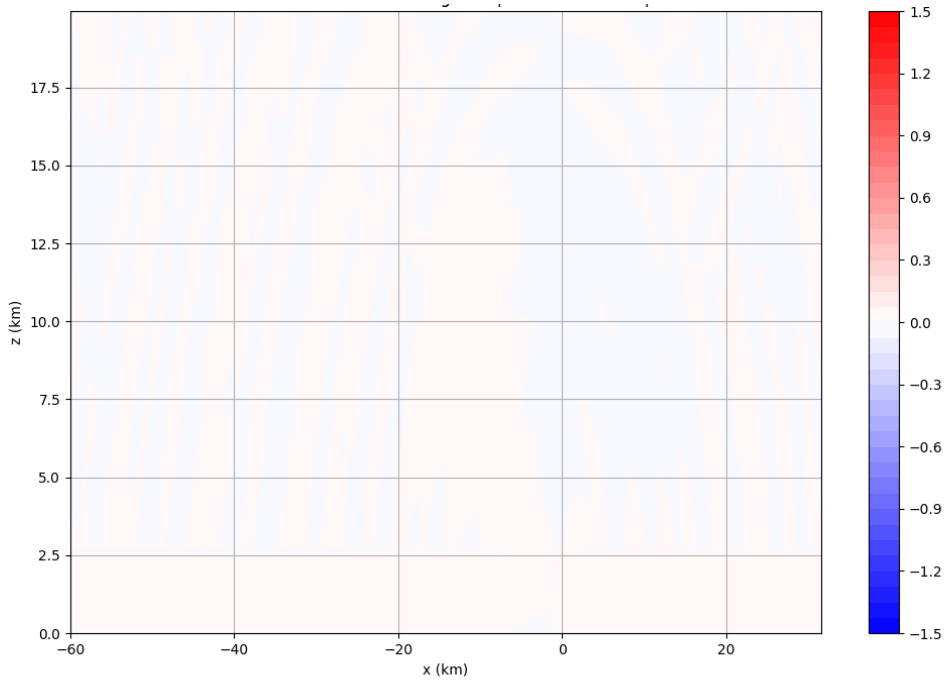

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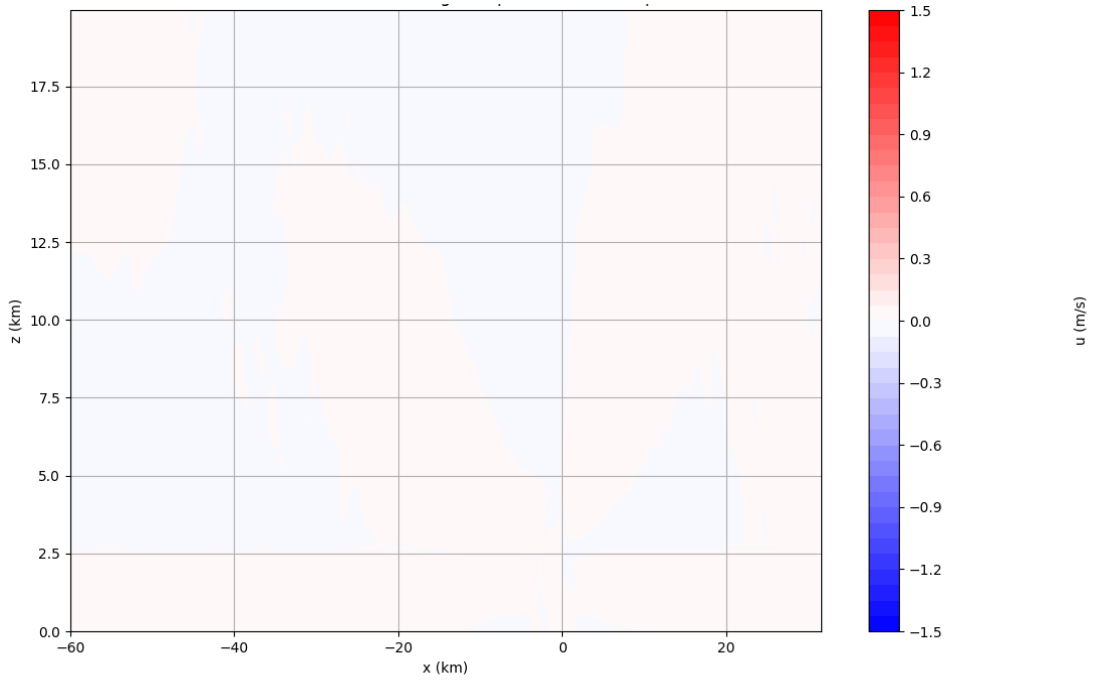

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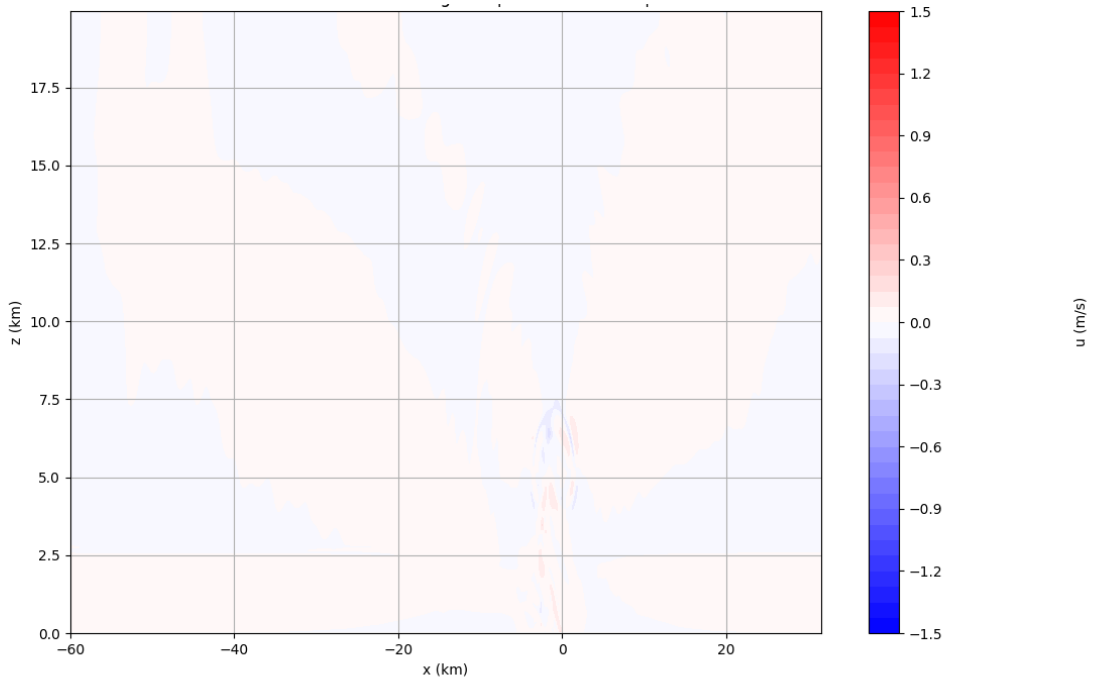

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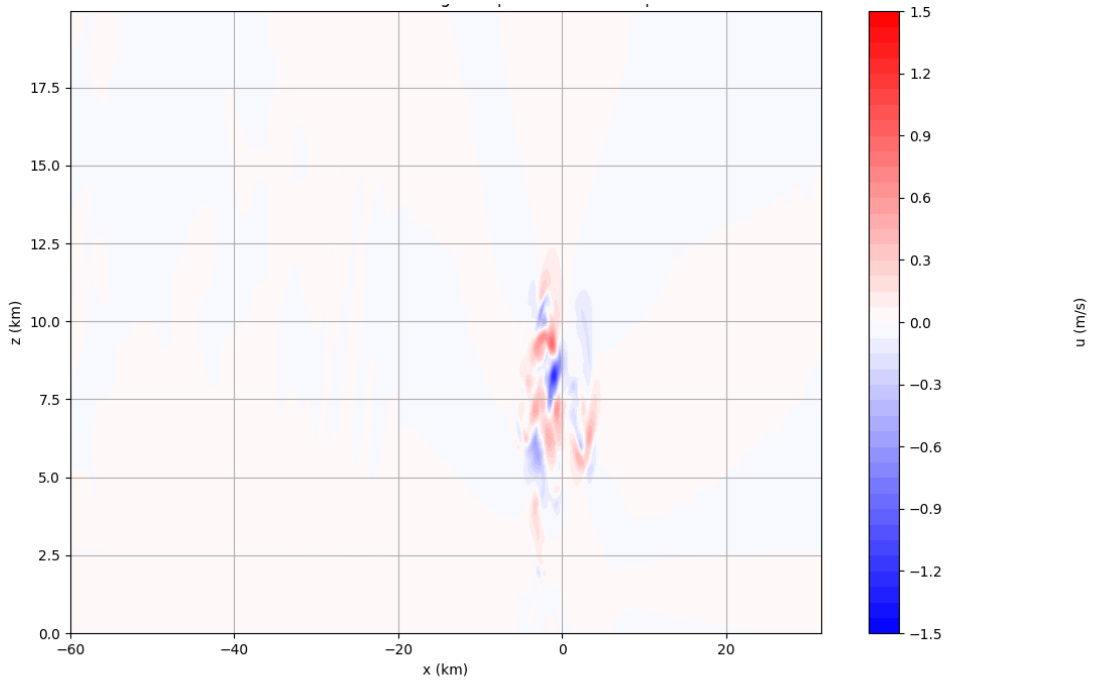

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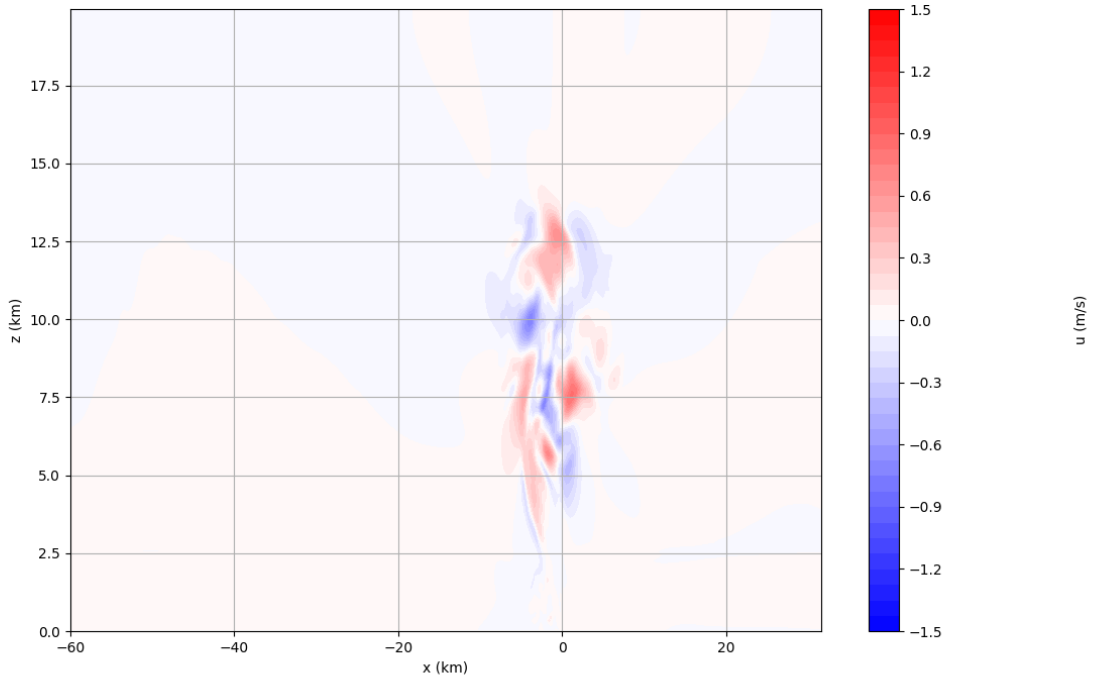

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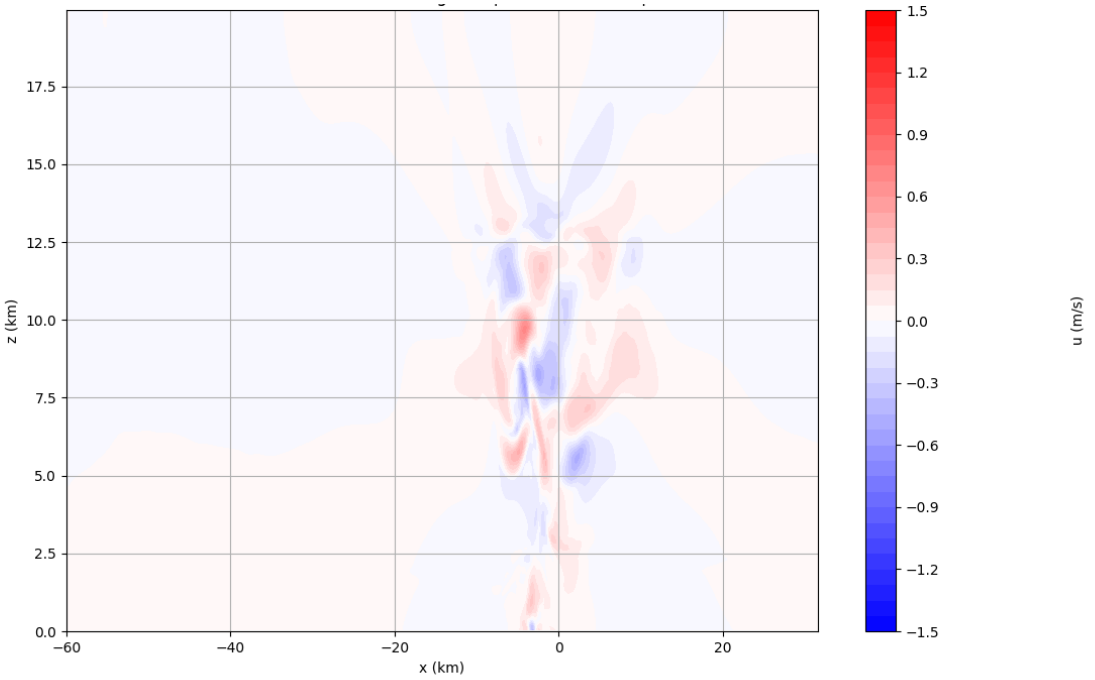
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u (m/s)
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7.5
5.0
2.5
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−40
−20
0
20
1.5
1.2
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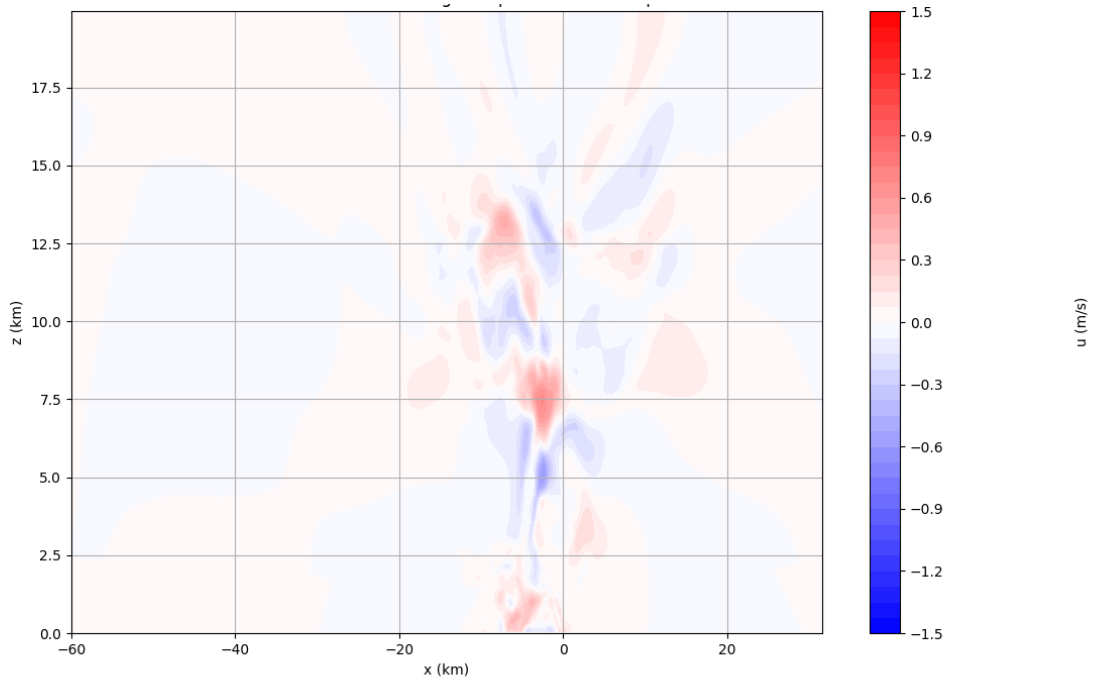
−1.5

35 min: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−20
0
20
1.5
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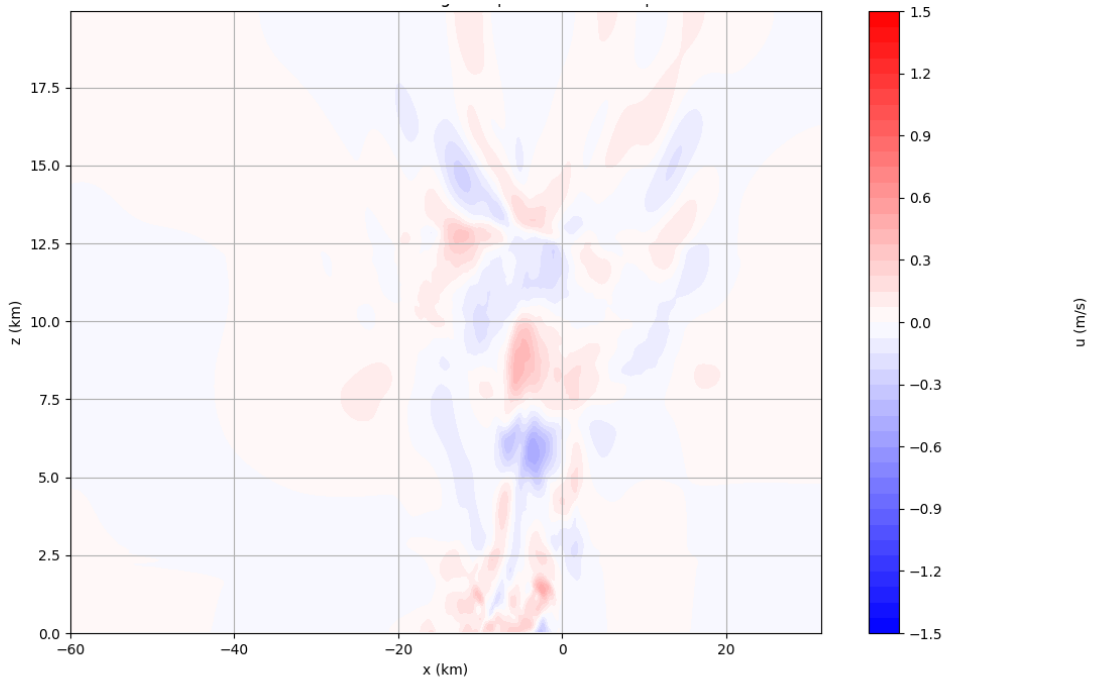

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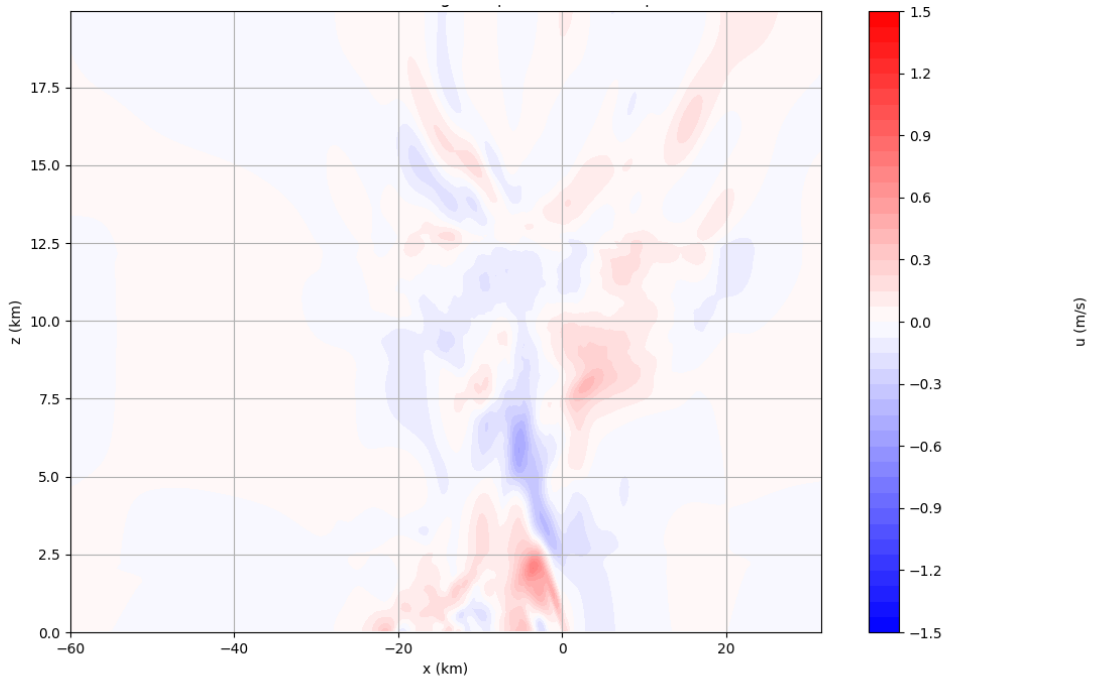

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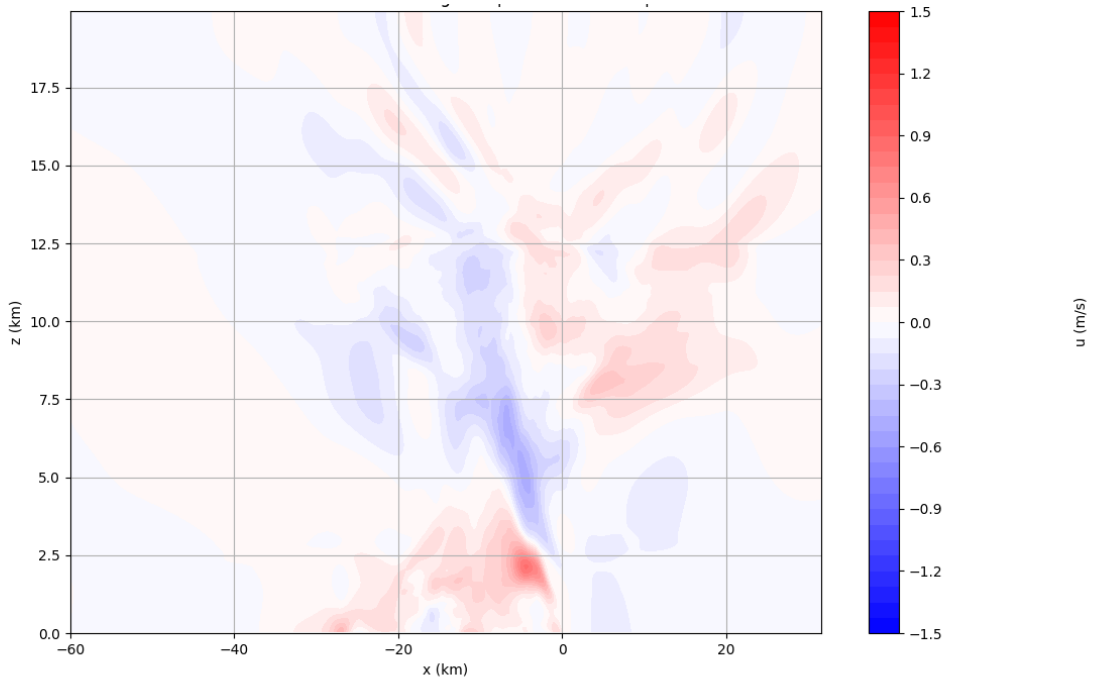
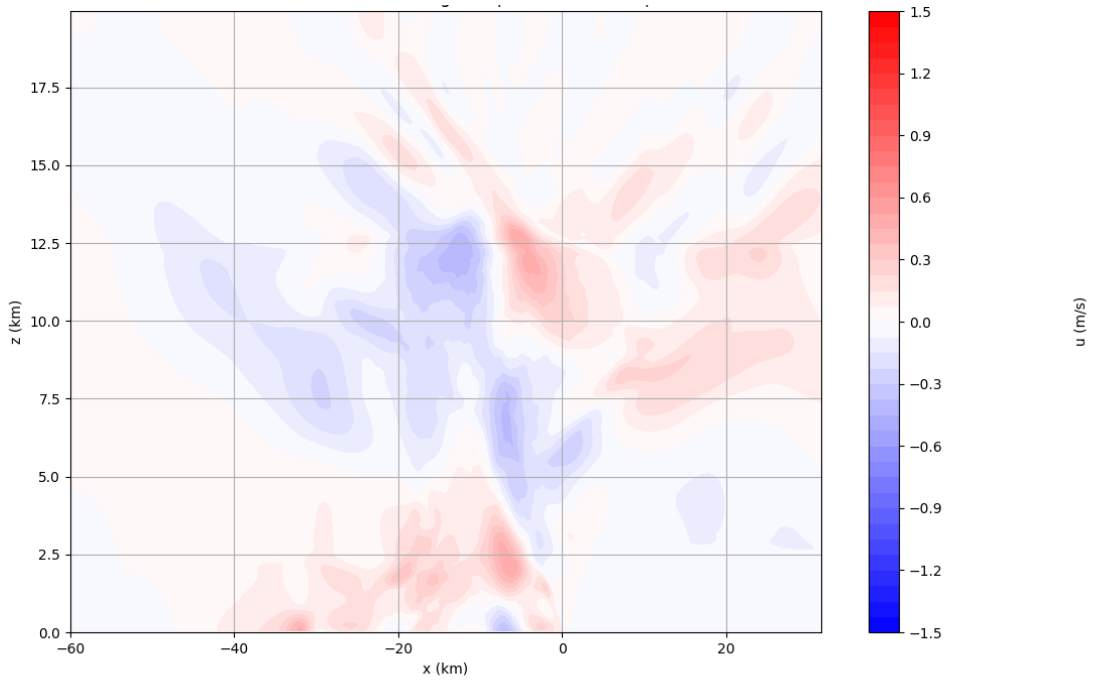
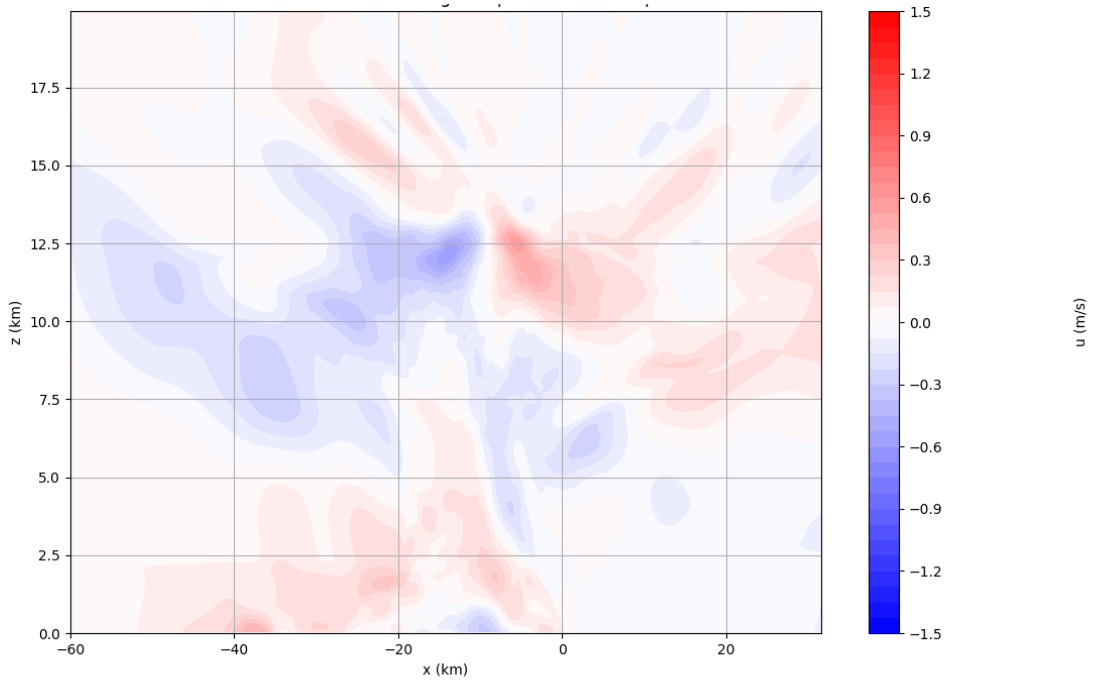

z (km)
x (km)
u (m/s)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.5
1.2
0.9
0.6
0.3
0.0
−0.3
−0.6
−0.9
−1.2
−1.5

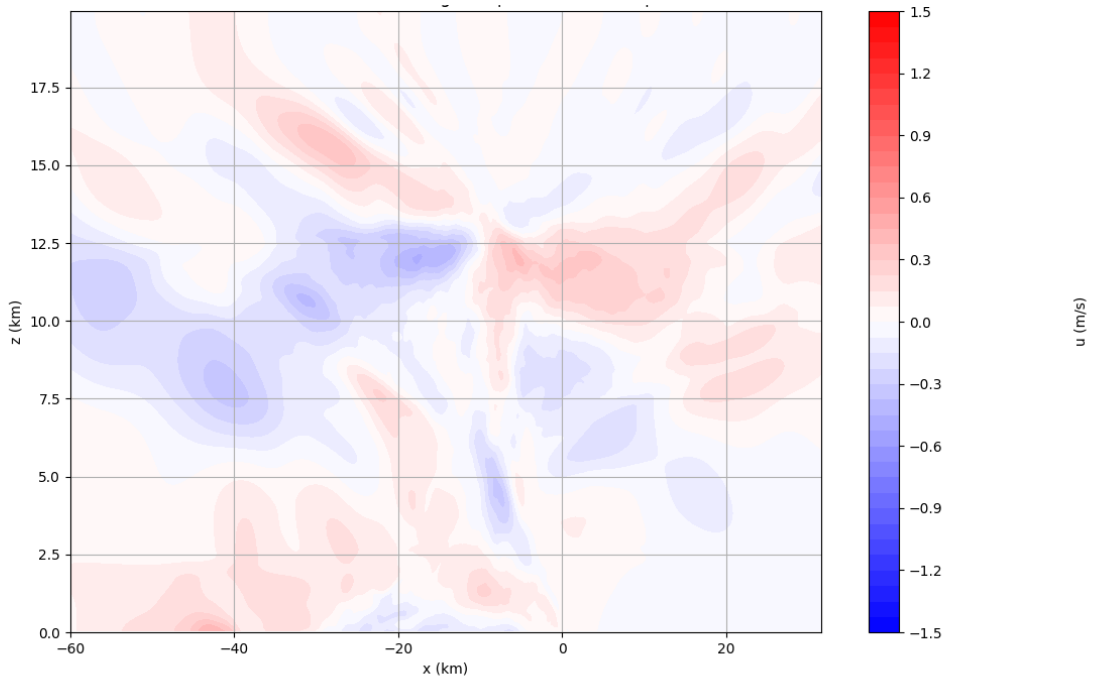
55 min:


z (km)
x (km)
u (m/s)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.5
1.2
0.9
0.6
0.3
0.0
−0.3
−0.6
−0.9
−1.2
−1.5

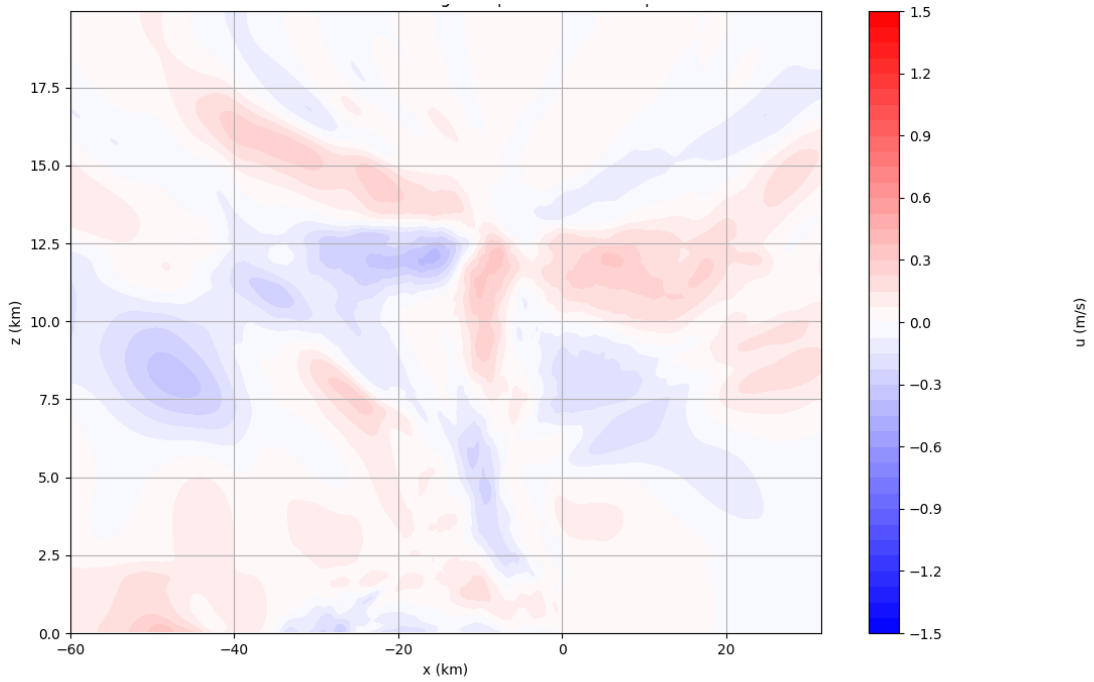
60 min:



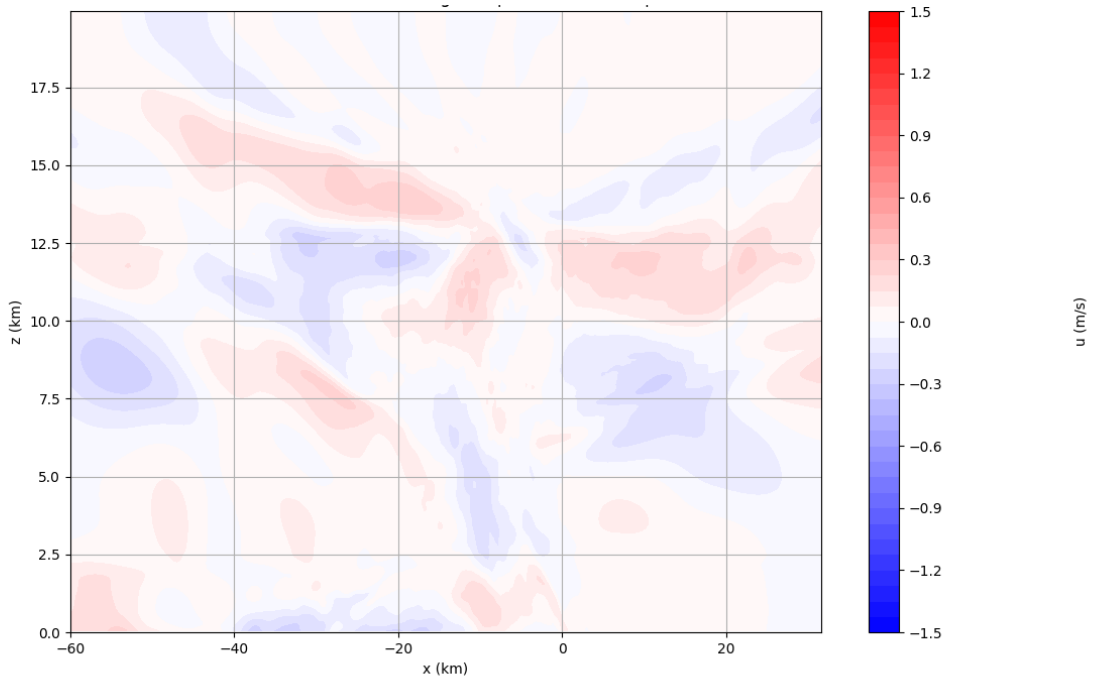
65 min:



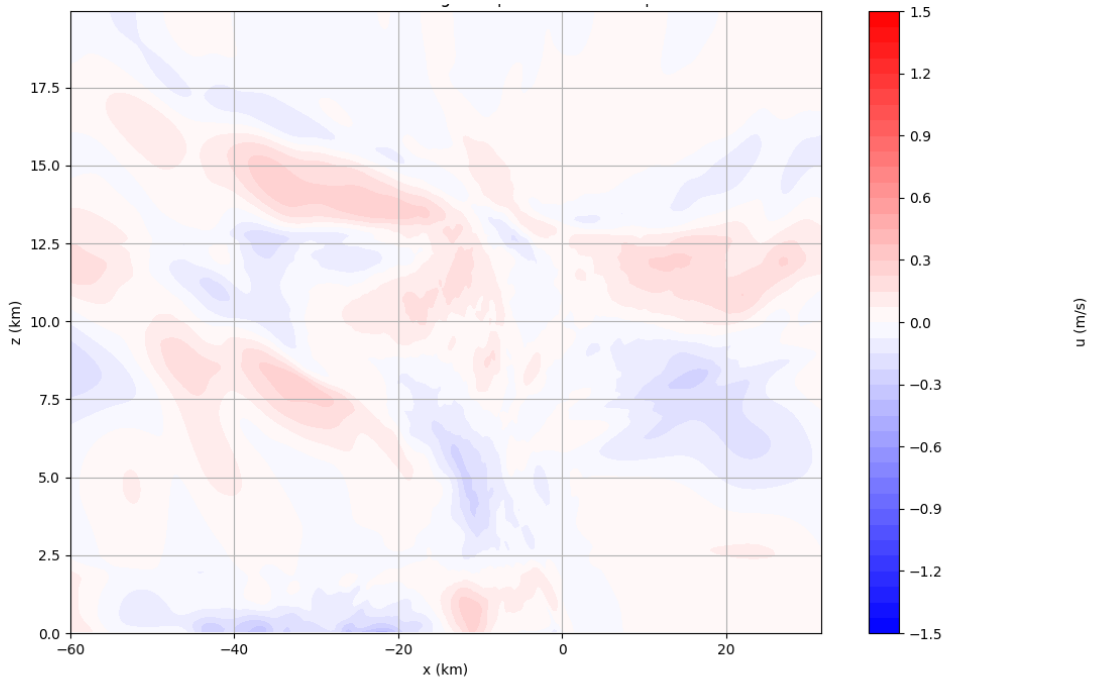
70 min:



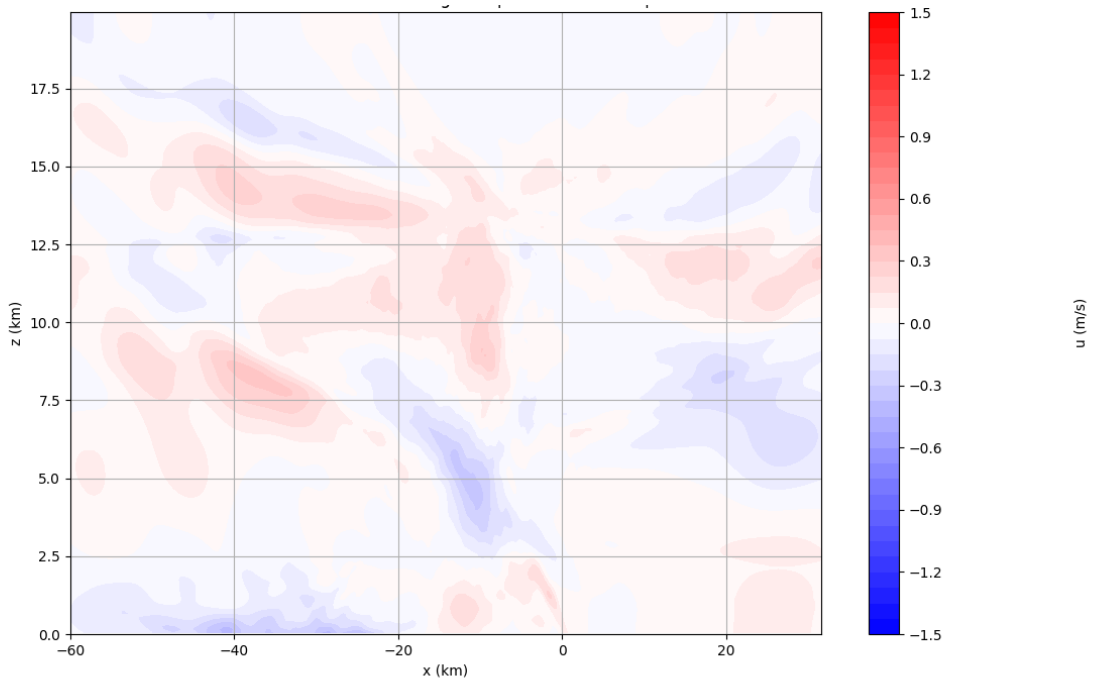
75 min:



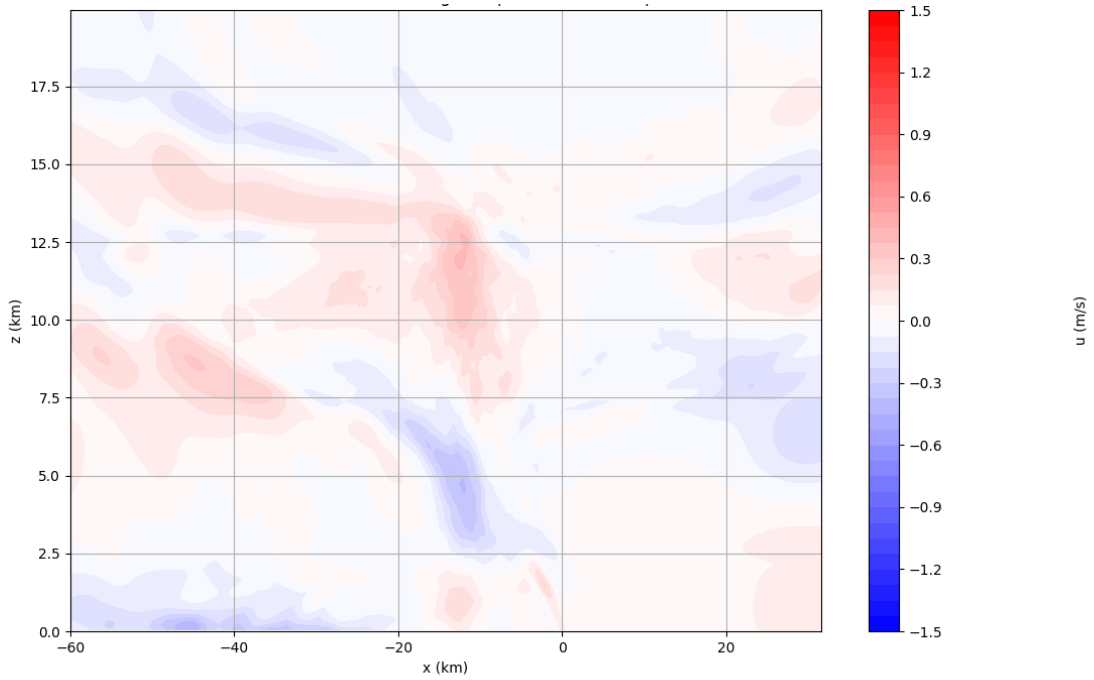
80 min:



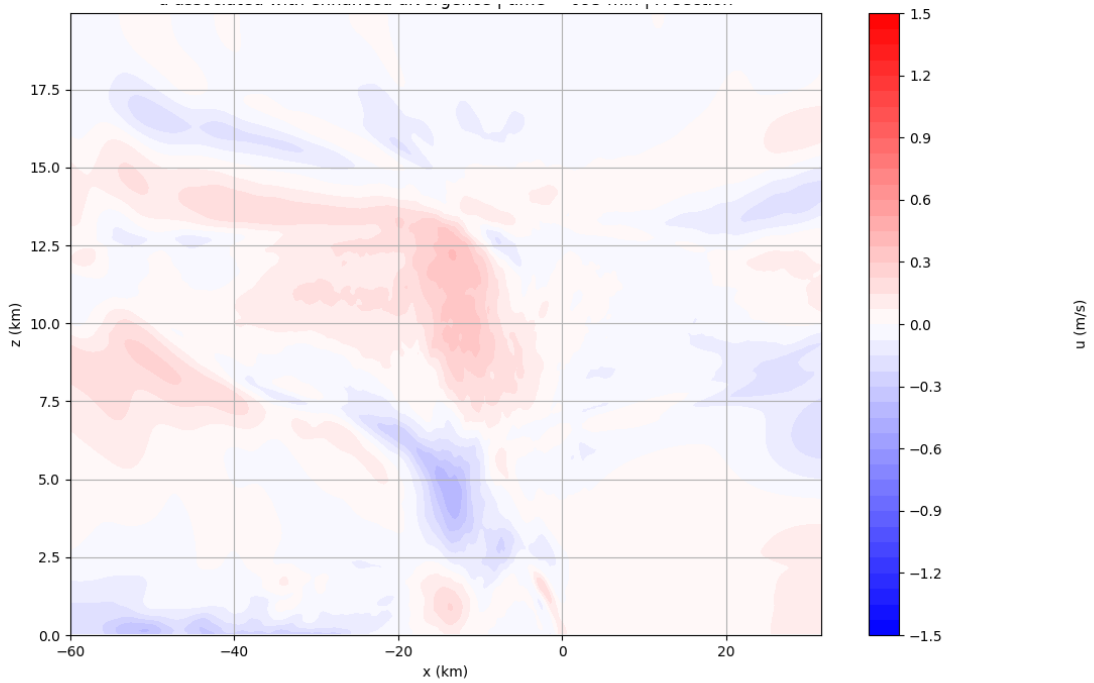
85 min:



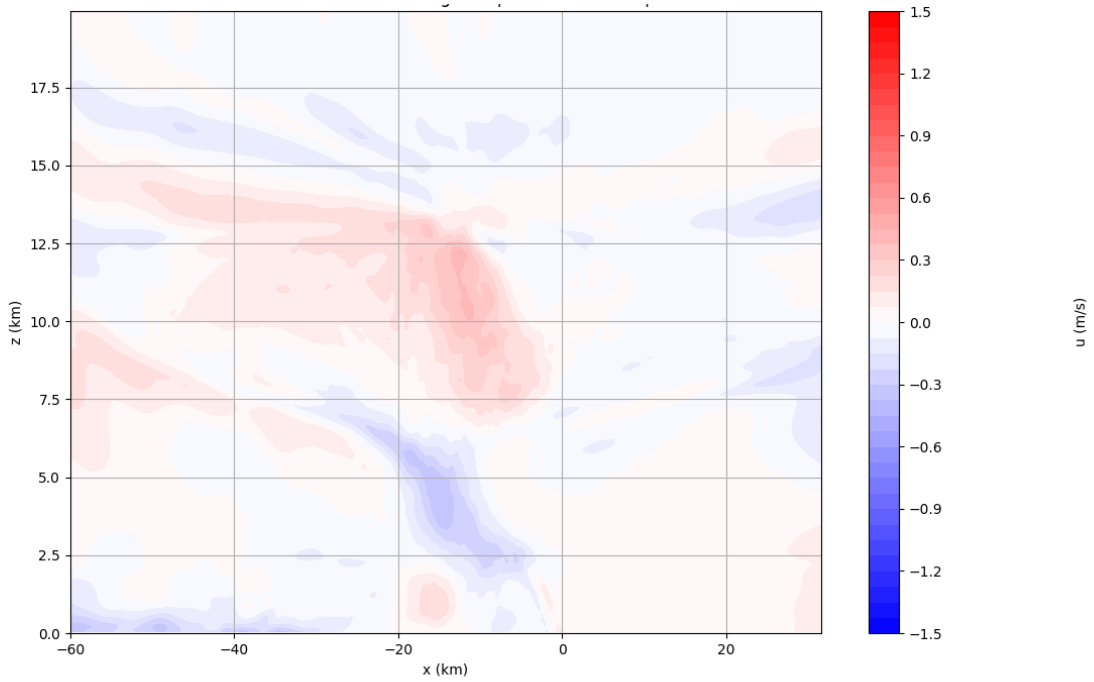
90 min:



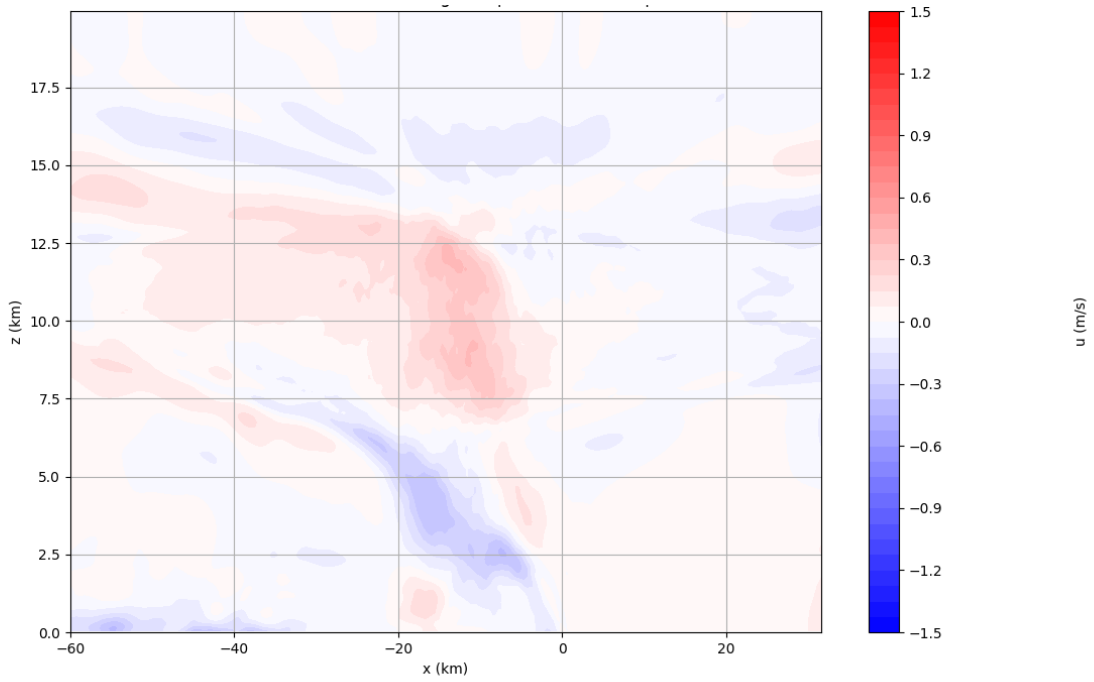
95 min:



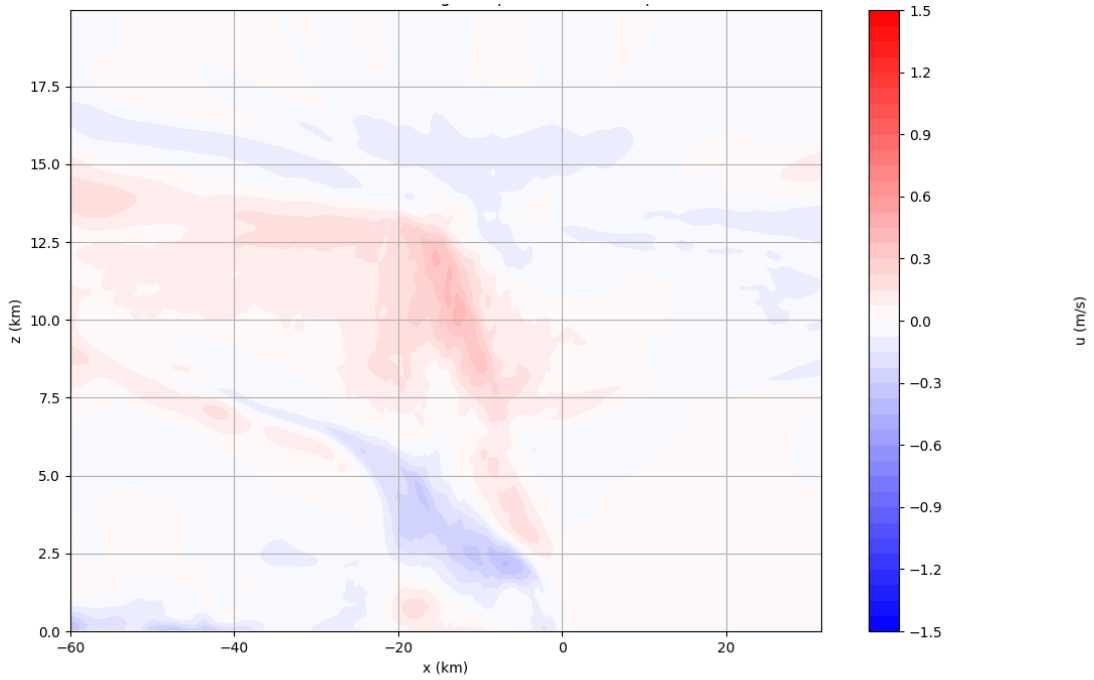
100 min:



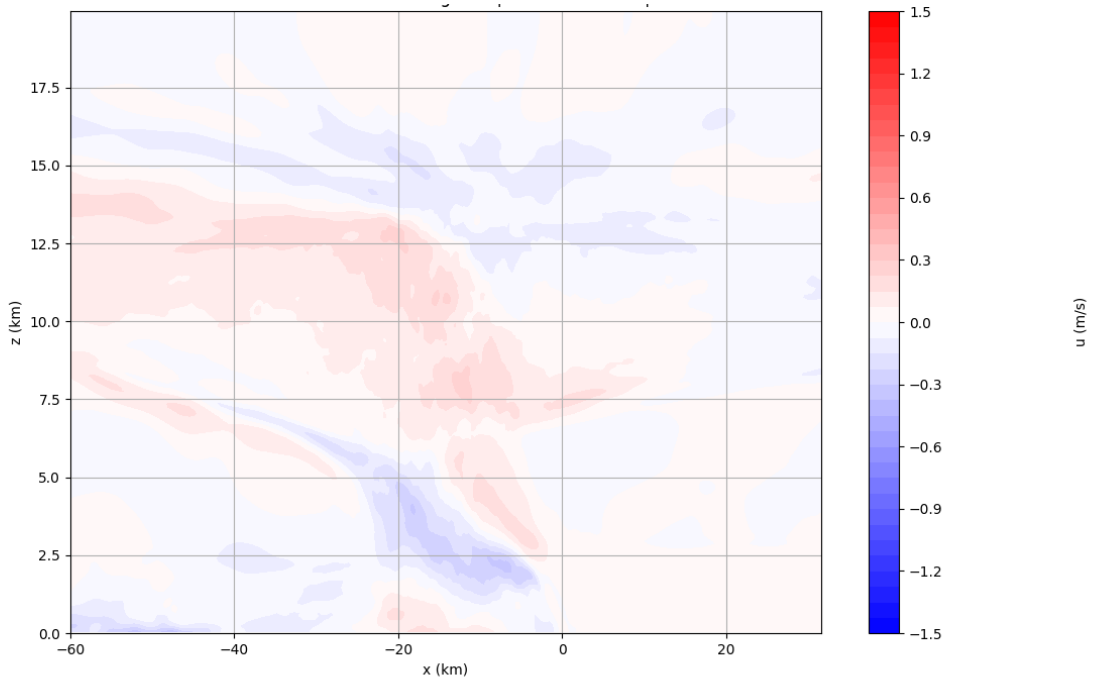
105 min:



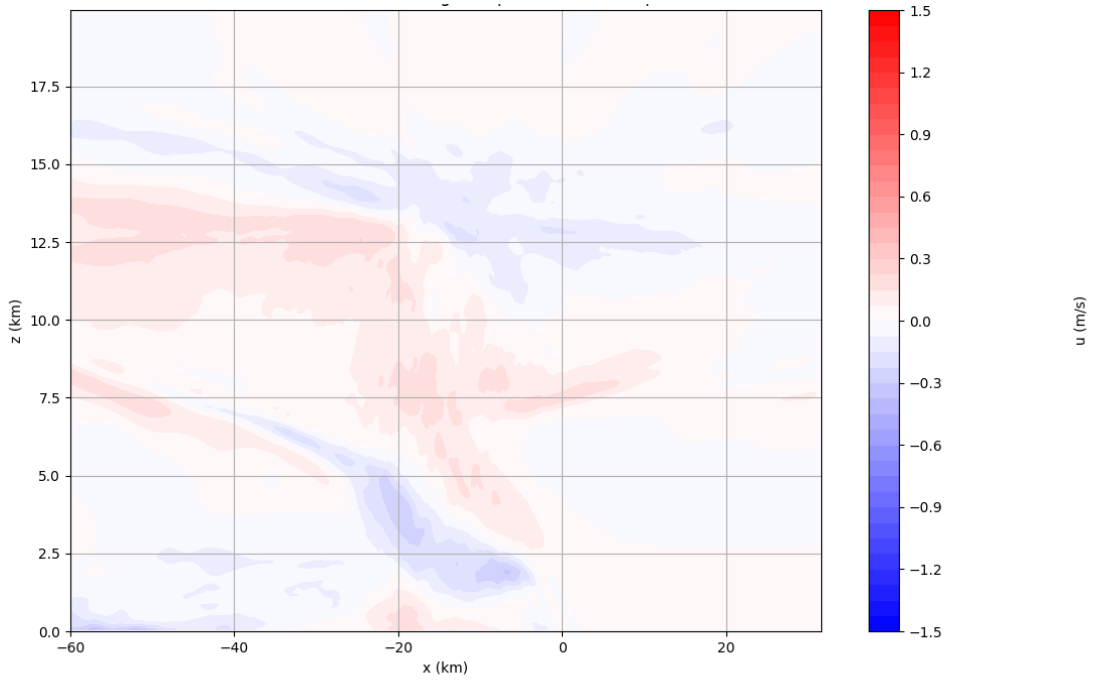
110 min:



115 min:

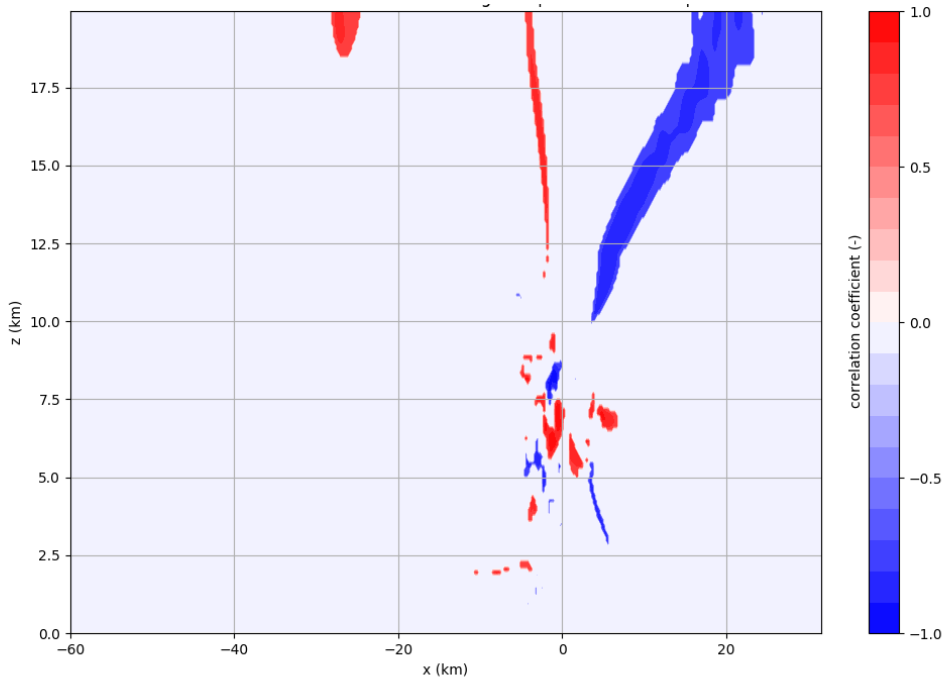


120 min:

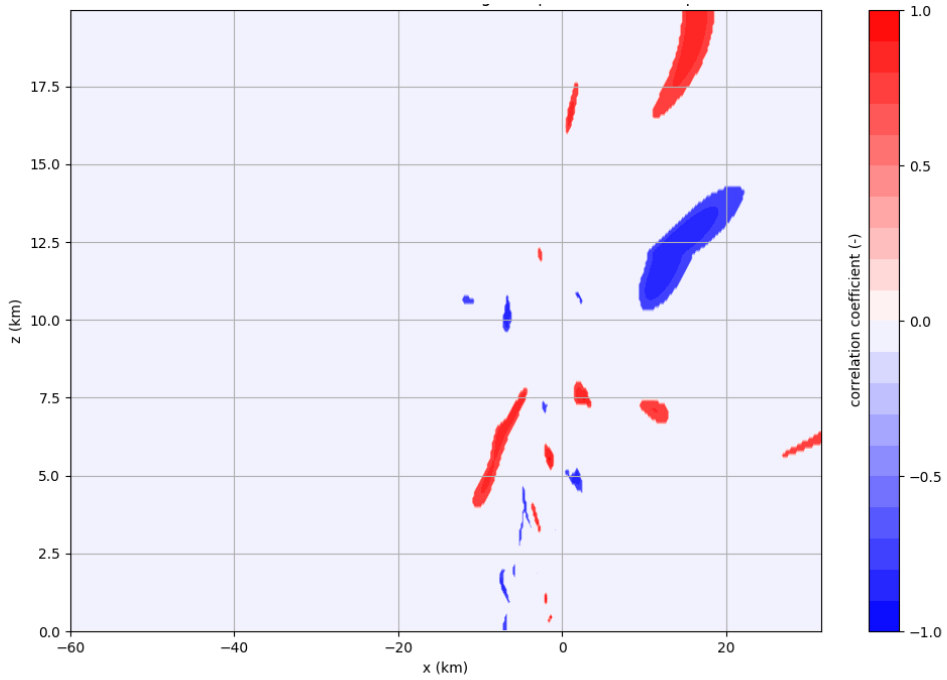


Masked correlation exceeding α = 0,05 threshold:

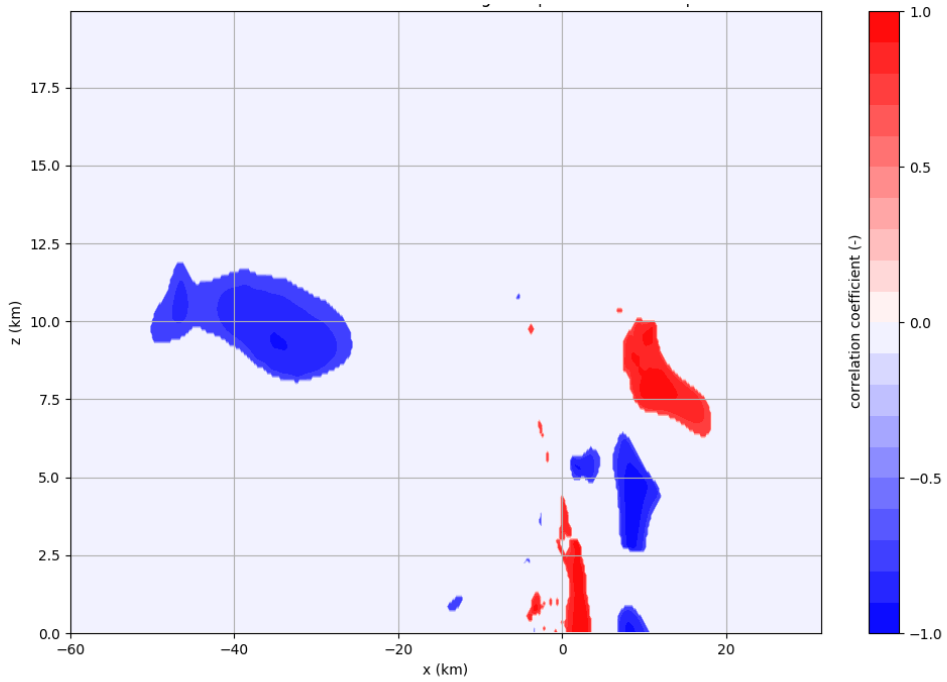
20 min:



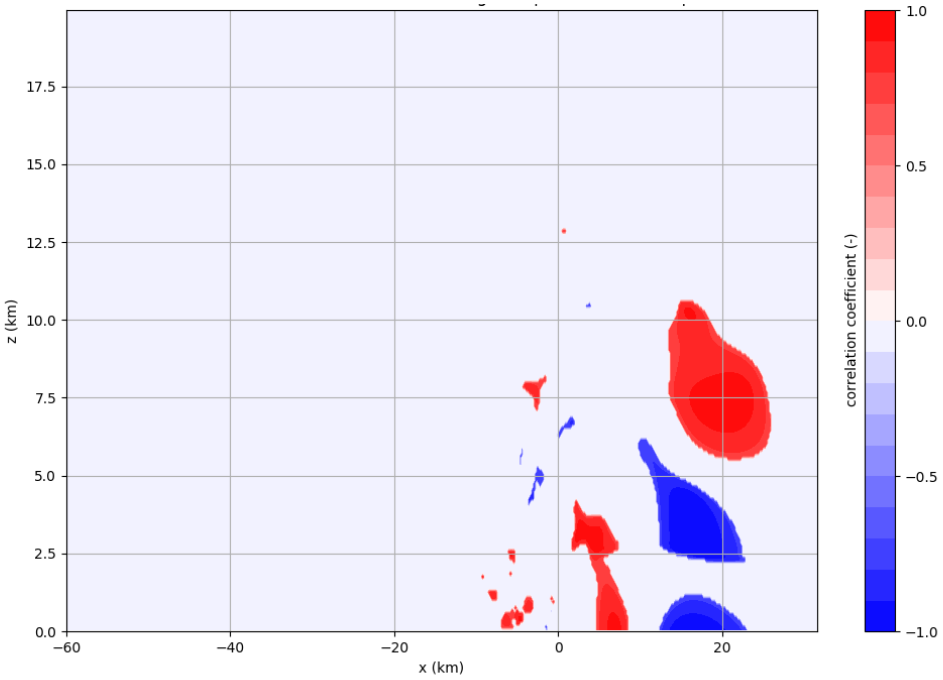
25 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

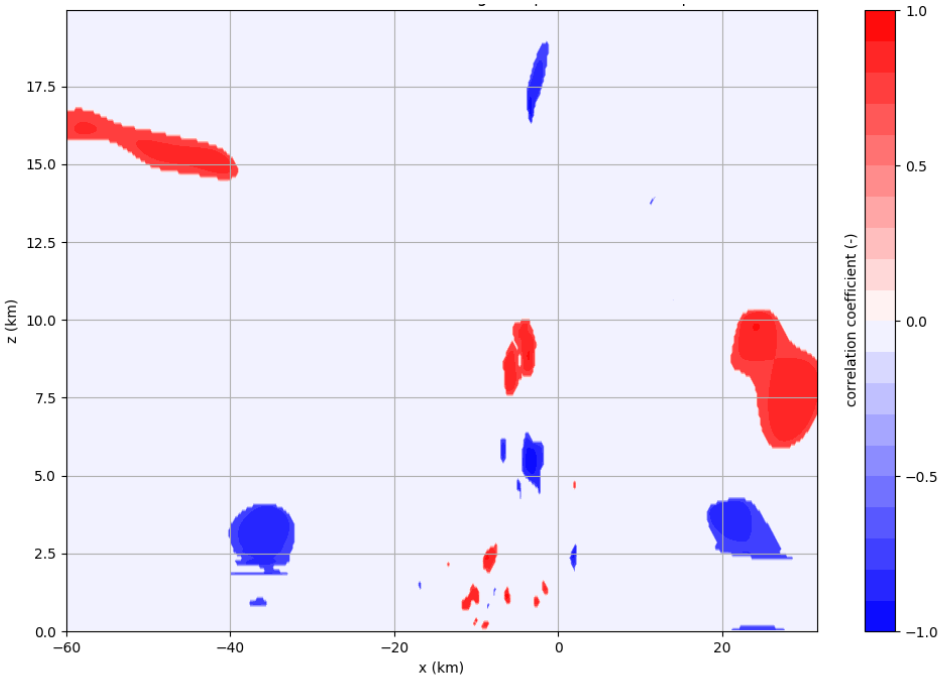
30 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

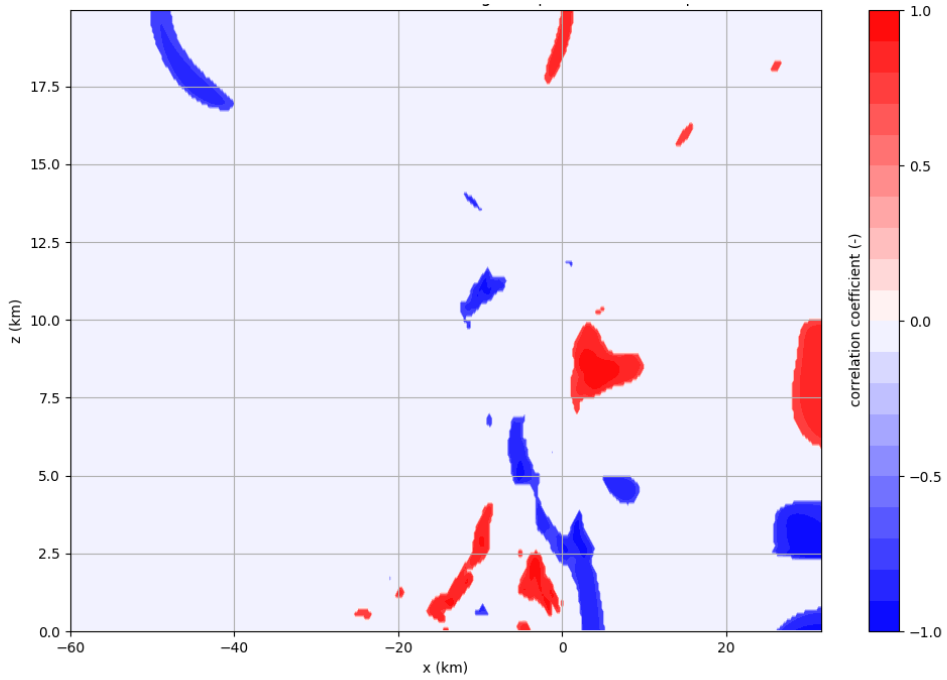
35 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

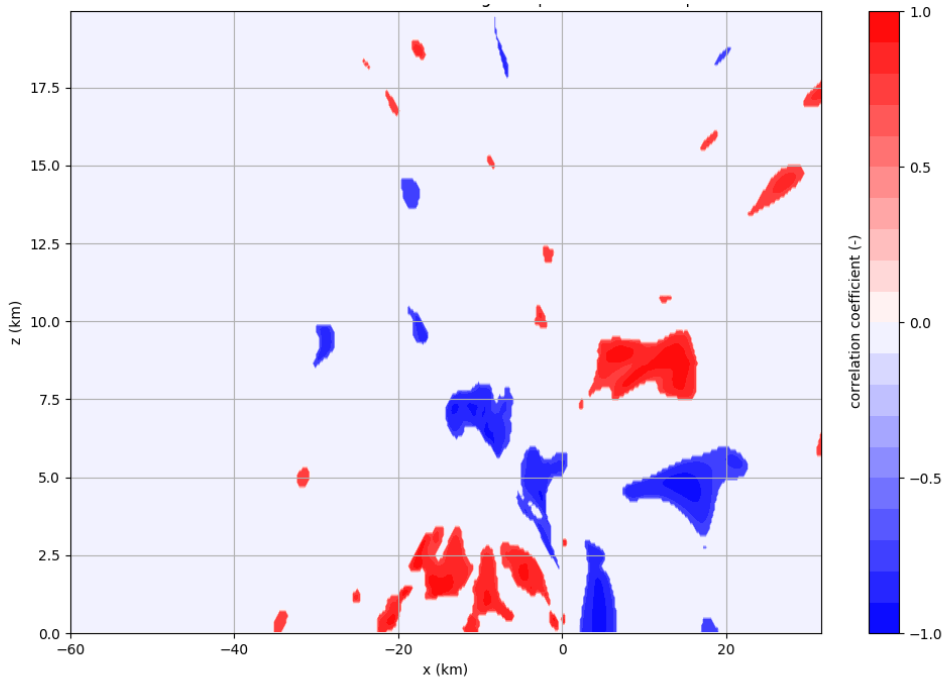
40 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

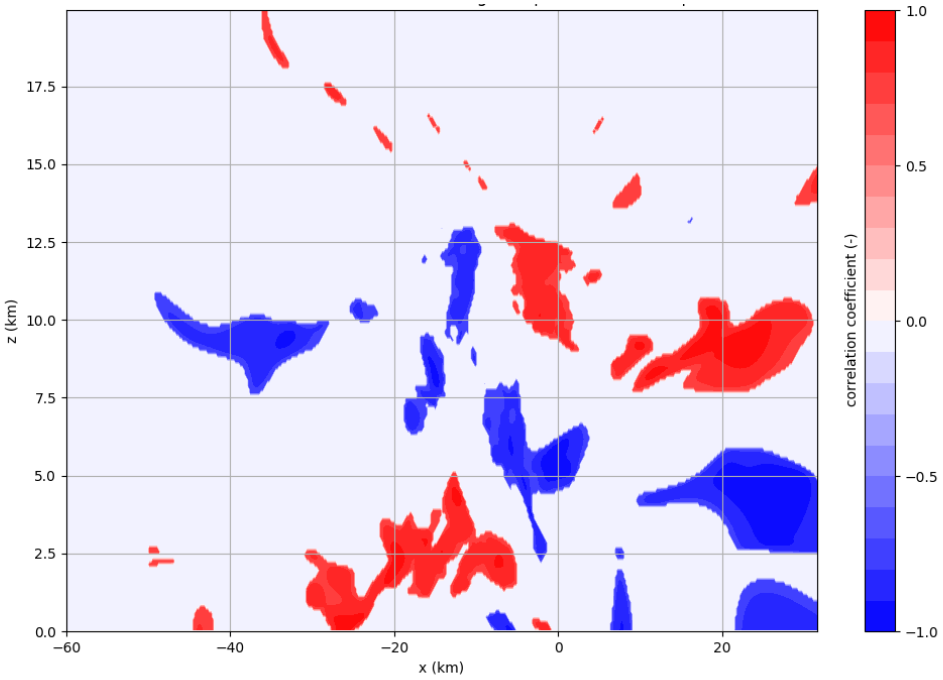
45 min:


z (km)
x (km)
correlation coefficient (-)
1.0
0.5
0.0
−0.5
−1.0

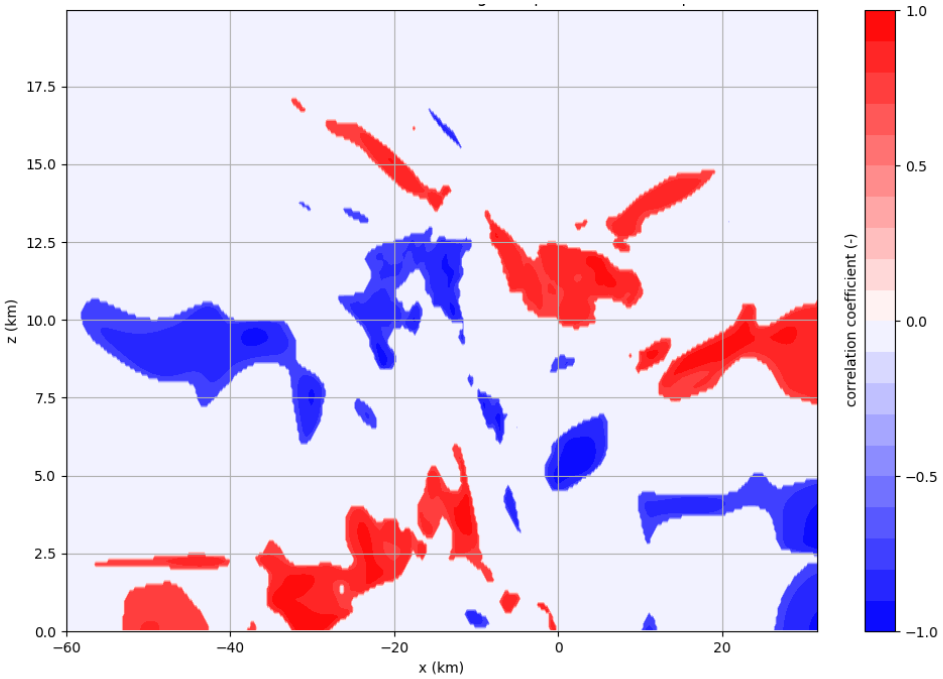
50 min:


z (km)
x (km)
correlation coefficient (-)
1.0
0.5
0.0
−0.5
−1.0

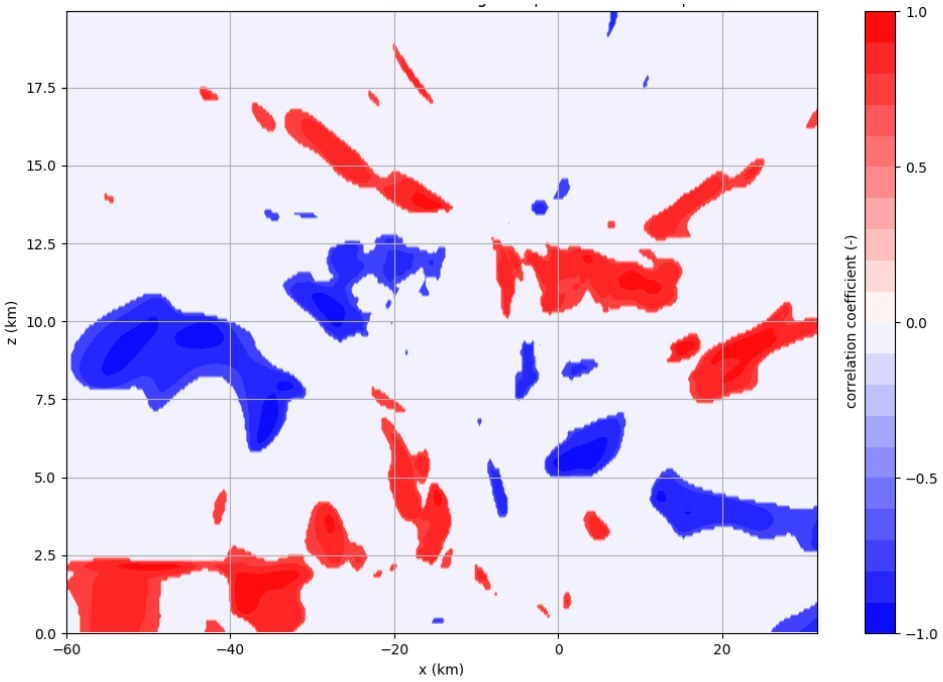
55 min:


z (km)
x (km)
correlation coefficient (-)
1.0
0.5
0.0
−0.5
−1.0

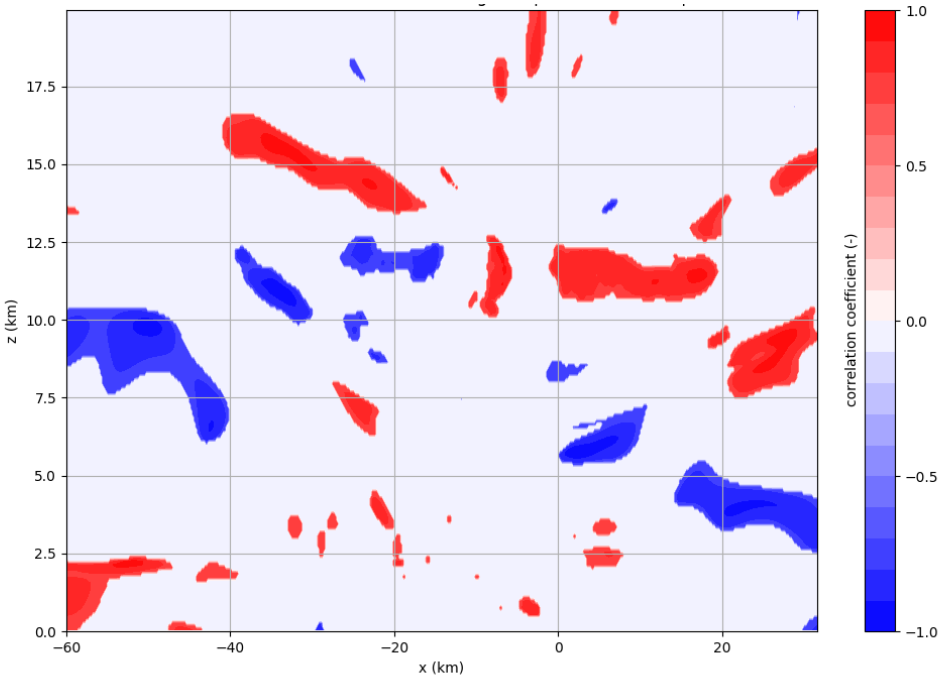
60 min:


z (km)
x (km)
correlation coefficient (-)
1.0
0.5
0.0
−0.5
−1.0

65 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

70 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
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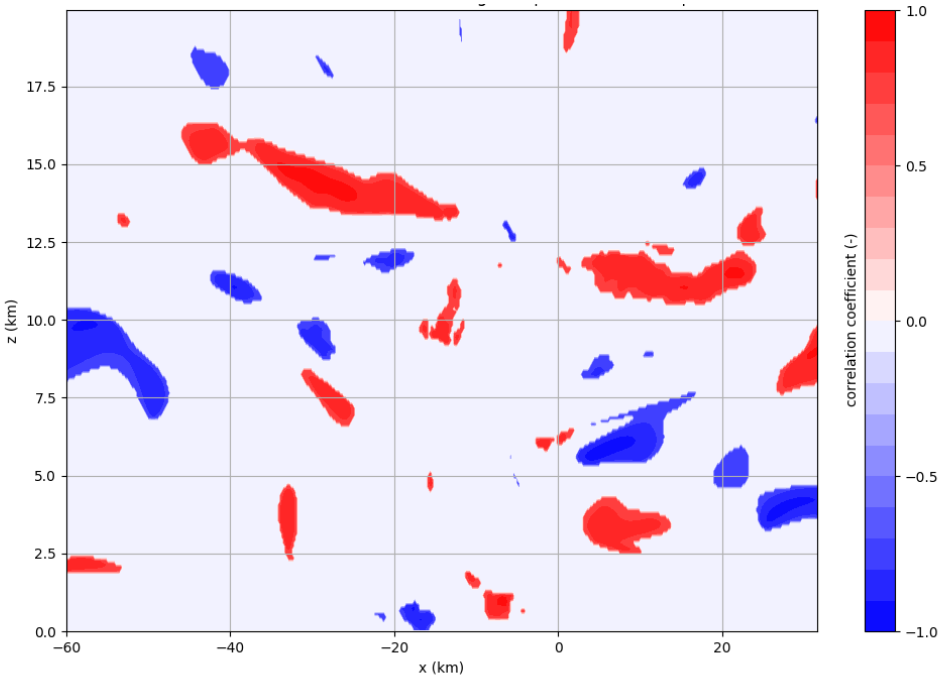
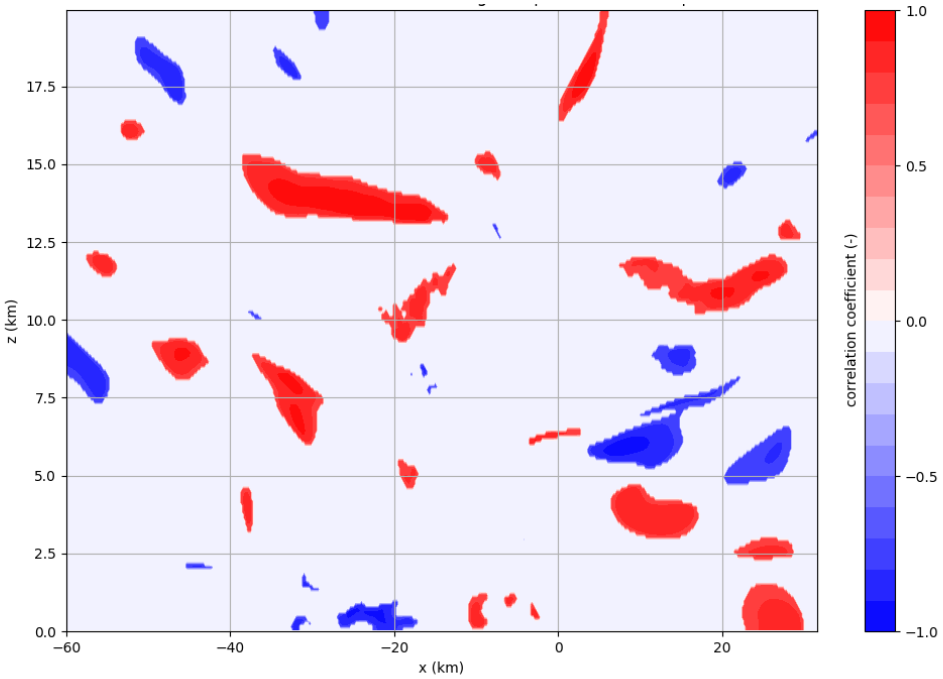
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

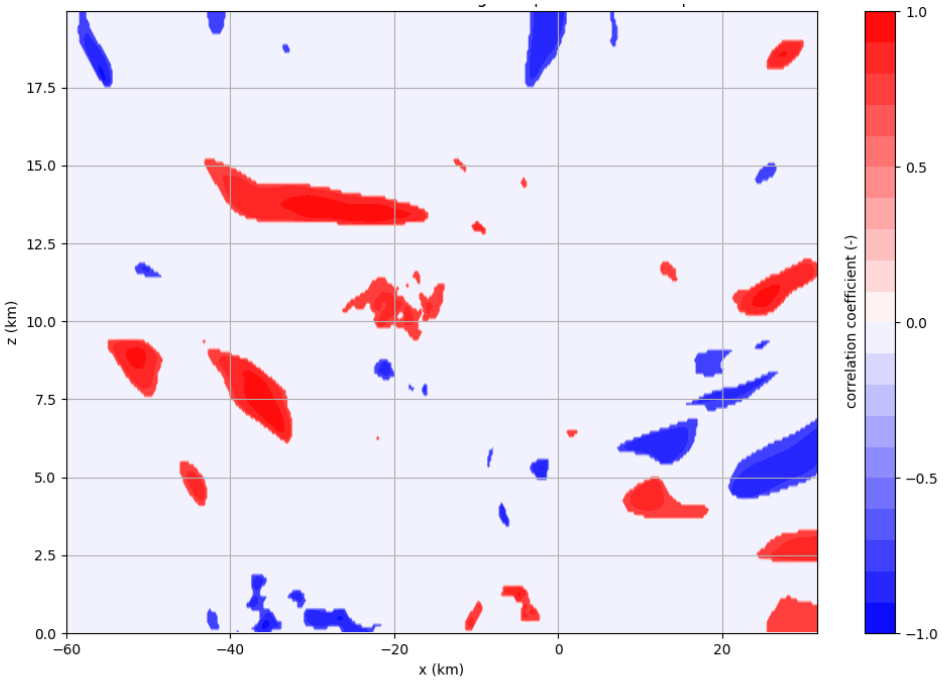
75 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

80 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
−60
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

85 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
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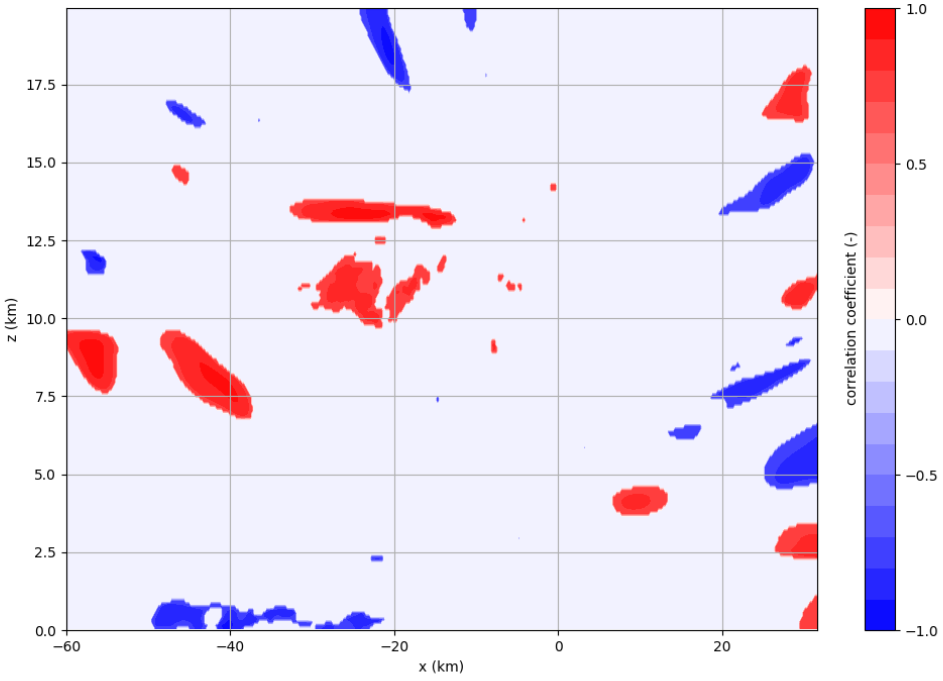
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

90 min:


z (km)
x (km)
correlation coefficient (-)
17.5
15.0
12.5
10.0
7.5
5.0
2.5
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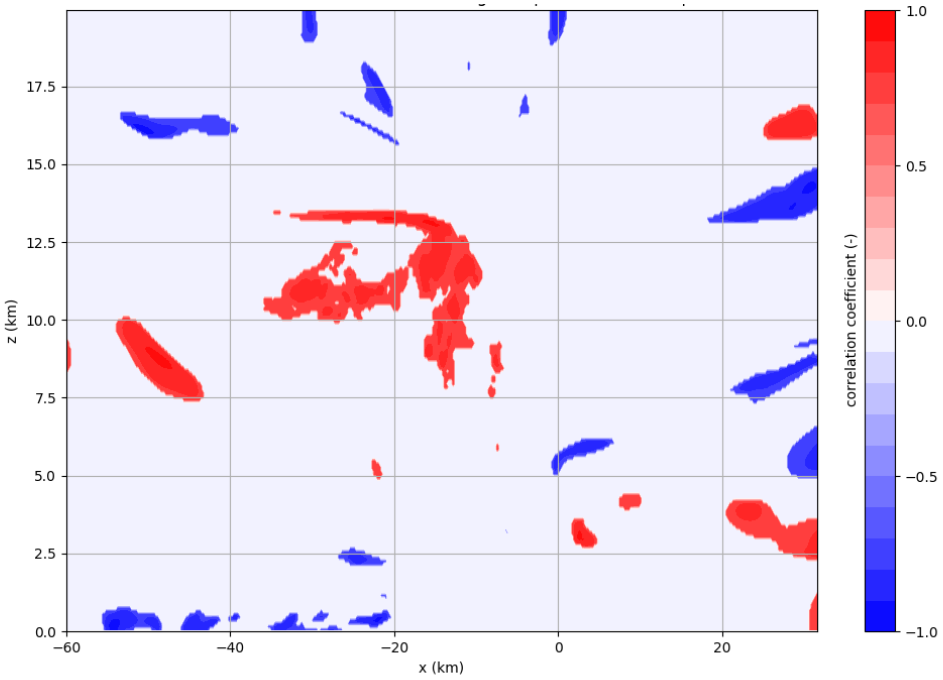
−40
−20
0
20
1.0
0.5
0.0
−0.5
−1.0

95 min:


z (km)
x (km)
correlation coefficient (-)
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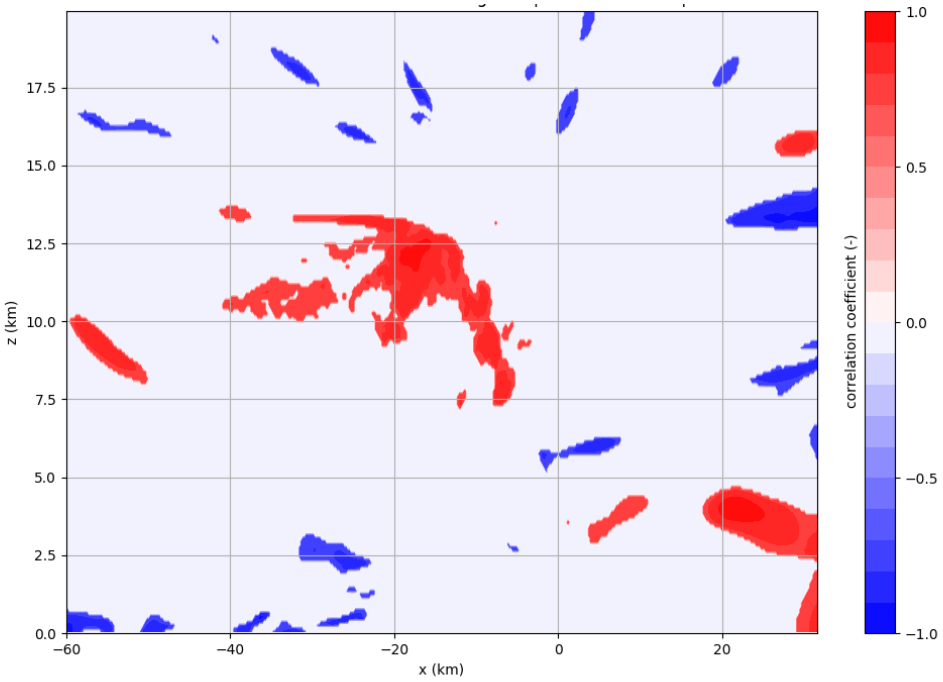
0.5
0.0
−0.5
−1.0

100 min:


z (km)
x (km)
correlation coefficient (-)
1.0
0.5
0.0
−0.5
−1.0